DUNE LBL Plans & Task List

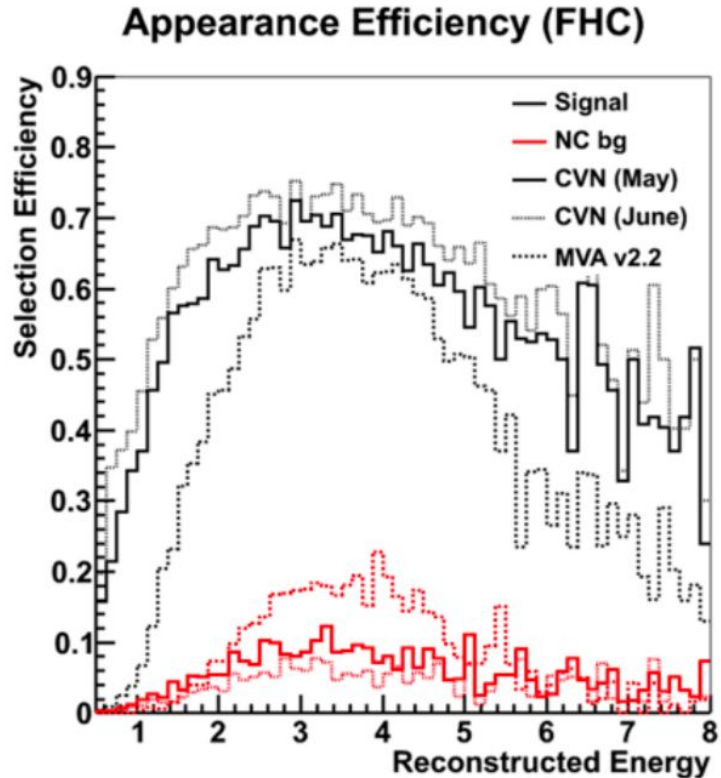Matt Bass
DUNE Physics Week
11/15/2017

Event Selections

Multiple event selections:

- A) Nue/Numu event selection with pmtrack/EMShower (*)
- B) Pandora PID based selections
- C) CVN-based PID (*)

Reco/Pandora based selections need further study and optimization.

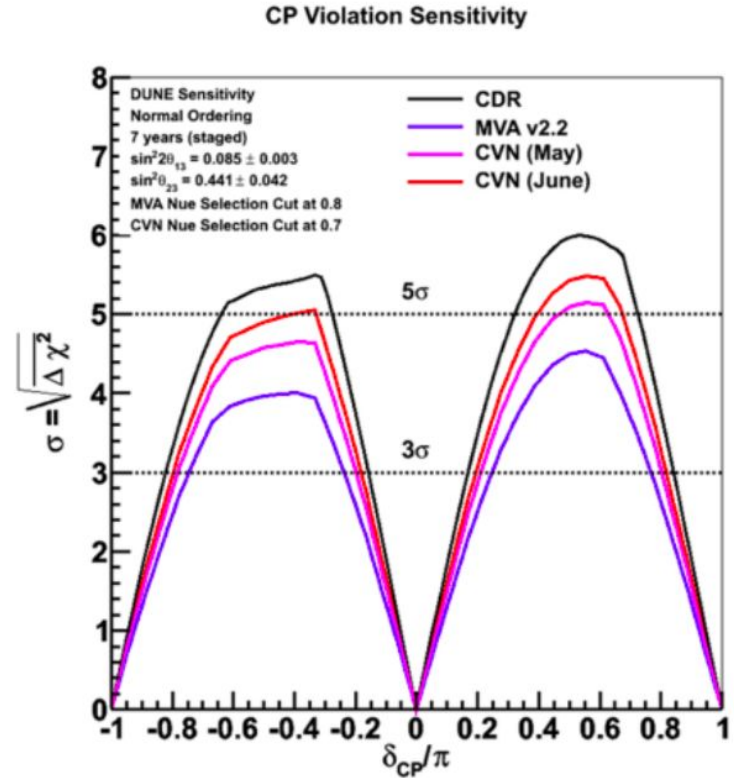CVN studies ongoing…

Appearance Efficiency (FHC)

Event Selections

Multiple event selections:

