A Relative Rate and Shape Measurement of the Neutrino Oscillation at the Daya Bay Experiment
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Smallest mixing angle in lepton sector
- Neutrino mass/flavor states related by 3x3 unitary PMNS matrix.

Neutrino Mixing Matrix
- Precision via relative measurement
  • Relative far vs. near measurement limits uncertainty

Oscillation Parameters
- Anti-neutrinos interact in the 0.1% Gadolinium-doped liquid scintillator inside the detector via the inverse beta decay (IBD) reaction:
  \[ \nu_e + p \rightarrow e^- + n \]
- The neutron is captured by gadolinium ~30µs later, providing a clear experimental signature.
- The detected positron energy carries important information about the original anti-neutrino energy.
- The oscillation parameters \( \theta_{13} \) and \( \Delta m^2_{31} \) can be obtained by comparing the positron spectrum between Near and Far detectors.

Inverse Beta Decay candidate selection
1. Prompt positron: \( 0.7 \text{ MeV} < E_p < 12 \text{ MeV} \)
2. Delayed neutron: \( 6.0 \text{ MeV} < E_n < 12.0 \text{ MeV} \)
3. Neutron capture time: \( 1 \mu s < t < 200 \mu s \)
4. Muon veto: Reject up to 1s of events after a cosmic muon
5. Multiplicity cut: \( N_{\text{tracks}} \) \( \leq 10 \)

A relative rate and shape measurement
- The philosophy is to apply the effect of oscillation to the spectrum measured by the Near detectors to match the spectrum distortion observed by the Far detectors.
- Such an oscillation analysis would reduce the uncertainty due to the imperfect modeling of the reactor anti-neutrino flux.
- Shape analysis is equivalent to 37 independent "rate-only" analysis for each energy bin.

The most precise measurement of \( \theta_{13} \)
- Result based on entire (217 days) six-detector data and 404 days eight-detector data.
- Precision measurement of \( \Delta m^2_{31} \), becoming comparable to MINOS: \( |\Delta m^2_{31}| = 2.4 \times 10^{-3} \text{ eV}^2 \)

Daya Bay’s 2014 Results
- Sin^2 2\theta_{13} = 0.804^{+0.005}_{-0.005}
- |\Delta m^2_{ee}| = 2.44^{+0.10}_{-0.11} \times 10^{-3} \text{ eV}^2