

What we've done sofar...

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International Neutrino Factory and Superbeam Scoping Study

Imperial College

14-21 November 2005

Outline

- Task from meeting at CERN
- Results & Comparison
- Stability of results
 - Threshold
 - Energy response
 - Correlations
 - ...
- Summary
- Open points

Experiments

- JHF phase II
- SPL
- β -beam $\gamma = 100$ and $L = 130$ km
- β -beam $\gamma = 350$ and $L = 700$ km
- neutrino factory with $E_\mu = 20$ GeV and $L = 1\,000$ km
- neutrino factory with $E_\mu = 50$ GeV and $L = 3\,000$ km

Experiments

We agreed on

- 10 years of total running time
- water Cherenkov detector with 500 kt fiducial mass
- magnetized iron calorimeter with 100 kt
- β -beam $\gamma = 100$ has $1.1/2.8 \times 10^{18}$ ions per year
- β -beam $\gamma = 350$ has $1/1 \times 10^{19}$ ions per year
- neutrino factory has 10^{21} decays per year

Benchmark points

The oscillation parameters were decided to be

$$\Delta m_{31}^2 = 2.4 \times 10^{-3} \text{ eV}^2, \quad \Delta m_{21}^2 = 7.9 \times 10^{-5} \text{ eV}^2,$$

$$\sin^2 \theta_{23} = 0.44, \quad \sin^2 \theta_{12} = 0.3.$$

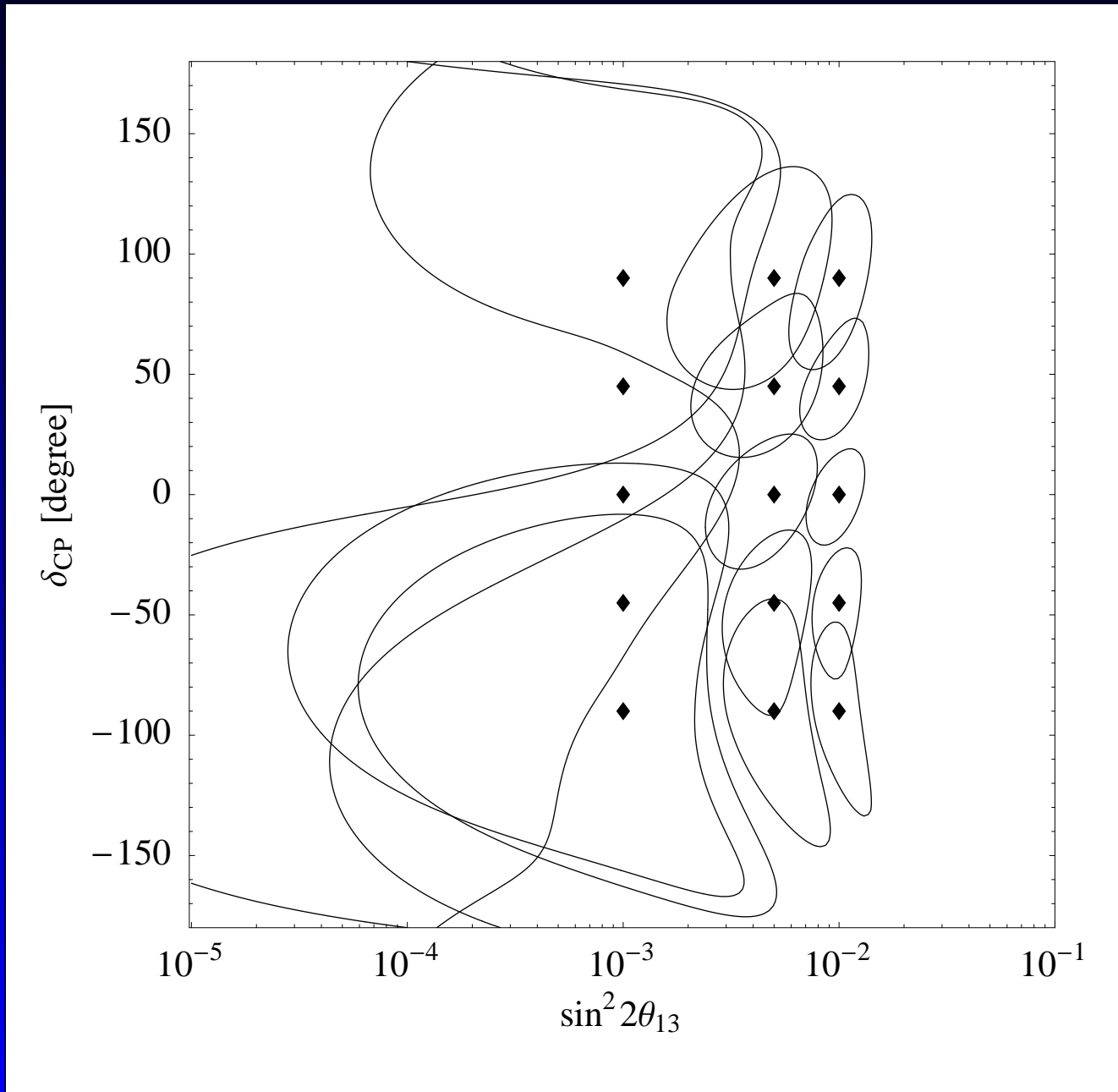
G. L. Fogli, *et al.*, arXiv:hep-ph/0506307.

Moreover we wanted to look at two parameter fits (2σ , 2 dof, i.e. $\Delta\chi^2 = 6.18$) of only the appearance channels for 25 points in the $\log \sin^2 2\theta_{13}$ - δ -plane:

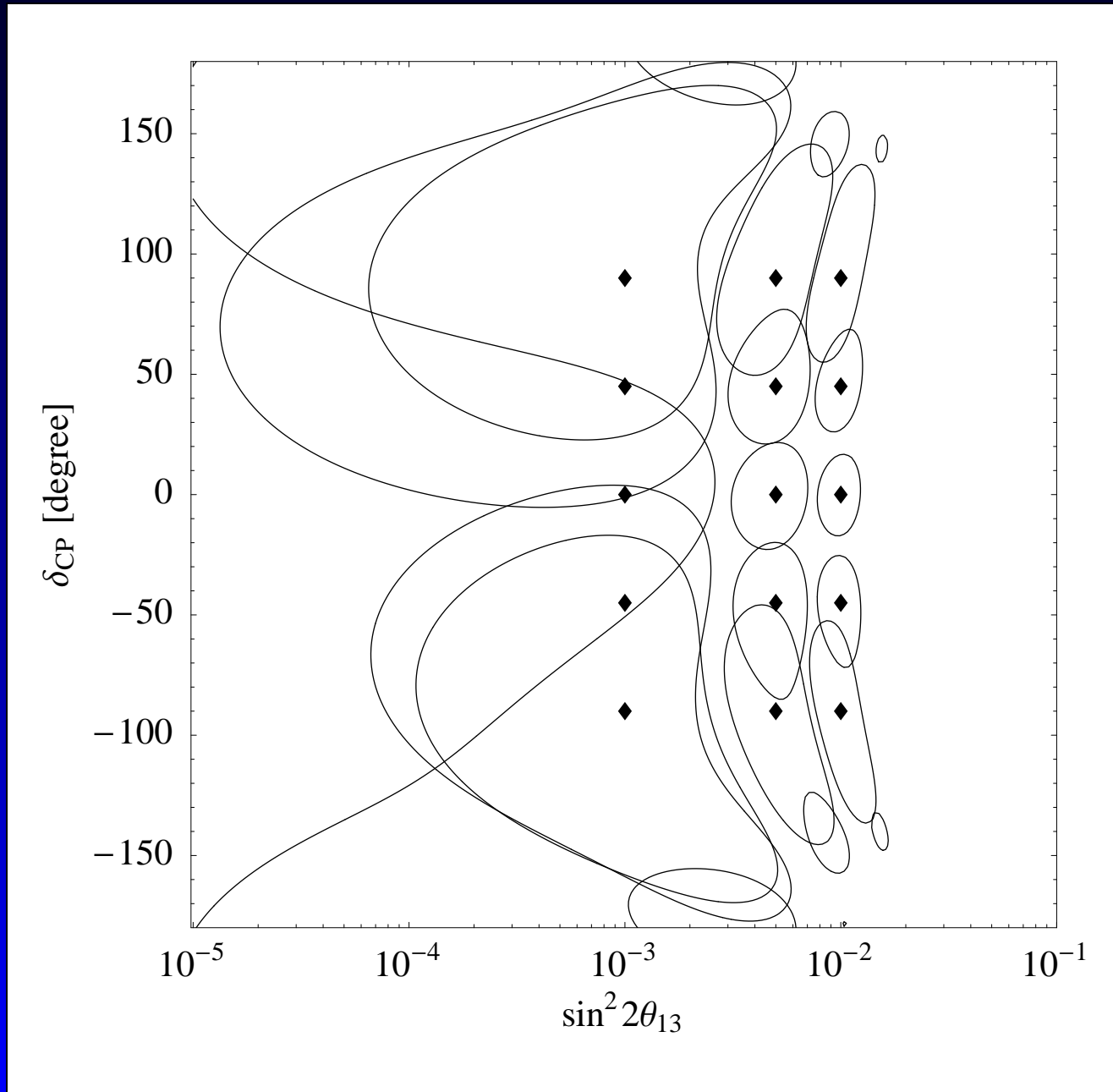
$$\sin^2 2\theta_{13} = \{10^{-4}, 5 \times 10^{-4}, 10^{-3}, 5 \times 10^{-3}, 10^{-2}\}$$

