Physics and Peformance Evaluation Group

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IDS-NF plenary meeting

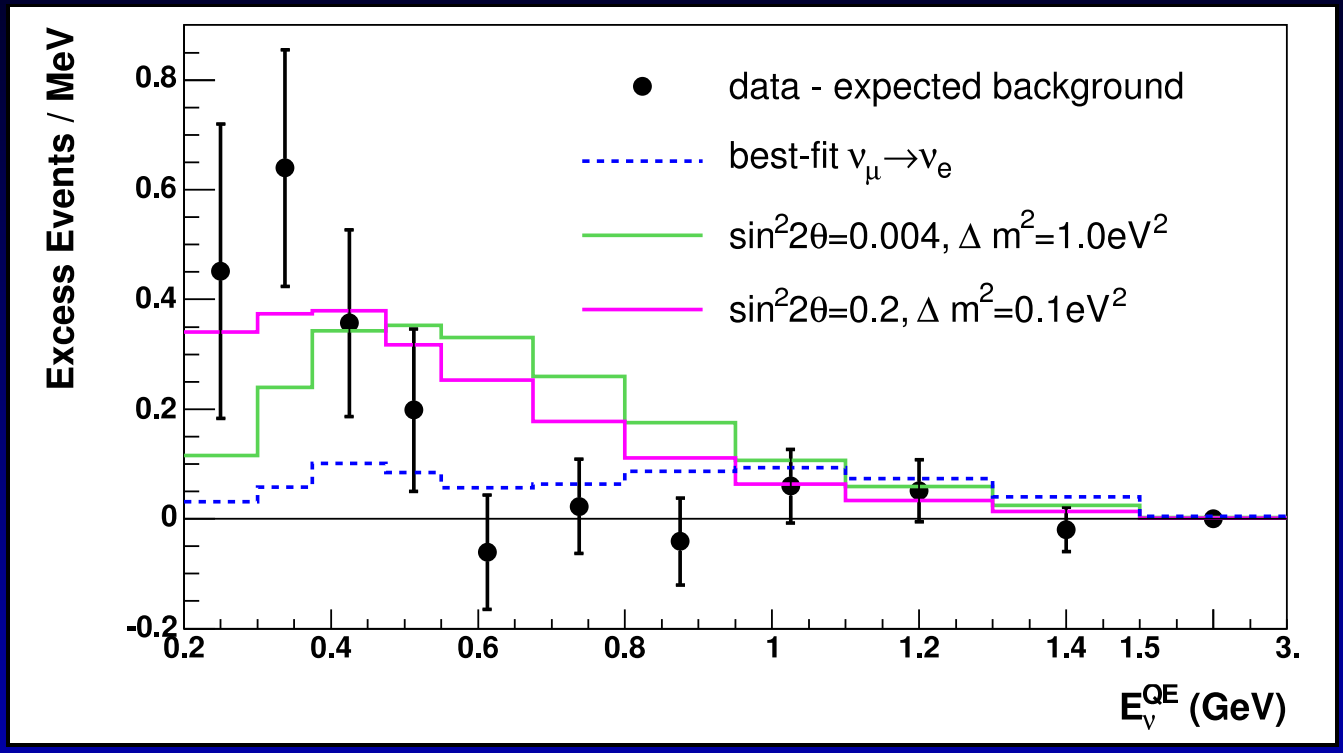
March, 2009

CERN

Outline

- Sterile ν
- Hints for $\theta_{13} \neq 0$
- The next generation
- Precision
- Outlook

