RSN4, 28-30 Gennaio 2026 - Auditorium Nazionale INAF, Napoli

Le politiche spaziali dell'ASI con un focus sulle tematiche di interesse per RSN4

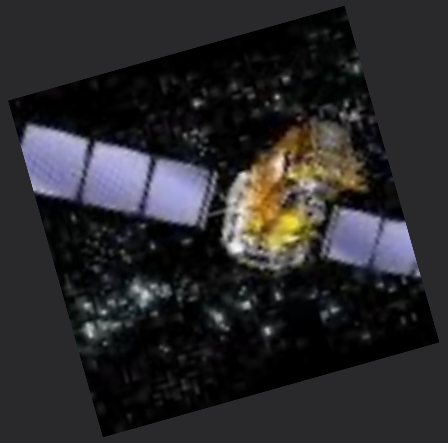
Imma Donnarumma

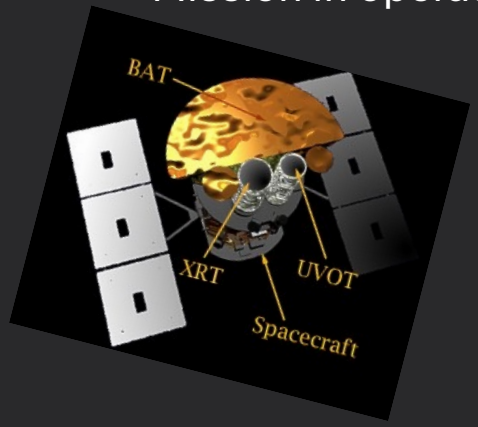
Ricerca, Sviluppo e Alta Formazione, ASI

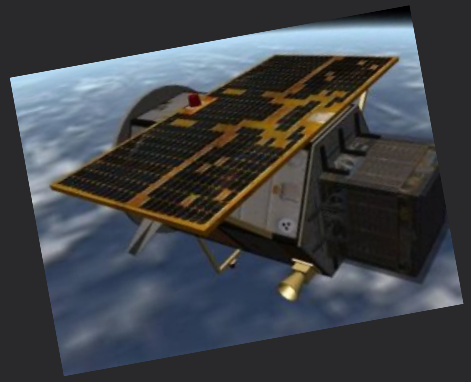
Outline

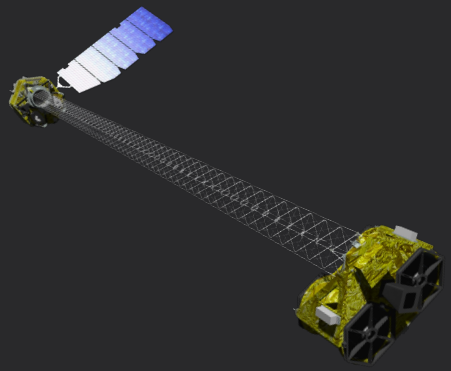
- Missions in operations and post-operations
- Future missions
  - ESA (Large Missions, M8 competition)
  - NASA
  - ALCOR: ASI Nanosat Program
- The ASI Roadmap for Astrophysics
- Moon Opportunities
- The evolution of the Space Science Data Center
- Italian Small Scientific Mission

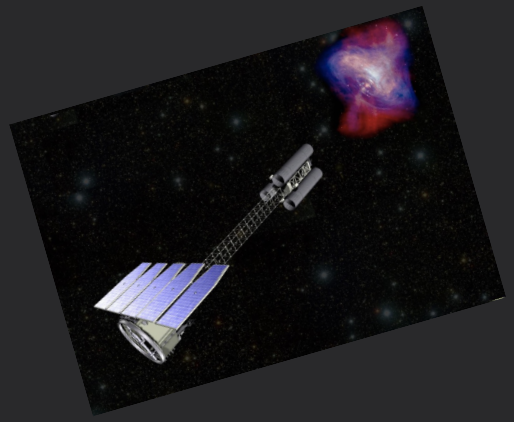
Mission in operations and post-operations











Missions in operations and post-operations

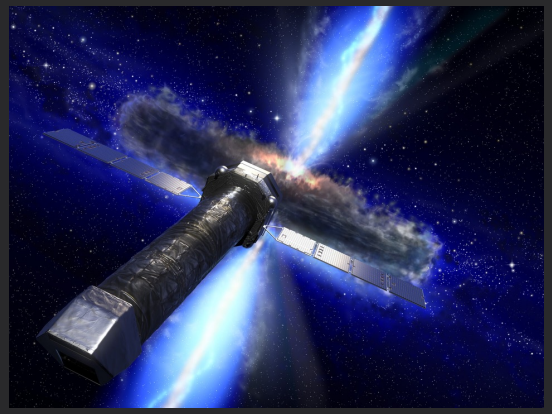
ASI supports the operative phase of each mission to which has contributed, both with hardware or software parts.

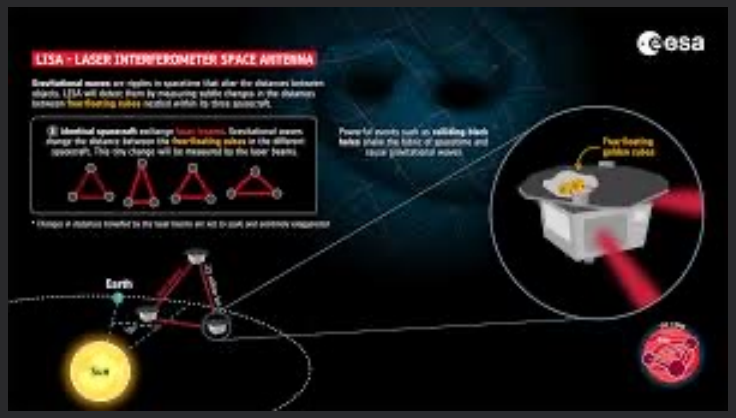
- **INTEGRAL:** PI of IBIS instrument, development of the PiCsIt detector in the IBIS telescope, along with IBIS main frame, key roles in the IBIS/INTEGRAL international collaboration. Relevant contribution to the SPI instrument. the operative phase was concluded by ESA on March 4th, 2025. ASI supports the scientific team till March 21st, 2026.
- **AGILE:** second Italian small mission (ASI supported hardware development/procurement and scientific activities), Malindi ground station, MOC, SOC with a key role of SSDC (former ASDC). The operative phase concluded on January 18th 2024. ASI supported the scientific team till December 8th, 2025.
- **Fermi:** Large Area Telescope tracker, calibrations, low and high level analysis tools, Data Quality Monitoring, key roles in the LAT international collaboration, relevant contribution from SSDC to the Data Quick view system running at the SOC (SLAC, California). ASI supports the scientific team with 2 separated contracts, INAF and INFN, which expire both in 2026. Starting September 2026 ASI will support only the Data Quality Monitor activities in the INFN contract with a new dedicated contract.
- **Swift:** XRT optics, relevant contribution to XRTDAS, archive mirror, Malindi ground station. NASA keeps operating the mission. ASI supports the scientific team with an on going contract which lasts till October 10th, 2027. ASI-NASA Implementing arrangement in place expires on September 30th, 2027.

Missions in operations and post-operations

- **NuSTAR:** NuSTARDAS package, the official NuSTAR data analysis software jointly developed by the ASI Space Science Data Center (SSDC, Italy) and the California Institute of Technology (Caltech, USA); SSDC, in collaboration with CALTECH, developed and maintains the NuSTAR calibration database (CALDB); SSDC hosts a mirror archive and developed on-line high-level data analysis at SSDC; dedicated contracts for data analysis in the first years of the mission, Malindi ground station. Implementing Arrangement ASI-NASA in place.

