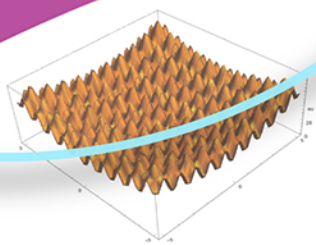
National Aeronautics and Space Administration

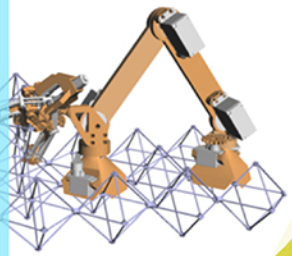
NASA

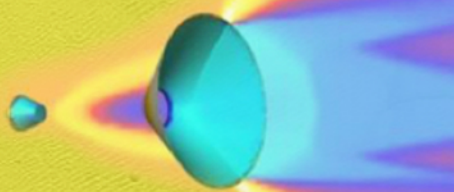
tech bytes

AMES' EMERGING TECHNOLOGIES



Focus on Research and Technology Funding





Summer 2019

In this issue:

Chief Technologist's Corner

This edition of Techbytes features the awardees from FY18 STMD's Center Innovation Fund (CIF) and Ames funded in-house awards for science and technology via the Internal Research and Development (IRAD) and Ames Research Innovation Award (ARIA). I'm also providing an update to the agency's Space Technology roadmaps and an updated NASA Technology taxonomy from the Office of the Chief Technologist (OCT), summarized here:

In 2012, NASA developed the initial edition of the agency's Technology Area Breakdown Structure (TABS) as part of its original Space Technology Roadmaps. TABS served as a valuable tool across the agency and among NASA's partners in industry, academia, and international space agencies to describe the areas where NASA had conducted technology development activities. In 2015 the agency released an update to TABS which, among other updates, expanded its scope to also include NASA's aeronautics technology areas. In continuation of this evolution the Office of the Chief Technologist (OCT) has led the development of the 2020 update that takes the lessons learned from past editions. The updated 2020 NASA Technology Taxonomy, or technology "dictionary", takes a more technology discipline based approach that also realigns like-technologies no matter their application within the NASA mission portfolio. This tool is meant to serve as a common technology discipline-based communication tool across the agency and with its partners in other government agencies, academia, industry, and across the world. In order to ensure the Taxonomy is of the highest quality and fully covers the wide breadth of NASA technologies OCT has been conducting a thorough review process. The recently completed internal NASA review will now be followed by a public comment period in which we invite technologists around the world to provide feedback on the Taxonomy. This public comment period will be announced in early May via a FedBizOpps.gov special notice.

- Harry Partridge

Research and Technology Funding

Center Innovation Fund (CIF)

The purpose of the CIF is to stimulate and encourage creativity, innovation, and collaboration within Ames and between Ames and other NASA Centers in addressing the technology needs of NASA and the Nation. CIF focuses on technology investments that are longer-term, higher-risk, high-impact, and not necessarily tied to any specific future mission opportunity.

Ames Research Innovation Award (ARIA)

The Ames Research Innovation Award (ARIA) promotes the vitality of Ames through strategic investments in scientific research, capabilities, and people. It encourages the development of new, high- risk/high return investigations that stress innovation, exploration, and/or interdisciplinary work. ARIA focuses on innovative or basic scientific research in areas that are relevant to Agency and Center goals, without necessarily being tied to any specific future mission opportunity. ARIA proposals must be research oriented and are considered seedling funding for innovative/disruptive research that will enable next generation science and research.

Internal Research and Development (IRAD)

The IRAD develops strategic technical capabilities in support of the Center competencies, and thereby enables science, technology, and engineering efforts for supporting future Agency missions. The advances in science and technology and in business capabilities expected through this program will help make Ames more competitive, provide opportunities for risk reduction and/or increased cost effectiveness, and initiate potentially transformational solutions to the most challenging mission-related problems.

ABOUT THE COVER

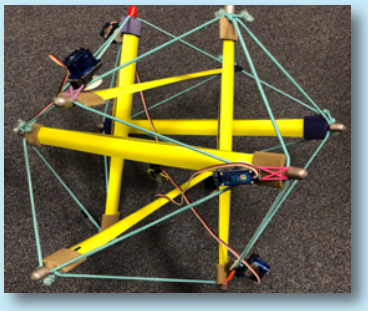
Cover background image design by Miki Huynh.

CIF

Development of Lightweight Mobility System for Passive Tensegrity Landers

PI: Adrian Agogino

Tensegrity robots can be light-weight, collapsible and highly capable making them an enabling technology for future low-cost planetary missions. This CIF project provided advancements that turned previously static tensegrity structures into active robots, allowing for a large collection of mobile structures that are applicable of a wide range of missions. It significantly reduced the time in production and successfully designed and tested three tensegrity robotic configurations. Through an innovative use of traction pulleys, the previous static structures were turned into actuated robots without significantly changing the structure. Robotic hardware tests achieved their mobility and robustness goals, and control algorithms were developed for a more complex robot than had been previously tested.



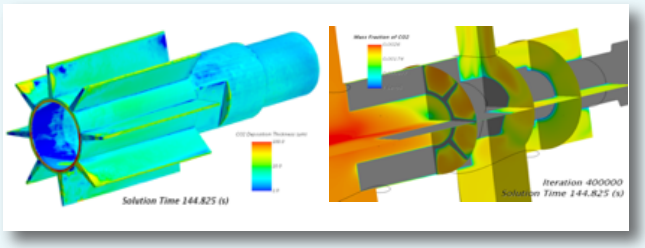
Six motors were added to Tensegrity design via a set of traction pulleys, allowing for effective actuation of an otherwise static structure.

CIF

Developing Cryogenic Heat Exchangers for Selective Cabin Air Separation

PI: Grace Belanciko

Improvements to the state-of-the-art CO2 removal system are critical for future deep space missions returning to the Moon or Mars. The CO2 Deposition system generates a cold surface to selectively deposit CO2 from air. This CIF project vastly improved the cold surface "finhead" design of the system. The most sensitive aspect of the system is the power requirement, so efficient collection of CO2 ice via the finhead is crucial. New designs that incorporated forked fins and helical twists to add surface area and better direct flow were 3D-printed in a copper alloy. The finheads were also modeled to better predict the effect of the design on system performance.



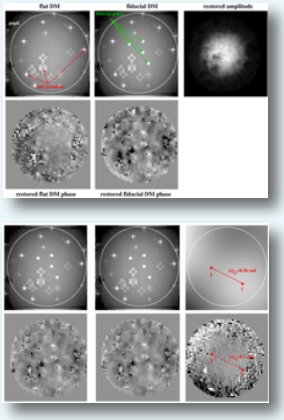
CO2 ice thickness on cold surface after 2.5min of flow (left), ppm CO2 in air flowing past the cold surface (right).

