

Hints for CP violation from upcoming neutrino oscillation experiments

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PH, M. Lindner, T. Schwetz and W. Winter, arXiv:0907.1896

NuFact 09

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Illinois Institute of Technology, Chicago

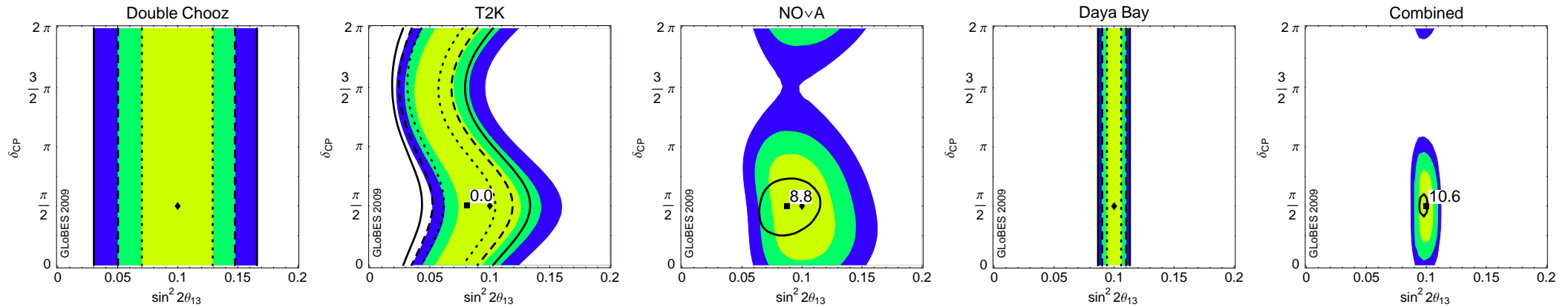
What we want to learn

- Size of θ_{13}
- mass hierarchy?
- $\theta_{23} = \pi/4$?
- CP violation in leptons?

The experiments

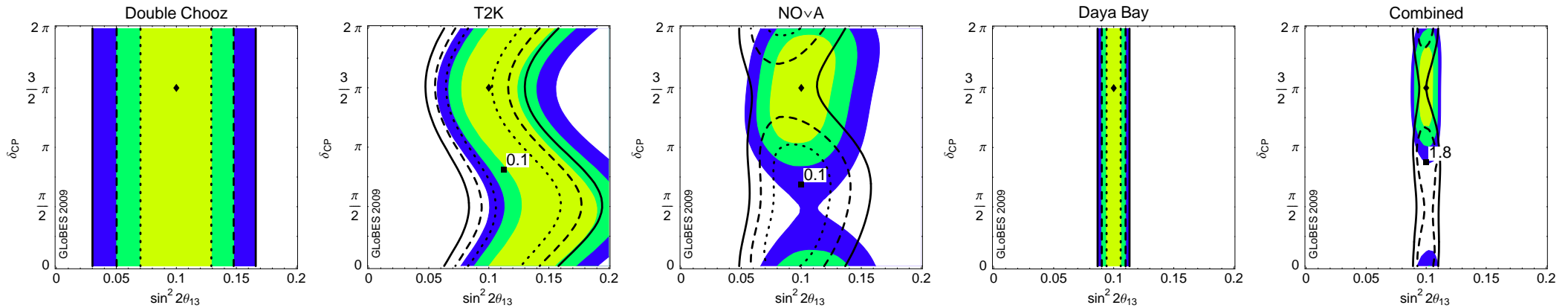
Setup	t_ν [yr]	$t_{\bar{\nu}}$ [yr]	P_{Th} or P_{Target}	L [km]	Detector	m_{Det}
Double Chooz	-	3	8.6 GW	1.05	L. scint.	8.3 t
Daya Bay	-	3	17.4 GW	1.7	L. scint.	80 t
RENO	-	3	16.4 GW	1.4	L. scint.	15.4 t
T2K	5	-	0.75 MW	295	Water	22.5 kt
NO ν A	3	3	0.7 MW	810	TASD	15 kt

CP violation



- inverted true hierarchy
- input values $\sin^2 2\theta_{13} = 0.1$ and $\delta = 90^\circ$
- at most a 2σ hint for CPV
- w/o reactor data no value of δ excluded at 3σ
- this is already the best case

