



NEWSLETTER 34

Italian National Institute for Nuclear Physics

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INFN researcher and Italian Industrial Liaison Officer at CERN*



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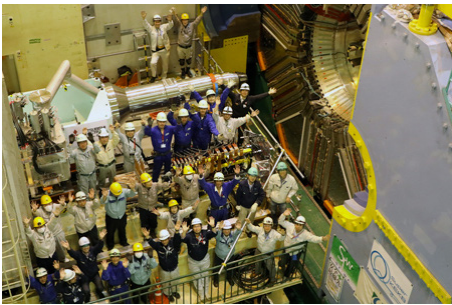
GRAN SASSO LABORATORIES: GERDA'S CHALLENGE TO MAJORANA'S NEUTRINO



AGREEMENTS

IN THE PRESENCE OF PRESIDENT MATTARELLA, INFN AND JINR RENEWED THEIR COLLABORATION

On April 12th, in the Italian Embassy in Moscow, and in the presence of Italian President Sergio Mattarella, the INFN and the Joint Institute for Nuclear Research (JINR) renewed their framework agreement on scientific cooperation. The agreement was signed by the President of INFN Fernando Ferroni and the Director of JINR A. Victor Matveev. The signing ceremony was attended by Cesare Maria Ragaglini, the Italian Ambassador in Moscow, Pietro Frè, Scientific Representative of the Embassy, and the INFN Italian delegation. The agreement, which was renewed for six years (2017-2022), stands in a tradition of broad cooperation, involving both theoretical and experimental aspects of nuclear, high energy and astro-particle physics and technological research; and it provides for collaborations between the two institutes consisting in exchanges of researchers, of information, of technologies and of scientific equipment. The agreement also aims to promote the shared organization of events that may stimulate and facilitate all these collaborations, such as scientific workshops, conferences, and training schools. All these activities will be coordinated by a Joint Committee which will be in charge of monitoring the initiatives of mutual interest, regulating the exchange of information on national and international activities, and proposing implementation arrangements for specific research projects, appropriate measures for the coordination of the activities and joint initiatives for the promotion and scientific advancement of the results. The research agreement between the two scientific institutes has deep roots, ideally tracing the origin of this successful cooperation between Italian and Russian physics to the historical figure of Bruno Pontecorvo, who conceived, in the laboratory in Dubna, all the ideas that make him one of Physics main players of the last century. ■

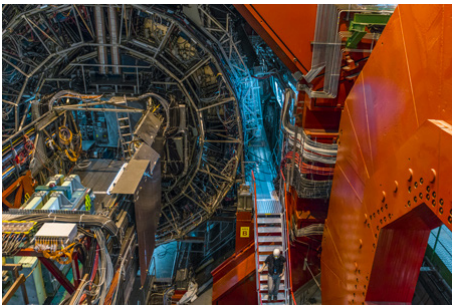


INTERNATIONAL COLLABORATIONS

JAPAN: BELLE II IS IN PLACE INSIDE THE SUPERKEKB ACCELERATOR

The Belle II detector is in place at the SuperKEKB accelerator's point of collision, in the KEK laboratory in Japan. A crucial step towards the beginning of scientific activities of what will be the world's highest intensity accelerator was thus completed. Indeed, on the afternoon of April 11th, there was the successful completion of the "roll-in", i.e. the positioning of the entire Belle II detector system on the particle beam line, an operation that followed the completion of the assembly in the assembly area and the integration of the various components of the detector. Belle II, which is 8 meters high, and consists of seven sub-detectors, bearing a total weight of roughly 1400 tonnes, was moved slowly and with extreme caution for about 13 meters, from the point of assembly to the beam collision point. It is now ready to collect the data of the future collisions produced by the accelerator, scheduled early next year.

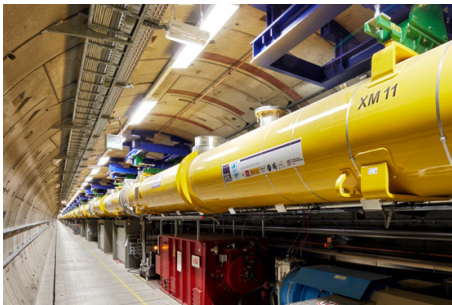
The Belle II experiment is the result of an international collaboration, which involves more than 700 physicists and engineers from 23 countries, and to which Italy contributes significantly with INFN. The INFN Italian community engaged in Belle II consist of more than 70 scientists from nine INFN sections and laboratories and Universities. The Italian groups are involved in the construction of several key elements of the experiment: the vertex detector (SVD), which is necessary for the precision measurement of the point where the particles decay, the particle identification system (TOP), which allows the recognition of particles passing through the detector, the electromagnetic calorimeter (ECL), capable of measuring the energy of the particles, and the K muon and meson detector (KLM). In addition, Italy ensures a considerable contribution to the calculation power necessary for the analysis of the enormous amount of data that the experiment will collect. ■



