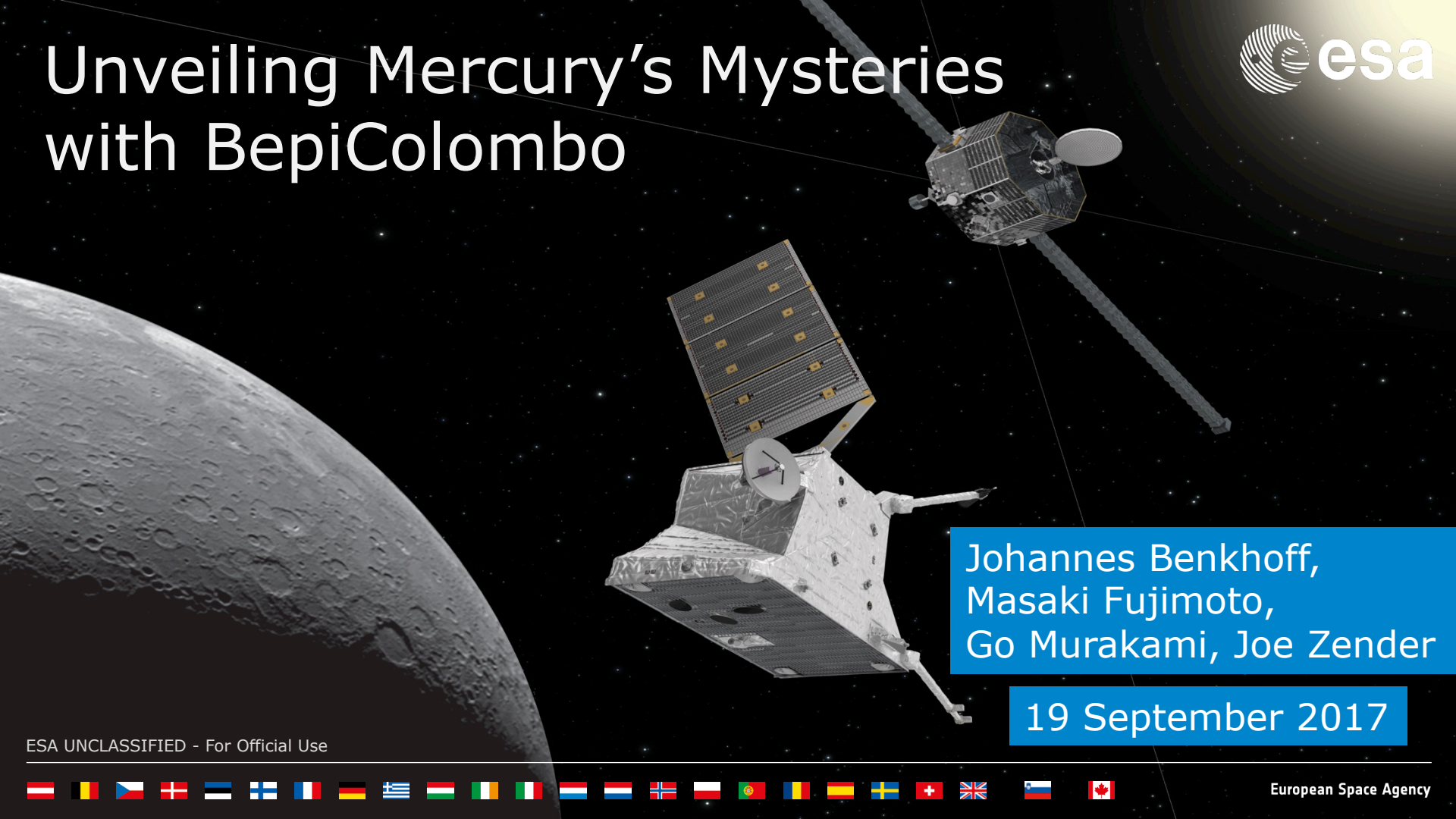
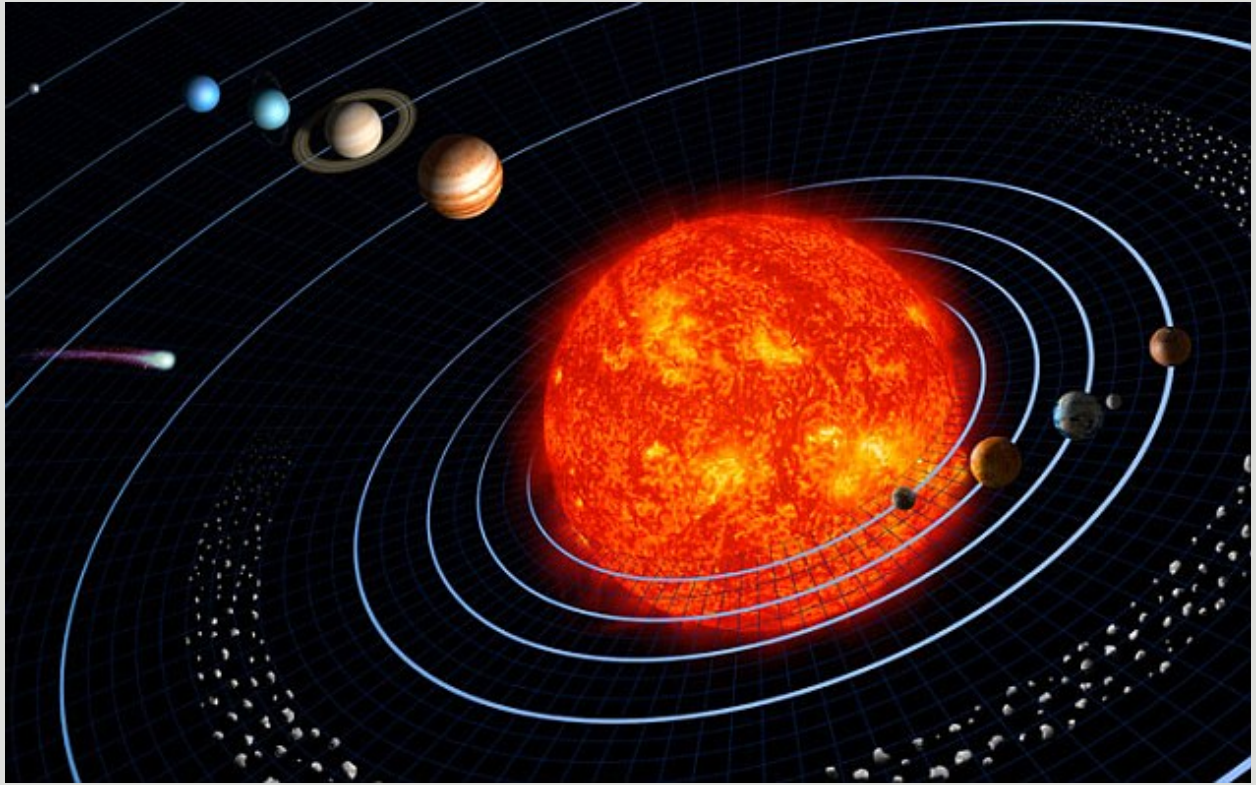
Unveiling Mercury's Mysteries with BepiColombo