CP violation



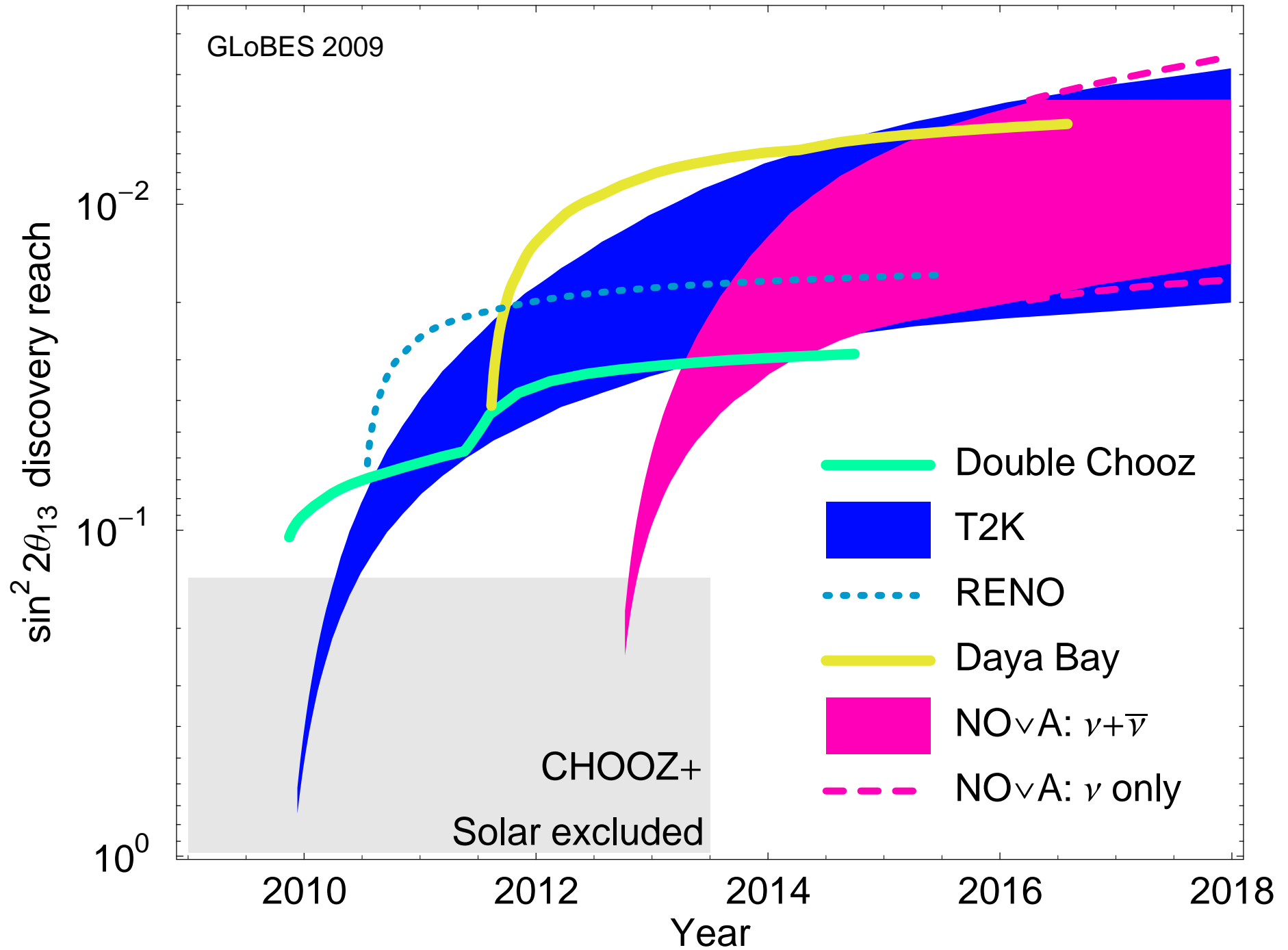
- inverted true hierarchy
- input values $\sin^2 2\theta_{13} = 0.1$ and $\delta = -90^\circ$
- no result for mass hierarchy
- no result for CPV

From hints to the hunt for θ_{13}

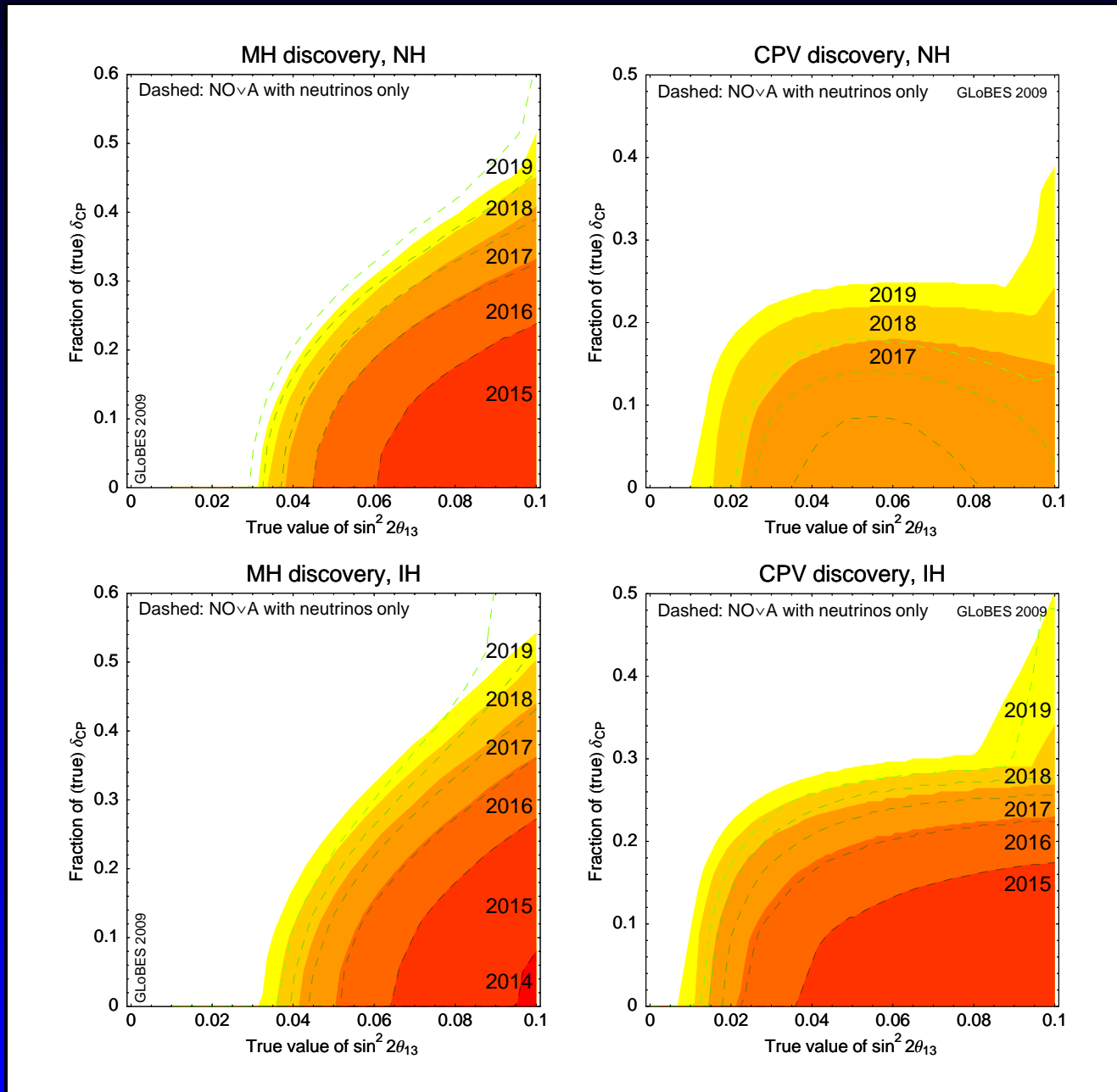
Timeline

- Double Chooz: Start 09/2009, 1.5 yr with FD only, then ND+FD, 5 years total **Talk by S. Peeters, NOW 2008**
- RENO: Start 06/2010, ND+FD, 5 years **Talk by Y. Oh, NOW 2008**
- Daya Bay: 7/2011 all modules, **Talk by R. McKeown, CIPANP 09**
- T2K: 09/2009 - 12/2012: 0 MW - 0.75 MW linear, neutrinos only **Talk by H. Kakuno, NOW 2008**
- NOvA: 08/2012 - 01/2014: 2.5 kt - 15 kt linear, 1/2 neutrinos & 1/2 antineutrino **Talk by M. Messier, ICHEP08**

