The Italian National Institute of Nuclear Physics (INFN)

Intense KickOff Meeting, October 7, 2020

A. Papa

INTENSE is a H2020-MSCA-ITN-2019 effort, GA 858199, 09/01/2020 – 08/31/2024
http://itnintense.df.unipi.it

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STEM: APERTE LE SELEZIONI PER IL FESTIVAL SCIENCE ON STAGE ITALIA

emergenza COVID-19

SCOPRI DI PIÙ SUL MONDO CHE TI CIRCONDA!
GLI ENTI DI RICERCA PER STUDENTI, INSEGNANTI E FAMIGLIE

research lines

- CSN1 Particle physics
- CSN2 Astroparticle physics
- CSN3 Nuclear physics
- CSN4 Theoretical physics
- CSN5 Technological research

public engagement

Mercoledì 23 settembre, ore 17:00,...

the Community

- emergenza COVID-19
- INFN Project - COVID-19
- NOTIZIARIO FONDI ESTERNI SU INIZIATIVE COVID-19
- R4I 2021 Research for Innovation

The National Institute for Nuclear Physics (INFN) is the Italian research agency dedicated to the study of the fundamental constituents of matter and the laws that govern them, under the supervision of the Ministry of Education, Universities and Research (MIUR). It conducts theoretical and experimental research in the fields of subnuclear, nuclear and astroparticle physics. All of the INFN's research activities are undertaken within a framework of international competition, in close collaboration with Italian universities on the basis of solid academic partnerships spanning decades. Fundamental research in these areas requires the use of cutting-edge technology and instruments, developed by the INFN at its own laboratories and in collaboration with industries. Groups from the Universities of Rome, Padua, Turin, and Milan founded the INFN on 8th August 1951 to uphold and develop the scientific tradition established during the 1930s by Enrico Fermi and his school, with their theoretical and experimental research in nuclear physics. In the latter half of the 1950s the INFN designed and built the first Italian accelerator, the electron synchrotron developed in Frascati, where its first national laboratory was set up. During the same period, the INFN began to participate in research into the construction and use of ever-more powerful accelerators being conducted by CERN, the European Organisation for Nuclear Research, in Geneva. Today the INFN employs some 5,000 scientists whose work is recognised internationally not only for their contribution to various European laboratories, but also to numerous research centres worldwide.

National Scientific Committee 1 (CSN1)

Particle physics

CSN1 studies fundamental interactions of matter in experiments using particle accelerators. At present, the best theory scientists have to describe our knowledge of subnuclear physics is the Standard Model. The aim of current research is to gain a deeper understanding of certain aspects, such as what generates the mass of these particles. In that context, discovering and determining the characteristics of the Higgs boson would represent a great leap forward. Scientists are hopeful that ongoing experiments will also enable them to discover new phenomena and fill some of the gaps in the Standard Model. One such example would be the discovery of supersymmetric particles, some of which are candidates for the constituents of dark matter (we know this pervades the universe, but have so far been unable to detect or describe its nature). Other examples would be the discovery of new signals that explain the asymmetry between matter and antimatter in our universe, or proof of the existence of further space-time dimensions.

National Scientific Committee 2 (CSN2)

Astroparticle physics

CSN2 coordinates research in the field of astroparticle physics. Its main purpose is to test the idea that all the fundamental interactions between the constituents of matter are unified in one fundamental force (the Grand Unified theory) and conduct research into new types of components of matter and energy (dark matter, dark energy). Since the only direct way of testing these theories would be to create much higher energy levels in a laboratory than the levels achievable using particle accelerators, they are tested indirectly using the universe as a natural accelerator. Astroparticle physics experiments are performed to study cosmic background radiation, cosmic rays, neutrinos, gravitational waves, very-high-energy gamma rays, other rare particles that could provide important clues to explain the matter-antimatter asymmetry in the universe, and particles that are thought to constitute the dark matter. The study of gravity and particularly of the gravitational waves predicted by Einstein, the existence of which has never directly been observed, represents one of the most fascinating challenges for scientists today.

National Scientific Committee 3 (CSN3)

Nuclear physics

CSN3 coordinates research into the structure and dynamics of nuclear matter. Italian nuclear physicists are contributing to the development of experimental techniques to study nuclei under extreme conditions. Experiments using particle accelerators enable scientists to study the mechanisms that control the development of stars in each stage of their life and to create in the laboratory the extreme conditions of density and temperature that resulted in a quark-gluon plasma, the state of the matter that probably existed in the universe for the first ten millionths of a second in the aftermath of the Big Bang. According to the fundamental theory of strong interaction (quantum chromodynamics), in this primordial phase the elementary particles of matter are distinct from one another, the nucleus of the atom does not exist and there are no protons or neutrons. The Committee is also concerned with the development of new applications, for instance, in the field of oncological hadron therapy.

