



Lunar Surface Innovation

C O N S O R T I U M

Extreme Access Focus Group Telecon

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Today's Agenda

- Notes about communication tools
- Review of Focus Group Mission
- Discussion of Year-1 Goal
- Summary of upcoming opportunities
- Open floor

Updates on Communications

- Monthly LSIC newsletter – first edition came out last week
 - <http://lsic.jhuapl.edu/Resources/>
- Mailing list
 - The listserv goes to all participants. Use with caution. But feel free to use!
 - If we need smaller, focused lists we can set those up
 - Follow the Code of Conduct, found on the Resources webpage
- Updates to the webpage - <http://lsic.jhuapl.edu/Focus-Areas/Extreme-Access.php>
 - Notes, slides, recordings from telecons posted here
- Wiki (in progress)
 - Server is currently being set up at APL
- Additional communications tools
 - Slack is a no-go
 - Mattermost, Wiki?
 - Other thoughts?
- Follow the Code of Conduct for all Focus Group communications

The LSIC is a US alliance of universities, non-profit research institutions, commercial companies, NASA centers and program offices, and other government agencies with a vested interest in our nation's campaign to establish a sustained presence on the Moon.

The Consortium will assist NASA in

- Identifying lunar surface technology needs and assessing the readiness of relative systems and components
- Making recommendations for a cohesive, executable strategy for development and deployment of the technologies required for successful lunar surface exploration
- Providing a central resource for gathering information, analytical integration of lunar surface technology demonstration interfaces, and sharing of results



Focus Groups are the primary means through which LSIC interacts with the community.

Focus Group Goals

- Establish collaborative relationships among members
- Identify technology needs
- Serve as an information clearinghouse
- Build community
- Develop talent

Surface Excavation & Construction

Extreme Environments

In Situ Resource Utilization

Lunar Dust Mitigation

Surface Power

Extreme Access

STMD is developing technologies enabling humans or robotic systems to efficiently access, navigate, and explore previously inaccessible lunar or planetary surface or subsurface areas.

- Technologies needed for accessing and navigating the lunar surface and subsurface
 - Mobility technology
 - Autonomous navigation technology
 - Communications
 - Operating in the lunar night/PSRs
 - ...What else?
- Technologies that enable a sustained, strategic presence at the lunar South Pole
 - Similar to above...
- What are the technology needs to enable sustained access and navigation?
- What technology already exists?
- What is being worked on?
- Where are the gaps?

STMD LSII Capability Development



LSII capability development spans the Technology Readiness Level (TRL) Pipeline

<u>ISRU</u>	<u>Surface Power</u>	<u>Dust Mitigation</u>	<u>Extreme Environments</u>	<u>Extreme Access</u>	<u>Excavation & Construction</u>
<ul style="list-style-type: none"> • ISRU Scaled Pilot Plant Demonstrations • Demonstrate systems for collecting and purifying water on the lunar surface, capable of scaling to tens of metric tons per month, operating with little to no human involvement. • Methods for size sorting granular lunar regolith. • Methods for measuring mineral properties/oxygen content before and after processing 	<ul style="list-style-type: none"> • Surface Fission Power • Adaptable Lunar Surface arrays • Energy Storage including Regenerative Fuel Cells • Power Beaming • Chemical Heat Integrated Power Source • Power Distribution Architectures • Advanced Rover Energy Storage 	<ul style="list-style-type: none"> • Dust tolerant textiles • Filtration • Dust Mitigation Structures • <u>Electromechanical & Magnetics</u> • Surface Stabilization • Nanomaterials & Coatings • Adaptation of Terrestrial Technologies • Dust Classification & Best Practices Guide 	<ul style="list-style-type: none"> • Enable rovers, manipulators, and other systems to operate in the lunar environment including lunar noon (150 °C), night (down to -180 °C), day/night cycles, and permanently shadowed regions (down to -240 °C). • Develop & publish Lunar Surface External Environments User's Guide 	<ul style="list-style-type: none"> • Sustained Surface Activities • Extended Ops in Permanently Shadowed Regions • Ingress, Exploration, & Egress of Voids • Hazard Detection in all lunar environments & conditions • Autonomous Operations • Navigation with minimal infrastructure 	<ul style="list-style-type: none"> • Excavation of hard regolith/ice material • Travel & traverse to mining locations • Reliability & Maintainability during ops • Material & Construction of requirements & standards. • Increased Autonomy

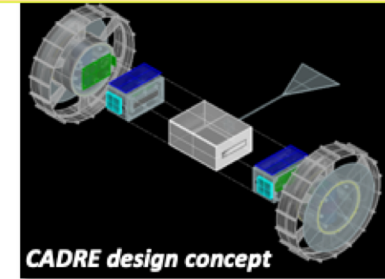
Extreme Access



STMD is developing technologies enabling humans or robotic systems to efficiently access, navigate, and explore previously inaccessible lunar or planetary surface or subsurface areas. Activities underway across TRLs 2-7.

