

THE MAPPING IMAGING SPECTROMETER FOR EUROPA (MISE): SCIENCE AND INSTRUMENT DEVELOPMENT STATUS

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Introduction: The Mapping Imaging Spectrometer for Europa (MISE) on the Europa Clipper Mission was designed and is being built as a high-optical-throughput push-broom imaging spectrometer high signal, low noise measurements within the challenging Jovian radiation environment around Europa.

Science: MISE will map the surface composition of Europa from global scale (10 km / pixel) down to local scale (7.5 m/pixel) at 10 nm spectral sampling over a spectral range of 0.8 to 5 μm . Materials identified and mapped include:

- Organics
- Salts
- Ices and radiolytic compounds

Figure 1 shows example spectral signatures that MISE will be able to map if they are present on Europa. The MISE team will use these data (e.g. Figure 2) to answer questions such as:

- Are there organics on Europa's surface originating from the ocean and where are they located?
- Is Europa's ocean habitable?
- Can locations of current or recent activity be identified?
- How does material from Europa's ocean reach the surface?

Instrument Design: MISE consists of a f/1.4 Dyson spectrometer with a CaF_2 dispersive element and a 3-mirror, off-axis telescope that views through an articulated flat mirror with $\pm 30^\circ$ of motion projected onto the ground [1]. Grating and slit are manufactured using an electron beam machine at the JPL Micro Devices Laboratory. The focal plane assembly is a mechanically cooled HgCdTe 320 \times 480-pixel CHROMA device that operates at 85K. MISE is controlled by a Data Processing Unit (DPU), which includes the spacecraft communication interface, power supply, scanner electronics, on-board memory, and instrument processing. Planned on-board processing includes identifying and discarding radiation noise and aggregating the cleaned spatially oversampled data into final high-SNR spatial-spectral frames.

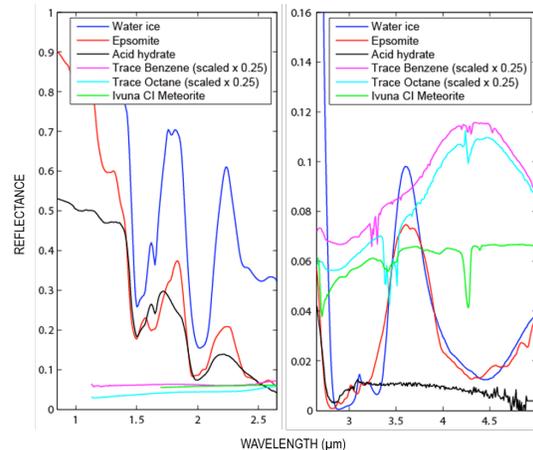


Figure 1. Key compounds at MISE spectral resolution and sampling. Ice and salt chemistry dominates wavelengths $<2.5 \mu\text{m}$ and low levels of organics are not detectable. At $>3.2 \mu\text{m}$ trace organics are easily visible.

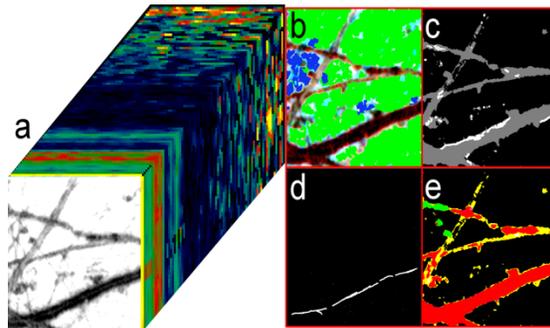


Figure 2. Synthetic Europa image cube illustrates how MISE can assess habitability. (a) 1 μm albedo map with full spectrum and compositional information at each pixel. (b) Map of ice phases: red=acid hydrate, green=crystalline ice, blue=amorphous ice. (c) Distribution of epsomite, (d) Map of thermal anomalies, and (e) Map of epsomite (red), benzene (green), and octane (blue). Yellow areas have both epsomite and benzene. MISE would assess this area as habitable due to the presence of all three indicators of habitability (salts, current activity, organics associated with bands).

Status: MISE has entered fabrication and assembly (see Figure 3) phase. All spectrometer flight optics (e.g. CaF₂ lens, slit, grating order sorting filter) have been received and fabrication of machined parts is ongoing. Electronic board fabrication has begun. MISE is scheduled to be delivered to the Europa Clipper Spacecraft in the summer of 2021.

References: [1] Bender et al. (2019) *Proc. SPIE 11130, Imaging Spectrometry XXIII: Applications, Sensors, and Processing*, <https://doi.org/10.1117/12.2530464>

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Table 1. MISE instrument parameters.

Key Instrument Parameters	
Spectral Range	0.8 to 5.0 μm
Spectral Sampling	10 nm
Spatial Sampling	25 m @ 100 km
Scanner Range of Motion	Nadir ± 30 degrees
Field of Regard	4.3° x 60°
Mass	60.8 kg CBE
Power	63.0 W CBE (data take)
Data Volume	5.8 Gb / flyby CBE
Data Storage	1 flyby plus redundancy
Detector Temp	85 K
Radiator Temp	220 K
Active cooling	LMPT Cryocooler

Figure 3. MISE flight hardware. MISE flight hardware is in fabrication and key parts have been built.

