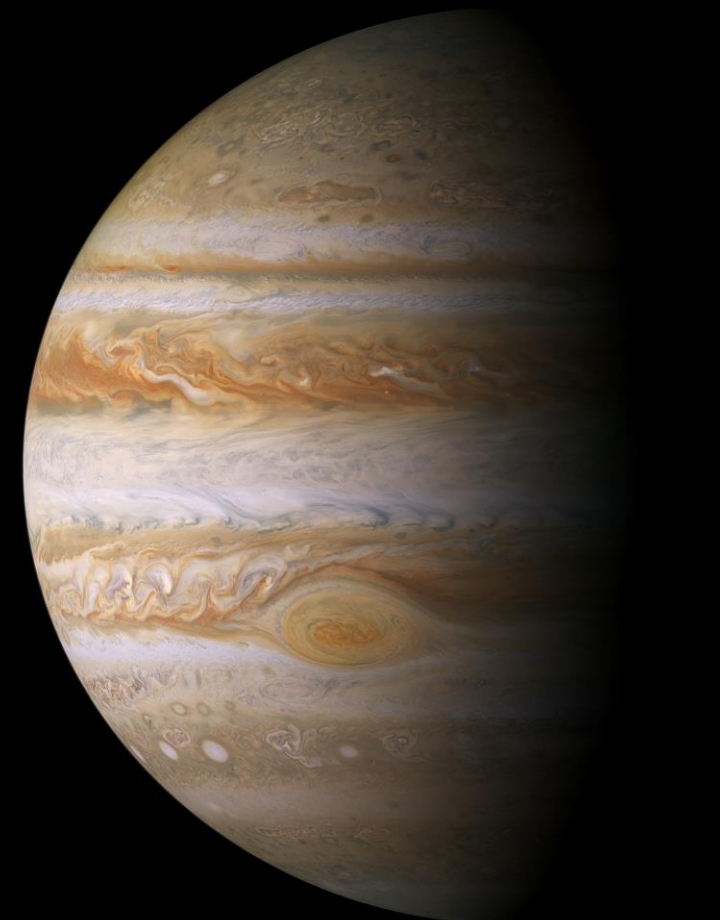


Cruise phase

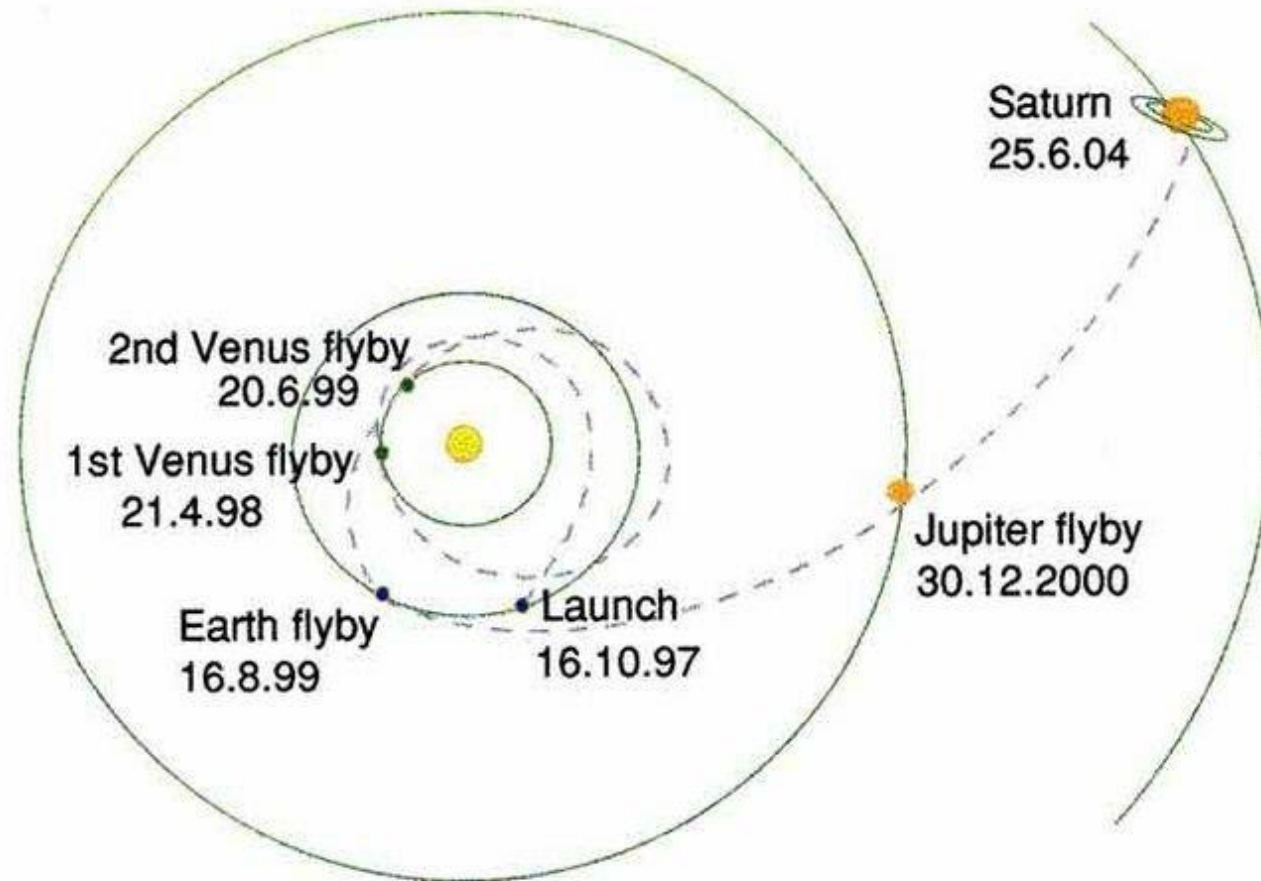
Olivier Witasse (10 slides in 15 minutes)

Matt Taylor (20 slides in 5 minutes)



What is a cruise phase?

Example of Cassini-Huygens



Examples of cruise phase




- Cassini-Huygens: 1997-2004 (7 years)
- Mars Express: 2003 (6 months)
- Smart 1 to the Moon: 2003-2004 (16 months) *electric propulsion*
- Rosetta: 2004-2014 (10 years)
- Venus Express: 2005-2006 (5 months)
- ExoMars orbiter: 2016 (7 months)
- Bepi-Colombo: 2018-2025 (7 years)
- ExoMars rover: 2020-2021 (8 months)
- JUICE: 2022-2029 (7 years)
- NASA Europa Clipper 2022-2025 (3 years to be confirmed)

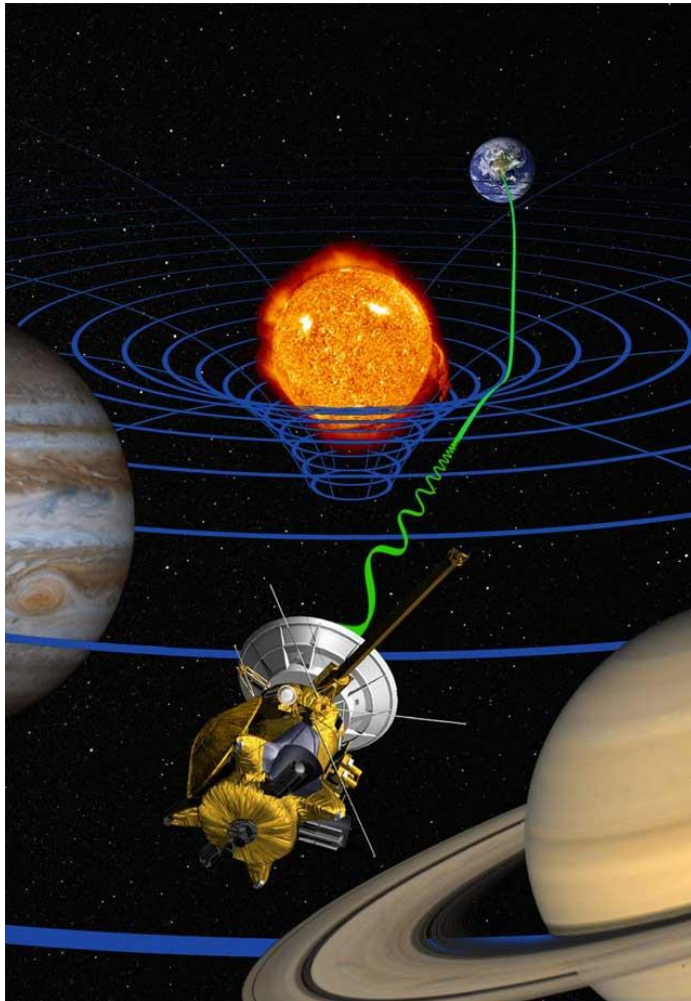
Cruise phase activities:

Do we quietly wait for the arrival???



