Technology, Innovation, and Engineering Committee Report
NASA Advisory Council Meeting

Mr. Michael Johns | Committee Chairman | January 18, 2023

TI&E Committee Hybrid Meeting Attendees: MSFC, Dec. 14-15, 2022

- Lisa Callahan, Lockheed Martin Space (virtual)
- Mike Gazarik, Ball Aerospace (virtual)
- Kathleen C. Howell, Purdue University
- Michael Johns, Kratos SRE
- Rebecca Kramer Bottiglio, Yale University
- Andrew Rush
- Brad Tousley, Raytheon (virtual)
- Mitchell Walker, Georgia Institute of Technology
- Mary Ellen Weber, Stellar Strategies, LLC

TI&E Committee Tour of MSFC: Dec. 14, 2022

- Space Nuclear Propulsion
- Cryo Fluid Management
- Advanced Manufacturing
- Lunar Thermal Regulation for Mission Sustainability
- Kinematic Navigation and Cartography Knapsack
- Payload Operations Integration Center

TI&E Committee Hybrid Meeting Presentations: Dec. 15, 2022

- Welcome to NASA's Marshall Space Flight Center
  - Ms. Jody Singer, Director, MSFC
- Space Technology Mission Directorate (STMD) Update
  - Mr. Jim Reuter, Associate Administrator, STMD
- NASA Nuclear Systems Update
  - Dr. Anthony Calomino, Space Nuclear Technologies Lead, STMD
  - Mr. Jason Turpin, Project Manager, Space Nuclear Propulsion, MSFC
- Technology Demonstration Missions: Cryogenic Fluid Management and Low-Earth Orbit Flight Test of an Inflatable Decelerator Updates
  - Ms. Trudy Kortes, Director of Technology Demonstrations, STMD
  - Ms Tawnya Laughinghouse, Program Manager, TDM Program, MSFC
  - Mr. Jason Adam, CFM project, MSFC
- Office of the Chief Engineer (OCE) Update
  - Mr. Joe Pellicciotti, NASA Deputy Chief Engineer
- Early Career Initiative Researcher Presentations
  - Lunar Thermal Regulation for Mission Sustainability (TheRMiS), Will Johnson, MSFC
  - Kinematic Navigation and Cartography Knapsack (KNaCK), Michael Zanetti, MSFC
- Moon-to-Mars Planetary Autonomous Construction Technology (MMPACT) and Advanced Manufacturing Update
  - Mr. Raymond G. "Corky" Clinton, MMPACT Principal Investigator, MSFC

