Background measurements at Hartlepool Nuclear Power Station to assess the viability of on-site-antineutrino detection.

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1. Introduction & Background

- **Nuclear reactors** used as source of antineutrinos in numerous experiments and proposed for safeguards applications: spectral evolution can estimate reactor fuel burnup and time-averaged power.
- **Antineutrinos** arise from beta-decays of fission product daughters, with an average number of decays (and thus antineutrinos) of about three per daughter and six per fission.
- **A potential site** for placement of an antineutrino detector is at **Hartlepool** Nuclear Power Station (NPP) in the UK.
- At Hartlepool antineutrino signal governed by: position, burnup, power, and various **backgrounds. The latter** are difficult to separate by the reactor signal.
- **The goal of this work: measure gamma and neutron backgrounds at Hartlepool, to help separate future reactor antineutrino signal from accidental background.**

2. Measurements at Hartlepool Advanced Gas cooled NPP

- **Hartlepool NPP (Figure 1) has two active cores with:**
  - ➢~1575 MW (thermal).
  - ➢Graphite moderator
  - ➢Carbon dioxide cooler
  - ➢Uranium dioxide fuel

- **5 gamma and neutron background measurements: 4 around the site and 1 off-site.**

Figure 2: Map of Hartlepool Nuclear Power Station with red dots marking the buildings where measurements were taken.
[1] Administration Building – 1 measurement performed here
[2] Reactor Building – 3 measurements performed here

3. Measurements Methodology

Two detectors used for backgrounds:

- for gamma: ORTEC trans-SPEC-DX-100T HpGe
- for neutron: Kromek TN-15 scintillation detector with a state-of-the-art Silicon photomultiplier.


1


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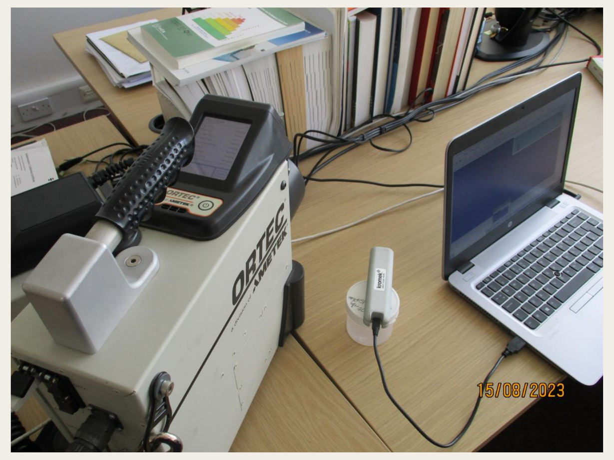
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Figure 3: Det. Location:
1) Reactor 1 Gas Circ. Annulus
2) Reactor 2 Gas Circ. Annulus
3) Reactor 1 Pile Cap
4) Administration Building
5) District Survey Lab

Gamma spectrum calculated by:

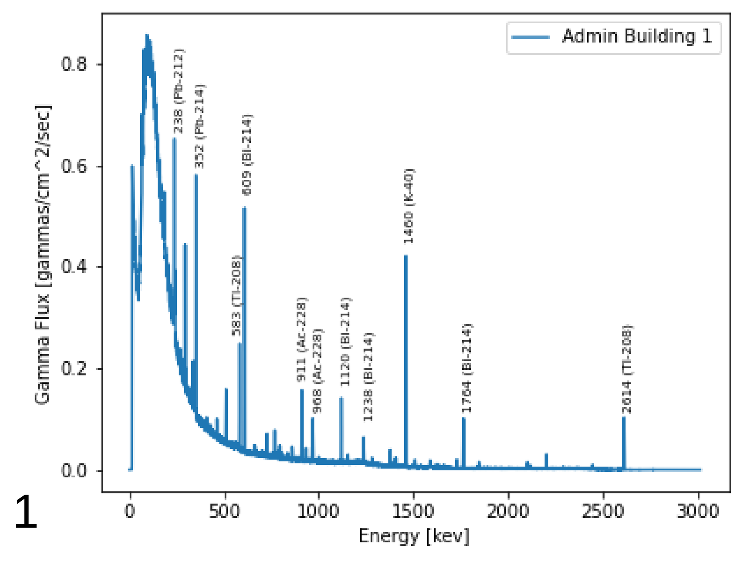
- Plotting calibration curve to find energy level for each channel.
- Dividing counts by time of each measurement acquisition to get count rate.
- Dividing count rate by intrinsic detector efficiency to get gamma flux in units of gammas/(cm^2/sec).