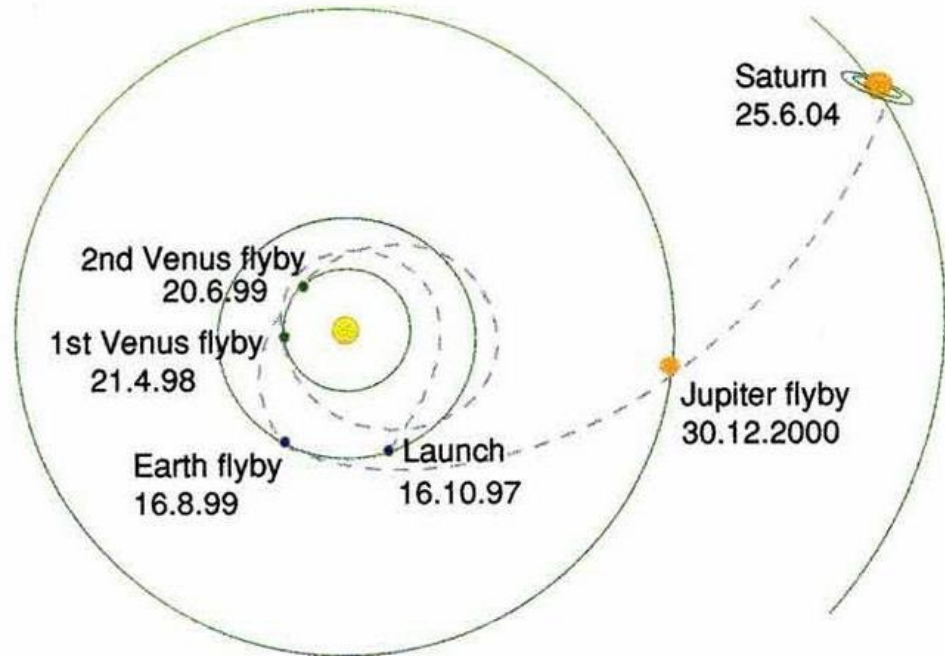
- Learn how to use the spacecraft
- Navigation activities
- Monitoring of the subsystems, inflight tests, instrument check-outs, calibration activities
- (limited) scientific measurements: flybys, gravity experiments, etc... 
- Preparation of the nominal scientific mission (science planning, archive etc...)
- Build the team spirit....

An example of great science



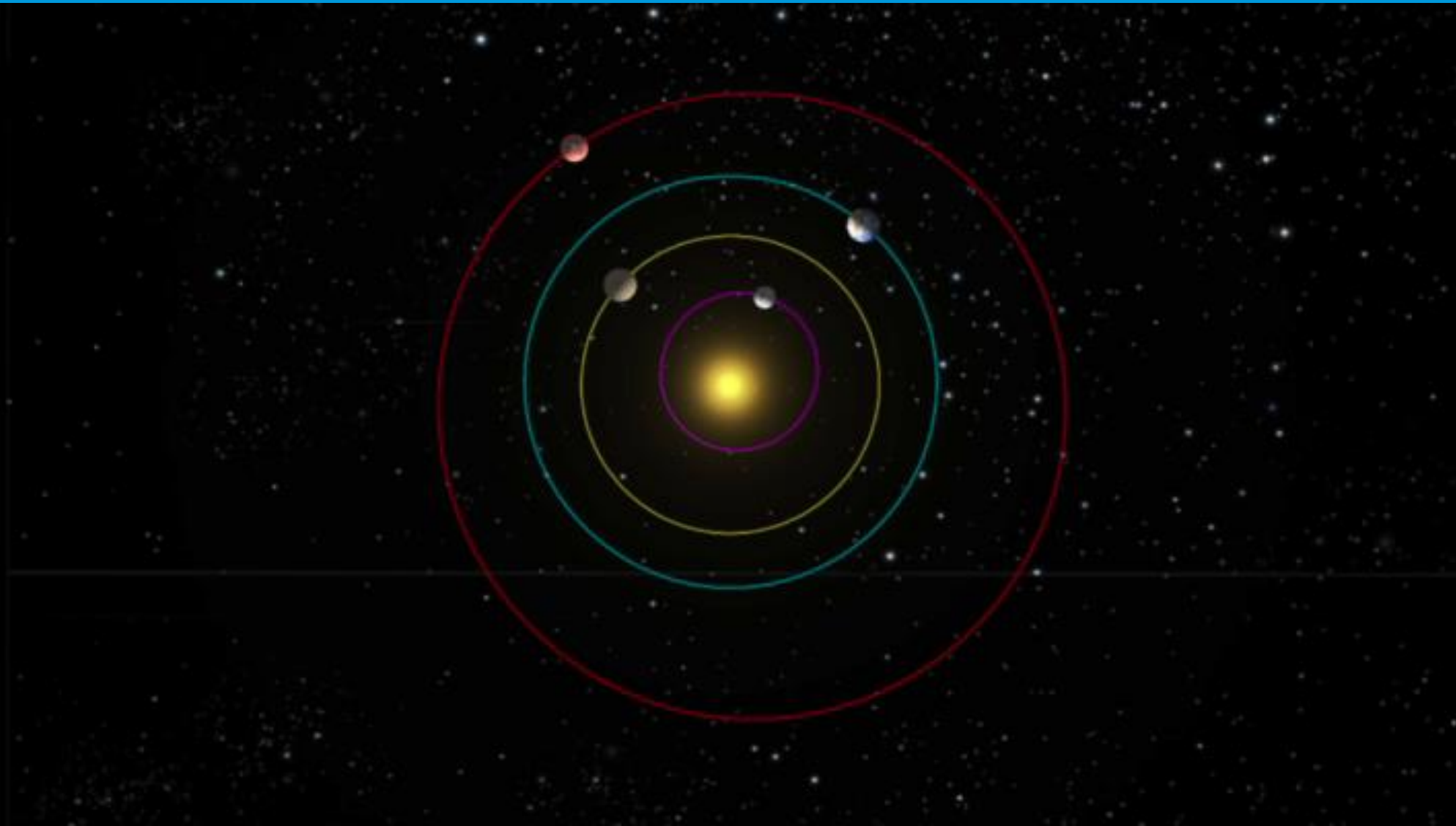
- Test done in 2002
- confirms Einstein's theory of general relativity with a precision that is 50 times greater than previous measurements.
- One of the most cited Cassini article!

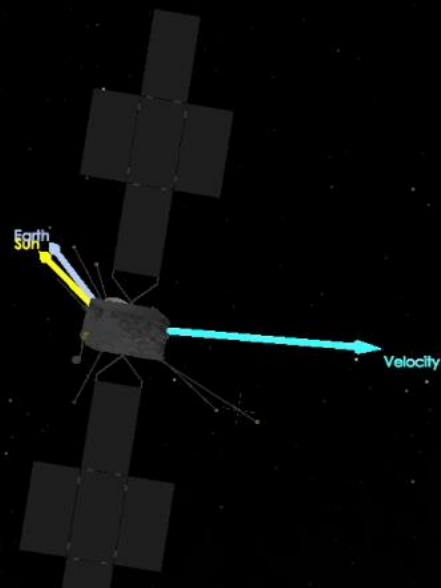
An example of a useful inflight test...

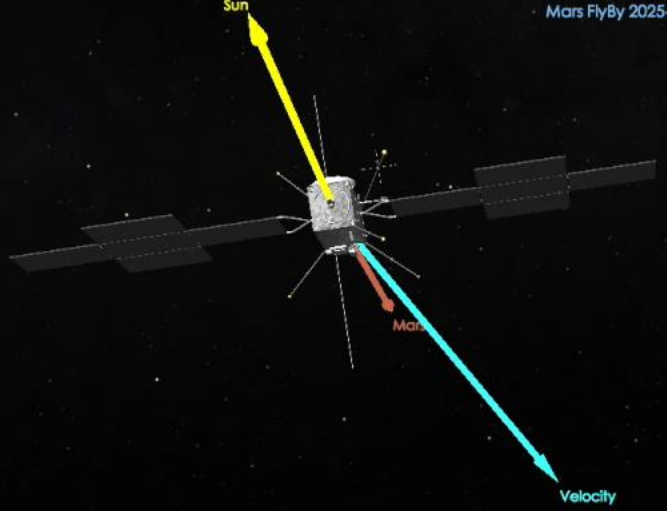


- Inflight test done in February 2000: test of the communication between the probe and the orbiter.
- The test was NOT done on ground (remember yesterday: *fly as you test, test as you fly....*)
- Findings: Huygens receiver onboard the Cassini orbiter has a bandwidth that is too small to accommodate the Doppler shift of the relay signal!!
- 4 years of work to redesign of the mission: redesign of the Cassini trajectory, high-altitude pass of Cassini above Huygens, pre-warming of the probe!
- Without this test, most of the data would have been lost.

