

SCIENCE AND TECHNOLOGY FOR SOCIETY

INFN's Technology Transfer





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The INFN's fundamental research not only generates knowledge but also drives innovative technological developments with applications in sectors vital to society and the economy.

Through active technology transfer initiatives, INFN fosters collaboration between researchers and companies, facilitating the commercialization of cutting-edge innovations.

This involves licensing patents and know-how, establishing academic spin-offs, undertaking joint research projects, and providing high-value services.

Ultimately, INFN aims to maximize its positive impact on society by promoting innovation and driving economic growth.

Electronics and Computing

DISTRIBUTED COMPUTING

SUPERCOMPUTERS

NOVEL HARDWARE AND COMPUTING INFRASTRUCTURES

ULTRA HIGH-SPEED ELECTRONICS

COMPUTATIONAL BIOCHEMICAL MODELING

Materials

NOVEL MATERIALS

ANALYSIS OF MATERIALS
AND TRACE ELEMENTS

ADDITIVE MANUFACTURING

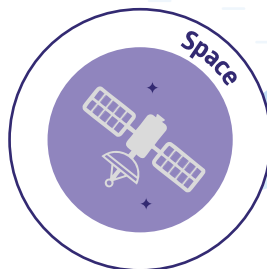
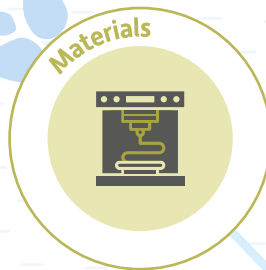
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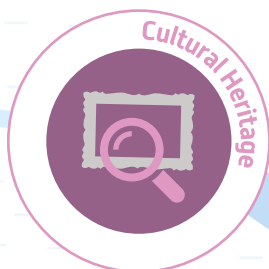
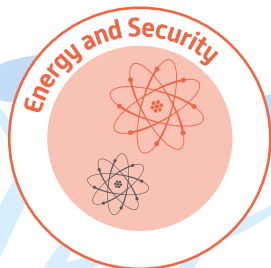
Space

ANALYSIS OF DEVICES
FOR SPACE APPLICATIONS

DETECTOR AND DEVICES
FOR SPACE APPLICATIONS

IRRADIATION TESTS





The technologies developed by INFN encompass a wide range of fields, from electronics and computer science to advanced sensor technology, imaging and diagnostic techniques, innovative materials, and nanotechnologies.

These cutting-edge developments find applications in various sectors such as medicine, aerospace, energy, environment, and security, significantly contributing to the advancement of innovation and competitiveness within both the national and international industrial landscape.

Medicine

HADRON THERAPY AND BNCT
FOR CANCER TREATMENT
PET AND NMR DIAGNOSTICS
RADIOPHARMACEUTICALS DEVELOPMENT
MEDICAL DOSIMETRY
AI AND COMPUTER AIDED DIAGNOSIS

Environment

CLIMATE ANALYSIS
MONITORING OF FINE
PARTICLES IN THE AIR
MONITORING OF GAS
EMISSIONS

Cultural Heritage

NON-DESTRUCTIVE ANALYSIS
OF ARTWORKS
DATING OF ARCHEOLOGICAL
AND HISTORICAL FINDS
ANALYSIS OF AUTHENTICITY

Energy and Safety

NUCLEAR FUSION
RADIOACTIVE WASTE MONITORING
RADIOACTIVITY MAPPING

Particle Accelerators

FROM FUNDAMENTAL PHYSICS TO CLINICAL APPLICATIONS

INFN uses its know-how in particle accelerators to develop advanced medical technologies.

Hadron therapy, a technique that uses proton or carbon ion beams, is used to treat cancer concentrating the radiations on the tumor, without damaging the surrounding healthy tissues. In this way, radiation-resistant cancer types can be successfully treated.

Through facilities like CATANA and CNAO,

INFN is transferring research results to real medical applications.

At the same time, INFN collaborates with hospitals to study radioisotopes for biomolecules marking. This highly selective radiopharmaceuticals are a powerful tool for focused diagnosis and therapies. The new cyclotron of Legnaro National Laboratories, part of the SPES (Selective Production of Exotic Species) project, is used to produce innovative radiopharmaceuticals.

