Schiaparelli and his Legacy
Meeting on Future planetary, scientific and robotic space missions
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Plato, Euclid and the New Hard X-Ray mission

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Medium sized missions of Cosmic Vision slice 1

- Shortlist of 3 projects (Plato, Euclid, Solar Orbiter) selected by the ESA advisory bodies as candidates for 2 launch slots in 2017-2018
- Plato and Euclid undergoing parallel and independent Definition Studies by 2 European contractors
- ThalesAlenia Space (I) leads one such study for each mission, after carrying out Assessment Studies (2008-9)
- Programme decision in June 2011; selected mission(s) will undergo Phase B1; then competition for Prime Contract
- Implementation Phase by the selected contractor to start mid-2012

New Hard X-ray Mission

- Evolution of mission concepts studied over the last 5 years under ASI sponsorship
- Will be presented as candidate for CV slice 2
- Proposals submitted by December this year; down-selection by Assessment and Definition studies; final selection by 2015; launch 2020-2022

PLAnetary Transits and Oscillations of Stars

Objective: Detect and characterise planetary systems, particularly earth-like planets in the habitable zone and their host stars

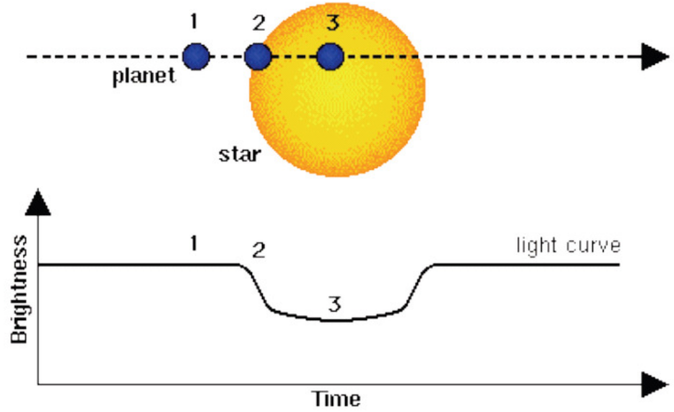
- Exoplanet detection: PLATO shall detect and characterise exoplanets through the transit signature in front of the parent star.
- Asteroseismology: PLATO shall measure seismic oscillations of the central stars of exoplanetary systems and other specific stars.

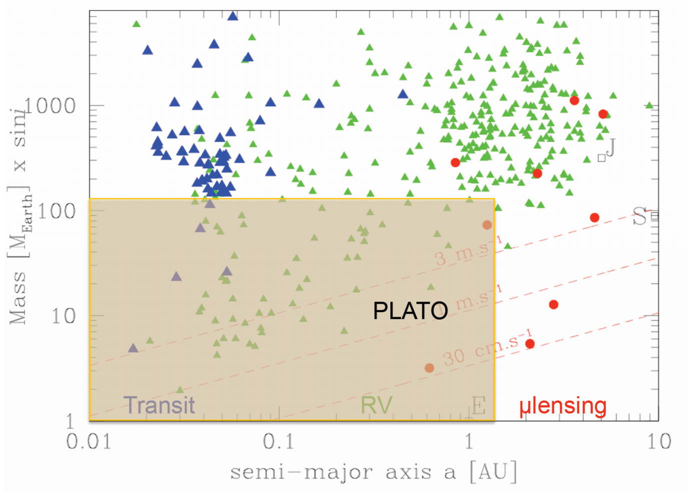
Techniques: Photometry (transits + asteroseismology) + ground based spectroscopy

- Photometric precision better than 2.7×10^{-5} in 1 hour for more than 20,000 cool dwarfs and subgiants with m_V <11.

