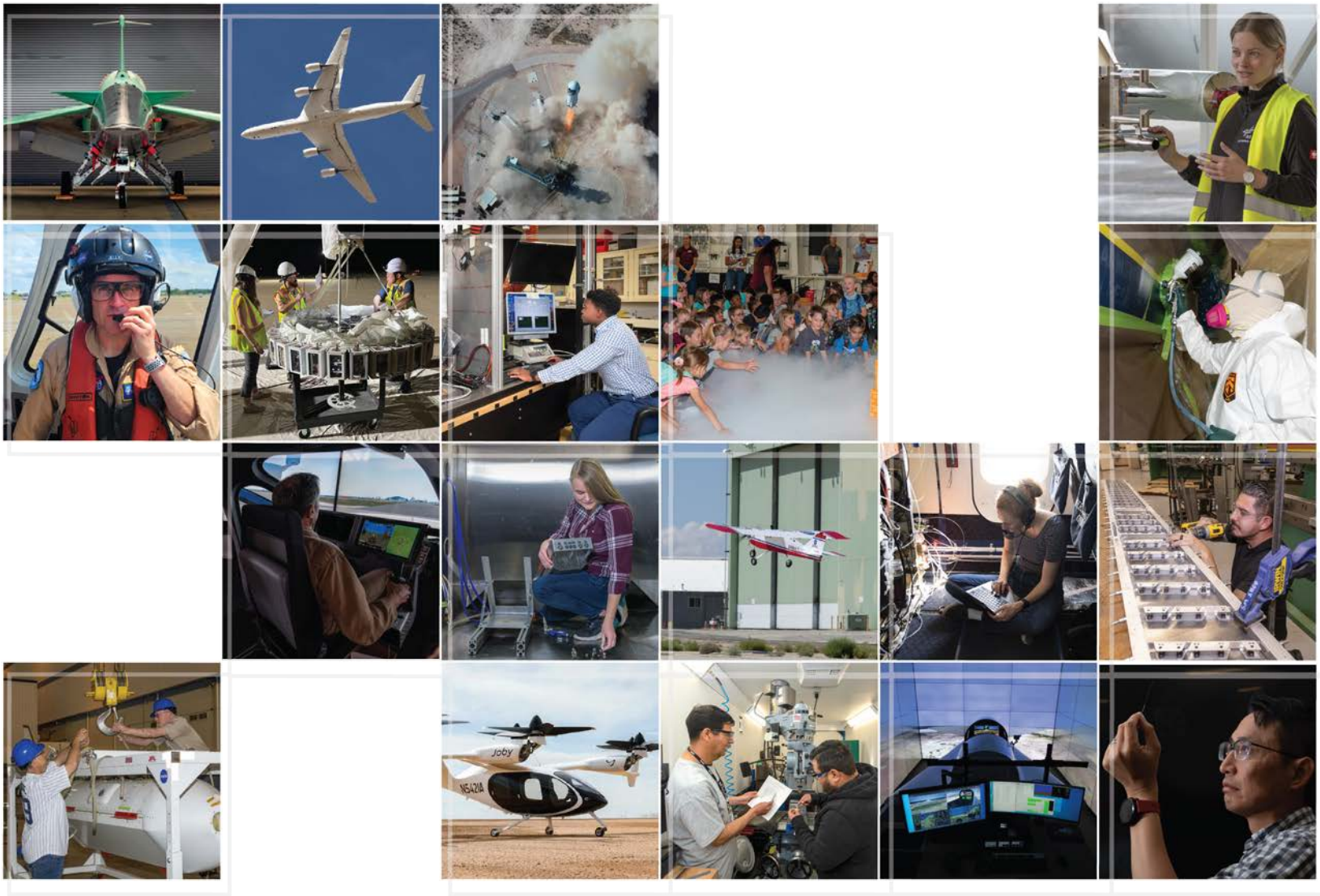
National Aeronautics and Space Administration

2023



Armstrong Flight Research Center

ANNUAL REPORT

www.nasa.gov

NASA MISSION

Exploring the secrets of the universe for the benefit of all.

