



Lunar Surface Innovation

C O N S O R T I U M

LSIC Dust Mitigation Focus Group

Monthly Meeting

December 15, 2022



JOHNS HOPKINS
APPLIED PHYSICS LABORATORY

Dr. Jorge Núñez
Senior Scientist
Space Exploration Sector

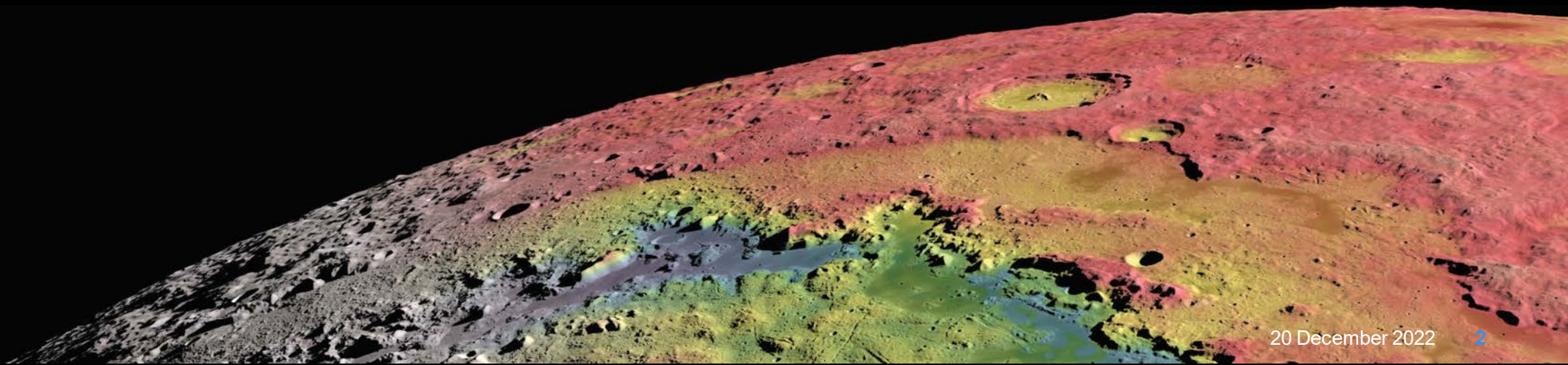
Facilitator_DustMitigation@jhuapl.edu

APL LSIC Dust
Mitigation Team:

Lindsey Tolis
Mark Perry
Richard Miller
Sarah Hasnain

Agenda

- Welcome, LSIC and Focus Group Updates
- Upcoming Opportunities and Meetings
- Recap from LSIC Spring and Fall Meeting
- Highlights and takeaways from 2022 Dust Mitigation FG Meetings
- Look ahead to 2023



Artemis 1 Launch!





Flyby of the Moon!

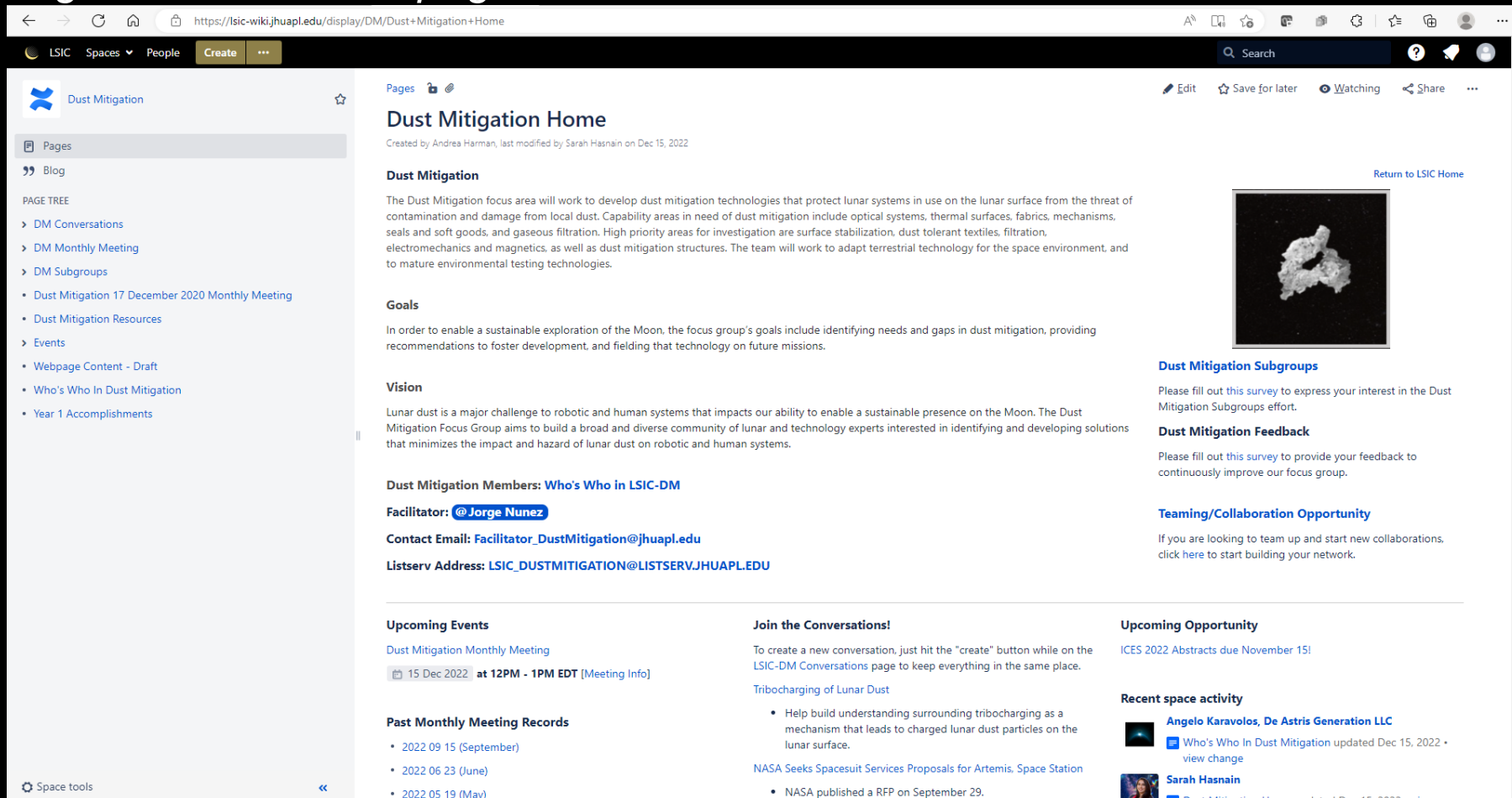


Splashdown!