- A) Nue/Numu event selection with pmtrack/EMShower (*)
- B) Pandora PID based selections
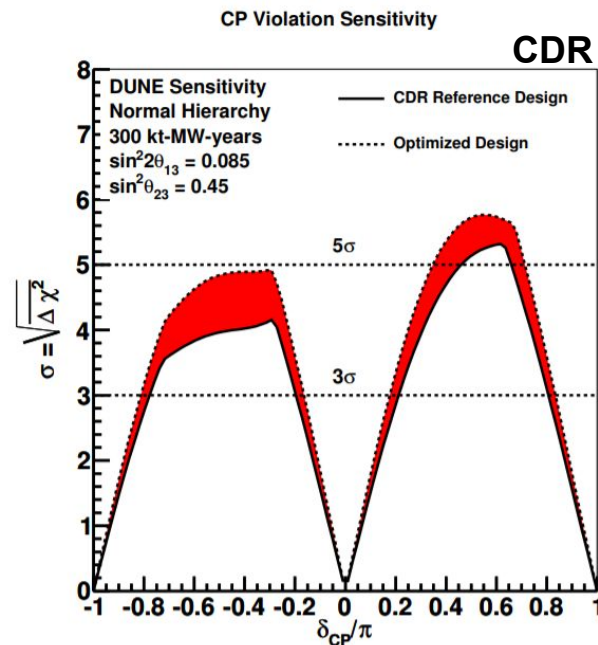- C) CVN-based PID (*)

Reco/Pandora based selections need further study and optimization.

CVN studies ongoing…

CP Violation Sensitivity

DUNE Sensitivity
Normal Ordering
7 years (staged)
$\sin^2 2\theta_{13} = 0.085 \pm 0.003$
$\sin^2 \theta_{23} = 0.441 \pm 0.042$
MVA Nue Selection Cut at 0.8
CVN Nue Selection Cut at 0.7

— CDR
— MVA v2.2
— CVN (May)
— CVN (June)

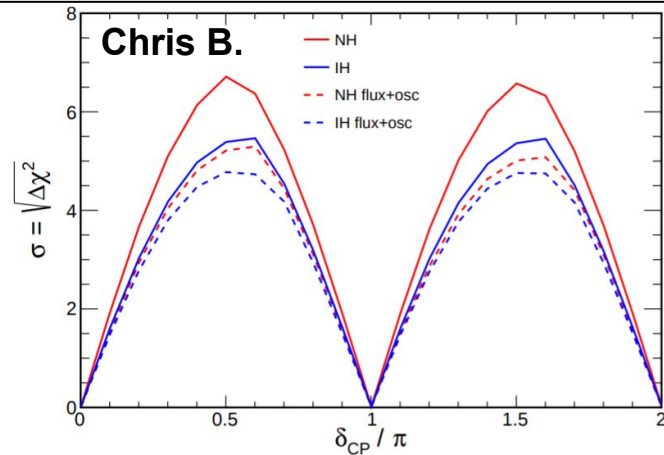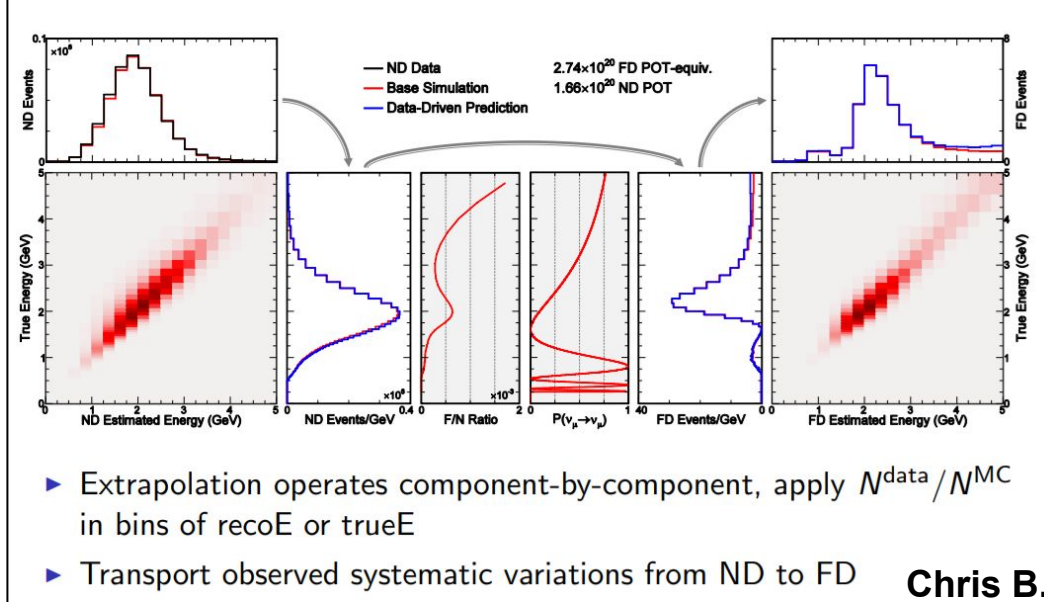$\sigma = \sqrt{\Delta \chi^2}$

