RECONNAISSANCE / SCIENCE

I-MIM MEASUREMENT DEFINITION TEAM

Humans to Mars Summit

18 MAY 2022

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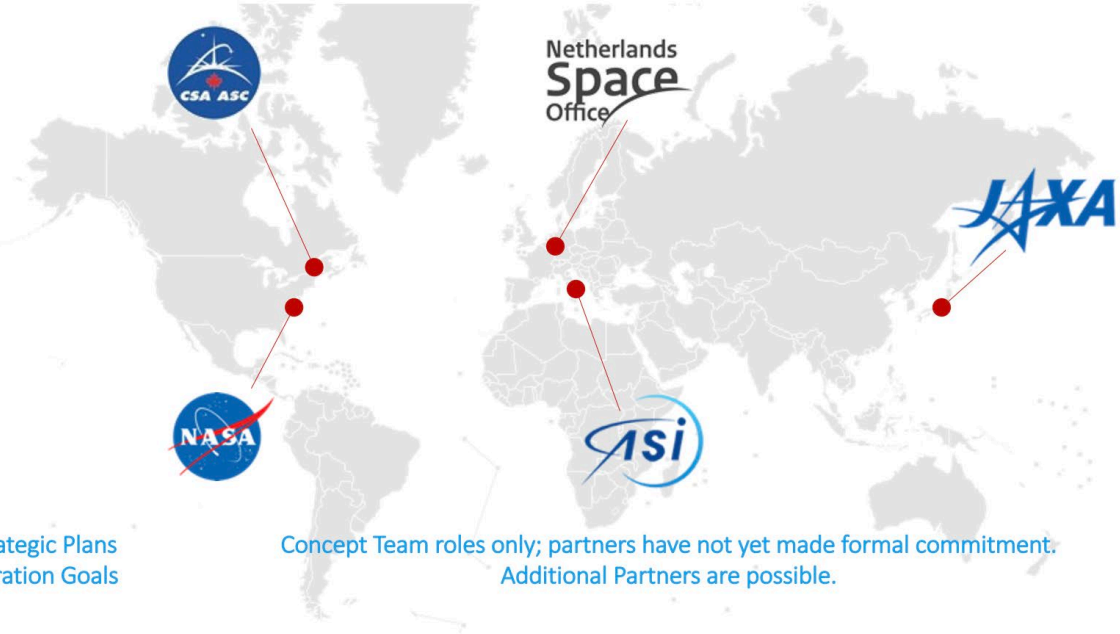
INTERNATIONAL
MARS ICE MAPPER MISSION

ASI – CSA – JAXA – NASA – NSO

I-MIM: An International Approach to Mapping Ice on Mars

- Many agencies have similar goals for both human exploration and science in their strategic plans related to ice for ISRU, and for the search for life and the geologic and climate history of Mars
- Highly leveraged cost-sharing partnership for affordability and achievability in the next decade

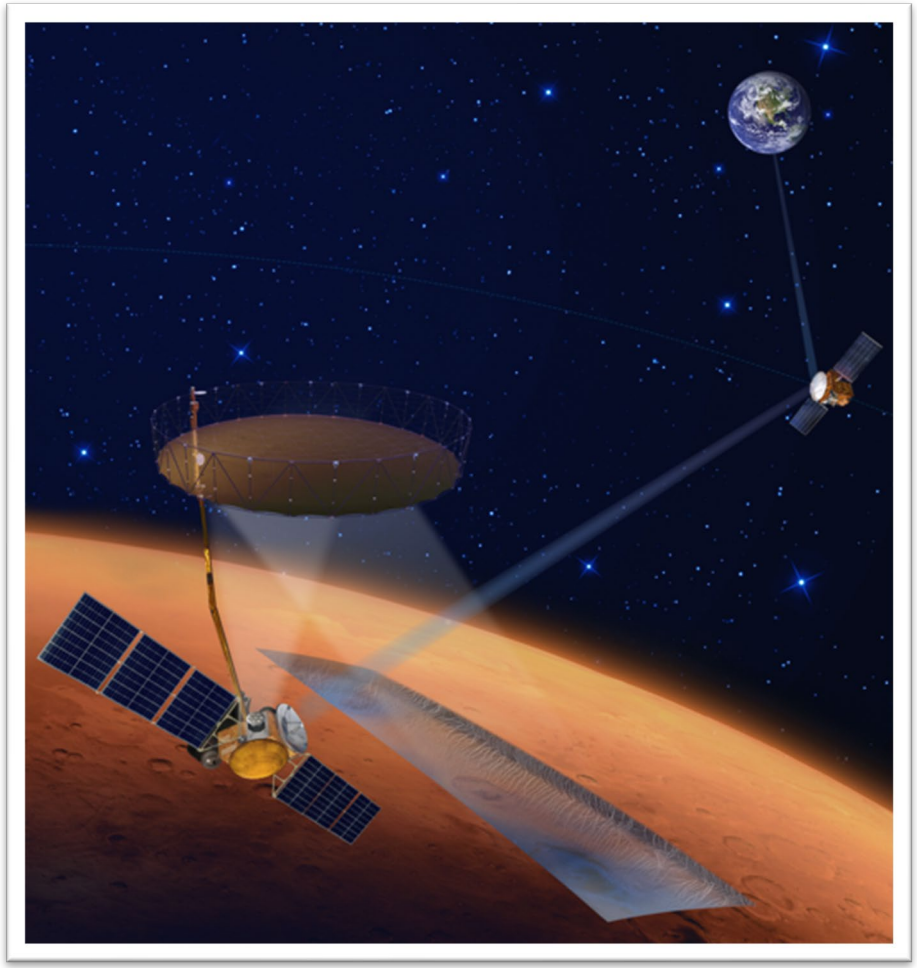
Multi-agency Strategic Plans
With Mars Exploration Goals



