Long Baseline Oscillation Experiments

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All-Scientist Retreat, Neutrino WG
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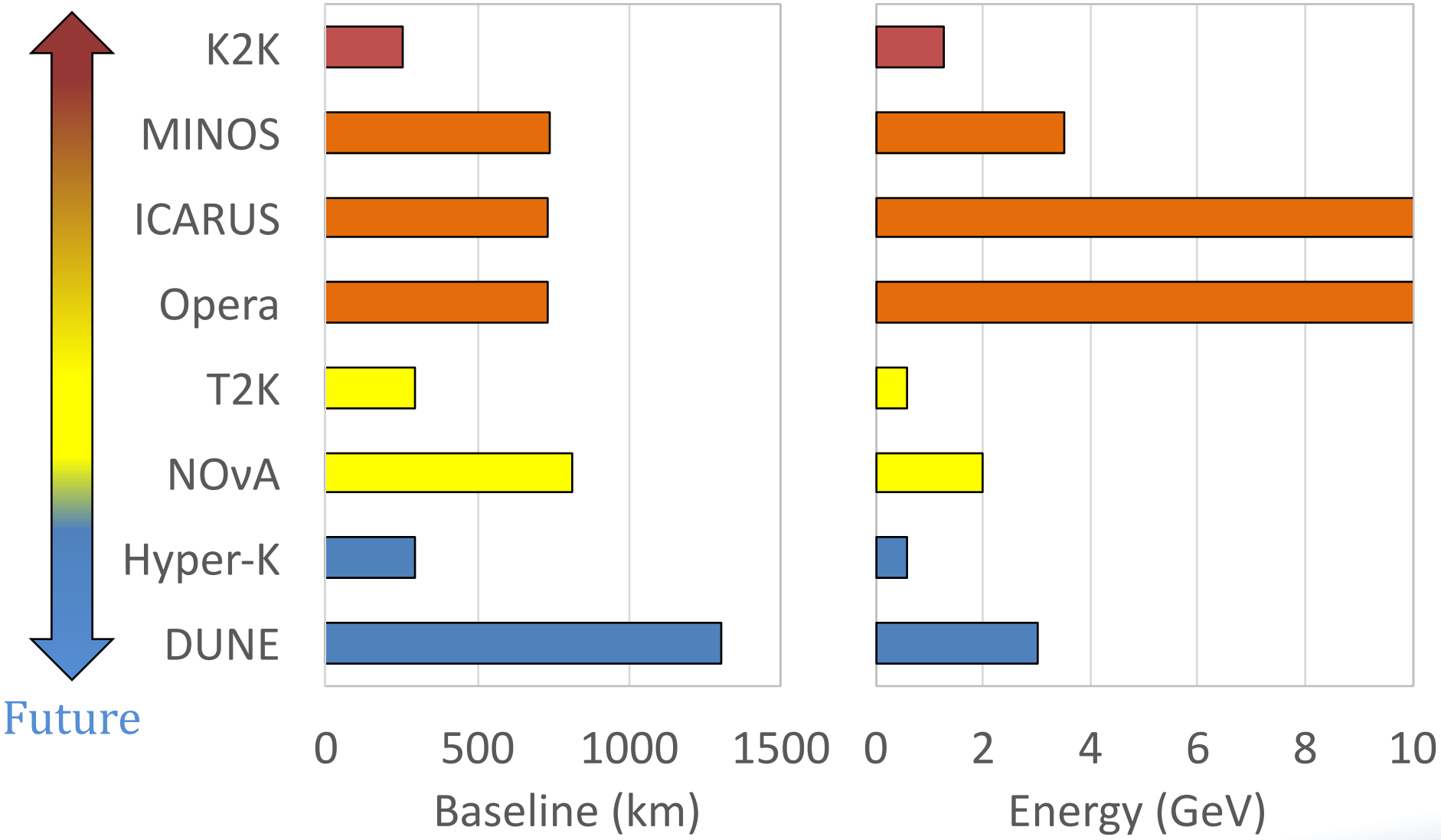
