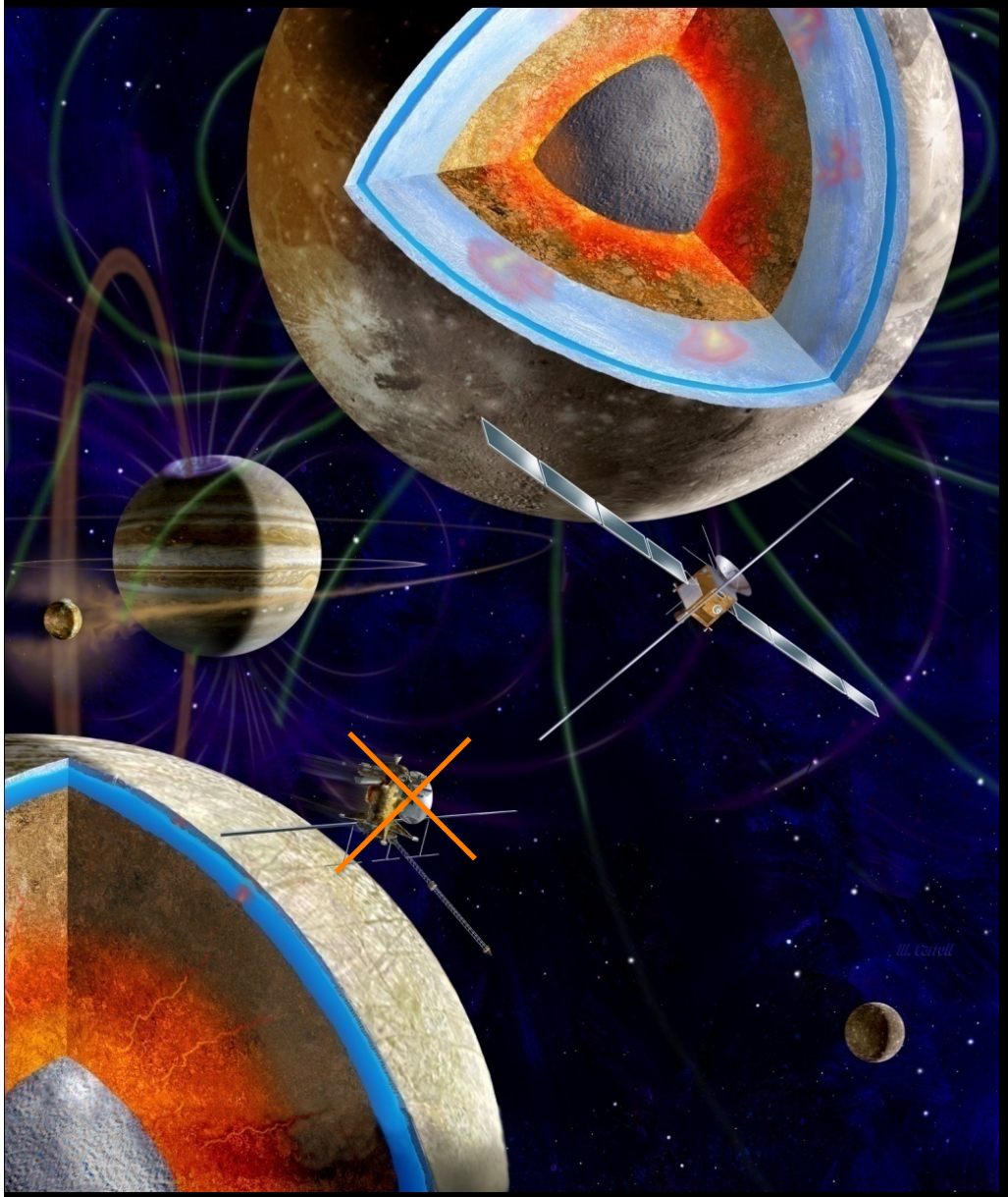
Summary: L-class Cosmic Vision Science

EJSM-Laplace



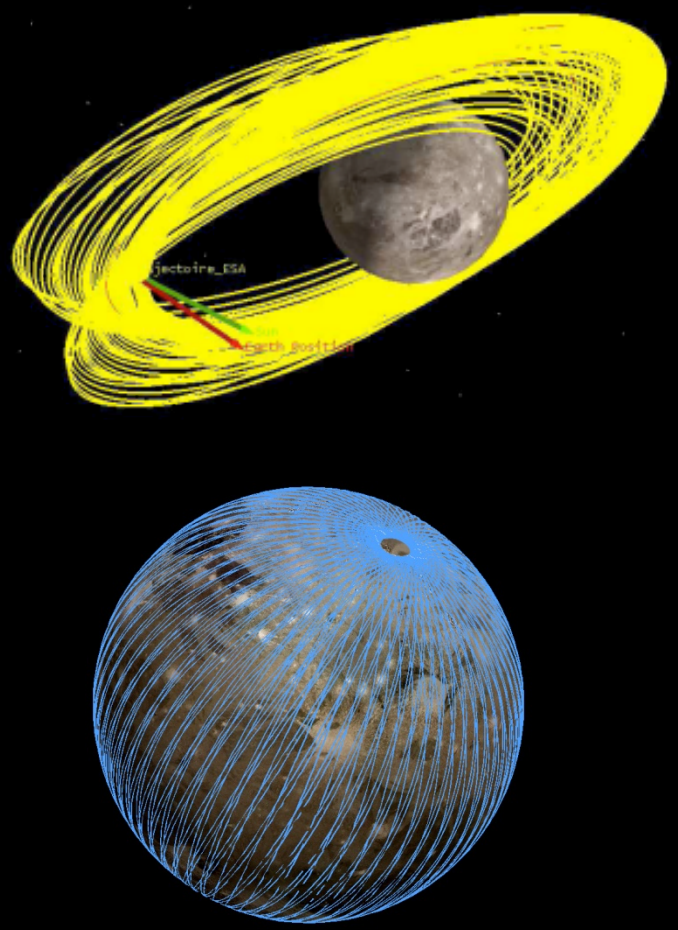
- Scientific goals and objectives are well-defined:
  - Broad appeal to different science communities
  - Flows from community priorities
  - Mature science coupled with exploration opportunities
- International cooperation:
  - JGO and JEO ~~will offer~~ unique scientific ~~synergies~~
  - JGO ~~and JEO each~~ address key portions of EJSM-Laplace science
  - JGO ~~and JEO could each~~ stand on their own to achieve compelling icy world and Jupiter system science
- Mission is judged feasible with no need for critical technologies
- Many opportunities for public outreach

JGO Trajectory Overview

Mission Trajectory

Launch	March 2020 (June 2022)
Interplanetary Transfer	5.9 years (7.3 years)
Jupiter Orbit Insertion to Callisto	~11 months
Callisto flybys	~13 months
Callisto to Ganymede	6 months
Ganymede (polar)	
10,000x200 km & 5000 km	120 days
500 km circular	120 days
200 km circular	60 days
Total mission duration	9.2 years (10.6 years)

Ganymede



The reformulation phase

Major task is to re-formulate the science case, to re-structure the mission and to “study if and which of the original science goals of the EJSM-Laplace mission concept can be achieved by a European led mission”

“The goal of this activity will be to examine to what extent it would be possible to preserve essential parts of the science goals of the original missions within the framework of a European-led mission with an affordable budget for Europe”

