Gas handling system for the T2K time projection chambers

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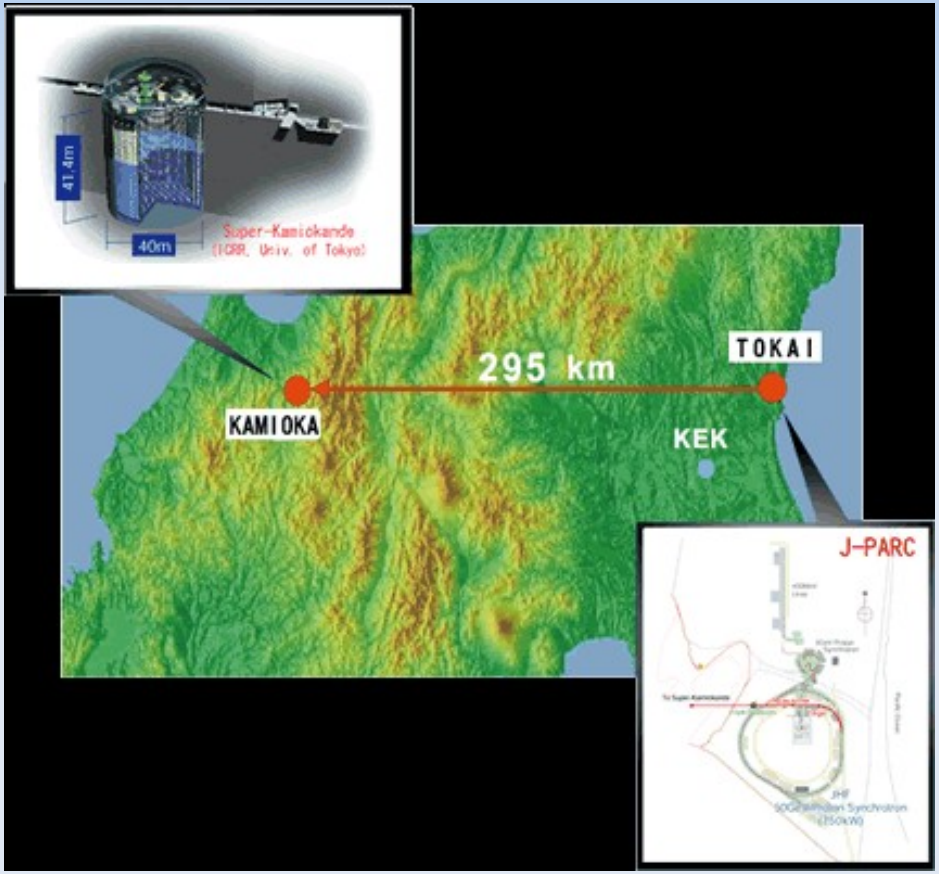
T2K and ND280

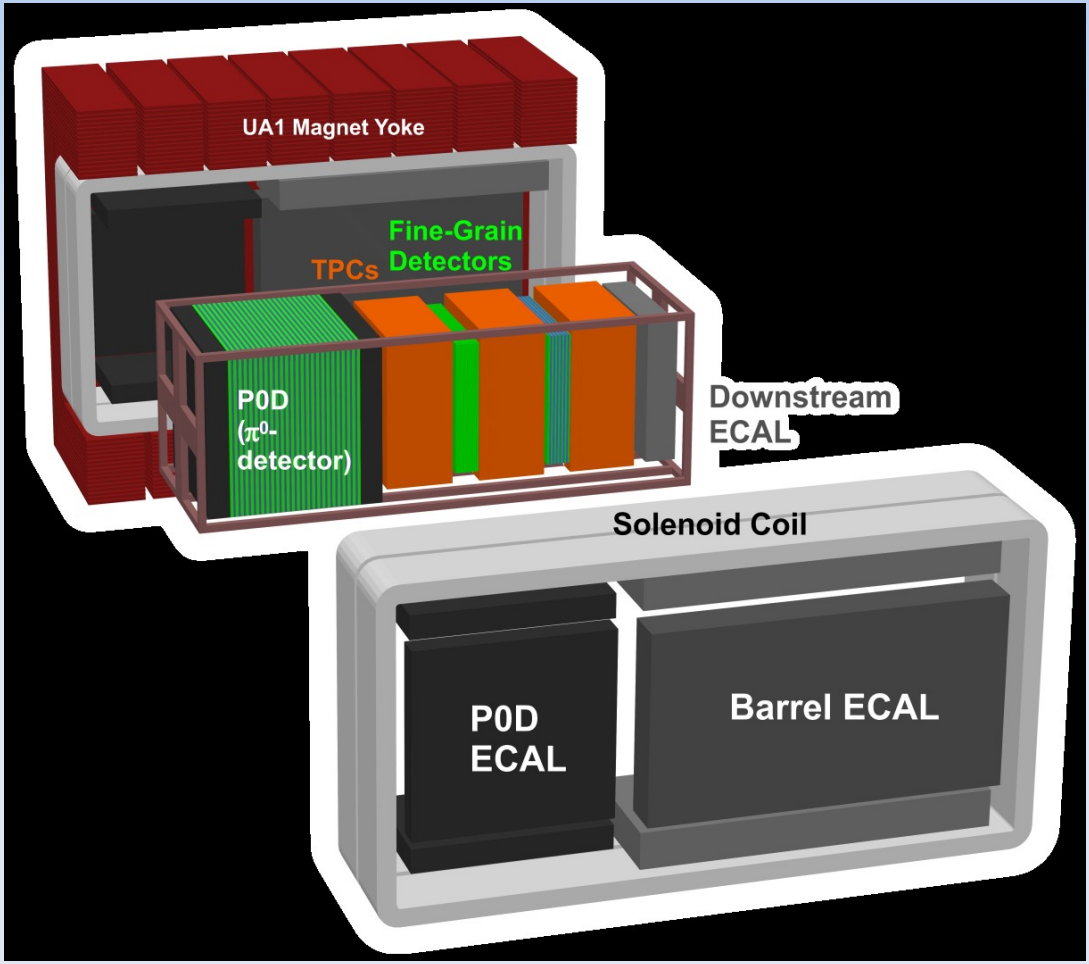
- Long baseline neutrino oscillation experiment.
- Top priority: Measurement of θ_{13}.
- ND280 to measure properties of initial beam.
- For a more thorough overview of T2K, see “Status of the T2K Experiment” by Michael Wilking today at 14:45 in BA 2175.