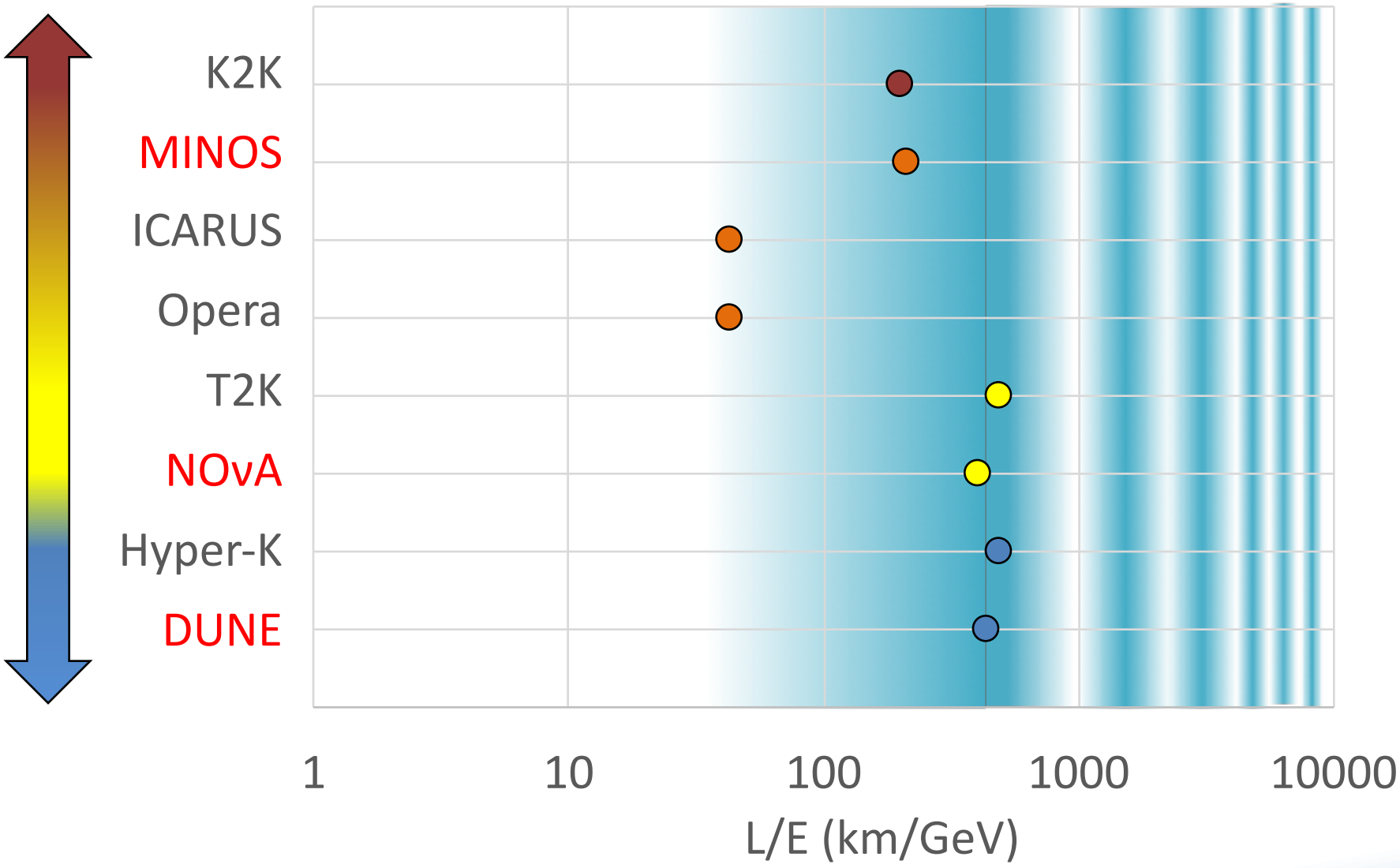
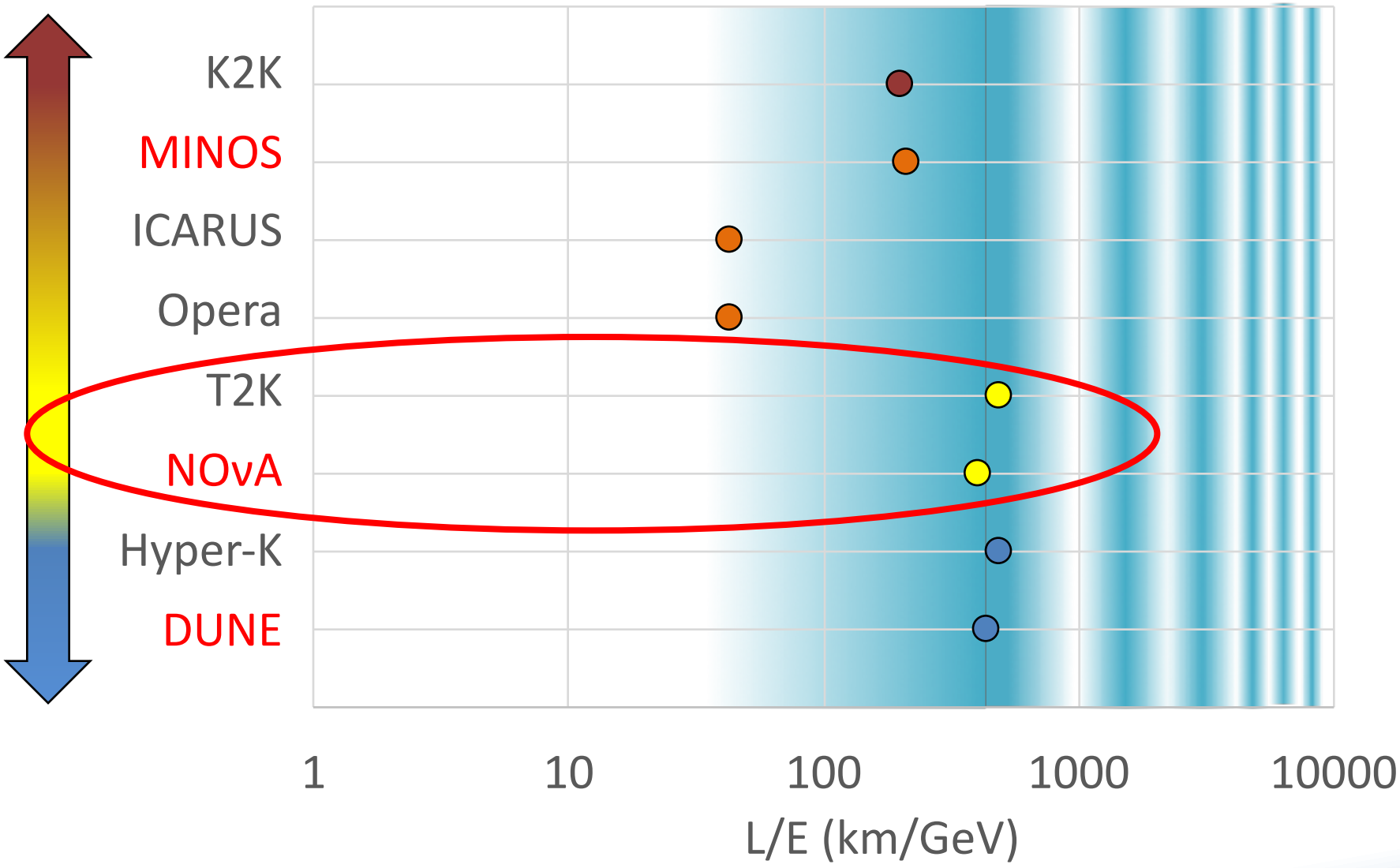
Long Baseline Experments



