GLoBES
A brief history of neutrino physics in the 21st century

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LAUNCH 17

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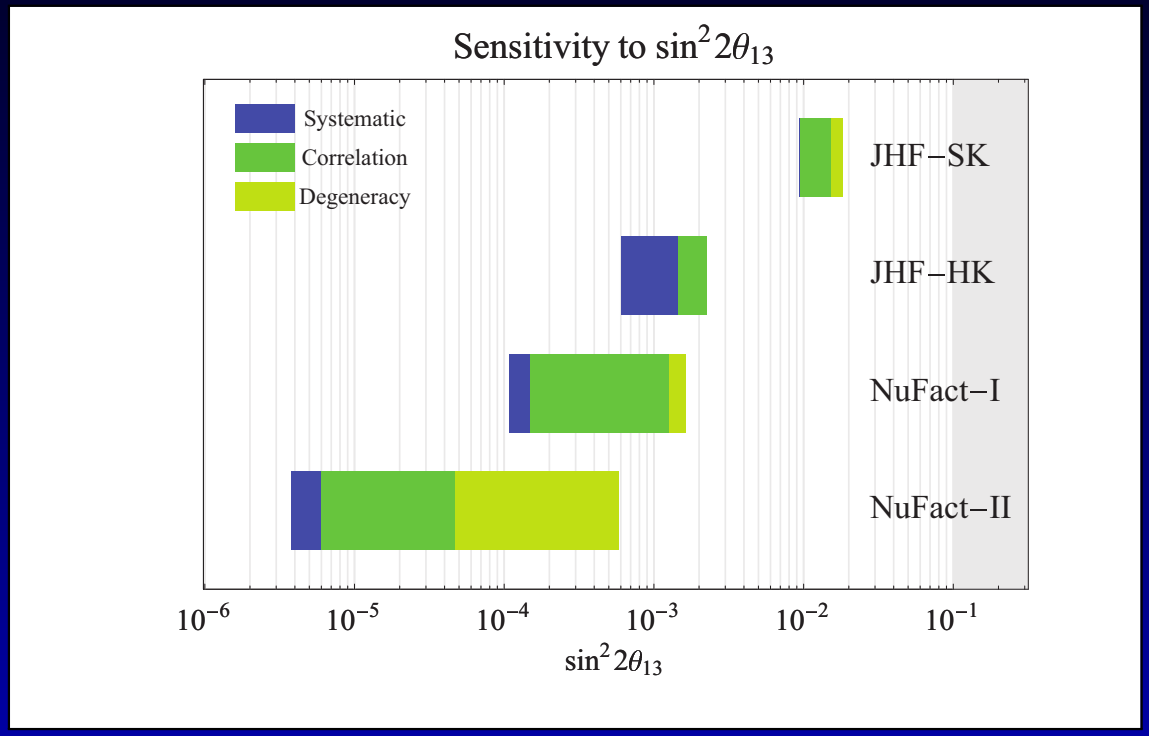
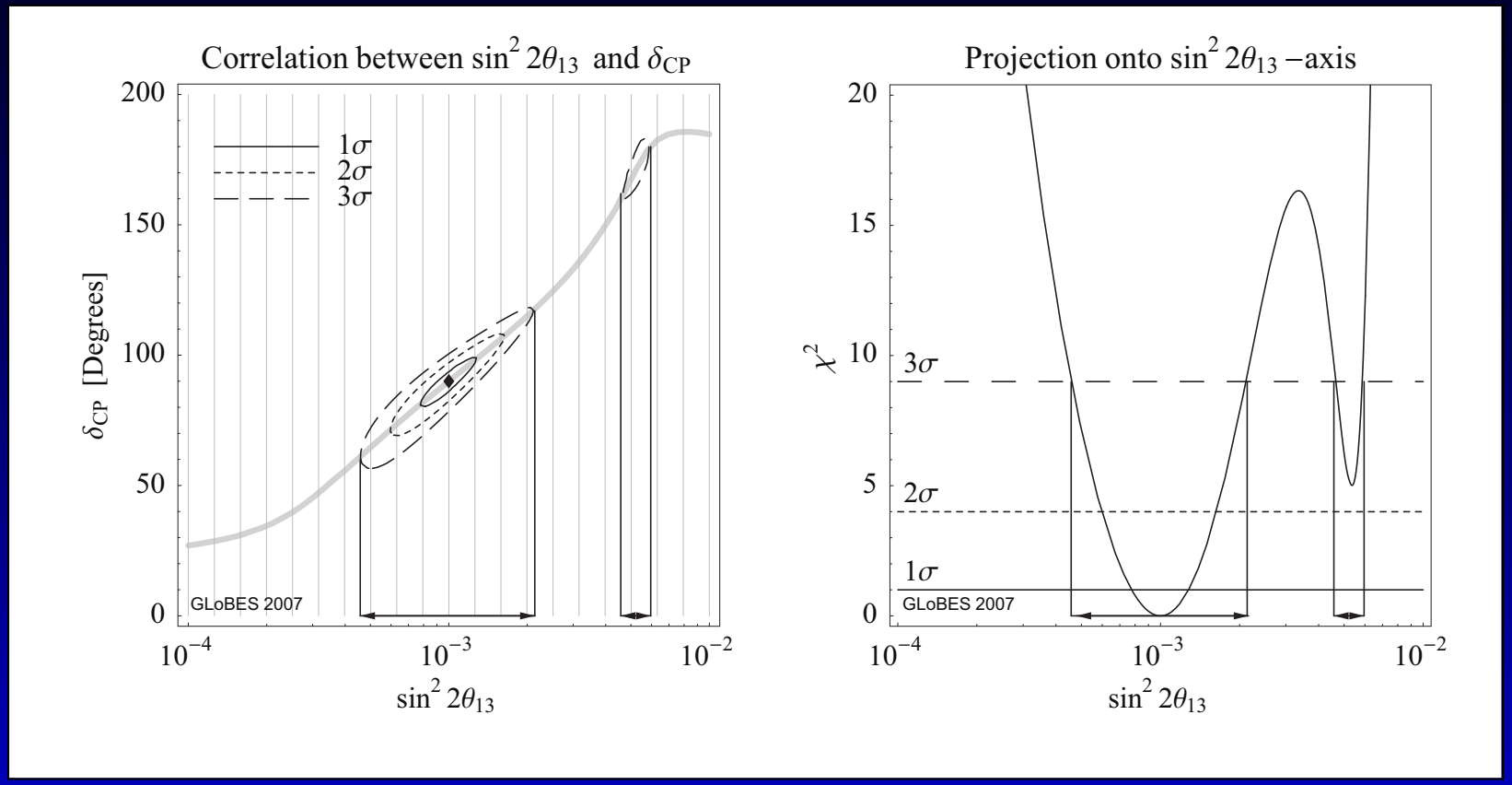
proto-GLoBES



PH, M. Lindner, W. Winter, 2002

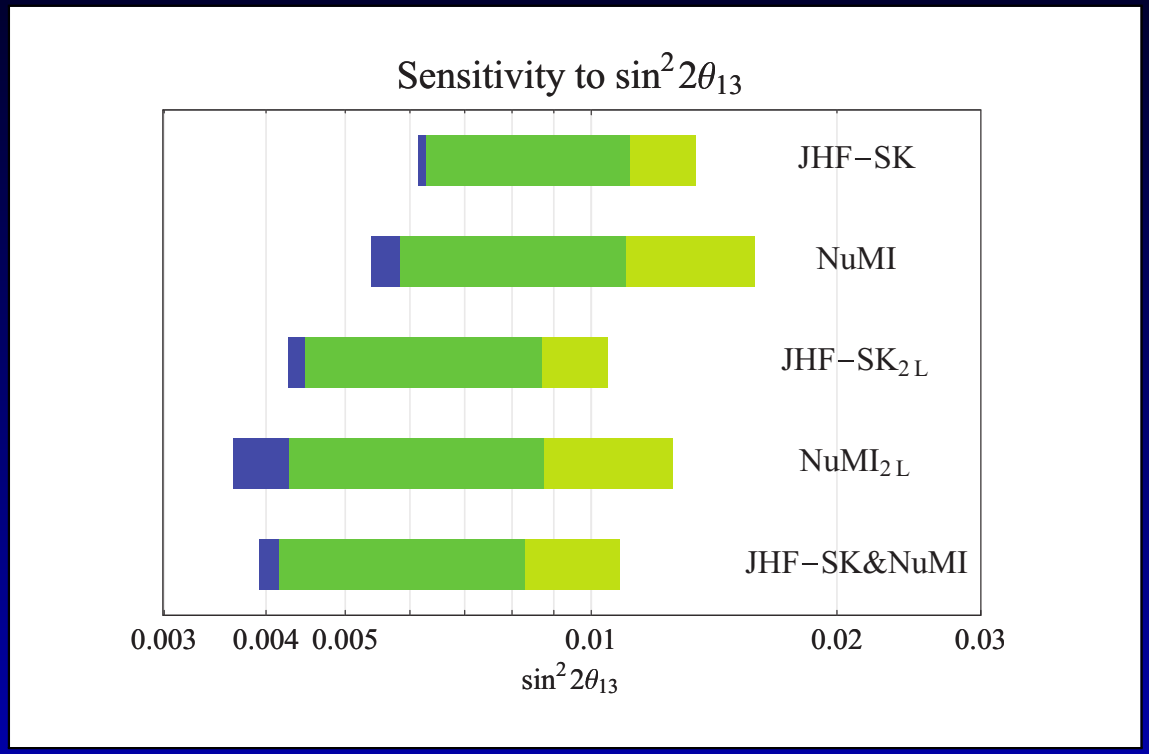
The appendices contain the core technology later implemented in GLoBES and for the first time the bulk of calculation was done in C.

