UNIVERSITÄT BERN

Media Relations

Media release, March 20, 2023

First detection of neutrinos made at a particle collider

A team including physicists of the University of Bern has for the first time detected subatomic particles called neutrinos created by a particle collider, namely at CERN's Large Hadron Collider (LHC). The discovery promises to deepen scientists' understanding of the nature of neutrinos, which are among the most abundant particles in the universe and key to the solution of the question why there is more matter than antimatter.

Neutrinos are fundamental particles that played an important role in the early phase of the universe. They are key to learn more about the fundamental laws of nature, including how particles acquire mass and why there is more matter than antimatter. Despite being among the most abundant particles in the universe they are very difficult to detect because they pass through matter with almost no interaction. They are therefore often called "ghost particles".

Neutrinos have been known for several decades and were very important for establishing the standard model of particle physics. But most neutrinos studied by physicists so far have been low-energy neutrinos. Previously, no neutrino produced at a particle collider had ever been detected by an experiment. Now, an international team including researchers from the Laboratory for High Energy Physics (LHEP) of the University of Bern has succeeded in doing just that. Using the FASER particle detector at CERN in Geneva, the team was able to detect very high energy neutrinos produced by brand a new source: CERN's Large Hadron Collider (LHC). The international FASER collaboration announced this result on March 19 at the *MORIOND EW* conference in La Thuile, Italy.

FASER enables investigation of high energy neutrinos

The properties of neutrinos have been studied in numerous experiments since their discovery in 1956 by Clyde L. Cowan and Frederick Reines. One of the leading experiments to study neutrinos is the Deep Underground Neutrino Experiment (DUNE) being built in the USA. The University of Bern is a key contributor. Experiments like DUNE are general purpose and can study many properties of neutrinos from a variety of sources. One aspect that is not covered is very high energy neutrinos.

The highest energy accelerator available is the LHC at CERN, where new particles are produced by two beams of protons smashing together at extremely high energy. However, neutrinos have never been detected at any collider because they escape the existing detectors at the LHC.

Media Relations
Hochschulstrasse 6
3012 Bern
medien@unibe.ch

The FASER experiment was proposed to fill this gap. “In this experiment we measure very high energy neutrinos produced by the LHC collider at CERN. The goal is to study how these neutrinos are produced, what their properties are and to look for signals of new particles,” says Akitaka Ariga, leader of the FASER group at University of Bern’s Laboratory for High Energy Physics (LHEP). The LHEP is part of the Physics Institute and of the Albert Einstein Center for Fundamental Physics (AEC). “The FASER experiment is a unique idea at the interface between the highest energy colliders and neutrino physics. Often new discoveries are made when taking such new approaches,” says Michele Weber, director of the LHEP of the University of Bern.

Hidden physics in neutrinos?

For the current observation of neutrinos, the experiment took data at the LHC in 2022. The team detected 153 events that are neutrino interactions with extremely high certainty. The neutrinos detected by FASER are of the highest energy ever produced in a lab and are similar to the neutrinos coming from deep-space that trigger dramatic particle showers in our atmosphere or the earth. They are therefore also an important tool to researchers for better understanding observations in particle astrophysics. “This achievement is a historical milestone for obtaining a new neutrino source with unexplored features,” says Akitaka Ariga. The presented result is just the very beginning of a series of explorations. The experiment will continue to take data till the end of 2025. “There might be hidden physics in neutrinos at high energy scale,” says Akitaka Ariga.

This project has received funding from the European Research Council (ERC) under the European Union’s Horizon 2020 research and innovation programme (Grant agreement No. 101002690, FASERnu)

Contact:
Prof. Dr. Akitaka Ariga
University of Bern, Laboratory for High Energy Physics (LHEP)
Phone: +41 31 684 46 04
E-Mail: akitaka.ariga@lhep.unibe.ch

Prof. Dr. Michele Weber
University of Bern, Laboratory for High Energy Physics (LHEP)
Phone: +41 31 684 51 46
E-Mail: michele.weber@lhep.unibe.ch

Further information can be found on the next page.

Media Relations
Hochschulstrasse 6
3012 Bern
medien@unibe.ch

University of Bern leading institute of FASERnu neutrino detector

The FASER experiment consists of the FASER detector, which is designed to search for new elementary particles, such as dark matter candidates (dark photons), and the FASERnu neutrino detector. It is looking at collisions happening in the center of the large ATLAS particle detector at CERN's Large Hadron Collider (LHC). A research group led by Michele Weber is involved in the ATLAS detector. Akitaka Ariga's research group has been active in FASER since the design of the experiment. In particular, the Bern group is the leading institute of the FASERnu detector which is collecting data between 2022 and 2025. The FASERnu detector is going to reveal neutrinos' properties with unprecedented sensitivity of all three different kinds (electron, muon and tau neutrinos).

Further information about FASERnu
Further information about ATLAS

The Laboratory for High Energy Physics (LHEP)

The Laboratory for High Energy Physics (LHEP) is a division of the Physics Institute at the University of Bern in Switzerland and is part of the Albert Einstein Center for Fundamental Physics. It conducts research in the field of experimental particle physics, with the main subjects: High-Energy Collider Physics, Neutrino Physics, Fundamental Neutron and Precision Physics, Muon Radiography, Development of Novel Particle Detectors and Medical Applications of Particle Physics.

Further information: https://www.lhep.unibe.ch/

The Albert Einstein Center for Fundamental Physics (AEC)

The Albert Einstein Center for Fundamental Physics (AEC) was founded in 2011. It has the goal of fostering research and teaching in fundamental physics at the highest level at the University of Bern. It focuses on experimental and theoretical particle physics and its applications (such as medical physics), as well as associated spin-off and outreach activities.
The AEC was founded with the collaboration of the Institute for Theoretical Physics (ITP) and the Laboratory for High Energy Physics (LHEP) of the University of Bern. With more than 100 members, the AEC is one of the largest university groups of researchers in the field of particle physics in Switzerland and a strong player at the international level.

Further information: https://www.einstein.unibe.ch/

Media Relations
Hochschulstrasse 6
3012 Bern
medien@unibe.ch