Requirements and Needs From Intensity Frontier Neutrino Experiments

Brian Rebel

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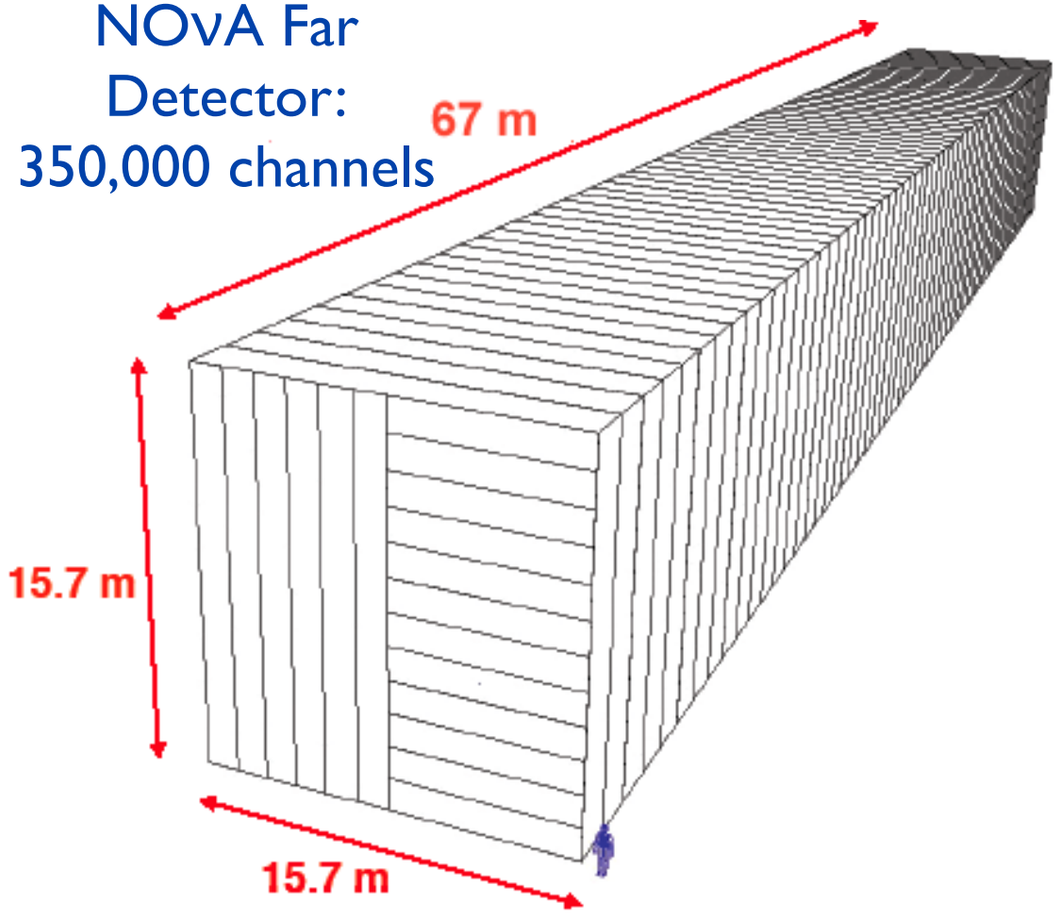
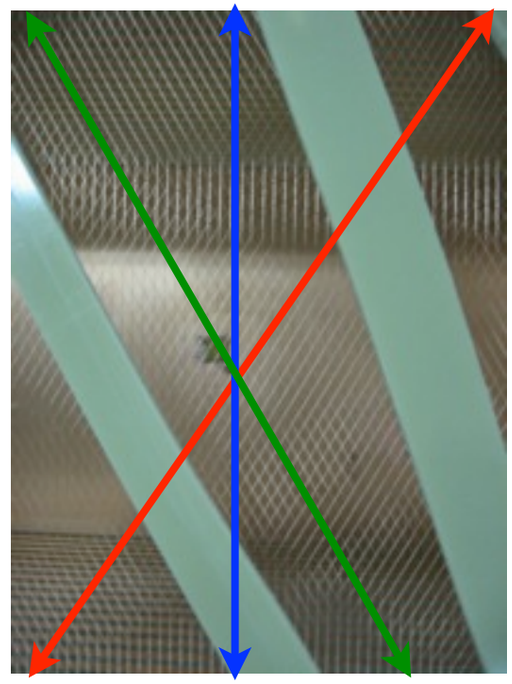
Outline

- Description of detector geometries
- Basics of simulation, reconstruction, and analysis chains
- Wish list of improvements for the software
- Computing needs of neutrino experiments

