

SST (PhD) activities at GSSI and UnivAQ: some highlights

Roberto Aloisio
Ivan De Mitri



Mauro Maccarrone
Mirko Piersanti



SST-PhD vs GSSI and the University of L'Aquila

Most of the SST topics are covered:

Curriculum 1: Observation of the Universe → GSSI ,UnivAQ

Curriculum 2: Earth and the Sun-Earth system → UnivAQ, GSSI

Curriculum 3: Planetary Sciences → UnivAQ

Curriculum 4: Astrobiology, Life Sciences and Space Medicine → UnivAQ

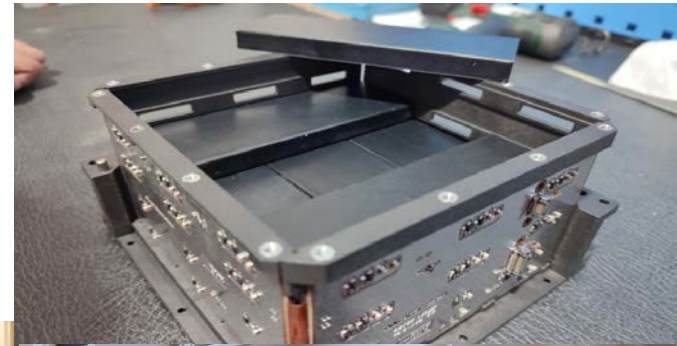
Curriculum 5: Space sensing and instrumentation → GSSI , UnivAQ

Curriculum 6: Engineering and satellite platform technologies → UnivAQ , GSSI

Curriculum 7: Economics, law and space diplomacy → GSSI



www.gssi.it
www.univaq.it



G S The DAMPE mission

S I

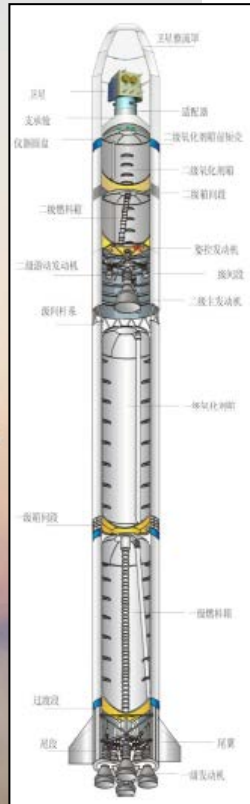
Launched on Dec. 17, 2015
 From the Juquan Space Center
 Gobi desert
 CZ(LM)-2D rocket



8th International DAMPE workshop, GSSI, December 2018

Three major scientific goals

Mass: 1850 kg (scientific payload 1400 kg)
 Power : 640 W (scientific payload 400 W)
 Orbit: sun synchronous
 Altitude: 500km
 Inclination: 97.41°
 Period: 95 minutes
 Downlink: 16 GB / day
 Lifetime: > 3 years



Cosmic ray physics ←



→ γ-ray astronomy

↓
 Dark matter indirect detection

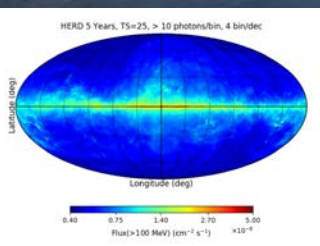
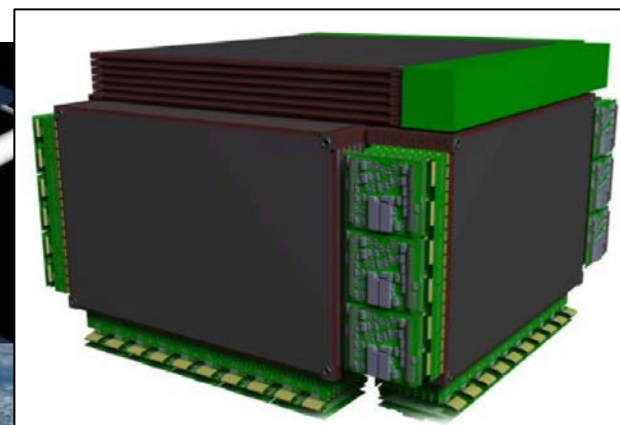
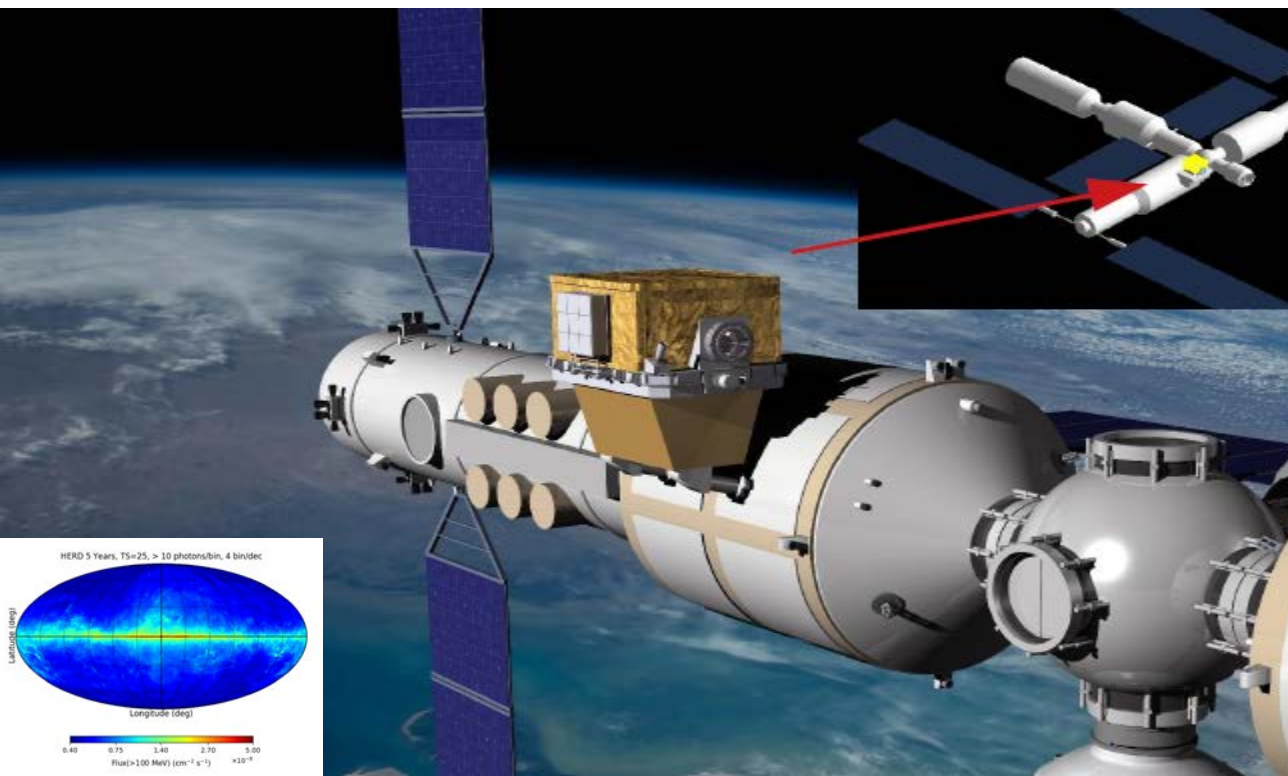
HERD: High Energy Radiation Detector

□ HERD is proposed as an astroparticle physics experiment onboard the China's Space Station, and is planned for operation starting around 2027 for about 10 years.



□ Main Science goals

- **Dark matter**: Indirect dark matter search with unprecedented sensitivity
- **Cosmic-ray**: Precise cosmic ray spectrum and composition measurements up to few PeV
- **Gamma-ray**: Gamma-ray monitoring and full sky survey





The NUSES mission

A space mission (lunch within the first half of 2026) pathfinder for new observation methods and technologies in the study of high and low energy radiations in space: enabling new sensors, tools and methodologies. The NUSES satellite hosts two payloads.