Technology Developments Underway:

- Cooperative Autonomous Distributed Robotic Explorers (CADRE) – TRL 7
- CubeRover - Tipping Point – TRL 5
- Day/night lunar rover obstacle avoidance and localization - TRL 5
- Smart Video Guidance Sensor – TRL 6
- Exploration of Lunar Pits - Phase III NIAC, TRL 5
- Miniaturized Payloads for Small Rovers Ideation Challenge – Over 100 Entries



Additional Investments:

- Robust, sustained surface activities (bulk transport of regolith, etc.)
- Extended operations in permanently shadowed regions
- Ingress, exploration, and egress of subsurface voids
- Hazard detection in all lunar environments and conditions
- Navigation with minimal infrastructure
- Autonomous operations





LSII Technology Demonstration Planning



Capability Area	Activity for Surface Demonstration	Targeted Initial Flight Demo
ISRU	Ice Mining Subscale Demonstrations (includes PRIME)	2 Sub-system Class: PRIME (FY22); Ice-mining Sub-scale Demo (FY24)
	Oxygen Extraction Subscale Demonstration	FY26
	ISRU Pilot Plant System (Includes excavation and power sub-systems)	System Flight Demo FY29 (Full Mission)
Surface Power	Chemical Heat Integrated Power Source (CHIPS)	FY26+ Sub-system Class
	Regenerative Fuel Cell/PV Power Demonstration	FY26+ Sub-system Class
	Wireless Power Transfer for Lunar Surface Demonstration	FY26+Sub-system Class
	Lunar Surface Solar Arrays	FY25+Sub-system Class
	Surface Fission Power Pilot	FY28 – Full Mission
Dust Mitigation	Multiple Lunar Dust Mitigation Demonstrations	3 Sub-system Class: #1 (FY23), #2 (FY25), #3 (FY27); 3 Component Class: #1 (FY22), #2 (FY24), #3 (FY26)
Extreme Environments	COLDArm with Bulk Metallic Glass Gears (BMGG) & LDRT	FY23 Sub-system Class
	Engineering Camera for Lunar Exploration (LunarCam) Demonstration	FY23 Sub-system Class
	Lunar Exposure Platform (Lunar MISSE)	FY22+ Component Class
	Lunar Night and Material Survivability	FY22+ Component Class
	Planet & Lunar Environment Thermal Toolbox Elements (PALETTE)	FY24+ Subsystem Class
	Extreme Environments System Demonstration(s)	2 Sub-system Class: #1 (FY26), #2 (FY28)
Extreme Access	Surface Robotic Scouts Technology Demonstration (CADRE)	FY23+ CADRE Sub-system Class
	Lunar LIDAR for Navigation Demonstration	FY24 Sub-system Class
	Exploration of Lunar Pits Demonstration	FY24+ Sub-system Class
	Micro Video Guidance System (μVGS)	FY22+ Component Class
	Day/Night Lunar Rover Autonomous Obstacle Avoidance and Localization	FY24+ Component Class
	Lunar Surface Communications Demonstrations	FY24+ Sub-system Class
	Lunar Surface Autonomous/Robotics Systems Demonstration(s)	2 Sub-system Class: #1 (FY25), #2 (FY28)
Excavation & Construction	Lunar Surface Construction Demonstration(s) (Scaled Landing Pad Demo)	2 Sub-system Class: #1 (FY26), #2 (FY28)
	Lunar Surface Excavation Demonstration(s)	2 Sub-system Class: #1 Small Pilot Excavator (FY24), #2 FY26; Part of ISRU Pilot Plan (FY29)
Technology Research	LSII Allocation for Technology Research Opportunities (STRG, STTR, etc.)	Component Class: #1 FY23, #2 FY25, #3 FY27, #4 FY29

➤ STMD Technology Demonstrations on CLPS flights will be a combination of payloads co-manifested on SMD-led CLPS Missions and STMD-led CLPS missions.

➤ The '+' sign by flight dates indicates the earliest year that the technology could be ready for flight. If CLPS missions are not available and architecture needs can be met, can consider later flight year.