$\sin^2 2\theta_{13}$ discovery potential (NH, 90% CL)



Time evolution of physics reach

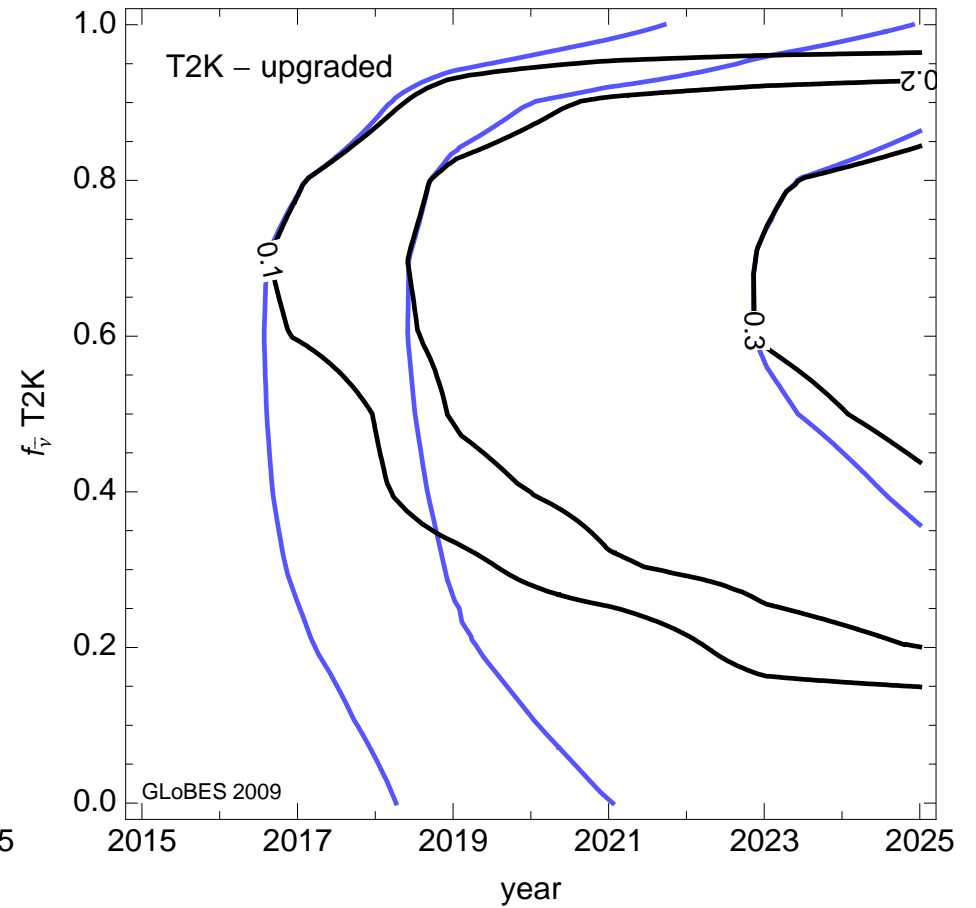
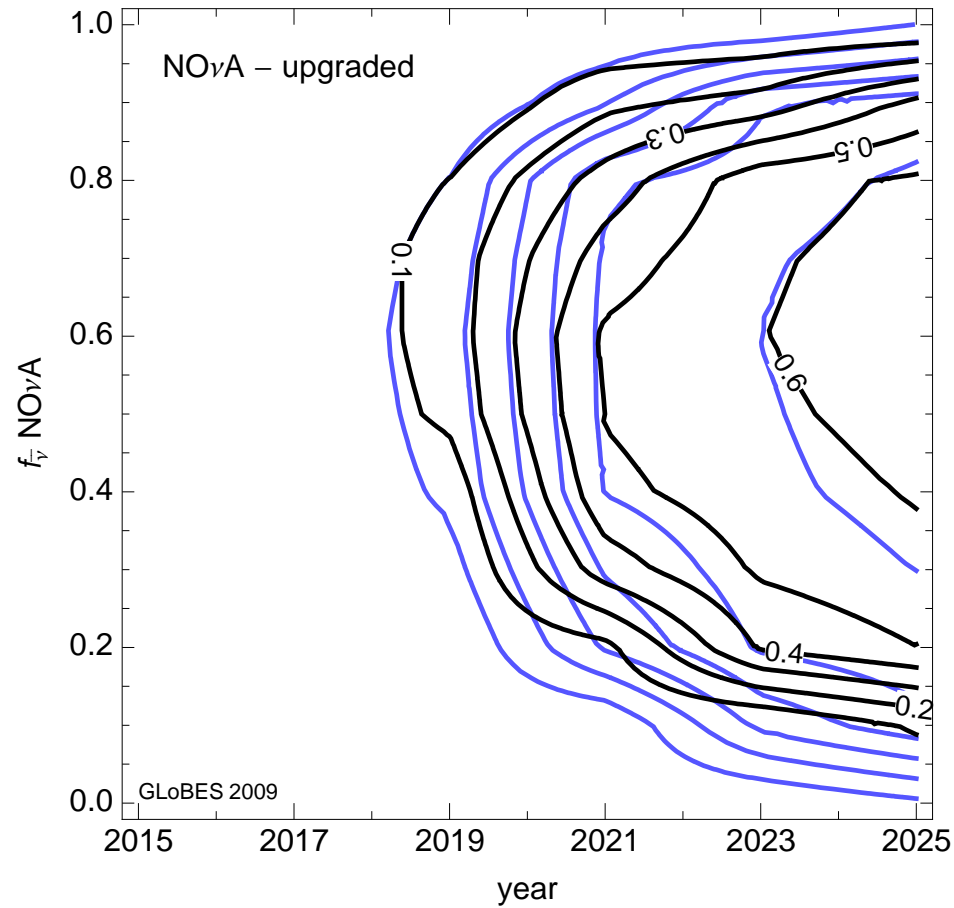


