ASI programs in astronomy, astrophysics and fundamental physics

Elisabetta Cavazzuti
Italian Space Agency
Exploration and Observation of the Universe Department

17th Vulcano Workshop - May 26th, 2018

Exploration and Observation of the Universe Dept (EOS)

funds and leads scientific space programs, since Phase 0 studies, i.e. from paperwork only to final delivery of the payloads and (for AGILE) disposal of the mission (THE END)

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- synergic (not only) with the EOS group is the Research Dept.

Exploration and Observation of the Universe Dept (EOS)

ASI is part of the European Space Agency and cooperate in bilateral or multilateral programs with the other space agencies (NASA, JAXA, Roscosmos, CNSA etc)

ASI Ground segment

ASI own an equatorial ground base in Malindi (Kenya), involved in many space programs.
Currently it is supporting AGILE, Swift and NuSTAR and it is foreseen in future EOS missions.

Exploration and Observation of the Universe Dept (EOS)

- synergic with the EOS group is the Science Community (INAF, INFN, CNR, Universities...)

YOU

ASI science programs

Cosmology

Stellar astronomy

High Energy Astrophysics

Cosmic rays

Fundamental physics

Solar system and exoplanets

....

ASI science programs

Cosmology

Stellar astronomy

High Energy Astrophysics

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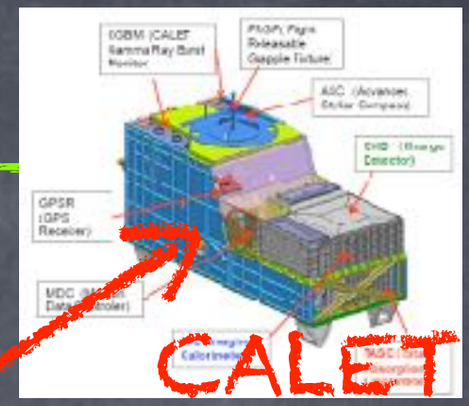
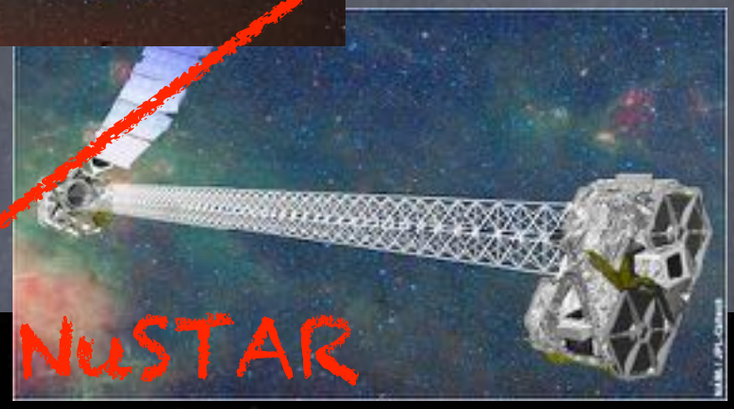
Fundamental physics

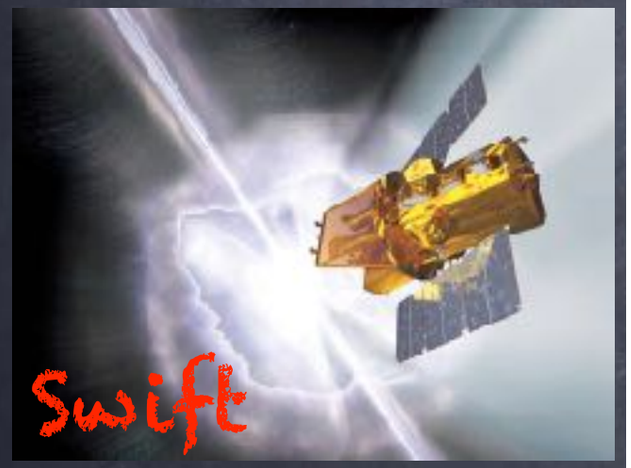
~~Solar system bodies, Exoplanets~~

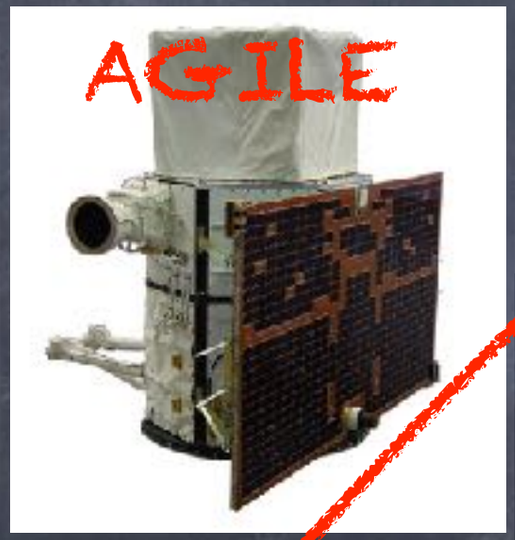
....

