Meeting focus: DUNE Physics Week Summary and follow up progress

Indico link: https://indico.fnal.gov/event/15248/
Attendees: Kendall, Sowjanya, Tom J., Josh K, Vitaly K, Chris Backhouse., Elizabeth W., Jennifer Haigh, Glenn Horton Smith, Juergen R., Steve Kettell, Chuck Lane and possibly others.

Talk 1: Detector Physics Week (DPW) Summary

- A rich agenda with kick-off, discussion, joint & hands-on sessions was planned for DPW. Getting more hands-on work done and recruiting/engaging new people to help still turned out to be more challenging than expected. But, productive discussions were held at the DPW with other conveners to scope out a plan towards TDR goals.
- The main items of DPW included understanding where calibrations fit into the Technical Proposal (TP) and TDR, how should collaboration converge on calibration related decisions (especially hardware systems), how should the TF interface with LBL and Sim/Reco groups in terms of tools and understanding the impact on LBL physics. The one hands-on activity that progressed during DPW is the alignment studies with cosmics by Tom Junk.
- For the technical proposal, the goal is to include a 2 page summary of calibration strategy. A path is defined on how to converge on calibration by the TP timeline. The process will start by TF leaders presenting a strategy at the upcoming collaboration meeting and seeking input from the collaboration. This will be followed by a Calibration workshop where key criticisms/questions from the collaboration is addressed with a goal of converging on the strategy by the TP timeline. For the TDR, the goal is to develop the systems presented in TP into concrete proposal through additional studies.
- From the Sim/Reco side, developing tools (e.g. fhicl knobs) & interfaces (both at sim/reco levels) that propagate calibration quantities into LBL to assess impact were discussed.
- From the LBL side, various methods of inclusion (pseudo data, parametrized uncertainty) were discussed and existing LBL tools are discussed. The goal is to take a test case (e.g. space charge) and use various approaches to fully propagate through the chain.

Discussion:
Josh: (on categorizing calibration quantities) Low level is about measuring parameters or corrections— e.g. gain or electron lifetime is a correction to data or models in MC. Then there are tests of that models. Michel electrons, pi0 which let us test whether or not it makes sense (much like the standard candles). Difference between model and what we measure can be an estimate of systematic. Other option is to take uncertainties on parameters, and vary those in simulation; variation in parameters predicts the systematic; less satisfying because model has everything in it.
Tom: Picking some standard candles to calibrate, and some to test. May end up tuning Michels.
Josh: Deliverable for the TDR— low level calibration, is a parameter, with uncertainties. High level calibration will be a test of the model and a data set.
Tom: Systematics to cover inconsistencies as well as measurements (we should discuss bias)
Sowjanya: For the TDR, there is also the section on detector validation, some of the low-level pieces fit there. Lifetime and recombination go to a model, but they also validate the detector. E.g. Electron lifetime validates the purification/recirculation system.
Josh: Discussed the same thing for ProtoDUNE – agreed what is called detector performance are integrated. Electron lifetime is "x" is detector validation. What we care for calibration is the electron lifetime with time with a certain precision.
Josh: (on the Feedthroughs) What is the timeline for FT approval from cryostat team? If there is time, it would be good to produce a laser track illumination map to see the track coverage. It would not require any LArSoft just some fake simulation of a box with laser parameters.

Talk 2: Standardized Calibration Interface Proposal

- Follow up work based on discussions at DPW. The goal is to develop a calibration interface at the reconstruction level (both for charge and light signals) that is centrally available and is independent of simulation. A first hand implementation (deliberately minimalistic) of code is already available. This calibrator interface can be made available to other experiments as well. In the current implementation, there is a charge calibrator and a photon calibrator. Some discussion already happened at the sim/reco meeting on this, next it will also be discussed at an upcoming LArSoft meeting for more input/feedback.

Discussion:

Josh: (comments on the code snippet suggested the need to be careful with units)

Sowjanya: In terms of the TDR timeline, trying to go to the level of reconstruction is too far. For the initial rounds we would want to focus on the simulation side, implementing fhicl knobs or providing E-fields maps which can then be propagated etc. to assess impact on physics.

