



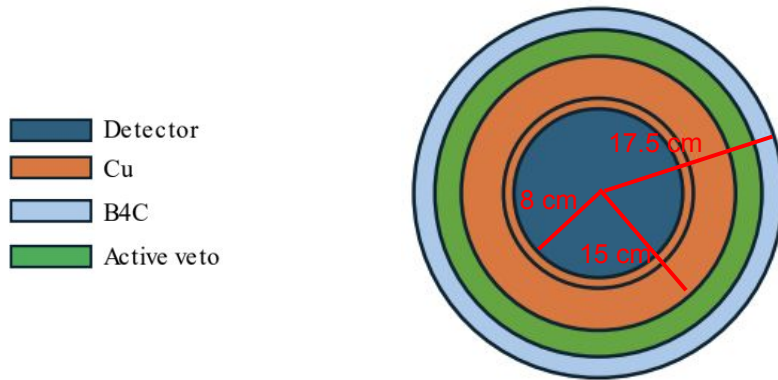
Internal shielding for BULLKID-DM at LNGS

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Digest, 12/11/2025

Internal shielding

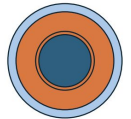
- Original proposal exceeded the mass limit inside the cryostat
- NEW1 was proposed (sent by Angelo)
 - 1 cm of ultrapure copper
 - 6 cm of external copper for sides and bottom of the detector
 - 12 cm of external copper on top of the detector
 - 2 cm of B₄C
- Total mass of 232.8 kg



Configuration: New1

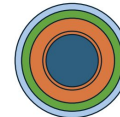
Name:	NEW_1									
Description:	Internal Copper, no active veto									
Element	Name	IR [dm]	OR [dm]	t_lat [dm]	t_up [dm]	t_down [dm]	cyl_height [dm]	Density [kg/dm ³]	weight [kg]	
1	Detector	0	0.8				1.6			
2	Ultrapure Cu	0.8	0.9	0.1	0.1	0.1	1.6	8.96	12.22	
3	External Cu	0.9	1.5	0.6	1.2	0.6	1.8	8.96	186.96	
4	B4C	1.55	1.75	0.2	0.2	0.2	3.6	2.53	28.62	
Total									232.8016	

60 mm Cu, 20 mm B₄C, 10 mm Cu
t_{up} = 120 mm



to procure copper sheets with a thickness of 60 mm

We can include the active veto option using sheets with 40 mm and 20 mm thicknesses

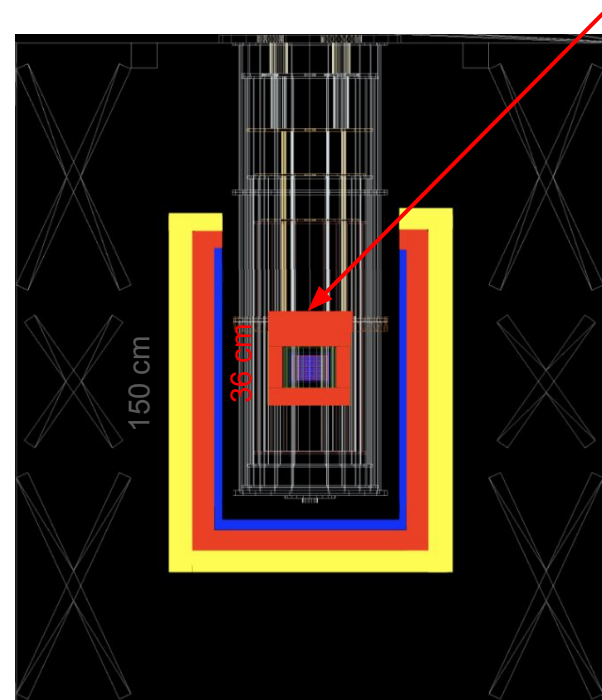


Internal shielding

- Considering external shielding plus internal copper shielding (no B4C)
- Main gamma contributions simulated

