DUNE Nucleon Decay WG: Status

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Working Group Organization

- **Conveners**
  - **Expect to make announcement for one convener soon**
- **Working group**
  - **Would like to get census of people involved / interested**
    - **Currently DUNE-PHYSICS-PDK email list stands at 36 participants**
    - **If you're not yet on the list, please subscribe**
    - **If you're planning to do some work, please send me an email describing your level of interest, and potential scope of work**
- **Task List**
  - **Will be working w/ new convener(s) to generate list of tasks**
    - **These will be posted on the WG web page**
    - **Some first ideas on next slides**

Nucleon Decay WG: List of Tasks – First Pass

- **Understanding p → K ν sensitivity**

  1) **Detection Efficiency Studies** p → K ν, with K → μ ν.
     - Simulate, run/develop LArSoft-based reconstruction.
     - Acceptance studies: Kaon track position, orientation, energy dependence.
     - K-decay kink recognition; momentum resolution for decay muon.
     - Identify calibration sources

  2) **Detection Efficiency Studies** p → K ν, with K → other channels
     - Event Reconstruction, Kaon decay vertex, mass, collinearity, etc., distributions.

  3) **Background Rejection Studies**
     - p/K/pi/mu separation via dE/dx
     - Rejection of accompanying particles in atmospheric nu background events
     - De-excitation gamma studies

Nucleon Decay WG: List of Tasks – First Pass (cont'd)

- **Understanding p → K ν sensitivity (cont'd)**
  1) **Background Estimation Studies**
     - MC-based studies for atmospheric neutrino & CR muon induced backgrounds
     - Studies of background-like events in MicroBooNE or MINERvA
     - Identification of control samples for background studies
     - Bottoms-up background estimates, considering factorized background rejection steps

- **Investigation of other channels**
  1) **Other channels with Charged and Neutral kaons**
  2) **Channels with pi's, eta's, leptons, gammas, …**
  3) **N-Nbar oscillations**
     - Many of the same studies need to be carried out for all of the above
     - Additionally, impact of rescattering of final state particles

Nucleon Decay WG: List of Tasks – Closing comments

- **Will work with conveners to expand / priority-order list of tasks**
  - **Ideas from the group at large are welcome**
    - For now, please send suggestions to JU
  - **Will aim for fleshed out list by time of next meeting**
    - There will be lots of room for people to contribute.
    - Need to make “tangible progress” on key studies by time of CD-3a review – i.e., Nov/Dec.

Additional Material

Preliminaries

- **Charge to Physics Working Groups**

  1) **Extend our understanding of scientific capabilities of DUNE with the detector and beam line configurations being developed.**

     "Extend" → at progressively more realistic levels, driving toward full sim+reco.

     → close attention to tools, analysis strategies, systematics, backgrounds

     → attention to the evolving experimental landscape

  2) **Further develop the scope and strength of the physics program for DUNE through exploration of new ideas, with inputs from the experimental and theoretical communities at large**

- **Notes:**
  - Executing charge is essential for articulating our physics case!!
  - Note that emphasis is on physics!
  - Not present in charge: detector optimization → FD Task Force

Goals for Nucleon Decay WG

- **First, we need to identify real conveners for this group!**
  - **This is in progress…**
- **Now, what are the goals that fit the charge on previous slide**

1) Shore up our understanding of capabilities on marquee modes

- So far focus has been on p→Kν.
- Some work done evaluating backgrounds (cosmogenics / atmospheric nu's)
- But only back-of-envelope estimates for acceptance/detection efficiency
- And background estimates not comprehensive! i.e., focused on rates for background processes with REAL kaons. Only back-of-envelope for mis-reco/id.
- Really need full simulations and/or hard estimates of effcy/background rejection.

2) Catalog sensitivities for full suite of possible/plausible decay modes

- Very little work has been done on this within DUNE context.

Goals for Nucleon Decay WG…cont'd

- **More Goals…**

3. **Other topics**
   - i.e., $\Delta B=2$ processes, i.e., N-Nbar oscillations: evaluate sensitivity.
   - Exotic signatures? (i.e., monopole-catalyzed proton decays?)
   - Generally, what can we do to extend scope of physics covered by DUNE?

4. **Assist FD Optimization Task Force**
   - Note relevant aspects of FDTF charge:

   "develop the simulation and reconstruction for SNB and nucleon decay physics"

   "produce detector optimization studies, for example, 3mm vs 5mm wire pitch, wire angle and the efficiency of the light readout system for different configurations"

   - Note, much of this is aligned with our other goals!
   - We'll hear more about this from Lisa!

Goals for Nucleon Decay WG…cont'd

- **More Goals…**

  5. **Make case that we understand the sensitivities we arrive at.**
     - i.e., validation of tools, techniques, etc..
     - At high priority demonstrate understanding for simplest channels:

       a) Why should somebody believe us?

       b) Show (i.e., to LBNC) that we are making progress toward WG and FDTF goals
     - Addressing (a) will mean carrying out studies of systematics!
     - Addressing (b) will mean developing milestones for WG progress!

- **Other ideas?**