Beam upgrades

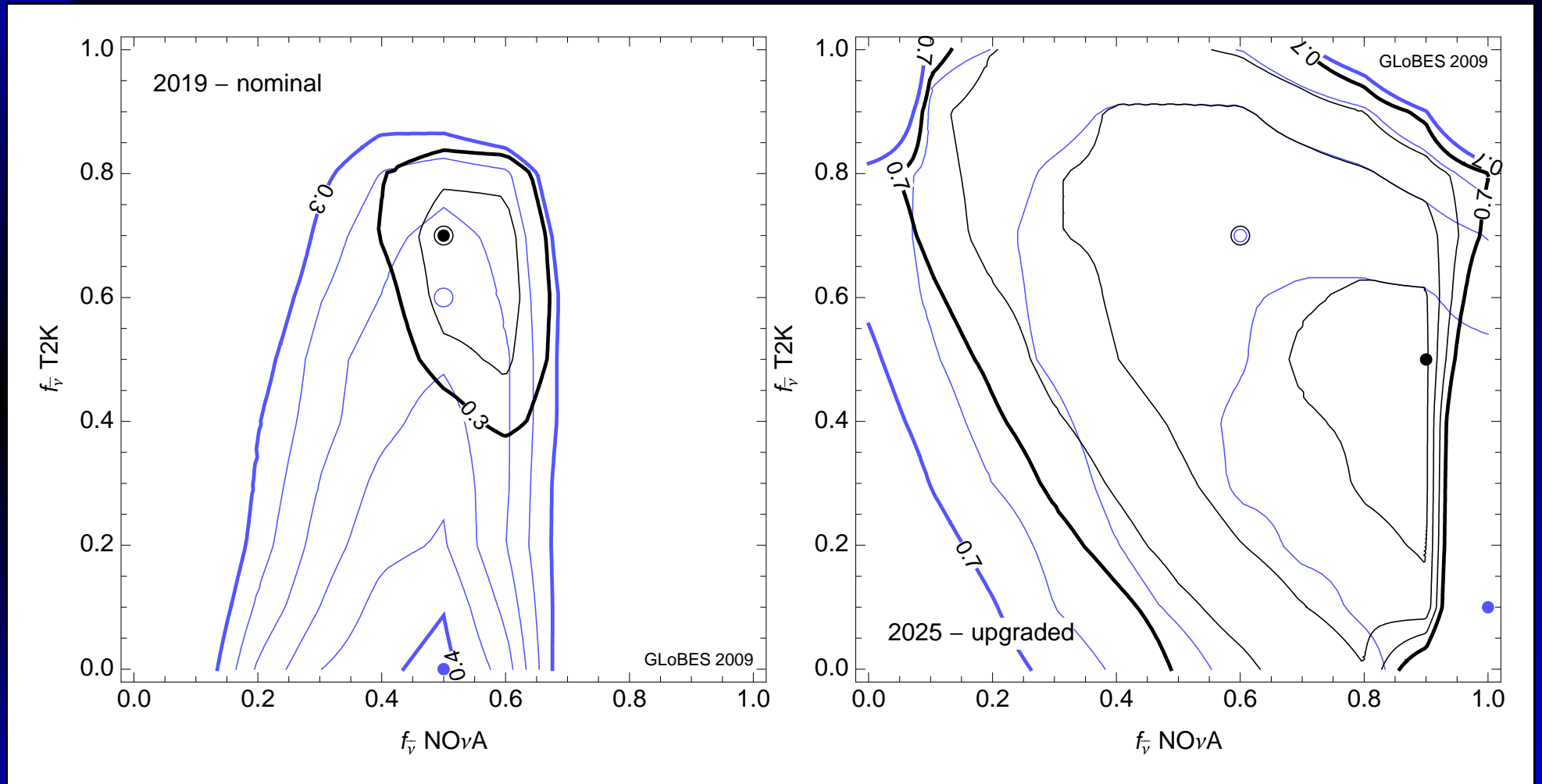
- T2K: 2015 - 2016: 0.75 MW - 1.66 MW linear
Talk by K. Hasegawa, NNN 2008
- NOvA: 03/2018-03/2019: 0.7 MW - 2.33 MW
linear, Project X [Project X: resource loaded schedule](#)

