

The image features a 3D rendering of the Europa Multiple Flyby Mission spacecraft orbiting the icy moon of Europa. The spacecraft is shown from a high-angle perspective, with its two large solar panel arrays extended. The moon's surface is covered in a complex network of reddish-brown linear features, likely cracks or ridges, set against a lighter, icy background. In the upper left, the mission logo consists of three blue horizontal bars followed by the word 'EUROPA' in large white letters, with 'MISSION' in smaller white letters below it. The background is the dark, star-filled space.

EUROPA
MISSION

**Europa Multiple Flyby Mission:
Science Update to OPAG**

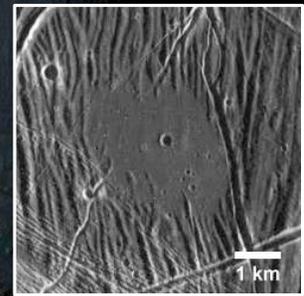
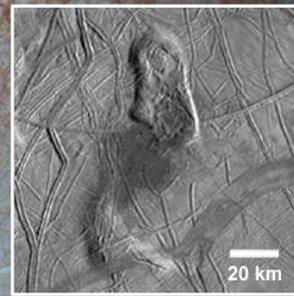
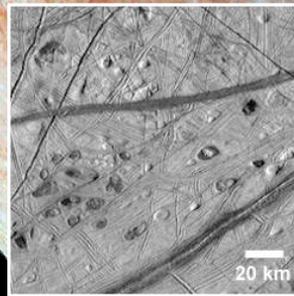
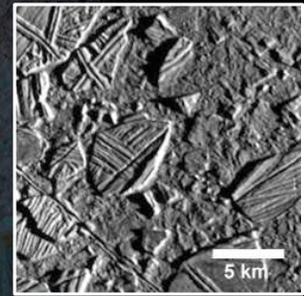
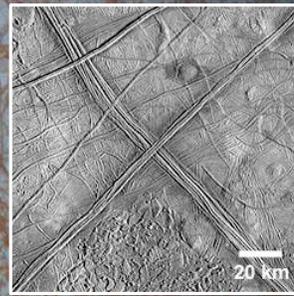
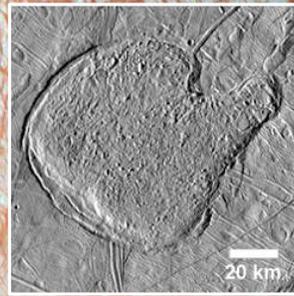
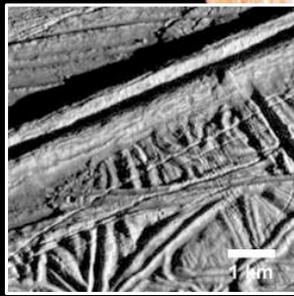
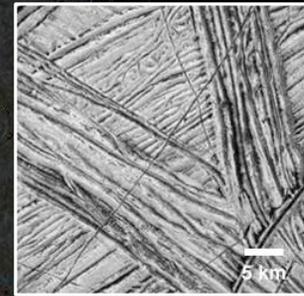
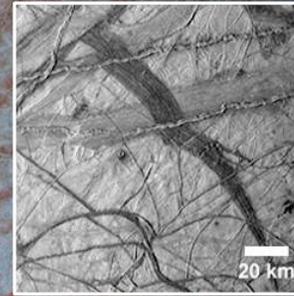
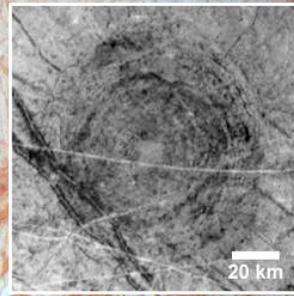
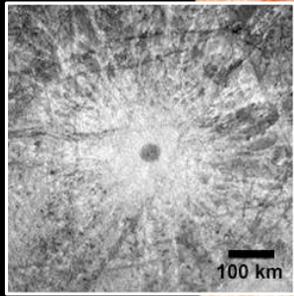
Bob Pappalardo, EMFM Project Scientist

Jet Propulsion Laboratory, California Institute of Technology

Feb. 22, 2017

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Europa: What a World, What of Life?



NASA-Selected Europa Instruments

Europa-UVS
UV Spectrograph
surface &
plume/atmosphere
composition

MASPEX
Mass Spectrometer
sniffing atmospheric
composition

EIS
Narrow-Angle Camera +
Wide-Angle Camera
mapping alien landscape
in 3D & color

SUDA
Dust Analyzer
surface & plume
composition

E-THEMIS
Thermal Imager
searching for hot spots

ICEMAG
Magnetometer
sensing ocean
properties

MISE
IR Spectrometer
surface chemical
fingerprints

REASON
Ice-Penetrating Radar
plumbing the ice shell

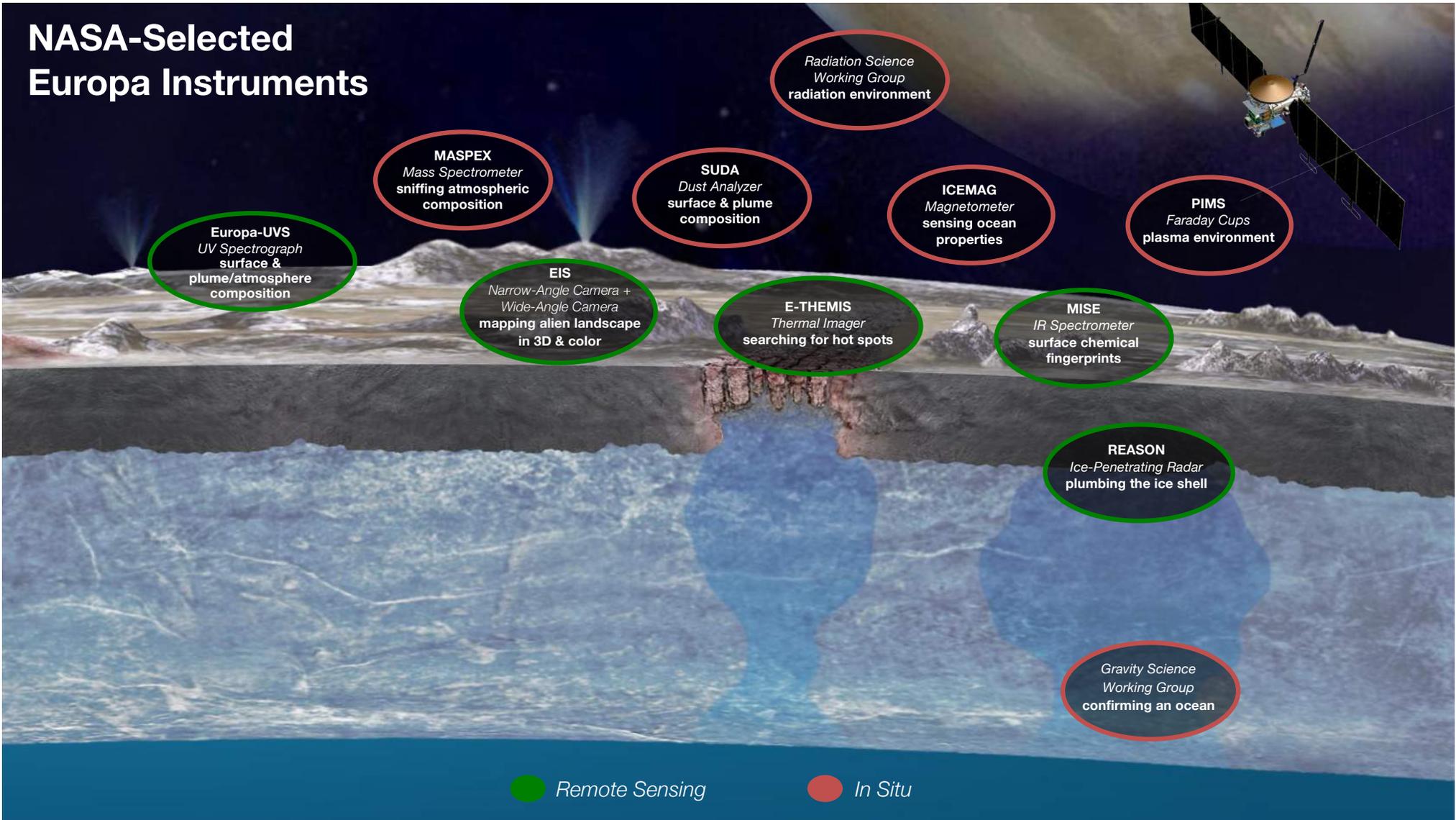
Gravity Science
Working Group
confirming an ocean

Radiation Science
Working Group
radiation environment

PIMS
Faraday Cups
plasma environment

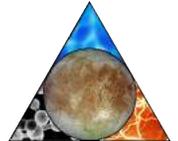
● Remote Sensing

● In Situ

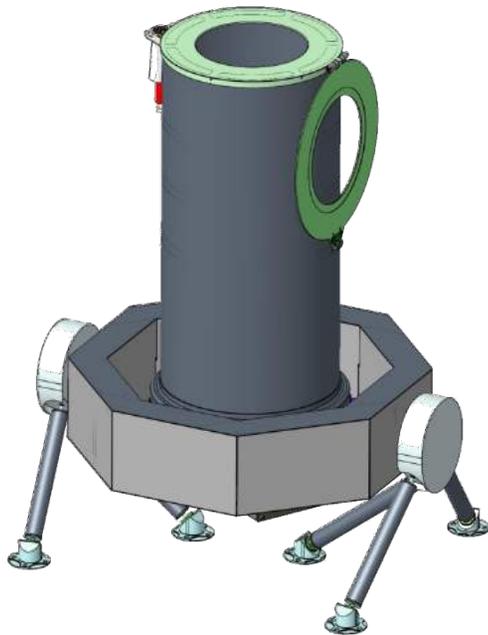




Europa Instrument Overview: EIS

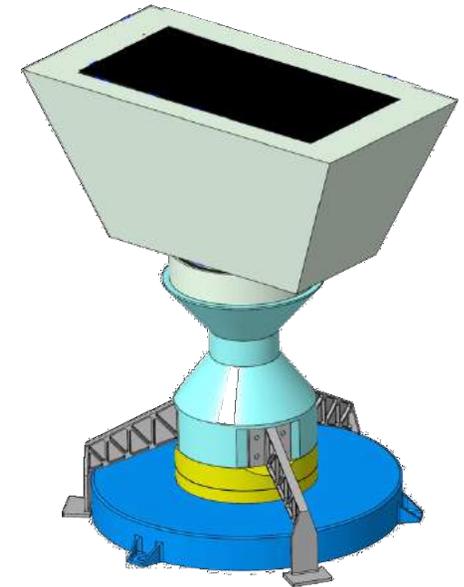
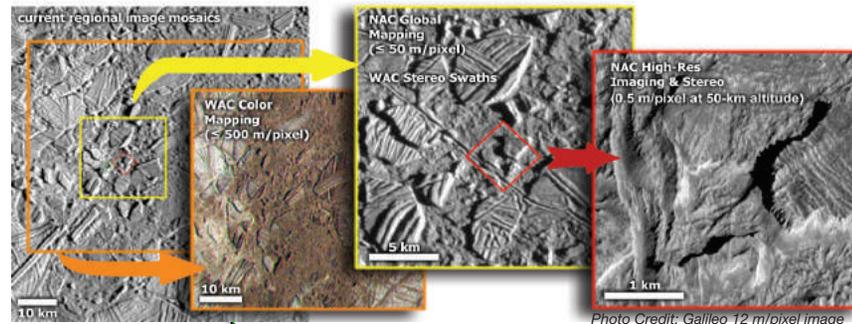


EIS-NAC *Europa Imaging System Narrow Angle Camera*



Produces visible maps of the surface of Europa, to describe its topography (including possible lander landing sites), understand its geology, and to search for plumes.

