NDK-High-E & Sim/Reco

Aaron Higuera
University of Houston

NDK-High-E

- **Nucleon Decay**
- **Atmospheric Neutrinos**
- **Cosmogenic**

One person's signal is another person's background

- **Nucleon Decay**

  Atmospheric Neutrinos

  Cosmogenic

- **Cosmogenic**

  Calibration w/ cosmic-ray muons

- **Atmospheric Neutrinos**

  Atmospheric neutrinos provide a complementary analysis approach to beam neutrinos, and can help resolve ambiguities in beam-only analyses

Proton Decay Analysis

Analysis

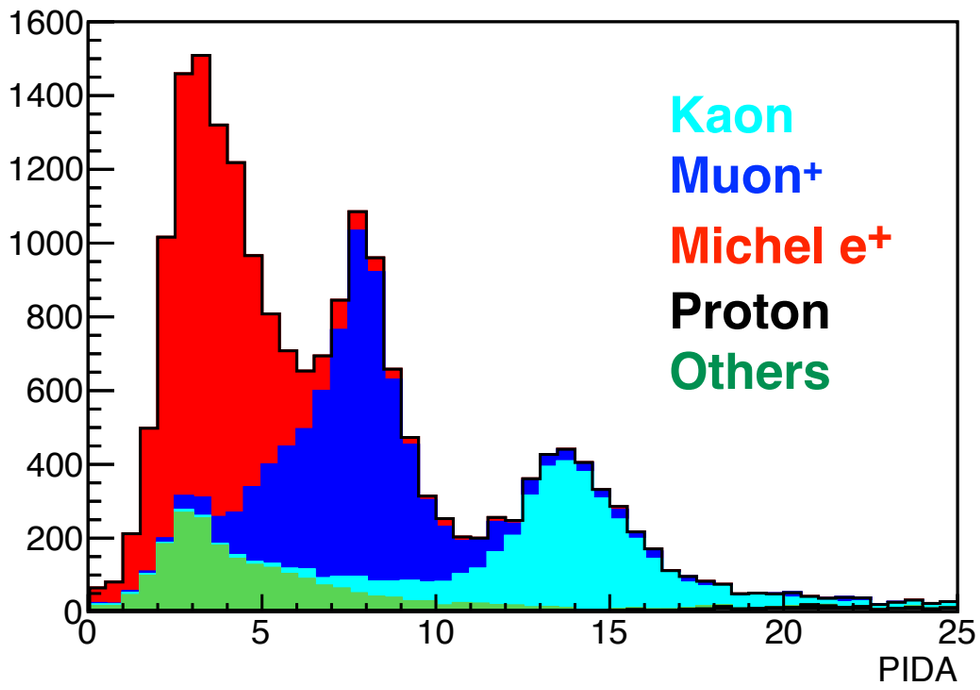
Far Detector Task Force Report

p→ K+ν̄

Requirement	$p \to \bar{\nu} K^+_{\mu 2}$ signal efficiency (%)	Atmospheric ν background rate ($\text{Mton}^{-1} \cdot \text{year}^{-1}$)
None	100.0	2.9×10^5
Kaon tracking efficiency	61.8	N/A
Kaon and muon ID	38.0	9.2×10^3
Not shower-like	30.7	1.0×10^3
Vertex-muon separation	23.2	1.2×10^2

Far from what we promised in CDR

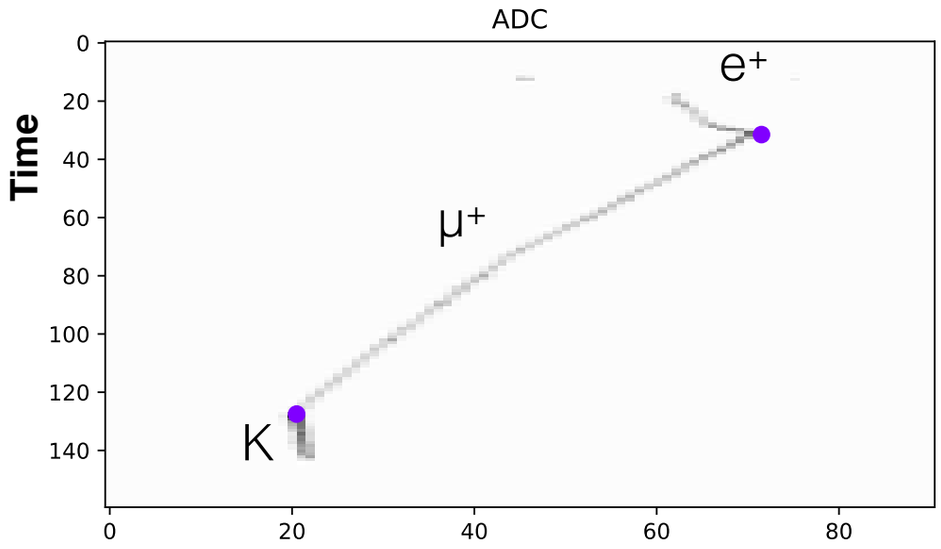
We would focus only on K → μ^+ + ν_μ events and atmospheric neutrino events as background

