



Agenzia
Spaziale
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**Analysis of ESA's scientific
programme and human and
robotic exploration programmes:
opportunities and impacts for the
Italian system**

Conducted by the European Science Foundation on behalf on the Italian Space Agency

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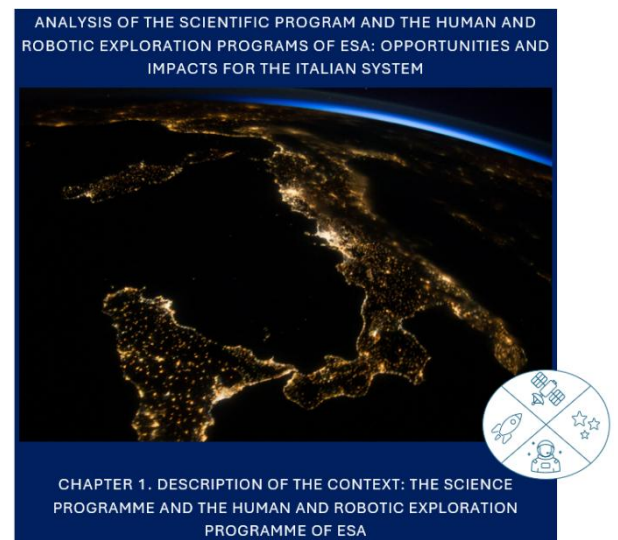
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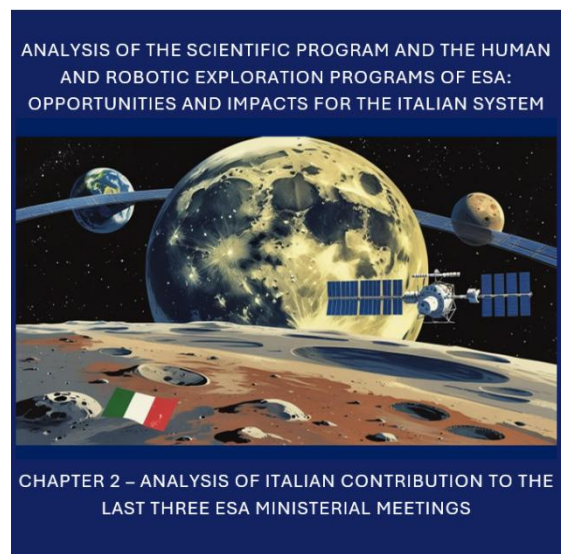
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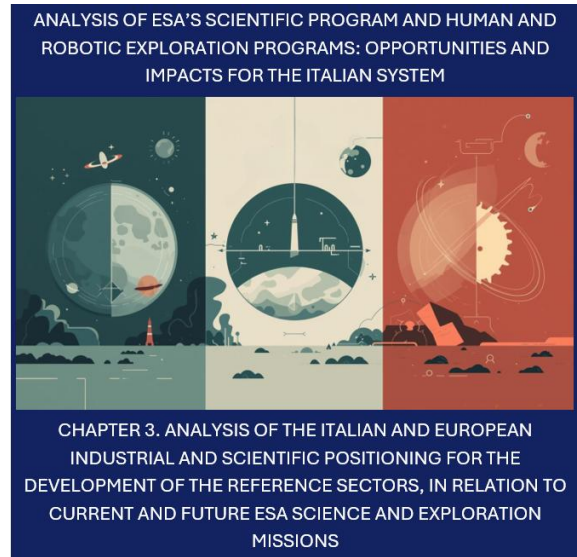
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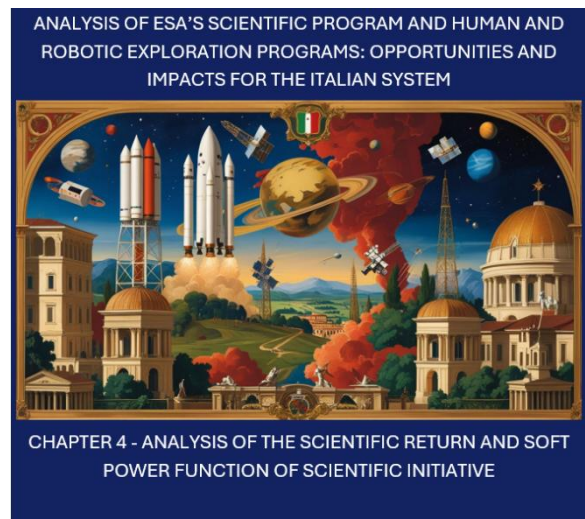
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INTRODUCTION

