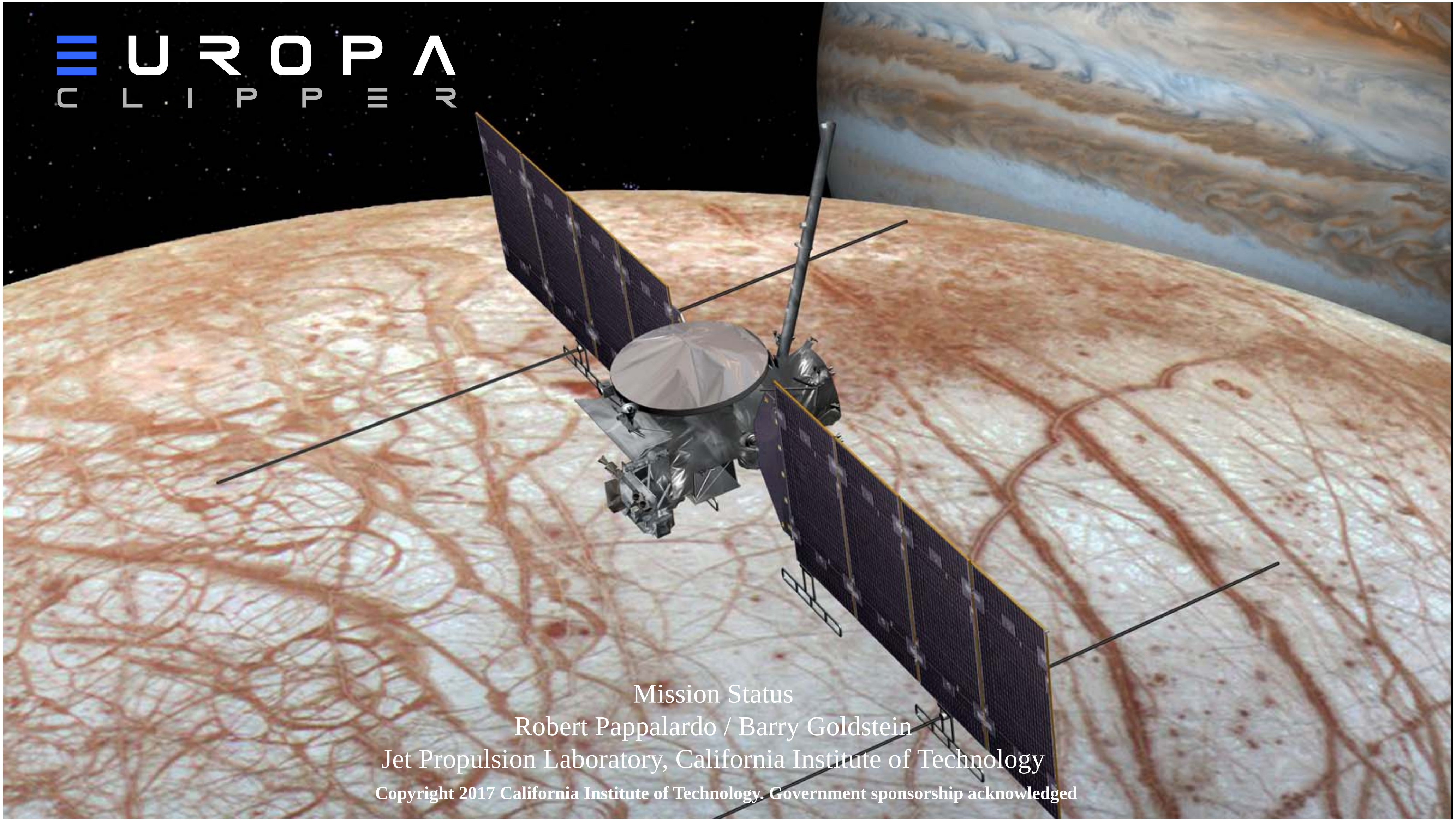


EUROPA CLIPPER

Mission Status

Robert Pappalardo / Barry Goldstein
Jet Propulsion Laboratory, California Institute of Technology

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

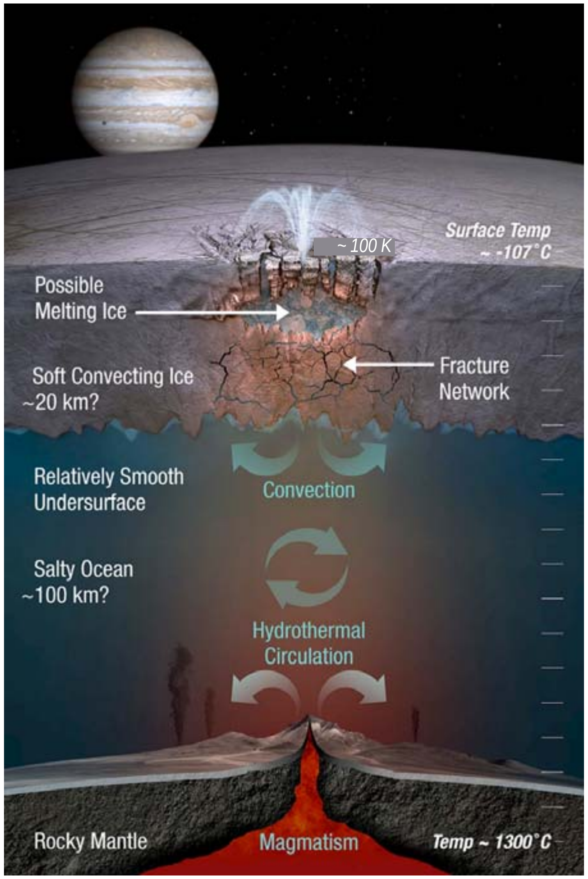
Energy:

- Chemical energy could sustain life
- Surface irradiation creates oxidants
- Mantle rock-water reactions could create reductants (hydrothermal or serpentinization)

Activity:

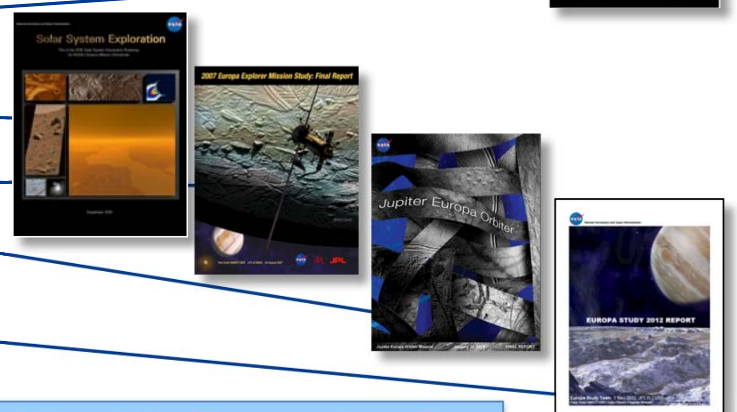
- Geological activity "stirs the pot"
- Possible cyclical activity, as tied to Io

Europa Flyby Mission will verify key* habitability *hypotheses



Timeline of Europa Mission Science Definition

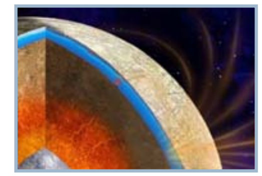
- Europa Orbiter Science Definition Team (1999)
- A Science Strategy for the Exploration of Europa, COMPLEX, National Research Council (1999)
- NASA Campaign Science Working Group on Prebiotic Chemistry in the Solar System (1999)
- New Frontiers in Solar System Exploration, Decadal Survey, (2003)
- Jupiter Icy Moons Orbiter (JIMO) Science Definition Team (2004)
- Scientific Goals and Pathways for Exploration of the Outer Solar System, OPAG (2006)
- NASA Solar System Exploration Roadmap (2006)
- Europa Explorer (EE) Report (2007)
- Jupiter Europa Orbiter Mission Final Report (2008)
- Europa Study Report (2012)

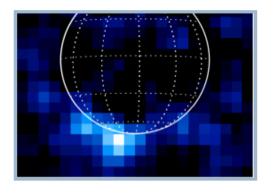


The Europa science objectives and Level 1 science categories have a long history of evolution and refinement

Europa Clipper Science Overview

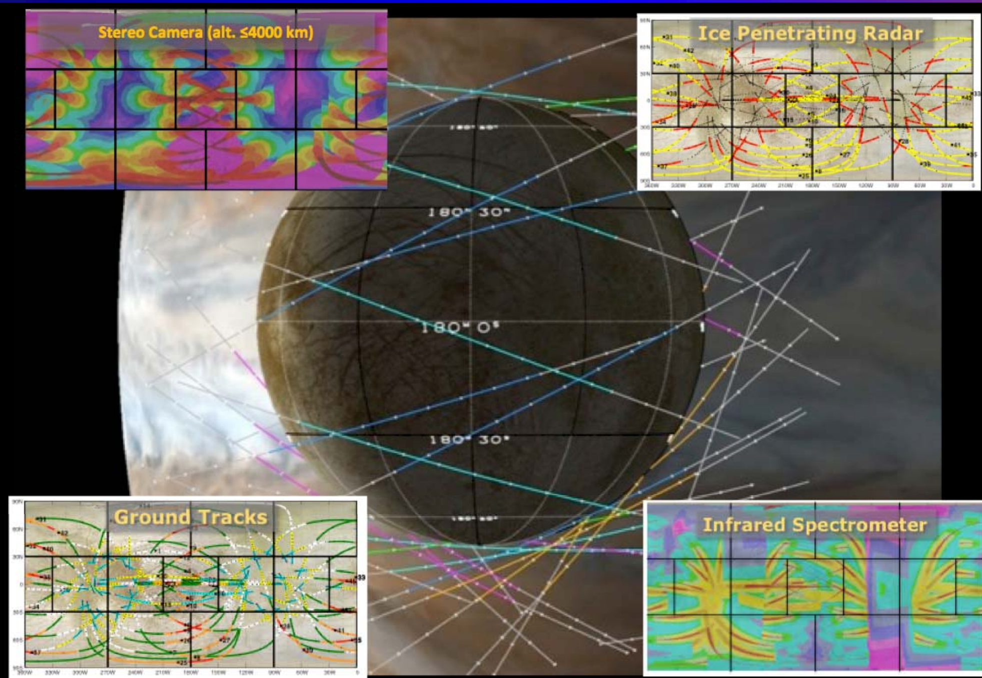
- *Goal:* **Explore Europa to investigate its habitability**
- *Level 1 Science Categories:*
  - **Ice Shell & Ocean:** Characterize the ice shell and any subsurface water, including their heterogeneity, ocean properties, and the nature of surface-ice-ocean exchange
  - **Composition:** Understand the habitability of Europa's ocean through composition and chemistry
  - **Geology:** Understand the formation of surface features, including sites of recent or current activity, and characterize high science interest localities*
  - **Current Activity:** Search for and characterize any current activity, notably plumes and thermal anomalies

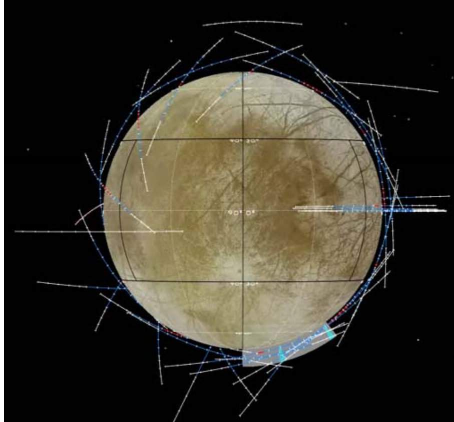




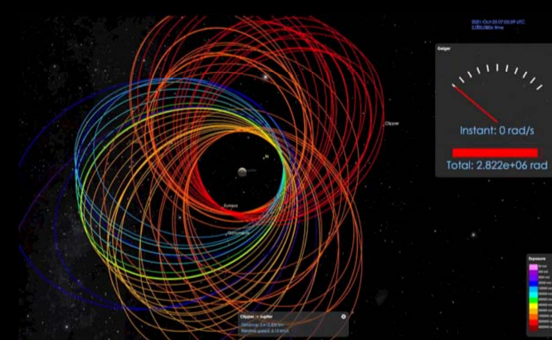
Note: Science Definition Team's "Reconnaissance" goal has been folded into the Geology objective

Innovative Mission Concept





Radiation Accumulation



Flyby Comparison: Galileo vs. Europa Clipper

(Animation)

