

Reactor gamma background study at HFIR in support of PROSPECT-II and future antineutrino measurements

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On behalf of the PROSPECT collaboration

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Overview

- Description of experiment hall and sources of background
- Outline work done to characterize backgrounds at HFIR
- Detector configuration for recent Ge based gamma study
- Show preliminary results from gamma study
- Future work and goals



Background - High Flux Isotope Reactor

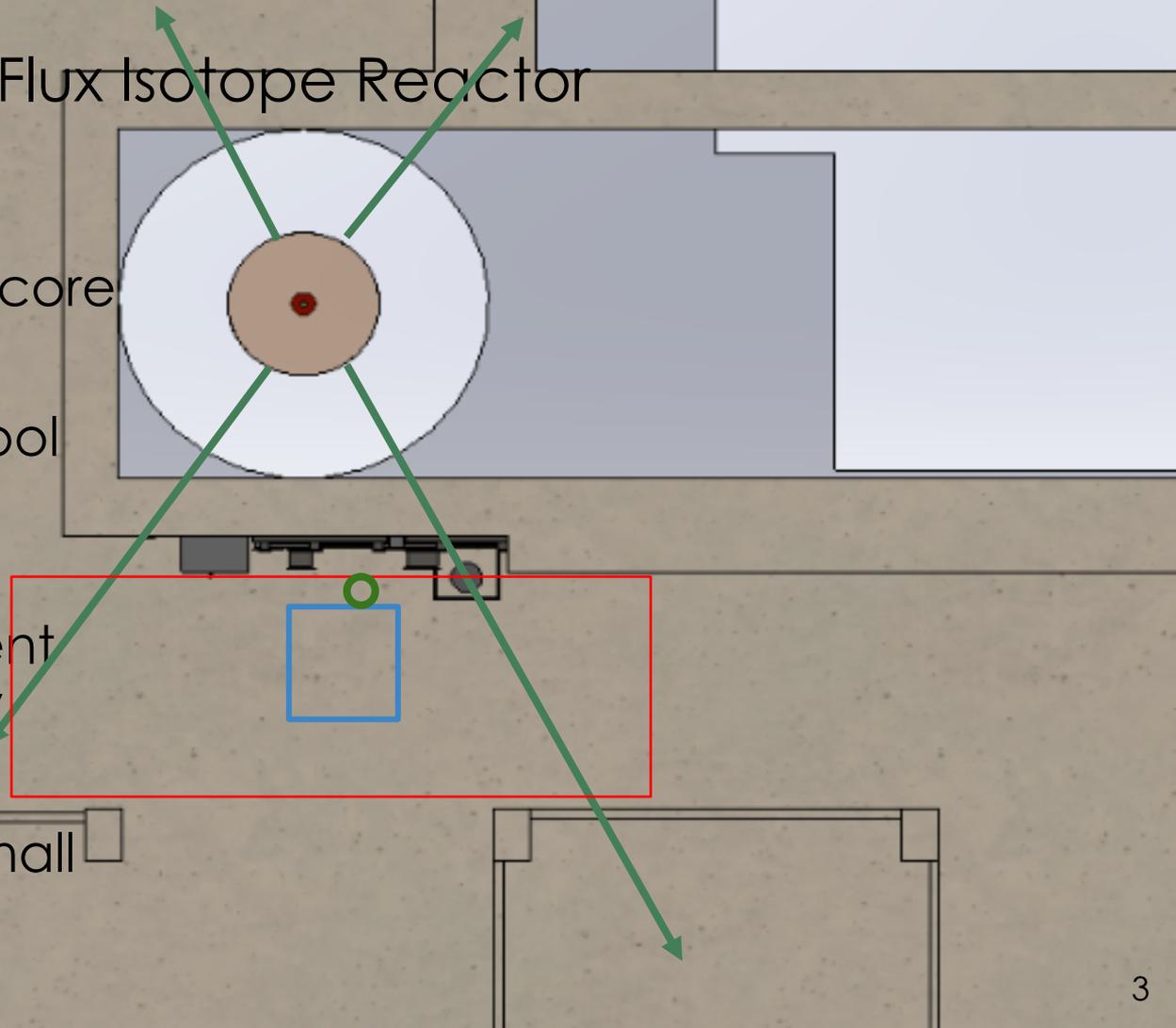
85 MW HEU reactor

Compact cylindrical core
(.5m x .4m diameter)

