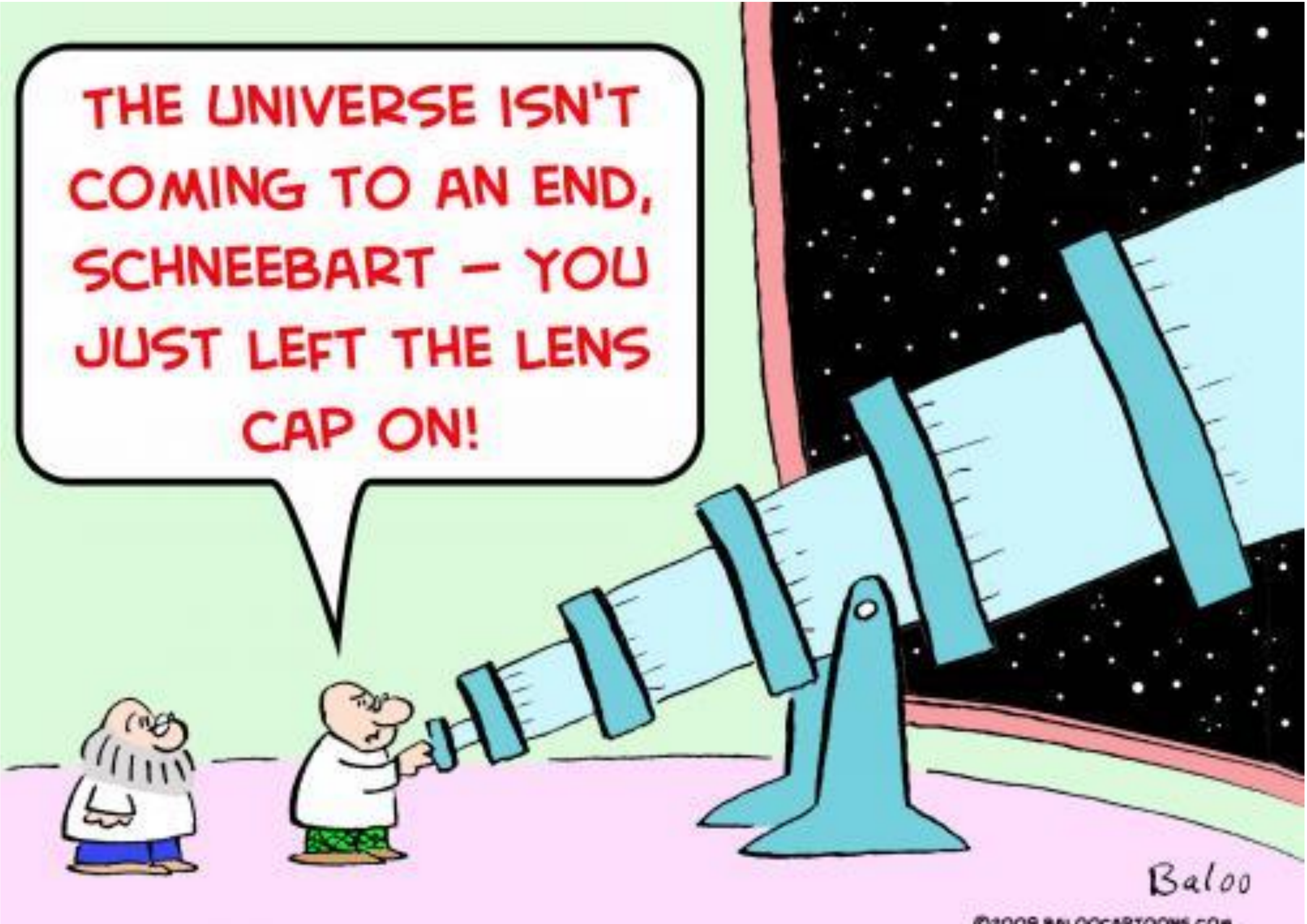
THE UNIVERSE ISN'T COMING TO AN END, SCHNEEBART – YOU JUST LEFT THE LENS CAP ON!
Baloo
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Juice

19.3.2025

Hannu Määttänen

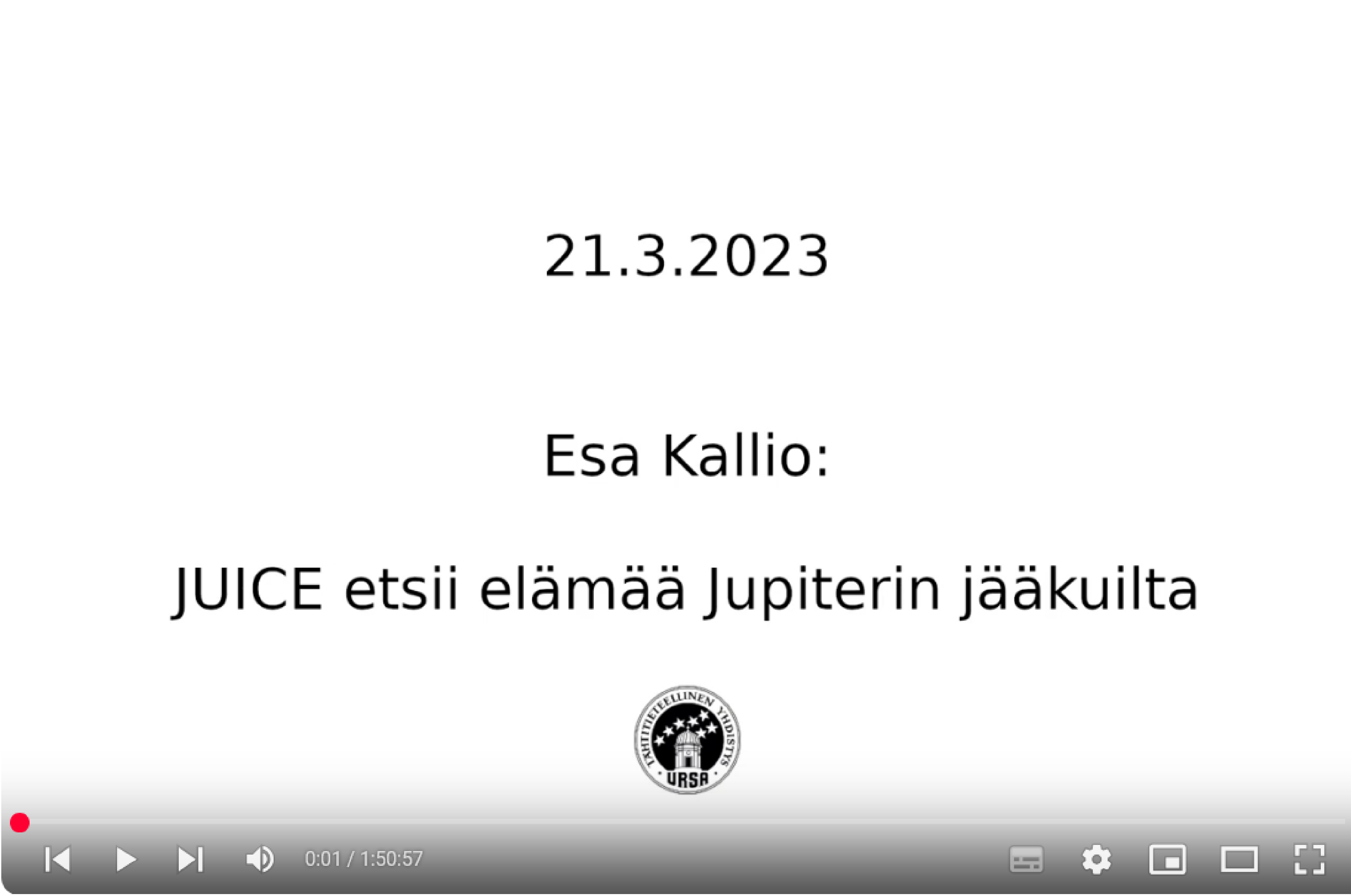
Mistä ei kyse

Juice

Kauas on pitkä matka

Juice

ESA's Jupiter Icy Moons Explorer



Esitelmä löytyy Youtubesta Ursan kanavalta

Background

The mission started as a reformulation of the Jupiter Ganymede Orbiter proposal, which was to be ESA's component of the cancelled Europa Jupiter System Mission – Laplace (EJSM-Laplace). It became a candidate for the first L-class mission (L1) of the ESA Cosmic Vision Programme, and its selection was announced on 2 May 2012.

In April 2012, Juice was recommended over the proposed Advanced Telescope for High Energy Astrophysics (ATHENA) X-ray telescope and a gravitational wave observatory (New Gravitational wave Observatory (NGO)).

In July 2015, Airbus Defence and Space was selected as the prime contractor to design and build the probe, to be assembled in Toulouse, France.

By 2023, the mission was estimated to cost ESA 1.5 billion euros.

Historiaa – Googlen käännös

Pioneer 10 ja 11 (1973 ja 1974): Nämä olivat ensimmäiset luotaimet, jotka lensivät Jupiterin ohitse. Pioneer 10 kulki Jupiterin läheltä vuonna 1973 ja ensimmäisenä lähetti kuvia planeetasta.

Voyager 1 ja 2 (1979): Voyager-luotaimet tekivät uskomattomia havaintoja Jupiterista, sen arvioimattomista kuukausista, kuten Ganymedes, Callisto, Io ja Europa, sekä Jupiterin rengasjärjestelmästä. Ne paljastivat myös planetan voimakkaat myrskyt ja suuret pilvi- ja kaasukerrostumat.

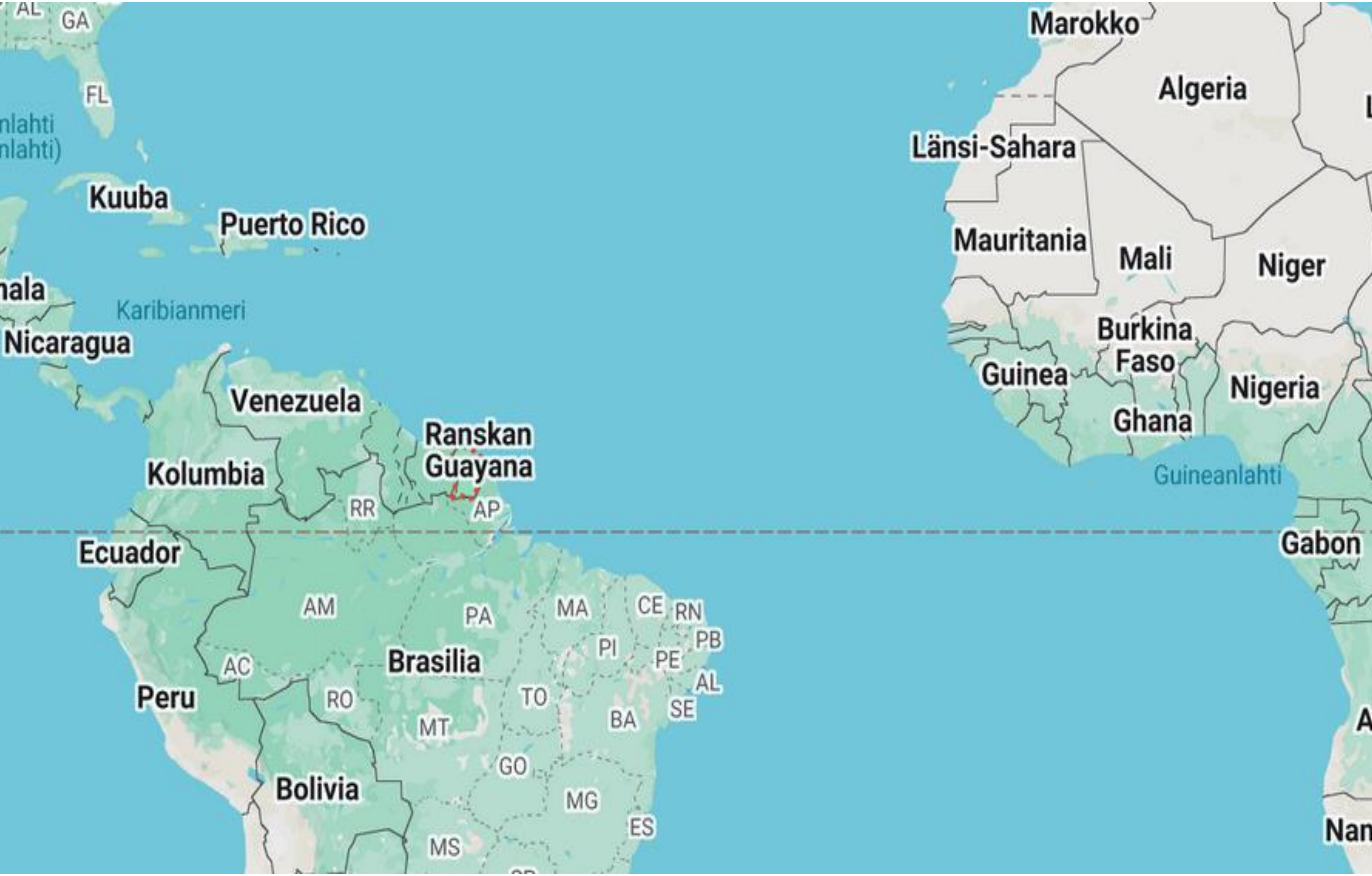
Galileo (1995-2003): Tämä luotain oli ensimmäinen, joka kiersi Jupiteria ja sen kuita pitkällä aikavälillä. Se toimitti arvokasta tietoa Jupiterin ilmakehästä, magneettikentästä ja kuiden geologiasta. Galileo tutki erityisesti Europan mahdollisia vesivarastoja, jotka voisivat sisältää elämää.

Juno (2016-nykyisin): Juno on edelleen aktiivinen ja tutkii Jupiterin ilmakehää, magneettikenttää ja sisäistä rakennetta. Se on tuottanut paljon tietoa planeetan syvistä kerroksista, sen kaasuvirtauksista ja revontulista. Juno on myös keskittynyt tutkimaan Jupiterin suurta punaista pilkkua.

The journey

Launch: 14 April 2023.
Launch location: Europe's Spaceport in French Guiana.
Launch vehicle: Ariane 5.
Flybys en route: August 2024 Lunar-Earth, August 2025 Venus, September 2026 Earth, January 2029 Earth.
Arrival at Jupiter: July 2031.

Due to launch on 13 April 2023 to begin an eight-year journey to the largest planet in the Solar System, ESA’s Jupiter Icy Moons Explorer, Juice, will spend three and a half years in the Jupiter system, and in the final phase of its exploration will go into orbit around the largest Jovian moon, Ganymede.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Marokko
Algeria
Länsi-Sahara
Mauritania
Mali
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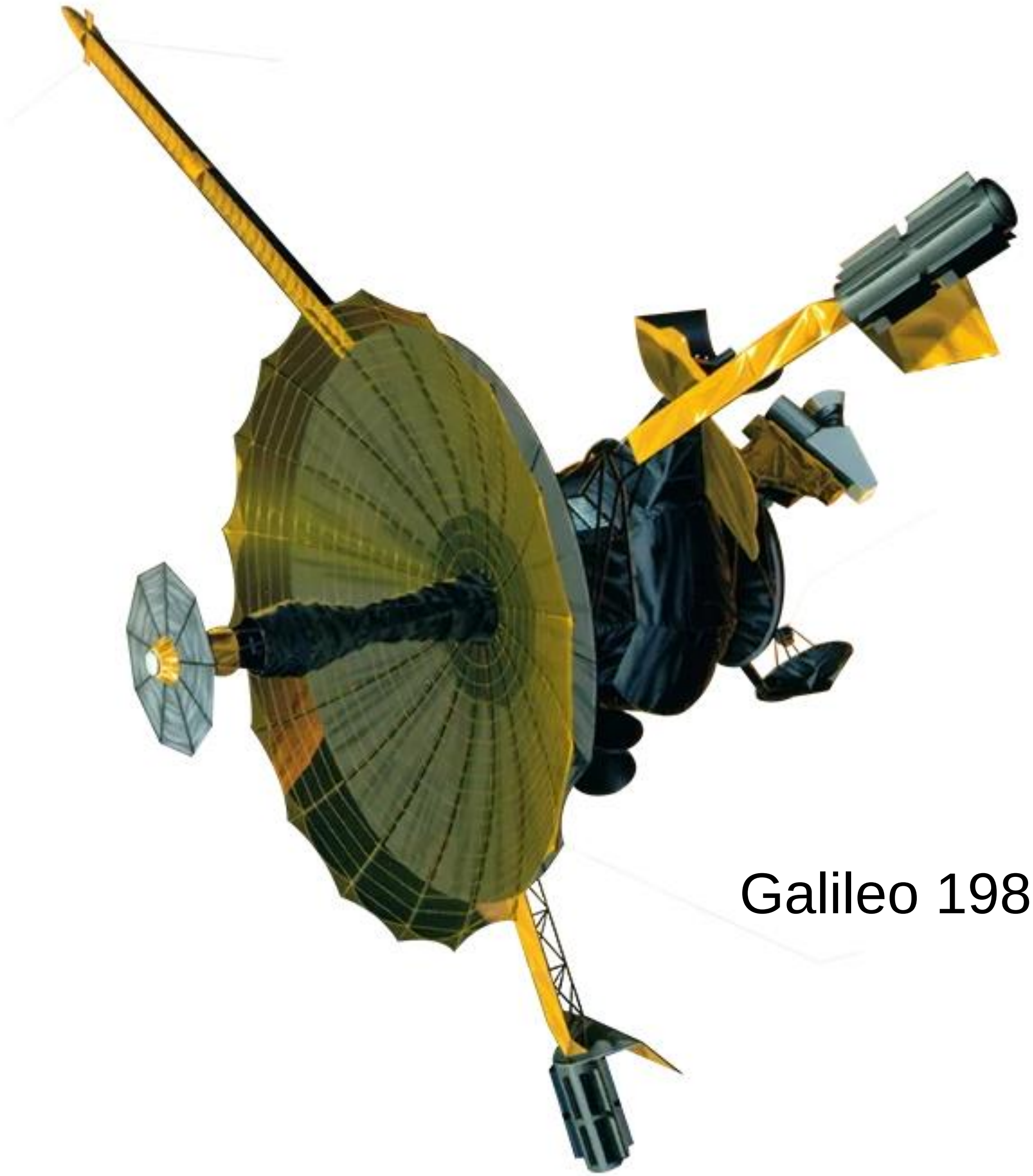
Burkina
Faso
Guinea
Nigeria
Ghana
Guineanlahti
Gabon

Only two spacecraft have orbited Jupiter: the Galileo probe, which studied the gas giant between 1995 and 2003, and Juno, which has been circling the planet since 2016.

