

# Background from Crystal and crystal PMTs update

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# Simulations status

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Geometry: default UPoP

Crystal: diameter 4", length 8"

## Crystal intrinsic contaminations:

Completed simulations: 40K, 87Rb, 85Kr, 238U (full chain), 232Th (full chain)

[All data analyzed.](#)

[Issues found with 228Ra, 228Ac, 234Pa](#)

## Crystal cosmogenic contaminations:

Completed simulations: Na22, Na24, 125I, 126I, 129I, 121Te, 121mTe, 123mTe, 125mTe, 127mTe, 113Sn

[Analysis ongoing](#), will be presented at next meeting

## Crystal PMT contaminations:

Completed simulations:

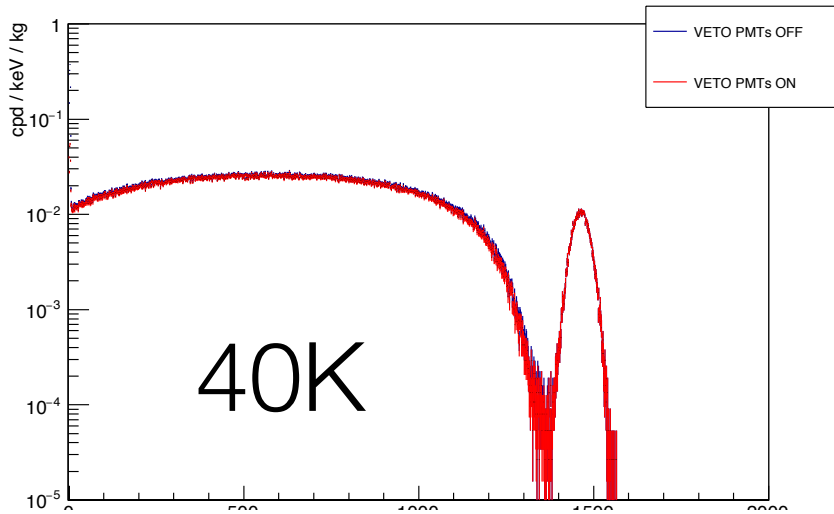
40K, 60Co, 232Th (full chain), 238U upper chain, 238U lower chain for PMT window, body and feedthrough

[All data analyzed.](#)

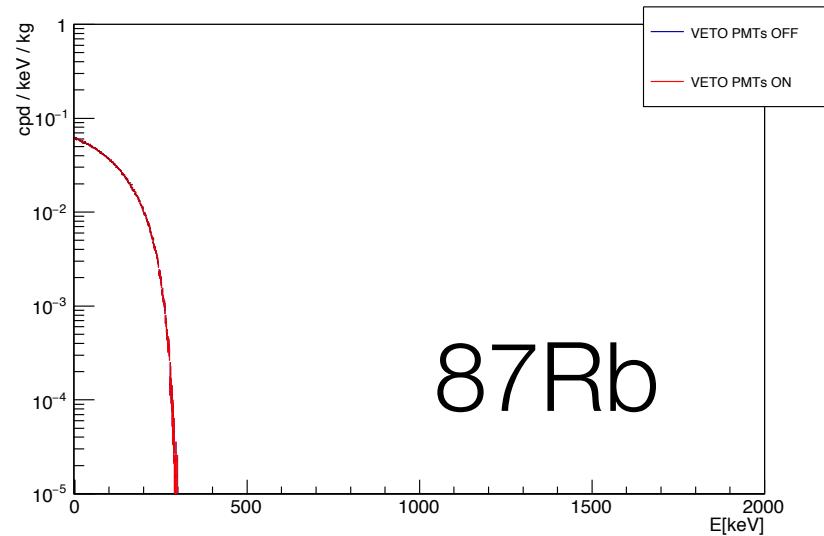
Same issues for the 238U and 232Th chains

# Background due to Crystal intrinsic contamination

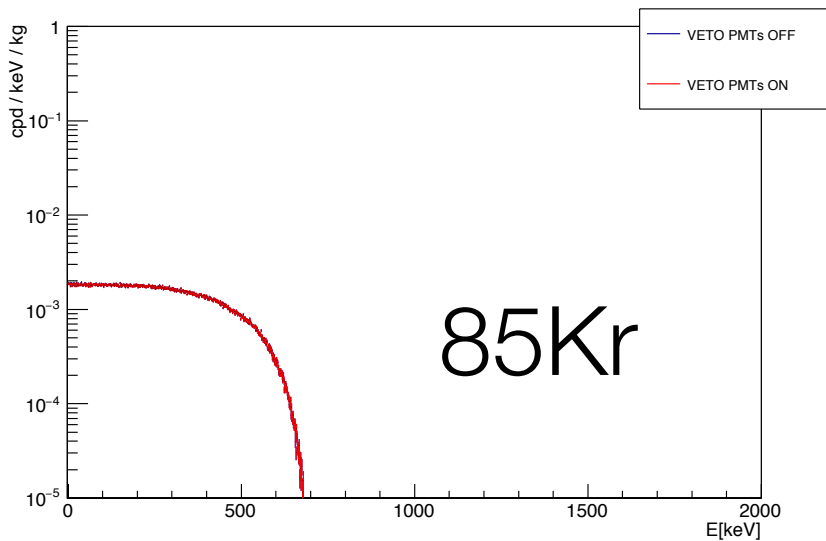
DMM background due to crystal contamination by K40



