RMS vs Light Yield

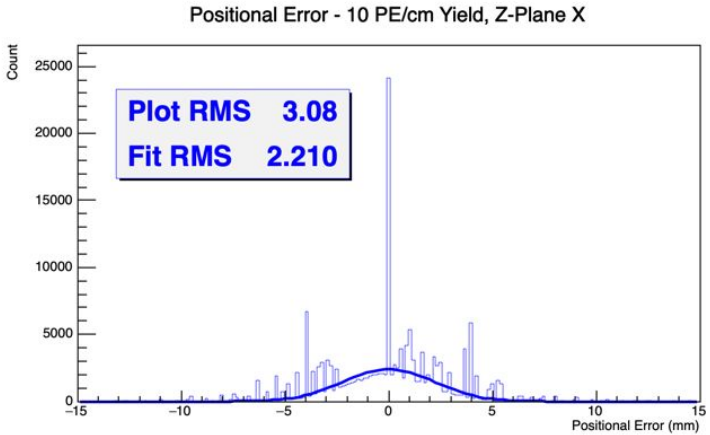
Omar Shohoud, January 20

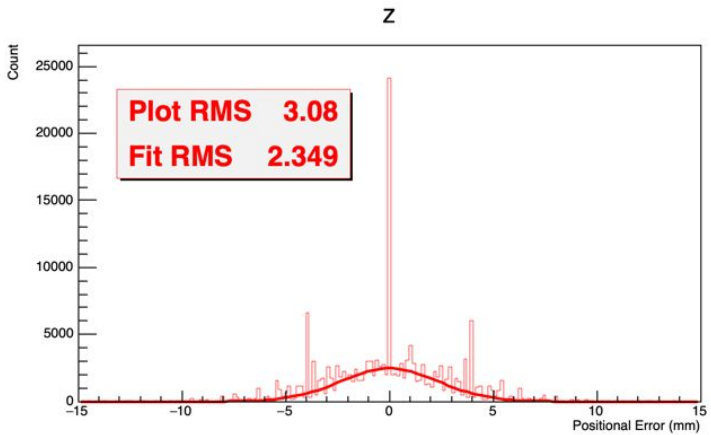
Questions:

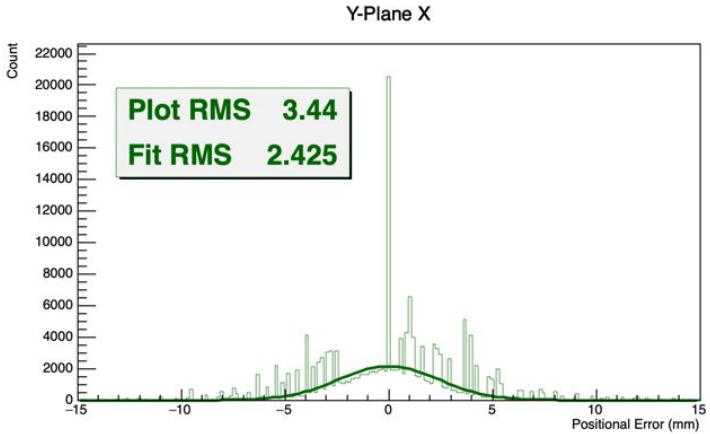
1) When improving RMS, at approximately what value does light-yield become eclipsed by other factors?

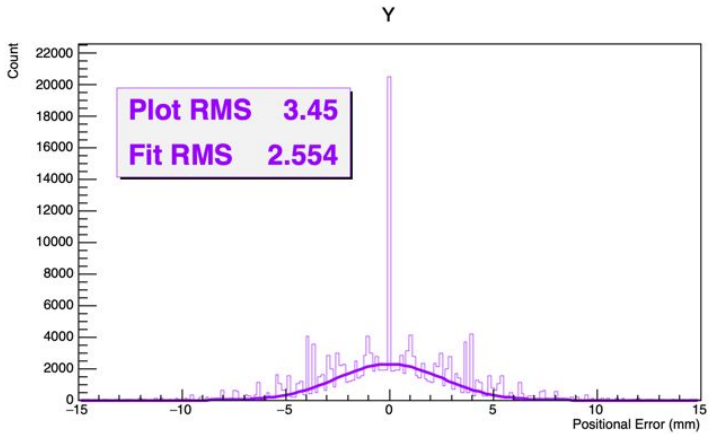
2) Tests thus far have been done at 50 PE/cm yield, is that sufficient?

