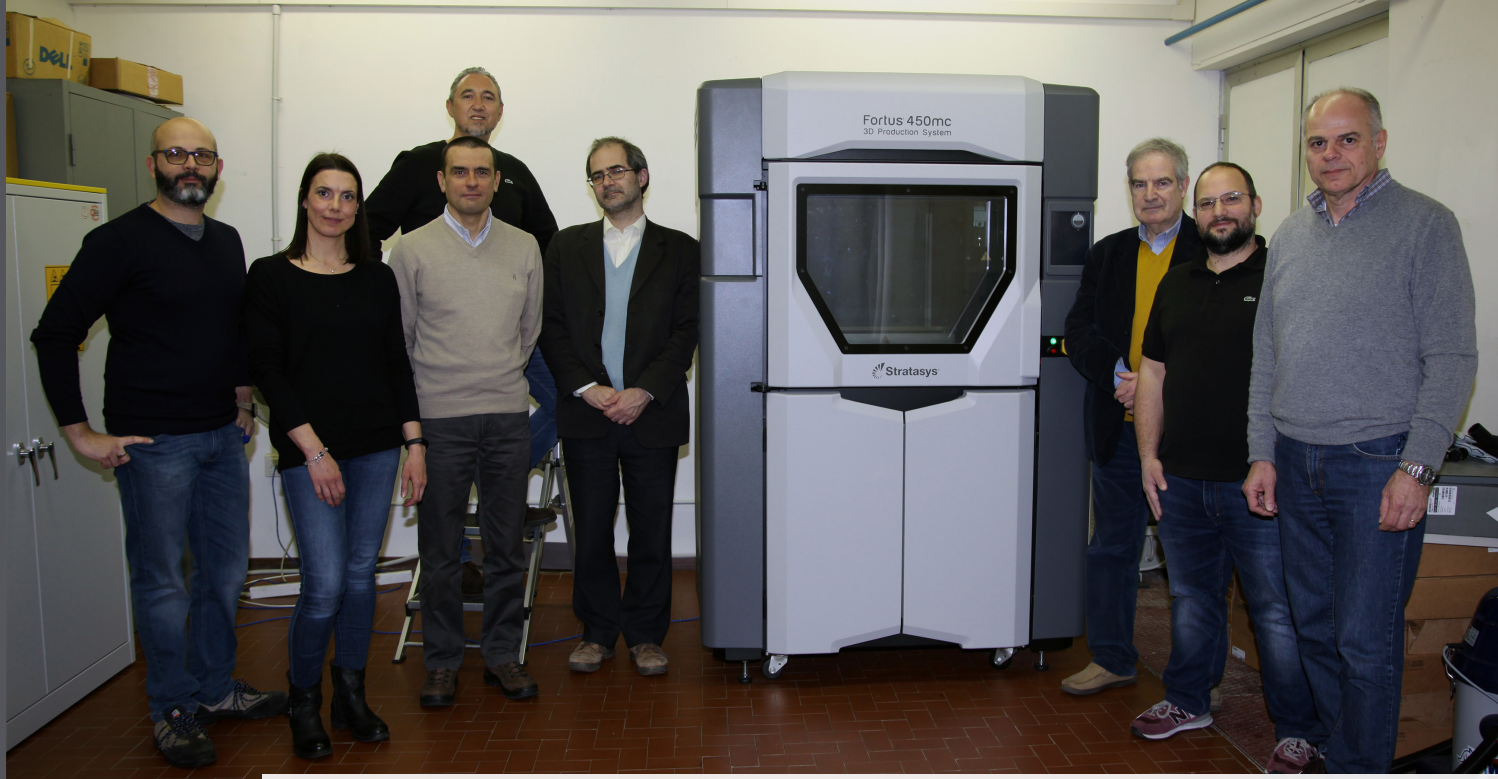
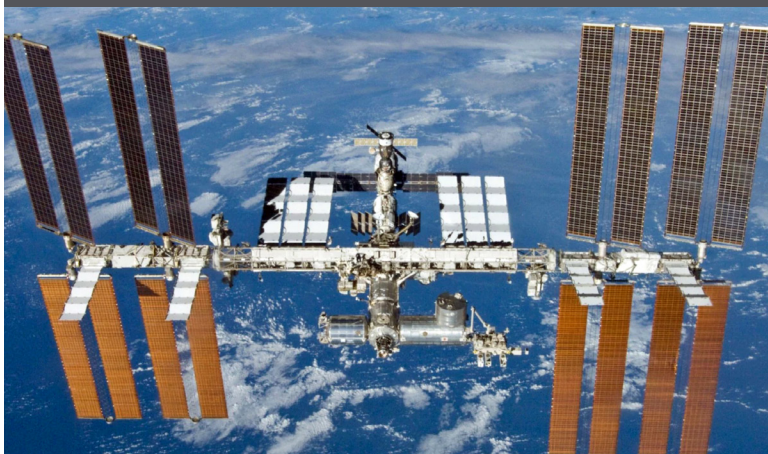


The team in charge of the development of Mini-EUSO at Laboratori Nazionali di Frascati (LNF), part of INFN, and their Fortus 450mc.

