SpinSat

A Comprehensive and Flexible Approach to Mars- relevant Science & Technology Development Activities

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https://www.nasa.gov/ames-studies-current/spinsat/

Problem Statements

Human Health and Environmental Control & Life Support System (ECLSS):

Radiation exposure incurred during space exploration is one of the greatest threats to an astronaut's health. There is insufficient knowledge of the health effects of space radiation and the space radiation environment to provide recommendations on crew exposure limits and design requirements for long-duration missions.

Space Biology:

Current capabilities for providing the Biological & Physical Sciences (BPS) communities access to combined deep-space radiation and gravity ranges are limited.

National Academies "...The research opportunities that are envisioned to exist within cis-lunar space are expected to be severely limited in volume and frequency. This sets an interesting conundrum where some critical research cannot be met with the current deep space platforms, yet they would richly inform human exploration beyond LEO during the Artemis missions."

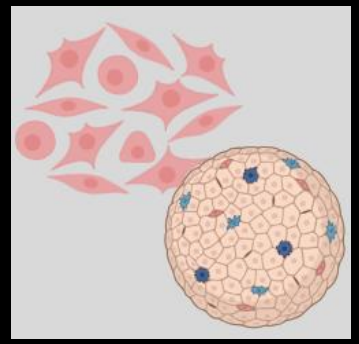
NASA needs access to deep space radiation environments, those regions above the Van Allen Belts.
https://www.nasa.gov/directorates/esdmd/hhp/space-radiation/

SpinSat:
Designed to Satisfy a Range of Objectives

O-1	**Simultaneous long duration exposure to deep space radiation environment over a range of (0 -> 1G) gravities simultaneously, including 1g control**
O-2	**Low cost per experiment** Many experiments can be hosted on the platform Allows for multiple copies of experiments / enhanced statistical significance
O-3	Allow for **frequent access** to space: O-3a: LV Agnostic O-3b: Orbit agnostic
O-4	Interfaces consist of the highly familiar "**Cubesat" interfaces** based on the "U" Other configurations are achievable and not a priori precluded. PI focus on the experiment, not the s/c.
O-5	**Easy integration**/ payload access Stretch: Permit "just-in time" loads for biology prior to launch
O-6	Addition of regolith simulant allows for simulation of **lunar* radiation** environment.

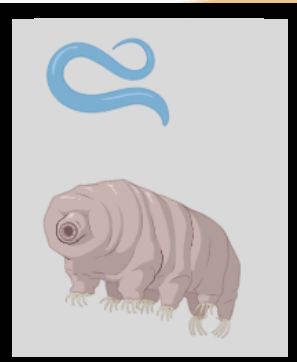
Science Opportunities

Human Cells

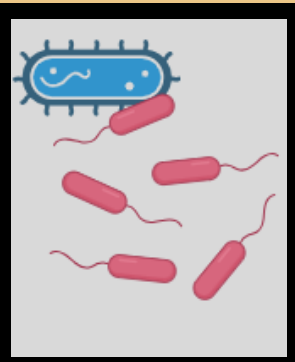


- Stem cells
- Neurons/glia
- Intestinal cells
- Cancer cells

Model Organisms



- C. Elegans
- Tardigrades



- Microbiome
- E. coli
- B. subtilis

- S. Cerevisiae
- S. Pombe
- Saccharomyces

- Microalgea
- Cyanobacteria
- Arabidosis

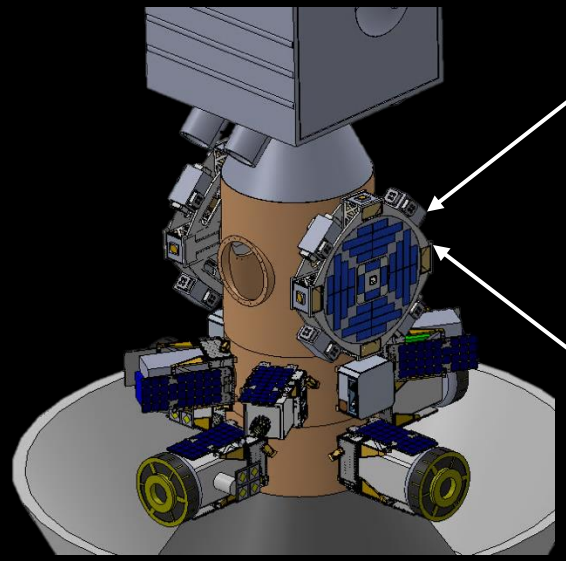
Synthetic Biology

- Central Nervous System
- Cancer
- Bone and Muscle Health
- Pathogenesis and Wound Healing
- Microbiomics
- Pharmacologics
- Food Sources
- Environmental Control and Life Support

