Energy reconstruction in DUNE Dual Phase LAr TPC
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The Deep Underground Neutrino Experiment (DUNE)

- Next generation long-baseline neutrino experiment (beam in 2026)
- 1300 km baseline and beam power optimized for sensitivity to CP violation and mass hierarchy in a single experiment

Far detector: four 10 kt Liquid Argon Time Projection Chamber (LArTPC)
1. Single Phase (SP) design
2. Dual Phase (DP) design

Dual Phase LArTPC

- Charged particles produce ionization charge and scintillation light
- An electric field drifts the charge upward, light is collected by PMTs
- Charge is extracted from the liquid to the gaseous argon
- A Large Electron Multiplier (LEM) amplifies the charge extracted
- The charge is collected at the anode shared equally on two perpendicular readout planes

Features of the DP design:
- Fully active volume
- Tunable Signal to Noise Ratio
- High granularity (3 mm/view)
- Never tested on large scale

DUNE Dual Phase prototypes at CERN

3x1x1 m³ (2017)

- Small scale prototype: ∼0(1 m) drift, 4t LAr fiducial volume
- Aim: foreseen technical challenges for larger detectors
- Detector operated in different configurations allowing an extensive scan of extraction and amplification field
- 400k triggers of cosmic ray data collected during Summer–Fall 2017
- First test for noise filtering and track reconstruction strategies
- Analysis is ongoing to assess detector response, gain

6x6x6 m³ – ProtoDUNE – DP (2018)

- Large scale prototypes meeting DUNE requirements ∼0(10 m) drift, 300 t LAr fiducial volume
- Aims:
  - Design validation and optimization
  - Anticipate FD construction and commissioning challenges
  - Validation of detector full simulation
  - Measure impact of space charge effects and test light collection system
  - Test for reconstruction and analysis techniques

Neutrino energy reconstruction @DUNE

- Extracting oscillation parameters from spectral information demands outstanding energy resolution over a broad range (0.5–5 GeV)
- Thanks to the tracking capacity of LArTPCs, topological features of the event can be used to reconstruct the primary lepton energy
- The hadronic (and electromagnetic) contribution to the total neutrino energy is estimated using calorimetric information
- We present estimates of DUNE DP far detector energy resolution, using full simulation for the first time

νₑ CC events:

- Momentum of the primary lepton can be reconstructed the longest track in the event:

νᵯ CC events:

- select em shower with the largest charge

References


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