Conquering the Cosmos: INFN Overcomes Research Production Challenges with Additive Manufacturing

> “Using Stratasys FDM 3D printing throughout the production of the Mini-EUSO’s mechanical structure enabled us to reduce the overall cost of the project by a factor of ten.”

Marco Ricci
Lead Researcher and INFN Country Manager for Collaboration EUSO SPB2 Italia



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Case Study

Founded in 1951, Istituto Nazionale di Fisica Nucleare (INFN – National Institute for Nuclear Physics) is an Italian government research center tasked with promoting, coordinating and conducting scientific research in nuclear, subnuclear and astroparticle physics. Working under the supervision of the Italian Ministry of Education, Universities and Research (MIUR), INFN consists of four laboratories and close to 20 branches throughout the country, and cooperates with major Italian universities and international research centers.

The Laboratori Nazionali di Frascati branch is INFN's largest lab, housing a Design and Mechanical Engineering department with a strong reputation for deploying disruptive technologies to conduct its experiments. Given its specialized work requirements, selecting the right technology to enable effective design and production is particularly important.

"We perform research projects and experiments that typically only require small volumes of production – in some cases, just one or two prototypes or production parts are required," explained Tommaso Napolitano, Head of Mechanics Design and Construction Department at INFN, Laboratori Nazionali di Frascati. "As a result, the long lead times and high costs associated with traditional manufacturing methods make these processes unviable for us for such low volumes. 3D printing provides the ideal on-demand solution, enabling us to produce the exact quantity of parts we need quickly and cost-effectively, without the need for expensive tooling or machining."

