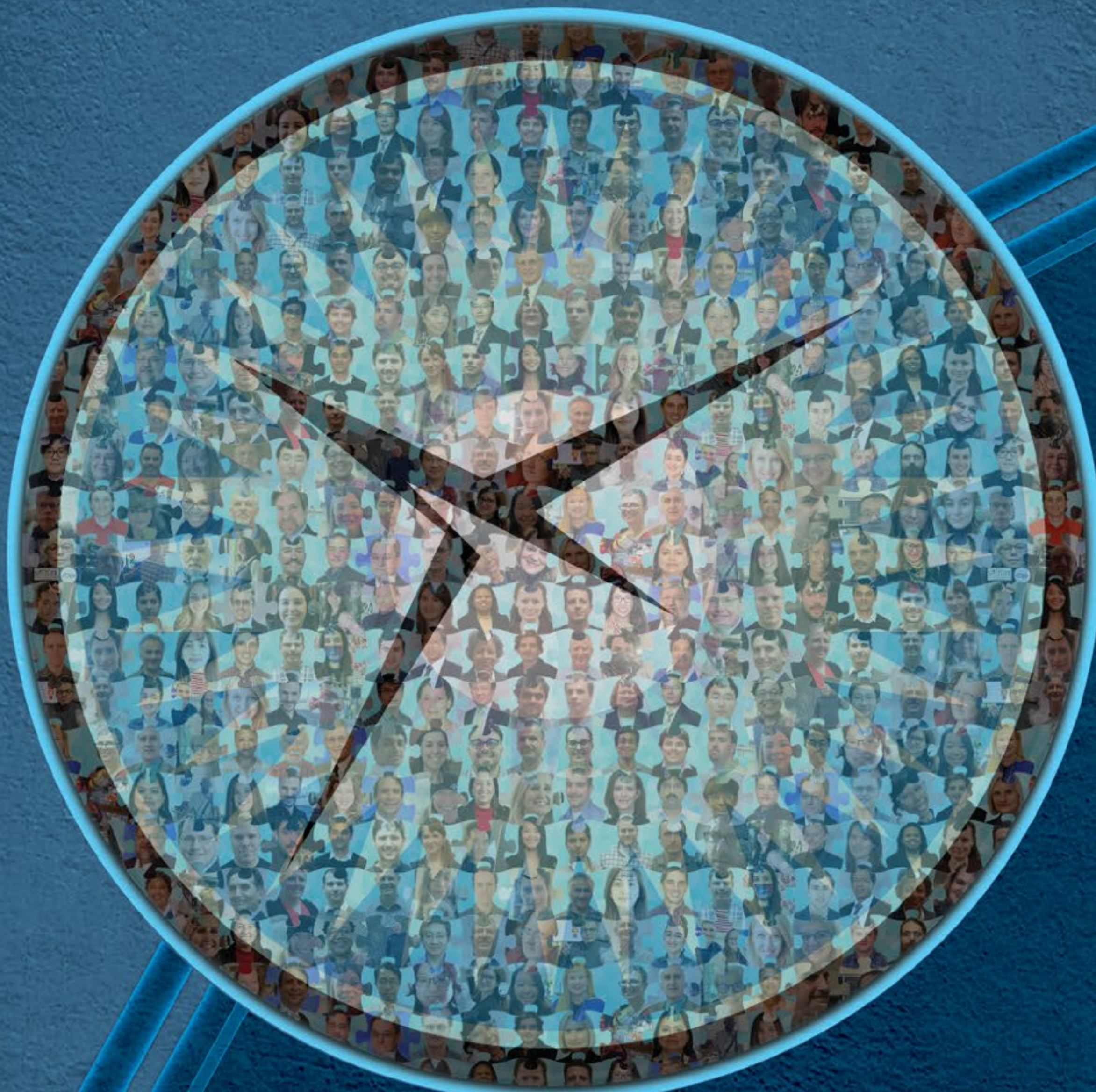
NIA

NATIONAL INSTITUTE OF AEROSPACE

Leaders in innovative aerospace research, exemplary education and inspirational outreach



2021 Annual Report

About Us

The National Institute of Aerospace (NIA) is a 501(c)3 nonprofit research, graduate education, and outreach institute created in 2002 by NASA's Langley Research Center. NIA collaborates with NASA, other government agencies and laboratories, universities and industry to conduct leading-edge research and technology development in aeronautics, atmospheric science and space exploration. In addition, NIA offers a broad, multi-university graduate education program and award-winning educational and public outreach.

Our Vision

TO BE A NATIONAL LEADER IN INNOVATIVE AEROSPACE RESEARCH, EXEMPLARY EDUCATION AND INSPIRATIONAL OUTREACH

Our Mission

- **Lead and conduct** synergistic research with government, academia and industrial partners to stimulate innovation and creativity
- **Deliver** unique, collaborative, and comprehensive graduate and continuing education in science and engineering
- **Inspire** the next generation of aerospace engineers and scientists
- **Develop and commercialize** transformative aerospace technologies

Our Values

- Our people are our strength.
- We are dedicated to our stakeholder's success.
- We value diversity, equity, inclusion and accessibility; and believe a variety of backgrounds, experiences, and opinions drives innovation.
- We share one vision and act as one team.
- Trust and accountability in all relationships.
- We embrace change and reward innovation.

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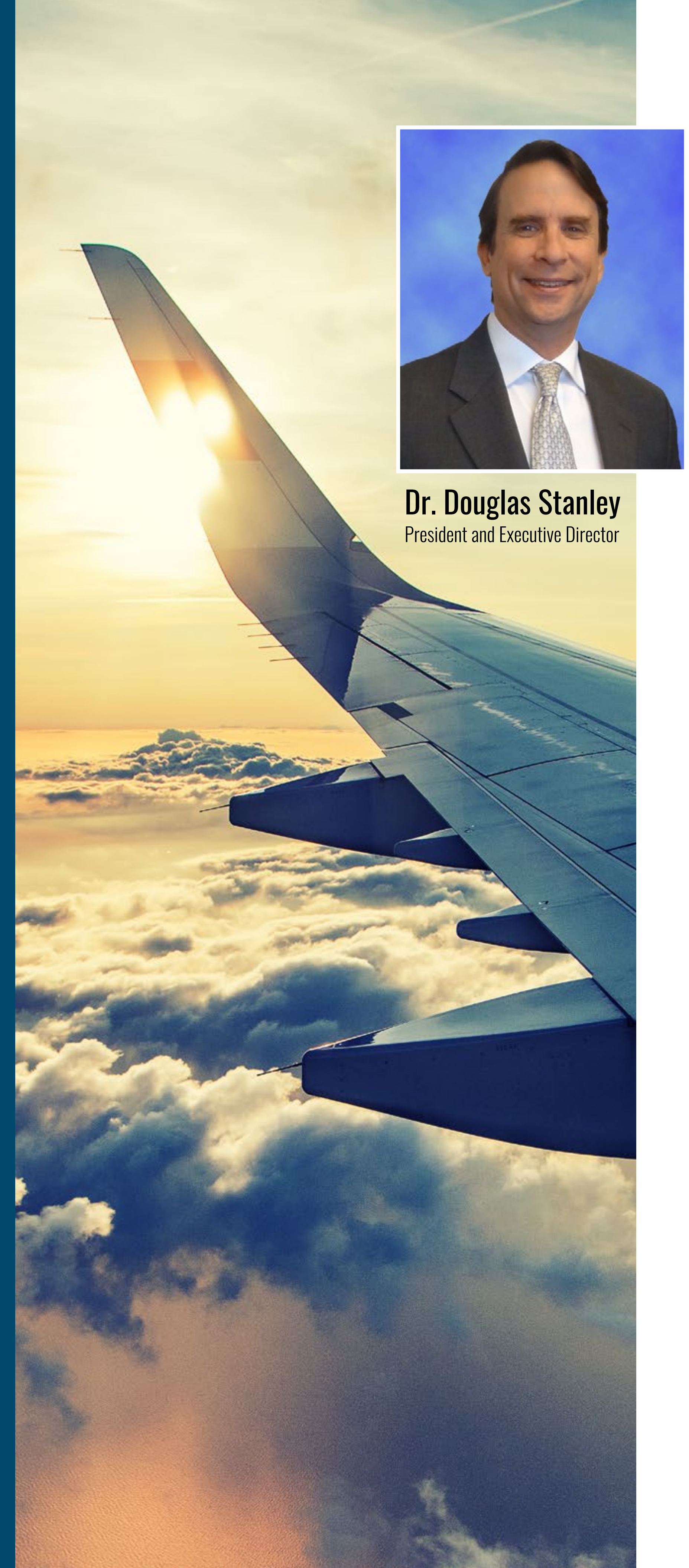


Dr. Douglas Stanley
President and Executive Director

President's Message

2021 has once again been a devastating year for our nation and the world. We mourn the millions who have lost their lives or have been placed in hardship by the global COVID-19 pandemic. We are blessed to have been minimally impacted at NIA during this difficult period. Only a small subset of our employees contracted COVID-19, and all of them returned to full health. All of our employees were able to keep their jobs and remain highly productive despite having to work from home, as in 2020, for much of the year. We were able to keep our offices and labs open and COVID-free through strict protocols. We continued to have a wide variety of virtual, drive-through, and socially distanced events to promote employee morale. Despite the challenging circumstances, our NIA team was able to continue the innovative research, exemplary education, and inspirational outreach that has characterized NIA since our founding.

