CALCI + Calibration WG joint session: PNS

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DUNE Collaboration Meeting
September 24, 2020

Connection with Low-E Physics

- **What is going on within the PNS WG?**
  - Measured neutron-argon interaction cross-sections: ACED, ARTIE
  - Acquired neutron data at ProtoDUNE-SP using a DD generator
  - Developing analysis tools to identify neutron capture events in liquid argon TPC
- **Neutrons are important for Low-E Physics:**
  - Part of the signal components of supernova event
  - Dominant background for solar neutrino event
- **Open questions needing studies**
  - How do the new cross-section measurements affect the Low-E physics programs?
  - How is the neutron capture analysis useful to the reconstruction of Low-E events?
  - What are the common reconstruction needs?
- **The PNS WG should coordinate with various groups e.g. Backgrounds, Calibration, Low-E, LBL, etc. to establish a work plan**

General PNS Open Tasks

- **Neutron source design with simulations**
  - Is a moderator needed?
  - What is a good shield design?
- **Neutron transport simulation with far detector module**
  - Need to incorporate the PNS source model into the detector geometry
  - Need to add/modify the detector components in simulation
- **Neutron capture analysis**
  - Simulation of correlated gamma cascade
  - Background rejection and Neutron capture tagging
  - Photodetector sim & reco for t_0 determination
- **Validation of PNS calibration system**
  - Build an end-to-end simulation flow: field non-uniformity, electron lifetime variation
  - Analyze the neutron generator data taken at protoDUNE Run-I. Question: what are the limitations? What needs to change in ProtoDUNE Run-II?

Specific Needs for ProtoDUNE-SP DDG data

1. **Raw signal processing:**
   - Noise filtering, hit finding,…
2. **Cosmic veto and background rejection**
   - Cosmic rays and 39-Ar
3. **3D reconstruction:**
   - Spatial distribution of neutron capture activities
   - Assign charge to 3D space points.
4. **Neutron capture clustering:**
   - Associate all gammas from a neutron capture (challenging due to the high background)
5. **Energy analysis:**
   - Understand detector response to low-energy gammas
   - Low energy specific reconstruction: ADC to charge, electron lifetime correction, recombination correction.
6. **Photodetector response to neutrons**
   - Precise t_0 determination. Is it possible?