From: http://www-nu.kek.jp/jhfnu/index_e.html

The TPCs

- Placement in ND280.
- Gas based detector.
- Charged particles ionize the gas along their track.
- Resulting electrons drift under the applied electric field to the ends to be measured.
- For a more thorough overview of the TPCs, see “T2K Near Detector Time Projection Chambers” by C. Bojechko today at 14:30 in BA 2175.

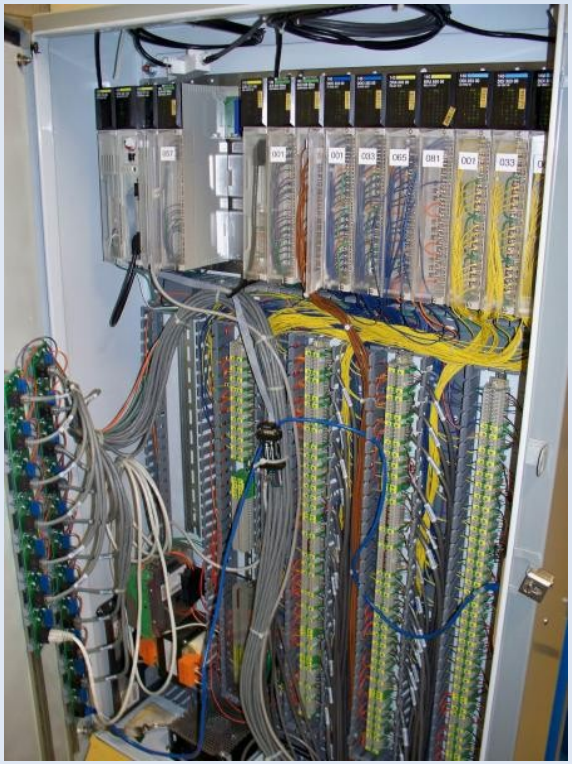


dE/dx in the TPCs

- Largest background for θ_{13} measurement: ν_e component of beam.
- TPCs in the near detector provide best discrimination of ν_μ and ν_e through the dE/dx.
- Good dE/dx resolution requires:
  - stable gas properties
  - low gas contamination
  - monitoring of gas density changes