Immersed in water pool
8m below surface

Fuel surrounded by
aluminum containment
vessel, surrounded by
beryllium reflector

7m from experiment hall



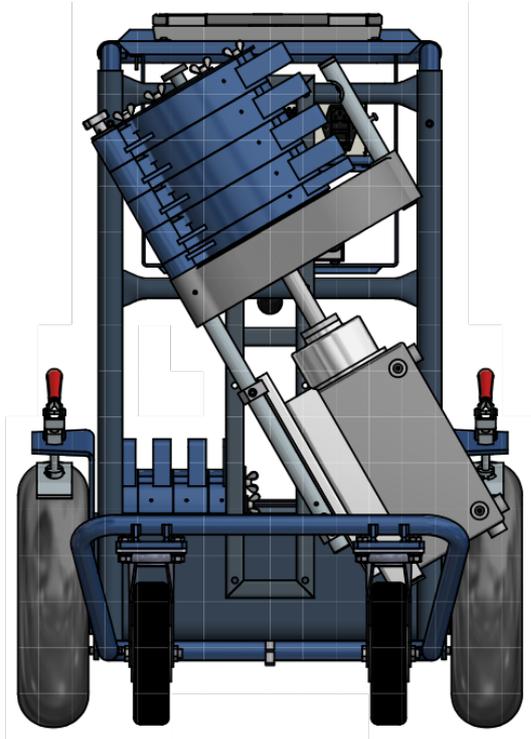
HFIR Background Measurements Overview

- [Background surveys at 3 power reactors](#)
- 2015-2016 gamma and neutron measurement campaign (NaI, ^3He) - spacial survey
- 2018 PROSPECT
- 2021 high resolution gamma studies

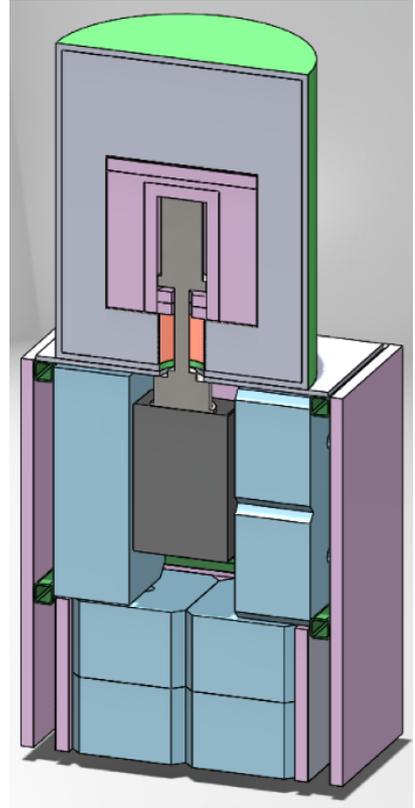
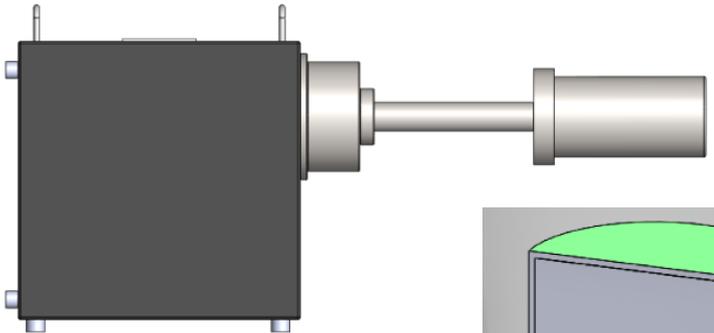
“Background radiation measurements at high power research reactors”
<https://arxiv.org/abs/1506.03547>