In the following $\sin^2 2\theta_{13} = 0.1$

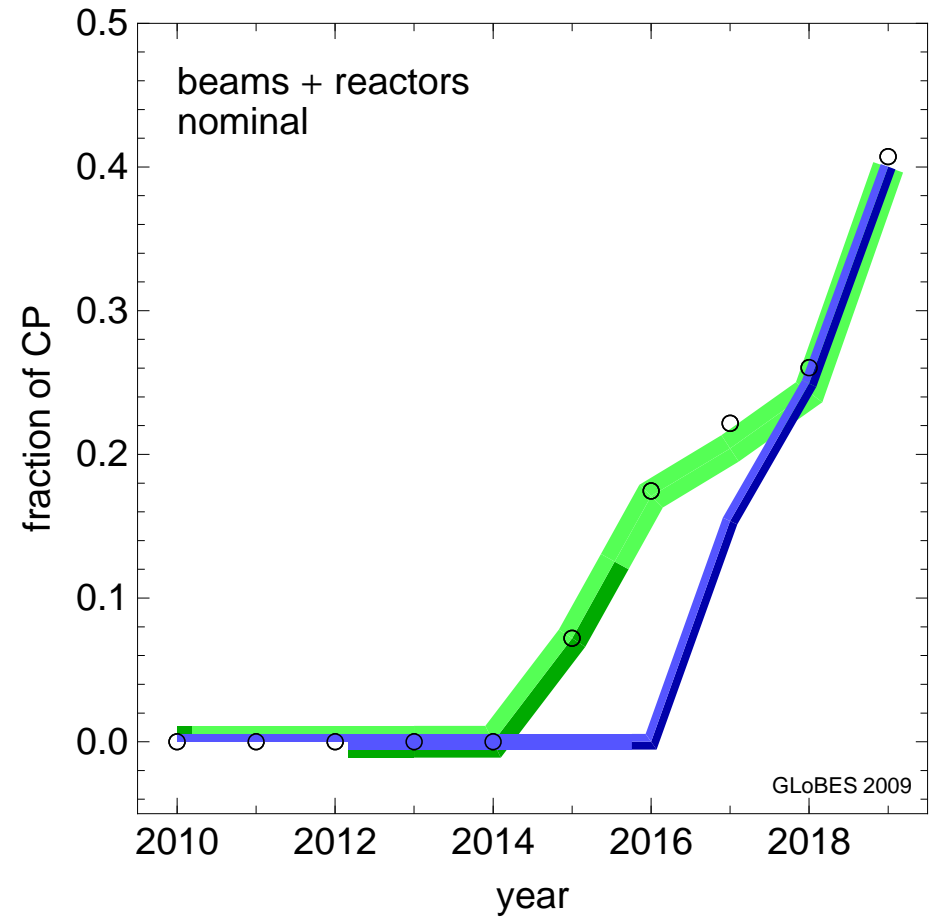
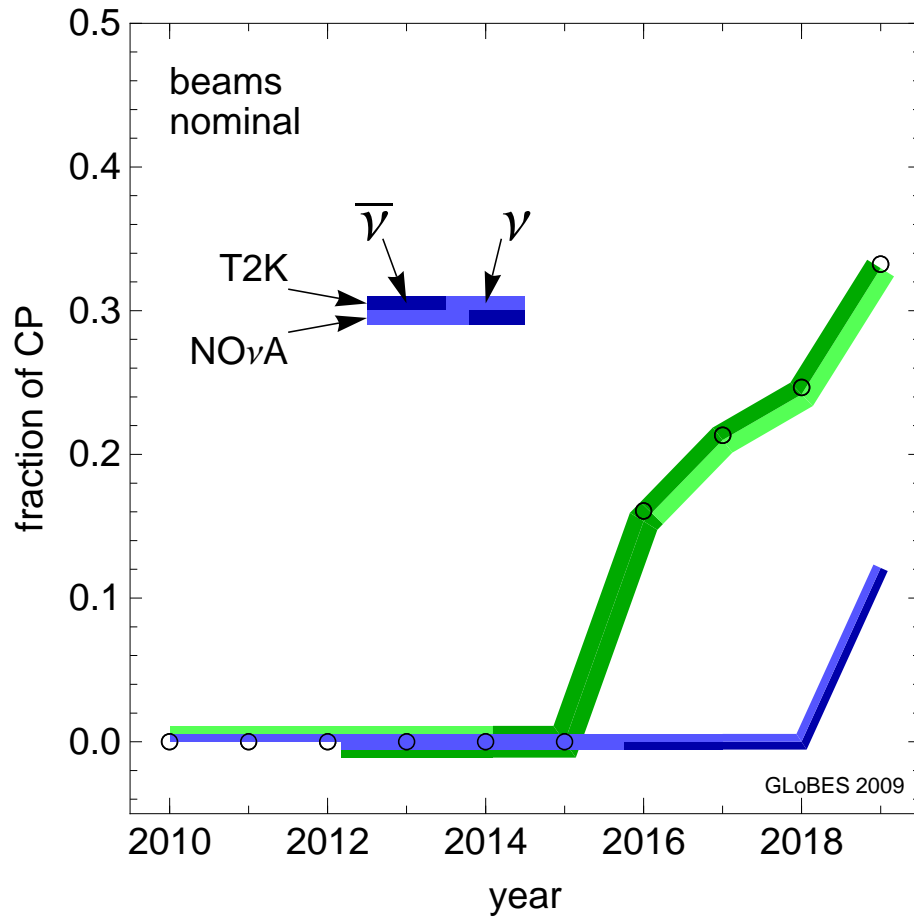
Single experiment – $\bar{\nu}$ fraction



