Space It Up: the Italian consortium for space science and technology

Antonio Moccia
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Space It Up Board of Directors

Presentation outline

- the scenario
- overall project and consortium description
- focus on some work package

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2020
The 2021-27 National Research Program (PNR) is the document that guides research policies, priorities and objectives in Italy.

Testo approvato dal Comitato interministeriale per la programmazione economica con Delibera 15 dicembre 2020, n. 74, pubblicata nella Gazzetta Ufficiale, Serie Generale n. 18 del 23-1-2021: Approvazione del «Programma nazionale per la ricerca 2021-2027». (Delibera n. 74/2020)

https://www.mur.gov.it/sites/default/files/2021-01/Pnr2021-27.pdf

PNR 2021-2027
Programma nazionale per la ricerca

Ministero dell'Università e della Ricerca

Areas of research and innovation and related areas of intervention

SPACE IT UP!

SALUTE	CULTURA UMANISTICA, CREATIVITÀ, TRASFORMAZIONI SOCIALI, SOCIETÀ DELL'INCLUSIONE	SICUREZZA PER I SISTEMI SOCIALI	DIGITALE, INDUSTRIA, AEROSPAZIO	CLIMA, ENERGIA, MOBILITÀ SOSTENIBILE	PRODOTTI ALIMENTARI, BIOECONOMIA, RISORSE NATURALI, AGRICOLTURA, AMBIENTE
Temi Generali	Patrimonio culturale	Sicurezza delle strutture, infrastrutture e reti	Transizione digitale - I4.0	Mobilità sostenibile	Green technologies
Tecnologie farmaceutiche e farmacologiche	Discipline storico, letterarie e artistiche	Sicurezza sistemi naturali	High performance computing e big data	Cambiamento climatico, mitigazione e adattamento	Tecnologie alimentari
Biotecnologie	Antichistica	Cybersecurity	Intelligenza Artificiale	Energetica industriale	Bioindustria per la Bioeconomia
Tecnologie per la salute	Creatività, design e made in Italy		Robotica	Energetica ambientale	Conoscenza e gestione sostenibile dei sistemi agricoli e forestali
	Trasformazioni sociali e società dell'inclusione		Tecnologie quantistiche		Conoscenza, innovazione tecnologica e gestione sostenibile degli ecosistemi marini
			Innovazione per l'industria manifatturiera		
			Aerospazio		

Areas of research and

SALUTE	CULTURA UMANISTICA, CREATIVITÀ, TRASFORMAZIONI SOCIALI, SOCIETÀ DELL'INCLUSIONE	SICUREZZA PER I SISTEMI SOCIALI	DIGITALE, INDUSTRIA, AEROSPAZIO	CLIMA, ENERGIA, MOBILITÀ SOSTENIBILE	PRODOTTI ALIMENTARI, BIOECONOMIA, RISORSE NATURALI, AGRICOLTURA, AMBIENTE
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			Aerospazio		

PNR 2021-2027
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Aerospace topics

SPACE IT UP!

1. New generation rotary-wing aircraft
2. Reducing environmental impact and increasing comfort in aviation
3. Autonomous vehicles
4. Smart structures, supermaterials and innovative technologies
5. Air traffic control
6. Sub-orbital and hypersonic flight, stratospheric platforms, reentry
7. **Earth observation**, telecommunications and navigation
8. **Exploration and observation of the universe**
9. Access to space
10. **New generation spacecraft**
11. **Human space exploration**

2021
The systemic PNRR initiatives of the Italian Ministry of University and Research on component: From Research to Business

Indications:
- formation of public-private extended partnerships, i.e. large networks of universities, research institutes, and other public and private, organized in a consortium structure.

https://www.mur.gov.it/sites/default/files/2021-10/Decreto%20Ministeriale%20n.1141%20del%2007-10-2021%20-%20Linee%20Guida_MUR_PNRR_M4C2.pdf

2021
The systemic PNRR initiatives of the Italian Ministry of University and Research on component: From Research to Business

Indications:
- governance of extended partnerships is entrusted to public bodies controlled by the Ministry.

https://www.mur.gov.it/sites/default/files/2021-10/Decreto%20Ministeriale%20n.1141%20del%2007-10-2021%20-%20Linee%20Guida_MUR_PNRR_M4C2.pdf

The research programs, whether basic or applied, will be oriented towards the themes provided by the National Research Program and the Horizon Europe clusters.

15 topics were proposed and their main goals briefly outlined:

topic 1: Artificial intelligence
topic 2: Energy
…
topic 13: Ageing
topic 14: Telecommunications
topic 15: Space

Concerning topic 15: Space

1. Improving space-based observation and enhancing its applications for disaster prevention, space weather, extreme geological events, extreme weather and climate conditions, water resources forecasting, sustainable agriculture, …

2. Exploration architectures, sustainable design of possible future extraterrestrial habitats.

Agenzia Spaziale Italiana

BANDO DI FINANZIAMENTO

per le

"Attività spaziali" (tematica 15), di cui all'avviso MUR n. 341 del 15/03/2022, per "Partenariati estesi alle università, ai centri di ricerca, alle aziende per il finanziamento di progetti di ricerca di base"

* * * * *

Prot. CI-2022-DSR-042 del 18 luglio 2022

2022
Funding call issued by the Italian Space Agency (ASI) and pursuant to 2021 directives of the Italian Ministry for University and Research

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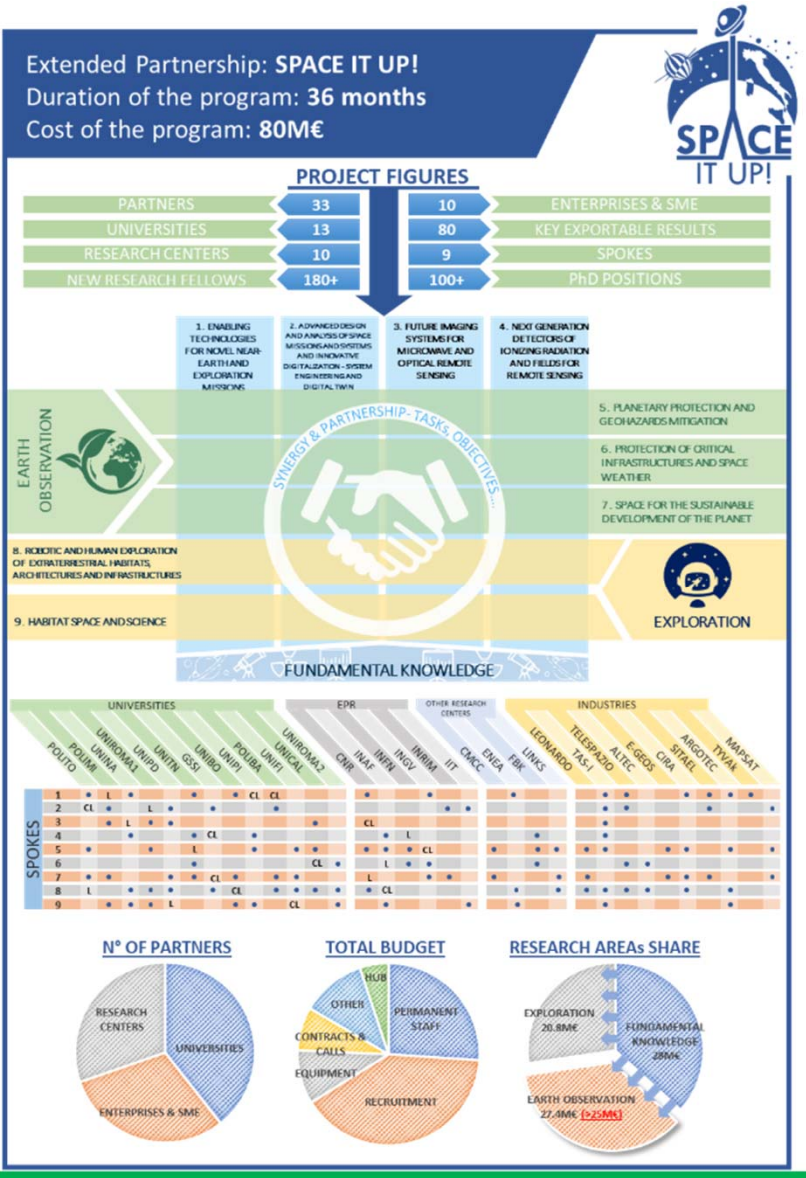
After winning the tender and completing the negotiation phase, the public-private consortium Space It Up was established

Space It Up mission statement:

The project aims at developing innovative ideas and disruptive space-based solutions

- to further consolidate Italy's position as a leading country in space science and technology, by exploiting interdisciplinary synergies among universities, research institutions, and small, medium, and large industries.
- that advance sustainability and resilience, both on Earth and in space.