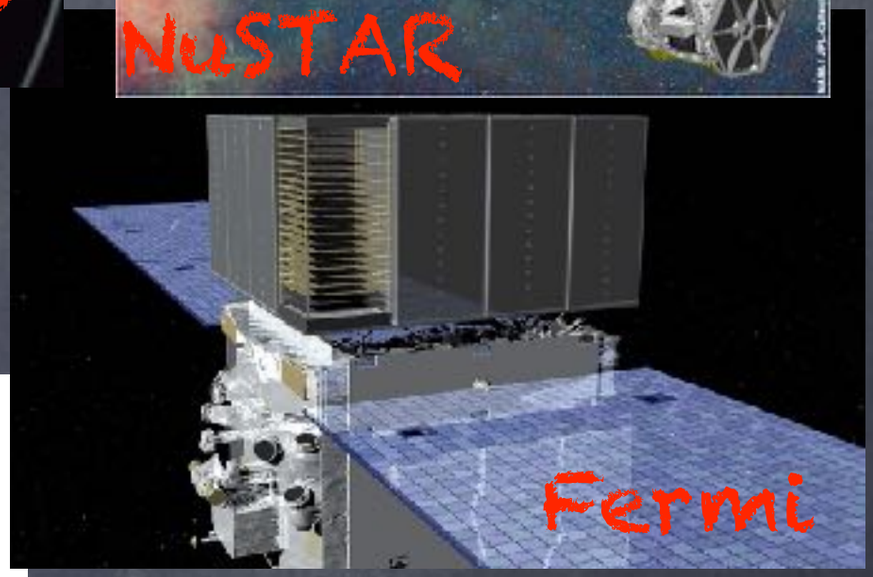
In orbit missions

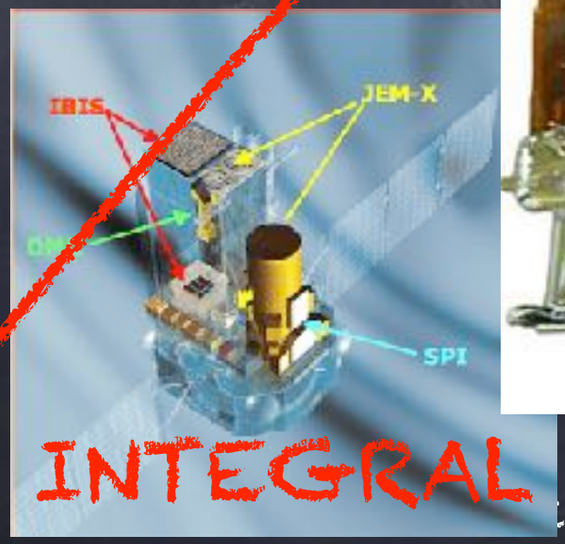












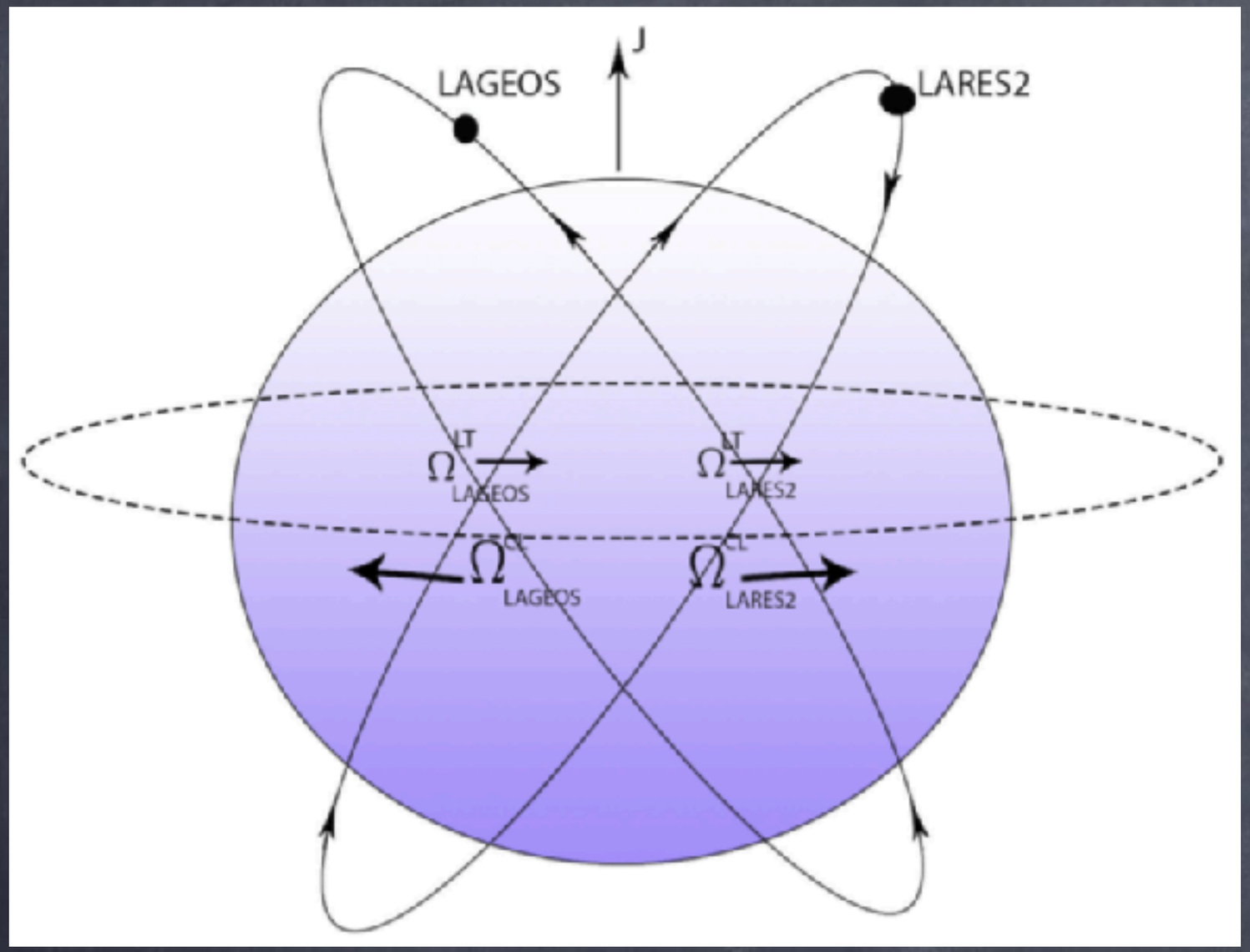
time

credits: ASI, ESA, NASA, JAXA, INFN

Next missions

LARES-2 (ASI, launch 2019)
Euclid (ESA, launch 2021)
IXPE (NASA, launch 2021)
Athena (ESA, launch 2030)
LISA (ESA, launch 2034)

LARES-2



S. Dell'Agnello talk

frame-dragging or Lense-Thirring (LT) effect and the Newtonian classical (CL) precession of the nodes of two satellites with supplementary inclinations such as LARES 2 and LAGEOS.

gravitational and fundamental physics, including accurate measurements of General Relativity.

LARES 2 will also achieve determinations in space geodesy.

EUCLID

A space mission to map the Dark Universe

- Telescope (T=125K, passive):
  - 1.2m aperture primary, 3 mirror Korsch anastigmat
- 2 Instruments (VIS, NISP) – T = 100-140 K (passive)
  - Wide field instrument, VIS: 36 e2v 4kx4k CCDs $0.55<\lambda<0.92$ µm, 576 M pixels, 0.11 arcsec/pix, 0.53 deg^2 FoV
  - Photom. (Y, J, H) +spectrom.: 16 H2GR HgCdTe detectors;
  - 64 Mpixels, 0.30 arcsec/pix, 0.53 deg^2 FoV (=VIS)
  - Grism slitless spectro (1B + 3R grisms) $0.92<\lambda<2.05$ µm, R>250

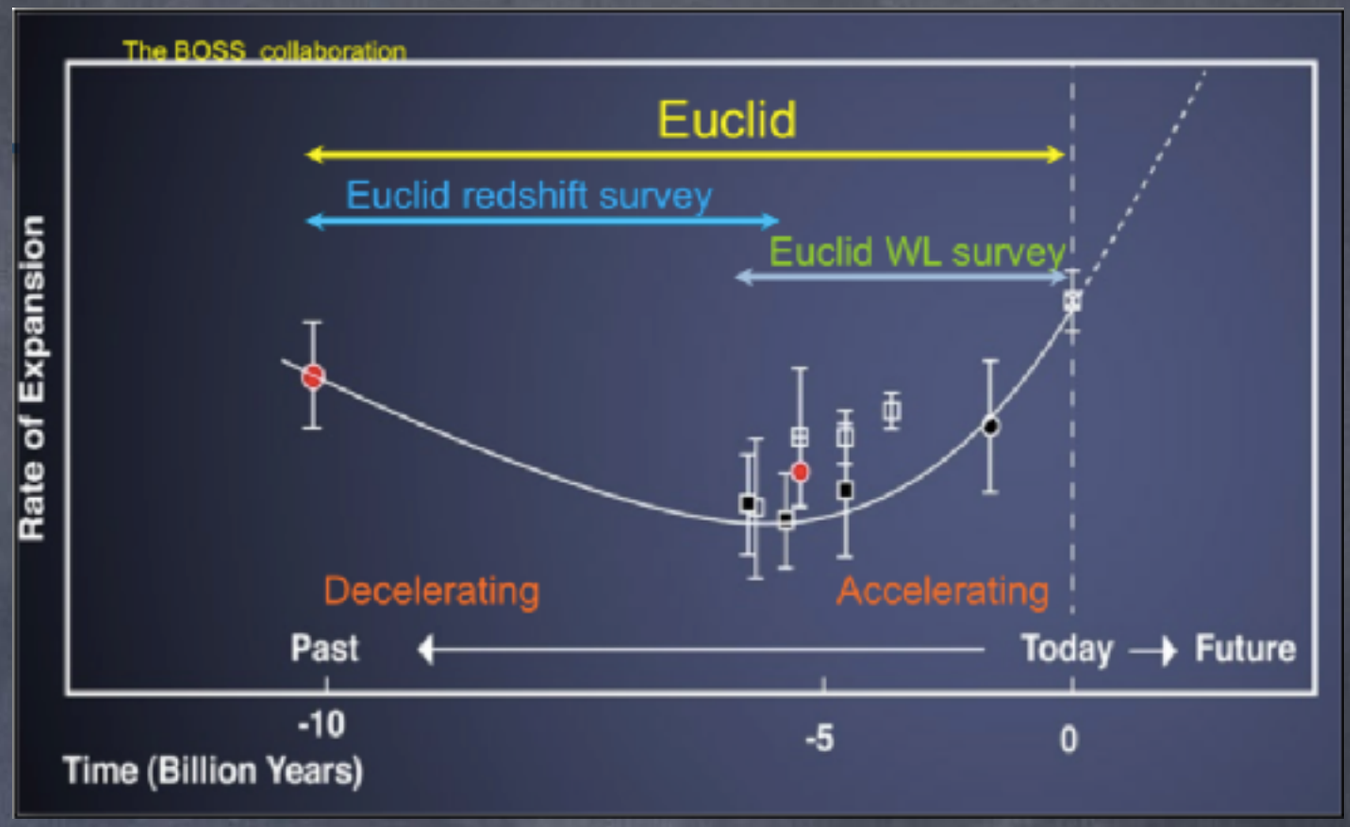
L2 orbit

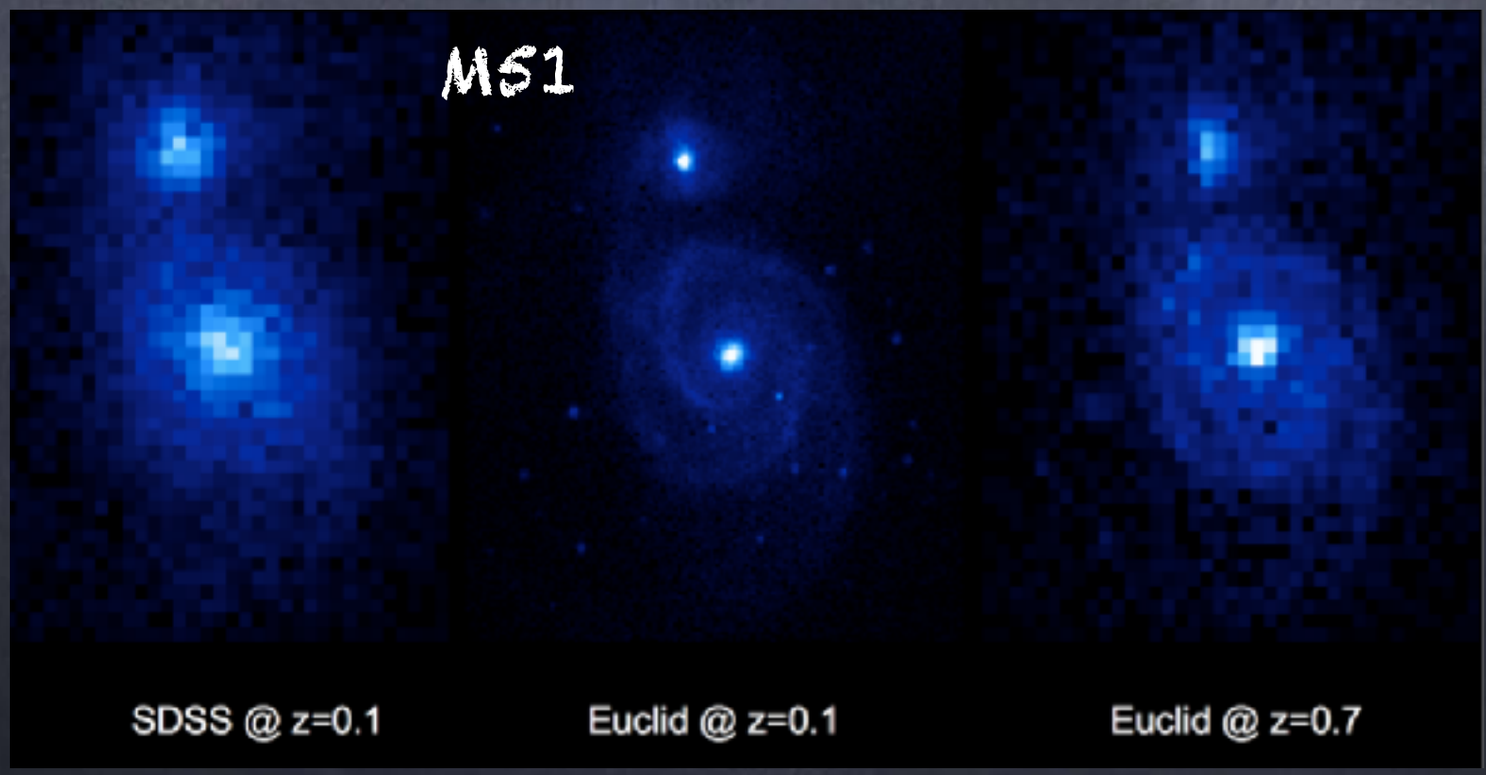
7 years

The mission will investigate the distance-redshift relationship and the evolution of cosmic structures by measuring shapes and redshifts of galaxies and clusters of galaxies out to redshifts ~2, or equivalently to a look-back time of 10 billion years. In this way, Euclid will cover the entire period over which dark energy played a significant role in accelerating the expansion.

