EJSM Jupiter Ganymede Orbiter (JGO)

Mission Overview
Model (planning) Payload
Study Schedule

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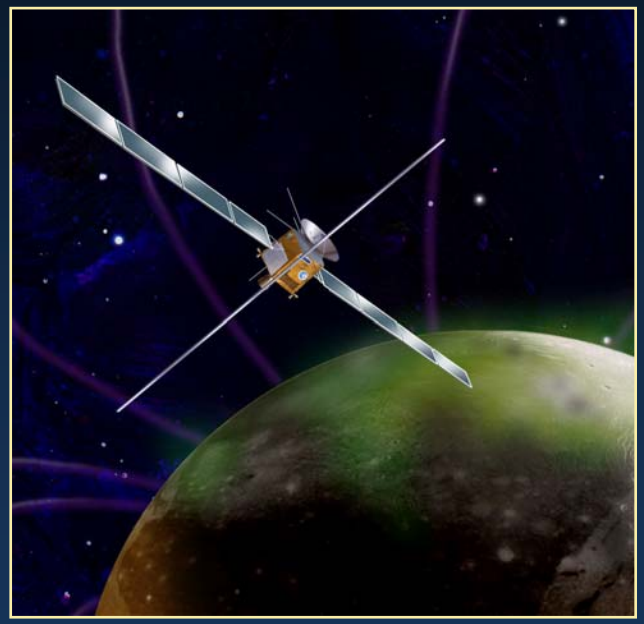
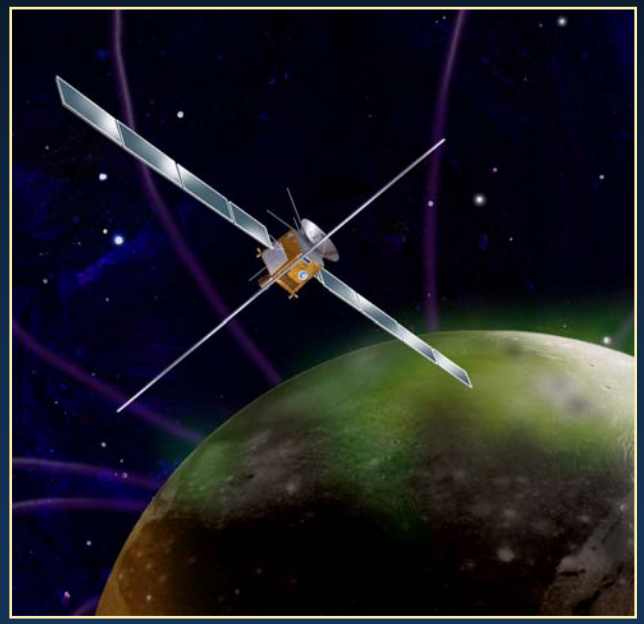
JGO Baseline Mission

- ESA-led portion of EJSM
- Objectives: Jupiter System, Callisto, Ganymede
- Launch vehicle: Ariane 5
- Power source: Solar Arrays
- Mission timeline (After ESA Internal assessment) study :
  - Launch: 2020
    - 6-year Venus-Earth-Earth gravity assist trajectory
  - Jovian system tour phase: ~28 months
    - ~9 Ganymede flybys
    - ~21 Callisto (19 close flybys)
  - Ganymede orbital phase: ~9 months
  - End of prime mission: ~2029
  - Spacecraft final disposition: Ganymede impact
- **Radiation**: ~85 krad behind 8 mm of Al



JGO Study Overview

- 1-year ESA internal assessment study was conducted in 2008
- 1-year Phase 0/A (July ‘09-July ‘10)
  - 2 // Industrial studies
    - EADS/Astrium
    - Thales Alenia Space
  - 11-instrument model payload
  - Mission Analysis (Callisto and Ganymede phase) under revision
  - SCIRD, SRM, PDD
  - In // instrument studies (in response to ESA DOI call) and Technology Development Activities initiated ==> TRL 5-6 in 2012/13



Purpose of Model payload

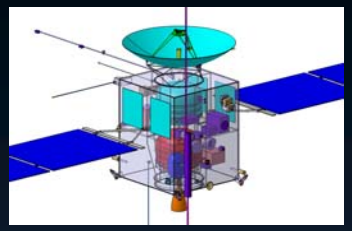
- Model Payload for current Phase 0/A was updated compared to the one used during previous ESA Internal Assessment study (CDF)
- Inputs for model payload documented in Payload Definition Document (PDD); inputs provided by community payload experts (teams) in response to SCIRD and SRM; Achieving coherency between the three documents is part of the on-going work at JSDT level
- Model payload is used as representative payload to allow:
  - sizing the spacecraft resources for designing a mission that implements the science goals & objectives
  - to support defining payload interfaces for the upcoming AO

