



National Aeronautics and
Space Administration

EXPLORE MARS

Eric Ianson

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Mars Exploration Program Director

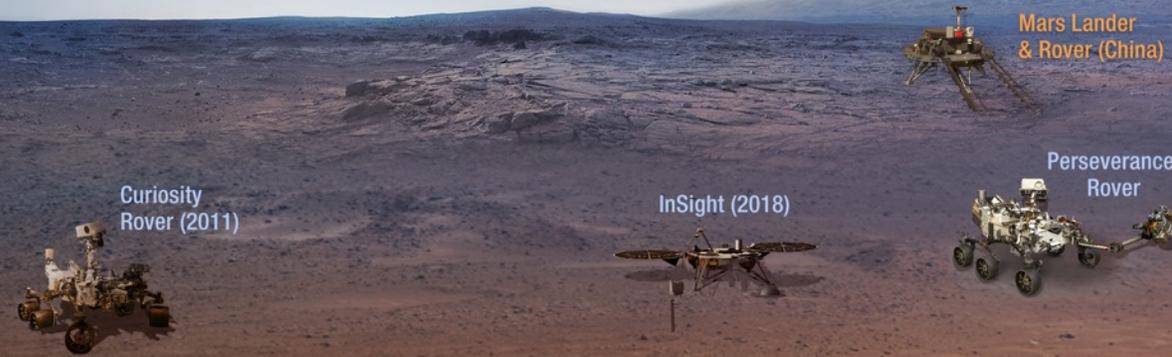
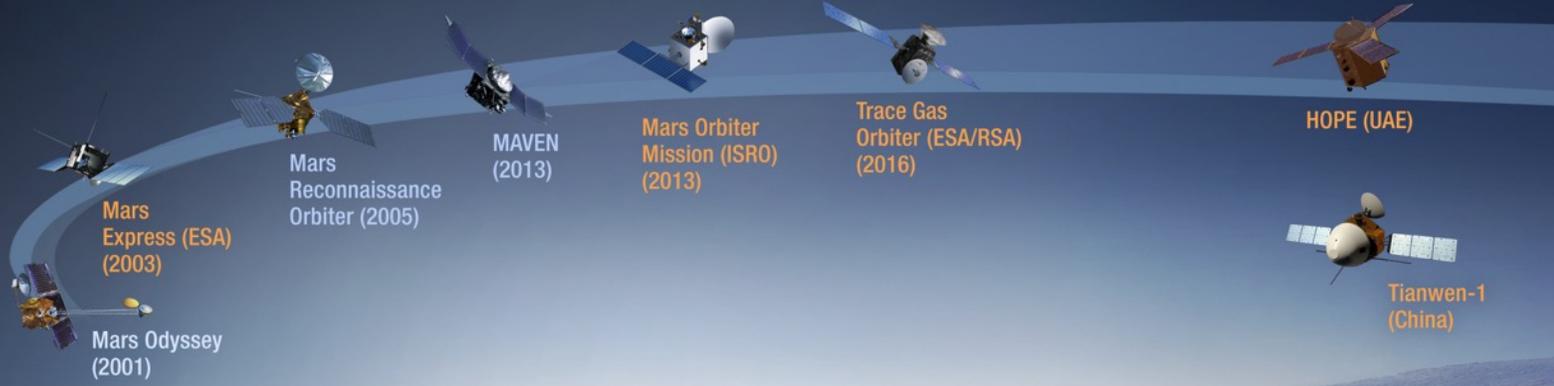
Planetary Science Advisory Committee