National Aeronautics and Space Administration

Marshall Space Flight Center Welcome

Jody Singer, Director
NASA Marshall Space Flight Center

December 15, 2022

Marshall’s Economic Impact

Alabama

$8.3B
Economic Impact

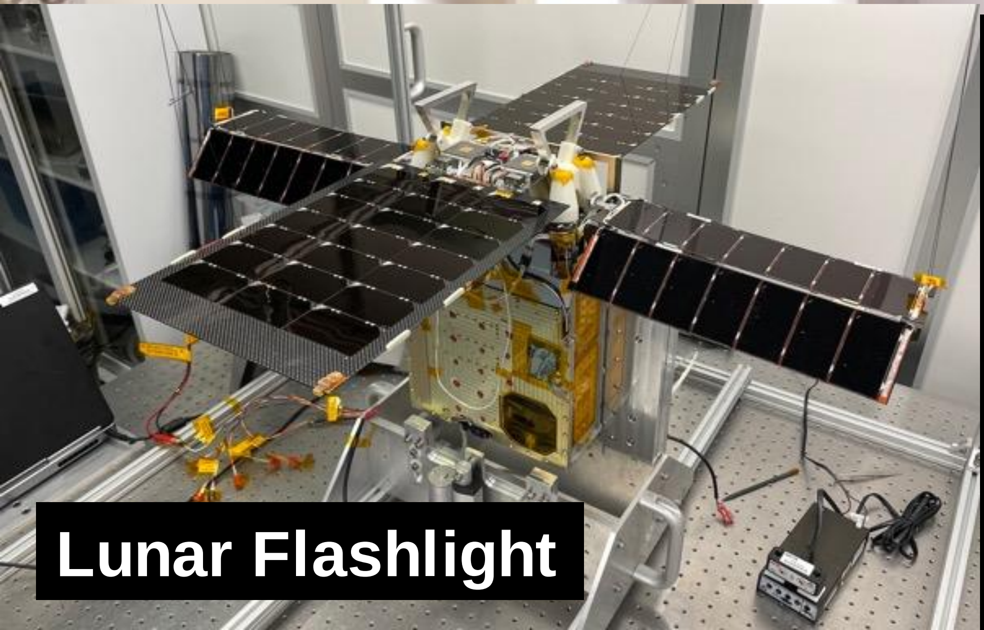
41,000
Jobs

$234M
Tax Revenue

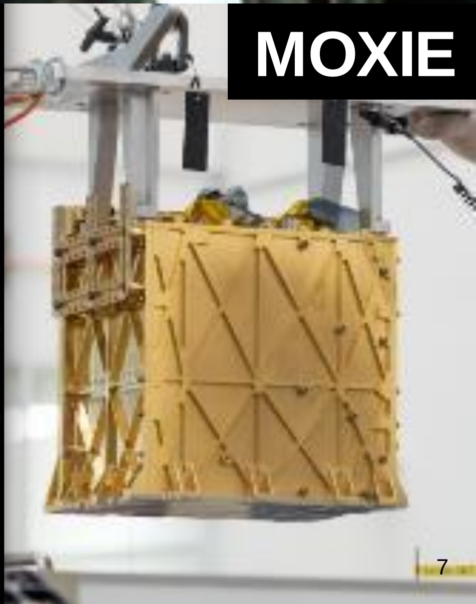
$2.7B
Labor Income


CAPSTONE

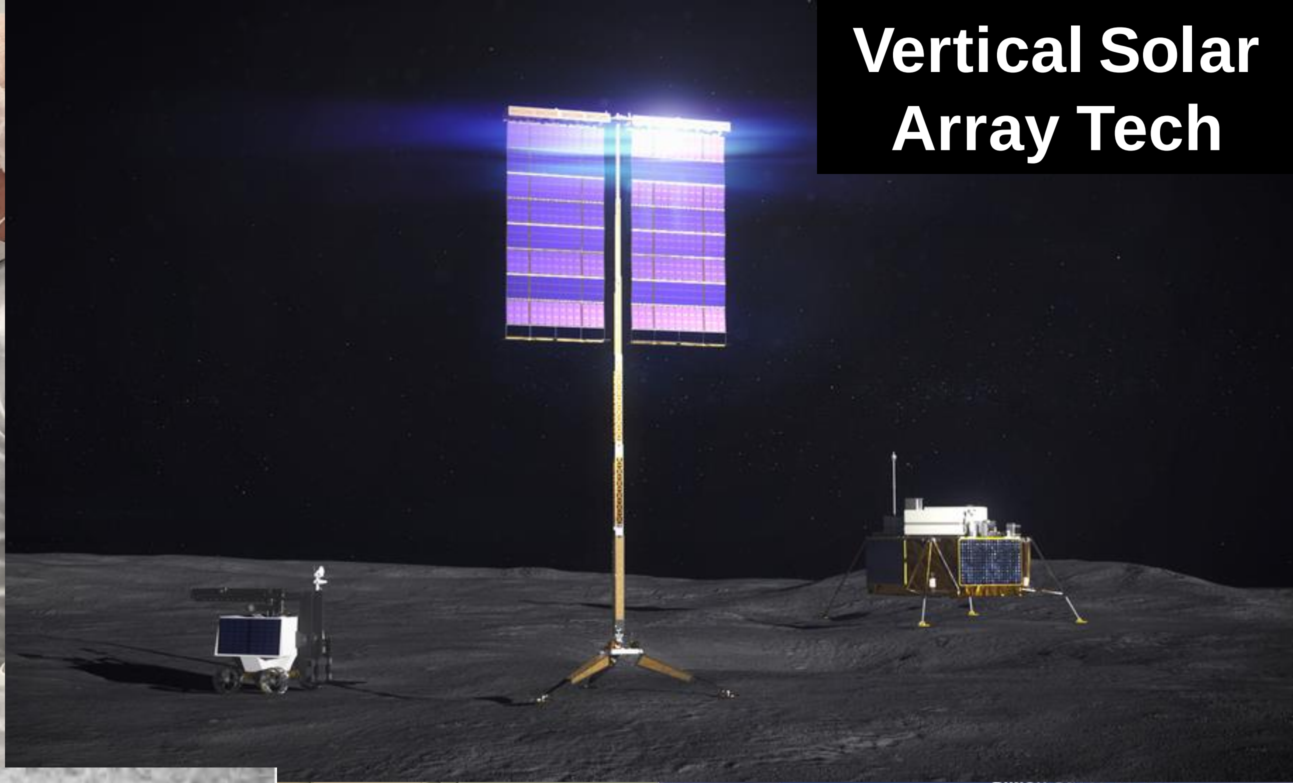

LOFTID


Lunar Flashlight


LCRD

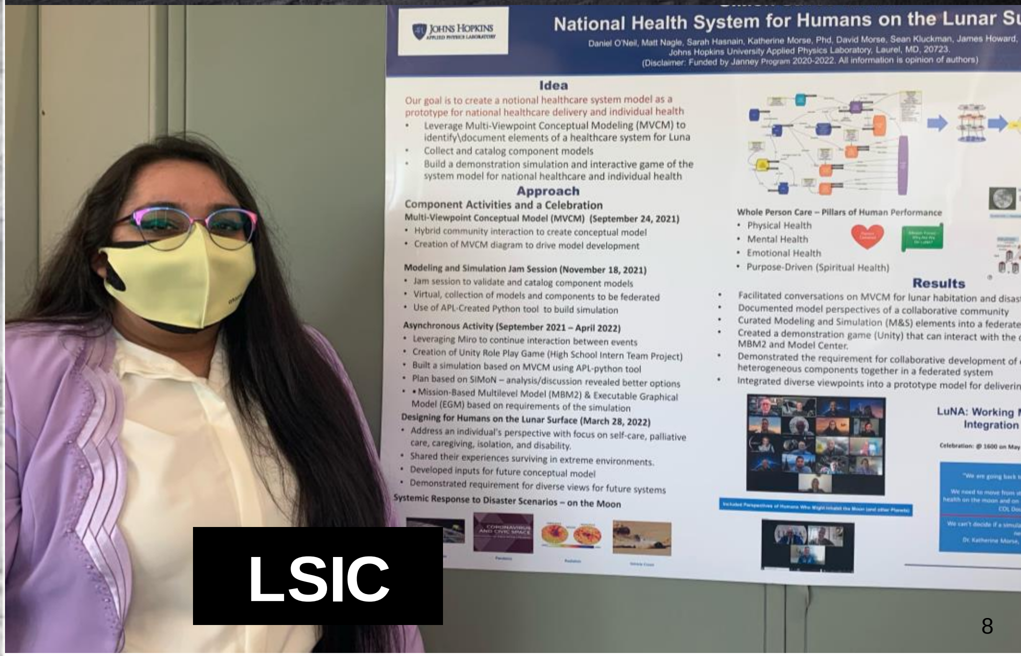

MOXIE


PRIME-1


Vertical Solar
Array Tech


HPSC
MICROCHIP
HPSC-21


CADRE


LSIC
JOHNS HOPKINS
National Health System for Humans on the Lunar Su
Idea
Approach
Results

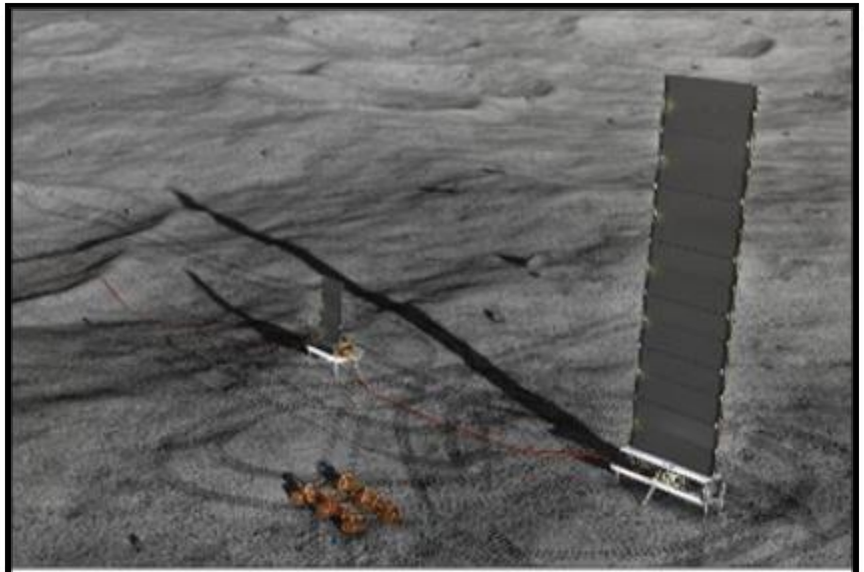
EXPLORESPACE TECH
TECHNOLOGY DRIVES EXPLORATION

Space Nuclear Technology Portfolio

Dr. Anthony Calomino | Space Nuclear Technology Portfolio Manager
Mr. Jason Turpin | Space Nuclear Propulsion Project Manager

December 15, 2022

Fission Surface Power Strategy



Power: 40 kWe scaleable to higher power
Mobility: Capable of being transported
Mass: less than 6,000 kg
Life: 10 years

Need
Establish a durable, high power, sun-independent power source for NASA missions

- **Design a fission power source that supports Lunar and Mars surface exploration requirements**
- **Build and ground test a flight-qualified, fully integrated power system for Lunar demonstration**
- **Transition of Design, Development, Test and Evaluation of the FSP system to industry**

- Develop a 40 kWe lunar fission power system for delivery to the launch site by 2029
- Design must show extensibility to a Mars mission (power maybe lowered to meet mass limits)
- Project remains in program formulation as a technology development effort
- Project scope will include development of the FSP flight hardware after transitioning to a space demonstration mission (prior to releasing an industry solicitation for Phase 2)
- DOE/Idaho National Laboratory (INL) is managing industry design contracts

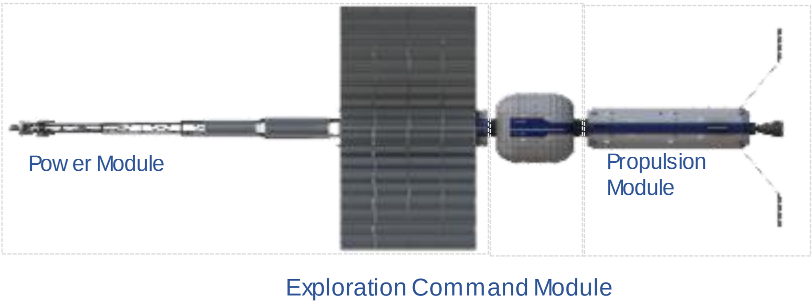
Nuclear Propulsion

Nuclear electric provides very high propellant efficiency (>2000 sec Isp) with less system mass

