National Aeronautics and Space Administration

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Tests begin on X-57 motors

By Matt Kamlet
Armstrong Public Affairs

The cruise motors that will power NASA's first fully-electric X-plane to the skies have begun endurance testing on the ground.

Using a test stand called Airvolt, Armstrong engineers are testing the motors and their motor controllers, collecting data to help verify that the experimental electric propulsion system is ready to be deemed flightworthy. If successful, the motors along with their controllers and propellers can then be integrated into what will become NASA's first all-electric experimental airplane, or X-plane – the X-57 Maxwell.

The X-57 is a highly modified Tecnam P2006T aircraft that features the replacement of traditional combustion engines and wing with an experimental distributed electric propulsion system and endeavors to demonstrate the potential to achieve high efficiency, reduced carbon emissions and lower the operating costs for aircraft. The X-plane, which will be NASA's first manned experimental airplane in two decades, will undergo several modifications, conducting flight tests with each stage.

AFRC2017-0269-03 NASA/Lauren Hughes

A JM-X57 cruise motor undergoes testing on the Airvolt stand at Armstrong. The Airvolt stand is instrumented to measure system voltage, current, temperature, vibration, torque and thrust.

Before such an experimental system can be used for flight it needs to undergo extensive testing to validate its safety and functionality in order to be deemed flightworthy according to NASA's flight qualification process.

"We want to confirm that the motor system is as safe as possible before X-57 begins flight testing. The testing is important at this

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Moon return, experimental aircraft, in proposed 2019 Trump budget

By Jay Levine
X-Press editor

The Trump administration's proposed 2019 NASA budget provides resources to advance exploration of the moon and deep space and pursue cutting-edge science, technology and aeronautics research breakthroughs.

In NASA Acting Administrator Robert Lightfoot's address Feb. 12 on the state of the agency, he explained that the Trump administration wants to see a focus on moon missions as part of the fiscal year 2019 proposed $19.9 billion NASA budget. To those ends $10.5 billion is focused on lunar exploration.

"This proposal provides a renewed focus to our human spaceflight activities and expands our commercial and international partnerships," Lightfoot said.

The concept for the Mars mission came from a study from the re-established National Space Council that became Space Policy Directive 1, which the president signed and is funded in this budget proposal. The plan is intended to lead to the development of space infrastructure for a lunar orbital platform gateway. The first piece is scheduled for

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MicroCub makes first flight

By Rebecca Richardson
Armstrong Public Affairs

The Subscale Research Lab at Armstrong recently introduced a new addition to their fleet of miniature aircraft. The not-so-small MicroCub is a Bill Hempel 60-percent scale Super Cub, modified by research lab staff to support engineering campaigns focused on the integration of Unmanned Aircraft Systems (UAS) into the National Airspace System (NAS). Through cutting-edge engineering and expert piloting of small unmanned aircraft, NASA is leading a critical phase for UAS integration into the NAS by educating engineers and validating key technologies that will directly apply to the next generation of large-scale unmanned vehicles.

Armstrong's Subscale Research Lab team piloted the MicroCub for its inaugural flight Jan. 18, successfully demonstrating the aircraft's airworthiness. This initial flight was intended to check the ground handling and flight characteristics of the aircraft, along with validating the Command and Control (C2) system, verifying the "remote control only" mechanism, setting the tuning for autopilot gain, performing engine runs, gauging fuel consumption and testing stall speed.

Though small in size, the MicroCub is a powerful vehicle in the realm of small to midsize UAS aircraft. Specifications of the vehicle include a 21-foot wingspan, a Piccolo Autopilot guidance system and a JetCat SPT-15 Turboprop – a design only model aircraft fanatics could dream up!

The successful maiden flight means the MicroCub will undergo additional aircraft modifications to validate risk reduction technology. Eventually, this technology will be integrated onto other NASA UAS aircraft, such as NASA Ames' Sensor Integrated Environmental Remote Research Aircraft, SIERRA-B.

