Measurement of the evolution of reactor antineutrino flux and spectrum at Daya Bay

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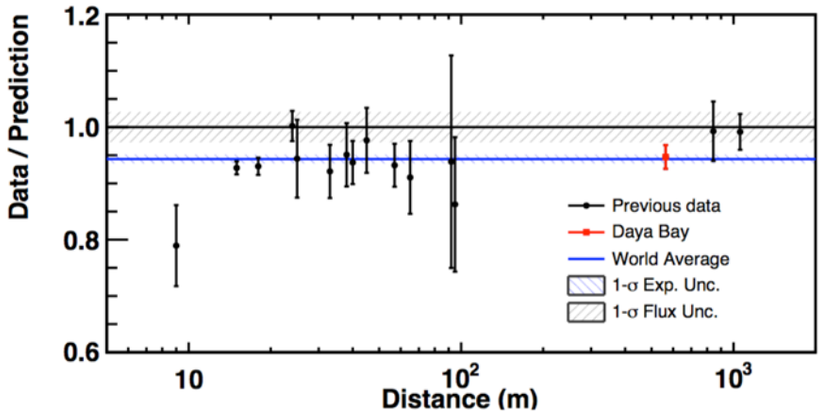
David Martinez Caicedo, Illinois Institute of Technology
on behalf of Daya Bay Collaboration

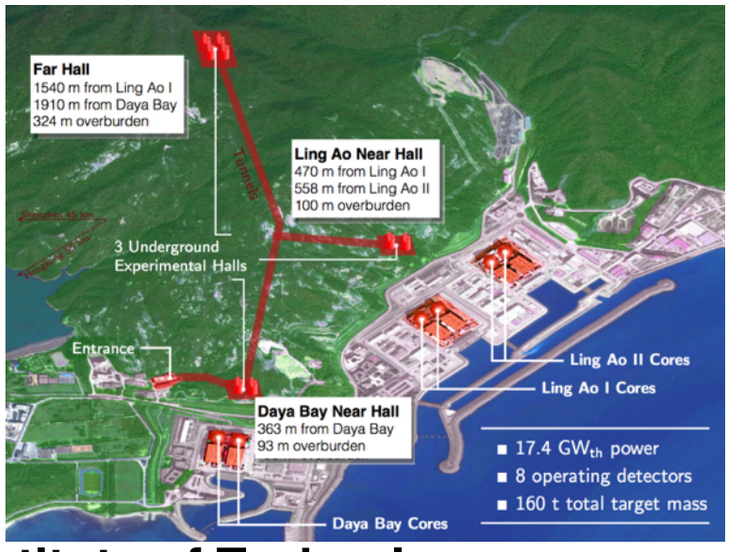
Introduction

- Reactor antineutrino experiments observed deficit in antineutrino rates compared with predictions
- Experiments at LEU reactors, including Daya Bay observed spectral deviations



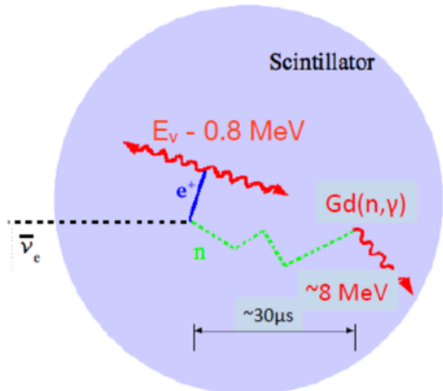
Daya Bay Experiment

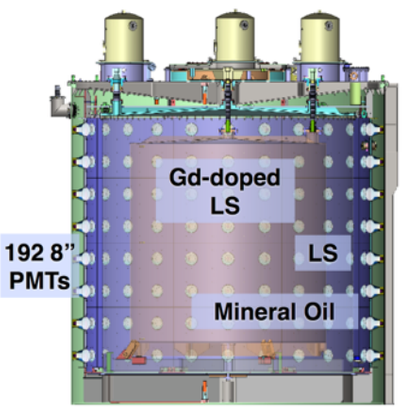
- 8 'identical detectors' near reactor power plant in China
  - 4 near detectors constrain reactor antineutrino flux
  - 4 far detectors see if any neutrinos have disappeared



Inverse Beta Decay (IBD) Event Selection

- Detect IBD with Gd-doped liquid scintillator
- Coincidence of the prompt scintillation from the positron and the delayed neutron capture on Gadolinium provide a distinctive ν_e signature
- 2.5 M IBDs in 1230 days of data taking

