First observation of Neutrino Candidates in ProtoDUNE

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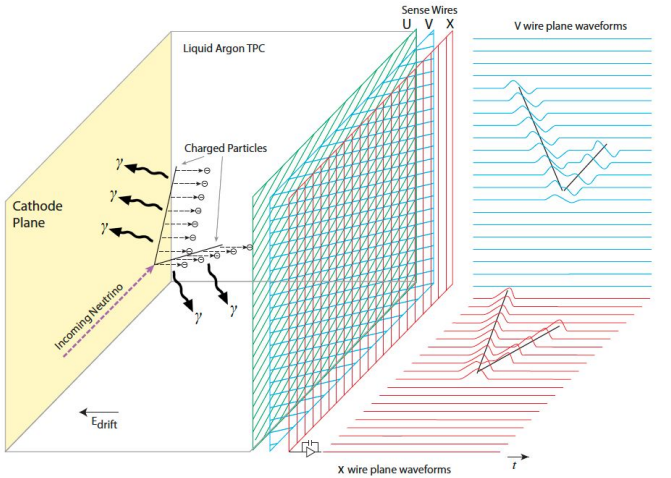
ProtoDUNE

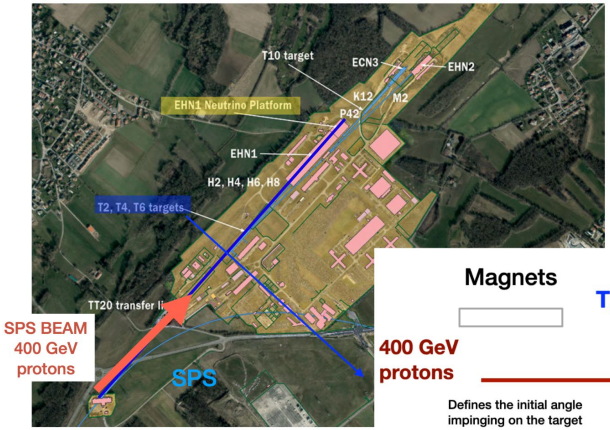
The **Neutrino Platform** at CERN hosts and operates two **ProtoDUNE** modules to test the LArTPC technologies for the DUNE Far Detectors.

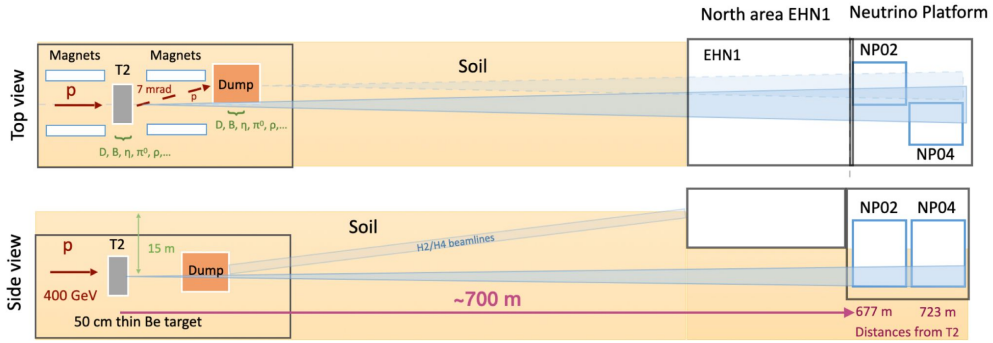
In a **LArTPC**, ionisation electrons drift under a uniform electric field toward the anodes, where they are collected, providing arrival time and charge measurement.

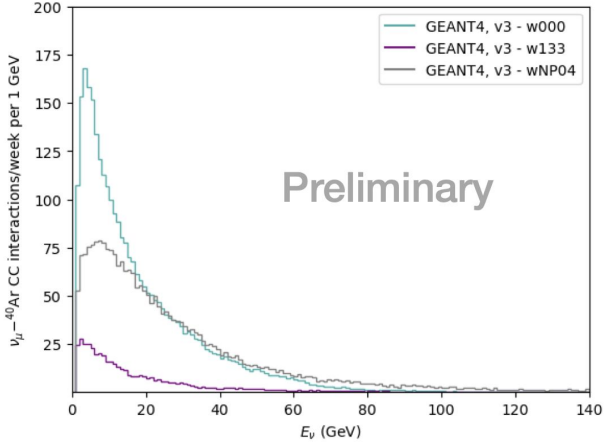


Beam complex

The **SPS proton beam** hits the T2 target **~700m before the ProtoDUNE area**. The ProtoDUNE detectors are **almost perfectly on axis** with the collision, therefore we **parasitically** benefit of a beam of long living neutral particles (neutrinos, maybe BSM).







