National Aeronautics and Space Administration

BIG IDEA CHALLENGE

Breakthrough, **I**nnovative & **G**ame-changing Idea Challenge

2021 Call for Proposals: Lunar Dust Mitigation Solutions

NASA plans to land American astronauts, including the first woman and the next man, on the Moon by 2024, and establish sustainable lunar missions by 2028. The Moon's environment presents unique challenges, and lunar dust is one of the principal limiting factors in returning to the Moon's surface for missions of any extended duration. Lunar dust is difficult to remove or mitigate as it is extremely abrasive, highly cohesive, small in size, and may be electrostatically charged. In addition to threatening astronaut health, lunar dust issues have also resulted in incorrect instrument readings, obscured vision/optical system obscuration, performance reduction, altered thermal properties, and equipment failure. High-velocity dust ejected by descent engine exhaust can even cause damage to the lander and nearby surface assets. For future lunar exploration missions, dust will inevitably be introduced into habitable spaces, where, under lunar gravity, certain particle sizes will be a health hazard to humans. No single technology completely solves the challenges of dust, but rather a suite of technologies will be required to address them.

To enable sustainable human operation of the Moon in the coming decade, NASA is looking for near term, innovative and viable solutions for dealing with the Moon's abrasive dust. In this year's BIG Idea Challenge, **teams of 5-25 students from Space Grant-affiliated colleges and universities are invited to submit robust proposals on novel concepts for near-term active and/or passive dust mitigation (or dust tolerant) technologies that could be used for lunar applications near or in the Moon's South Pole.** Selected teams will receive awards ranging between **$50,000 and $180,000** to bring their ideas to life.

2021 BIG Idea Challenge Proposal Categories

Through the 2021 BIG Idea Challenge, NASA solicits student team proposals 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** - to preclude or protect from plume/surface interactions which may result in damaged landers and nearby surface assets.
- **Spacesuit Dust Tolerance and Mitigation** - to limit dust adherence to spacesuits and other damaging effects to its subsystems.
- **Exterior Dust Prevention, Tolerance, and Mitigation** - to protect lunar surface systems or preclude dust from entering habitats and landers.
- **Cabin Dust Tolerance and Mitigation** - to clean habitable volumes and their interior surfaces, which helps prevent dust from making it back to Gateway and Orion when the lander returns to lunar orbit from the surface.

Active vs. Passive Dust Mitigation Technologies

- **Active technologies** are those that are used to clean a surface or to protect it from dust deposition through external forces.
- **Passive technologies** are those in which items are pretreated physically or chemically in order to minimize dust adherence, or do not require the use of external forces.

Example technologies could include:

- Dust free zones (landing pads, lunar surface modification, dust-free workspaces)
- Optical systems (i.e., viewports, camera lenses, solar panels, space suite visors, mass spectrometers, other sensitive optical instruments)
- Thermal systems (i.e., thermal radiators, painted surfaces, or connections)
- Dust-tolerant textiles and fabrics (i.e., space suit fabrics, soft wall habitats, mechanism covers)
- Dust-tolerant mechanisms (i.e., linear actuators, bearings, rotary joints, hinges, quick disconnects, valves, linkages)
- Seals and soft goods (i.e., space suit interfaces, hatches, connectors, hoses)
- Airborne Particle Gaseous filtration (i.e., atmosphere revitalization, In-Space Resource Utilization [ISRU] processes)

For detailed information on the types of dust mitigation technologies NASA is interested in, teams are encouraged to refer to the 2016 Dust Mitigation Gap Assessment Report.

http://BIGidea.nianet.org

Required Design Constraints

- Able to manage and mitigate abrasive dust
- Able to mitigate small particles (~1-50 µm)
- Minimal barriers to NASA adoption (low mass, small size, low power, etc.)
- Cost-effective solutions
- Non-flammable
- Able to work in harsh lunar South Pole environment (e.g., drastic temperature swings, etc.)
- Technologies should reach a minimum TRL of 4

