Sensitivity studies with GLoBES

Group C

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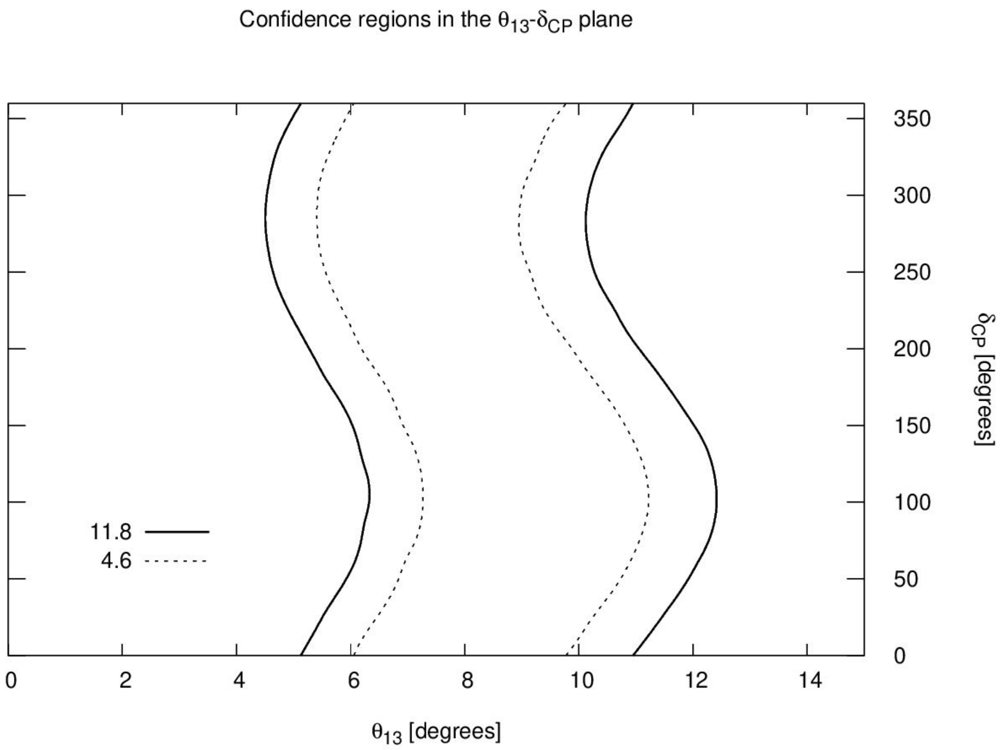
PART I:

Sensitivity studies in the θ_{13}-δ_{CP} plane for T2K experiment

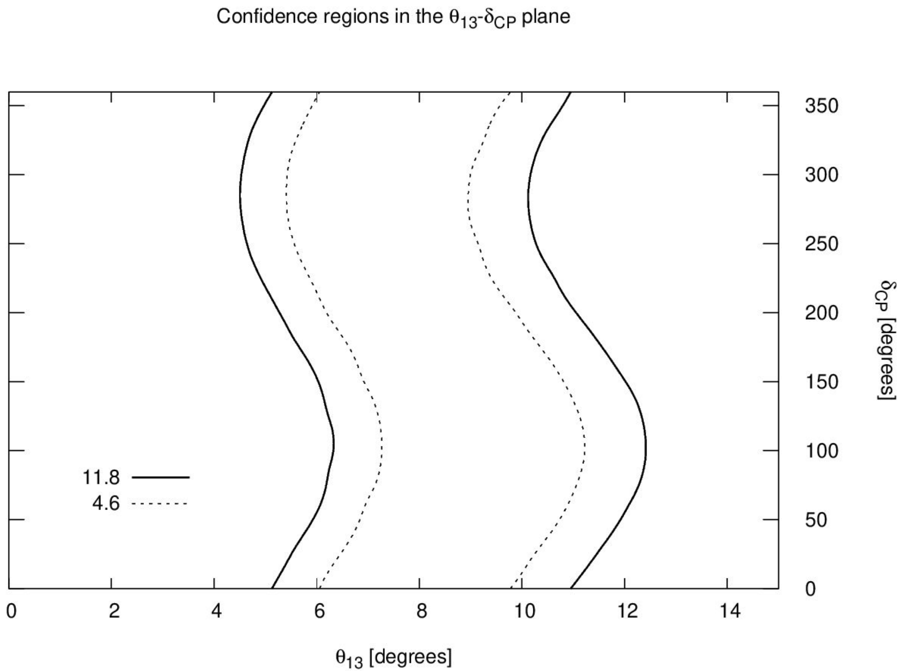
Confidence regions in θ_{13}-δ_{CP} plane for T2K expt

