Lunar Surface Innovation
CONSORTIUM

Extreme Environments Focus Group March Telecon

March 9, 2021

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Today's Agenda

- LSIC & FG Updates (15 min – Greenhagen, Stockstill-Cahill, Somervill)
- LSIC-EE Winter/Spring Meeting Cycle (30 min – Greenhagen)
  - Schedule / Plan
  - List of Lunar Specific Surface Environments
- Open floor (time permitting)

Next month: April Meeting is scheduled for Tuesday 4/13/21 at 2:30pm EST (2-hour length)

LSIC Updates

LSIC Spring Meeting scheduled for May!

- May 11-12 (Tuesday-Wednesday)
- Virtual Meeting
- Day 1: Focus on Community Updates
- Day 2: Focus on Contributed Presentations / Posters

LSIC Workshops

- Dust Mitigation Workshop (2/4/21)
- Extreme Access Precision Landing Workshop (3/2-3/4/21)
- Commercial Lunar Payload Services Workshop (Summer 2021)
- TBD Joint Focus Group Workshops (starting Summer 2021)

LSIC Updates

LSIC Focus Group Meeting Schedule

Subgroup	Meeting Times (ET)	Lead	Email
In Situ Resource Utilization	3rd Wed @ 3 pm	Karl Hibbitts	Facilitator_ISRU@jhuapl.edu
Surface Power	4th Thu @ 11 am	Wes Fuhrman	Facilitator_Power@jhuapl.edu
Extreme Environments	2nd Tue @ 3:05 pm	Ben Greenhagen	Facilitator_ExtremeEnvironments@jhuapl.edu
Extreme Access	2nd Thu @ 3 pm	Angela Stickle	Facilitator_ExtremeAccess@jhuapl.edu
Excavation and Construction	Last Fri @ 3 pm	Athonu Chatterjee	Facilitator_ExcavationConstruction@jhuapl.edu
Dust Mitigation	3rd Thu @ 12 pm	Jorge Núñez	Facilitator_DustMitigation@jhuapl.edu

Many Focus Groups are starting to form subgroups!

LuSTR Update

NASA selected six project proposals under its first-ever Lunar Surface Technology Research (LuSTR) solicitation

"Through LuSTR, NASA selected three university-led proposals to research innovative ways to identify resources, like water, on the Moon, and inventive designs for extraction and utilization equipment.

- The University of Texas in El Paso – one of the largest Hispanic-serving institutions in the country – will research an advanced thermal mining approach that could release, trap, and transport water vapor found on the Moon. The team, led by principal investigator Ahsan Choudhuri, plans to experimentally demonstrate over two pounds (about one kilogram) of collection capacity within 11 hours.
- Washington University in St. Louis will build a rover-mounted drill to quantify the 3D distribution of water at the Moon's South Pole. A laser instrument located at the bottom of the drill, capable of analyzing regolith, would quantify the amount of water and other chemicals present beneath the surface. Principal investigator Alian Wang will lead the research team and reconnaissance instrument development.
- Michigan Technological University in Houghton will adapt a heated percussive cone penetrometer – an engineering instrument regularly used on Earth – to characterize the strength of lunar soil, or regolith. Understanding a lunar region's regolith strength could inform methods of excavating water and building structures using local materials. Paul van Susante will serve as the project's principal investigator."

LuSTR Update

"Complementing this research, three other university teams will mature next-generation energy storage and power distribution technologies. The projects could help power in-situ resource utilization operations and other robust infrastructure on the Moon.

- The University of California in Santa Barbara, led by principal investigator Philip Lubin, will research wireless power transfer feasibility from a base station to multiple distant assets on the Moon. Small rovers, for example, could be equipped with low-power beacons capable of receiving around 100 Watts of power in regions where solar or tethered power transfer is impractical, such as in the Moon's deep and dark craters.
- Vanderbilt University in Nashville will look into using silicon carbide power components for lunar surface applications. At present, these power components are particularly susceptible to radiation and frequently fail or experience reduced performance in space. Principal investigator Arthur Witulski will lead the project.
- The Ohio State University in Columbus will explore flexible energy distribution between multiple, different power grids – that may use solar, radioisotope, and battery sources – that could be deployed on the lunar surface to support the Artemis program. The project, led by Jin Wang, will focus on control methodologies and perform both hardware and software demonstrations.

