NEWSLETTER 01

***Italian* National Institute for Nuclear Physics**

JULY 2014

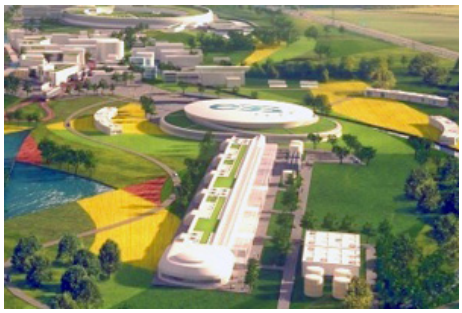
NEWS

PEOPLE

FOCUS ON

TECHNOLOGY TRANSFER

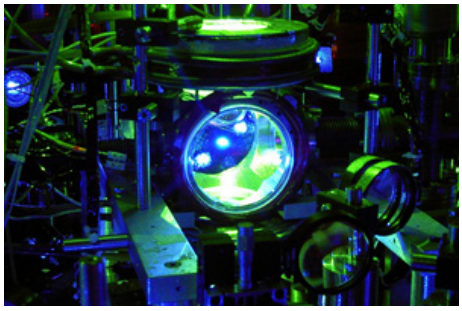
NEWS



EU Collaboration

ITALY IN THE ESS PROJECT

In the autumn, implementation of the most powerful neutron source in the world will begin in Lund, Sweden. The project is called European Spallation Source (ESS) and Italy is participating with the Ministry of Education, University and Research (MIUR), INFN, the National Research Council (CNR) and Elettra Sincrotrone Trieste. ESS will represent a state-of-the-art infrastructure and the results of the multidisciplinary research that will be carried out thanks to the neutron source will contribute to improve research activities in various sectors of knowledge growth and of its application sectors: from life sciences, materials chemistry, energy research, study of magnetic and electronic phenomena, materials engineering, archaeology and preservation of the cultural heritage, to fundamental and particle physics.



Science

A "QUANTUM TRAP" FOR GRAVITY

Measurement of the gravitational constant G, a challenge that has involved scientists from all over the world for over two hundred years, is getting increasingly closer to the exact value. The results, published in *Nature*, were achieved with the Magia experiment by researchers at the INFN and the European Laboratory for Non-Linear Spectroscopy (LENS). The study used an innovative atomic interferometry technique, exploiting the wave-particle duality of matter: a number of Rubidium atoms were dropped and then cooled to a temperature close to absolute zero, in order to slow down their motion to a speed of a few millimetres per second. At this speed the atoms behave as waves and can be studied with an interferometer: the variation in their acceleration was measured by comparing their interference in the Earth's gravitational field with that obtained when the atoms interact with a reference gravitational field, generated by a 500 kilogram mass of tungsten.

Italia del futuro
Edizione 2014

Dissemination

"ITALY OF THE FUTURE" IN STOCKHOLM

During the Italian Presidency Semester of the EU Council, the Ministry of Foreign Affairs is promoting the new 2014 edition of the "Italy of the future" exhibition. The first stop of the exhibition is in Stockholm, where it will remain open until 24 August. Implemented thanks to the collaboration between INFN, the National Research Council (CNR), the Italian Technology Institute (IIT) and the Scuola Superiore Sant'Anna of Pisa, the exhibition aims to divulge Italy's scientific excellence abroad. This new edition of "Italy of the future" will cover, in particular, robotics, particle physics and new technologies for the restoration and preservation of the archaeological and cultural heritage. The exhibition will include, among others, a virtual tour of the INFN's Gran Sasso National Laboratory and the presentation of the iCub humanoid robot, which is the size of a three-year-old child and can hear, see and carry out actions autonomously.

» PEOPLE

INFN IN EUROPE

Interview with Fernando Ferroni, President of the Italian National Institute for Nuclear Physics.

Let's start from the future: what is INFN's part in ESFRI, the European Strategy Forum on Research Infrastructures?

The first major project in which INFN is a leading player in ESFRI is certainly Km3Net, the underwater observatory for neutrinos off the coast of southern Sicily: besides being hosted in Italy, numerous INFN researchers are among its project leaders.

