ENUBET (Enhanced NeUtrino BEams from kaon Tagging)
- A new source based on tagging of large angle $e^+$ from $K^+ \rightarrow e^+ \pi^- \nu_e$ decays in an instrumented decay tunnel.
- Reduce systematic uncertainties in the knowledge of the neutrino flux to $\lesssim 0.1\%$ level. [1]
- ERC funded project (n. 681647, P.I. A. Longhin), Expression of Interest to CERN-SPSC. [2]

Physics case and applications
- A new generation of neutrino cross section experiments with unprecedented control on the flux.
- The first step toward a time-tagged $\nu$-beam, where the $\nu$ at the detector is correlated with the lepton in the tunnel.
- A phase-II sterile neutrino search, especially in case of a positive signal from the FermiLab SBL program.

Deliverables of ENUBET:
1) conceptual design of the beamline 2) Construction of a 3 m x $\pi$ section of the instrumented tunnel as a principle demonstrator.

Tagged neutrino beam concept
- Hadron beam-line: collects, focuses, transports $K^+$ to the 50 m long $e^+$ tagger
- $e^+$ tagger: real-time, "inclusive" monitoring of produced $e^+$

The positron tagger
Challenges
The decay tunnel: a harsh environment
- particle rates: $> 200 \text{ kHz/cm}^2$
- backgrounds: pions from $K^+$ decays
- extended source of $\sim 50$ m
- grazing incidence
- spread in the initial direction

Adopted solution
Conventional beam-pipe replaced by alternative instrumentation
Key points:
- longitudinal sampling
- perfect homogeneity
- radiation hardness
- cost effectiveness

ENUBET impact on $\nu_e$ cross section meas.

The hadron beamline
- At the tunnel entrance particles must be collimated (< 3 mrad) and energy selected (8.5 GeV $\pm 20\%$)

Focusing system Proton extraction from accelerator
A: pulsed device (magnetic horn) Unconventional: many (10$^9$), short (2-10 ms) pulses with few protons (< 3 x 10$^11$)
B: static devices (DC magnets) O(1s) long slow extractions

Scenario B is the way to a "time-tagged" $\nu$ beam: proton "time-dilution" $\rightarrow$ t-coincidences between $e^+$ and $\nu_e$ at the detector

Reconstruction: full tagger GEANT4 simulation
- Event building and clustering of neighboring UCM to avoid pile-up effects
- Artificial NN with 5 variables
- Sequential cuts exploiting info from $\gamma$-veto
- $\pi^0$ rejection: ~ 97%
- $\nu_e$ rejection: ~ 99%

References, additional info
http://enubet.pd.infn.it

[2] CERN-SPSC-2016-036; SPSC-EOI-014

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