NASA SBIR-2024-Phase 1 Solicitation

Proposal Details

Proposal Number: A1.02-1000
Subtopic Title: Quiet Performance - Propulsion Noise
Proposal Title: A Gas-Kinetic Relaxation Scheme for Fan Broadband Noise Prediction

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 1 - 4
Technical Abstract (Limit 2000 characters):

This SBIR project proposes to investigate the feasibility of using a gas-kinetic relaxation scheme for fan broadband noise prediction. Since fan broadband noises

result from the interaction of turbulence with solid surfaces, it is important to resolve turbulent eddies up to a certain scale and further preserve those turbulent eddies shed from the rotor blades at least up to the downstream stator blades in order to achieve an accurate fan broadband noise prediction. Unfortunately, the so-called shock-capturing schemes are found too diffusive to resolve and preserve those turbulent eddies while they are able to handle the shocks better than the central schemes. To take advantage of both central and upwind approaches, this SBIR effort will pursue a gas-kinetic relaxation approach, in which the relaxation parameter is used to minimize the difference between the numerical dissipation inherent in the upwind approach and the subgrid-scale (SGS) model. As a feasibility study, the NASA 22-in fan noise source diagnostic test (SDT) case will be used in Phase I to demonstrate the capability of the proposed methodology for accurate prediction of fan broadband noise. Therefore, it is meaningful to further refine the methodology and develop a computational software tool for commercialization in Phase II.

Duration: 6

Proposal Details

Proposal Number: A1.02-1005
Subtopic Title: Quiet Performance - Propulsion Noise
Proposal Title: Predictive Low-Cost Large Eddy Simulation Capability for Fan and Open Rotor Noise

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 3 - 4
Technical Abstract (Limit 2000 characters):

The research proposed addresses substantial capability advancements within the newly developed immersed boundary Wall-Modelled Large Eddy Simulation (WMLES) method for turbomachinery noise predictions. This will enable accurate and computationally efficient broadband aeroacoustic predictions for fan and open rotors. Substantial advancement of the current state-of-the-art is anticipated; the Phase-I proposal includes a WMLES demonstration of "overnight" R4 Rotor LES with farfield noise predictions using very modest computational resources - 2x NVIDIA RTX 4090 GPUs on an engineering workstation with aggressive performance and aero-acoustics accuracy targets. Additionally, the typically cumbersome pre-processing workflow starting with a CFD-ready CAD to the start of the LES will be entirely automated. This includes automated (but user-guided) surface and volume grid generation. In-situ, post-processing for flow visualization as well as in-situ (streaming) far-field acoustic propagation via the FWH analogy will be included as part of the demonstration. Two major advancements are needed in order to accomplish these goals: a) computationally efficient sliding mesh capability for overset rotating Cartesian grids, and b) time-step sub-cycling to mitigate the small time-steps required to resolve the flow in the rotor tip clearance. Both algorithmic enhancements are critical in order to maintain the advantages of the Cartesian immersed boundary WMLES capability for turbomachinery applications These advancements would expand the targeted market for Volcano ScaLES and make it available to US OEMs such as GE Aerospace, Pratt & Whitney, Honeywell, and RTX Corporation.

Duration: 6

Proposal Details

Proposal Number: A1.02-1015
Subtopic Title: Quiet Performance - Propulsion Noise
Proposal Title: High-Temperature Piezoelectric Microphones for Aft-Engine Noise Measurement

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 3 - 4
Technical Abstract (Limit 2000 characters):

The Interdisciplinary Consulting Corporation (IC2) proposes the development of an instrumentation-grade, robust, high-temperature piezoelectric microphone for model-scale ground test and full-scale static engine test applications. The goal of this research is to extend the operating temperature range of IC2's piezoelectric microphones and dynamic pressure sensors using advanced microelectromechanical systems (MEMS) fabrication and packaging techniques to enable wide-band performance and full NIST-traceable calibration at targeted operating frequencies. The resulting fully calibrated sensor will thus directly enable quantifiable fluctuating pressure measurements in flows at temperatures up to 600°C (1112°F). The sensor technology is particularly well suited for use in a variety of National Aeronautics and Space Administration (NASA), Department of Defense (DoD), and other industry- and university-owned model- and full-scale engine test facilities by virtue of its robust, reliable, small form factor. The proposed innovation is to extend the operating temperature range of IC2's recently commercialized piezoelectric MEMS dynamic pressure sensors. These MEMS piezoelectric sensors are capable of high-bandwidth (up to 1 MHz) fluctuating pressure measurement and are supplied with a full magnitude and phase response throughout the entire operating bandwidth determined using IC2's patented reciprocal calibration method; however, their maximum operating temperature is currently restricted to 85°C

due to temperature limitations of the commercial off-the-shelf (COTS) electronics located directly behind the sensor. This proposal seeks to extend the operating temperature of this proven technology to 600°C (1112°F) by implementing changes to the device structure, electronics, and packaging while maintaining the necessary bandwidth and resolution to enable accurate, quantitative measurements in model- and full-scale engine test applications.

Duration: 6

Proposal Details

Proposal Number: A1.02-1029
Subtopic Title: Quiet Performance - Propulsion Noise
Proposal Title: Fully-Integrated Prediction of Propulsion Noise and Acoustic Scattering for Early Design

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 2 - 5
Technical Abstract (Limit 2000 characters):

Research in Flight will develop an early-design tool to predict aircraft propulsion noise and its scattering by airframe components. This new tool will enable the study of aeroacoustic interactions with configuration designs in much greater detail and with more fidelity than heretofore deemed practical in the early phases of design. The tools will also assist agencies such as NASA and the FAA to study UAM noise from a regulatory perspective. The current state of the art is inadequate in predicting this interaction in advanced aircraft designs. To address this gap, we propose to develop a fast and efficient tool using a Cartesian-octree-based finite volume method for predicting the acoustic scattering of engine noise by the airframe. Game-changing speedups over existing tools will be acheived by using the existing FligthStream surface-vorticity solver to calculate the mean flow. This tool will be incorporated into the existing commercial FlightStream® panel-method flow solver. FlightStream® will integrate evaluations of fan or propeller aerodynamics with airframe acoustic interactions, allowing for the prediction of engine noise generation and scattering without user intervention. The tool will incorporate impedance boundary conditions to simulate noise-absorbing materials, enabling the reduction of PAA interaction impact through the optimized placement of absorbing materials. FlightStream® is particularly well suited to handle this problem since it generates detailed volumetric flow data for a fraction of the computational cost of high-fidelity CFD. Currently, FlightStream® is integrally coupled with an acoustic formulation based on the FW-H equations to compute tonal noise components. The solver has since been extended for transonic and supersonic aerodynamics. Realization of the technical objectives will yield a unique, integrated, robust, and modular software, enhancing the simulation and analysis capability for aircraft designers and regulatory agencies.

Duration: 6

Proposal Details

Proposal Number: A1.03-1007
Subtopic Title: Low Emissions/Clean Power - Environmentally Responsible Propulsion
Proposal Title: Airborne holographic probe for small ice detection

Small Business Concern

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Estimated Technology Readiness Level(TRL Begin - TRL End): 2 - 4
Technical Abstract (Limit 2000 characters):

Contrails formed by aircraft emissions are the major component of the radiative impact of aviation, contributing more to forcing than emitted carbon dioxide and nitrogen oxides combined. Efforts to reduce the negative impacts of aviation on climate must therefore account for contrail formation and require better understanding of contrail formation and ageing. The research community, including NASA scientists, currently lack an appropriate in situ measurement system capable of characterizing the small ice crystals and droplets relevant to contrail formation and aging processes. We propose development of a new cloud probe designed for operation on research aircraft and other platforms capable of measuring the properties of ice crystals, droplets, and aerosols in the size ranges relevant for contrail formation and potentially distinguishing between them. The proposed instrument would use a digital holographic approach that has been previously demonstrated for cloud measurements, but heavily modified to better measure smaller particles than is currently possible with existing approaches. Our system will be capable of delivering the measurements required to better understand contrail formation and related aviation impacts on climate, as well as be applicable to a wide range of commercial applications, such as the detection and classification of airborne allergens, pathogens, and other large particles that have impacts on the atmosphere, plant, animal and human health, and visibility, among others.

Duration: 6

Proposal Details

Proposal Number: A1.03-1015
Subtopic Title: Low Emissions/Clean Power - Environmentally Responsible Propulsion
Proposal Title: Cavity Enhanced LED-Induced Fluorescence Detection of Nitrogen Dioxide

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 2 - 4
Technical Abstract (Limit 2000 characters):

We propose to create an induced fluorescence-based monitor for the detection of nitrogen dioxide where the light source is a light emitting diode. Sensitivity of such a device will be greatly enhanced by the use of a high finesse optical cavity formed by two very high reflectivity mirrors which provide for many passes of the light emitted by the LED. The goal is to provide a monitor capable of measuring concentrations from to 10 parts per trillion to 1 part per million with 1 second sampling using proprietary CAPS-based technology. A major advantage of such an approach is that it provides a true measurement of NO2 rather than one derived from chemical manipulation in a highly robust, easy to use package.

Duration: 6

Proposal Details

Proposal Number: A1.04-1005
Subtopic Title: Electrified Aircraft Propulsion
Proposal Title: Efficient and Sustainable Paradigm for MW-hr. Electric Propulsion (ESP for MEP)

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 2 - 4
Technical Abstract (Limit 2000 characters):

PCI is proposing an advanced solid oxide fuel cell (SOFC) that efficiently converts the energy in H2 or liquid fuels into electrical energy. The technology is specifically targeted for sustainable electric air propulsion (EAP) needs. The technology is significantly more power dense than other systems in development and is a higher efficiency, higher power density (gravimetric and volumetric) and lower cost compared to alternatives e.g., low temperature proton exchange membrane fuel cells and batteries. During Phase I, a feasibility study, including validation of advanced SOFC performance that meets exceeds solicitation requirements (i.e., cell power density ≥0.80 W/cm2 for ≥60 min continuous, and ≤10 μV/h degradation over 250 h at peak power density) will be confirmed. A system model and stack design suitable for EAP will be identified in Phase I. Experimental data and modelling will be used to verify compliance in Phase I for meeting dynamic EAP loads. During Phase II, performance metrics will be rigorously examined, including long-term durability and potential to meet NASA requirements. A 1 kW prototype will be fabricated, demonstrated, and delivered. to NASA. The technology is being developed for other applications and the proposed effort will leverage those advances to mitigate risk of failure.

Duration: 6

Proposal Details

Proposal Number: A1.04-1007
Subtopic Title: Electrified Aircraft Propulsion
Proposal Title: Fuel Cell Thermal Management Concepts for Electrified Aircraft Propulsion

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 2 - 4
Technical Abstract (Limit 2000 characters):

Advanced Cooling Technologies, Inc (ACT) proposes to develop a thermosyphon (i.e., passive two-phase heat transfer device) to extract and transfer the waste heat generated by the membranes in the hydrogen fuel cell stack and maintain the in-plane thermal gradients to ≤10 Δ ºC. The proposed thermosyphon has the following advantages: high thermal conductance, light weight, high reliability, easy to fabricate and can be easily integrated with the hydrogen fuel cell stack. In Phase I, ACT will perform a detailed trade study to design a thermosyphon that can extract the waste heat from the membranes. A variable conductance feature will be added to the thermosyphon in order to passively keep the membrane temperature near the optimal range (80°C) regardless of the heat rate amount and heat sink conditions. The proof-of-concept prototype will be fabricated and its thermal performance under different testing conditions and dielectric working fluids will be demonstrated in Phase I. During Phase II, the proposed thermal management system will be integrated with a small-scale fuel cell stack to test the stack thermally and electrically. By the end of the Phase I and II programs, the technology readiness level will mature to a TRL of 4 and 5, respectively.

Duration: 6

Proposal Details

Proposal Number: A1.04-1016
Subtopic Title: Electrified Aircraft Propulsion
Proposal Title: High Energy Density, Fast Discharge Li-S Batteries for Electrified Aircraft Propulsion

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 3 - 4
Technical Abstract (Limit 2000 characters):

The U.S. aviation industry is a vital part of the economy, contributing more than $1.9 trillion to the U.S. economy in 2019. Modern propulsion systems consume significant amounts of fuel and produce substantial carbon emissions. To reduce cost and minimize carbon emissions, NASA has identified the need for new energy storage technologies to support widespread integration of electrified aircraft propulsion. Electrification of aircraft is a major part of NASA’s Aeronauts Research Mission Directorate (ARMD). Within NASA’s Strategic Implementation Plan (SIP), EAP research supports Mega Driver 2 (Affordability, Sustainability and Energy Use) and Strategic Thrust 3 (Ultra-Efficient Subsonic Transport). Giner’s solution is a catalyst-incorporated Lithium-Sulfur battery, utilizing specially formulated high temperature electrolytes and integrating passive components for improved safety and thermal

runaway prevention. The Phase I program will focus on materials engineering, formula optimization, and integration of optimized electrode, electrolyte, and safety components into pouch cells to demonstrate performance. The result is an energy storage device offering > 400 Wh/kg at the system level at 2C discharge, high temperature operation up to 100 °C, can fast charge (15 minutes or less), and incorporated thermal runaway prevention. When successful, the proposed technology will provide widespread benefits to the EAP industry, enabling air taxi, urban mobility, passenger aircraft, fleet operations and other applications. The Phase I deliverable is successful demonstrate of the above performance milestones summarized in a technical report.

Duration: 6

Proposal Details

Proposal Number: A1.06-1004
Subtopic Title: Vertical Take-Off and Landing (VTOL) Vehicle Technologies - Multimodal Design Tools
Proposal Title: OpenAirFrame: A Framework for eVTOL Multimodal Design-Space Exploration and Optimization

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 2 - 4
Technical Abstract (Limit 2000 characters):

DARcorporation and Auburn University propose the development of a design, analysis, and optimization framework OpenAirFrame, that specifically tackles the challenges associated with assessing system architectures and conceptual aircraft design in a complex, multimodal design space with both continuous and discrete design variables. The proposal responds directly to the needs identified within SBIR Topic A1.06 – Vertical Takeoff and Landing (VTOL) Vehicle Technologies – Multimodal Design Tools. The proposed solution will address some challenges that are inherent to the design of VTOL aircraft as well as several unresolved challenges and shortcomings of existing tools and capabilities: • Urban Air Mobility (UAM) VTOL aircraft pose particularly challenging design problems due to the vast configurational design space (with no preferred configuration thus far), multiplicity of propulsors, distributed electric propulsion, and transitions between vertical (thrust-borne) and horizontal (wing-borne) modes of flight. The dimensionality of the design space expands even further when electrified (as opposed to all-electric) propulsion is considered through hybrid-electric and turbo-electric propulsion. • There are commercial tools available that allow integration of other software for performing optimization. From a practical standpoint, however, the time, effort, and cost of molding them to perform the highly customized analyses and trade studies required for advancing electrified VTOL design will likely be comparable to that required for developing a unique software. • While there are existing tools that can manage continuous variable optimization in high-dimensional design spaces, they do not have an outer-loop manager for handling multiple disconnected parts of the design space within a simultaneous design study. In Phase I, the core functionalities will be demonstrated through sample design studies focusing on two of the reference RVLT UAM configurations.

Duration: 6

Proposal Details

Proposal Number: A1.06-1006
Subtopic Title: Vertical Take-Off and Landing (VTOL) Vehicle Technologies - Multimodal Design Tools

Proposal Title: UAM Design Space Exploration Framework with Embedded Version Control

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 2 - 4
Technical Abstract (Limit 2000 characters):

There are no tools available to NASA that are capable of managing UAM design space exploration. The framework proposed here seeks to address that need. The framework will rely on external analysis tools, such as VSPAERO, to provide disciplinary analysis. It will also rely on external optimization frameworks, such as OpenMDAO, to perform multidisciplinary design, analysis, and optimization. The framework proposed here will feature a JSON-based vehicle architecture designed around multi-model UAM concepts. Additionally, the framework will have a version control system embedded in it to handle vehicle version management. This is made possible by the text-based nature of the JSON format.

Duration: 6

Proposal Details

Proposal Number: A1.08-1002
Subtopic Title: Aeronautics Ground Test and Measurement Technologies: Diagnostic Systems for High-Speed Flows and Combustion
Proposal Title: High speed measurements of velocity, temperature and water content in hypersonic flows

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 3 - 4
Technical Abstract (Limit 2000 characters):

NASA is currently interested in improving the capabilities of its supersonic and hypersonic wind tunnels to continue development of high speed aerospace vehicles, for both military and commercial applications. In order to develop these improved designs, inflow air conditions to the test articles need to be well characterized. For the particular tunnels that use combustion and vitiated air to generate the high speed flows, one can

use the spectroscopic properties of water, arising from the combustion, to measure the static gas temperature and velocity, which leads to the mass capture ratio. Southwest Sciences proposes to design, build, test, calibrate and deliver a laser-based absorption, very high speed, mass capture analyzer. In this SBIR program, we will focus on the 8-foot diameter hypersonic tunnel noted in the Solicitation. Expanding on this design after Phase II, it would be capable of performing tomographic measurements of water vapor density, temperature and velocity a variety of wind tunnels. This sensor will be fully turnkey, autonomous, compact, and designed to operate in different wind tunnels with minimal modification. The Phase I research will focus on a single crossed beam channel with >10kHz response.

Duration: 6

Proposal Details

Proposal Number: A1.08-1004
Subtopic Title: Aeronautics Ground Test and Measurement Technologies: Diagnostic Systems for High-Speed Flows and Combustion
Proposal Title: Laser-Induced Incandescence Sensor for Soot Particle Size and Concentration

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 2 - 3
Technical Abstract (Limit 2000 characters):

An instrument will be developed to measure the mass concentration and particle size of non-volatile particulate (nvPM) emissions exiting a nozzle into an altitude chamber for contrail condensation studies at NASA's PAL and other facilities, with a potential future transition to onboard instrumentation for flight studies. Experimental studies will be conducted to optimize laser-induced incandescence for aircraft nvPM conditions at the 12-inch standoff distance required for the PAL facility, allowing it to be used for characterizing particles entering the chamber in situ, i.e., in their natural state. An existing numerical model will be improved to include relevant effects that will enable accurate interpretation of data from the in situ measurements. A calibration method for non-volatile soot mass and particle size will be developed that will anchor the method to accepted best practices and a detailed Phase II prototype design will be developed. Such measurements are needed to help determine which sustainable aviation fuels (SAFs) have the lowest sooting propensities, and thus would produce minimal contrails, which can trap heat in the Earth's atmosphere. The proposed work directly addresses the objective of achieving cleaner, faster, and safer air travel in ways that minimize adverse impacts on the environment called out in NASA's ARMD 2023 Strategic Implementation Plan. A significant market opportunity exists in research groups worldwide, including universities, government agencies, engine manufacturers, and industrial settings. A calibrated and validated in situ soot property diagnostic could replace extractive instruments in many applications, such as those concerning environmental control regulations for aircraft engine manufacturers, commercial airlines, industrial processing plants (i.e., stack monitors), commercial trucks, and automobiles.

Duration: 6

Proposal Details

Proposal Number: A1.08-1014
Subtopic Title: Aeronautics Ground Test and Measurement Technologies: Diagnostic Systems for High-Speed Flows and Combustion
Proposal Title: Simultaneous Velocimetry, Thermometry, and Chemical Species Measurements for High-Enthalpy Flows

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 4 - 5
Technical Abstract (Limit 2000 characters):

NASA SBIR 2024 Phase I Solicitation A2.08 called for spatially and temporally resolved diagnostics for NASA high-speed wind tunnel flows (supersonic, hypersonic), both with and without combustion. Improved measurement capabilities are needed for velocity, temperature, density, and/or species concentrations in harsh wind tunnel environments, from short-duration (~msec) to long-duration (~min) flow facilities. Measurement systems should be reliable and robust and preferably would be able to be implemented in multiple wind tunnel facilities and facility types including blowdown tunnels, combustion-heated tunnels, shock tubes, shock tunnels, and arc jets. Planar or volumetric, spatially resolved measurements are preferred. The ability to measure multiple parameters simultaneously is desirable. Measurement systems should be validated against accepted standards (thermocouples, calibration flames, etc.) to determine measurement accuracy and precision. We propose a well-developed method of obtaining gas parameters velocity, temperature, and composition measurements with the possibility of extension to simultaneous pressure measurements in high-speed flows using laser absorption spectroscopy (LAS) techniques. This will enable deployment of the method in large-scale ground test facilities, including short duration facilities with both reacting and non-reacting flows. We will leverage our current capabilities such as our absorption spectroscopy diagnostics systems with a demonstrated capability of

100+ kHz in situ temperature and species concentration measurements for gas temperatures 300 - 4000+ K and gas pressures 1 - 150 bar to facilitate the development of an improved sensor system that can achieve the needs of multiple NASA facilities.

Duration: 6

Proposal Details

Proposal Number: A1.09-1001
Subtopic Title: Zero-Emissions Technologies for Aircraft
Proposal Title: Sustainable Aviation Fuels from Agricultural Waste

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 3 - 5
Technical Abstract (Limit 2000 characters):

This proposal seeks to develop a novel, cost-competitive and scalable process for manufacturing of 100% bio-based jet fuels ranged branched hydrocarbons, referred here to as Sustainable Aviation Fuels (SAF), from agricultural and other inedible lignocellulosic biomass waste. These wastes have abundant supply on scale necessary to meet SAF's commercial demand by Federal and non-Federal aviation industries. Globally over 106 billion gallons of jet fuels are annually consumed for petroleum, accounting for ~2% of global carbon emissions. Only a fraction of jet fuels is currently produced from bio-feedstock. In this project, we will develop an integrated manufacturing processes for SAF production and mitigate scale up challenges arising from oxygenated feed that meets NASA's net-zero emissions goals of topic described in topic A1.09. The technology platform entails energy-efficient conversion of biomass into low carbon numbers intermediates and their catalytic condensation to SAF consisting of C10-C15 branched hydrocarbons. The team has reported good SAF yield at quantitative conversion of raw materials in the batch process, which exhibited certain scale up challenges. In this project, we will develop a process-intensified integrated manufacturing process for SAF to mitigate challenge observed in the batch process. We will develop reactor modules, develop reaction conditions to obtain SAF that meets Federal Aviation Administration (FAA)'s SAF composition profile. The reactor module will enable concurrent water removal to debottleneck the scale up challenges. The key technical objectives are: 1.Develop, optimize and validate tubular reactors for unit operations 4 and 5. 2.Determine preliminary kinetic data 3.Tier alpha and beta specification measurements of SAF 4.Perform cost and global warming potentials analyses We aim to produce SAF that meet ASTM metrics and NASA's zero-emission goals. We anticipate a final TRL of 5.

Duration: 6

Proposal Details

Proposal Number: A1.09-1005
Subtopic Title: Zero-Emissions Technologies for Aircraft
Proposal Title: Innovative System for Aircraft Emissions Reduction and Performance Improvement

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 3 - 3
Technical Abstract (Limit 2000 characters):

Ongoing work in ultra-efficient subsonic air-vehicles clearly shows the potential of evolutionary and revolutionary concepts to meet the performance and emissions goals of future aircraft. Propulsion and auxiliary system electrification plays a critical role in achieving these goals since it enables the reduction of fuel burn, emissions, and onboard system complexity, all the while enabling aircraft to undertake more diverse missions; however this comes at a cost – namely the need to provide sufficient electricity with minimal weight and size penalty. For example, batteries have, and will have for the foreseeable future, low energy density compared to aviation fuels or hydrogen, which means that aircraft designers (or integrators in the case of upgrading/adapting legacy aircraft) must trade the performance benefits that electrification brings with the challenges of integration. The proposed effort led by Continuum Dynamics, Inc. seeks to address these issues by developing a system of retrofittable electrical generators (wingtip turbines) that not only harvest energy from an aircraft's wake, but also improve the performance of the aircraft by generating thrust (to reduce total system drag). Prior theoretical and experimental work established the technical feasibility of wingtip turbines, and Phase I seeks to undertake the preliminary design of an optimized turbine and quantification of net performance trades (e.g. electricity generation, fuel, carbon and weight savings) and maintenance concerns. Phase II would see the more detailed system design and possible hardware development and testing to address NASA's aircraft emissions reduction and performance improvement needs.

Duration: 6

Proposal Details

Proposal Number: A1.09-1012
Subtopic Title: Zero-Emissions Technologies for Aircraft
Proposal Title: High Power Density Motors/Generators for Single and Double Aisle Passenger Aircraft using Multifilamentary High Purity Aluminum Coils at 20K

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 3 - 4
Technical Abstract (Limit 2000 characters):

This SBIR proposal is submitted in response to Topic A1.09, “Zero Emission Technologies for Aircraft”. For this Phase I and II we propose to develop and demonstrate stator coils using multifilamentary, low AC loss, high purity aluminum (HPAL) strands for 20-30 K operation. These strands can be safely cooled using gaseous or liquid helium in the 20-30K range. Liquid hydrogen can be the fuel in the aircraft by using a heat exchanger and a secondary loop of pressurized liquid helium to cool the motor or generator. The use of HPAL low AC loss stands will enable high power density motors and generators in the 35-45 kW/kg range, with efficiencies in the range of 99%. HPAL low AC loss coils for stators can enable rotating machines at higher frequencies than superconductors, allowing for much higher rpm machines that are light weight. During the Phase I we will fabricate and test multifilamentary low AC loss strands, cables and coils. During a Phase II effort we will fabricate and demonstrate HPAL stator coils and test the stator coils in an existing 100 kW motor test bed. After the Phase II effort, the technology demonstrated will lead to the commercialization of 2 MW class motors and generators for single and double aisle passenger aircraft.

Duration: 6

Proposal Details

Proposal Number: A1.09-1014
Subtopic Title: Zero-Emissions Technologies for Aircraft
Proposal Title: SAF-compatible Hybrid-Electric propulsion for a fixed-wind aircraft

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 3 - 5
Technical Abstract (Limit 2000 characters):

Rune Aero Inc. is developing a remotely piloted unmanned aircraft that incorporates cutting-edge hybrid-electric technologies that will help the U.S. to ultimately achieve net-zero carbon emissions from aviation by 2050. In this SBIR Phase I proposal and follow-on Phase II proposal, Rune Aero Inc. will partner with Auburn University to develop a hybrid-electric systems intended for cargo delivery missions that is remotely piloted. The purpose of the Phase I project, is to conduct preliminary assessments and formulate detailed plans for the Phase II proposal. Auburn University will support the prime contractor in both these objectives. In Phase II, the team will conduct more extensive analyses, build a subscale prototype, and flight test it. The objectives of Phase I include multi-disciplinary design optimization, stability and control analysis, flight and propulsion system control law development, and the design and simulation of subscale prototypes. These efforts aim to maximize the performance potential of the aircraft design and ensure its operational success. Phase I of the project involves several tasks, including creating a geometry model of the aircraft, incorporating weight estimation relationships, aerodynamic data, and engine performance data that will serve as the baseline for further analysis. Utilizing the baseline model, a Multi-disciplinary Design Analysis and Optimization MDAO will be conducted to optimize design variables; followed by high-fidelity CFD analysis to optimize the distributed electric propulsion system, aiming to reduce fuel burn and emissions by 75%. Detailed stability and control characteristics will be assessed, including dynamic stability, controllability, and failure scenarios, using MADCASP, and flight and propulsion control system architecture will be implemented. Lastly, a subscale prototypes will be designed and simulated using PEACE and MADCASP, providing insights into feasibility and performance.

Duration: 6

Proposal Details

Proposal Number: A1.09-1016
Subtopic Title: Zero-Emissions Technologies for Aircraft

Proposal Title: ZEBRA Aerospace Engine

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 2 - 4
Technical Abstract (Limit 2000 characters):

Exquadrum's proposed technology will contribute to NASA's effort to make US carbon neutral by 2050. The proposed technology offers higher energy conversion efficiency with no emission of pollutants such as CO2, NOx, SOx, PM, VOC etc. The propulsion system is compact and lightweight compared to the State-of-the-Art. The fuel and its products are safe to handle and the propulsion system is reliable under extreme weather conditions. It can be used for new aircrafts or retrofitted to existing transport aircraft that fall under FAA part 23 (<19 passenger) or FAA part 25 (>19 passenger). The energy conversion leverages past 20-30 years technology development and commercialization efforts led under US DOE, ARPA-E and DARPA for Fossil, Solar, Nuclear and Geothermal energy conversion while energy storage and production leverages efforts led under US Navy and DoD for underwater vehicles.

Duration: 6

Proposal Details

Proposal Number: A1.10-1005
Subtopic Title: Structural Sensors for Health Monitoring of Hypersonic Vehicles
Proposal Title: High Temperature Thin Film SHM Sensor

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 3 - 4
Technical Abstract (Limit 2000 characters):

Hypersonic vehicles have various commercial and research uses, including faster global travel, space tourism, cargo, and scientific exploration. However, operating at hypersonic speeds poses new engineering challenges, as conventional aircraft equipment is not adequate for such extreme environments. High-temperature sensors are necessary to monitor structural components during flight and gather data for scientific research. The development of structural health monitoring (SHM) systems for hypersonic flight conditions would allow in-flight monitoring for maintenance scheduling and life cycle monitoring using actual flight history. In addition, knowing the effects of the continuous use strain and stresses could even allow for in-flight trajectory modifications to compensate for any alterations in structural components due to fatigue from continuous harsh environment use. Such systems would be vital in the implementation of operational reusable hypersonic aircraft for long-term use. GTL proposes to design a SHM that can monitor strain and temperature using an additive thin film approach. Using these methods, various sensor types such as thermocouples, RTDs, strain gauges, and more can be produced directly on the surface of the structural components under monitoring. This method offers many advantages including flexibility in material selection, oxidation resistance, superior surface adhesion and is produced additively, allowing the placement of sensors to be highly adaptable to different applications. Previous efforts have shown many successes in using thin film deposition of high temperature, oxidation-resistant materials to produce high temperature sensors and cables. The SHM sensor will use the fabrication methods developed by GTL to produce a single sensor array consisting of both a strain gauge element as well as a thermal sensing element. The design of the strain sensor can be easily adapted to accommodate various load types.

Duration: 6

Proposal Details

Proposal Number: A1.10-1009
Subtopic Title: Structural Sensors for Health Monitoring of Hypersonic Vehicles
Proposal Title: SHM system for Hypersonic Vehicles

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 3 - 4
Technical Abstract (Limit 2000 characters):

The U.S. hypersonic ground- and flight-test communities require robust structural sensors that operate in relevant hypersonic environments. The focus of this project is the development of vehicle structural health monitoring (SHM) systems for use with hypersonic vehicles in extreme environments (e.g., high thermal, vibrational, and acoustic environments). For hypersonic vehicles in order to deploy SHM systems through a wide range of environmental conditions experienced by the vehicle, it is crucial to develop hardware that can function at those temperatures in addition to robust structural monitoring algorithms. The key to this is the development of sensor systems that can survive the harsh usage conditions and the extreme working environments. This program will develop Bismuth Scandium Lead Titanate based SHM systems for Hypersonic Vehicles. The goal will be to develop SHM systems that will include 3 major components a. High-temperature sensors: a flexible sensor layer with BSPT sensors fabricated for use in hypersonic vehicle nonablative areas facing temperatures approx. 600 C . A novel manufacturing process will be developed during the SBIR to enable the production and packaging of the sensors along with methods for their installation in the high temperature areas. b. Data-Acquisition (DAQ): a passive-active electronic module that interfaces with the BSPT sensors will be developed that will use ultrasound induced transducers combined with low to high frequency data collectors. c. SHM Software: advanced algorithms to detect, characterize, and track damage (including impacts, cracks, disbonds, etc.) along with an easy-to-use graphical user interface (GUI). Physics-informed diagnostic software will be developed to use Artificial Intelligence (AI) and Machine Learning (ML) using the data from the sensors to detect damage under extreme environment and to characterize environmental conditions through ML techniques.

Duration: 6

Proposal Details

Proposal Number: A2.01-1008
Subtopic Title: Flight Test and Measurement Technologies
Proposal Title: TabletFTS - Advanced EFB applications for rapid, lowcost, flight test execution

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 2 - 4
Technical Abstract (Limit 2000 characters):

Tablet-computer based Electronic Flight Bags (EFB) have become ubiquitous in airplane flight decks in recent years. IO Aeronautical Autonomy Labs proposes this project to extend these tablet applications with a series of functions, specifically designed to provide real-time support to NASA and the flight test community in the execution of flight test. Some specific functionalities that we envision as being useful to flight testers include: • interactive test cards that track test point execution in real-

time and verify test point completion, • calculation of dynamics and control inputs for getting precisely on condition given the current aircraft state, • sensing, calculating, and plotting important parameters in the cockpit, • and annunciations of potential safety concerns to the pilot and flight test engineers. However, before such a system can be made a reality, critical components must be analyzed to define their limits as they currently exist and to uncover improvements that can be brought to bear. As such, this proposal addresses two key enablers for the development of flight test applications: 1. an analysis of the suitability of the sensing platform included with iPads, as well as, how modern algorithms can be used to augment their capability and what other technologies can be integrated in to improve functionality, and 2. the development of tablet applications to support test pilot operations in real-time in flight (TPilS) evaluated initially through a piloted simulation platform. Looking ahead to Phase II, the project will produce a prototype that can be developed alongside NASA test pilots and engineers to improve its usefulness in flight test. For Phase I, the goals are to to analyze and develop sensor models for electronic flight bags and develop and test applications on the EFB to support flight test execution for NASA and the flight test community at large.

Duration: 6

Proposal Details

Proposal Number: A2.01-1009
Subtopic Title: Flight Test and Measurement Technologies
Proposal Title: High Accuracy Time Synchronization, Cloud-Based Data Management and Visualization Enhancements for Real Time Data Telemetry

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 3 - 6
Technical Abstract (Limit 2000 characters):

Boom's Testing and Telemetry Product Suite is a high-efficiency, high-volume, very low-latency flight test data acquisition, data management and analysis software package. It comprises an air-to-ground data telemetry acquisition, processing and visualization system, an automated flight test and data management system and an automated sensor validation subsystem. It is capable of integrating multiple sources of telemetry and possesses a flexible modular architecture, making it widely applicable to a range of flight test environments. At present, OEMs develop proprietary telemetry software, and while some COTS options exist, they lack flexibility in implementing custom functions, incur high costs for scalability, and lack security and reliability. Boom’s Product Suite improves upon these systems through multiple novel features and capabilities. The Product Suite has been under development for more than 5 years at Boom, and the following specific features are proposed to be implemented in Phase I: - Establishing Time Synchronization across Asynchronous DAS - Preflight Instrument Validation using Historical Trends - Cloud-based Data Storage - Visualization Utility Development Anticipated Phase I deliverables include a mid-term and a final report describing the architecture in further detail as well as successes, challenges and opportunities for further development. Phase II deliverables (if awarded) would include maturation to TRL6, including validation and demonstration during a flight test event. Completed standalone software will also be delivered. The Product Suite will offer capabilities that far exceed existing COTS flight test data acquisition, processing, and display software. Further development of the Product Suite, as well as validation, demonstration and delivery of software under a potential Phase II award, would enable NASA and the aerospace industry to conduct flight research more effectively and rise to the challenges of cutting-edge R&D activities.

Duration: 6

Proposal Details

Proposal Number: A2.02-1018

Subtopic Title: Enabling Aircraft Autonomy
Proposal Title: Low-cost UAS for Wildfire Logistics and Management

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 5 - 6
Technical Abstract (Limit 2000 characters):

In this Phase I SBIR effort, Dragoon Technology proposes to assess the capability of its long endurance low-cost UAS platform, Coriolis, as applied to the wildfire environment. Specifically, investigation of autonomous behaviors enabled by a combination of the Coriolis aircraft, a low-cost sensor suite, and a communications radio will be completed. Dragoon believes that several basic autonomy behaviors can be created by such a system, including a long-dwell communications relay which can optimize navigation based on terrain and signal strength, intelligent tracking of personnel and assets, and detection and tracking of critical features in the fire environment. The intended use of the funding is to research the above areas, integrate communications equipment onto an existing Coriolis aircraft, and perform a flight test with the equipment onboard. In the commercial sector, target markets for a long-endurance low-cost UAS capability are numerous. The original application for the Coriolis aircraft is long duration weather sensing missions, but the aircraft can also be applied broadly to disaster relief and linear infrastructure inspection. The aircraft is

well suited to missions where a long endurance capability is required but return of the aircraft may be uncertain.

Duration: 6

Proposal Details

Proposal Number: A2.02-1026
Subtopic Title: Enabling Aircraft Autonomy
Proposal Title: Disaster Autonomous Aerial Response Technology

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 3 - 5

Technical Abstract (Limit 2000 characters):

DAART (Disaster Autonomous Aerial Response Technology) is an advanced UAV autonomy framework for disaster response missions. It integrates state-of-the-art AI techniques to enable highly autonomous, resilient, and transparent multi-UAV operations in complex, dynamic environments. DAART combines adaptive multi-modal sensor fusion, deep learning-based semantic segmentation, hierarchical anomaly detection, decentralized swarm coordination, case-based reasoning for high-level decision making, reinforcement learning for navigation, and explainable AI for human-machine teaming. The sensor fusion module adaptively combines visual, thermal, LiDAR, and other sensor data to maintain robust situational awareness in degraded conditions. Semantic segmentation identifies mission-relevant objects while anomaly detection ensures reliable operation. Decentralized coordination enables scalable, fault-tolerant collaboration of UAV swarms. Sim-to-real transfer learning accelerates policy development for navigation in novel environments. Intuitive human-machine interfaces and explainable AI foster trust and effective intervention. DAART achieves unprecedented autonomy and resilience for UAVs in disaster response while meeting strict SWaP constraints. Phase I funding will support prototyping and feasibility demonstration in high-fidelity simulation. Our UAV autonomy architecture, SCOUT, which has been showcased to NASA stakeholders through demonstrations on operational UAVs in flight, and our aircraft Probabilistic Roadmap Path Planner, which plans aggressive, collision-free 3D routes in complex environments in close proximity with moving objects (useful in disaster management, public safety, and emergency response), demonstrate our proficiency in developing advanced UAV coordination systems, efficient and reliable perception and navigation solutions, robust anomaly detection algorithms, and intuitive human-machine interaction interfaces.

Duration: 6

Proposal Details

Proposal Number: A2.02-1027
Subtopic Title: Enabling Aircraft Autonomy
Proposal Title: Improving Aerial Fire Retardant Drop Efficiency using a Dynamic Targeting Device

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 1 - 3
Technical Abstract (Limit 2000 characters):

Wildfires continue to grow in intensity as many areas around the US have been in prolonged drought conditions. These areas may lack the funds and resources to adequately maintain the forested areas. This vulnerability along with poorly maintained energy infrastructures has the potential for severe devastation on the environment and community. Aerial firefighting is dangerous and somewhat inefficient. Over seven decades of aerial attack, there has been a remarkable lack of technological advancements. Delayed containment and missed drops add cost, intensify the negative impact on the environment and increase low level flight risk to aerial firefighters. Technology is needed to improve the selection of drop locations and to objectively measure post drop assessment. 9k Vantage is proposing the development of a dynamic targeting device. This low-cost device will allow a pilot to evaluate a proposed drop location, measure distances between objects and perform an objective post-retardant drop assessment using images captured and analyzed in near real-time. This technology will reduce retardant waste, hasten containment, allow for the collection of metrics to improve targeting and delivery methodology and ensure compliance with environmental regulations. The versatile design will enable a plane, helicopter, or UAV to use this revolutionary technology.

Duration: 6

Proposal Details

Proposal Number: A2.02-1029
Subtopic Title: Enabling Aircraft Autonomy
Proposal Title: SkyAID: A Safe Autonomy Infrastructure for Disaster Response

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 3 - 6
Technical Abstract (Limit 2000 characters):

Emergency response applications such as wildfire suppression present an important and challenging proving ground for autonomous aviation in the near future. Autonomous operation is desirable because these scenarios are dangerous for pilots and can be more cost-effective. They are challenging because autonomous decision-making has to work with incomplete information (e.g., partial visibility with smoke) in a dynamically evolving environment such as loss of communication. To meet these challenges the autonomy stack has to establish a higher degree of resilience to off-nominal conditions. Systems should have the ability to dynamically adapt to changes in the external environment - such as visibility, GPS availability, connectivity to human operators and other agents in the fleet - as well as internal (vehicle-level) failures and degradation. The system should be able to rationally self-organize the sensing and communication architecture based on current estimate of available resources. Finally,

system designers should be able to provide evidence for certifying the safe operation of the whole system at design time and monitor its performance at runtime. Towards accomplishing these goals, and more broadly aligned with NASA's strategic plans for enabling aircraft autonomy, our team at Rational CyPhy Inc. will develop SkyAID - a framework for enabling autonomous aircraft operations. The fundamental technical breakthroughs anticipated are: * Fast timescale adaptation with safe, multi-objective, detect-and-avoid algorithms that lower workload in beyond visual line of sight operations; * Autonomous adaptation to changing environment for optimized perception and communication, based on recent innovations in safe learning-enabled control; * Continuous verification, validation, and certification technologies reducing development cycles and increasing overall safety and mission success.

Duration: 6

Proposal Details

Proposal Number: A2.02-1040
Subtopic Title: Enabling Aircraft Autonomy
Proposal Title: Target Acquisition and Guidance System (TAGS) for Wildfire Response

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 3 - 4
Technical Abstract (Limit 2000 characters):

The Target Acquisition and Guidance System (TAGS) is an platform-agnostic navigation solution designed for Unmanned Aircraft Systems (UAS) to enhance wildfire management and disaster relief operations. This technology integrates autonomous cooperative planning algorithms and decision-making capabilities directly onboard, enabling multiple UAS to perform complex missions in dynamic environments with minimal human intervention. TAGS focuses on improving operational efficiency and safety by allowing one operator to supervise multiple drones, facilitating early detection, damage assessment, and logistical support in disaster-affected areas. The core technology employs a hierarchical communication system, decentralized control mechanisms, and advanced sensor data aggregation to enable effective coordination among UAS. Funding will support the development of TAGS's autonomous navigation and cooperative planning capabilities, refinement of its distributed control algorithms, and expansion of its sensor integration for better environmental perception and risk assessment. Target markets include government agencies involved in emergency management and wildfire suppression, utility companies seeking infrastructure inspection and maintenance solutions, and insurance companies requiring accurate risk assessment and claims management. TAGS aims to revolutionize the approach to disaster management, significantly reducing the reliance on human pilots and streamlining operations in critical scenarios, ultimately saving lives, preserving property, and minimizing the environmental impact of natural disasters and emergencies.

Duration: 6

Proposal Details

Proposal Number: A3.01-1001
Subtopic Title: Advanced Air Traffic Management for Traditional Aviation Missions
Proposal Title: Turbulence-Impact Collaborative Response System

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 3 - 4
Technical Abstract (Limit 2000 characters):

Turbulence is a major hazard to all classes of aircraft, affecting aircraft on a daily basis. While a variety of systems are currently deployed to support the detection of forecasting of turbulence, all have limitations, many are proprietary, and often costly. Our innovation is a real-time turbulence identification system that can provide a uniquely accurate up-to-the-second representation of turbulence, can geofence boundaries around hazard regions, determine the impacts to Air Traffic Management (ATM), and provide a collaborative ATM mitigation plan. Automatic Dependent Surveillance – Broadcast (ADS-B) data, updated every 1 second, is used as the basis for in situ up-to-the-second turbulence detection. ADS-B-based turbulence data, when fused with other turbulence nowcasts, provides a clear representation of where turbulence exists, and where turbulence has been positively demonstrated not to exist (clear-air-altitudes). This solution does not mount any new hardware or software onto any aircraft, however, it receives data "for free" from every aircraft in the sky.

Duration: 6

Proposal Details

Proposal Number: A3.01-1011
Subtopic Title: Advanced Air Traffic Management for Traditional Aviation Missions
Proposal Title: A Framework for Unlocking Hidden Air Traffic Management Data Sources Through Advanced Technologies

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 1 - 3
Technical Abstract (Limit 2000 characters):

Our proposed innovation, Air Traffic Language Analysis System for Coordination, Operational Prediction, and Enhancement (ATLASCOPE), is an Artificial Intelligence-based airspace service that improves the efficiency of traditional civil aviation missions in the near-term NAS, thus directly addressing Subtopic A3.01. ATLASCOPE does this by unlocking crucial ATM information hidden in unstructured, non-traditional data sources. A key example is unpublished traffic management initiatives (TMIs) that are

negotiated between FAA facilities via phone conversations and implemented without being published via SWIM or other sources. Lack of information on these TMIs prevents airlines from making preemptive adjustments to minimize impact to their networks, leading to significant, avoidable operating costs. Information on unpublished TMIs can be inferred indirectly from controller-pilot conversations. ATLASCOPE Monitors these voice comm data feeds, Converts the audio to text, Extracts crucial information from the text via AI-based NLP, and Provides insights and predictions based on this information to airlines and other NASA Digital Information Platform (DIP) users. ATLASCOPE supports NASA ATM-X's DIP sub-project's plans for demonstrating the pre-departure rerouting digital service (called CDDR) in the SNFP-Ops demos, by providing a hitherto unavailable source of information on the impact of unpublished TMIs on departure route capacities and departure delays. This increases the effectiveness of CDDR. The SBIR brings together an innovative approach for creating training datasets for fine-tuning audio-to-text conversion Large Language Models, cutting-edge AI model training techniques that avoid pitfalls of over- and under-fitting, and an innovative flight track processing-based approach for creating unpublished TMI activity truth dataset. The anticipated Phase I result is demonstration of the ATLASCOPE prototype on one or more historical unpublished TMIs scenarios.

Duration: 6

Proposal Details

Proposal Number: A3.01-1015
Subtopic Title: Advanced Air Traffic Management for Traditional Aviation Missions
Proposal Title: Monitor and Forecast System for Airport and Network Operational Risk

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 2 - 4
Technical Abstract (Limit 2000 characters):

The Monitor for Airport and Network Operational Risk (MANOR) aims to be a single source for integrating multiple sources of data to monitor and forecast combinations of conditions at major airports that generate operational risk. MANOR monitors and forecasts operating conditions at individual airports and captures interactions with other airports through an Airport Dependency Index. MANOR aims to address traffic flow disruptions from demand-capacity imbalances by focusing on factors that interrupt schedule execution and efficient operations. MANOR does not address the detailed considerations that go into flight planning, such as airport elevation, airport opening and closing times, and certification for CAT III landings. MANOR consists of two components: Airport Operational Risk Component monitors and forecasts each airport for potential exposure to disruptive factors and provides estimates of those impacts. Airport Dependency Model Network Component addresses network effects and identifies the impacts on airport efficiency due to upstream and downstream effects from other airports. Together, these components provide operators and the FAA a comprehensive decision support system to monitor the overall operational status of the NAS and provide detailed insight into potential operational risks for individual airports. The system provides current status on the most recent data sources and forecasts up to 15 hours in advance. Different forecast models will offer different forecast periods depending on the value of an extended forecast and the accuracy of the forecast method. For example, MANOR will provide hourly arrival rate forecast probabilities 15 hours in advance. This offers an airline dispatch manager coming on duty at 0600 an extended perspective on the possible operational challenges for that day. The dispatch manager coming on duty for the overnight shift will have access to forecasts for the following day to support planning for the next day.