CIF

Integrated Focal Plane Waveform Estimating for Space Mission Coronagraphs

PI: Ruslan Belikov

This CIF project demonstrated a new method for wavefront estimation as a part of an integrated high-contrast imaging coronagraph. Specifically, an adaptive wavefront correction system was developed at the ACE Coronagraph Laboratory, which measures and corrects, in real time, the dynamically changing optical aberrations caused by long term mechanical and thermal instability of the system - critical for direct imaging missions. The implemented focal plane based wavefront sensing provides an accurate coronagraph model sufficient both for coronagraphic wavefront control algorithms and adaptive wavefront correction. Unexpectedly, the coronagraphic suppression of starlight is improved by almost a factor of 10 when combined with the technology developed here.



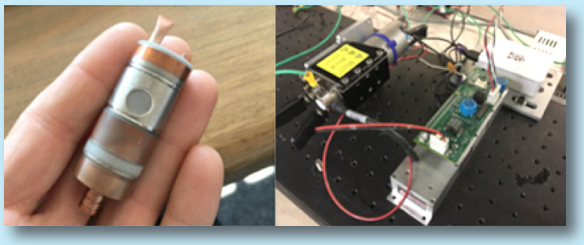
Top: The Lyot plane phase and amplitude measurements performed with the "official" flat DM surface and with a fiducial pattern applied to the DM. Bottom: Restoration of dynamically changing (artificially with the DM) coronagraph aberrations.

CIF

Development of an X-ray Tube for Planetary Instruments

PI: David Blake

This CIF project developed flight qualifiable X-ray tubes that contribute significantly to the success of a DALI proposal for an XRD/XRF instrument for lunar regolith analysis. The specific design of the X-ray tube impacts technological capabilities that do not presently exist. For example, the bipolar design of the tube (-15 KV cathode +35 KV anode) enables the development of a 50 KV accelerating potential in a High Voltage Power Supply that is rated for 35 KV capacity. The design of the cathode focusing grid allows for electronic beam blanking (essentially turning the X-ray beam on and off) so that a simpler non frame-transfer CCD design can be used in our prototype instruments (XTRA, MapX, CheMin-X).



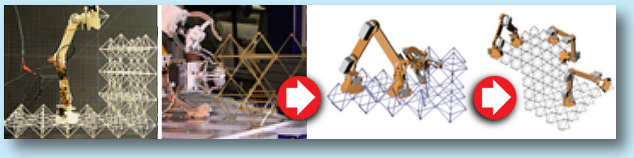
Left: Fabrication of the 20mm housing RTW tube "NASA specs" prototype; Right: Instrumented test of a 40mm housing RTW tube using Spellman HVPS and control board.

CIF

Collective Robotic Assembly of Discrete Lattice Elements (CRADLE)

PI: Kenneth Cheung

This CIF enables cost-effective manufacturing of very large space structures, which enable higher performance for a variety of missions, such as communication antennas and space telescopes, large surface area for energy collection, or habitats for long distance travel. Achieving the scale required for such systems is an ongoing challenge for space exploration and operations. Deployable structures are limited to the mass and volume constraints of a single launch vehicle. Alternatively, on orbit construction can bypass launch load limits by incrementally building structures larger than those that can be accommodated in a single launch. However, this does not currently take advantage of the recent renaissance in automation capabilities afforded by the scaling of sensing, computing, and electromechanical hardware brought on by consumer product manufacturing automation and embedded. The work from this CIF applies the benefits of automation cost scaling observed in industry to space structures manufacturing through a novel application of an integrated robot-structure-material system based on discrete lattice construction using task specific robots.



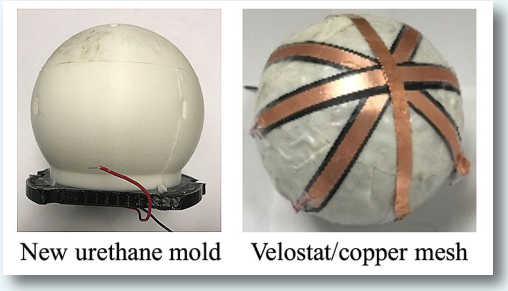
Robotic testbed demonstrating modular robotic architecture for modularization of structural assembly tasks, including transport (left) and fastener installation (right). Costa, Allan, et al. "Algorithmic Approaches to Reconfigurable Assembly Systems." IEEE Aerospace Conference Proceedings. 2019.

CIF

Autonomous Proprioceptive Terrain Detection for Compliant Rovers

PI: Terry Fong

This CIF project explored several methods and sensor configurations to estimate terrain properties and robot's state. The new prototype sensors and algorithms that were developed increase the ability of pseudo-soft and reconfigurable systems to detect properties of their state and surroundings. Prototypes include cable feed and tension sensors, soft and deformable contact sensors, a classification algorithm to detect ground contact, an algorithm to improve cable tension measurement, and a "long short-term memory" (LSTM) recurrent neural network algorithm to detect terrain type using inertial measurement data. The results of this CIF can be infused in other robot systems (e.g., cable-driven robots, planetary rovers, etc.) to enhance future missions and increase their sensing capabilities. The work is also highly beneficial for SUPERball v2 and similar tensegrity robots, and could be an enabling technology for future missions that make use of these lightweight and impact-resistant structures.



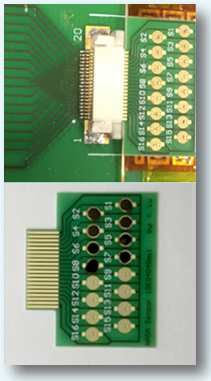
Soft sensor for contact detection.

CIF

Ultra-Low Power and Wearable CO_2 Sensors

PI: Jing Li

This CIF project helped fill a technology gap in the development of deployable air quality sensors that can operate for months-to-years without needing to be recharged. The project was a steppingstone in developing a low power and small footprint nanosensor and RFID capable of providing long life, one-button operation, and mobile/always-on environmental sensing capability. Specifically, this CIF team successfully developed a sensor that can detect CO_2 from 400 ppm to 4000 ppm, delivered four sensor chips to NASA JSC for integration with their RFID platform - which can acquire the sensor data and transmit the data, provided the sensor chip pinout and interface information to JSC for the electronics design, and tested the sensors at various temperatures and humidity levels. The device can be made wearable, peel-stick, or fit where needed, and can be distributed inside space vehicles, habitats and helmets for air quality monitoring, and thus ensure the astronauts safety during a space mission, especially during a deep space mission. Similar sensors can also be made for other gases detection, such as ammonia, hydrazine, carbon monoxide, nitrogen peroxide/dioxide, etc. This work has great potential for developing a new class of in-situ, real time detectors that can be made and deployed not only air quality monitoring, but also for fuel leak detection, life support system monitoring, and atmosphere chemical composition measurement.