JEO & JGO Model Payloads

JEO	JGO
Wide Angle and Medium Angle Camera	Wide Angle and Medium Resolution Camera
Narrow Angle Camera	High Resolution Camera
Vis-IR Imaging Spectrometer	Vis-IR Hyperspectral Imaging Spectrometer
UV Spectrometer	UV Imaging Spectrometer
Radio Science	Radio Science
Magnetometer	Magnetometer
Ice Penetrating Radar	Sub-Surface Radar
Laser Altimeter	Laser Altimeter
Thermal Instrument	
	SubMillimeter Wave Instrument
Particle and Plasma Instrument	Plasma Package & Ion Neutral Mass Spectro.
Ion and Neutral Mass Spectrometer	
	Radio and Plasma Waves Instrument

Instruments	Characteristics
A 104 kg model payload including the following instruments has been identified:	
Laser Altimeter	25 cm aperture, Single beam @ 1064 nm, 10 m spot @ 200 km
Radio Science Package	Ka/Ka, X/X, X/Ka transponders, Ultra Stable Oscillator, range (30 cm) and range rate (1.5 μm/s)
Subsurface Radar	Single frequency, 20 – 50 MHz, 10 m dipole antenna, 10 m vertical resolution up to 5 km depth
Visible IR Hyperspectral Imager	2 channel, 400 – 5200 nm, resolution 2.8 & 5 nm, IFOV 0.125 – 0.25 mrad
UV Imaging Spectrometer	EUV: 50 – 110 nm, FUV+MUV: 110 – 320 nm
Wide Angle Camera	WAC: framing, 350 – 1050 nm, 12 filters, IFOV 2 mrad
Medium Resolution Camera	Pushbroom + sterero, 4 color + panchromatic, 350 – 1050 nm, IFOV 0.25 mrad
High Resolution Camera	Push broom, panchromatic, 350-1050 nm, IFOV 0.005 mrad
Magnetometer	2 tri-axial fluxgates, 3 m boom, ΔB 4 pT – 2 nT
Plasma Package + Ion & Neutral Mass Spectrometer	Thermal plasma number density: T_e < 10 eV, Electrons: 1 eV – 20 keV, 15 keV – 1 MeV, Ions: 1 eV – 5 MeV, ENA: 10 eV – 10 keV INMS: M/ΔM > 1000
Submillimeter Wave Instrument	2 channels, 557 & 1200 GHz, 1 GHz bandwidth, 100 kHz resolution, IFOV 3 – 1.3 mrad
Radio & Plasma Wave Instrument	Electrons & Ions 0.01 – 20 eV, E field 1 kHz – 45 MHz, M field 0.1 Hz – 20 kHz, Radio Waves 10 kHz – 45 MHz

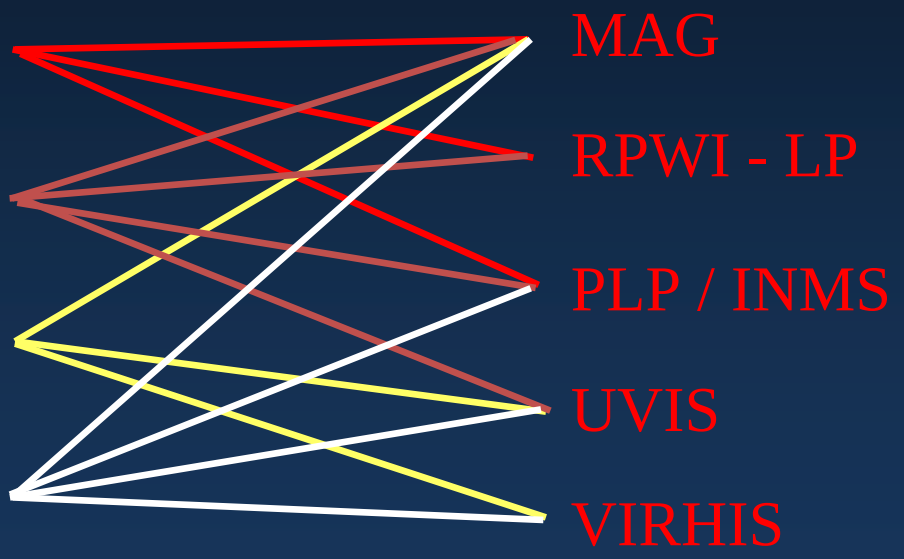
Model Payload Capability (ex 1)



