



International Mars Ice Mapper Mission

Update & Participation Opportunity:
Reconnaissance/Science
Measurement Definition Team (MDT)

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Presentation to MEPAG

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NASA Mission Status

NASA AGENCY-LEVEL RECONNAISSANCE MISSION: Assigned to SMD/MEP

Provides an opportunity for science and reconnaissance not otherwise possible given budget constraints

- LRO: Analogous Exploration-driven, Science-serving Mission Model
 - Originally conceived for human exploration purposes with supplemental science (hybrid: ORDT process)
 - In operation since 2009, science-driven after exploration goals were achieved (> 1 petabits)
 - LRO model cited in Decadal (2011) as a “positive example of synergy between the human exploration program and science”; I-MIM can be as well

SIGNED MULTILATERAL STATEMENT OF INTENT (JAN 2021): Concept Study currently underway among ASI, CSA, JAXA & NASA

FY22 PRESIDENT’S BUDGET REQUEST:

I-MIM identified as new budget line item within MEP

PRE-PROJECT LEAD CENTER:

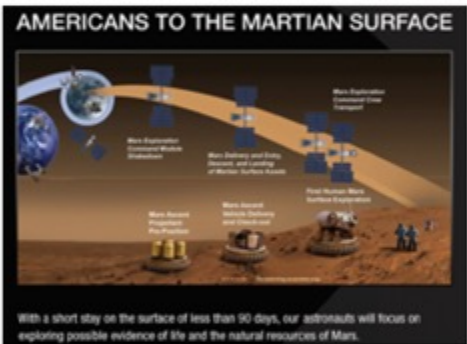
Goddard Space Flight Center (GSFC)

PROGRAM MANAGEMENT ROLE:

Mars Program Office (MPO) at JPL for strategic alignment with MEP



Mission Overview



GENESIS: In a 2019 Agency-level multi-Directorate Summer Study on Preparing for Human Exploration, NASA considered:

“What grand science questions could be addressed with the power of humans and machines at Mars?”

- something worthy of the endeavor -



RESULT:

Search for Life, with Water Ice as a Focusing Requirement for the first Human Surface Mission

GAP: Broadly Distributed Surface Ice Deposits at Mid-low Latitudes:

Where? What form? Enough for Sustainability? How accessible?

Provides significant insight into climatic & geologic history and potential astrobiology