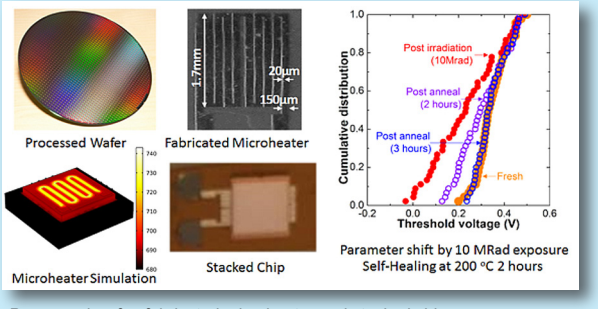
The upper image is the socket. The lower is the sensor chip (top 8 channels with carbon nanotubes (black), lower 8 channels have no sensing materials).

CIF

Self-Healing Electronics for Deep Space Missions

PI: Meyya Meyyappan

This CIF project evolved space electronics operating in extreme radiation environments, and therefore has the potential for great impact on extending mission lifetime and mission safety. Radiation hardening of space electronics is a critical part of all space missions. This is not only expensive and adds to the payload weight but, lately, the number of qualified vendors in the US with the capability to develop such electronics is rapidly diminishing. This work accomplished in this CIF has demonstrated a disruptive concept, for the first time, of self-healing electronics wherein the chip recovers from radiation-induced damage on the fly. It successfully demonstrated a commercial-off-the-shelf (COTS) chip showing the recovery of the chip after exposure to gamma radiation, as well after experiencing other stress.



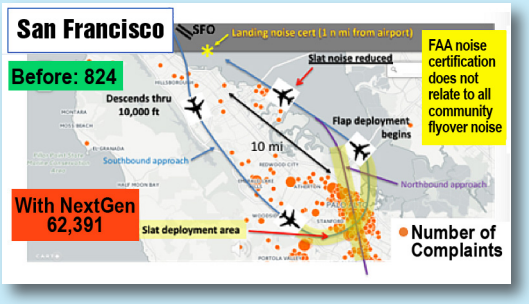
Processed wafer, fabricated microheater and stacked chip.

CIF

Quiet Commercial Aircraft via Reduced Slat Deflection

PI: Bruce Storms

This CIF projected developed a Flyover Data System including both acoustic and aerodynamic measurements of commercial aircraft. The numerous overflights measured by the new data system confirmed the earlier "manual" measurements, thereby providing more confidence and motivation for continued study of reduced-slat configurations. The project helped address NASA's strategic thrusts toward safe, efficient growth of global operations as well as ultra efficient commercial vehicles. Related to global operations, quieter commercial aircraft can enable advances in NextGen performance by minimizing the public protest and legal barriers. Ultra Efficient Commercial Vehicles aims to improve community noise levels to 1/2 of the perceived noise of 2005 best-in-class by 2035. By reducing slat deflection during early approach, this work could reduce associated flyover noise by as much as 5-8 dB (depending on the aircraft). This would have a significant impact in residential areas that lie directly below the GPS flight paths and are exposed to frequent overflights. As a result, future advances in NextGen air-traffic control will meet less resistance from the public.



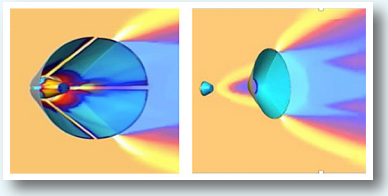
Effect of Next-Gen on noise complaints at San Francisco International airport.

CIF

Single-Event Drag Modulated Aerocapture at Venus for a Small Satellite Science Mission

PI: Ethiraj Venkatapathy

Aerocapture has been shown to have significant benefit in terms of delivered mass for in-situ science missions and human exploration missions. By separating a large drag skirt, at a precise time during entry, the main spacecraft achieves the desired velocity reduction and is placed in orbit with small periapsis velocity correction. The approach taken in this CIF project simplified the requirement for GNC as compared to lift modulation and achieves the benefit with less complexity and risk. This work identified risks of a small spacecraft aerocapture mission at Venus, a most challenging destination for entry, and significant results in addressing key risks to the drag modulated aerocapture technology in general. A feasible trajectory space was established, for which aerothermal environments were defined. The entry heating predictions led to selection and sizing of the TPS. The key challenges associated with drag modulation aerocapture for Small Satellites, which were the focus of this study, were successfully addressed through the partnership between Ames, JPL and UCB: (1) Vehicle stability throughout atmospheric flight, and the effects of tipoff and/or potential recontact between the two bodies after separation were addressed. Ames developed CART-3D CFD Solver was used to identify a simple drag skirt design that utilized aerodynamics to solve separation. Exploratory ballistic range testing was performed to confirm the ease of separation; (2) Conformal PICA, an emerging ablative TPS technology, was shown to be both mass efficient and capable of meeting the entry environment.



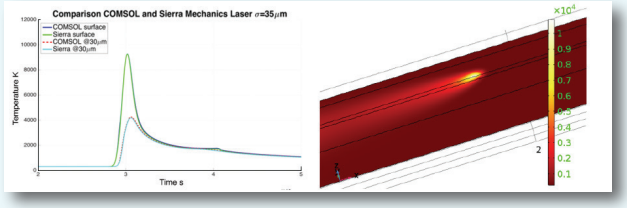
Four-petal (left) and a single skirt (right) concepts.

CIF

Predicting Deformation and Stress as a Function of Additive Manufacturing Process Parameters for Europa Drill

PI: Kevin Wheeler

This CIF project has great downstream potential for optimization of future additively built parts, which will mitigate residual stress and, for a given geometry, potentially identify critical initiators of faults resulting from improper process parameters. The capability to create new design geometries that satisfy mission constraints and simultaneously take into consideration additive manufacturing constraints has significant impact. It could potentially lead to a new class of parts with reduced mass, increased safety margins (e.g. thermal), and potentially even new functionality with gradient materials. The results of this CIF project were vital to predicting residual stresses in bi-metallic parts, and have been transitioned into the STMD/GCD/RAMPT (Rapid Analysis and Manufacturing of Propulsion Technology) project to predict the deformation and cracking (residual stresses) in bi-metallic parts. The utilization and refinement of these model codes continues to support the bi-metallic combustion chamber development.



