

Updated Event Selection for Precision Reactor Oscillation and SPECTrum Experiment

Xiaobin Lu On Behalf of PROSPECT collaboration

Introduction

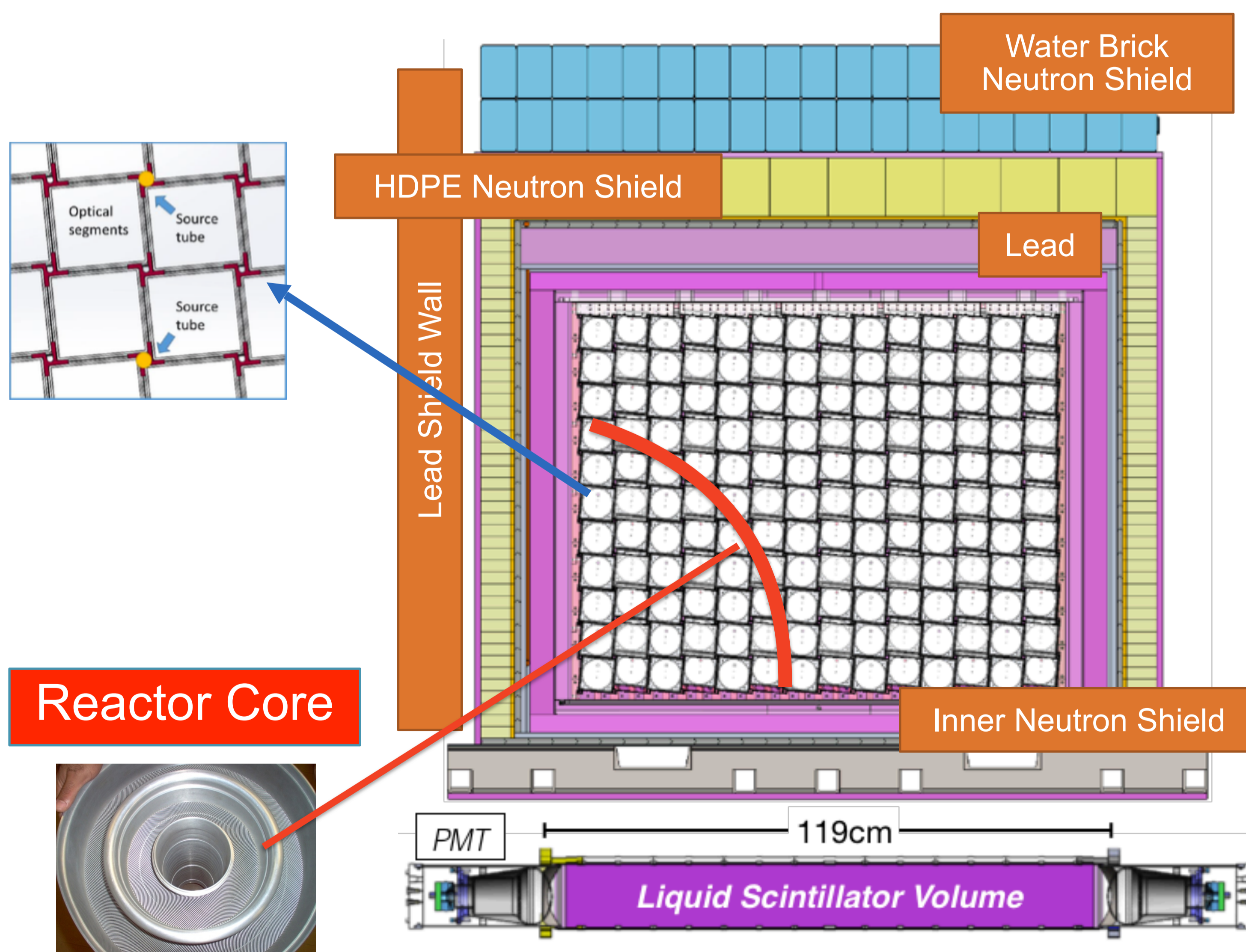
The Precision Reactor Oscillation and SPECTrum Experiment (PROSPECT) is a short-baseline reactor neutrino experiment designed to conclusively address the Reactor Anti-neutrino Anomaly and anti-neutrino spectral distortion around 5 MeV.

The main physics goals of PROSPECT includes:

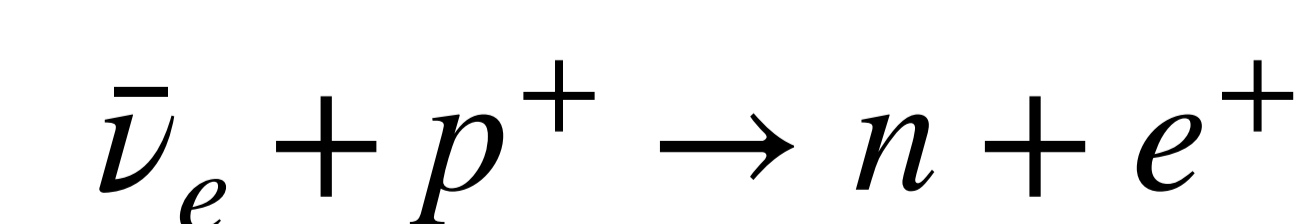
- Model-independent search for oscillations into eV-scale sterile neutrino
- Precise measurement of ^{235}U anti-neutrino prompt spectrum

