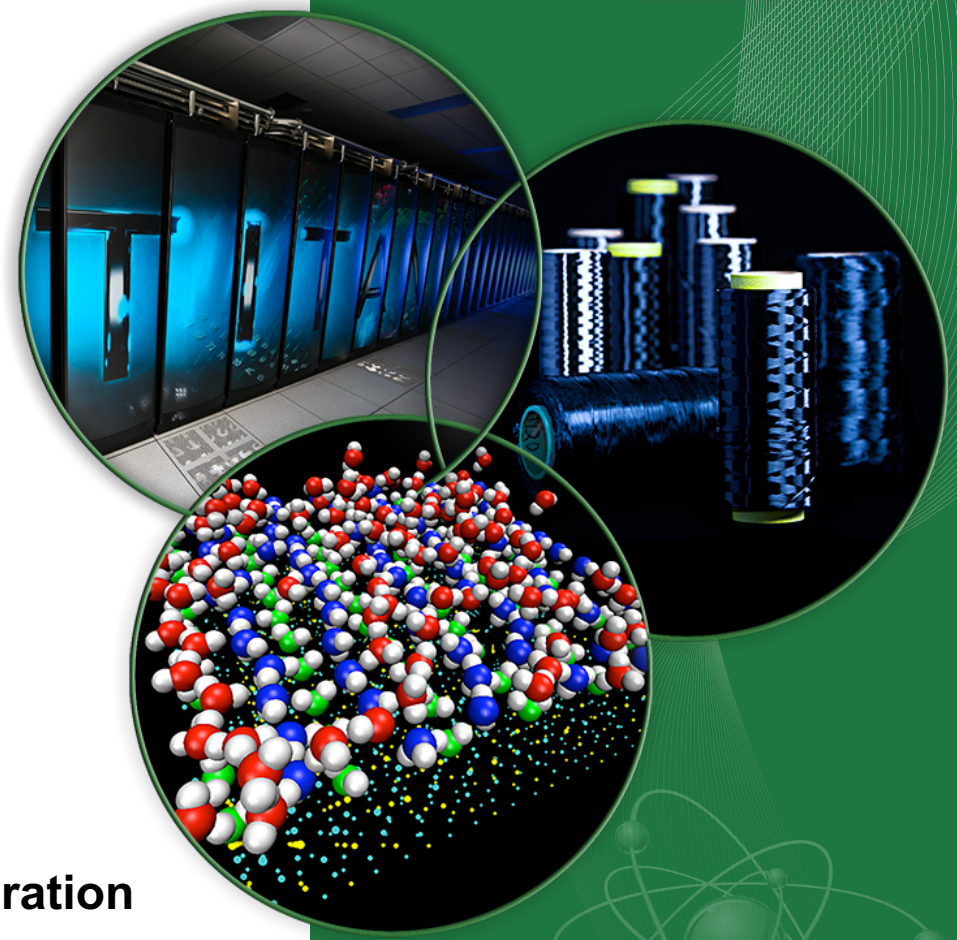

Jeremy Lu
On behalf of the PROSPECT collaboration

June 19, 2018

Related posters at Annual User Meeting:

- Assembling, Installing and Calibrating The PROSPECT Short-Baseline Antineutrino Detector – X. Zhang
- Searching For Sterile Neutrinos With PROSPECT - P. T. Surukuchi

ORNL is managed by UT-Battelle
for the US Department of Energy

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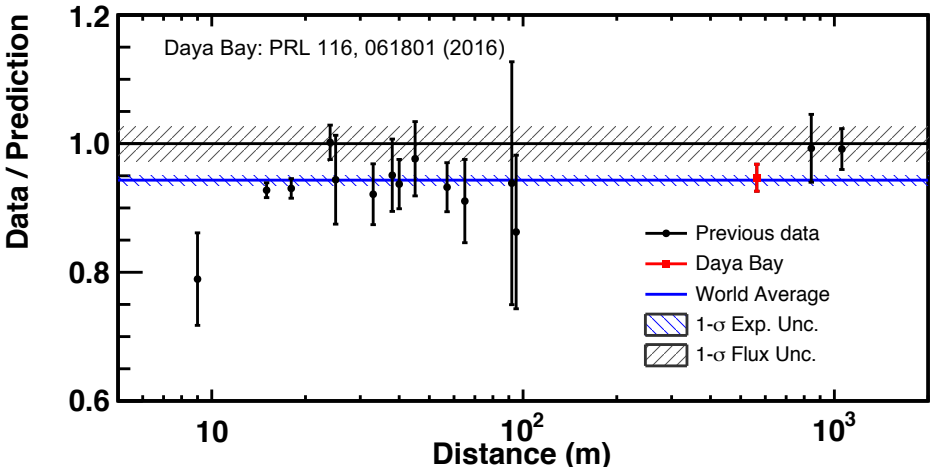
Outline

