The T2K Experiment and DownStream Electromagnetic Calorimeter

T2K Lancaster
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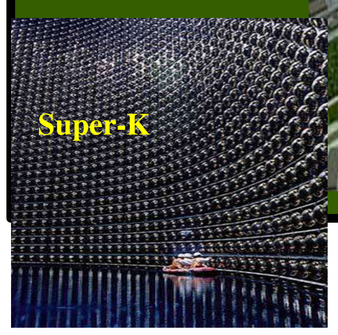
T2K Overview

T2K (Tokai to Kamioka) is a long-baseline neutrino-oscillation experiment. A ν_μ beam generated in a 50GeV proton accelerator at the J-PARC facility in Tokai is directed 295km toward the 50kton water Cherenkov detector, Super-Kamiokande. T2K will measure ν_μ oscillation to ν_e, with the aim of obtaining a value for θ_{13}.

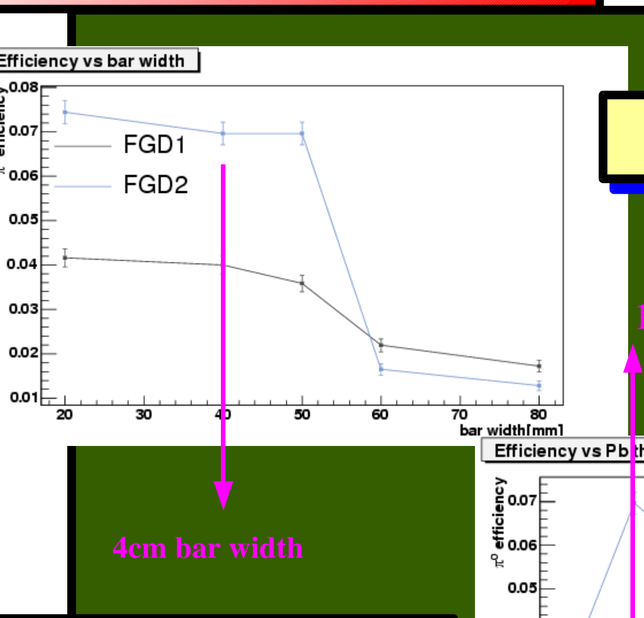


Neutrinos change flavour as they travel. The oscillation between different neutrino types is parameterised by the PMNS matrix. Several of its components are not yet well-measured. For example, the mixing angle θ_{13} has limits but no direct measurement.

ND280

The Near Detector at 280m downstream of the ν_μ production target has the task of characterising the beam before the neutrinos oscillate by measuring:

- ν_μ flux and energy.
- ν_e beam background.
- π^0 production.
- ν interaction x-sections.

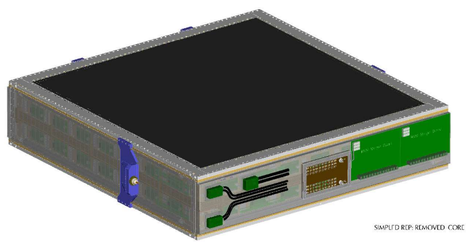


P0D: Narrow layers of lead alloy and plastic scintillator or water dedicated to π^0 ID.
3 TPCs: High-resolution tracking chambers with Micromegas readout.
2 FGDs: Fine-Grained Detectors with high-granularity layers of lead and plastic scintillator or H_2O.
ECal: Tracking electro-magnetic calorimeter with PID.
SMRD: Side Muon Range Detector. Slabs of plastic scintillator inside iron magnet yoke.

DownStream Electromagnetic Calorimeter

Requirements

- EM shower containment ⇒ 10 χ_0.
- π^0 reconstruction/PID ⇒ fine granularity, crossed geometry.
- Space restrictions (50cm) ⇒ thin plastic layers.
- Sampling fraction ⇒ thin lead layers.
- Signal uniformity ⇒ double-ended R/O of long bars.
- Design and construction issues ⇒ identical modules for all ECal.
- Structural rigidity and light-tightness ⇒ carbon-fibre casing for each module.

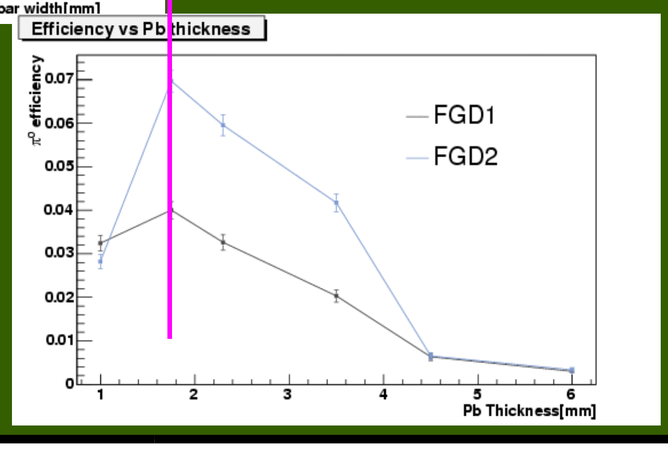


- Lead-plastic scintillator sandwich.
- 33 lead layers, 34 plastic layers .
- 1 module (2m x 2m).
- Has the highest ν flux of all ECal.
- Most events start showering in FGDs.
- Calibration Module as well as DS.
  - Built first .
  - Cosmic ray calibration.
  - To CERN for test beam studies.
- Then straight to Japan.