Despite COVID restrictions in 2021 that limited research and conference travel, our researchers authored 80 technical publications, received several NASA Medals and paper awards, and were awarded a record 15 patents! Dr. Vesselin Yamakov was awarded the prestigious NASA Exceptional Scientific Achievement Medal for his work on computational materials simulation of fundamental material behavior. Daniel Kiggins received the NASA Exceptional Public Service Medal for significant achievements, outstanding support, and innovative contributions to NASA aerospace research and technology. Robert Conn was honored with the NASA Silver Achievement Medal in recognition of his contributions to the Hayabusa2 reentry observation campaign conducted in Australia during the height of the pandemic. In addition, NASA recognized six other NIA employees with Group Achievement Awards for exceptional team contributions to NASA programs and missions. Dr. Prahladh Iyer won the AIAA Hampton Roads Section 2021 Laurence Bement Young Professionals Best Paper Award, and Dr. Boris Diskin and University of Maryland Langley Professor, Olivier Bauchau won 1st runner-up in the prestigious NASA Langley H.J.E Reid Best Paper Competition. It was another productive year of research despite the ongoing pandemic.

Our unique graduate education program had 30 full-time and 23 part-time graduate students on-site, plus 65 more at home campuses, in 2021. Our students can earn degrees from any of our nine member universities and take up to half of their classes from other universities. We graduated seven Ph.D. and four masters' students from our on-site program in the past calendar year. Our Samuel P. Langley Professors-in-Residence at NIA from our member universities all continued to excel in 2021 by publishing 80 peer-reviewed publications and conference papers. Congratulations to Old Dominion University graduate student Forrest Miller and his advisor Prof. Colin Britcher for authoring the 1st place paper in the AIAA Region I student conference!

The pandemic didn't thwart our world-class educational and public outreach programs either as we continued to garner new customers, audiences, and awards. In 2021, we broadcast 260 episodes of our "Innovation Now" radio program, which features exciting innovations in aerospace engineering, science, and space exploration. This year, its audience increased to over 29 million daily listeners. We also produced and distributed 139 new video episodes under our flagship "NASA 360" video brand. NASA 360 counted 36.8 million video views and reached upwards of 72 million fans and followers through its social media platforms in 2021. With more than 90,000 downloads per month, our "NASA eClips" program continues to reach classrooms around the globe. Our RASC-AL, BIG Idea, Moon to Mars Ice and Prospecting, and new Gateways to Blue Skies student challenges continued to engage hundreds of university students worldwide in creating concepts and technologies for NASA applications. We also continued the highly successful NASA iTech program virtually to encourage startup companies to address new technologies and ideas relevant to NASA. Finally, our exciting new "First Woman" graphic novel and multimedia app reached over 467 million people in print, video, or on-air and 108 million people on social media in its first two months!

We are looking forward to working with all our stakeholders in a (hopefully) post-COVID 2022 to provide the highest quality research, education, and outreach programs.

Samuel P. Langley Professor Program

The Samuel P. Langley Professor Program was established by NASA's Langley Research Center to enable an on-site, high-value graduate education program for Langley personnel, as well as graduate students, that would ensure a pipeline of new talent with relevant technical interest and expertise. Langley Professors are selected to be in residence at NIA after establishing themselves as research and thought leaders in fields that are aligned with and complementary to the strategic research directions at NASA's Langley Research Center.

Branch heads and researchers across NASA Langley regularly seek out Langley Professors for collaborative research, or to obtain high-valued research advice and direction. Langley Professors also assist in providing master's and doctoral students to work side-by-side with NASA Langley researchers for extended periods, while addressing their coursework, to perform research on-site at both the National Institute of Aerospace and NASA Langley. Each Langley Professor specializes in a technical discipline that aligns with an element of the research program and interests of NASA's Langley Research Center.

NIA Samuel P. Langley Professors

Dr. James Baeder
University of Maryland

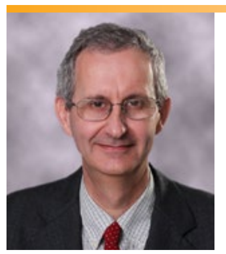
Center for Rotorcraft Aeroacoustics

Computational Aerodynamics and Aeroacoustics

Dr. Mool Gupta
University of Virginia

Center for Photonics, Sensors and Solar Energy

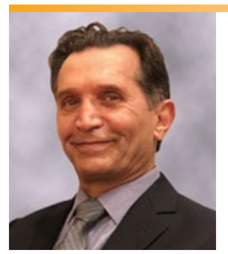
Photonics, Sensors, Solar Energy, and Nanomaterials



Dr. Olivier Bauchau
University of Maryland

Center for Structural Dynamics

Multibody Dynamics, Rotorcraft Aero-Mechanical Comprehensive Modeling, Structural Dynamics, and Composites Materials and Structures



Dr. Abdollah (Ebbie) Homaifar
North Carolina A&T State University

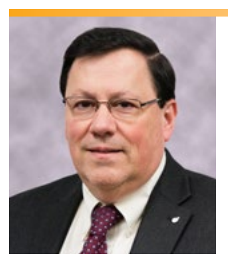
Autonomous Control and Information Technology Institute

Testing, Evaluation, and Control of Heterogeneous Large-scale Systems of Autonomous Vehicles

Dr. Christopher Fuller
Virginia Tech

Center for Aerospace Acoustics

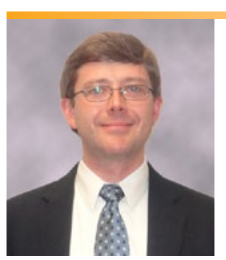
Acoustics, Active Noise Control, and Acoustic Meta-Materials



Dr. Dimitri Mavris
Georgia Institute of Technology

Aerospace Systems Design Laboratory @NIA

Design of Space Systems, Vehicles and Architectures



Dr. Brian German
Georgia Institute of Technology

Center for Urban and Regional Air Mobility (CURAM)

Aircraft Electric Propulsion, Autonomous Flight, and Emerging Aviation Markets

Dr. Fuh-Gwo Yuan
North Carolina State University

Center for Integrated Systems Health Management

Advanced Smart Materials, Non-Destructive Evaluation, and Integrated Systems Health Management

Research

MESSAGE FROM VICE PRESIDENT OF RESEARCH

David Throckmorton

During 2021, NIA researchers continued to perform cutting-edge research and technology development in support of NASA's Langley Research Center, and our other government and commercial aerospace customers. Even in the face of workplace challenges resulting from the COVID pandemic, the population of the NIA research staff continued to grow - evidence of the value our customers receive from the engagement of NIA researchers in the performance of their research and technology development pursuits.

Multiple NIA researchers were recognized, this year, for the outstanding quality and impact of their work:

- The NASA Exceptional Scientific Achievement Medal (the agency's highest form of individual recognition) was presented to Associate Principal Engineer, **Dr. Vesselin Yamakov** – *"For exceptional contributions to development of computational materials simulation of fundamental material behavior."*
- The NASA Silver Achievement Medal was presented to Research Scientist, **Robert Conn** – *"For outstanding service to NASA and the Nation to advance space science under exceptional hardship and personal risk, capturing reentry observations from Hayabusa2."*
- Six NIA researchers were members of teams that received NASA Group Achievement Awards. These awards recognized significant contributions in support of the Hayabusa reentry observation campaign, development and verification of algorithms supporting the safety of automatic dependent surveillance-broadcast (ADS-B) systems in the nation's airspace, development of innovative approaches to evaluate damage tolerance in spaceflight pressure vessels, and demonstration of technologies for air traffic management of piloted and un-piloted vehicles operating in tandem in support of disaster response.

The following pages provide snapshots of a select few of the exciting research contributions of NIA researchers in 2021, as well as a bibliography of technical publications that evolved from the efforts of the NIA research staff.

Research Labs at NIA

As a part of our research strategy, NIA has established Research Centers of Excellence and Labs that bring together experts from NIA, multiple universities, industry, and NASA to perform focused collaborative research activities. These centers and labs are complementary to NASA's research and actively seek funding from outside sources. Langley Professors have their own NIA-based research centers and labs for which they serve as directors.

- Center for Aerospace Acoustics
- Center for High Performance Computing
- Center for Integrated Systems Health Management
- Center for Photonics, Sensors and Solar Energy
- Center for Planetary Dynamics
- Center for Rotorcraft Aeroacoustics
- Center for Structural Dynamics
- Center for Urban and Regional Air Mobility
- Aerospace Systems Design Laboratory @NIA
- Autonomous Control and Information Technology Institute
- Boron Nitride Nanotube Laboratory

Modeling Space-Radiation Induced Cancer Risks

Floriane Poignant, NIA Research Scientist

Traveling beyond low Earth orbit to the Moon or Mars will pose significant health risks for astronauts. The NASA human research program has identified space radiation exposure as a major hazard with potential long-term consequences, including cardiovascular disease, cognitive impairment, and cancer. As part of NASA's Langley Research Center's Multi-model Ensemble Risk Assessment (MERA) team, ongoing research at NIA focuses on modeling and estimating health risks.

In deep space, astronauts will be exposed to a constant flux of galactic cosmic rays and intermittent solar particle events. High charge and energy (HZE) ions make up ~1% of galactic cosmic rays, are extremely difficult to shield, and are significantly more damaging than radiation encountered on Earth. When reaching the human body, HZE ions deposit energy by interacting with atoms and molecules that make up human tissues, creating ionizations and excitations along their path. Each human cell contains many chromosomes made of deoxyribonucleic acid (DNA), which carries the genetic instructions fundamental for the development, functioning and growth of the organism. At the cellular scale, radiation-induced ionizations and excitations create DNA strand breaks that, if improperly repaired, lead to the formation of chromosome aberrations. If cells survive the injury and divide, sustainable mutations appear, some of which can develop into cancer over time. Compared to terrestrial radiation, HZE ions have a high linear energy transfer (LET), which characterizes the amount of energy deposited per unit length. High LET ions favor the formation of multiple, closely located DNA breaks, which are more difficult for the cell to repair and are more prone to forming chromosome aberrations. Understanding and quantifying space-radiation-induced chromosome aberrations is of interest, as they can be a driver for tumor initiation and can be used as a biomarker for space-radiation-induced carcinogenesis in astronauts. Our research focuses on modeling these mechanisms, from early ionization and excitation events (the ion track), to DNA breaks and repair, and chromosome aberration formation.

