Long-baseline sensitivity studies and comparison, introduction

NuFact 2011

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Geneva, Switzerland

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Task assignment

- Sensitivity and optimization studies
  - Concentrate on *feasible* projects (i.e., for beta beams)
  - Express sensitivities in terms of error on parameters

- Provide statement on precision that is interesting for measurements of $\nu_\mu \Rightarrow \nu_\tau$ and $\nu_e \Rightarrow \nu_\tau$ *oscillation* measurements. Report on studies of such measurements for superbeam and neutrino factory.

Interpretation: Comparison

- What does “feasible“ mean?
  - Concentrate on setups for which feasibility is actively being studied, such as within Euronu, IDS-NF
  - Concentrate on setups for which a cost estimate is in preparation
    [implies that some experimentalists have thought about “feasibility“]
- More specifically:
  a) Superbeams: LBNE (or T2HK, maybe)
  b) Beta beams: BB100+SPL?
  c) NuFact: IDS-NF baseline, low-E alternative
- Express in terms of “error on parameters“:
  main impact parameters, systematics, …

Interpretation: ν_τ issue

- Here: $\nu_\mu \Rightarrow \nu_\tau$ and $\nu_e \Rightarrow \nu_\tau$ *oscillation* measurements
  $\Rightarrow$ "oscillation" means mostly at far detectors
- Example: Neutrino Factory

David vs. Goliath

4-10 kt (M)ECC 17% eff.	100 kt MIND 80% eff.

- Factor 50-100 more statistics in golden (disappearance) versus silver (discovery) channels
  - Trivial answer: ν_τ always interesting for ~ 0.5 Mt MECC (unrealistic!)
  - What kind of physics shows up with an enhancement of 50-100 in the silver/discovery channels in spite of almost maximial θ_{23}?
    $\Rightarrow$ Talk by Toshihiko Ota
- Addl. problem: not so many studies for SB …

Format of session

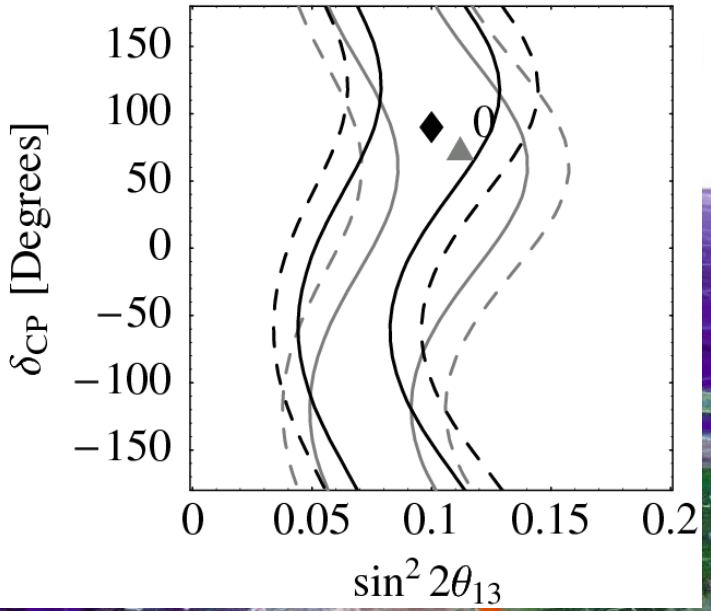
- Part 1: Comparison of facilities
  - Short talks by champions (10+5 mins):
    - Superbeams: Jim Strait
    - Beta beams: Elena Wildner
    - Neutrino factory: Ken Long
  - Comparison of facilities: Walter Winter (10 mins)
  - Discussion (about 30 mins)

- Part 2: Precision required for ν_τ: Toshihiko Ota (25+5 mins review)