Duration: 6

Proposal Details

Proposal Number: A3.02-1000
Subtopic Title: Advanced Air Traffic Management for Nontraditional Airspace Missions and Aerial Wildfire Response
Proposal Title: Avian Collision Mitigation: A Predictive Advanced Air Mobility Guidance App for Enhanced Aviation Safety

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 1 - 2
Technical Abstract (Limit 2000 characters):

The Advanced Air Mobility (AAM) Guidance App will enhance the safety of AAM aircraft through prevention of collisions with airborne wildlife by leveraging real-time data collection and analytics used to predict the occurrence and movement of critical species. The app will provide the safest pathways for aircraft by minimizing the probability and consequence of collision with airborne wildlife. The proposed AAM Guidance App integrates data inputs into an aircraft-wildlife collision risk prediction provided to users through an app interface. The app's core will use sophisticated algorithms that incorporate predictive analytics. Funding will be used to conduct research focused on three key areas of the subtopic scope description: Human-autonomy teaming, dynamic route planning and scheduling, and integration with

legacy operations. The Phase I objectives include: identify data inputs; review sensor technologies; theorize predictive models for animal movement, complete user needs assessment, identify user-specific communication tools; explore risk assessment components; and develop the commercialization plan for Phase II development and testing. The AAM Guidance App Phase I project will address critical gaps in the development of airspace Concepts of Operations by providing a Phase II-ready solution that will facilitate human-autonomy teaming and that will provide ATM technology. The Phase I deliverable is a report that provides a roadmap for Phase II delivery of the AAM Guidance App. The AAM Guidance App will provide economic benefits such as reduced accident risk, optimized flight paths and better traffic management, and increased scalability to potential customers that include AAM aircraft manufacturers, AAM aircraft operators, Air Traffic Control authorities, federal, state, and local governments, and airport and vertiport operators.

Duration: 6

Proposal Details

Proposal Number: A3.02-1006
Subtopic Title: Advanced Air Traffic Management for Nontraditional Airspace Missions and Aerial Wildfire Response
Proposal Title: NextGen Incident Response Communication System

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 2 - 3
Technical Abstract (Limit 2000 characters):

Global warming continues to set unwelcome records: 2023 was the earth's hottest year in over a century and a half; January 2024 is the hottest January on record; Decade after decade since the 1960s has seen a steady increase in average temperatures. From coastal flooding to prolonged heat waves, global warming has caused the frequency and intensity of extreme weather events to increase. This includes wildfires, which have grown significantly in scale and duration. The World Resources Institute estimates that forest fires are burning twice the amount of tree cover today as they were 20 years ago. The grim reality is that in the face of global warming there is a dire need to invest more in wildland firefighting capabilities to protect and safeguard the American public and its property. One monumental need facing today's firefighting operations is the lack of a reliable, resilient, and secure data communications system to enable quick information dissemination and support effective decision making. The proposed innovation – the NextGen Incident Response Communication System (NIRCS) – is a mobile, long-range, multi-purpose NextGen broadcast communications system. The innovation directly addresses the cited need: providing a reliable, resilient, and secure data communications system for quick data dissemination. NIRCS makes use of ATSC 3.0 technology, a digital terrestrial broadcast system built on the internet protocol (IP) that enables one-way communication of any IP-compatible data, including ultra-high-definition video, high-fidelity audio, and other types of data packets (e.g., encrypted UTM or UAM messages). As a multi-content-compatible general communication system, NIRCS can fulfill several important use cases, to include the broadcast of vehicle position and operational volume data, temporary flight restrictions (TFRs), Notices to Air Missions (NOTAMs), weather information, UAS surveillance video, and high-fidelity audio.

Duration: 6

Proposal Details

Proposal Number: A3.02-1023
Subtopic Title: Advanced Air Traffic Management for Nontraditional Airspace Missions and Aerial Wildfire Response

Proposal Title: Placeholder

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 2 - 3
Technical Abstract (Limit 2000 characters):

Advanced Air Mobility (AAM) is an emerging aviation ecosystem that leverages an array of innovative propulsion, airframe, and aircraft technologies that are enabling new opportunities for transportation in the National Airspace System (NAS). Developing an operational concept and solution that provides collaborative, scalable, dynamic, efficient, and safe UAM operations in complex urban airspace is an extremely difficult task. As AAM operations become more accepted by the general community, the tempo of operations is expected to increase, which will require significant innovation of airspace management concepts to address dynamic route planning, dynamic scheduling, and NAS integration. As of today, two competing AAM operational models have been identified: pre-defined, or “fixed”, airspace solutions using defined corridors, and dynamic “free-flight”-based solutions, using automation systems to identify available route options. The Nodal Environment Matrix (NEM) developed by The Belmont Group introduces a novel approach to airspace management for AAM operations. The NEM employs a multi-layered mesh structure of nodes overlaying a designated airspace. The nodes serve as navigation waypoints and data

exchanges, predicting availability based on aircraft trajectories and their spatial envelopes. The NEM's two main components, the nodal mesh matrix and Aircraft Occupancy Envelopes (AOEs), enable strategic deconfliction, dynamic route planning, and on-demand scheduling while accommodating a diverse set of UAM use cases. Our nodal matrix enables a hybrid airspace management model, utilizing the best concepts from predefined, structured airspace solutions, along with dynamic route pathing flexibility typical of free-flight pathing solutions. Phase I efforts will focus on the required system engineering documentation as well as developing and refining an initial prototype NEM to demonstrate the concept's feasibility.

Duration: 6

Proposal Details

Proposal Number: A3.02-1027
Subtopic Title: Advanced Air Traffic Management for Nontraditional Airspace Missions and Aerial Wildfire Response
Proposal Title: CHRP-I: Adding Imagery to a low-cost multi-network / multi-path horizontal communications communication hub and routing platform

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 2 - 5
Technical Abstract (Limit 2000 characters):

CHRP-I provides the capability to send and receive imagery over a low-cost mesh network. The data will then be transferred when available over a high bandwidth SATCOM link to Fire management personnel. Groups have been exploring methods of sending “Multi-Packet LoRa (MPLR), for transmission of large messages, such as images, in LoRa networks”. The consensus is that it is “challenging but possible with some using new protocols in order to alleviate the low data rate that LoRa has, while others use the physical layer in order to overcome the packet collision problem and few methods deal with the compact image representation” . There have been hobbyists developing solutions. A library called loracamera allows transmission of sound and images over a 915MHz LoRa link to a base station near a Wi-Fi connection. Currently it is set up to a send a frame from a serial TTL camera and a few seconds of sound from a microphone, but it can be adapted for most data using LoRa directly. CHRP-I will provide a carry-on solution for ground personnel and aircraft.

Duration: 6

Proposal Details

Proposal Number: A3.02-1028
Subtopic Title: Advanced Air Traffic Management for Nontraditional Airspace Missions and Aerial Wildfire Response
Proposal Title: GAS on Fire (Guided, Accurate Slurry drops on Fire)

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 2 - 3
Technical Abstract (Limit 2000 characters):

RoGO was born of wildland firefighting. We create technologies providing communications and situational awareness in austere and cellular-denied areas like Wildland Firefighters often work in. RoGO's DropBlock technology empowers Wildland Firefighters with the ability to communicate, collaborate and be informed of current fire weather behavior, GPS locations of human and non-human firefighting resources and tactical collaborations at the edge. RoGO's small, satellite-enabled "DropBlock" devices are now deployed with Wildland Firefighters in 7 western U.S. States. RoGO proposes improving our DropBlock communications devices with the ability to provide GPS slurry drop start point, vector positioning and wind drift data to aerial resources from DropBlocks on the ground. This technology serves two critical aerial firefighting purposes: 1) It makes slurry drops more accurate and effective 2) It improves firefighter safety by confirming an "All-Clear" to the slurry bomber, denoting if all firefighters have evacuated the drop zone or not, and if it is safe to drop the slurry. Proposal supports the TX10 subtopic of A2.02: Enabling Aircraft Autonomy. But we find primary fit with TX16 subtopic A3.02 for Aerial Wildfire Response. I believe readers will appreciate that supporting RoGO in our TX16 application supports the TX10 mission symbiotically. Use of funding is validating needs of the ideas/features above with Federal and State Air Attack operators and Wildland Firefighters. Funds will be used to disseminate if the proposed negates the need for a spotter aircraft to fly ahead of a slurry bomber: If true, this can save thousands of dollars per slurry drop. We investigate integrating our DropBlock API with an aircraft's electronic flight bag (EFB) for ease of pilot use and clarity of data to aircraft in flight. Target markets are public/private sector fixed/rotor wing aerial firefighting organizations, utility and insurance industries.

Duration: 5

Proposal Details

Proposal Number: A3.03-1016
Subtopic Title: Future Aviation Systems Safety
Proposal Title: Services for Ongoing Assessment of Risk (SOAR)

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 1 - 3
Technical Abstract (Limit 2000 characters):

The Longbow Group, LLC (LONGBOW), with Daniel H. Wagner Associates, Inc. (DHWA) as a subcontractor, will demonstrate the feasibility of developing key components of a future In-Time Aviation Safety Management System (IASMS) and commercializing those components as IASMS Services, Functions, and Capabilities (SFCs) within one or more Supplemental Data Service Providers (SDSPs) supporting Uncrewed Aircraft Systems (UAS) Traffic Management (UTM). Services for Ongoing Assessment of Risk (SOAR) will be able to monitor and record real-time telemetry

data from UAS and provide efficient safety prognostic decision-supporting tools that can identify and alert the operator about emergent anomalous behaviors to prevent critical system failures. Specifically, SOAR will monitor, record, and assess UAS subsystem health & status, including battery health, RF signals for Command and Control (C2), GPS signal strength, and IMU and Compass data. SOAR will utilize state-of-the-art Machine Learning (ML) models to perform short-term prediction of subsystem status/behavior, where each model has been trained on large amounts of recorded flight data of the same type, including operations with controlled subsystem failures (e.g., lost link, lost GPS, battery failure, etc.). Initial target markets are other ANSPs and UTM providers and UAS Operators with use cases such as Security, Search and Rescue, Disaster Relief and Air Cargo transportation. Future target markets include Advanced Air Mobility (AAM) Air Taxi providers.

Duration: 6

Proposal Details

Proposal Number: A3.03-1022
Subtopic Title: Future Aviation Systems Safety
Proposal Title: Surface Anomaly and Intent Forecast System

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 1 - 4
Technical Abstract (Limit 2000 characters):

Surface operations at an airport require careful coordination between pilots and air traffic controllers. Currently, when any deviation from planned routes occurs, the air traffic controller must actively observe and intervene actively to avoid any potential conflicts. The in-time safety assurance goals of NASA's In-time Aviation Safety Management System (IASMS) necessitate a proactive monitoring and alert tool instead of the reactive alerts provided after an encroachment or incursion occurs. Our innovation offers a robust, extensible surface track monitoring alerting tool that integrates the effective operational configuration, and ATC clearances to identify deviations as soon as they occur. The Surface Anomalies and Intent Forecast (SAIF) tool provides an additional layer of safety assurance over the operations by monitoring surface traffic patterns and ATC-pilot communications to infer deviations by pilots or air traffic controllers. The existing layers of safety provided by ASDE-X and controller interference are reactive in nature and an alert is generated after an incursion or when significant deviation occurs. The proposed SAIF tool leverages the live surface data, ATC-pilot comms, and historic operational patterns to generate a proactive identification of any controller/pilot deviations. Context awareness of SAIF helps alert the controllers to any potential non-compliance immediately after it occurs. We will leverage our expertise in speech-to-text models, real-time data processing, and integrated monitoring to build the Phase I POC for ATL and JFK. The two airports are characterized by complex but varying operational patterns and will be a good proving ground for the technology. The POC will focus on devising a general, extensible, and validated architecture applicable to any airport operations. We will demonstrate and validate the functionality on live data for the two airports by the end of Phase I.

Duration: 6

Proposal Details

Proposal Number: A3.03-1023
Subtopic Title: Future Aviation Systems Safety
Proposal Title: Digital Airport Safety Twin

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 1 - 3
Technical Abstract (Limit 2000 characters):

Predictive safety risk tools for airports utilize data analytics, Machine Learning (ML), and Artificial Intelligence (AI) to forecast potential safety hazards and risks in airport operations before they escalate into incidents or accidents. These tools analyze patterns, trends, and anomalies in historical data to train ML models, forming the basis for real-time safety and risk monitoring systems. Parallel to predictive tools, digital twin technology has evolved, initially focusing on facility maintenance but increasingly applying to airport and airspace operations using real-time data, enabling simulation, efficiency optimization, safety enhancement, and decision-making support. These models can identify operational bottlenecks, improve safety protocols, and provide predictive analytics for informed decision-making. The proposed "Digital Airport Safety Twin" platform offers a comprehensive approach to managing airport safety risk by merging predictive safety tools and digital twin technology into a homogenous safety and risk management system that enables continuous monitoring of safety and risk patterns across airfields through historical operational data, human factors, weather data, and safety-related information. It employs ML algorithms to assess and quantify safety risks associated with various airport operations, helping prioritize safety improvements. By analyzing a wide range of data sources, including airport surface movement, flight operations quality, and weather data, the platform can predict safety incident likelihoods and support safety enhancements. AI and Large Language Models (LLMs) help translate complex human factors and interactions into measurable safety and risk metrics. The innovation can be used in-house at NASA to

support aviation safety platforms and research (i.e. the DIP, ATM-X) but can also be integrated into commercial ATM tools and platforms as a safety service to support risk planning, Trajectory-Based Operations (TBO), and others.

Duration: 6

Proposal Details

Proposal Number: A3.03-1033
Subtopic Title: Future Aviation Systems Safety
Proposal Title: In-Time Flight Risk Assessment Tool (IFRAT) with Certification Compliance

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 2 - 4
Technical Abstract (Limit 2000 characters):

This proposal develops an In-Time Flight Risk Assessment Tool (IFRAT) and adds an evaluation of certification and regulatory compliance to further expand upon a traditional FRAT. The IFRAT tool could be used by pilots/dispatchers in place of a traditional FRAT and by USS' to assist with flight planning/approval. The IFRAT provides a framework for in-time flight approvals to support UAS BVLOS, operations over people and moving vehicles, m:N operations, and later manned operations in a Digital Flight Rules (DFR) environment. The IFRAT will build upon Anzen's current static safety case tools to become a secure, in-time cloud-based service with defined interfaces to many UTM-USS' (through ASTM's F3548 standard for UTM-USS Interoperability). As part of flight planning, the pilot/dispatcher will identify the planned aircraft, equipment/AE, flight route, and operator information, which is then transmitted to the IFRAT. The IFRAT then checks that the: • Pilot, organization, equipment/AE, and aircraft had the appropriate approvals for the requested flight plan • Planned flight is compatible with the location's characteristics (i.e. air and ground risk) • Required aircraft safety and communications equipment is operational If the proposed operation is consistent with the operator's approved safety case and certification, then the IFRAT sends the request to the UTM-USS for deconfliction and other USS services (e.g. weather SDSP). If the IFRAT detects an inconsistency with the approved configuration or location, the pilot/dispatcher is notified of the discrepancy before take-off. IFRAT also provides data for organizations to proactively address "no-go" causes as part of their SMS, and for organizations like NASA and the FAA look at anonymized industry data for potential safety improvements.

Duration: 6

Proposal Details

Proposal Number: A3.05-1004
Subtopic Title: Advanced Air Mobility (AAM) Integration
Proposal Title: Sensing Weather for Advanced Air Mobility

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 5 - 7
Technical Abstract (Limit 2000 characters):

Accurate monitoring of weather conditions is critical (particularly at low altitudes) to ensure safe and efficient Advanced Air Mobility (AAM) aviation. While permanently installed weather sensors exist at local airports for traditional aviation, AAM will magnify the points of departure by orders of magnitude, necessitating hyper-local weather sensing at lower cost and with increased portability. ASTM International has formed a working group to establish the ASTM F3673-23 standard specifically to address this need even though no currently available sensors fully meet the performance and cost targets required by AAM. To address the gap in available weather sensing technologies, Intellisense Systems, Inc. (Intellisense) proposes to develop the Sensing Weather for Advanced Air Mobility (SWAAMI) system, the first commercial system specifically targeted at meeting ASTM F3673-23 Tier 2 performance standards. It will be low cost to promote widespread adoption and deployment and suitable for fixed or portable use. The SWAAMI system will be based on a novel integration of existing and emerging breakthrough technologies. Specifically, Intellisense will modify its existing portable Micro Weather Station product to include the latest in optical precipitation and present-weather sensing technologies to form the SWAAMI system, which will be the first of its kind in a product category that will become essential to AAM operations, measuring temperature, pressure, humidity, wind speed and direction, atmospheric visibility, present weather, cloud height, lightning, icing, and additional derived parameters, all in an integrated, hand-portable system. Funding will be used to develop and demonstrate a prototype of this system in Phase I and to begin marketing it within the AAM weather sensing space in which Intellisense is well established. Phase II will focus on increasing maturity, test installations for early adopters, and updates to F3673-23 release.

Duration: 6

Proposal Details

Proposal Number: A3.05-1005
Subtopic Title: Advanced Air Mobility (AAM) Integration
Proposal Title: Real-Time Detection of Low Altitude Icing Conditions

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 2 - 4
Technical Abstract (Limit 2000 characters):

Our proposal addresses a pain point in the aviation sector, especially within Advanced Air Mobility (AAM) operations: a lack of high-fidelity detection of hazardous icing conditions. Leveraging novel weather sensors, including the Vaisala CL61, Meteomatics Meteodrone, and the Weather Scout UAS, alongside an atmospheric moisture classification ML algorithm, our project will seek to detect conditions conducive to icing and begin work towards an ML-based estimate of icing event likelihood. This will lead to development of a high-resolution short-range icing risk

forecast model in Phase II, providing unprecedented safety and operational reliability in aviation, particularly in AAM corridors below 5,000 feet AGL. The technology's purpose is to respond to client identified pain point for in-cloud icing. During a 2023 weather workshop by the non-profit AeroX, icing was identified as one of the highest impact weather hazards affecting the AAM industry. This finding was based on the risk to safety posed by icing as well as uncertainty in the timing and location of icing. Thus, the ability to safely operate AAM platforms in the national airspace system (NAS), efficiently, requires timely, high-resolution data to detect and avoid hazardous icing conditions. The funding will research sensors that can detect icing potential and develop a framework to produce ML algorithms to produce real-time icing risk assessments for the safe integration and operation of AAM systems in the NAS. The proposed assessments will serve the emerging $68.1B (by 2032) middle-mile drone and air taxi industries to reduce weather-related disruptions, both real and perceived, enhance flight safety, and increase operational efficiency. The objective is when icing products produced for the NAS today depict icing conditions, potentially stopping flight operations without knowing whether icing really exists, the TruWeather system will be able to report, with certainty, either icing does, or does not exist.

Duration: 6

Proposal Details

Proposal Number: A3.05-1016
Subtopic Title: Advanced Air Mobility (AAM) Integration
Proposal Title: A Portable Multi-Resolution Holographic Particle Imaging System to Improve Awareness of Icing Potential for AAM Operation

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 3 - 4
Technical Abstract (Limit 2000 characters):

This proposed research aims to develop a portable multi-resolution holographic particle imaging system (MHPIS) to achieve real-time, in-situ measurements of shapes and size distributions of airborne supercooled water droplets and ice crystals for improved awareness of icing potential for AAM operation. For the proposed MHPIS, a small-scale, portable 632 nm laser is utilized as the light source, passing a neutral density filter, a spatial filter and a collimation lens to generate a magnified collimated laser beam. The laser beam then illuminates the airborne water droplets/ice particles in the measurement region to form a magnified diffraction pattern on the image plane of a camera. If the scattered wave from the airborne droplets/particles is small compared with the unscattered reference laser wave, the interference pattern on the image plane forms a hologram. The hologram is stored as 2D digital images and then will be reconstructed to generate 3D information of the droplets/particles by Kirchhoff–Helmholtz transform. The multi-resolution is achieved by changing the distance between the measurement region and the camera. The in-situ measurement data can be fed into icing prediction modules to realize real-time icing prediction. Due to its compact size, lightweight and cost-effective characteristics, the proposed MHPIS can be easily integrated into any AAM vehicle to measure the airborne supercooled water droplets and ice crystals in the icing clouds up to 3,000 feet in altitude to collect spatially dense observation data within a cubic region of width of 300 feet. As a result, the MHPIS can provide a set of enriched statistical data on icing-related parameters for more accurate icing prediction. Compared to traditional icing observation systems and icing sensors, the proposed MHPIS is a breakthrough technique for evaluating icing potential to ensure safer and more efficient AAM operation under all weather conditions.

Duration: 6

Proposal Details

Proposal Number: A3.05-1017

Subtopic Title: Advanced Air Mobility (AAM) Integration
Proposal Title: Ultralow cost and size radar for AAM enhanced mobile weather station

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 3 - 4
Technical Abstract (Limit 2000 characters):

would be tested with our teammates at Oklahoma University to ensure its sensitivity and cost-effectiveness. The C-band radar, designed for affordability, can detect light rain within a 10 km radius, offering 360-degree coverage. The Ka-band radar would be engineered to identify cloud formations up to 10 km away, aiding in weather prediction. These radars can be deployed individually or as a set, complying with ASTM standards for integration into nowcasting networks. For the S-band radar, Agile RF Systems would be conducting simulations with Oklahoma University to validate its performance and cost. The C-band radar's architecture would be finalized based on weather modeling, with a focus on key performance metrics set with NASA. It will feature an Active Electronically Steered Antenna (AESA) and a detailed cost model. The Ka-band radar's design process includes confirming performance metrics with NASA, optimizing its reflector and feed design, and establishing a cost model. Each radar's cost model will detail essential components like single board computers and

Radome enclosures. Development roadmaps and ASTM compliance plans will be documented. With low implementation risks, these radars are slated for demonstration in a subsequent Phase II project.

Duration: 6

Proposal Details

Proposal Number: H3.11-1006
Subtopic Title: Spacecraft Water Recycling Systems for Short Duration Human Exploration Missions
Proposal Title: Photocatalytic Water Recycling for Short Duration Missions

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 2 - 4
Technical Abstract (Limit 2000 characters):

This proposal outlines the development of an innovative Water Recovery and Management (WRM) system, designed for efficient operation in the confined spaces of early-phase lunar and Mars habitats, landers, and pressurized rovers. The current WRM system used on the International Space Station (ISS) has considerable size and complexity, primarily due to the Catalytic Reactor in the Water Processor Assembly (WPA) and the Urine Processor Assembly (UPA). Our proposed system introduces a novel photocatalytic oxidation (PCO) reactor system, replacing the traditional 2-phase Catalytic Reactor. This reactor utilizes TiO_2 as a photocatalyst under UV radiation, enabling oxidation of organic compounds in single-phase liquid water. The ambient operational conditions of the PCO reactor significantly simplify the contaminant oxidation process, reducing the need for heaters, pressure regulators, and other complex components associated with the current system. A novel aspect of our approach is the integration of the PCO reactor with an ion-exchange (IX) bed in a recirculation loop, dramatically enhancing energy efficiency and reducing IX resin requirements. Addressing the challenges of system dormancy, particularly for lunar missions, we propose a strategy for system recovery and recirculation to ensure water quality post-dormancy. The PCO reactor's design is robust against extended periods of inactivity, while the impact on sorption media will be thoroughly tested during the Phase I and II programs. Our approach includes a novel urine pretreatment method, utilizing non-toxic chemicals for biological control, significantly reducing Equivalent System Mass (ESM) and enhancing safety. The proposed PCO/IX system is compact, energy-efficient, and low-maintenance, meeting NASA's stringent water quality specifications. It represents a significant advancement in space-based water processing technology, offering a scalable and reliable solution for future space missions and planetary bases.

Duration: 6

Proposal Details

Proposal Number: H3.11-1012
Subtopic Title: Spacecraft Water Recycling Systems for Short Duration Human Exploration Missions
Proposal Title: Reliable, simple, and lightweight water recycling using pressure-driven distillation

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 3 - 5
Technical Abstract (Limit 2000 characters):

OsmoPure Technologies proposes a new class of simple, reliable, and lightweight water recovery systems for humidity condensate and urine treatment. The core of these water recovery systems is the OsmoPure pressure-driven distillation (PD) membrane module. In the PD module, applied pressure is used to drive water flow through a highly selective, chemically robust membrane. The PD module offers high removal of total organic carbon (including dimethylsilanediol), ions, and other contaminants. PD is also chemically robust, allowing the membrane to be used in direct contact with chemicals used to stabilize humidity condensate and urine. The chemically resistant nature of PD membranes also permits membrane cleaning with hydrogen peroxide after extended periods of dormancy. Because PD only requires a small high-pressure pump, operation is simple and low energy. The selectivity, robustness, and ease of implementation of PD make it appealing for applications requiring high-purity treated water including water recycling systems used in short- and long-term space travel. In the proposed treatment train, PD is followed by an activated carbon module (to polish product water) and ultraviolet irradiation (to provide final disinfection). The proposed process will weigh 11.7 kg and produce 285 kg of potable water from humidity condensate over the course of a 30-day mission. Overall, the OsmoPure Technologies water recovery system offers dramatically decreased mass and simplified operation compared to current water recycling processes.

Duration: 6

Proposal Details

Proposal Number: H3.11-1013
Subtopic Title: Spacecraft Water Recycling Systems for Short Duration Human Exploration Missions
Proposal Title: On-demand novel electrochemical device for wastewater reclamation

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 3 - 4
Technical Abstract (Limit 2000 characters):

As NASA begins to return crews to the lunar surface, new types of environmental control and life support systems challenges have emerged, requiring innovative solutions including the need for new methods to recycle wastewater. This need arises because new mission scenarios are projected to require small water recycling systems that can sustain a limited number of crew for durations ranging from days to several months. For these missions, new wastewater recycling methods are needed with low system complexity, low mass characteristics, and improved reliability. New technologies should function in partial gravity and should be compatible with periods of dormancy followed by a return to full service. The aim of the Phase I study is to demonstrate the feasibility of novel electrochemical device for wastewater recycling. The new device operates at low temperatures and pressures, eliminates the need for expendables and is uniquely compatible with a fully closed loop life support system. Preliminary test results and engineering analysis indicate the device has favorable mass and power consumption characteristics. A key feature of the device is that it is constructed from highly stable electrochemical materials, so the device operates long term without degradation of performance. Preliminary results also show that the device can be readily cycled on or off and can be easily scaled as mission requirements evolve. The Phase I study will demonstrate the device's function as both a pre-treatment method and a post-treatment method, with the goal of achieving high efficiency water recovery.

Duration: 6

Proposal Details

Proposal Number: H3.12-1004
Subtopic Title: Quiet and efficient fans for spacecraft cabin ventilation
Proposal Title: Low-Noise High-Efficiency Spacecraft Ventilation Fan

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 2 - 3
Technical Abstract (Limit 2000 characters):

This proposal targets the quieting of the NASA Quiet Spacecraft Fan (QSF) by 5 dB while achieving same or better fan aerodynamic performance at the same design point. The team of AVEC and Techsburg proposes to address the solicitation requirements by applying a suite of modern technologies drawn from our experience in designing quiet, high-efficiency fans and propellers for many applications both military and commercial. To this end, a hierarchy of aerodynamic and acoustic computational tools will be used for guiding the fan design from conceptual design trade studies through high fidelity analysis for risk assessments prior to fabrication and testing. This effort differs from previous design approach in that both aerodynamic and acoustic tools will be used concurrently in the quieting of the QSF unit.

Duration: 6

Proposal Details

Proposal Number: H3.12-1005
Subtopic Title: Quiet and efficient fans for spacecraft cabin ventilation
Proposal Title: Quiet Fan for Spacecraft Cabin Ventilation

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 2 - 3
Technical Abstract (Limit 2000 characters):

The proposal is in response to NASA SBIR Phase I H3.12 for a quiet and efficient fan for spacecraft cabin ventilation system. The proposed fan design method and process employs mature and reliable design/analysis tools for both aerodynamics and acoustics. Coupled with the extensive real-world fan design experience of the proposal team, which is accumulated from multiple industrial design, build and test projects, the proposed work can produce a successful design that meets or exceeds both efficiency and noise goals. The proposal discusses using analytical tools and computational fluid dynamics to benchmark the current ventilation fan system and design a quieter and more efficient fan. The benchmark proves as a verification in accuracy in modeling methods. Analytical tools (XROTOR and DFDC) and medium fidelity CFD (FlightStream®), will also be used in the design process of the fan. This gives the capability to run a wide range of case studies in fan blade geometry, number and chord and twist distribution before simulating the fan in a higher fidelity CFD model (STAR-CCM+). The fan design needs to be capable of a mass flow of 150.3 cfm, an efficiency of 75% or better and an overall sounds pressure level decrease of 5 dB from 66 dB. The target market is not limited to the aerospace industry including NASA Centers such as JSC and GRC, as well as NASA partners such as Blue Origin, Sierra Space, Nanoracks, Voyager Space, Lockheed Martin and Northrop Grumman. DARcorporation will also market to aviation industry for aircraft cabin usage and use the experience gained to offer improved services in ventilation fan design for other industries. IT will also be marketed towards the automotive, energy, agricultural industries. From car ventilation systems, irrigation systems to server farm cooling.

Duration: 6

Proposal Details

Proposal Number: H3.12-1011
Subtopic Title: Quiet and efficient fans for spacecraft cabin ventilation
Proposal Title: Toroidal Spacecraft Ventilation Fan

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 2 - 4
Technical Abstract (Limit 2000 characters):

Aboard crewed spacecraft, such as the ISS or Apollo Command Module, acoustic noise has continuously been a point of concern in regards to communications, , and overall habitability. More specifically, ventilation fans within the Environmental Control and Life Support (ECLS) system have been the main source of acoustic noise on recent crewed missions. Mainstream proposes to develop a toroidal fan to reduce acoustic noise generated by spacecraft ventilation systems. Toroidal fans are manufactured by sweeping the trailing edge of one blade backwards to connect with the leading edge of the following blade. This significantly reduces vortices, turbulence, and flow separation, which account for a large fraction of noise produced by axial fans. In Phase I, Mainstream will leverage our existing CFD and design toolsets to select a toroidal geometry and experimentally demonstrate its viability at reducing acoustic noise while meeting aerodynamic performance metrics. In Phase II, Mainstream will further develop the toroidal fan geometry and integrate the fan into a full-scale ventilation system, ready for drop-in replacement aboard the ISS. The system's full acoustic signature will be determined, as well as additional characterization at sub-ambient conditions, representative of vehicles and habitats of cis-lunar and Mars-transit architecture.

Duration: 6

Proposal Details

Proposal Number: H3.12-1012
Subtopic Title: Quiet and efficient fans for spacecraft cabin ventilation
Proposal Title: Design of an Ultra-low Noise Ventilation Fan for Space Applications

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 3 - 4
Technical Abstract (Limit 2000 characters):

Ventilation fans play a critical role in spacecraft and space habitats, functioning as a key component in environmental control and life support systems. However, these fans have been grappling with operational noise issues, causing significant annoyance to astronauts and interfering with communication equipment. Over the past decade, NASA has actively engaged in noise mitigation efforts, particularly focusing on reducing noise related to rotor-stator interaction using techniques commonly employed in turbofan engines. In this program, Whisper Aero proposes a solution that leverages their novel ultrasonic fan design to create a highly efficient and ultra-quiet fan. The intended benefits include alleviating the production of annoying blade passing frequency tones, reducing structural-borne vibratory noise, cutting down fan weight and associated imbalance noise, and simplifying the mechanical layout for an extended operational lifecycle. Phase I activities will involve sizing and designing the fan based on NASA's requirements, utilizing Whisper's multidisciplinary optimization software toolkit. Additionally, aerodynamic and acoustic performance characterization will be conducted, along with addressing risks related to material selection, manufacturing, and evaluating viable motor options.

Duration: 6

Proposal Details

Proposal Number: H4.09-1008
Subtopic Title: Long-Duration Exploration Portable Life Support System (PLSS) Capabilities
Proposal Title: Gravity Independent Condensing Heat Exchanger

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 3 - 5
Technical Abstract (Limit 2000 characters):

The proposal aims to develop a g-independent, robust, and efficient Capillary Condensing Heat Exchanger (CCHX) that can effectively condense and recover water. The CCHX design offers significant performance benefits over traditional CHX solutions including: 1. Eliminates Dependency on Coatings: The CCHX achieves "perfect wetting" through its unique cusp geometry, eliminating the need for performance-degrading coatings. 2. Improved Heat Transfer: Achieves dropwise condensation on ~80% of the surface, leading to an up to 10x improvement in heat transfer compared to film condensation. This allows for a potentially smaller and lighter CCHX. 3. Complete Water Recovery: Continuous flow drain ports and 3D capillary connectivity provide 100% water collection and eliminates the need for slurping mechanisms. 4. Reduced Carry-Over: Robust pinning edges minimize condensate carry-over, simplifying drain design and improving stability. 5. Efficient Drying: The high liquid surface area to volume ratio created by the cusps allows for faster condensate evaporation, which can be beneficial during storage, safing, or other equipment handling procedures. 6. Ground testable: The horizontal nature of the CCHX allows for accurate ground testing in ‘right-side-up’ or ‘upside-down’ configurations. Overall, the CCHX offers a more reliable, compact, efficient, and easier-to-use solution for water recovery in space compared to traditional CHX designs. Funding will be used to design, prototype, and test the CCHX, with a focus on meeting the specific requirements. The target markets for the technology include government space agencies, private aerospace companies, manufacturers of space

systems and components, and research institutions and universities involved in space science and engineering.

Duration: 6

Proposal Details

Proposal Number: H4.09-1016
Subtopic Title: Long-Duration Exploration Portable Life Support System (PLSS) Capabilities
Proposal Title: Reusable Electrochemically Enabled CO2 Scrubber for Life Support Systems

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 2 - 3
Technical Abstract (Limit 2000 characters):

Faraday Technology and RoCo Global will demonstrate the feasibility of a novel material that can fit into the current NASA's spacesuit or portable life support system (PLSS) and that can be switched from a CO2 absorbing state (Scrubbing Mode) to a CO2 desorbing state (Regeneration Mode). This method will enable the capacity of the CO2 scrubber to be regenerated in theatre, without the typical carry along mass associated with the LiOH or Metal Oxide canister currently used by NASA in PLS system to remove CO2 from the ventilation loop while operating in a partial atmosphere such as that on Mars. Additionally, the scrubber will be capable of rapid regeneration in theatre operation without the use of high temperatures, chemical solvents, or vacuum. The resulting product of the SBIR activity will be the CO2 Absorbing Regenerable Scrubber (CAReS) Cartridge prototype and design for NASA's PLS system. Phase I will mitigate technical risks and establish the viability of the approach to first selectively absorb CO2 at a high capacity, followed by regeneration of the CO2-absorbing material, over multiple cycles, for a range of environmental conditions. Phase II will optimize and finalize the cartridge design, such that operational and environmental testing.

Duration: 6

Proposal Details

Proposal Number: H4.09-1023
Subtopic Title: Long-Duration Exploration Portable Life Support System (PLSS) Capabilities
Proposal Title: Innovative Method for Water and CO2 Sequestration and Reclamation in Long Duration PLSS

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 1 - 4
Technical Abstract (Limit 2000 characters):

NASA is interested in extending the duration of EVA's in order to support operations on the Moon and eventually Mars. Mission time requirements will increase in these demanding environments and new challenges will need to be addressed in order to accommodate them. One critical function of the space suite is to maintain the CO2 and water levels in the ventilation loop at acceptably safe levels. With the increased demands of the Lunar and Martian environments, there is a strong need to recover the water and CO2 removed from the ventilation loop oxygen supply. Previously developed control modules have not been designed to accommodate these requirements and thus, there is a need for an improvement in this technology. Reaction Systems intends to develop a new method to control CO2 and water in the xEMU ventilation loop that is capable of recovering the removed products as well as accommodating longer mission times. Reaction Systems will utilize a hollow fiber module to contact the ventilation loop flow from the crewmember against compounds that will rapidly adsorb CO2 and control water to the required levels. The gas flow will be directed through the lumen side of the module and sorbents contained in the liquid phase will be maintained on the shell side of the module. The liquid volume will be large enough to contain the quantity of CO2 and humidity produced in an extended EVA. At the end of the EVA, the liquid phase will be heated to moderate temperature to drive the CO2 out where it can be recovered along with the extra water collected in the liquid phase. In addition to NASA, the market for this technology will include many of the private companies that are investing large amounts of resources to develop their own exploration capabilities. There is also a growing need to identify cost effective methods to control CO2 emitted into the atmosphere, and identifying new sorbents could contribute to this important objective.

Duration: 6

Proposal Details

Proposal Number: H4.10-1010
Subtopic Title: Materials for Mars Thermal Environment
Proposal Title: Space Suit Materials for Use in Cryogenic Cold

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 2 - 3
Technical Abstract (Limit 2000 characters):

One of the greatest challenges to conducting exploration and long-duration missions on Mars or the lunar surface is the development of space suit materials that can operate in these austere environments such as the Permanently Shaded Regions (PSRs) of the Moon. Operating in extreme cold without fracture is particularly challenging for polymeric materials, especially when experiencing strain from flexing. Several crosscutting materials solutions will be studied in this program to identify materials that meet the required performance metrics for application in boot outsoles, glove

TMG palm pads and knee/elbow pads. Moonprint will leverage materials knowledge from previous flexible cryogenic container programs to develop materials that meet the space suit need. Proposed material solutions are able to support high strain without cracking, survive thermal shock and abrasion, resist puncture, and are readily adaptable to space suit component configurations and manufacturing technologies at commercial space suit manufacturing companies. Materials will be tested at the coupon level and component level to generate materials property data and performance data of articles tested in representative environments. Component design and manufacturing modifications will also be studied to reduce mass, improve penetration resistance, and improve space suit mobility. Materials solutions will be applicable to Mars space suits, lunar space suits, and other flexible structure technology intended for use in extreme cold.

Duration: 6

Proposal Details

Proposal Number: H4.10-1012
Subtopic Title: Materials for Mars Thermal Environment
Proposal Title: Ambient Pressure-Dried Ormosil Hybrid Aerogel Composite Blankets for Advanced Space Suit Insulation

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 2 - 4
Technical Abstract (Limit 2000 characters):

NASA is seeking innovative thermal insulation solutions for extravehicular activity (EVA) suits on the Martian surface. In this program, Optowares Inc. proposes to develop “Ambient Pressure (AP)-Dried Ormosil Hybrid Aerogel Composite Blankets for Advanced Space Suit Insulation”. The key innovation in our approach is to combine already-demonstrated unique aerogel material systems, functional (nano)additives, and aerogel processing methods to simultaneously improve mechanical properties, adhesion of aerogel matrix to fibers, and rubbery effects. Due to their synergistic effects, our proposed AP-dried Ormosil hybrid aerogel composite approaches will overcome not only the weak and brittle dust-generating nature of conventional silica aerogel composite materials, but also the stiffness, flammability, and high thermal conductivity of conventional organic aerogel composite materials. This is achieved while providing low density and superior thermal insulation associated with the nanopore structure of aerogel materials. As a result, our proposed AP-dried aerogel composites will demonstrate good flexibility and drape, less/no dust generation from different deformation fields, and good cycling performances, along with good thermal insulation. Additionally, our proposed aerogel composites can be economically produced without using the expensive CO2-supercritical drying equipment or the similarly expensive freeze-drying (FD) equipment, and the excessive hydrophobicity agents. Overall, our proposed aerogel composites will provide superior thermal insulation and inherent radiation protection suitable for NASA advanced EVA suits, space hardware, and vehicles as well as many other aerospace, military, and commercial insulation applications. Therefore, the overall aims of this program are i) to demonstrate the feasibility of our proposed aerogel composite approach to fully satisfy NASA’s requirements, and ii) to provide economic viability of the scaled-up commercial manufacturing.

Duration: 6

Proposal Details

Proposal Number: H4.10-1015
Subtopic Title: Materials for Mars Thermal Environment

Proposal Title: Ceramic Composite Nanofiber Aerogel Insulation for EVA Suits

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 2 - 3
Technical Abstract (Limit 2000 characters):

NASA's EVA suits are typically made of multiple layers: an inner bladder made of polyurethane-coated nylon for suit pressure, protected by a Dacron™ restraint liner. The outer layers serve as the thermal micrometeoroid garment (TMG), with a neoprene-coated nylon liner providing thermal and micrometeoroid protection. The insulation comprises five layers of aluminized Mylar reinforced with nylon scrim spacers. While effective in vacuum and microgravity, this insulation may not suffice for Mars due to interstitial gases and extreme temperatures that can compromise its properties. Thus, alternative insulation materials must be developed. In this proposed Phase I research, MMI will develop ceramic aerogel-based insulating materials for use as thermal insulation inserts in Extra-Vehicular Activity (EVA) suits for Martian exploration. The extremes of temperatures, the presence of CO2 and the 8 Torr pressure of the Martian atmosphere necessitate the development of robust insulation materials that go beyond the currently used Mylar-based fabrics. We propose the development of a ceramic composite nanofiber aerogel that is strong, chemically stable, thermally conducting, and radiation absorbing, all of which will make it suitable

for use as insulation inserts in spacesuits. Phase I will involve establishing proof of principle, and design of scaled-up systems based on optimized process parameters.

Duration: 6

Proposal Details

Proposal Number: H5.01-1005
Subtopic Title: Lunar Surface 50 kW-Class Solar Array Structures
Proposal Title: Redeployable Solar Array Structure for Lunar Base Infrastructure

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 2 - 3

Technical Abstract (Limit 2000 characters):

Atomic-6 proposes to develop a novel redeployable structure and deployment mechanism to enable relocatable 50-kW-class lightweight solar arrays near the lunar south pole for powering second-generation lunar base infrastructure. Atomic-6 has developed a proprietary composite manufacturing process that results in higher fiber to resin ratios and interlaminar shear strength than most pre-preg composites. The product of the Atomic-6 process is a composite part with higher specific strength and stiffness than most other composite manufacturing technologies. Atomic-6 applies our unique process to three space products that together comprise a unique and innovative solar array architecture proposed as a solution to NASA's H5.01 solicitation: Space Mast™, Space Hinge™, and Solar Backsheet™. During Phase I, Atomic-6 plans to perform design and analysis to scale our solar array structure architecture to meet NASA's objectives defined in H5.01. The structure includes a twin mast, deployed from the yoke at the root of the array. Directionally stiffened solar blankets are connected to each other and the array frame by a shape memory, directionally stiffened hinge that runs along the full width of the blanket. The blanket is floated on top of the structure which self-tensions during deployment. Our architecture leverages the strengths of Z-fold panel solar blankets with reliable and redeployable roll out masts. This approach provides the benefits of both approaches and none of the weaknesses. Moreover, our key technologies have been produced at subscale and a pathway is defined to scale to the sizes NASA needs. Atomic-6 plans to implement a redeployer that rolls and unrolls Space Mast™ to deploy, retract, and redeploy the array structure. The architecture is a twin mast system that utilizes to coordinated redeployers to unwind and rewind the twin Space Mast™. Atomic-6 plans to mount the array on a base similar in design to the proven of the SpaceX Starlink user terminal.

Duration: 6

Proposal Details

Proposal Number: H5.01-1007
Subtopic Title: Lunar Surface 50 kW-Class Solar Array Structures
Proposal Title: 50kW Pneumatic Relocatable Solar Array (PRSA)

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 2 - 3
Technical Abstract (Limit 2000 characters):

NASA developed a state-of-the-art scalable conceptual design of a high-performance 60kW/m3 deployable solar array with very low mass, compact stowage, and reliable deployment, called the Compact Telescoping Array (CTA). The CTA consists of a slender telescoping mast that deploys vertically and supports a large area flexible photovoltaic array. A retractable and relocatable (5-10x) CTA configuration was developed by NASA for use at the lunar south pole to harvest the sun's energy and generate power to support activities in Permanently Shaded regions (PSRs). The packed array will deploy from a PSR and will therefore experience cryogenic cold (-213C) and constant exposure to natural and anthropogenic sources of lunar dust over its >10-year life. This program will build upon NASA concepts to establish a 50kW class Pneumatic Relocatable Solar Array (PRSA) system design that leverages simple mechanical systems to create an extremely robust lightweight system. Pneumatic deployment of telescoping masts is commonplace in terrestrial military and commercial applications used in austere environments. High modulus carbon-epoxy tubes will be designed and fitted with a bladder to facilitate simple deployment and retraction requiring very little power or complex mechanical systems to operate. The mast sections will be depressurized between relocation events and is not reliant on pressure maintenance for structural rigidity. Mast sections will latch and unlatch from pressurization to create a simple robust structure that can be automatically packed and deployed numerous times. All elements will be dust tolerant, but a layered dust protection methodology will be employed to assure life targets are met. A system design will be established, supported by analysis, and a demonstration mast will be fabricated and tested to establish feasibility.

Duration: 5

Proposal Details

Proposal Number: H5.01-1018
Subtopic Title: Lunar Surface 50 kW-Class Solar Array Structures
Proposal Title: Extra Large Vertical Solar Array Technology (VSAT-XL)

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 2 - 4
Technical Abstract (Limit 2000 characters):

As the pace and scale of lunar exploration grows over the next decade, generating, storing, and transmitting power to lunar surface assets will be a critical infrastructure need for a future permanent lunar settlement. There is no existing lunar surface power generation and transmission solution that can satisfy the next generation of power needs at the 50 kW scale and above. Therefore, Astrobotic proposes the VSAT-XL as a SWAP-efficient power solution to address this demand. Astrobotic defines its VSAT product line as a deployable, relocatable, self-leveling, sun-tracking solar powered

system. We are developing both static and mobile variants of the VSAT. Therefore, the VSAT-XL will be designed to be integrated with landers and rovers and will be grounded in Astrobotic and Redwire's mature power systems. This system incorporates engineering solutions developed from Astrobotic's lunar landers, Astrobotic's rovers, Redwire's Mega Roll Out Solar Arrays (ROSA), and most importantly, Astrobotic's state-of-the-art 10 kW VSAT system. We envision VSAT-XL to be a continuation of the 10 kW lunar VSAT Astrobotic is currently developing. The VSAT-XL increases the scale from 10 kW to 50 kW power output by physically linking multiple ROSAs to each other into a "Mega-ROSA" mounted on a leveling and pointing gimbal mechanism. The resulting system could be used to power surface-based systems like pressurized rovers, habitats, and future in-situ resource utilization (ISRU) pilot plants. The VSAT-XL is inherently scalable to power outputs well above 50 kW by linking multiple VSAT-XLs together. The VSAT-XL can be either stationary (e.g. lander-integrated) or integrated to a mobile base. The mobile base is capable of traveling autonomously to new lunar sites, thus mitigating dependency on an external rover for its placement.

