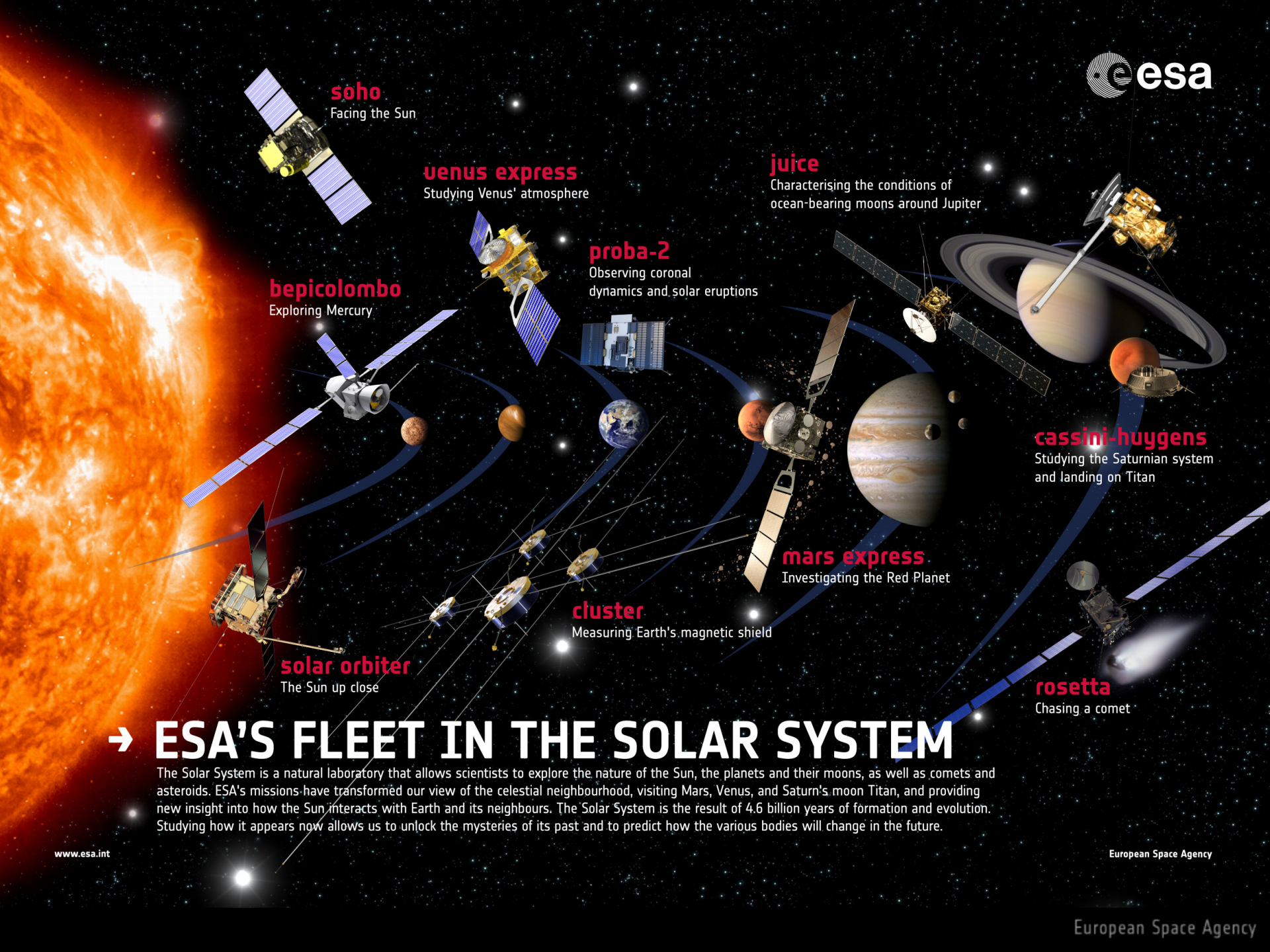
ESA BepiColombo Mission

Sara de la Fuente


Mercury
Venus
Earth
Mars
Ceres
Jupiter
Saturn
Uranus
Neptune
Pluto
Haumea
Makemake
Eris



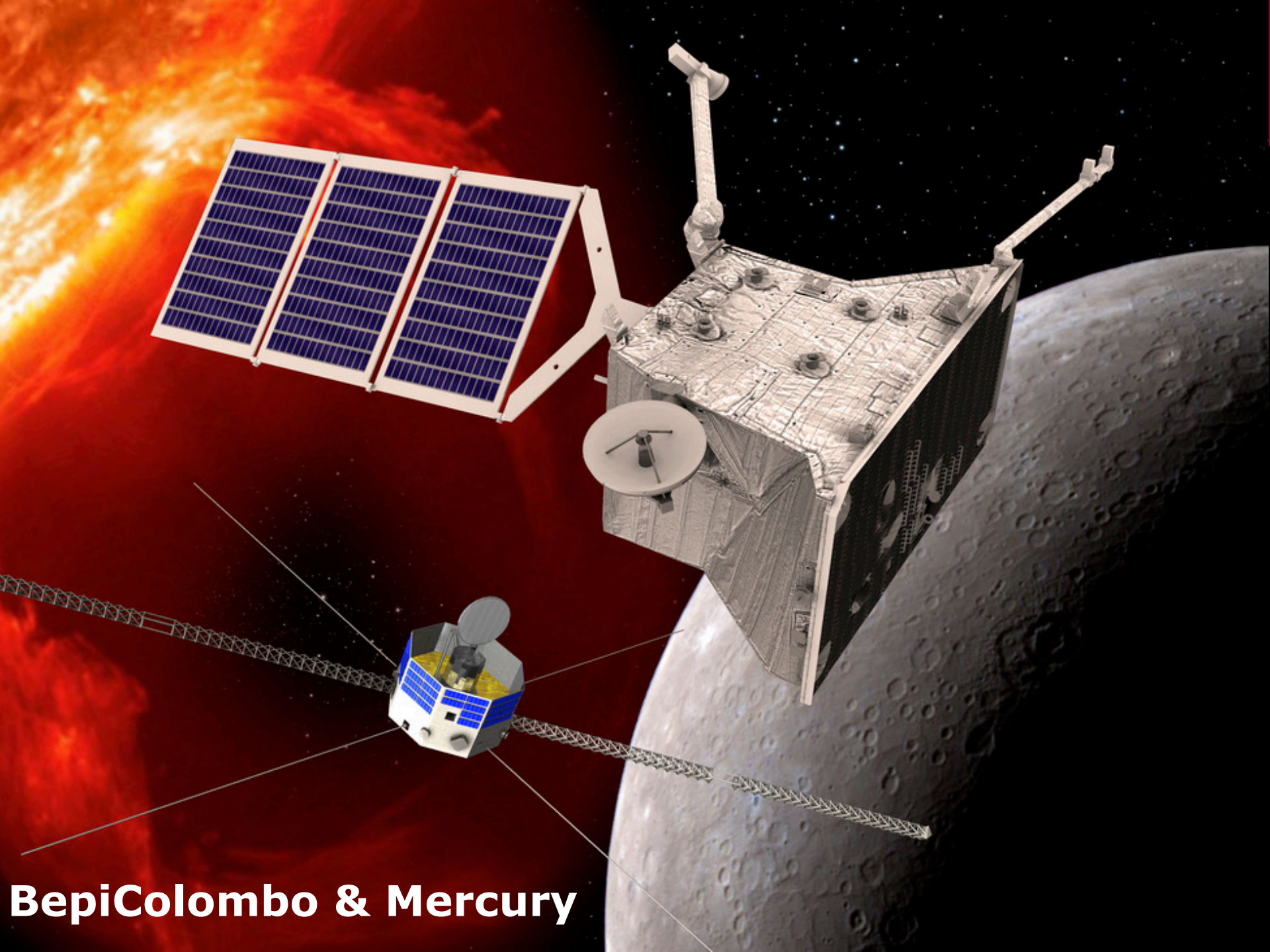
ESA'S FLEET IN THE SOLAR SYSTEM

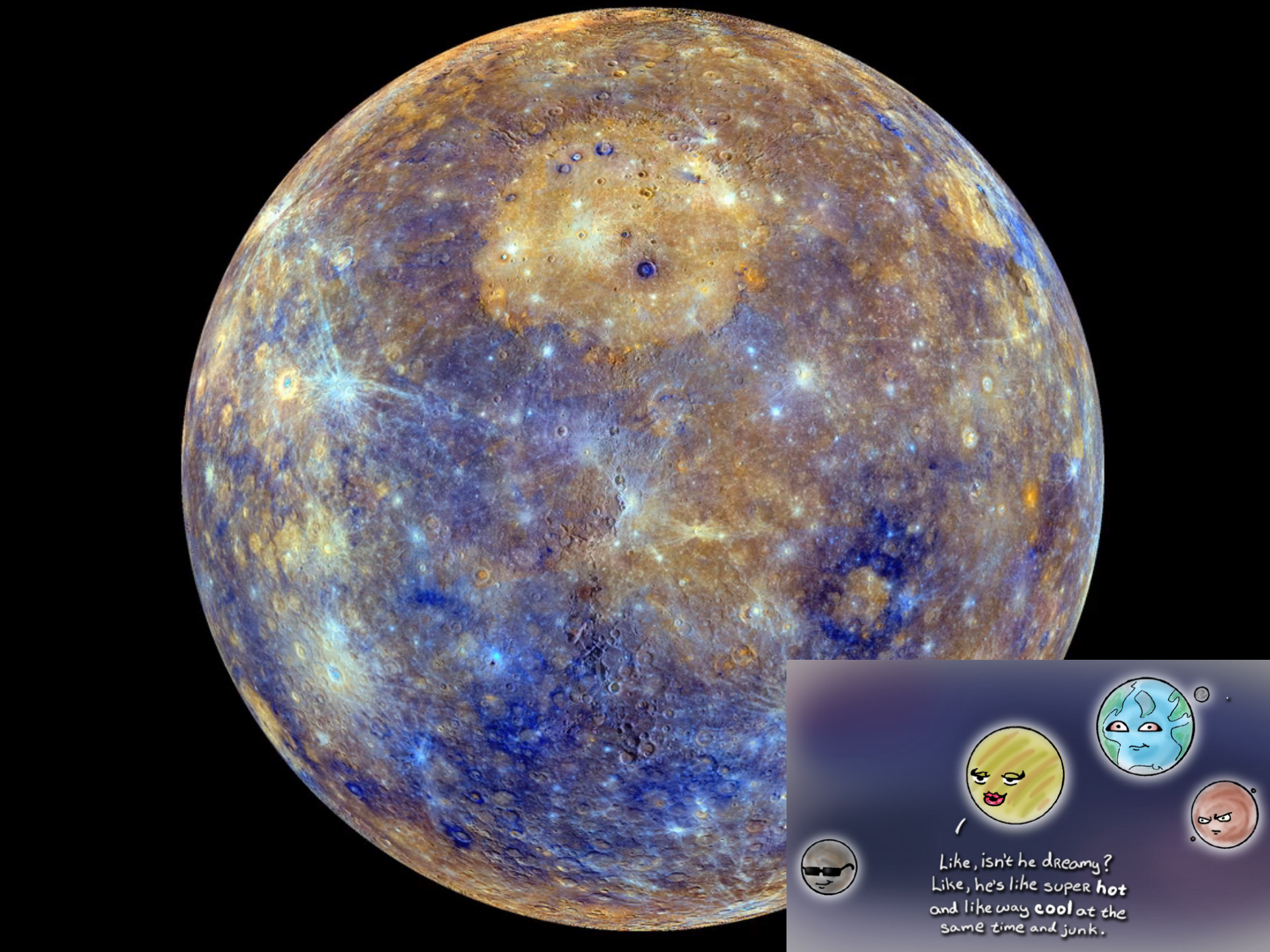
The Solar System is a natural laboratory that allows scientists to explore the nature of the Sun, the planets and their moons, as well as comets and asteroids. ESA's missions have transformed our view of the celestial neighbourhood, visiting Mars, Venus, and Saturn's moon Titan, and providing new insight into how the Sun interacts with Earth and its neighbours. The Solar System is the result of 4.6 billion years of formation and evolution. Studying how it appears now allows us to unlock the mysteries of its past and to predict how the various bodies will change in the future.

www.esa.int

European Space Agency

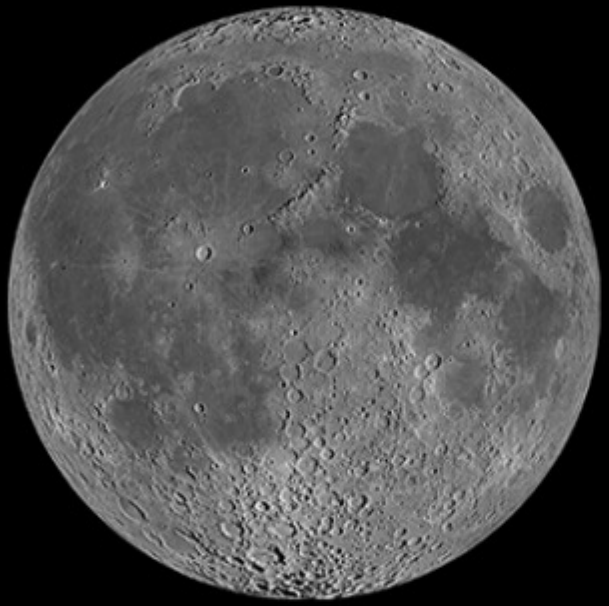
European Space Agency


BepiColombo & Mercury

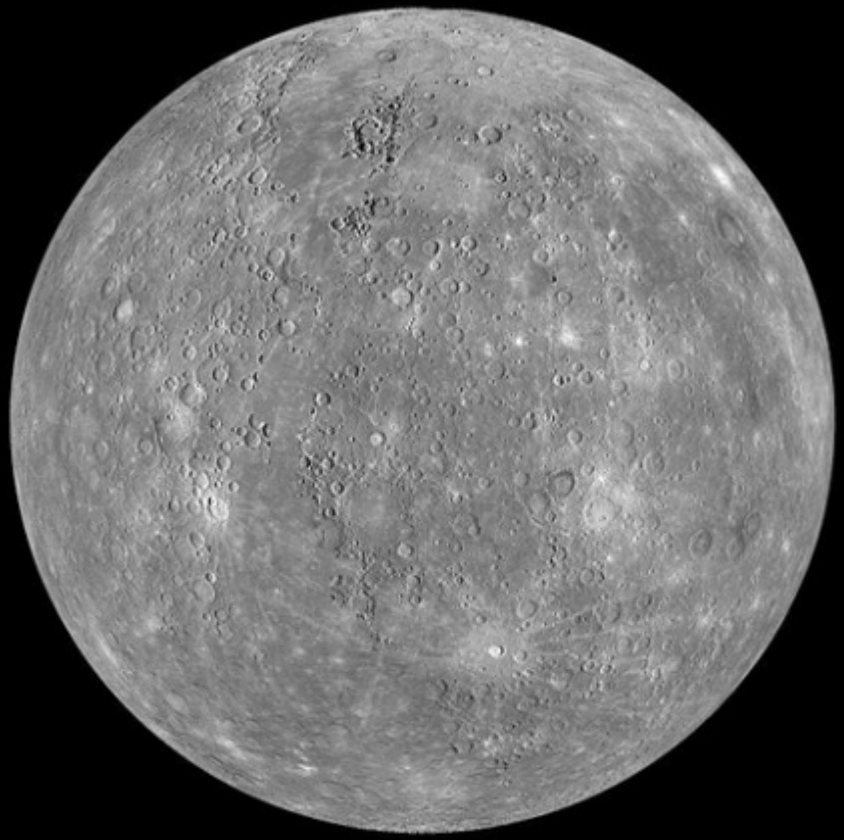

Like, isn't he dreamy?
Like, he's like super hot and like way cool at the same time and junk.

Terrestrial Planets

Mercury vs The Moon



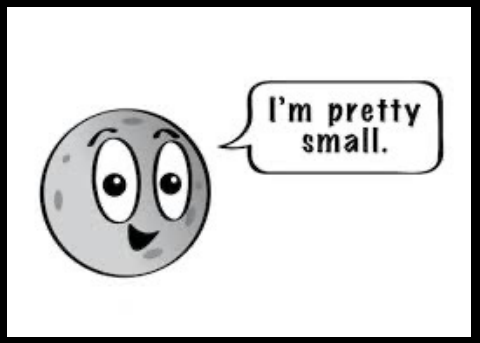
Moon (3476 Km)



MERCURY (4880 Km)

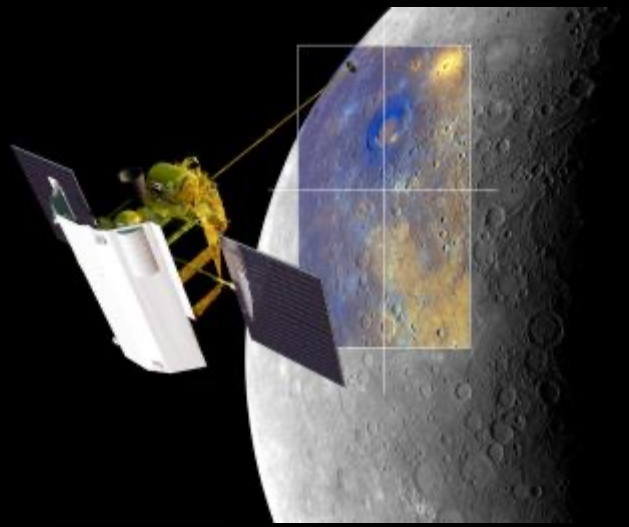
- Mercury is the planet closest to the sun (the sun looks 3 times bigger than on Earth)
- Temperatures from -170 deg to + 440 deg
- Has no atmosphere
- Magnetic field like Earth (but 100 times weaker)

Mercury vs. the Earth

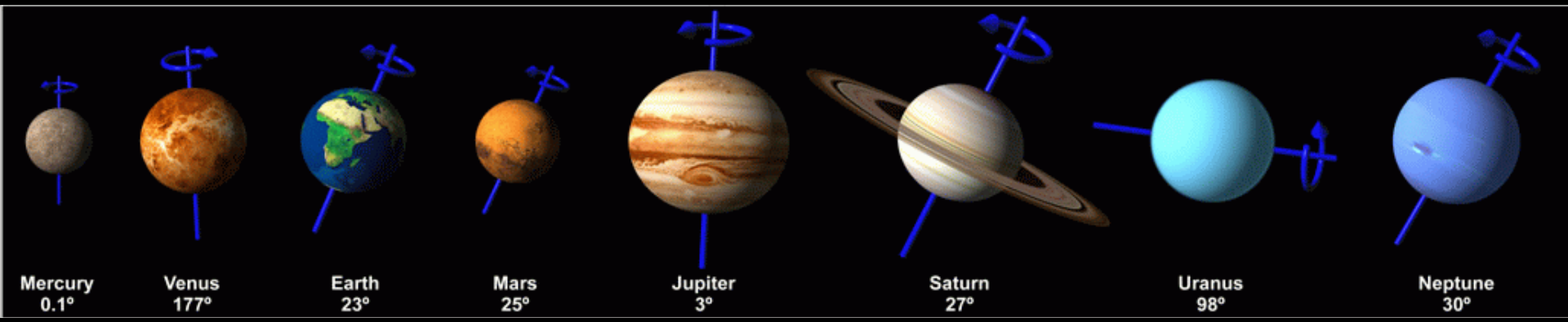


Mercury from Space

- NASA Mariner 10 (1974-1975), 3 fly-bys
- NASA MESSENGER (2004, 2011-2015), orbital
- Why only a few missions to Mercury?
  - Costly, since requires a lot of fuel
  - Harsh environment, quick degradation of the instruments

