ROSETTA

One Comet Rendezvous and two Asteroid Fly-bys

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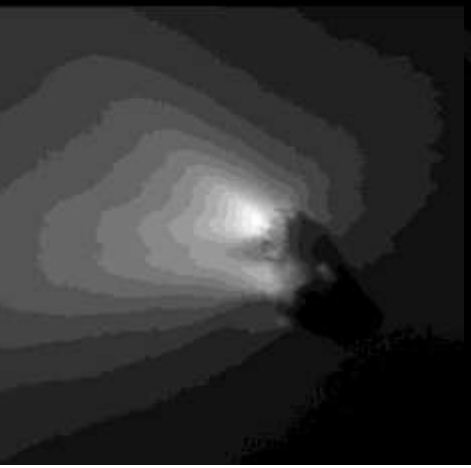
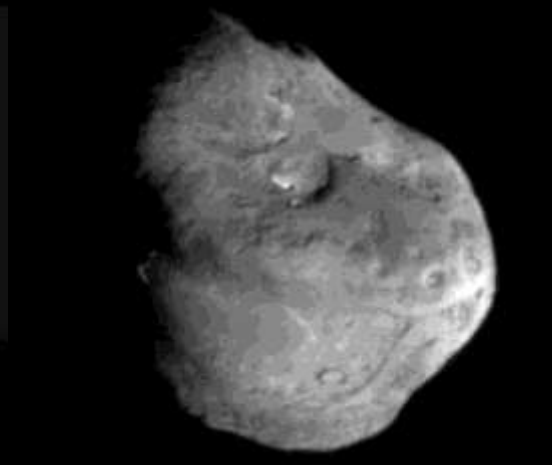
Rosetta Project Scientist

esa SCIENCE

Giotto Mission 1986 1P/Halley	DS-1 Mission 2001 19P/Borrelly	Stardust Mission 2004 81P/ Wild 2	Deep Impact Mission 2005 9P/Tempel
			
15.3 x 7.2 x7.2 km	8 x 3.2 x ? km	5.3 x 4.0 x 3.3 km	r_m = 3.0 km (d = 5.0-7.5 km)

Unfortunately:

very few in-situ compositional measurements

- **gas coma – only from comet Halley**
- **dust coma – from Halley and Wild-2**

Stardust sample return of coma dust

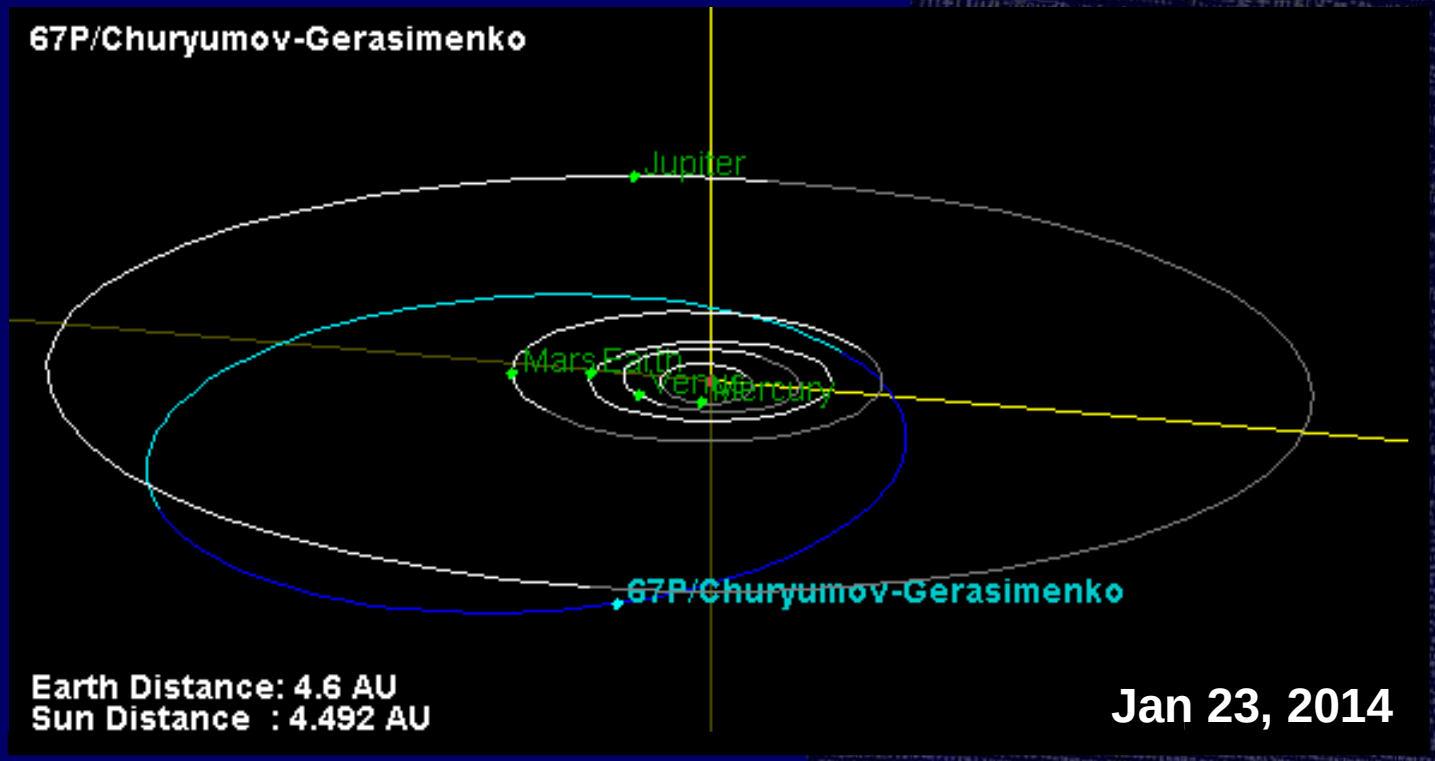

ROSETTA
A COMET RENDEZVOUS MISSION

ROSETTA SCIENTIFIC OBJECTIVES

1. Investigate the origin of the Solar System by studying the origin of comets
2. Global characterization of the comet nucleus, dynamic properties, surface morphology and composition
3. Determination of chemical, mineralogical and isotopic compositions of volatiles and refractories in a comet nucleus
4. Determination of the physical properties and interrelation of volatiles and refractories in a comet nucleus
5. Study of the development of cometary activity and the processes in the surface layer of the nucleus and inner coma (dust/gas interaction)
6. Characterisation of main belt asteroids including dynamic properties, surface morphology and composition

THE ROSETTA STONE

Rosetta arrival at the comet



67P/Churyumov-Gerasimenko

Heliocentric Period:	6.59 years
Perihelion:	1.30 AU
Aphelion:	5.73 AU
Discovery:	1969

