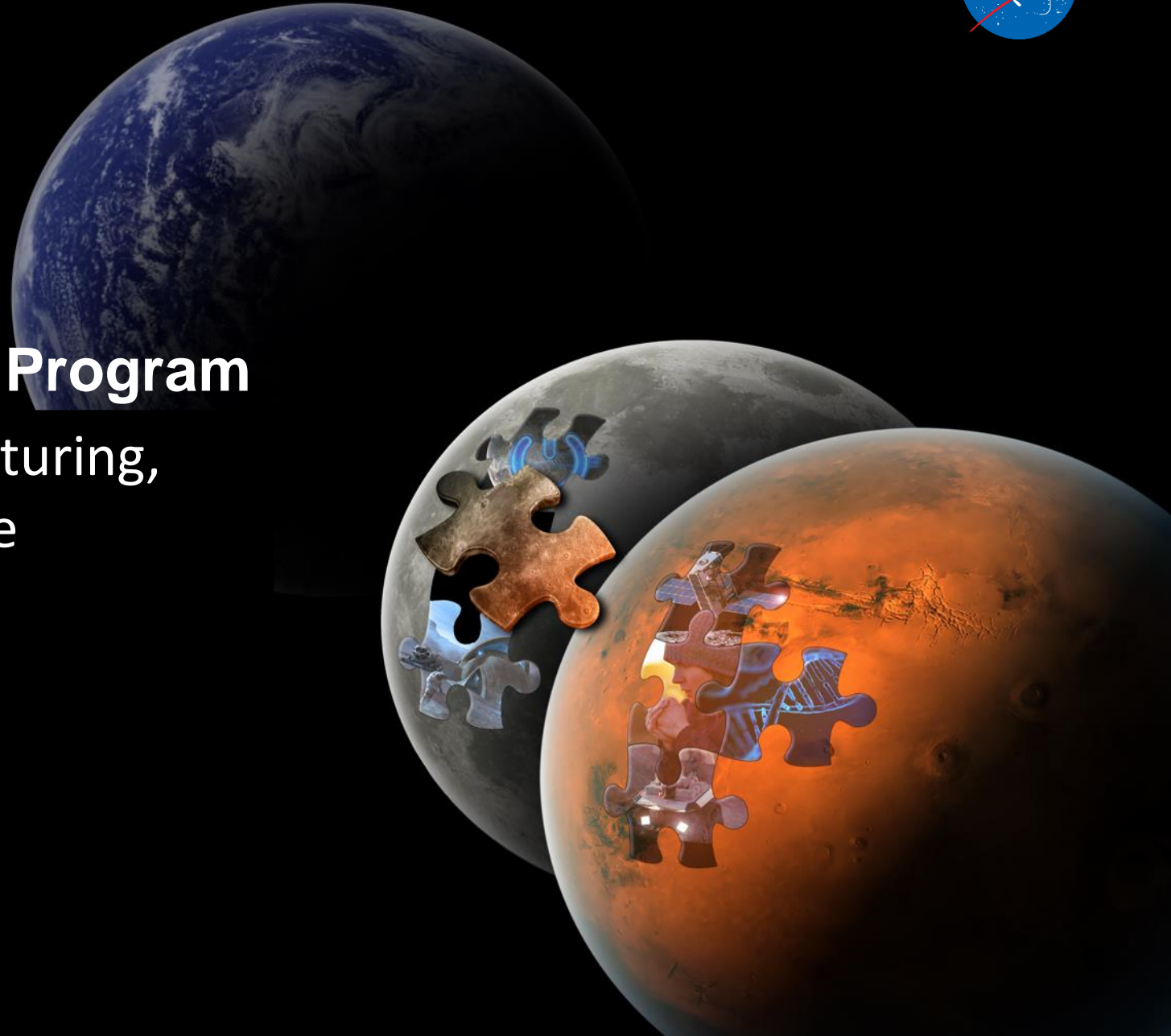


Centennial Challenges Program

Lunar Excavation, Manufacturing,
and Construction Challenge

Jul 31, 2020



NASA Prizes and Challenges



NASA Solve

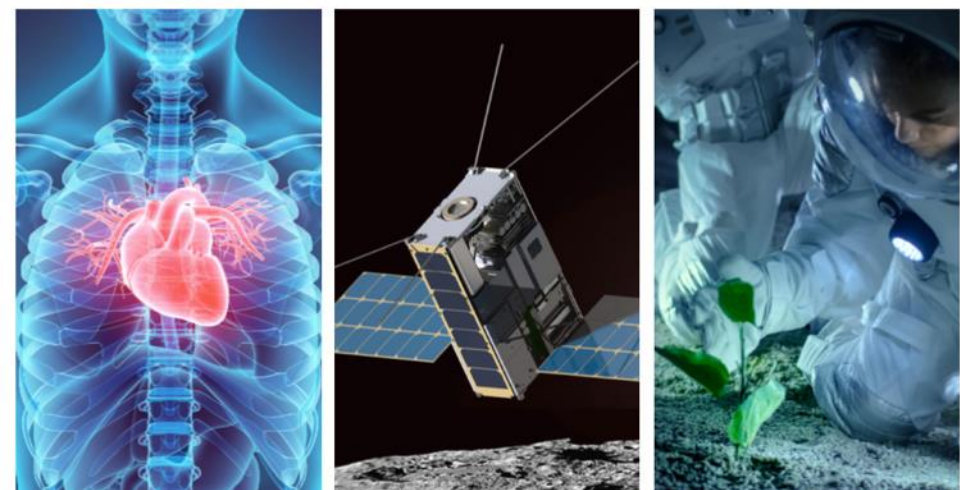
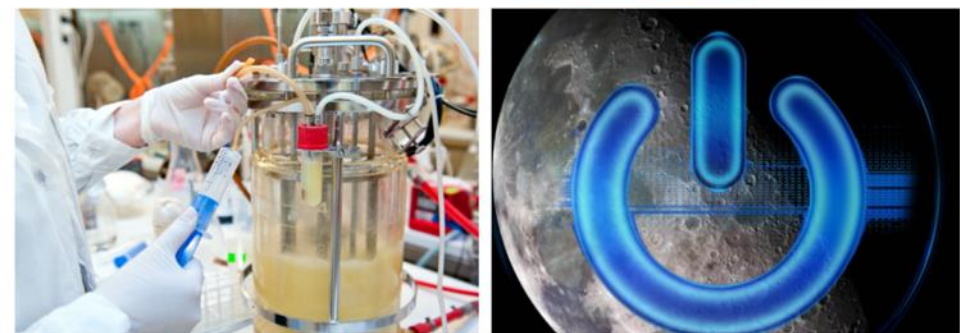
- **Centennial Challenges Program**
- **NASA Tournament Lab**
- **Space App**
- **Citizen Science**
- **NASA Education**
- **NASA @ Work**





ABOUT US:

- NASA's first prize program
- Established to conduct prize competitions in support of the Vision for Space Exploration and ongoing NASA programs
- Inspired by Orteig Prize and Ansari X Prize, among others
- Established (per NASA Prize Authority, 51 USC 20144): "to stimulate innovation in basic and applied research, technology development, and prototype demonstration that have the potential for application to the performance of the space and aeronautical activities of the Administration."
 - <https://uscode.house.gov/view.xhtml?req=granuleid:USC-prelim-title51-section20144&num=0&edition=prelim>
 - First competition opened in 2005



Since 2005 the **NASA Centennial Challenges** Program is Making **Exciting Progress**