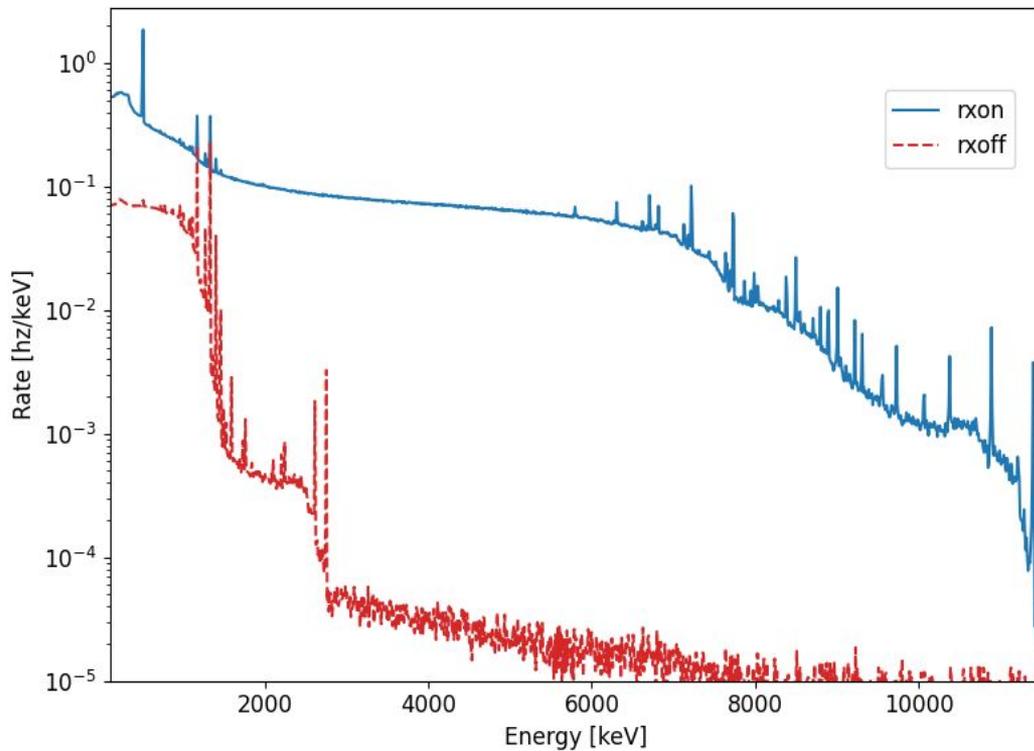
Detector Configurations



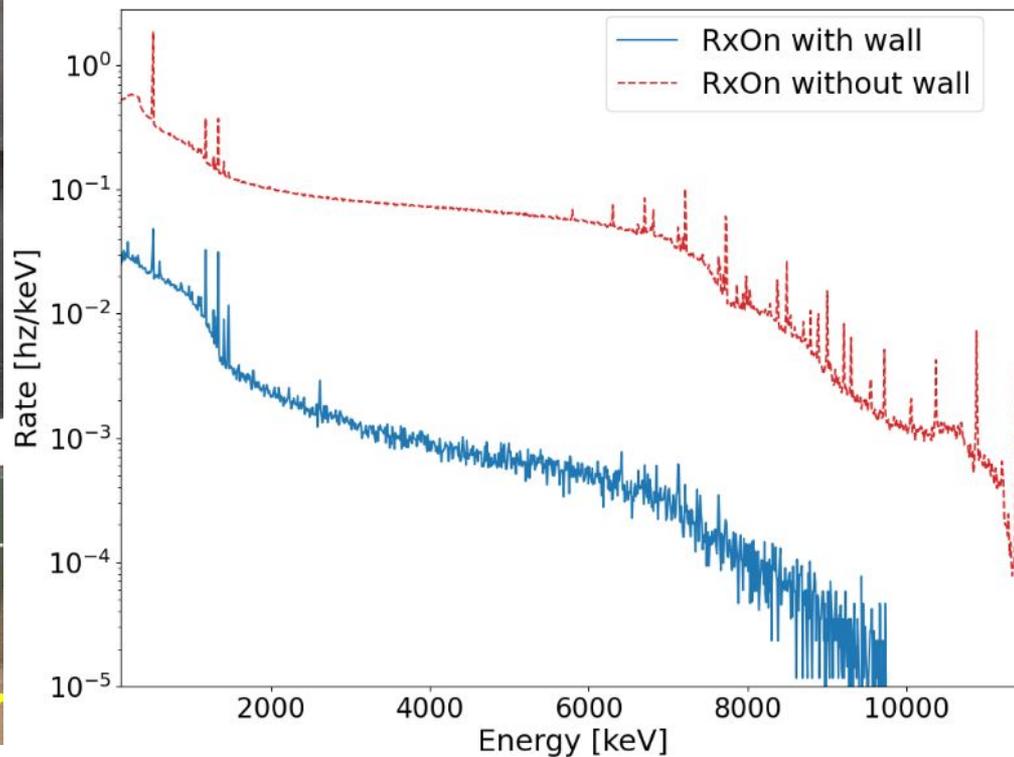
VIEW10