Key issue: θ_{13} hint

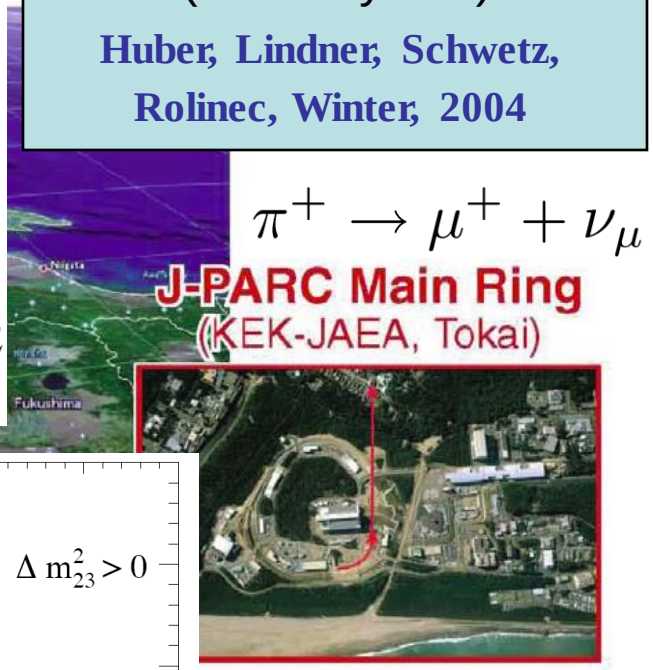
T2K (Tol

Super-Kamiokand
(ICRR, Univ. Tokyo)

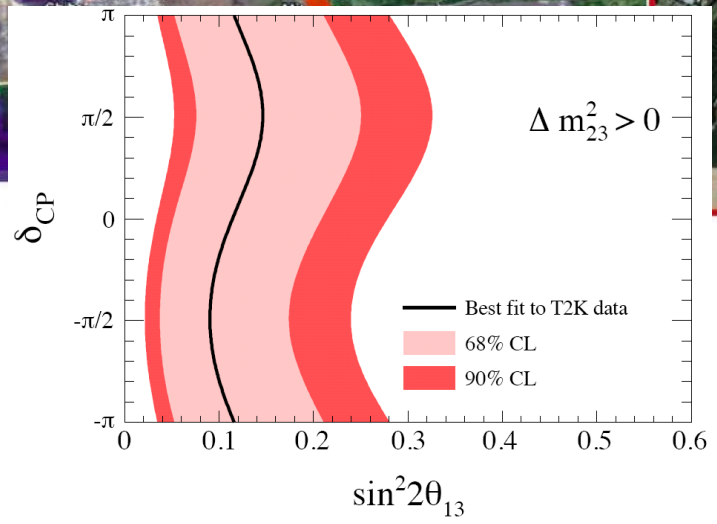


Matches e.g.
$\sin^2 2\theta_{13} \sim 0.1$, $\delta_{CP}=\pi/2$
(here: 5 years)

Huber, Lindner, Schwetz, Rolinec, Winter, 2004



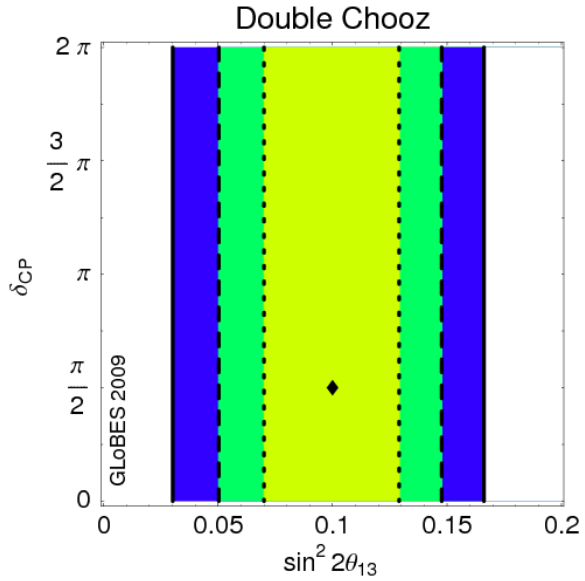
15.06.2011:
"Indication of Electron Neutrino Appearance from an Accelerator-produced off-axis Muon Neutrino Beam"
2.5σ exclusion of $\theta_{13}=0$