Integrated thermal neutron fluence:

- Diving total number of counts by the time of acquisition to find count rate.
- Diving the neutron count rate by sensitivity of the detector and multiplied by the weight of the detector to calculate the neutron flux in units of neutrons/(cm^2/sec).

4. Results and Conclusions

Gamma Spec in the 5 location:



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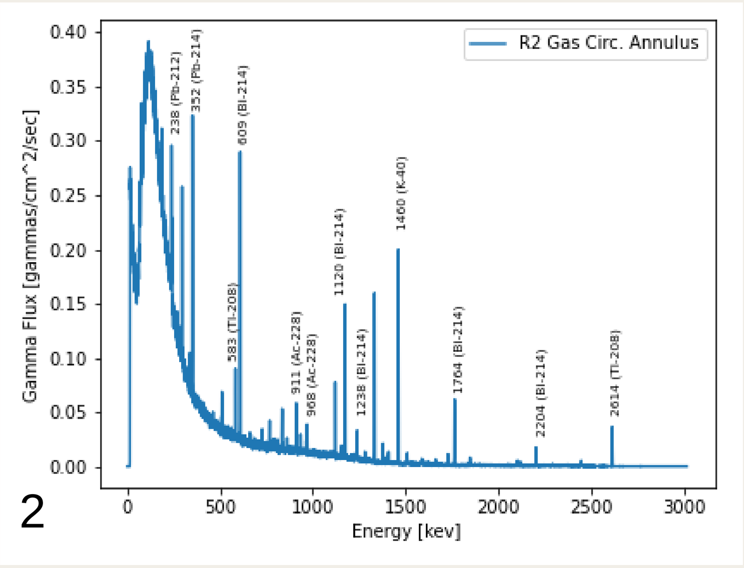

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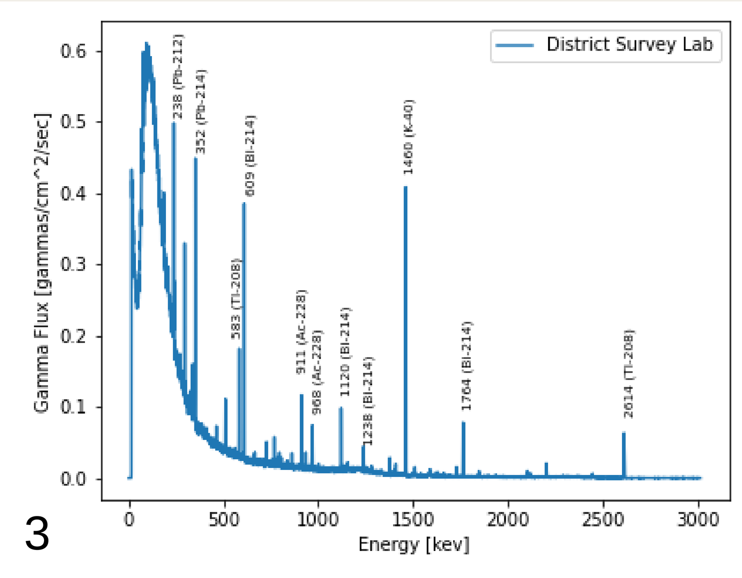