**19
Challenges**



**307
Teams**



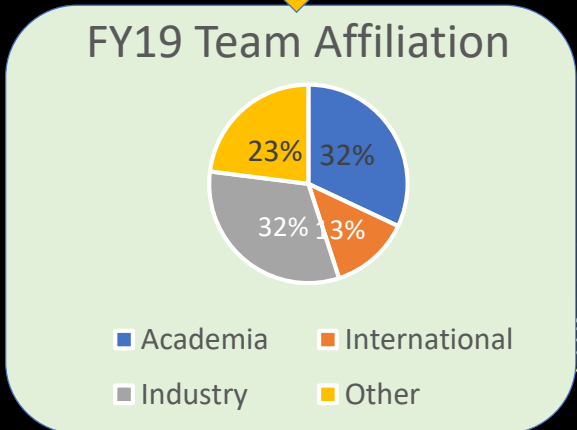
**\$10.33M
Awarded**



**42 States
24 Countries**

Four circular images showing project results:

- Lunar Lander**
Masten
- Astronaut Glove**
Final Frontier
- Cube Quest**
3 Payloads in Artemis-1; one team with ISS
- 3D Printed Habitat**
AI Space Factory, Branch Tech, ICON, SEARCH+



CURRENT CHALLENGES



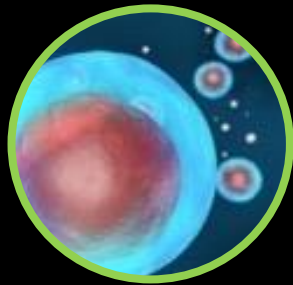
**3D-Printed
Habitat**

\$3,150,000



**Cube
Quest**

\$5,000,000



**Vascular
Tissue**

\$500,000



**CO₂
Conversion**

\$1,000,000



**Space
Robotics**

\$1,900,000



**Lunar
Nutrition**

(Up to \$3 M)



**Lunar
Power**

(Up to \$5 M)



**Lunar
Excavation,
Manuf. &
Construction**

(Up to \$5 M)

COMPLETED

ACTIVE

DEVELOPMENT



The NASA Team



Amy Kaminski
STMD Program Executive for
Prizes & Challenges



Monsi Roman
CCP Program Manager



Denise Morris
CCP Deputy Program
Manager



Angela Herblet
Data & Information Specialist
III
CCP Challenge Manager



Dawn Turner
CCP Challenge Manager



Amanda Adams
CCP Communication
Integrator



Naveen Vetcha
CCP Challenge Manager



Lane Stafford
CCP Project Coordinator



Rosalind Cylar
MSFC Legal Council



Chris Frangione
Challenge Development
Consultant



Jen Bravo
Challenge Development
Consultant



Alisa Ferguson
Challenge Development
Consultant



NASA CHALLENGE PTs AND SMEs:



John Vickers
NASA Headquarters
Principal Technologist



Jerry Sanders
NASA Headquarters
Principal Technologist



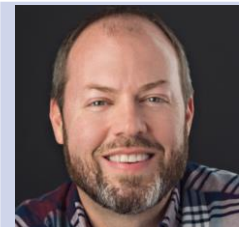
Mark Hilburger
NASA Headquarters
Principal Technologist