Spacecraft Trajectory

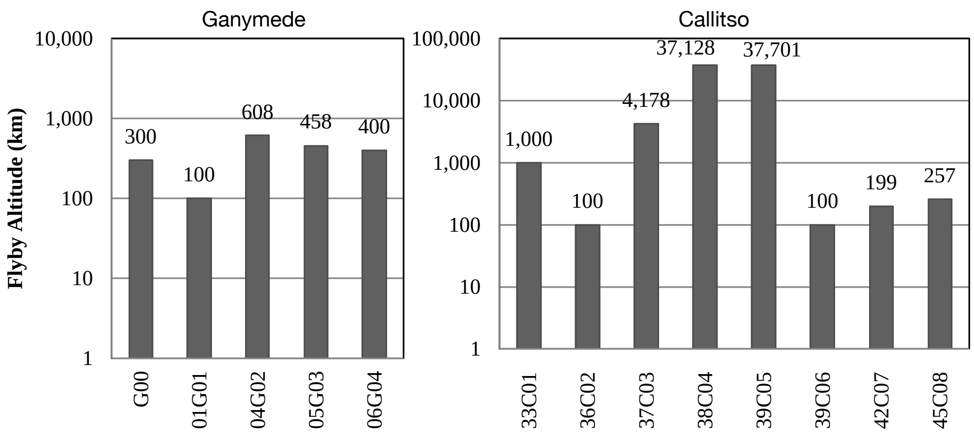
- $25\ km \leq r_{alt} \leq 50\ km$
- $50\ km < r_{alt} \leq 400\ km$
- $400\ km < r_{alt} \leq 1000\ km$
- $1000\ km < r_{alt} \leq 4000\ km$

Flyby Altitude Distributions

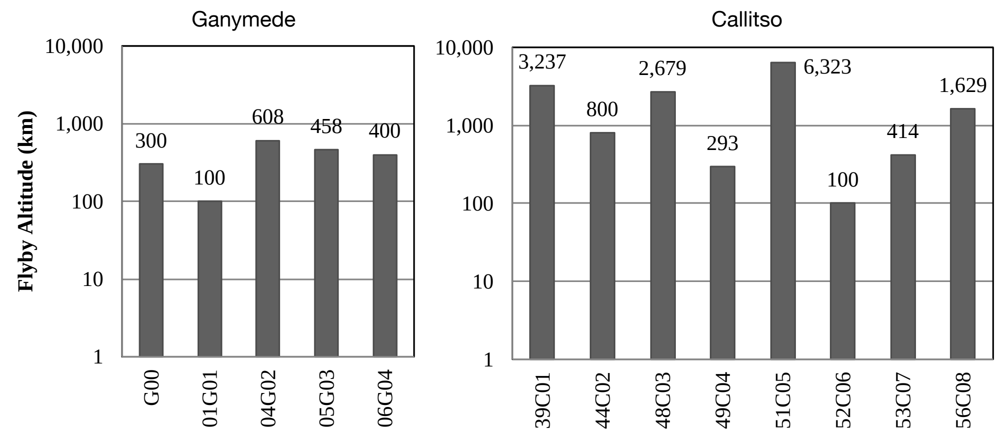
Europa Flyby Altitudes

Altitude Bin	16F11	17F12	17F13
>1000 km	4	3	6
100 – 1000 km	13	16	22
50 – 99 km	5	12	12
25 – 49 km	21	15	14

17F12



17F13



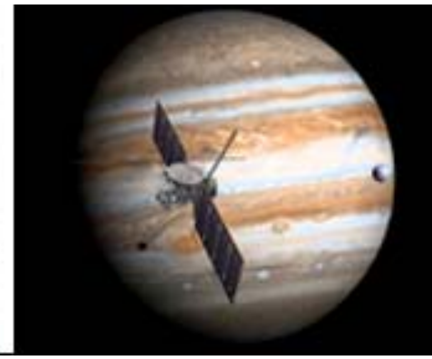
Mission Overview

Earliest Launch

*Period: 6/4/22 – 6/24/22 (SLS)
*Period: 6/18/22 – 7/8/22 (EELV)

Cruise:

2.5 Years (SLS)
7.4 Years (EELV)



Jupiter Orbit Insertion

12/24/24 or 5/1/25 (SLS)
11/26/29 (EELV)

Jovian System Operations

Transition to Europa Science: 12 months
Prime Europa Flyby Campaign: 36 months

*** - Dependent on Funding**

- **Project Category 1**
  - LCC > $1B
- **Mission Risk Class A (Tailored)**
- **NPR 7120.5E Compliant**
- S/C design compatible with both SLS and EELV

Mission Partners and Roles

Kennedy Space Center:
- LSP office – EELV Interface
- GSDO – SLS Launch Site Support

Marshall Space Flight Center:
- Program managing center
- Launch service provider (SLS)
- Propulsion Subsystem component engineering

***Jet Propulsion Laboratory & Applied Physics Laboratory**
- Project Management
- Science
- System Engineering
- Navigation
- Mission Operations
- Payload Management

Goddard Space Flight Center:
- Propulsion Subsystem lead

Langley Research Center:
- High Gain Antenna testing and calibration

***-Lead Center**

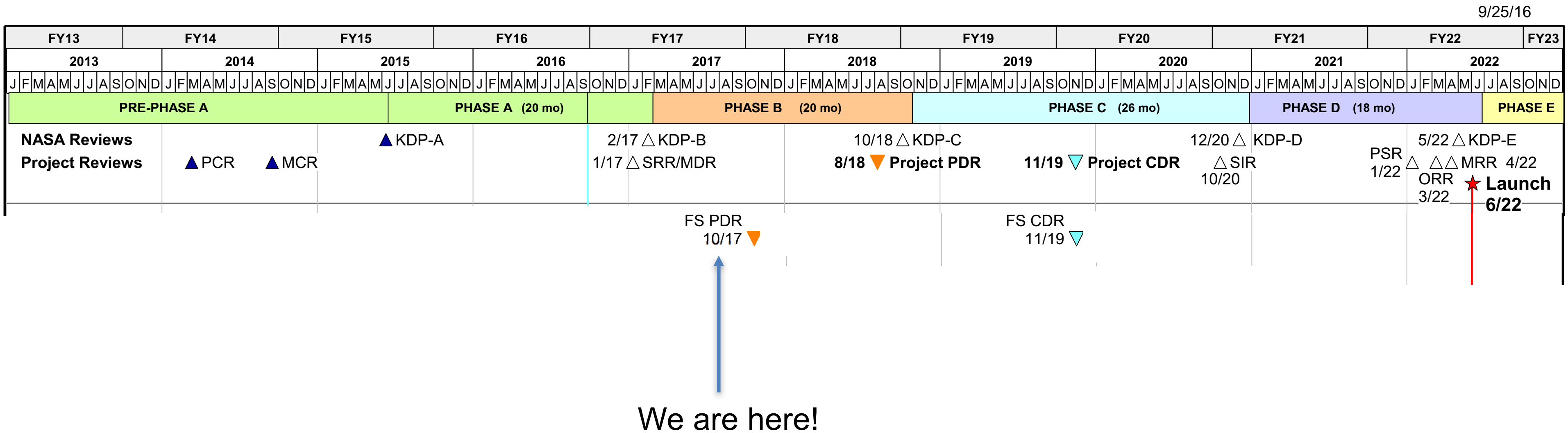
Science Investigations

The University of Texas at Austin	Johns Hopkins Applied Physics Laboratory	Southwest Research Institute	Jet Propulsion Laboratory, California Institute of Technology	University of Colorado Boulder	Arizona State University
Ice Penetrating Radar (REASON) *Dr. Donald Blankenship*	**Europa Imaging System (EIS)** *Dr. Elizabeth Turtle* **Plasma Instrument (PIMS)** *Dr. Joe Westlake*	**Mass Spectrometer (MASPEX)** *Dr. Hunter Waite* **Europa Ultraviolet Spectrograph (Europa UVS)** *Dr. Kurt Retherford*	**Magnetometers (ICEMAG)** *Dr. Carol Raymond* **Short Wave Infrared Spectrometer (MISE)** *Dr. Diana Blaney*	**Dust Detector/Analyzer (SUDA)** *Dr. Sascha Kempf*	**Thermal Imager (E-THEMIS)** *Dr. Phil Christensen*

Project-Level Lifecycle Schedule

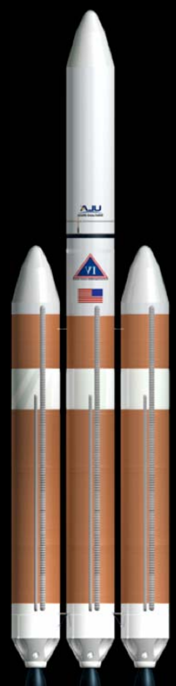
Key Project Reviews

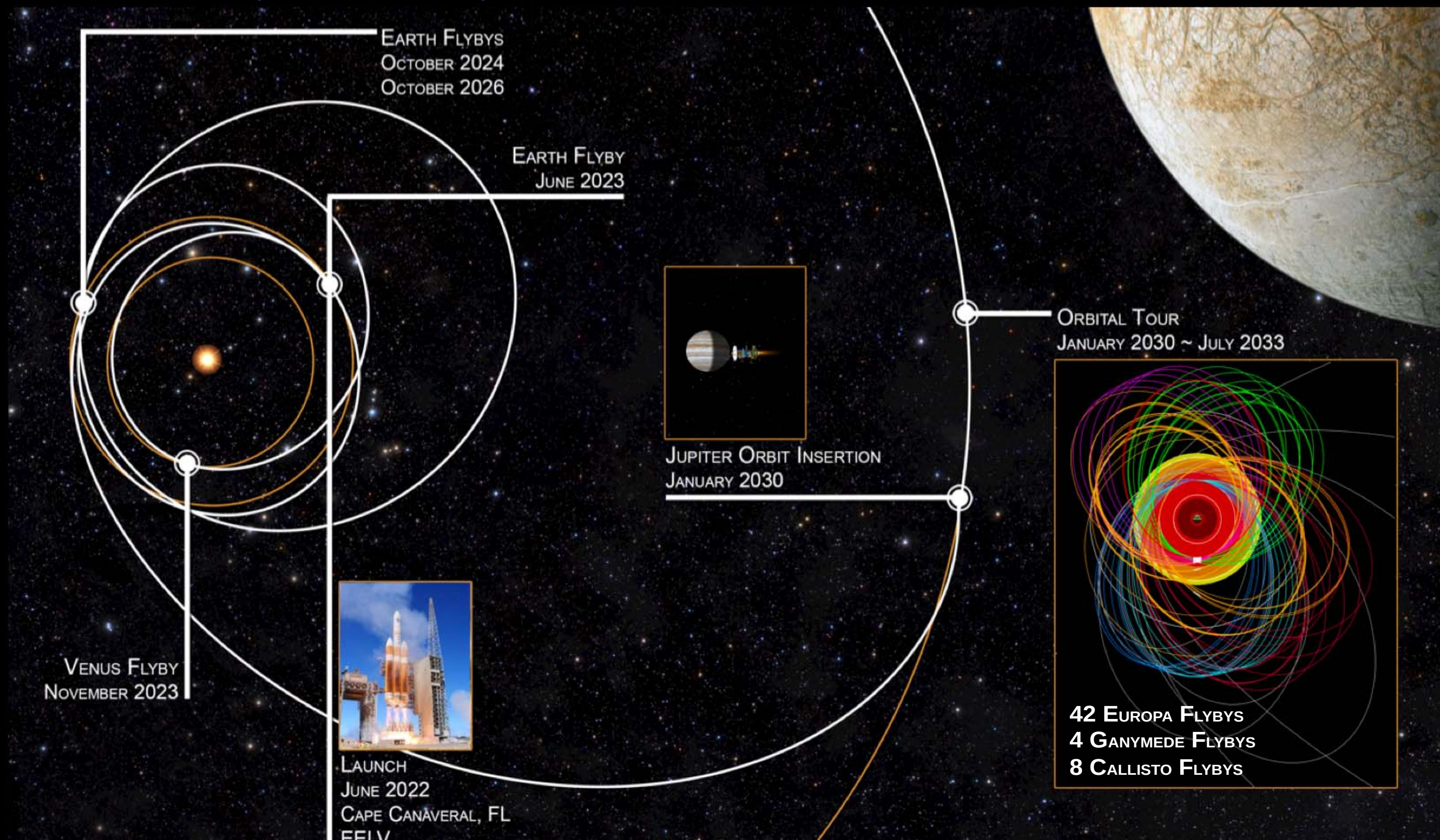
Europa Multi-Flyby Mission (SLS) - Spacecraft



EVEEGA Interplanetary Trajectory

EELV Launch Option– (Delta-IV Heavy /Falcon Heavy)

