The NOvA Experiment At Fermilab

Mark Messier
Indiana University

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Neutrino parallel session

21 May 2007 at Fermilab

The NOvA Collaboration

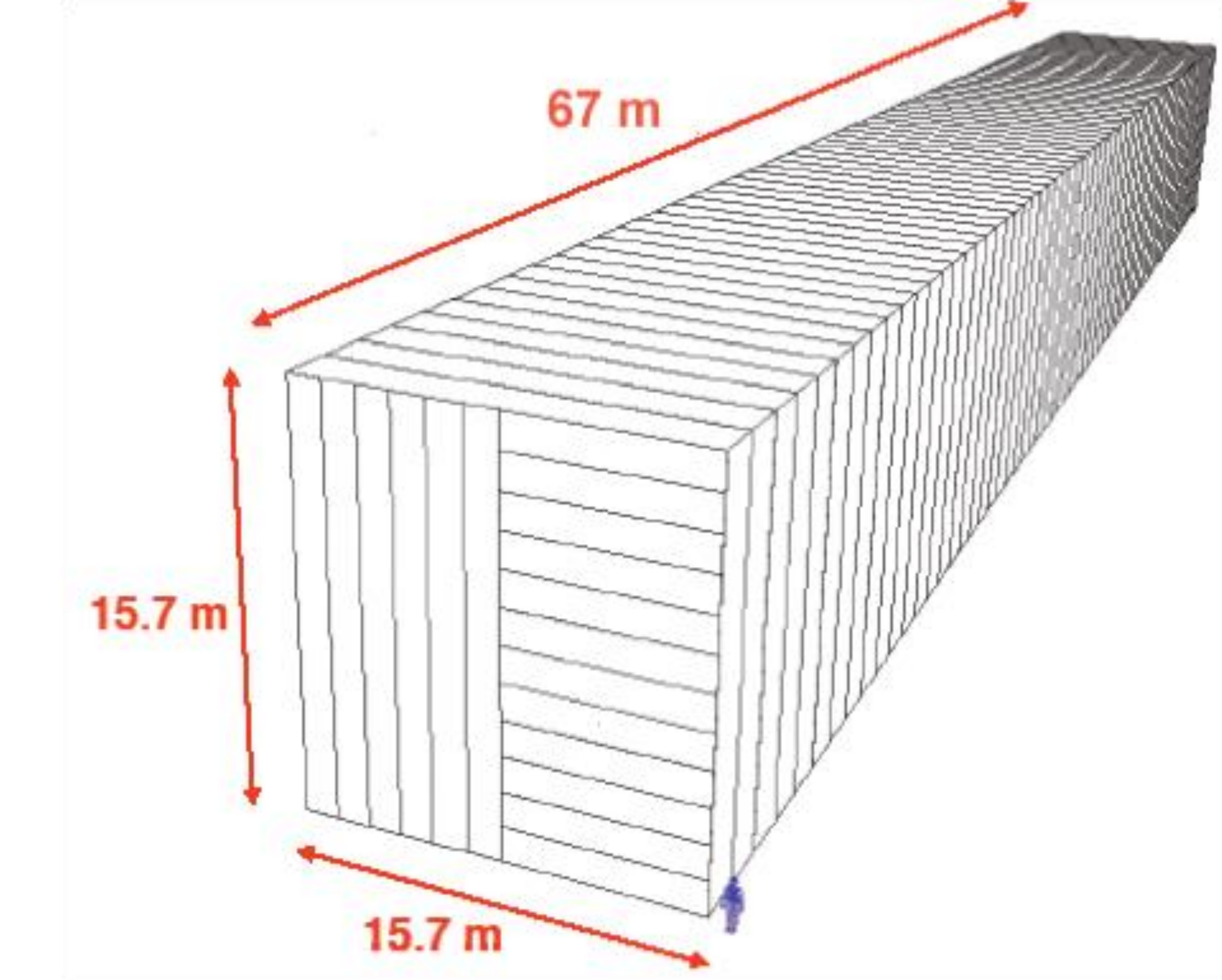
http://www-nova.fnal.gov

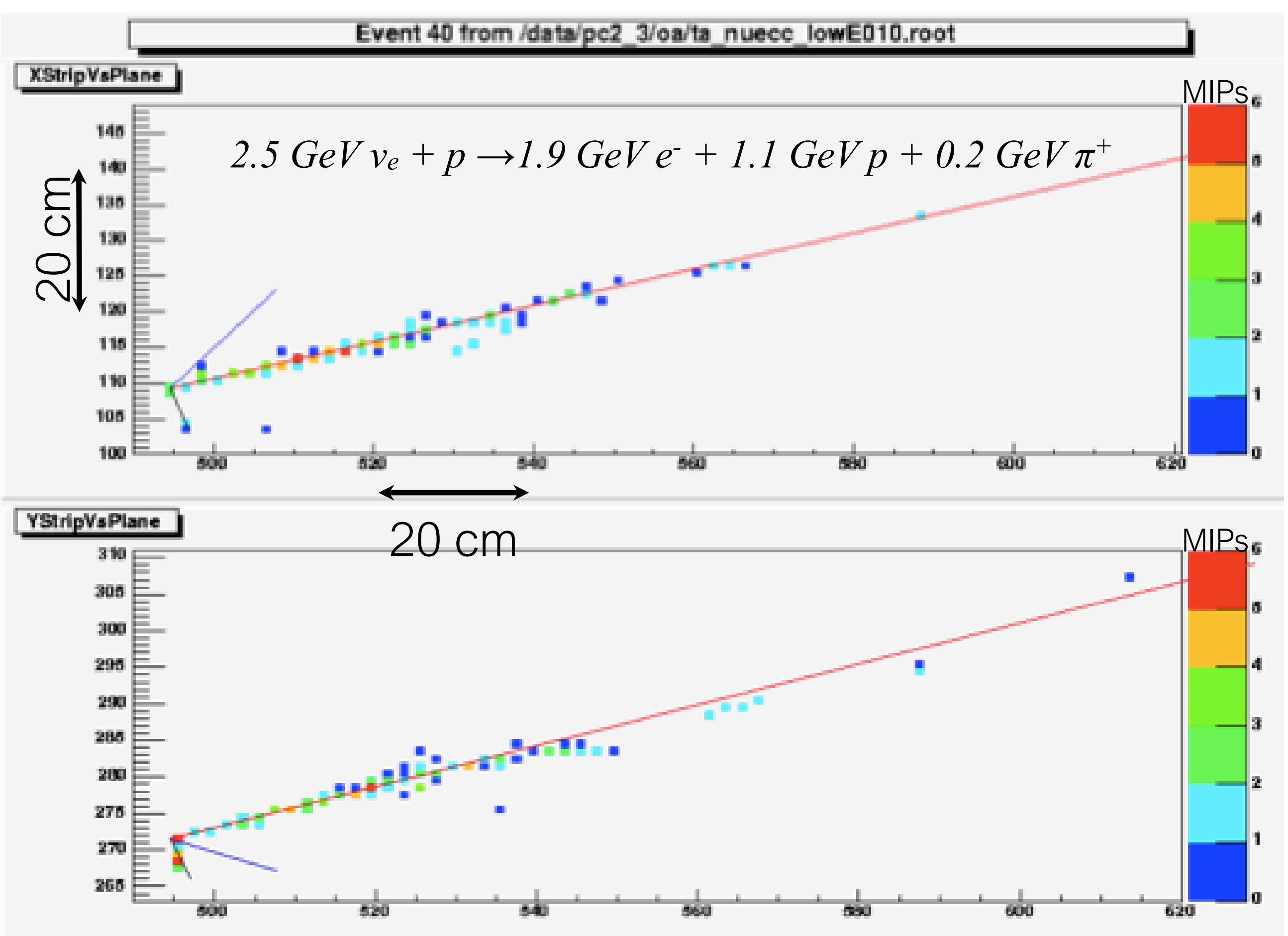
181 scientists and engineers, 26 institutions

Argonne National Laboratory - University of Athens - California Institute of Technology - University of California, Los Angeles - Fermi National Accelerator Laboratory - College de France - Harvard University - Indiana University - Lebedev Physical Institute - Michigan State University - University of Minnesota, Duluth - University of Minnesota, Minneapolis Technische Universität München, Munich - State University of New York, Stony Brook Northern Illinois University, DeKalb Ohio State University, Columbus - Pontifícia