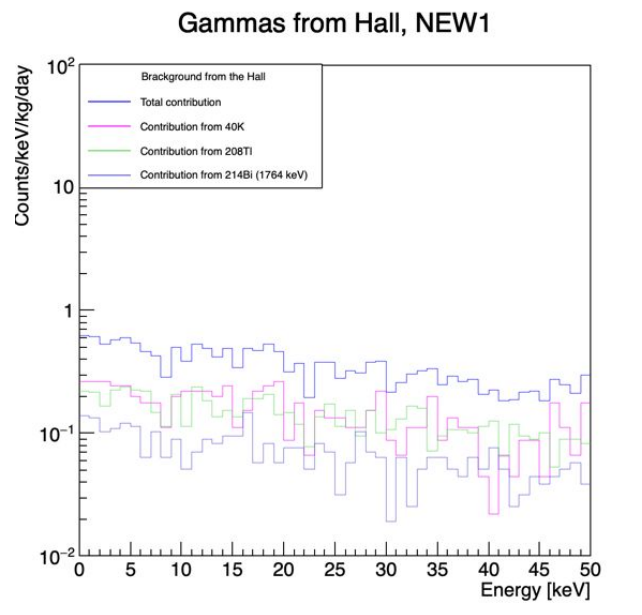
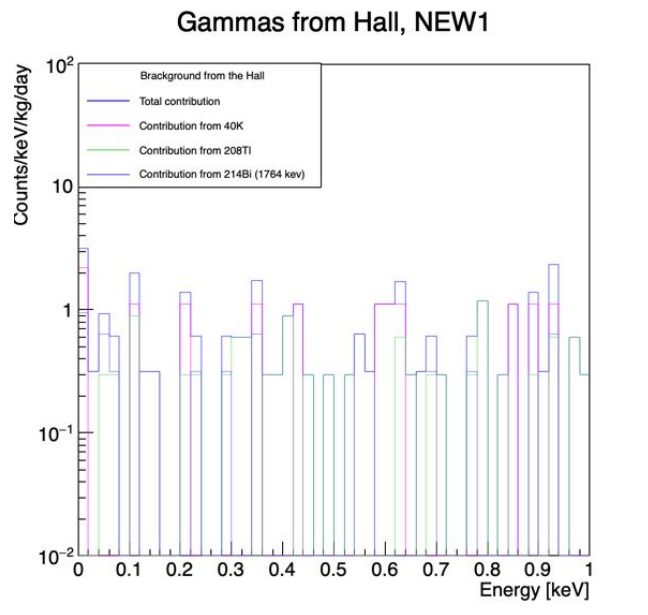
NEW1

Isotope	Energy [keV]	Intensity [$\text{cm}^{-2}\text{s}^{-1}$] $\times 10^{-3}$
^{208}Tl	2614	9.03
^{214}Bi	1764	9.49
^{40}K	1460	33.56



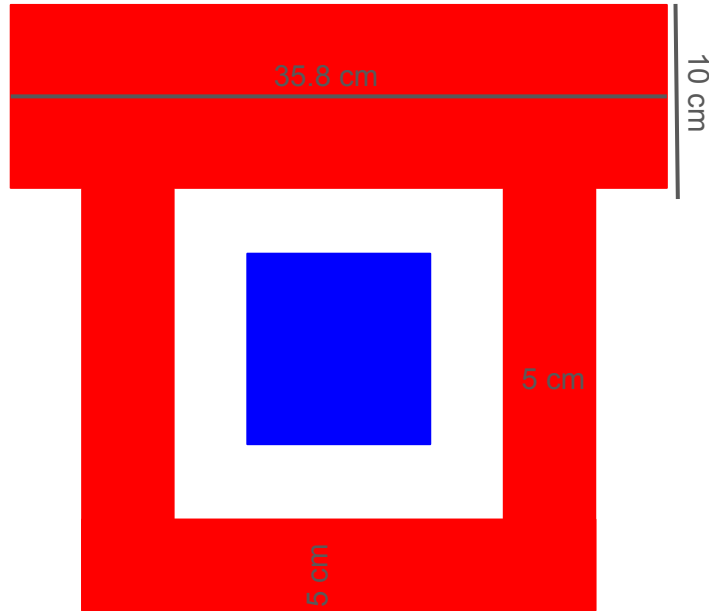
Internal shielding: background contribution with NEW1

