



The Daya Bay Experiment: Overview and Timeline

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(on behalf of the Daya Bay Collaboration)

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- **Goal:**
Measure neutrino mixing angle θ_{13}
- **Description of the Experiment**
- **Systematics and Sensitivity**
- **Schedule**

Why θ_{13} ?

$$|\nu_f\rangle = \sum_i U_{fi}^* |\nu_i\rangle \quad \text{Interaction eigenstates} \neq \text{Mass eigenstates}$$

$$U_{if} = \begin{pmatrix} 1 & 0 & 0 \\ 0 & c_{23} & s_{23} \\ 0 & -s_{23} & c_{23} \end{pmatrix} \times \begin{pmatrix} c_{13} & 0 & s_{13}e^{-i\delta} \\ 0 & 1 & 0 \\ -s_{13}e^{i\delta} & 0 & c_{13} \end{pmatrix} \times \begin{pmatrix} c_{12} & s_{12} & 0 \\ -s_{12} & c_{12} & 0 \\ 0 & 0 & 1 \end{pmatrix}$$

$c_{ij} \equiv \cos \theta_{ij}$ and $s_{ij} \equiv \sin \theta_{ij}$

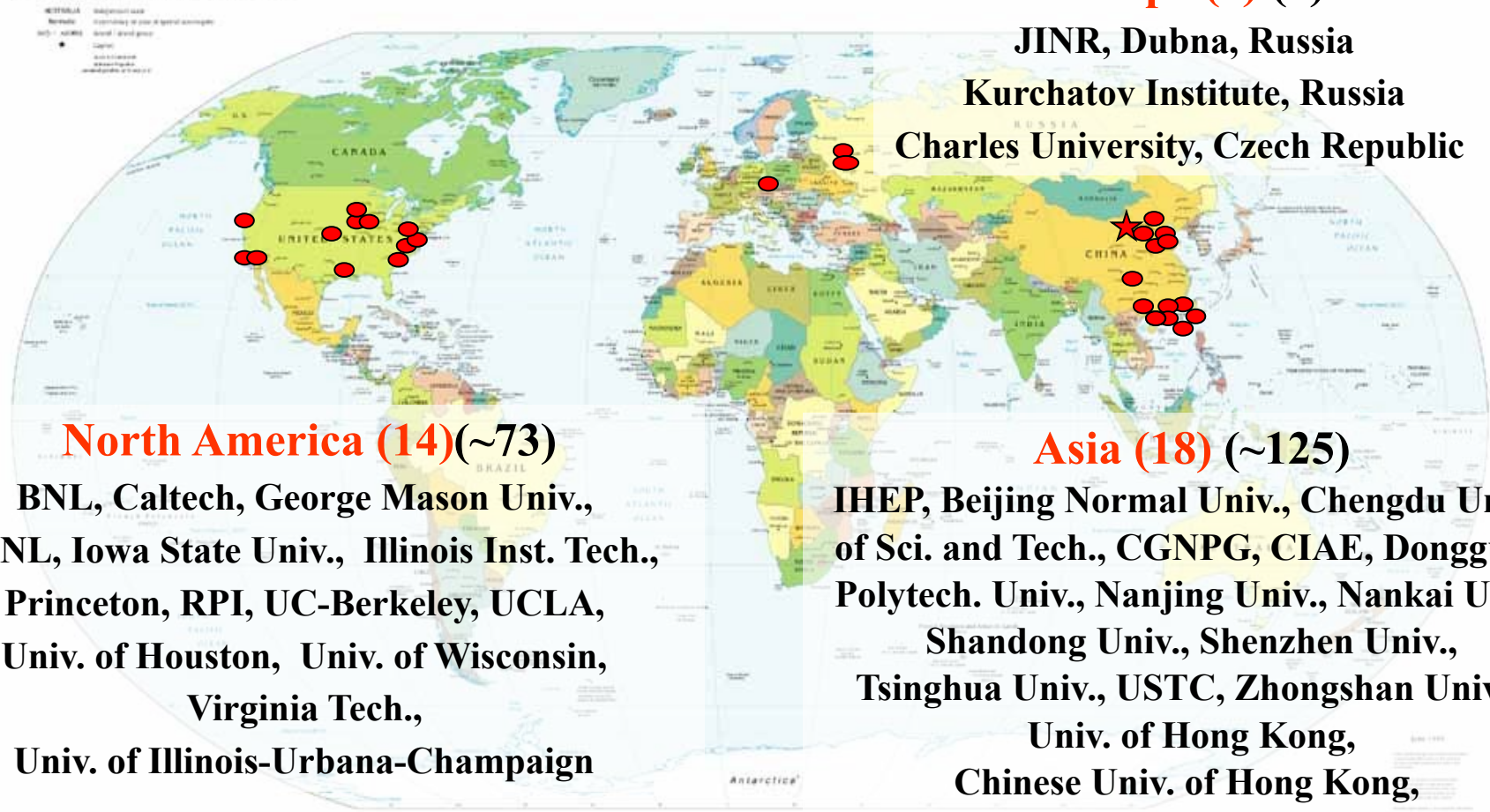
- $\theta_{23} \sim 45^\circ$**
 Atmospheric ν
 Accelerator ν
- $\theta_{13} < 10^\circ$**
 Short-Baseline Reactor ν
 Future Accelerator ν
- $\theta_{12} \sim 35^\circ$**
 Solar ν
 Long-Baseline Reactor ν