LSIC Dust Mitigation Confluence Site

- Please contact Andrea Harman (ams573@alumni.psu.edu) to get set up with an account!
- *Dust Mitigation Discussion page and wiki*



The screenshot shows the Confluence page for the LSIC Dust Mitigation Home. The page is titled "Dust Mitigation Home" and was created by Andrea Harman, last modified by Sarah Hasnain on Dec 15, 2022. The page content includes:

- Dust Mitigation:** The Dust Mitigation focus area will work to develop dust mitigation technologies that protect lunar systems in use on the lunar surface from the threat of contamination and damage from local dust. Capability areas in need of dust mitigation include optical systems, thermal surfaces, fabrics, mechanisms, seals and soft goods, and gaseous filtration. High priority areas for investigation are surface stabilization, dust tolerant textiles, filtration, electromechanics and magnetics, as well as dust mitigation structures. The team will work to adapt terrestrial technology for the space environment, and to mature environmental testing technologies.
- Goals:** In order to enable a sustainable exploration of the Moon, the focus group's goals include identifying needs and gaps in dust mitigation, providing recommendations to foster development, and fielding that technology on future missions.
- Vision:** Lunar dust is a major challenge to robotic and human systems that impacts our ability to enable a sustainable presence on the Moon. The Dust Mitigation Focus Group aims to build a broad and diverse community of lunar and technology experts interested in identifying and developing solutions that minimizes the impact and hazard of lunar dust on robotic and human systems.
- Dust Mitigation Members: Who's Who in LSIC-DM**
- Facilitator: @Jorge Nunez**
- Contact Email: Facilitator_DustMitigation@jhuapl.edu**
- Listserv Address: LSIC_DUSTMITIGATION@LISTSERV.JHUAPL.EDU**

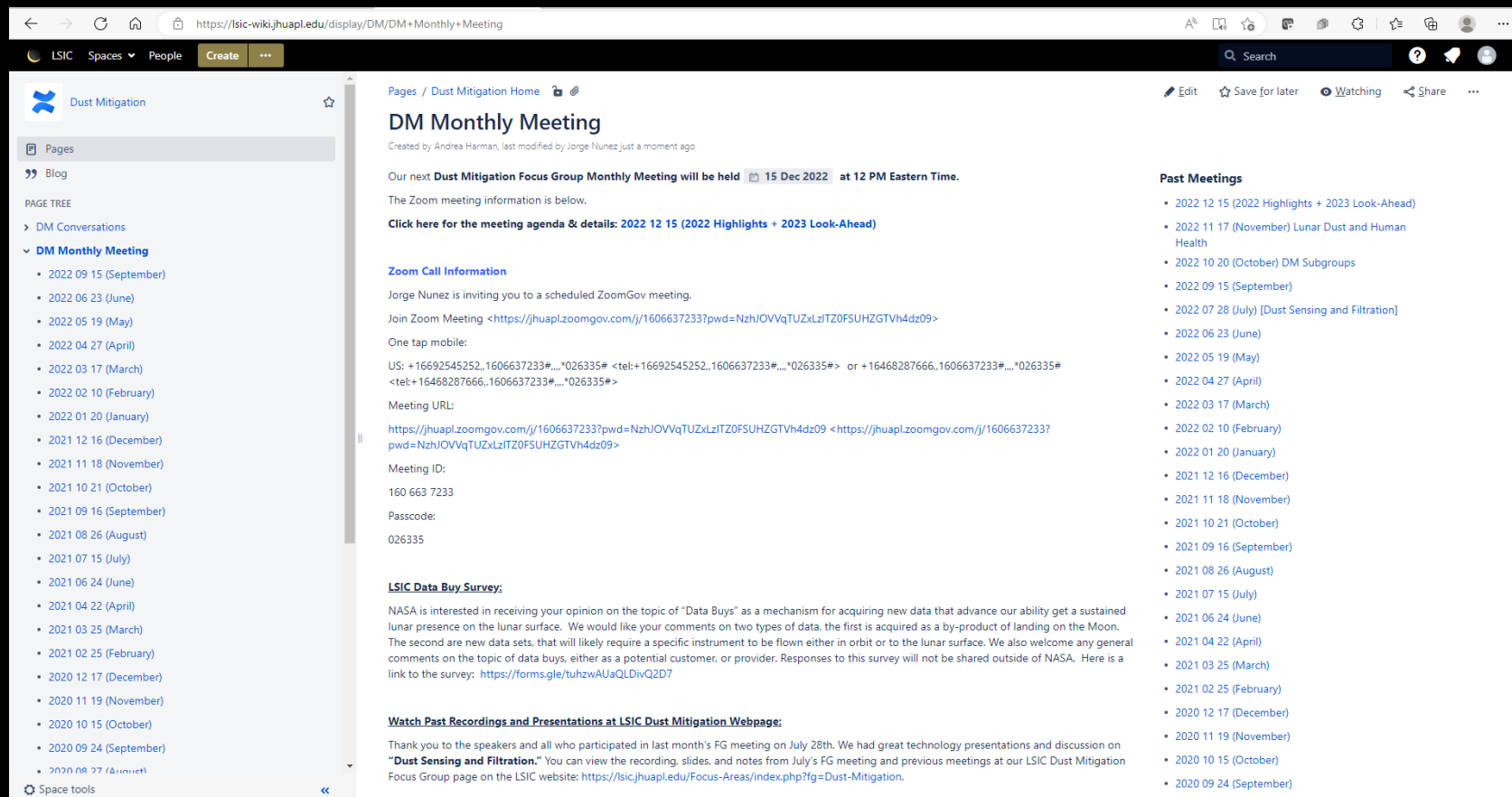
The page also features several sidebars and sections:

- Pages:** A sidebar menu with options for "Pages", "Blog", and "PAGE TREE". The "PAGE TREE" includes links for "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".
- Upcoming Events:** A section titled "Upcoming Events" listing the "Dust Mitigation Monthly Meeting" on 15 Dec 2022 at 12PM - 1PM EDT.
- Past Monthly Meeting Records:** A section titled "Past Monthly Meeting Records" listing previous meetings: 2022 09 15 (September), 2022 06 23 (June), and 2022 05 19 (May).
- Join the Conversations!:** A section titled "Join the Conversations!" with instructions on how to create a new conversation and a list of recent discussions: "Tribocharging of Lunar Dust" and "NASA Seeks Spacesuit Services Proposals for Artemis, Space Station".
- Upcoming Opportunity:** A section titled "Upcoming Opportunity" listing "ICES 2022 Abstracts due November 15!".
- Recent space activity:** A section titled "Recent space activity" listing recent updates: "Angelo Karavolos, De Astris Generation LLC", "Who's Who In Dust Mitigation updated Dec 15, 2022", and "Sarah Hasnain".

Join the Discussion on Confluence Site

- Please contact Andrea Harman (ams573@alumni.psu.edu) to get set up with an account!
- *Dust Mitigation Discussion page and wiki*

- 1. Sign-in to add a comment
- 2. Add comment at bottom of page
- 3. You can comment before, during, or after today's meeting



Pages / Dust Mitigation Home

DM Monthly Meeting

Created by Andrea Harman, last modified by Jorge Nunez just a moment ago

Our next **Dust Mitigation Focus Group Monthly Meeting will be held** **15 Dec 2022** at 12 PM Eastern Time.

The Zoom meeting information is below.

Click here for the meeting agenda & details: 2022 12 15 (2022 Highlights + 2023 Look-Ahead)

Zoom Call Information

Jorge Nunez is inviting you to a scheduled ZoomGov meeting.

Join Zoom Meeting <<https://jhuapl.zoomgov.com/j/1606637233?pwd=NzhjOVVqTUZxLzlTZ0FSUHZGTVh4dz09>>

One tap mobile:

US: +16692545252,,1606637233#,*026335# <tel:+16692545252,,1606637233#,*026335#> or +16468287666,,1606637233#,*026335# <tel:+16468287666,,1606637233#,*026335#>

Meeting URL:

<https://jhuapl.zoomgov.com/j/1606637233?pwd=NzhjOVVqTUZxLzlTZ0FSUHZGTVh4dz09> <<https://jhuapl.zoomgov.com/j/1606637233?pwd=NzhjOVVqTUZxLzlTZ0FSUHZGTVh4dz09>>

Meeting ID:

160 663 7233

Passcode:

026335

LSIC Data Buy Survey:

NASA is interested in receiving your opinion on the topic of "Data Buys" as a mechanism for acquiring new data that advance our ability get a sustained lunar presence on the lunar surface. We would like your comments on two types of data, the first is acquired as a by-product of landing on the Moon. The second are new data sets, that will likely require a specific instrument to be flown either in orbit or to the lunar surface. We also welcome any general comments on the topic of data buys, either as a potential customer, or provider. Responses to this survey will not be shared outside of NASA. Here is a link to the survey: <https://forms.gle/tuhzwAUaQLDivQ2D7>

Watch Past Recordings and Presentations at LSIC Dust Mitigation Webpage:

Thank you to the speakers and all who participated in last month's FG meeting on July 28th. We had great technology presentations and discussion on "**Dust Sensing and Filtration.**" You can view the recording, slides, and notes from July's FG meeting and previous meetings at our LSIC Dust Mitigation Focus Group page on the LSIC website: <https://lsic.jhuapl.edu/Focus-Areas/index.php?fg=Dust-Mitigation>.

Past Meetings

- 2022 12 15 (2022 Highlights + 2023 Look-Ahead)
- 2022 11 17 (November) Lunar Dust and Human Health
- 2022 10 20 (October) DM Subgroups
- 2022 09 15 (September)
- 2022 07 28 (July) [Dust Sensing and Filtration]
- 2022 06 23 (June)
- 2022 05 19 (May)
- 2022 04 27 (April)
- 2022 03 17 (March)
- 2022 02 10 (February)
- 2022 01 20 (January)
- 2021 12 16 (December)
- 2021 11 18 (November)
- 2021 10 21 (October)
- 2021 09 16 (September)
- 2021 08 26 (August)
- 2021 07 15 (July)
- 2021 06 24 (June)
- 2021 04 22 (April)
- 2021 03 25 (March)
- 2021 02 25 (February)
- 2020 12 17 (December)
- 2020 11 19 (November)
- 2020 10 15 (October)
- 2020 09 24 (September)

Updates and Communications

- Monthly LSIC newsletter – New edition came out early December 2022
 - <https://lsic.jhuapl.edu/Resources/LSIC-Resources.php>
 - Mailing list
 - The listserv goes to all participants. Use with caution. But feel free to use!
 - Please make sure to add LSIC_DUSTMITIGATION@LISTSERV.JHUAPL.EDU to safe senders list.
 - If we need smaller, focused lists we can set those up
- Updates to the webpage - <https://lsic.jhuapl.edu/Our-Work/Focus-Areas/index.php?fg=Dust-Mitigation>
 - Notes, slides, recordings from telecons posted here
- Wiki is ready!
 - Confluence is free to you and available to all registered LSIC members
 - To request an account, please email Andrea Harman: ams573@alumni.psu.edu
- Lightning Talks at monthly focus group meetings
 - Anyone can volunteer to give a featured talk (~15 mins)
 - Email me if you want to sign up: Facilitator_DustMitigation@jhuapl.edu