Via the LuSTR selections, NASA aims to stimulate lunar technology development within academia and help fast-track the readiness of critical lunar technologies and components. The NASA funding for each project varies. The maximum grant amount is $2 million per selection, over two years."

Focus Group Updates

Who's Who in LSIC-EE!

- Table of information describing LSIC-EE members and/or member institutions

Who Are You? (Individual or Institution)	What Do You Do?	What Do You Want Others to Know About You?	Other Comments	Website, Contact Info, POC, etc.
Example: MoonCheese, Inc.	Example: Prospect for and mine Münster, Gouda, and other soft cheeses from mid-latitude Procellarum-KREEP terrain	Example: Happy to license Cheese Detection and Ranging (CheDAR) technology to NASA and commercial partners	Example: Working with STMD; looking to engage with SMD and Wisconsin dairy farmers	Example: MoonCheese.space; info@MoonCheese.space
Ben Greenhagen, LSIC-EE FG Facilitator	As the LSIC-EE Facilitator, I help to form a collaborative alliance of NASA, industry, academia, non-profits and government in areas relevant to Extreme Environments. My research interests focus on thermal emission spectroscopy from airless bodies. I love flight missions and am the Deputy PI of the LRO Diviner Lunar Radiometer, a Co-I of Lunar Flashlight, a Co-I of L-CIRiS, and a Co-I of the BepiColombo MERTIS. I also run a laboratory spectroscopy facility, the Simulated Airless Body Emission Laboratory.	I'm here to help build this community. Our goal is to build bridges not just between between you and NASA but also between community members. If you are looking for opportunities to be more active in this community, let me know!	Beautiful, beautiful. Magnificent desolation.	http://lsic.jhuapl.edu/Focus-Areas/Extreme-Environments.php Facilitator_ExtremeEnvironments@jhuapl.edu benjamin.greenhagen@jhuapl.edu

https://lsic-wiki.jhuapl.edu/display/EE/Who%27s+Who+in+LSIC-EE

Focus Group Updates

Subgroups are currently supporting both the LSIC-EE Winter/Spring Cycle activities and community resources / guidance documents

- Lunar Radiation Environment Guidance
  - https://lsic-wiki.jhuapl.edu/display/EE/Lunar+Radiation+Environment+Guidance
- Regolith/Surface Interface Resource Guide
  - https://lsic-wiki.jhuapl.edu/pages/viewpage.action?pageId=6260391
- Space Weather / Plasma Environment Guidance
  - https://lsic-wiki.jhuapl.edu/pages/viewpage.action?pageId=6260116
- Thermal and Illumination Environment Literature Review Summary Report & Library
  - https://lsic-wiki.jhuapl.edu/pages/viewpage.action?pageId=4031599
- Vacuum Testing Chamber Guidance
  - https://lsic-wiki.jhuapl.edu/display/EE/Vacuum+Testing+Chamber+Guidance

Karen's Corner – Monthly Confluence Highlight

Kevin's Corner – NASA News and Notes

Winter/Spring Meeting Cycle

Each Focus Group is tasked with compiling community inputs on relevant topics

- Some FGs have conducted ~6-hour topic-specific workshops (e.g. ISRU Supply and Demand, Dust Mitigation) but there are other possible approaches
- Desirable to leverage unique structure of LSIC-EE and broad-based expertise
- Piloting a multi-month approach including a “supersized” monthly tag-up

- First topic: Identifying and Classifying Specific Lunar Surface Environments
  - “Breaking Down the Lunar Environment Monolith”
  - How do different environments stress technologies in different ways
  - How do specific lunar environment differ from descriptions of the general lunar environment?
    - NASA Cross-Program Design Specification for Natural Environments (DSNE) Revision H
    - https://ntrs.nasa.gov/citations/20205007447