↑

Goal: Measure $\sin^2 2\theta_{13} < 0.01$ (90% CL)

Daya Bay Collaboration

Political Map of the World, June 1999



Europe (3) (9)

- JINR, Dubna, Russia
- Kurchatov Institute, Russia
- Charles University, Czech Republic

North America (14) (~73)

- BNL, Caltech, George Mason Univ.,
- LBNL, Iowa State Univ., Illinois Inst. Tech.,
- Princeton, RPI, UC-Berkeley, UCLA,
- Univ. of Houston, Univ. of Wisconsin,
- Virginia Tech.,
- Univ. of Illinois-Urbana-Champaign

Asia (18) (~125)

- IHEP, Beijing Normal Univ., Chengdu Univ. of Sci. and Tech., CGNPG, CIAE, Dongguan Polytech. Univ., Nanjing Univ., Nankai Univ., Shandong Univ., Shenzhen Univ., Tsinghua Univ., USTC, Zhongshan Univ., Univ. of Hong Kong, Chinese Univ. of Hong Kong, National Taiwan Univ., National Chiao Tung Univ., National United Univ.

~207 Collaborators

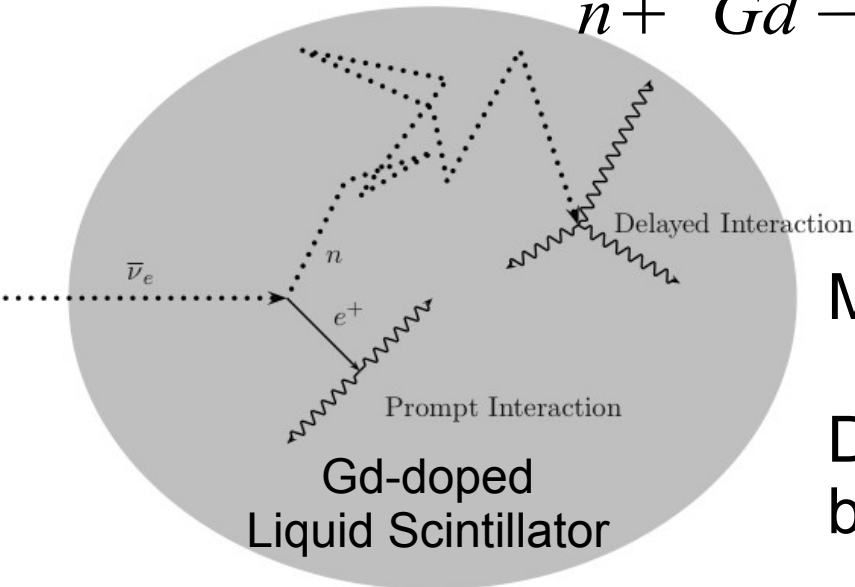
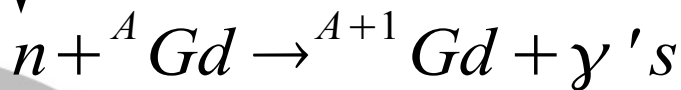
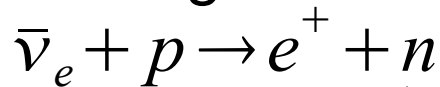
Reactor Anti-neutrinos