Correlations & degeneracies



GLoBES manual

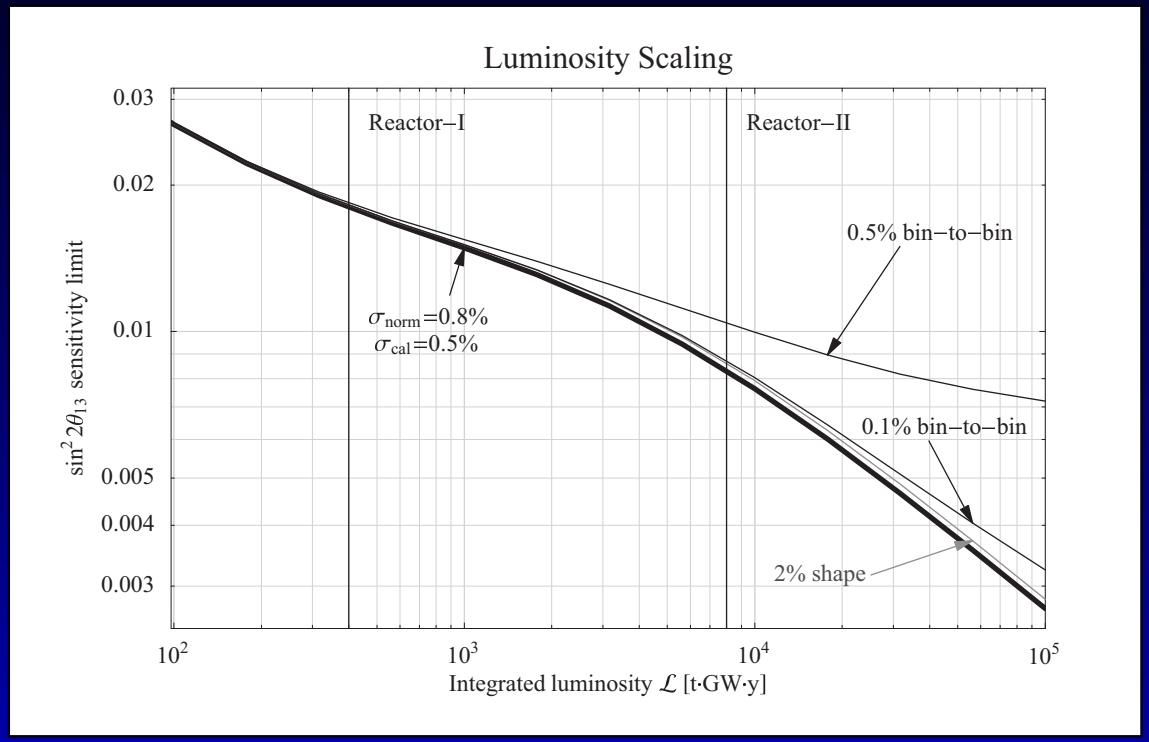
NuMI



PH, M. Lindner, W. Winter, 2002

This work took center stage at Fermilab at the workshop NOvA was born.

Reactor neutrinos



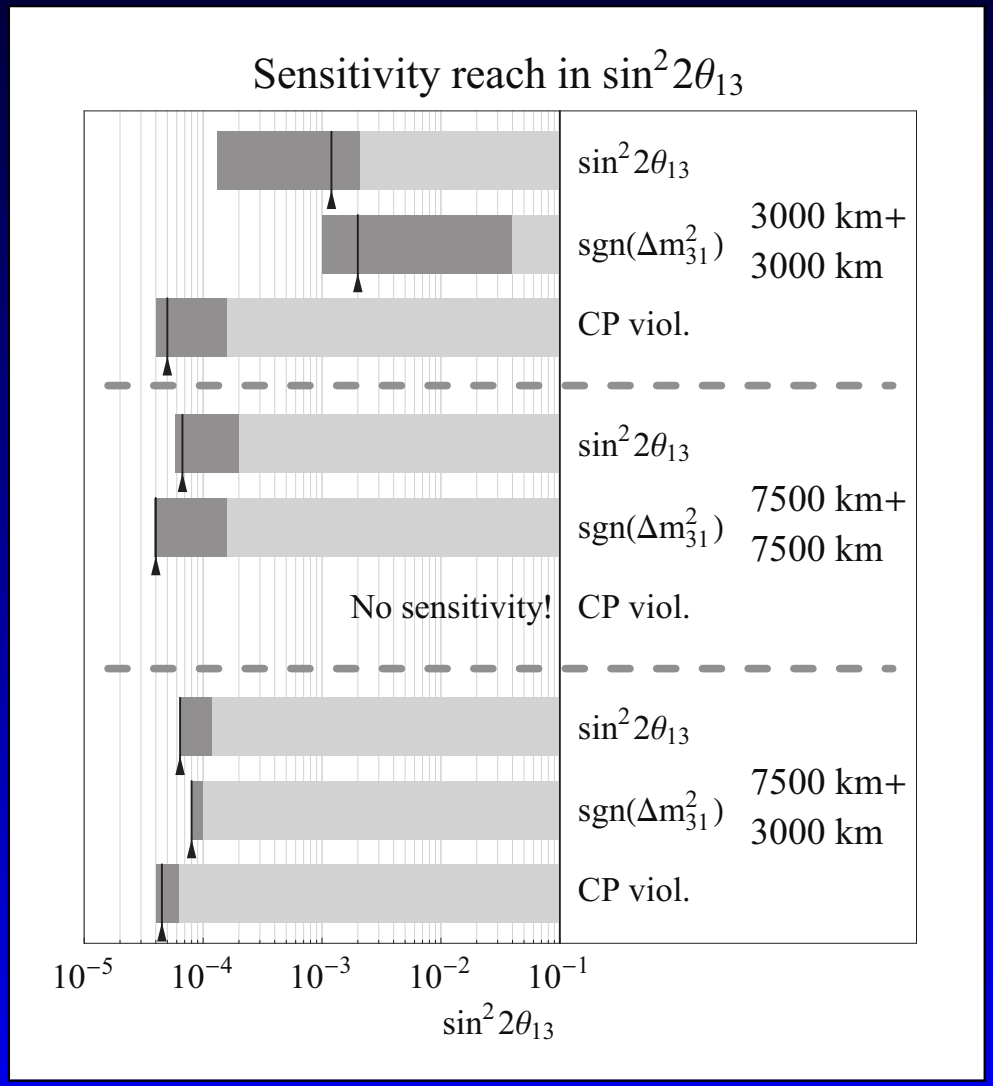
PH, M. Lindner, Th. Schwetz, W. Winter, 2003

Reactor-I would become Double Chooz
Reactor-II would become Daya Bay

NB: for this project Manfred had to do quite some convincing that this would be worthwhile...

Magic baseline

At that time, neutrino factories where the rage...



PH, W. Winter, 2003

Manfred:
You have to a name to things.

GLoBES

GLoBES is a software package designed for

- Simulation
- Analysis
- Comparison

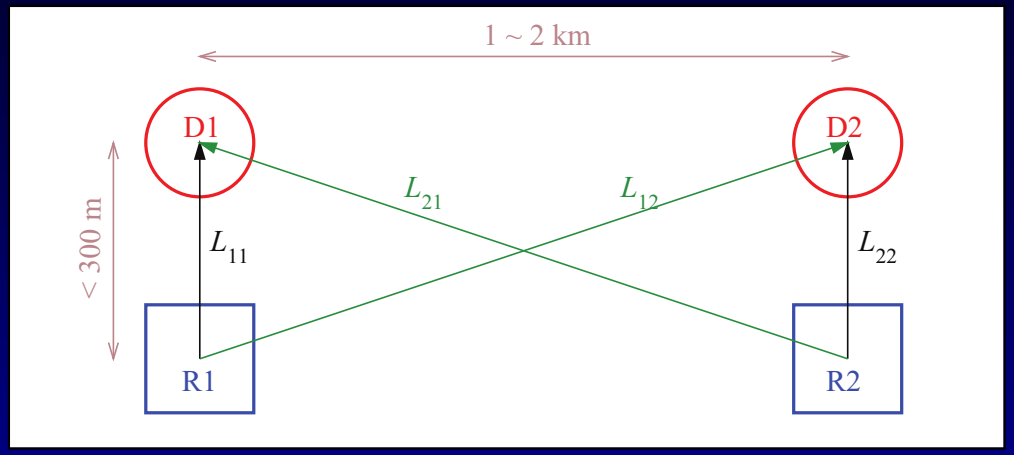
of neutrino oscillation experiments and is developed and maintained by PH, Joachim Kopp, Manfred Lindner and Walter Winter.

