

# Precision Reactor Oscillation and SPECTrum Experiment: Upgrade & Science Goals

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## Primary Physics Goals

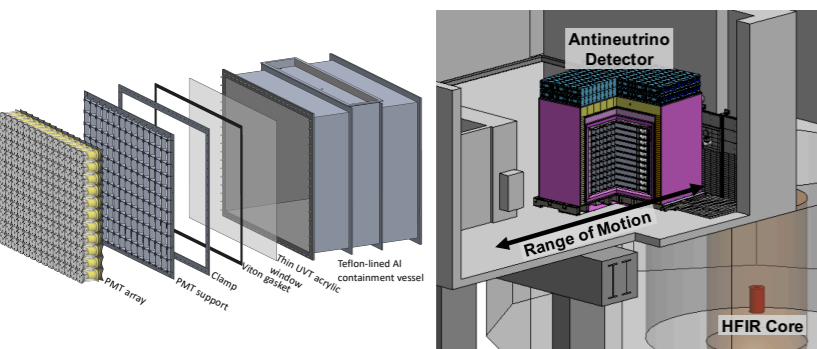
- Search for sterile neutrino oscillation within unique parameter space important for the reactor anomaly and Long Baseline experiments.
- High-resolution  $^{235}\text{U}$  spectrum and flux measurement addresses observed shape discrepancies

## PROSPECT measurement strategy

- Unique  $^6\text{Li}$ -doped liquid scintillator as inverse beta decay target; distinct IBD topology
- Highly segmented array for background rejection and event localization
- $\sim 7\text{m}$  baseline to very compact highly-enriched reactor core provides unique sensitivity at high  $\Delta m^2$ .
- Robust oscillation signature; simultaneous spectrum measurement at multiple baselines

## PROSPECT-II Concept

Reusable, risk-reducing design, highly leveraged on PROSPECT-I lessons learned, same footprint at HFIR



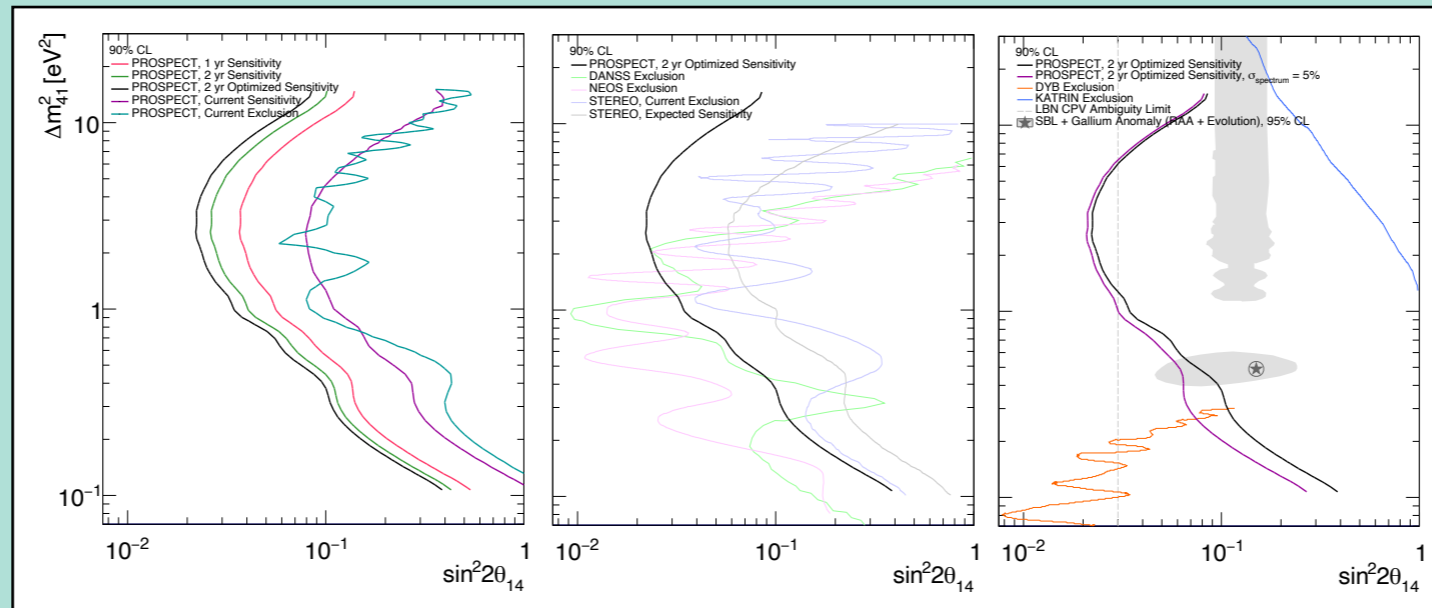
## Robust Design:

- PMTs separated from liquid scintillator, repairable/replaceable
- Scintillator system drain-and-replace capable

## Performance upgrade options:

- +40% in fiducial volume - improved statistics
- x 2 increase in  $^6\text{Li}$  concentration - increased efficiency & reduced background
- Potential multi-site or multi-reactor operation; increased oscillation sensitivity

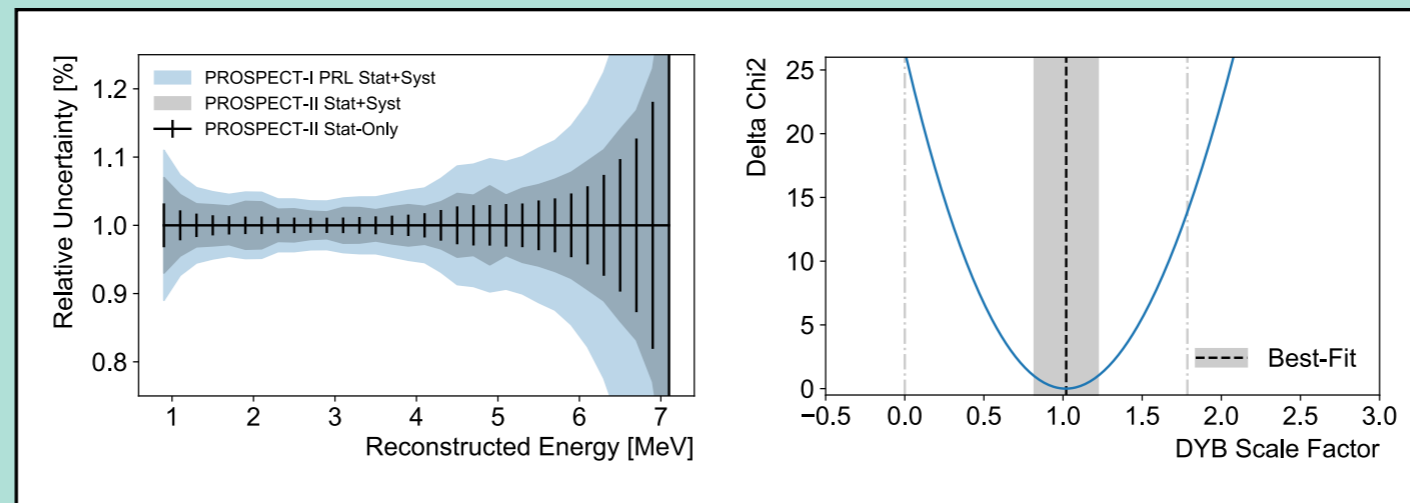
# Upgrade significantly expands oscillation physics reach in unique parameter space



**Left:** Comparison of sterile oscillation sensitivities for current and projected PROSPECT-II datasets. **Center:** Projected PROSPECT-II sensitivity compared to selected short-baseline reactor experiments. **Right:** Overlap of three year PROSPECT-II sensitivity with relevant regions of parameter space

