RMS vs Light Yield

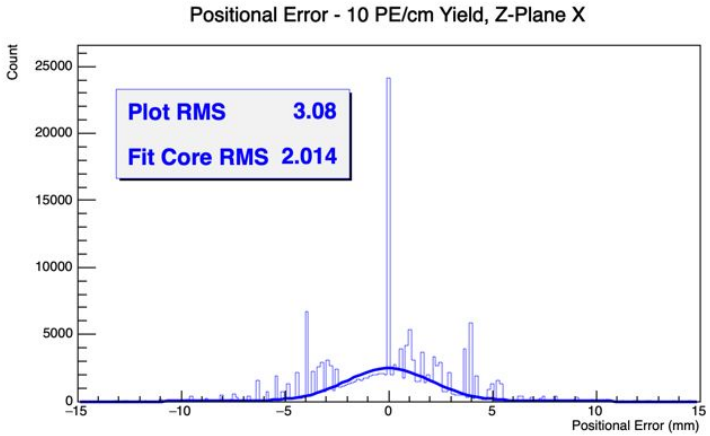
Omar Shohoud, January 20

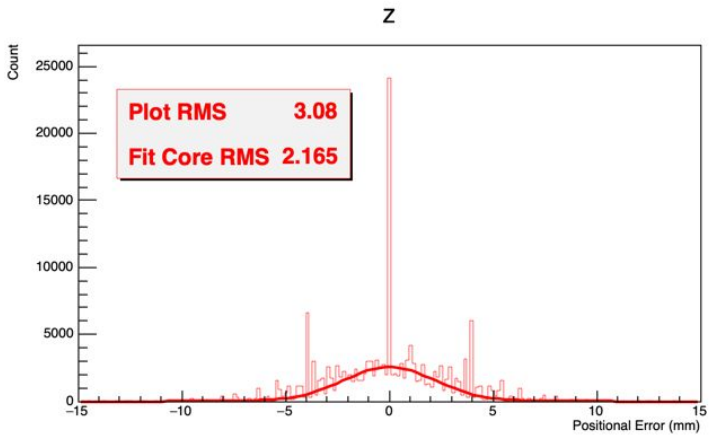
Questions:

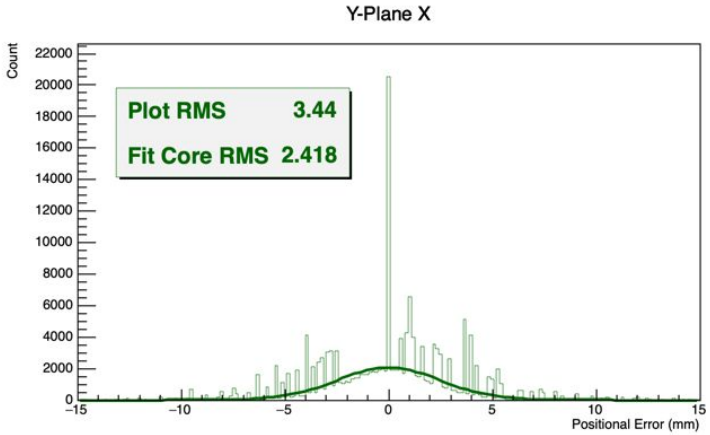
1) When improving RMS, at approximately what value does light-yield become eclipsed by other factors?

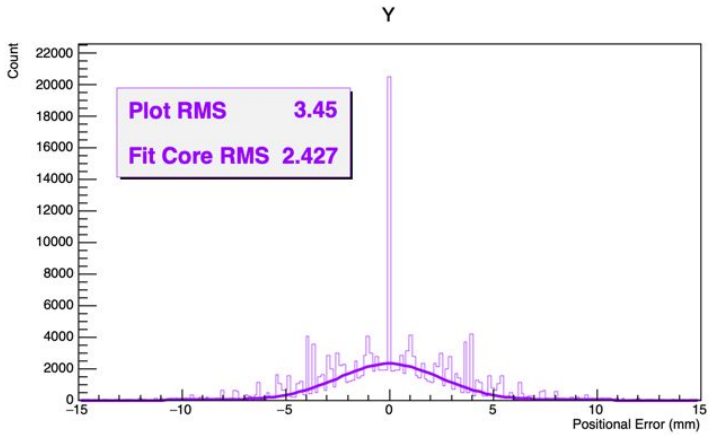
2) Tests thus far have been done at 50 PE/cm yield, is that sufficient?

