



# Lunar Surface Innovation

C O N S O R T I U M

## LSIC Dust Mitigation Focus Group

Monthly Meeting

September 21<sup>st</sup>, 2023



JOHNS HOPKINS  
APPLIED PHYSICS LABORATORY

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# Agenda

## Extended 1.5hr session

- Welcome
- Upcoming Opportunities
- LSIC DM-EE Workshop
- Featured Panelists: How to Test with Dust
  - **Dr. Andrea Cammarano, University of Glasgow**
  - **Dr. Hossein Zare-Behtash, University of Glasgow**
  - **Nathan Jimenez, NASA Glenn**
  - **Dr. Katy Hurlbert, NASA JSC**
  - **Dr. Addie Dove, University of Central Florida**
  - **Melissa Roth, Off-Planet Research**
- Discussion



# NASA Space Technology Graduate Research Opportunities (NSTGRO)

- “This call for graduate student space technology research proposals, titled NASA Space Technology Graduate Research Opportunities – Fall 2024 (NSTGRO24), solicits proposals on behalf of individuals pursuing or planning to pursue **master’s or doctoral (PhD) degrees in relevant space technology disciplines** at accredited U.S. universities.
- It is NASA’s desire to infuse the university-developed space technology through sustained interaction with the student and their faculty advisor. NASA Space Technology Graduate Research Fellows will **perform research at their respective campuses and also at NASA Centers**. Each recipient will be **matched with a technically relevant and community-engaged NASA researcher** who will serve as the research collaborator on the award. Through this collaboration, graduate students will be able to take advantage of broader and/or deeper space technology research opportunities directly related to their academic and career objectives, acquire a more detailed understanding of the potential end applications of their space technology efforts, and directly disseminate their research results within the NASA community.
- Awards resulting from this solicitation will be made in the form of grants to accredited U.S. universities with the faculty advisor as the Principal Investigator (PI). “
- **Proposal Due November 1, 2023; Letters of Recommendation Due November 6, 2023**
- <https://nspires.nasaprs.com/external/solicitations/summary.do?solId=%7B4FB626AC-C4FA-72A6-9FDB-C5305D6F5E38%7D&path=&method=init>

# Human Lander Challenge

- Through the 2024 HuLC competition, NASA's Human Landing System (HLS) Program provides college students the opportunity to explore innovations and potential solutions to lunar Plume-Surface Interaction (PSI) risks and challenges.
- NASA's HLS Program is responsible for the transportation in deep space to carry humans to and from the surface of the Moon for NASA's Artemis lunar exploration program. Crews will board the HLS in lunar orbit and descend to the surface where they will collect samples, perform science experiments, and observe the lunar environment before returning to orbit in the HLS.
- Teams are invited to submit proposals for **innovative, systems-level solutions to understand, mitigate, and manage the impacts of lunar PSI that can be implemented within 3-5 years**. The potential solutions teams can propose to could include, but are not limited to, the following categories:
  - Trade Studies on Landing Trajectories that Minimize PSI
  - Reduction / Mitigation of Erosion (Cratering) and Ejecta during Descent, Landing, and Ascent
  - Development of PSI Flight Instrumentation / Measurement Methods and Concepts
  - Tracking Dust During Descent, Landing, and Ascent
  - Instrumentation Performance Through the Dust Cloud During Landing
  - HLS Asset Safety (ejecta damage, excessive lander heating, etc.)
  - PSI Modeling and Validation
- **Notice of Intent (NOI) Due October 22, 2023; Full Proposal Due March 4, 2024**
- [https://hulc.nianet.org/challenge\\_details/](https://hulc.nianet.org/challenge_details/)





Lunar Surface Innovation Consortium

FALL MEETING 2023 | OCTOBER 10-11  
COMMERCIAL WORKSHOP | OCTOBER 12

COMMUNITY COLLEGE OF ALLEGHENY COUNTY & ONLINE VIA ZOOMGOV



REGISTRATION DEADLINE:  
**SEPTEMBER 24<sup>TH</sup>**

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# Path to Sustainable Technologies in the Lunar Surface Environment Workshop