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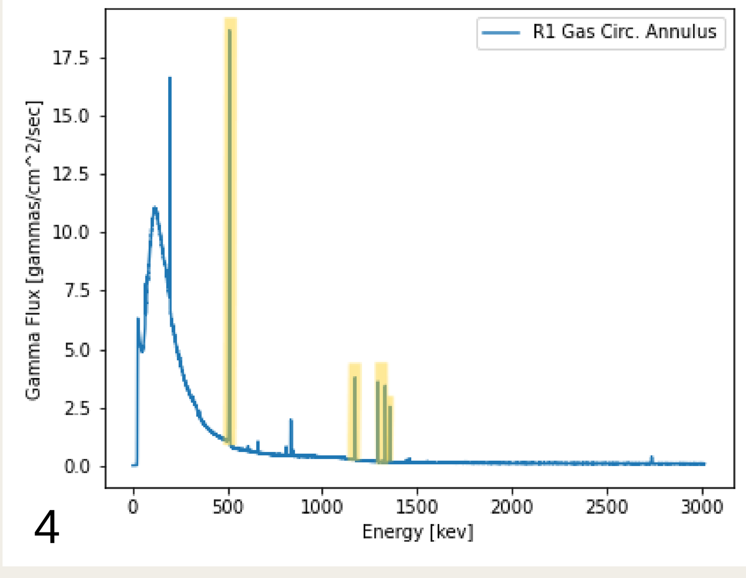

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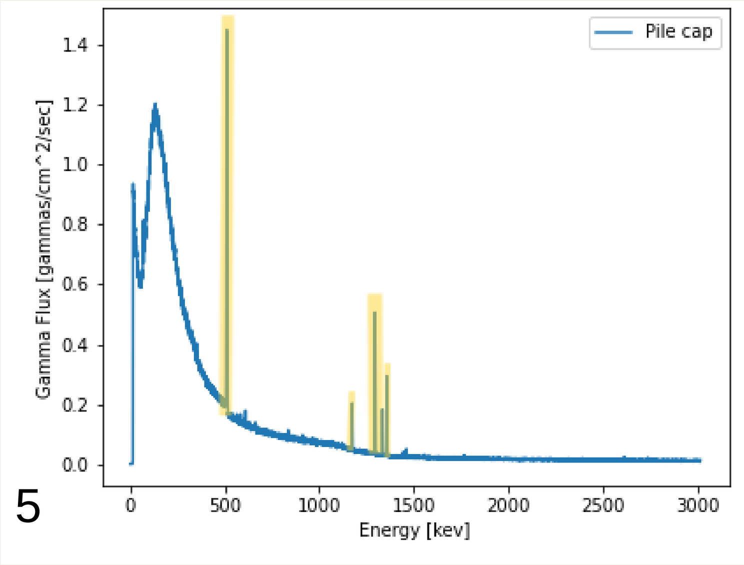

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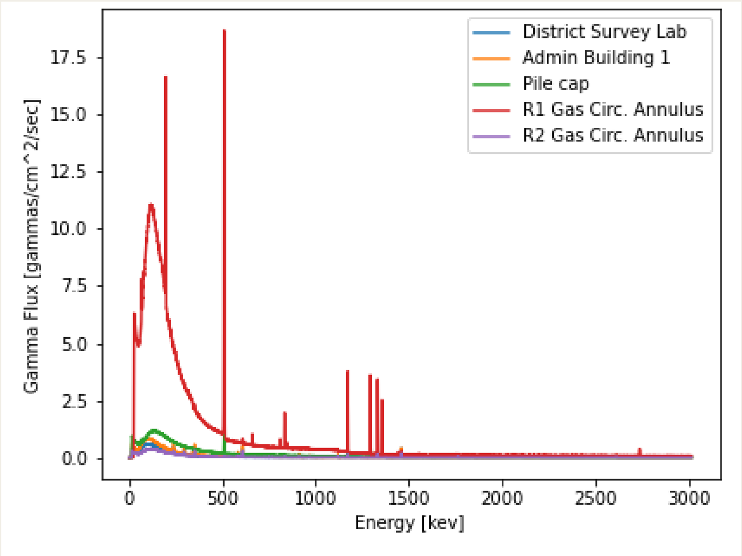
Comparison of all 5 gamma fluxes:



Neutron fluences :

1) 0.00019 neutrons/cm^2/sec
2) 0.0002 neutrons/cm^2/sec
3) 0.00456 neutrons/cm^2/sec
4) 0.00075 neutrons/cm^2/sec
5) 2e-05 neutrons/cm^2/sec

5. Future Work

More measurements will be performed for: **muon** and **fast neutron** at the same locations to further help identify the total accidental background for future antineutrino signals.

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