NASA ARMSTRONG MISSION

Advancing technology and science through flight.

NASA VISION

NASA explores the unknown in air and space, innovates for the benefit of humanity, and inspires the world through discovery.

NASA ARMSTRONG VISION

To separate the real from the imagined through flight.

TABLE OF CONTENTS

Explore NASA Armstrong

No. 1 Social Media Post

With the Airborne Schlieren Photography System, NASA's Armstrong Flight Research Center in Edwards, California, is refining schlieren photography equipment to support flight testing of NASA's X-59 aircraft for the Quesst mission. Such imaging will help engineers validate sonic boom-reducing technologies. Social media posts about this work was our top post for Facebook and X (formerly Twitter) in 2023.

NASA

CENTER DIRECTOR MESSAGE

Bradley C. Flick
Center Director

For nearly eight decades, NASA's Armstrong Flight Research Center in Edwards, California, has expanded our understanding of the physics of flight, studied our planet and the cosmos, and validated new technologies to make air travel safer and more efficient. From our earliest days, when 13 engineers and technicians came to the California desert to participate in man's assault on the sound barrier, the center has grown, projects have come and gone, and our tools and technologies have changed, but the center's dedicated professionals have maintained excellence in solving the aerospace problems of the day.

This report describes the center's 2023 accomplishments and economic impacts. We're proud to be NASA's home for experimental flight and strive to build on our legacy while tackling the challenges of tomorrow.

Brad Flick
NASA Armstrong
Center Director

NASA Photo of the Year 2023, People Category

Jim Ross, photo lead at NASA's Armstrong Flight Research Center in Edwards, California, was awarded first place for an image he took while flying upside down in a two-seat T-34C research aircraft. In the photo, right, NASA research pilot Nils Larson and Ross complete aerobatic maneuvers in a NASA Armstrong-owned T-34C aircraft during a proficiency flight.

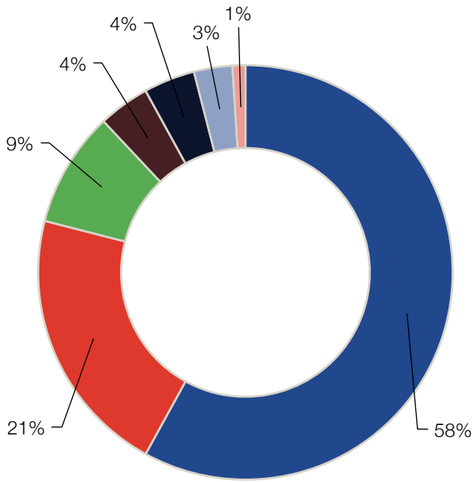
NASA/Jim Ross

Armstrong PEOPLE

Explore Armstrong People

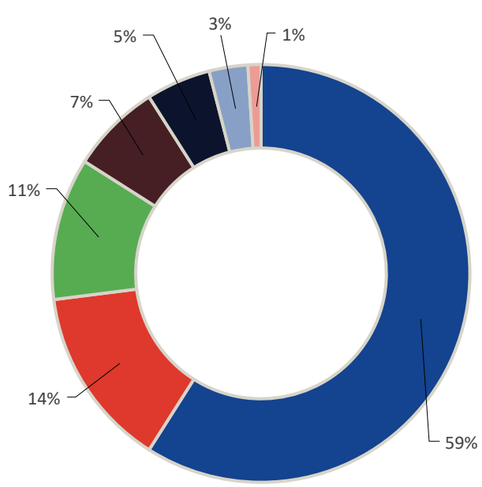
Like Neil Armstrong, it is our people who put the spotlight on NASA Armstrong as a leader among industry partnerships to explore, innovate, and inspire for the benefit of all.

