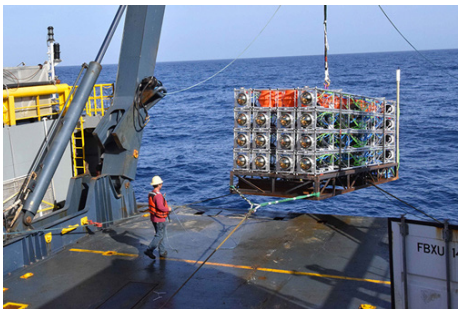
NEWSLETTER 05

Italian National Institute for Nuclear Physics

NOVEMBER 2014

NEWS

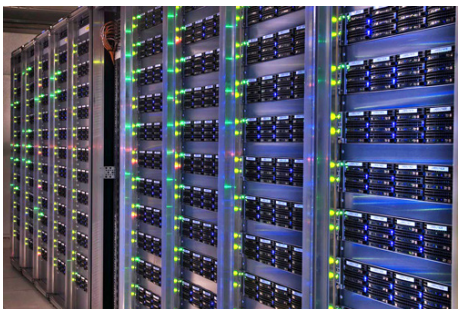


SCIENCE
KM3NET: A SUBMARINE TOWER FOR NEUTRINOS

The first tower of the KM3NeT-Italia neutrino observatory, a project in which INFN plays a key role thanks to the contribution of its Southern National Laboratories (*LNS*), has been anchored to the seabed at a depth of 3500 metres off the coast of Sicily. "The success of this operation represents another important step towards the construction of KM3NeT-Italia and therefore towards the completion of the Italian node of the European research infrastructure", said Giacomo Cuttone, KM3NeT-Italia project manager and Director of LNS. The experiment, in the final conformation of this phase, will implement a three-dimensional array of sensors for the detection and measurement of high energy neutrinos which, upon its completion, will be the largest astrophysics neutrino telescope in the northern hemisphere and will constitute the first portion of the Italian node in the Km3NeT pan-European research infrastructure. The ultimate goal is to expand the detector, exceeding the sensitivity of the US IceCube neutrino telescope operating in the glaciers of Antarctica.
The KM3NeT project has so far been largely financed with European structural funds - for the Italian part with PON 2007-2013 funds - and has already been included in the list of European research infrastructures selected by the European Strategy Forum on Research Infrastructures (ESFRI). ■

TECHNOLOGY TRANSFER
INFN LAUNCHES THE FIRST INNOVATION MEETING

In November 2014, the "1st INFN Innovation Meeting", promoted and organised by INFN and hosted by the Bicocca University of Milan, was held. An event dedicated to the topic of cooperation between the worlds of scientific research and industry, with a discussion on development opportunities in the technology transfer field. This innovation meeting was intended to be a discussion and meeting forum between researchers and industry to facilitate the sharing of skills developed in both sectors (knowledge sharing), as well as the identification of advanced technologies developed in basic research which could be applied in a production context (technology transfer).
The event is also part of the activities linked to the EU Horizon2020 programme to reward projects that promote synergy between business and research. ■



OPEN ACCESS
RESEARCH IN A CLICK

INFN is taking part with interest in the Open Access and Open Data programmes which envisage free access to scientific research and experimental data. In November it signed, along with other Institutions, the 2014-2018 Roadmap for the creation of an Italian route to Open Access. INFN had already taken steps in this direction and since 2013, with the signing of an international memorandum of understanding, is the organization that represents Italy in the European consortium called SCOAP3 for open access to the most important scientific journals in the field of particle physics. The high-energy physics community has always been a staunch supporter of the Open Access concept as a great opportunity for the development and circulation of ideas. A conviction that in November led CERN to launch the Open Data Portal which, for the first time, publishes the data of the LHC, reprocessed in order to facilitate its fruition and accompanied by the programmes and the documentation necessary for its interpretation. These initiatives will allow not only preservation of the data but also possible reuse for new analyses. The new portal will also provide data that can be used in educational projects, such as the Master Classes in particle physics, which each year involve and excite over ten thousand high school students from across Europe. ■