GLoBES is using parameterized detector responses and fast MC techniques combined with a custom-made abstract experiment definition language (AEDL).

Timeline

- Development started 2004 – PH, M. Lindner, W. Winter
- First release July 2004 – version 2.0.0
- Major bug fix release March 2005 version 2.0.11
- J. Kopp joined in July 2005
- January 2007 – version 3.0, addition of major features
- Major releases every 3-4 years
- June 2016 – version 3.2, new systematics interface
- >400 publications citing the GLoBES papers, creating a total of >11,000 citations

R2D2



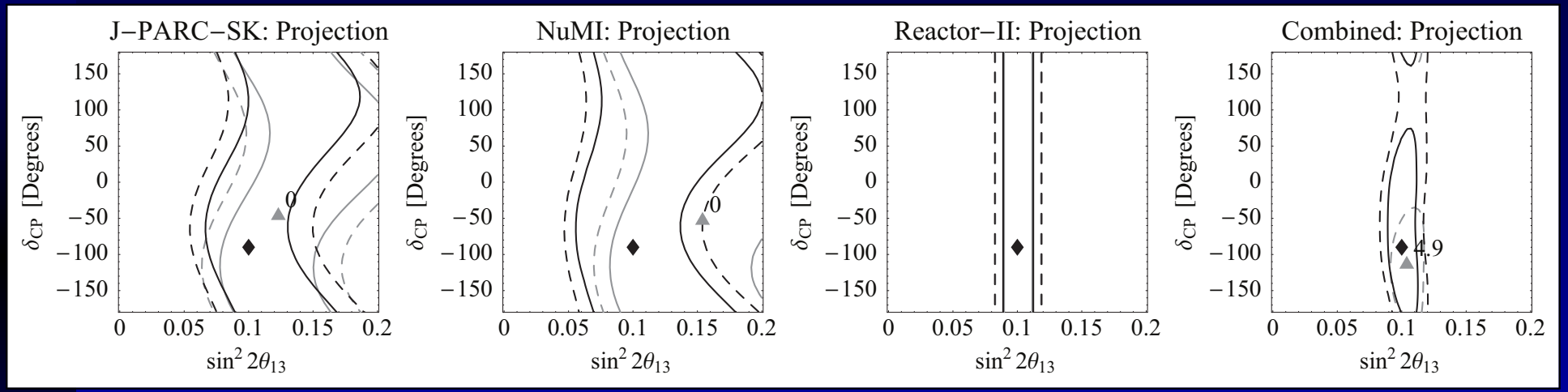
PH, M. Lindner, T. Schwetz, 2004

I am not sure whether Manfred fully appreciated the Star Wars reference...

In 2008, I joined Daya Bay...

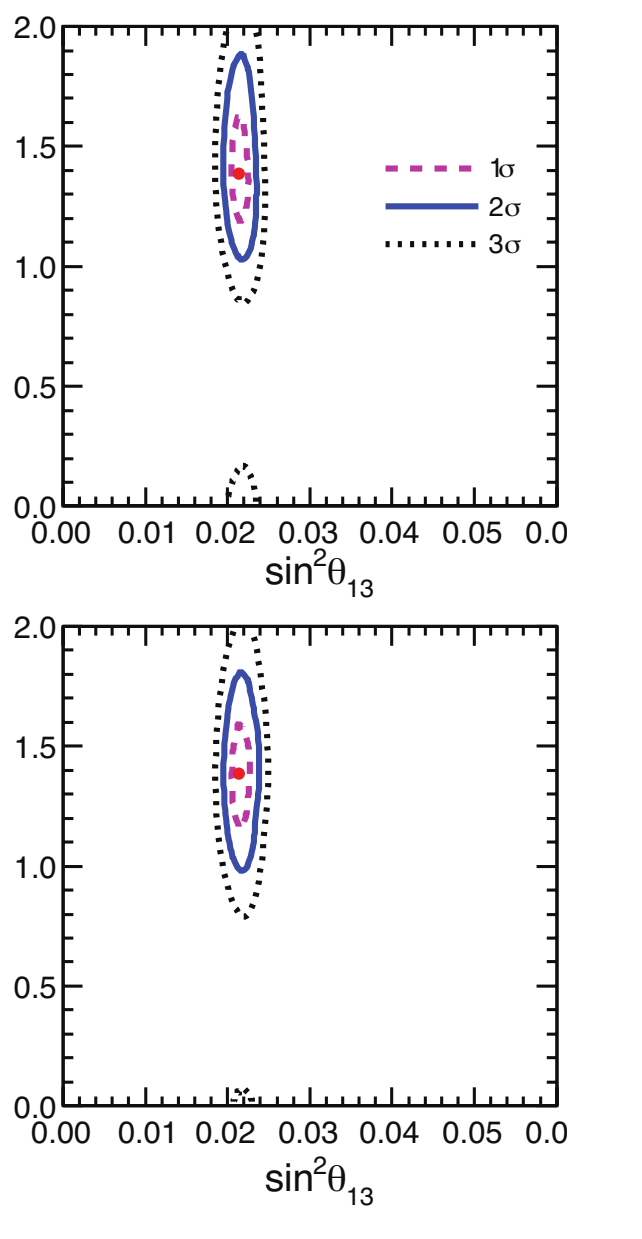
Predictions

In 2004 we considered this an unlikely case.



