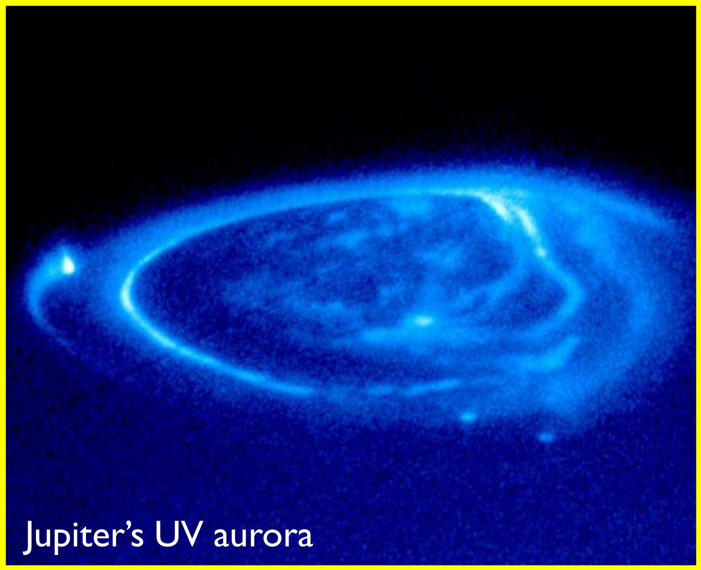
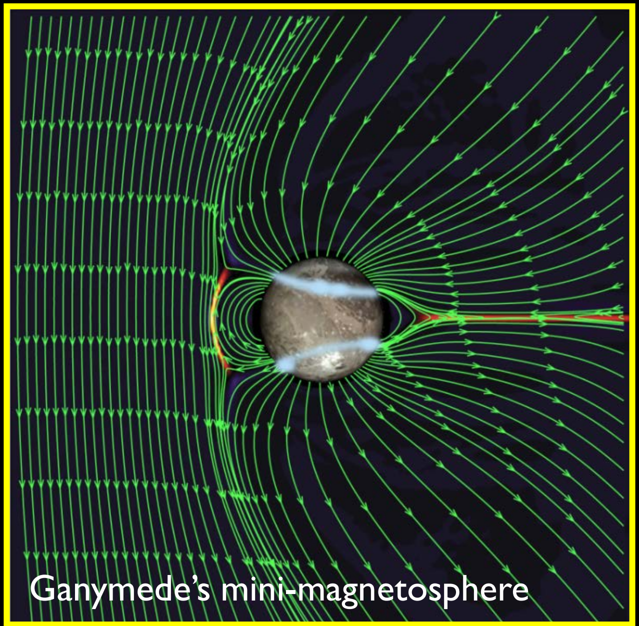
JUpiter ICy Moons Explorer (JUICE)