Snapshot of the project



Snapshot of the project: figures

Extended Partnership: **SPACE IT UP!**

Duration of the program: **30 months** ⇒ **extended to 42 months**

Cost of the program: **80M€**

(#) plus 12 universities and a research center as external contractors

PROJECT FIGURES

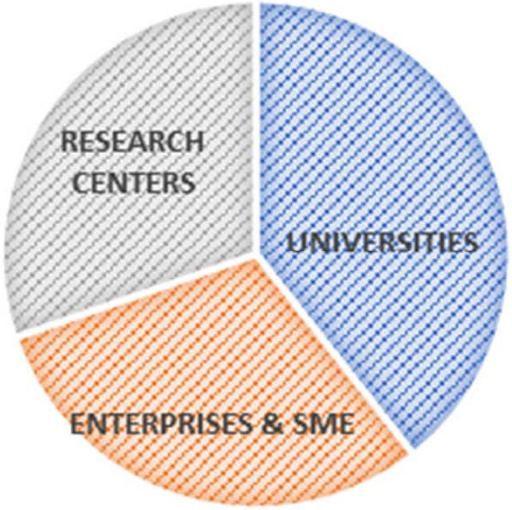
PARTNERS	33	10	ENTERPRISES & SME
UNIVERSITIES (#)	13	80	KEY EXPORTABLE RESULTS
RESEARCH CENTERS	10	9	SPOKES
NEW RESEARCH FELLOWS	180+	100+	PhD POSITIONS