MiniBooNE – neutrino mode

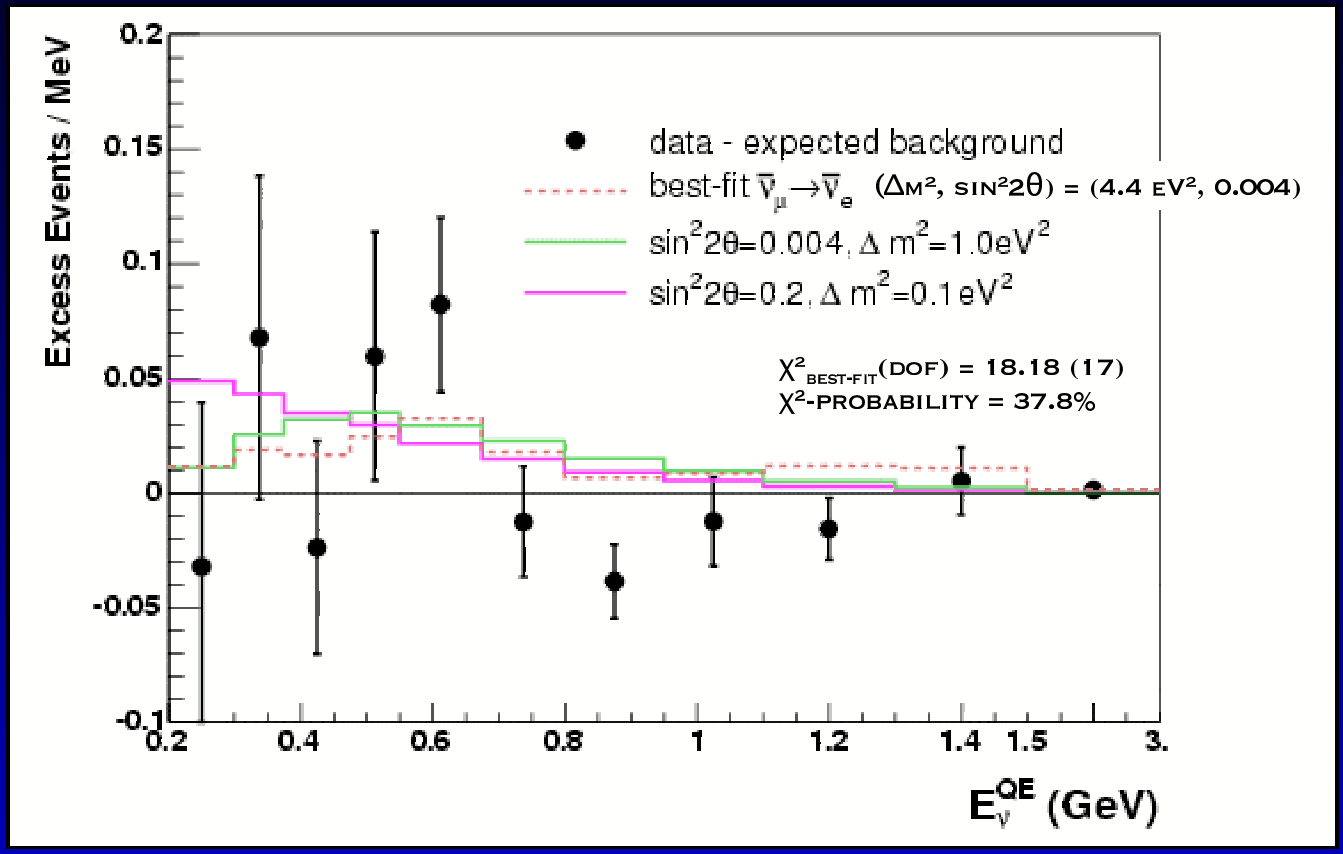


Below 475 MeV: 544 events seen vs 415.2 ± 43.4 expected

Above 475 MeV: 408 events seen vs 385.9 ± 35.7 expected

from MiniBooNE collaboration, arXiv:0812.2243v2.

MiniBooNE – anti-neutrino mode



Below 475 MeV: 61 events seen vs 61.5 ± 11.7 expected

Above 475 MeV: 61 events seen vs 57.8 ± 10.0 expected

from talk by H. Ray

MiniBooNE vs LSND

Any interpretation of LSND as solely due to neutrino oscillation is very strongly disfavored for any number of neutrinos, by the lack of evidence for neutrino disappearance at short distances.

MiniBooNE basically only adds a few units of $\Delta\chi^2$ in a fit with more than 100 degrees of freedom

M. Maltoni, T. Schwetz, arXiv:0705.0107.

Light sterile neutrinos?

Does this imply that that we no longer need to look for light sterile neutrinos?