Universidade Católica do Rio de Janeiro - University of South Carolina, Columbia - Southern Methodist University - Stanford University - Texas A&M University - University of Texas, Austin - University of Texas, Dallas - Tufts University - University of Virginia, Charlottesville - The College of William and Mary

The NOvA Experiment

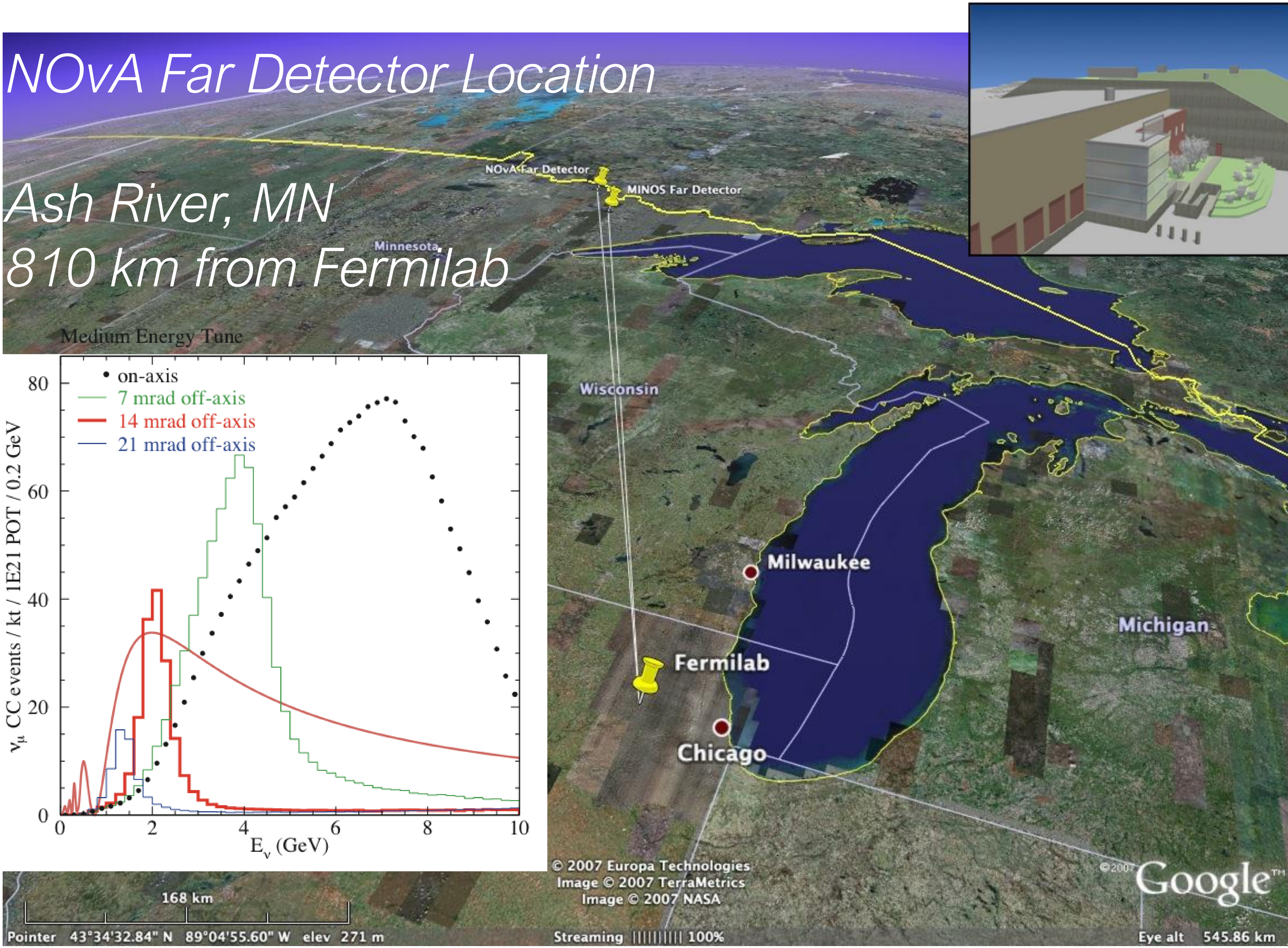
- NOvA is a second generation experiment on the NuMI beamline which is optimized for the detection of $\nu_\mu \to \nu_e$ and $\bar{\nu}_\mu \to \bar{\nu}_e$ oscillations
- NOvA is:
  - An upgrade of the NuMI beam intensity from 400 kW to 700 kW
  - A 15 kt “totally active” tracking liquid scintillator calorimeter sited 14 mrad off the NuMI beam axis at a distance of 810 km
  - A 215 ton near detector identical to the far detector sited 14 mrad off the NuMI beam axis at a distance of 1 km