PH, M. Lindner, M. Rolinec, Th. Schwetz, W. Winter, 2004

Fast forward 2016

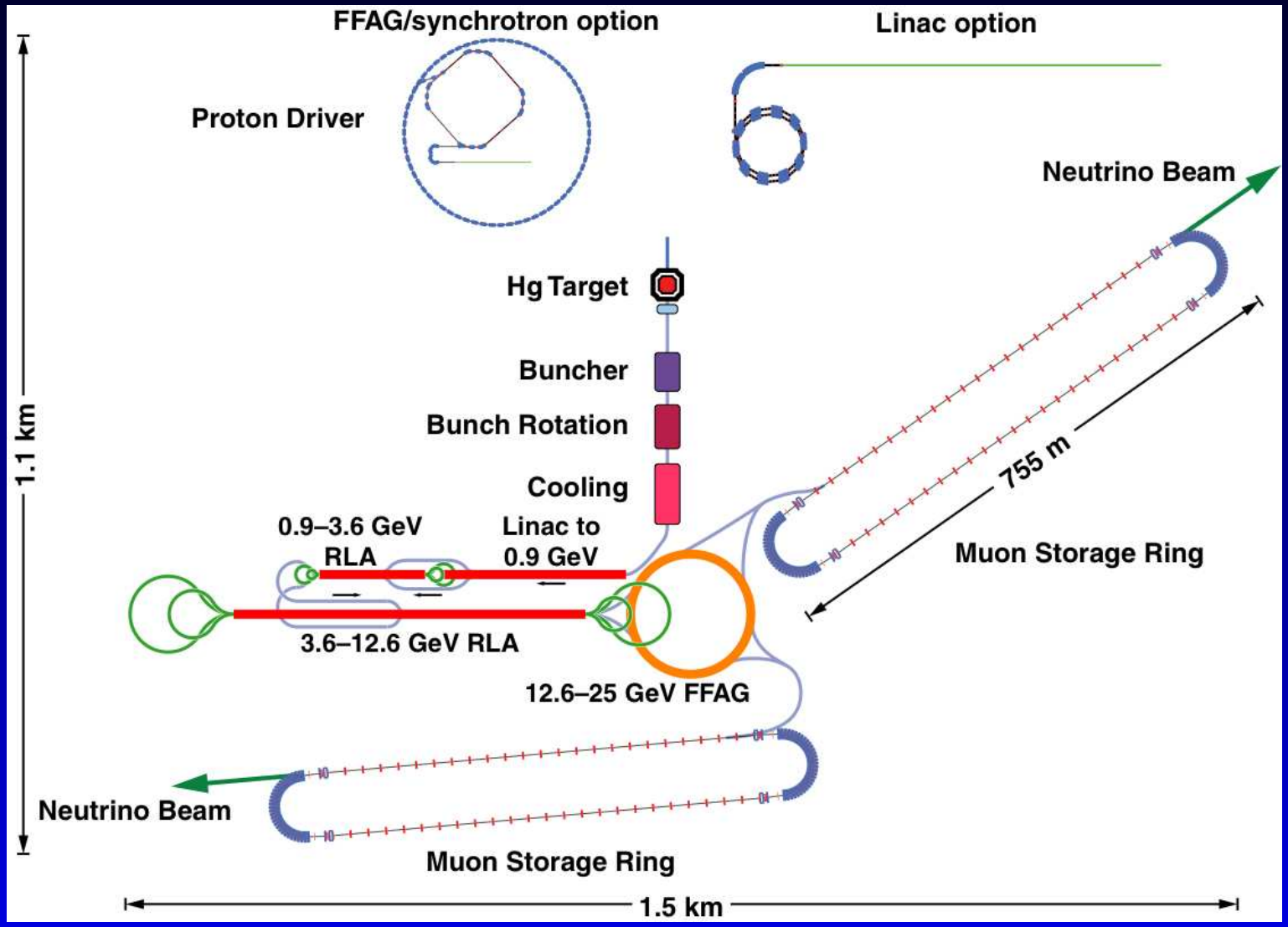


Marrone, Neutrino 2016

Latest T2K & NOvA combined with θ_{13} constraint from Daya Bay

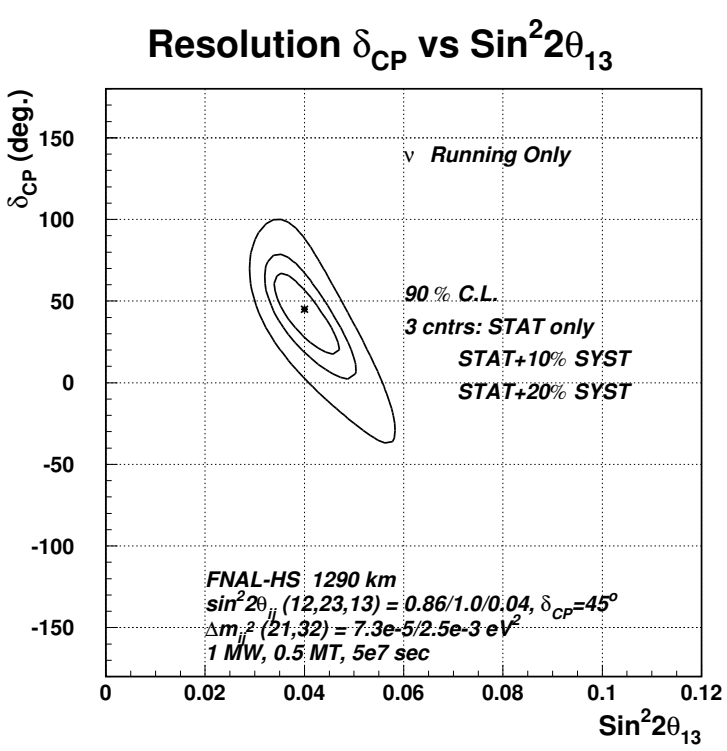
Hint for $\delta = -\pi/2$?

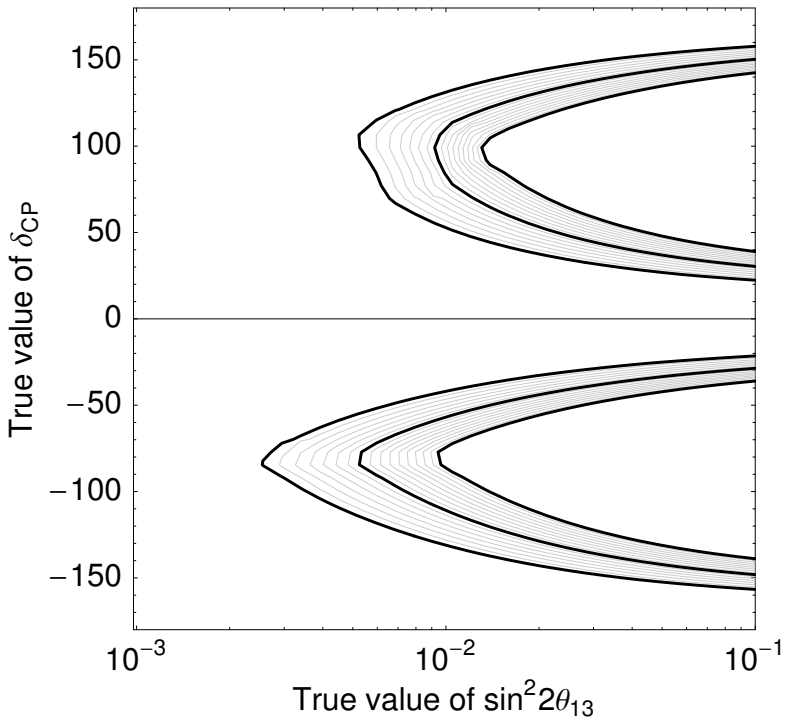
Beta beams, neutrino factories



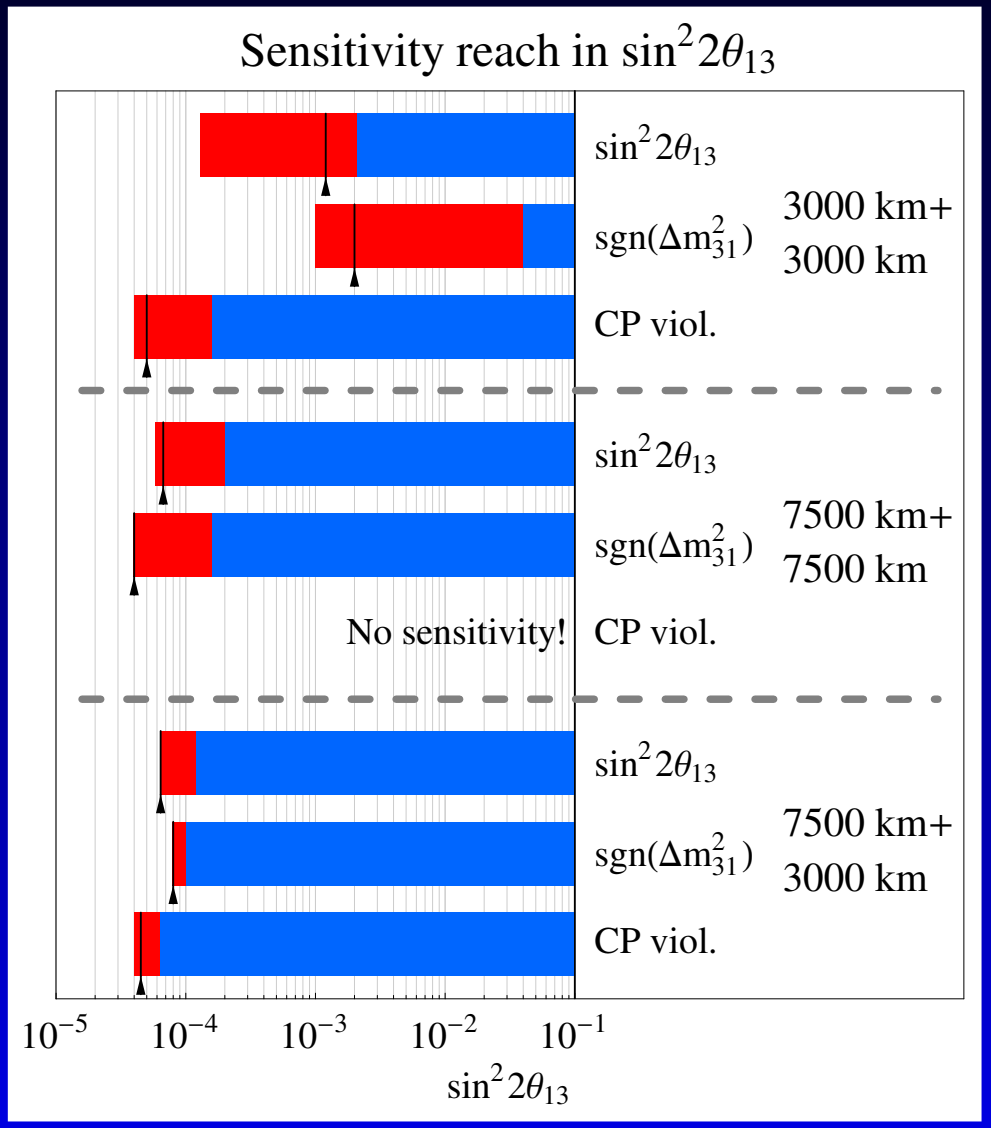
Design studies, roadmaps, reports. . .