Defining Our Focus Group Goals

- Collaboratively decide on a 1-year goal for us to work on as a group
 - Actionable
 - Impactful
 - Relevant to focus area
 - Doable within 1 year
 - Uses capabilities of focus group members
 - Can be accomplished with existing resources
 - Inspired by current issues
 - Beneficial broadly to all stakeholders
- Won't be the only thing we work on! But it can be a focus/consensus need.
- Want this identified and defined by the September meeting

Potential Example:

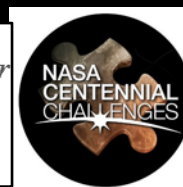
NASA needs XX to ensure robotic exploration of the Moon. Today, this does not exist, and there is no accepted path to its completion. We will provide specific recommendations to NASA for maturing technologies to achieve...

Open Discussion

In the realm of Extreme Access,

- What is the hardest problem that you're working to solve?
- What info are you lacking that would make your work better/easier/more robust?
- How do you see your work connecting to the whole lunar surface infrastructure system?
- Are there specific technologies that you see as vital to enabling access on the Moon?
- Are there specific other technologies, which might be represented in other focus groups, that would be enabling? For example, “if we had this kind of power, it would...” etc. How should we build these bridges?

- 2020 Tipping Point and Announcement of Collaborative Opportunity (ACO) Solicitations – Selection September
- Small Business Innovative Research (SBIR) Surface Power Sequentials process underway (\$5M)
- Selected 8 universities for the Breakthrough, Innovative and Game-changing (BIG) Idea Challenge for ideas on systems and technologies to explore and operate in Permanently Shadowed Regions in and near the Moon's polar regions (announced February 14, 2020)
- Multiple NASA LSII focused Early Career Initiatives (ECI)
- NASA Innovative Advanced Concepts (NIAC) awarded for lunar technology enabling exploration of lunar pits
- Centennial Challenges Program formulating LSII-related challenges, including Surface Power and Excavation.
- Two crowdsourcing challenges through NASA Tournament Labs including a call for payload designs for small lunar scouts and an open-source design challenge for the pilot excavator



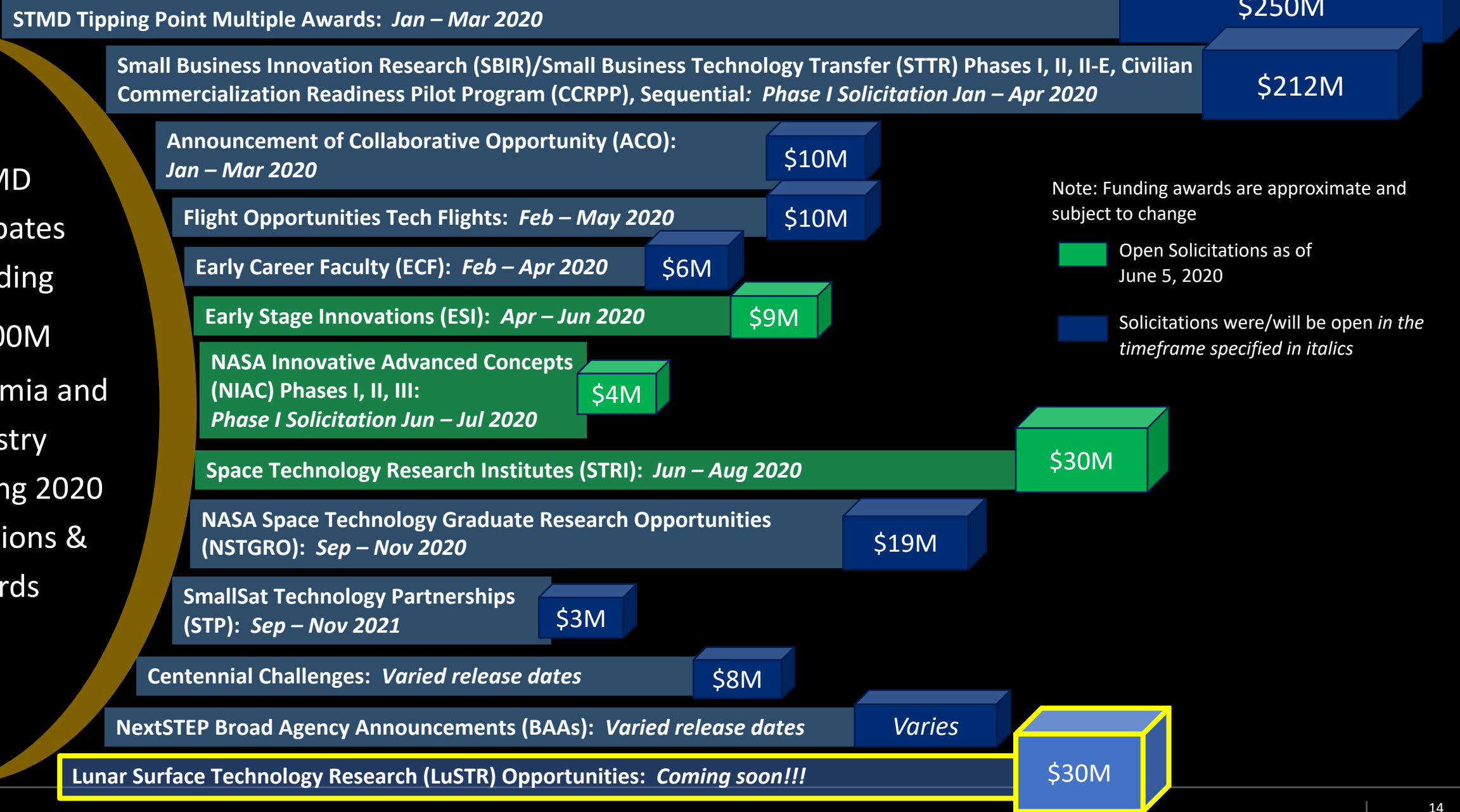
STMD Recurrent Solicitation Opportunities