Histograms by Light Yield - 10 PE/cm

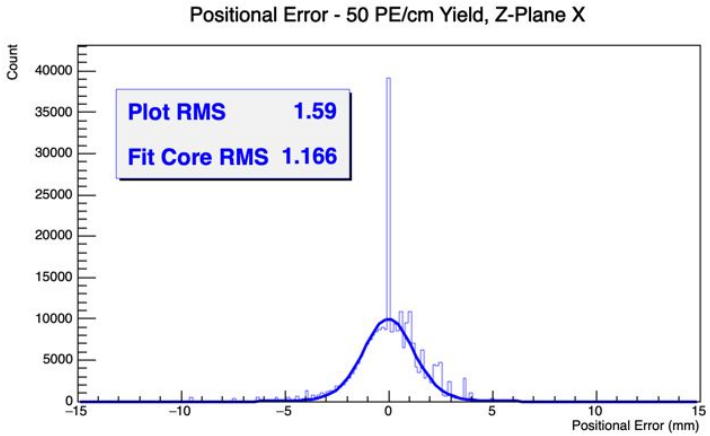


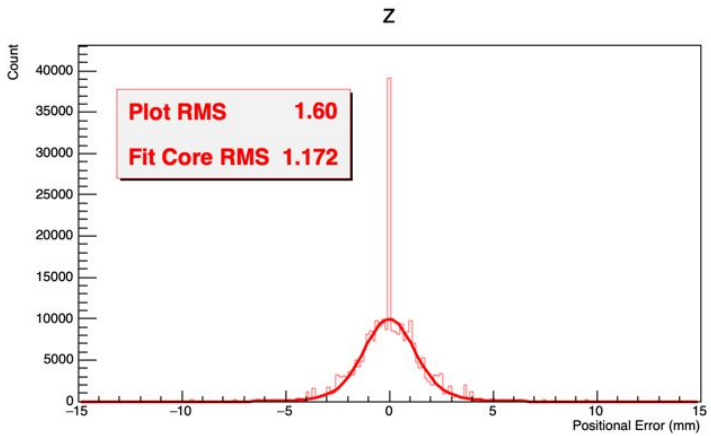


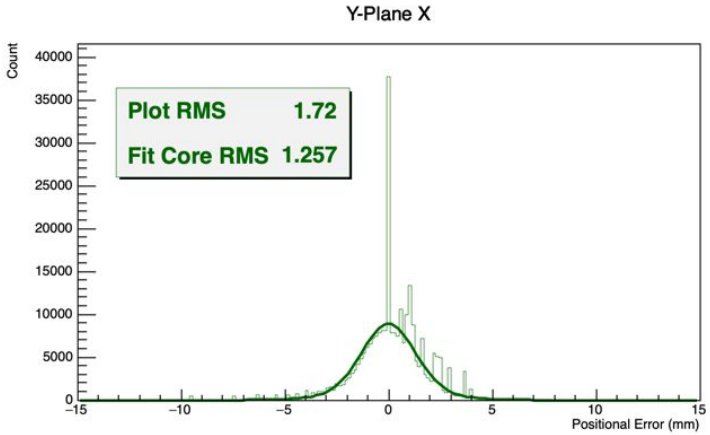


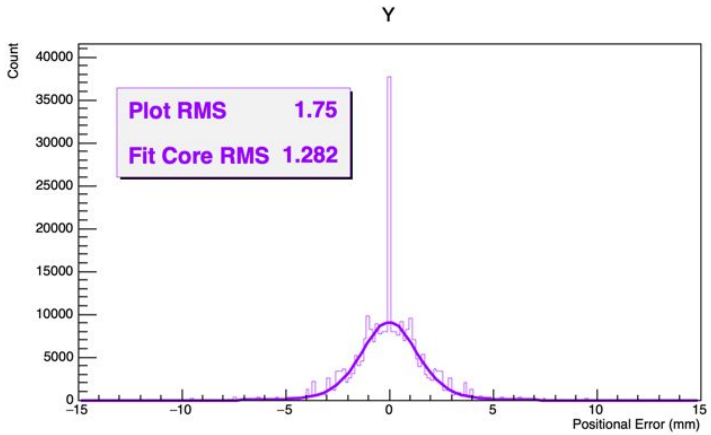


Histograms by Light Yield - 50 PE/cm

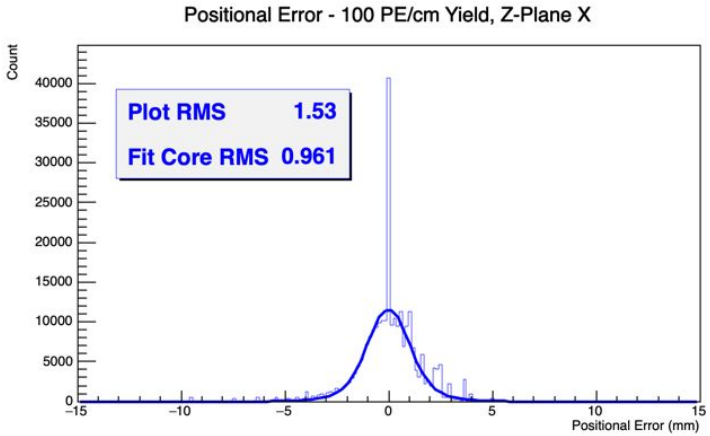


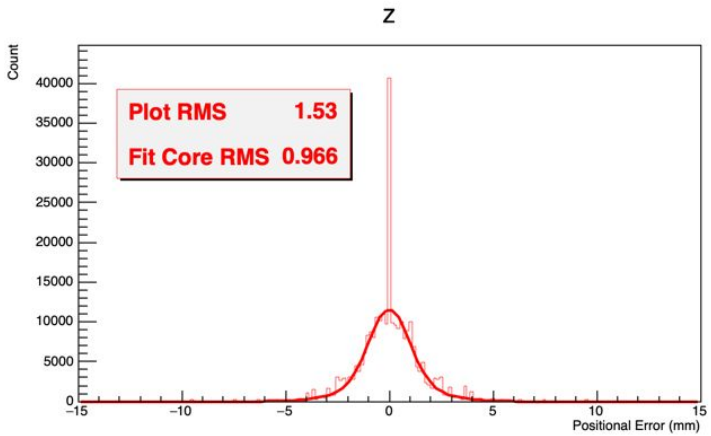


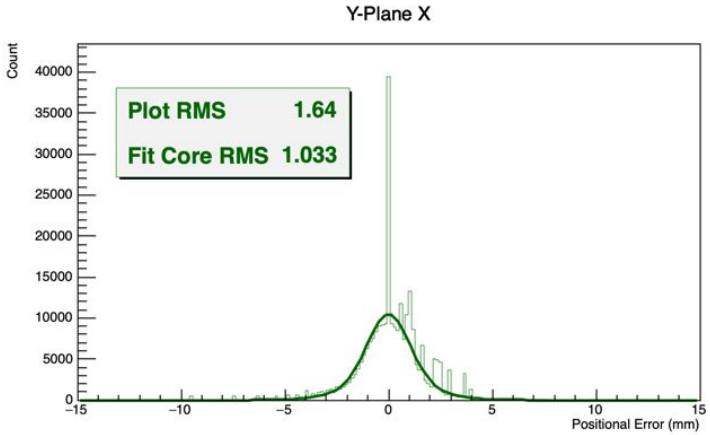