Nuclear thermal provides high propellant efficiency (900 sec Isp) and high thrust (>25,000 lbf) capability

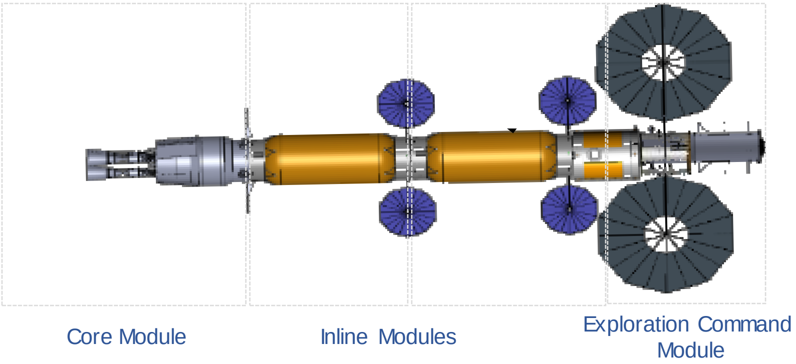
NEP technology maturation plan considerations

- Multi-megawatt, high-assay, low enriched uranium reactor
- High efficiency Brayton cycle power conversion
- High-power (≥100 kWe) electric thruster system
- High-power, high-voltage power distribution system
- Cryogenic fluid storage and management of



NTP technology maturation plan considerations

- Multi 100-megawatt, high-assay, low enriched uranium reactor
- Extreme temperature reactor fuels and materials
- Reactor materials, manufacturing, and design methods
- Integrated subscale engine design and build
- Cryogenic fluid storage and management of hydrogen propellant



SNP Reactor Phase 1 Contracts

Reactor Phase 1 Design Reviews Complete

- NASA selected three industry efforts for a preliminary reactor design efforts in August 2021.
- Design a 12,500 lbf, 900 sec Isp, HA-LEU reactor with a mass less than 3500 kg.
- Demonstrate design feasibility, manufacturability, and scalability

- Assessed each design against ability to meet top-level requirements with acceptable risk
- Final review demonstrated a significant risks in design complexity (manufacturing) and performance of high temperature reactor materials and fuels (feasibility)
- All industry partners need to focus on fuel development qualification efforts

USNC ULTRA SAFE NUCLEAR

- USNC partnered with Blue Origin, General Electric and Framatone
- Phase 1 extension content includes continued design maturation, instrumentation and control, and non-nuclear unit cell manufacture demo, and reactor subsystem development testing, and manufacturing demonstration of a non-nuclear fuel/moderator unit cell

BWXT BWX Technologies, Inc.

- BWXT partnered with Lockheed Martin, and Aerojet Rocketdyne
- Phase1 extension content includes continued design maturation, nuclear fuel sample manufacturing, testing and post irradiation examination along with moderator manufacturing,

GENERAL ATOMICS ELECTROMAGNETICS

- General Atomics partnered with with X-Energy and Aerojet Rocketdyne
- Phase 1 extension content includes continued design maturation with focus on additive manufacturing and subscale high temp fuel element fabrication with non-nuclear testing.

Phase 1 extensions focused on fuel fabrication and testing

Space Nuclear Technology Key Takeaways

- STMD is actively engaged with internal and external agency groups to establish cooperative technology practices, procedures, and roadmap that leverage common priorities and resources

- STMD advancements leverage investments from terrestrial and other government agency activities to develop space-based nuclear design, safety, launch, operation, and governance practices

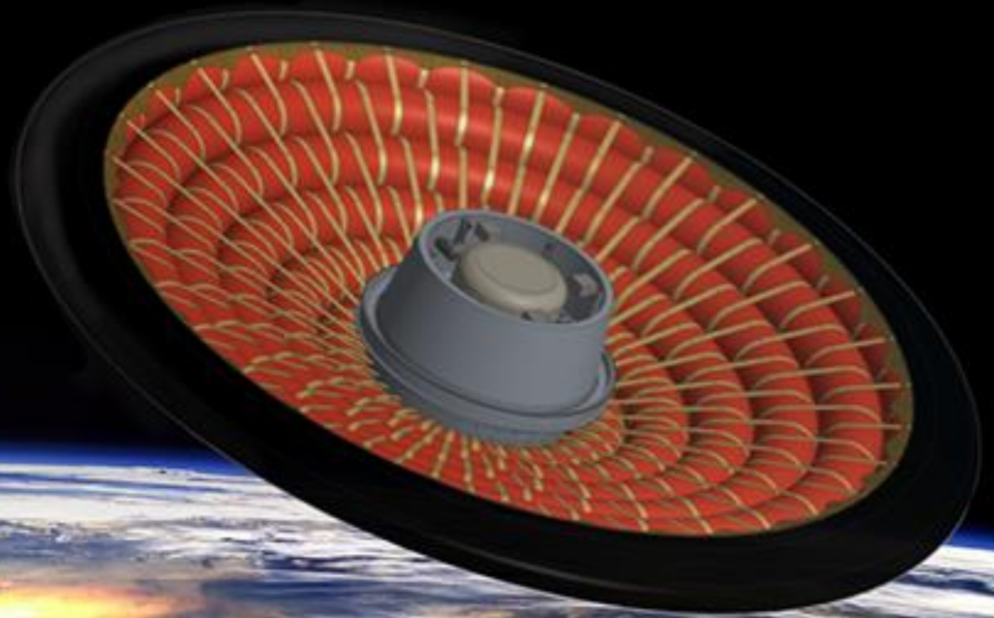
- NASA continues to closely engage commercial capabilities and innovations for HA-LEU reactor solutions

- NASA technology maturation efforts also target related key non-nuclear systems needs, including cryogenic fluid management capabilities critical for NTP and NEP

Technology Demonstration Missions Highlights

National Aeronautics and
Space Administration

NASA Advisory Council
Technology, Innovation, and Engineering Committee



Trudy Kortes
Program Director for Technology Demonstrations
NASA's Space Technology Mission Directorate

Tawnya Laughinghouse
Program Manager, Technology Demonstration Missions

Jason Adam
Project Manager, Cryogenic Fluids Management Portfolio

December 15, 2022

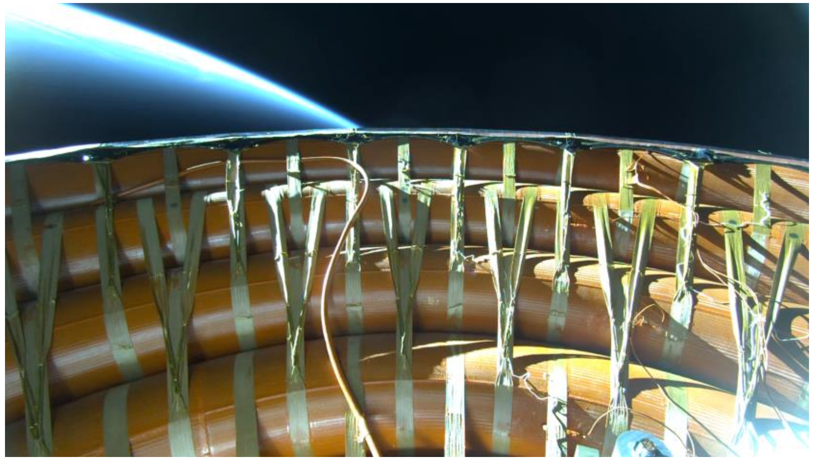
Low-Earth Orbit Flight Test of an Inflatable Decelerator (LOFTID)