Detector at High Flux Isotope Reactor(HFIR)

- 85MW highly enriched ^{235}U
- high electron anti-neutrino flux $\sim 2.0 \times 10^{19}/\text{sec}$
- compact core (h=0.6m, d=0.4m)
- reactor-on/off cycle for background subtraction
- ~ 4 ton ^6Li -loaded liquid scintillator
- 14x11 optical segmentation
- Double-ended PMT readout
- Access to in-situ calibration
- $\sim 50\text{k}$ anti-neutrino IBD interactions



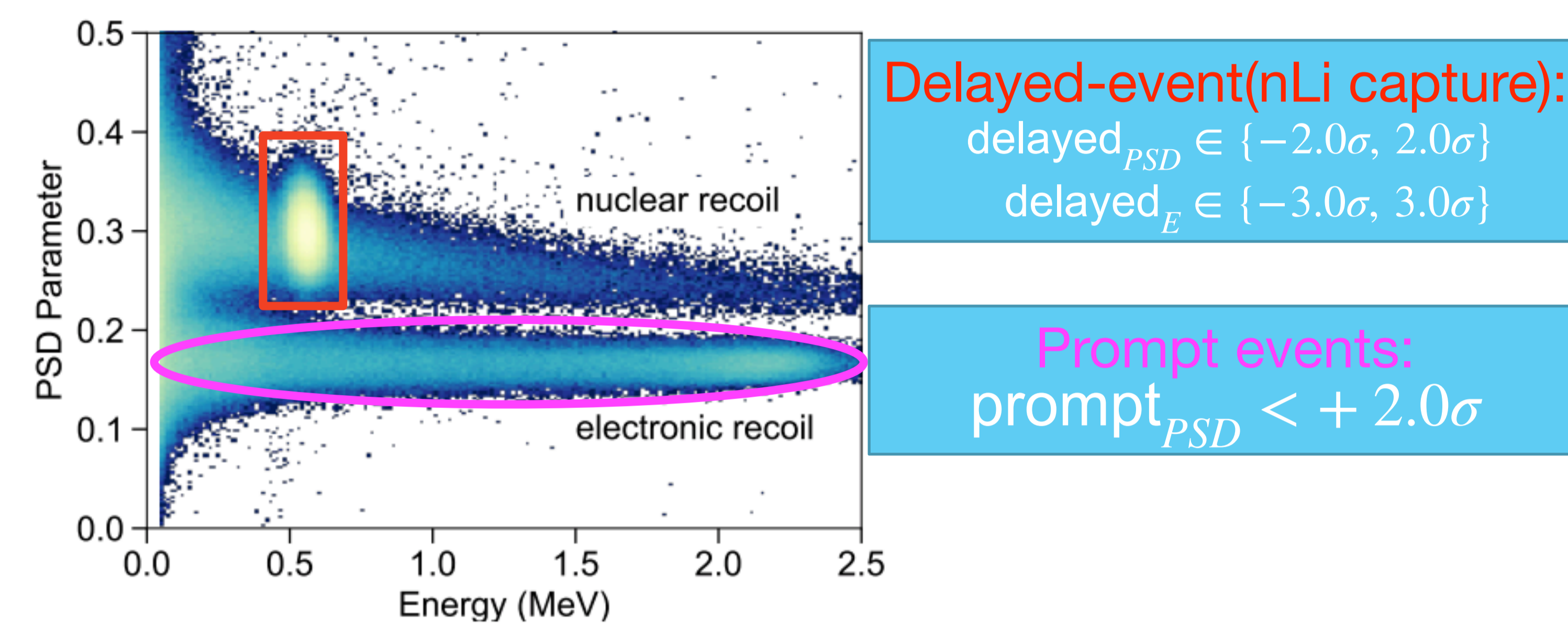
Inverse Beta Decay(IBD)