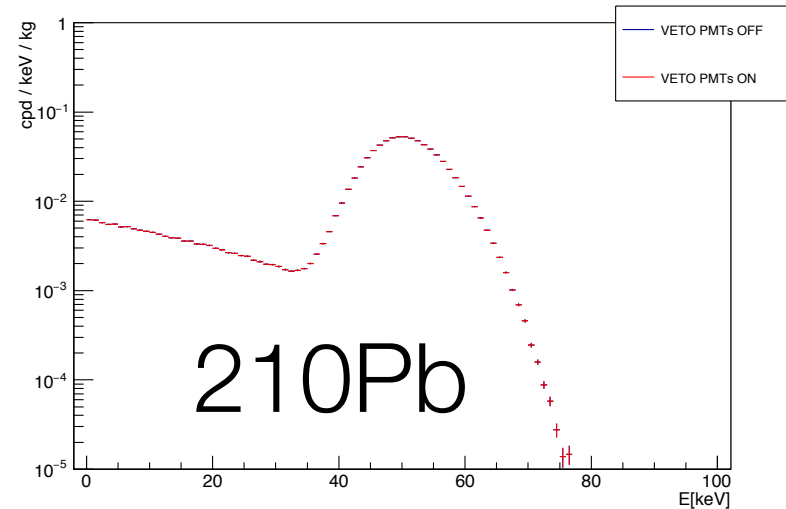
DMM background due to crystal contamination by Rb87