Snapshot of the project: study logic

Snapshot of the project: organization in Hub&Spokes

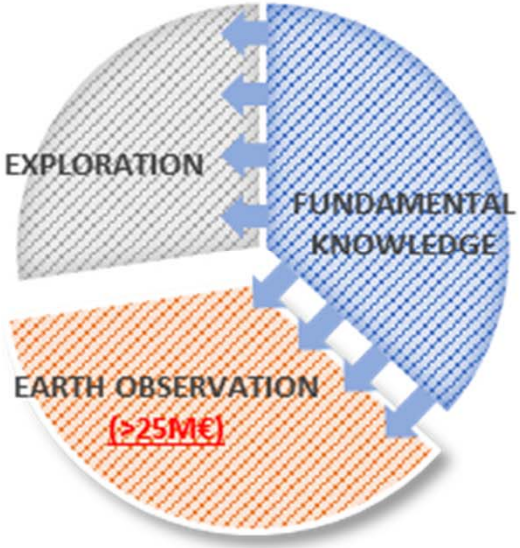
Snapshot of the project: sharing

N° OF PARTNERS

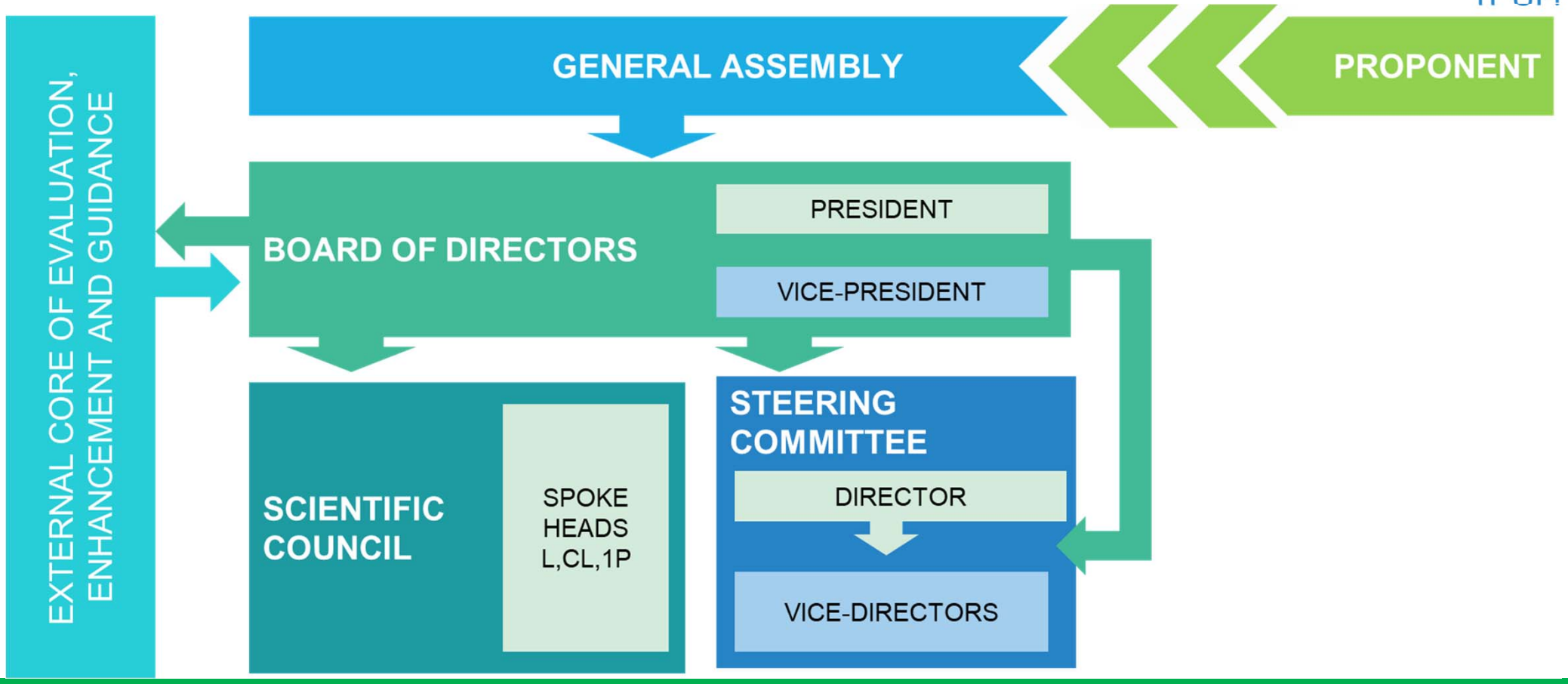


TOTAL BUDGET

RESEARCH AREAs SHARE

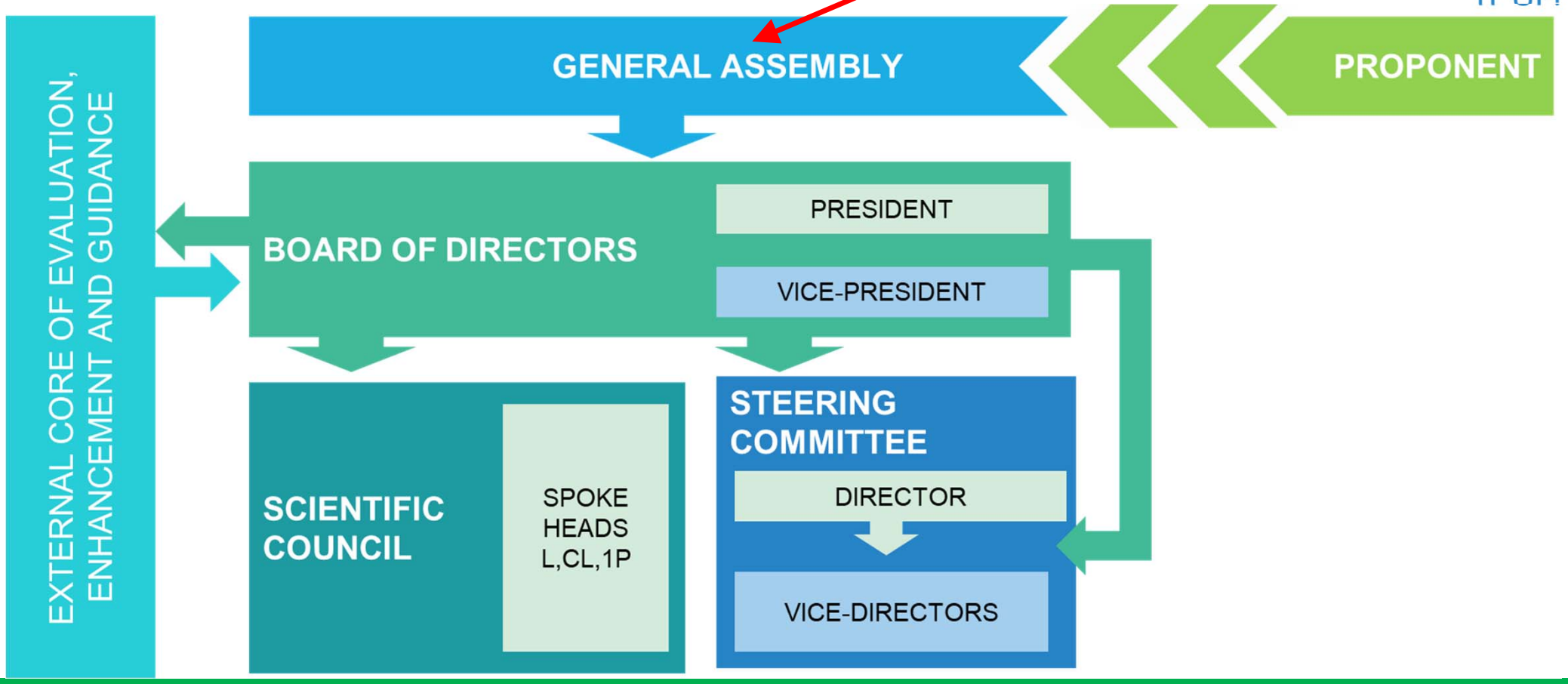


Consortium governance

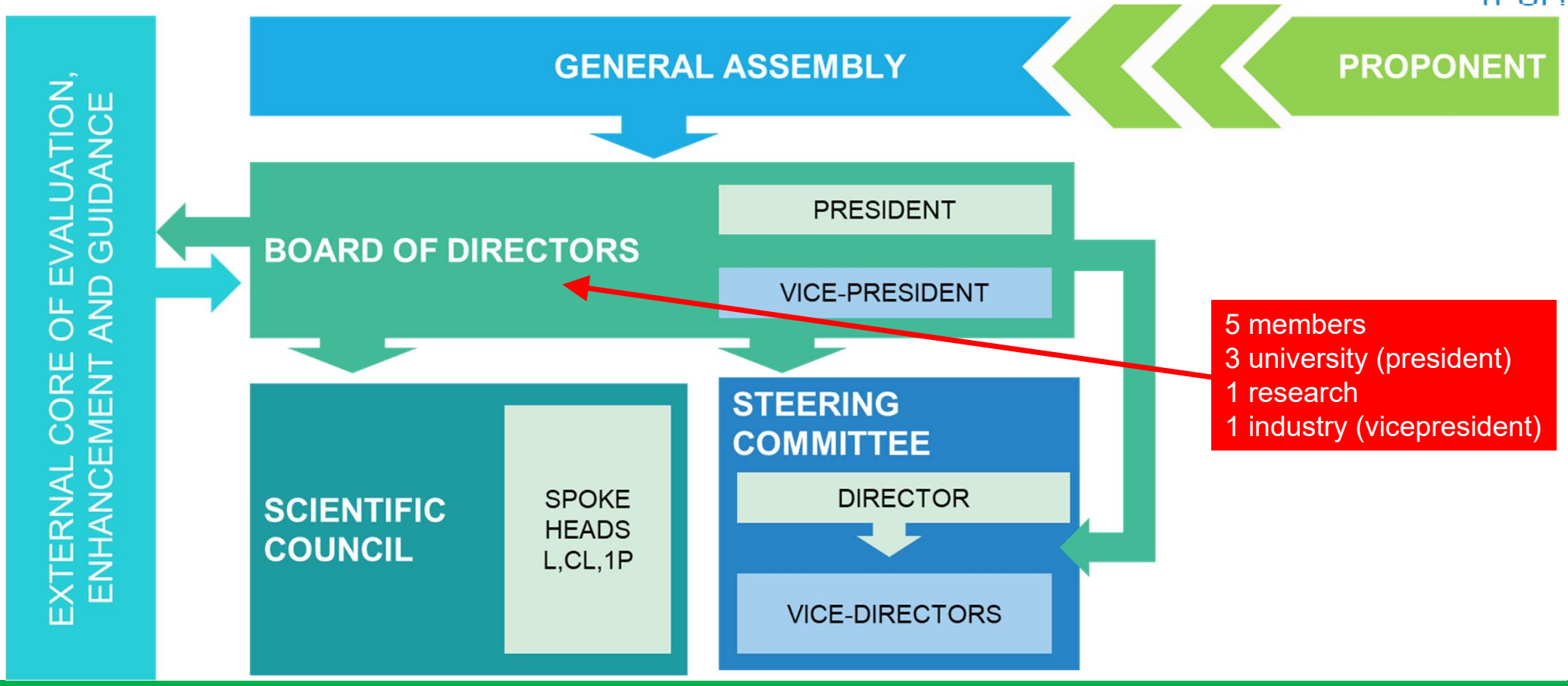


Consortium governance

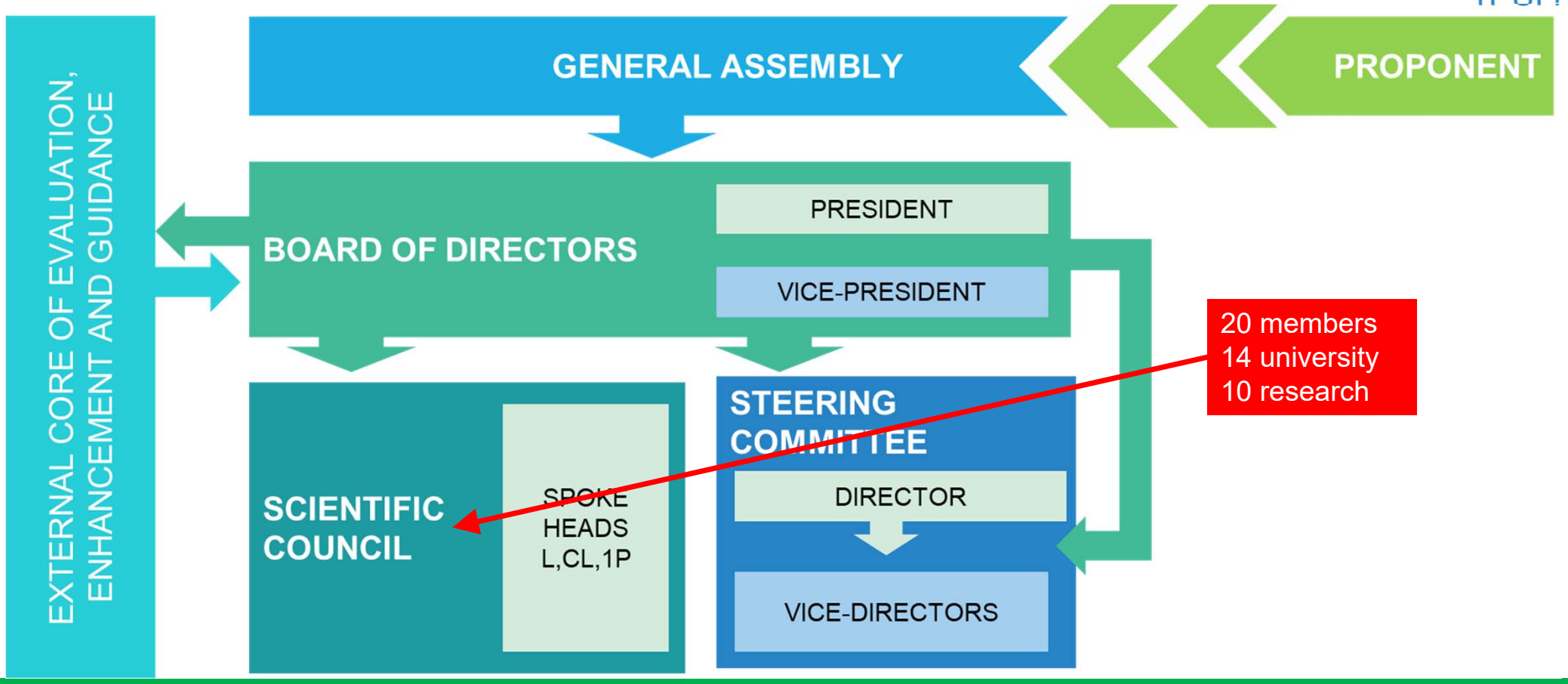
33 members
13 university
10 research
10 industry



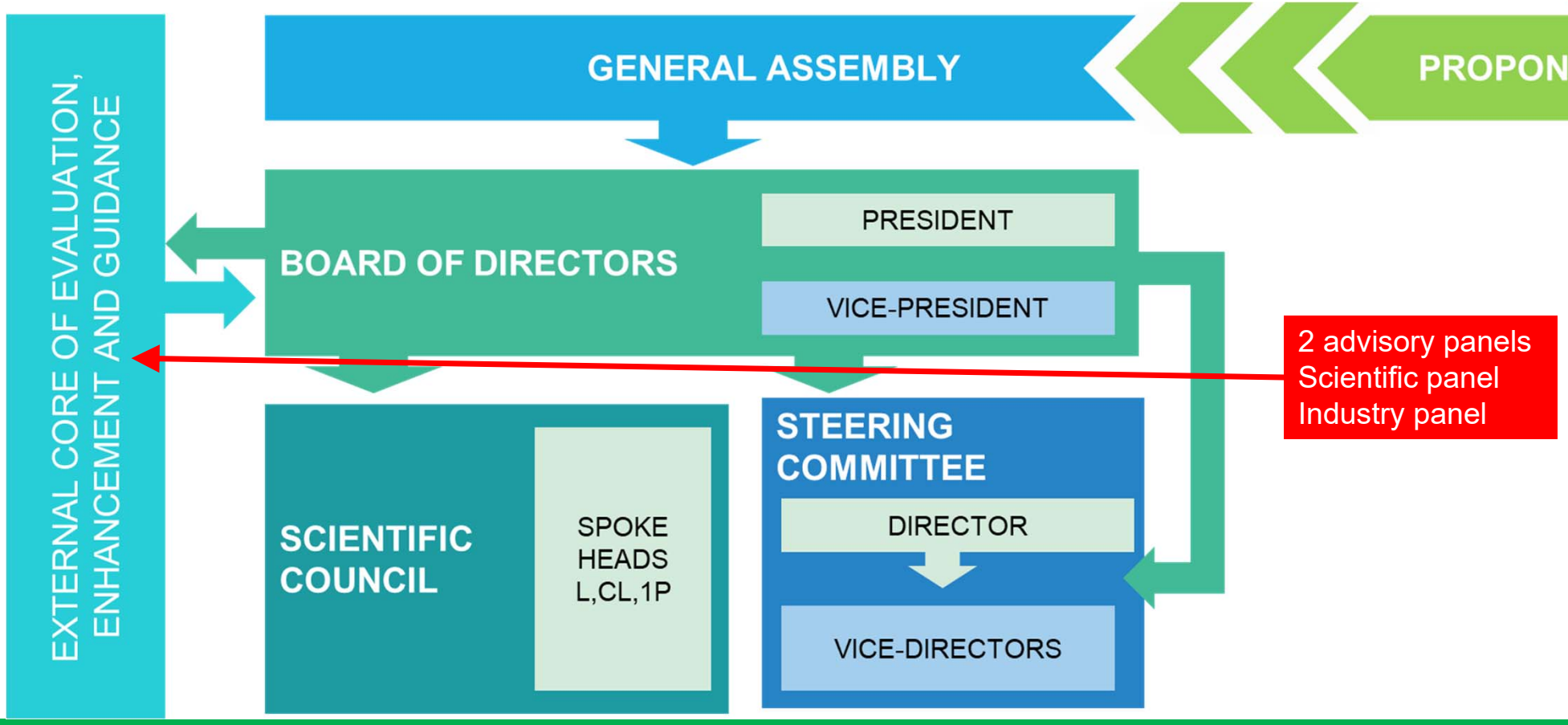
Consortium governance



Consortium governance



Consortium governance



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Spoke 1 – ENABLING TECHNOLOGIES FOR NOVEL NEAR-EARTH AND EXPLORATION MISSIONS