Motivation

The goal of the study is to identify neutrino interactions in the current ProtoDUNE data, which will benefit DUNE and ProtoDUNE by:

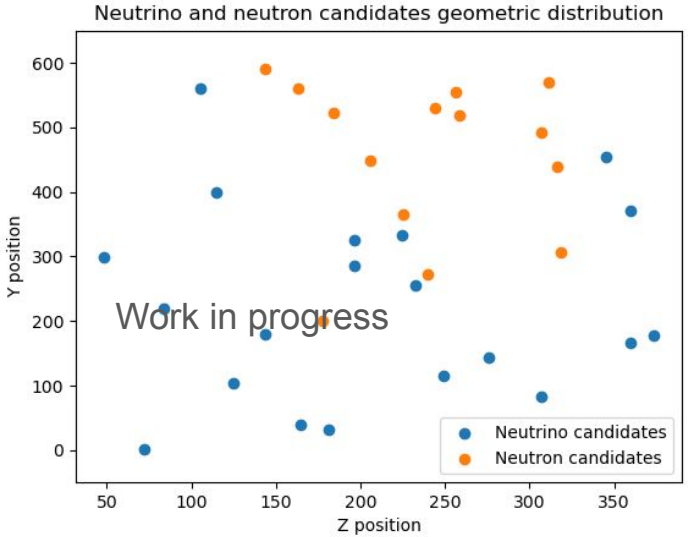
- Providing **real neutrino interaction data** to test and improve reconstruction software.
- Providing a **proof of principle** for beyond-the-Standard-Model (BSM) searches with ProtoDUNEs.
- Providing a strong physics case to improve and test the **DAQ and trigger algorithms**.

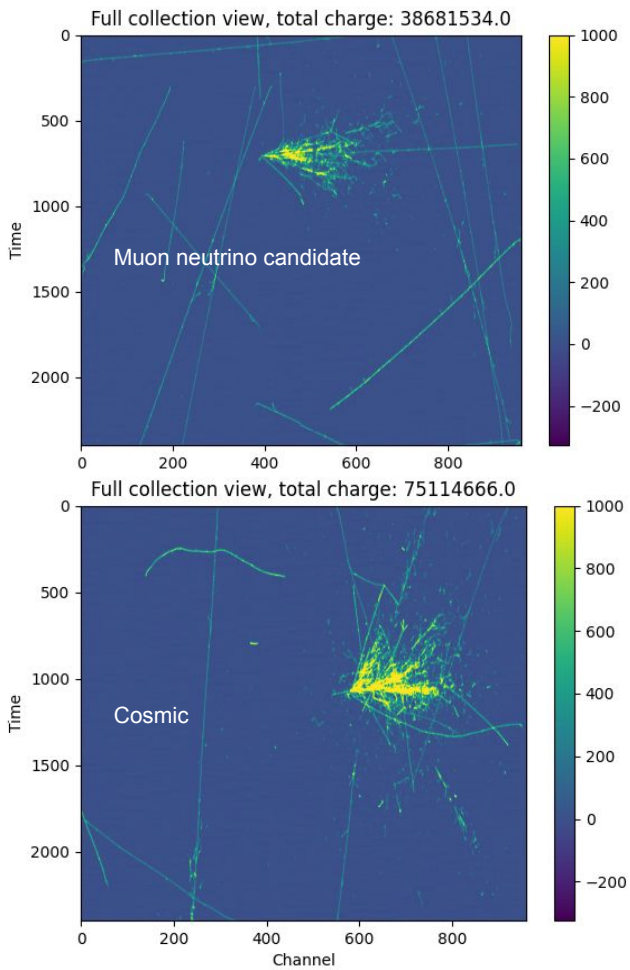
Manual Search

The events must pass 4 different filters, on position, the charge distribution, the presence of a muon “tail” and its angle.

