



Gamma - Nucleus Interaction

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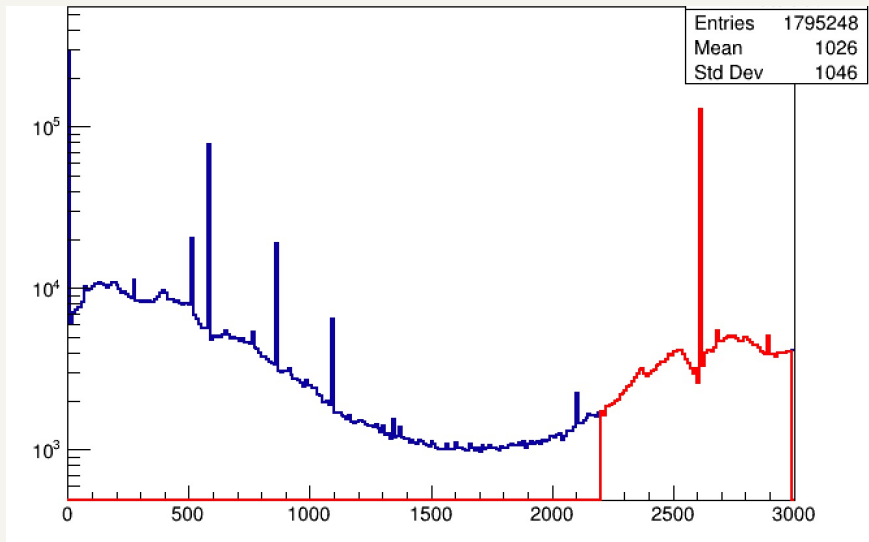
Motivation

- ❖ Shawn Westerdale presented the possibility of 400keV neutrons being produced from the PMMA:
 - https://agenda.infn.it/event/28537/contributions/144689/attachments/85220/113058/gamman_01oct2021.pdf
- ❖ Hypothesis:
 - Gammas produced from other detector materials (particularly those from the ^{208}Tl line) could cause the production of neutrons in the PMMA.
- ❖ Therefore the flux of gammas from the ^{208}Tl with an energy $> 2.2\text{MeV}$ was investigated.
- ❖ This was chosen as the 2.6MeV line of ^{208}Tl has a branching ratio of 99%.
- ❖ Interested in gammas that cross the acrylic surface so look for deposits in the acrylic or the TPC argon.



Flux of Gammas

Prompt_qdepMat[7] + Prompt_qdepMat[8]



Blue is the energy deposited in the PMMA and active argon.

Red is after 2.2MeV Cut.

Can clearly see the 2.6MeV line of Tl.
Suspect that, on average, there is > 1 gamma per decay

- ❖ Generated gammas from the ^{232}Th chain.
- ❖ Selected only gammas from ^{208}Tl line (using the pdg).
- ❖ Plotted the energy deposited in the PMMA and the TPC active argon.

For TPC PDM's

- ❖ Total number of primaries:
 - $1.80\text{E}+6$
- ❖ Total depositing > 2.2MeV:
 - $4.13\text{E}+5$
- ❖ Fraction of total gammas generated:
 - 0.23
- ❖ ~23% gamma events result in a deposit > 2.2MeV



For all Components

Location	Fraction above 2.2MeV	Th ²³² Activity [Bq]	Rate (Hz)
TPC PDUs	0.230	4.76E+00	1.09E+00
Acrylic	0.117	3.30E+00	3.86E-01
Veto PDUs	0.069	2.81E+00	1.94E-01
Titanium Vessel	0.006	1.10E+00	6.60E-03
Cryostat	0	7.30E+04	0.00E+00
Total Rate			1.68E+00

← Largest contribution

- ❖ Fraction of events above 2.2MeV calculated using Monte Carlo simulation (selecting TI line, etc, described in previous slide).
- ❖ Th²³² activity from materials spreadsheet.
- ❖ Rate calculated by multiplying the fraction of events > 2.2MeV by the Th²³² activity.
- ❖ Can use the activity of Th even though we are selecting TI as the Th chain is in secular equilibrium.



Conclusions

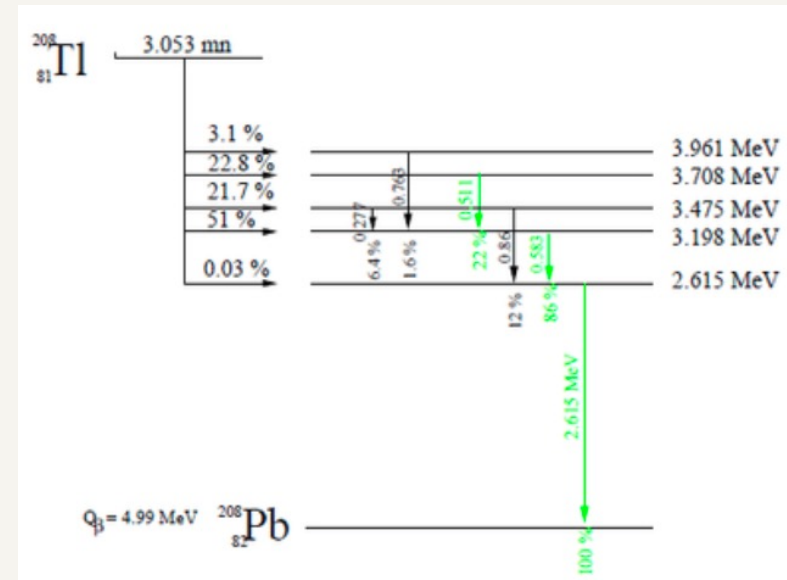
- ❖ Total rate from all components is 1.68Hz.
- ❖ The largest component is from the TPC PDU's, 1.09Hz.
- ❖ Need to update this with the most recent activity estimates.
- ❖ Can be used as input to estimate the rate of neutrons produced.



Back-up - Deposits $> 2.6\text{MeV}$

- ❖ The 2.6MeV gamma is the most probable.
- ❖ However, there is a transition with a probability of 86% and another with a probability of 22%.
- ❖ Both of these mean that it is likely to have more than one gamma per decay.
- ❖ This is the suspected reason for having deposits with an energy $> 2.6\text{MeV}$.

^{208}Tl Transitions



Back-up

^{232}Th Decay Chain

