Lunar Surface Innovation
CONSORTIUM

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LSIC Newsletter

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.

Director's Corner

Hello LSIC Community!

I have a handful of updates to share this month. First off, continuing on the Moon to Mars Architecture theme from last month, I wanted to make sure that everyone has seen that the feedback process for that document is now underway. I encourage all of you to read through the document and think about where your technologies could contribute.

For those who missed, or would like to rewatch parts of, this year's LSIC Spring Meeting, the videos and some of the slide decks are now posted on the LSIC webpage under past events. If you did attend and still want to provide feedback about the event, the Spring Meeting survey is still available. We are already working on plans for the Fall Meeting in Pittsburgh (October 10–11), so any feedback received will be extremely helpful as we formulate our plans for sessions at that meeting. Similarly, if you attended the Space Technology Competitive Opportunities Workshop, please consider providing feedback to that at the workshop's survey.

Finally, don't forget that we have two workshops coming up in July, both of which are open for registration. The Lunar Proving Grounds Definition Workshop on July 12–13 will focus on exploring the needs, attributes, and performance capabilities that will be necessary for a Lunar Proving Grounds. The Power System Reliability Workshop will be held later next month, on July 26–27. This workshop will:

- Focus on characterizing and quantifying reliability at both the system and component levels.
- Carefully consider the level of redundancy necessary for both crewed and robotic systems.
- Strive to maximize interoperability and simplicity at the earliest phases of technology development in order to streamline maintenance and repair of a fully realized future lunar grid.

To the Moon!

Rachel Klima
Director, Lunar Surface Innovation Consortium
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Focus Areas

Monthly Telecon Schedule

Dust Mitigation
Third Thursdays at 12PM Eastern

Excavation & Construction
Last Wednesdays at 2PM Eastern

Extreme Access
Second Thursdays at 3PM Eastern

Extreme Environments
Second Tuesdays at 3PM Eastern

In Situ Resource Utilization
Third Wednesdays at 3PM Eastern

Interoperability
First Wednesdays at 1PM Eastern

Surface Power
Fourth Thursdays at 11AM Eastern

LSIC General Updates

Save the Date: Lunar Proving Grounds Definition Workshop, July 12–13

The Lunar Surface Innovation Consortium (LSIC) will host a hybrid Lunar Proving Grounds Definition Workshop on July 12–13 at the Johns Hopkins Applied Physics Laboratory (APL) in Laurel, Maryland. The topics of test facilities and Earth-based Lunar Proving Grounds (LPG) have come up across all six Focus Areas of LSIC, and component- and instrument-level testing have been developed extensively at various facilities across the U.S. However, an integrated testing facility (or network of testing locations) where technology developers can verify and validate their technologies in conjunction with other dependent technologies at the larger system level, specifically to ensure system readiness for flight and operation on the lunar surface, still requires development. Over the course of this two-day workshop, we will dive into these topics and explore the requirements and characteristics that will be necessary for a unified LPG.

While the LSIC Lunar Proving Grounds Definition Workshop will be offered in hybrid format, we strongly encourage in-person participation, if possible, to maximize discussion and collaboration opportunities. A tentative agenda and a link to register will be disseminated shortly. Registration is free but required for participation, and a catered lunch may be purchased during the workshop registration process if desired.

Additional Upcoming Meetings

- Power System Reliability Workshop, July 26–27 (virtual)
- Joint Excavation & Construction/Extreme Access Autonomy Workshop, August 21 (virtual)
- 2023 LSIC Fall Meeting: October 10–12 (hybrid) & Transition to Industry Workshop
  Hosted by Community College of Allegheny County, Pittsburgh, PA
- 2024 LSIC Spring Meeting: Week of April 22, 2024 (hybrid)
  Johns Hopkins Applied Physics Laboratory, Kossiakoff Center, Laurel, MD

LSIC harnesses the creativity, energy, and resources of the nation to help NASA keep the United States at the forefront of lunar exploration. LSIC operates in collaboration with the NASA Space Technology Mission Directorate under the Lunar Surface Innovation Initiative, fostering communications and collaboration among academia, industry, non-profits, and government. Visit http://lsic.jhuapl.edu for more information.