Instrument: telescope array, wide field of view

Observing strategy: 2 long runs (2 to 3 years) + several short runs





1 - Identification of planetary systems by detection and characterization of planet transits

- From Radius and Mass → Bulk Density
- Radius from Transits, Mass from Radial Velocity (ground based)
- Small variations, photon limited → bright stars (v<11 mag)

$$\frac{\Delta F}{F_*} \propto \left(\frac{R_{Pl}}{R_*}\right)^2$$

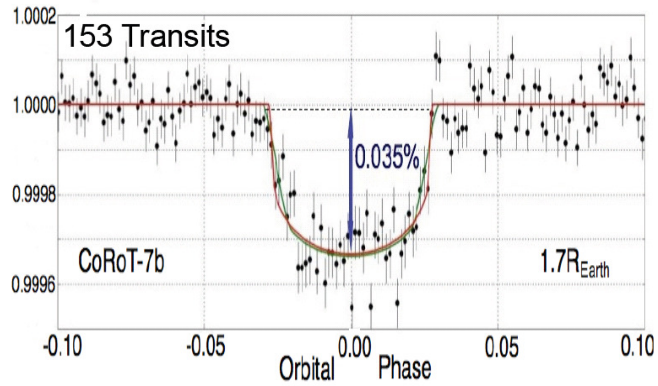
2 - Characterization of host stars by stellar oscillations

- Ultra-high precision, high duty cycle, long duration photometric monitoring of large samples of bright stars

Many stars to improve statistics

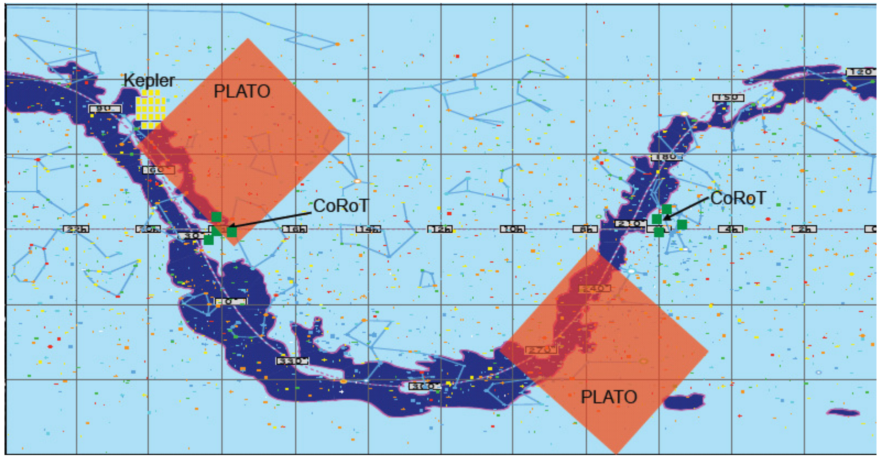
- Maximize Field of View
- Maximize collecting area
- Extend mission lifetime to observe several sky fields

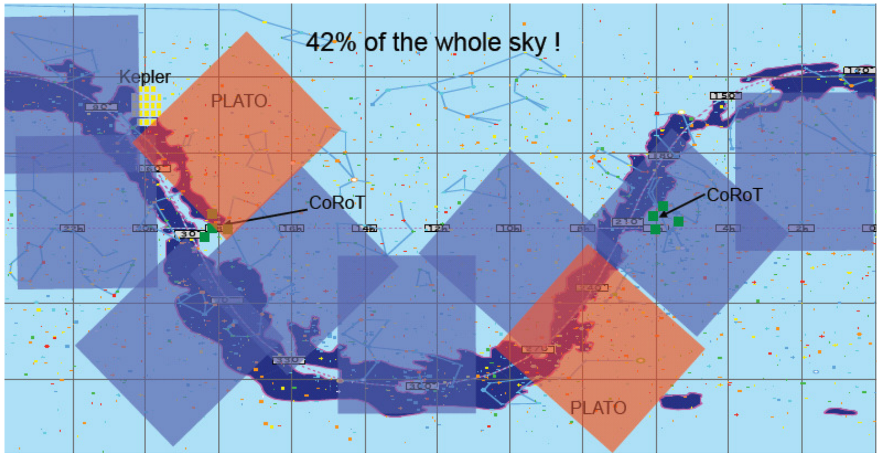
Multi-aperture approach for large field of view and wide collecting area