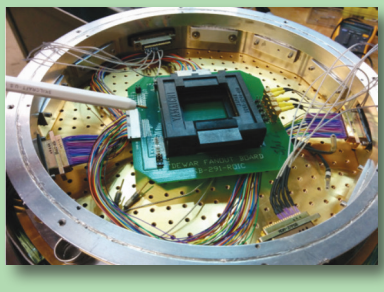
Comparison of COMSOL and Sierra Mechanics temperatures during laser melting. The top lines are for the temperature at the surface and the bottom two lines are at 30um deep into the material. The temperatures are so high due to lack of evaporation physics and lack of fluid dynamics in the melt pool. The peak temperatures are so close that they appear as a single line.

IRAD

Advancing Technologies to Study the Atmospheres of Exoplanets

PI: Tom Greene

Ames is collaborating with Professor Taro Matsuo of Osaka University to advance the technology needed to study the atmospheres of Earth-like planets around other stars with future space observatories. Prof. Matsuo has developed an optical testbed that uses a simulated star and an infrared detector from Ames in a system to simulate observing a transiting Earth-like planet from space. We will test this complete system at extremely low temperatures (below 10 Kelvin, close to absolute zero) in an Ames laboratory. The tests will measure its stability, which translates to how precisely the signatures of water, methane, carbon dioxide, ozone, and other gasses in the atmospheres of planets around nearby stars can be measured. This is needed to inform how well future observatories, like the Origins Space Telescope now being studied by NASA, will be able to measure the atmospheres of Earth-like planets around other stars and assess whether they are habitable.



Densified pupil and spec testbed.

IRAD

PHALANX

PI: Terry Fong

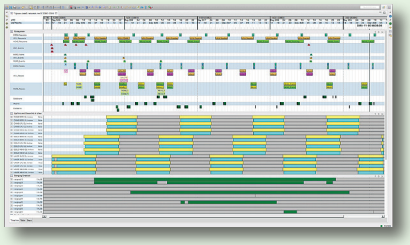
Targets of scientific interest in planetary exploration increasingly lie in areas such as steep slopes, lava tubes, or crevasses that are inaccessible to traditional mission paradigms. The PHALANX project builds upon promising work in miniature, expendable projectile sensors that can be lobbed or rolled into place from a mortar-like delivery mechanism. The key idea is that the launching system can be carried as a payload to extend the reach and exploration capability of traditional landers, rovers, or drones. Our current work develops self-organizing swarms of projectile sensors for science applications, incorporating distributed algorithms for data storage and forwarding, network failure resilience, relative location state estimation, and dense topological map generation. In a demonstration of our concept, we recently conducted mapping of solar irradiance over time across a swath of planetary analog terrain. This modality could be valuable in characterization of small shadowed areas on the Moon for prospecting.

IRAD

Jigsaw: Software for Critical Event Deconfliction for Interplanetary NanoSat Missions

PI: Matthew D'Ortenzio

The first cadre of interplanetary NanoSat missions, which includes ARC's BioSentinel and three SSTP CubeQuest Challenge missions, is set to launch on NASA's Space Launch System (SLS) / Orion Exploration Mission 1 (EM-1) in 2020. Each of these missions will soon be faced with the prospect of a lengthy and costly communications scheduling negotiation for their early-mission critical events. ARC's Jigsaw software is being developed to help the NanoSat mission teams tackle this challenge head on. Initiated by a FY16 Center Innovation Fund award, and further supported by a Center IRAD in 2018, the Jigsaw team has adapted ARC-developed artificial intelligence scheduling software and is in the process of integrating it with optimization algorithms that will allow the Deep Space Network (DSN) and its NanoSat mission customers to efficiently and accurately construct early-mission communications schedules for the periods of time when contention for their ground antennas will be highest. The software allows the user to create requests, elaboration on them with key mission preference information, and visualize them in the context of other key events and resource profiles. Once all requests are in, Jigsaw schedules the most activities in can, stretching and or shifting them as necessary to meet constraints, while at the same time enforcing fairness between missions. If adopted by the NanoSat teams, employing Jigsaw could drastically reduce the amount of time (potentially up to 100 times), that it will take to create a viable early-mission



DSN schedule for the EM-1 launch.

IRAD

MiDAR: Multispectral Imaging, Detection, & Active Reflectance Instrument – kW-class Transmitter & Receiver Development

PI: Ved Chirayath

Our multi-year IRAD award consisted of the design and development of the first 10-band kW-class UV VNIR MiDAR transmitter and onboard computational receiver for NASA airborne and spaceborne active remote sensing. In summary, our project remains on schedule, however the shutdown postponed the first piggyback MiDAR field test to May 2019, with subsequent field tests planned for September 2019. A 200W MiDAR prototype subunit was tested and validated in the lab. This unit contains 60 total LED transmitters in 8 visible bands driven over a DMX protocol. The LEDs are coupled to a glass total internal reflection (TIR) optic, followed by a cooled collimator optic, and 5-degree Fresnel lens.

Images from top to bottom: LED board with 60 LEDs mounted to heatsink, NASA logo as viewed through collimation optic, LED TIR optic within collimation tube.

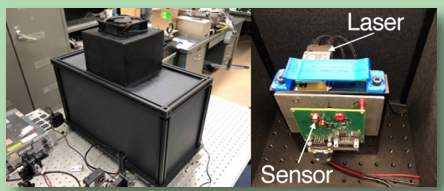
IRAD

Maturation of a Laser Nephelometer for In-Situ Atmospheric Missions

PI: Anthony Colaprete

Venus and Saturn missions called out in the NASA Decadal Survey include observations of clouds and aerosols within the atmosphere. Remote sensing techniques to derive cloud properties, including density and particle size, are limited by how far observed wavelengths can penetrate into the respective atmospheres. A nephelometer is an instrument that measures particle concentrations directly (i.e., in-situ). The last in-situ nephelometer to fly in space was on the Galileo Probe.

Through IRD funding a new nephelometer has been prototyped that takes advantage of the continuing reduction in size and increased power efficiency of Near InfraRed (NIR) diode lasers. This nephelometer measures the laser light scattered off of atmospheric particles. The estimated mass and power for this nephelometer is 1.7 kg with an average power of less than 1.5W. The system is small enough to be integrated into a range of in-situ atmospheric missions, including descent probes and landers (for comparison, the Galileo Nephelometer was 4.7kg and averaged 11W). A specialized test chamber has also been designed and built that will allow careful characterization of the instrument. Over the next year the instrument will be tested and packaged into a flight-forward form, raising the instrument to a TRL5 and capable of participating in the next round of New Frontiers proposals, and possible use in Earth aircraft/UAV missions.



