The Nobel Prize in Physics 2013 was awarded to François Englert και Peter W. Higgs for the theoretical discovery of the Higgs particle.

The greek contribution to this discovery was significant, as presented in the following paper of John Ellis, Dimitri Nanopoulos and Emmanuel Tsesmelis.

## Greek Contributions to the Discovery of the Higgs Boson

The Nobel Prize in Physics 2013 was awarded jointly to François Englert and Peter W. Higgs "for the theoretical discovery of a mechanism that contributes to our understanding of the origin of mass of subatomic particles, and which recently was confirmed through the discovery of the predicted fundamental particle, by the ATLAS and CMS experiments at CERN's Large Hadron Collider (LHC)."

In 1964, Francois Englert, Robert Brout and independently Peter Higgs proposed how force-carrying gauge particles could become massive, and Higgs pointed out that a key prediction was the existence of a massive particle of a novel type, which has come to be known as the Higgs boson. In 1967 and 1968 Steven Weinberg and Abdus Salam used these ideas to construct the Standard Model of particle physics, but for several years neither theorists nor experimentalists thought much about looking for the Higgs boson.

The first paper to discuss the characteristics of the Higgs boson and its possible experimental signatures was written **at CERN by John Ellis, Mary Gaillard and Dimitri Nanopoulos in 1975** . In this paper they made a first calculation of the decay of the Higgs boson into a pair of photons, which is one of the channels used by the ATLAS and CMS experiments to discover the Higgs boson in 2012. In 1978, Howard Georgi, Sheldon Glashow, Marie Machacek and Nanopoulos calculated the production of the Higgs by gluon collisions, which is the dominant mechanism at the LHC, and Glashow, Nanopoulos and Asim Yildiz calculated Higgs production in association with a massive gauge boson, another of the processes being studied at the LHC.

The Higgs particle was discovered by the ATLAS and CMS collaborations, each of which involves over 3000 people from all around the world. They have constructed sophisticated instruments – particle detectors – to study proton collisions at CERN's LHC, itself a highly complex instrument involving many people and institutes in its construction.

Greek researchers have made notable contributions to the experimental search for the Higgs boson. The exploitation of the LHC is currently the main objective of Greek researchers at CERN, who have

made a strong commitment to the LHC and in particular to its two main general-purpose experiments – ATLAS (through the National Technical University of Athens, the University of Athens, the University of the Aegean, and the Aristotle University of Thessaloniki) and CMS (through the University of Athens, the National Center for Scientific Research Demokritos, and the University of Ioannina). The Greek institutes have participated in the design, construction and commissioning of the barrel muon systems of ATLAS, and of the preshower detector and data acquisition system of CMS. These detector systems have been used for the discovery of the Higgs boson and the Greek teams have also had a strong involvement in the corresponding data analysis. These experiments have been the primary research effort in particle physics in Greece and have been funded through the General Secretariat for Research and Technology (GSRT).

The Greek effort has also contributed to the large-scale, data-intensive computing for the LHC through the World-wide LHC Computing Grid (WLCG), an international collaboration to distribute and analyse LHC data. Distributed Tier-2 computing Grid centres have been realised in Greece.

A novel activity for the Greek scientific community is the successful participation of a team of 12 engineers in the LHC accelerator cryogenics integration during the years 2006-2008 and currently of a team of 11 engineers in the magnet group for the LHC accelerator consolidation during the LHC long shutdown period.

The discovery of the Higgs boson is the start of a major programme of work to measure the particle's properties with the highest possible precision for testing the validity of the Standard Model and to search for further new physics at the energy frontier. In view of this, Greek scientists are also participating in the R&D for the high-luminosity upgrade for the ATLAS and CMS experiments, with the development of MICROMEGAS muon detectors as well as the trigger and data acquisition systems.

**John Ellis**
**Dimitri Nanopoulos**
**Emmanuel Tsesmelis**
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