Background from the shielding materials in LS and crystals

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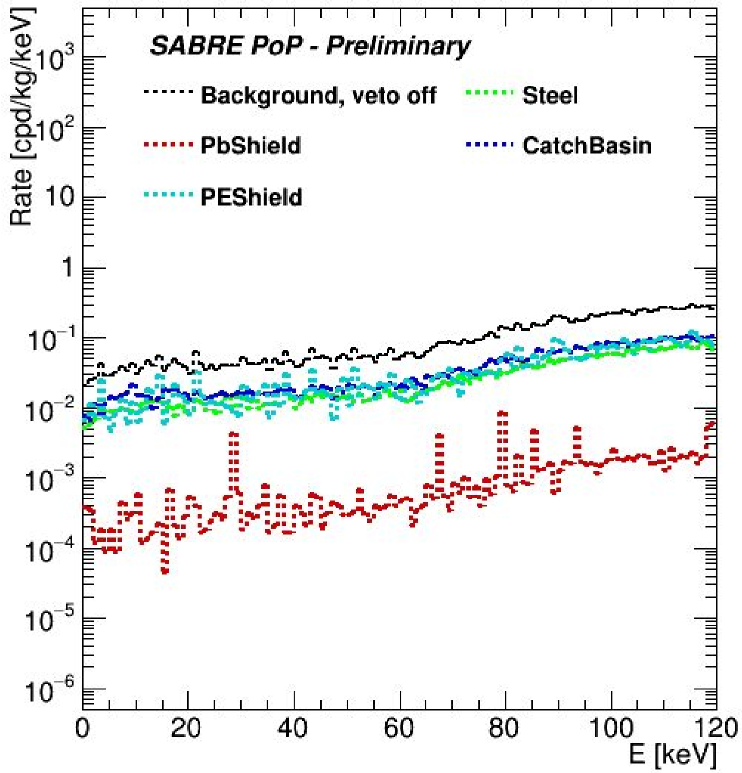
Radioactive contamination of the shielding materials

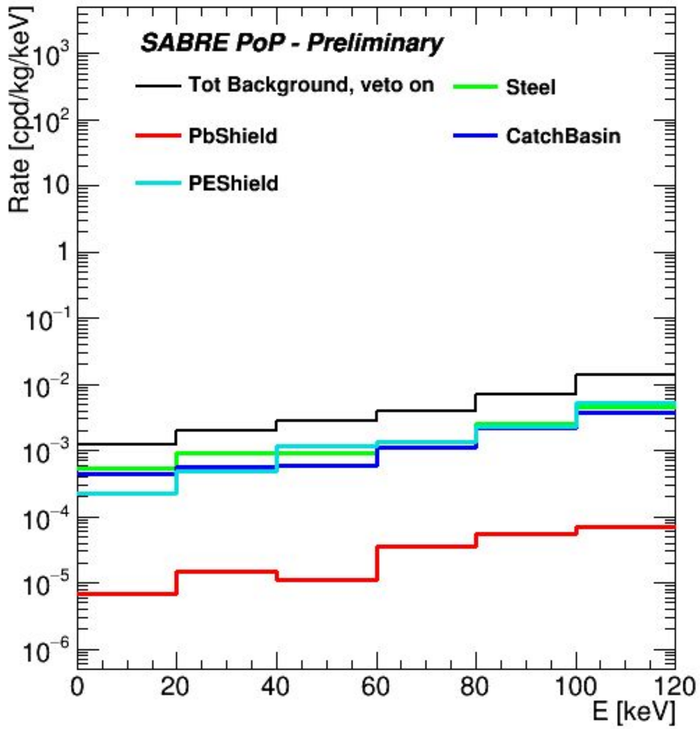
Credit to M. Laubenstein

Material	Refurbished Pb [mBq/kg]	PE [mBq/kg]	SS Sample n.1 [mBq/kg]	SS n.2 Sample n.2 [mBq/kg]
Ra228	< 0.36	< 0.72	2.6 ± 0.5	2.8 +- 1.2
Th228	< 0.39	0.8 ± 0.2	7.7 ± 0.6	15.9 +- 1.5
Ra226	< 0.15	1.4 ± 0.3	2.4 ± 0.3	3.5 +- 0.6
Th234	< 4.7	< 9	< 63	< 400
Pa234m	< 9.7	< 4.4	29 ± 16	< 180
U235	< 56	< 0.81	1.0 ± 0.4	< 4.9
K40	< 1.8	< 5.9	1.5 ± 0.7	< 4.6
Cs137	< 2.0	< 0.28	< 0.26	< 0.62