Occupation Distribution



- Professional Science & Engineering
- Professional Administrative
- Engineering Technician
- IT Specialists
- Safety & Quality
- Administrative Assistant/ Technician
- Equipment Facilities & Services

Workforce Diversity



- White
- Hispanic or Latino
- Asian
- Black or African American
- Undeclared
- American Indian or Alaska Native
- Native Hawaiian or Pacific Islander

Workforce Education

41% *Bachelors* + **29.3%** *Master* + **18.5%** *No Degree* + **8.9%** *Associate* + **2.3%** *Doctorate*

WORKFORCE SKILLS

NASA Armstrong capabilities and facilities enable the center's most important asset: the workforce to advance science and technology through flight. NASA Armstrong employs about 1,200 government and contractor personnel at its campuses in Edwards and Palmdale, California. It's the in-house knowledge – research and engineering; aircraft modification, maintenance, and operations; flight simulation and range operations; project and institutional management – that drives the airworthiness and flight safety decisions to execute NASA's mission.

NASA pilot Liz Ruth prepares for flight in NASA's F-18.
NASA/Genaro Vavuris

Shedrick Bessent is a member of NASA's X-59 Flight Test Instrumentation System team.
NASA/Steve Freeman

The Dryden Remotely Operated Integrated Drone 2 aircraft is prepared for flight.
NASA/Steve Freeman

Explore Armstrong Capabilities & Facilities

Programs and Projects

The Programs and Projects directorate manages all of NASA Armstrong's flight programs and projects. It serves the center and other NASA installations, military and other federal agencies, industry, and academia.

Flight Operations

The Flight Operations directorate manages and provides technical direction for all center flight operations and flight support activities. The directorate's flight crew, aircraft maintenance, and operations engineering teams keep NASA Armstrong's crew and aircraft functioning safely and efficiently.

Research and Engineering

The Research and Engineering directorate provides research and project support engineering. It is comprised of six disciplines: Aerodynamics and Propulsion; Aerostructures; Dynamics and Controls; Flight Instrumentation; Flight Systems; and Systems Engineering and Integration.

Mission Operations

The Mission Operations directorate provides world-class test systems capabilities and flight test and research support through cutting-edge products and services, including high-fidelity engineering simulations, range support of flight operations and low Earth-orbit missions, and flight data capture and archiving.

Support Services

The employees who serve in mission support roles facilitate our partners' needs from introduction to the center through execution. Support services include procurement, finance, facilities, education, information technology, security, legal, aerial and ground photography, videography, public affairs, safety, and technical publications.

Armstrong by the NUMBERS

579
civil servants

621
contractors

$127.7M
awarded to
small businesses

Empirical Systems Aerospace developed the X-57 with NASA.


X-59 build

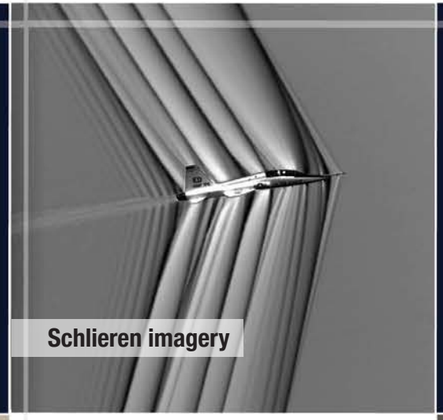
$447.6M
Armstrong
budget
(fiscal year 2023)


F/A-18 aircraft

846 flights
and **1,697**
flight hours
(no Class A or B mishaps)

Reached
audience of
2.9M
at exhibits

1,110,210
social media
followers


Schlieren imagery

Best Place to Work
23rd
out of 432
subcomponent
agencies

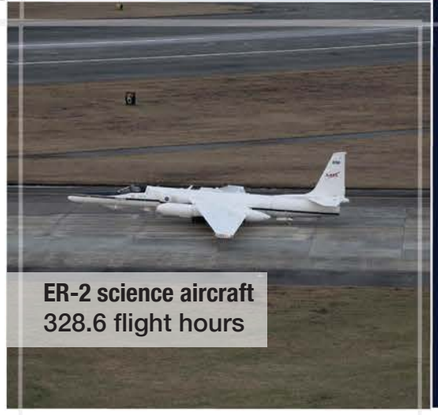

DATR (Dryden Aeronautical Test Range)