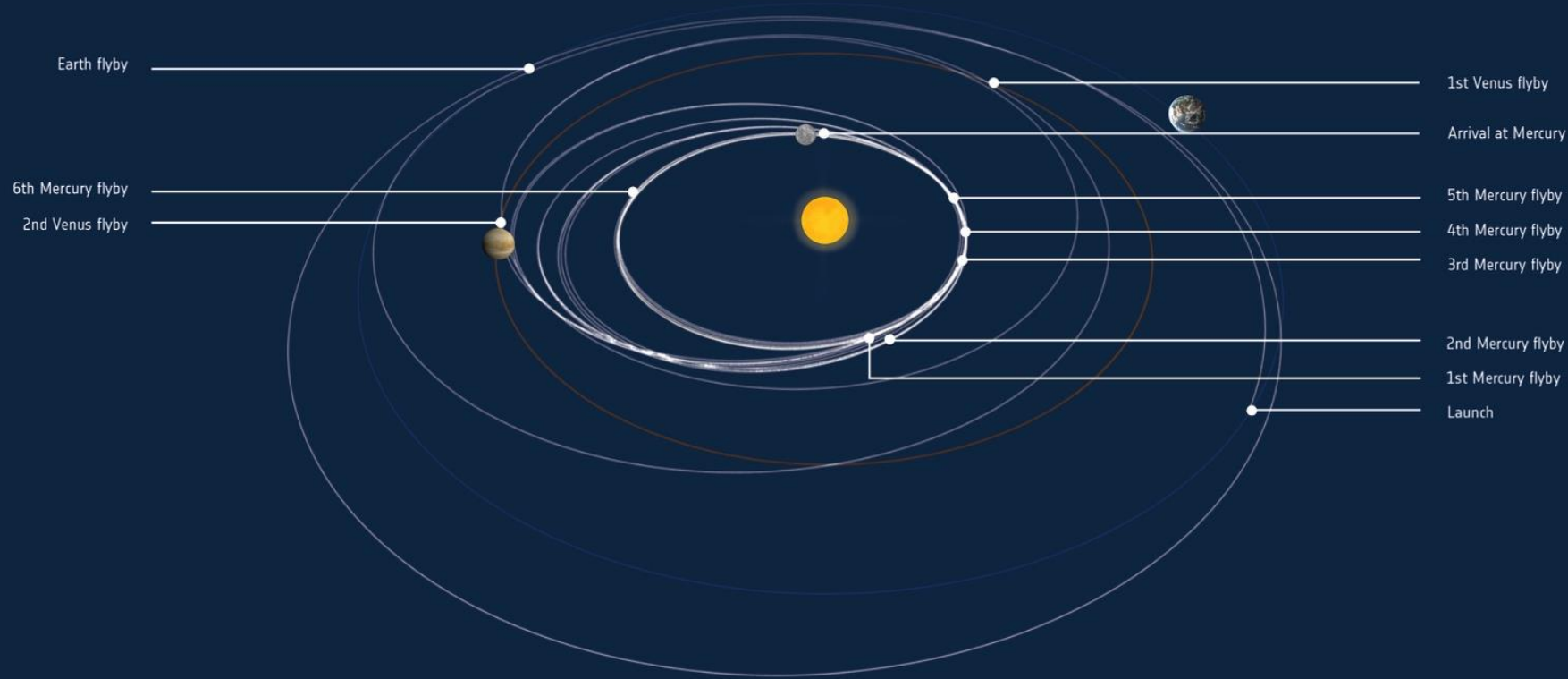
JUICE Trajectory

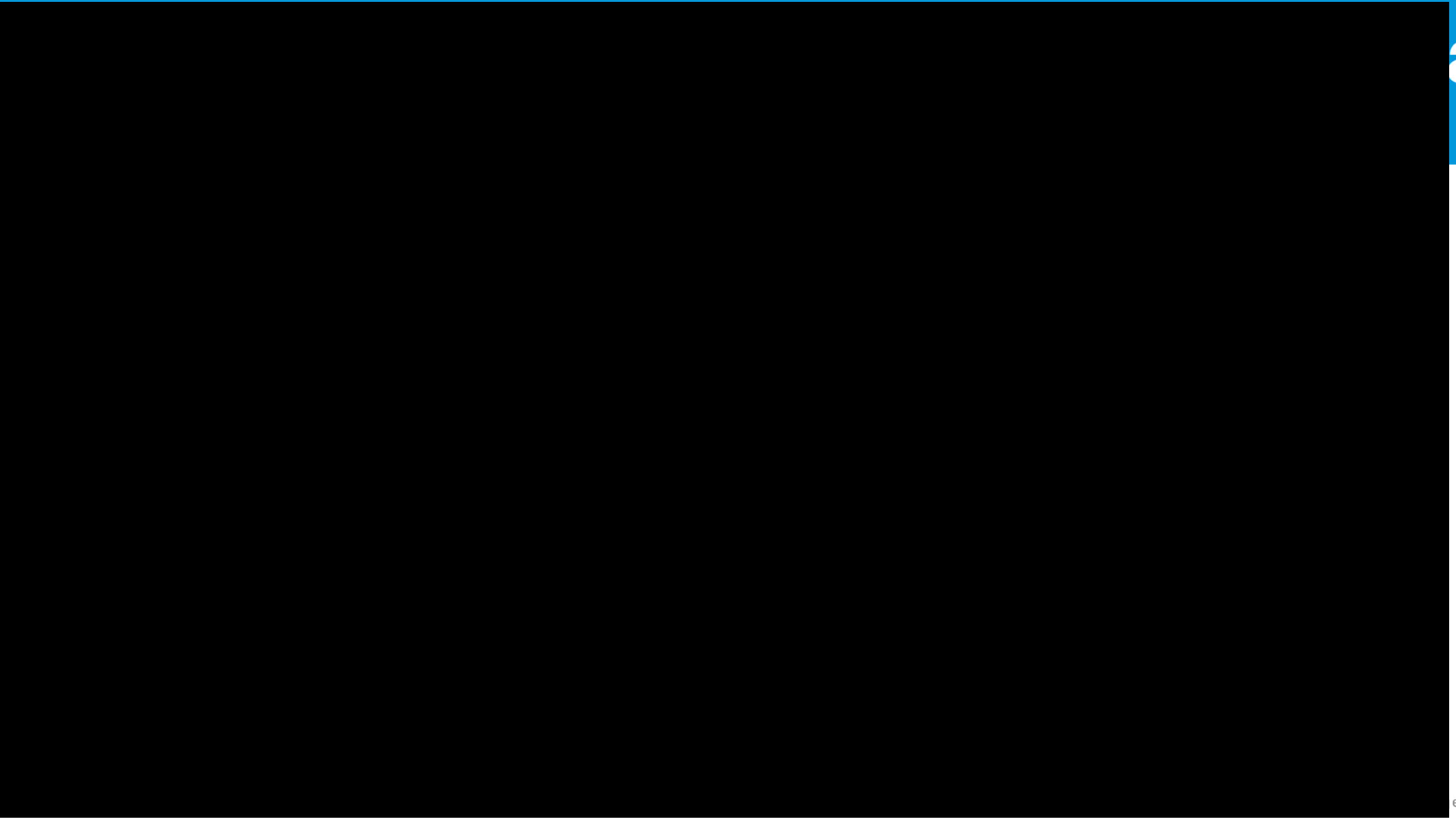


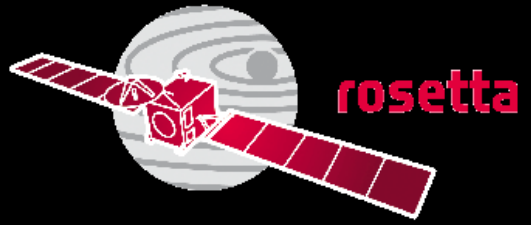




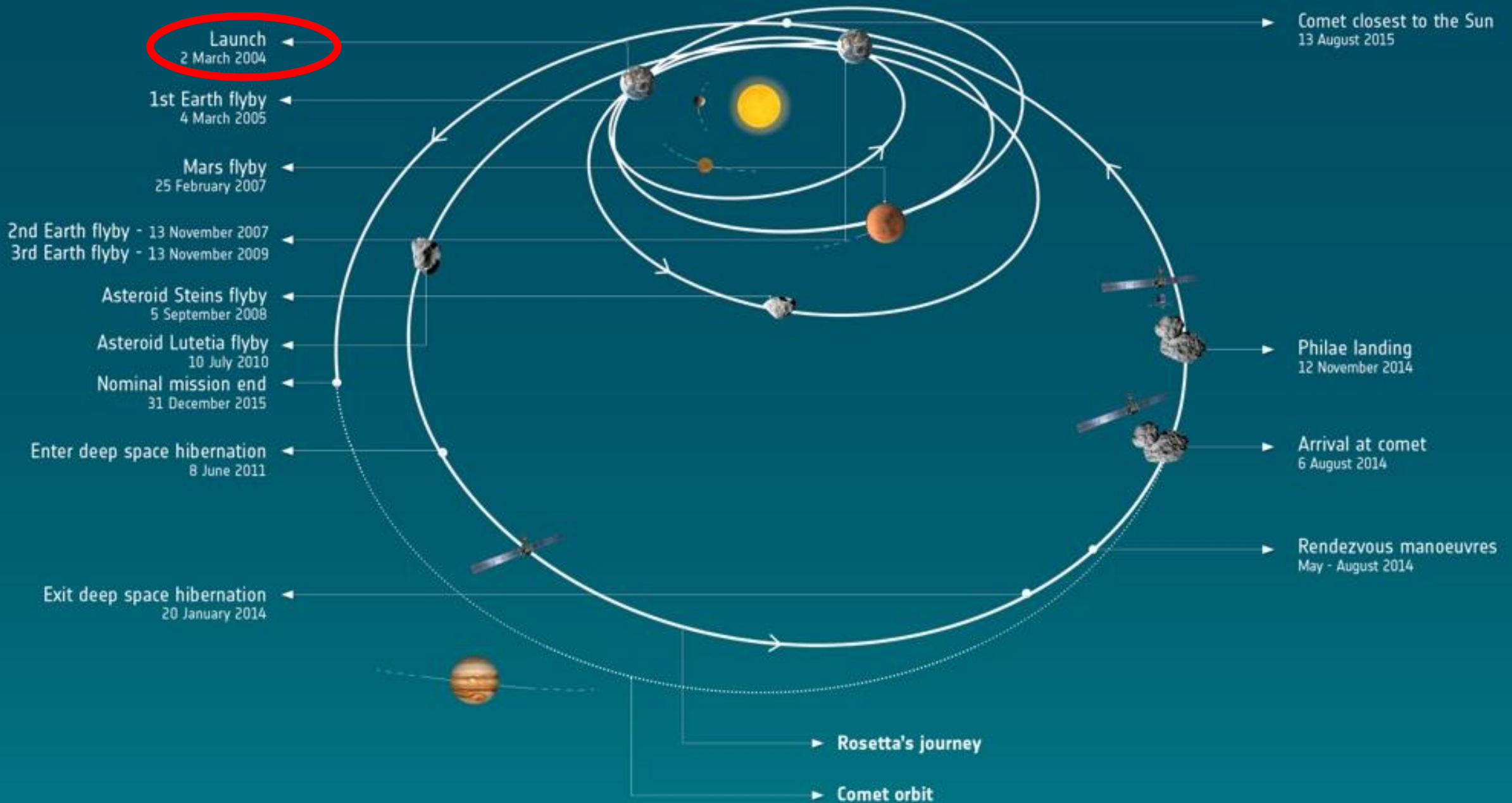
Bepi-Colombo







on the way there...