Follow the Code of Conduct for all Focus Group communications

<https://lsic.jhuapl.edu/Resources/LSIC-Resources.php>

Space Technology Funding Opportunities

Current Tech Development Opportunities

- [Space Technology Research Institutes \(STRI\) Solicitation »](#)
 - Invited Full Proposals were Due November 3, 2022
- [NASA Space Technology Graduate Research Opportunities – Fall 2023 \(NSTGRO23\) »](#)
 - Proposals were Due November 2, 2022
- [Announcement for Partnership Proposals \(AFPP\) to Advance Tipping Point Technologies »](#)
 - Final Proposals Due November 22, 2022
- [NASA Payloads and Research Investigations on the Surface of the Moon »](#)
 - Proposals Due December 20, 2022
- [NASA Innovative Advanced Concepts \(NIAC\) 2022 Phase II Call for Proposals »](#)
 - Proposals Due January 18, 2023

Future Solicitation and Opportunities

- [NASA Innovation Corps Pilot »](#)
 - Proposals may be submitted at any time through March 29, 2023, but applications will be reviewed in intervals on the following dates: July 22, 2022; Sept. 16, 2022; Nov. 17, 2022; and Jan 20, 2023

NASA PRISM 3 Solicitation

- This third Payloads and Research Investigations on the Surface of the Moon (PRISM) program element solicits proposals for an investigation that includes development and flight of science-driven suites of instruments that will be delivered to the lunar surface by the Commercial Lunar Payload Services (CLPS).
- This PRISM call is for science investigations that will be delivered to the lunar surface in mid-Calendar Year 2027.
- This delivery will go to a safe landing site identified and justified by the proposer that resides within $\pm 75^{\circ}$ of the lunar equator.
- Both nearside and far side destinations are open to consideration.
- This PRISM call provides the opportunity to leverage survive-the-night services and mobility services provided by the CLPS provider.
- **Step 1 due: October 24; Step 2 due: December 20;**
- Questions and comments concerning PRISM may be directed to Debra Needham and Ryan Watkins at HQ-PRISM@mail.nasa.gov.

LSIC Activities

Recent and Upcoming LSIC Meetings and Workshops (<https://lsic.jhuapl.edu/Events/>)

- LSIC Fall Meeting (11/02 – 11/03)
 - University of Texas – El Paso
 - Agenda and registration posted on LSIC website
 - <https://lsic.jhuapl.edu/Events/Agenda/index.php?id=350>
- LSIC Dust Mitigation Focus Group Meeting (12/15)
 - End of Year Recap & Look Forward
- LSIC Spring Meeting (03/29 – 03/30, 2023)
 - Applied Physics Laboratory (Hybrid)
- LSIC Dust Mitigation Workshop (Spring 2023)
 - Follow-up to DM Workshop from 2021
 - Dates TBD

Other Recent and Upcoming Dust Mitigation Related Workshop and Meetings

- Commercial Lunar Payload Services Survive the Night Technology Workshop (12/06-08)
 - Cleveland, OH/Virtual; Program Available;
 - Registration for In-Person US Citizens: 11/22 (International was 10/31); Virtual Registration: 12/08
 - <https://www.hou.usra.edu/meetings/clps2022/>

LSII | Data Buys Survey

- NASA is interested to learn more about the interest in the LSIC community of NASA conducting data buys from commercial providers
- There are two types of data to consider
 - Data acquired as a by product of landing on the Moon
 - Dedicated data that require a specific instrument to be flown
- What kind of data access is required?
 - Does NASA buy an entire data set and put it in PDS?
 - Do users buy data directly from the providers?
- Survey Link:
<https://forms.gle/tuhzwAUaQLDivQ2D7>

LSIC | Spring Meeting, May 4-5th, 2022

The Lunar Surface Innovation Consortium (LSIC) Spring Meeting provided a forum for NASA to share their envisioned futures (EF) for a sustained presence on the Moon with the space technology community and to discuss technical progress towards establishing a sustained presence on the lunar surface.

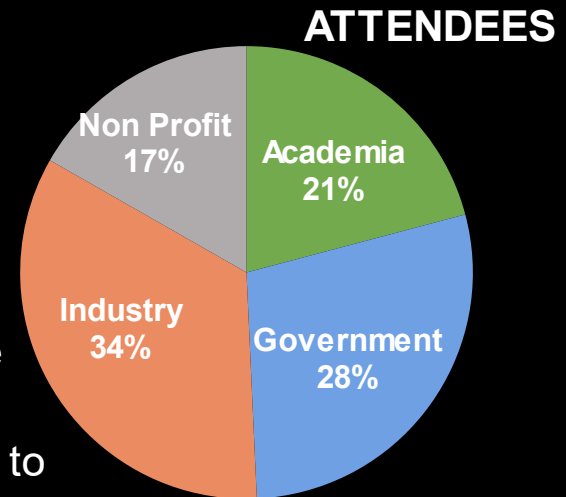
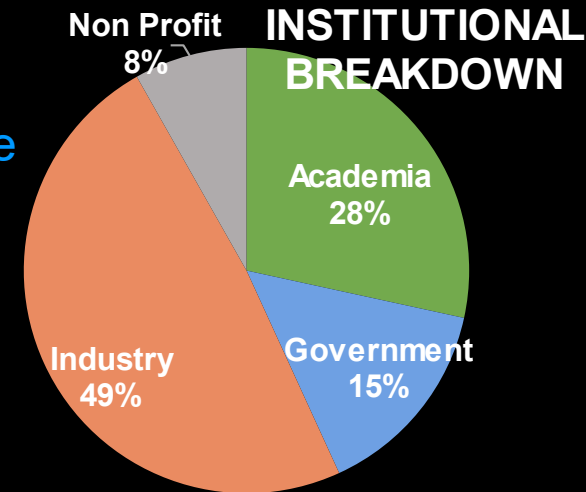
430 individuals (160 in-person) representing 189 different institutions from 30 states, DC, and 18 countries attended the meeting over the course of two days.

Meeting Content Included:

- Keynote address, NASA Associate Administrator Bob Cabana
- NASA Space Technology Mission Directorate Investments & Strategy
- Panels, Community Technical Presentations, Breakout Discussions

Community Feedback:

- Industry and academia are eager to make use of the Commercial Lunar Payload Services or other launch opportunities to prove their technology is ready to feed into NASA missions and architecture
- A "Mock Preliminary Design Review (PDR)" could be leveraged as a mechanism for defining expectations and communicating to industry what the requirements of EF technical solutions ought to be, identifying knowledge gaps, stakeholders, and more.
- There is both a need and an opportunity now to resolve policy issues such as resource rights, disposal management, and standardization. An official organizing body could help establish these norms and oversee technical and system standards.



