Measurement of $\sin^2 2\theta_{13}$ via neutron capture on hydrogen at Daya Bay

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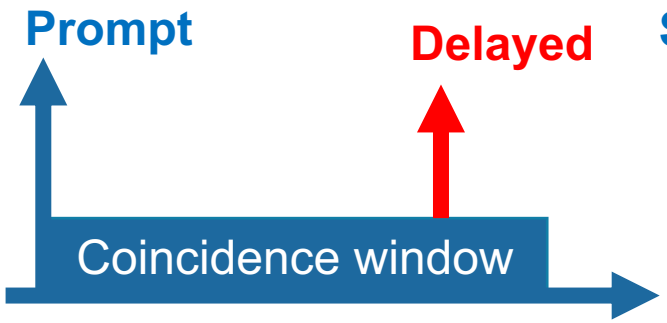
IBD Selection and Backgrounds

- Next to 6 × 2.9 GW_{th} reactors providing large flux of $\bar{\nu}_e$
- 8 identical-design antineutrino detectors (ADs) deployed in three sites
- Inverse Beta Decay (IBD): $\bar{\nu}_e + p \rightarrow e^+ + n$
  - Prompt signal: kinetic energy of e^+ and annihilation gammas
  - Delayed signal: neutron capture gamma



Select IBD with neutron captured on hydrogen (nH)

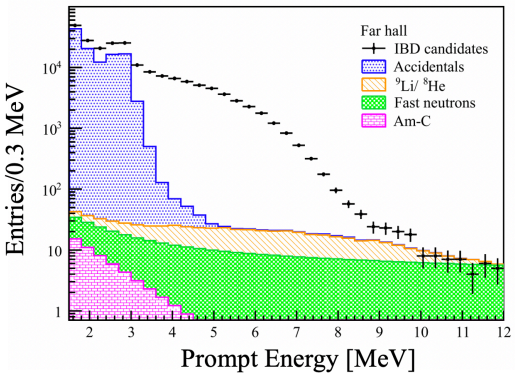
- Flasher cut & Muon Veto
- Energy cut: 1.5 MeV< E_p < 12 MeV, μ - 3σ < E_d < μ + 3σ
- Coincidence time: [1, 400] us
- Coincidence distance: [0, 500] mm
- Multiplicity cut: reject ≥ 3 coincidence

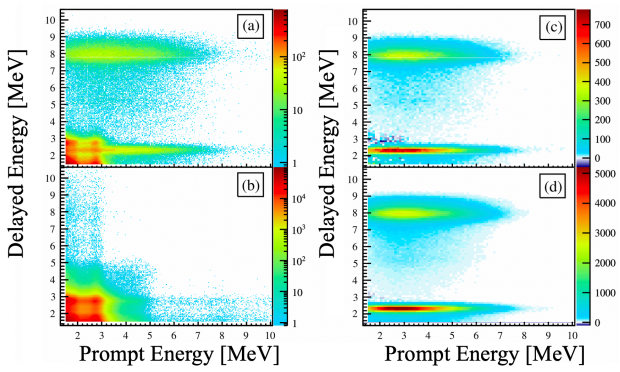
Correlated backgrounds:

- Muon-induced ^{9}Li/ ^{8}He:
- Muon-induced fast-neutron:
- Am-C calibration source

Accidental background:

- two uncorrelated AD events that satisfied the IBD selection criteria





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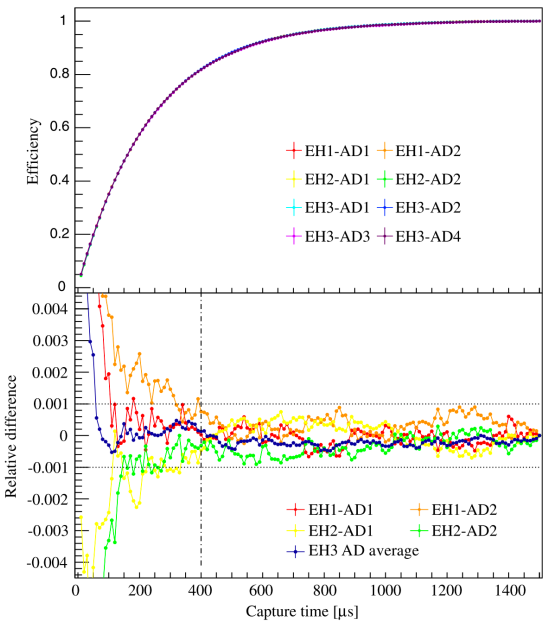
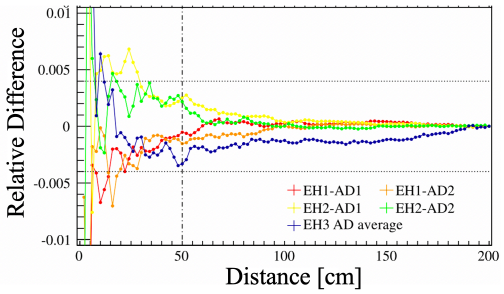
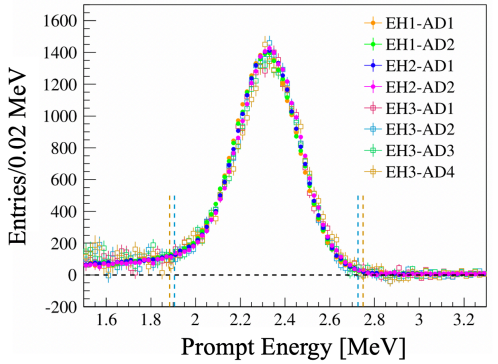
Efficiencies and AD Identicalness

