Gamma – Nucleus Interaction

Update in PLAN_C

17/05/2022

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Summary: previous simulation

- Estimated gammas flux from energy deposits (simulation in PLANC geometry)
  - Plotted the energy deposited in the PMMA and the TPC active argon and define the gammas fraction due the Tl-line (above 2.2 MeV)

Location	Fraction above 2.2MeV	Th Activity [Bq]	Tl Activity [Bq]	Rate [Hz]
TPC PDUs	2.30E-01	4.76E+00	1.67E+00	3.83E-01
Acrylic	**1.17E-01**	**3.30E+00**	**1.16E+00**	**1.35E-01**
Veto PDUs	6.90E-02	2.81E+00	9.84E-01	6.79E-02
Titanium Vessel	6.00E-03	1.10E+00	3.85E-01	2.31E-03
Cryostat	0.00E+00	7.30E+04	2.56E+04	0.00E+00

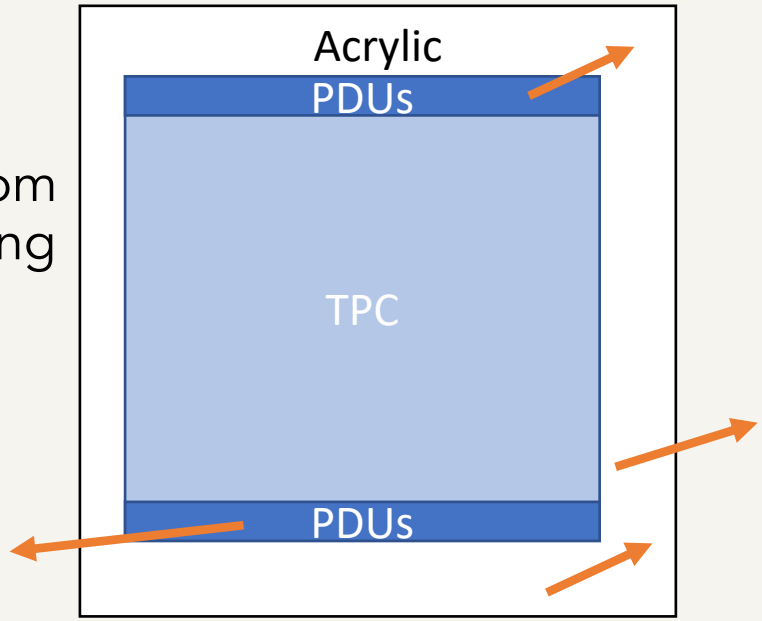
- New simulation including kinetic energy & Investigate the flux of individual gammas. The simulation was done in PLAN A geometry

Location	# gammas above 2.2MeV	Total Tl Gammas	Fraction above 2.2MeV	Tl Activity [Bq]	Rate [Hz]
TPC PDU's	1.41E+04	1.45E+05	9.70E-02	1.67E+00	**1.62E-01**
Acrylic	**1.59E+02**	**3.11E+03**	**5.12E-02**	**1.16E+00**	**5.91E-02**

New Simulation: PLANC

- Investigate the flux of individual gammas, previously looking at events and so may be including multiple gammas.
- Created a new G4DS simulation storing the kinetic energy of the gammas travelling through the acrylic. (AcrylicTPCVessel volume, including top&bottomTPC)
- Ran the simulation for the TPC PDUs and the Acrylic.
- Perform the same analysis (next slide) as before but counting the number of gammas.

Example of gammas from PDU's or Acrylic travelling through in the acrylic.