Launch
2 March 2004

1st Earth flyby
4 March 2005

Mars flyby
25 February 2007

2nd Earth flyby - 13 November 2007

3rd Earth flyby - 13 November 2009

Asteroid Steins flyby
5 September 2008

Asteroid Lutetia flyby
10 July 2010

Nominal mission end
31 December 2015

Enter deep space hibernation
8 June 2011

Exit deep space hibernation
20 January 2014

Comet closest to the Sun
13 August 2015

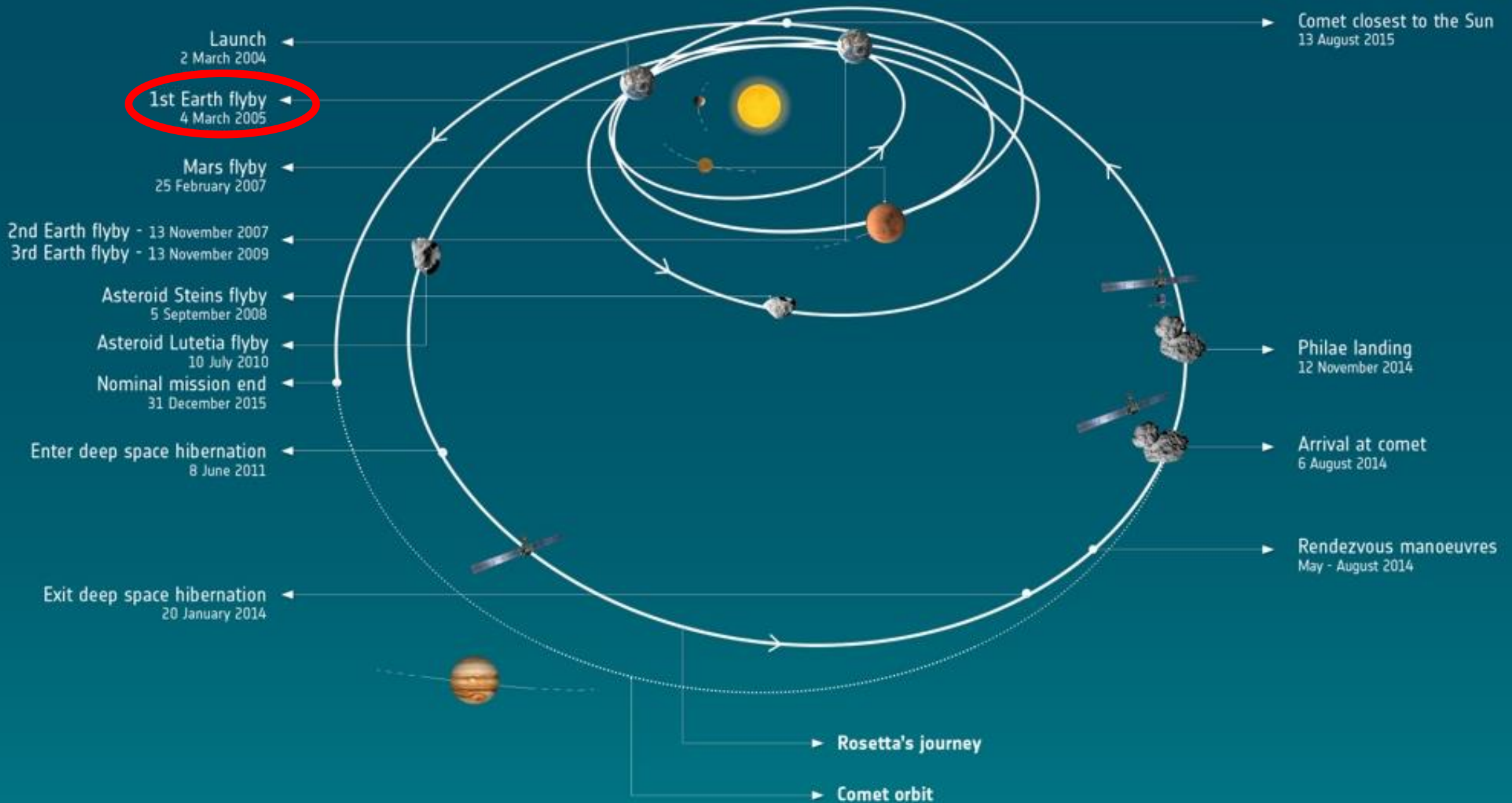
Philae landing
12 November 2014

Arrival at comet
6 August 2014

Rendezvous manoeuvres
May - August 2014

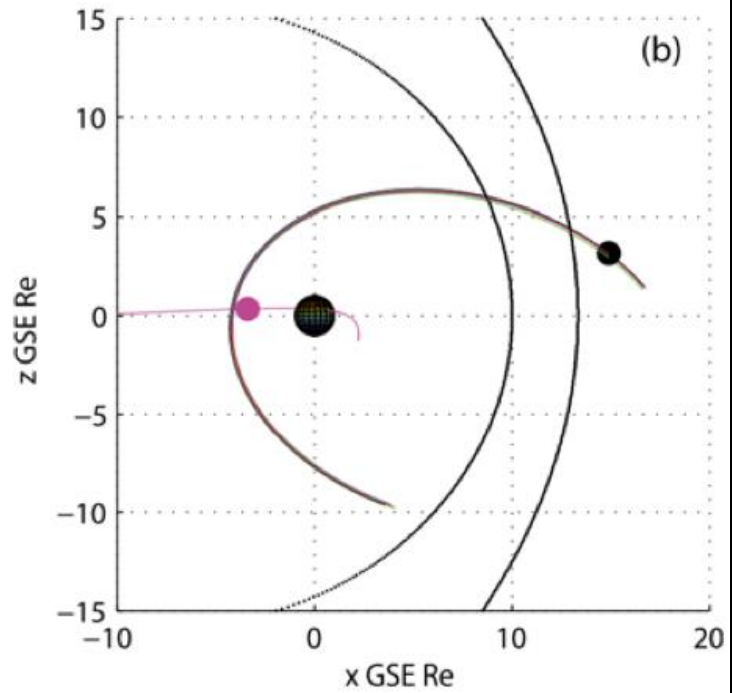
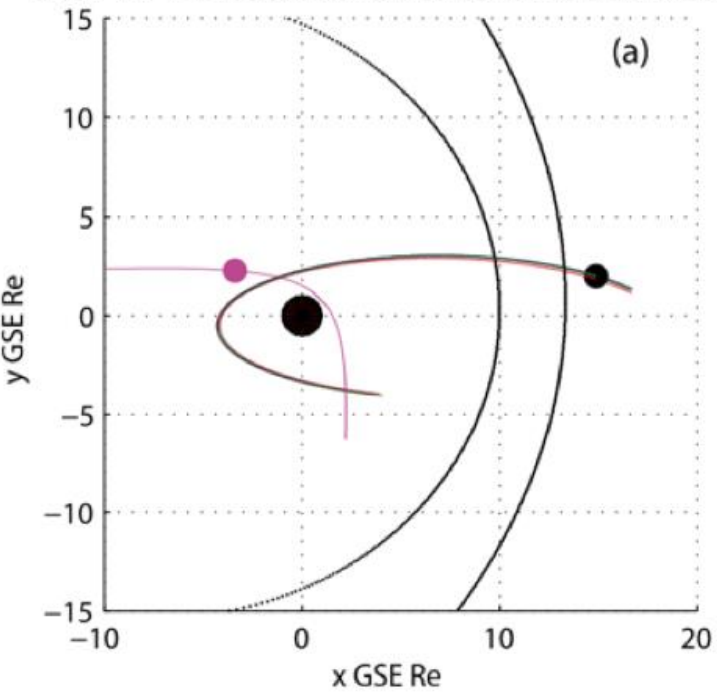
▶ Rosetta's journey