Zirè

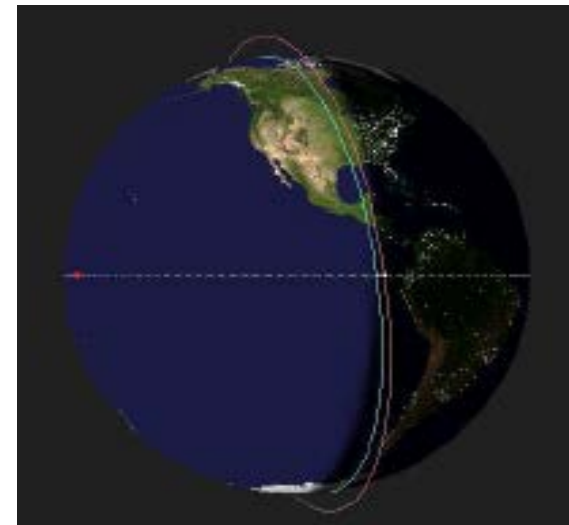
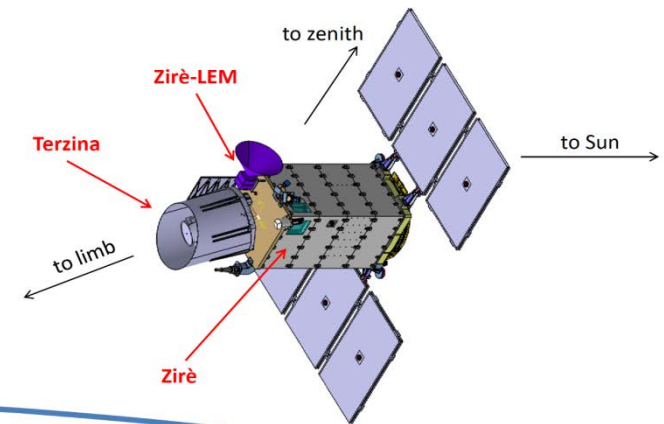
Monitors the fluxes of low energy (<250 MeV) electrons and protons, to study Van Allen belts, space weather and the magnetosphere-ionosphere-litosphere couplings (MILC) in case of seismic/vulcanic activities.

Detect 0.1-10 MeV photons for the study of transient (GRB, follow up of GW events, SN emission lines) and steady astrophysical sources of gamma rays.

Terzina

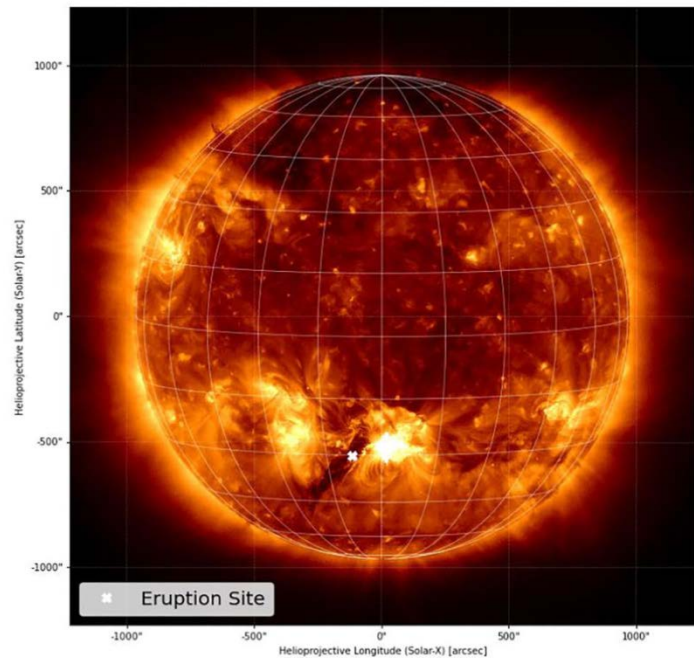
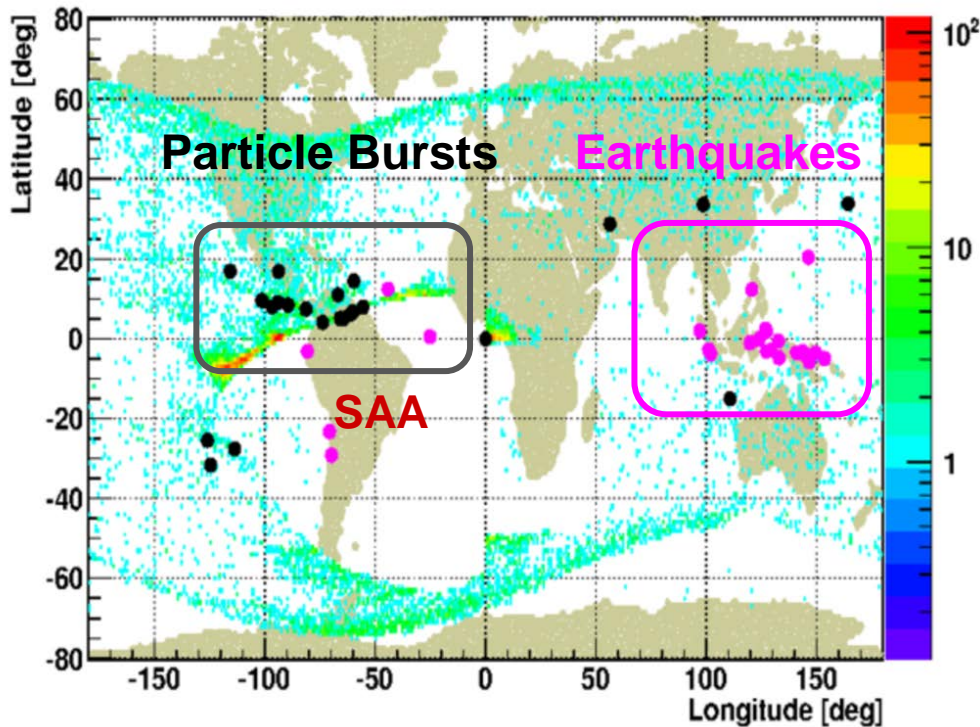
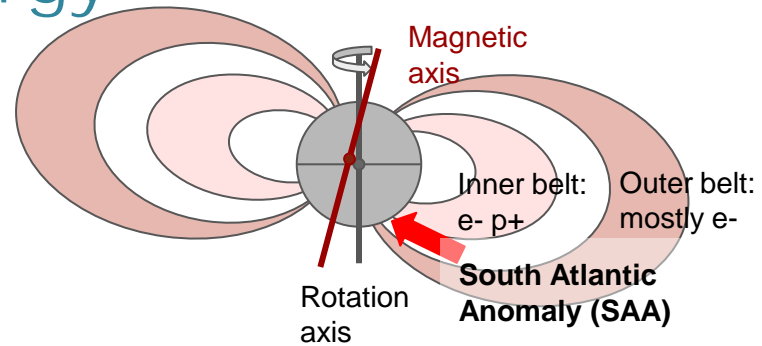
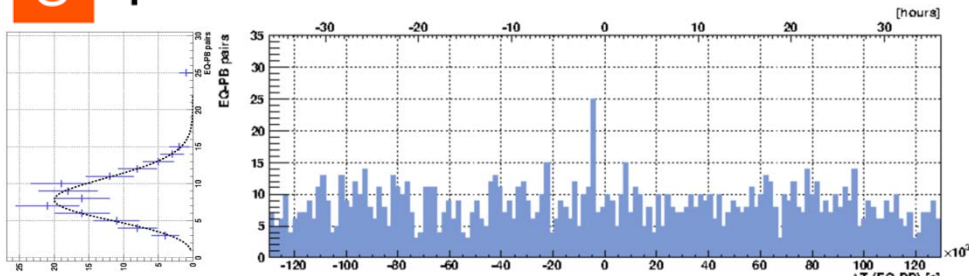
Path-finder of future missions devoted to the detection of high energy ($E > 1$ PeV) astrophysical neutrinos and cosmic rays through space-based detection of the atmospheric Cherenkov emission.