δ_{CP}/π

Fitters (GLoBES)

- **GLoBES** based sensitivity studies are the current baseline with multiple configurations available
    - **CDR** configurations
    - **MVA** (multiple versions) and **CVN** based configurations (via MVAtoGLoBES)
- Tools and configurations available in lbl [github](#)
- Will continue to maintain GLoBES configurations, but still planning to use a more flexible, custom oscillation analysis tool

CP Violation Sensitivity

CDR

DUNE Sensitivity
Normal Hierarchy
300 kt-MW-years
$\sin^2 2\theta_{13} = 0.085$
$\sin^2 \theta_{23} = 0.45$

CDR Reference Design
Optimized Design

5σ

3σ

$\sigma = \sqrt{\Delta \chi^2}$

δ_{CP}/π

Fitters (CAFAna)

- Initial **CAFAna** port from NOvA done at February LBL hack days
  - C++/ROOT based
- Used for initial MVA-based sensitivity studies and some ND studies with systematics
  - GENIE reweighting
- Validation in progress (next slide)
- Not much development work planned on CAFAna during physics week
  - Plan to get some documentation in place

► Extrapolation operates component-by-component, apply N^{data}/N^{MC} in bins of recoE or trueE

► Transport observed systematic variations from ND to FD

Chris B.

Chris B.

Fitter validation

To ensure compatibility of fitter results we have established a [fitter validation](#) exercise.

- Standard parameter sets (oscillations, mass, beam power, etc)
- Spectra comparisons
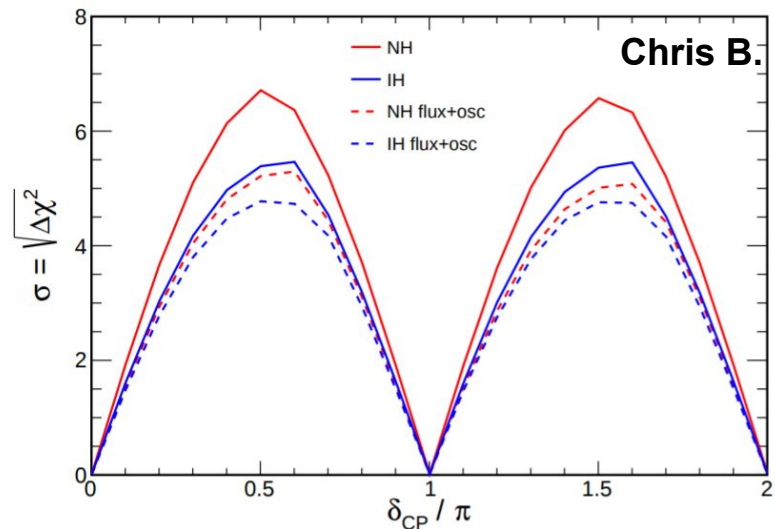- Systematic error propagation
- Direct X^2 comparisons

Baseline is from GLoBES since it was used for CDR. CAFAna validation plots have already by [generated](#) by Chris.