- **IXPE:** Co-PI ship, development of the entire focal plane with 3 GPDs, DCU, calibrations, key roles in the IXPE international collaboration, ASI and INAF Project Scientists, relevant contribution to the on board IXPE software, Malindi ground station; most of the Instrument-related software and calibration database (CALDB) were developed by the ASI Space Science Data Center (SSDC, Italy), with contributions by the IXPE Instrument Team at Istituto Nazionale di Astrofisica (INAF) and at Istituto Nazionale di Fisica Nucleare (INFN). Implementing Arrangement ASI-NASA in place. ASI supports INAF and INFN scientific teams with ongoing contracts until February 2026 (extension until 2029 in progress) and December 2027, respectively



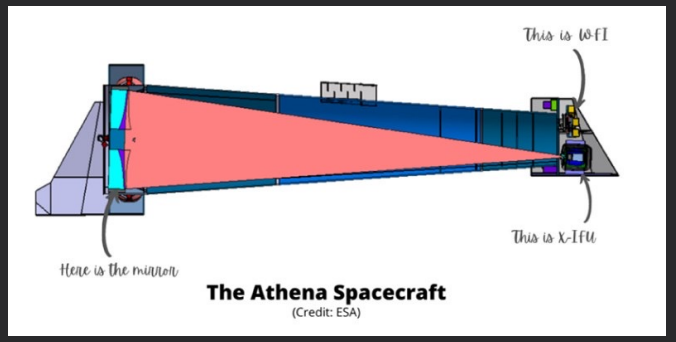


ESA credits

ESA missions (NewAthena and LISA)

The NewAthena X-ray Observatory – Italian contributions

The mission is currently in B phase
(adoption foreseen in 2027)



Italian scientific activities:

- Development of the CryoAC detector
- WFI and X-IFU filters
- Development of the X-IFU ICU
- Support to BEaTRix+VERT-X

- Development of high-level coding and theory of ionized gas (TEPID, WINE, CoG): level-population, line emissivities and radiative transfer.
- XRISM data analysis (high– and low–resolution X-ray spectra of variable AGNs, transients, galaxy clusters and groups, galaxy halos).
- Atomic Database: analysis of the laboratory measurements of X-ray atomic database acquired at Elettra.
- Study of the feasibility of NewAthena-XIFU observations of EM counterparts of GW (expecially Einstein-Probe) events.
- Contribution to the performance evaluation of WFI AGN surveys, using accurate SIXTE simulations.
- Definition of the XIFU Innovation Center (high-level scientific analysis and support to GRB TOOs) tentatively @SSDC

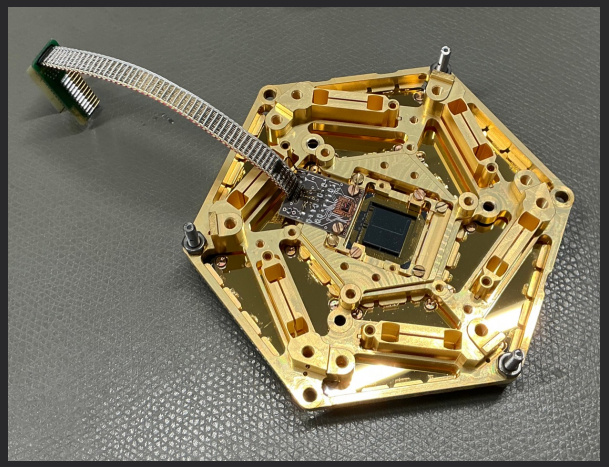
- Chairship of the NewAthena XSAT
- Coordination of the Background Working-Group (BWG) of NewAthena.

Involved Italian Team :
INAF (Roma, Bologna, Torino, Palermo, Trieste)
Universita' di Genova
Universita' di Palermo
CNR/IFC
Thales Alenia Space Italia S.p.A.

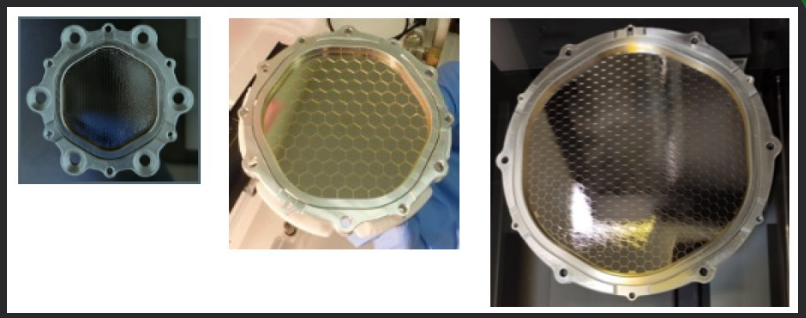
The New Athena X-ray Observatory – recent achievements

The first test of the Cryogenic AntiCoincidence detector (CryoAC) inside the X-IFU Demonstration Model 1.1 has been successfully completed

The X-ray Integral Field Unit (X-IFU) is the cryogenic instrument onboard NewAthena mission.
The Cryogenic AntiCoincidence Detector (CryoAC) is a TES based active shielding system working at the same temperature of the TES array. It can efficiently detect background particles, thus allowing their signals to be filtered out.



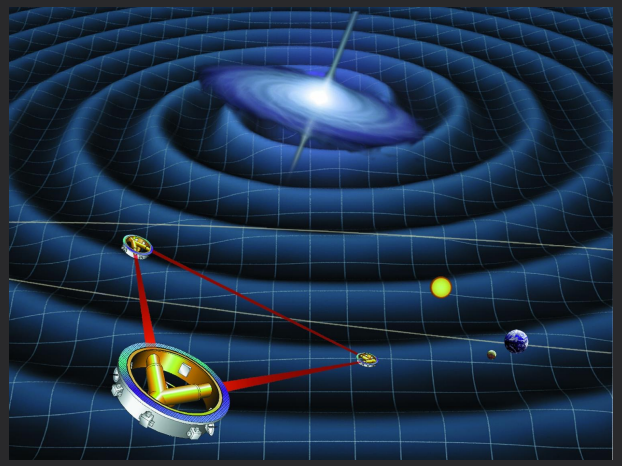
The **CryoAC demonstration prototype** integrated in the detectors flange of the Focal Plane Assembly Demonstration Model 1.1. Image credit: SRON.



Pictures of the three representative **thermal filter** samples investigated for the TRA activity performed before the reformulation: THF0, THF2, and THF300. The breadboards will undergo a series of optical and environmental characterisation tests to demonstrate the Technology Readiness Level 5/6.

Laser Interferometer Space Antenna – LISA (ESA adoption in 2024)

First space-based observatory dedicated to studying gravitational waves below 0.1 Hz

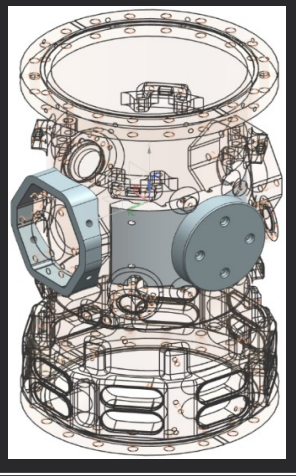


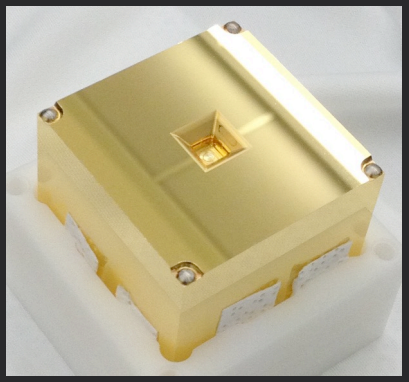
Core science objectives:

- **Study Massive Black Holes:** Trace the origin, growth, and mergers of supermassive black holes
- **Map Galactic Binaries:** Observe tens of thousands of compact binary star systems
- **Probe Strong-Field Gravity:** Test General Relativity by observing the merger of objects into supermassive black holes (Extreme Mass Ratio Inspirals, or EMRIs).

