Aim to determine the last unknown mixing angle $\theta_{13}$ with a sensitivity of 0.01 or better in $\sin^2 2\theta_{13}$.

$$U_{\text{Mixing}} = \begin{pmatrix} 1 & 0 & 0 \\ 0 & C_{23} & S_{23} \\ 0 & -S_{23} & C_{23} \end{pmatrix}$$

$\delta$ and $\theta_{13}$ are unknown.

Why reactor neutrinos?

- $P_{\nu_e} \approx \sin^2 2\theta_{13} \sin^2 (1.27 \Delta m^2_{\text{sol}} L/E)$
- The electron antineutrino disappearance probability doesn't depend on $\delta$ or $\theta_{13}$ (unlike long-baseline $\nu_L \rightarrow \nu_x$ experiments)

at a baseline of ~1 km, $P_{\nu_e}$ term isn’t significant – unambiguous measurement of $\theta_{13}$

Detector

- Based liquid scintillator
- Gd-loaded (0.1%) LAB-based
- Target region: efficiency = 78% neutron detection efficiency = 98% positron detection and bottom reflectors on top circumference, PMTs around the

Antineutrino detectors

- 3 ports: $^{40}$Ge, $^{238}$U, LED
- $\gamma$-catcher: 20 tons LAB-based liquid scintillator (42.5 cm thick)
- Oil buffer: 40 tons mineral oil (48.8 cm thick)
- 5 m
- Energy resolution = 12%/$E$

Sensitivity

- Baseline sensitivity
- Source
- Detector
- Reactor Signal Statistics
- Uncertainty
  - $0.36\%$ (baseline)
  - $0.18\%$ (goal)
  - $0.13\%$
  - $0.2\%$

Graphs showing signal statistics and sensitivity over time.

Daya Bay

Nuclear power complex located in Shenzhen, China (55 km from Hong Kong)

- 4 x 20 ton detector modules
- 1985 m from Daya Bay cores
- 1615 m from Ling Ao cores
- 355 m (910 m.w.e.) overburden

Backgrounds produced by cosmic muons

1) $^6$Li/$^8$He isotopes – have significant beta-neutron decay branching fractions
2) Fast neutrons – recoil proton gives prompt signal followed by neutron capture
3) Accidentals – coincidence of neutron capture with natural radioactivity in the detector

Muon veto system

- To study and reject cosmonergic backgrounds
- A 2.5 m active water shield around the antineutrino detectors instrumented with 8-inch PMTs
- Water shield divided into inner region and outer region separated by Tyvek partitions
- RPCs on top of the water pool
- Combined system has muon tagging efficiency of >99.5%

Schedule

- Groundbreaking in October 2007
- Surface Assembly Building and tunnels under construction now
- Daya Bay near site commissioned by end of 2009
- All three sites taking data by end of 2010

For the Daya Bay Collaboration