November 30, 2020

MARS MISSIONS

OPERATIONAL 2001–2020

2022 AND BEYOND



Follow the Water

Explore Habitability

Seek Signs of Life

Prepare for Future Human Explorers

■ U.S. Missions ■ non-U.S. Missions

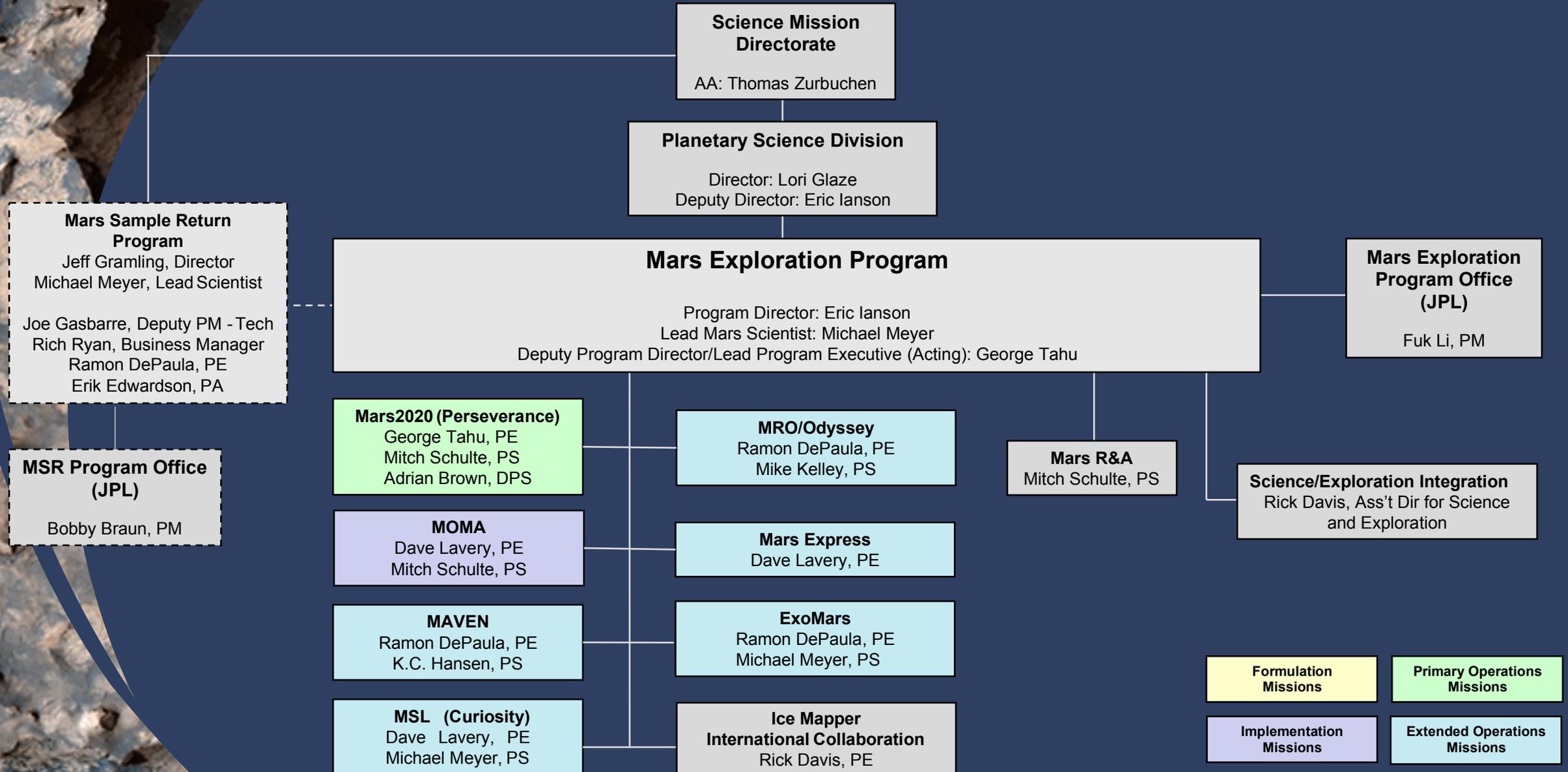
Recent News (1 of 2)

- Jim Watzin has departed the Mars Exploration Program (MEP) and PSD for a position supporting NASA's Associate Administrator for Strategy and Plans (Tom Cremins) on efforts associated with human exploration of Mars
- Eric Ianson named Director of the MEP in addition to his existing role as Deputy Director of PSD
- Michael Meyer serves as Lead Scientist for MEP and Mars Sample Return (MSR)
 - Provides the science bridge between the programs
 - Ensure coordination of M2020 caching with MSR
 - Preparing science recommendations for facility and management of returned samples with MEP
- George Tahu appointed Acting Deputy Director / Lead Program Executive for MEP