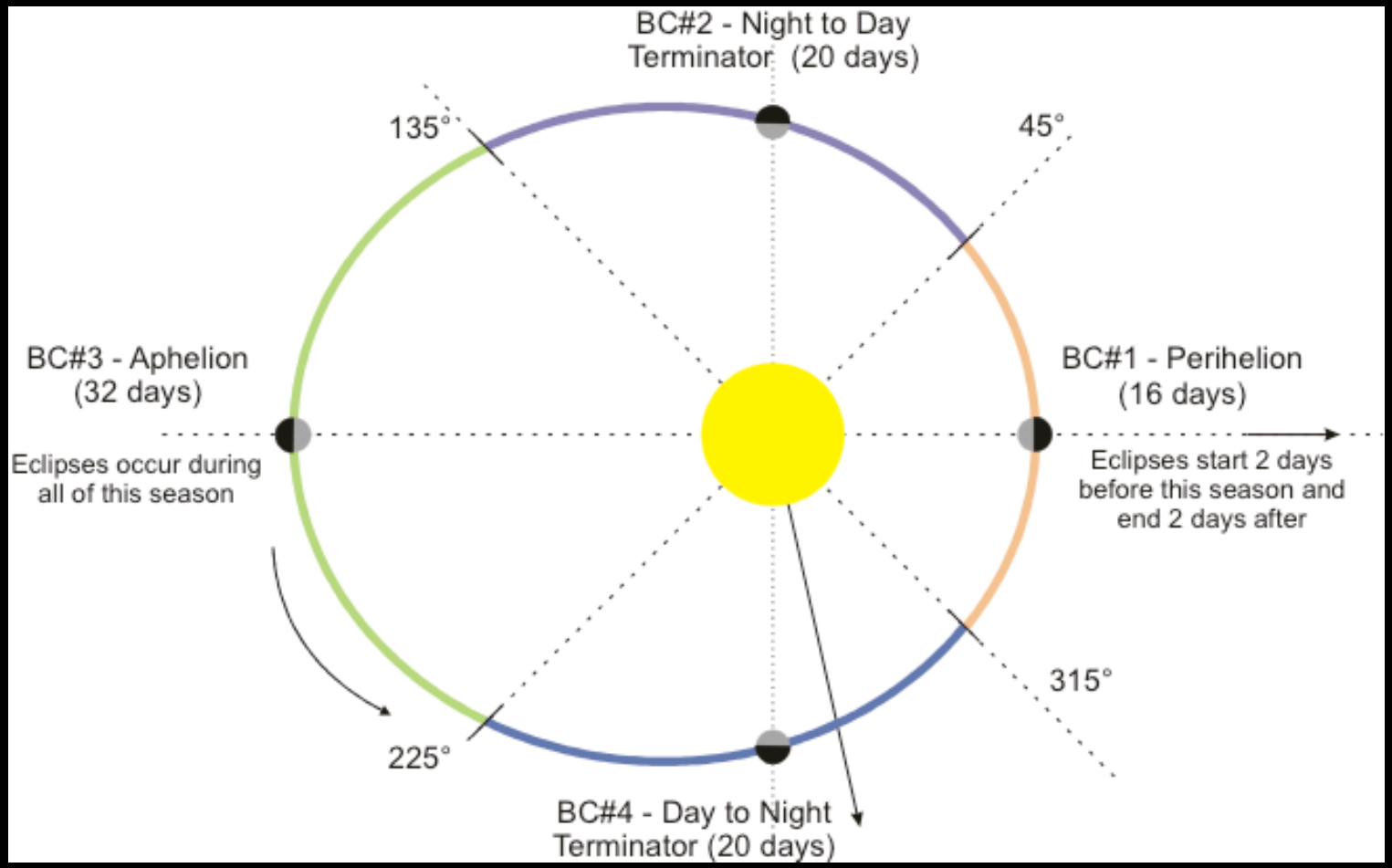


Rotation axis, days and years

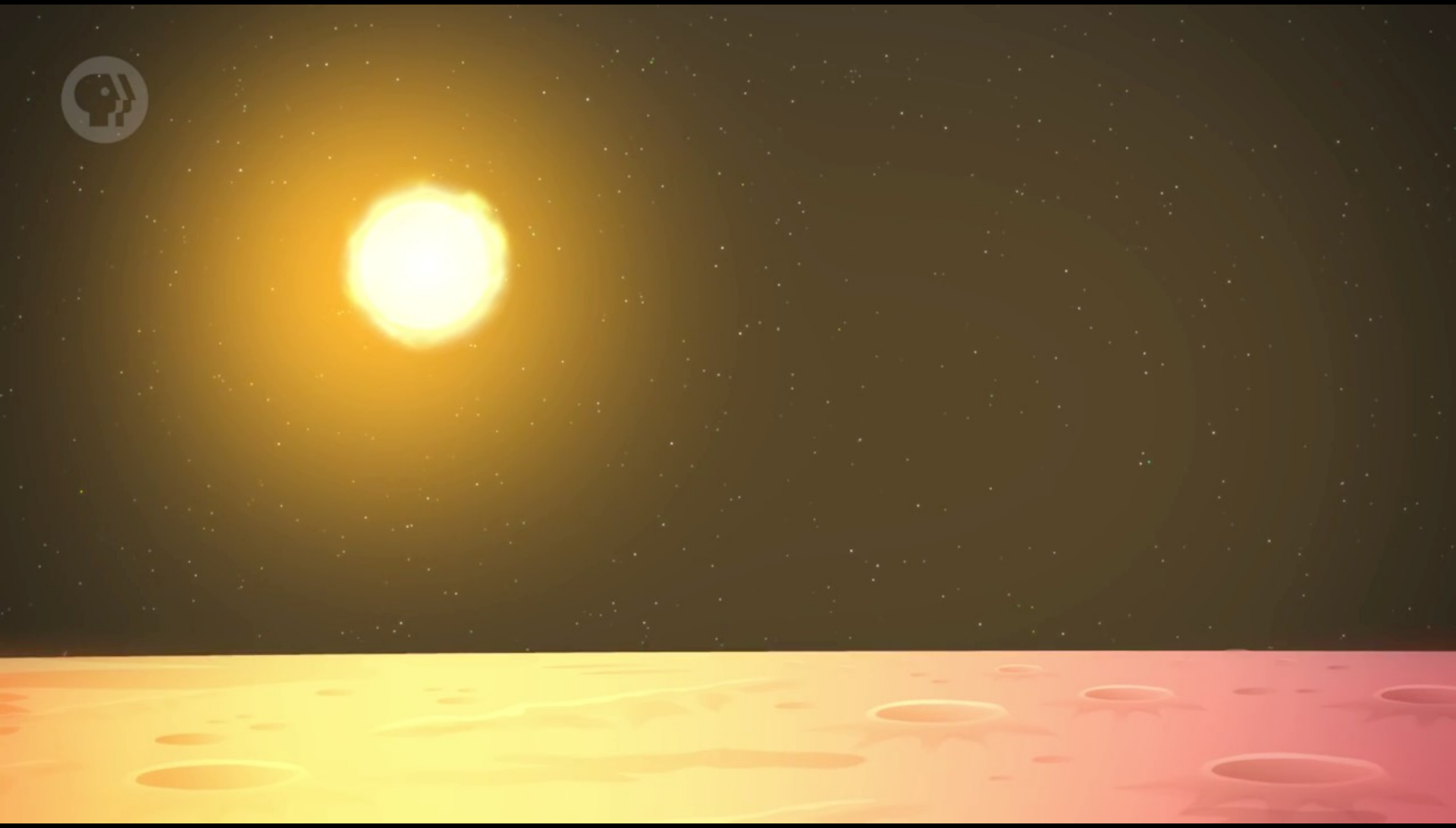


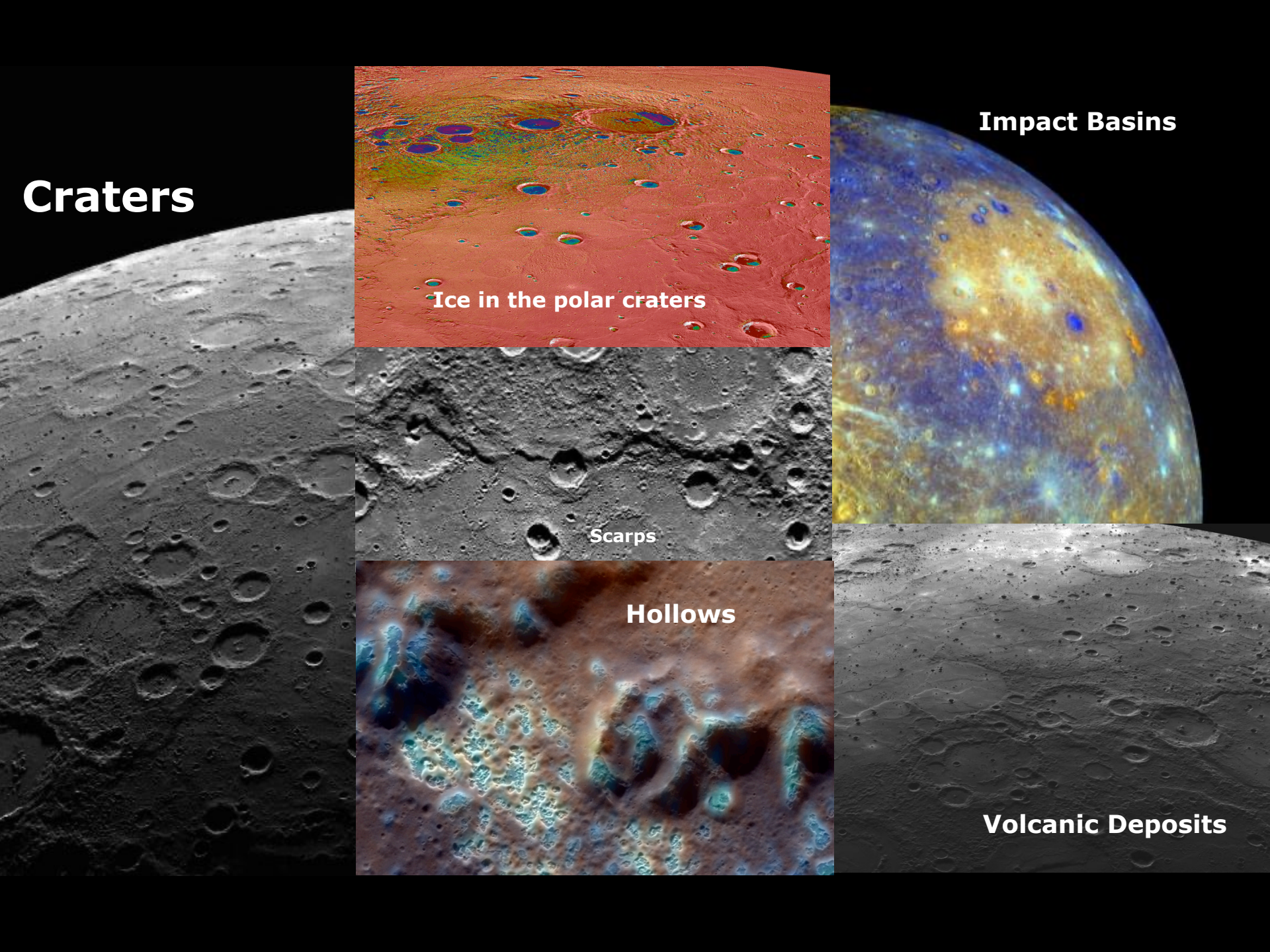
- 1 Hermean day: 59 Earth Days
- 1 Hermean year: 88 Earth Days

Mercury orbit and "seasons"

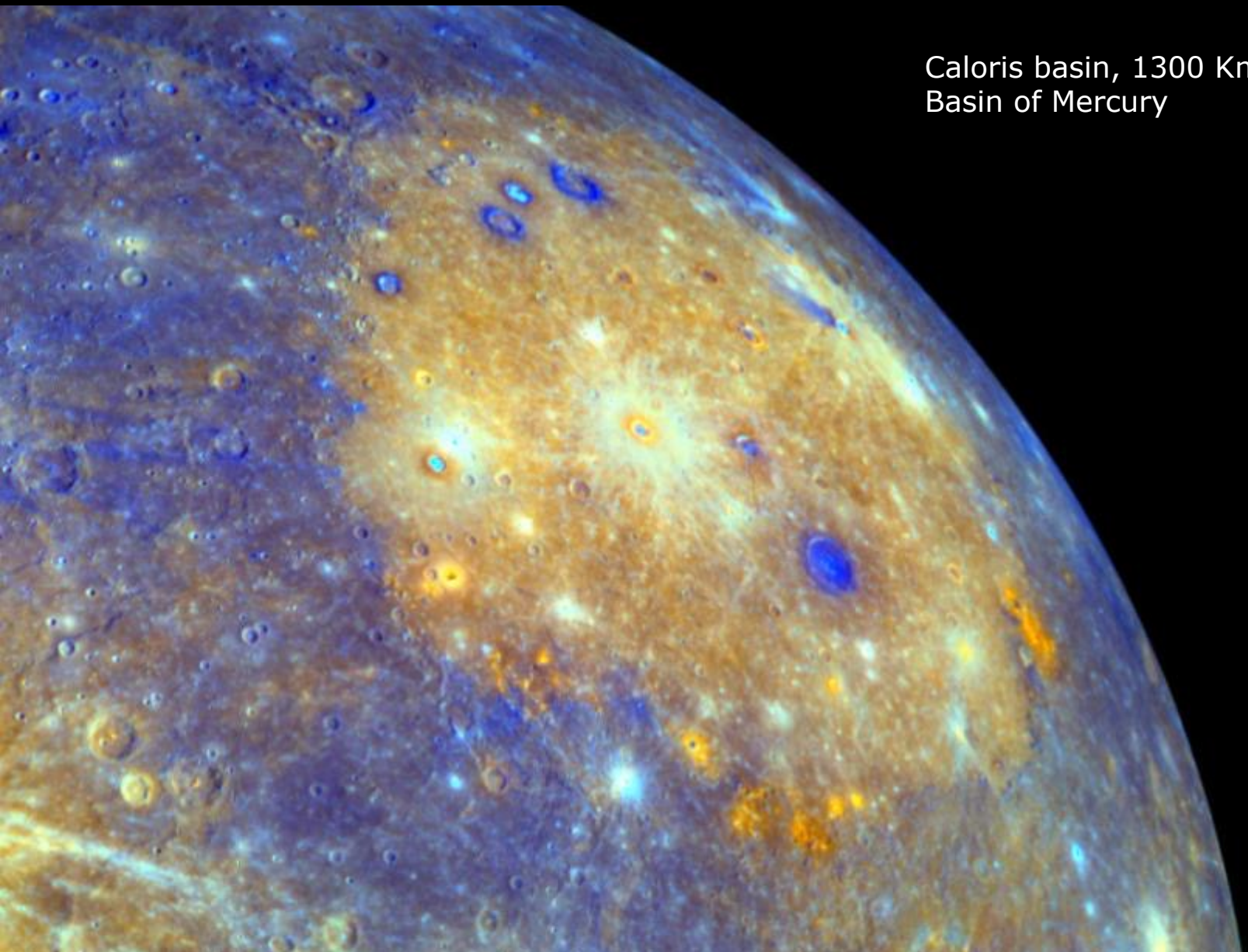


Days at Mercury



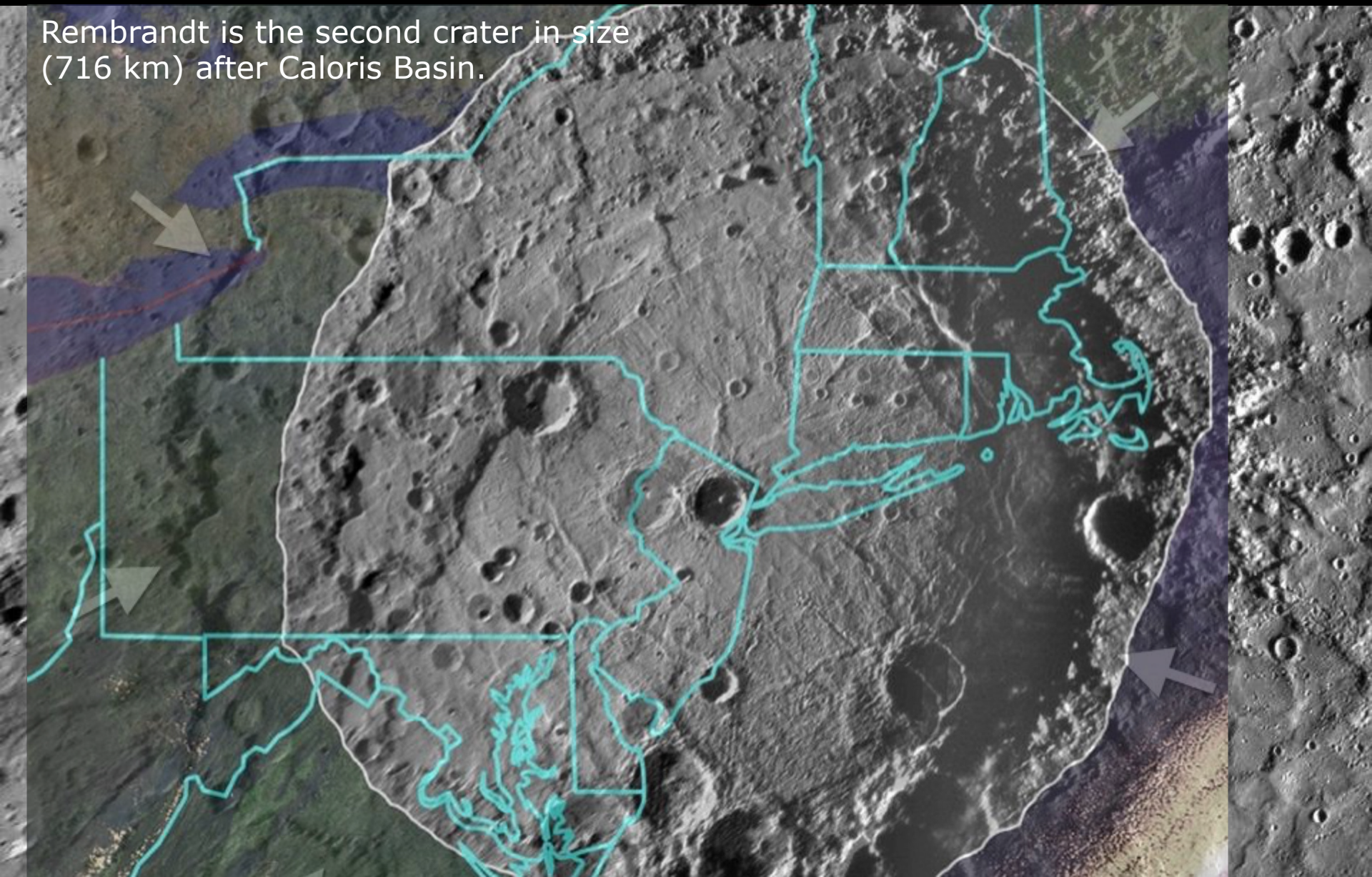

Craters
Ice in the polar craters
Impact Basins
Scarps
Hollows
Volcanic Deposits

Craters and Impact Basins (I)

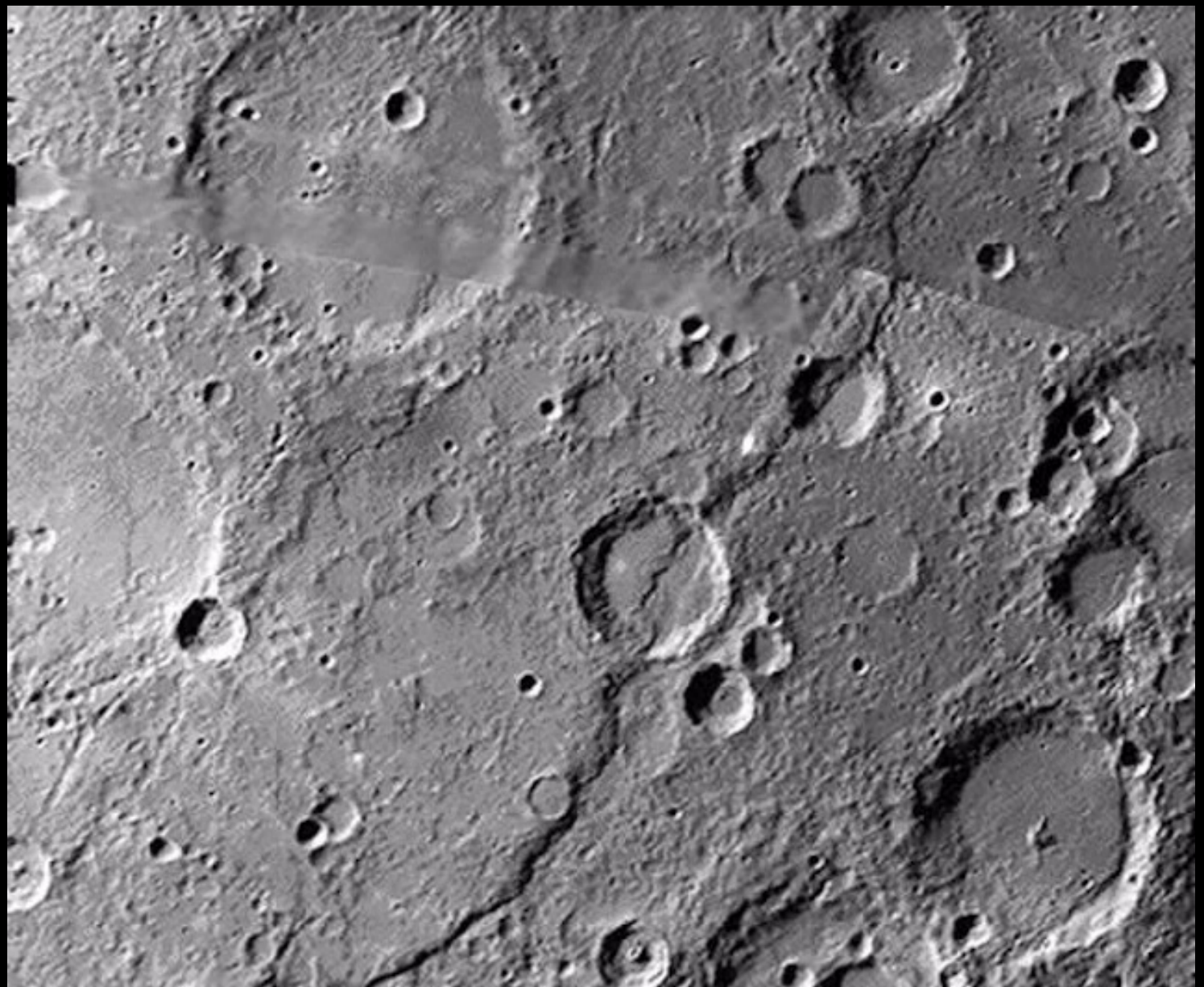


Caloris basin, 1300 Km, Biggest Basin of Mercury

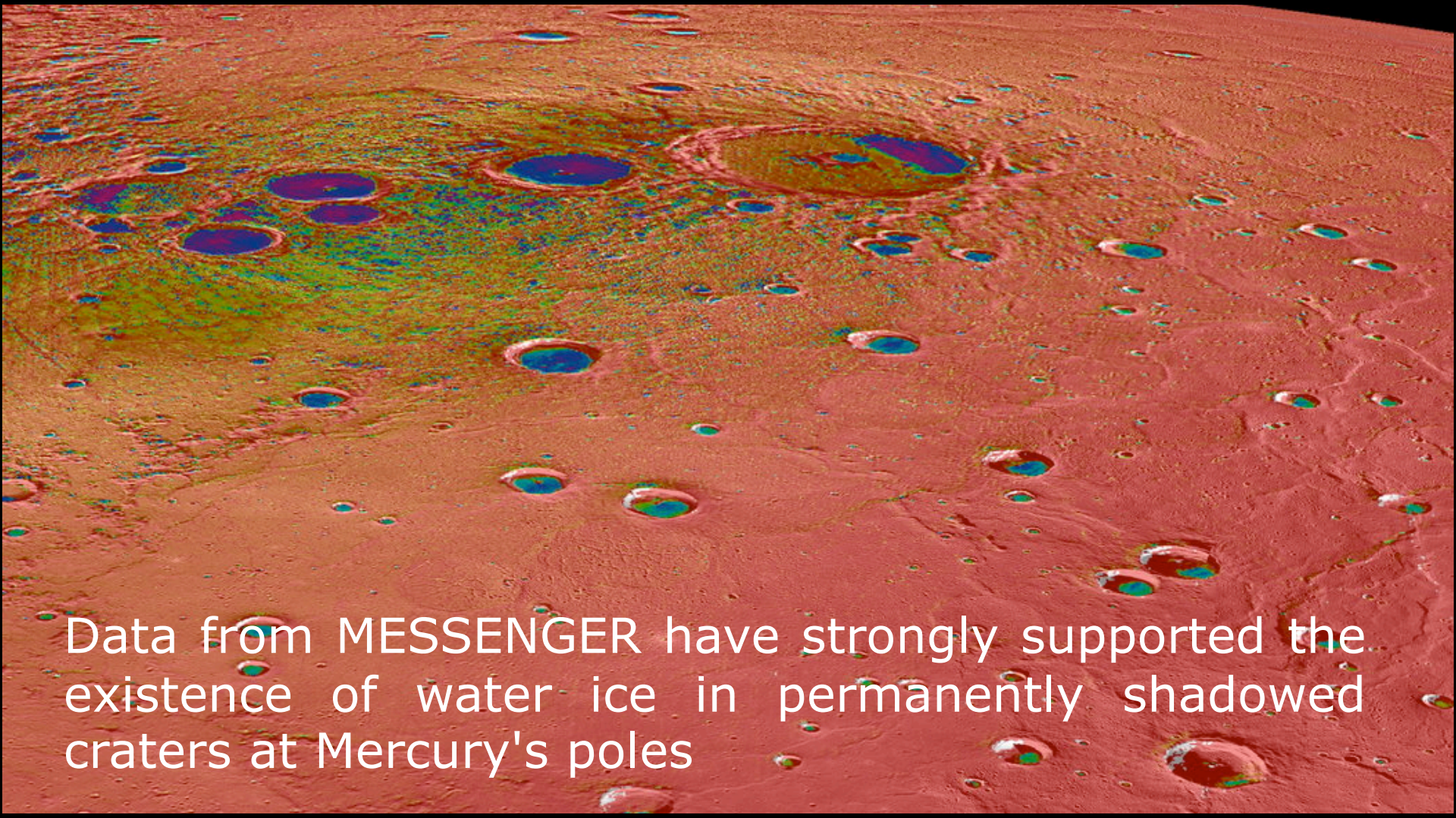
Craters and Impact Basins (2/3)



Sharps: A Shrinking Planet?

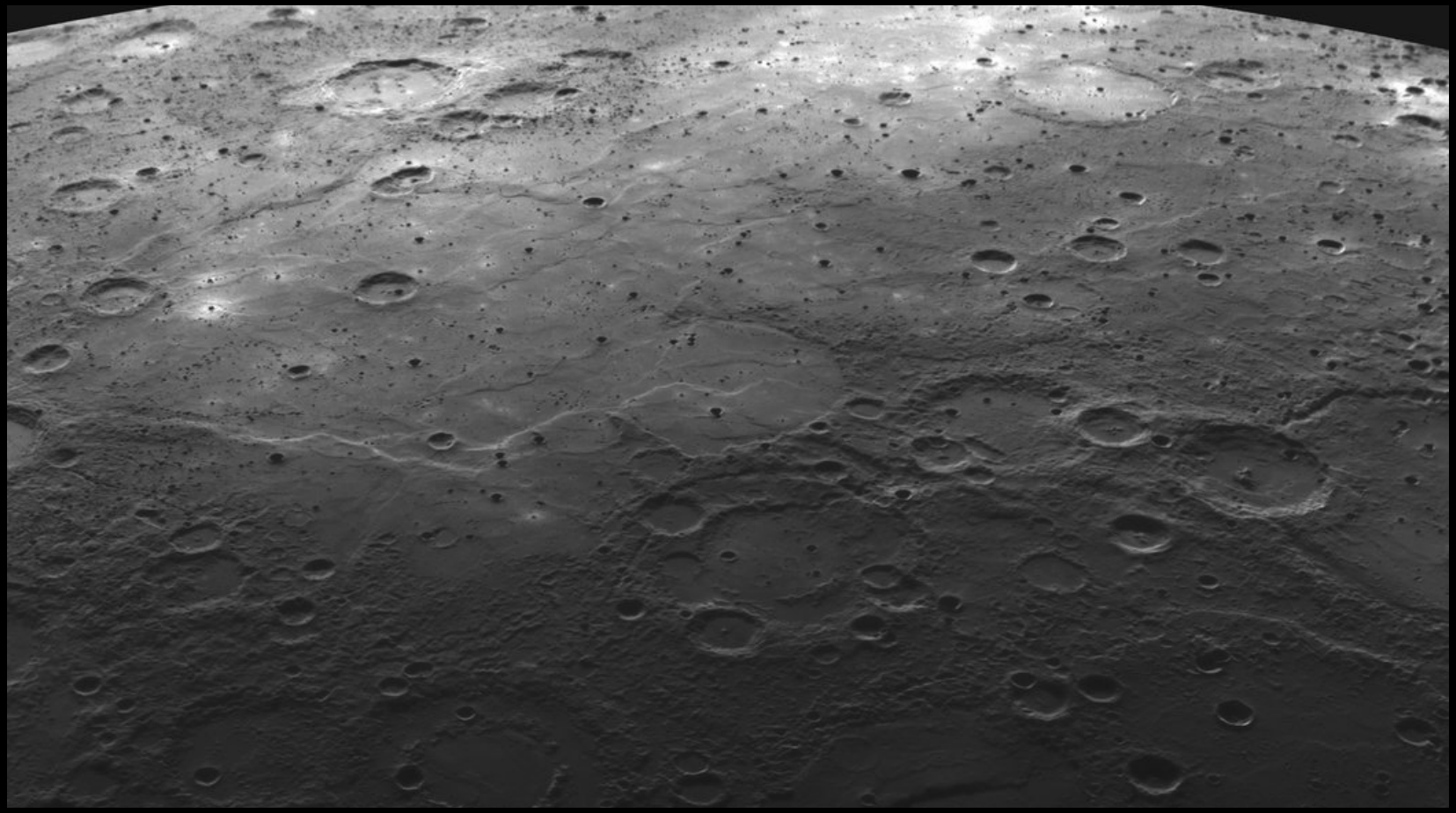


Ice in the poles

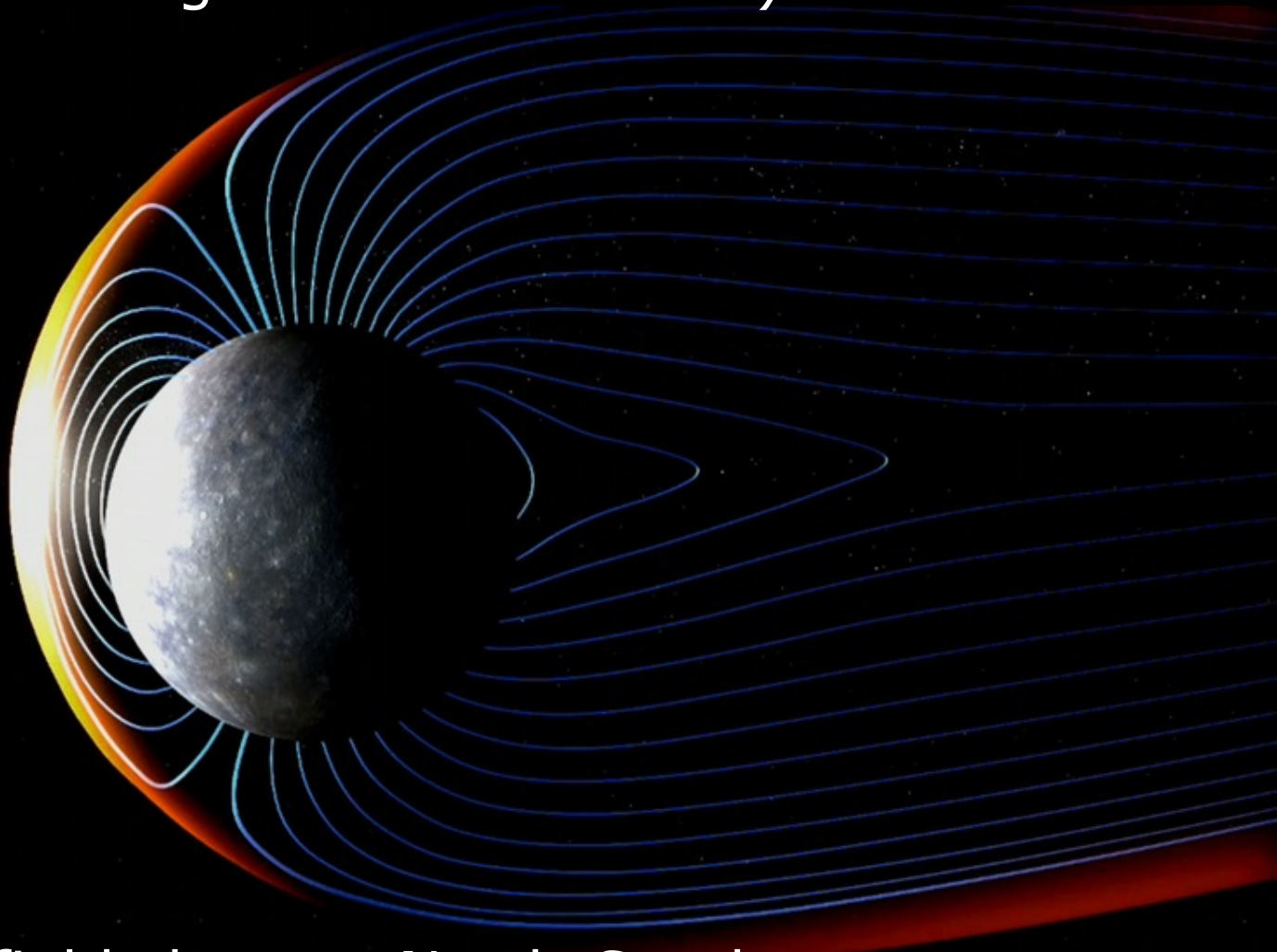


Data from MESSENGER have strongly supported the existence of water ice in permanently shadowed craters at Mercury's poles