→ See Chiara's slides

Expected rate in the crystal



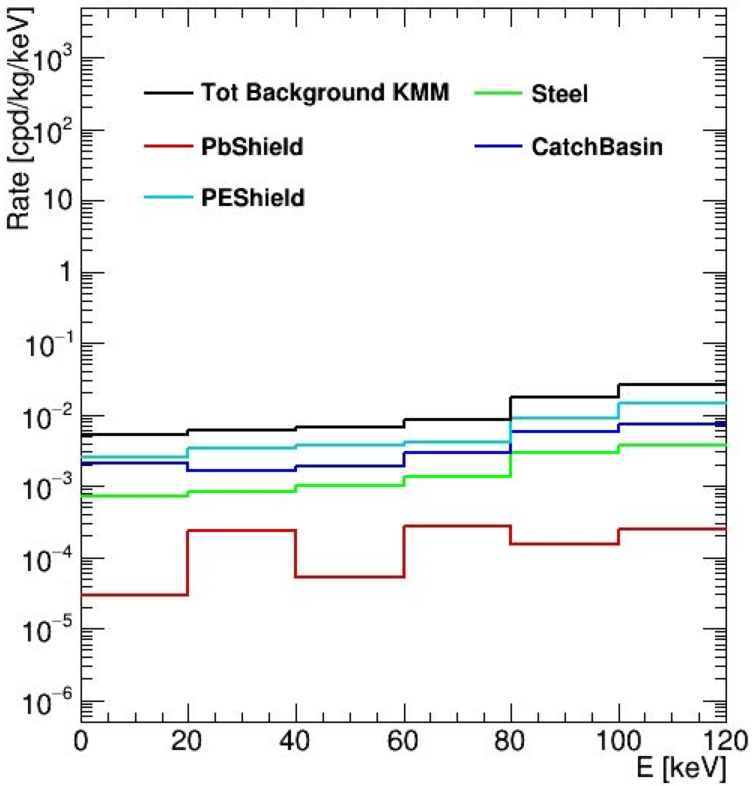


Low statistics in DMM - Only upper limits

Total BKG from shielding < 2e-03 (Crystal gives 1.5e-02)

Material	Bkg (90% cl limit) [cpd/kg/kev]
PE Shielding	< 5e-04
PB Shielding	< 2e-05
Top Steel	< 8e-04
Catch basin	< 7e-04

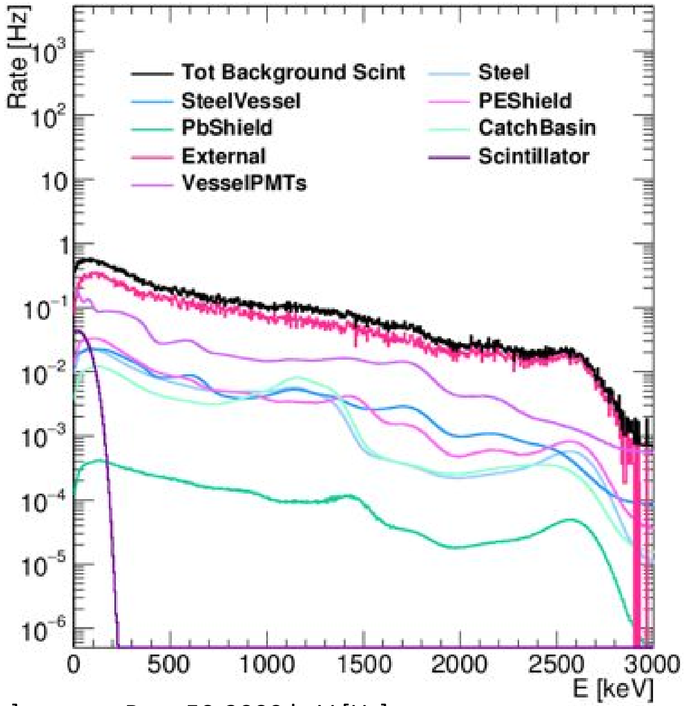
Expected rate in KMM



Material	Bkg (90% cl limit) [cpd/kg/kev]
PE Shielding	< 5e-03
PB Shielding	< 3e-04
Top Steel	< 7.5e-3
Catch basin	< 3e-3

