



Scattering and Neutrino Detector
at the LHC



A new era of neutrino physics at LHC: the **SND**@LHC experiment

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Neutrinos at the Large Hadron Collider

OPEN ACCESS
IOP Publishing

J. Phys. G: Nucl. Part. Phys. 46 (2019) 115008 (19pp)

Journal of Physics G: Nuclear and Particle Physics

<https://doi.org/10.1088/1361-6471/ab377c>

Physics potential of an experiment using LHC neutrinos

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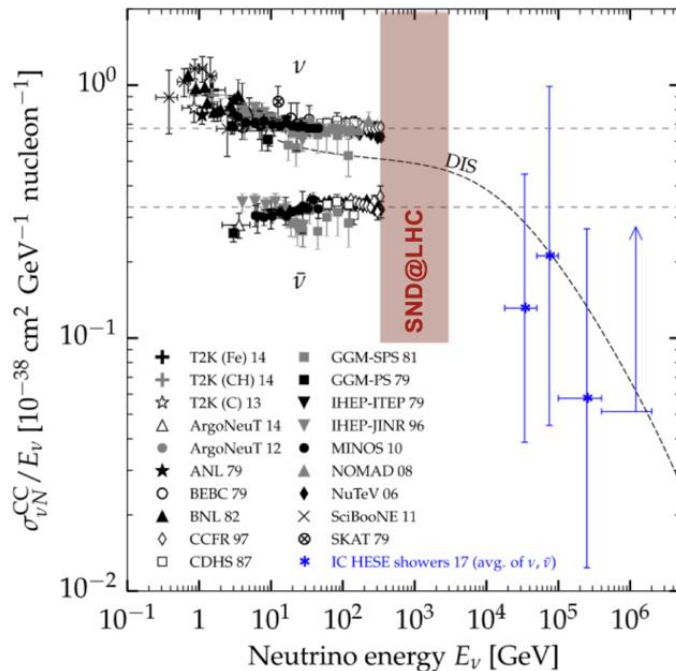
J. Phys. G: Nucl. Part. Phys. 47 (2020) 125004 (18pp)

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<https://doi.org/10.1088/1361-6471/aba7ad>

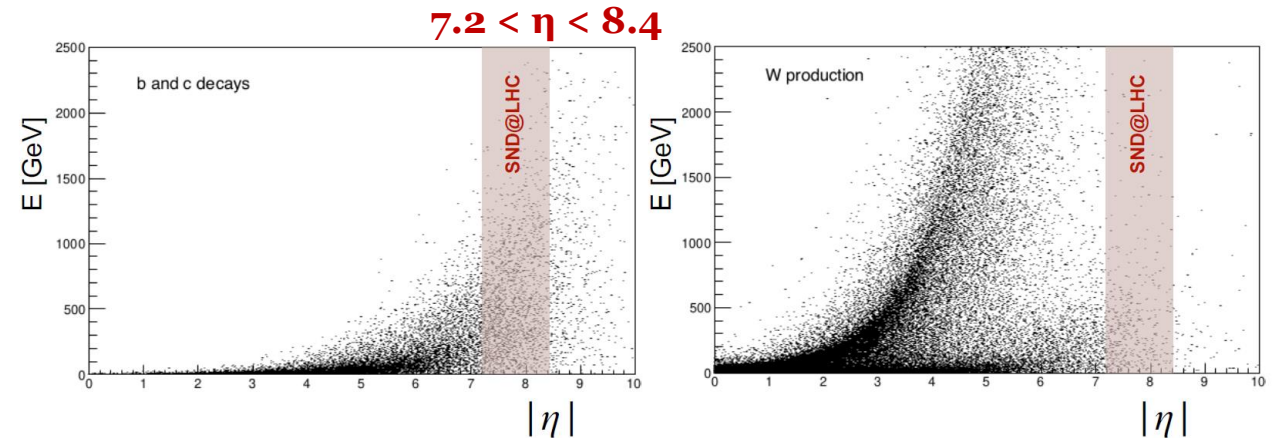
Further studies on the physics potential of an experiment using LHC neutrinos

Longstanding discussion to explore a **neutrino physics program** at the LHC



- Neutrinos produced at the pp collisions at the LHC ($pp \rightarrow \nu_X X$)

- fall under the **unexplored energy range** (350 GeV – few TeV)
- lie in **unexplored pseudorapidity range** - arise from **charm hadron decays** – Heavy flavour physics
- large flux of least studied tau **neutrino** (only 20 studied)



