# NuFIT 2.1: Three-neutrino fit based on data available in May 2016

**Ivan Esteban,**[a] **M. C. Gonzalez-Garcia,**[a,b,c] **Michele Maltoni,**[d] **Ivan Martinez-Soler,**[d] **Thomas Schwetz**[e]

[a] *Departament d'Estructura i Constituents de la Matèria and Institut de Ciencies del Cosmos, Universitat de Barcelona, Diagonal 647, E-08028 Barcelona, Spain*

[b] *Institució Catalana de Recerca i Estudis Avançats (ICREA), Spain*

[c] *C.N. Yang Institute for Theoretical Physics, State University of New York at Stony Brook, Stony Brook, NY 11794-3840, USA*

[d] *Instituto de Física Teórica UAM/CSIC, Calle de Nicolás Cabrera 13–15, Universidad Autónoma de Madrid, Cantoblanco, E-28049 Madrid, Spain*

[e] *Institut für Kernphysik, Karlsruhe Institute of Technology (KIT), 76021 Karlsruhe, Germany*

*E-mail:* ivan.esteban@ecm.ub.edu, concha@insti.physics.sunysb.edu, michele.maltoni@csic.es, ivanj.m@csic.es, schwetz@kit.edu

Abstract: We present updated results for our global analysis of solar, atmospheric, reactor, and accelerator neutrino data in the framework of three-neutrino oscillations. We perform two independent analyses, which we denote as "LEM" or "LID" according to which of the two alternative $\nu_e$-appearance data samples released by the NO$\nu$A collaboration is used. We also provide $\chi^2$ tables for the various one- and two-dimensional projections of the global analysis. If you use these results, please refer to both [1] and [2]. Data sets which have been updated with respect to NuFIT 2.0 are marked by the "⇒" tag.

## Solar experiments

- Chlorine total rate [3], 1 data point.
- Gallex & GNO total rates [4], 2 data points.
- SAGE total rate [5], 1 data point.
- SK1 full energy and zenith spectrum [6], 44 data points.
- SK2 full energy and day/night spectrum [7], 33 data points.
- SK3 full energy and day/night spectrum [8], 42 data points.

⇒ SK4 2055-day energy and day/night spectrum [9], 46 data points.

- SNO combined analysis [10], 7 data points.
- Borexino Phase-I 740.7-day low-energy data [11], 33 data points.
- Borexino Phase-I 246-day high-energy data [12], 6 data points.

⇒ Borexino Phase-II 408-day low-energy data [13], 42 data points.

## Atmospheric experiments

- SK1–4 (including SK4 1775-day) combined data [14], 70 data points.

⇒ IceCube/DeepCore 3-year data [15, 16], 64 data points.

## Reactor experiments

- KamLAND combined DS1 & DS2 spectrum [17], 17 data points.
- CHOOZ energy spectrum [18], 14 data points.
- Palo-Verde total rate [19], 1 data point.

⇒ Double-Chooz FD-I (461 days) and FD-II (212 days) spectra [20], 54 data points.

- Daya-Bay 621-day spectrum [21], 36 data points.
- Reno 800-day near & far total rates [22], 2 data points (with free normalization).
- SBL reactor data (including Daya-Bay total flux at near detector), 77 data points [21, 23].

## Accelerator experiments

- MINOS $10.71 \times 10^{20}$ pot $\nu_\mu$-disappearance data [24], 39 data points.
- MINOS $3.36 \times 10^{20}$ pot $\bar{\nu}_\mu$-disappearance data [24], 14 data points.
- MINOS $10.6 \times 10^{20}$ pot $\nu_e$-appearance data [25], 5 data points.
- MINOS $3.3 \times 10^{20}$ pot $\bar{\nu}_e$-appearance data [25], 5 data points.
- T2K $6.57 \times 10^{20}$ pot $\nu_\mu$-disappearance data [26], 16 data points.
- T2K $6.57 \times 10^{20}$ pot $\nu_e$-appearance data [27], 5 data points.

⇒ T2K $4.01 \times 10^{20}$ pot $\bar{\nu}_\mu$-disappearance data [28, 29], 63 data points.

⇒ T2K $4.01 \times 10^{20}$ pot $\bar{\nu}_e$-appearance data [30], 1 data point.

⇒ NO$\nu$A $2.74 \times 10^{20}$ pot $\nu_\mu$-disappearance data [31], 18 data points.