$$\delta_{CP} = \{-90^\circ, -45^\circ, 0^\circ, 45^\circ, 90^\circ\}$$

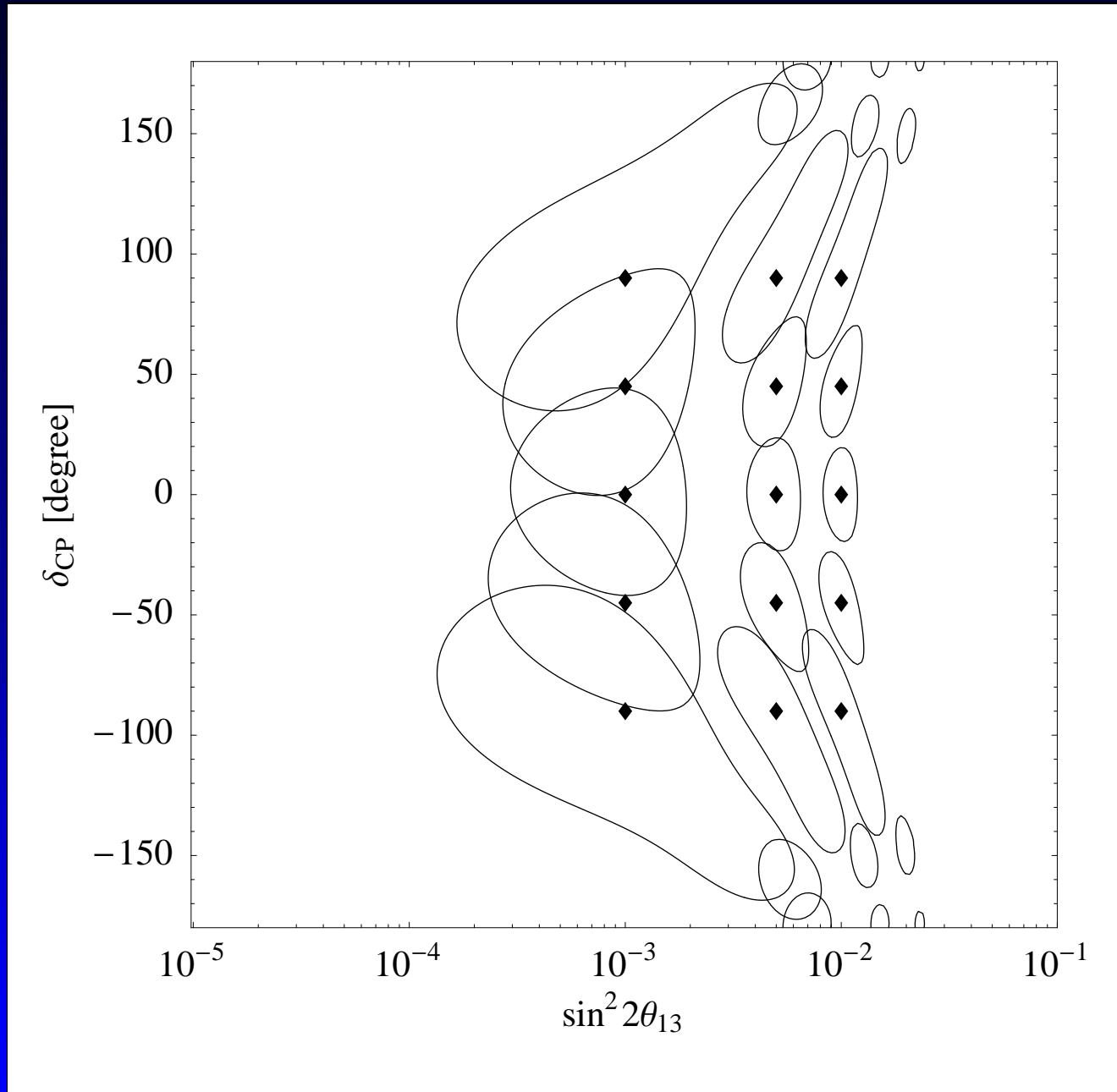
JHF



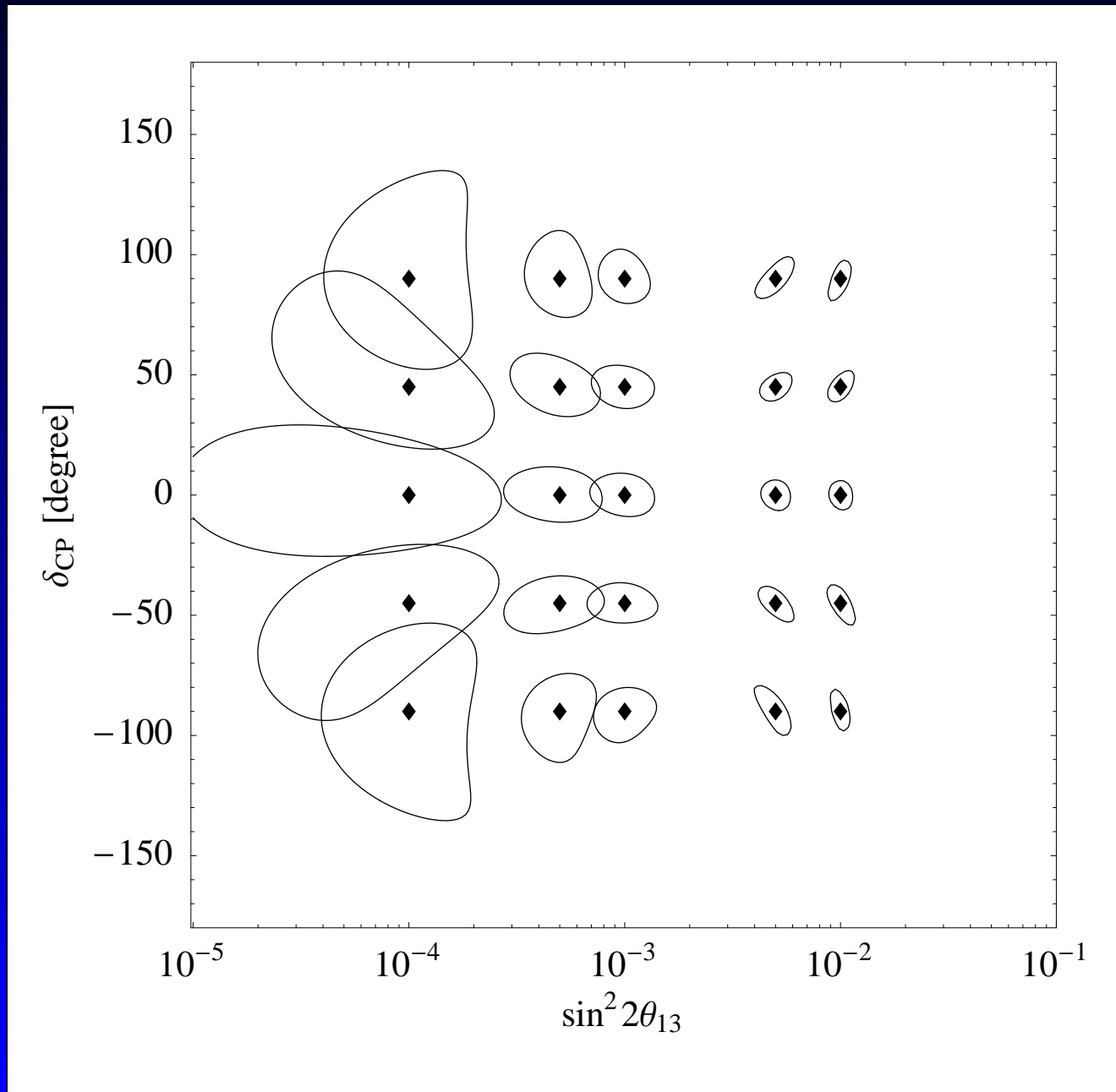
SPL



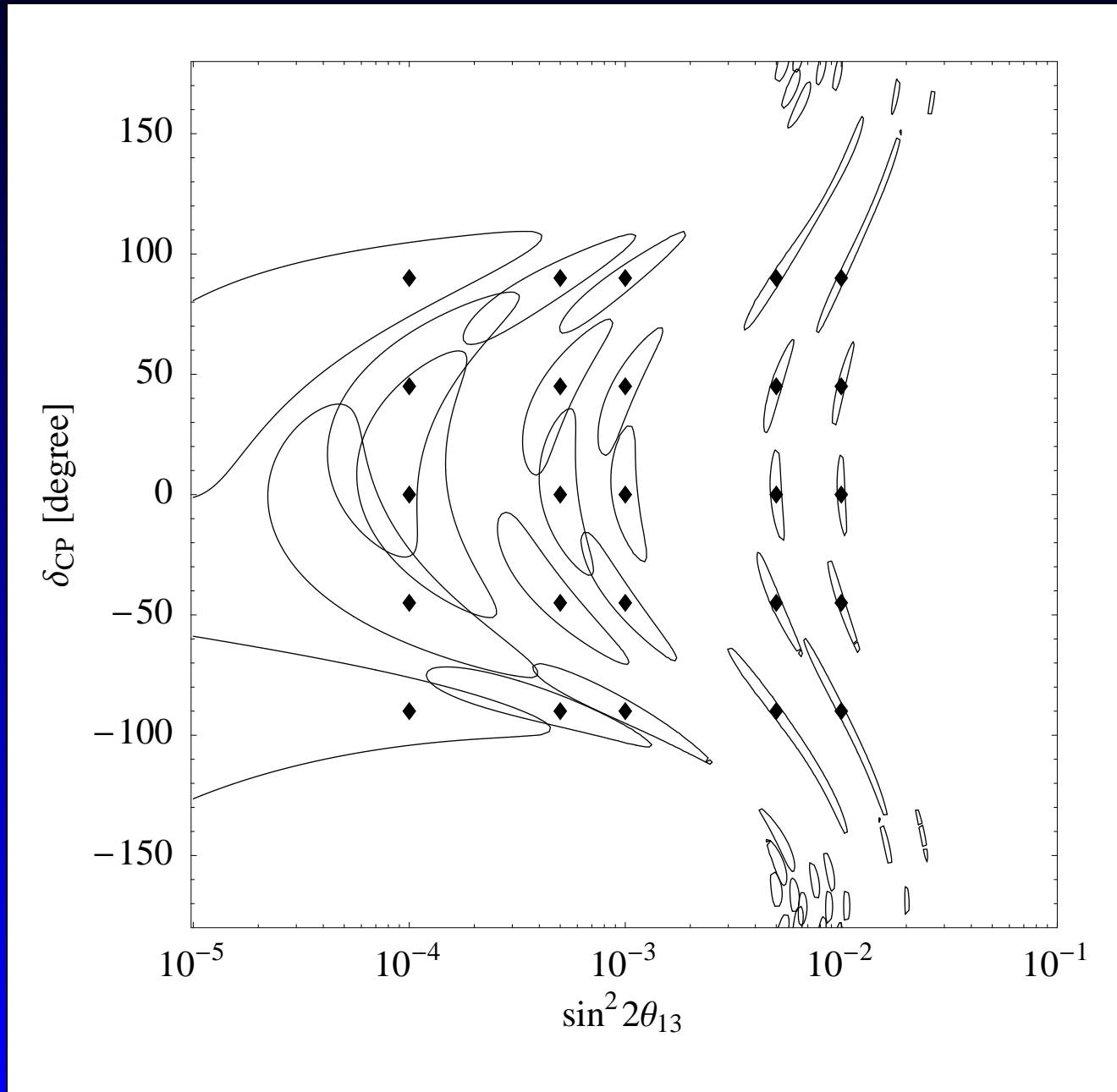
β -beam $\gamma = 100$



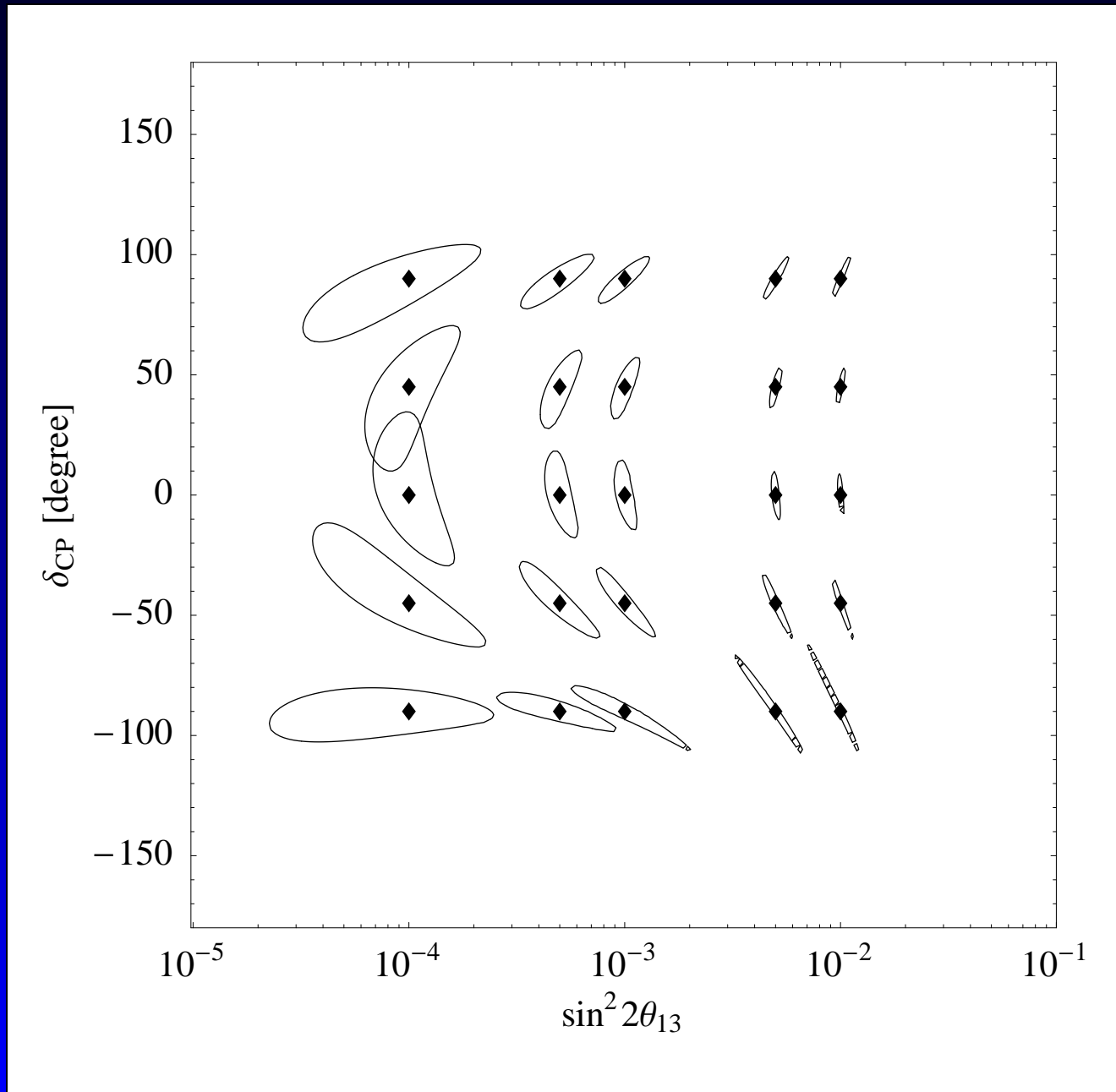
