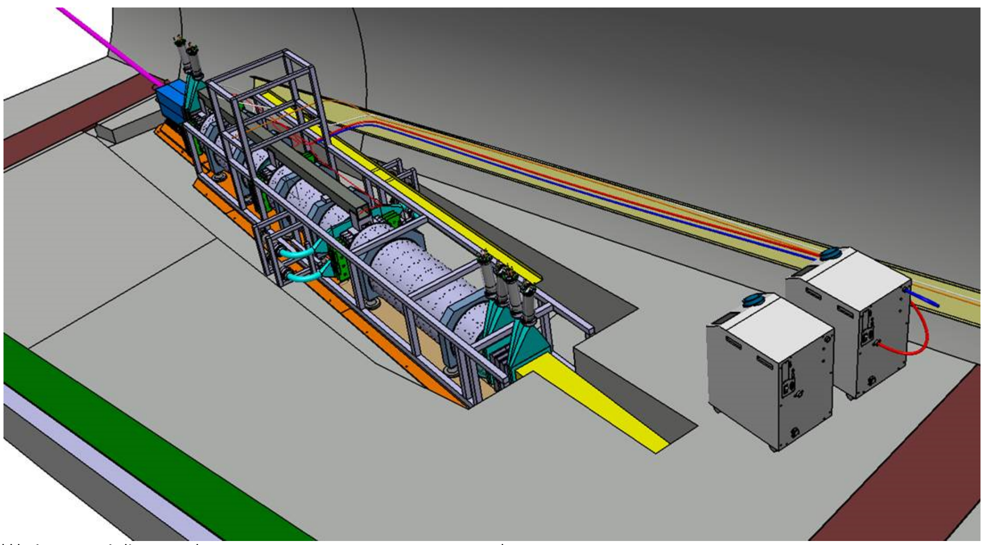
*Voir en français (//fr/news/news/physics/fasers-new-detector-expected-catch-first-collider-neutrino)*

# FASER's new detector expected to catch first collider neutrino

## The first-of-its-kind detector could initiate a new era in neutrino physics at particle colliders

17 DECEMBER, 2019 | By Ana Lopes (/authors/ana-lopes)



(//cds.cern.ch/images/CERN-HOMEWEB-PHO-2019-142-1)

Illustration of the FASER experiment. The new FASERν detector, which is just 25 cm wide, 25 cm tall and 1.35 m long, will be located at the front of FASER's main detector in a narrow trench (yellow block in the bottom right of the image). (Image: FASER/CERN)

No neutrino produced at a particle collider has ever been detected, even though colliders create them in huge numbers. This could now change with the approval of a new detector for the FASER experiment at CERN. The small and inexpensive detector, called FASER*ν*, will be placed at the front of the FASER experiment's main detector, and could launch a new era in neutrino physics at particle colliders.

Ever since they were first observed at a nuclear reactor in 1956, neutrinos have been detected from many sources, such as the sun, cosmic-ray interactions in the atmosphere, and the Earth, yet never at a particle collider. That's unfortunate, because most collider neutrinos are produced at very high energies, at which neutrino interactions have not been well studied. Neutrinos produced at colliders could therefore shed new light on neutrinos, which remain the most enigmatic of the fundamental particles that make up matter.

The main reasons why collider neutrinos haven't been detected are that, firstly, neutrinos interact very weakly with other matter and, secondly, collider detectors miss them. The highest-energy collider neutrinos, which are more likely to interact with the detector material, are mostly produced along the beamline – the line travelled by particle beams in a collider. However, typical collider detectors have holes along the beamline to let the beams through, so they can't detect these neutrinos.

Enter FASER, which was approved earlier this year (/news/news/experiments/faser-cern-approves-new-experiment-look-long-lived-exotic-particles) to search for light and weakly interacting particles such as dark photons – hypothetical particles that could mediate an unknown force that would link visible matter with dark

Related Articles

a helpi... (/news/news/physics/na61shine-gives-neutrino-experiments-helping-hand)
Physics | News |
28 November, 2019

Celebrating LEP's physics legacy (/news/news/physics/celebrating-leps-physics-legacy)
Physics | News |
11 October, 2019

(/news/news/experiments/tests-start-cern-large-scale-prototype-new-technology-detect-neutrinos)
Experiments | News |
9 October, 2019

View all ne

matter (/science/physics/dark-matter). FASER, supported by the Heising-Simons and Simons Foundations, will be located along the beamline of the Large Hadron Collider (LHC), about 480 metres downstream of the ATLAS experiment (/science/experiments/atlas), so it will be ideally positioned to detect neutrinos. However, the detection can't be done with the experiment's main detector.

"Since neutrinos interact very weakly with matter, you need a target with a lot of material in it to successfully detect them. The main FASER detector doesn't have such a target, and is therefore unable to detect neutrinos, despite the huge number that will traverse the detector from the LHC collisions," explains Jamie Boyd, co-spokesperson for the FASER experiment. "This is where FASER$\nu$ comes in. It is made up of emulsion films and tungsten plates, and acts both as the target and the detector to see the neutrino interactions."

FASER$\nu$ is only 25 cm wide, 25 cm tall and 1.35 m long, but weighs 1.2 tonnes. Current neutrino detectors are generally much bigger, for example Super-Kamiokande, an underground neutrino detector in Japan, weighs 50 000 tonnes, and the IceCube detector in the South Pole has a volume of a cubic kilometre.

After studying FASER's ability to detect neutrinos and doing preliminary studies using pilot detectors in 2018, the FASER collaboration estimated (https://arxiv.org/abs/1908.02310) that FASER$\nu$ could detect more than 20 000 neutrinos. These neutrinos would have a mean energy of between 600 GeV and 1 TeV, depending on the type of neutrino produced. Indeed there are three types of neutrinos – electron neutrino, muon neutrino and tau neutrino – and the collaboration expects to detect 1300 electron neutrinos, 20 000 muon neutrinos and 20 tau neutrinos.

"These neutrinos will have the highest energies yet of man-made neutrinos, and their detection and study at the LHC will be a milestone in particle physics, allowing researchers to make highly complementary measurements in neutrino physics," says Boyd. "What's more, FASER$\nu$ may also pave the way for neutrino programmes at future colliders, and the results of these programmes could feed into discussions of proposals for much larger neutrino detectors."

The FASER$\nu$ detector will be installed before the next LHC run, which will start in 2021, and it will collect data throughout this run.

neutrino (/tags/neutrino) LHC (/tags/lhc)

## Also On Physics

- NA61/SHINE gives neutrino experiments a helpi... (/news/news/physics/na61shine-gives-neutrino-experiments-helping-hand)
  Physics | News | 28 November, 2019
- The plot thickens for a hypothetical "X17" pa... (/news/news/physics/plot-thickens-hypothetical-x17-particle)
  Physics | News | 27 November, 2019
- Probing dark matter using antimatter (/news/news/physics/probing-dark-matter-using-antimatter)
  Physics | News | 13 November, 2019

**View all ne**