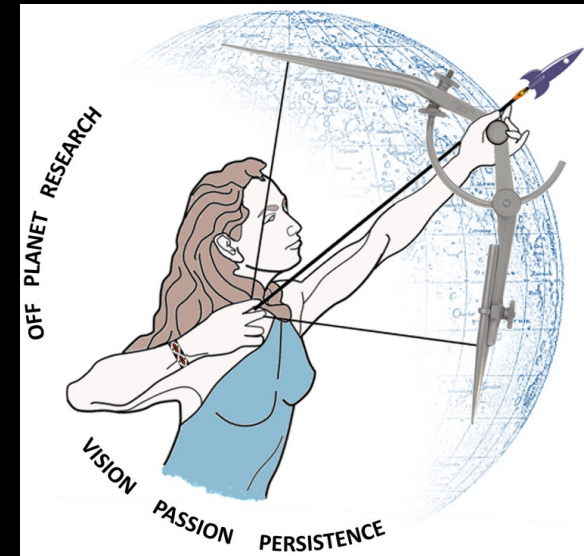
An aerial, top-down view of a simulated lunar base. The base consists of several interconnected white and grey modules, some with yellow accents, arranged in a roughly rectangular pattern. A central module has a large, circular, yellow-tinted dome. The surrounding terrain is dark grey and textured, representing the lunar surface. In the upper right, there is a circular feature with a yellow triangle inside, possibly a landing site or a specific piece of equipment. The overall scene is dimly lit, suggesting a low sun position.

- **DM & EE Joint Workshop** - November 7, 2023 - Interactive, Virtual Workshop
- We will focus on the qualification path to fielding long-lived technologies on the lunar surface. Stakeholders across industry, academia, and NASA will come together in a collaborative format to discuss the current state of the art, as well as essential knowledge and technology gaps related to the combined lunar and dust environment.
- **Topics**
  - Existing Standards and Facilities
  - Stakeholder Needs
    - NASA panel
    - Industry & Academia Panel
  - Town Hall on Next Steps
  - Q&As for all presentations
- Registration is free, and required. Closes September 24<sup>th</sup>.  
<https://lsic.jhuapl.edu/Events/Agenda/index.php?id=481>



# Today's Featured Panel

## Dust Testing



# Discussion: How to Test with Dust

- What is your biggest lesson learned from past dust testing?
- Did anything about testing with simulant surprise you?
- What areas of expertise were needed to set up an effective test?
- Did you need to bring in outside expertise for testing?
- How did you acquire simulant(s)?
- How did you select simulant(s)?
- Any tips for working on NASA projects?
- What dust projects are you pursuing currently?
- Are there any factors or effects that you would like to add to your testing? (G-negation, vacuum, thermal shock, etc.)
- What is your preferred facility for dust testing?
- Have you experienced any surprising results as part of your dust testing?
- What testing is there an urgent need for in the dust community?
- Does your organization have plans to share dust or testing information with the larger community?





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# Lunar Surface Technology Demonstration Strategy

## Power, ISRU, Autonomy, Robotics, Excavation, Construction

Early lunar surface demonstrations will increase technology readiness for key infrastructure capabilities with opportunities for collaboration with OGAs, industry, academia, and international partners

### ◆ IM-2 Demo (on CLPS IDIQ)

- Polar Resources Ice Mining Experiment (PRIME-1)
- Nokia 4G LTE Communications
- Intuitive Machines Deployable Hopper (TP)



Oxygen Extraction Ground Demo

### ◆ CT-1 Space Tech CLPS Demo

### ◆ CT-2 Space Tech CLPS Demo

CT Candidate Technologies (in formulation):