Total BKG from shielding < 1.5e-2
Total BKG from internal ~ 2.7e-2
K signal ik KMM ~ 1.9e-1

Expected rate in LS



Shielding + Other materials close to the LS

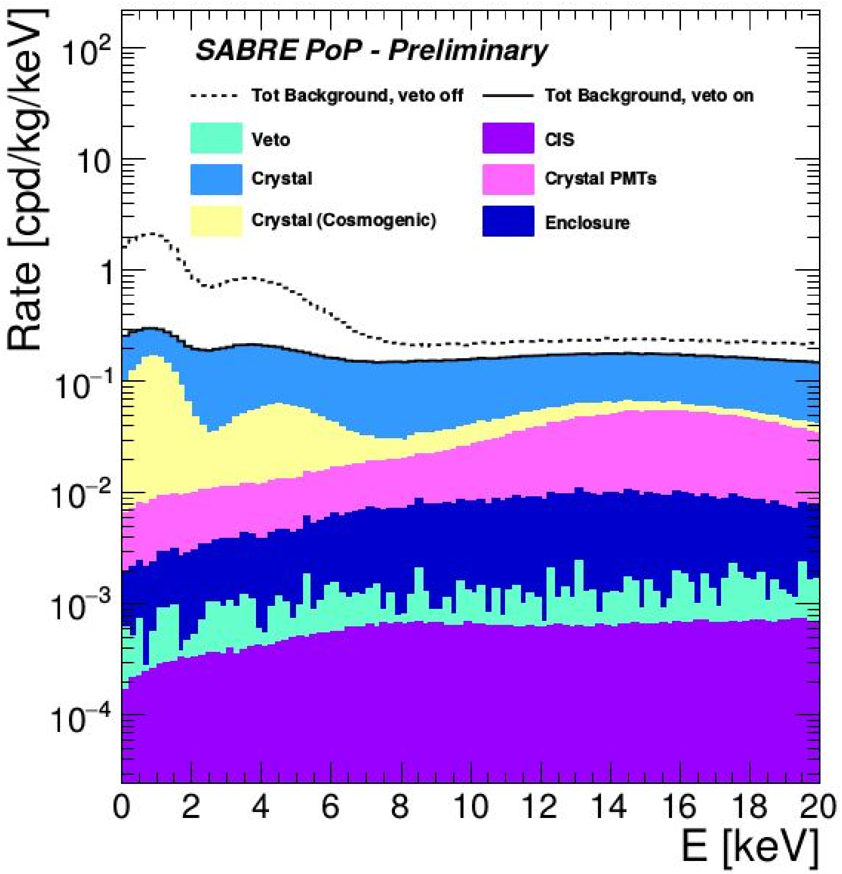
#	Rate 100-3000 keV [Hz]	Rate 50-3000 keV [Hz]
Steel	2.04 ± 0.02	2.26 ± 0.02
SteelVessel	2.52 ± 0.02	2.74 ± 0.02
CatchBasin	1.58 ± 0.01	1.70 ± 0.01
PbShield	0.058 ± 0.008	0.062 ± 0.008
PEShield	2.63 ± 0.03	2.95 ± 0.03
External	37.8 ± 0.4	40.9 ± 0.4
Scintillator	0.075 ± 0.006	0.34 ± 0.01
VesselPMTs	10.2 ± 0.04	11.5 ± 0.05
Total	57 ± 0.4	62.4 ± 0.4

BACKUP

Total internal background for DM measurement

Internal note MC

veto: E(Scintillator) > 100 keV
E(Crystal) ∈ [2,6] keV



	Rate, veto OFF [cpd/kg/keV]	Rate, veto ON [cpd/kg/keV]
Veto	$3.0 \cdot 10^{-2}$	$5.7 \cdot 10^{-4}$
CIS(*)	$3.7 \cdot 10^{-3}$	$4.6 \cdot 10^{-4}$
Crystal	$3.5 \cdot 10^{-1}$	$1.5 \cdot 10^{-1}$
Crystal Cosmogenic(*)	$3.0 \cdot 10^{-1}$	$3.9 \cdot 10^{-2}$
CrystalPMTs	$1.3 \cdot 10^{-2}$	$8.3 \cdot 10^{-3}$
Enclosure(*)	$9.5 \cdot 10^{-3}$	$3.6 \cdot 10^{-3}$
Total	$7.1 \cdot 10^{-1}$	$2.0 \cdot 10^{-1}$