Duration: 6

Proposal Details

Proposal Number: H5.05-1004
Subtopic Title: Inflatable Softgoods for Next Generation Habitation Systems
Proposal Title: E-textile Sensor Development and Integration for a Softgoods Structural Health Monitoring System

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 2 - 4
Technical Abstract (Limit 2000 characters):

A current issue in progressing the state of the art of space-based inflatable habitats is a lack of robust methods and technologies for monitoring the mechanical integrity of these softgoods structures. Unlike currently used metal-alloy space habitats, the softgoods structures present challenges in health monitoring through the complexity of their mechanical behavior under extended loading durations and difficulties of integrating legacy structural health sensors to softgoods materials. In this proposed effort a suite of novel E-textile strain sensors will be developed as a proof-of-concept structural health monitoring system for inflatable structures. Two distinct E-textile sensor types will be explored that allow for strain measurements within the expected strain regimes of structure deployment and lifecycle creep strain. Integration methods for the sensors will be identified that allow for accurate strain sensing and minimize impacts to structural material properties and fabrication processes. Sensor and integration validation will be conducted through uniaxial tensile testing of sensors integrated to a single piece of high strength Kevlar webbing. Particular attention will be paid to identification and integration methods of required auxiliary electronics/wiring assemblies for power and data pass through from sensors to crew. Further analysis of global structure sensor placement will be pursued to identify optimum SHM system architecture. Finally, a preliminary SHM diagnostic software tool will be developed to serve as an example interface between crew and SHM data.

Duration: 6

Proposal Details

Proposal Number: H5.05-1005
Subtopic Title: Inflatable Softgoods for Next Generation Habitation Systems
Proposal Title: An Adjacent Inductive Coil Sensor (AICS) System for Structural Health Monitoring of the Restraint Layer

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 2 - 5
Technical Abstract (Limit 2000 characters):

For long-duration missions, one of the primary concerns is the potential for structural material failure of the inflatable softgoods restraint layer due to creep. Creep is a phenomenon where deformation occurs under sustained loading. Structural health monitoring (SHM) of the restraint layer in inflatable systems is essential to ensure the safety of crew members and the continued operation of NASA missions. To address this issue, there is a need to develop a new SHM approach to accurately and actively measure creep of the restraint layer. The current methods include adhesive foil strain gages, fiber optics, accelerometers, and acoustic sensors which all have their potential drawbacks and require extensive wiring which must survive deployment. To address this critical need, X-wave Innovations, Inc. (X-wave) proposes to develop an Adjacent Inductive Coil Sensor (AICS) system to monitor the creep of the restraint layer in multilayer systems. The proposed AICS system improves upon the current state of the art sensors by not requiring any electrical cabling or wiring to the restraint layer. The proposed sensor system is also advantageous over other types of SHM sensors such as fiber optics or other flexible materials in that the proposed sensor does not need to withstand significant elongation during deployment or while in operation. The AICS system will be an integrated sensing system that utilizes multiplexing to monitoring the restraint layer as a whole. The AICS system will use non-contact interrogation of the

restraint layer from the interior of the inflatable softgoods structure, therefore interference from the thin metallic depositions of the outer layer will have no effect on the performance of the sensor system. The AICS system will include a prognostication algorithm that will predict the creep behavior of the restraint layer and notify the crew members of any anticipated failures.

Duration: 6

Proposal Details

Proposal Number: H5.05-1007
Subtopic Title: Inflatable Softgoods for Next Generation Habitation Systems
Proposal Title: Weaved distributed fiber optic sensor (WevFOS™) inflatable habitab structural health monitoring system

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 2 - 4
Technical Abstract (Limit 2000 characters):

Redondo Optics Inc. (ROI), proposes to design, build, laboratory and field test, and deliver to NASA an innovative, autonomous, lightweight, low power, wireless communication woven distributed fiber optic sensor (WevFOS™) structural health monitoring and diagnosis system suitable for the in-situ, real-time, global assessment of the passive and dynamic loads/stress/strains, temperature, pressure, and acoustics state within large and entire cross-sections of the inflatable soft-goods materials and restrain layer structures used in the construction of NASA's future space habitat systems for space exploration missions. In the Phase I program, ROI will implement a manufacturing methodology for weaving fiber optic strain sensors within Vectran or Kevlar textile fabrics, braids, and strands used in the construction assembly of the inflatable habitat bladder structural restrain layer. Using the produced "Smart" restrain layer textile fabrics, ROI plans to produce a simulated down-scale laboratory test prototype of an inflatable structure incorporating a distributed array of 8- to 12-sensor fibers, each integrating a multiplex array 12- to 16 strain sensors suitable for the multi-point distributed of the global load/stress/strain, temperature, and pressure state of the bladder restrain layer inflatable simulator under a variety of loads (≥ 20,000-lbs/in in width) and harsh environmental conditions expected in NASA's inflatable habitat structures. In Phase II, ROI will complete the engineering development, produce, extensively laboratory test, environmentally qualify, and demonstrate the assembly production of a down-scale inflatable habitat platform integrated with a WevFOS™ SHM system for the real time global measurement of the strain dynamics of the bladder restrain layer under standard space environment operational conditions. In Phase III with the support of a strategic partner, ROI will transition the WevFOS™ technology to NASA's inflatable habitat programs, and commerc

Duration: 6

Proposal Details

Proposal Number: H5.05-1009
Subtopic Title: Inflatable Softgoods for Next Generation Habitation Systems
Proposal Title: MultiSense: a Multiplex Structural Health Monitoring System for Softgood Architectures' Restraint Layer to Monitor Creep & Strain

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 2 - 4
Technical Abstract (Limit 2000 characters):

Inflatable habitat structures are pivotal for future space exploration, offering increased livable space with reduced launch mass and costs. However, ensuring their long-term structural reliability, particularly against creep deformation and micrometeoroid impacts, is essential for the safety of space missions. Max Space addresses this challenge with MultiSense, an innovative structural health monitoring (SHM) system tailored for inflatable habitats. This system features embedded multiplex sensors, including Fiber Bragg Grating (FBG), piezoelectric materials, and Capacitive Strain Gauges (CSG), to provide real-time, accurate strain measurements and detect structural issues as they arise. Partnering with Thin Red Line Aerospace (TRLA), Max Space utilizes a unique braiding technique to incorporate these sensors into the habitat's cordage tendons, without integrating them during the braiding process. MultiSense is designed to endure initial deployment strains of 2 to 5% and sensitively detect creep strains from 0 to 0.5% in operational conditions. The research also considers cutting-edge materials like Carbon Nanotubes (CNTs), graphene, and spray-on superhydrophobic sensors, which could further advance SHM technology pending additional development. While MultiSense is specifically tailored for Max Space's premier space expandable modules which utilize uni-directional softgood architecture, it is also poised to enhance the safety and reliability of other entities' inflatable space systems that can adapt to their softgood design, such as basket-woven inflatables which ensures wide applicability in the market. The successful integration of MultiSense will enhance the monitoring and maintenance of inflatable habitats' structural integrity, aligning with NASA's objectives for secure and sustainable human spaceflight. This proposal promises to elevate confidence in inflatable habitats, facilitating their broader adoption for NASA's space exploration missions.

Duration: 6

Proposal Details

Proposal Number: H6.22-1008
Subtopic Title: Deep Neural Net and Neuromorphic Processors for In-Space Autonomy and Cognition
Proposal Title: Radiation Hardened Power Efficient Artificial Intelligence and Machine Learning (AIML) Processor

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 2 - 4
Technical Abstract (Limit 2000 characters):

Radiation Hardened Artificial Intelligence and Machine Learning (AIML) processors are essential to NASA applications due to unavoidable evolution in technology that brings computational complexity. Traditional radiation hardening methods incur high size, weight, and power (SWaP) cost. We propose a radiation hardening scheme that employs intelligent analysis of vulnerabilities in the AIML processor that enables hybrid selective redundancy implementation to allow self-healing from radiation effects. The proposed radiation analysis method will use statistical and probabilistic models that can capture the stochasticity of AI, ML and Neural net inference. In Phase I, we will design the radiation hardened AIML processor using a defined testbed and simulation process. We will calculate the performance characteristics, including error mitigation and SWaP cost, and derive guidelines for improved design. In Phase II, we will optimize the design to meet NASA requirements, build a prototype, and experimentally verify the performance of radiation hardened AIML processor.

Duration: 6

Proposal Details

Proposal Number: H6.22-1015
Subtopic Title: Deep Neural Net and Neuromorphic Processors for In-Space Autonomy and Cognition
Proposal Title: ASICS – Adaptable, Scalable, Intelligent Computing for Space

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 1 - 3
Technical Abstract (Limit 2000 characters):

As we embark on increasingly ambitious missions in Earth orbit, to the Moon, and beyond, the need for advanced artificial intelligence and machine learning (AI/ML) capabilities becomes ever more apparent. While AI/ML technologies are often deployed on Earth using either massive cloud computing resources or specialized commercial-grade chipsets, applications for space are far more constrained. Astrobotic proposes the development of a new rugged, radiation-tolerant computing solution using a processor tailored specifically for Size, Weight, and Power (SWaP) constrained AI/ML applications: the AMD Versal Adaptive System on Chip (ASoC) Edge Series. The Versal Edge Series is a new space-grade processor with dedicated on-chip AI Engine resources that are optimized for power efficient, high bandwidth AI/ML computations. SWaP are crucial parameters for maximizing the efficiency, reliability, and performance of any spacecraft, and to date these constraints have been especially limiting in AI/ML applications requiring high computational resources. Our Phase 1 work titled Adaptable, Scalable, Intelligent Computing for Space (ASICS) will address these limitations and provide a path for artificial intelligence beyond Earth's atmosphere via: 1. Analyzing and maturing a Versal Edge Single Board Computer (SBC) design to support board manufacturing in Phase II. A test plan will also be developed for Phase II mission specific environmental and reliability testing. 2. Developing a robust AI/ML application roadmap for the Versal Edge space computer. In support of this application roadmap, a software workflow will be developed to show how new AI/ML models will be deployed to the Versal Edge space computer. 3. Deploying an existing AI/ML model for lunar landing hazard detection to the Versal Edge VEK280 development board. 4. Measuring performance and power during hardware-in-the-loop (HiTL) testing to assess the real-world benefits of the unique Versal Edge ASoC architecture.

Duration: 6

Proposal Details

Proposal Number: H6.22-1020

Subtopic Title: Deep Neural Net and Neuromorphic Processors for In-Space Autonomy and Cognition
Proposal Title: Spiking Neuromorphic Hardware Accelerator with ReRAM

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 1 - 3
Technical Abstract (Limit 2000 characters):

The proposed innovation targets the scope of Radiation-Tolerant AIML Learning Hardware as outlined in subtopic H6.22 of the 2024 SBIR solicitation. A RRAM-based radiation-tolerant spiking neuromorphic computing architecture within an unsupervised spiking neural network model will be developed in Phase I. This architecture leverages RRAM's unique properties to enhance the efficiency and robustness of AI systems in space environments. By leveraging RRAM's radiation tolerance, our proposed architecture provides a solution to ensure uninterrupted operation of AI systems in space missions, addressing a critical challenge where traditional approaches fall short. Evaluation will involve fault injection testing and TID radiation margining, utilizing SPICE simulation to demonstrate the proof of concept of a radiation-tolerant design approach. Hardware development will include schematic representation and physical layout in Cadence database, utilizing GlobalFoundries 22FDX technology process with RRAM IP provided by the University at Albany, SUNY. The design will incorporate

critical circuitry such as input drivers, leaky integrate and fire circuits, and detection circuitry for firing signals. Additionally, circuits for LTD and LTP programming, as well as a pad ring with design for test circuitry, will be implemented for testing purposes. Radiation tolerance of the circuitry will be addressed using techniques like triple redundant latches, extended corner simulations, and back gate biasing. The outcome of Phase I will be a proof of concept utility demonstrating the benefits and efficiency gains of the proposed design, directly applicable for Phase II research and beyond, facilitating the identification of efficiencies in larger designs.

Duration: 6

Proposal Details

Proposal Number: H8.01-1002
Subtopic Title: In Space Production Applications (InSPA) Flight Development and Demonstrations on ISS
Proposal Title: nVasive: Unraveling the Enigma of Metastasis

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 3 - 4
Technical Abstract (Limit 2000 characters):

Metastasis is a complex non-linear cascade of events regulated by various cellular mechanisms through overlapping mechanisms. The complexity of this process has resulted in our limited understanding of this phenomenon, underscoring the importance to investigate and comprehend processes governing tumor invasion. To this end, we propose the development of a next-generation TOC system, called nVasive, that will enable us to model metastasis and tumor invasion. The new biochip will grow microtumors for several weeks and allow the cancer cells to detach and migrate from the initial primary microtumor location and invade into a secondary chamber. With nVasive, each microtumor will have a predefined location within the biochip, allowing us to precisely track cellular invasion and monitor variations among samples. This enables automated imaging, data collection, and interpretation, that is particularly beneficial for high-throughput datasets. The nVasive biochip will be utilized in extended assessments over several weeks, as invasion and metastatic behavior analysis occur over longer time periods. The goal of the current proposal is to further develop nVasive, and to demonstrate technical feasibility, pinpoint critical technical hurdles, establish key performance indicators that predict metastasis, assess commercial viability, and outline a plan for commercialization. nVasive will enable investigations into the metastatic behavior, cell motility, and tumor invasion of metastatic and non-metastatic patient-derived tumor samples at a cellular level. In phase I, we will perform preliminary terrestrial experiments to validate the functionality of the automated metastasis-on-a-chip system and integrate it into our on-orbit implementation partner automation systems, PAUL and CubeLab, creating a functional prototype ready for launch. Ultimately, in phase II, we will develop and produce the first clinical diagnostic tool for patient specific metastasis prediction.

Duration: 6

Proposal Details

Proposal Number: H8.01-1014
Subtopic Title: In Space Production Applications (InSPA) Flight Development and Demonstrations on ISS
Proposal Title: In-space production of dacarbazine loaded nanofibers for cancer treatment

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 2 - 4
Technical Abstract (Limit 2000 characters):

TruSpin is developing a platform process to manufacture custom nanofibers using alternating current electrospinning (ACES) for scalable and cost-efficient drug delivery applications. Design of this platform for in-space manufacture would enhance the controllability and speed of the process, supporting the discovery and development of nanofiber-based drug delivery systems. Nanofiber-based drug delivery has the potential to improve patient outcomes by providing enhanced bioavailability and targeted and controlled drug release while minimizing toxicity and dosage frequency, exactitude that is currently lacking from conventional enteral and parenteral routes of drug delivery. Despite these benefits, advancement beyond the proof-of-concept stage has been challenged by their biopharmaceutical performance and ensuring that nanofiber production generates the necessary morphological, mechanical, and chemical properties. When working in gravity environments on Earth, changes in any of these parameters can modulate the diameter of the nanofiber while also carrying the potential for jet breaking and the formation of beads. Recognizing these limitations, TruSpin proposes to leverage the low-gravity environment on the International Space Station (ISS) to speed up the development and discovery of optimal parameters for nanofiber fabrication and drug loading. The controlled environment has the potential to significantly advance drug-loading rates while also increasing the manufacturing

output rate. Toward this goal, this proposal seeks to design the nanofiber production platform for efficient implementation on the ISS. Our process would advance capabilities in drug delivery, and R&D on the ISS holds promise in providing the ideal environment for manufacturing a clinically relevant nanofiber-based drug delivery system. As such, our technology will serve medical applications with the target market being pharmaceutical and drug development companies.

Duration: 6

Proposal Details

Proposal Number: H8.01-1017
Subtopic Title: In Space Production Applications (InSPA) Flight Development and Demonstrations on ISS
Proposal Title: Physical vapor deposition reactor design and validation for in-space manufacturing of aluminum nitride single crystals

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 3 - 5
Technical Abstract (Limit 2000 characters):

Aluminum nitride (AlN) has been identified as the wide bandgap semiconductor with superior material properties, that could enable revolutionary improvements in power electronics and optoelectronics devices beyond silicon carbide (SiC) and gallium nitride (GaN) device performance limits. AlN has made great advancements in the last 20 years towards becoming commercially viable, however there are significant challenges with the substrate material. AlN with dislocation densities below 10,000 per cm2 and between 1-2 inches in diameter can currently be produced terrestrially. For the commercial requirement of large area high power electronic devices, there are three technological gaps that needs to be solved: (i) a 10 - 100 x reduction in dislocations, (ii) increasing the diameter of wafers by a factor of 3, (iii) reduction in point defects by two to three orders of magnitude to mid-1015 per cm3. All three of these issues could be mitigated by growing crystals in the microgravity environment. Leveraging the space environment will (a) promote uniform mass flux at the crystal growth front, (b) control thermal gradients while scaling size of crystal, and (c) will allow for growth closer to the ideal growth rate for AlN. AlN is grown using physical vapor deposition (PVD) at temperature around 2100 oC. Currently there is no infrastructure for crystal growth of high temperature materials such as AlN in space. This is primarily limited by the electrical power level in the range of 500-1000 watts available for operating crystal growth furnaces at the International Space Station (ISS). In this proposal, a novel energy efficient PVD reactor will be designed for AlN bulk crystal growth at 2100 oC operating at power levels level in the 400-1000 watts for crystal diameters in the range of 1 - 6 inches. The fabricated PVD reactor will be designed per the space design constraints and tested for AlN bulk growth in terrestrial conditions.

Duration: 6

Proposal Details

Proposal Number: H9.03-1007
Subtopic Title: Flight Dynamics and Navigation Technologies
Proposal Title: Advanced Techniques for Trajectory Design and Optimization

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 1 - 3
Technical Abstract (Limit 2000 characters):

Traditional multi-body mission design and trajectory optimization processes are notorious for their laborious and time-intensive nature, requiring weeks or even months to generate a single reference trajectory for these multifaceted missions. This underscores the critical necessity for novel techniques and tools capable of expediting and enhancing the trajectory design and optimization process. Not only is the design space infinite, system uncertainties in this complex and sensitive dynamical environment are not yet well understood. For this phase I effort, Navigation Uncertainty ANalysis in the Cislunar Environment (NUANCE) aims to partner with Purdue University to analyze spacecraft system uncertainties in a multi-body dynamical environment through the evaluation of two relevant test cases. This effort proposes to introduce Gaussian uncertainty by employing sigma sampling techniques to the initial conditions of deterministically-optimized transfer scenarios. By propagating the trajectories from these sampled points using the originally optimized maneuver values (ΔV, transfer time), this study aims to observe the position uncertainty over time during orbit transfers in cislunar space. Taking another approach of analyzing the sigma-like points, maneuver errors will be assessed by re-optimizing the transfers from these sampled points and observing the spread in ΔV and transfer time. Test case options include transfers along unstable manifolds transferring to and from periodic or quasi-periodic orbits and utilizing “free” ΔV transfers between orbits around L1 and L3 via “Cycler” orbits, which offer a unique case to compare propagated sigma-point trajectories. Target markets include NASA missions beyond the Earth, small commercial spacecraft companies and universities that would benefit from lower propellant requirements and increased navigation/maneuver knowledge, and the military organizations interested in cislunar space operations.

Duration: 6

Proposal Details

Proposal Number: H9.03-1009
Subtopic Title: Flight Dynamics and Navigation Technologies
Proposal Title: Architecture for Space Trusted Responsive Autonomy (ASTRA)

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 2 - 3
Technical Abstract (Limit 2000 characters):

Successfully executing complex missions in space such as Rendezvous, Proximity Operations, and Docking (RPOD), or In-space Servicing, Manufacturing and Assembly (ISAM), will require spacecraft that can interpret and react to their environment intelligently and in real time. To meet this technical challenge, Rogue Space Systems is proposing to develop an Architecture for Space Trusted Responsive Autonomy (ASTRA) based on well-established engineering principles of modularity, hierarchical decision making, and optimal control theory. ASTRA will integrate state-of-the-art guidance, navigation and control (GNC) algorithms with spacecraft survival, maintenance and homeostasis (SSMH) behaviors and space domain awareness (SDA) behaviors to create a flexible and responsive autonomy system. The primary goal of ASTRA is to create a framework with which spacecraft can autonomously select optimal sequences of actions to achieve mission objectives over the lifetime of the spacecraft. The core modular element of ASTRA is the behavior module. Behavior modules will have an objective expressed as a cost function and will use model predictive control to select optimal sequences of actions for the spacecraft to achieve that goal. Where practicable, behavior modules will execute well-established GNC algorithms to leverage and expand on the current SOTA in spacecraft control. Action sequences will be created and passed between behavior modules as behavior trees. Behavior modules will be arranged hierarchically by function, such that low level behaviors are responsible for basic survival and maintenance activities. High-level behaviors will integrate plans from the low-level behaviors to compose a unified action plan to be executed by the spacecraft. Behavior modules will be general purpose, reusable, and composable such that ASTRA can serve as an autonomy framework to support a wide range of spacecraft types and mission profiles.

Duration: 6

Proposal Details

Proposal Number: H9.03-1021
Subtopic Title: Flight Dynamics and Navigation Technologies
Proposal Title: Missfit: Statistical Multi-Event Missed-Thrust Optimization for Low-Thrust Trajectories

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 2 - 5
Technical Abstract (Limit 2000 characters):

We propose to develop an optimization tool called Missfit, which will make a low-thrust trajectory more resilient to missed thrust events. Missfit will analyze the effect of multiple missed thrust events occurring during a mission, and will use a statistical model to improve the overall likelihood of mission success and reduce mission risk. The software will be developed in a way to take advantage parallelism and leverage large-scale cloud computing, allowing the user to scale the problem appropriately for the intended mission and available resources. We will use these SBIR funds to develop this software, test and validate it, and thoroughly document it. This product is intended for any entity involved in the design of low-thrust trajectories, including the commercial and government sectors.

Duration: 6

Proposal Details

Proposal Number: H9.08-1005
Subtopic Title: Lunar 3GPP Technologies
Proposal Title: Advancing Lunar Communication Infrastructure Using Flexible Software Defined Radio

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 2 - 3
Technical Abstract (Limit 2000 characters):

To contribute to the development of lunar applications of 3GPP networks, Astranis will integrate commercial 3GPP 5G microcell firmware/software in small satellites (smallsats) equipped with software defined radios (SDRs) to create 5G networks for lunar communications. The networks can also be used to collect RF channel data to improve lunar radio frequency (RF) channel modeling. The combination provides a low-cost approach to create a communications network with full lunar coverage which can evolve the latest in 3GPP standards. The study will analyze the feasibility of implementing 5G-gNB microcell technologies within the Astranis SDR hardware and evaluate the potential performance and risks of using microcells as part of a broader adaptive lunar communications architecture. The study will evaluate a range of architectures and orbits to provide guidance on how to implement 5G protocols in a lunar orbital environment with differing ranges and channel effects than terrestrial networks such as doppler or scintillation. The funding for the SBIR will cover labor costs to conduct the feasibility study and operation of the tools to run the analysis.

Duration: 6

Proposal Details

Proposal Number: H9.08-1006
Subtopic Title: Lunar 3GPP Technologies
Proposal Title: Future Lunar surface comms using Cognitive 3gpp Radio Access Networks for Ubiquitous Mission success (FULCRUM)

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 5 - 7
Technical Abstract (Limit 2000 characters):

AiRANACULUS, a Boston-based startup and developer of NASA sponsored CLAIRE and INSPiRE technologies, along with, RadiSys, Reed Engineering (Prof. Jeff Reed, Virginia Tech, IEEE Fellow and Dr. Nishith Tripathi, NTN expert) and Prof. Ricardo Lent (DTN Expert, U. of Houston) propose Future Lunar comms architecture using Cognitive 3gpp Radio Access Networks for Ubiquitous Mission success (FULCRUM), that provides cognitive delay tolerant Networking leveraging disparate technologies

such as 4G / 5G / 5G-NTN, Wi-Fi, Bluetooth, LoRa as well as Legacy NASA Radios. This enables resilient communications and reduces the probability of outage. FULCRUM will reduce the mission and network operations burden, increase mission science data return, improve resource efficiencies for NASA missions and communication networks, reduce power consumption, and ensure resilience in the unpredictable space environment. FULCRUM will be enhanced by the NASA sponsored CLAIRE and INSPiRE technologies, which are protocol agnostic and may be applied to 4G / 5G / Wi-Fi and legacy NASA Radios. FULCRUM architecture, incorporating CLAIRE and INSPiRE as xAPPs / rAPPs, create the next generation Software Defined Network (SDN) for Lunar and Earth Data Networks (LDN / EDN) over heterogeneous wireless communications technologies. FULCRUM uses published Release 17 5G specifications and the ongoing 3GPP Release 18 work to specify network architectures to facilitate connectivity between surface and orbital assets for trunk links, continuous coverage of the lunar south pole and far side, as well as potential direct-to-handheld orbital 5G links. Specifically, the project uses 3GPP features such as the Non-Terrestrial Network (NTN), Integrated Access and Backhaul (IAB), 5G NR sidelink communications, network slicing, local breakout (LBO), and simultaneous 3GPP access and non-3GPP access.

Duration: 6

Proposal Details

Proposal Number: H9.08-1007
Subtopic Title: Lunar 3GPP Technologies
Proposal Title: SPATIAM DTN Network Function for 3GPP Lunar System

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 2 - 4
Technical Abstract (Limit 2000 characters):

The drive from the US government administration and NASA to have an active and permanent presence on the lunar surface will dramatically multiply the need for communications and space networking. PWC forecasts that the Lunar Data, telemetry, entertainment, and environmental markets will grow to $12B by 2040. NASA SBIR Topic H9.08 Lunar 3GPP Technologies identifies that “NASA is seeking to leverage this (3GPP) extensive development” and “encourage development that is needed to translate terrestrial 3GPP technologies into a format suitable for the lunar environment”. Our innovation, the SPATIAM DTN Network Function for 3GPP Lunar System, is an operational Network Function in cislunar space that integrates with 3GPP Systems for delivering network and user services using DTN technologies. The SPATIAM DTN Network Function for 3GPP Lunar System introduces pivotal enhancements, including: - Design, and delivery of a LunaNet-compatible DTN Network Function to enable Interoperability between lunar surface and orbiting relay architectures, including delay tolerant networking. - Definition of a DTN network architecture that supports lunar user services, network interfaces, and functionality requirements to provide continuity to the 3GPP Lunar System. - Creation of an initial software prototype for the SPATIAM DTN Network Function. We aim to advance the SPATIAM DTN Network Function to TRL 4 during Phase I, through the following objectives: - Formal architectural definition of the SPATIAM DTN Network Function. - Definition of the SPATIAM DTN Network Function modes of operation. - Initial software prototype of a DTN Network Function. The objectives will be delivered through a Concept of operations for the SPATIAM DTN Network Function, a prototype demonstration, and a Phase II plan. The SPATIAM DTN Network Function for 3GPP Lunar System will bring us closer to commercialization of lunar communications and networking services.

Duration: 6

Proposal Details

Proposal Number: H10.02-1011
Subtopic Title: Autonomous Operations Technologies for Launch Systems and Surface Infrastructure
Proposal Title: Lunar Autonomy Enabled by Simultaneous Localization and Mapping for Space

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 3 - 5
Technical Abstract (Limit 2000 characters):

NASA seeks Autonomy Enabling Technologies (AETs) in software, mechanical, or combined forms to enhance autonomy, flexibility, and reliability in various space exploration tasks, including vehicle processing, launch operations, and surface maintenance. AETs employ intelligent algorithms and robotic tools crucial for uncrewed systems in extraterrestrial environments. PickNik proposes developing and testing new and existing Visual Simultaneous Localization and Mapping (V-SLAM) algorithms, as well as high-fidelity 3D simulation environments for surface and launch systems operations, to enable the testing and training of robotic surface operations, including excavation and construction tasks. We will upgrade, merge, and link heritage state of the art simulation environments (Gazebo VIPERSim and LunExt) with Space

ROS scenarios to allow for interoperable simulation and operation of a variety of different AET tasks, such as automatic traversals from one location to another. This phase 1 focuses on the development of computer vision-based navigation and mapping techniques via simultaneous localization and mapping (SLAM) algorithms. Phase 1 will test and extend ORB-SLAM3, an innovative form of V-SLAM as a key AET for further Lunar development efforts. The rover's motion model and odometry as well as orientation information from a star tracker system will be added to increase its accuracy and robustness. Additionally, topological features will be labeled via machine learning generated semantic labelings(i.e. rocks, craters, etc) to aid with relocalization and improve map quality. These developments will benefit NASA by improving a variety of autonomous systems including but not limited to mobile based robotic arms, roving systems, and fixed robotic arm systems. Phase 1 will be tested in a software simulation environment, while a future Phase 2 will enhance and mature these capabilities, and include a hardware-based ground demonstration in a mock Lunar environment.

Duration: 6

Proposal Details

Proposal Number: H10.02-1012
Subtopic Title: Autonomous Operations Technologies for Launch Systems and Surface Infrastructure
Proposal Title: Multiple Rover Efficient Automated Mapping

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 2 - 5
Technical Abstract (Limit 2000 characters):

Stottler Henke's Multiple-Rover Efficient Automated Mapper (M-REAM) will provide the highest resolution and most frequently updated maps of the Lunar South Pole surface changes as a result of autonomous operations with minimal to zero impact on the primary science mission of those surface assets. This will bolster both the autonomous operations on the surface accuracy and science on the ground with the highest-quality digital twins of the Lunar South Pole operations. Our approach is divided into two components: an innovative 3D collaborative SLAM technique and scoring the "interestingness" of certain areas to adjust path planning algorithms. We will implement a custom-designed SLAM approach for the challenges of the Lunar South Pole from the low solar angle and long shadows. A learned Neural Radiance Field (NeRF) representation of the lunar regolith and localizations for rovers will be augmented by a Neural Visibility Field (NeRV), treating materials as reflectors of light rather than emitters. While we primarily update the lunar mapping utilizing images that a rover captures throughout its typical daily routine, we introduce a scoring mechanism for "interestingness" that allows for minimal adaptation of the rover's primary mission to capture massive amounts of new information. For example, a RASSOR taking the same path from digging to the regolith processing site would be incentivized to take a slightly different route to update areas of the map that might be interesting. Interestingness is largely defined by autonomous operations in the area by a surface asset but is also driven by pixel-wise errors rendered by the NeRV NN, a learned time-decay function to account for meteorite impacts and other unexpected changes, or manually by a human operator. By developing, leveraging, and integrating these two cutting-edge technologies, the system will push the present boundaries of mapping on the lunar surface and enable more sophisticated science and missions.

Duration: 6

Proposal Details

Proposal Number: H10.02-1018
Subtopic Title: Autonomous Operations Technologies for Launch Systems and Surface Infrastructure

Proposal Title: Lunatone

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 2 - 3
Technical Abstract (Limit 2000 characters):

LUNATONE addresses the problem of depth from disparity algorithms breaking down in lunar environments due to insufficient test conditions for algorithm improvement. This effort will deliver an innovative method to create a reliable synthetic vision precision navigation test environment for areas with limited or no access to real-world testing, such as the lunar environment. The competitive advantage of our proposal is that it will deliver an improved testing environment at a very similar cost compared with existing synthetic environment development technology. Our competitive advantage is achieved by implementing an innovative combination of existing tools used in the gaming industry with machine learning tools to rapidly create unique displacement maps to produce unique key features effectively. There is already a sizable market for autonomous (robotic) systems of $3 billion per year, which is expected to grow significantly with the increase of autonomous vehicles. Though harder to quantify, the cost of failure is higher because of the increased interest in exploring the surface of the moon, with three landing attempts in the last 12 months. Lunar exploration is a significant growth area for our technology and a significant

portion of the development and certification of vision-based navigation systems is for training and testing. Any improvement of the development process will be valuable. Because qualifying a new vision system for precision navigation requires a significant investment on the part of the developer, the adoption of a training and testing technology will only occur if there is a high-performance benefit equal to the cost.

Duration: 6

Proposal Details

Proposal Number: H12.08-1000
Subtopic Title: High-Throughput Platform for Identification of Senescence Altering Therapeutics Post Space Radiation Exposure
Proposal Title: Platform for Radiation-Induced Senescence using Multiorgans" (PRISM) for high throughput senolytics screening

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 3 - 4
Technical Abstract (Limit 2000 characters):

In response to ionizing radiation (IR), cells can undergo premature senescence, known as stress-induced senescence, triggered by various stimuli like DNA damage, oxidative stress, and oncogenic activation. Senotherapeutics discovery is crucial for overcoming the obstacle of space radiation in long-duration missions. However, the identification of senescence remains challenging due to a lack of robust biomarkers. Biopico Systems realized that with advancements in organ-on-a-chip technologies, new senotherapeutics can be designed to target specific senescent cell subpopulations. Therefore, Biopico Systems, in collaboration with UC Irvine, is proposing the Platform for Radiation-Induced Senescence using Multiorgans (PRISM) for senotherapeutics screening, to NASA. This platform aims to translate strategies into clinical outcomes for preventing or halting senescence using 3D brain and gut organ models exposed to ionizing radiation. To commercialize the organ platform, Biopico Systems Inc. has filed several patent applications. An alpha prototype of the organ plates and recirculation system has been established, and collaborations are ongoing for drug development. Additionally, there is interest from drug developers developing therapies for neurological diseases, indicating potential customers. The proposal aims to validate organ models for high-throughput senotherapeutics testing, characterize organ models for senescence markers, and screen senescence-modulating interventions for space radiation exposure applications. Apart from NASA's application in radiation countermeasures, health monitoring, and space mission planning, the product will target therapies that induce senescence in cancer cells, potentially slowing down the aging process and extending healthy lifespan, and addressing various age-related diseases such as cardiovascular disease, neurodegenerative disorders, and diabetes.

Duration: 6

Proposal Details

Proposal Number: H12.08-1004
Subtopic Title: High-Throughput Platform for Identification of Senescence Altering Therapeutics Post Space Radiation Exposure
Proposal Title: Mizar S/TAR High-Throughput Platform for Identification of Senescence Altering Therapeutics

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 3 - 4
Technical Abstract (Limit 2000 characters):

Mizar Therapeutics aims to leverage our Space/Time-Activity Relationship (S/TAR) platform, a new paradigm for target activity assays and drug discovery, for the identification of novel senotherapeutics. S/TAR's foundational enabling technology is Mizar's proprietary super-resolution, high-content imaging system adapted to track single molecules in living cells with minimal phototoxicity due to 6-10x greater photon efficiency. This allows us to track the spatial and temporal movements of individual target molecules in living cells at a finer scale than ever before, enabling target validation and the identification of specific changes in target activity at baseline and in response to various treatments in real-time and in a 96-well plate format. S/TAR provides a target activity assay, rather than a phenotypic one, enabling built-in target validation, enhancing mechanism of action studies, and driving more accurate structure–activity relationship modeling. This improves the accuracy and efficiency of compound screens and helps avoid costly and time-consuming mistakes due to misidentified targets. The unique advantages of the S/TAR platform make it an exceptional solution for more sensitive detection, quantification, and spatiotemporal delineation of cellular processes like senescence. In this Phase I SBIR project, Mizar will demonstrate the distinctive benefits of the S/TAR platform for the screening of countermeasures that target senescence as an approach to prevent radiation-induced health risks in astronauts.

Duration: 6

Proposal Details

Proposal Number: H12.08-1006
Subtopic Title: High-Throughput Platform for Identification of Senescence Altering Therapeutics Post Space Radiation Exposure
Proposal Title: High-throughput Live Cell Senescence Countermeasure Screening Platform

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 1 - 3
Technical Abstract (Limit 2000 characters):

As spacecraft shielding remains insufficient against heavy-ion space radiation, it poses a significant hazard to astronauts and presents a major barrier to mission success. The heightened risk of senescence during and following prolonged deep space missions is among the most alarming long-term effects of space radiation exposure. Implementing effective countermeasures (CMs) to target senescence has the potential to mitigate the impact of ionizing radiation (IR) exposure and ensure the well-being of astronauts during extended space missions. Because of lack of a reliable individual marker of senescence, there is an unmet need to establish a high-throughput screening platform aimed at devising a comprehensive medical countermeasure strategy to combat heavy-ion space radiation-induced senescence and protect astronauts. Lynntech proposes a novel high-throughput live cell screening platform for precise quantification and identification of senescent cells.

Duration: 6

Proposal Details

Proposal Number: H15.01-1001
Subtopic Title: Autonomous Capabilities for Lunar Surface Mobility Systems
Proposal Title: Efficient On-Board Autonomy Using RFS-SLAM for Robust Lunar Surface Mobility

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 2 - 3
Technical Abstract (Limit 2000 characters):

Navigation on the lunar surface is difficult due to a lack of terrestrial equivalent infrastructure and landmarks. This Phase I program will develop a solution for robust lunar surface mobility operations of autonomous robotic agents within this sparse feature environment by using Random Finite Set (RFS) theory integrated with Simultaneous Localization and Mapping (SLAM) techniques. By using RFS-SLAM performance is improved by reducing the number of particles used internally in the particle filters allowing for reduced computational operating costs necessary for accurate results. The RFS-SLAM can handle additional clutter allowing for a wider range of sensors usable for SLAM. Phase I will focus on evaluating RFS-SLAM and its performance, employing flight ready sensors and processors as models using established robotic software frameworks and simulation tools. Point cloud generating sensors to be evaluated with this Lunar RFS-SLAM include stereo optical+thermal cameras and LIDAR. Odometry generating wheel odometers, inertial measurement units, and sun trackers will be evaluated for further improvements. In order to support near term operations, the RFS-SLAM algorithms will be implemented in Python and integrated into ASTER Labs' SWARM Toolset. Additional software frameworks and tools that offer ease of integration into NASA Lunar missions will be architected, including ROS, along with its safety optimized derivative SpaceROS. The SWARM Toolset with the RFS-SLAM module will be used in simulations to evaluate system performance within a reduced development time. Python prototype software will serve as validation tests for future optimized implementations. The software developed under this project will apply to commercial markets of automated navigation on resource and infrastructure constrained platforms such as self-driving vehicles and indoor robots.

Duration: 6

Proposal Details

Proposal Number: H15.01-1014
Subtopic Title: Autonomous Capabilities for Lunar Surface Mobility Systems

Proposal Title: Modular Software Architecture and Algorithms for Fast and Efficient Lunar Mobility (M-SAFE)

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 2 - 5
Technical Abstract (Limit 2000 characters):

ProtoInnovations, LLC proposes a software architecture for autonomous mobility solutions tailored to meet the demanding speed-made-good and reliability requirements during challenging semi-autonomous NASA lunar missions. Building upon ProtoInnovations's previous successful experience in developing reconfigurable and modular mobility software architectures and robotic systems for autonomous rover operations, we propose an optimized mobility software architecture for high-speed and high-cadence missions in dynamic lunar operating conditions. The software architecture provides onboard autonomy capabilities for high-speed mobility systems through computationally-efficient, power-efficient, and real-time supervisory and coordinated mobility control. Factoring in the need for speed, traction in mixed terrain, robustness to known terrain hazards, and minimizing energy consumption, we propose a suite of dynamic mobility controllers with a supervisory value assessment module for optimal high-progress-rate mobility. The software architecture operates while the mobile system is in motion, continually responding to the state of the rover, current

lunar terrain conditions, and mission-level mobility performance needs to make the best controlled decision. As NASA and the space industry prepare for progressively more complex and longer lunar surface missions, such as the Lunar Terrain Vehicle (LTV) and Extravehicular Activity and Human Surface Mobility (EHP) missions, our software architecture aims to provide the necessary functionality and performance to meet evolving requirements for faster and more autonomous lunar operations.

Duration: 6

Proposal Details

Proposal Number: H15.01-1024
Subtopic Title: Autonomous Capabilities for Lunar Surface Mobility Systems
Proposal Title: A low-power, high-dynamic range sensor system for long-term autonomy, navigation, and mapping on the lunar surface

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 3 - 4
Technical Abstract (Limit 2000 characters):

Tangram Vision will develop a low-power sensor system for a Lunar Terrain Vehicle (LTV) that utilizes a wide-FOV stereo pair of event cameras (a.k.a. neuromorphic camera or dynamic vision sensor), along with an IMU, to enable quick localization and confident mapping in environments with extreme lighting conditions. This combination of novel sensor modalities will enable the creation of an event-informed dense depth map of the environment that is consistent over time and lighting conditions, due to an event camera's ability to identify occlusions and objects in motion relative to the world coordinate frame. Funding will be used to create a hardware prototype of the proposed sensor system. The remaining capital will be allocated to the technical experts for their investigations and contributions to the project. At the end of this phase, Tangram Vision will have demonstrated that a stable depth synthesis pipeline can be created from two stereo event cameras. If a stable pipeline has not been achieved by the end of this phase, Tangram Vision will report how such a pipeline could be achieved given different resources or approaches. Target markets for such a system extend well beyond lunar exploration. A sensor suite like the one proposed has applications in robotics, autonomy, drones, and any system moving at a high speed through challenging lighting conditions. We see this work as the first step towards fully commercialized event sensing, which currently does not have a presence in the sensor market.

Duration: 6

Proposal Details

Proposal Number: H15.01-1025
Subtopic Title: Autonomous Capabilities for Lunar Surface Mobility Systems
Proposal Title: Long Range Navigation Capabilities for Autonomous Mobile Manipulation

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 2 - 4
Technical Abstract (Limit 2000 characters):

The need for fully and semi-autonomous Lunar Terrain Vehicles (LTV) and Pressurized Rovers (PR) is paramount to establishing a long-term lunar presence. This proposal addresses the critical requirement for innovative autonomous mobile manipulation systems capable of operating in the challenging conditions of the lunar surface, specifically focusing on long-range navigation capabilities. PickNik proposes adding new capabilities to our software platform, MoveIt Pro, that enable the execution of complex mobile manipulation tasks that create a high degree of operator confidence, trust in the system, and that are indicative of a robust and technologically sophisticated solution, all available via a ground control operator interface. We will do this by focusing on two primary goals. First, to develop behavior trees incorporating long distance robot navigation behaviors from Nav2 with MoveIt Pro-based manipulation behaviors. Second, we propose to augment MoveIt Pro's operator frontend to provide similar situational awareness and sliding autonomy capabilities for rover control as are already available for arm control. PickNik's MoveIt product line targets robotics applications that use robot arms for manipulation in many vertical markets. Our technology is multi-use and has had extensive deployments for terrestrial markets such as oil & gas, warehouse logistics, agriculture, healthcare, food preparation, construction, and advanced manufacturing. In the space industry, we are targeting various applications of robot arms and mobile manipulators from Intra Vehicular Robotics (IVR) needs, to In-Space Servicing, Assembly, and Manufacturing (ISAM) applications.

Duration: 6

Proposal Details

Proposal Number: S11.01-1008
Subtopic Title: Lidar Remote-Sensing Technologies
Proposal Title: Spaceborne Scanning Lidar Sensor

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 3 - 4
Technical Abstract (Limit 2000 characters):

To address NASA's need for novel lidar technologies with an emphasis on compactness, efficiency, reliability, lifetime, and high performance, Intellisense Systems, Inc. (Intellisense) proposes to develop a new Spaceborne Scanning Lidar (SBSL) Sensor for three-dimensional (3D) mapping, suitable for deployment on unmanned aerial vehicles, SmallSats, and CubeSats, or stratospheric platforms. The innovations (1) in the sensor design using geometric phase (GP) flat lenses in an afocal telescope integrated with (2) a wide-field-of-view (WFOV) electro-optical phased

array exploiting the Talbot light redistribution for 100% fill factor, and (3) a flat adaptive lens for the telescope athermalization supporting diffraction limit performance will allow the system to achieve down to <1 m space resolution from >100 km altitude, >20 deg FOV with 0.2 arcsec pointing accuracy, and <10 ms rate per sweep in the SBSL sensor. The size, weight, and power consumption (SWaP) do not exceed 1.26 cub. ft, 6 lb, and <60 W, respectively. Thus, the SBSL addresses several of the key technological gaps suffered by existing lidar sensors. In Phase I, Intellisense will develop a viable conceptual design of the SBSL sensor that satisfies NASA's resolution and range requirements, including SWaP, FOV, pointing accuracy, and sweep rate, and demonstrate the design's feasibility by modeling and simulation of the sensor performance under Mars landing conditions. We will also identify additional research and development work and formulate a Phase II plan including potential risks and risk mitigation strategies. In Phase II, Intellisense will optimize and refine the design and build, test, and deliver a demonstration SBSL prototype at TRL-5. The key milestone of Phase II will be testing of the prototype in a relevant environment. Preliminary designs will be made for a Phase III device.

Duration: 6

Proposal Details

Proposal Number: S11.01-1012
Subtopic Title: Lidar Remote-Sensing Technologies
Proposal Title: CO_2 Airborne Lidar Enabling Science for Carbon Efficiently (COALESCE)

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 2 - 3
Technical Abstract (Limit 2000 characters):

This proposal seeks to verify the feasibility of developing a small, low power, airborne, CO2 lidar that would be capable of sharing resources with NASA's High Altitude Lidar Observatory (HALO) instrument, enabling simultaneous measurement of CO2 and CH4 without the expense of hosting a separate instrument on an additional port of a NASA research aircraft. The basis for this work is the Multifunctional Fiber Laser Lidar (MFLL), originally developed by ITT Space Systems (now L3Harris Technologies) as an airborne prototype to evaluate a novel intensity modulated continuous wave (IMCW) measurement approach that leverages high-reliability telecommunications components and techniques to achieve a high-accuracy measurement of CO2 in an integrated-path differential absorption (IPDA) measurement [Dobbs, 2007; Dobler, 2013]. This unique approach enables continuous online and offline measurements which share many of the same noise sources from amplification, atmospheric scintillation, surface reflectivity changes and receiver electronics, of which the multiplicative components cancel out in the ratio of the channels used to determine the differential absorption. MFLL was selected as a key instrument in the NASA Earth Venture Suborbital mission Atmospheric Carbon Transport - America (ACT-America) mission, conducting 89 flights over 4 extensive field campaigns between 2016 and 2020. The results of this work showed very high accuracy CO2 measurements could be made using this technique [Campbell et al., 2020]. The MFLL instrument data from ACT-America has also enabled improved algorithms for OCO-2 [Bell, 2020; Baker, 2022] and unique insights into CO2 variations across frontal boundaries [Pal, 2020; Walley, 2022].