Volcanic Deposits

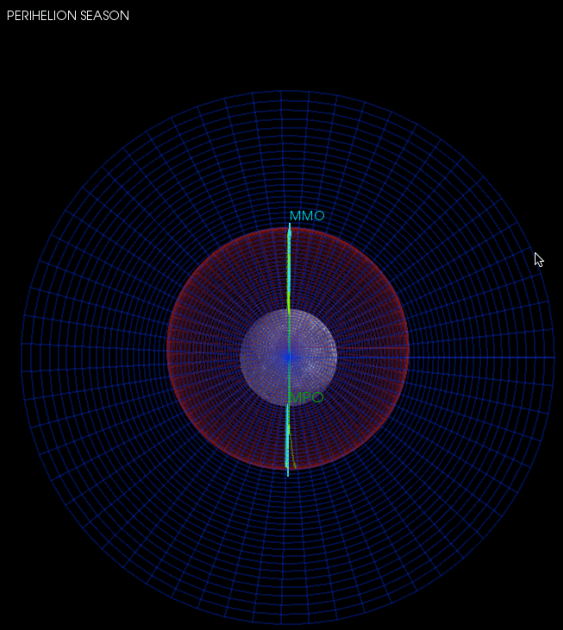


It is the only planet with a magnetic field similar to that of Earth (although ~ 100% weaker)



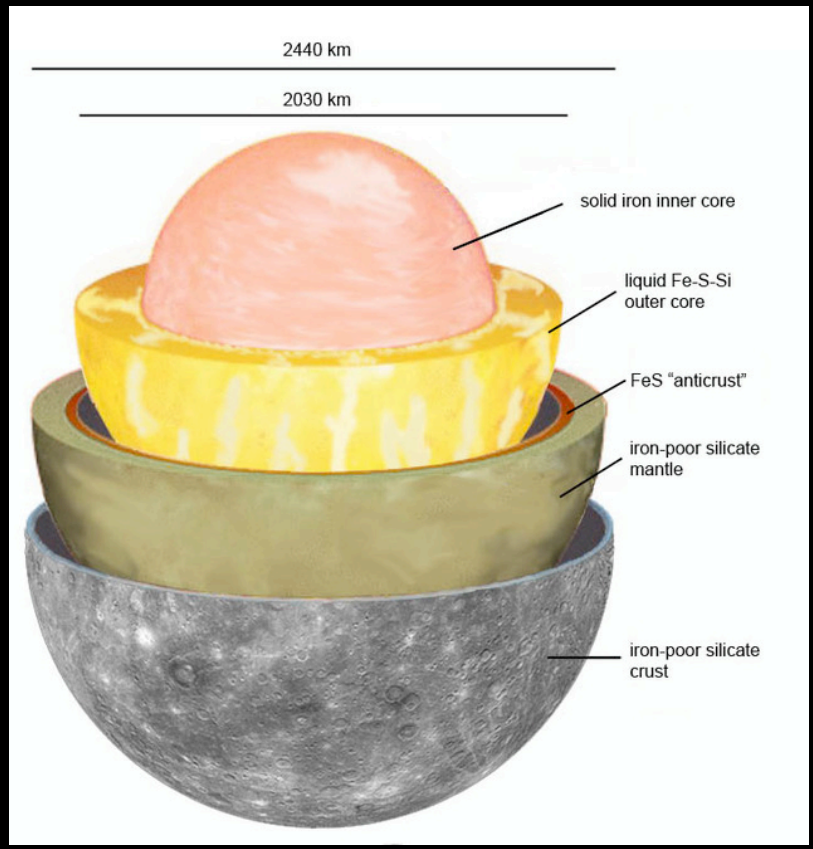
The magnetic field shows a North-South asymmetry on the surface

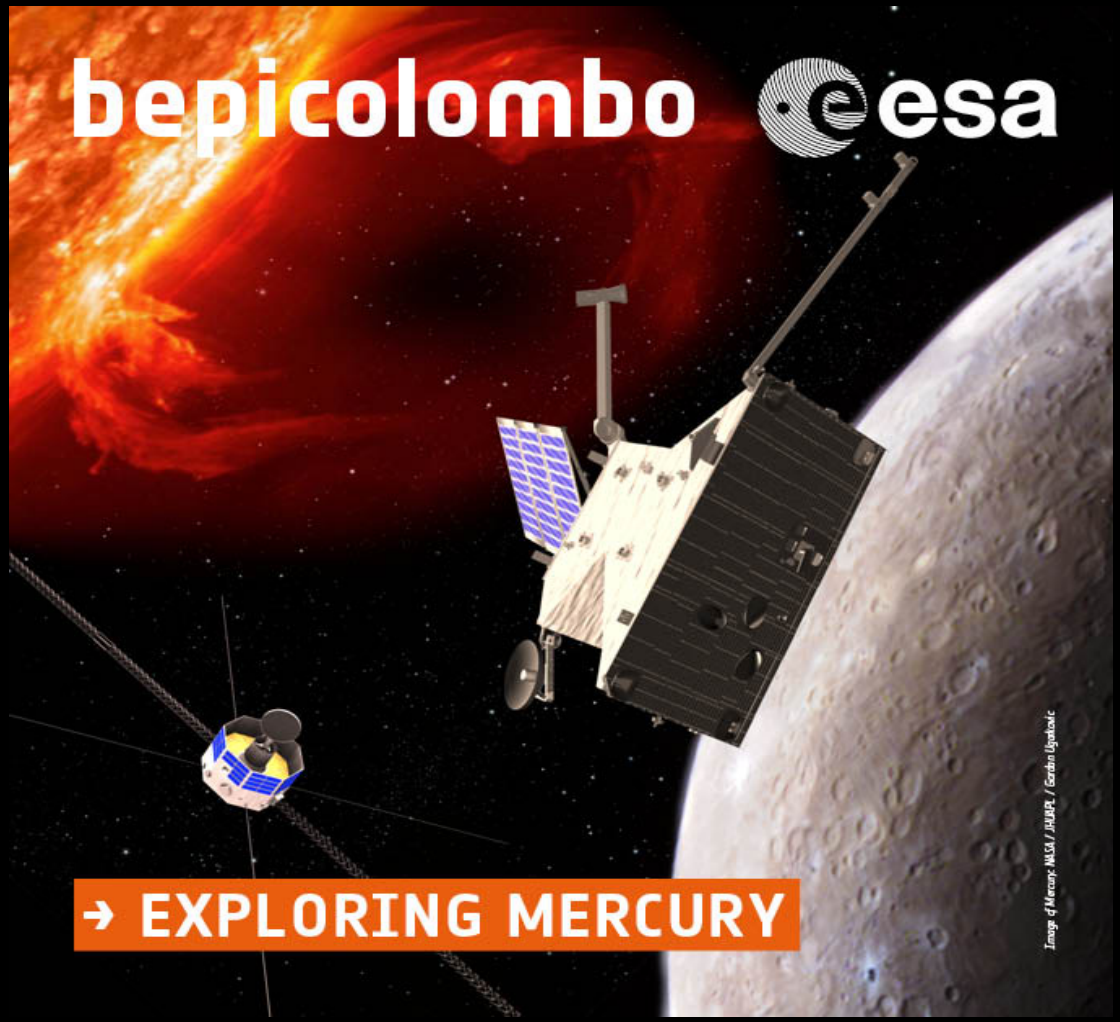
Mercury Magnetic Field

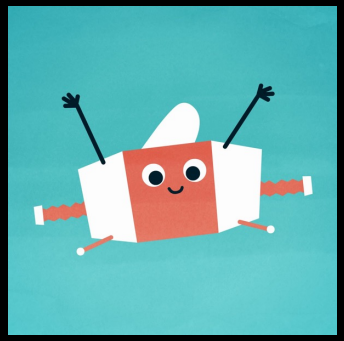


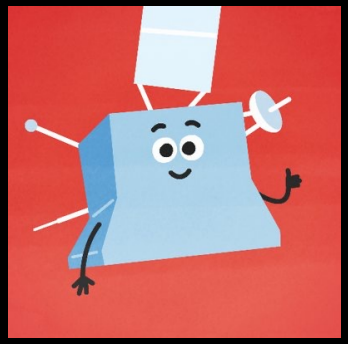
Mercury Interior

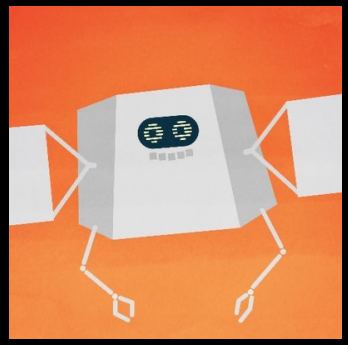
- Mercury is the second most dense planet in the Solar System (after Earth)
- Iron-rich core that occupies more than 80% of the planet.
- The outer part of the core is believed to be made of cast material. This is where Mercury's magnetic field is generated - a characteristic shared with Earth, unlike Venus, Mars, or the Moon.





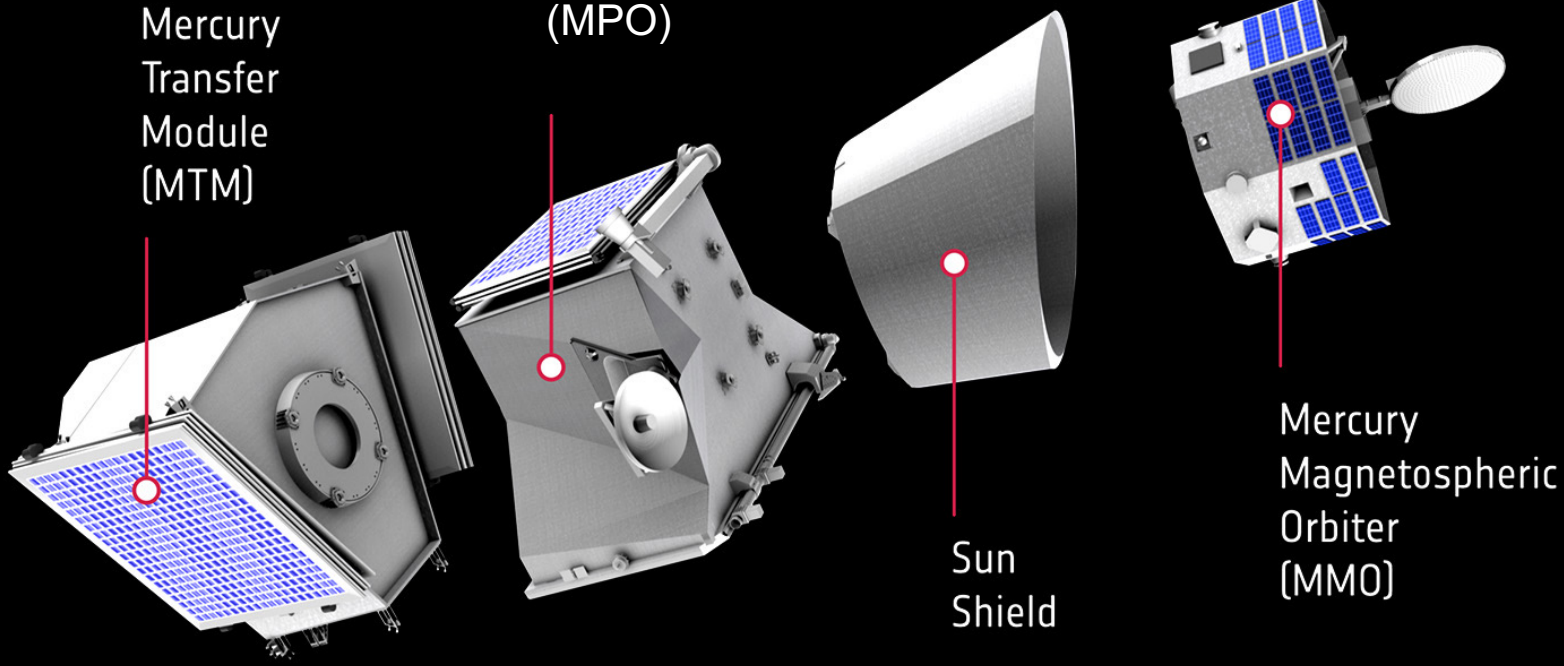






European-Japanese Mission to Mercury

3 in 1!


Mercury
Transfer
Module
(MTM)
Mercury
Planetary
Orbiter
(MPO)
Sun
Shield
Mercury
Magnetospheric
Orbiter
(MMO)

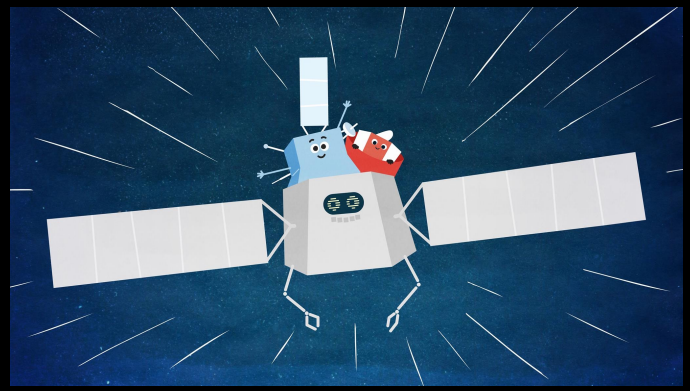
Objective: Mercury

Launch: 20 Oct 2018

Cruise: 7.2 years

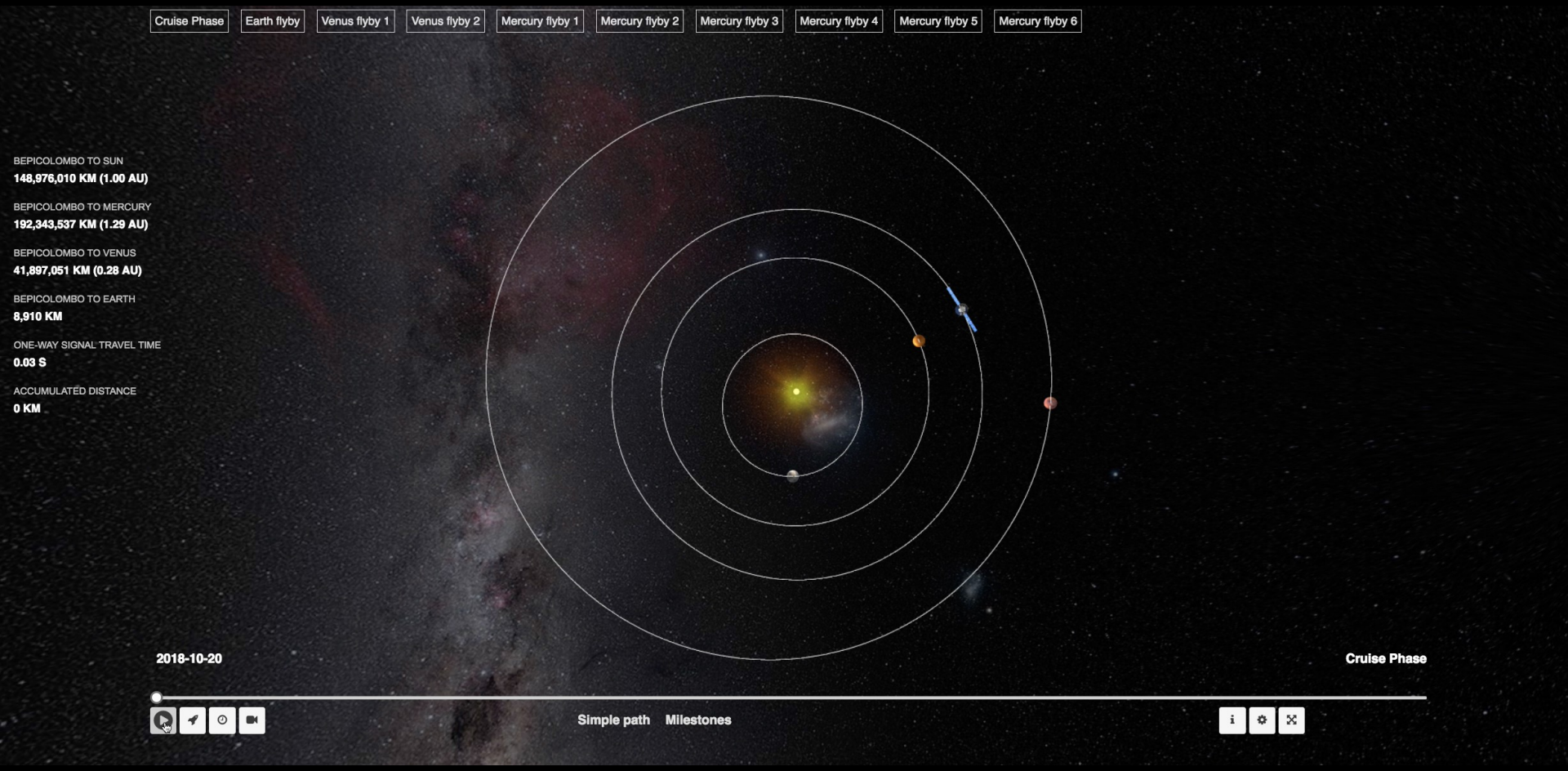
Science Phase: 1 Earth year from March 2026. Extension of 1 Earth year

Scientific Payload: 11 MPO, 5 in MMO

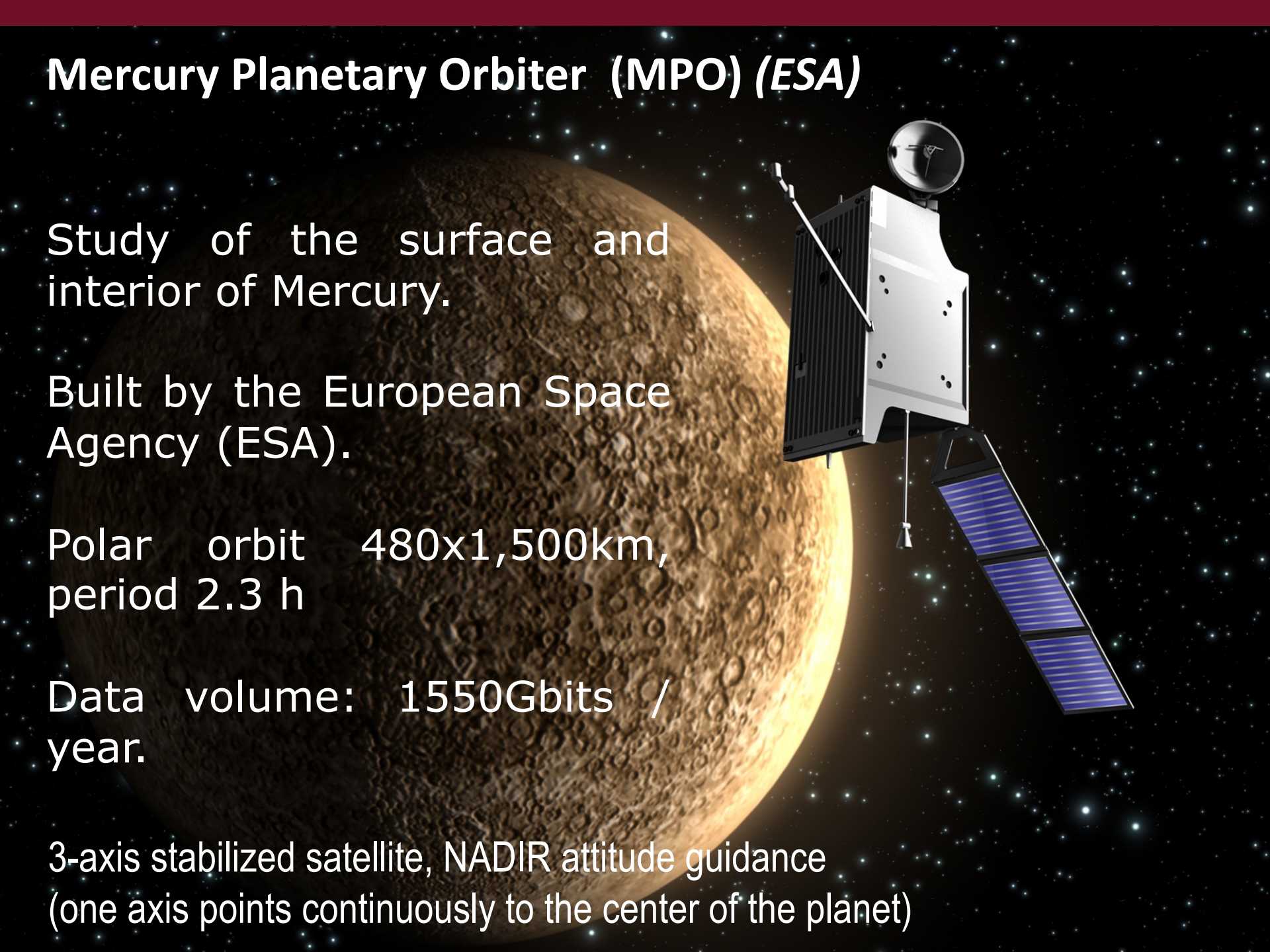


Route to Mercury

- **Launch:** 20 October 2018
- **Interplanetary Cruise:** 7.2 years, 9 billions kms, 18 loops to the Sun
- **9 "flybys":** 1 Earth, 2 Venus y 6 Mercury



Mercury Planetary Orbiter (MPO) *(ESA)*



Study of the surface and interior of Mercury.

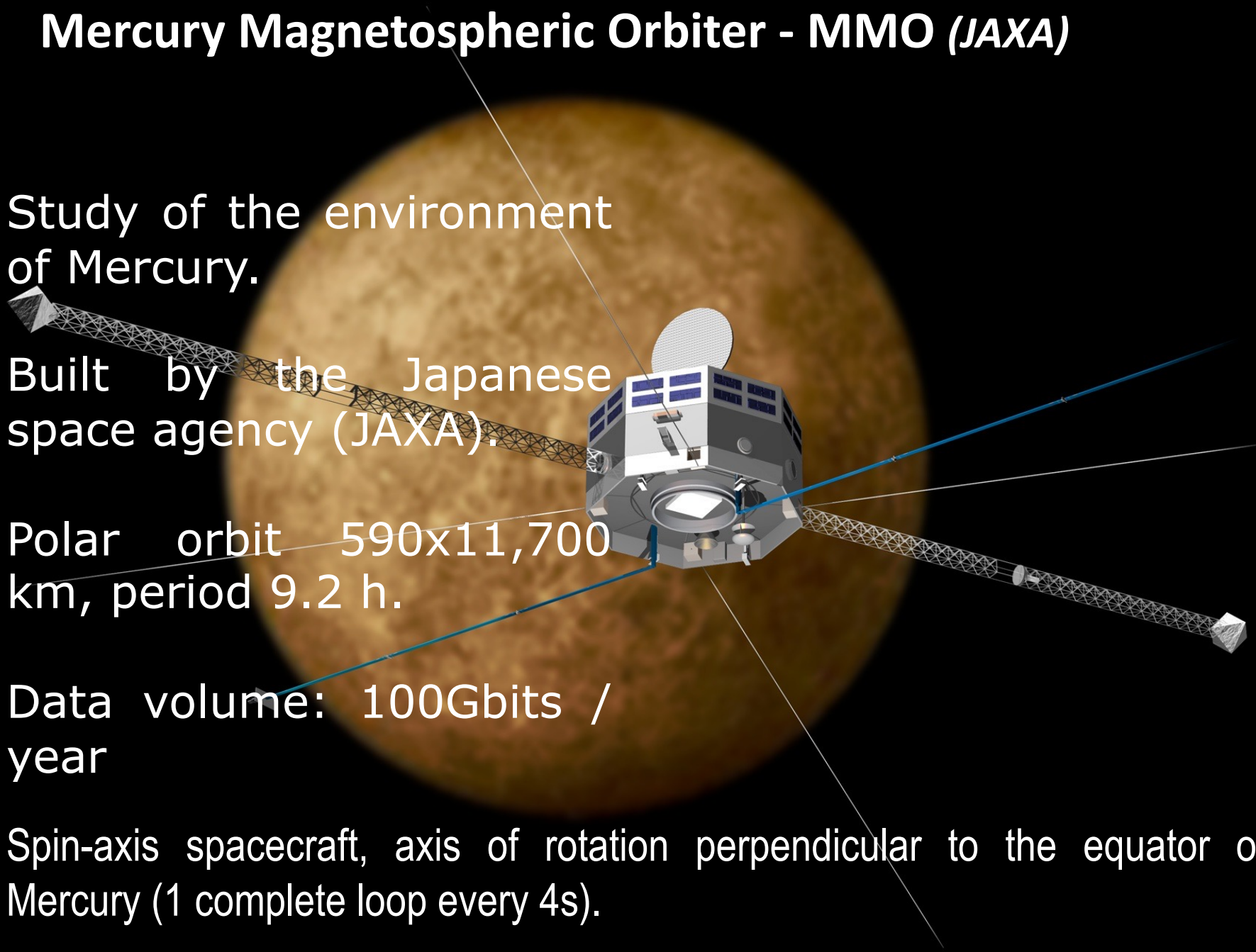
Built by the European Space Agency (ESA).