In addition, INFN, along with CNR and Electra, for Italy, were recently given the go-ahead to join the European Spallation Source (ESS) project to build the world's largest neutron source, in Sweden. This infrastructure offers high potential for basic research and has important multidisciplinary implications. INFN has already started to provide part of the contribution in kind provided for in the participation agreement. In the context of the Extreme Light Infrastructure (ELI) project, INFN is leader of the group responsible for the construction, in Romania, of ELI-NP for nuclear physics applications, and is actively involved in the ELI MED project, dedicated to ELI medical applications. INFN's formal participation in the X-ray free electron laser (XFEL) project and Facility for Antiproton and Ion Research (FAIR) project in Germany is also under discussion.

In addition to the projects under development, what actions is INFN taking towards Europe?

As in the ESFRI context, the idea of setting up a European Research Infrastructure Consortium (ERIC) for major research infrastructures - including for example Km3net and ESS - is becoming increasingly popular. We are currently discussing with other EU countries the possibility of establishing this type of legal framework for INFN's infrastructures with a strong European impact, in which EU countries are directly involved. Among these there are certainly the Gran Sasso Laboratory, which for many years has been hosting researchers and experiments from around the world, and the EGO French-Italian Consortium for measuring gravitational waves, near Pisa. We also plan to use our existing collaborative networks to create an ERIC for Cultural Heritage.

Whether the infrastructures are dedicated to basic research or technological applications, the ERIC legal framework would ensure more agile and intense collaboration between the countries involved and strengthen the development of research and technology transfer.

What are the main points of contact with the Horizon 2020 programme?

INFN has been taking part for many years, very often as leader, in many thematic calls on a wide spectrum of areas. INFN has undertaken strategic commitments regarding technologies applied to the field of cultural heritage and the development of new accelerator technologies, in particular in the field of plasma-wave acceleration.

Over the last decade significant investment has been made in computing, particularly in High Performance Computing projects, in collaboration with national and worldwide computer centres and leading industries, such as Cineca and Eurotech. In computing services, INFN's activity is particularly aimed at the expansion of Grid services, originated from several successful INFN projects in FP7, on Cloud platforms, in conjunction with other partners interested in their application to other areas of the expertise acquired by INFN in the management of LHC computing at CERN.

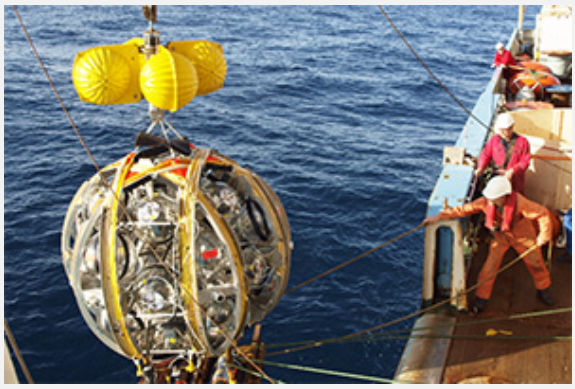
INFN has also acquired considerable experience in the design of Digital Agenda services, such as Marche Cloud OCP (Open City Platform), a public service prototype for access to medical records which, supported by Marche Region, can be easily extended to other regions of Italy and to other application fields.

Using structural funds, there will also be the new phase of the Km3Net project for the construction of a scientific observatory able to integrate research on neutrinos, sea sciences and geo-volcanology, in connection with the Etna monitoring activity developed by INGV. On the training front, INFN is involved - among others - in the higher education pilot programme using the structural funds of Abruzzo Region, with a centre at the Gran Sasso National Laboratory.

Given the number of Italian researchers involved and the level of roles covered, CERN absorbs a considerable part of INFN's commitment at the European level.

