Sterile Neutrino Searches at Neutrino Reactor Experiments

Alvaro H.Cabezudo
In collaboration with: Mona Dentler, Joachim Kopp, Pedro A.N. Machado, Michele Maltoni, Ivan Martinez Soler and Thomas Schwetz.

karlsruher Institut fuer Technologie

alvaro.cabezudo@kit.edu

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Reactor Anomaly

Revaluations of the theoretical $\bar{\nu}_e$ fluxes coming from the nuclear reactors (*Huber-Muller models*) led to the discovery of the Reactor Anomaly: (arXiv:1106.0687v4, arXiv:1101.2663v3)

- $\sim 6\%$ **deficit** of the measured events with respect to the theoretical predictions.

Two possible explanations

- New Massive Neutrino: $P_{\bar{\nu}_e \to \bar{\nu}_e} \simeq 1 - \sin^2 2\theta_{14} \sin^2 \left(\Delta m^2_{41} \frac{L}{4E_\nu} \right)$
- Miscalculation in the Theoretical Flux Predictions: recent measurement of the fluxes by the Daya Bay collaboration, **disfavours** the new **massive neutrino** in favour of the miscalculation of the theoretical fluxes. (arXiv:1704.01082)

- The anomaly disappears doubling the theoretical uncertainties.

Reactor Experiments, Combined Analysis

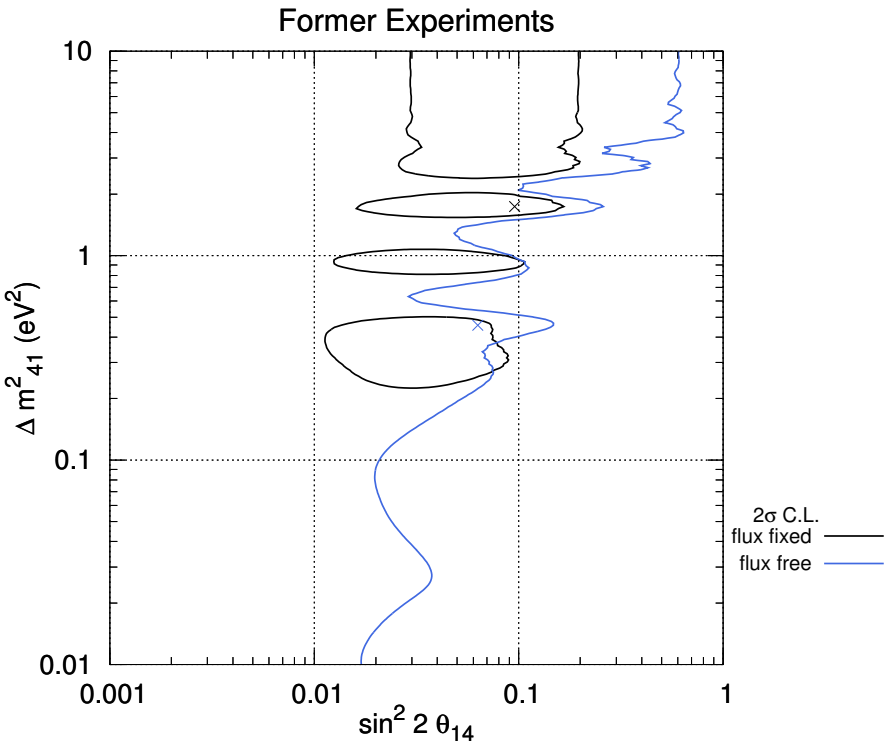
Two kind of analysis:

- **Flux Fixed Analysis:** using the *Huber and Muller* theoretical flux predictions.
- **Flux Free Analysis:** not assuming anything for the flux, so that we are not biased by the predictions.

Experimental Results Used

- Former Experiments: Short Baseline experiments, Palo Verde, RENO and KamLAND.
- New experiments spectral information (analysis $\sim$ **flux independent**):
  - Daya Bay update
  - NEOS
  - DANSS