POPULARISATION
BEYOND THE LIMIT

The exhibition “Beyond the Limit. A journey to the frontiers of knowledge” has been inaugurated at the MUSE in Trento; it was sponsored by MUSE and INFN, with the participation of the Italian Space Agency and with the collaboration of the University of Trento and the Bruno Kessler Foundation, under the High Patronage of the President of the Italian Republic. It is the largest temporary exhibition staged since the opening of the Museum and proposes a journey to discover the limits faced by physics and astrophysics in an attempt to understand and describe the universe and its history. The exhibition lets us take a close look at these invisible limits, allowing us to see with our imagination the far away worlds that science is committed to explore. The exhibition is divided into four thematic areas, each representing a contemporary challenge: Time and Space, Energy and Matter, Visible and Invisible, Origins. The itinerary is a total immersion, characterised by the presence of multimedia video installations, interactive exhibits, original components from experiments, models and videos. The exhibition is the result of the INFN's long-standing collaboration with Italian video artists and creative programmers. The exhibition will remain open to the public until 14 June 2015. ■

» INTERVIEW

ASTROPARTICLE PHYSICS IN EUROPE

Interview with Stavros Katzanevas, Chairman of the General Assembly of APPEC* (AstroParticle Physics European Consortium) with the responsibility for the coordination and funding of national research efforts in astroparticle physics.

Astroparticle physics is a relatively new research field ...

Astroparticle physics was born at the intersection of astrophysics, particle physics and cosmology. It had multiple origins: the movement towards underground laboratories to study the decay of the proton and neutrino properties, the first detection of high energy photons using particle physics methods, the large surveys searching for astronomical dark matter. Today it addresses the physics of primordial Universe, the nature of dark matter and dark energy; the eventual unification of fundamental interactions; the properties of neutrinos and their role in cosmic evolution; the origin of cosmic rays; the Universe at extreme energies studied using multi-messenger probes including high energy cosmic rays, photons, neutrinos and gravitational waves.
After the Higgs discovery, with the measurement of neutrinos oscillations and the precision results the PLANCK satellite, we have for the first time the theoretical and experimental possibility to formulate a coherent picture of the Universe covering a multitude of energy scales: from the electroweak symmetry breaking scale, or Higgs scale if you wish, to this of inflation.

Which priorities has APPEC set for the next future and which short or long term results can we expect?

The APPEC Scientific Advisory Committee, under the chairmanship of Antonio Masiero, vicepresident of INFN, is currently in the process of elaborating a roadmap “respecting the budgetary constraints”, that will become APPEC policy after discussions in the APPEC General Assembly early 2015; so what I can say now is still tainted by the priorities of the previous APPEC roadmap, elaborated in 2011, although informed by the current process to which I participate.

» INTERVIEW

The first and foremost expectation in the next few years is the first detection of gravitational waves in the advanced Virgo and LIGO antennas, so our support to the gravitational observatories, should be unfailing. An increase of sensitivity by two orders of magnitude in dark matter searches, e.g. by the detector Xenon 1T, and an order of magnitude increase of sensitivity in what is called neutrino-less double beta decays for neutrinos mass studies is also expected in the next few years.
Then the next two years will see the start of construction of the Cherenkov Telescope Array (CTA) observatory of high energy photons, the completion of the first phase of the KM3Net high energy neutrino observatory and the start of the upgrade of the Auger observatory of ultra high energy cosmic rays. In parallel, the large surveys of dark energy on ground (LSST) and in space (EUCLID) are funded and in advanced stage of construction.
Furthermore, an importance tendency of the astroparticle infrastructures is towards internationalization, since their size starts exceeding national or regional possibilities.
In this respect, APPEC has organized this summer in Paris, an international meeting implicating the leaders of world-wide agencies and leading principal investigators to promote the global coordination concerning the large infrastructures necessary to study the remaining parameters of the neutrino. Agencies and researchers converged on a well marked path for the following years.
A second meeting to gauge the progress is currently organized in April at Fermilab, in Chicago. This is global coordination path is source of optimism in the community but is not exempt of course of potential hurdles. Last but not least, the APPEC agencies wish to increase their contributions to the current and future cosmology program beyond this of dark energy, since the recent results from the LHC to PLANCK show that this is an area where important results may be obtained, through missions in space or on ground.
Surprisingly, although the above program seems large and ambitious, it does not require large increases of the yearly budget spent on astroparticle physics and Cosmology in Europe today, provided that projects come in a well thought time-order and coordination among European agencies is increased.