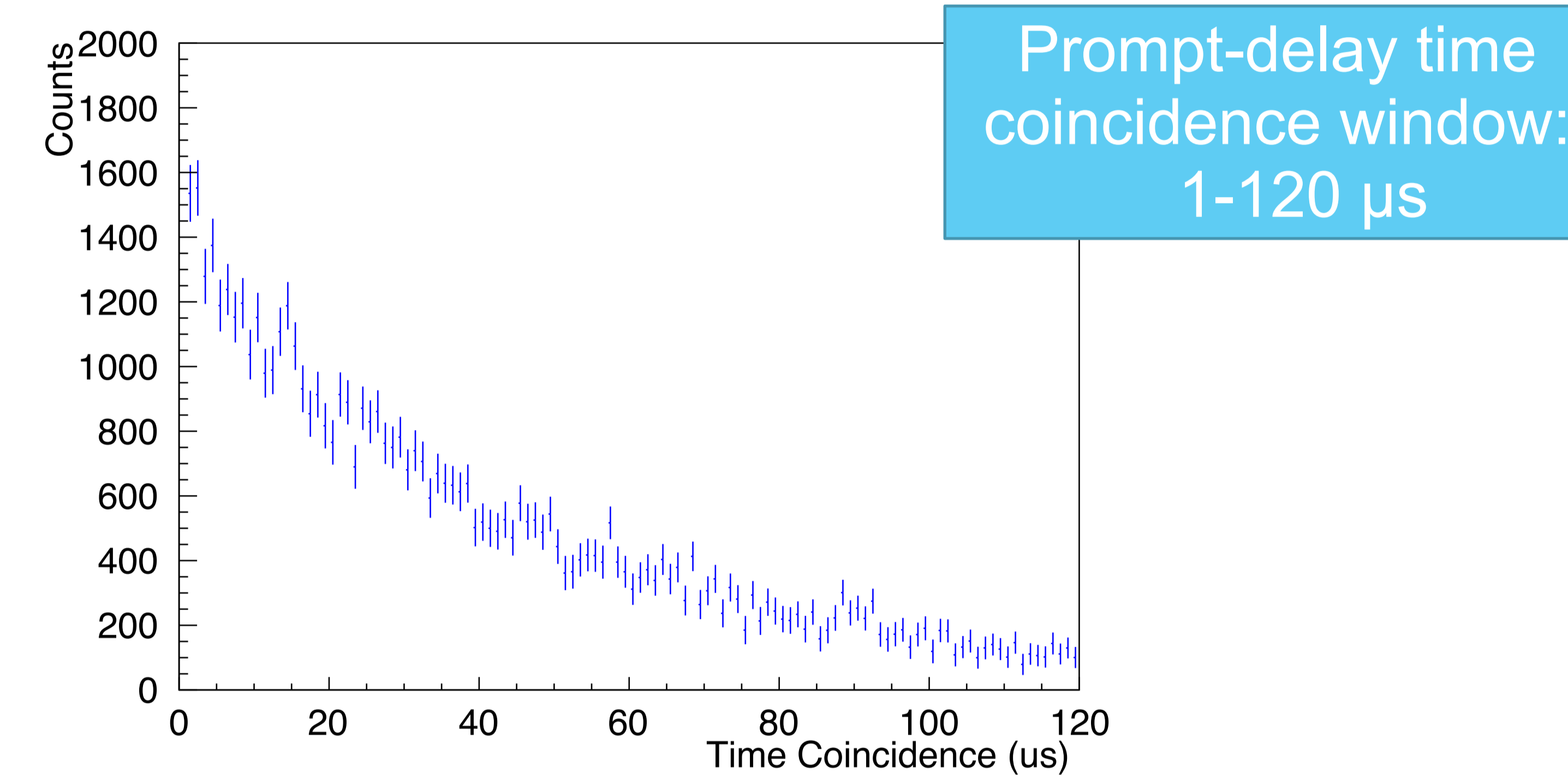
- **Prompt signal:** $\sim 1\text{-}10$ MeV positron energy
- **Delayed signal:** ~ 0.5 MeV neutron capture on ^6Li

IBD Event Topology Cut

Identify the prompt and delayed events in PSD & energy space.