AFRC2018-0011-53 NASA/Lauren Hughes

The MicroCub, a modified Bill Hempel 60-percent scale Super Cub, approaches Armstrong for a landing. During the first flight of the MicroCub the crew validated the aircraft's airworthiness.

AFRC2018-0011-22 NASA/Lauren Hughes

Robert "Red" Jensen, left, and Justin Hall, right, of Armstrong's Subscale Research Lab perform a series of preflight system checks of the MicroCub to ensure the aircraft is ready for its maiden flight.

"In addition to helping with UAS integration into the NAS efforts, the MicroCub is a configurable aircraft that can be modified and utilized for a variety of flight tests at NASA," said Justin Hall, an Armstrong operations engineer and UAS pilot.

Since the initial flight in January, the Armstrong crew has installed an onboard smoke system – a see-and-avoid tool that can be used for visual identification (VID) of the aircraft, ensuring that small to midsize UAS are detectable by other aircraft during flight. By testing this technology on the MicroCub first, NASA can record VID data during test flight encounters. That will help researchers understand just how visible small UAS aircraft, like SIERRA-B, are from a variety of distances, without the risk or high cost of testing such a technology on larger UAS like NASA's Ikhana Predator B.

MicroCub's small but versatile design offers a lower-cost solution to validate one-off airframe designs, further define requirements for UAS technologies, integrate payloads, contribute to risk reduction and airworthiness tests, prove autonomous technology capabilities, and achieve a variety of other UAS-NAS related objectives.

The MicroCub is one small step in familiarizing the public with a tangible representation of what the future of unmanned flight could look like in the sky above them. As NASA expands its research and development of small unmanned aircraft vehicles, the MicroCub will continue to support UAS efforts that will ultimately change and redefine UAS flight in the future.

L.A. County Air Show set for March 24-25

The L.A. County Air Show at Fox Field in Lancaster is set for March 24-25.

Armstrong, NASA's Jet Propulsion Laboratory and Ames Research Center will be involved.

Armstrong is set to have a flyby in the ER-2, static aircraft such as the G-III and F/A-18 and some of the center's experimental subscale aircraft.

Tickets are on sale in the Armstrong Gift Shop for $15.

Volunteers are needed for staffing both days. Contact Mary Ann Harness at ext. 3446 for more.

NASA's 60th Anniversary of Earth Observations with Explorer 1 and ER-2

AFRC2017-0176-18 NASA/Ken Ulbrich

NASA's 60th anniversary of Earth observations from space was celebrated Jan. 31. Something many people may not know is that aircraft based at Armstrong support satellite programs. Many satellites in the development stage complete test flights on aircraft like the high-altitude ER-2, and continue to be supported through satellite validation flights to verify the accuracy of sensor data coming down from space.

SOFIA studies star birth

By Nicholas A. Veronico
SOFIA Science Center
NASA Ames Research Center

To have a full picture of the lives of massive stars, researchers need to study them in all stages – from when they're a mass of unformed gas and dust, to their often dynamic end-of-life explosions.

NASA's flying telescope, the Stratospheric Observatory for Infrared Astronomy, or SOFIA, is particularly well-suited for studying the prenatal stage of stellar development in star-forming regions, such as the Tarantula Nebula, a giant mass of gas and dust located within the Large Magellanic Cloud, or LMC.

Researchers from the Minnesota Institute for Astrophysics, led by Michael Gordon, went aboard SOFIA to identify and characterize the brightness, ages and dust content of three young star-forming regions within the LMC.

"The Large Magellanic Cloud has always been an interesting and excellent laboratory for massive star formation," said Gordon. "The chemical properties of star-forming regions in the LMC are significantly different than in the Milky Way, which means the stars forming there potentially mirror the conditions of star formation in dwarf galaxies at earlier times in the universe."

In our galactic neighborhood, which includes the LMC, massive stars – generally classified as stars more than eight times the mass of Earth's Sun – are believed to form exclusively in very dense molecular clouds. The dark dust and gas absorb background light, which prevents traditional optical telescopes from imaging these areas.