DMM background due to crystal contamination by Kr85

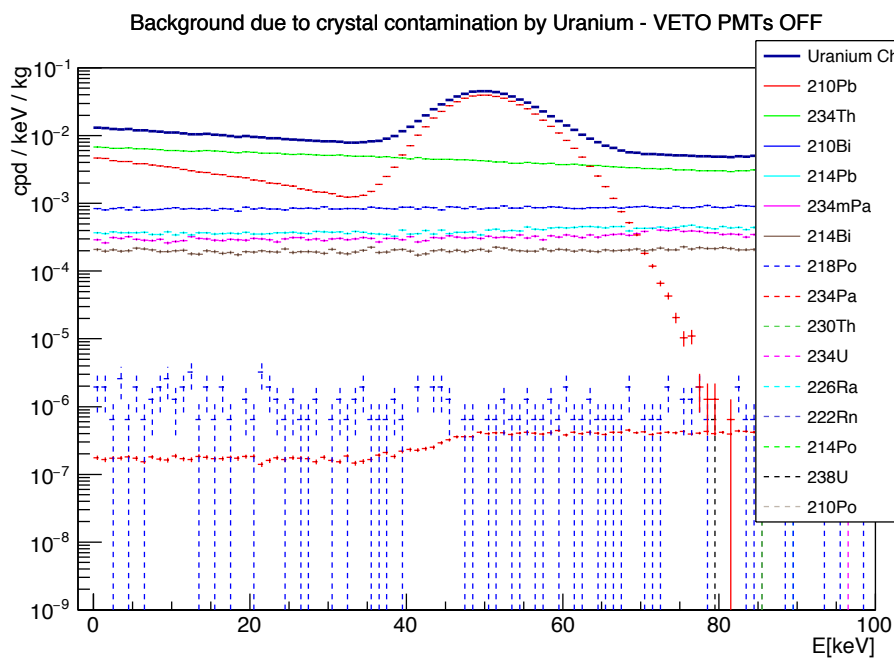


DMM background due to crystal contamination by Pb210

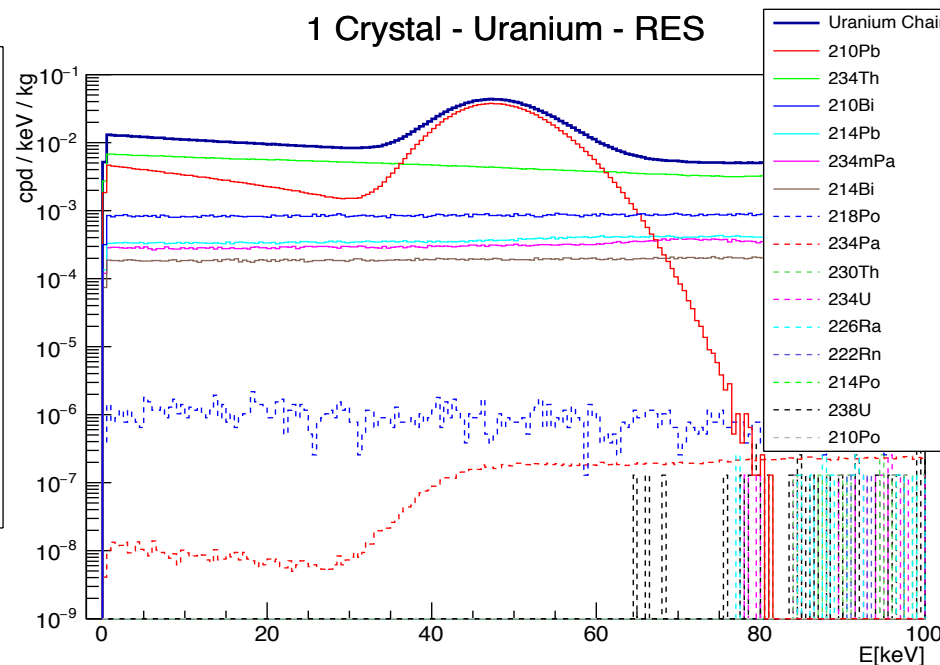


# Background due to crystal intrinsic contaminants

## $^{238}\text{U}$ (0.6 ppt) – VETO PMTs OFF



NEW – G4.10.2



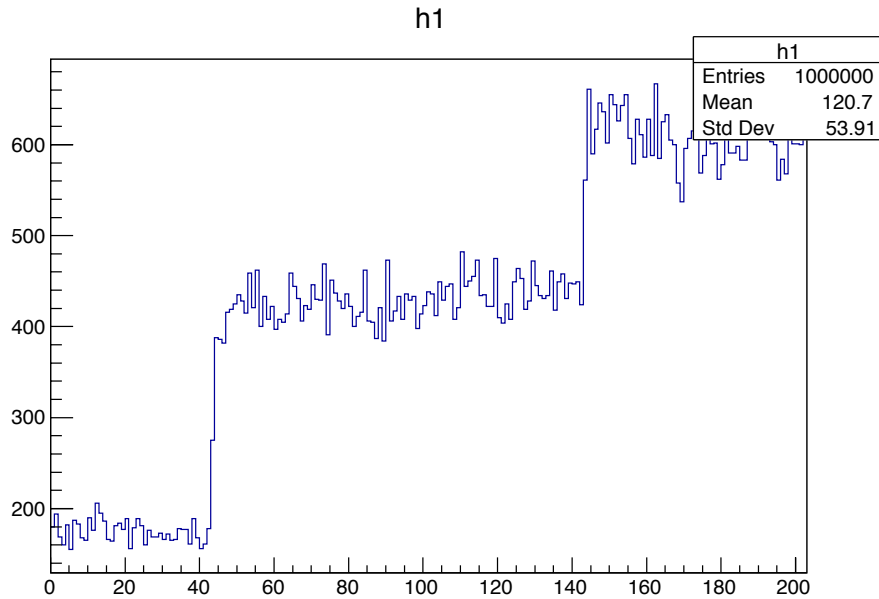
OLD – G4.10.2.b1

Good compatibility with old results, except for  $^{234}\text{Pa}$  that seems to give a higher BG ( $\sim 10^{-7}$  cpd/keV/kg vs  $\sim 10^{-8}$  cpd/keV/kg).