Proposed Solutions Must Consider

- Solution should be ready for use on the Moon by 2026
- Cost-effective solutions
- Operational use and simplicity (minimize required crew time for use and maintenance)
- Verification of dust mitigation capability
- Design for the lunar environment [temperature/vacuum/complete darkness/unique lunar lighting (high contrast)/ power/degraded communications/abrasive regolith/rugged terrain, etc.]
- Deployment on a NASA/commercial lunar surface system
- Deployment method (autonomous or crew assisted)
- Data rate requirements for data downlink (if necessary)
- Innovative design
- Potential stakeholders/funders (i.e. Exploration, Science, Commercial)
- Effective packaging for launch and Moon landing
- Credible fabrication and material selection

Verification Testing - Finalist teams will be required to build and conduct high-fidelity verification testing on their solutions. Teams are encouraged to be creative and design their own accurate and realistically simulated testing scenarios.

Award Funding for Finalist Teams

A wide range of award sizes is expected **(in the range of $50,000 - $180,000)**, depending on the scope of the work proposed. Each team will submit a detailed and realistic budget in their proposals, not to exceed $180K. We anticipate funding several larger-scope awards (typically $125-$180K) and several smaller-scope awards (typically $50K - $125K). Proposers are encouraged to request what is actually needed to conduct the proposed work.

BIG Idea Challenge funding is to be used for full participation in the competition, including (but not limited to) the purchase of hardware/software, creation of analog testing environment, stipends for student research that directly supports the proposed activity, and travel to the culminating design review (2021 BIG Idea Forum).

These are abbreviated requirements.
For more information on the 2021 BIG Idea Challenge (including design requirements and guidelines) visit

http://BIGIdea.nianet.org

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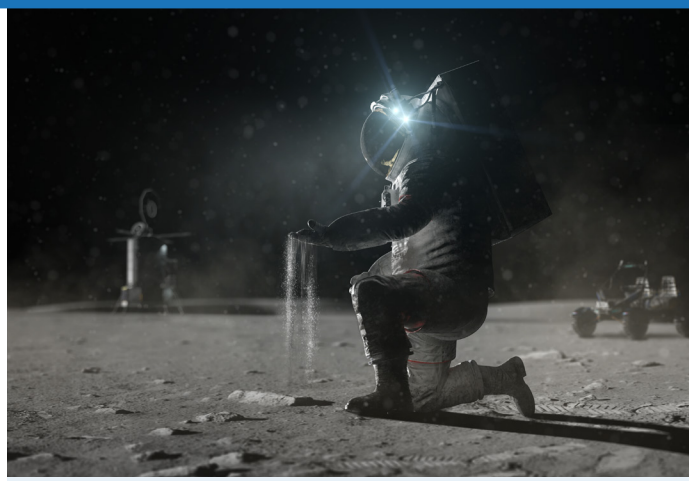

Important Dates

- Notice of Intent Deadline: September 25, 2020
- Proposal and Video Deadline: December 13, 2020
- Selection Notifications: January 29, 2021
- Mid-Project Review Deadline: May 20, 2021
- Technical Paper Deadline: October 27, 2021
- 2020 BIG Idea Forum: November 17-19, 2021

Eligibility

The 2021 BIG Idea Challenge is open to teams of 5-25 undergraduate and/or graduate students at **accredited U.S.-based colleges and universities officially affiliated with their state's Space Grant Consortium.** Non-Space Grant affiliated universities may partner with a Space Grant affiliated academic institution who takes a primary role on the project. Foreign universities are not eligible to participate in the BIG Idea Challenge. Minority Serving Institutions are encouraged to apply.

Please see the BIG Idea website for full eligibility requirements.

The Game Changing Development Program is a part of NASA's Space Technology Mission Directorate, *advancing space technologies that may lead to entirely new approaches for the Agency's future space missions and provide solutions to significant national needs.*
gameon.nasa.gov

The BIG Idea Challenge is a sponsored by NASA through a unique collaboration between the Space Technology Mission Directorate (Game Changing Development Program) and the Office of STEM Engagement (Space Grant Consortium), and is managed by the National Institute of Aerospace (NIA).

NASA

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