Polar orbit 480x1,500km, period 2.3 h

Data volume: 1550Gbits / year.

3-axis stabilized satellite, NADIR attitude guidance
(one axis points continuously to the center of the planet)

Mercury Magnetospheric Orbiter - MMO *(JAXA)*



Study of the environment of Mercury.

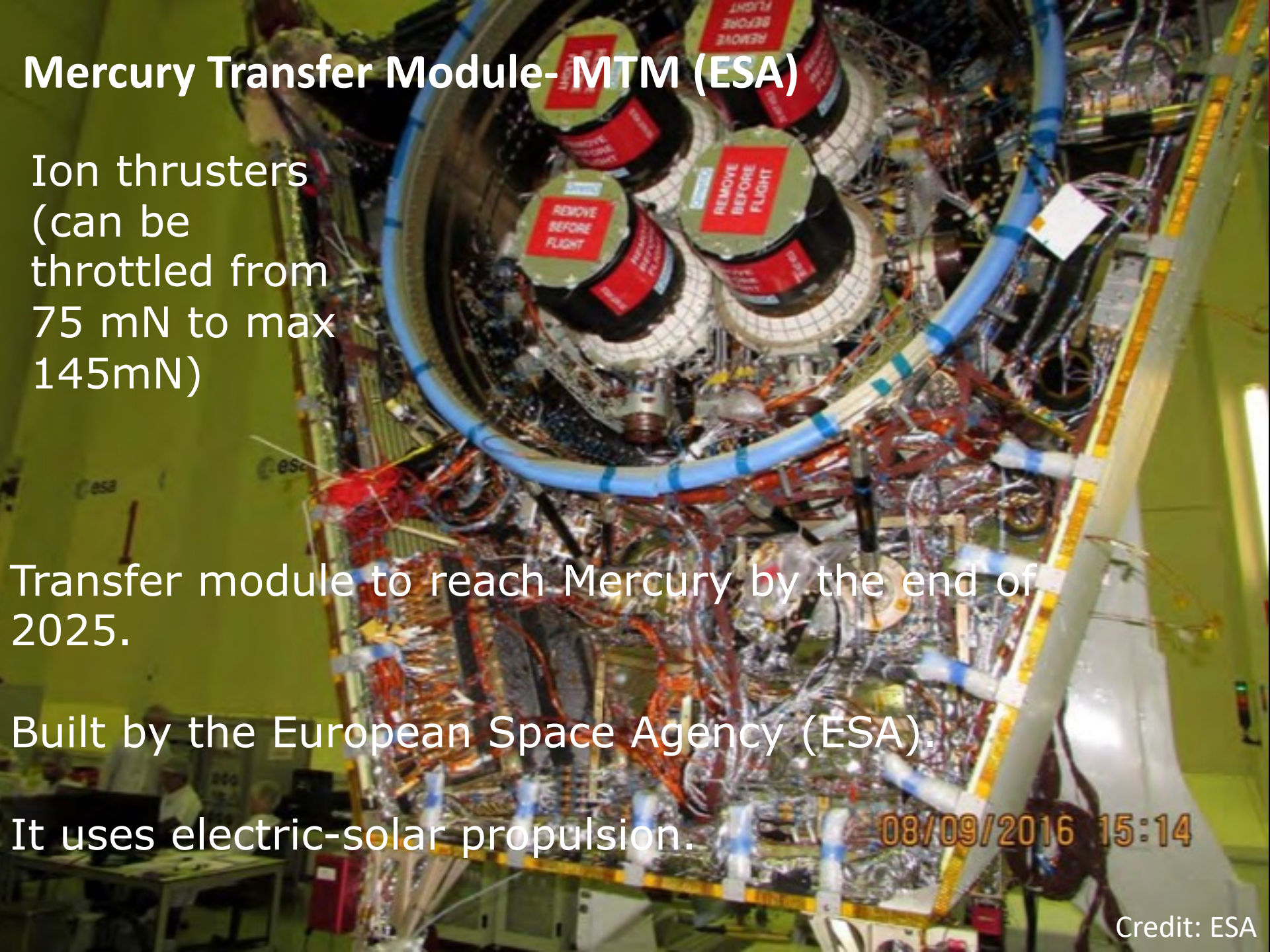
Built by the Japanese space agency (JAXA).

Polar orbit 590x11,700 km, period 9.2 h.

Data volume: 100Gbits / year

Spin-axis spacecraft, axis of rotation perpendicular to the equator of Mercury (1 complete loop every 4s).

Mercury Transfer Module- MTM (ESA)



Ion thrusters (can be throttled from 75 mN to max 145mN)

Transfer module to reach Mercury by the end of 2025.

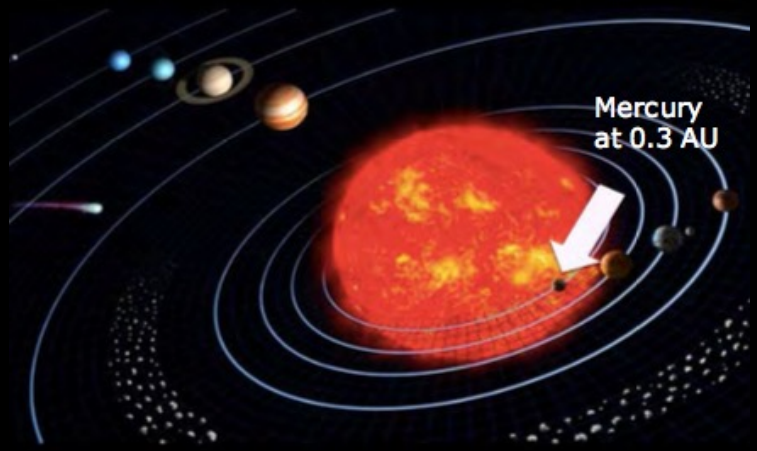
Built by the European Space Agency (ESA).

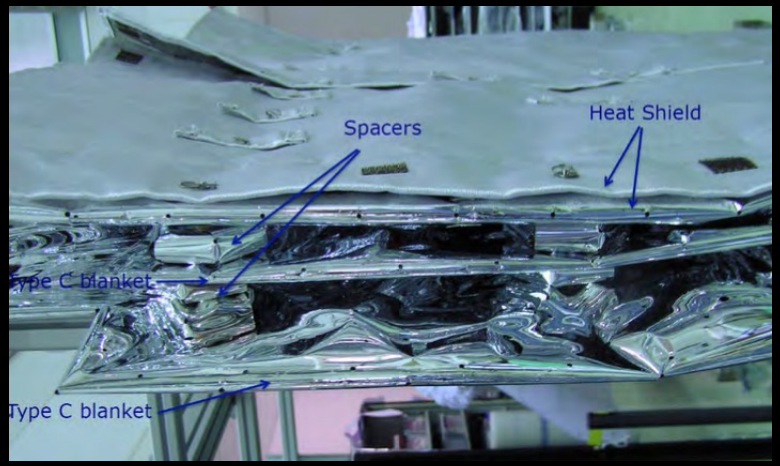
It uses electric-solar propulsion.

Credit: ESA

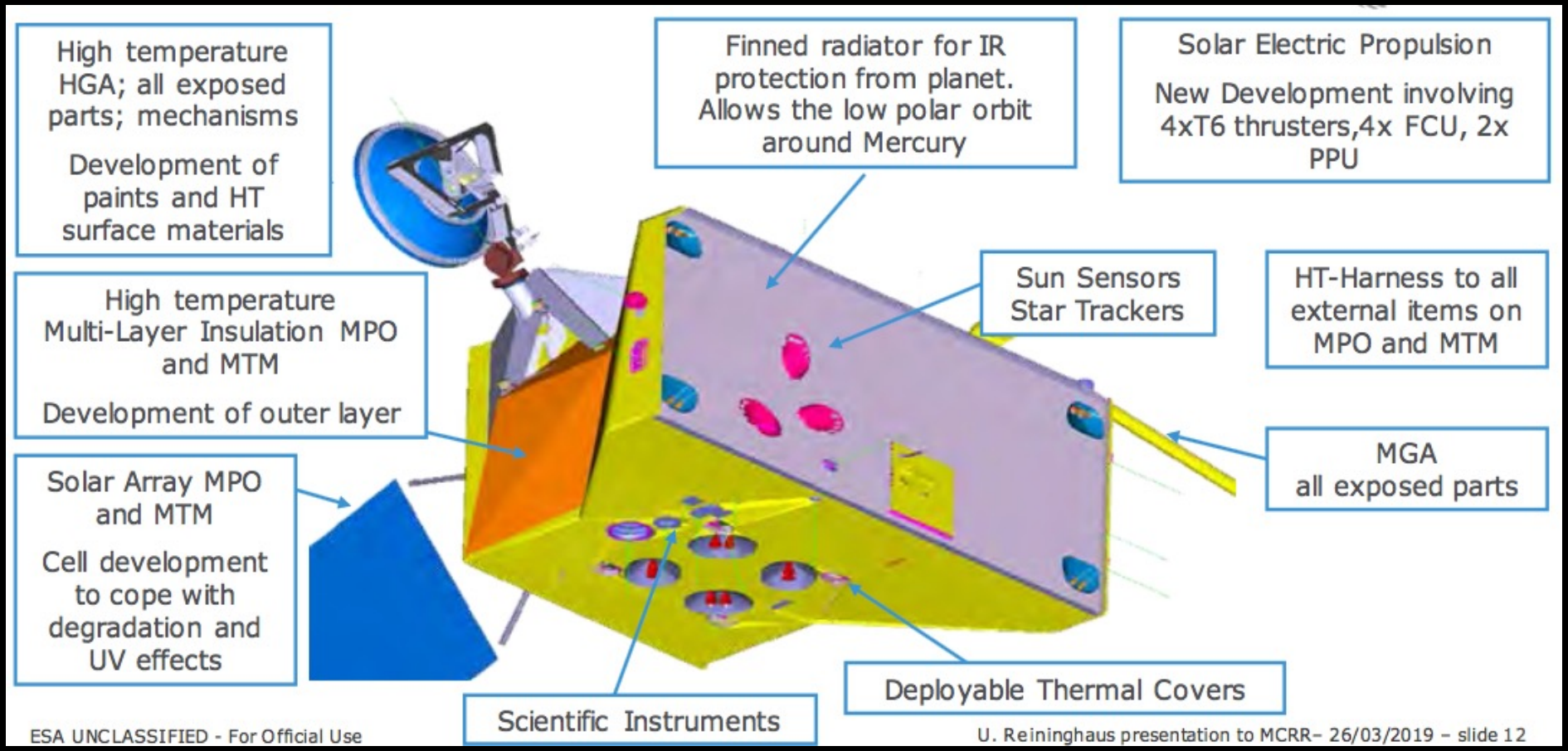
Mission Challenges

- Global coverage of the planet => targeted nadir
- High resolution => low orbit altitude
- Mercury is at 0.3 AU
- 10 times solar radiation and surface temperatures up to 450 degrees.
- 5 of 6 sides and spacecraft antennas facing the Sun and infrared radiation
- More tan 70% of the S/C is a specific development of BepiColombo.
- The cruise trajectory requires chemical gravity assistance and electric propulsion arches.





Technology challenges



Operations: Ground Segment

- BepiColombo is operated and controlled from the European Operations Center (ESOC), in Germany, from launch to arrival at Mercury.
- The JAXA Sagamihara Space Operations Center, with the Usuda station in Japan, will take over the operation of the MMO once it is in orbit around Mercury.
- The scientific operations of the MPO will be prepared by the scientific operations center (ESAC) located in Villafranca, Madrid, Spain and those of the MMO from the JAXA Sagamihara Scientific Operations Center (SSOC).

Comunications: Cebreros Station

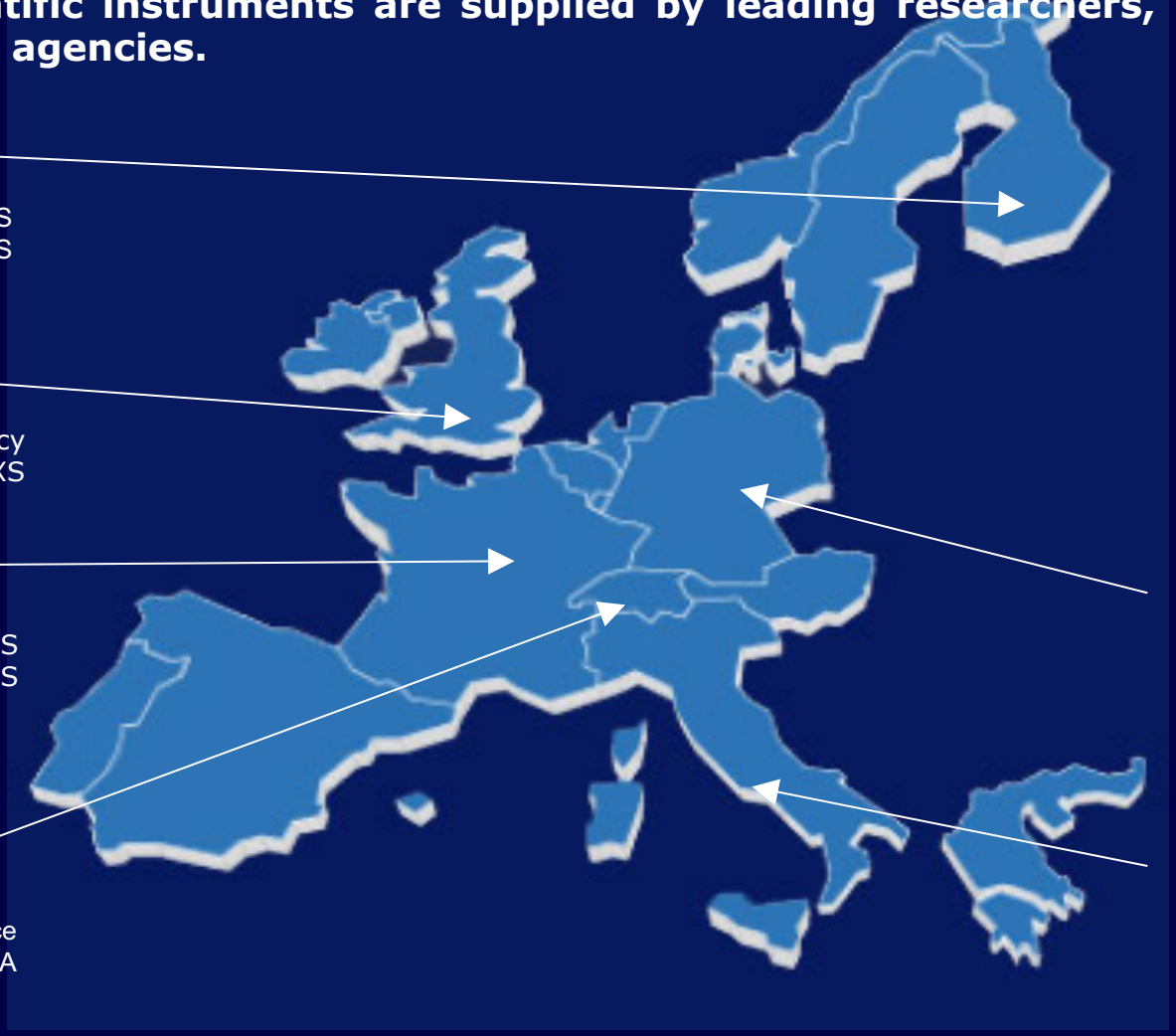
Cebreros station is located 77 kilometers west of Madrid, Spain. Cebreris is a 35 meter antenna with X band transmission and reception and Ka band reception. Provides communication 8 hours a day.

Provides routine support for missions in space, including Mars Express and Gaia, and BepiColombo.

Malargüe station, in Argentina, will be another station to be used in BepiColombo Mercury Operations.

BepiColombo – Collaboration

BepiColombo is an ESA mission to Mercury in collaboration with JAXA. Scientific instruments are supplied by leading researchers, funded by 8 agencies.



