LBNE Physics Tools Status and Projections

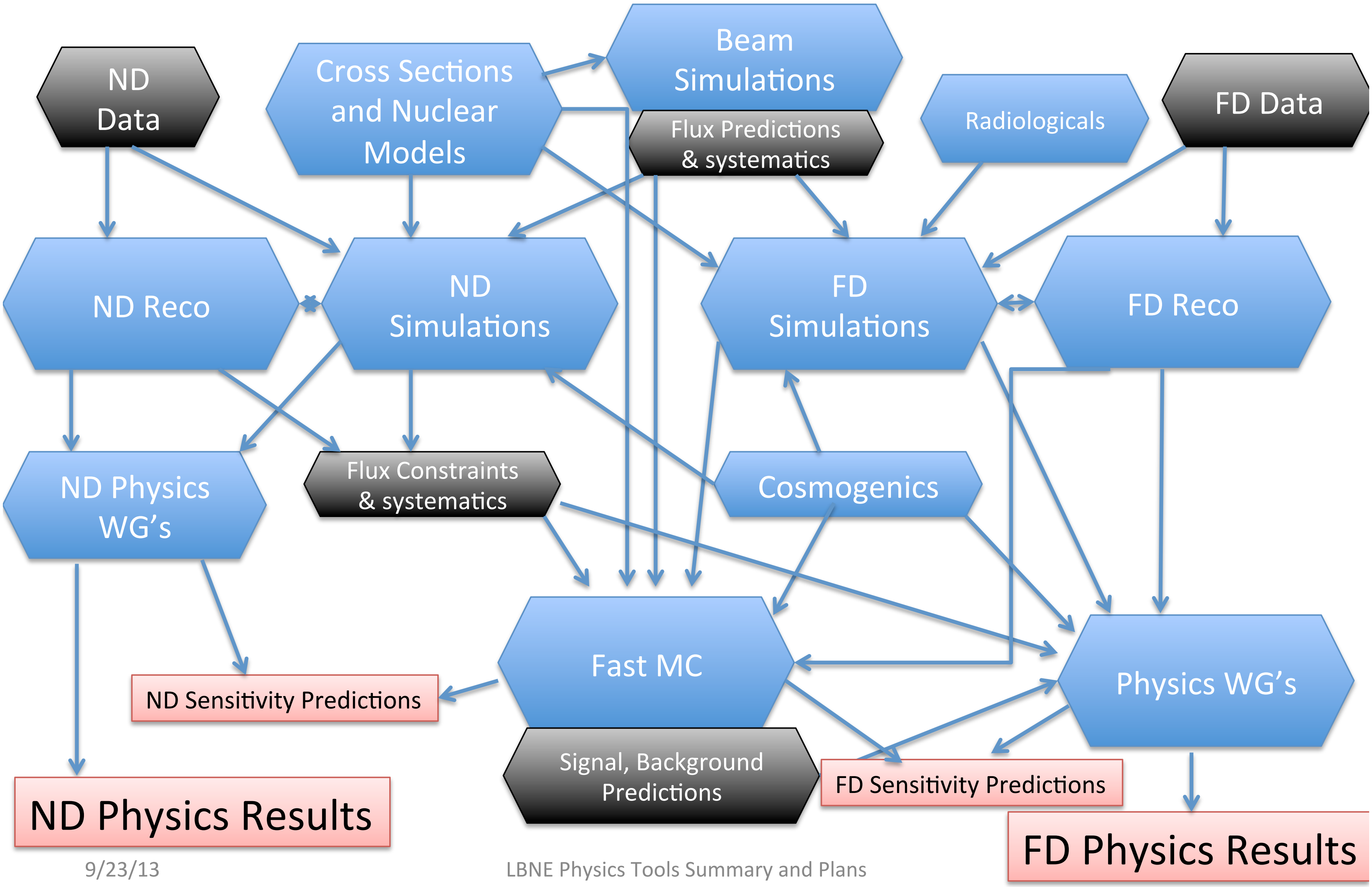
Tom Junk
Fermilab

- Physics Tools Summary and Status
- Software Suites
- Resource Utilization
- Future Projections

Active Physics Tools Working Groups

Group	Meeting Frequency	Conveners
FD Simulation and Reconstruction	Weekly (+ extra meetings)	Tom Junk (FNAL) Brian Rebel (FNAL) Matthew Szydagis (UC Davis) Eric Church (Yale) Mike Kirby (FNAL)
ND Simulation and Reconstruction	Weekly general ND meetings	Christopher Mauger (LANL) Kevin Yarritu (LANL) Bipul Bhuyan (IIT Guwahati)
Beam Simulations	Weekly	Kevin Yarritu (LANL) Laura Fields (Northwestern)
Cross Sections and Nuclear Models	Collaboration Meeting Reports. Independent Efforts.	Martin Tzanov (LSU) Dan Cherdack (CSU)
Cosmic Rays and Cosmogenics	~Monthly	Vitaly Kudryavtsev (Sheffield) Dongming Mei (U. S. Dakota)
Fast MC	Bi-weekly	Dan Cherdack (CSU)
Radiological Backgrounds and Cleanliness	Organized within institutional groups	Xinhua Bai (SDSMT) Vic Gehman (LBNL)

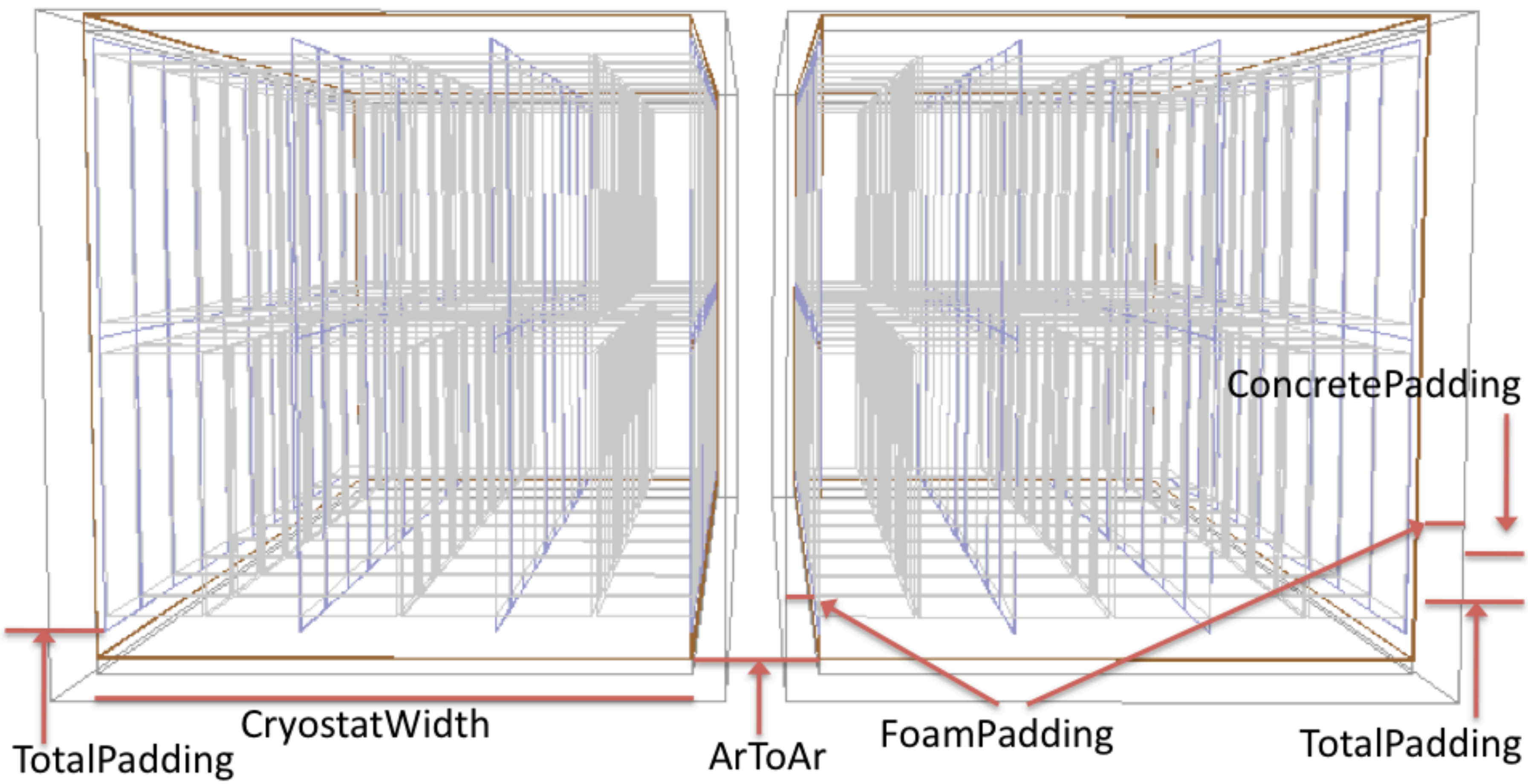
Flow of Physics Tools Deliverables



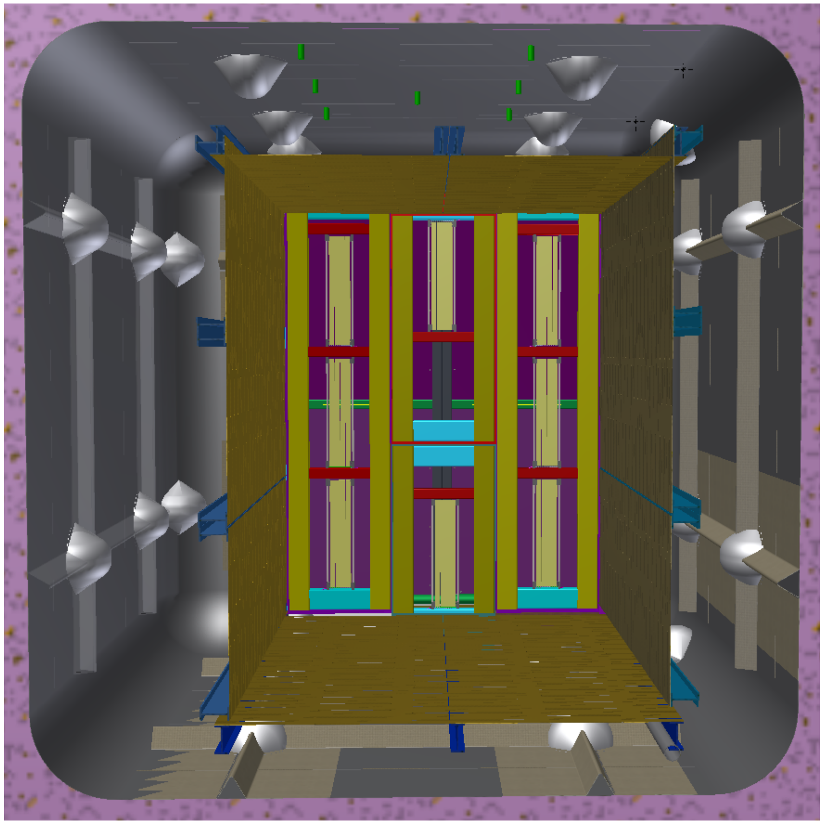
10 kt Realistic Surface FD Geometry in LArSoft (GEANT4)

Other versions:
- 34 kt Underground Geometry
- 4-APA reduced geometry for prototyping code
- All with 45° and 36° induction-plane wire angle versions

