ENUBET

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On Behalf of the ENUBET Collaboration

Enabling high precision flux measurements in conventional neutrino beams

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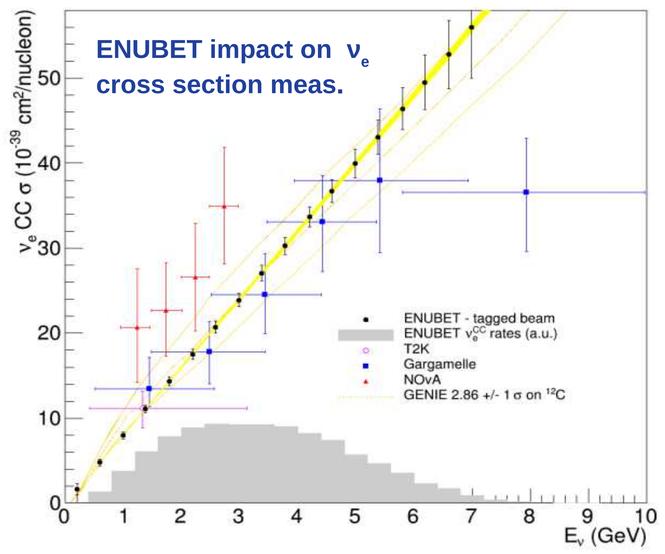
ENUBET (Enhanced NeUtrino BEams from kaon Tagging)

- A novel ν_e **source** from $K^+ \rightarrow e^+ \pi^0 \nu_e$ decays by **tagging the e+** in an instrumented decay tunnel
- Reduce **systematics on neutrino flux to O(1%) level** by monitoring the positrons produced at large angle in the decay tunnel of **conventional neutrino beams**

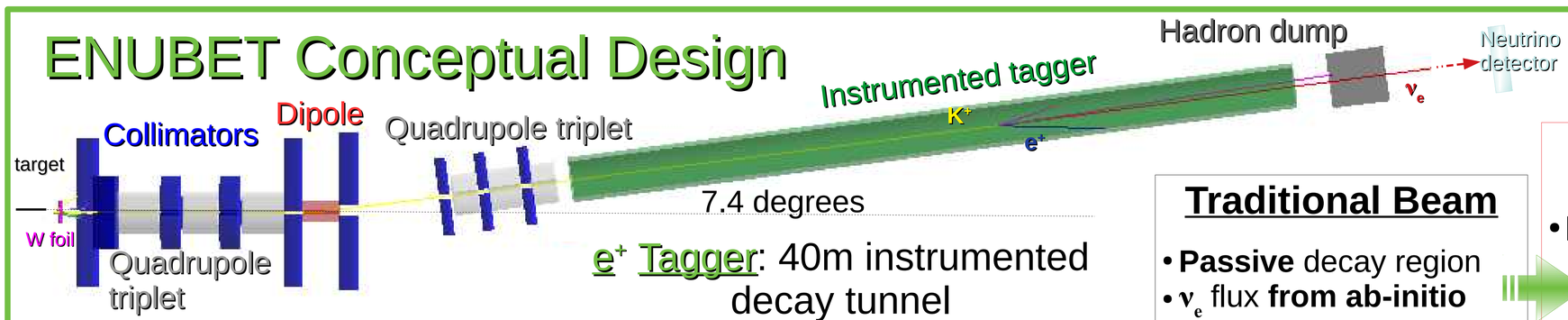
→ New generation of neutrino cross section experiments with unprecedented control on the flux

→ First step towards time-tagged ν-beam: the ν at the detector is correlated with the lepton in the tunnel

→ Highly beneficial to long baseline $\nu_\mu \rightarrow \nu_e$ programs



ENUBET Conceptual Design



Hadron beam line: collection, focusing, transport K^+ to the **e^+ tagger**

e^+ Tagger: 40m instrumented decay tunnel
→ real-time monitoring of produced **e^+**

Traditional Beam

- **Passive** decay region
- ν_e flux **from ab-initio simulation** of full chain
- **Large uncertainties** from hadro-production, K/π ratio, POT