LSIC Fall Meeting

- Dates: November 2-3, 2022
- University of Texas at El Paso (UTEP), Virtual and In-Person
- The LSIC 2022 Fall Meeting concentrated on understanding NASA's plans and technology investments relevant to building a sustained presence on the lunar surface.
- The event featured interrelationships between the six focus areas identified by the Consortium, with a specific focus on how they relate to excavation and construction.
- The fall meeting featured individual invited talks, group and panel discussions, as well as poster sessions, breakout groups, and networking opportunities.
- Tours of University of Texas, El Paso facilities, White Sands Test Facility, and ICON's 3D printed barracks at Fort Bliss.
- **Fall Meeting Website:**
<https://lsic.jhuapl.edu/Events/Agenda/index.php?id=200>
- Recordings and Presentations will be posted on the Fall Meeting Website soon!



LSIC | Fall Meeting, Nov 2nd-3rd 2022

The Lunar Surface Innovation Consortium (LSIC) Fall Meeting, hosted by the University of Texas at El Paso (UTEP), provided a forum for NASA and the community to discuss technology development for establishing a sustained presence on the Moon, specifically focusing on lunar excavation and construction.

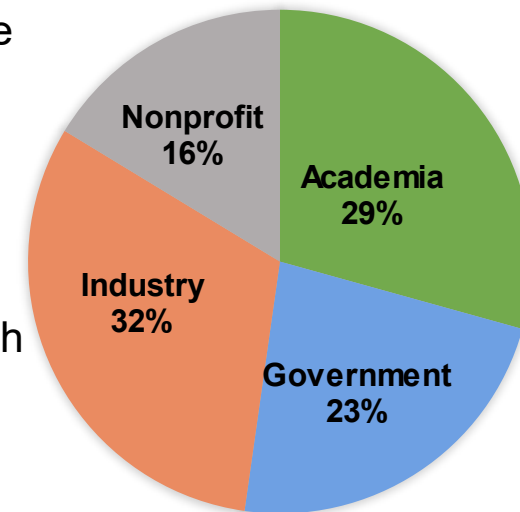
Over the course of two days, 443 individuals, representing >170 institutions attended. Nearly half (49%) of those who attended have not worked with NASA's Space Tech before.



Meeting Highlights:

- Congresswoman Veronica Escobar introduced the Keynote by NASA's Associate Administrator for Space Technology, Jim Reuter
- Former astronaut and current professor at UC Davis, Dr. Steve Robinson, shared a keynote about the Space Technology Research Institute (STRI) Habitats Optimized for Missions of Exploration (HOME)
- UTEP's Aerospace Center, shared their mission and success preparing students from UTEP (>80% Hispanic, majority first-gen) for high-paying jobs in the aerospace industry
- Technical talks and panels on topics including applying terrestrial lessons to lunar excavation, proving grounds, early infrastructure, lunar resources, and emerging technology and space law
- Tours of UTEP facilities, laboratories, and proving grounds, highlighted student's applied research with numerous opportunities for discussion between the students and attendees
- A breakout discussion group between student attendees and Space Tech leadership
- Local tours to visit 3-D printed barracks at Fort Bliss and testing facilities at White Sands

ATTENDEES



LSIC | Fall Meeting, Nov 2nd-3rd 2022

Key Findings:

- Continued understanding of what potential facilities and/or locations exist that can serve as lunar proving grounds will enable developers to mature their technology as effectively as possible on Earth, and will also help identify whether modifications to some of these facilities could help further fill gaps. For instance, large facilities such as White Sands or the Nevada Test Site may have the flexibility to customize areas for specific system-level field tests to prepare for deployment on the Moon. **Impact of dust was not considered equally across proposed proving grounds.**
- NASA's envisioned futures, coupled with discussions between NASA and the community, have provided a strong framework for understanding the challenges and needs for establishing infrastructure on the lunar surface. Continued integration of community feedback, as well as inclusion of the community in master planning will help incentivize private investment. **Industry, academia, and international partners are taking their cues from NASA.**
- NASA's Intellectual Property office models and contracting vehicles are creating constructive models for IP development other sectors are adopting. Cis-lunar technology development, in particular, is projected to have the strongest and highest sustained annual growth (8.6%) in the space sector over the next decade, with significant private investment beyond what NASA is investing. **Effort to increase confidence in this number will continue to build momentum on the commercial side.**
- The community continues to seek to learn more about specific requirements from NASA. The Moon to Mars objectives provides a good starting point, but **the more this framework can be built out in a way that the community can understand concrete needs, the better.**
- Policy content was well-received at this event, compared to the previous LSIC Spring Meeting. Despite calls for a working group, given the inconsistent community appetite for this content **a well-constructed policy workshop may be more beneficial than a recurring meeting.** Consider partnering options.
- The community would like to have a better understanding of who (if anyone) might be a potential long-term customer, especially if there are other governmental needs beyond NASA and the Artemis program. **We need to work to better understand the hand-off following NASA's use of the Moon.** The Moon as a proving ground for more for decades is an idea well received by many within the LSIC community.
- Many technical gaps fall into the category of environmental, such as long-term night survival, radiation hardening, and prolonged dust and vacuum exposure, and logistical, such as standards, interoperability, and management of byproducts from activities (especially ISRU). **It is unclear if environmental complications are being effectively retired in the course of technology directed at other focus areas.**

Topics For DM FG Meetings

- January: Passive Dust Removal
 - Jacquelyne Black, NASA Johnson Space Center
 - “DuSTI Outbrief: Dust Mitigation Characterization of Coatings and Pliable Cleaners”
 - Dr. Stephen Furst, Founder and CEO of Smart Material Solutions, Inc.
 - “Passive Nano- and Micro-Textured Dust-Mitigation Surfaces in Space”
- February: Passive/Active Dust Removal
 - Dr. Kristen John, NASA Johnson Space Center
 - Update on “DuSTI Outbrief: Dust Mitigation Characterization of Coatings and Pliable Cleaners”
 - Dr. Christopher Wohl, NASA Langley Research Center
 - “Updates from the LO-DuSST Team”
- March: Dust Mitigation for Space Suits/EVA
 - Anthony (Drew) Hood, NASA Johnson Space Center
 - “High Level Introduction on EVA Tool Development for Space Suit Dust Mitigation”
 - Dr. Inseob Hahn, NASA Jet Propulsion Laboratory, California Institute of Technology
 - “Lunar dust mitigation technology using electron beam”
- April: Joint E&C and Dust Mitigation FG Meeting
- May: STMD Envisioned Futures