**PROSPECT-II uniquely addresses a high  $\Delta m^2$  region between 1 eV<sup>2</sup> - 15 eV<sup>2</sup>, and will reach the 5°  $\sin^2(2\theta_{14})$  sensitivity over much of this range (impacting interpretation of LBN CP violation)**

# Upgrade reduces uncertainties below 5% through key parts of spectrum

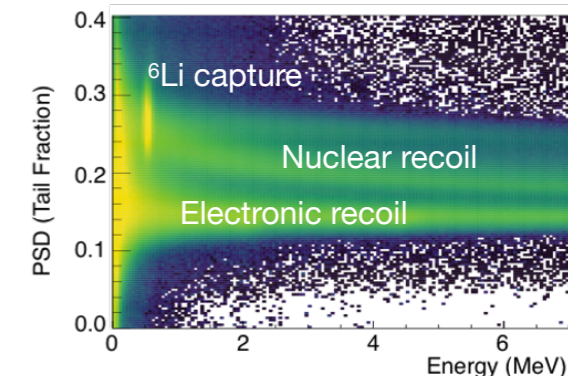


**Left:** PROSPECT  $^{235}\text{U}$  spectrum measurement uncertainties after two years of PROSPECT-II data. **Right:** Expected PROSPECT-II precision in measuring the amplitude ( $n$ ) of a bump-like feature in the 4-6 MeV prompt energy regime as observed by Daya Bay, RENO and Double Chooz.

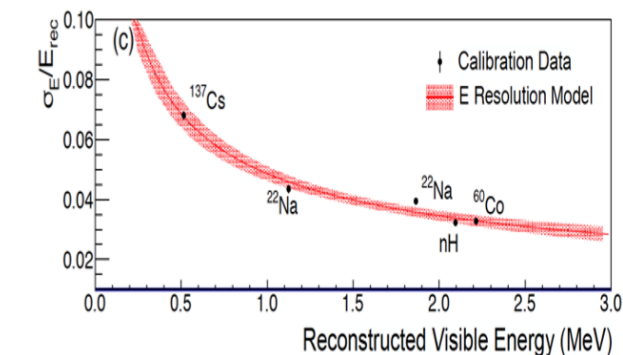
**PROSPECT-II will address hypotheses for the origin of the spectral excess between 4 -6 MeV at high confidence level**



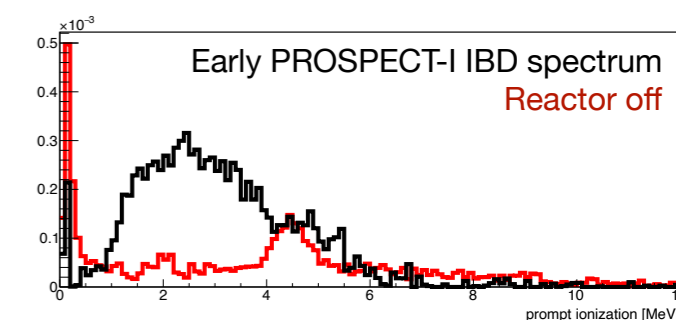
## PROSPECT-I demonstrated excellent performance



Pulse shape discrimination (PSD) capable scintillator with high light yield allows for excellent background rejection and  $> 5\%/\sqrt{E}$  resolution.



Detailed Monte Carlo of systematics validated with extensive calibration campaign



Early PROSPECT-I data demonstrated **3:1 signal to background**, best for a surface deployed antineutrino detector

Please see other PROSPECT posters and talk

Updated Event Selection for the PROSPECT Experiment, #158  
Measurement of the Uranium-235 Antineutrino Spectrum by PROSPECT, #516  
PROSPECT: Latest results for Sterile Neutrino Oscillation search, #408  
PROSPECT upgrade and science goals, #540  
A Joint Measurement of the  $^{235}\text{U}$  Reactor Antineutrino Spectrum, #556