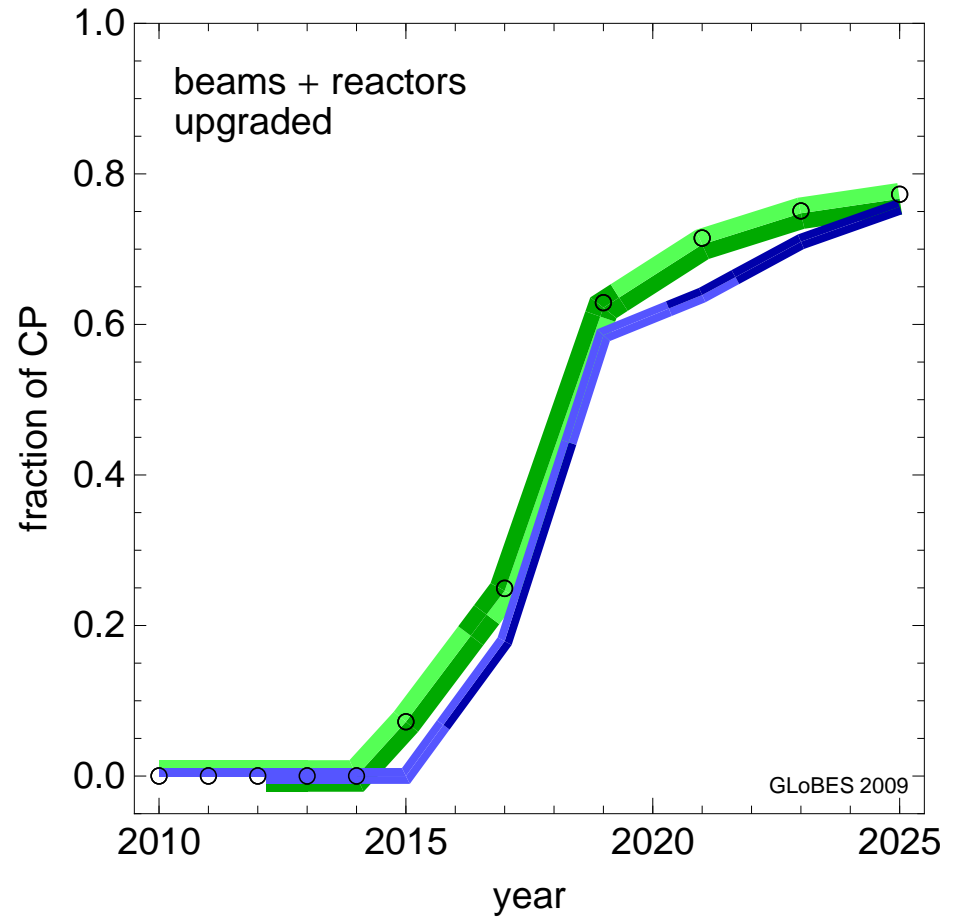
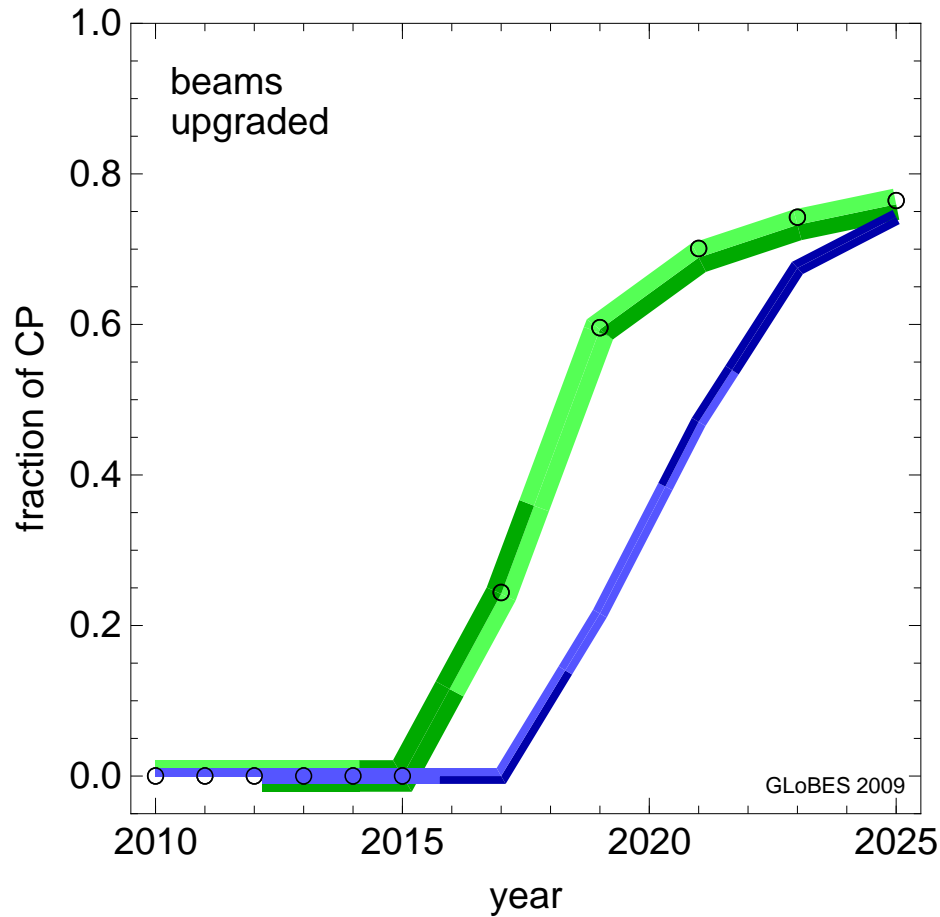
Two experiments – $\bar{\nu}$ fraction



