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Italian National Institute for Nuclear Physics

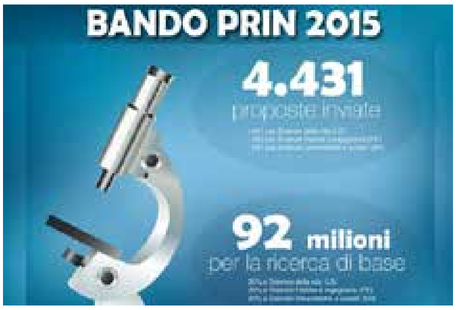
NEWS

SCIENTIFIC COOPERATION
WASHINGTON: BILATERAL MEETING BETWEEN INFN AND DOE-NSF

On 3^{rd} and 4^{th} October, the bilateral meeting for scientific cooperation between INFN, represented by the President, Fernando Ferroni, and by the Executive Committee, the Department Of Energy (DOE) and the National Science Foundation (NSF) was held in Washington. The meeting provided the opportunity to discuss in detail and in an informal manner research activities involving the collaboration between Italian and US physicists. In this edition, the topics addressed were: neutrino physics at Fermilab and, in particular, the Icarus project, coordinated by Nobel laureate Carlo Rubbia; the collaboration between Virgo and LIGO in the study of gravitational waves and the future prospects with surface, underground and space detectors; the experiments based at the INFN Gran Sasso National Laboratory (LNGS) with US participation, in particular for the search for dark matter and for neutrinoless double beta decay; LHC and computing; research in the nuclear physics field and, in particular, the collaboration with the Jefferson Laboratory. ■

INTERNATIONAL COLLABORATION
THE EUROPEAN COMMISSION ANNOUNCES EMSO-ERIC CONSORTIUM

The European Commission announced the EMSO-ERIC (European Multidisciplinary Seafloor and water-column Observatory European Research Infrastructure Consortium). The Consortium is made up by eight founding countries: France, Greece, Ireland, Italy, Portugal, Romania, Spain and UK; the head office will be based in Rome.
EMSO is a technologically advanced pan-European Research Infrastructure of fixed seafloor observatories among which the neutrino observatory KM3NET and the cabled observatory installed near the harbour of Catania. In Italy it involves the Istituto Nazionale di Geofisica e Vulcanologia (INGV), the INFN, the Consiglio Nazionale delle Ricerche (CNR), the Stazione Zoologica Anton Dohrn and the Istituto Superiore per la Protezione e la Ricerca Ambientale (ISPRA). ■



PROJECTS
INFN PARTNER IN FOUR WINNING PRIN PROJECTS

Four projects in which INFN is partner have won PRIN (Projects of Relevant National Interest) 2015 calls. Three are in the physics field. The "Non-perturbative Aspects of Gauge Theories And Strings" project. A theoretical physics project which has the objective of developing and applying non-perturbative methods in field and string theory. The development of an advanced atomic interferometer as a quantum sensor for gravitational physics experiments is the theme of the project entitled "Advanced atomic interferometer for experiments on gravity and quantum physics and applications in geophysics". Finding an answer to the questions that are still open after the discovery of the Higgs boson, is the purpose of the "Search for the Fundamental Laws and Constituents" project. An attempt to go beyond the so-called Standard Model of elementary particles, the backbone governing our current knowledge of the physical universe. The fourth project concerns the life sciences. Entitled "Preclinical tool for advanced translational research with ultrashort and ultraintense X-ray pulses", its purpose is to provide a new source of X-rays for in vivo imaging studies and radiotherapy. ■

» THE INTERVIEW

STRATEGY AND ROLE OF EVALUATION OF RESEARCH AND THIRD MISSION AT INFN

Interview with Giorgio Chiarelli, coordinator of the INFN Working Group on Evaluation and ANVUR expert for evaluation of the Third Mission

Since 1997, INFN has entrusted the evaluation of its research activities to an International Evaluation Committee (CVI), composed of seven experts from different countries, including an expert in economics and a representative of the industrial world. The report of the CVI, in addition to the evaluation aspects, also contains proposals aimed at improving the overall performance of the institution. Since 2000, in order to prepare the documentation for the CVI, and to coordinate the response to its (CVI) suggestions, the internal evaluation of research is coordinated by the Evaluation Working Group (GLV), which –among other things- evaluates the milestones proposed annually by individual experiments, the impact of the Institution's participation in international experiments and the degree of leadership exerted by INFN researchers. In addition, the GLV reports to the CVI on Third Mission activities, in terms of economic exploitation of research and production of public goods of a social, educational and cultural nature. Testifying the growing impact of the Third Mission on the research system is the fact that the National Agency of University and Research System Evaluation (ANVUR) has included these activities in carrying out the Research Quality Evaluation (VQR). We discussed these issues with Giorgio Chiarelli, since 2012 National Coordinator of the GLV and, since 2015, national expert of the Third Mission evaluation for ANVUR.

