The Time Projection Chambers for the T2K Experiment
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T2K (Tokai to Kamioka)
The T2K experiment is a second generation long-baseline neutrino-oscillation experiment to study the nature of neutrinos. An artificial neutrino beam generated in the JHF 500GeV high-intensity proton accelerator in J-PARC (Tokai, Japan) is directed towards the 50m矮水 Cherenkov detector, Super-Kamiokande, which is located about 1000m underground in Kamioka mine (95% of the beam at 295km away from Tokai).

Physics goals
- SEARCH FOR ν → ν' APPEARANCE
measurement of θ13 with more than an order of magnitude better sensitivity than any previous experiment
- MEASURE ν DISAPPEARANCE
more accurate determination of the “atmospheric” parameters θ23 and Δm23

OFF-AXIS BEAM
The off-axis beam can produce the highest possible intensity with a narrow energy spread.

A key element of the design of the T2K facility is that the neutrino beam is directed so that the beam axis misses Super-Kamiokande. This results in a considerable improvement in the quality of the beam for the νµ appearance experiment. This arises from the kinematics of the νµ decay, which result in a enhancement in the neutrino flux produced over a very narrow range of energies which depend on the exact off-axis angle. By selecting the correct angle, this narrow peak can be near the oscillation maximum at the far detector.

Advantages over a conventional on-axis beam:
- the off-axis neutrino flux at the desired energy (the oscillation maximum) is larger than on-axis;
- there are fewer high-energy neutrinos, which do not contribute to the appearance signal but contribute to the background, in particular through the neutral current production of ντ (which decay to produce the νµ's which can, if they are energetic enough, be misread for the single electron characteristic of a charged current interaction with νe);
- the background due to intrinsic contamination of the beam by νe is less at the off-axis position due to the different kinematics of the decay that lead to νµ.

Electron contamination due to intrinsic contamination of the beam by νe is less at the off-axis position due to the different kinematics of the decay that lead to νµ.

Why is Calibration needed?

TPC Calibration
- E & B field imperfection  spatial distortion  field maps, laser system & cosmics
- Changes in atmospheric pressure  drift velocity variation  laser & cosmics
- Gas density fluctuation  MM gain variation  test bench
- Module misalignments  spatial distortion  laser system & cosmics

MM Test Bench
The Test-Bench is a small drift chamber with a MicroMegas implemented on one side and a cathode on the other side. X-Y stages move a 55Fe source behind the cathode over each pad to provide a good pad per pad analysis. To maximize the gain the calibration box is filled with Ar:CF4:CO2 (95:2:3).

Gain variation: 2.3%
Gain ≈ 1500
Energy resolution: 8.6%

Why is Calibration needed?

Laser Calibration
UV laser light from a fiber will be spread by lenses on the central cathode (cc) Precise positioned aluminum patterns will emit drift electrons

Precise positioned aluminum patterns will emit drift electrons
Detection will be used to calibrate drift distortion, drift velocity and module misalignment

Integrating charge on the pad plane in one event

Cosmic Ray Test at CERN
The MicroMegas was mounted on the ex-HARP TPC field cage, to study the MicroMegas detector performance. In particular, measurements at the same B field as in the near detector (e.g. 0.2 T) have been taken.

A microMegas module mounted on the HARP field cage with AFTER ASIC and cooling system
Cosmic ray test demonstrated a target resolution of ~0.6 mm per pad row in a 0.2 T field