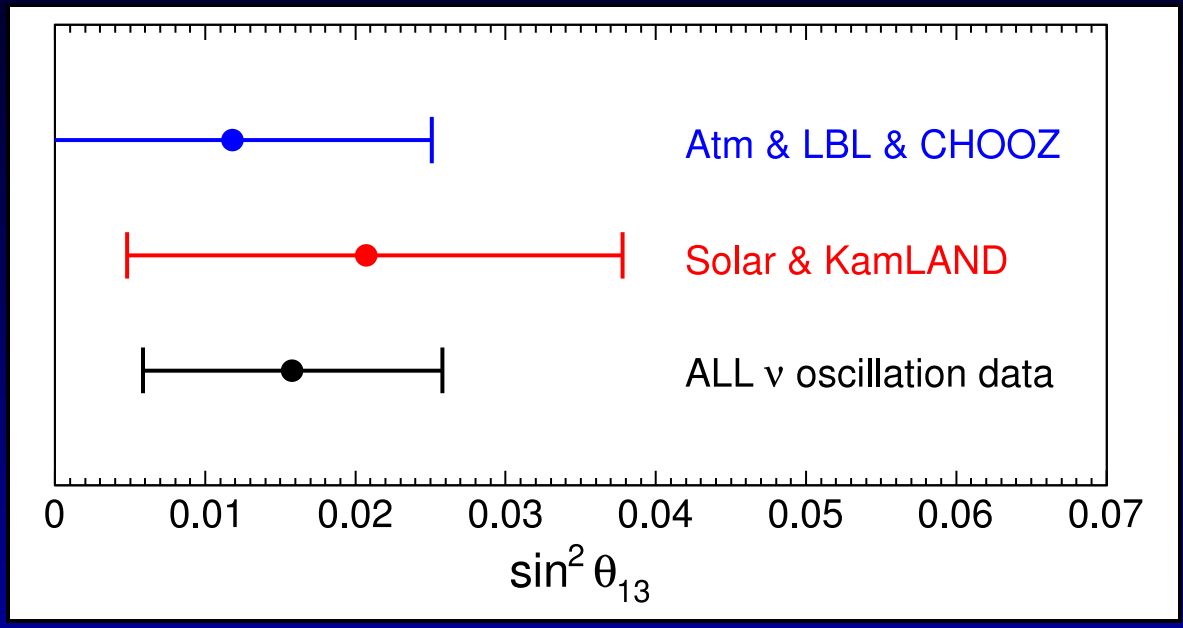
NO

- The seesaw scale is essentially unknown see *e.g.*, A. de Gouvea, J. Jenkins, N. Vasudevan, hep-ph/0608147.
- Even with $m_R \sim 10^{15}$ GeV, the resulting neutrino mass matrix can have more than 3 small eigenvalues.
- eV scale sterile neutrinos can play a role in certain astrophysical contexts, like *e.g.* r-process nucleosynthesis

Implications for IDS-NF

- We should study how well we can constrain the parameter space of neutrinos independently of the LSND result.
- We should, however, not try to redesign the facility for that purpose but try to run in parasitic/symbiotic mode with the 3-flavor program.

Hints for $\theta_{13} \neq 0$



E. Lisi, *et al.*, arXiv:0806.2649.

- weak hint in atmospheric data was already there
- more KamLAND data
- more SNO NC data

$\sin^2\theta_{13} = 0.016 \pm 0.010$ or $\sin^2 2\theta_{13} = 0.06 \pm 0.04$

Hints for $\theta_{13} \neq 0$

However, other authors pointed out that the atmospheric contribution is not robust and thus the hint resides solely in KamLAND and solar data.

In that case result is

$\sin^2\theta_{13} = 0.01^{+0.016}_{-0.01}$ or $\sin^2 2\theta_{13} = 0.04^{+0.06}_{-0.04}$

T. Schwetz, J.W.F. Valle, M. Tortola, arXiv:0806.2016. M. Maltoni, T. Schwetz, arXiv:0806.3161.

Hints for $\theta_{13} \neq 0$ – MINOS

MINOS' first ν_e appearance results

35 events seen vs $27 \pm 5 \pm 2$ expected for $3.14 \cdot 10^{20}$ pot

The odds that this is a fluctuation are, depending on the size of the systematic error

27 ± 0	1:13
27 ± 2	1:10
27 ± 4	1:8

Their best fit $\sin^2 2\theta_{13} \simeq 0.1 - 0.15$ or $\sin^2 \theta_{13} \simeq 0.03 - 0.04$