Tyler Alion

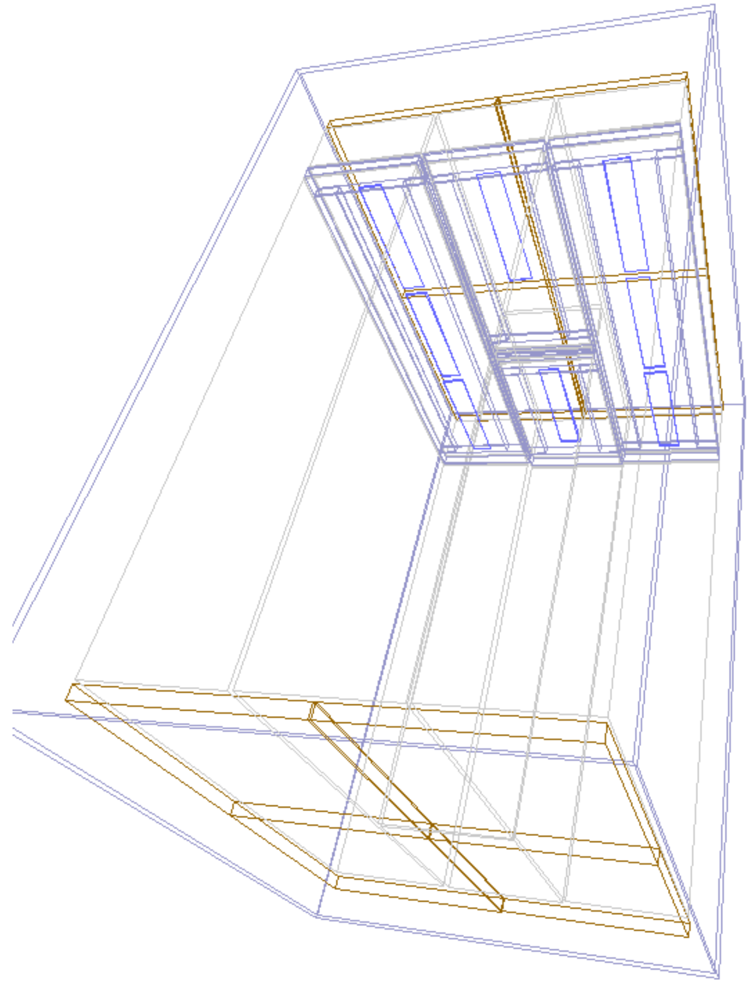


Updated 35 t Prototype Geometry in LArSoft



Engineering Drawing

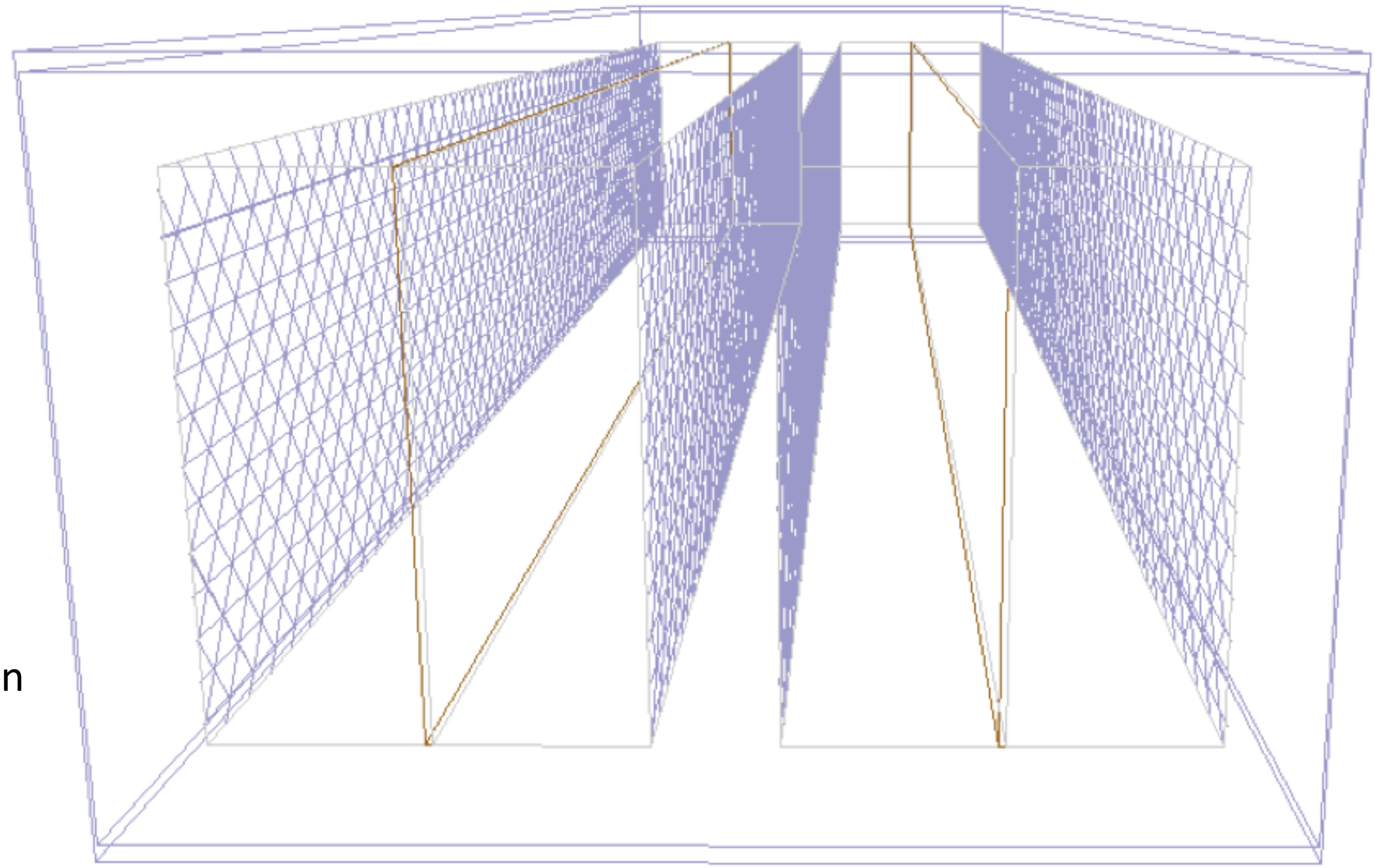
Tyler Alion



GEANT4 visualization

Supersedes Previous 3-APA Design.
Getting ready to generate samples (photon detector simulation library being built)

ICARUS T600 Geometry in LArSoft

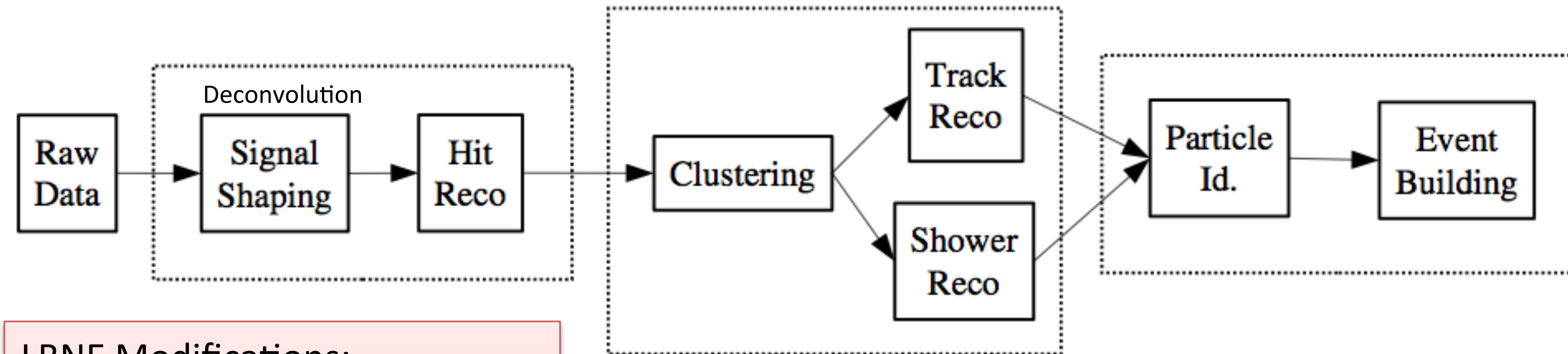


Tyler Alion

ICARUS has volunteered to send us raw data for purposes of exercising our reconstruction algorithms. We are getting ready for it.

LArSoft FD Reconstruction Chain

As used by ArgoNeuT and MicroBooNE



LBNE Modifications:
Raw Data are zero-suppressed, and likely other compression algorithms applied. Cannot unpack
it all at once.

One wire at a time, and apply deconvolution and hit reco on blocks of nonzero data

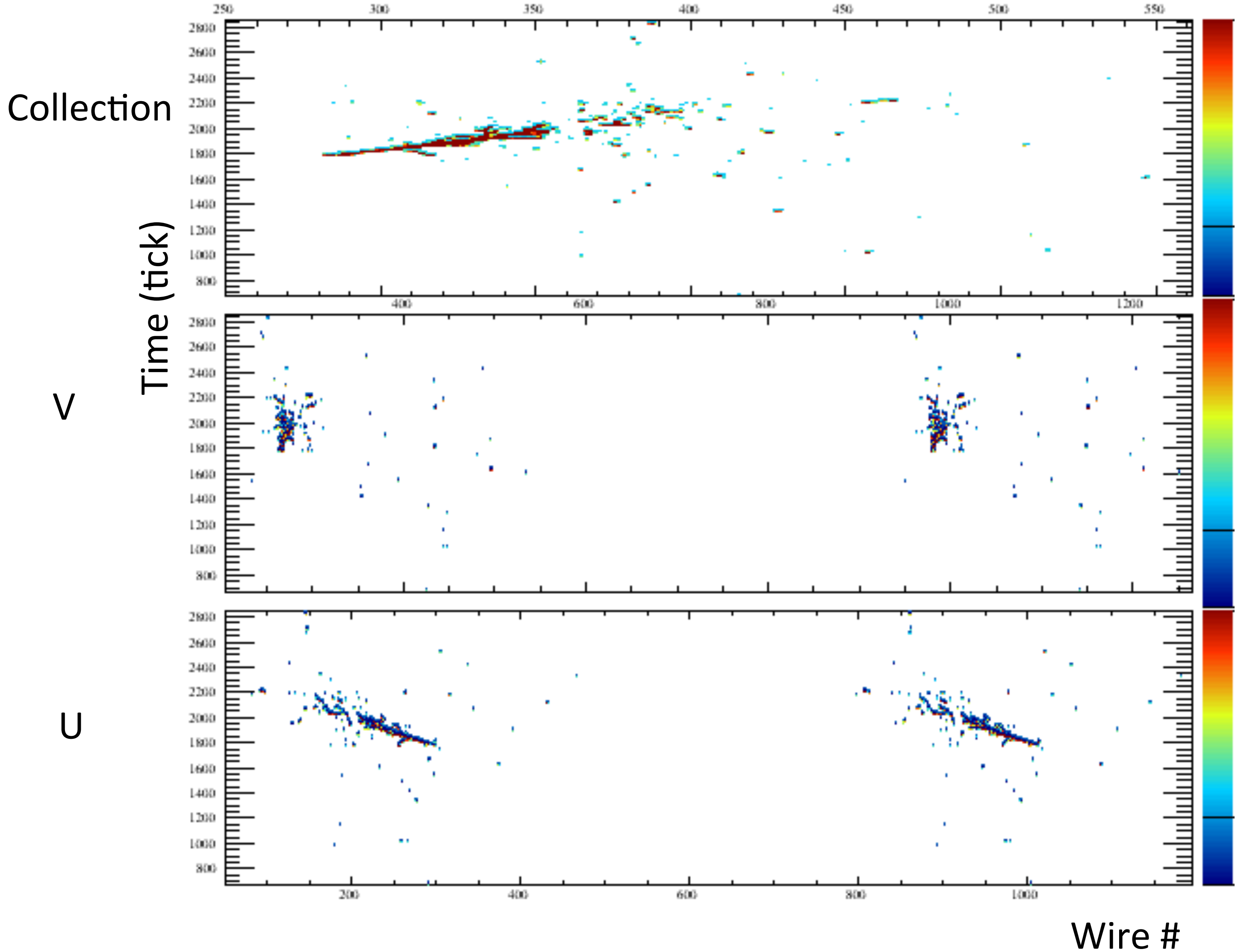
Need a fast version for software triggering

LBNE Modifications:
Ambiguity breaking for induction-plant hits.

Reconstruct one APA at a time
vs. global tracking and shower finding.

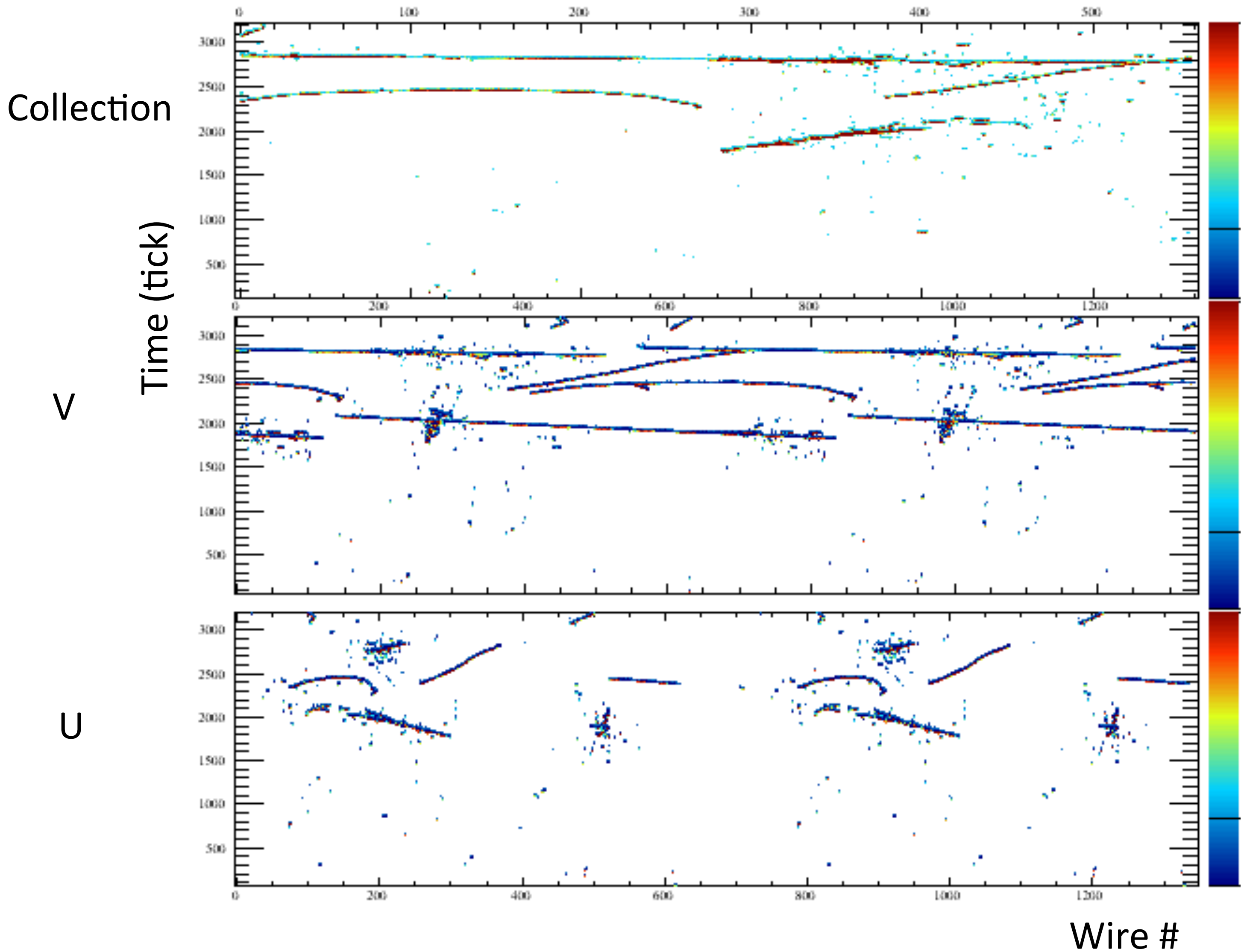
Cosmic-ray rejection may be done at a faster, more approximate level and events selected for further processing

A CC nue Event in the 10 kt FD Simulation – No cosmics. Cryostat 1. TPC 54



Tom Junk

The Same Event, Re-Simulated, with Cosmic-Ray Overlay



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Deliverables for FD Reconstruction: Physics Performance

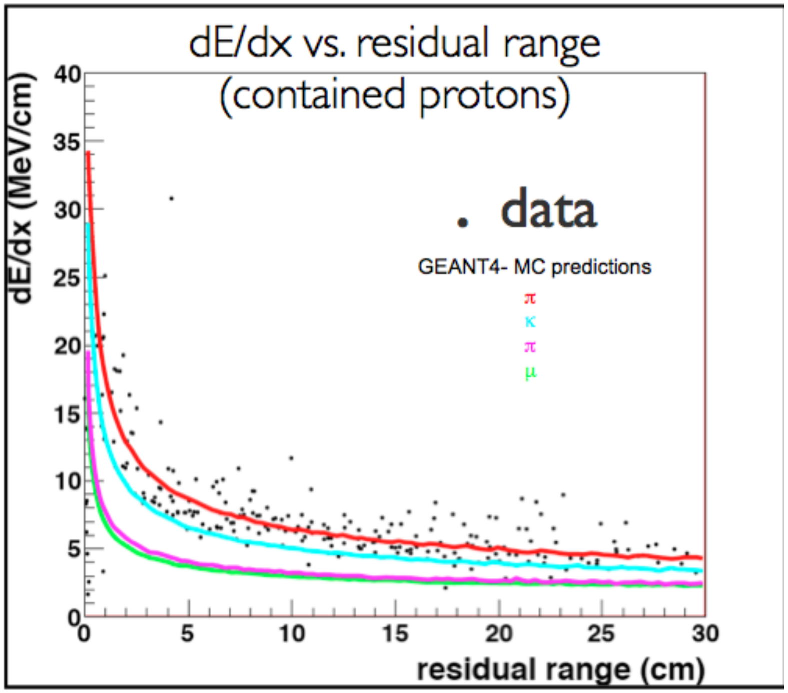
Monte Carlo predictions of, and systematic uncertainties on the following:

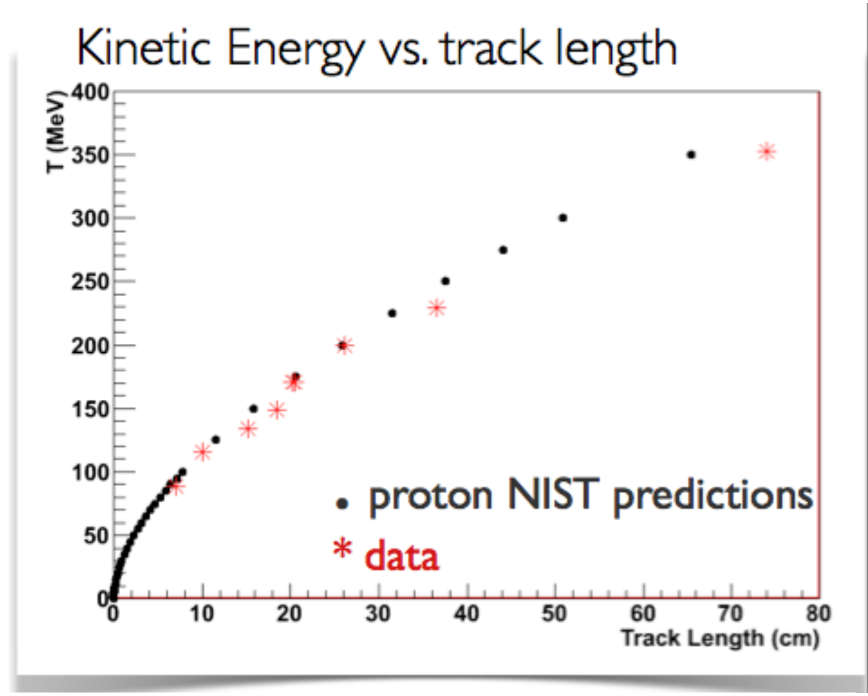
- **Efficiency** for detecting muons, electrons, protons, pions, and kaons as functions of
  - Energy
  - Whether they exit or not (and how much is detected)
  - Angle
  - Whether they cross a gap or cross the APA

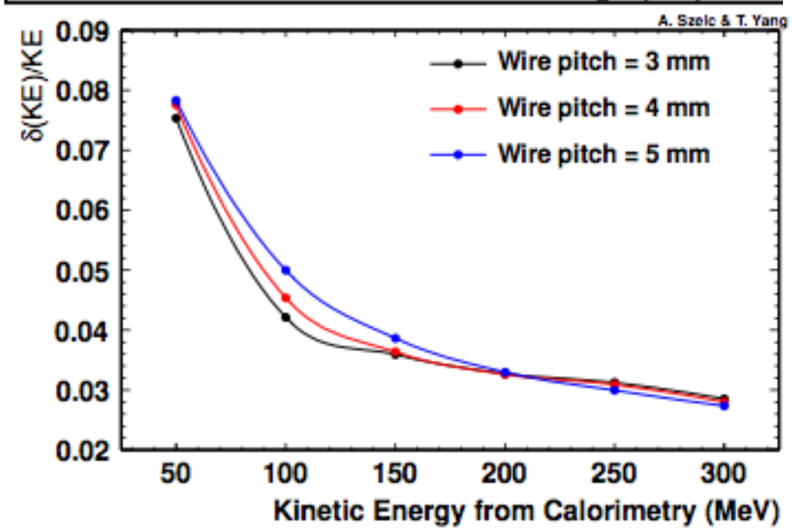
- **Energy Resolution** for muons, electrons, protons, pions, and kaons as functions of
  - Energy
  - Whether they exit or not (and how much is detected)
    Energy resolution for exiting muons and electrons is
    difficult – scattering angles
    and extrapolations needed. Extended readout window helps for some tracks.
  - Angle
  - Whether they cross a gap or cross the APA

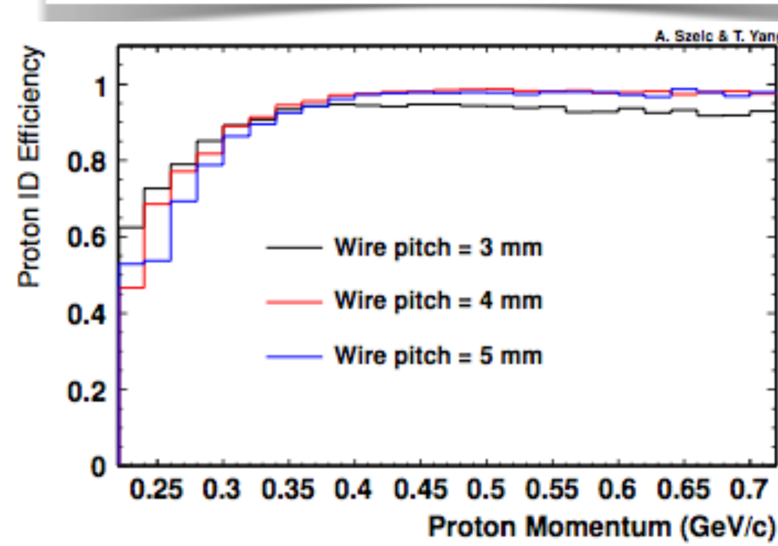
- **PID** fake-rate matrices for each of the particles
  - dE/dx performance plot
  - Functions of energy, angle, and position.
  - Optimize cuts on PID MVA's and fiducial cuts on events

Examples of Delivered Performance Plots (ArgoNeuT)







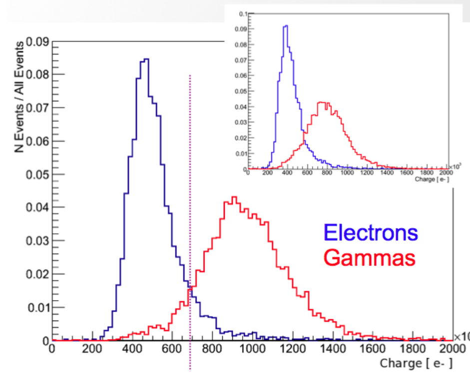


e/γ Separation

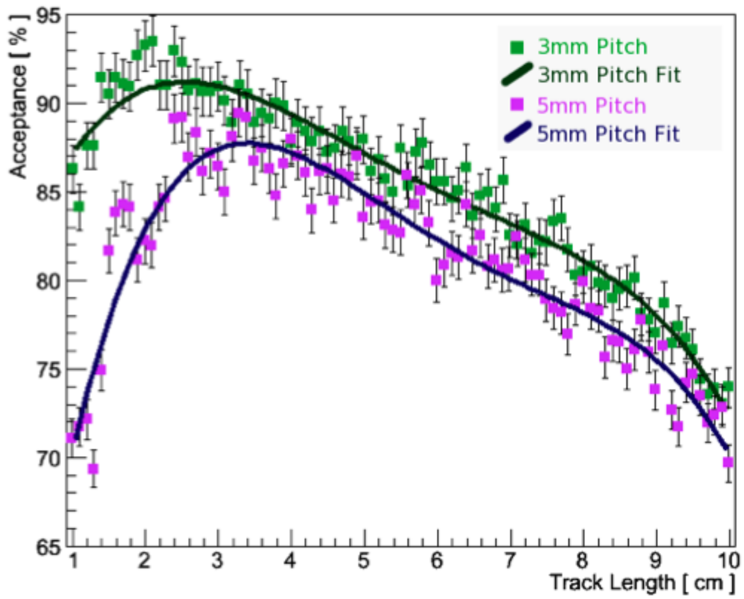
Matthew Szydagis, Daniel Coelho

Measured charge in the first part of an EM shower used to tell one MIP from two

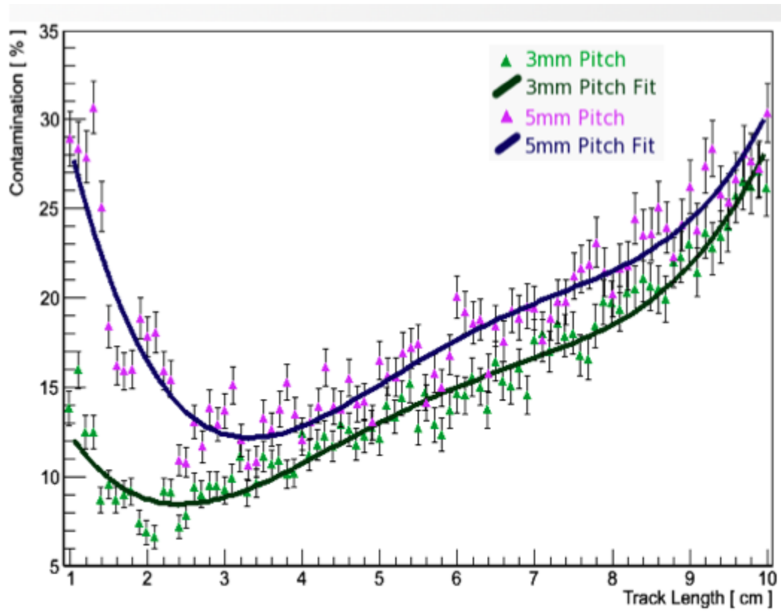
Consulting with ICARUS colleagues to optimize performance



Acceptance for selecting electrons

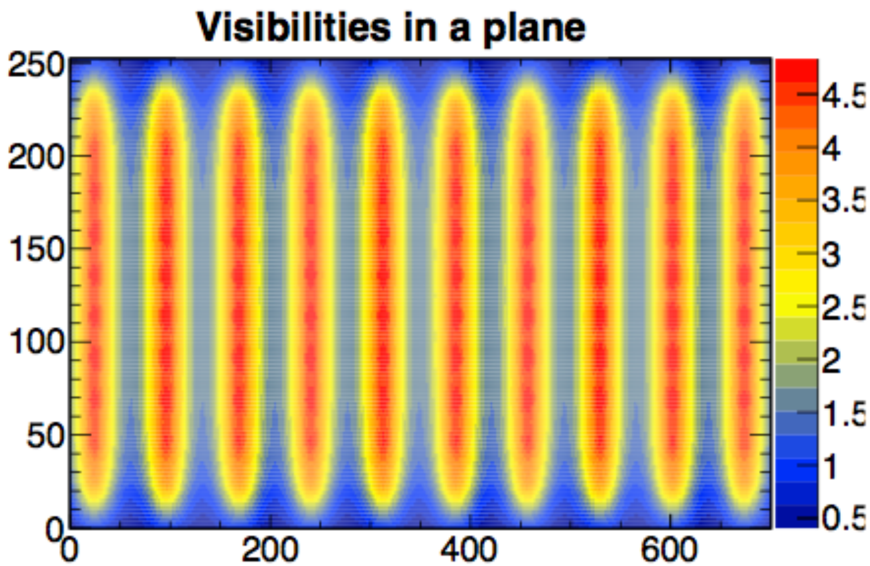


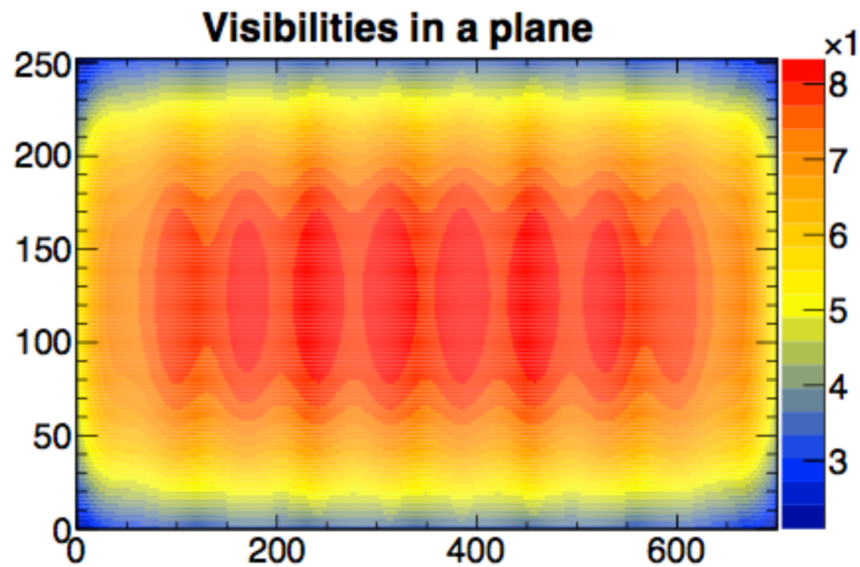
Fraction of selected events that are misID



Recent update – Negligible impact on the performance of this metric if we use 36 degree induction-plane wires instead of 45-degree induction-plane wires

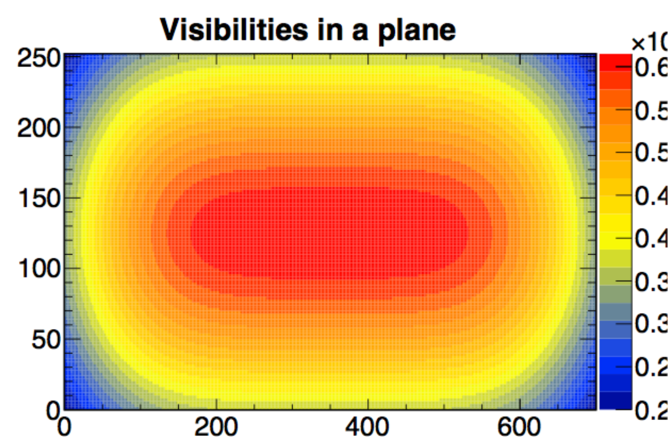
Parameterized Photon Simulation – 10 kt





Just visibilities to the bars, no attenuation function in the bars on this page.

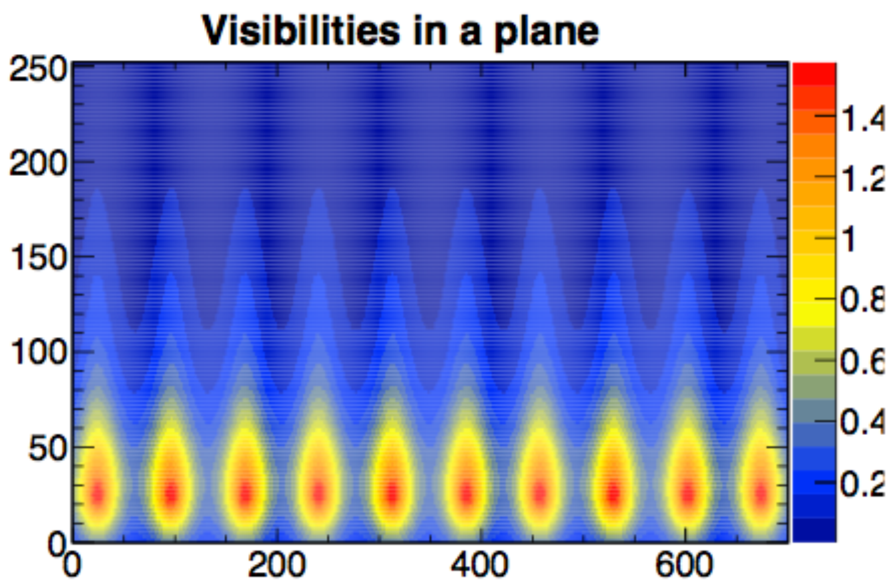
200 cm from APA

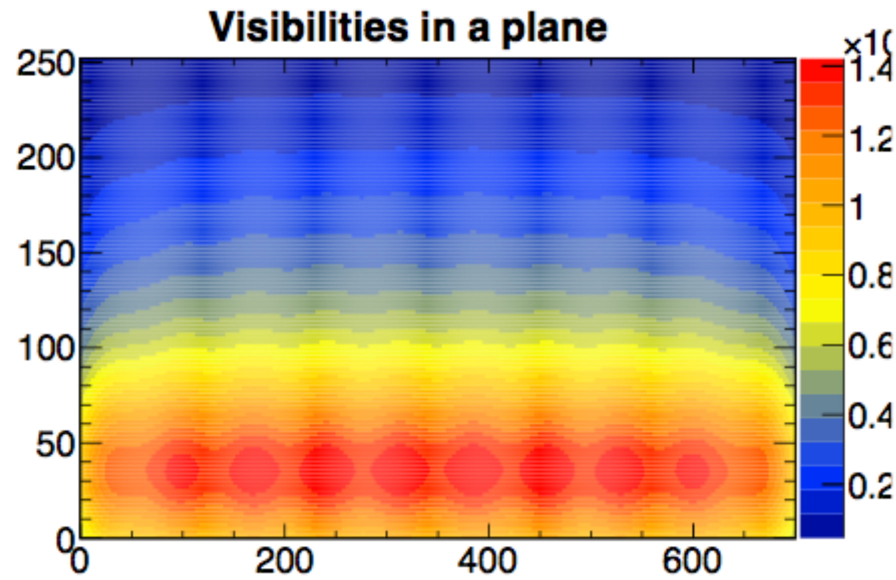


Visibilities within an APA. Pattern continues for many APA's and fills in edges.