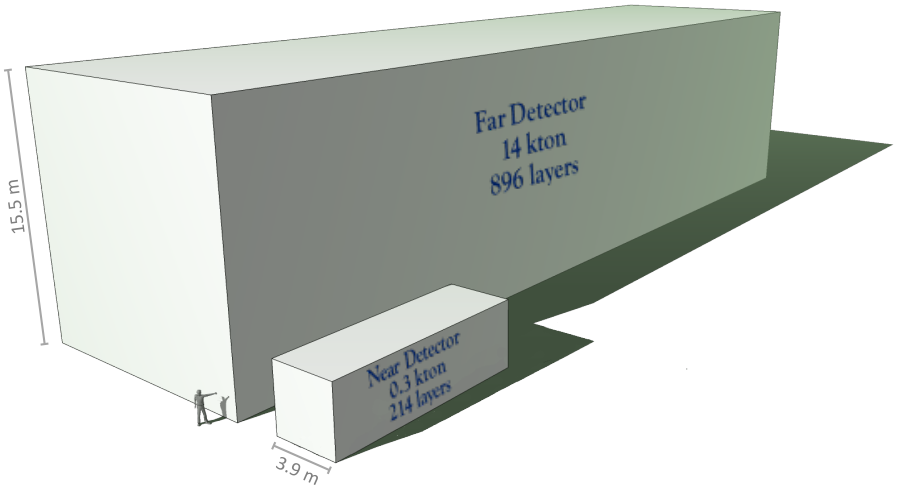
Long Baseline Experments

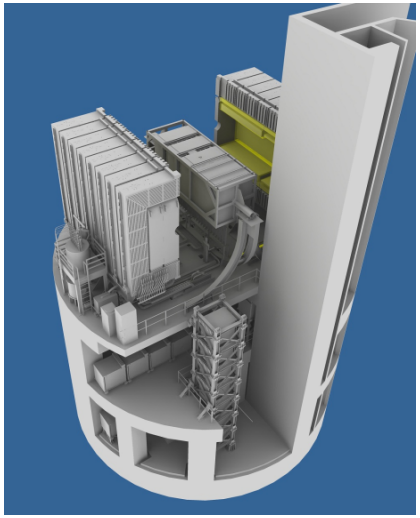


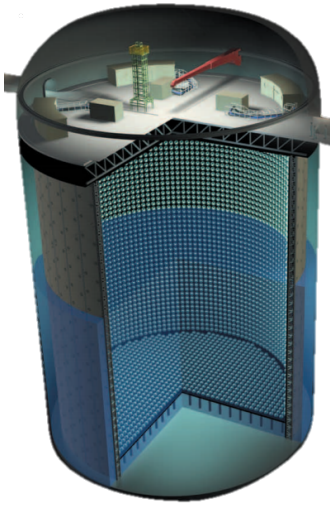
Long Baseline Experments



Current Experiments







Fermilab

j-PARC

What We Don't Know

atmospheric accelerator ν_μ | short baseline reactor accelerator ν_e | solar long baseline reactor