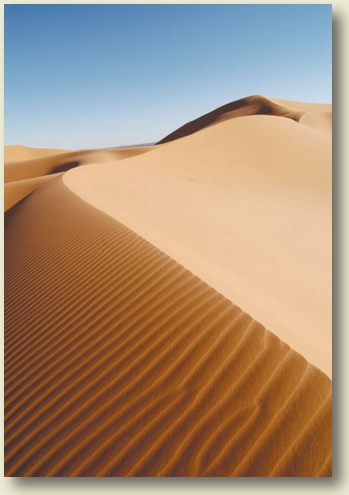
(Left) Specialized test chamber that allows clean air and controlled flow of particles for instrument testing (Right) Nephelometer prototype using a single laser and diode in the test chamber.

ARIA

Measuring Air Pressure Using Wind-Blown Sand

PI: Thomas Bristow

The aim of this project is to test the hypothesis that the size distribution of sand grains in dunes is a proxy for air density, meaning that wind-formed sandstones could be used to measure the weight of ancient air on Earth and Mars. While theoretically grounded, this method has only begun to be applied to the natural environment, and it remains unclear if it can be a useful barometer. We are making progress in assessing if the signal is strong enough to be identified from the background noise as many physical processes can affect grain sorting. If successful, this technique would enable the use of wind-formed sandstones found throughout the geological record as proxies of air density and so will contribute to our understanding of the evolution of Earth's atmosphere, and to the assessment of habitability of extrasolar planets.

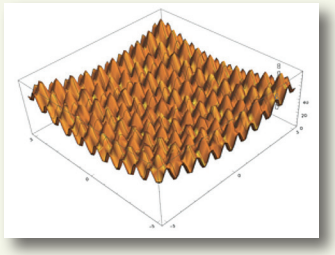


The different sizes of grains in sand dunes may reflect the overlying air pressure

A Genetic Algorithm- Based Bootstrappig Approach to Problem Encoding for Quantum Annealing Computation

PI: Silvano Colombano

The hope of Quantum Computing is to derive advantage from the inherent parallelism of its computational properties. We now have a class of "Quantum Annealing" (QA) computers that are able, in principle, to solve optimization problem. However, this is possible only if the problem can be encoded in correct machine parameters, a very difficult problem in general. We are experimenting with the use of a Genetic Algorithm (GA) to find the correct parameters. This creates a system whereby the GA and QA work in tandem to find solutions to a) the correct QA parameters and b) the original optimization problem. After the correct machine parameters are found, the original optimization problem is solvable at the speed allowed by the Quantum Annealer. Student intern researcher Samuel Stromswold from the University of Binghamton was hired for the project. Currently, two test cases are being used. The first, the Rastrigin function is commonly used for testing classical optimization problems. As a second test, we are examining unit cell relaxations in crystalline structures. Output from the quantum annealer will be treated as a set of numbers which can then be used to specify lattice parameters and atom locations within the unit cell. Results from the D-Wave machine will then be compared against those obtained by a traditional genetic algorithm as well as a simulated annealing system, both in terms of computational speed and accuracy. It is hoped that these results will show favorable performance for the D-Wave machine as programmed using genetic algorithms.

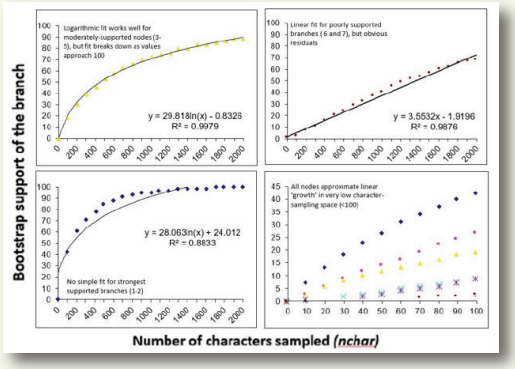


The Rastrigin function, commonly used for testing classical optimization problems.

Bootstrapping the Bootstrap: New Approaches to Improve Biological Sequence Analysis.

PI: Craig Everroad

The bootstrap is the most common measure used today to estimate statistical support in molecular phylogenies. However, assumptions of the bootstrap, namely the independence of characters, are violated. We are investigating the statistical properties and rigor of the bootstrap method on modern molecular phylogenetic data, to inform current practices in tree determination. We are also exploring reduced character-sampling and modeling methods to minimize bias, and plan to develop analysis pipelines using these approaches to reduce computation demands while maintaining robust statistics. The results of this research will improve future evolutionary analyses and are of strategic value to astrobiology research in support of the NASA Ames astrobiology core competency.

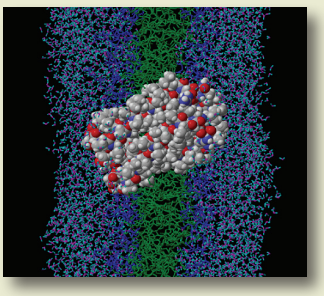


As more characters are sampled, support for branches increases differently based on the underlying phylogenetic signal. Can these increases predicatively modeled?

In vitro evolution of biomolecular devices in cell-like compartments: studies on the origin of life meet synthetic biology

PI: Andrew Pohorille

With the aid of in vitro evolution, we use novel in vitro evolution techniques to create a device called proton pump, which uses external energy, for example light, to generate proton gradient across cell walls. In cells, this gradient, produced by complex protein assemblies, is subsequently used to drive synthesis of the high-energy compound, adenosine triphosphate, the common energy currency of life, which facilitates a wide range of biochemical reactions. Instead of employing complex proteins, we evolve proton pump from a simple protein that dissipates rather than creates proton gradient. This study is the first example of evolving in vitro a biomolecular device working in cell-like structures. In this project, we demonstrate that there exists a relatively straightforward evolutionary path from passive transport to bioenergetics of nascent cells. This device can be also used to provide energy that drives biochemical reactions in artificial cells that are being developed for a host of applications to biotechnology and medicine. It also opens the doors for evolving other protein-based molecular devices with the aid of similar technique, and by doing so holds great promise for significant advances in biotechnology. (P.I. Andrew Pohorille and Mark Ditzler)



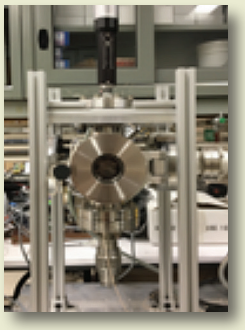
A simple protein that mediates proton transport across cell walls embedded in a model cell membrane. Non-polar core and polar head groups of the membrane are in green and dark blue, respectively. On both sides, the membrane is surrounded by lamellae of water.