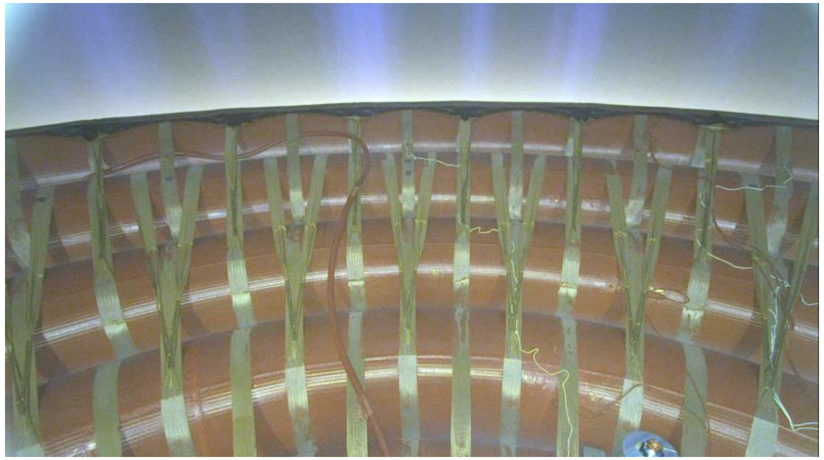
- Deployable aeroshell that stows for launch and cruise, then deploys to decelerate payloads at destinations with atmospheres
- Secondary payload on an Atlas V rocket
- Goal was to test technology at a scale and entry conditions relevant to Earth and Mars missions
- NASA partnership with ULA

Low-Earth Orbit Flight Test of an Inflatable Decelerator (LOFTID) Mission Highlights

- Orbital velocity re-entry flight demonstration of advanced inflatable aeroshell
- Validate structural and thermal performance capability against mission relevant flight loads
- Launch from Vandenberg Space Force Base as a secondary payload on an Atlas V
- Partial trajectory dataset received in real time through Iridium network
- Performance data recorded onboard; unit jettisoned before splash down

Launch and Recovery





LOFTID Mission Status

➢ LOFTID Flight hardware

- Successful LOFTID launch, re-entry, and splashdown off the coast of Hawaii
- Successful recovery of LOFTID flight RV and Ejectable Data Recorder
- LOFTID flight vehicle documented, data extracted, RV packaged up and is in transit back to LaRC (expected arrival Dec 6)
- LOFTID will conduct a quick-look Post-Flight Snapshot Assessment Dec 16th

➢ Initial LOFTID Post-Flight Results

- Aeroshell sensor, FADS, and FOSS data recovered from EDR, and IDR
- Flight video and IR data recovered from EDR and IDR
- Issue with initialization of MACH box resulted in loss of MACH IMU data; project is extracting lower data rate secondary source of IMU data from EDR & IDR
- Initial aeroshell performance results indicate LOFTID performed as predicted
- Aeroshell impressions: Inflatable Structure looks pristine! Damage noted to TPS on nose-cap resulted from splashdown in ocean.

LOFTID DEMONSTRATION WAS SUCCESSFUL

Cryogenic Fluid Management (CFM) Portfolio Project

Jason Adam
CFMP Project Manager

December 15, 2022

Cryogenic Fluid Management (CFM) Portfolio Project

__Objective:__ Mature CFM technologies essential to NASA's future missions in science and exploration which utilize both chemical and nuclear in-space propulsion, landers, and in-situ resource utilization

CFMP is a TDM portfolio project comprised of twenty-four individual CFM technology development activities, spread across four portfolio areas
Technology entrance minimum of **TRL 4**, with project end state objective of **TRL 7**

CFMPP was established to consolidate management and integration of TDM CFM technology development activities
NASA MSFC partnering with GRC for management and execution of the portfolio project

System Demonstration Complexity

Technologies

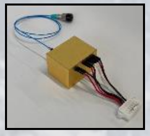
Scope: Design, development, testing, and evaluation of critical-need cryogenic components enabling long-duration CFM storage and propellant transfer

Major Activities:

Hydrogen low-leakage valves and cryo-couplers

Radio Frequency Mass Gauge (RFMG)

Next-generation FOSS (fiber optics sensing system)



Solar White thermal coatings

Subsystems

Scope: Design, development, and testing of complex systems of technologies to address technical challenges for specific CFM mission needs

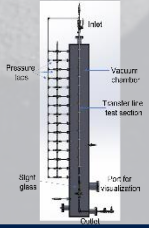
Major Activities:

20W/20K Cryocooler

90W/150K Cryocooler

Cryocooler Electronics and alternate generic 20W Cryocooler

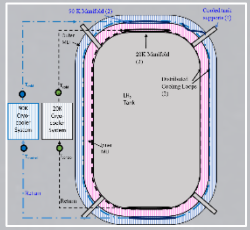
Reduced Gravity Cryogenic Transfer (RGCT)



Demonstrations

Scope: Design, build, and test integrated flight and ground systems comprised of multiple CFM subsystems, enabling TRL 5 - 7 maturation for many technologies

Major Activities:
Large CFM Demonstration Concept Planning
Tipping Point Contract Demonstrations



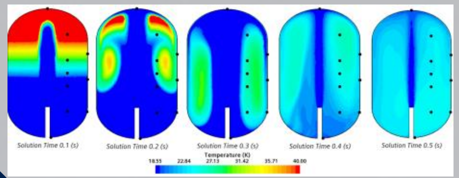
Two-Stage Cooling Demonstration

CryoFILL Liquefaction Demonstration

Modeling

Scope: Develop, enhance, validate, and demonstrate Computational Fluid Dynamics (CFD) and Nodal tools to address capability gaps for predicting cryogenic fluid behavior in 1-G and microgravity environments for use as design tools for future NASA missions

Testing and demo activities <u>across the CFMP portfolio</u> are used within modeling tools to predict CFM behavior at a flight vehicle scale in a relevant environment including microgravity



System Validation

CFM TECHNOLOGY ACTIVITIES TO GAP MAPPING

Activities Within the NASA CFM Portfolio Project		LCC $	Critical Cryogenic Technologies																										
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
FY20 Tipping Points																													
Lockheed Martin - CDM		$$$	x	x	x	x	x*	x	x	-	-	x	x	x	x	x	-	x	x	-	-	-	x	-	x	-	-	x	x
Eta Space - LOXSAT		$$$	-	x	x	x	-	x	x	-	x	-	x	x	-	-	-	x	-	-	-	-	x	-	-	-	-	x	-
SpaceX		$$$	-	-	x	-	-	x	x	-	x	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	x	-
ULA		$$$	x	-	x	x	-	x	x	-	x	-	-	-	-	-	-	-	x	-	-	x	-	-	-	-	-	-	x
CCSC Smart Prop (CR Version)	N/A	$	-	-	-	-	-	-	-	-	x	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CELSIUS– FY18 Tipping Point	N/A	$	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	x	-	-	-	-	-	-	-	-
Intuitive Machines RFMG*		$	-	-	-	-	-	-	-	-	-	-	-	-	-	-	x	-	x	-	-	-	-	-	-	-	-	-	x
NTP Fuel Densification		$	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	x	-
Hydrogen Valves / Low Leakage Components		$	x	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2 Stage cooling		$$	-	-	-	-	-	-	-	-	-	-	-	-	x	-	-	-	-	x	-	-	x	-	-	x	-	-	-
90K SBIR Creare New Phase 3 (CR)		$$$	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	x	-	-	-	-	-	-
Generic 20k - CC (not Creare)		$$$ (FY24+)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	x	-	-	-
Cryofill		$$	-	-	-	-	-	-	-	x	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ACO - Sensuron	N/A	$	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	x
Reduced Gravity Cryo Transfer		$$	-	-	x	-	-	x	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Solar White	N/A	$	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	x	-	-	-	-	-	-	-
Creare 20k20W Cryo-cooler		$$	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	x	-	-	-
TVS augmented Injector		$	-	-	-	-	-	x	x	-	-	-	-	-	-	-	-	-	x	-	-	-	-	-	-	-	-	-	-
Cryo coupler		$$	-	-	-	-	x	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FY19 Tipping Points			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Blue Origin Liquefaction #49		$$	-	-	-	-	-	-	-	x	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Space X Cryo-coupler #31		$	-	-	-	-	x	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Oxeon Engy Liquefaction #53		$	-	-	-	-	-	-	-	x	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