Focus and Working Group Updates

Dust Mitigation

The Dust Mitigation (DM) Focus Group held its monthly meeting on May 18. The meeting centered on the topic of "Using In Situ Materials for Dust Mitigation" and featured a technology presentation by Dr. Alexander Niecke from RWTH Aachen University and Dr. Alexander Lüking from FibreCoat on "MoonFibre—Solving Lunar Dust Problems by Using Dust as Raw Material." In addition, we also discussed monthly LSIC updates, upcoming opportunities and workshops, and LSIC Spring Meeting major takeaways, and provided an update on our DM subgroups. If you are interested in leading or joining a DM subgroup, please fill out our survey.

You can view the recording, slides, and notes from May's DM Focus Group meeting and previous meetings on the LSIC Dust Mitigation Focus Group page.

Update on the 2nd LSIC Dust Mitigation Workshop: The workshop has been moved to early fall 2023 to deconflict with other workshops held in the spring and summer. This workshop is a follow-on to the successful LSIC Dust Mitigation Workshop held in 2021 and will feature a combination of invited presentations from NASA and the community, contributed talks, and breakout discussion sessions. Dates will be announced!

Our next Focus Group meeting will be held Thursday, June 15, at 12:00 p.m. EST. The meeting will include featured technology presentations along with a discussion session. We look forward to seeing you then!

Excavation & Construction

The Excavation and Construction (E&C) Focus Group hosted a meeting on May 31. We heard from two sets of speakers—first was Naveen Kumar Muthumanickam from the National Renewal Energy Laboratory (NREL), who discussed outfitting. This was followed by a briefing from Chris Dreyer of the Colorado School of Mines. He discussed tools and methods for autonomous landing pad construction on the Moon's surface.

This meeting was followed by two breakout sessions for our four subgroup communities—one breakout room for Autonomy & Site Planning and Additive Manufacturing & Raw Materials, and a second for Site Prep, Horizontal & Vertical Construction and Outfitting & Maintenance.

Extreme Access

It has been a very busy month for the Extreme Access (EA) Focus Group, with a lot of informative speakers and a few exciting updates. Our main telecon meeting featured Mark Moll from PikNik Robotics with a presentation regarding "A General Framework for Remote Command and Control of Robots in Space." Our Mobility Technology Subgroup hosted Rawyn Duvall of Carnegie Mellon University discussing work on the Iris Lunar Rover. Over in the Communications Subgroup, Lindsay Papsidero from Crescent Space discussed "Parsec Lunar Relay Satellite System." And finally, our Position, Navigation, and Timing (PNT) Subgroup featured a riveting talk from Phillip Linden at Open Lunar Foundation, who made the case for a standard lunar time in his presentation entitled, "Possibilities for a Local Lunar Time Standard."

We are excited to announce the launch of our newest effort, the Autonomy Subgroup. This subgroup will be led by APL's Dr. Alhassan Yasin. Dr. Yasin is a multidisciplinary scientist with a background in physics, ML/AI, and engineering. His current research spans topics related to quantum computing, AI, ML, theoretical and computational physics, and mechanical engineering. The Autonomy Subgroup will meet on the fourth Wednesday of the month at 1:00 p.m. EST, beginning June 28! As a strengthening of LSIC's emphasis on autonomy, the group is planning an Autonomy Workshop for the end of summer. More details on this event will be forthcoming.

We are still soliciting feedback on the community-driven whitepaper shared earlier this month.

The EA Focus Group Leader, Sarah Withee, has announced she is stepping down from her role to pursue exciting opportunities elsewhere at APL. We thank Sarah for all of her hard work leading the EA community, and we wish her success as she takes on the challenges of solving interesting and exciting problems in her field. Taking her place is Mario Lento, a member of the senior professional staff in APL's Space Exploration Sector. Mario has a background in Aerospace Engineering, earning his bachelor's and master's degrees at the Florida Institute of Technology on Florida's space coast. Mario also works with Johns Hopkins University's Whiting School of Engineering, serving as an instructor for the Space Systems Engineering program.