Magnetic environment

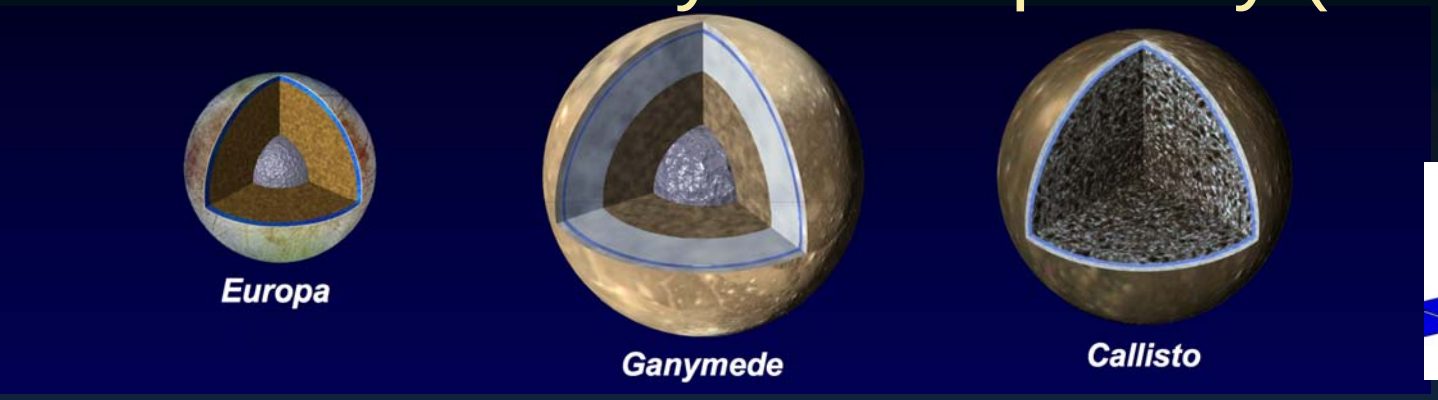
- Magnetosphere : size, spatial/temporal variations
- Particle distributions inside Ganymede's magnetosphere
- Exosphere and ionosphere characteristics
- Location of the boundary between open and closed field lines - Correlation with surface and exosphere features?

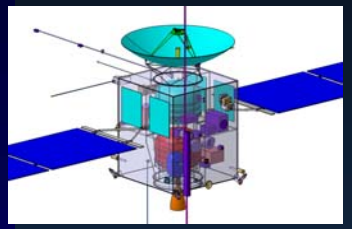
QuickTime™ et un décompresseur sont requis pour visionner cette image.



JGO elliptical orbits (200 x ~10000 km) - 80 days
JGO circular orbits - > 180 days
JEO flybys

Model Payload Capability (ex 2)