DATR enabled
+250
missions
supporting X-57, X-59, space station, Stratolaunch, and more


International Space Station


High-altitude balloon flight

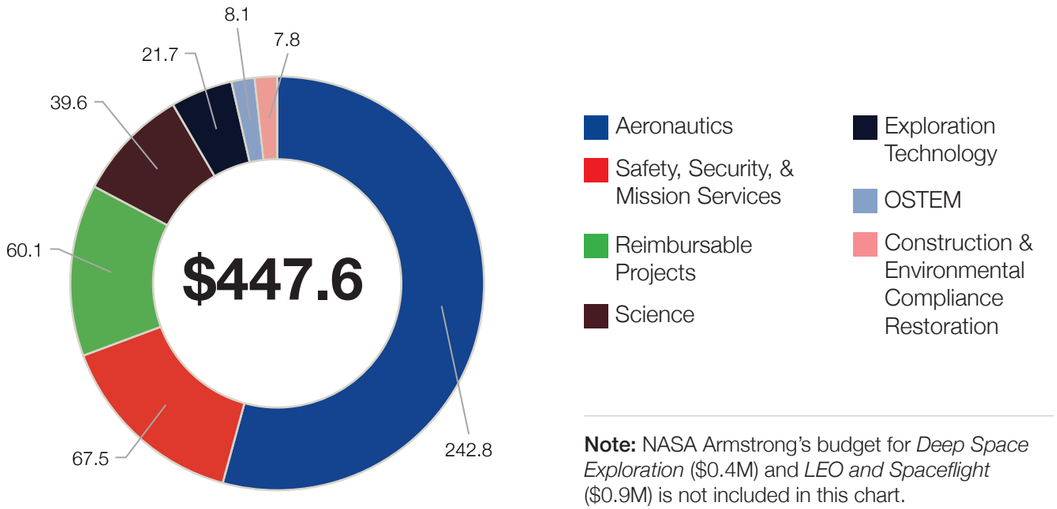
Flight
Opportunities
31 payloads
via 20 flights using six commercial providers


ER-2 science aircraft
328.6 flight hours

767.4
Science
flight hours
(C-20, DC-8, ER-2)

Translated
20
products for
NASA en español

NASA Armstrong FY23 Budget ($M)



Note: NASA Armstrong's budget for *Deep Space Exploration* ($0.4M) and *LEO and Spaceflight* ($0.9M) is not included in this chart.

Doing Business with NASA Armstrong

NASA Armstrong's Small Business Office performs outreach to small and large companies and universities as a source of information for firms seeking procurement opportunities at the center.

Explore more:

- *Subcontracting, Partnering, and Employment Opportunities*
- *Partnerships*

FY23 Top 10 Armstrong Business Contractors

Contractor	$ Obligated
The Boeing Company*	$69,674,682
General Electric Company	$41,116,080
magniX USA Inc.	$25,592,435
Northrop Grumman Systems Corporation	$23,035,654
Lockheed Martin Corporation	$22,600,752
New Horizons Aeronautics LLC	$18,971,478
Lead Builders Inc.	$13,427,325
Astrobotic Technology Inc.	$13,209,287
ASRC Federal System Solutions LLC	$13,030,542
Vertex Aerospace LLC	$12,748,314
Kay and Associates Inc.	$10,062,049
Total	**$263,468,598**

*Includes Funded Space Act Agreement.

BUDGET & PROCUREMENT

Procurement is the cornerstone of NASA's current and future missions. Our exceptional acquisition support enables NASA Armstrong to advance technology and science through flight.