Mike Fiske
Jacobs Space Exploration
Group
Subject Matter Expert



Tracie Prater
Marshall Space Flight
Center
Subject Matter Expert



Kurt Leucht
Kennedy Space Center
Subject Matter Expert

Bob Moses
Langley Research Center
Subject Matter Expert



Eric Reiners
Caterpillar
Subject Matter Expert



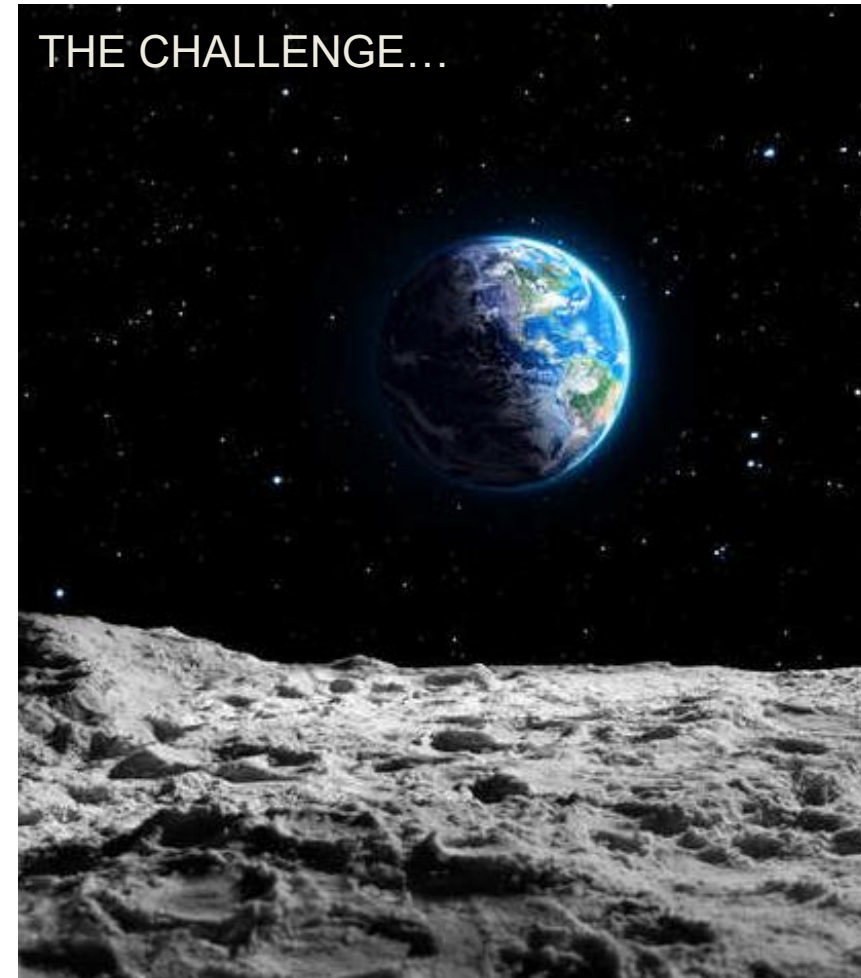
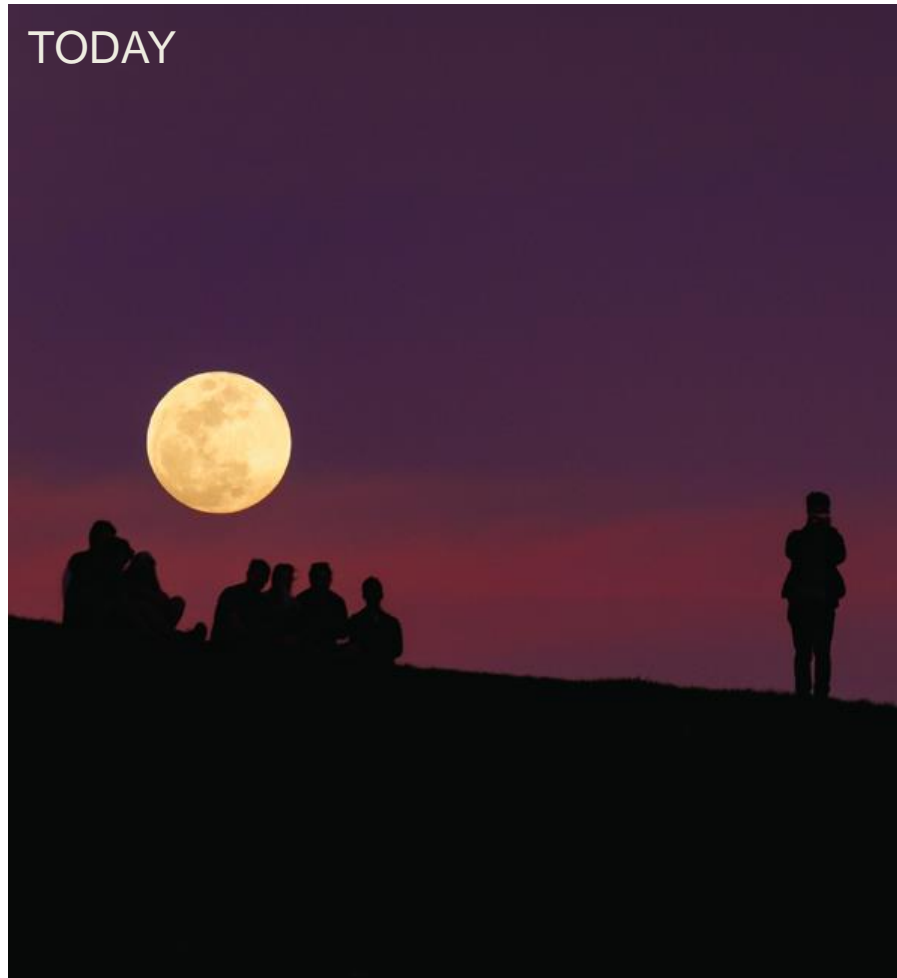
Pete Carrato
Challenge Development
Consultant and Subject
Matter Expert