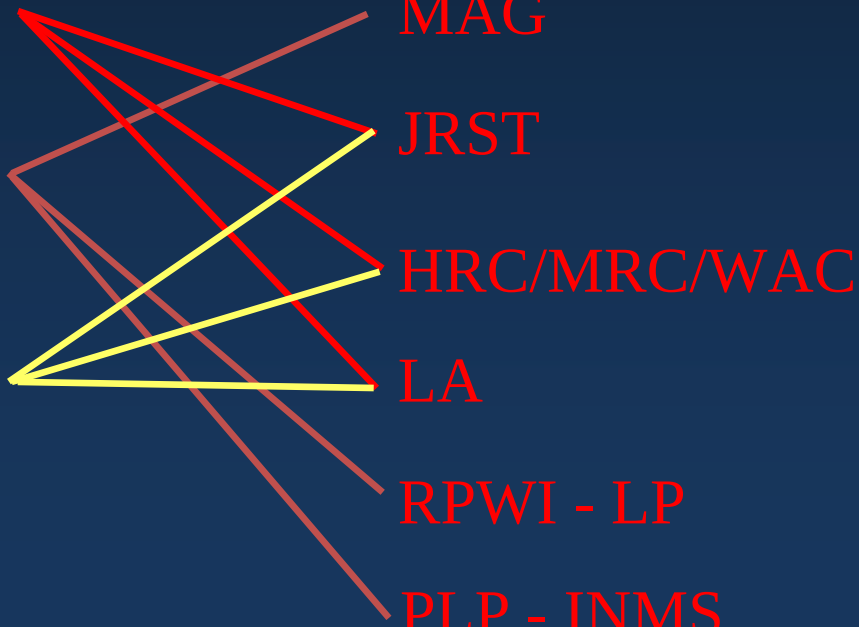


A global subsurface ocean

Study of the tidal variations of Ganymede's potential and shape

Detailed characteristics of the magnetic field at multiple frequencies

Amplitude of forced libration and obliquity, and non-synchronous rotation



Penetrator Study (UK-led activity)

- Option for a penetrator on JGO left open in industrial study
- Penetrator study initiated in July. KO expected soon
- Science objectives and priorities were discussed by EJSM JSDT on 18-19 Sept. in Potsdam

Foci for Ganymede and Europa penetrators

- Ganymede: geophysics focus, composition key measurements, astrobiology lower priority
- Europa: astrobiology focus, geophysics and composition key measurements

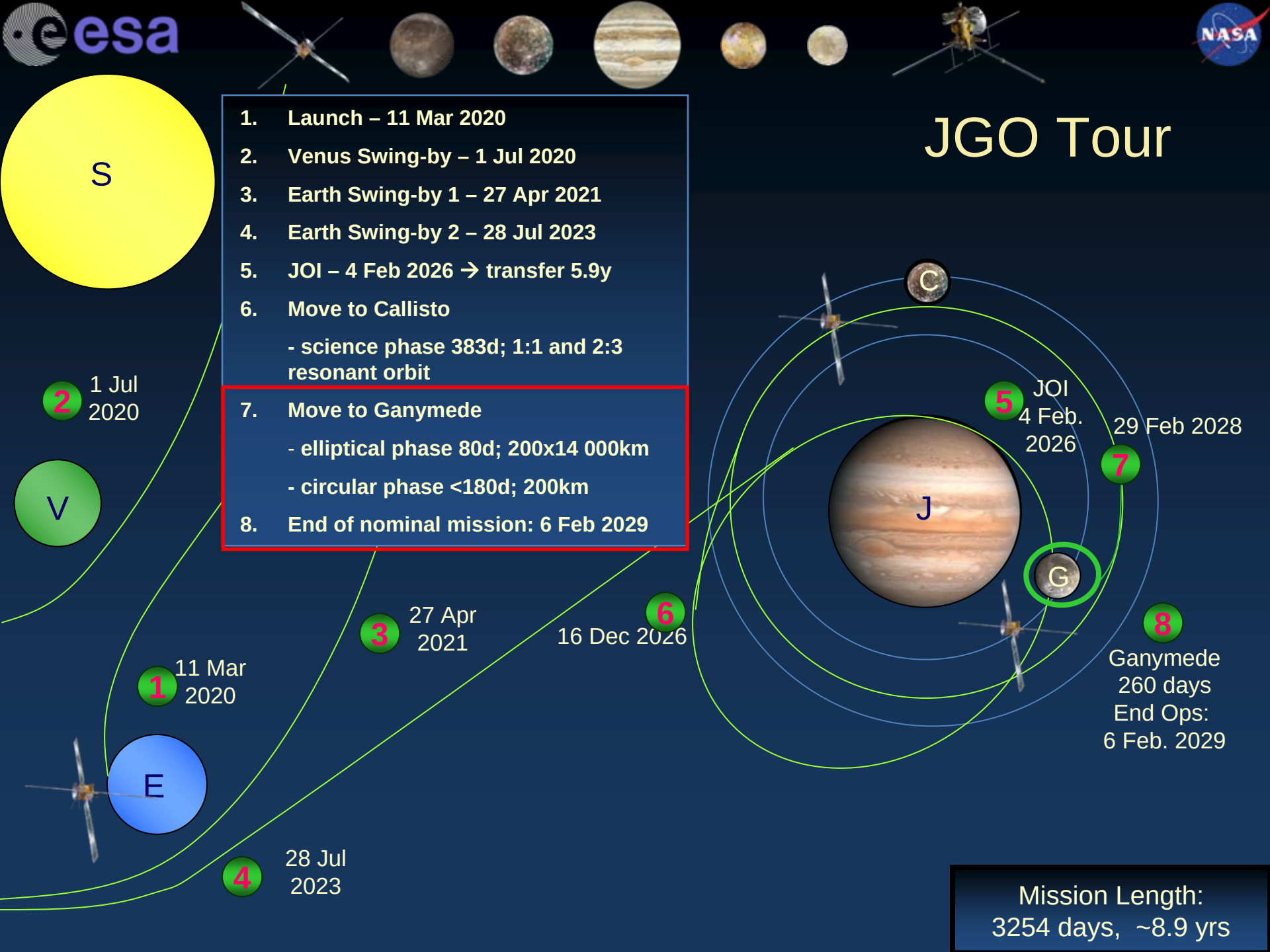
Focus topics supplemented by other measurements as possible from engineering constraints