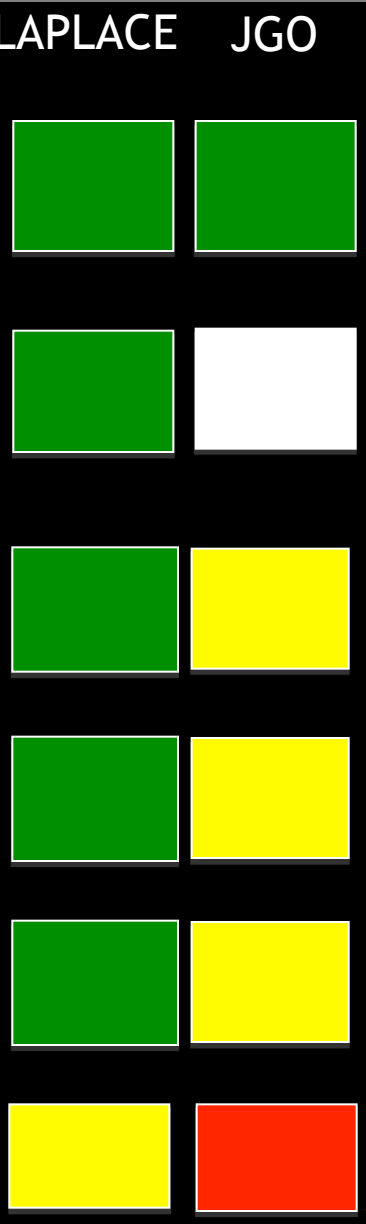
EJSM – LAPLACE is over – Welcome to JUICE

JUICE is not a new mission but an upgraded version of JGO-alone

The redefinition phase

JUICE

I. From LAPLACE to JUICE- the facts



- **Ganymede :**
  Characterise Ganymede as a planetary object including its potential habitability

  Ganymede being the main focus of JGO, it is not affected by the loss of JEO.

- **Europa :**
  Explore Europa to investigate its habitability

  No Europa science from the existing mission profile. It was devoted to JEO.

- **Jupiter System**

  Jovian atmosphere

  To go from yellow to green requires:
  Extended tour
  higher inclination during the tour

  Jovian magnetosphere and environments

  Extended tour
  Variation of inclinations

  Callisto

  Increase the number of flybys

  Io and small bodies

  Not envisaged

The redefinition phase

1. From LAPLACE to JUICE

Recovery of the science of Europa

Action envisaged

- Significant reduction of the model P/L
- Increase of shielding to allow for a few tens of Europa flybys
- No Callisto phase
- Reduction of the tour

Pro

- The only way to recover the habitability objectives of EJSM-LAPLACE

Cons

- To recover JEO objectives requires at least 50 flybys.
- All other objectives sacrified
- The reduction of the model P/L does not provide enough margin.

The redefinition phase

JUICE

Options considered using JGO as a reference

1. JOI to Callisto (11 mon)
2. Callisto flyby **alternative options:**
   - OR
     - a. ~~9 Callisto flybys as in baseline JGO mission (11 mon)~~
     - b. Callisto flybys for increase of inclination: reaching Jupiter latitudes up to 30°, 12 flybys (200 d)
3. Europa flyby **alternative options:**
   - OR
     - a. Composition: 1 science +1 backup flyby immediately following each other; same true anomaly of Europa, outer flyby at ~180° $long_{Europa}$, 400 – 500 km, 35.5 d
     - b. ~~Geophysics: 2 flybys at different true Europa anomalies, outer flyby at ~180° $long_{Europa}$, 400 – 500 km, desires articulated HGA flybys interleaved with Callisto option (2.b) (high Jupiter latitudes)~~
4. Callisto to Ganymede (6 mon)
5. Ganymede (polar) phases
   - a. 10,000x200 km & 5,000 km (120 d – TBC) **90 days**
   - b. 500 km circular (120 d – TBC) **60 days**
   - c. 200 km circular (60 d – TBC) **>30 days**
6. Disposal on Ganymede's surface

The redefinition phase

From LAPLACE to JUICE

Two Europa flybys added + new CPO

Action envisaged

- New design of the Callisto flybys as before
- Europa flybys interleaved with Callisto option
- Reduction of the Ganymede phases

Pros

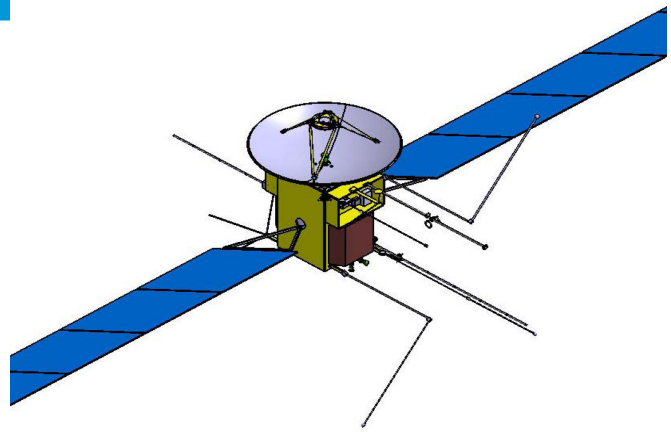
- Will provide new science at Europa
- Recover Jupiter and Magnetosphere objectives