Assessment: DNA damage | Protein damage | Cell membrane damage | Mitochondrial damage | Germination | Growth | Tropisms | 2° metabolite production

Technical Approach

Technical Approach: A phased approach enables validation of overall approach & rapid execution of initial experiments, followed by more extensive and larger platforms while remaining cost-effective:



As an ESPA-port secondary can accommodate *at least* 48 'U' worth of experiments (12x BioSentinel*).

Operational Demo (LEO/SSO):

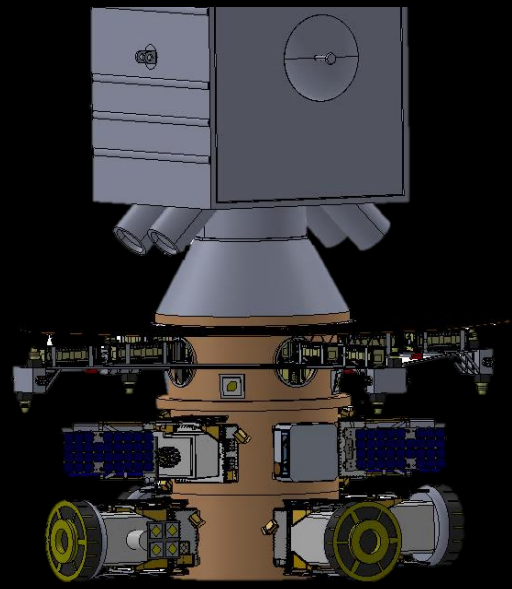
- **Up to 12 separate "4U" payloads**
- **Micro, Lunar, Mars, & Earth Gravity**
- **Compatible ESPA Grande 610mm Ring**
- **1.5 m Diameter; >300W**
- **ESPA Port Mount: ~LV agnostic**
- **Common Simple Data Interface**
- **~6 month lifetime (TBR)**

Block 1: Production Design (Deep Space)

- Up to 16 separate "4U" payloads
- Deep space orbit agnostic goal
- ~1 - 3year lifetime

Block 2: Production Design (Deep Space)