Cf JIMO SDT report: Europa lander, recommended one of astrobiology and geophysics with both highly desired, geological-compositional lower priority

Priorities for penetrator measurements

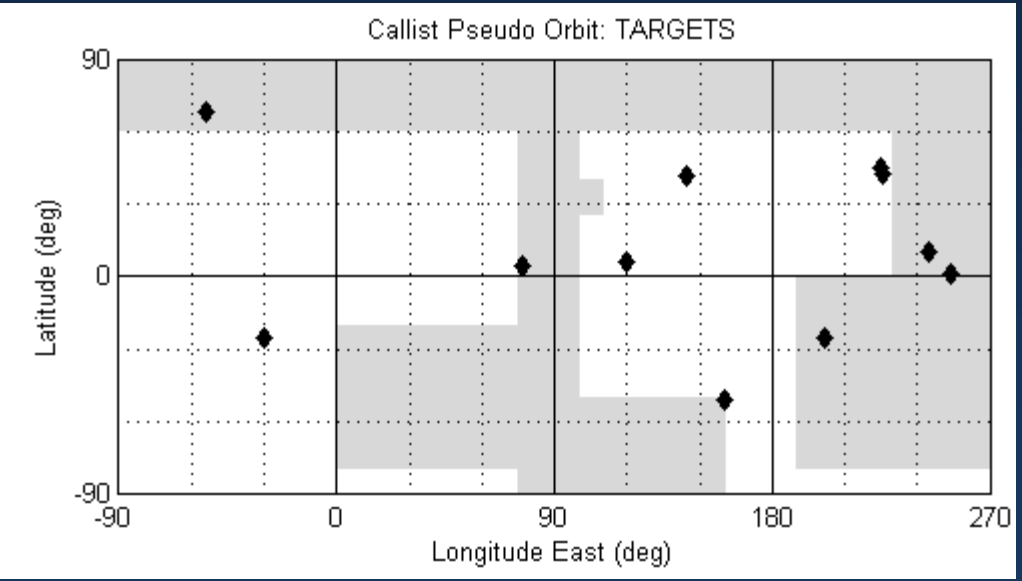
	JGO priority	JEO priority
1. Geophysics: confirm existence of and determine ice depth to moon's ocean	2	2
2. Geophysics: determine additional constraints in interior structure	2	0.5
3. Geophysics: Characterise surface physical properties, and if possible their variation with depth	2	1
4. Chemical composition	1	1
5. Astrobiology of surface and sub-surface	0.5	2