Scientific Payload

Rosetta

11 Orbiter Instruments/ (Instrument Packages) ⇒18 Experiments

Payload Mass: ~170 kg
+ Lander: ~110 kg

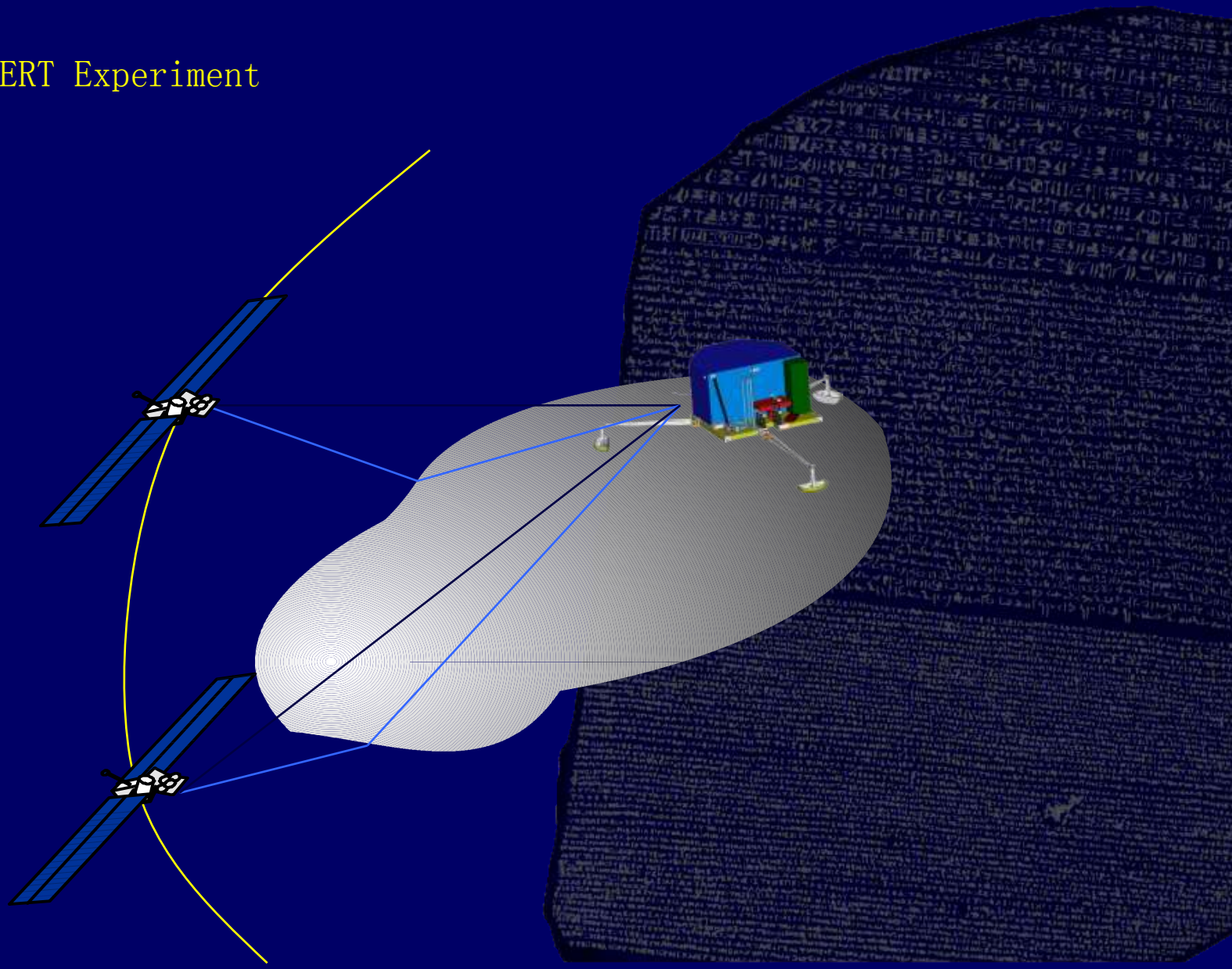
10 Lander Instruments/ (Instrument Packages) => 16 Experiments

Payload Mass: ~27 kg

Rosetta Spacecraft and Payload

- OSIRIS: Optical, Spectroscopic and Infrared Remote Imaging System (MPAE, Lindau, Germany)

CONSERT Experiment



Rosetta Spacecraft and Payload


Philae Lander and Payload
Imaging
Composition analysis
Physical properties
Nucleus large-scale structure
Magnetic field and plasma
Drill and sampling device
CIVA, ROLIS
APX, COSAC, Ptolemy
MUPUS, SESAME
CONSERT
ROLIS
SD2

COSAC

Organic Molecules

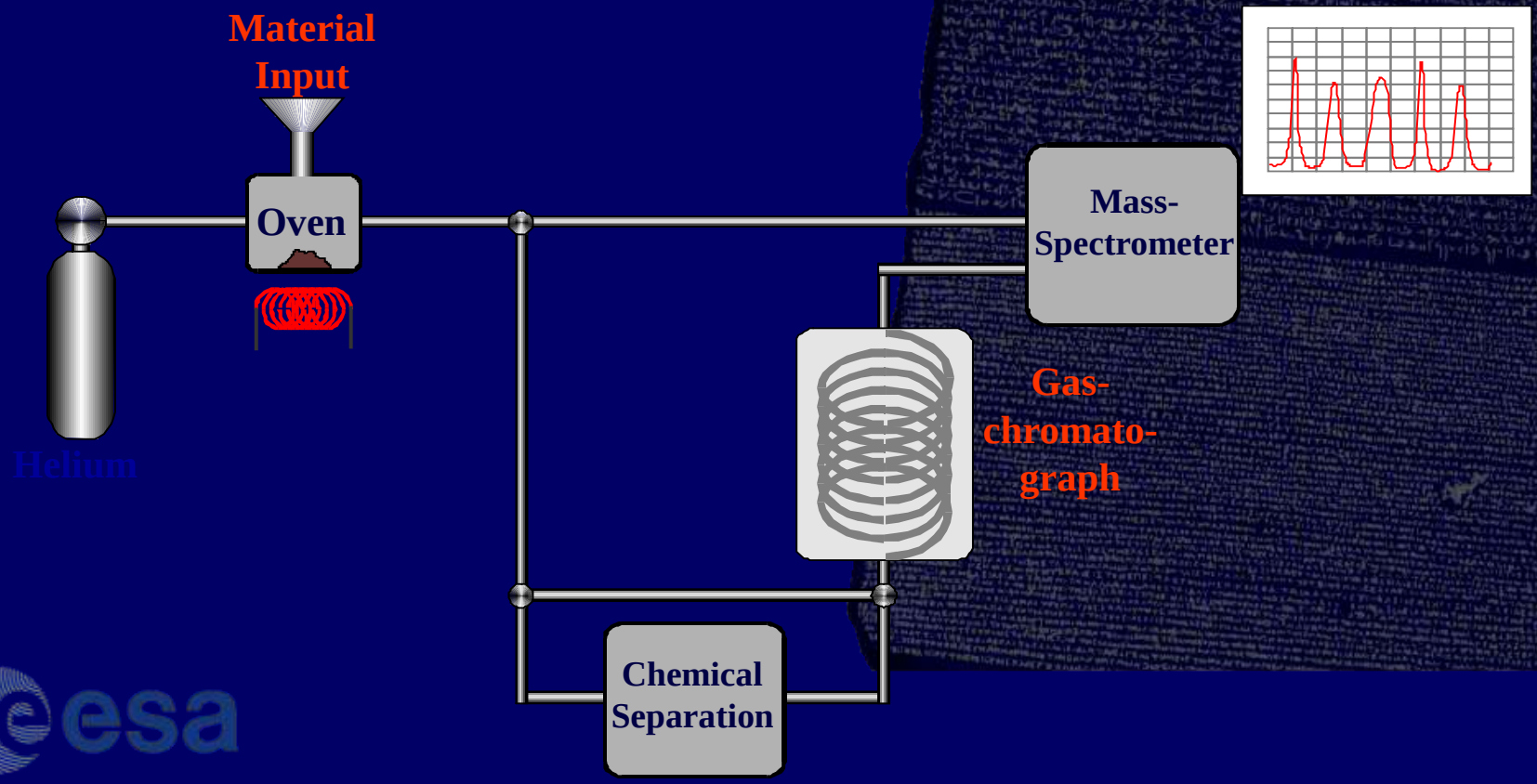
Mass-resolution 3000

Up to 1000 amu

MODULUS

Isotope analysis (H, C, N, O)