Cons

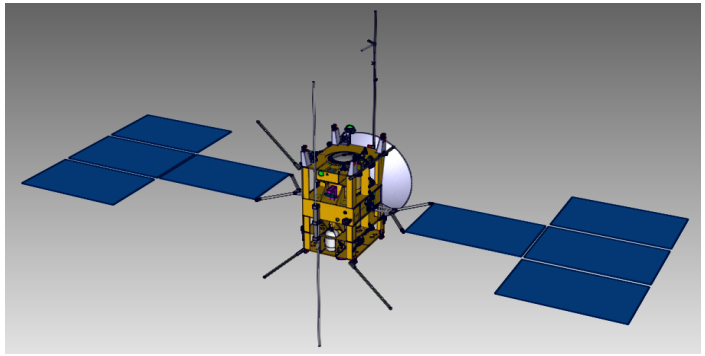
- It has a price for Ganymede

UPDATE GOOD NEWS

- More system mass available (update of launcher capability & longer transfer time)
- more accurate 3D radiation modeling
- Two Europa flybys can be added without reducing the Ganymede phases



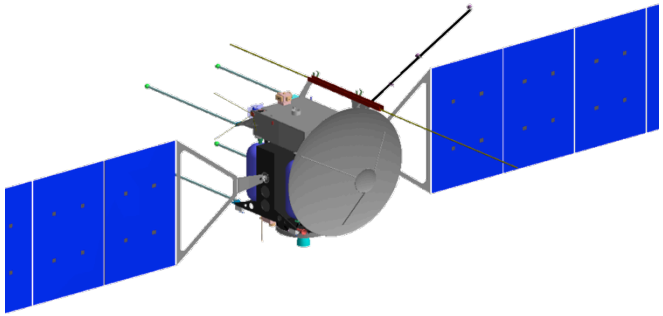
JUICE Mission Status



C. Erd

JUICE Open Workshop, EPSC Nantes

2/10/2011



Space Agency

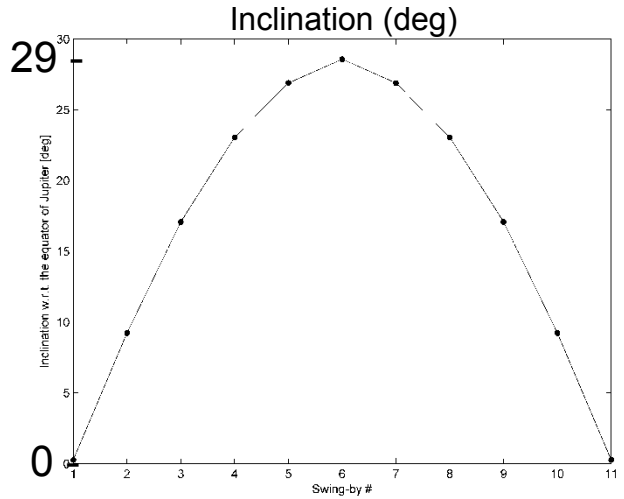
Mission Profile – Launch and Interplanetary Transfer

