

The Lunar Surface Innovation Consortium is administered by the Johns Hopkins Applied Physics Laboratory, and operates in collaboration with the NASA Space Technology Mission Directorate under the Lunar Surface Innovation Initiative. Its purpose is to harness the creativity, energy, and resources of the nation to help NASA keep the United States at the forefront of lunar exploration. To find out more, sign up to participate, or access past additions of this newsletter, please visit lsic.jhuapl.edu.

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Director's Update

We are looking forward to meeting with many of you soon at our LSIC Spring Meeting (<http://lsic.jhuapl.edu/News-and-Events/Agenda/index.php?id=124>), which will be held virtually on May 11-12. We are thrilled to announce that the acting NASA Chief of Staff Dr.



Bhavya Lal will be presenting a key note address on the first day of the meeting. Much of the first day will focus on providing updates about NASA and LSIC, including discussing the annual goals and planned activities of LSIC and its focus groups and continued discussion of funding and flight opportunities for the community. The second day will be focused on technical presentations (short talks and posters) and networking events. If you would like to present at

the meeting, the abstract deadline is April 7. A draft agenda will be posted on the meeting website as soon as it is available, and registration will open by the second week of April.

I would like to thank the community for the enthusiastic participation that we have had in both consortium-wide meetings and focus group meetings over the last year. We are eager to continue to provide a forum for technical discussions and to provide opportunities for new partnerships and other collaborations. Focus group facilitators are working to try to get more discussions from focus group meetings captured on the LSIC Confluence site, so that participants can catch up and join in on these exchanges even if they cannot make it to a given meeting. Similarly, we are using this site to post outcomes from the semi-annual meetings. Please don't be shy about providing feedback on our findings—LSIC is here for you, and we are eager to know how we can continue to evolve to meet the needs of the community. If you do not have an account for Confluence, please contact Andrea Harman (ams573@alumni.psu.edu) and she will get you set up.

Rachel Klima

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Focus Area Monthly Telecon Schedule

If you'd like to participate in a focus area's monthly telecon, please sign up on the LSIC website here: lsic.jhuapl.edu/Events/survey.php

Dust Mitigation

Third Thursdays at 12PM Eastern

Excavation & Construction

Last Friday at 3PM Eastern

Extreme Access

Second Thursdays at 3PM Eastern

Extreme Environments

Second Tuesdays at 3PM Eastern

In Situ Resource Utilization

Third Wednesdays at 3PM Eastern

Surface Power

Fourth Thursday at 11AM Eastern

LSIC Spring Meeting 11-12 May 2021

The LSIC Spring Meeting will be held virtually on May 11-12. The meeting will include updates from NASA, networking opportunities, and contributed technical content from the community. We invite the community to submit abstracts describing technical capabilities within the six LSIC focus areas, as well as those that identify lunar surface technology needs and assess the readiness of relative systems and components. Other topics of interest include defining the parameters and constraints of the architecture required to support a sustained presence on the lunar surface, as well as economic and policy considerations. All abstracts are due by April 7th, 2021. Additional information and submission portal can be found on the event webpage here: <http://lsic.jhuapl.edu/News-and-Events/Agenda/index.php?id=124>

Funding Opportunities

NLRA 2021-3: Technology Advancement and Applied Research on the ISS National Lab (STEP 2)

<https://www.issnationallab.org/research-on-the-iss/solicitations/nlra2021-3/>

Step 2 Proposal Deadline: 26 April 2021



Novel Orbital and Moon Manufacturing, Material, and Mass-efficient Design (NOM4D)

https://beta.sam.gov/opp/511428768def43728a6a190ec2541c5c/view?keywords=nom4d&sort=-relevance&index=&is_active=true&page=1

Proposal Deadline: 27 April 2021

NLRA 2021-5: In-Space Production Applications: Advanced Manufacturing and Materials

<https://www.issnationallab.org/research-on-the-iss/solicitations/nlra2021-5/>

Step 1 Proposal Deadline: 06 May 2021 - Step 2 Proposal Deadline: 22 June 2021

Minority University Research and Education Project (MUREP) Space Technology Artemis Research (M-STAR) solicitation

<https://nspires.nasaprs.com/external/solicitations/summary.do?solId=%7b417DB666-0D23-6D49->

