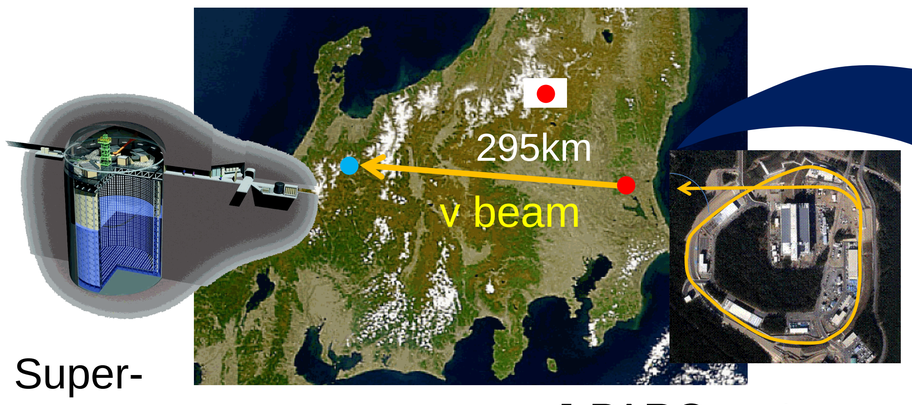
T2K Near Detector FGD
Initial neutrino beam measurements

NNN10

Kei Ieki for T2K FGD group

1. T2K experiment



Super-Kamiokande (Kamioka)

J-PARC proton accelerator (Tokai)

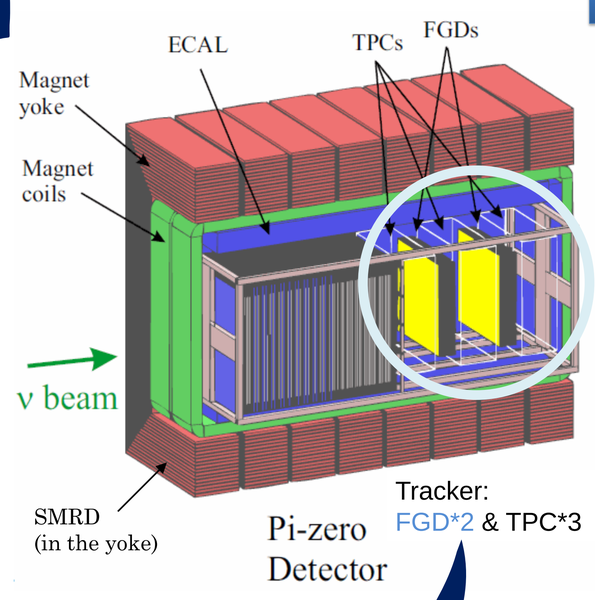
High intensity beam & Giant detector

Goal:
- Discovery of θ_{13} ($\nu_\mu \rightarrow \nu_e$)
- Precise measurement of θ_{23} ($\nu_\mu \rightarrow \nu_x$)

Physics run started from 2010.

2. Near detector (Off-Axis)

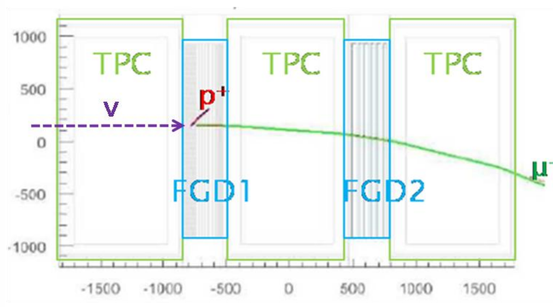
Located 280m downstream from the neutrino production target.
Consists of detectors surrounded by a magnet to measure beam flux and energy spectrum prior to oscillation.



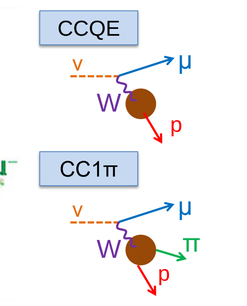
Tracker: FGD*2 & TPC*3

Tracker

Optimum detector for CC interaction measurement
FGD: Measure short tracks around ν interaction vertex ⇒ Identify the interaction type
TPC: Measure the momentum of long tracks
⇒ Reconstruct neutrino energy