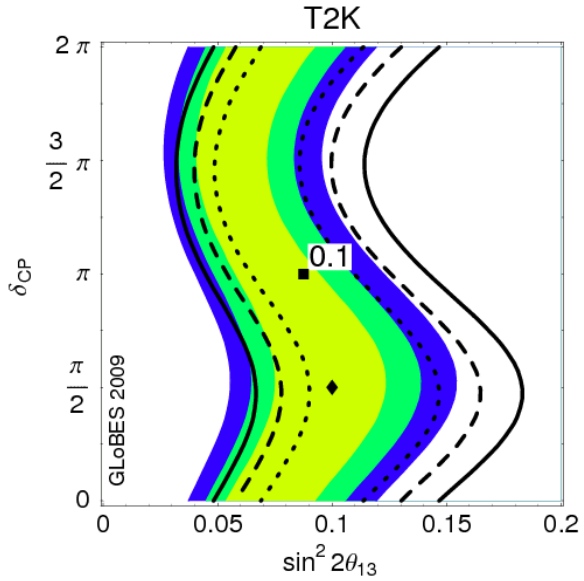


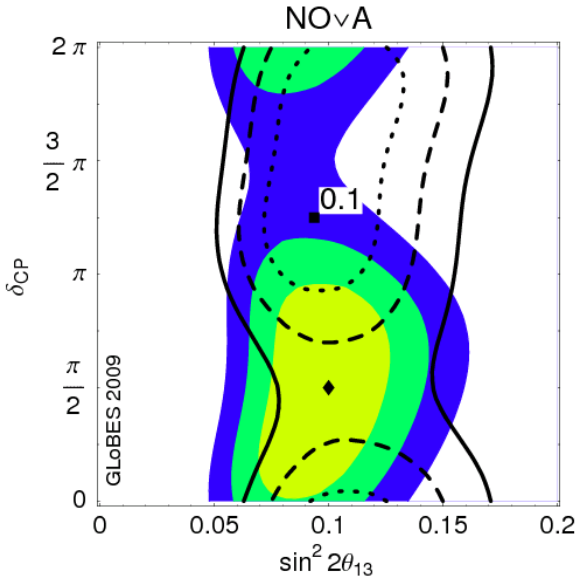
Source: T2K

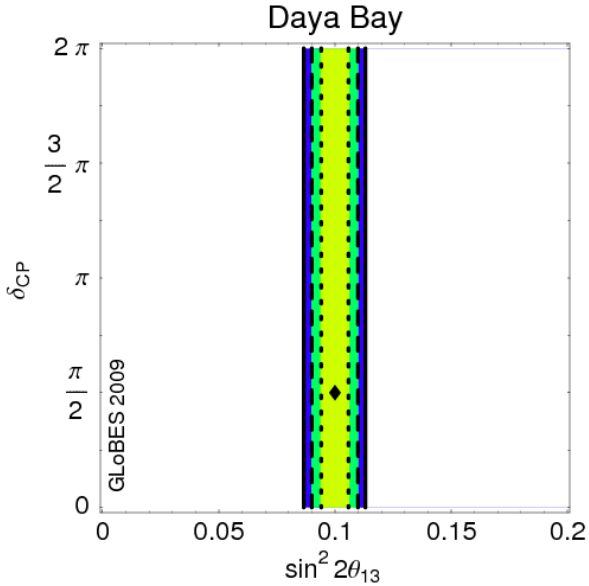
Consequences of T2K hint

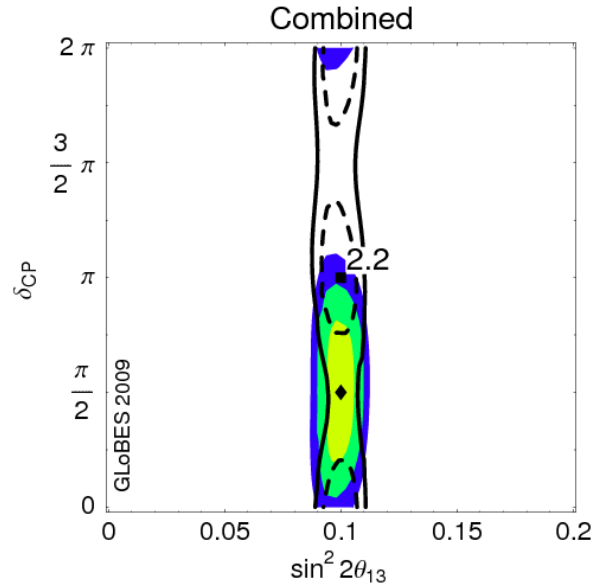
Huber, Lindner, Schwetz, Winter, 2009











- Parameter space for δ_{CP} starts to become constrained; CP violation difficult (need to exclude δ_{CP}=0 and π)
- Need new facility!

Questions to champions

- Optimization (L, E, etc) of the setup
  - Is that the physics-wise optimal setup for that class?
  - Under which boundary conditions was that obtained:
    - physics-wise, e.g., where in parameter space?
    - technology-wise, e.g., constrained to some site?
- Does the optimization change for large θ_{13}?
- Sensitivity (MH, θ_{13}, CPV); assumptions going into that (luminosity, systematics, etc.)
- Performance for large θ_{13}?
- Critical systematics/other important impact factors for physics potential
  [e.g. external knowledge on cross sections required, which cannot be obtained with near detectors]