Jennifer Edmunson
Jacobs Space Exploration
Group
Subject Matter Expert

**Lead NASA CENTERS – Marshall Space Flight Center
and Kennedy Space Center**



LUNAR EXCAVATION, MANUFACTURING, and CONSTRUCTION* CHALLENGE



*Placeholder name



OVERVIEW



GOAL

Develop autonomous icy regolith excavation technologies for near-term lunar missions that address key operational elements and environmental constraints

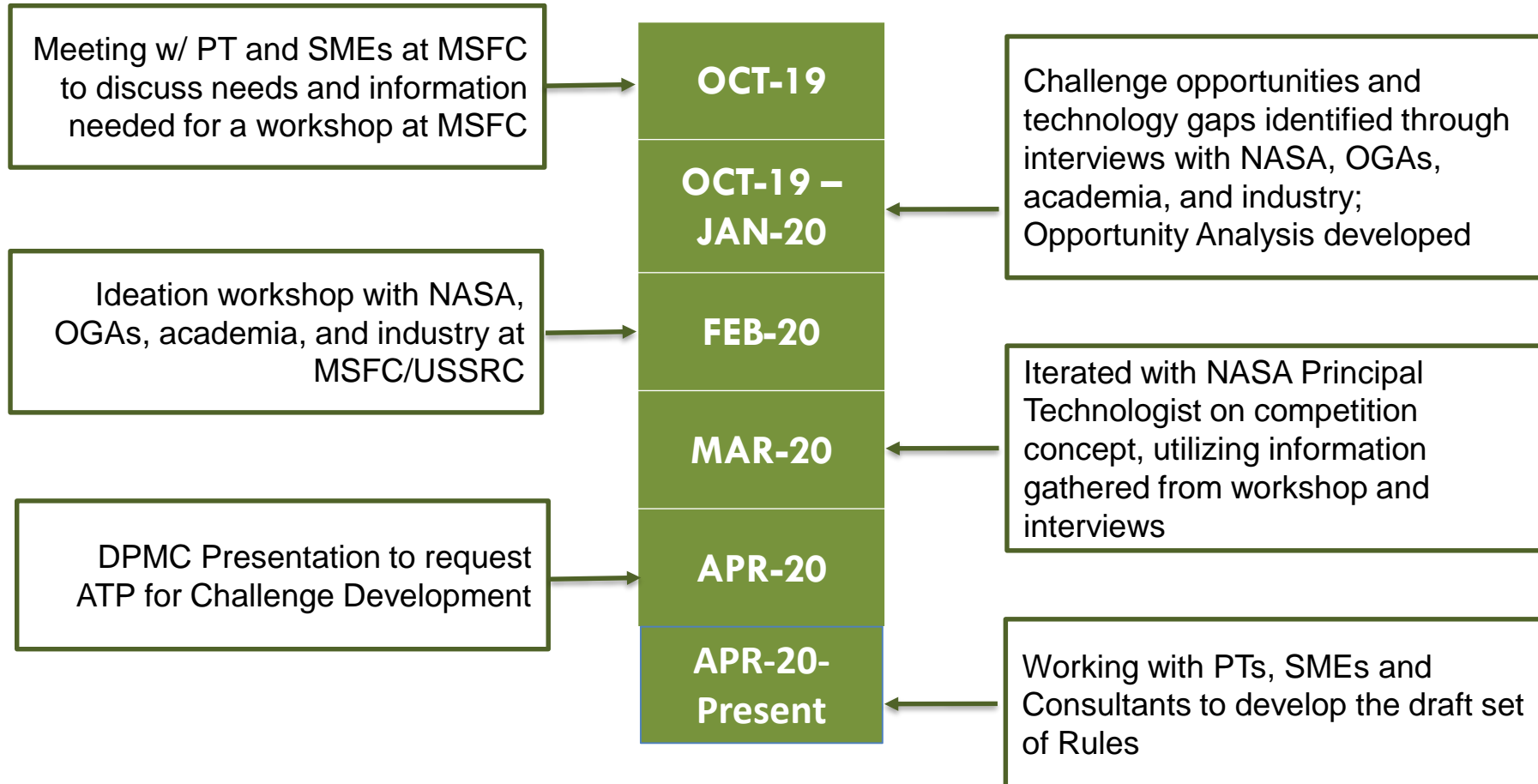
PRIZE PURSE

Up to \$5M PRIZE PURSE

Phase 1 (Up to \$0.5 M)

Phase 2 (Up to \$4.5 M)