What is the purpose of internal research evaluation?

With a quip I could say: to improve ourselves. The (self-)evaluation of our activities is inherent in INFN's DNA. Every experiment, within the individual National Scientific Committees (CSN), has its own referees who follow it right from the proposal phase. This discussion is useful: there are observations, sometimes criticism, but always constructive. In addition, the referees often intervene to understand if there are any problems and to help. Even if an important part of our research takes place abroad, and is therefore nevertheless subject to the scrutiny of structures outside the Institution, the monitoring and evaluations we do internally as GLV provide our management and the CVI with the information necessary to improve

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ourselves. The goal of everyone is to obtain positive results, helping INFN to pursue its mission.

What tools, in addition to those of a bibliometric nature, have been provided?
The collection of bibliometric (but not only) indicators by the Institution is dictated by historical reasons, because they are used during evaluations by the Ministry of Education, Universities and Research (MIUR) or by other agencies. There is, however, more interesting data that we collect: from degree and PhD theses to the talks of our researchers in certain conferences, from leadership roles in international experiments to the number of articles written in collaboration with foreign researchers, to make a few examples. Over time we have added information, driven by both internal and international debate, or sometimes directly from ideas emerging in the discussion with the CVI. In recent years, for example, there has been increasing attention to information on gender, in order to understand if and where phenomena that artificially alter the balance occur. More recently, the post-training destination of our young researchers has acquired a growing importance. Part of INFN's mission is to train the scientists of the future: understanding what are the job opportunities is an important piece of information and, at the request of the CVI, we have also published one of these studies. Then, currently, the main goal is to understand how to monitor (and evaluate) activities in the enormous LHC experiments. Understanding what is important in our activity is part of the "measuring" challenge. In this we are helped by being linked to the debate that takes place in the National Scientific Committees and by the scientist's approach, which means trying different methods and comparing the results.

Third Mission means knowledge and technology transfer. Thus, also organisations that are traditionally involved in basic research are required not only to communicate but also to evaluate the economic impact of their activities. How can that be done?
First of all, I would like to outline that looking at the economic impact of research, as important as it may be, can be restrictive and sometimes short-sighted. Therefore, in the following, by "impact" I always mean also social impact.
Research Institutions are an extremely diversified world, ranging from Institutions that have activities in almost all research areas, to other small but significant organisations, as well as others which also have an important role outside research. Looking for a possible common denominator, I think the first step is to realise that we (Institutions) possess a wealth of knowledge that must be exploited by transfer to society.
In the last fifteen years, with an accentuation since the 2008 crisis, a strong emphasis has been placed on knowledge transfer that also implies an economic exchange (patents, spin-offs, etc.). This emphasis has led many Institutions to think they are being left out, since they are engaged in basic research or research without technological implications. In reality, I think we should change our way of thinking. The impact (especially innovative impact) requires a change of vision. If we start by listening to the needs of our country, all Institutions can play a role. The experience of VQR, which aims to provide an overall

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picture of the Third Mission activities of all Institutions, can play an important role.

What are your suggestions for INFN?
As for INFN, the tradition of involvement in research outreach activities is in its favour, but we must bear in mind that the world changes. I am thinking, for example, of the recent changes in the secondary education system in Italy, with the introduction of modern physics in last year syllabuses and of School-Employment Alternation. They can be excellent opportunities, but to seize them it is necessary to adapt the way we work, we must organise courses and opportunities for discussion on these issues. As for technology transfer, this is less part of our DNA, often we do not understand the value of what we do and, let's be frank, we have limited experience in fields such as intellectual property or company start ups. INFN has made and is making efforts in this direction, and I think the time has come to expose the younger researchers to these issues.