Detector Geometries

NOvA Near Detector: 18,000 channels



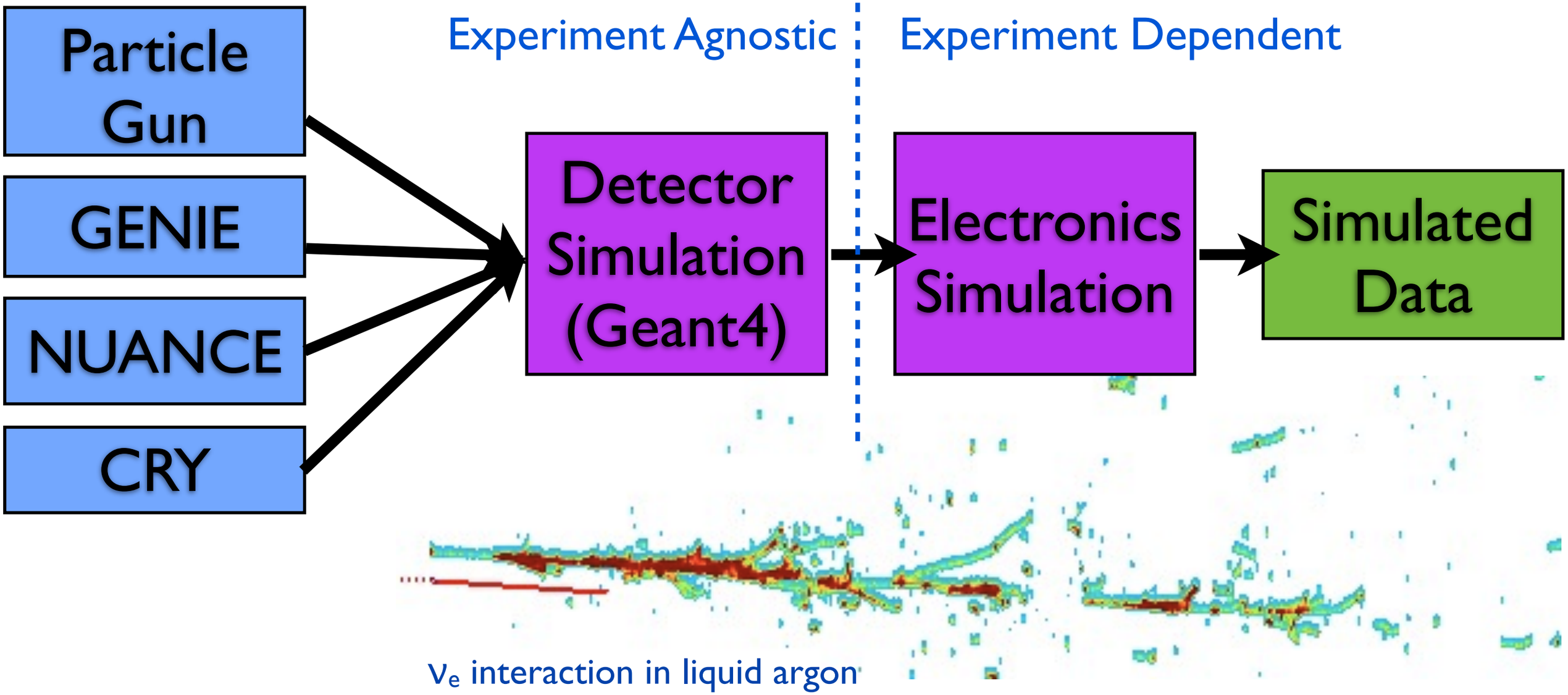


LArTPC: 1.3M channels in LBNE

- Detectors tend to be made of many copies of a basic unit
  - NOvA has cells that are ganged together into modules that are ganged together into blocks
  - μBooNE has 3 planes of readout wires
  - LBNE has a lot of TPCs, each with 3 planes of readout wires