- ISRU Subscale Demo
- Power (e.g. Vertical Solar Array, Power Beaming, Fuel Cells)
- Dust Mitigation
- Autonomy & Robotics (e.g. Mobility, Navigation, etc.)
- Excavation
- Construction

### ◆ Fission Surface Power Demo

### ◆ ISRU Pilot Plant

Volatiles Investigating Polar Exploration Rover (VIPER)  
(Science Mission Directorate)

### ◆ Space Tech Lunar Surface Demo

2023

2033





# Near-term Lunar Technology Demos

Early lunar surface demonstrations, via the Commercial Lunar Payload Services (CLPS) Program, are opportunities to mature the capabilities required for NASA and industry

## Astrobotic Peregrine-1 Mission

Launch date under assessment



Astrobotic Terrain Relative Navigation (ATRN) - Tipping Point with Astrobotic

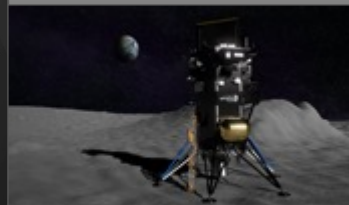


Thruster for Advancement of Low Temperature Operations in Space (TALOS)

## Intuitive Machines (IM)-2 Mission

Planned for Q4 CY23

Launch date under assessment



Polar Resources Ice-Mining Experiment (PRIME-1)



LTE Proximity Comms (Tipping Point w/Nokia)



Deployable Lunar Hopper (Tipping Point w/ IM)

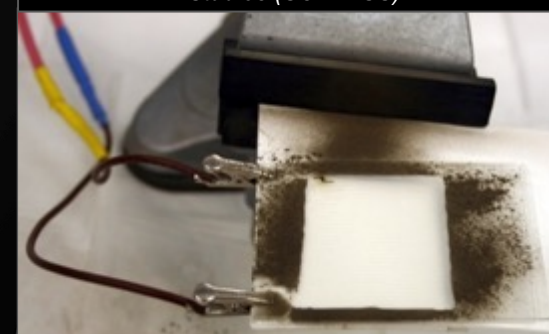
## CLPS 19D Mission (Firefly)

Planned for Mid-CY24

Launch date under assessment



Stereo Camera for Lunar Plume Surface Studies (SCALPSS)



Electrodynamic Dust Shield (EDS)

## CLPS CP11 Mission (IM)

Early/Mid 2024



Cooperative Autonomous Distributed Robotic Explorers (CADRE)

# Space Technology Funding Opportunities

## Current Tech Development Opportunities

- [NSF SBIR and STTR »](#)
  - NSF recommends treating the submission window like a deadline, but you can submit anytime within a year of receiving an official invitation from NSF. (NSF uses submission windows to help gather and review proposals, but sometimes proposals are reviewed as they are received.)  
Windows: March 2, 2023 - July 5, 2023 July 6, 2023 - November 1, 2023
- [NASA Innovation Corps Pilot »](#)
  - Proposals may be submitted at any time through July 22, 2022, but applications will be reviewed in intervals on the following dates: Sept. 16, 2022; Nov. 17, 2022; and Jan 20, 2023
- [Technology Advancement Utilizing Suborbital and Orbital Flight Opportunities “TechFlights” »](#)
  - Mandatory Preliminary Proposals Due - 6/7/2023 Full Proposals Due - 10/4/2023
- [Human Lander Challenge](#)
  - Notice of Intent (NOI) Due October 22, 2023; Full Proposals Due March 4, 2024
- [NASA's 2024 BIG Idea Challenge »](#)
  - Notice of Intent Deadline – September 20, 2023; Q&A Session for Interested Teams – October 12, 2023; Proposal Deadline – January 23, 2024; 2024 BIG Idea Forum – November 5-7, 2024