[8BF4-F4EAF4B0AF5D%7d&path=&method=init](#)

Proposal Submission Deadline: 10 May 2021

Deep Space Food Challenge

https://www.nasa.gov/directorates/spacetech/centennial_challenges/spacefood/index.html

Phase 1 Registration Deadline: 28 May 2021 - Submission Deadline: 30 July 2021

Break the Ice Lunar Challenge

<https://breaktheicechallenge.com/>

Registration and System Architecture Submission Deadline: 18 June 2021

See more funding opportunities on the LSIC website here:

<http://lsic.jhuapl.edu/Resources/Funding-Opportunities.php>

Feature Article: Dust Mitigation Workshop Outbrief (February 2021)

On February 4, 2021, the Lunar Surface Innovation Consortium's Dust Mitigation Focus Group held a one-day virtual workshop focused on Dust Mitigation. The purpose of the workshop was to bring together lunar architecture systems developers, dust mitigation technology developers, and lunar scientists to discuss outstanding challenges and knowledge gaps in dust mitigation, identify technology solutions that are already available, and define areas that require future investment.

The workshop consisted of invited presentations, contributed lightning talks, and breakout discussion sessions. Nine invited presentations provided an update on the current state knowledge of lunar dust, NASA's dust mitigation strategy, and NASA's lunar architecture elements, including Gateway, HLS, lunar rovers, xEMU, and ISRU. Nineteen contributed lightning talks highlighted new technologies and challenges for dust mitigation, including new dust tolerant mechanisms, joints, and connectors, active/passive dust removal tools and surfaces, and dust tolerant covers and fabrics. The breakout sessions enabled deeper discussions of current challenges and gaps in dust mitigation, and next steps and priorities for future opportunities. The five breakout groups focused discussions on the following areas: (1) Ascent/Descent, Dust Plumes, and Surface Modification; (2) EVA, Spacesuits, and Habitats; (3) Surface Mobility and Operations; (4) Instruments, Tools, and Mechanisms; and (5) ISRU and Surface Power.

A total of 344 attendees from 204 institutions participated in the workshop, and 142 participated in the breakout groups. Workshop participants broke down as follows: 20% Academia, 28% Government, 43% Industry, and 9% Nonprofit. Over 50% of attendees indicated they have not worked with NASA STMD before. Recordings of the workshop and associated information may be accessed at the workshop website.

Priority technology gaps identified by workshop participants:

- Abrasion resistant, passive dust repelling optical surface coatings
- Dust tolerant, abrasion resistant dynamic seals
- Dust monitoring and filtration inside habitats
- Multi-physics and multi-scale modeling capabilities (ex. thermal, electrostatic, structural, granular flows), and experimental / measurement data for software validation and verification

Challenges and Needs:

- **Establishing a standard set of tolerances allowing systems to operate “dirty.”** Complete mitigation or removal of lunar dust is not always possible. Providing design references and limits of allowed dust load is important for enabling dust tolerant systems to operate in dusty environments.
- **Acquisition of ground truth dust properties and plume/ejecta data from precursor missions to validate modeling tools and improve dust mitigation technology designs.** New data on lunar dust properties and plume ejecta is needed to improve mitigation technologies and validate ejecta models.
- **Developing and standardize simulants and testing conditions to better capture realistic dust problems.** As the number of lunar simulants and testing facilities grow, establishing standard testing conditions are necessary for approximating lunar dust environment(s) and enabling proper comparison of the effectiveness of different dust mitigation technologies.
- **Clear pathways and mechanisms for integrating dust tolerant/mitigation technologies into lunar systems and architecture.** As dust tolerant/mitigation technologies mature, there is no clear path for how these technologies can get integrated into lunar systems. Establishing clear pathways for integrating dust tolerant/mitigation technologies into lunar systems are critical for ensuring these technologies are incorporated in time without requiring major adaptation or redesign.
- **Technology demonstrations on CLPS landers to test in real-world conditions.** Many dust mitigation technologies have matured to the point of needing testing in the lunar environment for further development and validating performance under real world lunar conditions.

Article Alert: **Walking On Rocket Propellant**

From Aerospace America

Here’s a snippet from an opinion article written by Michael Nord, In Situ Resource Utilization Sub-Lead for O2 Extraction.