After that, a manual scanning is done to select the neutrino candidates.

Overall, 29 neutrino candidates were found in the hadron beam runs, while none were observed when the SPS beam was off.

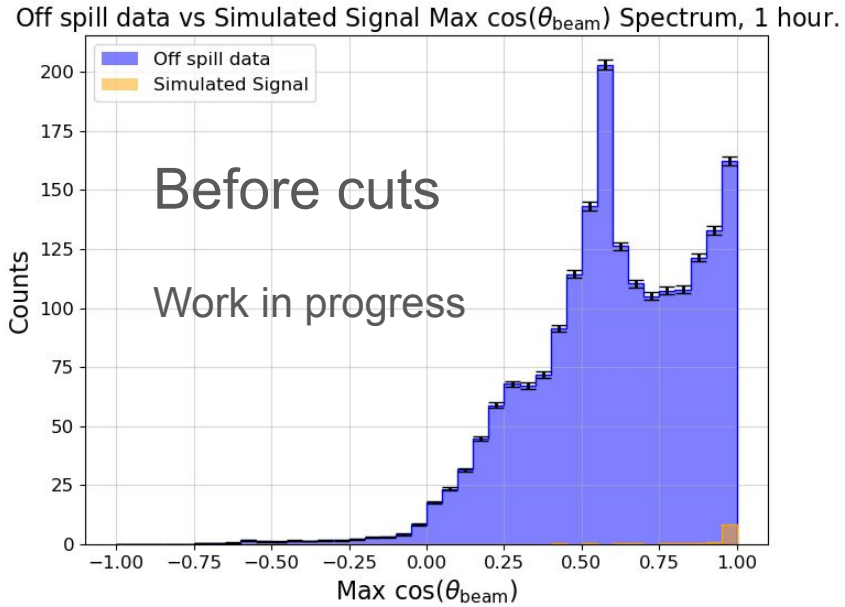


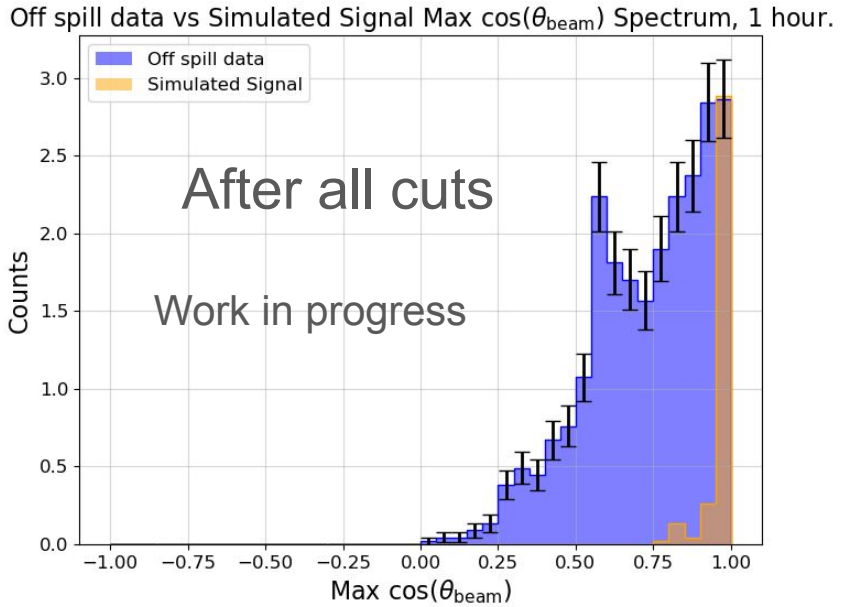


Automated Search

We apply a number of cuts on different variables to select the neutrino events.

#events/hr	Before cuts	After cuts	After/Before
Neutrinos (MC)	13.31	2.55	0.19
Cosmics (off spill data)	1960.44	1.79	0.00091





Conclusions

First neutrino interaction candidates have been observed in the ProtoDUNE detector at CERN.
The possibility to detect and measure these events has been shown using a simplified approach. Next, we are developing a fully automated selection to compare on-spill and off-spill data.

These studies can be used to validate the DUNE reconstruction software on **real neutrino interaction data**, and represent a first observation of the neutrino background relevant for BSM searches.

Thanks for the attention!