The Galileo mission found evidence that oceans of liquid water might exist underneath the ice crust of three of the four main Jovian moons: Europa, Ganymede and possibly Callisto. The mission also found that Ganymede has its own magnetic field — the only known moon to possess one — and that storms in Jupiter's atmosphere can be larger than Earth.

Juno, now in the extended part of its mission, revealed many more details about these storms and found that the planet's atmospheric weather layer extends beyond its visible clouds. The mission also discovered that a core of dilute heavy metals might hide within the mostly gaseous Jupiter.

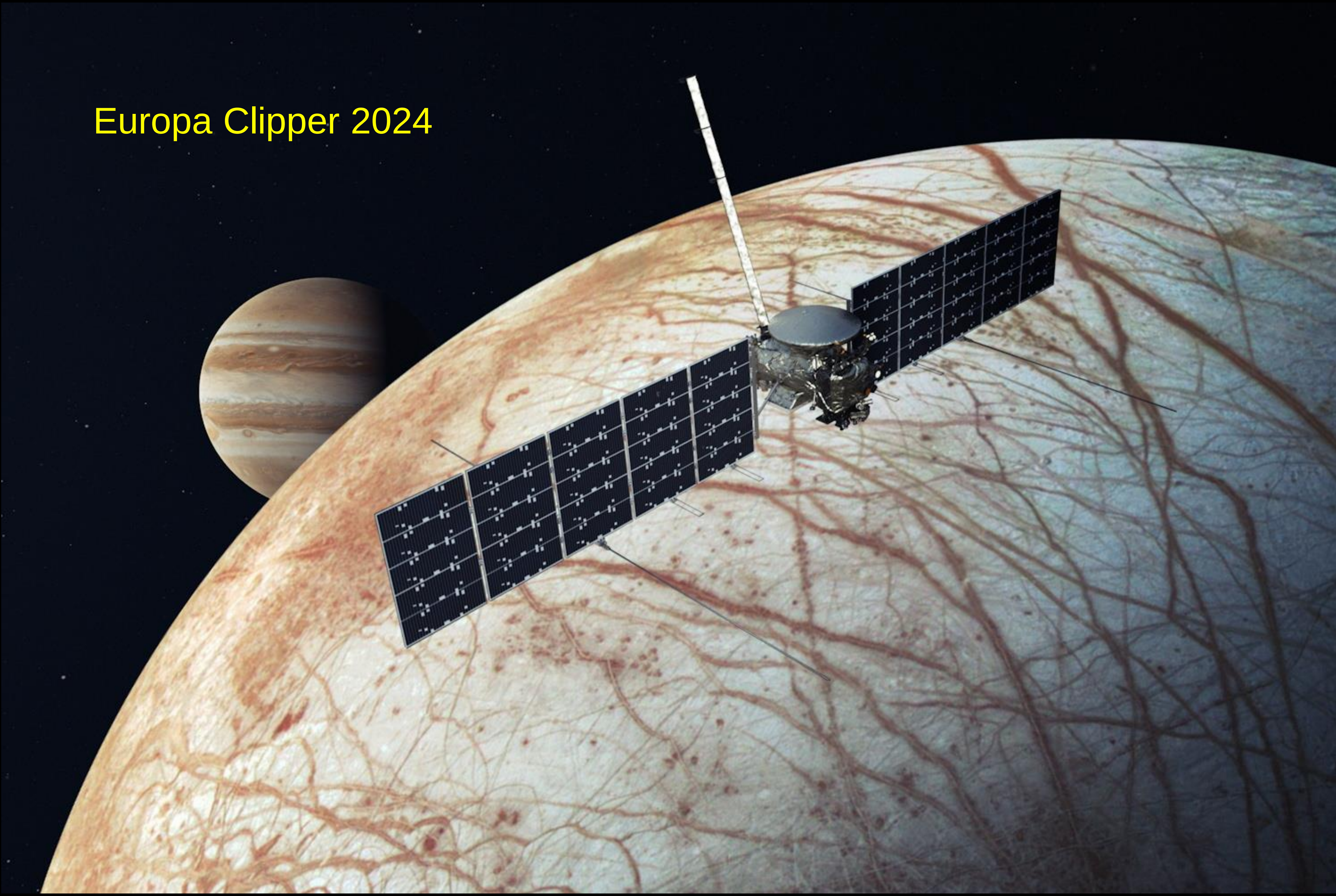


Galileo 1989 - 2003

Juno 2011 -

Because NASA's Europa Clipper spacecraft will already be orbiting Jupiter when JUICE arrives, making regular dives as close as a few dozen miles from Europa's surface, JUICE will focus mostly on Ganymede and the strange, less-explored Callisto.

JUICE will make only two flybys of Europa, coming within 400 kilometers of the moon's ice-covered surface during these excursions, according to ESA's JUICE launch kit. Europa orbits Jupiter at a distance of 671,000 km, nearly double the moon-Earth distance. However, considering Jupiter's extreme size and powerful magnetic field, any spacecraft would survive only a few months, at best, if it were to stay that close to the planet. NASA's Europa Clipper will also follow the flyby approach to exploring this moon, only briefly visiting to study the icy moon and surrounding environment.


Europa Clipper 2024

JUICE will perform 21 flybys of the most distant of the four main moons, Callisto, getting as close as 200 km from its surface. Orbiting nearly 1.9 million km from Jupiter, Callisto is a very different world than the lively Europa, which is believed to have water plumes squirting through its ice crust. At about the size of Mercury, Callisto is the second largest of Jupiter's moons and has a crater-riddled surface that scientists think is the oldest in the solar system. Scientists are unsure whether Callisto has a subsurface ocean like those of Europa and Ganymede, and JUICE is very likely to answer this question.

Before entering orbit around Ganymede, JUICE will perform 12 flybys of the moon, coming within 250 miles of the magnetically active body, according to the ESA launchkit.

Overall, around 24 000 solar cells are needed in total to cover five 2.5 x 3.5 m panels arranged in a distinctive cross-shape with a total area of 85 square metres. The panels will provide the necessary power to run the spacecraft and operate the science instruments once exploring the Jupiter system. They are also able to withstand temperatures from +110 to -230ºC

Dimensions (stowed for launch): 4.09 x 2.86 x 4.35 m

Dimensions (deployed in orbit): 16.8 x 27.1 x 13.7 m

Dry mass (without fuel): 2420 kg. This includes the 'payload adapter' that connects the satellite to the launcher.

Amount of propellant (full tank): 3650 kg. This is a reasonably large volume compared to the spacecraft’s dry mass due to Juice’s numerous planned flybys, manoeuvres and change of orbit from Jupiter to Ganymede (and subsequent necessary orbital reductions at Ganymede).

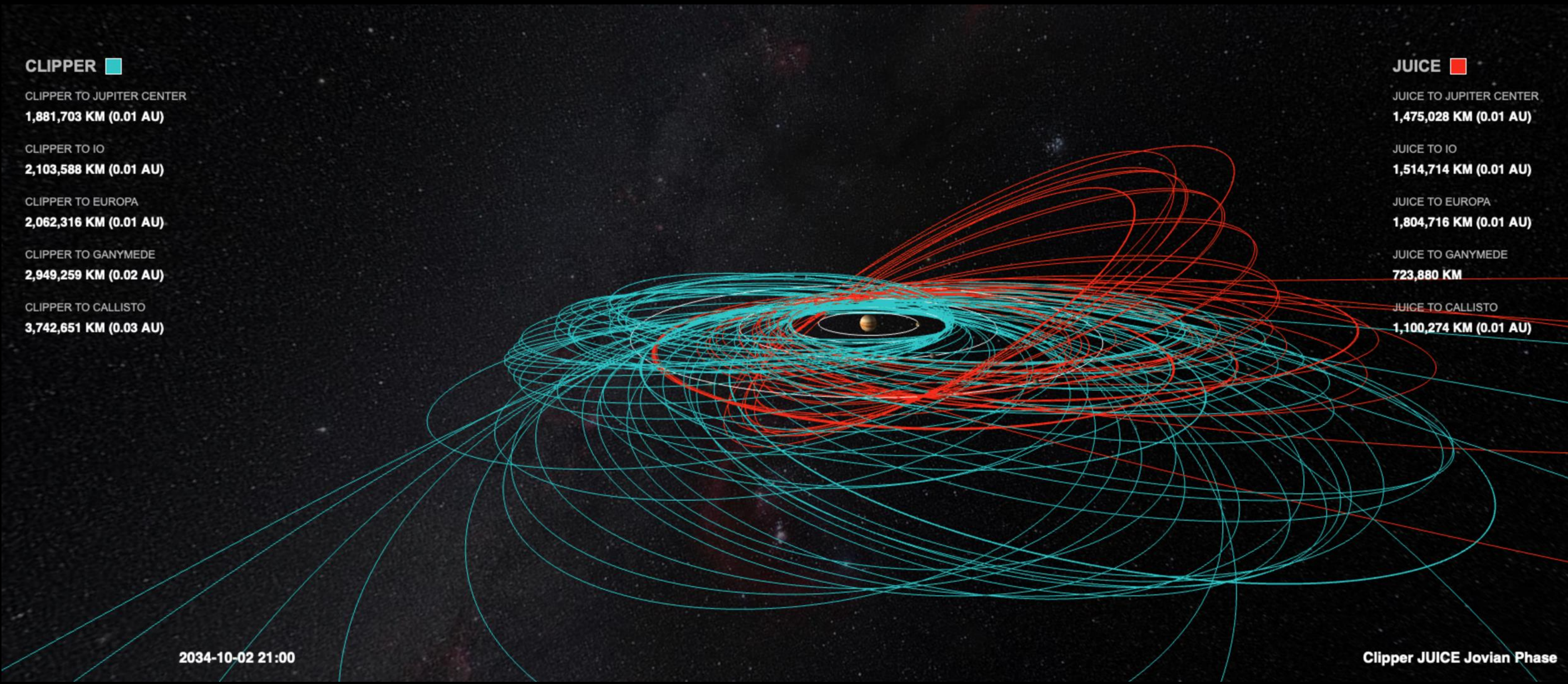
Instrument payload mass: 280 kg

"To reach the Jupiter system safely and on schedule, the spacecraft is taking a very special travel route. Like on any long trip, JUICE will head for various waypoints to 'fill up' with kinetic energy. After its launch into an orbit around the Sun, the spacecraft will first perform a flyby of Earth and the Moon in August 2024 and gain momentum. This momentum will catapult JUICE to Earth's neighbouring planet, Venus, where it will again significantly increase its speed with the next flyby in August 2025. After that, it will return to Earth twice more, in September 2026 and January 2029. JUICE will then have gained so much momentum through two more close fly-bys of our home planet that the spacecraft will finally reach Jupiter in July 2031. Jupiter orbits just over 600 million kilometres away from the Sun," says Christian Chlebek, JUICE Project Manager at the German Space Agency at DLR, explaining the complex flight manoeuvres of the JUICE mission. Once it arrives at Jupiter, the spacecraft will enter an orbit around the gas giant and make a total of 35 close flybys of the icy moons from July 2031 to November 2034

Mission Scenario and Operations

The JUICE spacecraft will be launched in 2023 by Ariane 5 and will use Venus and Earth gravity assists in its 7.6 years cruise to Jupiter. After the orbit insertion in January 2030 the spacecraft will perform a 2.5 year tour in the Jovian system focusing on continuous observations of Jupiter's atmosphere and magnetosphere.

During the tour, gravity assists with Callisto and Ganymede will shape the trajectory. Two targeted Europa flybys are included focusing on composition of the non water-ice material, and the first subsurface sounding of an icy moon. Additional, Callisto gravity assists will be also used to raise the orbit inclination to almost 30° and to enable observations of the Jupiter polar regions. The frequent Callisto flybys will enable unique remote observations of the moon and in situ measurements in its vicinity. The mission will culminate in a dedicated eight months orbital tour around Ganymede during which the spacecraft will perform detailed investigation of the moon and its environment and will eventually impact on Ganymede.



CLIPPER
CLIPPER TO JUPITER CENTER
1,881,703 KM (0.01 AU)
CLIPPER TO IO
2,103,588 KM (0.01 AU)
CLIPPER TO EUROPA
2,062,316 KM (0.01 AU)
CLIPPER TO GANYMEDE
2,949,259 KM (0.02 AU)
CLIPPER TO CALLISTO
3,742,651 KM (0.03 AU)
JUICE
JUICE TO JUPITER CENTER
1,475,028 KM (0.01 AU)
JUICE TO IO
1,514,714 KM (0.01 AU)
JUICE TO EUROPA
1,804,716 KM (0.01 AU)
JUICE TO GANYMEDE
723,880 KM
JUICE TO CALLISTO
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Clipper JUICE Jovian Phase

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CLEAR AREA
©2023 ESA-CNES-ARIANESPACE / Optique vidéo du CSG - S MARTIN

After that, things will get exciting again in December 2034. For the first time ever, a spacecraft will change from orbiting another planet to orbiting one of its moons. When JUICE reaches the moon Ganymede, it will also be the first spacecraft ever to orbit a moon other than Earth's natural satellite. In the final part of this journey, DLR's GALA instrument will primarily scan this moon's ice shell for evidence of a subsurface ocean, before JUICE impacts the moon's surface at the end of the mission.

Mistä kyse

ESA’s Jupiter Icy Moons Explorer, Juice, will make detailed observations of the giant gas planet and its three large ocean-bearing moons – Ganymede, Callisto and Europa – with a suite of remote sensing, geophysical and in situ instruments. The mission will characterise these moons as both planetary objects and possible habitats, explore Jupiter’s complex environment in depth, and study the wider Jupiter system as an archetype for gas giants across the Universe.

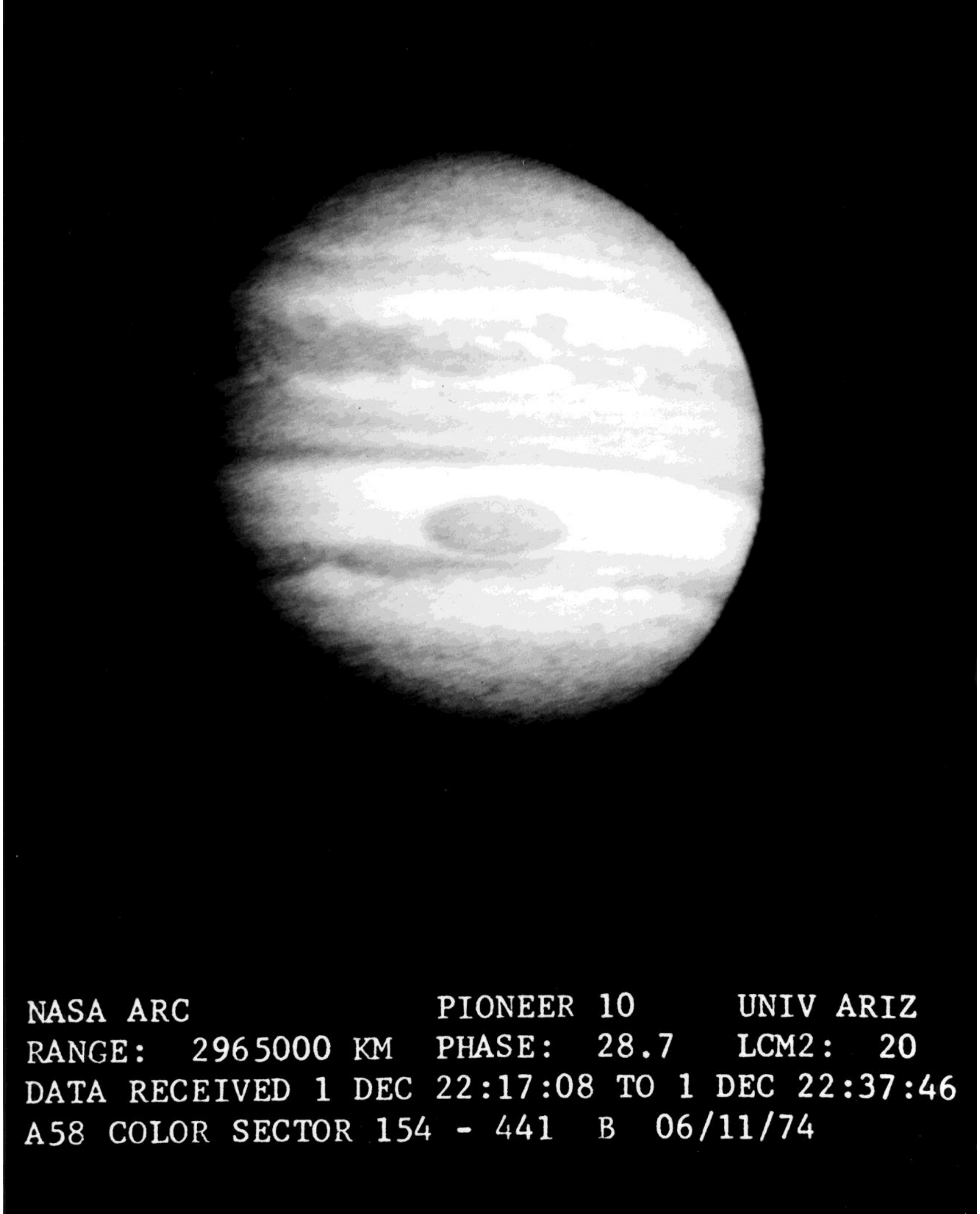
Mistä kyse

ESA’s Jupiter Icy Moons Explorer, Juice, is headed to the largest structure in the Solar System – not the gas giant itself but the mammoth magnetic field that it generates. Its exact size varies with the solar wind, but Jupiter’s magnetosphere is on average 20 million kilometres across, which is about 150 times wider than its parent planet and almost 15 times the diameter of the Sun. But within that field lurks a clear and present danger to space missions – intense belts of radiation much more energetic and intense than Earth’s own Van Allen belts.

Juice will fly past Callisto 21 times, but will only fly past Europa twice – in the process sustaining a third of all its lifetime radiation exposure – before settling into orbit around Ganymede, a moon with its own magnetic field, which works to shield some of Jupiter's radiation.

Enhanced image of Ganymede obtained by the JunoCam imager aboard NASA's Juno spacecraft (NASA/JPL-Caltech/SwRI/MSSS/Kalleheikki Kannisto).