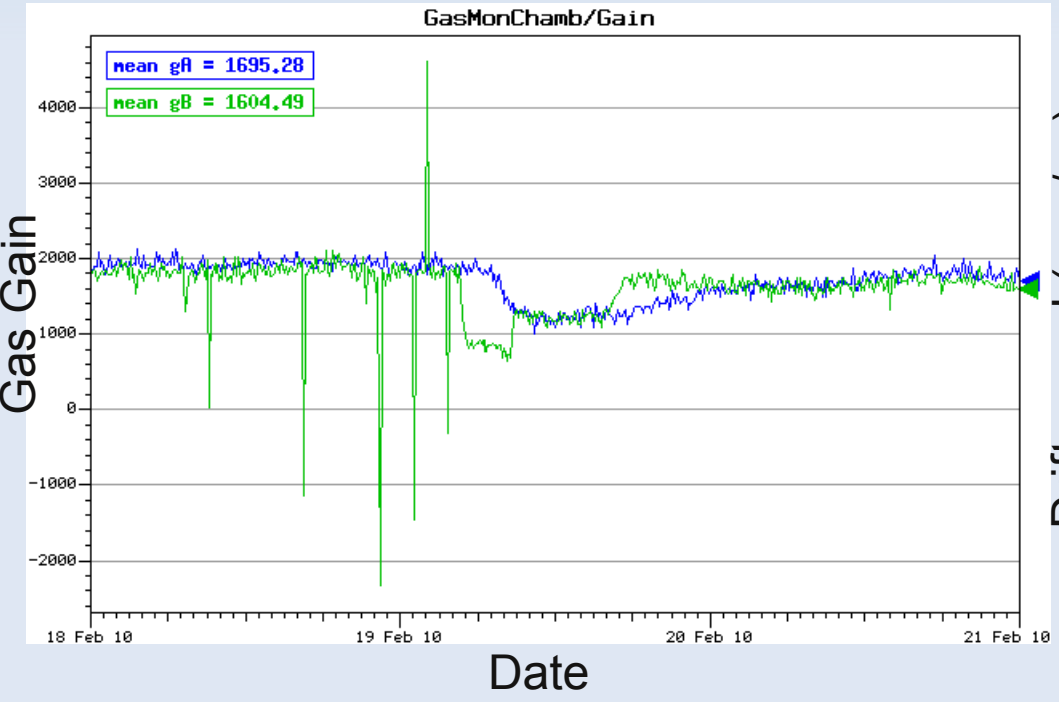
The Gas Handling System

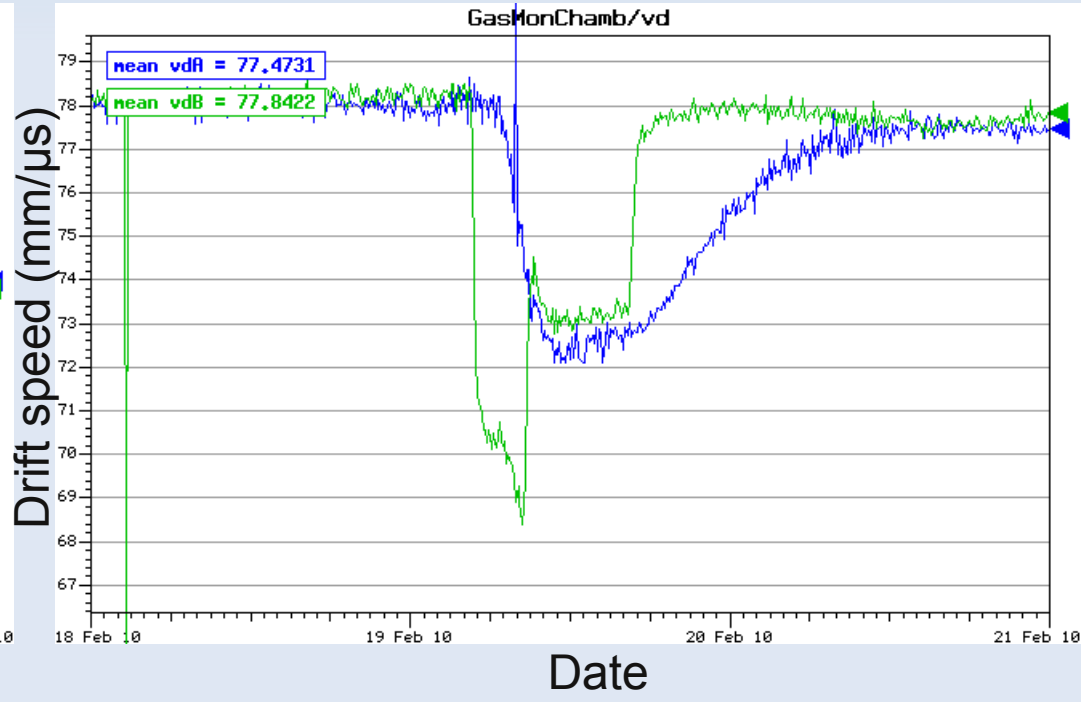
- Gas system hardware.
  - Supply 95:3:2 Ar:CF_4:isobutane to inner (drift) volume (90% recycled).
  - Supply CO_2 to outer (buffer) volume.
- The Programmable Logic Controller.
- Control system and data acquisition.