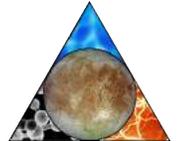
PI: Zibi Turtle
Johns Hopkins Applied
Physics Laboratory



EIS-WAC *Europa Imaging System Wide Angle Camera*

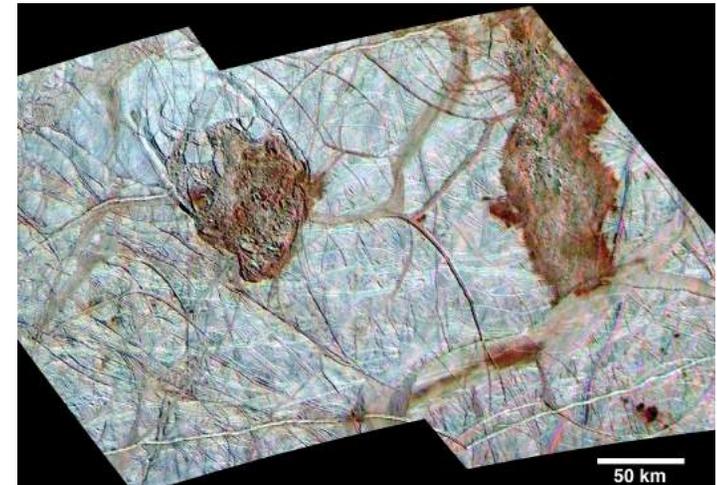
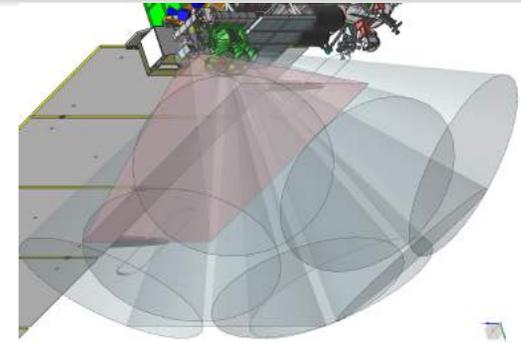


Europa Instrument Highlights: EIS



Europa Imaging System (EIS): Zibi Turtle, PI

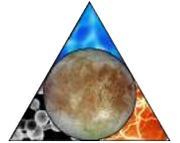
- Adding color capability to NAC
 - Scattered light analysis shows that addition of color stripe filters will not impede plume detection
 - Increases opportunities to gimbal-target coordination with other instruments, extrapolating to small scales and other regions
 - 10 m color resolution from 1000 km
 - Can join the “joint scan” planned for each flyby giving 200 - 400 m/pixel hemispheric color
 - Extrapolate composition information to smaller scales and other regions



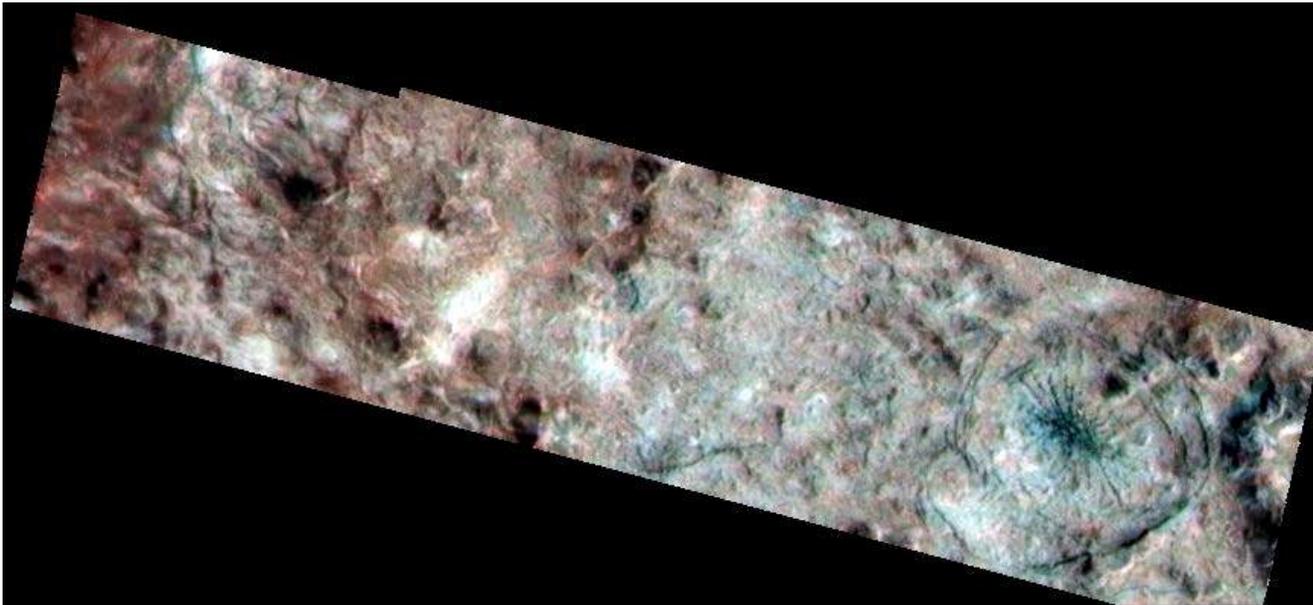
Thera & Thrace: Galileo 220 m/pixel combined with 1.4 km/pixel color



Europa Instrument Highlights: EIS



Europa Imaging System (EIS): Zibi Turtle, PI

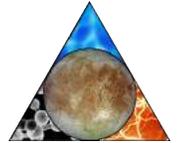


Mannannán: Galileo 20 m/pixel combined with ~80-140 m/pixel color

*Ridged plains at ~25 m/pixel:
WAC res from ~100 km;
NAC res from ~2500 km*



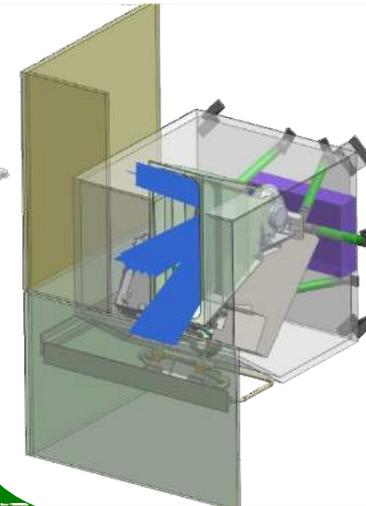
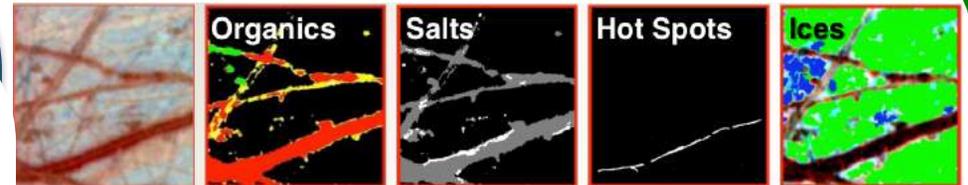
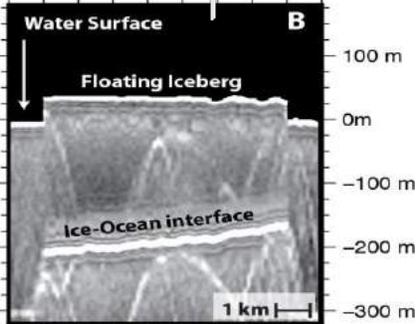
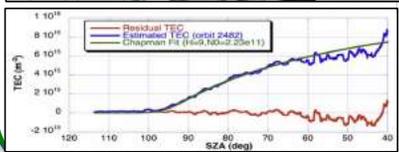
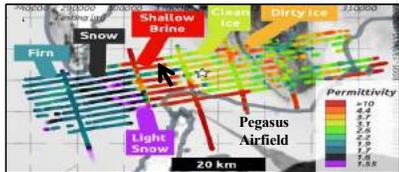
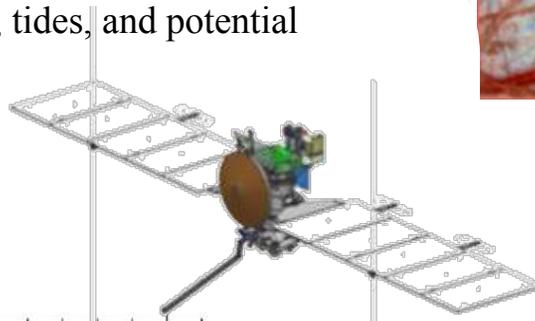
Europa Instrument Overview: REASON & MISE



REASON *Radar for Europa Assessment and Sounding: Ocean to Near-surface*

Uses VHF and HF bands to investigate Europa's ice shell, subsurface ocean, plumes, tides, and potential landing sites

PI: Don Blankenship
University of Texas
Institute for Geophysics



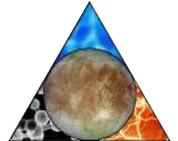
Produces maps of organic compounds, salts, hot spots and ices to assess habitability of the ocean and investigate geologic history of the surface