- We are close to 1 dru!
 - the rest of the gamma lines contribution will increase a little bit the background



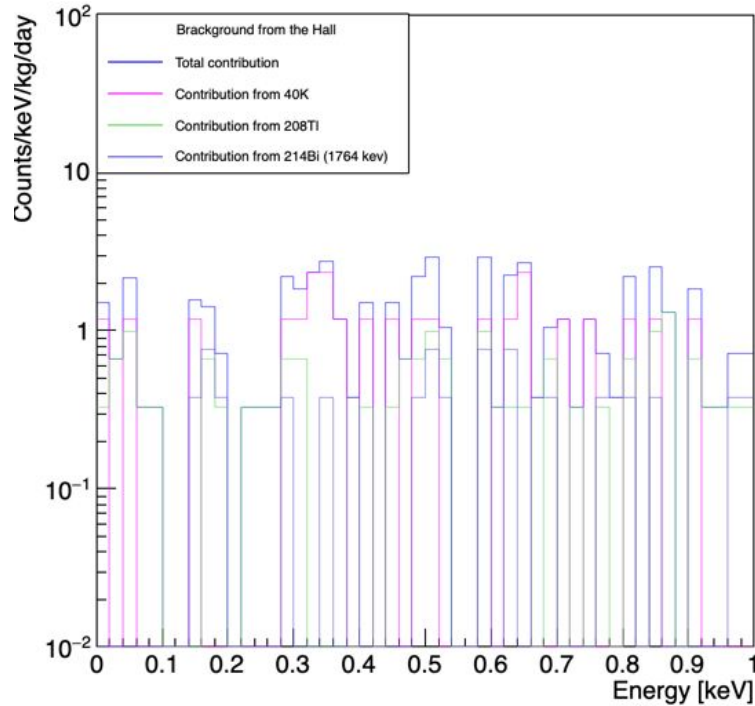
Internal shielding: tuning the internal shielding

- Increasing the radius maintaining the copper mass, radius from 15 cm to 17.9 cm
 - 10 cm on top, 5 cm + 1 cm on sides and bottom
 - 8 cm on top, 6 cm + 1 cm on sides and bottom

