Prioritized Technology:
Instruments to Identify Biomarkers* from Ocean Worlds

Technical Goal

- Determine the abundances and patterns (i.e., population distributions) of organic compounds in the sampled material, with an emphasis on identifying potentially biogenic characteristics.
- Determine the types, relative abundances, and enantiomeric ratios of of any amino acids in the sampled material. Map organic molecules, with compositional constraints to a limit of detection of 1-10 ppbw. *quantify enantiomeric excess with accuracy ≤ 5%*.
- Minimize false positives and false negatives

Ref: Hand et al. (2017) Report of the Europa Lander Science Definition Team.
**Biomarkers defined as molecular bio signatures*

Mission Applications

- Non-random patterns, terrestrial or not terrestrial, of molecular mass or non-equilibrium isomeric ratios particularly in racemic excess could be an indicator of metabolic activity.

Technical Status/SOA

- **Mass Spectrometry (MS)**
  Multiple flight missions; E.g., MSL, Cassini, ExoMars, Rosetta;
- **MS and Associated Separation Technologies**
  Gas Chromatography; Evolved Gas analysis; Laser desorption/ionization.
  e.g. MSL, ExoMars, Huygens
- **Vibrational Spectroscopy**
  Raman Mars 2020, ExoMars 2020;
- **Biopolymer Sequencing**
  Nanopore Technology
  ISS MinION demonstration;
- **Separation & Detection Technologies**
  Capillary Electrophoresis/Laser Induced Fluorescence/ Spectroscopy/Raman
  Liquid Chromatography, Ion Chromatography;
  PICASSO, MatISSE, COLDTech; ICEE-2;