Using only neutrino data

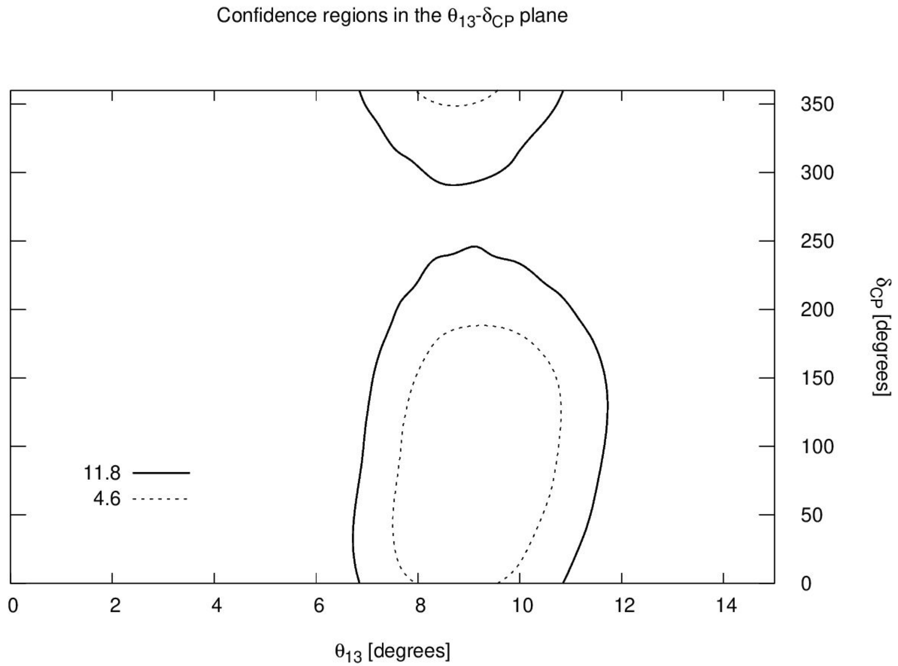
- ★ Assuming normal mass hierarchy i.e. $sgn(\Delta m^2_{31})$ degeneracy has been resolved.
- ★ Assuming $\theta_{13}=45°$, we can neglect the octant degeneracy.
- ★ Strong correlation between θ_{13} and δ_{CP} in the plot.