Tagged Beam

- **Fully Instrumented** decay region

$K^+ \rightarrow e^+ \pi^0 \nu_e$ → large angle e^+

- **ν_e Flux = e^+ counting**

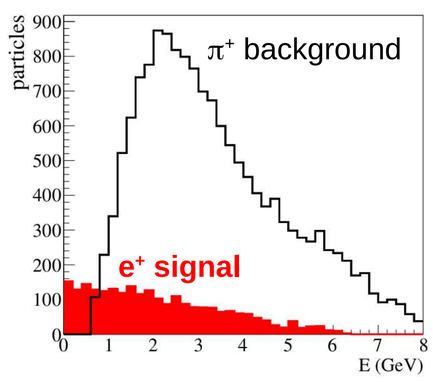
→ O(1%) systematic error achievable

The positron tagger

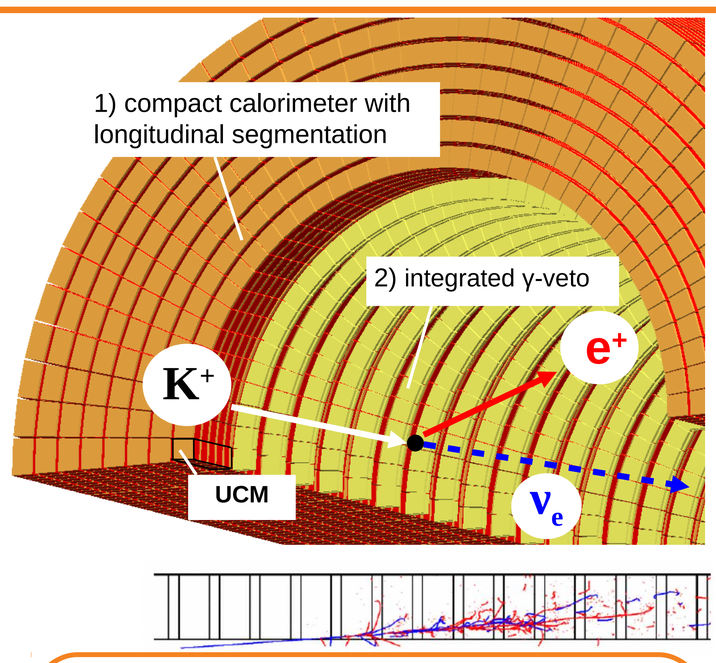
The decay tunnel

a harsh environment:

- **Particle rates** > 200 kHz/cm²
- **backgrounds**: pions from K^+ decays



- Extended source of ~50 m
- Spread in the initial direction

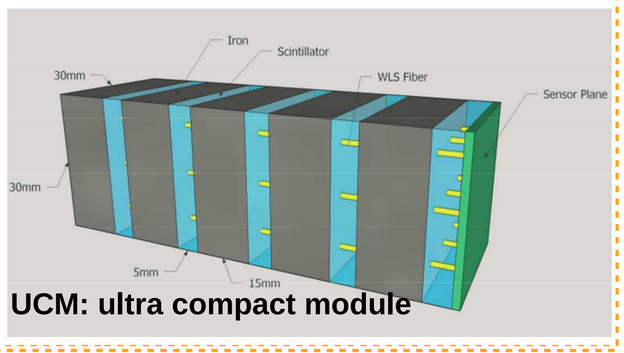


Conventional beam-pipe replaced by active instrumentation:

- **longitudinal sampling**
- **good uniformity**
- **radiation hardness**
- **cost effectiveness**

1) Calorimeter ("shashlik") → π^+ rejection

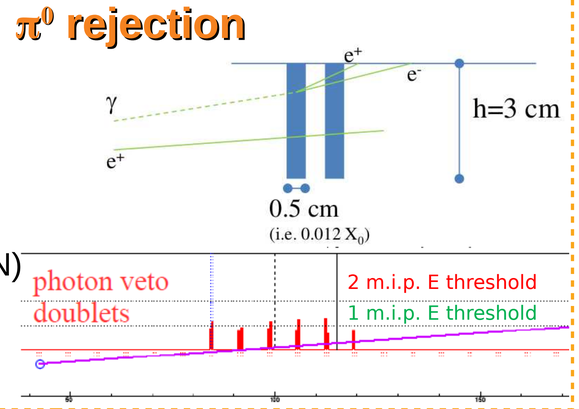
- **UCM** ($4X_0$ thick) read-out by **SiPM directly coupled to WLS fibres**
- Longitudinal sampling without dead zones
- Cheap, fast (<10ns time), radiation hard