Mission Lifetime	3 y
Mean Altitude	550 km, LEO
Semi-major axis (km)	6928 km
Eccentricity	0
Inclination (deg)	97.6 deg, SunSync
LTAN	18:00:00
Pointing	< 0.1 deg



G S Science goals 1 – low energy

S I



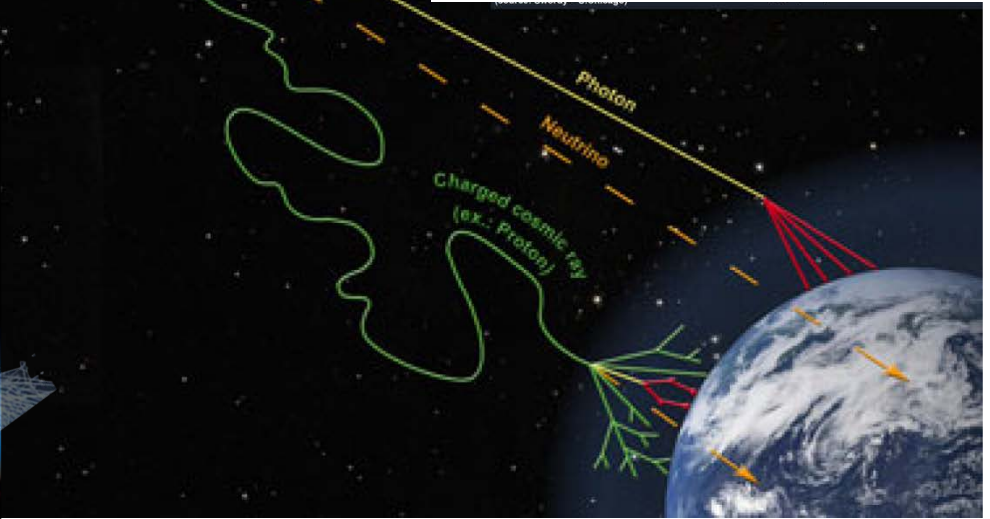
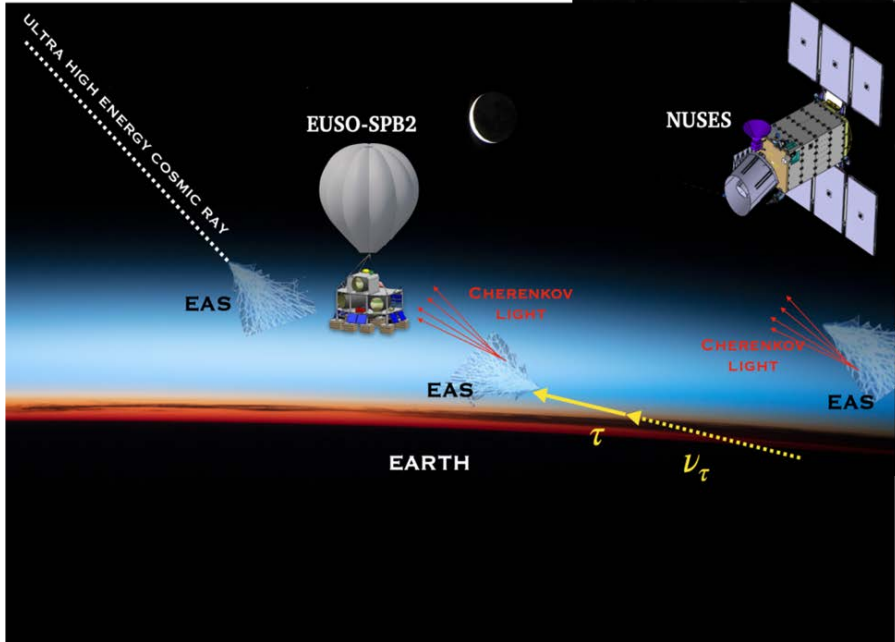
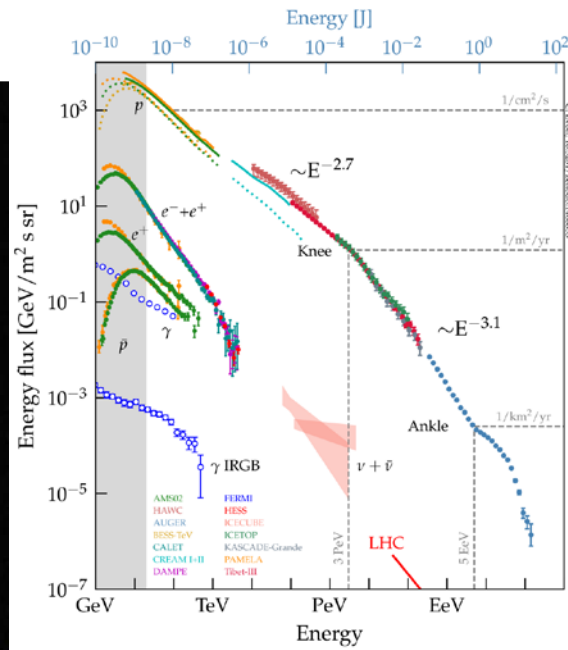
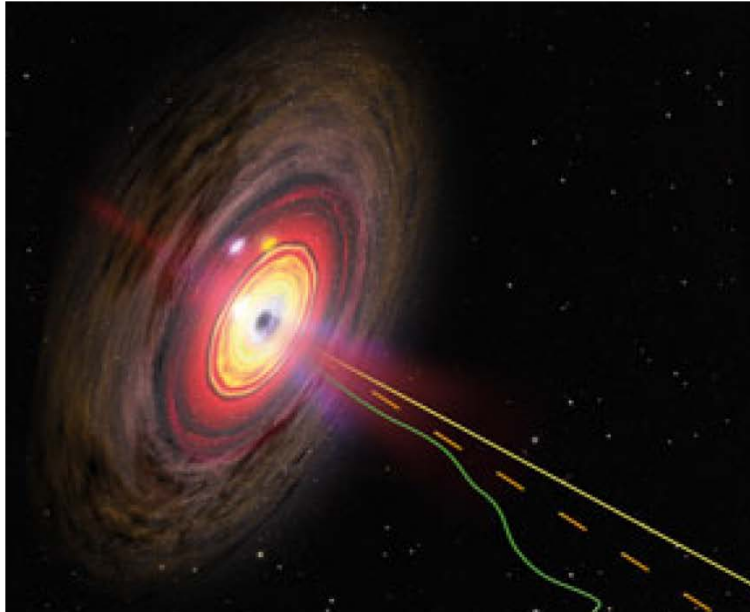
Particle Bursts and Earthquake $M > 5$ (hints of) time correlation. CSES1 and CSES2 missions, with Italian instruments onboard, are pursuing the same measurement.

Variable conditions of the Sun activity
Solar wind takes 1-2 days to reach Earth
Magnetic storms can produce strong EM fields