At the ESA Council Meeting at Ministerial Level in November 2022 (CM22), Italy reaffirmed its central role in Europe’s space endeavour, becoming the third largest contributing Member State after Germany and France. With a total investment of approximately €2.8 billion for the 2023–2025 period, an increase of nearly 40% compared to CM19, Italy accounts for more than 18% of the overall contributions of ESA Member States. This substantial commitment reflects the country’s ambition to consolidate its position as a leading actor in space science, exploration, and technological innovation.

In this context, the Italian Space Agency (ASI) commissioned the European Science Foundation (ESF) – the legal entity and host to the European Space Sciences Committee (ESSC) – to carry out an independent assessment of Italy’s participation in the ESA Science and Human and Robotic Exploration (HRE) Programs. The study provides a comprehensive analysis of Italy’s positioning within ESA, considering scientific excellence, industrial capabilities, and strategic alignment with European and international space priorities. Its overarching objective is to support evidence-based policy and strategic decision-making, ensuring that Italy’s investments continue to generate scientific, technological, and societal value within the evolving European space ecosystem.

The report opens by establishing the analytical and programmatic context. The first chapter examines ESA’s Science Program and the Human and Robotic Exploration Program through the Strengths, Opportunities, Aspirations, and Results (SOAR) framework. This analysis considers the scientific and strategic foundations of ESA’s long-term vision as articulated in the Cosmic Vision Program, Voyage 2050, Explore 2040 Strategy, and the Terrae Novae and Revolution Space roadmaps. It highlights how ESA’s integrated approach to science and exploration fosters excellence, strengthens international partnerships, and ensures continuity between fundamental research and applied innovation.

The second chapter analyses Italy’s financial and strategic engagement in ESA over the last three ministerial councils (2016, 2019, and 2022). It maps Italian contributions to the Science and HRE programs, tracking their evolution and alignment with ESA’s long-term strategies. This chapter also compares Italy’s participation with that of other major Member States, notably France, Germany and the United Kingdom. Through this comparative lens, it identifies key trends in funding, leadership, and strategic focus, providing a clearer picture of Italy’s growing influence in shaping Europe’s space policy priorities.

The third chapter explores the positioning of Italy’s scientific and industrial communities in the context of ESA’s strategic development areas. It assesses Italy’s participation in space science missions, technological innovation, and international collaborations, as well as the performance and competitiveness of the Italian space industry. The analysis considers direct and indirect benefits of Italian investments in ESA, such as industrial growth, academic excellence, knowledge transfer, and workforce development. The chapter evaluates how effectively Italy’s capabilities and priorities align with ESA’s evolving mission portfolio and future exploration goals.

The fourth chapter examines the broader impact of Italy’s engagement in ESA programs from the perspective of scientific return and international prestige. It evaluates how Italian investments have enhanced the nation’s scientific excellence, measured through publications, patents, leadership roles, and training, as well as its soft power, expressed through participation in international collaborations and global scientific governance. This assessment highlights how Italy’s contributions to ESA not only strengthen Europe’s collective capacity but also enhance Italy’s visibility and influence in the global space landscape.

Together, these analyses form a coherent narrative of Italy’s role within ESA’s Science and Exploration programs. The study combines qualitative and quantitative methods, including bibliometric analysis,

program evaluation, and stakeholder interviews, to ensure a balanced, evidence-based, and forward-looking perspective.