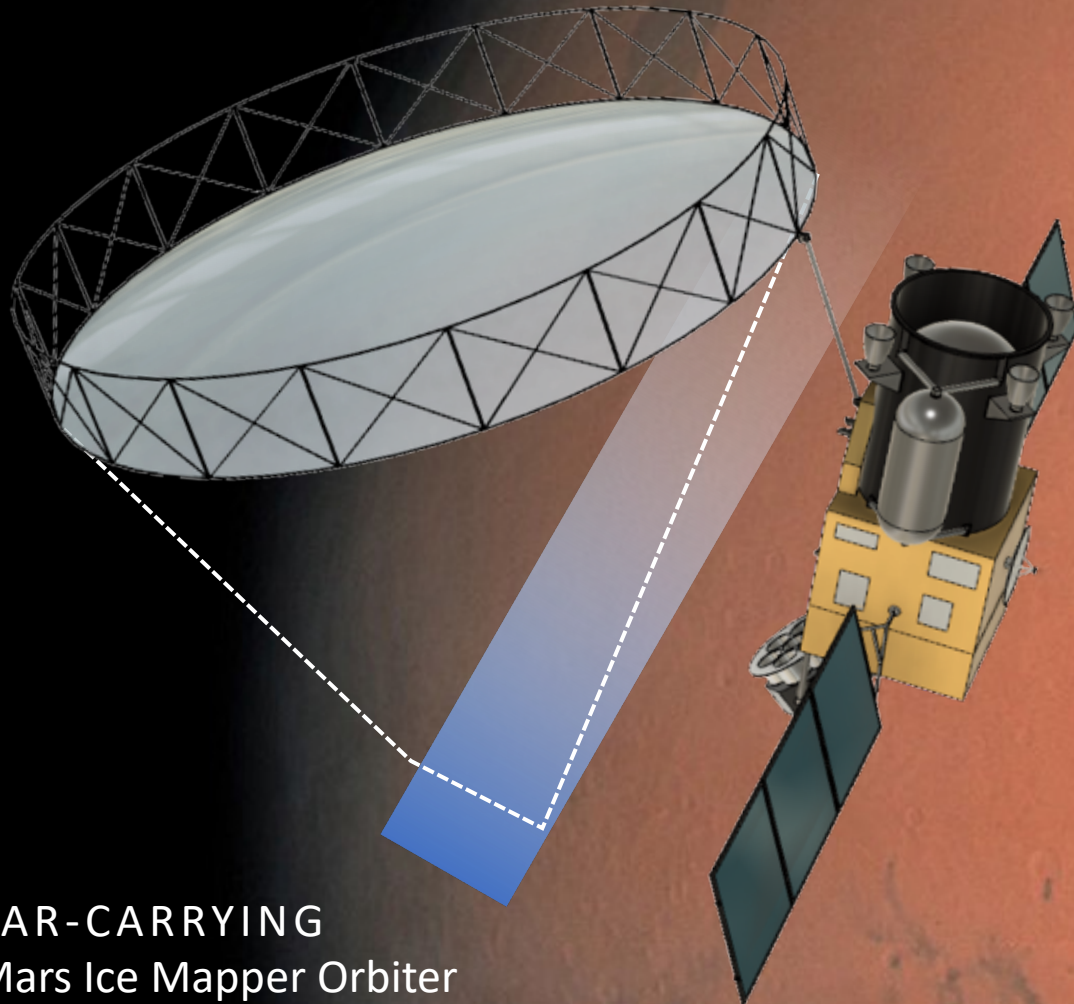


HIGHEST PRIORITY RECONNAISSANCE REQUIREMENT FOR 2020s

Map and characterize accessible (top 0-10m) subsurface ice and its overburden, in mid-low latitudes, to support planning for first human mission.

- ✓ Objective 1: Human-led, Robot-assisted accessing of subsurface ice & sample return
- ✓ Objective 2: Improve understanding of water ice feedstocks for eventual ISRU

Baseline Mission: Mars Ice Mapper Orbiter (“SAR-Bird”) Concept



SAR-CARRYING
Mars Ice Mapper Orbiter

Science Payload

- L-band polarimetric SAR/Nadir SAR Sounder (CSA)
- Potential Science Enhancement (NASA)

Spacecraft (JAXA)

- ~300 km altitude; sun synchronous, polar – 3PM LMST
- Approx. 2,800 kg, including 1,900 kg of propellant
- Direct Insertion from Earth
- 1,000 W power generation at EOL

Communications (ASI)

- X-band Steerable Proximity Link: up to 30 Mb/s
- Ka-band DTE Antenna: 9 Mb/s (to DSN 34m @ 1.5 AU)
- UHF Radio for surface relay

Launch (NASA)

- Medium lift Launch Vehicle
- Transfer Orbit Launch with a total delta V of 2.4 km/s