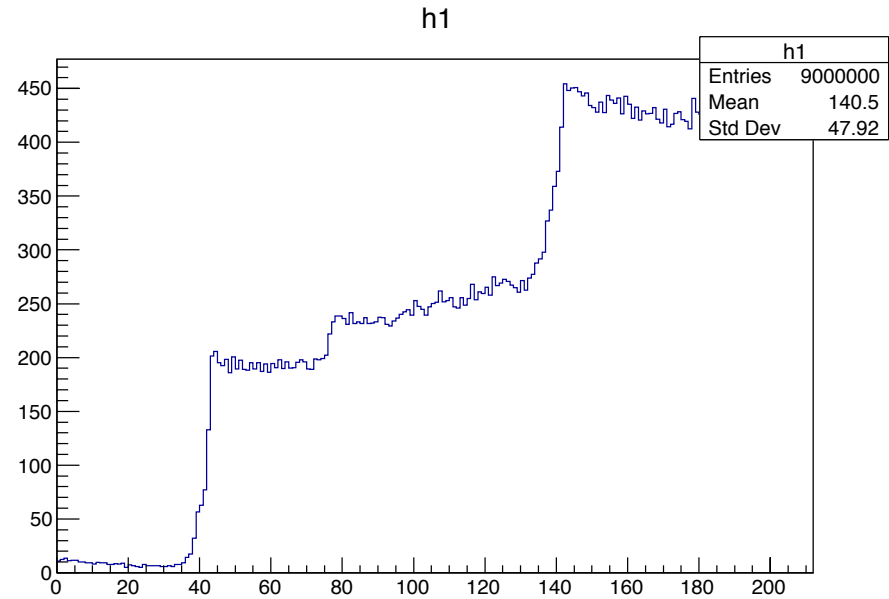
In the “OLD” result simulation was performed with a BETA VERSION of G4.10.2 while in the “NEW” result G4.10.2 was used.

# 234Pa spectrum

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G4.10.2



G4.10.2.b1

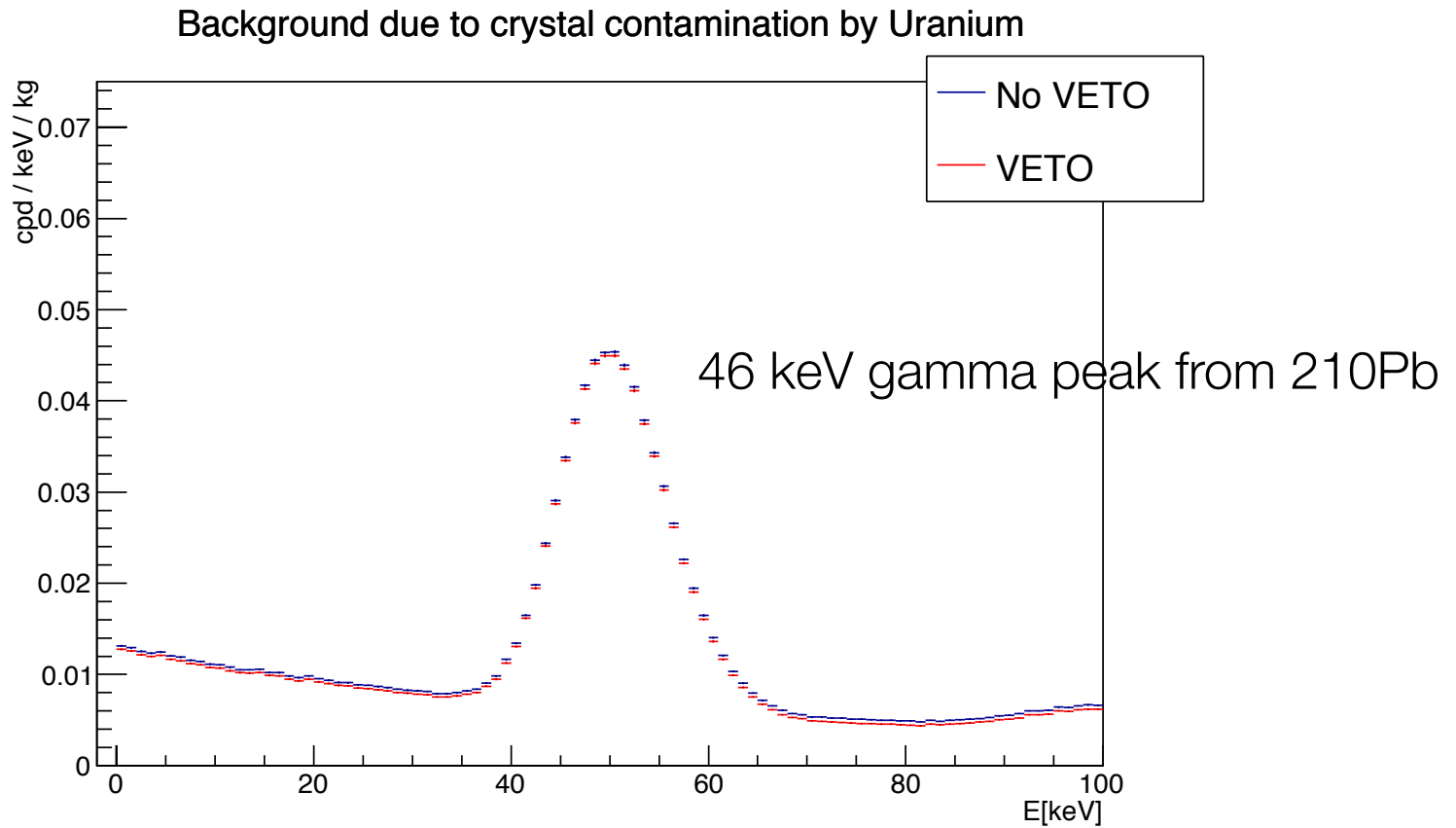
Histos are normalized to the same number of entries.

