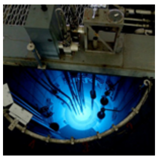
NEWSLETTER 15

Italian National Institute for Nuclear Physics

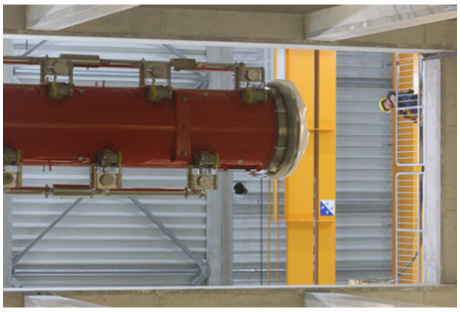
SEPTEMBER 2015

NEWS



RESEARCH
SEARCH FOR GRAVITATIONAL WAVES: INFN-CNRS AGREEMENT SIGNED FOR THE EGO CONSORTIUM

On 18 September, renewal of the agreement between INFN and CNRS for the Italian-French consortium EGO (European Gravitational Observatory), which manages the VIRGO experiment, the interferometer for the study of gravitational waves based in Italy, in Cascina, in the countryside near Pisa, was signed. Signing of the agreement coincides with the beginning of the first period of scientific activity of the two advanced LIGO (Laser Interferometer Gravitational waves Obervatory) interferometers in the United States, which are part of the worldwide network of gravitational detectors, in which VIRGO is also participating. The search for gravitational waves is one of the first examples of global research infrastructure in the sense that the interferometers situated in the various parts of the world (two in the US, two in Europe, in Italy and in Germany, and one in Japan) have been united in a global network, working together, that is, exchanging data and information. The network has also been adopted by the GSO (Group of Senior Officials on Global Research Infrastructures) as a prototype of Global Research Infrastructure, towards which today there is a tendency in other fields. For the EGO Consortium, in which currently Italy and France are participating but which could soon see the presence of Holland, there are therefore all the ingredients for implementing leading-edge scientific research in this field. EGO could also represent the first step towards the establishment of a European Research Infrastructure Consortium (ERIC), in which the infrastructure would take on the role of a veritable European gravitational observatory. ■



RESEARCH
FINAL PREPARATIONS FOR XFEL, EUROPEAN INFRASTRUCTURE THAT WILL SPY THE SECRETS OF THE NANOWORLD

The injector of the XFEL (X ray-Free Electron Laser), among the most important projects of the European Strategy Forum on Research Infrastructures (ESFRI) roadmap, has entered its final implementation stage in Hamburg. The third harmonic module   fundamental for removing the distortion of the electron beam at the exit of the injector   whose main components have been designed and produced in Italy, with the contribution of the Accelerator and Applied Superconductivity Laboratory (LASA) of the INFN Milan section, in close cooperation with the DESY laboratory in Hamburg, was transferred a few days ago to the beginning of the 3.4 km long tunnel. This is a fundamental stage of the INFN participation in the European XFEL project, to which the Institute is contributing with the delivery of half of the 800 superconducting accelerating cavities and most of the 100 crio-modules containing them.

XFEL, whose commissioning will start in 2016 to be fully operational in 2017, is a research infrastructure which, thanks to its unique characteristics an energy of 17.5 GeV, 27 thousand of X-ray flashes per second, at a very small wavelength, between 0.05 and 4.7 nanometres behaves like an enormous camera, able to capture details in the region of the Angstrom, a tenth of a billionth of a metre. This level of penetration of matter will, for example, allow XFEL to map the atomic details of viruses, film chemical reactions and take 3D images of the nanoworld. ■

DISSEMINATION

EUROPEAN RESEARCHERS NIGHT, INFN LABORATORIES AND DIVISIONS OPEN TO THE PUBLIC

Also this year, 25 September was the European Researchers' Night, now in its tenth edition. Dozens of initiatives organised throughout Italy - in the context of major outreach projects, SHARPER, DREAMS, TRACKS, funded by the European Commission - by the INFN sections and National Laboratories. An opportunity for encounter between scientists and citizens, which can discuss in an informal and entertaining manner in squares, theatres, streets and in the corridors of the laboratories, thanks to live scientific experiments and demonstrations, conferences and seminars, shows and concerts, as well as guided tours and exhibitions. Such as “La scienza illumina” (Science illuminates), organised by the Sapienza University of Rome and the Digital World Foundation, in collaboration with INFN Frascati and Asset Camera, for the International Year of Light. One of the protagonists of the Researchers' Night was the LHC (Large Hadron Collider), with a virtual tour of the CMS (Compact Muon Solenoid) implemented by the Bologna and Padua sections, projection at the Frascati Laboratories of Particle Fever, the documentary film on the discovery of the Higgs boson, and the MEET LHC installation, in Ferrara, on the 60 years of Italy at CERN. On the evening of 25th, in addition, the Photowalk 2015, the international competition for the best science photos, promoted by the InterActions network, was set in the Frascati Laboratories. Finally, during the Researchers' Night, travelling back in time was possible, with the physicists of the Gran Sasso National Laboratories and the time machine of the film "Back to the Future", the DeLorean, which on the 25th landed in L'Aquila within the scope of the SHARPER project. ■