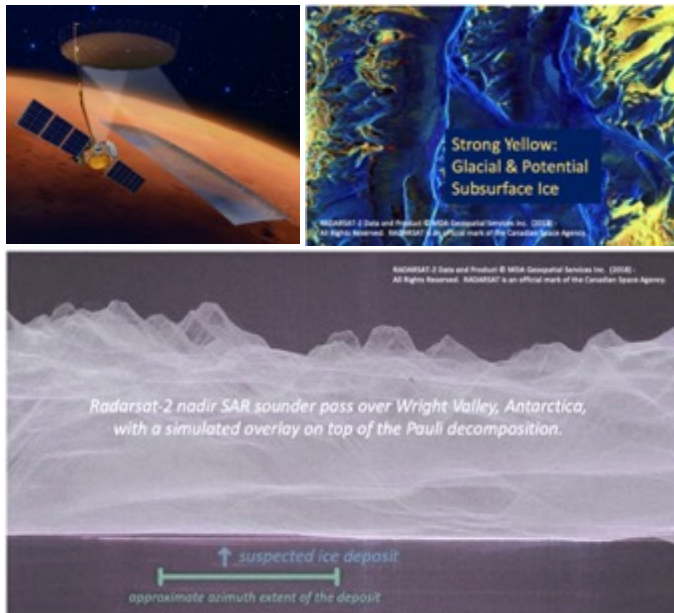
Reconnaissance Approach: Importance of Accessible Near-surface Ice

RECONNAISSANCE: “What do we need to know before we go?”

- Targets high-priority science measurements for human exploration - human *in situ* science investigations (e.g., accessing the ice, potentially through ice coring) and resources for sustainable human exploration (propellant etc.)
- Drives eventual human landing site selection and a human mission architecture

CSA-PROVIDED RADAR ANCHOR PAYLOAD* ADDRESSES HIGHEST PRIORITY RECON OBJECTIVES

[Validated By EXPERT REVIEW TEAM (Raney et al.), multiple studies including SAR data of Earth analogues, and articulated in forthcoming rationales White Paper]



- Map Water Ice in the “Reconnaissance Zone” – mid-low latitudes where human missions are operationally viable
 - Search for most equatorward ice-rich areas
 - Delineate the lateral and vertical extents of shallow ice at high spatial and vertical (depth) resolution
- Characterize Ice Accessibility by evaluating geotechnical aspects of candidate human landing sites, including surface roughness and shallow subsurface compactness
- Identify target areas of interest for high-resolution, advanced SAR techniques (e.g., interferometric, tomographic) that would support candidate human landing site characterizations

*POLARIMETRIC L-BAND SYNTHETIC APERTURE RADAR (SAR)/NADIR SAR SOUNDER

Mission Formulation Status: Signed Statement of Intent (SOI), Jan 2021

Primary Payload

- L-band polarimetric SAR/Nadir SAR Sounder

Decades of EO SAR expertise
through RADARSAT missions



Spacecraft

- Spacecraft bus and operations
Extensive spacecraft & SAR expertise
(Hayabusa, Hayabusa2, MMX, ALOS L-band, GPM SAR)



Mission Architect / Mission Management

- Launch vehicle/services
- Recon/Science Team Co-lead

Decades of experience at Mars



Communications Subsystem

- Communications Subsystem on SARbird
Decades of Radar + Communications Expertise
(Cassini, JUICE, Bepi Colombo)