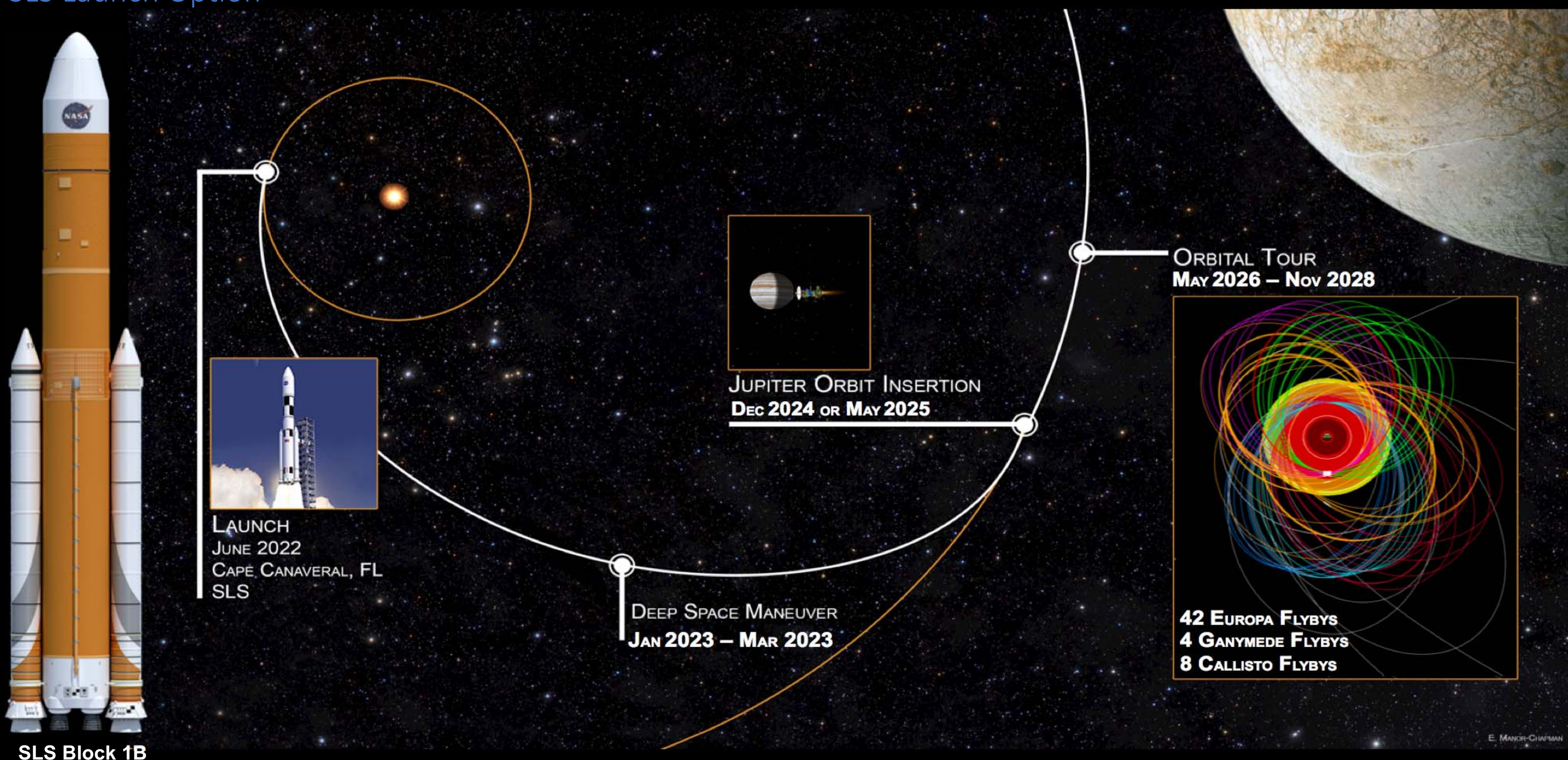




- 21 Day launch period opens June2022
- Earth/Venus/Earth/Earth Gravity Assist
- Arrive Jovian System January, 2030 (7.5 Years)

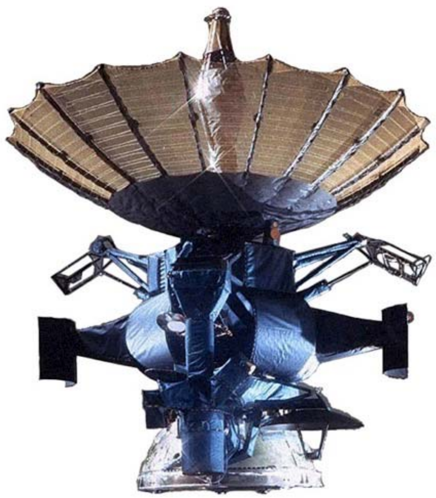
Direct to Jupiter Trajectory

SLS Launch Option

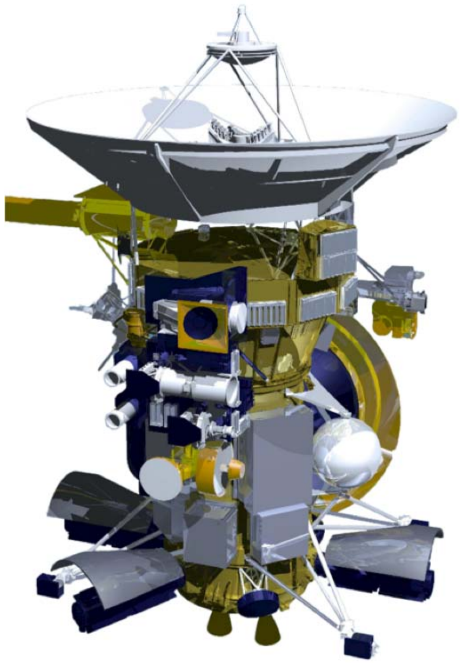


- 21 Day launch period opens June 2022
- Arrive Jovian System March, 2025 (2.7 Years)

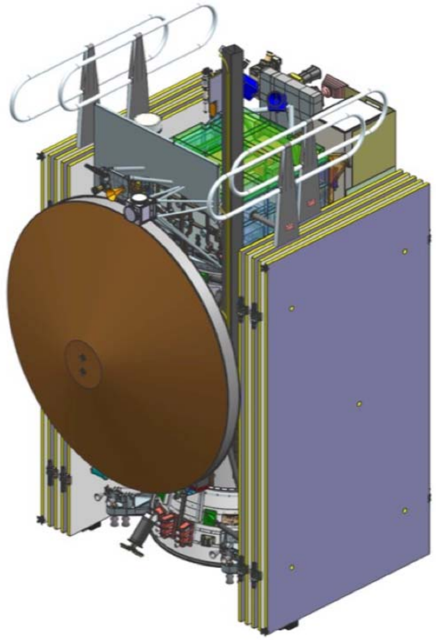
Outer Planet S/C



Galileo
Launch Mass: 2,562 kg

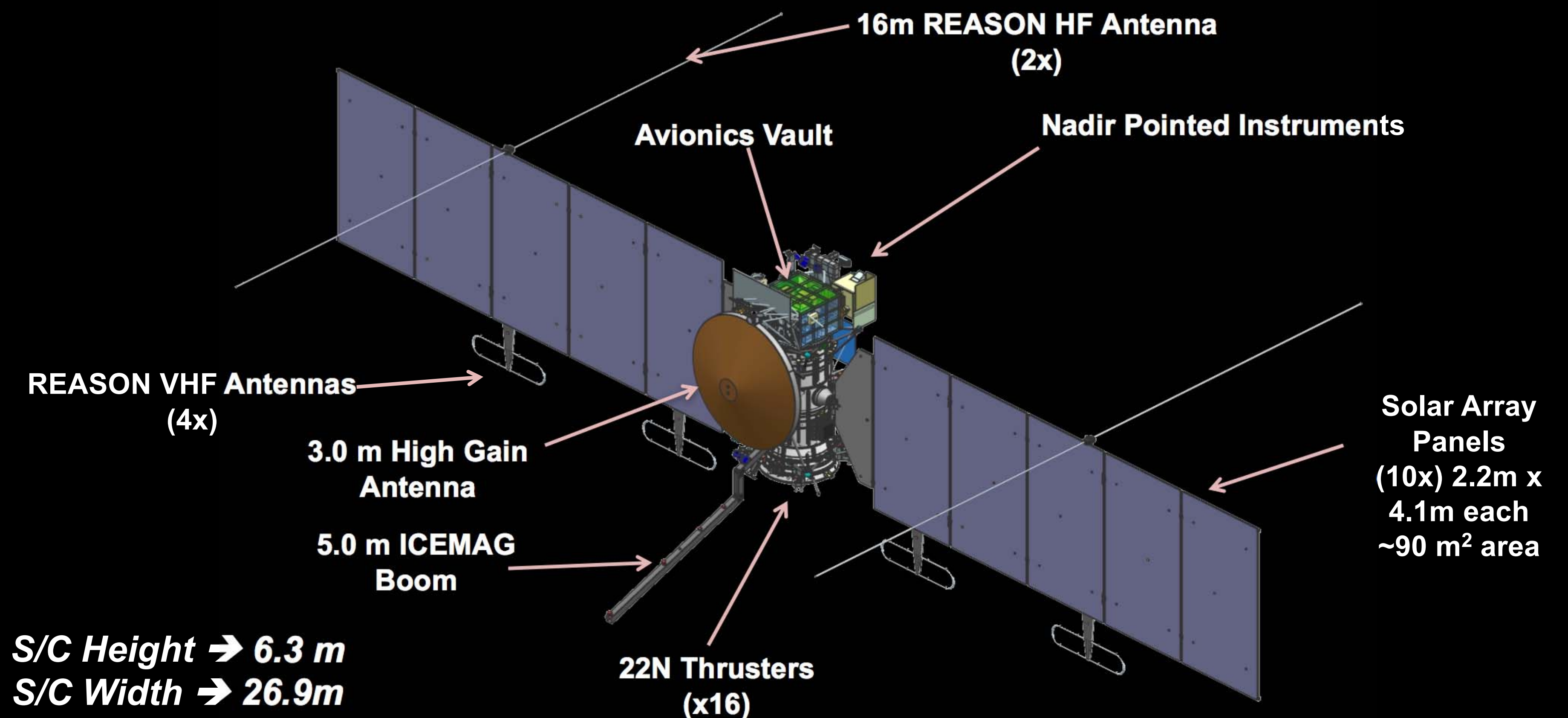


Cassini
Launch Mass: 5,655 kg

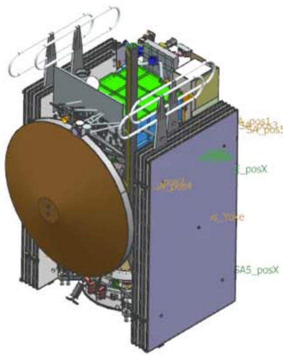


Planned Europa Clipper
Launch Mass: 6,000 kg

Clipper Spacecraft



Deployments



Significant Hardware Development Progress

Engineering Model Telecommunications Radio

Significant Hardware Development Progress

3 Meter Diameter High Gain Antenna Prototype

Significant Hardware Development Progress

Antenna Pattern and Gain Testing At Langley Research Center

HGA Prototype

Fan Beam Prototype

Significant Hardware Development Progress

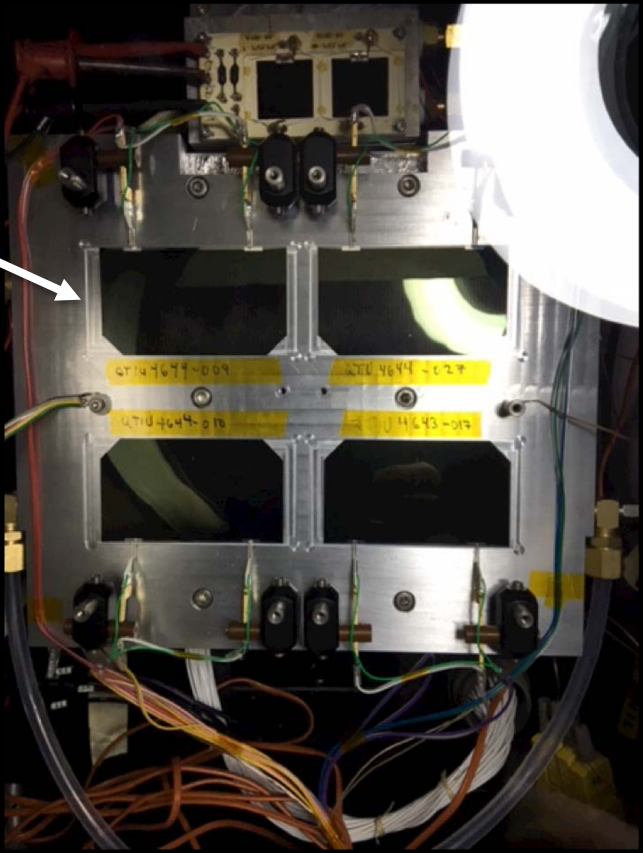
Battery Cell & Module Testing

Battery configurations being optimized

210 total Cells (~AA)

