The ENUBET monitored neutrino beam

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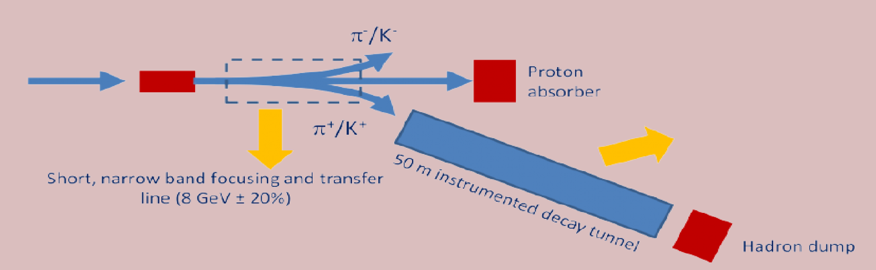
on behalf of the ENUBET collaboration

Enhanced NeUtrino BEams from kaon Tagging

New technique employed to determine the absolute ν_e and ν_μ flux based on the reconstruction of large angle positrons and muons in the instrumented decay tunnel from three-body $K+ \rightarrow e+ \pi_0 \nu_e$ decays.
Reduction of the systematic uncertainties on the knowledge of the initial neutrino flux to O(1%) level.

Physics programme:
The ideal facility for a new generation of cross section experiments: improvement by one order of magnitude the measurement of ν_e and ν_μ cross sections and precision study of neutrino interactions with nuclei. Highly beneficial for tackling the main open neutrino-related issues: (leptonic CP violation, mass hierarchy, θ_{23} octant) by reducing the systematic budget of DUNE and HyperK.
First step towards a time tagged neutrino beam: direct production/detection correlation.

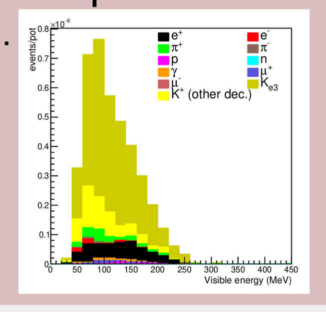
Monitored Neutrino Beams



The NP06/ENUBET experiments at the CERN Neutrino Platform will be the first "**monitored neutrino beam**" where nearly all systematics are bypassed monitoring the leptons in the decay tunnel at single particle level.

Lepton Reconstruction

Full Geant4 simulation of the detector (validated for reconstruction by prototype tests at CERN during 2016-2018):
particle propagation and decay from transfer line to detector;
hit level detector response; pile-up effects included
1. Ke3 reconstruction: Eff. = 22±0.2% & S/N = 2
2. Kμν reconstruction: Eff. = 34±0.6% & S/N = 6

1.


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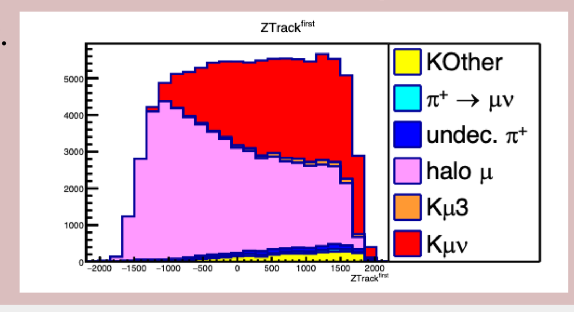
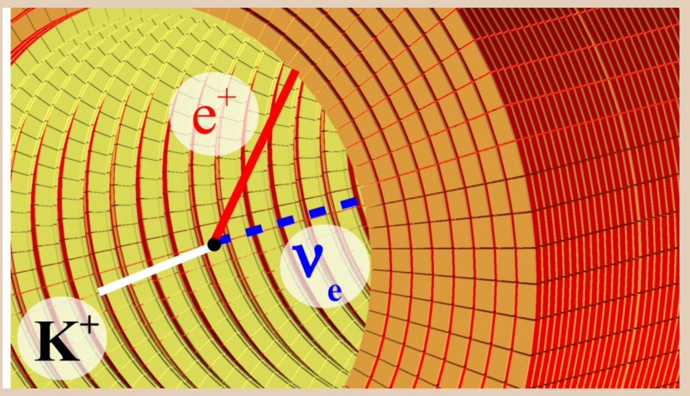
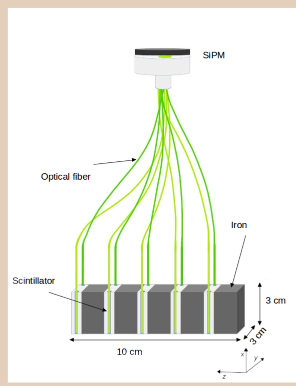