- Very Low-Earth Orbit Platforms
- Distributed Space Systems
- Deep-Space Exploration with Miniaturized Platforms

Spoke 1 – ENABLING TECHNOLOGIES FOR NOVEL NEAR-EARTH AND EXPLORATION MISSIONS

- High-efficiency DC/DC converters for minimizing power losses, thus reducing the battery size.
- This is especially advantageous in standardized platforms such as CubeSats, where stringent constraints on space and weight prevail.

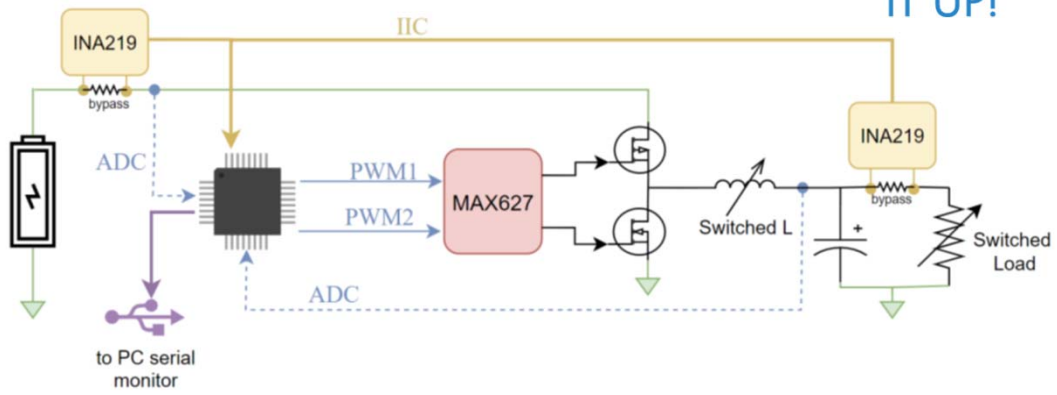


Fig. 2. Circuit diagram of the developed circuit board.

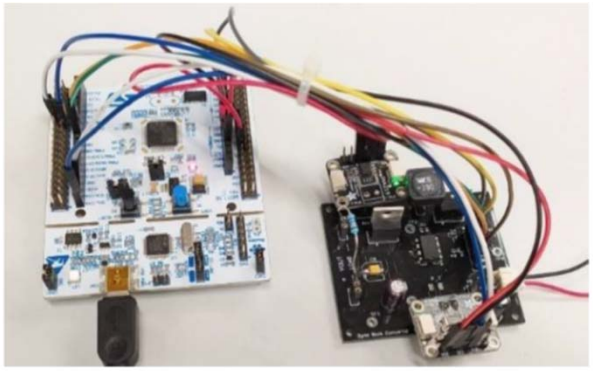
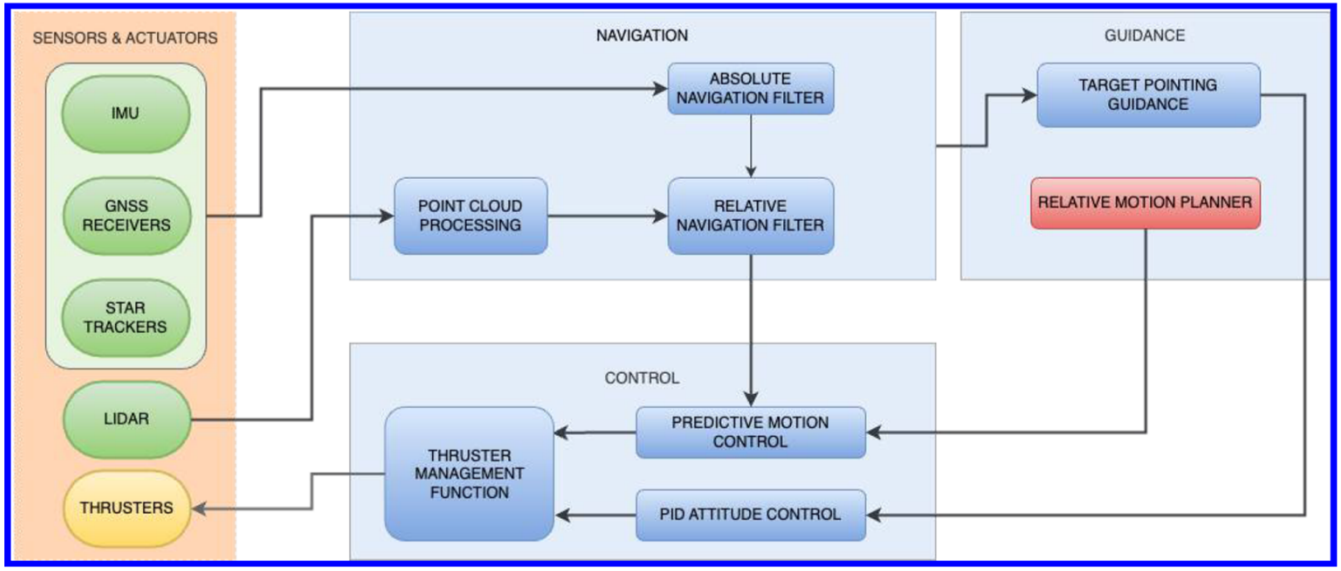


Fig. 3. Prototype realized with STM32 NUCLEO L476RG and two INA219 boards.

Nardelli et al., Lecture Notes in Electrical Engineering, Springer, 2025, ISBN 9783031840999

Spoke 1 – ENABLING TECHNOLOGIES FOR NOVEL NEAR-EARTH AND EXPLORATION MISSIONS

- Design of a guidance, navigation and control architecture for proximity operations around uncooperative space targets.
- Integration of a LIDAR as relative navigation sensor.
- Results highlight the effectiveness of the architecture in reducing the number of required firing cycles and propellant consumption.



Nocerino et al., AIAA SciTech 2025 Forum.

Spoke 2 – ADVANCED DESIGN AND ANALYSIS OF SPACE MISSIONS AND SYSTEMS AND INNOVATIVE DIGITALIZATION - SYSTEM ENGINEERING AND DIGITAL TWIN

- Model-based concurrent engineering
- Additive manufacturing and smart production
- Virtual reality for design, production, testing
- Digital twins and artificial intelligence tools

Spoke 2 – ADVANCED DESIGN AND ANALYSIS OF SPACE MISSIONS AND SYSTEMS AND INNOVATIVE DIGITALIZATION - SYSTEM ENGINEERING AND DIGITAL TWIN

- Integration of Cyber-Physical Systems into the Assembly, Integration, and Testing processes of aerospace components
- Augmented Reality as a powerful tool to enhance efficiency, accuracy and precision, and safety.
- Testing phase demonstrates capability to facilitate real-time monitoring of performance metrics, ensuring the accomplishment of stringent quality standards.

Pesce et al., 34th ICASS Congress, 2024.