How can APPEC influence national and Europe policies? Which are the tools it uses for defining recommendations to the national agencies?

Given the program above, it is clear that we are heading towards major decisions in 2017-2018, after the results of the current generation of dark-matter and double-beta decay experiments, the findings of the current LHC run, the end of the first phase of KM3Net, US and Japanese decisions on the neutrino program. APPEC prepares for this milestone date, through discussions at the scientific advisory committee, preparing the future evaluation committees and follow-up groups, assessing

» INTERVIEW

the current budgets at the level of its constituent funding agencies, promoting European Horizon 2020 programs aiming to coordinate the European underground laboratories, the gravitational wave antennas, the theoretical institutions and the large data centers. It also participates in programs of coordination with other large infrastructures, e,g of Astrophysics or Particle physics. Last but not least, as mentioned above, is very active in promoting the coordination with non-European agencies on global scale infrastructure issues.
But above all, the specificity of APPEC and in particular its APPEC general assembly is the fact that it gathers heads of agencies around Europe and observers from important international organizations as CERN, ESO and JINR making it a forum where the future coordination actions are discussed in extension and common endeavors emerge.

Both at the national and European levels, the research in this field often requires the realization of huge infrastructures and the preparation of challenging and costly space missions. Is it worth it?

Well, I always say that worth and value have a temporality. They have, that is, their own clock. And the temporality, of fundamental science is different from this of the other human activities. I often remark that for instance in the previous economic crisis around the 1930's while economy and politics was plunging, science was producing its best: from quantum mechanics and general relativity to astrophysics and cosmology, through experimental and theoretical discoveries that still shape the present world. I further believe that today we live in a similar period, economic crisis accompanied with many future-shaping fundamental discoveries.
This difference in temporality has many aspects. First any scientific activity reduced to the engineering level, without advanced research immediately declines. You can see for instance the great importance that upcoming world powers as e.g. China put on fundamental research. Second, and if one accepts the first premise, one has to take into account the fact that results of fundamental importance do not come everyday and that often many people have to spend entire lives on a subject till they obtain a significant result. Third, often solutions to problems of society do not come if one simply puts everyone available to think on the same problem, but often come in unexpected ways through synergies or transfer from activities for fundamental science.
In this last case the specificity of astroparticle physics research is that it uses the Geosphere as both target and detecting medium. In order to satisfy its fundamental physics goals, it needs to collect continuous time series data, deploying large often autonomous sensor networks in hostile environments (sea, desert, underground), pioneering thus what is called today the "internet of objects".

» INTERVIEW

These characteristics of astroparticle physics infrastructures build a natural synergy between astroparticle physics and the geosciences, atmospheric and climate studies, biodiversity and many industrial applications. APPEC has made a few years ago, a preliminary list of these applications, in a brochure called “From the Geosphere to the Cosmos”, that one can find in the APPEC website. You would be surprised by the magnitude and wealth of the interdisciplinary applications that are born or could develop in the future from astroparticle research infrastructures or space challenging investigations.

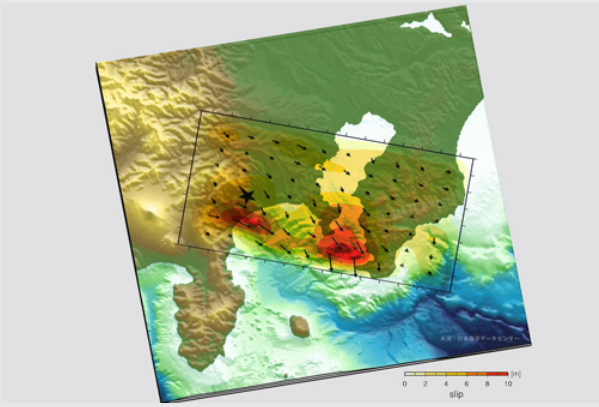
**APPEC includes 15 funding agencies, governmental institutions and institutes from 13 European countries. Created in 2012, it emanated from the astroparticle physics European Coordination committee founded in 2001 as an outcome of a decade of preparatory work by a consortium of representatives and of the intense preparatory work provided by the EU-funded ERANETs ASPERA and ASPERA-2 (2006-2012). This work paved the way to the present APPEC consortium through a series of funding mechanism studies, common roadmap elaborations, common calls for R&D proposals and common outreach and communication activities.*