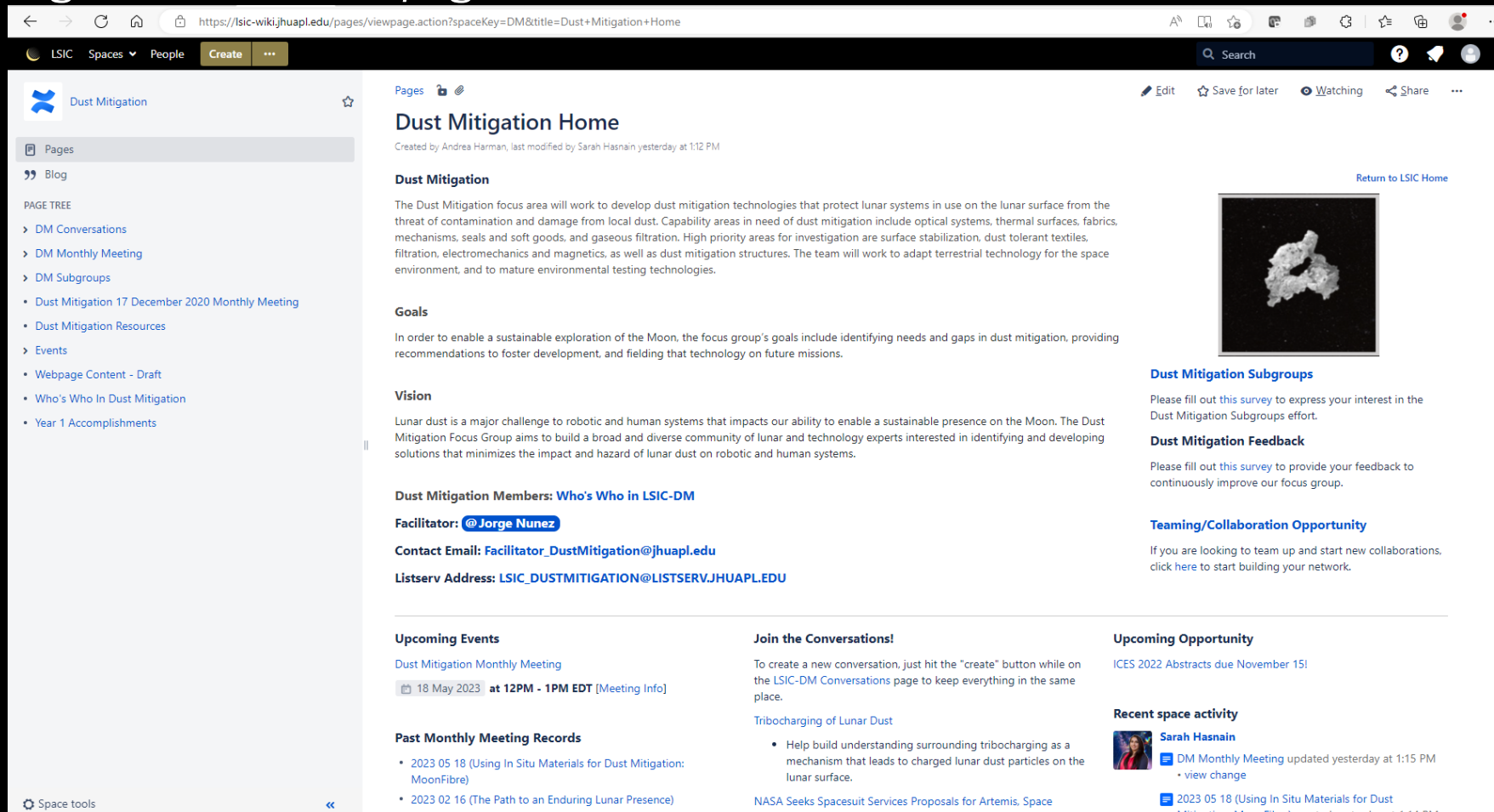
## Future Solicitation and Opportunities

- [NASA Innovative Advanced Concepts \(NIAC\) 2024 Phase I Call for Proposals »](#)
  - The NIAC program supports visionary research ideas through multiple progressive phases of study. Phase I studies are nine-month efforts to explore the overall viability and advance the technology readiness level (TRL). Eligible recipients of Phase I awards can propose for a follow-on Phase II study.