NOvA Far Detector Location

Ash River, MN
810 km from Fermilab



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5) Are neutrinos their own antiparticles? Do they give rise to lepton number violation, or leptogenesis, in the early universe? Do they have observable laboratory consequences such as the sought-after neutrinoless double beta decay in nuclei?

6) What can we learn from observation of the intense flux of neutrinos from a supernova within our galaxy? Can we observe the neutrino remnants of all supernovae that have occurred since the beginning of time?

7) What can neutrinos reveal about other astrophysical phenomena? Will we find localized cosmic sources of very-high-energy neutrinos?

8) What can neutrinos tell us about new physics beyond the Standard Model, dark energy, extra dimensions? Do sterile neutrinos exist?

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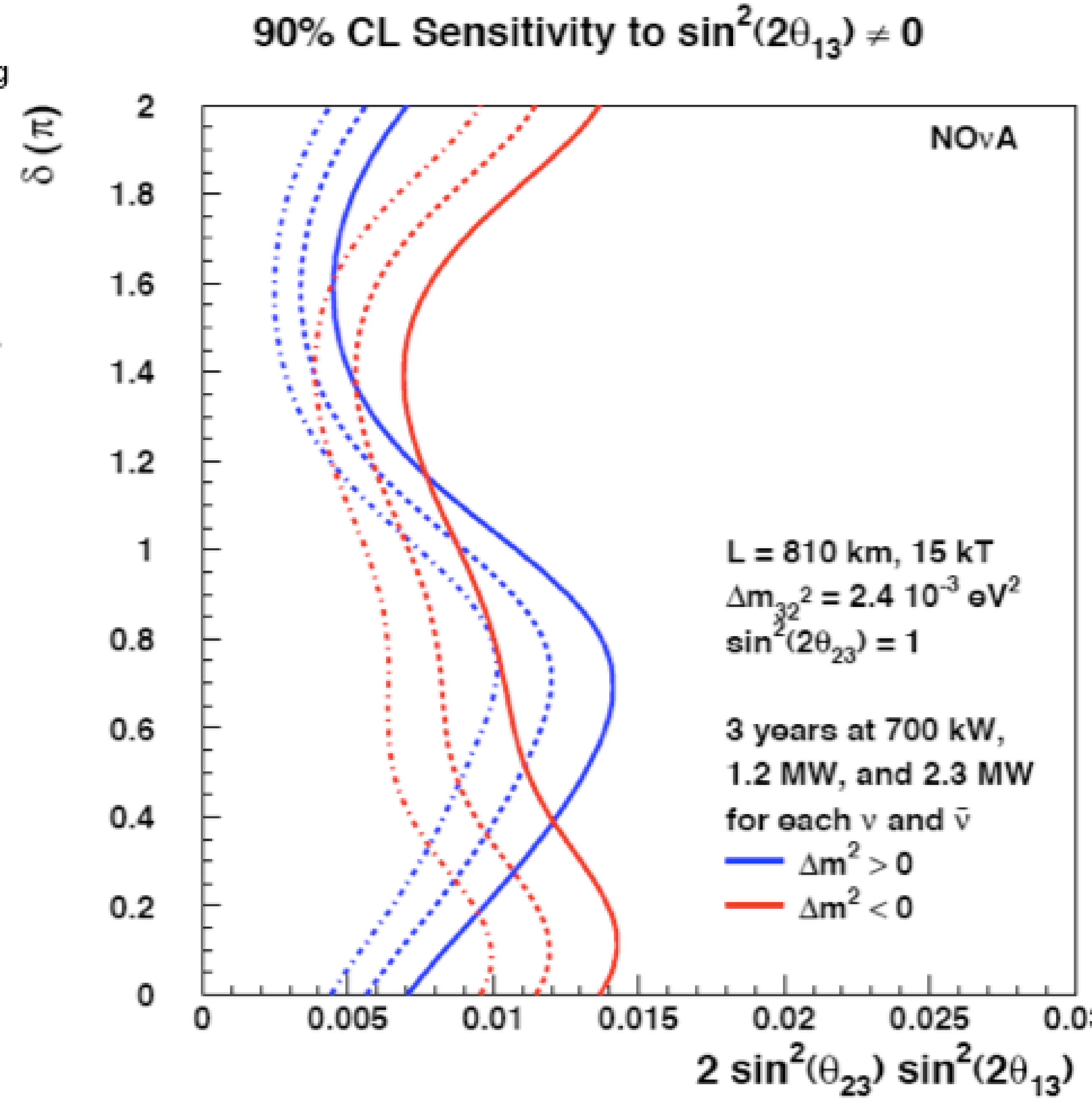