(*) after 180 days underground

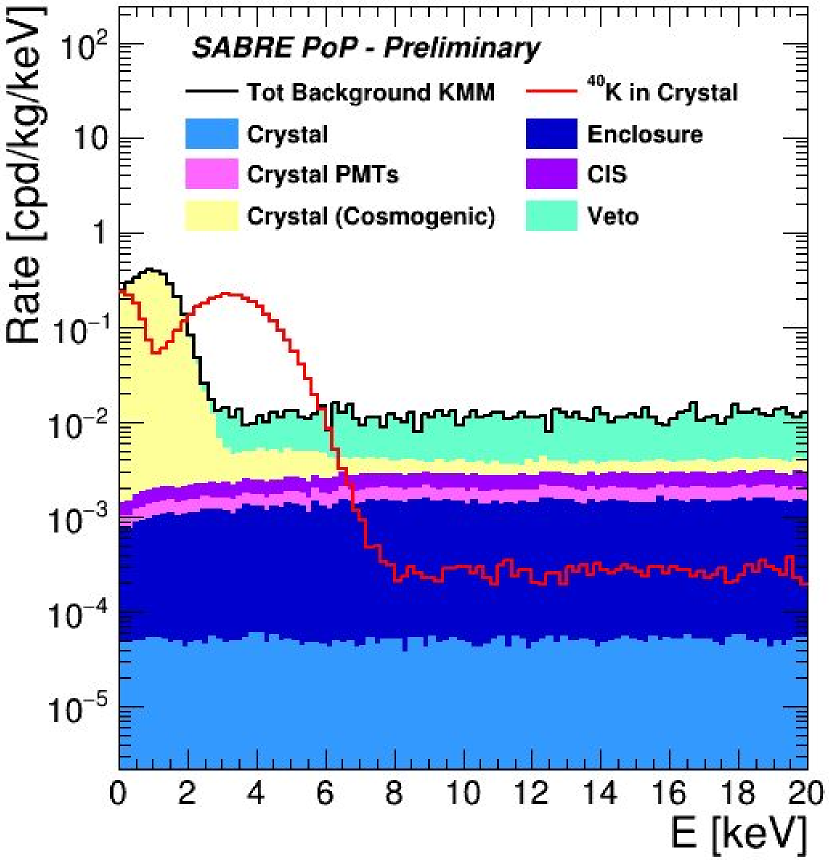
- Expected BKG **0.2 cpd/kg/keV in the ROI**
- Total veto rejection of internal bkg: **factor 3.5**
- **Crystal is the main source** of background
  - contaminations in the crystal measured with ICP-MS
  - dominant bkg ^{40}K → measured independently with ICP-MS at Seastar and PNNL
  - other bkg do not change the overall picture

Total internal background for K measurement

Internal note MC

- **Target ^{40}K electron capture** (3 keV e$^-$/x-rays + 1.46 MeV γ) in the crystal and other processes with large energy deposits in the scintillator
- Coincidences Cystal+Scintillator allow to study other intrinsic BKGs that give a energy release in the scintillator

E(Scintillator) ∈ [1280,1640] keV
E(Crystal) ∈ [2,4] keV



	Rate KMM [cpd/kg/keV]
Veto	$6.2 \cdot 10^{-3}$
CIS(*)	$7.7 \cdot 10^{-4}$
Crystal	$5.1 \cdot 10^{-5}$
Crystal Cosmogenic(*)	$1.8 \cdot 10^{-2}$
CrystalPMTs	$4.3 \cdot 10^{-4}$
Enclosure(*)	$1.3 \cdot 10^{-3}$
Total	$2.7 \cdot 10^{-2}$
Crystal ^{40}K	$1.9 \cdot 10^{-1}$

(*) after 60 days underground

- Largest bkg contribution from ^{22}**Na mostly below threshold of 2 keV**