The Monte Carlo code Relativistic Ion Tracks (RITRACKS), developed by NASA and NIA collaborators, models the interaction of ions of different types and energies with water (the main constituent of human cells) and enables the study of energy deposition events at the sub-cellular scale. Figure 1 shows examples of simulated cell irradiations with ions of distinct LET. As the LET increases, the number of ions that traverse the cell (represented by the vertical lines) decreases because the total dose deposited to the cell is kept constant, while the ionization events get clustered along the ion tracks. This results in the creation of clustered DNA breaks in the cell nucleus. Researchers can use this tool to study energy deposition distribution within cell nuclei, which correlates with biological damage. We performed calculations to investigate how radiation quality affects energy deposition distributions in cell nuclei, whether due to either a change in ion energy or type (or both), or due to the creation of secondary particles upon radiation transport through tissues. This quantity is referred to as "microdosimetry." Microdosimetry calculations

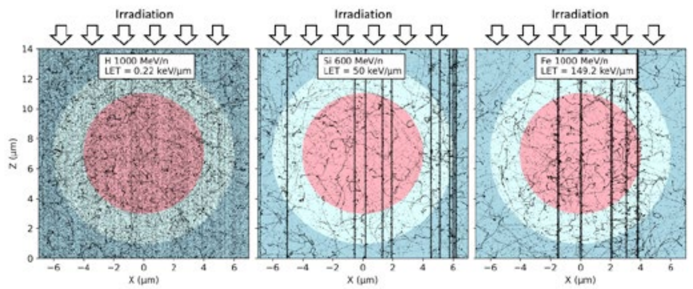


Figure 1 - Simulated track structure obtained with RITRACKS for ions (H 1000 MeV, Si 600 MeV/n and Fe 1000 MeV/n) of different LET for a dose (energy deposited per unit mass) of 0.5 Gy. The irradiation is oriented along the z-axis. A cross-sectional view of a cell is represented in pink (nucleus) and light cyan (cytoplasm), embedded in water. Vertical lines (ion tracks), particularly visible for high-LET ions, represent ion traversals of the irradiated volume. The lines are made of thousands of small black dots, each representing one ionization of a water molecule.

are also used to determine radiation quality factors in space, which are required to estimate risks.

A tool, "Radiation-Induced Tracks, Chromosome Aberrations, Repair and Damage (RITCARD)" was also developed by NASA and NIA collaborators. When paired with RITRACKS, RITCARD models the formation of DNA breaks following radiation exposure, and how this leads to the formation of chromosome aberrations. This includes modeling the 3-dimensional distribution of the DNA in the cell nucleus, repair processes over a 24-hour period, and the classification of the aberrations. As part of extensive benchmarking, we compare simulated results to experimental data obtained by NASA collaborators by irradiation of cells in ground-based accelerators for validation and continuous improvement of the models.

RITCARD also provides insights to help interpret experimental data. Recent work has focused on investigating how different physical (ion properties) and biological (cellular properties) parameters affect the yield of chromosome aberrations. While it's been well established that chromosome aberrations increase with increasing LET and peak at ~100 keV/μm, the impact of biological properties, such as the nuclear size and shape, or the 3-dimensional organization of the DNA, remains to be understood. Nuclei of distinct sizes and shapes have been modeled, and RITCARD simulations have shown that changes in nuclear geometrical properties largely influence the formation of chromosome aberrations. This is important, as different cell lines have distinct nuclear sizes and shapes, thus impacting their radiosensitivity. Besides, laboratory experimental conditions (in vitro) tend to flatten cells as compared to in tissue (in vivo). These results could thus help better translate risks assessed from in vitro conditions to realistic in vivo conditions.

Exploration Extravehicular Mobility Unit (xEMU): Electron Beam Welding of the Portable Life Support System (PLSS) Ti-6Al-4V Backplate with Integrated Cooling Channels

Bryan Koscielny, NIA Research Engineer

The Exploration Extravehicular Mobility Unit is the first clean-sheet design of the astronaut spacesuit in approximately 40 years. The electron beam welding team at NASA's Langley Research Center (LaRC), of which the author is a member, is leading the development of the weld technology required to manufacture the backplate component of the Portable Life Support System. This backplate will provide both structural support and integral cooling for the life support systems, communications, and other electronics inside the spacesuit.

Backplate fabrication begins as a 24" x 32" x 2.25" plate of Ti-6Al-4V, which is machined to allow for ten open cooling channels. Each of these cooling channels are to be enclosed by welding a custom, prefabricated Ti-6Al-4V coverplate over them using a Sciaky electron beam welder (Figure 1). The coverplates are initially tack welded, then fusion welded autogenously (without any filler metal) within this machine. The backplate is inspected, heat-treated, and then contour-machined to its final configuration after all welds have been performed.

Many different parameters and variables can be modified to change the shape and characteristics of the weld within the Sciaky welder. An immense amount of research was performed to identify the proper set of parameters that would result in an acceptable weld. The coverplate sits on a ledge within the cooling channels creating a seam that is to be fully consumed by the weld (Figure 2). However, the weld cannot intrude into the channel such that it would affect the flow of the cooling water.

Parametric studies were conducted on a series of different weldment geometries, ranging from small and simple to large and complex. Factors that can influence weld quality include, but are not limited to, machining tolerances, fixturing, thermal effects, and start/stops. Each of these variables was thoroughly evaluated. Welding of parameter development samples provided the information needed to develop a weld procedure that would enable any geometry to be joined successfully, including changing the beam current throughout the weld process, based on a trained thermal model and previously cross-sectioned weld samples.

Testing on a complex channel geometry, comparable in scale to the full-size backplate, built confidence in the weld procedure. Subsequently, the team moved to initial fabrication of a full backplate, notated Pathfinder 1. This process included machining, quality assurance, cleaning and etching, welding, and non-destructive evaluation.

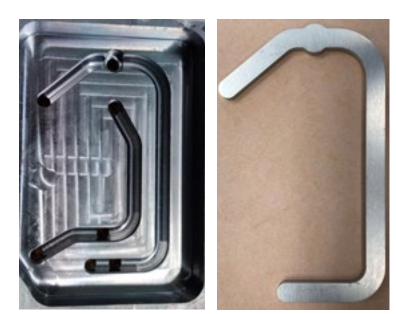


Figure 1 – Example of cooling channels machined into the backplate (left), and associated coverplate (right).

It was known from previous welding studies that special fixturing was needed to accommodate Pathfinder 1 in the Sciaky welder. The author designed this fixturing to secure the backplate between an aluminum tabletop and a stainless-steel perimeter clamp, preventing the plate from moving or warping during the welding process. Four witness coupons, located to either side of the backplate, are also secured to the aluminum tabletop. The witness coupons are welded during the welding of the channels in case there is a need for metallographic inspection at any point in the process.

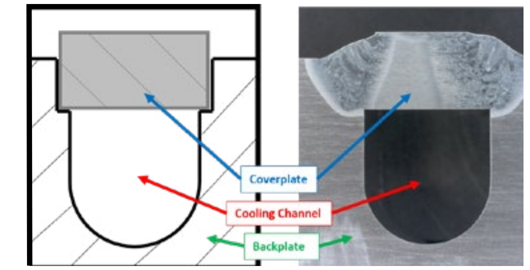


Figure 2 – Diagram of unwelded cross-section (left) and example of an acceptable welded cross-section (right).

Pathfinder 1 was fully tacked and welded without any major issues. Two of the welded channels can be seen in Figure 3. Completed welds were inspected in several different ways:

- Visually (top surface)
- Dial indicator measurements on the coverplates
- Video borescope inside each of the channels
- Coordinate measuring for warpage
- Helium leak check
- Non-destructive evaluation

Most of the welds fell into the acceptable regime from these inspections. However, there were several local areas where excess weld metal entered the channel cavity enough to raise questions. These areas comprised only approximately <2% of the total weld length.

The LaRC team presented its procedures and preliminary results to a Manufacturing Readiness Review Board following the completion of Pathfinder 1. Senior personnel from both LaRC and the customer organization, NASA Johnson Space Center (JSC) comprised the board. A second article, Pathfinder 2, will be fabricated with the objective of further refining the weld parameters and procedures to ensure a more consistent product. Pathfinder 2 will undergo final testing at JSC following welding and machining to the final configuration of the test article. The defined fabrication process technology will be transitioned to a commercial manufacturer that will be responsible for the fabrication of flight components at the conclusion of this development phase.

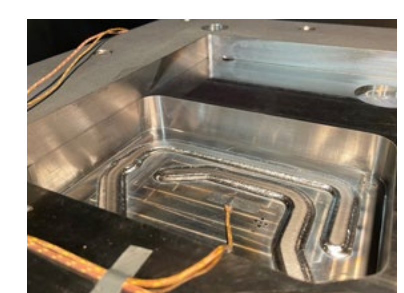


Figure 3 – Pathfinder 1 channels 1 and 2 fully welded

Development of Materials and Surfaces for Passive Lunar Dust Mitigation

Lopamudra Das, NIA Research Scientist

NASA's Artemis mission plans to send humans back to the moon have initiated widespread efforts to identify materials and mechanisms to effectively mitigate lunar dust surface contamination and infiltration. As first observed by the Apollo astronauts, lunar dust presents a significant challenge for long-term lunar exploration missions. It is hazardous to humans and tends to adhere strongly to all exposed surfaces. This characteristic causes degradation and can ultimately lead to a failure of components ranging from spacesuits, solar arrays, thermal radiators, and electronics. A major focus of current research is the development of materials that can endure the extreme lunar environment, as well as active and passive technologies to mitigate dust adhesion. These research objectives necessitate the creation of testing conditions in the laboratory that can replicate the lunar environment for the primary performance characterization of materials.