NOvA searches for electron neutrino appearance down to ~0.01 at 90% CL

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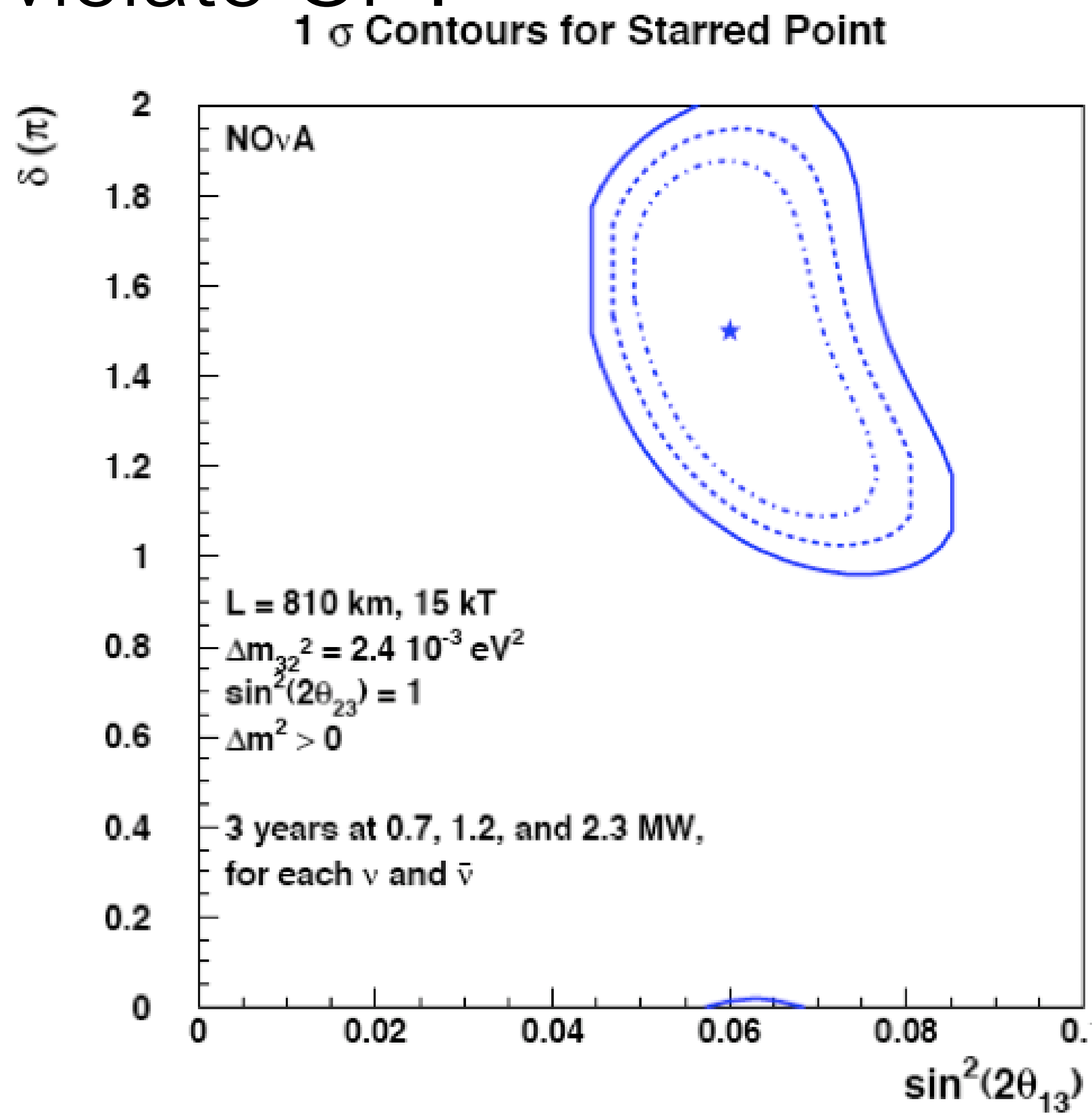