Extreme Environments

Attention, all Extreme Environments (EE) LSIC members! In June, we will be utilizing the Monthly Meeting to survey our community on our current subgroup structure and future workshop topics. Do you like the current subgroup themes? What would you like to see in our future EE workshops? What workshop and subgroup meeting format would you suggest to best serve your interests and needs? We are eager to hear from you and will try our best to incorporate these changes in the near future. Additionally, we will host a talk by a NASA SBIR awardee! Please come and join us. Jeffrey Olson from Lockheed Martin and Darren King from CU Aerospace will speak on "Three-Stage Cryocooler Cold Head for Advanced Heterodyne Sensors."

In Situ Resource Utilization

This month, the In Situ Resource Utilization (ISRU) Focus Group meeting featured Dr. Richard Wainner (Physical Sciences, Inc.), a Principal Research Scientist and PI of the DARPA-funded research, speaking on "Efficient Orbital Structures Manufactured using Melted Regolith Simulant." Dr. Wainner presented his team's project to develop processes and hardware to melt-process lunar regolith into building block parts for assembly into mass-efficient orbital structures. This assembly includes fabricating regolith glass rods (extruded) and nodes (molded) on the lunar surface, constructing truss-based regolith glass struts on orbit, and assembling very large structures from regolith glass struts and nodes. We closed the meeting with an extended, informal "coffee & donuts" discussion, focused on the Industry Whitepaper and general takeaways and thoughts from April's LSIC Spring Meeting. We also briefly discussed the goals and plans for the Lunar Proving Grounds Definition Workshop, to take place in hybrid format at APL on July 12–13.

Next month, we'll have two guest speakers at our June monthly telecon: Süleyman Salihler from Polimak will present on "Reliable Regolith Handling: A Modular, Low-Power Conveying System for Handling Abrasive Materials in Space and Lunar Environments," and Sarah Withee from APL will present "ISRU: What You Need to Know About Lunar Communications."

Surface Power

In May, the Surface Power (SP) Focus Group hosted a Vertical Solar Array Technology (VSAT)-themed telecon. The event focused on NASA's VSAT Phase 2 awards to develop, construct, and test low-mass prototype arrays that are dust-resistant, stable on sloped terrain, and deployable at the Lunar South Pole by the end of the decade. The systems developed through the VSAT program will create the foundation of the initial power grid on the Moon. Representatives from each of the three Phase 2 awardees, in addition to NASA's VSAT Project Manager Chuck Taylor, spoke at the telecon. The company presenters included Ryan Wiseman (Systems Engineering Lead and Deputy Project Manager for Lockheed Martin), Dean Bergman (Director of Strategy and Development for Exploration Systems for Honeybee Robotics), and John Landreneau (Project Manager for Lunar Surface Systems for Astrobotic). After the presentations, the four speakers participated in an extended panel discussion and answered questions submitted by the community. If you are interested in presenting at a future telecon, or coordinating a meeting with the SP Focus Group, please don't hesitate to reach out.

The SP Focus Group's next monthly telecon on June 22 will focus on power requirements for lunar habitats and potential uses of waste heat in bioregenerative life support systems. Speakers for the telecon will include Paul Kessler (NASA Surface Habitat Lead Architect), Ali Bazzi (UConn, Co-I for the Resilient ExtraTerrestrial Habitats research institute [RETHi]), and Marshall Porterfield (Pulsar).

Additionally, registration and abstract submission are open for the Power System Reliability Workshop that will take place virtually July 26–27 from 11:00 a.m. to 3:30 p.m. EST. Abstracts are due by July 1. You can find additional details for the event on the Workshop page.

Interoperability Working Group

Reminder that last month, we rebranded from MOSA Working Group to Interoperability Working Group to reflect the broader scope of our work. Join our next telecon on June 7: David LaBranch, a Geospatial Information Officer from the Office of the Assistant Secretary of Defense (Sustainment) will present on the DOD's Spatial Data Standards for Facilities, Infrastructure, and Environment (SDSFIE). More information can be found here. As always, recordings of our telecons, including last month's presentation on Lockheed Martin's Lunar Mobility Vehicle, can be found on the LSIC site.