Likely launch date: 2028

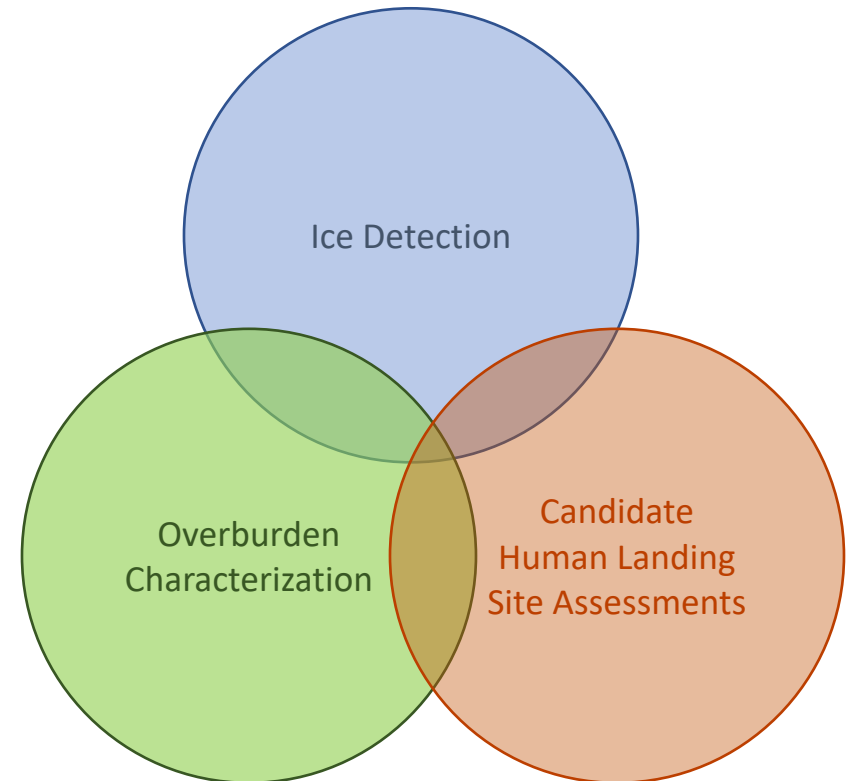
Concept Team roles only; partners have not yet made formal commitment. Additional partners are possible.



Reconnaissance/Science Measurement Definition Team (MDT)

Assumptions

- Core mission requirements are reconnaissance-driven
- Recon requirements must satisfy “measurement stakeholders”:
 - Detection of Adequate Near-surface Water Ice (for human-led surface science such as ice coring and ISRU)
 - Overburden characterization
 - Accessibility (potential ice coring, drilling, ISRU)
 - “Solid ground” for human-class EDL and ascent from the Martian surface and other assessments (e.g., plume impingement zones)
 - Civil engineering (structures, roads, additive manufacturing potential etc.)
 - Candidate human landing site assessments
- Per Agency partners’ commitment to maximize return on investment, high value, investigation-driven supplemental science and mission-support objectives will be a complementary focus



Ice Mapper measurement themes tied to reconnaissance objectives to satisfy core mission requirements

Status and Measurement Definition Team Opportunity

- Requirements for ice detection are relatively well-defined, but require refinement
- Requirements for overburden characterization (e.g., for ISRU, EDL, CE) and Human Landing Site Assessment are not well-defined
- Seeking community contributions to supplement concept study team expertise