Histograms by Light Yield - 10 PE/cm

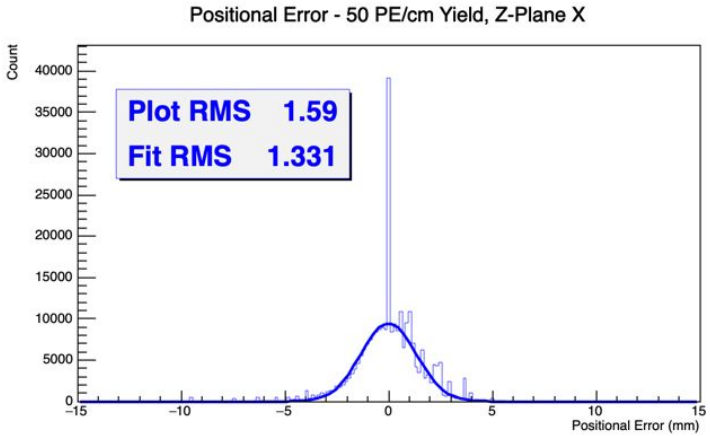


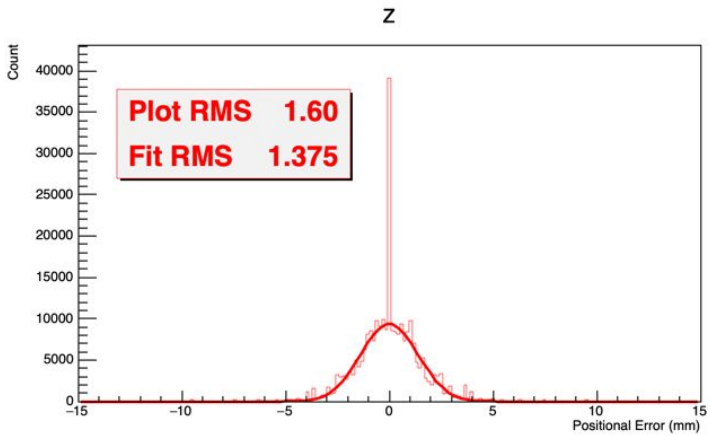


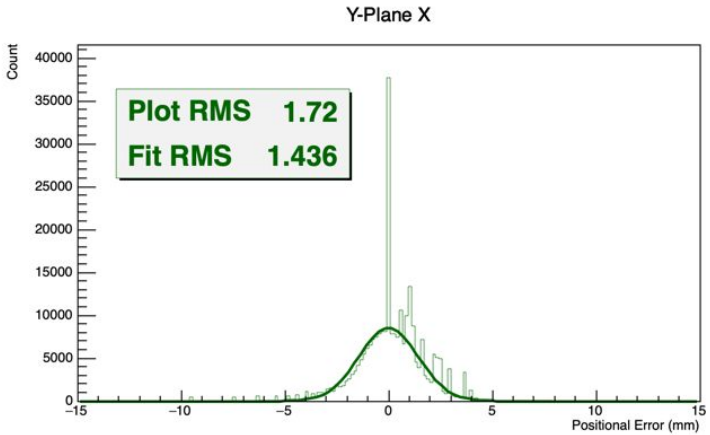


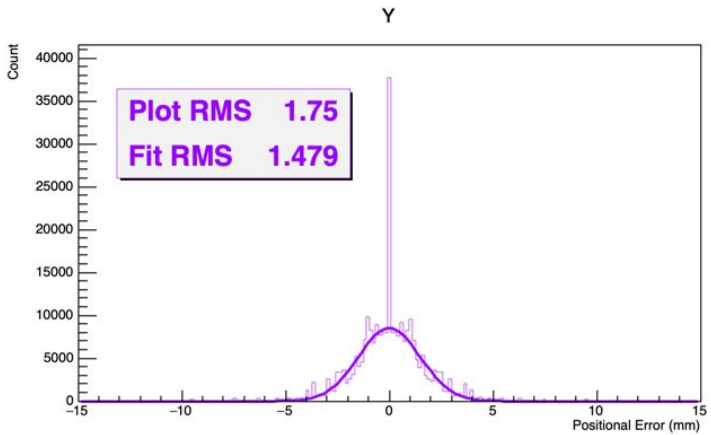


Histograms by Light Yield - 50 PE/cm

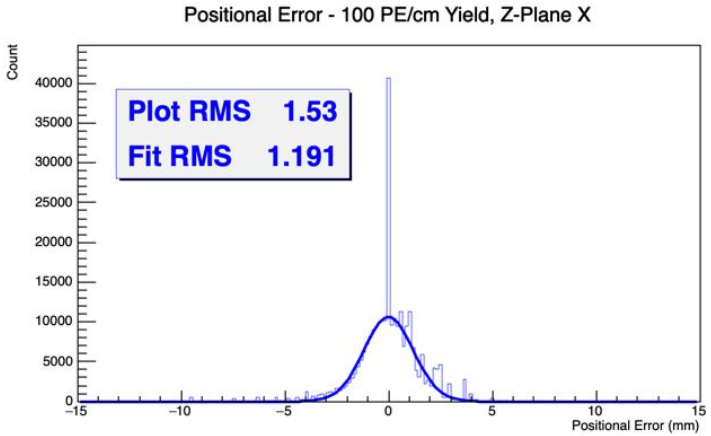


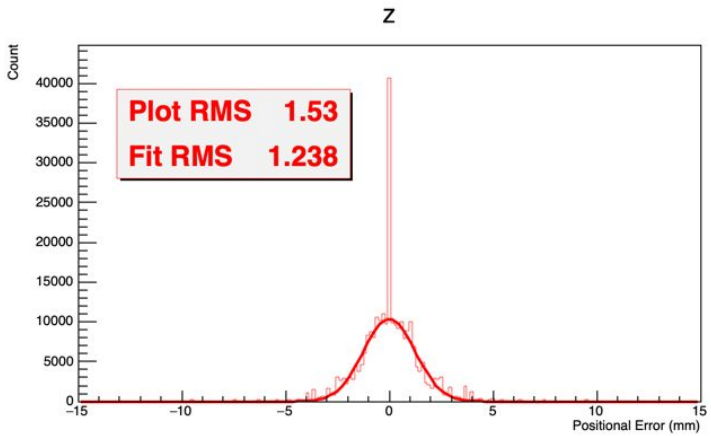


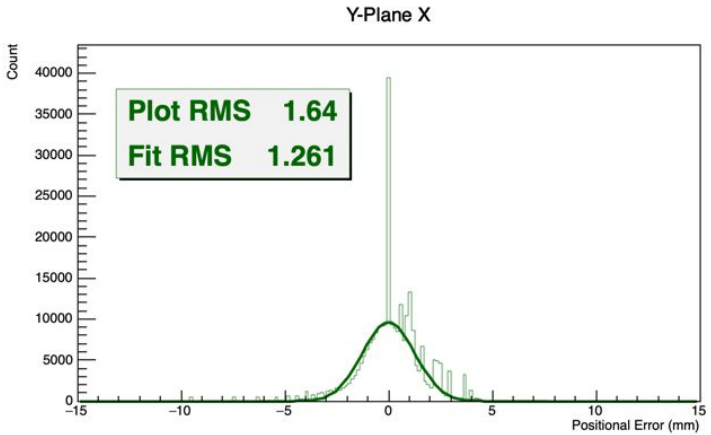