Tom: Don't know if simulation is right. Uncertainties are on simulation, not reconstruction.

Sowjanya: using reconstruction level quantities, we will be looking at a combination of effects and hard to separate biases. For example, recombination has angular dependance from theory but reconstruction also depends on angle. If we look at recombination at the reconstruction level, you see these two effects convoluted, hard to separate and understand which one is impacting physics. There are ways to do it, but for initial round, we should avoid having to deal with reconstruction issues. (Kendall agrees.)

Chris: This is reconstruction level, we can develop tools at the simulation level if you have specific requests.

Sowjanya: Agreed. A good next step would be for the TF leaders to go to Reco/Sim conveners with specific requests on the simulation side.

Juergen: Is the information in the code at wire hit level?

Chris: Yes.

Juergen: Each radioactive source creates 3 hits from induction and collection planes, with very close positions.

Tom: One has to be careful when summing charges otherwise we will be tripling the charge.

Josh: Where does the drift velocity and other drift parameters come from?

Chris: Kind of the point – interface where you could implement a scheme. Could put a fhicl parameter for velocity?

Juergen: Currently in LArSoft is a parameter of v(E)

Josh: One needs to keep this in mind and be careful as we move forward so they aren't forgotten.

Kendall: How do we handle particle dependent corrections?

Chris: I think this is a proton, please correct me if I am wrong. Corrections are MC coefficients, coded here or there unless you design something central.

Tom: We have calorimetry modules, where showers are treated differently from tracks.

Chris: Coefficients not done in a practical way.

Chris: (on the photon calibrator) may work badly, won't know position along bars?

Josh: Calibrating photon system, and cosmics, will be super super hard

Chris: While doing this, flash is already calibrated at PE, lost area information for the hits. Need internal piece to do it in two steps. Area to PE and PE to GeV.

Juergen: Do we have fhicl knobs for light yields?

Tom: Yes, but, not as fhicl knobs. It is doable, need to add them.

(A lot more discussion than what was presented above happened, that we are not able to summarize here.)

Action item: Kendall and Sowjanya to go to Sim/Reco group and Chris with specific sim/reco

requests.

Talk 3: Update on Alignment with Cosmics

- Tom Junk has started looking at the MUSUN sample (MCC9.1) that he generated for DPW (http://dune-data.fnal.gov/mc/mcc9/index.html) to do alignment with cosmics. The goal is to look for gaps in space points to understand alignment issues. Only 3% of the MC give cosmics in the detector volume. Lot of scattering and showering part is cut out for the analysis. An issue encountered accessing geometry since the code is in gallery which doesn't have access to geometry. Some interesting structure in space point plots shown (e.g. indicating some space points may not have corresponding collection hits or hits shared b/n various space points). Some event displays are also shown using pmtrack and pandora algorithms. Plan to continue the work.

Discussion:
Sowjanya: what is yaw?
Tom: yaw is rotation around y axis. Steering car is yaw. up and down is pitch, and rolling over is roll
Kendall: What does "isochronous tracks" mean?
Tom: Parallel-to-wire-plane tracks or showers
Sowjanya: Understanding what we can get from cosmics for alignment with whatever we have is important for the laser vs cosmics question.
Tom: Depends on what you want. Precisions for 35 ton for similar studies is presented (only did vertical but not horizontal gaps). 35 ton studies are enough to carry through, but, where are the weak spots is the real question.
Sowjanya: Good point, maybe we can direct the studies more towards weak spots?
Tom: Maybe there are so many weak spots, focus on the ones we care about. Motivation is to see what the laser teaches us vs. cosmic rays. Which of those things from laser do we care for physics. For example, muon momentum from multiple coulomb scattering, requires alignment over large distances. Maybe we want to see if we are weak to do that physics vs. the laser?
Tom: Maybe we don't care about the absolute location so much?
Juergen: How much would a top CR help you?
Tom: If you care about relative positions, then sure. But, do we care?

Action item: Kendall and Sowjanya go to Tom with specific request for studies geared towards weak spots in laser vs cosmics arguments.