* *Limited Data Rights on Demonstration Data*

Date: Nov 2022

Questions? Contact jason.r.adam@nasa.gov

LH_2	LO_2	LCH_4
	LN_2	

Legend	
x	Planned Demonstration, Pushing State-of-the-Art
x	Limited Demonstration Planned
x	High Priority Technology Gaps
x	Tech Gap; Longer-Term Mission Demand Unclear
-	No Planned Demonstration
$	< $4M
$$	$4M < x < $20M
$$$	> $20M

	ID	Critical Cryogenic Technologies
Tank-to-Tank Propellant Transfer	1	Valves, Actuators & Components
	2	He Pressurization of an Unsettled Tank
	3	Main Propellant System Line Chilldown
	4	Liquid Acquisition Devices (LAD)
	5	Automated Cryo-Couplers
	6	Propellant Tank Chilldown
	7	Transfer Operations
	8	Liquefaction Operations
	9	Autogenous Pressurization
	10	Flowmeters
Long Term Storage	11	Low Conductivity Structures
	12	High Vacuum Multilayer Insulation (MLI)
	13	Tube-on-Shield Broad Area Cooling (BAC)
	14	Vapor Cooling
	15	Composite Tanks
	16	Pump Based Mixing
	17	Thermodynamic Vent System (TVS)
	18	Tube-on-Tank BAC
	19	Advanced External Insulation
	20	Cryogenic Thermal Coating
	21	High Capacity 90K Cryocoolers
	22	Soft Vacuum Insulation
	23	Structural Heat Load Reduction
	24	High Capacity 20K Cryocoolers
	25	Para to Ortho Cooling
	26	Propellant Densification
	27	Unsettled Liquid Mass Gauging

Lunar Thermal Regulation for Mission Sustainability (TheRMiS)

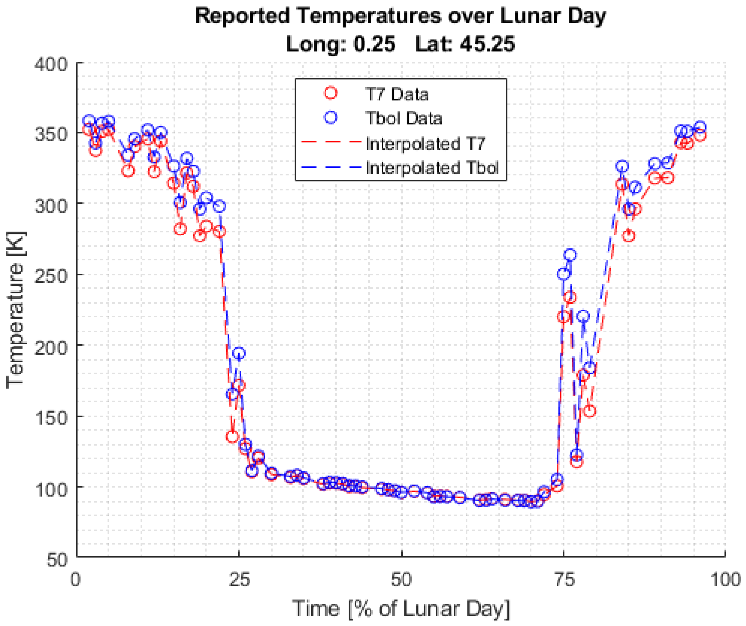
NASA Advisory Council
Technology, Innovation, and Engineering Committee

Will Johnson

2022-12-15

Motivation

- With the renewed focus from NASA on returning humans to the Lunar surface, small landers that lay the groundwork for the return are essential
- Multiple regions of the Lunar surface are extremely cold
  - During the night temperatures approach -200°C
  - Regions of extended and permanent shadow produce similar or even more severe temperatures
- Surviving in these regions is a difficult thermal challenge
  - Radioisotope heating is currently the only method that has demonstrated continued mission success
  - This brings added availability, political, schedule, and integration challenges that smaller robotic landers might not be able to overcome
- Enabling the initial wave of small landers to survive in extreme Lunar environments allows for increased science and exploration output



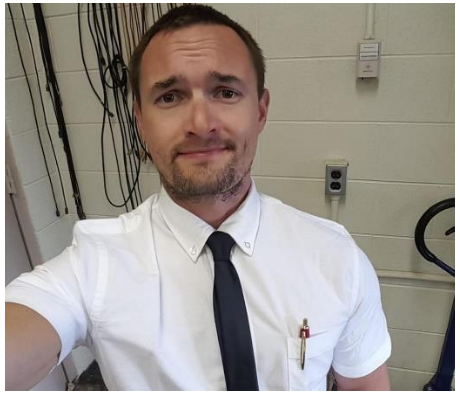
Team Members

Will Johnson
Principal Investigator

Parker Weide
Thermal Analysis and Test

Dr. Erin Hayward
Test Development and Integration

Alex Szerszen
Thermal Analysis and Test



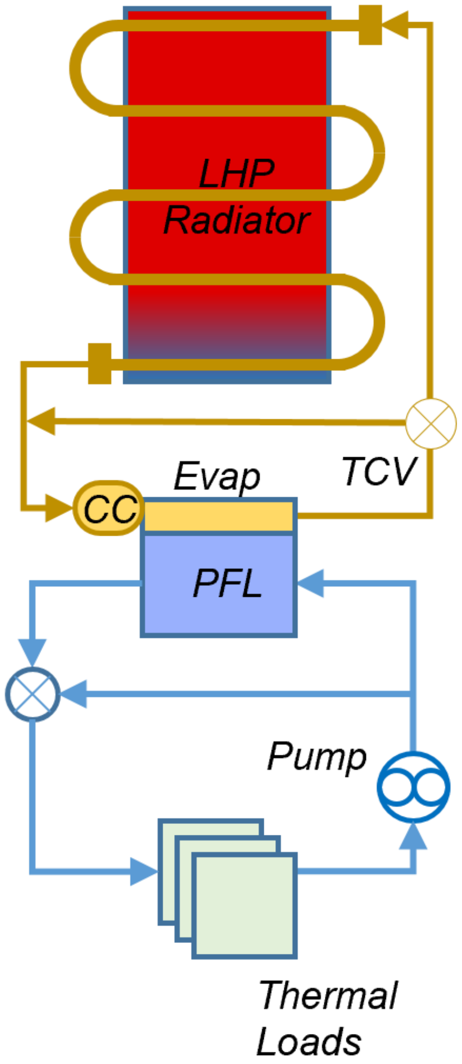
Travis Belcher
Thermal Test and Project Management