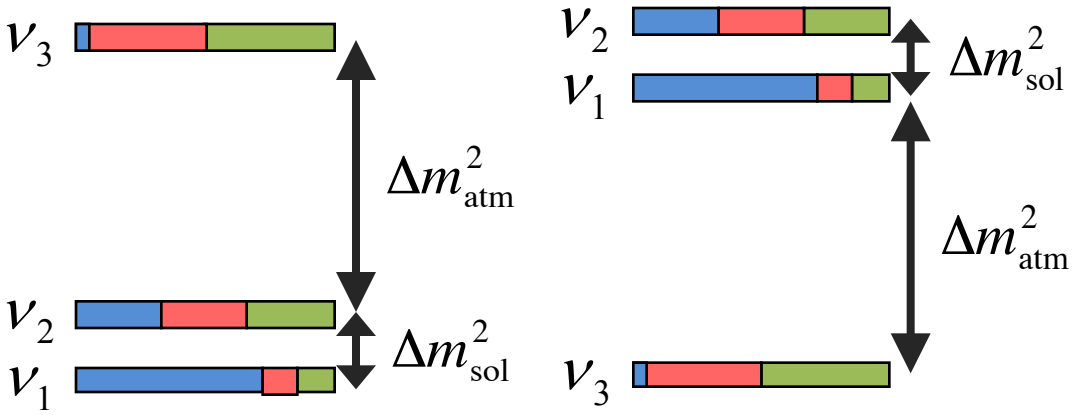
Flavor

$$\begin{pmatrix} \nu_e \\ \nu_\mu \\ \nu_\tau \end{pmatrix} = \begin{pmatrix} 1 & 0 & 0 \\ 0 & c_{23} & s_{23} \\ 0 & -s_{23} & c_{23} \end{pmatrix} \begin{pmatrix} c_{13} & 0 & s_{13}e^{-i\delta} \\ 0 & 1 & 0 \\ -s_{13}e^{i\delta} & 0 & c_{13} \end{pmatrix} \begin{pmatrix} c_{12} & s_{12} & 0 \\ -s_{12} & c_{12} & 0 \\ 0 & 0 & 1 \end{pmatrix} \begin{pmatrix} \nu_1 \\ \nu_2 \\ \nu_3 \end{pmatrix}$$

Mass

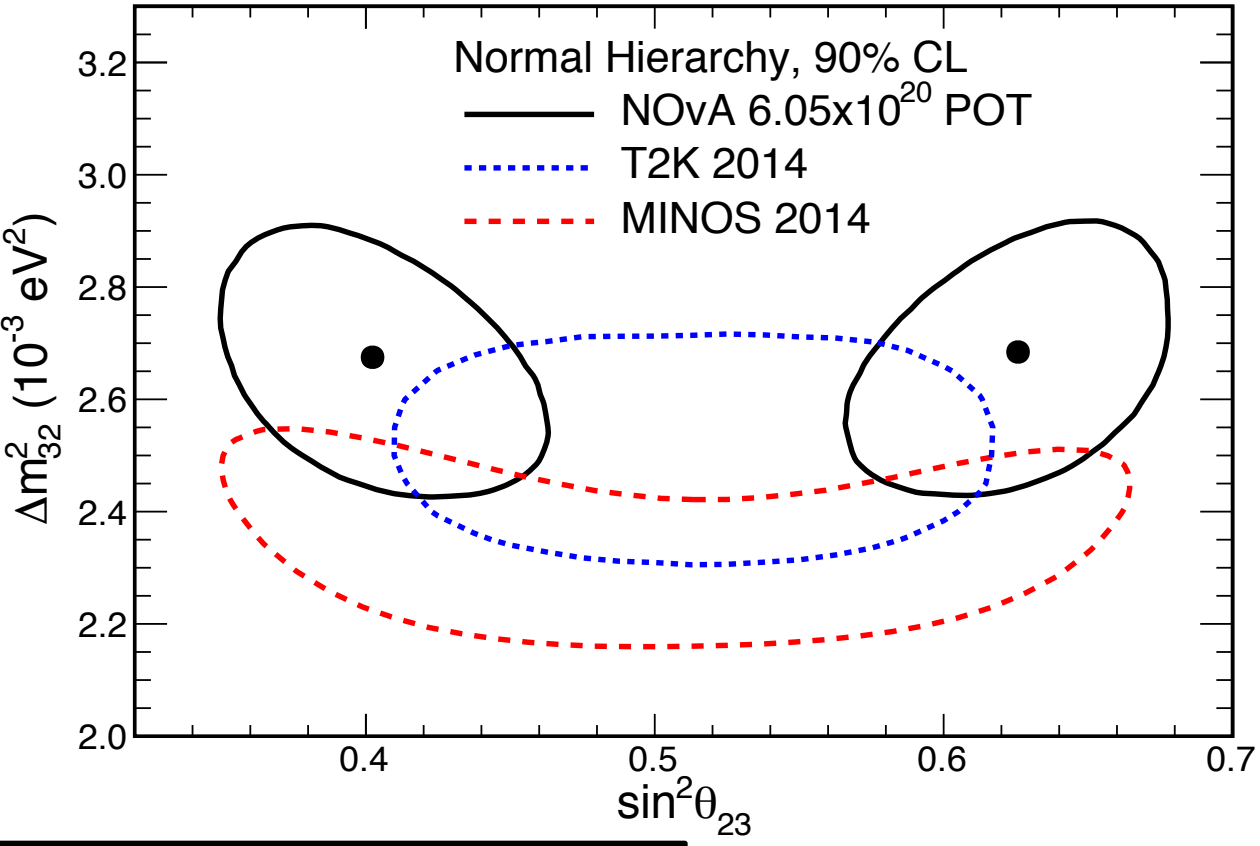
Is $\theta_{23} = 45°$? If not, below or above?