Duration: 6

Proposal Details

Proposal Number: S11.01-1022
Subtopic Title: Lidar Remote-Sensing Technologies

Proposal Title: Advanced Composite Design of Origami Inspired Deployable Metaoptic LiDAR Aperture

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 2 - 4
Technical Abstract (Limit 2000 characters):

By leveraging advanced remote sensing technologies like LiDAR, scientists can better understand and manage the complex interactions between the Earth's atmosphere, biosphere, hydrosphere, and lithosphere, ultimately contributing to the advancement of Earth science research and applications. Vistar proposes new deployable composite LiDAR telescope structure. Utilizing Meta-optics over conventional mirrors and lenses, these telescopes promise significant advantages over traditional systems from compact stowage within confined spacecraft to swift and precise deployment of larger apertures. Deployable origami inspired apertures offer a solution for multi-element transmissive telescope lens designs, enabling compact packaging and reduced launch costs. The focus of this work will be developing a multi-element metalens housed in a composite structure to serve as the primary collection optic in a transmissive telescope for a lidar instrument. The global LiDAR market has been experiencing significant growth driven by increasing demand for 3D mapping and modeling, urban planning, infrastructure development, autonomous vehicles, and environmental monitoring

applications. With affordable space-based LiDAR systems, persistent and affordable access to LiDAR data would enhance the current market and open new commercial markets.

Duration: 6

Proposal Details

Proposal Number: S11.02-1001
Subtopic Title: Technologies for Active Microwave Remote Sensing
Proposal Title: Rydberg Field Probes for QRR in airborne applications

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 2 - 3
Technical Abstract (Limit 2000 characters):

The overall objective of this Phase I R&D effort is to research and evaluate an existing Rydberg Field Probe (RFP) to develop a design for a next generation RFP that is robust to environmental conditions experienced during sub-orbital flight and has high sensitivity in the S-band and K-band. Rydberg field probes designed for 2-photon spectroscopy schemes are designed to deliver both the probe and coupler beams to the sensing element and efficiently collect the probe laser signal. We will perform a series of important experimental investigations to inform the mechanical stability of the probe head and service cord. In the first portion of the effort, we will evaluate RF signal reception under vibration tests of an existing RFP design to benchmark the stability performance of state-of-the-art RFP [3] against conditions typical for airborne use. In addition, we will investigate the impact of temperature dependence and local oscillator (LO) field quality on sensitivity and quality of RF signal detection. The information learned during the testing portion of this program will be used to develop an updated design for a mechanically stable and vibration hardened RFP that can operate at varying temperatures with a high-quality LO field. The goal of this effort, including all phases, is to develop an atom-based RF sensing prototype for integration with JPL's QRR initiative that includes real time atom-based RF signal detection in test flight demonstrations. The final objective of Phase I work is a final report with all analyses and research findings to advance the concept. A TRL level of 2/3 is expected at completion of the phase I effort.

Duration: 6

Proposal Details

Proposal Number: S11.02-1004
Subtopic Title: Technologies for Active Microwave Remote Sensing
Proposal Title: Deployable and/or Steerable Aperture Technologies

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 3 - 4
Technical Abstract (Limit 2000 characters):

Opterus addresses the small spacecraft reflector challenge with its patent pending Spiral Wrapped Antenna Technology (SWATH). SWATH is a fully continuous, solid surface deployable parabolic reflector architecture. The continuous solid surface enables higher frequency operation than mesh systems at lower costs. SWATH leverages Opterus' high strain composite (HSC) material technologies as the primary structural element; this material innovation provides material stiffness within the reflector shell while accommodating high bending strains to stow extremely compactly, readily conforming to CubeSat and SmallSat form factors. Further, SWATH leverages a mold-based manufacturing process for low-cost, rapid manufacturability.

Duration: 6

Proposal Details

Proposal Number: S11.02-1007
Subtopic Title: Technologies for Active Microwave Remote Sensing
Proposal Title: High Linearity V-band Low Noise Amplifier

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 2 - 4
Technical Abstract (Limit 2000 characters):

QuinStar Technology proposes to develop a packaged V-band LNA for NASA microwave sensing missions operating at 64-70 GHz. The LNA will achieve an optimized noise figure of 2.5 dB with an enhanced input referred P1dB greater than -10 dBm. We will accomplish these design goals by utilizing state-of-the-art 40nm GaN device technology and linearity optimized LNA design methodology.

Duration: 6

Proposal Details

Proposal Number: S11.03-1005
Subtopic Title: Technologies for Passive Microwave Remote Sensing

Proposal Title: Advanced Deployable/Inflatable Antenna Apertures at Frequencies up to Millimeter-Wave

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 5 - 5
Technical Abstract (Limit 2000 characters):

Opterus addresses the small spacecraft reflector challenge with its patent pending Spiral Wrapped Antenna Technology (SWATH). SWATH is a fully continuous, solid surface deployable parabolic reflector architecture. The continuous solid surface enables higher frequency operation than mesh systems at lower costs. SWATH leverages Opterus' high strain composite (HSC) material technologies as the primary structural element; this material innovation provides material stiffness within the reflector shell while accommodating high bending strains to stow extremely compactly, readily conforming to CubeSat and SmallSat form factors. Further, SWATH leverages a mold-based manufacturing process for low-cost, rapid manufacturability.

Duration: 6

Proposal Details

Proposal Number: S11.03-1006
Subtopic Title: Technologies for Passive Microwave Remote Sensing
Proposal Title: Noise Sources for 0.1 - 1.0 THz

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 3 - 4
Technical Abstract (Limit 2000 characters):

This proposal is responsive to NASA SBIR Subtopic S11.03: Technologies for Passive Microwave Remote Sensing (SBIR), Scope Title: Components or Methods to Improve Sensitivity, Calibration, or Resolution of Microwave/Millimeter-Wave Radiometers; specifically, the bullet item “Noise sources from G-band up to 1 THz with >6dB ENR (excess noise ratio).” Noise sources serve as calibration references for receiver systems used in radio astronomy and atmospheric remote sensing. The goal is to calibrate out the instabilities of the receiver system, for example, gain fluctuations in low noise

amplifiers (LNAs). To achieve this the noise source must have sufficient power, expressed as the excess noise ratio or ENR. Generally, an ENR of about 10dB is sufficient, although greater ENR can enable improved performance for noise injection radiometers (e.g. by requiring reduced coupler factor) and in test and measurement (e.g. overcoming coupling loss to the device under test). The other primary requirement is that the noise source itself must have sufficient stability. VDI has recently demonstrated improved performance above 110 GHz using a new diode Schottky diode design. Specifically, ENR above 10dB up to 220 GHz and useful ENR to 330 GHz have been demonstrated. Through the proposed Phase I research VDI will demonstrate the feasibility of this technology to achieve NASA's stated goal, and to investigate how high in frequency this technology can be extended through Phase II research and development.

Duration: 6

Proposal Details

Proposal Number: S11.03-1009
Subtopic Title: Technologies for Passive Microwave Remote Sensing
Proposal Title: AN ULTRA-FAST SAMPLING ADC ASIC INTERFACING WITH FPGAS

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 2 - 3
Technical Abstract (Limit 2000 characters):

Pacific Microchip Corp. proposes to develop an ultra-high (56GHz) sampling rate 8-bit ADC ASIC with a JESD204C interface convenient for data transfer to FPGAs. The proposed ADC ASIC is primarily targeted for spectrometer applications, especially those that require using FPGAs rather than ASICs for digital signal processing. These applications include unique signal processing functions required in instruments used for microwave remote sensing of Earth from space or for applications that require hardware-based evaluation before these solutions can be transferred to ASICs. The proposed solution will leverage a previously developed and silicon-proven 8-bit 56GS/s ADC IP block (DARPA award D17PC00116). Within the proposed project we will implement the JESD204C standard compliant output data interface which includes the 64B/66B encoding for bandwidth efficient data transmission at 32x14.4Gb/s, which is convenient for data interfacing with off-the-shelf FPGAs. The ASIC will also include new calibration algorithms required to achieve the 6-bit ENOB and 28GHz bandwidth. Within the Phase I project, we will prove the feasibility of the ADC ASIC implementation and achieving the 28GHz bandwidth, 8-bit resolution and 6-bit ENOB at 56GS/s rate. The project's Phase II will produce a fieldable ASIC for the NASA instrumentation.

Duration: 6

Proposal Details

Proposal Number: S11.04-1003
Subtopic Title: Sensor and Detector Technologies for Visible, Infrared (IR), Far-IR, and Submillimeter
Proposal Title: High Dynamic Range Visible/SWIR Imaging Arrays using DROICs and Wafer Scale Hybridization

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 2 - 4
Technical Abstract (Limit 2000 characters):

Princeton Infrared Technologies is proposing to build a Short Wave Infrared Imager (1.0 to 3.0 μm) 640x512 resolution camera with 28-bit dynamic range. The effective full well of this imager will be >3Ge-, allowing the wide spectral range detector to operate with minimal cooling. The detector will be composed of a lattice matched InGaAsSb on GaSb planar detector structure allowing for low dark current with minimal cooling. The use of 100 mm GaSb substrates grown by molecular beam epitaxy (MBE) for photodiode array (PDA) production will allow for low-cost production using a planar structure to reduce dark current and provide greater radiation tolerance than mesa-based devices. The 640x512 resolution imager will be placed in a deliverable camera allowing a read noise of <275e- and the ability to process >250 frames per second (fps) at full resolution and bit depth with a two-point correction. The camera will feature a common commercial output type, such as 10GiGe, allowing simple integration to various systems.

Duration: 6

Proposal Details

Proposal Number: S11.04-1014
Subtopic Title: Sensor and Detector Technologies for Visible, Infrared (IR), Far-IR, and Submillimeter
Proposal Title: High Temperature Ultra-High Performance MWIR/LWIR Detectors Based on Plasmonic-Enhanced Type II Superlattices

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 2 - 5
Technical Abstract (Limit 2000 characters):

For ultra-high-performance IR detectors the only viable choice is HgCdTe or III-V type II SL based detectors. III-V is preferred over HgCdTe due to cost and a commercial supply chain. However, for LWIR HgCdTe still has superior performance. Performance can be improved either via material improvements (lifetimes) or through new designs. Performance of uncooled conventional MWIR/LWIR photodiodes are limited by the

detectors' dark current. Dark current scales with the detector volume, V; dark current noise scales as Sqrt V; and D* scales as 1/sqrt V. We propose to develop a MWIR/LWIR detector with an ultra-thin type-II superlattice absorber illuminated at a high intensity by a newly discovered surface plasmon polariton (SPP) mode produced by a grating etched into a highly-doped InAs layer. Unlike typical SPP modes that focus the intensity of incident electromagnetic waves approximately equally at the metallic and dielectric layers, this new mode focuses the intensity almost entirely at the dielectric layer where the absorber is located. The desired extent of coupling between the absorber and the new SPP mode can be achieved by optimizing the doping concentration of the InAs layer and the geometry of the etched grating. Photodiodes developed in this program will use plasmonic concentration to enable reduction of detector volumes by 104 – 105 x improving D* by ≥ 100. Such photodiodes will no longer be dark-current-limited, instead being limited by background radiation. In Phase I we will; model the SPP mode to optimize geometry of the grating and thickness of the InAsSb layer; Grow, fabricate, and measure structures to verify predictions of the model; Model the nBn T2SL candidate structures to find design for matching to the depth and wavelength of the SPP mode; Grow, fabricate and test nBn T2SL detectors without an etched grating to verify design. In Phase II we will develop designs and devices and deliver prototype high operating temperature MWIR and LWIR FPA's.

Duration: 6

Proposal Details

Proposal Number: S11.04-1016
Subtopic Title: Sensor and Detector Technologies for Visible, Infrared (IR), Far-IR, and Submillimeter
Proposal Title: TECHNIQUES TO IMPROVE THE QUANTUM EFFICIENCY OF LWIR SLS FPAs

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 2 - 4
Technical Abstract (Limit 2000 characters):

Antimony-based type-II strained layer superlattice focal plane arrays (SLS FPAs) now achieve maximum quantum efficiencies (QE) in the longwave infrared (LWIR) of 50% (cutoff ~ 10-11 microns) and 40% (cutoff ~ 12-13 microns) in commercial production. With a couple changes to the material design, we think we can increase these QE numbers to 70% and 60%, respectively. Our optimism is based on our prior design attempts to increase the QE, combined with observation of material growth effects on QE. In Phase I, we will demonstrate a FPA with improved QE using SLS material that combines these techniques. In Phase II, we will optimize material design, maximize QE, and deliver a camera with a SLS FPA with the highest possible QE. Increasing the QE of FPAs will increase imaging sensitivity and detection range and benefit applications as diverse as infrared astronomy, missile detection and tracking, and imaging very small gas leaks.

Duration: 6

Proposal Details

Proposal Number: S11.04-1017
Subtopic Title: Sensor and Detector Technologies for Visible, Infrared (IR), Far-IR, and Submillimeter
Proposal Title: ALOHA - Adaptive Large-capacity Optical-infrared High-dynamic-range Array

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 2 - 3
Technical Abstract (Limit 2000 characters):

The proposed effort addresses a need expressed in Topic S11.04 Sensor and Detector Technologies for Visible, Infrared (IR), Far-IR, and Submillimeter, for photodiode arrays with in-pixel DROIC for high-dynamic-range IR imaging focal plane arrays to circumvent the limitations in charge capacity, by using in-pixel digital counters that can provide orders of magnitude larger effective well depth, thereby affording longer integration times needed for Earth-science applications in the infrared (IR) and far-IR regimes. The effort focusses on developing a high charge capacity ROIC optimized for sensing in the MWIR and LWIR bands, suitable for all typical detector types used for these bands, such as (but not limited to) quantum well IR photodetectors (QWIP), HgCdTe (MCT), III-V quaternary bulk detectors and strained-layer superlattice (SLS) detectors. Traditional analog pixel ROICs, although power-efficient, have charge capacity limitations due to the limit on the size of the capacitor that can be fit in a pixel. Digital pixel ROICs (DROIC) have an analog to digital converter (ADC) in the pixel to overcome the charge capacity limit, but at the expense of very high power. There are no known ROICs capable of achieving the high dynamic range requirements in NASA's advanced earth observing missions while fitting within power budget restrictions. The proposed SAAZ ROIC will feature several innovations to address the challenge by creating an adaptive high dynamic range (HDR) digital pixel based ROIC. The SAAZ team, with extensive space mission experience, is leveraging a close working relationship with NASA to develop an optimal ROIC solution for the high flux thermal band. The proposed adaptive high dynamic range ROIC will provide the

desired high well capacity, a high frame rate, a large format, space qualifiable design, while simultaneously keeping the cold space power very low, making it suitable for space missions.

Duration: 6

Proposal Details

Proposal Number: S11.05-1004
Subtopic Title: Suborbital Instruments and Sensor Systems for Earth Science Measurements
Proposal Title: Airborne Spectroscopic Static Temperature Sensor

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 2 - 5
Technical Abstract (Limit 2000 characters):

The goal of this proposal is to develop a high speed, high accuracy method to measure the static air temperature outside an airplane while in flight. This is in response to SBIR sub-topic S11.05 Suborbital Instruments and Sensor Systems for Earth Science Measurements which seeks a method to measure static air temperature “from aircraft to better than 0.1 °C accuracy”. We will use open path, high resolution infrared absorption spectroscopy. We will project a frequency-swept laser beam outside of the aircraft and reflect it back to its source, monitoring the resulting infrared spectrum. The laser will primarily probe undisturbed air which has not yet been affected by the approach of the aircraft. The static air temperature will be extracted from the infrared spectrum by monitoring the relative intensity of two spectral lines which have dramatically different temperature dependence. We expect to achieve measurement precision of at least 25 mK and measurement accuracy of at least 100 mK. The measurement rate can be as fast as 100 Hz which would provide time resolution of 10 ms and spatial resolution of a few meters while flying under cruise conditions. During the Phase I project we will choose the optimal spectral lines and test the spectroscopic precision and accuracy in laboratory tests designed to simulate flight conditions. We will also develop a preliminary optical design for deployment on research aircraft. Finally, we will investigate the structure of the boundary layer around the aircraft in consultation with Boeing engineers to help us choose the optimal optical beam path for a Boeing 777 airframe. The intended application for this open path thermometer will be NASA research flights investigating the formation of persistent contrails in the upper troposphere.

Duration: 6

Proposal Details

Proposal Number: S11.05-1006
Subtopic Title: Suborbital Instruments and Sensor Systems for Earth Science Measurements
Proposal Title: In-Situ Hyperspectral Transmissometer for Ocean IOP Closure

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 2 - 4
Technical Abstract (Limit 2000 characters):

The objective of this Phase I project is to assess the feasibility of a compact wavelength-scanning hyperspectral transmissometer to measure in-situ beam attenuation, a critical ocean inherent optical property (IOP), in support of oceanographic research. The instrument will perform measurements from ultraviolet to near-infrared wavelengths (approximately 360-750 nm) and at a resolution that meets the needs of NASA remote sensing satellite missions such as PACE, GLIMR, and SBG for hyperspectral ocean color remote sensing model development and data product validation. The instrument will utilize a broadband light source coupled to a continuous variable filter to selectively scan through source wavelength ranges to transmit to the sample. A reference detector will monitor source output to calibrate for instability. Upon passing through the sample volume, the transmitted light will be coupled to a spectral detector for measurement. The detector architecture will be defined from outcomes of a trade study in Phase I. By utilizing a wavelength-discriminating detector, we can simultaneously measure transmitted light (at the same wavelengths as the source wavelength range entering the sample volume) and inelastically-scattered light (at wavelengths greater than the source wavelength range entering the sample volume), increasing the scientific capabilities of the instrument and simplifying in-field calibrations. During Phase I we will perform optical and mechanical simulations of different instrument geometries to optimize SWaP and performance. We will design, assemble, and test an optical breadboard with different detector architectures to understand the tradeoffs (engineering and science) between different detectors and measurement configurations. We will assess measurement accuracy and reproducibility by measuring different sample standards and will ultimately benchmark our performance against commercially-available transmissometers to validate our breadboard to TRL 4.

Duration: 6

Proposal Details

Proposal Number: S11.05-1012
Subtopic Title: Suborbital Instruments and Sensor Systems for Earth Science Measurements
Proposal Title: Hyperspectral Optical Profiling System with Advanced Dynamic Vertical Sampling Resolution (Hy-OPS ADVSR)

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 3 - 5
Technical Abstract (Limit 2000 characters):

The principal innovation proposed by the Hyperspectral Optical Profiling System with Advanced Dynamic Vertical Sampling Resolution (Hy-OPS ADVSR) project is the development of a thruster-driven dynamically stabilized in-water hyperspectral profiler utilizing a harmonized Compact Optical Radiometric Element (CORE) and a modular design to support the collection of optical and ancillary data capable of meeting PACE mission spectral resolution and data product uncertainty requirements. This is in response to the solicitation S11.05 request for innovative, high-value sensors directly targeting the stated NASA need for ocean hyperspectral UV-Vis-NIR water-leaving radiance. The profiler will be optimized to address a critical gap in existing technology which is that no commercially available profiling package is available that can obtain hyperspectral measurements of the ocean upwelling radiance within the upper 1 m of the ocean with the high Vertical Sampling Resolution (VSR) necessary for compliant in-water profiling. The Hy-OPS ADVSR project is based on a modular concept to support a diverse Community of Practice (CoP), with multiple optical geometries and configurations to maximize the applicable sampling scenarios and simultaneously support scaling of system cost with science goals. Phase I funding will be used to focus on the development of the modular CORE component with radiance entrance optics and the ADVSR deployment architecture. The Phase II effort will advance the accomplishments of Phase I to build the envisioned hyperspectral prototype profiling system and exploit the modularity of the CORE, leading to a radiometrically compatible solar irradiance sensor. Target markets include Calibration, Validation and/or Research activities as well as environmental monitoring and sampling for case II and spatially constrained water masses, taxonomic identification and phytoplankton diversity studies, and Harmful Algal Bloom (HAB) detection algorithm development.

Duration: 6

Proposal Details

Proposal Number: S11.05-1015
Subtopic Title: Suborbital Instruments and Sensor Systems for Earth Science Measurements
Proposal Title: A Compact, Low-cost, Multi-angle, Multi-spectral Imager (cMAS) for Airborne, Spaceborne and Surface-based Observations

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 4 - 6
Technical Abstract (Limit 2000 characters):

Shortwave imagery and multi-angle polarimetry for cloud and aerosol remote sensing is an increasingly important element of NASA aircraft missions, including the future Atmosphere Observing System (AOS, planned launch of the inclined orbit in 2031). The novel imager proposed here, called cMAS (Compact, Low-cost, Multi-angle, Multi-spectral Imager), will fill the need for an imager with wavelengths and resolutions that have not previously been achievable at ground stations, on aircraft, or in low Earth orbit. The cMAS imager will not fully replace the functionality of its namesake, eMAS, because it will only feature a sub-set of the eMAS wavelengths. However, cMAS it will operate without moving parts and will add forward and aft imaging for multi-angle science. An issue with the historical systems is that they are often one-of-a-kind, expensive (millions of dollars), large, and/or developed for a specific mounting location on an aircraft. As a result, it is difficult to fly them routinely, especially when using aircraft that are not originally intended or designed for remote sensing. The goal of this proposal is to develop a compact, low-cost, instrument capable of multi-angle (± 45°), multi-spectral (350 to 1600 nm) imaging with a wide swath. Importantly for our proposal, the manufacturer of the camera (3DPlus™) has now put a new version on the market, which is sensitive over wavelengths ranging from 350 to 1,600 nm, without the need for active or passive cooling. The main task in Phase I is to develop and test wide field-of-view, moderately achromatized optics that support multiple wavelengths in the spectral range from 350 to 1,600 nm. This will be accomplished in the SPEC optics lab using custom optics and the new 3DPlus™ camera. In Phase II, SPEC will build and calibrate a fully-functioning, multi-spectral instrument and conduct test flights on SPEC's Learjet research aircraft. This will facilitate the eventual transition to a hardened, spaceborne instrument.

Duration: 6

Proposal Details

Proposal Number: S12.01-1006
Subtopic Title: Exoplanet Detection and Characterization Technologies
Proposal Title: Deployable Mini-Astrocomb

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 2 - 3
Technical Abstract (Limit 2000 characters):

Astronomers have used spectrographs for centuries to study distant stars, planets, and other celestial bodies to understand their compositions, motions, and other properties. Recently, a technique known as the Precise Radial Velocity (PRV) method has been used to characterize exoplanets and their velocities around their host stars, which involves detecting the minute Doppler shift in the spectra of light emitted from the host stars originating from their orbital motion. To perform such precise measurements, a precision calibration tool is necessary: the optical frequency comb. However, one of

the significant hurdles in the development of in-field (i.e., space-based) astronomical spectrograph devices lies with the optical frequency comb: they are far too bulky, power-hungry, and sensitive to their environments to be deployed in space, where aberrations in the measured spectrums due to the Earth's atmosphere can be avoided. To address this need, Opto-Atomics Corp. (OAC) proposes to develop a Deployable Mini-Astrocomb (DMAC), which will provide an optical frequency comb with tunable comb-tooth spacing and stability traceable to the SI definition of the second. DMAC will also be frequency-referenced, allowing for reliable and long-term calibration of deployed spectrographs. Most advantageously, DMAC will consume < 20 W of power during operation and be designed and packaged to achieve resilience to environmental perturbations.

Duration: 6

Proposal Details

Proposal Number: S12.01-1009
Subtopic Title: Exoplanet Detection and Characterization Technologies
Proposal Title: Serpentine Integrated Grating Spectrometer for Extreme Precision Radial Velocimetry

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 3 - 3
Technical Abstract (Limit 2000 characters):

We propose a novel ultra-high-resolution Serpentine Integrated Grating (SIG) spectrometer for use in Precision Radial Velocimetry (PRV) measurements of minute Doppler shifts gravitationally imparted on stellar spectra by orbiting Earth-size exoplanets. Detecting such small spectral shifts is extremely challenging, requiring exquisite instrument and spectral reference stability and spectral resolving powers exceeding 100,000 to maintain few cm/s precision for year(s). To overcome atmospheric limits on ground-based PRV, planned space missions require precision spectrometers with low size, weight and power (SWaP). SIG generalizes photonic gratings to two dimensions, and relies on the exquisite manufacturing fidelity of photonic integrated circuits (PICs), instead of grating ruling machines, to produce PIC gratings with record resolution. These folded gratings form the basis of a new class of miniature spectrometers with comparable resolutions to spectroscopic instruments thousands of times larger and more expensive. A SIG spectrometer requires only a few small optical components and can be readily integrated with emerging astrophotonic photonic lantern and microcomb technologies to implement a low-SWaP instrument suitable for space-based PRV. To date, we have demonstrated a proof-of-concept SIG combining a 5.2 cm (equivalent to 14.8 cm in free space) folded delay line with grating couplers in a footprint of just ~0.4 mm^2 to attain a resolving power of ~100,000 in the 1540-1650nm regime. During Phase 1 we will develop a photon-efficient SIG spectrometer design specifically targeting PRV at NIR wavelengths and investigate extending it to the visible regime. We will design new SIG variants with up to 1M resolving power, study SIG efficiency limits, compare low-SWaP calibration methods, evaluate instrument noise and stability, investigate new architectures, and design a prototype spectrometer which we will build and demonstrate during Phase II to attain TRL4.

Duration: 6

Proposal Details

Proposal Number: S12.02-1000
Subtopic Title: Precision Deployable Optical Structures and Metrology
Proposal Title: Biomimetic Zero CTE Lightweight Optical Structures

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 3 - 5
Technical Abstract (Limit 2000 characters):

This NASA SBIR Phase I proposal presents an unprecedented method to make zero CTE lightweight optical structures such as optics mounting structures, brackets, optical benches, and metering structures. With our successful history in a variety of AM processing for TPMS structures, this proposal has a great potential to succeed. A proof-of-concept demonstration will be carried out at the end of Phase 1. Prototypes will be delivered at the end of Phase II.

Duration: 6

Proposal Details

Proposal Number: S12.02-1006
Subtopic Title: Precision Deployable Optical Structures and Metrology
Proposal Title: Quasistatic Release Mechanism

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 3 - 4
Technical Abstract (Limit 2000 characters):

Heliospace has developed a unique release mechanism that exports near-zero shock during actuation and can be utilized for the purposes of deploying state of the art observatory systems and subsystems. Furthermore, the proposed release mechanism is designed to be field resettable which enables a customer to avoid expensive and time consuming off site reset and refurbish apparent with non-field resettable devices. This capability enables the devices to avoid costly and risk inducing test-as-you-fly waivers that are typically required with one shot release mechanisms and improves the flow of Integration and Test phases of a project. The release device can be scaled to meet needs from small scale CubeSat applications all the way up to flag ship space telescopes. The proposed release device has the potential to provide a unique capability by enabling the design and deployment of precision hardware for the entirety of the optical chain. It diversifies the current release mechanism market that is dominated domestically by

two manufactures. Finally. it increases the number of options available to engineers to achieve large- and small-scale deployable structures not achievable with current technologies.

Duration: 6

Proposal Details

Proposal Number: S12.03-1011
Subtopic Title: Advanced Optical Systems and Fabrication/Testing/Control Technologies for Extended-Ultraviolet/Optical to Mid-/Far-Infrared Telescopes
Proposal Title: A Physics-Based Approach to Solving the Near Angle Scatter Dilemma (FRTS)

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 2 - 4
Technical Abstract (Limit 2000 characters):

We propose a new physics based scatter model, which has the ability to predict Near Angle Scatter phenomena - mission critical for future flagship missions such as the Habitable Worlds Observatory (HWO) for seeing exoplanets. We intend to implement a software test-bench to compare measured Bidirectional Reflectance Distribution Function (BRDF) from the Solar UltraViolet Imager (SUVI) telescope to predicted results from the model. Additionally we will extend the proposed model to include higher order effects, such as secondary scatter. This new model has the ability to model any scattering surface and is derivated from first principles, and thus important for modeling Extreme UltraViolet (EUV) lithography optics and extremely smooth optics.

Duration: 6

Proposal Details

Proposal Number: S12.03-1012
Subtopic Title: Advanced Optical Systems and Fabrication/Testing/Control Technologies for Extended-Ultraviolet/Optical to Mid-/Far-Infrared Telescopes
Proposal Title: Retardation Mapping System for Astronomical Mirrors

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 3 - 7
Technical Abstract (Limit 2000 characters):

To meet the optical resolution requirements of the mirrors to be used in the Habitable Worlds Observatory (WHO), the birefringence of the mirrors must have a polarization birefringence uniformity on the order of 1% over their full aperture. The proposed work will develop a technology for measuring the birefringence across the 250 nm to 1000 nm wavelength range on non-planar mirrors. This will be achieve though a series of customization and upgrades to Axometrics' existing AxoScan™ product line. The function will primarily cover the required R&D labor for designing new optical retarders and detectors, extending the wavelength range of our light source, integrating the system, and performing measurements. The primary Phase I effort deliverable will be a series of test measurements performed on mirror samples provided by NASA.

Duration: 6

Proposal Details

Proposal Number: S12.04-1002
Subtopic Title: X-Ray Mirror Systems Technology, Coating Technology for X-Ray-UVOIR (Ultraviolet-Optical-Infrared), and Free-Form Optics
Proposal Title: Polymer Barrier, Protection and Cleaning for UVOIR and X-Ray Mirrors

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 2 - 3
Technical Abstract (Limit 2000 characters):

Maturing vacuum ultraviolet mirror coating technology for use in UV Astrophysics is on the critical path for NASA Flagship Missions such as the Habitable Worlds Observatory (HWO). In the Lyman Ultraviolet (LUV ~90-122nm), the reflection efficiency of current telescope mirror coatings drops precipitously. The best option, bare aluminum, forms a natural oxide coating in seconds and absorbs these wavelengths. One solution would be to fabricate the telescopes and mirrors in the vacuum of space to avoid oxygen. Recently, excellent progress has been made utilizing lithium and aluminum fluorides as protective and reflectivity-enhancing coatings on aluminum. However, these materials are easily scratched and must be protected from water vapor intrusion in assembly, testing, and while waiting for launch. This proposal suggests creating a family of removable polymer film coatings as water barriers and cleaners for water-sensitive and freeform optical surfaces. The Apply-Dry-Peel-No-Residue polymer coatings developed herein will also reduce or eliminate pinholes when used to clean and prepare the surface before depositing the aluminum mirror and fluoride overcoats-enhancing coating performance, longevity, and enhancing stray-light suppression. The nearly ubiquitous pinholes that occur in fabricating metal coatings lead to corrosion, light scattering, and coating failure. This technology will mitigate NASA's mission risk by enabling the cleaning of historically uncleanable surfaces and by pre-qualifying the safety of cleaning flight optics early in missions. Avoiding irreversible failures when contamination happens will save time and money. Without such pre-clearance, precision mission surfaces might have to, again, launch dirty or with a fingerprint, as with HST's primary mirror and the Wide Field Camera II. Indeed, Hubble's primary mirror had a 10% degradation in reflectivity due to pre-launch contamination.

Duration: 6

Proposal Details

Proposal Number: S12.04-1005
Subtopic Title: X-Ray Mirror Systems Technology, Coating Technology for X-Ray-UVOIR (Ultraviolet-Optical-Infrared), and Free-Form Optics
Proposal Title: Creating Blazed Gratings for Freeform Mirror Surfaces

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 2 - 4
Technical Abstract (Limit 2000 characters):

Spectrum Scientific proposes that the next state-of-the-art technique for blazing diffraction gratings onto freeform surfaces is reactive ion beam etching. Compared to traditional blazing techniques such as ruling and holography, reactive ion beam etching enables the fabrication of high efficiency and low stray light gratings with a wider range of blaze wavelengths from the extreme ultraviolet to the infrared. Performing the reactive ion beam etching process on a freeform surface can reduce the number of

optical components required through the combination of multiple surface functionalities, and in turn, reduce mission costs with the weight of the payload directly relating to the cost of launch. The application of aberration-corrected RIBE gratings to freeform surfaces has paradigm-shifting potential for both the functionality and feasibility of spaceborne instruments including CubeSat and SmallSat. The reactive ion beam etching technique used in this research will be based on the established process used in the semiconductor industry. Spectrum Scientific will apply the reactive ion beam etching process to a holographic diffraction grating and identify the parameters required to deterministically etch a specific blaze angle into the substrate. The methodology can then be translated to surfaces with higher complexities, including aspheric and freeform surfaces. The findings of this research will be targeted at low-cost and lightweight aerospace instrumentation, but they apply to all diffractive element users including the life science, photonics, and telecommunication industries.

Duration: 5

Proposal Details

Proposal Number: S12.04-1008
Subtopic Title: X-Ray Mirror Systems Technology, Coating Technology for X-Ray-UVOIR (Ultraviolet-Optical-Infrared), and Free-Form Optics
Proposal Title: Low-cost, free-form optics using silicon carbide additive manufacturing

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 4 - 6
Technical Abstract (Limit 2000 characters):

Silicon carbide (SiC) is an ideal optical substrate material due to its low density, high stiffness and low coefficient of thermal expansion. With SiC, thermal gradients during service are quickly dissipated and thermal expansion is low, thereby maintaining optical performance. However, silicon carbide has been traditionally expensive and difficult to manufacture because it cannot be readily machined and molding processes are expensive and slow. SiC produced via additive manufacturing (AM) has the potential to overcome the technical and commercial challenges to make SiC a more widely adopted material for optics. Additionally, the ability to create increasingly complex structures (both in the substrate support and in the optical surface) can enable the design of more efficient satellites and weapons. This proposal will focus on optimizing the densification process to improve the repeatability and dimensional tolerances of AM SiC for free-form optics. While prior work by the project team has shown the feasibility of using AM SiC for optics for small and microsatellites, the parts still required some amount of machining and grinding before they can be polished. With this funding, the team will develop thermal models and improved densification procedures to produce highly-toleranced SiC that can generate free-form optical surfaces. The initial target markets will be for small satellites that require free-form optical surfaces. As the process is refined, it is expected to be able to be used for larger and more complex optics. Additionally, AM SiC can be used for applications outside of optics, such as heat exchangers and automotive brake systems.

Duration: 6

Proposal Details

Proposal Number: S12.06-1001
Subtopic Title: Detector Technologies for Ultraviolet (UV), X-Ray, and Gamma-Ray Instruments
Proposal Title: Large Silicon Carbide Grids for X-Ray Microcalorimeter Blocking Filters

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 4 - 5
Technical Abstract (Limit 2000 characters):

X-ray Microcalorimeter Blocking Filters are a NASA Tier 1 technology gap. Existing soft X-ray filters are fragile and suffer transmittance decay and loss of calibration due to contaminant gettering. We propose to increase the strength of SiC grids to a level suitable for the large apertures of LEM and newAthena. The grids increase the filter temperature to preclude gettering. The grids will also increase the filter acoustic strength for newAthena air launch. The proposed strength increases will reduce the mass density and increase the strength of smaller grids for HEX-P, AXIS, and ARCUS, while reducing artifacts compared with other grid materials. The funding will be used to execute a design-of-experiments testing 9 different strength factors, increasing small grid strength by 2-3X. We will also fabricate a prototype 120mm LEM Main Shell Filter grid, test GEVS Qualification Level vibration performance, and measure vibration stress and damping in vacuum. These will establish a relationship between grid proofing and launch requirements, such that proofing ensures both flight durability and conformance to process capability. The target markets are X-ray telescopes, charged particle detectors, terrestrial X-ray and EUV equipment, UV detectors, and silicon carbide MEMS. The proposed strength increases will reduce the mass density of SiC grids to an even lower level than now possible, increasing their performance advantage relative to copper, nickel, silicon and steel X-ray grids. We expect that at the

end of Phase II our fabrication costs will be reduced by 40%, allowing profitable manufacture of grids for terrestrial applications. Some experiments, such as the etching of a newly available silicon carbide 3C-SiC polyphase, may result in even more dramatic cost reduction or strength increases.

Duration: 6

Proposal Details

Proposal Number: S12.06-1007
Subtopic Title: Detector Technologies for Ultraviolet (UV), X-Ray, and Gamma-Ray Instruments
Proposal Title: High-Sensitivity UV Solid-State Photon-Counting Devices and Arrays

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 2 - 3
Technical Abstract (Limit 2000 characters):

Purpose: In this Phase I SBIR program, a collaboration between Magnolia Optical Technologies and Georgia Institute of Technology, we propose to advance the development of GaN and AlGaN ultraviolet (UV), deep-UV (DUV), and far-UV (FUV) single-photon avalanche detectors (SPADs) using the well-developed Si photomultiplier (SiPM) concept and then, in future SBIR Phases, to commercialize practical devices for NASA system needs, e.g., Large UV/Optical/IR Surveyor (LUVOIR) and many other DoD, DoE, and commercial applications. Our team has collaborated on the development of III-N APDs in the past. Our overall innovation in this SBIR will be to ultimately create the III-N analog of the silicon-based avalanche photodiode (APD) arrays—commonly referred to as silicon photomultipliers (SiPMs): a back-illuminated hybrid III-N SPAD-focal-plane array (FPA) device flip-chip-bonded and electrically coupled to a Si CMOS read-out circuit. Use of Funding: These Phase I funds will be used to grow, process, and test additional GaN-based APDs to further evaluate some of our innovative concepts for improving the overall performance of photon-counting III-N UV SPADs. Markets: Future markets include NASA, DoD, DoE and many “dual-use” and commercial applications. Example applications include PET scanners, UV LIDAR, contamination control, early missile threat detection and interception, chemical and biological threat detection, UV flame monitoring, and UV environmental monitoring. The global commercial UV sensor market is projected to grow substantially over the next five years. The market growth is powered by commercial and defense applications that will transition to our UV-SPAD devices that can directly benefit from the performance capabilities and features of the III-N UV-SPAD detector technology.

Duration: 6

Proposal Details

Proposal Number: S12.06-1011
Subtopic Title: Detector Technologies for Ultraviolet (UV), X-Ray, and Gamma-Ray Instruments
Proposal Title: VIPER: Versatile Imager Platform with Enhanced Radiation hardness

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 2 - 4
Technical Abstract (Limit 2000 characters):

Alphacore will develop the capability to provide critical elements for very large space based imagers. These imagers will have sensitivity to UV, visible and NIR wavelengths. The proposed large-format, high-resolution focal plane arrays will meet the following specifications: 8k x 8k pixels Four-sides buttable (three-sides is the minimum requirement) Pixel size: <~7 µm (goal is 5 um) Read noise: ~1 e- rms Dark signal ~1x10-4 e-/pixel/sec Operating temperature >150 K Radiation hard The 4-sides buttable readout integrated circuit (ROIC) will be designed in a specific 65nm CMOS Image Sensor (CIS) fabrication process. This process provides photodiode options with enhanced UV and NIR sensitivity. It also provides stitching for fabrication of sensors that are larger than the reticle size (typically 25mm x 25mm) and advanced wafer stacking which allows practically 100% fill factor at small pixel area and 4-side buttable designs. 4-sides buttable FPAs and ROICs provide much higher level of flexibility in construction very large imagers, than 3-sides or 2-sides buttable devices. This provides great benefit to NASA's future missions. The ROIC will be the bottom layer in this stacked die FPA solution. The ROIC will be designed to be as versatile as possible so that different detector arrays can be bonded to it. The FPA will be implemented as radiation-hardened. Alphacore has extensive experience as a supplier of radiation hard electronics, as well as a radiation test services, to numerous customers. In the image sensor area, we have provided hardened solutions to extreme radiation environments in nuclear applications. Space and strategic radiation environments has been our other focus. Note that image sensor radiation hardening requires specific techniques for hardening the photodiodes and the pixel circuitry and these techniques are relatively unknown as compared to radiation hardening by design (RHBD) techniques for other types of CMOS ICs.

Duration: 6

Proposal Details

Proposal Number: S13.01-1002
Subtopic Title: Robotic Mobility, Manipulation, and Sampling
Proposal Title: Robotic Actuators for Cryogenic Environments (RACE)

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 2 - 3
Technical Abstract (Limit 2000 characters):

Motiv Space Systems (Motiv) is proposing the Robotic Actuator for Cryogenic Environments (RACE) to address the growing need for precision, high specific-torque robotic arm actuators to operate in low-gravity, extreme temperature environments like that of icy moons or ocean worlds with a premium placed on low energy usage. RACE is a novel approach to cryogenic actuators that is easily scalable and modular by design. RACE leverages Motiv's work developing planetary gearboxes with the Distributed Extreme Environments Drive System (DEEDS) program and will implement a single-pass cycloidal reducer as the output stage. RACE is a heater-free, BMG-based actuator with a small cycloidal output stage driven by a brushless DC gearmotor. Construction of the motor and gearbox is based on that developed for the Cold Operable Lunar Deployable Arm (COLDArm). Both COLDArm and DEEDS feature BMG components to enable operation at -180C, and both programs introduced BMG elements as "drop-in" substitutions for mechanism components typically made of standard materials comprising Motiv's designs. Motiv is thus in a unique and exceptional position to develop and compare the performance of established flight heritage designs to more leading-edge approaches offered by incorporating the BMG components. Additionally, Motiv's understanding of robotic systems from development and performance standpoints deeply informs the trade-space when introducing new advances such as the proposed innovation.

Duration: 6

Proposal Details

Proposal Number: S13.01-1005
Subtopic Title: Robotic Mobility, Manipulation, and Sampling
Proposal Title: Cold Ablation Drilling: Non-Contact Planetary Sampling Technology

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 2 - 4
Technical Abstract (Limit 2000 characters):

AstroForge proposes the Cold Ablation Drilling and Sampling (CADS) system, a novel, non-contact method for acquiring and analyzing samples from planetary bodies, moons, and asteroids. Leveraging ultrafast high peak power lasers, CADS performs precision drilling into regolith and other materials, converting them into powder without physical contact. This innovative approach minimizes cross-contamination risks and operates within the stringent power and mass constraints of space missions. The integration of Laser Induced Breakdown Spectroscopy (LIBS) enables real-time material identification, allowing for selective sampling and preservation of scientific integrity. Phase I objectives include demonstrating CAD's feasibility on surrogate materials, validating non-contact sample handling and separation, integrating LIBS for material identification, evaluating system performance and scalability, and developing a roadmap for Phase II advancement. Deliverables will include a detailed report on prototype design, development, and testing, alongside a comprehensive plan for future development. AstroForge's CADS system promises to revolutionize planetary sampling, offering a scalable, efficient solution that aligns with NASA's exploration goals and addresses critical technological gaps in robotic mobility, manipulation, and sampling.

Duration: 6

Proposal Details

Proposal Number: S13.01-1012
Subtopic Title: Robotic Mobility, Manipulation, and Sampling
Proposal Title: Boom-Enabled Actuating Manipulator (BEAM)

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 1 - 3
Technical Abstract (Limit 2000 characters):

The Boom-Enabled Actuating Manipulator (BEAM) system's primary purpose is to offer an advanced, multi-functional robotic manipulator solution that can accommodate a wide range of end-effectors, such as mechanical arms, advanced drilling units, and various manipulation tools. This versatility ensures BEAM's capacity to perform diverse tasks, from sample collection and analysis to intricate assembly or repair operations in the challenging environment of space. The intended use of the funding through the SBIR program includes the development and validation of the BEAM system's proof-of-concept, rigorous laboratory testing to establish material and structural integrity, and the construction of a subscale prototype. This funding will also support the exploration of novel materials and mechanisms, such as bi-stable booms and Shape Memory Alloy (SMA) tendons, which are critical for achieving SWaP-C (Size, Weight, Power, and Cost) optimization in space missions. Target markets for the BEAM system encompass a wide range of applications in space exploration, including NASA and other space agency-directed missions to various celestial bodies within our solar system. These missions require innovative solutions for mobility, manipulation, and sampling in low-gravity environments, where the BEAM system's unique capabilities can significantly contribute. Furthermore, the BEAM system's adaptability and efficiency position it as an attractive option for non-traditional space system

suppliers and commercial space entities focusing on satellite deployment, space station construction, and deep space exploration. The specific invention of the BEAM system will seek to leverage and build on existing NASA heritage and IP for deployable composite booms per listed active and pending patents.

Duration: 6

Proposal Details

Proposal Number: S13.03-1006
Subtopic Title: Extreme Environments Technology
Proposal Title: A Cryogenic Spectrometer ASIC

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 2 - 3
Technical Abstract (Limit 2000 characters):

In situ exploration of planets, moons, asteroids and comets requires spectrometers of minimized size, weight and power (SWaP) capable of tolerating cryogenic temperatures and harsh radiation. A specialized spectrometer ASIC is a critical component in these missions. With support from the NASA SBIR program, we developed a radiation tolerant, highly configurable spectrometer ASIC (P19800C) that meets a broad range of system requirements. This commercially available ASIC digitizes up to 4GHz bandwidth signals, splits the spectrum into 8k frequency bins, and accumulates the frequency-domain voltage or power within each bin over programmable time (2µs to 34s) while using less than 1.75W of power. Compared to solutions based on discrete components, this radiation tolerant ASIC greatly reduces the SWaP of spectrometers, and is used for several NASA missions (SSOLVE, HyMPI and V-WiSHeS). Based on this technology, Pacific Microchip Corp. proposes to develop a spectrometer ASIC capable of operating down to cryogenic temperatures. The expected performance parameters of the ASIC at cryogenic temperatures will improve or remain the same as of the P19800C ASIC, while the power consumption will be reduced to 1.4W. Phase I of the project will prove the feasibility of cryogenic spectrometer ASIC's implementation at architectural, circuit and layout level. By the end of Phase I, a conclusion on the implementation feasibility and a complete definition of the proposed ASIC will be provided. Phase II will produce the ASIC's prototype ready for commercialization in Phase III.

Duration: 6

Proposal Details

Proposal Number: S13.03-1007
Subtopic Title: Extreme Environments Technology
Proposal Title: Melanin composites for radiation hardening and thermal management

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 1 - 3
Technical Abstract (Limit 2000 characters):

We propose innovative melanin-silicone composites to enhance space exploration capabilities, particularly in environments characterized by high radiation and low temperatures, such as Jupiter's moon Europa. These composites aim to provide spacecraft electronics with low size, weight, and power (SWaP), radiation-hardened properties, and the ability to operate effectively across a wide range of temperatures. Electronics are susceptible to damage by space radiation and extreme cold, reducing the lifespan of missions. We aim to exploit the radioprotective and thermal properties of fungal melanin to introduce novel properties into silicone-based conformal coatings and potting compounds, which are regularly used on spacecraft electronics. The radioprotective capabilities of melanin have been demonstrated in multiple fungal species against various forms of ionizing radiation including UV, X-rays, gamma rays, and particulate radiation. Additionally, melanin provides heat by thermal absorption of radiation, low thermal conductivity, and high thermal resistance. These remarkable properties are exhibited by isolated melanin, which can be incorporated into diverse composites. This project aims to develop melanin-silicone composites that can be applied as conformal coatings of potting compounds to reduce reliance on large-SWaP enclosures for radiation and thermal protection. Funds will be used to create composites and test for radioprotective, photothermal, and durability properties when irradiated with ionizing radiation. The proposed melanin-silicone composites would offer low-SWaP electronics protection for not only deep space exploration but also low Earth orbit. Therefore, our target markets include private space/satellite companies, government agencies, and research institutions, all of which would benefit from the protection of sensitive electronics in low Earth orbit and deep space.