CERN is our reference for accelerator research at the European and global level and will continue to be so for some time to come. LHC is currently in an upgrade phase and will start up again in the first half of 2015 with the opening of the new phase, in which we will be involved for the next 15 years or so. The recently approved LHC High Luminosity project will begin in 2018 and will accompany CERN to the end of the next decade. Immediately after that we will need to establish a new direction, also as a result of the new physics that LHC will allow us to investigate starting from next spring. The strategy must be determined at a global level and, while American researchers continue to increasingly focus their efforts on the study of neutrinos, CERN will continue to have the task of building accelerator machines at the energy frontier. There are plans to double the energy for which the LHC was designed, following the development of new superconducting magnets, which also exploit the extremely advanced know-how of Italy and INFN in this field. An alternative hypothesis regards the construction of new colliders larger than the LHC, but we will not know the advisability of this choice for some years.

» FOCUS ON



KM3NET SEARCHING FOR NEUTRINOS

In the Mediterranean Sea, at a depth of 3500 metres off the coast of Sicily, a gigantic underwater telescope for neutrinos of cosmic origin is under construction: this is the Km3Net or "Cubic kilometre" project.

The project envisages the construction, by 2015, of a hundred or so underwater structures that will form an observation grid extending over one cubic kilometre of sea. The structures will act as a support for the gigantic undersea antenna, consisting of tens of thousands of optical sensors (photomultipliers) able to detect the blue light trail marking the passage of neutrinos, called "Cherenkov light".

Currently two of the hundred or so planned structures are operational. The last, implemented with a technology that allowed it to be progressively unrolled once anchored, was attached to the seabed, at a depth of 3500 metres, with a remote-controlled submarine robot in May 2014. The so-called "detection unit" consists of an electro-optical cable, approx. 200 m in length, to which the photomultipliers, the electronic eyes of Km3net, are connected. A fibre-optic communication cable transports the data recorded by the sensors in real time from the depths to the ground station of the INFN's National Southern Laboratory in Portopalo di Capo Passero.

Km3Net is funded by the EU as part of the project to enhance research infrastructures in southern regions. It was also supported by EU funding in 2006-2012 and, in Italy, by MIUR (Italian Ministry of Education, University and Research) as part of the PON research and competitiveness programme. Taking part in the Km3NeT international collaboration, in which Italy plays a fundamental role with the National Institute for Nuclear Physics, are Cyprus, France, Germany, Greece, Ireland, the Netherlands, Romania, Spain and the United Kingdom. Nine INFN groups are involved in the enterprise, in collaboration and in synergy with geophysics, oceanography and marine biology research institutes, including INGV and CNR.

http://www.km3net.org/

» TECHNOLOGY TRANSFER

PHYSICS FOR THE CULTURAL HERITAGE: THE FAKE LEGER

The Guggenheim Museum in Venice asked a team of INFN scientists, who for years have been working on the applications of physics to the field of cultural heritage, to analyse a painting attributed to Fernand Léger, the authenticity of which has always given rise to doubts. In February 2014, researchers from the Laboratory for the Environment and Cultural Heritage (LABEC) of Florence finally unravelled the mystery: it is a fake.

The canvas on which the painting was made was found to unequivocally date back to after the death of the French painter. The analysis was carried out with a particle accelerator using a non-destructive technique and extreme precision, able to date organic material, such as the canvas of a painting, by measuring the radiocarbon concentration: Accelerator Mass Spectrometry (AMS).

In this particular case, moreover, the results of the analysis were compared with the "bomb peak", or peak in the increase in carbon levels in the Earth's atmosphere, as one of the secondary effects of nuclear tests carried out during the cold war. Using particle accelerators it is possible to date organic material such as wood, bones or tissues up to approx. 50,000 years old. At the LABEC, the AMS technique has been used, for example, to date the remains of Saint Francis, the Cross of Rosano and the Papyrus of Artemidorus.

Among other techniques developed for basic research which have found application in the cultural heritage field are IBA (Ion Beam Analyses) that use accelerators to investigate the composition of the pigments used in paintings, ancient inks and metallic alloys. The most powerful IBA technique is the PIXE technique, which uses the emission of X-rays induced by accelerated proton beams. IBAs have been used, for example, to analyse the manuscripts of Galileo, the Madonna dei Fusi of Leonardo and the Trivulzio portrait of Antonello da Messina.

Italian National Institute for Nuclear Physics

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