By identifying Italy's strengths, opportunities, and strategic pathways, this report supports ASI and policymakers in refining future investment strategies and contributing to a sustainable and

competitive European space sector. It ultimately aims to inform upcoming ministerial decisions, reinforce Italy's scientific and industrial leadership, and ensure that Europe's collective investment in space continues to deliver innovation, knowledge, and societal benefits for decades to come.

Samantha Cristoforetti, the first European woman astronaut to command the ISS during Expedition 68 (2022). Credit : NASA/ESA (CC BY-SA 3.0 IGO)



Executive Summary - Analysis of the scientific program and the human and robotic exploration programs of ESA: opportunities and impacts for the Italian system

Overview

This study analysed the position of Italy in the space science and industry landscape in relation to ESA SCI and HRE programmes, with a particular focus on activities carried out during the last three ESA Ministerial councils (CMin). Furthermore, the study reports on the substantial expectations of Italian stakeholders regarding both the CMin25 deadline and the country’s medium- to long-term space strategy, aimed at fostering a sustainable and dynamic development of Italy’s space science and industrial assets. The analysis is supported by interviews with key Italian scientists, industry representatives, industry’s association representatives and ASI delegates.

Objectives of the study



Financing strategy of Italy within the HRE budget



Italy’s scientific role in ESA SCI & HRE missions, through the participation of Italian researchers in scientific payloads, ISS experiments, and related scientific outputs



Italy’s space industry role in ESA SCI & HRE missions, their economic factors, investments and resulting benefits



Italy’s scientific excellence and international prestige

Italy’s funding strategy to HRE and SCI over the last three CMin

Italy has contributed significantly to the HRE programme over the last three CMin, placing it as the top ESA HRE contributor as share of GDP, and just below Germany in gross contributions at CMin22. Italy has steadily expanded its role in ESA’s HRE programme, with contributions rising from €376M at CMin16 to €719M at CMin22 (+78%). Italy is now positioned as a central driver of ESA exploration programme.

Italy has a balanced and comprehensive strategy towards all HRE optional Activity Areas. Italy, together with Belgium and Spain, are the only Member States (MS) consistently funding all Activity Areas. At CMin16 Italy’s initial focus was on International Space Station exploitation and ExoMars, while at CMin22 it became the leading contributor in gross budget terms to Humans beyond LEO and Mars Robotic Exploration, second only to Germany for Humans in LEO. An increased commitment to Lunar Robotic Exploration has consolidated Italy’s leadership in lunar programmes such as Artemis and Gateway.

Italy’s strong commitment to the optional HRE programme, which allows flexibility and growth, complements its participation in the mandatory programme. The science budget has shown steady growth in absolute terms. While the fixed scale of the mandatory programme can act as a ceiling, in-kind contributions by MS to ESA science missions, as well as participation in other optional programmes, offer Italy the ability to expand its role beyond this envelope.

Italy's positioning in space sciences

Italy holds a leading role in ESA's science and exploration missions, with leadership in planetary exploration. Its strong presence in flagship planetary missions such as BepiColombo and JUICE, extending into upcoming astrophysics missions like EUCLID, PLATO and NewAthena, highlight Italy's recognised expertise and credibility. With 16 scientific payloads delivered for the 12 latest ESA science missions, and the highest number of PIs and Co-Is among MS, Italy is a central player within ESA science. The high level of involvement of the national scientific community reflects the scale of Italian expertise and commitment. To maintain this momentum and maximise impact, stakeholders emphasize the need to further strengthen opportunities for Italian participation in future missions.

Italy demonstrates excellence in scientific output, with publications consistently placing it at a very high level and on par with France, Germany, and the UK. Italian-affiliated publications account for more than 10% in flagship missions such as XMM-Newton, JUICE, BepiColombo, ExoMars, LISA pathfinder, reflecting strong involvement and expertise. Citations have also risen significantly, from 23% in past missions to 28% in operational missions, confirming Italy's growing visibility, influence, and leadership within ESA science.