Duration: 6

Proposal Details

Proposal Number: S13.03-1012
Subtopic Title: Extreme Environments Technology
Proposal Title: Radiation Shielding for Space Electronics in Severe Environments

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 4 - 5
Technical Abstract (Limit 2000 characters):

NASA has identified a need for radiation shielding for electronics in extreme environments. NanoSonic is a small, advanced materials company with expertise in the development of advanced shielding and protective materials for use in cryogenic through thermonuclear conditions. In this program, we shall develop electronics shielding for the harsh conditions specific to the Europa Clipper baseline concept with a mission life of 10 years, where the radiation environment is estimated at 2.9 Mrad TID (total ionizing dose). The materials herein shall be used to outperform 0.1-in.-thick

aluminum. In support of this research, NanoSonic has a Quantum Electronics and Sensors Division developing microelectronics that can be used in test scenarios during Phase I at the Brookhaven National Laboratory NASA Space Radiation Laboratory (BNL NSRL). The materials proposed in this program are the basis of our radiation shields that will be used in two CubeSat launches planned for the next calendar year.

Duration: 6

Proposal Details

Proposal Number: S13.03-1015
Subtopic Title: Extreme Environments Technology
Proposal Title: All-optical Magnetometer for Extreme Low-Temperature Environments using Nitrogen-Vacancy Center in Diamonds

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 3 - 4
Technical Abstract (Limit 2000 characters):

This proposal outlines the development of a quantum magnetometer based on nitrogen-vacancy (NV) centers in diamonds. The magnetometer is designed for use in extreme space environments, including those with high radiation levels and temperatures as low as -240°C, without the need for protective housing. Leveraging the quantum properties of NV centers, this technology offers a compact, low power consumption solution with pT Hz -1/2 sensitivity. The technology is motivated by the need for instruments capable of operating under the harsh conditions of space exploration, such as on icy moons like Ganymede, which exhibits unique magnetic phenomena. Traditional magnetometers, such as fluxgates and atomic gas magnetometers, are limited by their size, power requirements, and need for continuous calibration, making them unsuitable for deployment on smaller spacecraft or in conditions requiring high precision without environmental protection. The proposed NV center-based quantum magnetometer addresses these limitations by utilizing the atomic-scale defects in diamonds, which offer absolute field sensitivity, operational stability across a broad temperature range, and resilience to radiation deterioration. The device employs an all-optical readout for magnetic field detection and dynamical decoupling pulse sequences to achieve longer T2 coherence times, allowing both AC and DC sensing. Phase I will inclue optimization the proposed quantum magnetometer through simulation tools and microscopic modeling to analyze noise, along with CAD development for the device prototype, which will be fabricated and testing under simulated extreme conditions in the subsequent phase. The proposed innovation will provide a robust, efficient, and precise instrument for in-situ measurements on long-term explorative missions.

Duration: 6

Proposal Details

Proposal Number: S13.04-1004
Subtopic Title: Contamination Control and Planetary Protection
Proposal Title: GRIND: Genomic Rapid Inspection of Non-abundant bacteria after Decontamination

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 3 - 5
Technical Abstract (Limit 2000 characters):

This Phase I proposal focuses on advancing NASA's planetary protection mission by introducing an innovative lysis-based sample collection tool to enhance the existing swab-based sampling procedures. NASA currently employs swabs for microbial collection on diverse surfaces, followed by concentration and a lysis technique to extract nucleic acids from low biomass samples. However, the detection of challenging-to-lyse spores remains elusive in metagenomic sequencing and other nucleic acid techniques, despite being observable through culture methods. This underscores the critical need for enhanced, efficient, and integrated sample collection and processing techniques in planetary protection. In response to this challenge, our proposal introduces the development of an automated grinding lysis system. This cutting-edge system utilizes a standard collection swab to release genomic components from difficult-to-lyse, low-biomass samples. By automating the lysis process and integrating grinding mechanisms, our approach aims to surpass the limitations of conventional techniques, ensuring a more thorough and effective collection of nucleic acids for planetary protection purposes. During the Phase I work, we will demonstrate and quantitatively benchmark this technology on various contrived surfaces, featuring a diverse set of relevant microbes. Demonstrations will include the quantification of bioburden using qPCR and the identification of unknown samples using Nanopore sequencing. This novel system has the potential to significantly enhance and streamline sample collection methodologies, especially in scenarios involving elusive spores. Through these advancements, we aim to supplement the capabilities of NASA's planetary protection efforts, contributing to a more robust and reliable approach to safeguarding celestial bodies from microbial contamination.

Duration: 6

Proposal Details

Proposal Number: S13.04-1008
Subtopic Title: Contamination Control and Planetary Protection
Proposal Title: Development of a Modular Plasma-Activated Fog System for Enhanced Planetary Protection and Contamination Control

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): undefined - undefined
Technical Abstract (Limit 2000 characters):

AAPlasma LLC proposes the development of a Modular Plasma-Activated Fog System (MPAFS) to advance planetary protection and contamination control measures. This system leverages non-equilibrium plasma-activated fog to disinfect surfaces and equipment efficiently, addressing the significant challenges of spacecraft cleaning and in-situ decontamination. The project aims to mitigate undesired microbial, particulate, and molecular contamination, which is crucial for ensuring the integrity of NASA missions and compliance with planetary protection requirements. Phase I of this SBIR will support the prototype development of this innovative technology. Once fully developed by the conclusion of Phase II, the MPAFS promises to offer a versatile solution for decontamination, capable of being adapted to various applications and settings, thereby catering to both space and terrestrial needs. This technology, having demonstrated efficacy in reducing pathogens significantly without causing damage to sensitive equipment, stands to benefit multiple sectors by providing an effective, low-resource consumption method for preventing cross-contamination between sample collections during spacecraft missions.

Duration: 6

Proposal Details

Proposal Number: S13.04-1011
Subtopic Title: Contamination Control and Planetary Protection
Proposal Title: Cold Plasma Sterilization for Contamination Control

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 3 - 5
Technical Abstract (Limit 2000 characters):

This proposal offers a novel method to sterilize sensitive materials, electronics, and instruments using a Radio Frequency (RF) induced plasma. This approach does not use steam, high pressure, or harsh chemicals which are not compatible with sensitive materials and electronics. The technology will be used to sterilize spacecraft assemblies and components prior to launch. It may also be used to sterilize equipment and samples taken during planetary exploration, or from studies conducted on space stations, prior to returning them to Earth. The funding provided for this project will be used to conduct laboratory experiments to determine the ability of the plasma to sterilize into cracks, crevices, and through dirt/dust coated surfaces. The specific technical objectives for this project will be to: Objective 1: Demonstrate dry plasma can penetrate into a variety of surface crevices, undulations, and cracks. Objective 2: Demonstrate dry plasma can penetrate through dirt and dust coatings to sterilize a surface. Objective 3: Demonstrate that exposure to RF induced plasma does not degrade electronics or optics. The target commercial market for this technology includes the healthcare industry, as well as the logistics services industry (i.e., delivery services). The primary healthcare market will be hospital and dental surgical scopes and other high value, electronic equipment. For the logistic services companies, the technology will be used to clean their electronic signature devices between deliveries and/or between driver shifts. As companies move away from non-contact deliveries, cleaning between deliveries is important, as well as for shift changeover to prevent spread of diseases.

Duration: 6

Proposal Details

Proposal Number: S13.05-1001
Subtopic Title: In Situ Instruments and Instrument Components for Lunar and Planetary Science
Proposal Title: Electrochemical Detection of Salts Using MOF-Composite Electrodes for Space Applications

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 2 - 3
Technical Abstract (Limit 2000 characters):

The NASA Science Mission Directorate aims to develop in situ sensors capable of detecting salts and minerals on various celestial bodies such as Mars and ocean worlds. These sensors must meet specific criteria, including enhanced sensitivity and resolution, reduced mass, power, and volume requirements, increased data transmission rates while maintaining scientific capability, resilience to the harsh conditions of space and planetary environments, and the ability to analyze and manipulate very small sample sizes or low concentrations of substances. In response to this requirement, InnoSense Corporation proposes the development of MOGE SENS™, an electrochemical sensor designed for salt detection. MOGE-SENS integrates seamlessly with metal organic framework-based electrodes, facilitating the interface with salt solutions and enabling rapid, simultaneous, and quantifiable detection of multiple salts. Phase I of the project involves the preparation, characterization, and evaluation of electrodes and MOGE-SENS devices to demonstrate compliance with NASA's specifications. Phase II activities include optimizing electrode and sensor performance, designing and fabricating electronic components and a MOGE SENS prototype, and assessing sensor performance in simulated space and planetary conditions.

Duration: 6

Proposal Details

Proposal Number: S13.05-1006
Subtopic Title: In Situ Instruments and Instrument Components for Lunar and Planetary Science
Proposal Title: CHESS: Compact High-Entendue Spectrometer for Space

Small Business Concern

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Principal Investigator

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 3 - 4
Technical Abstract (Limit 2000 characters):

Leiden Measurement Technology (LMT) proposes to design and construct the Compact High-Entendue Spectrometer for Space (CHESS), a highly-sensitive and compact spectrometer designed for emission spectroscopy applications such as fluorescence and luminescence. CHESS fits into a bounding box of 90mm x 108mm x 200mm and is especially well-suited for applications including hyperspectral fluorescence microscopy, the detection of aromatic biosignatures and other analytes including PAHS, and water monitoring applications for the detection of many classes of organic pollutants. It can serve as a detector in many different existing instrument technologies including liquid chromatographs, flow cytometers, plate readers, and point-of-care diagnostic devices. CHESS boasts an entendue (total light throughput/sensitivity) that is 25- to 1,000-times higher than similarly-sized commercial spectrometers. CHESS draws heritage from previous highly-sensitive fluorescence detection instruments funded by NASA. LMT has been able to leverage engineering solutions from these past projects to realize CHESS' high-sensitivity packed into a rugged and compact form factor. CHESS has many applications but is especially well-suited for integration into the HYMDOL hyperspectral microscope, developed with NASA funding, for the detection and characterization of microbial life on Ocean Worlds and rocky bodies such as Mars. In this Phase I, our primary goal is to reduce the risk of moving into Phase II by validating the CHESS' optical design and producing detailed designs and requirements to be implemented in Phase II. In Phase II, we will manufacture and mature CHESS towards flight applications.

Duration: 6

Proposal Details

Proposal Number: S13.05-1013
Subtopic Title: In Situ Instruments and Instrument Components for Lunar and Planetary Science
Proposal Title: Compact Lidar Spectrometer for Lunar Science and ISRU

Small Business Concern

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Principal Investigator

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 2 - 3
Technical Abstract (Limit 2000 characters):

Fibertek proposes to develop a rover-based Compact Lidar Spectrometer (CLS) to enable long-range stand-off detection of water ice and other surface volatile species. The CLS system is designed to provide simultaneous range and spectroscopic absorption data within the 2.5 um to 4 um wavelength band. A stand-off measurement capability from 10 m out to 10,000 m is anticipated for the system. The CLS instrument addresses scientific objectives outlined in both 2012 and 2023 Planetary Decadal Surveys and the 2018 LEAG Next Steps for Lunar Exploration, including determining the presence and distribution of water ice and other volatiles. The LCROSS mission's discovery of water, hydrocarbon, and other species in Cabeus crater highlights the potential role of comets and micrometeorites in the delivery of water, organics, and other volatile species to the lunar surface. In-situ measurements of the D/H ratio of ices in permanently shadowed regions (PSRs) are needed to understand the relative importance of key processes which determined how these volatiles were first delivered to the polar cold traps and how they evolved over time. While the CLS instrument alone cannot provide answers to all these questions, the instrument can be used to rapidly map out large regions and identify areas of interest. Beyond planetary science goals, the CLS can similarly be used identify regions of water, methane, ammonia, and CO2 that are needed for in situ resource utilization. A CLS equipped rover can then strategically maneuver to areas most likely to provide the greatest return while minimizing risk. Once an area of interest has been identified, other scientific or ISRU instruments can be deployed to maximize mission goals. The enabling technology is a unique fan-out grating optical parametric oscillator resonator design providing broad infrared tunability within the 2.5 um to 4 um band. The proposed tunable IR laser transmitter heavily leverages heritage flight components to reduce dev risk.

Duration: 6

Proposal Details

Proposal Number: S13.05-1028
Subtopic Title: In Situ Instruments and Instrument Components for Lunar and Planetary Science
Proposal Title: Advancing SERS: Next-Level Organic Detection for Life Missions

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 1 - 3
Technical Abstract (Limit 2000 characters):

The proposal introduces an advanced Surface-Enhanced Raman Spectroscopy (SERS) architecture to revolutionize organic compound detection in space exploration, particularly for life detection missions. By leveraging plasmonic nanostructure-coated transparent viewports, the technology promises enhanced sensitivity and cost-effectiveness, suitable for budget-capped missions. Phase I funding will focus on demonstrating the feasibility of this SERS system, optimizing substrate-laser

interactions for improved detection limits, substrate stability, and selectivity. In addition to life missions, Impossible Sensing targets the marine Carbon Dioxide Removal (mCDR) Monitoring, Reporting, and Verification (MRV) market, filling the current gap in high-resolution, real-time data collection, a key impediment to the emerging mCDR industry.

Duration: 6

Proposal Details

Proposal Number: S13.05-1030
Subtopic Title: In Situ Instruments and Instrument Components for Lunar and Planetary Science
Proposal Title: (COSMOS) Compact Standoff Biomolecular Observation System

Small Business Concern

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Principal Investigator

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 2 - 3
Technical Abstract (Limit 2000 characters):

Nalu Scientific LLC (Nalu) proposes to develop and fabricate “Compact Standoff Biomolecular Observation System (COSMOS)”, a fast standoff video imaging system for searching for evidence of life through the sensitive detection of biomolecules and polyaromatic hydrocarbons (PAHs). The COSMOS system will be suitable for deployment on Mars and planetary rovers and also will function effectively in oceanic environments. It will use a compact solid state, conductively cooled Nd:YAG nano-second pulsed laser that simultaneously provides two excitation wavelengths, 355 and 532 nm, along with a compact, sensitive gated color 3.1M pixel CMOS camera detector. The system will be compact, portable, low mass and low power, and able to locate biological materials and organics with PAHs in an area ~1600 cm2 wide from a target distance of 3 m via live video using fast fluorescence signals. Through time gating, it is able to cleanly distinguish short-lived fluorescence signals from biological materials and PAHs from much longer-lived mineral phosphorescence and can operate in any ambient light conditions. The COSMOS instrument will be highly sensitive and capable of detecting PAH concentrations below 1 ppb from a stand-off distance of 1 m. Color imaging allows simultaneous detection of various objects in the targeted area through differentiation using shades of color and morphological features. The baseline system from which we will develop the COSMOS instrument has been successfully demonstrated during daylight for the detection of natural biological materials present in the oceanic waters surrounding Hawai’i and has also identified biological remains present in a 150 million year old fossil buried in a fluorescent clay matrix. COSMOS’s low size, mass and power as well as its wide-area video-speed imaging capabilities for biodetection has the potential to be extraordinarily useful in future NASA rover/lander life detection missions in both land and oceanic environments.

Duration: 6

Proposal Details

Proposal Number: S13.06-1008
Subtopic Title: Dynamic Power Conversion
Proposal Title: Multilayered Metal Insulation (MLMI) for Radioisotope Power System Designs

Small Business Concern

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Principal Investigator

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 2 - 3
Technical Abstract (Limit 2000 characters):

The Radioisotope Power Systems provide space power and energy storage that enable robotic spacecraft for exploration missions through our solar system. These systems must insulate hot parts from cold using advanced multilayered metal insulation (MLMI) that could reduce system losses. The conventional manufacturing method of MLMI suffers from poor insulative property, long lead time and high manufacturing costs due to manual position of standoffs between thin insulation layers (thickness of 100 micron with a target 100 micron gap). The challenge with achieving the targeted layer separation distance, layer thickness, control density and location of standoffs are critical aspects that effect the insulative property of MLMI. In Phase I, Faraday Technology and Physical Sciences, will address these challenges by demonstration of a manufacturing approach and thermal modelling to fabricate MLMI. Our current target for improved insulative properties is to decrease the thermal conductivity of MLMI from current value of 0.02 W/m·K to < 0.001 W/m·K. The proposed manufacturing approach will also reduce fabrication cost and lead time by combining additive manufacturing and electrochemical technologies to eliminate the manual application of standoffs. We will perform thermal analysis and develop thermal model to refine MLMI design. The Phase I results will be a platform from which Phase II would enable refinement of each manufacturing step and thermal model to improve the insulative properties of MLMI. We envision that by the end of the Phase II our team will develop a method such that completed MLMI packages for Radioisotope Power Systems will be fabricated and tested at NASA Glenn Research Center. In Phase III, we will work with commercialization partners and the NASA to transition and integrate this manufacturing method such that production costs and lead times for high performance MLMI can be further reduced.

Duration: 6

Proposal Details

Proposal Number: S13.06-1014
Subtopic Title: Dynamic Power Conversion
Proposal Title: Multi-Channel Stirling Convertor Space Controller (MC-SCSC)

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 2 - 4
Technical Abstract (Limit 2000 characters):

West Coast Solutions (WCS) and Sunpower, Inc. propose to build on a recent and highly successful NASA Phase I demonstration of a single-channel Stirling Convertor Space Controller (SCSC) by extending the architecture to support up to eight (8) convertors with the Multi-Channel SCSC (MC-SCSC). The proposed MC-SCSC Phase I Program directly addresses the electronic controller technical challenge identified under Topic S13.06. Phase I will focus on defining the optimum controller architecture to maximize the Stirling power convertor system performance and reliability. In addition, a brassboard demonstration of a multi-channel electronic controller will be performed with a combination of SCSC drives modified as required to incorporate the new functionality (e.g., synchronization, power sharing, etc.) and a representative set of simulated loads. WCS will thus exit Phase I with a clear definition of what is required to deliver a complete prototype, flight-design, radiation hard MC-SCSC in Phase II. By the end of Phase I, WCS and Sunpower will have defined the optimum multi-channel electronic controller architecture to maximize system reliability, maximize fault tolerance, and optimize performance. The team will also have performed risk reduction laboratory experiments with multiple simulated SRSC loads (minimum two, baseline four) as a robust proof-of-concept demonstration. During Phase II, a path-to-flight engineering development unit (EDU) MC-SCSC will be built and tested with Sunpower- or possibly government-provided SRSCs (or equivalent) to verify complete end-to-end performance of a multi-convertor Stirling power generation system, exiting the Phase II Program at TRL 5 (minimum). Achieving TRL 5 in Phase II will put the WCS-Sunpower Team in a strong position to offer this technology for near term future missions where solar power is not an option and there exists a need for long term operation of a spacecraft, lander, or rover for exploration.

Duration: 6

Proposal Details

Proposal Number: S13.06-1015
Subtopic Title: Dynamic Power Conversion
Proposal Title: Dynamic Power Conversion

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 2 - 4
Technical Abstract (Limit 2000 characters):

This project aims to produce a small, very high performance, radhard, modular AC-DC Fission Surface Power (FSP) controller that incorporates a novel fine dust and EM mitigation solutions. The program focus is to develop a small radhard power manager for a lunar rover mounted FSP generator enabling long duration operation in dark conditions. The solution is based on advances in radhard ASIC controller/modulator technology and radhard bidirectional wide bandgap (WBG) bidirectional converter power topology. Future work will expand to extending the controller system to a novel GaN-based bidirectional isolated converter for system-level demonstration meeting lunar and M2M Surface mission needs, especially in regard to supporting lander and rover missions. Our initial focus being development of small nuclear fission power delivery based on power electronics that can safely operate in lunar radiation/dust environments while providing power generation in the dark conditions as to enable long duration exploration in permanently shadowed areas or during lunar nights.

Duration: 6

Proposal Details

Proposal Number: S14.01-1005
Subtopic Title: Space Weather Research-to-Operations-to-Research (R2O2R) Technology Development and Commercial Applications

Proposal Title: An Advanced Surface Flux Transport Model for Space Weather

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 3 - 4
Technical Abstract (Limit 2000 characters):

The solar magnetic field (B) plays a key role in solar and heliospheric physics and is a crucial input for Space Weather Models. This input is in the form of full-Sun maps of B. Standard observatory maps are constructed diachronically and contain data that is as much as 27 days old. Assimilative Surface Flux transport (SFT) models can improve upon this input, by incorporating known surface flows and processes to produce a continuous approximation of the state of the photospheric magnetic field, as a sequence maps. These synchronic maps can allow space weather models to produce more accurate results. To assess uncertainty and sensitivity of solutions, SFT should produce multiple map realization sequences. Presently available SFTs are based on legacy codes that computationally can provide only a small number of realizations at low resolution in a practical amount of time. None are open source. Our project will develop OFTSWA (OFT for Space Weather Applications), an advanced SFT that will acquire and assimilate magnetograms and rapidly produce multiple realizations at high resolution that estimate the present state of the Sun's surface magnetic field. It is based the Open-source Flux Transport (OFT) model. In phase I, we will extend OFT to

multiple data sources and demonstrate a prototype of OFTSWA for a solar cycle with multiple realizations. In phase II, we will deliver OFTSWA to the CCMC, along with interfaces and tools that will the community to interact with OFTSWA and create map sequences for use in a variety of space weather models and applications. Within NASA, OFTSWA will be beneficial to the Community Coordinate Modeling Center (CCMC), especially as part of their support to the Moon to Mars Space weather Analysis Office. Outside NASA, NOAA Space Weather Prediction Center and the Air Force also require solar magnetic maps for Space Weather Models.

Duration: 6

Proposal Details

Proposal Number: S14.01-1009
Subtopic Title: Space Weather Research-to-Operations-to-Research (R2O2R) Technology Development and Commercial Applications
Proposal Title: Containerized Models to Predict Ionospheric Scintillations

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 1 - 5
Technical Abstract (Limit 2000 characters):

Ensemble's innovative proposal targets ionospheric scintillation characterization, monitoring, and prediction. The technology, designed for North America, aims to deliver precise scintillation indices estimates for amplitude and phase. This proposed effort covers four key tasks: - Data Pipeline Creation: Establishing a robust pipeline to collect and process diverse data relevant to scintillation, ensuring a reliable dataset for ML model training. - Data Transformation and Cleaning: Ensuring temporal and spatial alignment of data sources, addressing gaps, and preparing the dataset for ML model training, including solutions for an imbalanced dataset. - ML Model Development and Validation: Using AWS SageMaker, Ensemble will develop two ML models—convolutional neural network (CNN), and Long Short Term Memory (LSTM). - Model Deployment and Alert System: Deploying the models via AWS SageMaker, generating predictions up to 4 hours into the future at 15-minute intervals. Implementing an alert system for stakeholders when scintillation is predicted. This effort will involve data collection, processing, model development, cloud computing resources, and deployment infrastructure. Target markets include aviation, telecommunications, agriculture, construction, and emergency services, benefiting industries reliant on precise GNSS communication and positioning. Ensemble's methodology bridges critical space weather research gaps, contributing to national security objectives outlined by the SWORM subcommittee. Beyond operational reliability, the proposal offers actionable alerts, improved safety, and enhanced understanding of ionospheric scintillation phenomena.

Duration: 6

Proposal Details

Proposal Number: S14.01-1013
Subtopic Title: Space Weather Research-to-Operations-to-Research (R2O2R) Technology Development and Commercial Applications
Proposal Title: Applications for Differentiating Cybersecurity and Space Environment Hazards to Satellites

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 2 - 3
Technical Abstract (Limit 2000 characters):

The overall goal of this project is to safeguard the growing satellite fleet that underpins our intricately connected technological infrastructure. This critical asset faces both man-made threats and natural hazards from the space plasma and radiation environment that pose a complex challenge for reliable operations. To address these interdependent threats, we will develop a toolset to give commercial and government satellite operators real time and retrospective awareness of these space weather hazards and their relationship to cybersecurity threats. Phase I will evaluate methods, models, and user needs for identifying and differentiating between cyber and space environmental impacts to satellites on-orbit and define a prototype application to deliver this information to users. The proposed analysis and application development falls under subtopic S14.01 Space Weather Research-to-Operations-to-Research (R2O2R) and addresses priority area (1), which calls for “products that directly aid in spacecraft-anomaly resolution and assist end users such as spacecraft operators" and area (2) that calls for “Commercial and decision-making applications for space-weather technologies”. Our goal is to deliver an application that brings in cyber information, space environment data, and reported anomalies and allows cyber analysts, satellite operators, and space industry stakeholders to understand the current real time threats, evaluate longer term trends, and respond effectively. This project brings together cybersecurity experts, space weather scientists, application developers, and users to solve this problem in an information sharing environment with a collaborative approach to ensure success.

Duration: 6

Proposal Details

Proposal Number: S14.01-1017
Subtopic Title: Space Weather Research-to-Operations-to-Research (R2O2R) Technology Development and Commercial Applications
Proposal Title: Commercial data assimilation tool for operational thermospheric density

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 4 - 5
Technical Abstract (Limit 2000 characters):

The Low Earth Orbit (LEO) regime is becoming more congested as the number of satellites continues to grow with the rising popularity and establishment of SmallSat constellations. Accordingly, there is strong interest by U.S. agencies, companies, and international organizations to manage LEO collision hazards. Improved thermospheric density nowcasts and forecasts are a critical need identified by the Space Weather Operations, Research, and Mitigation (SWORM) Working Group, a Federal interagency coordinating body [National Space Weather Strategy and Action Plan, 2019]. The purpose of the proposed work is to provide a commercial data assimilation (DA) tool that combines various data sources to provide a corrected global density state. The nowcast corrected global density state can then be combined with Space Environment Technologies' (SET) operational forecast space weather indices to produce a forecast global density state 2- to 3-days in the future. Because the state-of-the-art in density estimation, the High Accuracy Satellite Drag Model (HASDM), is not available for use outside of the US Government, there is a need for a commercial DA tool that can provide operational nowcast and forecast densities to satellite operators for day-to-day operations. With a team of investigators that have experience with the development of HASDM, the intended use of funding is to construct a commercial DA tool that assimilates radar tracking data and Energy Dissipation Rates (EDRs) of calibration satellites to correct a background density model and produce a global density state. The end goal is an operational commercial density data stream that offers accuracy equal to or surpassing that of HASDM. We consider four cases of growth for our commercial data assimilation tool to improve thermosphere density forecasts: civilian agency satellites, defense applications, commercial satellites, and space traffic management.

Duration: 6

Proposal Details

Proposal Number: S14.01-1019
Subtopic Title: Space Weather Research-to-Operations-to-Research (R2O2R) Technology Development and Commercial Applications
Proposal Title: Enhanced System-Level Single Event Effects for Space Weather Operations

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 2 - 3
Technical Abstract (Limit 2000 characters):

For this proposal, Fifth Gait plans to develop enhancements to system-level single event effects for space weather operations. Integrating system-level modeling into the Space Ionizing Radiation Environment and Effects (SIRE2) family of tools would provide a seamless environment and system-level modeling tool to the community. The proposed work is designed to provide the capability to perform system design calculations more quickly, which enables new workflows. Integrated environment and system failure calculations will allow the system designer to iterate though a larger number of radiation environment scenarios and a larger number of system designs. The Fifth Gait team will investigate system-level probability of survival capabilities to identify the current workflows used by the community and evaluate how the workflows fit inside the SIRE2 family of tools. The evaluation will include prototyping the different workflows to assess the potential feasibility of each one. Fifth Gait will also develop an effects categorization capability to calculate the upset rate inside a simulated electronic board or package. The categorization capability will include the peak effect for the board or package at each timestep in a trajectory. Finally, the Fifth Gait team will investigate SEE models to assess each model for their potential integration into the SIRE2 family of tools during a Phase II effort. The Petersen Figure of Merit model will be added to the SIRE2 family of tools to estimate the SEE rate.

Duration: 6

Proposal Details

Proposal Number: S14.02-1004
Subtopic Title: In Situ Particles and Fields and Remote-Sensing-Enabling Technologies for Heliophysics Instruments
Proposal Title: Production of Magnetic Core Materials for Flux-Gate Magnetometers

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 1 - 3
Technical Abstract (Limit 2000 characters):

SkyVision Sciences proposes to develop a process for fabricating Mo-Permalloy (6-81.3). The material is used as the core material in advanced magnetometers. Sourcing of high quality Mo-Permalloy has become increasingly difficult in the U.S. and worldwide making its replacement imperative. The Phase I effort will develop an electrolytic process for fabricating the Mo-Permalloy foils. The resulting foils will be measured for their magnetic, mechanical, and electrical properties including Barkhausen noise in order to optimize its functionality. The Phase II effort is envisioned to further improve and characterize the materials properties, scale the fabrication process, and provide material to NASA or its partners for fabricating a magnetometer with this new core material.

Duration: 6

Proposal Details

Proposal Number: S14.02-1010
Subtopic Title: In Situ Particles and Fields and Remote-Sensing-Enabling Technologies for Heliophysics Instruments
Proposal Title: THz LO Sources for Heliophysics

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 2 - 4
Technical Abstract (Limit 2000 characters):

This proposal is responsive to NASA SBIR Subtopic S14.02: In Situ Particles and Fields and Remote-Sensing-Enabling Technologies for Heliophysics Instruments; the bullet item “Technologies for precise radiometry at THz bands corresponding to upper atmosphere thermal emissions in the 1-5 THz range, particularly at 4.7 THz.” The primary goal of this SBIR effort is the development of local oscillator (LO) sources for NASA applications in the 1 – 5 THz frequency range. A prime example is the measurement of wind and temperature in the lower thermosphere and E-region ionosphere using terahertz limb sounding measurements of the OI thermal emissions at 2.06 THz or 4.75 THz. The primary Phase I goal is to demonstrate a compact and power efficient LO source that achieves the ~2.0 mW required to fully pump a subharmonic mixer operating at 2.06 THz*. This prototype system will use a power amplifier at 172 GHz, followed by a varactor doubler to 343 GHz, and a new varactor tripler to 1.03 THz. The PA will use four-way power combining, generating about 450 mW. The dissipated power is estimated to be 14W. The doubler will generate more than 100 mW. Thus, the new tripler must achieve an efficiency of about 2%. However, even higher efficiency is greatly desired, and efficiency as high as 4% is feasible. The Phase I effort will include the design of a more powerful and power efficient power amplifier MMIC. In Phase II the new amplifier MMIC will be fabricated and used to greatly improve the power efficiency of the 2.06 THz source. The source will also be integrated into a single waveguide housing, creating a very compact and power efficient module ideal for use on a SmallSat or CubeSat platform. The work will also be extended to other frequencies, and potentially to 4.7 THz. *D.L. Wu et al, “THz limb sounder for lower thermospheric wind, oxygen density, and temperature,” J. Geophysical Research: Space Physics, Vol. 121, Issue 7, June 2016.

Duration: 6

Proposal Details

Proposal Number: S14.02-1013
Subtopic Title: In Situ Particles and Fields and Remote-Sensing-Enabling Technologies for Heliophysics Instruments
Proposal Title: 6 Meter Antenna and Boom System for CubeSats

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 2 - 4
Technical Abstract (Limit 2000 characters):

Heliospace Corporation proposes accelerated work in development of modular CubeSat-scale, 6 m length passively deployed antennas and instrument booms based on our successful larger SABER helical strip spring technology. While Heliospace has produced similar small-diameter antennas up to 2.7 m deployed length, demonstrating feasibility beyond 3 m requires focused research and development effort which, unless performed prior to and independently of mission formulation, may limit the required maturity of the technology for scientific and other objectives. Antennas and booms based on similar helical strip springs have traditionally been limited to deployed lengths under 3 meters and have demonstrated their suitability for CubeSats on SunRISE. Since then, the sole supplier of those elements has fully discontinued producing any springs of the needed geometry. Establishing an alternative CubeSat-scale helical strip spring production capability is critical for responsive production of low-cost systems antennas and booms for CubeSats. Proposed development of highly compact, modular deployment management mechanisms and specialized tether-harnesses will enable significant extension of deployed lengths past 3 m. The envisioned mechanisms will improve deployed physical properties, enabling their use as finely tuned monopole antennas, formed elements within larger antenna assemblies, and precision-length booms for sensors. The simple and compact nature of the proposed devices will enable better measurements by smaller, lower-cost spacecraft for space physics, planetary and earth science missions, as well as commercial and defense applications. Additionally, engineering and production efficiency will reduce system costs. Heliospace employees have significant experience and involvement with similar previous helical strip springs and their derivative systems. Work will be completed at Heliospace’s existing spaceflight hardware facility in Berkeley, CA.

Duration: 6

Proposal Details

Proposal Number: S15.01-1000
Subtopic Title: Plant Research Capabilities in Space
Proposal Title: Acoustilytix: An Intelligent Bioacoustics System for Monitoring Plant Health

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 3 - 4
Technical Abstract (Limit 2000 characters):

Cornerstone Research Group (CRG) proposes to develop an intelligent bioacoustics system capable of detecting and classifying the bioacoustics produced by plants when exposed to various stressors, addressing the need to produce crops during NASA's future space exploration missions. Plants have been shown to emit bioacoustics as a result of different stressors and provide a means for early detection of both gradually induced and sudden stressors that could impact grow yields and plant nutrition quality.

CRG will leverage a previously developed technical readiness level 6 software platform that was developed for detecting and classifying rodent ultrasonic vocalizations (DHP SBIR W81XWH-17-C-0032 and NIH STTR 1R41MH121119-01) to create a bioacoustics monitoring system capable of detecting bioacoustics emitted by plants with integrated machine learning to classify different types of stressors. This approach will improve upon the current state-of-the-art by providing more specific and timely information about the nature of the stressors, allowing early intervention and mitigating the potential loss of mission critical crops. The proposed team's track record of innovation positions CRG for successful development and implementation of this proposal to meet and exceed NASA's operational needs.

Duration: 6

Proposal Details

Proposal Number: S15.01-1003
Subtopic Title: Plant Research Capabilities in Space
Proposal Title: Au-TiO2-Al2O3 nanocomposites for multi-analyte detection and plant health monitoring

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 2 - 4
Technical Abstract (Limit 2000 characters):

Aimed to detect water, nutrient, and disease in plants by wearable sensors that operate in ISS or crewed habitat for generic plants with smooth or hairy leaves, we propose to develop a concurrent one-channel multi-analyte detection sensor that is composed of thin-film $Au-TiO_2-Al_2O_3$ nanocomposites (1-2 cm wide, 1-2 cm long, 10-50 µm thick, suitable for most crop leaves) to simultaneously detect water, ethylene (C_2H_4), and hexanal ($C_6H_{12}O$) on plant leaves (for concentrations as low as 1 ppm) based on the reversible adsorption, photooxidation (if applicable), and desorption process. This system would enable in situ and non-destructive detection of gaseous molecules of interest by recording real-time changes in electrical resistance of the thin-film sensor when these molecules are adsorbed and desorbed on the nanocomposite. The whole signal recording system will be designed to be miniaturized, easy to calibrate (on Earth and aboard ISS), easy to operate, and wireless (in Phase II). Goeppert will also provide detailed instruction on its calibration, operation, data collection, and artificial intelligence (AI)-driven analysis. Our instrument is designed to (1) enable low-concentration and multiplexed determination of inorganic and organic analytes from the emission of stomates on plant leaves, where more analytes in addition to water, ethylene, and hexanal will be studied after Phase I, and (2) establish a miniaturized, wireless, and AI-driven analytical laboratory for the health monitoring of plants in future ISS and NASA missions. Low-frequency maintenance and self-adjusted calibration also render critical values for space applications to minimize crew time costs. Our innovation will enable smart agricultural and vertical farming which significantly reduces transportation costs of vegetables into ISS and future lunar habitats.

Duration: 6

Proposal Details

Proposal Number: S15.01-1011
Subtopic Title: Plant Research Capabilities in Space
Proposal Title: Multi-Analyte VOC and Stressor Sensing Node for Plant Health Monitoring

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 2 - 5
Technical Abstract (Limit 2000 characters):

We propose an integrated system which includes an array of printed amperometric sensors for detection of methanol, ethylene and other VOCs indicative of plant health in growth chambers. This array of sensors will be printed on a thin polycarbonate film, leveraging processes developed for our standard SPEC Sensor air quality sensors. Since amperometric sensors are essentially fuel cells, power requirements will be negligible, easily powered by small solar cells and ambient light. Successful completion of this project will result in a flexible, self-powered plant health sensor that can be attached to plant leaves or integrated into the in-flight plant growth chamber hardware. This system will allow spaceflight personnel to identify problems early so they can take corrective action before crop health, productivity, and safety are negatively affected. The overall technical objectives of this project are: design, development and test in laboratory (Phase I) and real-world environment (Phase II) a low-power, accurate and lightweight sensor for monitoring the transpiration of VOCs indicative of plant growth and health, as well as the climate-related stressors in the chamber. The sensors must be sensitive to low-ppb concentrations, and accurate over a range of environmental conditions, including operation in microgravity and compatibility with cabin atmospheres Successful completion of Phase I will provide path toward a Phase II demonstration. A successful Phase II will demonstrate measurements that are reliable indicators of plant health, with deliverable prototypes for NASA testing, ready for in-flight demonstration. In addition to the NASA in-space applications, this new technology will be valuable for the rapidly growing greenhouse

and "vertical farming" markets. These markets are expected to increase even more rapidly as population growth and climate change deplete available farmland.

Duration: 6

Proposal Details

Proposal Number: S15.01-1014
Subtopic Title: Plant Research Capabilities in Space
Proposal Title: Sensors for Precision Agriculture and Crop Management Decisions

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 2 - 4

Technical Abstract (Limit 2000 characters):

Wearable plant sensors are expected to revolutionize agricultural data collection, according to the World Economic Forum, Center for the Fourth Industrial Revolution, Top 10 Emerging Technologies of 2023. Wearable plant monitors, and the resulting analytical decision tools, promise to improve plant health and increase agricultural productivity. To develop wearable plant monitors that provide actionable data on plant health for optimized growth and production of agricultural crops, sensors capable of the non-destructive evaluation (NDE) of critical plant signaling molecules are needed. The sensors developed in this effort will acquire relevant data that are easy to interpret. The sensors will be inexpensive, light weight, low power, long lasting, and capable of easily providing data to a centralized data storage and analysis tools. TDA Research's sensors will provide plant health data which will be critical to the implementation of precision agriculture, were each plant is optimized for agricultural production. On-plant studies during this research effort will help establish the form factor of the wearable monitor and establish sensor data correlation for optimum and stress growth conditions. According to the United States Department of Agriculture, from 2014 to 2021, the U.S. has lost 13.6 million acres of farmland. The United Nations Food and Agriculture Organization predicts that world food production will need to increase by 70% by 2050. NDE plant sensors that can be incorporated into a wearable plant monitor to enable precision agriculture to optimize production of food crops through individual plant management decisions will be necessary. As increases in agricultural productivity are required in higher density grow locations, both farmers on earth and space exploration will require wearable plant monitors to optimize agricultural productivity.

Duration: 6

Proposal Details

Proposal Number: S15.02-1002
Subtopic Title: In Situ Sample Preparation and Analysis for Biological and Physical Sciences in a Microgravity Environment
Proposal Title: Self-Contained Dual-Mode Sample Preparation Module Using Non-Hazardous Reagents

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 2 - 5
Technical Abstract (Limit 2000 characters):

AI Biosciences proposes to demonstrate the ability of a microgravity-compatible, compact, dual-mode automated sample preparation cartridge (DM-SPC) platform that processes samples from various sample matrices (swab, potable water, blood, urine, etc.) to yield high-quality nucleic acids for downstream molecular detection and identification in a closed-cartridge system. The use of novel, non-hazardous reagents will ensure crew safety. Its primary function will enable NASA to rapidly identify microorganisms that could affect crew safety. The design allow both manual and automated operation of the process. This highly flexible system, when operated in auto-mode, will allow previously complicated, labor-intensive, and time-consuming processes to be carried out by a programmable, turn-key, and closed system using pre-filled cartridges. The DM-SPC can also be used to capture and purify cell and protein targets.

Duration: 6

Proposal Details

Proposal Number: S15.02-1005
Subtopic Title: In Situ Sample Preparation and Analysis for Biological and Physical Sciences in a Microgravity Environment

Proposal Title: Design and Material Testing for a Self-contained system for Microgravity Sample Preparation

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 2 - 3
Technical Abstract (Limit 2000 characters):

This proposal seeks to develop technology to address difficulties relating to performing sample preparation methods in a microgravity environment. Transferring, retaining, and entraining liquids without the aid of gravity present challenges as liquids can simply float in air rather than flow to the bottom of vials or tubes. This also presents issues in attempting to interact solid or liquid samples with liquid reagents, as there is no force holding the materials in contact. What is proposed is a cartridge that contains the necessary reagents to perform a sample preparation procedure, into which the sample itself is loaded. By controlling liquid flow, removing air from the system, and keeping the system sealed to entrain the liquid, processing on the cartridge will not be affected by the presence or absence of gravity. This Phase I effort seeks to evaluate different component designs and materials for the cartridge to control flow, move liquids, allow for sample introduction, and remove air from the system. The proposed generic cartridge designs will allow for individual component evaluation and integrated component testing. The necessary hardware and software for cartridge component

testing will be fabricated as part of this effort. Once the individual components are fully evaluated, an integrated cartridge will be fabricated and tested for sample processing, and the results compared with traditional laboratory-based methods. Phase II work will create multiple cartridge designs specific for different sample processing methods.

Duration: 6

Proposal Details

Proposal Number: S16.03-1003
Subtopic Title: Guidance, Navigation, and Control
Proposal Title: Miniature High-Performance Integrated Photonics IMU

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 3 - 5
Technical Abstract (Limit 2000 characters):

We propose a radical new approach for to the design and fabrication of Inertial Measurement Unit (IMU) that will meet the requirements for future NASA applications. The IMU is based on photonic Planar Light Circuit (PLC) technology and will implement an Integrated Silicon-photonics interferometric Optical Gyroscope (iSOG). The iSOG includes all the sensor's optical elements in one small optical chip and enables the development of a 5 cube inches IMU that combines high-tactical grade performance (better than 1 deg/hr over temperature) with higher reliability, high level of robustness and lower cost. Such an IMU will provide the best performance in a compact, ruggedized configuration suitable for the future low weight and harsh radiation environments experienced by satellite and space exploration. The iSOG based IMU will have more than an order-of-magnitude improvement in bias stability over temperature when compared to the highest performance commercially available MEMs and FOGs in the same volume and is also inherently radiation hardened, vibration and shock hardened and is best suited technology for future NASA and DoD missions.

Duration: 2

Proposal Details

Proposal Number: S16.03-1021
Subtopic Title: Guidance, Navigation, and Control
Proposal Title: Enhancing Sensitivity of Ring Laser Gyroscopes and Accelerometers using Slow-Light Augmented Unbalanced Mach-Zehnder Interferometry

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 3 - 4
Technical Abstract (Limit 2000 characters):

Currently, there is a need for very accurate inertial measurement units, based on rotation sensing and accelerometry. For a ring laser, which can be used for measuring rotation and acceleration, the measurement sensitivity is proportional to the minimum measurable frequency shift (MMFS), which is given by the geometric mean of the spectral width of the ring laser and the measurement bandwidth, for conventional detection. Here, we propose to use a Slow-light Augmented Unbalanced Mach-Zehnder Interferometer (SLAUMZI) to reduce the MMFS substantially. In a SLAUMZI, a medium with a large group index (GI) is inserted in one arm of the MZI. GI as high as ten million can be produced using electro-magnetically induced transparency (EIT). The SLAUMZI amplifies the fringes, resulting from a frequency scan, by a factor of the GI, compared to a regular unbalanced MZI. The factor of reduction in the MMFS is is given approximately by the ratio of the slow-light group index, and the finesse of the ring laser cavity, if the SLAUMZI and the cavity have similar dimensions. In a recent paper, we have reported verification of this mechanism, producing close agreement between theory and experiment, and demonstration of a reduction in MMFS by a factor of as much as ~twenty thousand. Under this proposal, we will investigate the feasibility of using this approach to realize an ultra-sensitive ring laser gyroscope and accelerometer. A ring cavity, incorporating a spring-mounted mirror, will produce two counter-propagating Rb Raman lasers, with a frequency difference matching the free spectral range of the cavity, to eliminate the lock-in effect. The difference and sum of the frequency shifts of the two lasers will be proportional to rotation and acceleration, respectively. If this cavity has a finesse of ten thousand, comparable to that of the best ring laser gyroscope, a GI of ten million would improve the sensitivity of rotation sensing and accelerometry by a factor of a thousand.

Duration: 6

Proposal Details

Proposal Number: S16.03-1024
Subtopic Title: Guidance, Navigation, and Control
Proposal Title: Autonomous GNC Solution with Optical GEO Object Tracking

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 1 - 3
Technical Abstract (Limit 2000 characters):

Kayhan Space and TransAstra propose an innovative solution for autonomous Guidance, Navigation, and Control (GNC) with optical Geostationary Orbit (GEO) object tracking for cislunar spacecraft. This novel, passive method integrates Kayhan's Dynamics, a high-fidelity and computationally efficient orbit propagation and determination software, with TransAstra's Sutter Telescope Technology, known for its extreme optical sensitivity. This synergy enables the detection of distant, faint GEO belt satellites, which serve as waypoints for autonomous navigation, significantly reducing reliance on ground-based systems. The primary goal is to demonstrate the feasibility of an onboard cislunar Position, Navigation, and Timing (PNT) capability that promises a low Size, Weight, Power, and Cost (SWaP-C) footprint, making it a scalable solution across a broad spectrum of missions. The turnkey PNT payload will facilitate more robust and efficient mission operations, boosting engineering and

scientific returns. This proposal outlines a plan to achieve these objectives through a phased approach, starting with a feasibility study, developing a high-fidelity simulation environment, and conducting comprehensive covariance analysis and trade studies. The proposed technology supports the rapidly expanding cislunar market, addressing the pressing need for sustainable space operations amidst the growing number of missions and strained ground-based systems. Kayhan Space and TransAstra's collaboration brings together cutting-edge software and sensor technology to pioneer an autonomous navigation system that leverages the observable GEO belt satellites from lunar distances. This project not only showcases a path towards independent cislunar navigation but also paves the way for establishing a cislunar PNT ecosystem critical for future lunar and beyond-Earth missions.

