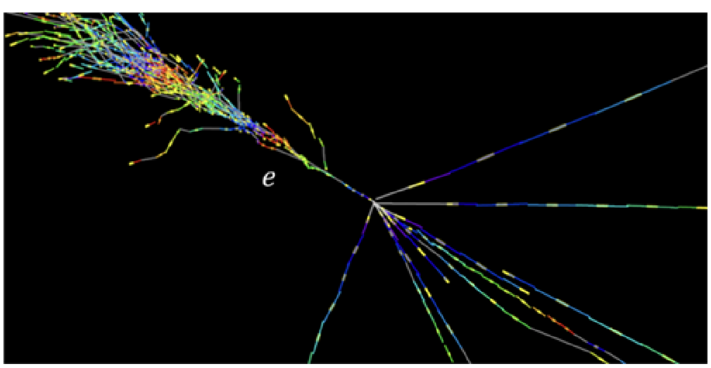
First Direct Detection of Electron Neutrinos at a Particle Collider

Electron neutrinos produced by proton–proton collisions at the LHC have been experimentally observed.

By **Nikhil Karthik**

The three flavors of neutrinos—electron, muon, and tau—are notoriously elusive, as they interact with ordinary matter only via the weak force. Notwithstanding this difficulty, neutrinos originating from astrophysical sources like the Sun and supernovae and from nuclear reactors and fixed-target experiments have been previously detected. In 2023, muon neutrinos produced by proton–proton collisions at a particle collider were directly detected by the Forward Search Experiment (FASER) at the Large Hadron Collider (LHC) at CERN in Switzerland (see **Viewpoint: The Dawn of Collider Neutrino Physics**). Now the FASER Collaboration has reported the first direct detection of another flavor—the electron neutrino [**1**].

The team used a detector made of tungsten placed 500 meters from the point where the protons circulating around the LHC collide. When an electron neutrino from a proton collision streams toward the detector and interacts with a tungsten atom, it produces a highly energetic electron along with many other particles. The FASER scientists inferred the arrival of a parent electron neutrino in the detector from the characteristic cascade of secondary electron–positron pairs and photons that envelop the trajectory of the daughter electron. In this way, they found four electron neutrinos. The scientists are confident, at 5-sigma statistical significance, that the particle tracks seen in their detector for these four events were not produced by chance by other electrically neutral particles mimicking a neutrino. (A 5-sigma significance means that the likelihood of the signal being from chance is just 0.00003%.)



Credit: R. M. Abraham *et al.* (FASER Collaboration) [**1**]

The researchers expect that the capability to detect and differentiate collider neutrinos of different flavors will allow them to probe electroweak interactions. It might also lead to neutrino-based investigations of the internal quark–gluon structure of the proton.

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REFERENCES

1. R. M. Abraham *et al.* (FASER Collaboration), "First measurement of ν_e and ν_μ interaction cross sections at the LHC with FASER's emulsion detector," **Phys. Rev. Lett. 133, 021802 (2024).**