Johannes Benkhoff,
Masaki Fujimoto,
Go Murakami, Joe Zender

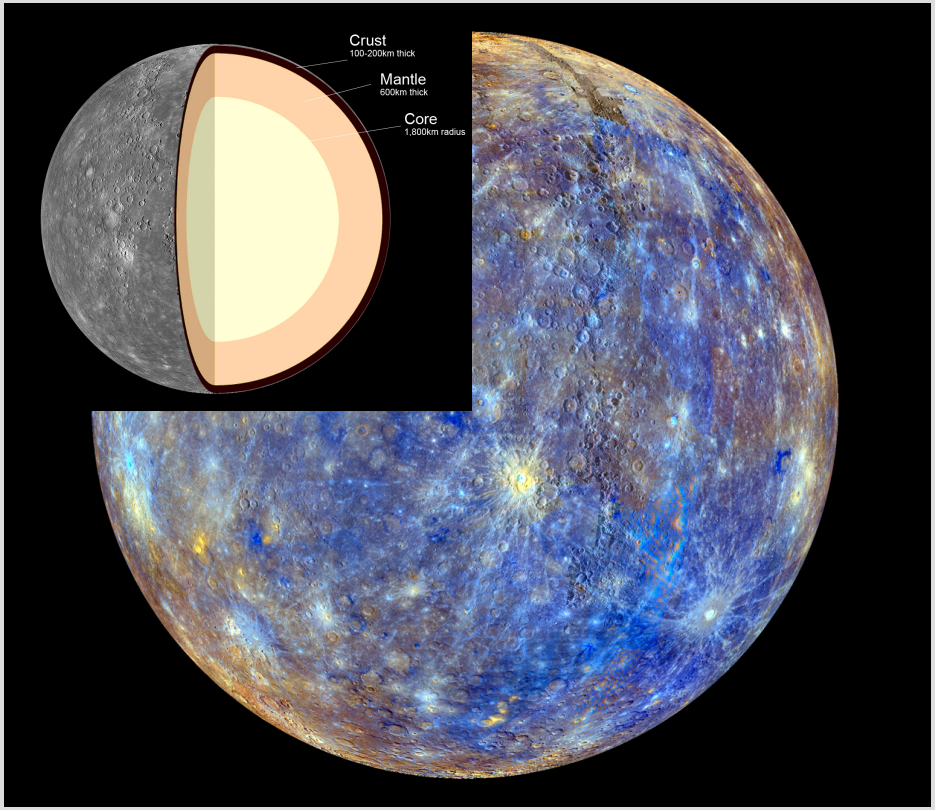
19 September 2017

Why Mercury?



- To study Mercury it is essential to understand the formation history of our Solar System
- Mercury is a key element in that puzzle because of its position so close to the Sun

Mercury – peculiar planet of mysteries

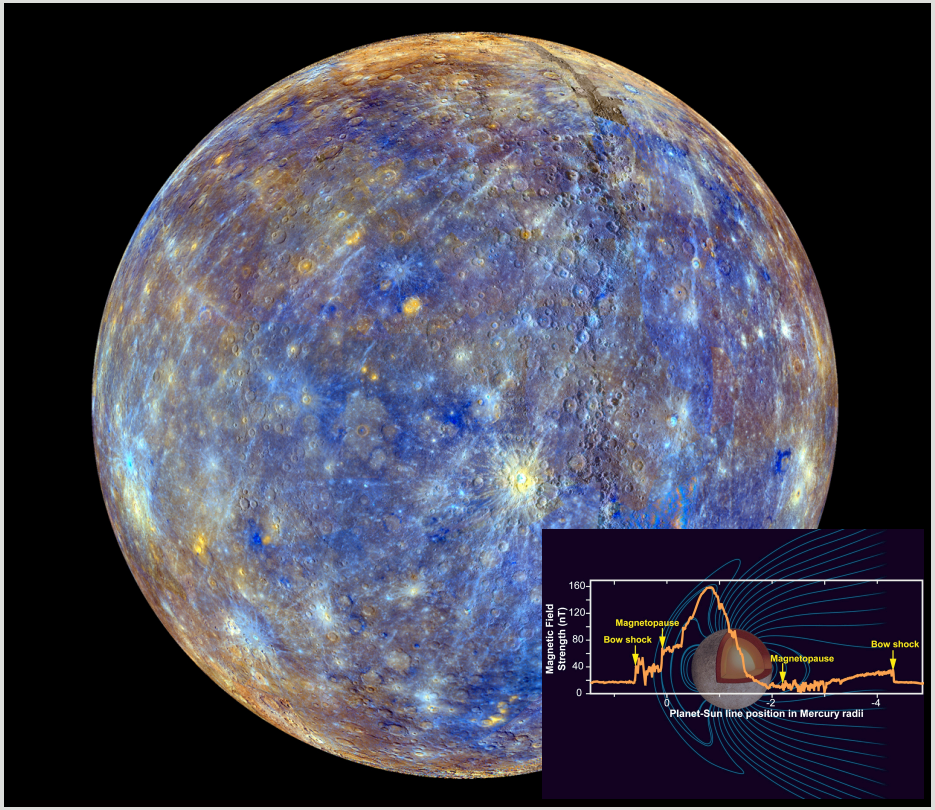


Credit: NASA/The Johns Hopkins University Applied Physics Laboratory/Carnegie Institution of Washington