CoRoT-7b, the first confirmed rocky extrasolar planet

Plato implementation requirements

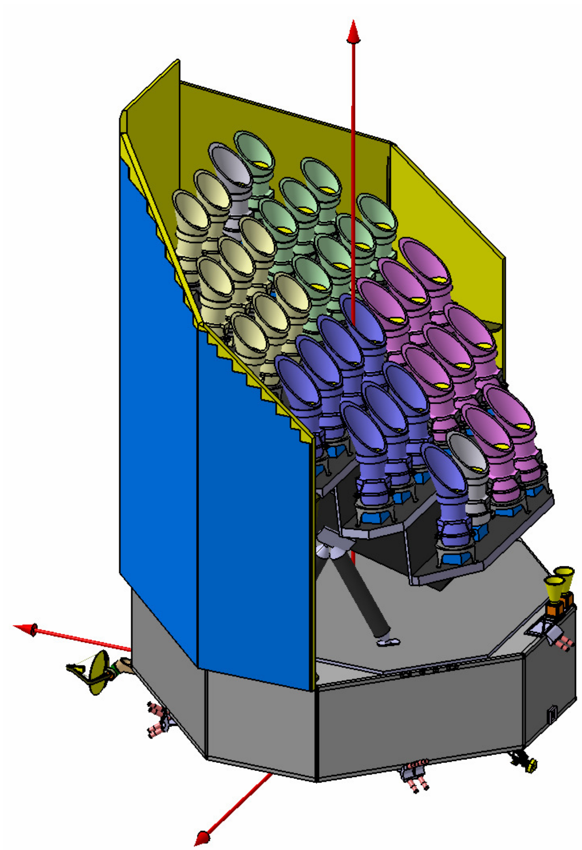


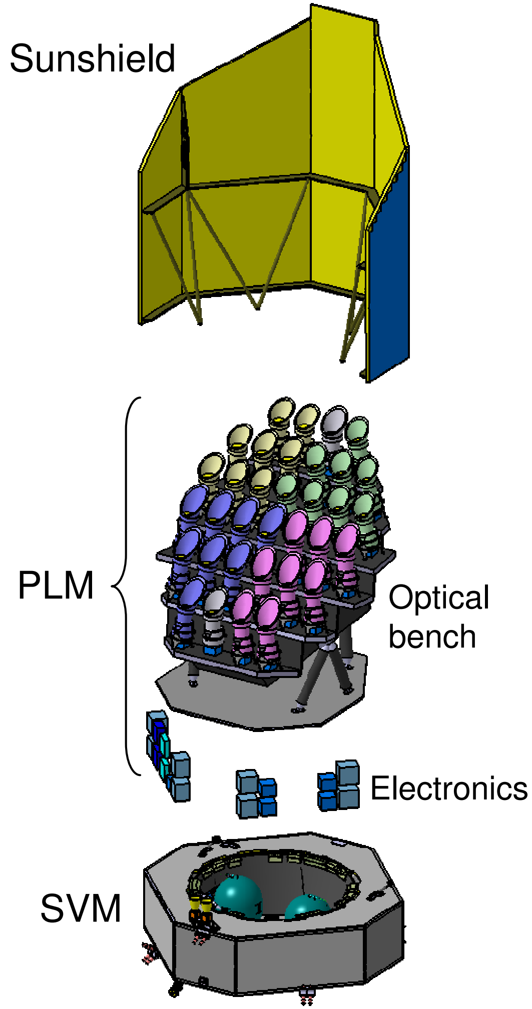


- **6-year mission, 2 long-duration phases + 1 step-and-stare phase**
- **Large amplitude orbit around L2 (thermal stability)**
- **3-axis stabilized spacecraft**
- **Periodic rotations around the mean Line of Sight of the cameras for continuous observation (power, straylight)**
- **Cold optics and CCD detectors (-85°C to -75°C) by passive cooling**
- **Classic Service Module and Payload Module approach**
- **X-band, 8.7Mbps, 109 Gb/day by 4h/day ground station contact**

PLATO system design

- 32 + 2 cameras on a staged optical bench
- 90° turn every 3 months
- Fixed semi-encompassing sunshield
- Payload electronics in the Service Module
- Gyro-based attitude determination and reaction wheel-based attitude control
- Steerable HGA
- Sunshield-mounted solar array