EUCLID

Euclid is an experiment combining Galaxy Clustering and Weak Lensing: an unprecedented match of an imaging and redshift survey from space, building a sample of >10^9 galaxy shapes and ~5 10^7 galaxy distances (and much more).



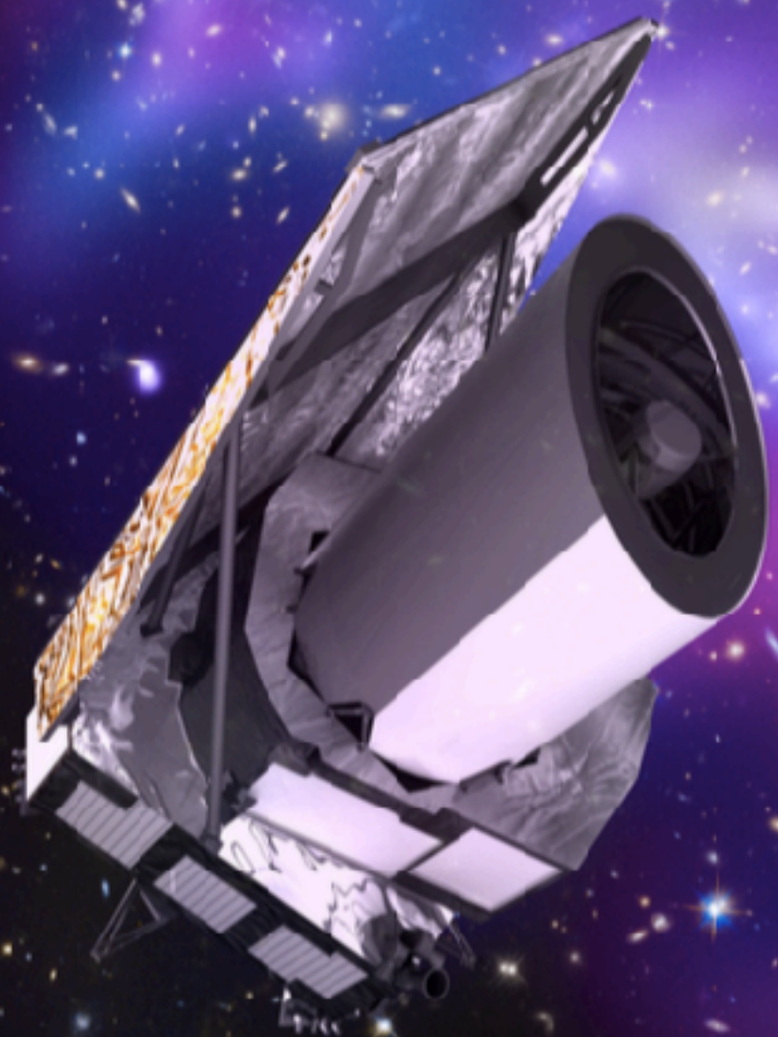


courtesy: EUCLID Consortium

EUCLID

Euclid Consortium

- 14 EU countries + NASA+ US labs
- More than 120 institutes/ labs
- More than 1100 members



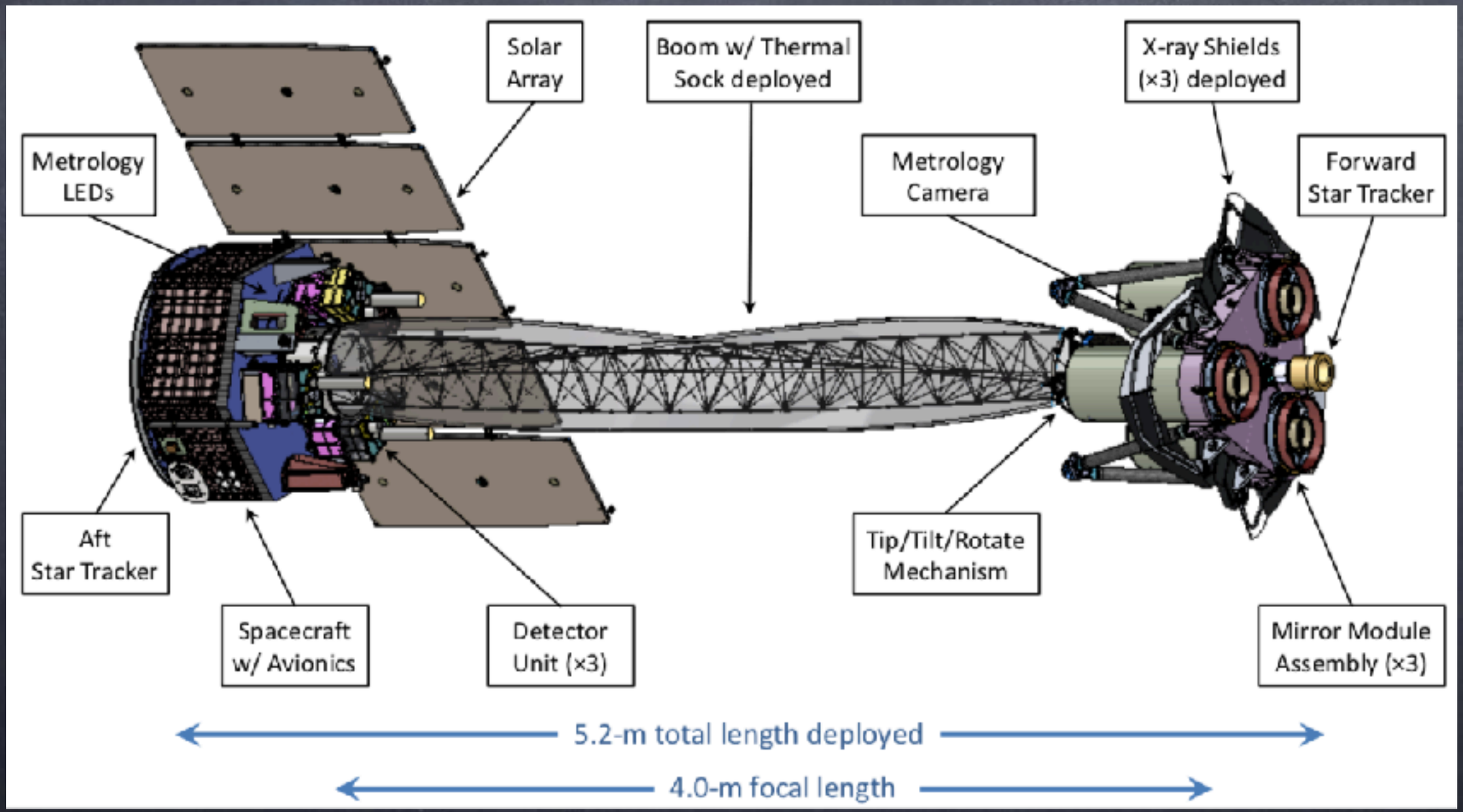
An artist view of the Euclid satellite – courtesy ESA

www.euclid-ec.org
sci.esa.int/euclid

IXPE - Imaging X-ray Polarimetry Explorer

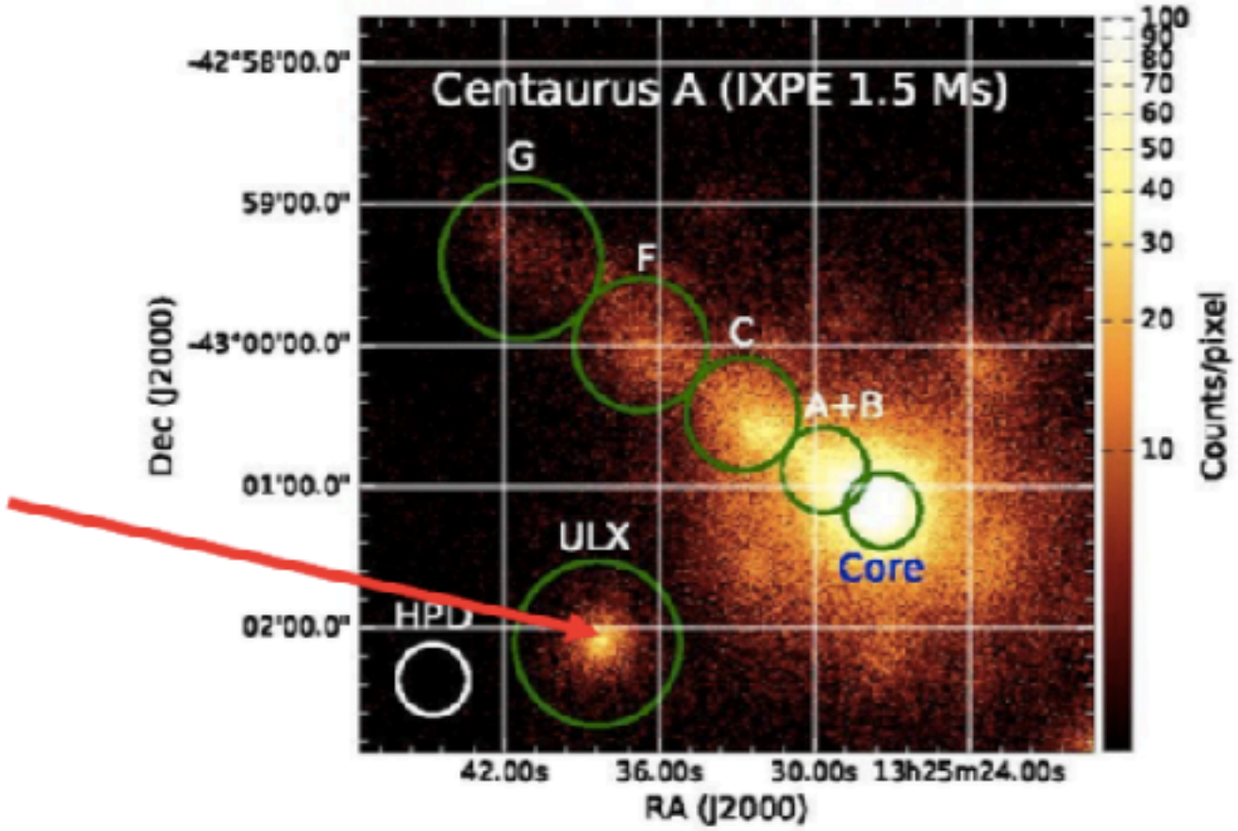
Opens a new window on the universe – imaging (30") X-ray polarimetry