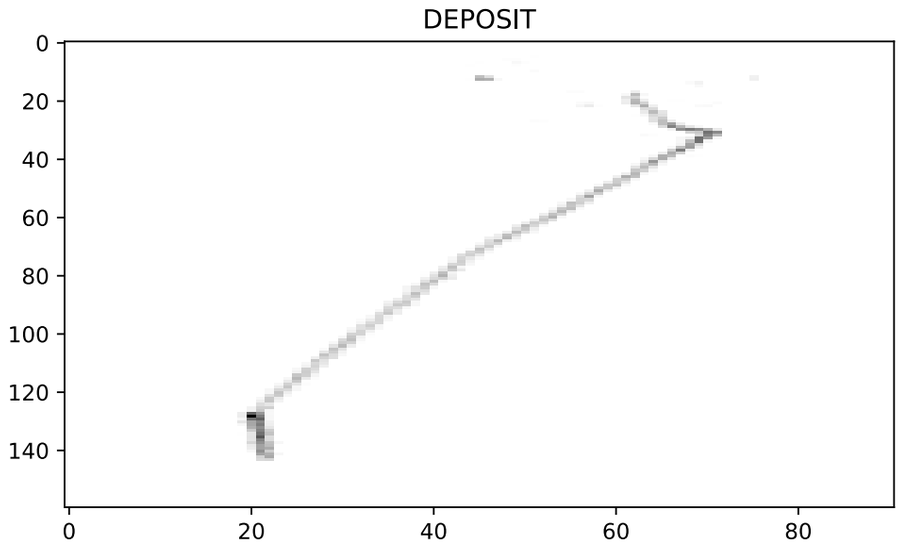


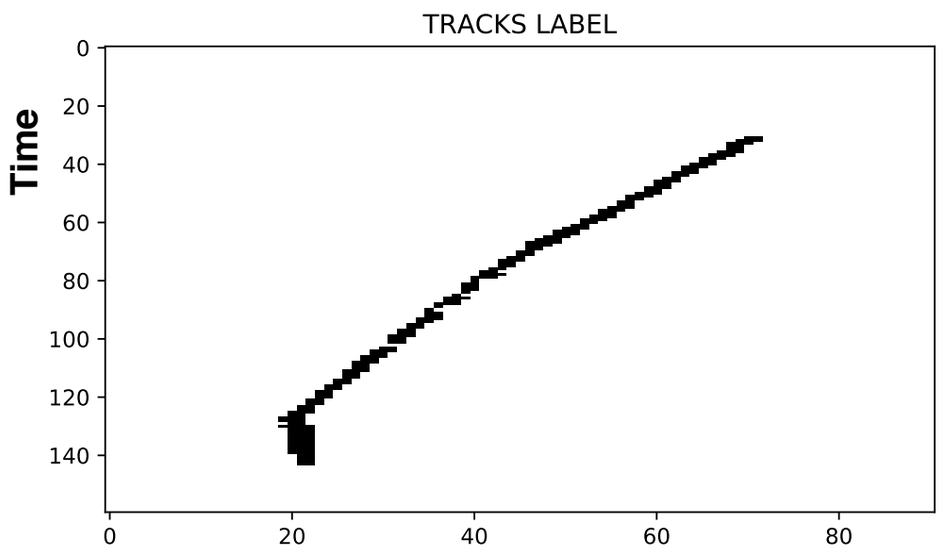
CNN Tools on the Proton Decay Analysis

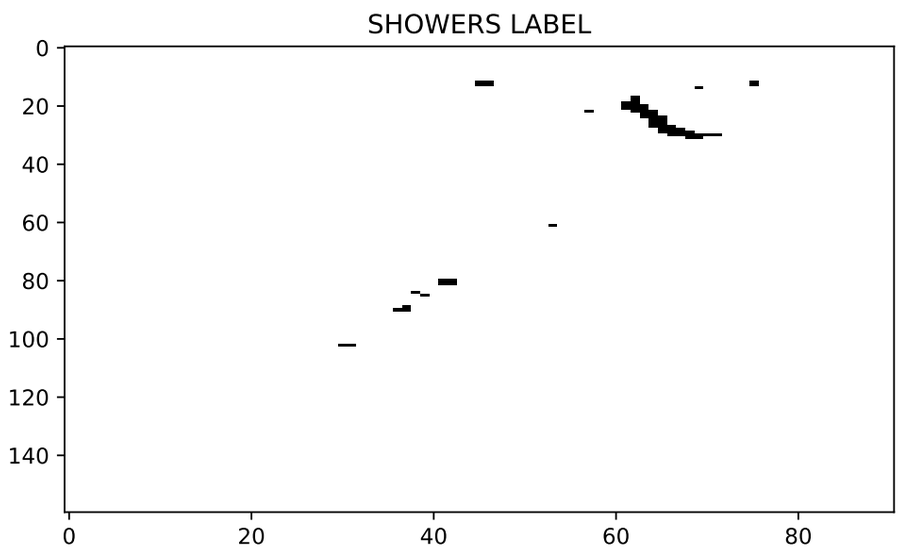