Mission setup:

- **Three Spacecraft:** triangular formation at 2.5 M km each
- **6 Laser-beam:** Interferometry Detection System (IDS 2 for each satellite)
- **6 Gravitation Reference Sensor:** GRS 2 for each satellite with 2 gold Test Mass (TM)
- **Expected Launch:** 2035 with Ariane 6 rocket
- **Life mission:** 5 years plus 5 years extension





ASI coordinates the development of the "beating heart" of the three satellites: the Gravitation Reference System (GRS)

- **Industrial and Technological Leadership** with OHB-Italia
- **Scientific Leadership in collaboration** with University of Trento/Roma ToV/Urbino/INFN/INAF
- **Ground segment coordination by** ASI SSDC

LISA Mission: INAF's Strategic Contribution to Data & Science

Data Systems & Pipeline Integration

DDPC System Coordination & Design

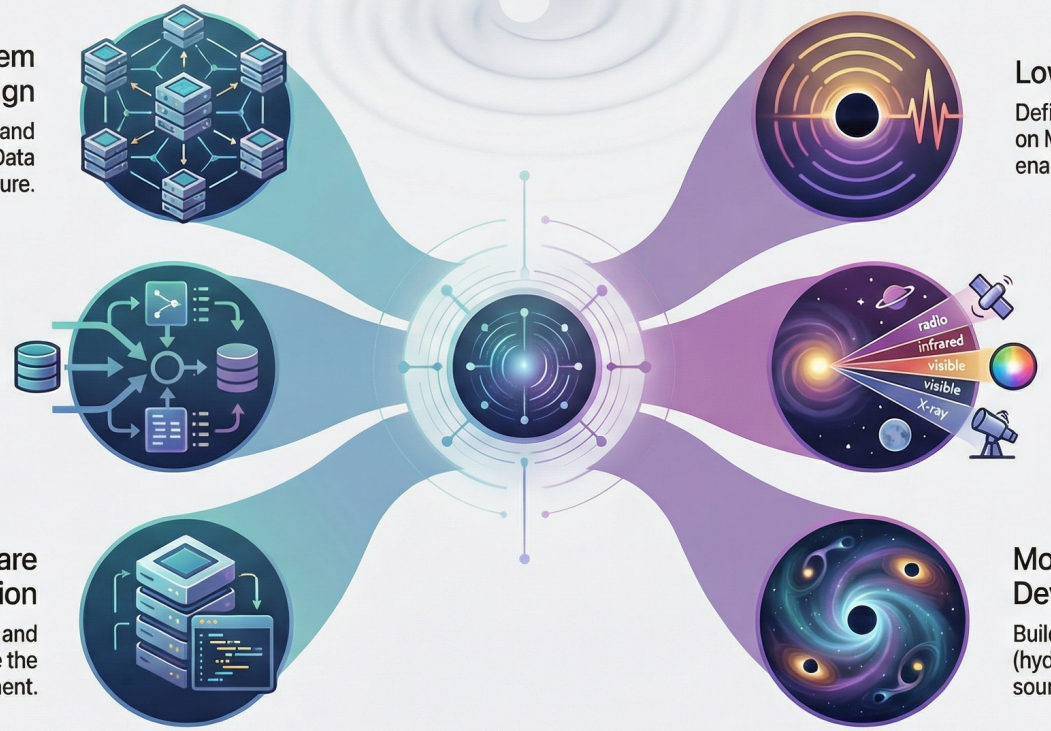
Ensuring technical coherence and design for the Distributed Data Processing Center infrastructure.

Advanced Pipeline Integration

Optimizing Global Fit and Low Latency Alert pipelines for portability and software performance.

Specialized Software Optimization

Identifying critical libraries and profiling strategies to stabilize the LISA scientific software environment.



Astrophysical Alerts & Source Modeling

Low Latency Alert Strategy

Defining requirements for rapid alerts on Massive Black Hole events to enable follow-up observations.

Multi-Wavelength Synergies

Monitoring "pre-LISA sources" across the electromagnetic spectrum using space and ground-based telescopes.

Mock Catalog Development

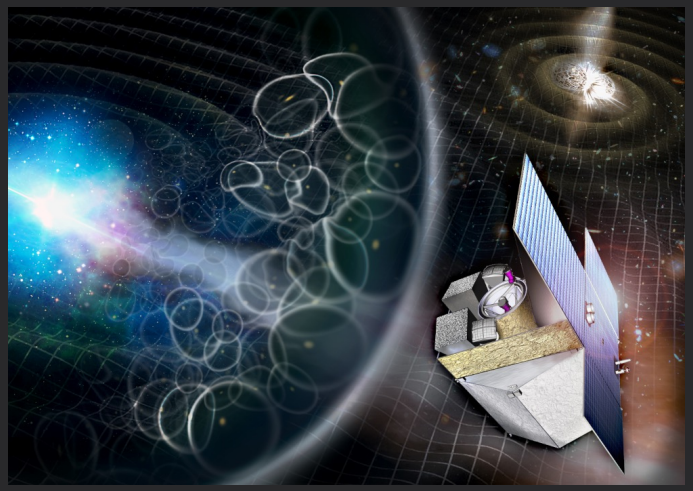
Building theoretical models (hydrodynamic/numerical) to simulate source populations for pipeline testing.

ESA cosmic vision- M7 candidate

THESEUS (Transient High Energy Sky and Early Universe Surveyor)

Payload consortium: Italy, Germany, UK, France, Switzerland, Spain, Poland, Denmark, Belgium, Norway, Hungary, Czech Republic, Slovenia, Sweden, Ireland, The Netherlands

Coordinators: L. Amati (INAF – OAS Bologna, Italy, lead proposer), A. Santangelo (Un. Tuebingen, Germany), P. O'Brien (Un. Leicester, UK), D. Gotz (CEA-Paris, France), E. Bozzo (Un. Genève, Switzerland) http://www.isdc.unige.ch/theseus/

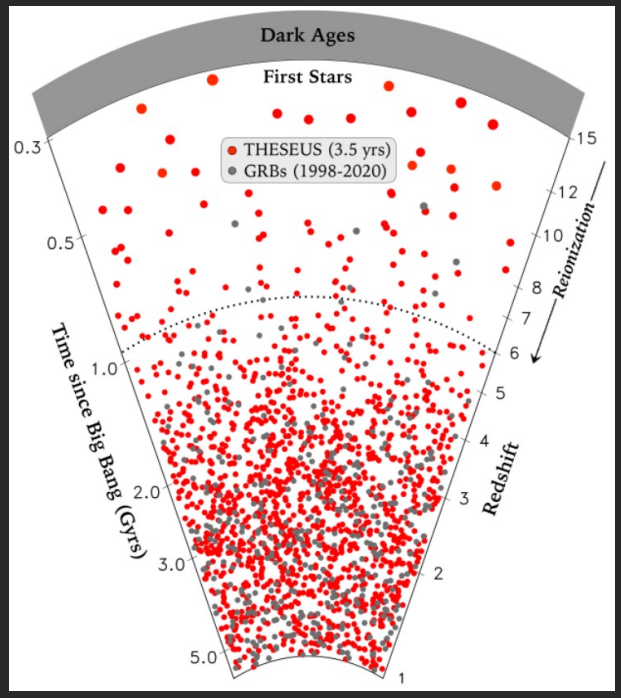


M7 Phase-A timeline

- Nov. 8th, 2023: SPC approval and ESA announcement of the three selected candidates (THESEUS, M-Matisse, Plasma Observ.)
- Jan. 2024: ESA internal Phase-A KO (17th); ESA KO with Consortium (29th)
- May. 2024: KO of industrial Phase-A
- Mar. – Apr. 2025: Mission Consolidation Review (MCR)
- **Feb. – Mar. 2026: Mission Selection Review (MSR)**
- **Mar. - May 2026: Final scientific evaluations (SARP, SSC)**
- **June 2026: Selection of one M7 candidate for Phase-B1**