NOvA provides the first look into the CPV parameter space

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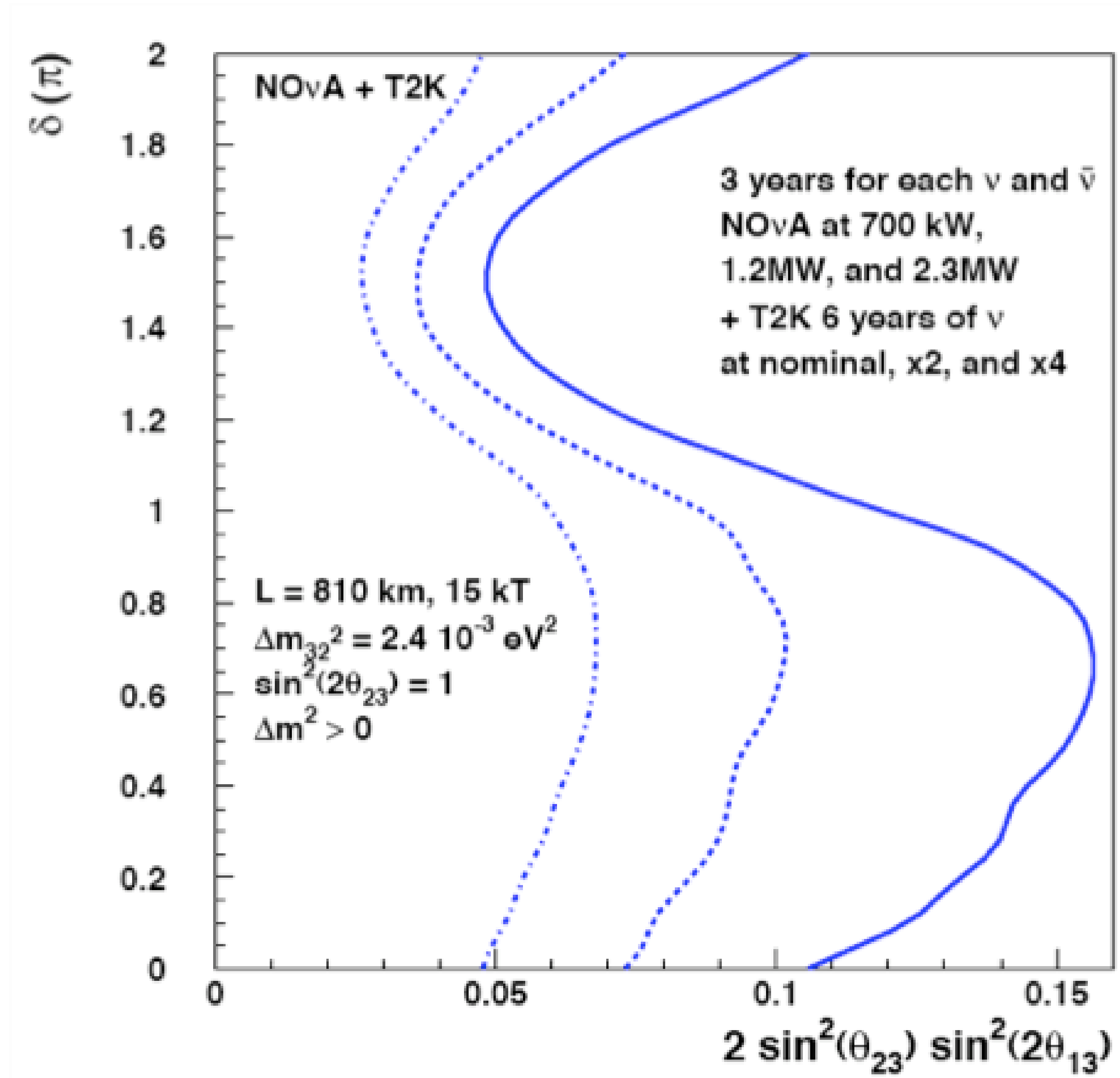

NOvA's long baseline makes it sensitive to the mass ordering

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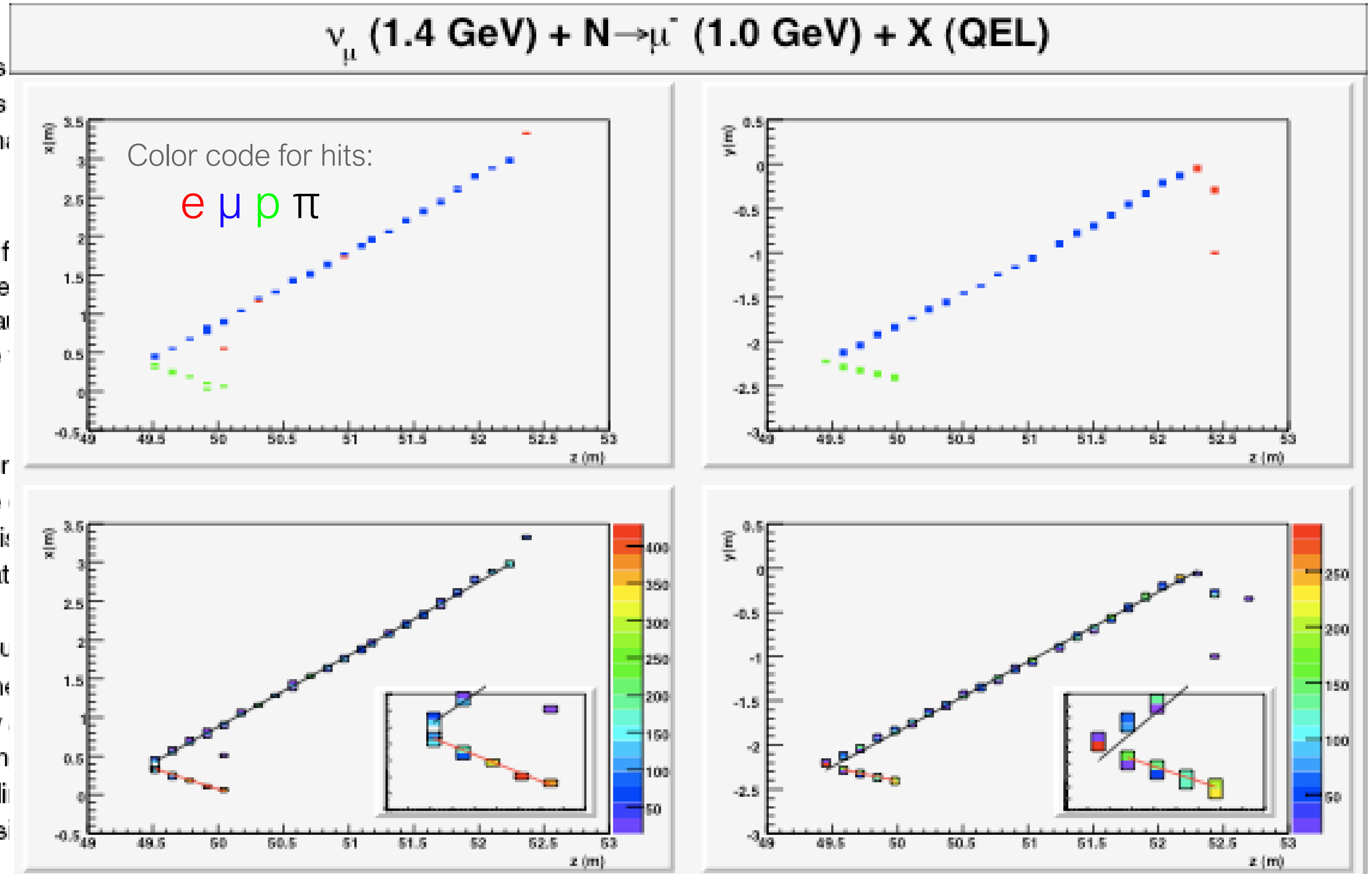