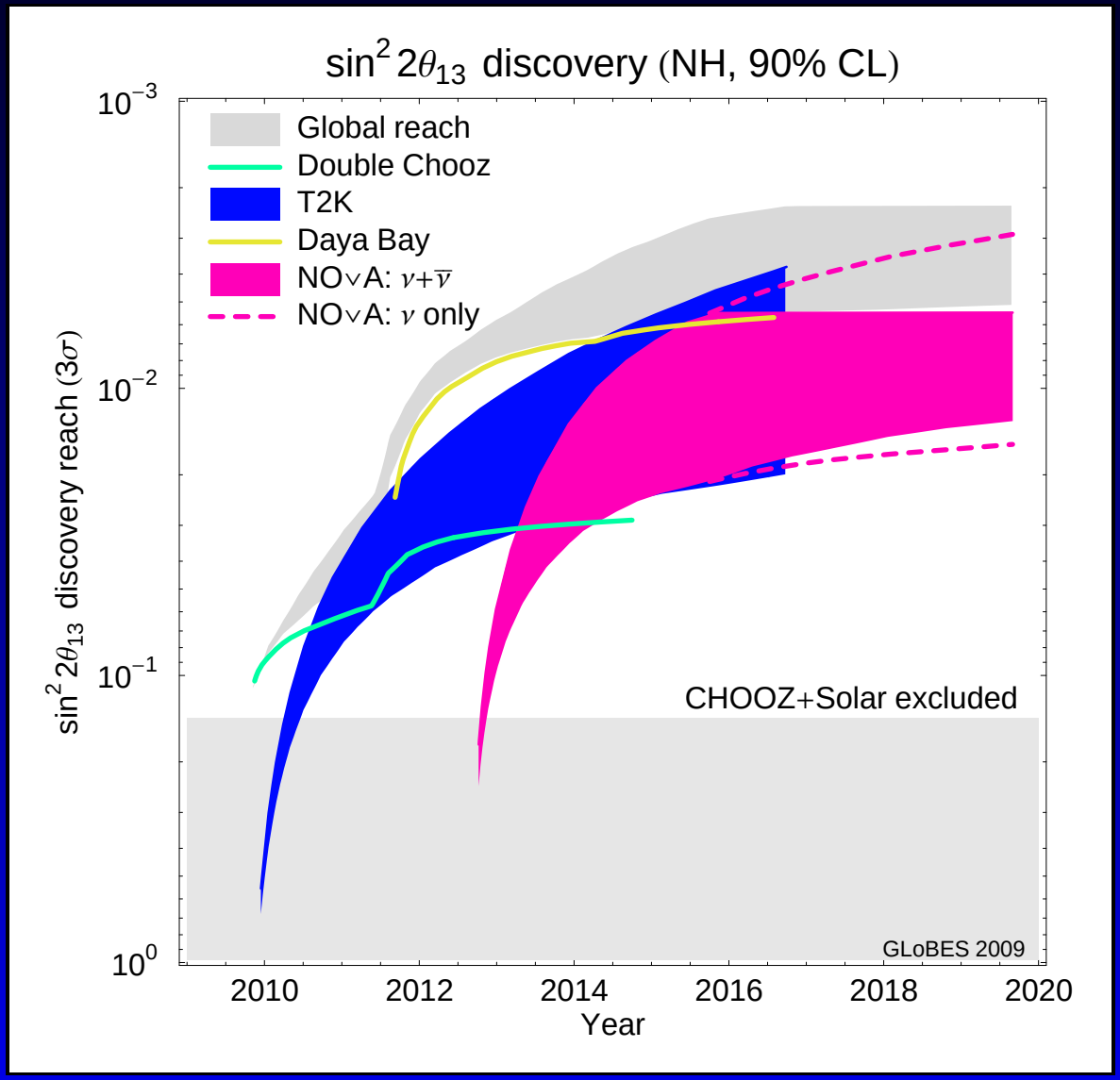
M. Sanchez, FNAL Wine & Cheese 27. Feb 2009.

From hints to the hunt for θ_{13}

Timeline

- T2K: 09/2009 - 12/2012: 0 MW - 0.75 MW linear, Talk by Kakuno, NOW 2008
- Double Chooz: Start 09/2009, 1.5 yr with FD only, then ND+FD, Talk by S. Peeters, NOW 2008
- Daya Bay: 7/2011 all modules, Talk by J. Napolitano at UC Davies
- NOvA: 08/2012 - 01/2014: 2.5 kt - 15 kt linear, Talk by M. Messier, ICHEP08

Time evolution of physics reach



PH, M. Lindner, T. Schwetz and W. Winter, work in progress

Implications for IDS-NF

- Should the hints be correct, then there should be a discovery within the next 1-3 years.
- The problem is, that the hints are vague and thus the error bars large. We only will know once experiments release their data.
- Thus we need to have contingency plan for both the midterm and final report.
- Thus, we need to better understand the merits of a NF in the large θ_{13} case and document our results