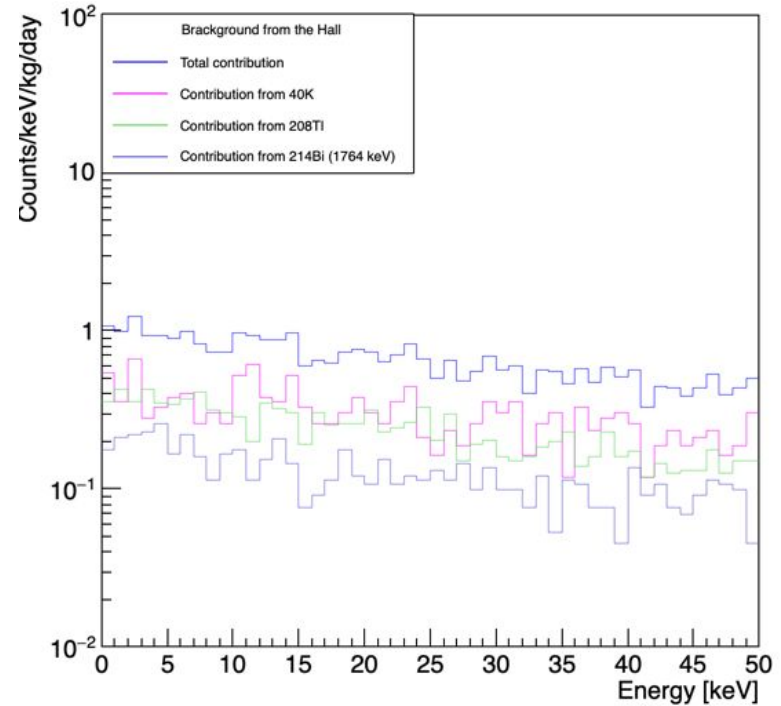


- Radius = 17.9 cm, 10 cm on top, 5 cm sides and bottom

Gammas from Hall, $r=179\text{mm}$, $h=10\text{cm}$

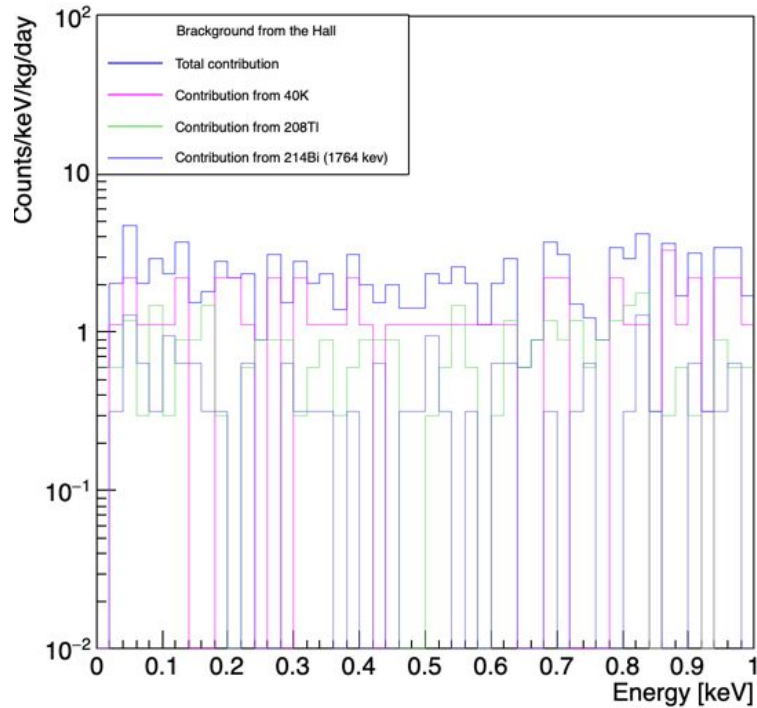


Gammas from Hall, $r=179\text{mm}$, $h=10\text{cm}$

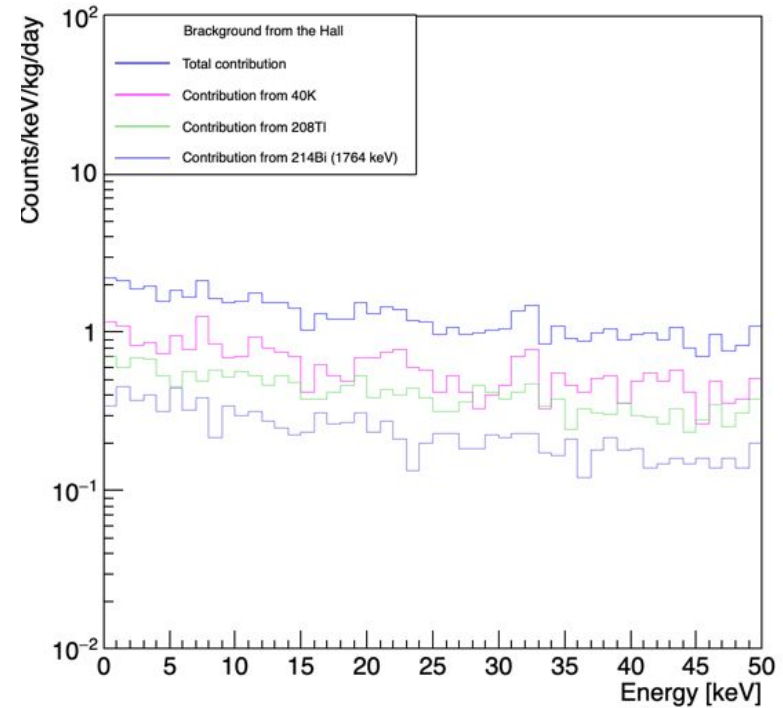


- Radius 17.9 cm, 8 cm on top, 6 cm sides and bottom

Gammas from Hall, $r=179\text{mm}$, $h=8\text{cm}$