Case study: assembly of a CubeSat's structure

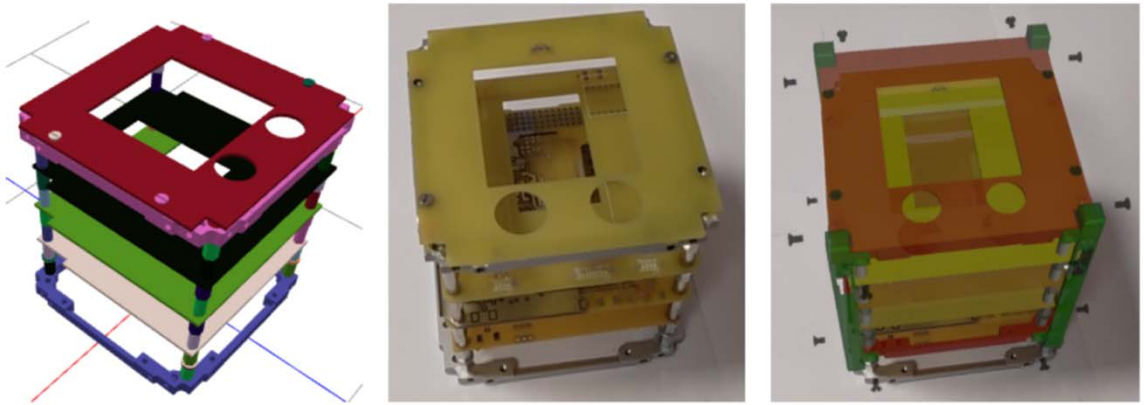


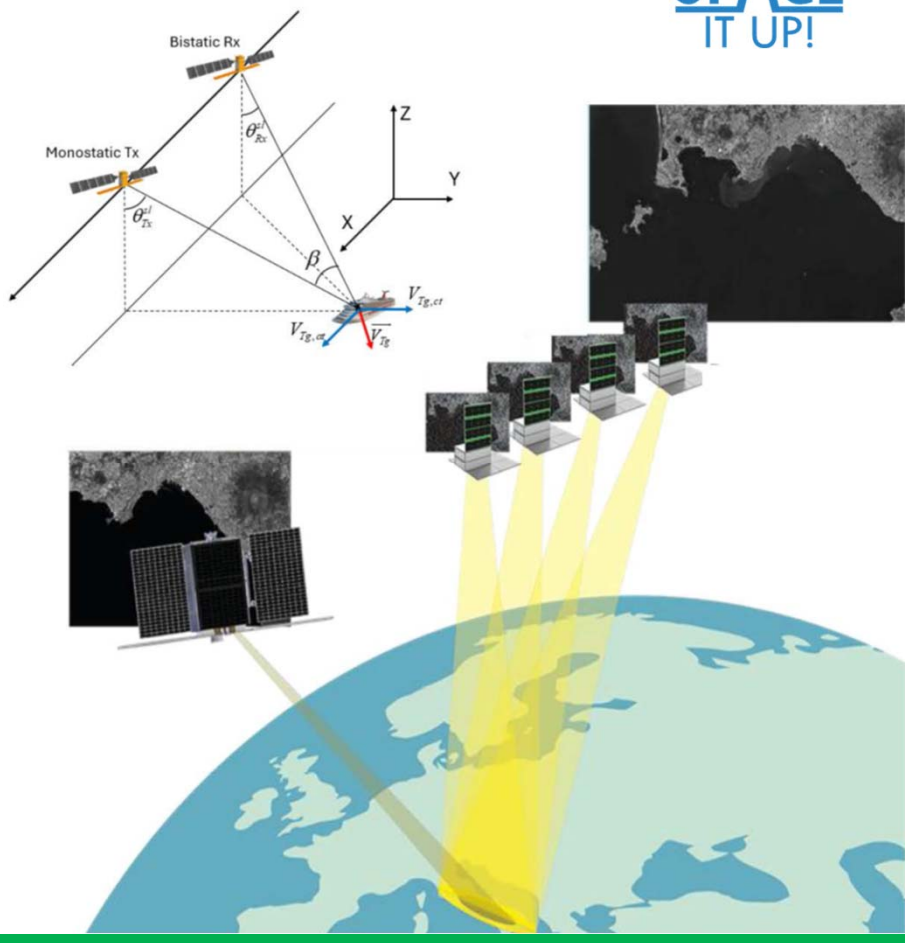
Figure 10 – The object recognition process for a step of the CubeSat's AIT: once the 3D model-based target is realized (a) the real object is recognized (b) and a 3D animation sequence showing the action to be implemented by the operator for the specific AIT step (i.e., screws insertion and tightening) is superposed within the AR visor (c).

Spoke 3 – FUTURE IMAGING SYSTEMS FOR MICROWAVE AND OPTICAL REMOTE SENSING

- Distributed SAR based on nano/cubesats operating in formation
- Digital radar technologies for advanced Earth Observation missions
- Key enabling technologies for optical imaging payloads on nano/cubesats

Spoke 3 – FUTURE IMAGING SYSTEMS FOR MICROWAVE AND OPTICAL REMOTE SENSING

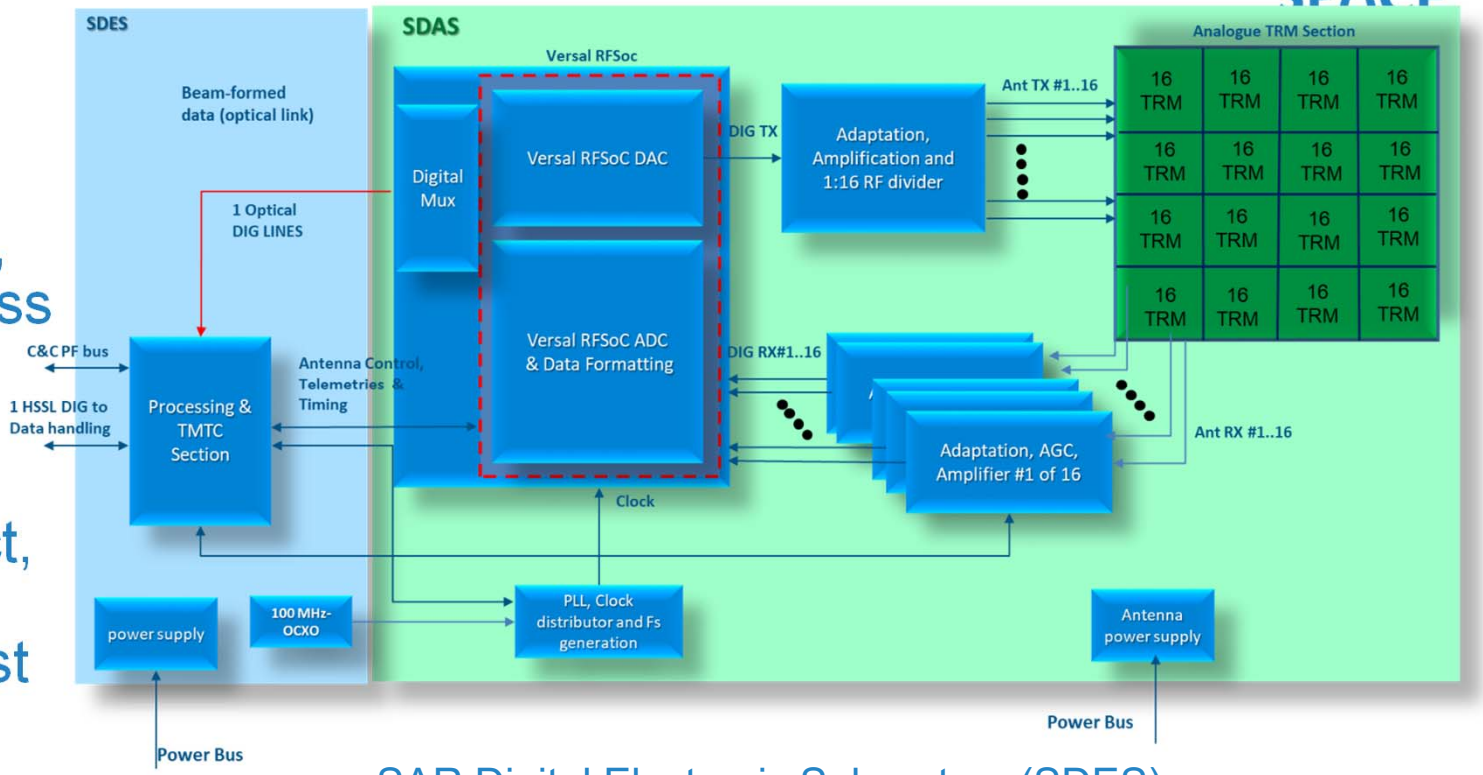
- Receivers operating on different satellites that observe the same area with an along-track separation
- PRF lower than Nyquist rate to achieve wide-swath imaging
- Unambiguous signal reconstruction in post processing by coherent combination of raw data collected at a lower PRF.
- Demonstration of applications:
  - Bistatic scattering and polarimetry
  - Ground motion and solid Earth
  - Moving targets
  - Radargrammetry



Renga et al., Multistatic Radar Workshop, 2025

Spoke 3 – FUTURE IMAGING SYSTEMS FOR MICROWAVE AND OPTICAL REMOTE SENSING

- Digital radar/SAR functions to obtain instrument flexibility, onboard reconfiguration, and payload compactness
- Preliminary enhanced SAR instrument architecture design shifting towards compact, digital hardware
- Identification of the best technologies for the digitalization and prototyping



SAR Digital Electronic Subsystem (SDES)
SAR Digital Antenna Subsystem (SDAS)

Courtesy Thales Alenia Space – Italy, 2025

Spoke 4 – NEXT GENERATION DETECTORS OF IONIZING RADIATION AND FIELDS FOR REMOTE SENSING

- Sensors and detectors for ionizing particles in space
- Gravitational remote sensing for geodesy and water cycle
- Earth-Sun interaction phenomena and Space weather monitoring
- New time and frequency references for detectors synchronization and deep space exploration

Spoke 5 – PLANETARY PROTECTION AND GEOHAZARDS MITIGATION

- Technologies for multipoint remote sensing
- Downstream New Methodologies
- Future trends and services

Spoke 5 – PLANETARY PROTECTION GEOHAZARDS MITIGATION

- Assessment of wildfire dynamics in southwestern Italy, by integrating multi-sensor spaceborne remote sensing data with climatic and land cover trend analyses.
- Application of Sentinel-2 imagery for differenced normalized burn ratio mapping and dynamic world land cover data for detecting short-term post-fire land cover changes.

