First Steps in Integrating ND Inputs in the Next Round of LBL Studies

Daniel Cherdack
University of Houston

DUNE LBL Meeting
Monday July 26th, 2021

My Charge

- Liaison between LBL and ND groups
- LBL sensitivity studies are hard!
  - There are a lot of detailed inputs and and "heavy computing machinery".
  - The details of the input matter and for many things we have no data to guide us.
  - The interactions between uncertainties matter as much as the uncertainties themselves, so it is hard to isolate effects, or to study anything at all if any major pieces are missing.
  - Full sensitivity studies take a long time (lots of CPU hours) so "running iteratively" is not a good option.
  - To some degree all results are contrived.
- Results of LBL studies can be hard to interpret and don't always say what we want them to say.
- LBL needs to start planning now for studies to be ready in ~1 yr.
- DUNE needs a comprehensive strategy to prove the case for a fully implemented ND facility with a science driven timeline.
  - What studies are required to make this case?
  - Do these studies need to be direct statements about LBL sensitivity?

Reaching Out

- LBL group wants to better understand what studies they might be expected to produce for presentations to the LBNC and for the ND TDR.
  - Many caveats to LBL sensitivity studies
    - challenging to perform
    - results are difficult to interpret
  - Studies often motivated by requests from the LBNC
  - Not necessarily communicated to the LBL group directly
- Need help to
  - **plan and prioritize** studies
  - understand exactly what the LBNC wants to know
- To provide studies for the ND TDR or LBNC they need:
  - To be informed of the request very soon
  - To work with your group on designing an appropriate study,
  - To help you identify necessary inputs (e.g. reco quantity smearing, detector systematics),
  - To work with other groups to build complementary inputs (e.g. flux and xsec systematics)
  - To build a narrative that helps explain the results.

- Imperative to describe intention of each study
  - LBL tools determine the feasibility and potential success of (seemingly straightforward) methodologies.
  - Studies that require a full sensitivity plots takes roughly one year,
    - ~ 6 months to develop inputs,
    - ~ 6 months to test machinery and run the fits
- To get things started:
  - Let LBL know of any studies planned or committed to or have suggested that the LBL group should do
  - Describe the point of the study
  - Explain how the study relates to DUNE LBL sensitivities
  - Describe how your group thinks the study should be performed and the intended timeline.
  - The LBL group will use this for initial planning and prioritization, then will discuss options for execution.
- If you plan to show the results of any previous LBL study or make any claims about DUNE LBL sensitivities: contact the LBL conveners to discuss the appropriateness of the plot/study, and for help with developing the associated narrative.

Reply from ND LAr

- This will be immensely helpful in facilitating discussion among the groups.
- Comes at a great time:
  - Accelerating ND physics analysis efforts within the ND-LAr consortium
  - Working toward a PDR at the end of the year
- Appreciate the timeline for a TDR-like analysis / understand the challenges of full reevaluation
- Expect all ND groups + LBL group + the collaboration want/need to update the sensitivities
  - Include full simulation and reconstruction in both the ND and FD.
  - Necessary inputs for such a study remain under development on the ND-LAr side
  - Fully-reconstructed ND analysis is an active area of development
  - Many opportunities; new contributions are very welcome
  - Timescale of PDR good time to begin a discussions
- Nearer-term goals (PDR) are somewhat modest
  - Demonstrate claims outlined in the ND CDR and enumerated in the ND-LAr
  - I.e. ND LAr can achieve or exceed the performance benchmarks
  - Using a full detector simulation and reconstruction chain
  - Include: resolutions, efficiencies, etc.
  - Validate assumptions made in the ND CAF pseudo-reconstruction, including high-level physics metrics related to performance

- What does the LBL group think of this approach? Any concerns or advice?
- Working with LBL group will be important to ensure we make a solid case for physics performance within the context of the existing results
- Interpretation and external presentation is very important, and input from the oscillation sensitivity is essential

- Communication is Key
  - Keep in touch regarding any external statements
  - Ensure we are focus on the right places
  - Ideas for how the groups can work together most effectively
  - Input from LBL in how best to proceed?
  - Possible to arrange a meeting with experts on the LBL fits?
  - Tutorial on inputs with discussion of what can be demonstrated with simulations?