CNN Tools on the Proton Decay Analysis

- To improve reconstruction
- To improve analysis





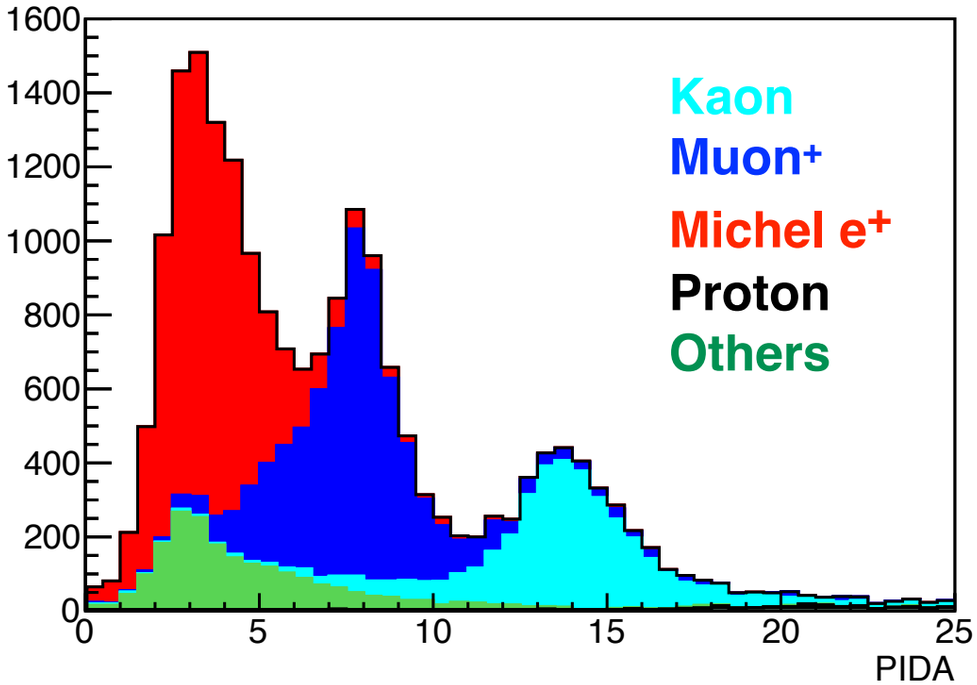