NASA's Langley Research Center's Lunar Dust Team, of which the author is a member, is working to identify effective passive dust mitigating materials and surfaces. Passive dust mitigation is an important strategy in that the material surface itself minimizes dust adhesion. This may be an intrinsic property of the material or imparted by a surface modification such as a coating, topographical design, or both. Passive dust mitigating surfaces are advantageous because they do not require an external power source and can be used in conjunction with active methods for optimum dust mitigation. While one aspect of this research is the materials development and surface modification techniques, another is characterizing the particle adhesion behavior of these materials and surfaces.

The first step in adhesion testing is the repeatable application of a uniform contamination layer to the surface of a material sample. Lunar dust is different from terrestrial dust in that it is jagged, highly abrasive, electrostatic, and sometimes magnetic. LHS-1D (procured from Exolith Lab) is a lunar highland simulant generated specifically for lunar dust adhesion evaluation. The particle size of the simulant is less than 25µm, which is characteristic of the finer dust particles that tend to adhere to surfaces strongly. Researchers have used LHS-1D in an extensive series of experiments designed and conducted to establish a method for the reliable deposition of a thin layer of simulant uniformly on a sample surface.

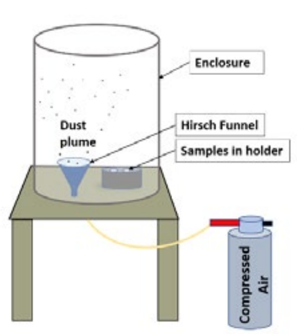


Figure 1 – Schematic of dust deposition method

A controlled airborne dusting technique using short bursts of air through a Hirsch funnel containing a measured quantity of the simulant delivered optimum and reliable results for depositing the simulant. (See Figure 1).

The next step is characterizing the dust mitigating properties of the material test article. For this purpose, we updated a setup of an ultrasonic processor and optical particle counter to make it fully operational. The contaminated test surfaces are attached to the tip of an ultrasonic wand and made to vibrate at varying amplitudes and time according to a set recipe. (See Figure 2). When the accelerating force exceeds the adhesion force, of dust particles, they are detached from the surface and collected by the optical particle counter. The team uses optical microscopy images of the surfaces taken at each step to compare the relative dust adhesion mitigation properties.

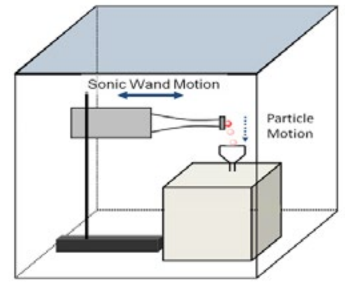


Figure 2 – Adhesion testing setup

The topographical surface structure of a material can also play an important role in dust adhesion, so some candidate materials were surface-engineered using techniques such as laser patterning and mechanical polishing. (See Figure 3).

During FY21, the Lunar Dust Team developed, modified, and tested several candidate materials. Some of these were selected to be flown to the lunar surface in 2024 on a commercial lander under the Regolith Adherence Characterization (RAC) project. Materials that are sent to the moon for dust adhesion testing will help establish the efficacy of Earth-based characterization and testing related to lunar dust adhesion mitigation. This will guide the development of materials and surfaces for successful long-term lunar exploration and habitation.

More materials, polymers, composites, metals/alloys, ceramics, fabrics, as well as different surface topographies are continuously being evaluated for dust adhesion mitigation. These include both commercially available space heritage materials as well as novel materials synthesized in-house. Natural surfaces such as the lotus leaf exhibit anti-contamination properties, and the author is leading an effort within the Lunar Dust Team to identify and develop bioinspired surfaces for dust adhesion mitigation. Once the optimum performing surfaces are characterized, the next step will be to develop methods to efficiently scale-up and fabricate those materials and surfaces.

(All images credit: NASA)

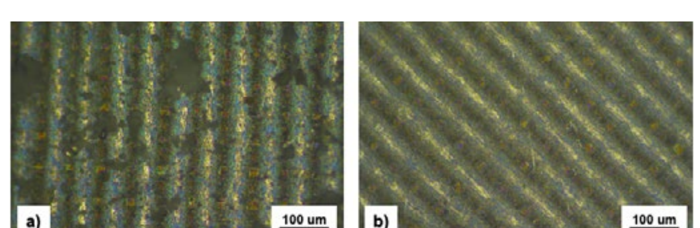


Figure 3 – Laser ablated Ti-6AL-4V crosshatch pattern sample surfaces a) after dust deposition and b) at the end of adhesion testing.

Development of Interatomic Force Fields for Modeling Ti-6Al-4V (Ti64) Alloy to Achieve Predictive Additive Manufacturing Processing

Vesselin Yamakov, NIA Associate Principal Scientist

Additive manufacturing (AM), as a version of 3-D printing technology, is receiving significant attention for application in manufacturing of aerospace components with highly sophisticated geometry and structural complexity. By avoiding or minimizing the assembling stage in device construction, AM has the potential to speed up production time, decrease complexity and reduce cost. In addition, by reducing the number of assembled components, AM can improve the reliability and durability of manufactured devices.

In recent years, AM of metallic alloys has been significantly advanced and is spreading broadly in fields such as electronics, robotics, and transportation, including the aerospace industry. However, AM presents many challenges. Controlling the mechanical properties of as-built parts produced by metallic AM is not as dependable as in other processing methods, such as casting or forging. The lack of suitable qualification and certification procedures for AM materials, as mandated by the Federal Aviation Administration (FAA), remains a significant hurdle to introducing AM processes in the aerospace industry. NASA has been engaged to help develop such procedures for multiple metallic alloys, based on the detailed investigation of a set of mechanical properties, including fatigue resistance and fracture toughness.

Aerospace alloy Ti-6Al-4V, known as Ti64 for short, has been identified by NASA as a key material in the aerospace industry for the fabricating parts via AM - a promising method for decreasing the cost and improving reliability. Ti64 is a lightweight alloy characterized by superior strength and thermal and corrosion stability. Ti64 typically exists as a mixture of two crystallographic phases, α- and β-phase. Their relative content and mixing depend strongly on the processing history of the material, which significantly affects the properties of the alloy that are crucial for its behavior in service.

AM of Ti64 involves very localized rapid heating and melting of the material provided as a powder, followed by rapid quenching and solidification. This produces strong thermomechanical gradients significantly affecting the microstructure at the grain and sub-grain levels. An empirical investigation of these processes is often difficult or impossible to perform.

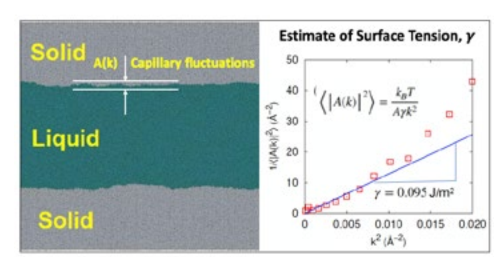


Figure 1 - Simulation and calculation to estimate interface energy, γ, of solid-liquid interface in Al melt using a method based on capillary fluctuations, A(k).**

**G.P.P.Pun et al., Phys Rev. Mat. (2020) 4:113807-1-19

In most cases, empirical data can only be used to provide proof of a processing effect but not an understanding of the cause. Theoretical analysis and computational modeling are vital tools for tailoring the processing parameters and predicting the outcome. However, the lack of consistent and available high-temperature material property and model validation data remains an issue. The current effort to provide reliable estimates of material properties at high temperatures, above the melting point, and under various non-equilibrium conditions such as rapid thermal changes and structural transformations employs a first-principles physics-based approach starting at the atomic level. This approach requires accurate modeling of interatomic forces and reconstructing, as precisely as possible, a variety of crystal phases computed using quantum mechanics (QM) methods.

Al	Simulation	Experiment	Standard deviation
Density kg/m³	2345	2340	0.002
Diffusivity A²/ps	0.8	1.0	0.2
Viscosity mPa.s	1.20	1.05	0.14
Surf. Tension J/m²	0.613	0.87	0.29

Ti	Simulation	Experiment	Standard deviation
Density kg/m³	4150	4100	0.012
Diffusivity A²/ps	9.9	10.5	0.06
Viscosity mPa.s	3.3	2.9	0.14
Surf. Tension J/m²	0.9	1.6	0.43

Table I - Simulated vs. experimental values of the measured melt properties for Al and Ti materials.

The Transformational Tools and Technology (TTT) team at NASA's Langley Research Center has been tasked to develop a force-field model to replace the computationally-intensive QM calculations for physics-based atomistic simulations of Ti-Al alloys, as an advancing step to create an atomistic model for the ternary Ti64 alloy. This effort emphasizes the prediction of melt properties of the alloy for use in higher-level modeling studies. It is a needed component of the planned Process-Structure-Property/Performance relationships that form the basis for next-generation qualification and certification procedures.

The author, in collaboration with a research team at George Mason University, has validated several types of interatomic force fields, both for aluminum and titanium by reproducing their melt properties of density, diffusivity, viscosity, and surface tension (Table 1). A novel machine-learning approach, based on artificial neural networks trained to precisely emulate QM forces, was implemented to create an accurate and computationally-efficient aluminum force field. This method enabled first-of-a-kind prediction of the interface energy of the solid-liquid interface, which is impossible to measure experimentally (Figure 1). Based on these results, an interatomic force field for the Ti-Al alloy is being developed and validated. The force field is tailored to accurately reproduce the formation energies of a variety of Ti, Al, and Ti-Al phases, the transition temperature between α- and β-crystallographic phases of Ti, the melting points of Ti and Al, the energies of various defect structures such as vacancies, interstitials, surface energies, and others. This effort advances modeling of the entirety of the AM process, including both the melt and solidification stages, and provides key parameters for predicting the microstructure and, subsequently, the microstructure-property relations in the AM manufactured material.