Dadkhah et al., Ecological Informatics, 90, 2025, Elsevier.

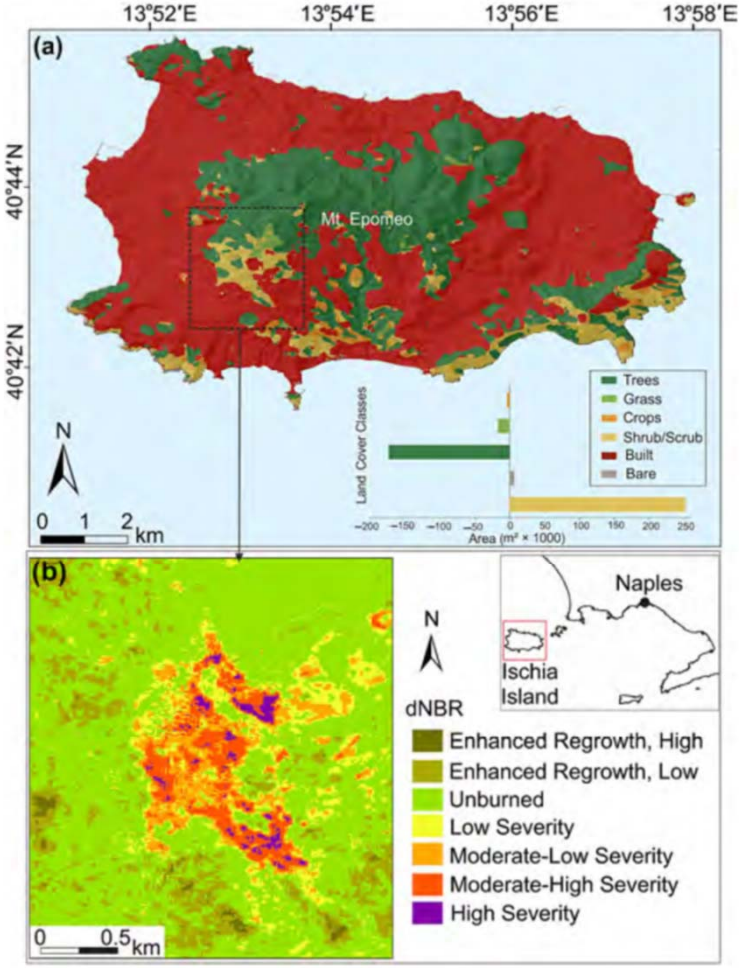


Fig. 11. (a) Land cover classification map of Ischia Island (2017), Italy. The bar chart illustrates changes in land cover area (m^2) before and after the August 2017 wildfire, highlighting the impact of the fire on vegetation. (b) Differenced Normalized Burn Ratio (dNBR) map of the wildfire-affected area, derived from Sentinel-2 imagery.

Spoke 5 – PLANETARY PROTECTION AND GEOHAZARDS MITIGATION

- GOES-17 geostationary satellite observation of explosive hydromagmatic volcanic eruptions.
- Detection of volcanic clouds formed by particles, such as ash, ice and water vapor.
- Detection of silicate particles, a fatal risks for aviation.

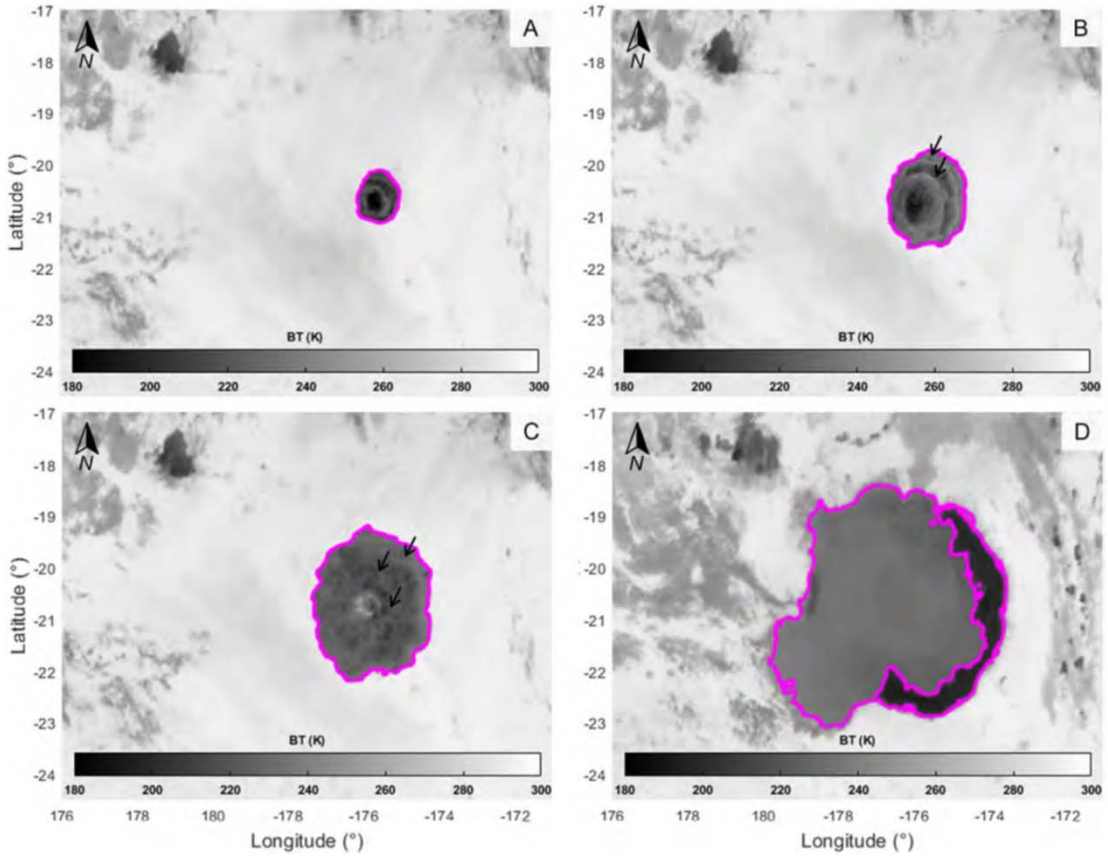


Figure 3. Four moments of the 15 January 2022 HTHH event: (panel A) from 04:20 to 04:29 UTC, (panel B) from 04:30 to 04:39 UTC, (panel C) from 04:40 to 04:49 UTC, (panel D) from 06:50 to 06:59 UTC. Black arrows point to perturbations due to the rapid upwelling of volcanic material that pushes masses of air upward. In magenta the contour of the volcanic clouds. The color bar is the BT at 10.30 μm.

Romeo et al., J. Geophysical Research: Atmospheres, 130, 2025, https://doi.org/10.1029/2024JD041196.

Spoke 6 – PROTECTION OF CRITICAL INFRASTRUCTURES AND SPACE WEATHER

- Innovative Space Architectures
- Space Weather nowcasting and forecasting

Spoke 6 – PROTECTION OF CRITICAL INFRASTRUCTURES AND SPACE WEATHER

- Joint use of Imaging X-ray Polarimetry Explorer and high-resolution Chandra data for spectropolarimetric analysis of Supernova Remnants of Cassiopea (Cas A).
- Evaluation of the degree of X-ray polarization in the 3–6 keV energy band.
- Estimate of the degree of magnetic turbulence from the measured photon index and polarization degree.

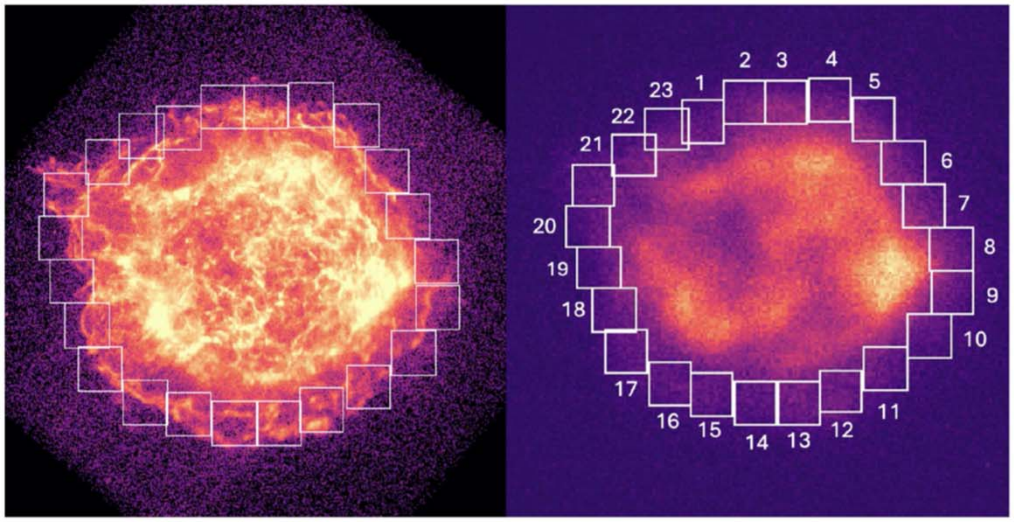


Figure 1. Cas A images of Chandra (left panel), in log scale with a pixel of size 0.″98, and IXPE (right panel), in the sqrt scale with a pixel of size 2.″6, in the 3–6 keV energy band. The regions selected for the spectral analysis around the SNR rims are indicated by white squares.