PI: Diana Blaney Jet Propulsion Laboratory

MISE *Mapping Imaging Spectrometer for Europa*

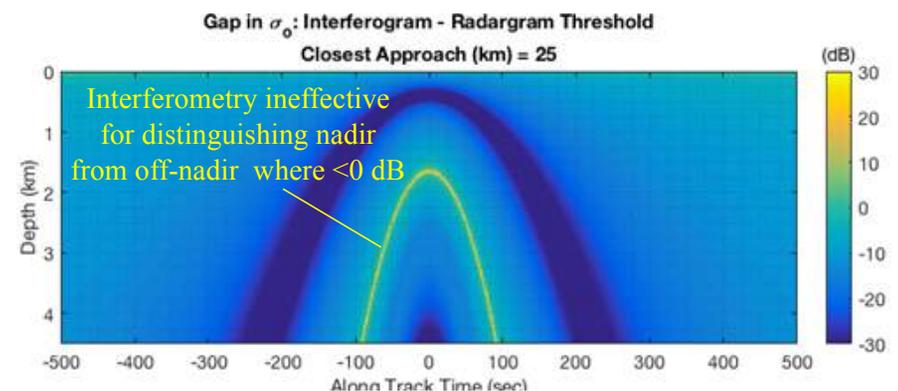
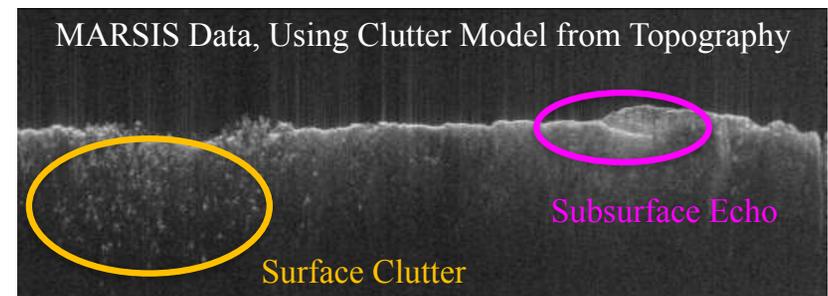


Europa Instrument Highlights: REASON



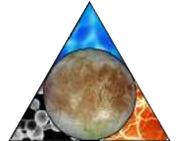
Radar for Europa Assessment and Sounding: Ocean to Near-surface (REASON): Don Blankenship, PI

- REASON can use both topography from EIS stereo imaging and VHF interferometry to distinguish off-nadir-surface from subsurface reflectors
- Developed tools to quantify the suppression and interferometric discrimination of surface clutter
 - Assists spacecraft design and future analyses
- Helps to clarify issues affecting REASON performance, esp. below 50 km





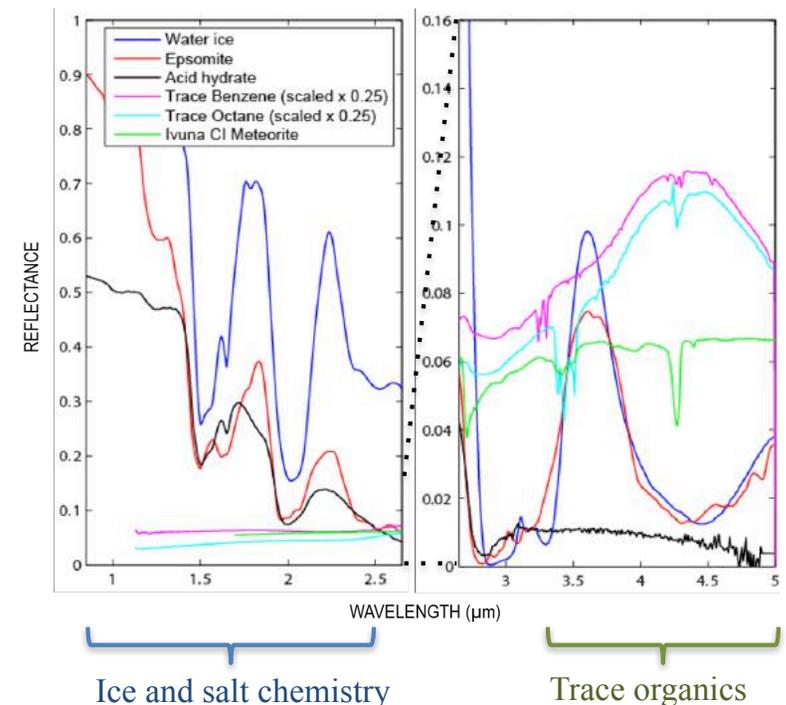
Europa Instrument Highlights: MISE



Mapping Imaging Spectrometer for Europa (MISE): Diana Blaney, PI

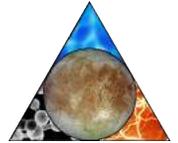
- Thermal accommodation is critical to MISE
 - Cryocooler performance testing is currently underway
- Examining trade of going from 2 to 1 cryocooler
 - Would reduce instrument mass, energy, cost
- For low-altitude observations, there can be mismatches between MISE scan mirror rate and surface target motion
 - Addressed by downlinking uncompressed MISE cubes for the highest-res data

Key compounds at MISE spectral resolution and sampling:

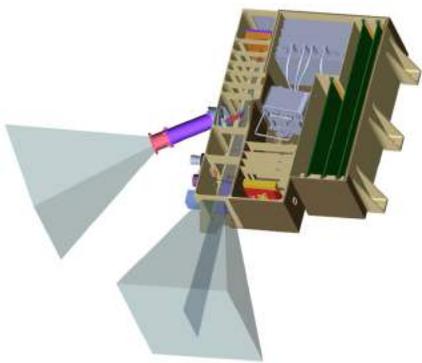




Europa Instrument Overview: Europa-UVS & E-THEMIS

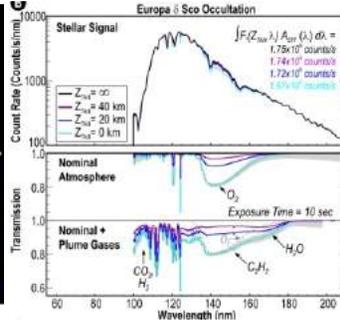
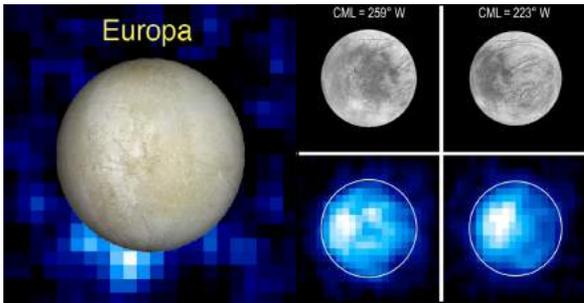


Europa-UVS *Europa Ultraviolet Spectrograph*



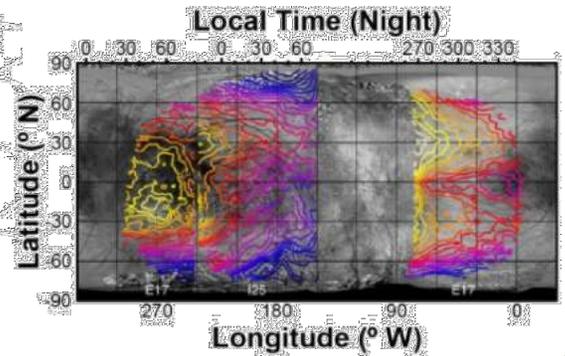
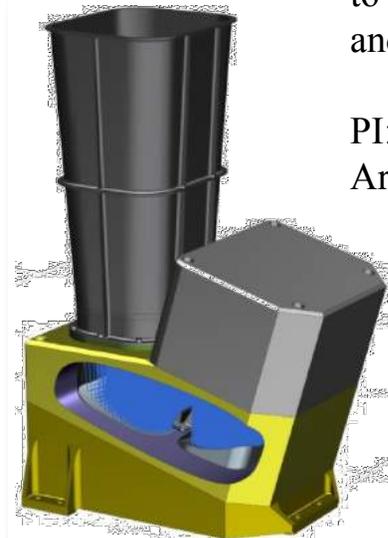
Obtains ultraviolet images to explore Europa's composition and chemistry, search for plumes, and investigate connections with Europa's environment

PI: Kurt Retherford
Southwest Research Institute



Characterizes thermal anomalies, active plumes, and surface properties to support landing site assessment and geology.

PI: Phil Christensen
Arizona State University



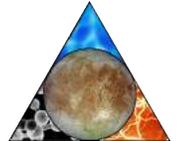
E-THEMIS *Europa Thermal Imaging System*

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Pre-Decisional Information — For Planning and Discussion Purposes Only

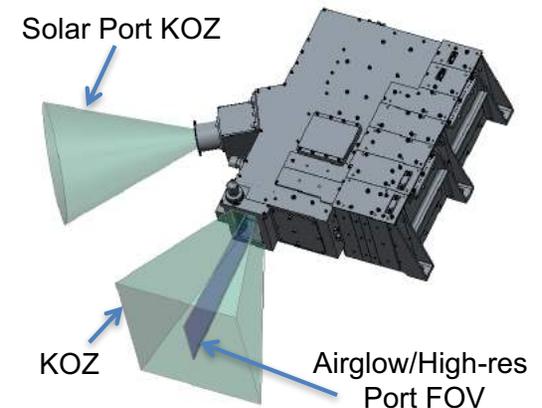


Europa Instrument Highlights: Europa-UVS & E-THEMIS



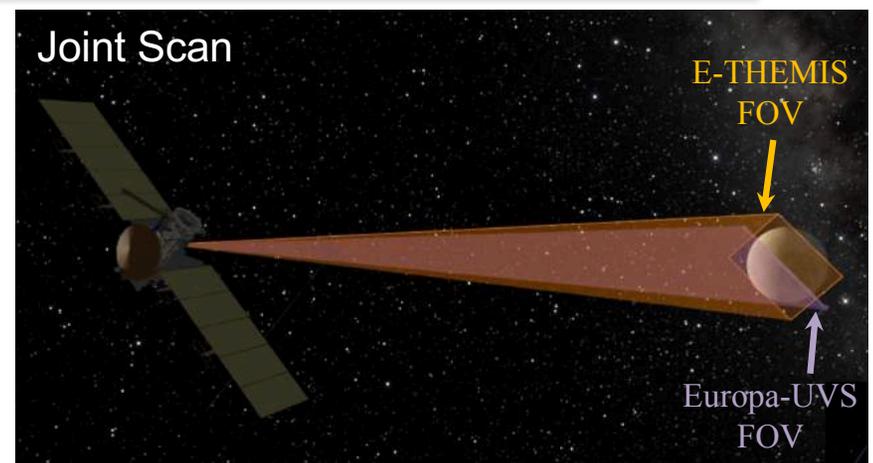
Europa Ultraviolet Spectrograph (Europa-UVS): Kurt Retherford, PI

