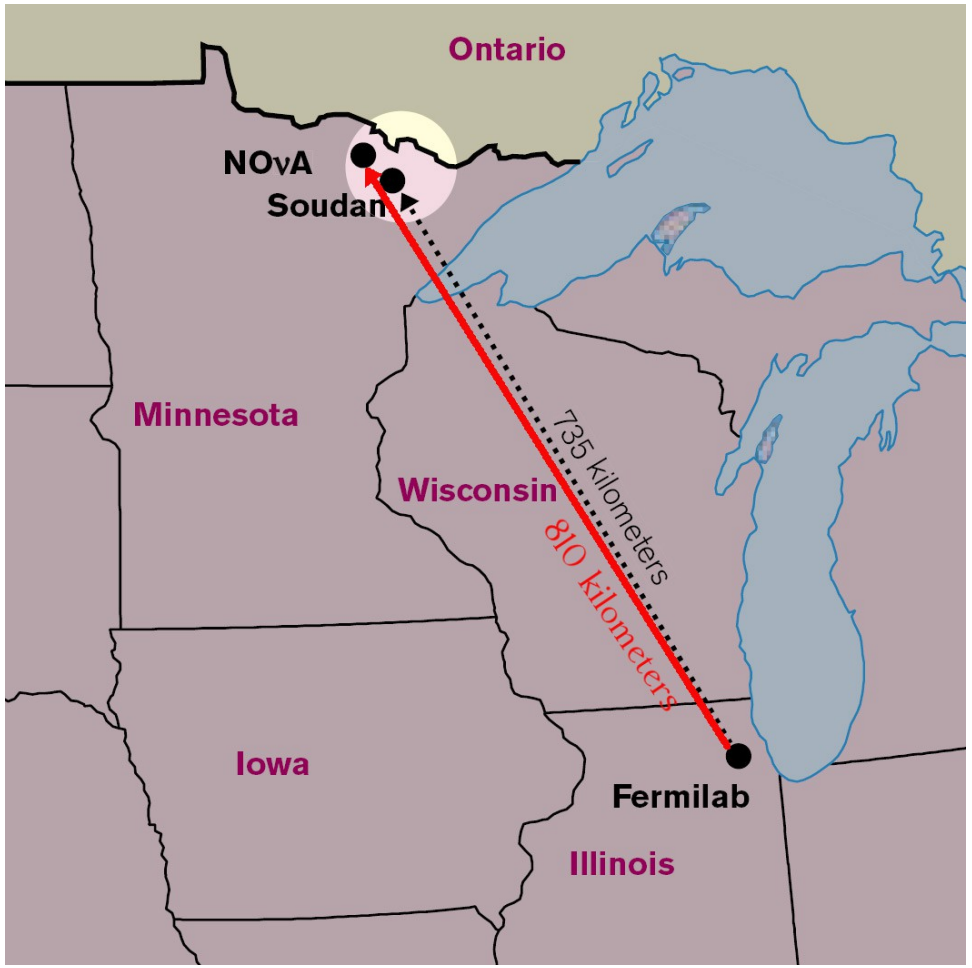
The NOvA Experiment

Xuebing Bu

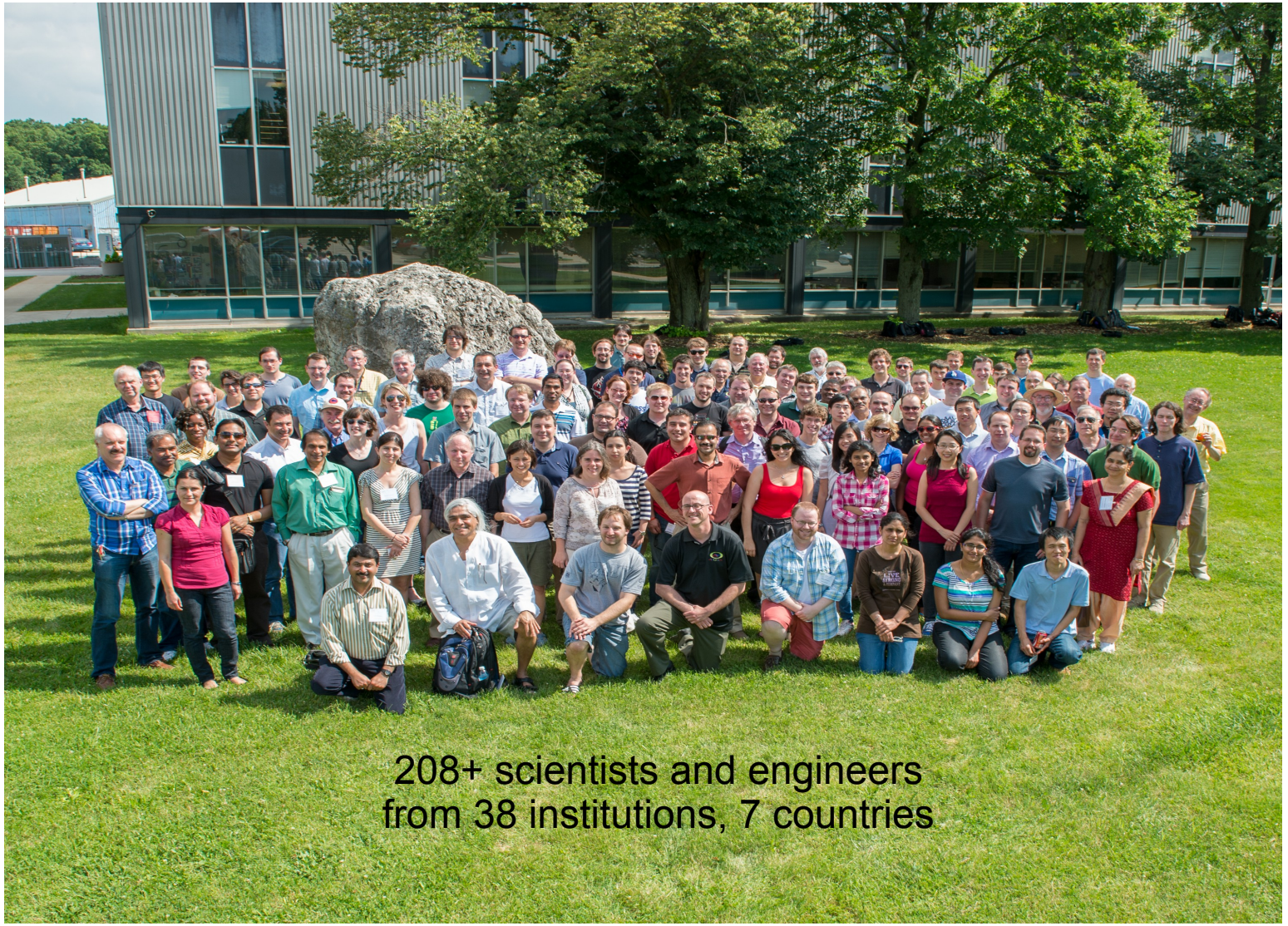
for NOvA collaboration

NOvA Experiment

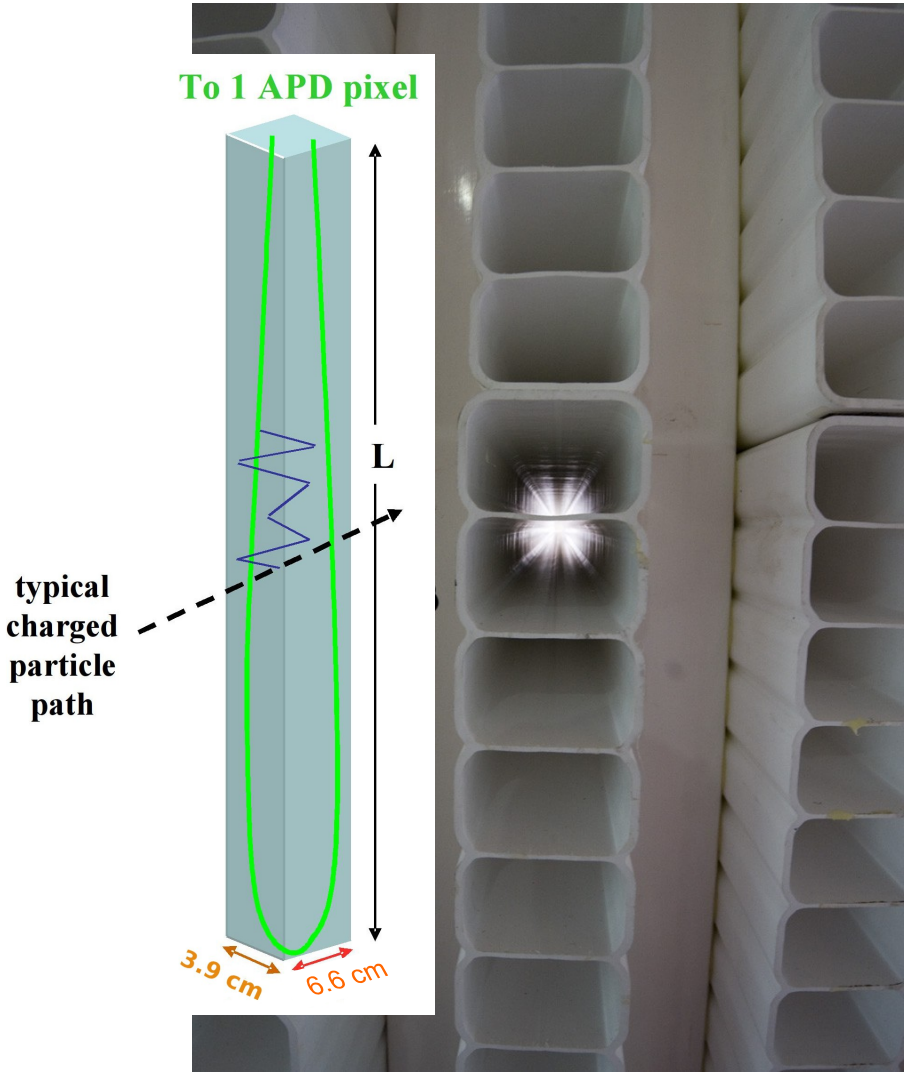


- Long-baseline experiment with two detectors
  - L/E ~ 400 km/GeV
- Physics goals
  - Study neutrino and antineutrino oscillations to determine mass hierarchy, CP violation , and more