Not Pictured

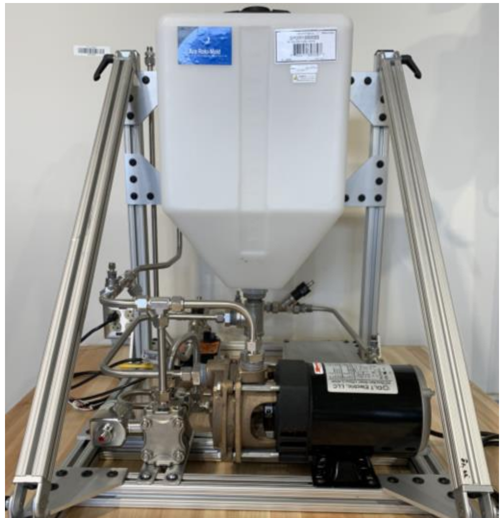
Mark Brethren
Mohammad Mokhtari
Thermal Modeling and Test Correlation

Hybrid Thermal Control System

- Joint project with Spacecraft and Vehicle Systems Department at MSFC
- "Hybrid" system utilizing both an active pumped fluid loop and a passive loop heat pipe
- Targeting human-rated systems
  - Pumped fluid loop collects waste heat inside habitable volume
  - Transfers heat to loop heat pipe evaporator
- Loop heat pipe is exterior of the system to radiate waste heat to environment
  - Thermal control valve allows system to passively shut down during Lunar night



Loop Heat Pipe with Thermal Control Valve



Pumped Fluid Loop

KNaCK

Kinematic Navigation and Cartography Knapsack

Mobile LiDAR Terrain Mapping and Navigation System

NASA Team:
PI: Dr. Michael Zanetti
Dr. Paul Bremner
Brian De Leon Santiago
Dr. Erin Hayward
Kyle Miller
Bridgette Steiner
NASA Marshall Space Flight Center,
Huntsville, AL 35808
Michael.R.Zanetti@nasa.gov

Torch Technologies Team:
Dr. Brian Robinson
John Jetton
Josh Walters
Arvind Draffen
4090 Memorial Parkway SW
Huntsville, AL 35802
BrianRobinson@TorchTechnologies.com

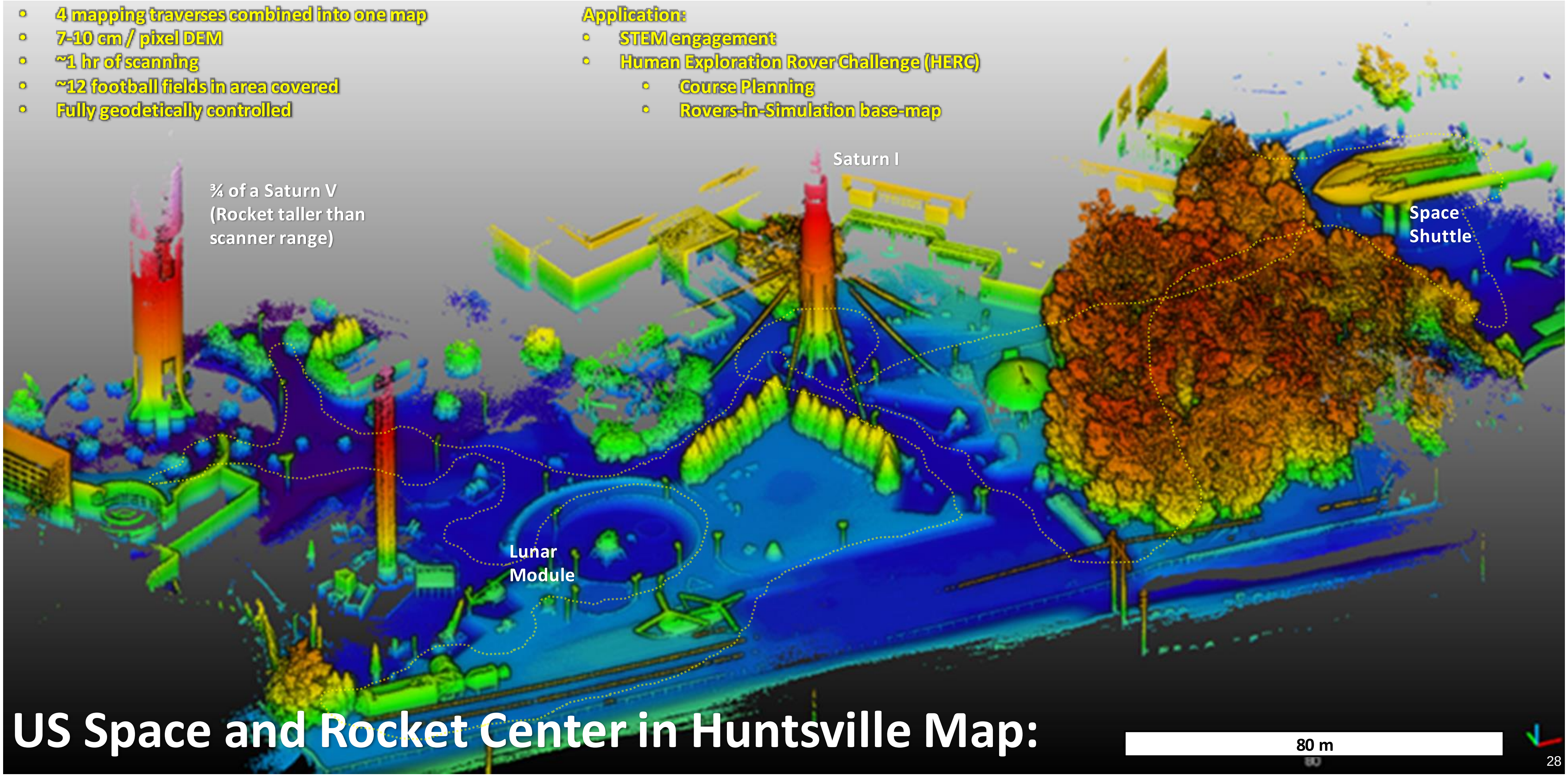
KNaCK Team Personnel

- **NASA ECI Core Team**
  - Kyle Miller
  - Dr. Erin Hayward
  - Bridgette Steiner (SW PM)
  - Dr. Paul Bremner
  - Brian De Leon Santiago
- **Torch Technologies Core**
  - Dr. Brian Robinson (PI)
  - John Jetton
  - Jacob Reeves
  - Arvind Draffen
  - Tanner Cordova
  - Joshua Walters
  - Kyle Bentley
- **Partners and Vendors**
  - ***Aeva Inc***
  - Rover Robotics
  - T-STAR
- **NASA Interns**
  - Niall McKinnon
  - Maria Voss
  - Tejas Lotay
  - Melvin Hernandez
  - Jeremy Coffelt
- **NASA Faculty Fellow**
  - Dr. Seongjai Kim
- **Capstone Teams Supported**
  - Texas A&M
  - University of Alabama, Huntsville
  - Florida State / Florida A&M
- **Academic Collaborators**
  - University of Arizona
  - University of Western Ontario

Mobile 3D-Mapping with Time-of-Flight LiDAR

- 4 mapping traverses combined into one map
- 7-10 cm / pixel DEM
- ~1 hr of scanning
- ~12 football fields in area covered
- Fully geodetically controlled