Monitoring gas properties

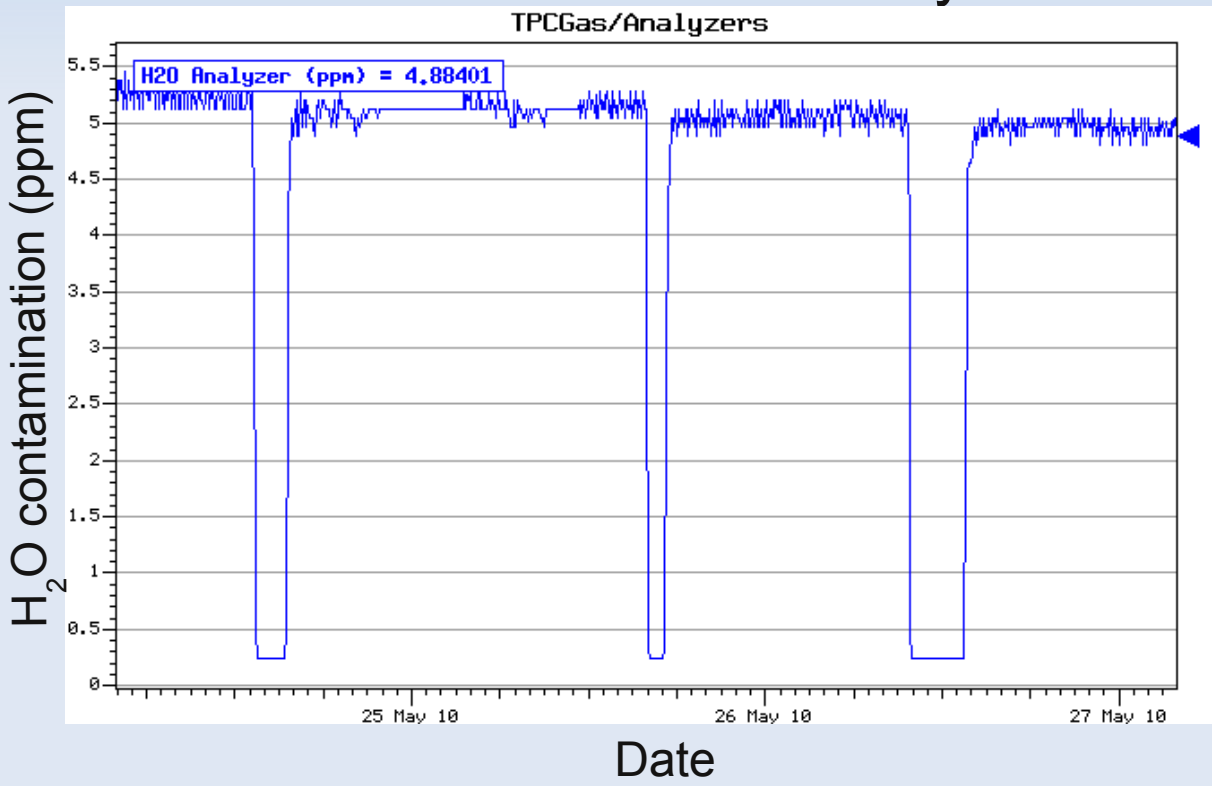
- Analyzers: H_2O, O_2, CO_2, CF_4, isobutane.
- Monitor Chambers: Measure gain and drift speed of gas entering and exiting the TPCs.
- Example of them seeing a change in gain (left) and drift speed (right) due to gas composition change:





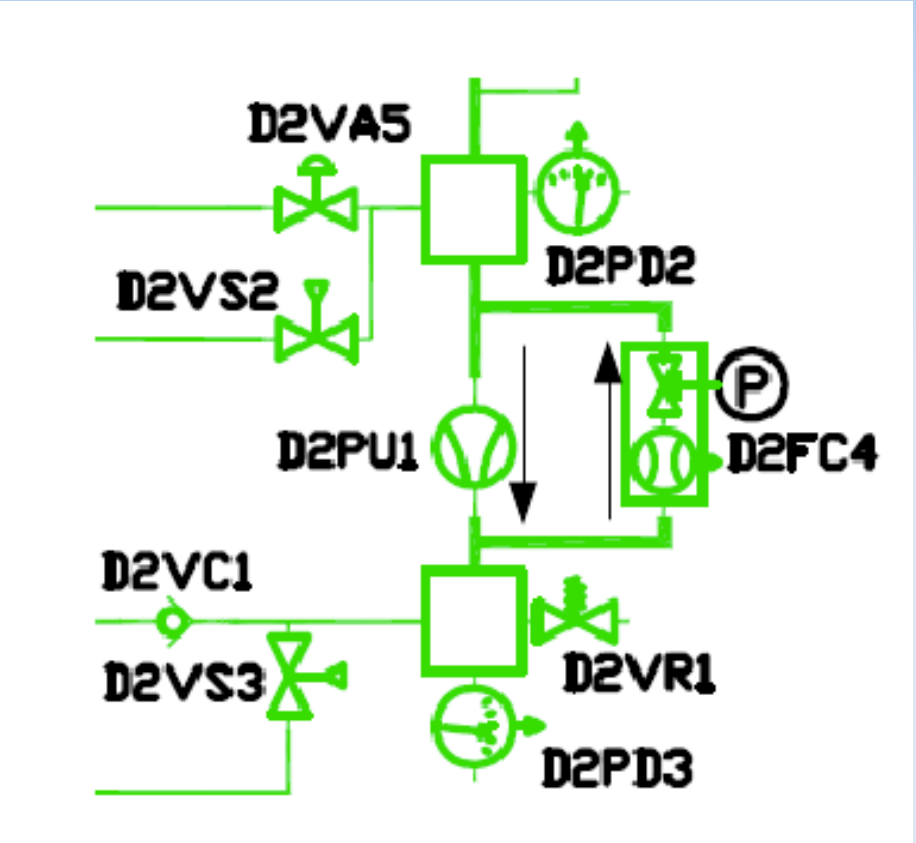
The purifiers

- Remove CO_2, H_2O, and O_2 from the gas being sent to the inner volumes.
- Contain 70% 5A molecular sieves and 30% R3-11 catalyst.
- Regeneration.
- Pre-saturation with CF_4 and isobutane.

