

# CAFAna port to DUNE and thoughts on AnaTree files

## DUNE LBL group meeting

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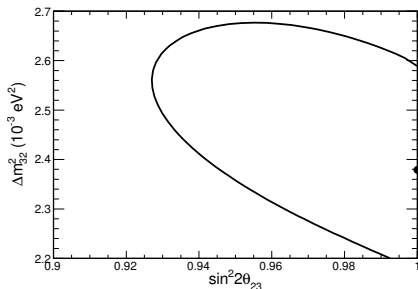
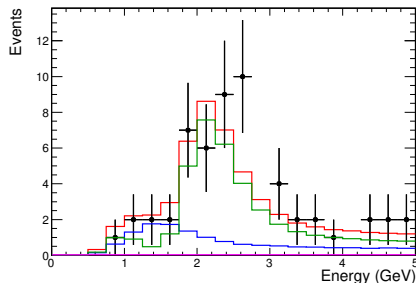
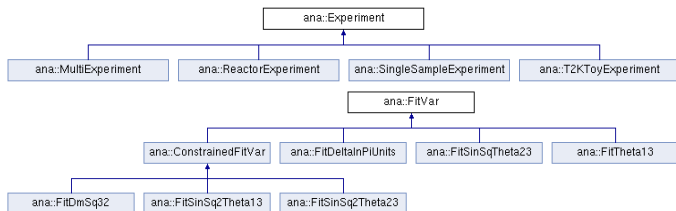
# Introduction

- ▶ Used by  $\nu_e + \nu_\mu$  + NC analysis groups in NOvA + several xsec analyses  
→ battle-tested, plenty of experienced users, code well-commented
- ▶ Input is NOvA's **C**ommon **A**nalysis **F**iles  $\approx$  AnaTree
- ▶ Structured as a bag of tools to plug together, flexible, not monolithic
- ▶ Fast turnaround for plot-making as well as oscillation fits
- ▶ Fast enough to use interactively.  $\mathcal{O}(\text{minutes})$
- ▶ Include systematics by profiling over pull terms. Includes FC tools

# Details

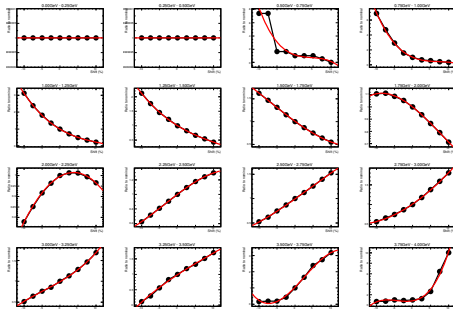
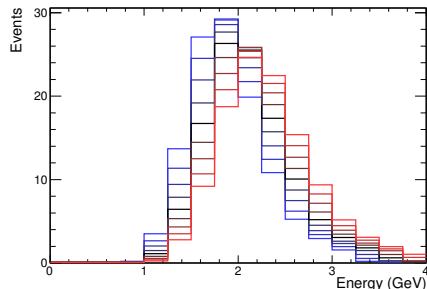
- ▶ Extract single property of an event record with `Var` or `Cut`
- ▶ Implement on-demand loading so not always sucking in the full tree
- ▶ These can be combined with simple arithmetic and logical operations
- ▶ `Spectrum` ( $\sim$ TH1) and `OscillatableSpectrum` ( $\sim$ TH2)
- ▶ Keep track of their POT through all operations, so it's hard to screw up exposure calculations
- ▶ Oscillations happen in  $1/E$  bins – much faster than event-by-event

# Fitting



- ▶ Basic object here is the Experiment – computes  $\chi^2(U_{\text{PMNS}})$
- ▶ Minuit minimizes LL of data to MC, profiling over nuisance params
- ▶ External constraints can easily be included
  - ▶ Quadratic penalty term to importing surfaces to mocked-up toy analysis

# Systematics



- ▶ Systematics transparent to almost all components
- ▶ Reweight (eg GENIE) or rewrite (eg E scale) records as they're loaded
- ▶ Last step before fit interpolates  $\pm 1, 2, 3\sigma$  histograms bin-by-bin
- ▶ Profile over systematic nuisance parameters
- ▶ Don't go crazy with the systematic count, but  $\mathcal{O}(10)$  works

# Port

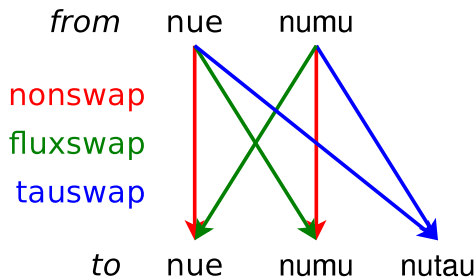
- ▶ Basic port accomplished at LBL hackdays
- ▶ Copy-pasted subset of NOvA files with adjustments for file loading
- ▶ Retained SRT build system for convenience

```
git clone https://github.com/DUNE/lblpwgtools.git
cd lblpwgtools/code/CAFAAna/
./checkout.sh
source setup.sh # on each login
cafe test/test_dune.C
```

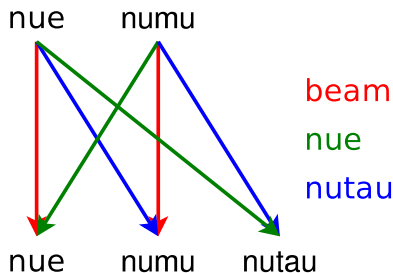
- ▶ Runs on AnaTree files, only variables available so far are:  
Ev\_reco, mvareresult, Ev, ccnc, beamPdg, neu
- ▶ Others are easy to add if necessary
- ▶ NOvA-centric help at [http://cdcvs.fnal.gov/redmine/projects/novaart/wiki/CAFAAna\\_resources](http://cdcvs.fnal.gov/redmine/projects/novaart/wiki/CAFAAna_resources)
- ▶ Results from Kirk in following talk

# Swap files

## NOvA



## DUNE



- ▶ Personally I find the DUNE swap names very confusing, and the pattern of swaps counterintuitive too
- ▶ Advantage of the MINOS/NOvA scheme: tauswap file is definitely subdominant and can be omitted in quick work
- ▶ Stated advantage of DUNE scheme: if you know the file-type you don't need to look at *from*

## Global comments

- ▶ Each row of a NOvA tree is a single StandardRecord object
- ▶ DUNE uses flat trees, no position yet on what's best technically
- ▶ Does require me to write boilerplate to load branches into object for CAFAna use
- ▶ Different swap types are all concatenated into one input file
- ▶ Have to know magic run numbers (beam = 20000001 etc) to decipher POT
- ▶ Three separate files best, different folders in one file if necessary
- ▶ POTs are scaled for 1.13kt, might be friendlier to pre-scale to expected FD mass



## Specific comments

- ▶ Consensus at workshop we need a unified tree structure (FD/ND, full sim/fast MC)
- ▶ NOvA StandardRecord variables for reference

[http://nusoft.fnal.gov/nova/novasoft/cafdox/html/classcaf\\_1\\_1StandardRecord.html](http://nusoft.fnal.gov/nova/novasoft/cafdox/html/classcaf_1_1StandardRecord.html)

- ▶ mvaResult meaning differs in numutest.root and nuetest.root
- ▶ Understandable but potentially very confusing
- ▶ Various nits about variable names etc
  - ▶ Truth and reco variables not clearly separated
  - ▶ coh/dis/mode redundant
  - ▶ cc/nc/ccnc redundant
  - ▶ Variable names unclear, e.g. neu
  - ▶ What is weight?
  - ▶ ...