- Working design to reduce angle to solar port, to permit smaller turns for solar occultations, while avoiding sun on SUDA
- Designing open/close solar port door actuator



Europa Thermal Imaging System (E-THEMIS): Phil Christensen, PI

- Candidate detectors undergoing radiation and spectral response testing
- Spacecraft scanning permits observing a range of local times of day on the surface

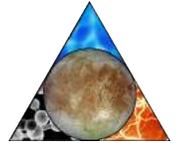


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Europa Instrument Overview: SUDA & MASPEX

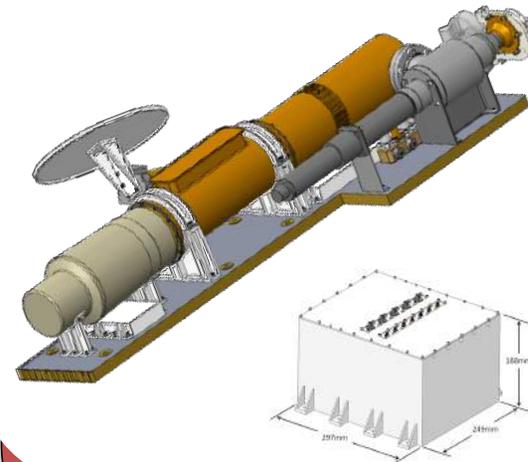
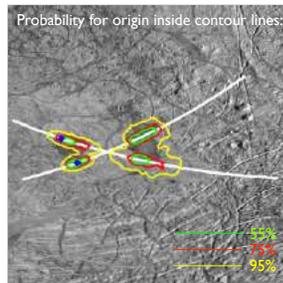
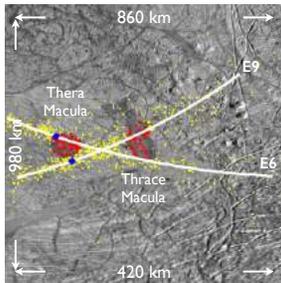
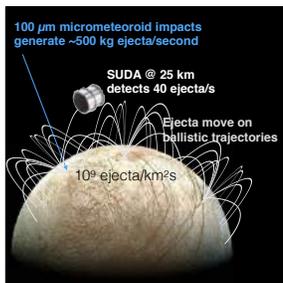
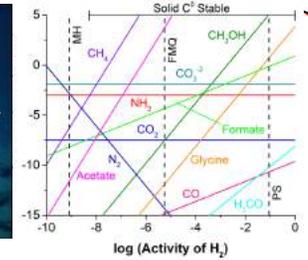
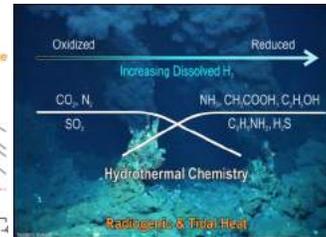
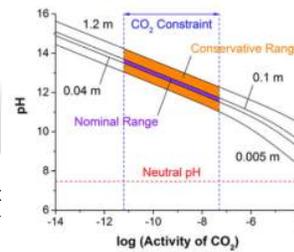


SUDA

Surface Dust Analyzer

Measures the composition of dust particles and constrains geological activities on and below the surface of Europa

PI: Sascha Kempf
LASP, University of Colorado Boulder



Sniffs Europa's atmosphere and exosphere to determine their chemical composition

PI: Hunter Waite
Southwest Research Institute

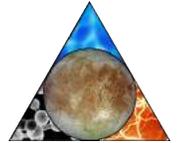


MASPEX

Mass Spectrometer for Planetary Exploration

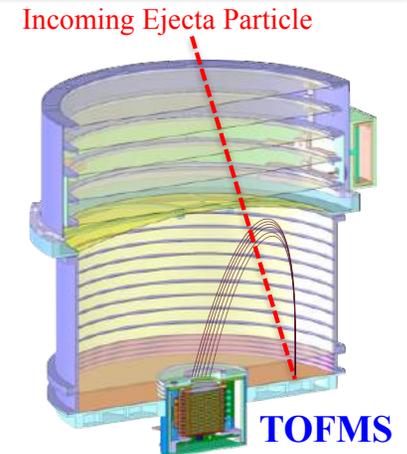


Europa Instrument Highlights: SUDA & MASPEX



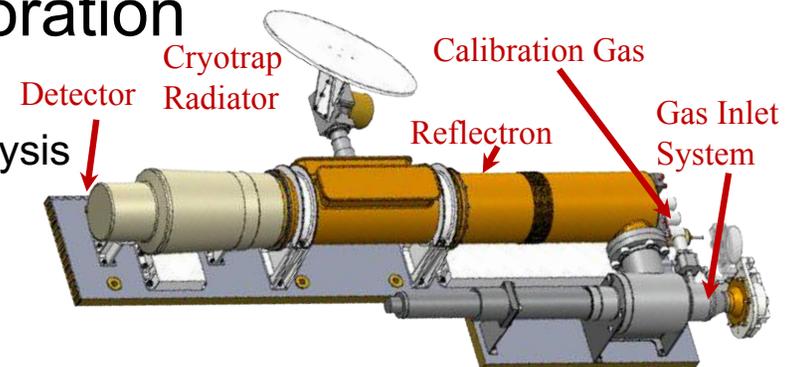
Surface Dust Analyzer (SUDA): Sascha Kempf, PI

- SUDA is oriented directly into dust ram at closest approach, when particle number density is highest
- Sun must be out of FOV while making dust measurements
- Improving TRL on Ir-coated detector through prototype testing
- Investigating innovative ways to lower instrument mass



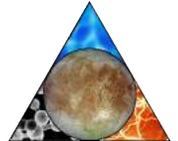
MASS Spectrometer for Planetary EXploration (MASPEX): Hunter Waite, PI

- VAT valve to reduce leak rate, facilitating cryosample analysis
- Performing lifetime testing on ion pump
- Fabricating parts for detector
- Contamination control is key
 - spacecraft cleanliness, FOV/KOZ incursions, thruster products

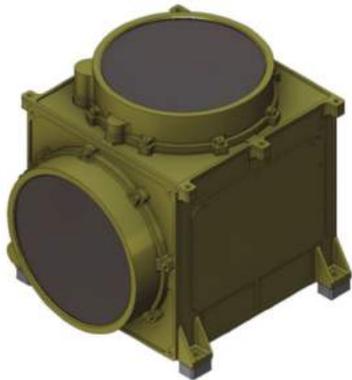




Europa Instrument Overview: PIMS & ICEMAG

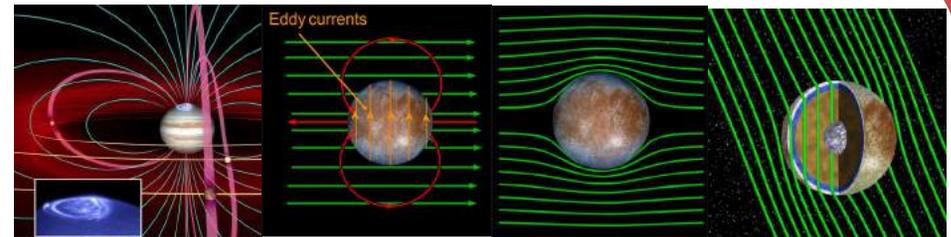
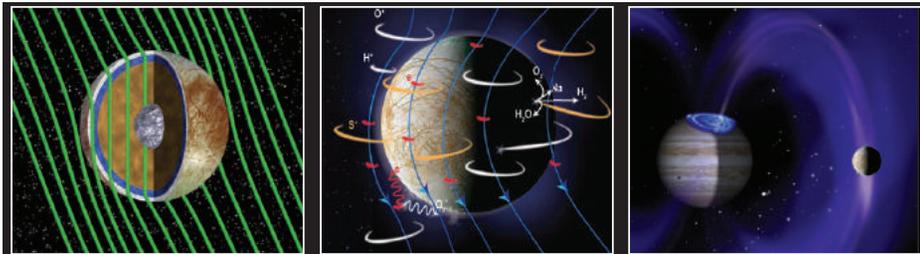


PIMS *Plasma Instrument for Magnetic Sounding*



Measures the plasma surrounding Europa to characterize its subsurface ocean, its ice shell, and plumes

PI: Joe Westlake
Johns Hopkins Applied
Physics Laboratory



Infers location, thickness and conductivity of Europa's ocean using electromagnetic sounding



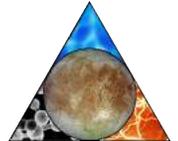
PI: Carol Raymond
Jet Propulsion Laboratory



ICEMAG *Interior Characterization of Europa using Magnetometry*

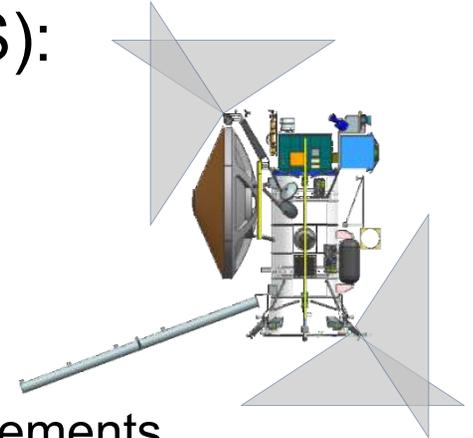


Europa Instrument Highlights: PIMS & ICEMAG



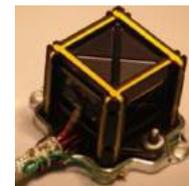
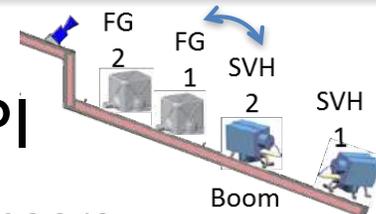
Plasma Instrument for Magnetic Sounding (PIMS): Joe Westlake, PI

- 2 sensors, each with 2 Faraday cups (90° FOV each)
- Moving electronics to within cups, improving grounding
- Modeling demonstrates mag cleanliness can be relaxed
- Developing tools to assess potential science impacts of spacecraft charging, which can affect ion or electron measurements

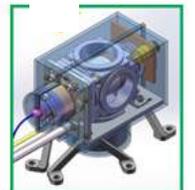


Interior Characterization of Europa using Magnetometry (ICEMAG): Carol Raymond, PI