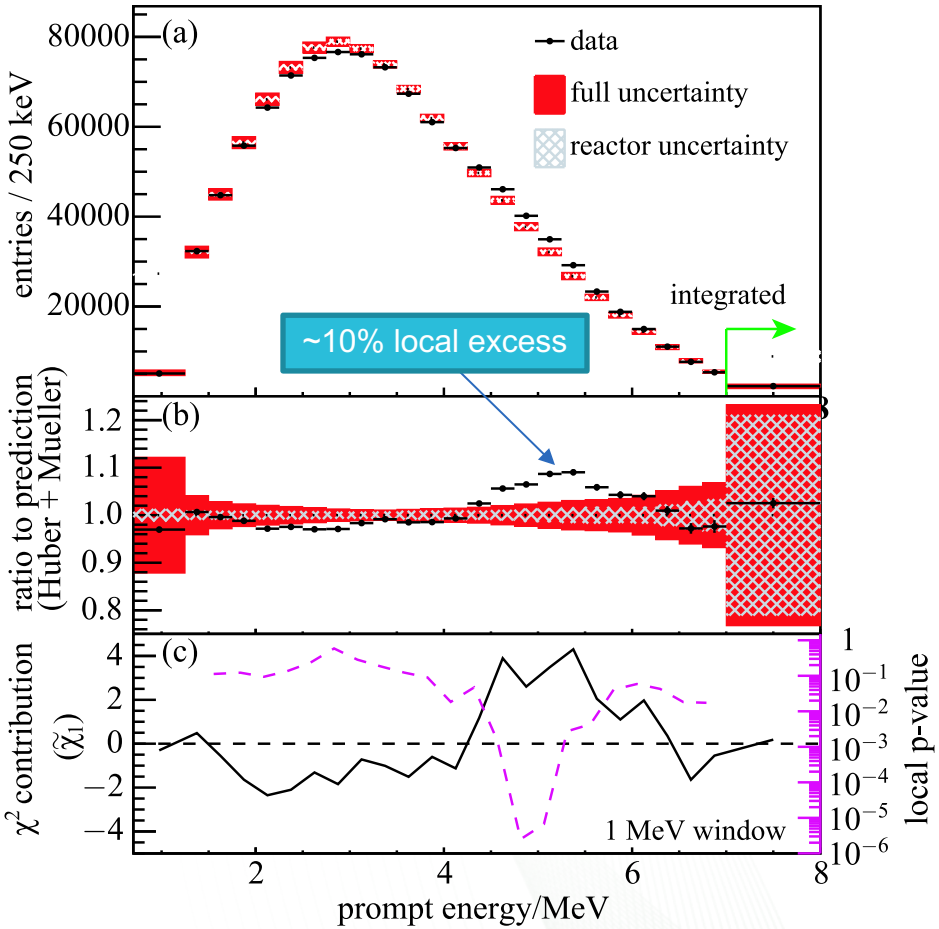
- Introduction to The Precision Reactor Oscillation and SPECTrum Experiment
- Backgrounds
- First Results
- Recap

Motivation

Reactor Antineutrino Anomaly (RAA)



Spectral Shape Distortion



PROSPECT physics goals:

- Model-independent search for oscillations into eV-scale sterile neutrino

$$P_{dis} \backsimeq \sin^2 2\theta_{14} \sin^2 \left(1.27 \Delta m^2_{14}(\mathrm{eV}^2) \frac{L(\mathrm{m})}{E_\nu(\mathrm{MeV})} \right)$$

- Precise measurement of ^{235}U spectrum

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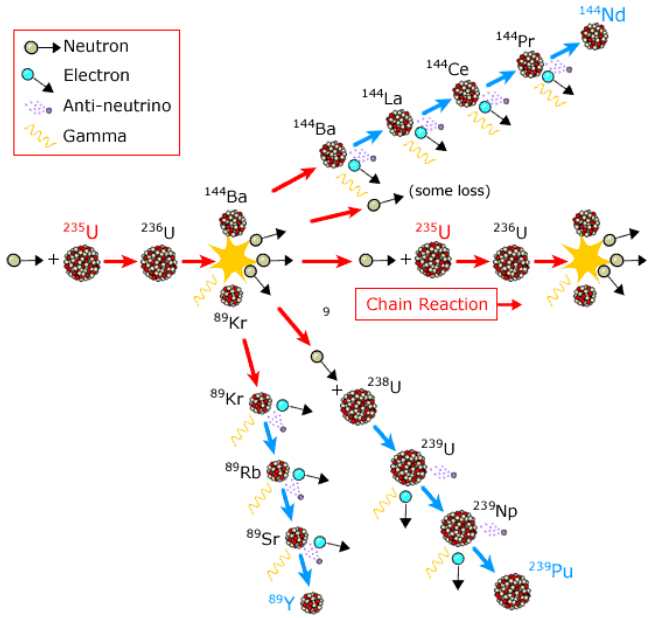
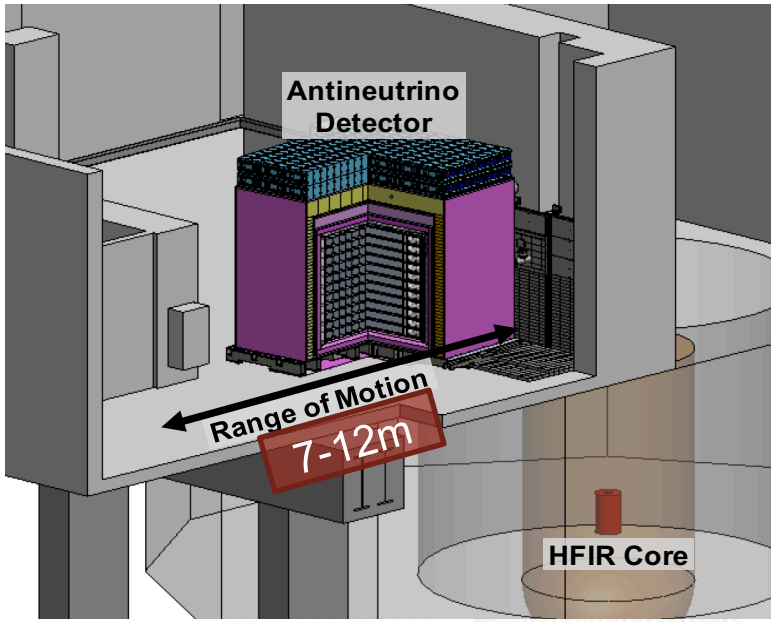
PROSPECT at HFIR