β -beam $\gamma = 350$



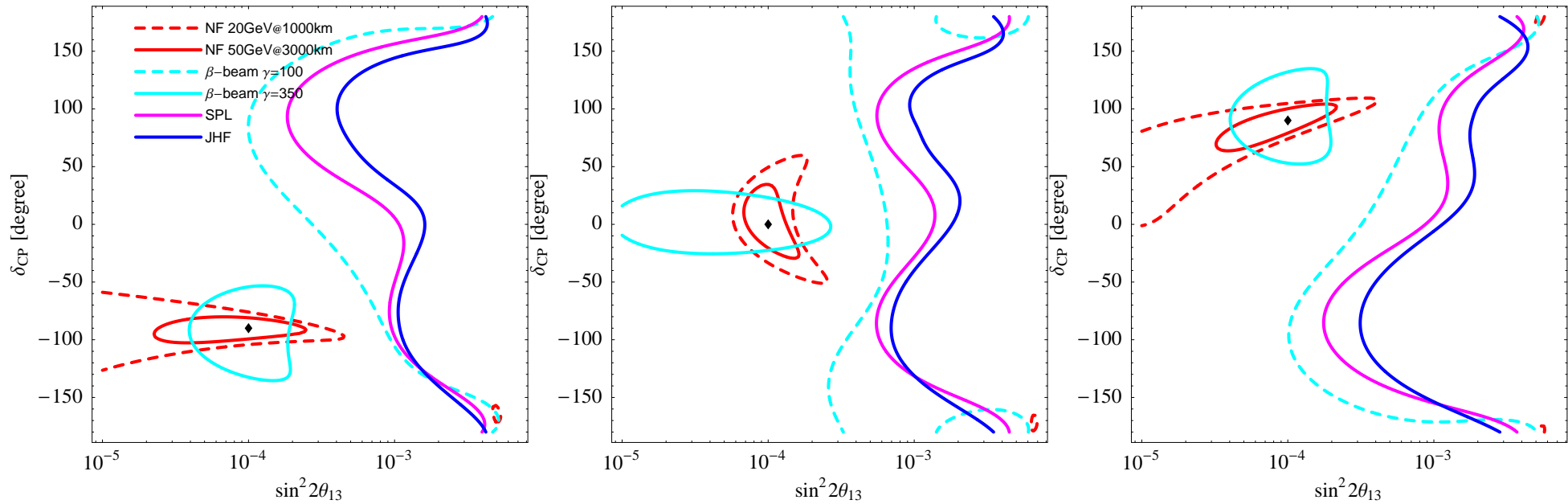
Neutrino factory 20 GeV



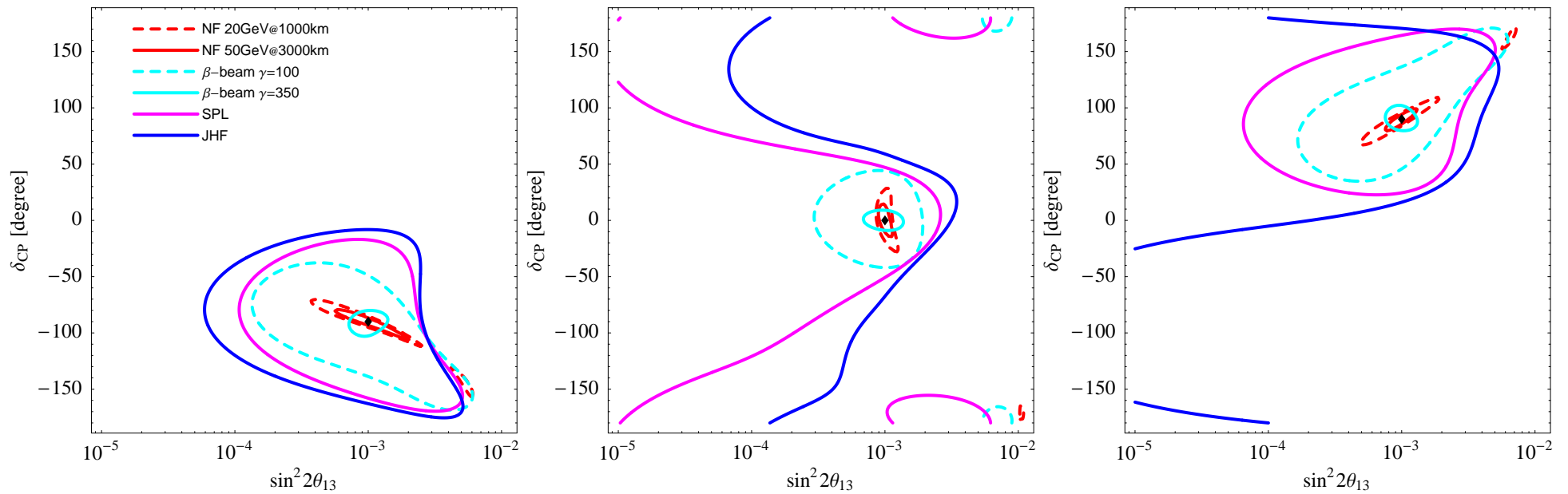
Neutrino factory 50 GeV



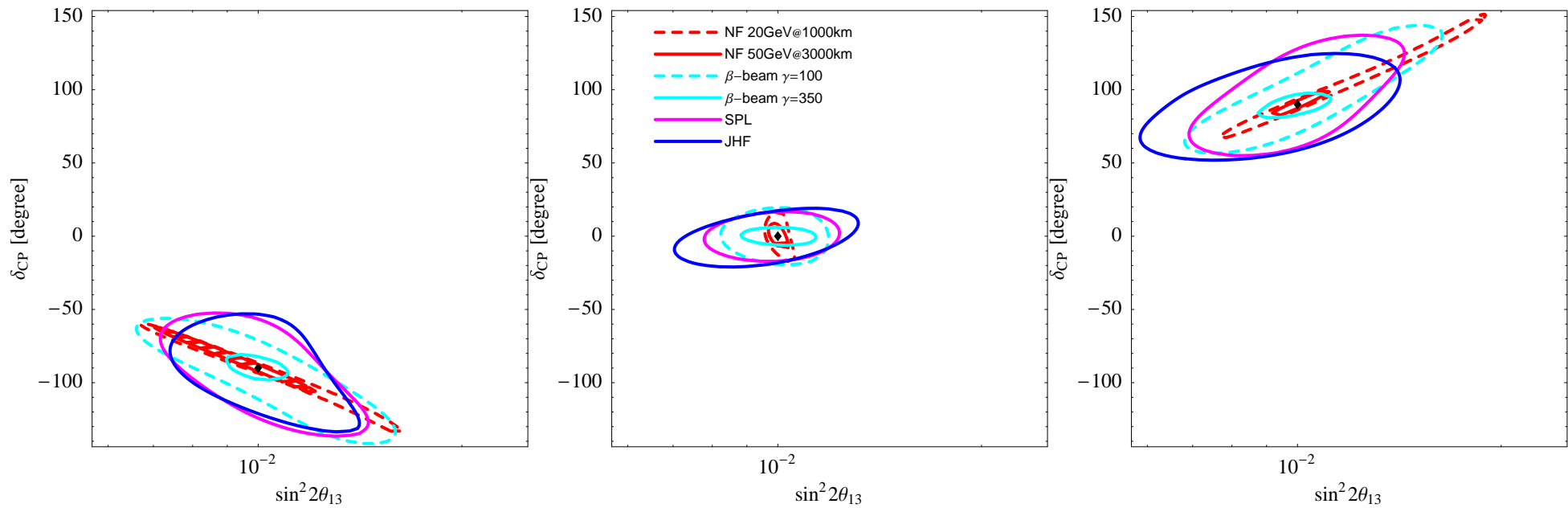
Comparison at $\sin^2 2\theta_{13} = 10^{-4}$



Comparison at $\sin^2 2\theta_{13} = 10^{-3}$