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1st Runner -Up

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Our People

The NIA team has

200+

employees

resident university professors

postdoctoral and graduate students

consultants

research scientists and engineers

education specialists

students

program and operational support staff

90% of researchers hold graduate-level degrees

The majority are doctoral-level degrees related to aerospace

Since 2002

91 NIA employees and students have been hired by NASA

30 employees have become permanent U.S. residents

24 employees have become U.S. citizens

NIA Takes Top Spot of Best Mid and Large-Sized Nonprofits To Work For in 2021

The NonProfit Times ranked the National Institute of Aerospace (NIA) as the "Best NonProfit To Work For" in the Nation among mid- and large-sized companies. Best Companies Group evaluated each nominated organization's workplace policies, practices, philosophy, systems, and demographics to determine the rankings. NIA particularly excelled in categories of pay and benefits, corporate culture and communications, and role satisfaction with near-perfect scores from its employees on topics such as workplace safety, the organization's commitment to a diverse and valued workforce, and the quality of employees' relationships with their direct supervisors.

"Our people are our strength' is not just something that we print and frame on the wall; it's a core value to NIA," said NIA's President and Executive Director, Doug Stanley. "This recognition is especially meaningful now because it reflects that strength and the resilience of our staff during unprecedented challenges."

NASA Honor Awards

Dr. Vesselin Yamakov
NASA Exceptional Scientific Achievement Medal
"For exceptional contributions to development of computational materials simulation of fundamental material behavior."

Robert Conn
NASA Silver Achievement Medal
Scientifically Calibrated In-Flight Imagery (SCIFLI) Hayabusa2 Airborne Reentry Observation Campaign (SHARC)
"For outstanding service to NASA and the Nation to advance space science under exceptional hardship and personal risk, capturing reentry observations from Hayabusa2."

Daniel E. Kiggins (Sub-contract SME)
NASA Public Service Medal
"For twenty years of exceptional public service for significant achievements, outstanding support, and innovative contributions to NASA aerospace research and technology."

NASA Group Achievement Awards

COPV (Composite Overwrapped Pressure Vessel) Life Test Assessment Team

"For outstanding contributions in the development of innovative approaches for evaluating damage tolerance life in human spaceflight pressure vessels."

NIA Team Member
Timothy Ruggles

CPR (Compact Position Reporting) Verification Team

"For outstanding contributions verifying the Compact Position Reporting Algorithm to support safety of Automatic Dependent Surveillance-Broadcast in National Airspace System."

NIA Team Members
Mariano Moscato
Laura Titolo

Scalable Traffic Management for Emergency Response Team

"For the perseverance to demonstrate the value of NASA technologies in support of disaster response efforts amid a pandemic."

NIA Team Member
Jacob Revesz

SHARC (Scientifically Calibrated In-Flight Imagery Hayabusa2 Airborne Reentry Observation Campaign) Team

"For outstanding service to NASA and the international aerosciences community obtaining unique atmospheric entry physics data during Hayabusa2 Capsule Reentry over Australia."

NIA Team Members
Robert Conn
Les Kagey

Member Institutions

NIA was formed by a consortium of prominent research and education institutions. Today these organizations continue to serve as collaborative partners, provide executive guidance, and offer unique graduate education opportunities, helping to make NIA a leader in innovative aerospace research, education and outreach.

AIAA Foundation Advancing Aerospace · Georgia Tech · Hampton University · North Carolina Agricultural and Technical State University · NC State University · Old Dominion University · University of Maryland · University of Virginia · Virginia Tech · William & Mary Chartered 1693

Continuing Education

NIA has always recognized the importance of continuing and lifelong learning for working professionals engaged in technical disciplines. It is also the case that education and training needs for engineers and scientists established in their fields might be distinct from individuals newly entering these fields. NIA hosts a range of short courses, workshops, conferences, seminars, and colloquia to assist those seeking to enhance and expand their knowledge in specialized and merging areas. Speakers include subject matter experts from NIA, NASA, academia, and industry.

Although the on-site component continued to be adversely affected by the COVID-19 pandemic in 2021, NIA still supported three short courses and eleven seminars. Member institutions offered and made available over 100 for-credit graduate courses each fall and spring semester, including a special topics class in summer 2021.

Visitor Program

NIA's Visitor Program facilitates research collaborations between scientists and engineers at NIA, NASA's Langley Research Center, and researchers, faculty, and graduate students from other institutions. The typical visit is for a semester or summer, but the Institute can accommodate longer or shorter durations. NIA supports this program with concierge services to assist with securing local lodging and transportation, visas for our international guests, access badges for Langley, and office accommodations. Participants usually conclude their stay with a seminar presentation for our resident faculty, research staff, students, and researchers from the NASA Langley community. Travel restrictions resulting from the COVID-19 pandemic severely limited the scope of the Visitor Program in 2021. Nevertheless, NIA still hosted a visiting researcher, Gwibo Byun, of Virginia Tech.

SAAP Smart Airport and Aviation Partnership

In Southern New Jersey, the Smart Airport and Aviation Partnership (managed by NIA) continued its economic development activity designed to increase and enhance regional aviation business. SAAP's 2021 Aviation Accelerator, flightPlan, included an impressive range of members: two firms specializing in airport security software; two firms utilizing artificial intelligence (AI), virtual and augmented reality in cutting-edge areas including weather visualization; a Bulgarian company entering air cargo markets with its own "middle mile" drone; an Unmanned Aircraft System Traffic Management (UTM) company specializing in new areas including port security; a former Air Force maintenance, repair, and overhaul (MRO) specialist who is bringing his special message about aviation careers to young STEM students; and a filmmaker who is an FAA-107 certified remote pilot who uses drones in film production and employing recent veterans for on-the-job training in both filmmaking and drone technology.

SAAP added a "Mini-Accelerator" to its 2022 offerings; the program will run two weeks rather than four months and will focus on Unmanned Aircraft Systems (UAS) use in public safety. SAAP sponsored a complex flight demonstration of post-disaster public safety use of UAS in a hurricane scenario in 2021 and is currently working with member companies in a port security flight exercise. SAAP's monthly newsletter, created to help foster communications with the UAS and greater aviation community during COVID-19 pandemic, has established a strong network of readers.

This year SAAP was delighted to bring on two new deputy directors to assist with its many projects, Robin Ford and Brandon Graham.

smartaviation.nianet.org

REaKTOR Business Technology Innovation Center

The REaKTOR Technology Innovation Center is where technology businesses become real, and ideas get transformed into products that change the world.

Since opening in 2012, REaKTOR Technology Innovation Center – formally known as the Peninsula Technology Incubator or PTI – and NIA have been committed to economic development in the City of Hampton and the Virginia Peninsula. We strongly believe that entrepreneurship can and should play a more significant role in job creation and retention of the best and brightest graduates from regional universities.

REaKTOR connects founders with experienced mentors, investors, support services, working space and startup education to move from idea to viable high growth venture. The outcome is an energetic technology innovation center that leads the convergence of regional entrepreneurial leaders and grows the innovation economy.

The Center fosters an environment designed to motivate member companies to move through the incubator process effectively and efficiently, providing business training, counseling and mentorship, technology transfer information, and educational resources related to fundamental business development and growth.

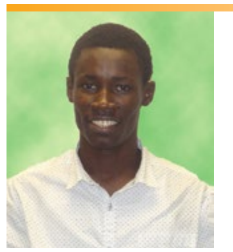
Dr. Richard Antcliff, a former senior executive at NASA, served as interim director for REaKTOR in 2021. Current clients and graduates include Advanced Aircraft Company, Psionic, and Pancopia.

www.reaktor757.org

Graduate Education

NIA's graduate program offers master's and doctoral degrees in a range of science and engineering disciplines from our nine member universities: Georgia Tech, Hampton University, North Carolina A&T State University, North Carolina State University, Old Dominion University, University of Maryland, University of Virginia, Virginia Tech and William & Mary. On-site students, NASA employees and contractors, and other local scientists and engineers can take advantage of these programs via local instruction and distance learning facilities. NIA maintains a department-sized academic presence via resident, visiting and adjunct faculty, plus the on-site research staff, supplemented by seminars, short courses, and other activities. Students can earn advanced degrees from leading research universities, including classes selected from multiple institutions, while performing critical research in a leading national laboratory with state-of-the-art facilities, working alongside renowned researchers.

2021 Graduates



Allan Anzagira
North Carolina A&T State University, August 2020
Ph.D. in Electrical Engineering

Dissertation Topic:"Visible Light Inter-Satellite Communication for Small Satellites: A Multiple Access Perspective"

Advisor: Dr. William Edmonson

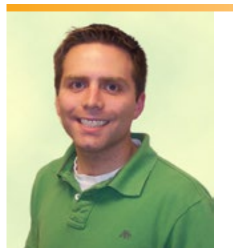
Allan is now employed as a Senior Associate in AI Research at JP Morgan Chase in New York, New York.

Debajyoti (Deb) Basu Sarkar
Hampton University, May 2021
Ph.D. in Atmospheric and Planetary Sciences

Dissertation Topic: "Tectonic Transitions Out of Heat Pipes"

Advisor: Dr. William Moore

Deb is currently a Data Analyst for Hexaider Technology LLC in Maitland, Florida.



John (Ryan) Somero
Virginia Tech, November 2020
Ph.D. in Aerospace Engineering

Dissertation Topic: "Structure and Persistence of Surface Ship Wakes"

Advisor: Eric Paterson

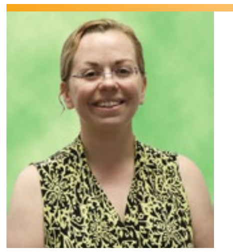
Ryan is currently employed as Ship Signatures Technical Lead at Newport News Shipbuilding in Newport News, Virginia.