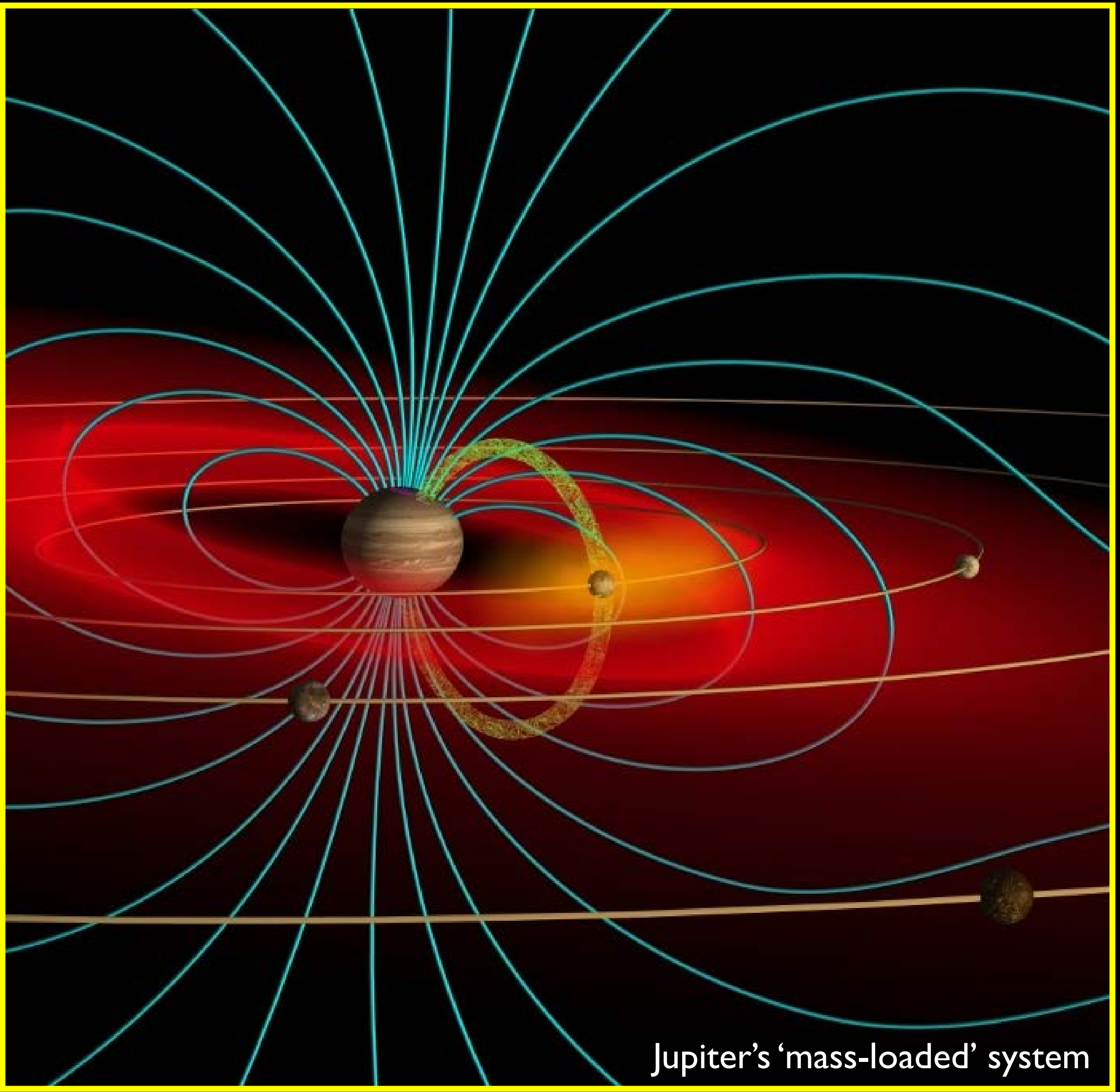
Mission Overview

Christian Erd

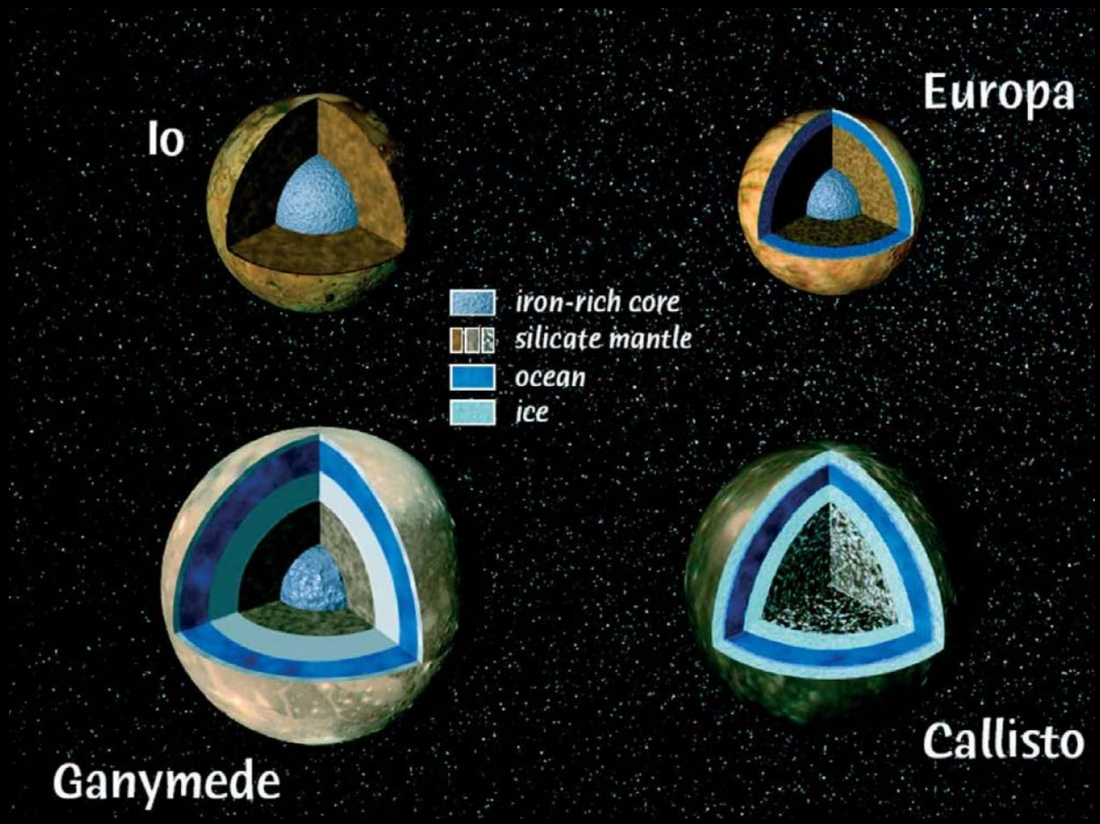
Jupiter’s Magnetosphere







JUICE Brief Science Summary



Europa

- A deep ocean
- An active world?
- Best example of liquid environment in contact with silicates

Ganymede

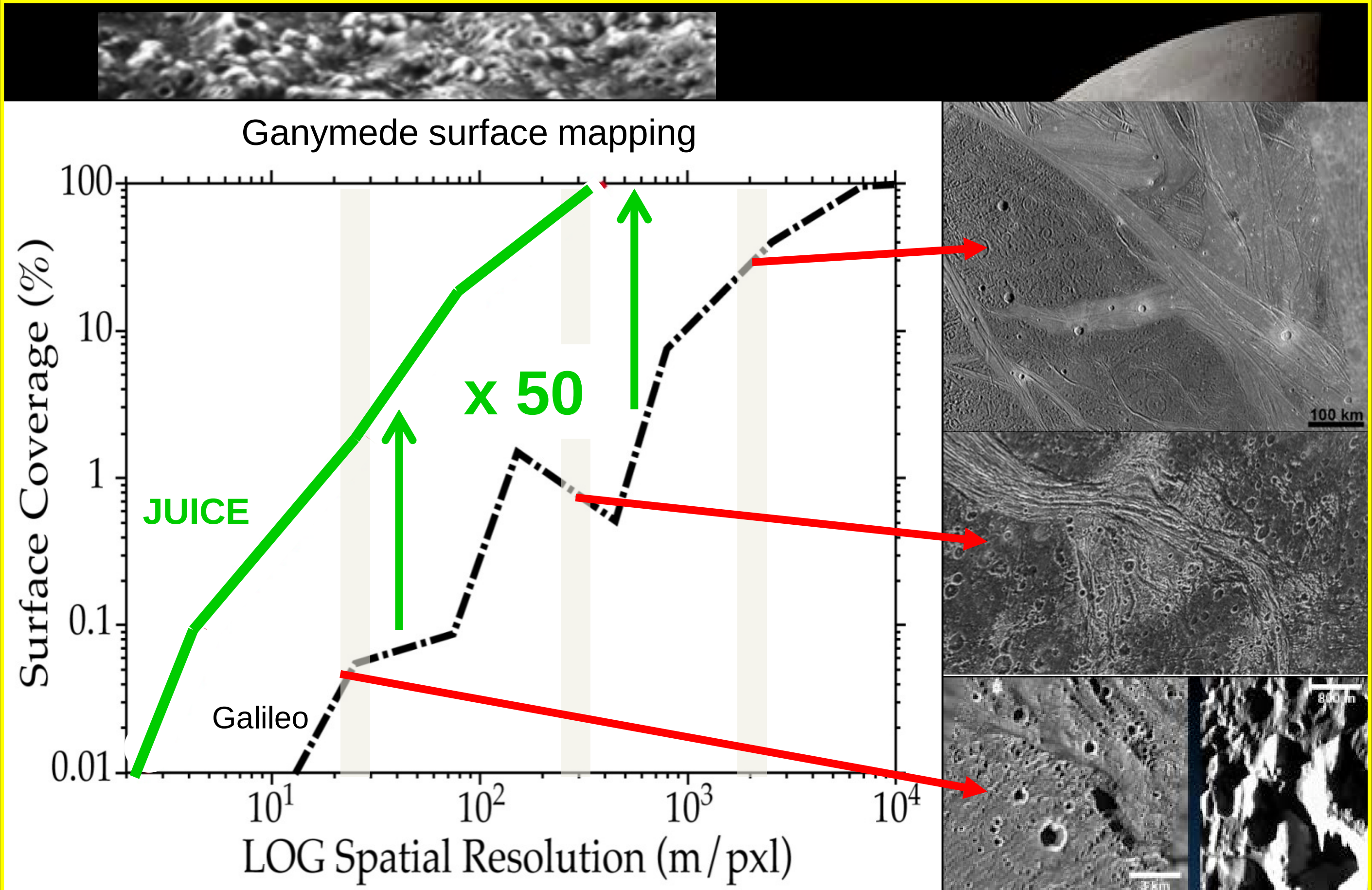
- Largest satellite in the solar system
- A deep ocean
- Internal dynamo and an induced magnetic field – unique
- Richest crater morphologies
- Archetype of waterworlds
- Best example of liquid environment trapped between icy layers