Well-established experimental technique.

Target + Detector:

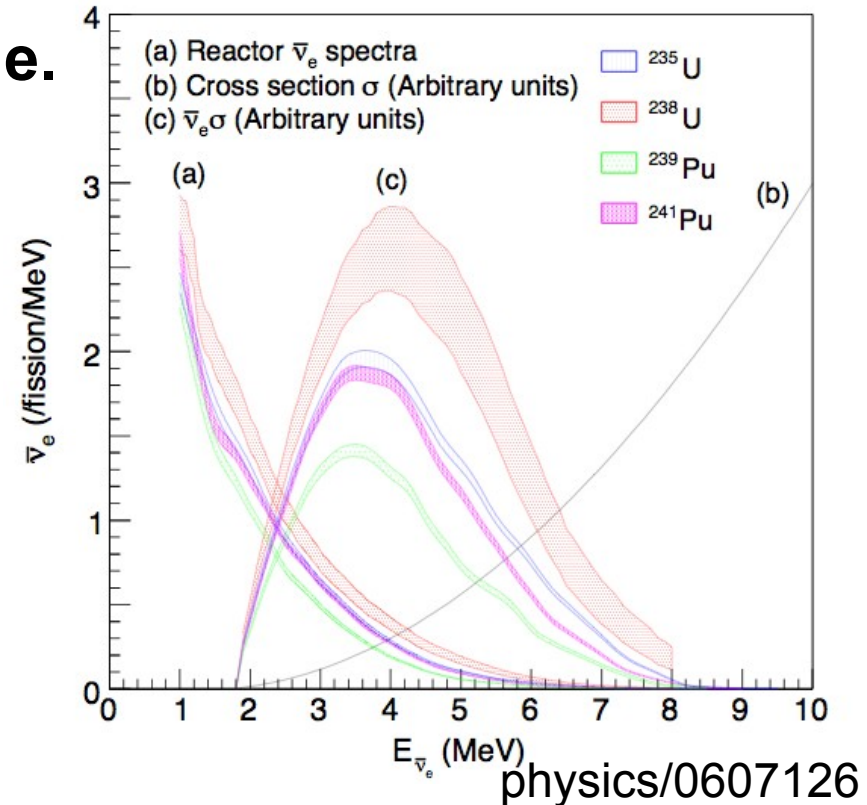
Gd-doped (0.1%) Liquid Scintillator

Detect using inverse- β decay:



Mean neutron capture time: $\sim 30\mu\text{s}$

Delayed event provides powerful background-rejection





The Daya Bay Experiment

Sensitivity is driven by:

reactor power, target mass, baseline, depth

Reactor site:

Daya Bay, Guangdong, China

Reactor Power:

11.6 GW_{th}
(17.4 GW_{th} in 2011)

Baseline:

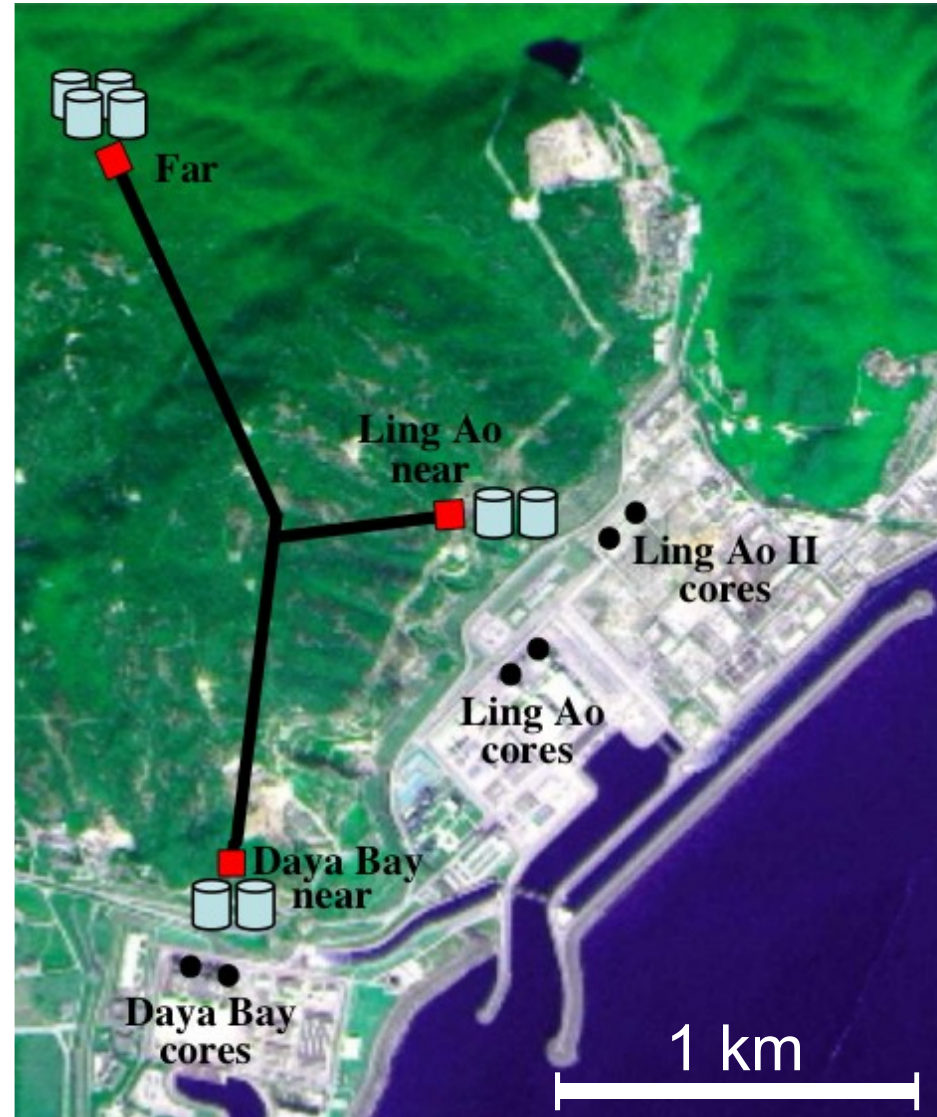
0.3-0.5 km to near sites
1.6-1.9 km to far site

Overburden:

~100 m at near sites
~350 m at far site

Identical 20 ton modular detectors:

2 at each near site (~1600 $\bar{\nu}$ /day)
4 at far site (~400 $\bar{\nu}$ /day)



Anti-neutrino Detectors

8 identical detectors:
Reduce systematic uncertainties

Each detector 3 nested cylinders:

Inner: 20 tons Gd-doped LS ($r=3\text{m}$)

Mid: 20 tons LS ($r=4\text{m}$)

