

LONG-BASELINE PHYSICS WORKING GROUP PHONE MEETING

29 September 2015

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Overview



- Introduction & Organization
- Interface with other groups
- Task List
 - Needs
 - Current work
- Timeline
- Roundtable

Long-baseline PWG Charge



- Extend understanding of DUNE physics reach
- Continue to build & defend scientific case for DUNE
- Develop analysis strategies for oscillation analyses
- Participate in the 3 task forces, all of which are related to long-baseline physics
 - Beam Optimization TF
 - Near Detector Optimization TF
 - Far Detector TF
- Provide input as needed to other DUNE WGs
 - Sim/Reco WG
 - FD Physics Performance WG
 - Calibration WG
 - protoDUNE Measurements WG
 - Others?

Organization



- Physics coordinator:
 - Jon Urheim: urheim@indiana.edu
- Physics deputy coordinator:
 - Ryan Patterson: rbpatter@caltech.edu
- Long-baseline PWG conveners:
 - Silvia Pascoli: silvia.pascoli@durham.ac.uk
 - Thomas Patzak: patzak@apc.in2p3.fr
 - Elizabeth Worcester: etw@bnl.gov
- Sharepoint webpage:
 - <https://web.fnal.gov/collaboration/DUNE/SitePages/Long-baseline%20Working%20Group.aspx>
- Mailing lists:
 - Long-baseline WG: dune-physics-lbl@fnal.gov
 - Meeting announcements will also be sent to dune-physics@fnal.gov
 - Systematics list: dune-physics-syst@fnal.gov
- Meeting time: Tuesday, 10 CT, DUNE Physics Weeks

Existing Tools

- GLoBES configurations (CDR)
 - Signal and background efficiencies and smearing from Fast MC
 - Normalization uncertainties only
- “New” GLoBES
 - More detailed systematics treatments possible
- Fast MC
 - Reweighting technique
 - Parameterized detector response at individual particle level
- MGT (GLoBES based fitting framework)
 - “Regular” GLoBES fits
 - Include individual sources of systematic uncertainty
 - Statistical ensembles of experiments
- VALOR
 - Near/far oscillation fitting framework developed in context of T2K
- LArSoft simulation/reconstruction

All of these would benefit from additional experts who can effectively use and further develop these tools.

Input Requests from other WGs

- Simulation/Reconstruction WG:
 - Priorities for sim/reco studies
- FD Physics Performance WG:
 - Detector performance requirements
- Calibration WG:
 - Detector performance requirements
- protoDUNE Measurements WG
 - Input on needed measurements
 - Evaluation of impact of measurements
- Beam Optimization TF:
 - Input on optimization metric
 - Machinery to evaluate beam options
- Near Detector Optimization TF:
 - Machinery to perform fit to four FD samples with systematics constraints applied
- Far Detector TF:
 - Algorithms and machinery to produce sensitivity estimates using reconstructed FD MC quantities
 - Define data structure requirements for FD MC output

Conveners of other WGs, please let us know if we've missed anything...

Sim/Reco WG



- Initial WG plans include:
 - Generating MC samples of beam neutrinos (ν_e , ν_μ , ν_τ)
 - Further developing reconstruction algorithms and evaluating their efficiency
 - Producing samples with different detector configurations (eg: wire pitch, wire angle) to evaluate design options
- Suggested additional studies:
 - Studies of single particle reconstruction efficiency, resolution, and bias using DUNE LArSoft for improving/justifying Fast MC inputs
 - Particle ID studies (eg: e/g separation) using DUNE LArSoft for improving/justifying Fast MC inputs
 - Study of reconstruction across multiple TPCs
 - Study of fiducial volume cuts
- We will need to collaborate closely with the Sim/Reco group to determine data format for full MC-based analysis

FD Physics Performance WG



- This is a detector WG tasked with making sure that the detector is designed to meet the physics performance requirements and coordinate a “FD technical board.”
- Will work together with the physics WGs to determine detector design parameters needed to meet the physics requirements.
 - eg: In the long-baseline PWG, we might set a requirement on vertex resolution. The FD physics performance group would take that input and (in collaboration with other working groups) set requirements on wire pitch, etc.
- Input needed: detector performance requirements

Calibration WG

Calibration Working Group Preliminary Charge Elements

Calibration WG will:

1. Provide complete list of parameters, corrections, efficiencies/acceptances to be measured
2. Generate requirements for calibration system(s)
3. Design a calibration program to meet requirements
 - May include analyses of data (cosmics, tagged events...)
 - May include explicit sources
 - Laser?
 - Cosmic tagger?
 - Radioactive sources
 - Radioactive spikes

J. Klein

- Input needed: requirements on knowledge of detector response as function of position and time
- Calibration WG will be designing a calibration program that includes physics analyses (tagged events, etc) – should be some overlap with LBPWG analysis topics

protoDUNE Measurements WG



- Now integrated into DUNE WG structure as protoDUNE Sim/Reco/Analysis WG under Software & Computing