Phase δ_{CP}, and potentially CP violation



The "mass hierarchy," the sign of the atmospheric Δm^2

What we know: Disappearance



Best Fit (NH)

$$|\Delta m^2_{32}| = 2.67 \pm 0.11 \times 10^{-3}\mathrm{eV}^2$$

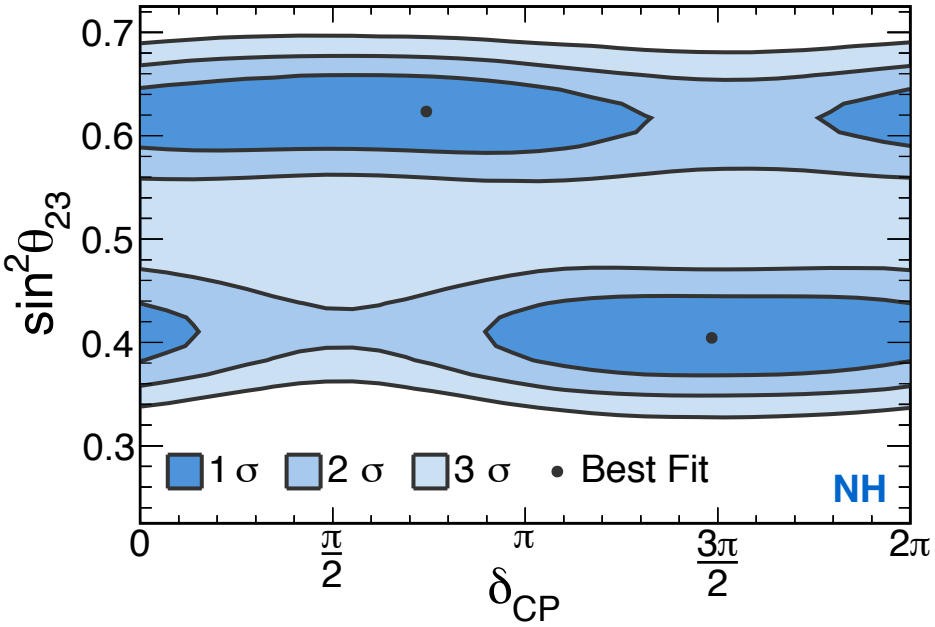
$$\sin^2\theta_{23} = 0.404^{+0.030}_{-0.022}(0.624^{+0.022}_{-0.030})$$