Chemical separation

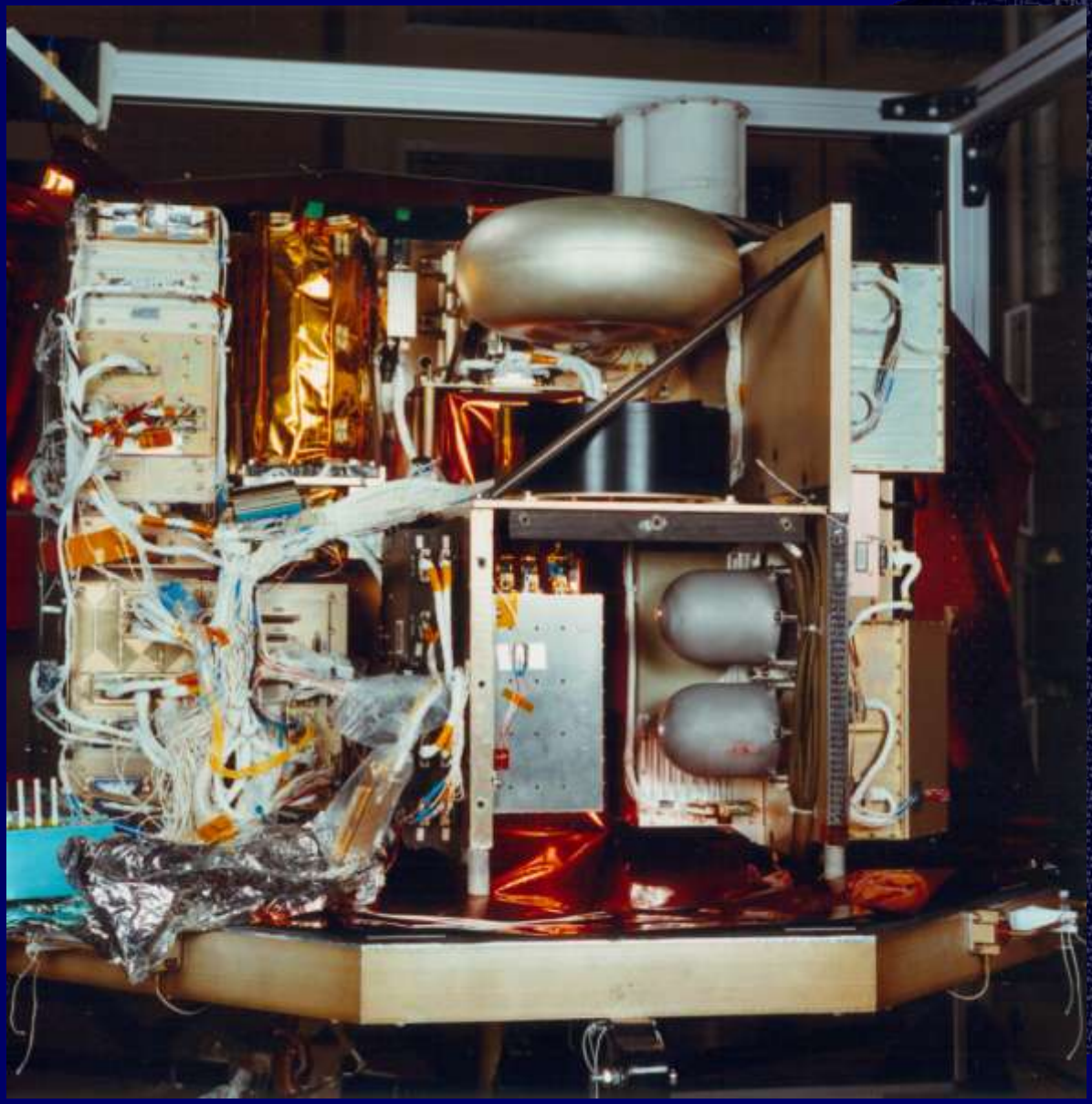


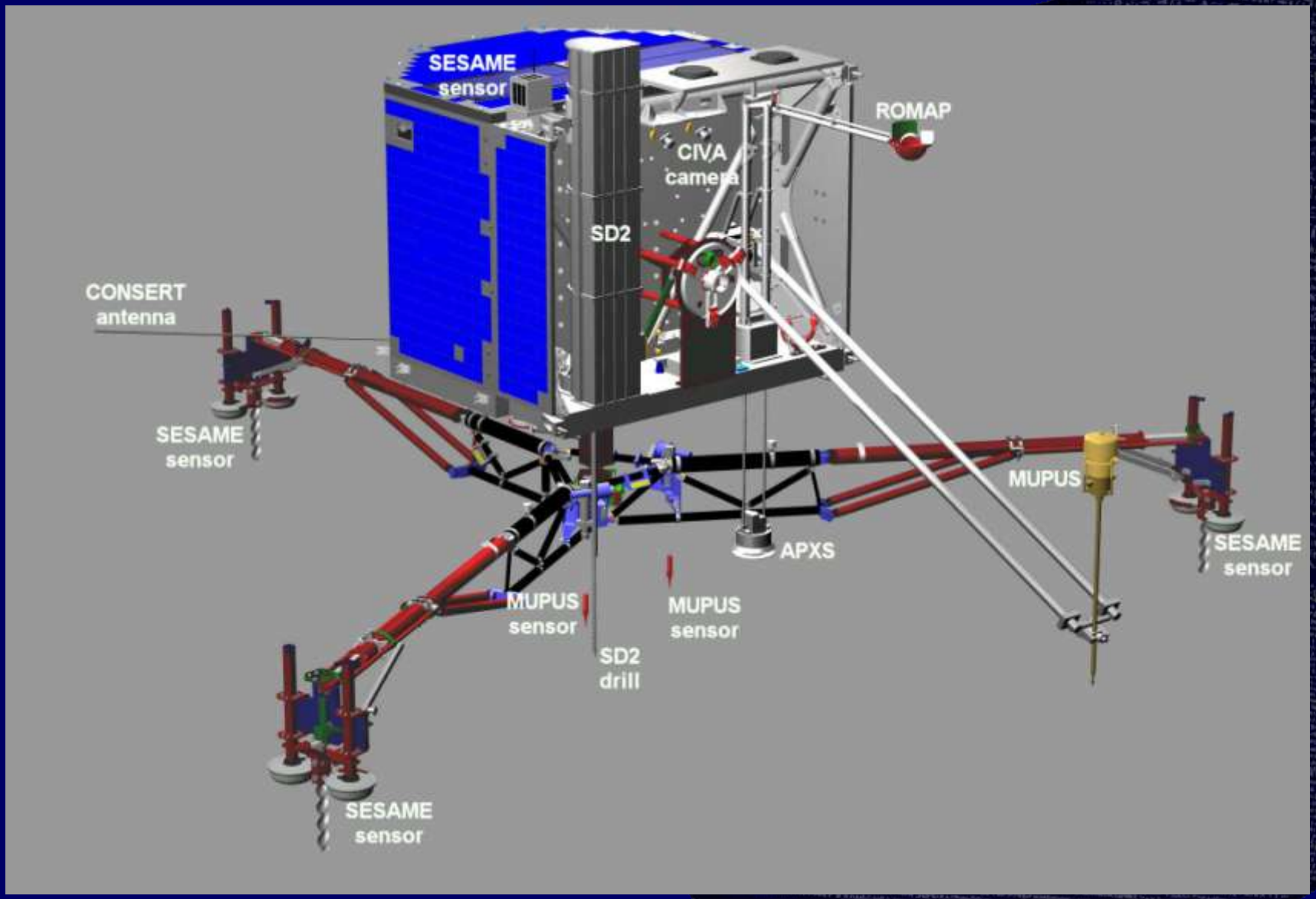
Drill sampling tube

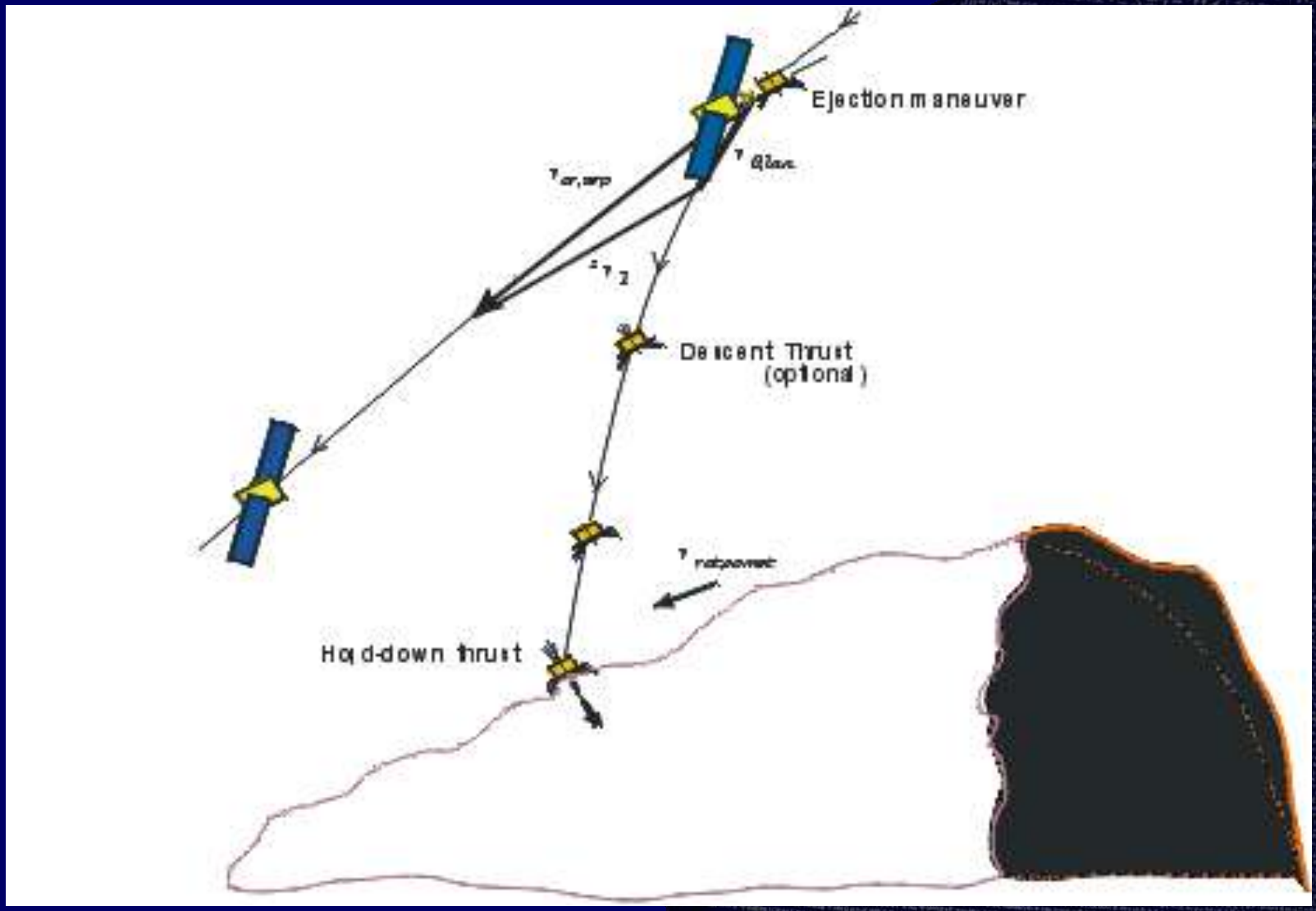
Carousel, ovens, tapping station

Medium temp. oven with sample


Drill (SD²)
SESAME sensor
CIVA camera
CIVA camera
CIVA camera
CIVA camera
ADS
COSAC
Batteries
Flywheel
TxRx
PTOLEMY
COSAC
CONSERT antenna
CONSERT antenna




SESAME
sensor
ROMAP
CIVA
camera
SD2
CONSERT
antenna
SESAME
sensor
MUPUS
APXS
SESAME
sensor
MUPUS
sensor
MUPUS
sensor
SD2
drill
SESAME
sensor


Ejection maneuver
Descent Thrust
(optional)