Callisto

- Best place to study the impactor history
- Differentiation – still an enigma
- Only known example of non active but ocean-bearing world
- The witness of early ages

Characterise Ganymede as a planetary object and possible habitat

3. Formation of surface features and search for past and present activity



Bright terrain: Rift-like tectonism, icy volcanism

Measurements

- Global imaging at 200-400 m/px
- High Resolution target areas
- Topography/ morphology
- Subsurface exploration
- Compositional relationships

Instrument Packages

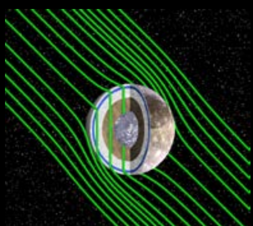
- Imaging
- Spectrometers
- Sounders

Explore Europa recently active zones

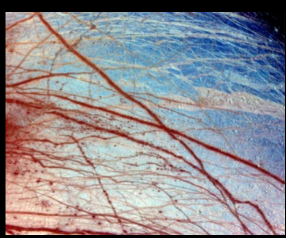
Flyby strategy:

- In-situ observations
- Imaging
- Infrared observations
- Ice penetrating radar
- altimetry

Will result in :

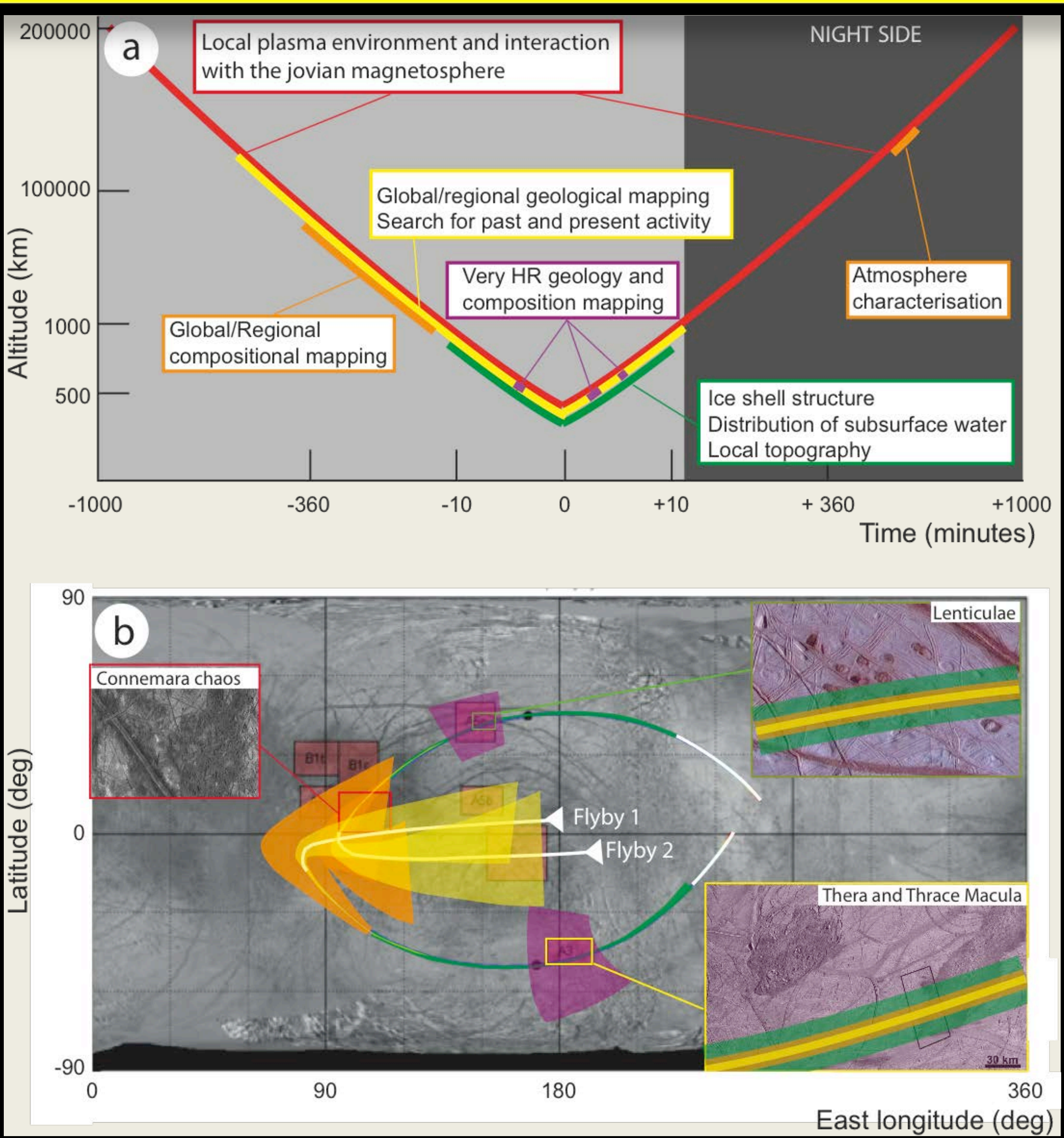


Characterisation of induced field