Topics For DM FG Meetings

- June: Dust tolerant mechanisms
 - Ron Creel, Apollo LRV Engineer and LSIC Dust Mitigation “Isolation Technologies” Subgroup Lead
 - “Lunar Dust Protection for Apollo Rover Mechanisms”
 - Dr. Hunter Williams, Honeybee Robotics
 - “Lunar Dust Tolerant Electrical and Data Connector for Small to Large Payloads”
 - Dr. Justin Scheidler and Dr. Erica Montbach from NASA Glenn Research Center
 - “Motors for Dusty and Extremely Cold Environments”
- July: Dust Sensing and Filtration
 - Daniel Cantin, INO (Institut National d'Optique)
 - “iSIPS an innovative dust characterization and monitoring tool: preliminary proof of concept and looking for Lunar applications”
 - Dr. Ben Sumlin, NASA Glenn Research Center
 - “Dust Detection Challenges in Complex Environments”
- August: Testing in Dusty Environments
 - AJ Gemer, Co-Founder & CTO of Lunar Outpost
 - “Particle Detection, Quantification, and Testing in Simulated Lunar Environments at Lunar Outpost”

Topics For DM FG Meetings

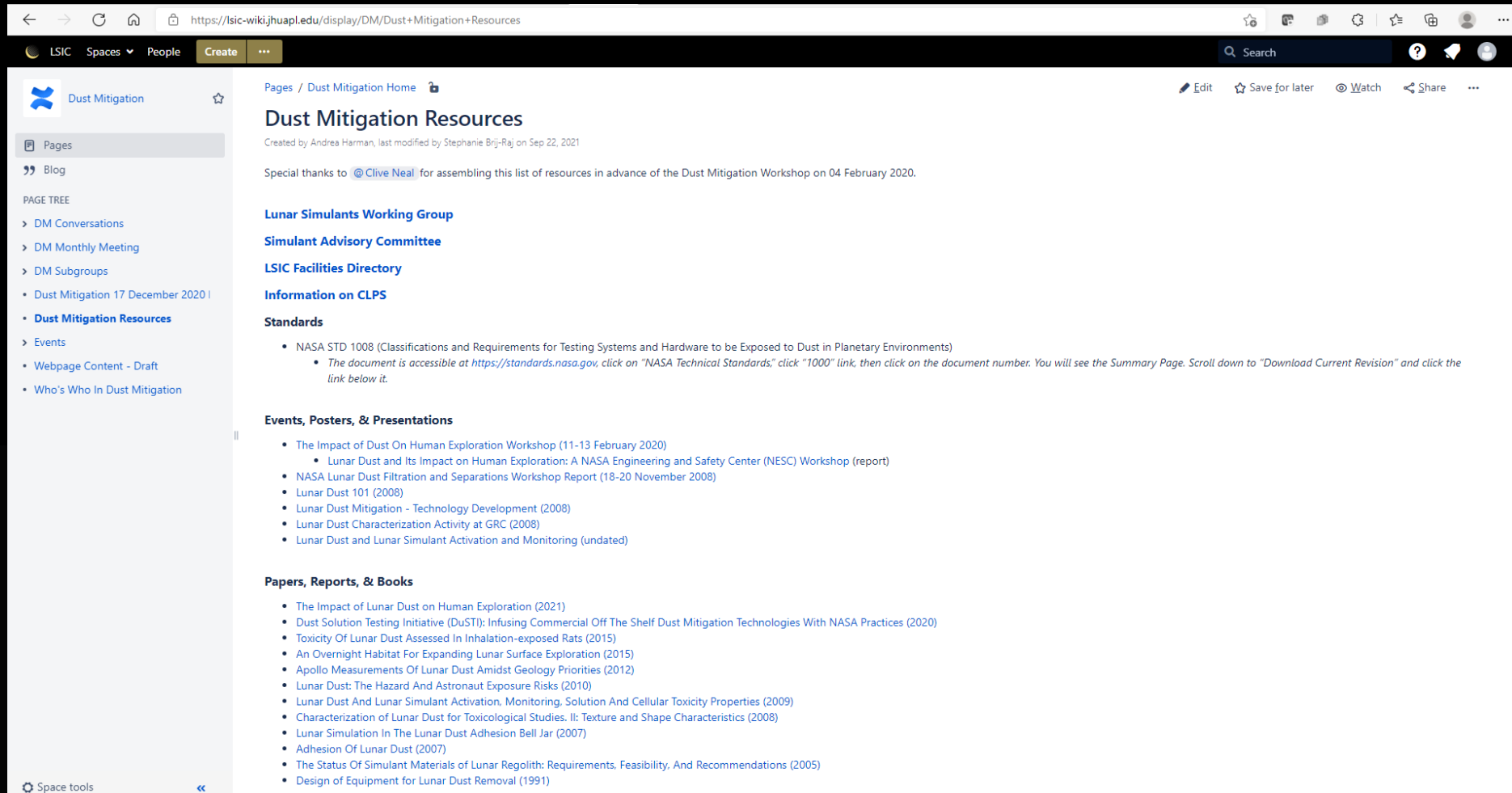
- September: Dust Testing Facilities and LSIC Facilities List
 - Dr. Josh Cahill, APL and LSIC Deputy Director
 - “LSIC Facilities List”
 - Dr. Hossein Zare-Behtash and Andrea Cammarano, James Watt School of Engineering, University of Glasgow, UK
 - “Facility for Dust Mitigation Studies at the University of Glasgow”
 - Dr. Erin Hayward, NASA Marshall Space Flight Center (MSFC)
 - “Planetary, Lunar, and Asteroid Natural Environment Testbed & Other Dirty Facilities at NASA MSFC”
- October: Dust Mitigation Subgroup Networking
- November: Lunar Dust on Human Health
 - Torin McCoy, Moon2Mars Deputy Chief Health and Performance Officer, NASA Johnson Space Center
 - “Crew Health and Lunar Dust: What To Know Before You Go”