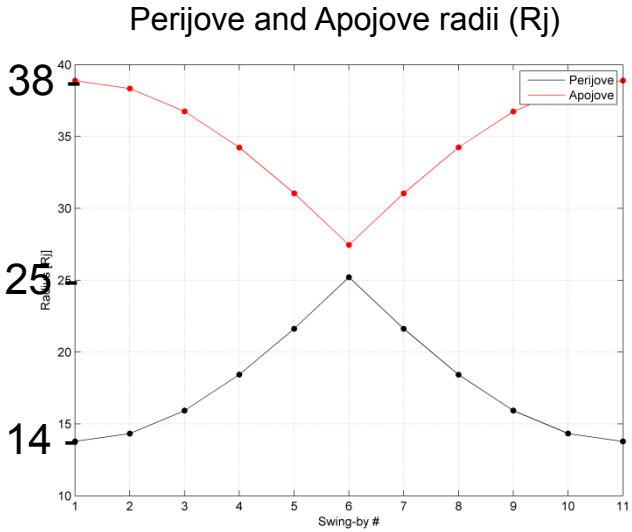
	Prev.Baseline (EJSM/JGO)	**Baseline JUICE**
Launch	March 2020 (June 2022)	**June 2022 (Aug 2023)**
Launch mass in kg	4212 (4681)	**4804**
Interplanetary transfer (Launch to Jupiter arrival) in yrs	5.9 (7.3)	**7.6 (8.0)**
Gravity assist sequence	VEE (EVEE)	**EVEE**
Jupiter arrival	Feb 2026 (Jun 2029)	**Jan 2030 (Aug 2031)**
Total ΔV in m/s	1032 (1223)	**1025 (1059)**
Max. available mass at Jupiter in kg	2830	**3140 (3100)**

Mission Profile – Jupiter Mission Phase

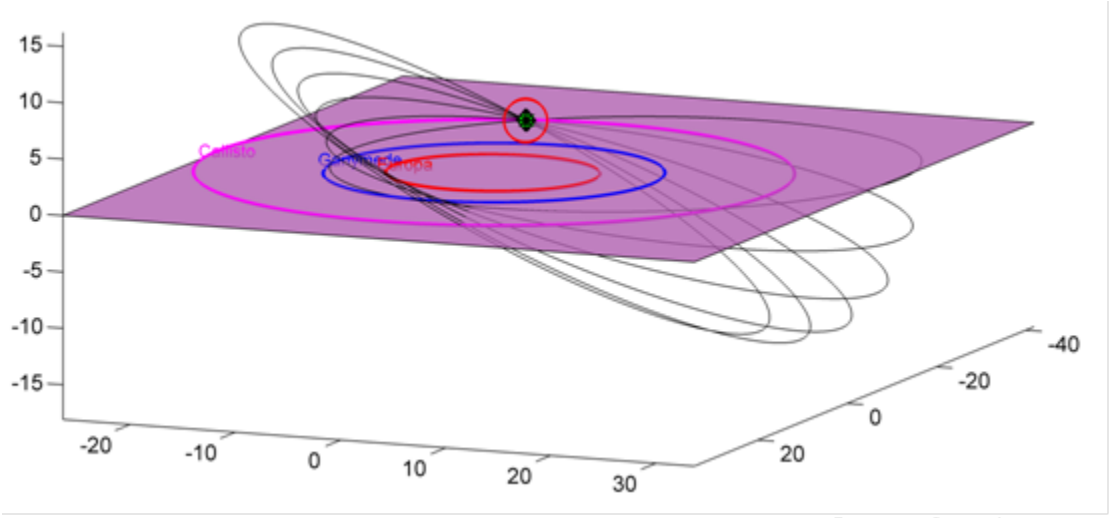
1. JOI to Callisto (11 mon)
2. Callisto flybys to increase of inclination: reaching Jupiter latitudes up to 30°, 12 flybys (200 d)
3. Europa flybys: 2 flybys immediately following each other; same true anomaly of Europa, outer flyby at ~180° $long_{Europa}$, 400 – 500 km, 43 d
4. Callisto to Ganymede (7 mon)
5. Ganymede (polar) phases
    a. Elliptic phase starting 10,000x200 km, 30 d
    b. High altitude circular phase 5,000 km, 60 d
    c. Elliptic phase ending 10,000x200 km, 30 d
    d. 500 km circular (120 d – TBC)
    e. 200 km circular (60 d – TBC)
6. Disposal on Ganymede's surface