Winter/Spring Meeting Cycle

Activities to Complete Before the LSIC Spring Meeting

- January Subgroups + February (2/9) & March (3/9) Focus Group Meetings
  - *Gather community inputs regarding interesting lunar environments / categorize types of sites*
- February & March Subgroup Meetings
  - *Subgroups summarize environments for each type of site*
  - *What do we know? What do we think? What do we not know?*
- April Supersized Focus Group Meeting (4/13)
  - *Discuss preliminary evaluations with focus group; seek feedback; identify missing information; identify needs*
- April Subgroup Meetings
  - *Revisit site types for additional characterization (as needed)*
  - *Rank site types by level of environmental stresses (hardest environments ranked higher / easier environments ranked lower)*
- LSIC Spring Meeting is May 11-12, 2021
  - *Preliminary report to LSIC community*

Winter/Spring Meeting Cycle

Subgroup Meeting Schedule

- All subgroup monthly tag-ups are scheduled for the 3rd or 4th week of the month

Subgroup	Meeting Times (ET)	Lead	Email
Radiation Environment	4th Wed @ 2 pm	Lawrence Heilbronn	lheilbro@utk.edu
Regolith / Surface Interface	4th Tue @ 11 am	Melissa Roth	melissa@offplanetresearch.com
Space Weather / Plasma Environment	4th Mon @ 2 pm	Justin Likar	justin.likar@jhuapl.edu
Thermal & Illumination Environment	3rd Tue @ 5 pm	Ahsan Choudhuri	ahsan@utep.edu
Vacuum / Exosphere Environment	4th Thu @ 12 pm	Stephen Indyk	sjindyk@honeybeerobotics.com

Winter/Spring Meeting Cycle

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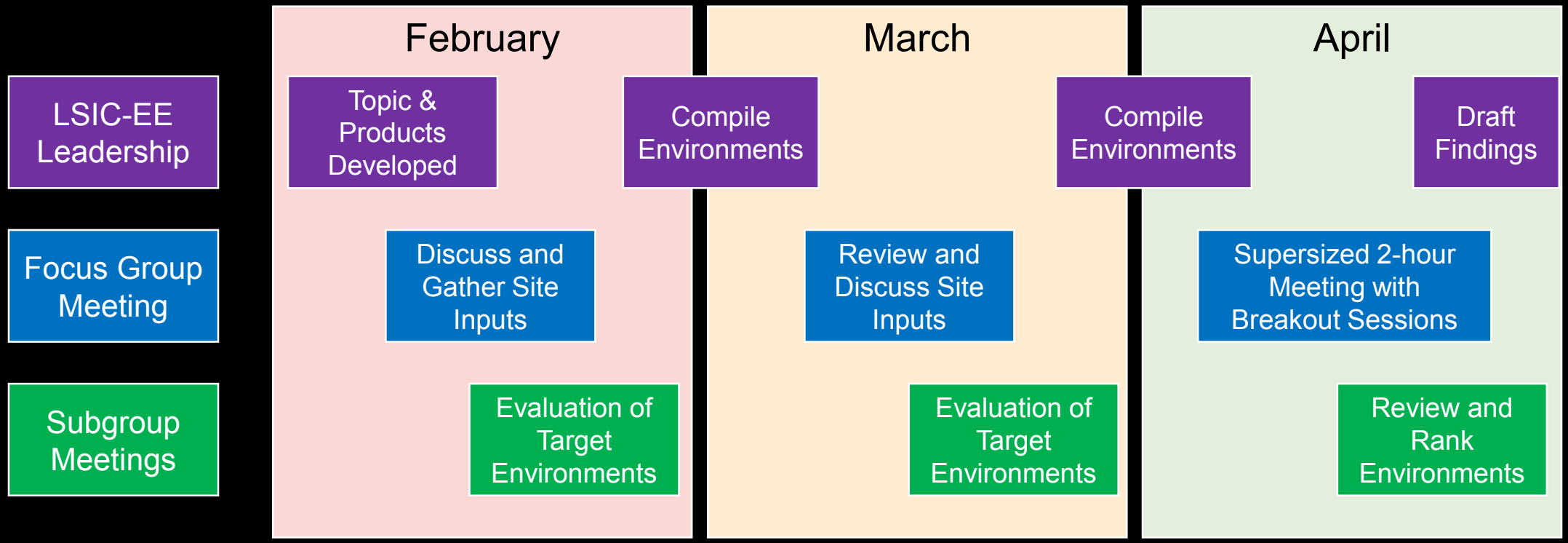
Winter/Spring Meeting Cycle