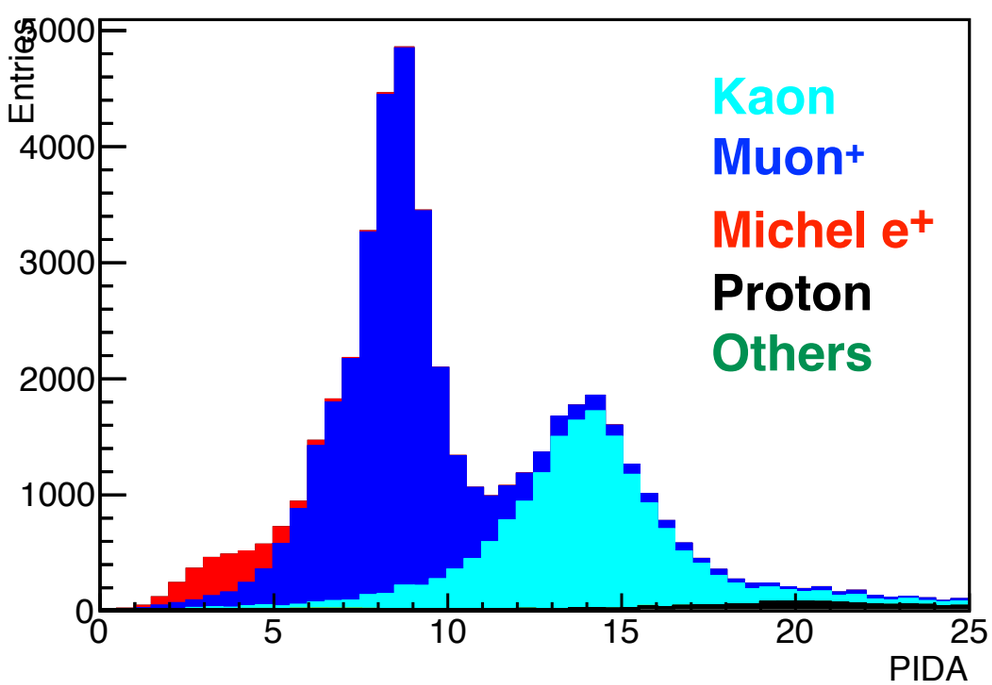
Proton Decay Analysis

Only on K → μ^+ + ν_μ events

Before using CNN



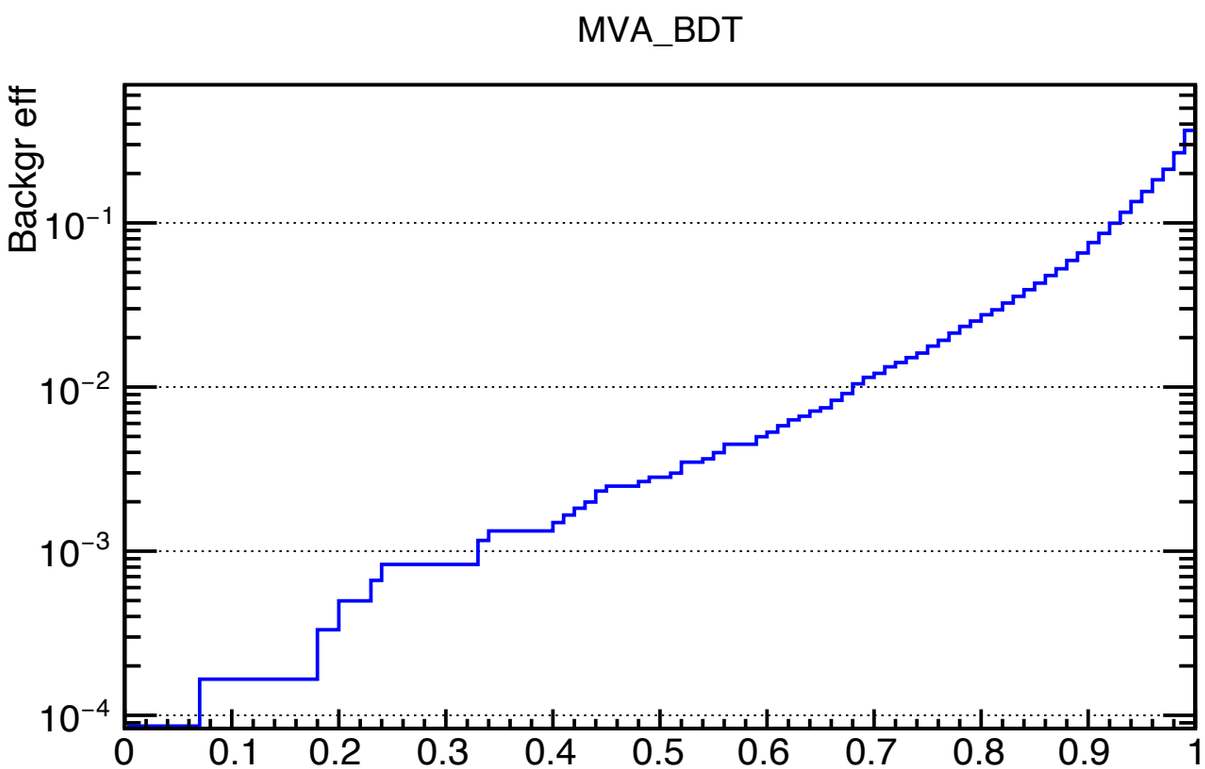