Models of planetary evolution indicate that Mercury's core is either frozen or solidified (Scientists believe in the 70's)

➔ No dynamic magnetic behavior expected: no core dynamo

Mercury – peculiar planet of mysteries



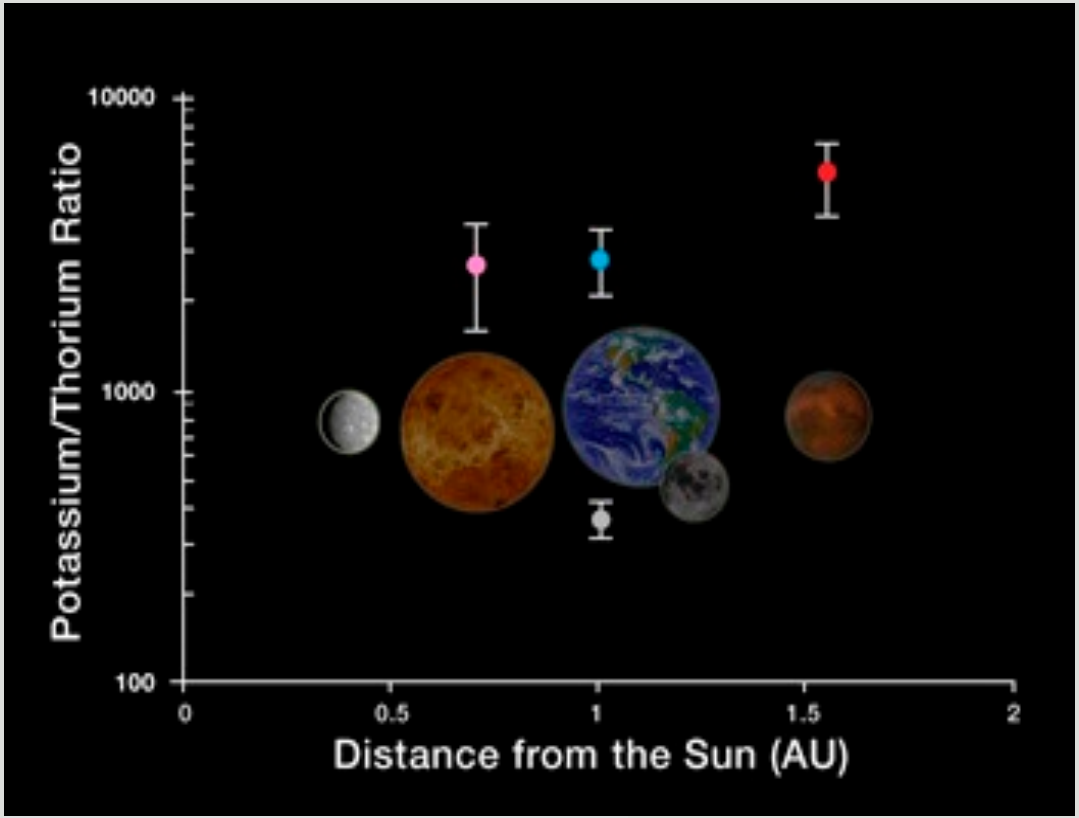
Credit: NASA/The Johns Hopkins University Applied Physics Laboratory/Carnegie Institution of Washington

Models of planetary evolution indicate that Mercury's core is either frozen or solidified (Scientists believe in the 70's)

➔ No dynamic magnetic behavior expected: no core dynamo

NASA's Mariner 10 mission shows that Mercury has an Earth like Magnetic Field

Mercury – peculiar planet of mysteries

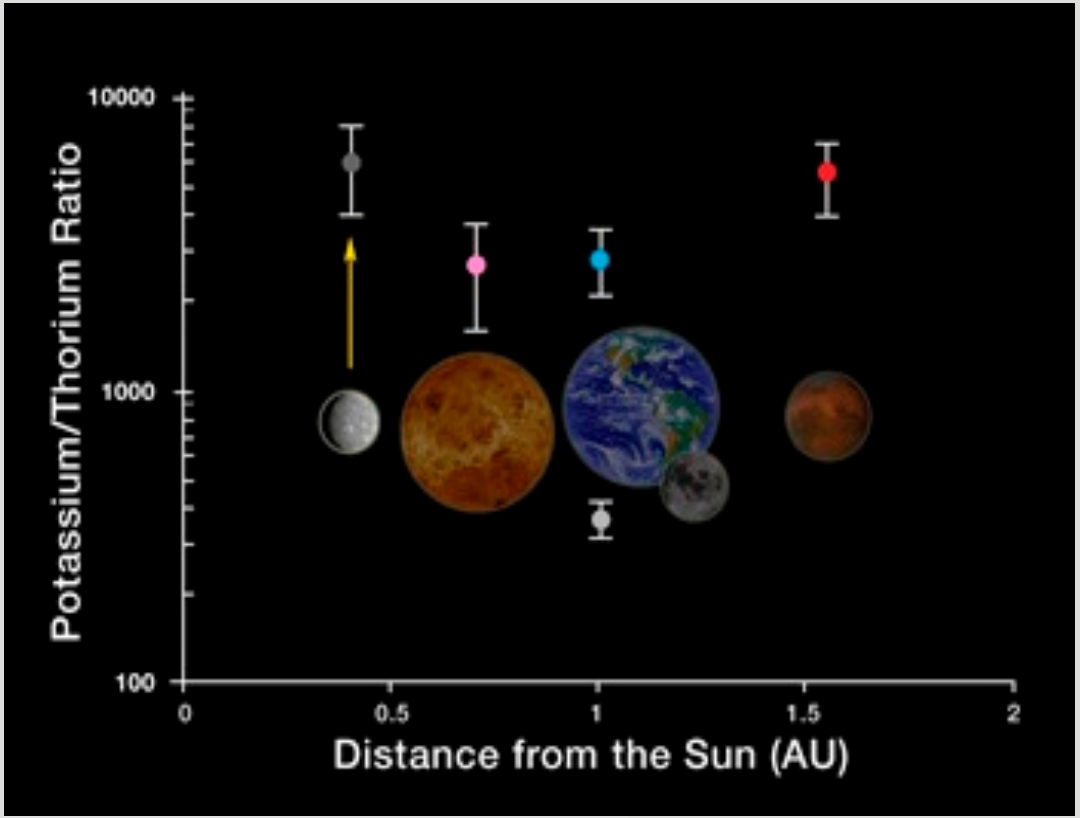


Credit: NASA/The Johns Hopkins University Applied Physics Laboratory/Carnegie Institution of Washington