Lunar Simulants Working Group

Our main activity in May has been organizing a speaker for the Lunar Simulants (LS) Working Group Speaker Series, and we are thrilled to announce that Dr. Doug Rickman (Jacobs/MSFC) will be our inaugural speaker in June! His talk, entitled "The Art of Simplification: Making the Choices that Allow Simulants to be Made, Chosen, and Used," will be held on June 15 at 1:00 p.m. EST—meeting invites to go out shortly. If you are interested in being invited to our Speaker Series, please join our LSWG email listserv by emailing our LS Working Group lead, Karen Stockstill-Cahill. We are also interested in hearing about your simulant-related research and are accepting topic suggestions that you'd like to hear more about. If you would like to volunteer to be a speaker or have an idea for a topic that you'd like covered, please email Karen. Finally, we continue to monitor the LSIC Lunar Simulant User Needs Survey, which helps us to advise NASA on current and upcoming simulants needs.

Feature Article

NASA Asks APL to Conduct Data Buy Survey

NASA's Space Technology Mission Directorate (STMD) asked APL to reach out to the Lunar community through the LSIC and conduct a "Data Buy" survey to help understand the needs for, value of, and costs of, data needed to develop a sustainable lunar presence and lunar economy.

APL conducted the survey to understand the community's perspective on potential data for use across a variety of stakeholders. The survey also attempted to gain insights on value, ownership, distribution, and access to the data. The APL-developed Data Buy survey remains open, and readers are encouraged to respond.

The survey attempted to identify the types of data needed, the fidelity of the data, and the frequency of collection. In addition to understanding the data needed, the survey asked questions to elicit information on how to control, distribute, and pay for the data collected.

One aspect of the survey was defining what is meant by "Data Buy." For the purposes of the survey, we used the following description for what a Data Buy could include:

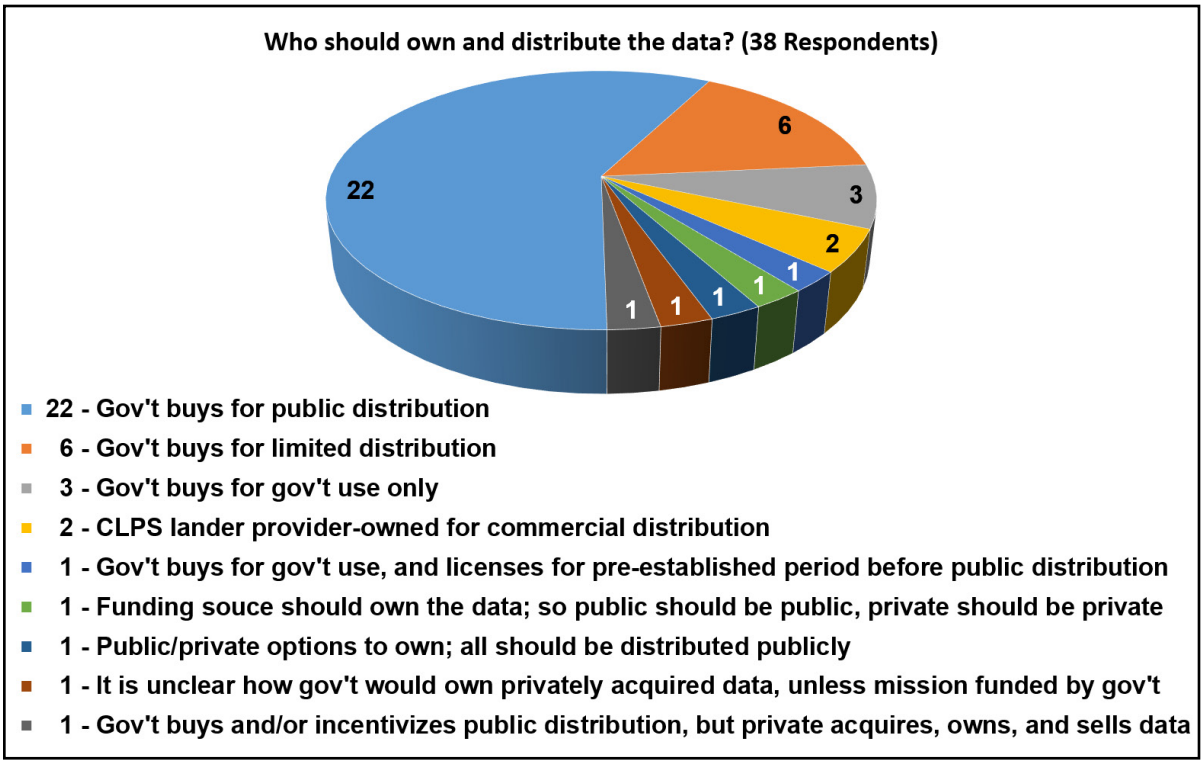
- Serving as the driver to develop missions and measurements to meet the request,
- Selling data that would be collected anyway during a future mission and was not a mission design driver,
- Buying data about the lunar surface from orbital assets, and
- Buying data from surface assets: landers, rovers, and human missions.