"The mid-infrared capabilities of SOFIA are ideal for piercing through infrared dark clouds to capture images of potential massive star-forming regions," Gordon said.

The observations were completed with the Faint Object Infrared Camera for the SOFIA Telescope, known as FORCAST. This infrared camera also performs spectroscopy, which identifies the elements present.

Astronomers study stars evolving in both the optical and the infrared to learn more about the photosphere, and the population of stars in the photosphere. The mid- and far-infrared data from SOFIA reaffirm dust temperature and mass accretion rates that are consistent with prior research of the LMC.

"We want to combine as many observations as we can from the optical, as seen through images from the Hubble Space Telescope, all the way out to the far infrared, imaged using the Spitzer Space Telescope and the Herschel Space Observatory, to

Nebula, page 8

News at NASA

Astronauts return from ISS mission

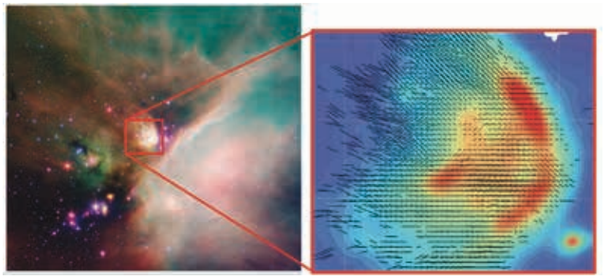
Three members of the Expedition 54 crew aboard the International Space Station (ISS), including NASA astronauts Mark Vande Hei and Joe Acaba, returned to Earth Feb. 27 after months of performing research and spacewalks in low-Earth orbit.

Vande Hei, Acaba and cosmonaut Alexander Misurkin of the Russian space agency Roscosmos landed in Kazakhstan southeast of the remote town of Dzhezkazgan.

Their time on station marked the beginning of the first long-term increase in crew size on the U.S. segment, enabling NASA to double the time dedicated to research and achieve a record-setting week of research that surpassed 100 hours. Highlights include investigations into the manufacturing of fiber optic filaments in microgravity, improving the accuracy of an implantable glucoses biosensor, and measuring the Sun's energy input to Earth.

The crew also welcomed four cargo spacecraft delivering several tons of supplies and research experiments. Orbital ATK's Cygnus spacecraft arrived at the station in November on the company's eighth commercial resupply mission, followed in December by SpaceX's Dragon spacecraft on the company's thirteenth resupply mission. Two Russian ISS Progress cargo craft arrived at the station in October and February.

Science of SOFIA



NASA/JPL-Caltech/Harvard-Smithsonian CfA. SOFIA/ HAWC+/Northwestern University /F. Pereira Santos

Left, NASA Spitzer image showing the portion of the Rho Oph dark cloud observed with HAWC+ instrument. Right, HAWC+ image showing systematic variations of the far-infrared polarization spectrum in the interstellar cloud. The background image shows the observatory's telescope.

By Nicholas A. Veronico
SOFIA Science Center
NASA Ames Research Center

Astronomers from NASA's Stratospheric Observatory for Infrared Astronomy (SOFIA), Northwestern University, and the University of Maryland attended the recent 231st meeting of the American Astronomical Society in Washington, D.C. They discussed new scientific results and how their studies of dust grain polarization and celestial magnetic fields are leading to a better understanding of star formation, theories about how gas cools in the interstellar medium and how magnetic fields are creating stellar winds around black holes.

The science results were obtained using SOFIA, a highly modified Boeing 747SP jetliner fitted with a 100-inch (2.5-meter) infrared telescope. SOFIA is an international partnership between NASA and the German Aerospace Center (DLR). The aircraft is based at Armstrong's Palmdale campus.

The flying observatory has a suite of seven different instruments – cameras and spectrometers – that are flown into the stratosphere to altitudes as high as 45,000 feet (13.7 km) on missions up to 10 hours in duration. This altitude puts the observatory above more than 99 percent of the Earth's water vapor that blocks infrared wavelengths from reaching the ground. SOFIA's ability to study mid- and far-infrared wavelengths (28-320 microns) provides data that cannot be obtained by any other current astronomical facility on the ground or in space, including those now under development.