In addition to leading the overall coordination of the international consortium, Italy is responsible for one of the three scientific instruments—the X/Gamma-ray Imaging Spectrometer (XGIS)—as well as for the optics of the InfraRed Telescope (IRT). It will also provide, through the Italian Space Agency, the ground segment (the Malindi antenna).

THESEUS Science



THESEUS YB, 2021

The main scientific goals of the proposed mission are to **explore the Early Universe (cosmic dawn and reionization era) by unveiling a complete census of the Gamma-Ray Burst (GRB) population in the first billion years.**

Specifically to:

- Perform unprecedented studies of the global star formation history of the Universe up to z ~ 10 and possibly beyond;
- Detect and study the primordial (pop III) star population: when did the first stars form and how did the earliest pop III and pop II stars influence their environments?
- Investigate the re-ionization epoch, the interstellar medium (ISM) and the intergalactic medium (IGM) up to z ~ 8 - 10: how did re-ionization proceed as a function of environment, and was radiation from massive stars its primary driver? How did cosmic chemical evolution proceed as a function of time and environment?
- Investigate the properties of the early galaxies and determine their star formation properties in the re-ionization era.

NASA collaboration

The COSI mission

Small Explorer NASA gamma-ray observatory
with a planned launch in 2027

Scientific objectives:

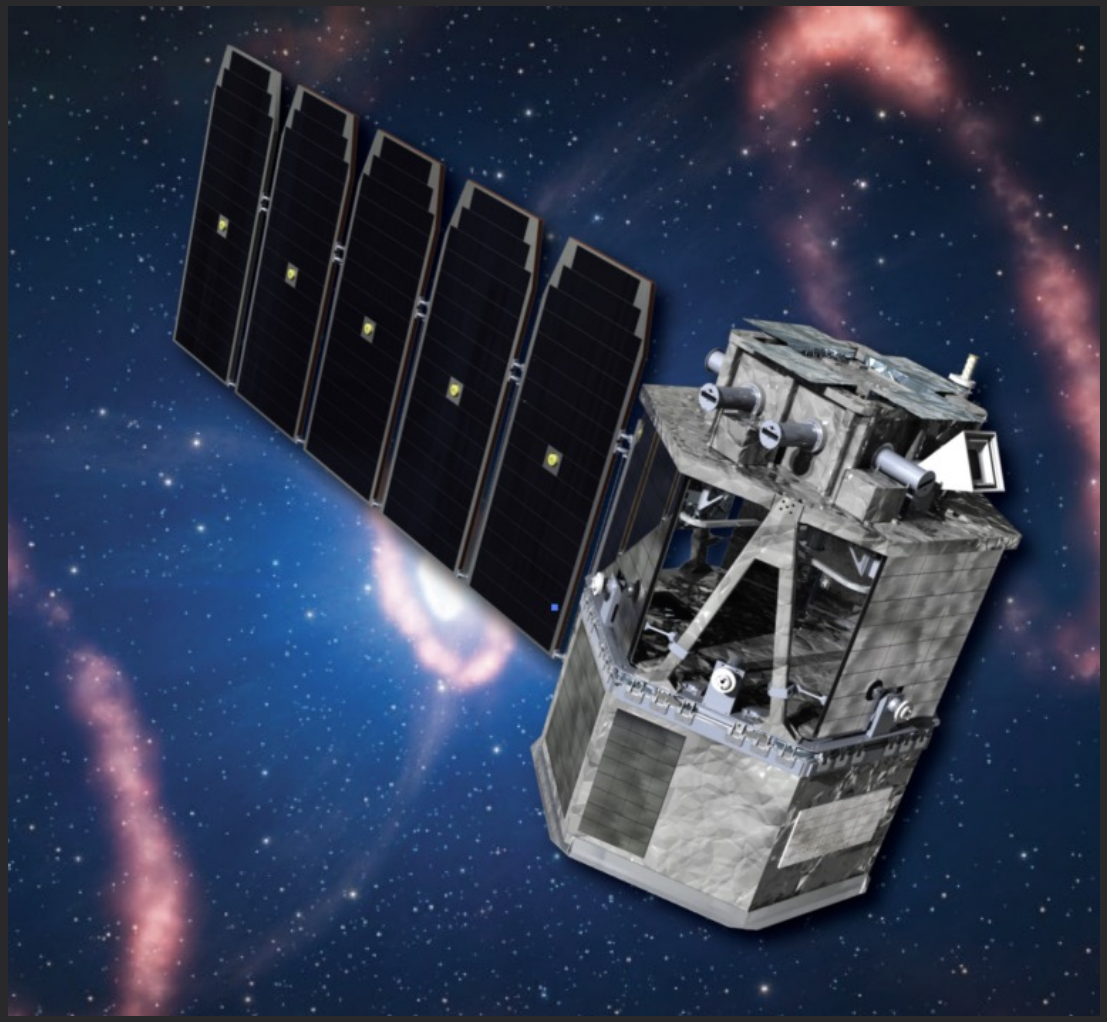
- Study of the galactic positron annihilation
- Study of the galactic element formation
- Study of the polarization at ~MeV
- Participation to multimessenger campaigns

Germanium detectors to achieve excellent
energy resolution

Compton telescope sensitive in
the 0.2-5 MeV region

Imaging capabilities over 120° field of view

Sensitivity to polarization



The Italian contribution

Italian Space Agency and SSDC

Development of the pipeline for transient detection at all time scales
Development of algorithms for the detection of transient sources
Development of machine learning algorithms for the reduction of background
Modeling of the background fluxes
Development of a data mirror in SSDC

INAF Bologna

Development of the pipeline for transient detection with short reaction time
Development of algorithms for the detection of transient sources
Calibration of the anticoincidence detector
Studies on the anticoincidence as a transient detector
Benchmarking of the simulations with laboratory data

INAF-Milano Brera

Development of emission models for polarization studies on GRBs
Development of emission models to estimate the detection rates of GRBs
Study of Blazars SEDs to estimate their detection rates