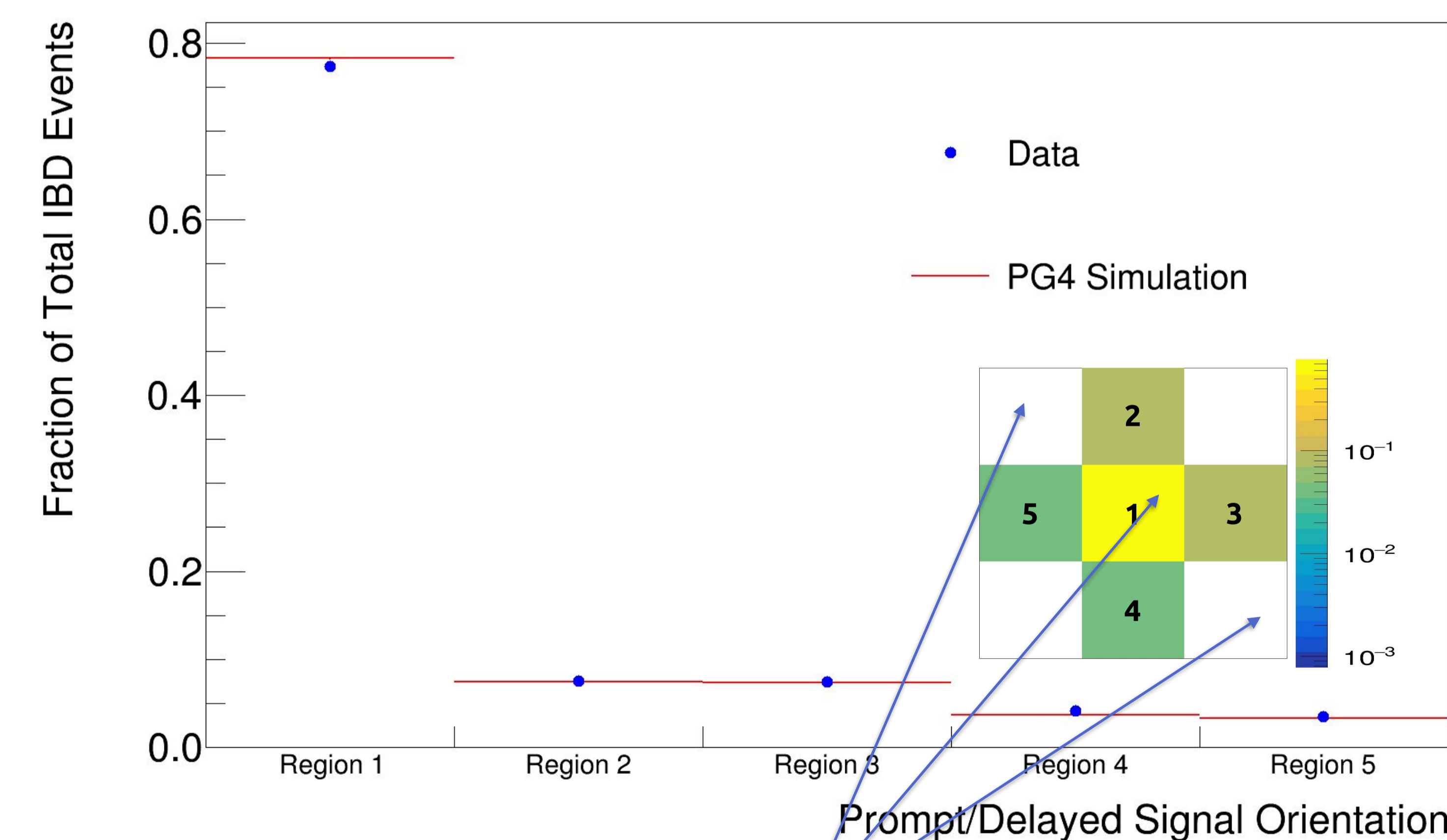


Correlated IBD prompt-delayed pair in time & space



Prompt-delay distance coincidence window:
dz = (140,100) mm

prompt/delay signal exhibit directionality

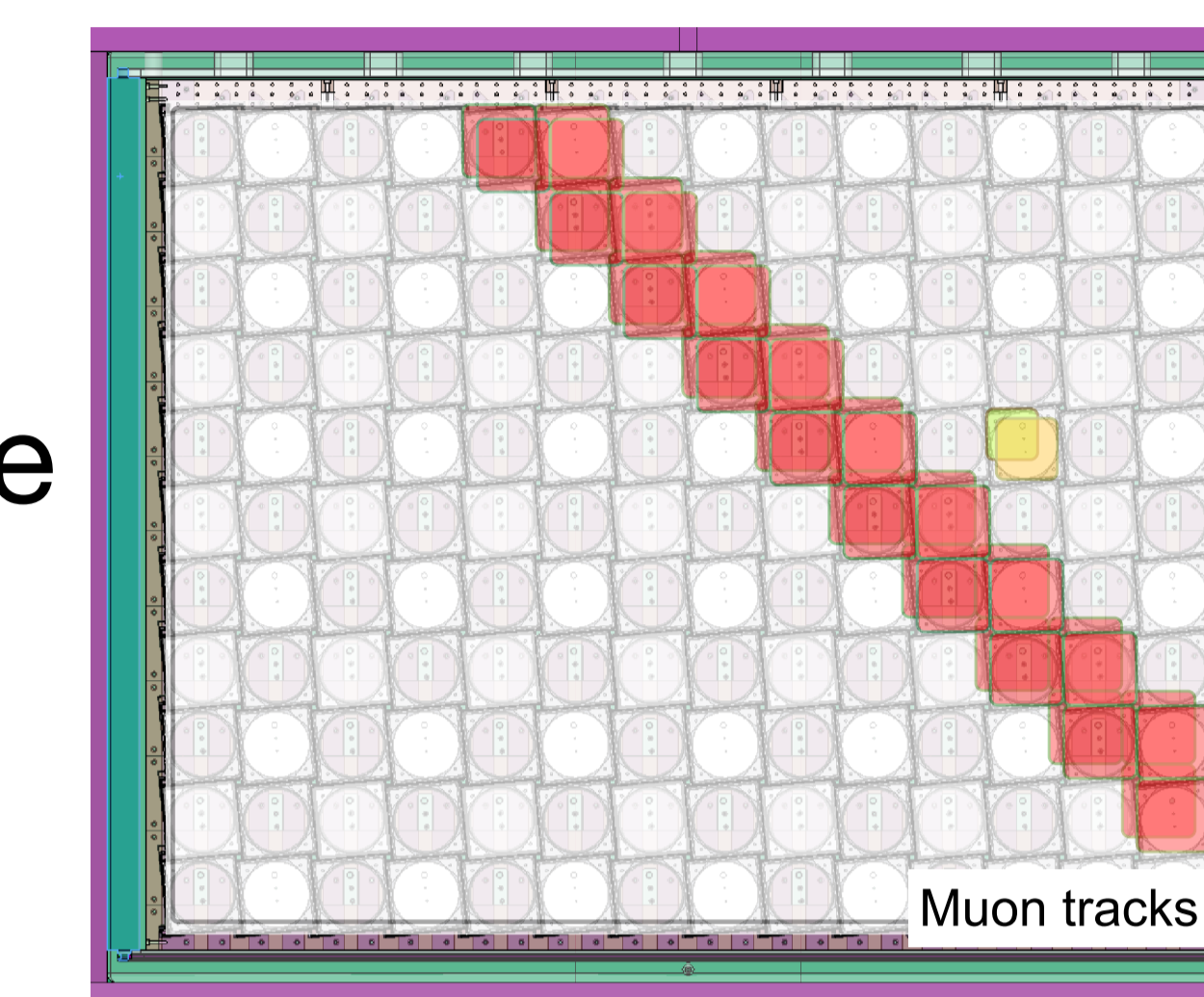


Additional fiducialization shields thermal neutrons and serves as gamma catcher to better energy reconstruction across the detector.