International scientific collaboration remains a challenge. Italy's participation in ESA joint initiatives, such as collaborative missions and programme white papers, is limited compared to other major MS. International engagement needs to be addressed to strengthen Italy's role in global space science.

Positioning of the Italian space industry

Italian industry is involved in the entire space supply chain, and particularly strong in exploration activities. Italian companies are strongest in vehicle and module prime contractorships. The sector has seen rapid growth over the past 3-4 years, especially among startups, driven by initiatives in the exploration domain and the expanding commercial space economy. ESA science and exploration contracts generate lower profitability due to inherent risks and programmatic uncertainties compared with telecommunications, Earth observation, and navigation. Nevertheless, Italy has established a particularly strong position in Exploration activities in recent years, both directly with the US and through ESA, as well as actors such as China or EAU. Science and exploration are recognized as strategically critical, fostering advanced capabilities, expertise, and long-term competitiveness.

Public fund investments are critical enablers (PNRR and ESA CMins). Beneficial initiatives following the recent increase of national funding from ASI, ESA and Italy's PNRR have acted as employment boosters (ex: Moonlight). Nevertheless, stakeholders fear losing momentum if these funding mechanisms are not maintained, as private investments alone will not be sufficient.

In addition to several reported benefits, ESA science and exploration contracts are significant drivers for job creation in Italy according to associations AIAD and AIPAS. Italy's space industry is a dynamic and expanding market, with the predominance of startups pointing to a competitive innovation ecosystem. Nonetheless, strategic challenges such as structural disadvantage in the geo-return mechanism dominated by larger players and brain-drain due to lower salaries has been reported. Sustained growth will depend on Italy's ability to address these barriers.

Scientific excellence and international prestige

Italian researchers demonstrate strong visibility and influence within ESA science structures.

They hold leading roles in several mission teams, working groups and consortia, with participation rates surpassing France, Germany, and the UK in BepiColombo, CHEOPS, Euclid, Comet Interceptor, ARIEL, and LISA. While representation in ESA advisory boards is evenly distributed among these four MS, it is slightly lower for Italy in ESA working groups. However, Italian researchers hold more positions within ESA topical teams, highlighting Italy's strong capacity to shape scientific agendas, although key stakeholders perceive this potential as underutilised.

While Italy excels in traditional scientific metrics such as publications and mission participation, it remains behind leading European countries on broader indicators of scientific prestige. Recognition through international awards remains limited, despite excellence in astrobiology and early-career astrophysics. Italian researchers hold fewer leadership roles in European and international scientific societies, suggesting potential challenges in achieving visibility and recognition abroad. In addition, Italy has secured less EU funding through H2020 and Horizon Europe framework programmes than not only France, the UK, and Germany, but also Spain and recently the Netherlands.

Italy's international standing depends on its collaboration with traditional partners as well as emerging actors. Ultimately, while science is often seen as a bridge across geopolitical divides, current realities frequently limit this ideal. Italy - and Europe more broadly - must balance pragmatism with independence, engaging selectively with both established and emerging players while reinforcing their own scientific and industrial autonomy.