Duration: 6

Proposal Details

Proposal Number: S16.04-1002
Subtopic Title: High-Altitude Platform Systems (HAPS) Capability Demonstration
Proposal Title: HAPS Day Night Hyperspectral Imaging Demonstrator

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 3 - 5
Technical Abstract (Limit 2000 characters):

High-altitude platform systems (HAPS) are a cutting-edge technology that can provide persistent Earth observations from the stratosphere. Innovative Imaging and Research (I2R) has partnered with Aerostar to develop a versatile HAPS Day Night (DANI) Hyperspectral Imaging Demonstrator to explore how HAPS can enable persistent hyperspectral imaging under both low light and bright sunlit conditions. The project will integrate an imaging payload consisting of a hyperspectral imager, a long wave infrared (LWIR) thermal infrared camera, and a high-resolution red-green-blue (RGB) visible camera into the Aerostar stratospheric Thunderhead Balloon system. The DANI hyperspectral imager will be designed to collect high-resolution spectra of night lights, which will be used to generate specific light maps to help us understand energy usage, light pollution, and human activity like never before. Taking advantage of the HAP's lower speed and altitude, the proposed system's sensitivity and dynamic range can be orders of magnitude higher than any moderate-resolution hyperspectral sensor in orbit or planned. The DANI hyperspectral imaging payload will also support the Surface Biology and Geology Mission by providing daytime hyperspectral measurements of leaf canopy chemistry during the growing season and, through persistent monitoring, by collecting data missed by traditional polar-orbiting satellites when significant changes occur between satellite overpasses. The thermal infrared camera will be used to detect clouds at night and provide insight into canopy temperatures. As an added benefit, it will also be able to monitor fires and potentially volcano eruptions and lava flow. A complementary high-resolution framing camera will be used to measure topography using structure from motion (SfM) techniques. These measurements support the needs described by the Surface Topography and Vegetation (STV) Incubation team, which identified the need for more frequent topography observations.

Duration: 6

Proposal Details

Proposal Number: S16.04-1003
Subtopic Title: High-Altitude Platform Systems (HAPS) Capability Demonstration
Proposal Title: Swift Ultra Long Endurance (SULE) High-Altitude Platform Systems (HAPS) Capability Demonstration

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 6 - 7
Technical Abstract (Limit 2000 characters):

The Swift Ultra Long Endurance (SULE), along with our experience in flight planning within FAA regulations, onboard computing, telemetry, payload selection/ integration, and successful SULE flight testing will be used to complete all Phase I deliverables for an effective transition into the Phase II flight demonstration. As a HALE aircraft, the SULE allows for near continuous surveillance, communications, and sensor coverage, operating as a pseudo-satellite while staying clear of the national airspace and remaining fuel independent thanks to solar power. Swift's previous and continued success with the SULE program has demonstrated our ability not only to plan and create detailed concepts of operations, but to actually perform our missions safely while working within FAA regulations. This experience combined with Swift's continued relationship with NASA on HAPS programs makes us the ideal and low risk partner for this SBIR. Funding will be used specifically for the labor involved with the Phase I deliverables. The funding will be using specifically for Phase I task labor to allow for Swift to continue its schedule 65K+ MSL flight testing without having to reallocate financial resources to complete Phase I flight planning. Each deliverable will be validated to set the conditions for an immediate start into Phase II. Phase II funding will fund the actual flight capabilities demonstration tasks. Target markets for this

technology are commercial communication, commercial scientific, and government agencies such as NASA, DOD, USFS.

Duration: 6

Proposal Details

Proposal Number: S16.04-1005
Subtopic Title: High-Altitude Platform Systems (HAPS) Capability Demonstration
Proposal Title: High-Altitude, Long-Endurance, Visible Through Extended SWIR Hyperspectral Imaging for Earth Sciences

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 3 - 4
Technical Abstract (Limit 2000 characters):

NASA has identified long-endurance, sub-orbital, stratospheric observations from High-Altitude Platform Systems (HAPS) as a key future capability for the Surface Biology and Geology (SBG) mission, and supporting the needs of commercial and government organizations for ecological, climate, earth resource and emergency management information. A key source of data for SBG and other applications is hyperspectral imaging (HSI) over the Visible through Short Wave Infrared spectral region (VSWIR). VSWIR HSI systems have been flown on aircraft below 50,000 ft and recently on low-Earth orbiting satellites. However, these platforms do not meet the combined wide-area coverage, spatial resolution, station keeping and long duration diurnal measurement requirements of SBG measurement campaigns. A HAPS VSWIR HSI solution is therefore an important science mission objective for NASA. Spectral Sciences, Inc. (SSI) proposes an innovative combination of our rugged Terrestrial Hyperspectral Imaging Apparatus (THIA) pushbroom VSWIR HSI, the Sceye Inc. Stratospheric HAPS, and Hood Technologies gimbal technology to meet SBG sensing needs. Our team proposes to fly THIA in a demonstration of HAPS capability to collect VSWIR HSI imagery from above 60,000 ft. In Phase I, we will develop a concept of operations and preliminary mission plan for a THIA-HAPS flight.

Duration: 6

Proposal Details

Proposal Number: S16.04-1008
Subtopic Title: High-Altitude Platform Systems (HAPS) Capability Demonstration
Proposal Title: Balloon Lasercom Terminal

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 2 - 3
Technical Abstract (Limit 2000 characters):

Relative Dynamics Inc. (RD) will develop a Balloon Lasercom Terminal (BaLT) with the capabilities required in NASA Subtopic S16.04: High-Altitude Platform Systems (HAPS) Capability Demonstration and SCOPE Title: Scope Title: Free-Space Optical Communications for a Stratospheric Balloon Platform. In Phase II, RD will develop both a Balloon Lasercom Terminal (BaLT) and a low-cost compatible Ground Lasercom Terminal (GroLT). An optical communication terminal has three major subsystems: gimballed telescope, modem and controller. To keep SWaP-C at a minimum the essential innovation is to leverage commercial parts for each subsystem. The key innovations for BaLT are: Lightweight gyro-stabilized UAV/drone gimbal Phase I effort will examine the trades between functionality, power, and cost in the design of an optical communication terminal suitable for NASA scientific balloon missions. Our preliminary investigation has led us to high-pointing-precision candidate gimbals. We will further investigate these commercial UAV/drone gimbals in Phase I. Internet/telecommunications modem RD has multi-year experience designing, building, and testing free-space optical communication terminals with commercial internet/telecommunications transceivers and optical amplifiers. Integrated-photonic Telcordia-qualified telecommunication transceivers provide a high-performance (multi-Gbps data rate), direct Ethernet compatibility robust, low size, weight, power at low-cost for commercial high-altitude-platform modems. In Phase 1, we will examine the trade space. Advantages of commercial transceivers include high-reliability, military-grade temperature range, flexible wavelength, flexible data rates and flexible data format compatibility, System-on-chip controllers with built-in optical transceiver capability RD has multi-year experience designing, building, and testing free-space optical communication terminals with commercial low-cost System-on-Chip controllers/computers.

Duration: 6

Proposal Details

Proposal Number: S16.05-1005
Subtopic Title: Thermal Control Systems
Proposal Title: Generative Design of Heat Exchangers via Variable-fidelity Networks

Small Business Concern

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Principal Investigator

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 2 - 3
Technical Abstract (Limit 2000 characters):

Cornerstone Research Group (CRG) will develop an approach for computational design of multi-functional components featuring optimized cellular flow path geometries for enhanced heat exchange and structural performance which are readily producible using emerging advanced manufacturing techniques. This design capability will take the form of a generative methodology automating material layout throughout arbitrarily shaped design domains subject to mechanical, fluid flow, and thermal performance metrics to enable low mass utilization for high performance systems.

Computation of analysis driving responses will be carried out by standing up a physics informed neural network trained using multiphysics simulations of variable fidelity. This machine learning model will be used as a surrogate to accelerate geometry revisions by using a genetic algorithm to adjust localized sizing parameters for optimal heat exchange while also meeting structural requirements. During Phase I, CRG will apply the implemented process to a selected design space for a cold plate heat exchanger followed by prototype fabrication and experimental evaluation for comparison with traditionally designed counterparts.

Duration: 6

Proposal Details

Proposal Number: S16.05-1017
Subtopic Title: Thermal Control Systems
Proposal Title: Flexible Variable Emission Material

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 2 - 4
Technical Abstract (Limit 2000 characters):

Thermal management is an enduring need for all space platforms and vehicles. Spacecraft are routinely exposed to extreme temperature fluctuations, and options for regulating temperature in the vacuum of space are limited and challenging. To address space craft temperature fluctuations, Plasmonics Inc. proposes to develop a new class of mission-tailorable, and autoregulating, thermal radiator coatings by leveraging its extensive experience in growing vanadium dioxide (VO2) on flexible substrates. Phase change materials (PCM) have been investigated for use in variable emittance regulators in the past; however, in all cases the PCM processing requirements appear to be incompatible with space craft radiator materials. Metalized Kapton has been used extensively in satellite platforms, playing key roles in radiator and sunshield systems. A recent and highly publicized example is the James Webb Space Telescope’s five-layer sunshield: Aluminized polyimide overcoated with silicon is designed to reflect solar radiation thereby preventing instruments from overheating. Accordingly, Plasmonics Inc. proposes to design, model, fabricate, and test coupons of tungsten-doped vanadium dioxide-base (WxV1-xO2)- variable emissivity materials (VEM). Various concentrations of W will be explored to evaluate its effect on transition temperature and VEM thermal emissivity. After design optimization and testing, the team will fabricate a VEM prototype on flight-certified flexible substrate such as Kapton in subsequent efforts. Demonstration of a successful flexible VEM this technology can be applied to a wide range of markets with the commercial satellite and smart glass as the most promising.

Duration: 6

Proposal Details

Proposal Number: S16.07-1004
Subtopic Title: Cryogenic Systems for Sensors and Detectors
Proposal Title: Sub-10K High Efficiency Stirling/Pulse Tube Hybrid Cryocooler

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 4 - 5
Technical Abstract (Limit 2000 characters):

West Coast Solutions (WCS) and Raytheon propose to leverage the existing, proven, high performance Raytheon Low Temperature Stirling / Pulse Tube Two-Stage (LT-RSP2) cryocooler as an extremely well-informed starting point to develop a new high capacity, sub-10 K linear cryocooler that takes advantage of the latest innovations at WCS and elsewhere in terms of regenerator technology and advanced modeling techniques. The resulting Sub-10 K (S10) Cryocooler will feature unmatched thermodynamic efficiency (>6.6% Carnot @ 10 K), and by utilizing the hybrid Stirling / pulse tube cold head arrangement, it will provide unique operational flexibility to efficiently operate over a wide range of temperatures. This combination makes the S10 Cryocooler the ideal cryocooler for 8-10 K applications (maybe lower) as well as the optimum upper-stage cooler for 4-6 K applications.

Duration: 6

Proposal Details

Proposal Number: S16.07-1006
Subtopic Title: Cryogenic Systems for Sensors and Detectors

Proposal Title: Superconducting coil operating at temperatures above 15K for ADR instruments

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 6 - 7
Technical Abstract (Limit 2000 characters):

The new high temperature superconducting (HTS) coil technology proposed for development in this program is vital for NASA to advance the capabilities of its ADR cooling systems that maintain important space-based instruments at milli Kelvin temperatures. It will provide unmatched benefits. This program will complete development of advanced ADR coils by applying our recently developed first-of-their-kind low loss HTS wires that meet all the requirements put out by NASA in topic S16.07 of the FOA for next generation HTS-based ADR coils, including low losses in ramped field to 4T, high, > 300 A/mm2 in-coil coil operating current densities at temperatures above 15K and fields to 4T, combined with very small cross-sections that enable the specified small 6 A to 8 A operating current. It was recently discovered that the highly preferred react-and-wind coil making approach can also now be applied to fabricate ADR coils with these low loss HTS wires where until then the more difficult wind-and-react approach seemed to be the only option. This program will now adapt long, >2.5 km length processes to make the drawn low loss HTS 2212 wire optimally

suitable for a react-and wind ADR coil making approach. This wire will then be utilized to complete the development of fully functional, ADR coils that operate at temperatures above 15 K. By the end of the Phase II program a 22 mm - 40 mm bore x 50 – 100 m length ADR coil will be produced and validated to meet all the requirements put forth, as well as having all of its vital auxiliary features developed, such as terminations, potting, so that no additional significant development will be required before NASA can start to qualify and incorporate this coil type into their next generation ADR systems.

Duration: 6

Proposal Details

Proposal Number: S16.08-1001
Subtopic Title: Quantum Sensing: Atomic sensors, optical atomic clocks, and solid-state systems
Proposal Title: Compact Optical Cavities for Quantum Photonics and Integrated Timing Solutions (COCQPITS)

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 3 - 4
Technical Abstract (Limit 2000 characters):

Vescent Technologies, Inc. (Vescent) proposes to develop a compact, low-power, environmentally robust ultra-narrow linewidth (UNL) laser module, based on a novel cavity architecture demonstrated by the Precision Photonic Synthesis group at NIST (NIST-PPS). Compared to incumbent UNL laser technology based on bulky reference cavities held under high vacuum, this solution will reduce size by ~1/70, weight by ~1/6, and power by ~1/10, and demonstrate a low-risk, rapid-development pathway to future space deployment. The resulting laser module is a critical component in optical atomic clocks and would enable future NASA missions such as FOCOS and MAGIS which seek to put optical lattice clocks in space for gravitational wave detection and searches for new physics. This novel UNL technology is based on a vacuum-bonded, compact optical reference cavity, which operates without the usual high vacuum enclosure of traditional ultra-low expansion cavities and has already been demonstrated through initial prototypes to operate at 2E-14 instability. This effort will integrate a vacuum-less cavity into a rigid mount for a breadboard clock laser demonstration and performance evaluation. Further, we will generate system designs for a complete <5 Hz laser module (including lasers, control electronics, and opto-mechanics), which occupies ~1 L volume, and which will be developed at an optical clock wavelength of interest in Phase II.

Duration: 6

Proposal Details

Proposal Number: S16.08-1005
Subtopic Title: Quantum Sensing: Atomic sensors, optical atomic clocks, and solid-state systems
Proposal Title: Space-qualified Single-frequency Blue Lasers for Optical Atomic Clocks

Small Business Concern

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Principal Investigator

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 3 - 5
Technical Abstract (Limit 2000 characters):

Optical atomic clocks using lasers in the visible or ultraviolet instead of microwave to excite the atoms can provide an evaluate accuracy of 10-18. However, there remains a large gap between the highest performing cold-atom and lattice based optical clocks and the SWaP required to support many technologies needed for NASA missions today. There is a great demand for space-qualified lasers for corresponding clock and cooling transitions. NP Photonics proposes to develop compact, robust, and reliable single-frequency blue lasers that will be developed using our unique highly doped short-length fiber laser technology and can be used for spaceborne optical atomic clocks. In this Phase I program, we will demonstrate the feasibility of the proposed laser sources by developing a diode-pumped single-frequency fiber laser oscillator and power amplifiers and second harmonic generation lasers at the wavelengths of interest. Space-qualified laser sources will be developed and delivered in Phase II.

Duration: 6

Proposal Details

Proposal Number: S16.08-1014
Subtopic Title: Quantum Sensing: Atomic sensors, optical atomic clocks, and solid-state systems
Proposal Title: Space-Ready Chip-Integrated Titanium:Sapphire Lasers

Small Business Concern

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Principal Investigator

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 1 - 4
Technical Abstract (Limit 2000 characters):

Brightlight Photonics proposes to develop a universal nanophotonic laser solution in the wavelength ranges 675 - 1000 nm and 375 - 475 nm for quantum technologies including optical atomic clocks, cold atom interferometers, and solid-state quantum sensors. The wavelength range 675 - 1000 nm will be addressed by a single, wideband Titanium:Sapphire (Ti:Sapphire) gain medium, integrated onto a nanophotonic chip. On-chip frequency doubling with thin-film lithium niobate (TFLN) will further extend the range to 375 - 475 nm. One of the major impediments to compactifying atomic clocks, interferometry setups, and solid state sensors is their common reliance on bulky, expensive lasers. Chip-integration of high-performance lasers below 1 micron wavelength remains an outstanding challenge. Reducing this critical barrier to adoption of optical atomic clocks in space applications could enable deep-space navigation,

explorations of dark matter, gravitational waves, and tests of general relativity as well as cold atom interferometers for inertial navigation and next-generation gravimeters. Our target foothold into commercial applications is optical atomic clocks for inertial navigation. The current atomic clock market is roughly $500 million annually, with the low-SWaP portion growing rapidly to accommodate the DoD need to operate in frequency-jammed theaters. At the same time we aim to diversify our commercial approach by establishing ourselves as a component supplier for cold atom quantum processors: reducing optical setups from rack-mounted lasers splaying across complex optical tables to an on-chip light source package integrated with EOMs. The SBIR Phase I funds will be used to build a low-linewidth demonstration laser locked to a rubidium vapor cell. We will also design high-gain on-chip amplifiers, explore pump-diode optimization, analyze the feasibility of integrating on-chip modulation components, and study the potential NASA needs of our technology.

Duration: 6

Proposal Details

Proposal Number: S16.08-1017
Subtopic Title: Quantum Sensing: Atomic sensors, optical atomic clocks, and solid-state systems
Proposal Title: UV/Visible Alpha-Barium Borate Acousto-Optic Modulators for Atomic Interferometry Applications

Small Business Concern

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Principal Investigator

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 3 - 4
Technical Abstract (Limit 2000 characters):

Research team at Brimrose Technology Corporation is proposing to systematically develop a novel high-speed and high efficiency acousto-optic modulators (AOM) using -BBO single crystals, with no moving parts, where the technology is appropriate for Atomic Quantum Sensing applications, with specifications and capabilities well beyond that of any other current material or devices. Acousto-optic modulators (AOMs) allow rapid, inertia-free focusing and scanning of an optical beam. Dynamic spatial control of atoms using acousto-optics or spatial light modulators has been of interest recent year. Quantum computing involves arrays of trapped atoms or ions or molecules that require optical addressing in order to program initial states, implement single qubit manipulations, or perform entangling 2-qubit gates. However, optical addressing is technologically challenging since the transition energy from the ground state is deep into the UV for most common atoms such as Rb, K, Cs, Yb, and Sr, and most optical beam manipulation devices are not transparent in the UV requiring the development of a new generation of efficient and high-performance UV modulators and deflectors. Currently available acousto-optic modulator materials such as TeO2, LiNbO3, GaP, and PbMO3 are not transparent into deep UV region. Although a few UV devices are commercially made using fused silica, KH2PO4 (KDP) and NH4H2PO4 (ADP), these devices exhibit low diffraction efficiencies due to low AO figures of merit in the material. alpha-BBO has the greatest potential of combining the best properties of all existing materials into a single crystal. With regard to the AOM development, our overall commercialization strategy will be to use the Phase II funding to develop a prototype product and then use retained earnings to develop this product to the point where it is ready to be introduced into the market.

Duration: 6

Proposal Details

Proposal Number: S16.08-1027
Subtopic Title: Quantum Sensing: Atomic sensors, optical atomic clocks, and solid-state systems

Proposal Title: Phosphorus doped quantum diamond for magnetometry

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 2 - 4
Technical Abstract (Limit 2000 characters):

Advent Diamond proposes to develop new devices, materials and subsystems for space-based quantum magnetometry utilizing diamond nitrogen-vacancy (NV) centers. In this project, we leverage recent breakthroughs in chemical vapor deposition of doped diamond materials to develop NV centers embedded in doped diamond structures for space-based magnetometry. The designs we propose enable the preferred electrical read-out, for compact system integration. In this project, we will grow phosphorous-doped diamond using chemical vapor deposition and perform material quality measurements, and determine magnetometry designs that benefit from phosphorous doped diamond with NV centers.

Duration: 6

Proposal Details

Proposal Number: S17.01-1000
Subtopic Title: Technologies for Large-Scale Numerical Simulation
Proposal Title: MIO: Tailoring Multi-level Decomposition for Storage I/O for Computational Applications

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 4 - 7
Technical Abstract (Limit 2000 characters):

As computational sciences usher in a new era with vastly improved model fidelity empowered by the recent advances in high-performance computing (HPC), there is an urgent need to re-design the data analytics toolchain in the commercial market so that it can better adapt to the rapid growth of data coming out of large-scale simulations and maintain a high level of productivity. To address this need, this project proposes to develop a multi-level data retrieval library for hierarchical storage systems, so that

users can request the minimum amount of data from fast storage tiers and pay higher input/output overheads only when needed. This project aims to address Focus Area 13 Information Technologies for Science Data to provide S17.01: Technologies for Large-Scale Numerical Simulation. Through co-designing the decomposition and recomposition over hierarchical storage, this project will offer new capabilities to the user communities, including those in the federal market (e.g., GEOS-5, FUN3D developers) and private sectors, and vastly improve the efficiency and flexibility of data analysis.

Duration: 6

Proposal Details

Proposal Number: S17.01-1010
Subtopic Title: Technologies for Large-Scale Numerical Simulation
Proposal Title: Accelerating Design of ML and AI Experiments in Scientific Simulation

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 6 - 6
Technical Abstract (Limit 2000 characters):

Artificial intelligence (AI) and machine learning (ML) have demonstrated incredible success across industry and scientific fields. This impact is felt across scientific simulation domains, where AI and ML techniques are being used to explore complex patterns, improve accuracy of physics solvers, and accelerate time to insight. However, "black box" integration of AI and ML tools into simulations has yet to demonstrate significant impact, leading practitioners to develop their own implementations and integrations to satisfy their workflow needs. In this proposal, we seek to reduce the barriers to adoption of AI and ML tools for mature scientific simulation codes. In Phase I, we will focus on demonstrating an in situ ML toolbox for coupling mature simulation codes to AI and ML tools. We will leverage our team's expertise, applying our toolbox to two approaches to computational fluid dynamics relevant to NASA missions, large eddy simulation and Reynolds averaged Navier Stokes, which each have unique requirements and methodologies for incorporating AI and ML for improved model accuracy. By exploring these two regimes of CFD, we seek to highlight the flexibility of our approach to empowering mature simulation codes with cutting edge AI and ML tools, aiming toward other physics domains of interest to NASA in future work. Phase I funding will support this research and development effort, laying the groundwork for improved access to new AI and ML tools, and improved infrastructure for simulation users to experiment with these cutting edge tools.

Duration: 6

Proposal Details

Proposal Number: S17.01-1016
Subtopic Title: Technologies for Large-Scale Numerical Simulation
Proposal Title: SALT-FM: Source Analysis Toolkit for Fortran and Mixed-Language Software

Small Business Concern

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Principal Investigator

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 4 - 6
Technical Abstract (Limit 2000 characters):

SALT-FM, the Source Analysis Toolkit for Fortran and Mixed-Language Software, will enhance developers' productivity and boost the efficiency of software applications written in various programming languages, including Fortran. Fortran finds extensive use in both private and government sectors, spanning computational fluid dynamics, chemistry, earth science, and weather prediction, often in tandem with other languages. Despite its prevalence, accessible and platform-agnostic tools for comprehensive performance analysis, static analysis, and program transformation remain scarce. Whether modernizing legacy code, porting components to languages like C++, or optimizing for contemporary hybrid computing systems and accelerators, few cross-platform solutions adequately support Fortran and its multiple recent language standards. SALT-FM will harness and leverage the government funded LLVM Flang project's robust capabilities, to develop a static analysis and program transformation toolkit. The funding will solely cover software development and requirement discovery. In Phase I, the focus lies on creating a prototype capable of instrumenting Fortran and mixed-language programs for profiling with the TAU Performance System. Subsequent efforts will prioritize refining and hardening the profiling and instrumentation tool and expanding static analysis and program transformation functionalities. These enhancements aim to facilitate tasks like language porting, interface generation, and legacy application modernization. Anticipated markets for SALT-FM include various industries such as aerospace, automotive, nuclear power, energy, manufacturing, earth science, weather prediction, chemistry, and life sciences, in addition to government entities like NASA, DOE, DOD, NRC, and others.

Duration: 6

Proposal Details

Proposal Number: S17.02-1011
Subtopic Title: Integrated Campaign and System Modeling
Proposal Title: Advancing the SmallSat Digital Twin (SSDT) for Active Debris Removal Simulations

Small Business Concern

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Principal Investigator

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 3 - 6
Technical Abstract (Limit 2000 characters):

TMC Technologies (TMC), in partnership with the West Virginia Small Satellite (SmallSat) Center (WVSSC), has recognized a significant need for a mature simulation test bed (i.e., digital-twin) to evaluate and analyze space-based laser techniques for active debris remediation/removal (ADR). There is currently no simulation software suitable for performing space-based laser ADR research that provides as high-fidelity digital twin as TMC's SmallSat Digital Twin (SSDT) software. In this SBIR Phase I titled Advancing the SmallSat Digital Twin (SSDT) for Active Debris Removal (ADR) Simulations, TMC is proposing to enhance the SSDT software such that it contains additional models (optical, multi-camera, radar, debris) that support ADR analyzes, specifically space-based lasers being the first application. The upgraded SSDT will function as a digital twin platform, proficient in assessing the efficacy of various ADR technologies and algorithms within a digital flatsat environment that incorporates actual spacecraft flight and ground operations software. Furthermore, we will develop a strategic course for the inception, validation, and integration of new instrument models into the SSDT, positioning it as an optimal tool for ADR feasibility studies, prototyping, and future SmallSat mission planning.

Duration: 6

Proposal Details

Proposal Number: S17.02-1016
Subtopic Title: Integrated Campaign and System Modeling
Proposal Title: Highly Photorealistic Programmable 3D Worlds

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 4 - 6
Technical Abstract (Limit 2000 characters):

Midgard AI is aiming to enhance space mission simulations with a state-of-the-art platform for generating highly realistic, programmable 3D worlds without any 3D expertise increasing the adoption and utility of simulation & modeling. This technology is designed to align with NASA's rigorous requirements for mission simulations, providing an unparalleled tool for designing, developing, and executing simulations with unmatched realism and precision. The objectives include adapting the platform's capabilities to create and modify 3D off-world environments, enhancing the simulation of off-world lighting, shadows, and shading to replicate extraterrestrial conditions accurately, and expanding the library of off-world 3D assets to support comprehensive scenario modeling. Funding will support these objectives, focusing on delivering adaptable, high-fidelity simulations crucial for NASA's diverse mission scenarios. Midgard AI targets a broad market spectrum of industries that require advanced high realistic environments for AI, simulation, and robotics. Those markets include national security, domain awareness, automotive, recreational boating, residential robotics, hobby UAS, and commercial UAS, amongst others.

Duration: 6

Proposal Details

Proposal Number: S17.02-1031
Subtopic Title: Integrated Campaign and System Modeling
Proposal Title: 6-Degree-of-Freedom Multi-Fidelity Closed-Loop Trajectory Tool

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 2 - 4
Technical Abstract (Limit 2000 characters):

Recent innovations and the transition to digital engineering has led to ever-growing modeling and simulation environments. These environments provide invaluable benefits, but they typically require immense amounts of data. One crucial task that must wait far into the design of a vehicle is control system design. Overall mission design and high-level vehicle closure can be done with a 3-degree-of-freedom (3DoF) simulation, but validating control authority to meet the attitude requirements necessitates a 6DoF simulation. To allow for data-driven control architecture trade studies for a more confident design, SpaceWorks proposes a novel tool that can operate at varying levels of fidelity across the vehicle design process. For control architecture design, this tool can read the aerodynamic data of the neutral outer mold line (OML) and calculate the required forces and moments for mission closure and closed-loop control. Engineers can use these requirements to size their control system and validate that design with higher-fidelity aerodynamic data that includes the moment contributions from the deflected control surfaces. With this tool, control architecture trades and 6DoF simulations of different vehicle configurations become significantly cheaper, allowing for the design team to more easily find the optimal solution. In this Phase I effort, SpaceWorks will develop a proof-of-concept executable showing the control architecture sizing and validation use cases. SpaceWorks will leverage work from previous efforts to streamline the development effort, allowing for an emphasis on the implementation of closed-loop control algorithms with applications for a multitude of aerospace vehicles.

Duration: 6

Proposal Details

Proposal Number: S17.02-1037
Subtopic Title: Integrated Campaign and System Modeling
Proposal Title: Rapid Generation of SysML Models using NLP/LLM

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 2 - 2
Technical Abstract (Limit 2000 characters):

The proposed project is to demonstrate the feasibility of building a NLP/LLM based application that accelerates the generation of SysML models of complex space systems by smartly extracting information from textual descriptions, and transforming these into SysML model elements. One of the primary challenges in creating SysML models from textual technical documents is the diversity of document types, writing styles, and languages. NLP and LLMs can help address these challenges by employing advanced techniques for text preprocessing, entity recognition, and semantic analysis. NLP, a subfield of artificial intelligence, focuses on the interaction between computers and human language. It equips machines with the ability to understand, interpret, and generate human language, making it a valuable technology for processing unstructured textual information. Accelerating the development of SysML models is critical in order to support future space missions by making model development cost effective. NASA centers are using Model Based System Engineering (MBSE) and creating Systems Modeling Language (SysML) representations of their systems, following best Systems Engineering practices. These models are difficult and expensive to develop. NASA MBSE based system engineering development could be dramatically more efficient through the use of a toolset that can automatically generate the various SysML models from textual descriptions such as requirements documents, concept of operations, Design Reference Mission (DRM) and other technical descriptions. Such a toolset can be applied to a wide range of projects within NASA centers and could be adapted to other agencies and industries that are using the MBSE approach.

Duration: 6

Proposal Details

Proposal Number: S17.03-1001
Subtopic Title: Fault Management Technologies
Proposal Title: Fault Management Architecture for Distributed Systems

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 2 - 3
Technical Abstract (Limit 2000 characters):

An effective fault management design is a critical necessity for long term sustainable missions for spacecraft, especially those that are built for full or significant levels of autonomy. The design of such autonomous spacecraft has evolved and has now become increasingly complex with multiple interacting modules, developed by different manufacturers, working in close coordination to achieve the mission objectives. Given the complex nature of current missions and spacecraft, an effective distributed onboard fault management system is pivotal to preempting failures, ensuring operational integrity, and sustaining the safety of space missions where real-time human oversight and intervention is either severely limited or not feasible. Qualtech Systems, Inc. (QSI) through this proposed effort plans to address the above fault management challenges. QSI proposes to develop and evaluate potential fault management architectures that leverage QSI's TEAMS causal models and reasoning engines that can work effectively in a distributed decision-making system and evaluate them for a select set of currently planned NASA missions with the aforementioned distributed system architecture needs.

Duration: 6

Proposal Details

Proposal Number: S17.03-1016
Subtopic Title: Fault Management Technologies
Proposal Title: Loss of Signal Prediction

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 3 - 7
Technical Abstract (Limit 2000 characters):

We propose and present Loss of Signal (LOS) predictor technology for International Space Station (ISS) operations. Our prototype technology transforms the ISS Antenna Manager software tool used by flight controllers on console in the ISS mission control center (MCC) into a cognitive communication system that predicts off-nominal unscheduled loss of communication between the ISS and MCC. The system learns complex signal blockage configurations far too complex for the human to process in real-time. The cognitive IAM tool removes the subjective nature of LOS calls by flight controllers in the flight control room and provides advanced warning to the flight control team (who can subsequently inform the crew) of forthcoming comm outages that produce loss of telemetry, audio/video, and payload data. Initially, this technology will be implemented for ISS operations in FRC-1 with the anticipation of developing an onboard cognitive communication system for future missions equipped with advanced command and data handling systems (e.g. neuromorphic processors). This technology can be characterized as actionable AI since autonomous systems can use this communication link classification as input to higher level decision making.

Duration: 6

Proposal Details

Proposal Number: S17.03-1022
Subtopic Title: Fault Management Technologies
Proposal Title: ASTERIA

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 2 - 3
Technical Abstract (Limit 2000 characters):

Lynntech proposes the development of advanced Fault Management (FM) Technologies for NASA's missions by leveraging contemporary Artificial Intelligence (AI) and Machine Learning (ML) techniques to enhance mission concepts, increase mission survivability, and alleviate the workload of FM engineers and mission operators. As NASA's missions grow in complexity and face tighter timetables and budget constraints, autonomous systems become imperative. To address both operational challenges and design complexities, Lynntech aims to utilize AI/ML for state estimation, fault diagnosis, and recovery strategies, alongside model-based system engineering (MBSE) and thus create advanced FM techniques that can significantly reduce the need for human intervention in spacecraft operations. Lynntech's approach encompasses addressing a wide array of hardware and software failures, sensor malfunctions, environmental interactions, and inter-subsystem fault propagation. This not only promises to increase spacecraft resilience and autonomy but also ensures uninterrupted scientific data collection. This effort also aims to accelerate the adoption of advanced FM techniques in future missions by significantly improving the understanding and implementation of FM early in mission planning and design thus leading to more reliable, cost-effective operations across a wide range of NASA missions. The technology can even have potential applications extending to launch vehicles and test stands. Deliverables include a detailed analysis, prototype development, and software showcasing the feasibility and commercial viability of the AI/ML-enhanced FM approaches. Success in Phase I will pave the way for Phase II prototype demonstrations and potential integration into NASA missions, contributing to increased mission reliability and autonomy in space exploration.

Duration: 6

Proposal Details

Proposal Number: S17.03-1027
Subtopic Title: Fault Management Technologies
Proposal Title: S17.03 - Fault Management Technologies

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 3 - 5
Technical Abstract (Limit 2000 characters):

Neoskye Inc. proposes the Autonomous Resilience Management System (ARMS), a groundbreaking innovation in spacecraft fault management that integrates advanced AI, ML, and RL algorithms. ARMS is designed to autonomously detect, recover from, and make decisions regarding faults in critical spacecraft subsystems, notably the Electrical Power System (EPS) and Attitude Determination and Control Subsystem (ADCS). Leveraging Convolutional Neural Networks (CNNs) for spatial data analysis and Reinforcement Learning for dynamic recovery strategies, ARMS aims to significantly enhance spacecraft resilience and autonomy. This system draws on Neoskye's extensive experience in AI-driven fault management for UAVs and armored vehicles, promising to reduce ground intervention significantly and enhance mission success rates. The technology's predictive analytics capabilities enable proactive fault management, extending mission life and operational efficiency. ARMS's innovation lies in its comprehensive integration of sensor data and AI-driven analytics, setting a new standard for autonomous spacecraft operations and offering broad applicability across NASA's mission portfolio.

Duration: 6

Proposal Details

Proposal Number: S17.04-1008

Subtopic Title: Application of Artificial Intelligence for Science Modeling and Instrumentation
Proposal Title: DeGaP: A Deep Gaussian Process Surrogate Model for Cleaning Data from Spatially Distributed Sensor Networks

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 2 - 6
Technical Abstract (Limit 2000 characters):

Spatiotemporal data from space and ground-based instruments are used in research and as a validation source for physical models throughout NASA fundamental space science and sensors on the ground and in space. While there are a wide range of measurement types and uses, all data suffers from non-physical errors that must be identified, and removed, before its use in science and operations. It is important that these data gaps be filled with scientifically-derived proxies automatically, and with as little latency as possible, for timely hazard detection. Our proposed innovation is to develop a Deep Gaussian Process surrogate model (DeGaP) that is used to fill in gaps due to either bad or missing data, while retaining the high precision and fidelity of the original measurements along with uncertainty quantification (UQ) of the filled-in measurements. Deep Gaussian Processes are a powerful technique to model complex system behavior while enabling uncertainty to be fundamentally incorporated by virtue

of the stochastic structure of the model. In Phase I, we will a) develop a prototype of the DeGaP model using a ground-based magnetic field sensor network, MagStar. b) quantify the accuracy and uncertainty of the model predictions in terms of spatial and temporal proximity to other magnetometers in the network c) host a web service for continuous dissemination of the DeGaP model output wherein gaps and transient disturbances in the magnetic field data are replaced and uncertainty quantification provided for the filled-in data. Potential applications for the Phase 1 development include the Space Weather Modeling Framework (SWMF) running at CCMC, World Magnetic Model at NOAA and space-based magnetometers. Potential private sector market for the product is the U.S. bulk power industry, entities that support US power utilities in regulatory response, and entities that need machine-learning (ML) ready data sets from sensor networks for ML models in production.

Duration: 6

Proposal Details

Proposal Number: S17.04-1010
Subtopic Title: Application of Artificial Intelligence for Science Modeling and Instrumentation
Proposal Title: Optimized Learning for Yielding Meteorological Predictions Using Surrogates

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 3 - 6
Technical Abstract (Limit 2000 characters):

NASA's current physics-based models are the gold standard for simulating atmospheric and heliophysics variables. These models, however, require very large amounts of compute power and several hours to produce a forecast. We propose to build the Optimized Learning for Yielding Meteorological Predictions Using Surrogates (OLYMPUS), comprising machine learning-based surrogate models to dramatically reduce the computational time and resources needed to make a prediction. We do not anticipate that these models will replace the physics-based ones, as they do not offer the same level of transparency and explainability. Rather, these models will be used to produce forecasts quickly and cheaply at a fraction of the cost. At the heart of our approach is a novel approach to dramatically reducing the size of gridded atmospheric data, making it feasible to use a modern deep learning architecture to predict sequences of this data. This methodology entails computing the Spherical Harmonic Transform (SHT) of atmospheric variables. The SHT will give us a global representation of atmospheric data on a sphere, efficiently compressing spatial information to a more compact, multi-scale level representation that captures both small-scale, high-frequency and large-scale, low-frequency variations. It will also reduce aliasing artifacts as the spherical nature of the transform allows for an accurate representation of features across different latitudes, mitigating distortions that arise with traditional grids. Performing principal component analysis across the resulting SHT coefficients from several different time periods will allow us to identify the principal components that are able to explain the bulk of the variance within the system and reduce the number of variables form millions to thousands or even hundreds. This reduction will allow us to use state-of-the-art deep learning model architectures that would otherwise not scale to the size of this problem.

Duration: 6

Proposal Details

Proposal Number: S17.04-1013
Subtopic Title: Application of Artificial Intelligence for Science Modeling and Instrumentation

Proposal Title: Solar Update Neural Network for Improved Event Prediction (SUNNIE)

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 1 - 4
Technical Abstract (Limit 2000 characters):

Several NASA Heliophysics models have been developed to predict solar energetic particle (SEP) events. As presented in the CCMC model catalog, most of these are either physics-based or empirical models with very few models utilizing machine learning (ML) techniques. However, none of the existing models leverage the combined power of physics models and ML: Physics informed neural networks (PINNs). To the best of our knowledge, there currently exists no PINN implementation of 3D time-dependent Magnetohydrodynamics (MHD), and there currently does not exist a PINN surrogate model for physics-based CCMC models, specifically, WSA-ENLIL-cone model. P3P proposes to build a Solar Update Neural Network for Improved Event prediction (SUNNIE) that leverages the cutting edge in Physics Informed Neural Network (PINN) architecture to enhance NASA's CCMC models for Solar Energetic Particle (SEP) event forecasting by integrating underlying numerical solvers directly into the training cycle. This will enhance SEP event predictability via higher spatial and temporal resolution, while requiring fewer data points and thereby

also reducing computational footprint. The implementation of SUNNIE offers significant benefits for a wide range of applications, from improving satellite and spacecraft safety to aiding in the strategic planning of space missions. By providing a more nuanced and accurate view of space weather events, SUNNIE aims to be an indispensable tool for agencies like NASA and the US Space Force, ensuring that space operations can be conducted more safely and effectively in the face of unpredictable solar activity.

Duration: 6

Proposal Details

Proposal Number: Z1.05-1018
Subtopic Title: Lunar and Planetary Surface Power Management and Distribution
Proposal Title: Optical Wireless Technology for Lunar to Mars

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 3 - 4
Technical Abstract (Limit 2000 characters):

This SBIR will develop optical wireless technology component technologies capable of long-range (0.1 to 20 km), scalable 100W to 5,000W of regulated power transfer with traceability to future Lunar and Mars missions. Particular attention is focused on meeting the environmental mission demands, securing high reliability, and improving overall power transfer efficiency relative to the state of the art.

Duration: 6

Proposal Details

Proposal Number: Z1.05-1021
Subtopic Title: Lunar and Planetary Surface Power Management and Distribution
Proposal Title: Cubic Boron Nitride Diodes and Transistors

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 2 - 5
Technical Abstract (Limit 2000 characters):

In support of missions to the Moon and Mars, NASA needs high-voltage, high-current power electronic components that tolerate heavy-ion-radiation-induced damage without catastrophic failure. Diodes with 1200V 40A capability and transistors that operate at 600V 40A are desired for use in systems. Even after ~25 years of development, space-qualified GaN components are limited to 300V operation. In 2014, Hirama and colleagues at NTT demonstrated the MBE growth of cubic BN [1-2] on (100) diamond substrates. In 2022, Storm [3] at NRL reproduced the Japanese MBE growth result. In 2022, OSEMI custom-built a c-BN MBE system in the configuration described by Hirama and utilized it to demonstrate the initial growth of c-BN epitaxial layers in 2023. In this NASA Phase I effort, OSEMI proposes to extend its work on c-BN epitaxy to include the doped layers required to make diodes and transistors in c-BN. Initially, the growth and processing of p-n diodes will be investigated on 2-inch diameter substrates. We will also attempt the growth and fabrication of a lateral c-BN MESFET followed by a c-BN n-p-n bipolar transistor with further refinements of all three devices, including radiation tolerance life testing in a Phase II program. The goal in a Phase II effort will be to scale the growth and fabrication technology to 100mm diameter wafers, complete life testing, and achieve a new generation of c-BN Power Electronic Components and RF devices to provide a foundation for a next generation of chemically inert radiation tolerant power subsystems and communication modules useful in extreme environment that include missions to the Moon, Mars and on satellites for NASA. In this program, OSEMI proposes to replace GaN electronic components with c-BN components that are anticipated to perform at higher voltage and current than GaN in extreme environments.

Duration: 6

Proposal Details

Proposal Number: Z1.05-1024
Subtopic Title: Lunar and Planetary Surface Power Management and Distribution
Proposal Title: Wireless Power Receiver Converter Systems

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 3 - 4
Technical Abstract (Limit 2000 characters):

According to the NASA Phase I subtopic Z1.05 Lunar and Planetary Surface Power Management and Distribution, there is a current need for AC-DC converter systems to support robotic operations. Ongoing developments in In-Situ Resource Utilization (ISRU) rovers and Lunar Terrain Vehicles (LTVs) present numerous challenges for reliable mechanical wired power connections due to lunar regolith, or dust storms on Mars. Wireless power transfer technology is a viable candidate that mitigates this challenge and can provide a long-lasting reliable solution. However, as the development of these ongoing efforts advances, new challenges have been identified. NASA has expressed a need for high efficiency converters for wireless power applications in the Wireless Power Beaming for Lunar and Mars Missions scope. Specifically, in the receiver unit, the AC-DC and DC-DC stages require a wide voltage range operation due to the inherent challenges of wireless power transfer technology. This leads to operational difficulties that can irreparably damage the system or create problems interfacing with rover battery management systems (BMS). Furthermore, these large input voltage ranges create thermal losses that are extremely difficult to mitigate in lunar environmental conditions. The proposed Wireless Power Receiver Converter System combines both AC-DC and DC-DC stages into a single unit. The proposed effort will use a Class-E rectifier with embedded voltage regulation capability and wireless communication for future cross-platform compatibility. This results in an ultra-wide voltage range capability with overall higher system efficiency, lower mass, and lower thermal requirements on rovers.

Duration: 6

Proposal Details

Proposal Number: Z1.09-1009
Subtopic Title: Energy Storage for the Lunar/Mars Surface
Proposal Title: Electrochemical Pumps For RFCs

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 2 - 4
Technical Abstract (Limit 2000 characters):

Regenerative Fuel Cells (RFCs) offer a energy dense storage solution for lunar applications. Many aspects of RFCs can be configured and customized for a specific scenario. One such component is the coolant pumps. In this scenario the coolant pumps must be capable of operating at high pressure in a thermal vacuum environment. Additionally, long operational life is desired as maintenance intervals are limited. To meet this solution Lynntech proposes an electrochemical pump which utilizes technology similar to the Electrolyser and Fuel Cell stacks to meet the fluid flow requirements for cooling RFCs in a lunar environment.

Duration: 6

Proposal Details

Proposal Number: Z1.09-1010
Subtopic Title: Energy Storage for the Lunar/Mars Surface
Proposal Title: Lunar Surface Secondary Battery Modules for Continuous Day/Night Operation

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 3 - 5
Technical Abstract (Limit 2000 characters):

Future science missions to the Lunar surface will require advanced secondary battery systems that can operate from -230 □C to +120 □C. Advancements that address battery operation at extreme temperatures, combined with high specific energy and energy density are critically needed. Conventional rechargeable Li-ion cells operate within a narrow temperature range of -20 to 40 ºC, and they particularly suffer from capacity loss at lower temperatures. Improved batteries that combined with light weight thermal management are critically needed for diurnal lunar survival. The solution is a new battery module using new low temperature tolerant battery cells and a novel diurnal thermal management system. It is also critical to use high voltage batteries to produce the high energy density battery modules that exceed >150 Wh/kg at the full system level including thermal management.

Duration: 6

Proposal Details

Proposal Number: Z1.09-1014
Subtopic Title: Energy Storage for the Lunar/Mars Surface
Proposal Title: High Energy Density Next-Generation Batteries for Lunar/Mars Surface Missions

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 2 - 4
Technical Abstract (Limit 2000 characters):

Imperia Batteries, a division of Physical Sciences Inc. (PSI), will develop and demonstrate a high energy density (>300Wh/kg) rechargeable lithium-ion battery capable of operating across the wide temperature range (-230 °C to 120 °C) necessary to support lunar/Mars surface missions. Imperia will leverage directly applied ceramic separator technologies, a custom low volatility electrolyte as well as a MOF-based composite separator to achieve the wide temperature range and a high capacity silicon anode material to achieve the target energy density. Additionally, Imperia will partner with UCI to perform in situ X-ray computed tomography imaging in order to characterize physical changes within the cells at extreme temperatures. During Phase I, Imperia will design cells and energy modules for the targeted NASA application, perform high fidelity thermal modelling to assess the ability of the cell design to accomplish program goals, as well as construct cells incorporating the target technologies to demonstrate their energy density and cycle-life at extreme temperatures. In the Phase II, Imperia will prototype the energy module and expand validation activities to ensure form, fit, and function. Successful completion of these efforts will demonstrate the readiness of the technology for further scale-up and demonstrations.

Duration: 6

Proposal Details

Proposal Number: Z2.01-1006
Subtopic Title: Spacecraft Thermal Management

Proposal Title: High Temperature Oscillating Heat Pipe Radiator

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 3 - 4
Technical Abstract (Limit 2000 characters):

High temperature heat rejection is a critical technology gap inhibiting full implementation of nuclear electric propulsion (NEP) for NASA inter-planetary and Lunar Surface missions. Nuclear electric thermal management requires rejection of 4-10MW of power at temperature approaching 900K; the target radiator areal density is <6kg/m2. NASA requires robust coatings exhibiting high emissivity and charge-dissipative characteristics. As stated in the FY24 Z2.01 solicitation ‘High-Temperature Heat Acquisition, Transport, and Rejection’ scope, “the large heat loads associated with nuclear power and propulsion systems require radiators that are a significant fraction of the total mass of the system, so lightweight high-temperature radiators are needed to enable such systems”. ThermAvant Technologies (TAT) proposes to develop an Oscillating Heat Pipe (OHP)-based structurally integrated low areal density radiator to meet this crucial need. TAT will conduct a hardware build/test program to quantify OHP manufacturing, operating metrics, and advances over the current state of the art (SOTA). Scope of this proposed phase I is specifically for novel high-temperature

radiator panel development; TAT will partner with coating specialists, and has a separate phase II pending selection for Z2.01 core acquisition and transport.