Zepeng Li

Parameterized Photon Simulation – 10 kt

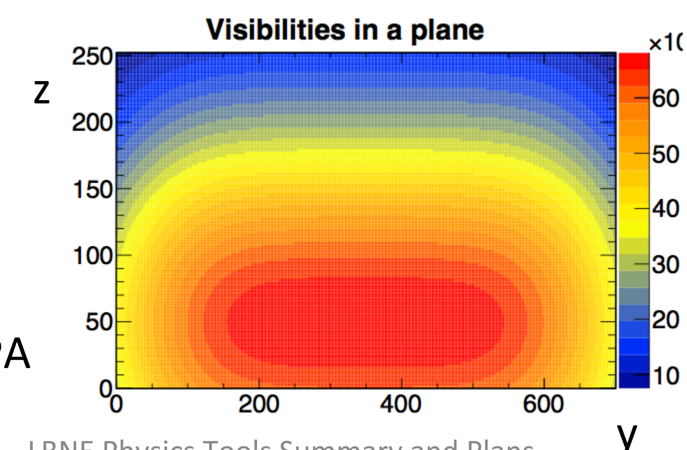




Including effects of attenuation in the acrylic bars

35t Photon simulation library with new geometry in progress

200 cm from APA



Need measured efficiencies and attenuation functions. These are placeholders.

Zepeng Li

FD MC Challenge Proposal

MC Files produced for:

(10 kt + 35t) x (With and Without MC Truth info) x (GENIE and GENIE+CRY)

LBNE nominal spectrum for CC nue+nuebar+numu+numubar unoscillated (and fully oscillated for nue(bar)). NC events from unoscillated numu spectrum.

Without MC truth info – true input vectors hidden from users but kept around for scoring the results.

Tasks:

1) Identify primary neutrino vertex and give location
2) Identify type of neutrino event – CC nue, numu, or NC
3) Measure energy of primary lepton in CC event candidates
4) Count and identify additional particles produced at the primary vertex
5) Estimate neutrino energy

Analysis Strategy: Using Data to Control Backgrounds and Efficiencies

We also need to develop tools for measuring, or at least constraining, using control samples,

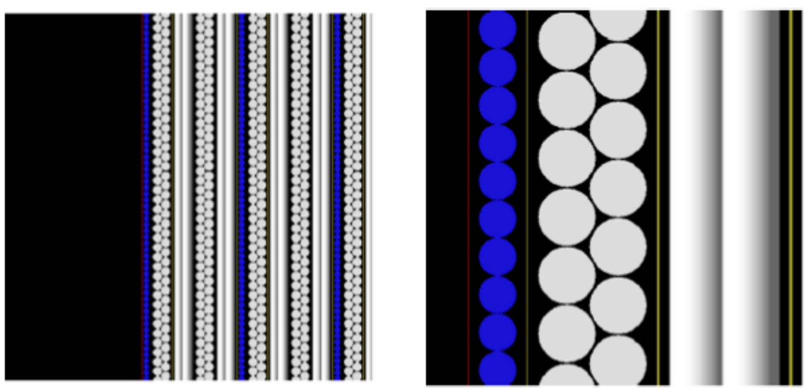
- reconstruction efficiency
- PID fake rates
- backgrounds

for the different particle types as functions of energy, angle, and position, using the FD data.

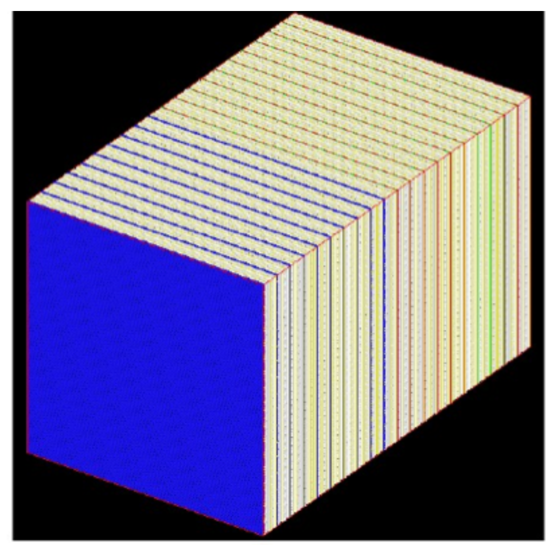
Backgrounds: Lots of beam-off data to constrain cosmics. Non-fiducial events to help constrain rock events. Instrument the volume outside the field cage with photon detectors?

Near Detector Simulation Status

- Preliminary GEANT4 Near Detector Simulation running
- High-resolution straw-tube tracker with water and radiator as target material (to update!)
- Uses the ART framework
- To do:
  - Set up full detector geometry and materials
  - Event Display
  - Use GENIE
  - Reconstruction
  - Performance studies



Blue: water targets, approximately 1 cm in diameter.
White: Straw Tubes (XXYY), approximately 20 mm in diameter.
Yellow: Carbon fiber for straw tubes to attach to.



Kevin Yarritu

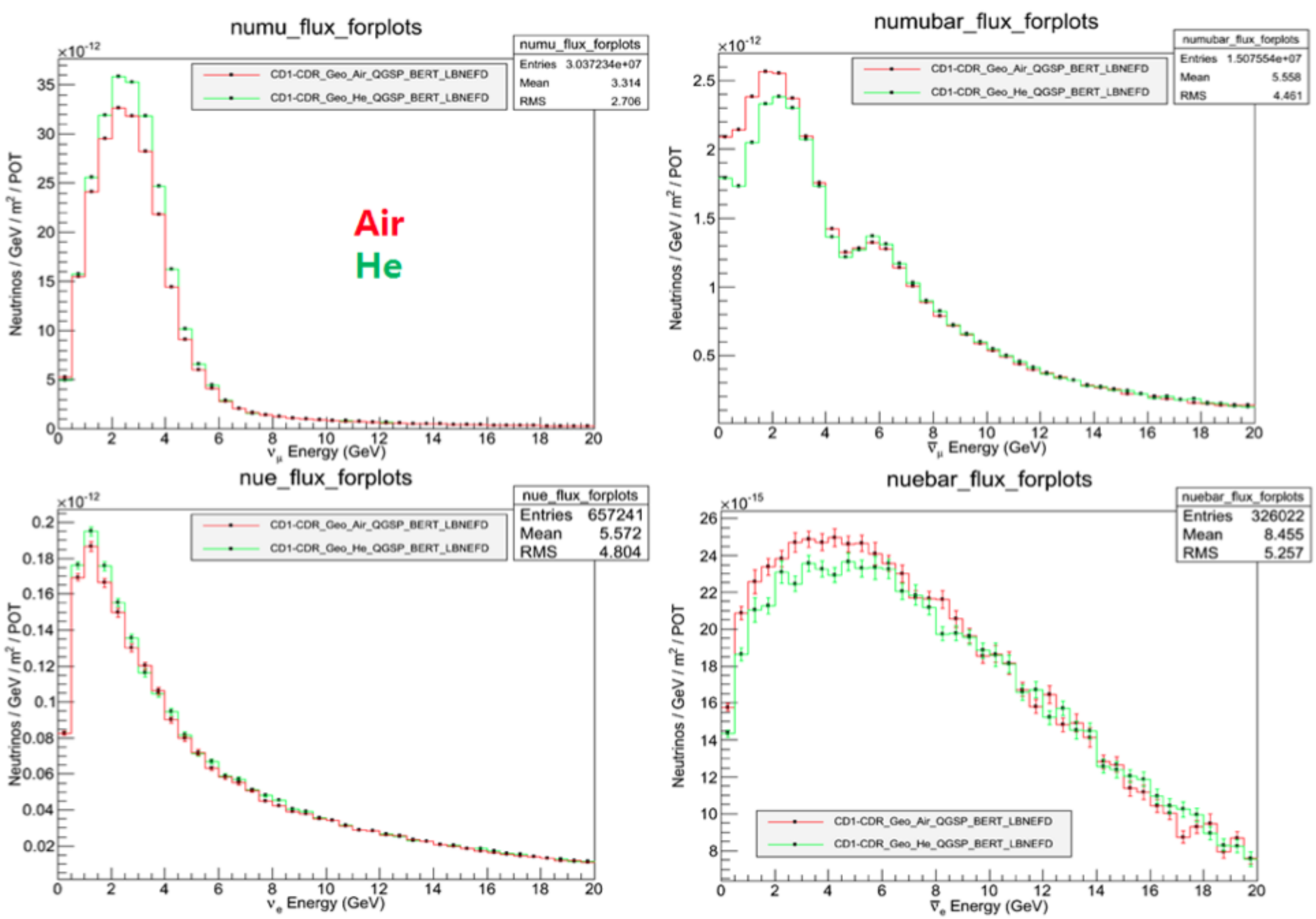
Bipul Bhuyan

Ashok Kumar

Beam Simulation Status

Air vs. Helium in the Decay Pipe

Seongtae Park



Integrated Flux Ratio in Helium Compared with Air

Nu	0~0.5GeV		0.5~1.5GeV		1.5~5GeV		5~10GeV	
	Nu-mode	Anti-nu-mode	Nu-mode	Anti-nu-mode	Nu-mode	Anti-nu-mode	Nu-mode	Anti-nu-mode
ν_μ	0.9331±0.0010	0.8707±0.0012	1.0430±0.0010	0.8389±0.0018	1.1080±0.0007	0.9521±0.0017	1.0442±0.0021	1.0175±0.0031
$\bar{\nu}_\mu$	0.8578±0.0013	0.9407±0.0011	0.8343±0.0019	1.0466±0.0010	0.9559±0.0018	1.1038±0.0007	1.0195±0.0034	1.0481±0.0024
ν_e	0.9960±0.0161	0.8797±0.0169	1.0429±0.0132	0.9198±0.0151	1.0256±0.0095	0.9350±0.0090	1.0292±0.0090	0.9926±0.0089
$\bar{\nu}_e$	0.9102±0.0170	1.0144±0.0179	0.9134±0.0230	1.0479±0.0137	0.9362±0.0098	1.0453±0.0114	0.9716±0.0093	1.0207±0.0111

- 10% increase in flux using helium over air
- less wrong sign contamination

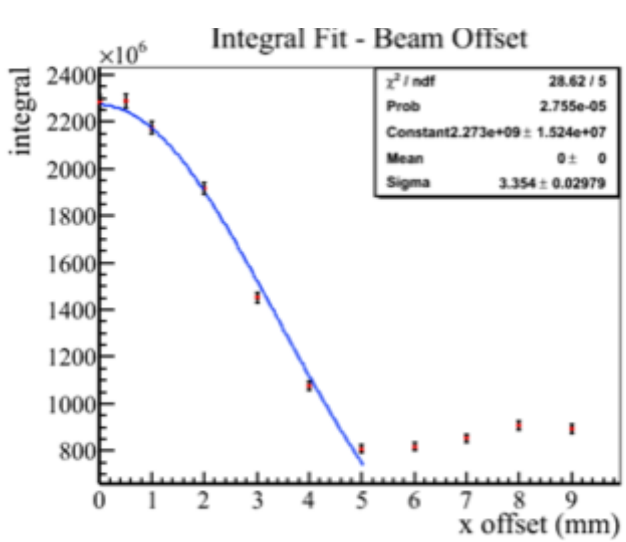
Seongtae Park

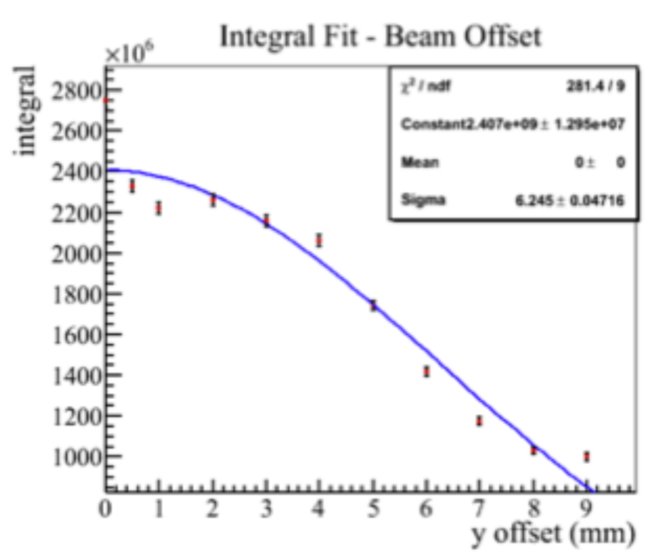
Alignment Studies Summary

Change in oscillated ν_μ flux in neutrino mode relative to nominal configuration

Variation	0-0.5 GeV	0.5-2 GeV	2-5 GeV	5-20 GeV	20-120 GeV
Beam X0 = 0.45 mm	0.998	0.992	0.995	1.003	1.038
Far Detector X = 21m	1.008	0.996	1.000	1.005	0.997
Decay Pipe Radius = 1.9 m	0.985	0.985	0.993	1.006	0.992
Beam Sigma = 1.4	0.997	0.994	0.997	1.002	1.032