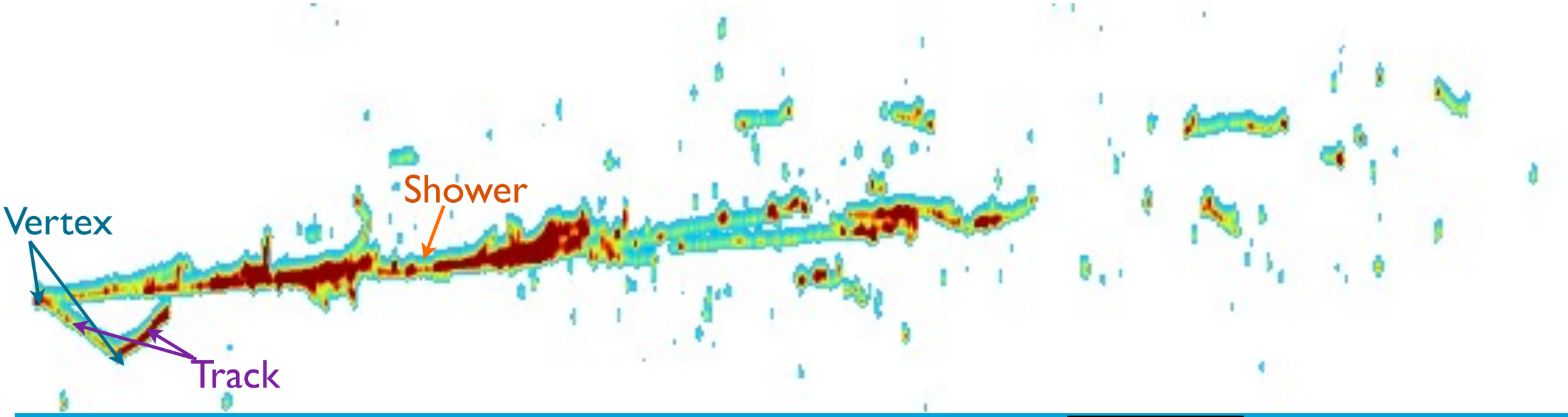
Simulation Chain

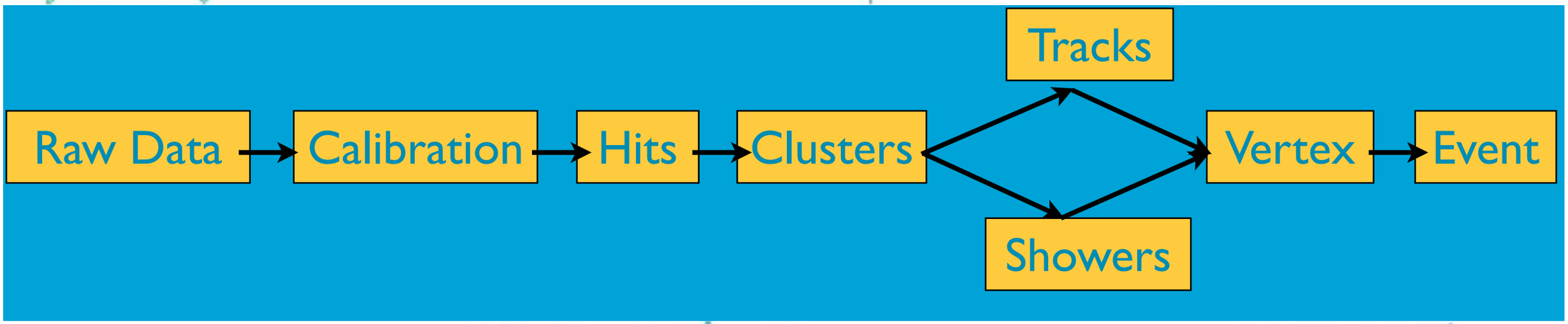
- The neutrino experiments have the same basic approach to simulation
- Making use of components that are shared amongst experiments and components that are experiment dependent