# LSIC Dust Mitigation Wiki Page

- To request access, please contact [lsic-wiki-admins@listserv.jhuapl.edu](mailto:lsic-wiki-admins@listserv.jhuapl.edu)
- *Dust Mitigation Discussion page and wiki*

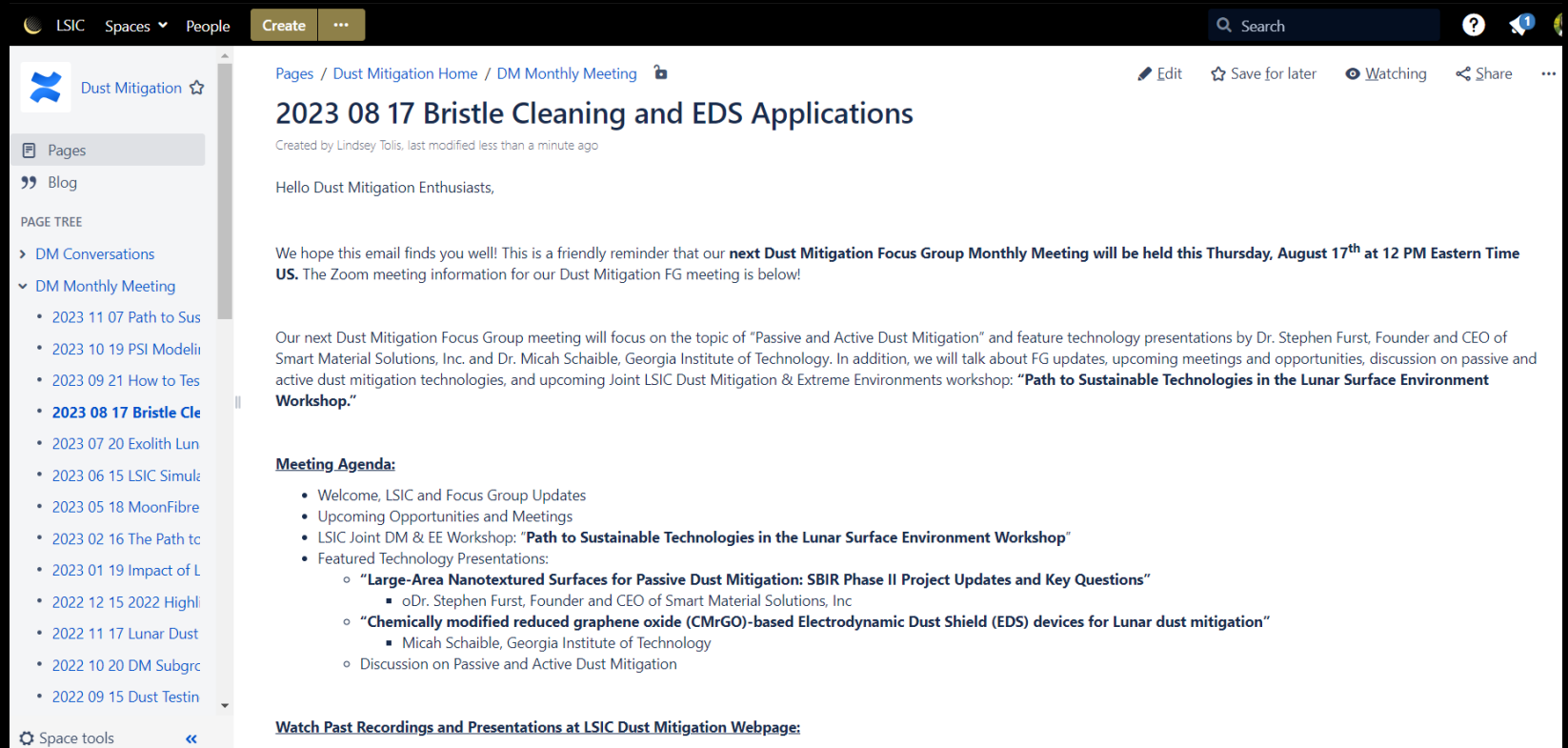


The screenshot shows the 'Dust Mitigation Home' page on the LSIC wiki. The page includes a navigation sidebar with links to 'Pages', 'Blog', and a 'PAGE TREE' containing 'DM Conversations', 'DM Monthly Meeting', 'DM Subgroups', 'Dust Mitigation 17 December 2020 Monthly Meeting', 'Dust Mitigation Resources', 'Events', 'Webpage Content - Draft', 'Who's Who In Dust Mitigation', and 'Year 1 Accomplishments'. The main content area features sections for 'Dust Mitigation' (description of the focus area), 'Goals', 'Vision', 'Dust Mitigation Members: Who's Who in LSIC-DM', 'Facilitator: @Jorge Nunez', 'Contact Email: Facilitator\_DustMitigation@jhuapl.edu', and 'Listserv Address: LSIC\_DUSTMITIGATION@LISTSERV.JHUAPL.EDU'. There are also sections for 'Upcoming Events' (Dust Mitigation Monthly Meeting on 18 May 2023), 'Past Monthly Meeting Records', 'Join the Conversations!', 'Upcoming Opportunity' (ICES 2022 Abstracts), and 'Recent space activity' (DM Monthly Meeting updated yesterday).

# Join the Discussion on our Wiki Page

- To request access, please contact [lsic-wiki-admins@listserv.jhuapl.edu](mailto:lsic-wiki-admins@listserv.jhuapl.edu)
- *Dust Mitigation Discussion page and wiki*

- Sign-in to add a comment at bottom of page
- You can comment before, during, or after today's meeting
- [Today's meeting](#)