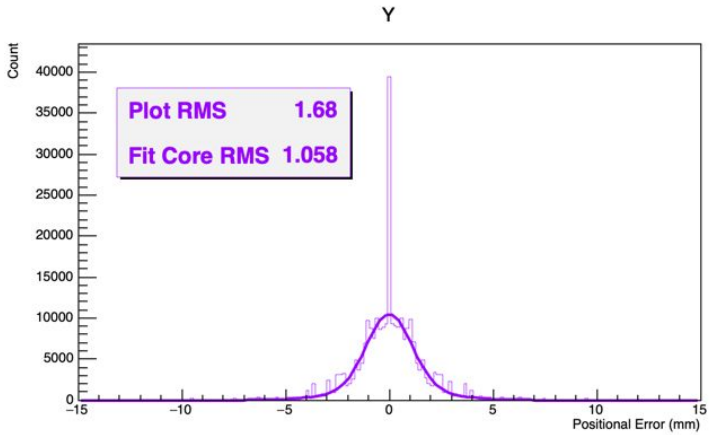


Histograms by Light Yield - 100 PE/cm

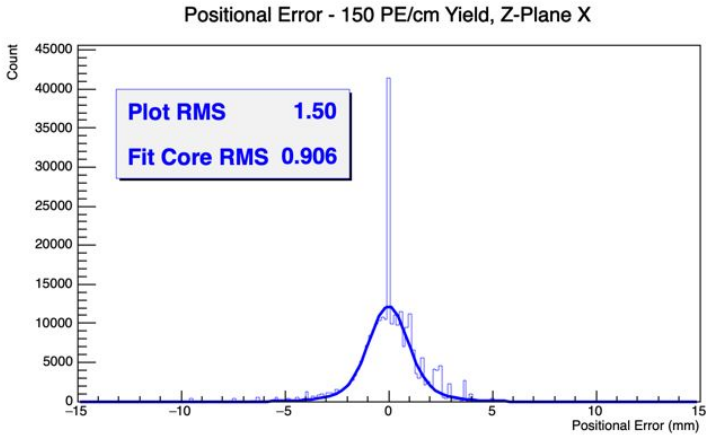


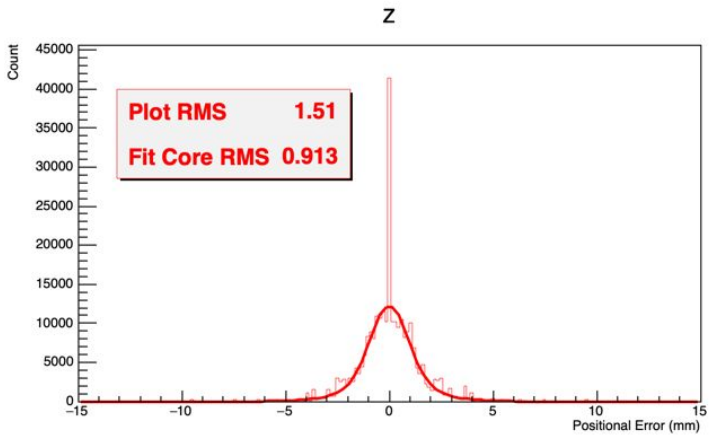


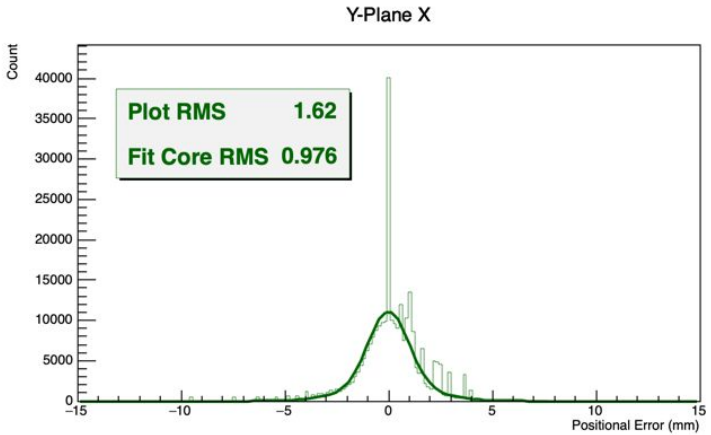


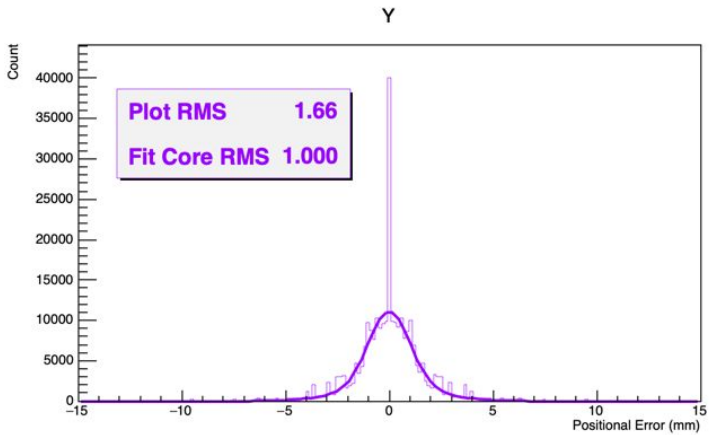


Histograms by Light Yield - 150 PE/cm

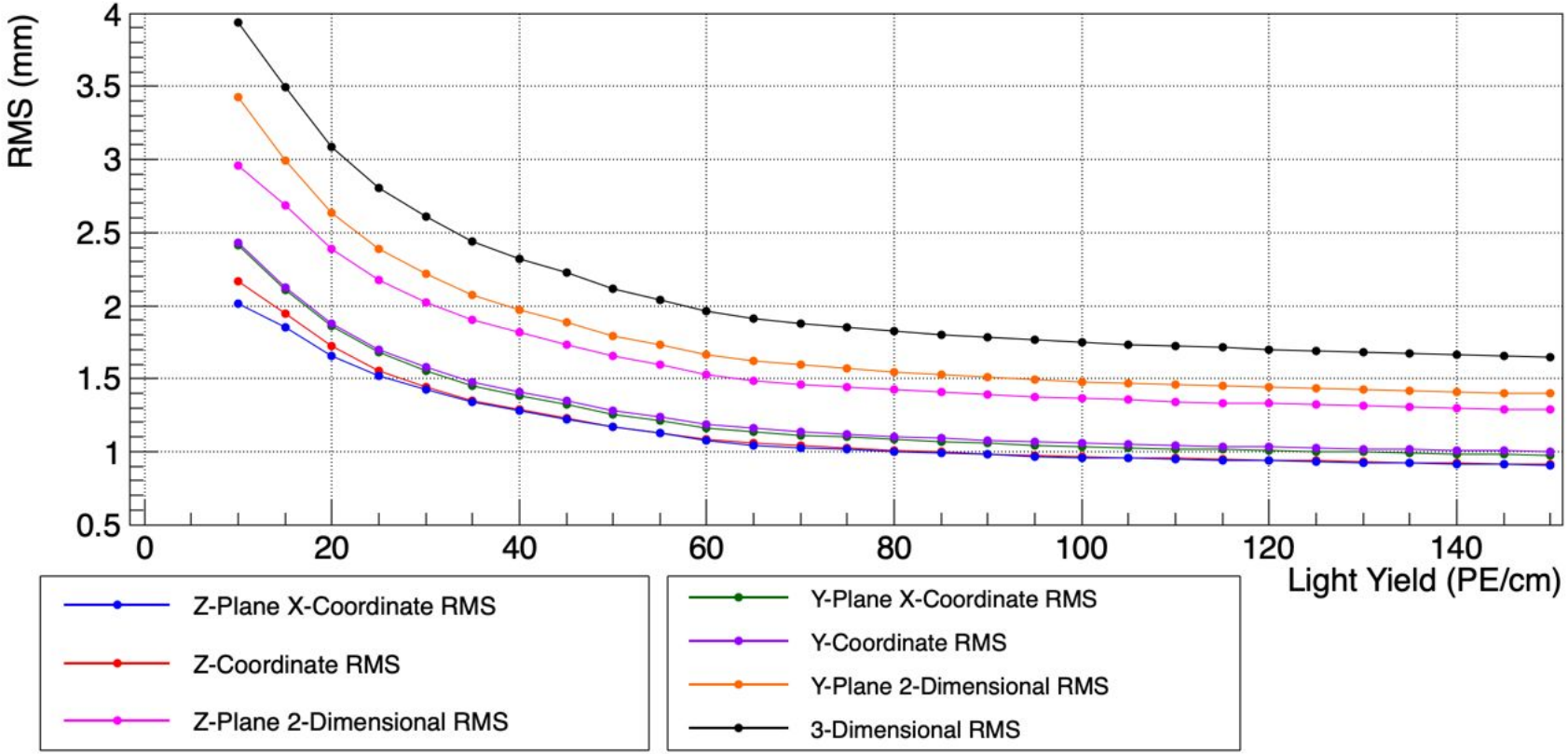






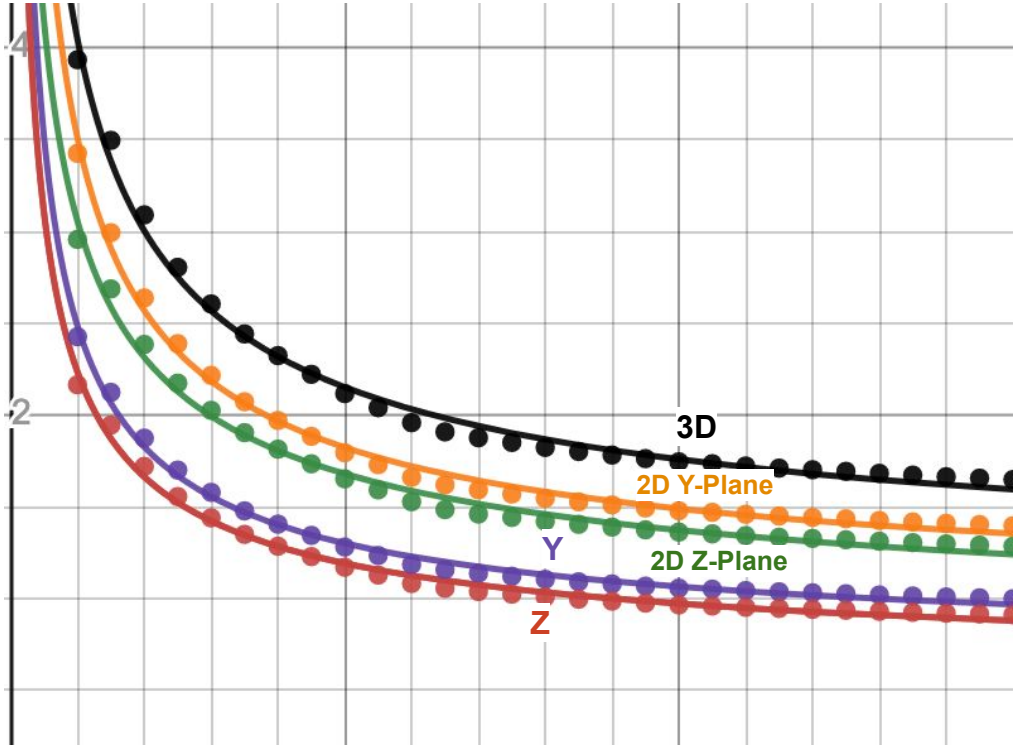