Application:
- STEM engagement
- Human Exploration Rover Challenge (HERC)
  - Course Planning
  - Rovers-in-Simulation base-map



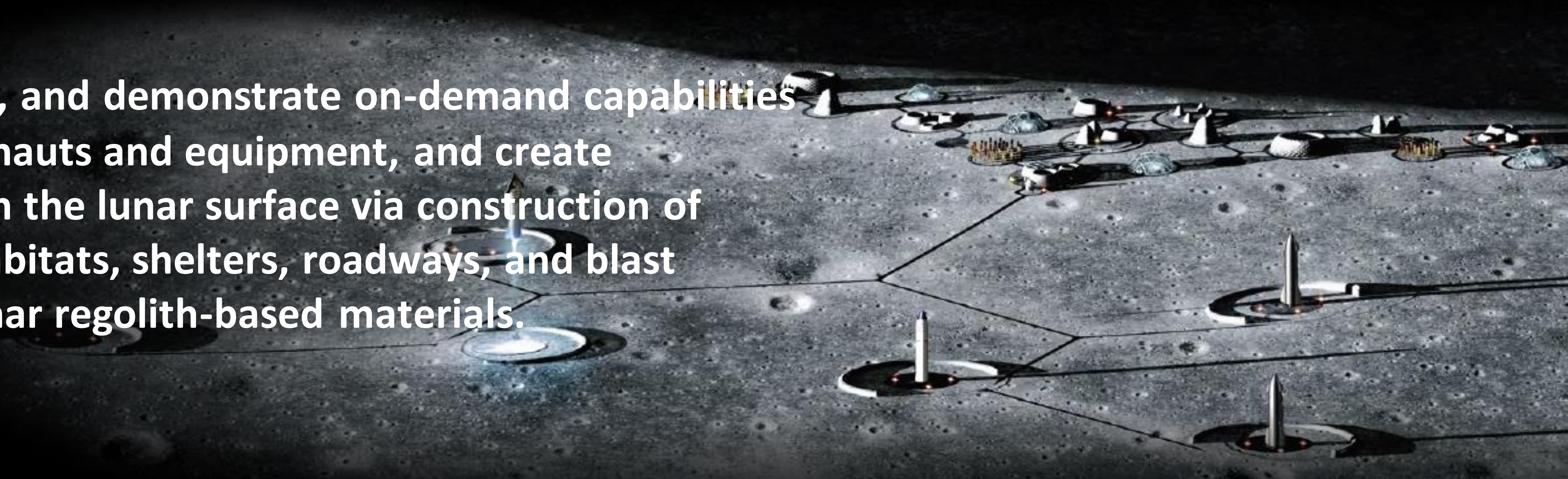
US Space and Rocket Center in Huntsville Map:

Moon-to-Mars Planetary Autonomous Construction Technologies (MMPACT) Overview

Mr. Raymond G. “Corky” Clinton, MMPACT Principal Investigator, MSFC

December 15, 2022

Moon-to-Mars Planetary Autonomous Construction Technologies (MMPACT) Overview



GOAL

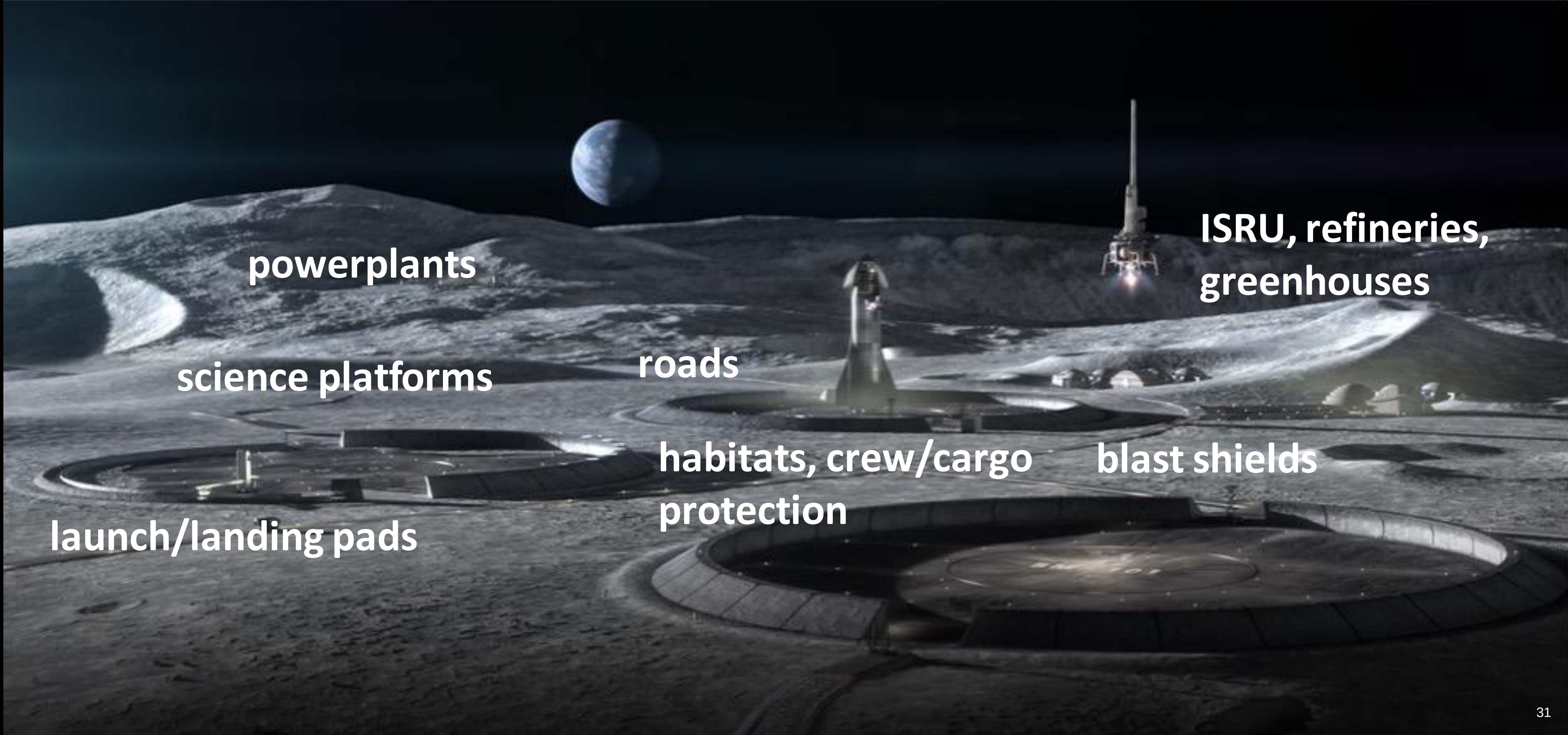
Develop, deliver, and demonstrate on-demand capabilities to protect astronauts and equipment, and create infrastructure on the lunar surface via construction of landing pads, habitats, shelters, roadways, and blast shields using lunar regolith-based materials.