The screenshot shows a web browser displaying a page on the LSIC Wiki. The page title is "2023 08 17 Bristle Cleaning and EDS Applications". The content includes a greeting to "Dust Mitigation Enthusiasts", a reminder for a meeting on Thursday, August 17th at 12 PM Eastern Time US, and a detailed agenda for the meeting. The agenda items include: Welcome, LSIC and Focus Group Updates; Upcoming Opportunities and Meetings; LSIC Joint DM & EE Workshop: "Path to Sustainable Technologies in the Lunar Surface Environment Workshop"; and Featured Technology Presentations, which include "Large-Area Nanotextured Surfaces for Passive Dust Mitigation: SBIR Phase II Project Updates and Key Questions" by Dr. Stephen Furst and "Chemically modified reduced graphene oxide (CMrGO)-based Electrodynamic Dust Shield (EDS) devices for Lunar dust mitigation" by Micah Schaible. The page also has a link to watch past recordings and presentations at the LSIC Dust Mitigation Webpage.



# Get Involved with Dust Mitigation

- Sign-up to Receive LSIC and Dust Mitigation FG Updates:
  - Fill out the [LSIC Sign Up](#)
  - Indicate interest in Dust Mitigation to receive news and event invitations
- Help us improve the Dust Mitigation Focus Group: [Feedback survey](#)
- Interested in Teaming/Collaborating with Others?
  - Add yourself to our Confluence [Who's Who page](#)
- Looking for info on lunar dust or dust mitigation resources?
  - Checkout our Confluence [resources page](#)
- Join one of the Dust Mitigation Subgroups!
  - [Subgroup Membership/Leaders survey](#)
  - Still looking for subgroup leads!