1.12.1974


NASA ARC
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UNIV ARIZ
RANGE: 2965000 KM
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LCM2: 20
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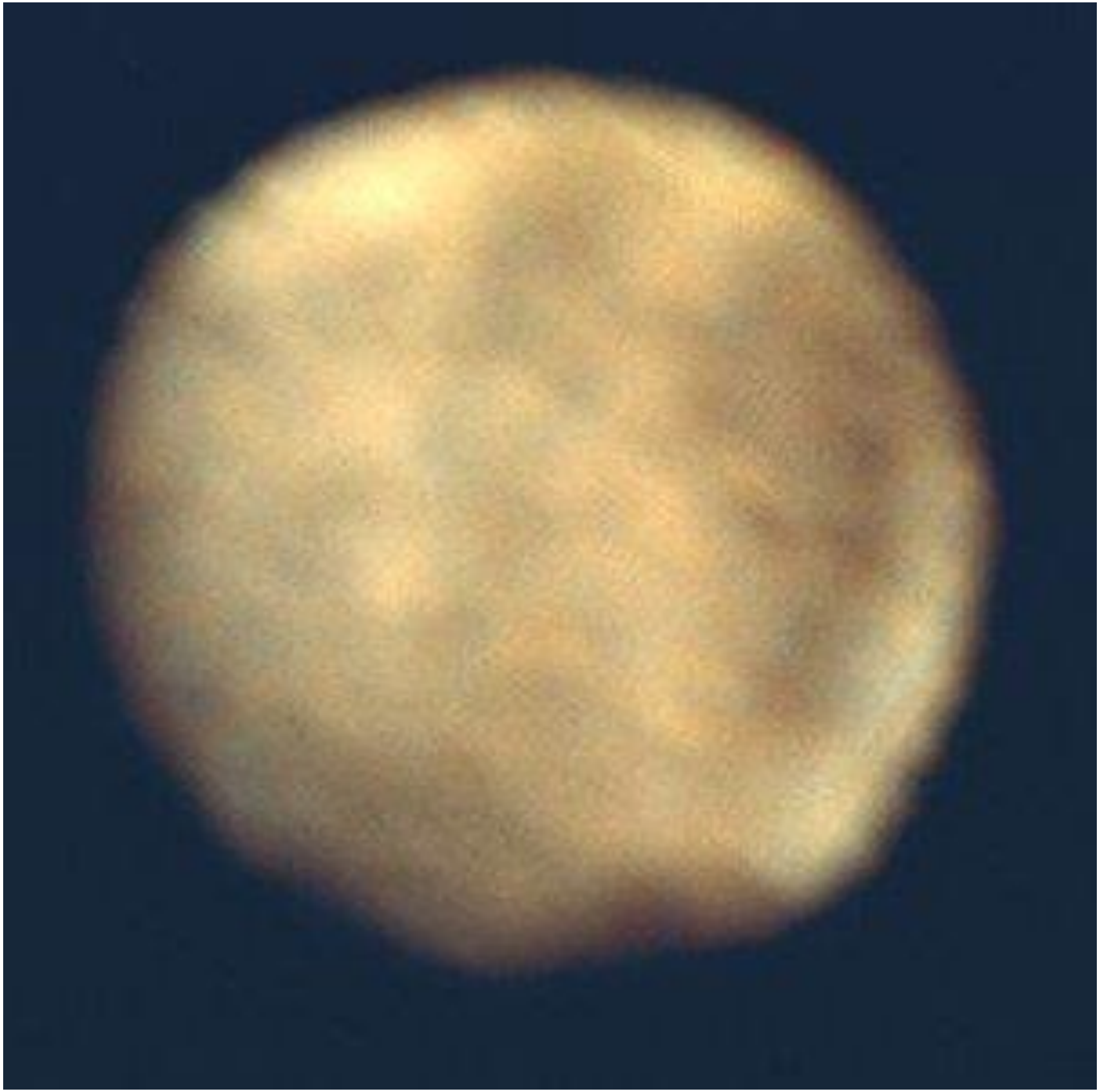
A58 COLOR SECTOR 154 - 441 B 06/11/74



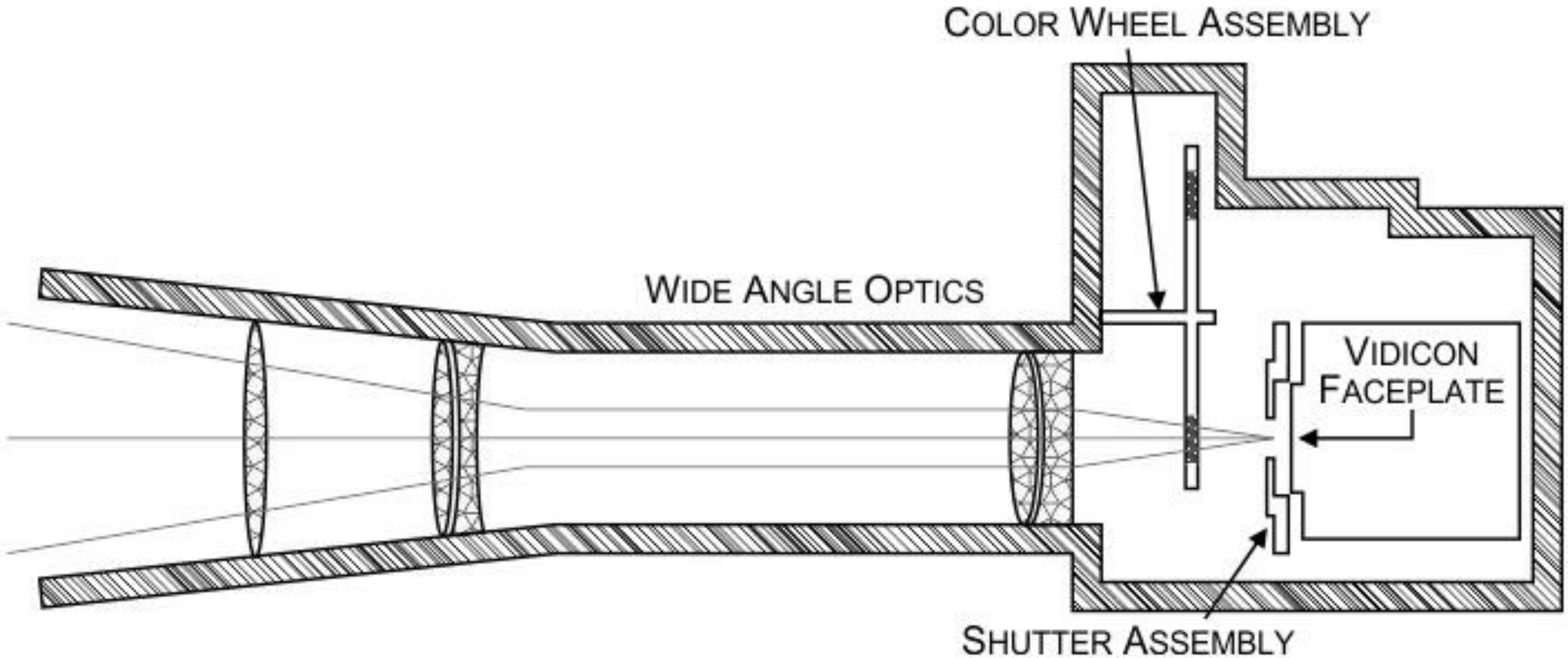
Pioneer 10 Ganymedes 1.7.1973

Voyager cameras

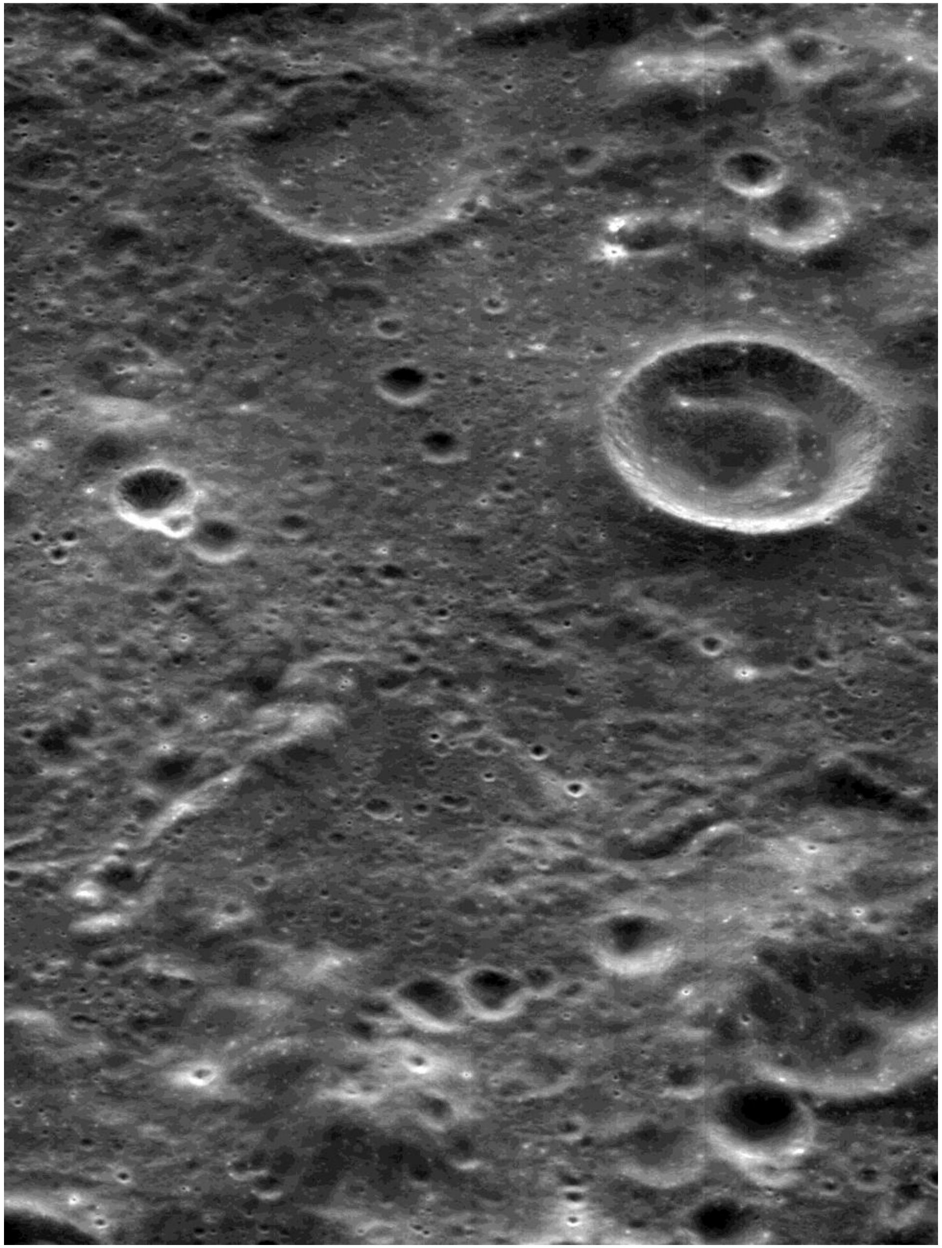
The cameras of Voyager had a resolution of 800 by 800 pixels. There are 8 bits per pixel. One with a 1500 mm telescope with a (horizontal and vertical) field of view of 0.424 degree (25.44 arcminutes) and a theoretical resolution of 1.18 arcseconds. The pixel resolution was 1.908 arcseconds. At the closest approach of Voyager 2 to Jupiter (570,000 km), the resolution was about 5.27 km/pixel.

The other wide angle camera with 202 mm focal length, a field of view of 3.169 degrees and a theoretical resolution of 2.87 arcseconds.

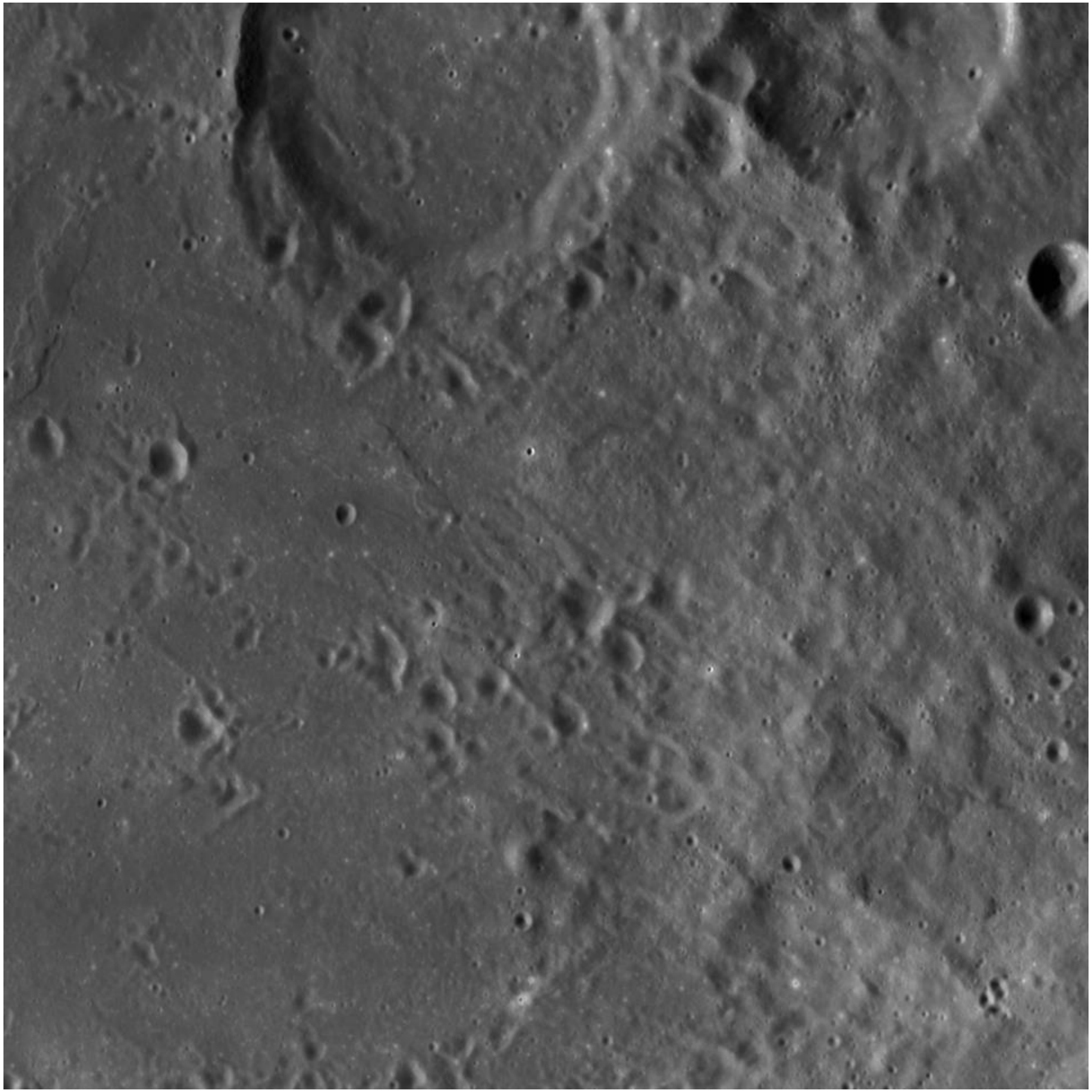
Voyager cameras



The other is a narrow-angle 1500 mm f.l., 176mm aperture, (f/11.8 effective aperture with obscuration and transmission losses) camera that is sensitive to a spectral range of 420 nm to 620 nm that has a field of view of 0.4°. A filter wheel with notch filters in the range of 345 nm to 590 nm filter has two clear filters, two green filters, and one violet, blue, orange, and ultraviolet filter.

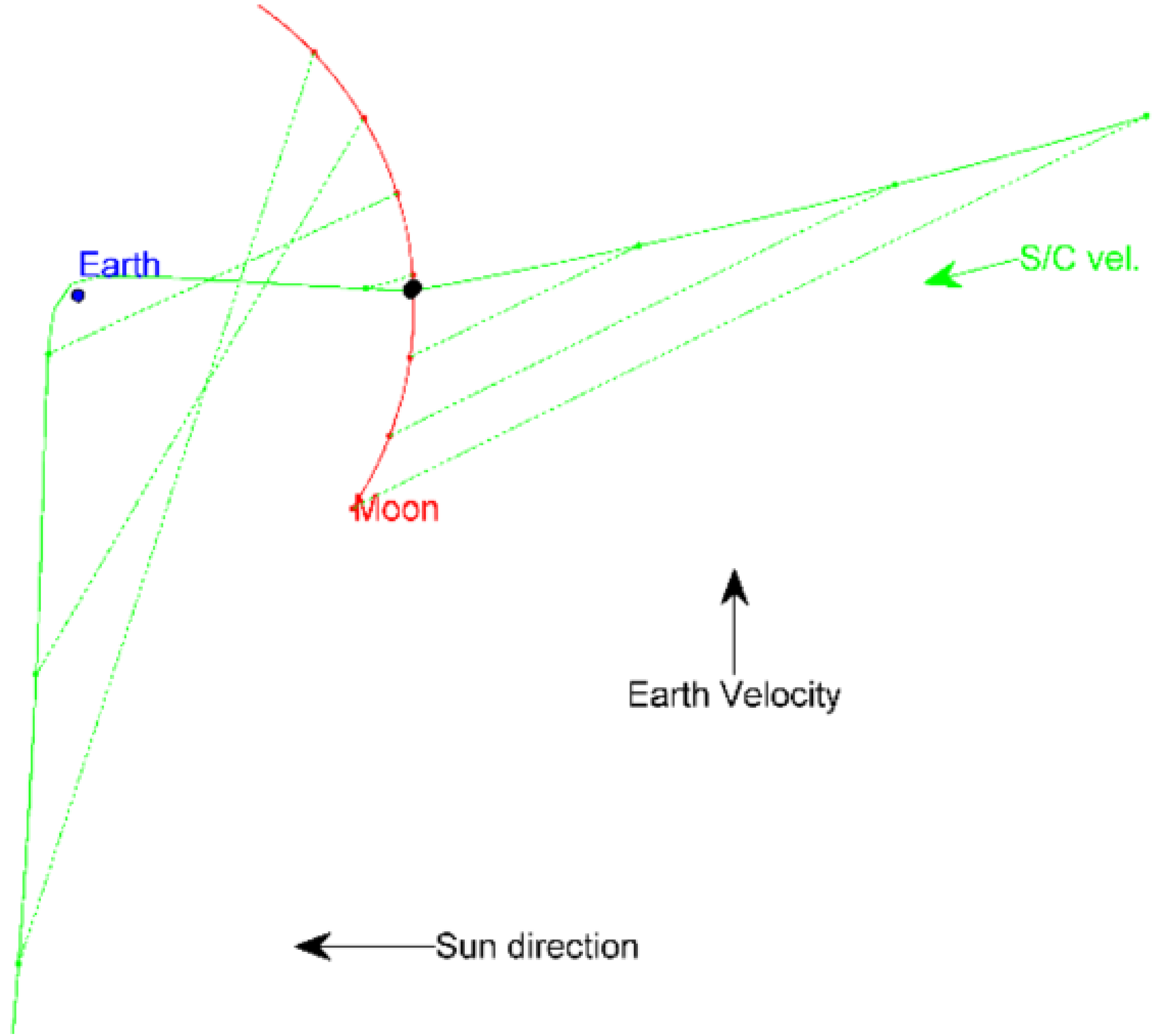


This image of our own Moon was taken during Juice’s lunar-Earth flyby on 19 August 2024. The main aim of JANUS’s observations during the lunar-Earth flyby was to evaluate how well the instrument is performing, not to make scientific measurements