Proposed measurements and tasks

- **Shower calibration (6 FTE)**
 - E-M showers (π^0 , γ , e)
 - Hadronic showers (π^\pm , K^\pm , p)
 - Various energies
- **Angular dependence (1FTE)**
 - Recombination using different angles of the beam and secondary particles
- **Bethe-Bloch parameterization of charged particles and PID (8FTE)**
 - Each particle, and for various energies and angles
- **Reconstruction effects (3 FTE)**
 - Difficult angles, 2D vs. 3D reconstructions (validation of reconstruction)
- **e/ γ separation (1 FTE)**
- **Cross section measurements (2FTE)**
 - Elastic scattering, absorption, charge exchange

J. Nowak

- Input needed: together with Calibration WG, what measurements are needed in protoDUNE to enable the long-baseline physics?
- protoDUNE will be working on sim/reco/analysis topics – should be some overlap with LBPWG topics

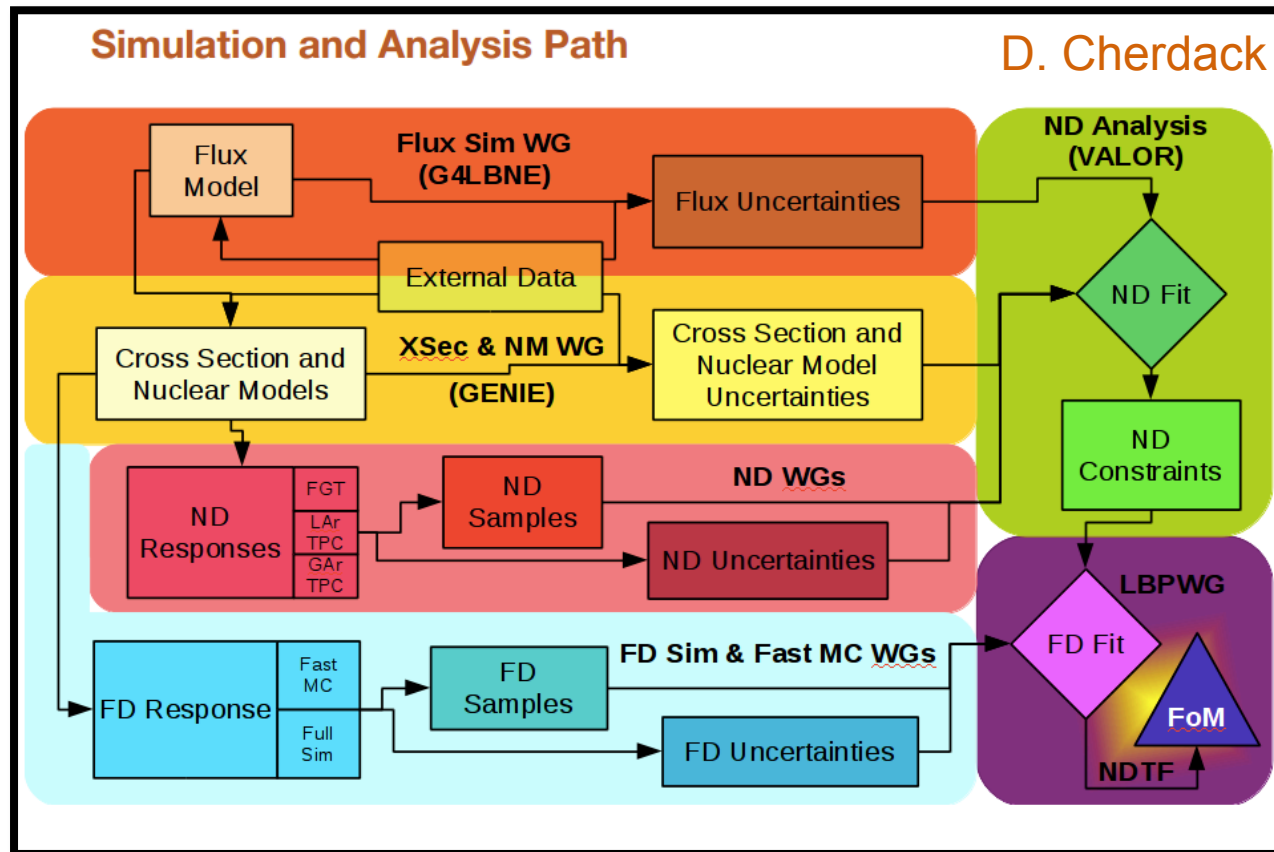
Beam Optimization TF

Needs from LBLPWG

L. Fields

- ❖ What we need from you:
 - ❖ **Input** on what we should be optimizing
 - ❖ So far, have concentrated on **75% CP coverage** and cross-checked that optimized beams are also good for other CP metrics and MH
 - ❖ Is there **anything else we should be worried about?**
 - ❖ **Software** for transforming fluxes into these quantities
 - ❖ Have used **Fast MC** in past.
 - ❖ Should we use **GLOBES** setup used for CDR, or something else?

