PROCEEDINGS OF SCIENCE

The Daya Bay reactor neutrino experiment

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The goal of the Daya Bay reactor neutrino experiment is to measure θ_{13}, the last unknown mixing angle, with a sensitivity in $\sin^2(2\theta_{13})$ of 0.01 at the 90% confidence level. Daya Bay will search for the disappearance of reactor antineutrinos from the Daya Bay nuclear power complex located in Shenzhen, China by measuring the antineutrino rates and energy spectrums with identical detectors located at different baselines.

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1. Introduction

The Daya Bay experiment will search for the disappearance of reactor antineutrinos by measuring the antineutrino rate and energy spectrum with identical detectors located at different baselines. The Daya Bay nuclear power complex is located in Shenzhen, China, 55 km from Hong Kong. There are currently a total of four 2.9 GW reactor cores located at two sites, Daya Bay and Ling Ao. Two more 2.9 GW cores will be added in 2011 at Ling Ao. Two detectors will be placed 363 m away from the Daya Bay cores with a 98 m (255 m.w.e) overburden. Two more detectors will be placed 481 m from the Ling Ao I cores (526 m from the Ling Ao II cores) with a 112 m (291 m.w.e) overburden. There will be four detectors at the far site, 1985 m from the Daya Bay cores and 1615 m from the Ling Ao cores with a 350 m (910 m.w.e) overburden.

2. Antineutrino detectors

Each antineutrino detector (AD) will have three nested cylindrical zones contained within a stainless steel tank. The inner target region will be 3.1 m in height and diameter and will be filled with 20 tons of Gd-loaded (0.1%) LAB-based liquid scintillator. The 42.5 cm thick middle region will be filled with 20 tons of LAB-based liquid scintillator. The outermost region will be 40 tons of mineral oil with a thickness of 48.8 cm. The regions are separated by transparent acrylic vessels. The entire module is 5 m in diameter and 5 m tall. Each AD will have 192 8-inch PMTs located around the circumference and reflectors on the top and bottom of the detector. The energy resolution with this configuration is $12\%/\sqrt{E}$. Each AD will be equipped with an automated calibration system using ^{68}Ge, LEDs, and a neutron source. Antineutrinos will be detected via inverse beta decay, $\overline{\nu_e}p \rightarrow e^+n$. The signal will consist of the prompt energy deposition from the positron, followed $\sim$30 μs later by the $\sim$8 MeV capture of a neutron on Gd. The efficiency for detecting positrons (neutrons) is approximately 98% (78%). The total expected detector-related uncertainty per AD is 0.38%.

3. Muon veto system

There are three important sources of backgrounds produced by cosmic muons: 1) ^{9}Li and ^{8}He isotopes produced by cosmic muons have significant beta-neutron decay branching fractions. 2) When fast neutrons produced by cosmic muons in the rock interact in the detector, a recoil proton followed by neutron capture can mimic the inverse beta decay signal. 3) Accidental coincidences of a neutron capture with natural radioactivity can also mimic the signal. To study and reject these cosmogenic backgrounds, we will have a muon veto system at each site. A 2.5 m active water shield will surround the ADs, instrumented with 8-inch PMTs. The water shield is divided into an inner region and an outer region separated by Tyvek partitions. Layers of resistive plate chambers (RPCs) will be located on top of the water pool. The combined system has a muon tagging efficiency >99.5%.

4. Sensitivity and Schedule

We expect a sensitivity of better than 0.01 in $\sin^2 2\theta_{13}$ with three years of data, as shown in Figure 1. Table 1 shows the main sources of uncertainty.

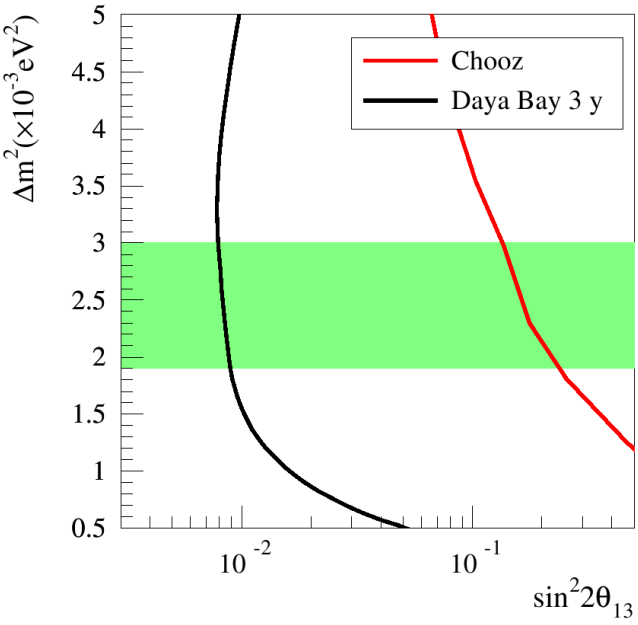

Figure 1: Daya Bay's expected sensitivity in $\sin^2 2\theta_{13}$ at 90% confidence level with 3 years of data. The current upper limit measured by the Chooz experiment is also shown.

Source	Uncertainty
Detector	0.38% (baseline)
	0.18% (goal)
Reactor	0.13%
Signal Statistics (3 years)	0.2%

Table 1: Summary of uncertainties.

The Daya Bay Collaboration currently has more than 200 members from 35 countries. The groundbreaking ceremony was held in October 2007. The surface assembly building and tunnels are under construction as of summer 2008. The Daya Bay site will be commissioned by the end of 2009, with all three sites taking data by the end of 2010.

References

[1] X. Guo *et al.* [Daya Bay Collaboration], arXiv:hep-ex/0701029.