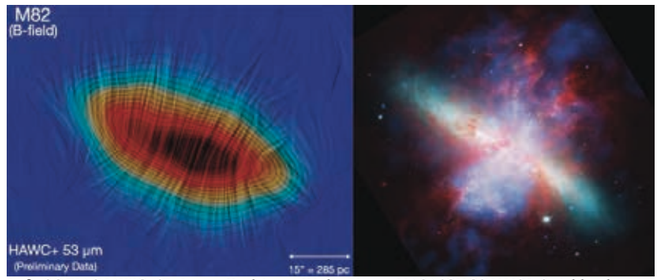
"SOFIA's unique suite of instruments provides researchers with the ability to gain new insights into the infrared universe," said Kimberly Ennico Smith, SOFIA project scientist at NASA Ames Research Center. "We are now seeing results from the most recent instrument to come on line, the new High-resolution Airborne Wideband Camera-plus (HAWC+), as well as the upgraded German Receiver for Astronomy at Terahertz Frequencies (GREAT/ upGREAT). These tools are expanding our knowledge about how stars form, the impact of magnetic fields on these processes, and the chemical compounds that are the raw material for new stars."

DLR/Clements Plank

NASA's Stratospheric Observatory for Infrared Astronomy (SOFIA) is shown inside the Lufthansa Technik hangar in Hamburg, Germany where it underwent C-check maintenance. A C-check is the biggest regularly scheduled maintenance event for an aircraft besides a complete overhaul. During the check in Hamburg, the aircraft's structure was thoroughly inspected and necessary repairs were made.

B-G Andersson • USRA/SOFIA
SOFIA/HAWC+ Polarization in the Envelope IRC+10216

Astronomers assume that the polarization maps that we observe with instruments, such as HAWC+, trace magnetic fields in space. To understand the polarization in detail, astronomers need to understand which grains contribute to the polarization, which do not and under what conditions. One theory about how these grains behave is known as the Radiative Alignment Torque (RAT) theory. Andersson presented the results of two recent tests supporting the RAT theory.



Left, SOFIA/HAWC+/E. Lopez-Rodriguez Right, X-ray: NASA/CXC/JHU/D.Strickland; Optical: NASA/ESA/STScI/AURA/The Hubble Heritage Team; IR: NASA/JPL-Caltech/Univ. of AZ/C. Engelbracht

The left image shows the large-scale magnetic field along the polar direction of the disk of the starburst galaxy M82. The HAWC+ imaging polarimetric observations show, for the first time, a relatively hot dust magnetically aligned along the direction of the outflows. The right image shows a multi-wavelength view of the galaxy, with the blue x-ray revealing gas that has been heated by the violent outflow.

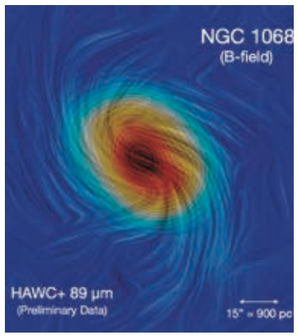
Fabio Santos • Northwestern University
HAWC+/SOFIA Observations of Rho Oph A: Far-Infrared Polarization Spectrum

Scientists have observed one of the closest star-forming regions to our Solar System, known as Rho Ophiuchi, located approximately 424 light-years away. In the central parts of the cloud, known as Rho Oph A, several young stars are currently being formed, some of which will probably become stars with planetary systems much like

SOFIA, page 8

Virtual SOFIA tour is available

Explore NASA's Stratospheric Observatory for Infrared Astronomy, or SOFIA, with a new 3-D virtual tour that brings users aboard. Users can view the aircraft's exterior, main deck mission control center, and flight deck. NASA signed a Space Act Agreement with Google in late 2016 to collaborate in providing virtual tours. The Google Expeditions app is available for free on Google Play and in the Apple App Store. For more information, visit: https://edu.google.com/expeditions/



NASA/SOFIA/HAWC+/E. Lopez-Rodriguez

The HAWC+ image of NGC 1068 shows, for the first time, the magnetized spiral arms of the host galaxy. The forces exerted by the magnetic fields are dominated by rotation of the disk, causing the dust grains to be aligned along the spiral arms as they are clearly detected by these HAWC+ polarimetric observations at 53 microns.