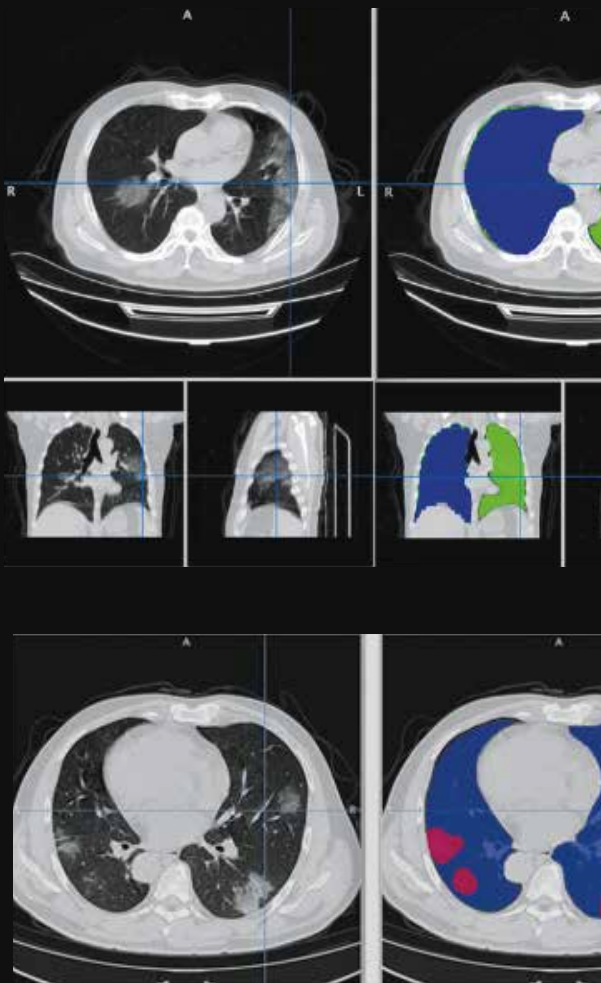


AI for personalized care

INFN has a strong expertise in processing vast amounts of data, often characterized by high dimensionality and great variability. This expertise, coupled with the advent of artificial intelligence, is revolutionizing the field of medical image analysis.

Traditionally, the interpretation of radiological images, such as X-rays, magnetic resonance imaging, and CT scans, has relied on the expert eye of radiologists. However, this approach is subject to some inter-observer variability and is time-consuming, especially considering the increasing volume of data produced by modern imaging systems.

Artificial intelligence, with sophisticated Computer-Aided Detection algorithms like DeepLook, developed by the INFN, offers an innovative solution. These algorithms can analyze large amounts of radiological data in few seconds, identifying anomalies with a precision that often exceeds human capabilities. The integration of these technologies with a patient's clinical data allows for the creation of detailed and personalized reports, paving the way for precision medicine.