ν_e interaction in liquid argon

Reconstruction Chain





Analysis Chain

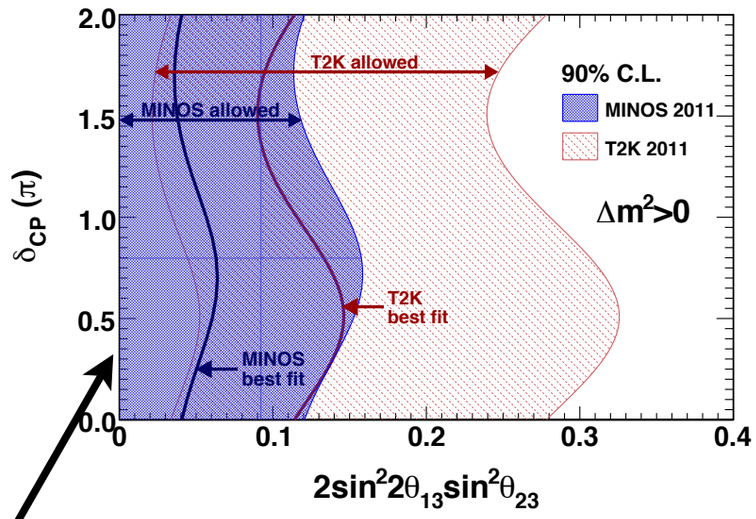
Reconstructed information

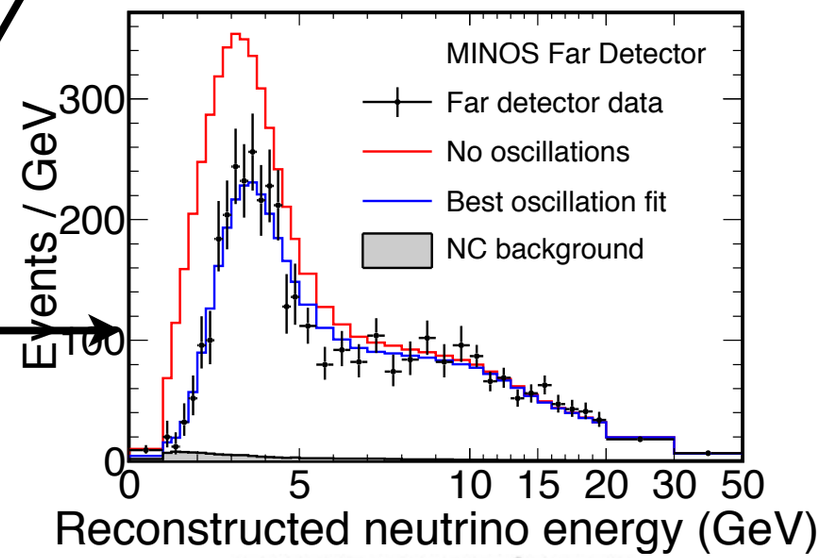
Calibrations

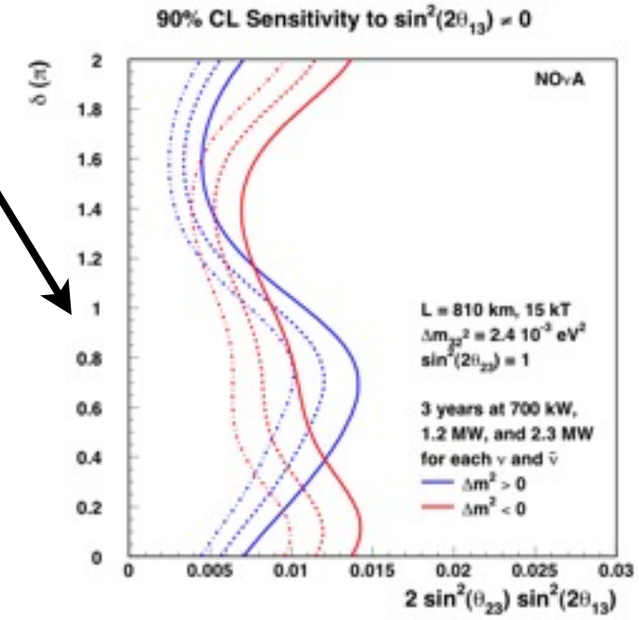
Particle ID

Event Selection

- Going from event selection to final result typically requires multiple iterations of the same step, ie finding best fit point in a space
- Making contours typically done with Feldman-Cousins method of creating thousands of pseudo-experiments
- Many opportunities for parallelization







Production of MC and Data files

- Most production of files will be done either using Fermigrid, OSG, or University clusters
- Some use will be made of small clusters provided through grants to individual university groups
- Want to be sure that people running on laptops and desktops are not excluded

Software Wish List

- We are not making use of parallelization - all software is single threaded
- Many algorithms would benefit from parallel operation
  - Reconstruction: Hough transforms, clustering algorithms, track finding in multiple views, etc
  - Geometries are all parallelizable, would be great to not have to load in the full geometry and just get the bits that are needed for the current event
  - Processing files at the event level could be made parallel (currently we get the poor man's version by processing files across a farm)
- The benefits of parallelization would like be more pronounced as detector channel counts continue to increase

Data Rates

Experiment	Event Size	Event Processing time	ν Events/year
NOvA	Varies, could be 500k at FD	0.1 s	1k FD, Millions ND
μBooNE	192 MB	6 s	~50k
LBNE	Varies, could be of order 1 GB at FD	Not yet known	5k FD, Millions ND

Computing Needs: Production

- Data movement:
  - Most processing of data would likely happen at Fermilab
  - Production of MC and perhaps some data processing at remote sites
  - For long baseline experiments also need to move data from the far detector to Fermilab
- Job size:
  - Some simulation jobs can take up to 1.5 GB of memory for the generator alone, currently avoid memory limits by breaking jobs up into smaller footprint chunks
  - Large geometries can take several hundred MB of memory as well
- Throughput:
  - Calibrations have historically taken too much time for MINOS, would like faster turn around
  - MC production can take quite a while, like to have at least 10x the data set; mainly an issue for near detectors

Computing Needs: Analysis

- Neutrino experiments typically have small data sets compared to collider experiments, but still would like to see faster throughput
- Need to minimize overhead when doing production runs
  - Files are written to disk each hour
  - Would like to gang multiple files together in a single job to make more efficient use of processes like loading constants