Simultaneously provides imaging, spectral, timing, and polarization data



IXPE - Imaging X-ray Polarimetry Explorer

- **Active galaxies are powered by supermassive BHs with jets**
  - Radio polarization implies the magnetic field is aligned with jet
  - Different models for electron acceleration predict different dependence in X-rays
- **Imaging Cen A allows isolating other sources in the field (2 Ultra Luminous X-ray sources)**



Region	MDP_{99}
Core	<7.0%
Jet	**10.9%**
Knot A+B	17.6%
Knot C	16.5%
Knot F	23.5%
Knot G	30.9%
ULX	**14.8%**

Includes effects of dilution by unpolarized diffuse emission

courtesy: IXPE Team

IXPE - Imaging X-ray Polarimetry Explorer

IXPE Team

NASA Marshall Space Flight Center PI team, project management, SE and S&MA oversight, mirror module fabrication, X-ray calibration, science operations, and data analysis and archiving	INAF ISTITUTO NAZIONALE DI ASTROFISICA NATIONAL INSTITUTE FOR ASTROPHYSICS, INFN Polarization-sensitive imaging detector systems
ASI agenzia spaziale italiana Detector system funding, ground station	LASP Mission operations
Ball Spacecraft, payload structure, payload, observatory I&T	ROMA TRE UNIVERSITÀ DEGLI STUDI, Stanford University Scientific theory
	McGill Co-Investigator
	MIT Massachusetts Institute of Technology Co-Investigator

A12567-151

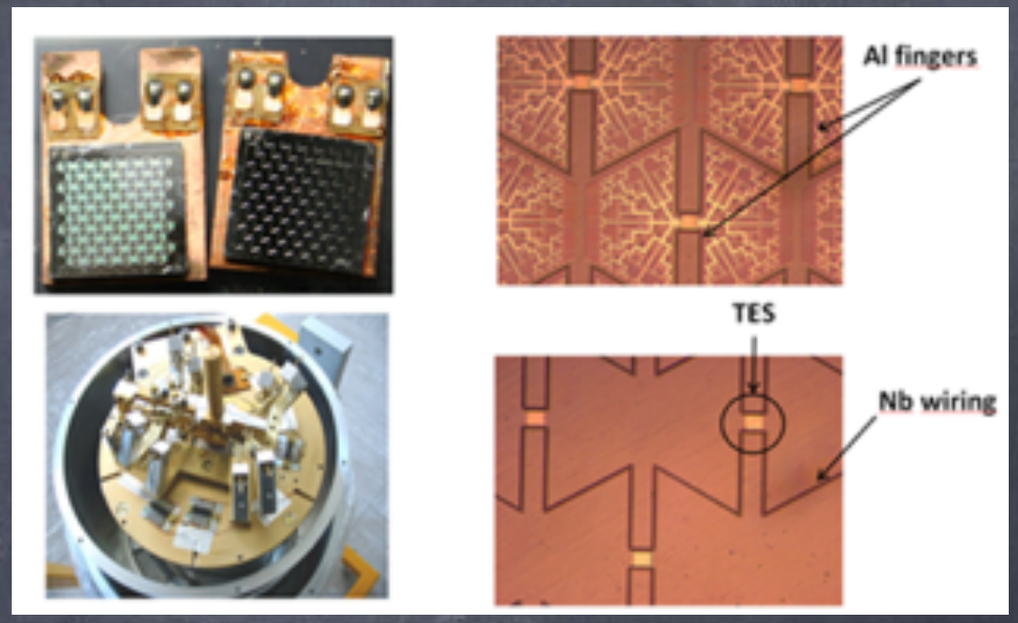
Co-Investigators: Luca Baldini, Ronaldo Bellazzini, Enrico Costa, Ronald Elsner, Victoria Kaspi, Jeffery Kolodziejczak, Luca Latronico, Herman Marshall, Giorgio Matt, Fabio Muleri, Stephen L. O'Dell, Brian D. Ramsey, Roger W. Romani, Paolo Soffitta, Allyn Tennant

ATHENA - The hot and energetic universe

L. Piro talk

Science, Mission and Instruments with leading role of Italian scientists and engineers

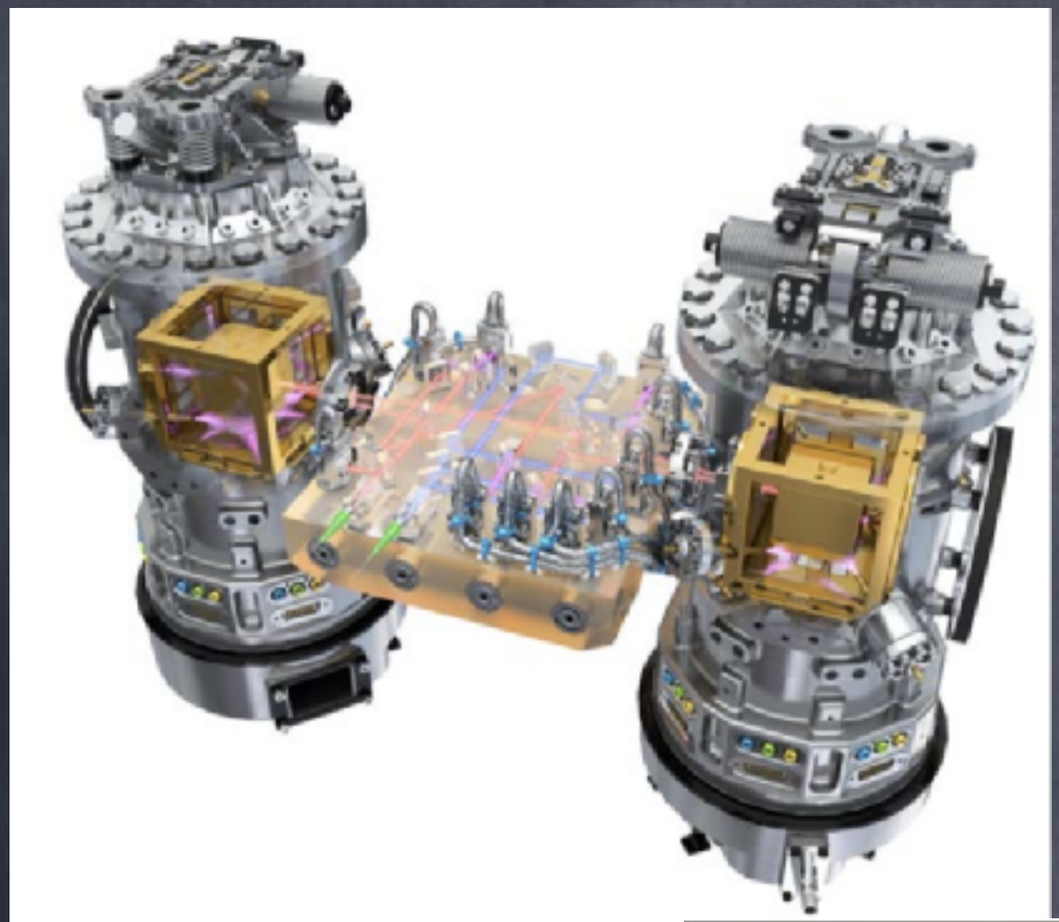
- XIFU CoPI-ship (INAF/IAPS):
  - TES microcalorimeter & background,
  - Instrument Control Unit,
  - Filters,
  - Science Innovation Center
- WFI: contribution synergical with XIFU



TES from UniGe tested in the CryoLAB@IAPS

- Italian representatives: 1 ESA Study Team, 9 co-chairs of Mission & Science WGs, ~200 Italian scientists and engineers from 30 institutions
- 10 institutes with responsibilities in h/w, s/w, science (from INAF, Universities and CNR)