TEKES
SIXS

UK Space Agency
MIXS

CNES
PHEBUS

Swiss Space Office
BELA

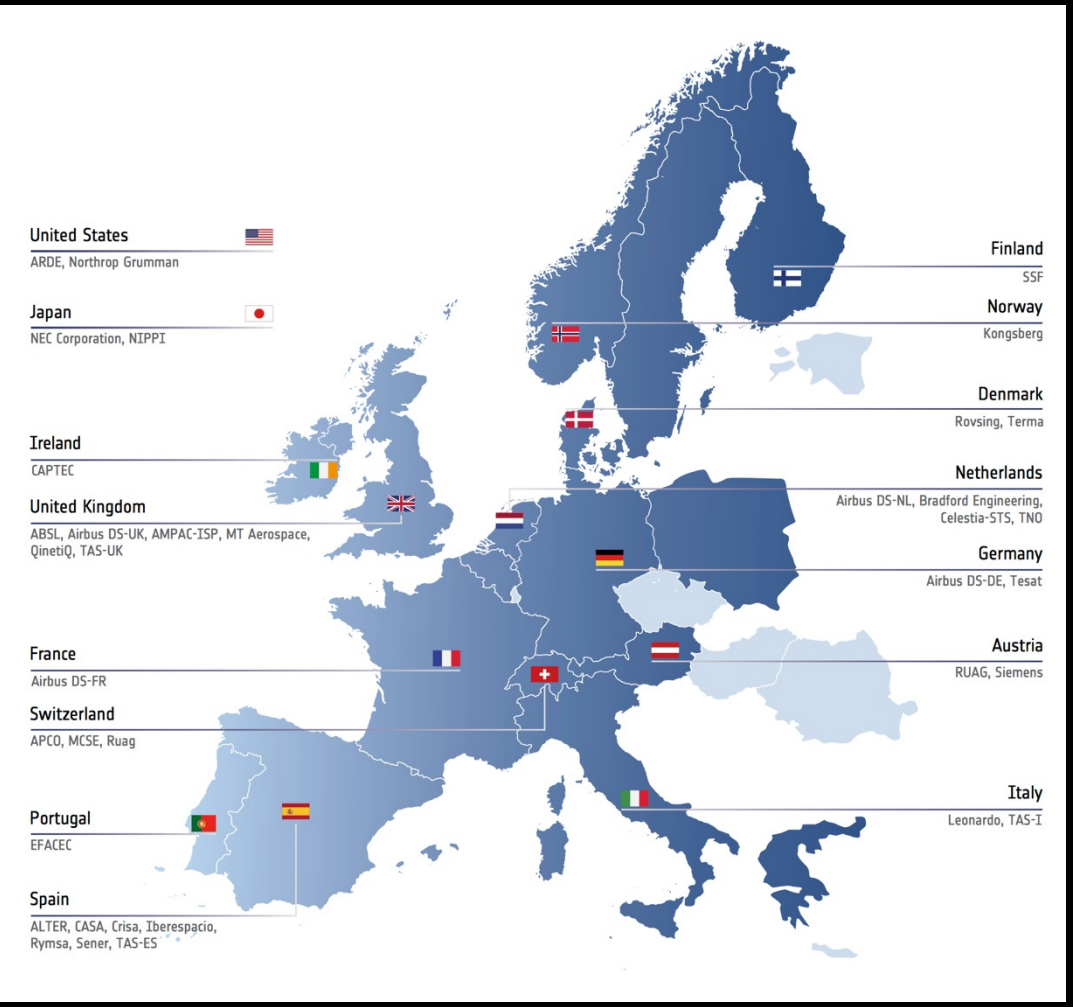
Japan Aerospace
Exploration Agency
MMO

Roscosmos
MGNS

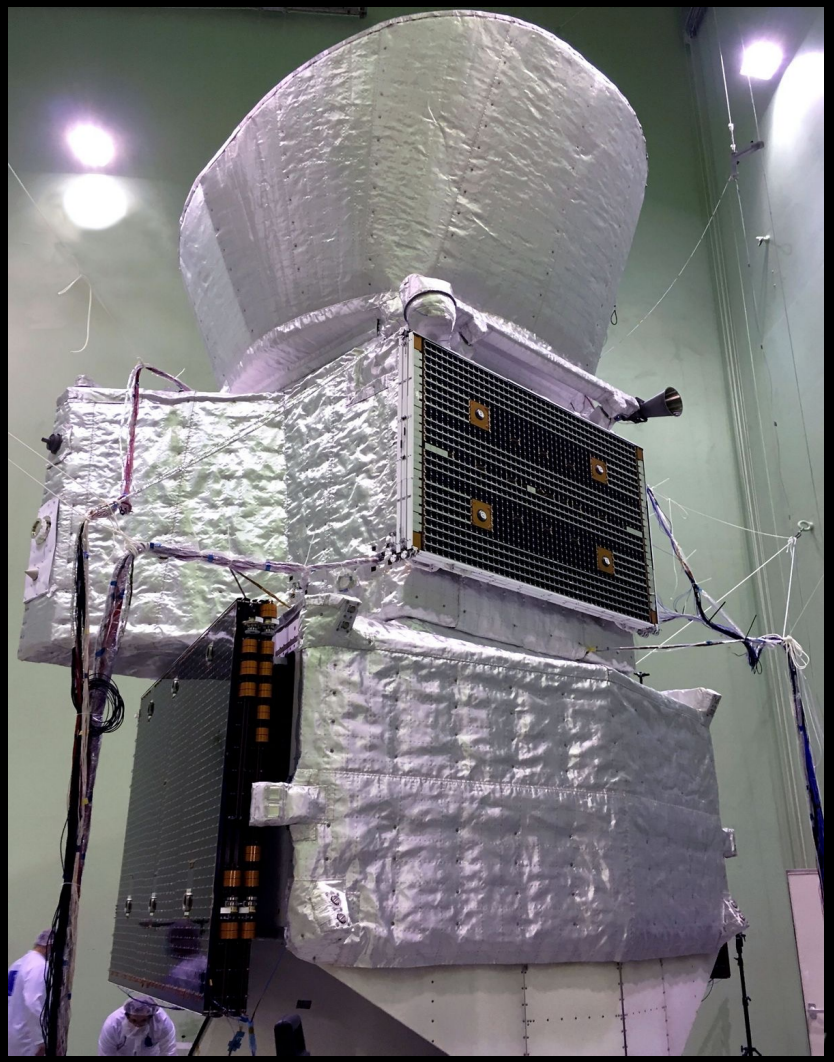
DLR
BELA
MERMAG
MERTIS

Italian Space Agency
ISA
MORE
SERENA
SIMBIOSYS

BepiColombo and Industry

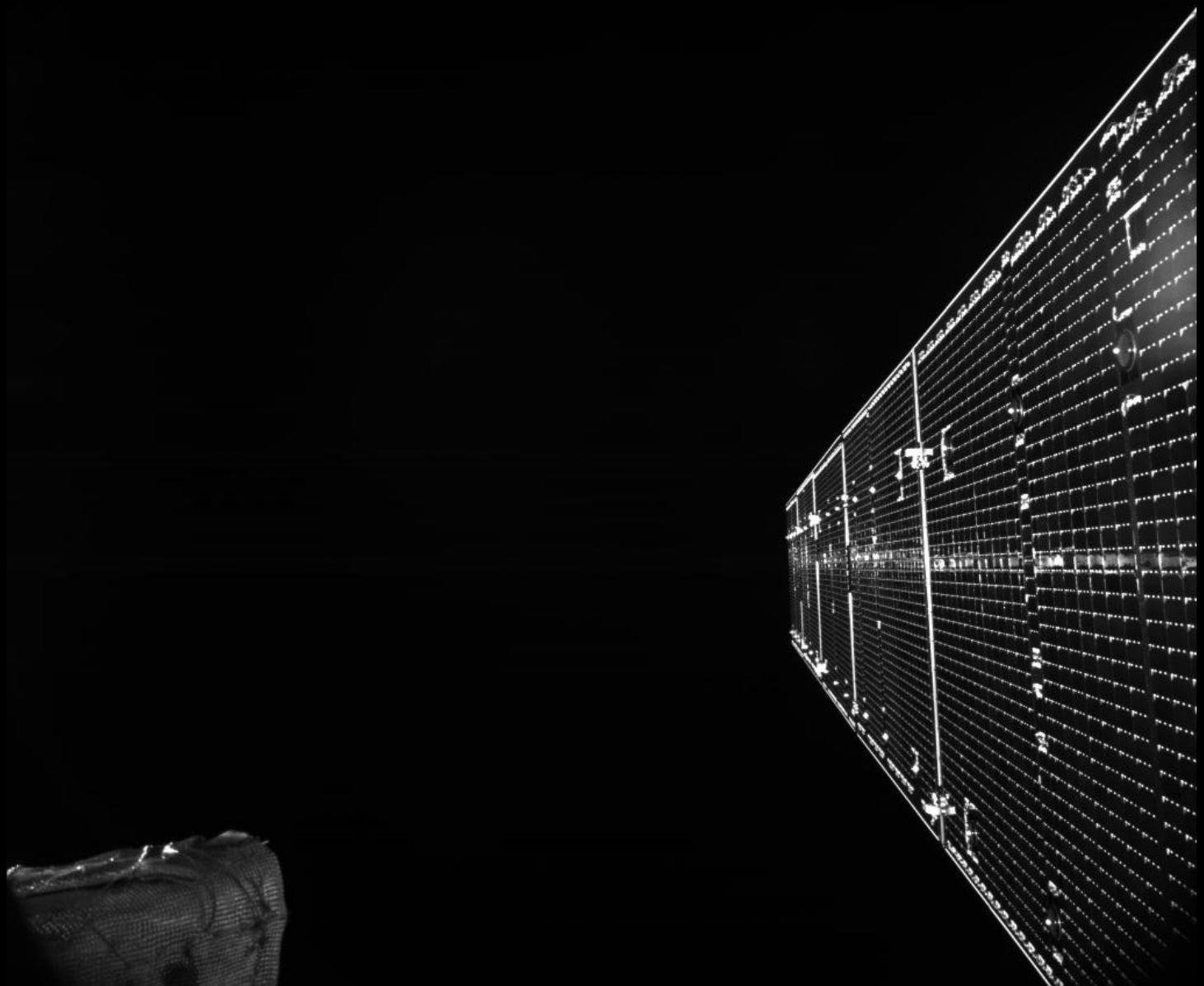


83 companies from 12 countries



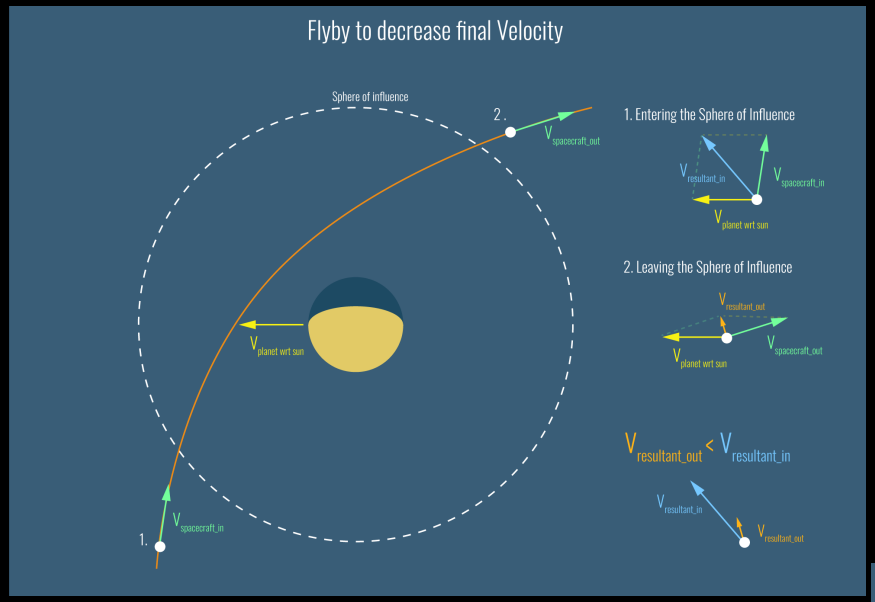
Launch 20 October 2018

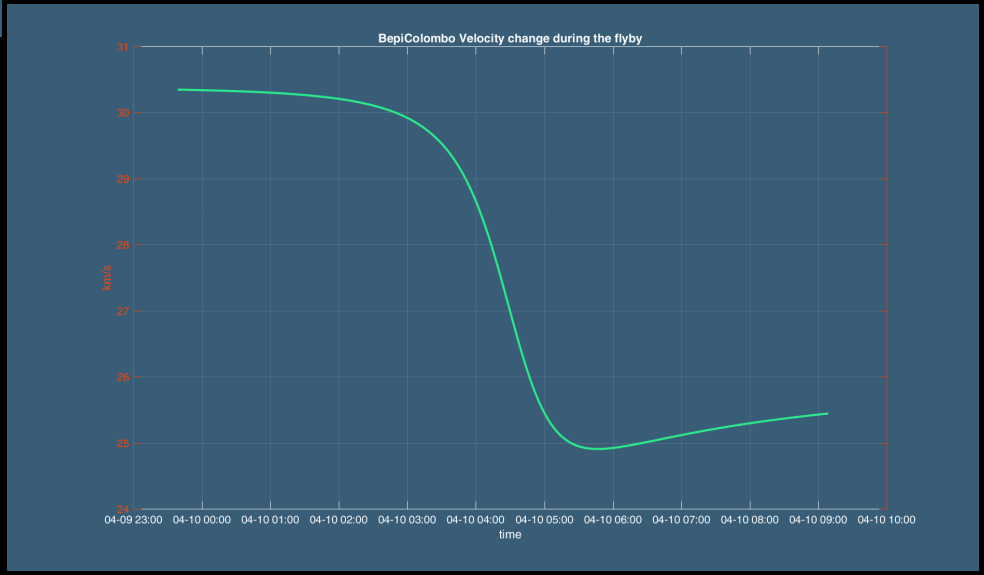

esa




1 x Earth

Earth Flyby1: 15 April 2020

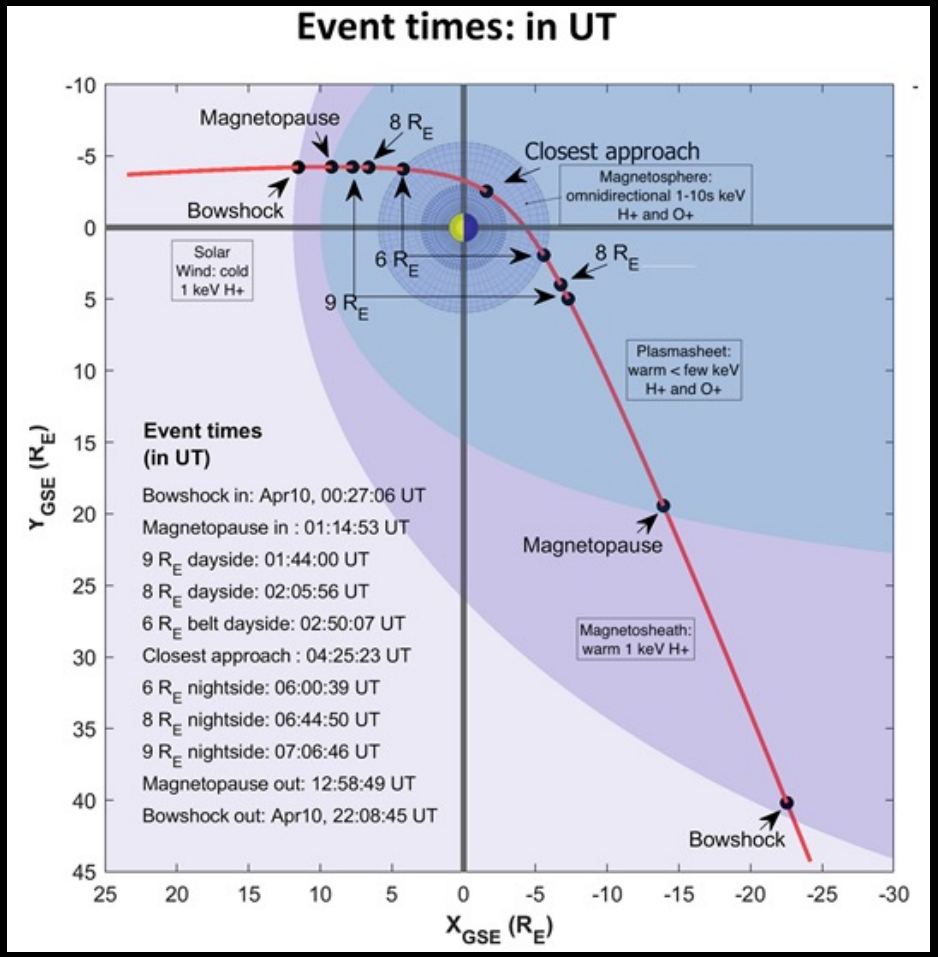




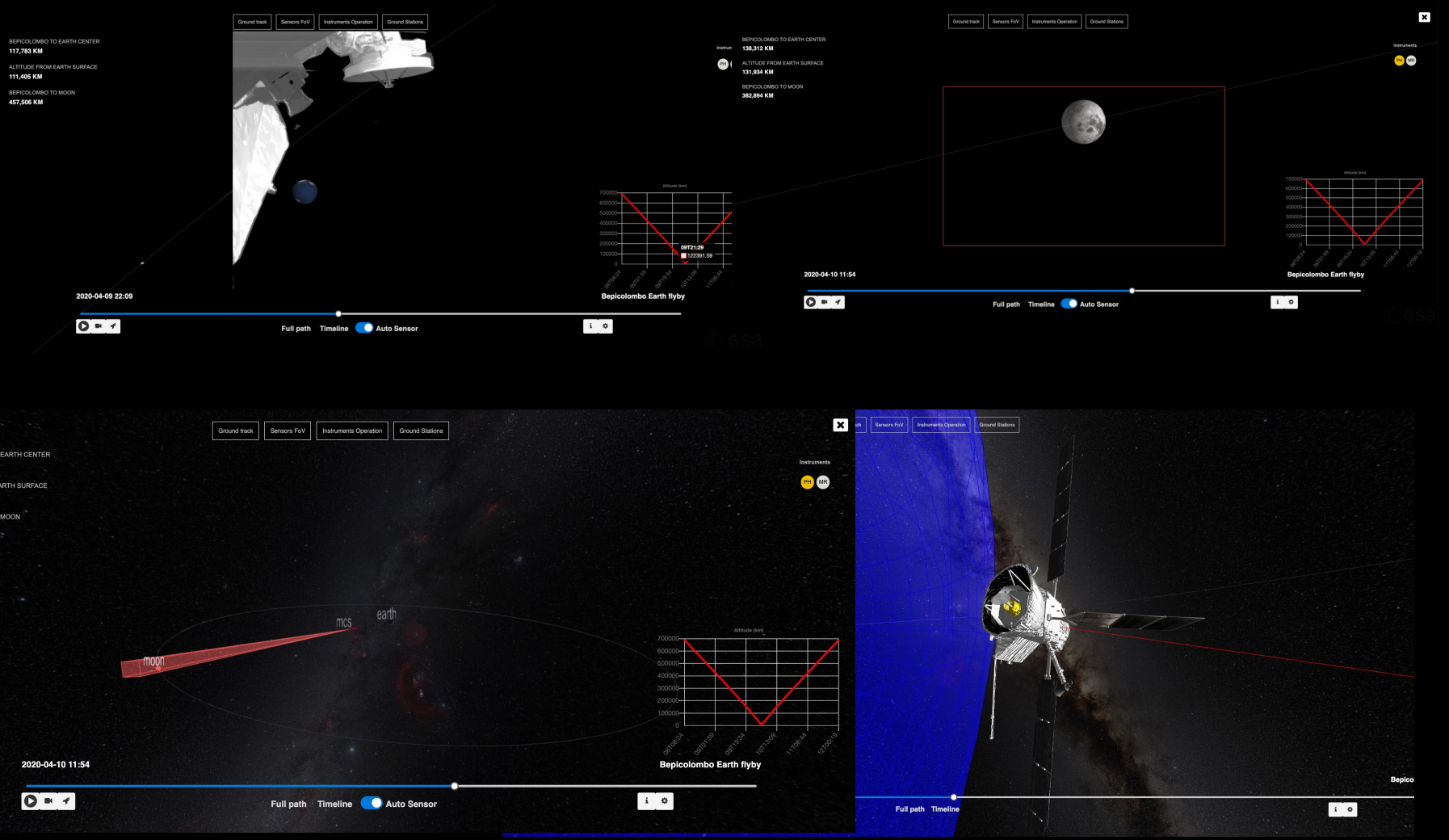
Earth Flyby1 Geometry

Closest approach = 2020-04-10 04:24:57

Earth flyby S/C Altitude at CA (km): 12692.90



Earth Flyby#1: Planning the Science Operations

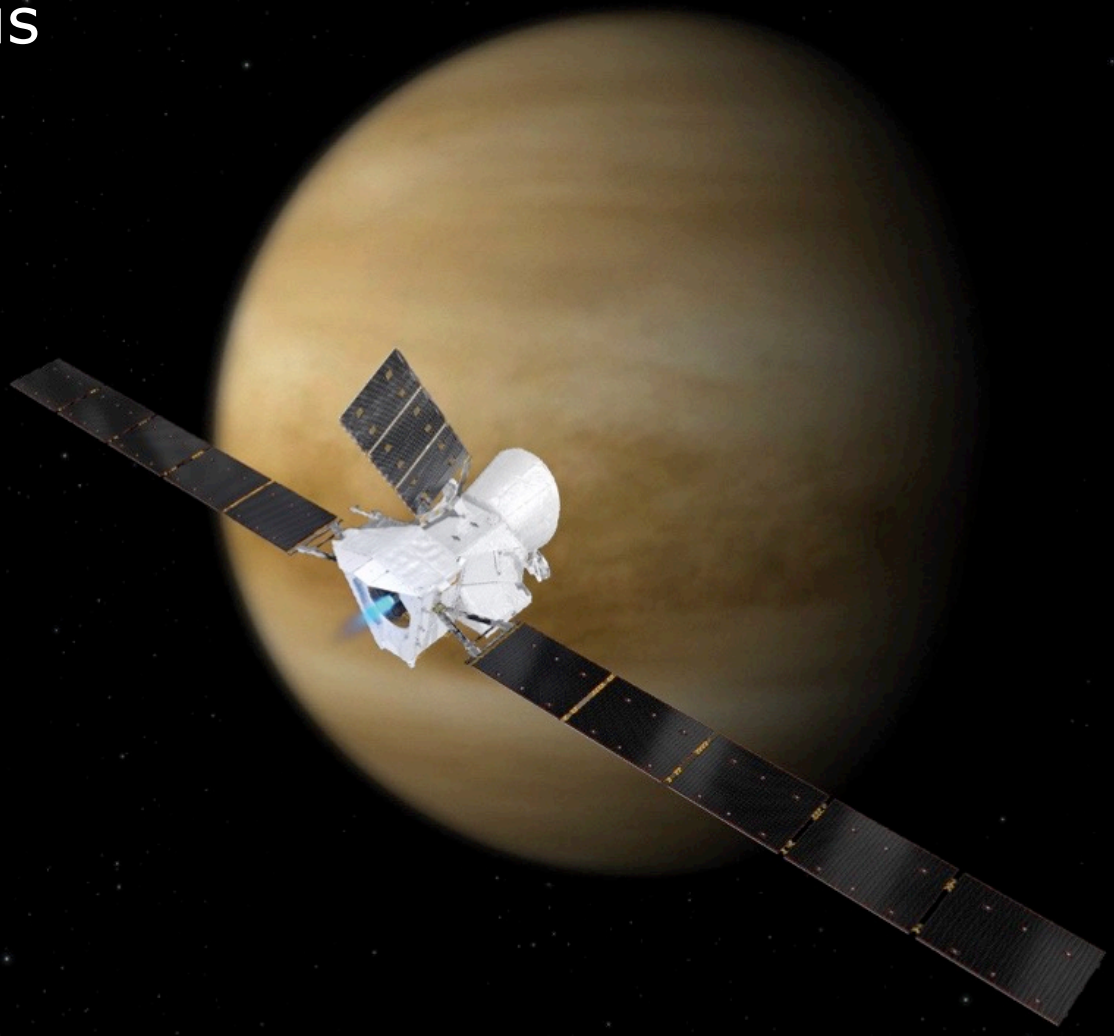


Earth Flyby video

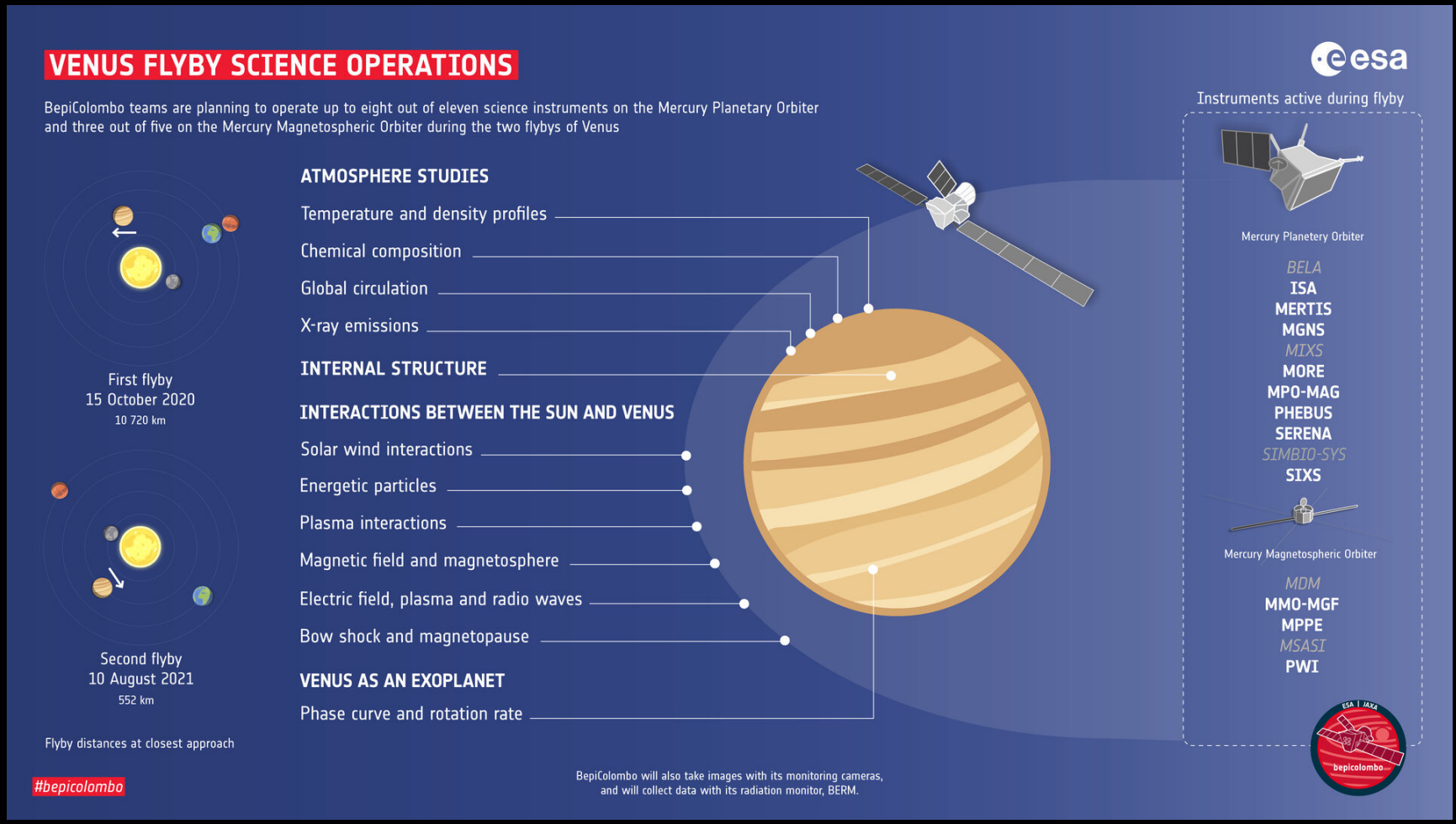
BepiColombo Selfies and Earth (I)

BepiColombo Selfies and Earth (II)

2 x Venus



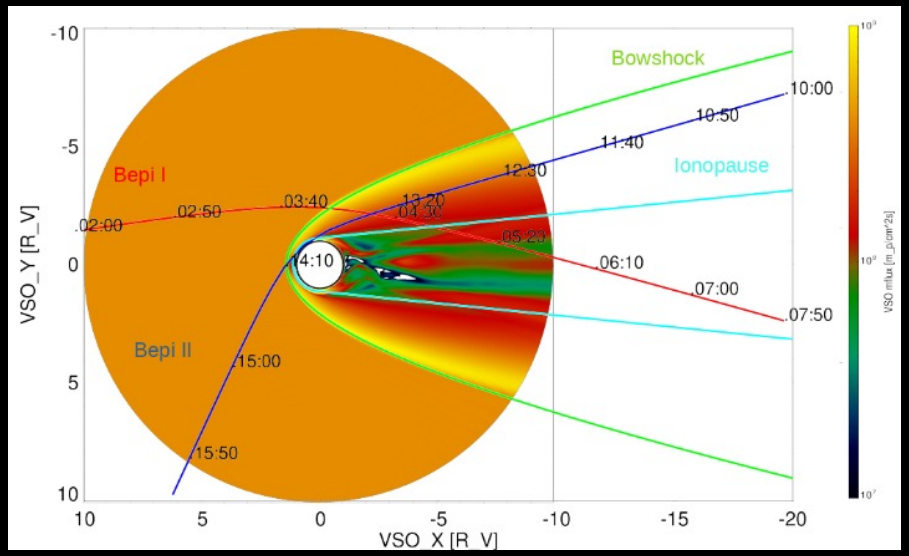
Venus Flyby#2: 10 August 2021

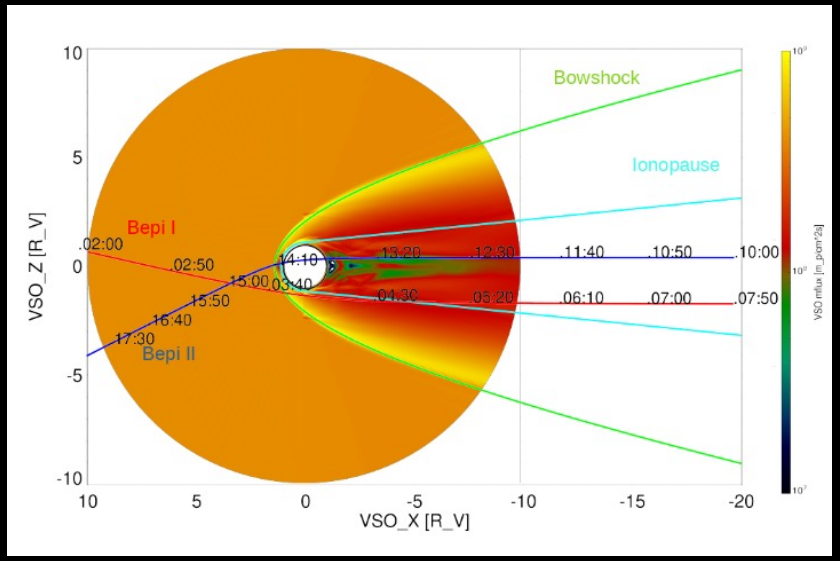


Venus Flyby#1: 15 October 2020

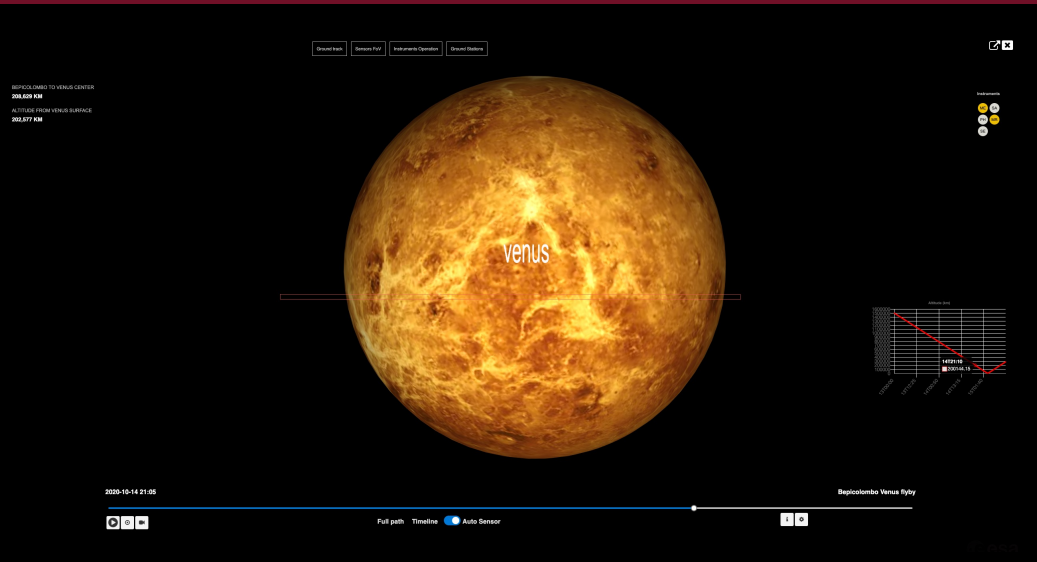
Venus Flyby#1 Geometry

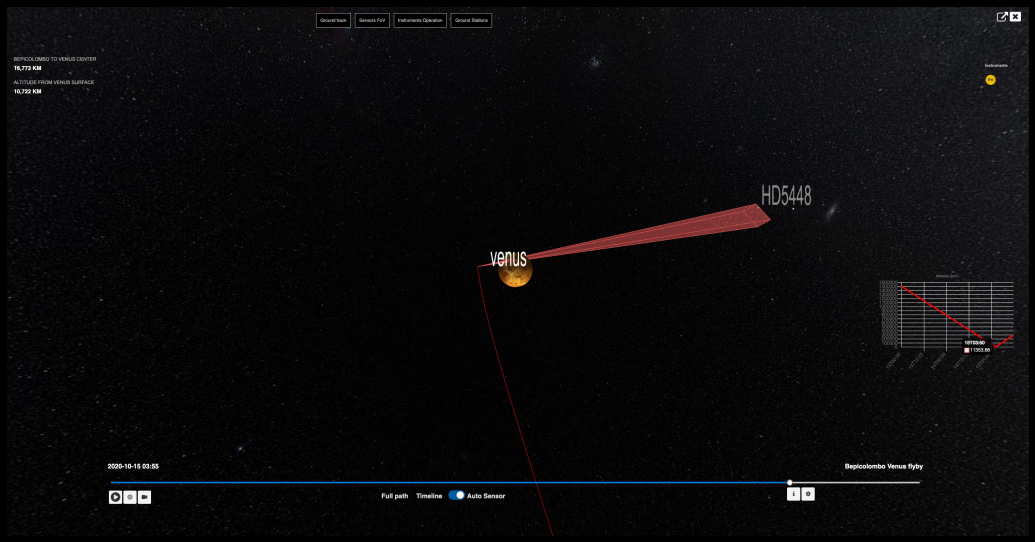
- Closest approach = 2020-10-15 03:58:32 UTC
- Venus flyby S/C Altitude at CA (km): 10722.464