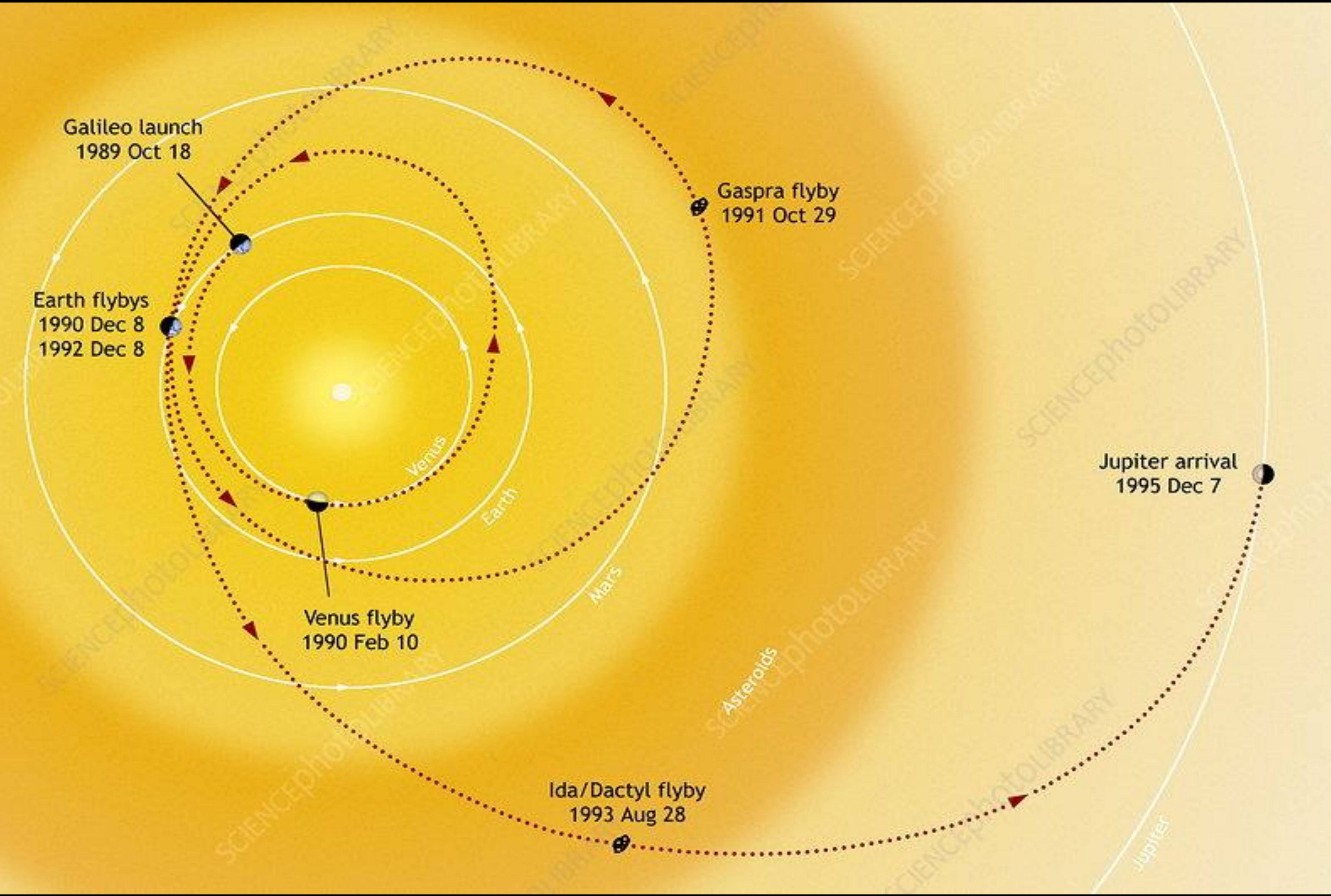
The closest approach to the Moon was at (21:15 UTC) on 19 August 2024, guiding Juice towards a closest approach to Earth just over 24 hours later at (21:56 UTC) on 20 August.

Navigointikameran kuva Kuusta

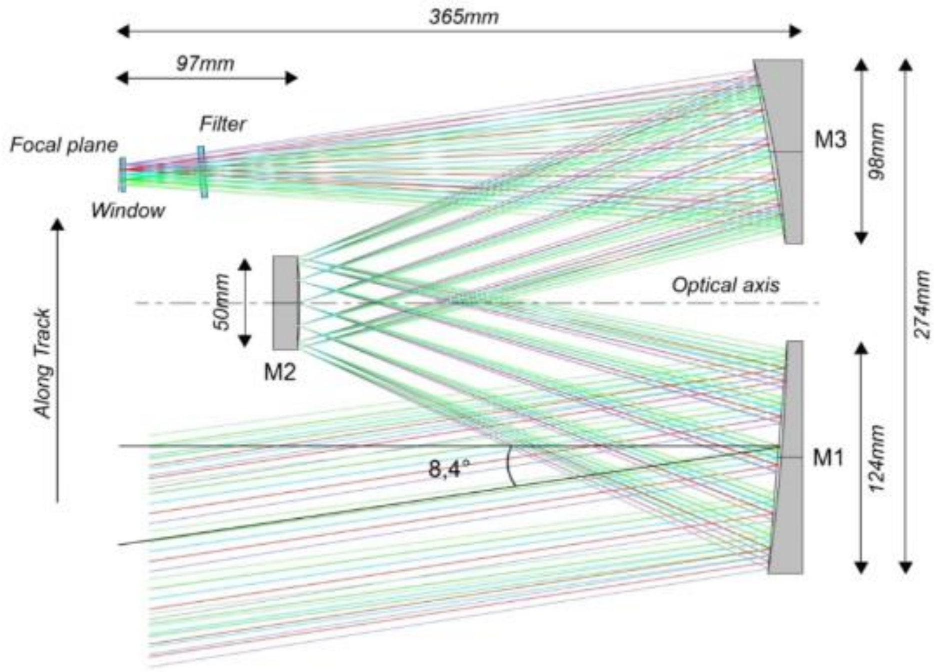

Earth
Moon
S/C vel.
Earth Velocity
Sun direction

The flyby of the Moon increased Juice's speed by 0.9 km/s relative to the Sun, guiding Juice towards Earth. The flyby of Earth reduced Juice's speed by 4.8 km/s relative to the Sun, guiding Juice onto a new trajectory towards Venus. Overall, the lunar-Earth flyby deflected Juice by an angle of 100° compared to its pre-flyby path.

The inherently risky flyby required ultra-precise, real-time navigation, but is saving the mission around 100–150 kg of fuel. In the month before the flyby, spacecraft operators gave Juice slight nudges to put it on exactly the right approach trajectory.

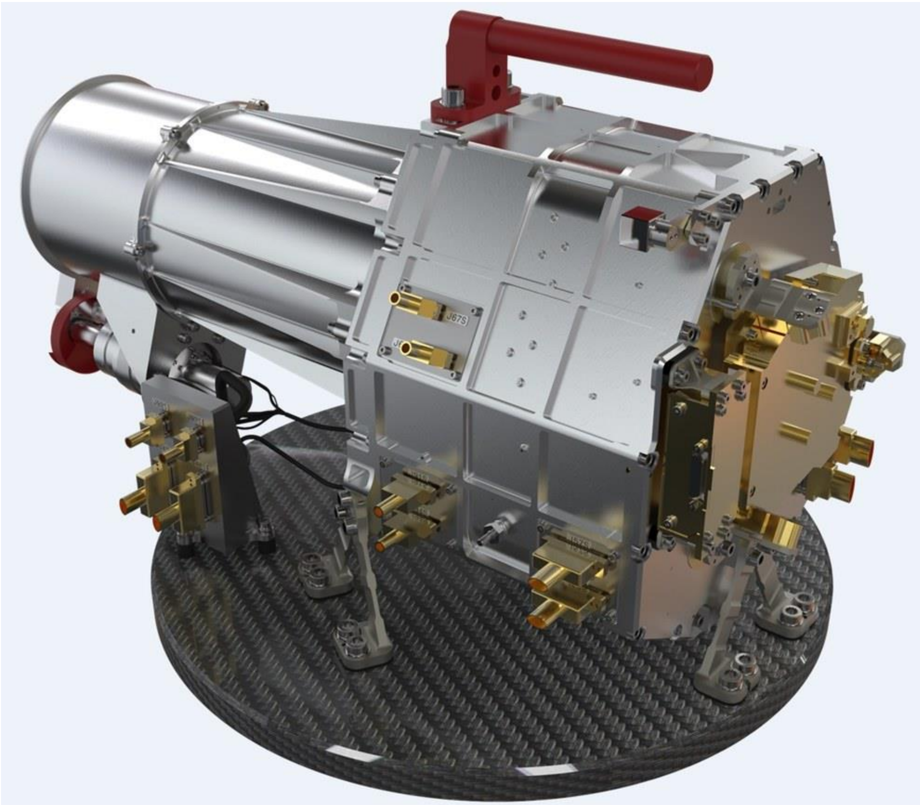


Galileo-luotaimen reitti Jupiteriin

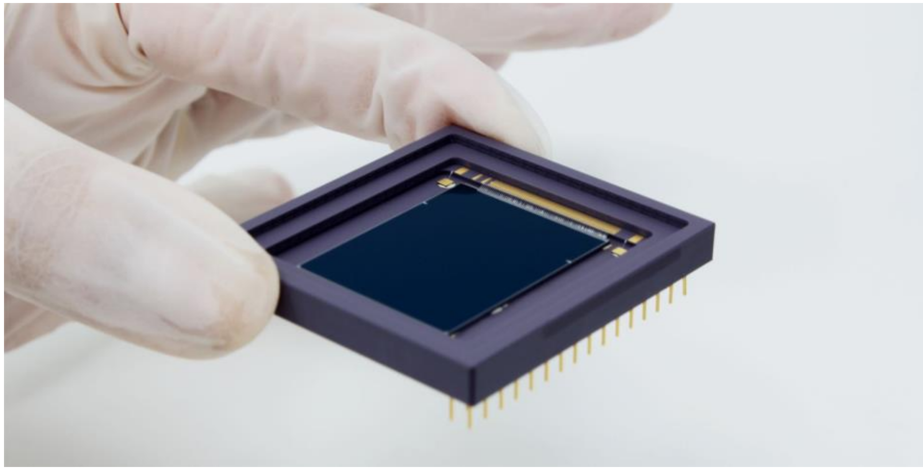


Specification	Value
Entrance pupil diameter	100 mm
Effective focal length	467 mm
F/#	4.67
Field of View	1.72 x 1.29 degree^2
Detector format	2000 x 1504
Pixel size	7 μm
Pixel scale	15 μrad/pixel
Spectral range	350 – 1050 nm

The JANUS camera onboard ESA's Jupiter Icy Moons Explorer (Juice) is designed to take detailed, high-resolution photos of Jupiter and its icy moons. JANUS will study global, regional and local features and processes on the moons, as well as map the clouds of Jupiter. It will have a resolution up to 2.4 m per pixel on Ganymede and about 10 km per pixel at Jupiter.



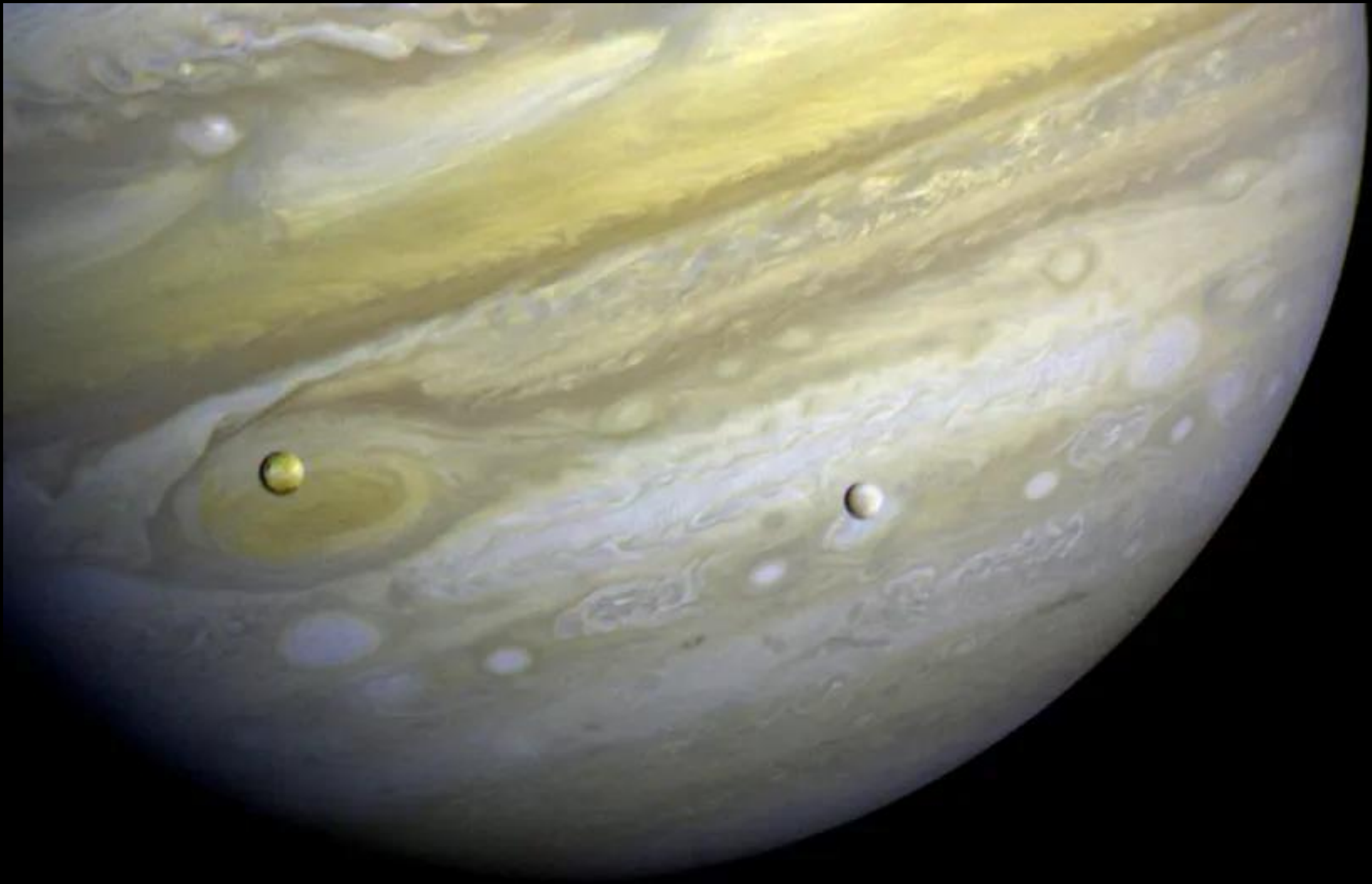
The JANUS camera consists of three spatially separated units – the optical head including the telescope, the filter wheel and the FPM. In addition, there are proximity and main electronics including camera control, data management, image data compression and a power supply unit. The catadioptric telescope – an optical system that has both refractive lenses and reflective mirrors – has excellent optical qualities and is coupled with a framing detector. This employs a sensor with 2000 by 1504 pixels, located in the FPM.



The CIS115 CMOS sensor is the second generation of an evaluation sensor, the CIS107. It is a back side illuminated detector with 4 parallel outputs.

Aperture: 116 mm Focal length: 467 mm
FOV: 1.29° x 1.72° (along track x across track)
Detector: Teledyne-e2v CMOS detector with 1504 x 2000 pixels
Detector pixel size: 7 x 7 µm2
Resolution: 7.5 m/pix from 500 km altitude
Number of Filter: 13 filters, covering the wavelength range 340 – 1080 nm.

Voyager 1



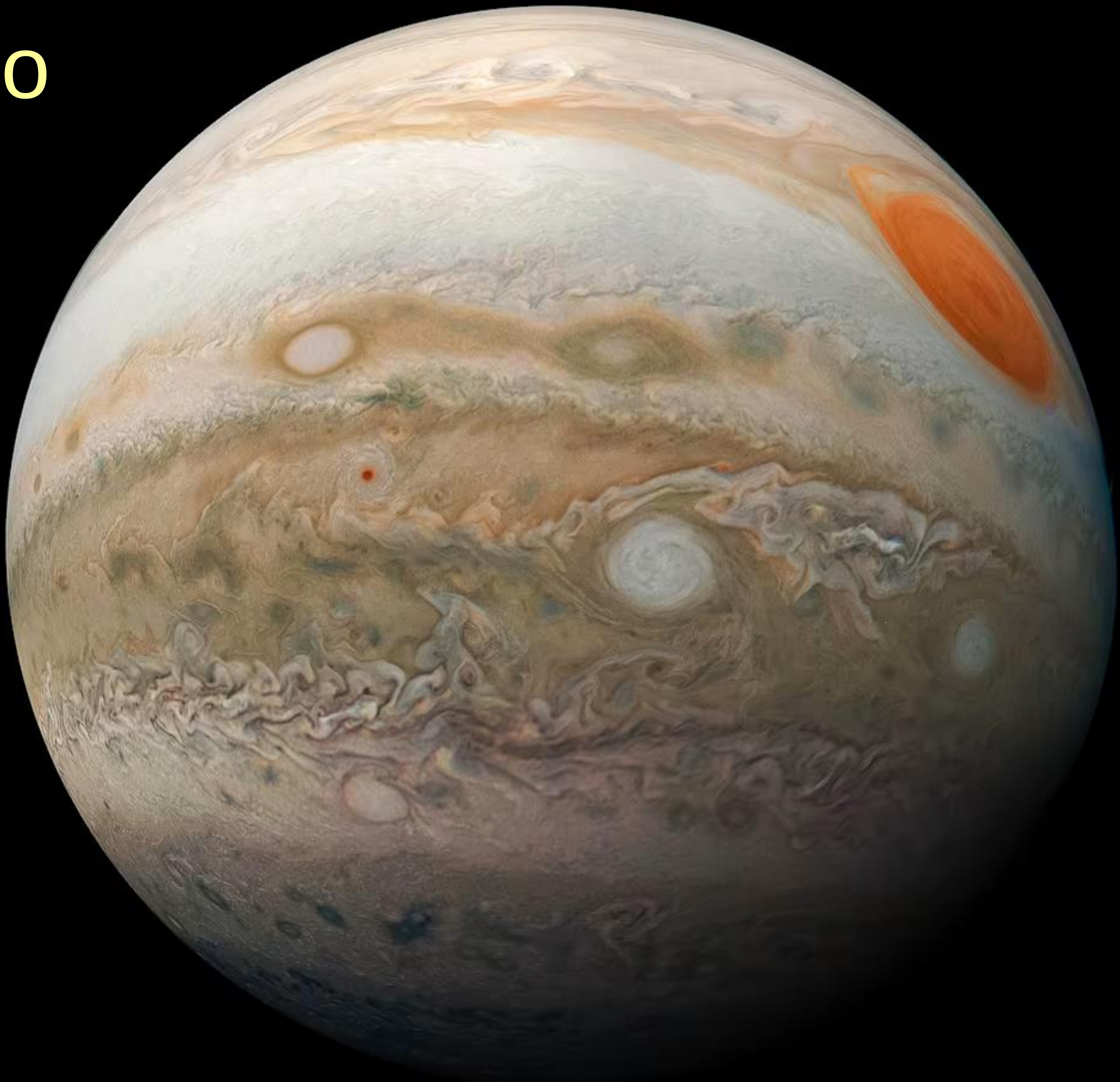
Maaliskuu 1979

This picture of Jupiter and Io was taken by Voyager 2 on June 10, 1979 from a distance of 24 million kilometers. On top of Jupiter's brightly colored cloud patterns is the shadow of Ganymede, the largest of the Jovian satellites.