NOvA Collaboration

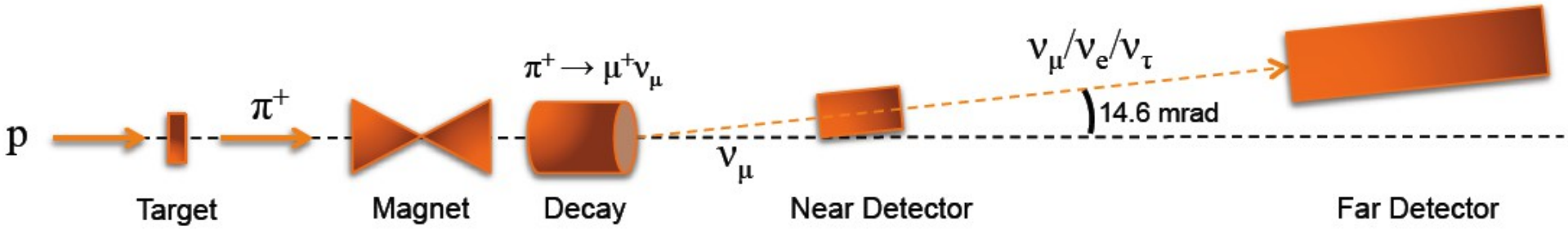


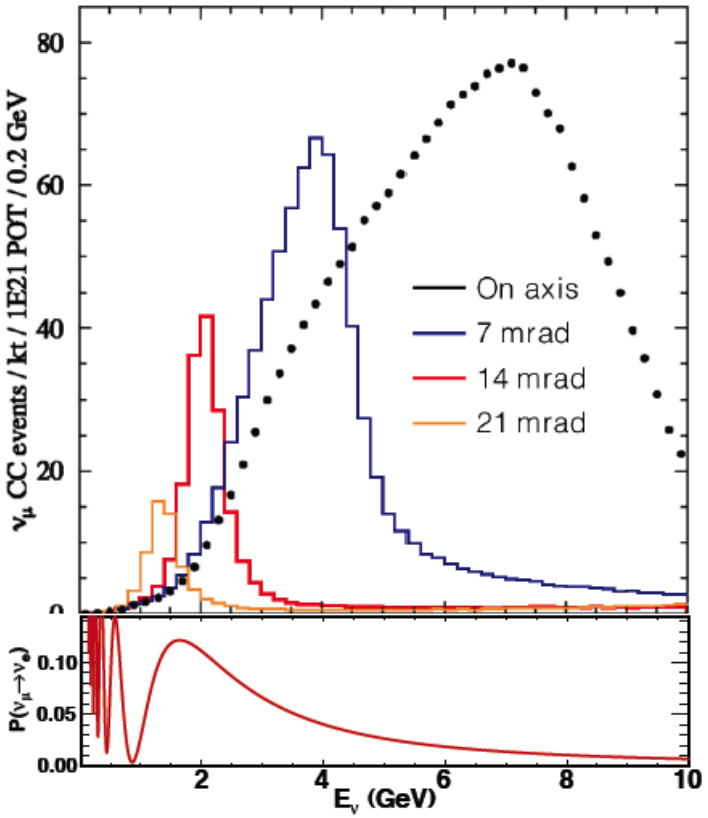
Detector Technology



- PVC cells (long tube)
- Each cell contains one wavelength-shifting fiber
- Filled with scintillator oil
- One module composed by 32 cells is read out by one avalanche photo-diode

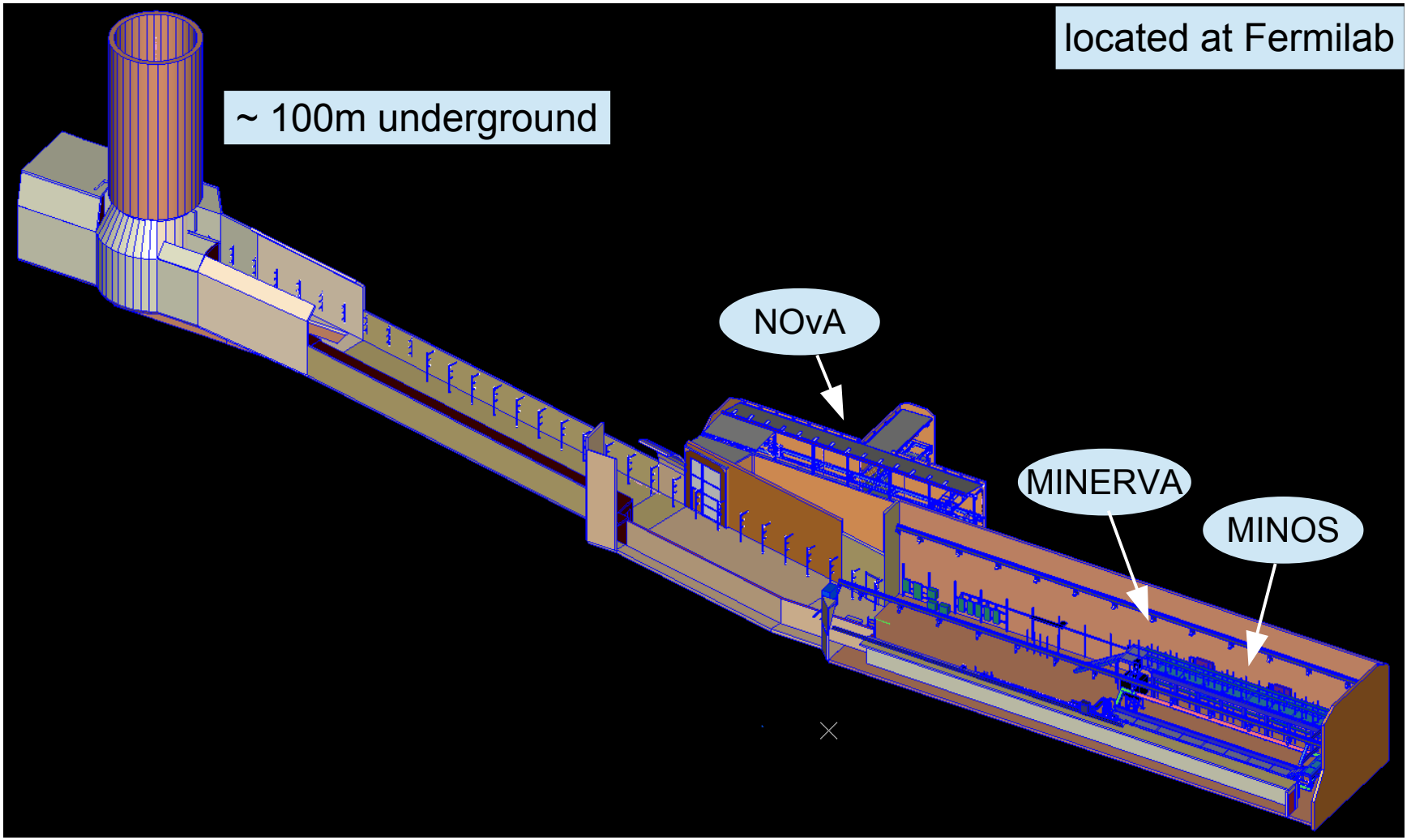
Off-Axis Beam



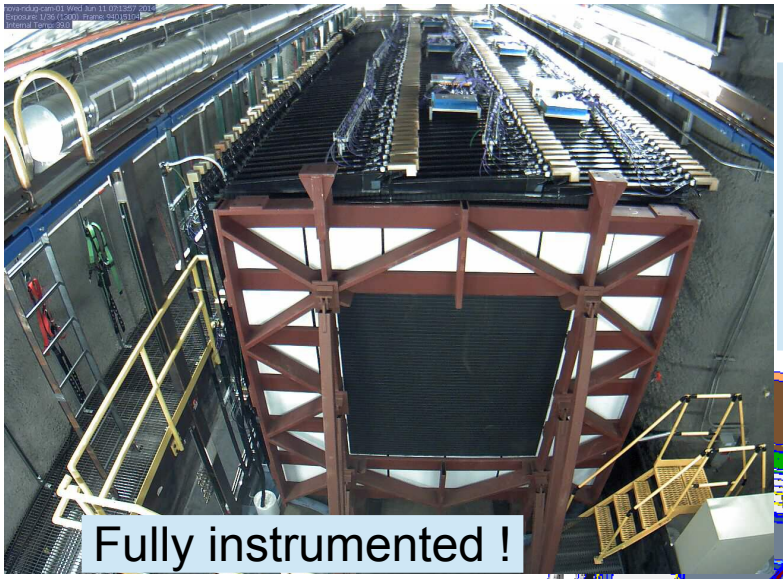


- Detectors are installed by 14.6 mrad off beam axis
  - Narrow band beam peaked at 2 GeV
  - Near maximum oscillation
  - Reduced high energy neutral current events

Near Detector

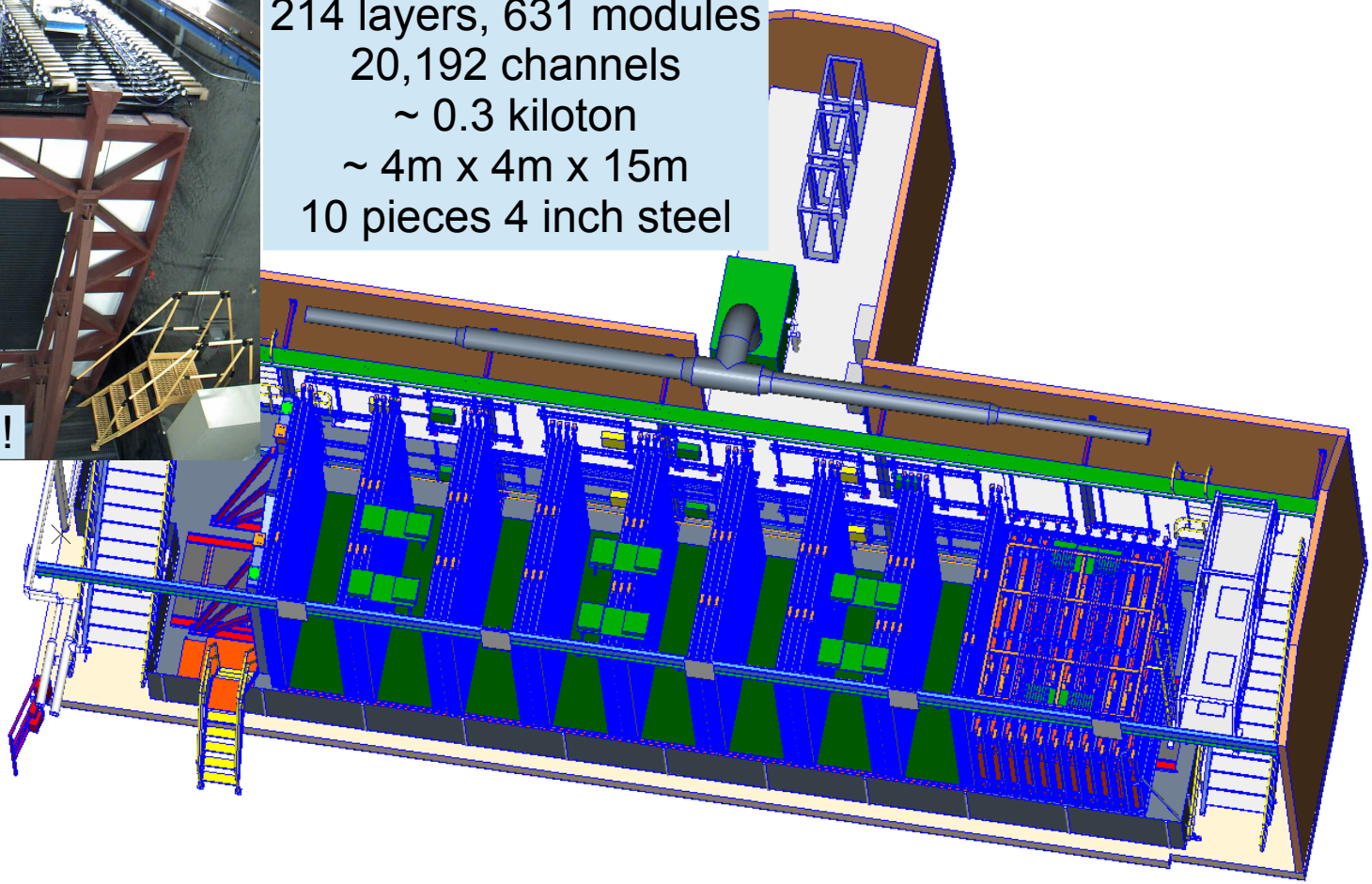


Near Detector



Fully instrumented !