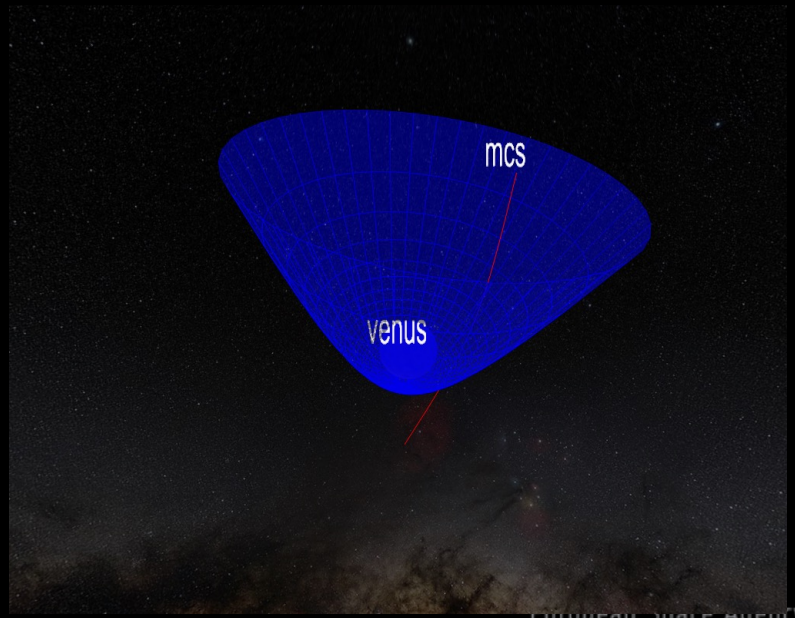




Venus Flyby#1: Planning the Science Operations





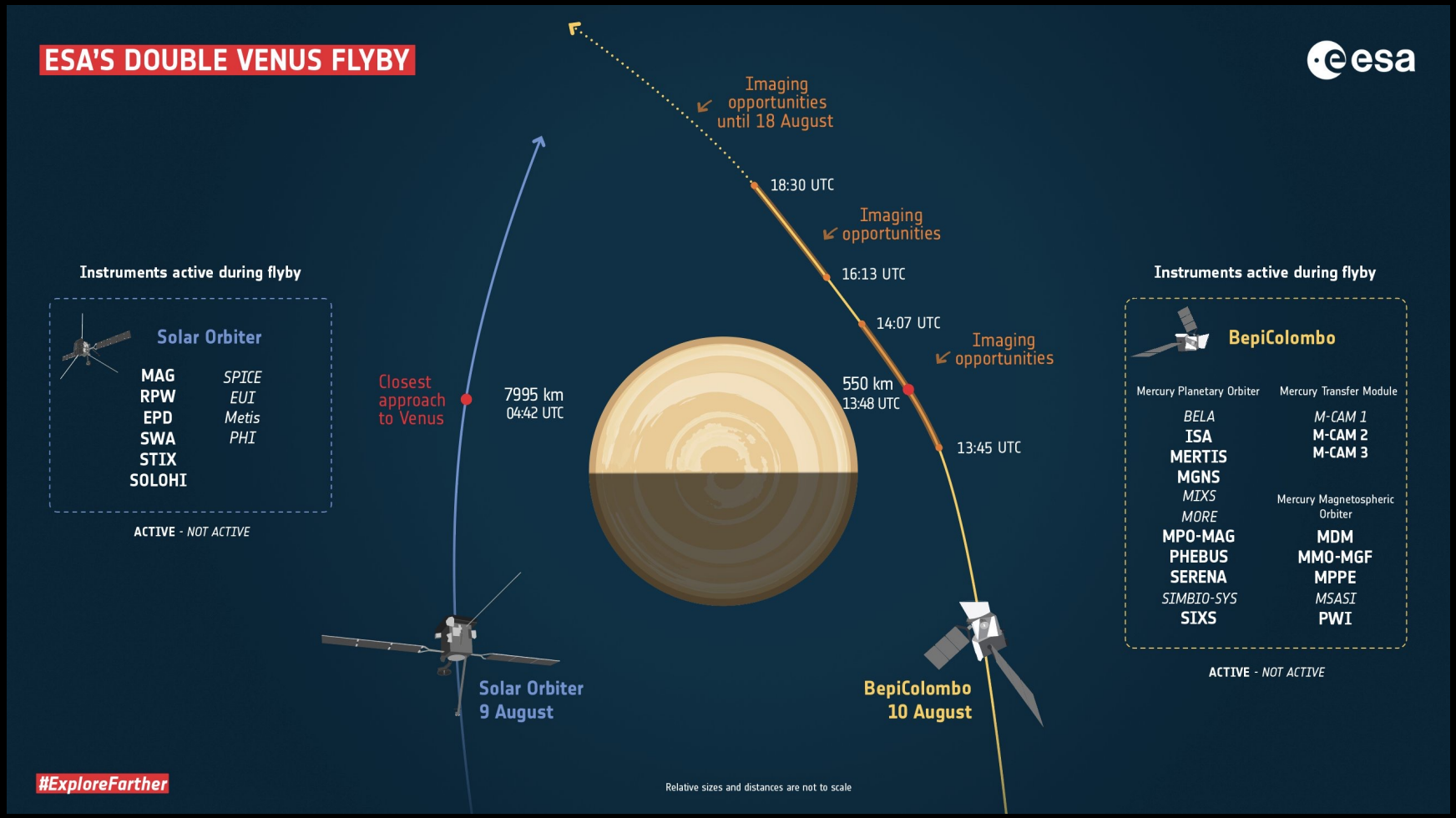


Venus Flyby#1 video

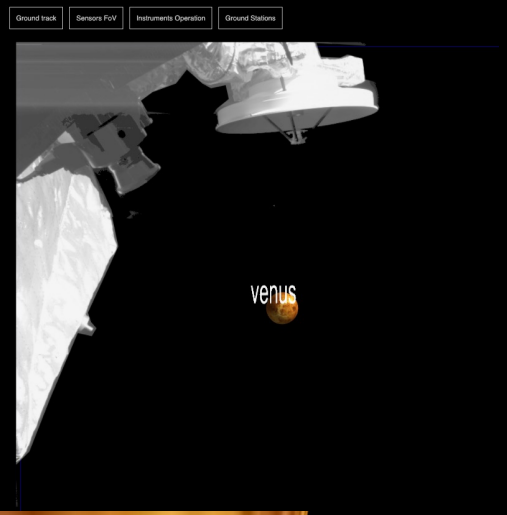
BepiColombo Selfies and Venus (I)

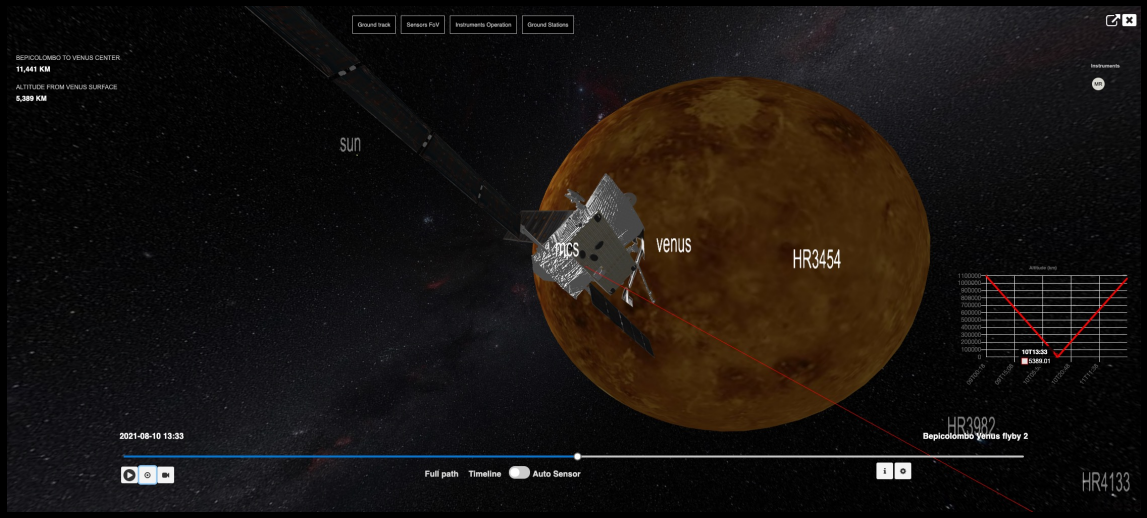
BepiColombo Selfies and Venus (II)

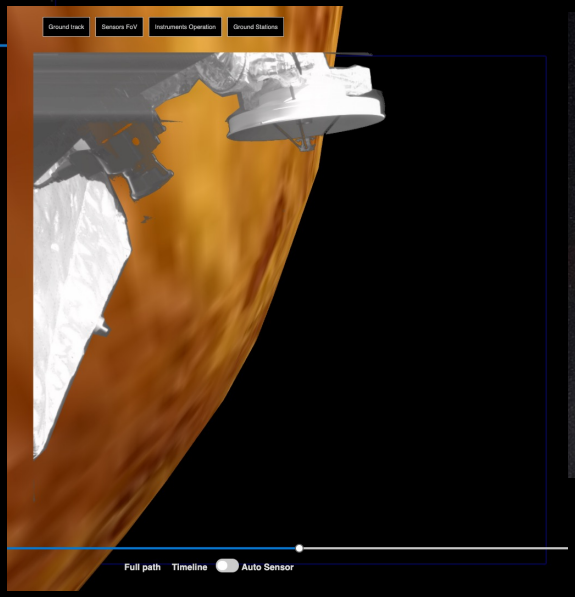
Venus Flyby#2: 10 August 2021

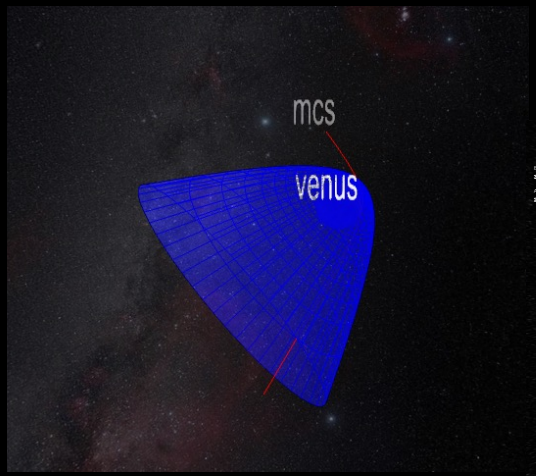


Venus Flyby#2: Planning the Science Operations





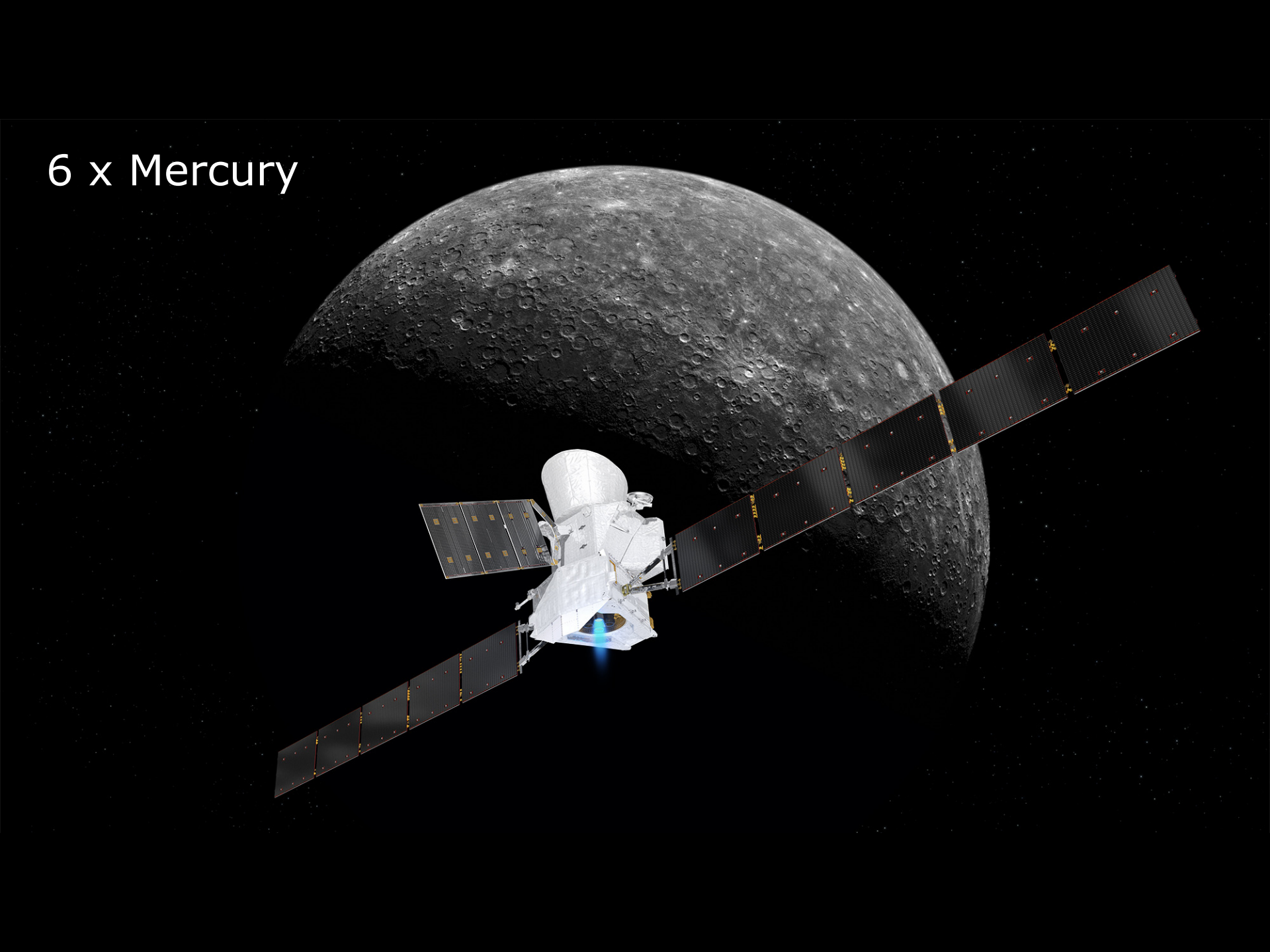




Venus Flyby#2 video

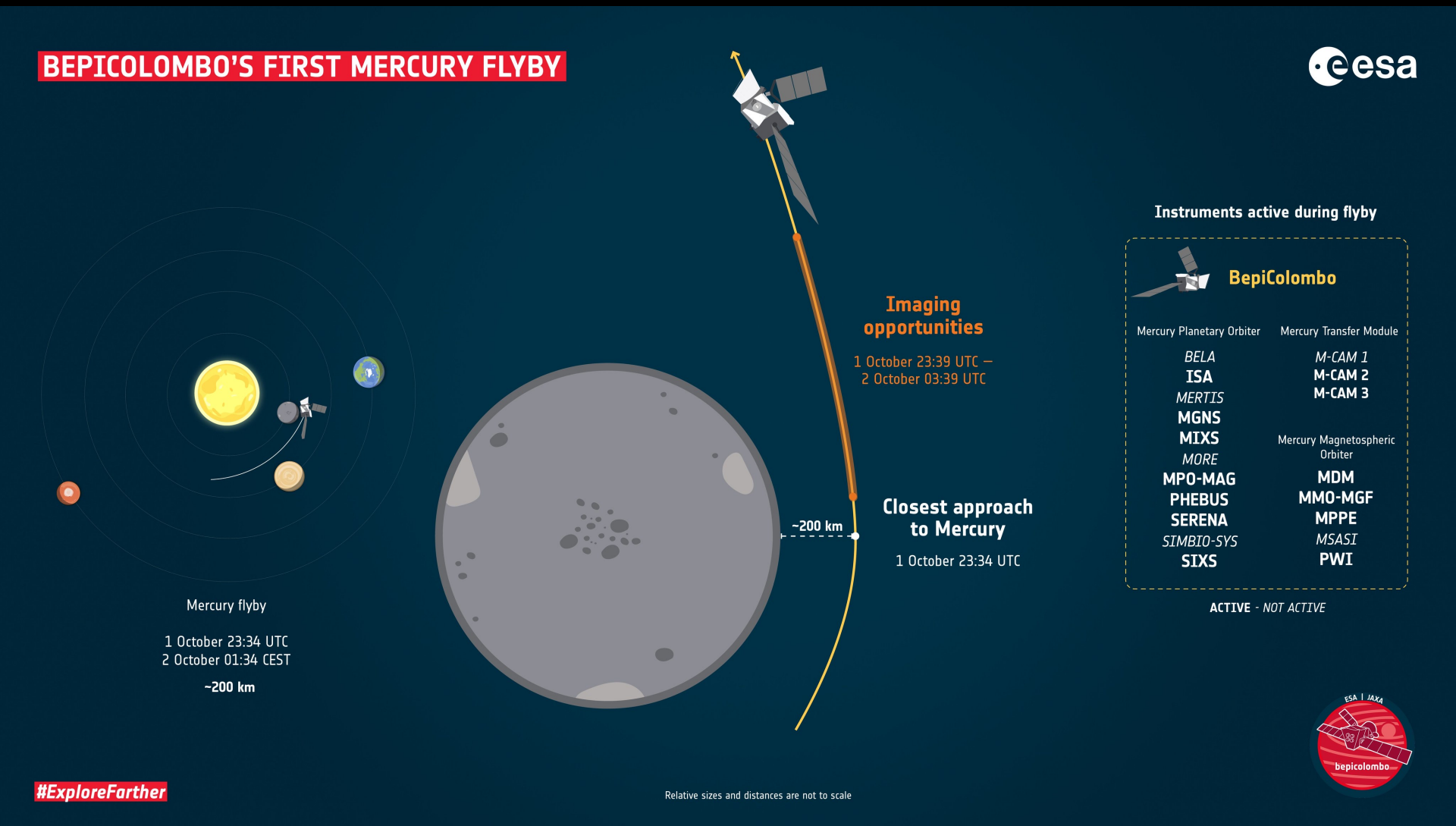
BepiColombo Selfies and Venus (II)

6 x Mercury



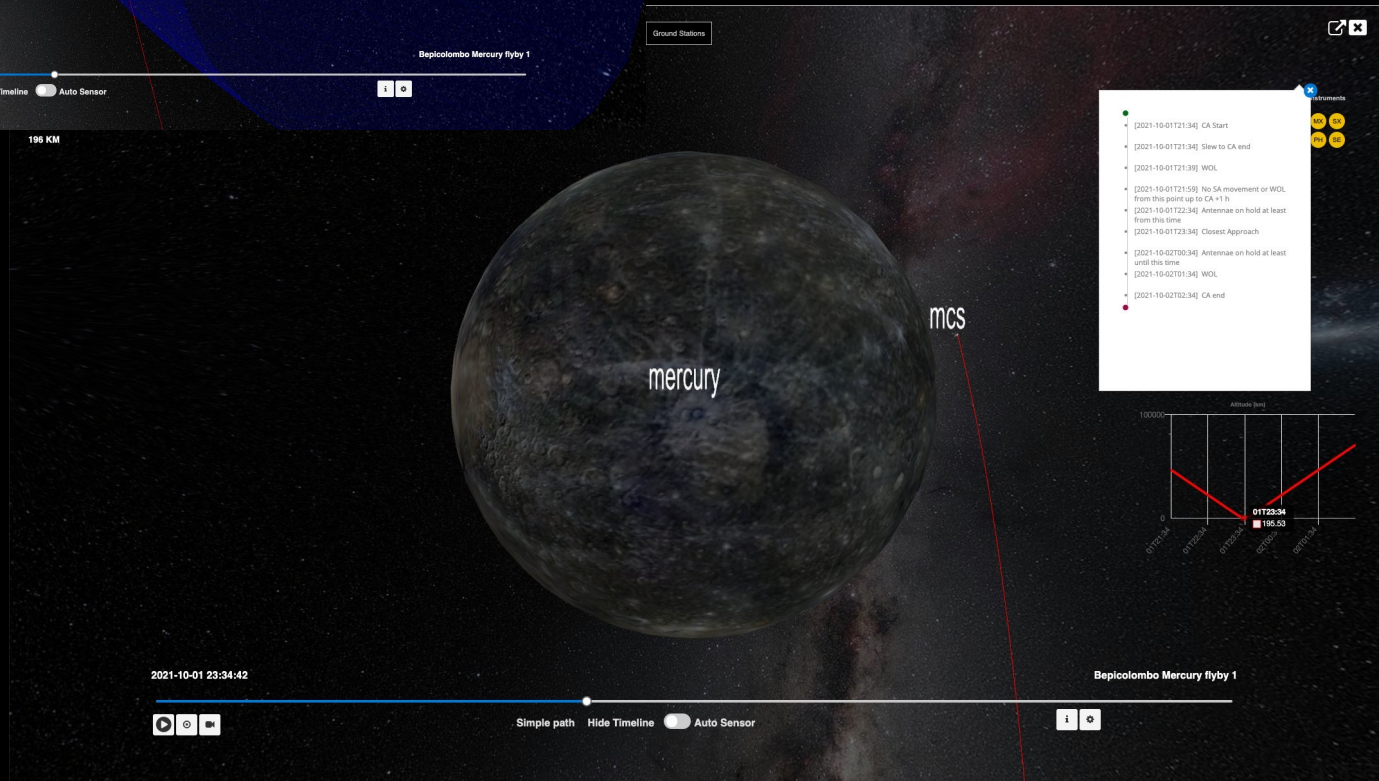
Bepi Mercury Flybys

Mercury Flyby#1: 1 October 2021

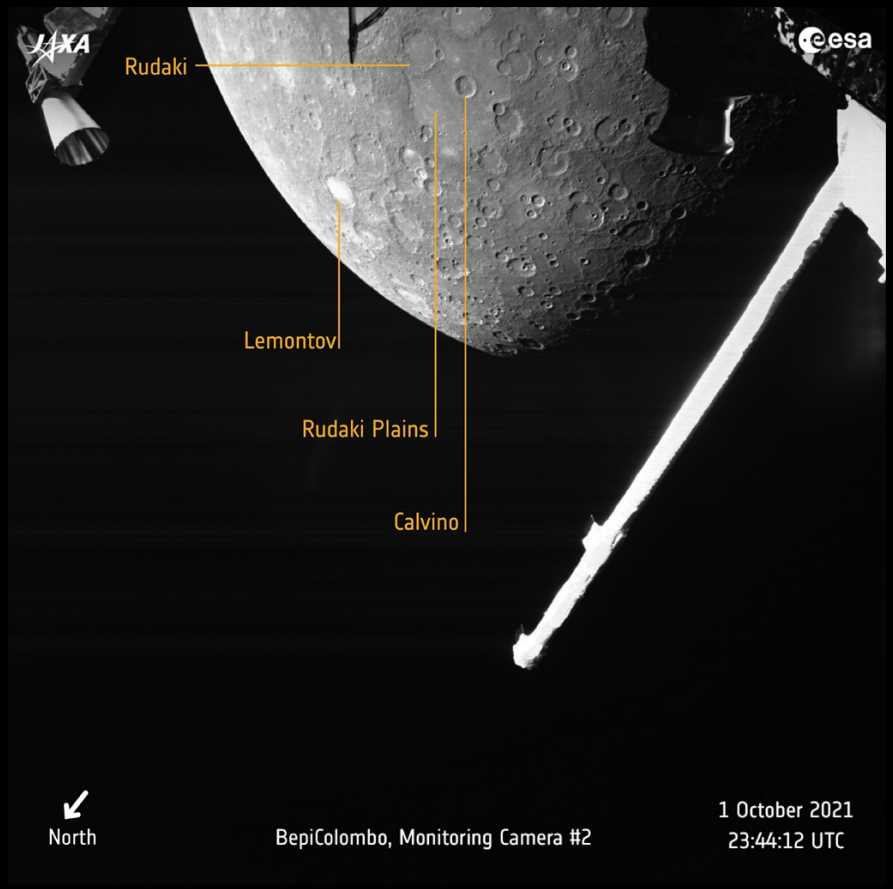


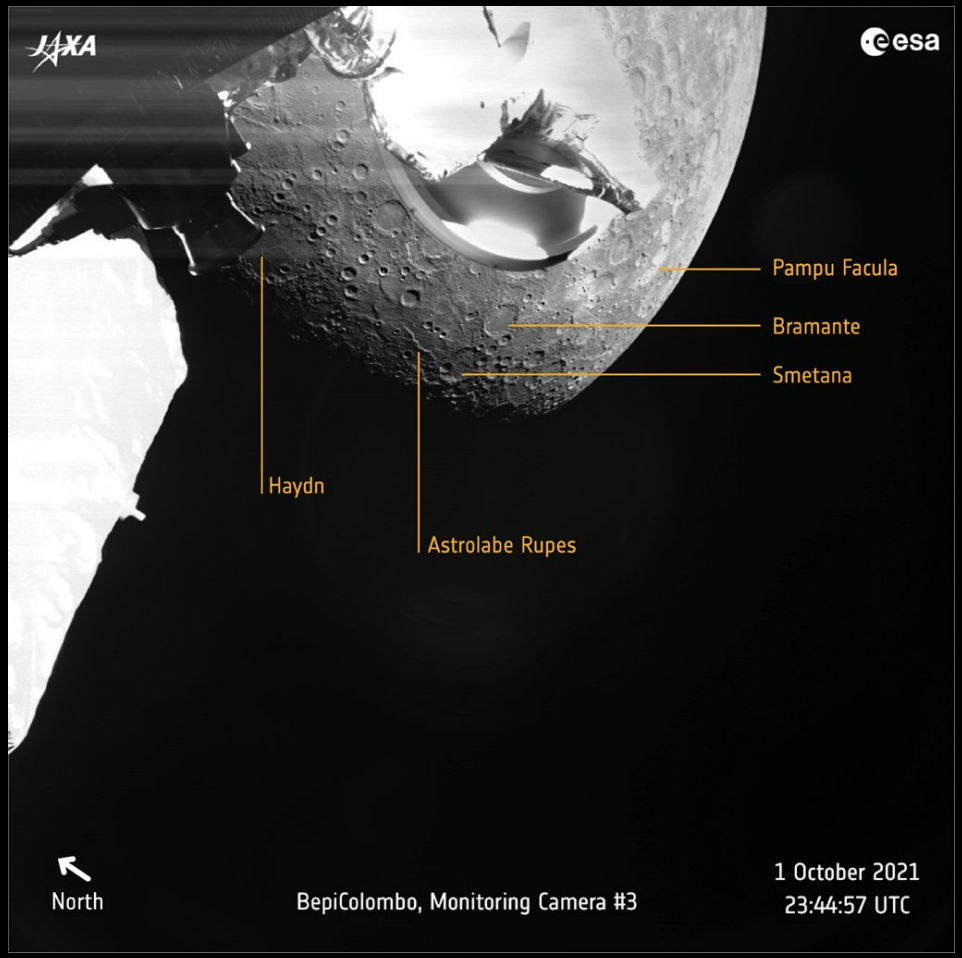
Mercury Flyby#1: Planning the Science Operations