After using CNN

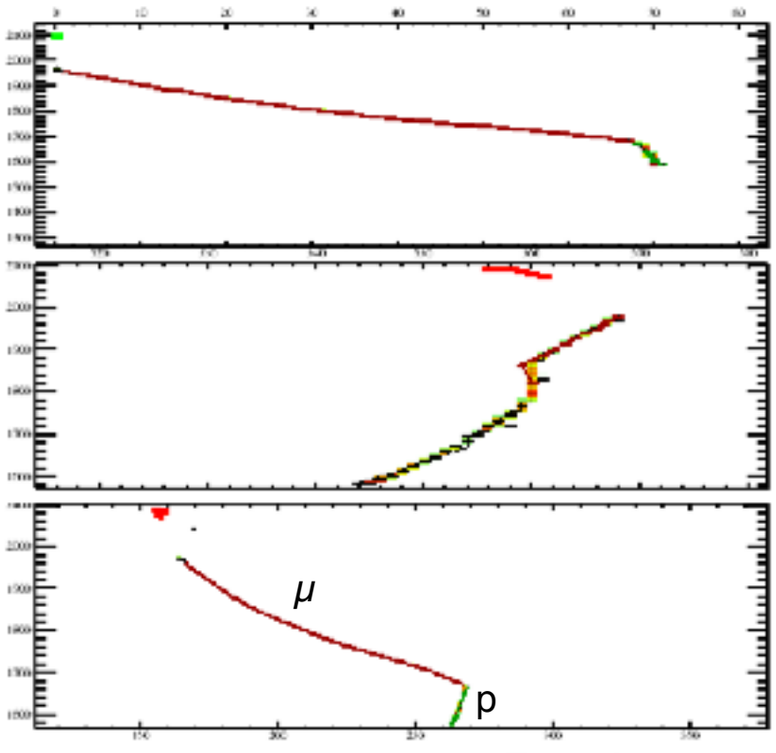


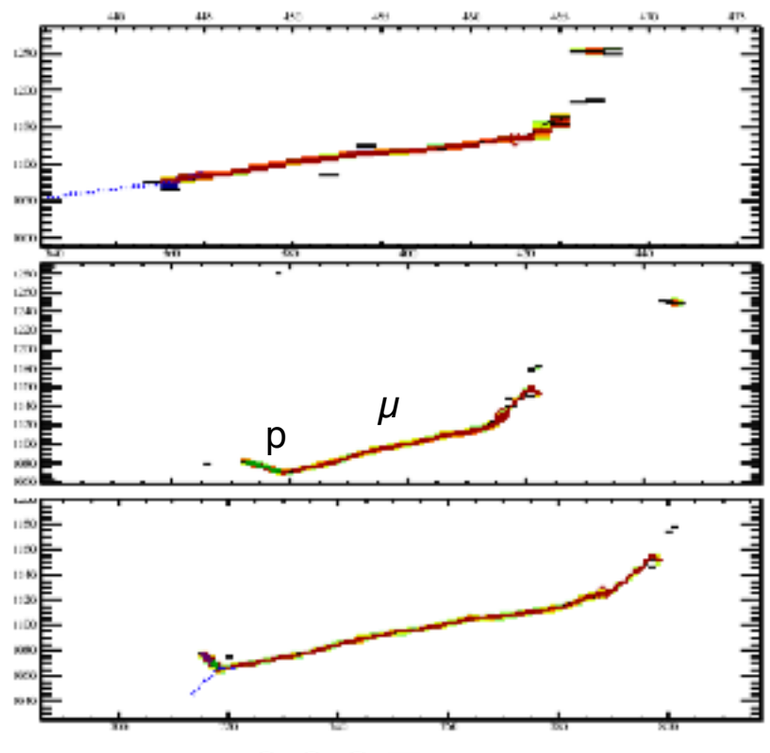
MVA for Proton Decay

Boosted Decision Tree (BDT)

