E02-013 Analysis Update

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Overview

- Continuing with GEANT4
- Worked in neutron arm geometry
- Scintillator output underway

Scintillation Yield

- GEANT4 propagation of optical photons too slow
- Energy deposition by scintillating particle at position y generates signal of amplitude:

$$A_0 = Y \frac{dE/dx}{1 + C_1 \frac{dE/dx}{\rho} + C_2 \frac{(dE/dx)^2}{\rho^2}} \tag{1}$$

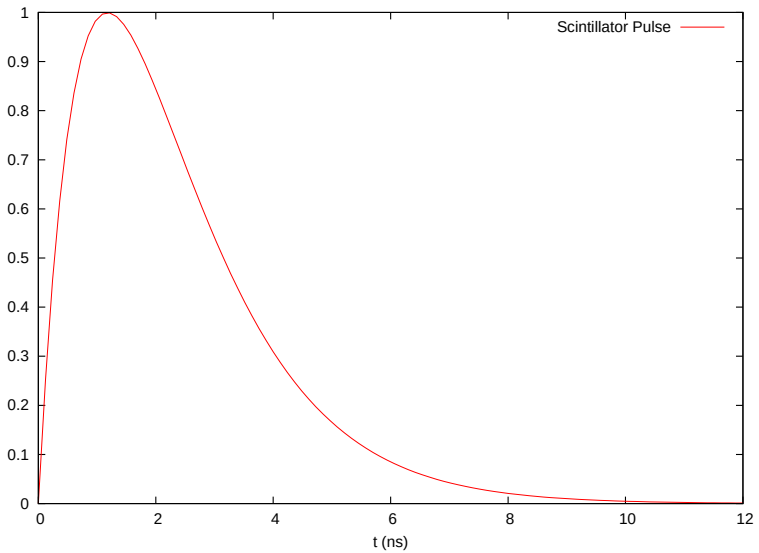
- For our scintillator:
  - $Y = 10000$ photons/MeV
  - $\rho = 1.023$ g/cm^3
  - $Q = 1$: $C_1 = 0.013$ g/(MeV $\cdot$ cm^2)
  - $Q > 1$: $C_1' = \frac{7.2}{12.6} C_1$
  - $C_2 = 9.6 \times 10^{-6}$ g^2/(MeV^2 $\cdot$ cm^4)

Scintillator Time Response

- Scintillator pulse shapes frequently described using:

$$I_{\text{scint}}(t) \propto e^{-t/\tau_1} - e^{-t/\tau_2} \tag{2}$$

- From manufacturer and literature:
  - Rise time (10% $\rightarrow$ 90% maximum) $\sim$ 0.9 ns
  - Pulse FWHM $\sim$ 2.5 – 3.0 ns
- Choosing τ_1 and τ_2 to best represent these characteristics:



PMT Output

- Time dependent PMT response is convolution of effects:

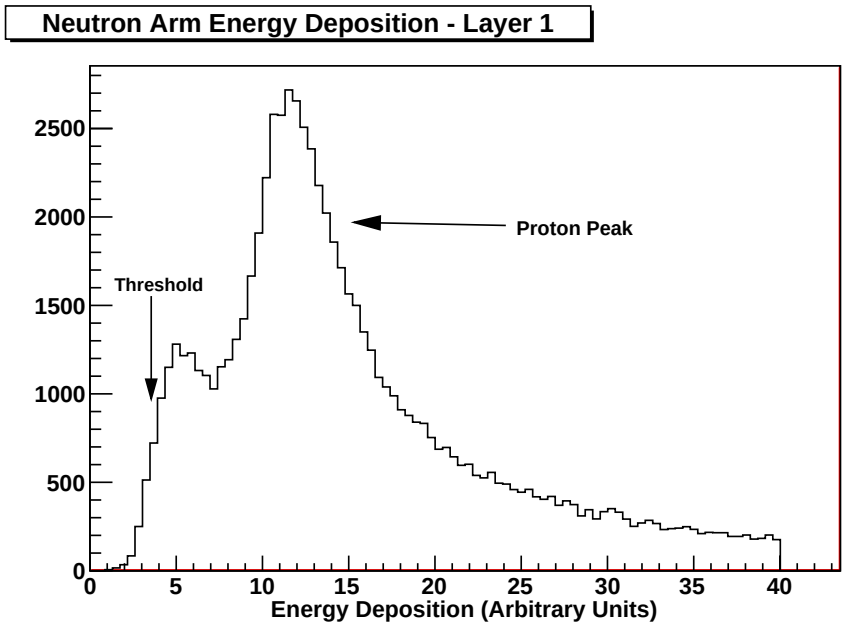
$$V_{\mathrm{PMT}}(t'') = I_{\mathrm{scint}}(t) \otimes \phi_{\mathrm{prop}}(t, t') \otimes \phi_{\mathrm{PMT}}(t', t'') \quad (3)$$

- ϕ_{prop} function of scintillator bar geometry, absorption length, reflectivity
- Will be determined from GEANT for each bar type
- ϕ_{PMT} modeled as RC circuit:

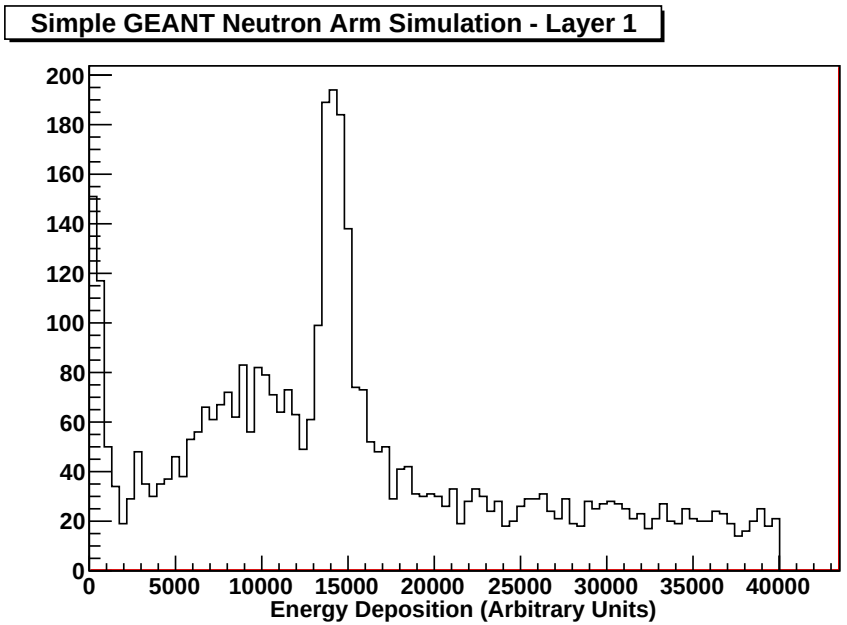
$$\phi_{\mathrm{PMT}}(t', t) = N(t') V e^{\frac{t'-t}{RC}} \quad (4)$$

Threshold Analysis

- Energies tuned to proton peak
- Threshold then determined by discriminator threshold in data



Data



GEANT

Things to Work On

- Veto bars are continuous - Need to separate?
- Planes are treated as uniform bars - Glasgow detectors are not included
- Need light guide dimensions and material
- Need to add random flat background?