The survey assumed that a Data Buy program would empower an even greater commercial participation in lunar exploration and could be instrumental in ensuring an effective transition from a NASA-led return to the Moon to a sustained industry presence.

To date, we have received 38 responses to the survey. Just over half were from industry, and one-quarter were from academia. The remainder were a mix of Government, nonprofit, and research organizations. Three tiers of data (Top, Middle, and Bottom) were identified for consideration in a Data Buy. The table below lists the data sets that were of most interest to responders.

Data set	Responders who defined data set as high interest (%)
Top Tier	
Elevation/Topography	55
Dust Mitigation	52
Imagery	47
Illumination	41
Middle Tier	
Landing Effects	33
Radiation	33
Thermal	30
Navigation	27
Bottom Tier	
Communications	16
System Performance	16
Other	3

Precision of the data was the most important attribute identified.



The survey respondents favored government ownership and public availability of the data.

Several themes emerged from the survey results:

- Most Commercial Lunar Payload Services (CLPS) providers are open to acquiring and selling data.
- The scale, value and ownership of collected data are still unclear, and further information gathering is needed.
- Prospecting data presents a particular challenge to establishing ownership and value.
- Academics and universities want NASA to own or allow data buy via NASA-funded programs.

Funding data buys was also explored. A data buy program must be established to provide needed programmatic certainty, to reduce risk. For larger companies, programmatic certainty can also result in significant matching contributions from the institution. The timeframe from selection to awarding the funds needs to be as short as possible. A program should be stood up within the next year or two. It is anticipated that NASA will make “gathering/acquiring data” a general requirement. Having a simple mechanism in place to “sell” the data to NASA would be valuable.

The survey results recommended that NASA explore ways to pilot data buy on the early CLPS missions already scheduled. Suggestions include doing something similar to the previously announced NASA buy of resources from the Moon, or using NASA-sponsored challenges to develop and fly sensors for Dust and Volatiles, which would return data of great interest to the community.

Readers are encouraged to contribute to the Data Buy survey.

Member Spotlight: Puli Space Technologies

By: Michael Buckley

How determined is the team from Puli Space Technologies to help humankind return to the Moon? Consider this: instead of waiting for the company to secure funds to develop a device to sniff out lunar water deposits, some of its team worked for free to turn their innovative idea into a workable sensor.

And that time investment paid off, with its results headed for the Moon later this year. Two Puli Lunar Water Snoopers will fly aboard Intuitive Machines' second Nova-C lander mission to the Moon's South Pole—one on the Micro-Nova hopper and another on Lunar Outpost's Mobile Autonomous Prospecting Platform rover.

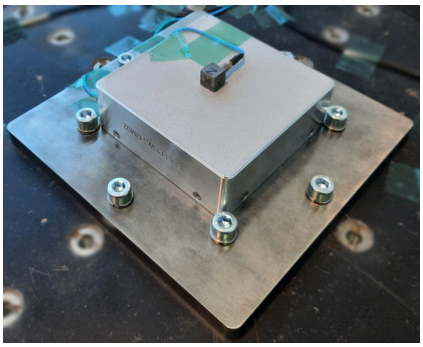
"It shows what can happen when you are devoted to a dream," said Puli Space CEO Tibor Pacher. "We have a very dedicated team of engineers and scientists who are passionate about the Moon."

