CLEANWATCH.py

Alex Healey, University of Sheffield

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Maths

The background rate (B_r) is defined as

$$B_r = a_i \times \eta_i$$

where a_i is the activity of a specific isotope and η_i is the efficiency of a specific isotope.

Variables

- decay constant of an isotope $= \lambda_i$
- Natural Abundance of an isotope $= NA_i$
- Mass of an isotope $= M_i$
- Parts per million of an isotope $= PPM_i$
- Tank radius $= r$
- Tank thickness $= t$
- Tank height $= h$

PMT Activity

PMT Activity is defined as:

$$a_i = \left(\frac{\lambda_i NA_i}{m_i \times 1 \times 10^6} \right) PPM_i \times m_{PMT} \times n$$

where m_{PMT} is the mass of the glass in the PMT and n is the number of PMTs.

Veto Activity

Veto activity is defined as:

$$a_i = \left(\frac{\lambda_i NA_i}{M_i \times 1 \times 10^6} \right) PPM_i \times m_{PMT} \times n$$

where n is the number of PMTs in the Veto region.

Tank Activity

The volume of the tank is defined as:

$$V_{tank} = 2\pi h r^2 - 2\pi \left((h - t)(r - t)^2 \right)$$

therefore activity is defined as:

$$a_i = PPM_i \times (\rho \times V_{tank})$$

where ρ is the density of the tank.

Concrete Activity

The volume of the concrete is defined as:

$$V_{conc} = \frac{51\pi}{2}\left(13^2 - 12.5^2\right) + \frac{\pi}{2}\left(13\right)^2$$

therefore the activity is defined as:

$$a_i = PPM_i \times \rho \times V_{conc}$$

where ρ is the density of the concrete.

Rock Activity

The volume of the rock is defined as:

$$V_{rock} = \pi\left((18^2)(35.5) - (13^2)(25.5)\right) \Rightarrow m_{rock} = \rho \times V_{rock}$$

The activity from the rock is defined as

$$a_i = \left(\frac{\lambda_i N A_i}{M_i \times 1 \times 10^6}\right) PPM_i \times m_{rock}$$

Water Activity

The volume of the water in WATCHMAN is defined as:

$$V_{water} = 2\pi h r^2$$

The $\rho = 1$ so the activity from the water is defined as

$$a_i = PPM_i \times V_{water}$$

Gd Activity

The volume of Gd is defined as

$$V_{Gd} = 2\pi h r^2$$

therefore the activity is defined as:

$$a_i = PPM_i \times V_{Gd} \times \rho \times 0.002$$