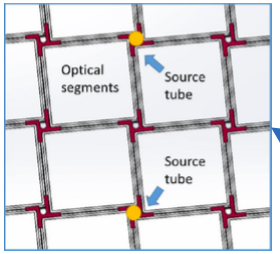
- High Flux Isotope Reactor (HFIR)
  - 85 MW research reactor
  - ~93% enriched ^{235}U fuel
  - >99% of anti-neutrinos emitted by ^{235}U fissions
  - Compact Core (h=0.6m d=0.4m)
  - Very close access
  - ~24 day cycle
    - No ^{239}Pu buildup(<0.5%)

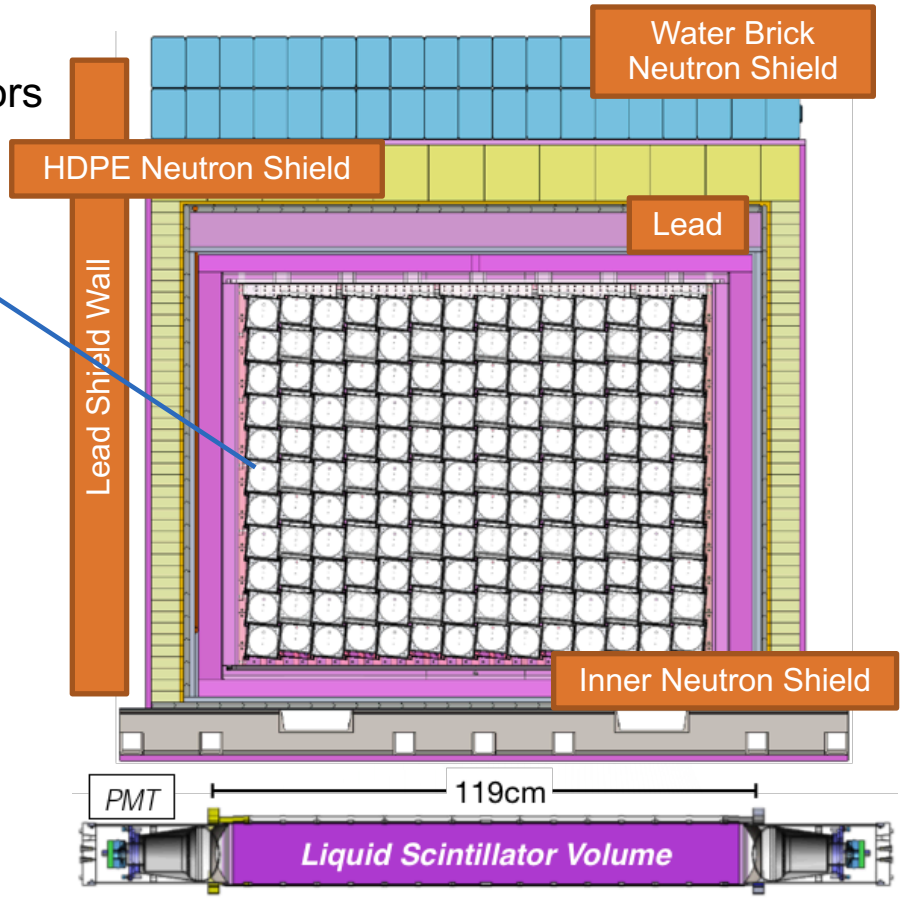


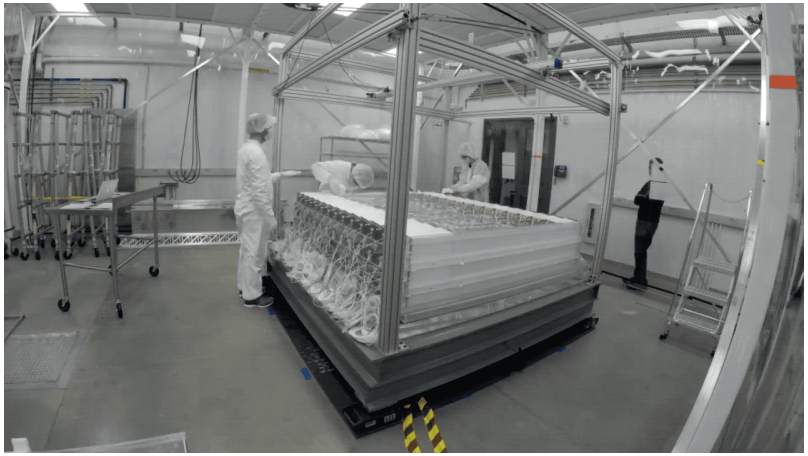


Detector Overview

- ~4 ton ^{6}Li-loaded liquid scintillator detector
- Optically segmented into 14x11 identical detectors
- Double ended PMT readout
- Access for in-situ calibration
- Low mass separator
- Best energy resolution ~4.5% at 1 MeV
- ~100k neutrinos detected/year, S:B ~ 3:1