Science goals 2 – high energy

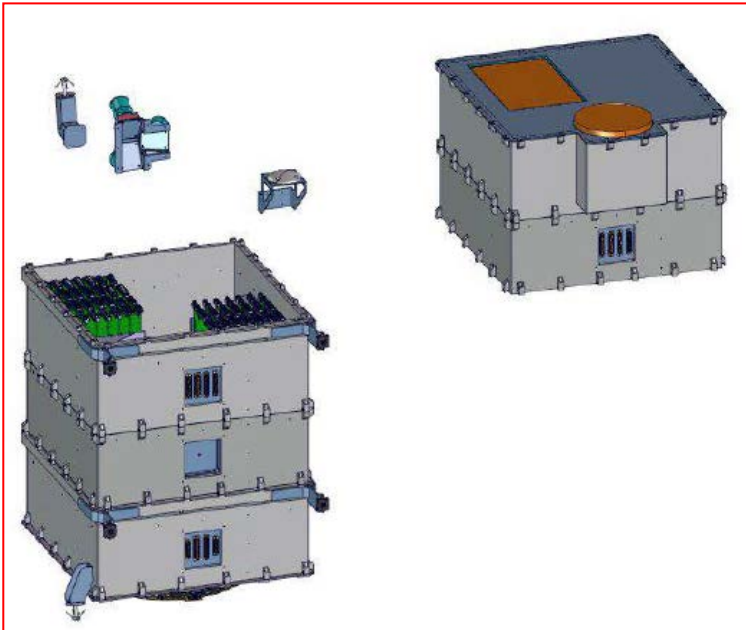
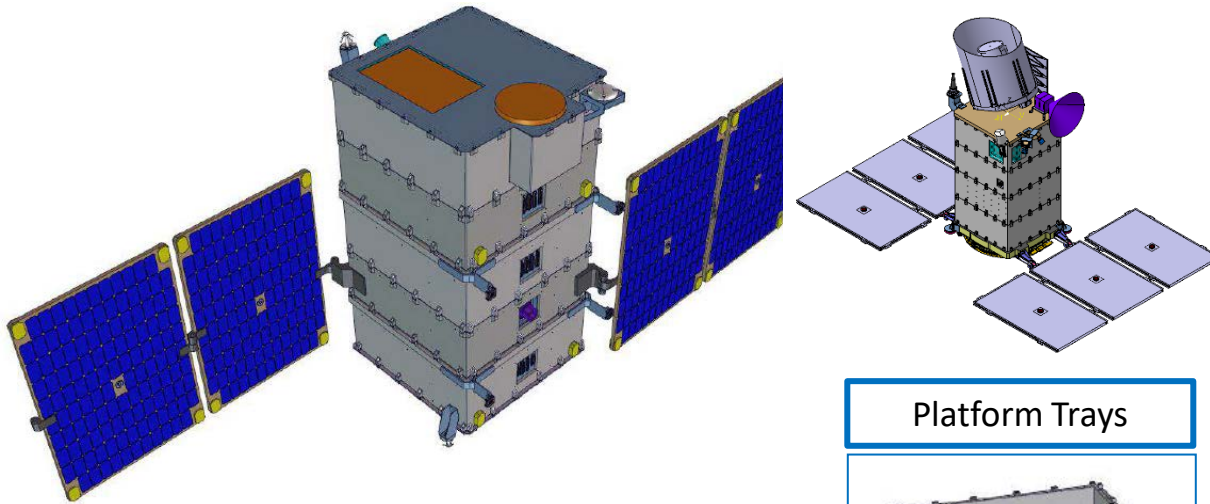
Observation of high energy ($E > 1$ PeV) cosmic rays and neutrinos through Cherenkov emission in the Earth atmosphere.

Direct observation of gamma rays in the energy band 0.1-10 MeV.

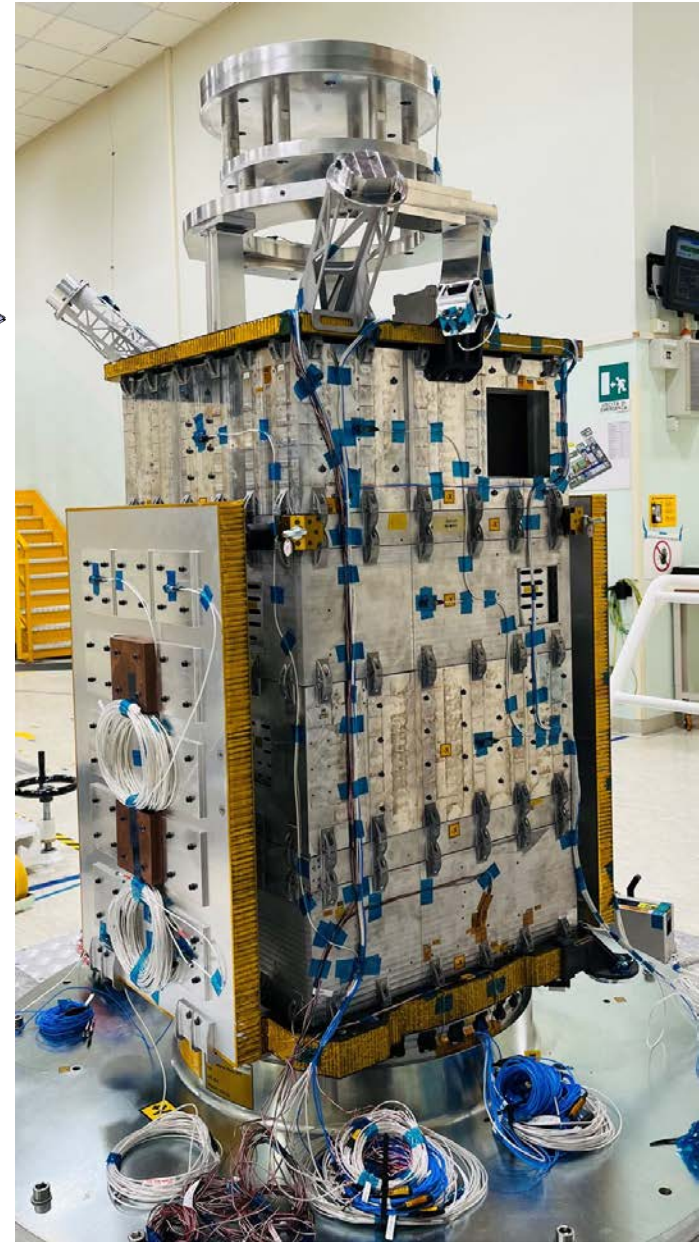
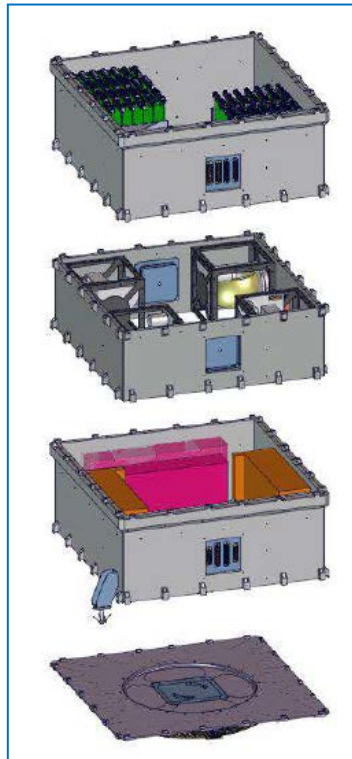


NIMBUS (New Italian Micro BUS)

is a new Platform concept which foresees a modular approach relying on standard trays.



Platform Trays



The VITALITY PNRR Project

Nine Universities from Abruzzo/Marche/Umbria



Research Institutions



Regional governments



Private partners



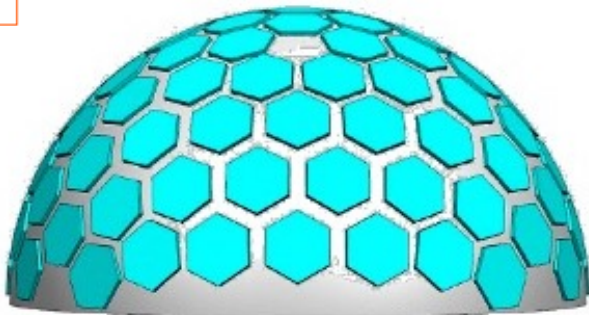
- ✓ hub composed by the nine Universities, lead by L'Aquila University
- ✓ 10 Spokes: 4 Abruzzo, 4 Marche, 2 Umbria
- ✓ Total grant: 120 Meuro, activities started 1/23 will be concluded by 6/25

Spoke GSSI – Advanced Space Technology and Research Alliance (ASTRA)

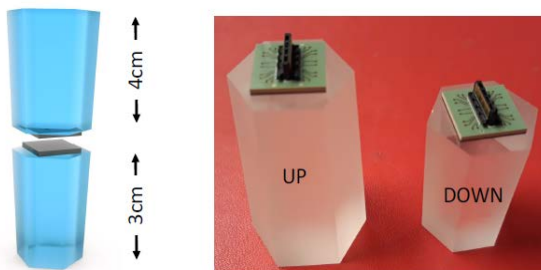
- ✓ Collaboration among: GSSI, Perugia University, INAF, FBK, TAS-I
- ✓ Three Work Packages, ten tasks
- ✓ 10 Meuro grant, 77 researchers from 5 partners, 12 new positions opened.
- ✓ End of the project June 2025.