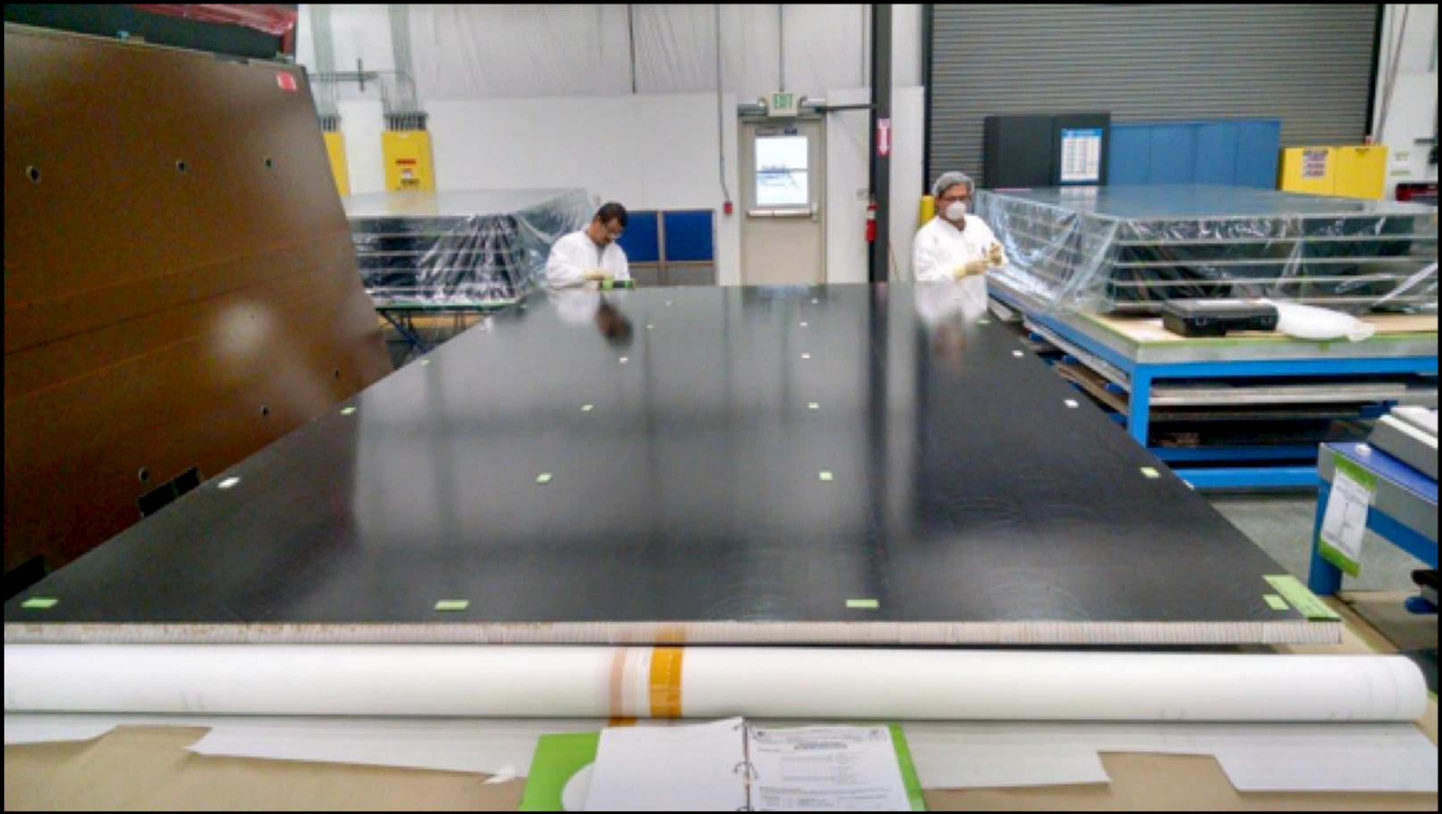
Significant Hardware Development Progress

Solar Cells in radiation test fixture



Solar Cell Low Intensity / Low Temperature & Radiation Testing

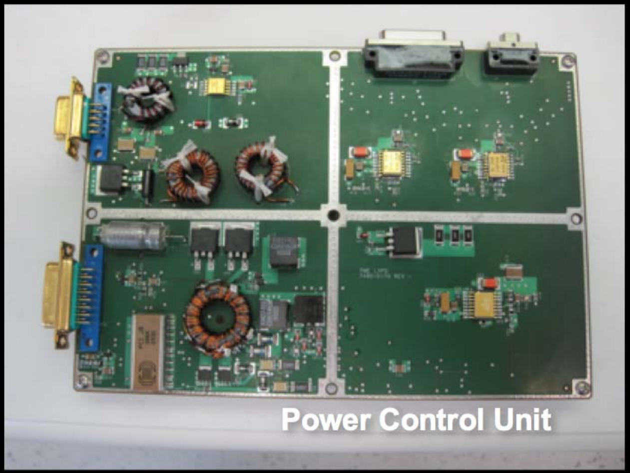
Significant Hardware Development Progress



Full Size Solar Array Panel Demonstrator (2.2m x 4.1m)

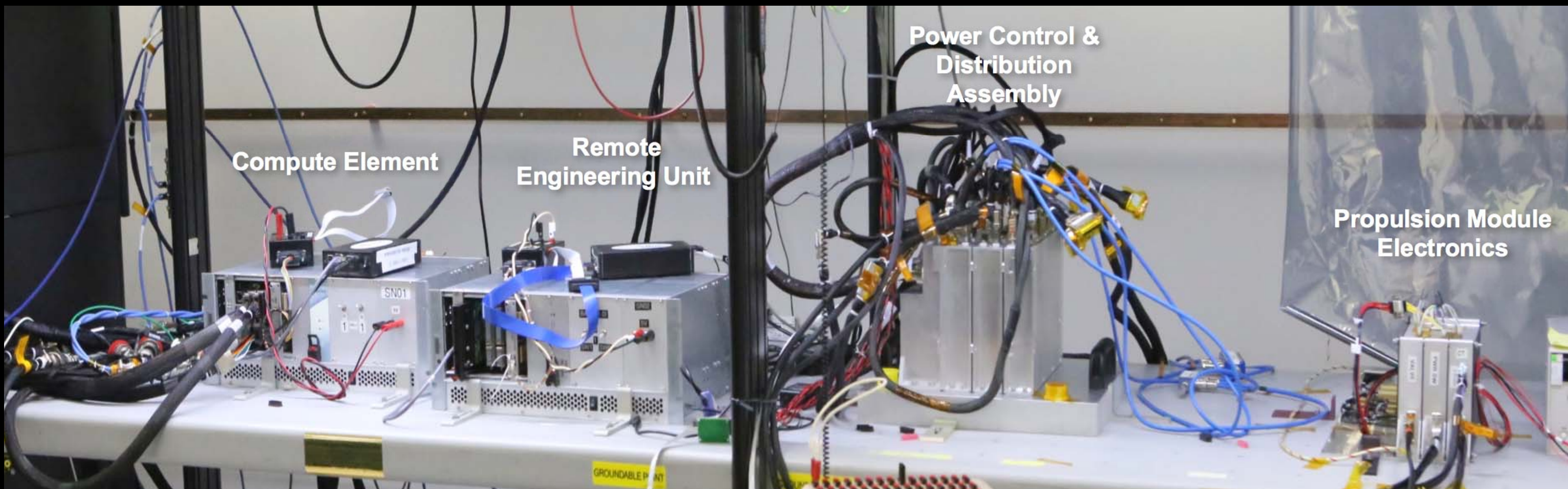
One of Ten!

Significant Hardware Development Progress



Power and Propulsion Module Electronics Prototypes

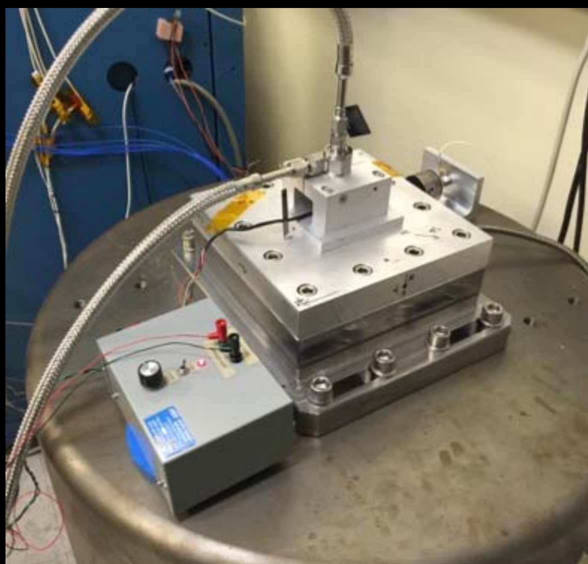
Significant Hardware Development Progress



Prototype Avionics Testbed

(Running Time/Space Partitioned Flight Software)

Significant Hardware Development Progress

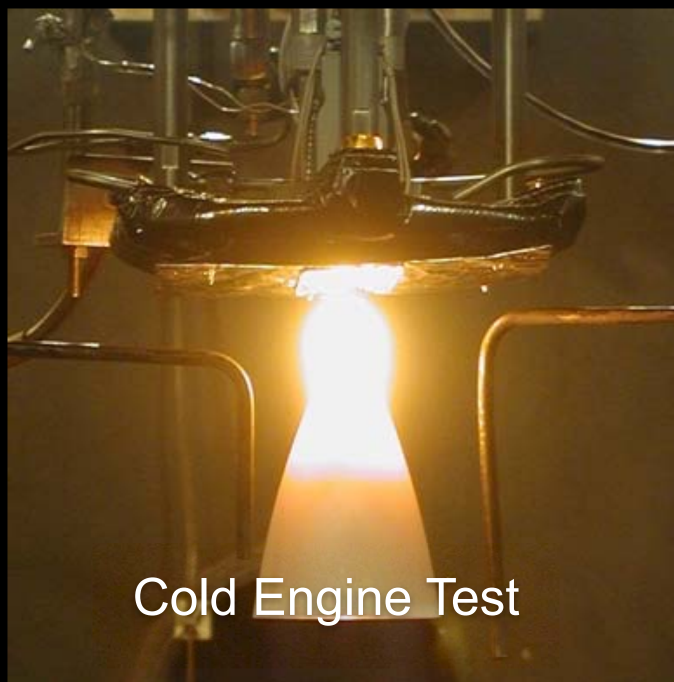


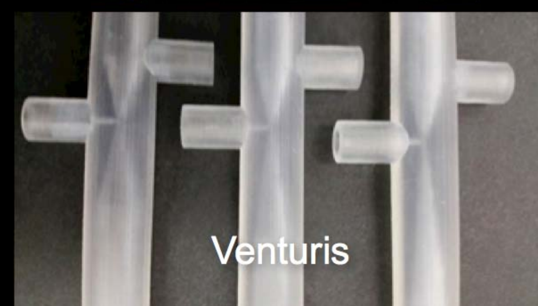
Thermal Pump Microphonics Test

Thermal Pump Life Test (Irradiated CFC-11)

CFC-11 Lifetime Buy

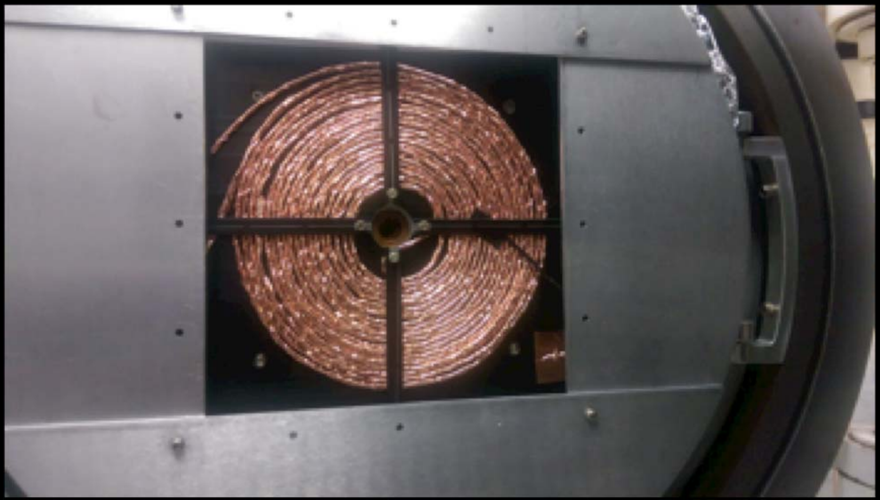
Significant Hardware Development Progress