IBD Background Veto Cuts

Veto window of 200 μs after a muon event(Muon Veto)

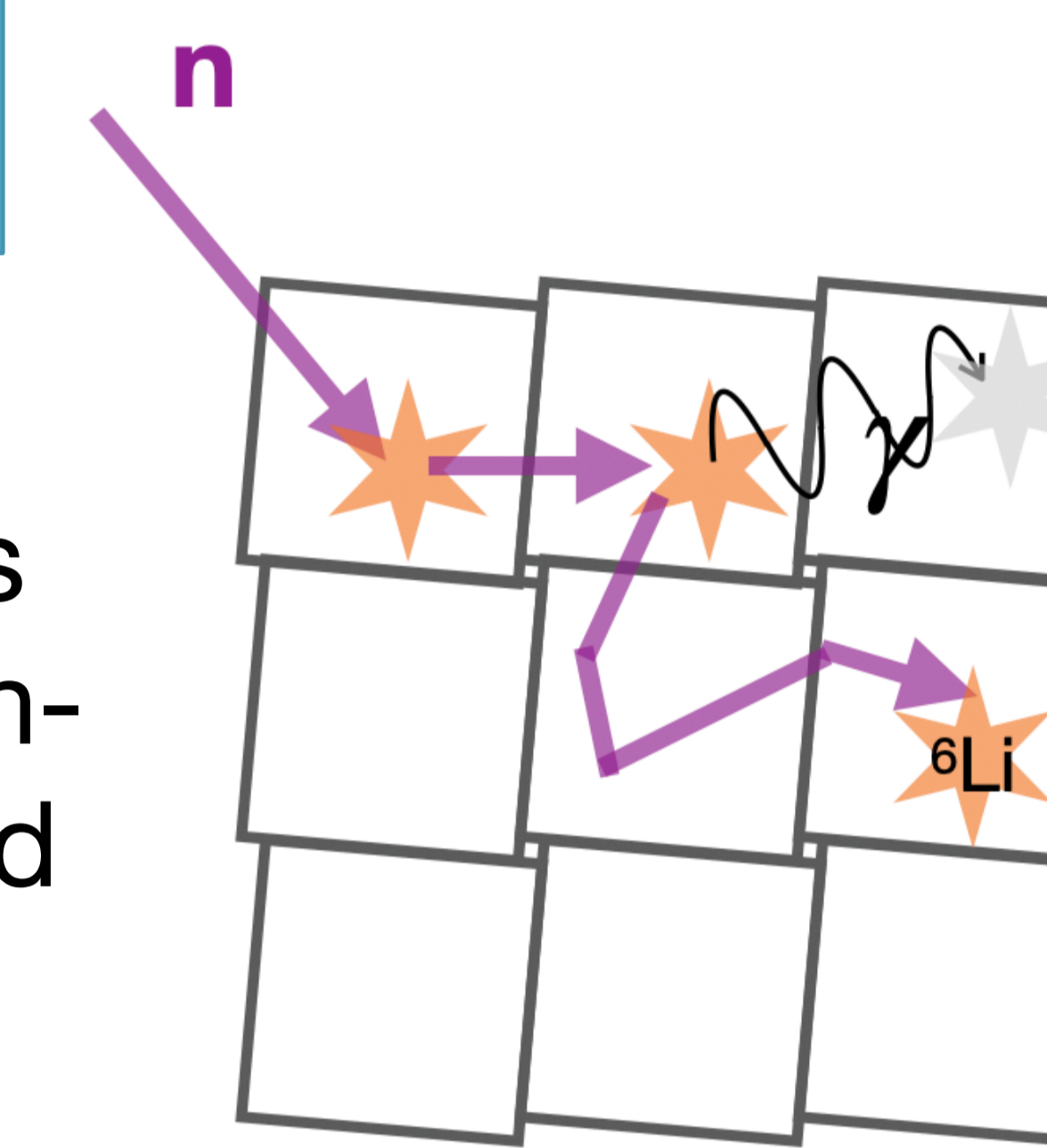
$E_{\text{Thresh}} > 15$ MeV



Muon induced neutrons inside inner detector generate correlated prompt gamma and neutron capture on ^6Li