The Euclid mission

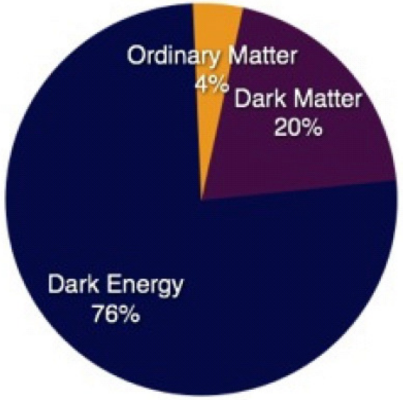
Outstanding questions in cosmology
- nature of Dark Energy and Dark Matter
- initial conditions (Inflation Physics)
- modifications to Gravity

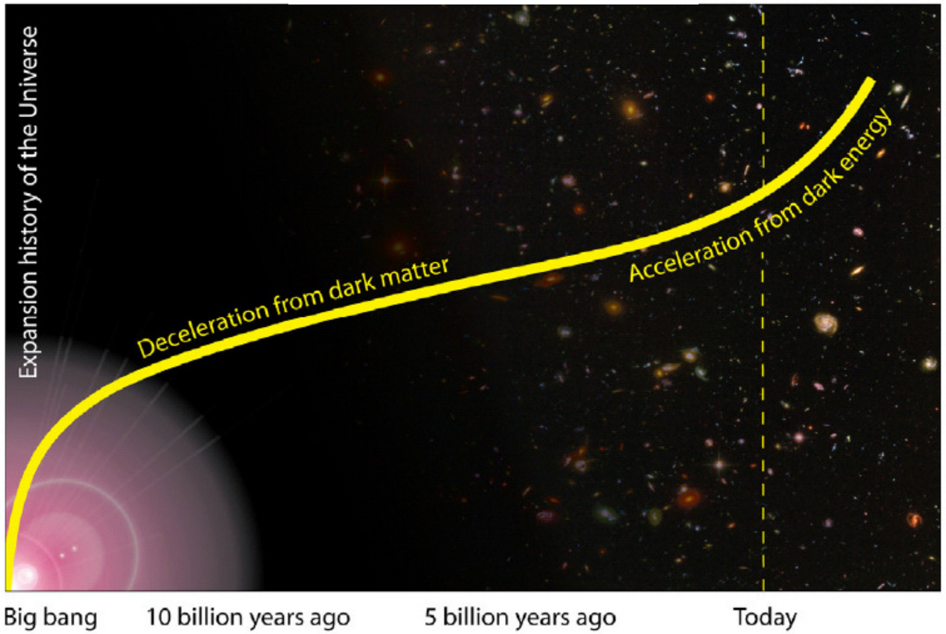
High-precision survey mission to map the geometry of the Dark Universe

Optimized for two complementary cosmological probes
- Weak Gravitational Lensing
- Baryonic Acoustic Oscillations
- Additional probes: clusters, redshift space distortions, Integrated Sachs Wolfe Effect

Full extragalactic sky survey with 1.2m telescope at L2
- High precision imaging at visible wavelengths / Photometry & imaging in the near-infrared
- Near Infrared Spectroscopy

Legacy science for many areas in astronomy

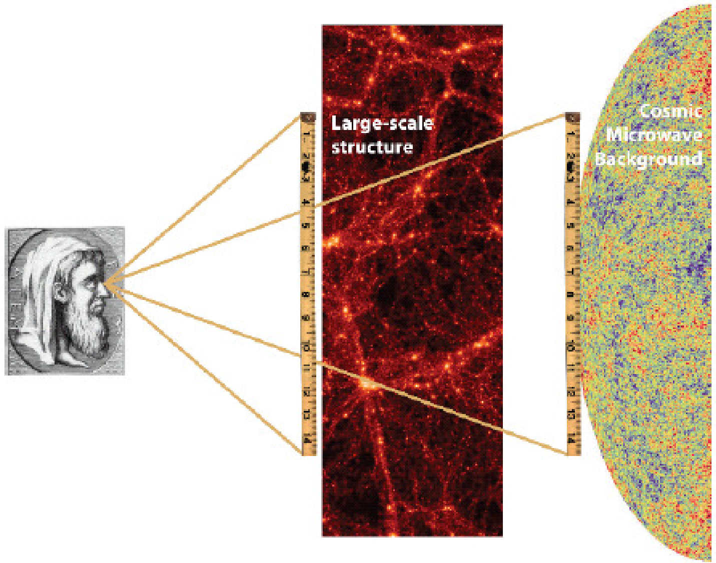




Euclid techniques

Weak gravitational lensing (WL)