Instrumentation

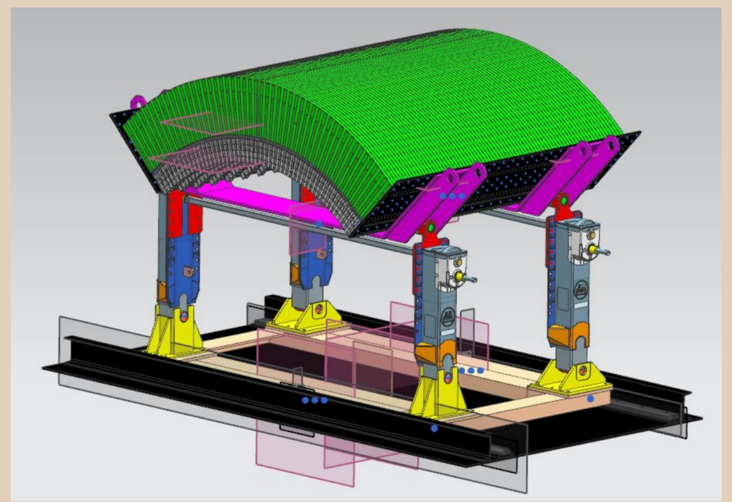




Modular sampling calorimeters logitudinally segmented (4.3 X0) with a photon veto.
Typical rate per channel: 500 kHz/ch
Doses: <10 10 n/cm 2 at the SiPMs, 0.1 Gy at the scintillator

All instrumentation to monitor positrons and muons have been prototyped, tested in charged particles beams and used to validate the MC.

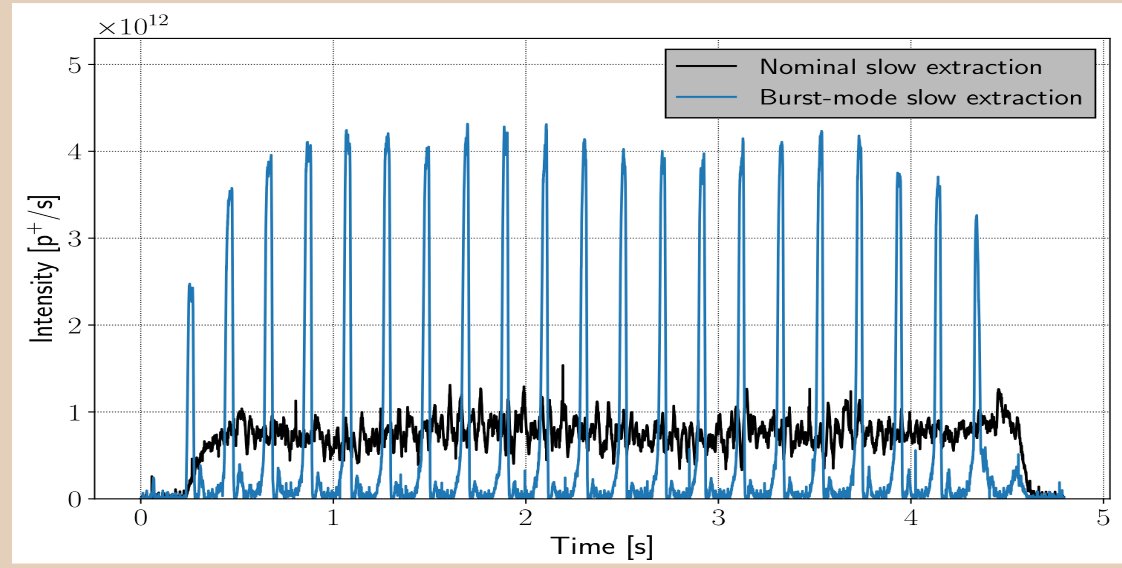
SiPM will be installed outside of the shielding, thus they will not be immersed in the hit by the particles produced in the hadronic shower;
Reduced neutron damage, better accessibility, possibility of replacement and maintenance, better reproducibility of WLS-SiPM optical coupling;