RESEARCH

LHC: ALICE OBSERVES NEW PHENOMENA IN COLLISIONS BETWEEN PROTONS

The ALICE experiment at the Large hadron collider (LHC) at CERN has observed for the first time in collisions between protons an increase in the production of so-called strange particles, which is one of the distinguishing phenomena of quark-gluon plasma, a very hot and dense state of matter which existed just a few millionths of a second after the Big Bang. So far, this characteristic of the state of primordial matter had only been observed in collisions between heavy nuclei, and nobody thought that it could also be found in proton collisions. This unexpected observation is a challenge to existing theoretical models, which do not include the increase of strange particles in these events. The result, published in *Nature Physics* on April 24th, was obtained from the analysis of data on collisions with 7 TeV protons on Run 1 of the LHC, and is based on the observation of the strange hadrons in proton-proton collisions in which a large number of particles is produced. Strange hadrons are well known particles, called like this because they are made of quarks, of which at least one is a strange quark. The strange quarks are heavier than quarks that make up "normal" matter and are difficult to produce. But this changes when we are in the presence of a high energy density, which rebalances the creation of strange quarks in relation to the non-strange ones, just like in heavy ion collisions. The new results show that, in the studied proton-proton collisions, the rate of production of strange hadrons increases with the 'multiplicity' (the number of particles produced in a given collision) faster than what happens for the other species of particles generated in the same collision. The data also show that the higher the number of strange quarks contained in the produced hadron, the greater the increase of its production speed. However, no dependence on the collision energy or the mass of particles generated is observed, demonstrating that the observed phenomenon is related to the fact that the particles produced contain strange quarks. The more precise study of these processes will be the key to understand more thoroughly the microscopic mechanisms of the quark-gluon plasma and the collective behaviour of the particles in small systems. ■



INTERNATIONAL COLLABORATIONS

THE EUROPEAN XFEL SUPERMICROSCOPE ACCELERATOR HAS STARTED FUNCTIONING

The European XFEL, the future European free electron super-microscope, successfully completed one of the last stages of its construction: the first beam of electrons was accelerated along the entire length of the machine, of 2.1 km. The first superconducting linear accelerator in the world of this size has hence started functioning: this is a crucial step for the commencement of the scientific activities, scheduled for next Autumn, when in the laboratories of the European XFEL in Hamburg, Germany, it will be possible to photograph and film, with atomic resolution, the biological, chemical and matter processes, both in the condensed and in the excited state of plasma. The European XFEL is, in fact, a project for the creation of a fourth generation synchrotron radiation source, based on the FEL (Free Electron Laser) process. That's the result of a scientific collaboration, led by DESY (Deutsches Elektronen-Synchrotron) and in which Italy, with INFN, is one of the leading international partners. The accelerator that is now operative will feed the X-ray laser and is therefore the key-component system, for a total length of 3.4 km, of what will be the free electron super-microscope. INFN has made an essential contribution to the accelerator's creation, by developing, at the LASA laboratories in Milan, some of the key elements of the machine. The Italian contribution, of roughly 40 million Euro, funded by the Italian Ministry of University and Research (MIUR) and brokered by the INFN, yielded an almost double return for the domestic industry, in terms of orders for advanced technologies. In addition, 10% of the researchers and engineers hired by European XFEL is Italian. Scientists at the European XFEL have crowned their twenty-year commitment to the development and construction of one of the largest and most ambitious European research infrastructures, with a cost of over 1.2 billion Euro. Indicated as one of the most important projects in the roadmap of ESFRI (European Strategy Forum on Research Infrastructures), the European XFEL will put Europe at the international forefront, opening new paths for the development of fundamental scientific knowledge and their applications in biology, medicine, and new materials. ■

» INTERVIEW



ITALY AT CERN: WHEN RESEARCH ATTRACTS INDUSTRY

Interview with Mauro Morandin, INFN researcher and Italian Industrial Liaison Officer at CERN

