



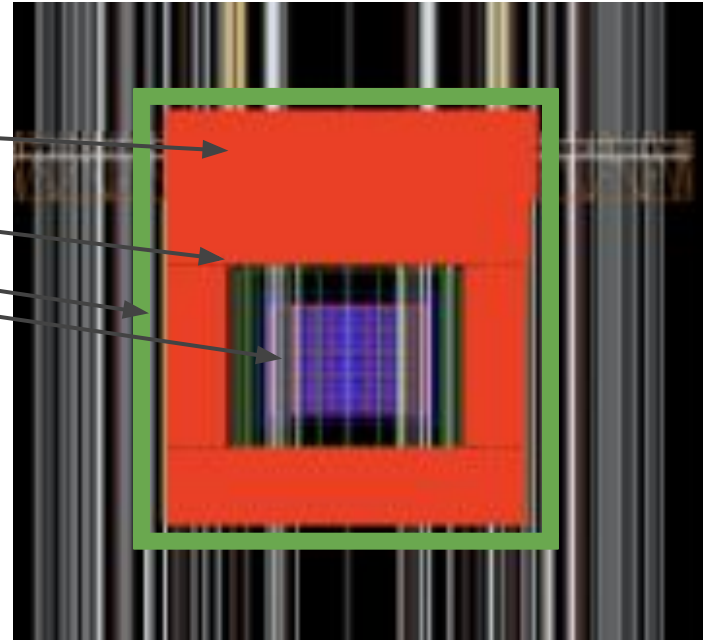
Purity assay from internal simulations for BULLKID-DM

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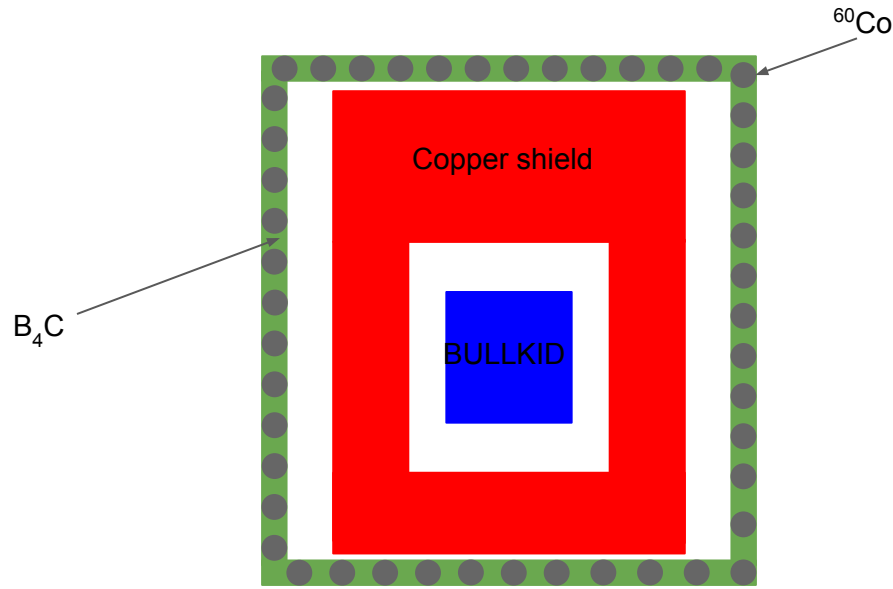
Internal contributions to the background

- Internal shielding
 - copper 6 cm
 - copper 1 cm
 - B_4C
- Holders, cables, screws, solder, PCB
- Cryostat components
 - rack
 - flanges
 - plates
 - vessels
 - shields



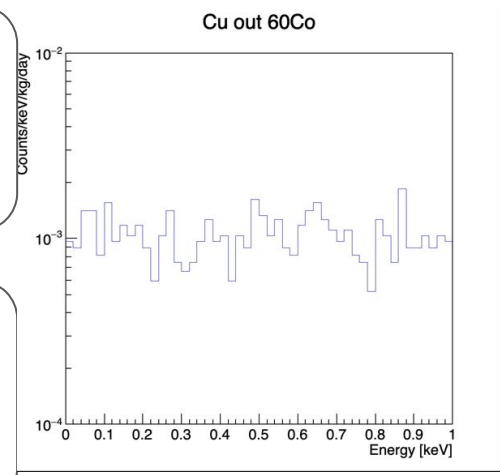
Internal contributions to the background

- Isotopes simulated inside each component
 - ^{40}K , ^{60}Co , ^{137}Cs
 - from ^{238}U : $^{234\text{m}}\text{Pa}$, ^{234}Th , ^{226}Ra , ^{214}Bi , and ^{214}Pb
 - from ^{232}Th : ^{228}Th , ^{228}Ac , ^{228}Ra , ^{212}Pb , ^{208}Tl
- Purity value fitted to reach 10^{-3} d.r.u. per 13 isotopes per 13 components
 - we reach 10^{-1} d.r.u. with all contributors



Internal contributions to the background

- After the simulation, a normalization to d.r.u. units is performed

$$\text{Rate} = \frac{\text{Counts from the simulation}}{\text{Time [s]} \times \text{Silicon mass [kg]} \times \text{Energy [keV]}}$$
$$\text{Purity [Bq/kg]} = \frac{\text{Number of isotopes simulated [desintegrations]}}{\text{Time [s]} \times \text{Component mass [kg]}}$$


