Euro Strategy Reaction- Neutrinos

Gary Barker

(University of Warwick)

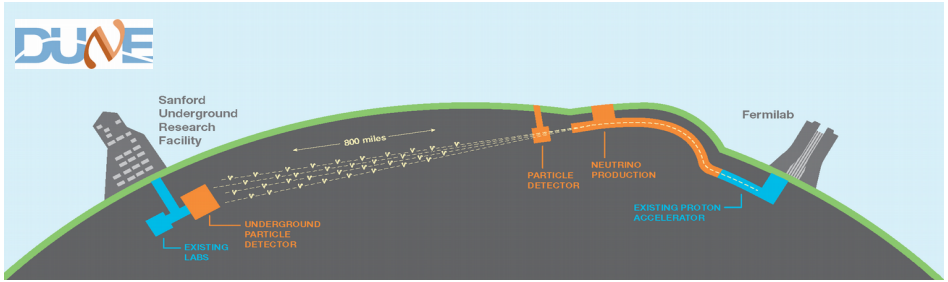
Endorsement of the Physics

- Neutrino oscillations are a compelling sign of new physics => neutrino mass
- Understanding the small mass may mean extending the neutrino sector e.g. the addition of light or heavy sterile neutrino states
- Neutrinos maybe their own antiparticles => lepton number violated and Majorana mass
- Role in matter-antimatter asymmetry of early universe?
- Mixing pattern very different to quarks and must be fully measured

Essential to pursue exploration of the neutrino sector with accelerator, reactor, solar, atmospheric and cosmic neutrino experiments

Long Baseline Oscillation Projects

- First priority is completion of measurement of oscillation parameters in particular: CP-violating phase and the neutrino mass ordering
- Next generation approved projects, DUNE (USA) and Hyper-K (Japan) are complementary with strong European participation

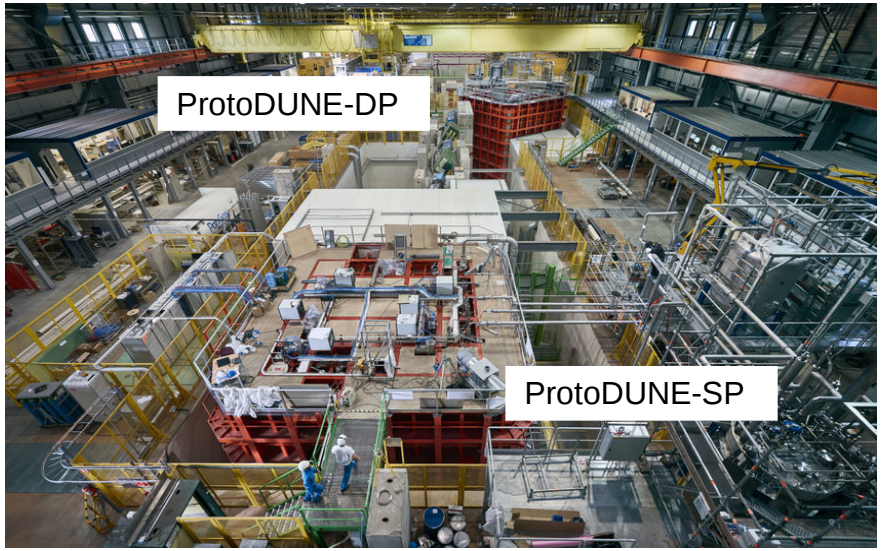


- Following 2013 Strategy direct CERN support has come through the Neutrino Platform and has been very effective: protoDUNE(s), ICARUS refurb. for the FNAL shortbaseline programme, upgrade of ND280 Near Detector for T2K

LBNF/DUNE

…should continue to collaborate with the United States and other international partners towards the successful implementation of the Long-Baseline Neutrino Facility (LBNF) and the Deep Underground Neutrino Experiment (DUNE).

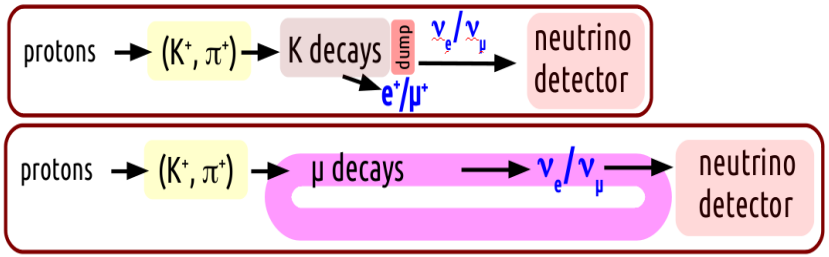
- Prototype DUNE LAr TPC far detectors (single phase and dual phase) hosted at CERN's Neutrino Platform
- CERN has developed these large scale cyrostats and will supply the cyrostat for the first DUNE FD module. Approval to also supply the 2nd module cyrostat is pending.