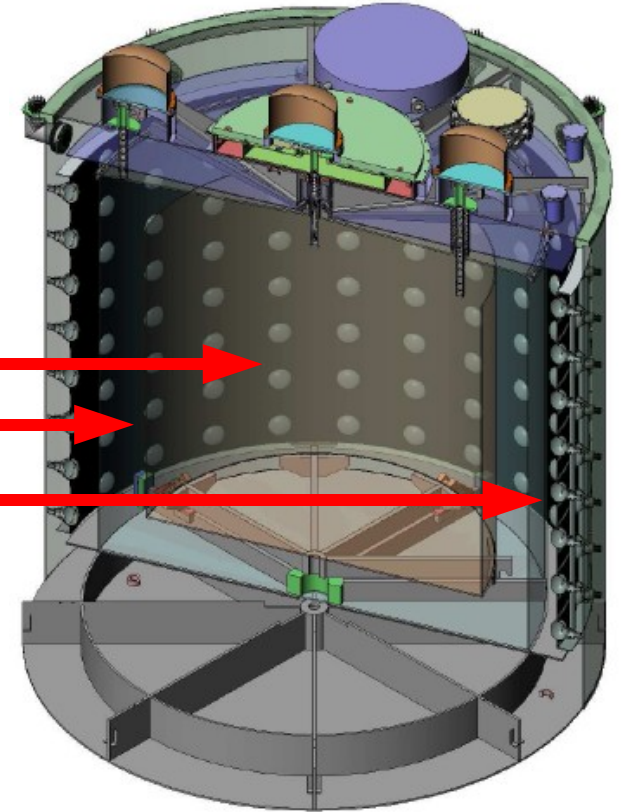
Outer: 40 tons mineral oil buffer ($r=5\text{m}$)

Each detector:

192 8-inch Photomultipliers

Reflectors at top/bottom of cylinder

Provides $12\% / \sqrt{E}$ energy resolution



Muon Veto

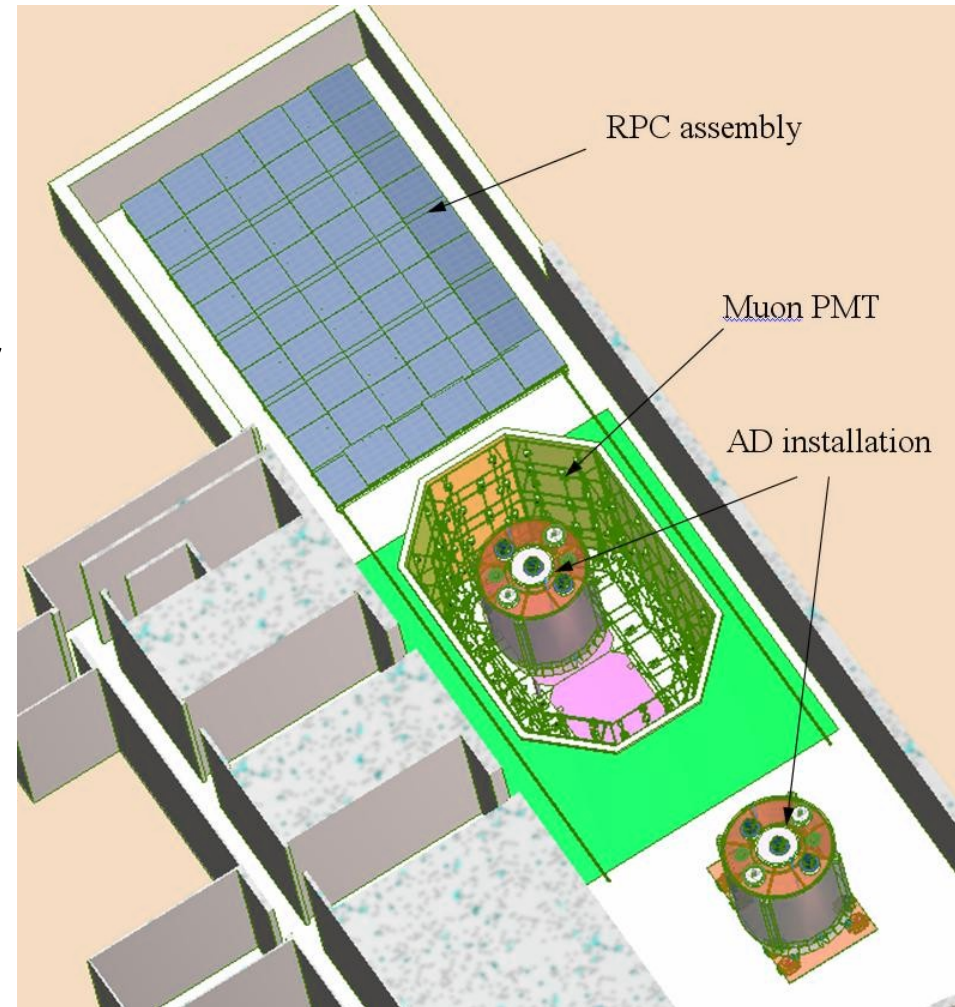
Multiple muon veto detectors:

Water Cherenkov:

- Detectors submerged in water
- Optically separated into inner/outer regions using Tyvek sheets
- 8-inch PMTs mounted on frames:
 - 289 at each near site
 - 384 at far site

RPC:

- Provides independent veto above water pool



Expected Systematics

Detector Uncertainty Sources		Baseline	Goal	Chooz Experience
Number of protons		0.3%	0.1%	0.8%
Detector Efficiency	Energy cut	0.2%	0.1%	0.8%
	H/Gd ratio	0.1%	0.1%	1.0%
	Time cut	0.1%	0.03%	0.4%
	Neutron Multiplicity	0.05%	0.05%	0.5%
	Trigger	0.01%	0.01%	0.01%
	Live time	<0.01%	<0.01%	<0.01%
Total uncertainty		0.38%	0.18%	1.7%

Two detector relative uncertainty

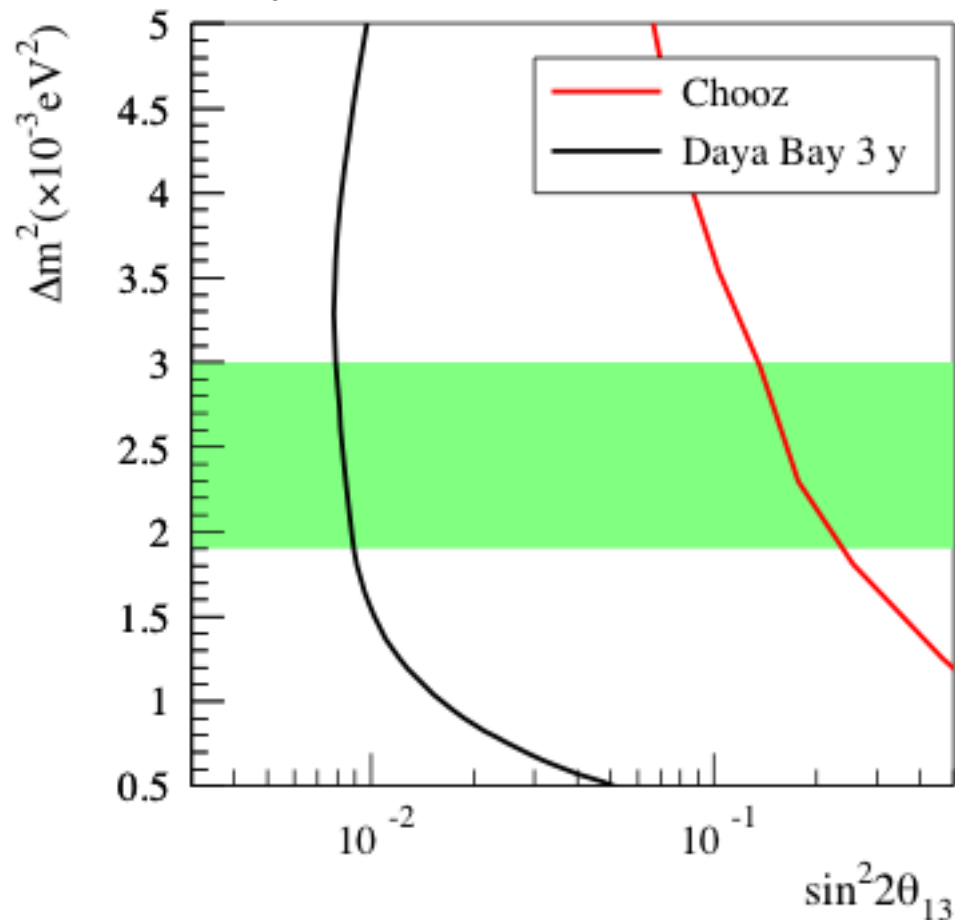
One detector absolute uncertainty

Most systematic uncertainties reduced through detector design

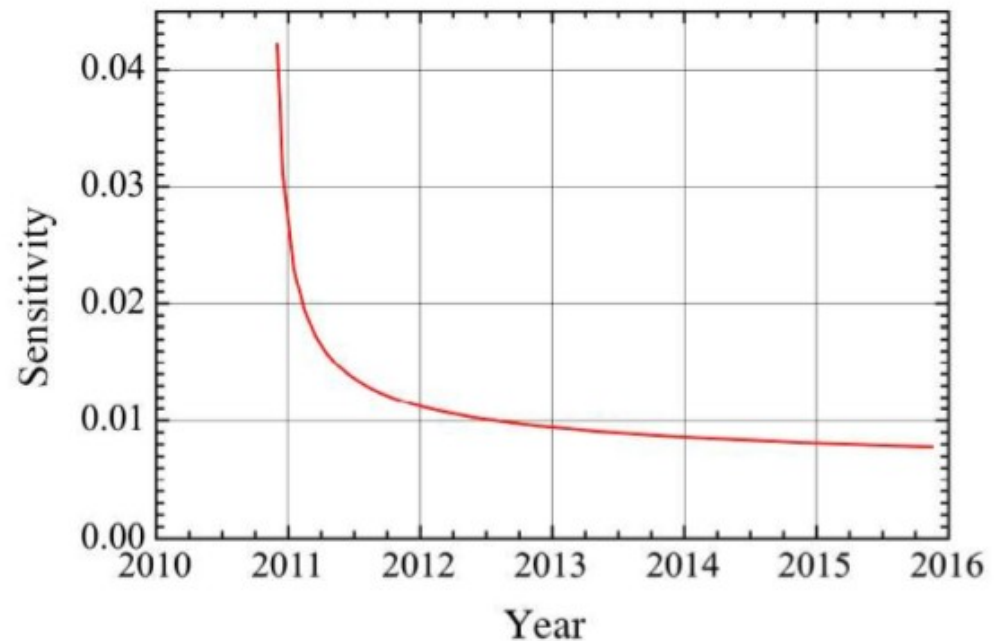
See *hep-ex/0701029* for details

Expected Sensitivity

Sensitivity (90% CL) assuming:
 Baseline systematic uncertainties
 3 years of data



Sensitivity (90% CL) vs. time
 ($\Delta m^2 = 2.5 \times 10^{-3} \text{ eV}^2$)



See hep-ex/0701029 for details

Schedule



Nov 2007: Civil Construction Began

Aug 2008: CD-3b Approval

Nov 2008: Occupancy of onsite assembly building