Spectra actually differ in shape and amplitude. Deeper investigation is ongoing

# Background due to crystal intrinsic contaminants

## $^{238}\text{U}$ (0.6ppt)

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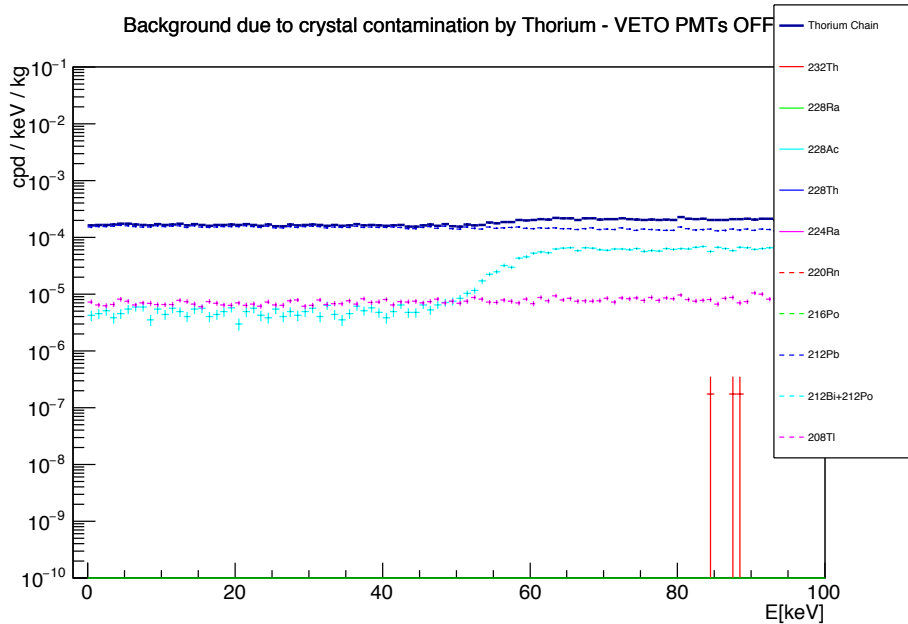


DMM:  $2.0 \times 10^{-2}$  cpd/keV/kg

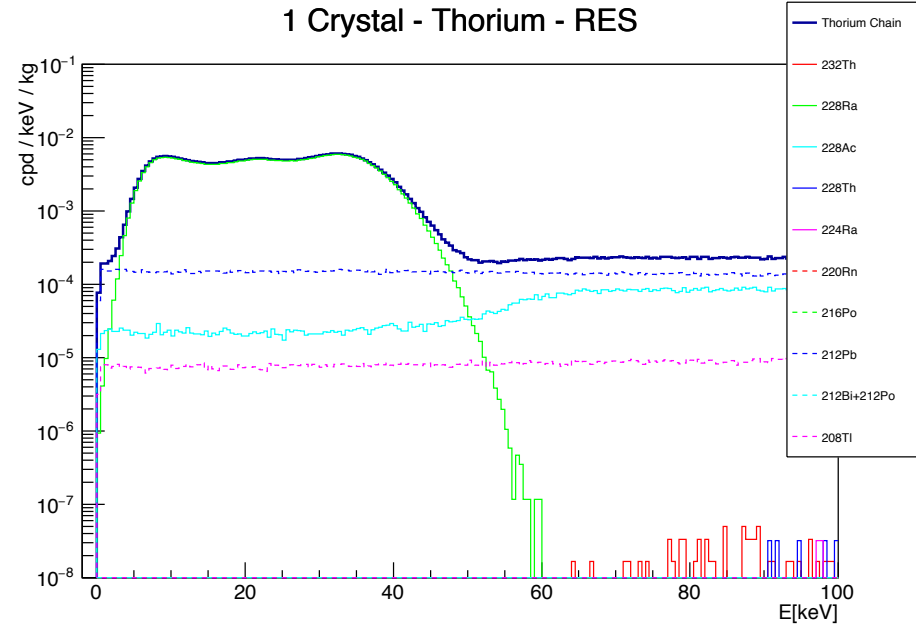
KMM:  $5.75 \times 10^{-5}$  cpd/keV/kg

# Background due to crystal intrinsic contaminants

## $^{232}\text{Th}$ (0.5 ppt) – VETO PMTs OFF



NEW – G4.10.2



OLD – G4.10.2.b1

Good compatibility with old results, except for

- $^{228}\text{Ac}$ , that seems to give lower BG (about a factor 2, order  $10^{-5}$  cpd/keV/kg).
- $^{228}\text{Ra}$  → completely missing

Deeper investigation ongoing in collaboration with G4 people

# 228Ra issue

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The isotope is strangely treated as stable (no secondaries are produced at tracking stage), even if the radioactive data file seems ok (in particular halflife is not zero...)