Upcoming SOFIA missions

By Nicholas A. Veronico
SOFIA Science Center, NASA Ames Research Center

NASA's Stratospheric Observatory for Infrared Astronomy (SOFIA), is preparing for its 2018 observing campaign, which will include observations of celestial magnetic fields, star-forming regions, comets, Saturn's giant moon Titan and more.

This will be the fourth year of full operations for SOFIA, with observations planned between March 2018 and January 2019. Research flights will be conducted primarily from SOFIA's home base at Armstrong. Highlights from these observations include:

- The observatory's newest instrument, the High-resolution Airborne Wideband Camera-plus, called HAWC+, will continue research with its polarimeter, a device that measures the alignment of incoming light waves. These investigations will help researchers understand how magnetic fields affect the rate at which interstellar clouds condense to form new stars.
- One such program will use the instrument to understand the impact magnetic fields have on stars forming inside a dark cloud. The stellar nursery filled with dust and molecules is called L1448.
- The HAWC+ instrument will also be used in a joint research program with the Atacama Large Millimeter/submillimeter Array (ALMA) to trace magnetic fields to better understand how planets form.
- Another program using the HAWC+ instrument will help astronomers better understand how energetic, active black holes contribute to the most luminous, distant galaxies. These observations will help them learn whether the luminosity of these active black holes is driven by star formation or accretion of material onto the central black hole.

Missions, page 8

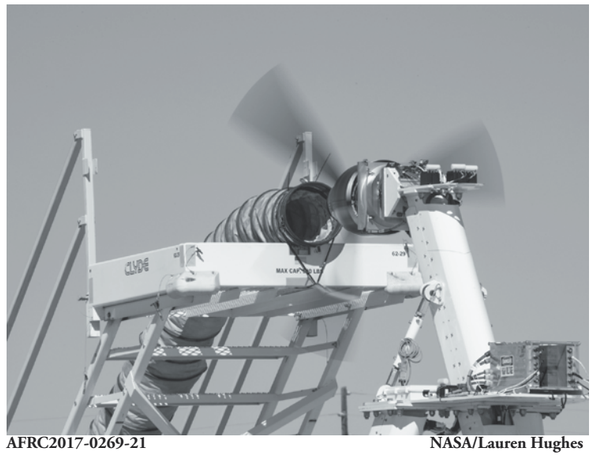
Motors... from page 1

stage because X-57 is a manned test research project, meaning the aircraft will have a pilot onboard," Airvolt Lead Systems Engineer Yohan Lin said. "Previous electric propulsion projects have been conducted using unmanned aircraft and at a smaller scale, but with a pilot onboard the level of risk is higher."

NASA Armstrong will receive a total of five JM-X57 cruise motors, designed and built by Joby Aviation in Santa Cruz, California. The team plans to use two of these electric motors in place of the standard Rotax 912 S3 piston engines for the first flight tests of the X-57's first modification, known as Mod II. While additional motors are currently being tested as spares, the idea would be to use the same two motors from Mod II as the primary propulsion system for the aircraft's later modifications, according to X-57 Principal Investigator Sean Clarke.

"The two motors that we fly in Mod II, ideally, will be the same two that we take and put on the following Mod III vehicle, which will see the standard Tecnam wing replaced with a thinner, high aspect ratio wing, and we'll also see the relocation of those cruise motors to the wing tips," explained Clarke. "After that we'll again evaluate the status of the motors and go with the best option for the wingtip cruise motors for Mod IV, which will add twelve smaller 'high-lift' motors along the new wing's leading edge."