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

5 I-MIM MDT Space Agency Partners

I-MIM Mission Concept Overview



Anchor Payload

- Anchor payload is a polarimetric Synthetic Aperture Radar (SAR)
- Tailored for detection of shallow subsurface ice and characterization of surface properties

Measurement Definition Team (MDT)

- Internationally competed team of radar, human exploration, and planetary science experts
- **Key Task:** provide measurement requirements for SAR payload and identify potential complementary payloads required to assess candidate human landing sites

CATEGORIES OF RECOMMENDED MEASUREMENTS

WHERE IS THE HUMAN-ACCESSIBLE ICE ON MARS?	**1. ICE PRESENCE AND CONCENTRATION**	1.1 Depth to Top of Ice Table (thickness of overburden)
		1.2 Ice Mass in Column of 10 m
		1.3 Nature of Ice/Overburden Transition
		1.4 Layering of Ice in Upper 10 m
		1.5 Candidate Ice Lenses in Overburden
	2. LATERAL EXTENT & CONTINUITY OF ICE	2.1 Spatial Continuity of Ice (Patchiness)
		2.2 Horizontal Distribution of Ice within 5 km Radius
	3. NON-ICE CONSTITUENTS IN THE MATRIX	3.1 Solutes in Ice or Ice Matrix
		3.2 Rocks in Ice or Ice Matrix
		3.3 Ice Porosity
		3.4 Layering and Tilt of Lithics in Ice
		3.5 Presence of Liquids
CAN REGIONS OF HUMAN-ACCESSIBLE ICE SUPPORT SURFACE OPERATIONS?	**4. OVERBURDEN PROPERTIES**	4.1 Thermal Properties of Overburden (thermal inertia)
		4.2 Density of Overburden
		4.3 Load-bearing Capacity of Overburden
		4.4 Average/Bulk Porosity of Overburden
		4.5 Hardness of Overburden
		4.6 Stratigraphy/Interbedding
	5. SURFACE CHARACTERISTICS	5.1 Surface Rock Size Distribution
		5.2 Lithology of Surface Cover
		5.3 Surface Morphology
		5.4 Surface Topography and Texture
WHAT ADDITIONAL ICE SCIENCE IS POSSIBLE?	**6. POST-LANDING SCIENCE**	6.1 Ice Emplacement
		6.2 Ice Age
		6.3 Ice/Snow/Firn Grain Size and Density
		6.4 Surface Frost Thickness, Extent, Seasonality, Composition
		6.5 Temperature Profile
		6.6 Surface Environment
		6.7 Subsurface Diurnal or Seasonal Ice/Ice-soil Mixtures
		6.8 Presence/Volume of Methane Clathrates
LONG-TERM HMP 'NICE TO HAVES'	Overburden Properties	Surface Seismicity
		Surface Impact Rate
		Surface Rock Fracture Toughness
		Surface Soil/regolith Angle of Internal Friction
		Surface Soil/regolith Permeability
	Post-landing Science	Degree of Mass Wasting
		Aeolian Changes
		Depth to Bedrock

I-MIM Provides Dual Reconnaissance and Science Benefits

To maximize return on investment, the MDT has identified significant scientific contributions that align with each partner Agency's strategic goals for Mars exploration.

ATMOSPHERIC SCIENCE
1 Volatile Cycling
Fine Structure of Layered Deposits
Seasonal Variability in:
Seasonal Ice Cap Thickness
Near-surface Ice Abundance
Depth to Ice Table
Presence of Snowfall
2 Ionosphere Irregularities (total electron content)
3 Recurring Slope Lineae
Near-surface Ice/Moisture Content
Surface Composition & Deformation

GEOLOGY		
Processes shaping the present.	**Cratering Rate**	
	Mobile Sediments, Mass Wasting, and Seasonal Change	
	Flowing Ice	
	Tectonic/Volcanic Activity	
Processes that shaped the geologically recent past.	**Polar deposits**	**PLDs**
		CO_2
	Mid-latitude Ice	
	Recent Volcanic Flow Emplacement, Texture, and Composition	
	Surface/Near-surface Regolith Properties	
Processes that shaped the more distant past.	**Identification/Characterization of Buried Landforms**	
	Crater Ejecta Emplacement and Degradation	
	Past Volcanic Flow Emplacement, Texture Stratigraphy, and Composition	
	Regolith Development	
	Unique Radar Terrains (Medusa Fossae, stealth regions, etc.)	
	Lava Tubes and Skylights	

HABITABILITY
1Presence of Liquid Brines
Global Distribution and Nature of Ice
Past Ice
Shallow ice
Subsurface Void Detection
Large voids (human scale)
Small Voids (microbe scale)
Past Fluvial and Glaciofluvial Activity
Planetary Protection
Human Health Hazards

MDT Preliminary Findings

Radar Observations Meet Reconnaissance and Science Needs

- Most of the high-priority reconnaissance objectives can be met with the currently scoped radar instrument, along with a broad suite of additional science investigations

Other Measurements May be Necessary

- The MDT is evaluating the merits of complementary instruments, including high-resolution imaging and low frequency radar sounding capabilities

Human Landing Site Assessment is a Multi-Step Process

- Ice and geotechnical property mapping orbiter would be an important first step in a tiered human landing site selection process

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