Comparison at $\sin^2 2\theta_{13} = 10^{-2}$



Threshold

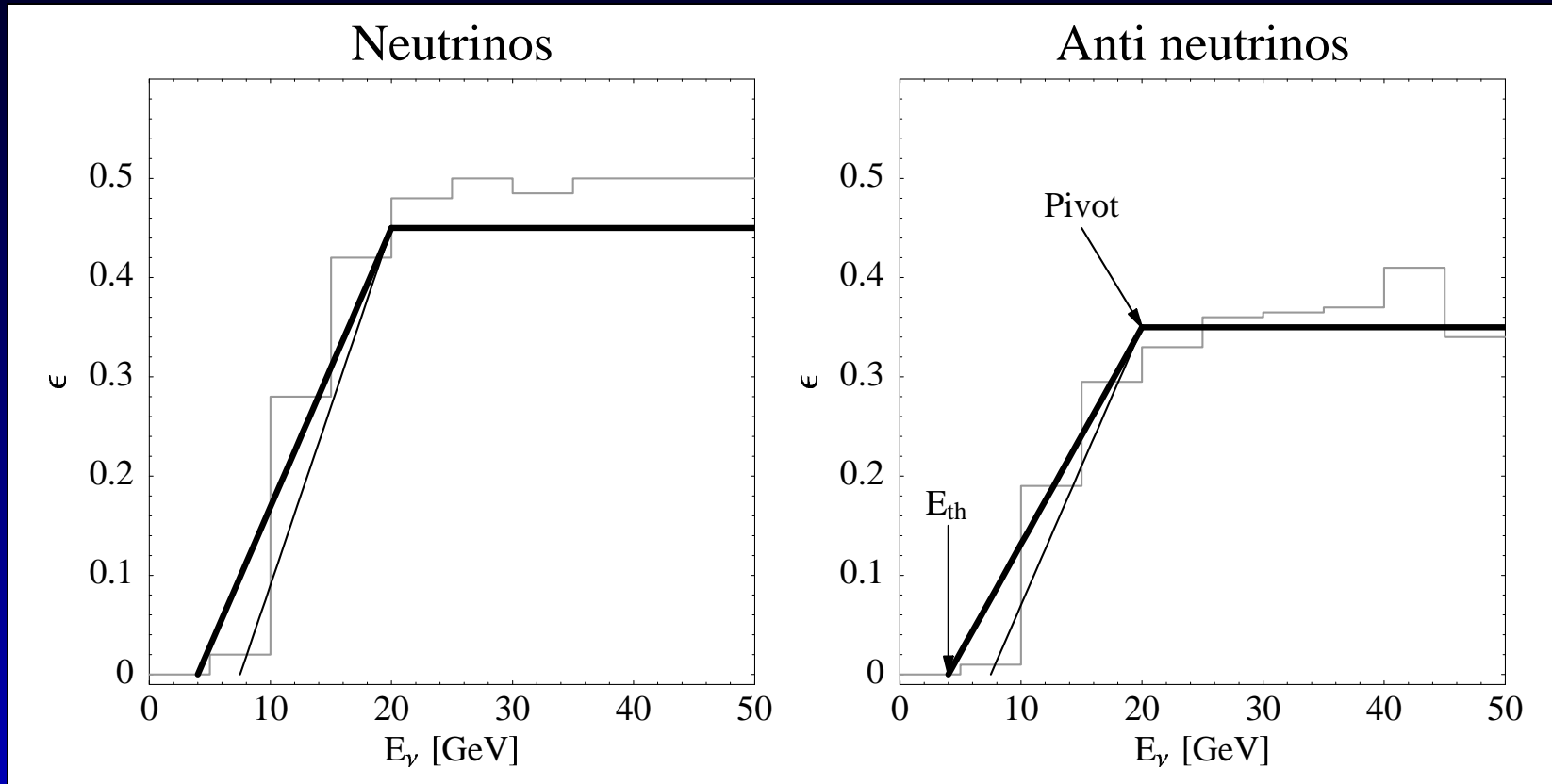


figure taken from PH, M. Lindner, W. Winter, Nucl. Phys. B **645** (2002) 3.

gray histogram taken from A. Cervera, *et al.*, Nucl. Phys. B **579**, 17 (2000)