Italy at CERN Seventh edition happened in the first week of April. This is the event that opens CERN doors to the national excellences in industry that work in fields interesting for laboratory activities. The event is organized by the Italian Industrial Liaison Office (ILO) at CERN, with the support of the Italian Chamber of Commerce for Switzerland and the Italian Permanent Delegation at the International Organizations in Switzerland. Thanks to ILO, Italian industries played a major role in the building of the Large Hadron Collider (LHC) and of its experiments. The return on these activities for Italian industries has been greater than the investment made by our country. Recently, ILO office's activities expanded to other European research infrastructures, widening the strategic role of research and Italian industry relationship, that has its roots at CERN.

What were the new elements of this edition?

I would say, first of all, that the response of the companies was particularly strong this year, with 40 companies attending the event. Perhaps this outcome was the result of few contingent factors. The most relevant was probably the interest in the upgrade project of the LHC, HiLumi LHC, with which there will be many opportunities, already this year, for industrial orders which are expected to increase further in subsequent years.

In this edition, prior to the event itself, a half-day workshop was organised with the heads of various CERN groups showcasing to companies the opportunities for collaborations with the industry in the coming years.

The best use of the available time was made with individual meetings of companies, providing an on-line booking system, which was ultimately used to program more than 170 meetings. Finally, the companies were given access, for a whole day, to an expert on tax and regulatory issues from the Italian Chamber of Commerce for Switzerland.

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What are the final considerations?

As for the final considerations, the early feedback we have had has been very positive, especially from the companies that were at CERN for the first time. These meetings are important opportunities for companies, not only to create and consolidate contacts with reference people from CERN, but also to enable companies to get to know and cooperate with each other. I think the companies also appreciated the considerable importance acknowledged by the Italian institutions to an industrial presence in CERN, witnessed by the presence of Ambassador Maurizio Serra, the Plenipotentiary Min. Fabrizio Nicoletti, Central Director for innovation and research of MAECI and Speranza Falciano who oversees relationships with industry within INFN.

What really matters are the results in terms of new opportunities taken by the companies, but this will be quantified in the coming months.

Italy at CERN is periodically organized by the Italian Industrial Liaison Officer (ILO) at CERN.

What is its the role of the ILO?

The ILO is a figure that is provided for in the organization of CERN in order to inform the industries of each Member State about the opportunities for contracts and partnerships, thus facilitating the laboratory in its search for the best European suppliers, and fostering competition amongst companies. Each member or associate country at CERN therefore has its ILO that acts as an interface between the domestic industry and CERN and that takes part in meetings of the Finance Committee where the most valuable tender offers are approved.

The Italian ILO at CERN is appointed by the Minister of Foreign Affairs in consultation with the Ministry of Education and with the INFN which then provides the resources to support its activities. In practice, the daily work of the ILO office is to inform companies about the opportunities for jobs and collaborations with CERN and how to take part in them, to advise about tender calls in a timely manner, to inform the procurement office about potential Italian suppliers, to organize or take part in meetings with the national or regional companies and, finally, to provide support to businesses in the event of any difficulty in the interaction with CERN. Then, the ILO will meet regularly in an ILO forum where they discuss with CERN management any amendments to procurement rules and, more in general, to all actions that can lead to a more effective interaction with industries and a balanced return among countries that finance CERN.

What are today's opportunities for Italian industries at CERN?

Italian industry has always played a leading role at CERN. There are key areas of technology for the construction of accelerators and large detectors in which our companies, also through the interactions with CERN, have become leaders in Europe and around the world, such as superconductivity, ultra-vacuum, lab electronics, acceleration systems, etc. Moreover, Italian companies are very competitive also in more traditional fields, ranging from construction to civil

» INTERVIEW

and industrial installations.

In general CERN highly appreciates the passion and flexibility with which small and medium Italian companies work, that sometimes allows them to overcome unforeseen technical difficulties with brilliant and innovative solutions.

The HiLumi LHC project, to which I referred earlier, represents a significant investment for CERN, for a total of roughly one billion Euro, and a greater part of the budget will be used on industrial orders for which Italian companies have all it takes to play an important role.

Data on the 2016 industrial return for Member States of CERN were recently published. How did our country do in it?