Shaohan Wang
North Carolina State University, May 2021
Ph.D. in Mechanical and Aerospace Engineering

Dissertation Topic: "Vibration-Based Damage Imaging in Structures Using High-Speed Camera with Digital Image Correlation"

Advisor: Dr. Fuh-Gwo Yuan

Shoahan works as an Algorithm Engineer at Cosco Shipping Lines in Shanghai, China.

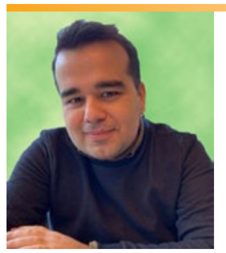


Heidi Glaudel
Old Dominion University, May 2021
M.S. in Aerospace Engineering

Thesis Topic: "A Model-Based Systems Engineering Approach to e-VTOL Aircraft and Airspace Infrastructure Design for Urban Air Mobility"

Advisor: Dr. Sharan Asundi

Heidi is continuing as an Engineer with Jacobs Inc. at NASA's Langley Research Center.

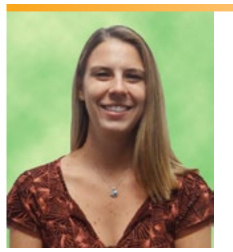


Ramiz Omur Icke
Old Dominion University, August 2021
Ph.D. in Aerospace Engineering

Dissertation Topic: "Development and Applications of Adjoint Based Aerodynamic and Aeroacoustic Multidisciplinary Optimization for Rotorcraft"

Advisor: Dr. Oktay Baysal

Omur is now working as a Research and Development Engineer II for ANSYS Inc. in Pittsburgh, Pennsylvania..

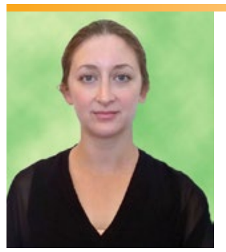


Melissa Polen
Virginia Tech, May 2021
M.S. in Mechanical Engineering

Thesis Topic: "ANC of UAS Rotor Noise Using Virtual Error Sensors"

Advisor: Dr. Christopher Fuller

Melissa is now employed as a Strategic Design Engineer at MITRE Corporation in McLean, Virginia.

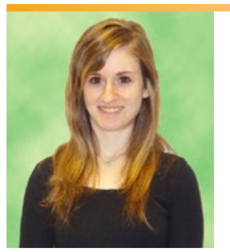


Michelle Weinmann
Old Dominion University, August 2021
M.S. in Aerospace Engineering

Thesis Topic: "A Digital One Degree of Freedom Model of an Electromagnetic Position Sensor"

Advisor: Dr. Colin Britcher

Michelle is employed as an Engineer at the Thomas Jefferson National Accelerator Facility (Jefferson Laboratory) in Newport News, Virginia.

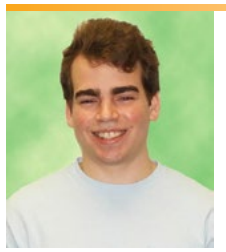


Rose Weinstein
University of Maryland, August 2021
Ph.D. in Aerospace Engineering

Dissertation Topic: "Global Nonlinear Modeling Using Automated Local Model Networks in Real Time"

Advisor: Dr. James Hubbard

Rose is continuing as an Engineer in the Flight Dynamics Branch of NASA's Langley Research Center.



William Nelson
University of Virginia, December 2021
M.S. in Electrical Engineering

Thesis Topic "Local Ultrasonic Resonance Spectroscopy of Lithium Metal Batteries for Aerospace Applications"

Advisor: Dr. Mool Gupta

William works an Acoustics Signal Processing Engineer at the Applied Research Laboratories of The University of Texas at Austin, Texas.

Rey-Yie (Abel) Fong
North Carolina State University, December 2021
Ph.D. in Mechanical and Aerospace Engineering

Dissertation Topic: "Ultrasonic Phase Estimation in Laser Speckle Interferometry"

Advisor: Dr. Fuh-Gwo Yuan

Abel is employed as a Researcher by HCL Technologies/Caterpillar in Peoria, Illinois.

Sakib Ashraf Zargar
North Carolina State University, December 2021
Ph.D. in Mechanical Engineering

Dissertation Topic: "Augmented Reality for Enhanced Visual Inspection Through Knowledge-based Deep Learning"

Advisor: Dr. Fuh-Gwo Yuan

Sakib is now employed as a Senior Scientist at Xerox Corporation in Cary, North Carolina.

Karthik Reddy Lyathakula
North Carolina State University, December 2021
Ph.D. in Mechanical Engineering

Dissertation Topic "Damage Diagnostics and Prognostics of Adhesively Bonded Joints"

Advisor: Dr. Fuh-Gwo Yuan

Karthik is working as a Battery Data Scientist for Wärtsila North America Inc. in Washington, D.C.

Each year, the **NIA Best Student Paper Award** recognizes and honors outstanding publications by NIA graduate students. For 2021, the award goes to

Karthik Reddy Lyathakula
North Carolina State University

"A Probabilistic Fatigue Life Prediction for Adhesively Bonded Joints via ANNs-Based Hybrid Model"
Karthik Reddy Lyathakula and Fuh-Gwo Yuan
International Journal of Fatigue, May 2021

Congratulations to **AIAA Region 1 Student Conference Master's Category Winner**

Forrest Miller
Old Dominion University

"Wake Structure Analysis of a Pitching Blunt Body Using Particle Image Velocimetry and Computational Fluid Dynamics"

The 2021 AIAA Regional Student Conference was hosted by Rutgers University in April. As a first-place winner, Mr. Miller was invited to attend and present his paper at the AIAA International Student Conference to be held in conjunction with the 2022 AIAA SciTech Forum in January 2022.

Educational Outreach Programs

In 2021, NIA's Educational Outreach Programs team continued to support NASA's Langley Research Center and our nation's Science, Technology, Engineering and Mathematics (STEM) education community with award-winning, inspirational and educational outreach programs, products and services.

NIA's staff improves STEM literacy, advances understanding and opportunities in STEM, increases the participation of underserved populations, and improves teacher competence and confidence in STEM pedagogies. NIA accomplishes this by developing and delivering research-based strategies, programs, and training in collaboration with industry, nonprofits, and federal, state and local governments, who reach audiences in both formal and informal learning environments for learners of all ages.

NIA's educational outreach program increases scientific literacy. It addresses the national concern of attracting and retaining students in STEM disciplines by nurturing their interest through a variety of approaches and mediums throughout their academic careers. Reaching minority and other underserved populations are of particular interest. Capturing students' early fascination in discovery and problem-solving through integrative approaches to STEM and maintaining and feeding that interest throughout their lives is key to this process.

K-12 Educational Programs

NIA continues to manage **NASA eClips™**, a NASA-supported project that brings together exciting video segments and resources with educational best practices to inspire students and increase STEM literacy through the lens of NASA. NASA eClips serves the national K-12 educational community by introducing students to STEM concepts and providing teachers with engaging resources and tools to support teaching and learning. Developed in 2008, NASA eClips offers free educational resources suitable for use in both classroom and nonformal settings. The suite of resources includes

- Video segments for K-12 students
- Student-produced Spotlite videos that address common science misconceptions
- Dual-language Spotlite videos
- "Ask SME" career connection videos
- The Spotlite Design Challenge
- Educator guides
- Interactive Spotlite lessons for K-12 teachers and nonformal educators
- VALUE Bundles
  (Varied and Accessible Learning Resources for Universal Engagement)

These resources give teachers and students choices in how they learn about a topic to meet the needs of a wide variety of learners.

nasaeclips.arc.nasa.gov

Higher Education Competitions

Managed by NIA, the **Breakthrough, Innovative, and Game-Changing (BIG) Idea Challenge** is designated as one of seven Artemis Student Challenges. NASA sponsors the challenge through a unique collaboration between the Space Technology Mission Directorate's Game Changing Development Program and the Office of STEM Engagement's Space Grant Consortium Project. Directly supporting NASA's Artemis Program, the 2021 Challenge solicited innovations from university teams for unique lunar dust mitigation (or dust tolerant) solutions with supporting original engineering and analysis in response to one of the following categories:

- Landing Dust Prevention and Mitigation
- Spacesuit Dust Tolerance and Mitigation
- Exterior Dust Prevention, Tolerance, and Mitigation
- Cabin Dust Tolerance and Mitigation

Nearly $1 million was awarded to eight finalist teams to build and conduct robust verification testing on their designs. Finalist teams presented their research to a panel of NASA and industry subject matter experts virtually at the "2021 BIG Idea Forum." NASA's Deputy Administrator Pam Melroy presented the forum's top award during the 2021 award ceremony. The presentations were broadcast live to the public using NIA's Media Communications Group's event webcasts on Livestream.

bigidea.nianet.org **livestream.com/viewnow/bigideachallenge**

NIA continued program management of NASA's Advanced Exploration Systems' annual **Revolutionary Aerospace Systems Concepts – Academic Linkage (RASC-AL)** engineering design competition for the 13th consecutive year. RASC-AL provides the opportunity for university-level engineering students to design projects based on real NASA engineering challenges while offering NASA access to new research and design ideas by top collegiate talent. Participation included submitting a proposal, technical paper, presentation/design review, and a digital poster on one of five themes that asked students to develop new concepts that leverage innovation to improve our ability to operate in space and on distant bodies. Sixteen teams convened virtually to compete at the "2021 RASC-AL Forum" before a panel of NASA and industry experts. NIA brought the student presentations to the public via NIA's Media Communications Group's event webcasts on Livestream.

