CYGNUS Background Simulation

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Outline

Rock neutrons

Vessel neutrons

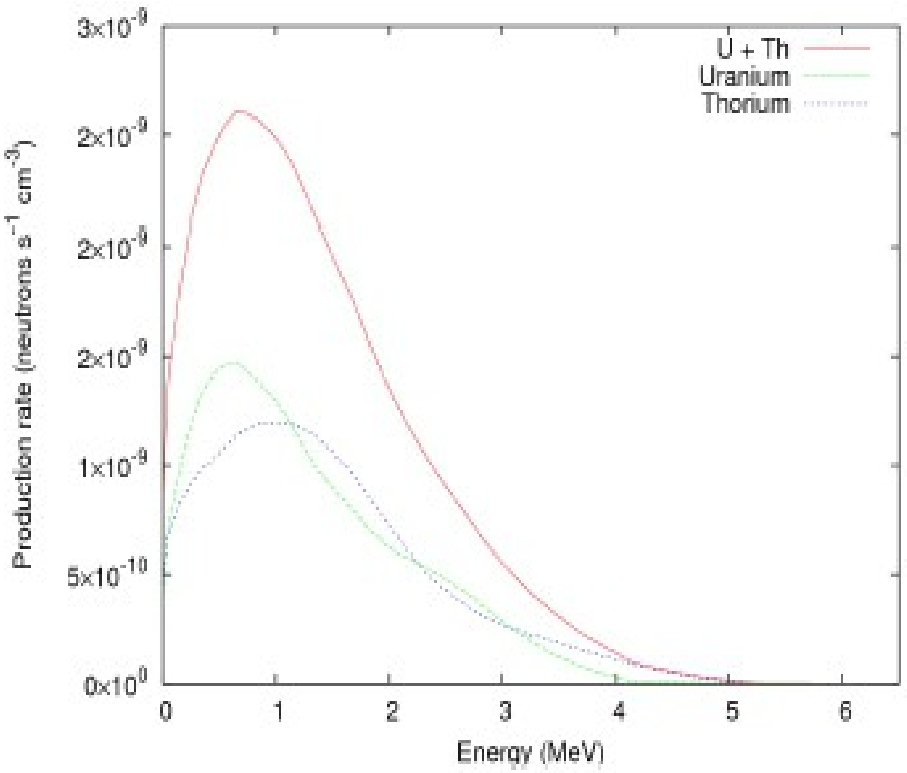
Read-out neutrons

Radon & RPRs

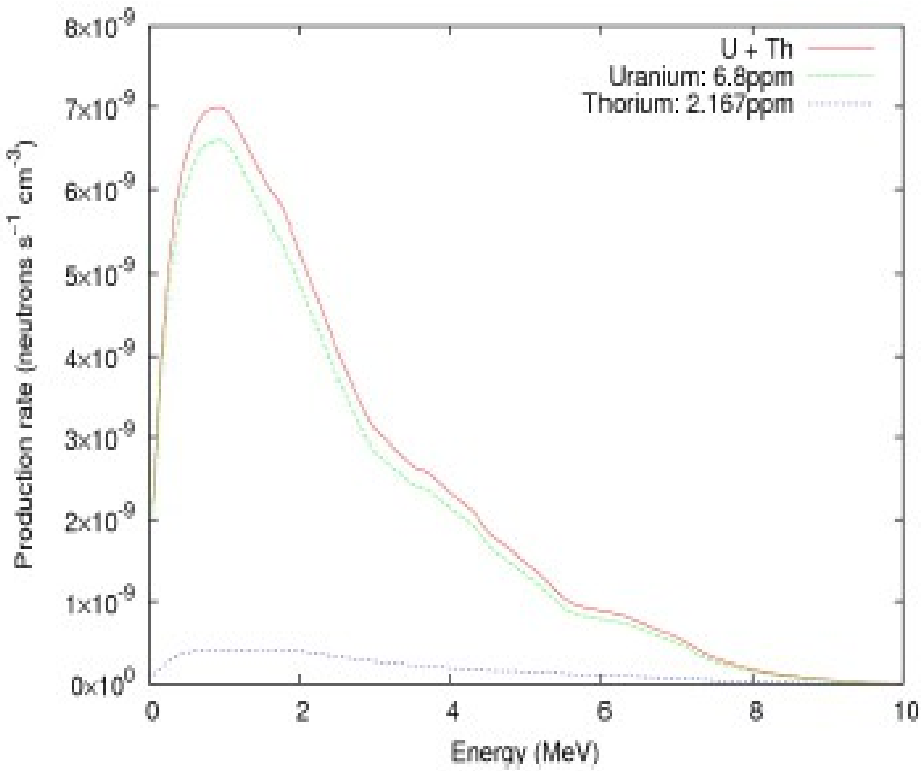
Gamma simulation

Rock Neutrons

- Neutron spectra for Boulby and LNGS HallA



Boulby 6.01×10^{-8} n/s/cm^3



LNGS 6.18×10^{-7} n/s/cm^3

Rock Neutrons

- Simulated different thickness of water shield to obtain < 1 nuclear recoil/ year

- ~ 75cm of external shielding (1keV threshold) at Boulby

- Currently working on repeating the simulation for LNGS

Vessel materials

- Looked at steel, Titanium and Acrylic

- 47Ton Acrylic vessel : can tolerate ~2.1ppt (1keV threshold)
- SNO+ (2.4ppt (U) – 9.6ppt (Th))
- Steel and Titanium require internal plastic shielding
- 1keV Thres : >30cm shielding (Steel)