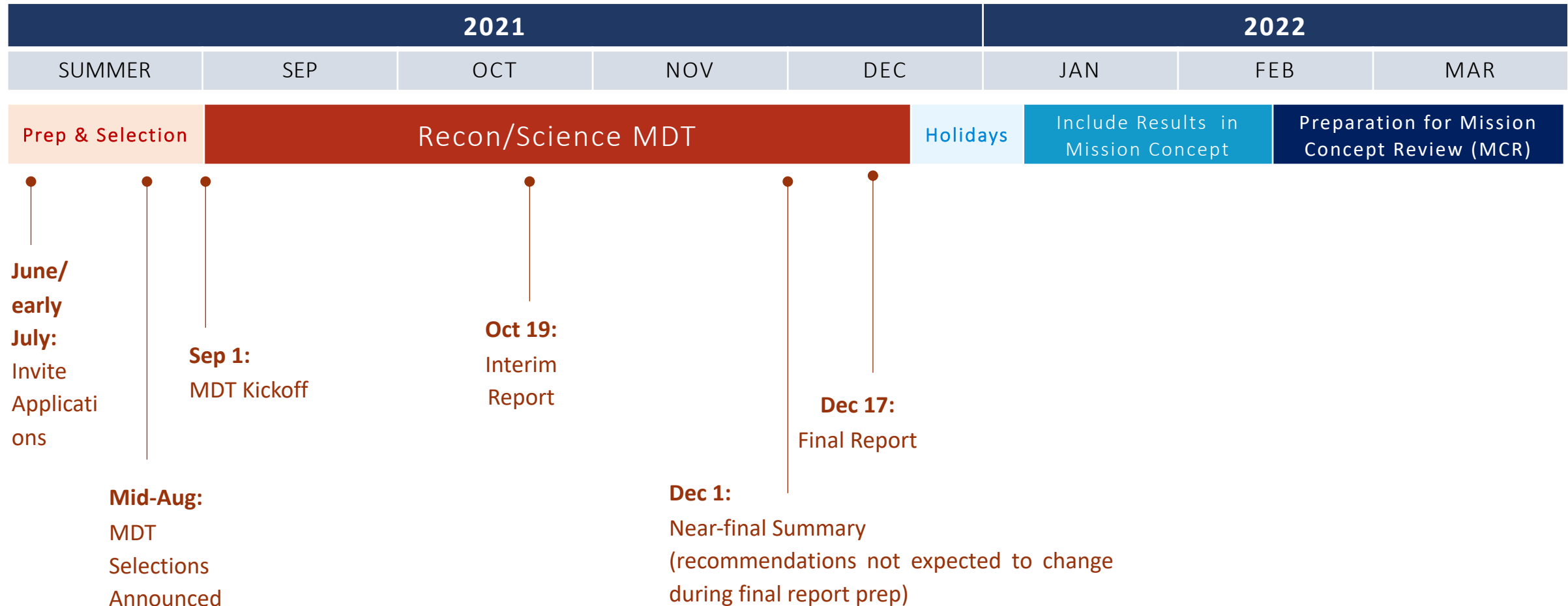
EXPERTISE SOUGHT: 15-20 (TBC) multidisciplinary/international expert, with representatives from each partner Agency (and potentially other nations) who together provide comprehensive knowledge of:

- Microwave remote sensing of volatiles (SAR, Radar Sounding)
- Geologic context for the subsurface sequestration of water ice (with associated climatology)
- Astrobiology, Glaciology, Remote Sensing etc.
- In situ resource utilization (ISRU), human-class entry descent, and landing (EDL) and ascent, and civil engineering (CE)
- Other related specialties

Recon/Science Measurement Definition Team Differs from Traditional SDT

- In a traditional process, a Science Definition Team defines mission objectives, observation requirements, and a notional payload suite.
- For I-MIM:
 - Agency partners have agreed upon preliminary Mission Concept goals, objectives, and spacecraft/payload assumptions to reflect both common and unique national reconnaissance and science goals for Mars exploration
 - the MDT is international, selected through multilateral process by a coordinated committee of Agency partners
 - the MDT is multidisciplinary, bringing together the traditional planetary science community AND users of the requirements-driven reconnaissance *measurement* data for human mission planning
 - **MDT main tasks** are:
 - 1. Defining measurements traceable to Recon Requirements** (ice detection, overburden characterization, and candidate human landing site characterization) **and ways to optimize the payload(s) for these purposes**
 - 2. Recommending potential high-value science/mission support enhancements** to maximize return on investment
 - 3. Describing a model concept of operations for tasks 1 and 2**
 - With these MDT recommendations, the multilateral Agency partners will modify the mission concept as appropriate, in preparation for Mission Concept Review (MCR)

Schedule



Draft* Additional Post-MDT Avenues for International Science Community Involvement

Core Recon/Science Team

- **SAR Anchor Payload** development, observation planning, commanding, health monitoring, data processing & archiving, delivery of L1 reconnaissance objectives
- Team membership competed prior to, or during, Phase A (member Agencies determine own TBD processes)

Investigations

- **Observatory Proposal Teams:** Teams bid to carry out observation campaigns; work with core science team to generate necessary data and analyze results

Observations of Opportunity

- **Currently considering models**
 - Notional Example: “SAR-Wish” modeled after Hi-Wish for HiRISE; users submit targets of interest and receive data to complement ongoing independent investigations

**In development. Subject to modifications, per current multilateral deliberations among Concept Team Agencies.*