Your Procurement Dollars at Work

State	$ Obligated
Alabama	$3,959,878
Arizona	$680,053
California	$71,571,269
Colorado	$679,983
Florida	$1,083,753
Georgia	$375,369
Illinois	$10,115,099
Iowa	$39,110
Kentucky	$100
Maryland	$16,306,648
Massachusetts	$2,008,529
Mississippi	$12,748,314
Nevada	$4,145,156
New Jersey	$57,871
New York	$32,860
North Carolina	$1,136,730
Ohio	$39,260,704
Oklahoma	$400,000
Pennsylvania	$13,209,287
Tennessee	$112,981
Texas	$8,354,305
Virginia	$31,939,170
Washington	$95,267,117
Total	**$313,484,286**

NASA FY21 Economic Impact Report

Click to read the report.

*NASA's next Economic Impact Report is due for release this year.

State Fact Sheets

As a follow-up to its biennial report demonstrating the economic impact of NASA nationwide, the agency released state-specific information. Each of the 51 facts sheets showcase how investments in NASA benefit humanity in all 50 states and the District of Columbia.

- *Directory of state fact sheets*
- *California fact sheet*

Armstrong HIGHLIGHTS

NASA Armstrong's mission is to advance technology and science through flight by:

- Performing flight research and technology integration to revolutionize aviation and pioneer aerospace technology.
- Validating space exploration concepts.
- Conducting airborne remote sensing and science observations.

2023 Project Highlights

Read the article.

Watch the video.

2023 Research, Technology, and Engineering report

Read the report.

NASA's X-59 quiet supersonic research aircraft sits on the ramp at Lockheed Martin Skunk Works in Palmdale, California, during sunrise, shortly after completion of painting, Dec. 12, 2023. NASA/Steve Freeman

Boeing's MD-90 aircraft flew from Victorville to Palmdale, California, on August 15, 2023. This aircraft will be NASA's future Sustainable Flight Demonstrator. NASA/Carla Thomas

Formation Flight

In August 2023, NASA's F-18B tail number (TN) 846 and F 18D TN 862 flew in formation at Armstrong Flight Research Center in Edwards, California. This was the first flight of NASA's newest F-18 freshly painted in the NASA livery and rare opportunity for multi-ship formation training for Armstrong's test pilots. F-18B TN 867 served as photo chase to document the flight. In 2023, NASA Armstrong conducted 846 flights, totalling 1,697 flight hours.

NASA/Jim Ross

ecoDemonstrator Project

NASA's DC-8 aircraft (not shown) from Armstrong Flight Research Center in Edwards, California, flew to Everett, Washington, in October 2023 to conduct science research about reducing engine particle emissions. Partners included Boeing, United, General Electric Aerospace, German Aerospace Center, the Federal Aviation Administration, and World Energy. Boeing's new passenger aircraft (pictured) used revolutionary Sustainable Aviation Fuel and NASA's DC-8 flew behind the Boeing plane to measure the fuel's impact throughout flight.

NASA/Jim Ross

Helping CryoFILL Turn Oxygen into Fuel

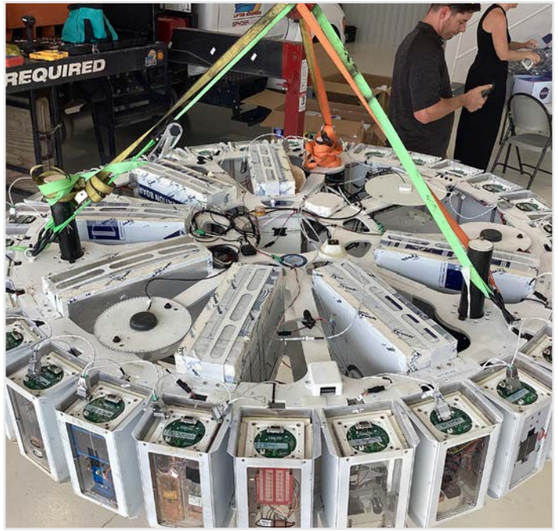
A tank is used in CryoFILL experiments to liquefy oxygen at minus 290 degrees Fahrenheit as it could be done on the Moon or Mars. The tests conducted at NASA Glenn Research Center, used Fiber Optic Sensing System (FOSS) developed by NASA's Armstrong Flight Research Center in Edwards, California, to measure oxygen temperatures inside the tank.