Signal	**Background Mton^{-1} year^{-1}**
100%	2.9 x 10^5
50%	**783**
20%	95



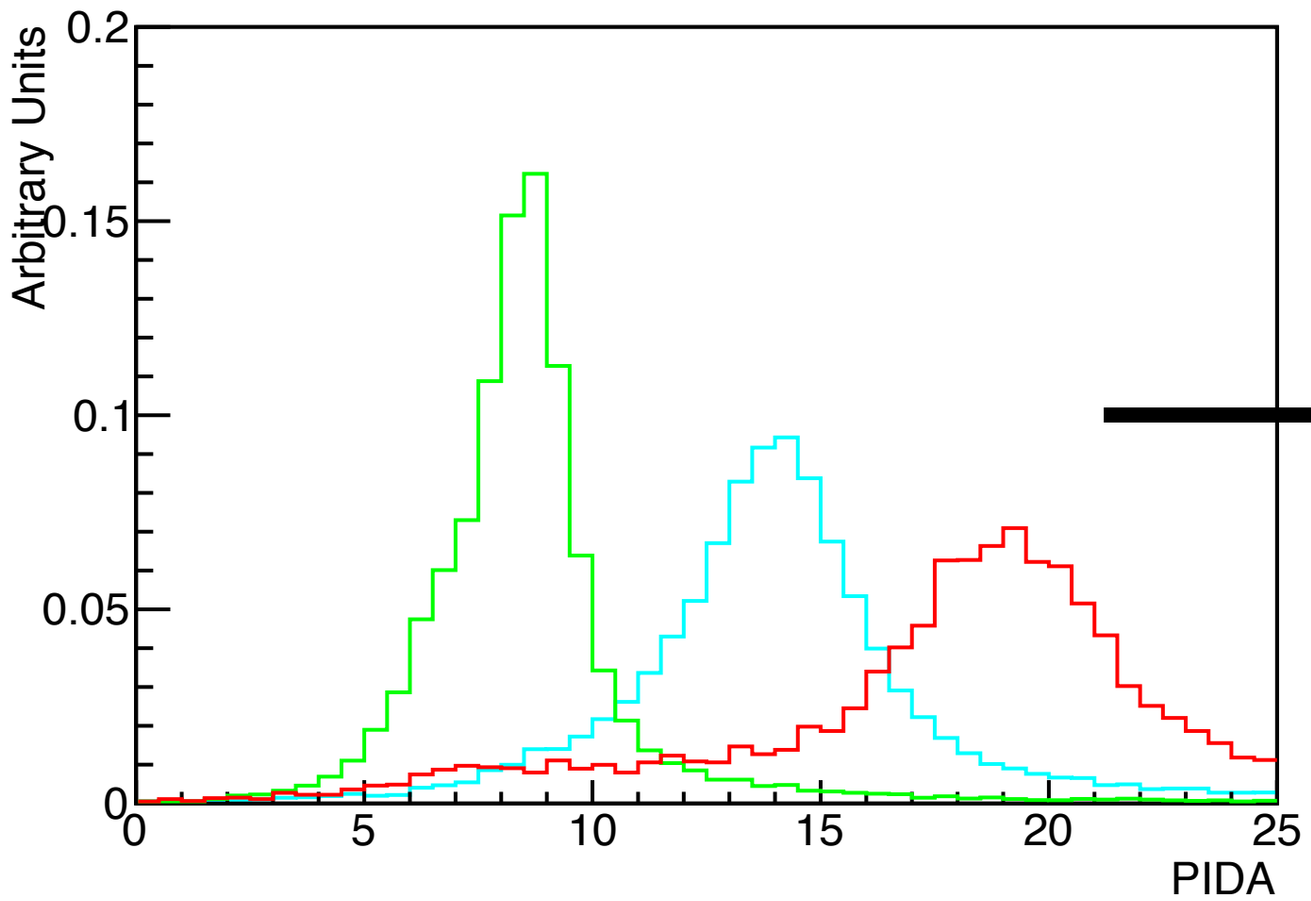


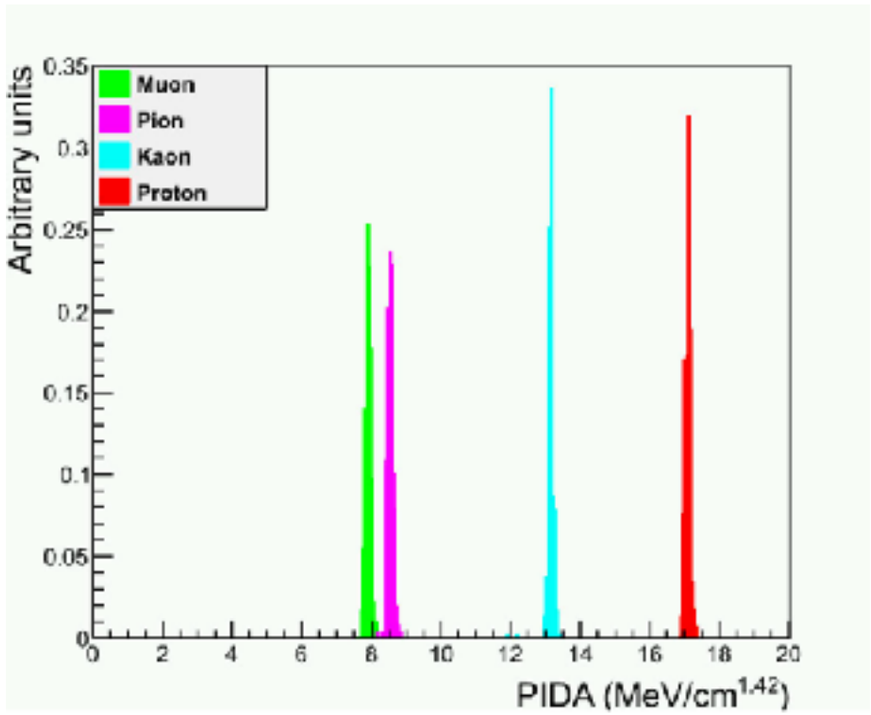