Mercuri et al., The Astrophysical J., 986:6, 2025, https://doi.org/10.3847/1538-4357/adcedb.

Spoke 6 – PROTECTION OF CRITICAL INFRASTRUCTURES AND SPACE WEAT

- Measurements of the magnetic field vector from the Fluxgate Magnetometer and of the ion data sampled at a resolution of 4 s from the Proton and Alpha Particle Sensor of the Solar Wind Analyser suite on ESA's Solar Orbiter.
- Investigation of the turbulence and kinetic parameters correlated to magnetic switchbacks, large-amplitude magnetic field deflections in the inner heliosphere.

Perrone et al., Astronomy & Astrophysics, 696, 2025, https://doi.org/10.1051/0004-6361/202453094.

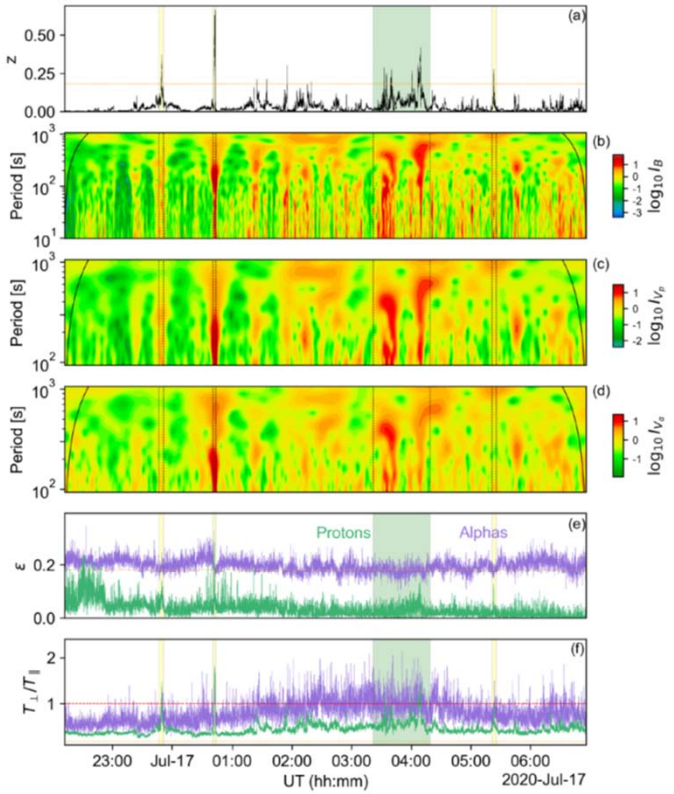


Fig. 1. (a) Dimensionless normalized deflection, z. The dashed horizontal orange line indicates $z = 0.18$, which we used as the threshold to select switchbacks in this interval (see Perrone et al. 2024, for details). (b) Logarithmic contour plots of the local intermittency measure (LIM) of the total magnetic fluctuations and of the total proton (c) and alpha (d) velocity fluctuations. The curved lines at each side of the plots indicate the cones of influence. (e) Non-Maxwellian parameter, ϵ, for protons (green) and alpha particles (violet). (f) Temperature anisotropy for protons (green) and alpha particles (violet) with respect to the background magnetic field, evaluated over the entire interval. The filled yellow (green) bands and dashed vertical lines denote isolated (a patch of) switchbacks.

Spoke 7 – SPACE FOR THE SUSTAINABLE DEVELOPMENT OF THE PLANET

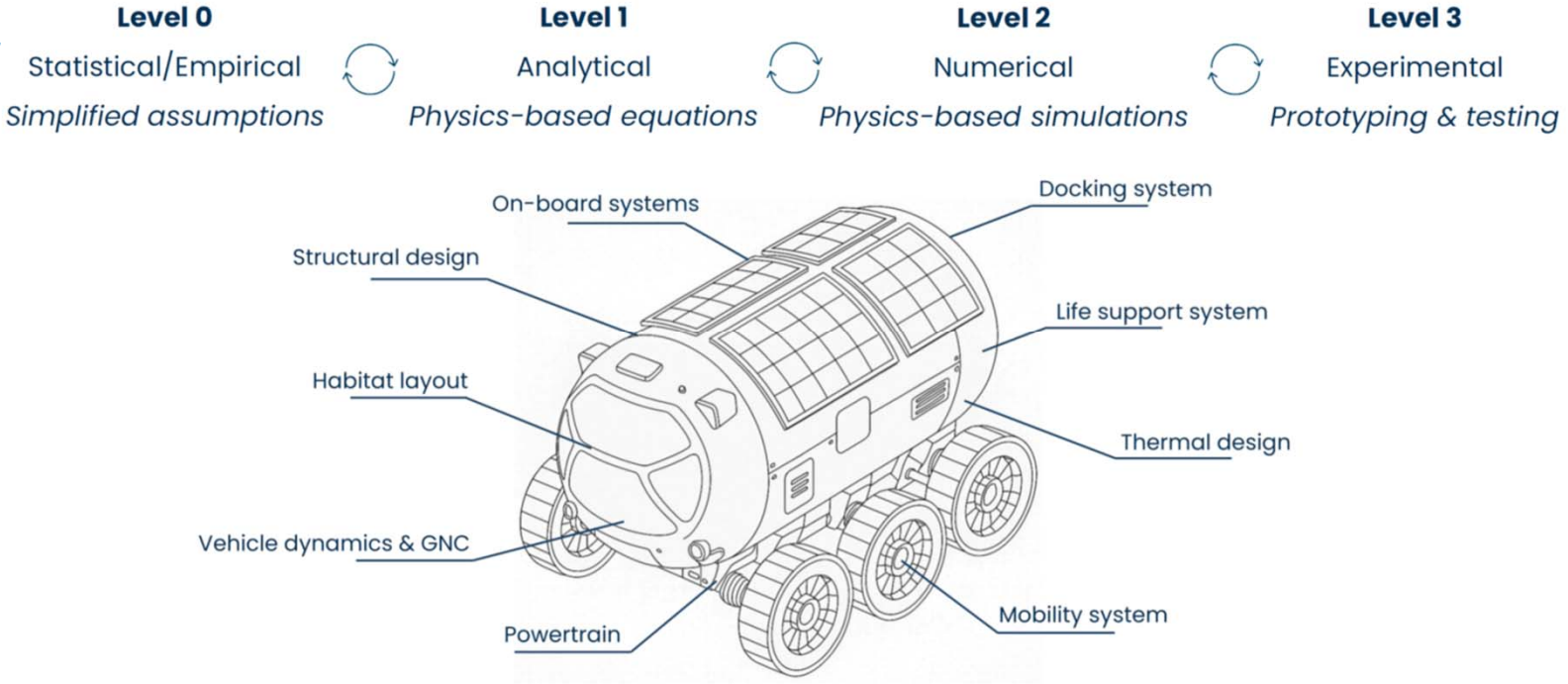
- Resilience to extremes
- Sustainable water and food
- Zero emission society
- Sustainable economic growth

Spoke 8 – ROBOTIC AND HUMAN EXPLORATION OF EXTRATERRESTRIAL HABITATS, ARCHITECTURES, AND INFRASTRUCTURES

- Technology developments for robotic exploration of potential extraterrestrial habitats
- Mission concepts and enabling technology for sustainable human exploration of the solar system
- Design of infrastructures for implementation and operations of sustainable exploration architecture

Spoke 8 – ROBOTIC AND HUMAN EXPLORATION OF EXTRATERRESTRIAL HABITATS, ARCHITECTURES, AND INFRASTRUCTURES

- Conceptual design of a lunar pressurized rover has been conceptualized through a multidisciplinary and multifidelity framework, integrating structural, mechanical and thermal design, vehicle dynamics, safety, powertrain sizing, human interface, etc.

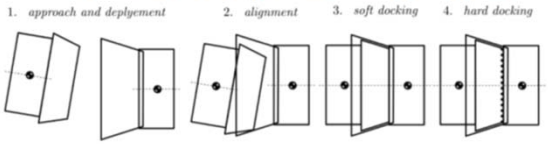


Abu Salem et al., 12th IAA Symp. on Future Space Exploration, 2025.