Composition and geology of areas of high interest

First subsurface exploration of recently active regions

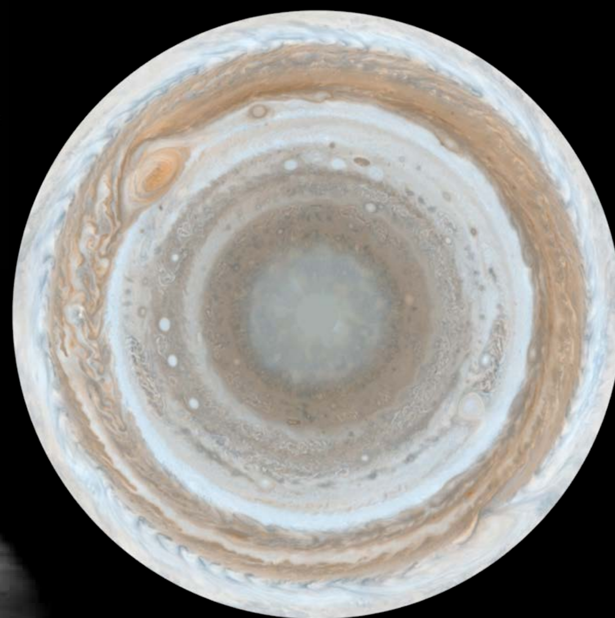


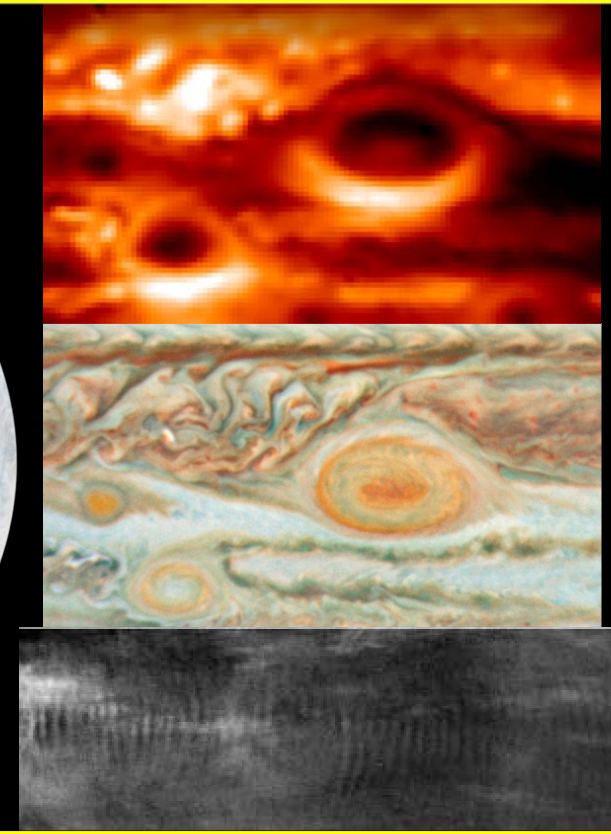
Europa

Year	2030	2031	2032	2033

Explore the Jupiter system as an archetype for gas giants

Characterise the Jovian atmosphere



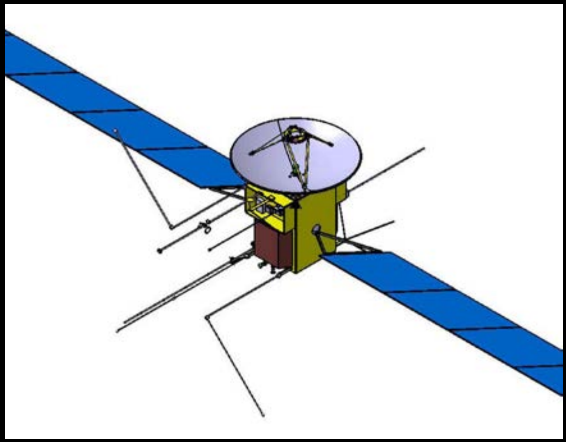


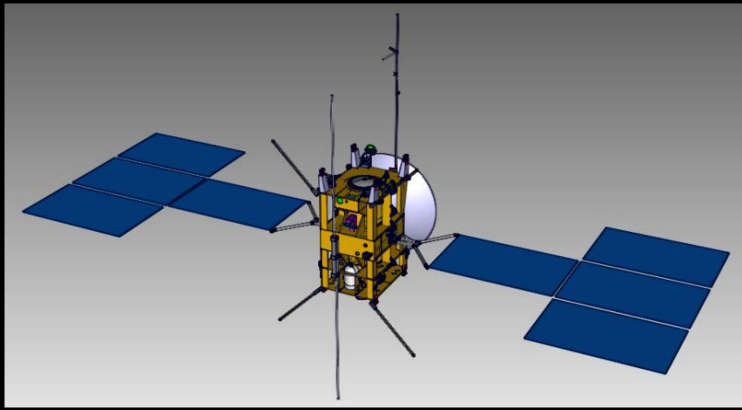
JUICE OBJECTIVES

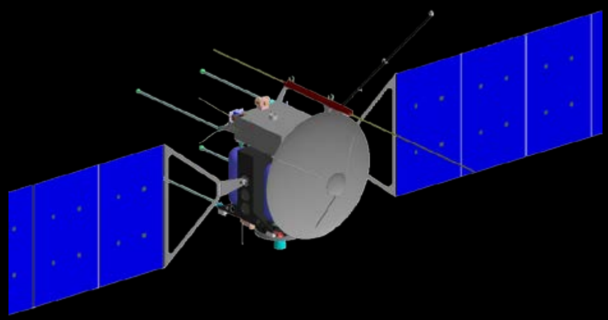
- Characterise the atmospheric dynamics and circulation
- Characterise the atmospheric composition and chemistry
- Characterise the atmospheric vertical structure

JUICE Spacecraft Summary

- Dry mass ~1900 kg, propellant mass ~2900 kg
- High Δv required: 2600 m/s
- Model payload 104 kg, ~120 – 150 W
- 3-axis stabilized s/c
- Power: solar array 60 – 70 m^2, 640 – 700 W
- HGA: >3 m, fixed to body, X & Ka-band
- Data return >1.4 Gb per 8 h pass, goal 4 Gb (1 ground station)

