CVN Tests on DUNE VD far Detector

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Deep Underground Neutrino Experiment-DUNE

- DUNE is designed to conduct to explore the three flavor model of Neutrino Physics in determination of but not limited to Neutrino Mass hierarchy CP violation
- DUNE relies on intense beam of neutrino from fermilab to far detector at SURF 1300 KM.
- Detector is LAr-TPC technologies.
Images from TPC

Energy: 3.01, cvn gaushit: 0.89
Simplified diagram of the DUNE CVN architecture.
Test One: Geometry of images oriented at +30, 90, -30

[Graphs and charts showing data analysis results.]
NUEMUCC Purity, efficiency and Background Distribution Graphs

![Graphs showing purity, efficiency, and background distribution for NUEMUCC](image)
NUECC  Purity, efficiency  and Back Ground Distribution Graphs

- Left graph: Plot of Events/10^12 POT vs CVN Score, with different colors for v_d_sig, v_d_bkg, numu MCC, numu CH, and NC.
- Middle graph: Plot of CVN Score vs CVN Score, showing a peak.
- Right graph: Plot of Purity, Efficiency vs CVN Score, with lines for VD Purity and VD Efficiency.
NUMuCC Selection Efficiency vs Energy

NUMuCC Selection Efficiency vs Leptonic Energy

NUECC Selection Efficiency vs Energy

NueCC Selection Efficiency vs Leptonic Energy
Pi-zero multiplicity

Pions multiplicity

VERY PRELIMINARY
Two Geometries
Left 0 45 90   right -30 +30 90
Two Geometries - CVN output and Score (efficiency x purity) distributions

Left 0 45 90  right -30 +30 90
Two Geometries - Energy distributions and efficiency vs. energy

Left 0 45 90    right -30 +30 90
Two Geometries – Leptonic Energy Fraction and efficiency vs. LEF
Left 0 45 90  right -30 +30 90
Two Geometries - Efficiency and Purity vs. CVN score
Left 0 45 90 right -30 +30 90
Summary

CVN is tested on the following Geometry
- Views -30, +30, 90 deg
- Views 0, 45, 90 deg
- CVN efficiency is shown in graphs with different aspects
- Purity, background rejection and efficiency graphs are presented for the two different geometry.
- Next:
  - CVN performance depends on neutrino energy? Apparently not.
  - Does it depend on the number of neutral and charged pions in the event? We do not know.
  - Should the selection threshold vary with energy and topology of the event? We do not know.

Preliminary, classic reconstruction type studies, suggested that the -30 +30 90 deg layout is better for lepton reconstruction efficiency, but may be worse for nueCC purity.