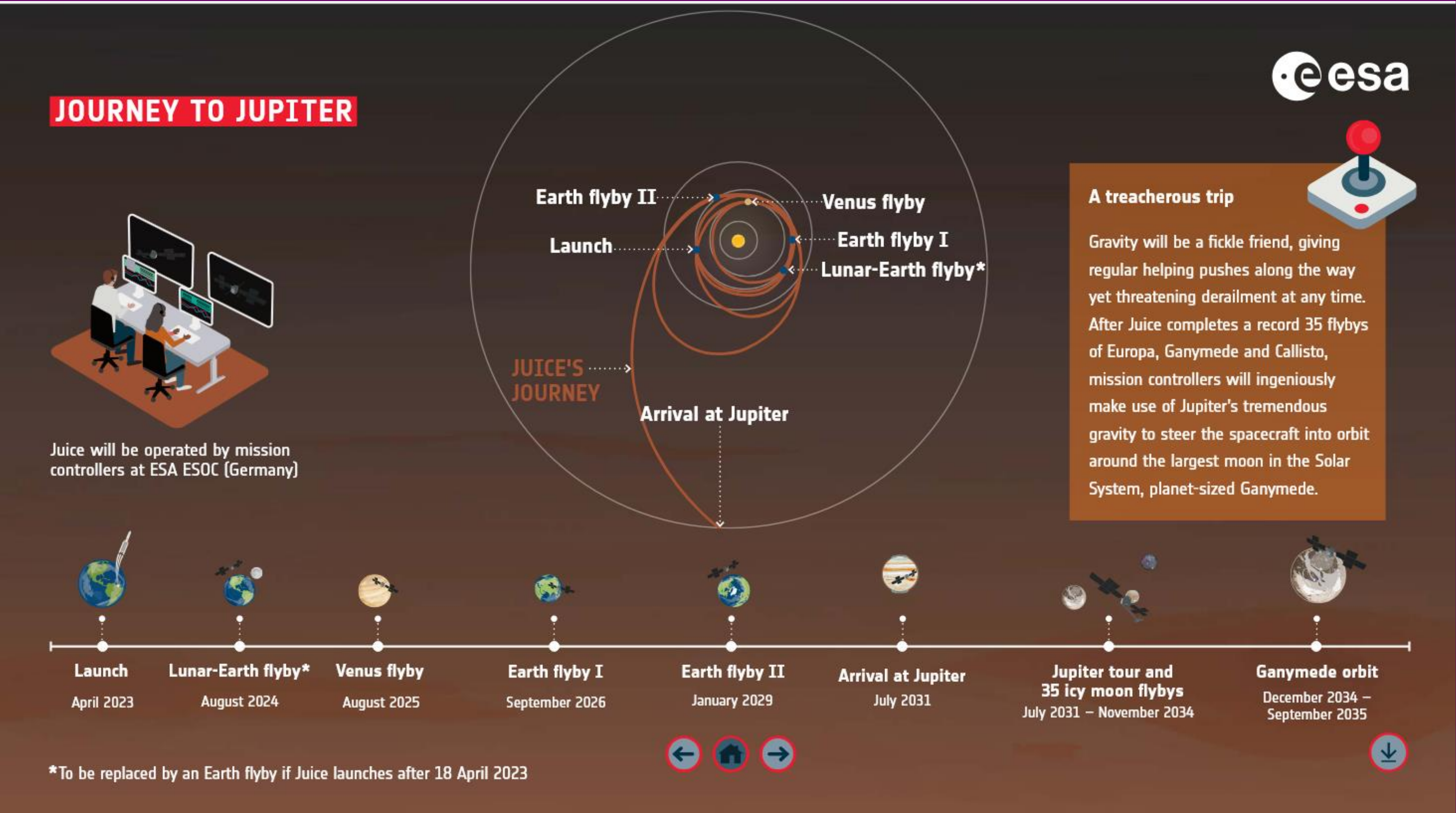
Cassini

This true color mosaic of Jupiter was constructed from images taken by the narrow angle camera onboard NASA's Cassini spacecraft on December 29, 2000, during its closest approach to the giant planet at a distance of approximately 10 million kilometers.
It is the most detailed global color portrait of Jupiter ever produced; the smallest visible features are approximately 60 kilometers across. The mosaic is composed of 27 images: and each of those locations was imaged in red, green, and blue to provide true color.

Juno



Juno



Operointikeskus Saksassa, Darmstadt

The station provides routine spacecraft tracking support to ESA's deep-space missions such as Venus Express, Mars Express and BepiColombo, and scientific missions such as Herschel, Planck, LISA Pathfinder and Gaia, as well as to other agencies' missions under resource-sharing agreements.

Malargüe, Argentina

The Malargüe station incorporates state-of-the-art technology. Its technical facilities comprise Ka-band reception (31.8–32.3 GHz) and X-band transmission and reception. It is prepared to host Ka-band transmission (34.3–34.7 GHz) and K-band reception (25.5–27 GHz).

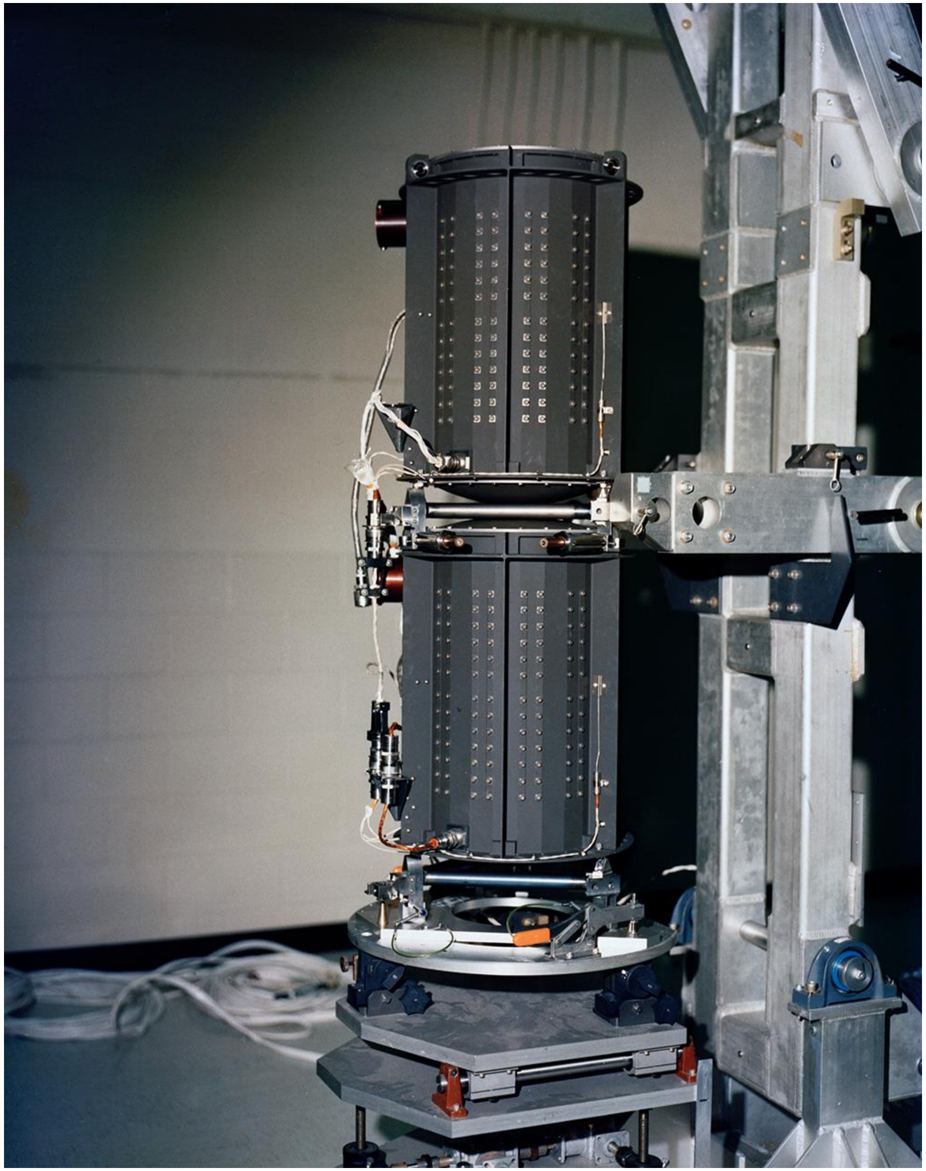
Its main functions are to receive telemetry, send telecommands and perform radiometric measurements (ranging, Doppler, Delta-DOR) on scientific and deep-space craft.

The dish is 35 m in diameter and the entire structure is 40 m high; its moving antenna weighs 610 tonnes. Engineers can move the antenna with a speed of up to 1 degree per second in all axes. The servo control system ensures the highest possible pointing accuracy under the site's harsh environmental, wind and temperature conditions.

The station has a frequency and timing system based on atomic clocks using masers and crycooled sapphires. Communications are via the ESA Operations Network (OPSNET). The site is equipped with a no-break power plant.

Voyager RTG

Both Voyager probes power themselves with radioisotope thermoelectric generators (RTGs), which convert heat from decaying plutonium-238 into electricity. The continual decay process means the generator produces slightly less power each year.



Aurinkokennoista

Divided into ten panels each measuring 2.5x3.5m, JUICE’s solar wings will produce energy during its long journey to Jupiter. The solar energy will enable JUICE to carry out 35 fly-bys of Europa, Ganymede and Callisto and generate the 820 watts of power needed to operate the ten scientific instruments on board.

NASAn Europa Clipper käyttää samaa aurinkokennoa.

Aurinkokennoista

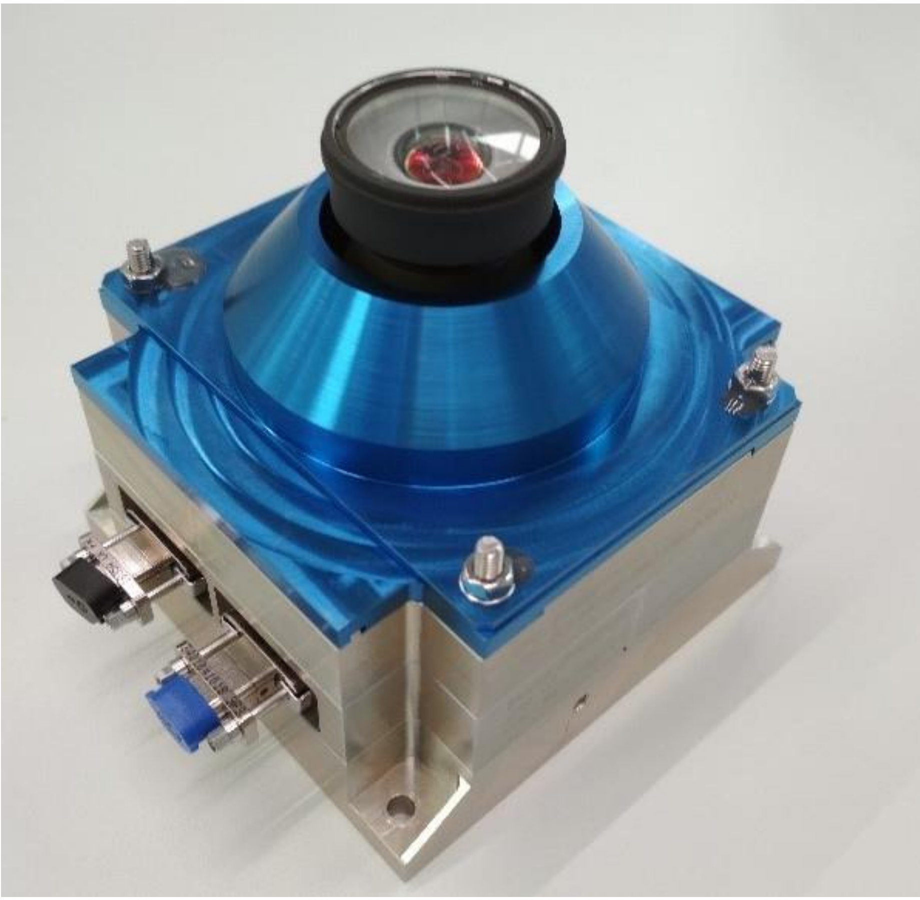
Operating with lower currents than the standard design meant the thickness of solar cell ’metallisation’ on their front side, used to transfer those currents, could be reduced without impeding functionality, while the Germanium backing that the cells were laid down on was also ground away – thinning each one from 150 down to 100 micrometres.

Conversely, the cover glass was thicker than normal, to protect the solar cells against radiation, coated with a nanometre-scale layer of Indium Tin Oxide and interconnected by tiny copper wires to prevent buildups of electrostatic charge from the energetic particles encountered in space – which might otherwise end up influencing results from Juice’s sensitive magnetic and plasma instruments.

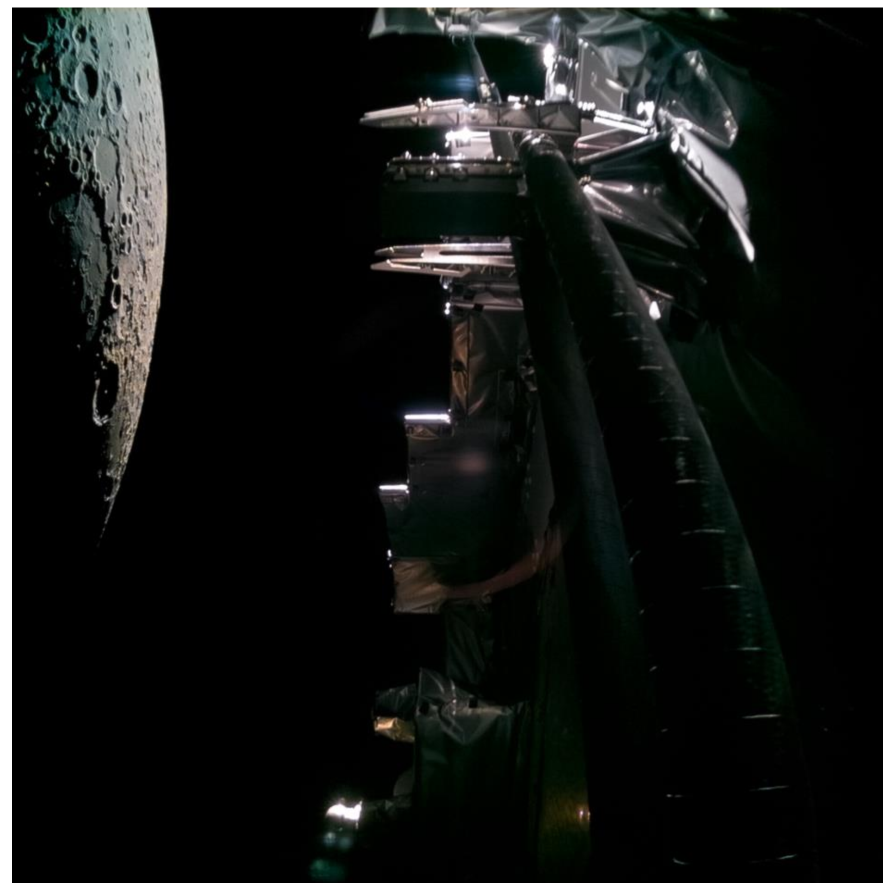

© AIRBUS 2022 / Jean Baptiste ACCARIEZ / Master Films
AIRBUS

Monitoring camera

The images are provided in 1024 x 1024 pixel resolution and can be processed in colour. Their purpose is to monitor the spacecraft's various booms and antennas, especially during the challenging deployment period following launch.



1024 x 1024 pixel resolution



Laitteista

Development: ESA-led mission. NASA has contributed one instrument (UVS) and hardware for two European-provided instruments (RIME and PEP), while JAXA has contributed hardware for various European-provided instruments (SWI, PEP, GALA, RPWI).