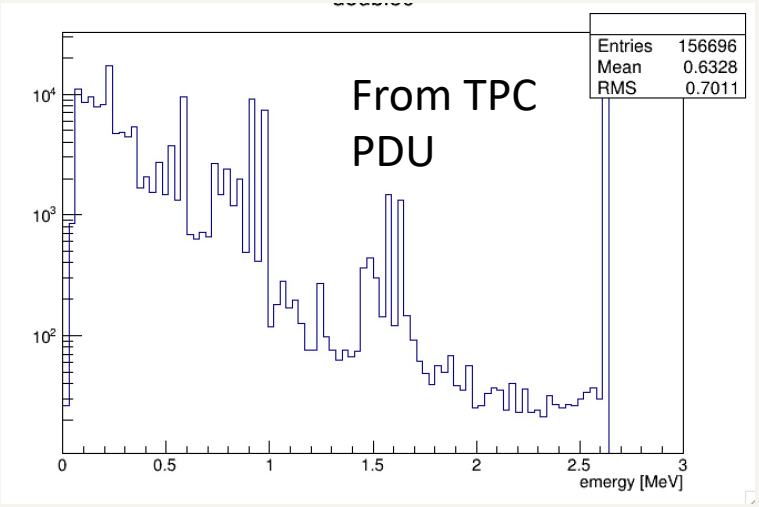


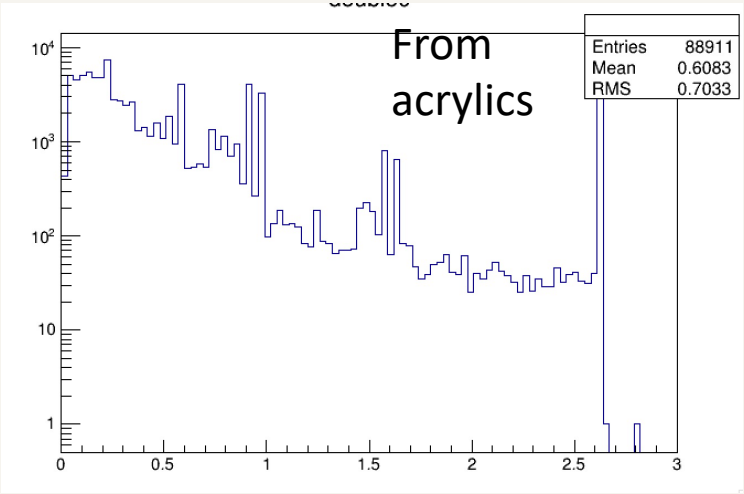
New Sim – Selecting Tl

- Select Tl events and then evaluate the number of gammas with an energy>2.2MeV when crossing the acrylic.

Location	# gammas above 2.2MeV	Total Tl Gammas	Fraction above 2.2MeV	Tl Activity [Bq]	Rate [Hz]
TPC PDU's	8.47E+03	1.80E+04	4.71E-01	1.67	7.87E-01
Acrylic	3.31E+03	7.82E+03	4.23E-01	1.16E+00	4.91E-01

Kinetic energy distribution





Doule Checking Gamma Sim

- Comparison between two computation method (kinetic energy & deposits), considering Gd-acrlycs:
  - Fraction above 2.2 MeV looking kinetic energy **0.42**
  - Fraction above 2.2 MeV looking energy deposit 0.17
- Discrepancy fixed: in the energy deposit looking only the deposit in pure acrylics and not in the Gd-acrylics -> redo analysis including Gd-acrlycs
  - Fraction above 2.2 MeV looking energy deposit **0.40**

- Similar results for gamma fraction considering cut on energy kinetic & energy deposit

Alpha, n

- Compare the gamma flux to the flux of alphas to determine whether (alpha, n) is dominant over (gamma, n).
- Roberto's back of the envelope calculation shows that:
  - alpha,n dominates over gamma,n: (a, n) / (g , n) = 70x44
- Compare the flux of alphas to that of gammas to confirm that (alpha, n) dominates.

Element	No Alphas in chain	Activity (from budget) [Bq]	Rate of Alphas [Hz]	
U	8	3.40E+01	2.72E+02	Summed activity for upper, lower and mid
Th	7	3.30E+00	2.31E+01	Old value for activity, current value is lower
		Total	2.95E+02	

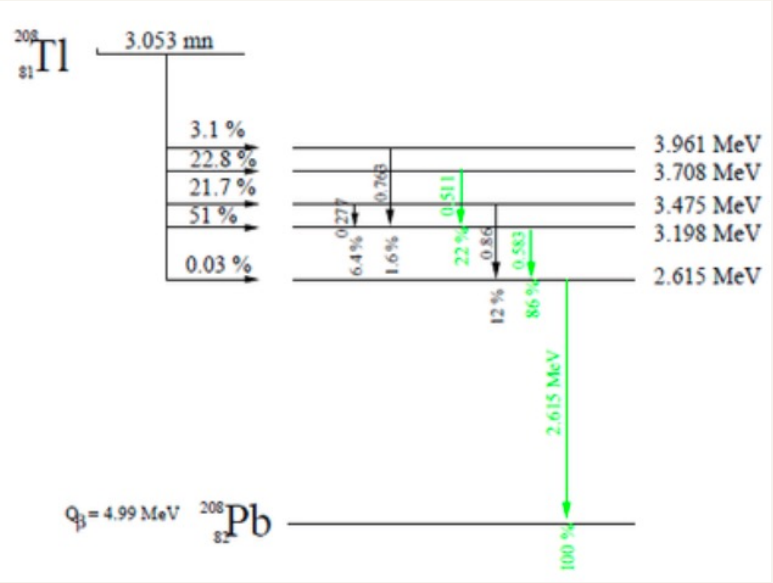
- Total flux of alpha's: 2.95×10^2
- Total gamma flux (TPC PDU's + acrylic): 1.28
- Therefore alpha flux >> gamma flux so (gamma, n) is subdominant.

Back Up

Back-up – Deposits > 2.6MeV

- 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 > 2.6MeV.

^{208}Tl Transitions



Back-up

^{232}Th Decay Chain