- Bending of light by the matter along the line of sight will cause an intrinsically circular galaxy to appear as an ellipse
- Small systematic distortions (“shear”) can be measured by correlating the shapes of large numbers of individual galaxies
- By doing this for galaxies at different distances, one can characterize the intervening mass distribution at different distances, and hence at different cosmic epochs

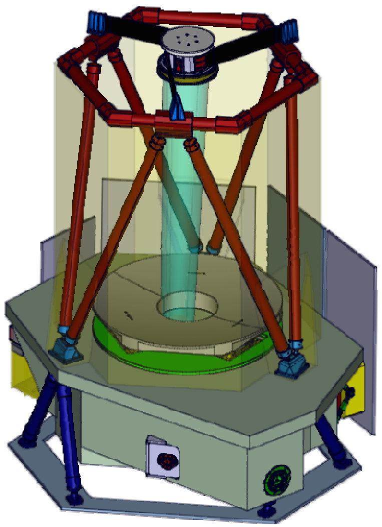


Baryonic acoustic oscillations (BAO)

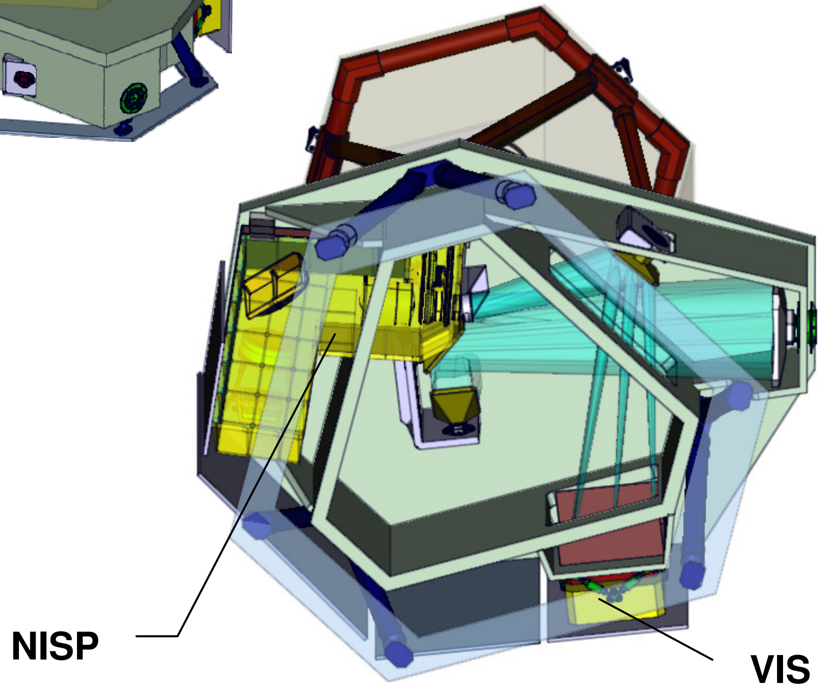
- The early universe possesses a universal standard rod, the scale of which is accurately known from the cosmic microwave background
- The same feature can be observed in the distribution of ordinary matter (galaxies), although at different phase and smaller amplitude
- By measuring the apparent scale as a function of redshift, we can directly estimate the expansion history and thus the equation of state of dark energy