Recent News (2 of 2)

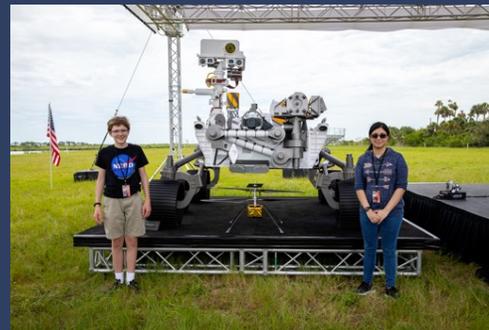
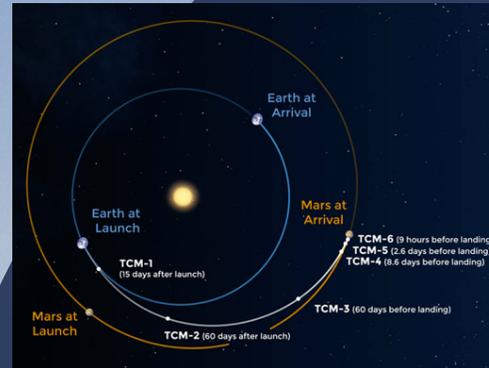
- Mars Sample Return has been established as a new program
 - Jeff Gramling named as the Program Director; reports directly to SMD Associate Administrator Thomas Zurbuchen
 - Close coordination remains with PSD and MEP
 - MSR Independent Review Board convened
 - Mission Concept Review successfully conducted October 9-13
 - Key Decision Point A planned for December 2020

SMD Mars Exploration Organization



Mars 2020 / Perseverance

- Successfully Launched on July 30, 2020!
 - Spacecraft is healthy and in cruise to Mars
 - Landing at Jezero Crater on February 18, 2021
 - First leg of the Mars Sample Return campaign
- *Ingenuity* Mars Helicopter (technology demo) will attempt up to five powered, controlled flights
- Virtual launch experience highly successful; some metrics as of July 31:
 - 7.1M social media engagements over launch week
 - 5.3M views of launch across all platforms
 - 66.2k virtual launch guests



Mars Exploration Status Updates (1 of 2)

- Operating missions did well in the 2019 Planetary Missions Senior Review. Odyssey, MRO, Curiosity, and MAVEN recommended for extended missions.
- Ongoing NASA missions are healthy and productive.
 - Odyssey: Continues to provide data on Martian geology, climate, and mineralogy, as well as thermal properties of Phobos. Also providing most of the relay support for InSight.
 - MRO: Providing radar 3D subsurface mapping of ice deposits and imagery and spectroscopy of surface features and weather; also supporting landing site assessments. Developing “Bent Pipe Communications” in support of Mars 2020 landing. Will continue to serve as major relay asset for surface missions (Curiosity, InSight, Perseverance, ExoMars).
 - MSL: Curiosity has traversed 23 km, climbed nearly 400 m, and just acquired a sample from its 29th drill hole. Continuing investigation of a clay-bearing unit on the side of Mount Sharp and will reach the transition to sulfate-bearing layers within several months.
 - MAVEN: Beginning 7th year in orbit; extended measurements have provided complete picture of global electric current system around Mars. Exciting science ahead during solar cycle 25; also providing relay for surface assets.
 - ExoMars/TGO (ESA): Providing ~50% of relay data from Curiosity & InSight
 - InSight (Discovery Program): Detected more than 450 marsquakes; measured the thickness of the crust for the first time; first observations of surface magnetic field; ongoing weather observations. HP³ mole now beneath the surface; burrowing efforts to resume.