Hold-down thrust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THE COMET
SEEN FROM
EVERY ANGLE

The Journey

Rosetta Milestones

- Launch: **2 March 2004 with Ariane 5**
- Journey:

3 Earth gravity assists
Mar 2005, Nov 2007, Nov 2009

1 Mars gravity assist
Feb 2007

2 Asteroid flybys
2867 Steins: Sep 2008, 21 Lutetia: Jul 2010

Comet Rendezvous maneuver
May 2014 m(4 AU)

Lander delivery:
Nov 2014 (3 AU)

Perihelion Passage:
Aug 2015 (1.24 AU)

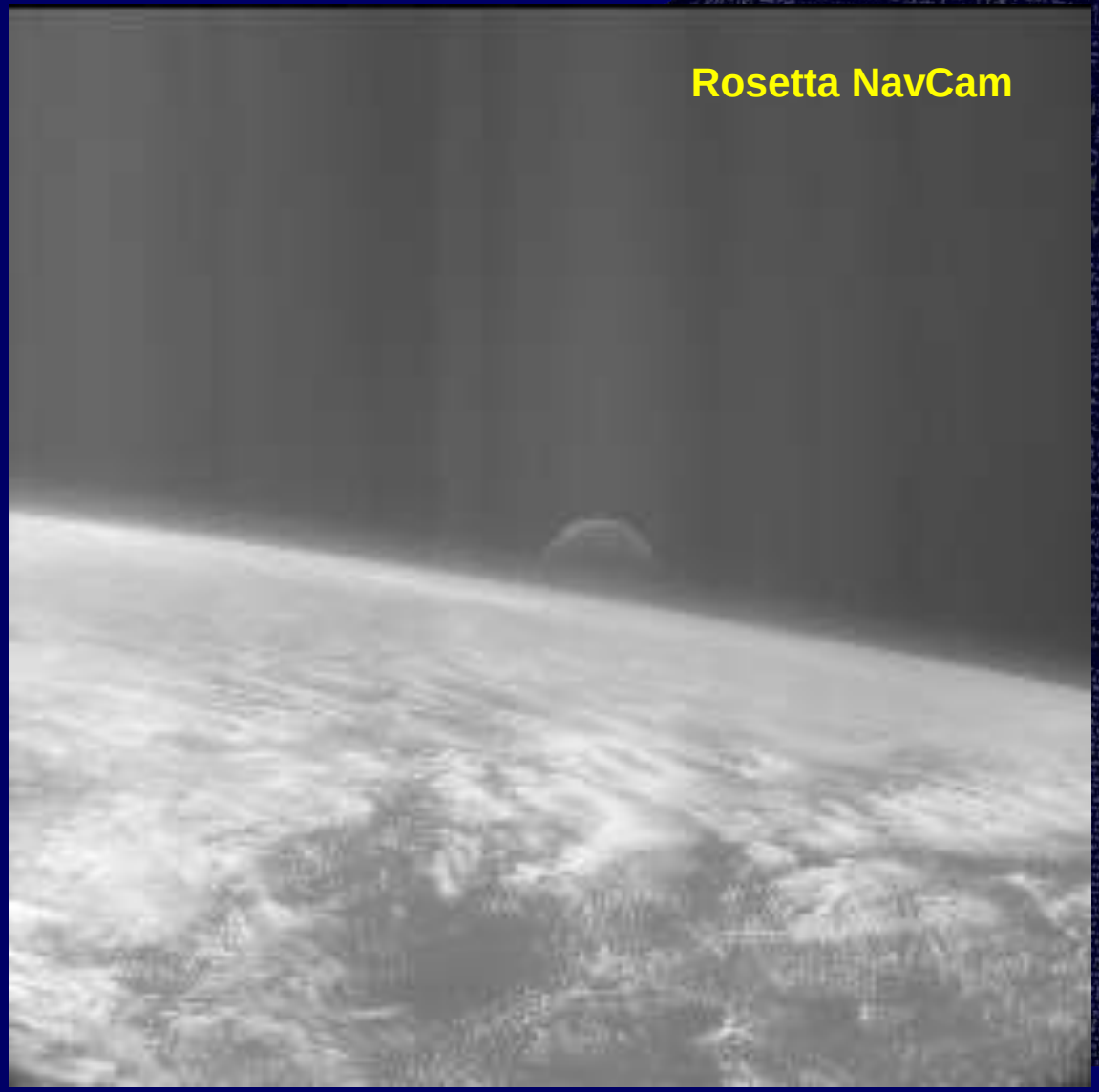
End of Nominal Mission:
Dec 2015 (1.9 AU **)

First Earth Swing-by

Closest Approach:

4 March 2005, at
1900 km altitude

In-flight Validation of
Asteroid Flyby Mode

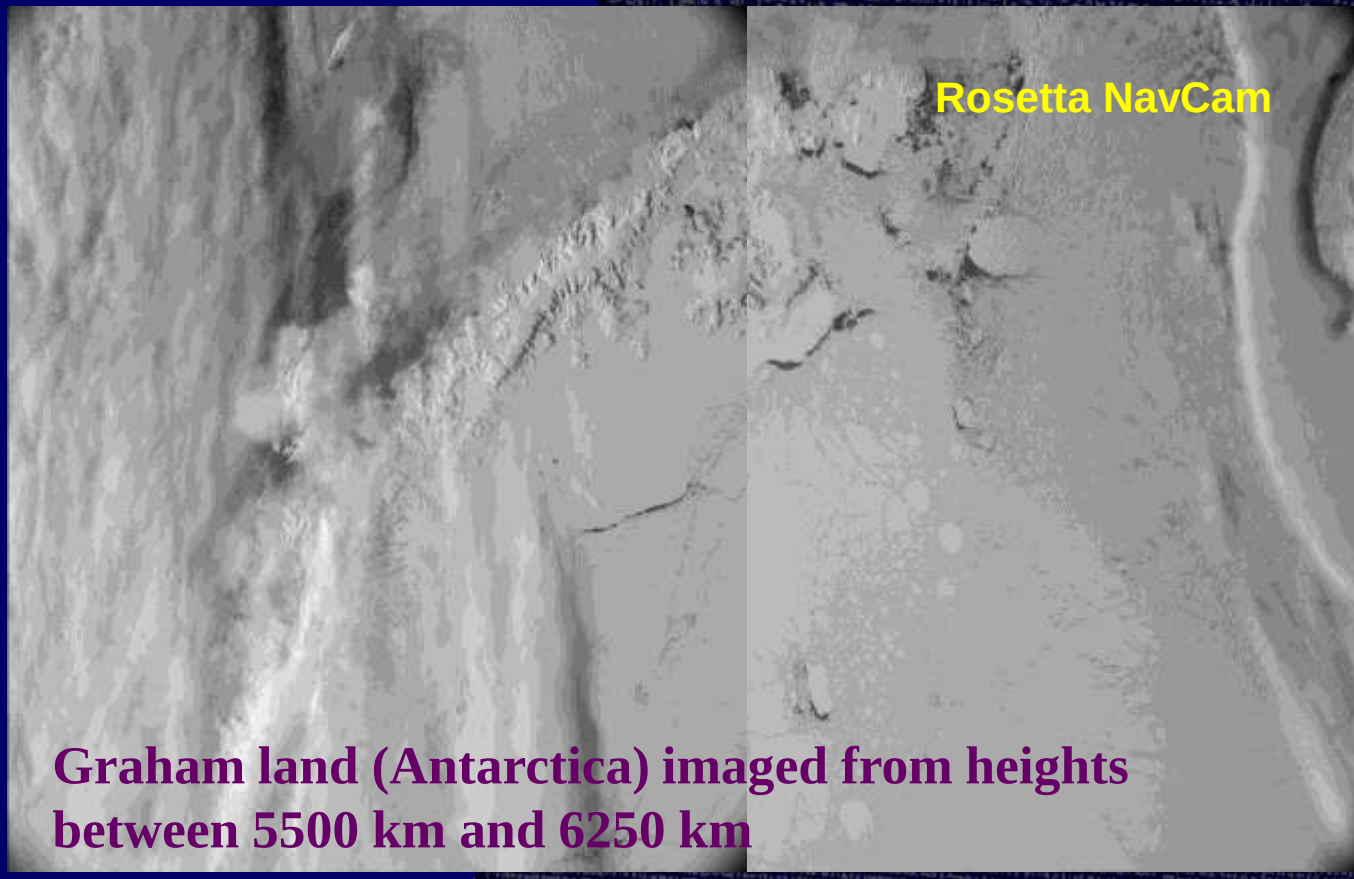


First Earth Swing-by

Closest Approach:

13 November 2007

at 5295 km altitude



Graham land (Antarctica) imaged from heights between 5500 km and 6250 km

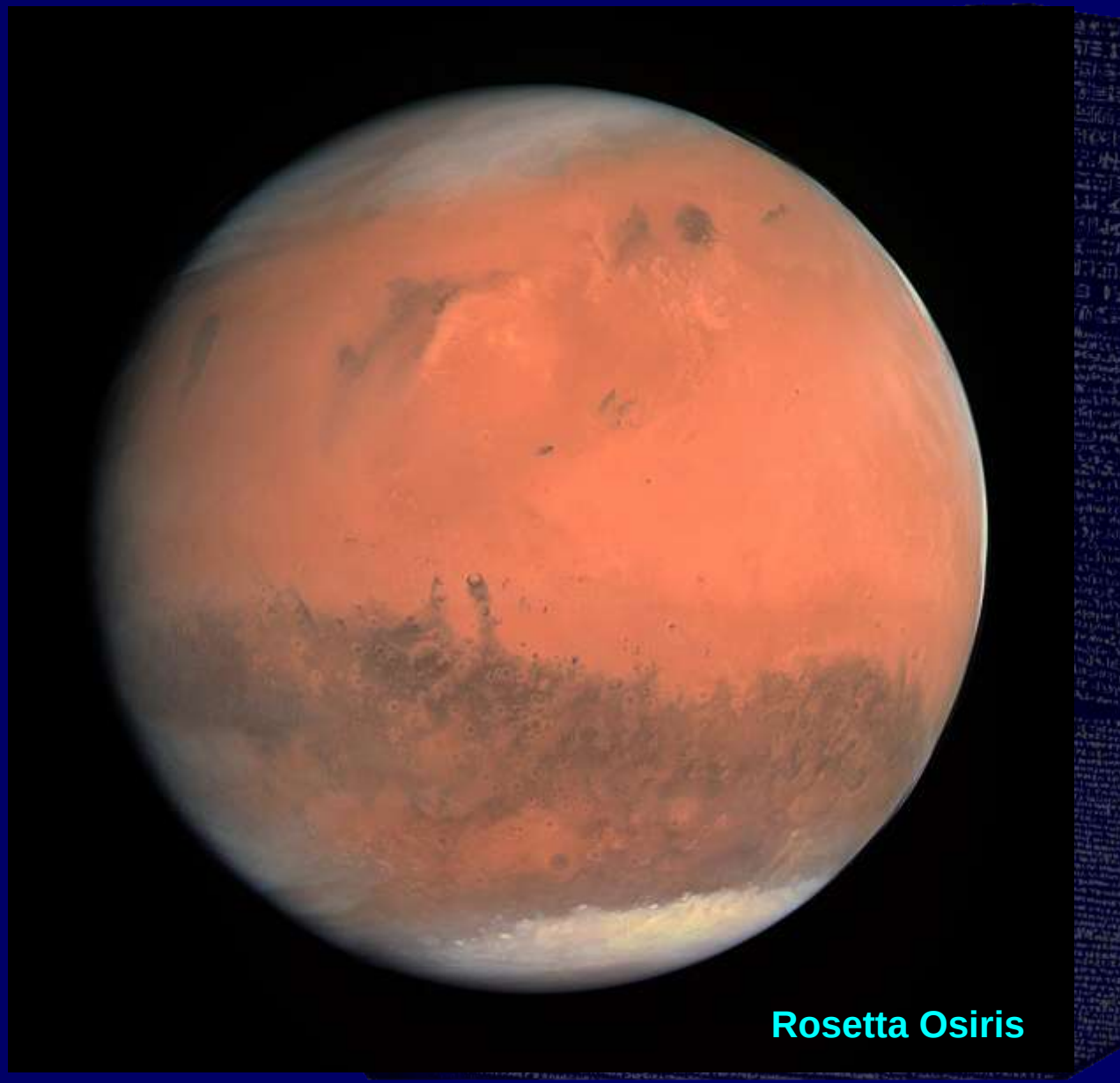
OSIRIS Pictures Europe and North Africa

Rosetta was also seen from the Earth

Mars Swing-by

Closest Approach:

25 February 2007,
at **250** km altitude



Mars Swing-by

Rosetta imaged with the Civa camera on the Philae Lander

Altitude: 1000 km

(2867) Steins Fly-by Overview

4 August 2008 to 3 October 2008

Closest approach:

5 Sept. 2008 18:38:19 UT

r_H = 2.14 AU, Δ = 2.41 AU

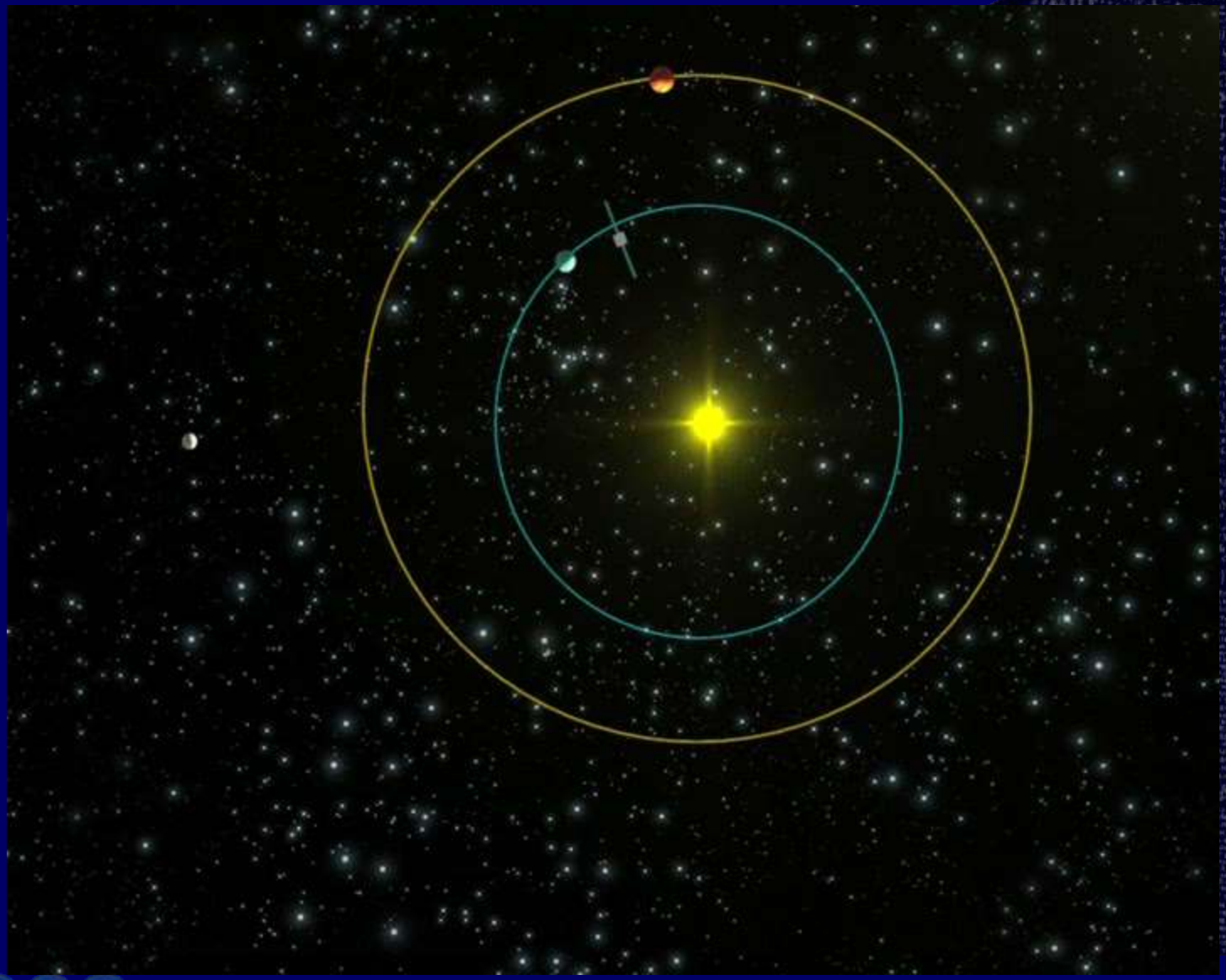
Relative velocity: 8.62 km/s

Minimum flyby distance: 802.6 km

(2867) Steins Fly-by Overview

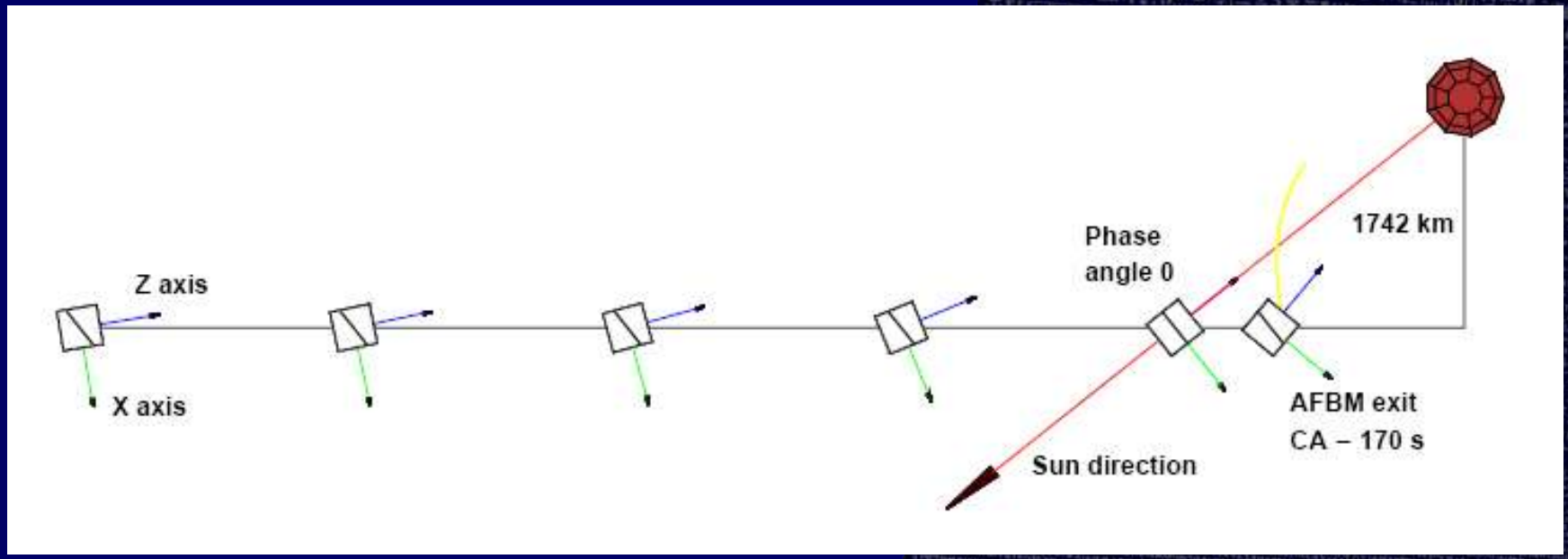
Fly-by on the Sun side of the asteroid
In the plane defined by relative velocity vector and Sun direction
⇒Fly-by through phase angle zero.

Phase angle coverage: 0-140°
Phase angle at approach: 38.5 deg
Phase angle zero at 1280 km

