

Muon energy reconstruction and neutrino astronomy with the DUNE far detector.

Jaydip Singh

for the DUNE collaboration

18-26 February 2021

XIX International Workshop on Neutrino Telescopes



Main Objectives

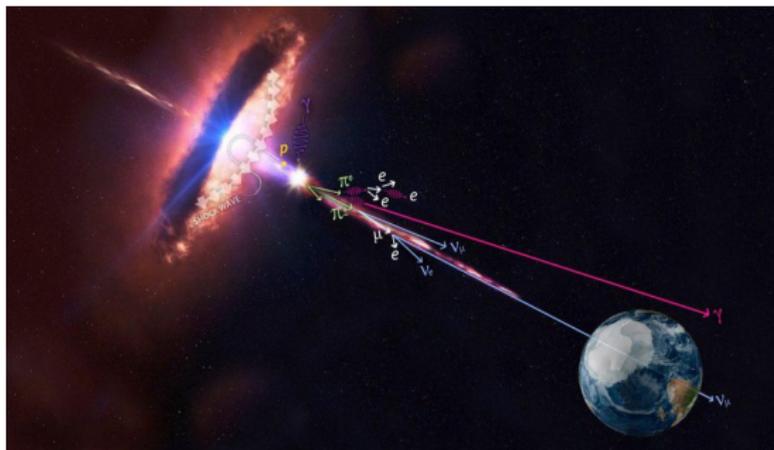
- Energy reconstruction of very high energy muons originating from cosmogenic neutrinos¹ and very high energy cosmic rays.
- Searches for Weakly Interacting Massive Particles (WIMPs) using neutrino-induced upward-going muons, as done by Super-Kamiokande².
- This kind of multimessenger astronomy works at the TeV scale and are being tested with IceCube³ and SK.
- DUNE far detector (FD) may also be used to detect high-energy (TeV range) muons.

¹Science 13 Jul 2018: Vol. 361, Issue 6398, pp. 147-151.

²S. Desai et al. Phys. Rev. D 70, 083523

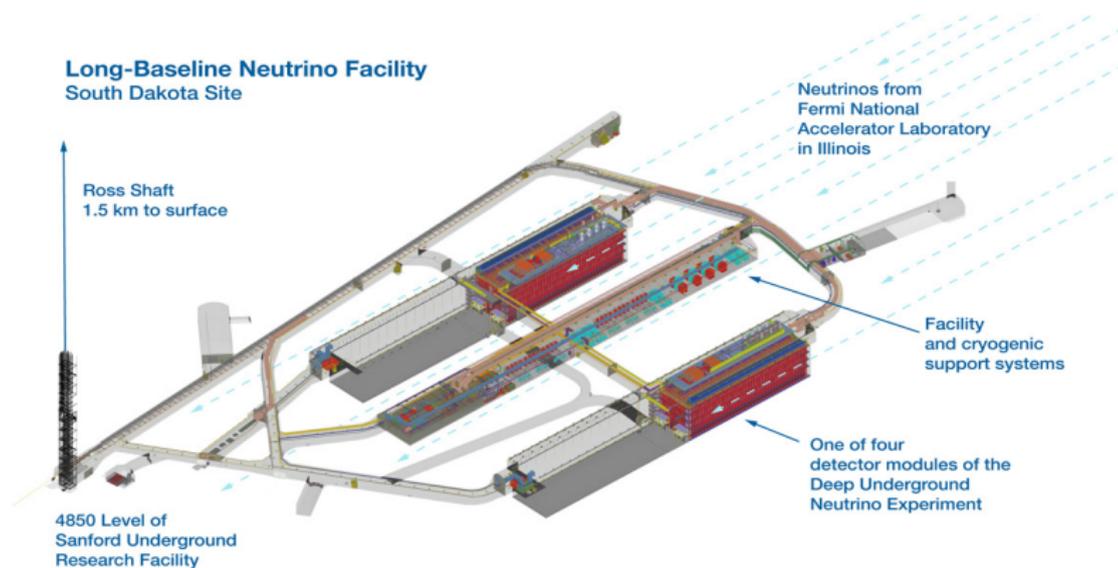
³R. Abbasi et al. NIM A703:190,2013, arXiv:1208.3430

Source of astrophysical neutrinos:



- Blazar emits both neutrinos and gamma rays that detected by the IceCube Neutrino Observatory ([IceCube](#)) as well as by other telescopes on Earth and in space.
- A Neutrino event from the blazar TXS 0506+056 detected by IceCube on 22 September 2017 was coincident in direction and time with a gamma-ray flare.

The DUNE Far Detector

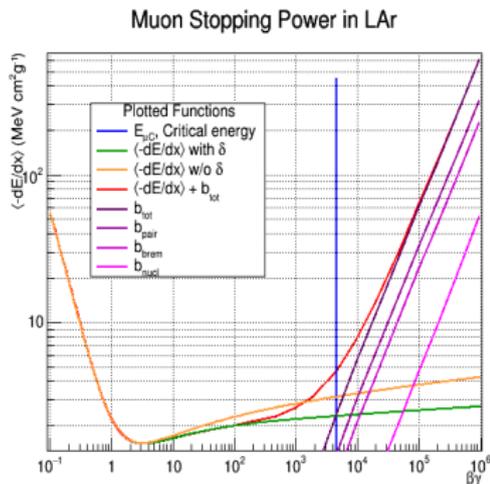


- A next-generation experiment for neutrino science, nucleon decay, and supernova physics⁴.