The Potassium/Thorium ratio indicates how much gaseous (volatile) material could be found at the surface

➔ Goal to proof existing formation models

Mercury – peculiar planet of mysteries



Credit: NASA/The Johns Hopkins University Applied Physics Laboratory/Carnegie Institution of Washington

The Potassium/Thorium ratio indicates how much gaseous (volatile) material could be found at the surface

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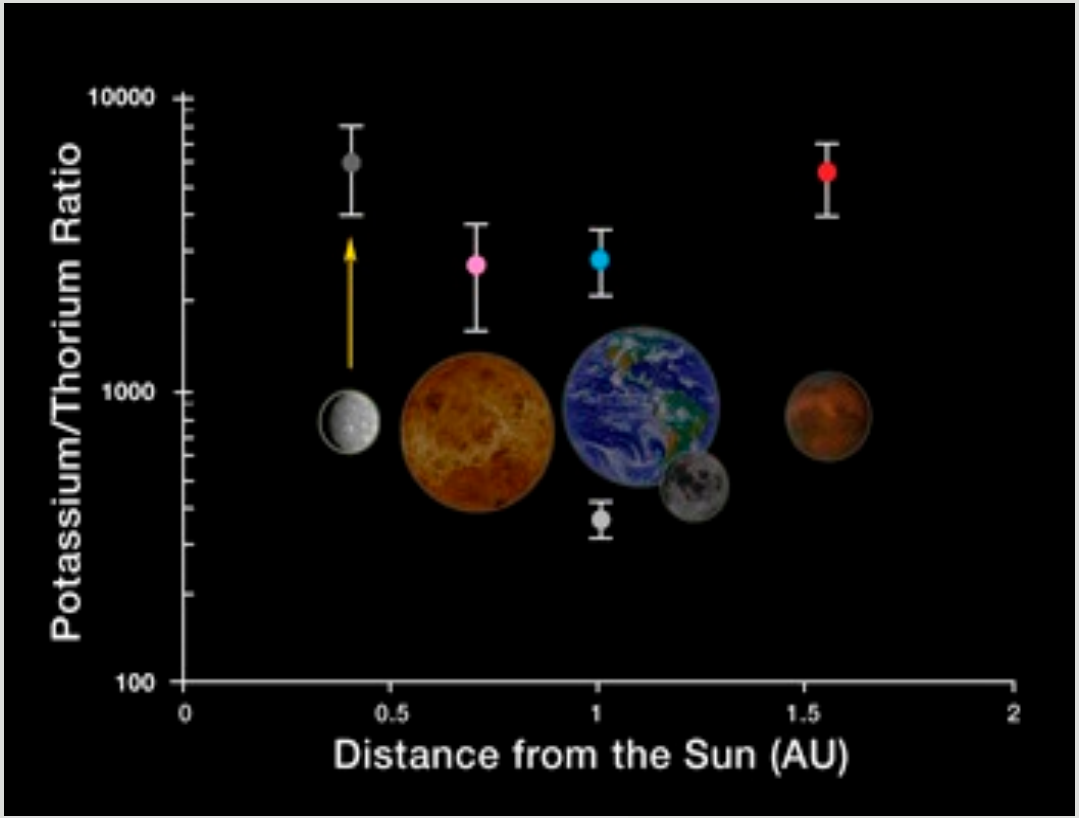
NASA's MESSENGER mission shows much higher value for the Potassium/Thorium ratio than expected

Mercury – peculiar planet of mysteries



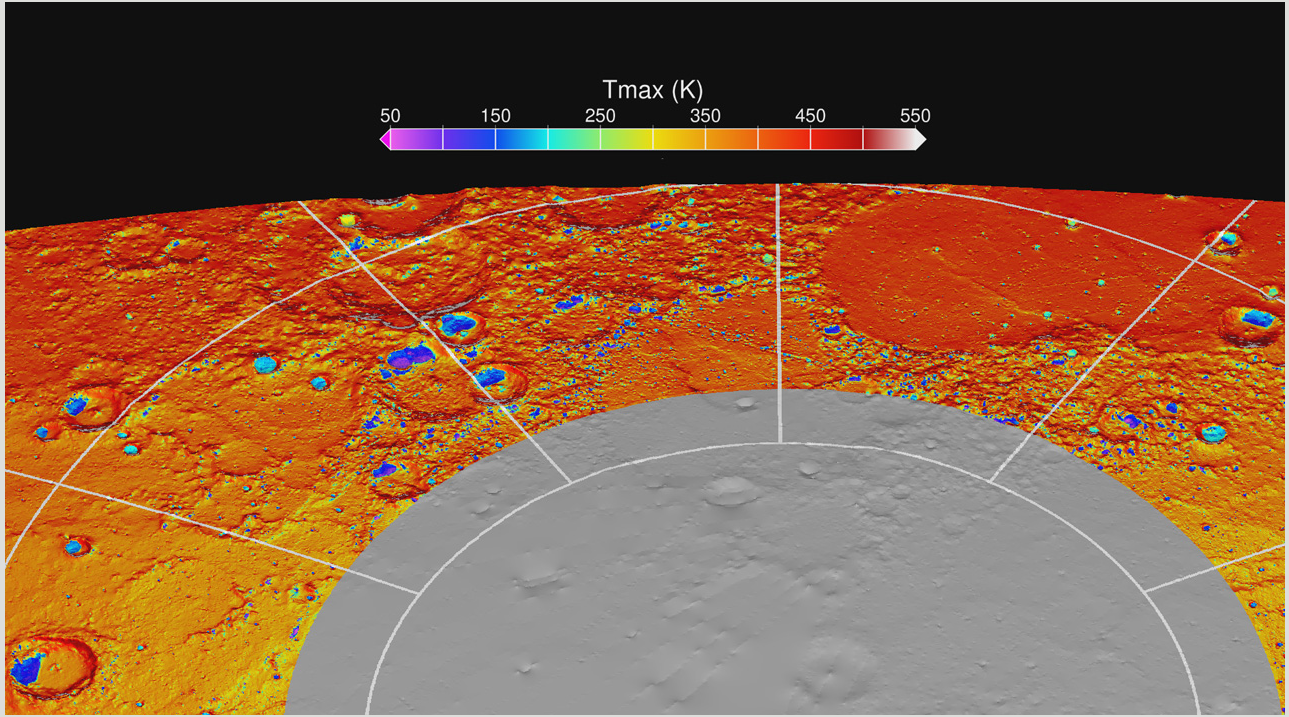
Credit: NASA/The Johns Hopkins University Applied Physics Laboratory/Carnegie Institution of Washington