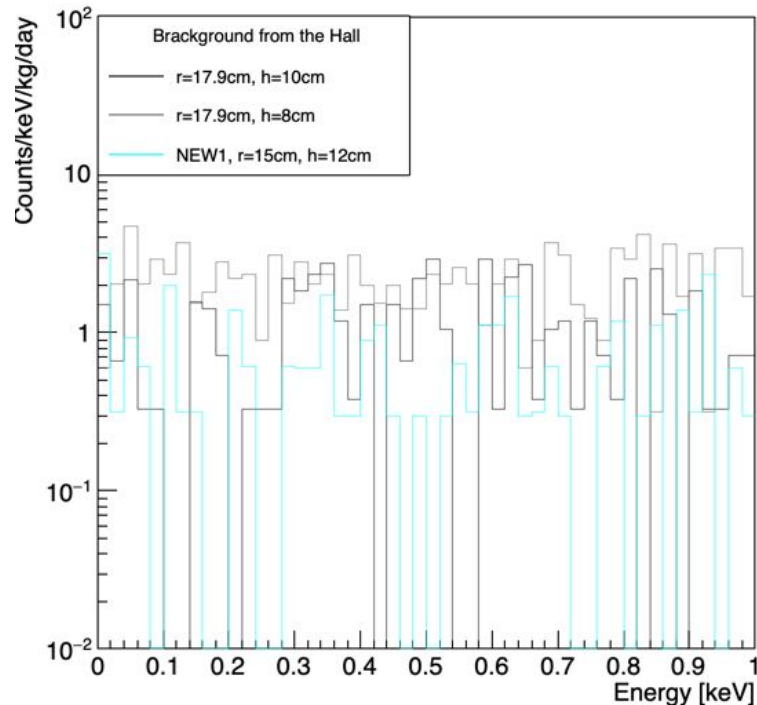


Gammas from Hall, $r=179\text{mm}$, $h=8\text{cm}$

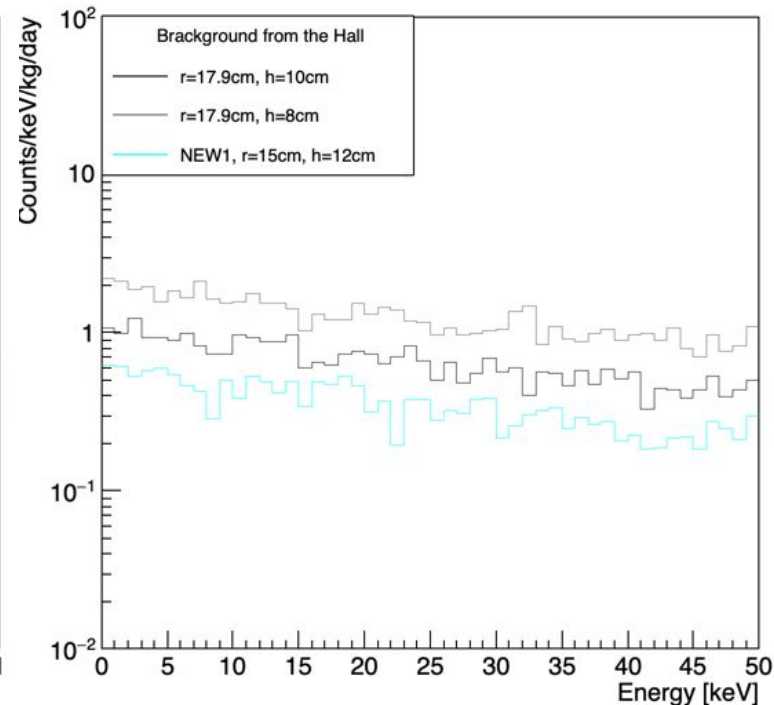


- The amount of copper on top has a major impact on reducing the background than the increase of the radius

Comparison



Comparison



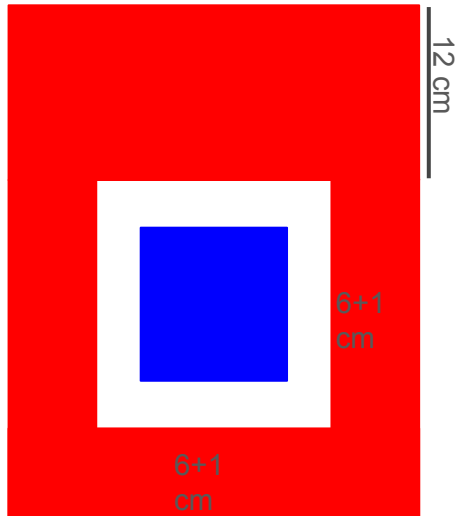
Top: 8 cm
side: 6 + 1 cm
 $r = 17,9\text{ cm}$