National Scientific Committee 4 (CSN4)

Theoretical physics

CSN4 coordinates theoretical physics research, which is concerned with developing hypotheses, models and physics theories to explain the results of experiments and open up new scenarios for physics. Theoretical physicists from CSN4 are currently mainly engaged in research into the origin of the mass of fundamental particles, the nature and characteristics of the dark matter, the explanation of the matter-antimatter asymmetry in the universe and the fundamental quantum unification of all interactions, including gravity. Other research projects address the nature and intrinsic structure of space-time, physics of the nucleus and of the constituent particles, including the processes that occurred at the time of the Big-Bang and the subsequent evolution of the universe. These theoretical studies are based on the results of experiments using particle accelerators and of astroparticle physics experiments, and also on mathematical methods and formal and numerical techniques.

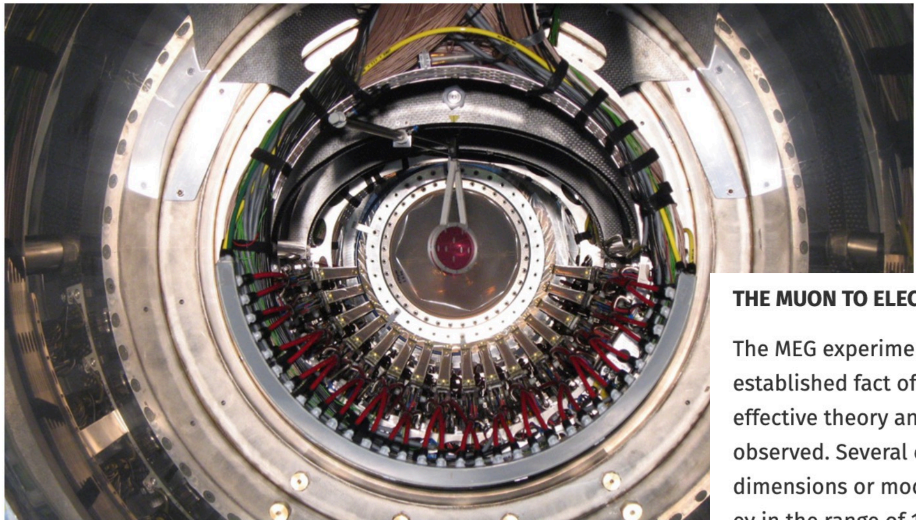
National Scientific Committee 5 (CSN5)

Technological and inter-disciplinary research

CSN5 coordinates technological research and promotion of the use of fundamental physics instruments, methods and technologies in other sectors. The INFN is a firm point of reference in Italy and worldwide for the development of next-generation prototypes and the production of today's particle accelerators. These are used not only in fundamental physics research projects, but also in other areas of research and economic and social life. Another branch of activity involves the development of radiation detectors, electronic and computer systems in close collaboration with other centres and as part of inter-disciplinary research projects. All these technologies have significant socio-economic impacts, for instance in the fields of medical imaging, hadron therapy to treat cancer, the development of radiotherapy treatment plans with protons and ions and protection of the cultural and environmental heritage.

The MEG experiment

Muon to Electron and Gamma experiment at PSI



THE MUON TO ELECTRON AND GAMMA EXPERIMENT AT PSI

The MEG experiment is searching for the Lepton Flavour Violating (LFV) decay of the muon: $\mu \rightarrow e\gamma$. With the established fact of neutrino flavour mixing and its finite mass, the Standard Model is now believed to be an effective theory and a low-energy manifestation of a more fundamental theory at higher energies could be observed. Several classes of models beyond the SM, such as supersymmetry, grand-unification, extra-dimensions or models with heavy right-handed neutrinos, for the branching ratio of LFV decays such as $\mu \rightarrow e\gamma$ in the range of 10^{-11} to 10^{-15}, thus validating that MEG search is complementary to that of high-energy TeV-scale accelerator searches for "New Physics".

The quest for $\mu \rightarrow e\gamma$ dates back more than sixty years to the pioneering efforts of Hinks & Pontecorvo in 1948, who first searched for a signal in cosmic-ray decays. MEG is searching now this decay at the most intense muon source in the world at PSI (CH), looking at the muon decay products at a rate of $3x10^7$ per second. The electron energy and decay time is detected within a magnetic spectrometer in which are mountes Drift Chambers and 60 ps resolution Timer Counters (Responsability of Genoa Group). The gamma is is detected by about 3 tons liquid Xe detector. All the 2000 readout channels from the detectors are fully digitised at about 2 GB/s. The experiment has completed in 2013 the first phase and the most updated upper limit on $\mu \rightarrow e\gamma$ is $5.7x10^{-13}$ respect to the muon normal, 20 times lower than the previous limit.