Systematics

Background	Normalization Uncertainty	Correlations	**CDR**
For $\nu_e/\bar{\nu}_e$ appearance:			
Beam ν_e	5%	Uncorrelated in ν_e and $\bar{\nu}_e$ samples	
NC	5%	Correlated in ν_e and $\bar{\nu}_e$ samples	
ν_μ CC	5%	Correlated to NC	
ν_τ CC	20%	Correlated in ν_e and $\bar{\nu}_e$ samples	
For $\nu_\mu/\bar{\nu}_\mu$ disappearance:			
NC	5%	Uncorrelated to $\nu_e/\bar{\nu}_e$ NC background	
ν_τ	20%	Correlated to $\nu_e/\bar{\nu}_e$ ν_τ background	

- **CDR** level systematics are normalization systematics
  - Uncorrelated signal and background normalizations on nue, nue-bar, numu, numu-bar channels (8 nuisance parameters)
  - Initial studies of interaction systematic effects using Fast MC
- Moving beyond this for **TDR** studies
  - Some CafAna [studies](#) with respect to ND
  - **Flux**, **interaction**, and **detector** systematics
  - Possible to supplement with top-down systematics studies
  - Not much recent progress, focus has been on event selections and reconstruction

Reweighting

Some initial work on **cross-section** and **flux** systematics were done with CAFAna, [here](#). Need to have common reweighting mechanisms committed in larsoft though.

There is a larsoft-based reweighting [package](#) in use by MicroBooNE

- Flux and GENIE interaction systematics
- Seems to be a good place to start

Will be exploring this during working sessions, input welcome.

Ongoing analyses/work

Likely an incomplete list...

Topic	People
Nue selection	Mike Wallbank, Jianming Bian, Dom Brailsford
Numu selection	Dom Brailsford
Neutrino energy reconstruction	Nick Grant, Tingjun Yang, John LoSecco
MGT/GLoBES Fits	Matthew Bass, Elizabeth Worcester
CVN for DUNE	Alexander Radovic
Pixel-level CNN	Dorota Stefan, Robert Sulej
CAFAna	Chris Backhouse, Erika Catano Mur, Chris Marshall, Kirk Bays
Dual phase event selections	Dorota Stefan
Matter density studies	Byron Roe
Nutau CC Analysis	Tingjun Yang, Herilala RAZAFINIME, Miriama Rajaoalisoa
DST/CafMaker files	Chris Backhouse, Tingjun, Matt B
Fitter validation	Elizabeth Worcester, Dan Cherdack, Chris Backhouse, Matt Bas
lfit	Tom Junk, Tingjun Yang

Working sessions

Fitter validations with GLoBES. (Elizabeth)

Initial **CAFAna** documentation. (Elizabeth)

Detector systematics (Mike Mooney) - *speaking next*

CafMaker, **reweighting**, production **fcl** updates (Matt Bass)

DUNE **CVN** (Alex Radovic) - *speaking next*

LBL Sessions

Wednesday:

LBL Intro Session: 10am-1pm (Snake Pit - 2NE)

LBL + FD Sim/Reco: 2pm-4pm (Snake Pit - 2NE)

LBL Working Session: 4pm-6pm (Snake Pit - 2NE)

Thursday:

LBL Working Session: 12pm-2pm (Snake Pit - 2NE)

LBL + FD Calibration: 2pm-4:30pm (Snake Pit - 2NE)

Friday:

LBL Working Session: 9pm-3pm (Dark Side - 6NW)

Wrapup:

Next LBL Meeting on 12/4

Resources

Slack channel: https://dunescience.slack.com/messages/physics-lbl/

GLoBES related:
      GLoBES website
      Configurations from CDR: arXiv:1606.09550v1
      MGT: https://github.com/DUNE/lblpwgtools/tree/master/code/mgt
      MVAtoGLoBES: https://github.com/DUNE/lblpwgtools/tree/master/code/MVAtoGLoBES

CafAna related:
      Github: https://github.com/DUNE/lblpwgtools/tree/master/code/CAFAna
      Overview/usage talks: 1, 2, 3

CVN & DL related:
      Deep Learning on DUNE workshop
      Pixel-level CNN for LBL neutrino events talk
      Overview/usage talks: 1

Reresources

Selections:

MVA selection and CAFMaker on redmine

MVASelect documentation

Pandora-based PID talk

LArSoft

Tutorial session from yesterday