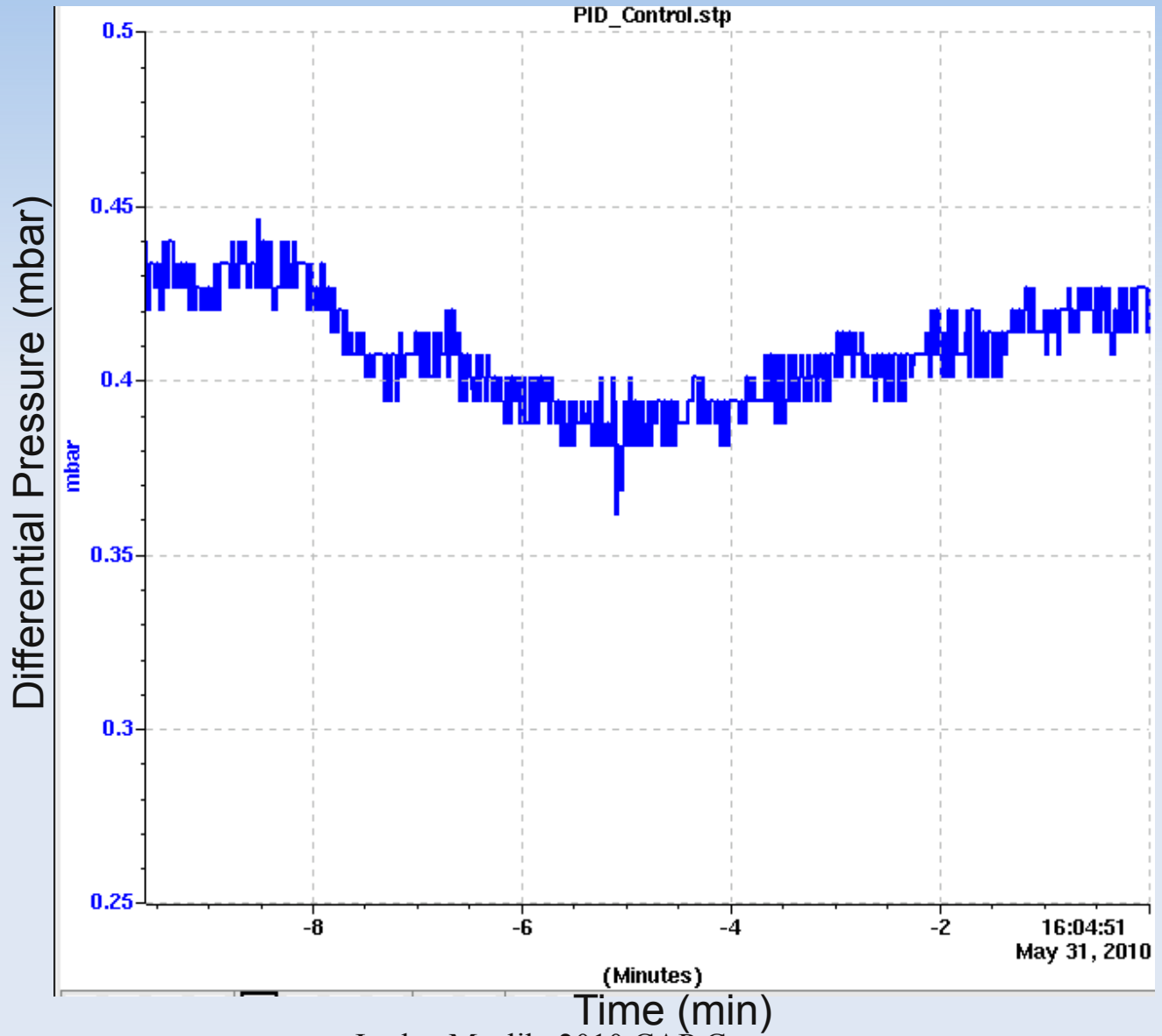


Pressure control: Overview

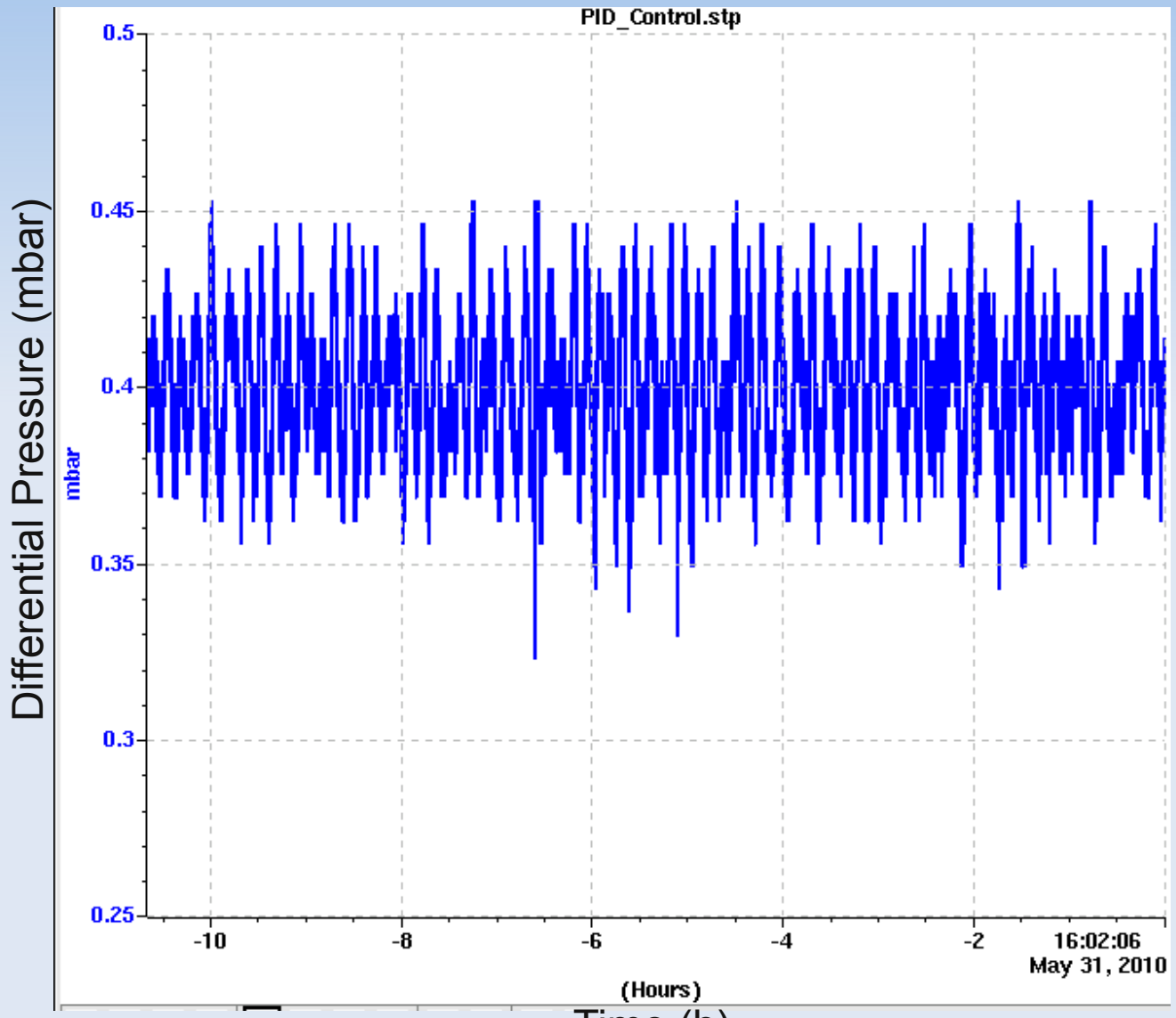
- Outer volume pressures track atmosphere.
- Differential pressure between inner and outer volumes measured (want to keep stable to within 0.1 mbar).
- Measurement used to control flow out of inner volumes (flow in is constant).