Background events are ν_μ CCQE

How we move forward?

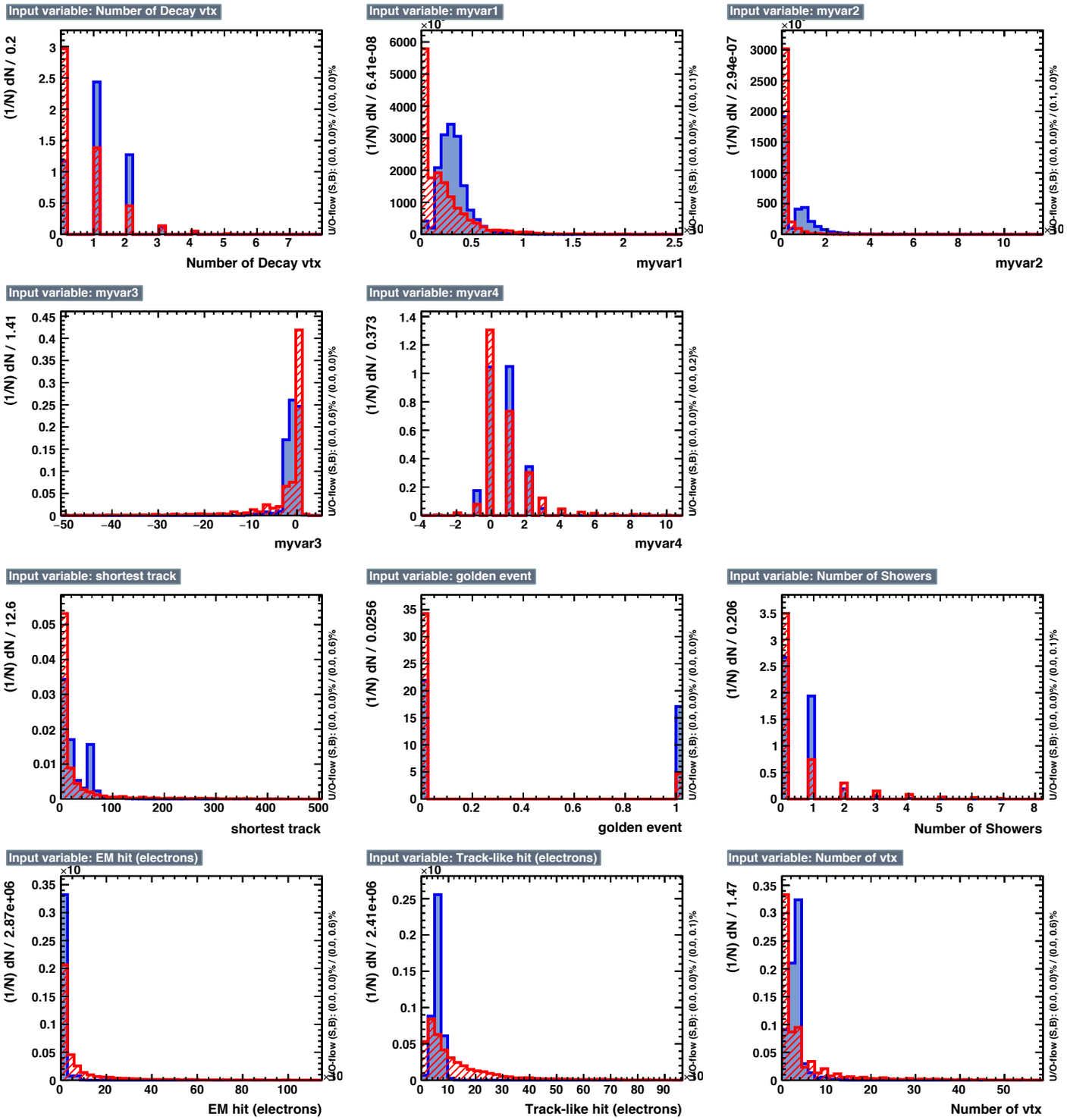
track-like hits(CNN) + PMA (linecluster)





