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Input from the SND@LHC collaboration to the 2026 Update to the European Strategy for Particle Physics

By observing collider neutrino interactions of different flavours, the SND@LHC and Faserν experiments have shown that the LHC can make interesting contributions to neutrino physics. This document summarizes why the SND@LHC Collaboration intends to continue taking data at the High Luminosity LHC (HL-LHC).

The upgraded detector will instrument the regions of both the neutrino vertex and the magnetized calorimeter with silicon microstrips. The use of this technology will allow us to continue the physics program of the current SND@LHC detector with higher statistics. It will also offer new possibilities. For instance, the magnetization of the hadron calorimeter will enable the separation between neutrinos and antineutrinos. This could lead to the first direct observation of tau antineutrinos.

The use of ultrafast timing layers will enable triggers to be sent to ATLAS, potentially allowing the identification of the charm quark pair that produced the neutrino interacting in the detector. Such tagging of the neutrino source would fulfill Pontecorvo's original proposal of a tagged neutrino beam. The experiment will perform unique measurements with high energy neutrinos and will also provide a means to measure gluon parton distribution functions in a previously unexplored domain (Bjorken-$x < 10^{-5}$).

Furthermore, the technological advancements of the upgrade and the experience that will be gained in the areas of operation and data analysis will play a crucial role in the design of the neutrino detector for the SHiP experiment.

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