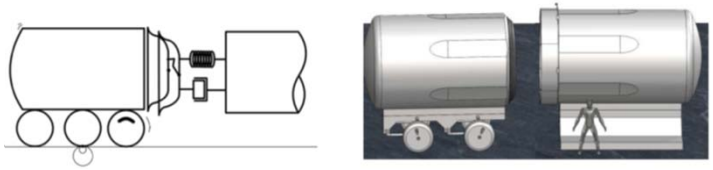
Spoke 8 – ROBOTIC AND HUMAN EXPLORATION OF EXTRATERRESTRIAL HABITATS, ARCHITECTURES, AND INFRASTRUCTURES

- Example: Docking system

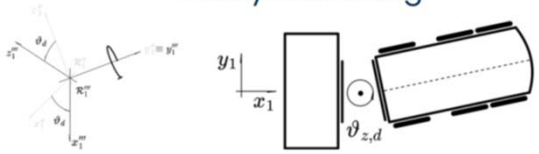
Simplified scheme
Mechanism layout & kinematics



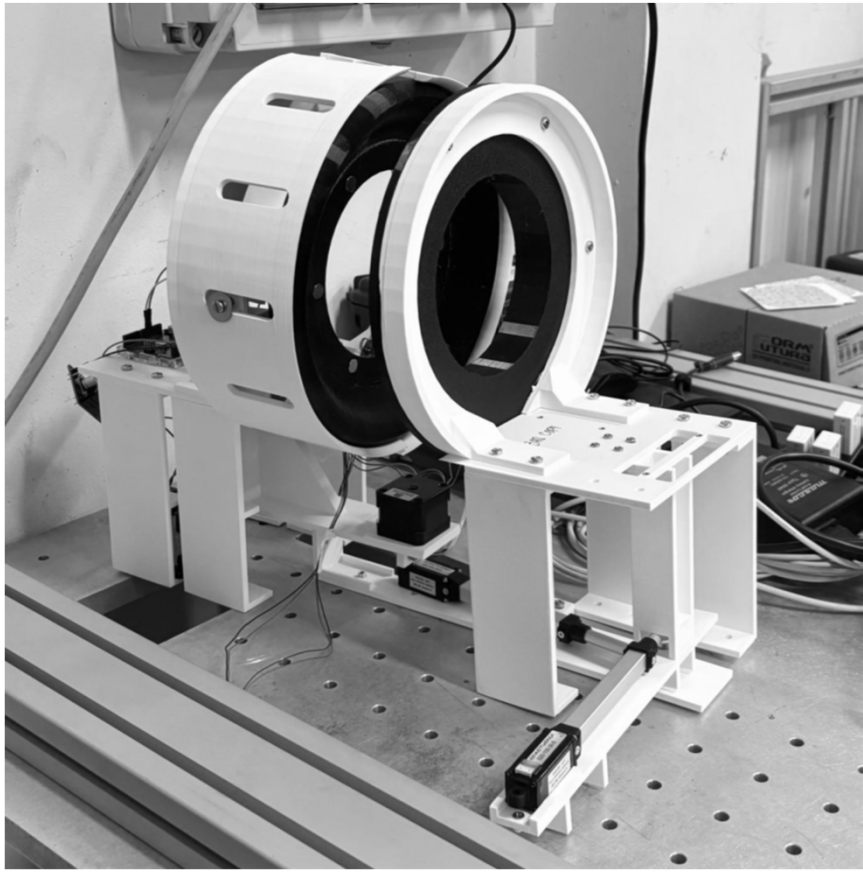
Numerical simulation
Multibody dynamic modelling



Theoretical approach
Analytical sizing



Experimental validation
Scaled docking model:
prototyping and testing



Abu Salem et al., 12th IAA Symp. on Future Space Exploration, 2025.

Spoke 9 – HABITAT SPACE AND SCIENCE

- Identification and characterization of potential extraterrestrial habitats
- Planetary resources: laboratory and in situ analyses, resource mapping
- Human Life Science & Space Medicine

Spoke 9 – HABITAT SPACE AND SCIENCE

⇒ Understanding plant acclimation in space.

- Investigation of the combined effect of chronic ionizing radiation and reduced gravity on plant growth and functionality.
- Experiment conducted in the MarSimulator, a device equipped with a random positiong machine to eliminate the effect of gravity and a γ-rays source, the main radiation capable of passing through the protective shielding layers.

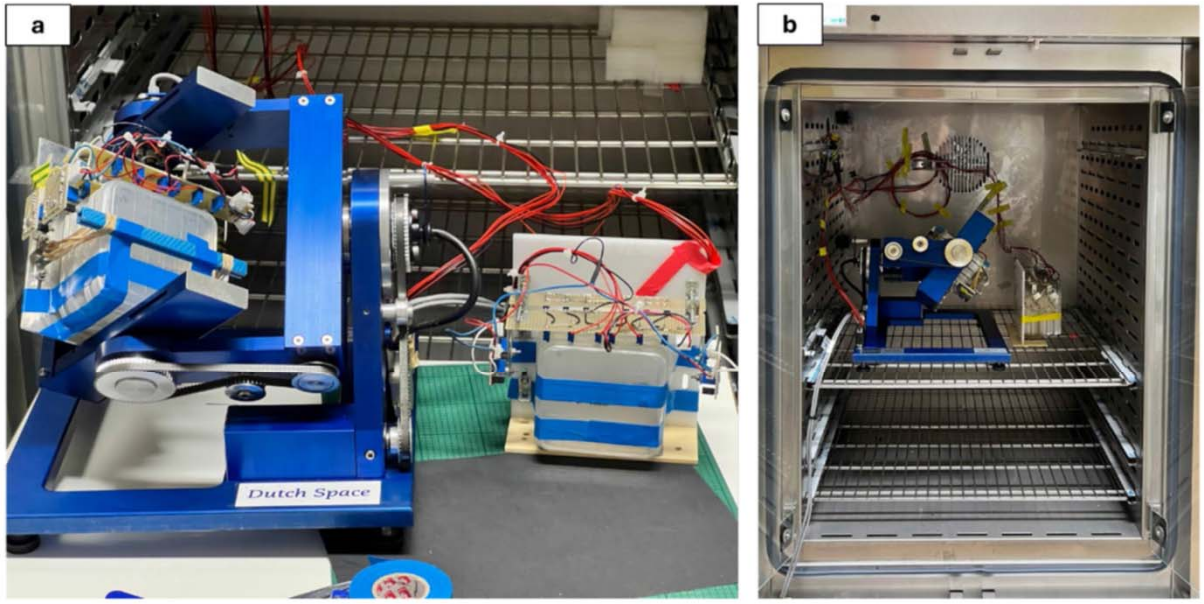


Figure 5. Example of sample configuration in the MarSimulator device for NoIR + 1 g and NoIR + μg conditions. (**a**) displays Petri dishes mounted on the rpm (NoIR + μg) and on the vertical support (NoIR + 1 g). (**b**) shows the samples inside the phytotron.

De Francesco, et al., Plants, 2025, https://doi.org/10.3390/plants14010064

Spoke 9 – HABITAT SPACE AND SCIENCE

Investigation of temporal duration of motion in the vertical direction to verify the hypothesis that the brain estimates the duration of vertical visual (i.e. target) and vestibular (i.e. passenger) motions by means of an internal model of gravity, predicting that downward motions are accelerated and upward motions are decelerated by gravity.

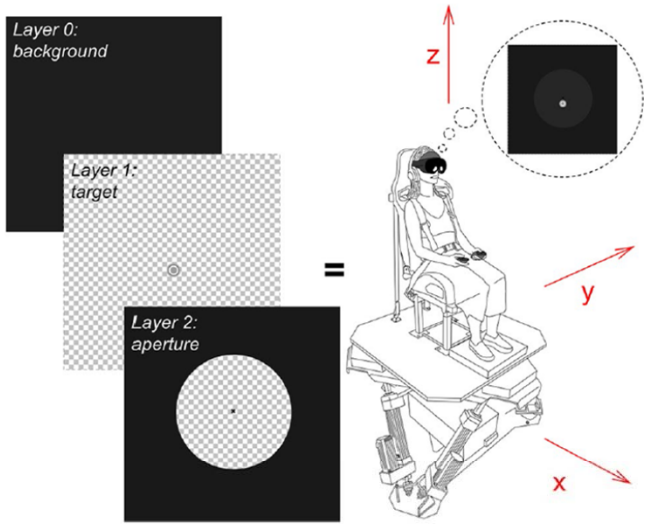


Fig. 1. Visual stimulation in the visual and visuo-vestibular sessions consisted of three superimposed layers, oriented perpendicular to the subject's antero-posterior axis from back to front (see Methods). Layer 0 comprised the background of the virtual scene. Layer 1, positioned immediately in front of Layer 0, contained the visual target, a grey-textured disk with a diameter of 1.68° of visual angle. Located in front of Layer 1, Layer 2 included two elements: a uniformly colored surface with a central circular aperture; and a black cross tilted by 45° at its center. In Layer 1 and Layer 2, transparent portions of the scenario are represented with a squared texture. The resulting 3D virtual scenario was perceived by the subject through the VR-headset system (see also Supplementary Video 1 and Supplementary Video 3). In the vestibular session, visual stimulation consisted solely of the background (Layer 0; see also Supplementary Video 2). The W_{RF} (axes x, y, z, represented in red in the figure) has its origin in the flying base motion centroid position when the flying base is in its home settled position. Motion centroid is the centroid of the joints below the flying base of the motion platform. The z-axis is orthogonal to the ground and oriented upwards. The x-axis is oriented along the posterior-anterior direction of the chair.

Delle Monache, et al., Nature Scientific Reports, 2025, https://doi.org/10.1038/s41598-025-94512-1

Conclusions

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⇒ The consortium's near-term task is to complete the contract with the Italian Space Agency (January 2028) and to fulfill the 2021-2027 National Research Plan goals.

Conclusions

⇒ Thanks to the experiences gained in the project and the critical mass of participants, the consortium also aims

► to become a national point of reference between universities, research centers and companies for cooperation in space science and technology and for exchanging skills and personnel between the research and industrial worlds;

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► to became the environment in which to build national partnerships capable of competing and cooperating more effectively internationally in space science and technology.