Pressure control: Stability

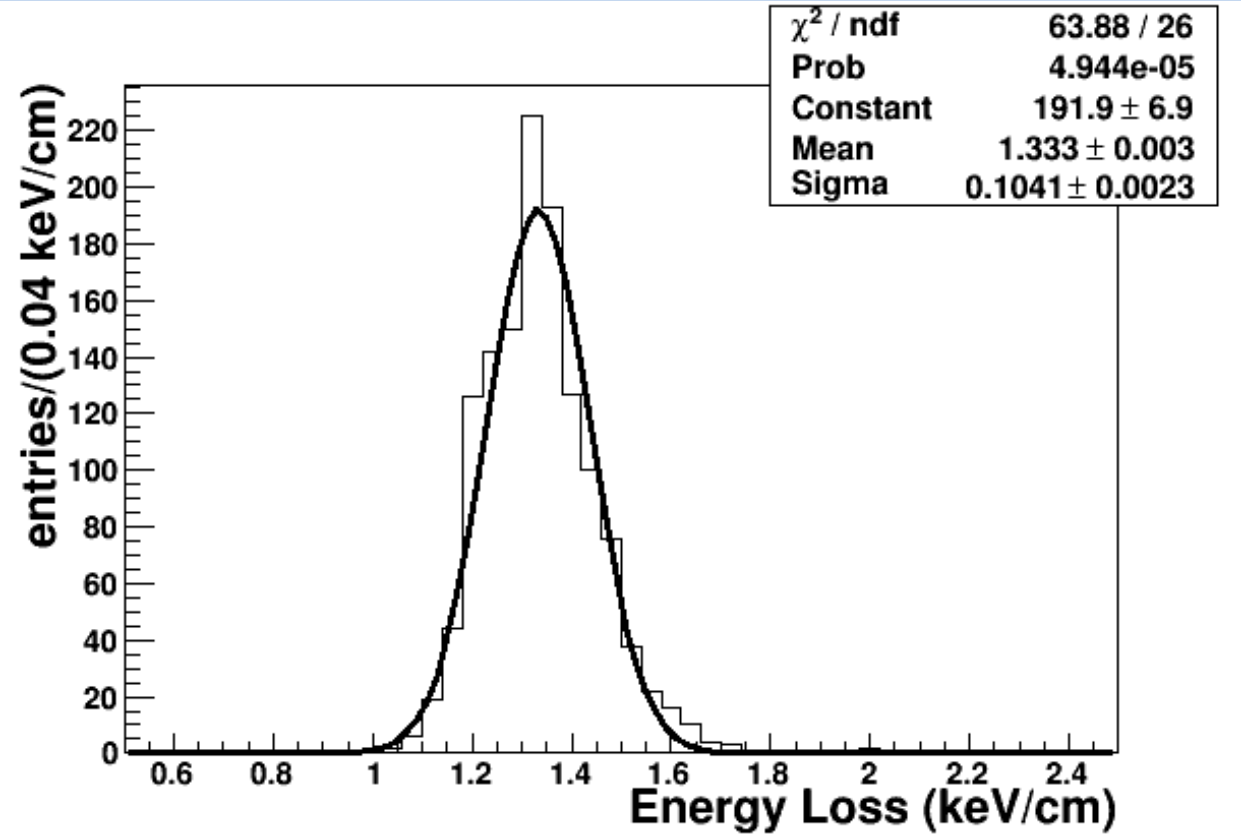


Pressure control: Stability



dE/dx performance thus far

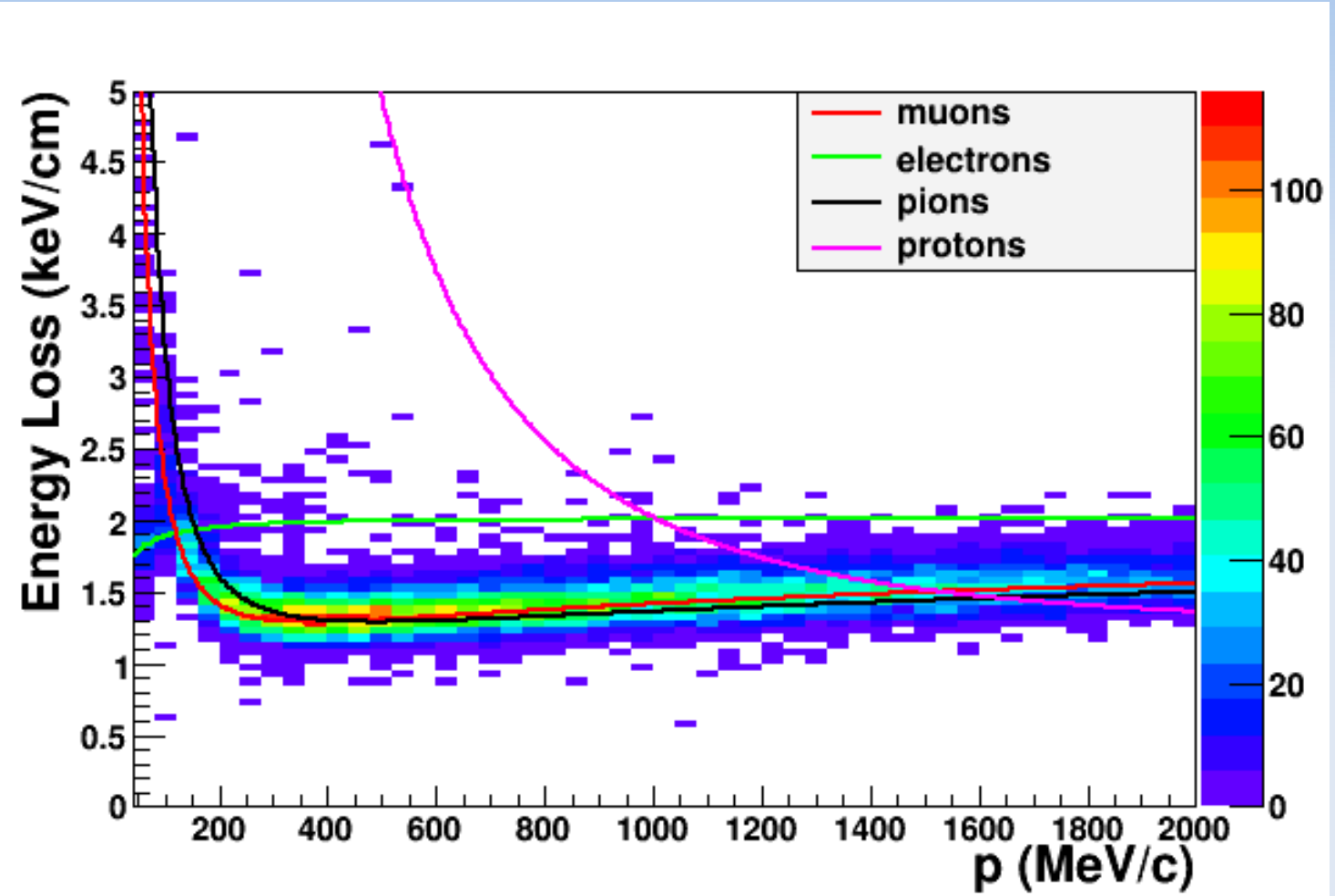
- Resolution is (7.8 ± 0.2)%.
  - Target was 10%.



