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FASER is born: New experiment will study particles that interact with dark matter

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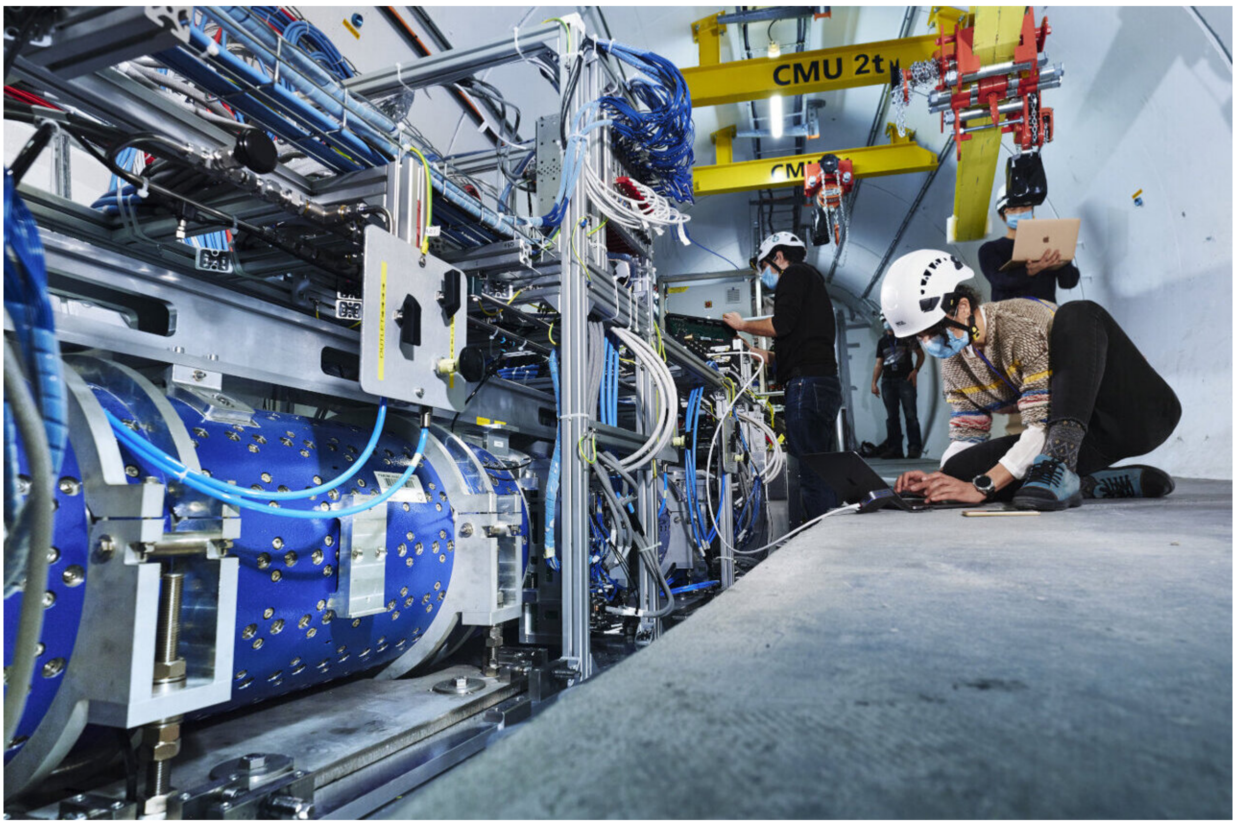


Researchers working to install the FASER detector at CERN. Credit: CERN

The newest experiment at CERN, the European Organization for Nuclear Research, is now in place at the Large Hadron Collider in Geneva. FASER, or Forward Search Experiment, was approved by

CERN's research board in March 2019. Now installed in the LHC tunnel, this experiment, which seeks to understand particles that scientists believe may interact with dark matter, is undergoing tests before data collection commences next year.