Option 1: Proposed Concept

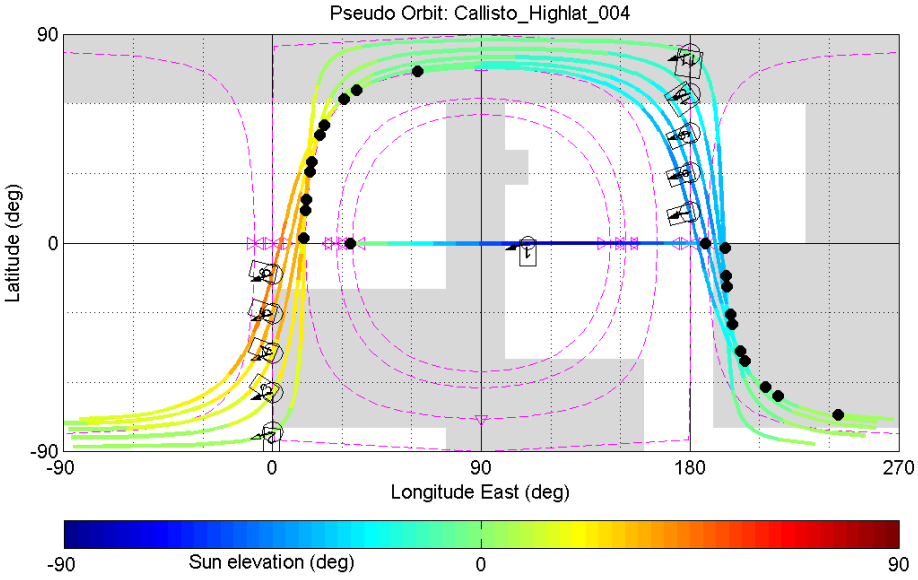




- 6 swing-bys are necessary to transfer from equatorial to maximum inclination
- The maximum inclination is ~29 deg
- The time to transfer is 100 days (100x2=200 days for the end-to-end transfer)