Euclid implementation requirements

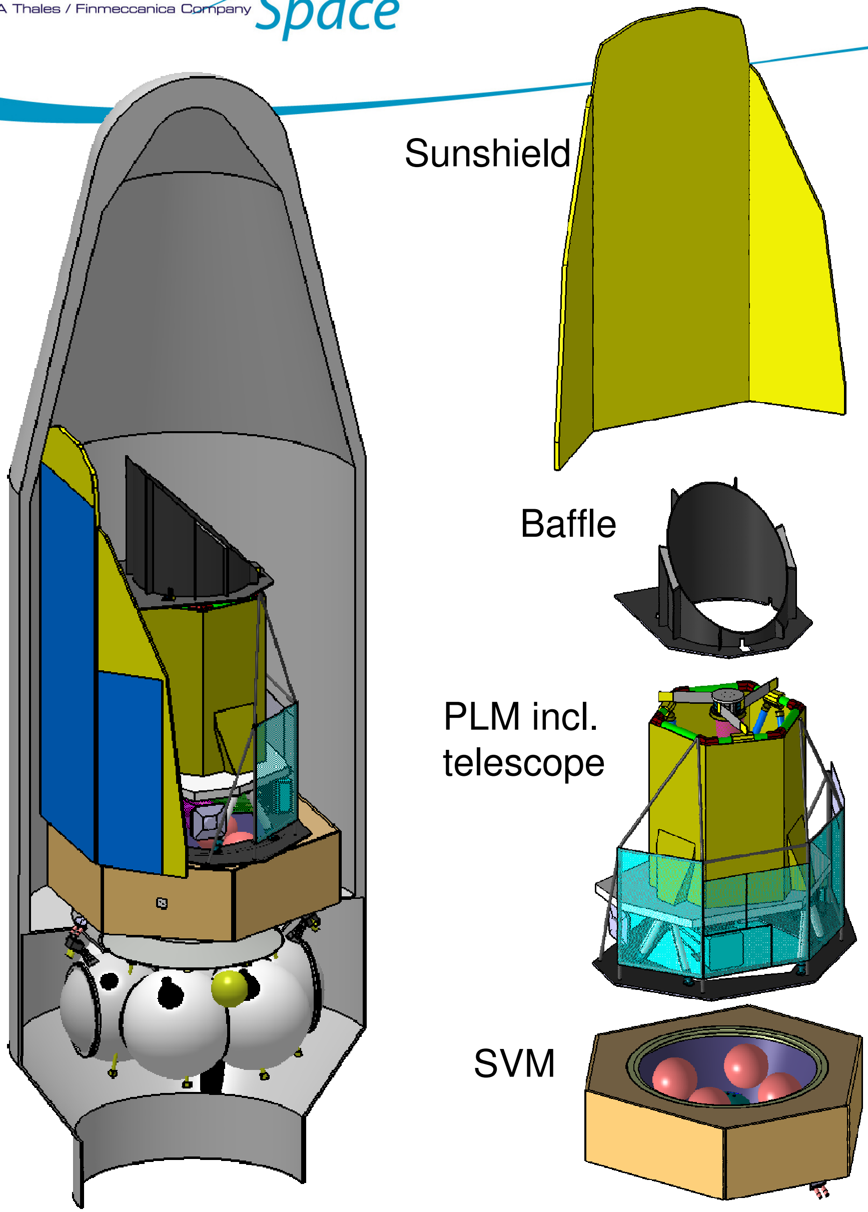
- Wide Extragalactic Survey 20 000 deg^2
- Deep Survey of 40 deg^2, 2 patches per hemisphere
- Properly Sample Galaxies
  - PSF < 0.2 arcsec
  - Ellipticity < 10%
  - Stable <0.02% rms
- Red shifts $\sigma z/(1+z) \leq 0.001$
- High resolution imaging across a wide band, simultaneous with spectroscopic channel
  - 3 mirror Korsch telescope with off axis field
  - 1.2m primary mirror, 24.5m effective focal length, dichroic separates imaging channel (VIS) and spectro-photometric channel (NISP)
- 0.5 deg^2 field of view, dithered
- VIS imaging instrument, 36 CCDs array
- NISP spectro-photometer, 16 NIR array
- 150K detector temperature



The central design driver for Euclid is the ability to measure WL and BAO simultaneously while providing tight control of systematic effects



Euclid system design



- L2 orbit
- 5+ year science mission
- Step and Stare observation strategy, 3000s per field
- Pointing Stability < 25mas @ 700seconds, Pointing < 10 as
- K-band telemetry, 850 Gbit/day
- PLM always in shadow of sunshield
- Payload electronics in the Service Module
- Fine-Guidance Sensor and magnetic-bearing reaction wheels
- Steerable X/X/K band HGA
- Sunshield-mounted solar array