- Optimizing location on the boom of the FG and SVH sensors
- Working with spacecraft team on sensor attitude knowledge and magnetic cleanliness requirements



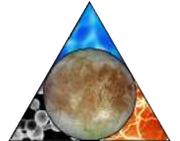
2 x Flux Gate (FG): vector



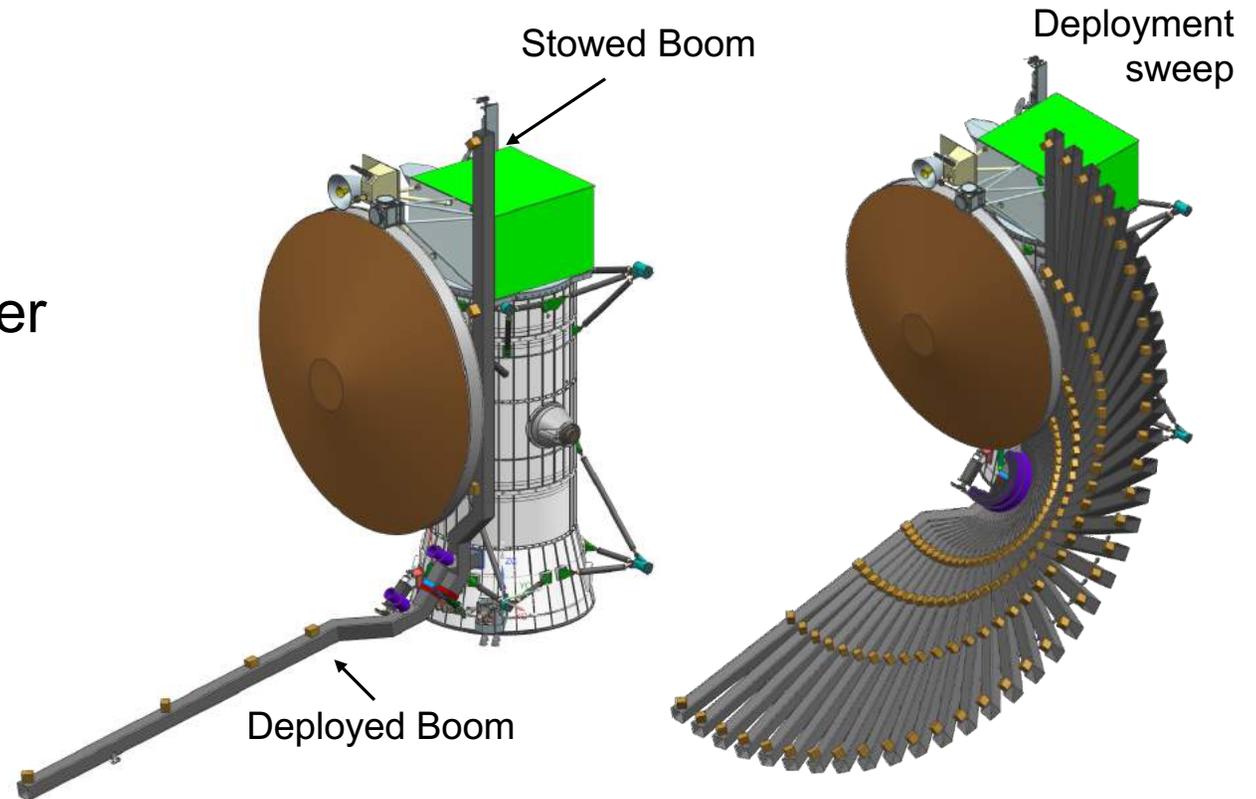
2 x Scalar/Vector Helium (SVH): alternating scalar and vector



Magnetometer Boom Deployment

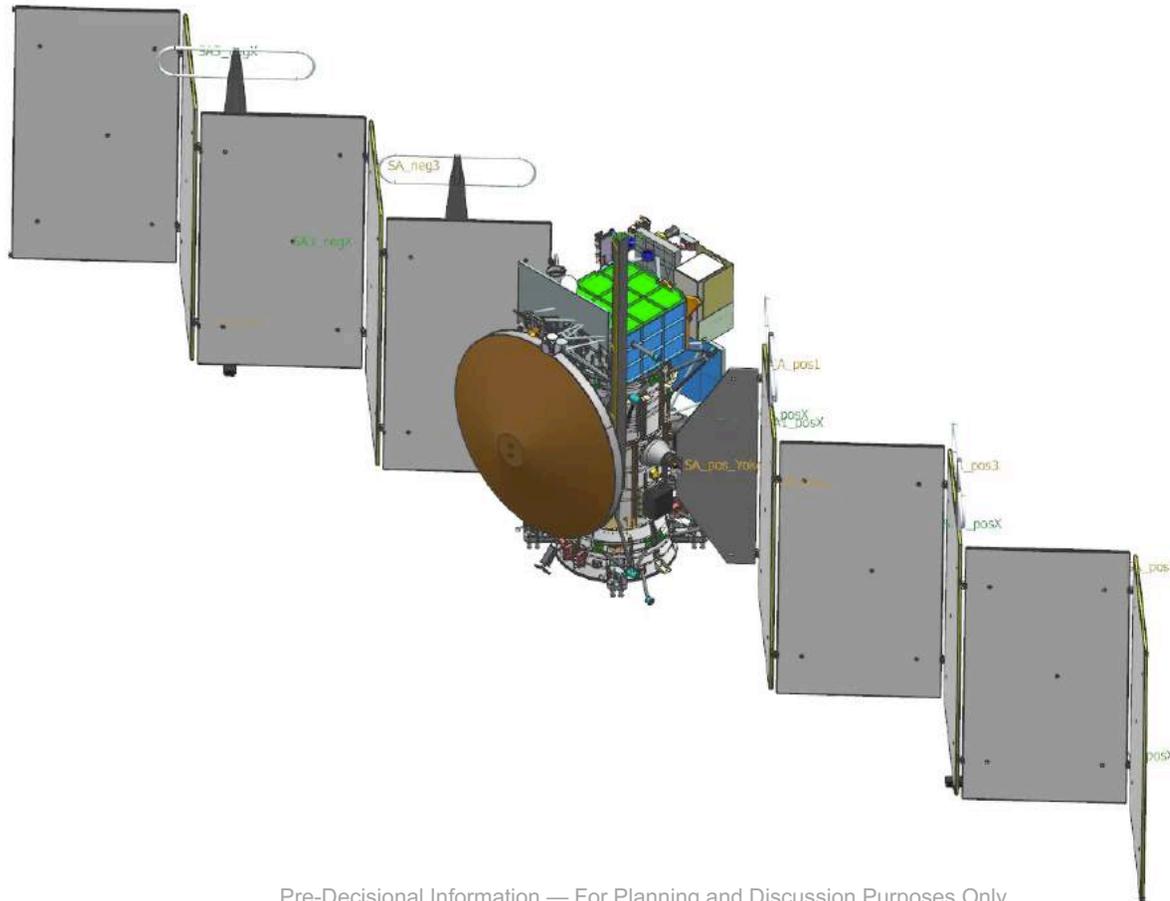
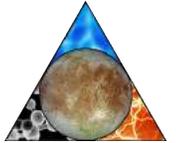


- Single hinge design
- Simple deployment
- Fewer unknowns reduces magnetometer pointing uncertainty