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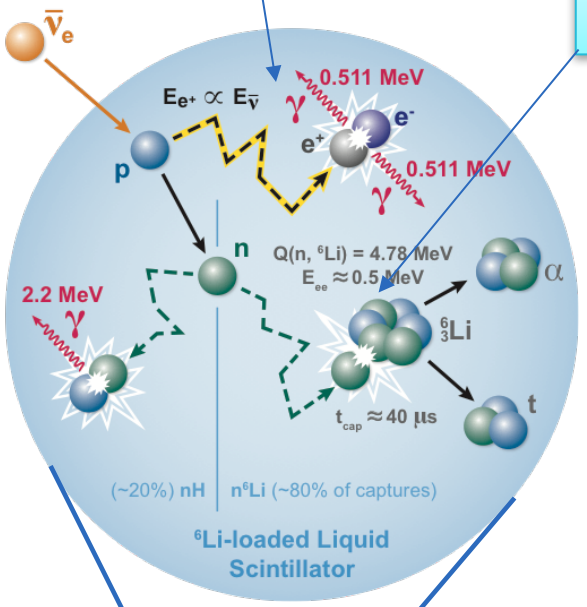
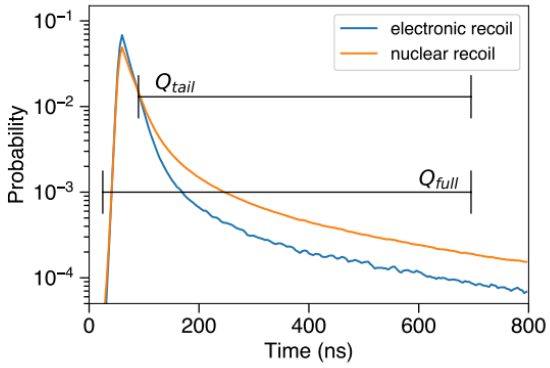
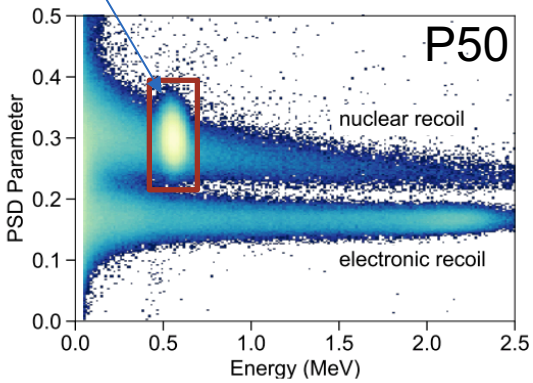
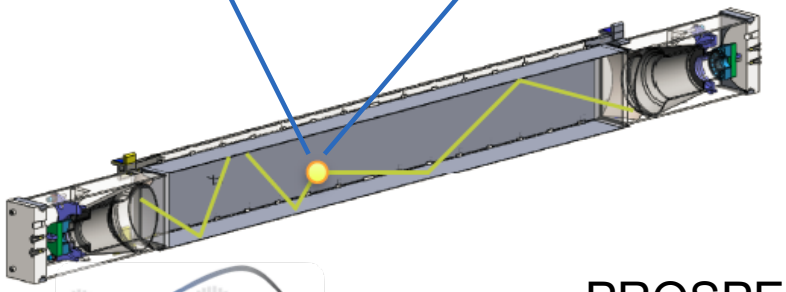
Inverse Beta Decay

- Prompt signal: 1-10 MeV positron energy deposition
- Delayed signal: ~0.5 MeV from neutron capture on ^{6}Li









Customized EJ-309-based ^{6}LiLS gives excellent PSD performance, which helps greatly on background suppression.