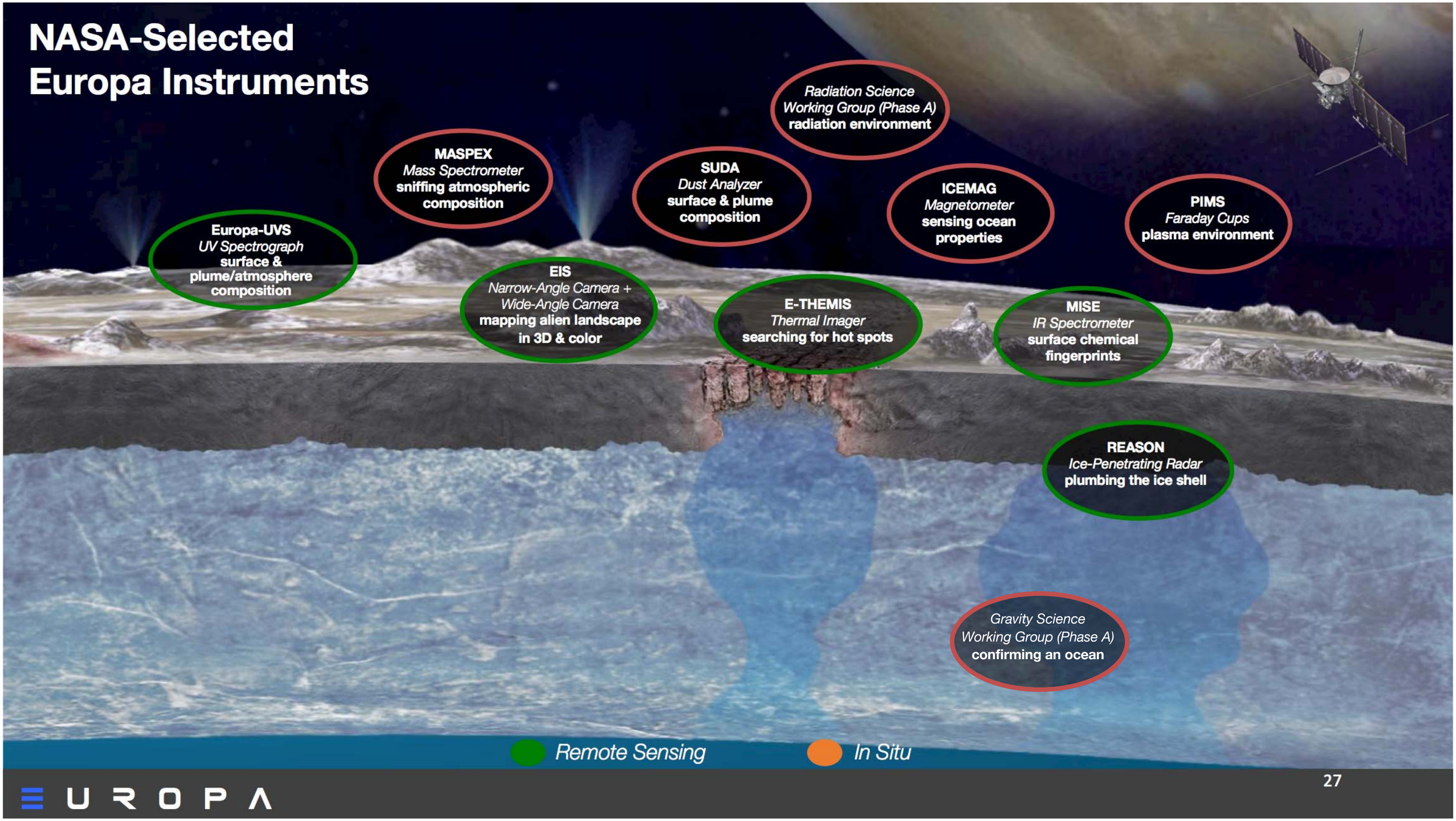


Propulsion Component Tests

Significant Hardware Development Progress



Cable Internal Electrostatic Discharge Testing

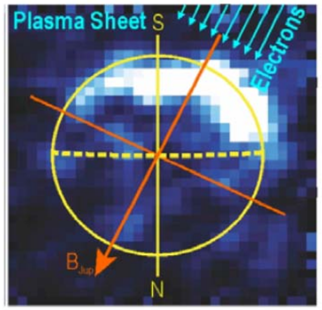

NASA-Selected
Europa Instruments
Radiation Science
Working Group (Phase A)
radiation environment
MASPEX
Mass Spectrometer
sniffing atmospheric
composition
SUDA
Dust Analyzer
surface & plume
composition
ICEMAG
Magnetometer
sensing ocean
properties
PIMS
Faraday Cups
plasma environment
Europa-UVS
UV Spectrograph
surface &
plume/atmosphere
composition
EIS
Narrow-Angle Camera +
Wide-Angle Camera
mapping alien landscape
in 3D & color
E-THEMIS
Thermal Imager
searching for hot spots
MISE
IR Spectrometer
surface chemical
fingerprints
REASON
Ice-Penetrating Radar
plumbing the ice shell
Gravity Science
Working Group (Phase A)
confirming an ocean
Remote Sensing
In Situ
EUROPA

Europa Ultraviolet Spectrograph (Europa-UVS)

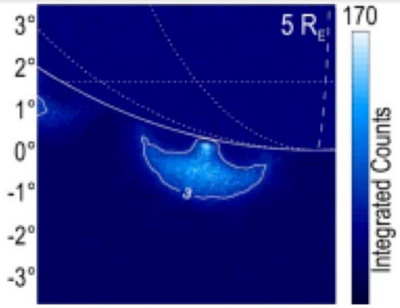
Kurt Retherford, Southwest Research Institute (SwRI), San Antonio

UV

- **Atmosphere:** Composition & chemistry, source & sinks, structure, & variability equator to pole
- **Plumes:** Distribution, structure, composition, and variability of active plumes
- **Surface:** Explore surface composition & microphysics and relation to endogenic & exogenic processes
- **Plasma Environment:** Investigate energy and mass flow into Europa's atmosphere, neutral cloud & plasma torus



Plasma Environment from Oxygen Emissions



Plume Detection and Density Model (high resolution mode)

- Spatial and spectral UV imaging
- High spatial resolution mode allows for imaging of detailed surface and plume structures
- Performs solar and stellar occultations to determine composition

Key instrument Parameters	
Wavelength Range	55 – 210 nm
Spatial Resolution	0.16° (low res); 0.04° (high res) Nyquist sampled
Spectral Resolution	$\lambda/\Delta\lambda$ = 220; <0.6 nm FWHM (point source)
Spectral Cube Size	2048 (spectral) x 512 (spatial)

Europa Imaging System (EIS)

Zibi Turtle, Johns Hopkins U. Applied Physics Laboratory (APL)

VIS

- Constrain the formation of surface features and potential for current activity
- Characterize the ice shell
- Characterize the surface regolith at small scales

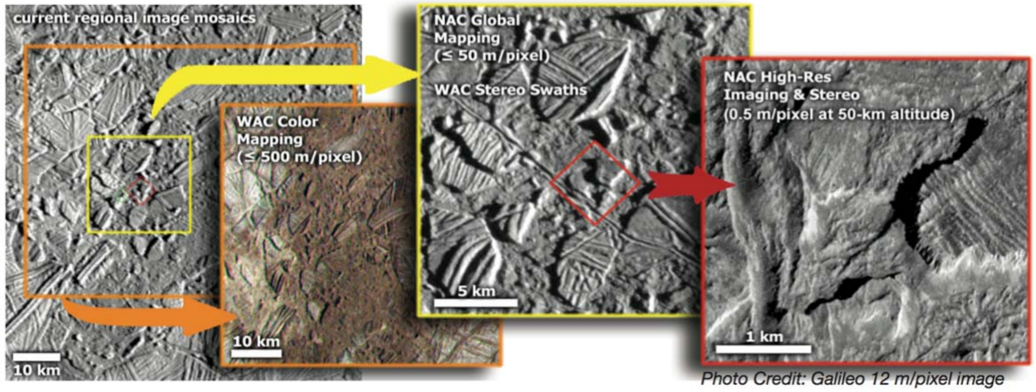


Photo Credit: Galileo 12 m/pixel image

- NAC: high-resolution, stereo imaging, color
- NAC gimbal permits independent targeting, enabling near-global mapping, including stereo, and high-phase observations to search for potential plumes
- WAC: along-track stereo & color context imaging
- WAC supports cross-track clutter characterization for ice-penetrating radar

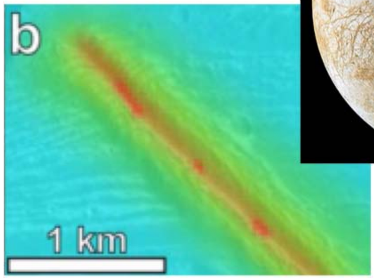
Key Instrument Parameters

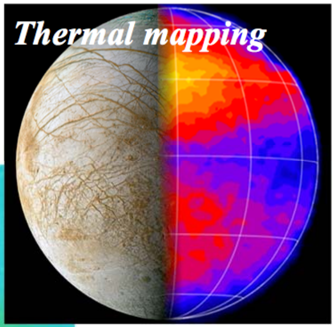
	NAC	WAC
Detector	4096 × 2048 rad-hard CMOS	
Wavelength Range	NEW Panchromatic plus 6 filters (350 – 1050 nm)	
Instantaneous Field of View	10 μrad (0.5 m/pixel at 50 km)	218 μrad (11 m/pixel at 50 km)
Field of View	2.347° × 1.173°	48° × 24°
TDI	Typically ≤18 lines of Time Delay Integration	

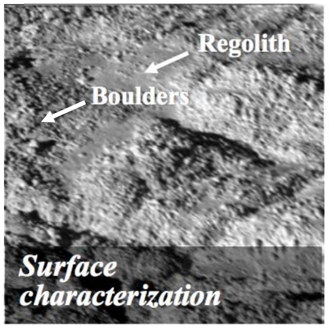
Europa Thermal Imaging System (E-THEMIS)

Philip Christensen, Arizona State University

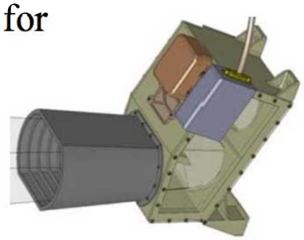
- Detect and characterize thermal anomalies that may indicate recent activity
- Identify active plumes
- Determine the regolith particle size, block abundance and subsurface layering for surface process studies







- High-resolution thermal images
- Uncooled microbolometer array with three spectral channels
- Time-delay integration (TDI) for measuring low temperatures



Key instrument Parameters	
Filters	7–14, 14–28, 28–70 μm
Resolution	5 – 35 m at 25 km range
Image width	5.7° cross-track (720 pixels)
Radiometric Precision	1 K for global-scale observations; 2 K for local-scale observations
Radiometric accuracy	1.25%
Time Delay Integration	16 lines

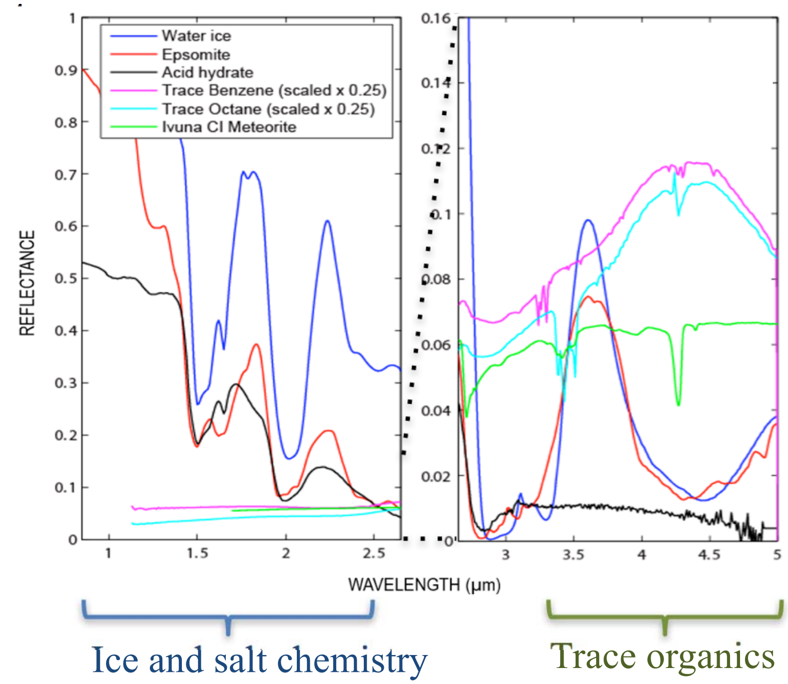
Mapping Imaging Spectrometer for Europa (MISE)

Diana Blaney, Jet Propulsion Laboratory (JPL)

- Assess the habitability of Europa's ocean by understanding the inventory and distribution of surface compounds
- Investigate the geologic history of Europa's surface
- Search for areas that are currently geologically active

Key instrument Parameters	
Wavelength Range	0.8 to 5.0 µm (800 – 5000 nm)
Spatial Resolution	10km/pixel full-disk images at 40,000 km range 25 m/pixel at 100 km range
Spectral Resolution	10 nm
Spectral Cube Size	300 lines x 80 to 300 samples x 451 spectral channels
Cubes Collected	Up to 8 per flyby
Signal-to-noise Ratio	>100:1 from 0.8–2.6 µm, 10:1 between 2.6 and 3.2 µm, >25 from >3.2 µm