Example study: Beam position offset relative to nominal



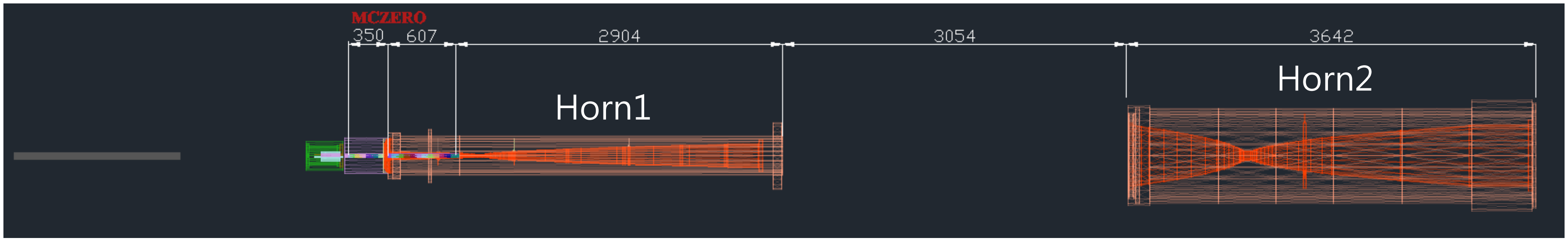


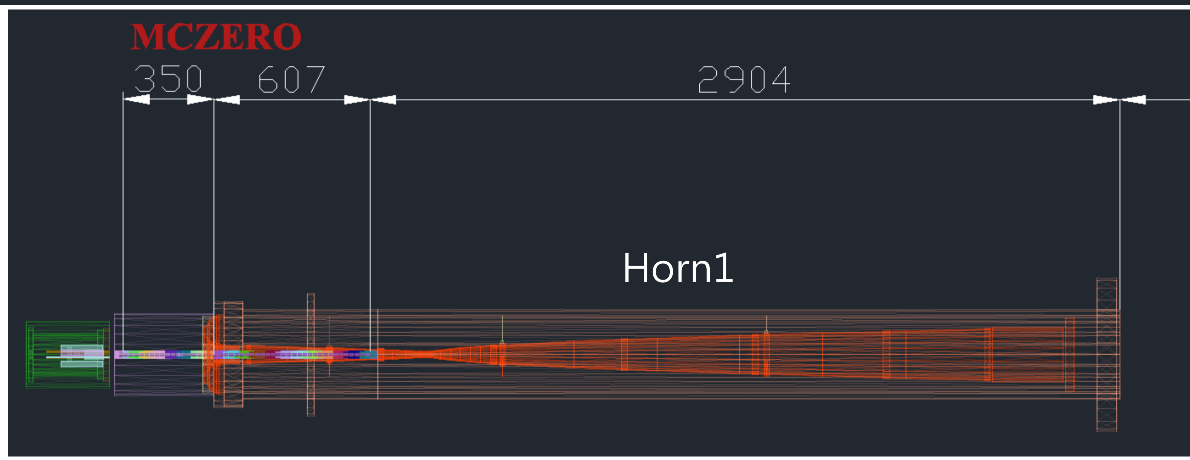
- proton beam width is ≈1.3 mm
- target:
  7.6 mm in x
  12 mm in y
- rise above 6 mm due to contact with baffle
- integral taken between 0.5-5GeV

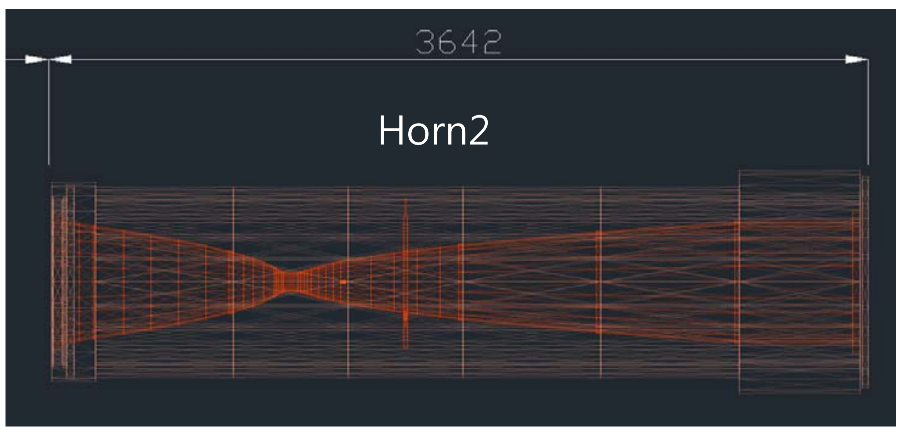
Amanda Steinhebel

G4LBNE V3

Baffle, target, first horn, second horn locations





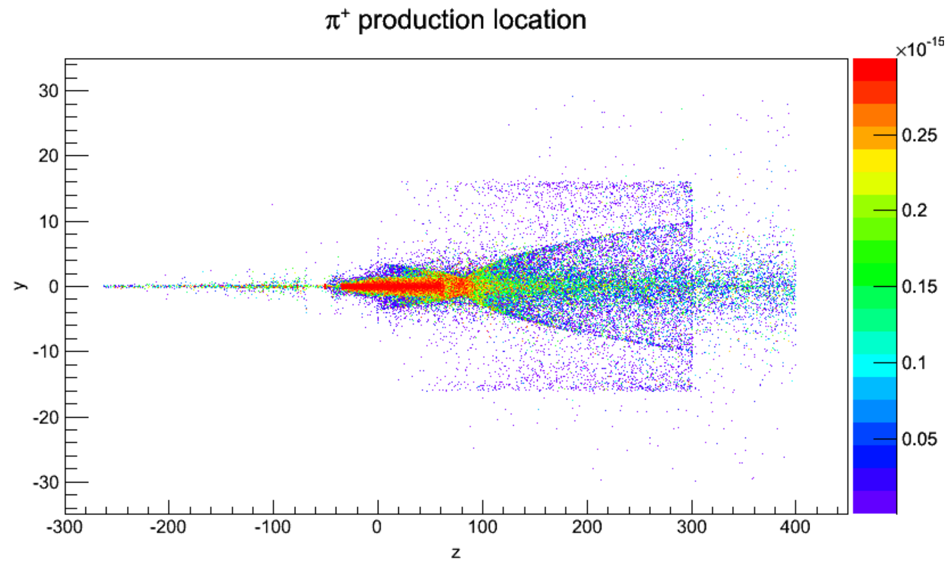


Paul Lebrun
Seongtae Park

Paul Lebrun, Seongtae Park
Shown are locations of the production points of particles that decay to neutrinos that enter the FD

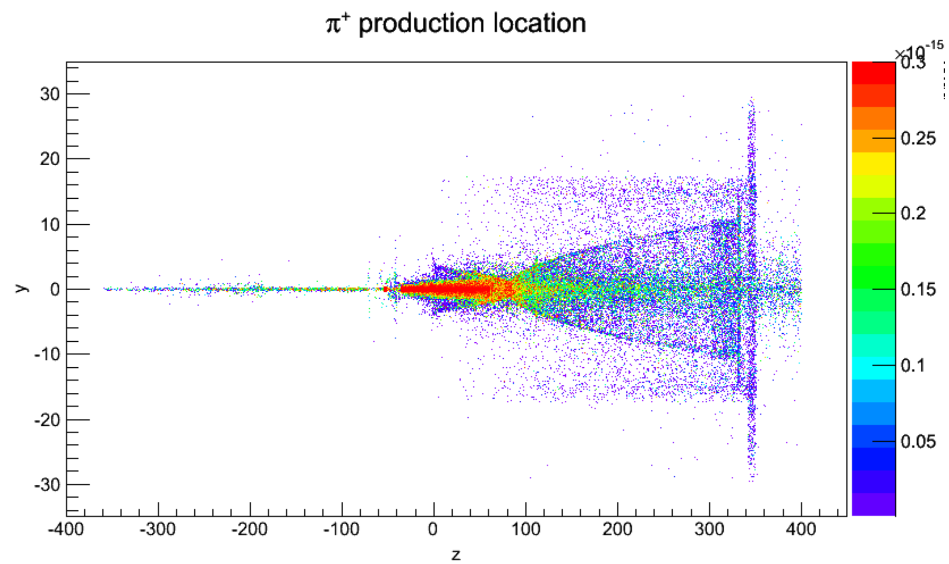
Target, Horn1

v2r2p1



L_{H1}=3m

v3r0p4

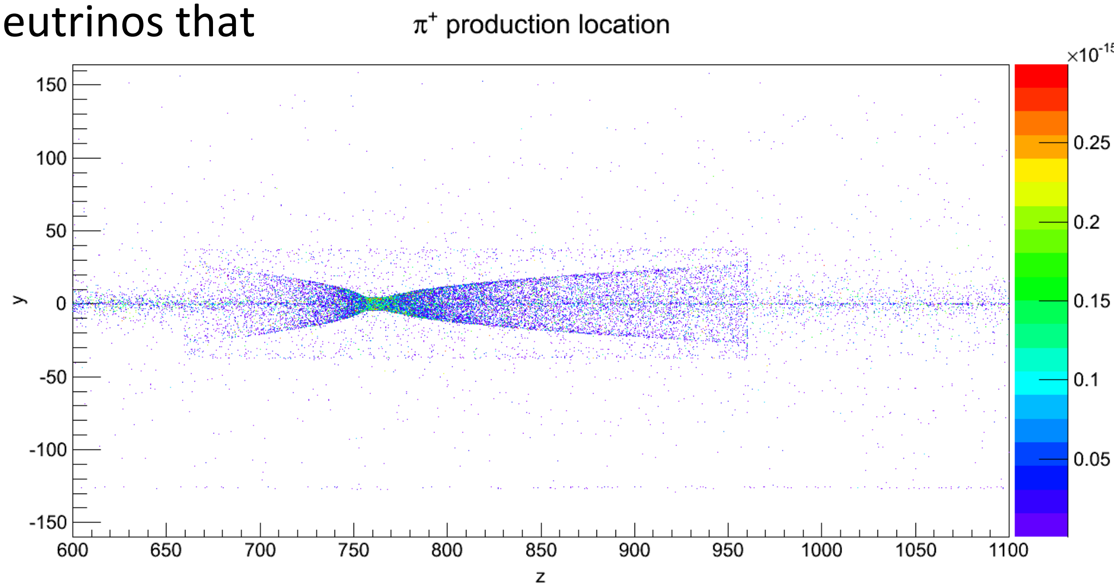


L_{H1}=3.5m

Paul Lebrun, Seongtae Park
Shown are locations of the production points of particles that decay to neutrinos that enter the FD

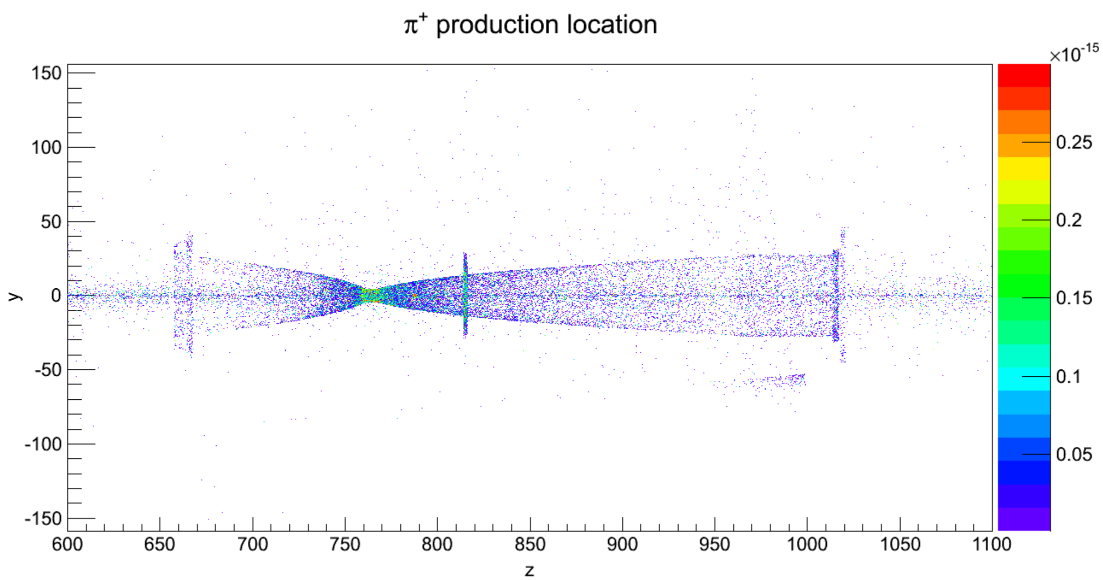
Horn2

v2r2p1



L_{H2}=3m

v3r0p4

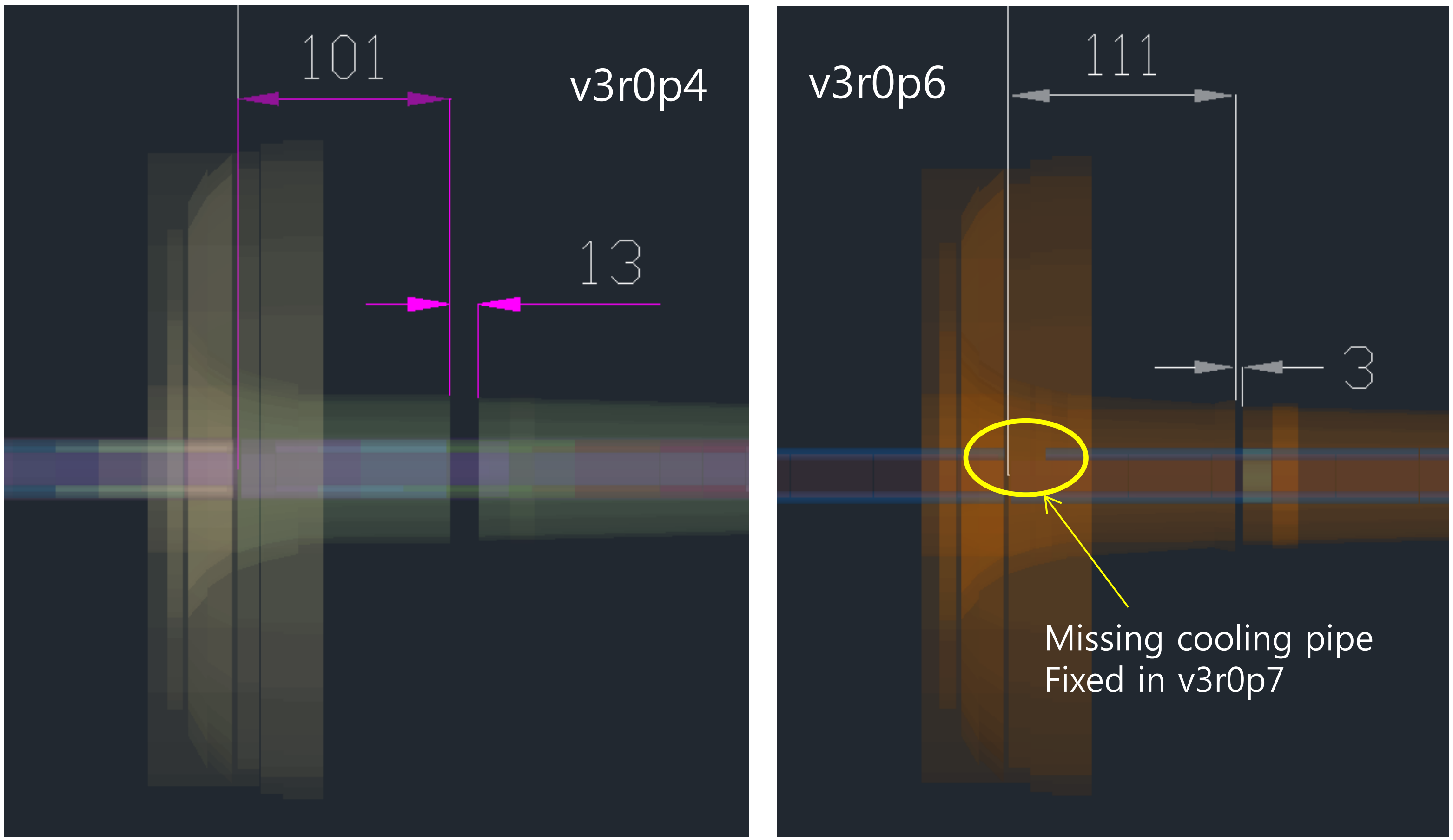


L_{H2}=3.6m

Paul Lebrun,
Seongtae Park

Geometry error fixed in v3r0p6

Horn1 inner conductor



Cross Sections and Nuclear Modeling

The main goal of the group is to provide accurate cross-sections and nuclear models relevant to both signal and background. In addition, provide realistic systematic uncertainties of the parameters.