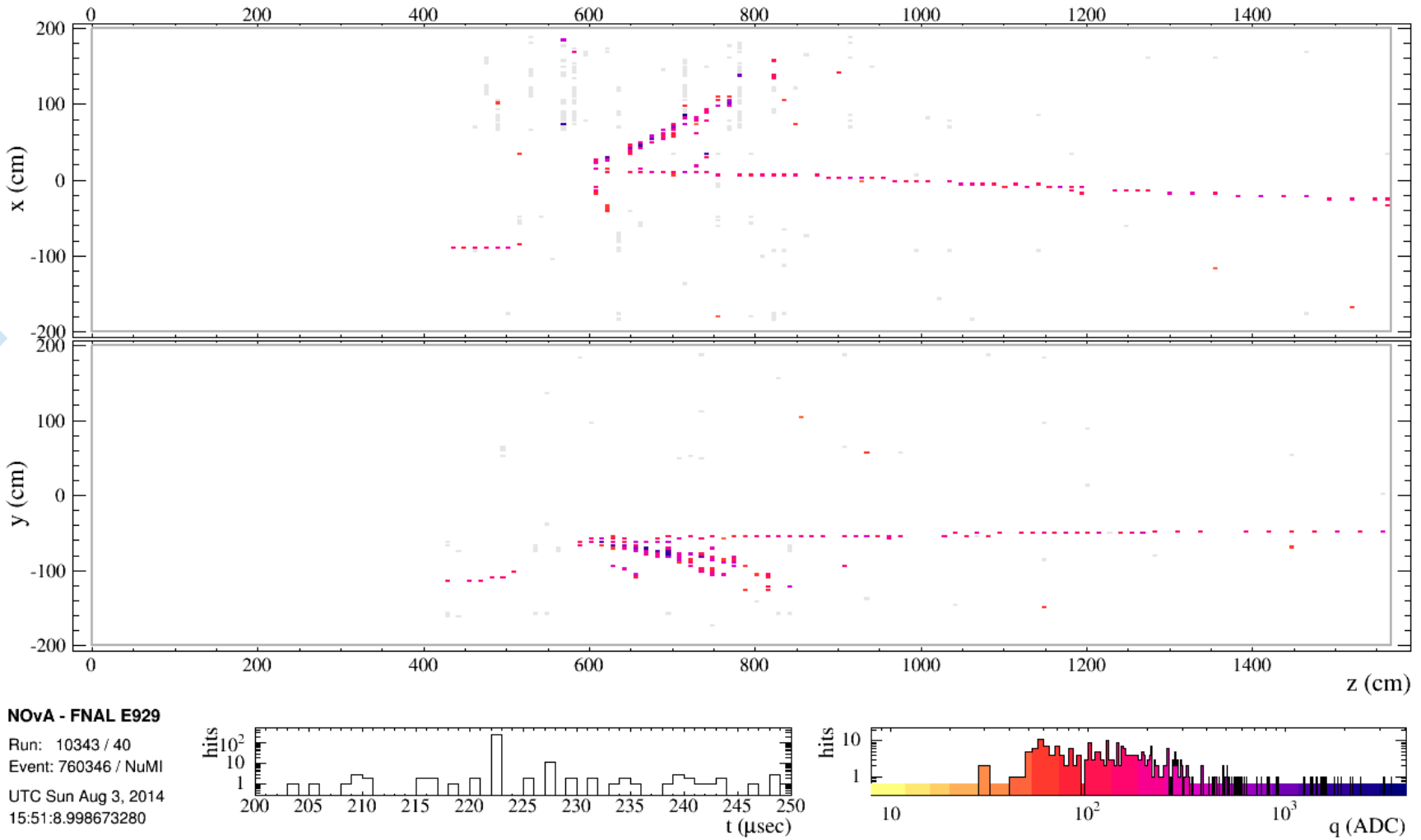
214 layers, 631 modules
20,192 channels
~ 0.3 kiloton
~ 4m x 4m x 15m
10 pieces 4 inch steel