ARIA

Development of Atmospheric Noble Gas Abundance SensorUsing Electric Discharge

PI: Jing Li

We are developing a method to make in-situ measurements of the concentration of noble gases such as He, Ne and Ar in planetary atmospheres using an electric discharge technique. In-situ measurements of noble gas abundance in the atmospheres of Uranus and Neptune is one of the key objectives incorporated in the ongoing NASA funded Small Next-generation Atmospheric Probe (SNAP) mission concept study, which is a secondary probe for the next planetary flagship mission to Uranus or Neptune. The SNAP study, funded by the PSDS3 element of ROSES-2016 has identified an electric discharge composition sensor as an enabling technology for noble gas abundance measurements. To study the feasibility of noble gas concentration measurements using an electric discharge device, we are measuring the relationship between electric discharge breakdown voltage, noble gas partial pressure and electrode gap sizes in various background conditions. A precise apparatus of running the experiment to discharge gases has been built in the lab (see the picture below, left) for above said studies. A Labview program has been written for running the experiment and recording the test results (see the picture below, right). The results from this desktop setup can guide the design of a miniaturized discharge gas sensor that uses a carbon nanotube bundle tip to point to a grounded metal plate, which can offer high sensitivity, high specificity and fast response tool with low mass and low power for in-situ noble gas abundance measurement.



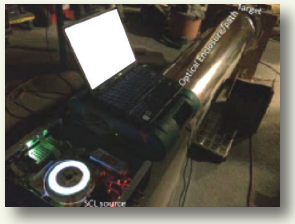
A setup for precise measure of the breakdown voltage of gases used in the discharge gas sensor development.

ARIA

The Lunar Laser Spectrometer (LLS) Laboratory Assessment of Supercontinuum Laser (SCL) Spectrometer Performance for Remote Detection and Characterization of Lunar Volatiles

PI: Ted Roush

The detection and mapping of volatiles in the permanently shadowed regions (PSR) of the Moon has been identified by the Lunar Exploration Analysis Group (LEAG) as one of the highest priority items from both the scientific and the resource utilization perspectives. LLS is a new class of rover- or lander-mounted active spectrometer that combines a supercontinuum laser (SCL) with a NIR spectrometer to generate spectra of shadowed areas on the lunar surface or lava tubes. It is designed specifically to measure the composition, lateral distribution, abundance, and particle size of surface volatiles, hydrated species, and primary mafic igneous minerals. The SCL, a laser that emits polychromatic light in the 0.45 – 2.40 μm region of the spectrum, is used to illuminate the target material from an arbitrary distance within the field of view of the spectrometer, which acquires spectra of the target. The use of a SCL instead of a lamp allows highly targeted observations to be performed at a greater range of distances and simplifies observation geometry. Here, a TRL 6 NIR spectrometer originally developed for the Mars 2020 Rover mission is combined with a commercially available NKT Photonics SCL to advance the concept to TRL 4 status. The ability of LLS to acquire spectra of both illuminated and dark targets in a spectral region populated by absorptions of diagnostic key volatile and mineralogical species make it uniquely suited for a broad range of landed lunar missions.



The supercontinuum laser (SCL), near the bottom of the figure, produces a broad wavelength (0.4 - 2.5 micrometers) beam of light that is used to illuminate a target within the enclosure. The illuminated target is observed with a telescope, which transmits the light via fiber optic to a laptop-controlled spectrometer.

ARIA

What Happens to Life in an Ocean World Plume?

PI: Carol Stoker

Subsurface oceans on Europa and Enceladus have the potential to harbor life. Missions are proposed to search for that life by collecting samples that are ejected into space in plumes. Knowledge of the type and expected quantity of these biomarkers will enable detection and sensitivity limits to be set for proposed life detection instrumentation. To this end our work focuses on understanding of the physical response of microorganisms to the highly desiccating conditions of space vacuum. To accomplish this objective, we fabricated an apparatus that can inject micron-sized water drops into a vacuum chamber. Samples containing known concentrations of microbes are fed from a pressurized piston outside the vacuum chamber through a nozzle inside the vacuum chamber. The nozzle and operating pressure were selected to create particle sizes comparable to those observed by Cassini in the Enceladus plume. Cold plates are installed in the base of the chamber for temperature control of the collected microbes. Drops from the nozzle are captured onto cooled metal capsules designed for imaging of wet samples in their native state by scanning electron microscopy (SEM) to visualize cellular integrity. Along with SEM images, analysis of the biomolecule ATP was performed to quantify the amount of surviving (or intact) cells vs. the ones that were destroyed under vacuum exposure. Preliminary results from the tests show that cellular integrity is maintained to some degree, even under vacuum. However, when collected at subzero temperatures there was a substantial decrease in whole cell retention.

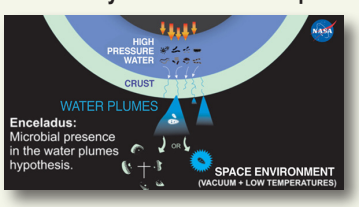


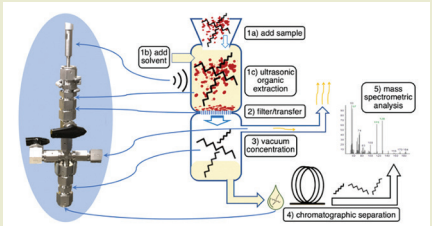
Image illustrates water plumes containing microbes ejected into space from the Enceladus subsurface.

ARIA

Miniaturization of Lipid Biomarker Extraction Techniques for Future Life Detection Missions

PI: Mary Beth Wilhelm Co-Is: Tony Ricco, Linda Jahnke

The objective of this work is to develop and test miniaturized techniques for extracting trace amounts of organic molecules (lipids) from natural samples. Soil organic matter is extracted into a minimal volume of solvent using state-of-the-art sonication technology. This is a critical step toward a spacecraft-scale system that could be flown on future life detection missions to Mars or Icy Worlds. Our instrument-development effort, ExCALiBR (Extractor for Chemical Analysis of Lipid Biomarkers in Regolith), builds on laboratory lipid biomarker analytical techniques that have been developed over the past 50 years in NASA ARC Exobiology laboratories. Lipids are organic molecules utilized by all life on Earth, primarily for building membranes that encompass cells. Many are resistant to degradation and are the oldest biomarkers preserved in the rock record on Earth, making them an attractive target for ancient habitable sediments on Mars. This technology will help to enable life detection science objectives by (1) conserving origin-diagnostic lipid structures/patterns by maintaining them in the liquid phase, (2) reducing signal interference by extracting lipids from the mineral matrix and filtering out minerals, and (3) increasing the concentration of lipids by an order of magnitude in the sample sent to downstream analytical instrumentation.



Sequence of sample preparation steps leading to separation and detection of individual target lipids. On the left, photo of breadboard ExCALiBR system, which has successfully implemented steps 1–3 of this sequence; component functions are keyed by arrows from the schematic.

