Monitored neutrino beams
ENUBET design and prototype performance

Leon Halić on behalf of the **nuSCOPE** collaboration

nuSCOPE – What is it?

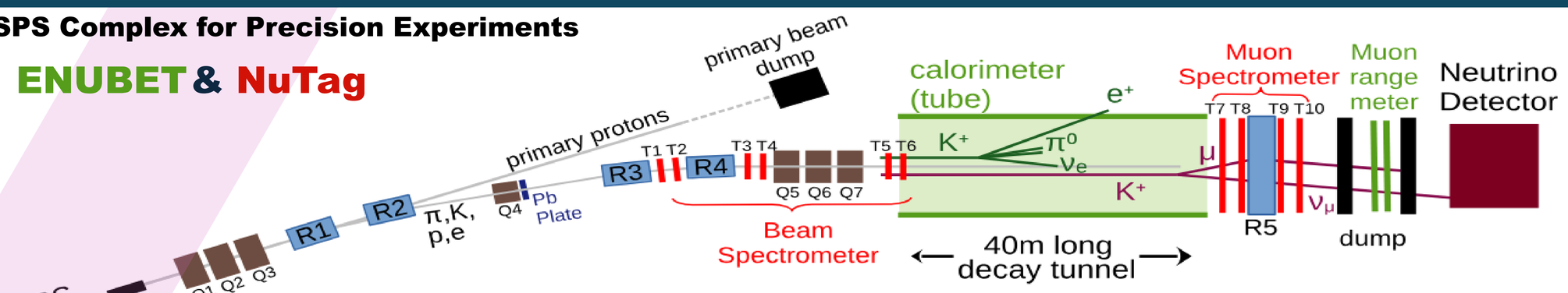
nuSCOPE proposal is a convergence of two novel technologies: **monitored** and **tagged** neutrino beams

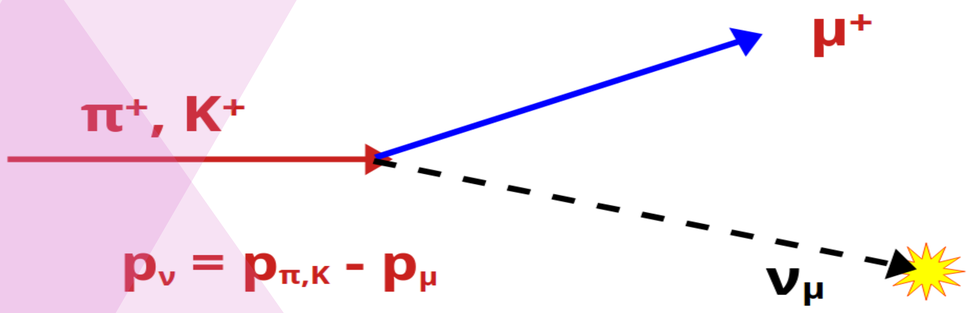
This combination enables flux monitoring at a ~1% level and provides neutrino energy measurement independent of final state particle reconstruction at the detector

The goal is to implement such a beamline at CERN and measure neutrino cross section at the ~1% level for DUNE and HyperK energy ranges

Neutrino SPS Complex for Precision Experiments

ENUBET & NuTag





NuTag – Tagging neutrinos event by event

The goal is to uniquely associate the interacting neutrino in the detector to its parent particles in the beamline **enabling sub 1% neutrino energy resolution**

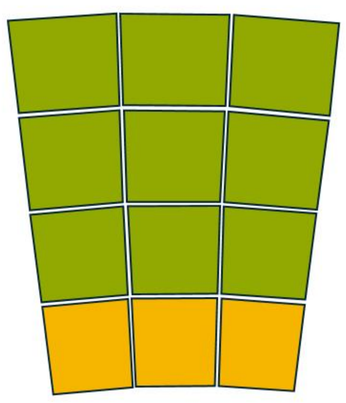
This is achieved by placing state-of-the-art silicon trackers in the beamline to monitor secondary mesons and their momenta

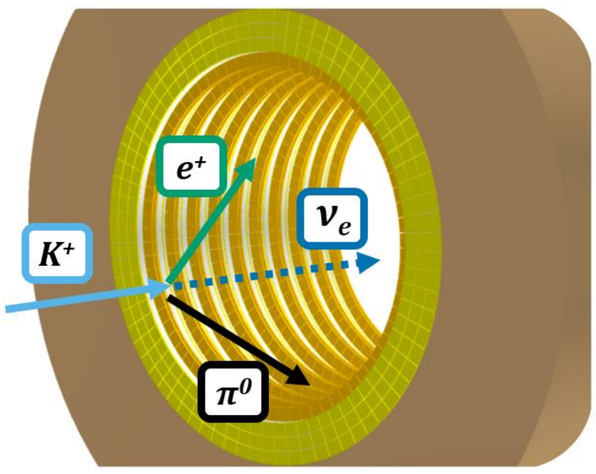
ENUBET – Monitoring the charged leptons

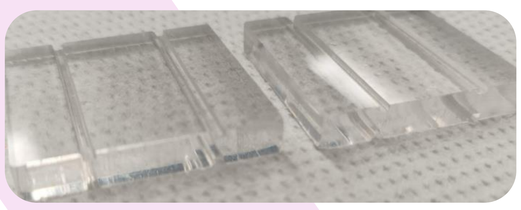
A project which designed and tested a prototype of **a monitored beam** – an instrumented decay tunnel with a goal of measuring the neutrino flux