Near Detector

Data event display, ν_μ CC candidate

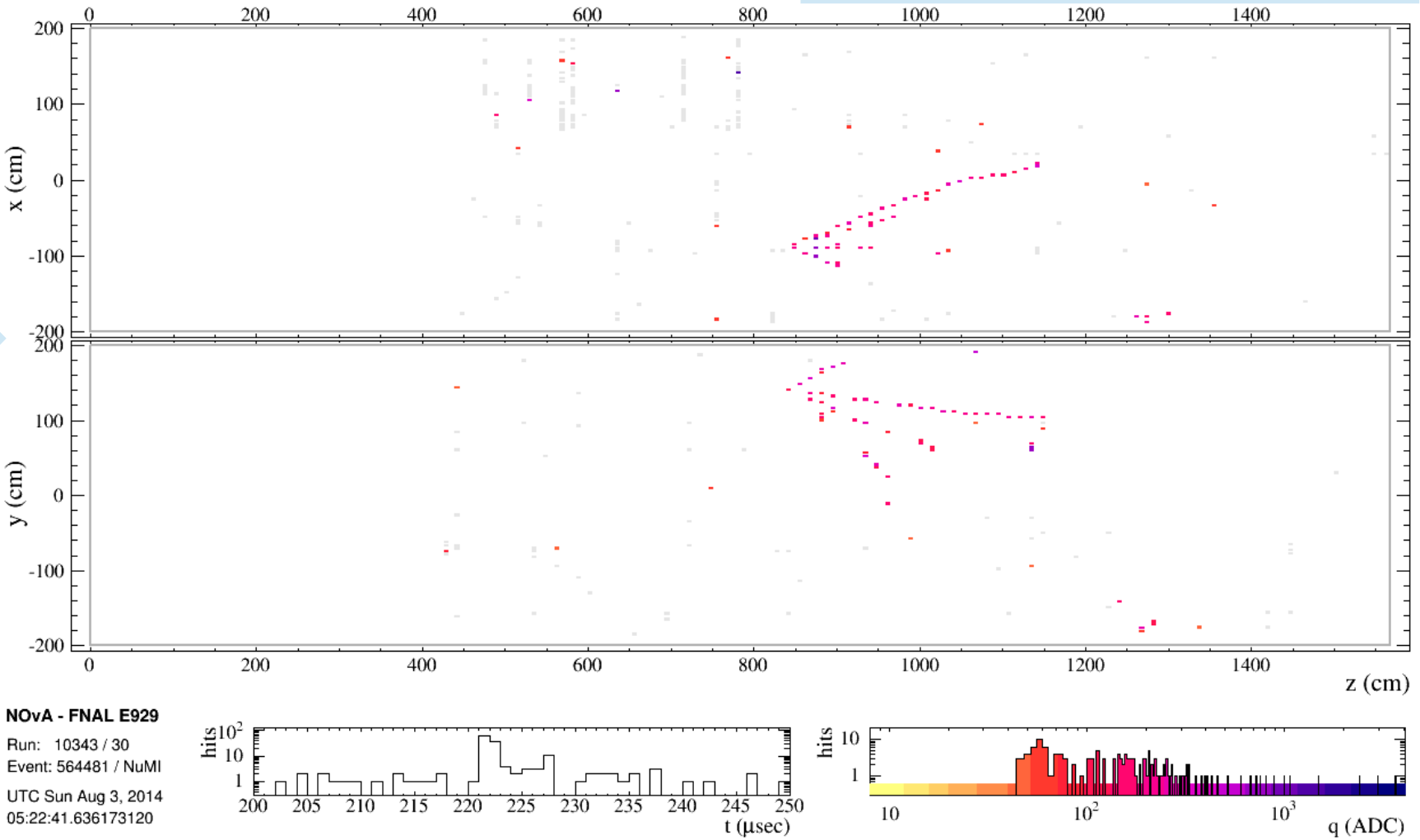
beam



Near Detector

Data event display, NC candidate

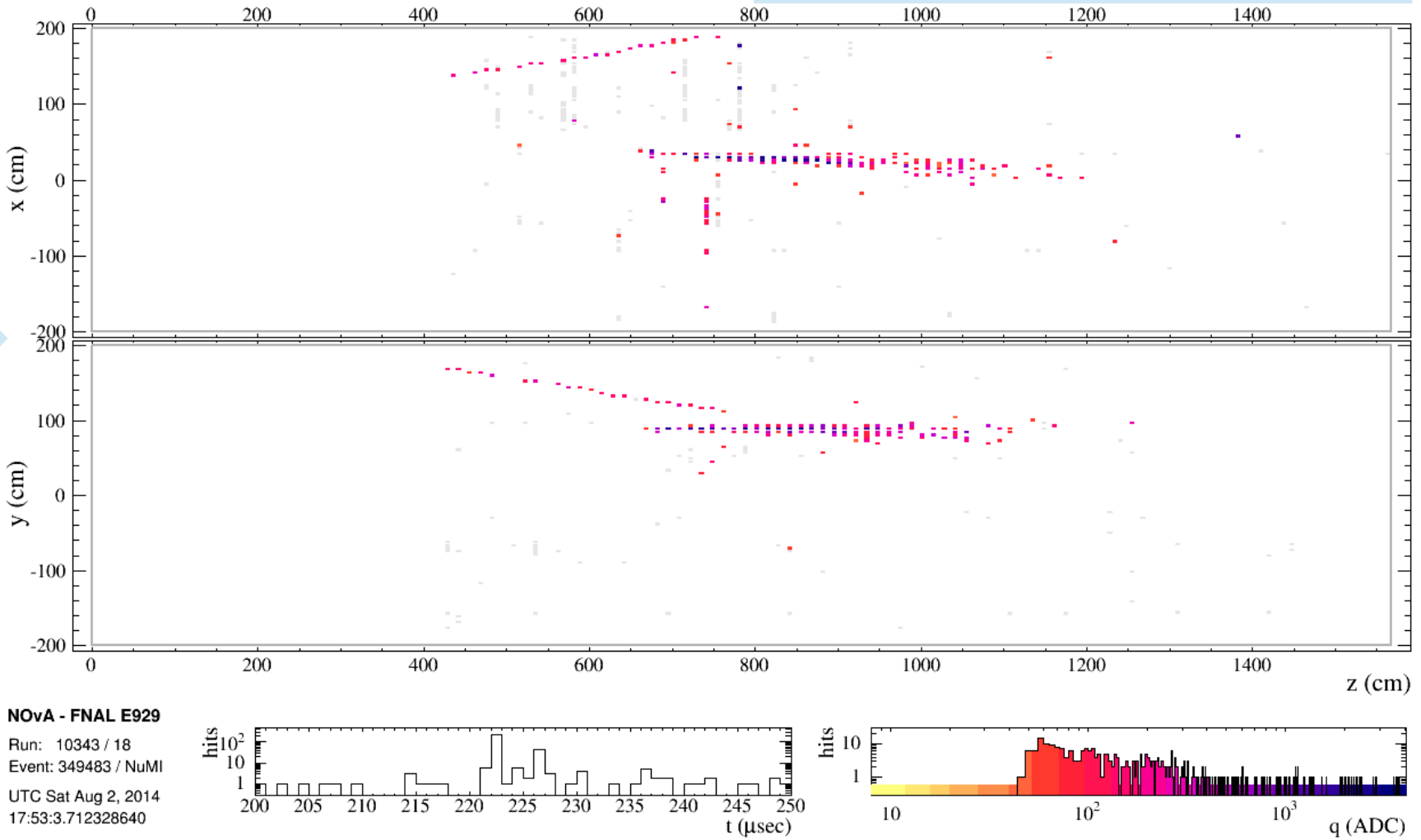
beam



Near Detector

Data event display, ν_e CC candidate

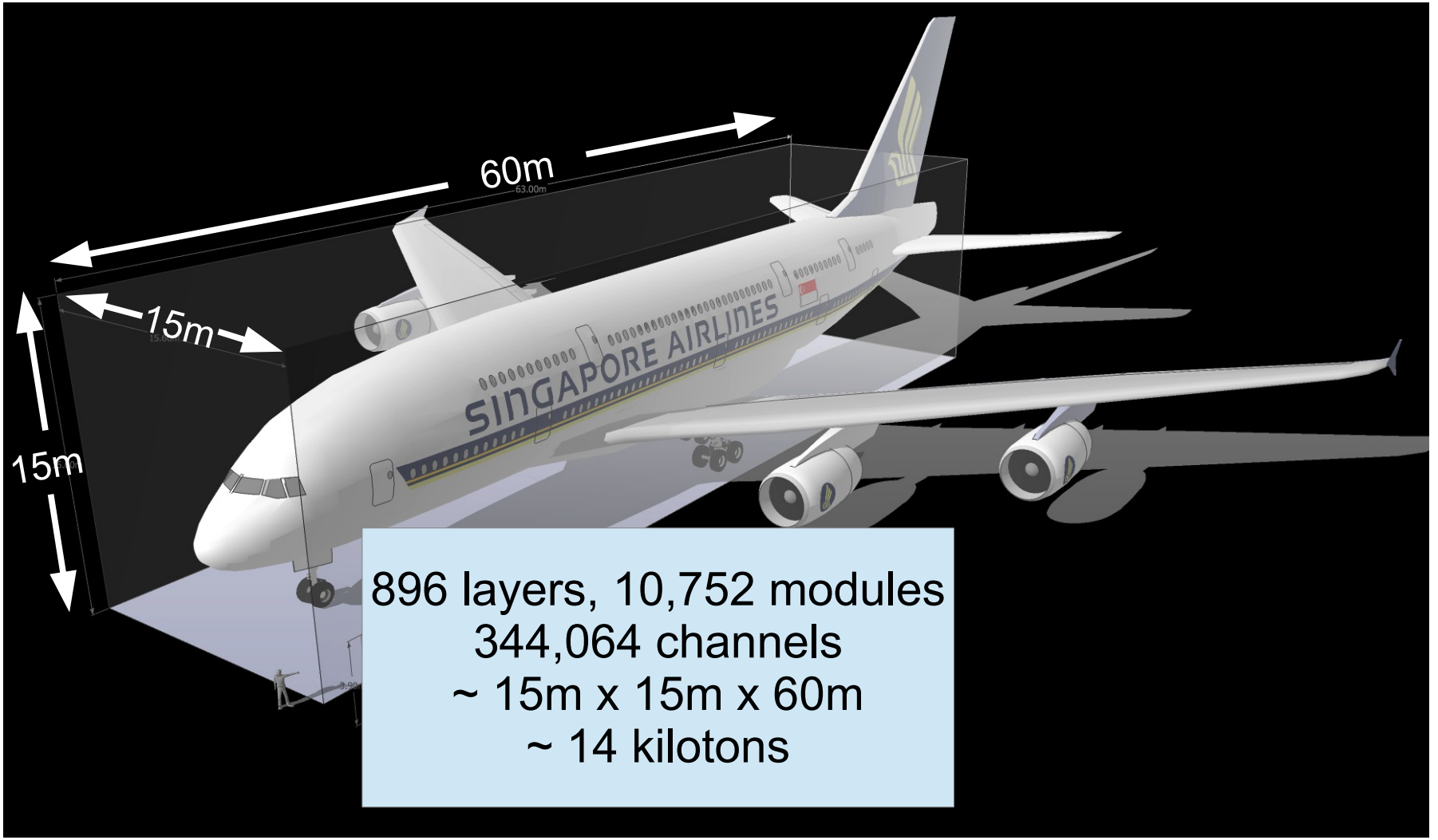
beam



Far Detector

located at Ash River, Minnesota

Far Detector



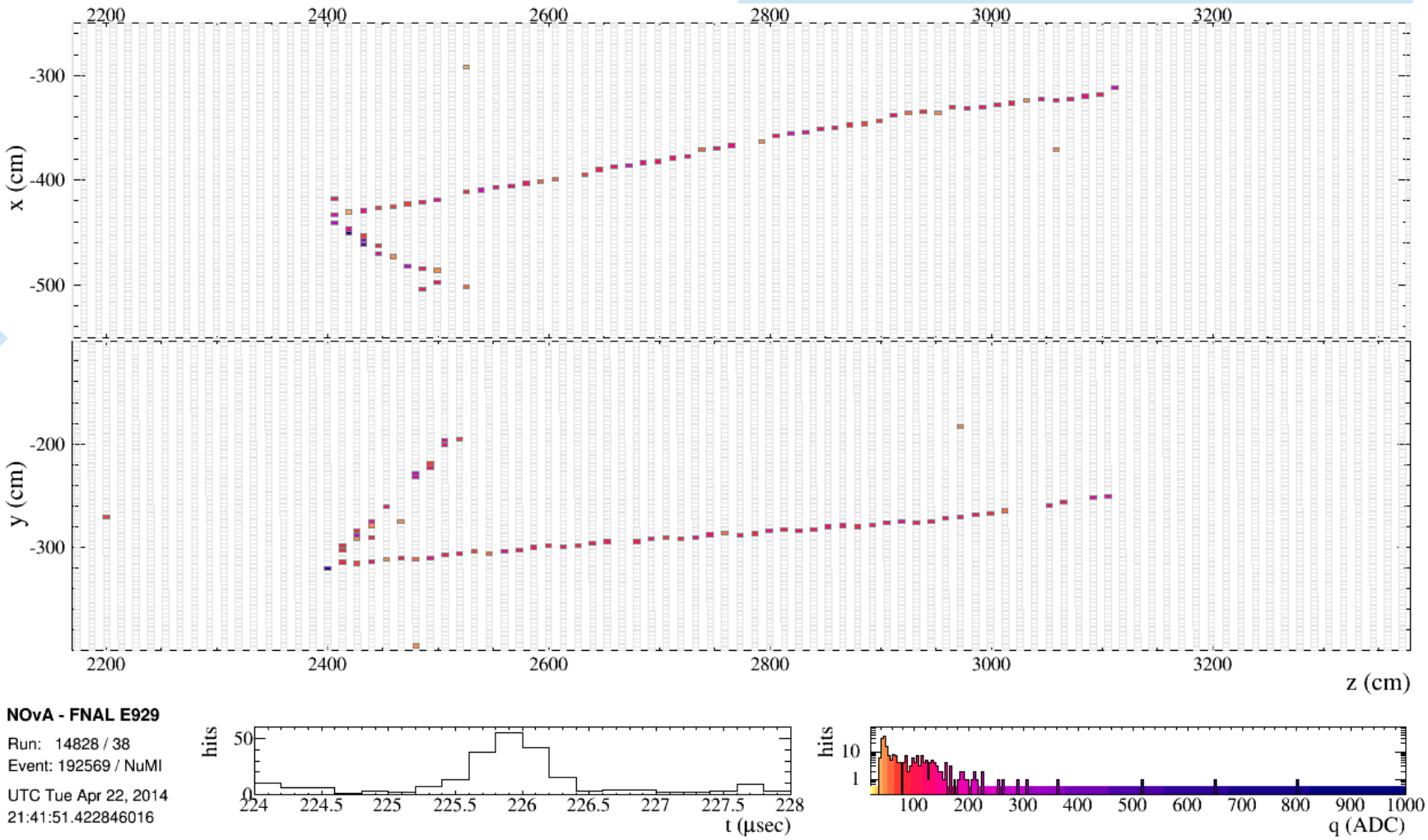
Far Detector

Fully instrumented !