“Returning to the moon to stay will require making rocket propellant on site on the moon, so that crews can rotate back to Earth. As it turns out, mining water ice may not be the fastest or easiest way to produce lunar rocket propellant. Michael Nord of the Lunar Surface Innovation Consortium at Johns Hopkins Applied Physics Laboratory in Maryland explains.”

Click here to read the full article: <https://aerospaceamerica.aiaa.org/departments/walking-on-rocket-propellant/>

Materials From Workshop On Lunar Mapping For Precision Landing **Now Available Online**

We’d like to once again thank the presenters and event attendees who helped to make the Workshop On Lunar Mapping For Precision Landing in March a huge success! All the presentations and videos from the event are now available on LSIC’s website, and can be accessed here: <http://lsic.jhuapl.edu/News-and-Events/Agenda/index.php?id=120>

Member Spotlight: MIT Space Exploration Initiative (SEI)

With humanity at the cusp of interplanetary civilization, the MIT Space Exploration Initiative (SEI) is building the technologies, tools, and human experiences of our sci-fi space future. We are creating space technologies that envision a bold and culturally rich “new space age,” from shareable CubeSat constellations, to bioastronautics wearables, to self-assembling space habitats. The SEI supports 40+ research projects and a team of over 50 graduate students, staff, and faculty; we foster community and collaborations across MIT and with other academic, government, and industry partners.

In addition to supporting regular zero-gravity and suborbital launch opportunities, SEI led the MIT Media Lab’s first ever International Space Station (ISS) internal and external missions, deploying [five payloads](#) to the station last year. Bolstered by an Memorandum of Understanding signed with Blue Origin to prospectively [manifest a payload](#) onboard its inaugural Blue Moon lunar lander, we are excited to push further into the solar system, supporting a range of ongoing activities related to lunar exploration.

Operating in the Lunar Environment: A new course for lunar engineering and science

As NASA prepares for a human return to the lunar surface, the agency has identified a set of key capabilities and core technologies that will be critical to its exploration strategy. This spring, the MIT Media Lab and MIT AeroAstro department have launched a new course, co-taught by SEI Director, Ariel Ekblaw, and MIT AeroAstro professor and former NASA Astronaut, Jeffrey Hoffman. The Operating in the Lunar Environment course provides a detailed exploration of the design and engineering challenges posed by operating in the lunar environment, in support of humanity’s return to the lunar surface.

In this course, students gain hands-on experience, working in teams, to design a payload to address strategic objectives associated with NASA’s Artemis program, aiming to enable near-term sustainable settlements on the lunar surface. Over the course of the semester, each student is also responsible for proposing a novel mission concept scenario, undergoing a rigorous mission formulation exercise and preliminary and critical design review processes.

Lectures and associated recitations explore varying mission goals and operating environments, from lunar-class launch, to orbiters, landers, rovers, and habitats. Guest lectures include prominent engineers, scientists, industry players and policymakers, with direct experience in lunar mission design and development. We encourage you to visit our course website (<http://tothemoon.pubpub.org/>) to view recordings of the lectures, as well as to see the current payload projects under development.

There are still opportunities to engage with the course, either through supporting student projects, sponsoring the course, or joining for design reviews and office hours sessions.

The Moon Dialogs

MIT SEI is a proud co-convener – along with the Arizona State University Interplanetary Initiative, Open Lunar Foundation, Secure World Foundation, and For All Moonkind – of the Moon Dialogs. The Moon Dialogs is a partnership focused on governance and coordination for the Moon. We bring together organizations and people exploring guardrails and frameworks that aim to help companies and countries going to the Moon to thrive and do so wisely and collaboratively. Every month we host a Full Moon webinar to dig into a topic, with a few hundred people attending each time. We have created a platform where people speak very different views, and discover the themes or shared challenges and opportunities. Most

recently, we hosted a session with Commander Chris Hadfield, Professor Yuguan Yang, China's regional coordinator of the Moon Village Association, Dr. Jinyuan Su, Professor at Wuhan University Institute of International Law, and Dr. Olga Volynskaya, a Russian space law and policy expert, on the recent announcement of the future Chinese and Russian International Scientific Lunar Station (the recording can be found [here](#)). The audience of the webinars typically includes decision makers from space agencies around the world, legal teams, companies, as well as professors and scientists.