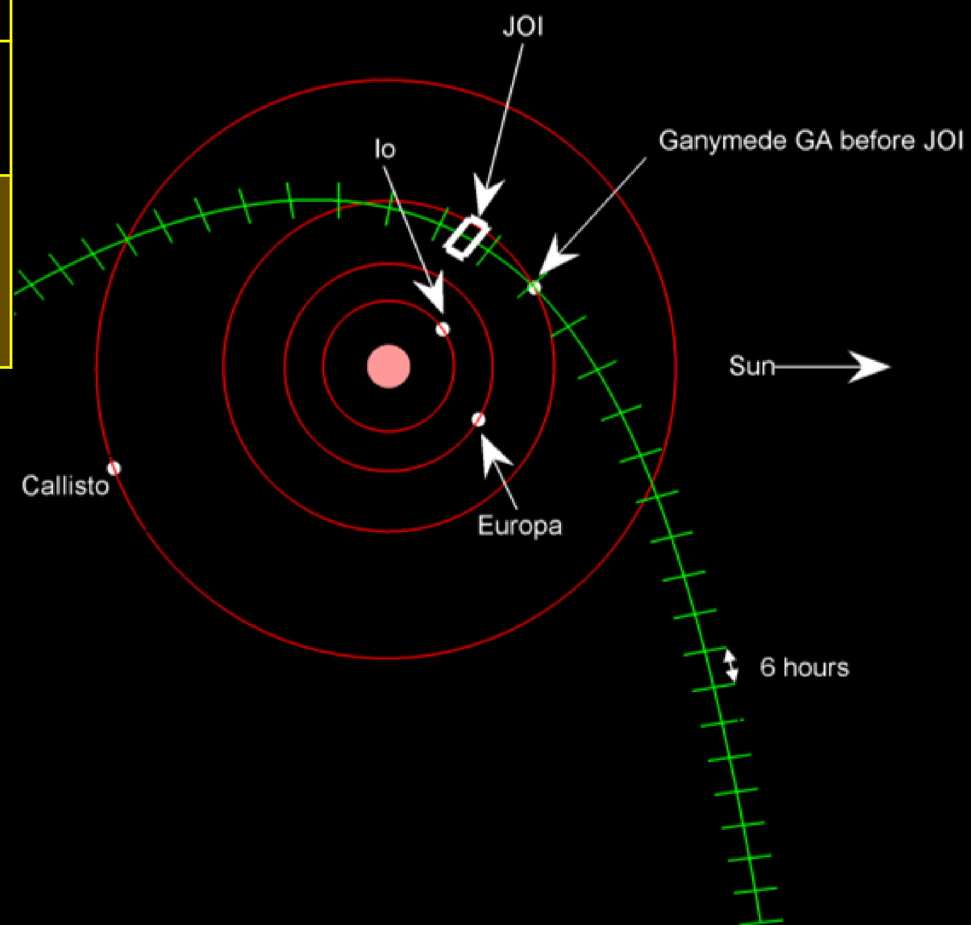






JUICE Mission Profile

Launch	June 2022 (August 2023)
Interplanetary transfer (Earth-Venus-Earth-Earth)	7.6 years (8 years)
Jupiter orbit insertion and apocentre reduction with Ganymede gravity assists	11 months



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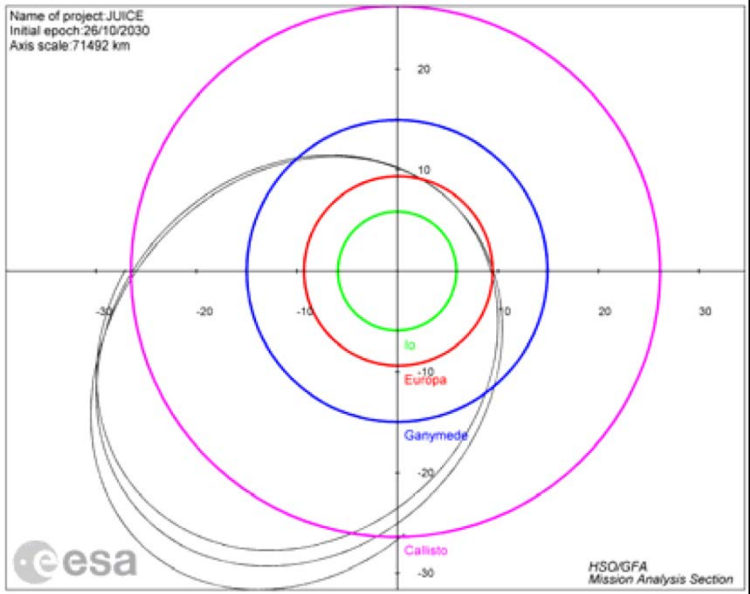

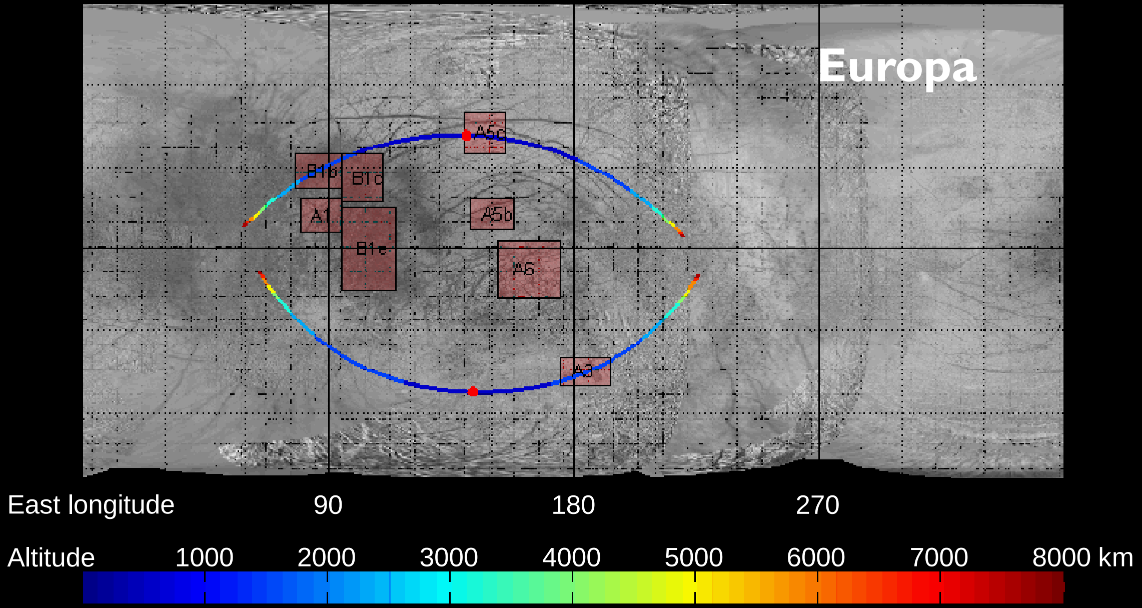

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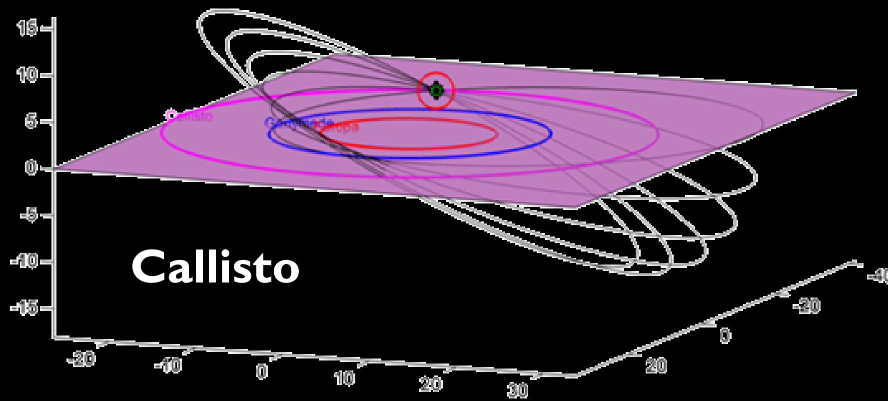
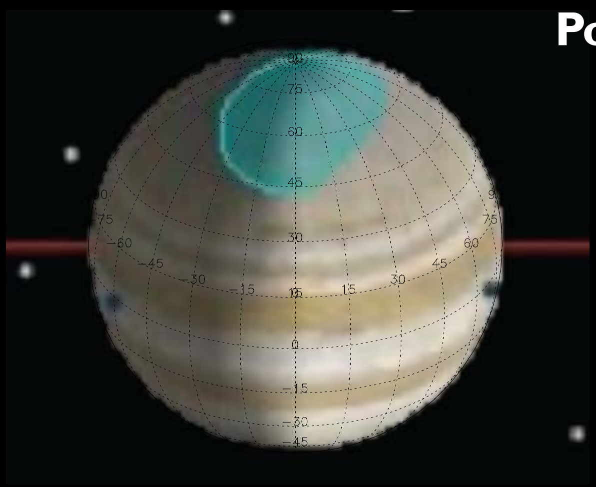
Reduction of v_{inf} (Ganymede, Callisto)	60 days
Increase inclination with 10 Callisto gravity assists	200 days