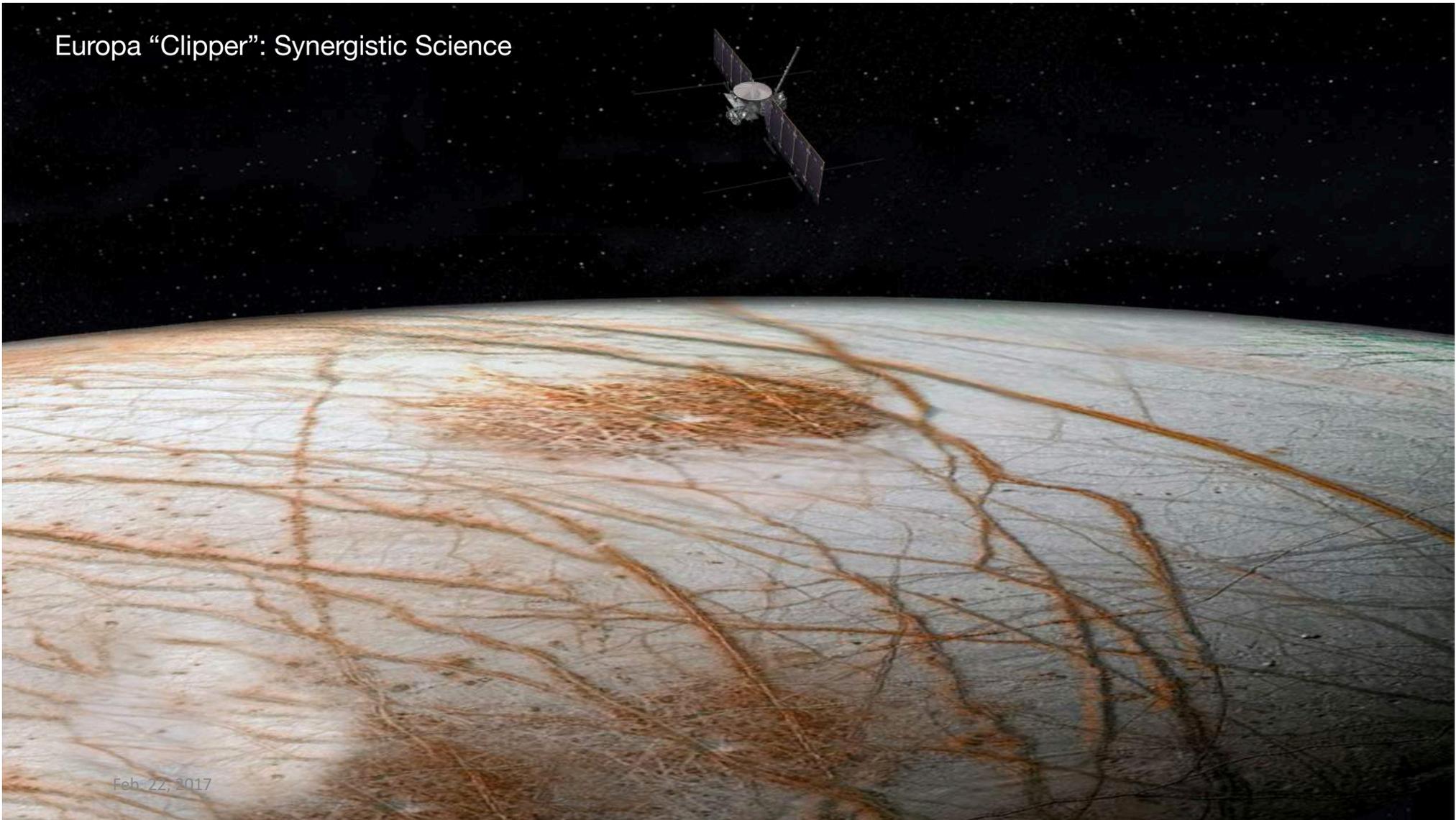
Spacecraft Deployment Sequence



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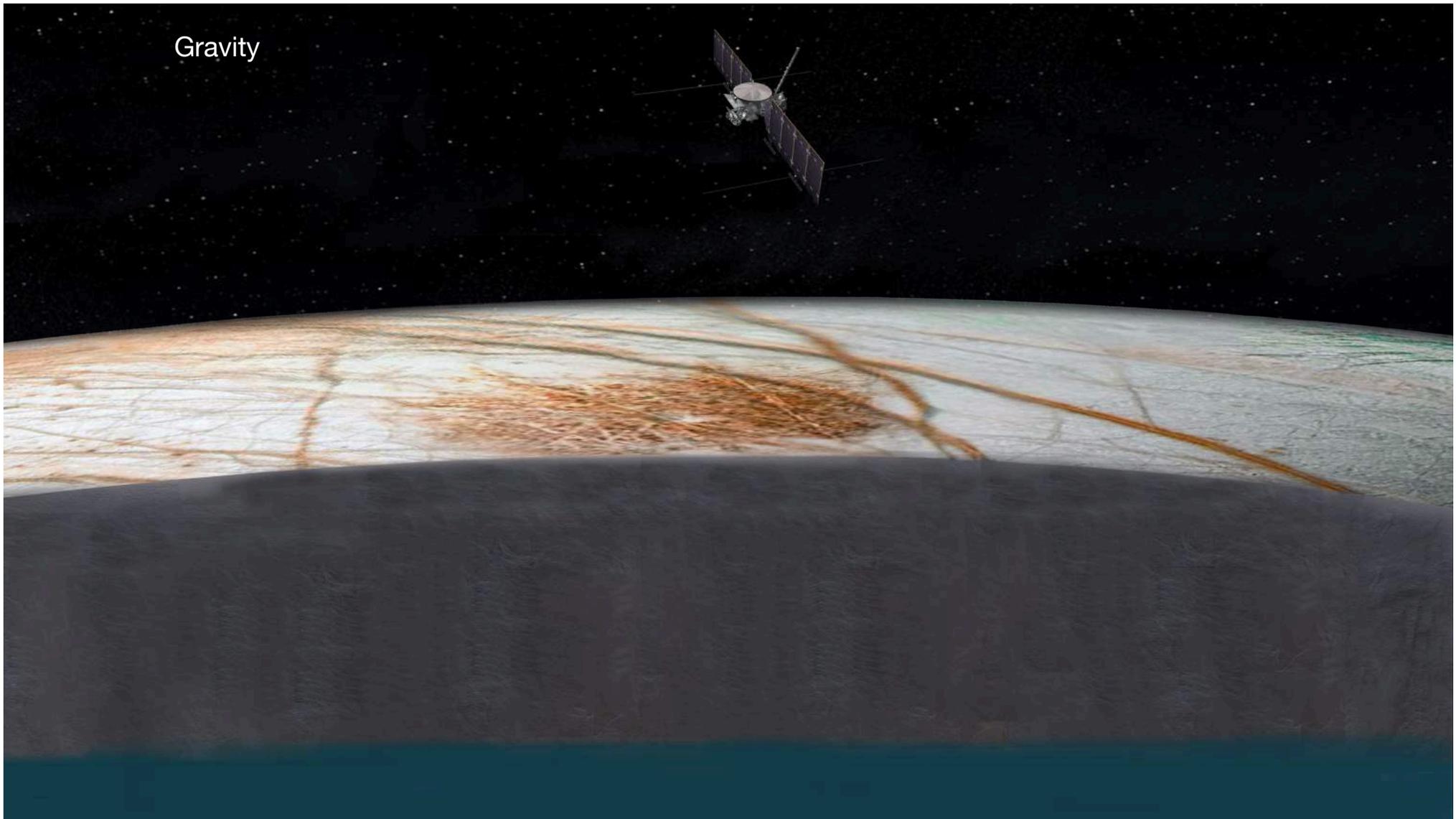
Pre-Decisional Information — For Planning and Discussion Purposes Only

Europa "Clipper": Synergistic Science

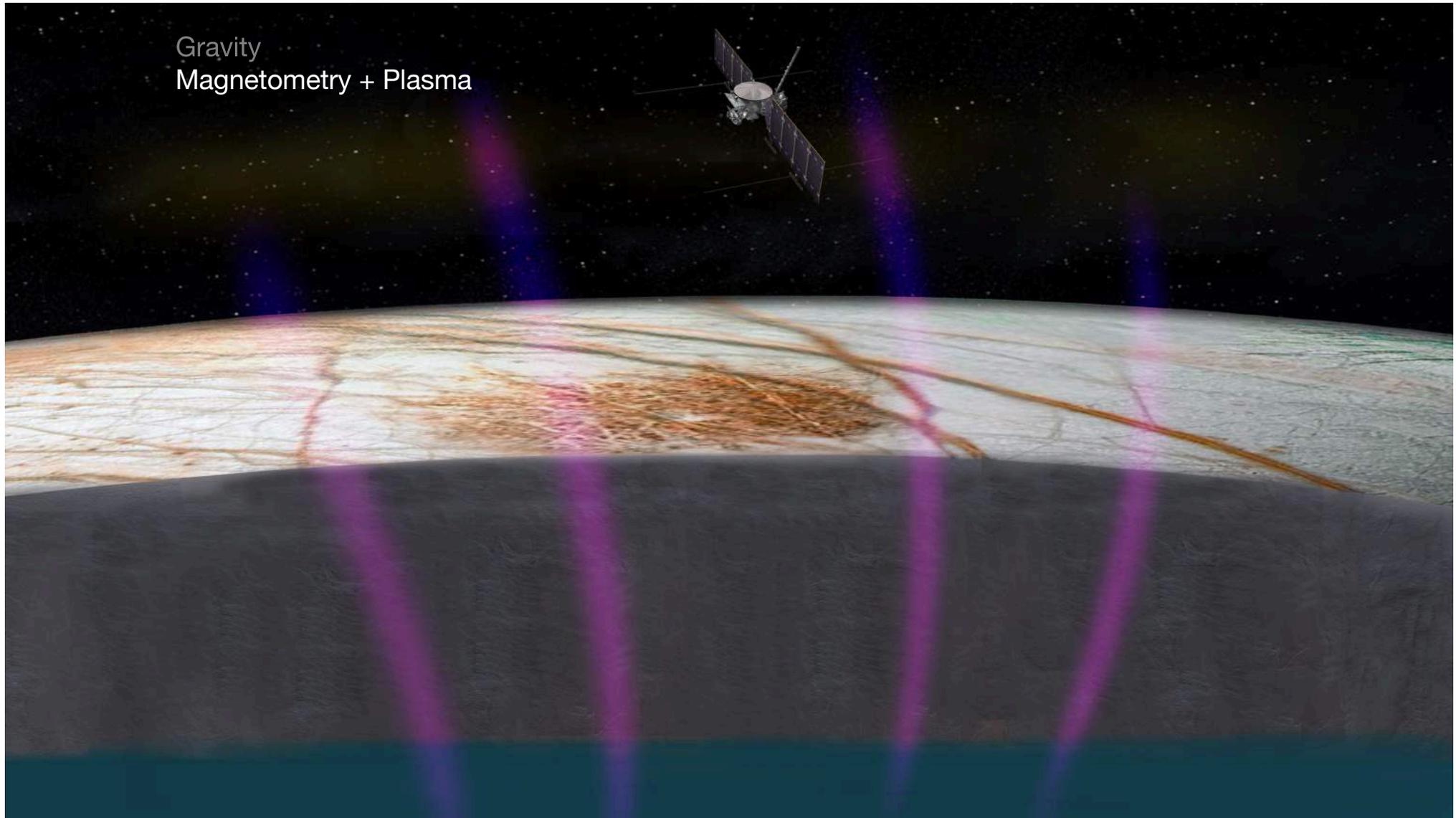


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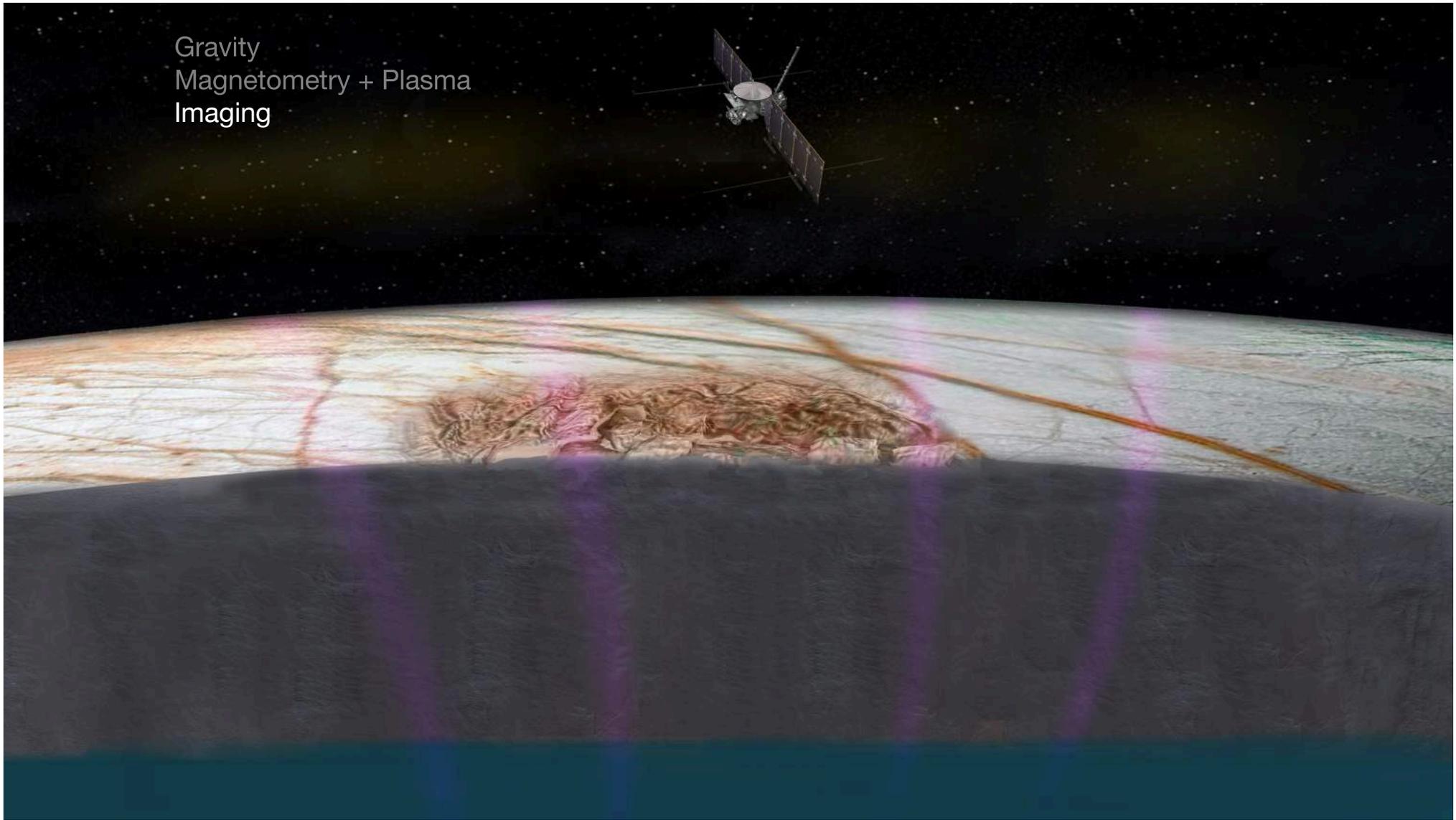
Gravity