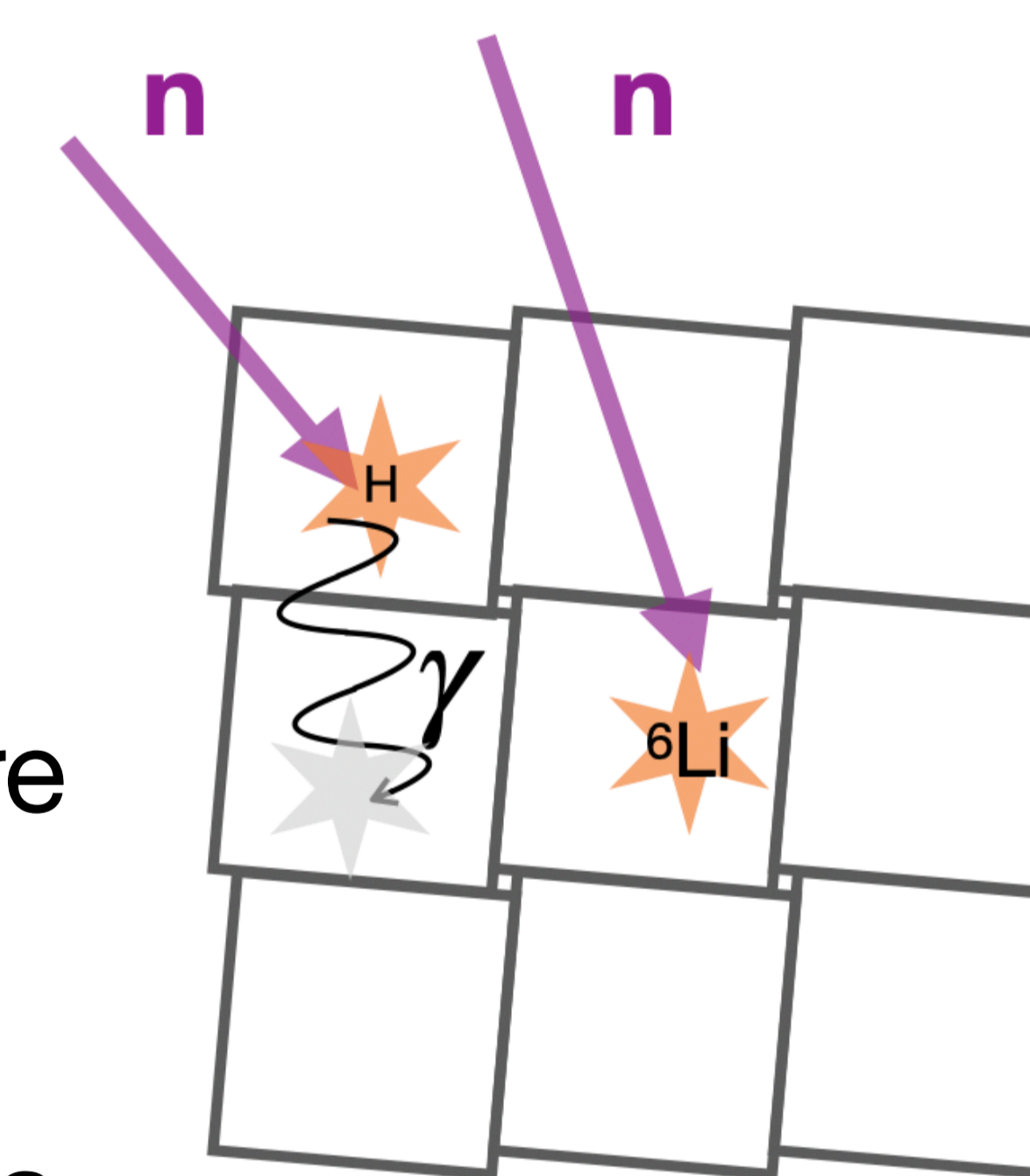
Veto window of 250 μs after a recoil event (Recoil Veto)

Fast neutron shower poses correlated background via in-elastic scattering on ^{12}C and subsequently followed by neutron capture on ^6Li