Threshold

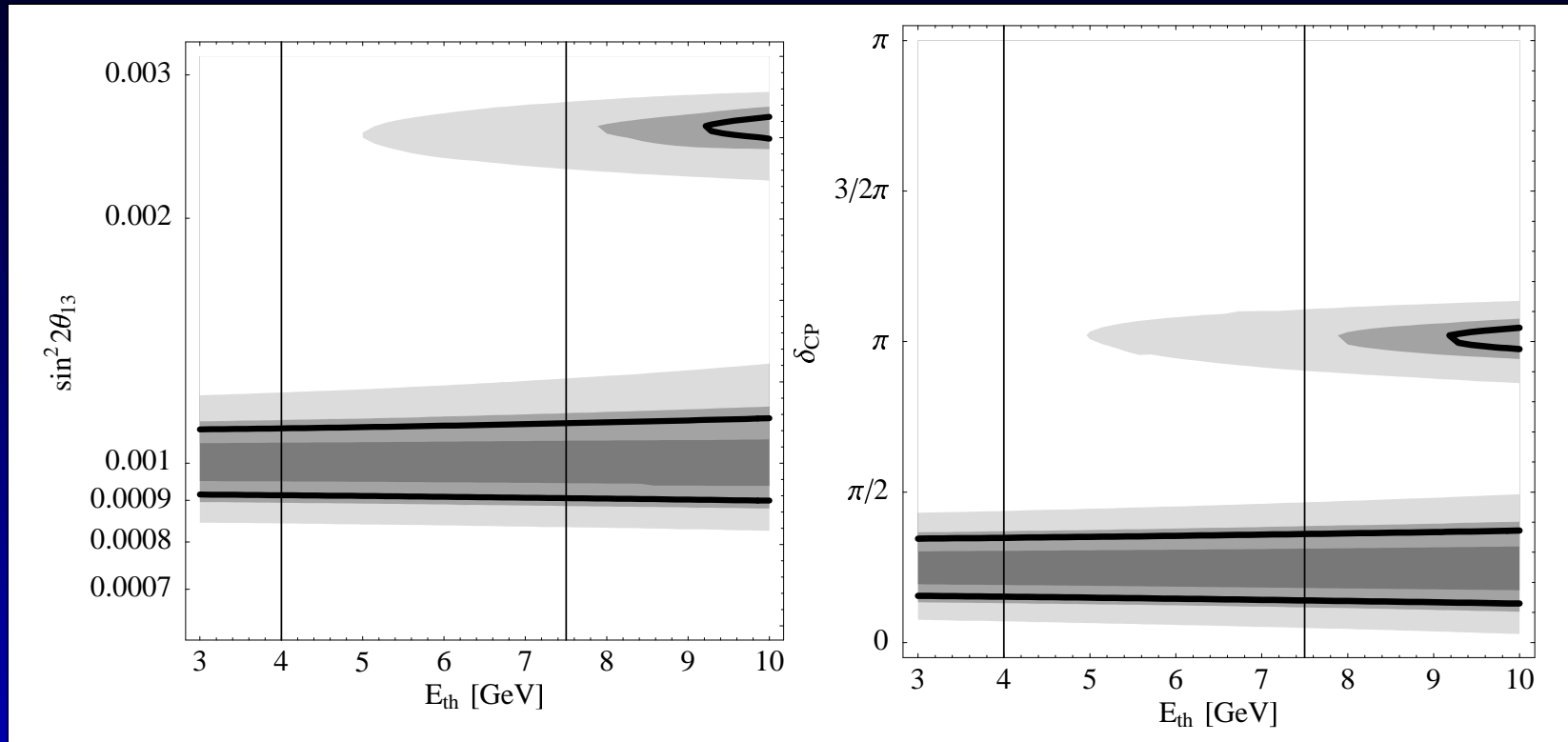


Figure taken from PH, M. Lindner, W. Winter, Nucl. Phys. B **645** (2002) 3.

Oscillation parameters on this and the next slide are:

$$\Delta m_{31}^2 = 3 \times 10^{-3} \text{ eV}^2, \quad \Delta m_{21}^2 = 3.7 \times 10^{-5} \text{ eV}^2,$$