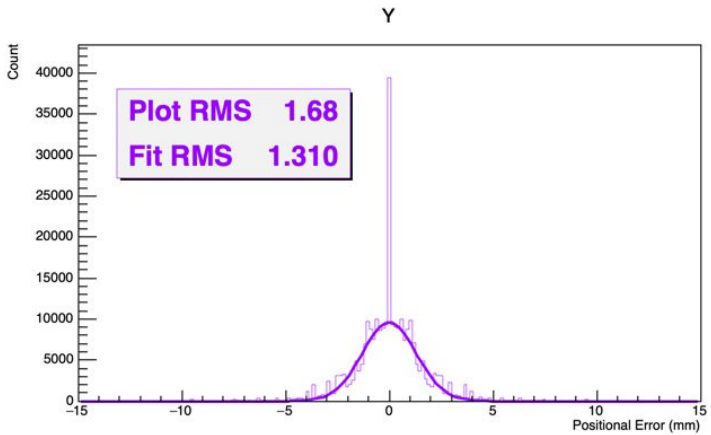


Histograms by Light Yield - 100 PE/cm

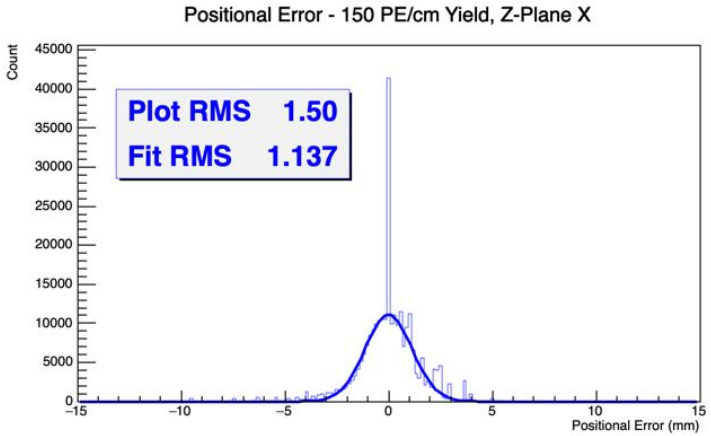


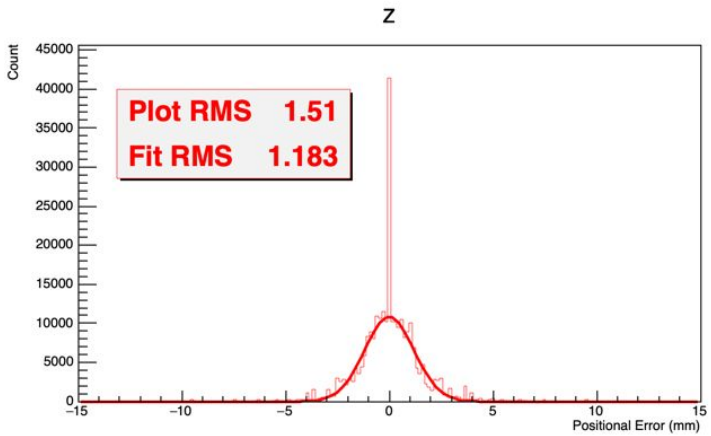


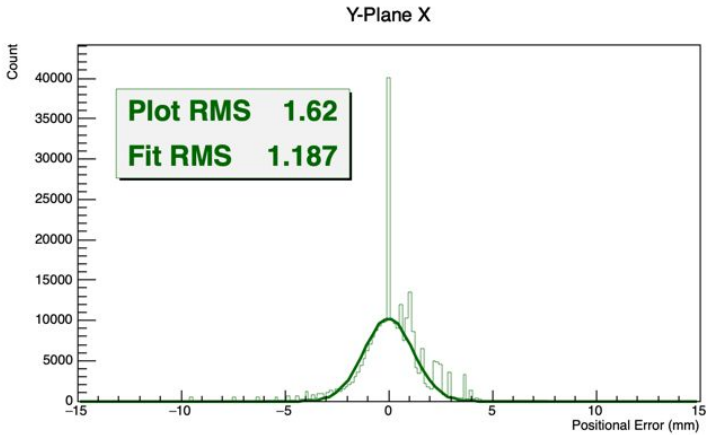


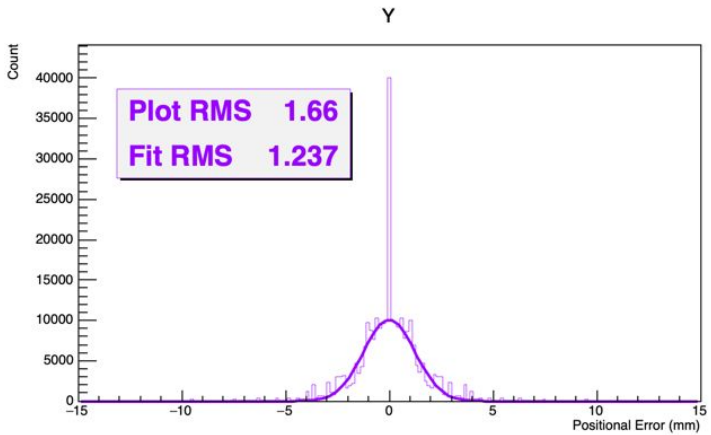


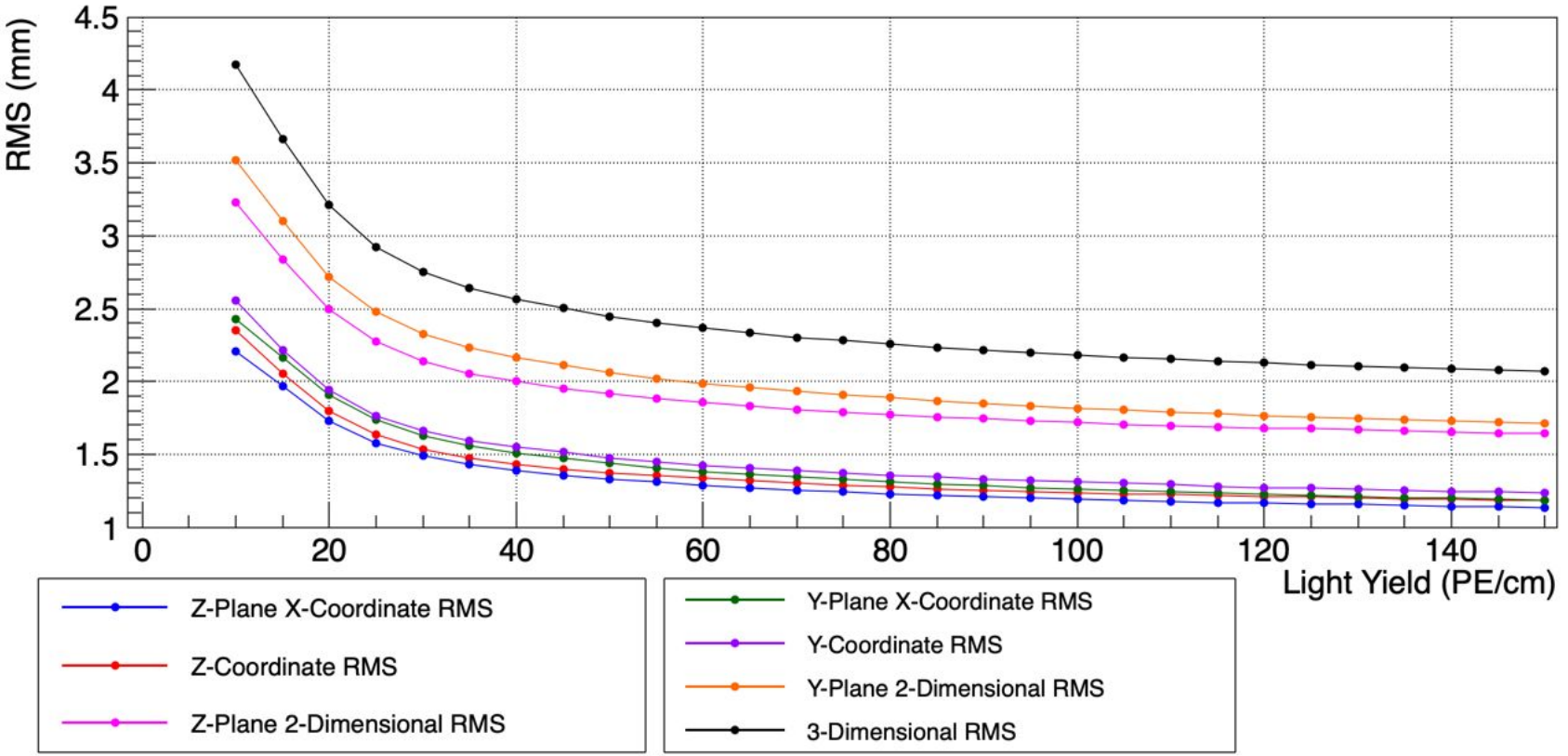
Histograms by Light Yield - 150 PE/cm





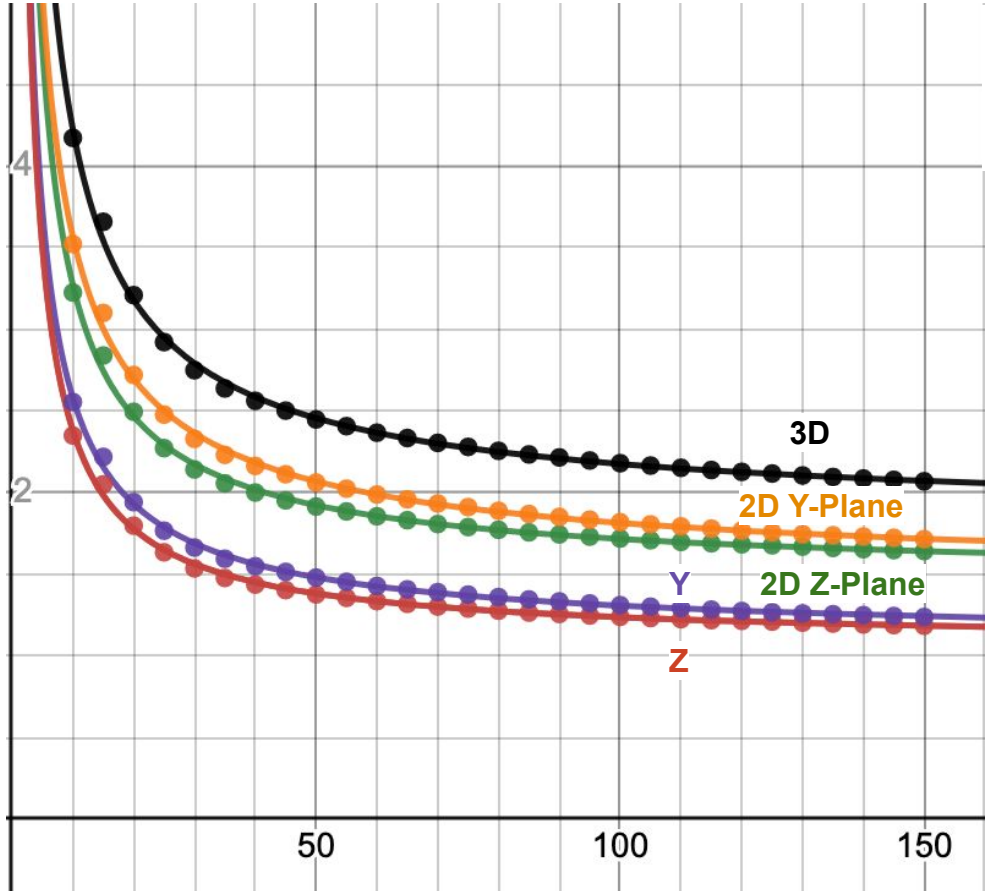