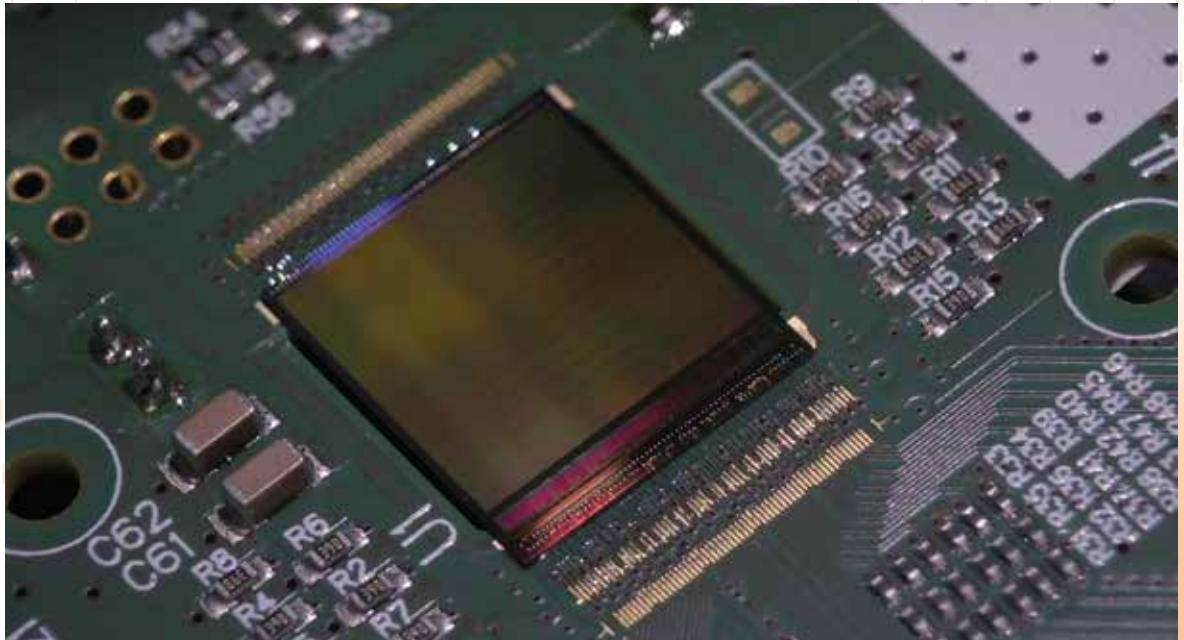
Microelectronics and Detectors

INNOVATIVE SOLUTIONS AND TECHNOLOGIES

INFN's research in the field of microelectronics has a significant impact on various sectors, for example medicine, security, industry and space exploration. Detectors developed by INFN have application in a wide range of devices, from particle detectors for fundamental physics to medical imaging tools, such as PET and SPECT.

INFN, thanks to its solid partnerships with leading companies in the semiconductor sector, is able to design and manufacture

specific integrated circuits (ASICs) with outstanding performances in terms of high density, reduced power consumption and high spatial and temporal resolutions. Our research groups, using state-of-the-art manufacturing technologies, develop monolithic CMOS sensors capable of operating in extreme environments and providing high-quality data. This synergy between research and industry is essential to accelerate innovation and develop increasingly high-performance solutions.





Big Data and supercomputing

ENABLING SUSTAINABLE FUTURE

Digitalization generates a continuous and growing flow of information that is an incredible resource but needs advanced tools to be managed and exploited. To harness the full potential of this data and remain globally competitive, it is crucial to have state-of-the-art computing infrastructure.

INFN coordinates the Italian National Center for High Performances Computing (HPC), Big Data and Quantum Computing, which, thanks to supercomputers such as Leonardo, is able to face increasingly complex computational challenges,

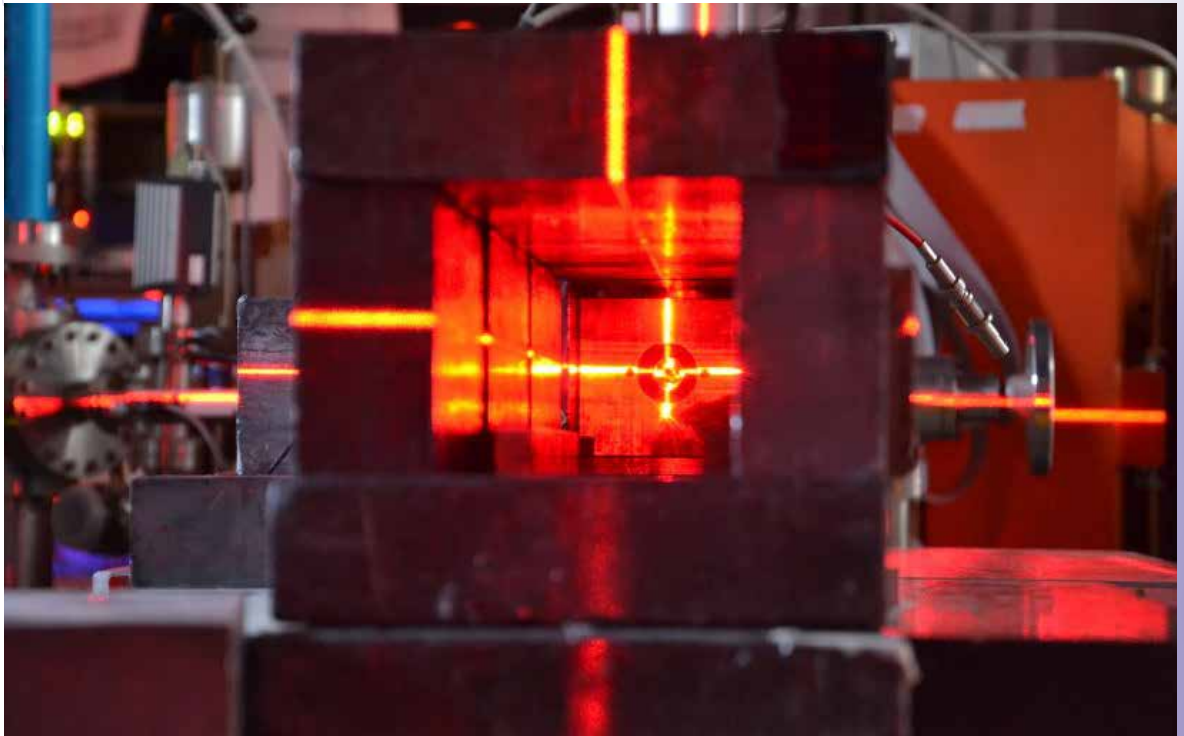
contributing to innovation in strategic sectors such as scientific research, industry and public administration.