That passion drove Pacher, a physicist with a background in management and accounting, to launch Puli Space in 2010. Based in Budapest, the company was founded to participate in the Google Lunar X Prize, with longer-term goals to involve Hungary in lunar exploration and to enter the rapidly growing private lunar industry.

Team Puli did officially enter the X Prize, which called for privately funded teams to land a robotic spacecraft on the Moon, and then have it explore the lunar surface and send video and images back to Earth. The contest ended without a winner, but Puli—the name of a small Hungarian dog breed— continued its technology development endeavors.

"We're very excited to be a part of the lunar technology ecosystem."

– Tibor Pacher, CEO, Puli Space Technologies



Designed to map lunar ice deposits, the small, lightweight PLWS is slated to fly aboard Intuitive Machines' Nova-C lander mission later this year.

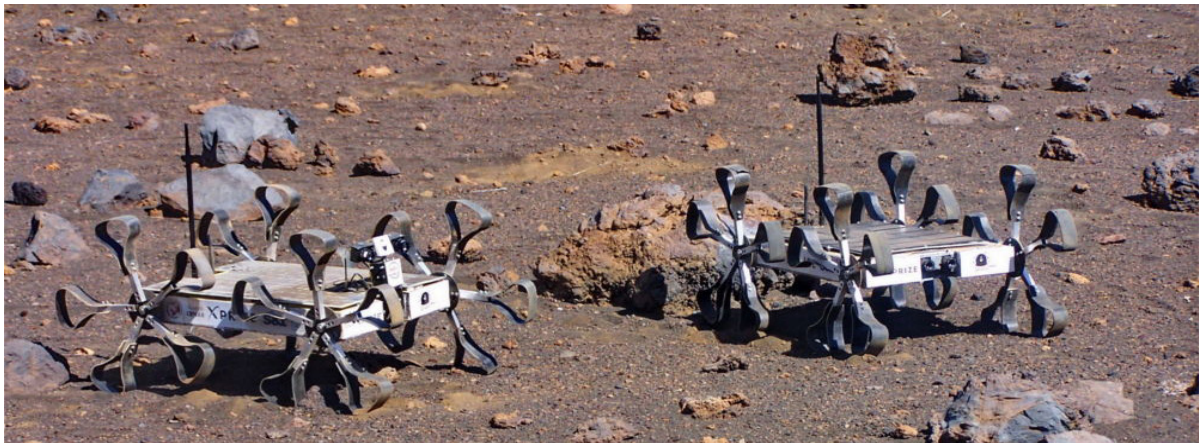
The Puli Lunar Water Snooper (PLWS) is a neutron spectrometer designed to map water ice deposits. "It is a low-cost, small, and extremely lightweight spectrometer for monitoring and characterizing the neutron environment, identifying and measuring subsurface hydrogen content of the lunar soil, and—when mounted on a small rover—mapping an area for water deposits," Pacher explained. "It's capable enough to support in-situ resource utilization activities and robust enough to survive the harsh environment on the Moon."

Pacher said the Puli team developed the PLWS for the "Honey, I Shrunk the NASA Payload" challenge in 2020 and the "Honey, I Shrunk the NASA Payload, the Sequel" follow-on in 2022. It won first prize in the initial challenge's Lunar Resource Potential category and captured second place in the follow-on challenge. The showing earned Puli Space $225,000 in NASA development funding, and the contacts Pacher made while preparing for the competition led to the instrument's placement on both the Intuitive Machines hopper and Lunar Outpost rover.

PLWS is novel in other ways as well. Its inclusion in the mission is a partnership between Intuitive Machines, Puli Space, and Arizona State University, and the partners are looking for teams interested in buying the data PLWS collects. While "data buys" are a common practice for Earth-observation datasets, the business model is unusual—if not untested—for a planetary mission.

"This mission will be a great technical, functional, and programmatic demonstration for the PLWS," Pacher said. "We're very excited to be a part of the lunar technology ecosystem."

While seeking other opportunities to fly the PLWS, Puli Space continues its work on a low-cost, lightweight planetary rover. The company has put a prototype through successful field tests across terrain simulating the Moon and Mars in Hawaii, Morocco, and Austria.