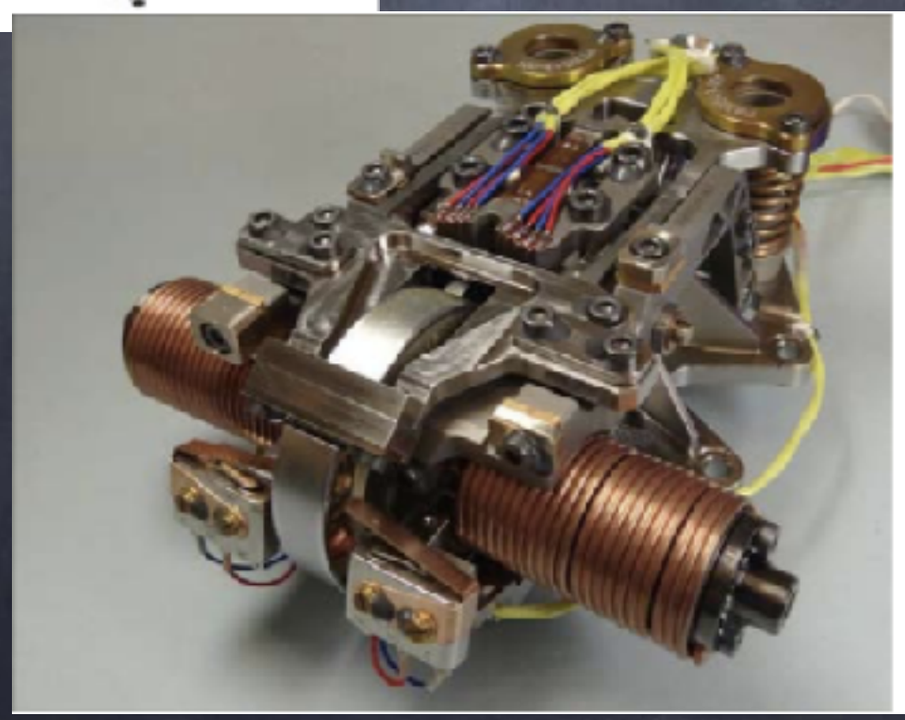
LISA - Laser Interferometer Space Antenna