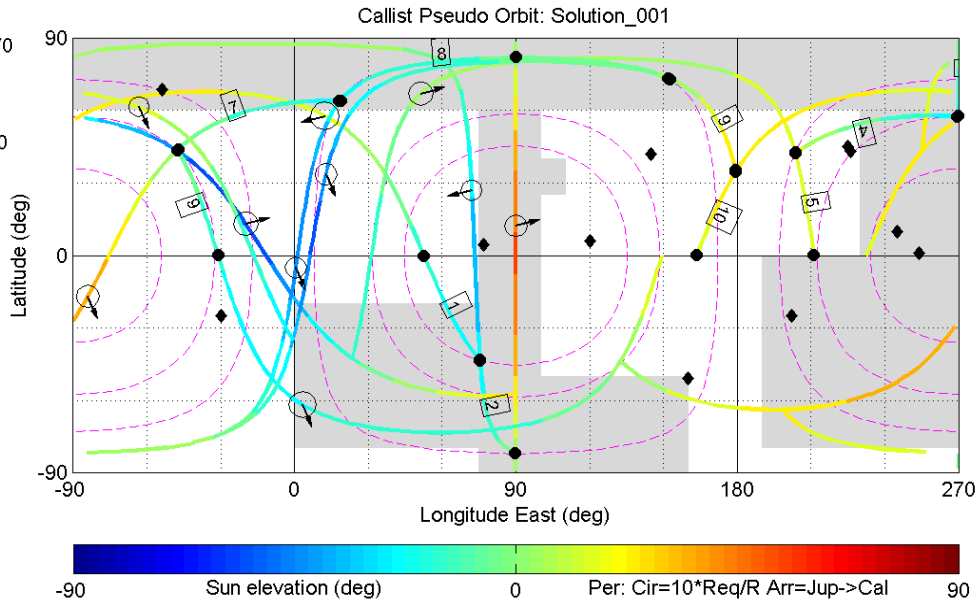


Option 1: Callisto Coverage



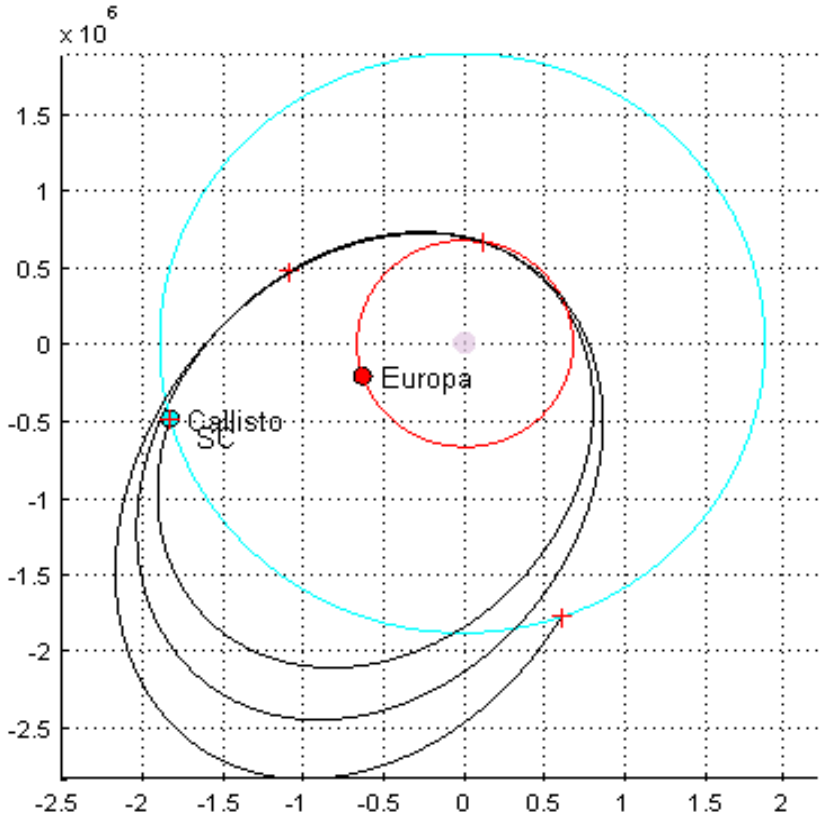
Jupiter High Latitudes Option

Pseudo-orbiter Option

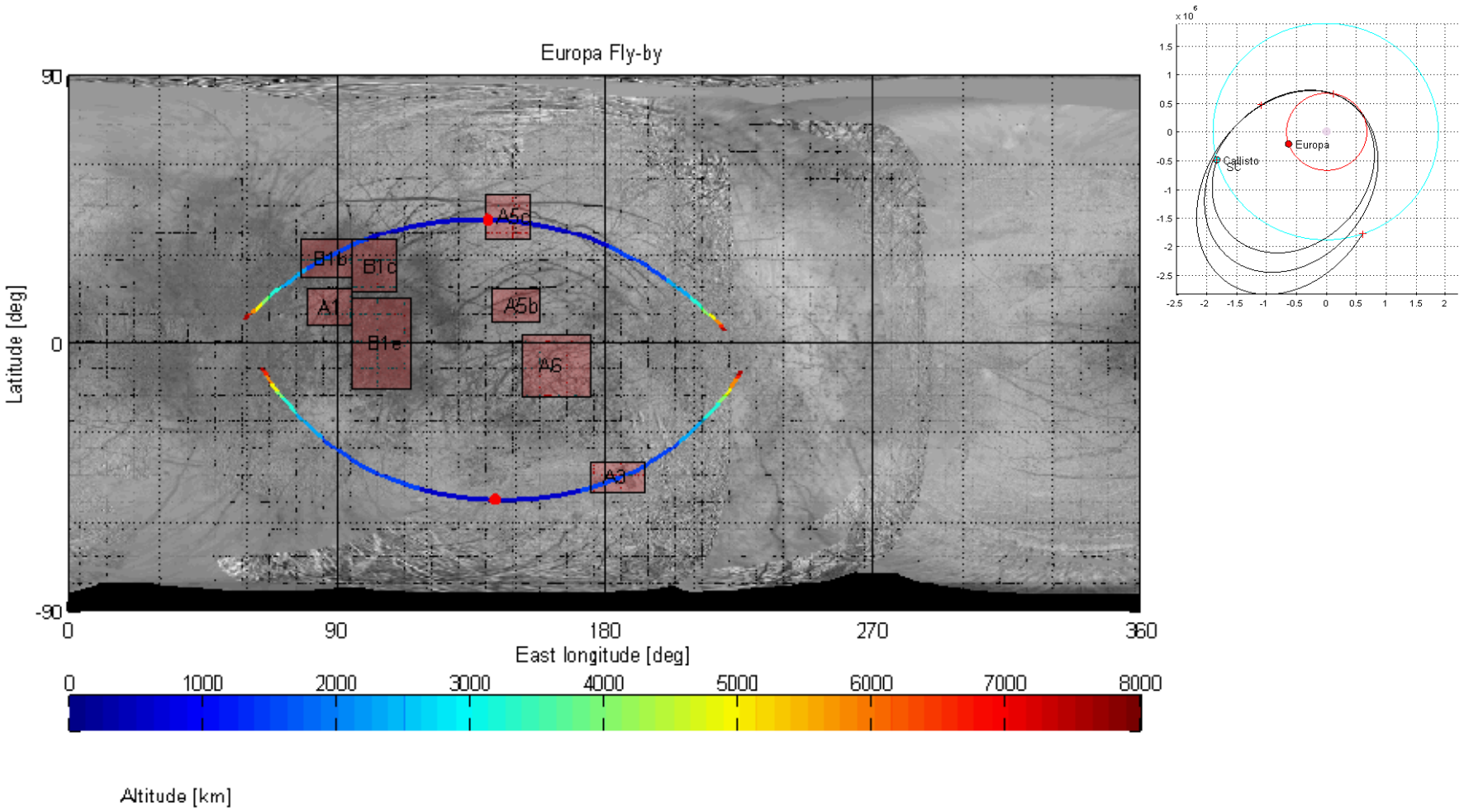


Europa Flyby Scenario

1. 40 day flyby period from leaving Callisto until return to Callisto
2. 2 Europa fly-bys
3. First 9.5 days after leaving Callisto
4. Second 14 days after the first



Europa Flybys Ground Tracks



Model of the Radiation Environment

1. Increase of modelled radiation exposure (2x wrt previous baseline)
2. Inclusion of Europa flybys (adds ~20% to total dose)
3. Radiation mitigation
    a. Higher shielding mass
    b. Use of high Z material (Ta) for shielding being considered
    c. Components with higher radiation tolerance needed (up to 30 krad)
4. Radiation environment close to Europa has higher instantaneous flux
    a. Higher background for sensors
    b. Mitigation of single event effects needed

Summary Spacecraft

1. Increase of radiation exposure balanced by
    a. Moderate increase of shielding mass by ~50 kg
    b. Higher component tolerance (up to 30 krad)

2. Minor additional ΔV required for the additional mission options
    a. Higher Jupiter latitude with Callisto gravity assists
    b. Europa flybys

3. Increased dry mass feasible due to
    a. Higher launch capability