PLWS prototypes navigate "lunar" terrain in a field test at Mauna Kea, Hawaii.

"With other members of LSIC, we really hope to engage in discussions about the next steps of utilizing resources—especially water ice—on the Moon," Pacher said, adding that Puli Space plans to establish an office in the U.S. within the next 6 to 12 months. "It's a step-by-step process that comes with real challenges. But there is a lot vision and technical development work that is extremely exciting."

Learn more about Puli Space Technologies.

The American Kennel Club describes the Puli as a lively, acrobatic dog; light, quick, agile, and able to change directions instantly.

NASA and Community News

NASA Pursues Lunar Terrain Vehicle Services for Artemis Missions

05/26/2023 \\ NASA \\ Vanessa Lloyd \ Kathryn Hambleton \ Tim Hall

https://www.nasa.gov/press-release/nasa-pursues-lunar-terrain-vehicle-services-for-artemis-missions

Japan's GITAI Raises $29 Million for Space Robotics Business

05/24/2023 \\ Space News \\ Jason Rainbow

https://spacenews.com/japans-gitai-raises-29-million-for-space-robotics-business

NASA Funds Small Business to Advance Tech for Space, Earth

05/23/2023 \\ NASA \\ Loura Hall

https://www.nasa.gov/directorates/spacetech/sbir_sttr/nasa_funds_small_business_to_advance_tech_for_space_earth

Bezos' Blue Origin Wins NASA Astronaut Moon Lander Contract to Compete with SpaceX's Starship

05/19/2023 \\ CNBC \\ Michael Sheets

https://www.cnbc.com/2023/05/19/nasa-awards-blue-origin-sld-crew-lunar-lander-contract.html

Technical Strengths and Lower Cost Led NASA to Select Blue Origin Lander

05/19/2023 \\ SpaceNews \\ Jeff Foust

https://spacenews.com/technical-strengths-and-lower-cost-led-nasa-to-select-blue-origin-lander/

NASA Begins Feedback Process for Moon to Mars Architecture

05/18/2023 \\ NASA \\ Rachel Kraft

https://www.nasa.gov/feature/nasa-begins-feedback-process-for-moon-to-mars-architecture

A Tiny NASA CubeSat Just Set a Big Data Speed Record with Lasers

05/16/2023 \\ Popular Science \\ Andrew Paul

https://www.popsci.com/technology/nasa-tbird-laser

Glass Fibers in Lunar Regolith Could Help Build Structures on the Moon

05/15/2023 \\ Universe Today \\ Matt Williams

https://phys.org/news/2023-05-glass-fibers-lunar-regolith-moon.html

Funding Opportunities

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.) Remaining windows: March 2 – July 5, 2023, and July 6 – November 1, 2023.

- **University Smallsat Technology Partnership (USTP) Appendix – 2023**

  Mandatory Preliminary Proposals Due: May 16, 2023, 5:00 p.m. EST; Full Proposal (by invitation only): July 18, 2023, 5:00 p.m. EST.

- **Early Stage Innovations (ESI23)**

  NOI Due: June 7, 2023, 5:00 p.m. EST; Proposal Due: July 6, 2023, 5:00 p.m. EST.

- **Technology Advancement Utilizing Suborbital and Orbital Flight Opportunities "TechFlights"**

  Mandatory Preliminary Proposals Due: June 7, 2023; Full Proposals Due: October 4, 2023.

- **NASA Entrepreneurs Challenge 2023 - Round 1**

  Venture to the Moon and Beyond with NASA: Launching Lunar Payloads and Unlocking Climate Science! Round 1 Submission Deadline: June 28, 2023, 2:00 p.m. PDT.

- **Lunar Terrain Vehicle (LTV) Services (LTVS) Request for Proposal**

  Proposal Deadline: July 10, 2023, 2:30 p.m. CDT.

- **NASA Innovation Corps Pilot**

  Proposals may be submitted at any time through July 22, 2022, but applications will be reviewed at intervals on the following dates: September 16, 2022; November 17, 2022; and January 20, 2023.

Future Solicitations 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.