Key compounds at MISE spectral resolution and sampling

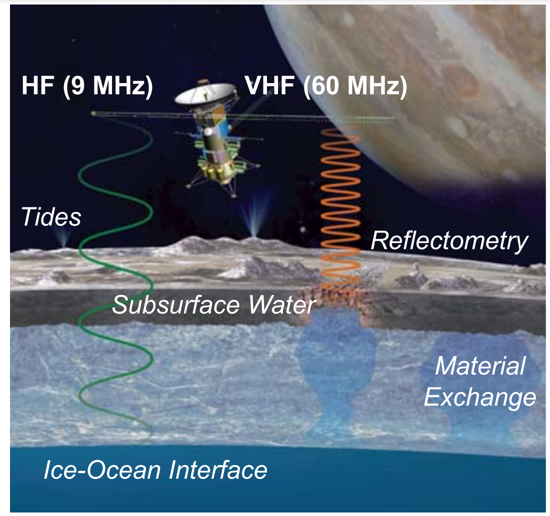


Radar for Europa Assessment and Sounding: Ocean to Near-surface (REASON)

Don Blankenship, University of Texas Institute for Geophysics, Austin

RADAR

- Characterize the distribution of any shallow subsurface water
- Search for an ice-ocean interface and characterize the ice shell's global thermophysical structure
- Investigate the processes governing material exchange among the ocean, ice shell, surface, and atmosphere
- Constrain the amplitude and phase of the tides
- Characterize scientifically compelling sites, and hazards, for a potential future landed mission



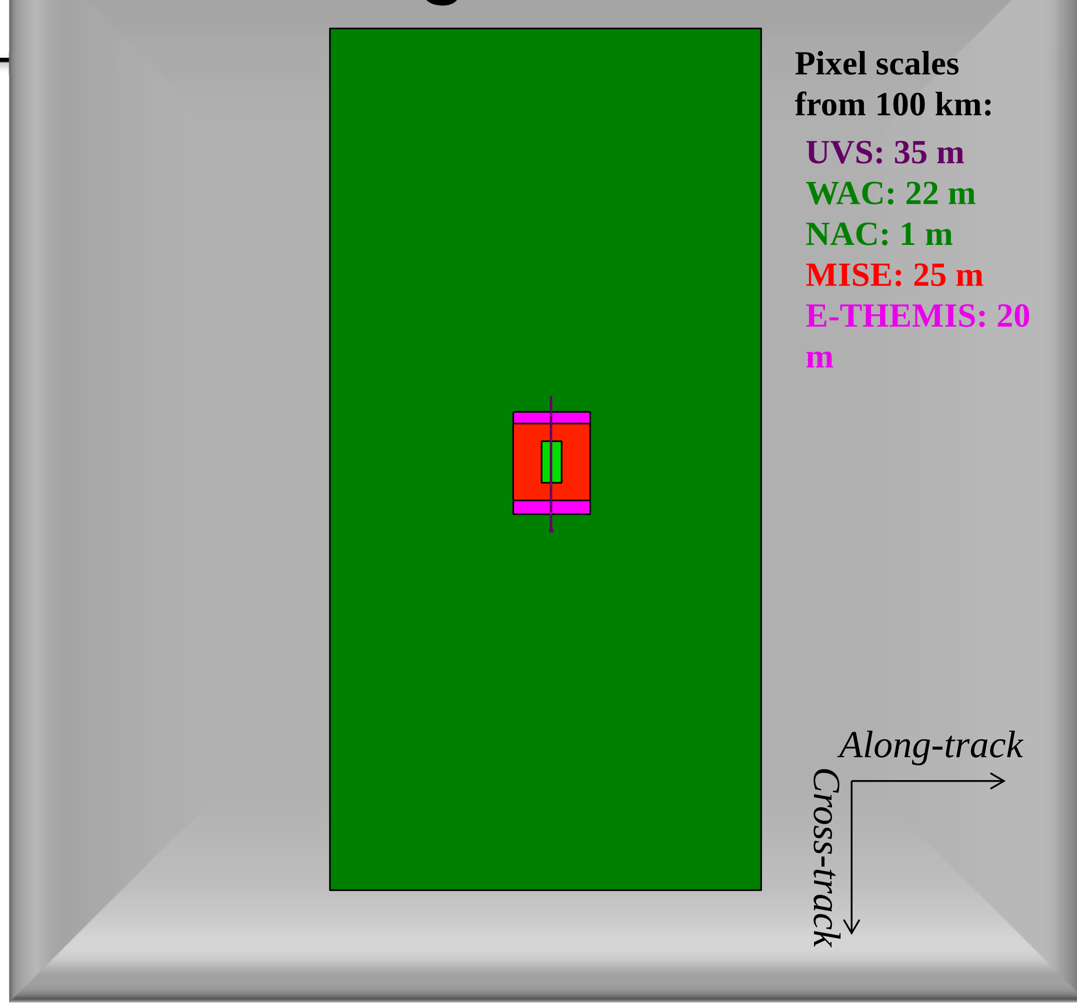
- Simultaneous high resolution, shallow sounding, altimetry, and reflectometry along with lower resolution full-depth sounding of the ice shell and plasma measurements

Key instrument Parameters	
Dual Frequencies	60 MHz (λ = 5 m) Very High Frequency (VHF) globally, and 9 MHz (λ = 33.3 m) High Frequency (HF) anti-Jovian
Vertical Resolution	*Shallow sounding*: VHF with <15 m resolution from depths of 300 m to 3 km; *Full-depth sounding*: VHF or HF with <150 m resolution from 1 to 30km depths; *Altimetry*: VHF with <15m resolution
Antenna	2 deployable HF and 4 VHF dipole antennas mounted on solar array
Radiated Power	10 - 30 W

Europa Remote Sensing Fields of View

- **Europa-UVS:**
  7.3° x 0.1°
  + 0.2° x 0.2°
- **EIS WAC:**
  48° x 24°
- **EIS NAC:**
  2.35° x 1.17°
- **MISE:**
  4.3°x 0.86 to 4.3°
- **E-THEMIS:**
  5.7° x 4.3°
- **REASON: 60°**

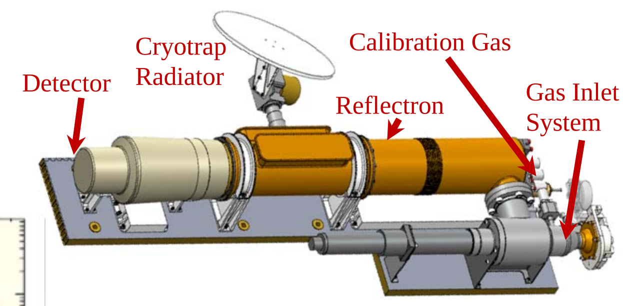
Note: Pushbroom imaging by EIS, UVS, E-THEMIS, REASON, and (at times) MISE enable arbitrary image lengths along-track (nadir at C/A)

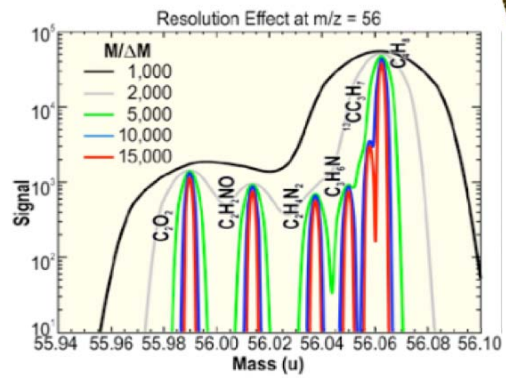


MAss Spectrometer for Planetary EXploration (MASPEX)

Jack "Hunter" Waite, Southwest Research Institute (SwRI), San Antonio

- Determine the distribution of major volatiles and key organic compounds in Europa's exosphere/plumes and their association with geological features (H_2O, H_2 , CH_4, C_2H_4, C_2H_6, HCN, $H_2O/^{40}Ar$)
- Determine the relative abundances of key compounds to constrain the chemical conditions of Europa's ocean





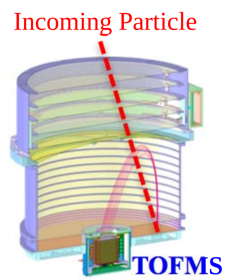
- Multi-bounce time-of-flight mass spectrometer
- Region-of-Interest scanning for high resolution over a broad mass range
- Cryotrap allows storage for high-resolution analysis at apoapse (for trace organics and ^{40}Ar)

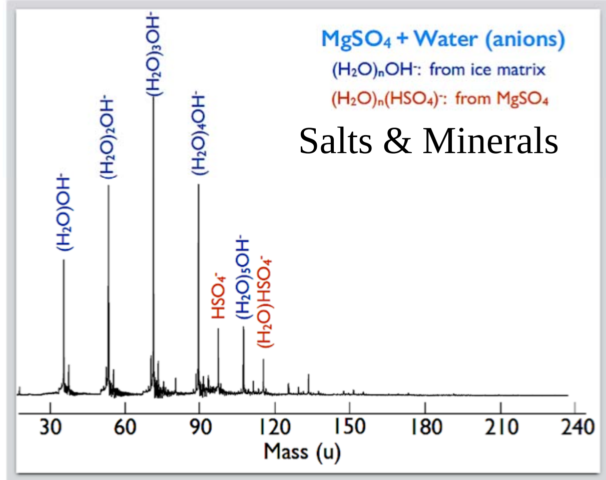
Key instrument Parameters Capability (Driving Requirements)	
Mass Range	2 – 1000 u
Mass Resolution	m/△m up to 24,500
Dynamic range	10^{10}
Min. Density	$5x10^5/m^3$

SUrface Dust Analyzer (SUDA)

Sascha Kempf, U. Colorado, Boulder

- Map the surface composition of Europa
- Characterize the alteration of Europa's surface via exogenous dust
- Determine the composition of the particulate matter in active plumes





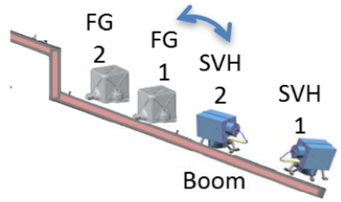
- Time-of-flight mass spectrometer (TOFMS)
- Composition of particles ejected from surface can be correlated with geologic features
- Trace amounts of complex organics can be detected in ice grains (better than 0.1 ppm)

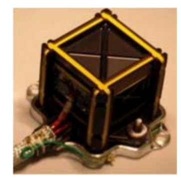
Key instrument Parameters	
Mass Resolution	$m/\Delta m \geq 200$ for $m \leq 150$ u
Dust Grain Properties	Impact Speed Range: 0.5 – 10 km/s ($\Delta \leq 1\%$) Charge Sensitivity $\geq$ 0.15 fC ($\Delta \leq 10\%$) Grain Size Range: 0.2 – 10 µm ($\Delta \leq 25\%$)
Surface Resolution	Better than spacecraft altitude
Detection Limits	40 ejecta per second

Interior Characterization of Europa using Magnetometry (ICEMAG)

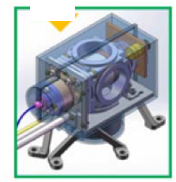
Carol Raymond, Jet Propulsion Laboratory (JPL)

- Determine the location, thickness, and salinity of Europa's ocean by magnetic field induction at multiple frequencies
- Identify sources of Europa's atmosphere and atmospheric loss processes by characterizing any active vents, plumes, and ionized plasma trails
- Understand coupling of Europa to Jupiter's ionosphere, and coupling of plumes to flowing plasma

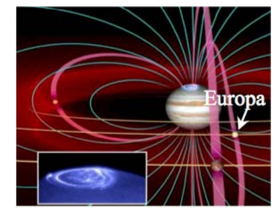




2 x Flux Gate (FG): vector



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



ICEMAG will characterize the complex magnetic environment at Europa

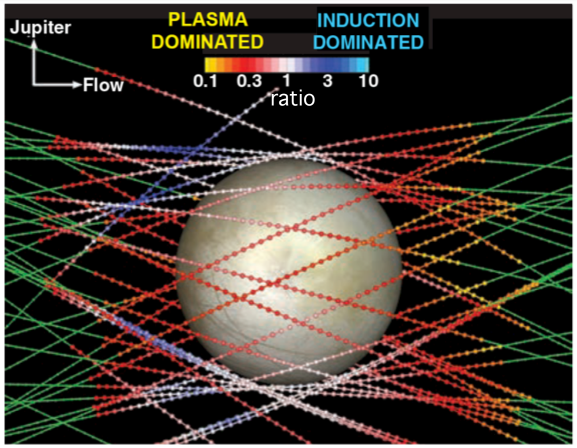
- Combines flux gate magnetometers & self-calibrating helium magnetometers
- Performs dynamical removal of the fluctuating spacecraft field, relaxing magnetic cleanliness requirement
- No need for special spacecraft maneuvers for calibration

Key instrument Parameters	
Vector magnetic field accuracy	< 0.8 nT
Range	± 1500 nT
Precision	0.01 nT
Baseline stability	< 0.1 nT over > 3 yr
Spacecraft magnetic field knowledge	< 0.5 nT
Sampling rate	16 samples / sec

Plasma Instrument for Magnetic Sounding (PIMS)

Joseph Westlake, Johns Hopkins U. Applied Physics Laboratory (APL)

- Determine Europa's magnetic induction response, corrected for plasma contributions, to estimate ocean salinity and thickness
- Understand mechanisms of weathering and releasing material from Europa's surface into the atmosphere
- Understand how Europa influences its local space environment and Jupiter's magnetosphere



Plasma near Europa has a strong contribution to the observed magnetic field and masks the induction response from the subsurface ocean.