Investigating now with G4 people.

As a result, in the latest simulations the 228Ra spectrum is empty and BG studies here presented doesn't include the contribution due to 228Ra.



# Background due to crystal intrinsic contaminants

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**CRYSTAL** diameter 4", length 8"

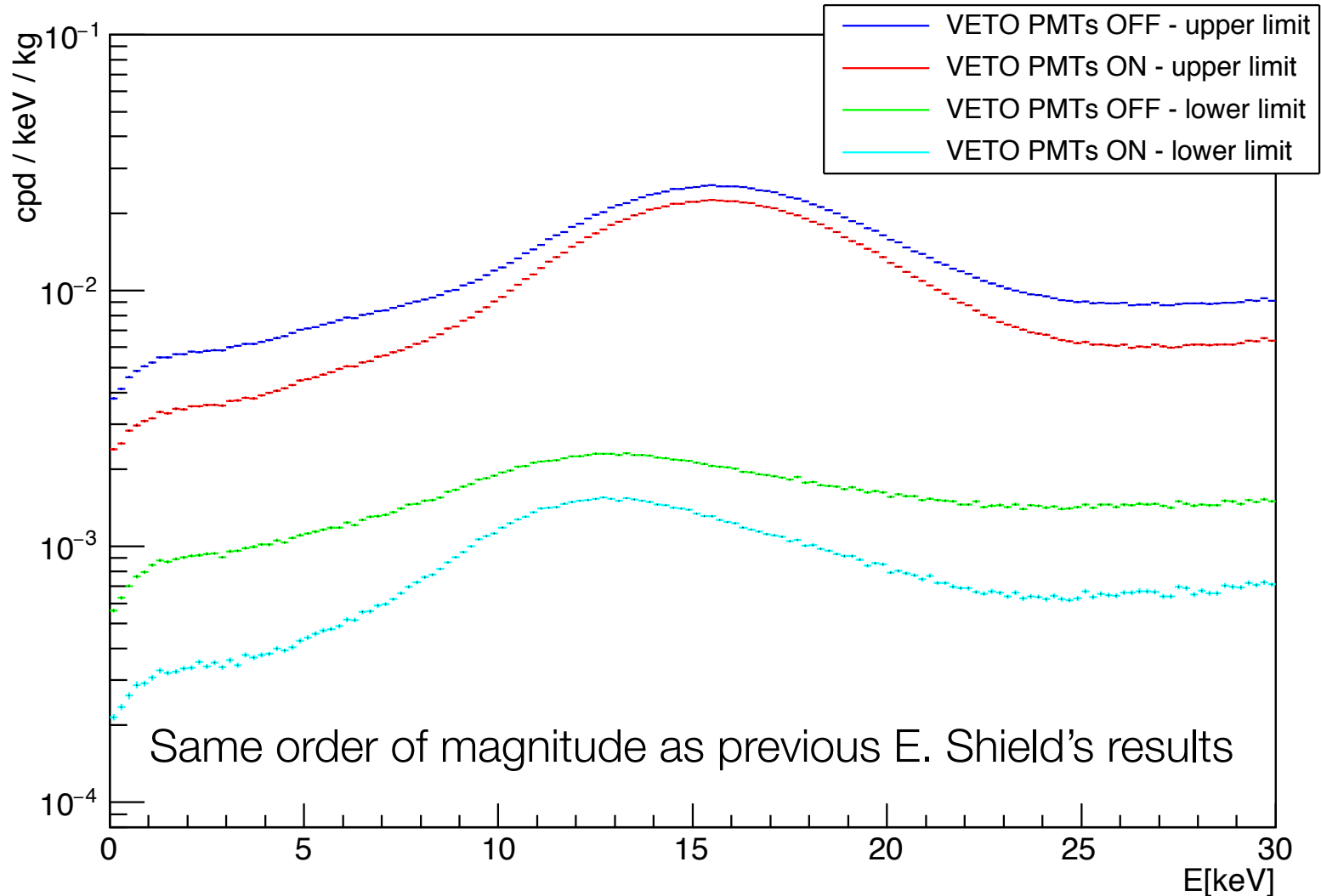
mass 5.17047 kg

*228Ra missing*

	concentration / specific activity	Activity (Bq/kg)	VETO PMTs OFF 2-6 keV cpd/keV/kg	DMM cpd/keV/kg	KMM cpd/keV/kg
40K	10 ppb	3.10e-04	2.46e-01	4.03e-02	1.90e-01
87Rb	0.1ppb	8.79e-05	6.13e-02	6.13e-02	0.00e+00
85Kr	10 uBq/kg	1.00e-05	1.87e-03	1.86e-03	0.00e+00