Advanced Technologies for Astroparticle in Space	Digital platforms for Space Industry	Technology Transfer and Impact Management
Crystal Eye: a novel satellite for X and gamma ray observation (follow-up of the NUSES-Zirè technology)	Automatic tuning, analysis, and optimization of systems using digital twins	Protection and Valorization of Intellectual Property
Cryogenic systems for the LGWA pathfinder	Trustworthiness of smart and autonomous systems	Supply chain development and spin-off creation
Infrared Adaptive-Optics facility at the AZT-24 telescope of Campo Imperatore	Onboard SW platform for New Space Applications	Ensuring the ethical use of new technologies
Multifunctional structures for space applications		

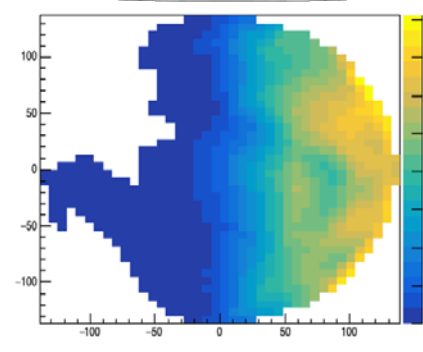
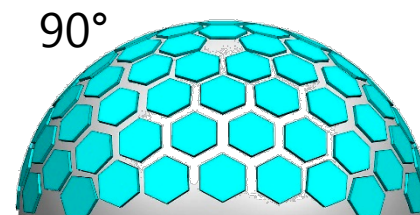
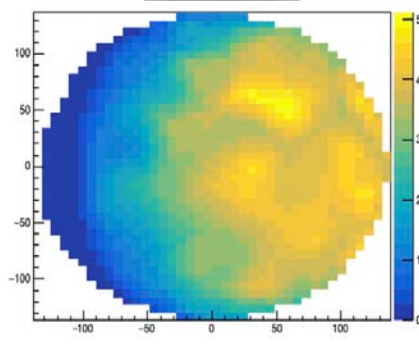
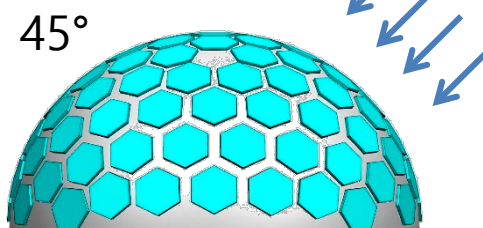
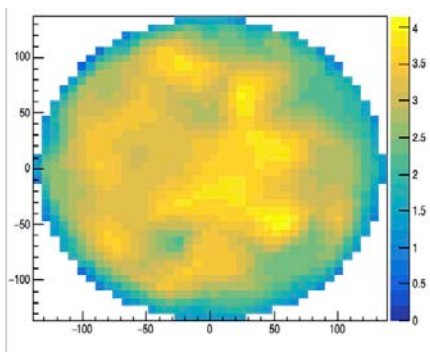
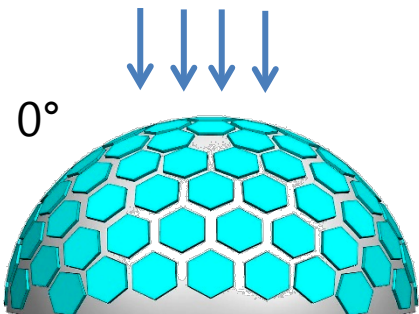


A follow-up of the NUSES-Zirè technology. A state-of-the-art space-based detector to observe gamma rays in the energy range 0.1 – 10 MeV, to study transient and steady sources. Double layer of LYSO pixels covered by a veto dome. The device will have 110 pixels per layer. Pixel readout with a 12 x12mm² SiPM array. A single module is expected to improve at least by a factor 3 the localization capability of current detectors as Fermi-GBM.



Technological pathfinder selected by ESA for the first SpaceRIDER

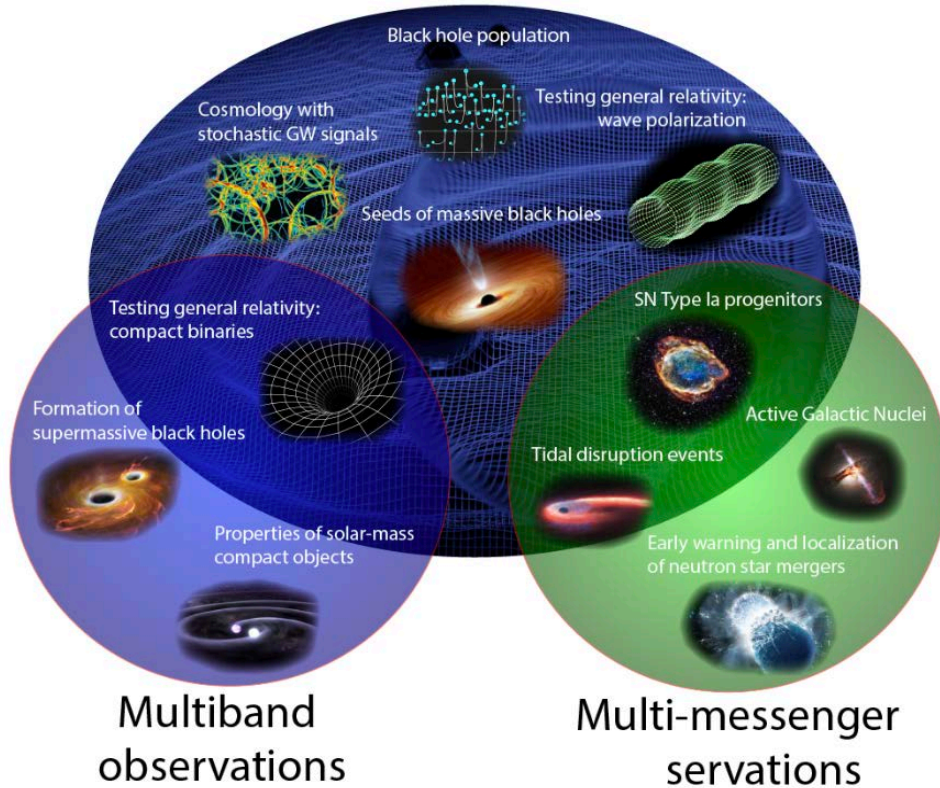
- 2024-2025: Integration and tests
- 2026: Prototype Flight onboard ESA Space Rider (2 months LEO)
- 2026: Pathfinder Flight onboard NUSES



Lunar Gravitational Wave Antenna



LGWA Science



GW observations from 1mHz to 1Hz, with peak sensitivity in the decihertz band.

The **LGWA pathfinder mission Soundcheck** was proposed for a geophysical study of a permanently shadowed region and as technology demonstrator and **selected by ESA for flight opportunities.**

