Upgrade significantly expands oscillation physics reach in unique parameter space

**PROSPECT** measurement strategy

- Unique $^6$Li-doped liquid scintillator as inverse beta decay target; distinct IBD topology
- Highly segmented array for background rejection and event localization
- ~7 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 $^7$Li concentration - increased efficiency & reduced background
- Potential multi-site or multi-reactor operation; increased oscillation sensitivity

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

**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$^2$ - 15 eV$^2$, and will reach the $5^\circ \sin^2(2\theta_{14})$ sensitivity over much of this range (impacting interpretation of LBN CP violation)**

**Early PROSPECT-I IBD spectrum**

**Left:** PROSPECT $^{235}$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.

**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 $^{235}$U Reactor Antineutrino Spectrum, #556
Supported by:

**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

**PROSPECT** measurement addresses observed shape discrepancies

**High-resolution within unique parameter space important**

**Comparison of sterile oscillation sensitivities for current and projected PROSPECT-II datasets.**

**Expected PROSPECT-II precision in measuring the amplitude ($n$) of a bump-like feature in the spectral excess between 4-6 MeV at high confidence level**