PROSPECT arXiv:1805.09245

Background Characterization

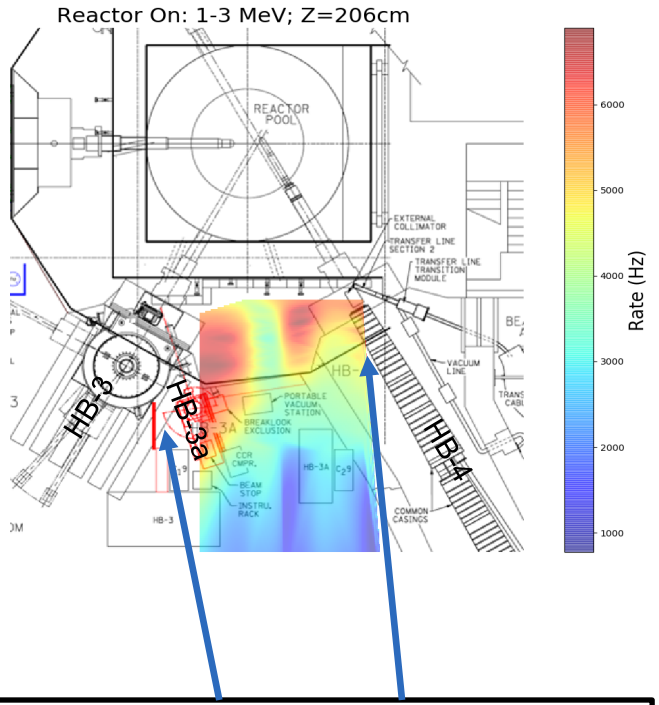
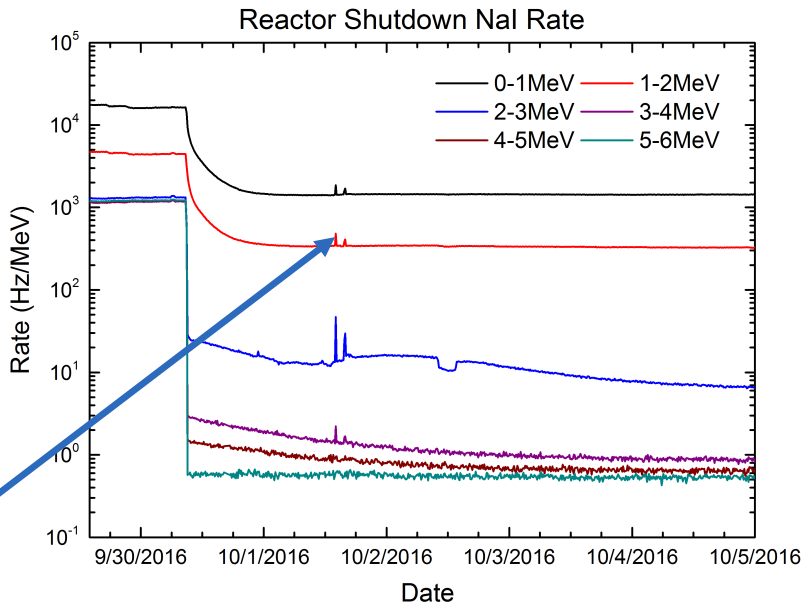


Figure 3.3: DANG: Detector Array for Neutron and Gamma detection.

Identifying hotspots from beamline underneath.

Sensitive to reactor operation such as fuel removal.



PROSPECT

Blaine Heffron & Brennan Hackett Master's Thesis, UTK

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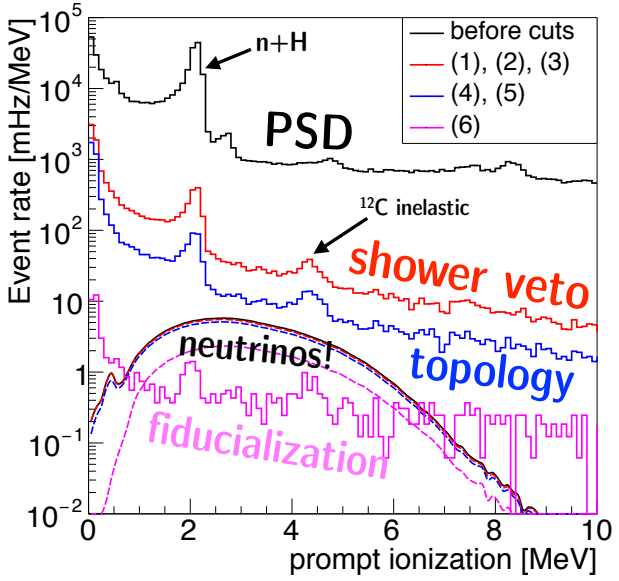
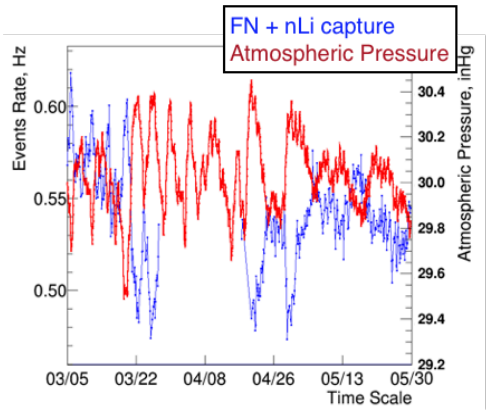
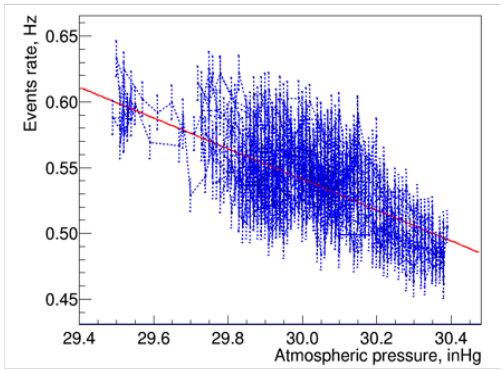
Cosmogenic Background

With PSD technique, shower veto, event topology and fiducialization, background noise can be greatly suppressed by order of magnitude of 4.