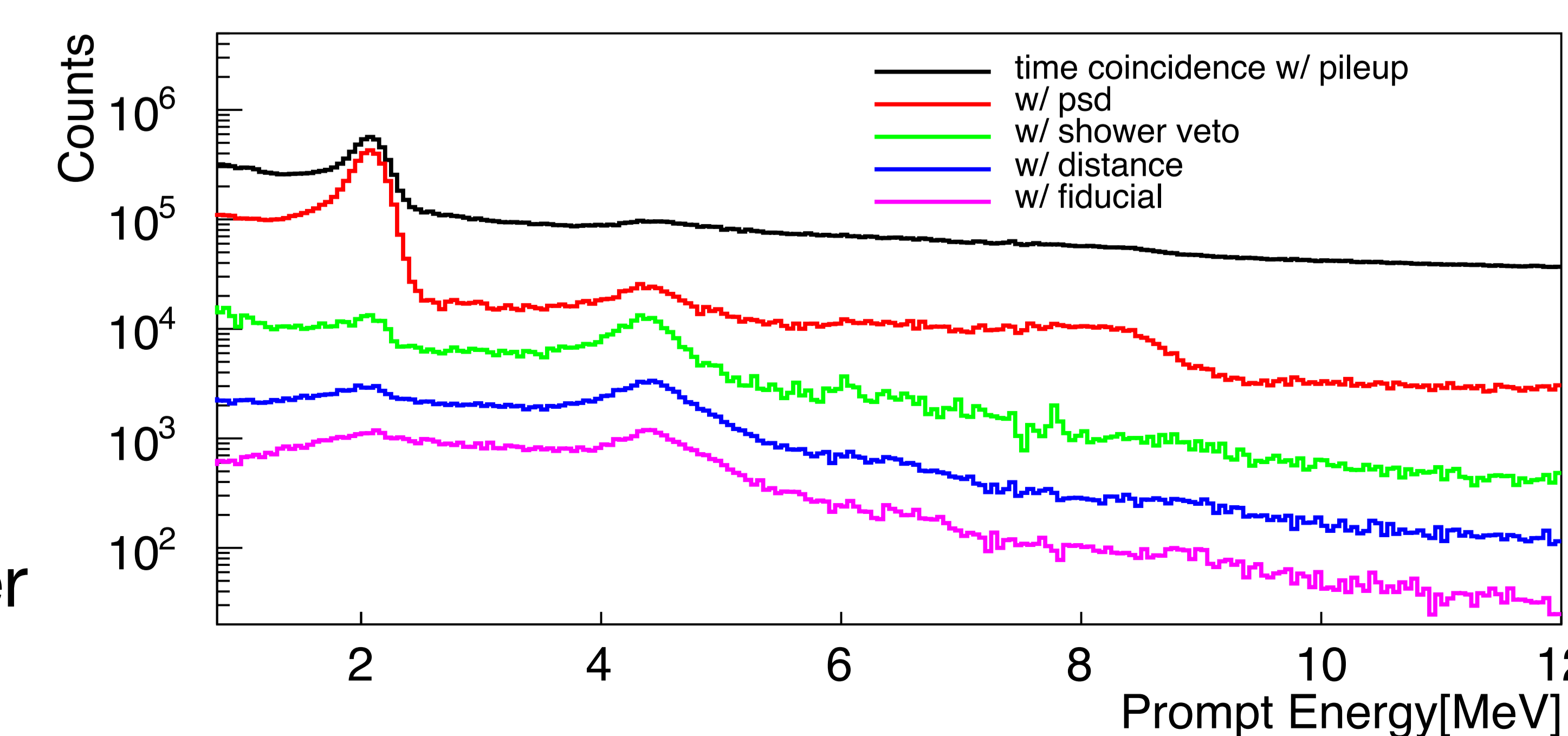


Veto window of 400 μs before and after a nLi event (Neutron Veto)

Multiple thermal neutrons from the shower can capture on hydrogen and lithium, generating fake prompt-delayed signature from IBDs