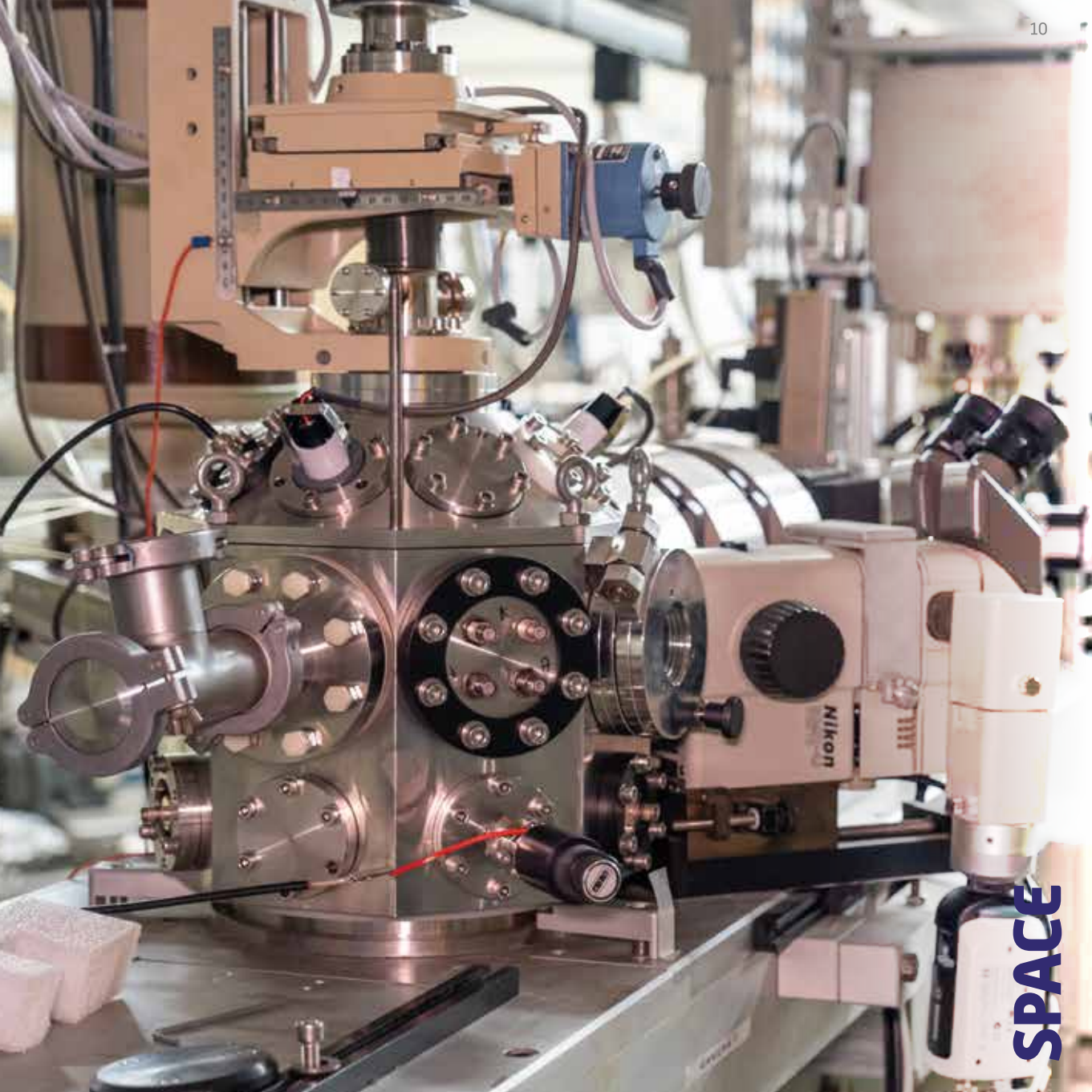
HPC gives businesses an unprecedented competitive advantage. The automotive, pharmaceutical, aerospace and finance industries are exploiting its potential to optimize processes, improve product quality and develop new innovative services. In addition, HPC enables artificial intelligence and machine learning, opening the door to an increasingly intelligent and connected future.