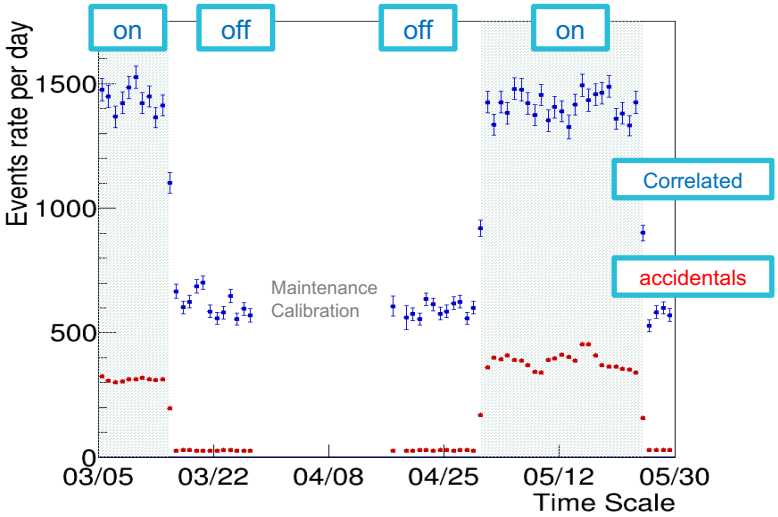
PROSPECT J. Phys. G: 43 (2016)







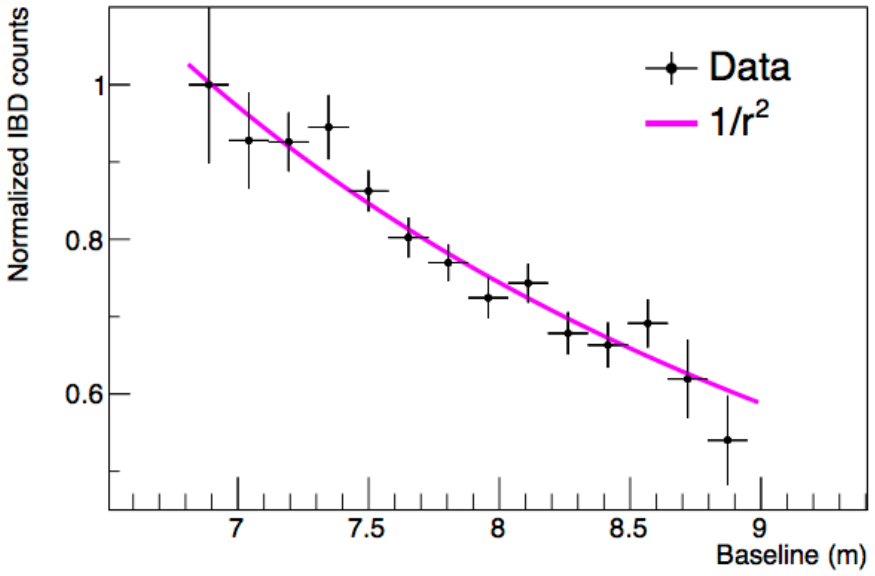
- Correlation between cosmogenic background and atmospheric pressure.
- Help correct background subtraction for reactor-on.



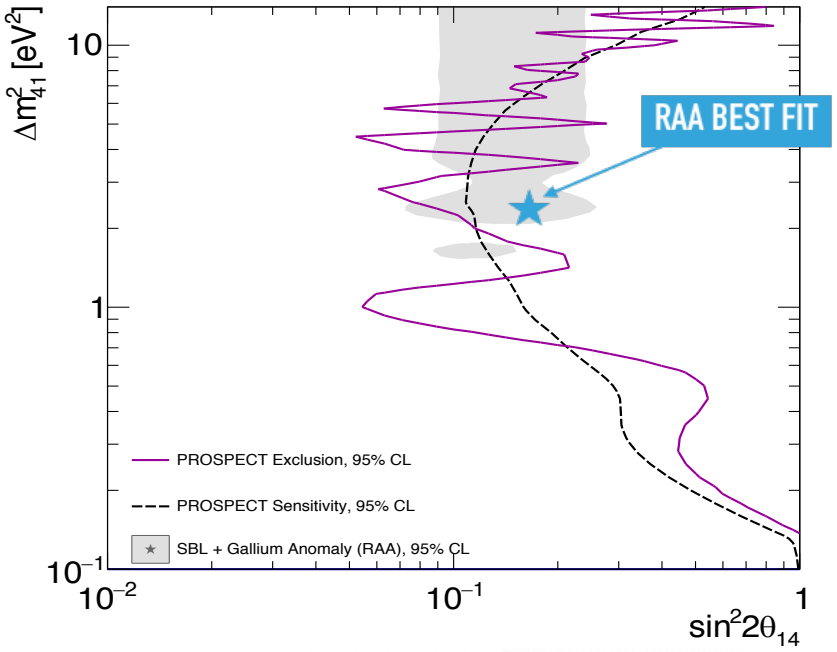
33 days of reactor on
28 days of reactor off
Average of 750 IBD/day

Recent Results

Data collection since March 5, 2018
We see neutrinos. First result paper **arXiv:1806.02784**
Disfavors reactor antineutrino anomaly best fit point at >95% (2.3σ)



Event rate shows $1/r^2$



Feldman Cousins method
Covariance matrix for each uncertainty

[first result presented at Neutrino 2018 at Heidelberg]