» INTERVIEW

THE NATIONAL LABORATORIES OF FRASCATI, CRADLE OF ACCELERATORS PHYSICS IN ITALY

Interview with Pierluigi Campana, director of the National Laboratories of Frascati

Pierluigi Campana is the new director of the National Laboratories of Frascati, one of the four INFN national laboratories, symbol of the tradition of accelerator physics in our country. It was precisely in Frascati in the 60s that the electron synchrotron and the Accumulation Ring (Anello di Accumulazione - ADA - in Italian), the prototype of future accelerators in which particle beams collide to produce new particles, were built. Ada is named after the aunt of Austrian physicist Bruno Touschek, the scientist who conceived such a revolutionary idea and guided its construction. Transferred in France after its construction, and tested in the Linear Accelerator Laboratory in Orsay (LAL), the machine is the ancestor of current particle accelerators, such as the giant Large Hadron Collider at CERN in Geneva.

What type of research are the Frascati Laboratories currently engaged in and what are the main experiments?

The Frascati Laboratories, due to the long tradition in accelerator physics, are engaged in multiple lines of research. For over a decade we have been working on DAFNE (Double Annular Factory for Nice Experiments), a low energy electron and positron collider with which we study some of the symmetries that govern the particle world and the structure of the strong interactions between the lighter quarks. Moving abroad, the Laboratories are currently engaged in the construction phase of the Extreme Light Infrastructure – Nuclear Physics (ELI-NP), a gamma ray source to be installed in Romania and that will be built by the EuroGammaS consortium, led by the National Institute for Nuclear Physics.
Looking to the future, there are many expectations regarding the SPARC_LAB (*Laboratorio Sorgente Pulsanta Auto-amplificata di Radiazione Coerente*) project designed to investigate the feasibility of accelerators at the frontier of technology, able to accelerate particles in a just few hundred metres, with very small dimensions therefore compared to the large accelerators currently in operation, such

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as the Large Hadron Collider.
Experiments' scientific communities are widely international and our physicists, technologists and technicians are collaborating in the Atlas, CMS, Alice and Lhcb experiments, the main LHC detectors, and in many other subnuclear, nuclear and astroparticle physics experiments in the most important laboratories in the world. In this frame, not only do they design and build new detectors and electronic systems, but they also take part in initiatives that have a more direct impact on society: accelerators and detectors for medicine, the cultural heritage or for environmental analyses. In short, much on our plate, but initiative and curiosity are the fascinating part of this job.

What vision do you have for the future of the Laboratories and which are the most promising fields?

Certainly, as I said before, being able in the future to build an accelerator able to produce the Higgs boson and which is of limited dimensions, for example, within the perimeter of the Frascati Laboratories, is a dream. But there are research frontiers, such as the studies on plasma acceleration, which study how to obtain large accelerating fields in a small space and which have already led to promising results such as, for example, at SLAC (*Stanford Linear Accelerator Center*) in California, but also in other laboratories, including ours.
We must continue on this road with commitment and resources without, however, forgetting other and future options that allow us to remain a fully-fledged member of the worldwide club of laboratories that know how to design, build and operate accelerators. And the club is not very big. Then there is fundamental physics and our ability to build large devices. We are in a period of great expectations for the first results of the LHC with energy at 13 TeV. We could be on the verge of big developments. If so, we must get ready for a new phase of particle physics. But to do everything well we need clear ideas, resources, great determination and young people of international excellence. In short, a poker to rely on.

You have been spokesperson of an important international collaboration at CERN, the LHCb experiment in which Italy has a very important role.