ND Optimization TF



- LBPWG Responsibility: Perform fit to 4 FD samples, including systematic uncertainties and constraints from ND (VALOR) analysis

Far Detector TF

L. Whitehead

LBL WG

- Main goal for the LBL WG is to develop algorithms to analyze a MC sample provided by the FD sim/reco WG and produce sensitivities.
 - No need to wait for a “real” MC sample - start developing now (based on Fast MC, for example)
- Decide on analysis framework and the basic file structure that will be handed off from FD sim/reco WG to the LBL WG
 - Analysis framework: Within LArSoft? Outside of LArSoft?
 - File structure: What reconstructed variables? What truth variables?
 - In conjunction with other physics WGs (atmospheric nus, SNB, etc) and software people
- My interpretation of this part of the charge is that we are developing the *capability* to produce sensitivities with a full FD MC.
 - Sensitivities produced this way might not be very good at first (or match our GLOBES estimates)
 - We’ll probably need to work out some kinks in the sim/reco chain, work on systematics, or perhaps develop more sophisticated particle ID algorithms

Note: Should we consider coordination with SBN?

Task List (I)

- Sensitivity experts needed to quickly evaluate experimental sensitivity in light of new developments
 - Excellent opportunity for student or new collaborator to engage with long-baseline physics
 - Experts responsible for previous sensitivity studies largely unavailable
 - **Jeremy Hewes** maintains scripts to create standard sensitivity plots
 - **Matt Bass, Dan Cherdack, Elizabeth Worcester** available to support GLOBES, Fast MC, and MGT studies
 - **Sam Kohn** getting up to speed on sensitivity calculations
- Fast MC Development: Implement analysis algorithms and update inputs
 - **Dan Cherdack** will continue as FMC developer

Task List (II)



- Systematics studies
 - Explore effect of beam variations, cross-section uncertainties, uncertainties in detector effects; set requirements on these uncertainties
 - **Jeremy Hewes** started looking at implementation of NuMI beam variations from Minerva flux correlation matrix and is available to support further work
 - **Sam Zeller** plans to hire a new postdoc to work on interactions and cross-section systematics
 - **Lisa Whitehead**'s student, **Cassandra Morris**, getting up to speed on FMC studies
 - **Elizabeth Worcester** studying energy resolution and bias uncertainties using FMC/MGT
 - **Michel Sorel** evaluating detector performance effects with LArSoft
- Neutrino interactions experts needed to keep up with experimental results, new models, new versions of interaction generators that will affect long-baseline systematics

Task List (III)



- LArSoft studies to evaluate Fast MC inputs
 - Current inputs to Fast MC based on literature, best guesses, MC simulations from other LArTPC experiments
 - Need DUNE-specific MC studies for single particle detection efficiency, energy resolution and bias, particle ID efficiency
 - **Tyler Alion** analyzing LArSoft handscan for ν_e appearance efficiencies
- Determine inputs and data format required from near and far detector simulations to feed into oscillation analysis
 - **Dan Cherdack** will facilitate interface between ND TF and LBPWG
- Develop oscillation analysis for DUNE

Task List (IV)

- Additional physics analyses
 - Neutral current
 - ν_τ appearance
 - NSI
 - **Joachim Kopp** did a GLoBES-based study for LBNE
 - **Fernando Torres** now working on this
 - Long-range interactions
 - Mixing with sterile neutrinos, including impact of a sterile that could be discovered in SBN on oscillation analyses
 - Large extra dimensions
 - Lorentz/CPT violation
 - **Jorge Diaz** will provide theory support for this analysis)
 - Unitarity test
 - Model independent sensitivity to MH/CPV?
 - More...
 - **Silvia Pascoli** will provide theory support for standard and non-standard oscillation physics

Timetable



- Highest priority must be work supporting the task forces as they are expected to have preliminary results by summer 2016
- Near-term Goals:
 - October 2015: Identify workers for all highest priority tasks
 - January 2016 Collaboration Meeting: Workers up to speed on tools and able to present initial studies and plans
 - March 2016 (6 months):
 - DUNE-specific LArSoft studies for Fast MC inputs
 - NuMI-based beam systematics implemented
 - Detector performance requirements established
 - First pass at analysis of FD MC samples with ND constraints applied

Roundtable



- For each group or individual on the phone, please tell us:
 - Your name(s)
 - Your institution
 - Number of people in group
 - Interest in long-baseline PWG
 - Interest in working on a specific task?
 - Interest in working on a task not listed?
 - Want to contribute but need suggestions for an appropriate task or need help getting started?
 - Just here to keep up with LBPWG activities but not able to contribute effort? (This is ok too!)