210Pb	10 uBq/kg	1.00e-05	5.50e-03	5.50e-03	0.00e+00
	30 uBq/kg	3.00e-05	1.65e-02	1.65e-02	0.00e+00
	600 uBq/kg	6.00e-04	3.30e-01	3.30e-01	0.00e+00
232Th	0.5ppt	2.03e-06	1.71e-04	1.05e-04	1.74e-06
	1ppt	4.06e-06	3.41e-04	2.10e-04	3.48e-06
238U	0.6ppt	7.46e-06	1.23e-02	1.20e-02	3.45e-05
	1ppt	1.24e-05	2.06e-02	2.00e-02	5.75e-05

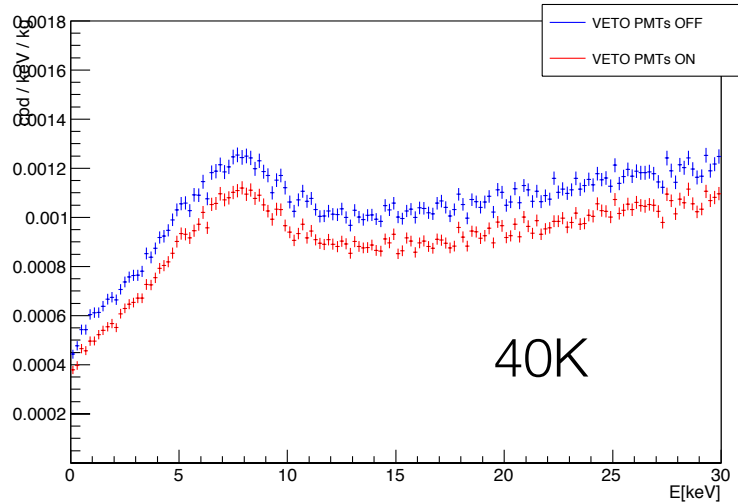
# Total Background due to crystal PMT

## Background from the 3" PMT - DMM

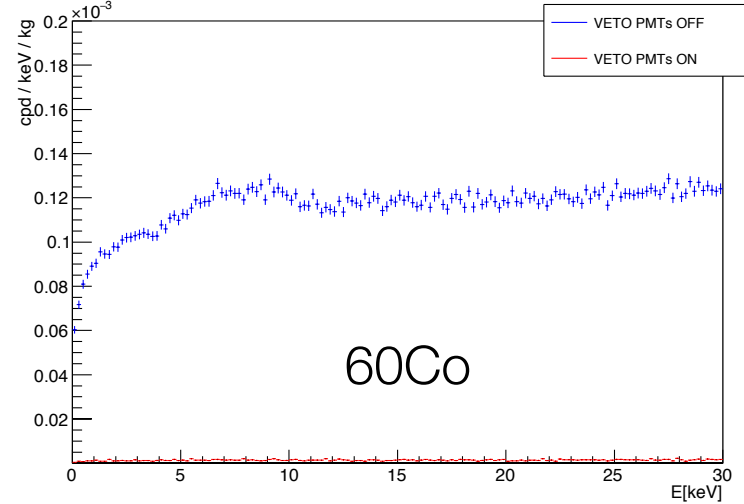


# Background due to crystal PMT – single contributions

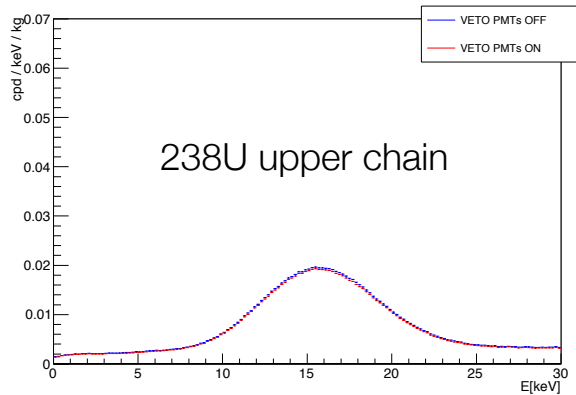
$^{40}\text{K}$  (2.42 mBq/PMT) background from the 3" PMT - DMM