Mars Exploration Status Updates (2 of 2)

- Mars Architecture Strategy Working Group (MASWG) formed in response to Decadal Survey Mid-Term Review
 - Defined four “mission arc” scenarios as examples of cost-effective Mars exploration that could be pursued beyond (in addition to or after) the sample return campaign
- ExoMars 2020 (rover named Rosalind Franklin) ESA launch delayed to 2022
 - NASA MOMA-MS contribution delivered and integrated into ESA rover
- Martian Moons eXploration (MMX) partnership with JAXA for launch in 2024
 - NASA MEGANE instrument approved to enter Phase C in May 2020
 - NASA Pneumatic Sampler (P-Sampler) tech demonstration successfully completed Preliminary Design Review in May 2020
- Mars Ice Mapper
 - International partnership Statement of Intent expected to be finalized soon
 - Pre-Acquisition Strategy Meeting planned for early 2021
- Integration of Mars activities (HEOMD, SMD) across the Agency
 - NASA has established a Federated Board to better integrate Lunar and Mars activities
 - Significant studies are underway to better understand Moon-Mars exploration synergies and to guide future work and collaboration

Mars Sample Return

- **Mars 2020 Phase E operations remain under the Mars Exploration Program, reporting to the Mars Program Director**
- A separate, dedicated MSR program office will be established at JPL
 - Will report to MSR Program Director at HQ
 - Will be the system-level 'project' organization for MSR
- MSR continues to work towards two launches in 2026 (NASA lander + ESA orbiter) and is on track to enter Phase A this Fall
- MSR Program will end with the initial containment of the samples (and Earth Return Vehicle) at the Earth landing site
- **Returned Sample Receiving Facility, along with curation and sample science investigations, remains under the Mars Exploration Program**

Soaring above Mars.

Recon for arriving explorers.

Finding water, seeking habitats for life.

Monumental data streams for discovery.

MARS Ice Mapper

- Numerous studies have identified near-surface ice (top 10 m) as a critical element of the human exploration of Mars.
 - Accessible Ground Ice as Rich in Science Potential
 - Astrobiology, Geologic & Climate History, & Modern Processes for both remote sensing and eventual human investigations “in the (Martian) field”
 - Accessible Ground Ice as an In Situ Resource for Human Exploration
 - Accessible Ground Ice as a Potential Driver for Human Landing Site Selection

- Planning for Human Exploration in the mid-2030s requires knowledge about the location, character, and extent of accessible ice beforehand, in the 2020s

***Reconnaissance = “What We Need to Know Before We Go”**

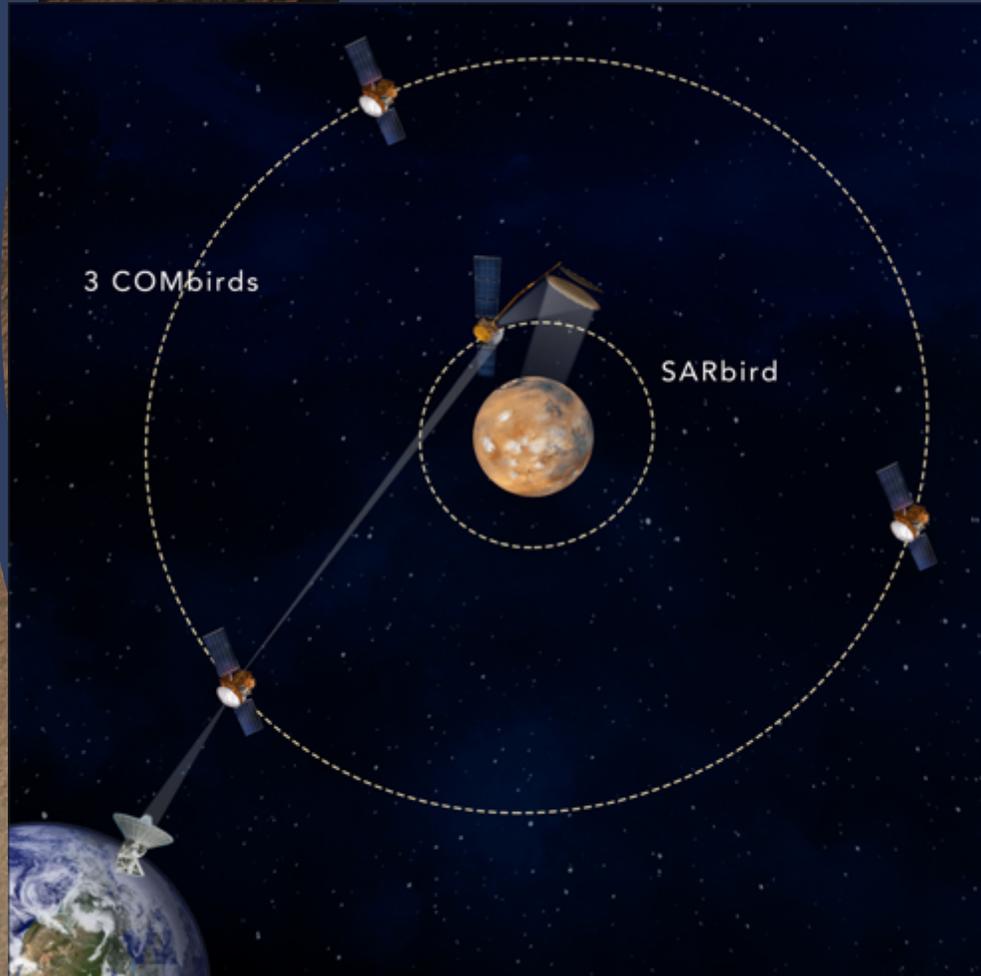
Relies on planetary science and contributes to it, with objectives targeted to high-priority science applications for human exploration.