The Potassium/Thorium ratio indicates how much gaseous (volatile) material could be found at the surface

➔ Goal to proof existing formation models

➔ All Formation models need to be adapted!!

Mercury – peculiar planet of mysteries

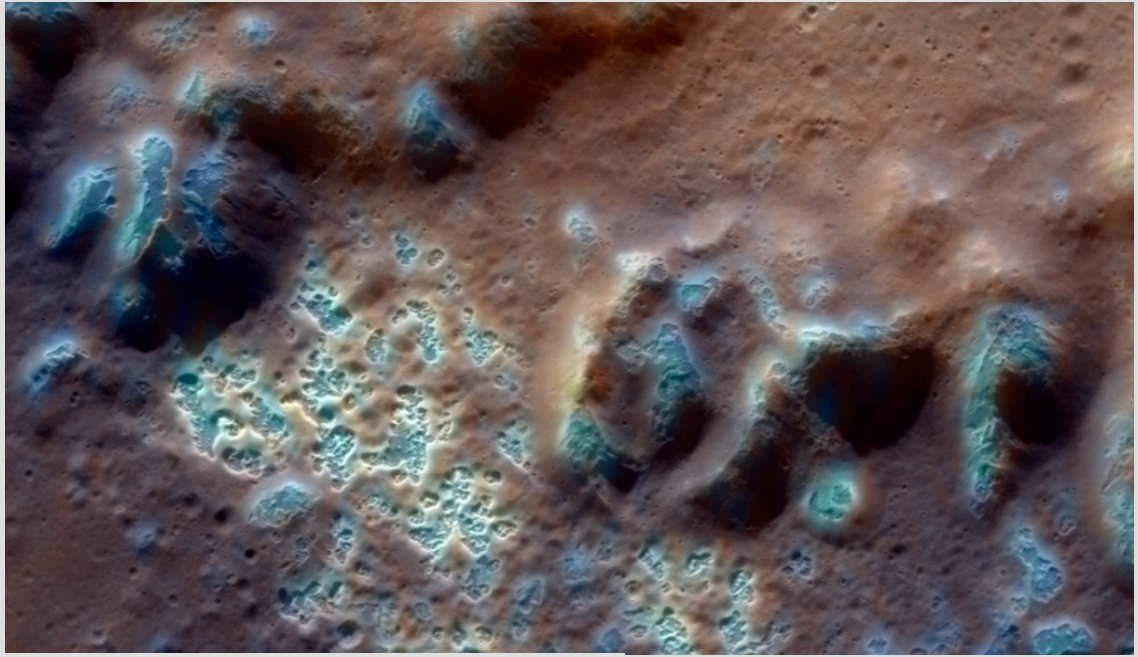


Credit: NASA/The Johns Hopkins University Applied Physics Laboratory/Carnegie Institution of Washington

Water ice in deep polar craters are consistent with all kinds of measurements from MESSENGER. (Temperature; Images; Laser; Albedo;……)

➔ What is the origin of the polar ice ?