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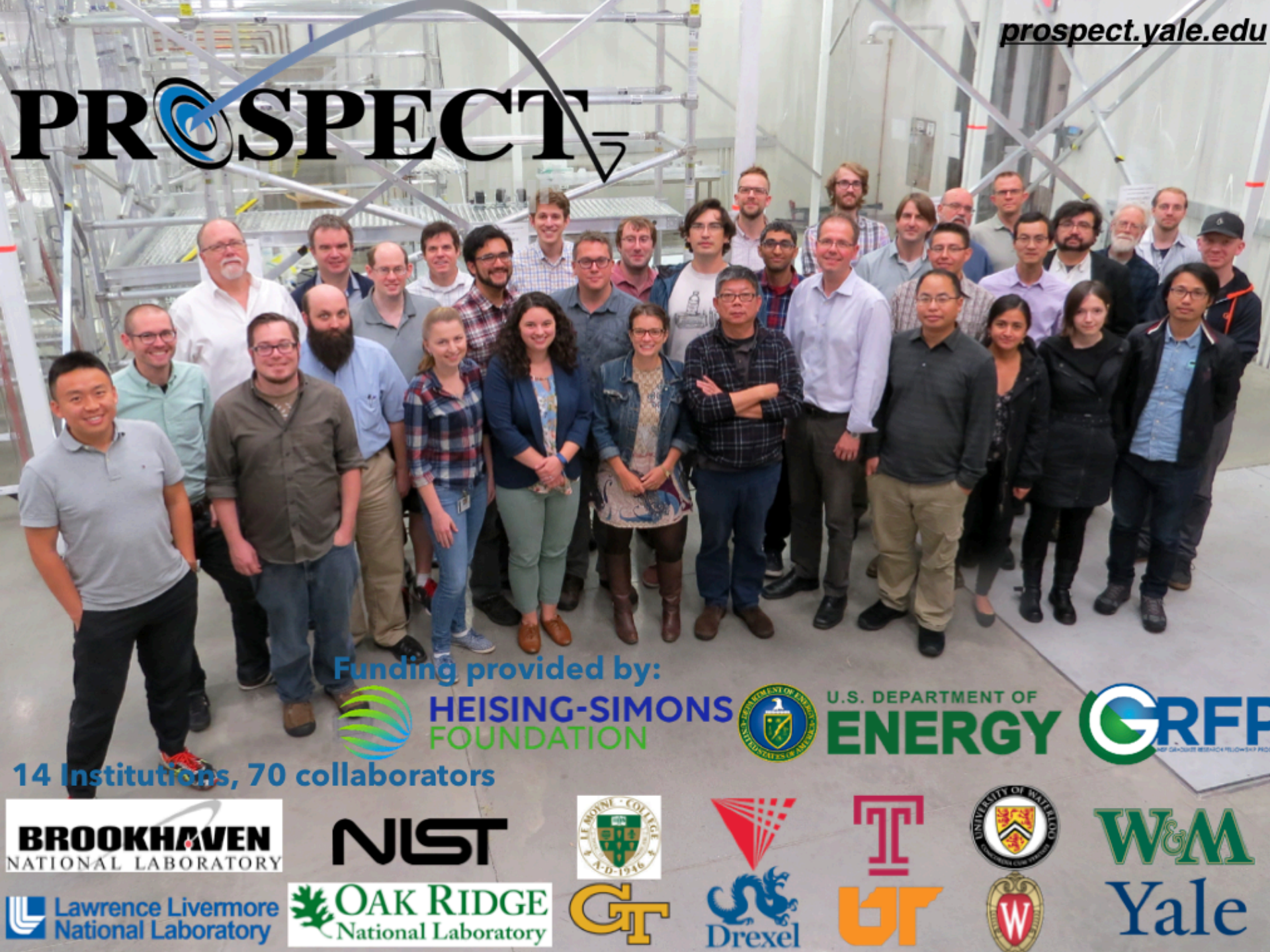
Recap

- Powerful anti-neutrino detector has been installed at HFIR. IBD is used to detect anti-neutrinos.
- Having minimal overburden, backgrounds are thoroughly examined.
- The detector is performing well and working towards high-statistics ^{235}U spectrum measurement.
- Stay tuned!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Backup slides - common possible questions