▶ Comet orbit



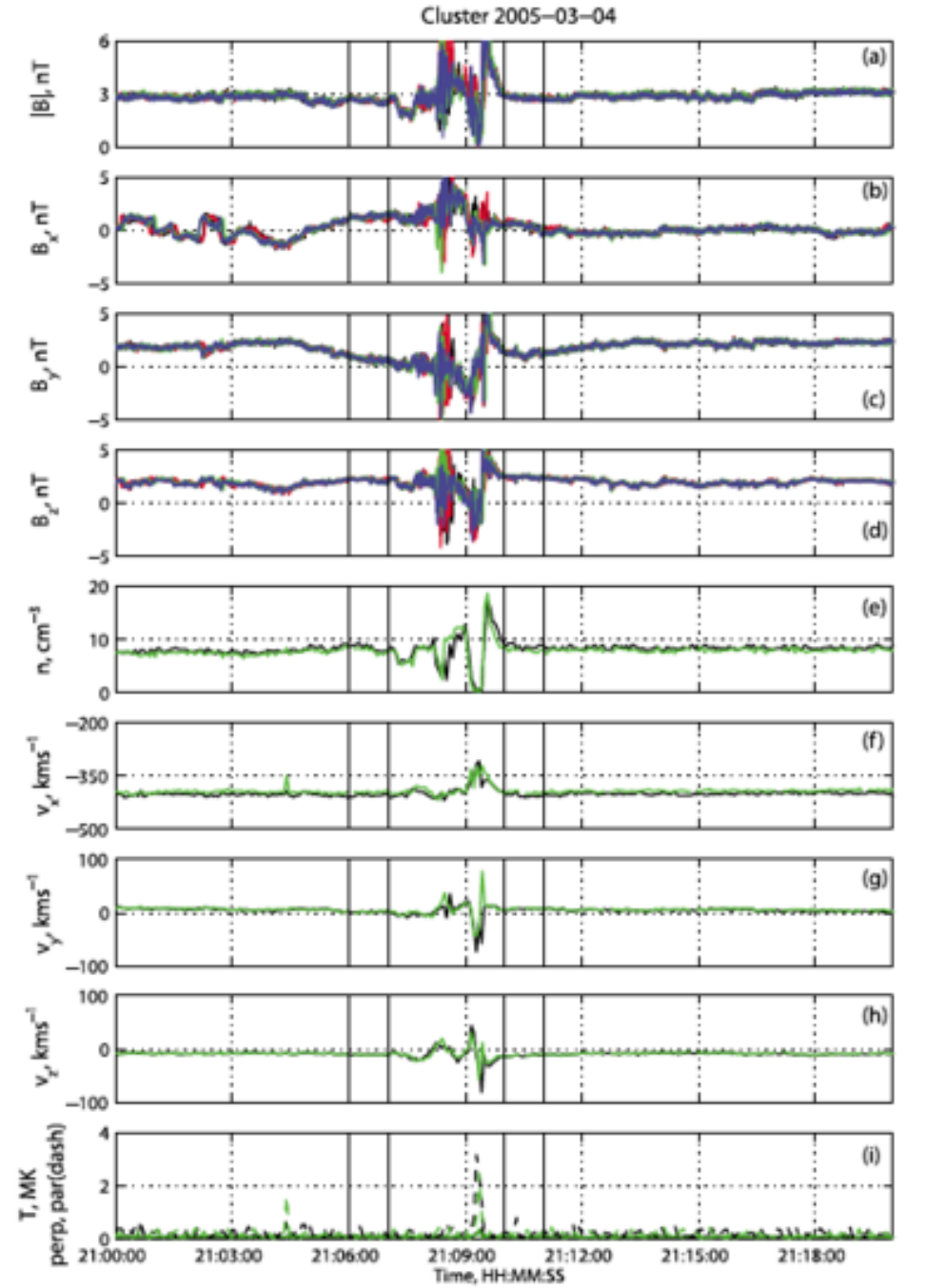
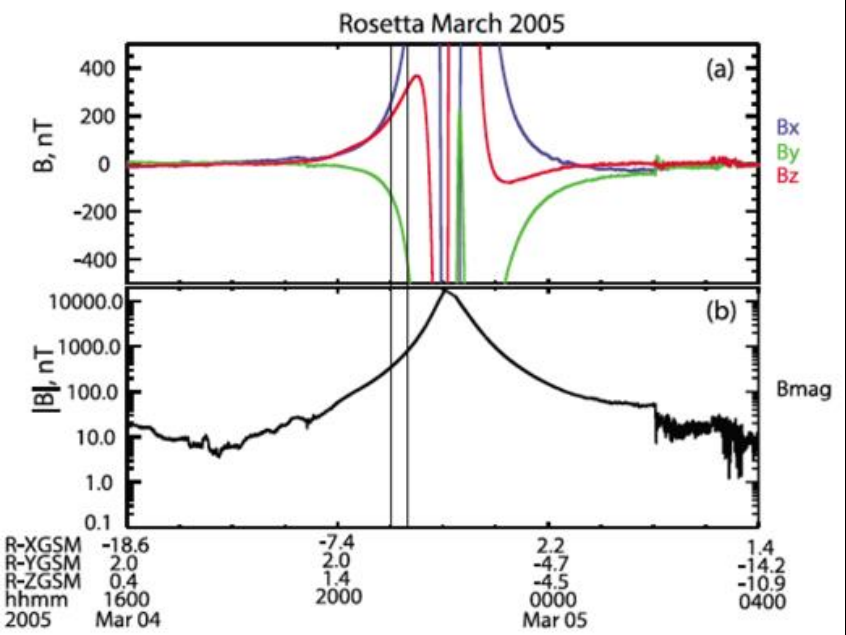


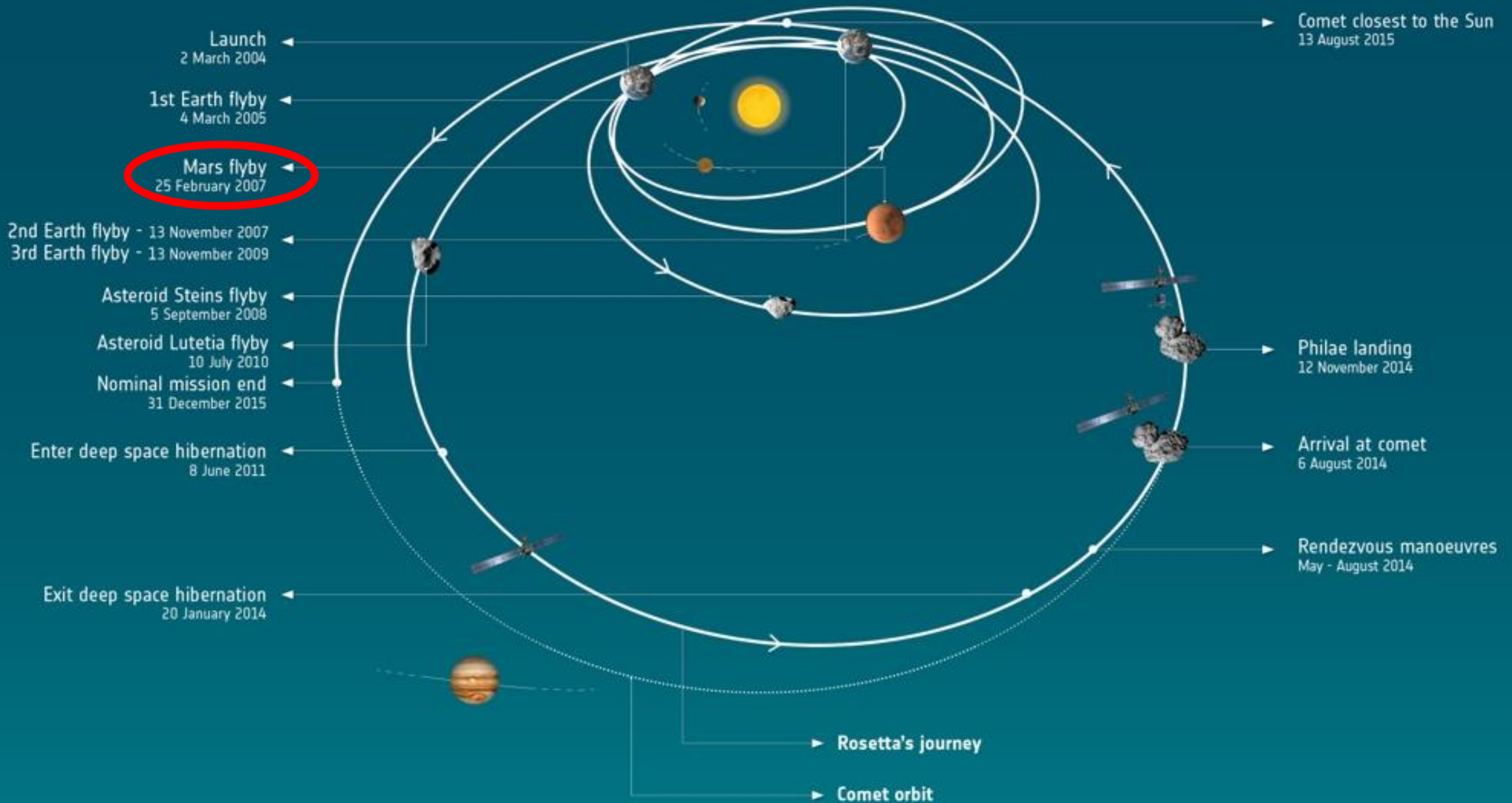
2005-03-04 Cluster/Rosetta, Farris model MP/Shock



Magnetic field measurements

used to identify generation of waves by interaction of current sheet with Bow Shock which permeate the magnetosphere.