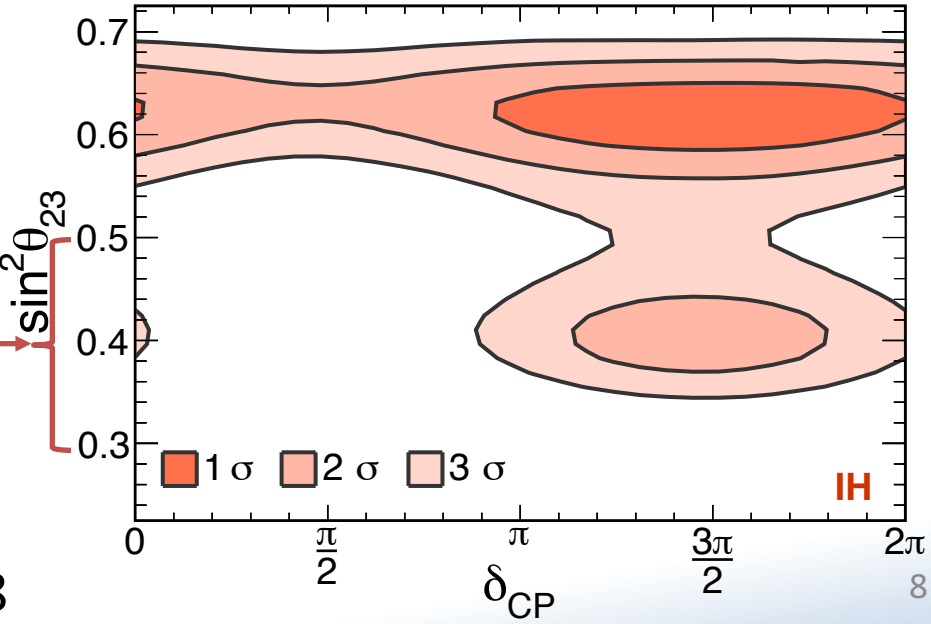
Disfavor maximal mixing at 2.6 σ

arXiv:1701.05891

What we know: Appearance in NOvA

- Two degenerate best fit points:
  - NH, $\delta = 1.48\pi$, $\sin^2\theta_{23} = 0.404$
  - NH, $\delta = 0.74\pi$, $\sin^2\theta_{23} = 0.623$
- Inverted hierarchy slightly disfavored.
  - $\Delta\chi^2 = 0.47$
- Lower octant in the IH is disfavored at 93%.
  - For all values of δ