⇒ NO$\nu$A $2.74 \times 10^{20}$ pot $\nu_e$-appearance data [32], 1 data point (both LEM and LID).

## Description of the $\chi^2$ data tables

We provide four gzip-compressed files, containing the $\chi^2$ data tables for both Normal and Inverted Ordering of our global LEM and LID analyses. Each file is divided into 21 sections, identified by a unique tag and corresponding to a particular one- or two-dimensional projections. The tags and the meaning of the data columns for each section are listed below (note that $\ell = 1$ for NO and $\ell = 2$ for IO).

| $N^\circ$ | Section tag | 1st column | 2nd column | 3rd column |
|---|---|---|---|---|
| 1 | `# T13/T12` | $\sin^2\theta_{13}$ | $\sin^2\theta_{12}$ | $\Delta\chi^2$ |
| 2 | `# T13/DMS` | $\sin^2\theta_{13}$ | $\log_{10}(\Delta m^2_{21} / [\text{eV}^2])$ | $\Delta\chi^2$ |
| 3 | `# T12/DMS` | $\sin^2\theta_{12}$ | $\log_{10}(\Delta m^2_{21} / [\text{eV}^2])$ | $\Delta\chi^2$ |
| 4 | `# T13/T23` | $\sin^2\theta_{13}$ | $\sin^2\theta_{23}$ | $\Delta\chi^2$ |
| 5 | `# T13/DMA` | $\sin^2\theta_{13}$ | $\Delta m^2_{3\ell} / [10^{-3}\ \text{eV}^2]$ | $\Delta\chi^2$ |
| 6 | `# T23/DMA` | $\sin^2\theta_{23}$ | $\Delta m^2_{3\ell} / [10^{-3}\ \text{eV}^2]$ | $\Delta\chi^2$ |

| $N^\circ$ | Section tag | 1st column | 2nd column | 3rd column |
|---|---|---|---|---|
| 7 | `# T13/DCP` | $\sin^2\theta_{13}$ | $\delta_{CP}$ / [deg] | $\Delta\chi^2$ |
| 8 | `# T23/DCP` | $\sin^2\theta_{23}$ | $\delta_{CP}$ / [deg] | $\Delta\chi^2$ |
| 9 | `# DMA/DCP` | $\Delta m^2_{3\ell}$ / [$10^{-3}$ eV$^2$] | $\delta_{CP}$ / [deg] | $\Delta\chi^2$ |
| 10 | `# T12/T23` | $\sin^2\theta_{12}$ | $\sin^2\theta_{23}$ | $\Delta\chi^2$ |
| 11 | `# T12/DCP` | $\sin^2\theta_{12}$ | $\delta_{CP}$ / [deg] | $\Delta\chi^2$ |
| 12 | `# T12/DMA` | $\sin^2\theta_{12}$ | $\Delta m^2_{3\ell}$ / [$10^{-3}$ eV$^2$] | $\Delta\chi^2$ |
| 13 | `# DMS/T23` | $\log_{10}(\Delta m^2_{21}$ / [eV$^2$]) | $\sin^2\theta_{23}$ | $\Delta\chi^2$ |
| 14 | `# DMS/DCP` | $\log_{10}(\Delta m^2_{21}$ / [eV$^2$]) | $\delta_{CP}$ / [deg] | $\Delta\chi^2$ |
| 15 | `# DMS/DMA` | $\log_{10}(\Delta m^2_{21}$ / [eV$^2$]) | $\Delta m^2_{3\ell}$ / [$10^{-3}$ eV$^2$] | $\Delta\chi^2$ |
| 16 | `# T13` | $\sin^2\theta_{13}$ | $\Delta\chi^2$ | — |
| 17 | `# T12` | $\sin^2\theta_{12}$ | $\Delta\chi^2$ | — |
| 18 | `# T23` | $\sin^2\theta_{23}$ | $\Delta\chi^2$ | — |
| 19 | `# DCP` | $\delta_{CP}$ / [deg] | $\Delta\chi^2$ | — |
| 20 | `# DMS` | $\log_{10}(\Delta m^2_{21}$ / [eV$^2$]) | $\Delta\chi^2$ | — |
| 21 | `# DMA` | $\Delta m^2_{3\ell}$ / [$10^{-3}$ eV$^2$] | $\Delta\chi^2$ | — |

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