60° UPLOOKING



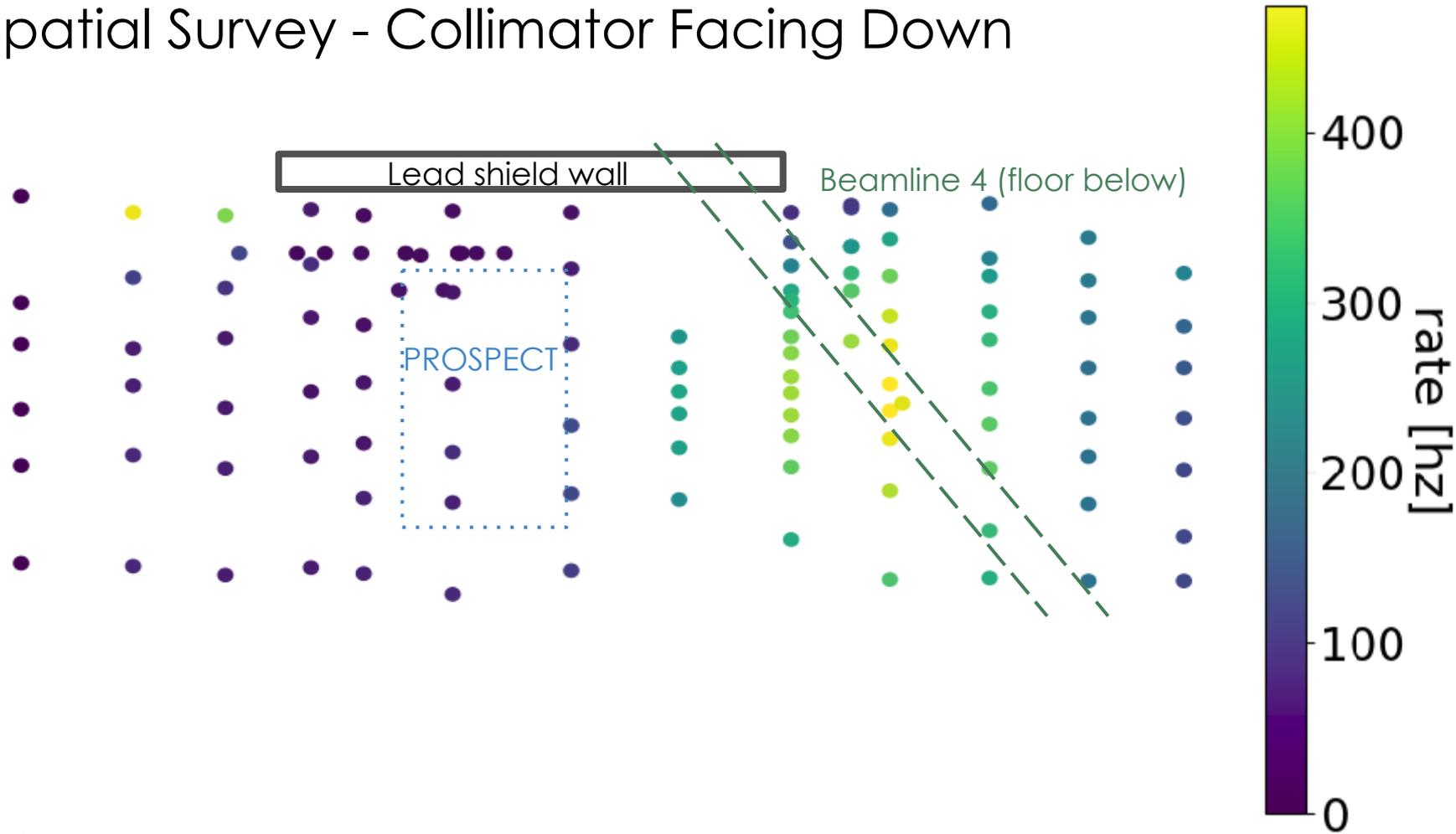
Reactor On vs Off Gamma Spectrum with Ge Detector



