To explore the most likely host of current life beyond Earth.

Exploration Science Forum
Dr. Curt Niebur
7/21/2015
Habitability: Ingredients for Life

✅ **Water**
- Probable saltwater ocean, implied by surface geology and magnetic field
- Possible lakes within the ice shell, produced by local melting

✅ **Chemistry**
- Ocean in direct contact with mantle rock, promoting chemical leaching
- Dark red surface materials contain salts, probably from the ocean

✅ **Energy**
- Chemical energy could sustain life
  - Surface irradiation creates oxidants
  - Mantle rock-water reactions could create reductants

Geological activity “stirs the pot”

**A Europa mission must verify key habitability hypotheses**
The Big Question: Is Europa Habitable?

How deep and salty is the ocean?  
Gravity, Magnetometry  
(GRAIL, GRACE)

How thick is the ice shell?  
Radar, Gravity  
(MRO, Cassini)

How active is the ice shell?  
Camera, Thermal Imager  
(MRO, ICESat)

What’s in the plumes?  
Mass & Dust Spectrometers  
(Cassini)

What’s the brown stuff?  
IR & Mass Spectrometers  
(Landsat, MRO)

The drive to answer these questions has guided mission concepts for 15 years, drawing on our experience at Mars, Saturn and Earth
Europa Multi-Flyby Mission Concept

<table>
<thead>
<tr>
<th>Science</th>
<th>Description</th>
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<tbody>
<tr>
<td>Objective</td>
<td>Description</td>
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<tr>
<td>Ice Shell &amp; Ocean</td>
<td>Characterize the ice shell and any subsurface water, including their heterogeneity, and the nature of surface-ice-ocean exchange</td>
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<tr>
<td>Composition</td>
<td>Understand the habitability of Europa's ocean through composition and chemistry.</td>
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<tr>
<td>Geology</td>
<td>Understand the formation of surface features, including sites of recent or current activity, and characterize high science interest localities.</td>
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<tr>
<td>Recon</td>
<td>Characterize scientifically compelling sites, and hazards for a potential future landed mission to Europa</td>
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### Science Investigations

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Instrument</th>
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<tr>
<td>REASON</td>
<td>Ice Penetrating Radar</td>
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<tr>
<td>MISE</td>
<td>Shortwave Infrared Spectrometer</td>
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<tr>
<td>EIS</td>
<td>Topographical Imager / Reconnaissance Camera</td>
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<tr>
<td>MASPEX</td>
<td>Mass Spectrometer</td>
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<tr>
<td>E-THEMIS</td>
<td>Thermal Imager</td>
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<tr>
<td>ICE-MAG</td>
<td>Magnetometer</td>
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<tr>
<td>PIMS</td>
<td>Faraday Cups</td>
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<tr>
<td>Europa-UVS</td>
<td>Ultra-Violet Spectrometer</td>
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<tr>
<td>SUDA</td>
<td>Dust Detector</td>
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<tr>
<td>GS</td>
<td>Gravity Science</td>
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### Mission Plan

- **Earliest Launch Opportunity**: June 6, 2022
- **Earliest Jupiter Arrival**: March 5, 2025
- **Science Tour**: 45 Europa Flybys
- **Primary Mission End**: December 6, 2028

**Key Technical Margins**

- **Mass**: 37 - 41%
- **Power**: 40%

- Depending on Launch Opportunity and Launch Vehicle

http://solarsystem.nasa.gov/europa
NASA-Selected Payload

- **MISE**
  - IR Spectrometer
  - Surface chemical fingerprints

- **MASPEX**
  - Mass Spectrometer
  - Sniffing the atmosphere

- **SUDA**
  - Dust Analyzer
  - Surface & plume composition

- **Gravity Science**
  - Confirming an ocean

- **EIS**
  - Wide-Angle Camera
  - Alien landscape in 3D

- **Europa-UVS**
  - UV Spectrometer
  - Surface & plume/atmosphere composition

- **EIS**
  - Narrow-Angle Camera
  - Surface mapping & preparing for future landing

- **ICEMAG + PIMS**
  - Magnetometer & Faraday Cups
  - Sensing ocean salts

- **REASON**
  - Ice-Penetrating Radar
  - Plumbing the ice shell

- **E-THEMIS**
  - Thermal Imager
  - Search for hot spots & preparing for future landing

- **Ice & Ocean**
- **Composition**
- **Geology**
- **Reconnaissance**