Jupiter Pole



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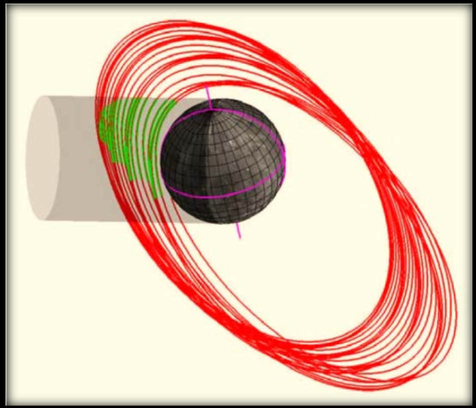
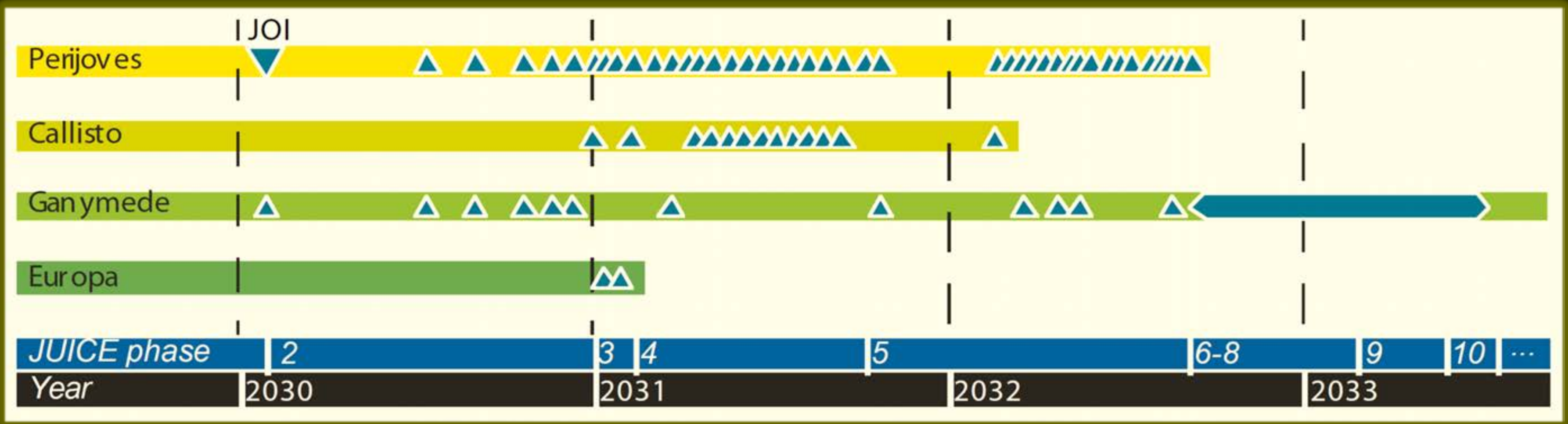
Callisto to Ganymede	11 months
Ganymede (polar) 10,000x200 km & 5000 km 500 km circular 200 km circular	 150 days 102 days 30 days
Total mission at Jupiter	3 years



JUICE Mission Profile

Mission Profile | Spacecraft Design | Technical implementation



JUICE Model Payload

Mission Profile | **Spacecraft Design** | Technical implementation

Total mass: 104 kg

Imaging	
Narrow Angle Camera (NAC)	10 kg
Wide Angle Camera (WAC)	4.5 kg

In situ Fields and Particles	
Magnetometer (MAG)	1.8 kg
Radio and Plasma Wave Instr. (RPWI)	11.2 kg
Particle and Plasma Instr. - Ion Neutral Mass Spectr. (PPI-INMS)	18.2 kg

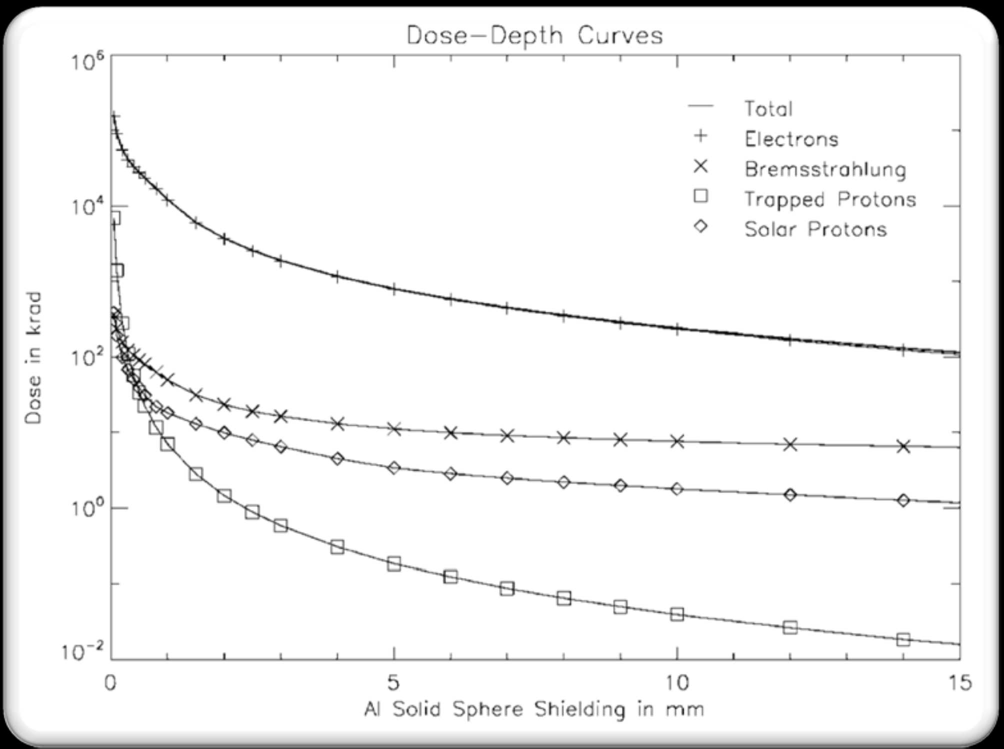
Spectroscopy	
Visible Infrared Hyperspectral Imaging Spectrometer (VIRHIS)	17 kg
UV Imaging Spectrometer (UVIS)	6.5 kg
Sub-mm Wave Instrument (SWI)	9.7 kg

Sounders & Radio Science	
Laser Altimeter (LA)	11 kg
Ice Penetrating Radar (IPR)	10 kg
Radio Science Instrument (JRST+USO)	4 kg

Model payload is based on heritage: BepiColombo, Juno, Mars Express, Double Star, Venus Express, Rosetta, Dawn, Cassini, etc.