Technology Educational Satellite 8 (TechEdSat-8) launches to the International Space Station Packed with Technology

NASA's Technology Educational Satellite 8 (TechEdSat-8) launched to the International Space Station on December 4th onboard Space X-16 launch vehicle from NASA Kennedy Flight Facility in Florida. TechEdSat-8 is the most technologically advanced satellite of the mission series that dates back to 2012. Packed with commercial and NASA-developed technologies being demonstrated in space for the first time, as well as the next generation of NASA's Exo-Brake, TES-8 was developed and built over this past summer by 17 undergraduate and graduate student interns mentored by NASA professional engineers and five NASA professional engineers.

The primary objective of TechEdSat-8 is to demonstrate a more robust version of NASA's Exo-Brake. At four meters square (13 feet) and made from a similar thin mylar material used in emergency blankets on Earth, the Exo-Brake is folded and packed into a 2U space (4 in x 4 in x 8 in) inside one end of the spacecraft. Sixty seconds after deployment from the International Space Station's NanoRacks deployer, the TechEdSat-8 spacecraft will release the Exo-Brake. Once unfurled, the Exo-Brake maintains its square shape through the use of two soft struts filled with few drops of water that reach to each side of the Exo-Brake and that expands upon exposure to the space environment. Additional rigidity is given to the struts by the addition of more water than previous versions of the Exo-Brake. This allows for finer and more precise modulation of the Exo-Brake as the team maneuvers it from the ground via communications provided by Iridium. The Exo-Brake is planned as a future costeffective way to return samples from the space station by guiding a return vessel to Earth through steering the Exo-Brake through the atmosphere.

The UNITE CubeSat after release from a deployer outside the International Space Station. Image Credit: NanoRacks

Students work with the TechEdSat 8 CubeSat before its launch to the International Space Station. Image credit: NASA

Among the complement of technologies to be demonstrated in space for the first time are two radios. The National Oceanic and Atmospheric Administration's (NOAA) radio will demonstrate transmissions to GOES East and West with transmissions being relayed to NOAA's ground station located in Wallops Flight Facility (WWF). The second radio is transmitting to NASA's Near Earth Network (NEN). Its is an X-band lunar radio capable of transmitting at 2000 megahertz that will allow to be use at a Lunar distance without relay; Also on board is the NVIDIA processor with a video compression rate of 200 frames to 1 that San Jose State Students and Professors develop, and will capture the deployment of the TechEdSat-8 spacecraft from the NanoRacks deployer, compress the video to allow its transmission over the NEN lunar radio, all within 30 minutes after deployment. It will also transmit pictures of Exo brake deployment and maneuvers via WiFi- ISM band using the ground station at WWF.

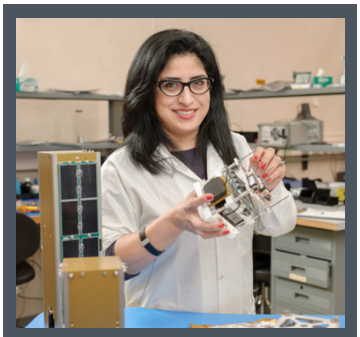
Additional technologies to be validated on TechEdSat-8 include a GPS system used on smartphones and an attitude control system. The mission is planned to last ten days.

The TechEdSat-8 mission is supported by the NASA Ames Engineering Directorate, the NASA Engineering and Safety Center, and the Small Spacecraft Technology Program within Space Technology Mission Directorate. The TechEdSat-8 mission was selected in 2017 to be launched as part of the Educational Launch of Nanosatellites (ELaNa) 21 CubeSat launch. ■

CONTACT debra.bubenheim@nasa.gov

NASA Ames Award Recipients

Ali Luna Receives Women of Color Outstanding Technical Contribution in Government Award



Ali Guarneros. Image Credit: Dominic Hart, NASA

Ali Guarneros Luna, aerospace engineer and deputy project manager and co-investigator for the SOAREX 10 and Safety Mission and Assurance for TechEdSat 5 and 6, received the Women of Color Outstanding Technical Contribution in Government Award on Oct. 13, 2018 in Detroit, Michigan.

The Women of Color STEM Conference hosts several award ceremonies for women who create innovation and inspiration. This year's conference was held in Detroit, Michigan on Oct. 12-13, 2018 and Ames' Ali Guarneros Luna, aerospace engineer, was awarded the Outstanding Technical Contribution in Government Award.

Ali was selected for this award based on her significant contribution to NASA and space research. She is the deputy project manager and co-investigator for the SOAREX 10 and Safety Mission and Assurance for TechEdSat 5 and 6. Additionally, she is the go-to person at Ames for issues related to International Space Station (ISS) safety and design practices.

Most noteworthy is Ali's international reach and impact. She was a principal contributor to a joint NASA-Mexican Space Agency project and her international recognition includes the Ohtli Award, presented to her on May 3, 2018.

The Mexican government reserves this honor for those who have assisted Mexican citizens or promoted their culture. Ali is globally recognized for her professional contributions to space and community outreach and has received the ISS Space Award for her role with the SPHERES, Modular Rapidly Manufactured Small Satellite, Nodes and TechEdSat Series projects. ■

HENAAC Great Minds in STEM Professional Achievement Level 2 Awarded to Andres Martinez

Andres Martinez. Image Credit: NASA

Andres Martinez, program executive for the Advanced Exploration Systems (AES) division at NASA, on Oct. 20, 2018 received the HENAAC Great Minds in STEM Professional Achievement Level 2 Award in Pasadena, California.

HENAAC Great Minds in STEM (GMiS) recognizes the achievements of America's top engineers and scientists within the Hispanic community during the annual HENAAC GMiS Conference. This year, Andres Martinez received the Professional Achievement Level 2 Award on Oct. 20, 2018 in Pasadena, California. Candidates in this category must be well-established managers or have project responsibility in a technical field with significant contributions in that arena.

Andres was selected for this award based on his outstanding reputation and work as a program executive for NASA. As program executive for the Advanced Exploration Systems (AES) division at NASA, Andres is responsible for defining, integrating and assessing project activities and to provide policy direction and guidance. He is responsible for strategic planning activities that are defining future missions using small satellites, as well as tactical management of various spaceflight projects.

His portfolio currently includes Lunar missions using small satellites, the Synchronized Position Hold Engage and Reorient Experimental Satellite (SPHERES) facility, the Astrobee free flying robot development and strategic collaborations with other federal agencies and foreign countries. Beyond this distinguished professional achievement, Andres is an international STEM champion. His efforts are recognized by the Mexican Space Agency (AEM) as successfully leading a formal agreement between NASA and AEM. ■

Andres was key to establishing a reimbursable Space Act Agreement leading to a formal internship program for Mexican students to participate in research projects at NASA Ames. Additionally, the collaboration led to the AztechSat-1 nanosatellite being developed by Mexican students. Andres also is at the forefront of Hispanic initiatives at Ames in his role as the chair for the Hispanic Advisory Committee for Employees (HACE). ■

NASA Drone Traffic Management Researcher Selected for Federal Award *- by Darryl Waller*

Parimal Kopardekar, senior technologist for air transportation systems and recipient of the 2018 Samuel J. Heyman Service to America Medal, attends a conference at NASA Ames. Image Credit: NASA Ames

Parimal H. Kopardekar, senior technologist for air transportation systems at NASA Ames, was presented a prestigious medal for government service at a gala in Washington, on Oct. 2, 2018.