NASA

NASA's X-57 Maxwell all-electric aircraft project, which concluded aircraft operational activities in 2023, provides aviation researchers with hundreds of lessons learned, as well as revolutionary development in areas ranging from battery technology to cruise motor control design. NASA

NASA Armstrong's Student Airborne Research Program celebrated 15 years of success in 2023. NASA/Carla Thomas

NASA's DC-8 aircraft flew to Everett, Washington, to conduct science research about reducing engine particle emissions. The DC-8 flew 232.4 flight hours in 2023, supporting three science campaigns. NASA/Jim Ross



Thirty experiments, housed in a World View zero-pressure balloon gondola, flew in the stratosphere above Page, Arizona, for more than four hours on July 24, 2023, as part of the NASA TechRise Student Challenge. NASA/Paul De León

More than 500 local students, ranging from grades first to eighth, joined NASA and COSI (Center of Science and Industry) in a Learning Lunchbox event where they saw a demonstration of how clouds form, and had the opportunity to ask NASA experts questions. NASA/Steve Freeman

2023 HIGHLIGHTS

NASA Armstrong's Model Laboratory supported a campaign to measure wind at low altitudes to gather data needed to enhance air taxi safety. NASA/Carla Thomas

NASA and Sikorsky conducted flight tests from Sikorsky Memorial Airport in Bridgeport, Connecticut, to evaluate autonomous flight software systems designed for Advanced Air Mobility concepts. NASA/Steve Freeman

NASA Armstrong's Fabrication Laboratory built up a helicopter-mounted camera and sensor pod for air taxi research. NASA/Genaro Vavuris

Evaluating OSIRIS-REx sampling system in microgravity via Flight Opportunities. NASA/James Blair

OSIRIS-REx Mission

In 2023, NASA's OSIRIS-REx (Origins, Spectral Interpretation, Resource Identification, and Security – Regolith Explorer) became the first U.S. mission to deliver an asteroid sample to Earth. The regolith sampling system used in that mission was matured through parabolic flight testing with NASA's Flight Opportunities program. On those flights, researchers evaluated their design and determined how much simulated asteroid rocks and dust the system could capture in reduced gravity.

Explore NASA Flight Opportunities

ER-2 Science Aircraft

2023: 328.6 flight hours

NASA operates two Lockheed ER-2 Earth science aircraft as flying laboratories. This year, the aircraft supported eight missions, which included deployments to Dobbins Air Reserve in Georgia and MacDill Air Force Base in Florida.