Priorities: 2=mandatory, 1=useful, 0.5=may help

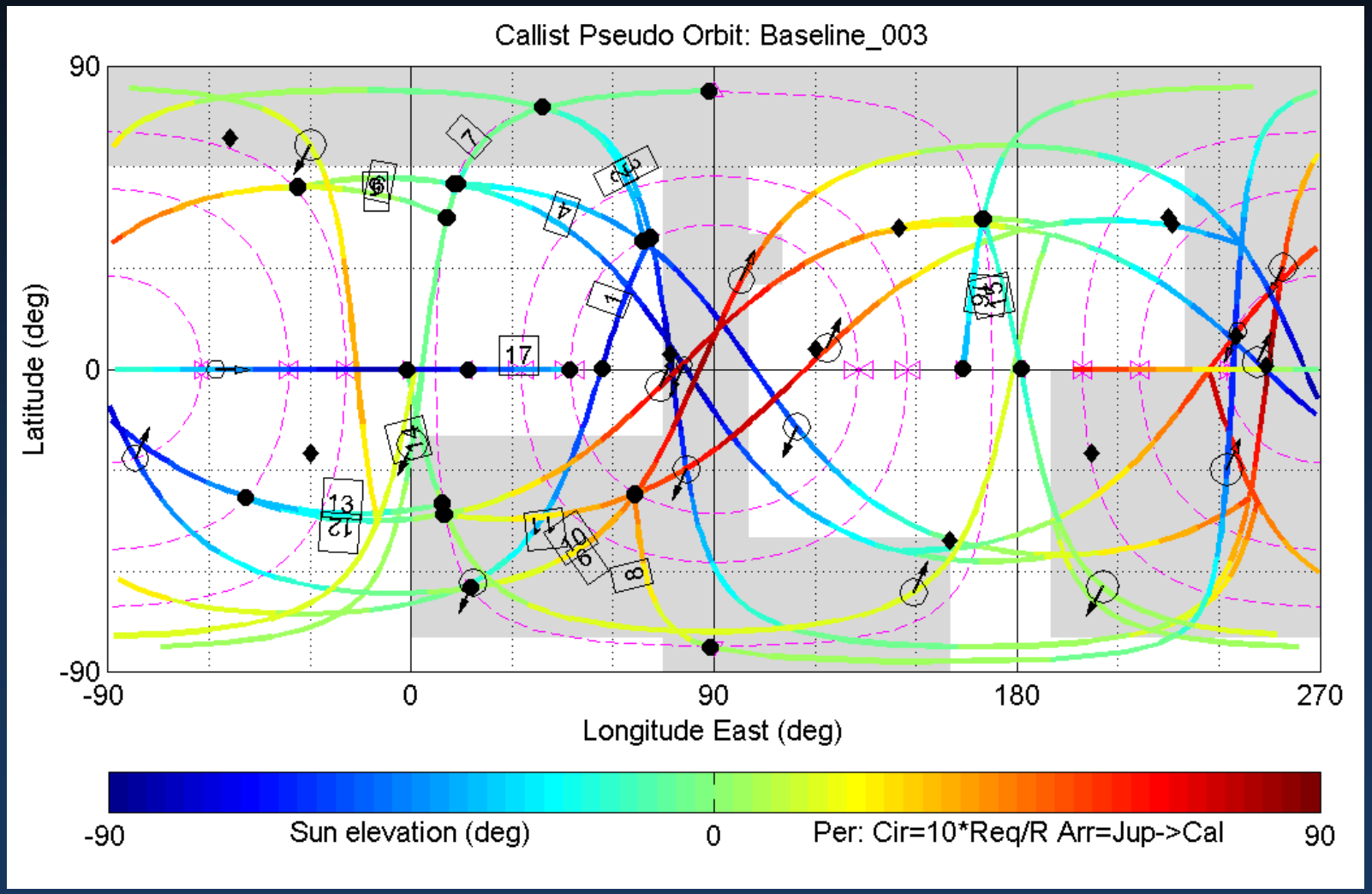

JGO Tour
1. Launch – 11 Mar 2020
2. Venus Swing-by – 1 Jul 2020
3. Earth Swing-by 1 – 27 Apr 2021
4. Earth Swing-by 2 – 28 Jul 2023
5. JOI – 4 Feb 2026 → transfer 5.9y
6. Move to Callisto
- science phase 383d; 1:1 and 2:3 resonant orbit
7. Move to Ganymede
- elliptical phase 80d; 200x14 000km
- circular phase <180d; 200km
8. End of nominal mission: 6 Feb 2029
S
V
E
J
C
G
1 11 Mar 2020
2 1 Jul 2020
3 27 Apr 2021
4 28 Jul 2023
5 JOI 4 Feb. 2026
6 16 Dec 2026
7 29 Feb 2028
8 Ganymede 260 days End Ops: 6 Feb. 2029
Mission Length: 3254 days, ~8.9 yrs