Reactor On Spectrum with and without Lead Shield Wall



Spatial Survey - Collimator Facing Down



Gamma lines

Isotope	Energy (MeV)	I _γ /I _γ (max) (%)	Natural abundance (%)	Neutron source
59Ni	11387 10054 9102	48.22 18.42 19.8	Unstable (76000 y ½ life)	Rxr
54Fe	9298 8886	100 18.64	5.8	Rxr, HB4
53Cr	9718 8884	18.48 50.57	9.5	Rxr
58Ni	8998 8534	100 47.48	68	Rxr, HB4
69Cu	7916	100	69	Rxr

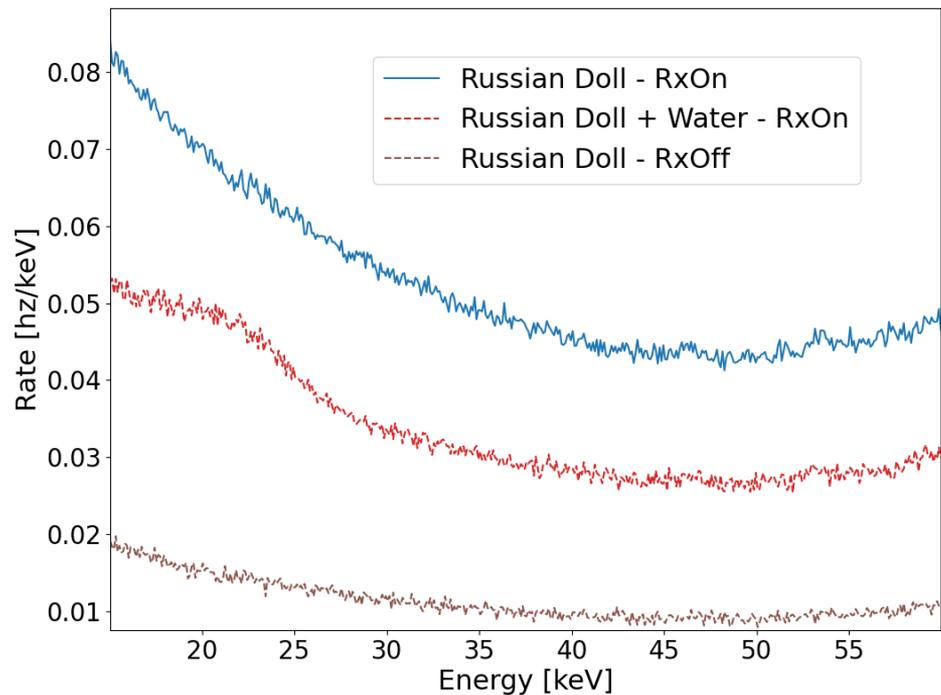
Gamma lines cont'd

Isotope	Energy (MeV)	I _γ /I _γ (max) (%)	Natural abundance (%)	Neutron Source
52Cr	7939 7938	29.4 100	83.8	Rxr
60Ni	7819	100	26.2	Rxr, HB4
27Al	7724 7693	96 11.8	100	Rxr, HB4
56Fe	7645 7631 7279	86.2 100 20.7	91.5	Rxr, HB4
9Be	6809	100	100	Rxr
48Ti	6760 6419	54.15 35.67	73.7	HB4