⁴arXiv:2002.03010

Muons stopping power

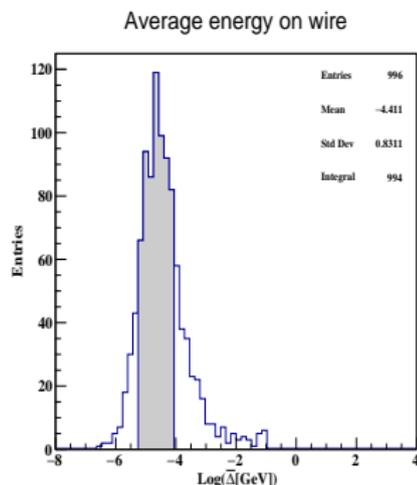
- At very high energies, energy loss is dominated by radiative processes that includes bremsstrahlung, pair production and nuclear interactions.
- Muon stopping power : $\langle dE_\mu/dx \rangle \approx a + bE_\mu$, where a accounts for ionization and b for radiative processes.



- Critical energy for LAr is around 484 GeV.
- Energy deposition dependent methods: used for momentum between 100's of GeV to TeV range, example experiments SK and IceCube.

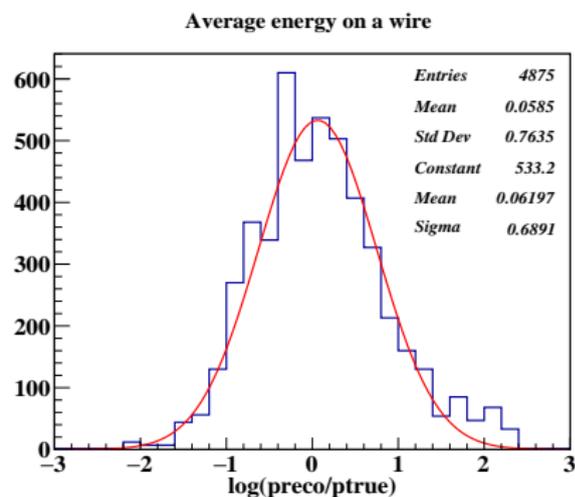
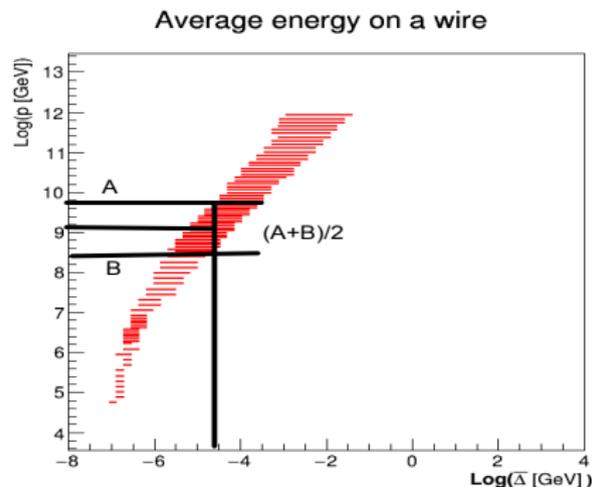
Muon energy reconstruction

- The energy deposited by the track is estimated from drifting ionization charge that is collected by anode wires.
 - Charge on wires are reconstructed as hits.
-
- Simulation are done for the muons for the energy range of 100 GeV to 50 TeV⁵.
 - The histogram shows the average energy deposition, dE/dx ($\bar{\Delta}$), for the 10 TeV muons track, 68.3% confidence intervals of the signals is selected for correlation.

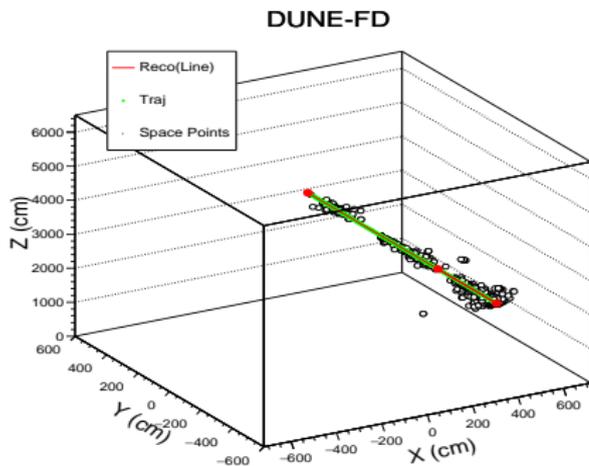


⁵Jaydip, for the DUNE collaboration, : [▶ New Perspectives-2020](#)

Muon energy reconstruction



- The confidence intervals calculated from the histograms become the input for the confidence belt.
- Neyman construction is used to correlate with the measured value.
- The abscissa of the measurement gives a upper and lower bound for the reconstructed momentum, right panel shows resolution for 10 TeV muons events.



Thank you for your attention and stay tuned with NuTel for more talks on DUNE and protoDUNE :

Thursday - Richard Diurba, Yashwanth Bezawada, Georgia Karagiorgi, Aleena Rafique, Jianming Bian

Friday - Mattia Fani, Federico Battisti, Junying Huang