Using neutrino + anti-neutrino data from T2K



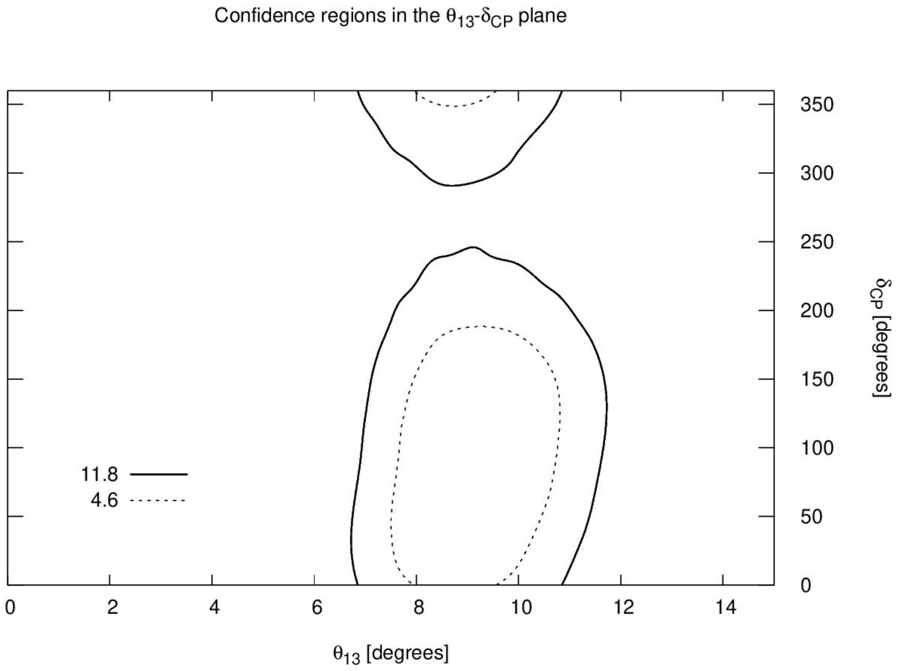
Only neutrino data



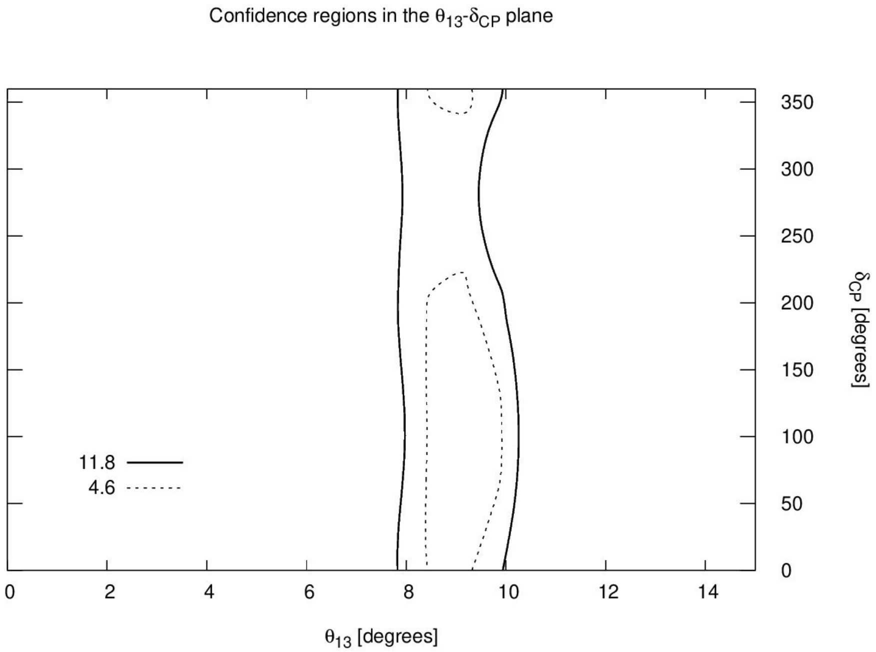
neutrino+anti-neutrino data

★ Better sensitivity for constraints on parameters. But generating anti-neutrino data is expensive.