Wide band beam

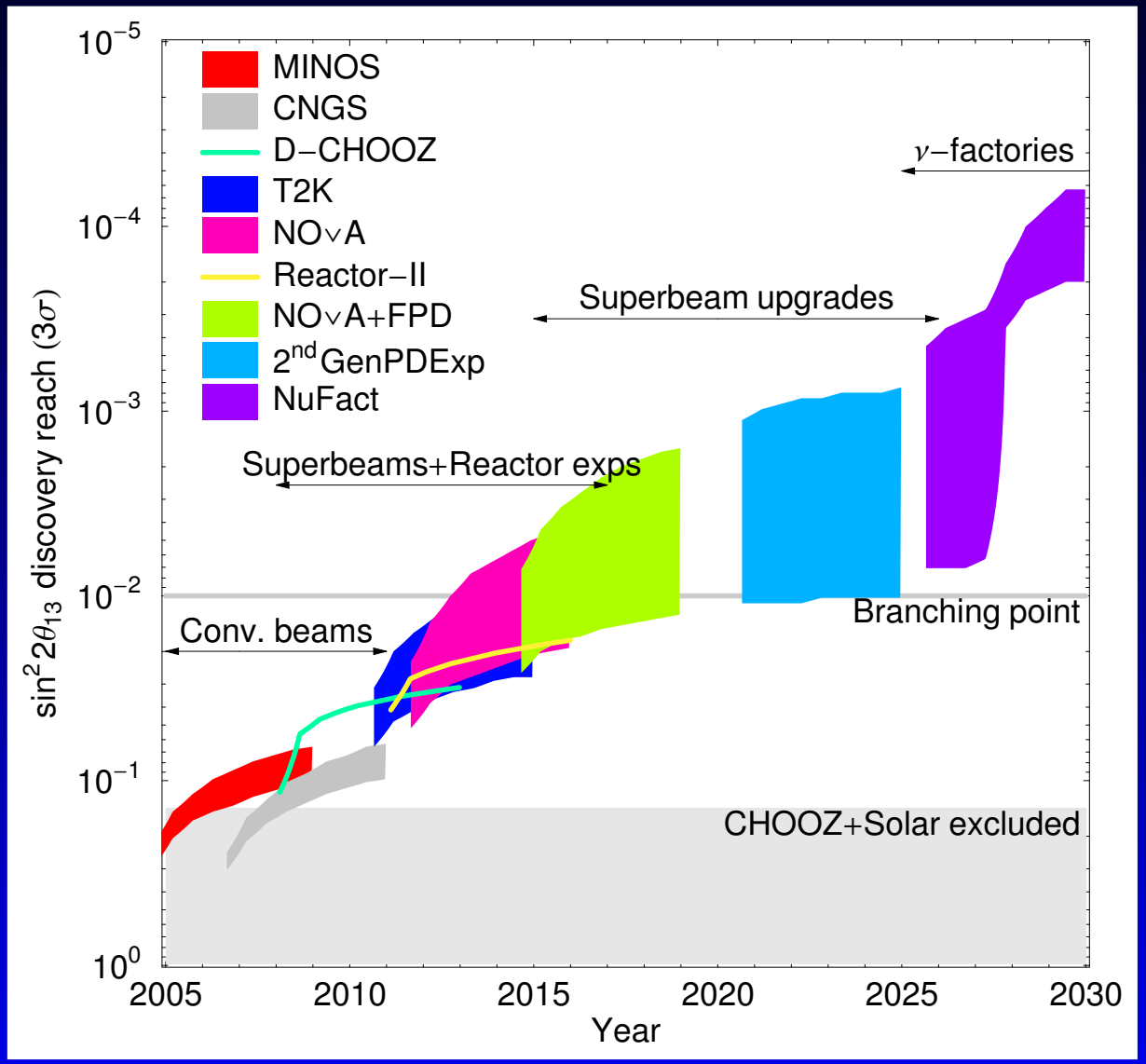




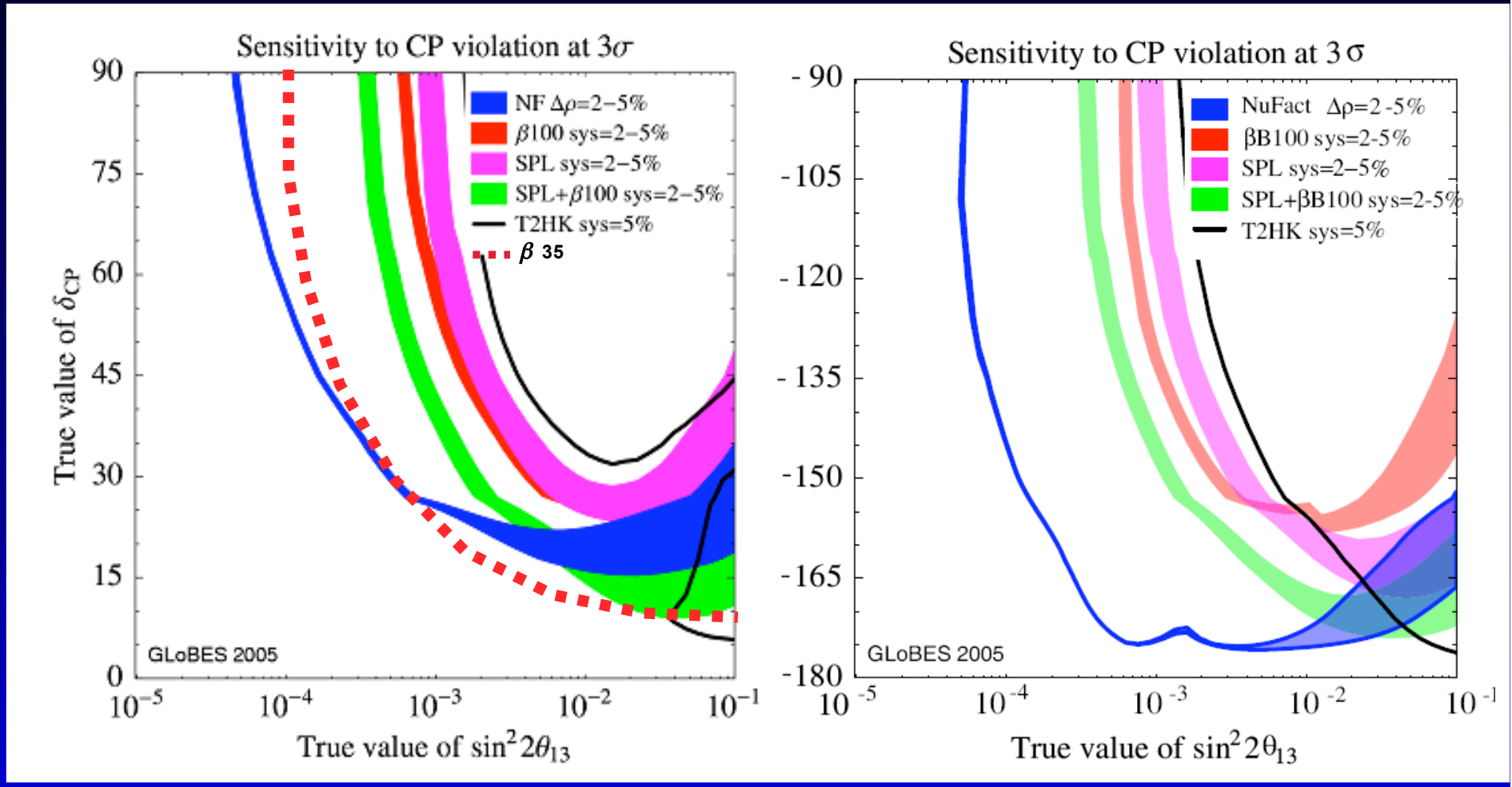
APS study


Sensitivity reach in $\sin^2 2\theta_{13}$
$\sin^2 2\theta_{13}$
$\mathrm{sgn}(\Delta m^2_{31})$
3000 km+ 3000 km
CP viol.
$\sin^2 2\theta_{13}$
$\mathrm{sgn}(\Delta m^2_{31})$
7500 km+ 7500 km
No sensitivity!
CP viol.
$\sin^2 2\theta_{13}$
$\mathrm{sgn}(\Delta m^2_{31})$
7500 km+ 3000 km
CP viol.
10^{-5} 10^{-4} 10^{-3} 10^{-2} 10^{-1}
$\sin^2 2\theta_{13}$