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Because of its excellent energy resolution NOvA can make ~1% measurements of muon neutrino disappearance using quasi-elastic channel

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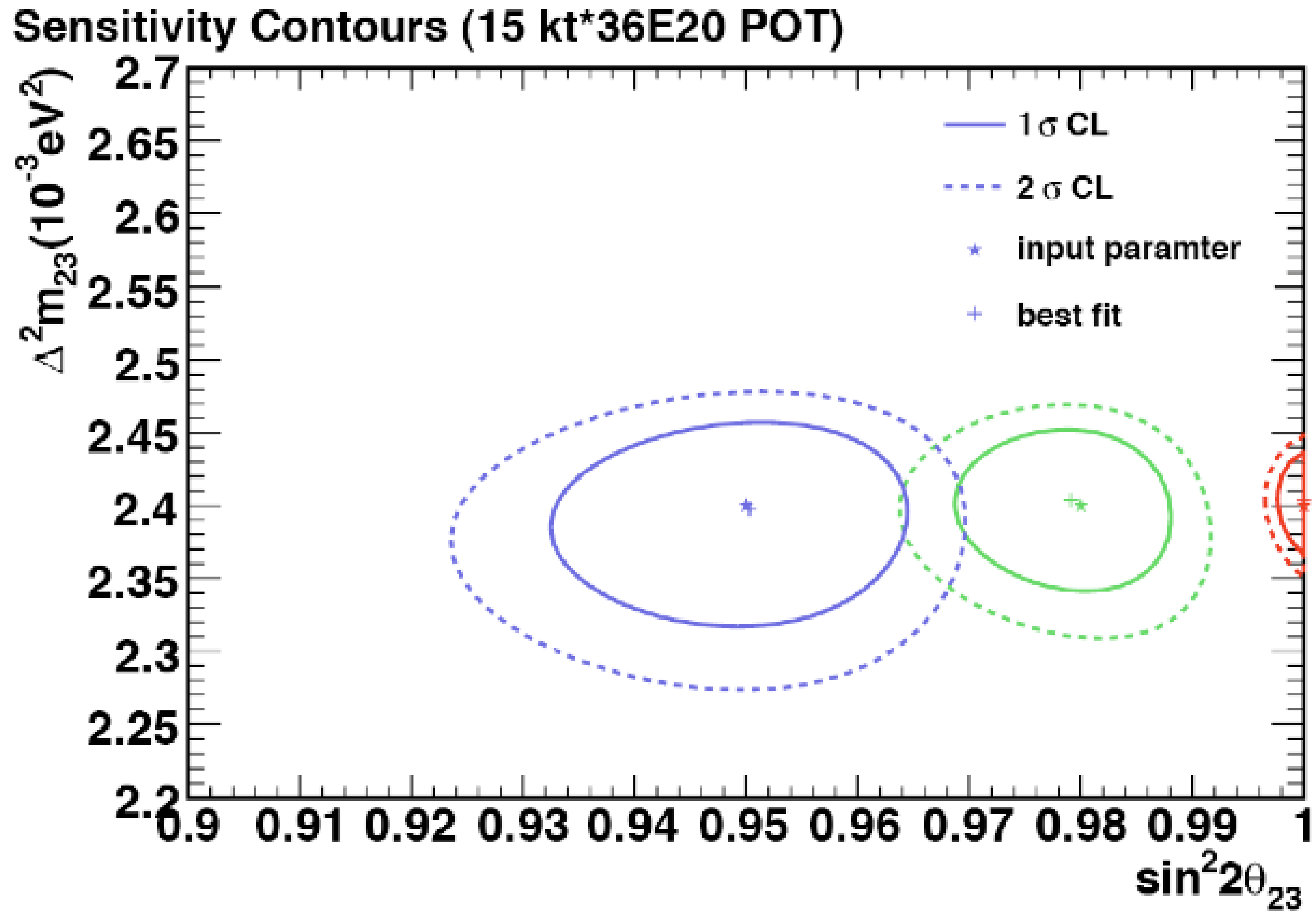