The fifth motor will undergo testing on Airvolt at its full operational capability and will then be taken apart to have its components inspected as part of what's called a "destructive inspection." The state of the bearings, rotor and magnets will be observed and analyzed to see how healthy they are. Destructive inspection provides more insight about the motor than can be observed by inspecting the exterior and NASA researchers will be able to learn more about the motor's performance and safety limits.



AFRC2017-0269-21 NASA/Lauren Hughes

A JM-X57 cruise motor undergoes testing on the Airvolt stand at Armstrong. The Airvolt stand is instrumented to measure system voltage, current, temperature, vibration, torque and thrust.

Cruise motor tests on Airvolt are designed in part to help researchers better understand the power and efficiency of the cruise motors in addition to making certain that the motor system will stay within safe operating limits during a flight. These tests are conducted using an automated procedure tool called Procedure Integrated Development Environment, or PRIDE, developed for NASA by TracLabs Inc. in Houston as part of the Small Business Innovative Research Program. This tool uses a given test profile and sends commands to the cruise motor controller, which in turn tells the motor how fast to spin.

The Airvolt stand is instrumented to measure system voltage, current, temperature, vibration, torque and thrust. These data are used by engineers to analyze not only how efficient the electric propulsion system is, but whether the motor components can operate while remaining within the high and low temperature limits set by the research team.

Vibration and thermal analysis are both important elements of the overall motor endurance testing on the X-57 cruise motors. Motor testing includes exposing the motor to various levels of vibration and temperatures. To do this the motor is exposed to both its nominal and maximum operating temperatures. Engineers will then analyze the motor's ability to remain operational through those conditions.

Data are also being gathered to better understand the torque and thrust produced by the motors. The data are obtained by testing the motor and the motor controller at various power and torque levels and exposing them to various amounts of stress for specific amounts of time.

These elements are critical in one of the X-57's primary roles as a pathfinder for electric propulsion – working to identify and establish airworthiness standards for future electric flight.

Because distributed electric propulsion is an innovative, experimental technology, airworthiness standards do not exist for the use of fully electric motors in flight. One of the primary objectives of Airvolt testing and of future X-57 research flights is to help the flight certification community including the FAA, the American Society for Testing and Materials, or ASTM, and others, identify and establish these standards for the future. The data gathered by these efforts will be provided to the certification community to be used in establishing standards for the future of electric aviation.

For Airvolt testing, this includes providing lessons learned through the evaluation of experimental components and any issues associated with them, such as electromagnetic interference, or EMI. In the case of X-57, engineers are analyzing the effect of EMI on these components, and providing multi-dimensional fixes necessary to make them more resilient.

"Learning these lessons now on the ground provides the benefit of preventing potentially costly errors later on in flight," said X-57 Project Manager Tom Rigney. "An important aspect of X-57 is that it is advancing electric propulsion system technologies and acquiring airworthiness test data from Airvolt, other ground testing and eventually flight testing that will be provided to the certification community to help establish new regulations in the future."

The completion of Airvolt testing of the flight cruise motors will mark an essential part of the X-57 project. If successful it will assure that the motors will meet the requirements that are necessary to keep the manned X-plane operational throughout the entire flight program including Mod II and beyond, according to Rigney.

"Mod II will require the complex integration and flight testing of newly developed, high electrical energy components that include motors, controllers and batteries. By putting the motors through a rigorous ground test program using Airvolt, we will be ensured that the motors will work effectively and safely when all the Mod II components are finally integrated and flight tested on X-57."

Budget... from page 1

delivery in 2022. Robotic landers acting as scouts will enhance scientific and strategic exploration of the moon leading to eventual human exploration of Mars.

The Space Launch System rocket and Orion spacecraft are critical backbone elements of NASA's future in deep space. The momentum continues this year toward the first integrated launch of the system in fiscal year 2020 around the moon and a crewed mission in 2023.

Direct support of the International Space Station is expected to end in 2025, with a transition of low-earth orbit operations to the commercial sector. A $150 million investment is included in the budget proposal to encourage U.S. space industry development of capabilities that could be used by the private sector and NASA. Commercial crew, an effort to seed development of transportation to ISS and allow astronauts to be launched from the United States, also is funded.