- With a given time, we obtain a certain purity for the material
- The time is modified until the rate is 10^{-3} d.r.u.
- That time is used to determine the purity

Results: purity for components

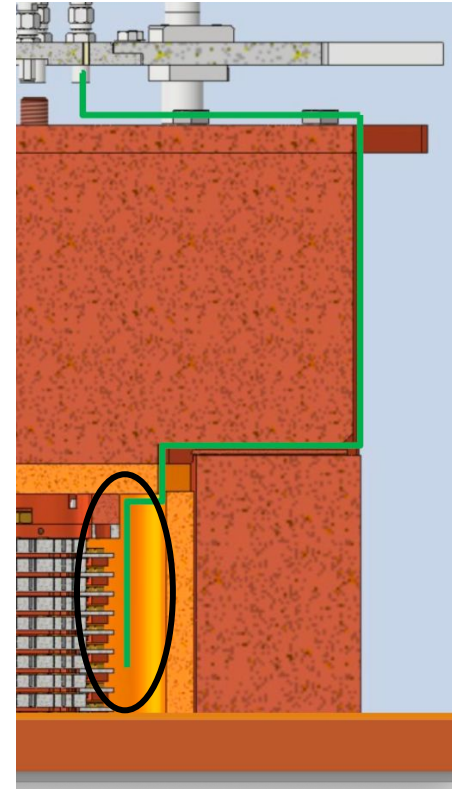
- Purity units $\mu\text{Bq/kg}$ for all cases

	^{40}K	^{60}Co	^{137}Cs	^{208}Tl	^{212}Pb	^{228}Ra	^{228}Ac	^{228}Th	^{214}Pb	^{214}Bi	^{226}Ra	^{234}Th	$^{234\text{m}}\text{Pa}$
Cu 6 cm (181 kg)	20	1	2	2	15	2570*	3	2000	9	3	355	85	4
Cu 1 cm (12 kg)	50	4	6	3	7	600	4	550	6	4	110	52	5
B ₄ C (28 kg)	950	70	390	60	950	2750*	210	2000	1300	130	42	1700	310
Holder (1 kg)	14	2	2	1	1	747	1	48	1	2	17	7	1
Cable (7×10^{-3} kg)	1710	1210	1120	1180	1285	2970*	1730	1610	1350	1290	1050	1350	1210

* Estimated from a Poisson distribution at 90% CL

Internal contributions to the background: cables

- We consider a general coaxial cable along BULLKID-DM
 - radius: 3.5 mm
 - length: 150 mm
 - the dimensions can be modified for the specific cable
- The cable closer to BULLKID-DM will be the main contributor
 - only simulated the cable running closer to the detector
- A long cylinder along the disks array, at 9.5 mm to the side of the holders, where the isotopes were simulated was created in the macro
- The mass considered is 0.45 grams/cm
 - total mass for the simulation: 6.7×10^{-3} kg

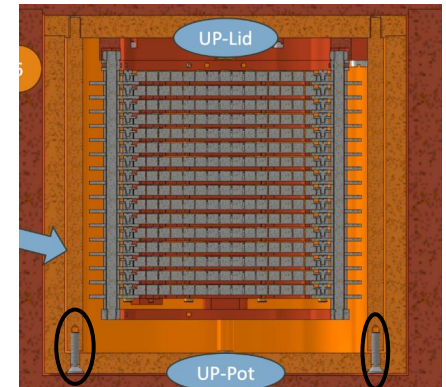
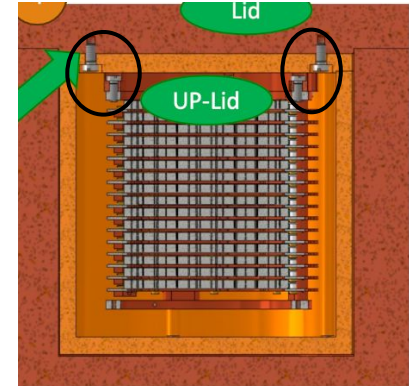


Internal contributions to the background: screws

- As with the cables, we only consider the screws closer to BULLKID-DM
- General radius dimension for screws used for metal small hardware
 - radius: 1.42 mm
 - length: 20 mm



- Considering 1.02 grams per screw for the mass
- Simulations running



Work to do

- Purity estimations for
 - solder
 - purity estimated will be compared to the radiopurity values from the sample Federico Ferraro presented at Grenoble
 - PCB
 - cryostat components

Sample:	lead free solder, LUNA
mass:	13 g
live time:	1111806 s = 12.9 d
detector:	GePaolo
radionuclide concentrations:	
Th-232:	
Ra-228:	< 32 mBq/kg
Th-228:	< 37 mBq/kg
U-238:	
Ra-226:	< 34 mBq/kg
Th-234	< 3.5 Bq/kg
Pa-234m	< 0.81 Bq/kg
U-235:	< 60 mBq/kg
K-40:	< 0.44 Bq/kg
Cs-137:	< 12 mBq/kg
Pb-210:	< 6.1 kBq/kg
Po-210:	< 830 Bq/kg
upper limits with $k=1.645$, uncertainties are given with $k=1$ (approx. 68% CL);	
Ra-228 from Ac-228;	
Th-228 from Pb-212 & Bi-212 & Tl-208;	
Ra-226 from Pb-214 & Bi-214;	
U-235 from U-235 & Ra-226/Pb-214/Bi-214;	
Pb-210 from Pb-210	
Po-210 from Po-210	