196 KM

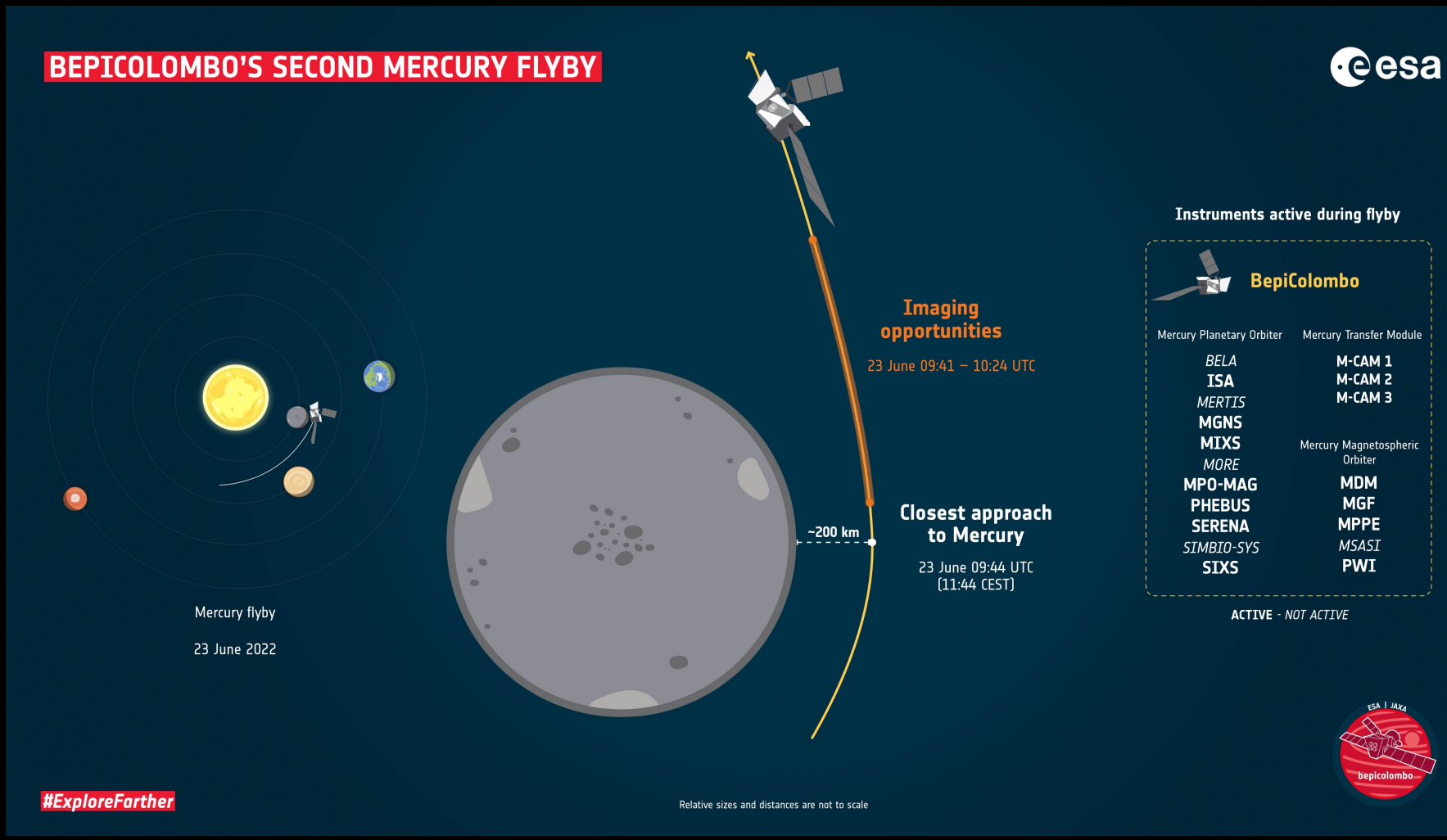


BepiColombo Selfies and Mercury



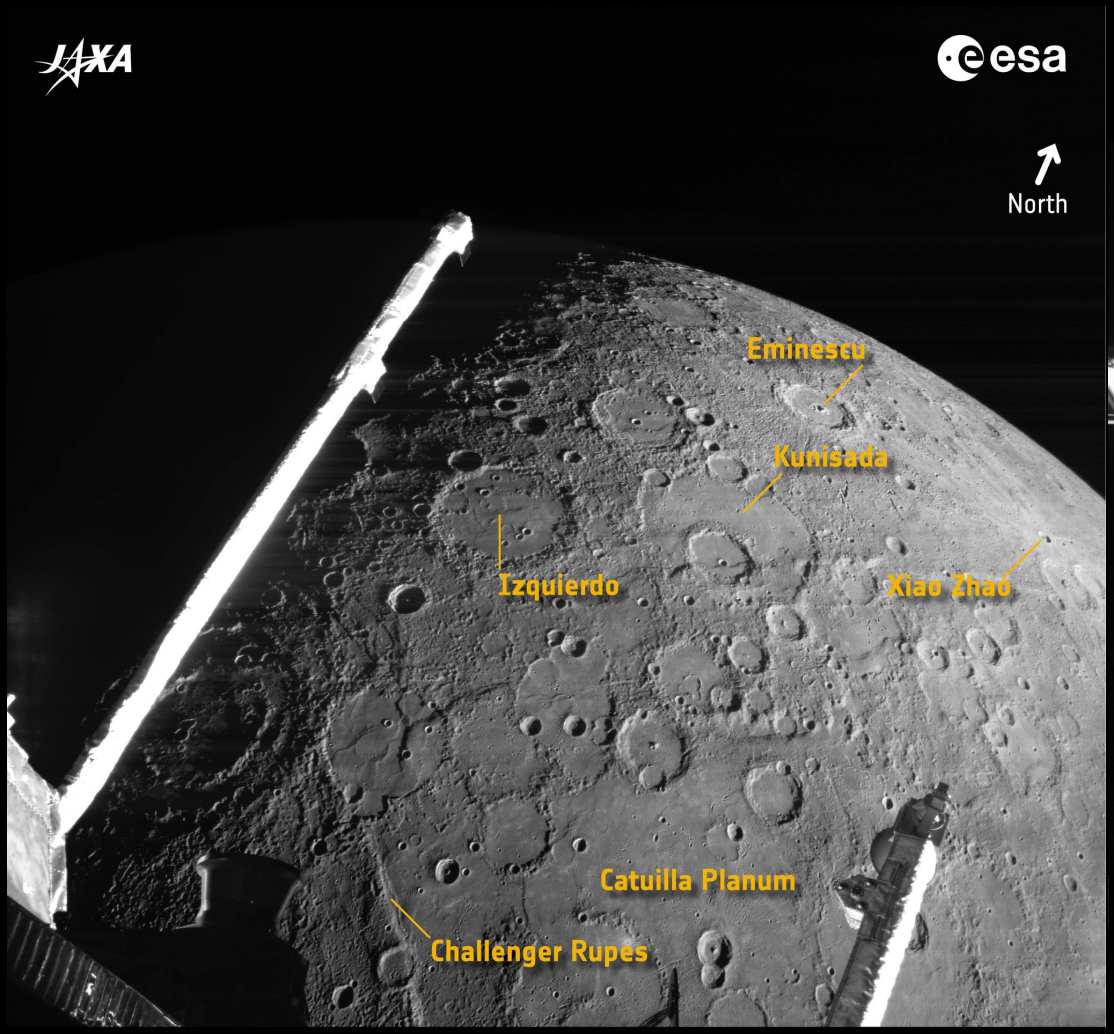


Mercury Flyby#2: 23 June 2022



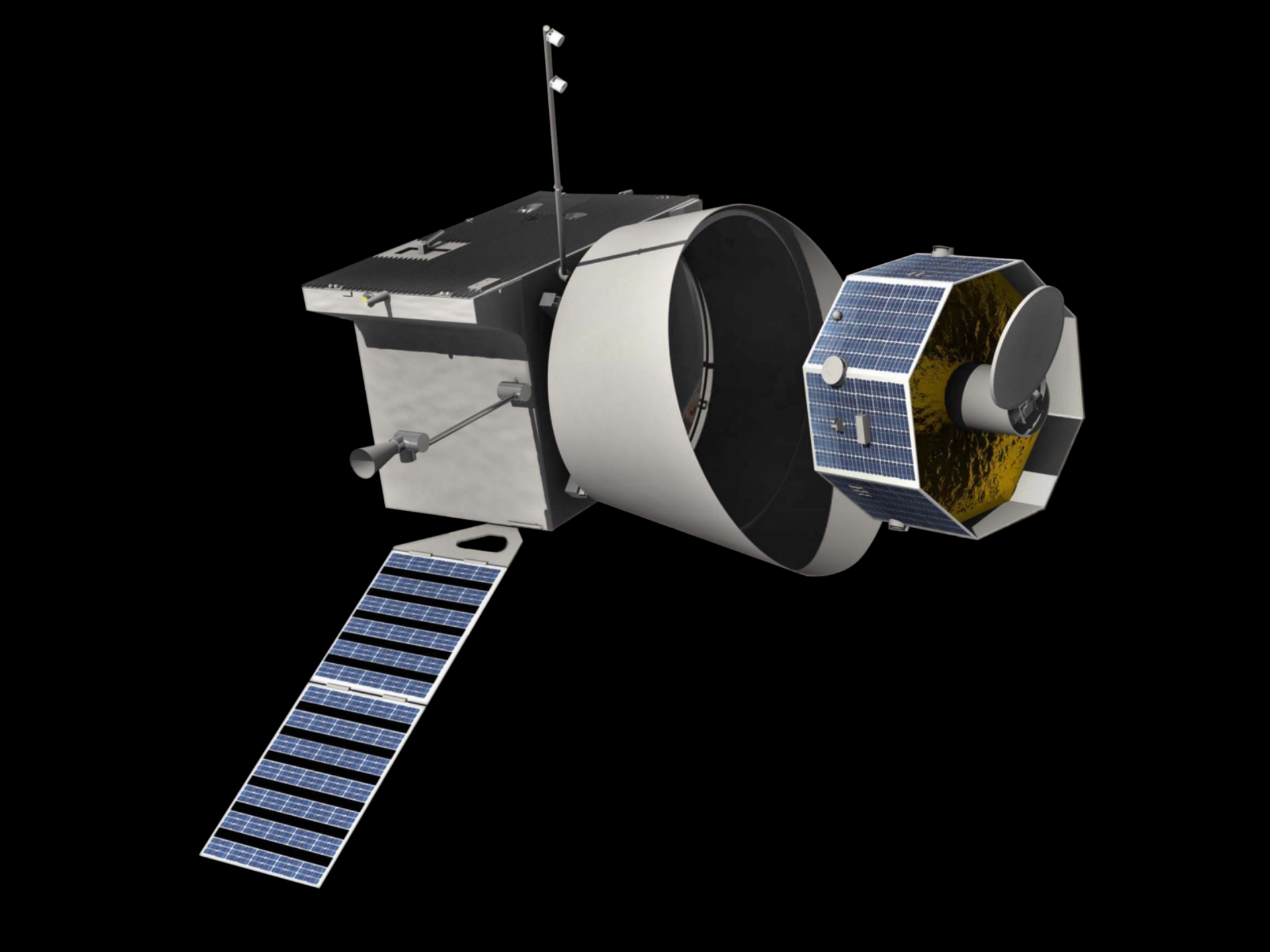
Mercury Flyby#2: Planning the Science Operations

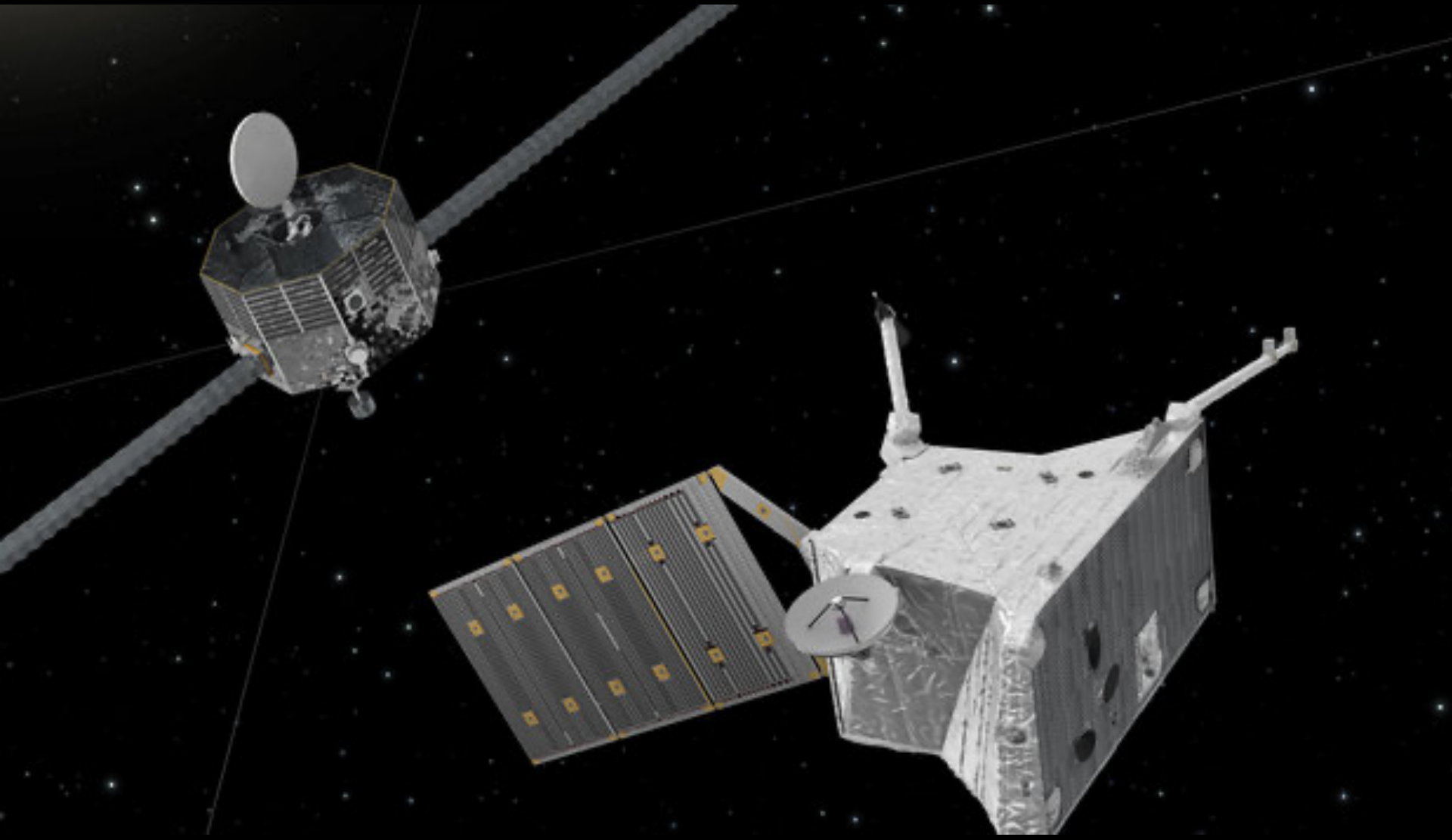
BepiColombo Selfies and Mercury

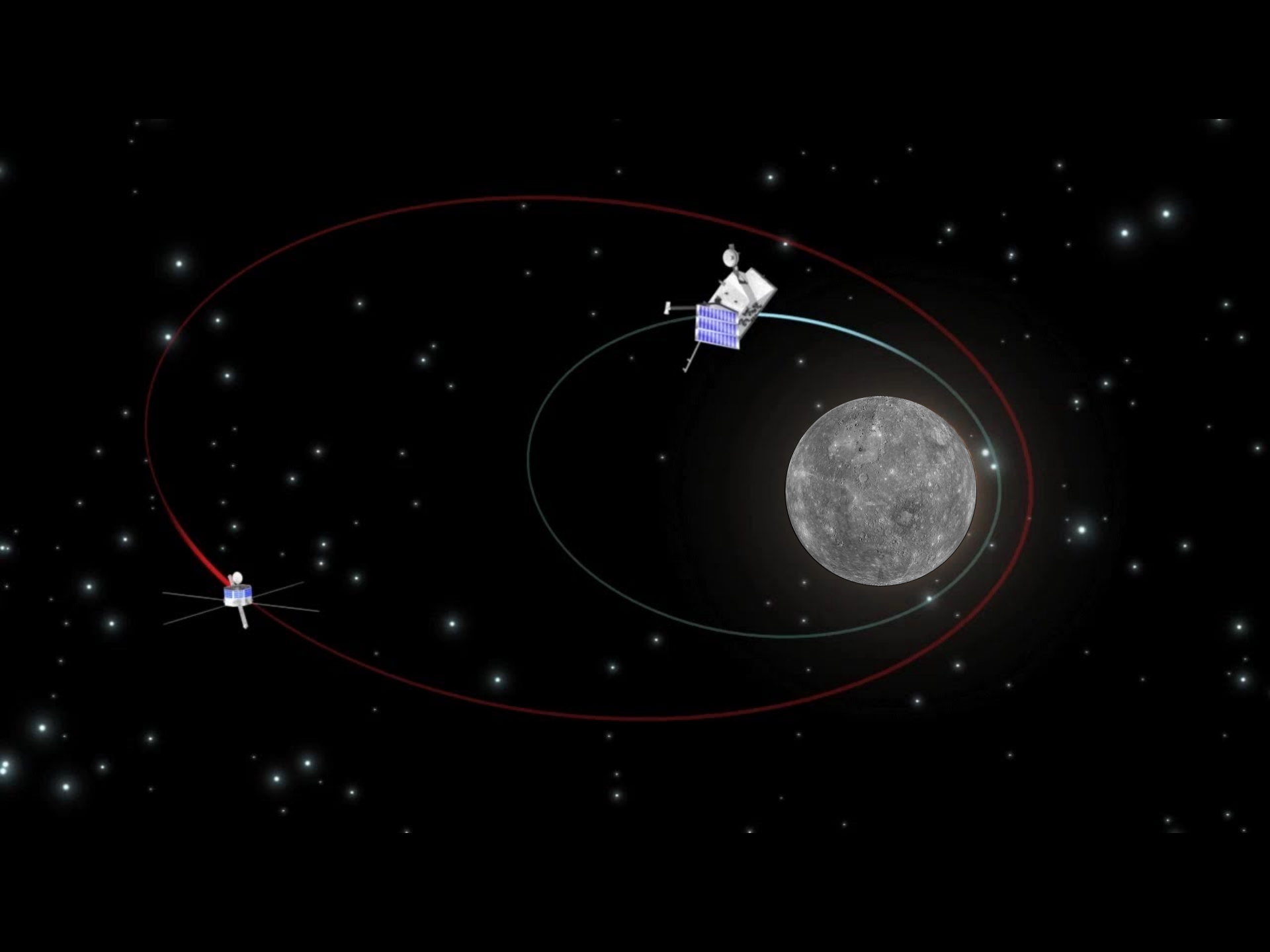


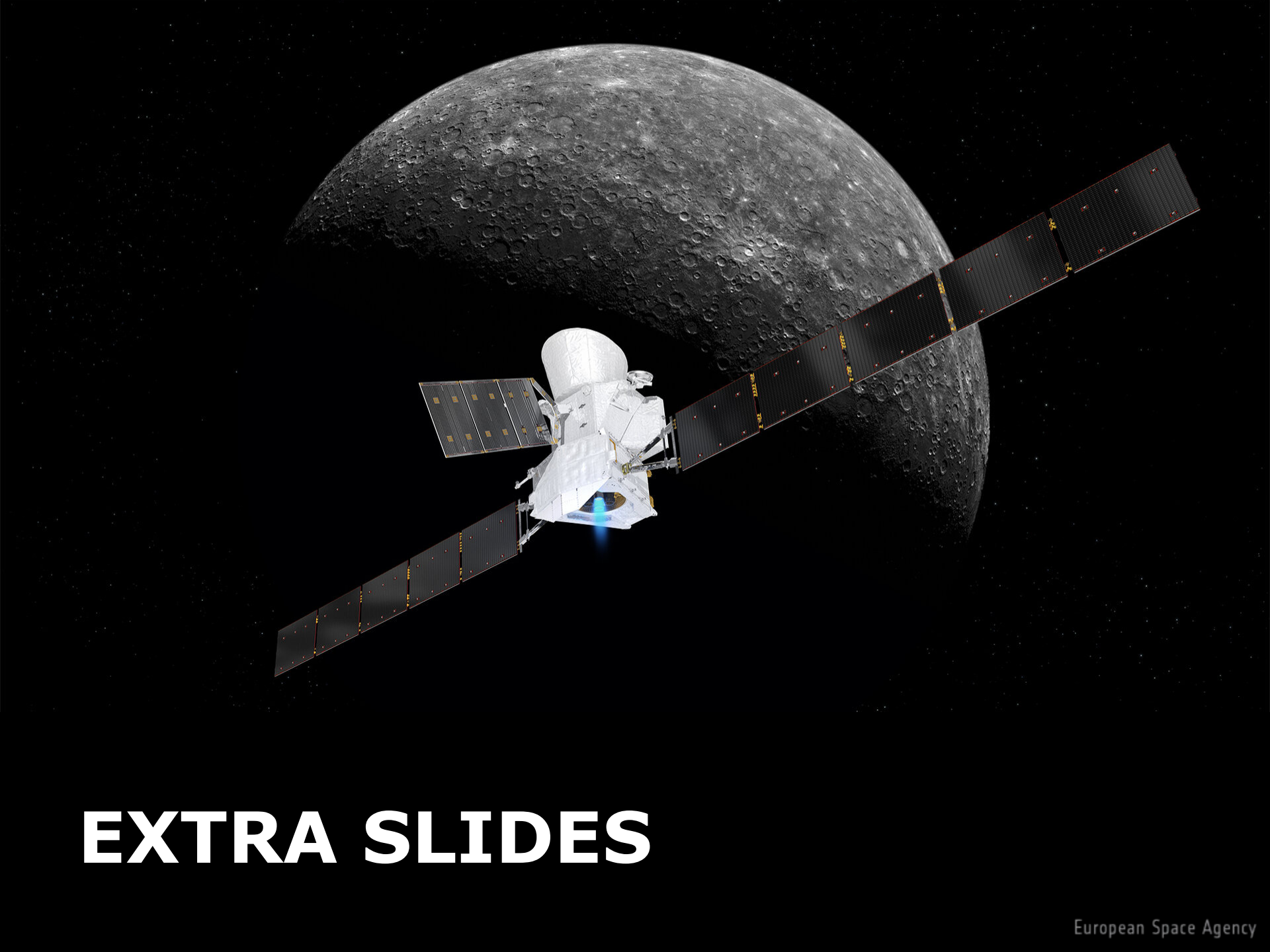
BepiColombo, Monitoring Camera 2 23 June 2022, 09:49:22 UTC