Mercury – peculiar planet of mysteries

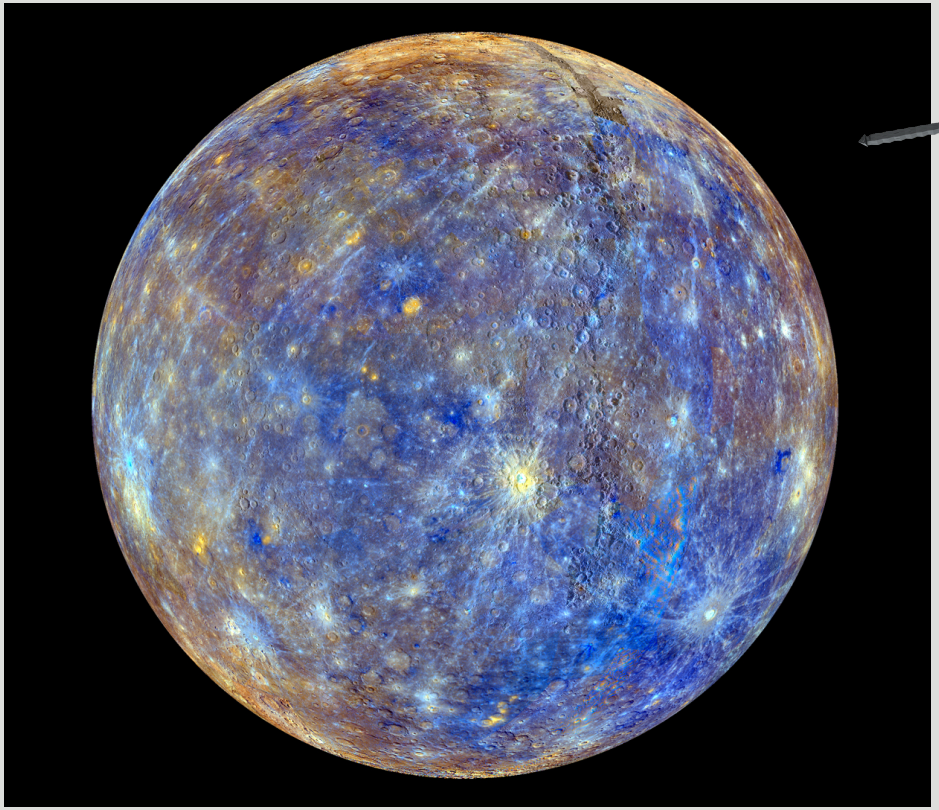


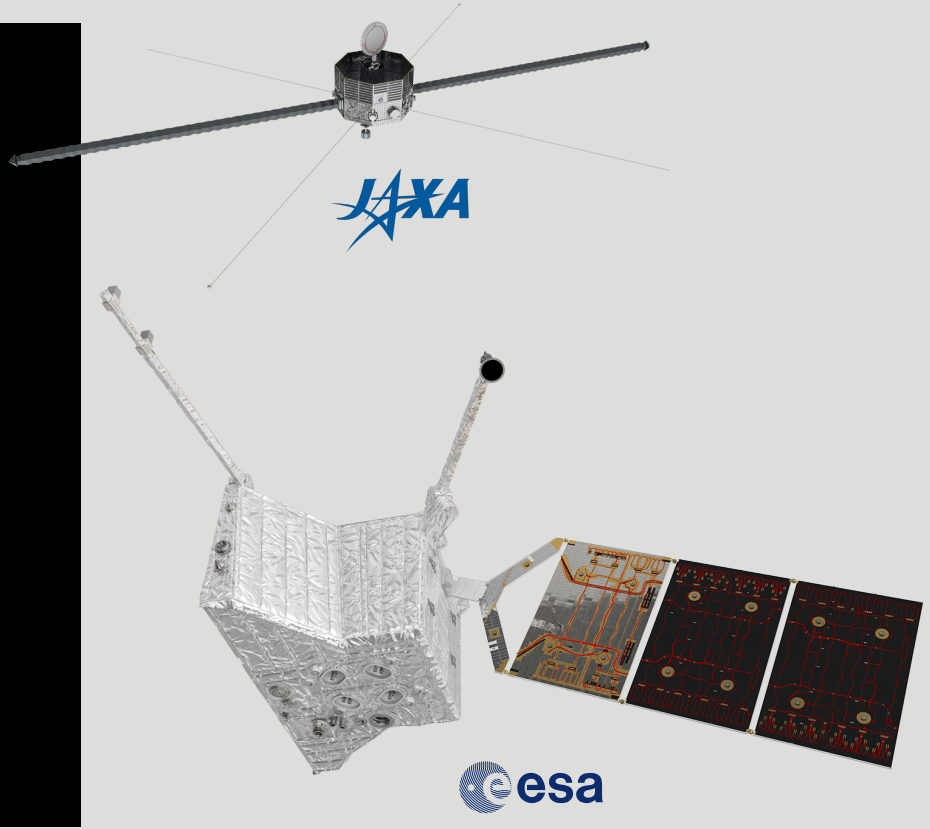
Credit: Science/AAAS

high-albedo, white-blue crater-floor deposits (Hollows) suggest a more abundant than expected volatile (gaseous) component in Mercury's crust

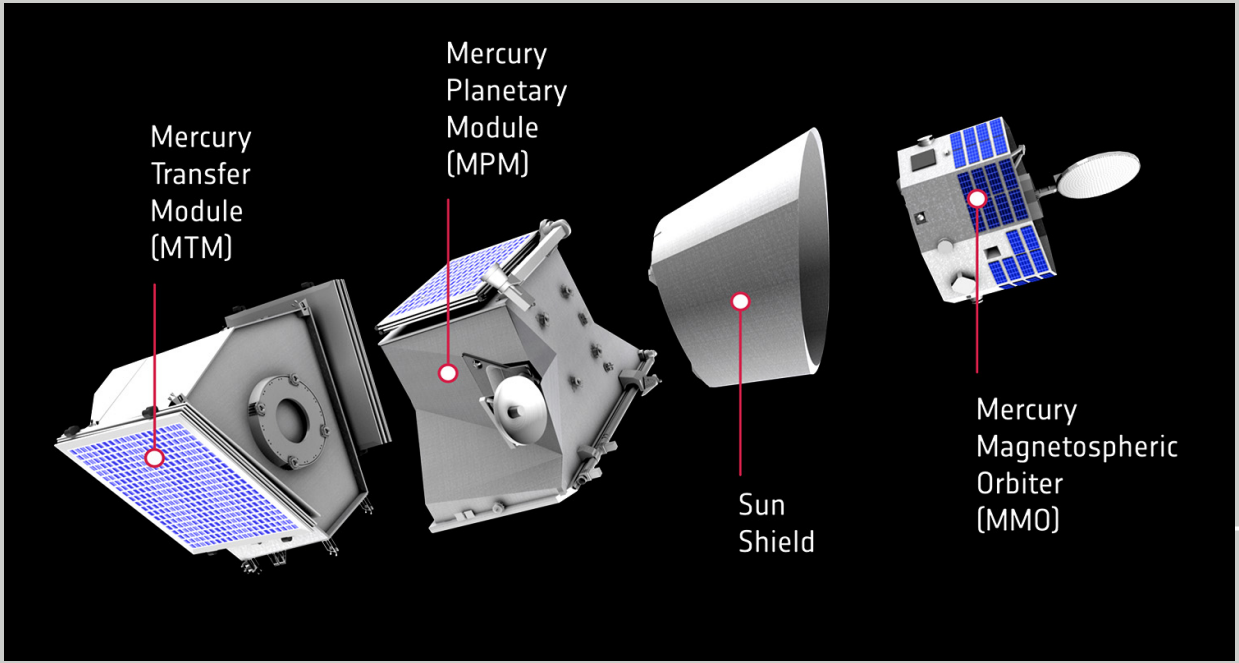
➔ What cause the formation of hollows ?