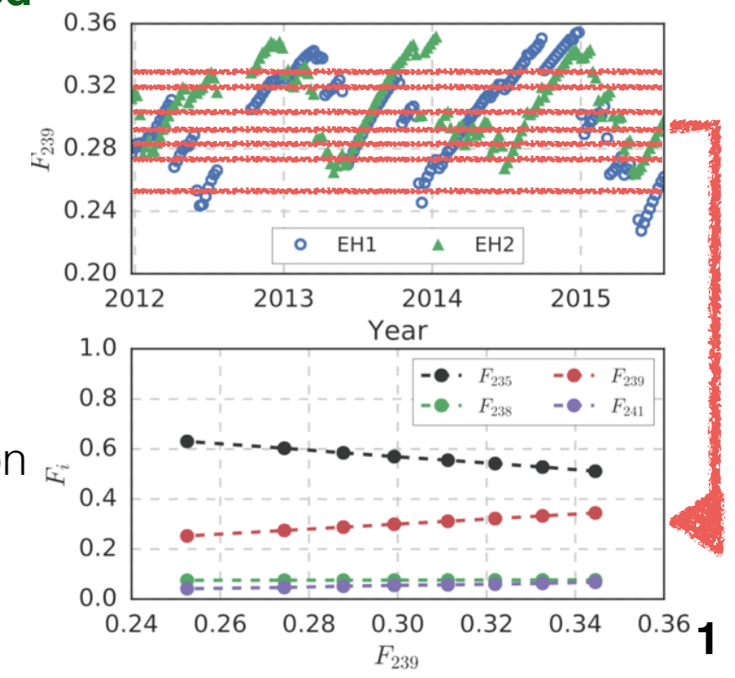




Analysis

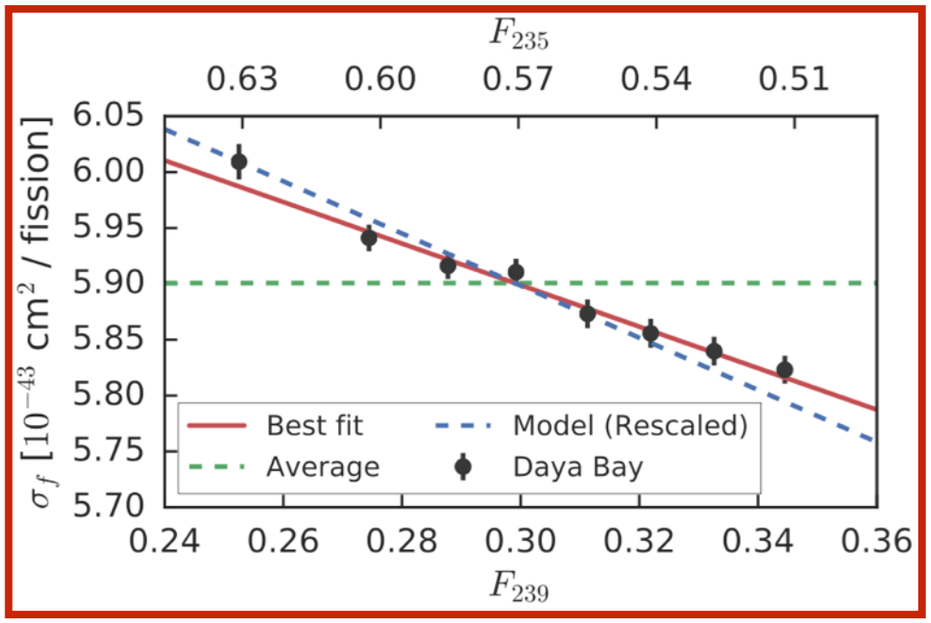
- **Calculate effective fission fraction observed by each detector**
- Compare IBDs from periods of differing effective fission fractions
- Doing this by combining periods of common fission fraction F_{239}

$$F_i(t) = \sum_{r=1}^{6} \frac{W_{\mathrm{th},r}(t)\bar{p}_r f_{i,r}(t)}{L_r^2 \overline{E}_r(t)} \Big/ \sum_{r=1}^{6} \frac{W_{\mathrm{th},r}(t)\bar{p}_r}{L_r^2 \overline{E}_r(t)}$$



Results: Flux Evolution

- Results in terms of IBD/fission σ_f
  - Take IBD/day and correct for time dependent quantities on a week by week basis
- Measured slope is different from Huber-Mueller model prediction at 3.1 σ



Results: Fitting Individual Isotopes

- Fit IBD/fission for ^{235}U, ^{239}Pu
  - Assume loose (10%) uncertainties on sub-dominant isotopes
- Dominant uncertainties: Statistics and absolute detection efficiency
- Hypothesis of ^{235}U only being wrong fits the data well
- Other hypothesis can fit the data: ^{239}Pu+ sterile, ^{235}U +sterile (Giunti et al, JHEP10(2017)143)
- Equal deficit of all isotopes disfavored at 2.8 σ

Results: Spectrum Evolution

- Analyze IBD prompt energy
  - IBD spectrum is changing with F_{239}
- First unambiguous measurement of this behavior