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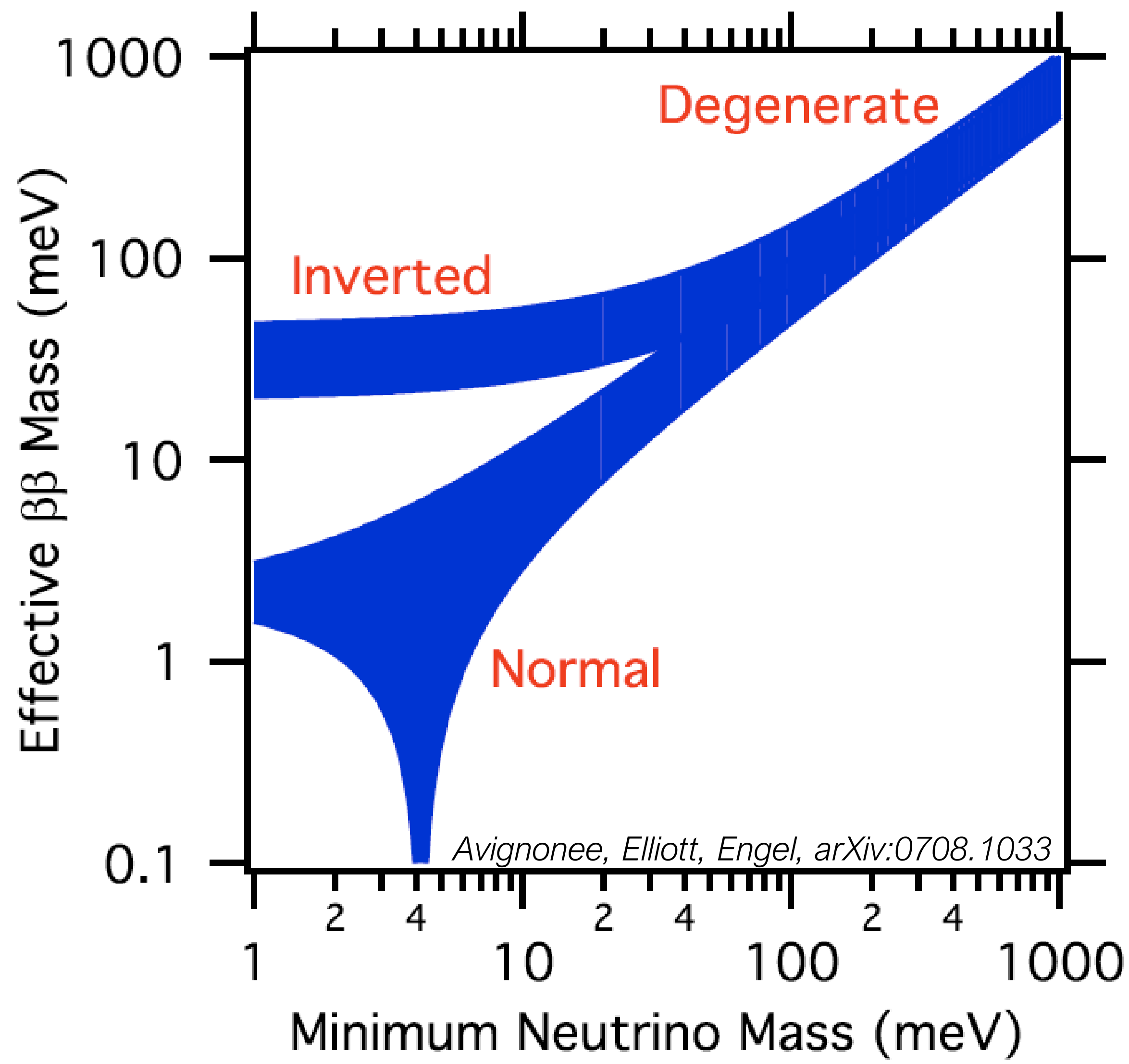

If NOvA establishes inverted hierarchy and next generation of 0νββ experiments see nothing, then it is very likely that neutrinos are Dirac particles

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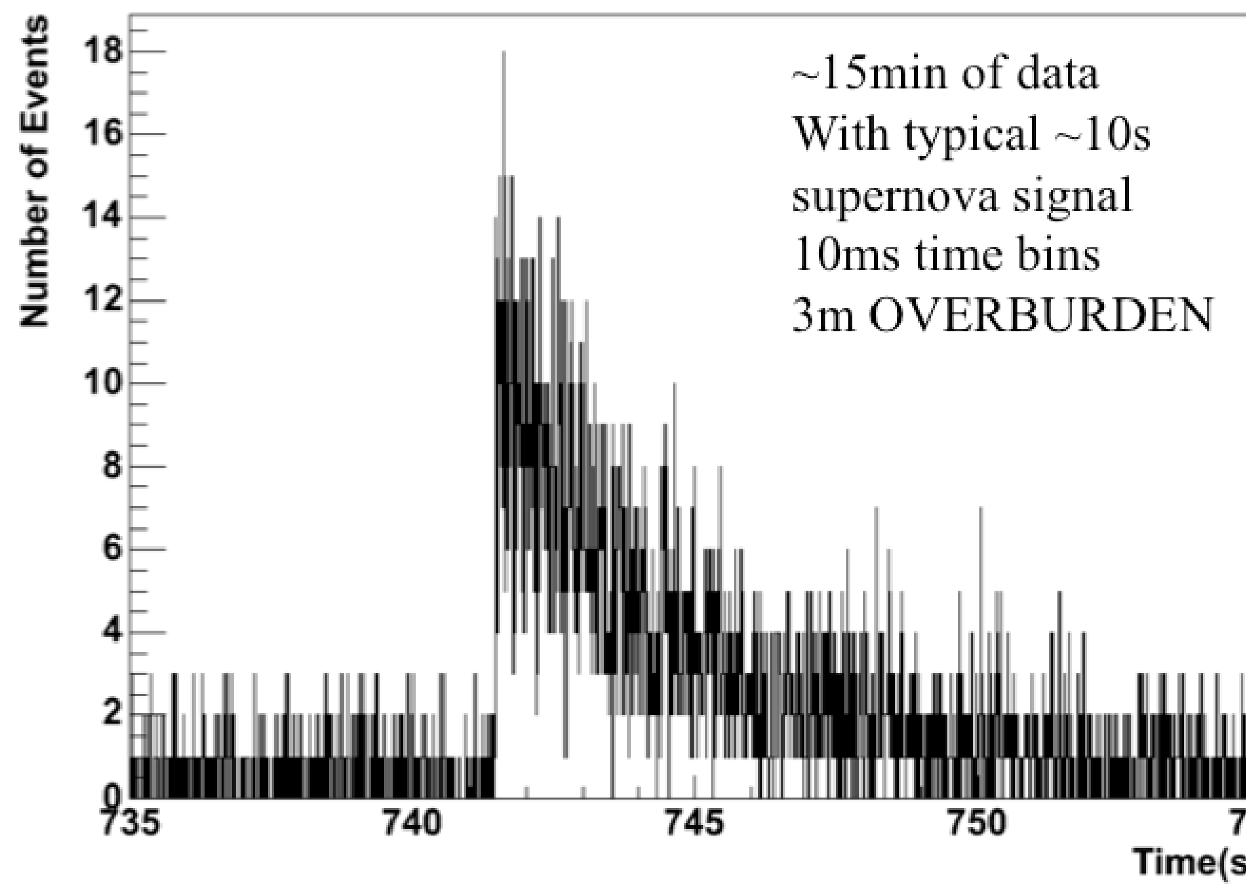