NASA

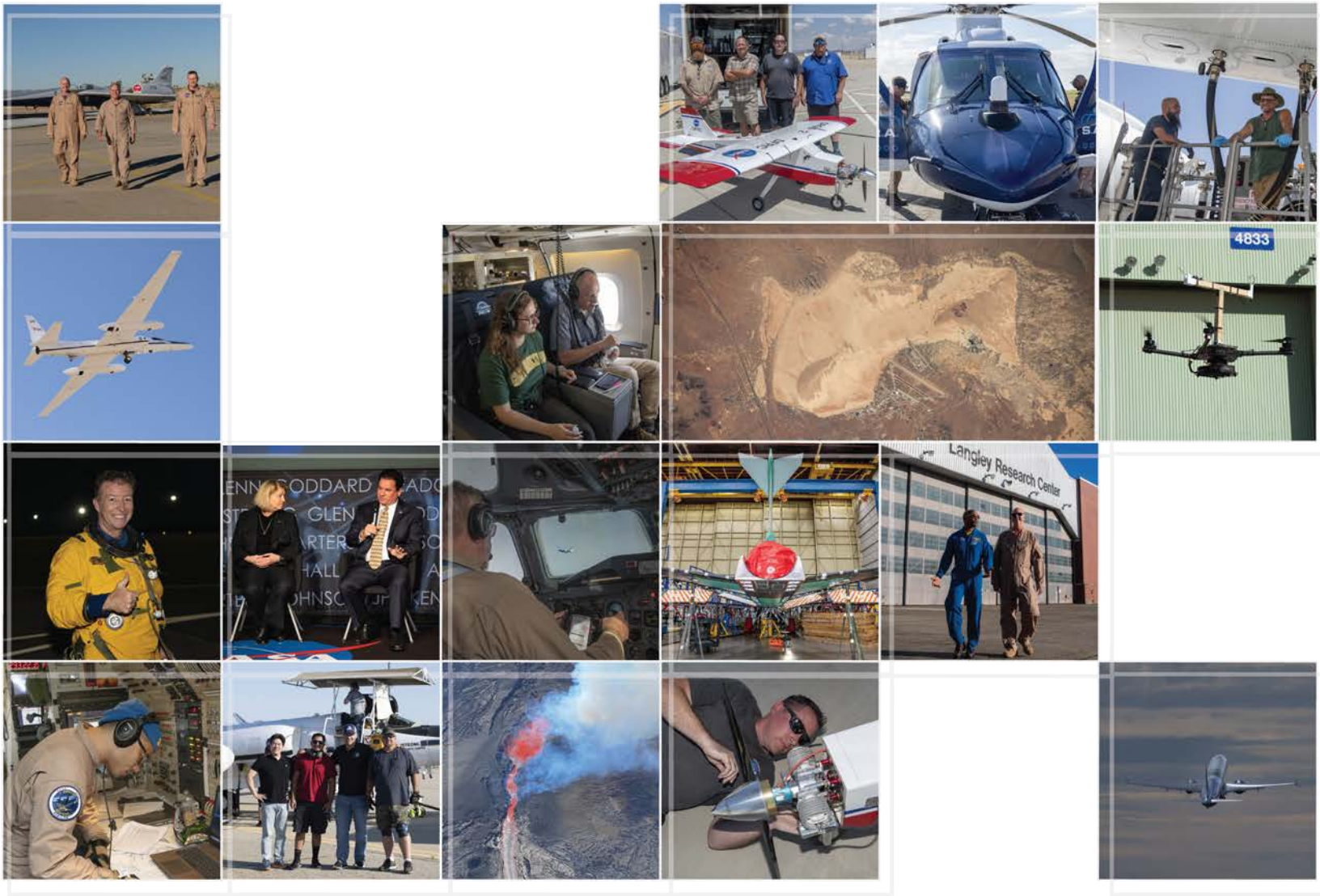
NASA Armstrong researchers developed an innovative atmospheric sensor suite that can monitor air quality, help uncrewed aircraft avoid dangerous wind shears, and aid noise studies. NASA/Lauren Hughes

NASA Armstrong researchers, pilots, and mission support teams traveled the country, showcasing aviation-inspired technology and the latest in NASA aeronautics research, space exploration, science, and more. The Miramar Air Show in San Diego, California, above, saw an estimated 700,000 visitors. NASA

Researchers tested NASA Armstrong's newly installed motion simulator in April 2023. The simulator includes virtual reality goggles depicting an aircraft cabin and city environment, as well as noise and seat motion, to simulate an air taxi ride. NASA/Genaro Vavuris

Robots battled it out at the Aerospace Valley Regional Robotics Competition, conducted March 29 through April 1 at Eastside High School in Lancaster, California. NASA Armstrong sponsored several Antelope Valley teams, employee volunteers served as mentors and judges, and the center's mobile fabrication shop helped with team repairs. NASA/Genaro Vavuris

Explore Armstrong Technology Development



National Aeronautics and Space Administration

Armstrong Flight Research Center
4800 Lilly Ave.
Edwards, CA 93523
www.nasa.gov/armstrong

www.nasa.gov

NP-2024-06-01-AFRC