Top: 10 cm
side: 5 + 1 cm
 $r = 17.9\text{ cm}$

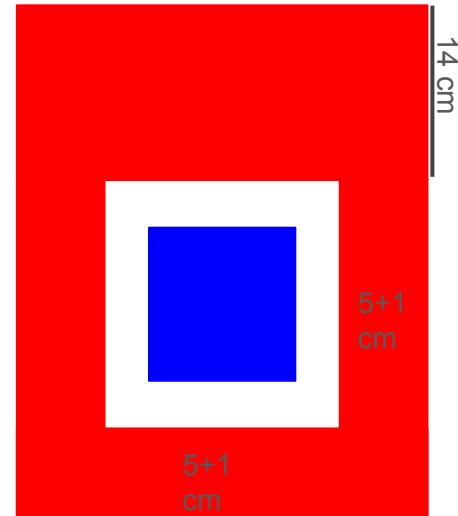
Top: 12 cm
side: 6 + 1 cm
 $r = 15\text{ cm}$

Next model

- Keep NEW1
- Sides and bottom to be reduced, increase the top
 - sides and bottom 5 + 1 cm
 - top $\square$ 14 cm
- It will start run soon
- These simulations must be performed with the full shield



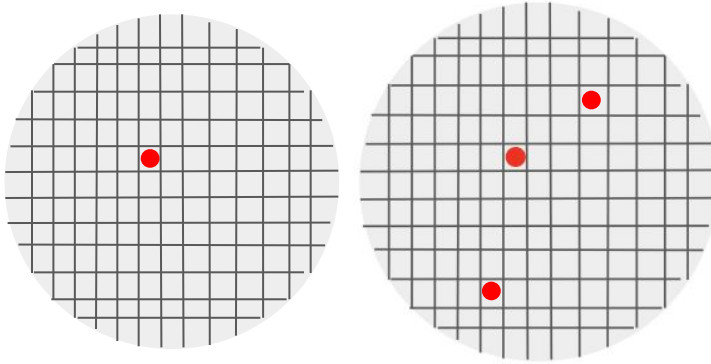
NEW1



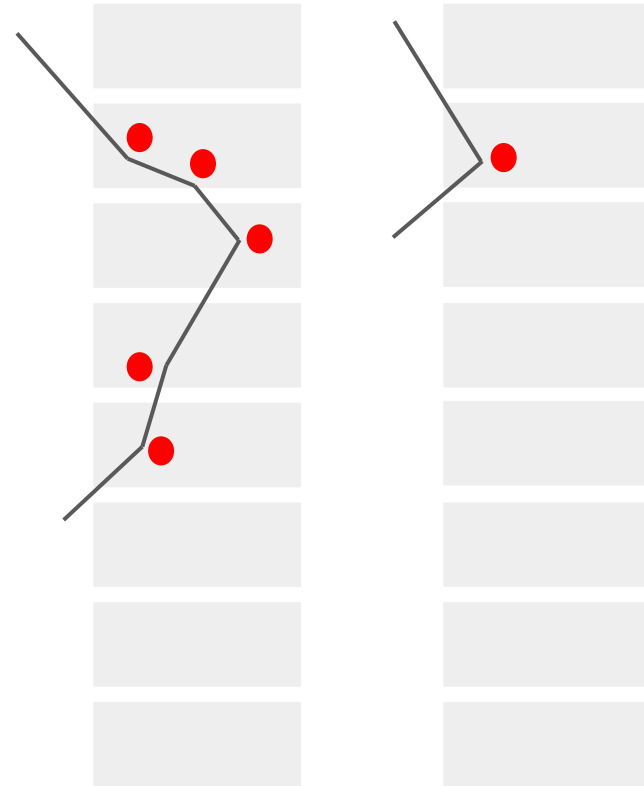
Next model

Cuts to implement

- Results presented so far consider
 - cut of the 8 neighboring dice
- What happens if we include cuts on:
 - single hit per wafer