Proton Extraction

R&D using the CERN-SPS as a benchmark, in collaboration with CERN A&T Division (p=400 GeV/c, 4.5 10 19 pot/spill).

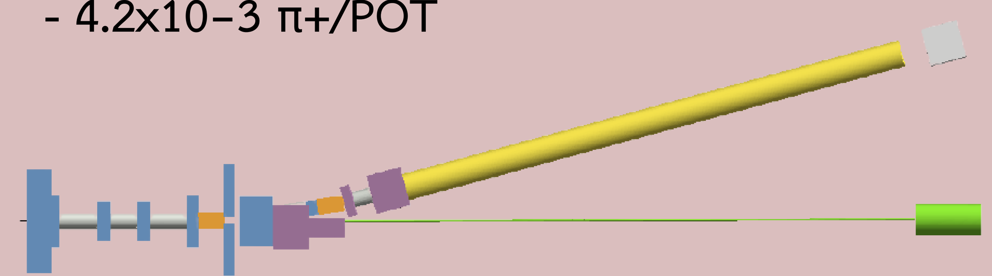
Focusing: "slow" extraction to mitigate the rate of leptons in the decay tunnel
Horn: 2-5 ms extractions in the flat top
Purely static focusing: 2 s extraction



Static Beamline

Large bending angle (14.8°) with 2 dipoles.
Collimated beam and reduced background from muons;
reduced from early decays in detector;
~14% contamination of in detector produced before tagger and after the 2nd bending dipole

Expected K+ and π+ at tagger entrance in the 8.5±5% GeV momentum range:
- 0.4x10−3 K+/POT
- 4.2x10−3 π+/POT

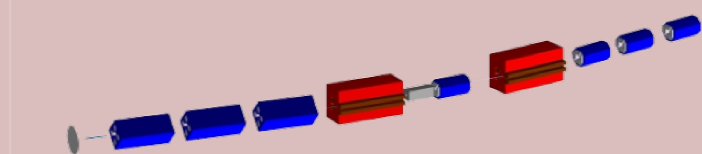


Multi-Momentum Beamline

-Set of different neutrino spectra spanning from the "Hyper-K" to DUNE regions of interest.
Focus 8.5, 6 or 4 GeV/c secondaries.
-Larger bending angle (18°)
-Tools: Optics optimization **TRANSPORT + G4Beamline**. Validation + higher order effects with **MADX/PTC-TRACK**. Doses and Background reduction studies: **FLUKA**

-Detailed description of existing magnetic elements

-Under consideration: whole beamline tilted w.r.t. target



BL Length	H - Ang	V - Ang	K^+ at Tunnel
25 m	20 mrad	16 mrad	0.7×10^{-3}/pot

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[1] "A novel technique for the measurement of the electron neutrino cross section", A. Longhin, L. Ludovici, F.Terranova Eur.Phys.J.C (2015) 75:155
[2] "NP06/ENUBET Annual Report for the SPSC (2021)", ENUBET Coll. CERN-SPSC-2021-013
[3] "A high precision neutrino beam for a new generation of short baseline experiments", ENUBET Coll. arXiv:1901.04768

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