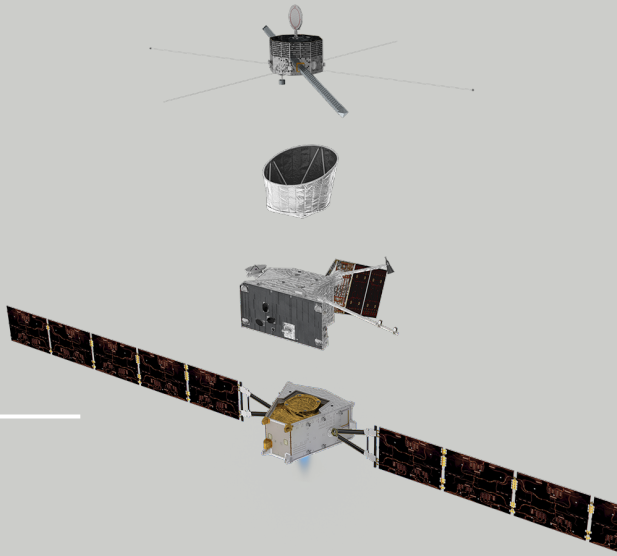
Mercury – waiting for BepiColombo





Spacecraft Configuration





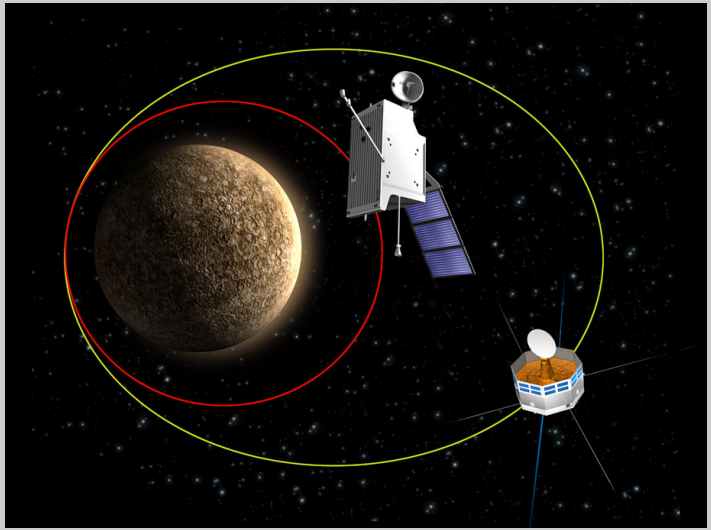
MPO& MMO Orbit and Nominal Configuration

Mercury Planetary Orbiter (MPO)

- Low-eccentricity polar orbit (480x1500 km)
- 2.3 hours period
- Downlink ~1550Gbits/year
- Mainly nadir pointing

Mercury Magnetospheric Orbiter (MMO)

- polar orbit (590x11640 km)
- 9.2 hours period
- Downlink ~100 Gbits/year
- Spinning (15 orbits/minute)

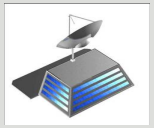


For **nominal** operations, the **Z-axis** is aligned with the **NADIR** direction.

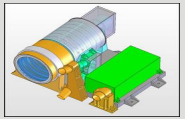
Most of scientific instruments are 'looking' at the Nadir direction

BepiColombo "Spectrum"

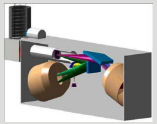
MORE



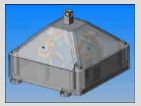
SIMBIO-SYS



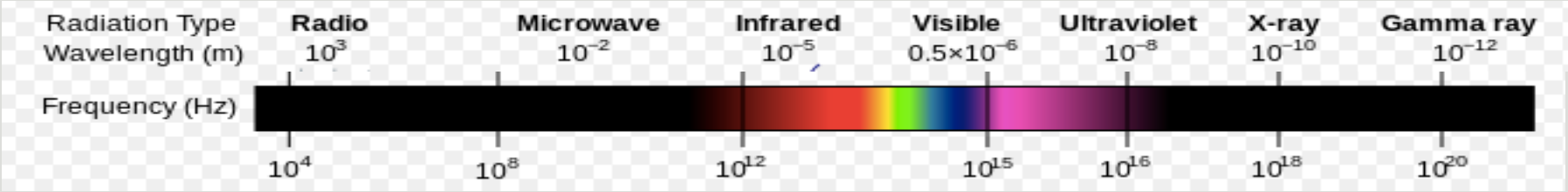
PHEBUS

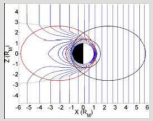


SIXS

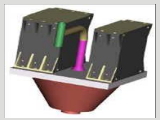


MGNS

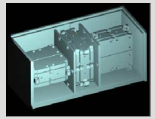




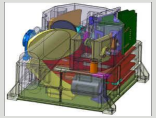
MERMAG



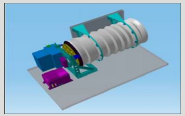
SERENA



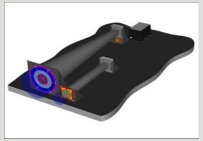
ISA



MERTIS



BELA



MIXS

MPO Instruments

	Instrument	Principle Investigator	Instrument description
BELA	BepiColombo Laser Altimeter	Hauke Hussman Nick Thomas	Characterise the topography and surface morphology of Mercury.
MORE	Mercury Orbiter Radio Science Experiment	Luciano Iess	Determine Mercury's gravity field as well as the size and physical state of its core.
ISA	Italian Spring Accelerometer	Valerio Iafolla	Study Mercury's interior structure and to test Einstein's Theory of Relativity.
MPO-MAG	Mercury Magnetometer	Karl-Heinz Glassmeier	Describe Mercury's magnetic field and its source.
MERTIS	Mercury Thermal Infrared Spectrometer	Harald Hiesinger	Study of Mercury's mineralogical composition, global temperature maps.
MGNS	Mercury Gamma-ray and Neutron Spectrometer	Igor Mitrofanov	Elemental composition of Mercury's surface distribution of volatiles in polar areas
MIXS	Mercury Imaging X-ray Spectrometer	Emma Bunce	Use X-ray fluorescence analysis a global map of the surface atomic composition.
PHEBUS	Probing of Hermean Exosphere by Ultraviolet Spectroscopy	Eric Quemerais	Characterisation of the composition and dynamics of Mercury's exosphere.
SERENA	Search for Exosphere Refilling and Emitted Neutral Abundances	Stefano Orsini	Study the interactions between the surface, exosphere, magnetosphere & the solar wind.
SIMBIO-SYS	Spectrometers and Imagers for MPO Integrated Observatory System	G. Cremonese	Provide global, high-resolution, and IR imaging of the surface
SIXS	Solar Intensity X-ray Spectrometer	Juhani Huovelin	Perform measurements of solar X-rays and particles at high time resolution.