Get Involved with Dust Mitigation

- Sign-up to Receive LSIC and Dust Mitigation FG Updates:
 - Fill out the LSIC Survey and indicate interest in Dust Mitigation to receive news and event invitations:
 - <https://lsic.jhuapl.edu/News/Sign-Up.php>
- Help us improve the Dust Mitigation Focus Group!
 - Feedback survey:
https://docs.google.com/forms/d/e/1FAIpQLSdjuTIK_TLMnCM4_aSMLAzLS762qtzbgmcOd2fgizlCsab6KQ/viewform
- Join one of the Dust Mitigation Subgroups!
 - Dust Mitigation Subgroup Membership/Leaders survey:
 - <https://docs.google.com/forms/d/e/1FAIpQLScB6iT2fgPqj2zlaP0s-rwWQDQ04TPfgVyiC5zn0AQPAT5CZA/viewform>
 - Still looking for subgroup lead for Monitoring and Filtration Subgroup!
- Interested in Teaming/Collaborating with Others?
 - Add yourself to our Who's Who page: <https://lsic-wiki.jhuapl.edu/display/DM/Who%27s+Who+In+Dust+Mitigation>
- Looking for info on lunar dust or dust mitigation resources?
 - Checkout our resources page on the Dust Mitigation Wiki page on Confluence: <https://lsic-wiki.jhuapl.edu/x/94Rf>

Dust Mitigation Resources

- Looking for info on lunar dust or dust mitigation resources? Checkout our resources page on the Dust Mitigation Wiki page on Confluence: <https://lsic-wiki.jhuapl.edu/x/94Rf>



The screenshot shows a web browser displaying the 'Dust Mitigation Resources' page on the LSIC Confluence Wiki. The page title is 'Dust Mitigation Resources' and it was created by Andrea Harman, last modified by Stephanie Brij-Raj on Sep 22, 2021. The page content includes a special thanks to @Clive Neal, followed by several sections: 'Lunar Simulants Working Group', 'Simulant Advisory Committee', 'LSIC Facilities Directory', 'Information on CLPS', 'Standards' (listing NASA STD 1008), 'Events, Posters, & Presentations' (listing various workshops and reports), and 'Papers, Reports, & Books' (listing numerous scientific publications). The left sidebar shows the 'Dust Mitigation' space with a page tree including 'DM Conversations', 'DM Monthly Meeting', 'DM Subgroups', 'Dust Mitigation 17 December 2020', 'Dust Mitigation Resources', 'Events', 'Webpage Content - Draft', and 'Who's Who In Dust Mitigation'. The browser address bar shows the URL: https://lsic-wiki.jhuapl.edu/display/DM/Dust+Mitigation+Resources.

Dust Mitigation Highlights, 2021-2022

- Themed Monthly FG Meetings on Key Technology Areas

- Dust Tolerant Connectors
- Dust/Plasma Environment
- Plume/Surface Interactions
- Passive/Active Dust Removal
- Space Suits/Fabrics
- Dust Tolerant Mechanisms
- Lunar Dust and Human Health

- Joint Extended Meetings with other Focus Groups

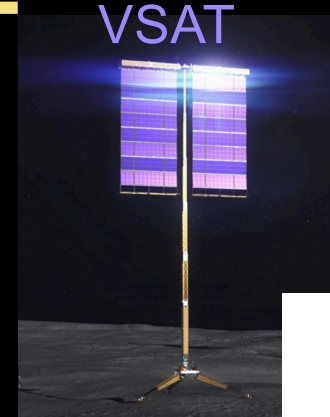
- Vertical Solar Array Technology – VSAT (Joint with EE & SP)
- Plasma Interaction with Lunar Regolith/Dust (Joint with EE)
- Designing Dust-Tolerant Systems (Joint with E&C)

- Special Dust Mitigation Events

- NASA Standards Document 1008: Dust Testing Standards
- CLPS/PRISM Overview and Opportunities
- BIG Idea Challenge Finalist Presentations: Dust Mitigation Technologies

- Networking Events

- CLPS/PRISM Teaming and Networking Event
- Subgroups Kickoff and Networking Event



Dust, Wear & Abrasion in Mining

Brad Blair
Mining Engineer / Mineral Economist
CTO, MoonRise Inc.
April 27, 2022

Dust-Plasma Interactions and Relevance to Exploration

Christine Hartzell
Department of Aerospace Engineering
University of Maryland
2021/08/26

EXPLORE SCIENCE
Payloads and Research Investigations on the Surface of the Moon (PRISM)

Dr. Ryan Watkins
Program Scientist
Exploration Science Strategy and Integration Office (ESSIO)
NASA HQ/SMD

NASA-STD-1008
Classifications and Requirements for Testing Systems and Hardware to be Exposed to Dust in Planetary Environments

BIG IDEA CHALLENGE

Smart Material Solutions

NASA

TEXAS

Passive Nano- and Micro-Textured Dust-Mitigation Surfaces in Space-Grade Materials Made with a Highly Scalable Fabrication Process

LSIC Lunch Meeting January 20, 2022

High Level Introduction on EVA Tool Development for Space Suit Dust Mitigation

Drew Hood | drew.hood@nasa.gov | 832.985.1125

Public Domain
Apollo Lunar Surface Journal

LSIC Dust Mitigation Findings, 2021-2022

- Focus groups and FG meetings are valuable for sharing information between NASA, industry, academia, and non-profit.
 - FG members are able to present their latest research and provide insights into the lunar dust environment and development of technologies for mitigating lunar dust
 - FG meetings provide opportunities to network and foster collaborations
 - NASA is able to disseminate information to community about new announcements and opportunities, and is able to get feedback quickly
- Lunar Dust is a major concern and dust tolerant/dust mitigation solutions are critical for enabling sustained surface operations.
- Bringing Dust Mitigation technology developers and system developers together (including ESDMD) is important for incorporating new dust mitigation technologies into systems/architectures in time.
 - Commercial providers are in good position to infuse new dust mitigation technologies into their systems
- High priority challenges and needs:
 - Establishing set of tolerances allowing systems to operate “dirty”
 - Acquisition of ground truth dust properties and plume/ejecta data from precursor missions to validate modeling tools and designs
 - Develop and standardize simulants and testing conditions to better capture real dust problems instead of approximations
 - Pathways and mechanism for integrating dust tolerant/mitigation technologies into lunar systems and architecture
 - Technology demonstrations on CLPS landers to test in real-world conditions