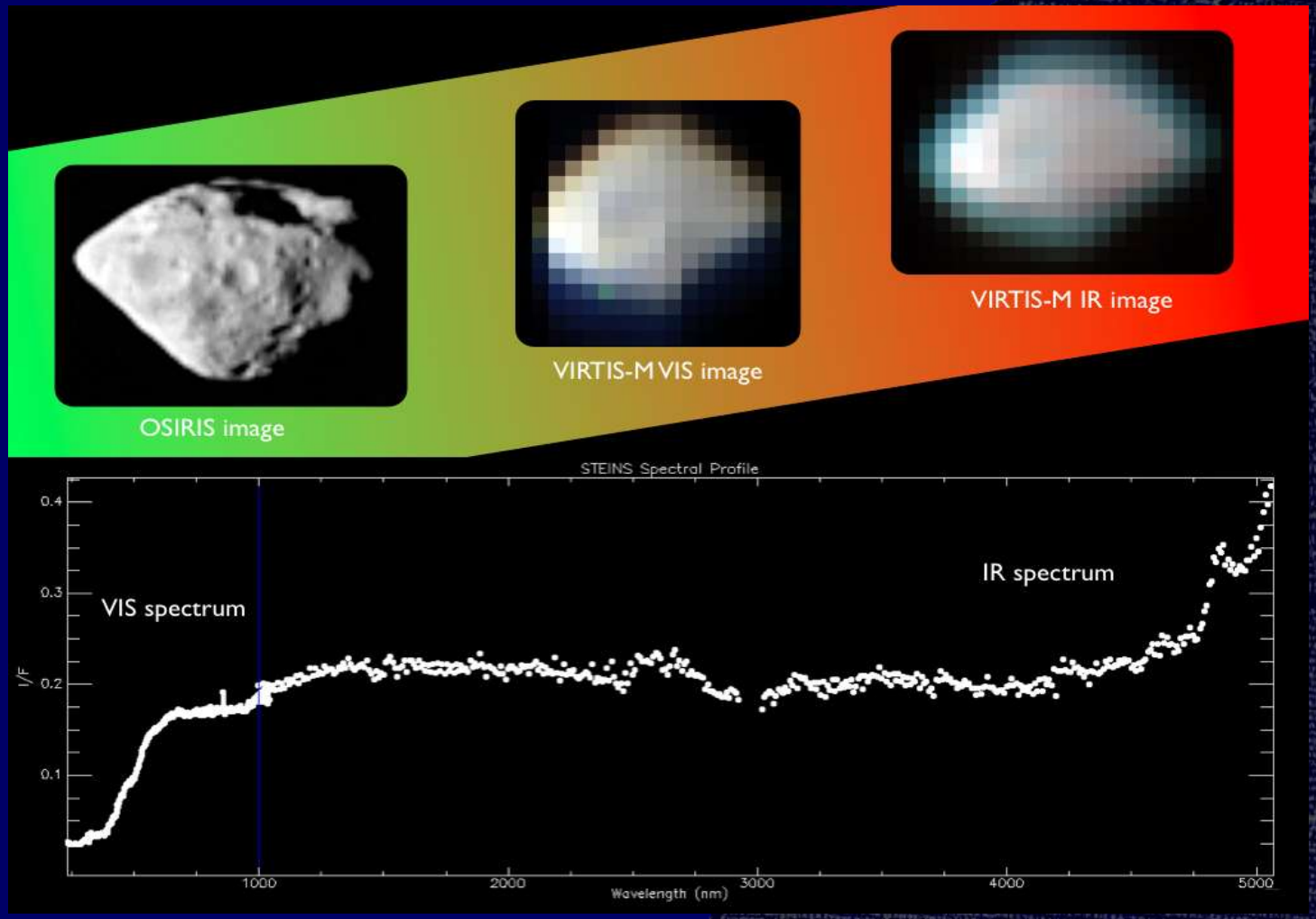


Tracking on (2867) Steins

(2867) Steins Fly-by Geometry



Steins Fly-by Results - VIRTIS



Galileo Avionica

DLR

INAF Istituto di Astrofisica Spaziale e Fisica Cosmica

l'Observatoire de Paris

agenzia spaziale italiana

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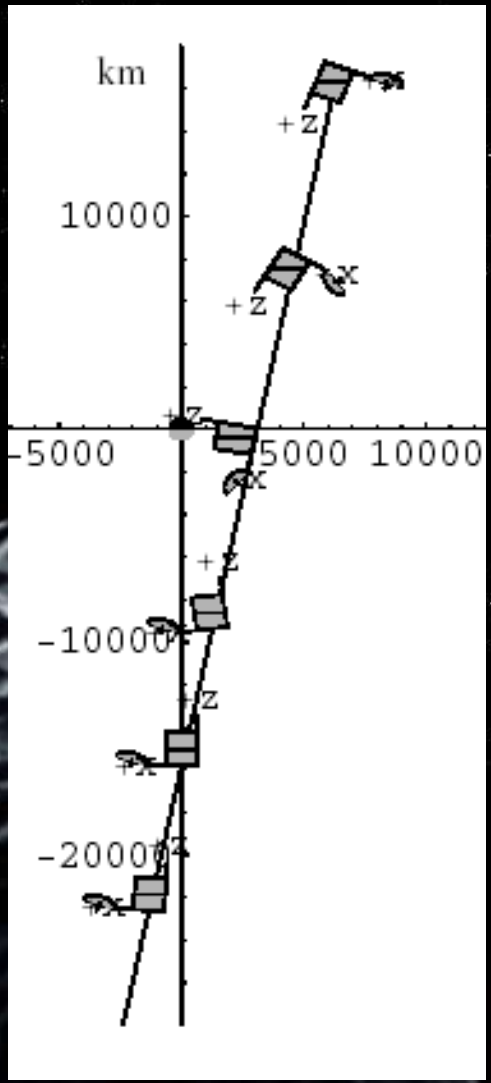
(21) Lutetia Fly-by Overview



8 August 2008 to 3 October 2008

Closest approach:

10 July 2010 15:51 UTC

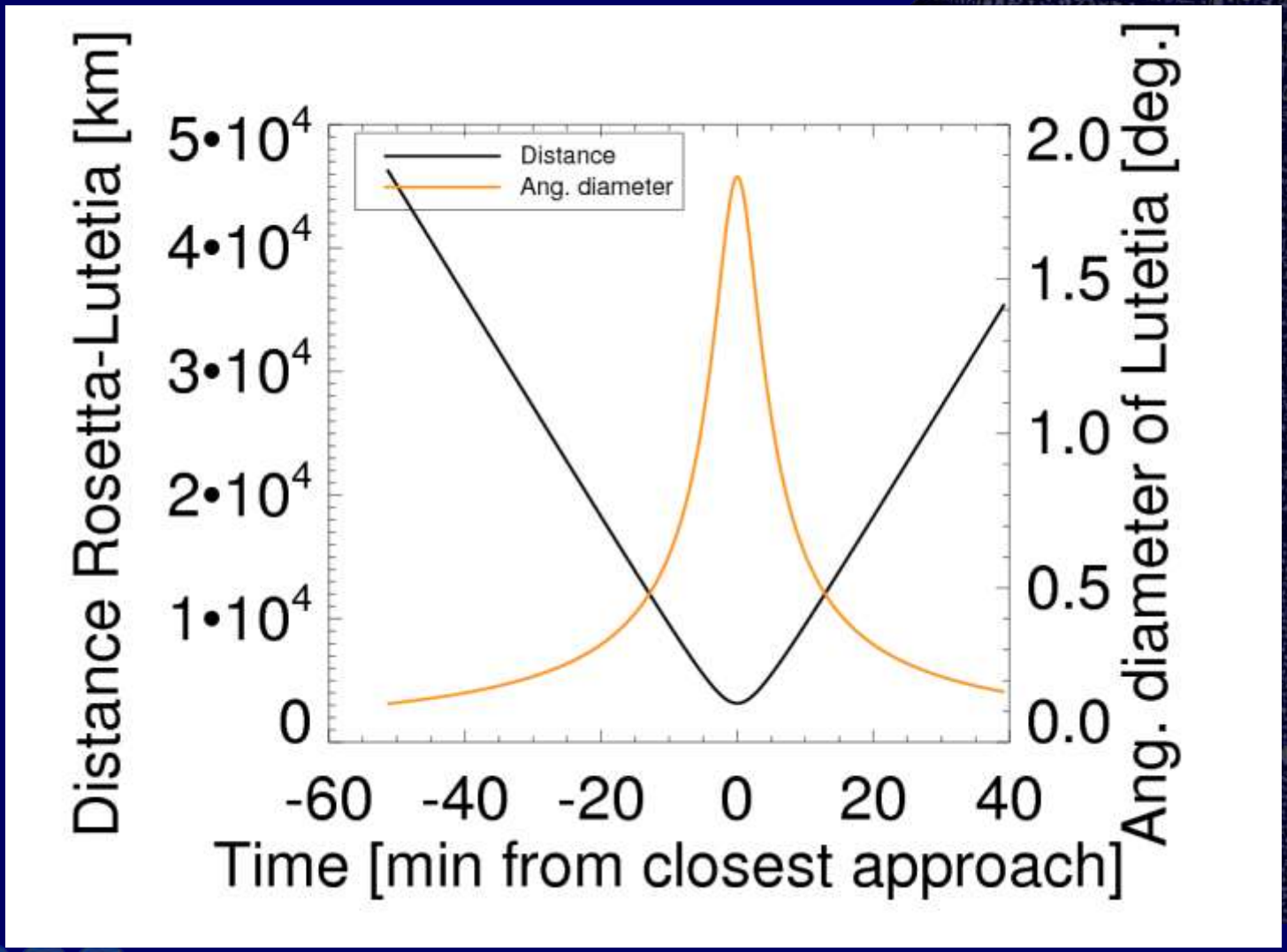
r_H = 2.72 AU, Δ = 3.05 AU

Relative velocity: 15 km/s

Targeted minimum flyby distance: 3160 km

Zero phase angle at 16400 km (18 min before CA)