- Work close with theorists to obtain realistic models of nuclear effects. Ongoing
- Work with neutrino generator developers to make sure the latest models are implemented. Ongoing
- Compare the models to existing measurements. Need people.
- Develop methods to constrain the cross section parameters from upcoming neutrino cross section measurements. This also provides the cross section systematic uncertainties. Work with current experiments to obtain the most useful measurements. Need people to develop fitting tools.
- Identify the largest systematics. Ongoing

Martin Tzanov
Dan Cherdack

NuINT 2014 is comng May 19-24, 2014 in London

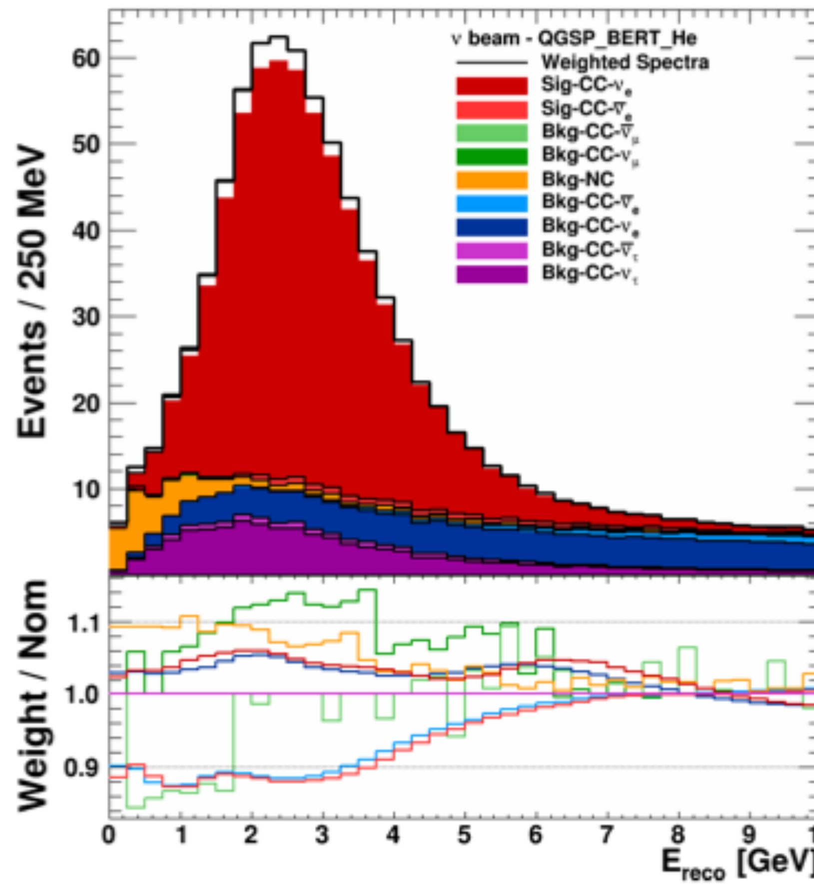
FastMC

Dan Cherdack

MC Chain - Flux

- Already working closely with the flux simulations group
- Currently use flux histograms
  - Generated from flux files
  - Direct input into GENIE (nominal flux)
  - Relative and absolute (POT) normalizations from (flux)x(inclusive cross section) histograms
- Alternate fluxes are read by the Fast MC software to generate weights
  - Function of true neutrino energy and species
  - Alternate beamline designs
  - Design tolerances
  - Alternate hadronization models
- ND fluxes generated and used to generate events

- Next generation flux:
  - FNAL flux driver (R. Hatcher)
  - Inputs flux files and detector geometry, location
  - Allows for event-by-event weights based on ν parentage (developed for MINERνA)
  - Beam tuning based on NA61 data, etc
- Include upgrades in Fast MC release 2.0 – hopefully this spring

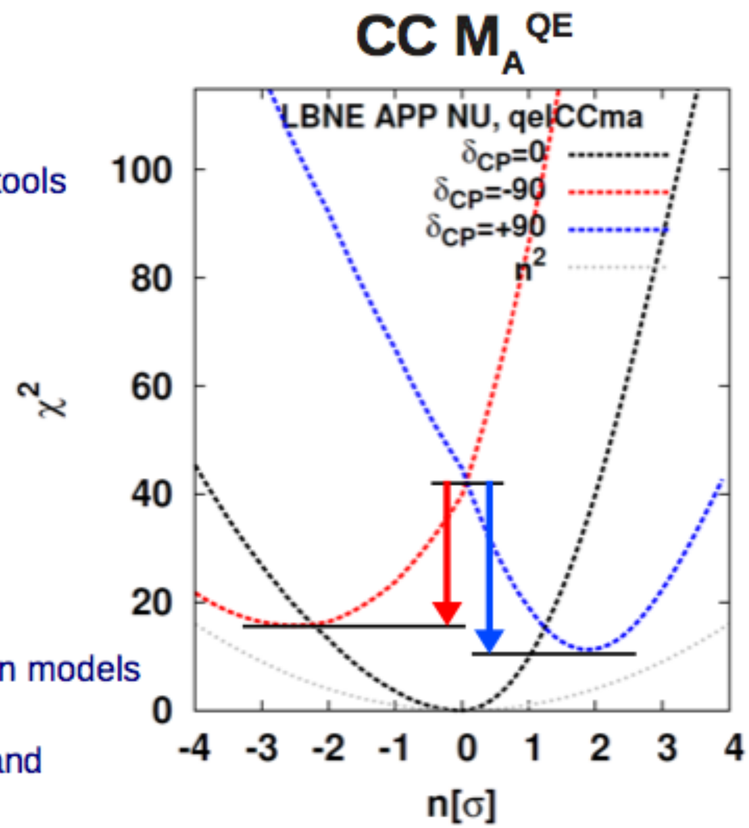


QGSP_Air → QGSP_BERT_He

Dan Cherdack

MC Chain – Cross Sections

- Already working closely with the cross sections and nuclear models group
- The Fast MC works as a extension of GENIE
  - Modified version of gsp flat tree converter
  - Incorporates the GENIE cross section reweighting tools
- There is plenty of generator work to be done:
  - MEC and RPA models for QE
  - Improved coherent interaction models
  - Alternate FSI model (GiBUU)
  - Much much more!
  - Most of this is happening outside of LBNE
- Improvements to the current implementation
  - Weights for hadronization model and DIS interaction models are too slow – currently not included
  - Need better understanding of each reweight knob and realistic PDFs
  - Need input systematic parameter correlations
    - Parameter / parameter correlations
    - ν / $\bar{\nu}$ correlations
    - ν_e appearance / ν_μ disappearance correlations



Changes in the ν_e- appearance $\Delta\chi^2$ for shifts in CC M_A^{QE}

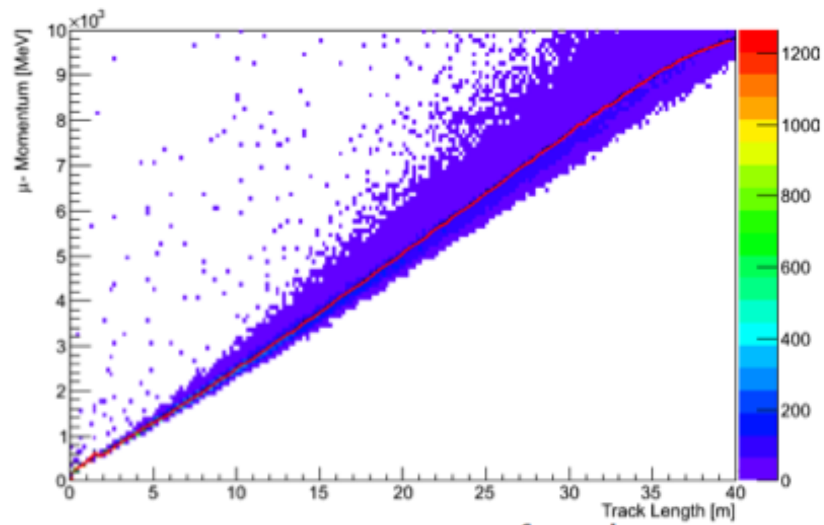
Dan Cherdack

MC Chain – Detector Response

- Detector response based on:
  - GEANT4 simulations of particle trajectories in LAr
  - Resolutions (E/p/θ) determined from ICARUS papers and LArSoft
- Reconstruction
  - Straightforward
  - $E_\nu = E_{lep} + \Sigma E_{had}$
  - Missing energy from neutrons and particles below threshold
- Required updates:
  - Neutron response
  - Charged pion fates
  - Updated smearing and threshold numbers
  - Improved response with a photon detector
  - Updated detector and FV dimensions

Smearing & thresholds inputs

Particle	Thresholds		Contained/Range		Exiting/Showering		Angle	
	Detection	Behavior	Bias	Spread	Bias	Spread	Bias	Spread
Units	[GeV]	[GeV]	[%]	[%]	[%]	[%]	[deg]	[deg]
mu+/-	0.030	5.0	0.0	5.0	0.0	30.0	0.0	1.0
e+/-	0.030	inf	0.0	15.0	0.0	15.0	0.0	1.0
pi+/-	0.100	0.5	0.0	5.0	0.0	30.0	0.0	1.0
pi0	0.042	inf	0.0	28.0	0.0	28.0	0.0	3.0
gamma	0.030	inf	0.0	15.0	0.0	15.0	0.0	1.0
p	0.050	1.5	0.0	5.0	0.0	30.0	0.0	5.0
n	0.050	1.5	0.0	30.0	0.0	30.0	0.0	5.0
Other	0.050	1.5	0.0	30.0	0.0	30.0	0.0	5.0



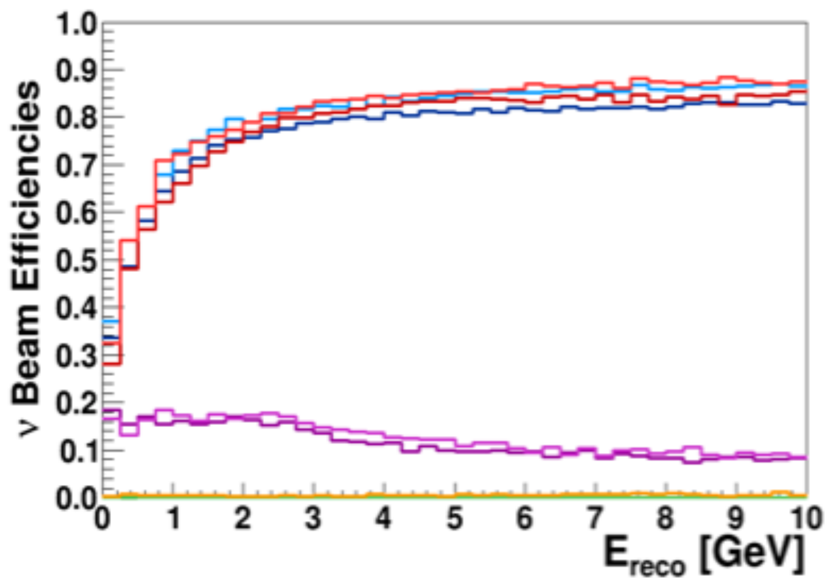
μ momentum as a function of track length

12

Dan Cherdack

MC Chain – Event Selection

- Classification:
  - CC-ν_μ: MIP-like track > 2 m
  - CC-ν_e: e-like EM shower (no μ candidate)
  - NC: no μ or e candidate
- Low energy response
  - Efficiency of selection based on:
    - Energy of candidate lepton
    - Multiplicity / hadronic shower energy
  - Selection probability = $(E_{lep} - E_{thr}) / (E_{lep} - \mathbf{m}E_{thr})$
  - Scanning study results used to tune **m**
- E/γ separation
  - Based on very preliminary studies
  - Requires 95% signal efficiency
  - Applied to low multiplicity (<4 prongs) events



- Required updates:
  - Updated scanning studies
    - Smaller energy bins
    - As a function of E_{lep} and E_{had}
    - Scan of events rejected by E/γ separation cuts
  - Updates on E/γ separation inputs
    - Require ~95% signal efficiency
    - NC selection probability as a function of E_γ and E_{had}

Dan Cherdack

MC Chain – Systematics

x_P	Description of P	$\delta P/P$	
$x_{M_A^{NCEL}}$	Axial mass for NC elastic	±25%	QEL
$x_{\eta^{NCEL}}$	Strange axial form factor η for NC elastic	±30%	
$x_{M_A^{CCQE}}$	Axial mass for CC quasi-elastic	-15% +25%	
$x_{CCQE-Norm}$	Normalization factor for CCQE		
$x_{CCQE-PauliSup}$	CCQE Pauli suppression (via changes in Fermi level k_F)	±35%	
$x_{CCQE-VecFF}$	Choice of CCQE vector form factors (BBA05 ↔ Dipole)	-	
$x_{CCRES-Norm}$	Normalization factor for CC resonance neutrino production		RES
$x_{NCRES-Norm}$	Normalization factor for NC resonance neutrino production		
$x_{M_A^{CCRES}}$	Axial mass for CC resonance neutrino production	±20%	
$x_{M_V^{CCRES}}$	Vector mass for CC resonance neutrino production	±10%	
$x_{M_A^{NCRES}}$	Axial mass for NC resonance neutrino production	±20%	
$x_{M_V^{NCRES}}$	Vector mass for NC resonance neutrino production	±10%	
$x_{M_A^{COH\pi}}$	Axial mass for CC and NC coherent pion production	±50%	COH
$x_{R_0^{COH\pi}}$	Nuclear size param. controlling π absorption in RS model	±10%	
$x_{R_{bkg}^{\nu p,CC1\pi}}$	Non-resonance bkg in νp $CC1\pi$ reactions	±50%	r_{ijk}
$x_{R_{bkg}^{\nu p,CC2\pi}}$	Non-resonance bkg in νp $CC2\pi$ reactions	±50%	
$x_{R_{bkg}^{\nu n,CC1\pi}}$	Non-resonance bkg in νn $CC1\pi$ reactions	±50%	
$x_{R_{bkg}^{\nu n,CC2\pi}}$	Non-resonance bkg in νn $CC2\pi$ reactions	±50%	
$x_{R_{bkg}^{\nu p,NC1\pi}}$	Non-resonance bkg in νp $NC1\pi$ reactions	±50%	
$x_{R_{bkg}^{\nu p,NC2\pi}}$	Non-resonance bkg in νp $NC2\pi$ reactions	±50%	
$x_{R_{bkg}^{\nu n,NC1\pi}}$	Non-resonance bkg in νn $NC1\pi$ reactions	±50%	
$x_{R_{bkg}^{\nu n,NC2\pi}}$	Non-resonance bkg in νn $NC2\pi$ reactions	±50%	