Kopardekar was selected from more than 300 nominees to receive a 2018 Samuel J. Heyman Service to America Medal for his vital role in designing a first-of-its-kind traffic management system for unmanned aerial vehicles, paving the way for the safe, expeditious and large-scale use of commercial drones in the national airspace system. ■

Ames Technologist Receives Women in Aerospace Achievement Award

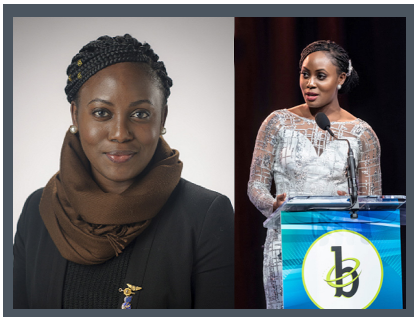
Dr. Jessica Koehne recently received recognition from the Women in Aerospace Awards committee. On November 1, Dr. Koehne was the recipient of the 2018 Achievement Award at the WIA Awards Ceremony and Banquet held in Arlington, VA.

This significant award was presented for "Noteworthy, proven, technical or scientific achievement on or contributions to a single aerospace project or program that represents a breakthrough in the aerospace field; commitment to professional growth; and service as a role model or mentor that shows dedication to the advancement of women in aerospace." The nomination was submitted by Ames Center Director, Dr. Eugene Tu. ■

Jessica Koehne Image Credit: NASA

Wendy Okolo Receives "Black Engineer's Most Promising Engineer in Government Award"

- from the March 2019 Astrogram



Dr. Wendy Okolo. Image Credit: NASA

Dr. Wendy Okolo, an aerospace engineer at NASA Ames, has received the "Black Engineer's Most Promising Engineer in Government Award" at the BEYA STEM Conference in Washington D. C. Okolo is a Special Emphasis Programs Manager in the Intelligent Systems Division at Ames.

Okolo is working on the System-Wide Safety (SWS) project and a Space Technology Mission Directorate Early Career Initiative (STMD-ECI) project at Ames. For the SWS project, she led the task of predicting GPS faults in unmanned aerial systems commonly known as drones.

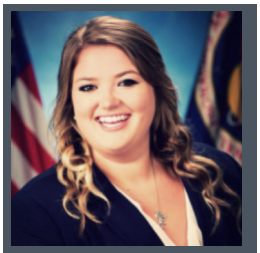
On the STMD-ECI project, she leads the controls team to develop unconventional control techniques for deployable vehicles, to enable precision landing and improve maneuverability during the entry, descent, and landing phases of spaceflight. The STMD-ECI project is a $2.5 million-dollar project that she proposed and won as part of a six-member early- career scientist team. Her previous research has been recognized and funded by the Department of Defense through

the National Defense Science and Engineering Graduate Fellowship; Zonta International, through the Amelia Earhart Fellowship; and the American Institute for Aeronautics and Astronautics through the John Leland Atwood Graduate Fellowship. Okolo was only 26 years old when she became the first black woman to obtain a Ph.D. in aerospace engineering from the University of Texas at Arlington. She earned both undergraduate and doctoral degrees in aerospace engineering from UT Arlington.

Okolo worked with Langley Research Center in Virginia to investigate flight data and facilitate data exchange across and within NASA centers.

NASA Space Technology Research Fellow Wins Zonta Amelia Earhart Fellowship

Kathrine Bretl, a NASA Space Technology Research Fellow who recently completed a research experience in the Space Biosciences Division at NASA Ames working with Dr. Marianne Sowa and Dr. Ann-Sofie Schreurs, has been selected to receive the 2019 Zonta International Amelia Earhart Fellowship. This fellowship is awarded annually to up to 30 talented PhD students worldwide. The award seeks to promote the future of women in aerospace-related sciences and engineering and can be used to cover research costs, living expenses, and/or travel expenditures. Ms. Bretl is a graduate student in the Bioastronautics Laboratory at the University of Colorado Boulder, investigating methods for improving the feasibility of using short-radius, intermittent artificial gravity as a comprehensive physiological countermeasure during long-duration human spaceflight. She is pursuing a PhD in Aerospace Engineering and will be receiving her Master of Science in Aerospace Engineering Sciences and Master of Engineering in Engineering Management in May of 2019. Ms. Bretl's NSTRF research coordinator is Dr. Francis Donovan (SCR). ■



Kathrine Bretl.
mage Credit: NASA

Ames FY20 Center Innovation Fund (CIF)

Request for Proposals (RFP)

The NASA Ames Research Center Office of the Center Chief Technologist (CCT) is pleased to announce the FY20 Center Innovation Fund (CIF) Request For Proposals (RFP). The purpose of the CIF is to stimulate and encourage creativity, innovation and collaboration within Ames, and between Ames and other NASA Centers in addressing the technology needs of NASA and the Nation. It is intended for exploratory investigations that offer breakthrough technologies. The ideas supported must align with Center priorities and leverage Center capabilities, but they do not necessarily need to correspond to the Centers Core Competencies. CIF proposals must be technologically oriented and may be viewed as 'seedlings' that will enable the next generation technology and exploration. The target technology readiness level (TRL) is 1-3. It is incumbent upon the proposer to demonstrate clearly the true innovation of the proposed project compared with existing state-of-the-art, and to demonstrate how the proposal supports Agency objectives and Center priorities.

Eligibility and Guidelines

Only Ames civil servants can serve as the Principal Investigator (PI) and submit proposals. However, partnerships are encouraged with on-site contractors and other external organizations that take advantage of mutual interests and capabilities as well as leveraged funding.

Award Amount

The FY20 CIF award guideline is up to $50K in procurement (including contract labor), and up to 0.2 FTE for one year. However, requests outside these guidelines may be considered. FTE awards are restricted to Ames civil servants only and no funds are available for travel. Decisions regarding awards will be based on availability of funds.

Award Duration

All CIF awards are for a single year only, and the planned work is to be completed during FY20. All funding must be obligated by September 30, 2020. Proposals for continuation awards (i.e., for projects that received a CIF award from a prior year) may be submitted. However, these are reviewed as new proposals and must have demonstrated progress in the previous award and still meet the exploratory and breakthrough criteria.