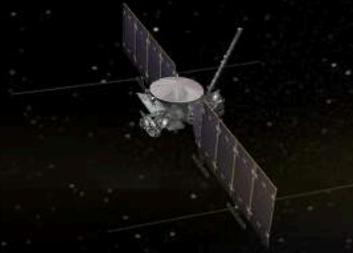
Gravity
Magnetometry + Plasma



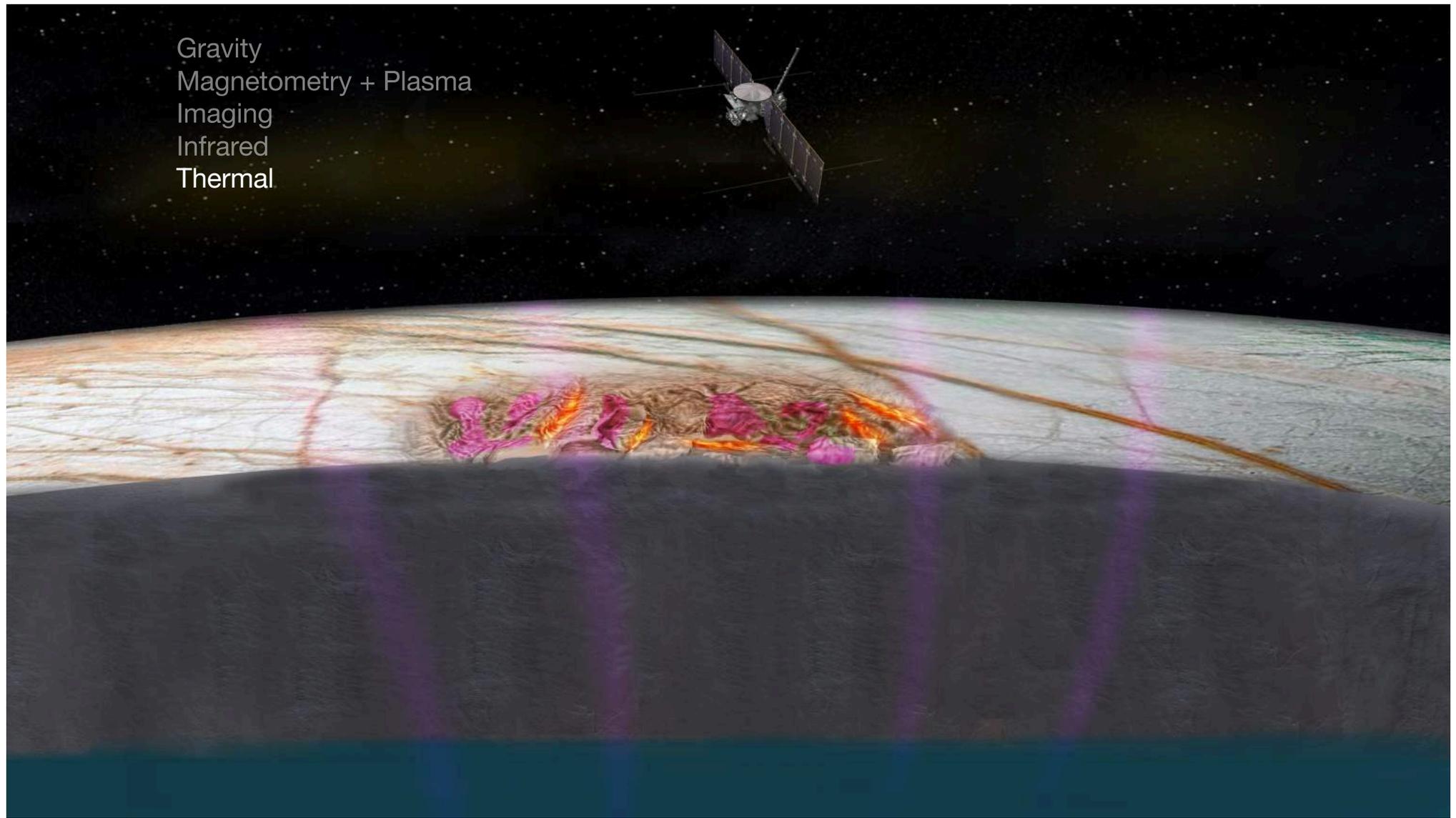
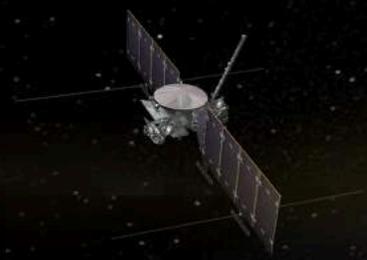
Gravity
Magnetometry + Plasma
Imaging



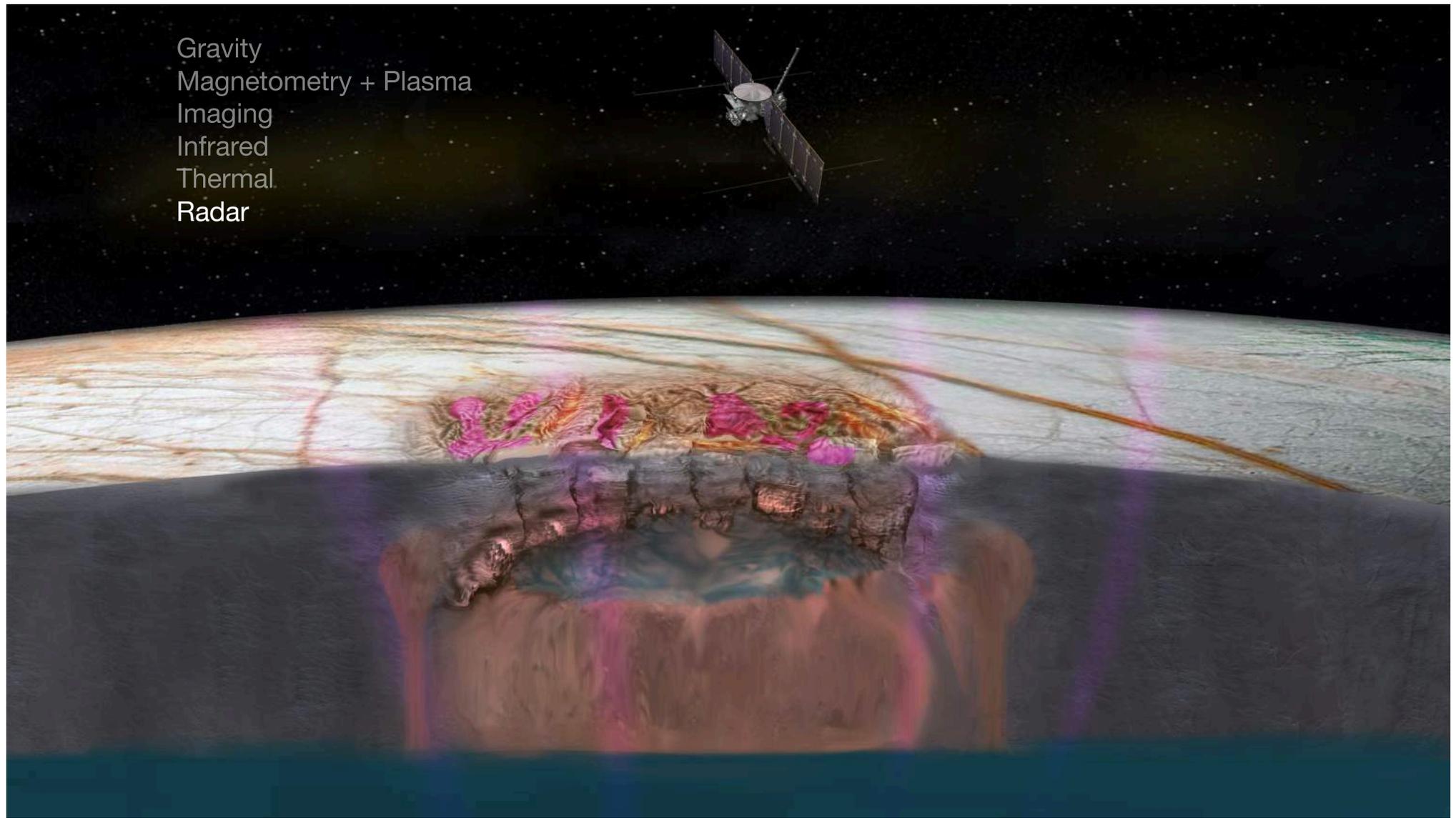
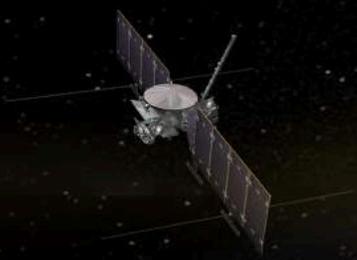
Gravity
Magnetometry + Plasma
Imaging
Infrared