Fit Core RMS vs Light Yield



Core RMS of Double 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 RMSes are given by $\sigma_{xz} = \sqrt{\sigma_{x_1}^2 + \sigma_z^2}$ and $\sigma_{xyz} = \sqrt{\left(\frac{\sigma_{x_1}+\sigma_{x_2}}{2}\right)^2 + \sigma_y^2 + \sigma_z^2}$ respectively.

Fits to Inverse Power Function



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

$$\lambda = 0.61 \pm 0.05,$$

$$\Delta = 0.082 \pm 0.004$$

σ_i is the Core RMS of the double-Gaussian fit 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 150% of the asymptotic value at 30 PE/cm, within 100% at 60 PE/cm, within 50% at 190 PE/cm, and within 25% at 585 PE/cm.

2) At 50 PE/cm, the RMS is within roughly 115% of the asymptotic value—lots of room for improvement.

Further Questions to Investigate

For double-Gaussian RMSes, inverse power function doesn't fit as well

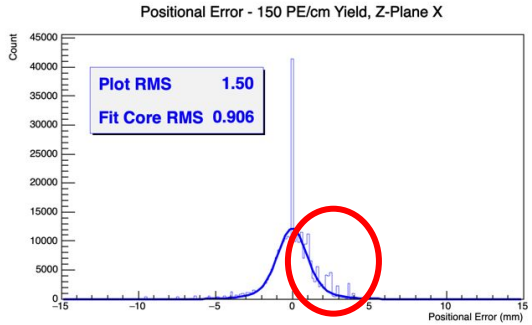
Other function could represent better, may be cause for outrageous values on previous slide

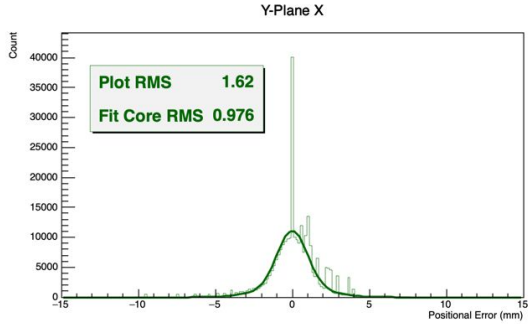
Strange asymmetry in X-value histograms?