FLUX

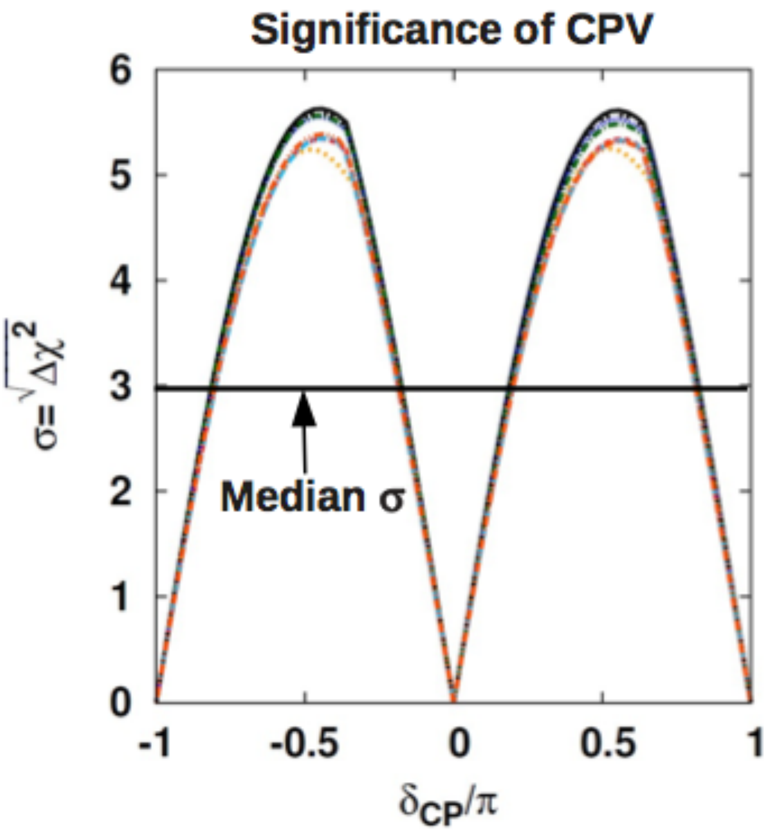
$x_{A_{HT}^{BY}}$	A_{HT} higher-twist param in BY model scaling variable ξ_w	±25%	DIS
$x_{B_{HT}^{BY}}$	B_{HT} higher-twist param in BY model scaling variable ξ_w	±25%	
$x_{C_{V1u}^{BY}}$	C_{V1u} u valence GRV98 PDF correction param in BY model	±30%	
$x_{C_{V2u}^{BY}}$	C_{V2u} u valence GRV98 PDF correction param in BY model	±40%	
x_{CCDIS}	Inclusive CC cross-section normalization factor		
$x_{CC\bar{\nu}/\nu}$	$\bar{\nu}/\nu$ CC ratio		
$x_{DIS-NuclMod}$	DIS nuclear modification (shadowing, anti-shadowing, EMC)		

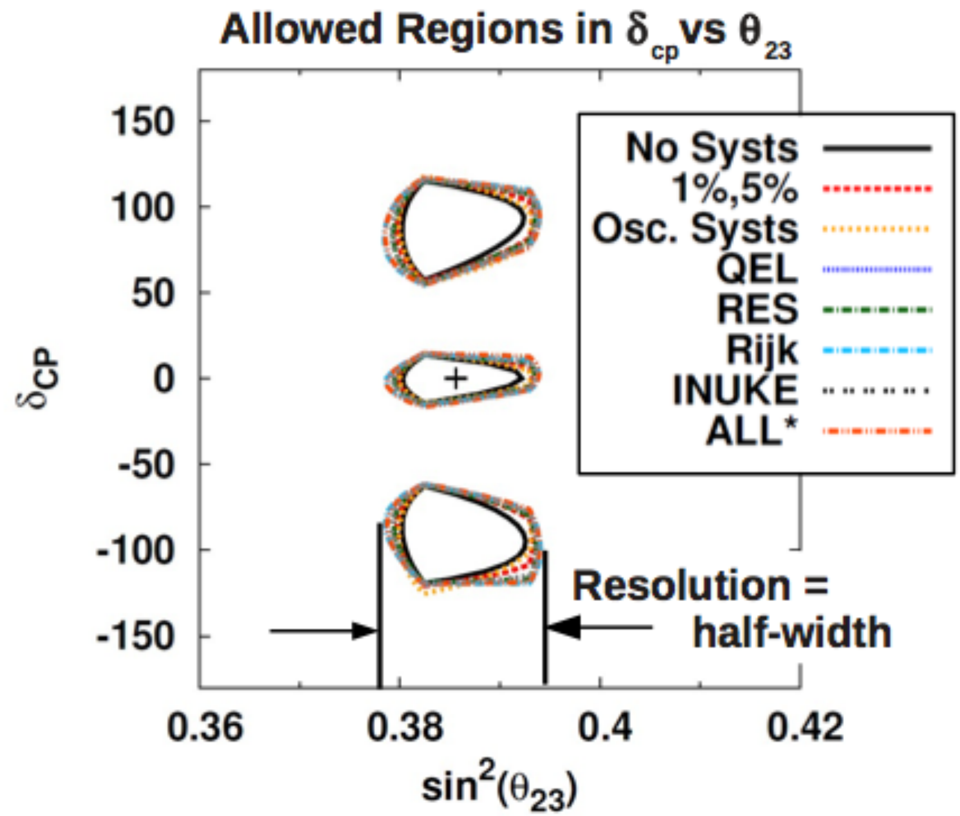
x_P	Description of P	$\delta P/P$	
$x_{AGKY}^{pT1\pi}$	Pion transverse momentum (p_T) for $N\pi$ states in AGKY	-	AGKY
$x_{AGKY}^{xF1\pi}$	Pion Feynman x (x_F) for $N\pi$ states in AGKY	-	
x_{fz}	Hadron formation zone	±50%	
$x_{\theta_\pi}^{\Delta\to\pi N}$	Pion angular distribution in $\Delta \to \pi N$ (isotropic ↔ RS)	-	
$x_{BR}^{R\to X+1\gamma}$	Branching ratio for radiative resonance decays	±50%	
$x_{BR}^{R\to X+1\eta}$	Branching ratio for single-η resonance decays	±50%	

x_P	Description of P	$\delta P/P$	
x_{mfp}^N	Nucleon mean free path (total rescattering probability)	±20%	INUKE
x_{cex}^N	Nucleon charge exchange probability	±50%	
x_{el}^N	Nucleon elastic reaction probability	±30%	
x_{inel}^N	Nucleon inelastic reaction probability	±40%	
x_{abs}^N	Nucleon absorption probability	±20%	
x_{π}^N	Nucleon π-production probability	±20%	
x_{mfp}^{π}	π mean free path (total rescattering probability)	±20%	
x_{cex}^{π}	π charge exchange probability	±50%	
x_{el}^{π}	π elastic reaction probability	±10%	
x_{inel}^{π}	π inelastic reaction probability	±40%	
x_{abs}^{π}	π absorption probability	±20%	
x_{π}^{π}	π π-production probability	±20%	

Dan Cherdack

Propagation of Systematics to Sensitivities





- Combined fit of $\nu_e + \bar{\nu}_e + \nu_\mu + \bar{\nu}_\mu$ samples
- Uncertainties on osc. params. and low multiplicity DIS event rate (Rijk) dominate
- Overall, effects are fairly small, considering no ND constraints/cancellations

Radiologicals and Cleanliness

- Preliminary ^{39}Ar model in LArSoft G4 simulation (computational challenge! 14K decays per readout window in 10 kt)
- Cosmogenically-induced radionuclides generated in Argon tabulated
- To do: Itemize radioactivity in solid detector materials and incorporate into simulation

- Cleanliness: Dust characterized in the SURF underground laboratory at the 4850 level and on the sufrace. To do: how radioactive is the dust?
- Radon levels measured underground and at the surface

Collector Deployment

Top: layout for surface runs. Bottom: layout for underground run.

Recording Dust

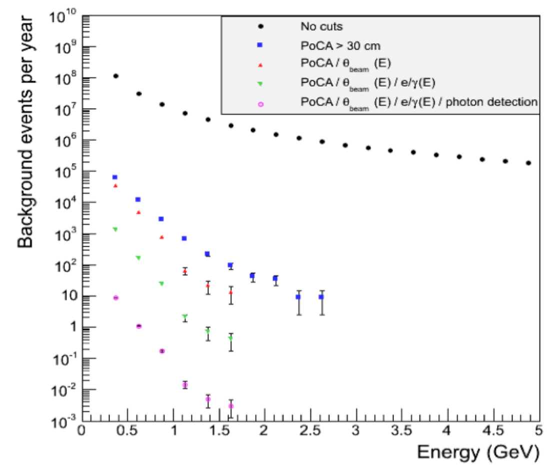
Cosmogenics Summary

Cosmogenics group wants to start working on 35t modeling

Backgrounds to Surface FD ν_e appearance analysis, per Calendar Year

Processes	$E > 0.25$ **GeV**	**PoCA and** $D > 30$ **cm**	**Beam angle**	$e/\gamma\,(E)$	**10 μs**
$\pi^0 \rightarrow \gamma \rightarrow e^{\pm}$	2.2×10^6	9.7×10^4	4.8×10^4	1.7×10^3	12
$\mu \rightarrow \gamma \rightarrow e^{\pm}$	7.1×10^6	12	0	0	0 (<0.003)
Ext $\gamma \rightarrow e^{\pm}$	1.9×10^6	660	340	13	0.1
$\pi^0, K^0 \rightarrow e^{\pm}$	1.4×10^4	810	240	240	1.7
Missing μ	1.3×10^4	1.8×10^3	580	20	0.1
Total μ	1.1×10^7	1.0×10^5	4.9×10^4	2.0×10^3	*14*
Atm n	8.1×10^4	5.2×10^4	2.0×10^4	710	5.1
Atm p (prelim)	1.1×10^5	7.3×10^4	2.5×10^4	910	6.5
Atm γ	10	5	2	0.05	0.0004
Total	1.1×10^7	1.2×10^5	5.6×10^4	2.2×10^3	**16**

Two or Three independent calculations of backgrounds – Sheffield, USD, Catania, BNL



Energy Spectra

Software and Computing Survey Snapshot of Results

Have responses so far from:
University of Minnesota Duluth
Notre Dame
University of Alabama
Duke University
University of Houston
University of Sussex
University of Cambridge
University of Sheffield
Indian Group (filled one response summarizing all)
Tufts University
SLAC
Oxford University
Syracuse University
BNL
FNAL
LBNL
Argonne
Colorado State University
Louisiana State University
LANL
University of Maryland
University of South Dakota
SDSMT
Kansas State University
Michigan State University
Boston University
Northwestern University
University of Catania
U. Texas at Arlington
UC Irvine
University of South Carolina
University of Washington
Kavli IPMU

Most of these are complete responses, some are provisional.

Each has a computing representative.

Software and Computing Survey Snapshot of Results

Survey responses returned late August/Early September 2013
Results in DocDB

Intention was to collect information about

- Whom to contact at each institution for computing issues
- Current software activity (people and FTE's)
    - FD sim/reco
    - ND sim/reco
    - Beam simulations
    - DAQ/Online
    - Databases
    - Fast MC
    - Physics Sensitivities
    - Framework/Core Computing
    - Software management
    - Data Handling
    - Collaboration Tools
    - Other

Results are informative, but a bit informal

Current Effort Breakdown by Task Group, Summed over Institutions

Informal Estimates by IB Reps

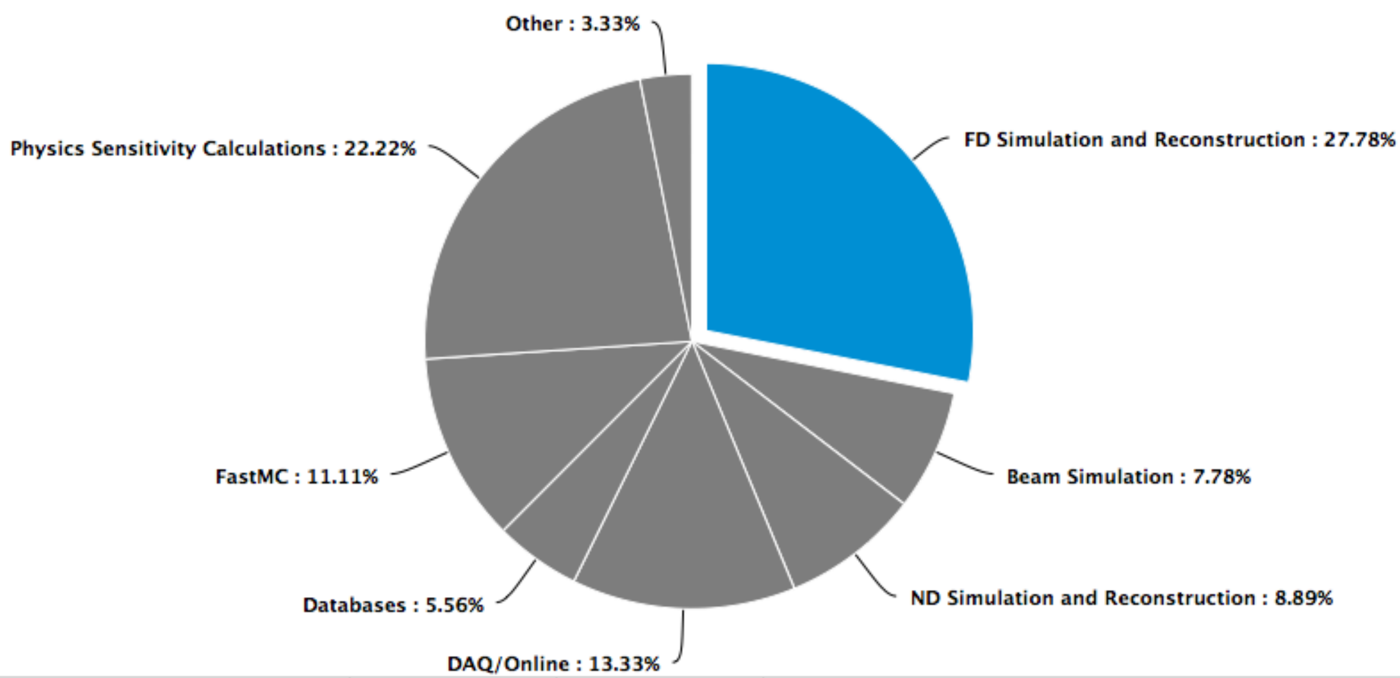
Task Group	Total People	Total FTE
FD Sim/Reco	37	13.4
ND Sim/Reco	4	1.1
Beam Simulations	15	3.76
DAQ/Online	7	1.8
Databases	5	0.85
Fast MC	11	2.85
Physics Sensitivity	26	7.65
Framework/Core Comput	9	3.25
Software Management	6	1.2
Data Handling	6	0.7
Collaboration Tools	5	2.3
Other (GENIE, 35t, ...)	9	2.7
Total	92	25.31

Incl. cosmogenics

Overlapping set of people. Only added Phys. Sensitivity in total

"People" = people x tasks. Many people split their effort and get multiply counted

Which Components of LBNE Software Would Your Group Like to Get Involved in Over the Next Two Years?



