Addressing Backgrounds for CUPID on Three Fronts

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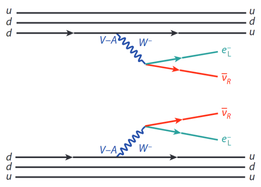
Neutrinoless Double Beta Decay

$$\hat{\nu} = \int \frac{d^3\overline{k}}{(2\pi)^3 2\omega_k} \sum_s \left[\hat{b}(\overline{k}, s) u(\overline{k}, s) e^{-ikx} + \hat{b}^\dagger(\overline{k}, s) v(\overline{k}, s) e^{+ikx} \right]$$

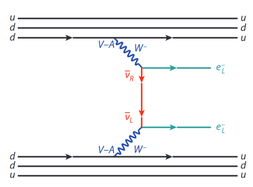
$$\mathcal{L}_{cc} = -\frac{g}{\sqrt{2}} \left[\overline{e}\gamma^\mu \left(\frac{1-\gamma_5}{2} \right) \nu W_\mu^- + \overline{\nu}\gamma^\mu \left(\frac{1-\gamma_5}{2} \right) e W_\mu^+ \right]$$

obeys lepton number conservation

allowed for majorana fermions, but relativistically-suppressed

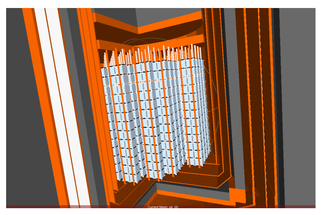


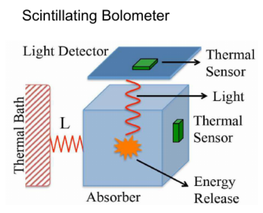
Two-neutrino double beta decay



Neutrino-less double beta decay

CUPID experiment





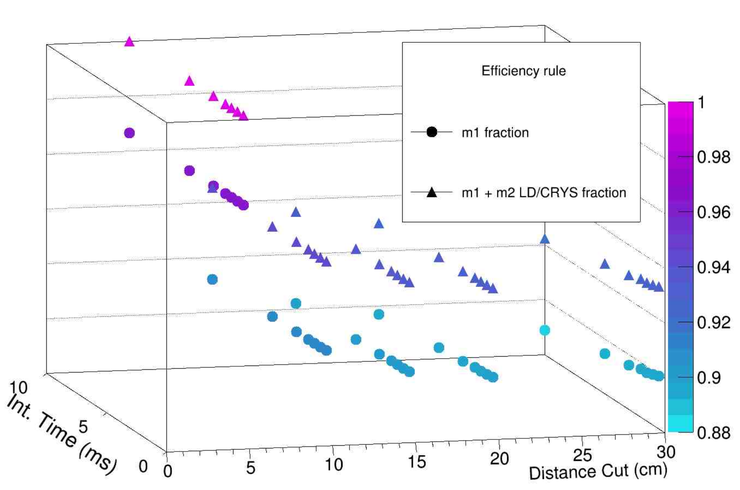
- Proposed $0\nu\beta\beta$ search using bolometric array of 1596 Li_2MoO_4 crystals, to be deployed in the CUORE cryostat[1].
- Aims to eliminate dominant background of alpha particles present in CUORE via thermal + scintillation signals.
- Are new backgrounds introduced with using a new isotope for the bolometers?

$$F_{0\nu} \propto \left[a\epsilon \sqrt{\frac{Mt}{b\Delta}} \right]$$

M	source mass (kg)
b	bkg index $counts/(kg \cdot yr \cdot keV)$
a	isotopic abundance (%)
t	exposure (yr)
Δ	energy resolution (keV)
ϵ	detection efficiency

Monte-Carlo simulation of $2\nu\beta\beta$

Irreducible background has non-negligible rate in the CUPID array



- **Mauris tempor** risus nulla, sed ornare
- **Libero tincidunt** a duis congue vitae
- **Dui ac pretium** morbi justo neque, ullamcorper

Eget augue porta, bibendum venenatis tortor.

A highlighted block

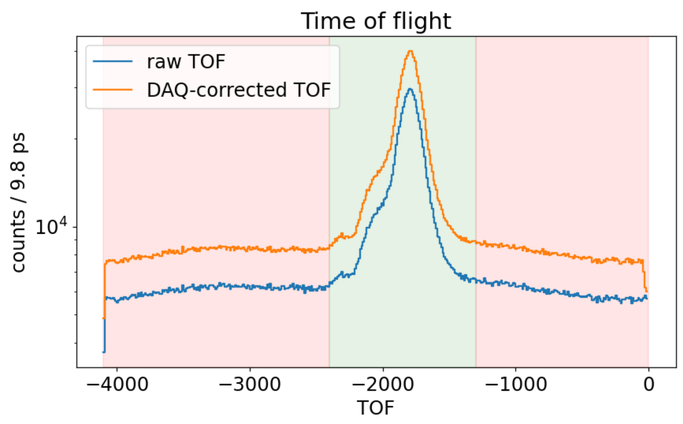
This block catches your eye, so **important stuff** should probably go here.

Curabitur eu libero vehicula, cursus est fringilla, luctus est. Morbi consectetur mauris quam, at finibus elit auctor ac. Aliquam erat volutpat. Aenean at nisl ut ex ullamcorper eleifend et eu augue. Aenean quis velit tristique odio convallis ultrices a ac odio.