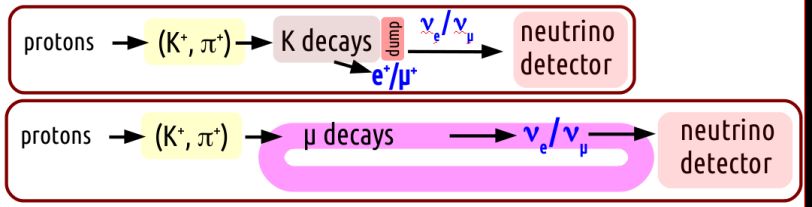
Neutrino Cross-Sections and Fluxes

To extract the most physics from DUNE and Hyper-K, a complementary programme of experimentation to determine neutrino cross-sections and fluxes is required. The possible implementation and impact of a facility to measure neutrino cross-sections at the percent level should continue to be studied.

- Oscillation experiments (e.g. T2K, NovA) continue to be reliant on the hadron production measurements of NA61/SHINE @ CERN. Important it continues and sufficient manpower is committed from the community.
- Oscillation programme stands to gain greatly from precision $\nu_{\mu,e}/\bar{\nu}_{\mu,e}$ — Nucleus cross section measurements:

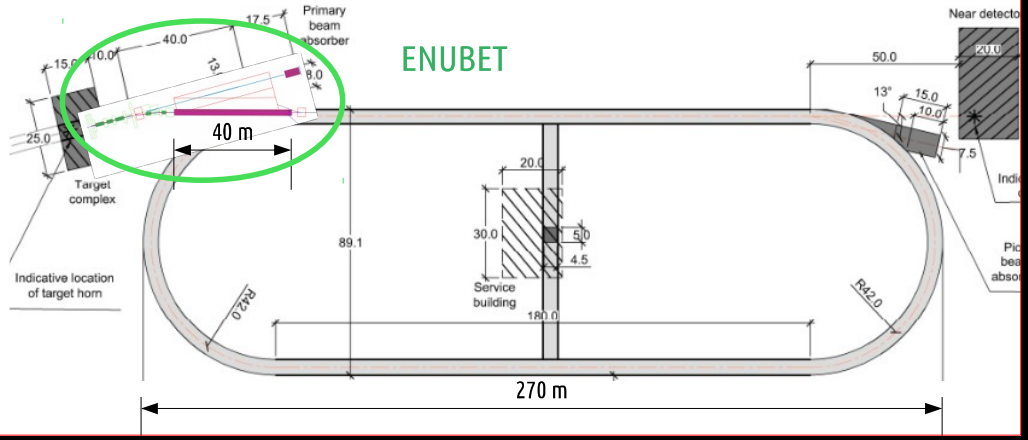


nuSTORM & ENUBET



	Decay region	Hadron dump	Proton extraction	Target, sec. transfer line, p-dump	Neutrino detector
ENUBET	~40 m. Instrumented.	Yes. Dumps muons in addition preventing a (small) ν_e pollution to K_{e3} - ν_e	Slow, 400 GeV (flexible)	Yes, similar	~100 m (some flexibility)
nuSTORM	Replaced by straight section of the ring (180 m).	No. Muons are kept: the most interesting flux parents.	Fast, 100 GeV	Yes, similar	> 300 m from target (ring straight section)

- Different concepts, budget, geometry.
- Main synergy: target facility, 1st stage of meson focusing, proton dump.

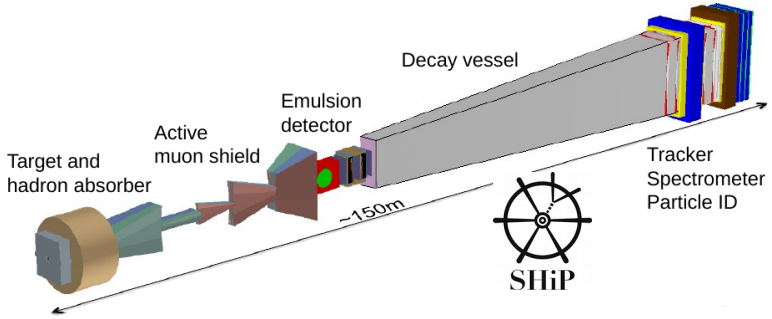


Non-Collider Neutrino Physics

The strategy did not say much about non-collider projects ….

Among the proposals for larger-scale new facilities investigated within the Physics Beyond Colliders study, the Beam Dump Facility (BDF) at the SPS emerged as one of the frontrunners. However, such a project would be difficult to resource within the CERN budget considering the other recommendations of this Strategy.

- Has consequences for SHiP which has leading discovery potential for HNL below B-mass
- R&D to continue (but at slower pace)
- Expected that the CERN MTP contains funding to continue studies for BDF



The study of the neutrino absolute mass and nature (Dirac or Majorana) is the other priority for the field

- National FA's and labs clearly have a key role here

..and finally

- The 2013 Strategy for Europe to participate in LBL programmes in Japan and USA, and not build a European LBL facility, is underway – large European participation in DUNE and Hyper-K with key leadership roles

Balanced European support for this worldwide effort will make it possible to secure the determination of the neutrino masses, oscillation parameters (including the CP violating phase) and to test for possible deviation from the 3 neutrino framework.

- To deliver this, the Strategy emphasises strongly the need to coordinate more closely national/ERC/CERN-funding in areas of common interest and to exploit synergies with astroparticle physics (solar, atmospheric, super nova neutrinos) and even nuclear physics (nucleon decay)

Thanks to: A. Golutvin, K.Long, F.Di-Lodovico, R.Saakyan, Y.Ramachers, S. Soldner-Rembold, D.Wark