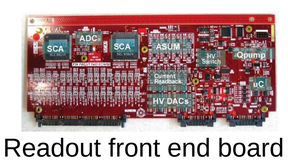
Simulated CC interaction in the Tracker



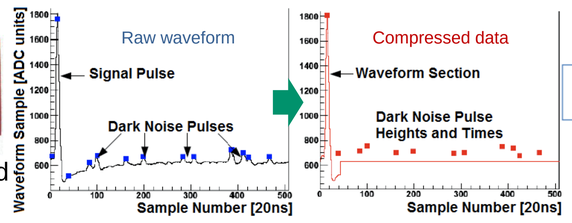
Short tracks have to be detected to distinguish interaction types

3. Fine-Grained Detector

AFTER ASIC chip

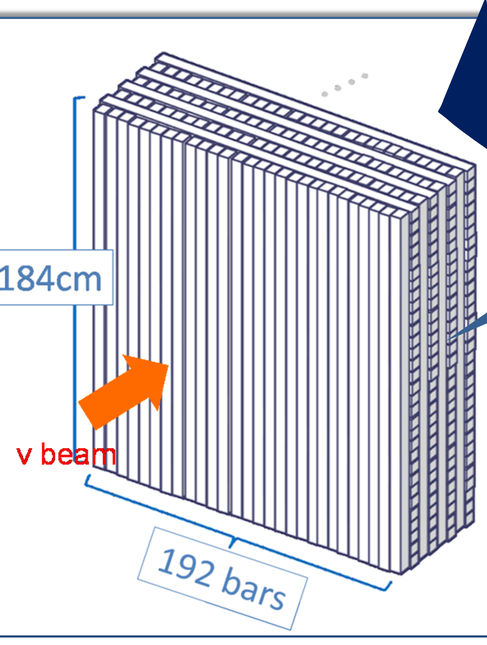


Readout front end board



MPPC waveform before / after data compression

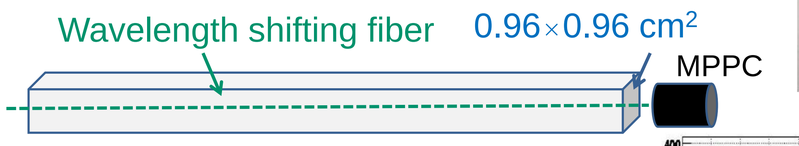
Special ASIC chip for readout
- Waveform digitization (50MHz)
- Pulse amplifier & shaper
  - ⇒ >20MIP dynamic range
    <5ns timing resolution
- 10μs readout time
  - ⇒ Capable of detecting Michel electron to distinguish p/π

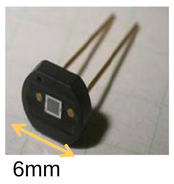


Finely segmented scintillator bars
- FGD1: Scintillator ~1t
- FGD2: Scintillator ~0.5t & Water layer ~0.5t

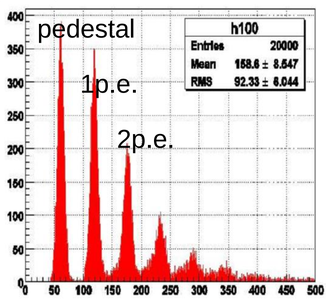
⇒Measure neutrino interaction rate in water (to compare with Super Kamiokande)

MPPC & fiber readout





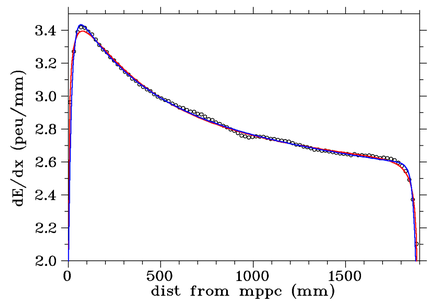
MPPC (Multi Pixel Photon Counter)
- Compact
- Photon counting capability
- Works in magnetic field
- High noise rate (10^2~10^3 kHz)
- Temperature dependency