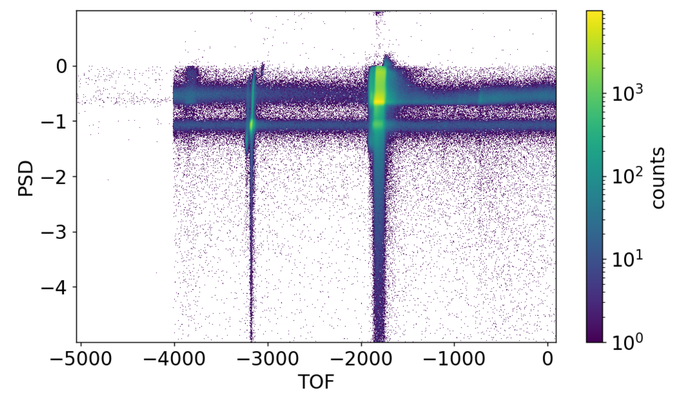
- **Fusce dapibus tellus** vel tellus semper finibus. In consequat, nibh sed mattis luctus, augue diam fermentum lectus.
- **In euismod erat metus** non ex. Vestibulum luctus augue in mi condimentum, at sollicitudin lorem viverra.
- **Suspendisse vulputate** mauris vel placerat consectetur. Mauris semper, purus ac hendrerit molestie, elit mi dignissim odio, in suscipit felis sapien vel ex.

Aenean tincidunt risus eros, at gravida lorem sagittis vel. Vestibulum ante ipsum primis in faucibus orci luctus et ultrices posuere cubilia Curae.

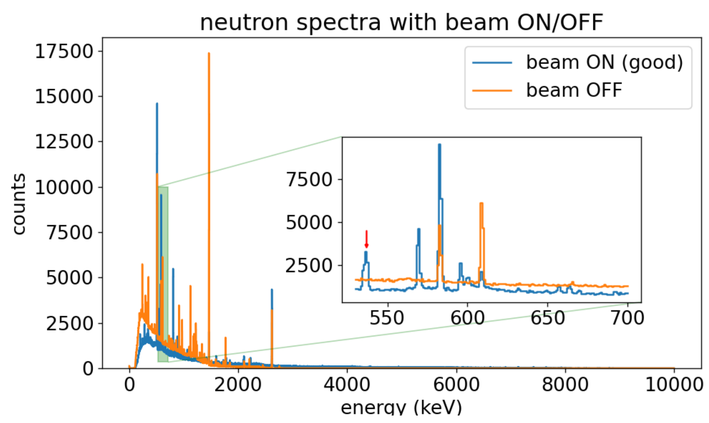
Neutron activation at DUKE: TUNL TANDEM beam



Time of flight spectrum of events from TANDEM accelerator detected in HPGe



PSD vs TOF to validate our TOF cut performed on data



Neutron spectrum and first excited state of ^{100}Mo

1. **Morbi mauris purus**, egestas at vehicula et, convallis accumsan orci. Orci varius natoque penatibus et magnis dis parturient montes, nascetur ridiculus mus.
2. **Cras vehicula blandit urna ut maximus**. Aliquam blandit nec massa ac sollicitudin. Curabitur cursus, metus nec imperdiet bibendum, velit lectus faucibus dolor, quis gravida metus mauris gravida turpis.
3. **Vestibulum et massa diam**. Phasellus fermentum augue non nulla accumsan, non rhoncus lectus condimentum.

Fusce aliquam magna velit

Et rutrum ex euismod vel. Pellentesque ultricies, velit in fermentum vestibulum, lectus nisi pretium nibh, sit amet aliquam lectus augue vel velit. Suspendisse rhoncus massa porttitor augue feugiat molestie. Sed molestie ut orci nec malesuada. Sed ultricies feugiat est fringilla posuere.

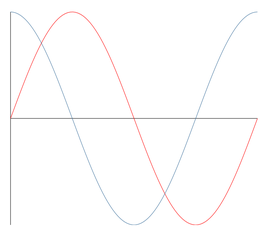


Figure 1. Another figure caption.

Nam cursus consequat egestas

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- **Sed consequat** id ante vel efficitur. Praesent congue massa sed est scelerisque, elementum mollis augue iaculis.
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  - Fusce ornare dignissim nisi. Nam sit amet risus vel lacus tempor tincidunt eu a arcu.
  - Donec rhoncus vestibulum erat, quis aliquam leo gravida egestas.
- **Sed luctus, elit sit amet** dictum maximus, diam dolor faucibus purus, sed lobortis justo erat id turpis.
- **Pellentesque facilisis dolor in leo** bibendum congue. Maecenas congue finibus justo, vitae eleifend urna facilisis at.

A highlighted block containing some math

A different kind of highlighted block.

$$\int_{-\infty}^{\infty} e^{-x^2}\,dx = \sqrt{\pi}$$

Interdum et malesuada fames $\{1, 4, 9, \ldots\}$ ac ante ipsum primis in faucibus. Cras eleifend dolor eu nulla suscipit suscipit. Sed lobortis non felis id vulputate.

A heading inside a block

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Another heading inside a block

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First column	Second column	Third column	Fourth
Foo	13.37	384,394	α
Bar	2.17	1,392	β
Baz	3.14	83,742	δ
Qux	7.59	974	γ

Table 1. A table caption.

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References

[1] Claude E. Shannon. A mathematical theory of communication. *Bell System Technical Journal*, 27(3):379–423, 1948.