- Studies with data
  - Distance cut
  - Coincidence time cut
  - Delayed energy cut
  - AD-uncorrelated uncertainty were estimated by comparison among 8 ADs.
- Studies with MC
  - Prompt energy cut, of which the uncertainty is fully due to the energy-scale variation among 8 ADs.







	Uncertainty (%)
Target protons ($N_{p,\mathrm{GdLS}}$)	0.03
Target protons ($N_{p,\mathrm{LS}}$)	0.13
Target protons ($N_{p,\mathrm{acrylic}}$)	0.50
Prompt energy (ε_{E_p})	0.10
Coincidence time (ε_T)	0.14
Delayed energy (ε_{E_d})	0.35
Coincidence distance (ε_D)	0.40
Combined (N_ε)	0.57

- Other IBD selection cuts have negligible uncertainty, such as: multiplicity cut, muon veto, etc.
- In our last publication, the uncertainty of distance cut and delayed energy cut are dominated in final analysis. New analysis is expected to yield a significant improvement.

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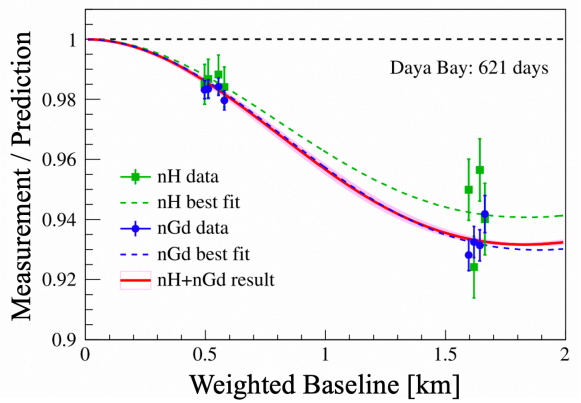
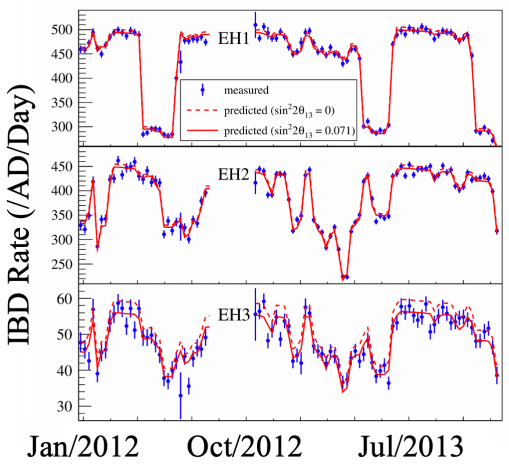
Oscillation Analysis Result

➢ χ^2 function of the rate-only analysis

$$\chi^2 = \sum_{\text{detector}} \frac{(\text{Measurement} - \text{Prediction} \times (1 + \varepsilon_{\text{reactor}} + \varepsilon_{\text{efficiency}}) - \text{Background} \times (1 + \varepsilon_{\text{bkg}}))^2}{\text{Measurement}} + \text{pull terms}$$

- ❑ Using 621 days of data, and ~1.0 million antineutrino interactions, we measured that $\sin^2 2\theta_{13} = 0.071 \pm 0.011$.
- ❑ Right figure: Measured IBD rate vs. time for each experimental hall (blue points). Each point spans one week.





➢ Towards a Rate & Spectral Shape Measurement

- ❑ Deficit of IBD rate at different neutrino energy range
- ❑ Good understanding of detector energy response

Thank you! Stay tuned~

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