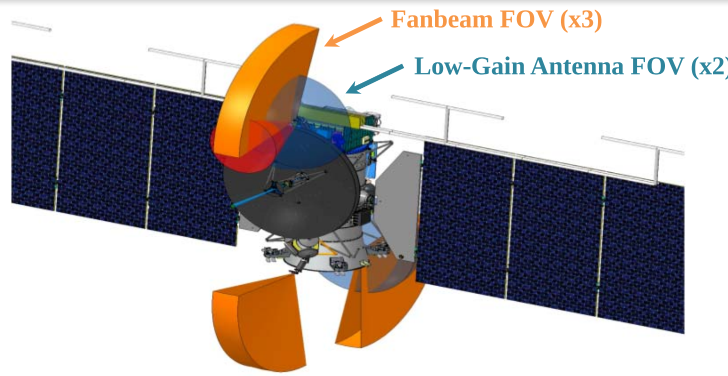
- 2 sensors, each with 2 Faraday Cups with 90° fields of view
- Instruments measure:
  – ion density, temperature, & velocity
  – electron density & temperature
- Sensors are immune to degradation and background noise from penetrating radiation

Key instrument Parameters	
Ion Energy Range	0.1 – 50 eV, 0.02 – 7 keV
Electron Energy range	0.1 – 50 eV, 0.01 – 2 keV
Energy Resolution	<15%
Sensitivity	0.5 – 10^5 pA/cm^2
Time Resolution	1 – 4 s

Gravity Science Investigation

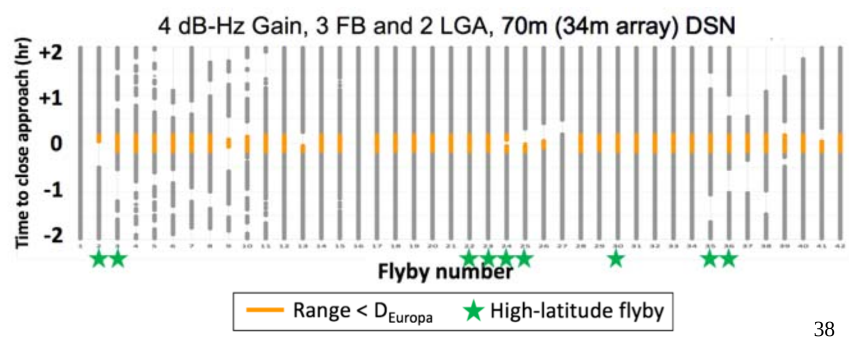
Sean Solomon, Chair, Gravity Science Working Group, for Phase A

- Characterize Europa's time-varying gravitational tides (k_2)
- Confirm the existence of Europa's subsurface ocean
- In combination with radar altimetry (h_2), constrain ice shell thickness



- Three Fixed Fanbeam (FB) antennas, plus utilizes two low-gain antennas (LGAs) to fill in coverage esp. for high-latitude fly-bys
- X-band up & down
- Radio Science Receivers used at DSN
- Opportunities for arraying DSN antennas and augmenting DSN with ESA antennas
- Non-intrusive with the suite of science instruments during flyby

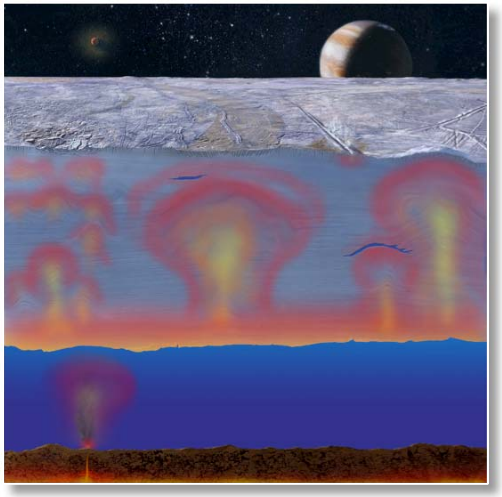
Key Parameters	
Gain	4 - 10 dB-Hz min @D/L
Fanbeam FOV	±15˚ by ±50˚
Resolution	0.07 mm s^{-1} (60 s integration time)



Europa Mission Science Objectives (1/3):
Ice Shell & Ocean

- ***Ice Shell & Ocean Objective:***
  Characterize the ice shell and any subsurface water, including their heterogeneity, ocean properties, and the nature of surface-ice-ocean exchange

- ***Ice Shell & Ocean Investigations:***
  - Characterize the distribution of any shallow subsurface water and the structure of the icy shell *[EIS, REASON]*
  - Determine ocean salinity and thickness *[ICEMAG, MISE, PIMS, SUDA]*
  - Constrain the regional and global thickness, heat-flow, and dynamics of the ice shell *[E-THEMIS, EIS, Gravity, ICEMAG, PIMS, REASON]*
  - Investigate processes governing material exchange among the ocean, ice shell, surface, and atmosphere [*EIS, ICEMAG, MASPEX, MISE, REASON, SUDA]*



Europa Mission Science Objectives (2/3): *Composition*

- ***Composition Objective:***
  Understand the habitability of Europa's ocean through composition and chemistry

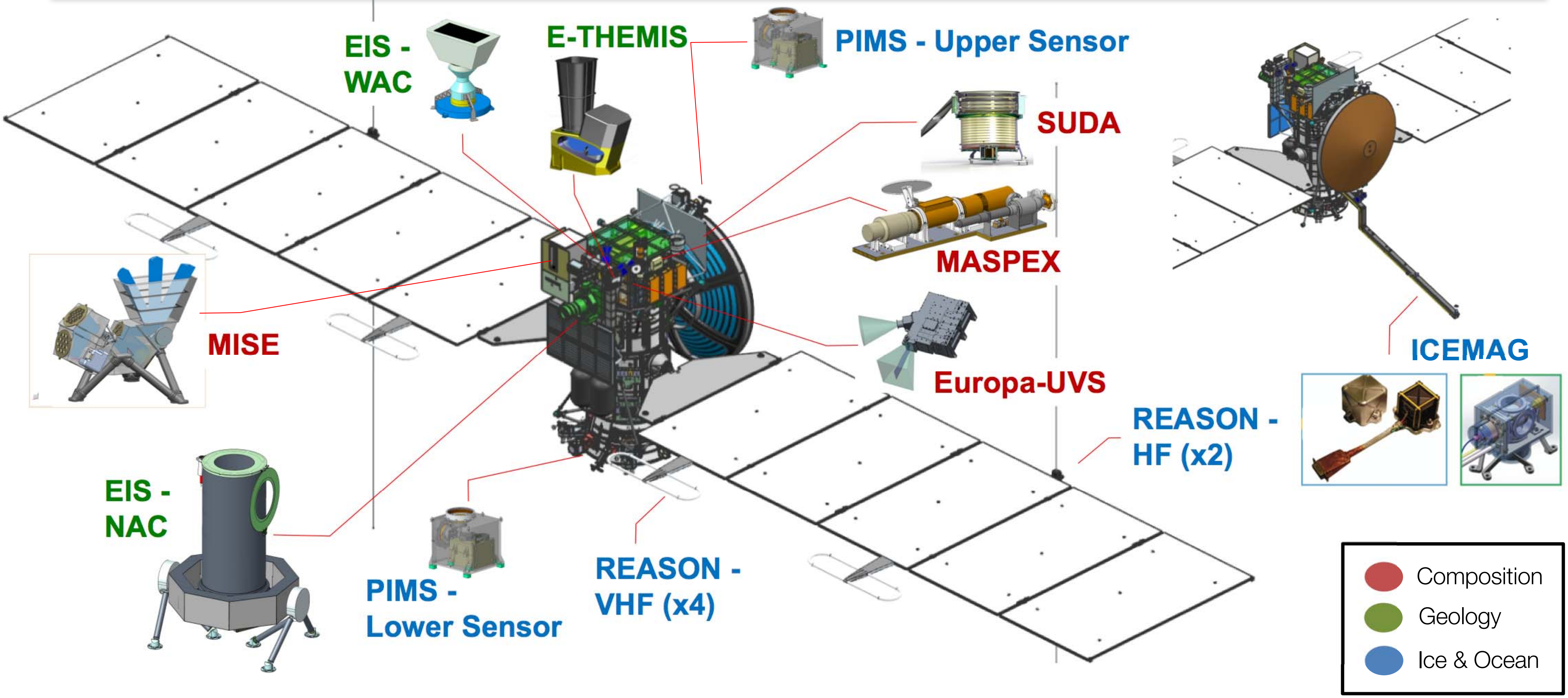
- ***Composition Investigations:***
  - Characterize the composition and chemistry of endogenic materials on the surface and in the atmosphere, including potential plumes *[EIS, Europa-UVS, ICEMAG, MASPEX, MISE, PIMS, REASON, SUDA]*
  - Determine the role of the radiation and plasma environment in creating and processing the atmosphere and surface materials *[EIS, Europa-UVS, MASPEX, MISE, PIMS, Radiation, REASON, SUDA]*
  - Characterize the chemical and compositional pathways in the ocean *[EIS, ICEMAG, MASPEX, MISE, SUDA]*

Europa Mission Science Objectives (3/3): *Geology*

- ***Geology Objective:***
  Understand the formation of surface features, including sites of recent or current activity, and characterize high science interest localities

- ***Geology Investigations:***
  - Determine sites of most recent geological activity, including potential plumes, and characterize localities of high science interest and potential future landing sites *[E-THEMIS, EIS, Europa-UVS, MASPEX, MISE, PIMS, Radiation, REASON, SUDA]*
  - Determine the formation and three-dimensional characteristics of magmatic, tectonic, and impact landforms *[EIS, REASON]*
  - Investigate processes of erosion and deposition and their effects on the physical properties of the surface *[E-THEMIS, EIS, Europa-UVS, PIMS, Radiation, REASON, SUDA]*

Europa Clipper Payload



Europa Science Team

PIs, Co-Is, Phase-A Working Groups, Project Science (133 total)