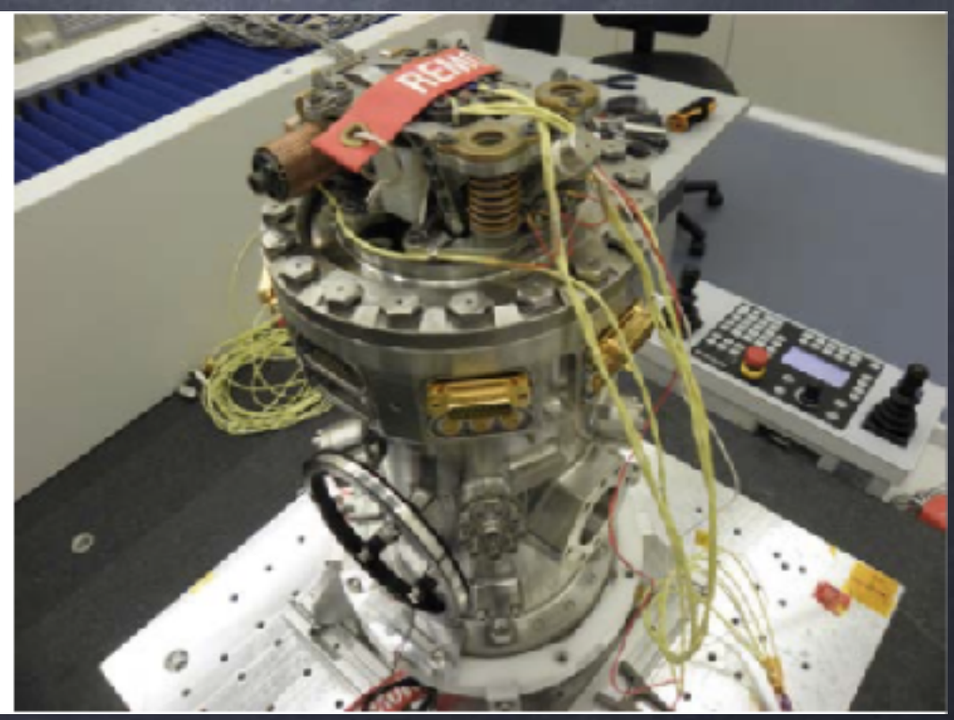


R. Dolesi talk

Gravitational Reference Sensor (GRS)
on board LISA PF

need to optimise GRS for LISA
S. Vitale, Uni Trento





courtesy: LISA-PF team

Cosmology with stratospheric balloons

E. Battistelli talk

LSPE

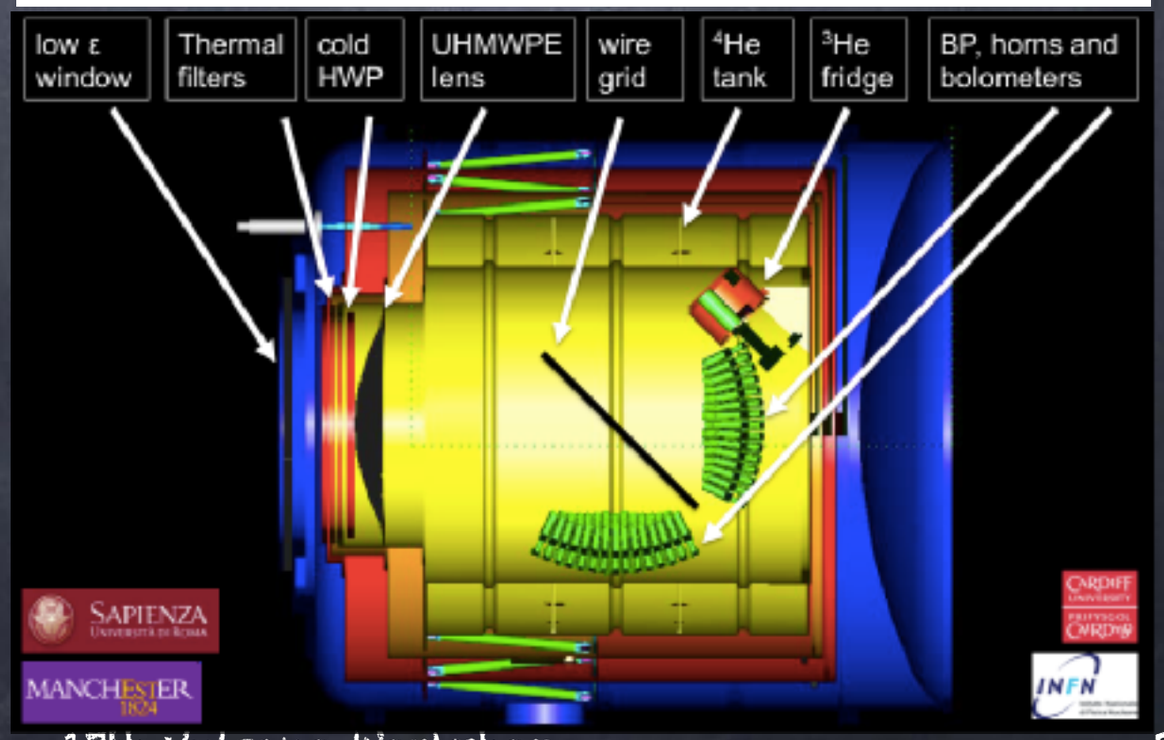
OLIMPO

S. Masi, Uni La Sapienza

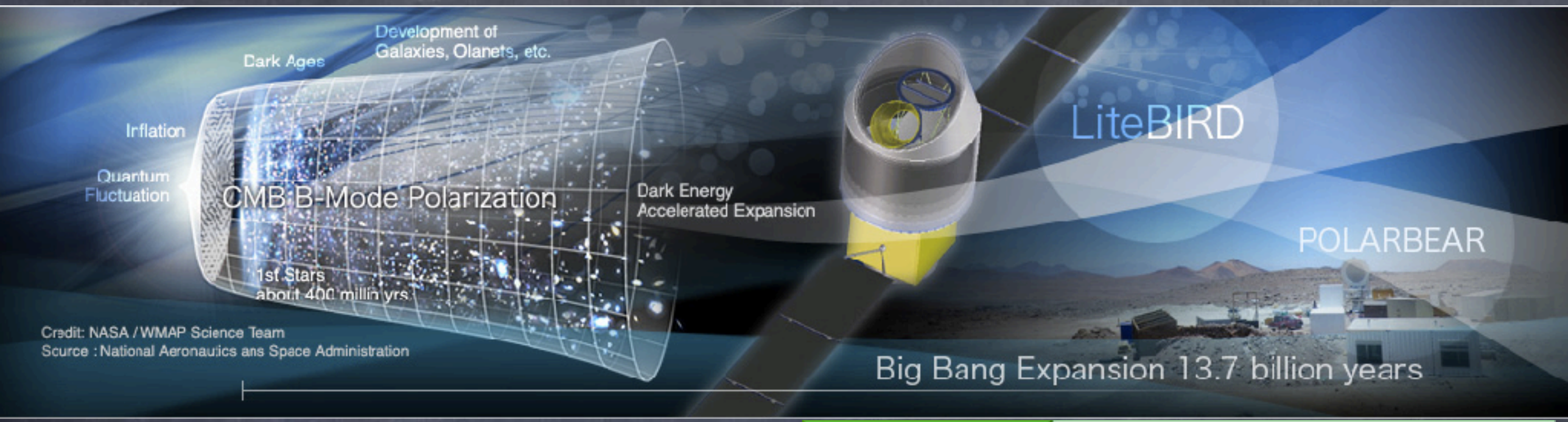
LSPE

SWIPE, Masi, Uni La Sapienza

STRIP, Bersanelli, Uni Milano



Cosmology from space

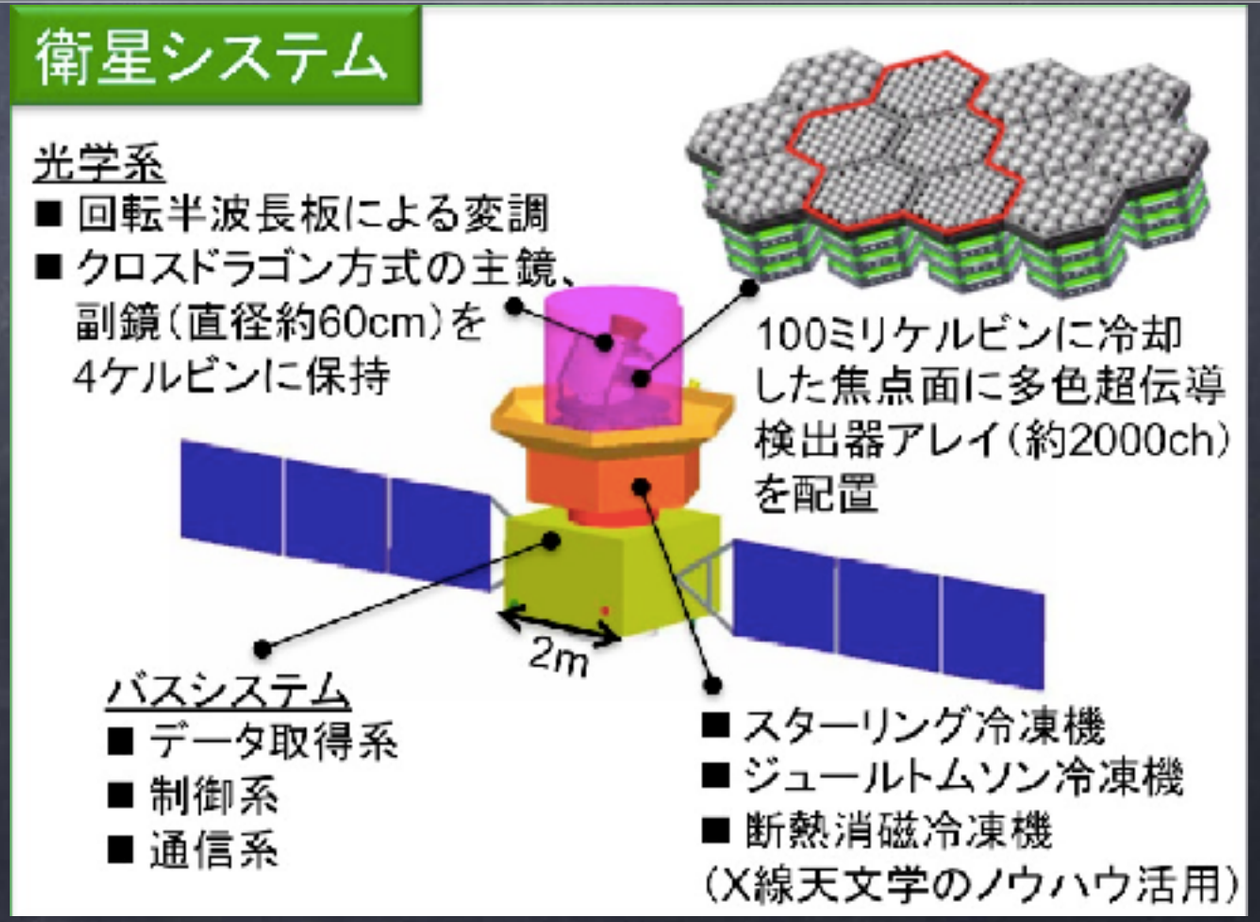


Jaxa mission

High Frequency Telescope (HFT)

Uni Tor Vergata and Roma La Sapienza

E. Battistelli talk



Stratospheric ballons

there has been a workshop in ASI on Dec 18 - 19, 2017:
https://www.asi.it/it/eventi/workshop/workshop-science-stratospheric-balloons

where a common discussion has started

proceeding will be published on Memorie della Societa' Astronomica Italiana

Just selected for phase A studies

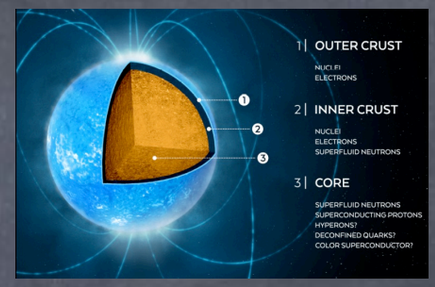
eXTP (CNSA, launch 2025)

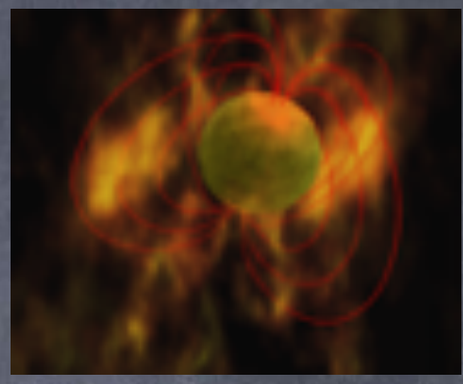
THESEUS (ESA, launch 2034)

eXTP - enhanced X-ray Timing and Polarization mission

SCIENTIFIC OBJECTIVES:

- Test General Relativity in strong-field regime
- Study state and nature of matter at supernuclear densities
- Test physics in the presence of ultra-strong magnetic fields





SCIENTIFIC PAYLOAD:

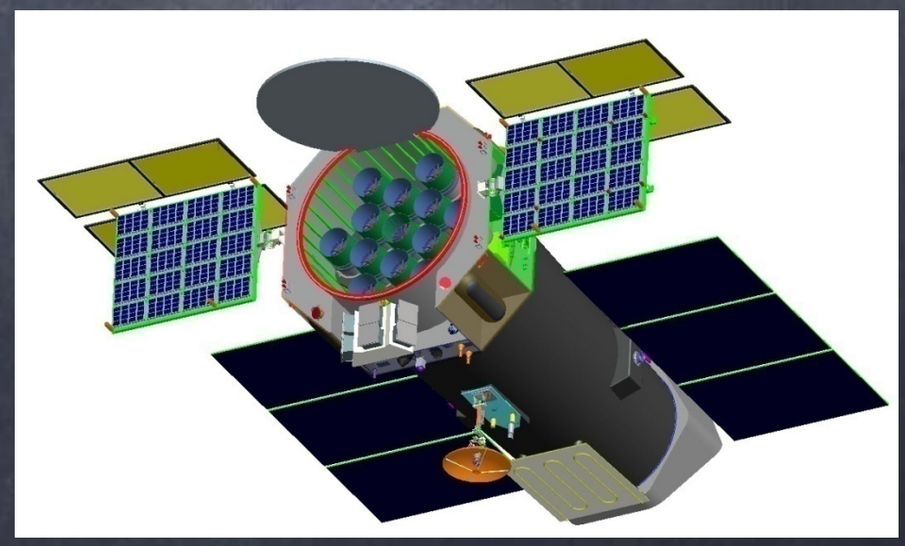
High-throughput, simultaneous spectral-timing-polarimetry:

Optics:

- Spectroscopy Focusing Array (9x)
- Polarimetry Focusing Array (4x)

Collimated:

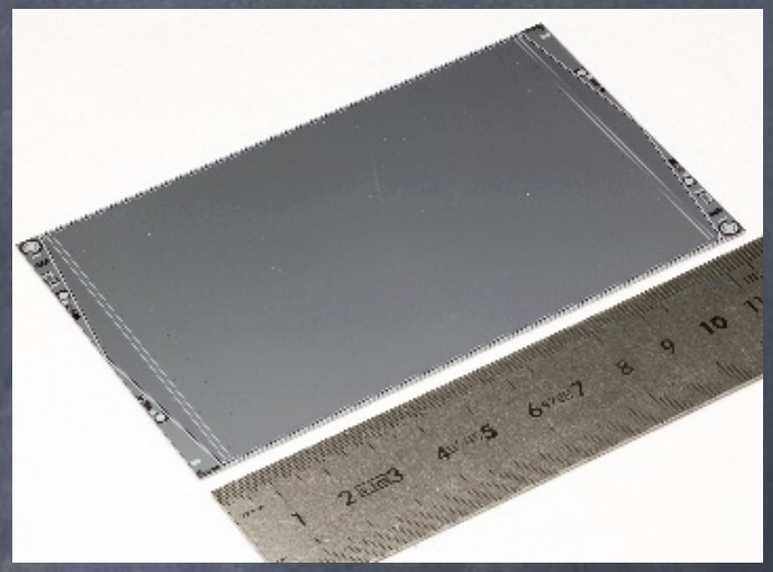
- Large Area Detector (40 Modules)
- Wide Field Monitor (3 Units)



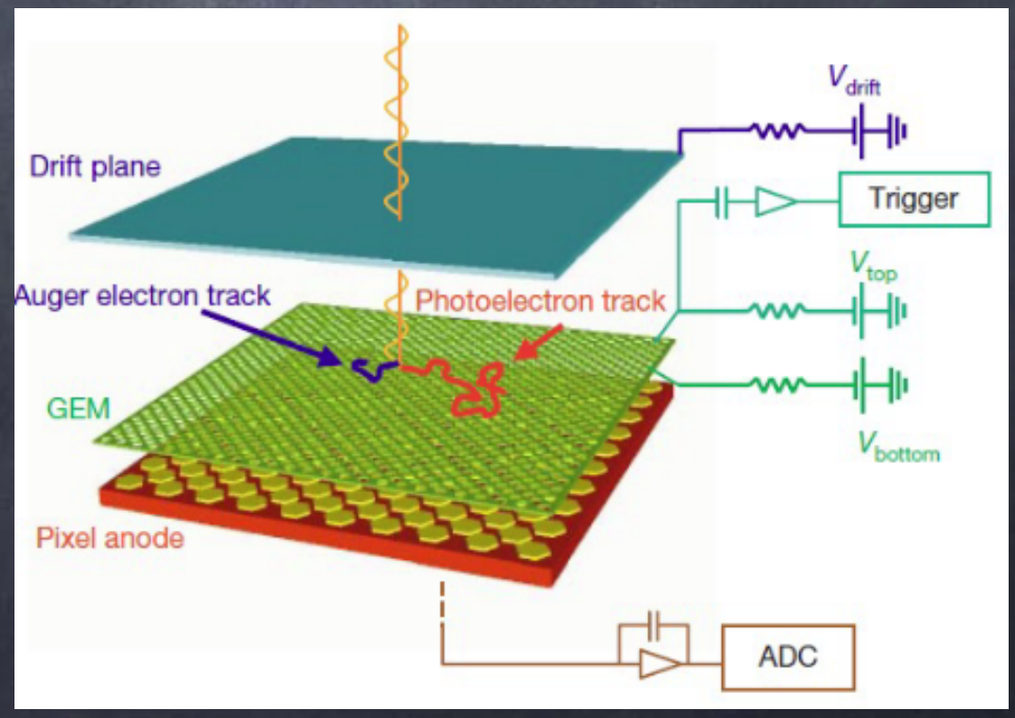
courtesy: M. Feroci

eXTP - enhanced X-ray Timing and Polarization mission

- Chinese mission (CAS and CNSA) with large European participation (IT, DE, FR, ES, CH, DK, CZ, PL, NL, UK)
- Phase A+, final approval December 2018