Activities to Complete Before the LSIC Spring Meeting



Winter/Spring Meeting Cycle

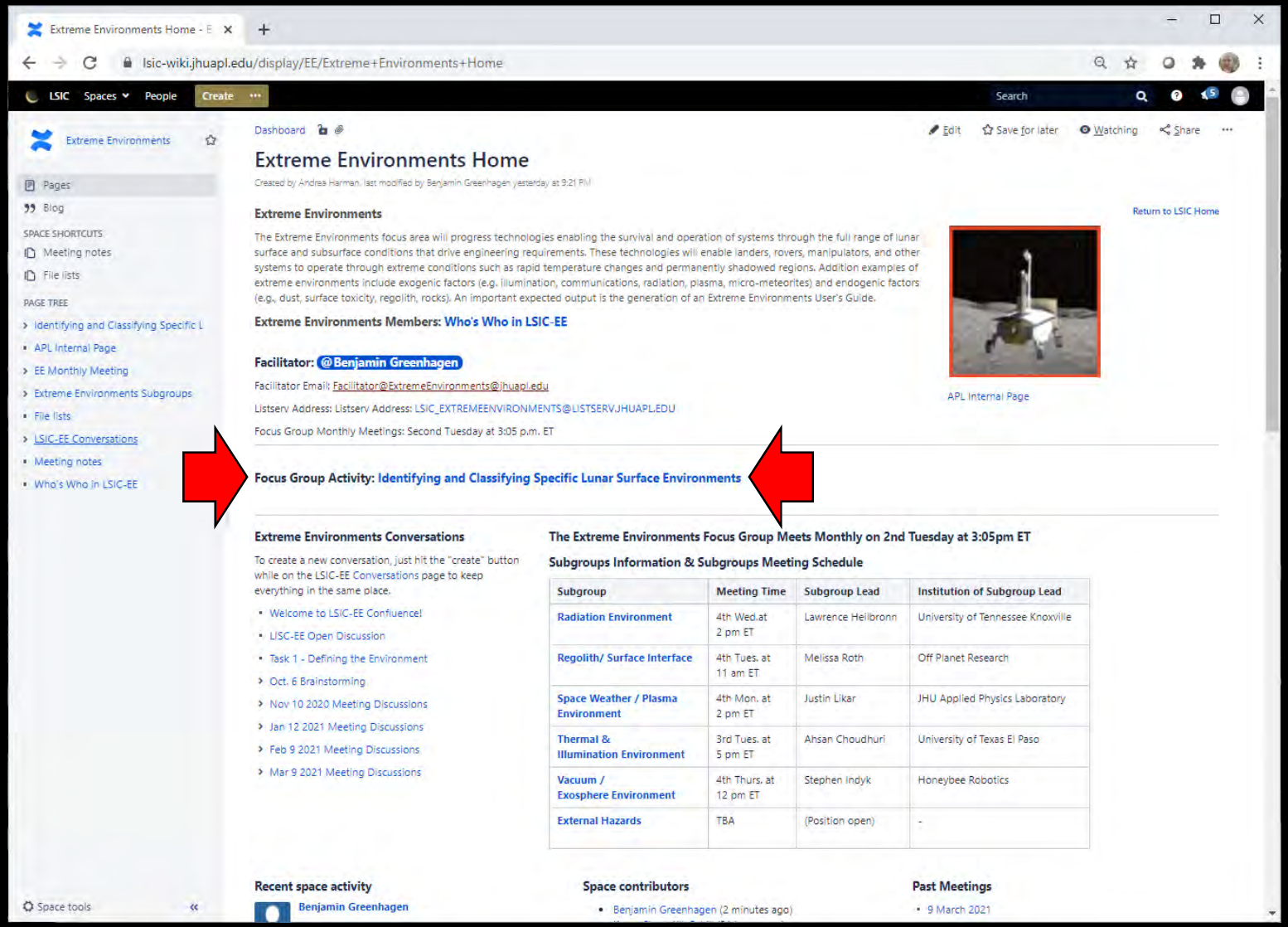
What Kinds of Environments or Types of Sites?