Energy loss distribution for negative particles with 400 < p (MeV/c) < 500

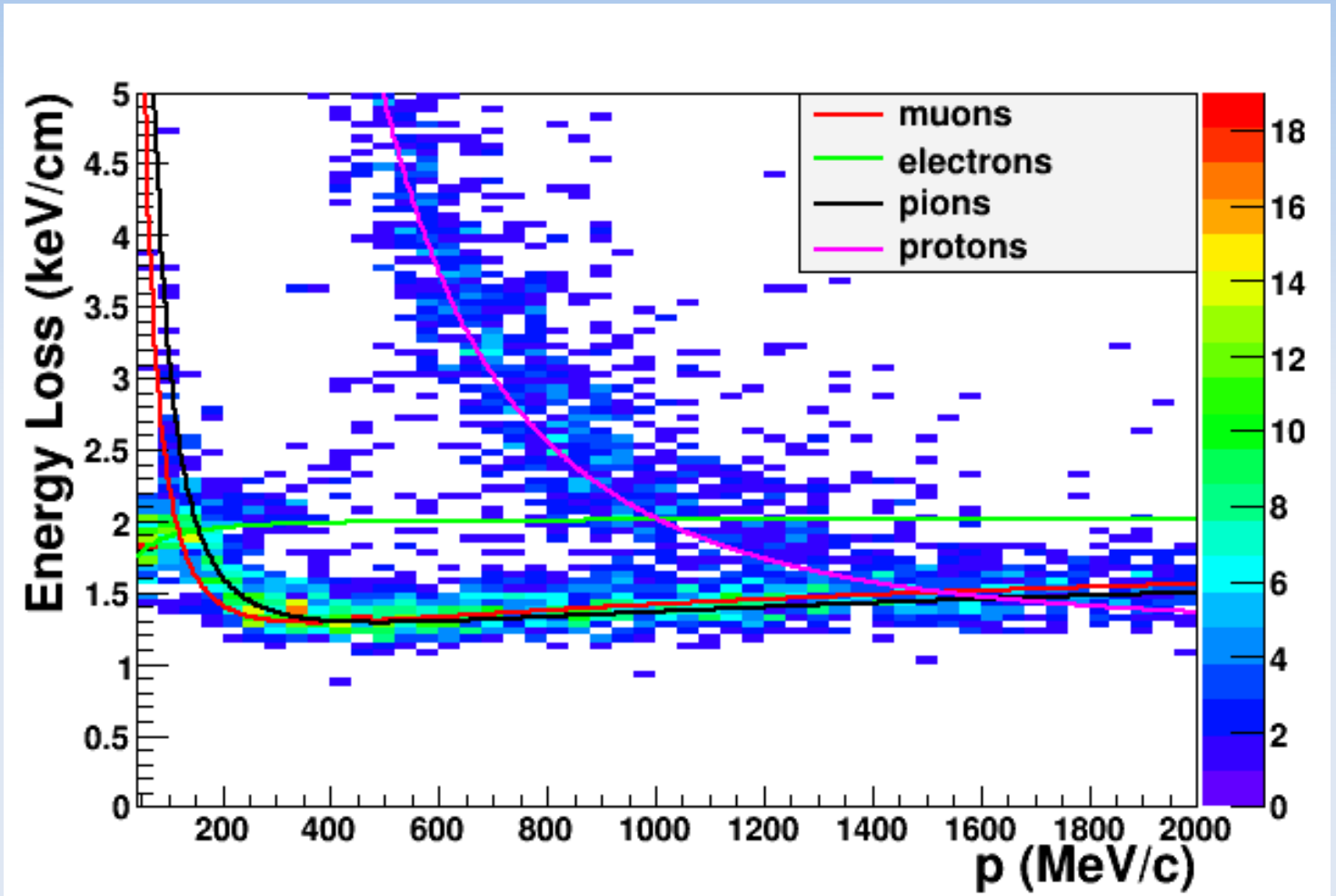
dE/dx performance thus far

- dE/dx for negative particles.
- Superimposed curves are expected values.
- From neutrino interactions.
- Mostly muons, some electrons, especially at low momenta.



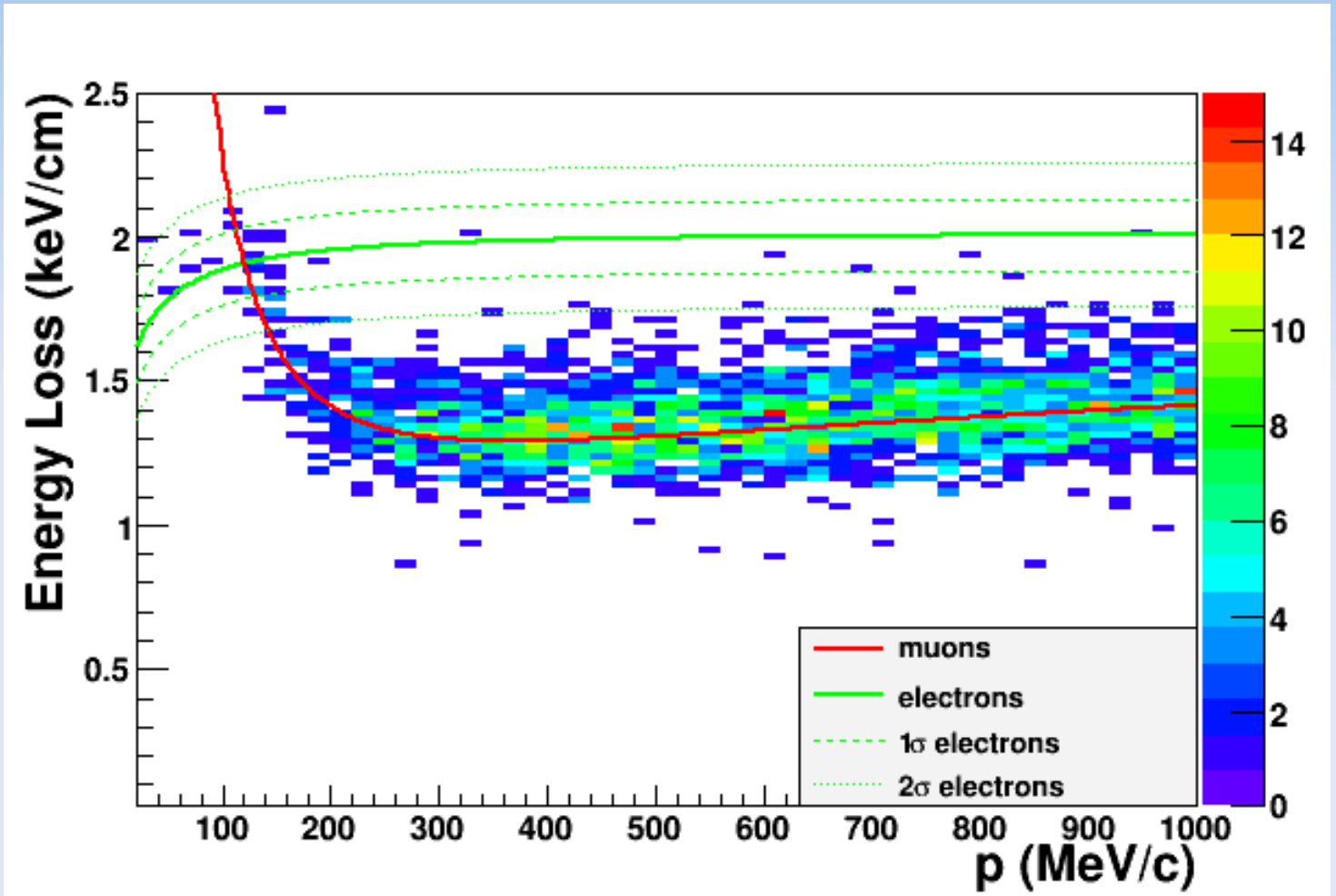
dE/dx performance thus far

- dE/dx for positive particles.
- Superimposed curves are expected values.
- From neutrino interactions.
- Mostly pions, protons, some low energy positrons.



dE/dx performance thus far

- Sample of muons.
- Mis-identification probability is less than 0.2%.
  - Expect to see of order 0.5% ν_e in the beam.



Acknowledgements

- The TPC project is an international project led by Canada.
- The gas handling system was designed and built at TRIUMF (with some components designed and built by collaborators in Germany and Italy.)