Far Detector

Data event display, ν_μ CC candidate

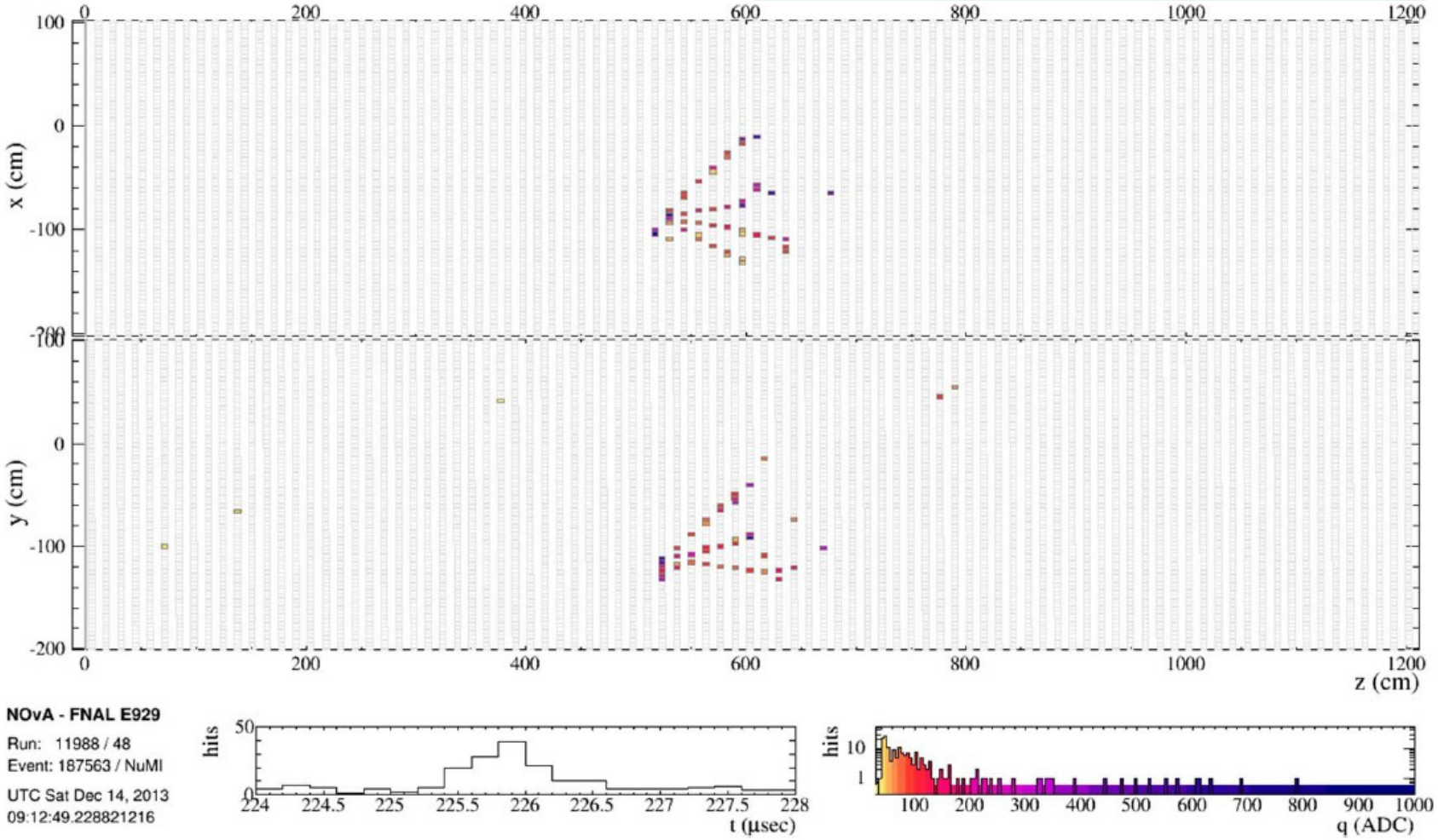
beam



Far Detector

Data event display, NC candidate

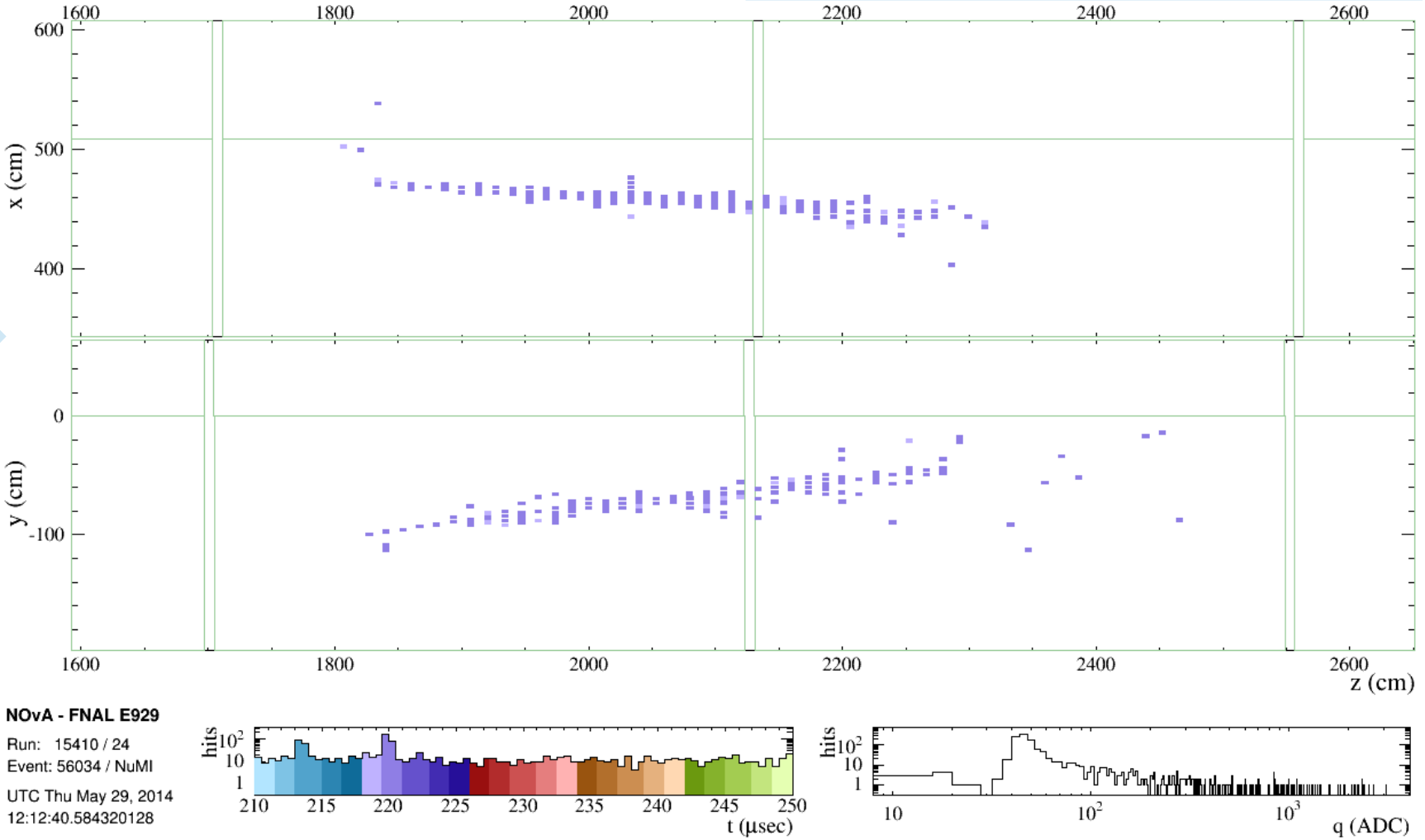
beam



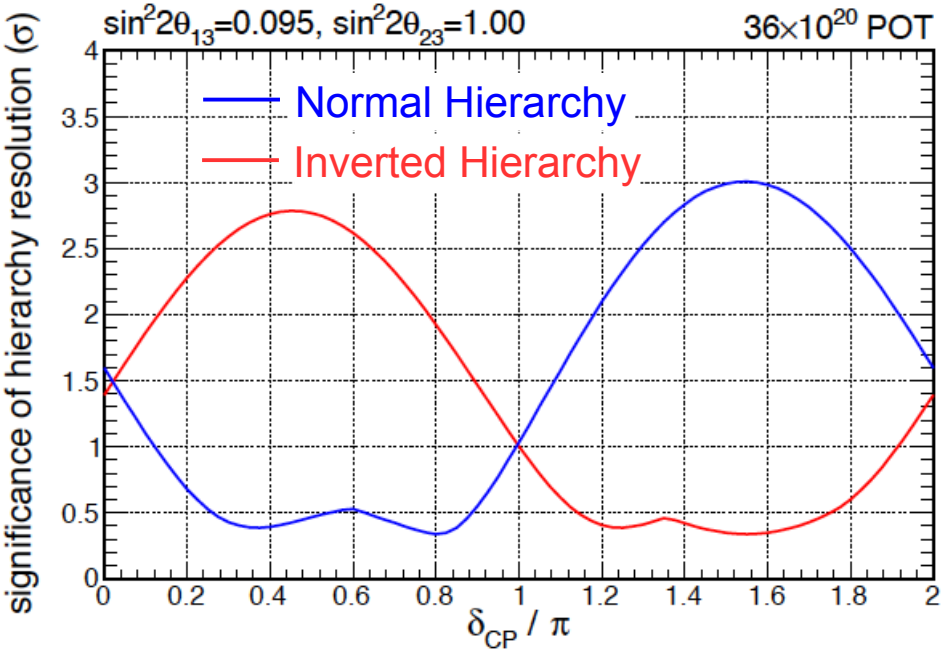
Far Detector

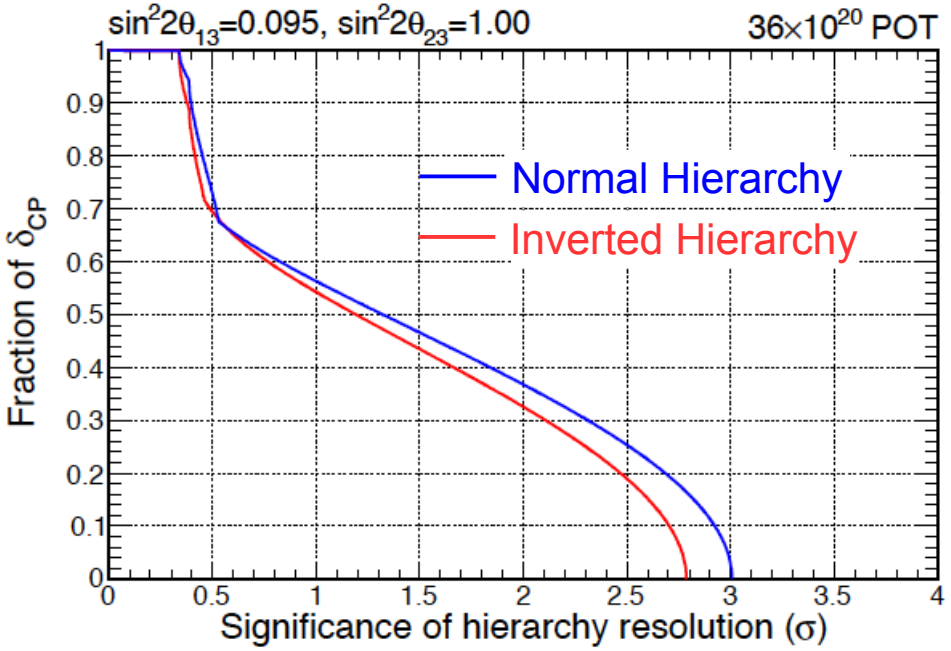
Data event display, ν_e CC candidate

beam



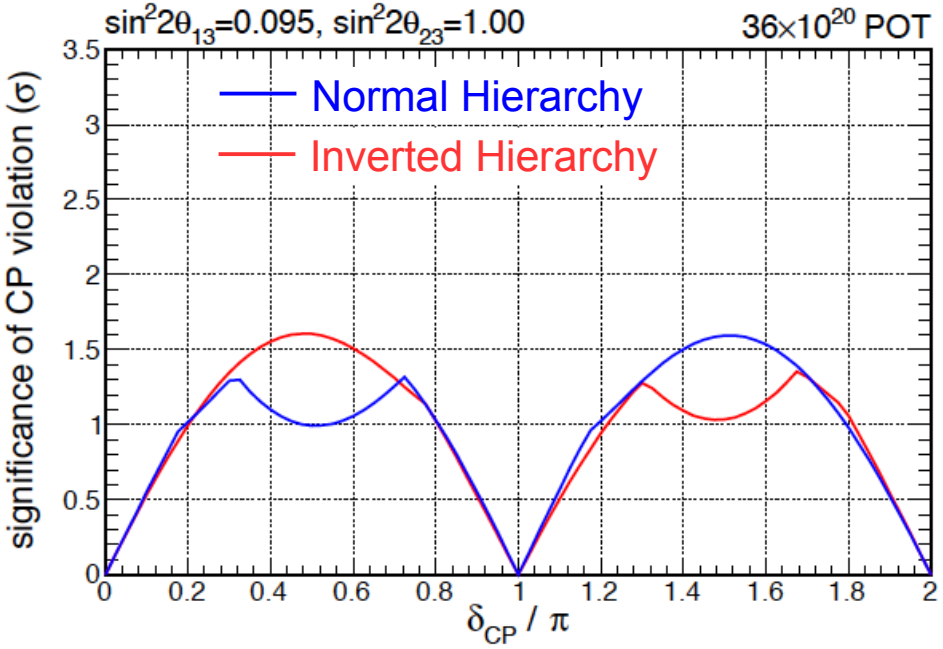
Physics Reach: Mass hierarchy

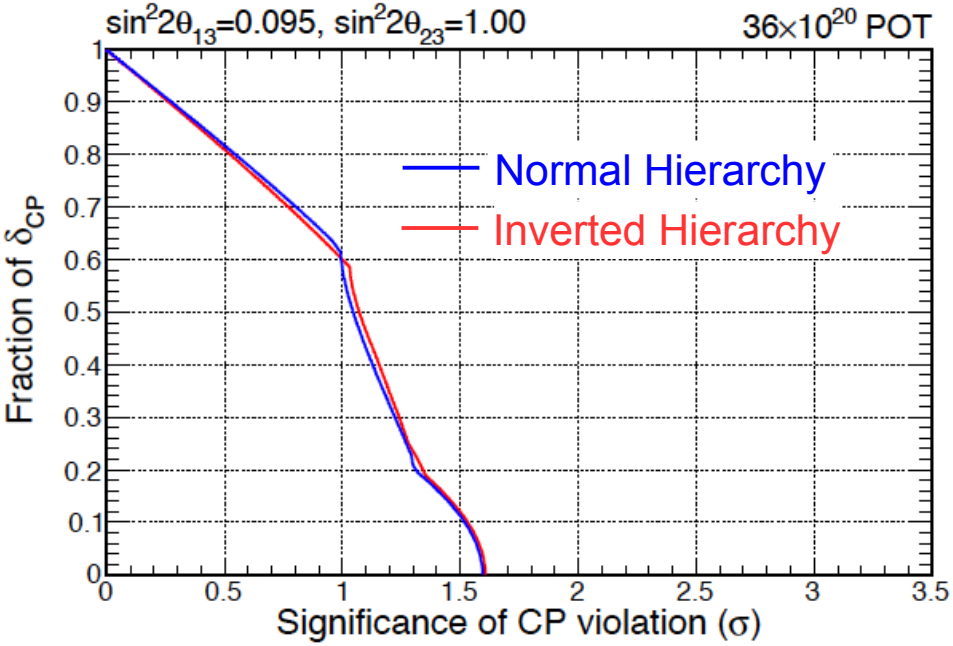




- NOvA: 3 years neutrino + 3 years anti-neutrino running