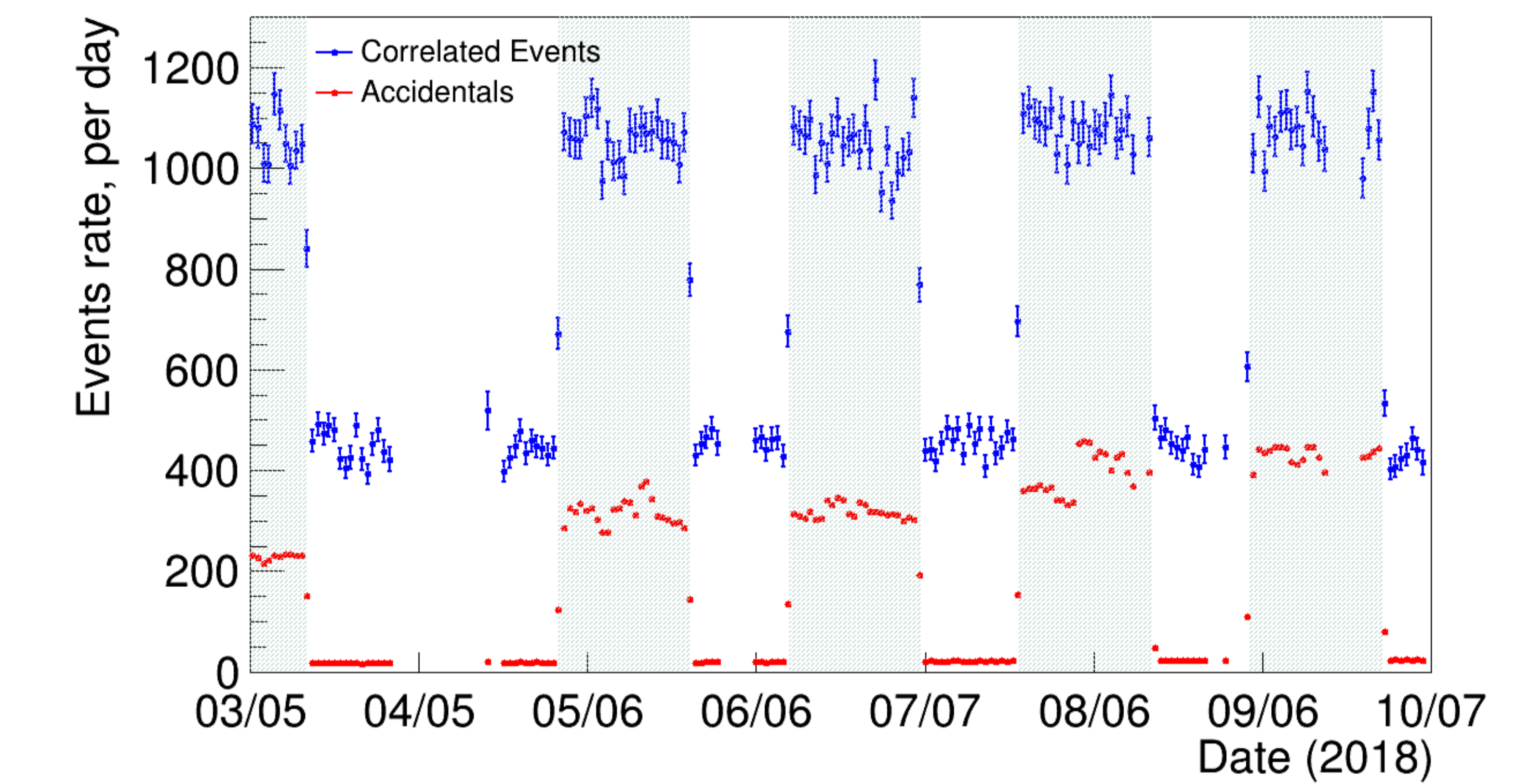


After sequential application of event selection, reduction of background is illustrated below.

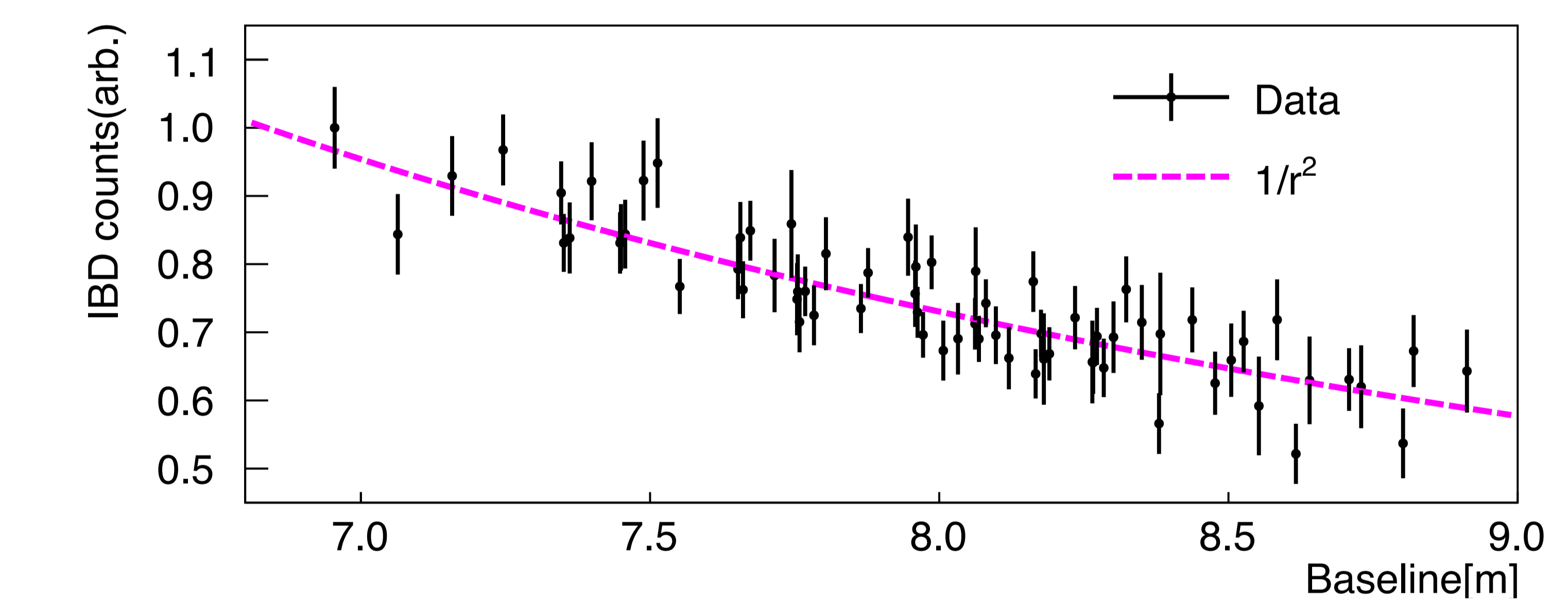


Analysis Results

Based on 96 reactor-on days, 73 reactor-off days.



Expected $1/r^2$ behavior of IBD counts vs baseline from a compact reactor core.



More PROSPECT results are available:

- Poster ID 516: Measurement of the Uranium-235 Antineutrino Spectrum by PROSPECT
- Poster ID 408: PROSPECT: Latest results for Sterile Neutrino Oscillation search
- Poster ID 527: Detector characterization and calibration for PROSPECT
- Poster ID 540: PROSPECT upgrade and science goals
- Poster ID 556: Towards a Joint Measurement of the ^{235}U Reactor Antineutrino Spectrum by the Daya Bay, PROSPECT, and STEREO Experiments

Conclusion

- Analysis event selection has been able to suppress background by order of magnitude of 4.
- With current event selection applied to less than one year's data-taking, yielding around 50k IBD interactions.

Acknowledgements

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