$$\sin^2 \theta_{23} = 0.5, \quad \sin^2 \theta_{12} = 0.28.$$

Threshold

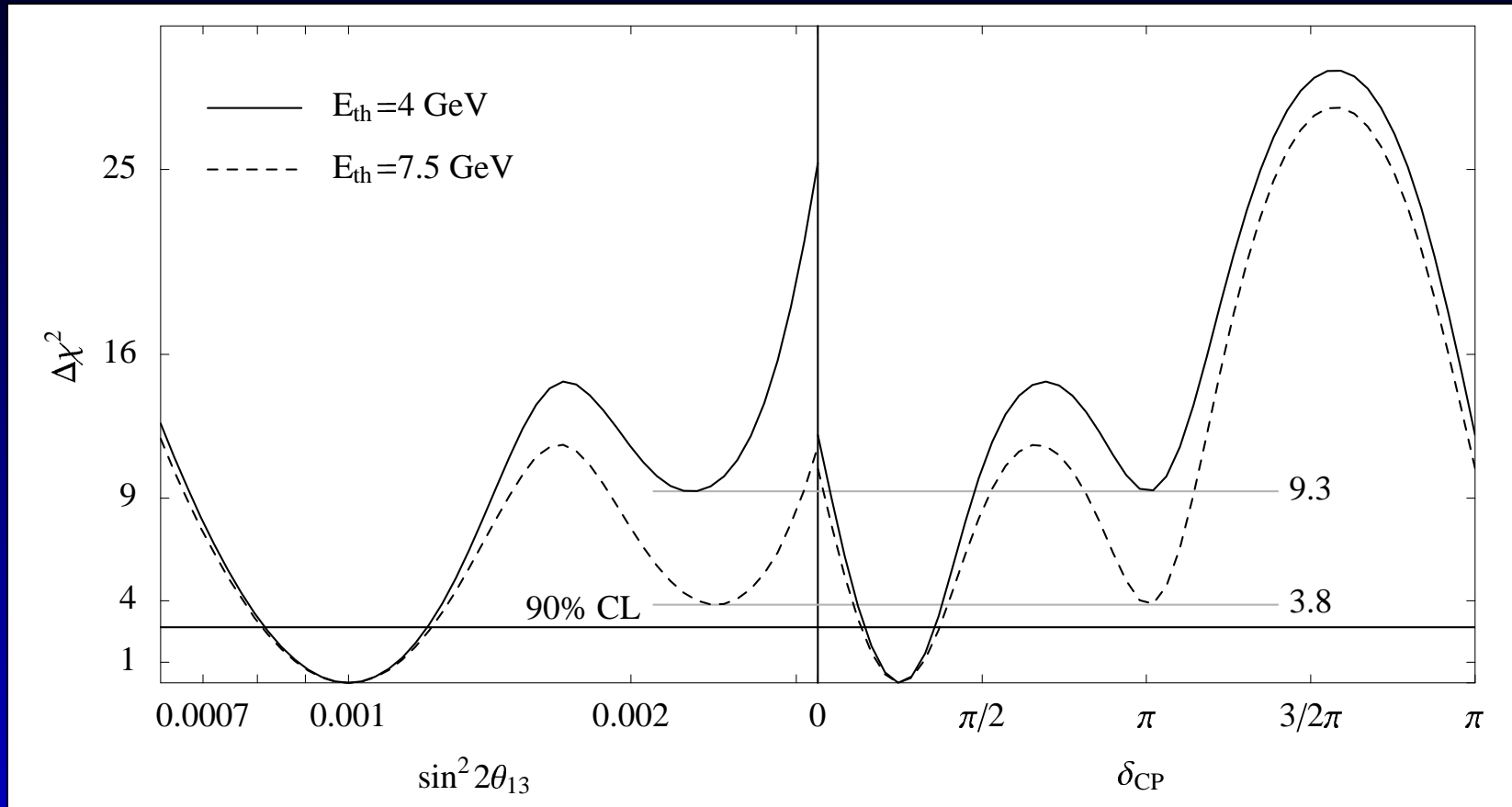
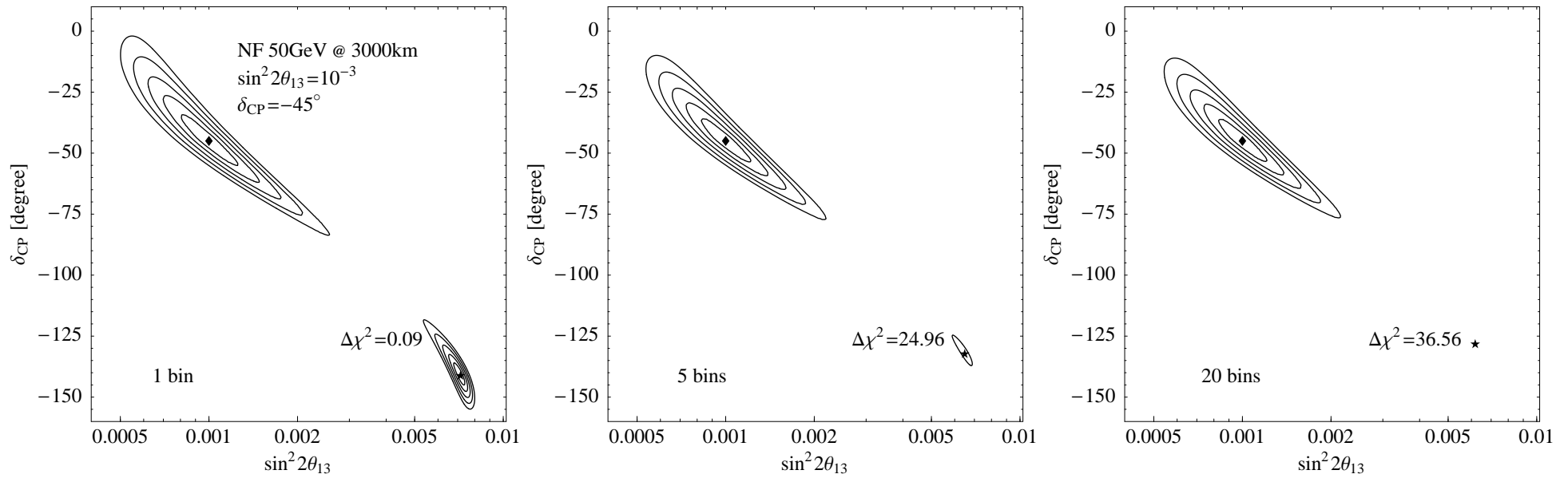
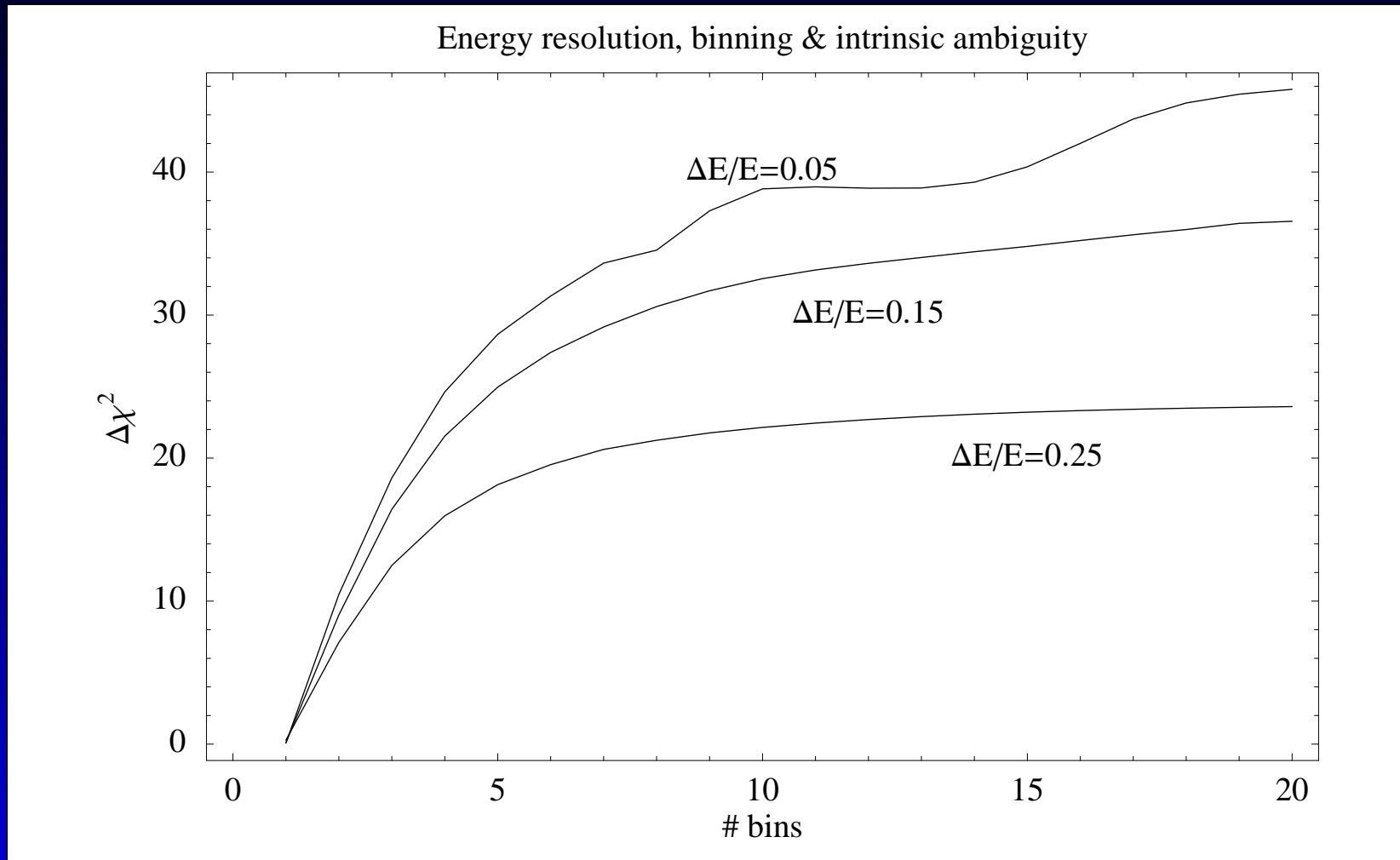


figure taken from PH, M. Lindner, W. Winter, Nucl. Phys. B **645** (2002) 3.