Oleg Abramov	Paul Feldman	Randy Kirk	Wes Patterson	James Slavin
Amy Barr Mlinar	Leigh Fletcher	Margaret Kivelson	Carol Paty	David Smith
Bruce Bills	Yonggyu Gim	Rachel Klima	Cynthia Phillips	Todd Smith
Jordana Blacksberg	Randy Gladstone	Wlodek Kofman	Sylvain Piqueux	Jason Soderblom
Diana Blaney	Thomas Greathouse	Peter Kollmann	Jeff Plaut	Krista Soderlund
Don Blankenship	Robert Green	Haje Korth	Dirk Plettemeier	Sean Solomon
Scott Bolton	Cyril Grima	William Kurth	Frank Postberg	John Spencer
Christelle Briois	Eberhard Gruen	Yves Langevin	Louise Prockter	Ralf Srama
Tim Brockwell	Murthy Gudipati	Jonathan Lunine	Lynnae Quick	Andrew Steffl
Lorenzo Bruzzone	Dennis Haggerty	Jean-Luc Margot*	Julie Rathbun	Alan Stern
Bruce Campbell	Kevin Hand	Marco Mastrogiuseppe	Trina Ray	Michael Stevens
Bob Carlson	Candy Hansen	Erwan Mazarico	Carol Raymond	Robert Strangeway
Lynn Carter	Alex Hayes	Tom McCord	Kurt Retherford	Ben Teolis
Tony Case	Paul Hayne	Alfred McEwen	James Roberts	Nick Thomas
Tim Cassidy	Matt Hedman	Melissa McGrath	Andrew Romero-Wolf	Gabriel Tobie
Phil Christensen	Alain Herique	Bill McKinnon	Lorenz Roth	Zibi Turtle
Roger Clark	Karl Hibbitts	Ralph McNutt	Chris Russell	Steve Vance
Corey Cochrane	Mihaly Horanyi	Mike Mellon	Abigail Rymer	Hunter Waite
Geoff Collins	Howett, Carly	Jeff Moore	Joachim Saur	Mike Watkins
Kate Craft	Terry Hurford	Olivier Mousis	Juergen Schmidt	Ben Weiss
Brad Dalton	Hauke Hussmann	Alina Moussessian	Britney Schmidt	Joe Westlake
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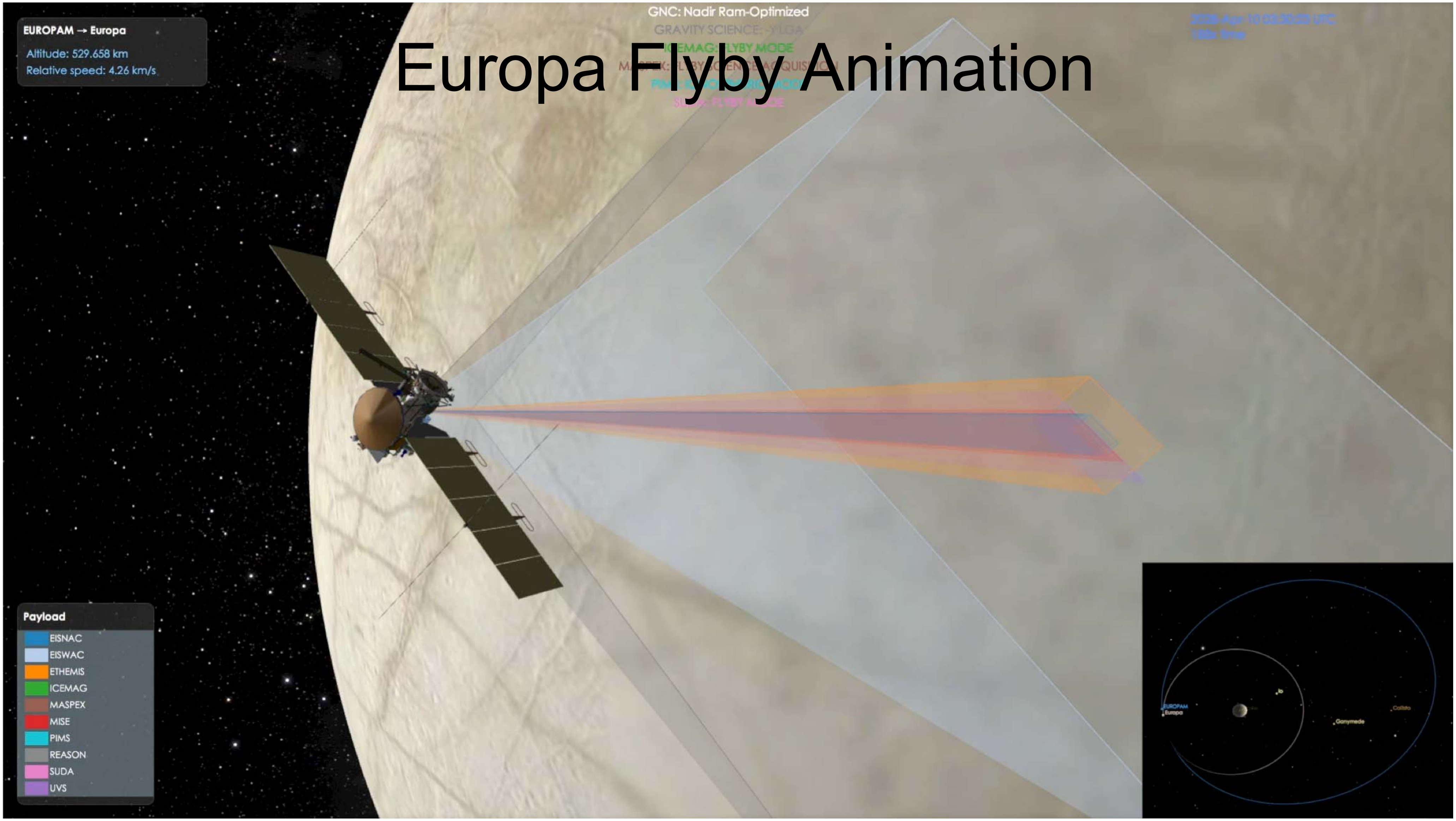
Ashley Davies	Steven Joy	Neil Murphy	Frank Seelos	Duncan Young
Serina Diniega	Insoo Jun	Francis Nimmo	Dave Senske	Cary Zeitlin
Scott Edgington	Justin Kasper	Bob Pappalardo	Mark Sephton	Mikhail Zolotov
Charles Elachi	Sascha Kempf	Chris Paranicas	Everett Shock	Maria Zuber
Carolyn Ernst	Krishan Khurana	Ryan Park*		

*Phase-B consultant

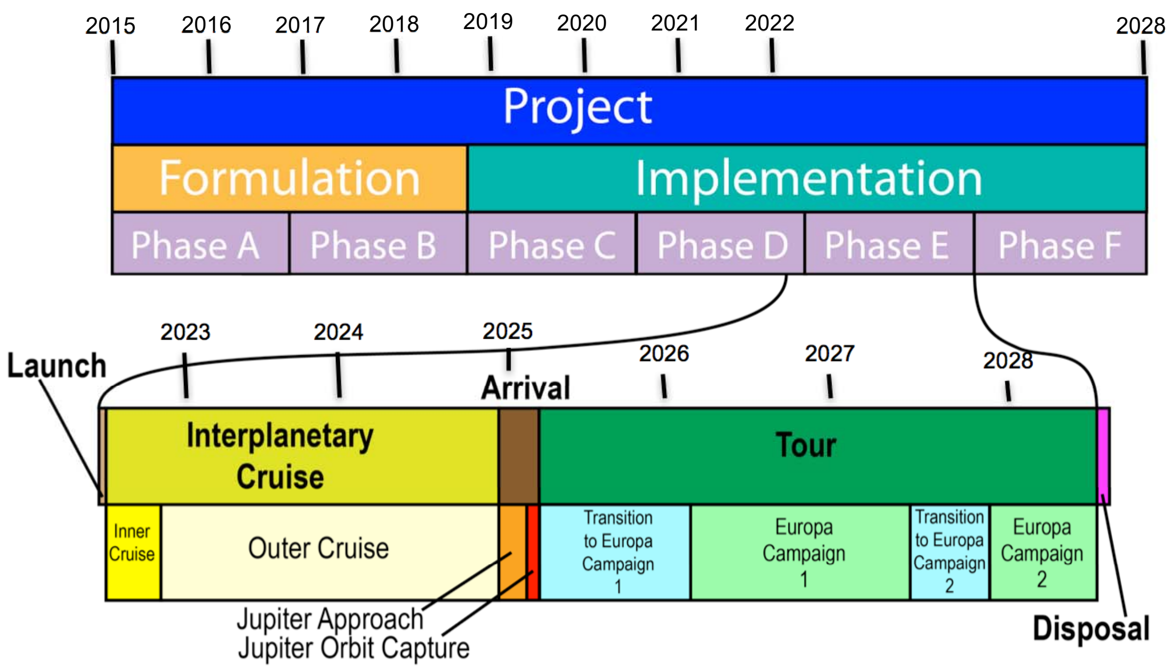
Europa Flyby Animation

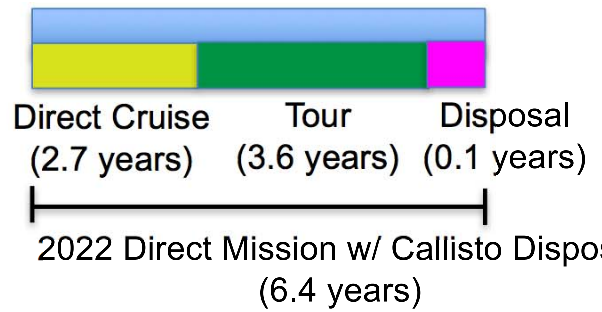


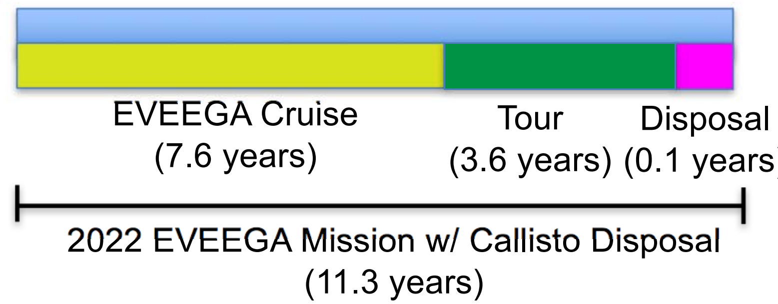

MSFC ★ KSC ★ ASU ★ UTIG
SWRI ★ CU-LASP ★ GSFC
EUROPA
CLIPPER
JPL ★ NASA ★ APL

Backup

Mission Timeline, Phases & Events







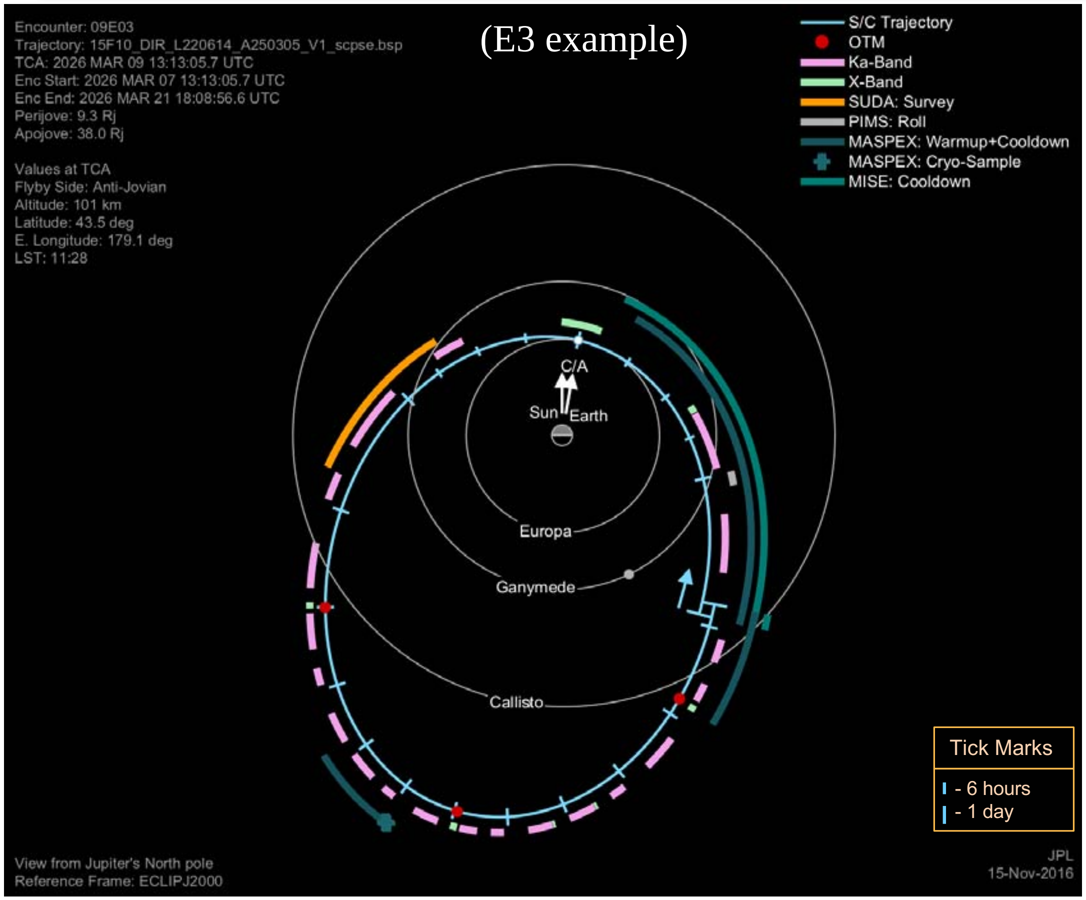
Derived Requirements

- [RQ102.123] Minimum FS Lifetime (Flight System) – 11.3 years
- [RQ102.119] Maximum Mission Duration (Mission) – 11.3 years
- [RQ102.100] Minimum SC Lifetime (Spacecraft) – 11.3 years
- [RQ102.123] Maximum Trajectory Duration (FS Planned Traj)
- [RQ102.089] Flight System Disposal Duration (FS Planned Traj)

TID Comparison (GIRE2p)

*EOM defined as the last Europa encounter before disposal

Europa Encounter Overview



Start:
E3 Encounter starts at E3 C/A-2 days

End:
E3 Encounter ends at E4 C/A-2 days

Duration: 14.2 days

Major Activities:
- Europa science acquisition
- Ongoing ICEMAG and PIMS environmental monitoring
- SUDA Survey
- Episodic calibration
- Decontaminations
- Playback and BDS maintenance
- OTMs, OPNAV
- RWA biasing (prior to approach OTM and during Departure)
- Ephemeris Update

Communications/Tracking:
- 34m @ ~50% duty cycle
- FBx and LGAx (X-band) for gravity science
- FBx (X-band) for OTMs
- HGA (X-band) for final contact prior to C/A
- HGA (Ka-band) with RWA control
- One ΔDOR pair/encounter

Model Scope

Europa Contamination Event Tree