Observations arising from the analysis

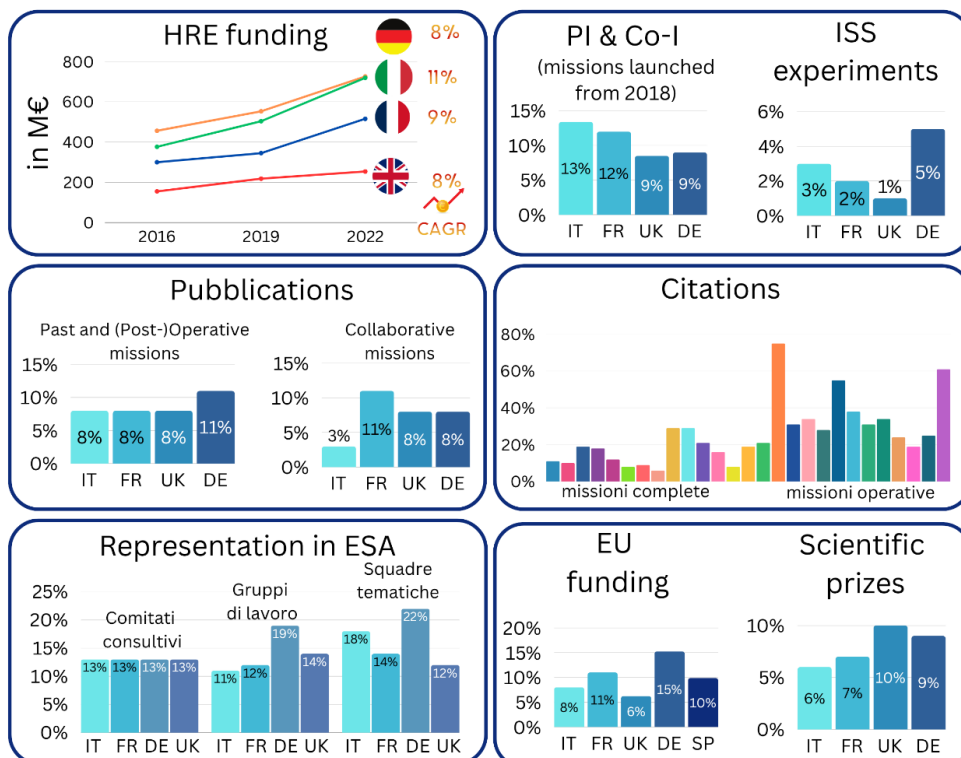
Science and exploration as key strategic drivers for industrial growth, technological independence, and scientific excellence. Funding should prioritise completion of existing national commitments to safeguard investments, particularly those related to ExoMars, MSR ERO (ZefIRO), LISA, Space Rider, Gateway, Argonaut, Moonlight and ARTEMIS.

Overarching strategic objective is to sustain the acquired momentum. With PNRR coming to an end, Italy needs a long-term, stable investment strategy, combining public and private mechanisms and balanced across the entire supply chain, enabling rapid R&D and industrial capability growth.

CMin25 is a decisive opportunity to strengthen Italy's role as a European and international leader in Exploration. Sustaining this position requires the development of a coherent, long-term national strategy that integrates scientific, industrial, and institutional efforts in a balanced ecosystem where large firms and SMEs co-develop the next generation of European and Italian space assets. Current geopolitical situation **presents an opportunity for Europe and Italy** to strengthen European autonomy by developing missing capabilities that would enable Italian scientific and industrial mastery of new missions and systems. CMin25 and ambitious mid-long-term strategy will be instrumental to achieve these goals.

Recommendations

- Adopt CNES model to **enhance strategic science planning and information exchange in Italy**
 - **Strengthen the scientific workforce and advisory structures at ASI** by appointing discipline-based science coordinators and establishing a science advisory structure.
 - **Align national funding mechanisms with ESA experiment selection** to ensure adequate support for Italian scientists.
 - Improve coordination between scientists and industry to **match technology needs with development capabilities**.
 - Reinforce national funding and commitments to ESA science and exploration missions to retain and grow Italian industrial leadership. **Broaden Industrial Access** across the supply chain.
 - **Bridge Skills and Pay Gaps** - support workforce development through STEM training, mobility programmes, and wage competitiveness to avoid sectorial drain. **Strengthen career pathways for Italian space sciences**.
 - **Leverage multi-use Technologies** - expand synergies across sectors (e.g., energy, health, mobility) using ESA-funded innovations to be injected in a broader national industrial strategy.
 - **Prepare for Post-ISS & Lunar Economy** by strategic investments in LEO successor platforms and Moon infrastructure (e.g. Moonlight, ORACLE) to avoid gaps and maintain continuity.
 - **Develop policy tools** to recognise and reward technology integration, transfer, and adaptation, not only formal Intellectual Property process.
- **Implementing these measures will enable ASI to define a more effective, integrated long-term strategy aligned with ESA priorities.**





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