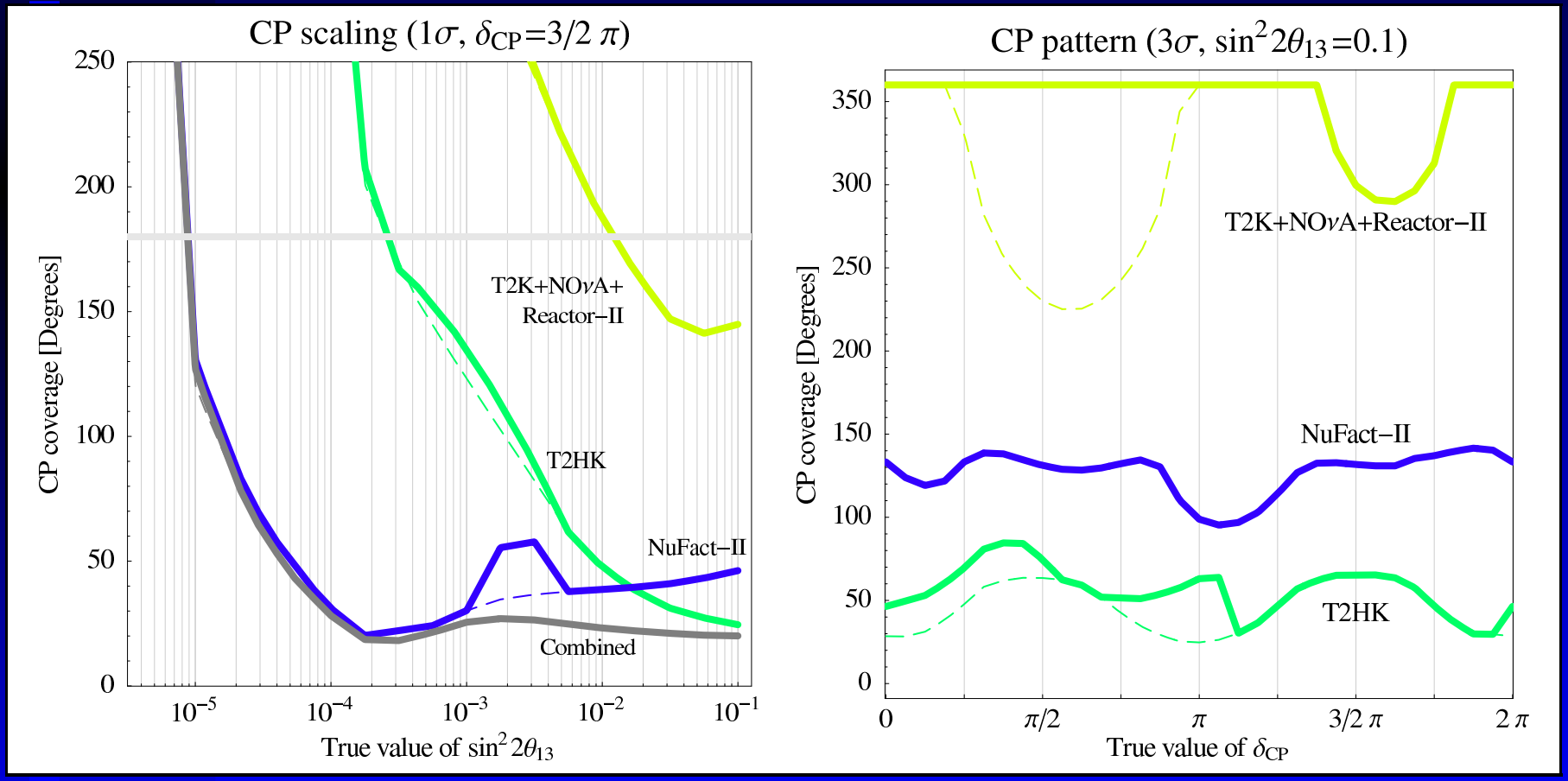
Precision

While it easy to say that a NF is a tool for precision neutrino physics, it is quite difficult to demonstrate that in a quantitative way.

- Better input on systematics needed from especially the detector WG
- No simple performance indicators yet
- We need to demonstrate the a NF is indeed the most precise tool

Precision – continued

Quantifying the precision on δ is a complex, high-dimensional problem and is quite hard to provide a concise summary.



PH, M. Lindner and W. Winter, hep-ph/04122199.

Summary

- MiniBooNE data does not change our current understanding of neutrino oscillation
- Hints for θ_{13} can become discoveries on timescales we can not ignore
  - Suggest to break physics study in a large and small θ_{13} case
  - Large θ_{13} should focus on precision, for this we need timely (!) input on systematics

Joint IDS-NF PPEG/EuroNu WP6 theory workshop at Cosener's house, UK, from June 8-10. The website is

http://www.ippp.dur.ac.uk/Workshops/09/Coseners/

Scientific Advisory panel

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