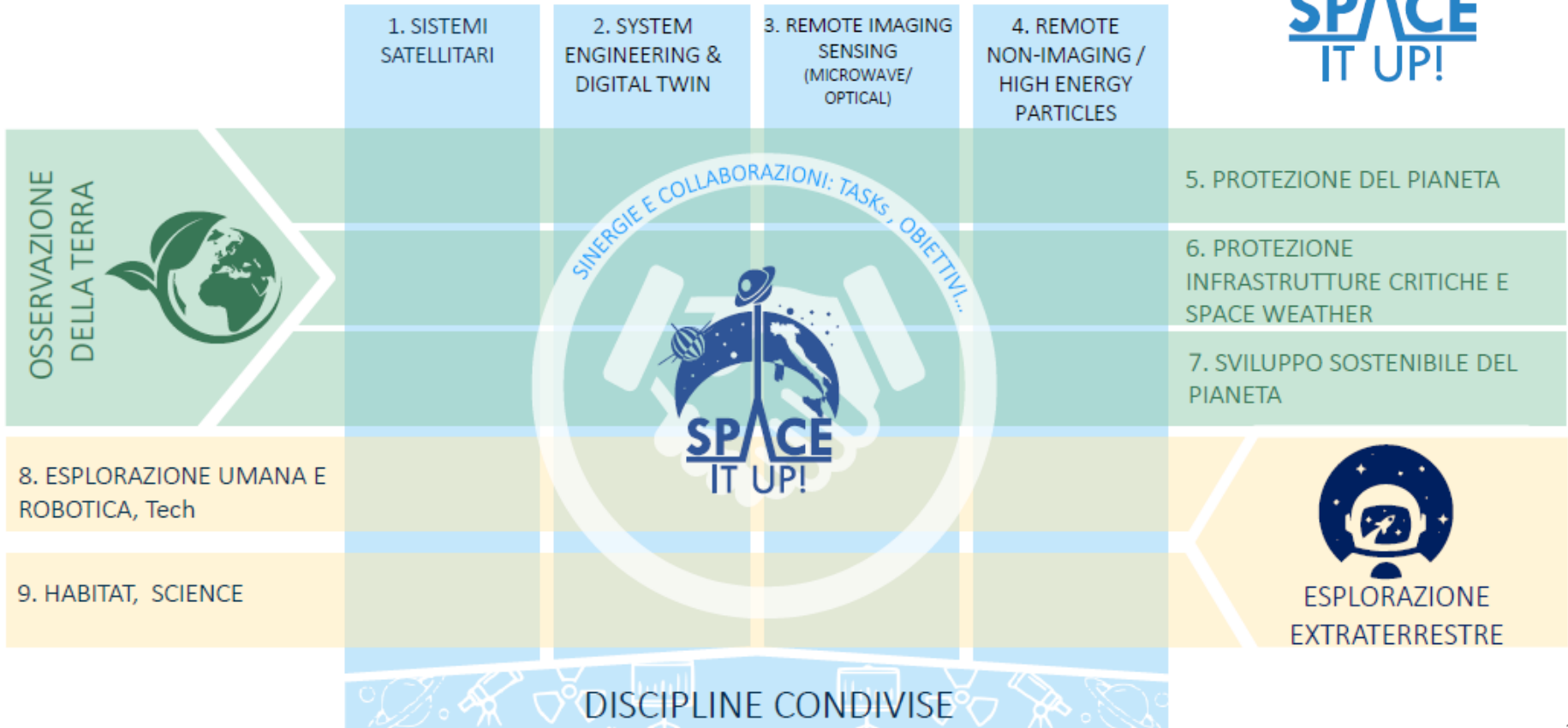


The Space it Up project



- ✓ Collaboration among more than 30 Italian Universities, research Institutions and private firms.
- ✓ Program funded by ASI with 80 Meuro
- ✓ GSSI in 4 spokes and in collaboration with SISSA, SSSA and IUSS

9 Spokes



A new laboratory

Space and Earth innovation Campus (SEIC) funded under PNRR

- ✓ 23 partners lead by GSSI
- ✓ 3,500 square meters infrastructure
- ✓ Total grant: 19 Meuro



REGIONE ABRUZZO



POLITECNICO MILANO 1863



INGV



SANOFI



H-FARM



GRANIT TECHNOLOGIES AND ENGINEERING (GRT) SA



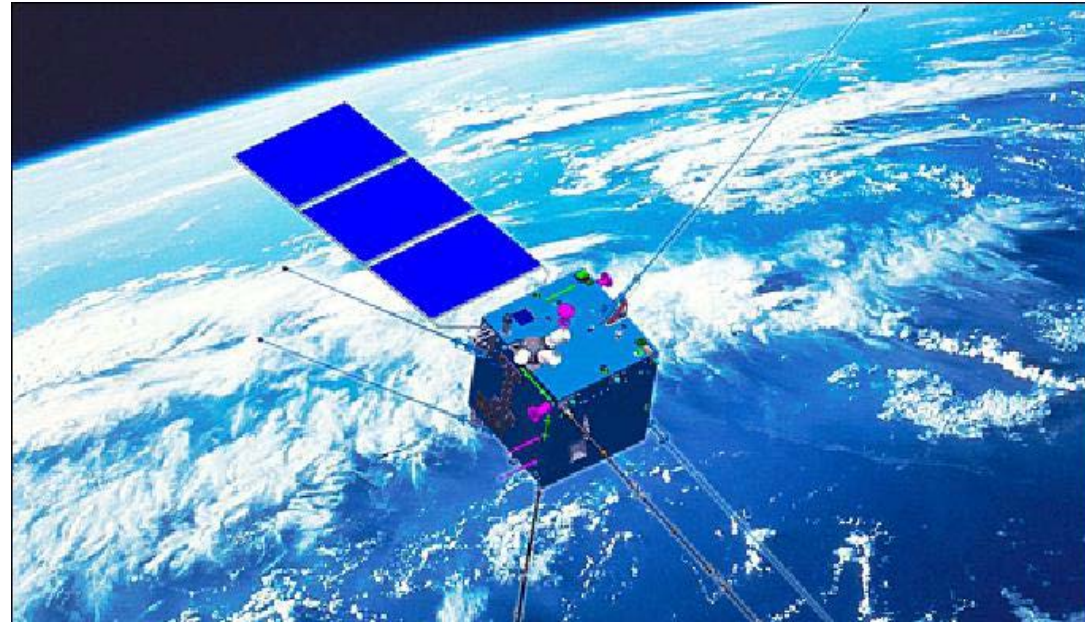


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The CSES-Limadou Mission



- Development of an electric field detector (EFD) for CSES-02 satellite together with INAF-IAPS;
- Commissioning phase of EFD and of its data validation/calibration;
- Scientific analysis of electric-magnetic and plasma data of both CSES-01 and CSES-02 satellite
- LiMIC group for the development of a theoretical model for the lithosphere-atmosphere-ionosphere coupling during both active solar conditions and high seismic activity.



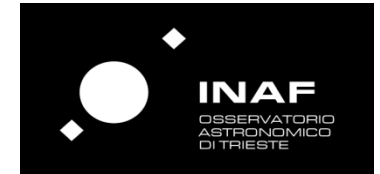
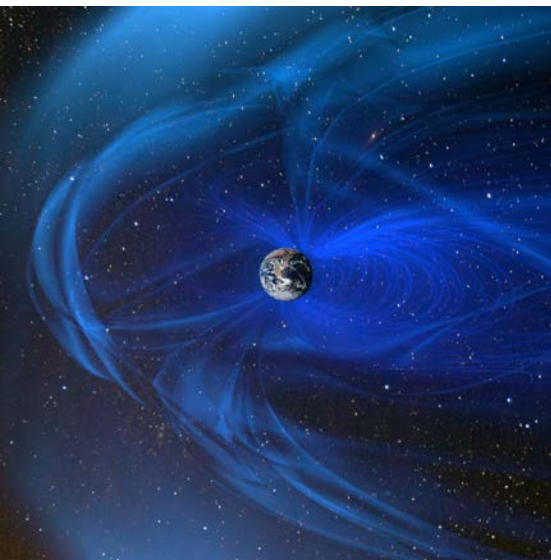
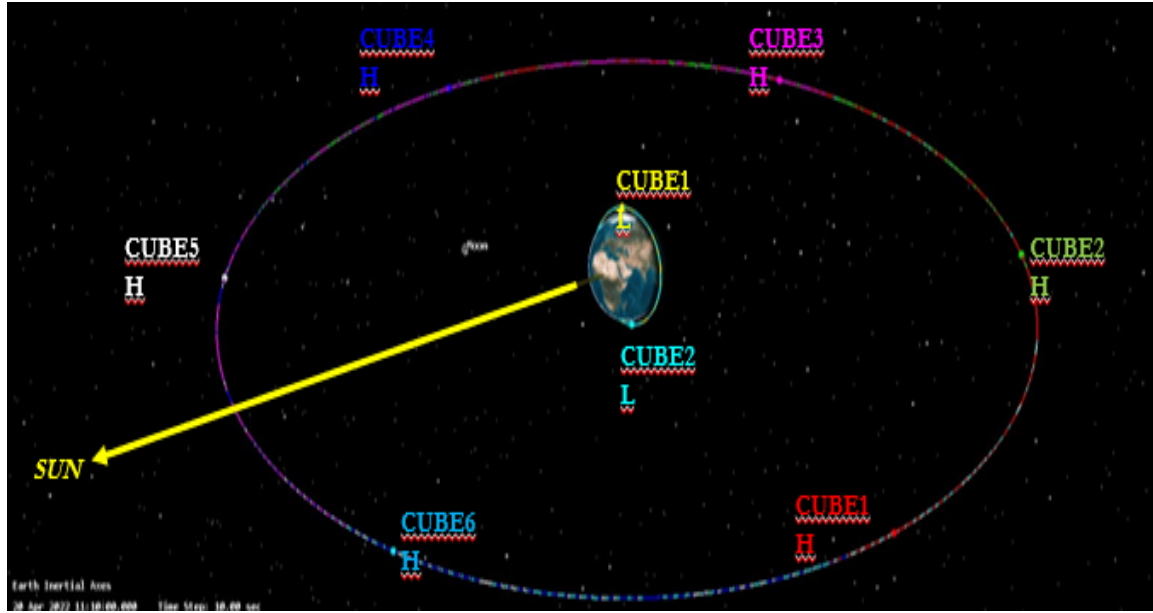