Duration: 6

Proposal Details

Proposal Number: Z2.01-1011
Subtopic Title: Spacecraft Thermal Management
Proposal Title: Advanced Hybrid Photonic Based Fiber Optic Sensor for Lunar Habitats

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 2 - 4
Technical Abstract (Limit 2000 characters):

IFOS introduces LunarSense™, a cutting-edge hybrid sensing system designed to revolutionize real-time environmental monitoring in NASA's lunar habitats. By integrating Fiber Bragg Grating (FBG) sensors for precise temperature and pressure monitoring with Fiber Optic Chemical Sensors (FOCS) for advanced chemical analysis, LunarSense™ ensures both safety and operational efficiency within lunar habitats. Its lightweight design and seamless integration with high-speed interrogators facilitate swift data processing, enabling informed decision-making in the demanding lunar environment. By safeguarding structural integrity and astronaut well-being, Lunar*Sense™ significantly enhances the success and longevity of lunar missions, aligning perfectly with NASA's vision for sustainable lunar exploration.

Duration: 6

Proposal Details

Proposal Number: Z2.01-1012
Subtopic Title: Spacecraft Thermal Management
Proposal Title: Self-Healing Radiator Coolant Tubes for Spacecraft Thermal Control

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 2 - 4
Technical Abstract (Limit 2000 characters):

Future space exploration missions require advanced thermal control systems (TCSs) to dissipate heat from spacecraft, rovers, or habitats to external environments. These thermal control systems must be lightweight, tolerant of extreme conditions, and highly-reliable. The typical layout for a thermal control system includes a large-surface-area radiator for heat rejection, embedded with fluid-filled heat pipes or coolant tubes with actively flowing liquid. Because radiators necessarily have a large footprint with exposure to space, they are particularly susceptible to strikes by micrometeorite and orbital debris (MMOD). Tubes breached by MMOD will invariably discharge their coolant, rendering the TCS inoperable. In this context a particular need has emerged for self-healing coolant tubes for resilience to MMOD impact. To meet this challenge, Creare proposes a unique coolant tube containment design, for which a multi-layered tube wall contains a microporous metallic internal matrix filled with a liquid reactant. The reactant is selected to rapidly polymerize with exposure to the internal pressurized coolant as it escapes into the vacuum of space, passively self-sealing the breach and ensuring continued operation of the TCS. In Phase I, we will collaborate with self-healing materials experts to select, develop and evaluate a test matrix of polymer systems with the potential to provide passive self-healing with exposure to one or more typical radiator coolants. We will then conduct a demonstration of a self-healing coolant tube, using a subscale multi-layered tube and the selected reactants, to evaluate the overall approach. Finally, we will develop the overall thermal, fluid, structural, and mechanical design of an integrated radiator complete with advanced features for self-healing. In Phase II, we will build a prototype radiator with self-healing features, demonstrate its performance in a representative thermal environment, and deliver the completed unit to NASA.

Duration: 6

Proposal Details

Proposal Number: Z2.02-1003
Subtopic Title: High-Performance Space Computing Technology

Proposal Title: A Resilient, Versatile, and Future-Proof Spaceflight Coprocessor Platform

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 1 - 3
Technical Abstract (Limit 2000 characters):

State-of-the-art NASA coprocessing for Digital Signal Processing (DSP) and Artificial Intelligence (AI) applications lacks the versatility, performance, and energy efficiency needed for future space missions which also require radiation resilience not found in commercial devices. This research and development accelerates high-bandwidth, real-time sensor DSP and AI data processing for autonomous perception, planning, and control applications. Our proposed work integrates radiation fault tolerance, health monitoring, and power reduction techniques into open-source General Purpose GPU (GPGPU) soft cores on latest generation radiation-tolerant, reprogrammable Field Programmable Gate Array (FPGA) devices. Additionally, GPGPU software programming toolchains are leveraged to enable flexible, parallel coprocessing needed for future spaceflight missions. Initial estimations show we outperform the baseline FPGA coprocessing technology found on the Mars Perseverance Rover by 24x for similar SWaP. A low-power, radiation-tolerant Application Specific Integrated Circuit (ASIC) translation boosts this gain to over 100x while retaining the GPGPU open

compute flexibility and inflight reprogrammability. Phase I funded work includes a proof-of-concept development for the FPGA-based GPGPU design. FPGA simulations validate our design choices by showing increase in versatility, performance, and energy efficiency on a radiation-tolerant, space-ready platform. NASA, DoD, and private space companies benefit from our future-proofed application coprocessing capabilities and resilience to natural and emerging, adversarial radiation space threats.

Duration: 6

Proposal Details

Proposal Number: Z2.02-1023
Subtopic Title: High-Performance Space Computing Technology
Proposal Title: Resilient Real-Time Reasoning RISC-V Robotic Operating System (R5OS)

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 3 - 4
Technical Abstract (Limit 2000 characters):

A key element of the rapid growth autonomous systems is the availability of open, reusable frameworks and libraries of software such as the Robot Operating System (ROS). AI/ML enhanced computing systems for automated vehicle applications are rapidly advancing but may not meet spaceflight environmental requirements. Combining ROS and RISC-V based processing systems provides a pathway to rapidly evolving autonomous systems for space applications. Secmation proposes Resilient Real-Time Reasoning RISC-V Robotic Operating System (R5OS). The goal of R5OS (Pronounced "R-Five-OS") is to evolve ROS into a capable, reliable, deployable tool for space robotics. Key R5OS elements: • Porting of ROS to RISC-V. R5OS will port ROS infrastructure and a suite of ROS nodes to relevant RISC-V hardware paving the way to High Performance Spacecraft Computing (HPSC) processor transition. A key element of the R5OS transition is a formal testing program to ensure transitioned components maintain the functionality and reliability of the original components. • Rapid ROS development. Secmation's AutonomyLock software, developed for the Office of Naval Research for robotic systems development, adds DevSecOps capabilities to the R5OS workflow reducing ROS development time and cost. • Flexible mixed criticality processing. Many ROS nodes that control driving, manipulation, and similar physical interactions should be executed with real-time constraints. Other nodes, such as path planning, may not lend themselves to real-time operation. R5OS will demonstrate a mixed criticality real-time/non-real-time implementation of ROS leveraging Secmation's Anneal real-time hypervisor developed for the Missile Defense Agency. • Alignment with AI/ML open standards. The Open Neural Network Exchange (ONNX) standard provides a path to more easily deployable, maintainable, reusable AI/ML neural network applications. R5OS will demonstrate ONNX integration with ROS including AI/ML hardware acceleration.

Duration: 6

Proposal Details

Proposal Number: Z2.02-1028
Subtopic Title: High-Performance Space Computing Technology
Proposal Title: Coprocessors for Digital Signal Processing (DSP) and Artificial Intelligence (AI)

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 3 - 4
Technical Abstract (Limit 2000 characters):

Ibeos is currently engaging with Microchip as an industry partner to leverage the High-Performance Spaceflight Computing (HPSC) Processor. This $50M NASA partnered development has produced an exceptional computing chip that has significant potential to solve significant space challenges over the next decade. For Ibeos' internal development of an HPSC-based computer (The Ibeos EDGE-HPSC), Ibeos has committed financial and personnel resources to develop a 3U SpaceVPX computer design that leverages this chip. The team is currently working with multiple stakeholders to develop requirements for the processor and make key design decisions. Ibeos aims to complete PDR on the EDGE-HPSC by the end of April 2024, with a fully functioning computer prototype by the first quarter of 2025 (pending availability of first HPSC chips). For this SBIR, Ibeos proposes to leverage this processor design to develop an entire computing ecosystem, that includes hardware, software, firmware, and middleware. These ecosystems provide developers with the total package required for rapid development and deployment of advanced capabilities, such as synthetic vision, robotics, autonomy, and artificial intelligence. In this proposal, Ibeos provides a significant step towards taking the High-Performance Spaceflight Computing Processor and turning it into a complete AI and autonomy edge computing ecosystem. In this proposal, Ibeos will make two significant contributions to the edge computing ecosystems. First, Ibeos will significantly improve the software development environment by enabling key libraries, tools and packages that will increase the speed of development and deployment of critical capabilities such as synthetic vision,

robotics, autonomy, and artificial intelligence. Second, Ibeos will address the current limitation in random access memory. Target markets include NASA deep space missions, autonomous operations, and other commercial and government missions.

Duration: 6

Proposal Details

Proposal Number: Z2.03-1003
Subtopic Title: Human Interfaces for Space Systems
Proposal Title: Exploration Extravehicular Mobility Unit Spacesuit Heads-Up Display

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 3 - 4
Technical Abstract (Limit 2000 characters):

To address NASA’s need for an augmented reality (AR) display system for extravehicular activity (EVA), Intellisense Systems, Inc. (Intellisense) proposes to develop a new Exploration Extravehicular Mobility Unit (xEMU) Spacesuit Heads-up Display (xHUD) based on innovative integration of laser projectors and waveguide pupil expander combiner (WPEC) optics. This approach incorporates miniature full-color laser light sources and low-profile, narrowband, reflective, see-through, toroid-shaped WPEC optics, which enable us to meet NASA xEMU spacesuit requirements for an AR display that is completely decoupled from the user's head and provides full sunlight readability with automated rapid ambient light response. The xHUD is equivalent to a display panel with a diagonal field of view of at least 30° and it can render complex graphics, including high-definition video, at a frame rate of at least 60 fps. xHUD offers full-color, high-resolution, collimated images with a large eye box, and it is highly suited to the space and weight constraints inside an astronaut’s xEMU spacesuit helmet. Intellisense plans to demonstrate the feasibility of the xHUD system by building and testing a preliminary prototype to technology readiness level 4 by the end of Phase I. Intellisense plans to develop in Phase II a fully functional prototype that mitigates thermal and radiation issues to demonstrate sunlight readability and HD resolution. When developing this deliverable proof-of-concept prototype, Intellisense will consider scalability and integration with other display components such as video processing electronics. The prototype will also be used to analyze ignition safety due to a 100% oxygen operating environment and vacuum and extreme temperature storage environments. The successful development of xHUD will offer NASA the capability to perform EVAs with an AR HUD internal to the helmet to improve crew safety and comfort and prevent misalignment of the display.

Duration: 6

Proposal Details

Proposal Number: Z2.03-1005
Subtopic Title: Human Interfaces for Space Systems
Proposal Title: Multifocal Augmented Reality Visual Informatics System

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 4 - 6
Technical Abstract (Limit 2000 characters):

The Proposed Innovation. Holochip's proposed innovation, the Multifocal Augmented Reality Visual Informatics System (MARVIS), is a spacesuit-integrated, head-decoupled, solid-state, augmented reality (AR) system designed to provide astronauts with an immersive, informative visual interface that significantly enhances decision-making capabilities and situational awareness (SA) during extravehicular activity (EVA). MARVIS provides accurate vergence and accommodation visual cues over a wide range of 35 cm to infinity while meeting the demanding optical requirements (i.e., eye box, eye relief and field of view) for integration within the Artemis Program Spacesuit helmet bubble (AHB). Further, MARVIS meets the extreme requirements associated with use and storage in space operations and 100% oxygen environment. These innovations enable the MARVIS to provide astronauts with a comfortable visual interface that addresses the physiological aspects of using an AR system periodically for up to 8 hr during a single EVA.

Duration: 6

Proposal Details

Proposal Number: Z2.03-1010
Subtopic Title: Human Interfaces for Space Systems

Proposal Title: Holographic Enabled Display for xEVA

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 2 - 4
Technical Abstract (Limit 2000 characters):

Providing suited astronauts with the critical information needed to perform their complicated and high endurance missions is a priority need for the NASA space program. Human interfaces to support this demanding work can be facilitated with a spacesuit Heads-In Display coupled to information systems and potentially Augmented Reality processors and sensors. With a suitable information display and an Augmented Reality interface the user will have greater autonomy as will be needed on missions where communications with mission control or data resources is delayed, limited or unreliable. Good information makes for better decisions, better outcomes, and improved safety. The proposed solution we will develop can bridge the technology gap that exists with state-of-the-art AR displays that can't simultaneously provide the metrics of eye relief, field of view, brightness and resolution needed in a spacesuit helmet display.

Duration: 6

Proposal Details

Proposal Number: Z4.05-1001
Subtopic Title: Nondestructive Evaluation (NDE) Sensors, Modeling, and Analysis
Proposal Title: In-Space Portable Multi-Functional Intelligent Evaluation Tool

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 3 - 4
Technical Abstract (Limit 2000 characters):

To support NASA needs for in-space non-destructive evaluation (NDE) tools, Intellisense Systems, Inc. (Intellisense) proposes to develop a new small-size, lightweight, and battery-powered In-Space Portable Multi-Functional Intelligent Evaluation Tool (SMIET) based on Compton imaging tomography (CIT). SMIET's innovative application of CIT for in-space in situ NDE provides three-dimensional (3D) visualization while its artificial intelligence enables true characterization of various defects/irregularities of in-space large multilayered components/structures with complex 3D geometries such as truss, stiffened, and welded and/or bonded structures fabricated using combinations of various aerospace materials including Inconel, titanium, aluminum, carbon fiber, thermoplastic composites, lunar regolith, and thermal blanket structures. SMIET performs volumetric NDE of space-based components/structures, estimates their in-depth integrity, and detects, identifies, and localizes defects/irregularities such as cracks, voids, delaminations, porosity, inclusions, micrometeoroid damages, and foreign object debris. SMIET can be used for the NDE of platforms on International Space Station and on planetary missions. Astronauts can use SMIET in a habitat or the space environment (i.e., on an extravehicular activity) or for automated inspection. In Phase I, Intellisense will demonstrate the feasibility of SMIET using a laboratory prototype, document SMIET's ability to detect structural defects/irregularities in terms of resolution, sensitivity, and speed of operation. We will describe SMIET's Phase II prototype and its application to the NDE of spacecraft components/structures. In Phase II, Intellisense will develop a full working prototype of SMIET along with plans for transition and commercialization. Intellisense expects the prototype to reach technology readiness level 6 by the end of Phase II.

Duration: 6

Proposal Details

Proposal Number: Z4.05-1010
Subtopic Title: Nondestructive Evaluation (NDE) Sensors, Modeling, and Analysis
Proposal Title: IR Thermography Based Real-time In-situ Defect Detection and Elimination of Defect Propagation for In-Space Additively Manufactured Structures

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 2 - 4
Technical Abstract (Limit 2000 characters):

The ability to perform In-Space Manufacturing (ISM) is critical for sustainable, flexible missions in orbit, in transit, and on the surface of the Moon or Mars. ISM offers on-demand fabrication of necessary supplies, such as tools, bolts, brackets, wire clamps, and other items needed for mission logistics and maintenance/repair of critical systems. Additive manufacturing (AM) was first performed and demonstrated on the International Space Station in 2014. Since then, numerous parts have been 3D printed in space using polymers. NASA is considering using lunar regolith as a local material for lunar infrastructure. One of the potential ways to print infrastructure with regolith-polymer mixture is to use a 3D print head that heats and extrudes the mixture to generate a desired geometry. While this approach is a game changer for prototype development of a single component, mass production of such infrastructural parts needs to overcome quality issues encountered in traditional extrusion-based AM. One of the major challenges going forward with ISM is verifying that the printed parts meet requirements. Currently, in-space inspection capabilities are limited to post-build visual inspection of the part. But the goal is to be able to inspect the part in-situ, during the build process, so that the part is "born certified." On Earth, infrared (IR) thermography is one of the most common nondestructive evaluation methods used for defect detection in materials. Thermography can be used on nearly all material types, and not only can it detect surface flaws, but it can also generate real-time images of structural components, which is essential to verify structural integrity. In this project, a system for in-situ defect detection and elimination of defect propagation using IR thermography will be developed. It is proposed to integrate a traveling, non-contact, IR camera with the extruder head to detect defects in the part in real time as it is being printed.

Duration: 6

Proposal Details

Proposal Number: Z4.05-1019
Subtopic Title: Nondestructive Evaluation (NDE) Sensors, Modeling, and Analysis
Proposal Title: Compact, Laser-driven, High-Energy X-ray Source for High-resolution NDE with X-ray Imaging and Computed Tomography

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 3 - 6
Technical Abstract (Limit 2000 characters):

Phase 1 proposal to accelerate the development of a compact, laser-driven, High-energy X-ray (HEX-ray) source for high-resolution NDE with X-ray imaging and Computed Tomography. The Innovation • HEX-rays in the MeV range can be produced with compact laser systems • Using laser generated X-rays, CT-scans with 100 µm resolu-tion have been demonstrated with high laser intensity on tar-get • We generated an laser-driven HEX-ray spectrum similar to that of an 800 keV X-ray tube at 100X

lower laser intensity than previously reported • The HEX-ray generation at low laser intensity allows scaling the technology into the kW average power regime RIC proposes deploying SBIR funds to dedicate labor, equipment and cleanroom facility to execute a rapid Phase 1 characterization and measurement campaign to prove commercial feasibility of RIC laser-driven HEX-ray source. This project aims to demonstrate a range of Laser-driven High-Energy X-ray Source's advantages, including: • 1-2 MeV X-rays for better object penetration and CT with lower absorption artifacts • 10-100X higher brilliance than any other lab source • 10 µm source size for X-ray energies <100 keV • 100 µm source size for X-ray energies 1 – 2 MeV • Compact source head for "inside-out" imaging • More compact than linear accelerator HEX-ray sources • Multi-use capability of X-ray source for NDE, medical imaging, micro-CT • Laser-machining market drivers and HE-LPXS's multi-use capability will make future HE-LPXSs in-flight capable Primary target markets include defense, aerospace and industrial manufacturing sectors where dense components and systems require precise nondestructive evaluation.

Duration: 6

Proposal Details

Proposal Number: Z4.05-1022
Subtopic Title: Nondestructive Evaluation (NDE) Sensors, Modeling, and Analysis
Proposal Title: Active Microwave Thermography Prototype Development for use as an In-Space Nondestructive Evaluation Tool

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 2 - 3
Technical Abstract (Limit 2000 characters):

NASA has needs for sensors and nondestructive evaluation (NDE) techniques that can operate in-space to be able to sustain rapid, safe, and efficient space transport, sustainable living and working farther from Earth, and to support transformative missions and discoveries. In particular, NDE is needed to support in-space assembly, manufacturing, and refueling, advanced propulsion techniques, in situ resource utilization, and surface excavation and construction. NDE modalities for in-space applications and use are limited. In this proposal, Texas Research Institute (TRI) Austin and the Missouri University of Science and Technology (MST) propose the development of active microwave thermography (AMT) for use as an option for NASA as in-space NDE. Phase I will focus on demonstrating the system capabilities and mapping out a design for a Phase II prototype system that will be delivered to NASA upon the completion of the Phase II effort.

Duration: 6

Proposal Details

Proposal Number: Z4.07-1004
Subtopic Title: Advanced Materials and Manufacturing for In-Space Operations
Proposal Title: SPACE (Solidified Profile Aluminum Cast Extrusions)

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 3 - 4
Technical Abstract (Limit 2000 characters):

The SPACE (Solidified Profile Aluminum Cast Extrusions) technology is a materials and manufacturing approach that comprised of additive free form casting and high strength aluminum alloy that enable lunar infrastructure construction by the free form casting of structural components such as truss members, angles, rods, and tubes from molten aluminum and other ISRU-derived metals. Merging the efficiency of Direct Chill (DC) casting with the precision of tube extrusion techniques, SPACE optimally utilizes ISRU-derived materials, casting them into complex shapes while leveraging latent heat of solidification (~420 kJ/Kg Al) to boost process energy efficiency. Furthermore, SPACE employs specially designed nozzles to capture and repurpose waste heat generated during solidification, using this recovered energy to power accumulators for molten material extrusion and normalizing heat-treatment. This approach not only enhances the system's energy efficiency but also significantly reduces reliance on Earth-sourced consumables and manufacturing equipment, making it an ideal solution for producing durable materials from aluminum and aluminum-scandium alloys. Designed to support Artemis missions and sustainable lunar colonization efforts, SPACE technology facilitates the construction of lunar infrastructure, promoting the sustainable use of in-situ resources.

Duration: 6

Proposal Details

Proposal Number: Z4.07-1005
Subtopic Title: Advanced Materials and Manufacturing for In-Space Operations
Proposal Title: Metal Alloy Cryogenic Interface Seal

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 1 - 3
Technical Abstract (Limit 2000 characters):

As NASA tries to proceed for the lunar exploration missions, the need arises for innovative technologies capable of withstanding the extreme lunar environment. This solicitation focuses on the development of interface seals that can sustain in extreme low temperatures. The proposed solution involves leveraging the mechanical strength and tolerance to solar radiation of advanced metal alloys. NASA's requirements for deep space exploration emphasize the importance of maintainability and reusability, making the development of durable interface seals imperative. The proposed seals aim to withstand cryogenic temperatures ranging from 300 to 90 K (evolvable down to 20 K) and pressure ranges of approximately 14 to 100 psi while maintaining seal integrity in dusty environments and tolerance to vacuum, ultraviolet (UV) radiation, atomic oxygen, and ionizing radiation. The solution seeks to achieve over 10 mate/demate cycles without permanent deformations. The proposal will include material design

idea, fundamental characterization, and proof-of-concept experiments demonstrating feasibility at low temperatures, with scalability considerations for fabrication of prototype seals. Lynntech has previously developed metal fittings and has records for several NASA proposals to achieve successful technologies for space explorations. With expertise, Lynntech will demonstrate the feasibility of the proposed approach during Phase I and the prototype of cryogenic metal alloy interface seal will be delivered to NASA during Phase II.

Duration: 6

Proposal Details

Proposal Number: Z4.07-1008
Subtopic Title: Advanced Materials and Manufacturing for In-Space Operations
Proposal Title: Development of a multifunctional SolidStir manufacturing technology for lunar infrastructure

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 3 - 5
Technical Abstract (Limit 2000 characters):

As a part of the Artemis mission, building a base camp on south pole for astronauts to land, live and explore has been planned. In order to support human presence and further exploration setting up metal extraction and primary manufacturing facility is essential. The extraction plants that are developed for earth on the moon is cost prohibitive and complicated since necessary consumable are not readily available on the moon. Hence special processes are being developed. The products from these processes expected to be with varying level of purity, smaller in quantities, and non-uniform in size. In such scenario the metal products also expected to have regolith entrapment on the surface. To convert such metal products into structural members in the form of angles, rods, or tubes requires an energy efficient, reliable, and contaminant tolerant process that is capable of consolidating and forming into required shapes. Enabled Engineering proposes to use a novel, 2023 Big IDEA Challenge award winning, modular and multifunctional SolidStir® manufacturing technology to produce structural truss elements such as tubes, angles and rods in solid-state. SolidStir is a Friction Stir Welding/Processing (FSW/P) based continuous plastic deformation process. This energy efficient technology can also be adapted for upcycling, additive manufacturing and joining. This process can be operated as independent system or augmented with other system with rotary axis. The objective of the program is to demonstrate the feasibility of manufacturing truss members such as tubes, square rods and angles from simulated metals from lunar metal extraction process using SolidStir® extrusion technology. The deliverables include a report on know-how of process, material-structure-process-property relationship with varying contamination levels, effect of process parameters on force and energy requirement, and specification and design of SolidStir® extrusion system for lunar environment.

Duration: 6

Proposal Details

Proposal Number: Z4.07-1018
Subtopic Title: Advanced Materials and Manufacturing for In-Space Operations
Proposal Title: Multiuse Quick Disconnect for Lunar Surface Fluid Transfer Operations

Small Business Concern

Firm: Creare LLC

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Principal Investigator

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 4 - 5
Technical Abstract (Limit 2000 characters):

Creare proposes to develop critical sealing technology needed to transfer cryogenic fluids on the lunar surface. We will build on existing technology that has already demonstrated the ability to repeatedly produce excellent seals at cryogenic temperatures over many mate/demate cycles. The sealing technology can be used as part of quick-disconnect couplings that can be easily handled by astronauts or robotic systems. We propose to modify the seal design to accommodate the dusty environment present on the lunar surface. In Phase I we will prove the feasibility of this approach by modifying the seal design and demonstrating performance under conditions that simulate operation on the lunar surface.

Duration: 6

Proposal Details

Proposal Number: Z4.07-1026

Subtopic Title: Advanced Materials and Manufacturing for In-Space Operations
Proposal Title: HELCoW: High energy laser capable of welding

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 2 - 3
Technical Abstract (Limit 2000 characters):

High Energy Laser for Construction & Welding, or HELCoW is a direct diode laser (DDL) subsystem capable of cleaning and conduction welding aluminum and stainless steel in orbital and lunar surface environments. HELCoW will be designed to be compatible as a payload on several Commercial Lunar Payload Services (CLPS) provider spacecraft, as well as orbital spacecraft, and shall be capable of operating in microtorr vacuum levels at lunar south pole daytime temperatures (-50 °C to 60°C). The proposed architecture allows the system to operate without consumables or maintenance for extended periods of time in the space environment while monitoring and adapting to system health. Funding will be used to advance the designs of the Laser Toolhead Subsystem, Robotic Positioning & Manipulation Subsystem, and the Lander Mounted (Control Electronics & Thermal Management) Subsystem to allow for system testing in thermal vacuum chamber environments and space environments on an orbital or lunar surface mission. Target markets include private space companies and several NASA programs.

Duration: 6

Proposal Details

Proposal Number: Z4.07-1029
Subtopic Title: Advanced Materials and Manufacturing for In-Space Operations
Proposal Title: Resource Extruder for Continuous Casting of Constant Cross-Section Hardware

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 3 - 4
Technical Abstract (Limit 2000 characters):

Blueshift, LLC doing business as Outward Technologies proposes to develop a Resource Extruder for Continuous Casting of Constant Cross-Section Hardware (RE4CH). The RE4CH system will produce cast glass and glass ceramic components on the Moon and on other planetary bodies. RE4CH will be capable of taking waste products from ISRU oxygen-extraction processes (i.e. slag), melting it down to a fully amorphous material, extruding the homogenized molten regolith for varied manufacturing processes, and heat treating the extruded components for controlled crystal growth tailored to achieving application-specific material properties. With the ability to adapt to a large variety of byproduct compositions, the RE4CH will be an extremely versatile piece of equipment able to produce many of the components identified by NASA as critical to a sustained presence on the Moon such as towers and truss-based structures. RE4CH can be broken down into three main subsystems: melting and refining, extrusion, and heat treatment. In its simplest configuration the RE4CH can be used directly to produce extruded components such as rods and tubes. Glass and glass-ceramics produced from processed regolith waste products represent significant launch mass and cost savings for producing mechanical hardware and structural members on the Moon. These materials have additional properties particularly well suited for use in lunar towers. Because of the drastic thermal cycling on the Moon, materials with low coefficients of thermal expansion will be needed to minimize deformation of structures over the lunar day and night. RE4CH will be able to incorporate many existing technologies with melted regolith waste products and will represent the state of the art in terms of fully melting, refining, and controlling crystal growth of manufactured regolith components and structural members at scale.

Duration: 6

Proposal Details

Proposal Number: Z5.06-1013
Subtopic Title: Servicing and Assembly Applications
Proposal Title: Acoustic Fluid Management Device

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 2 - 3
Technical Abstract (Limit 2000 characters):

Parabilis Space Technologies is pleased to propose the development of a novel acoustic propellant manipulation device in response to Z5.06 Servicing and Assembly Applications; Refueling and Storable Fluid Transfer. This device will be capable of liquid gas or fluid phase separation in propellant tanks, ensuring that pneumatic pressurant gas can be vented free of liquid propellant during refueling operations. During Phase I, Parabilis will complete computational analysis of the concept and design a test prototype suitable for microgravity experiments in the subsequent Phase II effort. This work will significantly reduce technical risk and the effort required for prototype testing.

Duration: 6

Proposal Details

Proposal Number: Z5.06-1015
Subtopic Title: Servicing and Assembly Applications
Proposal Title: Payload Universal Multi-purpose Adapter (PUMA)

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 1 - 3
Technical Abstract (Limit 2000 characters):

The Payload Universal Multi-purpose Adapter or "PUMA" is an interface for in-space and surface science instrument servicing, assembly, upgrading & swapping. The PUMA-Surface Science Configuration (PUMA-SSC) provides dust-compliant (utilizing both dust protection strategies and dust tolerant materials) mechanical, electrical, and data interfaces for the lunar surface. Dust compliant means the interfaces must operate in a dusty surface environment and should be designed to function with contamination present at all stages of operation. The PUMA-In-Space Configuration (PUMA-ISC) provides mechanical, electrical, and thermal/fluids interfaces for in-space use. Both PUMA variants are intendent to provide lower mass and volume options for payload developers whether they be operating on the lunar surface or in-space. PUMA takes inspiration from Aegis Aerospace's Materials International Space Station Experiment (MISSE) platform, which has 6 years of flight heritage. Aegis Aerospace will use SBIR funding and other NASA resources such as Flight Opportunities to raise the technology readiness level (TRL) of PUMA to a 9 through in-situ technology demonstrations. Target markets include commercial, government, and academic customers looking to operate instruments in-space or on the lunar surface. Aegis Aerospace has substantial experience in serving the testing and instrumentation markets through operating the MISSE platform and through the company's two lunar surface test beds that are slated for launch on CLPS landers: the Regolith Adherence Characterization-1 (RAC-1) and the Space Science & Technology Evaluation Facility-1 (SSTEF-1).

Duration: 6

Proposal Details

Proposal Number: Z5.09-1003
Subtopic Title: Robotic Hardware for In-Space Manipulation
Proposal Title: Robotic, Efficient Arm for Cargo Handling

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 4 - 4
Technical Abstract (Limit 2000 characters):

Currently NASA has a limited selection of very expensive flight robotic manipulators. Meanwhile, cost-effective, high-performance robot manipulators have become ubiquitous in labs and commercial spaces. NASA needs the best technologies to return to the Moon and ultimately Mars. This requires leveraging existing, de-risked terrestrial technology. This proposed work effort will characterize and validate Apptronik's novel Scorpio robotic manipulator technology to show its effectiveness for NASA applications. For NASA, the bottom line is a versatile, robust, and cost-effective solution to manipulate payloads off-planet for 1/10 the lift weight. Apptronik's transformative approach to manipulation led to the development of Scorpio - a robotic arm that lifts roughly what it weighs, a ten-fold improvement over traditional arms. The basic concept uses a spring element to compensate for gravity which accounts for the greater part of typical power draw. A Scorpio-style arm then only draws power for "floating" a payload in x and y axes. Apptronik's patents and key innovations center on rapidly compensating the spring element and a novel codebase needed to control the behavior of a manipulator with such distinct kinematics. Reducing the need to have gear boxes and high voltage electricity to fight gravity results in a much lighter manipulator. This lighter frame has several positive benefits: • Energy efficient, running off less than 50VDC • Works collaboratively with people, since it can stop faster and with less impact force • Highly mobile, with its light weight and minimal power requirements • Durable, rethinking older "spring lamp" technology with inherent robustness • Lower cost, designed to address real-world unstructured spaces instead of pristine factory floors

Duration: 6

Proposal Details

Proposal Number: Z5.09-1014
Subtopic Title: Robotic Hardware for In-Space Manipulation
Proposal Title: Space-Rated Modular Robotic Building Blocks

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 1 - 3
Technical Abstract (Limit 2000 characters):

HEBI Robotics proposes a robotic development technology that will lay the groundwork for cost effective, rapid, and practical development of robust and versatile space-rated robot systems. This Phase I project will involve research and development that will lay the foundation for a Phase II development project culminating in space-rated modular robotic building blocks that are compatible with the HEBI Robotics platform for robot development. Specifically, this Phase I project involves : Research of initial use cases for space-rated robots and calculate desired range of capabilities and specifications (torque, speed, mass, etc.). Research of specific challenges and considerations for a robot system to be capable of performing in space (extreme temperatures, exposure to radiation, etc.). Research of components and design considerations that will mitigate those challenges. Initial design and prototyping of space-rated modular smart robotic actuators. Planning for further development, presumably a Phase II SBIR project, to produce initial functional prototype building blocks and use the building blocks to create an initial space-rated robot system. Spun off from the Robotics Institute at Carnegie Mellon University in 2014, HEBI Robotics produces an agile platform for robotics development - modular robot building blocks and software tools that dramatically reduce the time and effort required to develop robust robot systems. Hardware components include a growing line-up of smart robotic actuation hardware plus batteries, electronics, and accessories. Software tools include APIs for common development platforms including ROS, Python, MATLAB and C++ as well as GUI configuration and diagnostic tools and programmable user interfaces. Robots that would be cost prohibitive or infeasible to develop with conventional tools are made practical by the HEBI platform.

Duration: 6

Proposal Details

Proposal Number: Z5.09-1017
Subtopic Title: Robotic Hardware for In-Space Manipulation
Proposal Title: Compact Integrated Sensing and Control of Magnetic Gear for End Effectors Suitable for Extreme Environments

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 2 - 3
Technical Abstract (Limit 2000 characters):

An identified need exists for lightweight, low-volume, and low-power actuation solutions with compact integrated sensing approaches to create end-effectors capable of robust fine dexterity for human-hand-like tasks and tool/interface manipulation that are for environmental extremes. Magnetic gear technology is recognized by NASA (through the Motors for Dusty and Extremely Cold Environments Game Changing Development project) to be capable of achieving attractive specific torque, efficiency,

and lifetime for future lunar missions. This proposal aims to leverage the spring-like behavior of magnetic gears to demonstrate integrated, compact, and accurate direct torque and position sensing using only two low cost encoders, and to experimentally validate the critical function of torque-feedback in achieving impedance control targets. While the physical demonstrator is created and tested and the control and sensing approach is validated, the team will simultaneously create an end effector model will be created by the target infusion application (robot arm) and in Phase II the team will test the integrated system. The funding will be used for prototype fabrication and labor for testing and modeling. The immediate target market is an end-effector for in-space satellite capture, but the scalable magnetic gear can be integrated to create an end-effectors for dual-use applications ranging from intravehicular, lunar surface, and in-space servicing tasks such as assembly, maintenance, and outfitting; installation, stowage, and handling of cables and fluid lines; manipulation of soft goods; sample collection in extreme environmental conditions, particularly cryogenic conditions; science utilization such as moving samples between cold storage and instruments, small and logistics management. This technology can also be used terrestrially or in low earth orbit to target semiconductor, pharmaceutical, beauty and personal care, and food and nutrients manufacturing industries.

Duration: 6

Proposal Details

Proposal Number: Z5.10-1003
Subtopic Title: Extensible Planning, Perception, and Control for Autonomous Robotic Systems
Proposal Title: Safe Persistent Operations with Cobots in Space (SPOCS)

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 2 - 4
Technical Abstract (Limit 2000 characters):

Motiv Space Systems (Motiv) presents a concept for Safe Persistent Operations with Cobots in Space (SPOCS), addressing codesign and development of an autonomous collaborative space robot system for operations in persistent platform interiors. In order for a persistent space platform to sustain persistent operations, its autonomous systems must maintain safe operational condition over substantial periods of time. Beyond a condition of safe operation, autonomous robotic systems in particular must safely operate with neither self-damage nor damage to assets within the persistent platform. This applies during periods of human crew occupation and periods when only robots and other non-embodied autonomous systems are at work in persistent platforms. This is noteworthy, as it is expected that NASA's lunar orbiting facility, Gateway, may have no crew onboard during most of a given year with crew occupying the station for only weeks at a time. Envisioned habitable elements, such as the Habitation and Logistics Outpost (HALO) and the International Habitation (I-HAB) module, will enable crew stays around the moon for at least a month. The expectation of intermittent crew occupation holds as well for Artemis lunar surface habitats and eventual Mars habitats. In the case of robots as embodied autonomous systems operating within persistent platforms such as orbital stations and surface habitats, this can be facilitated via a priori codesign considering features of the habitat, the robot design, and autonomy that synergistically manifest in the form of intelligent motion planning and control capabilities – all as an integrated solution. This SPOCS efforts will contribute to enhancing the safety of intravehicular robotics, for which the SOA platforms are represented by NASA's Astrobee free-flying robot and humanoid robots Robonaut 2 and Valkyrie. And it will complement those systems via broader availability of space collaborative robots and codesigned human-aware subsystems.

Duration: 6

Proposal Details

Proposal Number: Z5.10-1007
Subtopic Title: Extensible Planning, Perception, and Control for Autonomous Robotic Systems
Proposal Title: Autonomous Perception and Manipulation of Cables and Fluid Lines for Remote Infrastructure Maintenance for Orbital and Lunar Missions

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 3 - 4
Technical Abstract (Limit 2000 characters):

NASA's Moon-to-Mars roadmap calls for robotic systems which can complement and eventually replace humans for both routine and unplanned assembly, maintenance and inspection tasks for orbital and lunar surface infrastructure. The proposed innovation is an integrated perception and planning system to enable safe and productive interaction with cables and fluid lines, a ubiquitous element in any spacecraft or ground habitat, without human oversight. Handling cables and fluid lines involves a wide array of motion primitives and configurations. For example, they may need to be pulled aside to allow others to be installed, for panels to be inspected, or to unblock a passageway. Perhaps a gentle tug is necessary to confirm the connector it is linked to or to validate its stiffness before moving it more forcefully. As flexible materials, they settle in

unpredictable configurations, and robots need to be able to adapt to what they see in the moment, rather than memorizing precomputed response patterns. Funding will be put towards developing software for four key capabilities required to safely interact with cables and fluid lines: view planning, detection, mapping and manipulation planning. Development will occur mainly in simulation and then a representative end-to-end scenario will be demonstrated in a lab environment. This technology's space customers are NASA and other space agencies, as well as commercial space operators. It is intended to be deployed as a tech demo on Astrobee onboard the International Space Station. L5 would offer "Maintenance as a Service" at a rate which would drastically undercut the equivalent human labor rate. For Earth applications, it would support L5's ongoing strawberry harvesting activity, specifically for the perception and manipulation of tangled strawberry stems, whose occlusion can prevent ripe specimens from being picked.

Duration: 6

Proposal Details

Proposal Number: Z5.10-1018
Subtopic Title: Extensible Planning, Perception, and Control for Autonomous Robotic Systems
Proposal Title: EDORAS: Easing the Development of Robot Applications for Space Missions

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 2 - 4
Technical Abstract (Limit 2000 characters):

In order to address NASA's goals to establish a sustained presence in the Moon and beyond, there is the need for closer integration between robot and flight software, in order to take advantage of the state-of-the-art robot application tools, usually available as ROS 2-based libraries, and allow them to operate on space missions. During the last few years in particular, bridges between ROS 2 and cFS have been created such that they enable both frameworks to operate together. In this project, TRACLabs proposes to implement a set of software tools that eases the adaptation modifications that are often needed to efficiently integrate ROS 2 applications with flight software. Our main goal is to reduce development time by providing reusable, configurable libraries that make it easy for a robotics developer to adapt their existing (terrestrial) robot applications to be suitable for integration with flight software with its accompanying constraints. We call these tools EDORAS (Easing the Development of Robot Applications for Space Missions). To clarify, EDORAS is not a bridge; rather, it is a set of tools that can be used at a high-level (on top of an existing bridge) to reduce the overhead of adapting existing robot applications by providing tools to automate the conversion from ROS 2 to cFS message types, and providing tools to address the particular needs of the transmission of large message types, if they need to be transferred, considering the bandwidth limitations of the flight system.

Duration: 6

Proposal Details

Proposal Number: Z5.10-1021
Subtopic Title: Extensible Planning, Perception, and Control for Autonomous Robotic Systems
Proposal Title: Accelerating Space Robot Operating System for a Sustainable Lunar Future

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 3 - 5
Technical Abstract (Limit 2000 characters):

Earlier space robotics missions relied on bespoke development of hardware and software, which is expensive and does not lend itself to software interoperability or sustained collaborative operations. Many terrestrial robots are built on the Robot Operating System (ROS). ROS provides a common software infrastructure that enables interoperability between different robot hardware components and software systems from different vendors. By providing common infrastructure and tools, robots can be built more quickly and reuse software components. Work has already begun to bring these ROS concepts to space, in an international open source effort called Space ROS. Space ROS will be a key factor in building a sustainable lunar surface ecosystem that efficiently re-uses assets for rapid evolution of missions. Once Space ROS has flight heritage and has been established as certifiable software, it will be possible to apply it to any number of applications for Moon to Mars missions, and beyond. Space ROS will enable both more robots to be built for less money, but also the ability for sustained collaborative operations in space environments. The goal of this phase is to boost Space ROS's momentum in the community, demonstrate capabilities by pairing with cFS for control, and provide a space-focused test harness. We will provide a showcase for existing functionality, integrate third party software, and test Space ROS in a hybrid autonomy environment designed for space robot operators. A key outcome of this Phase 1 will be accelerating the adoption of Space ROS by at least 1 year. Our software platform, MoveIt Pro, is the primary way to monetize our work on Space ROS, and Space ROS is key to elevating the TRL and utility of MoveIt Pro for space.

MoveIt Pro serves automation and robotic needs in the emerging areas of CLD, ISAM/SAML, ADR, lunar and planetary missions. The space robotics market is estimated to have a total addressable market (TAM) of $58B by 2030.

Duration: 6

Proposal Details

Proposal Number: Z7.01-1000
Subtopic Title: Entry, Descent, and Landing (EDL) Flight Sensors and Ground-Testing Technologies
Proposal Title: Velocity and Altitude Sensing Hybrid LiDAR ASIC with Extremely Low SWaP

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 1 - 2
Technical Abstract (Limit 2000 characters):

Radiation tolerant LiDAR systems providing accurate range information are needed for rendezvous, docking, mapping, navigation, debris removal, and dynamic missions in space. However, a challenge exists with increasing LiDAR accuracy at both long and short range without sacrificing resolution or C-SWaP. SenseICs proposes to develop a radiation tolerant ”HyDAR” hybrid LiDAR ROIC combining the benefits of direct and indirect time of flight to achieve unprecedented range resolution at low C-SWaP to address these needs.

Duration: 6

Proposal Details

Proposal Number: Z7.01-1003
Subtopic Title: Entry, Descent, and Landing (EDL) Flight Sensors and Ground-Testing Technologies
Proposal Title: Wirelessly Activated Remote DAQ for Space (WARDS)

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 2 - 4
Technical Abstract (Limit 2000 characters):

IC2 proposes to develop a battery-operated, low power, small form factor wireless data-acquisition (DAQ) system which has been appropriately hardened for use in spacecraft. This system will include the ability to remain dormant for at least two years while remaining capable of immediate activation on demand. Once activated, the system will acquire sensor data for at least one month. The proposed system utilizes a distributed wireless sensor network to mitigate the challenges related to sensor installation, including technological, logistical, weight, and cost barriers. Because the proposed system uses wireless communication, it does not require penetrating or damaging the vehicle skin and provides the end-user with the ability to deploy more sensors due to a relaxation of cable routing and weight requirements. Limiting the cable routing requirements reduces installation effort over current systems and provides for substantially more flexible sensor placement options. The primary target application for the system is spacecraft instrumentation, while other applications requiring environmentally hardened low power wireless instrumentation could also be supported by the system’s capabilities. Funding will be used to establish target specifications and requirements based on NASA input and design constraints, develop the concept and proposal for a system level deployment, develop the conceptual design for a prototype system, build a functional prototype, and characterize the results.

Duration: 6

Proposal Details

Proposal Number: Z7.03-1000
Subtopic Title: Entry and Descent System Technologies
Proposal Title: Advanced Thermal Protection System (TPS) to Reduce Mass, Stowed Volume and Cost of Inflatable Structures

Small Business Concern

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Principal Investigator

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 2 - 4
Technical Abstract (Limit 2000 characters):

The project aims to develop and assess high-temperature thermal insulation by combining high-temperature fibers, opacifiers to block radiant heat, and high-temperature gas conduction inhibitors to minimize gas conduction in an insulating felt. By blending these materials, the insulation seeks to achieve superior thermal resistance, thereby improving efficiency in various aerospace and industrial applications. Initial phases involve synthesizing the composite insulation material in controlled laboratory settings, optimizing the proportions of each constituent for maximal effectiveness. Testing protocols will then subject the insulation to high-temperature environments to evaluate its thermal performance under realistic conditions. Key metrics include thermal conductivity, heat resistance, and durability. The project's objectives align with the broader goal of advancing insulation technology to enhance efficiency and reduce operational costs for planetary re-entry, electric vehicles and other industries. More efficient insulation materials offer numerous benefits, including reduced mass, stowed volume, and overall costs. By minimizing heat transfer, these advancements can lead to energy savings and improved system performance in applications such as manufacturing, automotive, aerospace, and energy generation. Furthermore, the project aims to address environmental concerns by promoting energy efficiency and reducing carbon footprints. Through collaboration with industry partners, the project seeks to accelerate the adoption of innovative insulation solutions, driving progress towards sustainability goals. Overall, the project represents a concerted effort to innovate in thermal insulation technology, leveraging novel material combinations to achieve superior performance, cost-effectiveness, and environmental sustainability in diverse industrial contexts.

Duration: 6

Proposal Details

Proposal Number: Z7.03-1001
Subtopic Title: Entry and Descent System Technologies
Proposal Title: High Temperature Inflation Hoses and Ports for Next Generation Inflatable Heat Shields

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 2 - 5
Technical Abstract (Limit 2000 characters):

NASA Langley Research Center (LaRC) led the successful flight test of a 6-meter diameter HIAD in November 2022 under the project called the Low earth Orbit Flight Test of an Inflatable Decelerator (LOFTID) project. This demonstration has led to new opportunities with commercial partners that require further scale-up of the deployable aeroshell technology. For example, NASA LaRC is developing a 10-meter diameter HIAD that is being considered for use by United Launch Alliance (ULA). Scaling the inflatable heat shield from LOFTID's 6-meter to a 10-meter class and beyond will require solving manufacturing, design, and procurement challenges for several materials, components, and systems. The Inflatable Structure (IS) system of NASA's 10m HIAD will benefit from larger hoses and ports than are currently available to inflate the heat shield. The hoses are located on the back side of the inflatable heat shield, somewhat protected from the front side heat pulse, yet must survive radiation from plasma trails and heat conduction through the heat shield during the ~5 min heat pulse. The hoses are expected to near peak external temperatures of 400C during reentry while the inside will need to resist hot gases from a gas-generator inflation system with gas temperatures up to 200C. JBE is proposing to demonstrate the design and manufacturing of a 1 inch and 2 inch diameter class hoses and ports, that can survive the requirements of an inflatable heat shield aeroshell component including packing and deployment, inflation load, max aerodynamic load, and the forementioned temperatures. The SOTA LOFTID hoses limit the inflation time of the inflatable heat shield. In PHI, JBE will focus on demonstrating the use of novel materials and manufacturing techniques to develop a 1 inch diameter class hose and port. In PHII, JBE will build upon the lessons learned in PHI, develop a 2 inch diameter class hose and port and validate the performance of both classes with thermo-mechanical testing.