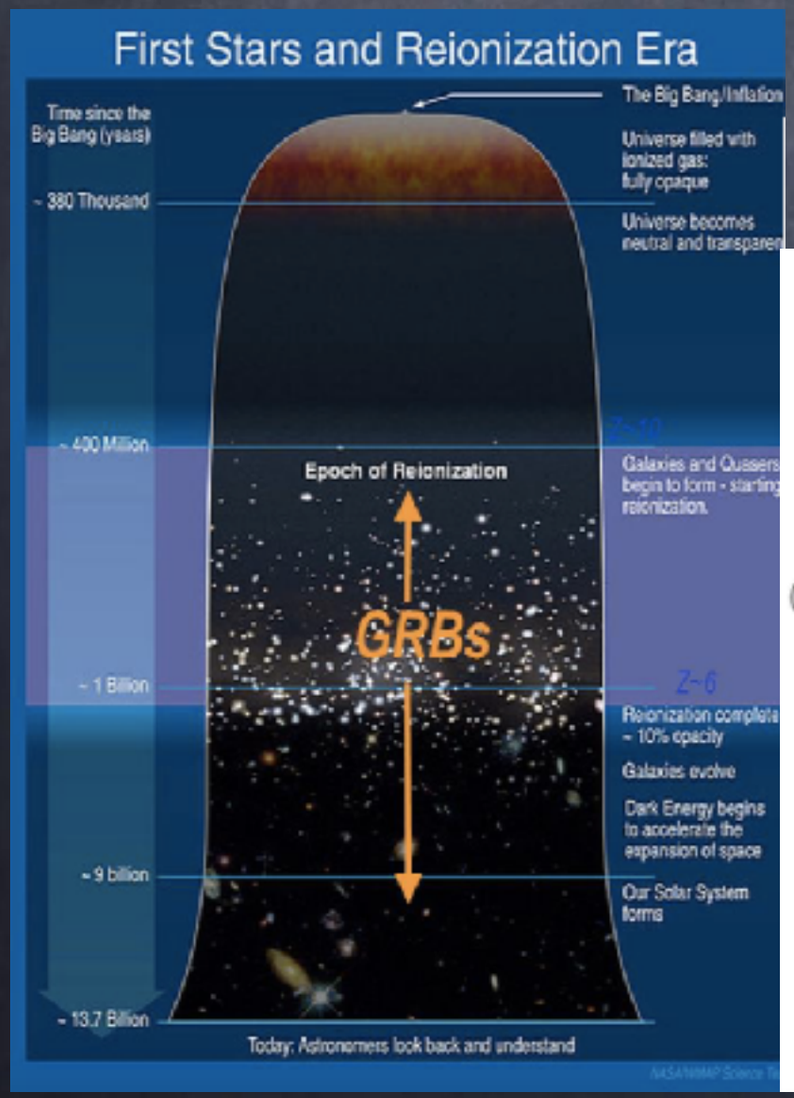
- CAS-ASI agreement signed May 2018
- Italian Coordination of the European consortium
- PI-ship of the Large Area Detector
- Co-I/PI-ship of WFM and PFA
- Provision of LAD and WFM detectors (large-area SDD)
- Provision of the ASIC and BEE for the PFA/GPD
- X-ray optics design
- Malindi ground station