rascal.nianet.org **livestream.com/viewnow/rascal-forum**

In 2021, NIA conducted the fifth annual **RASC-AL Special Edition: Moon to Mars Ice & Prospecting Challenge**. Ten finalist university teams were selected to receive $10,000 in funding to design and build prototype hardware that could extract water from simulated lunar and Martian subsurface ice, and also be able to accurately assess subsurface density profiles during drilling. After being unable to host technology demonstrations in 2020 due to COVID-19, the on-site tech demo portion of the challenge returned in September 2021. Due to ongoing restrictions at NASA's Langley Research Center, we held the 2021 event at the Hampton Roads Convention Center. In addition to the final competition, teams submitted a proposal, mid-project report, and final Technical Report and Poster detailing their concept's development, progress, and an explanation for how they would modify their Earth-based system for lunar and Martian environments. A panel of industry and NASA experts judged the teams' analyses and on-site demonstrations while seeking innovations that could apply to NASA's plans for future lunar and Martian in-situ resource utilization. The NIA Media Communications Group broadcast the competition via livestream to the public via a "NASA Science Live" episode.

specialedition.rascal.nianet.org

In FY21, NIA managed the second Federal Aviation Administration's (FAA) **2021 FAA Challenge: Smart Airport Student Competition**. The competition recognizes students with the ability to demonstrate innovative thinking focused on improving the efficiency and effectiveness of smart technology in and around the airport environment while enhancing the overall traveling experience. A panel of experts selected three finalist teams to design, build, and test their proposed smart technologies. The teams' technologies proposed to improve travelers' transportation experiences from home, through the airport environment, and to their final destinations. Finalist teams submitted a technical paper and pre-recorded video presentations demonstrating their concepts at the "2021 FAA Challenge Virtual Forum," which was broadcast online. The 2021 winning team was announced and presented the winning $25,000 check by Shelley Yak, Director of the FAA William J. Hughes Technical Center.

faachallenge.nianet.org **livestream.com/viewnow/faachallenge**

NIA's Center for Integrative STEM Education

Educators at NIA's Center for Integrative STEM Education (NIA-CISE) are leaders in the field and solicited for their expertise.

McDANIEL COLLEGE

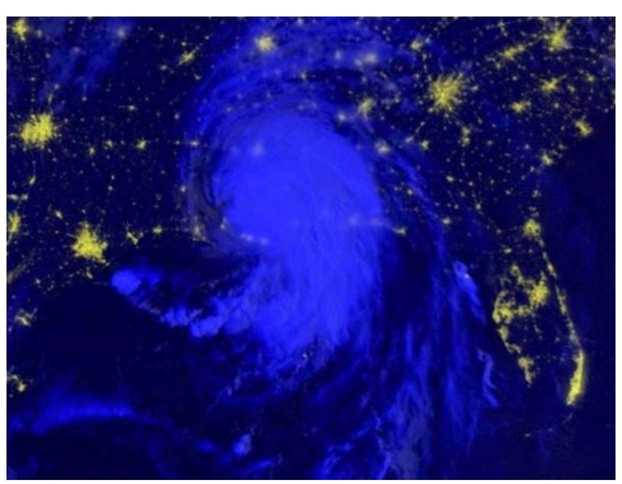
For nearly a decade, NIA-CISE has collaborated with **McDaniel College** to design, develop and deliver graduate coursework for the Maryland Higher Education Commission (MHEC) approved STEM Instructional Leader (SIL) certificate program. The NIA-McDaniel courses follow research-based best practices incorporating active learning, job-embedded tasks, systemic design, ongoing and sustainable learning, and reflective feedback. Dr. Sharon Bowers is the coordinator for the online SIL program.

NIA-CISE collaborated with NC State, one of NIA's member universities, to develop and field-test K-12 activities for **AeroEducate**, the educational outreach arm of the **Experimental Aircraft Association (EAA)**. NIA-CISE continues to work with EAA to disseminate these resources through professional organizations such as the International Technology and Engineering Educators Association (ITEEA).

NIA-CISE collaborates with Hampton City Schools (HCS) for the current **NIA Educator in Residence (EIR)** position. Through this partnership, Betsy McAllister, HCS's STEM teacher specialist, bridges the two organizations and keeps NIA-CISE abreast of educators' and students' needs. As she embeds NASA eClips into the HCS curriculum, she ensures greater dissemination and sustainability for the project and provides authentic, real-world, STEM-focused resources for this school district with an underserved and underrepresented population. This year, the EIR led the planning and implementation of a community-based James Webb Space Telescope (JWST) event where pioneering NASA engineer, Dr. Christine Darden and NASA Langley's Center Chief Technologist, Julie Williams-Byrd were keynote speakers.

HU-CARE Science Communication Interns

The NASA Disasters program area continued its successful Science Writer internship program, with a cohort of five interns in the fall 2020/spring 2021 semester and four others joining in the fall 2021/spring 2022 semester. Five of these students have hailed from NIA member-university Hampton University through the support of Dr. William B. Moore. Others have come from Millersville University, Western Washington University and William & Mary.



Day/night-band imagery can be used to identify differences in nighttime lights from cities. Loss of light may indicate power outages in the wake of a disaster. This image of Hurricane Ida approaching the southern U.S. was captured Aug. 30, 2021. Credits: NASA

NIA's Timothy "Seph" Allen, strategic communications specialist for the NASA Disasters program area, serves as interns coordinator. The team works closely with these interns to educate them about NASA and the Disasters program area and integrate them into meetings and workflows. This provides them with real-world experience and opportunities to publish their work online, which will aid their future endeavors. Science communication experts from across NASA served as guest mentors on topics such as "Communicating Controversial Science," "Interviewing Subject Matter Experts," and "Navigating a Science Communications Career." NIA guest mentors in 2021 included Dr. Moore, Dr. Linda Billings and Rebecca "Becky" Jaramillo.

The internship initiative's success was demonstrated as NASA Disasters hired former communications intern, Gabriella Lewis, as a junior science writer in spring 2021. Ms. Lewis has significantly contributed to the success of the program area's communications efforts, publishing numerous articles and using innovative storytelling methods, such as the interactive multimedia storymap, "2021 Disasters: A Look Back" that was featured on the homepage of www.nasa.gov.

Media Communications and Public Outreach

NIA collaborates with government, industry, universities, professional societies, nonprofits and others to develop and implement projects and campaigns that build excitement and support for NASA and the aerospace community.

NIA conducts a robust public outreach program and provides world-class creative services crafted to deliver award-winning campaigns. With internationally recognized work in video, radio, web, live broadcasts, conferences and events, social platforms and mobile applications, NIA provides valuable support for outreach and communications across the entire spectrum of 21st-century media.

2021

Videos produced by NIA in 2021 had more than 36.8 million views through web and social media platforms.

NASA 360

Facebook
FollowNASA360
57.5M People Reached

Twitter
@NASA360
14.7M Tweet Impressions
471 Tweets

YouTube
FollowNASA360
3.6M Total YouTube Views
158K YouTube Subscribers

NASA 360 is a suite of premiere NASA outreach programming that brings audiences the latest in NASA science, engineering and aeronautics. Productions under the NASA 360 media umbrella include compelling videos in traditional formats, as well as live event coverage, text videos, animations, and promotional trailers that meet client needs and capitalize on current media trends. NASA 360 engages millions of viewers each year through NASA's website and other broadcast platforms such as YouTube and Facebook, inviting the public to meet some of today's most brilliant scientists, engineers and explorers.

NASA 360 won five W3 Awards in 2021. The W^3 Award, sanctioned and judged by the Academy of Interactive and Visual Arts, celebrates digital excellence by honoring outstanding Websites, Web Marketing, Video, Mobile Sites/Apps & Social content. Less than 10% of all entries are selected as Gold Winners.

NASA Cooks Up Something Special with Deep Space Food Challenge	Robotic Bees Designed to Explore Mars	NASA Science Live: We're Going to Venus – NASA Selects Two New Missions	Countdown to Mars: A Story of Perseverance	Behind the Spacecraft – Perseverance Mars Rover
2021 Gold Winner	2021 Silver Winner	2021 Silver Winner	2021 Silver Winner	2021 Silver Winner

In 2021 NIA's NASA 360 team produced:

Planetary Defense by the Numbers
What do we know about the asteroids and comets in Earth's neighborhood? Planetary defense — which includes finding, tracking, & characterizing these near-Earth objects — is part of NASA's mission. This video series provides a monthly update about the near-Earth objects being studied by NASA.

We Asked a NASA Scientist:
Have questions? We have answers! NASA and NASA 360 partnered to release this video series that gives viewers an engaging and concise rundown of what they need to know about our home planet and beyond.

Behind the Spacecraft: Dart – Redirecting an Asteroid
NASA's DART mission is a first-of-its-kind test to change the motion of an asteroid in space so that we could use this technique if an asteroid were ever discovered to be a threat to Earth. But getting a spacecraft to impact an asteroid isn't as simple as it sounds. Meet the people and the personalities behind NASA's first planetary defense test mission.

The NASA 360 team also provided broadcast and outreach support for a host of other NASA-related efforts, including:

- NASA Launches and Mission Updates
- NASA Centennial Challenges
- NASA Innovative Advanced Concepts Program

NASA Science Live invites the public to interact with experts live, go behind the scenes, and watch as guests reveal the mysteries of our solar system and beyond. Co-produced by the NASA 360 team, each episode is broadcast on NASA TV, as well as the agency's Facebook, Twitter, and YouTube platforms. Viewers can submit their questions for science and engineering experts live using the hashtag #askNASA.

www.nasa.gov/nasasciencelive

2021 "NASA Science Live" Broadcasts

- Our First Attempt to Sample an Asteroid
- Rising Seas
- Lucy in the Sky with Asteroids
- You Too Can Do NASA Science
- How to See the Saturn and Jupiter's Great Conjunction
- Continuing a Legacy of Trailblazers
- We Landed on Mars!
- Modern-Day Explorers Search for Life Beyond Earth
- Connected by Earth
- Mars Helicopter and the Future of Extraterrestrial Flight
- We're Going to Venus – NASA Selects Two New Missions
- Engineering Human Tissue
- International Asteroid Day
- How to Become a NASA Intern
- Moon to Mars Ice and Prospecting Challenge
- Landsat: A Legacy of Seeing Earth from Space

Innovation Now brings listeners the stories behind the ideas that shape the future and benefit our lives. Developed in collaboration with NASA's Space Technology Mission Directorate and launched in September 2011, NIA produces and distributes about 260 radio segments annually. The 90-second interstitial is designed to air daily Monday through Friday and is available at no charge to broadcasters. WHRO/WHRV Hampton Roads is the public radio partner supporting online distribution of the program.

