DEEP UNDERGROUND NEUTRINO EXPERIMENT

Day 1 Near Detector simulations: progress & plans

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Reminder: DUNE-US "Day 1" ND

- ND that is part of the DUNE-US Project: ArgonCube + TMS/SSR
- Muon spectrometer is steel+scintillator range stack with magnetic field
 - Optimization of this design is within the scope of this work, but other options that require international contributions are not
- Envisioned as a temporary configuration, so physics motivation is limited to first ~3 years of DUNE FD data





Goals

- Demonstrate that this "Day 1" near detector concept meets the physics requirements of early DUNE running with improved simulations
 - 3σ CP violation sensitivity at $\delta = -\pi/2$
 - Unambiguous determination of mass ordering
- Improved simulations means
 - Event clustering in LAr
 - Muon tracking and momentum estimation in TMS
 - Neutrino energy reconstruction
- Timeline: January 2021 IPR

LAr+TMS reco





LAr reconstruction using ML

- Extensive work on reconstruction of 3D data in LAr, led by Kazu @ SLAC
- Build voxelized energy maps from existing ArgonCube Geant4
 simulations → interface it with existing reconstruction tools
- Tutorial scheduled for next week, join #lar_nd_reco for more information





Muon spectrometer

- Geometry files with and without magnetic field have been created
- Large (10M event) samples of LAr+TMS simulations were produced this week





Example event 1

- Very basic event viewer aka ROOT TH2
- Muon start and endpoint in LAr and TMS is shown, along with LAr fiducial volume and TMS active volume



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Example event 2

 Here's one where the muon goes into the outer TMS region and is bent back in



Track length in g/cm² vs. KE

- Muon energy is estimated by range
- Currently seeing ~8% resolution
 with several
 known problems,
 have been
 refining geometry
 description to fix
 bugs



Near-term plans

- Convert energy deposits to more realistic data-like output → scintillator strip hits
 - For now, punt on attenuation, electronics response, etc. which is not that important for pattern recognition
- Muon tracking back-to-front
- Incorporate Kalman filter based on MINERvA and T2K ND280 code