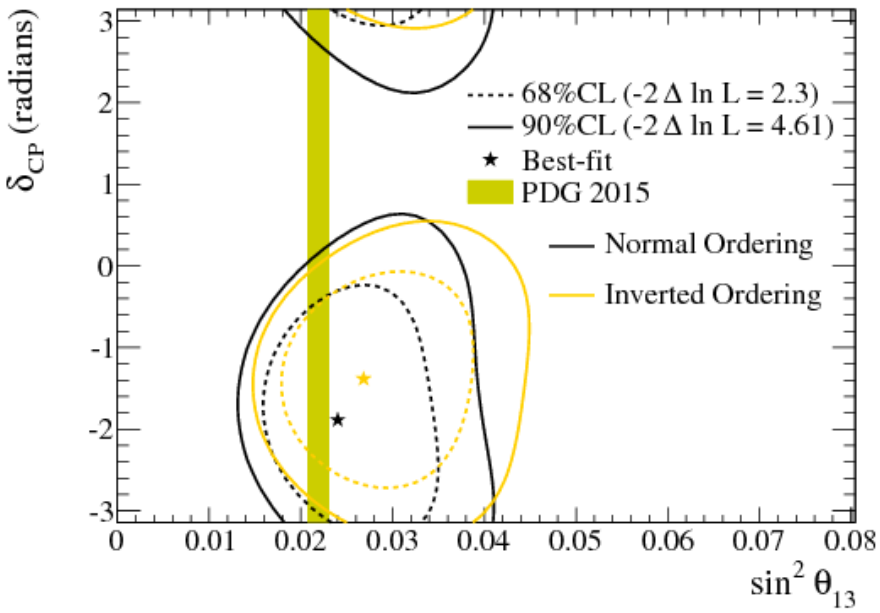


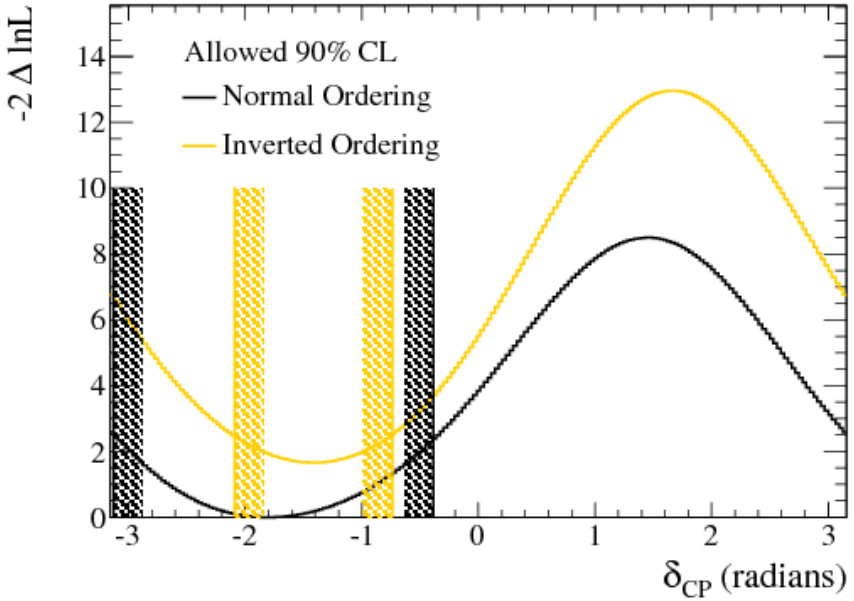


arXiv:1703.03328

What we know: Appearance in T2K

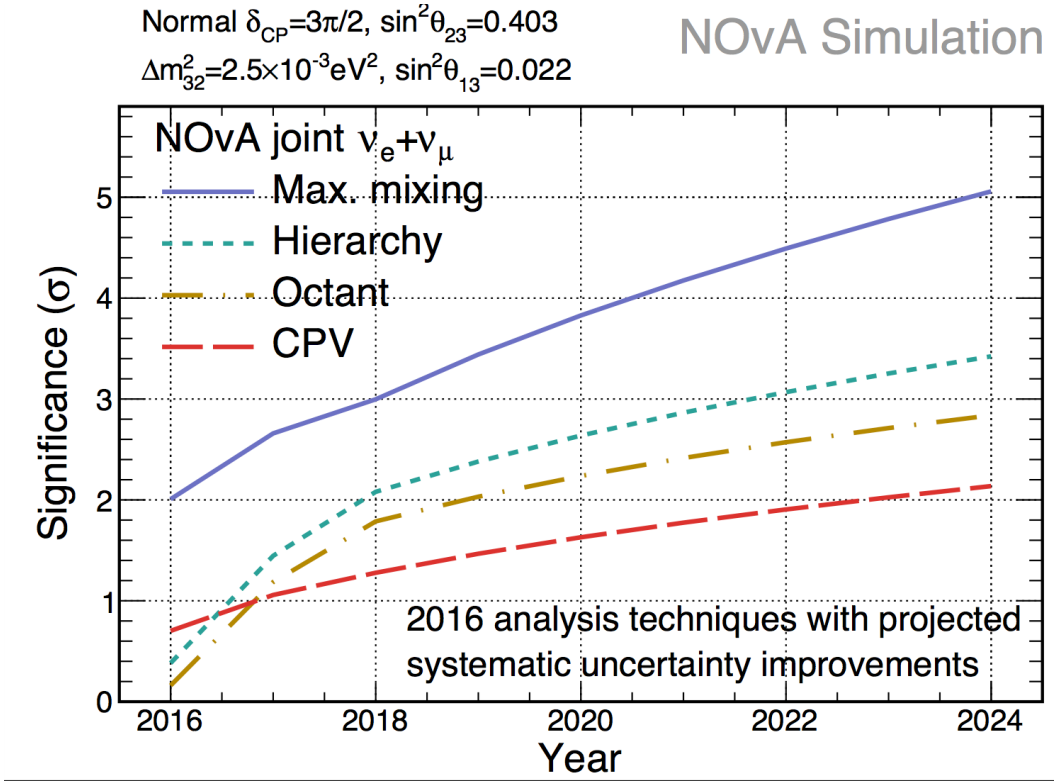
- Since T2K favors maximal mixing, results are presented differently.
- Excluding *CP*-conservation at the 90% C.L.
- arXiv: 1701.00432





Future Sensitivity for NOvA

- Sensitivity milestones
  - Caveat: they depend on assumed parameters, and these are not our most optimistic.
- 2018
  - 3σ on max. mixing
  - 2σ on hierarchy
- 2019
  - 2σ on octant
- 2022
  - 3σ on hierarchy
- 2024
  - 2σ on CPV
  - 5σ on max. mixing



Future Plans for T2K

- T2K approved POT will be reached in ~2021
- 3σ CPV sensitivity with 20×10^{21} by 2026
  - Also requires analysis and hardware upgrades
- Extended run with upgrades proposed.
  - Received "Stage-I" status from J-PARC PAC.
- arXiv:1609.04111