Answer	Count	Percent	20% 40% 60% 80% 100%
1. FD Simulation and Reconstruction	25	27.78%	
2. Beam Simulation	7	7.78%	
3. ND Simulation and Reconstruction	8	8.89%	
4. DAQ/Online	12	13.33%	
5. Databases	5	5.56%	
6. FastMC	10	11.11%	
7. Physics Sensitivity Calculations	20	22.22%	
8. Other	3	3.33%	
Total	90	100%	

Software and Physics Tools Survey Results

Feedback from Institutions

- Strong request for remote build features – use local resources, and network latency makes working difficult
- Various operating systems to be used for development (Mac, Ubuntu). Scientific Linux appears to be the standard for production services
- Some complaints about security hurdles being difficult to overcome

Batch, Storage, and Tape:

- Fermilab LBNE disk storage (30 TB data + 2 TB app) is about half full. Large resources waiting to be used at institutions
- More than 4000 batch slots opportunistically available, spread across institutions. Need to smooth over the procedures for putting them to good use for the collaboration

Physics Tools Summary

- Working groups are active and productive.   We benefit from:
  - A strong, attractive physics program
  - CD-1 Approval

- Many challenges lie ahead of us
  - Provide full simulation to back up physics sensitivity calculations
  - Provide reconstruction tools needed to get physics out of 35 t, ND, and FD
  - Provide plots of tool performance – efficiency, background, resolution
  - Devise analysis strategies that minimize total uncertainty
    - Statistical uncertainty for FD analyses will dominate early in the run
    - Systematic uncertainties dominate later – strategies to use the data to constrain systematics
  - Assist in the definition, design, and implementation of 35 t and FD software triggers

- We seek to work closely with ICARUS collaborators – we have much to learn.

Software Suites in Use on LBNE in Physics Tools Groups

FD Simulations and Reconstruction

- LArSoft
- ART
- GENIE
- CRY
- GEANT4
- NEST
- Root

Code management: svn + SRT
Transitioning to git + cmake
Documentation: LArSoft Redmine Wiki + experiment notes

https://cdcvs.fnal.gov/redmine/projects/larsoftsvn

Beam Simulations

- GEANT4
- G4LBNE (V2 and V3)
- CAD tools (Seongtae)
- Root

Code management:
cvs + makefile
Documentation: Beam Sim Redmine wiki + LBNE documents

https://cdcvs.fnal.gov/redmine/projects/lbne-beamsim

We should probably get good at running FLUKA too

MARSLBNE group: independent – runs MARS

Software Suites in Use on LBNE in Physics Tools Groups

ND Simulations

- ART
- GEANT4
- Root

Software Repository: git (I believe) linked on the NDC Redmine page

https://cdcvs.fnal.gov/redmine/projects/lbne-ndc

FastMC

- GENIE
- GLoBES
- Root

Software management: svn + makefile
Documentation:

https://cdcvs.fnal.gov/redmine/projects/fast_mc

Cosmogenics: GEANT4 + Root. Code Needs to be more centrally maintained.
-- Independent Sheffield and Sout Dakota efforts are good for cross-checks but we also need to archive and review

Collaboration Tools In Use by LBNE

DocDB
SharePoint
Redmine
Indico
ListServ
BNL Wiki Page

Used to use BaseCamp (do we still?)
Some large documents used shared svn repositories

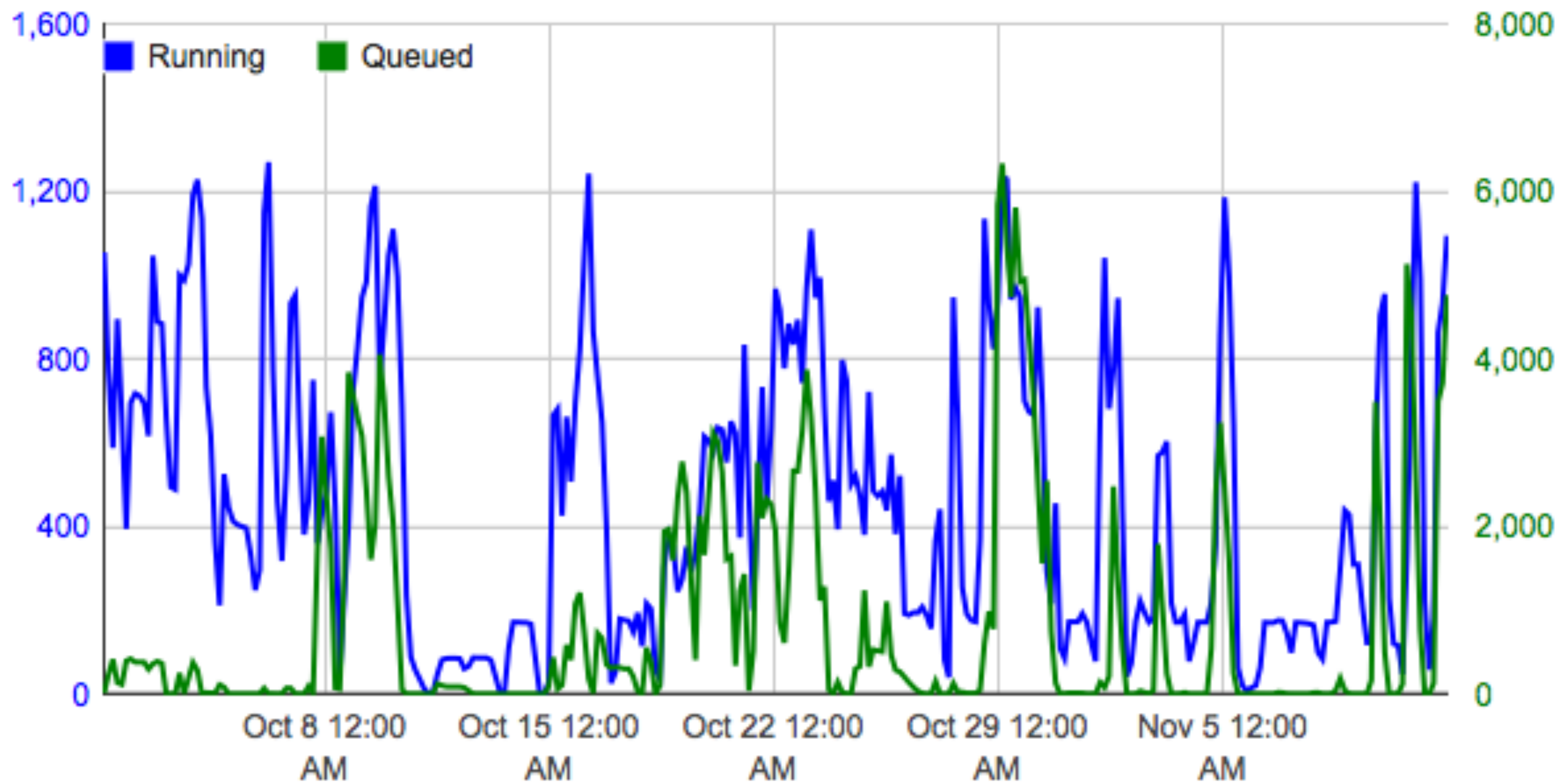
Need to evaluate a control-room logbook. FNAL SCD has a new one in development – had been demo'd at NuComp meetings

LBNE Computing Resource Usage

Since October 1, using FIFEMON

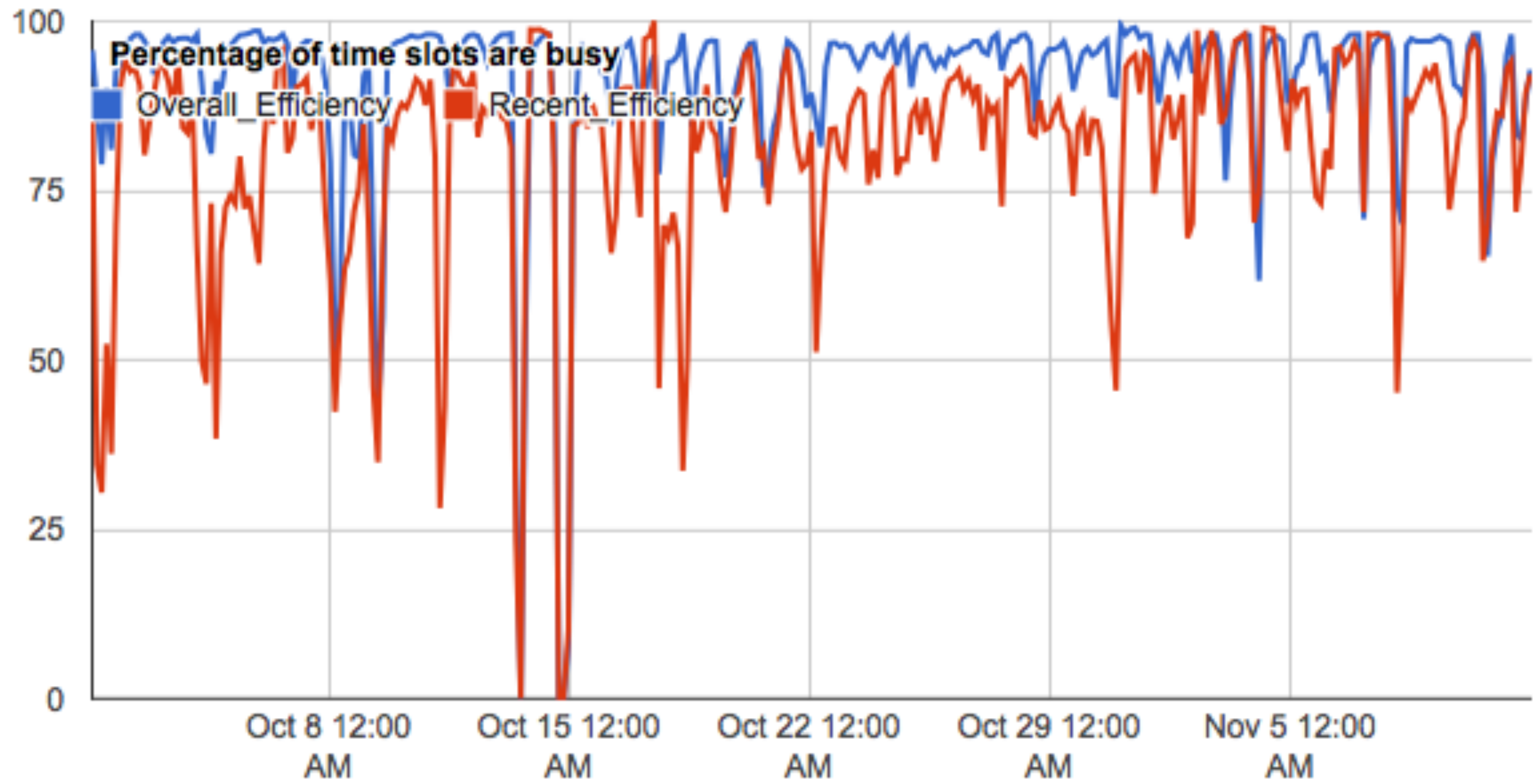
http://fifemon.fnal.gov/lbne/

Average Batch Slot usage: ~250
Spikes up to 1200
Queuing spikes up to 6000



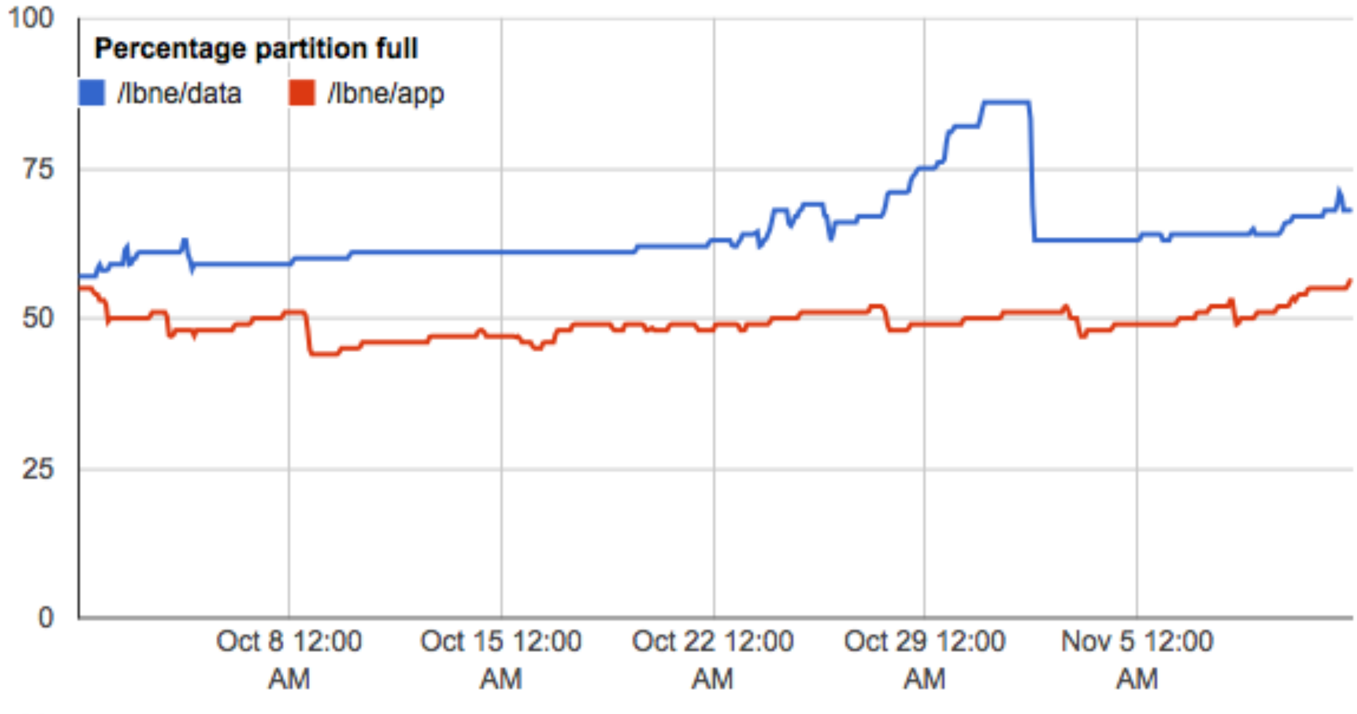
LBNE Computing Resource Usage

Another FIFEMON product – batch job efficiency. Jobs waiting for data delivery use CPU inefficiently. Even though LBNE is waiting for data, our batch jobs aren't



LBNE Computing Resource Usage

BlueArc Disk Usage History for LBNE since Oct. 1



df –h on lbnegpvm02 on Nov. 12 gives:

if-nas-0.fnal.gov:/lbnewc/app
2.0T 1.2T 844G 59% /lbne/app
blue3.fnal.gov:/lbnewc/data
30T 22T 8.6T 72% /lbne/data

LBNE Interactive Computing Resources

lbnegpvm01.fnal.gov SLF5
lbnegpvm02.fnal.gov SLF5

For Software Testing:
fermicloud001.fnal.gov SLF6 -- Ask Steve Timm for accounts
lbnesl6test.fnal.gov SLF6

DAQ Testing:
lbnedaqtest01.fnal.gov

For Data Upload:
lbnesamgpvm01.fnal.gov SLF6

Also a database server (shared?)

For developing GPU code

hpcgpu1.fnal.gov SLF5 -- Ask Don Holmgren for accounts
hpcgpu2.fnal.gov SLF5

Other LBNE Computing Resources

LBLPWG mainly does its computing work (GLoBES, pseudoexperiments, fits, etc.) on University computing facilities – see the software survey

FastMC runs typically at Fermilab but is highly portable. As is G4LBNE

Future usage – We've been signing up new users at a high rate. Brazil, UK, and Indian institutions are joining and becoming active. I expect to outgrow our 30 TB data disk area in a couple of months. We should start using the Enstore + dCache solution coming.

Extras

G4LBNE V3

Paul LeBrun, Seongtae Park