SOCIETÀ ITALIANA DI FISICA

A prestigious Italian Prize for the decisive contribution of the Italian physicists to the large experiments and discoveries at the LHC – Enrico Fermi Prize 2013

Bologna, 25 July 2013

The Enrico Fermi Prize 2013 of the Italian Physical Society (**SIF**) has been awarded for experimental elementary particle physics to:

Pierluigi CAMPANA (INFN Laboratori Nazionali di Frascati), Simone GIANI (CERN), Fabiola GIANOTTI (CERN), Paolo GIUBELLINO (INFN Torino) and Guido TONELLI (Università di Pisa and INFN Pisa), *for the outstanding results that the five large international collaboration experiments at the CERN LHC collider – LHCb, TOTEM, ATLAS, ALICE, CMS – have achieved during the first period of LHC data taking under the successful guidance of the awardees as spokespersons.*

In particular:

- to Pierluigi Campana*, for the first observation, with the LHCb experiment, of CP symmetry violation in B_s meson decays, and for a large number of high-precision measurements in "heavy flavour" physics;*
- to Simone Giani*, for the first direct confirmation, with the TOTEM experiment, at unprecedented collider energies, that the total proton-proton cross-section increases with energy, and for further precise in-depth studies on the proton structure*;
- to Fabiola Gianotti, *for the discovery, with the ATLAS experiment, of a new fundamental particle with mass around 125 GeV and properties consistent with a Higgs boson, theoretically predicted almost 50 years ago, the existence of which ensures a huge insight in the understanding of the Standard Model of particle physics;*
- to Paolo Giubellino, *for the unveiling, with the ALICE experiment, of the new features of the hottest and densest state of matter ever produced in very high energy nucleus-nucleus collisions, in particular those of the short lived, rapidly evolving and strongly interacting deconfined medium generated in such extreme conditions;*
- to Guido Tonelli, *for the discovery, with the CMS experiment, of a new fundamental particle with mass around 125 GeV and properties consistent with a Higgs boson, theoretically predicted almost 50 years ago, the existence of which ensures a huge insight in the understanding of the Standard Model of particle physics.*

The prize has been awarded starting from 2001 to commemorate the great scientist on the occasion of the centenary of his birth. The prize is assigned to outstanding SIF Members who have particularly honoured physics with their discoveries. The award ceremony will be part of the inaugural session of the 99th National Congress of the SIF, at the Aula Magna of the Rectorate of the University of Trieste on 23rd September 2013.

The Large Hadron Collider (LHC) is the world's largest complex for particle physics. It provides to the experiments collisions between counter-circulating beams of protons or of nuclei, depending on the operation mode, at unprecedented energies and luminosities. It was built by the Euroepan Organisation for Nuclear Research (CERN) from 1998 to 2012, with the aim of allowing physicists to test the predictions of the "Standard Model", the theory of the basic constituents of matter and of the fundamental forces, and to search for novel phenomena not predicted by the present theory. The LHC consists of a 27 km long ring of superconducting magnets with a number of accelerating structures to boost the energy of the particles along the way.

The five LHC experiments involve some of the largest and most complex experimental apparatuses ever devised. Novel detector technologies had to be developed during more than a decade to cope with the extreme conditions of the LHC collider. The experiments were designed and build by large collaborations of physicists and engineers from all over the globe and supported by the research Agencies and Governments of their Countries. Their construction took the dedicated work of thousands of people for about twenty years.

Two of the LHC experiments, **ATLAS** and **CMS**, are conceived as general purpose; three, **ALICE**, **LHCb** and **TOTEM**, are focused on more specific physics programmes.