- We can determine the mass hierarchy above 2σ for >30% δ_{CP} phase.

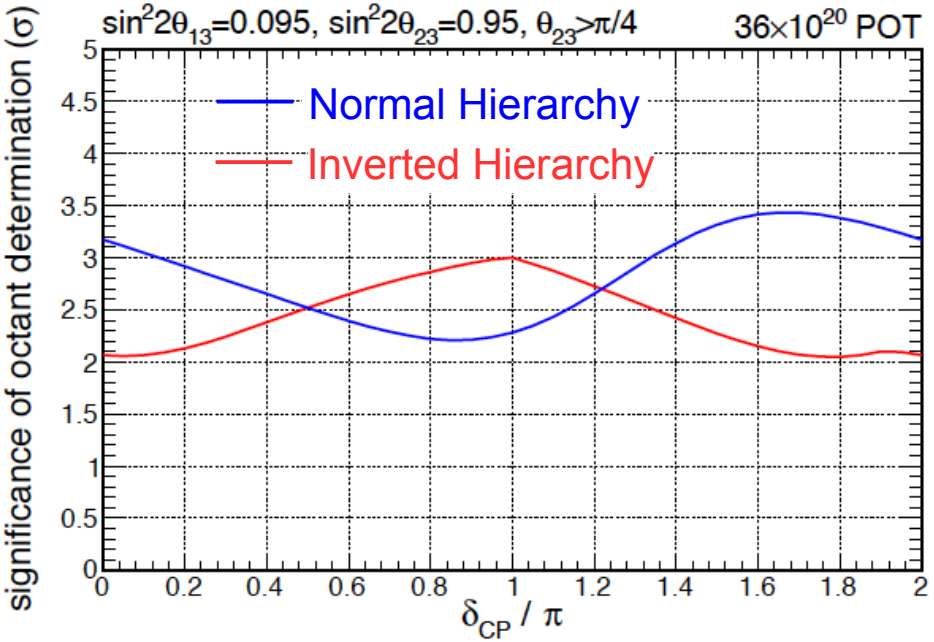
Physics Reach: CP violation

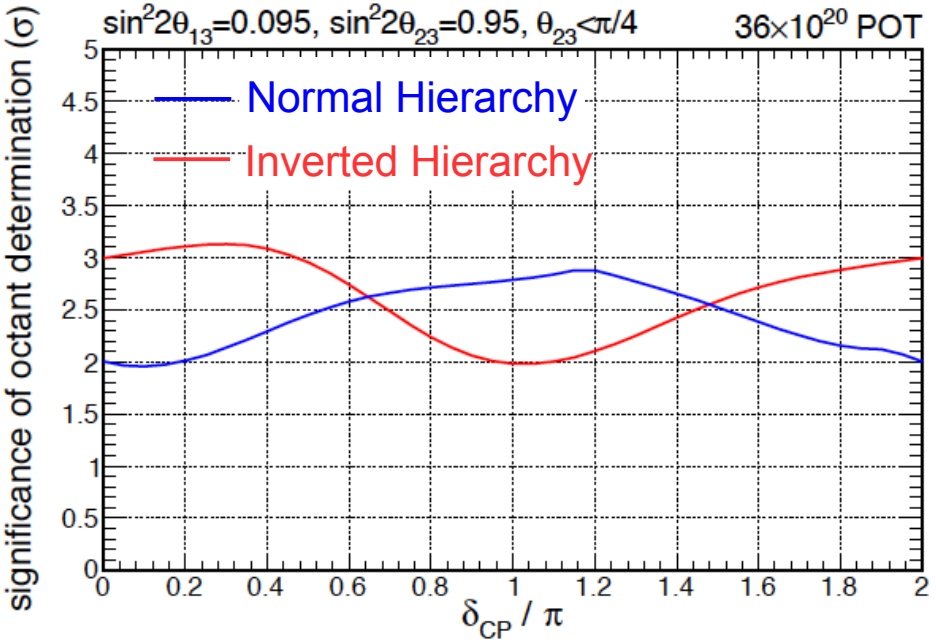




- NOvA: 3 years neutrino + 3 years anti-neutrino running

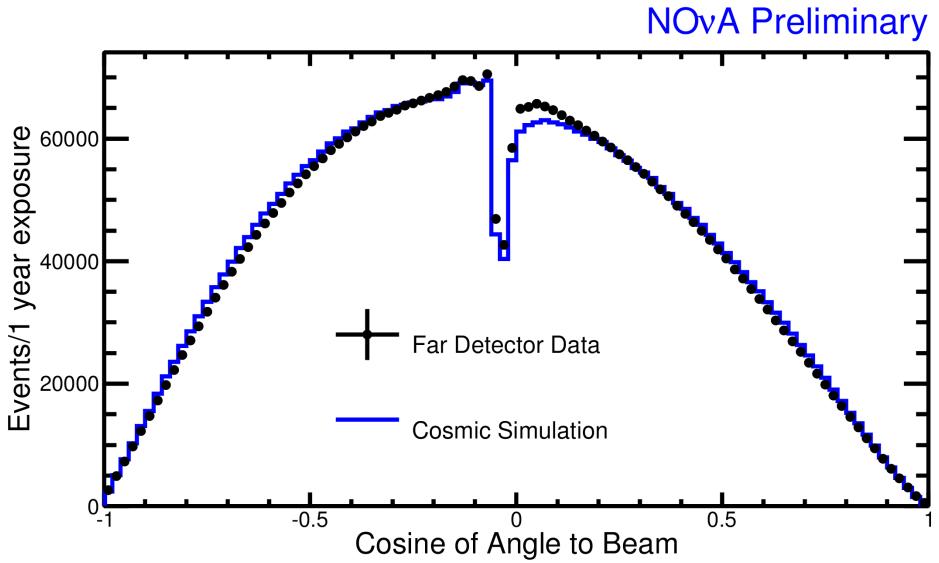
Physics Reach: Octant sensitivity



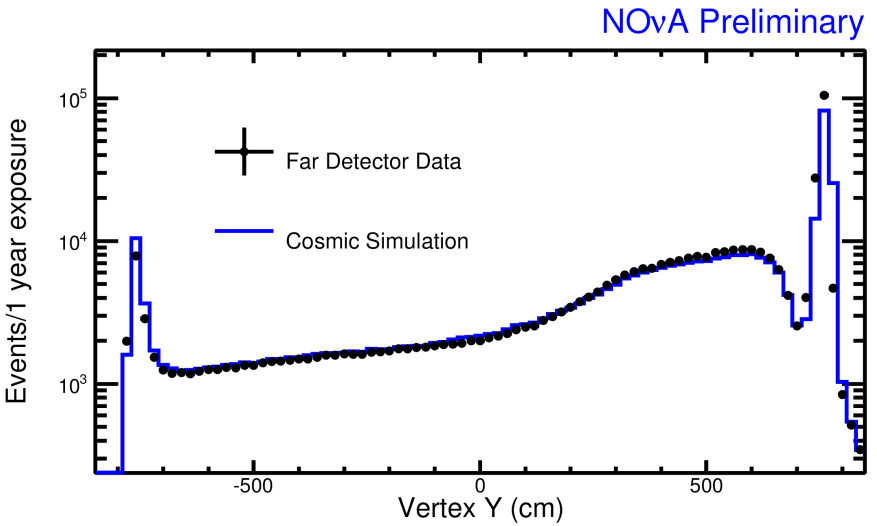


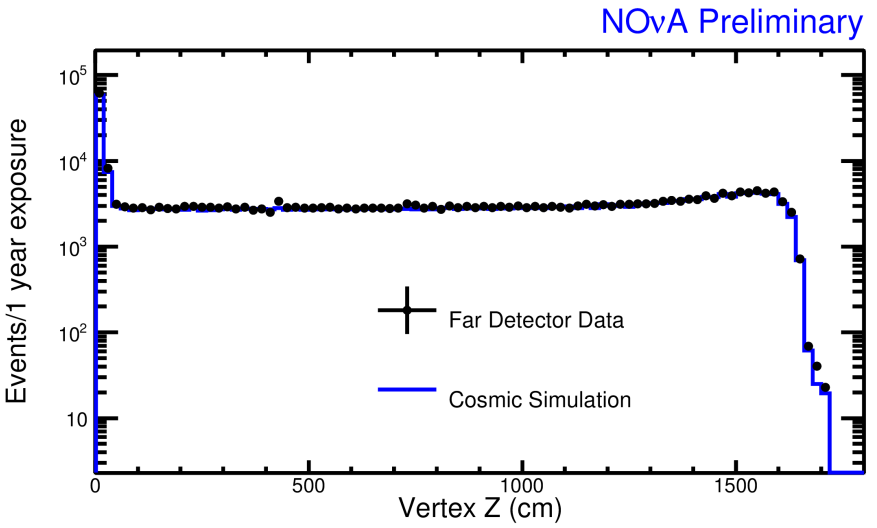
- NOvA: 3 years neutrino + 3 years anti-neutrino running
- We can determine the θ_{23} octant above 2σ for all δ_{CP} phase.