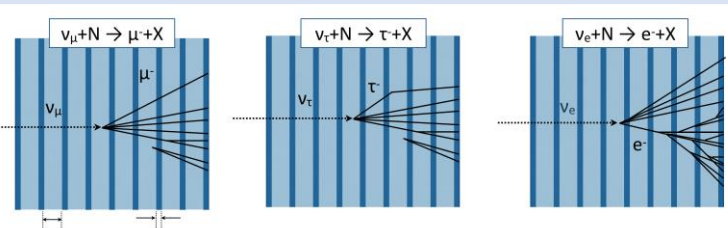
Two experiments in the **forward direction** in LHC Run 3 – **FASERν** and **SND@LHC**

Scattering and Neutrino Detector @LHC

Hybrid detector - for the identification of three neutrino flavours and detection of feebly interacting particles

Target, Vertex Detector & Electromagnetic Calorimeter

• 5 Emulsion Walls



Tungsten wall Film

➤ Detecting neutrino interactions

• 5 Sci-Fi trackers

- Time-stamp
- EM shower energy measurement

Veto system

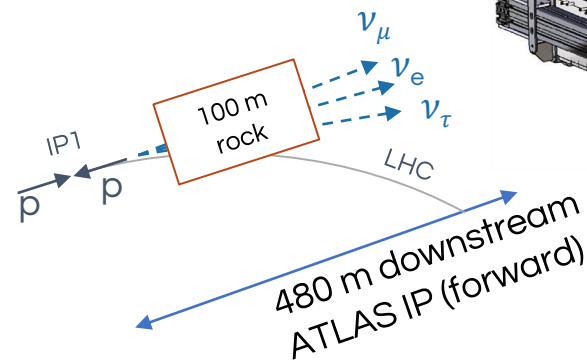
- Two 1 cm thick scintillator planes.
- Tag penetrating muon

Placed in the T118 tunnel

Muon system & Hadronic Calorimeter

- Iron blocks+ scintillator planes
 - Fast time resolution
 - Energy measurement (hadronic. cal)
- Last 3 scintillator planes - finer granularity
 - Track muons

Cross-sectional area: 40 x 40 cm²
 Length: 2.6 m
 Off-axis: $7.2 < \eta < 8.4$



VETO SYSTEM

VERTEX DETECTOR AND ELECTROMAGNETIC CALORIMETER

~ 85 X₀

HADRONIC CALORIMETER AND MUON SYSTEM

~ 9.5 λ_{int}

Editors' Suggestion

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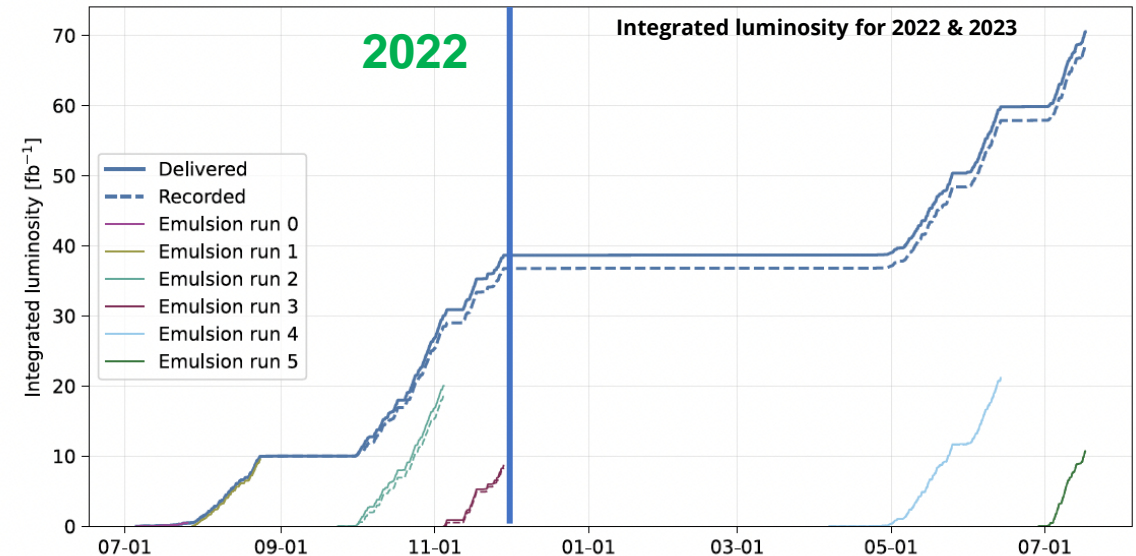
Observation of Collider Muon Neutrinos with the SND@LHC Experiment