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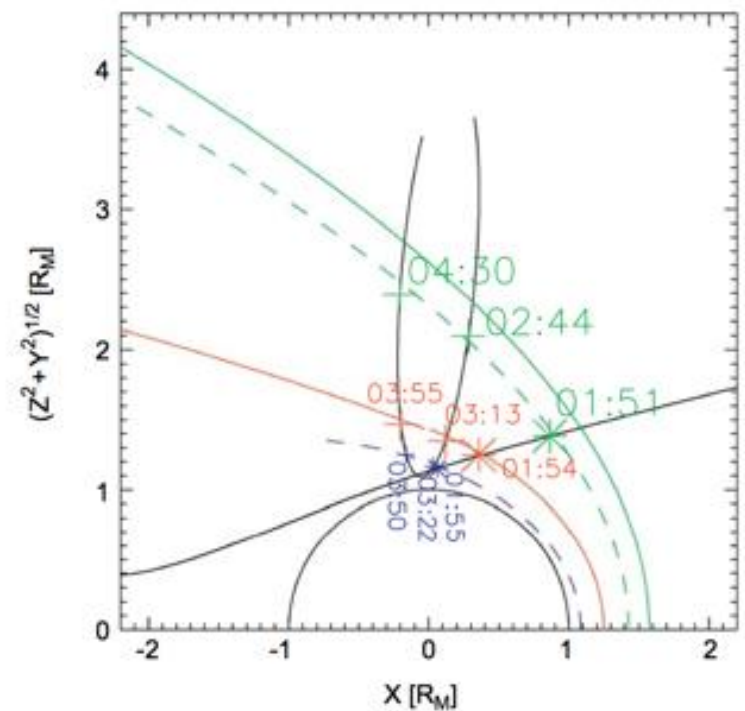
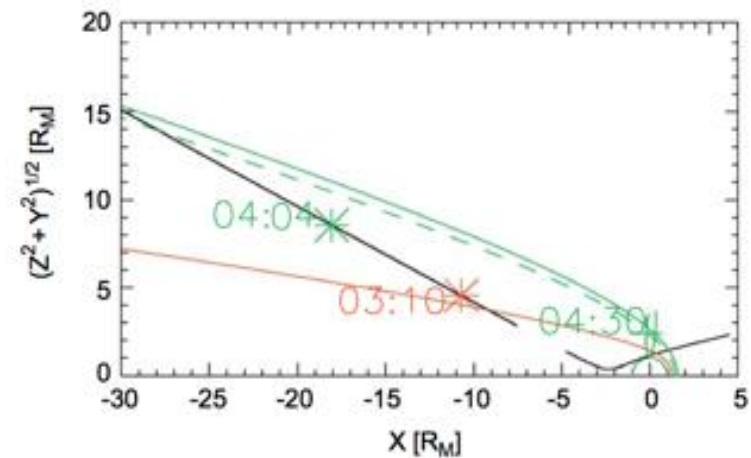
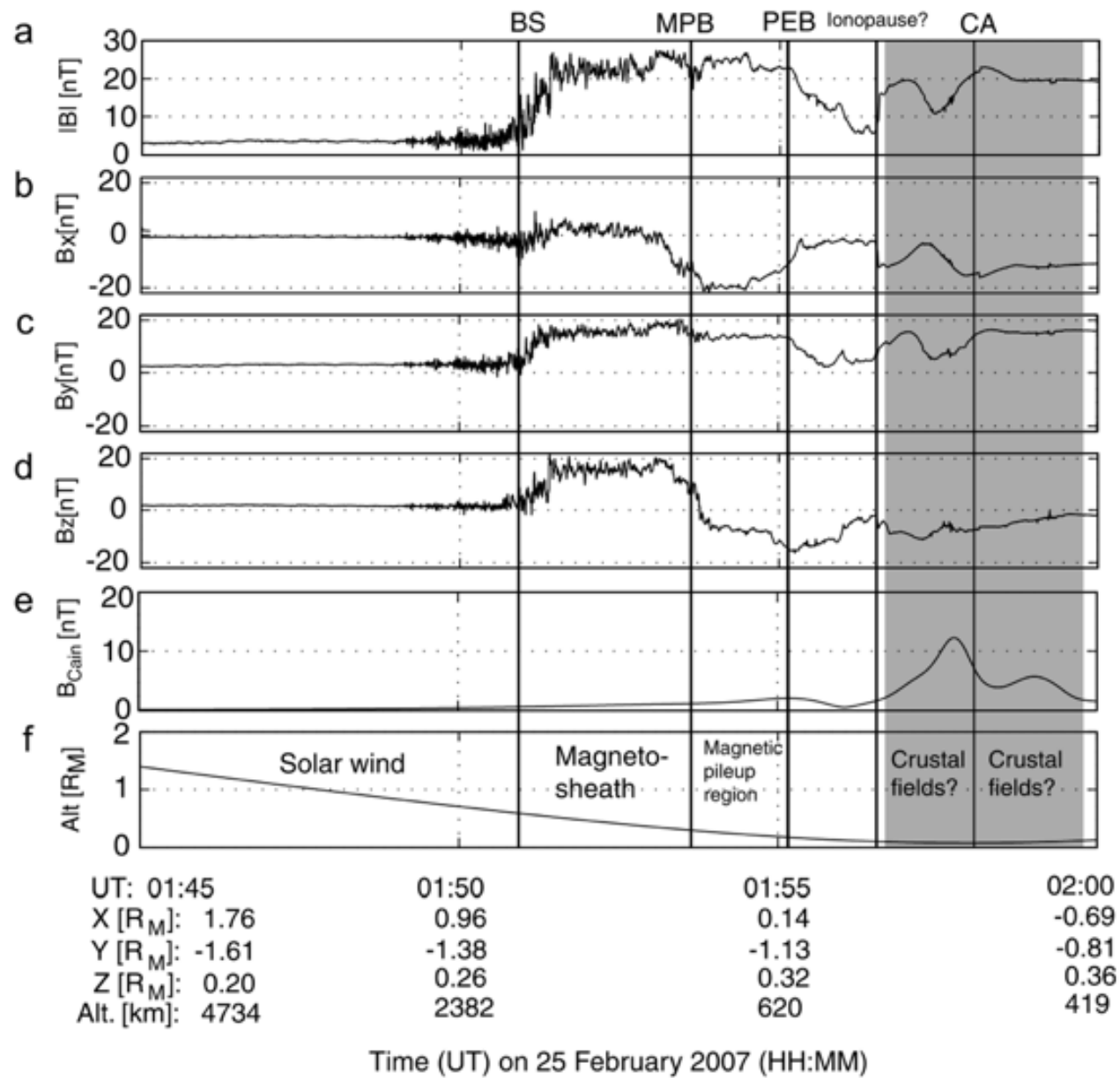
▶ Comet orbit