Duration: 6

Proposal Details

Proposal Number: Z7.03-1008
Subtopic Title: Entry and Descent System Technologies
Proposal Title: Dynovas Advanced Pressure Resin Transfer Molding (DAP-RTM) for Large Three Dimensional Woven Preforms

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 1 - 3
Technical Abstract (Limit 2000 characters):

NASA is progressing the development of thermal protection system (TPS) concepts using Large 3D-woven preform composites to facilitate both robotic and human space missions, particularly during entry and aerocapture phases. These advancements find application in missions to celestial bodies such as Mars, Venus, and Titan, as well as in suborbital missions and those returning to Earth. The woven preforms that serve as constituents for these new materials tend to have a high fiber density, large volume, and intricate weave patterns. These attributes have consistently shown that traditional resin transfer molding processes such as vacuum assisted resin transfer molding (VARTM) and vacuum resin film infusion (RFI) are incapable of achieving full densification (<2% void volume). The Dynovas Advanced Pressure Resin Transfer Molding (DAP-RTM) system specifically addresses NASA's call for development of an improved and more reliable method to infuse NASA's 3D Multifunctional Ablative TPS (3D-MAT) and other large three dimensional preforms. The DAP-RTM system provides a novel solution that leverages the extensive experience of the Dynovas staff in this technology area. The proposed development work plan will advance current state of the art, reduce schedule, increase yield, and reduce cost for Large Three Dimensional Woven Preforms Composites through implementation of three key process improvements: 1. Improved Resin Flow 2. Advanced Preform Preprocessing 3. Tailored Mechanical Injection

Duration: 6

Proposal Details

Proposal Number: Z7.03-1010
Subtopic Title: Entry and Descent System Technologies
Proposal Title: Solid-State Noncombustible Gas Generator

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 2 - 3
Technical Abstract (Limit 2000 characters):

Deployable aerodynamic decelerators are an enabling technology for missions to planets and moons with atmospheres as well as for returning payloads to Earth. These decelerators require a gas source for inflation, and the objective is to develop a noncombustible gas generator which will enable a wider range of applications, including near-term commercial applications, in the Earth environment. Anasphere has previously demonstrated hydrogen generators suitable for use with Hypersonic Inflatable Aerodynamic Decelerators (HIADs). In the present project, the gas storage medium in this baseline design will be changed to produce a mixture of two gases that will form the bulk of a noncombustible gas mixture. A makeup gas component will be produced by a separate element of the system to yield a final mixture which is noncombustible under Earth atmospheric conditions. Phase I work will focus on the new features of the system with particular emphasis on how the makeup gas is

generated. A small proof-of-concept generator will be built and tested to show that a noncombustible gas mixture is produced. Phase II work would include scaling up the new design and subjecting it to extensive environmental tests. Target markets include HIADs used for launch vehicle asset return and payload return from Earth orbit.

Duration: 6

Proposal Details

Proposal Number: Z7.07-1004
Subtopic Title: Plume-Surface Interaction (PSI) Technologies
Proposal Title: Fluffy Layer Ultra-low-Force Soil Compression ANalyser (FLUFSCAN)

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 2 - 4
Technical Abstract (Limit 2000 characters):

Cislune Inc., along with Dr. Fontes from Westmont College and Dr. Phil Metzger from the University of Central Florida, propose the Fluffy Layer Ultra-low-Force Soil Compression Analyzer (FLUFSCAN). This innovation addresses crucial gaps in understanding and mitigating plume-surface interactions (PSI) during lunar and planetary landings, aiming to significantly enhance mission safety and reliability. Leveraging a novel combination of ground-based laser instrumentation and penetrometry, FLUFSCAN measures the compaction and cohesion of lunar soil, enabling precise modeling of regolith erosion. Phase I funding will be utilized for experimental characterization of regolith compaction and erosion, development and prototyping of PSI-specific flight instrumentation, and calibration of numerical models to predict PSI effects. The target market includes NASA, commercial space companies, and international space agencies, with potential commercialization through mission integration and technology licensing. This proposal integrates advanced computational modeling, empirical data analysis, and innovative instrumentation design to provide a comprehensive solution for PSI challenges, setting a foundation for safer lunar and planetary explorations.

Duration: 6

Proposal Details

Proposal Number: Z7.07-1006
Subtopic Title: Plume-Surface Interaction (PSI) Technologies
Proposal Title: Nonintrusive Diagnosis of Ejecta Cloud from Plume Surface Interactions using High-Speed Digital Holography

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 5 - 6
Technical Abstract (Limit 2000 characters):

The physics of plume surface interactions (PSI) when a rocket-powered spacecraft performs an extraterrestrial surface landing involves producing soil erosion/cratering and high-speed ejecta which are fundamentally coupled. The crater shape and growth effects the speed and direction of the ejecta particles that may in turn be entrained by the flow field to alter the plume aerodynamic structure, the cratering process and even a space lander's orientation. A recent touch-down event by the Odysseus lunar lander where the lander tripped and fell onto its side on the cratered lunar surface may have resulted from a PSI phenomenon, highlighting the extent of the problem. Relevant mitigation techniques require understanding the physics of PSI events. More specifically, accurate 3D characterization of the high-speed ejecta particles in terms of particle size distributions, trajectories and velocities is needed by NASA to assess mitigation measures and for benchmark validation of modeling and simulation (M&S) tools. The current state of experimental findings on PSI is scarce and the in-situ diagnostics used to obtain data only provide two-dimensional information that are highly dependent on ambient light and visibility conditions making measurements difficult close to touchdown. Given these shortcomings, this work proposes to demonstrate the feasibility of high-speed digital holography (DH) in providing high resolution time-resolved 3D trajectories, velocities and particle size distributions of ejecta particles generated by PSI events of rocket powered spacecraft landings. Since digital holography makes it possible to numerically focus on discrete depth planes, a single digital holographic video is equivalent to 1000 conventional videos, each recorded at a different plane of focus. The effort will provide a prototype instrument for physics focused ground testing and a preliminary design for a compact DH flight instrument (HoloCam) for NASA's future mission needs.

Duration: 6

Proposal Details

Proposal Number: Z7.07-1014
Subtopic Title: Plume-Surface Interaction (PSI) Technologies
Proposal Title: Advancing ExoCam 360° Video Technology via In Situ Vacuum Chamber Test Relevant to Lunar Plume Surface Interaction

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 2 - 4
Technical Abstract (Limit 2000 characters):

The principal objective of this Phase I SBIR is to advance the TRL of our ExoCam 360° camera system by operating it in a relevant vacuum environment that will accurately simulate an active PSI ground test event (a rocket engine firing into a surface of lunar regolith simulant) within NASA Langley Research Center's (LaRC) new 60-ft Vacuum Sphere Test Facility, designed to emulate conditions of an actual landing on the Moon as closely as possible. Specifically, we will be researching and

ultimately testing a high-resolution, high framerate, 360° field of view (FOV) commercial off-the-shelf (COTS) color video camera in vacuum chamber at Honeybee Robotics Altadena lab facility. This will including thermal conditioning, satisfactory environmental isolation, and after-market custom avionics developments necessary to actuate "record" mode on the camera for a predetermined length of time, actionable by a wired "GO" signal similar to what would be provided by the LaRC test chamber during the engine fire test. All this development is in preparation for ultimately capturing a rocket engine firing into the surface of lunar regolith simulant at a new NASA Langley Vacuum Sphere government test facility (still under construction). Although a terrestrial test, this set of test conditions will emulate the conditions of a lunar lander landing on the surface of the Moon, and verifying our camera functionality in a relevant test environment ahead of time will allow our team to be ideally prepared for the first opportunity to test in the LaRC facility, and advance not only TRL but also our development timeline for inclusion on upcoming Commercial Lunar Payload Services (CLPS) flight opportunities. TRL for this system is anticipated to advance from 2-4 via initial testing in these relevant conditions.

Duration: 6

Proposal Details

Proposal Number: Z8.09-1005
Subtopic Title: Small Spacecraft Transfer Stage Development
Proposal Title: Advanced Transfer and Relay Stage

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 2 - 4
Technical Abstract (Limit 2000 characters):

In response to the 2024 NASA SBIR Phase I solicitation subtopic Z8.09, “Small Spacecraft Transfer Stage Development,” Advanced Space, LLC proposes to develop mission architectures and requirements for customizing a low-cost rocket transfer stage that will deliver small spacecraft to nontraditional orbits and provide position, navigation, timing (PNT) and communications relay services for the deployed small spacecraft. The proposed solution defines a set of modular mission architectures and concepts of operations (ConOps) that match launch vehicle and transfer stage capabilities to the deployment of a primary payload in its destination orbit. The proposed solution will result in a mission-planning system that defines the required capabilities of the transfer stage to satisfy any given design reference mission (DRM). Mission destinations to cislunar space impose cumbersome propulsion, navigation, and communication requirements on small spacecraft. Propulsion to reach the destination orbit, longer communication distances, and lack of Global Navigation Satellite Systems (GNSS) are significant contributors to increased spacecraft size, weight, power, and cost (SWAP-C). These hindrances drive the need to develop services that facilitate operating small spacecraft in these unique mission destinations. Previous awardees of this subtopic have designed transfer stage platforms to provide small spacecraft enough energy to reach cislunar space, lunar orbit, and beyond, but have not yet exploited the possibility of using the same hardware to provide needed communications and navigation services for these SWAP-limited missions as they embark on journeys to increasingly distant destinations. Any relief of these needs for small spacecraft will contribute to increasing the scientific or commercial return of the primary mission.

Duration: 6

Proposal Details

Proposal Number: Z8.09-1012
Subtopic Title: Small Spacecraft Transfer Stage Development
Proposal Title: Versatile, Low-cost, High Delta-V Small Spacecraft Transfer Stage

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 3 - 5
Technical Abstract (Limit 2000 characters):

To meet the NASA need, GigEngineer Inc. (“Gig”) proposes to develop a new Versatile, Low-cost, High Delta-V Small Spacecraft Transfer Stage ("Hohmann"). it can be used by NASA to close the small spacecraft orbit transfer capability gap by enabling small spacecraft payloads in the near term to the cislunar environment, with longer term potential for farther destinations such as near-Earth objects, Mars, or Venus. The Phase I funding will be used to advance the complete Hohmann vehicle to Preliminary Design Review maturity, fabricate and test key materials, and prototype vehicle components. With delta-v capability exceeding 4 km/sec, Hohmann is well suited for a variety on non-NASA missions, such as DoD NSS, and commercial (e.g., communication) satellite boost to MEO or GEO.

Duration: 6

Proposal Details

Proposal Number: Z8.09-1014
Subtopic Title: Small Spacecraft Transfer Stage Development
Proposal Title: Benchmark Single Asset Kick Stage

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 2 - 4
Technical Abstract (Limit 2000 characters):

For large orbit transfer logistics of the 25-200kg small spacecraft size range, Benchmark will combine our flight-proven high-test peroxide (HTP) bipropellant subsystem (Halcyon Avant), our multi-technology control electronics and SmartAIMTM propulsion control technology, a partner-supplied electric propulsion subsystem, and other commercial off-the-shelf (COTS) subsystems. The new development focus area will be to specify spacecraft interface and system design to maximize breadth of standard compatibility for a ‘universal fit’ across spacecraft and

launch vehicles. The primary objective of the proposed phase I statement of work is to develop a preliminary design review (PDR) data package, to include subsystem requirement setting and selection, digital design package, and mission profile description. The PDR package will act as a gate into a phase II effort that would aim to bring the newly integrated system & platform architecture to a Technology Readiness Level (TRL) of 6, where an integrated transfer-stage system would be developed and readied for laboratory Hardware-in-Loop testing. Following the prospective phase II work, the transfer stage platform would be ready to enter a qualification and on orbit demonstration campaign. The value in having an in-space propulsion leader with multi-technology integrations, and orbit transfer mission experience is critical in maximizing pace and efficiency of a deployable solution to these long transfer challenges. A multi-mode or multi-technology solution provides the optimal maneuver capability; of which BSS has experience optimizing bulk impulse needs across multiple propulsion subsystems for advanced missions; which will be necessary to provide both the speed, endurance, and form factor required in a small spacecraft transfer stage (SSTS.) BSS will combine that expertise with COTS power, communications, and other vehicle subsystems to produce an SSTS platform.

Duration: 6

Proposal Details

Proposal Number: Z8.13-1003
Subtopic Title: Space Debris Prevention for Small Spacecraft
Proposal Title: Tool for Optimal Reconfiguration of Satellite Swarms (TORSS)

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 1 - 3
Technical Abstract (Limit 2000 characters):

Satellite swarm reconfiguration is performed sporadically to ensure adequate separation between satellites and conformance to mission requirements. However, current reconfiguration techniques are computationally expensive, and often do not find globally optimal solutions. The Tool for Optimal Reconfiguration of Satellite Swarms (TORSS) detects impending loss of inter-satellite separation and separation with other tracked objects such as space debris. TORSS efficiently identifies satellite maneuvers with optimal conformance to the mission plan, fuel consumption, and inter-satellite separation. TORSS provides operators with recommendations for the identified optimal maneuvers to support their decision making. For example, TORSS iteratively monitors positions of satellites in swarms and propagates their trajectories in a simulated environment. When future loss of separation is anticipated, TORSS computes and recommends multiple efficient reconfiguration maneuvers. An operator may then verify and implement one of the recommended maneuvers to avoid loss of inter-satellite separation.

Duration: 6

Proposal Details

Proposal Number: Z8.13-1011
Subtopic Title: Space Debris Prevention for Small Spacecraft
Proposal Title: High-Performance Deorbit Engine with Minimal Power Requirements

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 3 - 4
Technical Abstract (Limit 2000 characters):

The two primary methods of deorbiting a spacecraft involve either applying drag or using a propulsion system. Atmospheric drag, tethers, and solar sails are examples of the former, and chemical propulsion and electric propulsion are examples of the latter. The orbit height, spacecraft mass, and spacecraft “frontal area” will determine the velocity change requirements and the time frame over which a system can deorbit a spacecraft. The minimum-mass solution for a given time frame will generally involve the use of both drag and propulsion: use a propulsion system to lower the spacecraft orbit and then let atmospheric drag further slow the spacecraft to complete the deorbit maneuver. In this project, Ultramet will investigate the propulsion and drag requirements for a minimum-mass system, and then focus on the development of a suitable propulsion system. Specifically, Ultramet will mature its existing green propulsion technology, and its high-reliability low temperature ignition system that is being developed for the Air Force, and apply them to the development of a high specific impulse (>300 sec) hybrid rocket with low size, weight, power, and cost (SWaP C) that can be used to lower the orbit of a small spacecraft to the point where atmospheric drag can complete the deorbiting process within the desired time frame.

Duration: 6

Proposal Details

Proposal Number: Z8.13-1015
Subtopic Title: Space Debris Prevention for Small Spacecraft
Proposal Title: AmmoniX: Low-Cost SmallSat End-of-Life Management Deorbiting Stage

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 2 - 4
Technical Abstract (Limit 2000 characters):

nou Systems Inc. (nSI), has developed a revolutionary new modular propulsion concept for SmallSats with exceptionally low SWaP-C and uncompromising performance. These developments represent a pivotal advancement in space propulsion technology and will revolutionize SmallSat end-of-life management. Our system is a compact, lightweight, and modular, propulsion system that is readily integrated with most SmallSat architectures. When a SmallSat reaches its end of life, it activates to

provide rapid and reliable deorbiting. Our system is useable at far higher orbits than passive deorbiting technologies (such as drag sails) and its architecture stands out for unparalleled simplicity, high ISP, sustainability, ease of storage and handling, low cost, and operational efficiency. With a significant portion of SmallSats lacking dedicated propulsion capabilities, our technology fills a critical gap, offering a simple, low-cost, and low-SWaP solution for meeting end-of-life disposal policies without contributing to additional space debris, all while using a low-cost green propellant. Phase I will include trade studies, analysis, and laboratory testing. Phase II will proceed with prototype assembly and testing at prototypical conditions laying the foundation for an airborne prototype unit to be demonstrated in Phase III.

Duration: 6

Proposal Details

Proposal Number: Z8.13-1016
Subtopic Title: Space Debris Prevention for Small Spacecraft
Proposal Title: RIDDANCE: Removal of Irregular Debris using Double Assisted Nets with Controlled Enhancement

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 2 - 4
Technical Abstract (Limit 2000 characters):

We propose a groundbreaking and cost-effective solution through our Removal of Irregular Debris using Double Assisted Nets with Controlled Enhancement (RIDDANCE) initiative. This innovative approach involves the deployment of a Double Debris Net (DDN) launcher in conjunction with our Deorbit Drag Device (D3), designed to entrap and deorbit space debris efficiently. The Phase I deliverables of this project are centered on the development and validation of a functional prototype for the DDN launch mechanism, complete with a designated target object. This crucial step will elevate the DDN technology from TRL 2 to TRL 4, marking a significant advancement in its development process. The integration of the DDN with the D3 is a pivotal aspect of our project. The D3 mechanism will be meticulously designed to seamlessly interface with the DDN, encompassing mechanical, electrical, and data components to ensure optimal functionality and compatibility. Through mathematical modeling and computer simulations, we will thoroughly analyze the operational dynamics of the DDN when deployed from a D3-equipped CubeSat. This analysis will delineate the operational boundaries of the DDN launch mechanism, including the mass and size limitations of the debris it can effectively capture. Key potential customers for RIDDANCE are companies specializing in space debris removal. Additionally, other customers include agents that seek space debris removal services to protect their valuable satellites and spacecraft. Because RIDDANCE is uniquely designed to de-tumble and obtain positive control of orbiting derelicts, companies specializing in on-orbit servicing and manufacturing will find RIDDANCE a valuable tool. By removing debris using RIDDANCE, the risk of collision decreases, thereby protecting operational satellites, while reducing costly damage and loss of revenue. The reduction in damage to spacecraft can also lower the cost of insurance premiums for satellite operators.

Duration: 6

Proposal Details

Proposal Number: Z10.01-1000
Subtopic Title: Cryogenic Fluid Management
Proposal Title: Efficient Models for Film Condensation in Cryogenic Tank Applications

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 2 - 3
Technical Abstract (Limit 2000 characters):

To support NASA's Cryogenic Fluid Management (CFM) design and operation initiatives subgrid computational fluid dynamics (CFD) models of cryogenic condensation/liquification are required to allow for efficient trade studies to be conducted on real systems over a range of conditions that may be prohibitive with laboratory testing. In the Phase I effort, a validated subgrid CFD model of cryogenic film condensation on a vertical flat wall will be developed which is capable of capturing the formation and growth of a cryogenic condensation layer and its movement along a wall boundary. A systematic test campaign will be undertaken to investigate the downflow film condensation of oxygen which is of relevance to CFM and In-Situ Resource Utilization (ISRU) initiatives. The Phase I test effort emphasizes experimental visualization of the onset of film condensation, understanding of relative importance of heat transfer processes, quantification of key film characteristics, including liquid film thickness, vapor thermal boundary layer, and condensation heat flux, and identification of governing parameters that influence cryogenic film formation and growth. The experimental data will be used for fundamental validation of a subgrid cryogenic film condensation CFD phase-change model, setting the stage for a Phase II validation program on prototype CFM geometries. The Phase II effort will extend the validation to tank geometries and incorporate the validated film

condensation model into commercial CFD tools used by NASA. The validated predictive simulation tools will help in identifying better designs and protocols related to cryogenic propellant transfer and ISRU thereby mitigating risk in outer space hardware deployment and operational strategies.

Duration: 6

Proposal Details

Proposal Number: Z10.01-1003
Subtopic Title: Cryogenic Fluid Management
Proposal Title: A Compact Electrically-Driven Booster Pump for Saturated LH2

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 2 - 4
Technical Abstract (Limit 2000 characters):

Future exploration to the outer reaches of our solar system and beyond will require high-thrust, high specific impulse propulsion systems to reduce transit time. For this reason, missions are being designed that would make use of propulsion systems using cryogenic propellants such as liquid hydrogen (LH2). A promising layout for these systems includes the use of a small electrically-driven pump able to provide a reliable boost to propellant pressure, simplifying the engine cycle and improving reliability and mass. To address this need, Creare proposes to develop a compact, low Net Positive Suction Head (NPSH), electrically-powered LH2 pump capable of operating with saturated liquid at its inlet. NASA mission projections indicate a need for pumping up to 0.6 kg/s LH2 flow with 45 psid head rise. The density of LH2 is relatively low; therefore, the volume flow rate and motor power are appreciable, and providing a substantial head rise requires high operating speeds, driving cavitation concerns. In Phase I, we will prove the feasibility of the cryogenic propellant pump by developing a preliminary design, predicting its overall performance, and demonstrating its key features by testing in simulant cryogenic fluids. In Phase II, we will optimize the pump design, fabricate an integrated pump assembly, demonstrate its steady-state and transient performance at representative conditions, and deliver it to NASA for further performance evaluation.

Duration: 6

Proposal Details

Proposal Number: Z10.01-1005
Subtopic Title: Cryogenic Fluid Management
Proposal Title: Space Exploration Hydrogen Boost Pump

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 2 - 4
Technical Abstract (Limit 2000 characters):

Concepts NREC proposes an electrically driven, boost pump, with an integrated motor to deliver liquid hydrogen saturated at 20 psia, at an increase in pressure of between 25 and 45 psid, and a flow rate of at least 0.6 kg/s. The target life will be 7500 hours with 3000 start/stop cycles. The boost pump can be used in conjunction with a high-pressure ratio pump for a variety of space exploration missions of interest to NASA. Because of differences in density, the hydrogen boost pump can be used for other fluids, such as LOX and methane, and satisfy are good portion of the flow and pressure rise needs for these propellants in launch and in-space applications. The pump will be designed with the intent to operate with other fluids to maximize its usefulness. The hydrogen pump development will enable more rapid development of other motor driven aerospace pumps for a variety of propellants and purposes for lower long term development costs.

Duration: 6

Proposal Details

Proposal Number: Z10.05-1002
Subtopic Title: Rotating Detonation Rocket Engine Nozzles and Instrumentation
Proposal Title: Venus Aerospace Rotating Detonation Nozzle Development

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 3 - 4
Technical Abstract (Limit 2000 characters):

Venus Aerospace proposes the testing of four nozzle contours to obtain high-fidelity datasets to anchor future experimental and CFD-based high area ratio RDRE nozzle development efforts. Testing will be conducted using proven RDRE hardware from Venus with modular interfaces for rapid integration and test. From the test data Venus will characterize the relative performance of four unique baseline RDRE nozzle contours . The Phase I effort will conclude with a Phase II planning effort containing (1) suggestions for optimized hardware for transition flight to demonstrations, (2) requirements for instrumentation to anchor later CFD models, and (3) a draft test plan. The Phase III plan is to conduct a high-speed, high-altitude, flight demonstration an RDRE with an optimal RDRE nozzle. Venus Aerospace will will first transition this flight proven model into a reusable hypersonic flight system to meet US Defense needs for rapid high speed test. The NASA Flight Opportunities program will utilize this system for high-altitude and high-speed research. The optimal RDRE will also be able to address space based missions such as landers, in-space mobility and logistic operations, and small launch systems. Venus will target integration with commercial providers in these mission area, as well as those that support NASA programs for the Human Landing System (HLS), and Commercial Lunar Payload Services (CLPS) lander missions.

Duration: 6

Proposal Details

Proposal Number: Z10.05-1007
Subtopic Title: Rotating Detonation Rocket Engine Nozzles and Instrumentation
Proposal Title: Performance of Expansion-Deflection Nozzles for Rotating Detonation Rocket Engines

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 1 - 3
Technical Abstract (Limit 2000 characters):

Rotating detonation combustion (RDC) has seen substantial research and development in recent years. Pressure-gain in RDC engines due to the detonation mode of combustion enables greater extractable energy potential, generating thrust more efficiently than conventional combustion engines. This increased efficiency is critical for both hypersonic air-breathing applications, where RDC can be coupled to ramjets to enable high-speed, long-range flight, and for in-space propulsion which benefits from the increased delta-v and compact geometry of rotating detonation rocket engines (RDRE). Exhaust nozzle design determines the overall performance at the design point, contributes significantly to the total engine weight, and can affect the stability of the detonation, yet it remains an under-researched aspect of RDREs. An expansion-deflection (ED) nozzle is proposed herein as a solution to maximize the thrust potential of RDREs operating in vacuum conditions. High fidelity CFD simulations of candidate RDRE experimental configurations will be conducted to identify performance trends and transient forces and heating on the combustor surfaces. A reduced-order modeling (ROM) approach will be adapted to provide more rapid evaluation of candidate nozzle contours, and a novel shock-tracking numerical approach will be tested to enable more efficient CFD simulations. In Phase II the ED nozzle designs will be prototyped and tested experimentally to validate the performance trends identified in the CFD. The ROM approach will be further developed to optimize the nozzle contours for increased thrust and reduced weight and length. Additionally, the feasibility of active thrust control through moving the center body pintle will be explored.

Duration: 6

Proposal Details

Proposal Number: Z10.05-1010
Subtopic Title: Rotating Detonation Rocket Engine Nozzles and Instrumentation
Proposal Title: CeramiFlux: Advanced Heat Flux Sensing

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 2 - 5
Technical Abstract (Limit 2000 characters):

Bryka Inc. proposes innovation in aerospace sensor technology with the development of CeramiFlux, a ceramic-based thick film heat flux sensor utilizing β-Ga_2O_3 (beta-phase Gallium Oxide). Designed for the extreme conditions of Rotating Detonation Rocket Engines (RDREs), CeramiFlux addresses the critical need for accurate and reliable thermal measurements in propulsion systems. β-Ga_2O_3's wide bandgap property enables the sensor to maintain semiconducting functionality at high temperatures, offering unparalleled durability and precision. The integration of advanced ceramic technology enhances the sensor's resistance to thermal shocks and extreme temperatures, ensuring consistent performance in harsh aerospace environments. CeramiFlux's innovative design not only promises to advance the efficiency and reliability of space propulsion technologies but also holds significant potential for applications in defense missile systems. With its robust construction and exceptional operational range, CeramiFlux is poised to set new standards in thermal management solutions, driving advancements in both space exploration and defense industries.

Duration: 6

Proposal Details

Proposal Number: Z10.05-1018
Subtopic Title: Rotating Detonation Rocket Engine Nozzles and Instrumentation
Proposal Title: Optimized and Lightweight Rotating Detonation Rocket Engine

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 2 - 3
Technical Abstract (Limit 2000 characters):

The complex nature of the spatio-temporal physics in a rotating detonation rocket engine (RDRE) makes it a difficult task to Figoptimize the thrust with only design thumb rules available for the geometry constraints. There is also ambiguity in the currently used methodologies in predicting engine performance and its loss mechanisms. In this research, we propose to bridge this technical gap with a rapid simulation strategy to assist the current NASA efforts on comprehensive RDRE performance plan. We offer a combination of an efficient design optimization simulation and a unique additive manufacturing concept for hot fire testing with the goal of reduction in the overall hardware mass. Phase I effort will focus on validating our approach in achieving better design with high performance. In the subsequent future research, our simulation method will assist in additively fabricating a lightweight RDRE. Using only passive radiative cooling, this hardware will consist of a smart combination of refractory material with significantly enhanced thermo-structural qualities.

Duration: 6

Proposal Details

Proposal Number: Z12.03-1016
Subtopic Title: Space Resource Processing for Consumables, Manufacturing, Construction, and Energy
Proposal Title: Compact Integrated Sorting Technology for Oxygen and Regolith Treatment (CISORT)

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 2 - 4
Technical Abstract (Limit 2000 characters):

Cislune Inc., in collaboration with Dr. Philip Metzger from the University of Central Florida, proposes CISORT, a lunar regolith processing technology for NASA's SBIR Phase I. CISORT employs vibrational sorting and magnetic separation to efficiently isolate high-purity materials from lunar soil, crucial for In-Situ Resource Utilization (ISRU). This scalable solution aligns with NASA's Z12.03 solicitation, aiming for lunar mining advancements and CLPS mission compatibility. CISORT's core innovation combines vibrational sorting with magnetic separation, optimizing oxygen, water, and metal extraction from lunar regolith, particularly from the Moon's immature highlands. The system is compact, designed for the lunar environment, and adaptable, enabling foundational ISRU process testing. Key components include vibrational size sorting, leveraging the Brazil nut effect and density variations, magnetic separation for valuable mineral concentration, and density-based beneficiation for enhanced separation purity. CISORT offers advantages over existing ISRU technologies with its enhanced efficiency, compact design, and scalability, supporting sustainable lunar exploration and a lunar economy. The technology, developed on solid scientific principles with expert guidance from Dr. Metzger, is a leap in ISRU capabilities, designed to reduce reliance on Earth-supplied materials and support NASA's vision for a sustainable human presence on the Moon.

Duration: 6

Proposal Details

Proposal Number: Z12.03-1021
Subtopic Title: Space Resource Processing for Consumables, Manufacturing, Construction, and Energy
Proposal Title: Immortal Molten Regolith Electrolysis Anode for Oxygen and Metals Extraction from Lunar Regolith (IMMORTAL)

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 3 - 4
Technical Abstract (Limit 2000 characters):

Lunar Resources, an American space industrial company and leaders in resource extraction from the Moon, proposes to NASA the "Immortal Molten Regolith Electrolysis Anode for Oxygen and Metals Extraction from Lunar Regolith" (IMMORTAL) project. This NASA SBIR Phase I project will mature, characterize, and evaluate a new and novel approach to enable long lifetime anodes for metals and oxygen extraction for molten regolith electrolysis (MRE) systems. This new and novel technology eliminates anode degradation eliminating challenges of the traditional MRE process. Furthermore, it can enable greater than an order of magnitude more production. And the technology can be directly swapped for existing MRE anode subsystems and utilize the same MRE reactor design and operation.

Duration: 6

Proposal Details

Proposal Number: Z12.03-1023
Subtopic Title: Space Resource Processing for Consumables, Manufacturing, Construction, and Energy
Proposal Title: EcoMine™ KREEP – Bioregenerative Rare Earth Element Mining from Lunar Mare Regolith

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 2 - 3
Technical Abstract (Limit 2000 characters):

NASA’s plans to establish a sustained Lunar presence for scientific research, Mars mission preparation, and a thriving commercial Lunar economy will require significant surface infrastructure. The use of in situ resources enables a more economical and sustainable approach to constructing this infrastructure. Lunar regolith contains an abundance of raw materials, like Rare Earth Elements (REEs), that can be used for in-situ construction on the moon, and on Earth. However, traditional Earth mining processes are not economically feasible on the moon, due to high energy demands, labor needs, high mass transport costs for consumable reagents, lower ore quality, and potential environmental and safety impacts. EcoMine™ is a bioregenerative mining facility for the Lunar surface that combines a closed-loop biomining process with an autonomous, self-powered, bioprocessing facility for commercial mining operations. EcoMine™ offers commercial Lunar mine operators an environmentally safe and more profitable way to recover REE and other valuable minerals, with less energy consumption, higher extraction efficiency, and significantly less mass transport costs than traditional chemical mining solutions. EcoMine™ is a major step towards a viable, sustainable lunar economy. In Phase I, Space Lab will demonstrate the technical feasibility of the EcoMine™ concept to autonomously, safely, and efficiently extract and separate REE minerals from non-polar Lunar mare regolith and prepare for future technology development. Project objectives are to demonstrate proof-of-concept for REE extraction, separation and recovery; and to investigate intra-facility regolith

transport solutions, accomplished through conceptual design and analysis, process validation with benchtop experiments, and EDU development planning.

Duration: 6

Proposal Details

Proposal Number: Z12.03-1039
Subtopic Title: Space Resource Processing for Consumables, Manufacturing, Construction, and Energy
Proposal Title: Advancing Modular Conveying System: Modular Static Auger Systems for Bulk material Handling for Material Processing Plant Systems based on Planets, Small Bodies, and Moons

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 2 - 4
Technical Abstract (Limit 2000 characters):

The technology proposed in this proposal will help future lunar missions by moving regolith on the moon in a way that has minimal impact from abrasive lunar dust and can be oriented at any angle, meaning the conveyance system can be anywhere between vertical and horizontal. The static auger conveyor is mass and energy efficient and can also be made modular. Other benefits include similar operation at any speed and the ability to change speeds on the fly. Ports can be placed anywhere along the tube to conduct sampling and measurements to determine composition. Funding will be used to conduct trade studies and develop and test small scale prototypes. Target markets of course include lunar applications, but also many applications on earth, such as manufacturing plants, agricultural conveyance applications, and industrial mining.

Duration: 6

Proposal Details

Proposal Number: Z13.05-1008
Subtopic Title: Components for Extreme Environments
Proposal Title: Radiation, dust and coolant freeze-out mitigation

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 2 - 3
Technical Abstract (Limit 2000 characters):

Current lunar orbit and surface habitat concepts incorporate conventional single-phase radiators coated with Z-93 to reject heat. These habitats will be exposed to high energy and ionizing ultraviolet (UV) radiation while traveling through the Van Allen belts that can last from hours to days. Also, during lunar landing and other dust generating surface operations, the highly adhesive lunar dust can coat the radiator surface. A combination of these two processes can degrade the radiator's optical properties leading to dramatic reductions in its heat rejection capability and performance. Prolonged operation in extremely cold temperature conditions can freeze the radiator coolant compromising the radiator performance. NASA developed passive louvers to protect the radiators from UV radiation and dust to address the above issues, but they have very slow actuation times and present significant mass and volume penalties. Analytical Scientific Products is proposing the development and demonstration of an innovative multilayered system that attenuates UV radiation, eliminates dust adhesion and prevents coolant freeze-out. Our technology is compact, lightweight and maintenance-free. It has fast actuation and a low power requirement. In Phase I, we propose to demonstrate the technical feasibility of mitigating the UV radiation and dust exposure using our technology through a combination of design, testing, and analysis. In Phase II, we will build the prototype device, test it over a broad range of conditions, and deliver it to NASA for additional testing and evaluation. Phase III consists of field testing and commercialization.

Duration: 6

Proposal Details

Proposal Number: Z13.05-1013
Subtopic Title: Components for Extreme Environments
Proposal Title: Flexible Lunar Robotics/Rover Dust Mitigation Covers

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 2 - 3
Technical Abstract (Limit 2000 characters):

One of the greatest challenges to conducting long-duration missions on the lunar surface or Mars is the effect of dust on mechanisms and mobility systems. The addition of covers to shield lunar dust was suggested on early Apollo missions, and the benefits were experienced on later missions when localized covers on some equipment were implemented. Moonprint Solutions will develop scalable and adaptable flexible hermetically sealed dust cover technologies that are broadly applicable to a range of uses on the lunar or Mars surface. This includes rotary, linear, and ball joints, as well as entire assemblies of rovers and robotics. Dust cover technology will be a part of a layered strategy where dust mitigation technologies compliment one another for maximum protection. Several innovations will be employed including polymeric materials that can survive repeated long-term cycling in lunar dust, flexing while at cryogenic temperatures (-213C), multi-layered cover designs for redundancy, and mobility joints in the cover that do not add torque to the robot or impede its mobility in any way. Several methods of attaching and sealing the covers to various robotic elements will be developed. The covers will be designed to keep dust out of sensitive mechanisms but could also be used to enhance thermal control, contain contamination sources for planetary protection, or to prevent offgassing from robotics that can affect sensitive equipment.

Duration: 6

Proposal Details

Proposal Number: Z13.05-1021
Subtopic Title: Components for Extreme Environments
Proposal Title: An Efficient Freeze Tolerant Radiator for Single-Phase Active Thermal Control Systems

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 2 - 4
Technical Abstract (Limit 2000 characters):

The next major step in human space exploration is to establish a sustainable presence on the Moon under the Artemis program. The NASA 2024 SBIR focus area Z13.05 Components for Extreme Environments, calls for heat rejection solutions that allow freeze and thaw cycles without experiencing any damage or performance degradation for human-rated spacecraft on the lunar surface. Specifically, NASA seeks novel freeze-tolerant coolant tubes in radiators or heat exchangers. Deep space habitats, such as Lunar Gateway, lunar landers, or surface habitats, require robust active thermal control systems (ATCS) to maintain cabin temperature despite wide fluctuations in heat loads (during crewed and un-crewed periods) and sink temperatures. NASA spacecraft to date have redundant dual loop single-phase ATCS architectures, because there are no known fluids that are both non-toxic (safe to use inside the habitat) and low-freeze point (reliable for use outside of the habitat). Thus, a low-freeze point fluid is utilized in an external loop and a non-toxic fluid (water) in an internal loop. Despite low-freeze temperature coolants, the external loop may still freeze, especially during lunar night. ISS and other heritage ATCSs permit higher pressures during freezing and thawing of coolant and prevent complete freezing during low heat loads. However, radiator tubes are still subject to structural failure under high pressure. The proposed innovation is a low-mass, corrosion-resistant, freeze-tolerant, deployable radiator for ATCS in a lunar surface habitat. The technology permits compression or expansion of the working fluid throughout the radiator system, enabling coolant freezing/thawing, while meeting other environmental and architecture requirements. The proposed innovation may even be used in a single loop architecture, removing the need of a dual loop and reducing system mass. In Phase I, Space Lab will investigate the feasibility of the Space Lab® FT-Radiator™ freeze-tolerant radiator.

Duration: 6

Proposal Details

Proposal Number: Z13.05-1030
Subtopic Title: Components for Extreme Environments
Proposal Title: Resonant Transformer Connectors for High Voltage Transmission Lines

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 3 - 4
Technical Abstract (Limit 2000 characters):

There are numerous challenges developing reliable and long-lasting charging infrastructures for electronic devices, such as rovers, on the Moon and Mars because of the extremely harsh environmental conditions. According to the NASA Phase I subtopic Z13.05 Components for Extreme Environments, there is a current need for dust-tolerant electrical connectors that can function with light dust coating on the lunar and Mars surface. This is especially important for critical interface connections to high voltage power grids to enable a continuous human presence and operations on the Moon. Regolith, including dust, can often create reliability challenges over time, such as insulating connector terminals from establishing reliable electrical connections. When lunar regolith accumulates at the conductive terminals of state-of-the-art (SOA) connectors, it is extremely difficult to reverse and can be a single point of failure for an entire power grid system because of regolith's strong insulating properties. The purpose of this R&D effort is to develop a resonant transformer connector system for high voltage AC transmission lines that can reliably interface with power sources on the Moon and Mars. It will be tested and verified electrically and mechanically for the accumulation of iron-enriched regolith to be more representative of the challenging Moon and Mars surface conditions. The proposed novel resonant transformer connector system will electrically interface with high voltage three-phase 3kV AC transmission lines and effectively provide more than 1kW of power, while being completely sealed with no exposed conductive terminals to operate effectively for the harsh environment on the Moon and Mars.

Duration: 6

Proposal Details

Proposal Number: Z14.01-1009
Subtopic Title: Lunar Surface Excavation
Proposal Title: Lunar Surface Excavation; Excavated Regolith Transport

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 3 - 4
Technical Abstract (Limit 2000 characters):

NASA anticipates extracting metals and oxygen from Lunar materials. The easiest material to employ initially will be regolith because it is already pulverized into small particles and can be loosely scooped. NASA will initially be constrained as to how much equipment can be boosted to the Moon so one factor will be how to initially reduce the number of types of machines needed for regolith excavation and movement. The second constraint, which is a driver for all terrain shaping activities, is the efficiency of material movement – how much how fast? The third issue will be

equipment wear and tear – Lunar regolith is light and relatively easy to scoop, but also due to its particular characteristics is notoriously invasive and potentially destructive of moving parts (bearings, gears, other wear surfaces). Due to vacuum and reduced gravity, the architecture of machines will likely have to be changed (for instance, machines that use counterweight mass will have to change). And finally, minimizing operator personnel (i.e. more mouths to feed and care for on the Moon) and simplifying maintenance will have substantial benefits. This effort will examine already prototyped excavator concepts developed under various NASA internally developed and from University-based completions. But, we will also bring into the analysis the wealth of knowledge in terrestrial Earth movers because each of these architectures was formed from some kind of specific need and a likely also applicable in some modified form on the Lunar terrain.

Duration: 6

Proposal Details

Proposal Number: Z14.01-1010
Subtopic Title: Lunar Surface Excavation
Proposal Title: Plug & Play Modular Robotic Mining System

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 2 - 3
Technical Abstract (Limit 2000 characters):

Our proposal to utilize Line Replace Units (LRUs) is a significant step toward enabling industrial-scale lunar operations. This innovative approach will enhance the system's self-maintenance capabilities and ensure its longevity, even as it excavates thousands of tons of material over years of operations. The scale of this task is exemplified in our estimate for a lunar propellant pilot plant, which will require the deployment of 37 robots for excavation, collection, and hauling functions. The maintenance of these robots is a critical aspect, necessitating a system that can effortlessly remove and replace worn-out subsystems and components through dedicated maintenance robots. Our innovation for maintenance enhancement modularity is a meticulously crafted comprehensive design approach that ensures the unit can be readily serviced robotically and with a high degree of autonomy. This approach addresses the critical factors of diagnostics, accessibility, interfaces, required tooling, and support systems. This innovation will also extend to OffWorld's terrestrial mining robots, further enhancing their serviceability and autonomy. OffWorld will review our lunar Prospector robot design and evaluate its terrestrial mining robots to identify the subsystems and components relevant to Prospector that have demonstrated the highest risk of failure. Terrestrial experience will be complemented by researching relevant system performance in the lunar environment from planetary rovers. A Reliability, Availability, and Maintainability analysis will be completed using the data from OffWorld's terrestrial mining system performance and available lunar rover performance. The resulting critical subsystems and components will be downselected to determine where the most benefits can be obtained. A development plan to obtain the necessary capabilities will be created. This plan will identify the expected performance capabilities, costs, schedule, and associated risks.

Duration: 6

Proposal Details

Proposal Number: Z14.01-1013
Subtopic Title: Lunar Surface Excavation
Proposal Title: Set Partitioning Framework for Identifying LRUs with Built-In Diagnostics

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 2 - 6
Technical Abstract (Limit 2000 characters):

ProtoInnovations, LLC proposes a novel method to define LRUs for space robotic excavators using a set partitioning framework, which analytically factors in key LRU features such as modularity, replaceability, robotic serviceability, built-in diagnostics, and lunar environment tolerances . We also propose an LRU diagnostics system (LRU-DS) which leverages existing onboard sensors and additional sensing as required by LRU key characteristics to perform real-time and efficient fault detection, isolation, and replacement alert generation. The LRU-DS conceptual design in Phase I will be a discrete external unit that will prepare for potential Phase II demonstration and Potential Phase III integration into a prototypical LRU that will provide necessary key LRU features including built-in diagnostic capabilities. We anticipate that the conclusion of a potential Phase II will culminate with a demonstration of an LRU at TRL 6. With this project we aim to impact the creation, development, and application of robotic systems for excavation on the Moon, and similar terrestrial applications.

Duration: 6

Proposal Details

Proposal Number: Z14.03-1006
Subtopic Title: Assembly and Outfitting of Tall Truss-Based Power Towers
Proposal Title: Lunar Joining of Elementary Structures (LUJES)

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 4 - 5
Technical Abstract (Limit 2000 characters):

Lunar Resources proposes to NASA the Lunar Joining of Elementary Structures (LUJES) SBIR Phase I project. The LUJES program will focus on joining aluminum truss joints on the Moon, without consumables, with new and novel advanced welding and joining technology.

Duration: 6

Proposal Details

Proposal Number: Z14.03-1008
Subtopic Title: Assembly and Outfitting of Tall Truss-Based Power Towers
Proposal Title: Freeform 3D Printing of a Tall Lunar Tower

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 2 - 4
Technical Abstract (Limit 2000 characters):

Branch Technology proposes using its lightweight, material-efficient, truss-producing additive manufacturing technology called "Freeform" 3D printing as inspiration for the challenge of assembling a tall truss-based tower for power generation and communications on the lunar surface. Branch has developed the capability to autonomously deposit and solidify printed material in free space without supports, creating a lightweight and geometrically optimized truss or lattice structure called the BranchMatrixTM that creates structural, volumetric geometries with minimal amounts of material. With reimagined deployment concepts and mechanical hardware for the relevant structure size and lunar environment, this fabrication process could be adapted to larger scale trusses, including the potential for lunar surface construction of a power/communications tower. In this project, Branch proposes to (1) identify a portfolio of viable approaches for constructing or assembling a lunar truss tower inspired by Freeform 3D printing, (2) create an initial design iteration concept for each approach, downselect the best approach and (3a) begin design of a robotic tool/end-effector and (3b) begin design of the tower structure and deployment/assembly sequence, (4) optimize the tower's structural design with Freeform 3D printing principles to minimize material usage and maximize strength, (5) incorporate potential tower outfitting strategies into the design, and (6) produce a 1/10th-scale demonstration tower based on the downselected design. The technology that enables this lunar infrastructure could be deployed for other lunar surface use-cases, as well as for structural fabrication and geometric optimization projects for terrestrial use – whether for spanning elements, bridge or trussing members, or building construction. The funds requested in this SBIR Phase I proposal will enable the preliminary design and demonstration objectives described above.

Duration: 6

Proposal Details

Proposal Number: Z14.03-1017
Subtopic Title: Assembly and Outfitting of Tall Truss-Based Power Towers
Proposal Title: Autonomous tall truss tower assembly by general purpose inchworm robot

Small Business Concern

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Summary Details

Estimated Technology Readiness Level(TRL Begin - TRL End): 1 - 3
Technical Abstract (Limit 2000 characters):

GITAI has identified the combination of general-purpose Inchworm robot and rover robot to be appropriate for a multi-purpose robot instead of human on the lunar surface. Also by increasing the number of these combinations, this concept has the scalability to build a larger and various infrastructure without adding another type of robot. Also, GITAI has already developed a high-TRL inch-worm robotic arm and has the capability to pursue the feasibility of infrastructure construction such as tower assembly through demonstrations by actual robots, not only through armchair theorizing. To achieve a sustainable infrastructure, various lunar development projects should be designed with the following two points: (1)“decrease in launch fee (cost per unit mass)” and (2)“total optimization perspective”. Let's compare two approaches of building a tower as an example Approach of building equipment that is one-off and self-sufficient and doesn’t require additional tools or equipment looks efficient at a glance. Whereas Approach of using multi-purpose Inchworm robotic arms becomes heavier in its initial mass, but once consider not only the tower construction but also the various infrastructure, variation of the infrastructure reaches a certain level(break even point), the total mass will become lower than that of former approach, because Inchworm robotic arm can be used for the other infrastructure. In order to confirm the feasibility of the above approach, GITAI has demonstrated its robotics technology for constructing a 5-meter-high communication tower in an environment simulating the lunar surface, and successfully completed. However, the feasibility study is still needed to determine if the assembly concept for this 5-meter tower and joint methods are scalable for a 50- to 80-m-tall tower, as it has not been studied well. So, in this SBIR phase I, GITAI proposes the feasibility study of the assembly concept scalable for a 50- to 80-m-tall tower.

Duration: 6