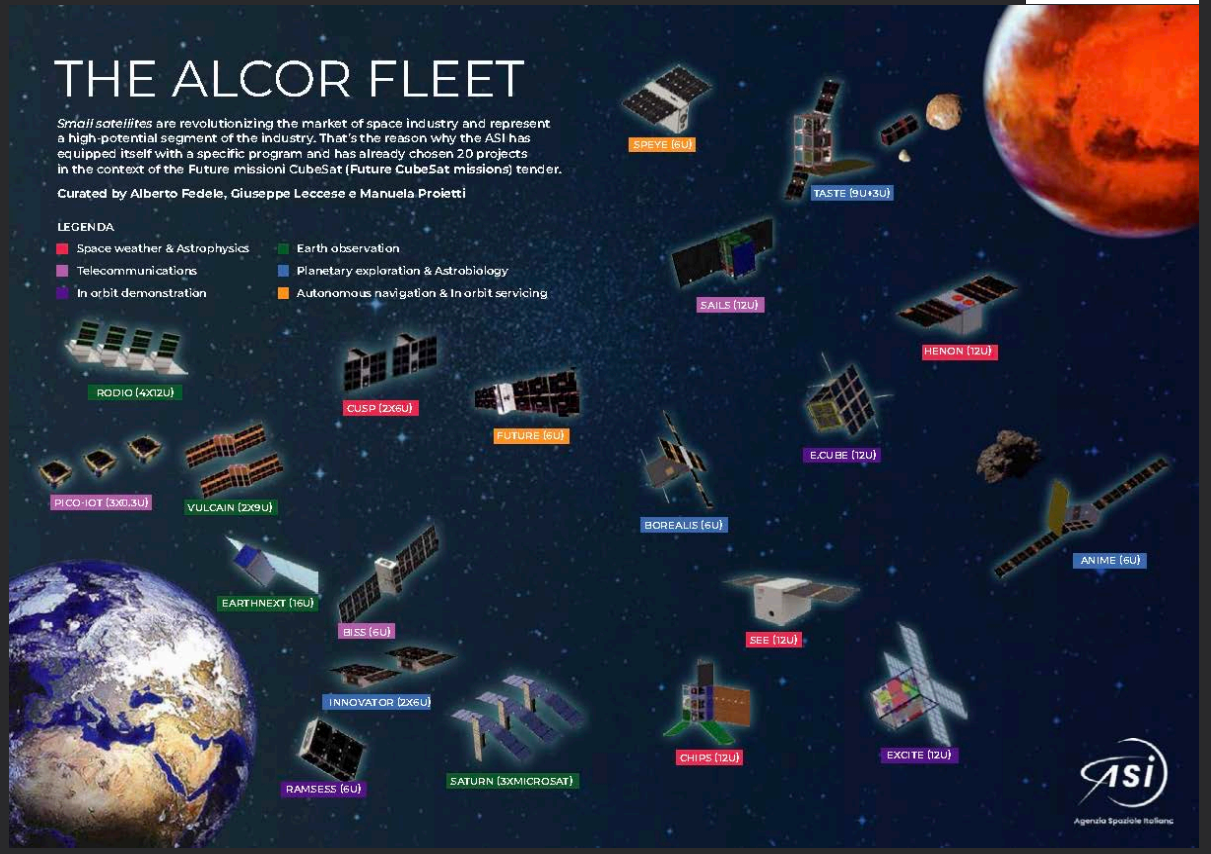
The ASI Nanosat Program (ALCOR)

ALCOR: ASI Nanosat Program

- First call for proposals for scientific and technological CubeSat missions in 2021.
- Proposals from companies, universities and research institutions.
- 20 missions selected
- Relevant mission domains:

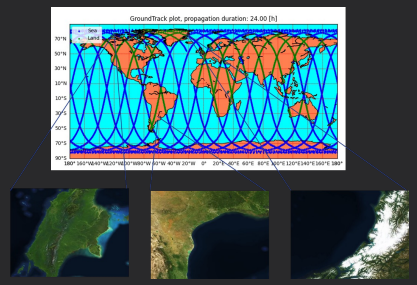
  Science: Planetary Exploration; Heliophysics/ Space Weather; Astrophysics; Astrobiology & Radiation.

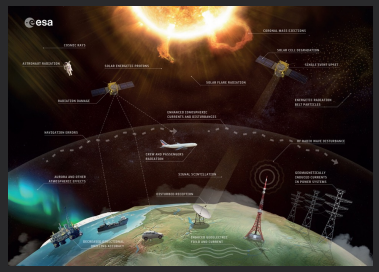
  Applications: Earth Observation; Telecommunications; In-orbit Demonstration

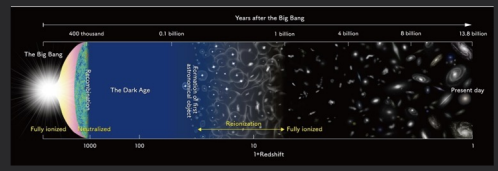


Scientific Nanosat Missions Overview

Name	Goal	Units	Target	Status
HENON	Space Weather	12U	DRO	Launch Q1 2027 Developed through ESA-GSTP
FUTURE	Exploration (Nav.)	6U	LEO	Phase C ongoing (Feb. 26) Launch Q2 2027
SEE	Heliophysics / Space Weather	12U	SSO (530 km)	Phase C starting Launch Q4 2028
LUMIO*	Exploration	12U XL	HALO @ Moon-Earth L2	Phase C starting; Launch 2027-2028 Developed through ESA-GSTP
RAMSESS	Radiation	6U	Earth Polar	Phase B closed
CUSP	Heliophysics / Space Weather	1-2 x 6U	SSO (500-600 km)	Phase B ongoing (June 2026)
BOREALIS	Biology	6U	LEO & 1600 km	Phase A/B ongoing (Feb. 2026)
ANIME	Exploration	12U	3 Near-Earth asteroids	Phase B in preparation (13 mo.)
TASTE	Exploration	12U + 4U	Deimos (Mars)	Phase B ongoing (March 2027)
CHIPS	Astrophysics	12U	SSO (500-600 km)	Phase A closed; project on hold





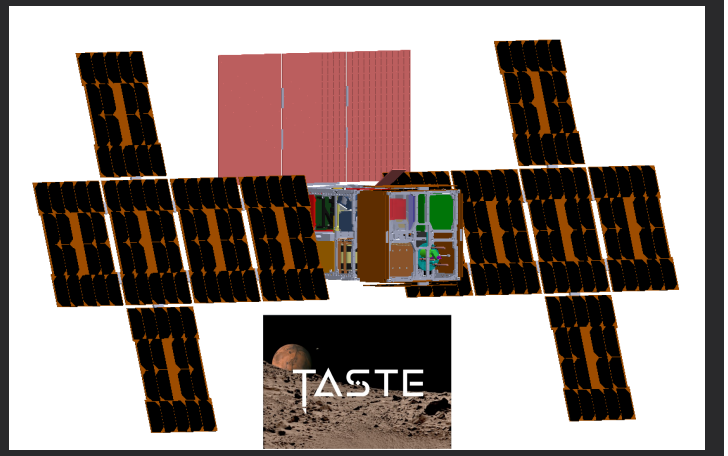


*Selected outside ALCOR initiative.