- An emerging multilateral partnership is beginning to plan for the mission (launch as early as 2026), as well as studying next-gen communications needs that could provide robustness for Mars Sample Return and a critical infrastructure for future Mars missions.
 - Leveraged prior NASA/CSA collaboration studies to jump start planning
 - Both NASA & CSA have received funding for planning and preparation
 - ASI, CSA, JAXA, and NASA are in the process of signing a Statement of Intent

INNOVATIVE
PARTNERING
AMONG WORLD LEADERS



MARS *Ice Mapper* CONCEPT OF OPERATIONS



Schematic Diagram of Ice Mapper Concept

Synthetic Aperture Radar (SAR) reconnaissance spacecraft in Low Mars Polar Orbit (benefits highly from upgraded data pipeline below)

- Deliver on reconnaissance priorities while maximizing science return
- Survey the depth, breadth, and purity of water-ice in the upper 5-10m of Martian subsurface
 - ISRU for propellant, back-up life support, civil engineering, mining, manufacturing, and eventually, agriculture
 - Identify water-ice-rich sites for high-value human-led, robot-assisted science investigations at candidate human landing sites
 - Seek potential “special regions” for possible habitable refuges
- Reveal details of Mars’ geologic and climate history

Constellation of Linked Comm Relay Spacecraft in a High-altitude Equatorial Orbit

- Enable continuous connectivity from Mars surface and low Mars orbit to/from Earth
- Generate data rates and data return, orders of magnitude greater than present capability
- Provides robustness for Mars Sample Return as well as critical infrastructure for future Mars missions, including large SAR data sets.

Advanced Studies / Technology Development

Mars Program Office at JPL provides advance planning, assessment, and analysis of mission alternatives and concepts for future Mars missions. Recent activity includes:

- Mars Returned Sample Handling studies (ground recovery, receiving facility, etc.)
- Access to previously unexplored regions
 - Missions to date have been limited to surface and near-surface access in regions compatible with current lander/rover capabilities
 - Next phases of Mars exploration can be enabled by capabilities for accessing new regions (e.g., extreme terrain, subsurface sounding/drilling, aerial via rotorcraft)
- Low-cost Access to Mars
 - Small spacecraft missions have potential to achieve significant science objectives
 - Leverage emerging commercial cubesat/smallsat spacecraft subsystems
 - Utilize low-cost methods to reach Mars (rideshares, new low-cost launch, etc.)
 - Can be further enabled by improved relay capabilities for small landers/orbiters
- Connections with human exploration (water mapping, telecommunications relay)

Mars Technology Development effort offers opportunities for new initiatives to advance technologies towards successful infusion on future missions. Recent activities include:

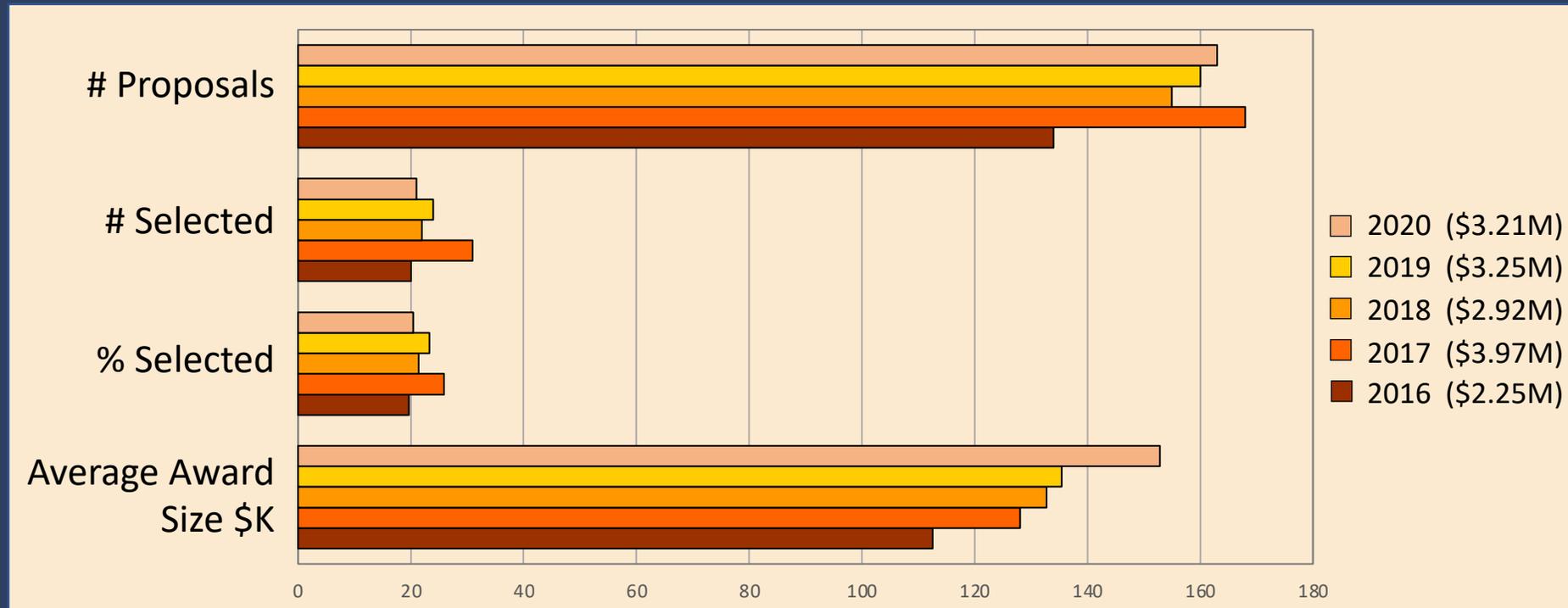
- Sample acquisition/caching/containment; Terrain Relative Navigation (TRN); fast traverse; MSR ascent; helicopter tech

Mars R&A / Mars Data Analysis Program

Funds the analysis of data returned from NASA and other missions to Mars.

- Enhances mission scientific return
- Broadens scientific participation in the analysis of mission datasets
- Funds high-priority areas of research that support planning for future missions

Mars-related research also supported by Solar System Workings, Habitable Worlds, and planetary instrument technology development programs.



Priorities for Mars Exploration Program

- Maintain NASA's position as a world leader in Mars exploration
 - Champion the interests of the Mars science community
 - Ensure continued successful operation of existing orbiters, landers, and rovers on Mars
 - Support and cultivate existing and future international partnerships
 - Promote future mission opportunities for Mars science
- Close coordination with the Mars Sample Return program and Planetary Science Division
- Implement priorities established through the 2023 Planetary Science Decadal Survey
- Maintain fiscal discipline to deliver a healthy Program within available resources
 - Support existing efforts
 - Enable future capabilities