The End

MVA for Proton Decay



Signal:

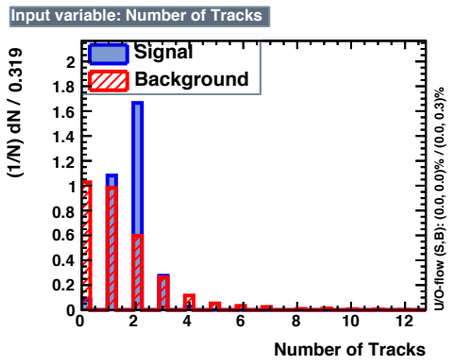
K → μ^+ + ν_μ events

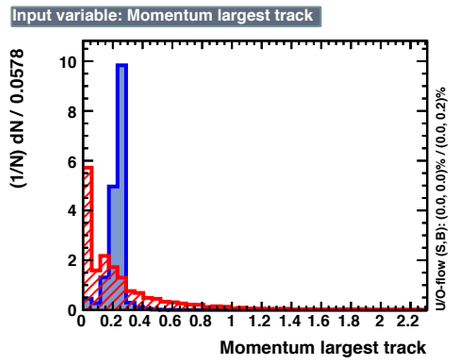
Background:

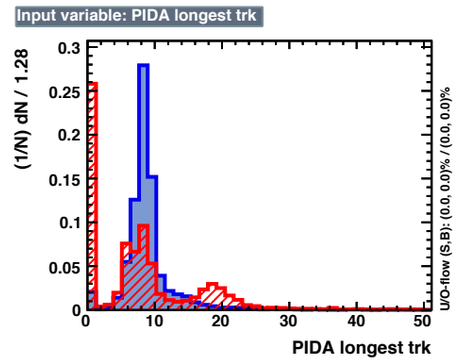
Atmospheric events

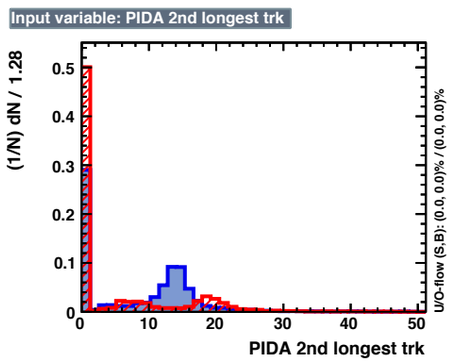
- Number of dcy vtx
- golden event
- Track-like hits
- EM-like hits
- Number of showers
- Total shower energy
- N tracks/trk-like hits
- N showers/em-like hits
- N trks - N vtx

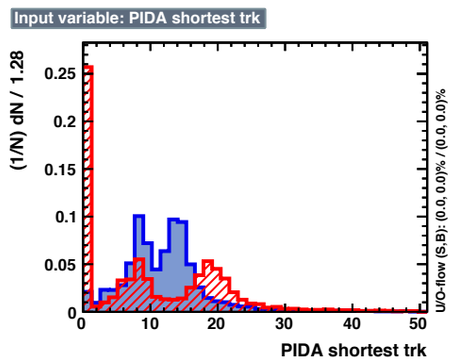
MVA for Proton Decay

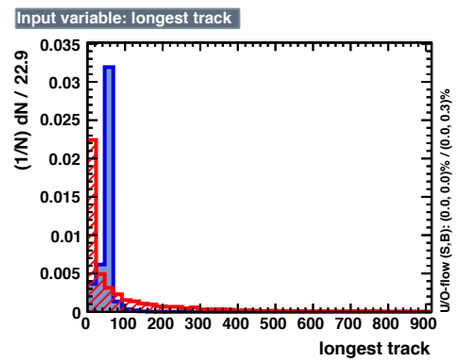












Signal:

K → μ^+ + ν_μ events

Background:

Atmospheric events

- Number of tracks
- PIDA
- Track length
- P by range