Results

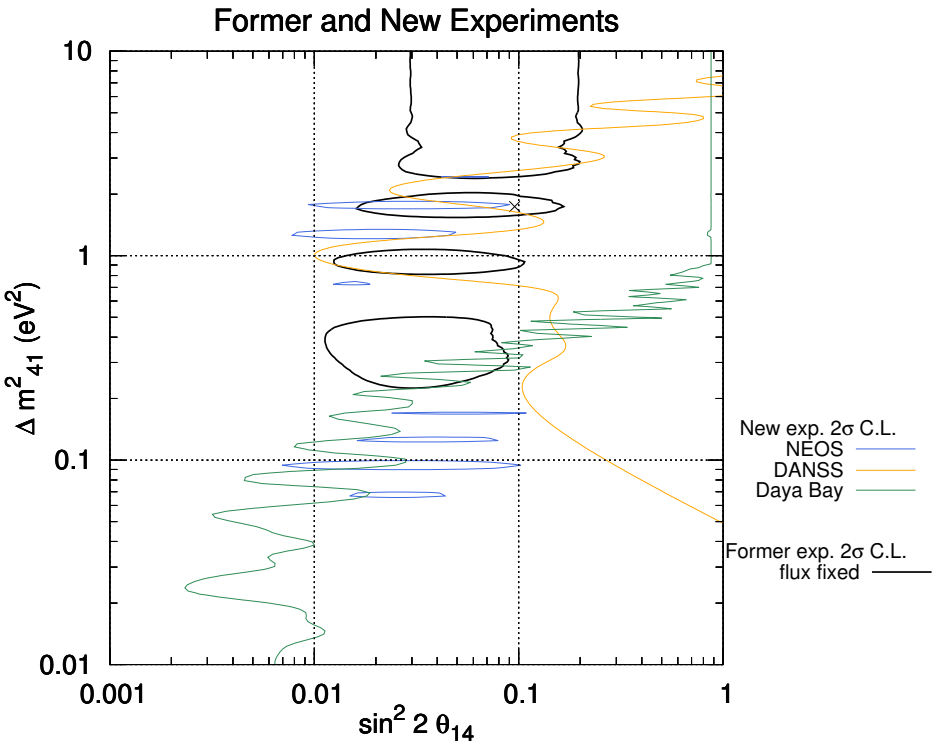


$$(\Delta\chi^2_{\text{no-osc}} \equiv \chi^2_{\text{no-osc}} - \chi^2_{min})$$

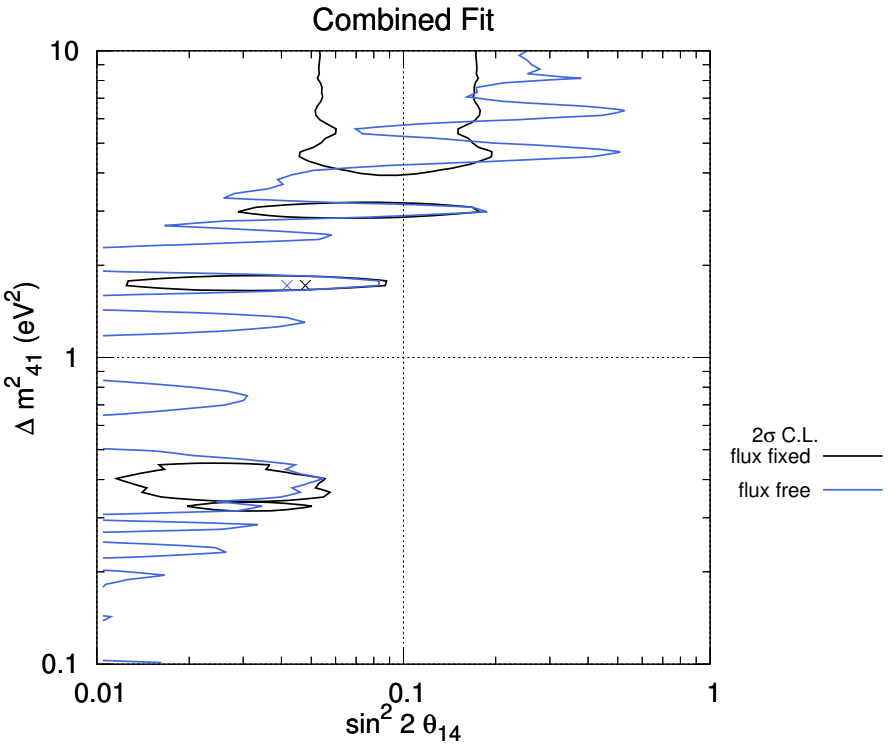
Flux Fixed $\Delta\chi^2_{no-osc} = 9.06;\ 2.6\sigma(C.L.)$

Flux Free $\Delta\chi^2_{no-osc} = 2.79;\ 1.2\sigma(C.L.)$

Results


Former and New Experiments
10
1
0.1
0.01
0.001
0.01
0.1
1
Δ m²41 (eV²)
sin² 2 θ14
New exp. 2σ C.L.
NEOS
DANSS
Daya Bay
Former exp. 2σ C.L.
flux fixed

Results



New experiments are compatible with the reactor anomaly and slightly increase the significance for the sterile neutrino:

$$\text{Flux Fixed } \Delta\chi^2_{no-osc} = 10.62;\ 2.8\sigma(C.L.)$$
$$\text{Flux Free } \Delta\chi^2_{no-osc} = 5.34;\ 1.8\sigma(C.L.)$$

Summary

- 1 - The new experiments (Daya Bay, NEOS, DANSS) are compatible with the reactor anomaly and increase slightly the significance for the sterile neutrino.
- 2 - The flux free analysis, a very conservative assumption, decrease the significance for the sterile neutrino but is still consistent with the reactor anomaly.

- The next step $\rightarrow$ including the new data of the Daya Bay flux measurements.
- A new global analysis of the sterile neutrino oscillations (update of Joachim Kopp et.al. arXiv:1303.3011v3) is coming soon. see M.Dentler inv17 talk.

Thank you for your attention