"Innovation Now" reaches more than 29 million listeners worldwide each day. The series is broadcast via public, college and commercial radio stations and is available for mobile devices through various podcast apps, such as NPR One. "Innovation Now" is discoverable on multiple smart speakers, including Roku, Alexa, and Google Home; and on dozens of streaming platforms, including iTunes, Stitcher, and Player FM. Each month video is added to one of the most popular radio segments to create visual content for streaming platforms.

2021

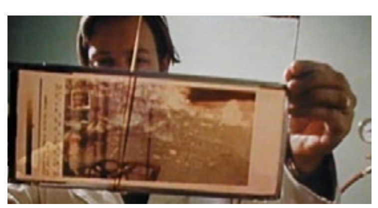
What can you discover in 90 seconds?

For the third consecutive year, online media distributors Feedspot and PlayerFM selected Innovation Now as "one of the top 30 podcasts you must subscribe to."

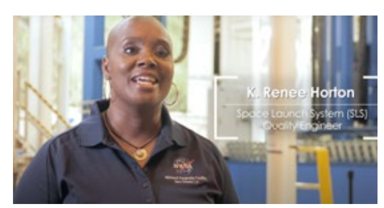
INNOVATION NOW

Facebook
innovationnow

Twitter
@innovationradio



"Innovation Now: Analyzing Mars"



"Faces of Technology: Meet Renee Horton"

"Faces of Technology," a complementary video product, takes viewers inside NASA Centers to give them an immersive glimpse of the people developing some of the NASA technologies featured in the podcasts. These 1-minute videos are distributed through social media and on the Innovation Now website. Targeted videos were released to support Women's History Month, Black History Month, and National Disability Employment Awareness Month. NIA produces select videos in both English and Spanish.

www.innovationnow.us

The NASA JSC Outstanding Outreach Award was awarded to **Harla Sherwood**, **Scott Bednar**, **Rebecca Jaramillo**, **Jessica Wilde**, **James Lucas**, **David Shelton**, **Caleb Stern**, **Seth Robinson**, and **Matthew Schara** for their outreach efforts supporting Orion.

NASA's First Woman

NIA collaborated with NASA and bully! Entertainment to develop "First Woman," a series of interactive graphic novels. The first issue, Dream to Reality, follows the character of Callie Rodriguez as she becomes the first woman to explore the Moon. While Callie is fictional, the first female astronaut and person of color will soon set foot on the Moon – a historic milestone and part of upcoming NASA Artemis missions.

"First Woman" graphic novels are enabled by virtual reality (VR) and augmented reality (AR). The free app, available on iOS and Android, lets viewers walk through life-size scenes from the graphic novel and explore NASA's highlighted technologies, which helped Callie, and will help real astronauts, sustain life on the Moon.

Within the first two months of release, "First Woman" reached over 467 million people in print, video, or on-air media and 108 million people on social media. People from over 70 countries from around the world downloaded the novel. In just one month, the Spanish version of the graphic novel reached 80.1 million people.

Event Webcasts

NIA's Media Communications Group provides live web broadcast and public engagement support for conferences, events, and workshops. These broadcasts broaden public exposure to some of the most exciting new developments at NASA and in the aerospace industry, and stimulate an interest in science, engineering, and technology relevant to aerospace. As events moved to virtual platforms, NIA broadcast capabilities evolved to allow audiences to actively participate in these forums. NIA aired 16 live broadcasts during 2021, providing live web streaming and support for virtual events such as the "2021 Virtual FAA Challenge," "2021 NASA Innovative Advanced Concepts Symposium," "2021 RASC-AL Virtual Forum," and the "2021 BIG Idea Challenge."

livestream.com/viewnow

NASA iTech

NASA iTech is a unique program to find innovative ideas that address critical problems here on Earth and hold great potential to solve critical technology challenges in future space exploration. Those ideas may come from small or large businesses, academia, other government organizations – or others who may not have previously had a forum to present their solutions to NASA leadership or its industry partners.

Two "Ignite the Night" events were held virtually in 2021. These virtual events provided a select group of startups the opportunity to "fast pitch" their ideas on stage to an esteemed panel of NASA's Center Chief Technologists, industry experts and investors. Full Cycle Bioplastics won "Ignite the Night TAMPA," which focused on Power Generation/Energy, Resource Optimization, Small Satellite Technology, and Space-Age Packaging Solutions. United Aircraft Technologies Inc. came out on top at the "Ignite the Night AERONAUTICS" virtual event, which emphasized technologies including Autonomous Systems for Aeronautics, Community Integration of Advanced Air Mobility (AAM), Electric Aircraft, Enabling Technologies for Handling and Ride Quality in Urban Air Mobility Vehicles and X-Factor Aeronautics innovations.

BlueSpace.ai Inc. joined the companies above as winners of the "2021 Cycle I Forum" which was held virtually in May 2021 and concentrated on Autonomous Systems for Aeronautics, Electric Aircraft, Power Generation/Energy, Small Spacecraft Technology, Space-Age Packaging Solutions and X-Factor Innovations. 2021 concluded with the NASA iTech Cycle II forum in December, which was held at NIA-member university NC State University and showcased technologies from companies in areas including Enabling Technologies for Commercialization of Low-Earth Orbit, Hybrid Electric Aircraft Technologies and Alternative Fuels, Physics-Based Machine Learning for Artificial Intelligence, Technologies Using NASA Data to Foster Climate Resilience and X-Factor Innovations.

www.nasaitech.org
livestream.com/nasaitech

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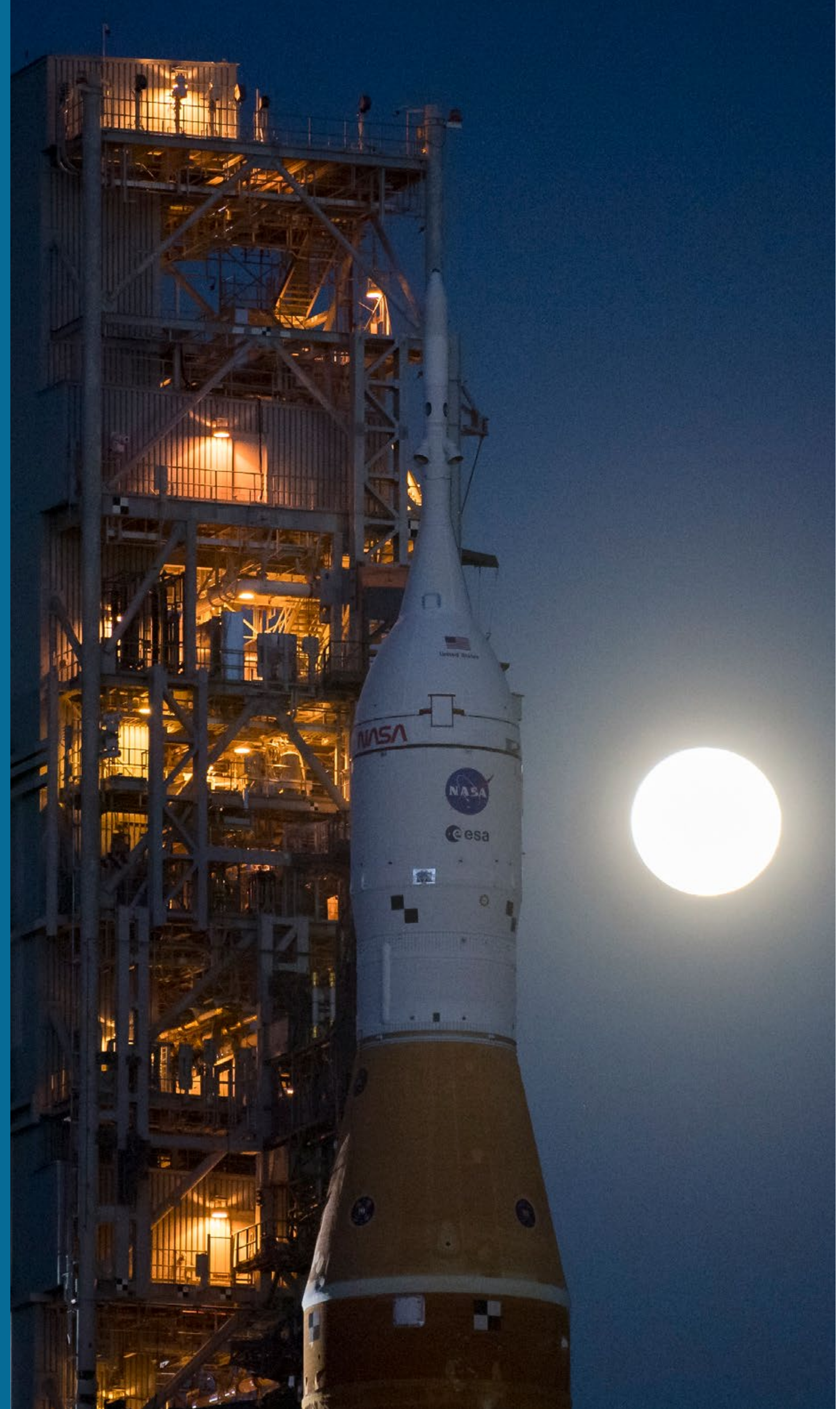

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The Moon is seen rising behind NASA's Space Launch System (SLS) rocket with the Orion spacecraft aboard.
Credit: NASA / Aubrey Gemignani

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