  > 20cm (Titanium)

Gamma from vessel materials

- Simulated gamma background from U238,Th232,K40
- Estimate the gamma rejection for < 1 Compton scattering per year (1keV Threshold)

Material	Concentrations	Rate Hz	Rejection factor (90% CL) /year
Steel	0.81ppb U 0.51ppb Th, 0.05 ppm K	55.65±0.02	$(2.3351\pm0.0008)\times10^{-10}$
Steel 30cm		18.87±0.01	$(6.888\pm0.004)\times10^{-10}$
Titanium	0.00729ppbU, 0.057ppb Th, 17.44ppb K	2.2002±0.0006	$(5.907\pm0.002)\times10^{-9}$
Titanium 20cm		1.1431±0.0004	$(1.1369\pm0.0004)\times10^{-8}$
Acrylic /!\	0.01ppb U/Th 0.05ppm K40	10.564±0.002	$(1.2302\pm0.0003)\times10^{-9}$

Neutrons from read-out materials

- We simulated neutrons from read-out materials.

  MuPics : polymid

  GEMs : copper, kapton

  MWPCs : ceramic + steel + plastic frame

Neutrons from read-out materials

1keV Threshold

Red means > 1 nuclear recoil per year
Green means < 1 nuclear recoil per year

Material	Th (ppb/g)	U (ppb/g)	Mass estimation
Polymid (1.2ppmU 5.6ppm Th)	$(9.35 \pm 0.02) \times 10^3$	$(1.870 \pm 0.004) \times 10^3$	2200kg
Copper (0.5ppb)	$(5.6 \pm 0.1) \times 10^4$	$(5.6 \pm 0.1) \times 10^4$	89.6kg
Kapton (8ppb U 9ppbTh)	$(2.60 \pm 0.03) \times 10^4$	$(2.60 \pm 0.03) \times 10^4$	1140kg
Ceramic (0.5 ppm U 2ppm Th)	$(1.200 \pm 0.001) \times 10^4$	$(3.001 \pm 0.003) \times 10^3$	22.6kg
Steel Wires (1.5ppbU 5ppbTh)	$(8.57 \pm 0.05) \times 10^4$	$(1.714 \pm 0.009) \times 10^5$	3.9kg
Acrylic Frame (2.4ppt U and 9.6 ppt Th)	$(3.53 \pm 0.05) \times 10^4$	$(3.53 \pm 0.05) \times 10^4$	86.4Ton

Neutrons from read-out materials

1keV Threshold

Red means > 1 nuclear recoil per year
Green means < 1 nuclear recoil per year

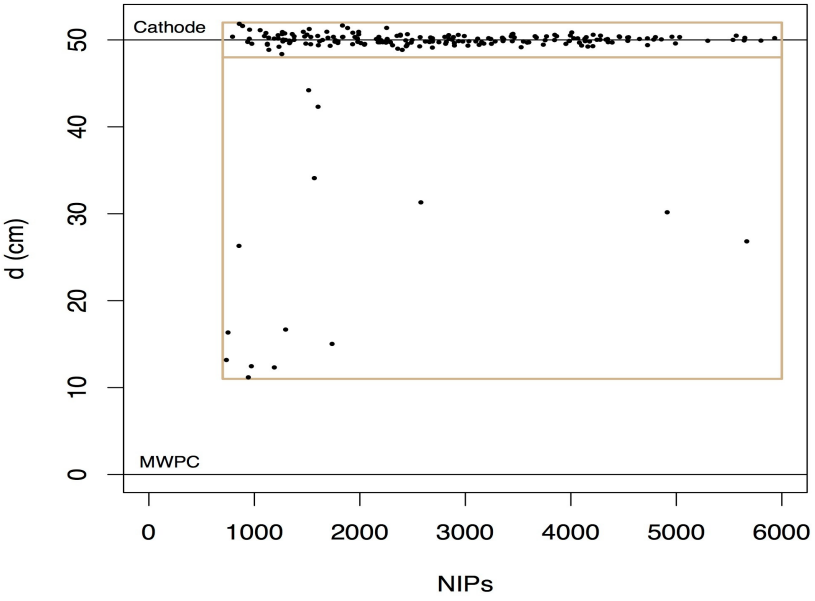
Material	Mass estimation	Max allowed mass
Polymid (1.2ppmU 5.6ppm Th)	2200kg	1.627±0.002 g
Copper (0.5ppb)	89.6kg	0.1127±0.0001 Ton
Kapton (8ppb U 9ppbTh)	1140kg	3.166±0.004 kg
Ceramic (0.5 ppm U 2ppm Th)	22.6kg	4.130±0.005 mg
Steel Wires (1.5ppbU 5ppbTh)	3.9kg	14.30±0.01 kg
Acrylic Frame (2.4 ppt U and 9.6 ppt Th)	86.4Ton	48.80±0.02 Ton

Radon & RPRs

- We simulated the spread of RPRs in 50Torr SF6 near the cathode
- Assumed a rate of RPRs proportional to DRIFT, and the same Z-resolution as CS2 (from the minority carriers).

Reproduced the 2cm cut

Rate of RPRs
2.57×10^{-16} events/day
(90%CL)



Work in progress

- Gamma background from read-out
- Rock background at LNGS
- Writing the muon simulation