Oscillation Calculation Assumptions

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The following are the assumptions that have been used in the GLoBES-based calculation of long-baseline neutrino oscillation sensitivities for both NuMI and LBNE-based options. More information can also be found here [1].

I. OSCILLATION PARAMETERS

- $\theta_{12} = 0.593 \pm 0.018$ [2]
- $\theta_{13} = 0.154 \pm 0.005$ ($\sin^2 2\theta_{13} = 0.092 \pm 0.005$) [3]
- $\theta_{23} = 0.705 \pm 0.078$ [2]
- $\Delta m^2_{21} = (7.58 \pm 0.23) \times 10^{-5}$ eV^2 [2]
- $\Delta m^2_{31} = (2.35 \pm 0.12) \times 10^{-3}$ eV^2 [2] (> 0 for NH, < 0 for IH)
- matter density: constant 2.8 g/cm^3 with a 2% uncertainty [4]

II. BEAM PARAMETERS

- NOvA: 700 kW at 6×10^{20} POT/year (pre-2020)
- LBNE and NOvA phase-2: 700 kW = 7.3×10^{20} POT/year (post-2020)
  (this may be too high but this is what has been assumed for all of the default LBNE sensitivity calculations)
- T2K: 300 kW (2013-2020)

III. DETECTOR PARAMETERS: LAR

We assume standard LBNE assumptions for LAr detector performance [5].

- appearance:
  - ↪ signal: (with $15\%/\sqrt{E}$ energy resolution)
  - ↪ backgrounds:
    - ⋆ 1% NC ν_μ (with NC energy smearing from WC simulation)
    - ⋆ 1% CC ν_μ (with $\sigma/E = 15\%/E$ energy resolution)
    - ⋆ 80% intrinsic CC ν_e (with $\sigma/E = 15\%/E$ energy resolution)
    - ⋆ wrong-sign backgrounds are taken into account for antineutrino mode running
  - ↪ 1% uncertainty on signal normalization
  - ↪ 5% uncertainty on background normalization
- disappearance:
  - ↪ signal: 85% CC ν_μ efficiency for both ν_μ and $\overline{\nu}_\mu$ (with $\sigma/E = 20\%/\sqrt{E}$ energy resolution)
  - ↪ backgrounds: 0.5% NC ν_μ (with $\sigma/E = 20\%/\sqrt{E}$ energy resolution)
  - ↪ 5% uncertainty on signal normalization
  - ↪ 10% uncertainty on background normalization
  - ↪ 2% energy scale uncertainty on both signal and background

IV. DETECTOR PARAMETERS: NOVA (FROM GLOBES)

- 14 kton fiducial mass
- signal: 35% CC ν_e efficiency and 37% $\overline{\nu}_e$ CC efficiency (both with $\sigma/E = 10\%/\sqrt{E}$)
- neutrino mode backgrounds:
  - ↪ 0.34% NC ν_μ (with $sigma/E = 10\%/\sqrt{E}$)
  - ↪ 0.08% CC ν_μ (with $\sigma/E = 5\%/\sqrt{E}$)
  - ↪ 8.2% intrinsic CC ν_e (with $\sigma/E = 10\%/\sqrt{E}$)
- antineutrino mode backgrounds:
  - ↪ 0.30% NC $\overline{\nu}_\mu$ (with $\sigma/E = 10\%/\sqrt{E}$)
  - ↪ 0.01% CC $\overline{\nu}_\mu$ (with $\sigma/E = 5\%/\sqrt{E}$)
  - ↪ 10% intrinsic CC $\overline{\nu}_e$ (with $\sigma/E = 10\%/\sqrt{E}$)
- 5% uncertainty on signal normalization
- 50% uncertainty on background normalization
- 2.5% energy scale uncertainty on both signal and background

V. DETECTOR PARAMETERS: T2K (FROM GLOBES)

- 22.5 kton fiducial mass
- signal: 50% QE ν_e and $\overline{\nu}_e$ efficiency (both with $\sigma/E = 8.5\%/E$)
- neutrino mode backgrounds:
  - ↪ 0.56% NC ν_μ (with $\sigma/E = 8.5\%/E$)
  - ↪ 0.03% CC ν_μ (with $\sigma/E = 8.5\%/E$)
  - ↪ 50% intrinsic ν_e (with $\sigma/E = 8.5\%/E$)
  - ↪ 50% intrinsic $\overline{\nu}_e$ (with $\sigma/E = 8.5\%/E$)
- antineutrino mode backgrounds:
  - ↪ 0.56% NC $\overline{\nu}_\mu$ (with $\sigma/E = 8.5\%/E$)
  - ↪ 0.03% CC $\overline{\nu}_\mu$ (with $\sigma/E = 8.5\%/E$)
  - ↪ 50% intrinsic $\overline{\nu}_e$ (with $\sigma/E = 8.5\%/E$)
  - ↪ 50% intrinsic ν_e (with $\sigma/E = 8.5\%/E$)
- 10% uncertainty on signal normalization
- 5% uncertainty on background normalization
- 5% energy scale uncertainty on the backgrounds

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[1] `https://cdcvs.fnal.gov/redmine/projects/lbne-lblpwgtools`
[2] G.L. Fogli *et al.*, Phys. Rev. D84, 053007 (2011), arXiv:1106.6028 [hep-ph].
[3] we use the Daya Bay central value and systematic uncertainty assuming that statistics will improve over time; F.P. An *et al.* [Daya Bay collaboration], arXiv:1203.1669 [hep-ex].
[4] A.M. Dziewonski and D.L. Anderson, Phys. Earth Planet Interiors 25, 297356 (1981); F.D. Stacey, Phys. of the Earth, 2nd edition, Wiley (1977).
[5] T. Akiri *et al.* [LBNE collaboration], arXiv:1110.6249 [hep-ex], appendix A.