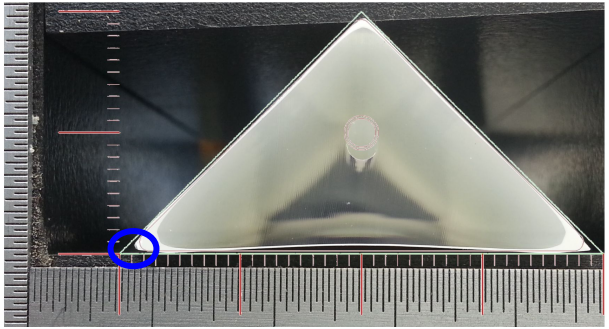
Cause unclear at the moment

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

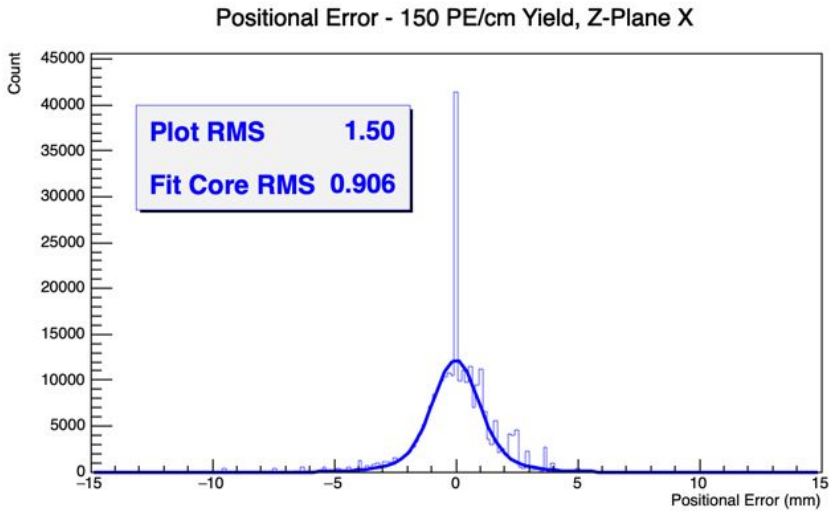
Tests with these defects removed—how much would RMS improve? How good is good enough?

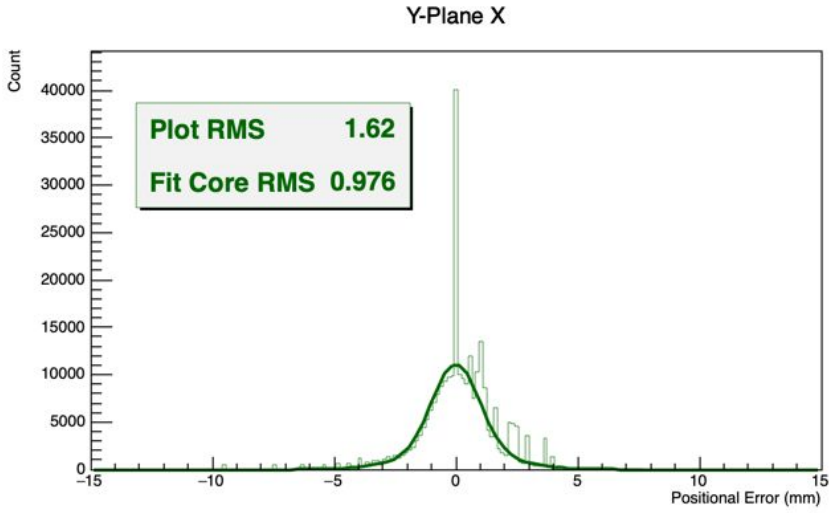






Questions?


Positional Error - 150 PE/cm Yield, Z-Plane X
Count
Plot RMS 1.50
Fit Core RMS 0.906
Positional Error (mm)


Y-Plane X
Count
Plot RMS 1.62
Fit Core RMS 0.976
Positional Error (mm)