- NASA's broad portfolio in dust-mitigation technologies is making progress, but continued investment is needed to mature these technologies for flight.
- It is difficult to determine if technologies will be ready when needed, and whether progress is advancing at a satisfactory pace.
 - There are no "need dates" for the technologies, no links to specific flight programs.
 - Requirements flow down and traceability is missing. No phased-development programs, partly because most technologies are still low TRL and development schedules are variable.
 - The lack of requirements flow-down makes it difficult to set priorities, if that becomes necessary.
- Better coordination between STMD and ESDMD is needed
 - Need clear infusion plan between technologies and the architecture.
 - E.g., links between the STMD spacesuit technology development programs and the ESDMD suit developers are missing.
 - Coordination is needed to minimize redundancy in development and testing programs
- Additional flight demonstrations are needed to mature DM technologies and incorporate them early in precursor demo flight demonstrations.

- For the initial, short-duration missions, there are existing methods to address dust mitigation.
 - These existing methods do not eliminate the need to find solutions for a sustained presence.
 - Some are labor intensive (clean solar panels or suits by hand),
 - Some are wasteful and expensive (replace mechanisms, seals, or spacesuits when they wear out).
 - Masks, replaceable filters
- There has been little work on the effects of and mitigation for nanoparticles (<1 micron), which are likely to cause both mechanical and health problems. At least part of the deficiency has been a lack of facilities capable of working with nanoparticles.
 - Recommend developing facilities that focus on small particles.
- Many dust technologies are at a low TRL.
 - Although NASA's investments in dozens of dust-mitigation technologies have made important advances, no dust-mitigation technology has been demonstrated in relevant environments, most are <TRL 5, and the links to the seals, cleaning, filtering, etc. needed for early missions are unclear.



Dust Mitigation Gap Assessment Report - Recommendations

- Develop level 1 and level 2 (derived) requirements and include dust-tolerance. Trace these requirements from individual technologies to flight-program needs.
 - Build and maintain a database of dust requirements, research, and technologies.
- Create a prioritized list for developing technologies.
- Coordinate research between the focus groups to eliminate duplication, utilize overlap, and ensure dust-related requirements each group are incorporated into planning by the dust-mitigation group.
- Develop a process for scheduling facilities for testing dust-mitigation technologies and procedures. Create a form and institute a central location for requesting testing.
- Expand the roadmap and provide supporting details. Incorporate needs from other technology Focus Areas.
- Coordinate soft-material research and cleaning technologies with spacesuit developers.
- Review major issues and initiate workshops where it is useful to gather the community. Usually, this applies to new or unsolved problems that need reevaluation. Examples include
 - Spacesuit materials that are resistant to abrasion by dust and that repel dust or are easily cleaned.
 - “From Dust to Flight: Infusing Dust Mitigation Technology into Flight Programs”

What is next for Dust Mitigation FG?

What would you like to see for Dust Mitigation Focus Group in 2023

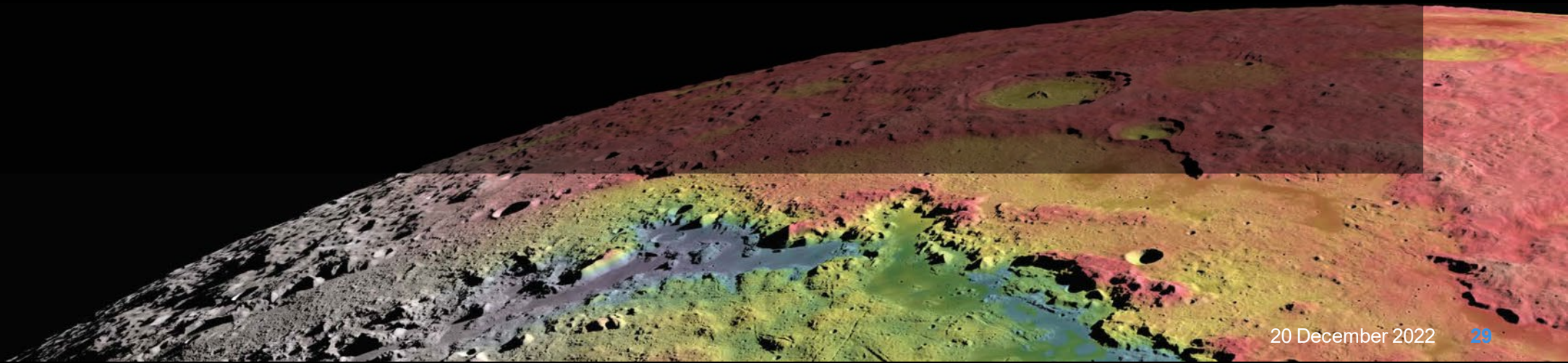
- What benefits have you gained from being part of the LSIC Dust Mitigation Focus group?
- Is there anything else you enjoy about monthly meetings? Anything you'd like to see us change?
- Is there anything you liked about this past year that you'd like to see continue?
- Is there anything about this past year that you'd change going forward?
- Are there any topics we have not covered you would like to see covered (or see more)?
- Are there other activities you would like to see us organize?

- **Please fill out the feedback survey:**

- https://docs.google.com/forms/d/e/1FAIpQLSdjuTIK_TLMnCM4_aSMLAzLS762qtzbgmcOd2fgizICsab6KQ/viewform

Looking forward to 2023

- LSIC Spring Meeting (March 29-30, 2023)
- LSIC “White Paper”
- LSIC Dust Mitigation Workshop (Spring 2023)





JOHNS HOPKINS
APPLIED PHYSICS LABORATORY