ND GAr

- Uncertainty in how to move forward with ND-GAr
  - LBNC fully agrees having ND-GAr is critical to DUNE reaching CPV sensitivity
  - US DOE Project does not have room for ND-GAr
  - ND-GAr group have been told by DOE: "work on other things"

- Demonstrating rigorously how exclusive pion channels measured GAr TPC can improve the LBL fit
  - Constrain systematics on the LAr measurements
  - Very important for LBNC and funding agencies (NSF, DOE).
- Need help getting fits implemented
  - Asking for some time
  - Offered to help,
  - Asking that it be done by existing LBL experts
  - Response so far: it's very complicated, not enough time to help ND GAr learn tool due to constant deadlines
- Most important study for ND-GAr
- Need and want help in getting this moving!

- Next up: Impact of including of high-angle CC samples on reducing uncertainties on the LBL measurements.

SAND

- Need: Dedicated people from SAND directly participating in LBL work
  - Working to identify people
  - What tasks are required?
- LBL could present in the SAND meeting
  - If not regularly, occasionally,
  - Report on status and requests to/from the LBL group
  - Need input on input format, etc
- Need closer connections
  - Between LBL and SAND
  - Within ND group (e.g. through the ND software group)
  - Among LBL and the entire ND group
  - Two-way communication would be more beneficial

- Potential studies (top 5 current ideas):
  - Flux, especially beamline systemics and NuMI-like target degradation
  - Impact of low p_T and low-ν samples/constraints
  - Full p_T momentum and low-ν samples with full selections with LBL generated Mock Data
  - Constraints on cross section parameters as defined by DIRT
  - Potential bias without constraints on multiple targets, specifically:
    - H/D for nucleon level processes
    - C for comparisons with majority of modern cross section data
- More complete information can be found in these slides:
  https://docs.google.com/presentation/d/18A37fKAO3zIbV3U1ArdXL6CnPVNIm21xVmOPbDuiOOM/edit?usp=sharing

ND Simulation & Reconstruction

- ND SimReco doesn't drive choice of studies for TDR
- Do need to know those goals
  - To accomplish them
  - Alfons, Alan, and Hiro need to be in the loop

- Focused on preparing samples for studies
- List of infor required to produce samples is well established
- Solicited simulation requests from
  - ND WGs
  - DUNE Physics groups
  - Have long list of request
  - Focusing on a core set of on-axis ND configurations
  - Currently producing "mini-productions" though GEANT4 for validation
- Coordinating with the FD reco/Sim group
  - Align GENIE and GEANT for core LBL samples
  - Formal agreement soon would be helpful

- Need input on systematic sample to produce
- List of physics studies that can be used to validate the software? $\longrightarrow$ Input from LBL is very welcome

- Need more people at the table for this discussion on prioritization
  - Agenda item at our ND software meetings?
  - Discussion at the general ND session?
  - Happy to brainstorm with interested parties
- Regular Meeting attendees: ND leaderships, representative from each sub detector, LBL representative
  - Sub detector reps give a status reports
  - Themed meeting aligned with our overall plan for productions, e.g.:
    - overlay discussion
    - geometry readiness
    - metadata
  - each sub detector asked to comment on status and readiness

Recommendations for a Path Forward

- Everyone seems to agree that more communication and coordination is key
  - Conveners slack channel and mailing list
  - Regular ND round-table status updates at LBL
  - Regular LBL updates at ND meetings
  - Convener level meetings to discuss planing and prioritization
- A plan for "a perfect world"
  - LBNC provides list of "points to prove"
  - LBL+ND design studies to prove points
  - LBNC approves list (after some iteration)
  - LBL+ND implement studies and include in presentations and documents