RMS of Gaussian fits vs light yield. The differences in RMS between the Y- and Z-Planes are the results of their relative positioning; the Z-Plane is in front of the Y-Plane and causes additional scattering and emission of secondaries. The 2- and 3-dimensional RMS is given by $\sigma_{xz} = \sqrt{\sigma_{x_1}^2 + \sigma_z^2}$ and $\sigma_{xyz} = \sqrt{(\frac{\sigma_{x_1}+\sigma_{x_2}}{2})^2 + \sigma_y^2 + \sigma_z^2}$ respectively.

Fits to Inverse Power Function



$$\sigma_i = A_i \left(\frac{1}{L^\lambda} + \Delta \right), \; R^2 = 0.997$$

$$\lambda = 0.83 \pm 0.06,$$

$$\Delta = 0.112 \pm 0.006$$

σ_i is the Gaussian fit RMS,

and L is the light yield.

$\implies$ For a given L, $\frac{\sigma_i(L)}{A_i \Delta}$ is the same for each coordinate.

I.e. the proportion of RMS at a given light yield to the asymptotic value is the same for each coordinate.

Conclusions

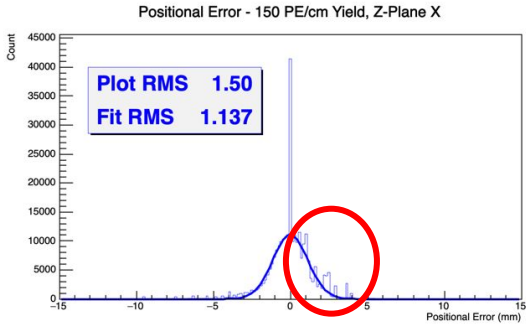
1) RMS is within 50% of the asymptotic value at about 30 PE/cm, 25% at 75 PE/cm, 10% at 225 PE/cm, and 5% at 500 PE/cm.

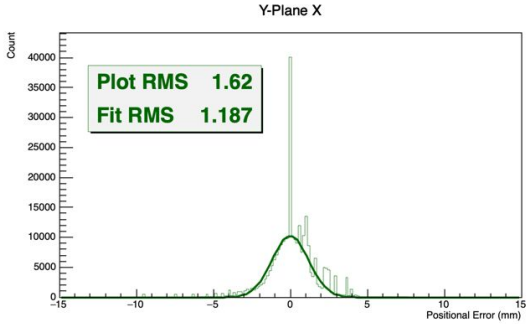
2) At 50 PE/cm, the RMS is within roughly 35% of the asymptotic value—is that good enough for us?