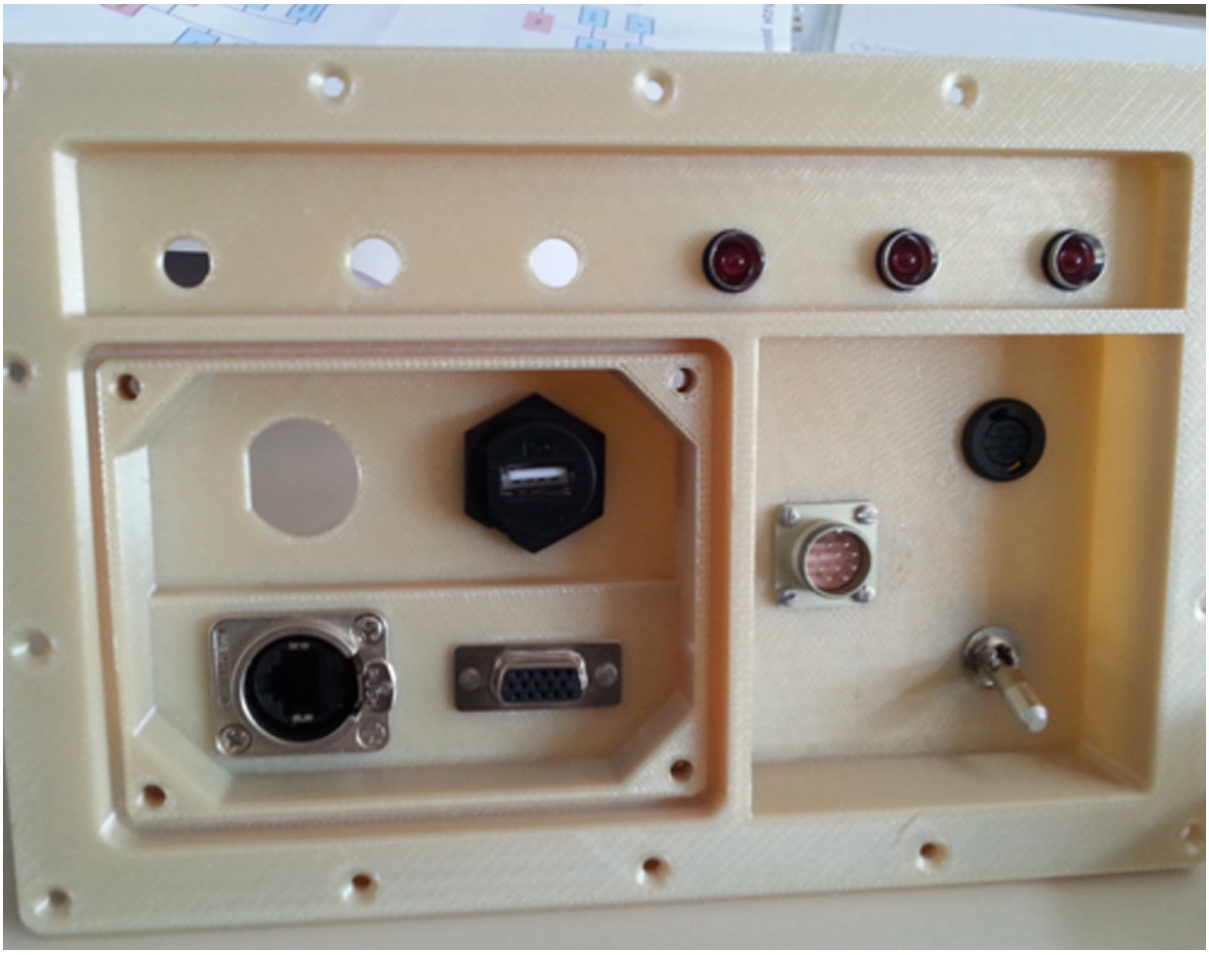
Optimizing Design and Production

Having tested several additive manufacturing technologies, the company decided to invest in Stratasys FDM® additive manufacturing from Stratasys' local partner, CAD Manager, part of Energy Group. The efficiency impact was immediate and INFN soon purchased another FDM system, a Stratasys Fortus 450mc™, to extend its production capability. In addition, it introduced PolyJet™ 3D printing for the first time to further boost its design work.

The structure of the Mini-EUSO Flight Model was3D printed using ULTEM™ 9085 resin on a Fortus 450mc 3D printer.

Today, the engineering team is leveraging additive manufacturing for every project. According to Napolitano, this has enabled the team to design with much more freedom and versatility, as well as accelerate the overall development and production process.

"We're using our Stratasys 3D printers full-time, enabling us to carry out our projects and experiments entirely in-house," he said. "With PolyJet 3D printing, we're producing highly accurate prototypes for design verification and testing, which has saved us significant time and cost during the development process. With our Fortus 450mc, we're leveraging a range of advanced materials to manufacture customized functional parts for our research, with many deployed in harsh conditions, such as those found in space. The ability to have this design and production flexibility is simply not possible with the traditional technologies used in our in-house mechanical workshops."



A part of Mini-EUSO produced in ULTEM™ 9085 resin by the team at Laboratori Nazionali di Frascati using its Stratasys Fortus 450mc 3D printer.

3D Printed Mini-EUSO Project Takes Off

As part of a cross-party collaboration with the Italian Space Agency and Roscosmos, the Russian Space Agency, INFN was recently tasked with developing a first-of-its-kind cosmic UV telescope to study terrestrial and cosmic UV emissions from the International Space Station (ISS). However, producing the mechanical structure of the telescope, named Mini-EUSO[1], presented several challenges. Most notably, the team had to find a material that could meet the stringent certification requirements of the aerospace industry and the ISS, while also being able to bear the mechanical stress and vibrations of a rocket launch.

"We explored numerous ways in which we could achieve the expected performance while meeting material certification. We even built a full prototype in aluminum, one of the most commonplace materials for aerospace. But the results were far from expectation – the structure was too heavy and it did not provide the insulation required for the interior electrical currents," explained Napolitano. "As a result, we turned to our Fortus 450mc 3D printer and found that the ULTEM™ 9085 resin offered the perfect alternative. Not only is the material extremely durable, but it's lightweight. And crucially, it also offers exceptional insulation properties, as well as

1 Multiwavelength Imaging New Instrument used by the Extreme Universe Space Observatory

INFN Overcomes Research Production Challenges with Additive Manufacturing

high chemical and thermal resistance. It's fair to say that without the capability to print the Mini-EUSO structure in this material, we would not have met the safety and weight restrictions of the ISS."

ULTEM™ 9085 resin also fulfilled the objective to protect the two Fresnel lenses and the Photo Detector Module from harmful vibrations. Importantly, the material also met the need to ensure insulation and correct operation of the photomultiplier units that detect light and convert it into electrical impulses.

The Fortus 450mc was subsequently used to 3D print the entire structure of the Mini-EUSO telescope, which today sits onboard the ISS. According to Marco Ricci, Lead Researcher and INFN Country Manager for Collaboration EUSO SPB2 Italia, 3D printing's impact on this project has been transformational.

"Using Stratasys FDM 3D printing throughout the production of the Mini-EUSO's mechanical structure enabled us to reduce the overall cost of the project by a factor of ten, as well as save us about one year of development time. It's an incredible outcome for us that I have to say I never expected from 3D printing," he said.

The Mini-EUSO program is part of JEM EUSO (Joint Experiment Missions – Extreme Universe Space Observatory), a wider international project including France, Germany, Italy, Japan, Poland, Russia, Slovakia, Sweden, Switzerland and the United States, aimed at exploring the origin and nature of ultra-high energy cosmic rays from space.

"We are now in the process of analyzing the first data recorded by Mini-EUSO and the results are very promising. From a researcher's perspective, I'm extremely proud of the way the project was executed and very excited with the achievements. For me it's clear now how 3D printing can significantly contribute towards the future success of scientific research," concluded Ricci.

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