Callisto Science Requirements

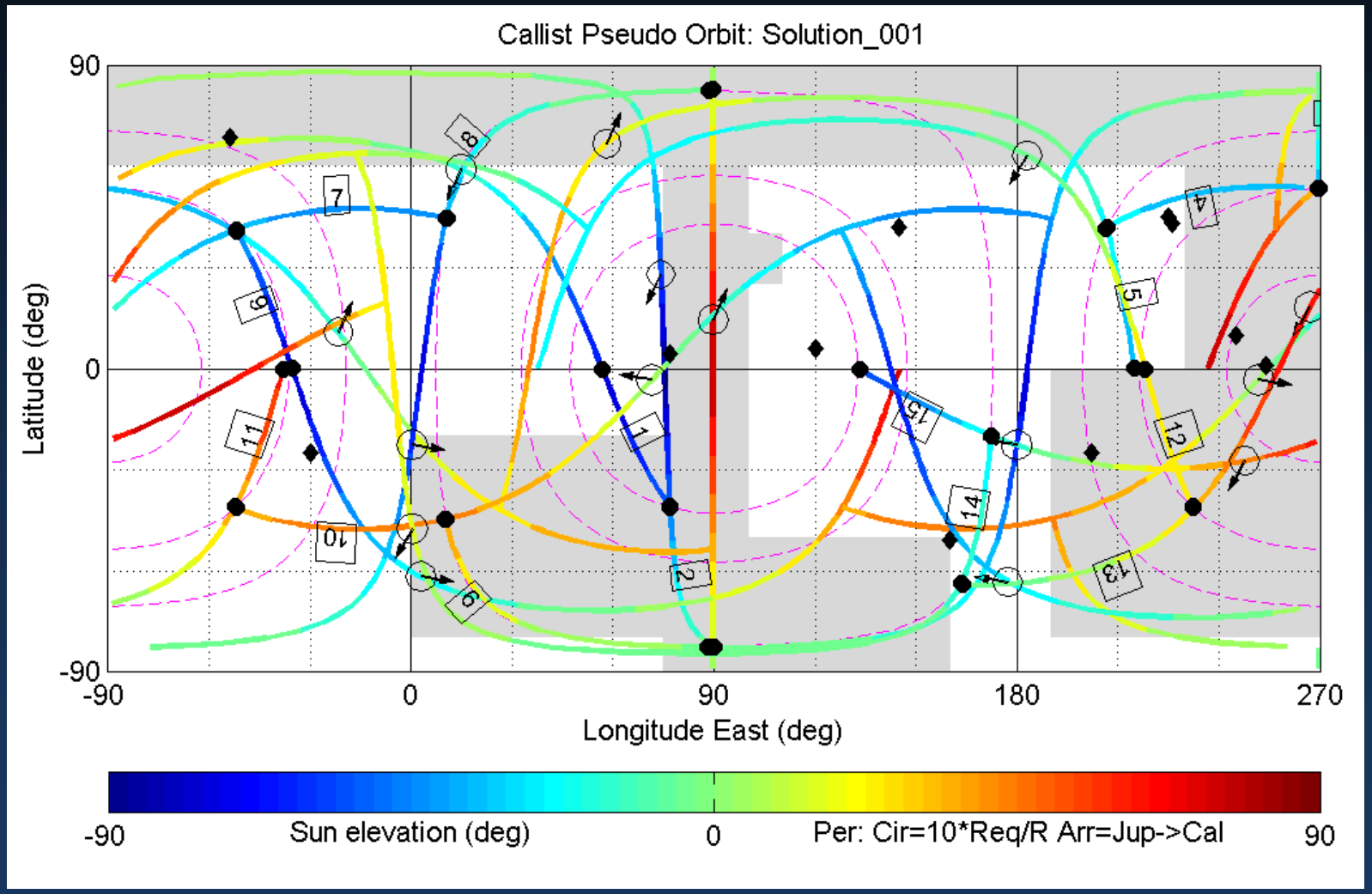
- One polar and one equatorial to study the interior structure
- At different true anomalies of Callisto's orbit to study tides and the magnetic field (pericentre and pericentre +/- 45 deg or more)
- Galileo and Voyager gap filling to study the geology
- Some special targets
- One at 50 km to study the atmosphere
- High latitude observations to study the composition
- Up- and down-stream of the magnetic flow to study the magnetosphere
- One at 100 km to study the atmosphere
- One equatorial at leading or trailing side to study the geology