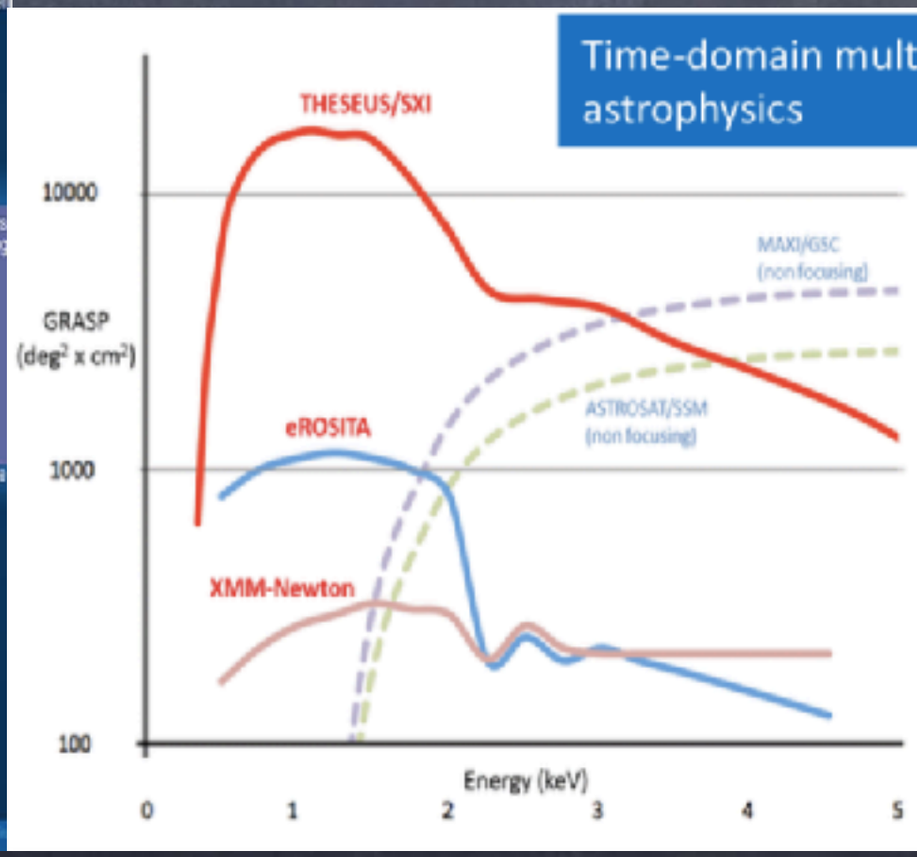


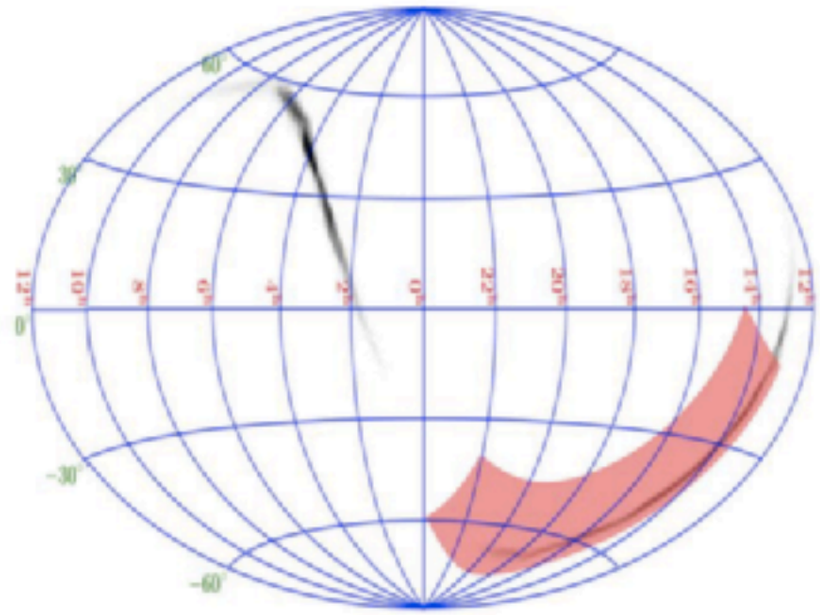
THESEUS

Transient High Energy Sky and Early Universe Surveyor

probing the early universe with GRBs



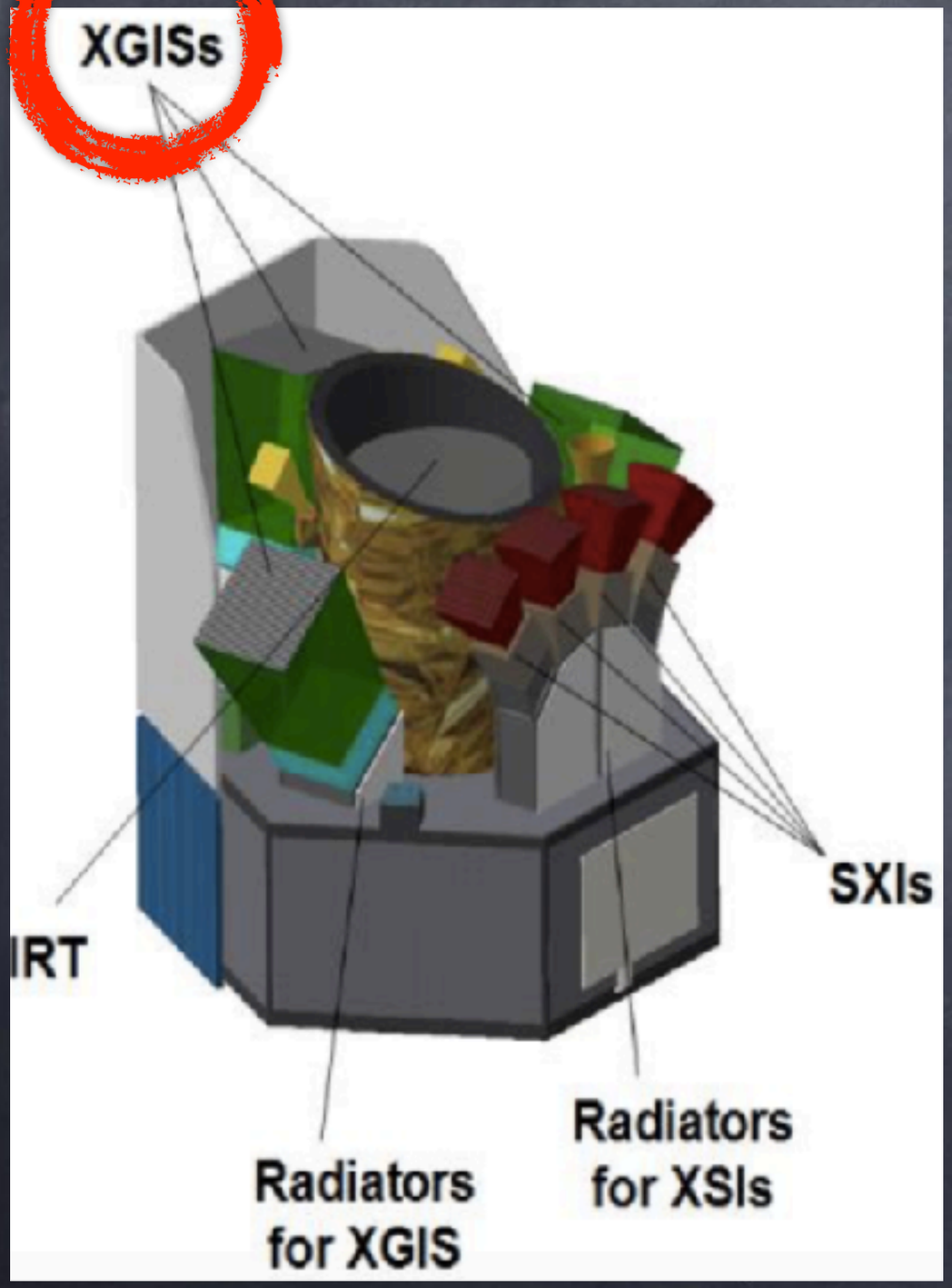




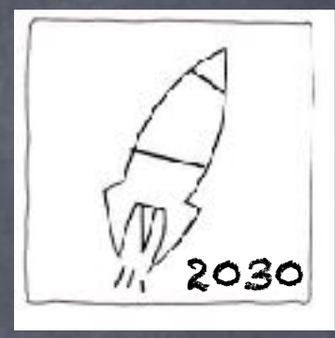
courtesy: L. Amati

THESEUS

italian contribution



Candidate M5 ESA Mission



- Soft X-ray Imager (SXI): a set of four sensitive lobster-eye telescopes observing in 0.3 - 6 keV band, total FOV of ~1sr with source location accuracy < 1-2';
- X-Gamma rays Imaging Spectrometer (XGIS): 3 coded-mask X-gamma ray cameras using bars of Silicon diodes coupled with CsI crystal scintillators observing in 2 keV - 10 MeV band, a FOV of ~2sr, overlapping the SXI, with ~5' source location accuracy;.
- InfraRed Telescope (IRT): a 0.7m class IR telescope observing in the 0.7 - 1.8 μm band, providing a 10'x10' FOV, with both imaging and moderate resolution spectroscopy capabilities

courtesy: L. Amati

Astrophysics and Cosmology studies

Two 3-year grants:

- Studio di Astrofisica delle Alte Energie
- Studio di Cosmologia

ASI issues calls for R&D and participates to MIUR calls (Progetti Premiali)

ASI calls rely on international peer review

the 2007 - 2010 calls on R&D studies have led to the selection of IXPE

Technological studies

2016 ASI and MIUR calls

- X-ray optics
(Athena, Linx, eXTP) (G. Pareschi, INAF)

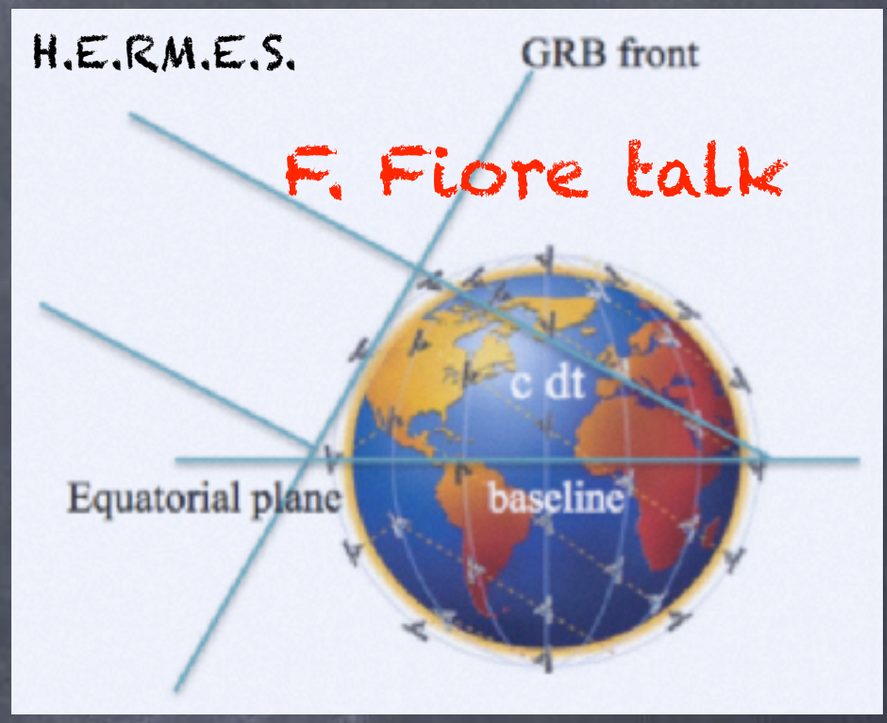
- Silicon Drift Detectors
(eXTP) (M. Feroci, INAF)

- H.E.R.M.E.S.
(L. Burderi, Uni Cagliari)

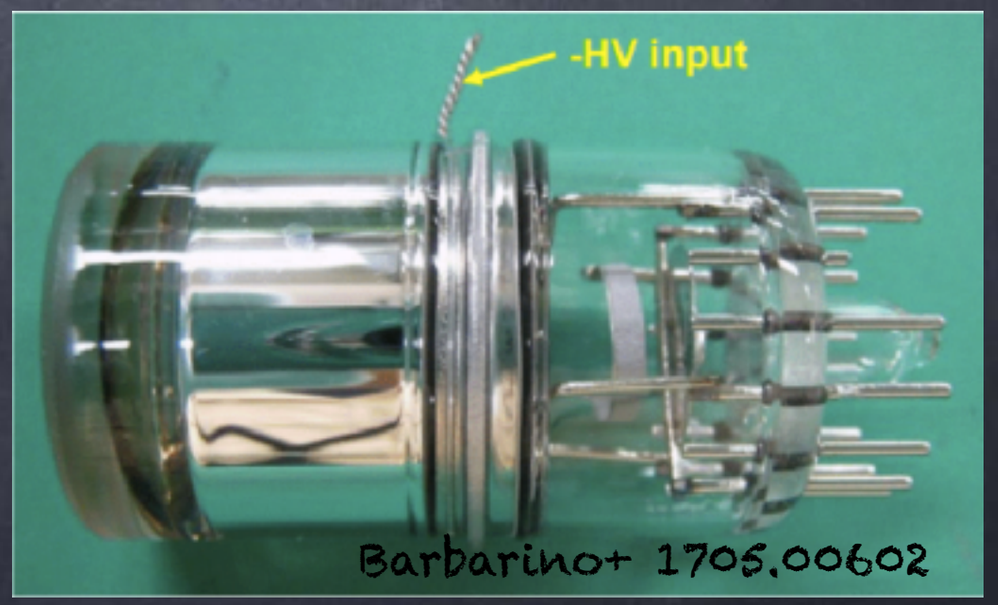
- next generation of Gas Pixel Detectors
(IXPE) (L. Baldini, INFN)

- Microcalorimeters
(Athena) (C. Macculi, INAF)

- Vacuum Silicon PMT
(G. Barbarino, Uni Napoli)



F. Fiore talk



Technological studies

2017 ASI call

- 3D-CZT Module (3DCaTM) for spectroscopic imaging, timing and polarimetry in hard X-/soft γ-rays satellite mission (E. Caroli, INAF)
- FluChe - Fluorescence and Cherenkov light detection with SiPM for space applications (O. Catalano, INAF)
- Increase of the Technological Readiness Level for the realization of hard X-/soft Gamma-ray Laue optics (E. Virgilli, Uni Ferrara)
- STAR-X: the next generation of X-ray imaging surveys (R. Gilli, INAF)
- POX (Pangu [sub-GeV γ-ray telescope] Optimization and eXperimental verification) (D. D'Urso, Uni Sassari)

What happens after launch?

2017 ASI call

data analysis is funded for both on orbit missions with ASI contribution as well as proposals approved by Time Allocation Committees of other missions (Chandra, HST etc)

20 proposals for 18-month long projects

What happens after launch?

2017 ASI call

data analysis is funded for both on orbit missions with ASI contribution as well as proposals approved by Time Allocation Committees of other missions (Chandra, HST etc)

20 proposals for 18-month long projects

there will be another call in late 2018

Open Day for 10 years of Fermi satellite

June 11, 2018
@ Italian Space Agency