



Lunar Surface Innovation

C O N S O R T I U M

LSIC ISRU Focus Group Monthly

<http://lsic.jhuapl.edu/>

<http://lsic-wiki.jhuapl.edu/> (“Confluence” sign-up required)

July 28, 2021

Kirby Runyon, Karl Hibbitts, Michael Nord

Kirby.Runyon@jhuapl.edu

Karl.Hibbitts@jhuapl.edu

Michael.Nord@jhuapl.edu



JOHNS HOPKINS
APPLIED PHYSICS LABORATORY

Agenda

- 3pm – General updates to include high-level take-aways from the Power workshop
- 3:10 – Introduce the themes and objectives of the four Breakout Groups:
 - Water prospecting and mining –what we need to understand about the abundance, distribution, and form of ice in PSRs in order to use it as a resource, and what measurements are needed to obtain this information
 - O2 extraction and metals – ensuring we have an effective and holistic system approach. Mapping regolith properties to preferred extraction tech.
 - Value Chain Development for ISRU -ensuring industry and government efforts are linked to customer (future) needs and the right technologies are being identified for development.
 - Laboratory Facilities for ISRU - ensuring we have what is needed and access to it, for testing ISRU technologies.
- 330 – Presentation by Kartik Kumar (Sat Search) and David Kornuta (Blue Origin) on Value Chain mapping.
- 345 – Short discussion and wrap up
- 350 – **Transition to our breakout groups that will again remain open until 430pm.
-
- ** 35 minutes in a randomly assigned room (you can switch rooms immediately afterwards to your breakout room of choice).
- Networking rooms will be mapped to the themes of the Breakout Groups.
 - Water. Moderator: Karl Hibbitts
 - O2 tech. Moderator: Michael Nord
 - Value Chain. Moderator: Brenda Clyde
 - Laboratory Facilities. Moderator: Jodi Berdis
- The conversations will be recorded.

Updates

- The next Lunar Surface Science Workshop, Aug 18-19, the NASA Biological and Physical Sciences Division is hosting a workshop on fundamental and applied research on the Moon in physical sciences. There is an ISRU component. Registration deadline is: Aug 13.
<https://www.hou.usra.edu/meetings/lunarsurface2020/>
- LSIC Excavation & Construction Workshop. Aug 20. 2pm EDT. 2-hour duration.
- The LSIC Fall meeting is Nov 3- 4.
- ASCEND. 15-17 Nov. Registration open. Session topics include: regolith processing, ISRU economics.
- Continue to check out the Resources page on Confluence at: <https://lsic-wiki.jhuapl.edu/pages/viewpage.action?pageId=6258941>.
- There are new updates on Confluence associated with the ISRU breakout sessions.
- “Who’s Who in ISRU” at <https://lsic-wiki.jhuapl.edu/display/ISRU/Who%27s+Who+in+ISRU>

Power Beaming Workshop

- Power beaming (wireless transfer of power; optical, mm, and microwave) on the Moon could be a viable option in regions without direct sunlight and/or for mobile equipment such as rovers.
- Gap Analysis: Figure of Merit for power beaming still uncertain, “How much delivered power is lost per unit of distance, i.e., what is the transmission efficiency?”, and “How much power can be beamed per unit mass of the transmission system?”
- Modality would influence which activity would benefit most from which type of beaming power: optical (small systems, long distances), microwave (large systems, short distances), mm (middle ground between optical and microwave). Laser choice influences beam quality and efficiency, receiver choice influences efficiency too.
- Several power beaming technologies currently in development: Astrolight (Watts on the Moon Challenge), Reach Labs, Powerlight, Light Bender (NASA Innovative Advanced Concepts), CASSIOPeiA, XISP-Inc.
- Thermal management also still uncertain and being considered; how much heat is wasted, how is it expelled, where does it go? How can the source and receiver units be thermally managed, what are their thermal limits, could thermal cycling be performed?
- Power beaming into PSRs can provide benefits for exploration, excavation, and ISRU through wirelessly charging rovers, surviving lunar night, accessing steep slopes, long-distance activities, etc.

