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Detecting and studying high-energy neutrinos with FASERnu at the LHC

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FASER, the Forward Search Experiment at the Large Hadron Collider (LHC), is an experiment aiming to search for light, weakly-interacting new particles. The particle detector will be located 480 m downstream of the ATLAS interaction point. In addition to searches for new particles, we proposed a new detector (FASERν) to study neutrinos at the highest man-made energies and got approval by the CERN Research Board in December 2019. To date, neutrino cross-section data exist up to a few 100 GeV with accelerator-based neutrino beams. With FASERν, the neutrino cross-sections will be measured in the currently unexplored energy range between a few 100 GeV and 6 TeV. In particular, electron-neutrino and tau-neutrino cross sections will be measured at the highest energy ever. Furthermore, the channels associated with heavy quark (charm and beauty) production could be studied. As a feasibility study, we performed a test run in 2018 at the proposed detector location with a 30-kg lead/tungsten emulsion detector and collected data of 12.5 fb^{-1}. By analyzing the data, we selected several neutrino interaction candidates and are performing a multivariate analysis for the separation from the background towards a first detection of neutrinos at the LHC. From 2021 to 2023 (2024) during Run 3 of the LHC, we will deploy an emulsion detector with a target mass of 1.2 tons, possibly coupled with the FASER magnetic spectrometer, which would yield roughly 1,300 ν_e, 20,000 ν_μ, and 20 ν_τ interacting in the detector. Here, we present an overview and the status of the FASERν program, as well as the analysis for the neutrino detection in the 2018 data.

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