Radiation Environment

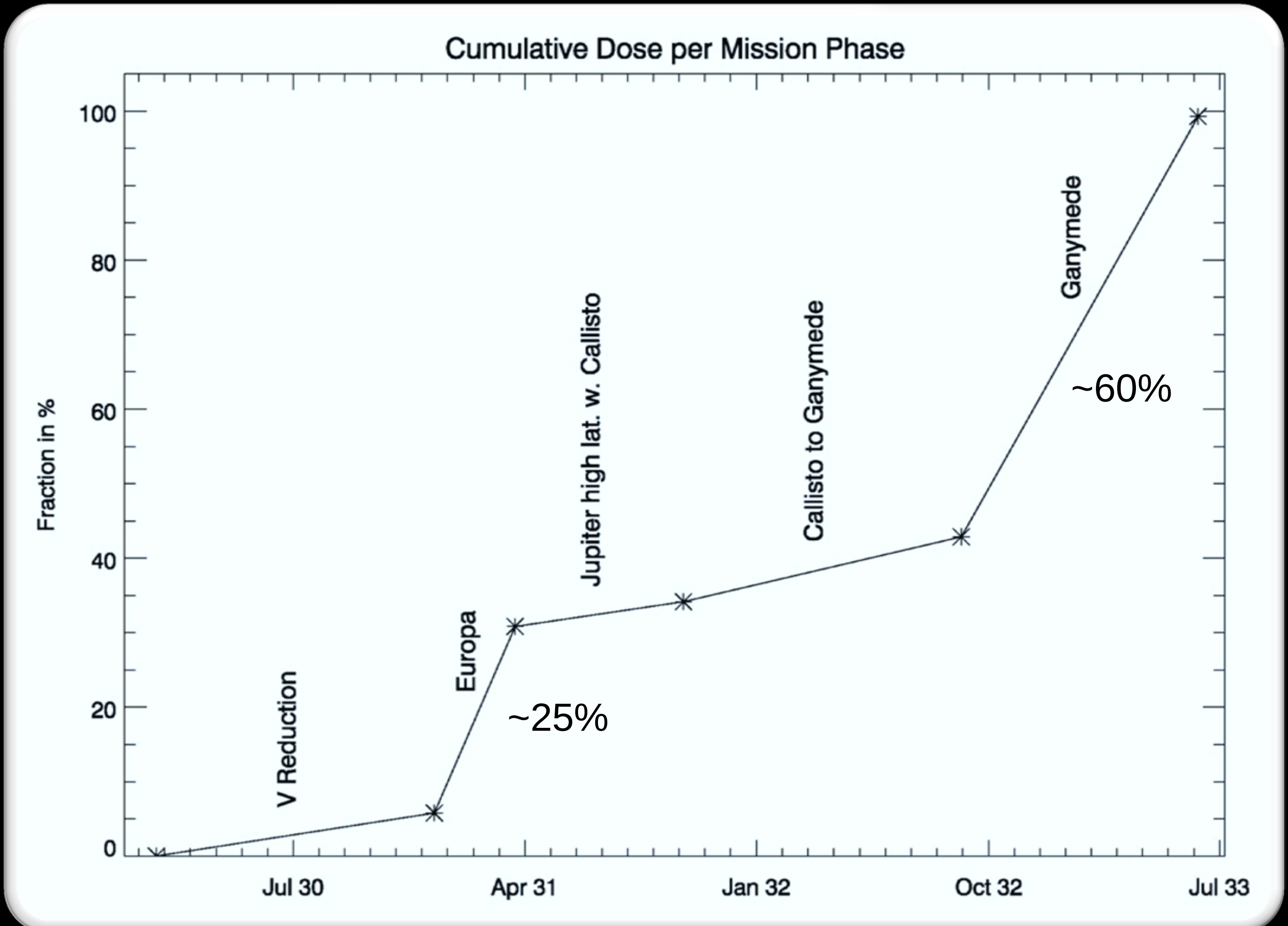
Mission Profile | Spacecraft Design | **Technical implementation**



- Radiation is dominated by electrons
- Solid spheres is an overestimate – detailed radiation transport simulations are needed
- Studies indicate that shielding with Al & Ta allow using component tolerance 50 krad