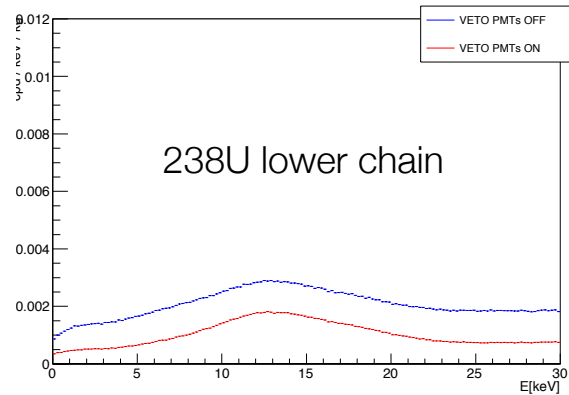
$^{60}\text{Co}$  (0.09 mBq/PMT) background from the 3" PMT - DMM



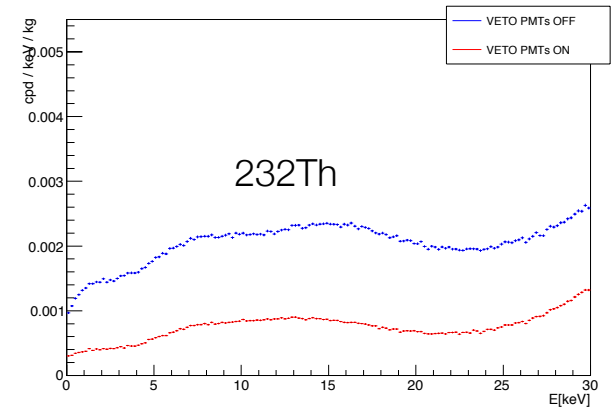
$^{238}\text{U}$  Upper Chain (3.13 mBq/PMT) background from the 3" PMT - DMM



$^{238}\text{U}$  Lower Chain (0.58 mBq/PMT) background from the 3" PMT - DMM



$^{232}\text{Th}$  (0.46 mBq/PMT) background from the 3" PMT - DMM



# Background due to PMT - Window

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*228Ra missing*

## WINDOW

[ natK ] < 0.081 mBq/PMT

[ 60Co ] < 0.0045 mBq/PMT

[ 232Th ] < 0.011 mBq/PMT

[ 238U upper chain ] < 0.33 mBq/PMT; [ 238U lower chain ] = 0.036 mBq/PMT

		DMM	KMM
	Activity (Bq/kg)	cpd/keV/kg	cpd/keV/kg
40K	2.7e-03	2.85e-04	9.20e-06
60Co	1.5e-04	9.47e-08	2.90e-06
232Th	3.67e-04	7.98e-05	5.91e-06
238U	1.10e-02 upper / 1.2e-03 lower	2.21e-03	3.26e-05
238U upper chain	1.10e-02	1.93e-03	1.26e-06
238U lower chain	1.2e-03	2.81e-04	3.13e-05

# Background due to PMT - Body

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## KOVAR BODY

[ natK ] < 0.99 mBq/PMT

[ 60Co ] = 0.07 mBq/PMT

[ 232Th ] < 0.34 mBq/PMT

[ 238U upper chain ] < 0.095 mBq/PMT; [ 238U lower chain ] < 0.26 mBq/PMT

	Activity (Bq/kg)	DMM cpd/keV/kg	KMM cpd/keV/kg
40K	1.06e-02	4.50e-04	2.31e-05
60Co	7.53e-04	0.93e-06	1.67e-05
232Th	3.66e-03	3.94e-04	5.46e-05
238U	1.02e-03 upper / 2.79e-03 lower	3.44e-04	6.60e-05
238U upper chain	1.02e-03	7.52e-05	5.88e-08
238U lower chain	2.79e-03	2.69e-04	6.59e-05

# Background due to PMT - Feedthrough plate

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## FEEDTHROUGH PLATE

[ natK ] = 1.35 mBq/PMT

[ <sup>60</sup>Co ] < 0.016 mBq/PMT

[ <sup>232</sup>Th ] = 0.11 mBq/PMT

[ <sup>238</sup>U upper chain ] < 2.7 mBq/PMT; [ <sup>238</sup>U lower chain ] = 0.28 mBq/PMT

		DMM	KMM
	Activity (Bq/kg)	cpd/keV/kg	cpd/keV/kg
40K	9.00e-02	4.03e-05	7.89e-06
60Co	1.07e-03	2.55e-07	1.89e-06
232Th	7.33e-03	2.53e-05	4.34e-05
238U	1.8e-01 upper / 1.87e-02 lower	2.20e-04	2.00e-05
238U upper chain	1.8e-01	1.74e-04	7.18e-07
238U lower chain	1.87e-02	4.60e-05	1.93e-05