Further Questions to Investigate

Strange asymmetry in X-value histograms?

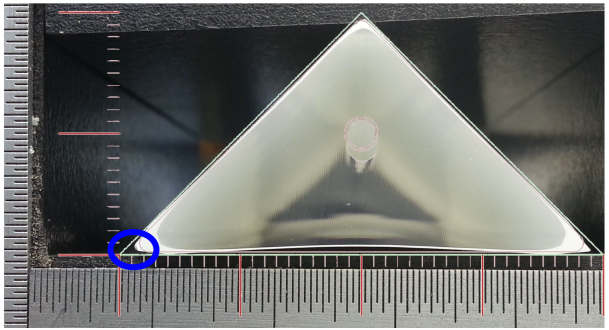
Cause unclear at the moment



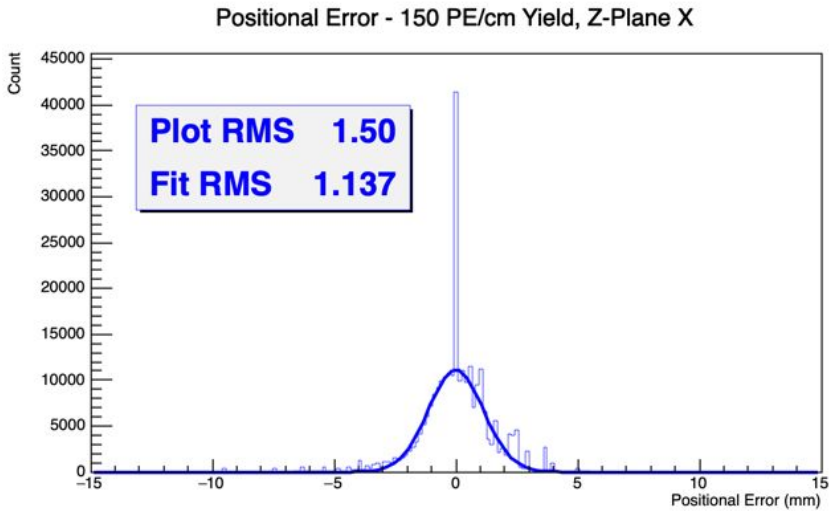


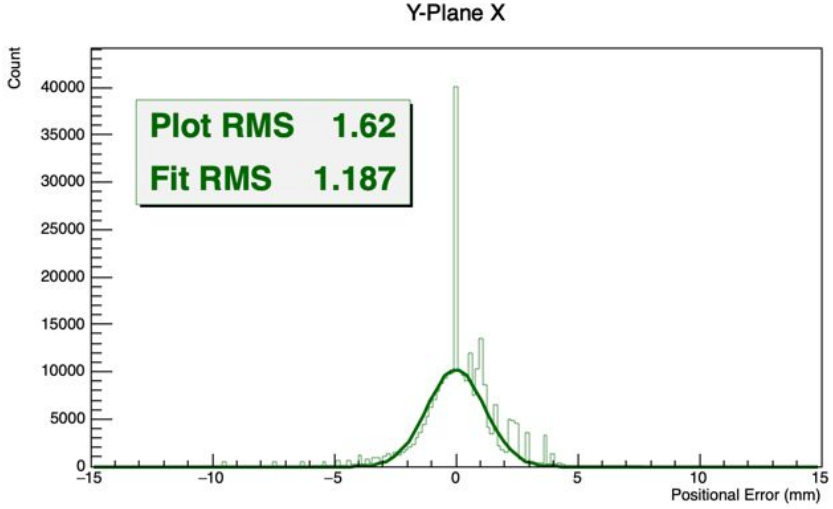
New proposed R&D to address “dead zones” and fiber hole in scintillator cells

Tests with these defects removed—how much would RMS improve? How good is good enough?



Questions?


Positional Error - 150 PE/cm Yield, Z-Plane X
Count
Plot RMS 1.50
Fit RMS 1.137
Positional Error (mm)


Y-Plane X
Count
Plot RMS 1.62
Fit RMS 1.187
Positional Error (mm)