ISRU Focus Group Break-out groups

- Rationale for topics: High-priority and/or popular areas within the ISRU FG as identified from a year of meetings, the Spring survey, and feedback from last month's networking event.
- Goal of Break out groups:
 - Impact NASA. – help address high-priority needs within SpaceTech for the development of technology for enabling a sustained presence on the Moon from the perspective of ISRU.
 - Enable the FG members – help focus group members understand and influence what technologies should be developed and how to be matured. Help FG members better understand and influence where ISRU technology is going and needs to go.
- Implementation of Break-out Groups
 - Run by FG members, enabled/organized by APL FG leads
 - Integrated into the networking that now follows at the end of every monthly FG meeting (additional meetings can be held at the discretion of the members of the breakout groups).
 - Intend for heavy use of Confluence – to maintain momentum and discussions outside of meetings; capture information for future reporting.
 - We begin today. Show up to the break out groups you are interested in and we'll begin discussions. There will be opportunity to sign up for separate email lists relevant to each Breakout group.

ISRU Focus Group Break-out groups

- Water prospecting and mining
 - what we need to understand about the abundance, distribution, and form of ice in PSRs in order to use it as a resource, and what measurements are needed to obtain this information.
 - Is it useful to do demo's even not knowing waterice situation? This answer may be different for each water ice mining effort being developed.
 - At least one product will be a short white paper with recommendations to be submitted to STMD.
- O₂ extraction and metals
 - ensuring we have an effective and holistic system approach.
 - Map regolith properties to preferred extraction tech. More a system perspective; less a focus on individual O₂ extraction technologies. For instance, identify the common needs/attributes/requirements between the various O₂ extraction technologies. Metal purity needs for metal use.
 - One product will likely be a recommendation list of which technologies/components/etc would benefit from being demonstrated on a lunar lander.
- Value Chain Development for ISRU
 - ensuring industry and government efforts are linked to customer (future) needs and the right technologies are being identified for development.
 - One product can be the development of a roadmap.
- Laboratory Facilities for ISRU
 - ensuring we have what is needed and access to it, for testing ISRU technologies.
 - One product will likely be a report to STMD with recommendations for what specific facility capabilities including access/costs/use policies/frequency of use/... are needed by the community. NASA and private industry may have different needs.

ISRU Focus Group Break-out groups

- Water prospecting and mining

- what we need to understand about the abundance, distribution, and form of ice in PSRs in order to use it as a resource, and what measurements are needed to obtain this information.
- Is it useful to do demo's even not knowing waterice situation? This answer may be different for each water ice mining effort being developed.
- At least one product will be a short white paper with recommendations to be submitted to STMD.

Ideas: consider a demonstrator that is agnostic to water ice form/distribution/etc.

Jeff Plate: likely disseminated ice. Maybe part of regolith grains or not. Global survey followed by rovers for ground truth.

Define the problem: How well do we know water ice? How well do we need to know it?

Interstellar mining: 2% is cut-off for abundance. Wants a sub 1.5km circle. To then send rover to prospect to 100m with rover.

What missions do we need to accomplish this? Are there other ideas for needs?

Fly mining equipment that is agnostic to ice form.

May need about a dozen points to characterize any one homogenous area.

Chandrayaan 3 has L and S band SAR. Will it map large blocks of water ice?

Show a visceral demonstration with public appeal of the existence of water ice on the Moon.

Technical Presentation

Value Chain Mapping

Kartik Kumar, SatSearch

David Kornuta, Blue Origin

Wrap-Up and Transition to Breakout Groups

Water. Moderator: Karl Hibbitts

O₂ tech. Moderator: Michael Nord

Value Chain. Moderator: Brenda Clyde

Laboratory Facilities. Moderator: Jodi Berdis



JOHNS HOPKINS
APPLIED PHYSICS LABORATORY