Fermilab proton driver

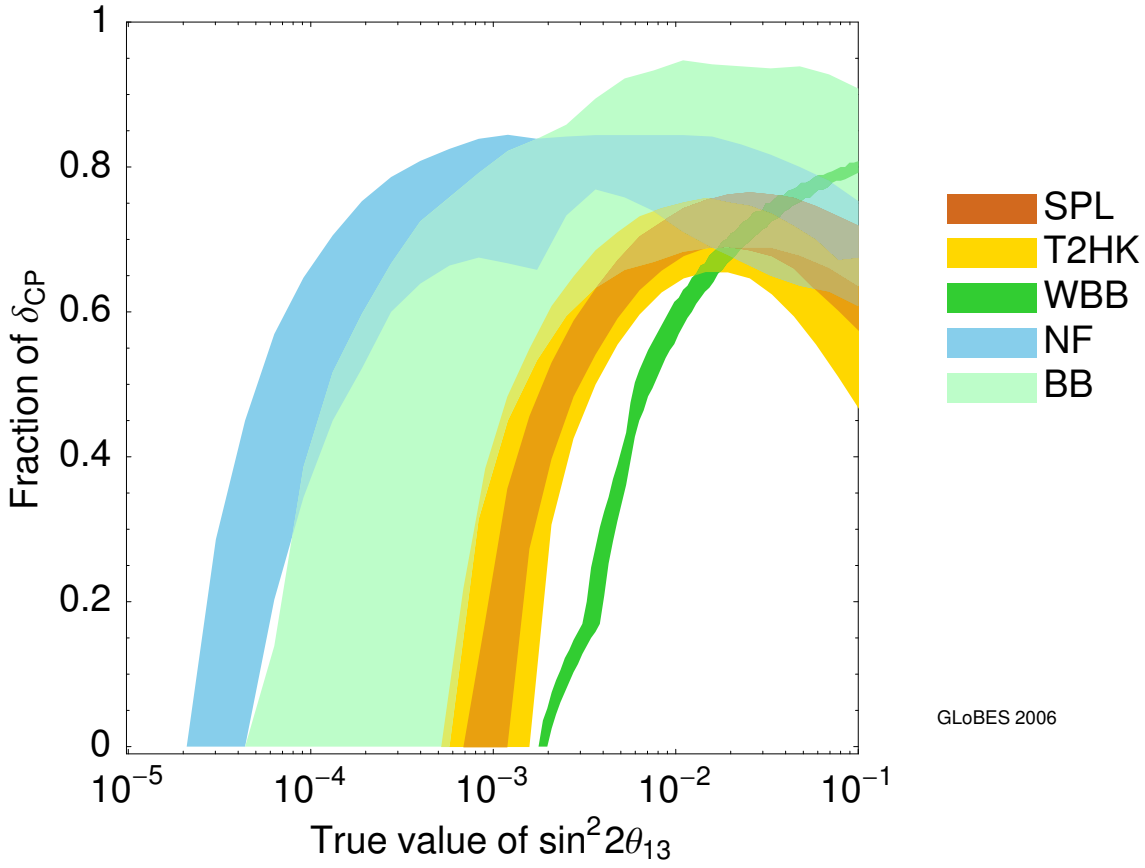


CERN strategy

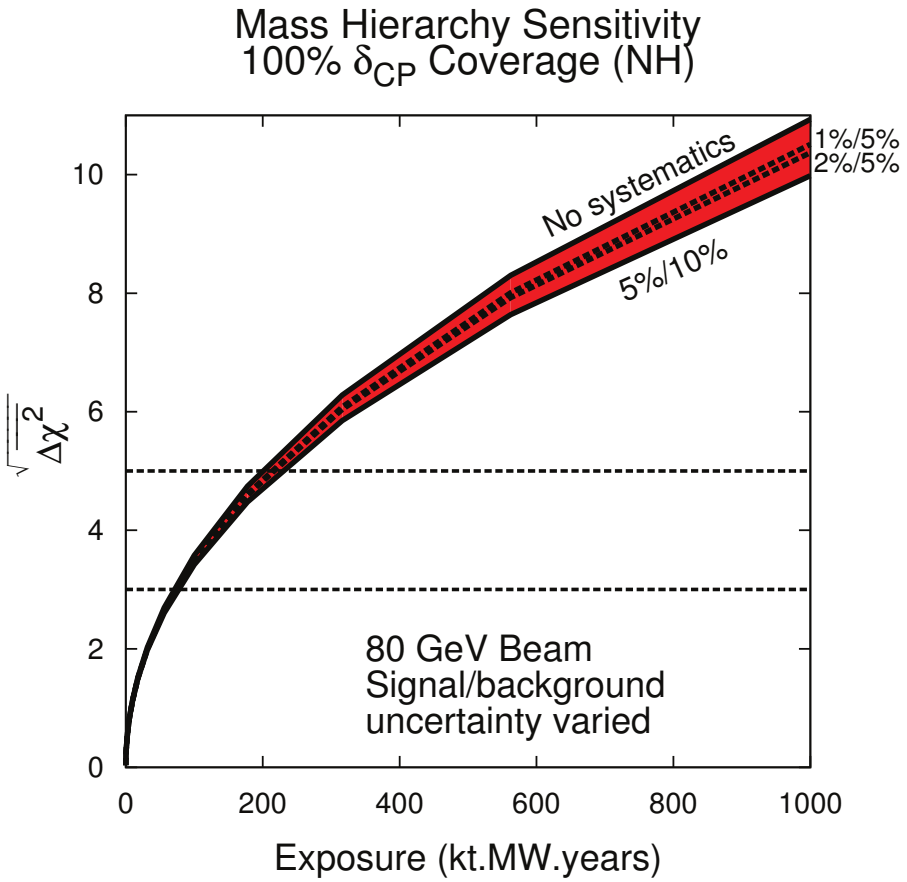


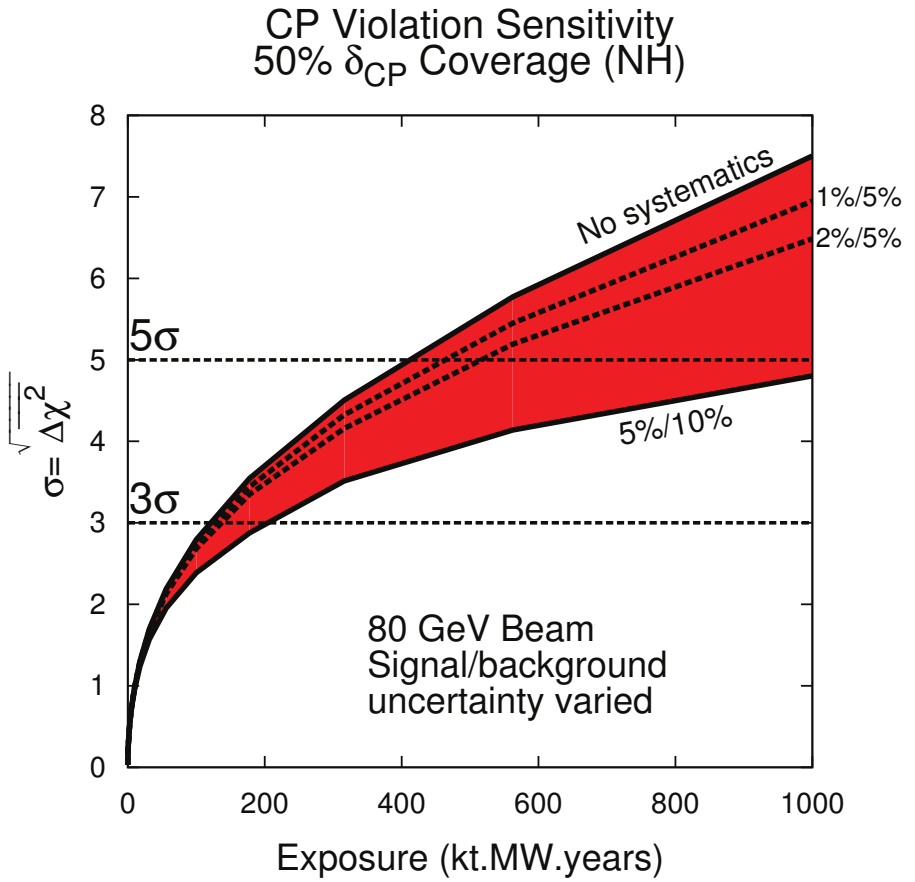
International scoping study

ISS



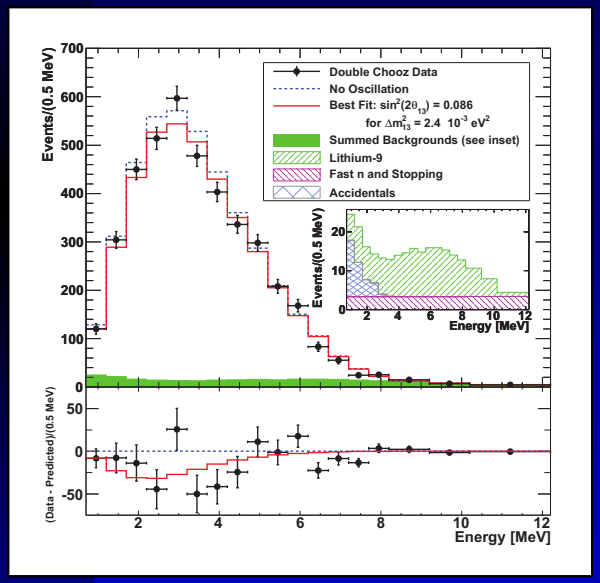
LBNE aka DUNE



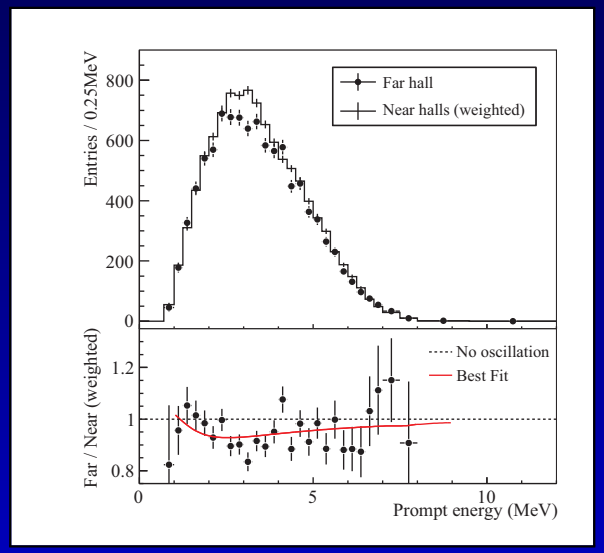