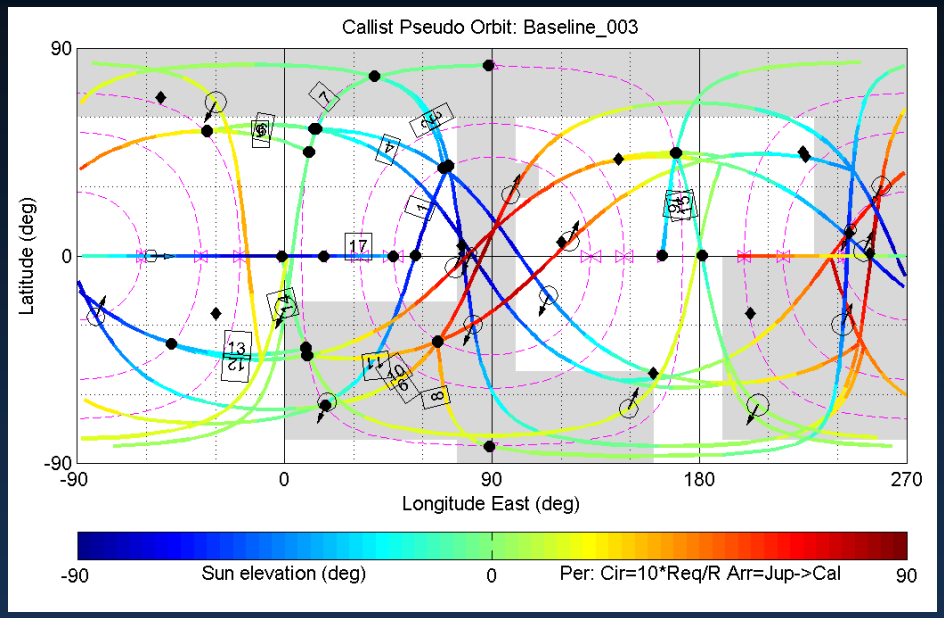
Scenario 3: latitude-longitude

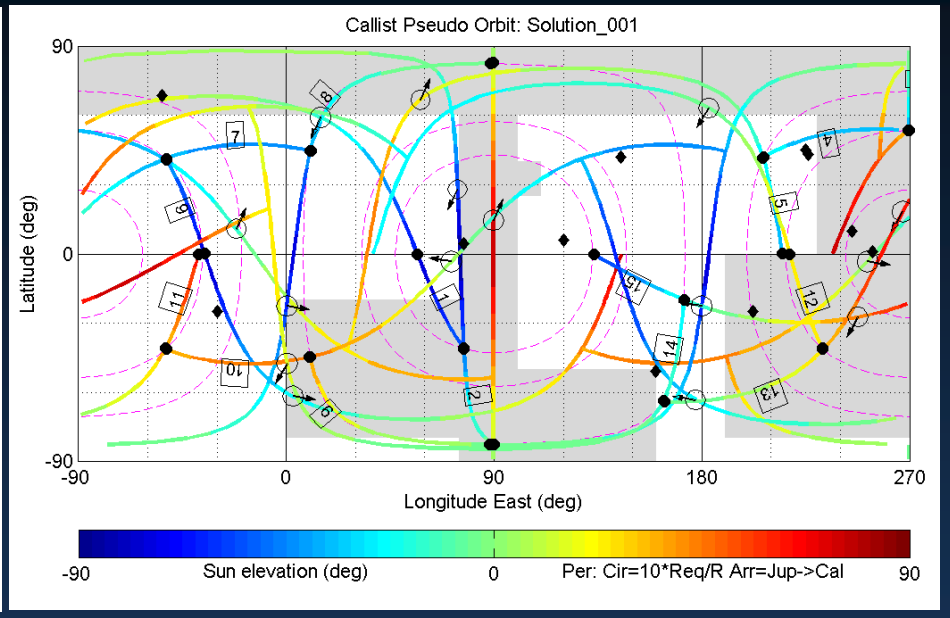


Scenario 4: latitude-longitude



Scenario 3 vs Scenario 4





- Denser coverage of the gaps with S3 (leading/trailing side)
- Day and night coverage of the gaps with S3
- Equivalent coverage of the areas of interest
- 4 Callisto orbital positions for S4 vs 3 for S3
- All swing-bys below 500 km for S4, 2 swing-bys above 2000 km for S3
- Less radiation for S4 (no 2:3 resonance)

JGO study – schedule

Date	Activity
June 2009 – June 2010	2 Competitive industrial studies; nationally funded instrument studies in parallel
September 2010	Due date for L-Class assessment report
Late 2010	Selection of 2 (out of 3) L-class missions for launch in 2020: Candidates: EJSM/JGO, IXO (Xeus), LISA
1st quarter 2011 to mid 2012	Industrial studies (start of phase B1) – Definition Phase Instrument AO process (early 2011)
End 2012	Selection of 1st L-class mission for launch in 2020 → mission moves into phase B2 (12 months)
May 2015 – Nov. 2016	Phase C (30 months)
Nov. 2016 – Nov. 2019	Phase D (36 months)
11 March 2020	Launch

Cosmic Vision 2015-2025 Implementation