Winter 2009: Install first pair of detectors at Daya Bay near site

Winter 2010: Begin data taking with both near and far sites





More Details...

Session MC: Neutrino Physics: Instrumentation II

Sunday, October 26, 2008, 10:30AM - 12:30PM

The Daya Bay Calibration System: Key to θ_{13} [*Jianglai Liu*](#)

Design and Simulation of the Daya Bay Antineutrino Detectors [*Wei Wang*](#)

Measurements of Liquid Scintillator and Water Properties for Daya Bay Detectors [*Johnny Goett*](#)

The PMT testing system for the Daya Bay Experiment [*Wenqin Xu*](#)

Muon Veto System and Expected Backgrounds at DayaBay [*Hongshan Zhang*](#)

Posters:

Studies of the Capability of the LED Calibration System in Measuring the Attenuation Length of the Liquid Scintillator for the Daya Bay Detectors [*Brian Lester*](#)

Precision Measurement of the Target Mass in the Daya Bay Antineutrino Detectors [*Patrick Mende*](#)

Summary

- It is an exciting time for Neutrino Physics.
- The Daya Bay Experiment will provide the most sensitive measurement of θ_{13} in the next few years.
- The experiment has funding approval and civil construction is progressing.
- For more details about the experiment come to:
Session MC: Neutrino Physics: Instrumentation II