BepiColombo, Monitoring Camera 1 23 June 2022, 09:48:22 UTC



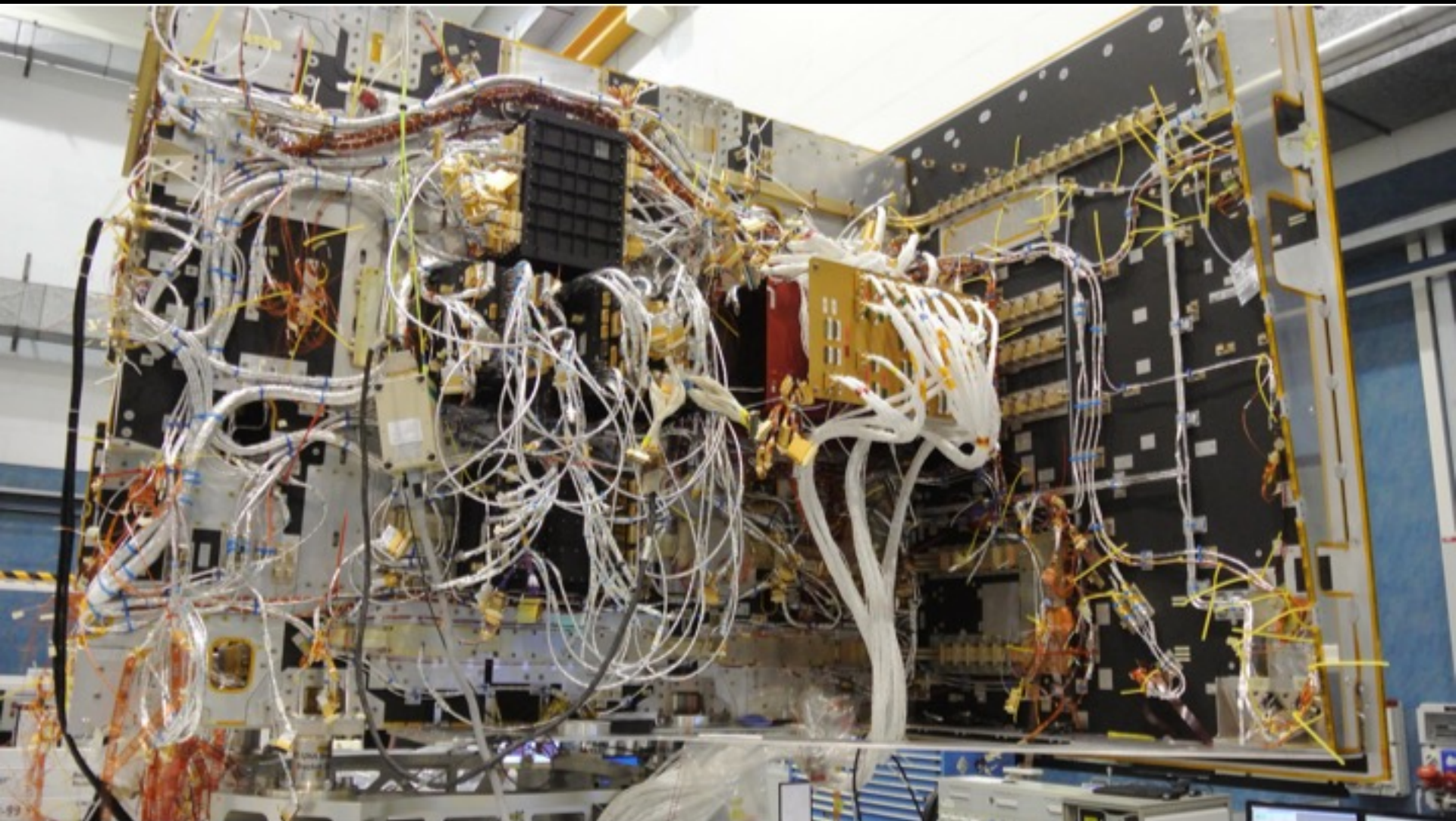






EXTRA SLIDES

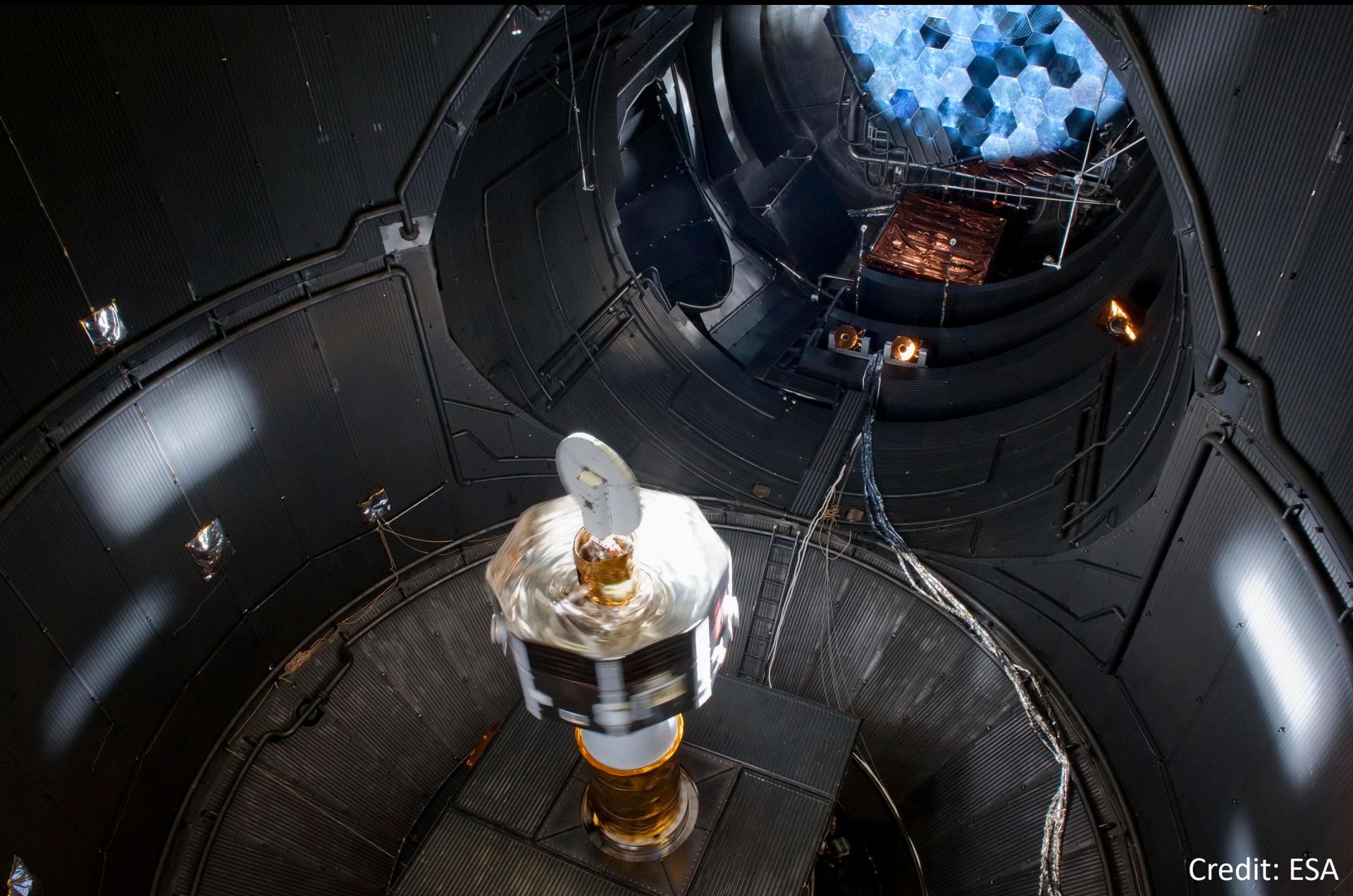
MPO electrical Model



MPO model testing

Credit: ESA

MIO testing in Simulator



Credit: ESA

MPO testing in TAS-I, Italy

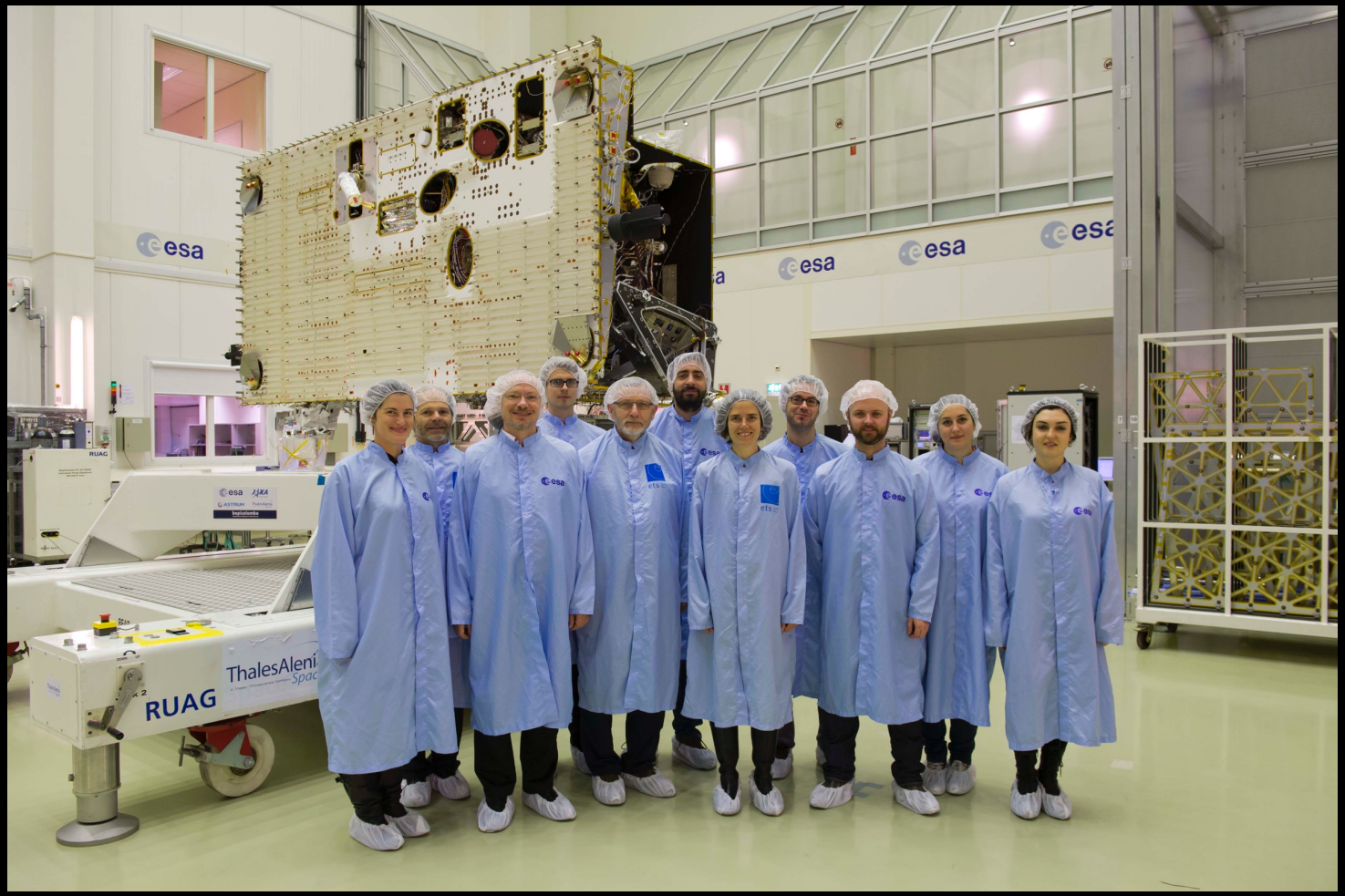
MPO testing in TAS-I, Italy

MPO at ESTEC: Entering the simulator

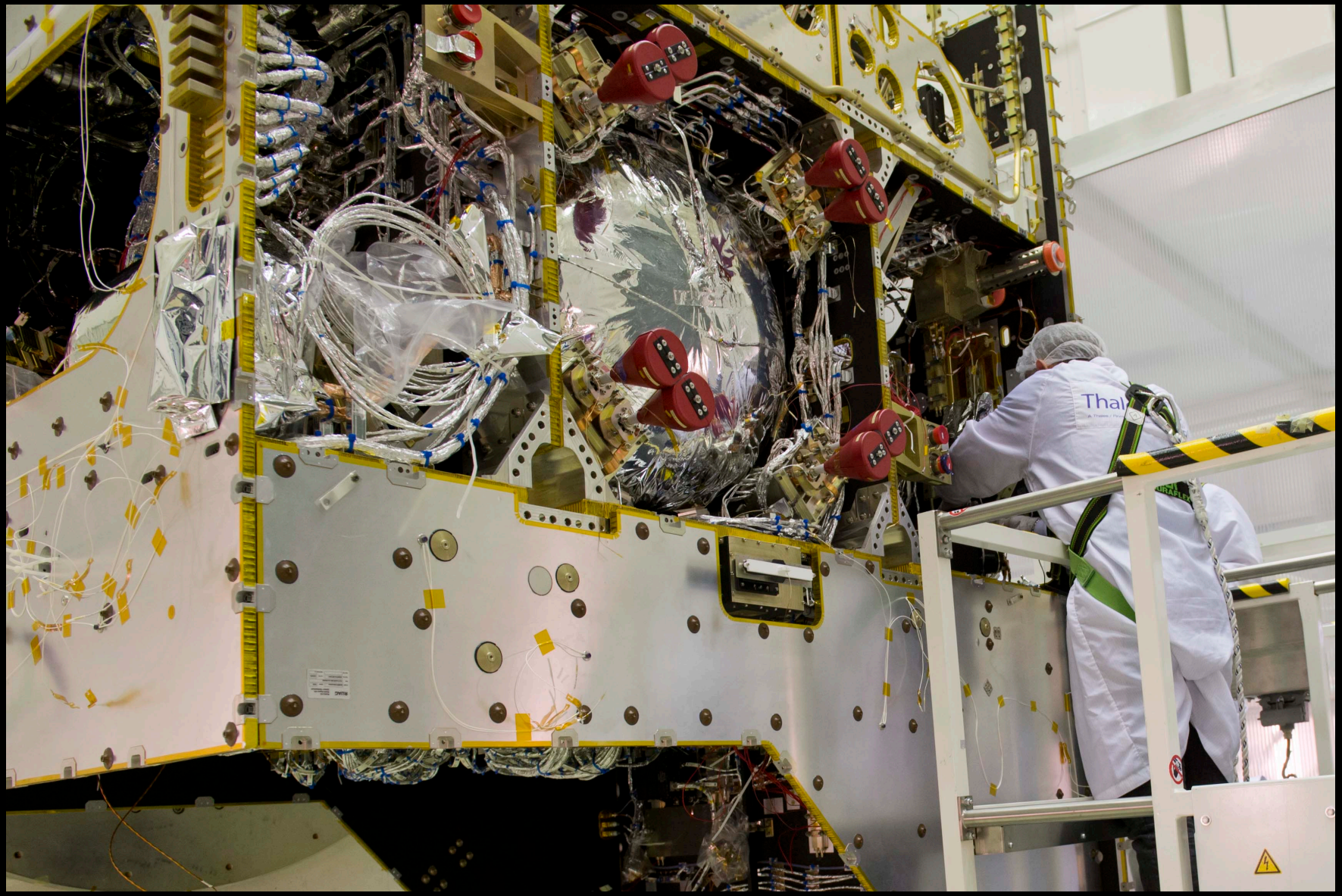
MPO inside simulator

MIO testing at ESTEC testing Floor

MPO Test in ESTEC testing floor



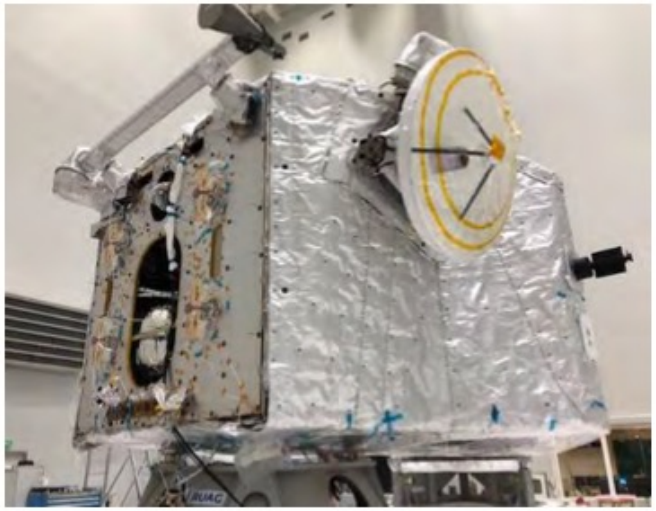
Wiring and parts integration



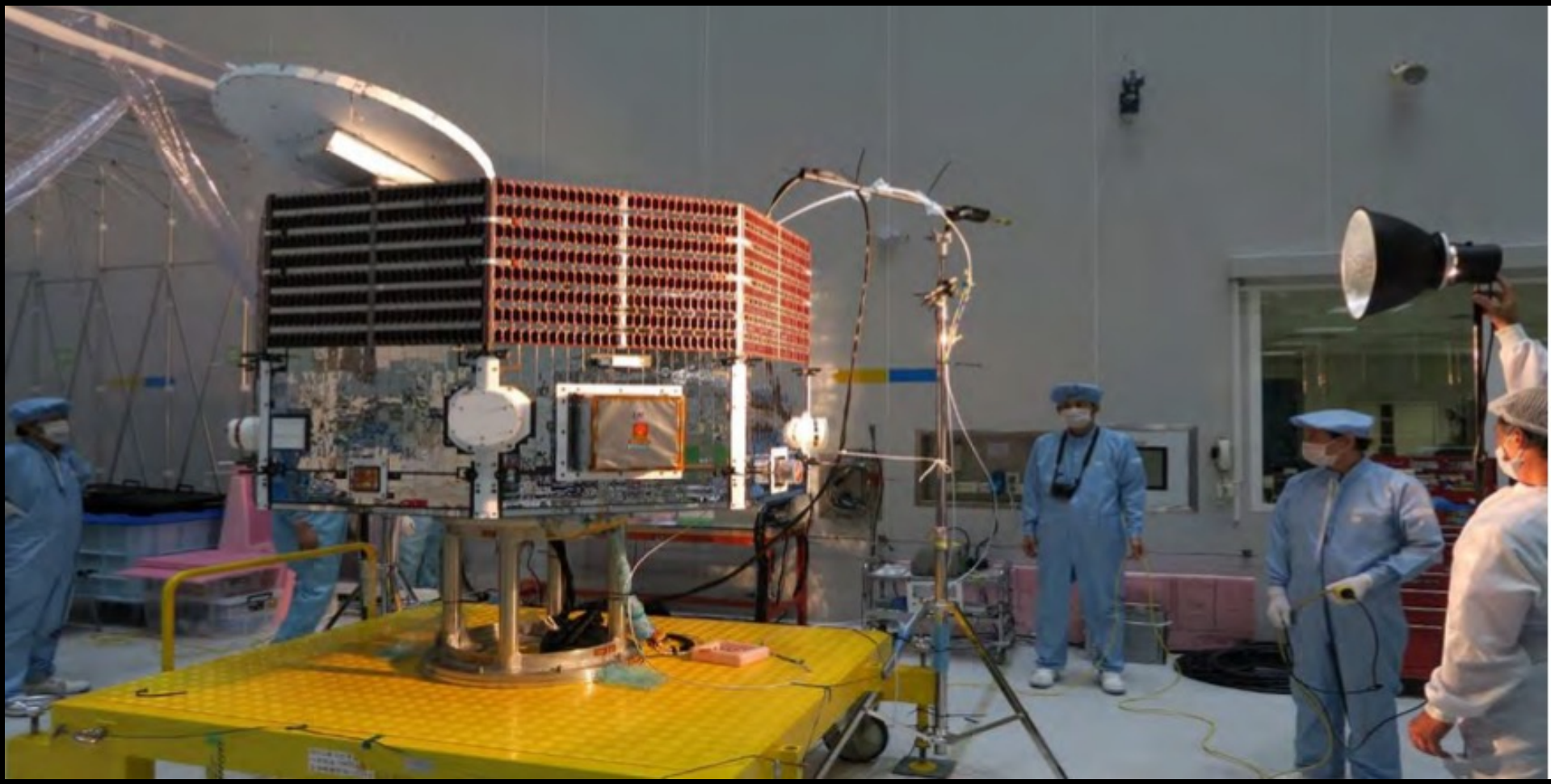
Kourou Arrival

Solar panel deployment at 0g

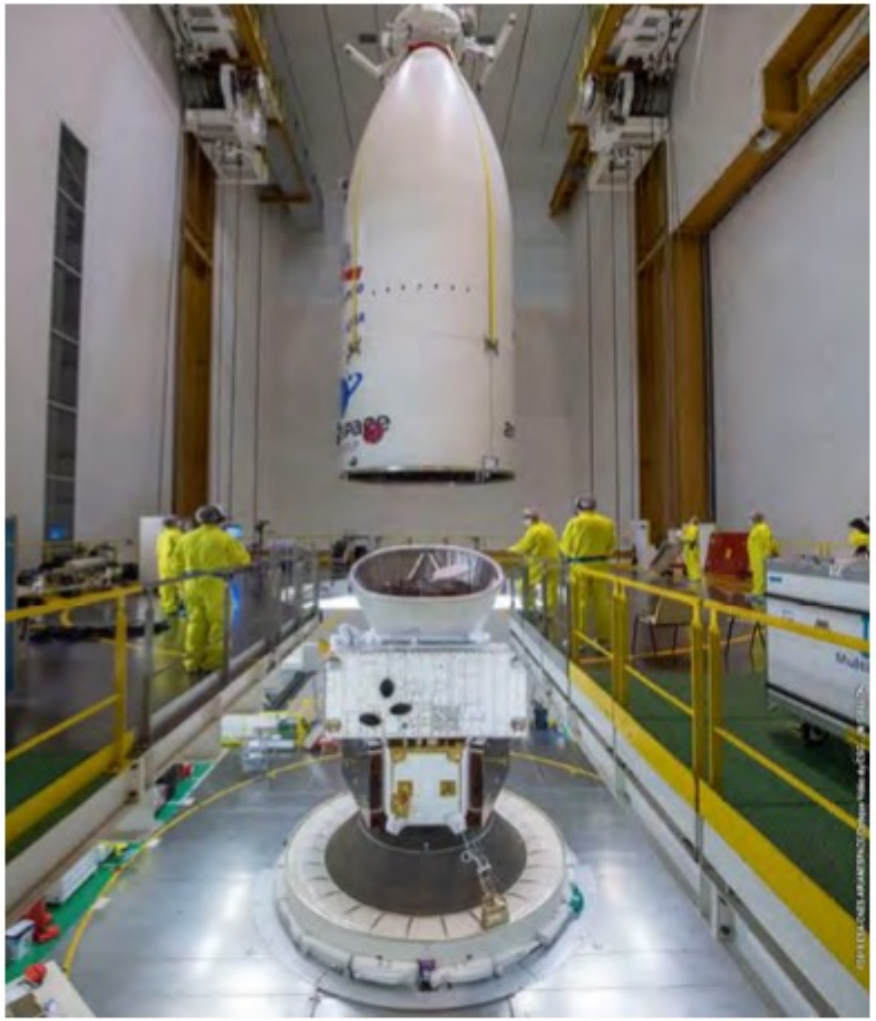
MPO under testing



MMO: Light test

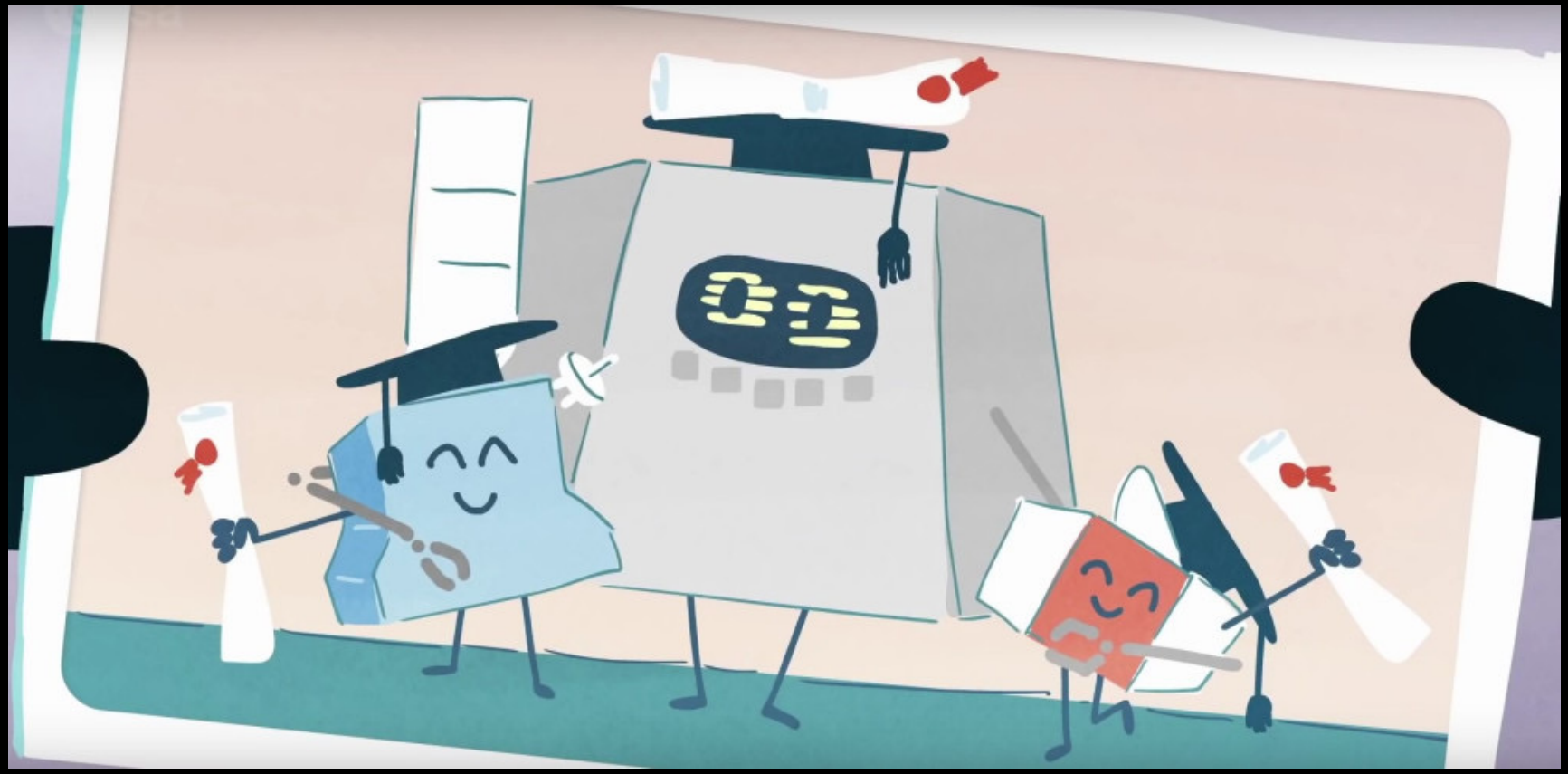


Arianne V Integration



Before Launch

THANKS!!



The EPIC adventures of BepiColombo