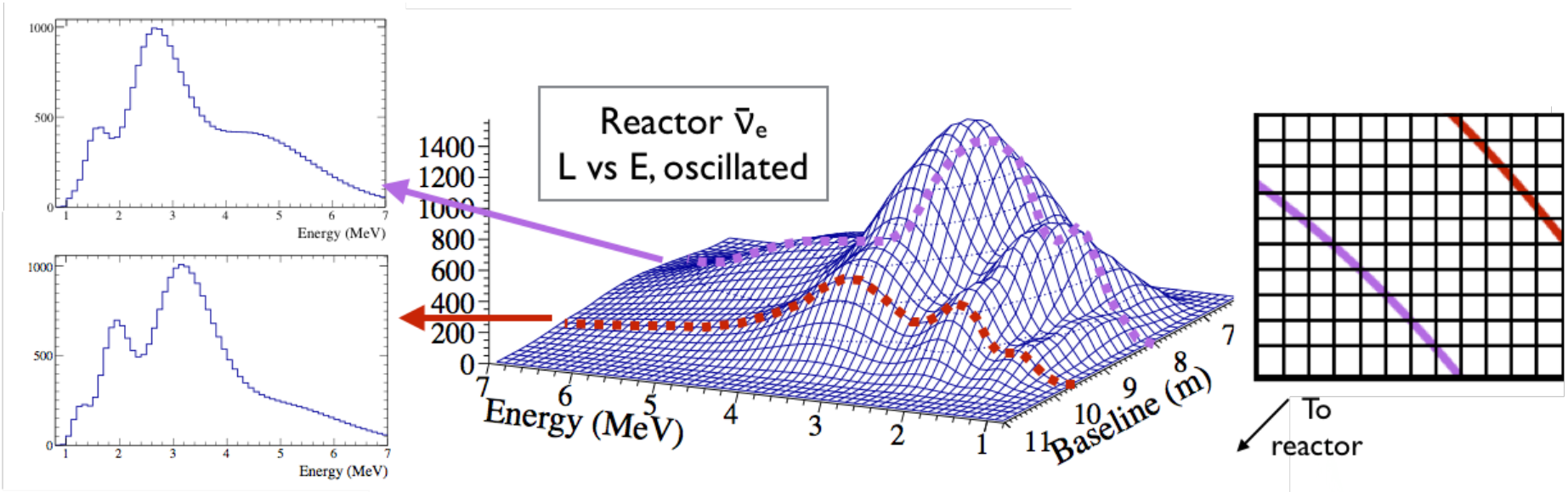
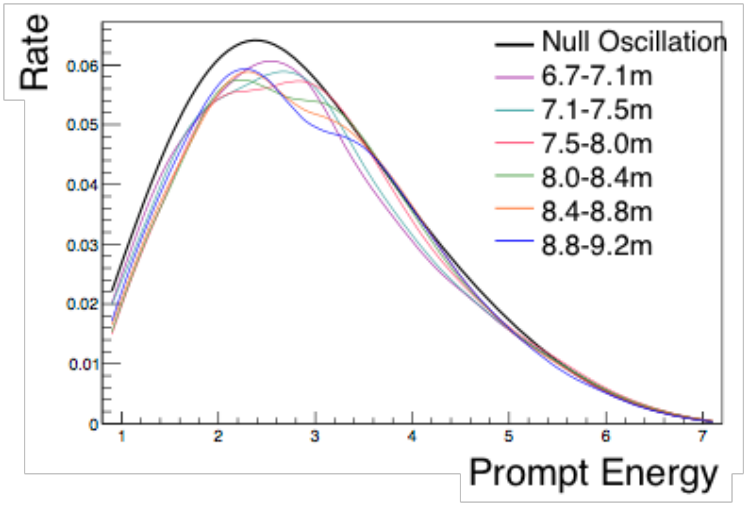
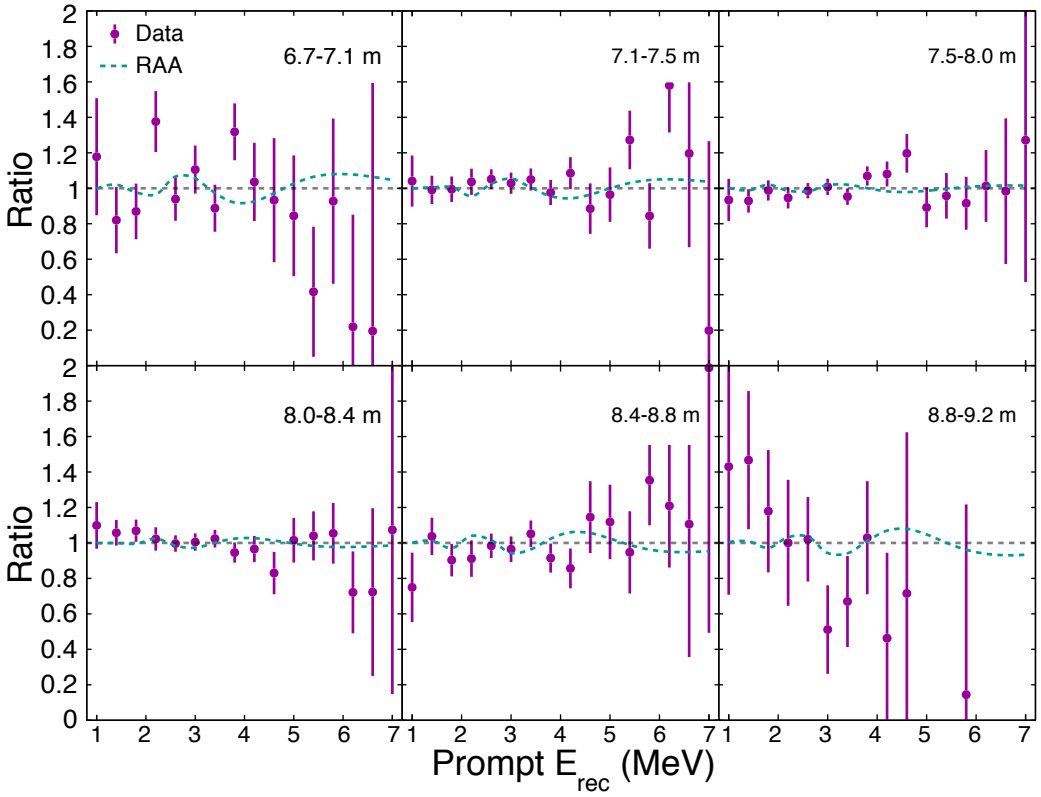


Figure from B. Littlejohn

Baseline analysis





- **Null-oscillation would yield a flat ratio for all baselines**
- **Direct ratio search for oscillations, reactor model independent**

Backup slides

Neutrino 2018 PROSPECT related talk

- https://www.mpi-hd.mpg.de/nu2018/programme

PROSPECT: The Precision Reactor Oscillation and Spectrum Experiment	Thomas J. Langford	Yale University

PSD performance