International Mars Ice Mapper Mission

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

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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:


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

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:** “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 Columbo)

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
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

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**June/early July:** Invite Applications

- **Sep 1:** MDT Kickoff
- **Mid-Aug:** MDT Selections Announced
- **Oct 19:** Interim Report
- **Dec 1:** Near-final Summary (recommendations not expected to change during final report prep)
- **Dec 17:** Final Report

- **Jun 20:** Include Results in Mission Concept
- **Feb 2022:** Preparation for Mission Concept Review (MCR)
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.