I would say that we cannot really complain. In 2016, CERN paid over 46 millions of Swiss francs to Italian companies, and the coefficient of industrial return, that is the ratio between the quota of orders won by Italian companies and the quota of Italian funding to CERN, exceeded the values that classify a country as "well balanced", both for the supply of goods, and of services. With the exception of France and Switzerland, advantaged by the fact that they host CERN, none of the 22 Member States is in this position. Even early signals about the investments for the HiLumi LHC project are encouraging: indeed, last year Italian companies invoiced for orders of several million Euro, 17% of the total industrial orders, well above the quota with which Italy is funding CERN, at about 11%.

The ILO does not just support relations between the domestic industry and CERN, but it also encourages the collaboration of our companies in other major international scientific projects. What are the other possibilities?

Prior to broadening the scope beyond Geneva, I would like to mention the work done in collaboration with the Italian Diplomatic Representatives who last year allowed us to organize meetings to introduce companies to the opportunities that exist both at CERN, and within UN sites and in other international organizations in Geneva, which plan to make investments of hundreds for millions of Swiss francs in the coming years. The experience gained by Italian companies at CERN can indeed be valuable to start working also with other organizations in the area.

As for other international laboratories in Europe, a support activity to businesses has started also at the ESS centre in Lund, Sweden, where, unlike at CERN, important components of the new machine were entrusted to Research institutions of the Member States, including INFN, that have directly taken charge of their creation. Other initiatives were organized with colleagues at ESRF (European Synchrotron Radiation Facility) in Grenoble, France, and I believe that in the near future we will be increasingly heading in the direction of offering companies several chances for an overview of the opportunities existing within all the major international laboratories in Europe that use accelerators. ■

» FOCUS



GRAN SASSO LABORATORIES: GERDA'S CHALLENGE TO MAJORANA'S NEUTRINO

The GERDA experiment at the INFN's Gran Sasso National Laboratories (LNGS) has reached a very important scientific milestone: it is the first and only experiment that can claim the title of "background free" experiment in the study of the extremely rare and never yet observed neutrinoless double beta decay. Measuring this process is both difficult and crucial.

There is a fundamental property of neutrinos that is currently still unknown: we do not know whether neutrinos are Majorana particles, in other words identical to their antiparticles. If they were, we should be able to observe a process, the double beta decay, which is forbidden by the Standard Model of elementary particles. Expected by many other theories, such as those created to explain the absence of antimatter in our universe, this decay is never observed experimentally. The detection of this very rare phenomenon offers the opportunity to investigate unexplored regions of nature and provide important clues to the discovery of New Physics beyond the Standard Model.

The search for neutrinoless double beta decay, however, implies a strenuous battle against other much more common natural events, "background processes", which simulate the sought signal, thus polluting it and making its detection difficult.

Following the latest improvements, and for the entire duration of the data collection, roughly 3 years, GERDA should record no background event in the search range set by the energy resolution of the detectors. GERDA is therefore one of the leading experiments in this field, thanks to its special germanium detectors: these are powerful devices for the search of neutrinoless double beta decay, because they allow to drastically reduce the decay search range and thus exclude events caused by non interesting radioactive decays. In particular, whilst 8% of natural germanium is made by isotope 76 - the only one among germanium ones that can originate a double beta decay - the percentage in the germanium detectors employed by GERDA is increased to 86%. This feature, obtained with a procedure similar to the uranium enrichment one, helps to reduce the background events with respect to the

» FOCUS

signal by a factor of 10.

GERDA is set up in the Gran Sasso Laboratories, where the overlying mountain shields the experiment from cosmic rays, which would create interference signals on the detector. The germanium detectors work within a cryostat containing 63 cubic meters of liquid argon at a temperature of -190°C , immersed in a container filled with 590 cubic meters of ultra-pure water. The argon and the water, free from contamination, act as shields against radiation coming from the external environment. The battle against the background events also entails a careful selection of all the material close to the detectors (cables, supports etc.), so that it may be free from radioactive contamination.

GERDA is a European collaboration involving more than 100 scientists from Germany, Italy, Russia, Switzerland, Poland and Belgium. Italian physicists contributed to the construction of the experiment, the data collection and the consequent analysis. The involvement of Italian industry was also very significant: Di Zio constructed the water tank, CAEN supplied the high voltage power supplies for the germanium diode, Tecnomec supplied the high voltage and signal cables.

GERDA will continue to operate until mid-2019, quadrupling the data obtained so far and remaining "background free". ■

ITALIAN NATIONAL INSTITUTE FOR NUCLEAR PHYSICS

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Entrance to the INFN Gran Sasso National Laboratories