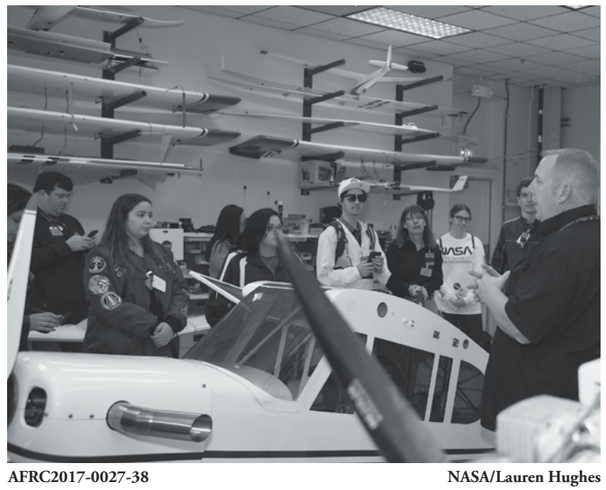
The president's proposed budget calls for winding down the NASA Office of Education and elimination of the Wide Field Infrared Survey Telescope, a NASA observatory designed to perform wide field imaging and surveys of the near infrared sky.

The Aeronautics budget is $633.9 million to improve air traffic management, make progress integrating unmanned aircraft systems into the National Airspace System, fund the X-57 distributed electric propulsion aircraft, begin construction of the experimental supersonic airplane called the Low-Boom Flight Demonstrator aircraft and increase financial support for hypersonic research.

Armstrong's budget is $292.1 million, which is up from last year overall, mostly as a result of the X-57 ramping up for flight testing. The X-57 is expected to validate more efficient distributed electric motors and reduce noise and emissions.

AFRC2017-0027-06 NASA/Lauren Hughes

NASA Armstrong Center Director David McBride answered questions about the Trump administration's 2019 budget released Feb. 12.



AFRC2017-0027-38 NASA/Lauren Hughes

Robert "Red" Jensen talked to attendees Feb. 12 at the Dale Reed Model Shop at the State of NASA event at NASA Armstrong.

"We have a bold set of plans going forward," said Armstrong Center Director David McBride. "The X-57 will be delivered in a few weeks and a vendor will soon be selected to begin construction of a new supersonic experimental airplane. We will be flying it to continue with low-boom supersonic studies to see if we can reduce the noise to levels acceptable to people."

In addition, Armstrong is working toward a 2019 launch of the Ascent Abort 2 capsule that would rescue Orion astronauts if there were an emergency on the launch pad. The center continues support with aircraft to conduct Earth science missions that fly all over the world as well as work to safely integrate Unmanned Aircraft Systems (UAS) Integration into the National Airspace System. That work could lead to expanding government and industry partnerships toward the development of an urban air mobility system that could lead to flying taxis.

Of the proposed $292 million Armstrong budget, Aeronautics, Safety, Security and Mission Services and Science comprise the biggest portions: $146.1 million, $59.6 million and $59.4 million respectively. Rounding out the funding are $4.4 million for Exploration Research and Technology, $15 million for Deep Space Exploration Systems, 0.3 million for Low Earth Orbit and Spaceflight Operations and $7.2 million for Construction and Environmental Compliance and Restoration.

The Stratospheric Observatory for Infrared Astronomy also is funded through 2019, when the result of a senior science review is expected to factor into the program's future.

Armstrong operates the airborne astronomical observatory that is capable of observing a wide variety of astronomical objects and phenomena. In addition, the center will continue to support the Flight Opportunities Level 2 Program Office.

Following the budget announcement, each center sponsored a State of NASA event for social media and Armstrong also invited news media. Armstrong's event focused on tours and two panel discussions: one on the Future of Flying Vehicles - UAS and the other focusing on X-ploring Aeronautics – X-planes.

Missions... from page 5

• Researchers will continue to search for methane on Mars. SOFIA will conduct observations during the same Martian season that the Curiosity Rover previously detected the gas to better understand how methane levels change with the Red Planet's seasons.