But is it really possible to establish a common ground for discussion with political and economic players that interact with the research world? To find a shared language and measurement system?
Good question! Let's say there is definitely the need to talk with all the players involved: the Third Mission cannot be carried out without interacting with the economic and social forces. The language differences are a reflection of a different way of addressing the same issues, of looking at the same problem from different angles. Certainly everyone has to make an effort, because finding a common language is the first step towards working together. As for identification of the measurement system, this is an ongoing process. Perhaps the most important thing today is to understand that the indicators cannot be static. Each measurement changes the object measured and we must be able to follow these changes. ■

» FOCUS

n_TOF: THE MYSTERY HIDDEN IN THE FIRST THREE MINUTES OF LIFE OF THE UNIVERSE

It is a mystery that has lasted now for half a century. And that dates back to the beginnings of the universe. To its first three minutes of life after the Big Bang. A time space during which the lighter and more abundant elements in the universe were formed. Something, however, is not quite right. Lithium. The estimate of the theoretical models is more abundant by a factor of three compared to that inferred by observations. It is the so-called *cosmological lithium problem*.
The so-called Big Bang Nucleosynthesis (BBN) theoretical model, in fact, accounts with considerable precision for the observed abundance of light elements and their isotopes in the cosmos. The observed quantities of deuterium and helium compared to hydrogen fully reflect the BBN predictions. When it comes to lithium, however, the observed value is three times lower than expected. Physicists from the n_TOF Collaboration at CERN, in which INFN researchers are participating, have addressed it by performing complex measurements on beryllium.
n_TOF is a pulsed neutron source coupled to two flight paths at 200 and 20 meters designed to study neutron-nucleus interactions for neutron kinetic energies ranging from a few meV to several GeV. The neutron kinetic energy is determined by time-of-flight, hence the name n_TOF. The study of these reactions is of large importance in a wide variety of research fields, including the stellar nucleosynthesis. The new results of n_TOF collaboration have already led to a publication in the Physical Review Letters (PRL).
The study, due to its importance, was also selected by the journal as the "Editors' Suggestion".
The n_TOF researchers chose beryllium (^{7}Be), because cosmological lithium is almost exclusively produced by its decay in the so-called BBN. One possible explanation of the abundance of lithium is that the theoretical models overestimate beryllium production. Or that its destruction is underestimated, as a result of reactions induced by neutrons or charged particles.
The ^{7}Be, an unstable beryllium isotope, decays into ^{7}Li with a half-life of approx. 53 days. Three minutes

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after the Big Bang the light elements just formed no longer interacted with each other. The quantities present remained "frozen". The ^{7}Be, however, was gradually transformed into ^{7}Li, halving its quantity every 53 days. In no time at all it completely disappeared. That is why observing a lithium deficiency implies that the initial ^{7}Be was less than that predicted by the BBN model. To explain this effect, we must find an alternative mechanism which prematurely destroyed the ^{7}Be (another possibility is that initially less ^{7}Be was formed, even if this hypothesis is given much less credit).
Almost all the possible nuclear reactions in the scenario of the very first minutes of the universe, however, have been measured with remarkable precision. The only ones remaining to try to explain the premature destruction of ^{7}Be are two neutron-induced beryllium reactions, widely present in the primordial scenario. Alternatively, it would be necessary to postulate New Physics or an error in the estimate of primordial lithium in astrophysical observations.
For over 50 years, the measurements have proved prohibitively difficult, since they require the combination of several factors: a neutron beam with energy similar to that of the primordial scenario and with an extremely high flux, ^{7}Be targets in sufficient quantities and purity and an adequate measuring device. One of the main limitations for many years has been the lack of an adequate quantity of ^{7}Be, a highly radioactive isotope that disintegrates rapidly and poses significant radiation protection issues.
In recent years, the n_TOF Collaboration has therefore tried to finally provide an answer to the lithium mystery. The neutron beam with the characteristics required by the experiment has been available since 2014 in the new "EAR2" experimental area at CERN. The high efficiency and selectivity experimental apparatus was developed by the INFN group, in particular at the Southern National Laboratories (LNS) in Catania.
The measurement of one of the two reaction channels - as illustrated in the study just published - indicated a reactor rate, in the range of interest for the BBN, to be able to provide a value ten times lower than currently used in the theoretical models, unequivocally clarifying that this reaction channel is not able to solve the *cosmological lithium problem*. The mystery, therefore, remains. And, according to some models, it could also be a sign of physics beyond the Standard Model.
The scientists at the n_TOF Collaboration are therefore already looking elsewhere. And have decided to carry out new measurements. On a new reaction channel. Recently another experiment was carried out, again at EAR2 at n_TOF, with an experimental setup developed together with a group from the University of Lodz. The new experiment should close the loop of all the nuclear reactions involved in Primordial Nucleosynthesis. Data analysis is in progress. An analysis, at the end of which, physicists hope to finally find the solution to one of the enigmas dating back to the origins of the universe, awaited now for 50 years. ■

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COVER
A detail of n_TOF experiment.
Source: The n_TOF collaboration.