A Collaborative Network for Space Electronics

INFN has a long history in developing and testing electronic devices for high-energy physics experiments. This expertise extends to space applications as well. To further strengthen this capability, the INFN Irradiation Facilities Network program was established with a collaborative effort bringing together electron, neutron and proton irradiation facilities distributed

along INFN laboratories to support industrial, institutional, and research centers working with electronic, electrical, and electromechanical components. INFN accelerators facilities are used to test industrial components in radiation environments simulating the harsh space conditions of commercial and scientific satellites.





Laser reflectors for satellite positioning

Navigation systems, telecommunications, Earth monitoring are only few examples of satellite-based services which are becoming fundamental for our everyday life. All these technologies require an extreme accuracy in positioning of the satellites. INFN developed special reflectors qualified for space environment, which can be mounted on a satellite; a laser beam, fired from another satellite or a ground station is then used to determine the position relative to the other satellites of the constellation.

The same kind of reflectors are also mounted on Mars exploration rovers, like Insight and Perseverance, and used to monitor their position from the orbit as well as for physics studies.

The reflectors are designed to withstand the harsh space environment maintaining their dimensional stability and optical properties, so their construction is the result of a combination of cutting-edge knowledge in optics and material technology, making INFN a global recognized leader in this field.





Space radiation protection

Space radiation severely affects astronauts' safety and equipment integrity. Radiation protection is of great importance for satellites as well for future human missions in space. Working with particle accelerators gave INFN a vast expertise in radiation monitoring that can be transferred to space applications and thus leverage a further development of space economy.

ArduSiPM is a radiation detector based on silicon photomultipliers [SiPM]

completely integrated into a chip that can be equipped in the on-board computers of picosatellites like the Pilot-1, launched by the Italian startup CShark. The idea is to make ArduSiPM a standard equipment of each satellite so it will be possible to continuously measure the level of radiation to which the satellite is exposed, and send an alarm signal to the rest of the systems, ordering them, for example, to shut off when the particle flow is too high, as in the case of solar storms.

From Research to Industry

The challenges posed by particle accelerators, which require components capable of withstanding extreme conditions, have led to develop cutting-edge surface modification techniques. Among these, a special plasma electropolishing process patented by INFN, allows for extremely smooth and resistant metal surfaces, ideal for sectors such as automotive and aerospace.

Physical vapor deposition (PVD) offers even greater versatility. By depositing thin layers of material onto a substrate, it's possible to create surfaces with unique characteristics, such as extremely hard coatings to protect mechanical components or biocompatible coatings for surgical instruments.

INFN provides companies with a wealth of knowledge and technologies resulting from years of research, enabling them to develop higher-performing, innovative, and environmentally friendly products. Through collaboration with INFN, companies can increase their competitiveness and conquer new market challenges.



Additive Manufacturing

SIMPLICITY IN COMPLEXITY

Creating complex objects no longer requires equally complex production processes. Additive Manufacturing enables the realization of intricate shapes without the constraints of traditional manufacturing processes. This industrial revolution can produce objects that are impossible or too costly to make with traditional techniques.

At INFN, the technologies developed for the construction of accelerators and scientific instruments are transferred to the productive

world. Innovative materials and processes, such as the Sinter_TT Spark Plasma Sintering system and the DragonCopper nanocomposite, with improved electrical, thermal, and mechanical properties, find application in various industrial sectors.

Thanks to INFN research, companies can benefit from cutting-edge solutions to improve their products and production processes, opening up new frontiers in manufacturing.



Technologies for Heritage Preservation

The INFN CHNet competence network is an international reference point for the study and conservation of cultural heritage. Thanks to cutting-edge technologies, such as non-invasive diagnostic analyses and radiometric dating, CHNet unveils the hidden secrets behind works of art and archaeological, playing a crucial role in their authentication and preservation. Imagine being able to "see" inside a painting to discover the materials and techniques used, or to accurately date an artifact and reconstruct its history.