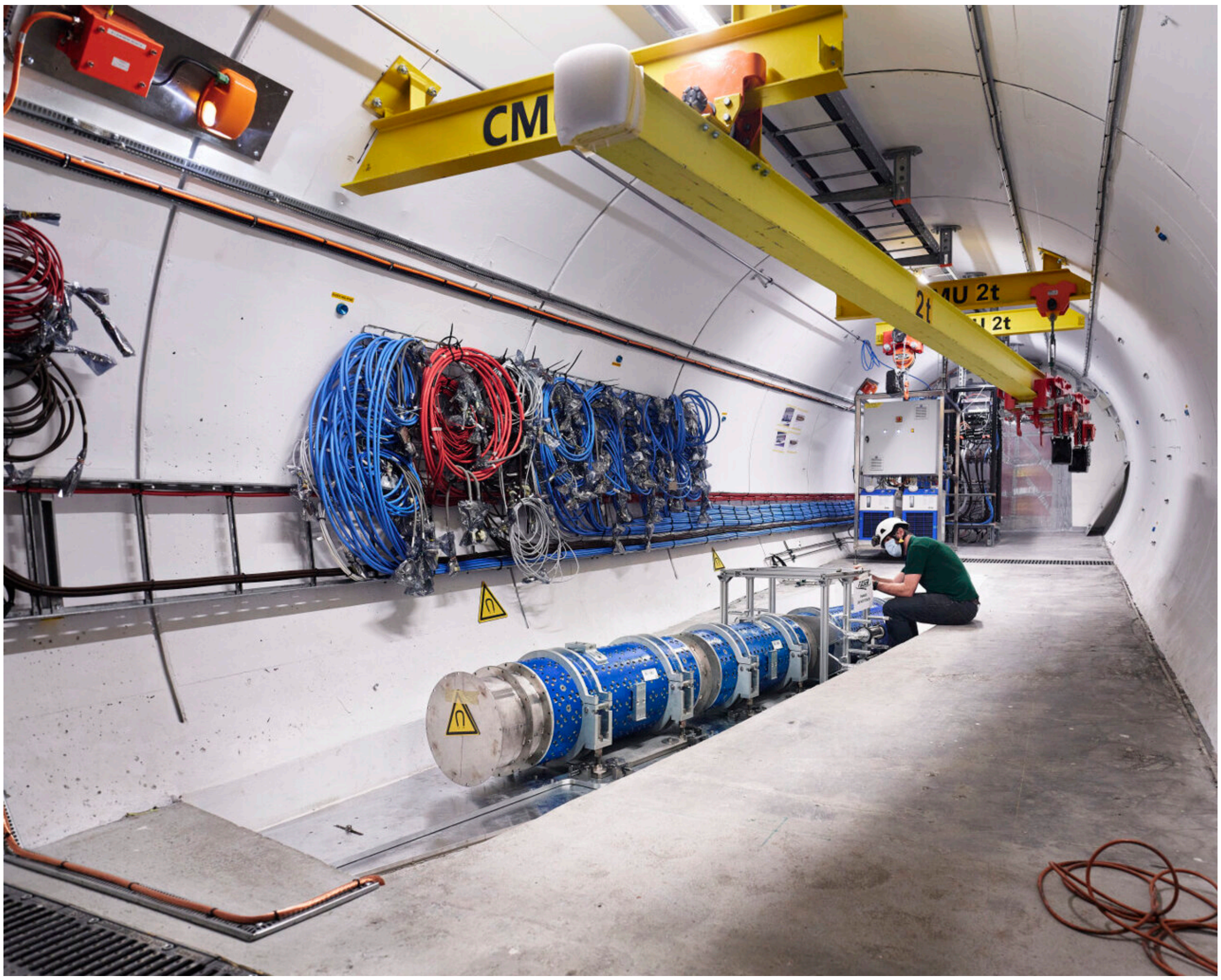
"This is a great milestone for the experiment," said Shih-Chieh Hsu, a FASER scientist and University of Washington associate professor of physics. "FASER will be ready to collect data from collisions at the Large Hadron Collider when they resume in spring 2022."

FASER is designed to study the interactions of high-energy neutrinos and to search for new, as-yet-undiscovered light and weakly interacting particles, which some scientists believe interact with dark matter. Unlike visible matter, which makes up us and our world, most matter in the universe—about 85%—consists of dark matter. Studying light and weakly interacting particles may reveal clues to the nature of dark matter and other longstanding puzzles, such as the origin of neutrino masses.

The FASER collaboration consists of 70 members from 19 institutions and eight countries. FASER scientists at the UW include Hsu, postdoctoral researcher Ke Li, doctoral student John Spencer and undergraduates Murtaza Jafry and Jeffrey Gao. The UW team has been involved in efforts to develop software and evaluate the performance of portions of the FASER detector, as well as scrutinize data from the detector during its commissioning period. They will also monitor the performance of instruments in the detector and analyze data when collisions at LHC resume next year.

Researchers believe that LHC's collisions produce the light and weakly interacting particles that FASER is designed to detect. These may be long-lived particles, traveling hundreds of meters before they decay into other particles that FASER will measure.

The experiment is located in an unused service tunnel along the beam collision axis, just 480 meters—or almost 1,600 feet—from the interaction point of the LHC's six-story ATLAS detector. That proximity puts FASER in an optimal position for detecting the decay products of the light and weakly interacting particles.



FASER's three magnets were installed in November, in a narrow trench excavated by a team at CERN. Credit: CERN

The first civil engineering works for FASER started in May 2020. In the summer, the first services and power systems were installed, and in November, FASER's three magnets were put in place in the trench.

"We are extremely excited to see this project come to life so quickly and smoothly," said CERN scientist Jamie Boyd, a FASER co-spokesperson. "Of course, this would not have been possible without the expert help of the many CERN teams involved!"

The FASER detector is 5 meters long, or about 16.5 feet, and two scintillator stations sit at its entrance. The stations will remove background interference by charged particles coming through the cavern wall from the ATLAS interaction point. Next is a dipole magnet 1.5 meters, or about 5 feet, long. It is followed by a spectrometer that consists of two dipole magnets, each 1 meter or just over 3 feet long, with three tracking stations, two at either end and one between the magnets. Each tracking station consists of layers of precision silicon strip detectors. Scintillator stations for triggering and precision time measurements are located at the entrance and exit of the spectrometer.

The final component is the electromagnetic calorimeter. This will identify high-energy electrons and photons and measure the total electromagnetic energy. The whole detector is cooled down to 15 C, or 59 F, by an independent cooling station.

Some of these components were assembled from spare parts of other LHC experiments, including ATLAS and LHCb, according to Boyd.

FASER will also have a subdetector, called FASERν, which is specifically designed to detect neutrinos. No neutrino produced at a particle collider has ever been detected, despite colliders producing them in huge numbers and at high energies. FASERν is made up of emulsion films and tungsten plates to act as both the target and the detector to see the neutrino interactions. FASERν should be ready for installation by the end of the year. The whole experiment will start taking data during Run 3 of the LHC, starting in 2022.

More information: faser.web.cern.ch/index.php/

Provided by University of Washington