TASTE: Terrain Analyzer and Sample Taster Explore

Mission Goals: to understand the origin of Deimos Martian moon by combining both:

- global morphology and composition data obtained by an orbiter
- local surface elemental, organic and mineralogic composition obtained by a lander



Platform: 16U CubeSat (12U Orbiter + 4U Lander) equipped with Electric (Primary) and Chemical (Secondary) Propulsion

Payload:

Orbiter: Multispectral camera and miniaturized X-γ-ray Spectrometer (heritage of HERMES Pathfinder)

Lander: VIS-IR camera, a Tilting Mechanism, a Sample Acquisition Mechanism and a Lab-on-Chip

Mission Status: Phase B ongoing

- Expected launch date Q3 2029

		Payload				
		Orbiter			Lander	
		Camera	Spectrometer	Radio Science	SSA	Camera
Objectives	Global morphology and settings	✓				
	Global elemental abundance		✓			
	Landing site morphology and texture	✓				✓
	Landing site organic contents				✓	
	Landing site properties compare to global surface properties	✓	✓		✓	✓
	Gravity field determination and internal structure			✓		

CUSP: CUbesat Solar Polarimeter

Goal: heliophysics CubeSat missions to study the Hard X-ray polarization (heritage of IXPE):

- HXR polarimetry could improve the knowledge of the initial conditions of the eruption of most powerful CMEs

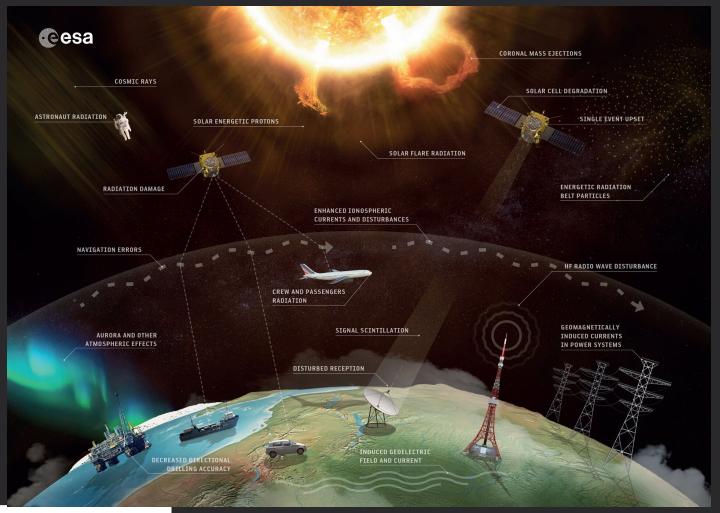
Platform: 1-2 6U CubeSat(s)

Payload:

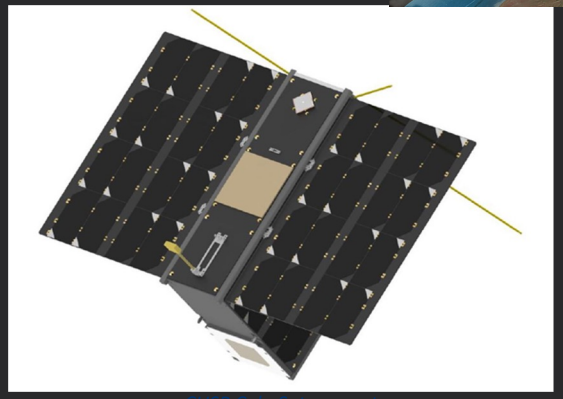
- dual-phase Compton-scattering polarimeter

Mission Status:

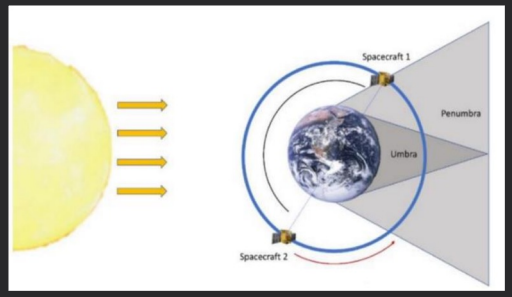
- Phase B ongoing
- Expected launch date 2028-2029



(courtesy ESA)



CUSP CubeSat concept



CUSP coverage

Agenzia Spaziale Italiana · INAF · IMT Ingegneria Marketing Tecnologia · Università della Tuscia · Alma Mater Studiorum Università di Bologna · CIRI AEROSPACE · deda.

Moon Opportunities

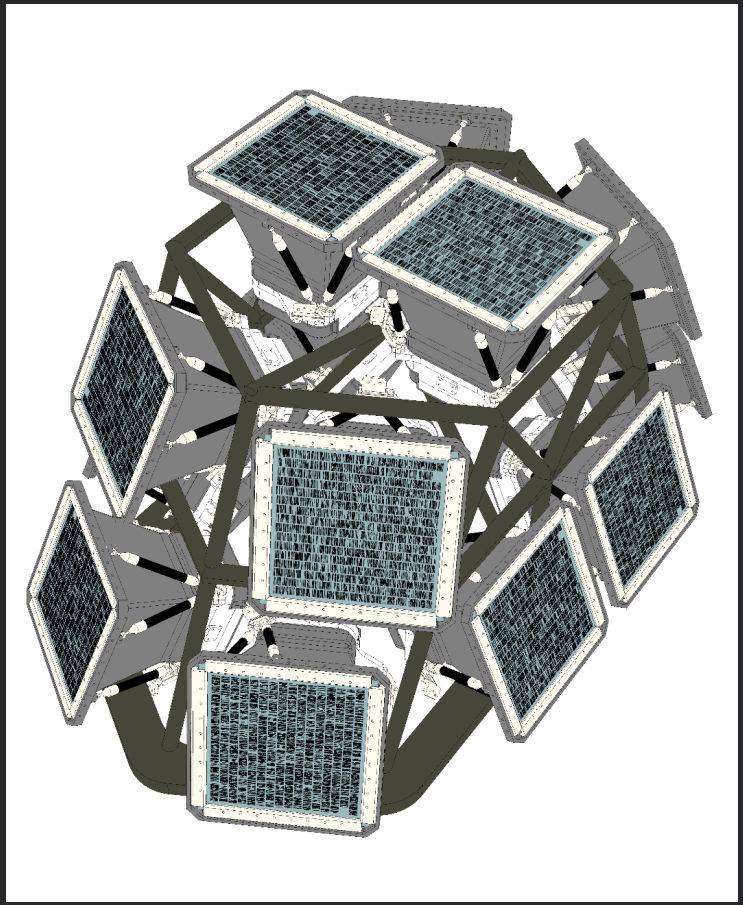
LEM-X
The Lunar Electromagnetic Monitor in X-rays

- **Scientific Motivation:** Provide the X-ray access to the new era of multi-messenger astrophysics by complementing Gravitational Waves, and neutrino and multi-frequency observatories with wide-field/all-sky fast X-ray localization and long-term monitoring of high-energy transients (e.g., GRBs).
- **Instrument Profile:** LEM-X is a modular, wide-field, coded-aperture imaging telescope operating in the 2–50 keV energy range with an accuracy of ~1 arcmin and 350 eV energy resolution. Multiple identical cameras expand the field of view.
- **Deployment:** Designed for the Lunar surface, leveraging the Moon's stable environment and rotation to continuously monitor a large portion (half) of the sky at any time. Intrinsic modularity, reducing the installation constraints and with the potential to expand (e.g., two sites would enable full-sky access).
- **Programmatic Framework:** Development started within the Italian Earth-Moon-Mars (EMM – 2023-2026) program (INAF, ASI, CNR) to advance lunar astronomical observations and test technologies for future Mars exploration.