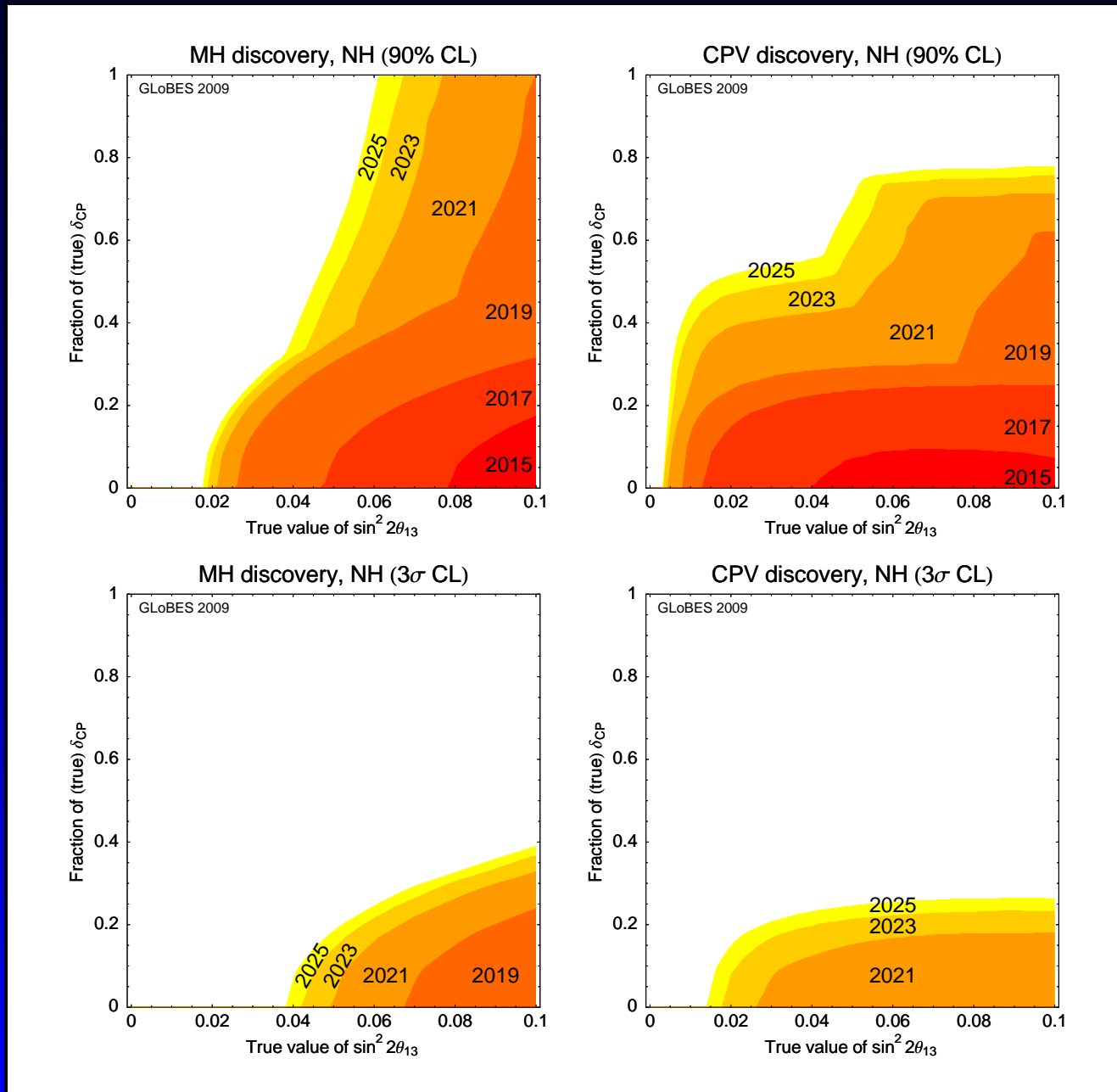
Joint optimization – nominal



Joint optimization – upgraded



Optimal sensitivities

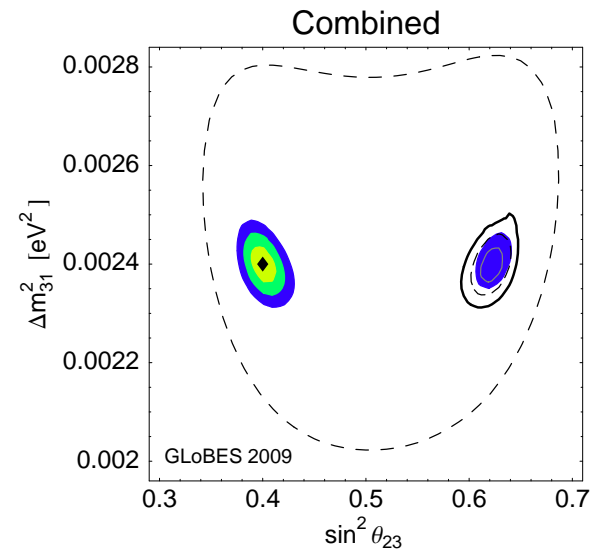
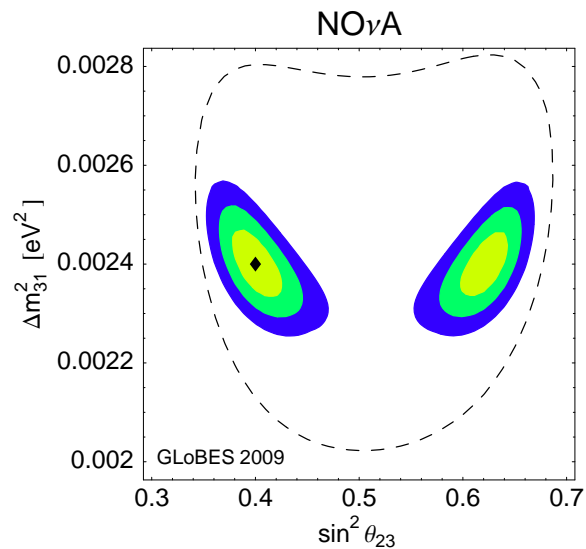
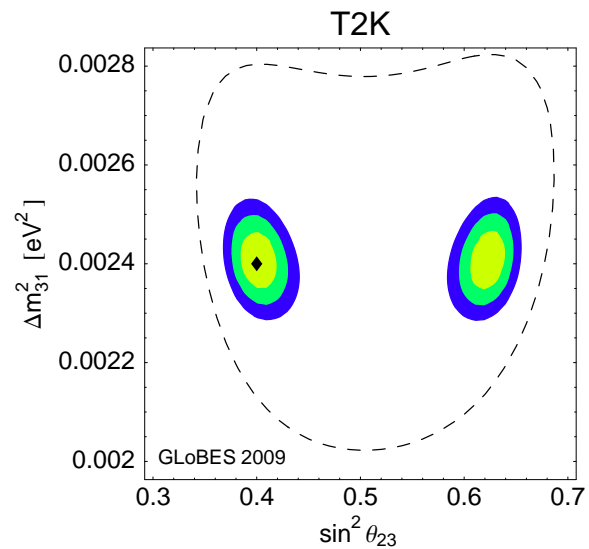
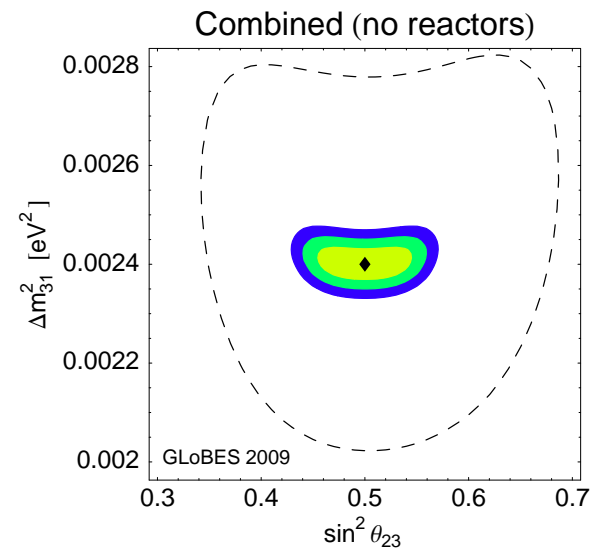
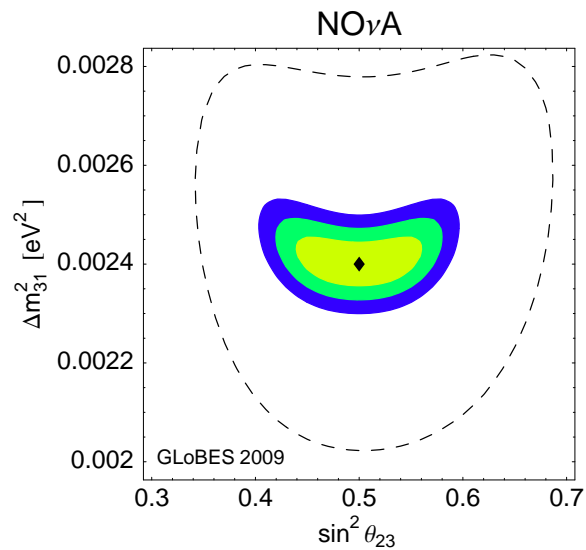
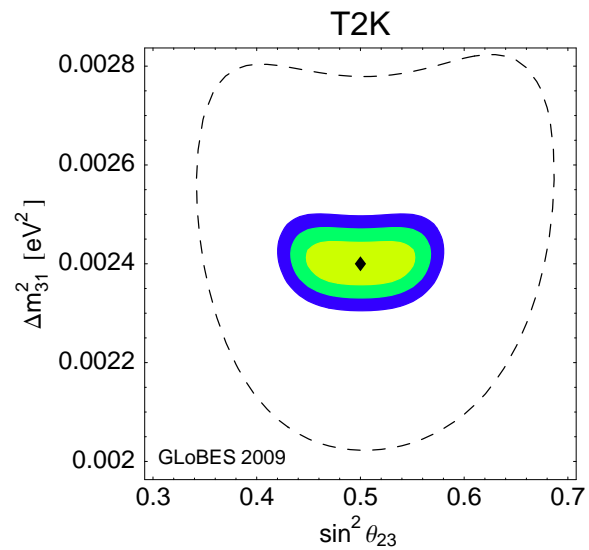