This year, we have also launched three new theme areas with associated action teams exploring accessibility, peace, and sustainability on the lunar surface. For more information on these action teams and getting involved: <https://www.moondialogs.org/2021-approach>.

The upcoming Moon Dialogs research salon will be hosted by the MIT SEI on Thursday, April 15th, held during the annual Beyond the Cradle event as part of [MIT Space Week](#), and the theme will center around Accessible Moon. Registration information will be posted soon on the Moon Dialogs website.

For more information, please visit moondialogs.org.

The Lunar Open Architecture: building an open, shared, and collaborative future of lunar exploration

The Lunar Open Architecture (LOA) is a project led by MIT SEI to develop an open-source, collaborative, and dynamic roadmap for lunar exploration. Rather than generating top-down static roadmaps, that reflect a narrow set of objectives and goals that will soon be out of date, LOA tracks developments around the world in technology, science, industry, as well as policies that support lunar exploration. This mapping allows us to identify gaps and synergies towards collectively achieving objectives that will unlock lunar exploration.

Community Bulletin Board

Planetary & Terrestrial Mining Sciences Symposium and the Space Resources Roundtable (SRR)

Submitted by Angel Abbud Madrid, Colorado School of Mines

Just a quick reminder that registration is [open](#) and that abstracts for the 11th joint meeting of the Planetary & Terrestrial Mining Sciences Symposium (PTMSS) & the Space Resources Roundtable (SRR) are due on April 12th. You can submit your abstract through [this page](#). Detailed information on abstract preparation, registration, sponsorship opportunities, and other logistical material of this virtual meeting can be found in the conference website: <https://www.ptmss.ca>

The Planetary & Terrestrial Mining Sciences Symposium and the Space Resources Roundtable (SRR) will hold their 11th joint meeting virtually the week of June 7-11, 2021. The meeting will be hosted by the Canadian Minerals and Metals Plan Secretariat. This conference will bring together world experts from space agencies, research organizations, academia, the mining supply chain, the general extractive industry, equipment manufacturers, private enterprise, financial and legal experts, and policy makers to present innovative approaches in space resource characterization, technology development, public and private partnerships, capability and regulatory regimes.

NASA News

NASA 2021 SBIR Program Phase I Selections

25 March 2021 (RELEASE 21-034): Small businesses are vital to NASA's mission, helping expand humanity's presence in space and improve life on Earth. NASA has selected 365 U.S. small business proposals for initial funding from the agency's Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) program, a total investment of more than \$45 million.

"At NASA, we recognize that small businesses are facing unprecedented challenges due to the pandemic," said Jim Reuter, associate administrator for the agency's Space Technology Mission Directorate (STMD). "This year, to get funds into the hands of small businesses sooner, we accelerated the release of the 2021 SBIR/STTR Phase I solicitation by two months. We hope the expedited funding helps provide a near-term boost for future success."

NASA selected 289 small businesses and 47 research institutions to receive Phase I funding this year. More than 30% of the awards will go to first-time NASA SBIR/STTR recipients. "We are excited to have a large cohort of new small businesses join the NASA family via the SBIR/STTR program," Reuter said.

[Click here](#) to read more.

NASA Mega Moon Rocket Passes Key Test, Readies for Launch

18 March 2021 (RELEASE 21-030): The largest rocket element NASA has ever built, the core stage of NASA's Space Launch System (SLS) rocket, fired its four RS-25 engines for 8 minutes and 19 seconds Thursday at NASA's Stennis Space Center near Bay St. Louis, Mississippi. The successful test, known as a hot fire, is a critical milestone ahead of the agency's Artemis I mission, which will send an uncrewed Orion spacecraft on a test flight around the Moon and back to Earth, paving the way for future Artemis missions with astronauts. [Click here](#) to read more.

(18 March, '21): The core stage for the first flight of NASA's Space Launch System rocket is seen in the B-2 Test Stand during a second hot fire test, Thursday, March 18, 2021, at NASA's Stennis Space Center near Bay St. Louis, Mississippi. The four RS-25 engines fired for the full-duration of 8 minutes during the test and generated 1.6 million pounds of thrust. This and additional images can be found by going to: <https://images.nasa.gov/album/GreenRun>

