# 1 Where should the Alpha Source Go?

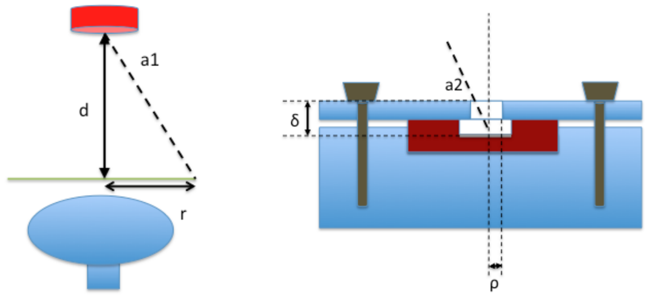


Figure 1: Figure showing alpha source position

The solid angle of alpha emission seen by the TPB plate approximately equal to the smallest of of the angles a1 and a2 shown in figure 1. Of course, in both cases, the cartoon above only approximately represents the average solid angle - Christie will do a proper simulation of possible paths to determine the acceptance distribution accurately later.

The angle a1 is given approximately by

$$tan(a_1) = \frac{r}{d} \tag{1}$$

The angle a2 by

$$tan(a_2) = \frac{\rho}{\delta} \tag{2}$$

In either case the fractional solid angle is given by

$$\frac{1}{4\pi}\int_{a'=0}^{a_i} dcos(a')d\phi = \frac{1-cos(a_i)}{2} \tag{3}$$

The source holder we designed has $\rho = 2.5mm$, and $\delta \sim 1/8" = 0.31mm$. This corresponds to a solid angle of ˜11%. The solid angle as a function of source distance in inches is shown in figure 2. Below 8", the solid angle is limitted by the source angle. Above 8", the solid angle is limitted by the plate radius. Therefore anything above 8" gives a reasonably full exposure of the plate. However, the further from the plate the source goes, the more uniform the exposure across the plate surface. This is an important consideration if we want to determine optical assembly quantum efficiency. The tradeoff is that large d means less photons, giving less statistics for the nitrogen shape analysis.

Polonium 210 has a characteristic alpha energy of 5.3MeV. Alpha particles in argon have a scintillation yield at zero field for a MIP is $4 \times 10^4 \gamma/MeV$. Protons have a measured quenching factor of 0.7. Therefore the number of photons produced at zero field by a polonium alpha is expected to be 148400.

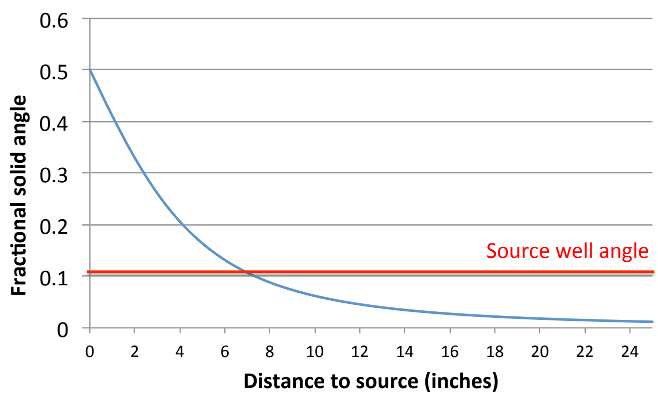


Figure 2: Fractional solid angle as a function of source distance

For alpha particles, the ratio of singlet to triplet states is $I_S/I_T = 1.3$, which corresponds to 56% fast light and 44% slow light. If we integrate pulses for one liftetime, which is $1.6\mu s$ after the prompt flash we will collect 68% of the slow component. The quantum efficiency of our PMT assemblies is somewhere between 1.5% and 6%, with large uncertainties as we don't know whether we have the WARP effect or not. We evaluate the expected PE at these best and worst values, as.

$$PE = 148400(\gamma/\alpha) \times f_{fast/slow} \times \epsilon_{counting} \times QE \times \int \frac{d\Omega}{4\pi} \tag{4}$$

The solid angle dependence of the number of fast and slow photons expected is shown in figure 3

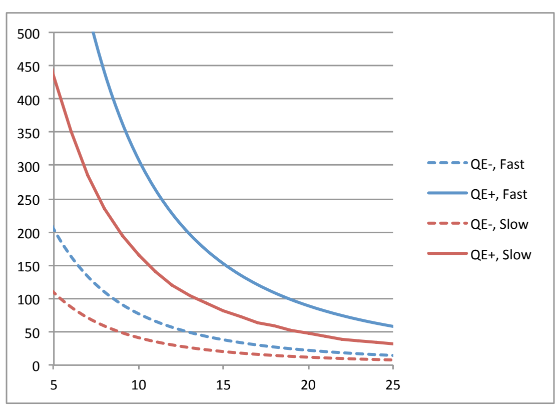


Figure 3: Number of fast and slow photons expected per alpha for best and worst case QE values