Large θ_{13}

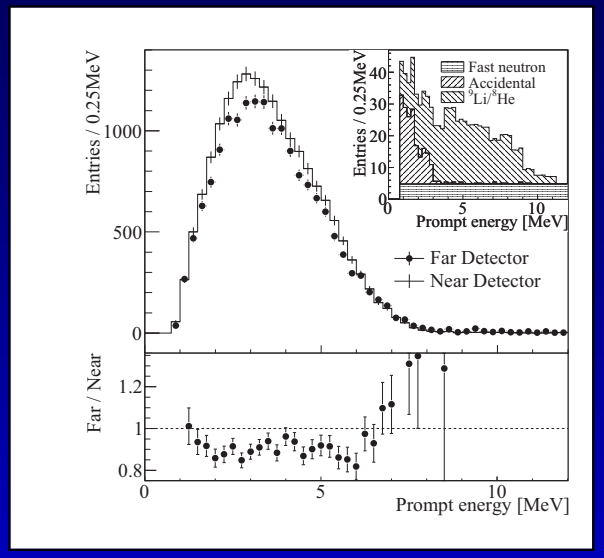
$$\sin^2 2\theta_{13} \simeq 0.1$$



Double Chooz, Dec 2011



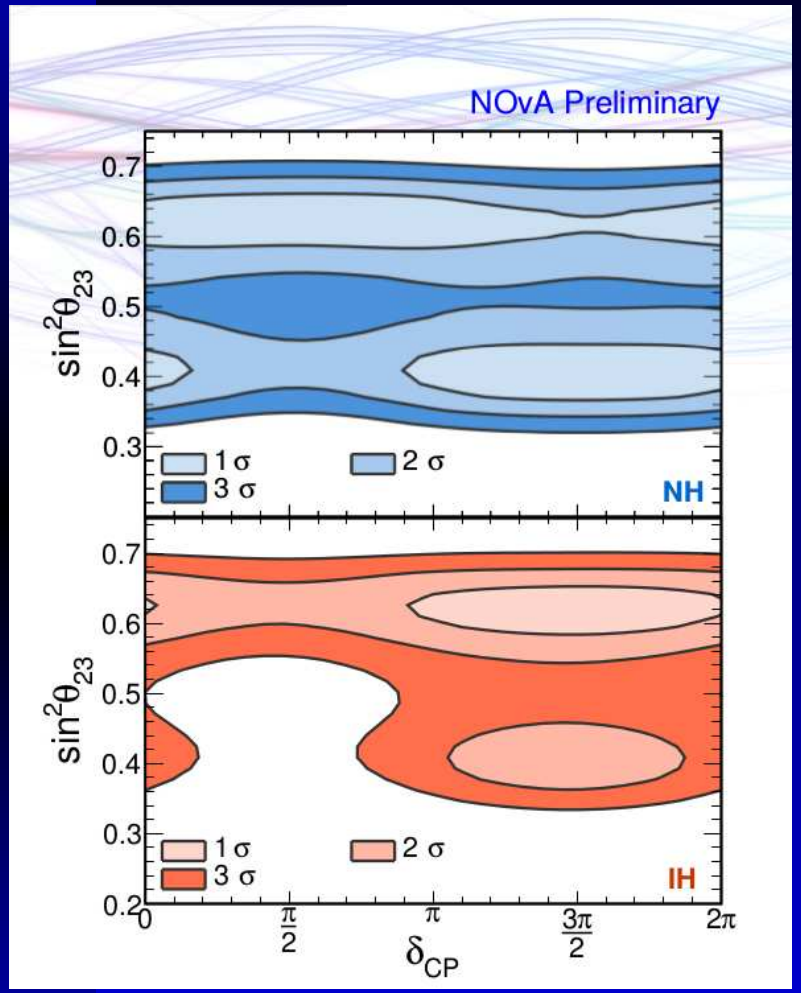
Daya Bay, Mar 2012



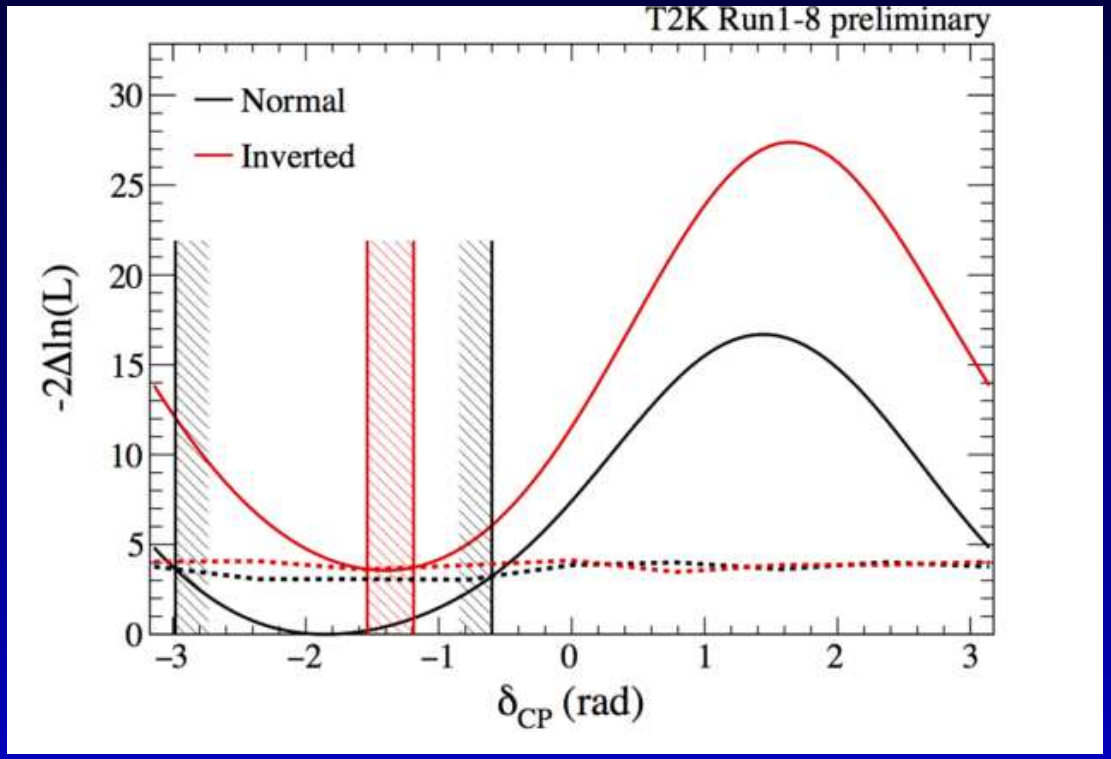
RENO, Apr 2012

Unlike in the movies, the Dark Side prevails with 5.2σ.