    b. Longer interplanetary transfer (reduction of ΔV)

4. Mission feasible with dry mass margin close to 20%

Next Steps: Plans for Reviews and Milestones

1. New issue of Yellow Book ready	Nov 2011
2. ESA internal review	Nov/Dec 2011
3. Evaluation of reformulated mission by ESA advisory bodies (SSEWG)	Dec 2011/Jan 2012
4. SPC Down-selection	Feb 2012
5. If down-selection successful –	
a. ITT for industrial Phase A/B1	Q2/2012 (tentative)
b. Issue of instrument AO	Q2/2012 (tentative)

Instrument Workshop Announcement
9 – 11 November 2011 at ESOC

1. Technical discussion with instrument study teams
2. Update on latest mission profile
3. Critical items to be taken into account during development
    a. Modelling of the radiation environment
    b. Radiation mitigation approach in the Definition Phase (A/B1)
4. Platform for instrument study teams to share status and experience
    a. Discussion of common issues/difficulties
    b. Search for possibilities of resource optimization by sharing (combined functions for redundancy, etc)
    c. Short presentations from instrument study teams solicited – abstract required
5. Exchange with ESA technical personnel working on ongoing development activities with potential applications/benefits to instrument study teams

6. Registration: birgit.schroeder@esa.int Abstracts: arno.wielders@esa.int