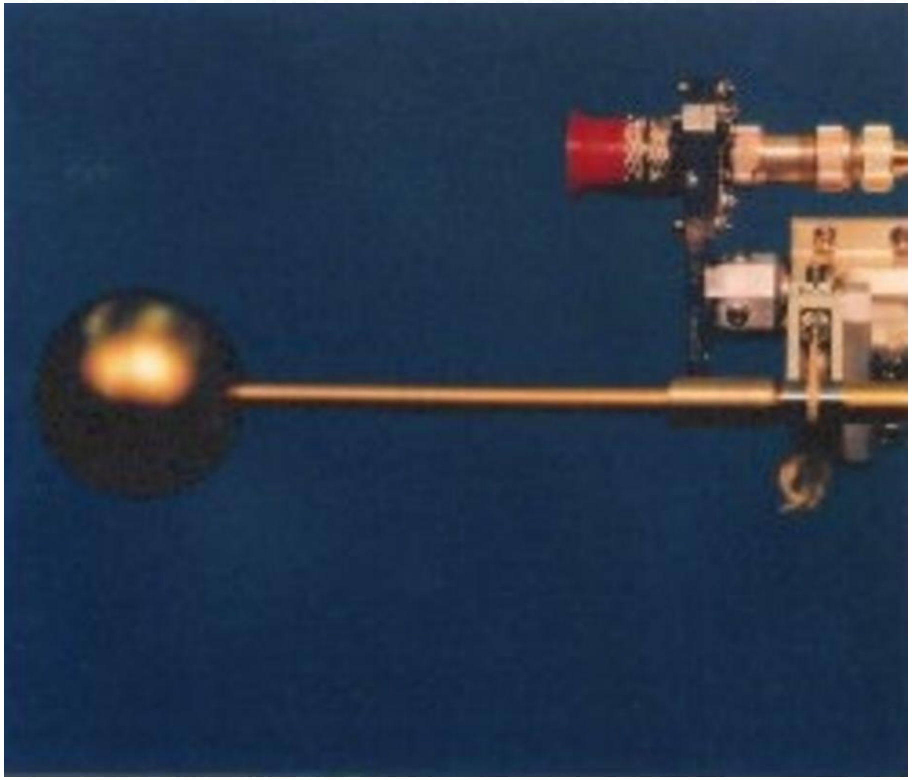
Laitteista

A remote sensing package (JANUS, MAJIS, UVS, SWI) includes imaging and spectral imaging capabilities from the ultraviolet to the sub-millimetre wavelengths

A geophysical package comprises a laser altimeter (GALA) and a radar sounder (RIME) for exploring the moons' surface and subsurface, and a radio science experiment (3GM) to probe the atmospheres of Jupiter and its satellites and to measure their gravity fields

An in situ package contains a powerful suite of instruments to study the particle environment (PEP), a magnetometer (J-MAG), and a radio and plasma wave instrument (RPWI), including electric and magnetic fields sensors and four Langmuir probes

Langmuir-anturi



ESA Cassini's Langmuir probe

Langmuir-anturi on laite, jota käytetään plasman elektronien lämpötilan, elektronitiheyden ja sähköpotentiaalin määrittämiseen. Se toimii asettamalla yksi tai useampi elektrodi plasmaan siten, että eri elektrodien välillä tai niiden ja ympäröivän suonen välillä on vakio tai ajallisesti vaihteleva sähköpotentiaali.

Laitteista

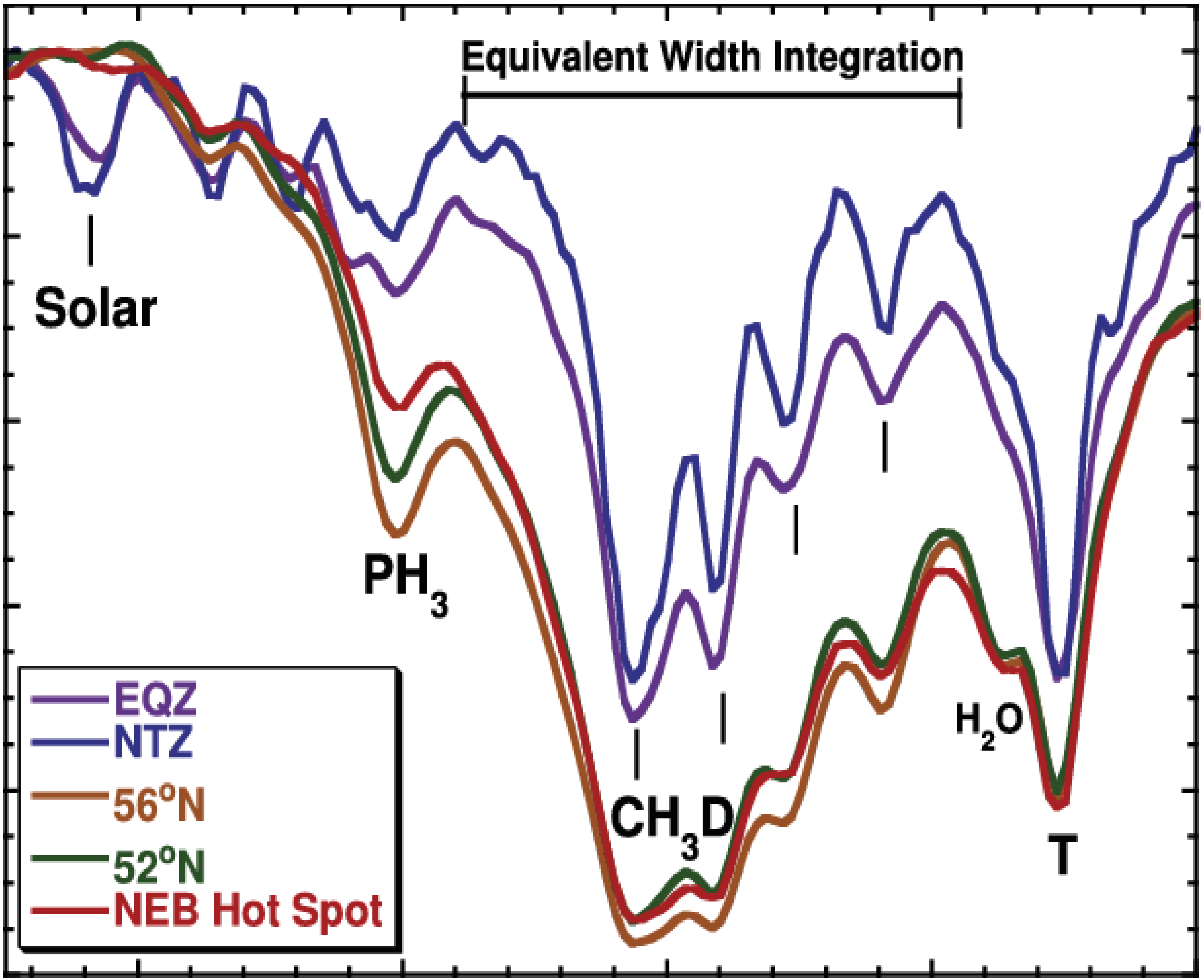
JANUS - Camera system
An optical camera to study global, regional and local morphology and processes on the moons, and to perform mapping of the clouds on Jupiter.
JANUS will have 13 filters, a 1.3 degree field of view, and spatial resolution up to 2.4 m on Ganymede and about 10 km at Jupiter.

Principal Investigator: P. Palumbo, Università degli Studi di Napoli "Parthenope", Italy
Lead Funding Agency: ASI, Italy

MAJIS

MAJIS - Moons and Jupiter Imaging Spectrometer
A hyper-spectral imaging spectrometer for observing tropospheric cloud features and minor species on Jupiter and for the characterisation of ices and minerals on the surfaces of icy moons.
MAJIS will cover the visible and infrared wavelengths from 0.4 to 5.7 microns, with spectral resolution of 3-7 nm. The spatial resolution will be up to 25 m on Ganymede and about 100 km on Jupiter.

Principal Investigator: F. Poulet, Institut d'Astrophysique Spatiale, France
Lead Funding Agency: CNES, France



Jupiterin spektriä eri kohdilta noin 4,6 mikrometrin infrapuna-alueella

UVS

UVS - UV imaging Spectrograph

A UV spectrometer to characterise the composition and dynamics of the exospheres of the icy moons, to study the Jovian aurorae, and to investigate the composition and structure of the upper atmosphere. The instrument will perform both nadir observations and solar and stellar occultation sounding.

UVS will cover the wavelength range 55-210 nm with spectral resolution of <0.6 nm. Spatial resolution will reach 0.5 km at Ganymede and up to 250 km at Jupiter.

Principal Investigator: R. Gladstone, Southwest Research Institute, USA

Lead Funding Agency: NASA, USA

UVS - First instrument delivered for Jupiter Icy Moons Explorer - 25 February 2020

SWI

SWI - Sub-millimeter Wave Instrument
A sub-millimeter wave instrument to investigate the temperature structure, composition and dynamics of Jupiter's stratosphere and troposphere, and the exospheres and surfaces of the icy moons.
SWI is a heterodyne spectrometer using a 30 cm antenna and working in two spectral ranges 1080-1275 GHz and 530-601 GHz with spectral resolving power of ~107.

Principal Investigator: P. Hartogh, Max-Planck-Institut für Sonnensystemforschung, Germany
Lead Funding Agency: DLR, Germany

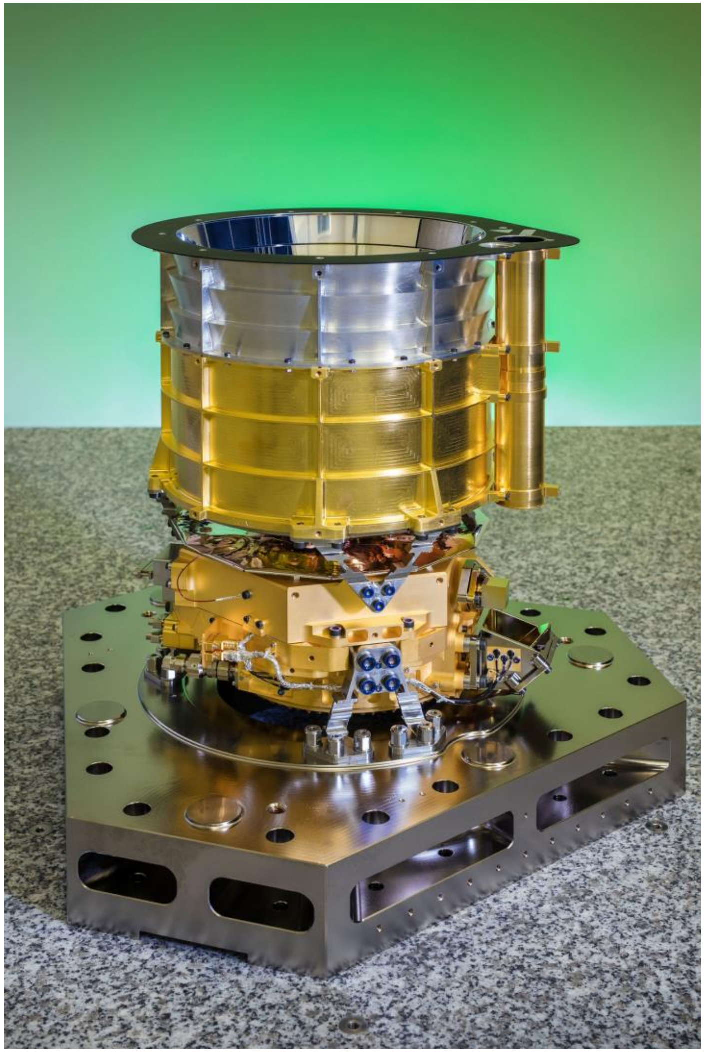
GALA

GALA - GAnymede Laser Altimeter
A laser altimeter for studying the tidal deformation of Ganymede and the morphology and topography of the surfaces of the icy moons.
GALA will have a 20 m spot size and 0.1 m vertical resolution at 200 km.

Principal Investigator: H. Hussmann, DLR, Institut für Planetenforschung, Germany
Lead Funding Agency: DLR, Germany

Vyöryfotodiodi

When conducting measurements, GALA sends short laser pulses down to the surface of the icy moon currently under investigation, Europa, Ganymede or Callisto. At the surface, the pulses are reflected and detected by the receiving telescope, which has a diameter of 25 centimetres, and sent to a highly sensitive detector called an avalanche photodiode.



Valon kulkuaikaan perustuva etäisyysmittari.

RIME

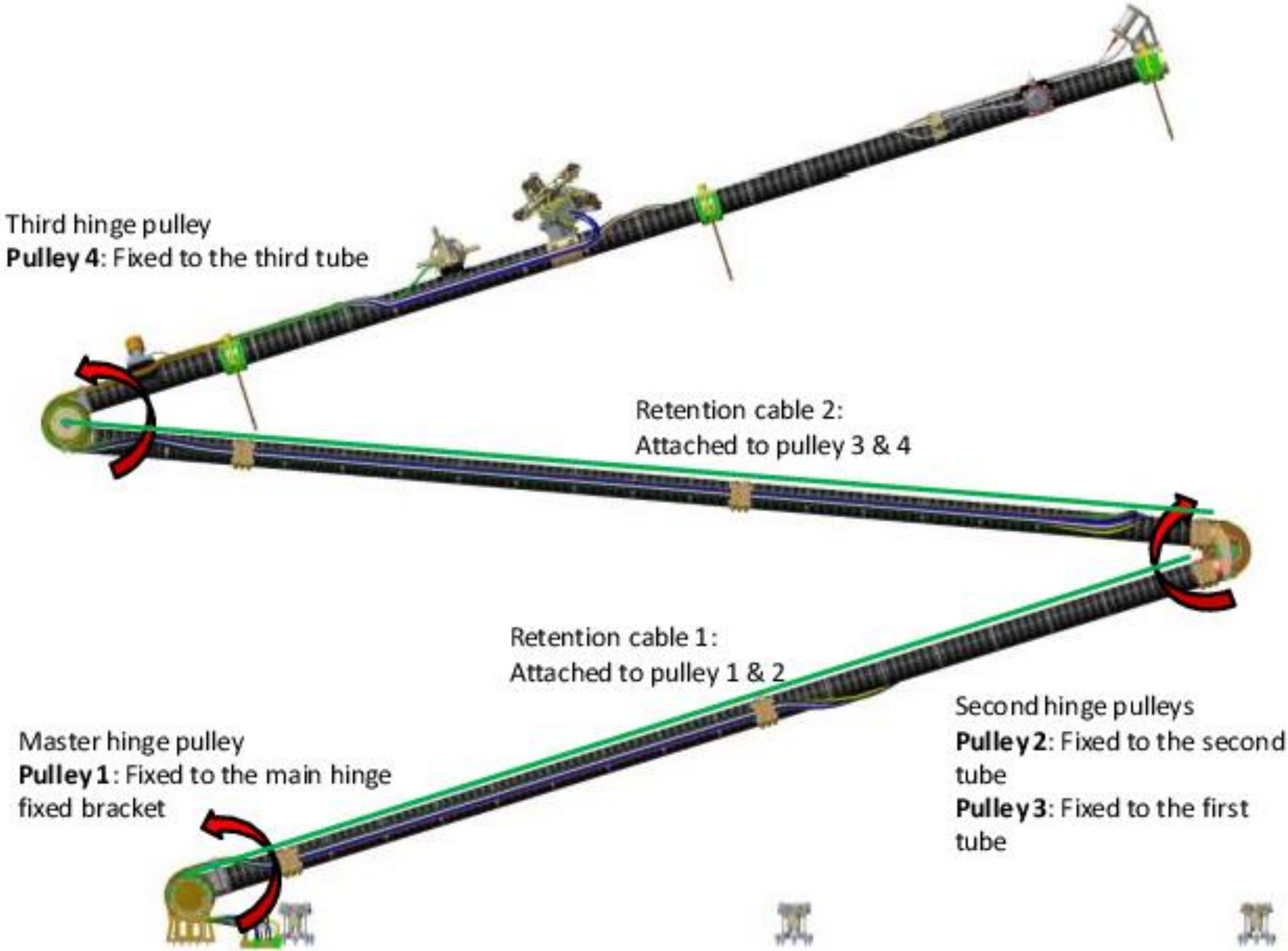
RIME - Radar for Icy Moon Exploration
An ice penetrating radar to study the subsurface structure of the icy moons down to 9 km depth with vertical resolution of up to 30 m in ice. RIME will work at a central frequency of 9 Mhz (n. 330 m aallopituus 1 and 3 MHz bandwidth) and will use a 16 m antenna.

Principal Investigator: L. Bruzzone, Università degli Studi di Trento, Italy
Lead Funding Agency: ASI, Italy

J-MAG

J-MAG - A magnetometer instrument for JUICE
A magnetometer to characterise the Jovian magnetic field, its interaction with the internal magnetic field of Ganymede, and to study subsurface oceans of the icy moons.
The instrument will use fluxgates (inbound and outbound) sensors mounted on a boom.

Principal Investigator: M. Dougherty, Imperial College London, United Kingdom
Lead Funding Agency: UKSA, United Kingdom


Third hinge pulley
Pulley 4: Fixed to the third tube
Retention cable 2:
Attached to pulley 3 & 4
Retention cable 1:
Attached to pulley 1 & 2
Second hinge pulleys
Pulley 2: Fixed to the second tube
Pulley 3: Fixed to the first tube
Master hinge pulley
Pulley 1: Fixed to the main hinge fixed bracket

PEP

PEP - Particle Environment Package
A plasma package with sensors to characterise the plasma environment in the Jovian system.
PEP will measure density and fluxes of positive and negative ions, electrons, exospheric neutral gas, thermal plasma and energetic neutral atoms in the energy range from <0.001 eV to >1 MeV with full angular coverage.
The composition of the moons' exospheres will be measured with a resolving power of more than 1000.