MPPC ADC distribution

- Light yield ~25p.e. for MIP
- >99% hit efficiency

⇒ Capable of reconstructing charged particle tracks with good efficiency



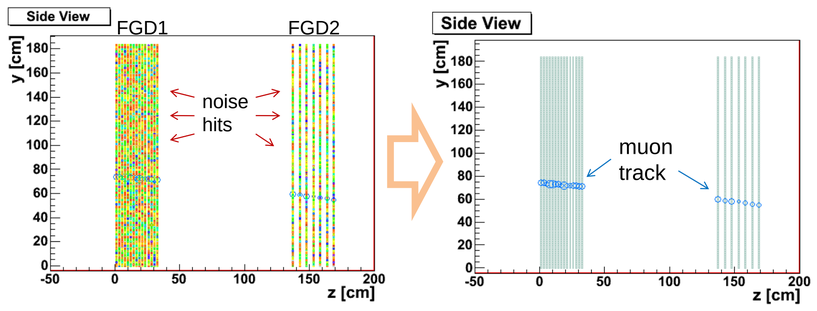
Light yield vs. Position on bar

Excellent performance for detecting charged particles around ν vertex

4. Initial beam measurements

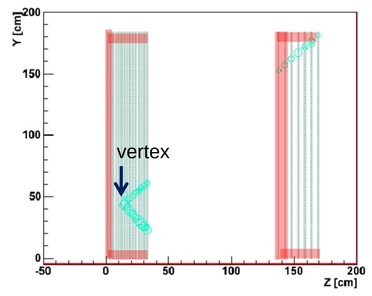
We accumulated ~3*10^{19} POT (Proton On Target) data in the first half of 2010. We analyzed the neutrino event rate in FGD to confirm the performance of the detector and beam.

Simple neutrino event selection:
1. Noise rejection
   - Hit time clustering (2.5pe noise threshold, 80ns coincidence)
   - Beam timing cut (expected timing ±70 ns)
2. Charged Current event selection
   - Fiducial volume cut (cut if the vertex is in the veto region)
   - 3 XY layers continuous hits (enhance CC muon track)

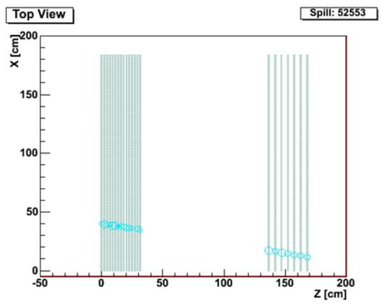


FGD Event display before / after noise cut

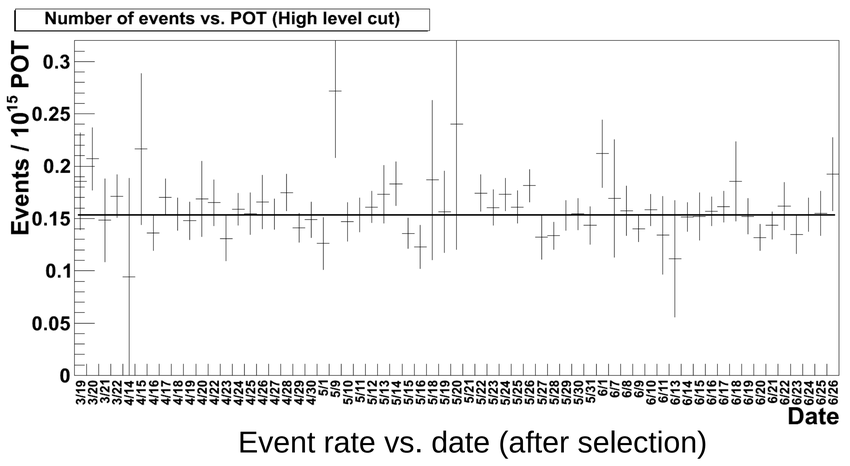
>99.9% of noise hits can be rejected by hit time clustering.



Selected event: Charged Current interaction in FGD FV. Red band shows the veto region.



Background: Muon from the ν interaction at the upstream wall. Rejected by fiducial volume cut.



Event rate vs. date (after selection)

As a result, we confirmed that the FGD is observings neutrino events with stable rate. The measured event rate was 1.5 events / 10^{15} POT (chi-square / ndf = 0.77). Systematic error for this number is not calculated yet, but this number roughly agree with the expected event rate in MC.

Successful operation of detector & beam
⇒ About to present first physics results!

5. Summary

The T2K FGD detector is designed to measure neutrino interactions in the near detector complex. The powerful combination of MPPC and AFTER ASIC chip readout provides excellent performance for detecting charged particle tracks around interaction vertex.

We started physics run in 2010 and accumulated ~3*10^{19} POT data. Our simple hit level analysis shows that the neutrino events rate is stable and the beam operation is successful. The first result of neutrino oscillation analysis will be presented very soon.