CHNet services are available to a wide community: restorers, museums, archaeologists, and anyone working in the field. By collaborating with CHNet, it is possible to access advanced diagnostic tools, specialized consultations, and joint research projects, in order to ensure the best possible conservation and enhancement of our cultural heritage.



Machina

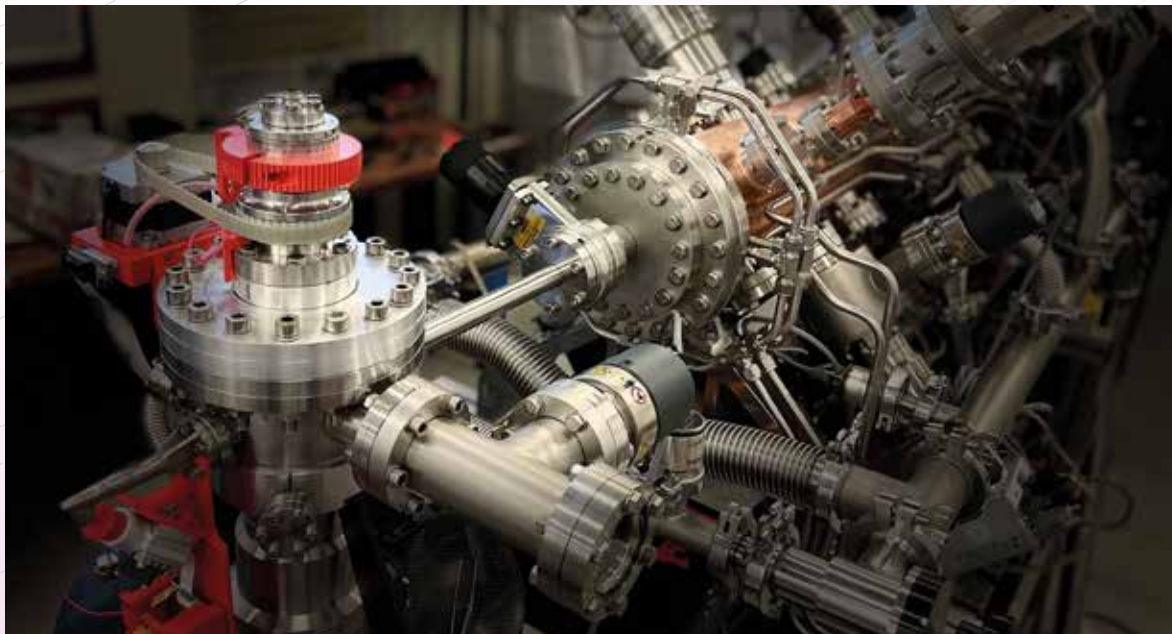
THE MOVABLE ACCELERATOR FOR CULTURAL HERITAGE IN-SITU NON-DESTRUCTIVE ANALYSIS

A groundbreaking collaboration between CERN and INFN, through its CHNet cultural heritage network, has successfully completed MACHINA, the next generation of high-performance compact and movable accelerator, dedicated to the analysis of cultural heritage.

The accelerator is based on radio frequency quadrupole technology (HF-RFQ) developed at CERN and on accelerator skills developed

at INFN-LABEC in Florence, and will be full-time dedicated to non-invasive diagnostic studies for the restoration and analysis of materials of historical finds and works of art.

Weighing less than 300 kg and being only 2 meters long, MACHINA's size allows for transport to analyze large, immovable works like frescoes, or artworks too fragile to be moved.



Nuclear technologies for safety and environment

Nuclear technologies which INFN uses to detect trace elements in fundamental physics experiments can be applied also for the detection of pollutants in the environment and in food, even at extremely low concentrations.

Thanks to their extreme sensitivity, these techniques are able to detect very low quantities of radioactive isotopes naturally present in substances, use them to trace the path of pollutants and measure the impact of human activities.

Nuclear technologies are useful in the environmental field for monitoring radioactivity and detecting radioactive sources. In the field of safety, they make it possible to create systems for explosives and nuclear materials detection, or for the control of waste.

Companies can access the highly specialized skills of INFN to develop new products and services, and improve their production processes.





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