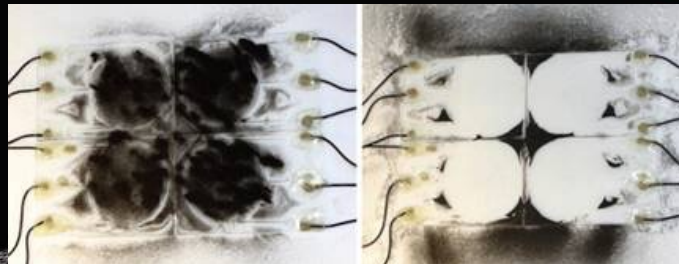
# Dust Mitigation FG Subgroups

- **Standards & Interoperability [Subgroup Lead: Dan Hawk]**
  - Standards and interoperability across testing and operational use cases
- **Isolation Technologies [Subgroup Lead: Ron Creel]**
  - Technologies that keep dust out
- **Materials & Coatings**
  - Optical Systems – Viewports, camera lenses, solar panels, space suit visors, mass spectrometers, other sensitive optical instruments
  - Thermal Surfaces – Thermal radiators, thermal painted surfaces, thermal connections
  - Fabrics – Space suit fabrics, soft wall habitats, mechanism covers
  - Seals and Soft Goods – Space suit interfaces, hatches, connectors, hoses
- **Mechanisms & Connectors**
  - Mechanisms – Linear actuators, bearings, rotary joints, hinges, quick disconnects, valves, linkages
  - Dust-tolerant connectors
- **Modeling & Monitoring**
  - Gaseous Filtration – Atmosphere revitalization, ISRU processes
  - Dust monitoring – Cabin and external dust monitoring
  - Dust plume modeling

Interested in leading a  
Dust Mitigation Subgroup?

Fill out our survey!

<https://forms.gle/AGpyJcNZBd6ihdaq7>



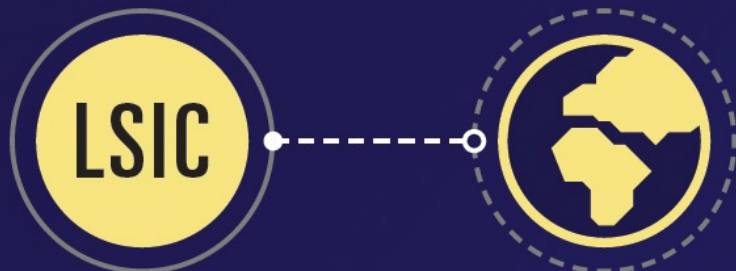


# THE PATH TO AN ENDURING LUNAR PRESENCE

In the early 2030s, lunar infrastructure could support a science outpost and exploration proving grounds that can also bootstrap commercial activities.

The LSIC community is publishing a white paper to share their perspectives on key enabling actions that will help our nation and the world move together toward our shared use of the lunar surface.

LSIC Community  
Draft White Paper





# LSIC White Paper and M2M Feedback

## LSIC Whitepaper

### *The Path to an Enduring Lunar Presence*

Perspectives on key enabling actions that will help our nation and the world move together toward our shared use of the lunar surface.

Access White Paper:

<https://lsic.jhuapl.edu/Resources/files/The%20Path%20to%20an%20Enduring%20Lunar%20Presence.pdf>

Send feedback to: [LSIC-Feedback@jhuapl.edu](mailto:LSIC-Feedback@jhuapl.edu)

## NASA Moon to Mars Whitepapers

### *Architecture Concept Review*

Systems Analysis of Architecture Drivers

Why NRHO: The Artemis Orbit

Why Artemis will Focus on the Lunar South Polar Region

Gateway: The Cislunar Springboard for International and Sustainable Human Deep Space Exploration

Mars-Forward Capabilities to be Tested at the Moon

Mars Transportation

Access White Papers:

<https://www.nasa.gov/MoonToMarsArchitecture>