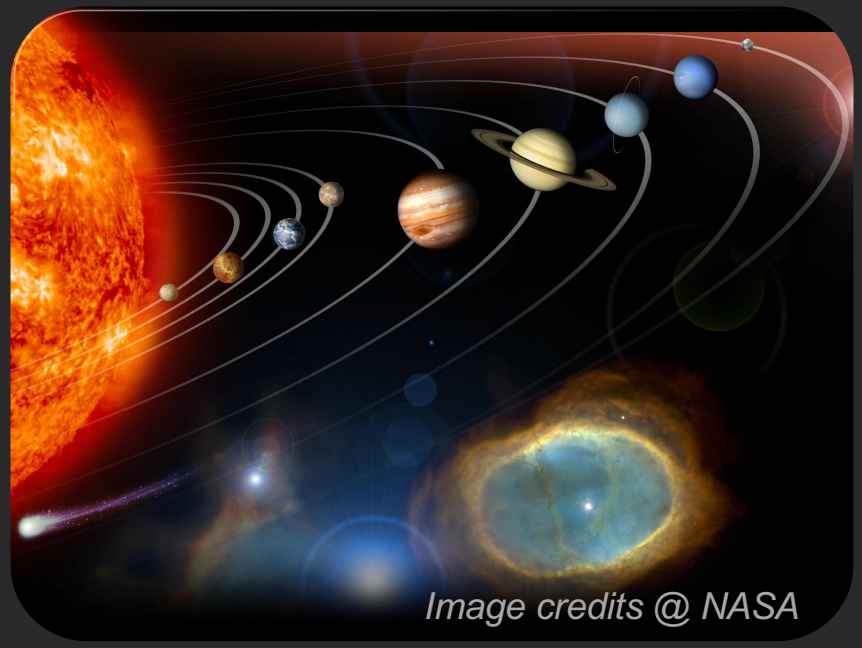
Finanziato dall'Unione europea NextGenerationEU
Ministero dell'Università e della Ricerca
Italiadomani
Agenzia Spaziale Italiana

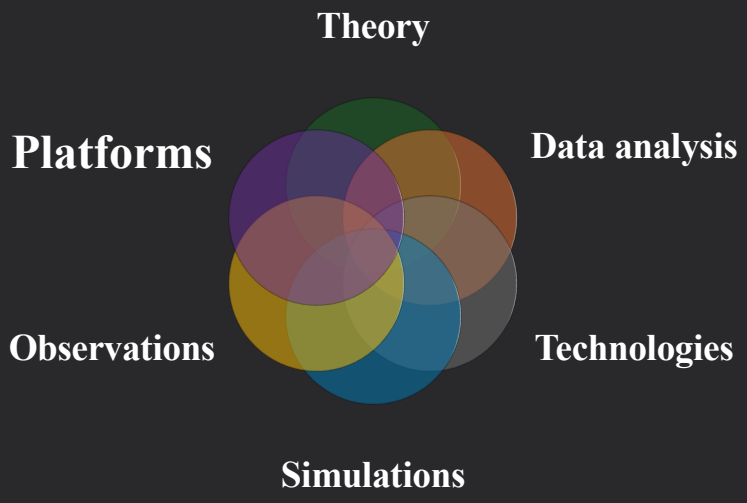
The LEM-X instrument

- The Lunar Electromagnetic Monitor in X-rays (LEM-X) project aims at developing a large, permanent X-ray observatory on the surface of the Moon.
- The instrument is an all-sky monitor operating in the X-ray energy band.
- LEM-X (full instrument) is composed of seven pairs of coded aperture cameras on a dome-shaped structure.
- When deployed on the Moon's surface it will simultaneously monitor half of the sky.
- Two stations at opposite Moon's locations would provide full-sky monitoring.



Future perspectives in solar system and astrophysics sciences

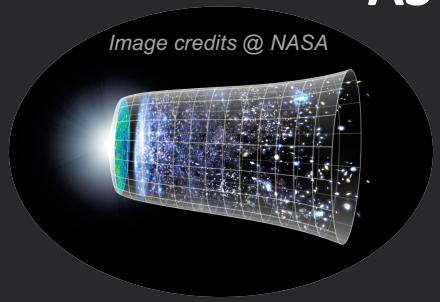




2023: ASI sponsored and coordinated a Working Group with national experts from ASI, Universities and research centers to envision national roadmaps to advance in the two fields of **Solar System** and **Astrophysics**

in synergy with roadmaps/studies by international agencies but with a national focus

ASTROPHYSICS Working Group: composition



Origin and evolution of the Universe

Gianluca Polenta (ASI)
Alberto Oliva (INFN)
Stefano Ettori (INAF)
Matteo Viel (SISSA)
Martina Gerbino (INFN)
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Francesco Piacentini (Univ. Roma Sapienza)
Marina Migliaccio (Univ. Roma Tor Vergata)
Valerio Vagelli (ASI)

Extreme Universe

Luigi Costamante (ASI, former)
Valerio Vagelli (ASI)
Fabio Muleri (INAF)
Andrea Marinucci (ASI)
Fabio Gargano (INFN)
Alessandra De Rosa (INAF)
Elena Amato (INAF)
Gabriele Ponti (INAF)
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Galaxy, Stellar and Planetary formation and evolution

Elisabetta Tommasi (ASI)
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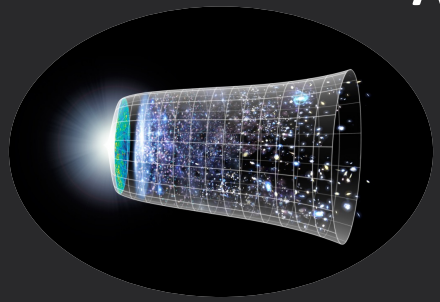
Maria Pia Di Mauro (ASI)
Simona Gallerani (SNS)
Elena Pancino (ASI)
Paola Santini (ASI)

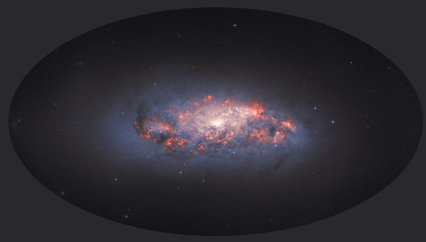
Coordinator: **Immacolata Donnarumma (ASI)**

ASTROPHYSICS Working Group: outcome



Origin and evolution of the Universe

Extreme Universe



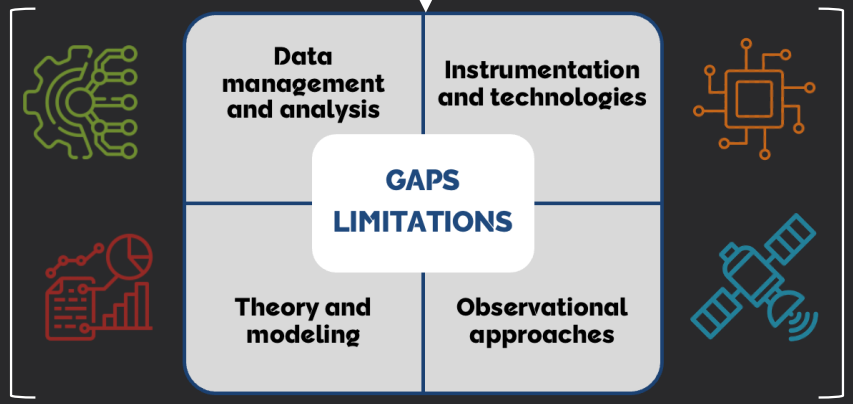
Galaxy, Stellar and Planetary formation and evolution

2-year activity:

i. Scientific frontiers to be tackled
ii. State of art
iii. Diagnostic and observables
iv. Gaps and limitations

presented to the italian community at workshop in 2025

Document soon to be published



Perspectives

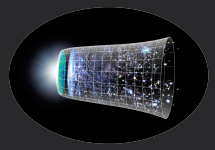
Extend /update the analyses

Gather feedbacks and inputs from the scientific community

Analyse the national heritage and know-how

Maintain an up-to-date reference on state-of-art, gaps, heritages

Origin and evolution of the Universe

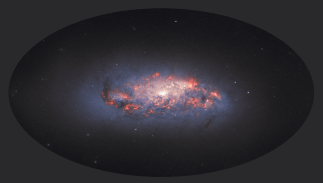


Q1: How did the Universe begin?
Q2: How did the cosmic structures form and evolve?
Q3: What is the nature of DM and dark energy?
Q4: What is the origin of the matter/antimatter asymmetry?
Q5: How did the Universe get reionized?
Q6: The thermal history of the Universe

Extreme Universe

Q1 - What is the **origin of cosmic rays** of all species and energies?
Q2 - Which are the mechanisms of **acceleration of particles** in the Universe?
Q3.1 - How does matter **accrete** and is **ejected** from compact objects?
Q3.2 - How is a relativistic jet **formed** and how does it **dissipate** its energy?
Q4 - How do the environment, accelerated particles, and astrophysical sources **co-evolve**?
Q5 - How to explore **Fundamental Physics** and **Cosmology** with extreme Astrophysical sources?
Q6 - How to probe the **particle nature** of Dark Matter?