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The CME – ESA Mission



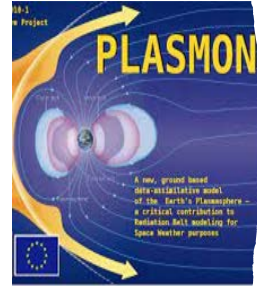
- Nanosatellite constellation for natural hazard monitoring.
- Development of a Plasma Analyzer for nano-satellites together with INAF-IAPS
- Solar wind-magnetosphere-ionosphere coupling modelling.





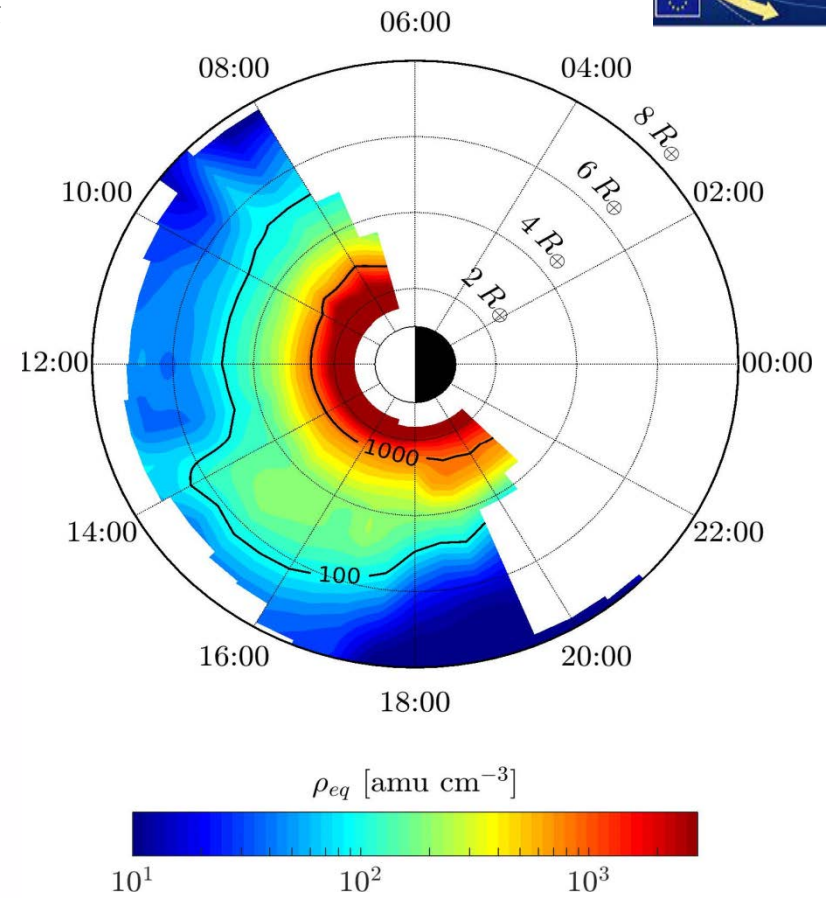
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Monitoring the magnetosphere

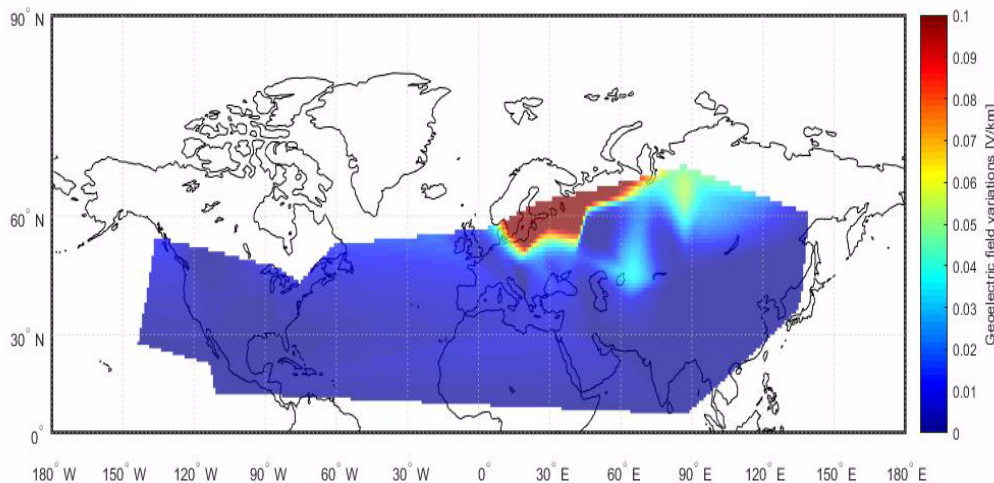


- Field line resonance along EMMA array (managed by University of L'Aquila).
- Remote sensing of the magnetospheric plasma density via magnetic field observations at ground (EMMA)
- Magnetospheric response to solar event in terms of electric currents and field lines configurations;
- Evaluation of Geomagnetically Induced Currents (GIC) hazard at ground during active solar conditions.

01 June, 2013 (DoY 152)



**GIC at ground during September 2017
Geomagnetic Storm**



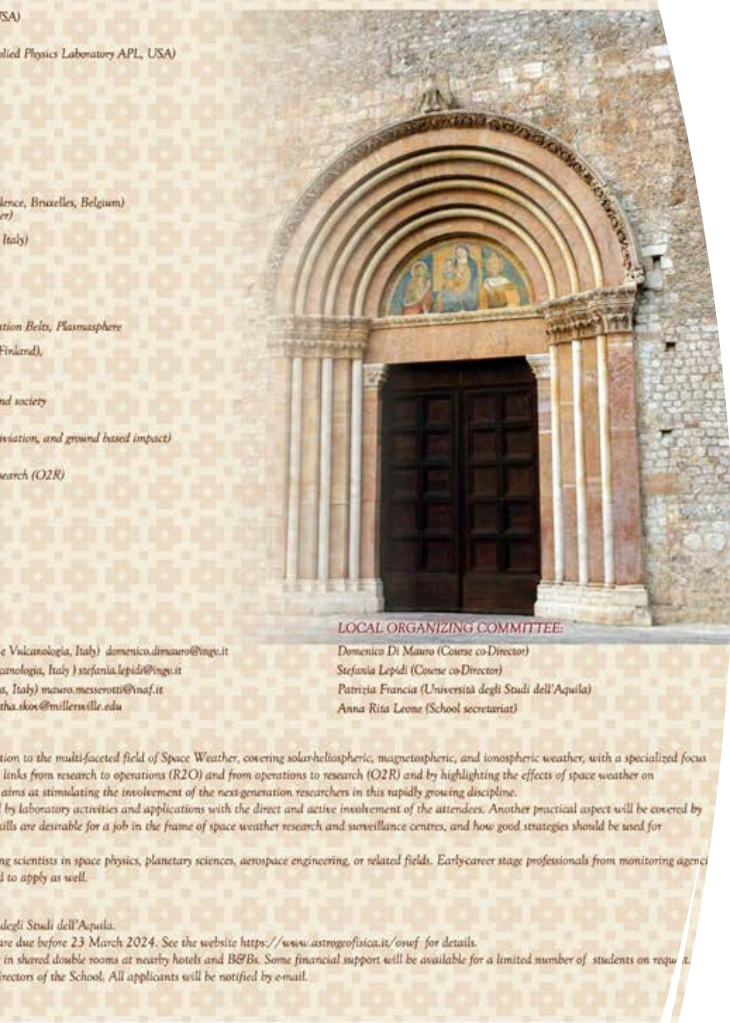


INTERNATIONAL SPACE WEATHER FUNDAMENTALS

13-17 May 2024

L'Aquila - ITALY

Programme and Lecturers



LOCAL ORGANIZING COMMITTEE:
 Domenico Di Mauro (Course co-Director)
 Stefania Lepidi (Course co-Director)
 Patrizia Francia (Università degli Studi dell'Aquila)
 Anna Rita Leone (School secretariat)