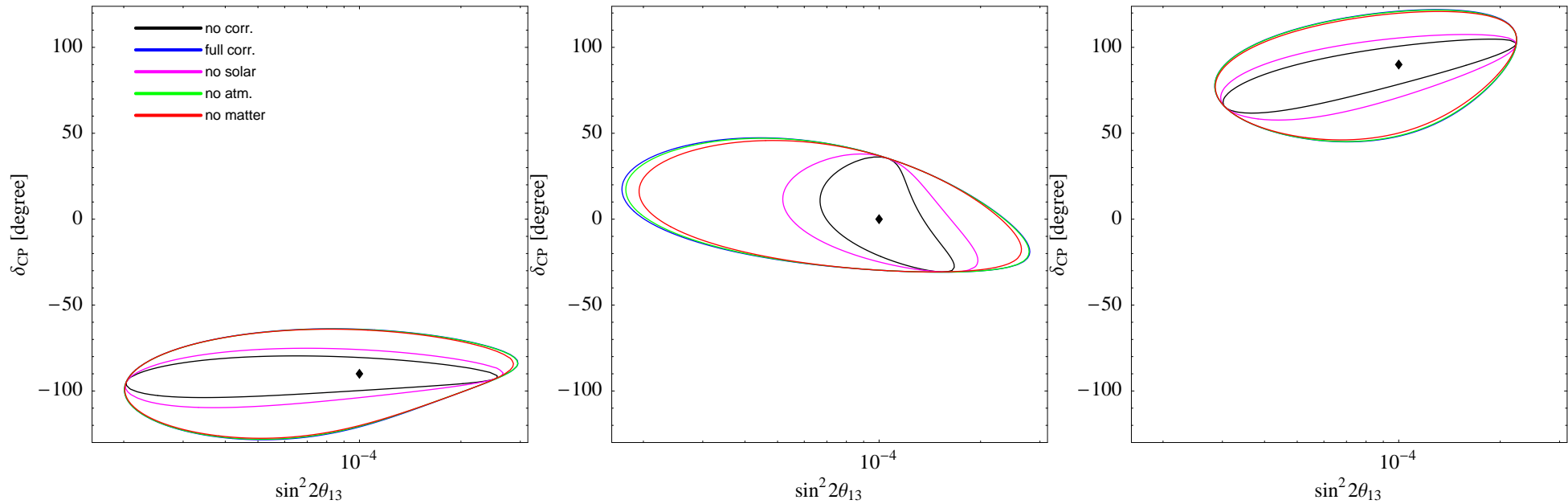
Energy response



Energy response

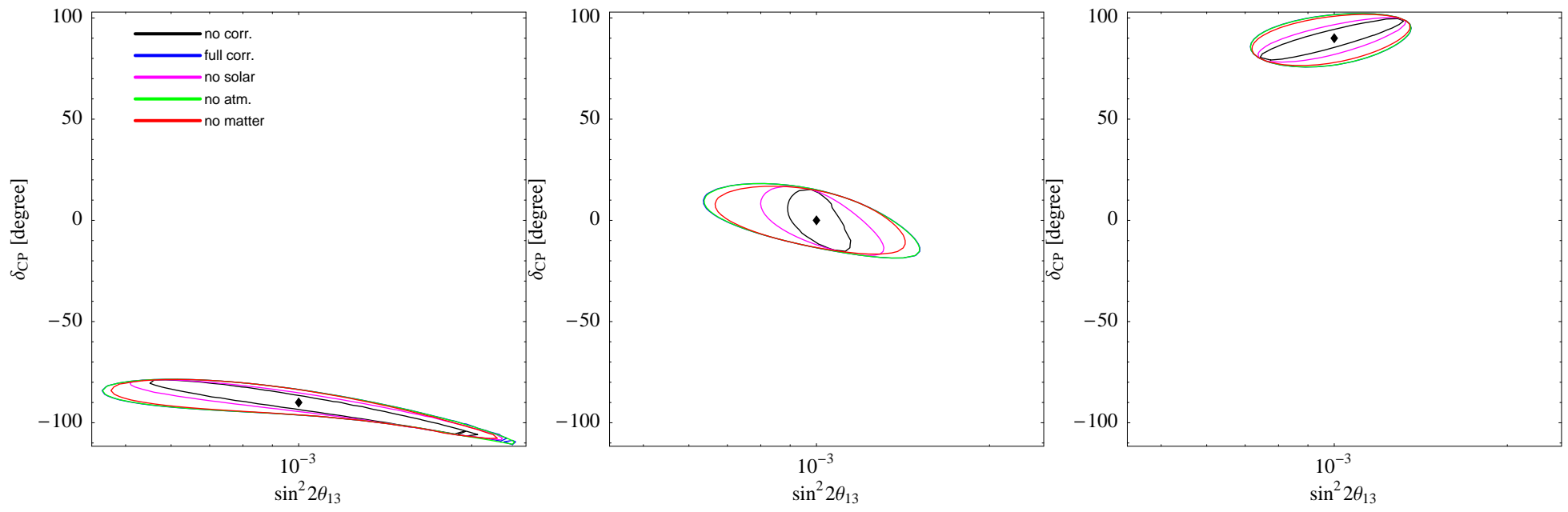


Correlations at $\sin^2 2\theta_{13} = 10^{-4}$

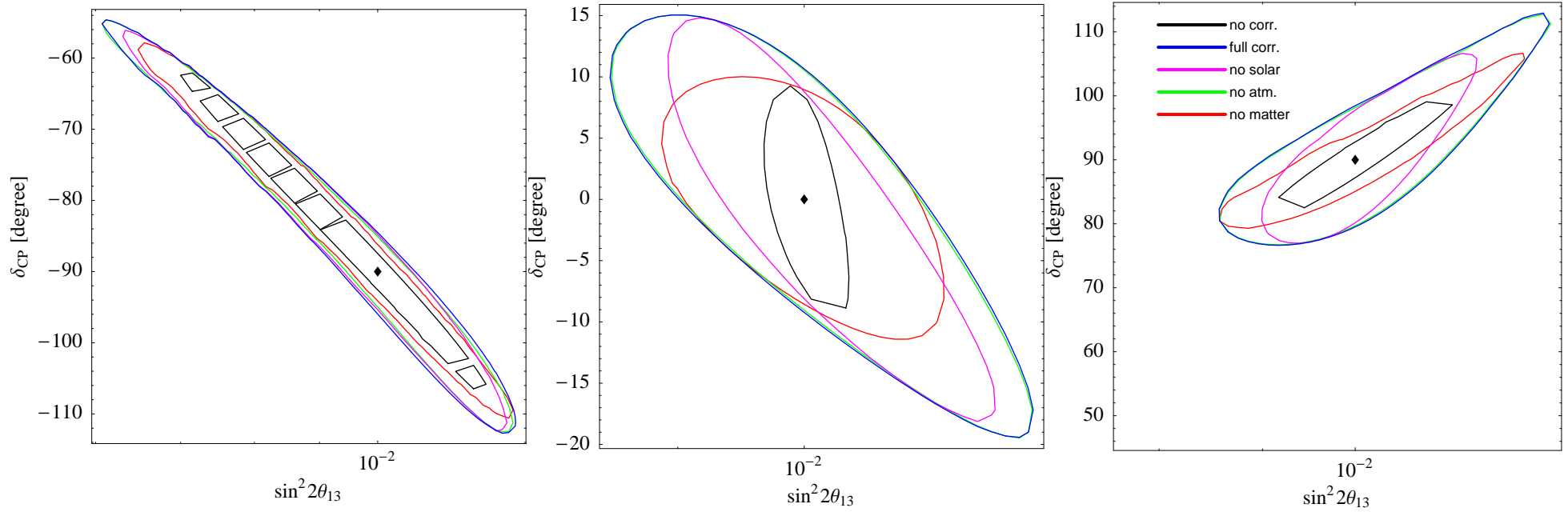


From here on ν_{μ} and $\bar{\nu}_{\mu}$ disappearance included

Correlations at $\sin^2 2\theta_{13} = 10^{-3}$



Correlations at $\sin^2 2\theta_{13} = 10^{-2}$



Summary

The performance/analysis result depends on many factors

- detector threshold
- energy response – binning and resolution
- systematics (not covered here)
- correlations
- number of channels
- variation of parameters like central value of Δm_{31}^2 (not covered here)
- ...

Open points

- Database of assumptions & results – CVS?
- What would we like/need to know from the
 - detector working group
 - accelerator working group
- How are we going to divide the work load?
- Parameters of interest, performance indicators, figure of merit
- Stability of result needs to be better understood
- What can be done this week, what needs to be done later