- 3+m Diameter, 2.0 kW, >300 "1U" Payload Volume
- Deep space orbit agnostic

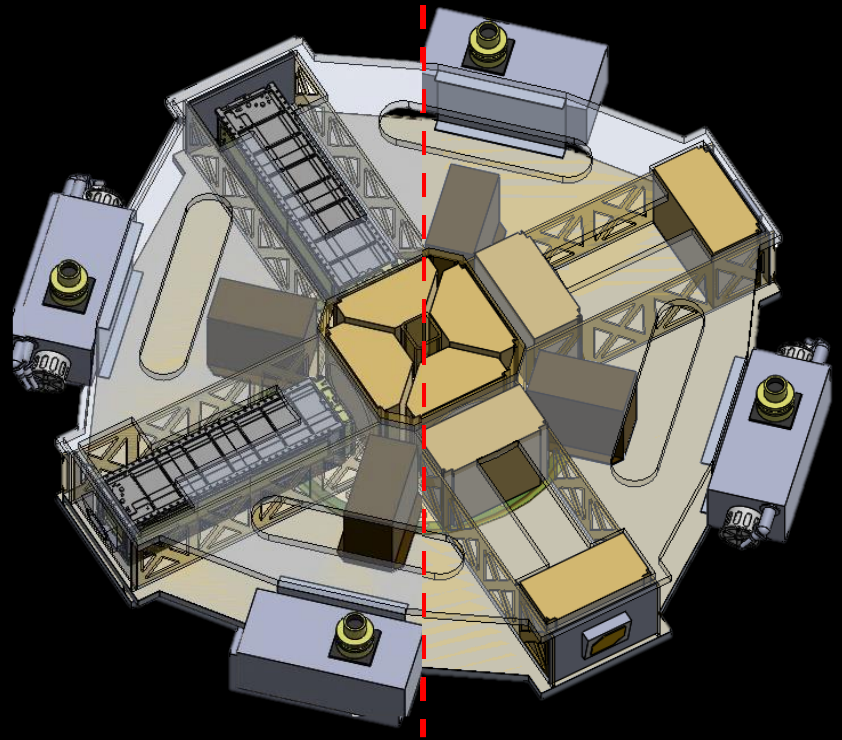


As an ESPA-stack secondary up to 300 'U' (75x BioSentinel), allowing for a robust program of biological experiments.

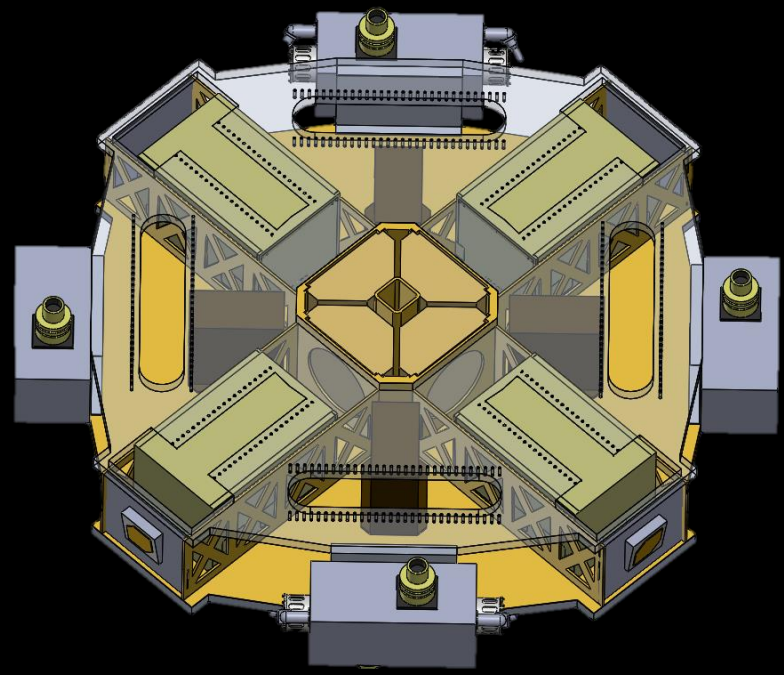
SpinSat Provides Alternate "Gravity Fields"

