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Collider Neutrinos | SND@LHC

The recent first direct observation of neutrinos at the LHC, achieved by FASER and SND@LHC, opens the window for the exploration of Neutrino Physics at colliders. Portugal has a major involvement in the SND@LHC experiment, steering both physics analyses and detector upgrade. The exploitation of the potential of the HL-LHC with some key detector improvements will largely extend the physics reach of the experiment both in neutrino physics and in BSM searches. We strongly support the upgrade of the SND@LHC detector, that will allow the exploration of neutrino physics during the HL phase of the LHC.

The SND@LHC experiment is a newcomer to the field since the last ESPPU (2020). It has been approved in 2021, started data taking in 2022 at the start of LHC Run3, and delivered first physics results in 2023. The physics objective is the detection of high-energy neutrinos produced by the LHC to study neutrino properties and to probe heavy flavor production in the very forward region. The collaboration recently reported the observation of collider neutrinos, demonstrating the effectiveness of such compact detectors and paving the way for new physics studies with higher statistics.

The Portuguese group is a founding member of SND@LHC, having been centrally involved in the construction and calibration of the detector and in the physics exploration of the data collected. Group members led the observation of collider muon neutrinos, are carrying out first searches for BSM particles (FIPs), and have been entrusted by the collaboration with central coordination roles (Physics Coordination, Editorial Board, Upgrade). The group has deployed a new sub-detector, based on the novel sealed-RPC technology, for extended muon-flux background measurements, and group members have a leading involvement in the definition of the upgraded detector for HL-LHC.

The design of the detector for operating during the HL-LHC phase involves novel precise instrumentation of the neutrino target based on silicon sensors. Minimal civil engineering will be needed to lower the tunnel floor to fit the slightly larger upgraded detector. The experiment will use silicon strip detector modules inherited from the CMS outer barrel tracker. It also foresees high-precision timing layers, based on scintillator or RPC technology, that may be explored to correlated neutrino-like events with ATLAS data via a dedicated trigger.

The upgraded detector will further extend the scope of direct BSM searches along with unique heavy flavor measurements in the forward region not accessible by other experiments. Collaboration with the ATLAS and CMS general-purpose experiments is foreseen. Significant synergy exists in detector R&D in particular for the SHiP experiment, with a highly complementary physics case.