Galaxy, Stellar and Planetary formation and evolution

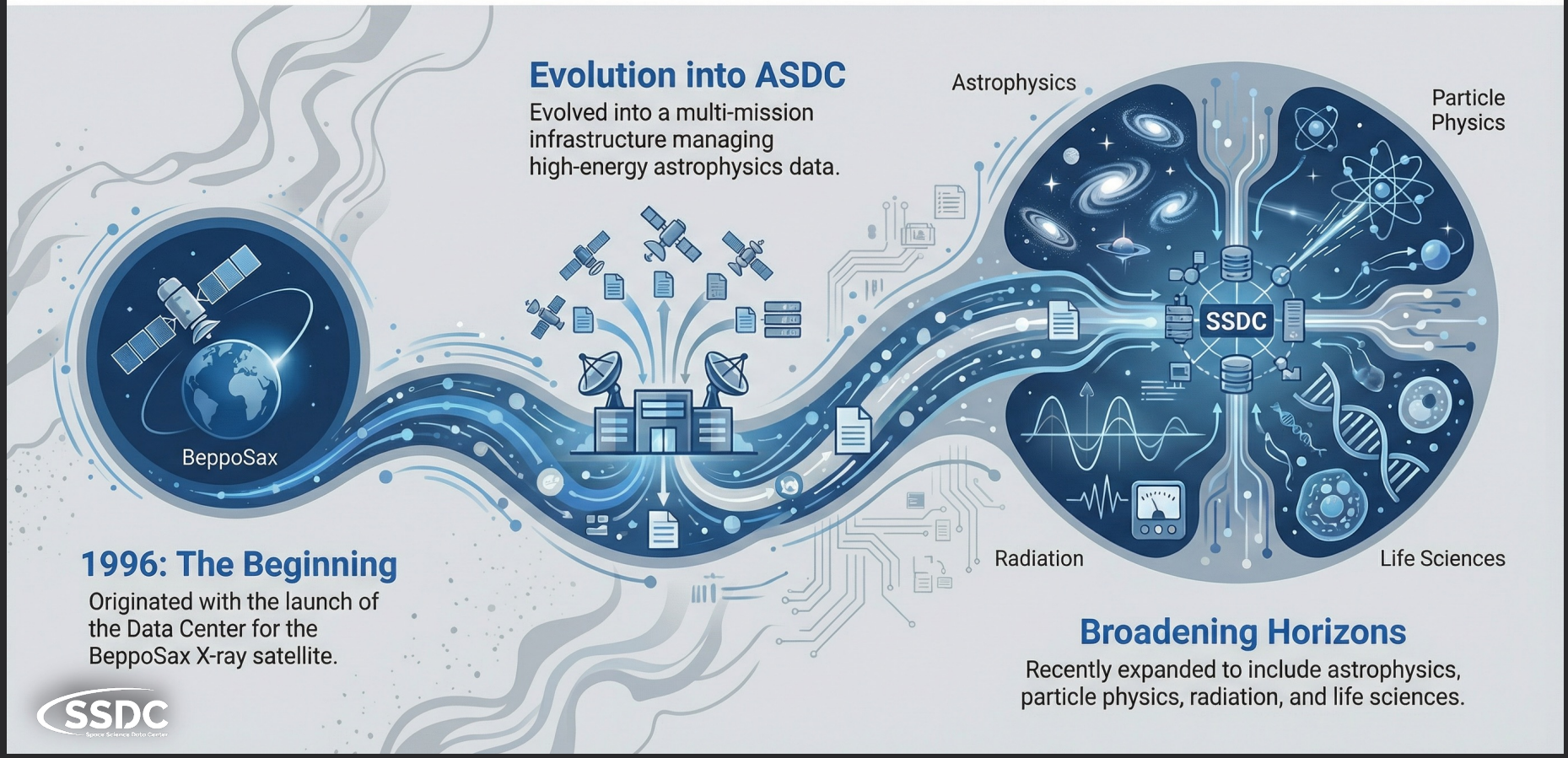


Planets and planetary systems **- Q1**: How do planetary systems form and evolve? **Q2:** How is the architecture of planetary systems linked to their host stars? **Q3:** What can we learn about exoplanet interiors, atmospheres, and potential biomarkers?

Stars, Milky Way, and Local Group **- Q1:** How do stars form? **Q2:** How do stars evolve and how do they die? **Q3:** How did stellar populations in the Galaxy and Local Group form and evolve over time?

Galaxies **- Q1:** What is the role of star formation, dust and gas in galaxy evolution? Q2: How do galaxies form and evolve in the early Universe? Q3: What is the impact of AGN on the host galaxy properties and the intergalactic medium? Q4: How do the first black holes form and grow?

The Journey of the ASI Space Science Data Center



SSDC: Hub of Competencies

Powering Scientific Space Operations

Astrophysics

Planetology

Heliophysics

Particle Physics

Life Sciences

Data Acquisition & In-Flight Operations • Processing • Archiving • Distribution

45%
Operational Missions

Currently operational missions, with others concluded, in development, or planned.

The ASI Space Science Data Center (SSDC) coordinates the management of scientific data from national and international space missions, providing services and support to maximize usability for the scientific community.

Innovating Data Management & Analysis

Advanced Software & Online Analysis Tools: Enabling high-level scientific analysis and multi-mission comparison.

Pioneering New Techniques: Using AI and Machine Learning

Next-Generation Infrastructure: A framework enabling data fusion from different missions for coordinated exploitation.

Italian Small Scientific Mission – Initiative Overview & Key Steps

Program Objectives

- Support the selection and development of innovative, Italian PI-led small space missions (Fast Track, max 100kg for payload) in Low Earth Orbit (LEO).
- Strengthen collaboration across Italian research institutes, universities, and industry.
- Enable payload development, Science Operation Center (SOC) activities, and international cooperation.

Process Steps & Timeline (Agreement ASI-INAF n. 2026-2-HH.0 started in end Jan 2026):

- Publication of the A/B1 Phase Call for Ideas (by INAF): early Feb 2026
- Presentation of Industrial Platforms: ASI 13 Feb 2026 https://www.asi.it/event/presentazione-delle-carrozze-industriali-per-la-partecipazione-al-bando-inaf-per-la-piccola-missione-scientifica-nazionale/
- Submission deadline for mission proposals: mid Apr 2026
- Evaluation by the ASI–INAF Coordination Board
- Negotiation & Final Ranking (max 3 selected projects)
- Start of Phase A/B1 (12 months)
- Selection of up to 2 missions for Phase B2: early 2027
- Start of Phase B2 (12 months)
- Completion of preliminary design up to PDR
- Final Workshop & Results Presentation
- Selection of the mission to enter Phases C/D: early 2028
- Launch: 2031