Far Detector News and Requirements

Events of interest to the collaboration

- February 22-26 ProtoDUNE workshops at CERN.
  - DAQ workshop
  - Single phase/ dual phase coordination
  - Coordination of European EOI
- March 2-3: DUNE Cold Electronics Integration Planning Meeting at BNL.
  - Testing, test stand, QC needs.
- March 7-11: TPC and integration workshops at BNL.
  - Field cage, cathode plane design assessment
  - QA/QC assessment
  - Cryostat, cryogenics
  - Integration, installation

Introduction

- Existing requirements: https://fermipoint.fnal.gov/project/LBNF/Project%20Office/Systems%20Engineering/SitePages/Science%20Objectives.aspx and http://docs.dunescience.org:8080/cgi-bin/ShowDocument?docid=112
- are very high level (L2).
  - Global science requirements.
  - Far Detector Science Requirements.
  - Far Detector parameters

larfd-l2-se-99	**requirement**	**The time projection electric field**	**The time projection electric field shall be optimized to provide stable drift velocity, uniform response**	**The chosen value for the electric field is 500 V/cm which corresponds to 180 kV for 3.6 m drift distance.**

- We need to extend the requirements to L3.
- But this has been slow-going…

Full Simulation

- Checking design choices with full simulation goes very slowly.
- Restrict this to high level performance issues
  - E.g., detection efficiencies, backgrounds. → domain of physics and reconstruction groups.
- And major discrete choices.
  - E.g., APA wire pitch = 3mm vs. 5mm → domain of Far Detector Task Force.
- Not practical for many other choices, e.g.,
  - APA placement tolerance,
  - APA orientation tolerance,
  - APA wire placement tolerance,
  - APA wire tension tolerances,
  - …..

Possible Organizational Scheme for getting to L3 requirements: add some heuristic tolerances

- Eg: existing L2 requirement on drift field:

larfd-l2-se-99	**requirement**	**The time projection electric field**	**The time projection electric field shall be optimized to provide stable drift velocity, uniform response**	**The chosen value for the electric field is 500 V/cm which corresponds to 180 kV for 3.6 m drift distance.**

- Add:

Electric field distortions	**10**	**percent**	**The field cage and cathode plane shall be designed and installed in such a manner that the electric field components do not deviate from the nominal field at the center of the fiducial volume by more than the requirement over the entire nominal fiducial volume.**

This would allow for specific checks to be made on particular design choices:

- FC bar size, shape, placement, and straightness.
- Field cage bar caps.
- CPA flatness and orientation….

Other “L2.5” possibilities for TPC

- Protect the fiducial volume:

Positioning and orientation	**10**	**percent**	**No TPC misalignments or shape distortions of TPC components shall result in a fiducial volume loss greater than the requirement. This includes APA and CPA placement, spatial orientation, and deviations from flatness.**

- Hold the spatial resolution close to the diffusion limit:

Wire position	**10**	**percent**	**The wire locations for the APA shall be known to sufficient accuraccy to cause no increase greater than the requirement on the nominal reconstructed spatial location uncertainty of any ionization event in the fiducial volume, with the nominal resolution set by contributioons due to diffusion.**

More "L2.5" possibilities for TPC

- Noise contributions from TPC wires:

Microphonics	**10**	**percent**	**Wires in APA planes shall be placed, spaced, and tensioned in such a manner that extra contributions from microphonics does not increase overall front end electronics noise by an amount exceeding the requirement.**

- Stability to fluid flow

Response to fluid flow	**25**	**mm/s**	**The TPC positioning and orientation requirements shall be maintained for conditions of differential fluid flow across any TPC components up to this requirement.**

Fault tolerances

- HV:

Maximum HV	**200**	**kV**	**The TPC shall be able to function at all HV values up to this requirement.**
CPA HV fault	**10**	**percent**	**In the event of HV discharge from the CPA to any other point, the CPA must recover in such a way to satisfy the electric field distortion requirement.**
FC HV fault	**10**	**percent**	**In the event of HV discharge from the FC to any other point, the FC must recover in such a way to satisfy the electric field distortion requirement.**
System HV fault	**1**	**percent**	**No single HV fault shall disable more APA front end channels than the requirement.**

- Wires

Broken wire	**1**	**m**	**A single broken wire in an APA plane shall not have the possibility of causing failure in neighboring wires that are farther away from the broken wire position than this requirement.**
Wire tension safety factor	**2**		**Wires in APA planes shall be tensioned to a value not to exceed the breakage tension divided by the wire tension safety factor at both warm and cold operating consitions.**
Wire tension creep	**0.5**	**%/year**	**The tension in APA wire planes shall change at a rate less than that specified by the requirement.**

Thoughts of the photon detector

- Radiopurity: this is surely something like:
  - Contributions from radioactive decays of Rn-222 and other radionuclides within the cryostat shall not increase those of Ar-39 radioactive decays by more than 10(?) %.
- And a harder one:
  - The photon detector system will be designed to produce a response of at least X photo-electrons per MeV of ionization energy deposition in the center of the fiducial volume.
  - The present value for X is nominally 0.1; this results in a ~50% detection efficiency for 50 MeV visibile energy, assuming a plausible 5 PE cut.
  - What should X be for SN physics (1.0 ?)
  - How well do we even know X?