Far Detector Data and MC

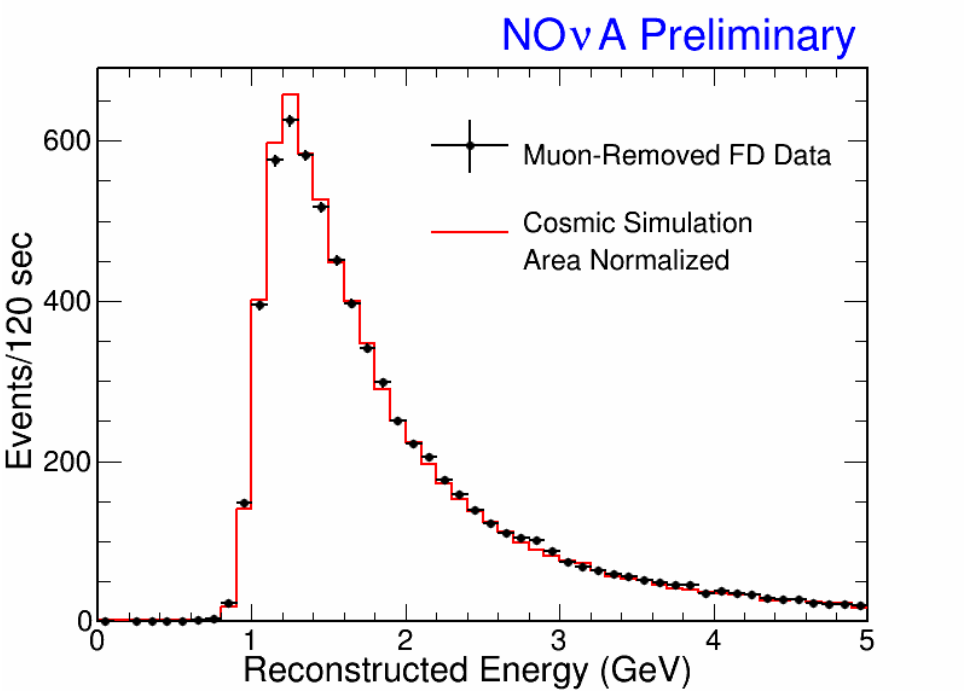


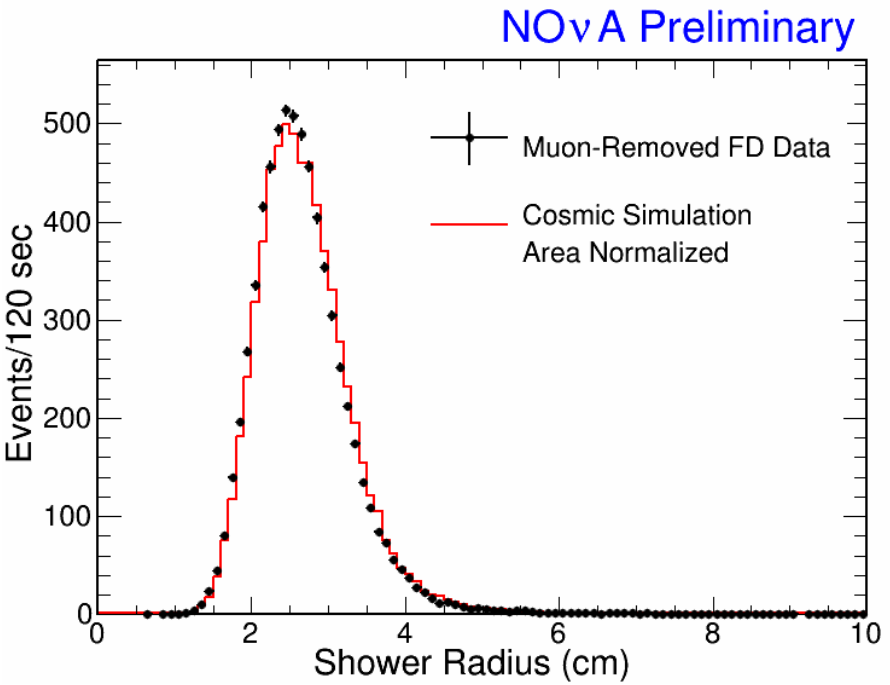
Good agreement
between data and MC (CRY cosmic).





Far Detector Data and MC





- Cosmic-induced EM showers:
  - Muon stop and decay into electron
  - Muon “decay” into electron before stop
- Good agreement between data and MC (CRY cosmic).

Electron neutrino oscillation analysis

	All Events	Preselection + Fiducial	Cosmic Rejection	Particle ID NN>0.7	Particle ID Library Match > 0.37
ν_μ CC	557	30.0	23.0	0.7	1.1
NC	380	83.5	57.4	3.9	3.5
ν_e CC non-oscillated	28.1	2.9	2.5	1.5	1.5
Cosmic	19M	56K	834	0.5	0.9
All Background	19M	57K	917	6.5	7.0
ν_e CC oscillated	36.7	24.7	21.2	13.9	14.0

Events normalized to 6E20 POT.
For details of event and energy reconstruction, please see Nicholas Raddatz's talk !

Muon neutrino oscillation analysis

	All Events	Cosmic Veto	Containment	Particle ID	Cosmic Rejection
NC	380	273	195	5	4
Cosmic	19M	6M	120K	44K	1
ν_μ CC	127	125	109	86	74

Events normalized to 6E20 POT.
For details of event and energy reconstruction, please see Nicholas Raddatz's talk !

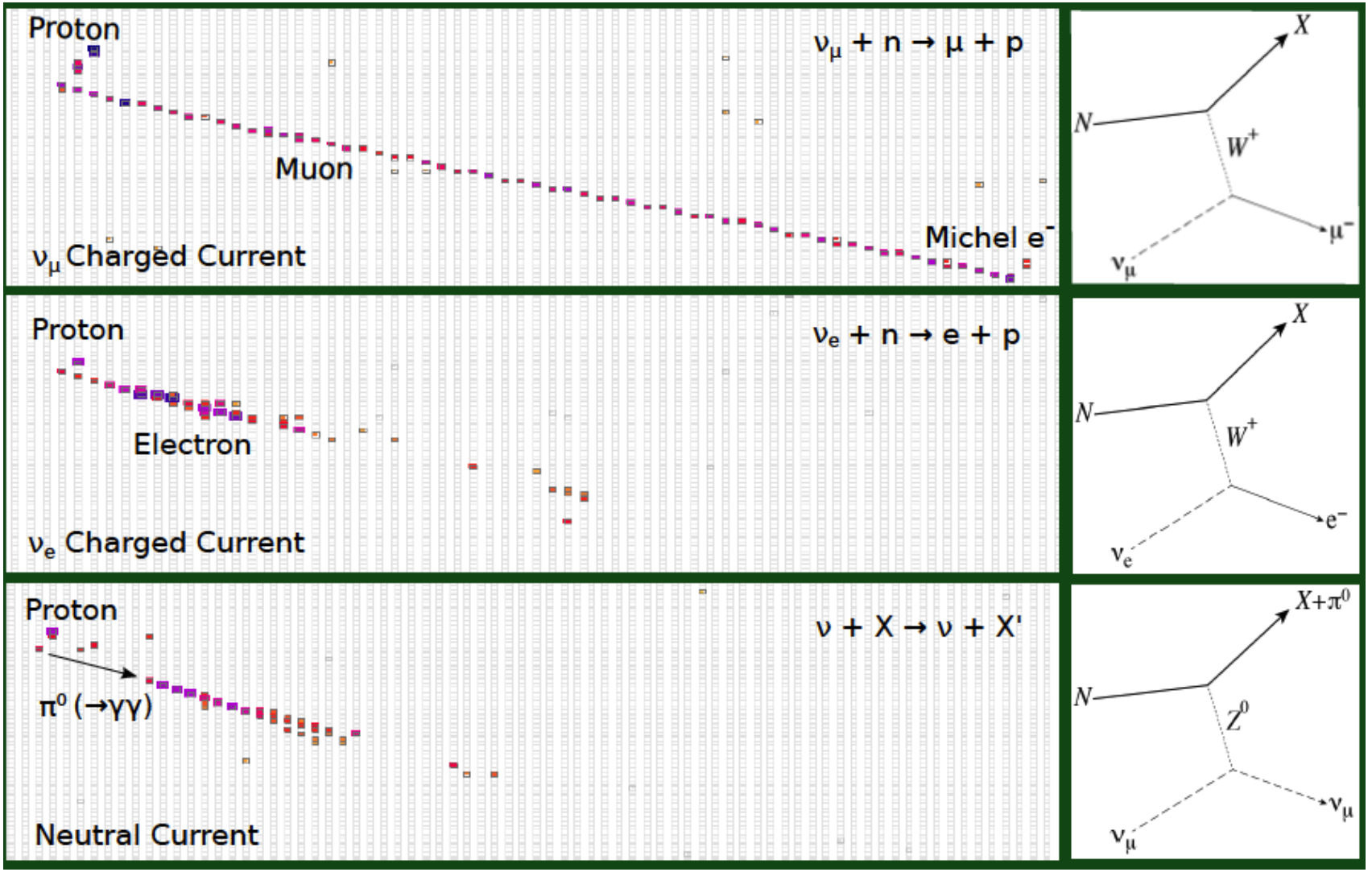
Summary

- Quite exciting time is ahead of NOvA, both near detector and far detector are fully instrumented !
- NUMI beam neutrinos are observed in both detectors.
- First neutrino results by end of this year.
- For more details, please see our other talks:
  - *Event and energy reconstruction of NOvA,* Nicholas Raddatz
  - *Measurement of CC QE neutrino cross section using prototype detector,* Lisa Goodenough

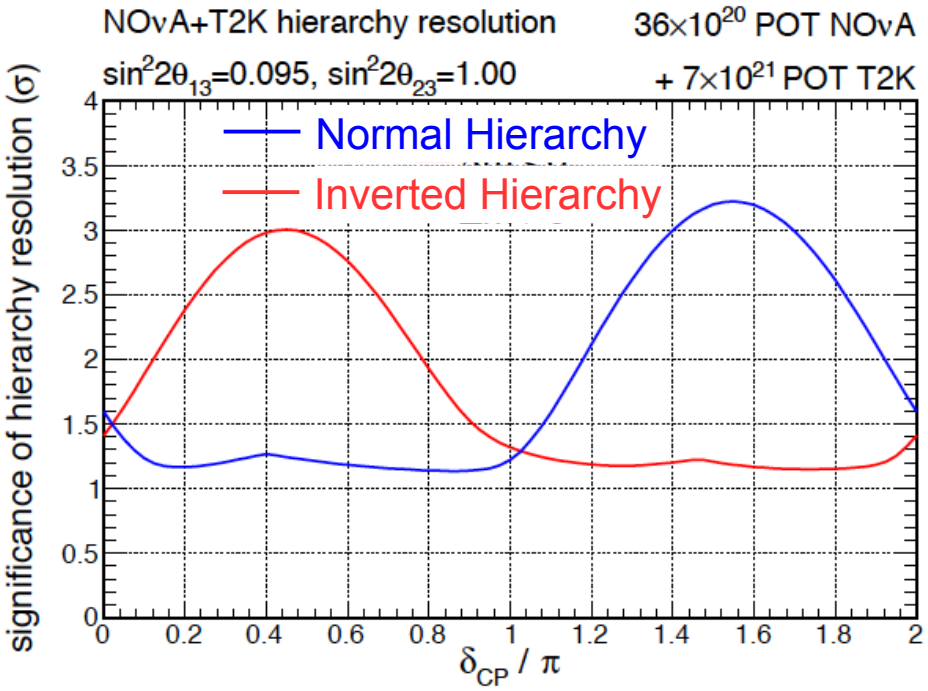
  and Posters:
  - *Overview and current status of NOvA*, Jan Zirnstein
  - *Event selection for muon neutrino oscillation analysis,* Nicholas Raddatz
  - *Energy estimation for muon neutrino,* Susan Lein

