The T2K Experiment and DownStream Electromagnetic Calorimeter

T2K Overview

T2K (Tokai to Kamioka) is a long-baseline neutrino-oscillation experiment. A $\nu_\mu$ beam generated in a 50GeV proton accelerator at the J-PARC facility in Tokai is directed 295km toward the 50km water Cherenkov detector, Super-Kamiokande. T2K will measure $\nu_\mu$ oscillation to $\nu_e$, with the aim of obtaining a value for $\Delta m^2_{21}$. 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 $\theta_{13}$ has limits but no direct measurement.

Requirements
- EM shower containment $\Rightarrow$ 10 $\chi^2$.
- $\gamma$ reconstruction/PID $\Rightarrow$ fine granularity, crossed geometry.
- Space restrictions (50cm) $\Rightarrow$ thin plastic layers.
- Sampling fraction $\Rightarrow$ thin lead layers.
- Signal uniformity $\Rightarrow$ double-ended R/O of long bars.
- Design and construction issues $\Rightarrow$ identical modules for all ECal.
- Structural rigidity and light-tightness $\Rightarrow$ carbon-fibre casing for each module.

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.

DownStream Electromagnetic Calorimeter

The Near Detector at 280m downstream of the $\nu_\mu$ production target has the task of characterising the beam before the neutrinos oscillate by measuring:
- $\nu_e$ flux and energy.
- $\nu_e$ beam background.
- $\mu$ production.
- $\pi$ interaction x-sections.

POD: Narrow layers of lead alloy and plastic scintillator or water dedicated to $\mu$ 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 H2O.
ECal: Tracking electro-magnetic calorimeter with PID.
SMRD: Side Muon Range Detector. Slabs of plastic scintillator inside iron magnet yoke.

Optimising ECal Parameters

- 1.75mm lead thickness
- 4cm bar width
- determined by $\gamma$ reconstruction efficiency for events originating in FGD 1 or FGD 2.

Scintillator bar QA

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 1cm$^2$ cross section. The bars have a 2mm central hole for 1mm WLS fibre.

CR telescope to test scintillator.