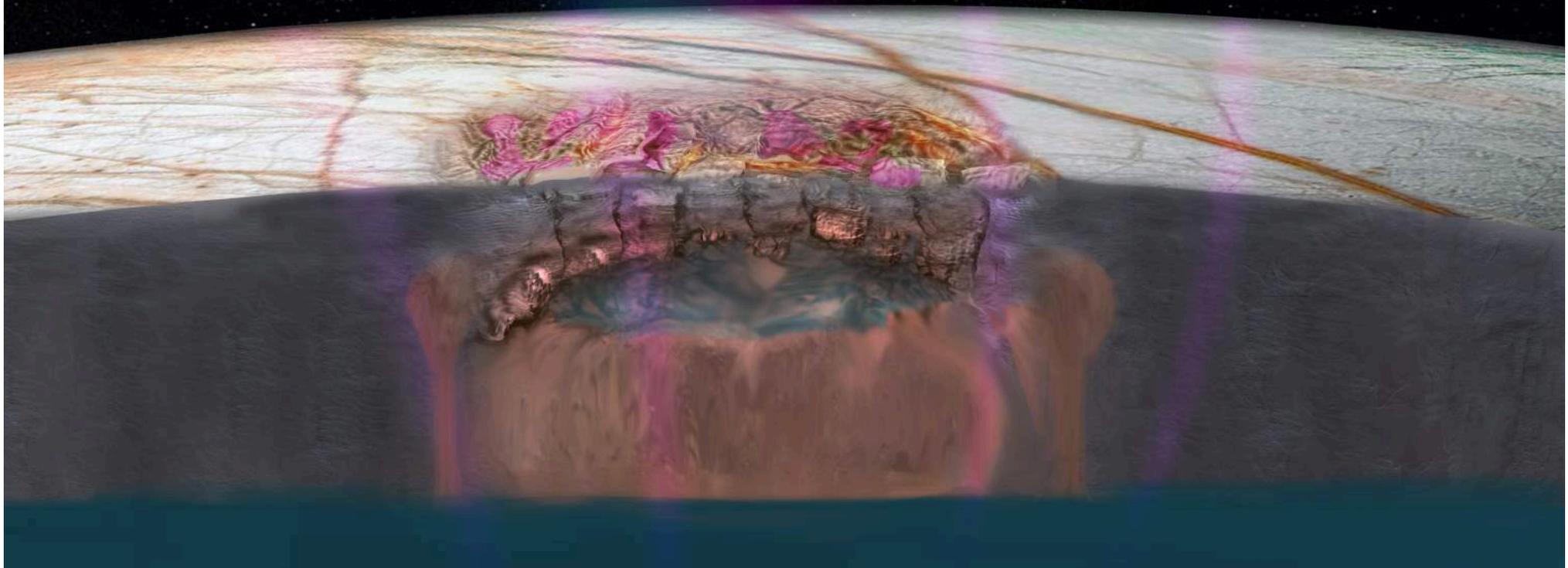
Gravity
Magnetometry + Plasma
Imaging
Infrared
Thermal



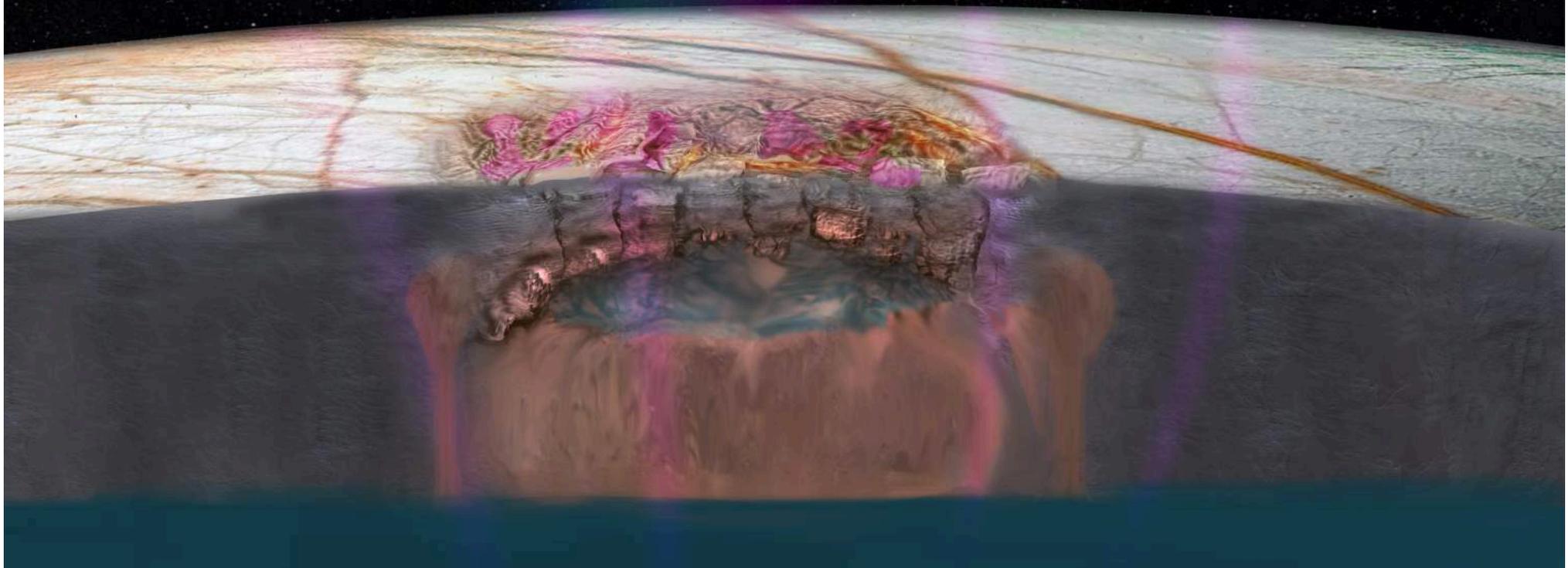
Gravity
Magnetometry + Plasma
Imaging
Infrared
Thermal
Radar



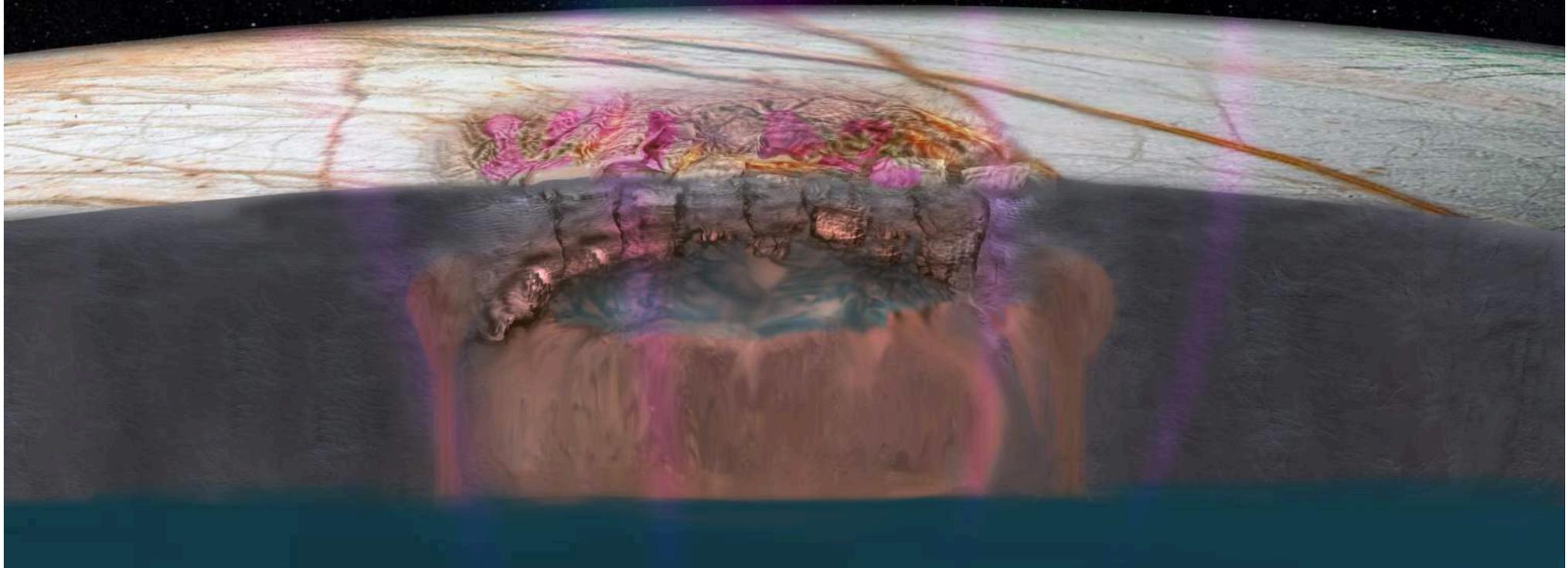
Gravity
Magnetometry + Plasma
Imaging
Infrared
Thermal
Radar
Ultraviolet



Gravity
Magnetometry + Plasma
Imaging
Infrared
Thermal
Radar
Ultraviolet
Gas + Dust Mass Spectroscopy



Gravity
Magnetometry + Plasma
Imaging
Infrared
Thermal
Radar
Ultraviolet
Gas + Dust Mass Spectroscopy



EUROPAM → Europa
Altitude: 529,658 km
Relative speed: 4.26 km/s

Europa Flyby Animation

GNC: Nadir Ram-Optimized

GRAVITY SCIENCE - YLGA

ICEMAG - LYBY MODE

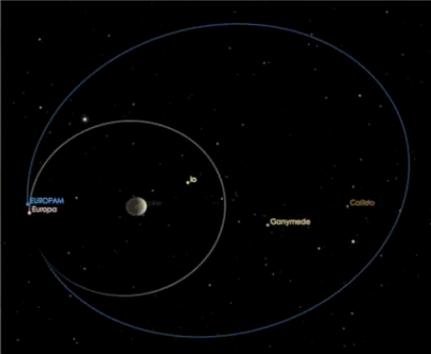
MAG - LYBY KERN WAQUIS - LON

PERIAPSIS - 1000000000000

SLIP - 1.1781 1.0000

2028-Apr-17 02:00:00 UTC
1.0000 km/s

- Payload**
- EISNAC
 - EISWAC
 - ETHEMIS
 - ICEMAG
 - MASPEX
 - MISE
 - PIMS
 - REASON
 - SUDA
 - UVS



Pre-Decisional Information — For Planning and Discussion Purposes Only