Incorporating reactor neutrino data with neutrino data from T2K



Only neutrino data



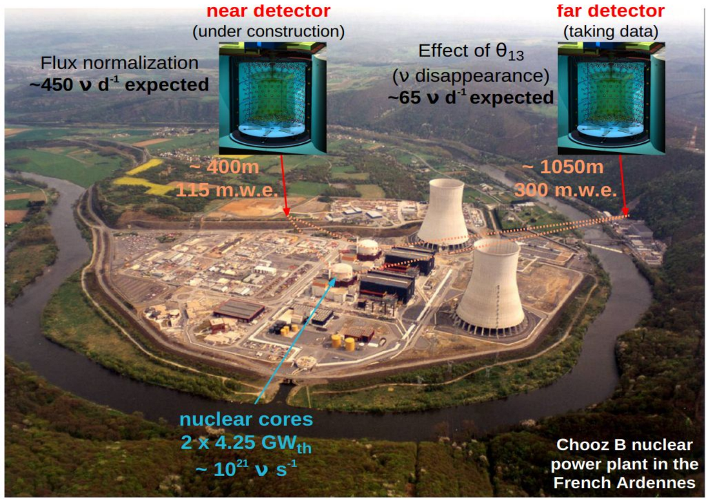
neutrino + reactor neutrino data

★ Reactor data is competitive to data obtained from more expensive anti-neutrino running.

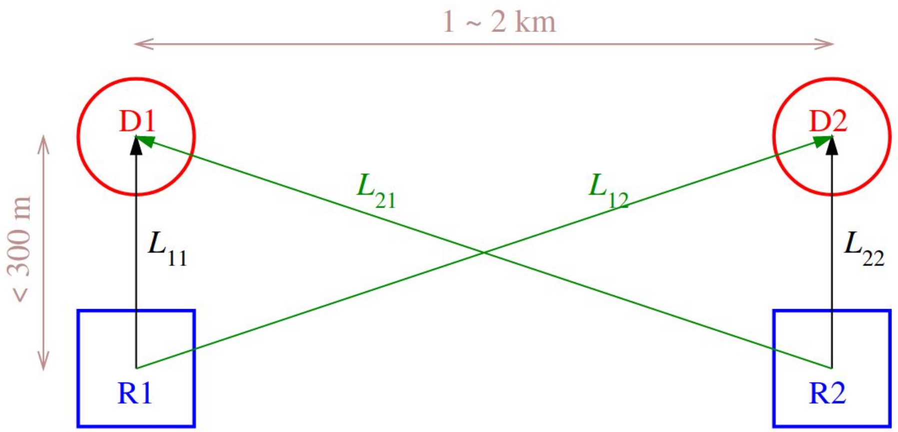
Part II: Systematic uncertainties in Reactor Experiments using **GLoBES**

Double CHOOZ vs R2D2 Experiment

Reactor experiments with a Two-Detector setup



Double CHOOZ (CNRS/APC - Vincent Durand)



R2D2 Experiment arXiv:hep-ph/0411166

- **Advantage of a multiple detector setup:** better constraint of systematic uncertainties - cancellation of systematics from neutrino source (relative normalization between the detectors remaining).

Systematic uncertainties

Normalization + Calibration

- Flux uncertainties
- Fiducial mass error
- Energy calibration

Shape error

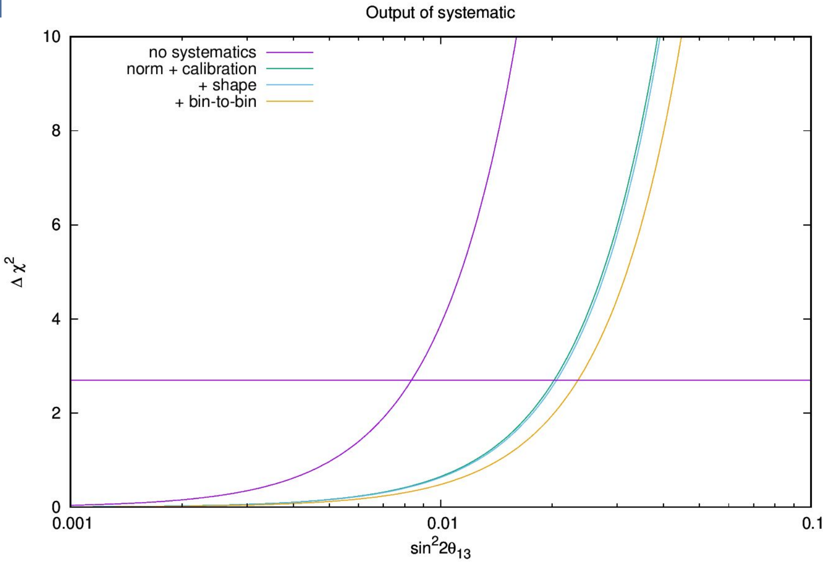
- Uncertainties in the energy spectrum as the initial neutrino flux is only known up to a certain accuracy (uncorrelated between the energy bins).