NOvA would see burst of 5000 events for a supernova at the center of the galaxy

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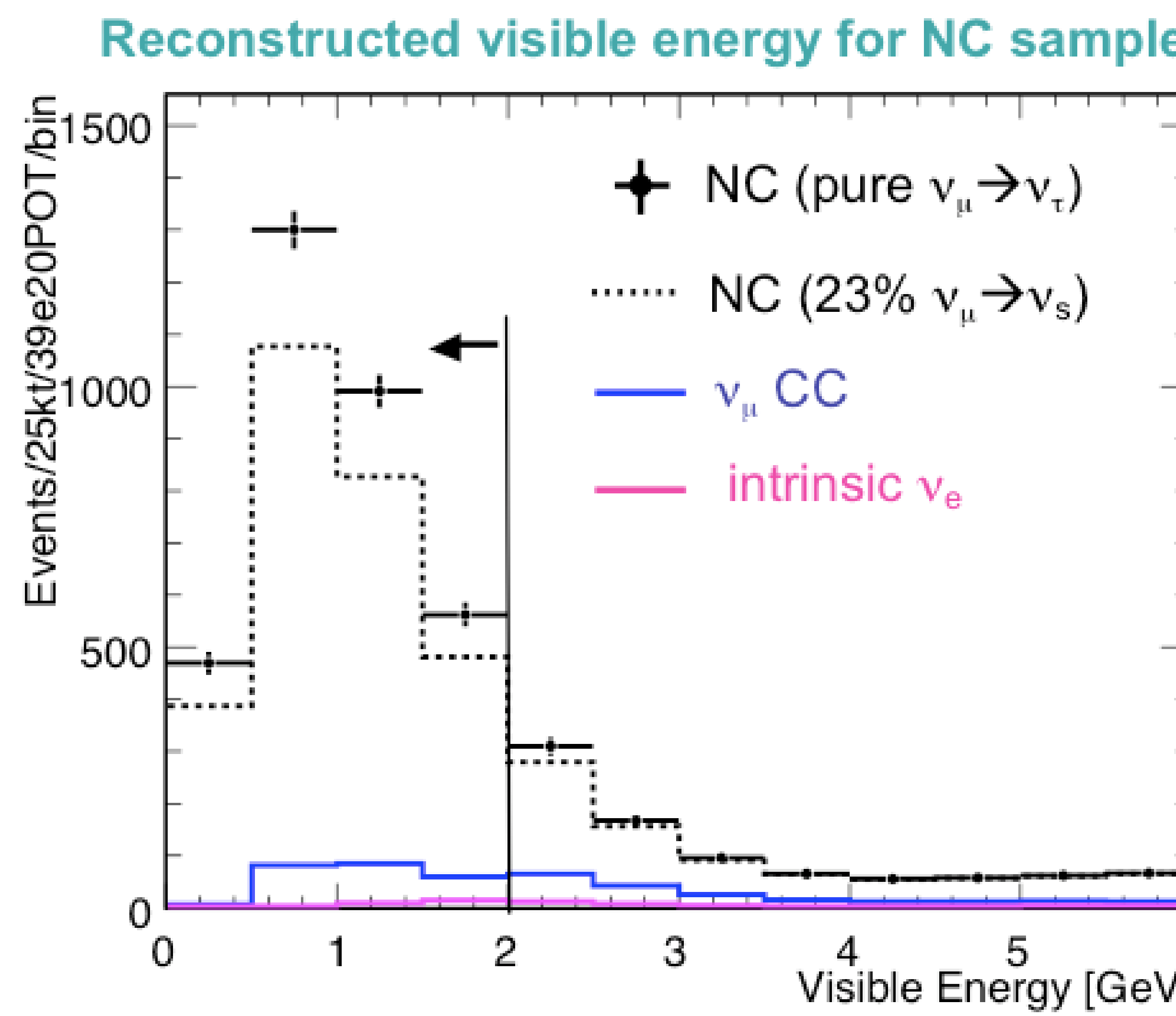

NOvA's granularity allows for clean neutral-current measurements facilitating searches for sterile neutrinos

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Schedule

- NOvA passed its Department of Energy, Office of Science CD2/3a. Ready to start civil construction at far site in March 2008
- FY2008 omnibus budget passed by Congress in December of 2007 zeroed funding for NOvA in FY08. Formally closed the project office, but we able to make some progress with small amount of FY07 carryover and with university groups.
- FY08 funding required new cost and schedule to be drafted and reviewed. Those reviews passed in April and June of 2008. Expect CD2 process to be complete in August of this year.
- Emergency funding bill passed by Congress passed this month. Included $62.5M additional funding for HEP. NOvA is funded at $9.5M for this fiscal year. Project office officially reopened. $9.5M is enough to complete roughly 3/4 of the remaining design and R&D tasks in our schedule.
- Including anticipated 4 month delay in FY09 Congressional budget process:
    - Start of construction April 2009
    - First 2.5 kt taking data August 2012
    - Detector complete January 2014
- NOvA construction schedule is driven by funding profile. We know what we want to build and we could build it faster.

NOvA is the foundation of the US accelerator neutrino program

- It addresses 7 of the 8 physics questions called out by P5 as the focus of the neutrino program over the next decade
- Among the next generation experiments, NOvA uniquely provides information on the mass hierarchy and CP phase
- NOvA provides the incentive and continuity to increase the NuMI beam power from 400 to 700 kW and ultimately to 2.3 MW
- Ensures a robust future program.