Long Baseline-Calibration Planning

What is the physics impact of calibration?

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What physics do we want to propagate to LBL?

- *What are the critical physics effects we are worried about?*

  - LBL perspective: Existing studies point to the importance of (and level of) E scale, has there been more learned about physics requirements?

What physics do we want to propagate to LBL?

TPC response model
- Argon ionization energy
- Electron drift velocity
- t_0 offsets
- Electron lifetime
- Recombination parameters
- Electric field
- Longitudinal and transverse electron diffusion
- Wire positions/geometry
- Wire field response
- Channel gain
- Overall electronics analog transfer function
- Electronic crosstalk
- Electronics noise, including correlated noise
- ADC linearity (differential and integral).

Photon detector response model:
- <similar list here>

(See Backup for more)

High level quantities
- Position reconstruction biases
- Direction reconstruction biases
- Energy scale
- Energy resolution
- Particle ID efficiencies
- Noise removal efficiencies
- …
- …

Particle response
- Charged hadron propagation
- Neutron response
- …

- Is this list complete?
- Position/time dependance?
- Needed precision?
- How to constrain? How much can you relay on external measurements?

Also, are effects propagated to next level?
E.g. E-field distortions propagated to recombination?

What physics do we want to propagate to LBL?

- *Are there general categories of calibration effects which we can use to make categories of uncertainties?*

  - Example: E field distortions from: space charge or similar effects, resistor failure, etc. Re-use space charge machinery for (different problem) E field map?

    - Related: This lets us test the (general, ill defined) concern about E field importance in physics

  - Example: Electron lifetime (multiple systems may measure, can compare via one parameter)

- *Can we sufficiently approximate a given physics effect into existing uncertainties?*

  - Example: Radioactive source, determine effect on E scale (independent from LBL simulation), then re-use E scale parameter.

Discuss: Other effects? General categories?

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Interface with other efforts

- Some calibration insight, quantities to be determined externally
  - ProtoDUNE, MicroBooNE, ICARUS, ArgoNEUT, etc
  - ND during experiment
- *Discuss with relevant groups what additional physics we should consider (may be lacking in existing models, or current challenge to physics output)*
  - Coordinate master physics effect list with these groups
  - Still try to propagate calibration physics based on a given effect category (e.g. E field distortion)

How do we want to propagate it?

- *Suggest two channels to test calibration impact on physics: dedicated uncertainty (fcl) dial, and/or pseudo data - Agreement on this?*
  - What machinery exists for dials? What needs development?
  - What machinery exists for pseudo data? Does anything need development/unification
- *Some shared effort with cross section systematic uncertainties*
  - Discussion of DUNE weighting package (based on T2K tools), parameterized dials?
  - But, for calib, we don't need ND (directly) see previous page

Additional (logistical) considerations

- *What are our expectations for the workflow?*
  - Proceed from a template (test case) or better to have an initial set? Do we need time to iterate?
  - How much lead time is needed to turn a single physics study around with LBL? For the TDR timescale, when are inputs needed?
- *We understand this is a collaborative effort*
  - What help does LBL need from Calibration TF?

Calib TF to do list

- Build a master physics effect list which calibration constrains
  - What is factorizable? What can be absorbed into existing (or easy to implement) parameters
  - What tools exist on current experiments? How have we previously parameterized detector systematic uncertainties?
    - How can we categorize groups of systematic uncertainties, and are there any physics effects known to be small // not to be considered?
- Take a test case and do a feasibility study of propagating the effect
  - Implementation, interface checks

Other thoughts/Comments from the group?

Backups

Latest knowledge from LBL is?

- *Previously: flat E scale, E scale variation w*
  - What machinery exists for dials? What needs development?
  - What machinery exists for pseudo data? Does anything need development/unification
- *What are our expectations for the workflow?*
  - Proceed from a template (test case) or better to have an initial set? Do we need time to iterate?
  - Do we see collisions in manpower/time?
- *We understand this is a collaborative effort*
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Many Calibration Quantities: not a complete list

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On the Simulation side
(Big Picture Needs)

Want to know what model and what parameter values went into simulation?

E.g. drift velocity? Lifetime? E-field? Diffusion values? Recombination models & parameters?

Also, do we have knobs (fcl dials) to adjust these parameters?

Goal: generate samples with varying parameters and assess impact on physics

Calibration Sources: not a complete list

- Purity Monitors
- Temperature monitors
- Survey
- Current monitors
- υ_μ CC events
- Michel electrons
- Stopping muons
- Stopping protons
- Muon Crossers, APA/CPA piercers
- Ar^{39}
- Laser system
- CRT tagger
- Other radioactivity

- Michel electrons
- υ_μ CC events
- π^0 mass peak
- Other decays (K^0s…)
- Tagged events

On the Reconstruction side (Big Picture Needs)

Ideally would want to be able to reconstruct all calibration sources starting from Cosmic muons

High priority reconstruction topics (for now):

- Cosmic muon reconstruction
- Cosmic T0-tagging
- PDS T0 reconstruction
- Stopped muon filter
- Michel electron filter
- Calorimetric reconstruction to assess impact of various effects (dQ/dx to dE/dx)