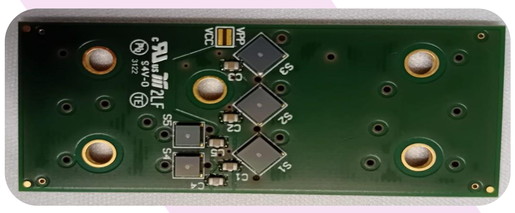
By observing the charged leptons which are produce in the neutrino creation process, we can estimate **the neutrino flux to ~1% uncertainty**

This is achieved by instrumenting a calorimeter in the walls of the decay tunnel to **detect charged leptons** passing through it







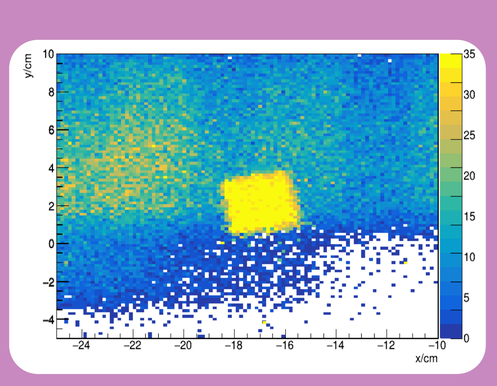


Demonstrator – What is it?

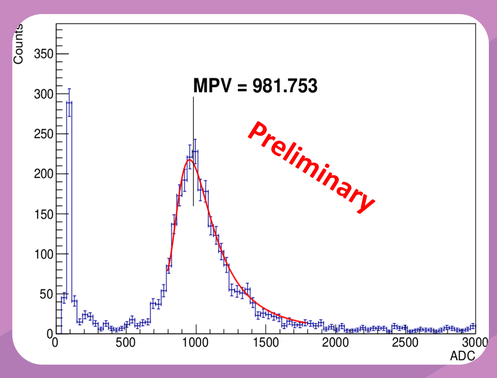
A prototype of the instrumented decay tunnel was built and tested multiple times at the CERN PS accelerator

- 3 × 3 cm^2 plastic scintillator tiles
- 15 channels along the z direction
- 10 Φ channels in the first 8 z layer and 25 Φ channels in the remaining 7 layers
- 30 cm Borated PolyEthylene shielding that protects the SiPMs from neutron irradiation

Channel equalization



Efficiency map of a single channel



Landau fit of a MIP peak

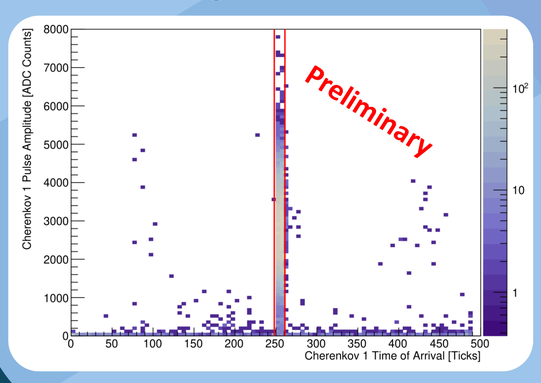
Energy resolution for electrons

Considering only electron whose electromagnetic showers are fully contained within the calorimeter

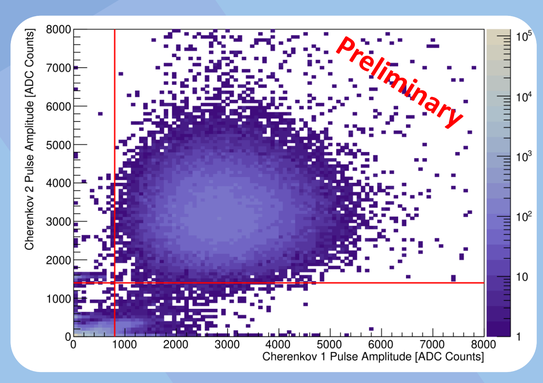
Electron selection using 2 Cherenkov detectors filled with CO_2

1st detector's CO2 pressure: < Pion Ch. threshold 2nd detector's CO_2 pressure: < Muon Ch. threshold

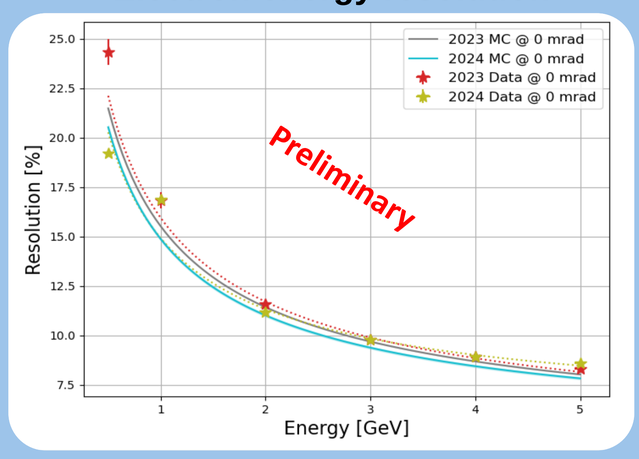
Timing information



Signal amplitude



Electron energy resolution



Further reading

- F. Acerbi et al., SBN@CERN A short-baseline neutrino beam at CERN for high-precision cross-section measurements. Arxiv: 2503.21589v1

Find out more on ENUBET and NuTag