Current global program

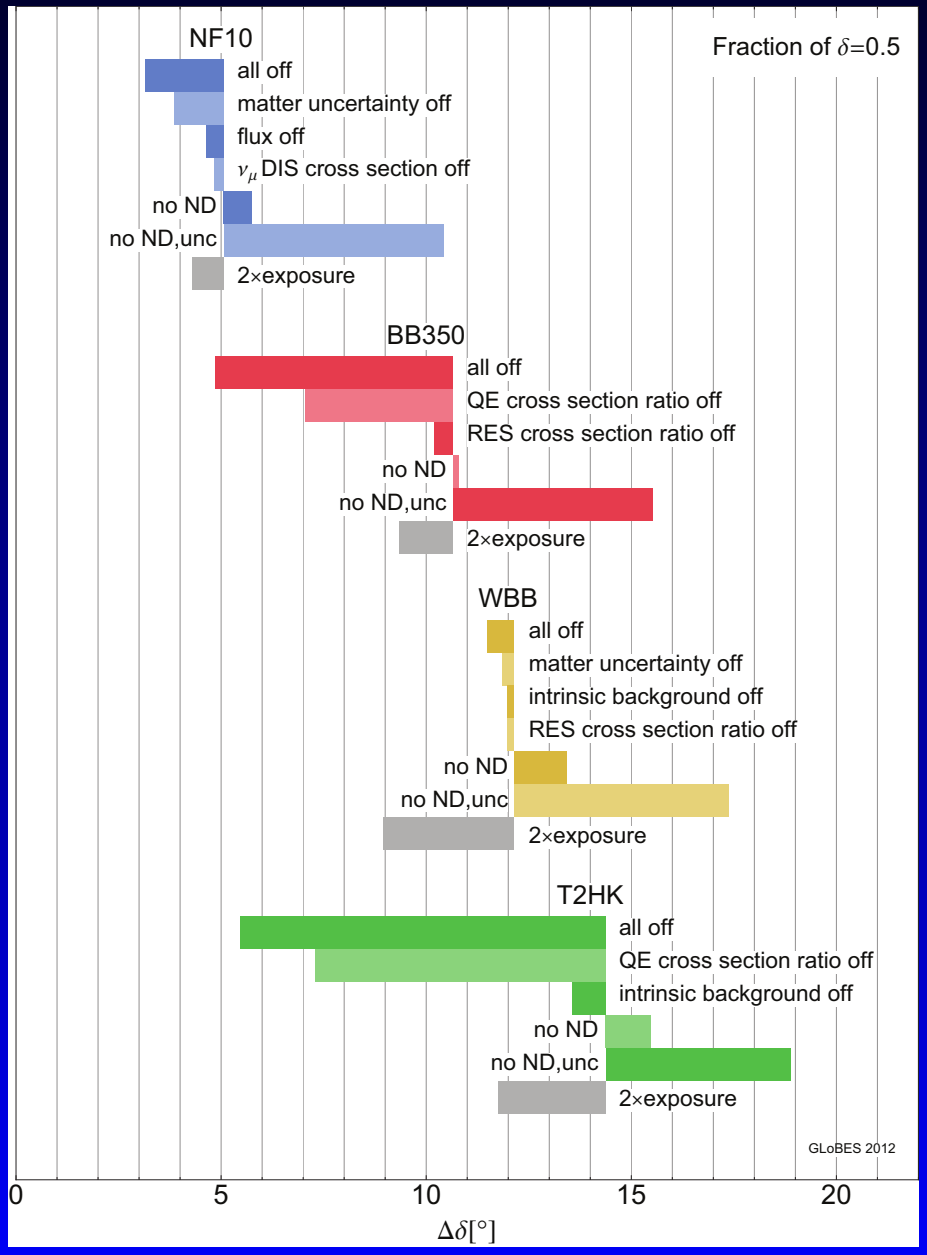


NOvA 2016



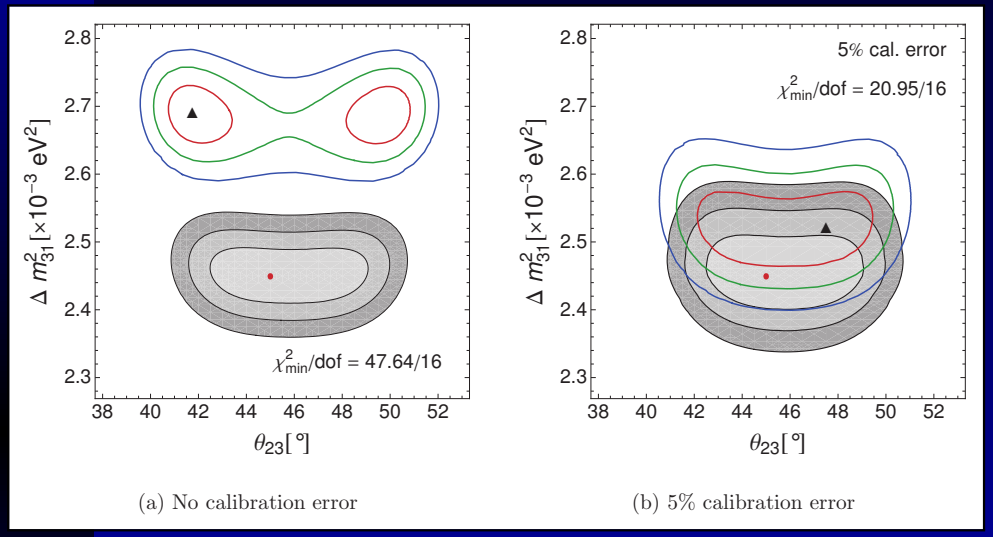
T2K 2017

Systematics

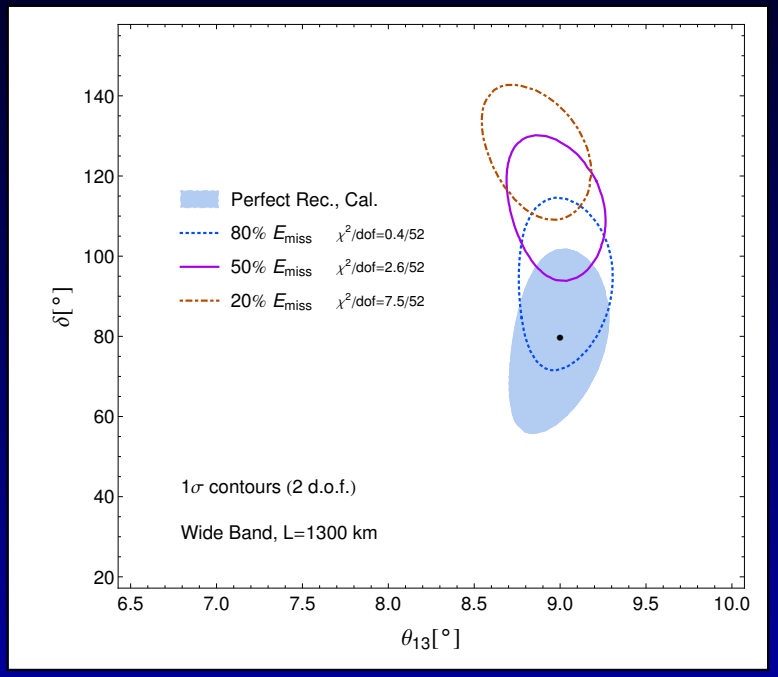


P. Coloma, PH, J. Kopp, W. Winter, 2012

Cross sections



P. Coloma *et al.* 2013

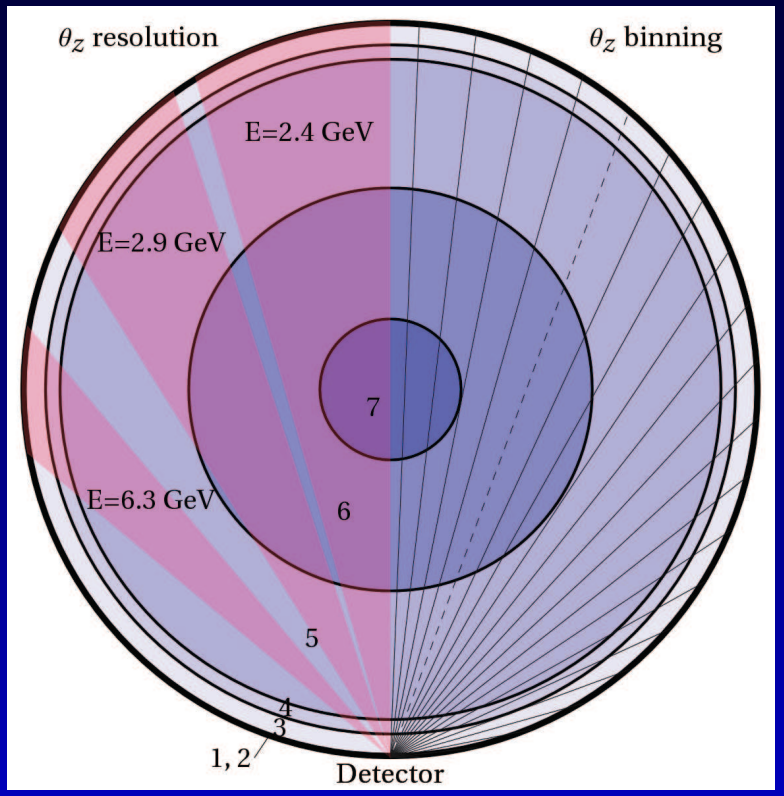


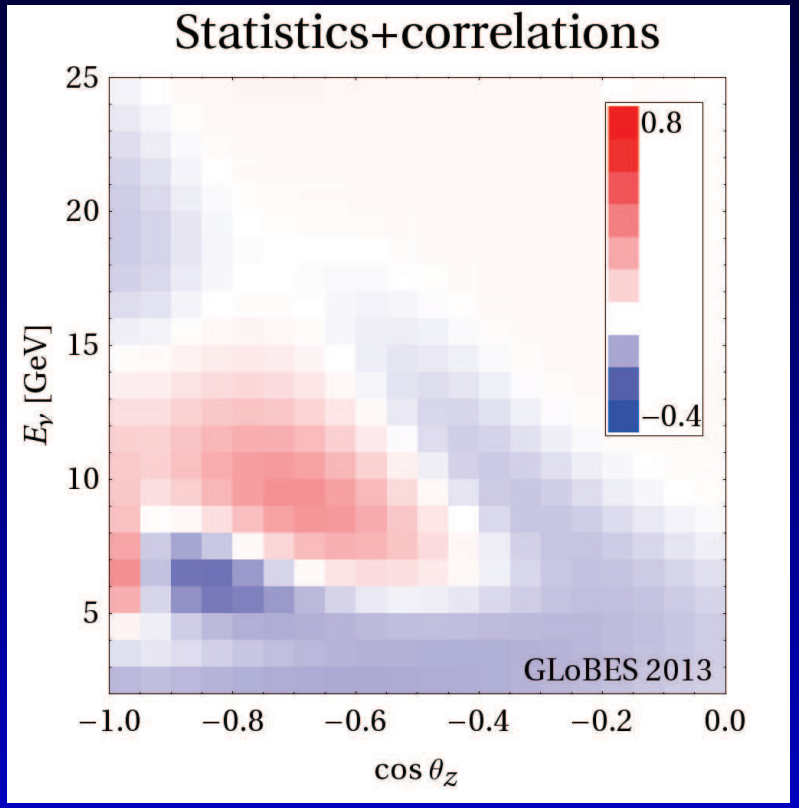
A. Ankowski *et al.*, 2015

GLoBES allows to understand the impact a wide range of cross section uncertainties on oscillation sensitivities.

Recent developments

Atmospheric neutrinos





Winter 2013, 2015

Future directions

Actively under development:

- Documentation for advanced systematics implementation
- Full integration of 2D binning for atmospheric neutrinos
- Fitting of real data

Ideas:

- Implementation on GPUs
- Solar neutrinos?
- . . .

Summary

GLoBES was crucially involved in

- the launch of the current reactor experiments
- the launch of NOvA
- the launch of DUNE

and all the decision making processes leading to these.

GLoBES is currently helping to phrase and address the cross section problem.

The current neutrino landscape would look very different without GLoBES.

The Department of Physics at Virginia Tech invites applications for a tenure-track faculty position in Particle Physics Phenomenology with a focus on neutrinos and dark matter.

Email: pheno_search@phys.vt.edu
Phone: +1 (540) 231 8727
URL: http://listings.jobs.vt.edu/postings/79786