“Russian Doll” Shield measurements



Low Energy Region with Russian Doll Shielding

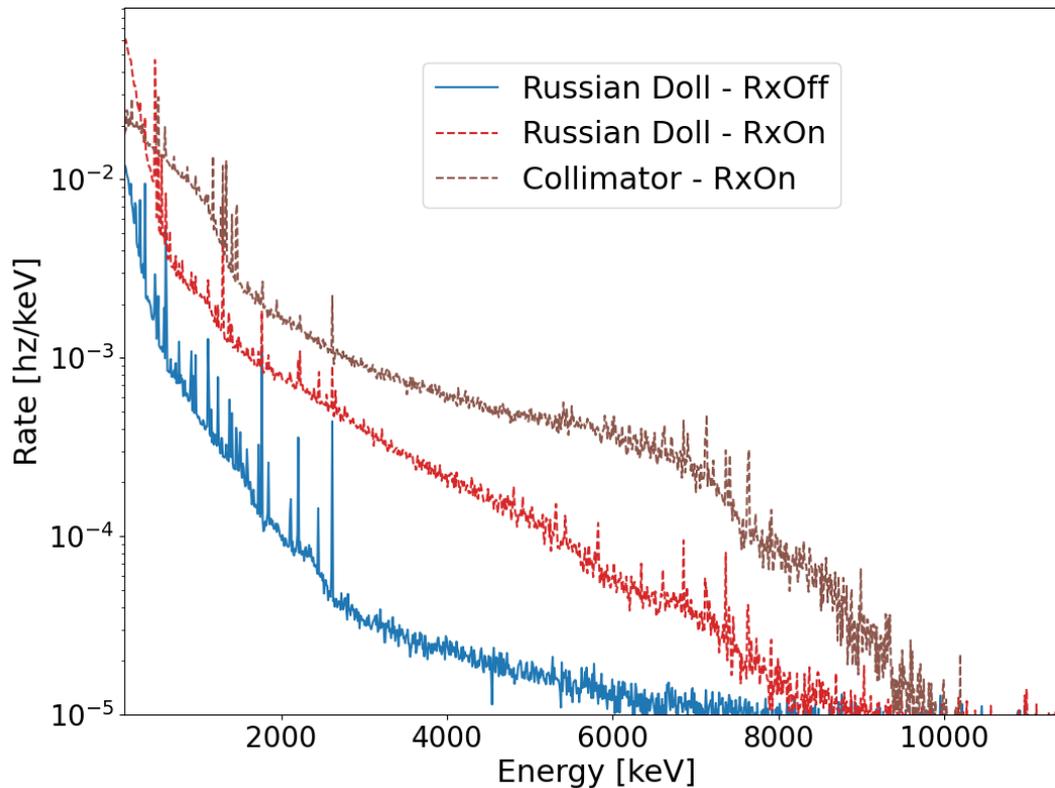


Full Energy Range in Russian Doll

Collimator measurement is at approximately the same location as Russian Doll shield

Russian Doll shields high energy gammas

Downscatters higher energies into lower energy bins



Summary and Future Work

- Scans around the experiment hall using a collimated high resolution Ge detector have been performed
- High statistics measurements with Ge in layered shielding have been taken
- Sources of background have been identified
- Mitigation of backgrounds at source for PROSPECT-II
- Simulations need to be performed to quantify the Ge response to gammas and thermal neutrons
- Simulations of the reactor geometry for neutron propagation need to be performed to understand the neutron flux and its impact on future experiments

Acknowledgements

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