» THE EUROPEAN PROJECT

SPES: NUCLEAR PHYSICS FROM STARS TO BIOMEDICINE AND NEW MATERIALS

It will study atomic nuclei produced in the most advanced stages of the evolution of stars and, at the same time, produce radioisotopes for medicine. This is the dual goal of SPES (Selective Production of Exotic Species), the project currently under construction at the INFN National Laboratories in Legnaro. Another aspect of the project concerns the possibility to study the properties of new materials through irradiation with neutrons.
At the core of the project is a high-intensity cyclotron, a circular accelerator capable of producing and accelerating protons at the rate of ten million billion protons every second. Two proton beams will be extracted from the cyclotron, one dedicated to the study of nuclear astrophysics and the other for applications, in particular those in the medical field.
For nuclear physics, the most fascinating aspect of SPES is the ability to produce highly unstable nuclei, very different from those found on Earth. Most of our knowledge on the properties of nuclei has been gained through the study of existing stable nuclei. The SPES beams will provide a new perspective allowing the properties of nuclei to be understood in extreme conditions. At the same time, SPES will be used for the production of particular radionuclides for nuclear medicine; in this way it will be possible to produce radiopharmaceuticals of an experimental and innovative nature, useful for the diagnosis and treatment of heart disease and cancer.
Finally, among the innovative aspects of the project, the funding system is worthy of mention. For the operation of SPES, the funds that can be obtained from the production of radioisotopes for medical purposes will be crucial, an aspect which provides the project with a prospect of autonomy and continuity.
SPES is part of a larger European project, Eurisol, which today sees European nuclear physicists engaged in the implementation of three radioactive ion beam infrastructures. In addition to SPES, in France a similar machine, SPIRAL2, is under construction and at CERN, the existing ISOLDE equipment is in the process of being upgraded. These three machines will constitute a distributed European infrastructure, available to scientists of the old continent. ■

» TECHNOLOGY TRANSFER



WITH JAPAN TO STUDY VOLCANOES

A mutual declaration of interest, recently signed at the Italian Embassy in Tokyo between the Italian Institute for Nuclear Physics (INFN), the Italian Institute for Geophysics and Volcanology (INGV) and the Earthquake Research Institute (ERI) of the University of Tokyo, marks the formal step of the collaboration already in place between Italy and Japan and between INFN and INGV for the use of elementary particles - muons and neutrinos - for Earth and seismic event studies. With the aim of promoting research and technological innovation in this field, the collaboration project is part of the Executive Programme of the Bilateral Agreement for Scientific and Technological Cooperation between Italy and Japan and is of great interest to both countries that can reap mutual benefit from cooperation in areas in which both are at the forefront. The agreement also marks an alliance between Earth sciences and elementary particle physics for the study of phenomena, volcanoes and earthquakes, of interest to the entire population.
Among the new techniques developed, muon radiography is certainly the most promising: it allows magmatic ducts or other internal structures in the emerging part of volcanoes to be seen using muons, particles that anyway incessantly rain down on the Earth, generated by the impact of cosmic particles in the atmosphere. Their ability to penetrate through very thick layers of rock makes these particles a valuable investigation tool which, introduced by Japanese scientists, was later developed both in Italy and in Japan.
The declaration of interest between the Japanese and Italian research institutes will be followed by a collaboration agreement between the three institutions which envisages the exchange of researchers and students, the development of research of mutual interest and circulation of the results of academic knowledge and information. The project also lays the foundations for further joint research in the study of seismic phenomena and volcanic eruptions and extends the consolidated collaboration between Italian and Japanese scientists to an innovative research field. ■

ITALIAN NATIONAL INSTITUTE FOR NUCLEAR PHYSICS

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