Optimising ECal Parameters

4cm bar width

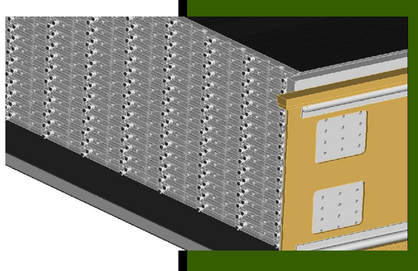
1.75mm lead thickness



- determined by π^0 reconstruction efficiency for events originating in FGD 1 or FGD 2.

Construction

- All 34 layers built first.
- Module bulkhead assembled.
- Layer by layer construction.
- 2D scan with 3 mCi ^{137}Cs source as each layer is laid.
- Cooling plates, electronics and light-tight skin attached.
- Cosmic-ray data-taking for 3 months at Lancaster (end 2008).
- Test-beam calibration at CERN spring 2009.
- Shipped to Japan June 2009.
- Commissioning late 2009.

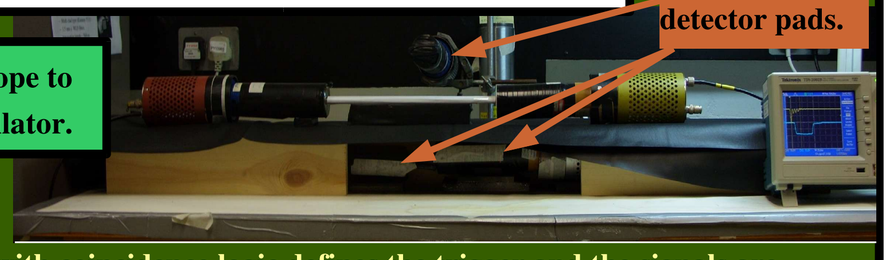


The experience and infrastructure from this effort will be available for the construction and QA of the rest of the ECal modules.

Scintillator bar QA

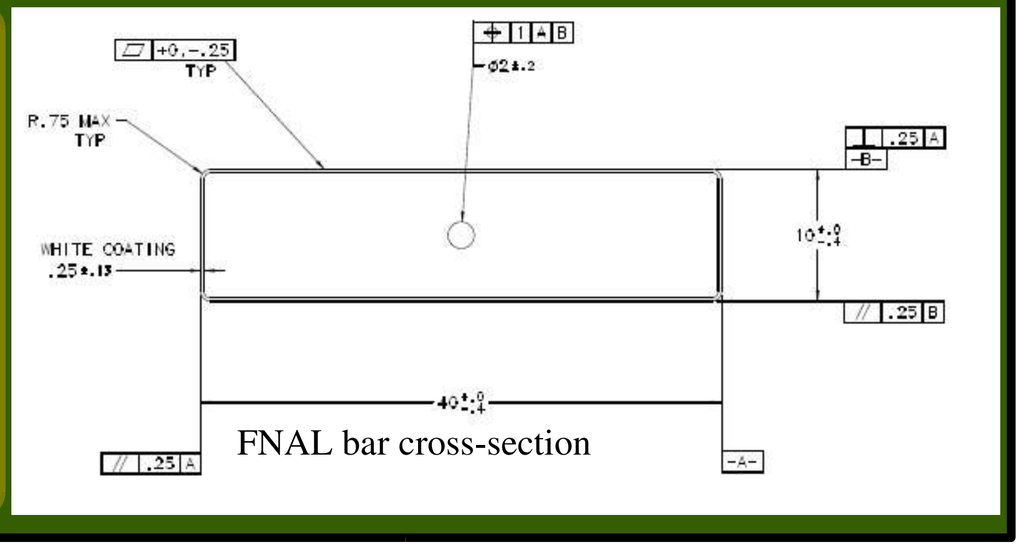
3 – 4.5 x 5 cm² detector pads.

CR telescope to test scintillator.



A pulse height analysis with coincidence logic defines the trigger and the signals are digitized in VME/ADCs controlled by a LabView DAQ, to measure absolute light-yield (in pe/MIP). Visual inspections for shape deformations and transportation damage, checks on the physical dimensions and light output will be done.

Each scintillator bar has 4 x 1cm² cross section. The bars have a 2mm central hole for 1mm WLS fibre.



FNAL bar cross-section