International School of Space Science (ISSS)

From 1991 DSFC - UnivAQ and Consorzio Area di Ricerca in Astrogeofisica organize the ISSS. The last one «Operational Space Weather Fundamentals» took place between 13-17 May 2024.

The School is supported/sponsored by:
 Università degli Studi dell'Aquila, Istituto Nazionale di Geofisica e Vulcanologia / Il Consorzio Area di Ricerca in Astrogeofisica, Istituto Nazionale di Astrofisica / European Space Weather and Space Climate Association (ESWAN), Millers / IUGG, IAGA, Fondazione Carispaq, PECASUS Consortium, Space Weather Community (SWiCo).



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e Biologiche

The EMEC project



Biophysical Chemistry 00 (2001) 00–00

Biophys
Chemist
www.elsevier.nl/loc



Table 1
Kinetic parameters of the dioxygenation of linoleic acid by LOX-1

LOX-1	K_m (μM)	V_{max} ($\mu\text{M min}^{-1}$)	k_{cat} (s^{-1})	k_{cat}/K_m ($\text{M}^{-1} \text{s}^{-1}$)
On ground (1g)	10.5 ± 0.5	22 ± 1	46	4.4×10^6
In flight (10^{-2}g)	$2.6 \pm 0.1^*$	$23 \pm 1^{**}$	48^{**}	$18.5 \times 10^6^*$

*Denotes $P < 0.01$, **denotes $P > 0.05$ compared to on ground controls, as calculated by the non-parametric Mann-Whitney test ($n=6$).

The catalytic efficiency of soybean lipoxygenase-1 is enhanced at low gravity

Mauro Maccarrone, Monica Bari, Natalia Battista, Alessandro Finazzi-Agrò*

The EMEC (effect of microgravity on enzyme catalysis) module showed that microgravity improves the activity of lipoxygenases that might act as molecular gravity sensors.

The ROALD project

The FASEB Journal • Research Communication

5-Lipoxygenase-dependent apoptosis of human lymphocytes in the International Space Station: data from the ROALD experiment

Natalia Battista,^{*,1} Maria A. Meloni,^{†,1} Monica Bari,[‡] Nicolina Mastrangelo,[‡] Grazia Galleri,[†] Cinzia Rapino,^{*} Enrico Dainese,^{*} Alessandro Finazzi Agrò,[‡] Proto Pippia,[†] and Mauro Maccarrone^{*,§,2}

^{*}Department of Biomedical Sciences, University of Teramo, Teramo, Italy; [†]Department of Physiological, Biochemical, and Cellular Sciences, University of Sassari, Sassari, Italy; [‡]Department of Experimental Medicine and Biochemical Sciences and [§]Center for Space Biomedicine, University of Rome Tor Vergata, Rome, Italy; and [§]Santa Lucia Foundation, Rome, Italy

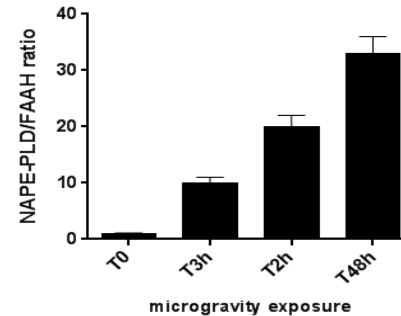


The ROALD (role of apoptosis in lymphocyte depression) experiment was hosted on the International Space Station (ISS) in 2008, as part of the BIO-4 mission of the European Space Agency. The findings provided an unprecedented molecular background for the immune dysfunction observed in astronauts during space missions, and revealed 5-LOX (5-lipoxygenase) as potential new marker to monitor health status of ISS crew members.



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The ROALD-2 / RESLEM project



Altered Anandamide Metabolism in Microgravity: the “RESLEM” experiment

Natalia Battista¹, Monia Di Tommaso¹, Alejandro Norfini², Marco Passerai², Valerio Chiurchiù³, Mauro Maccarrone^{3*} and Monica Bari^{4*}

¹ Facoltà di Bioscienze e tecnologie agro-alimentari e ambientali, Università degli studi di Teramo, Italy

² Kayser (Italy), Italy

³ Facoltà di Medicina e Chirurgia, Università Campus Bio-Medico di Roma, Italy

⁴ Dipartimento di Medicina Sperimentale e Chirurgia, Università degli Studi di Roma Tor Vergata, Italy

The **Roald-2** experiment was flown on the ISS in 2012 to extend the investigation of microgravity effects to another group of bioactive lipids : “endocannabinoids”. Data showed that **endocannabinoids are increased under authentic microgravity**, due to increased activity of their biosynthetic enzyme NAPE-PLD (N-acylphosphatidylethanolamines-specific phospholipase D).

The SERiSM project

SCIENTIFIC REPORTS

OPEN

Human osteogenic differentiation in Space: proteomic and epigenetic clues to better understand osteoporosis

Alessandra Gambacurta^{1,2}, Giulia Merlini¹, Cristina Ruggiero¹, Giacomo Diedenhofen¹, Natalia Battista³, Monica Bari⁴, Michele Balsamo¹, Sara Piccirillo⁵, Giovanni Valentini⁵, Gabriele Mascetti⁵ & Mauro Maccarrone^{5,7*}



In the frame of the **VITA mission of the Italian Space Agency (ASI)**, the **SERiSM (role of the endocannabinoid system in reprogramming human pluripotent stem cells under microgravity)** project was flown on the ISS to further demonstrate that **endocannabinoids are engaged in bone homeostasis**, by driving conversion of stem cells into bone-forming osteoblasts.



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Simulated Microgravity Affects Specialized Pro-Resolving Mediators and Human Inflammatory Homeostasis in a Cell-Specific Manner

Alessandro Leuti ^{1,2}, Marina Fava ^{1,2}, Niccolò Pellegrini ¹, Giulia Forte ¹, Federico Fanti ³, Francesco Della Valle ³, Noemi De Dominicis ^{4,5}, Manuel Sergi ⁶ and Mauro Maccarrone ^{2,5,*}

¹Department of Medicine, Campus Bio-Medico University of Rome, Via Alvaro del Portillo 21, 00128 Rome, Italy, m.fava@unicampus.it, ²European Center for Brain Research, IRCCS Santa Lucia Foundation, Via del Fosso di Fiorano 64, 00143 Rome, Italy, ³Department of Bioscience and Technology for Food, Agriculture and Environment, University of Teramo, Via R. Balzarini 1, 64100 Teramo, ⁴Department of Physics, University of Trento, 38123 Trento, Italy, ⁵Department of Biotechnological and Applied Clinical Sciences, University of L'Aquila, 67100 L'Aquila, Italy, ⁶Department of Chemistry, Sapienza University of Rome, Piazzale Aldo Moro 5, 00185 Rome, Italy



ISGP 2024
Dubai, May 26th – 31st

Ionizing Radiations and Microgravity on Immune Response (ASI Grant n. CE-DSR-UCO/2023-2)



Agenzia Spaziale Italiana



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