View of 1x4U Radial Payloads

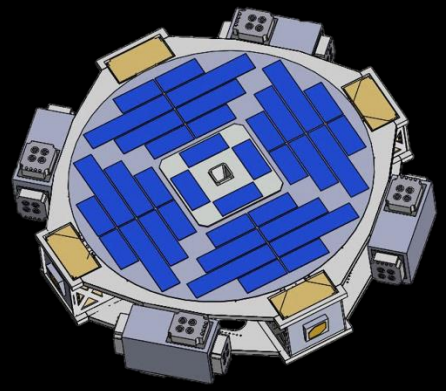
View of 2x2U Payloads



Top View – Solar Arrays Removed

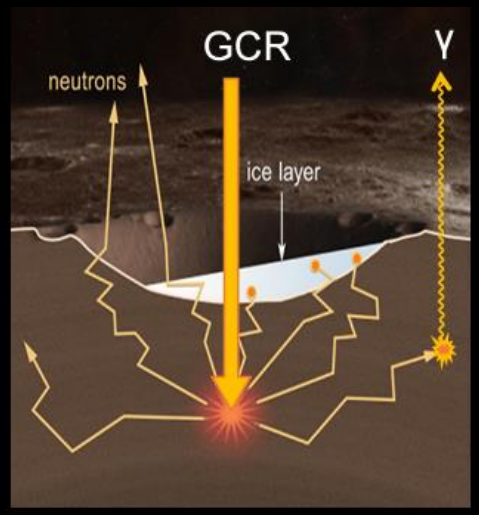


SpinSat Addresses PI Needs

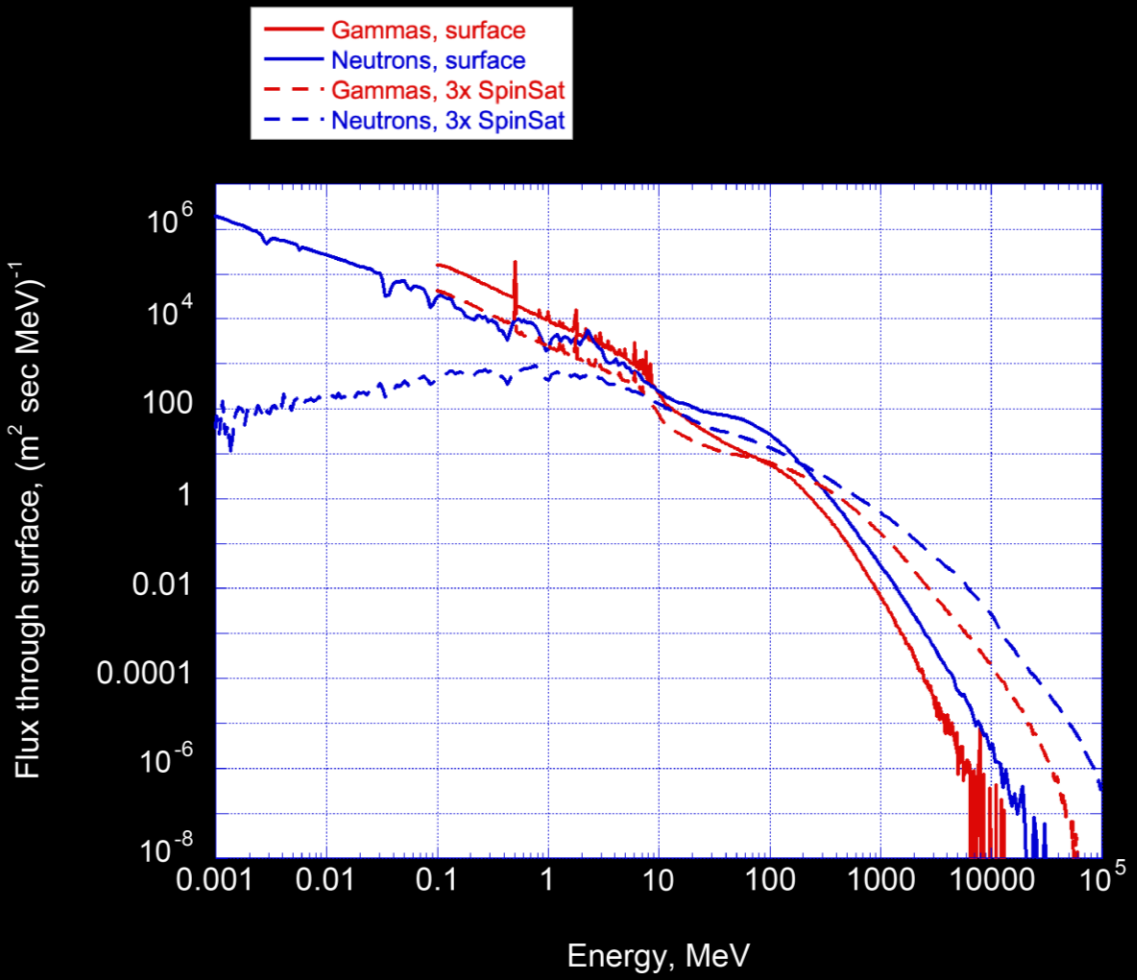


- A highly cost-effective “standardized” secondary-compatible Class D “Plug-n-Play” spinning platform
- Utilizes standard “open source” U-form factors for experiments
- Allows PI to focus on the experiments and not the spacecraft
- Offers increased flight opportunities for experiments needing the combined microgravity effects from near-0 to 1-g simultaneously, deep space or lunar radiation environments.

GEANT4 Simulation of the Lunar Radiation Environment



- **Fast neutrons cause direct cellular damage and also produce ionizing radiation**
- Simulation of a 1U block of 2 g/cc ferroan anorthosite (FAN) bombarded isotropically by GCRs, tabulated all particles except neutrinos coming out of the block.



Implementation Timeline