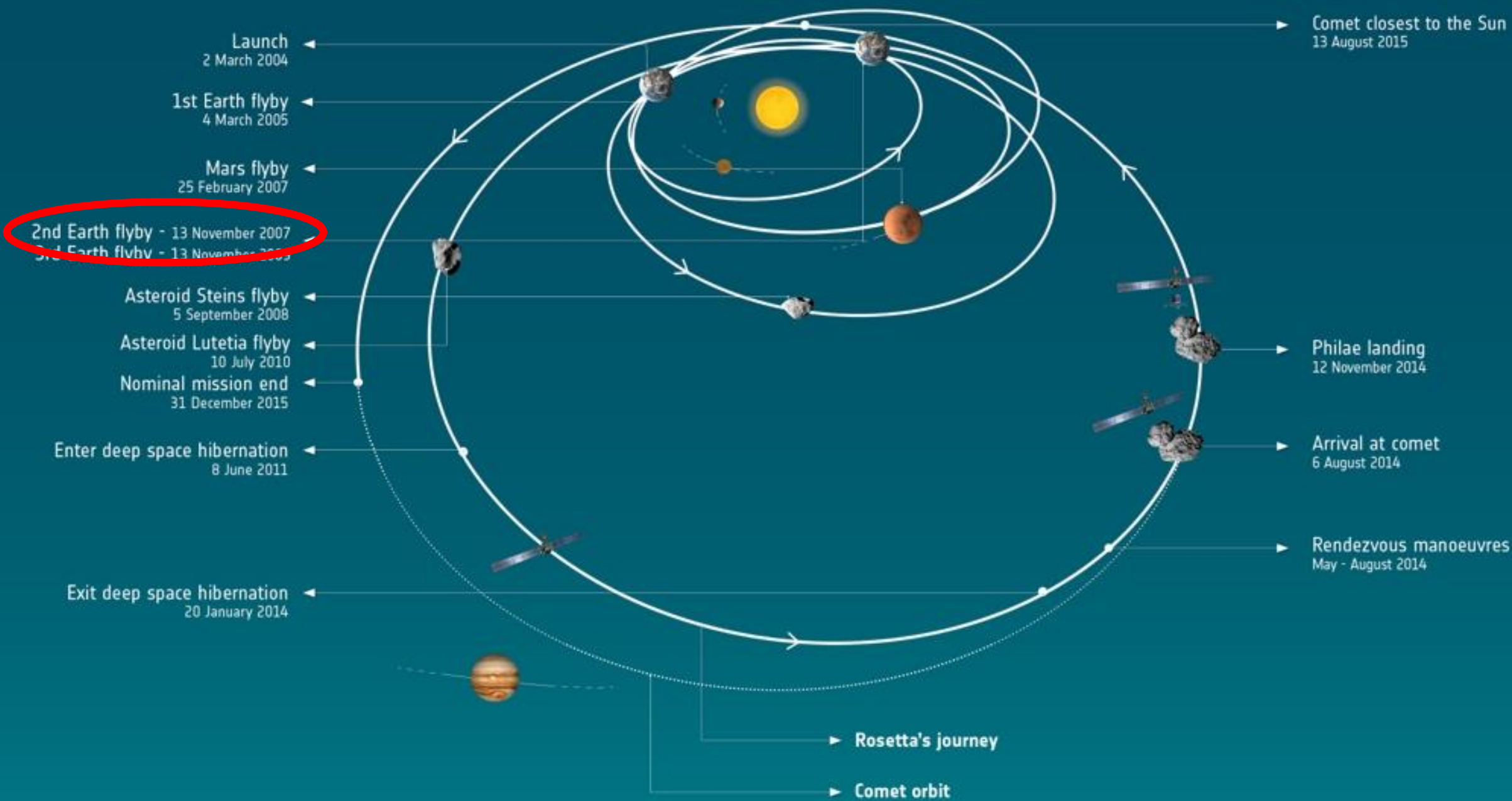


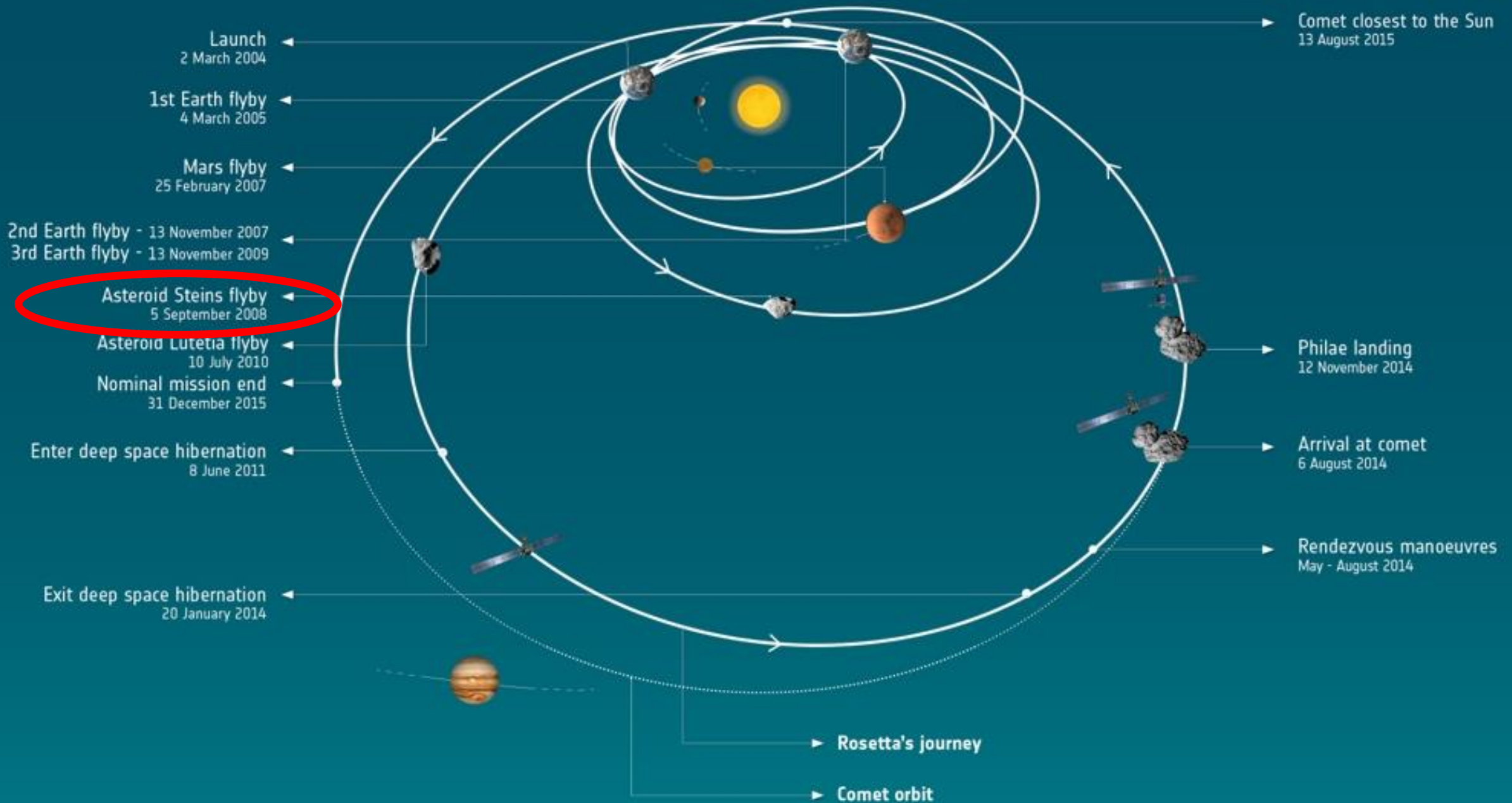
As seen at 240,000km, one day before fly-by on February 25, 2007 / ESA



Near closest approach at 1,000km, February 25, 2007 / ESA





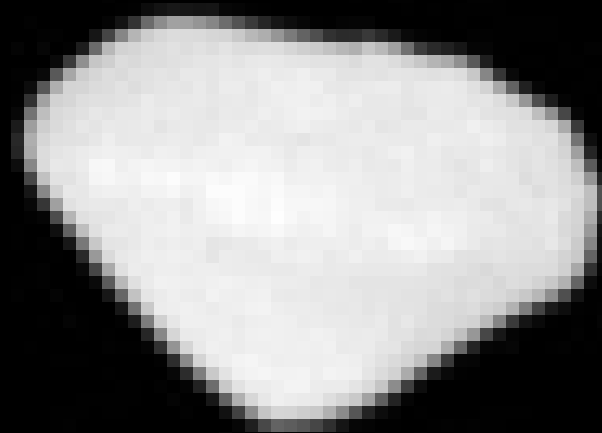


Asteroid 2867 Šteins

Unlocked physical properties of this main-belt asteroid.

Loosely-bound 'rubble pile' whose diamond shape has been honed by the YORP effect, the modification of an object's rotation by the Yarkovsky-O'Keefe-Radzievski-Polyakov effect, the modification of an object's rotation by the Yarkovsky-O'Keefe-Radzievski-Polyakov effect, the modification of an object's rotation by the Yarkovsky-O'Keefe-Radzievski-Polyakov effect.

This is the first time this effect has been seen in a main-belt asteroid.