R. Albanese *et al.* (SND@LHC Collaboration)

Phys. Rev. Lett. **131**, 031802 – Published 19 July 2023

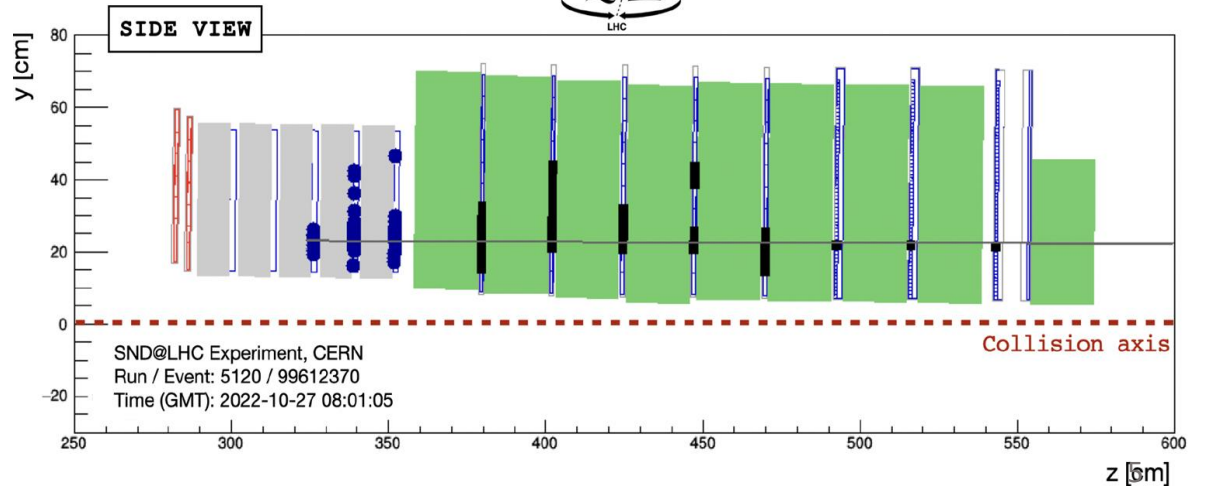
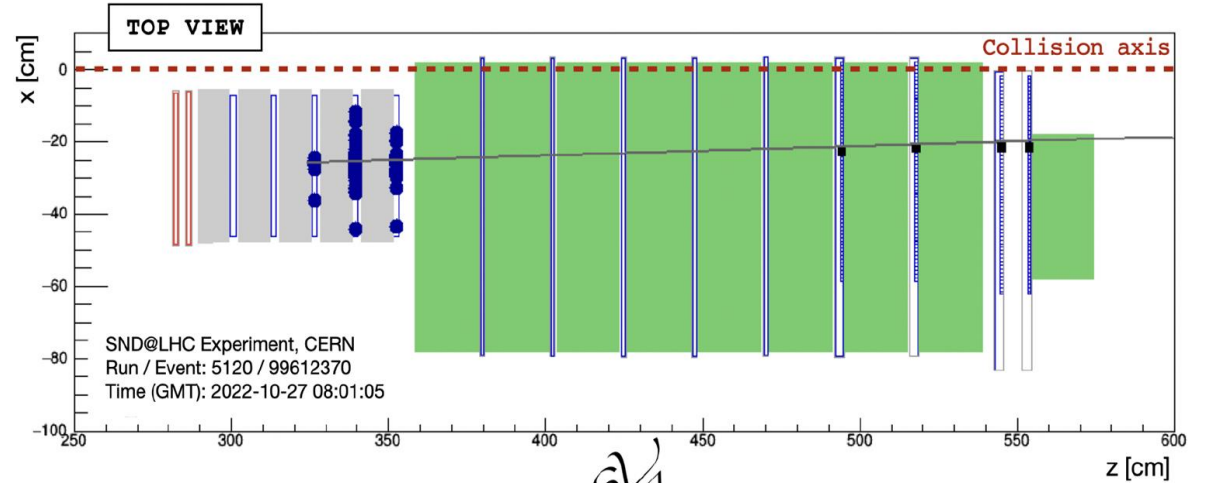
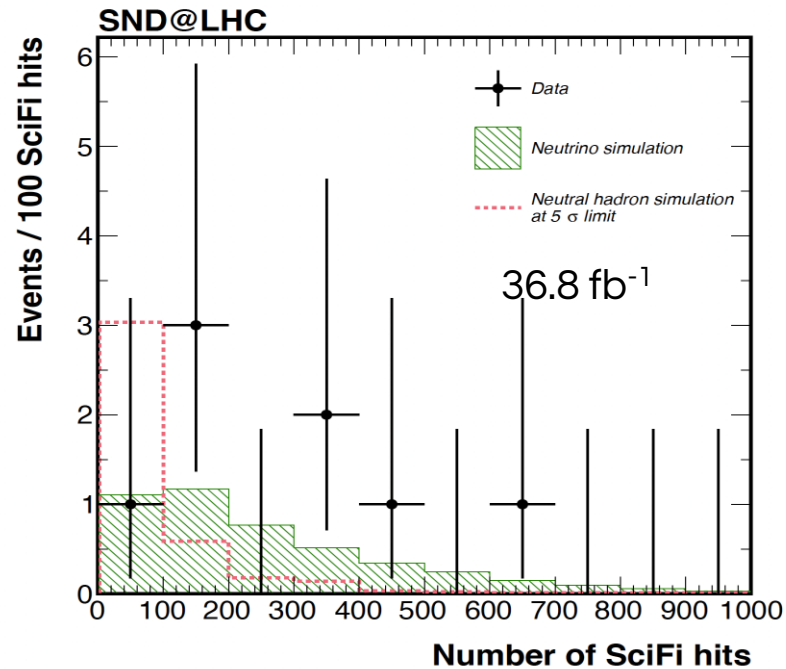