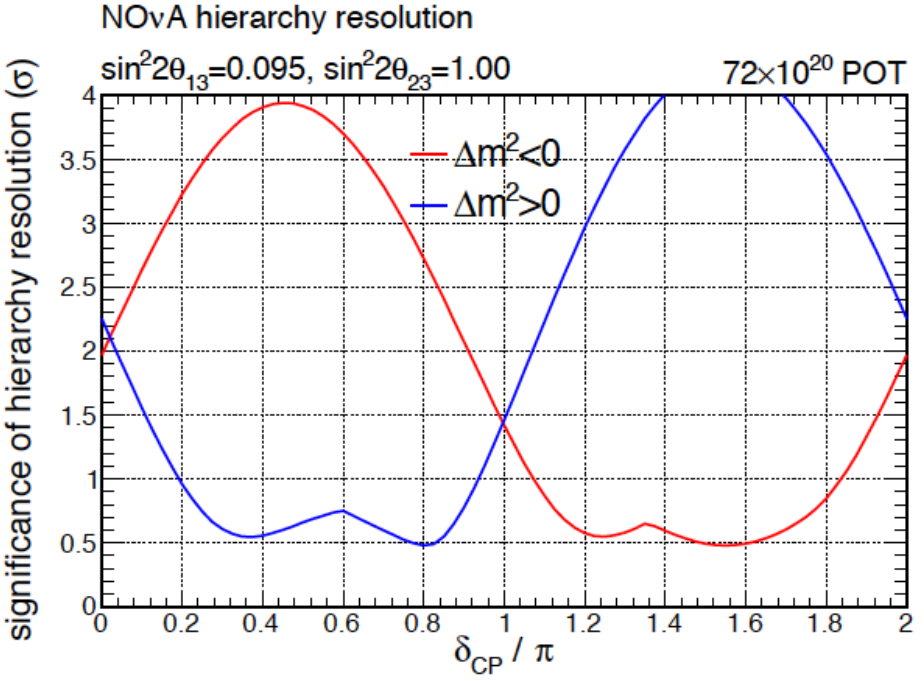
back-up

MC Event Topologies



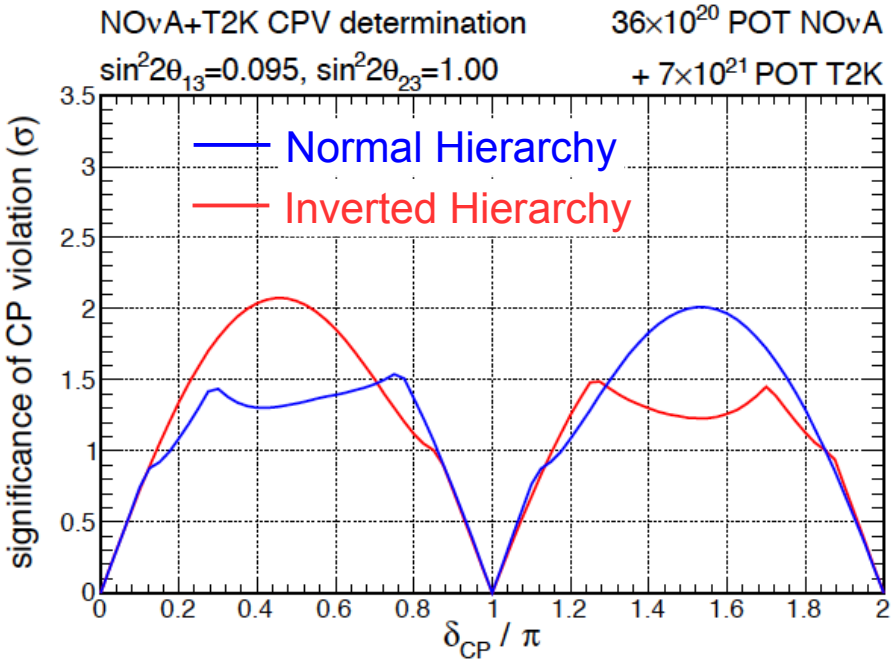
Sensitivity for mass hierarchy

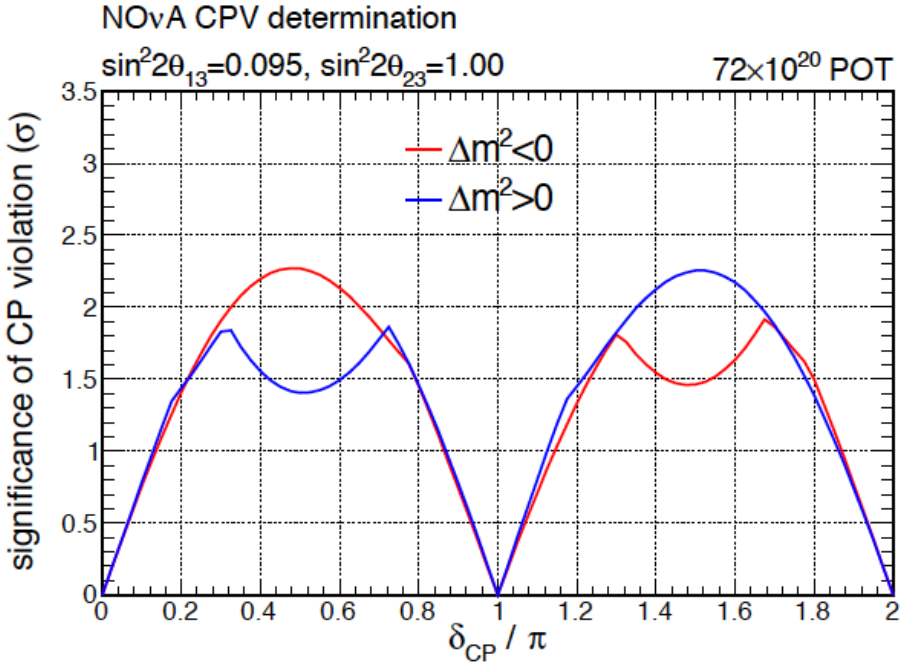




- Left: NOvA (6 years) + T2K (Neutrino 2012)
- Right: NOvA (12 years)

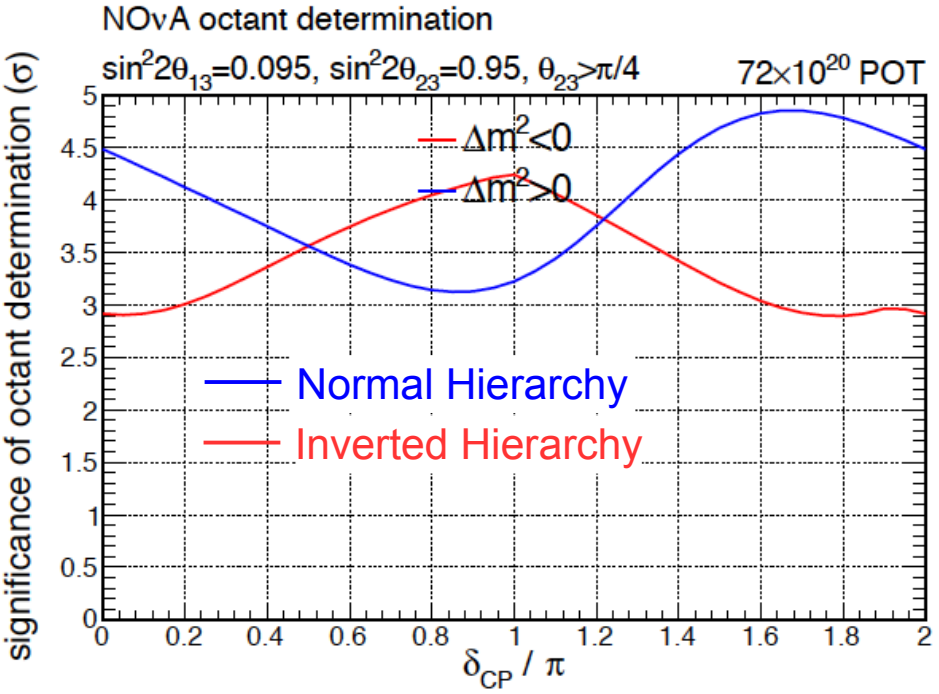
Sensitivity for CP violation

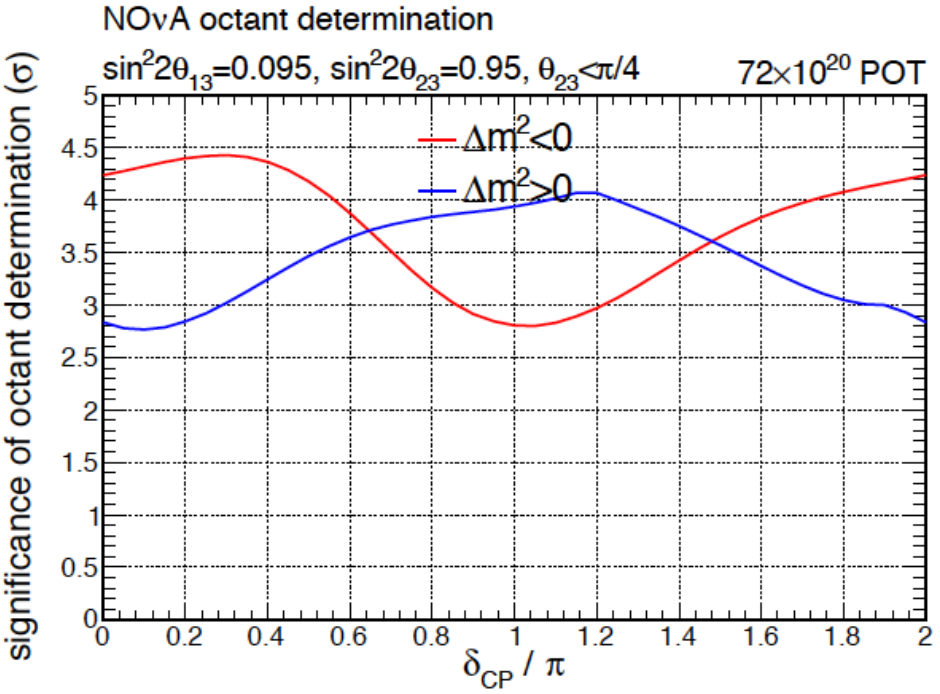




- Left: NOvA (6 years) + T2K (Neutrino 2012)
- Right: NOvA (12 years)

Sensitivity for Octant





- NOvA (12 years)