Principal Investigator: S. Barabash, Swedish Institute of Space Physics (Institutet för rymdfysik, IRF), Kiruna, Sweden
Lead Funding Agency: SNSB, Sweden

RPWI

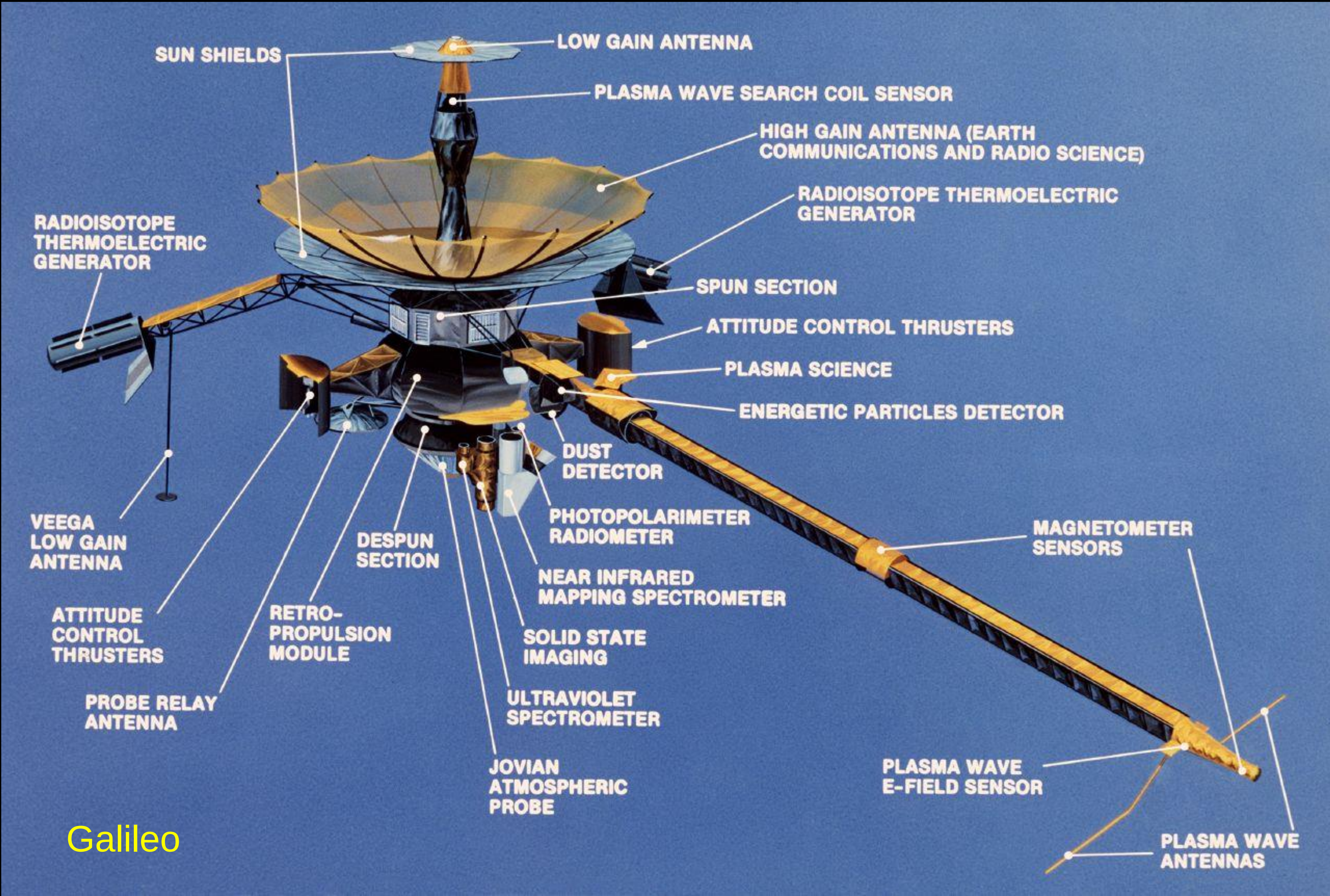
RPWI - Radio & Plasma Wave Investigation
A radio plasma wave instrument to characterise the radio emission and plasma environment of Jupiter and its icy moons.
RPWI will be based on four experiments, GANDALF, MIME, FRODO, and JENRAGE. It will use a set of sensors, including two Langmuir probes to measure DC electric field vectors up to a frequency of 1.6 MHz and to characterize thermal plasma and medium- and high-frequency receivers, and antennas to measure electric and magnetic fields in radio emission in the frequency range 80 kHz- 45 Mhz.

Principal Investigator: J.-E. Wahlund, Swedish Institute of Space Physics (Institutet för rymdfysik, IRF), Uppsala, Sweden
Lead Funding Agency: SNSB, Sweden

3GM

3GM - Gravity & Geophysics of Jupiter and Galilean Moons
A radio science package comprising a Ka transponder and an ultrastable oscillator.
3GM will be used to study the gravity field - up to degree 10 - at Ganymede and the extent of internal oceans on the icy moons, and to investigate the structure of the neutral atmospheres and ionospheres of Jupiter (0.1 - 800 mbar) and its moons.

Principal Investigator: L. Iess, Università di Roma "La Sapienza", Italy
Lead Funding Agency: ASI, Italy



SUN SHIELDS
LOW GAIN ANTENNA
PLASMA WAVE SEARCH COIL SENSOR
HIGH GAIN ANTENNA (EARTH COMMUNICATIONS AND RADIO SCIENCE)
RADIOISOTOPE THERMOELECTRIC GENERATOR
RADIOISOTOPE THERMOELECTRIC GENERATOR
SPUN SECTION
ATTITUDE CONTROL THRUSTERS
PLASMA SCIENCE
ENERGETIC PARTICLES DETECTOR
DUST DETECTOR
PHOTOPOLARIMETER RADIOMETER
MAGNETOMETER SENSORS
VEEGA LOW GAIN ANTENNA
DESPUN SECTION
NEAR INFRARED MAPPING SPECTROMETER
ATTITUDE CONTROL THRUSTERS
RETRO-PROPULSION MODULE
SOLID STATE IMAGING
PROBE RELAY ANTENNA
ULTRAVIOLET SPECTROMETER
JOVIAN ATMOSPHERIC PROBE
PLASMA WAVE E-FIELD SENSOR
PLASMA WAVE ANTENNAS

Galileo

Suomen osuus

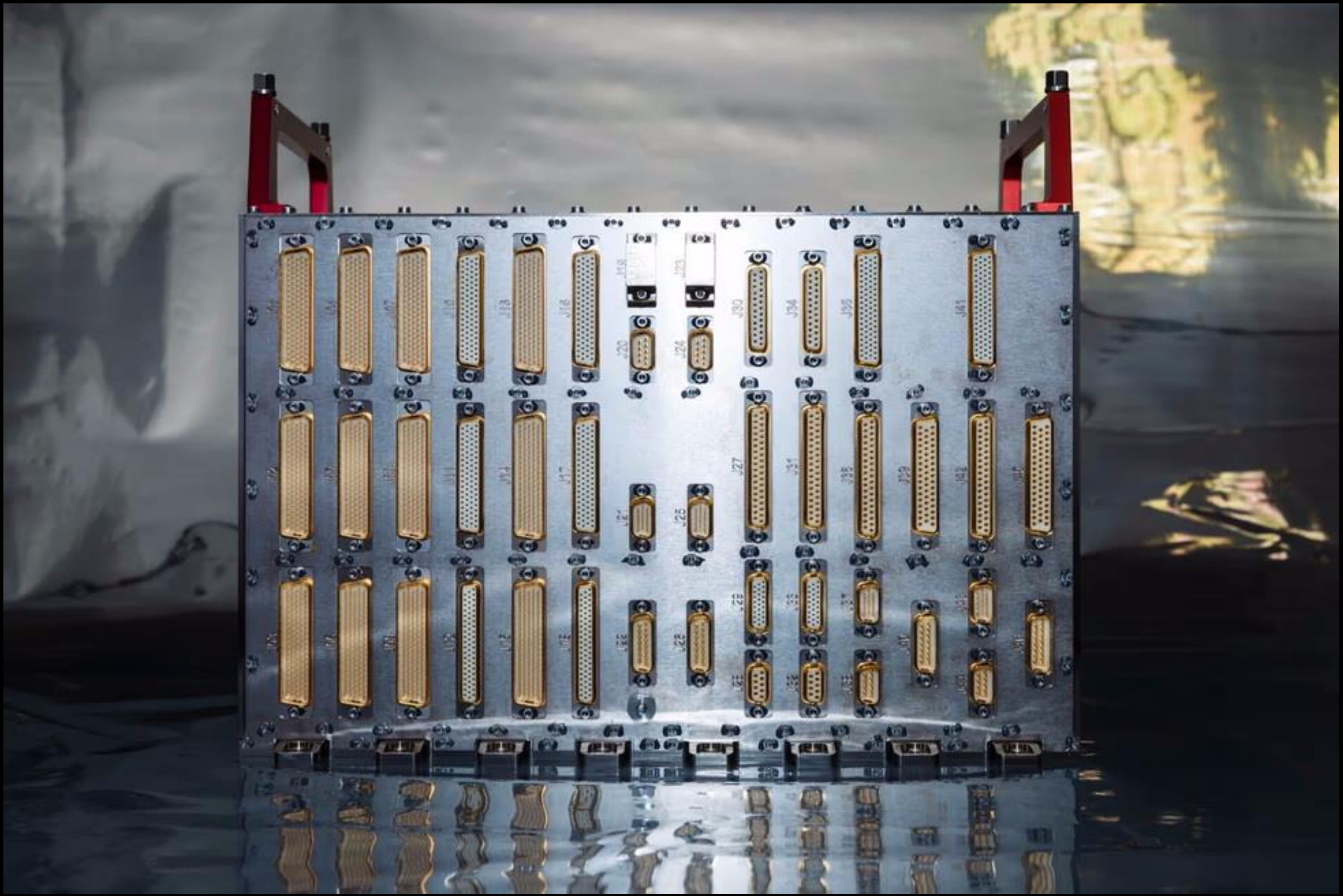
Ilmatieteen laitos on mukana kuita ympäröiviä kaasuhiukkasia tutkivassa PEP-mittalaitteessa, jonka päävastuu on ruotsalaisella IRF:illä (Institutet för Rymdfysik, Kiruna).

PEP – Particle Environment Package – tutkii kuiden ympärillä olevia niin sähköisesti varattuja kuin sähköisesti neutraaleja hiukkasia. Mittaukset antavat tietoa kuiden pinnan ja sisäosien koostumuksesta. Lisäksi mittauksen lisäävät tietoamme siitä, miten Jupiterin hiukkaset ovat muovanneet kuiden pintaa vuosimiljoonien saatossa.

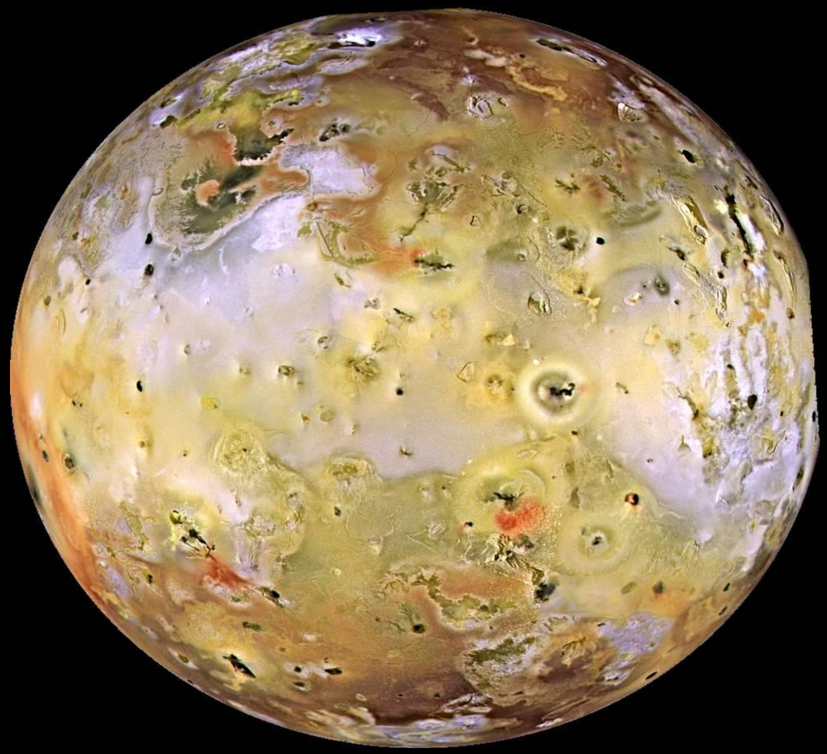
Marsin kaasukehää. ASPERA-4-mittalaite Venus Express -luotaimessa puolestaan tutki Venuksen kaasukehää.

Ilmatieteen laitos on toimittanut yhteistyössä Aalto yliopiston kanssa PEP-mittalaitteen keskustietokoneen (DPU) sekä sen peruskäyttöohjelmiston. Yksi tämän tietokoneen erityispiirteistä on avaruuskelpoisen, säteilynkestävän FPGA-mikropiirin sisälle toteutettu prosessori. Jupiterin ympäristön ankaran säteilyn siedon lisäksi ratkaisu mahdollisti myös PEP-laitteen vaatimia erityistoimintoja vähemmällä komponenttien määrällä ja virrankulutuksella.

DPU:n lentomalli toimitettiin jo viime vuonna ja nyt on saatu valmiiksi myös laitteen varamalli. Työ on jatkoa kolmelle aikaisemmalle samantyyppiselle mittalaitteelle, joiden rakentamiseen Ilmatieteen laitos on osallistunut toimittamalla keskustietokoneen. ASPERA-mittalaite mittasi Marsia vuonna 1989. Tällä hetkellä ASPERA-3-mittalaite on Express-luotaimessa ja tutkii Marsin kaasukehää. ASPERA-4-mittalaite Venus Express -luotaimessa puolestaan tutki Venuksen kaasukehää.



Jupiteriin Juice-luotaimen mukana matkaava tärkeä ohjaus- ja signaalinkäsittely-yksikkö on valmistettu Tampereella. Painoa yksiköllä on reilut 16 kiloa. Yksikkö kuvattiin Tampereella elokuussa 2019 vain joitakin päiviä ennen sen luovuttamista. Kuva: Enna Rautiainen / Sanoman arkisto



Kallisto ja Io Galilei-luotaimen kuvaamina

PRIDE

PRIDE - Planetary Radio Interferometer & Doppler Experiment
PRIDE will use the standard telecommunication system of the JUICE spacecraft and VLBI - Very Long Baseline Interferometry - to perform precise measurements of the spacecraft position and velocity to investigate the gravity fields of Jupiter and the icy moons.

Principal Investigator: L. Gurvits, Joint Institute for VLBI in Europe, The Netherlands
Lead Funding Agency: NWO and NSO, The Netherlands

JANUS: Camera system

MAJIS: Moons and Jupiter Imaging Spectrometer

UVS: UV Imaging Spectrograph

SWI: Sub-millimetre Wave Instrument

GALA: Ganymede Laser Altimeter

RIME: Radar for Icy Moons Exploration

J-MAG: Magnetometer for JUICE

PEP: Particle Environment Package

RPWI: Radio & Plasma Wave Investigation

3GM: Gravity & Geophysics of Jupiter and Galilean Moons

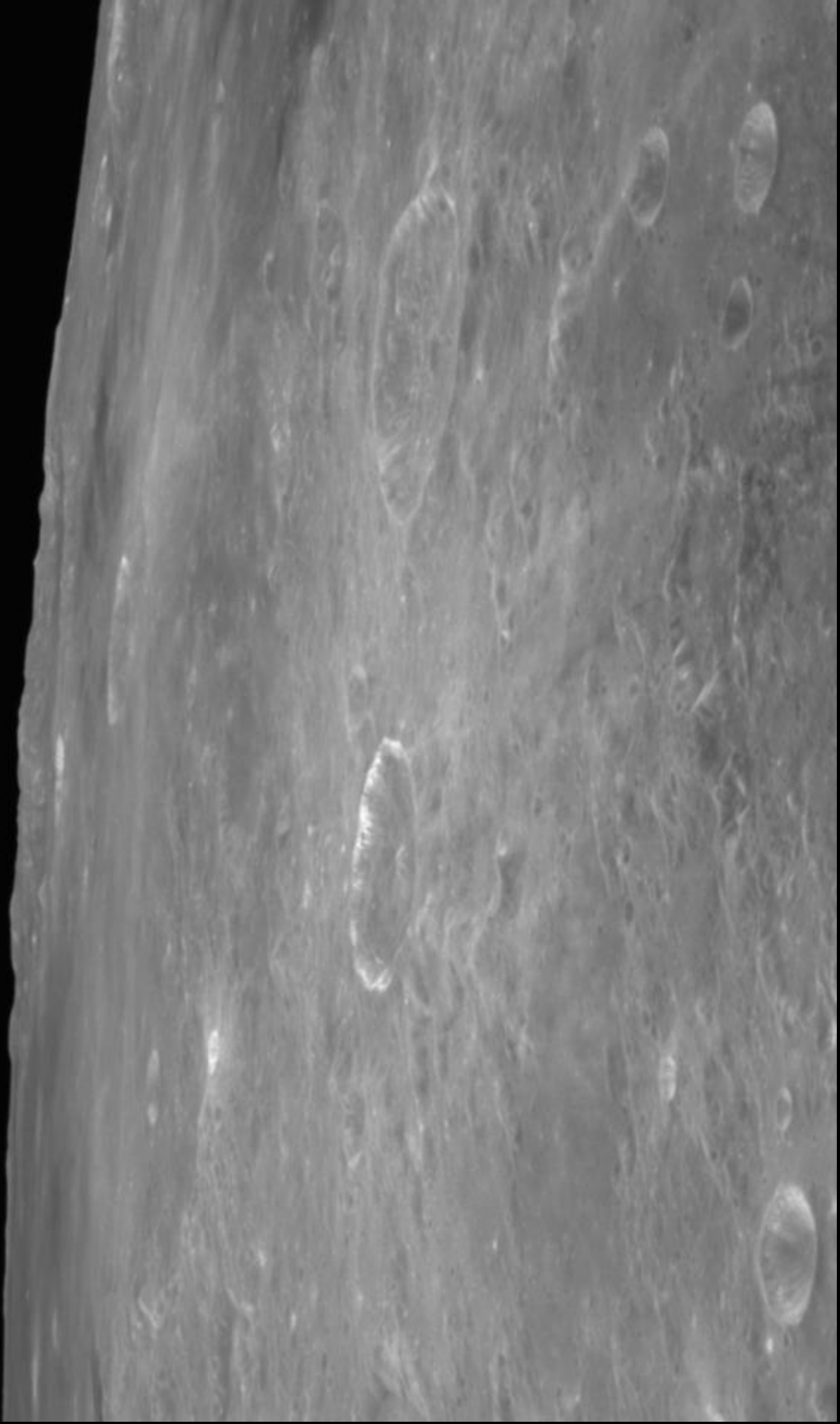
PRIDE: Planetary Radio Interferometer & Doppler Experiment (note this does not include spacecraft hardware but will exploit VLBI – Very Large Base Interferometry – to conduct radio science)

JANUS

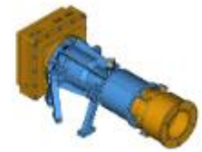
Jovis, Amorum ac Natorum Undique Scrutator