The New Hard X-Ray mission

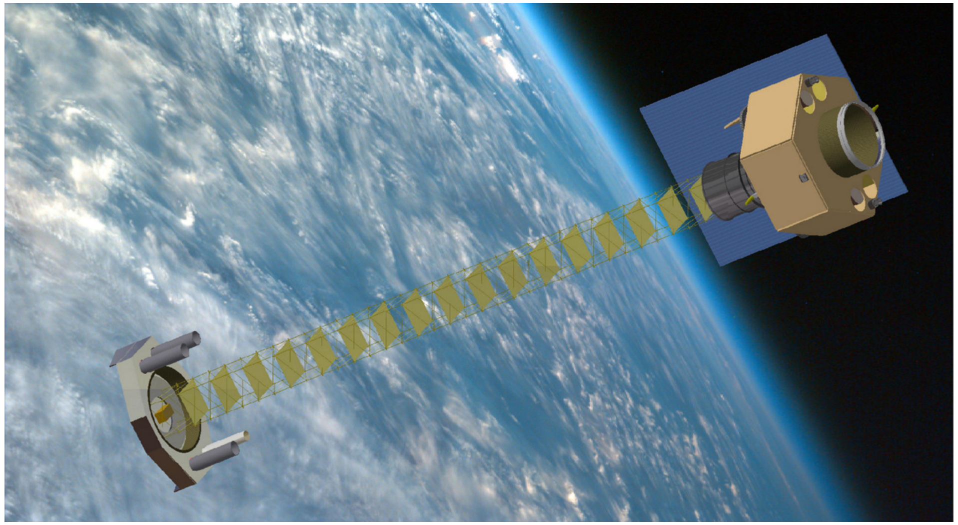
The New Hard X-ray Mission (NHXM) is an ASI initiative, started in the mid-2000's, for the development of a national high energy (0.5 to 80 keV) X-ray satellite with imaging and spectroscopy capabilities

- Two missions were initially considered, Simbol-X (a cooperation with CNES) and Hexit-Sat (High Energy X-Ray Imaging Telescope SATellite)
- After cancellation of Simbol-X, interest focused on an Hexit-Sat concept augmented with an X-ray polarimetric channel.

NHXM is first priority for ASI and the national high-energy astrophysics community

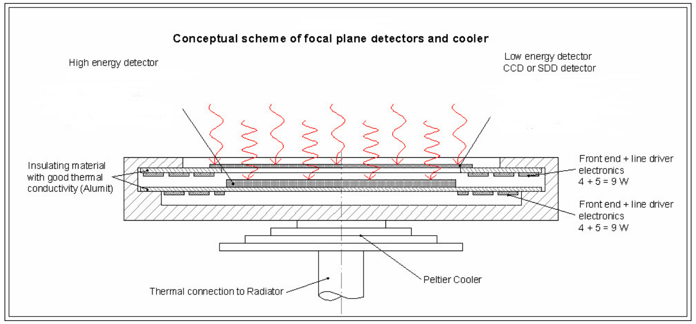
- It will consolidate the Italian leadership in X-ray satellites and technologies by opening up a whole new perspective
- The key technology for high energy X-ray imaging is the multi-layer optics developed by Osservatorio di Brera

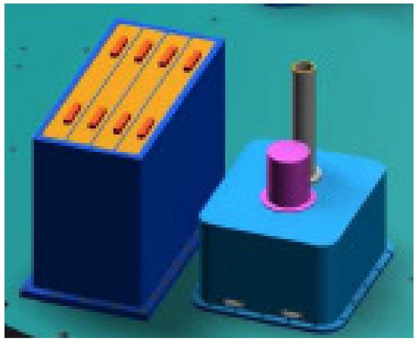
NHXM will be presented as candidate for the next slice of ESA Cosmic Vision missions



NHXM mission and payload

- **Medium-sized satellite on a circular equatorial orbit around 600 km altitude (BeppoSAX-like)**
- **Launched by low-cost vehicle such as Vega**
- **Payload complement includes:**
  - Four Mirror Modules
  - Three focal plane cameras for imaging and spectroscopy, each co-aligned with its Mirror
  - One X-Ray Polarimeter Camera co-aligned with the fourth Mirror
- **The focal distance (mirror – detector) in the 8 to 10 m range**





NHXM (HexitSat) system design