OBJECTIVES

- Develop and demonstrate additive construction capabilities for various structures as materials evolve from Earth-based to exclusively *In Situ* Resource Utilization (ISRU)-based
- Develop and demonstrate approaches for integrated sensors and process monitoring in support of *in situ* verification & validation of construction system and printed structures
- Test and evaluate materials from candidate processes for use in the lunar environment
- Validate that Earth-based regolith simulants and testing environments are sufficient analogs for lunar operations

Building a Sustainable Presence on the Moon

What infrastructure are we going to need



MMPACT – Current Partners

NASA Centers
- MSFC
- LaRC
- KSC
- JPL

OGA Leveraging

Potential:
- Innovation Unit US Air Force (AF)

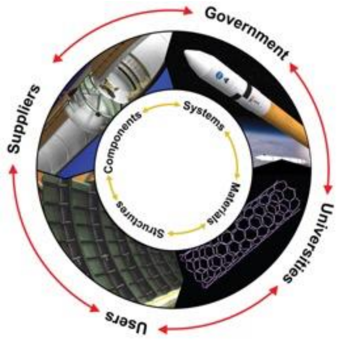
Contributing:
- AF Civil Engineering Center
- AF Special Operations Command
- Defense Innovation Unit
- Texas Air National Guard
- USAF

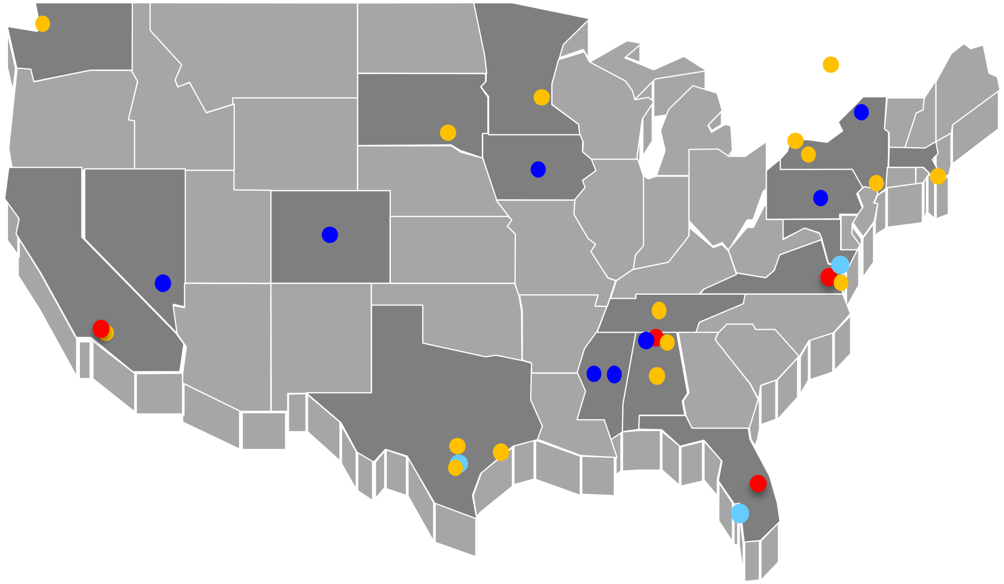
Public/Private Partnerships/Co ntract
- ICON Build
- Dr. Holly Shulman
- Radiance Technologies
- RW Bruce Associates, LLC
- Blue Origin
- Jacobs Space Exploration Group
- JP Gerling
- Microwave Properties North
- Southeastern Universities Research Association
- Southern Research Engineering/Kratos
- Space Exploration Architecture (SEArch+)
- Bjarke Ingels Group (BIG)
- Cislune
- Washington Mills

Technology Providers/ Contributing Partners: Academia
- Colorado School of Mines
- University of Texas in San Antonio
- Mississippi State University
- Pennsylvania State University
- University of Mississippi
- University of Nevada Las Vegas
- University of Alabama in Huntsville
- Clarkson University
- Iowa State University
- Crown College
- Sinte Gleska University
- Drake State

SBIR/STTR
- Construction Scale Additive Manufacturing Solution
- Millimeter Wave Camera
- High Efficiency Sintering via Beneficiation of the Building Material

Potential Customer
- Artemis
- Commercial





Collaborative multidisciplinary partnerships to leverage fiscal resources, ideas, knowledge & expertise.

TI&E Committee Finding on SBIR Direct-to-Phase II Authority

Short Title of Finding: SBIR Direct-to-Phase II Awards Authority

Finding: The Committee praises the Space Technology Mission Directorate's funding and management of the SBIR/STTR programs for NASA – one of the largest small business technology development portfolios across the U.S. government. The Committee finds that NASA should continue to urge Congress to prioritize the expansion of its current Phase II pilot program which does not currently include NASA (only the NIH, DOD and DOE).

Direct-to-Phase II awards at NASA would greatly expedite the path for infusion as they would enable Phase II development work to start approximately one year earlier than if the completion of a Phase I were required prior to the onset of Phase II work. While NASA could maintain a commitment to making a healthy number of traditional Phase I and II awards, adding this authority would provide increased flexibility to fund the further development of promising technologies that address immediate needs in a timely manner. This would provide NASA with a better tool to help small businesses more quickly make a meaningfully contribute to the agency's missions.

In addition, the ability to go Direct-to-Phase II for high priority technologies would allow for funding of new ideas at Phase I. If NASA does not need to fund a Phase I simply to be able to make a firm eligible for a Phase II award, the budget allocated to that Phase I could instead be used to make an award to another firm to investigate a potentially game changing technology that could benefit from the feasibility study typically expected at Phase I.

TI&E Committee Finding on Cryogenic Fluid Management Tech Demonstrations

Short Title of Finding: Prioritization of Cryogenic Fluid Management (CFM) Technology Demonstrations

Finding: Mature Cryogenic Fluid Management (CFM) technologies are essential to NASA's future missions in science and exploration. STMD has significant investments in CFM, including four firm-fixed-price Tipping Point contracts with industry to advance key CFM technologies through in-space demonstrations. However, a comprehensive, system-level CFM demonstration is required after these four key technology demonstrations are complete. The Committee urges the agency to prioritize this key, system-level demonstration in its upcoming FY 2025 budget planning cycle.

TI&E Committee Finding on NASA Workforce

Short Title of Finding: Focus on the NASA Workforce

Finding: After hearing briefings from both Kennedy and Marshall Center Directors, as well as other NASA leaders, the TI&E Committee finds that there is a growing concern with workforce attrition. The agency is struggling to attract and keep its employees due to competition with the commercial sector. Although the Committee notes that the workforce issue also reflects the anticipated drop-off of the overall national population that will soon affect every sector, the Committee finds that both a short- and long-term strategy should be developed and implemented to ensure that NASA can continue to hire and maintain the most qualified, diverse and innovative workforce.

TI&E Committee Recommendation: Establish a Program Management Training Bootcamp for Early Career Initiative Awardees

Short Title of Recommendation: Establish a Program Management Training Bootcamp for Early Career Initiative Awardees

Recommendation: The Space Technology Mission Directorate and the agency should establish comprehensive training in project management, accounting, and financial reporting, purchasing, contracts, and other critical skills that will be necessary to run a successful Early Career Initiative (ECI) program. This could take the form of an ECI bootcamp that could be implemented after project selection but before award, or shortly after the award of project funds.

Major Reasons for the Recommendation: The ECI program provides NASA early career civil servants with an opportunity to competitively propose two-year technology development projects that engage with industry, academia, and other government agency partners with the opportunity to gain valuable management skills while leading a multidisciplinary project team. Feedback from ECI awardees is consistent that the program provides valuable development opportunities, but they find themselves unprepared for the challenges of running a large multidisciplinary program. ECI participants would benefit from early training in program management fundamentals such as project management basics, accounting and finance, contracts, procurement processes, and others. Early training in these areas allows for more focused research efforts and more efficient program execution.

Consequences of No Action on the Recommendation: ECI awardees will not be as prepared as they could be and will spend valuable time and resources learning program management skills on their own that could otherwise be spent achieving their project goals.

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