As I have stressed many other times, the position that was assigned to me was the result of a great team effort, in which the role of the INFN, of my colleagues and of the Frascati Laboratories were decisive. Our research is successful abroad because we have a modus operandi that people like and appreciate. The adventure in LHCb was exciting and enriched me greatly. But managing a laboratory the size of Frascati, with over 1000 people including staff, students and users, and with the weight of its tradition on your shoulders is, however, a different and definitely "challenging" enterprise, as our

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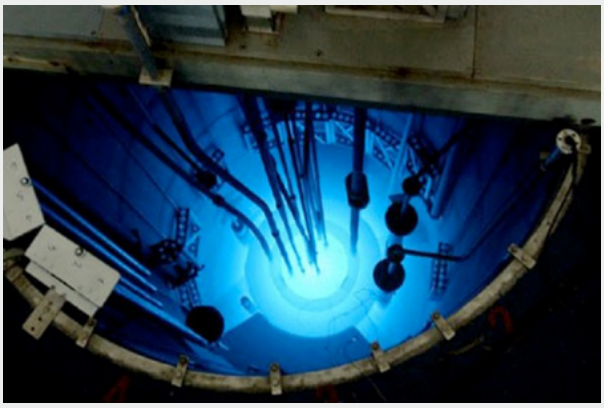
Anglo-Saxon colleagues would say. Not only the scientific programmes but also management skills, relationships with staff and the support of the Organisation are important. Frascati can count on a staff that is in every way as good as that of the great laboratories worldwide. It is up to us to capitalise on this extraordinary human capital.

In the Laboratories in Frascati basic research is carried out, but it is from these studies that technologies and applications that are integrated in society arise.

Accelerators are an example that demonstrates how improving technology to allow us to improve our research ultimately has an effect on society as a whole. A fraction of the more than 10,000 machines spread around the world is dedicated to basic research; the majority is used for industrial or medical applications, or for the preservation of the cultural heritage. Not many people know that under the Louvre there is a particle accelerator: we have a similar laboratory in Florence. And then there are particle detectors in the operating theatre to guide the surgeon in eradicating the tumour in the precise point. And, more recently, someone had the idea of reviving an old mine in Sardinia to extract the rare gases necessary for the study of dark matter, but also used as in the diagnosis of tumours in medicine: here the impact is immediate. In addition, if the operation is successful, it will create jobs in an infrastructure which is unique in the world. ■

» FOCUS ON



BORON NEUTRON CAPTURE THERAPY (BNCT), AN EXPERIMENTAL SELECTIVE RADIOTHERAPY AGAINST CANCER CELLS

This is a particular form of cancer hadron therapy. An experimental radiotherapy based on neutron irradiation of tumours after treating patients with a drug containing boron ten (^{10}B): *Boron Neutron Capture Therapy* (BNCT). BNCT was discussed this month in Pavia during the eighth edition of the *Young Researchers BNCT meeting*. Organised by the INFN of Pavia - with the support and patronage of many institutional and private partners and with the participation of the *National Center of Oncological Hadrontherapy* (CNAO) - this is an international conference dedicated to young researchers, offering them the opportunity to discuss with leading BNCT experts on various aspects of basic research and clinical application of this technique. Moreover, a workshop was organised in Pavia, which was attended by clinicians applying BNCT worldwide and by CNAO radiotherapists, to discuss the common and complementary aspects of BNCT and proton and carbon ion therapy.

BNCT is an interdisciplinary methodology that requires the collaboration of physicists, clinicians, chemists and biologists. It uses thermalised neutrons, i.e. neutrons slowed down to very low energy levels, comparable to thermal energy. The method is based on the ability of ^{10}B to capture thermal neutrons with consequent emission of a nucleus of lithium and a nucleus of helium. In the medical application, ^{10}B is bound to special molecules which, administered to the patient, are absorbed by cancer cells to a larger extent than healthy cells. Neutron irradiation of the patient triggers the capture reaction on the ^{10}B. The energy released by these reactions, and transported by the lithium and helium nuclei, is absorbed locally within distances comparable to the average size of the cells. BNCT therefore selectively destroys the malignant cells, because the damage is confined to the cell containing the boron, preserving the functionality of the surrounding healthy tissue.

Until now, the neutron beams used to conduct BNCT clinical trials on patients suffering from various forms of cancer (glioblastoma multiforme of the brain, head and neck cancer, cutaneous melanomas) have been derived from suitably modified nuclear research reactors. Many patients have been treated

» FOCUS ON

at these facilities located in Europe, Japan, USA, Argentina and Taiwan, and the clinical results have shown that BNCT is effective and safe, even against recurring and inoperable tumours. On the other hand, the specific design and safety requirements of a nuclear plant are too challenging to install reactors in the hospital environment. For this reason, since several years, basic BNCT research has been increasingly focusing on the development and construction of particle accelerators dedicated to the production of neutron beams sufficiently intense for BNCT. For example, this is happening at the INFN National Laboratories in Legnaro, which are developing an RFQ (*Radio Frequency Quadrupole*) proton accelerator; neutron fluxes adequate for BNCT are obtained from the collision of protons on a suitable target. In collaboration with the Pavia INFN Unit, a beam for clinical applications of BNCT is being designed as part of the MUNES (*Multidisciplinary Neutrons Source*) project. ■

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