BepiColombo MMO Instruments

	Instrument	Principle Investigator	Instrument description
MMO-MAG	Mercury Magnetometer	Wolfgang Baumjohann	Provide a detailed description of Mercury's magnetosphere and of its interaction with the planetary magnetic field and the solar wind.
MPPE	Mercury Plasma Particle Experiment	Y. Saito	Study low- and high-energetic particles in the magnetosphere.
PWI	Plasma Wave Instrument	Y. Kasaba	Make a detailed analysis of the structure and dynamics of the magnetosphere.
MSASI	Mercury Sodium Atmospheric Spectral Imager	I. Yoshikawa	Measure the abundance, distribution, and dynamics of sodium in Mercury's exosphere.
MDM	Mercury Dust Monitor	Hiromi Shibata	Study the distribution of interplanetary dust in the orbit of Mercury.

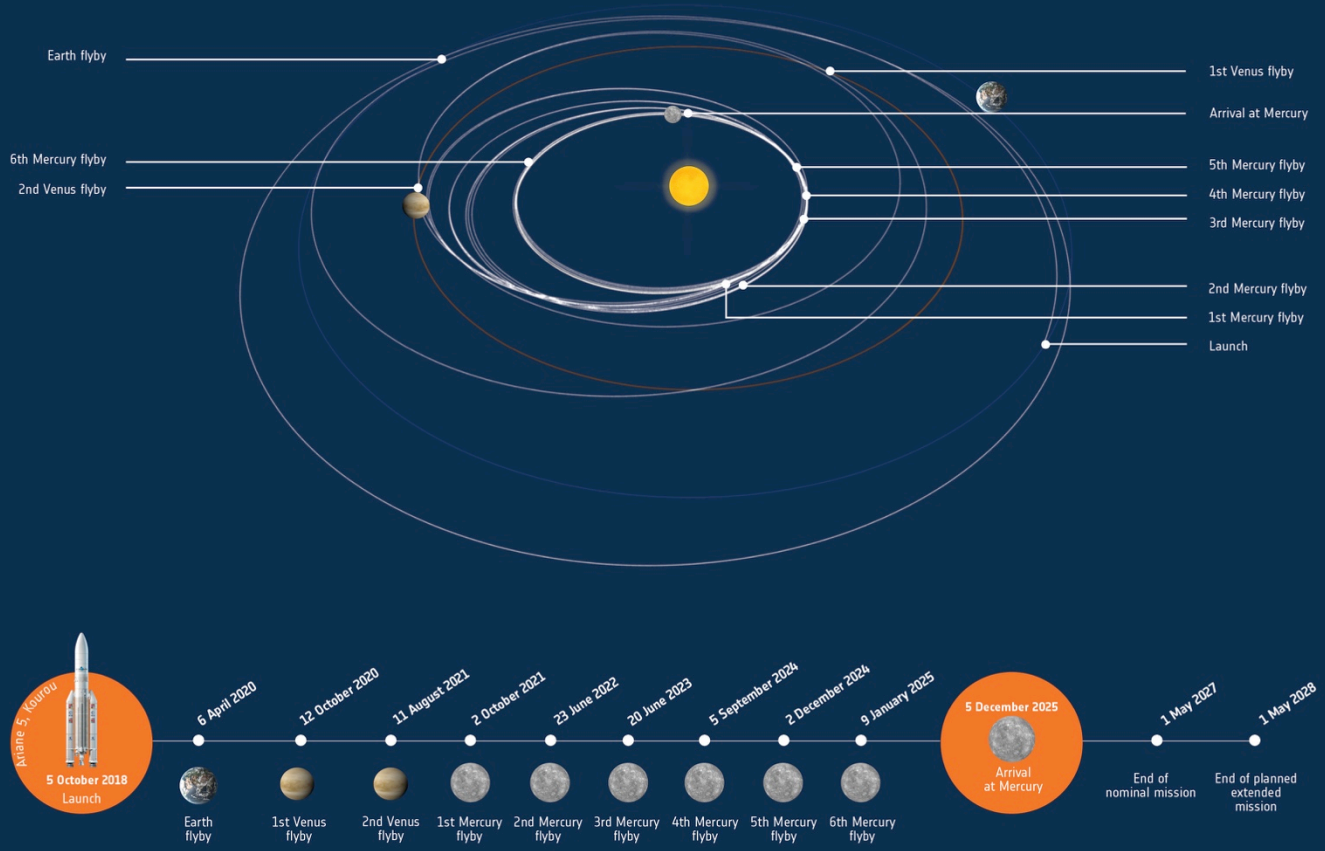
BepiColombo Status

BepiColombo is on track for launch in October 2018

Next milestones

- MTM Thermal Vacuum Test - November 2017
- Qualification Acceptance Review – March 2018
- Start Launch campaign in Kourou - April 2018
- Opening of launch window – 5 October 2018

Mission design



- **Launch**
  October 2018
- **Arrival**
  late 2025
- **Start Science**
  March 2026
- **Nominal Mission**
  until May 2027

Conclusion

BepiColombo as a joint ESA/JAXA mission will send two spacecraft to Mercury for comprehensive investigation of the planet and its environment

BepiColombo will increase our knowledge of the "planet of Mysteries" and will provide clues to a better understanding of the formation history of the planets and our Solar System

BepiColombo will follow up on MESSENGER results

BepiColombo is (almost) ready for launch in Oct 2018

BepiColombo in a Nutshell

Science Objectives:

- Origin and evolution
- Interior, structure, geology, composition
- Exosphere - composition and dynamics
- Magnetosphere - structure and dynamics
- Origin of Mercury's magnetic field
- Test of Einstein's theory of general relativity

- Dual spacecraft mission
  - MPO – Planetary Orbiter (ESA – 11 instruments)
  - MMO – Magnetospheric Orbiter (JAXA – 5 instruments / suites)
- Launch in October 2018
- Arrival @ Mercury late 2025
- Status: Acceptance testing on-going