5.9 x 4 km, from 800 km at 8.6 km/s



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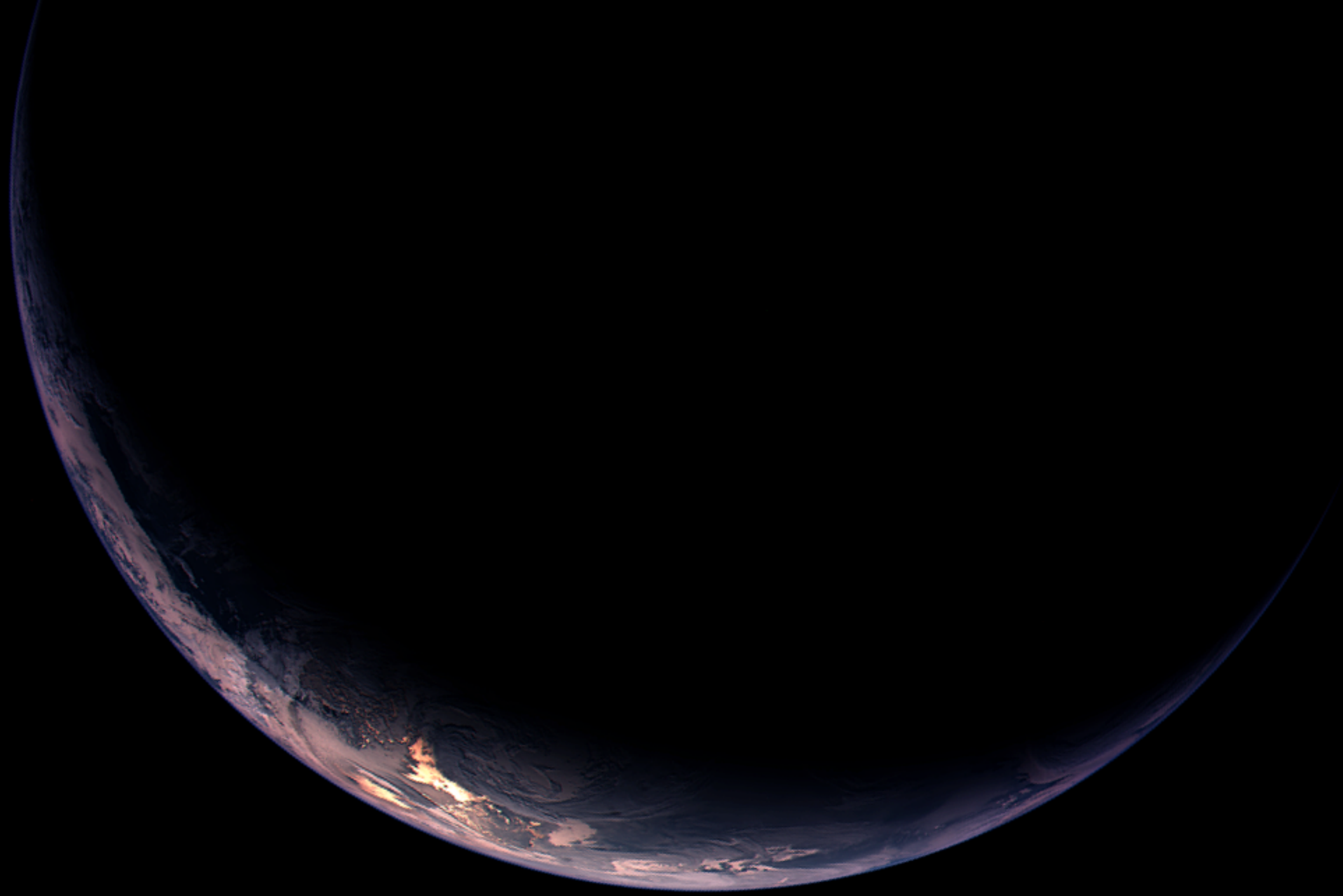
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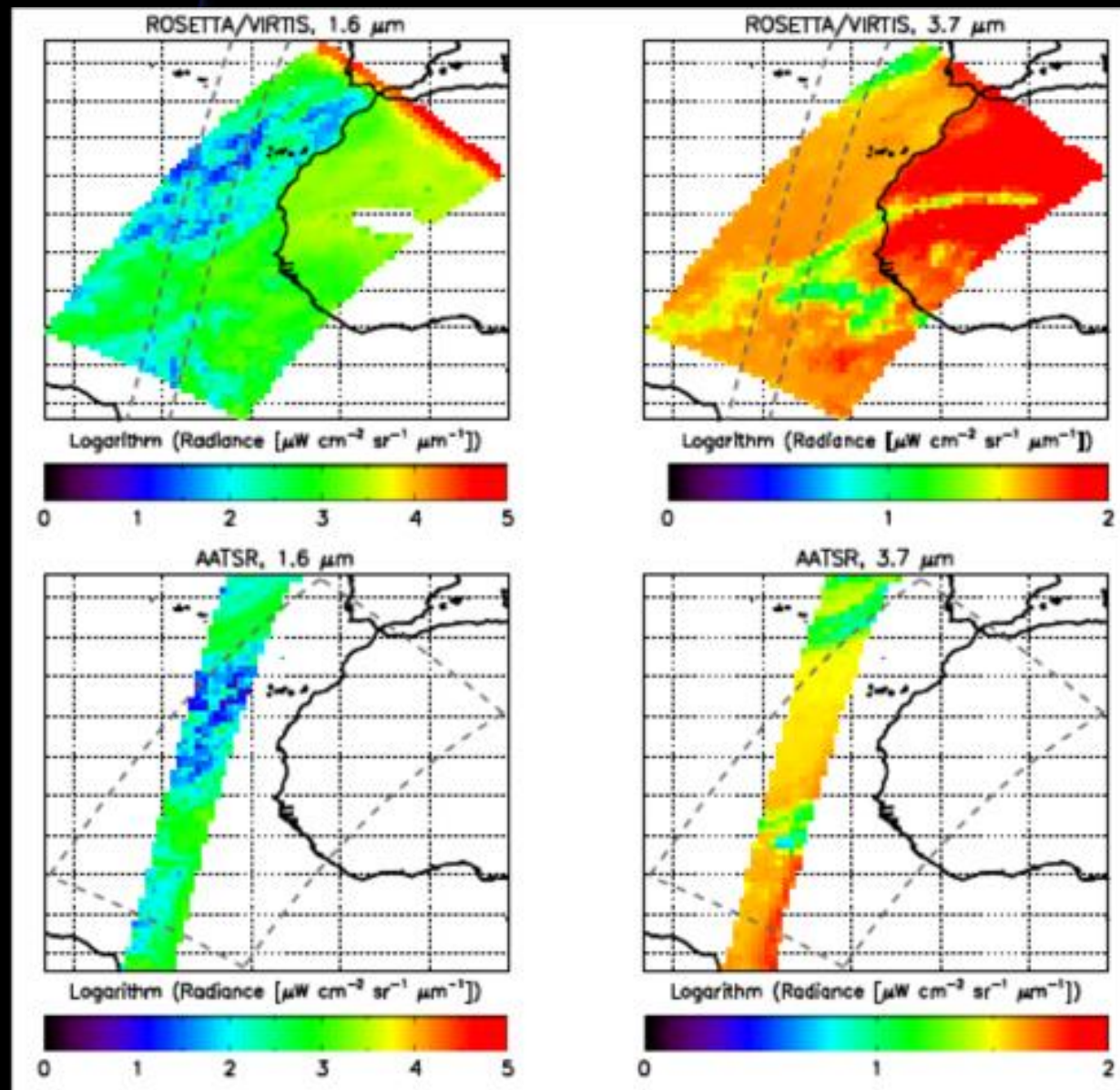
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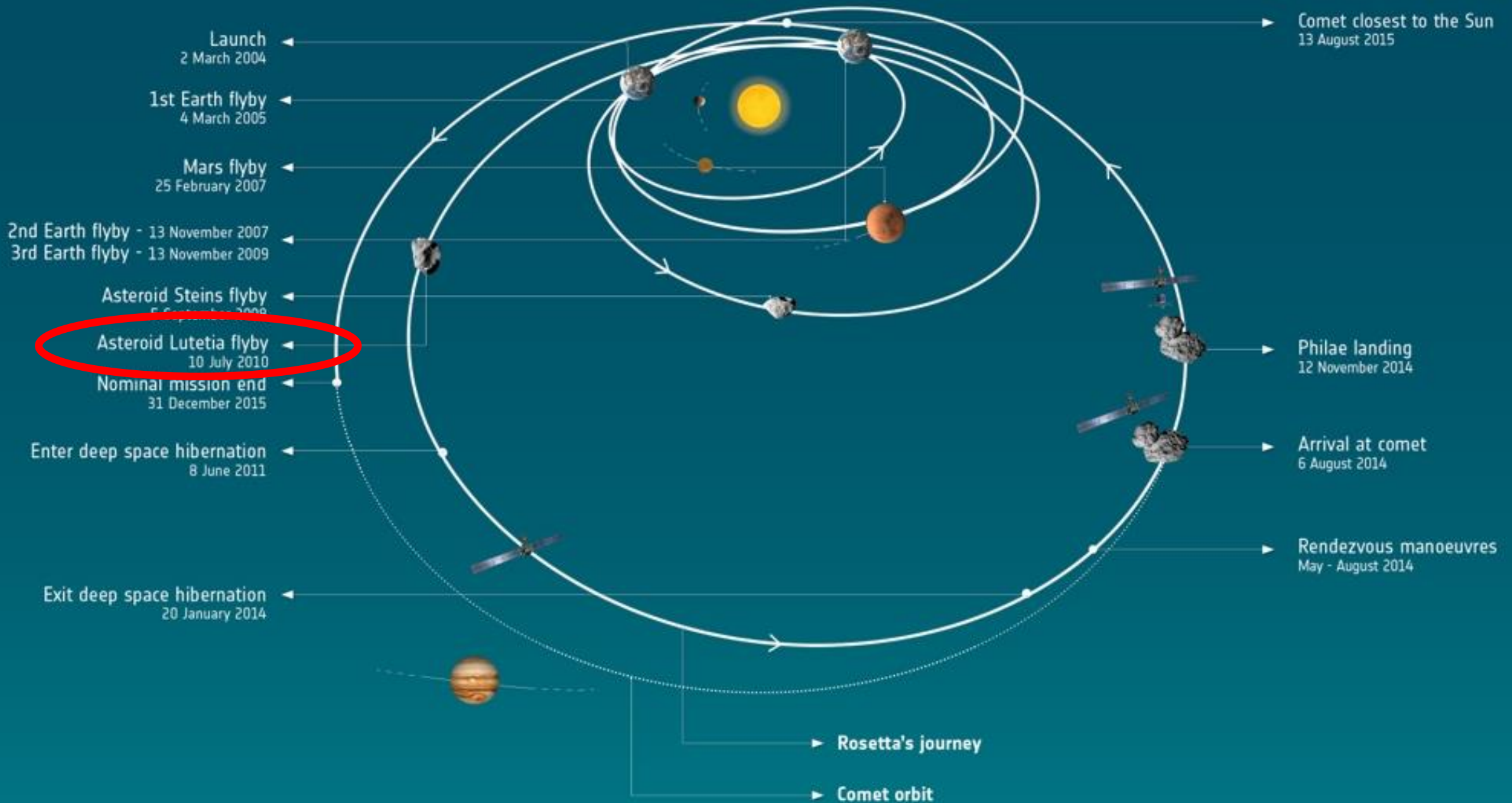
Rendezvous manoeuvres
May - August 2014

▶ Rosetta's journey

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Asteroid 21 Lutetia

More than 350 craters were identified with diameters between 600 metres and 55 km and depths of up to 10 km

A small white dot representing Asteroid 21 Lutetia, centered in the lower half of the image.

121 km x 101 km x 75 km from 3170 km at 15 km/s

Some issues with spacecraft

Reaction Control system (thrusters) were found to have a leak – had to work out how to continue the mission and ensure capability during main (comet) phase.

Also – reaction wheels – some issues in them having some increased friction

Work arounds put in place (hybrid mode)