Using Proton-proton collision data in 2022



Observation of collider muon neutrinos with 2022 data

Observed **8 neutrino event candidates**
Expected background : $(8. \pm 6 \text{ } 3.8) \times 10^{-2}$
Statistical significance of **6.8 σ**

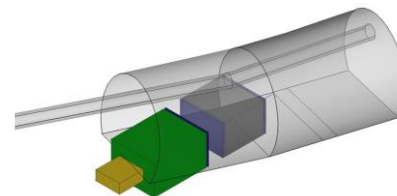
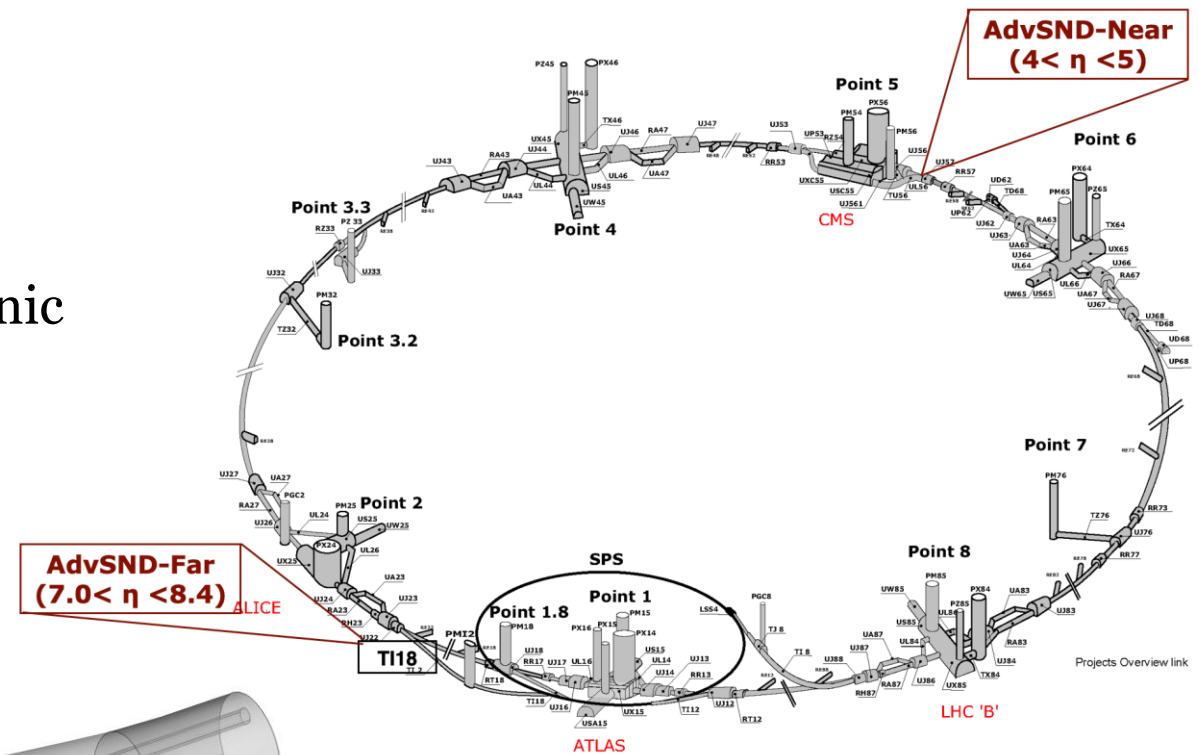
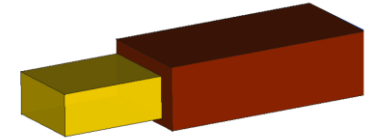


HL-LHC Upgrade: AdvSND@LHC

- ▶ Improve statistics, reduce systematics
- ▶ Separate ν from $\bar{\nu}$

Major upgrades in the detector:

- Replace emulsions with compact electronic trackers for high intensity muon rates.
- Magnet ($B = 1$ T over 2 metres) with two high-resolution tracking stations.





Thank You :)

Do visit EX 16 to learn more about the experiment and the ongoing work