Opportunity	Solicitation Totals for New Awards*	Solicitation
Tipping Point (TP)	\$250M	Jan-Mar
Space Technology Research Institutes (STRI)	\$30M	June-Aug alt. years
SBIR/STTR Phase I, II, Phase II-E, CCRPP, Sequential	\$212M	Jan-April (Phase 1)
NASA Innovative Advanced Concepts (NIAC) Phase I, II, III	\$4M	Jun-Jul (Phase 1)
Announcement of Collaborative Opportunity (ACO)	\$10M	Jan-Mar
Early Career Faculty (ECF)	\$6M	Feb-April
Early Stage Innovations (ESI)	\$9M	April-June
<u>Smallsat</u> Technology Partnerships (STP)	\$3M	Sep-Nov alt. years
Flight Opportunities Tech Flights	\$10M	Feb-May
NASA Space Technology Graduate Research Opportunities (NSTGRO)	\$19M	Sep-Nov
Centennial Challenges	Prize purse varies	Varies
Lunar Surface Technology Research (LuSTR) Opportunities		In Development

*Based on FY 2020 Operating Plan

STMD Opportunities for Academia and Industry

STMD anticipates awarding ~\$600M to academia and industry supporting 2020 solicitations & awards



Lunar Surface Technology Research (LuSTR) Opportunities

University-led efforts to develop and mature technologies that address high-priority lunar surface challenges

Technical Characteristics:

- Unique, disruptive or transformational lunar surface technologies: *in situ* resource utilization, sustainable surface power, extreme access, extreme environments, surface excavation and construction, and lunar dust mitigation
- Low to mid Technology Readiness Level (TRL): TRL 2-5
- Post-award infusion opportunities

Eligibility

- Organization submitting proposal must be an accredited U.S. university
- PI must be a professor at the submitting university; co-Is are permitted
- $\geq 60\%$ of budget must go to accredited U.S. universities
- Up to 40% paid teaming with other universities, industry and non-profits encouraged

Award Information

- Expected duration: **2 years**
- Anticipated awards (inaugural solicitation): **10-15 awards** valued at up to **\$1-2M** each
- Oversight: Annual reviews and semi-annual briefings at LSIC meetings
- Award instrument: Grants
- Release Date: **July 2020**

Upcoming Meetings

- Focus Group Telecons (2nd Thursday each month, 3-4 pm EDT)
 - [July 9, 2020](#)
 - August 13, 2020
 - Recent conflicts arose with NASA sponsors, so may have to shift. Look for another poll!
- LSIC (virtual) meeting, September 2020 (dates still TBD)

- Funding Opportunities:
 - NASA Innovative Advanced Concepts (NIAC) Step A Proposal due July 22, 2020 5 pm EDT
 - Lunar Surface Technology Research (LuSTR) - scheduled for early summer release 2020
- NASA/NAS Planetary Science & Astrobiology 2023-2032 Decadal Survey white papers
 - “Community input in these areas and related activities—including, theory, computing, **technology development**, laboratory studies, planetary defense, **and human exploration activities**—are critical for the success of the survey.”
 - Science white papers due July 15
 - Mission concepts due August 15
 - Technologies, infrastructure, etc. due September 15
 - <https://www.nationalacademies.org/our-work/planetary-science-and-astrobiology-decadal-survey-2023-2032>

Next Steps

- Before the next Focus Group meeting, by email, wiki, etc.
 - Think about/decide on other communication tools we want to utilize
 - Discuss the Year-1 goal
- At the next Focus Group meeting, let's
 - Decide on the Year-1 goal to be ready for the September meeting
 - Identify overlap topics to be discussed in September, desired breakout sessions, etc.



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