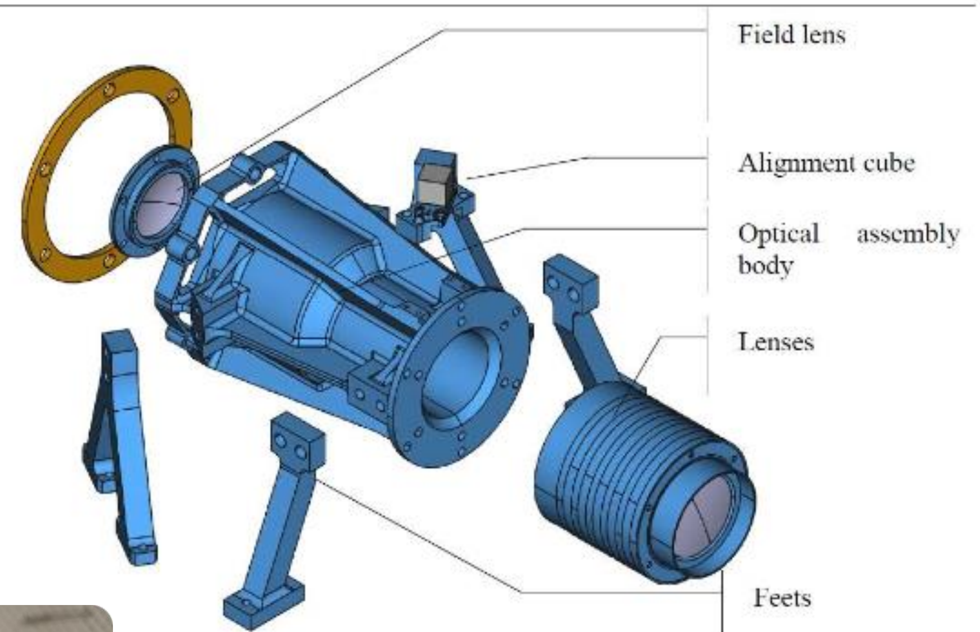
Jupiter, rakkauksien ja lasten etsijä kaikkialla

NavCam-kuvaa Kuusta



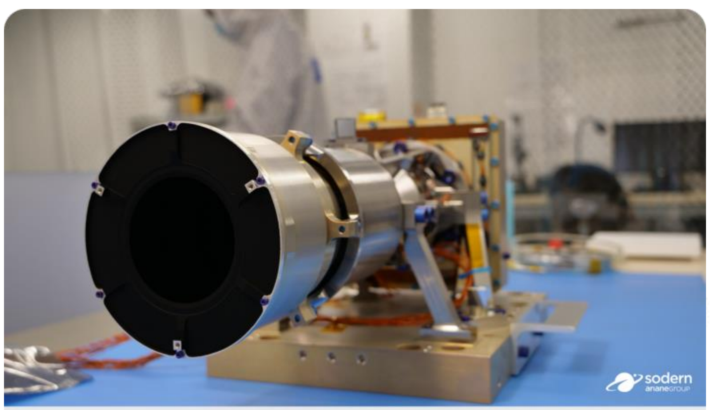
« NAVCAM JUICE » NAVIGATION CAMERA





Lens Assembly features:

- ❑ **Field of View = 4°**
- ❑ **Pupil diameter = 80mm**
- ❑ **Magnitude (star detection) = 8.8**

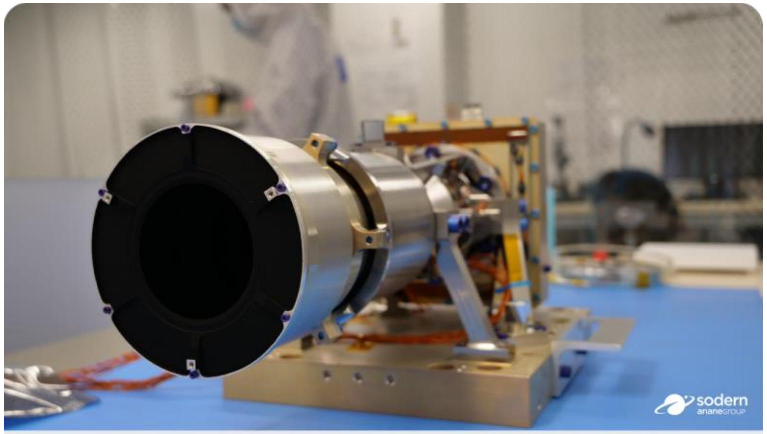


JUICE

Discover the cosmos with Sodern's NavCam, a pivotal technology in the JUICE mission, navigating Jupiter's moons while optimizing spacecraft guidance and fuel efficiency in a radioactive environment.

Launched in 2022

sodern arianeGROUP



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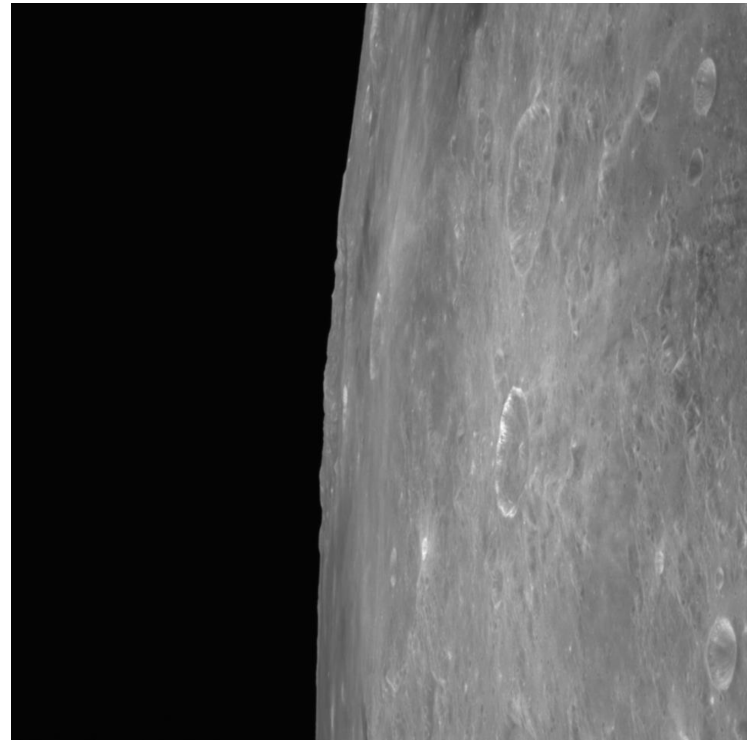
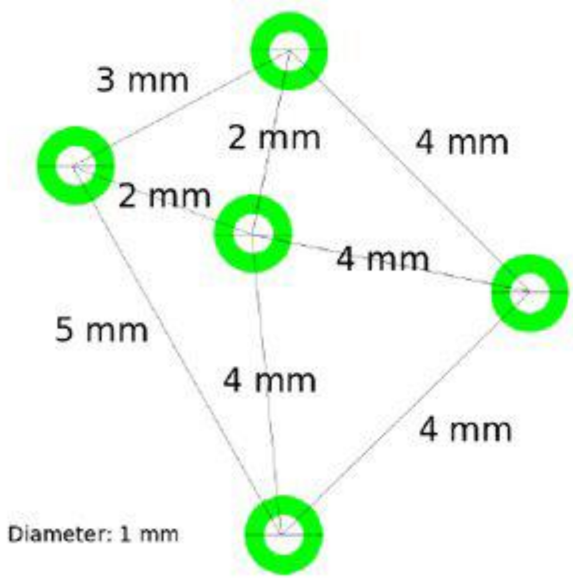
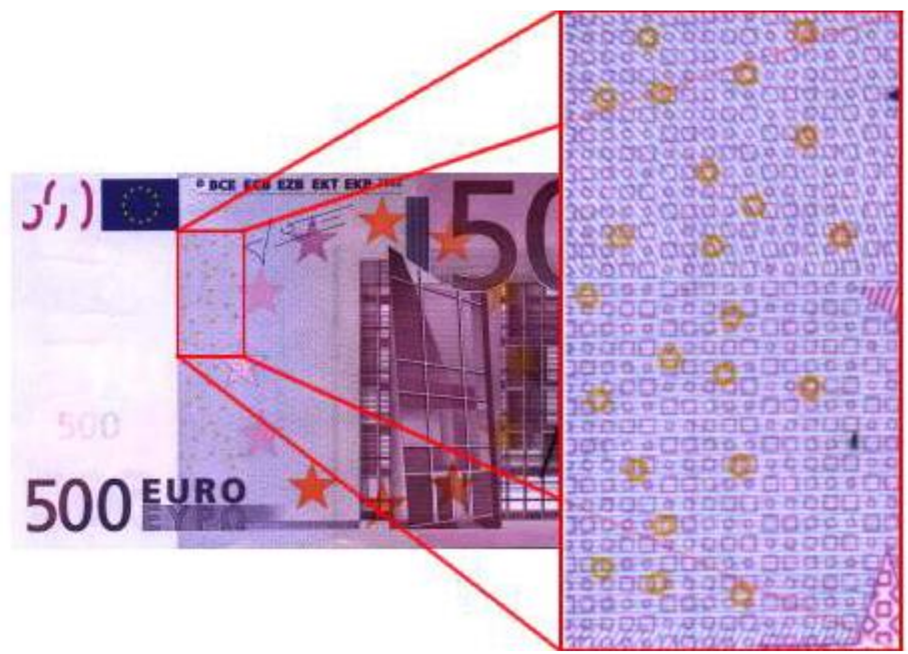






Designing the JUICE Trajectory

https://link.springer.com/article/10.1007/s11214-024-01093-y

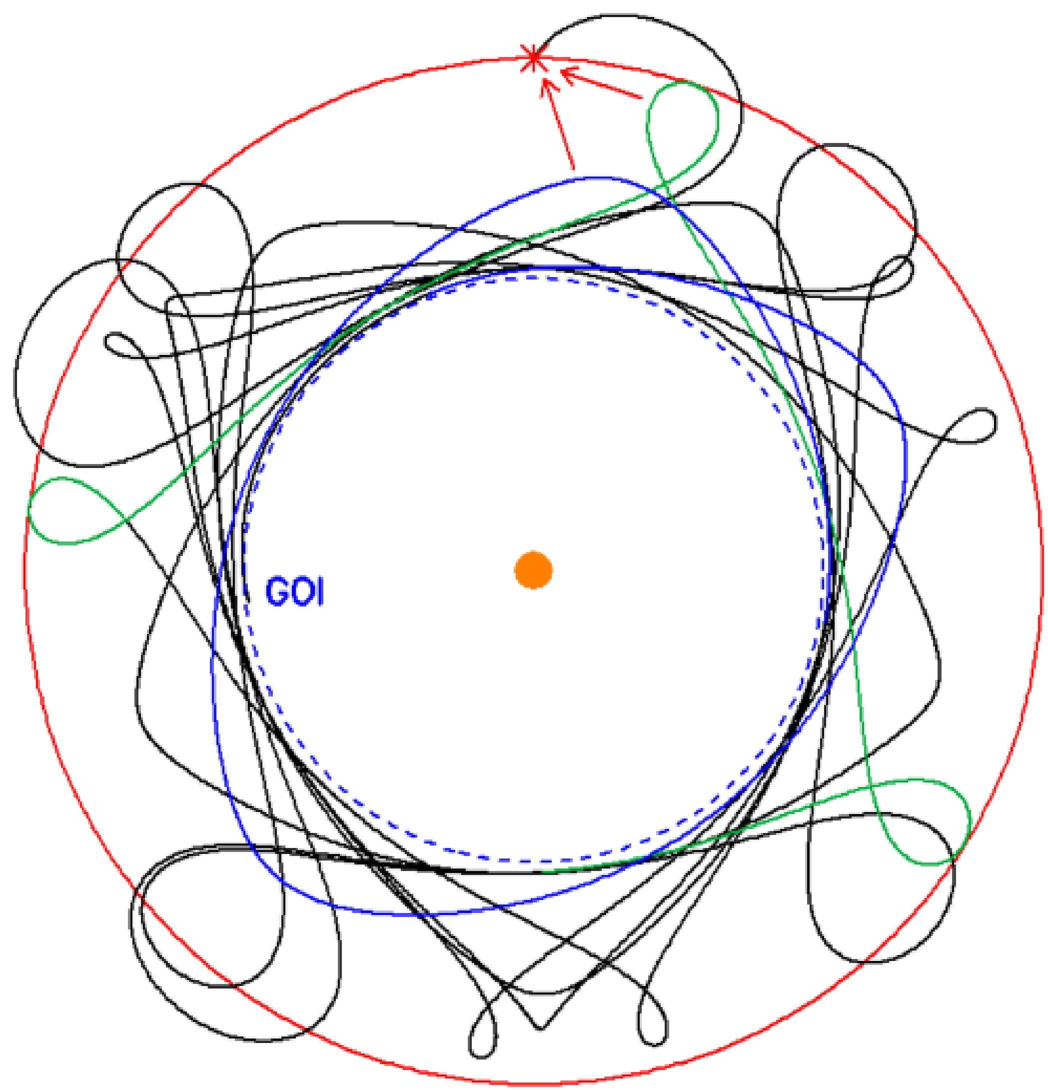


Fig. 35 Sequence of grazing encounters with a departure on May 1, 2034, and two phasing orbits as seen in the rotating frame of Callisto. The red circle corresponds to the orbit of Callisto, with the red star corresponding to the fixed position in the rotating frame. There are two relevant encounters (red arrows) which are both at a distance of ∼ 470,000 km. Even that far from Callisto, the encounter on the 5:3 leg (green track) raises the perijove by ∼ 6000 km, which is beneficial as it reduces the Delta-V budget required for insertion by ∼ 12 m/s. The dashed blue circle is the orbit of Ganymede

Europa Clipper will seek to confirm the presence of its ocean. For example, measurements of the amount of flexing due to the tides are one important indicator -- if the ocean exists, the tides should deform the surface by about 30 m; if the moon is frozen through, the tides should stretch the surface by only one meter. Also of great interest will be the composition of the reddish material on the surface. Scientists would like to know if this material holds clues to the composition of the ocean and whether material is cycling between the surface and the interior.

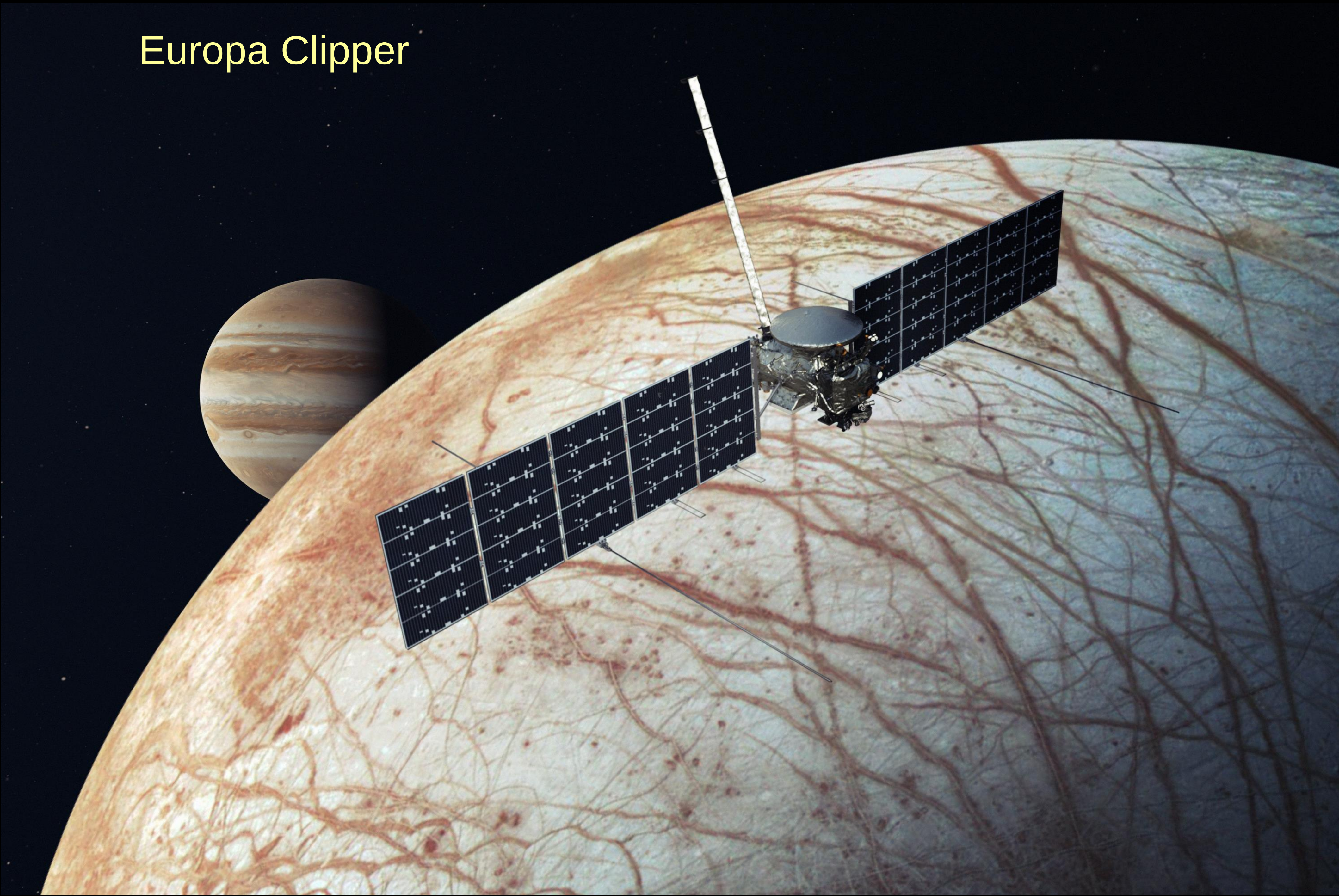
Spacecraft properties	
Manufacturer	Jet Propulsion Laboratory
Launch mass	6,065 kg (13,371 lb),[3][4][5] including 2,750 kg (6,060 lb) propellant[6]
Dry mass	3,241 kg (7,145 lb)[7]
Payload mass	352 kg (776 lb)
Dimensions	Height: 6 m (20 ft) Solar panel span: 22 m (72 ft)[4]
Power	600 watts from solar panels[8]
Start of mission	
Launch date	October 14, 2024, 16:06:00 UTC (12:06 p.m. EDT)
Rocket	Falcon Heavy Block 5[9]
Launch site	Kennedy, LC-39A
Contractor	SpaceX

Magnetic footprints

Juice’s mission goes beyond studying oceans, with the quest to also understand the origin of Ganymede’s unique magnetic field. Bigger than planet Mercury, Ganymede is the only moon in the Solar System to generate its own intrinsic magnetic field, creating a little magnetic bubble inside Jupiter’s much larger magnetic field.

The solar system's largest moon, Ganymede, in orbit around Jupiter, harbors an underground ocean containing more water than all the oceans on Earth. Scientists were already fairly confident in the ocean's existence, based on the moon's smooth icy surface—evidence of past resurfacing by the ocean—and other observations by the Galileo spacecraft, which made a handful of flybys in the 1990s.

Europa Clipper lähdössä. Spacex Falcon Heavy 14.10.2024


Europa Clipper

Juice

ESA’s Jupiter Icy Moons Explorer