Radiation Environment

Mission Profile | Spacecraft Design | **Technical implementation**



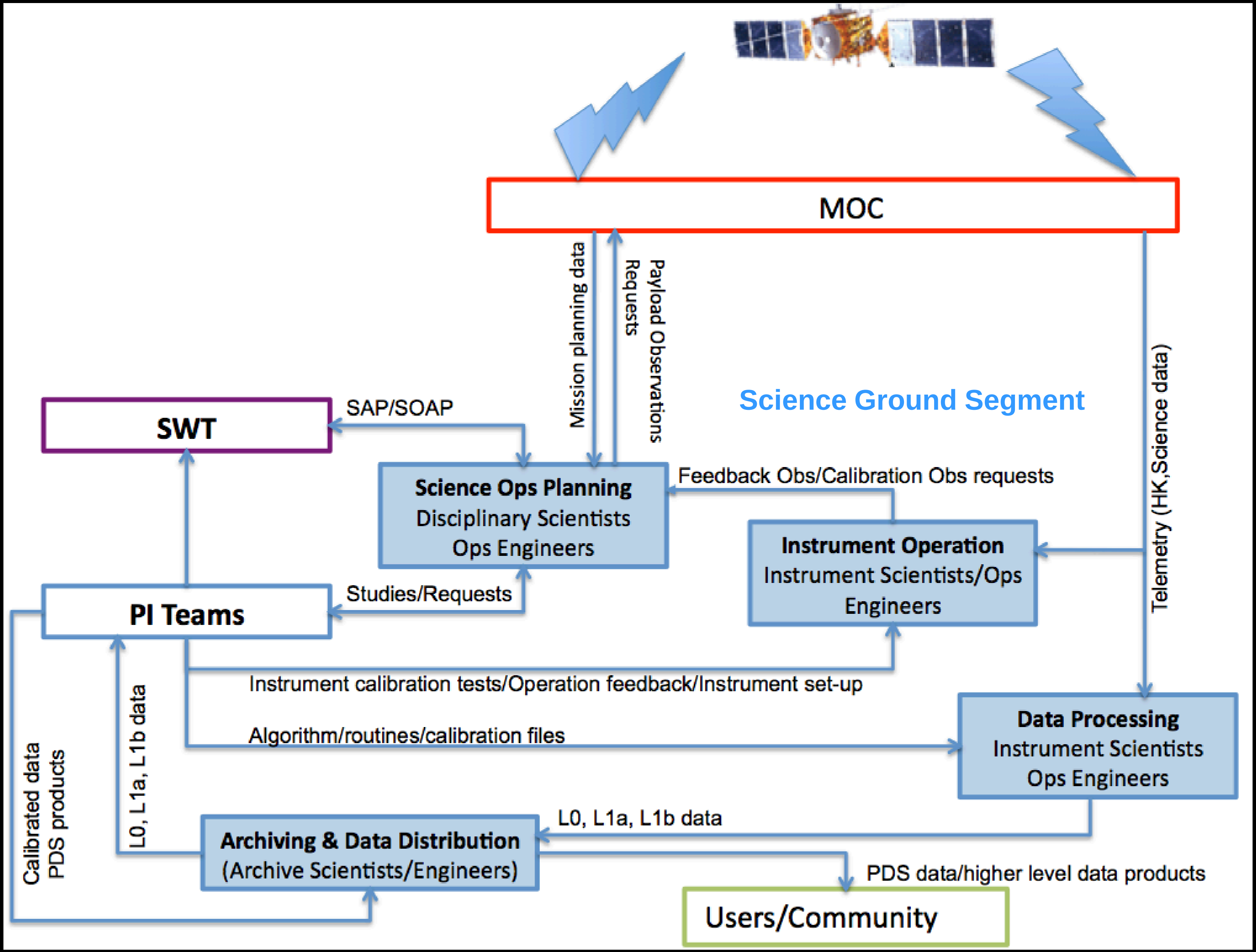
JUICE Communication Considerations

- Scientific return of the mission depends largely on the total amount of data returned
- Telemetry data rate
  - Assumed 48 kbps (1 ground station, 8 h pass: 1.4 Gb per day)
  - Goal (4 Gb per day) ➔ 139 kbps
  - Instruments can easily fill the available data rate hyper-spectral imager, camera, ice penetrating radar
- Signal round trip time
  - Jupiter and Earth: 1^h05^m to 1^h48^m
  - Significant time could be lost, if a data lock or handshake is needed

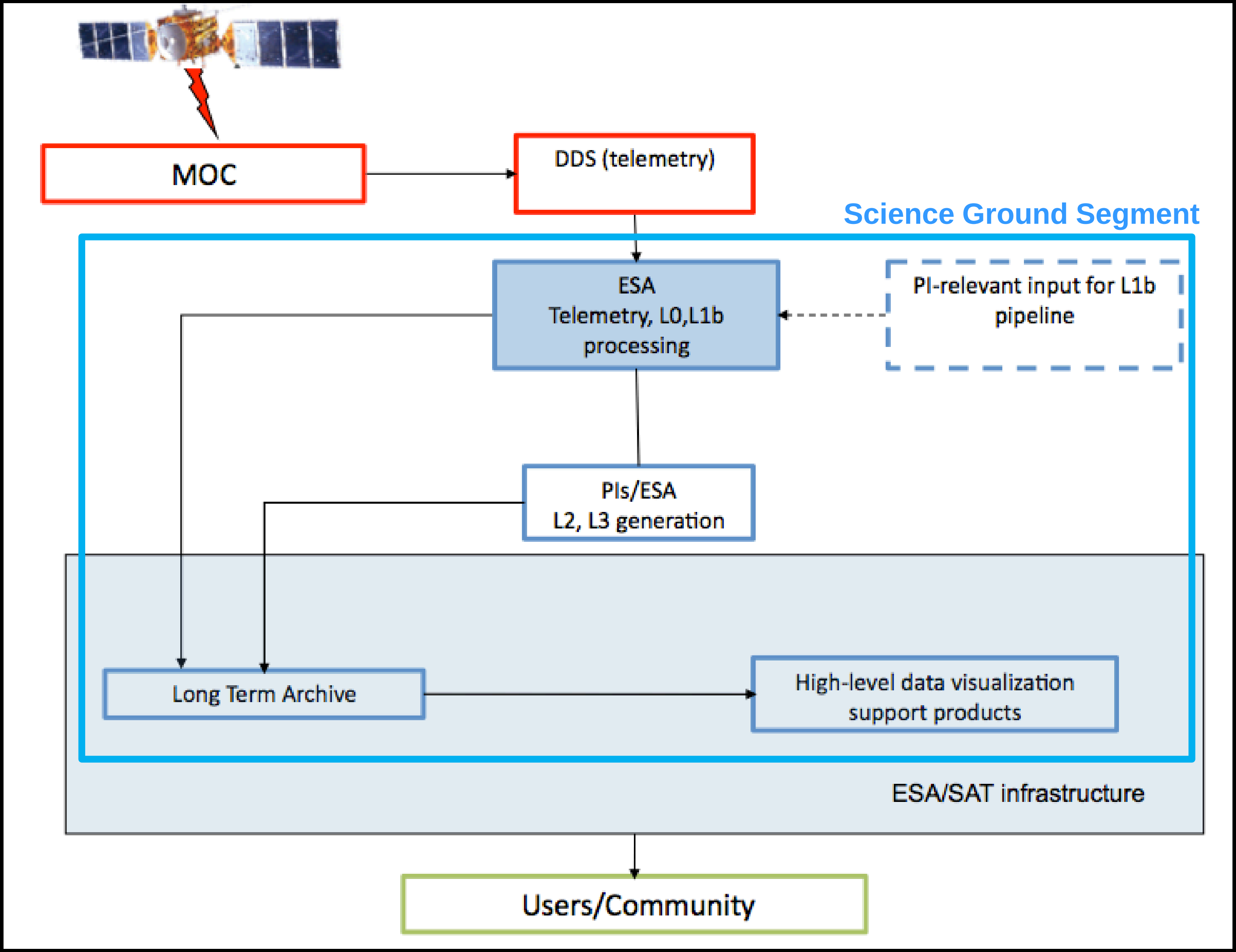
- Use of Ka band is considered
  - Ka band data rate based on weather prediction
  - Acceptance of data lost
  - Data retransmissions the following days

- Consequently file-based transfer should be considered, if Ka-band provides significant gain in telemetry rate/volume

JUICE Science Operations Concept



JUICE Science Data Processing Concept



JUICE Status and Next Steps

- Assessment Phase study report (Yellow Book) issued Jan 2012
  http://sci.esa.int/science-e/www/object/index.cfm?fobjectid=49837

- Evaluation of L-class candidates by ESA advisory bodies (SSEWG/AWG/PSWG) Jan – Mar 2012
- SPC Down-selection 2 May 2012

	System
July 2012	ITT
Sept 2012	Proposals due
Oct 2012	KO
Sept 2013	PRR
Q2/2014	SRR
Q4/2014	Mission adoption

	Instruments
June 2012	AO
Oct 2012	Proposals due
Dec 2012	PRC recommendation
Feb 2013	SPC confirmation
Sept 2013	PRR
Q2/2014	SRR

JUICE Web: http://sci.esa.int/juice