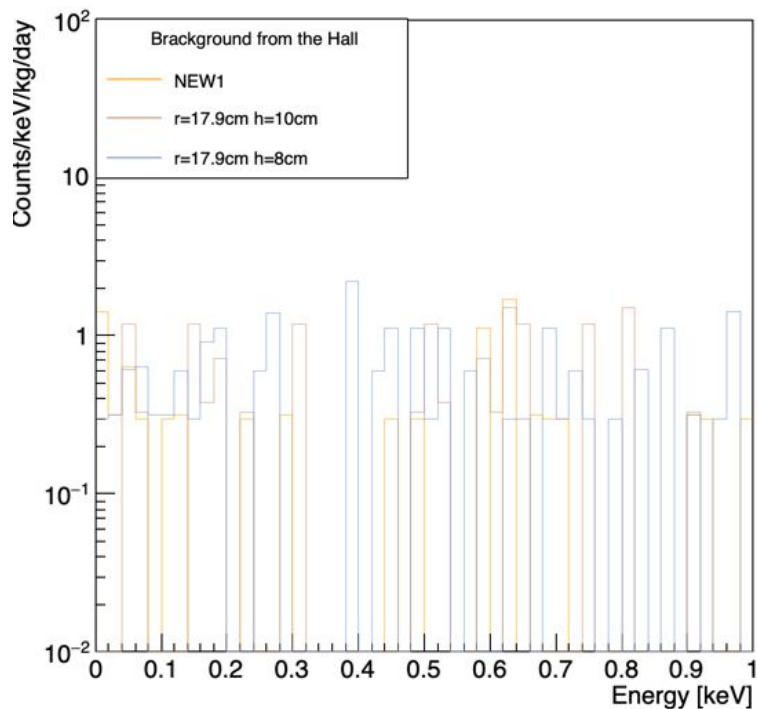


- single hit in the 16 wafer stack

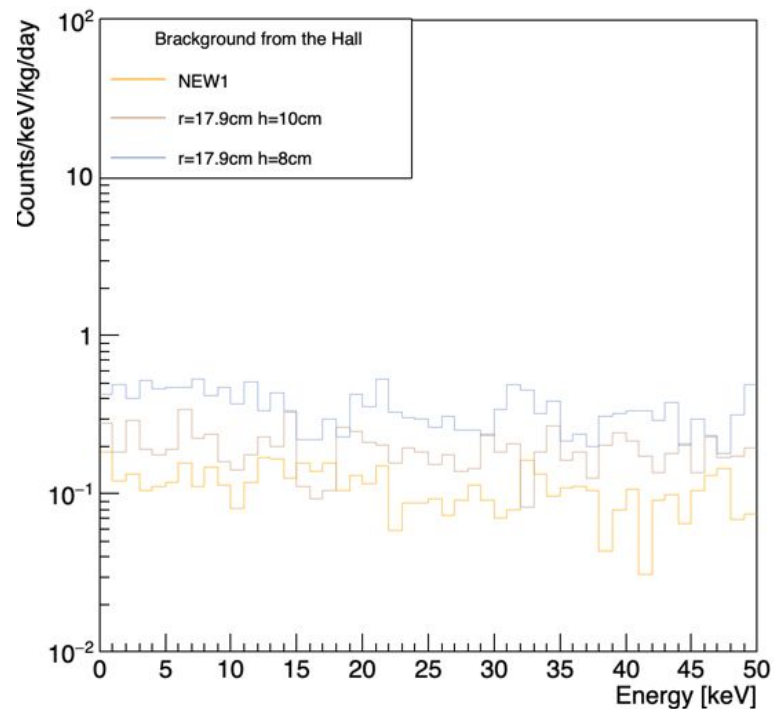


Single hit in 16 wafer stack

All Cuts Comparison

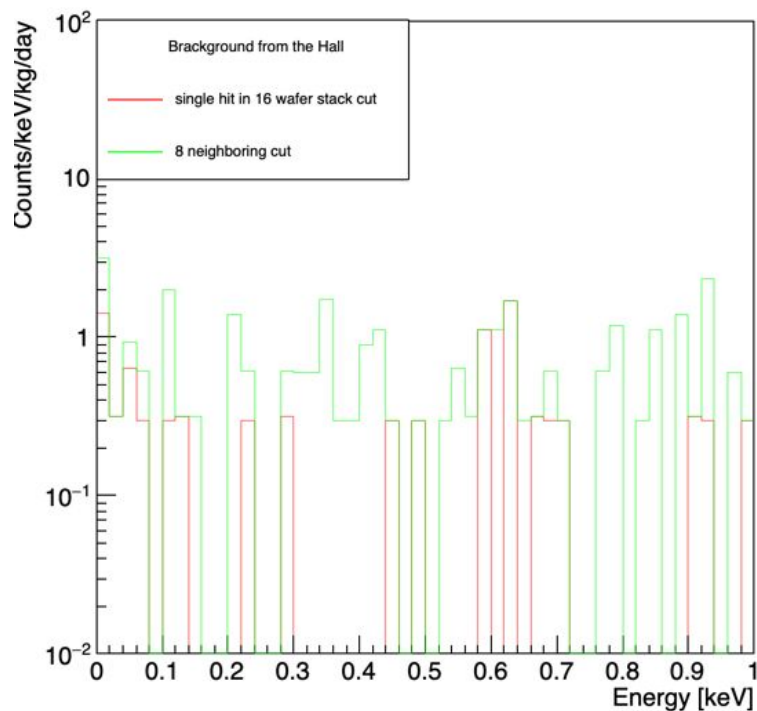


All Cuts Comparison

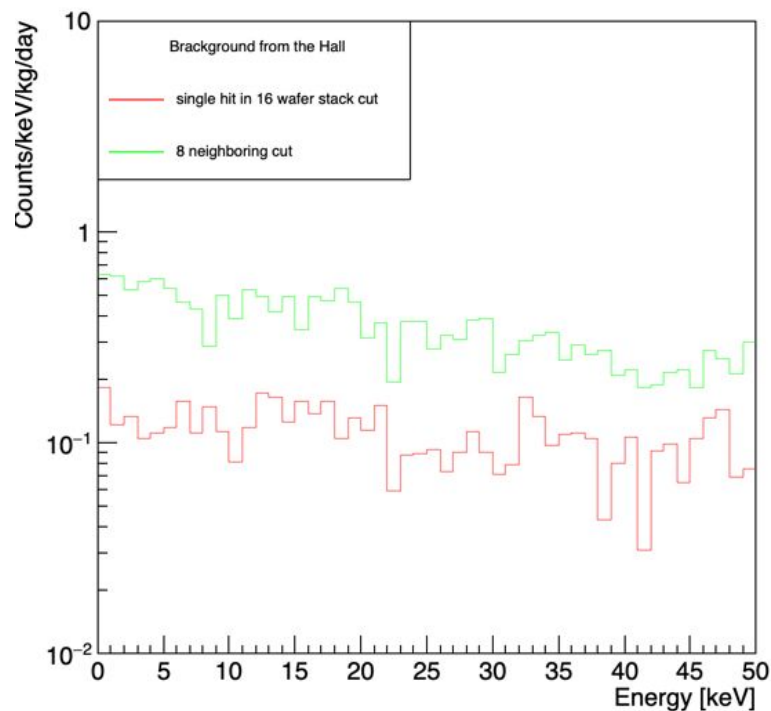


Comparison 8 neighboring vs single hit in 16 wafer stack

Cut Comparison NEW1



Cut Comparison NEW1



Summary

- The amount of copper on top has a major impact on reducing the background more than the increase of the radius
- Including all the expected cuts (single hit in the 16 wafer stack), NEW1 is around 10^{-1} dru
- The sides and bottom could be reduce to increase the top shield (lo de la nueva diapositiva sus medidas)
- B_4C not included in the simulations
 - its effect to stop gammas is smaller than copper but will contribute to the reduction of background
- Results ready by the end of the year