• Another team of researchers is planning to study comet 46P/Wirtanen as it passes close to the Earth to search for clues in the comet's dust that may help us understand the evolution of the early solar system.

In June and July, SOFIA will return to Christchurch, New Zealand, to study objects that are best viewed from the Southern Hemisphere, including neighboring galaxies the Large and Small Magellanic Clouds. Observations planned while operating from there include:

• Researchers will create a large-scale map of the biggest star-forming region in the Large Magellanic Cloud, 30 Doradus, (also known as the Tarantula Nebula.) This map will be used as a template for understanding bursts of star formation that are the origin of a large part of the stars in all galaxies.

• The HAWC+ instrument will be onboard SOFIA for its first observations from the Southern Hemisphere to study magnetic fields in star-forming regions and around black holes in the Large and Small Magellanic Clouds.

• Researchers will utilize SOFIA's mobility to study the atmosphere of Saturn's moon Titan by studying its shadow as it passes in front of a star during an eclipse-like event called an occultation. These occultation observations are part of an effort to monitor changes in Titan's atmosphere over time now that the Cassini spacecraft's mission has ended.

SOFIA... from page 5

our Sun. With HAWC+, researchers at Northwestern University have observed for the first time that systematic variations of the far-infrared polarization spectrum exist within an interstellar cloud.

Enrique Lopez-Rodriguez
• USRA/SOFIA
A Far-Infrared View of Active Galactic Nuclei with SOFIA/HAWC+

HAWC+ has opened a new window to explore active galactic nuclei (AGN) and starburst galaxies, providing the best angular resolution and polarimetric capability within the 50-220 micron range. Lopez-Rodriguez presented preliminary results of AGN and starburst galaxies observed with the far-infrared polarimeter HAWC+ onboard SOFIA. These observations of NGC 1068 at 53 microns have shown, for the first time, a magnetized arm along the spiral inner arm of the galaxy.

Elizabeth Tarantino • University of Maryland – College Park
Characterizing the Multi-Phase Origin of the [CII] Emission in M101 and NGC 6946 with GREAT

The interstellar medium (ISM) found between stars is the building block from which future stars will form. A common mechanism to cool down the gas in the ISM is through radiation from singly ionized carbon. Ionized carbon radiation can arise from three phases of the ISM: molecular gas, atomic gas, and ionized gas. Unraveling which phase the ionized carbon emission comes from and how it is dependent on environment is crucial for understanding the initial stages of star formation. This separation is better done with the GREAT instrument on SOFIA, which has the unique capability to measure the far-IR ionized carbon line at high spectral resolution.

"SOFIA's suite of new and upgraded instruments are now providing the astronomical community with unprecedented sensitivity and spatial resolution at mid- and far-infrared wavelengths," said USRA's Director of SOFIA Science Mission Operations Harold "Hal" Yorke. "We can now explore a wide range of science questions that cannot be examined anywhere else in the world."

SOFIA is a joint project of NASA and the German Aerospace Center, DLR. NASA Ames manages the SOFIA program, science and mission operations in cooperation with the Universities Space Research Association headquartered in Columbia, Maryland, and the German SOFIA Institute (DSI) at the University of Stuttgart.

Nebula... from page 3

get as broad a picture as possible," Gordon continued. "No previous researchers have used FORCAST's wavelength range to effectively study massive star formations. We needed SOFIA to fill in the 20- to 40-micron gap to give us the whole picture of what's taking place."

In summer 2017, further research of the Tarantula Nebula was accomplished aboard SOFIA during the observatory's six-week science campaign operating from Christchurch, New Zealand, to study the sky in the Southern Hemisphere. Gordon and his team are hopeful that when analyzed, data obtained from the Christchurch flights will reveal previously undiscovered young massive stars forming in the region, which have never been observed outside of the Milky Way.

The X-Press is published the first Friday of each month for civil servants, contractors and retirees of the NASA Armstrong Flight Research Center.

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