UCM: ultra compact module

2) Integrated γ-veto → π^0 rejection

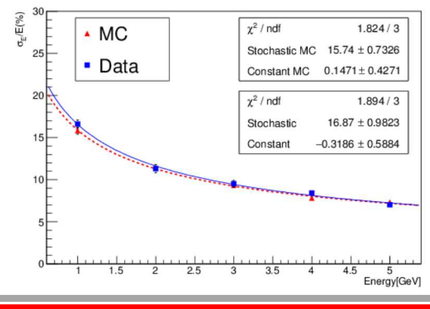
- Rings of 3x3 cm² pads of plastic scintillator
- 1mip/2mip separation (successfully tested @ CERN)

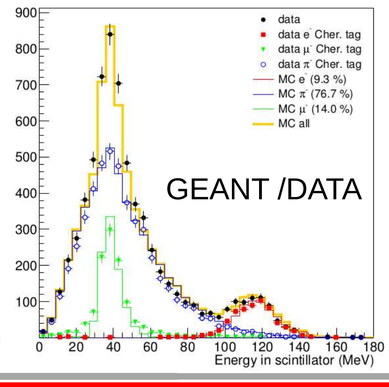


R&D Activities - Tagger Prototype Test @ CERN

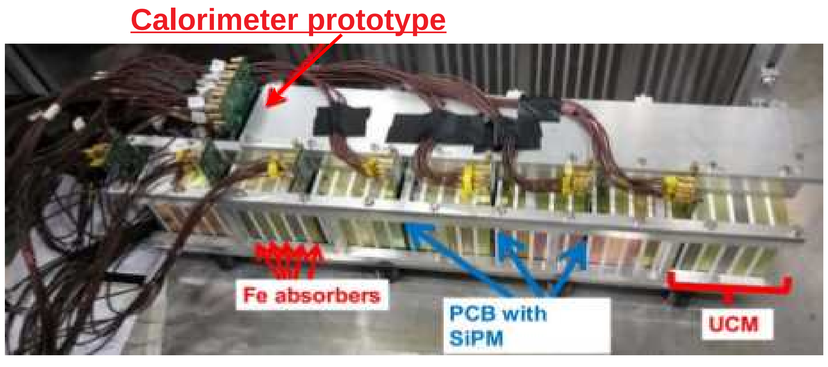
Tested response to MIP, electrons and charge pions

- em energy res 17%/√E(GeV)
- Linearity <3% in 1-5 GeV
- From 0 to 200mrad tilts tested→no significant differences
- MC/data already in good agreement, longitudinal profiles of partially contained π reproduced by MC @ 10% precision





Calorimeter prototype



Expected Rates

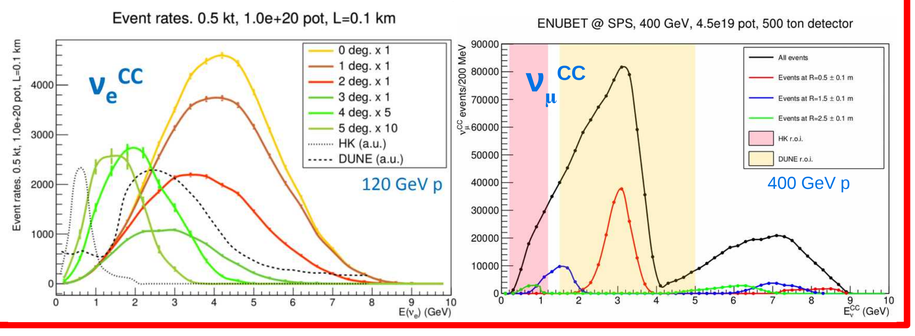
Expected Hadronic rates @ Tunnel Entrance

In parenthesis (ENUBET EPJ [1] initial estimate)

Preliminary	π^+/pot (10^{-3})	K^+/pot (10^{-3})	Increase factor wrt [1]
Horn-based transfer line	77.3 (33.5)	7.9 (3.7)	~2.2
Static transfer line	19.0 (3.6)	1.37 (0.43)	3-5

Expected Neutrino rates @ ν Detector

ν-CC rates expected from ENUBET beam line @ ν detector for 120 GeV (ν_e) and 400 GeV (ν_μ) protons with HK and DUNE r.o.i.



References

http://enubet.pd.infn.it

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