Bin-to-bin error

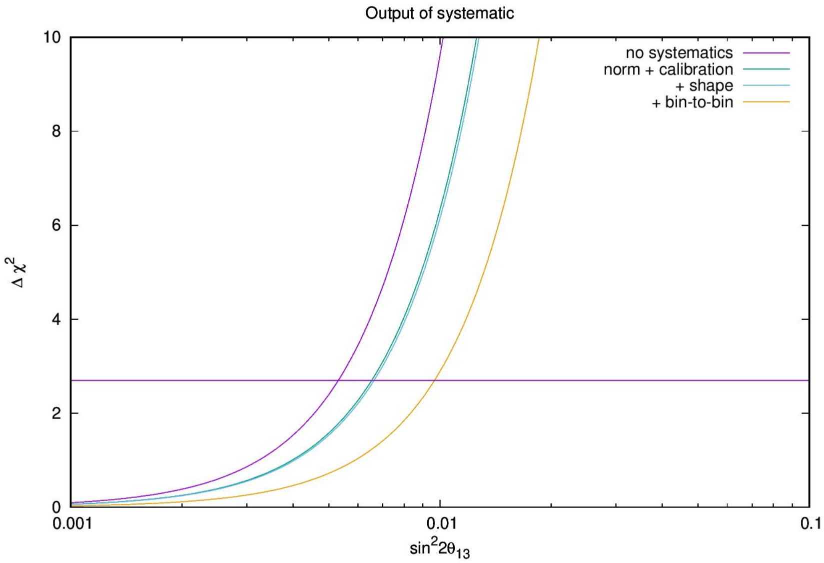
- Similar to shape error but uncorrelated between the detectors.

	Double CHOOZ	R2D2
Flux Normalizations	2% error	2% error (uncorrelated between reactors)
Fiducial mass	0.6% error (uncorrelated between the detectors)	0.6% error (uncorrelated between the detectors)
Energy calibration	0.5 % error	0.5% for each detector
Shape error	2% spectral error	2% spectral error
Bin to bin	2% for each bin.	2% for each bin

Sensitivity Comparison



Double CHOOZ



R2D2 Experiment

- A multi-detector setup allows for an effective cancellation of shape systematics.
- The R2D2 is very efficient at “self-calibrating”: the uncertainties from the flux cancel by the comparison of the 2 detectors and the uncertainties associated with the detectors cancel since both acts simultaneously as near and far detector (calibrate each other).


KEEP
CALM
AND
CHECK
BACKUP SLIDES

Normalization + Energy calibration systematics

$$\chi^2 = \chi^2_F + \chi^2_N + \chi^2_{\text{pull}}$$

$$\chi^2_F = \sum_i \frac{[(1 + a_{F,\text{fid}} + a_{\text{norm}})T_{F,i} - O_{F,i}]^2}{O_{F,i}},$$

$$\chi^2_N = \sum_i \frac{[(1 + a_{N,\text{fid}} + a_{\text{norm}})T_{N,i} - O_{N,i}]^2}{O_{N,i}},$$

$$\chi^2_{\text{pull}} = \frac{a^2_{F,\text{fid}}}{\sigma^2_{F,\text{fid}}} + \frac{a^2_{N,\text{fid}}}{\sigma^2_{N,\text{fid}}} + \frac{a^2_{\text{norm}}}{\sigma^2_{\text{norm}}}.$$