Summary

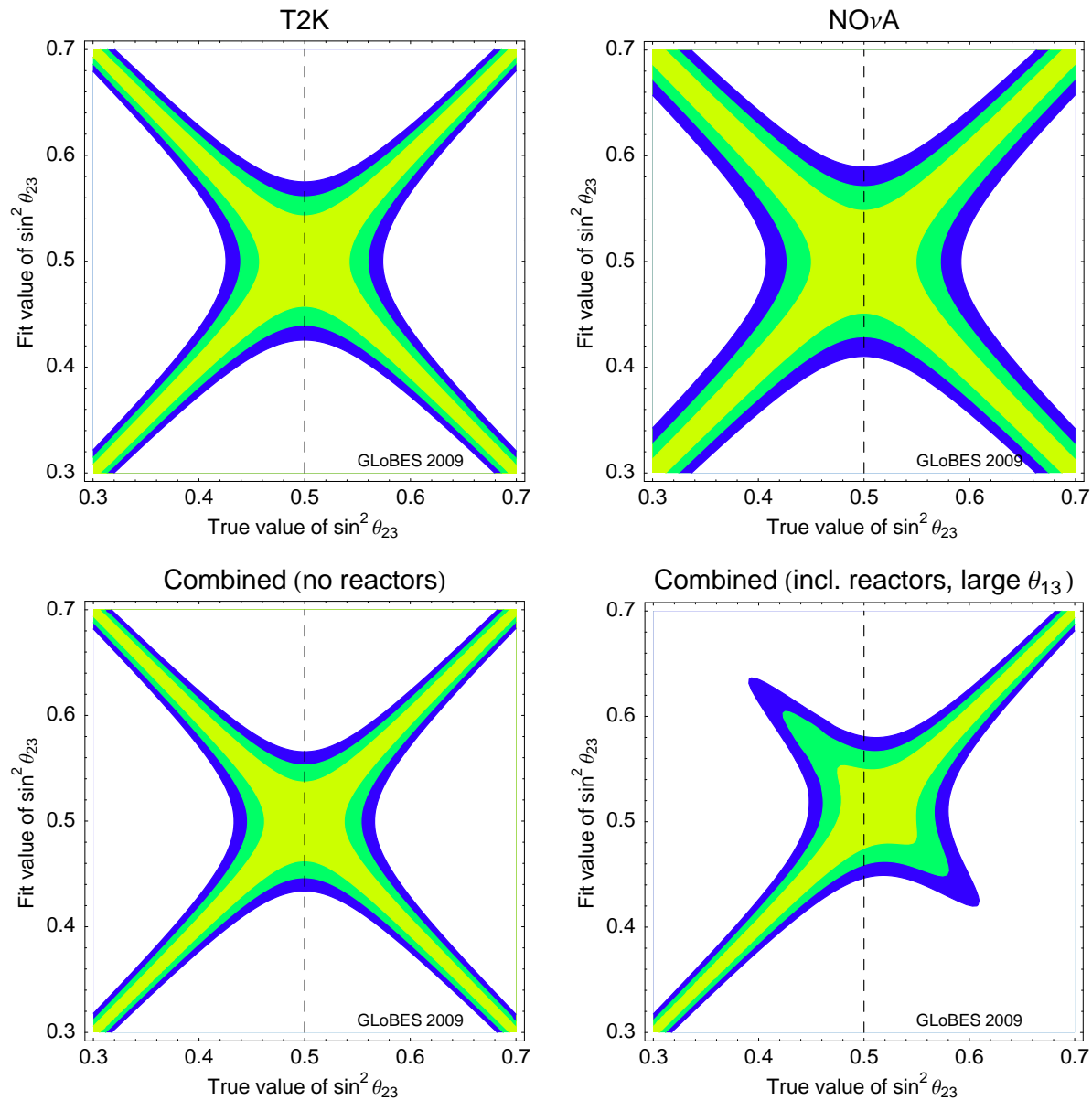
- If current hints for θ_{13} are true, we should expect exciting results in 1-2 years
- Very difficult to get CP or mass hierarchy without upgrades, even in the best case!
- With upgrades, good chances at 90% CL ($\sin^2 2\theta_{13} > 0.01$)
- With upgrades, 20-30% chance at 3σ ($\sin^2 2\theta_{13} > 0.02$), no 5σ
- Final sensitivities governed by Daya Bay, T2K and NO ν A
- Coordination between beams crucial for early physics!

Backup slides

Atmospheric Parameters



Maximal Mixing



Nominal Sensitivities