- Any lunar surface environment that represents a challenge or requires a technical mitigation to allow surface survival and operations

Polar Specific Environments	Environmental Variations
Permanently Shadowed Regions (PSRs)	• PSRs with significant reflected illumination • PSRs without significant reflected illumination • PSRs with hydrogenated regolith • PSRs without hydrogenated regolith
Areas of High Illumination (>55% Illumination)	• Naturally high illumination • Mobility-enabled high illumination
Mixed Polar Environments	• Illuminated terrain with rover-accessible macro cold traps (10s to 100s+ meter PSRs) • Illuminated terrain with rover-accessible micro cold traps (1 - 10 meter PSRs) • Occasionally illuminated terrain with subsurface volatile stability • Polar lava tubes or pits (hypothetical)

Non-Polar Environments	Environmental Variations
Apollo-style Environments	• Maria • Highlands
Topographic Margins	• Crater features (rims, peaks, floor fractures) • Volcanic features (vents, domes, riles)
Lunar Pits & Lava Tubes	• Mare basalt features • Impact melt features
Surface Anomalies	• Irregular Mare Patches • Regolith Texture Anomalies (High/Low Dust, Pyroclastic, etc.) • Magnetic Anomalies

Winter/Spring Meeting Cycle



https://lsic-wiki.jhuapl.edu/display/EE

Winter/Spring Meeting Cycle

What to Expect at the Supersized 2-hour April 13th Focus Group Meeting

- 2:30 - Introduction, Scope, and Products (Ben - 5 min)
- 2:35 - Review of Environment Drivers (Subgroup Leads or Alternate - 5 min lightning talks)
- 3:00 - Transition to Breakout Zooms (5 min)
- 3:05 - Breakout Sessions (55 min)
  - Polar Specific Environments (Moderated by Ben)
  - Non-Polar Specific Environments (Moderated by Karen)
- 4:00 - Transition to Plenary Zoom (5 min)
- 4:05 - Brief Recaps / Burning Questions (Ben and Karen - 5 min each)
- 4:15 - Next Steps and Discussion (Ben - 15 min)

Product #1: Preliminary environmental assessments for each type, archived on Confluence

Product #2: “Final” list of environments ranked by subgroups according to difficulty

Thoughts? Discussion?

Looking Ahead to 2021-22 Cycles

Activities to Complete After the LSIC Spring Meeting (Summer 2021 through Spring 2022)

- Prioritize Specific Lunar Environments to Focus on During LSIC Year 2
  - *Likely a mixture of NASA priorities and community identified stressing environments*

- For a Few Prioritized Types of Sites:
  - Identify Observation (Knowledge) and Simulation (Prediction) Capabilities and Gaps for Specific Lunar Environments
  - Identify Technology Capabilities and Gaps for Specific Lunar Environments
    - *Seek to coordinate this with release of NASA Strategic Technology Plans (STPs)*
  - Identify Experimental Testing and Technology Maturation (including Facilities) Capabilities and Gaps for Specific Lunar Environments

- Format Could Be Based on Types of Sites OR Types of Capabilities and Gaps
  - Workshop or working meetings are possible

Questions?

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