Distance and angular size of Lutetia



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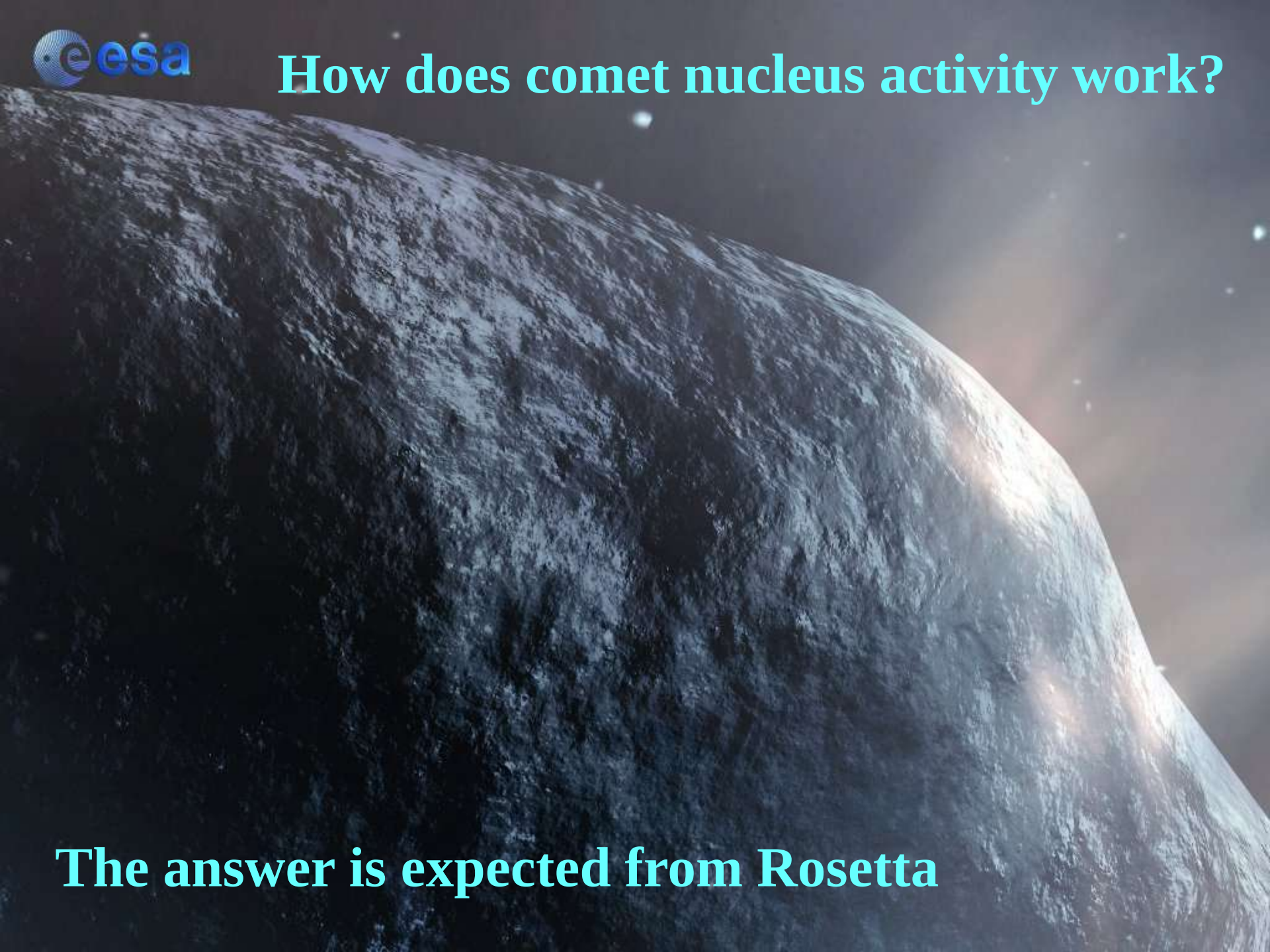
Material is lifted off active areas

This material is being analysed in-situ in the coma

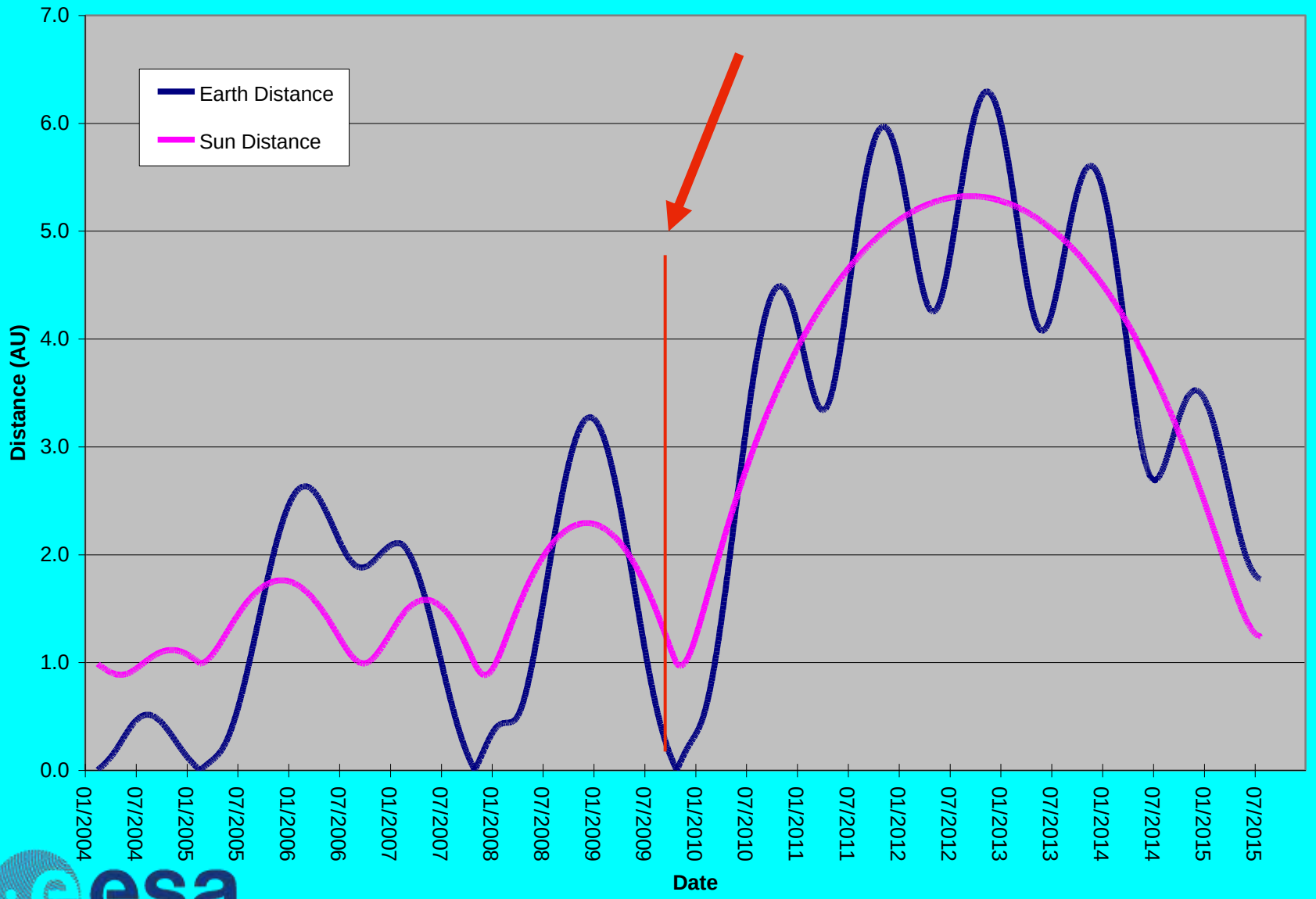
Heavy material falls back on active area

→ never reaches the coma

Rosetta Lander will provide clues !


How does comet nucleus activity work?
The answer is expected from Rosetta

Where is Rosetta Today?



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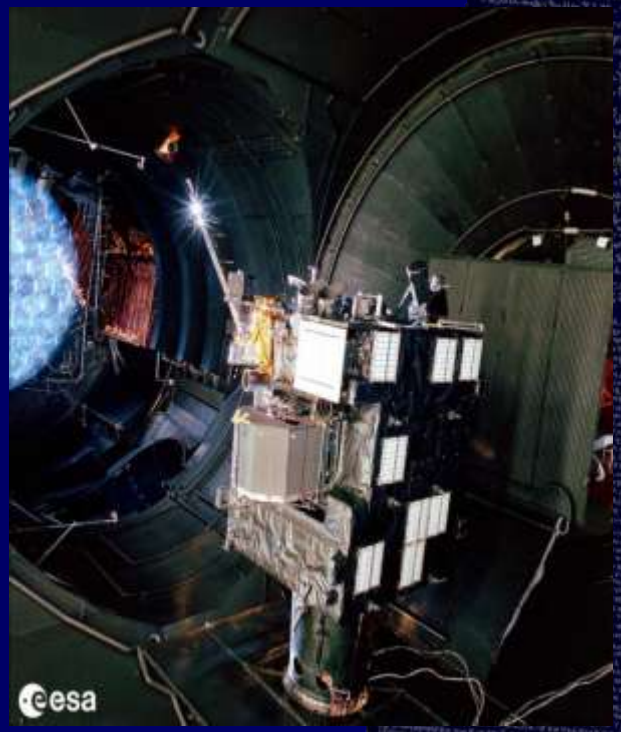
Rosetta Launch Preparations

Preparation of vibrations testing

In vacuum chamber



Arrival in Kourou

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Long Distance Communication

ESA's Deep Space Antenna:
- Built in New Norcia, Australia
- 35 metre diameter antenna
- Radio frequencies S band, X band

Operations:
- From ESOC in Darmstadt
- 50 minute communication travelling time from spacecraft to Earth
- Data links from 10 to 22,000 bits per second
- On-board solid state memory of 22 Gbits


The End