HISTORY OF FORMULATION



CHALLENGE WILL COMPLEMENT & SUPPORT NASA'S CURRENT WORK



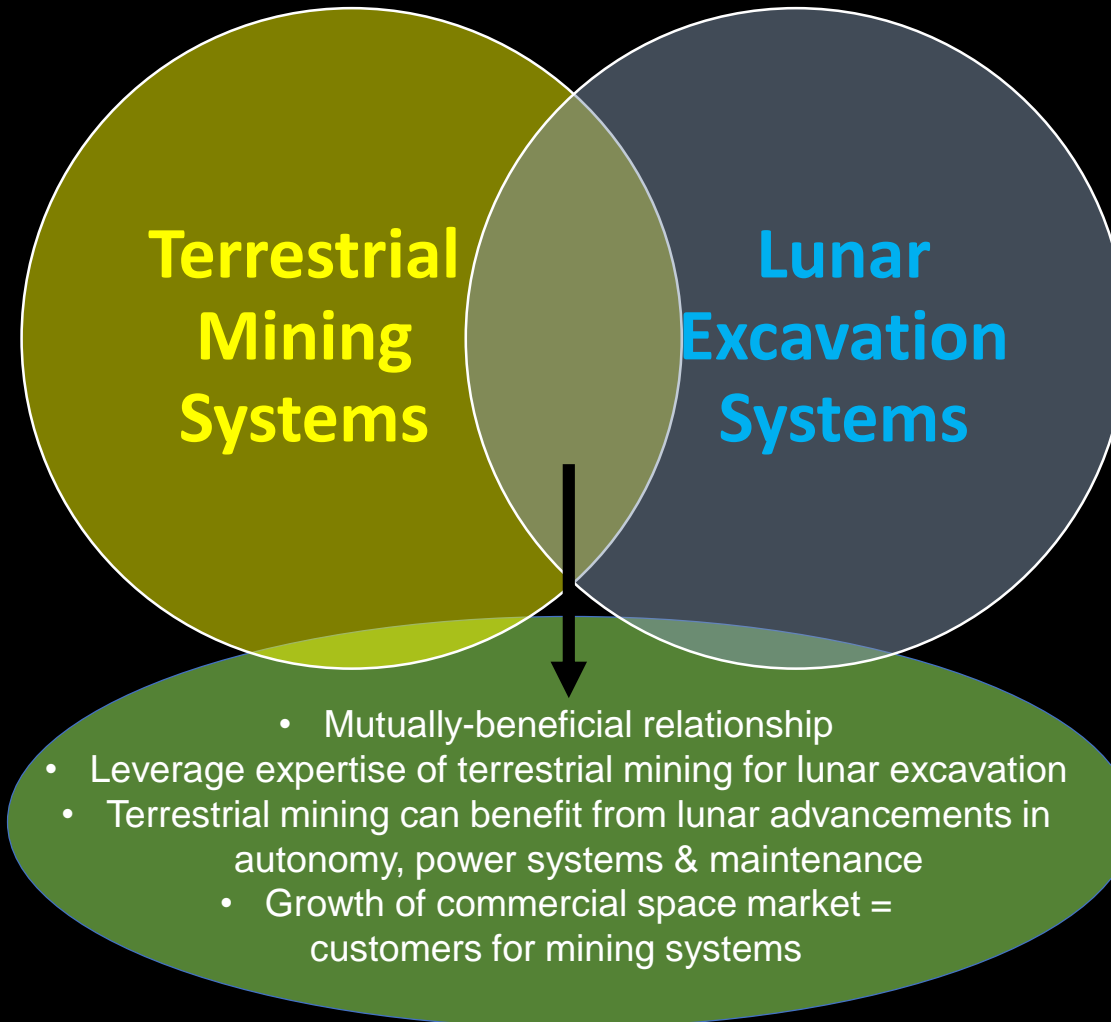
NASA is funding prospecting missions to further identify key lunar resources, but excavating those resources in extreme environments represent critical technology gaps



The Lunar EMC Challenge will leverage lessons learned from previous challenges, and will address specific excavation scenarios with demonstration tests in scenarios closer to the lunar environment

INTERSECTION BETWEEN TERRESTRIAL & LUNAR APPLICATIONS

- An **established** market
- Is optimized for earth applications
- Is developing autonomous operations
- Is evolving materials advancements
- Offers multi-billion \$ market opportunities
- Consists of primarily conventionally-fueled systems



- An **emerging** market
- Requires high energy density
- Requires fully electric systems
- Needs to address extreme environmental conditions
- Requires low/no maintenance of machinery
- Requires easy manufacture and replacement of high wear parts
- Offers a novel niche market opportunity



CHALLENGE SUMMARY

CHALLENGE GOALS:

Develop autonomous icy regolith excavation technologies for near-term lunar missions that address key operational elements and environmental constraints.

PRIZE PURSE:

- \$5 million total over up to 2 Phases

STRUCTURE:

- Phase 1: Design
 - Track A: Design icy regolith simulant models
 - Track B: Design excavation architecture for one or more mission scenarios
- Phase 2: Subscale Development
 - Track A: Develop lab-scale icy regolith simulants. End of the Track
 - Track B:
 - Develop sub-scale hardware elements for excavating icy regolith in a given set of harsh lunar environmental conditions
 - Develop full-scale hardware for excavating icy regolith

DURATION:

Challenge to open for registration November 2020

Duration of Challenge NTE 36 months

Open Registration: ~3 months

Phase 1: ~6 months

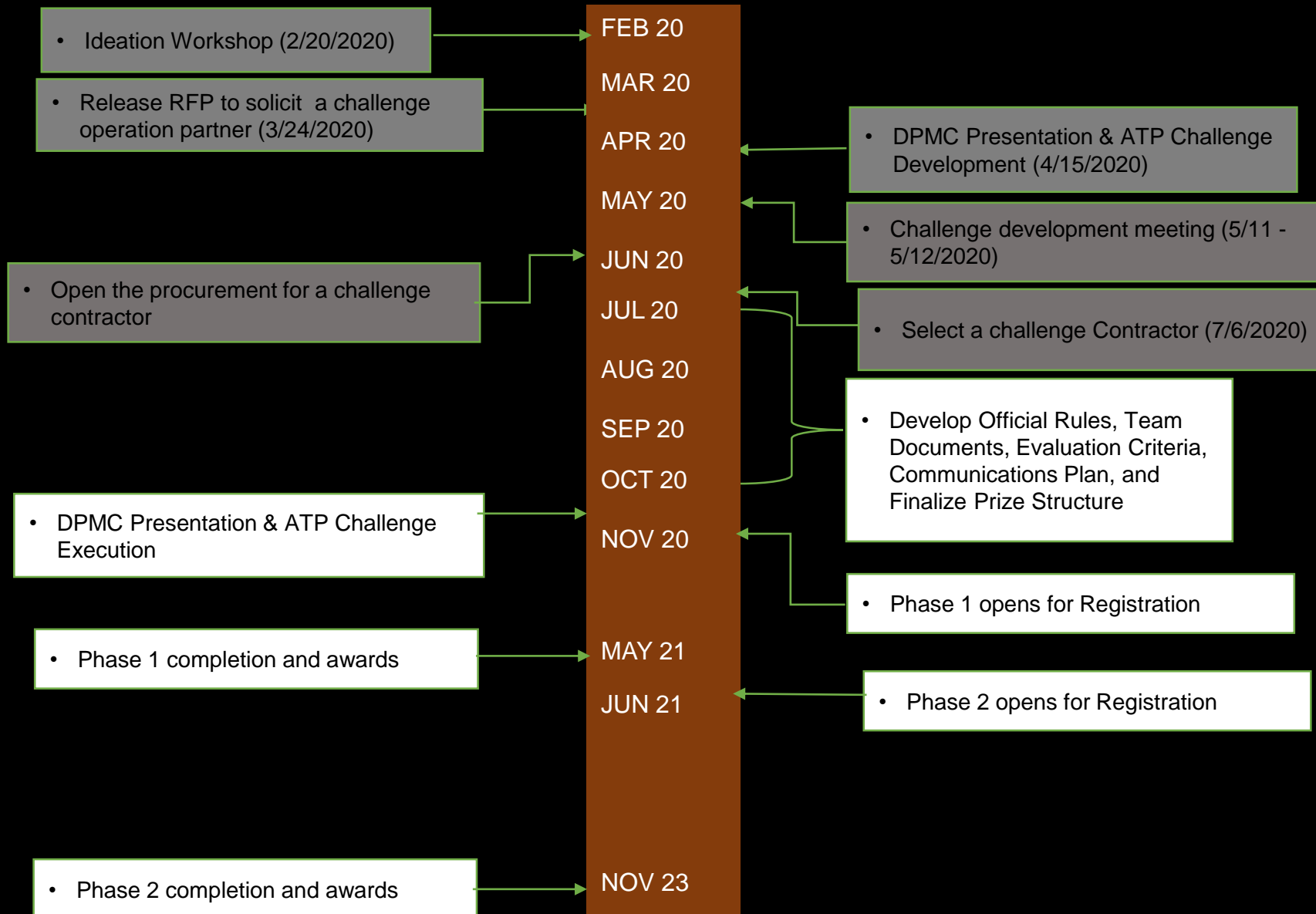
Phase 2: ~27 months



CHALLENGE TIMELINE



CHALLENGE TIMELINE





Centennial Challenges Program

Daring you to ask...

What if?

Monsi Roman, Program Manager