The above mentioned Standard Model of particle physics describes in an unique mathematical structure all the basic forces of Nature, with the exclusion of gravity. It has been tested with very high accuracy in experiments at accelerators and colliders of the previous generations and all its elements, leptons, quarks and the mediators of the

forces, have been discovered and studied. All but the most important, the “Higgs boson". It is the one that gives mass to the mediators, the quarks and the leptons. **ATLAS** and **CMS** were then designed to search for the Higgs in all the energy interval where it could reasonably be. However, their research programme is much richer. Entering in a new energy domain may open the way to new phenomena, such as the possible existence of extra dimensions of the space, of new types of particles as possible components of the dark matter, like the “supersymmetric” ones, or microscopic black holes or some unexpected surprises.
ATLAS is about 45 m long, more than 25 m high, and weighs about 7,000 t. It is about half as big as the Notre Dame Cathedral in Paris and weighs the same as the Eiffel Tower. The ATLAS collaboration involves roughly 3,000 scientists at 177 Institutions in 38 Countries.
The **CMS** detector is built around a huge solenoid magnet that generates a field about 100,000 times the magnetic field of the Earth. The detector has 12,500 t weight. The CMS collaboration involves 3500 physicists, engineers, technicians and students from 182 Institutes in 42 Countries.
ATLAS and CMS have already discovered the new, already famous boson and started to determine its properties. All the observed ones coincide with the predictions of the Standard Model, but we are still at the beginning of LHC operation and much more work will be needed in the future.

The **LHCb** experiment, a collaboration of approximately 620 scientists and engineers from 63 scientific Institutes from 17 Countries, is specialized the physics of the “beauty” particles. Indeed, three pairs of quarks exist of increasing masses. To them physicists gave names out of their imagination: up (u) and down (d), charm (c) and strange (s), top (t) and beauty (b). LHCb measures, in particular, the tiny differences between the behaviour of particles and antiparticles, the violation of the CP symmetry, which connects the particles to their anti through the mirror. The experiment has already discovered CP-violation in the “strange and beauty” meson, the one composed of a b-quark and an s-antiquark.

The **ALICE** collaboration, consisting of approximately 1200 scientists and engineers from 32 scientific Institutes from 17 Countries, has built a dedicated heavy-ion detector to exploit the unique physics potential that nucleus-nucleus interactions provide at such high energies. Its aim is to study the physics of strongly interacting matter at extreme energy densities, where the formation of a new phase of matter, the so called "quark-gluon plasma", is expected. The existence of such a phase and its properties are key issues in the theory of the strong interactions that bound quarks in protons and neutrons, and the latter in nuclei. In this new phase quarks and gluons are not anymore confined in the nucleons which dissolve into a very short lived drop of extremely hot plasma. Very important features of such a new state of matter have been already unveiled.

Unlike the other LHC experiments, **TOTEM** is composed of relatively small, a few metres long, sub-detectors located very close to the beams at different distances from a collision point. Its programme is dedicated to the precise measurement of the proton-proton interaction cross section, as well as to the in-depth study of the proton structure which is still poorly understood. Novel results in an energy region unexplored by accelerators so far have been already obtained.

Large scientific collaborations with scientists of different cultures from all over the world, as those of the LHC experiments, require also well structured and organised management. The top responsibility is in the spokesperson, which is chosen through an election, and appointed for a limited period of a few years, by the full collaboration.

The five awarded Italian physicists have had contemporarily the honor and the burden to be the spokespersons during the difficult and exciting initial stages of the LHC, which lead the CERN international collaborations to such a high scientific success. This coincidence was not by chance, being rather a consequence of the excellence of the Italian research in the field and of the strong commitment and investments of the Italian Institute for Nuclear Physics (**INFN**) in the construction of the LHC experiments.

To the ATLAS and CMS collaborations, the 2013 prize of the Elementary Particles and High Energy Division of the European Physical Society (**EPS**) has been also awarded.

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More information:
On Società Italiana di Fisica: http://www.sif.it
On Enrico Fermi prize: http://www.sif.it/SIF/it/portal/attivita/premio_fermi
On European Physical Society: http://www.eps.org
On CERN and LHC: http://home.web.cern.ch/
On ALICE: http://aliceinfo.cern.ch/Public/Welcome.html
On ATLAS: http://atlas.ch/
On CMS: http://cms.web.cern.ch/
On LHCb: https://lhcb-public.web.cern.ch/lhcb-public/
On TOTEM: http://home.web.cern.ch/about/experiments/totem