TB analysis

NA62 data, Binning, ToyMC

Andrei Zelenov, 18/01/2024

6.2 Resolution from drift time distributions

In the procedure described in this section, the spatial resolution $\sigma(Y)$ was obtained from drift time resolution applying statistical methods to the measured V-shape. The time resolution $\sigma_t(Y)$, in turn, was evaluated from a Gaussian fit of the drift time distributions obtained individually for narrow slices of the Y_{tr} coordinates. The total Y range of a V-shape was divided into slices of 100 µm. Explicitly, a distribution of measured drift time t was obtained for each slice and fitted with the following Gaussian distribution, with mean T, standard deviation σ_t and a normalisation factor C:

$$N(t, T, \sigma_t) = \frac{C}{\sigma_t\sqrt{2\pi}} \cdot exp\left(-\frac{(t-T)^2}{2\sigma_t^2}\right). \tag{13}$$

The fit was performed in the region of the most probable value for the bins with statistics exceeding 10% of the most populated bin content. Figure 35 shows examples of the time distributions for four different Y_{tr} slices along with the Gaussian fit results. At the straw edges, Figure 35 (a), there are less track signals and the results are more prone to noise hits. The two parameters T_i and $\sigma_{t,i}$ are thus obtained as fit results for every Y_i value. Statistical uncertainties on the mean drift time δT and the drift time resolution $\delta\sigma_{ti}$ were estimated within the fit procedure. Examples of the resulting $T(Y_{tr})$ and $\sigma_t(Y_{tr})$ dependencies are shown in Figure 36 for the short straw tube with wire eccentricities of 0.02 mm, 1.10 mm and 1.97 mm. Note the Y coordinate is shifted by about 1 mm with respect to the straw center.

For a small variation of Y, the dependence $T = F(Y)$ can be considered as quasi-linear. Therefore, within a narrow slice Y_i, the reconstructed coordinates $Y = F^{-1}(t)$ can also be

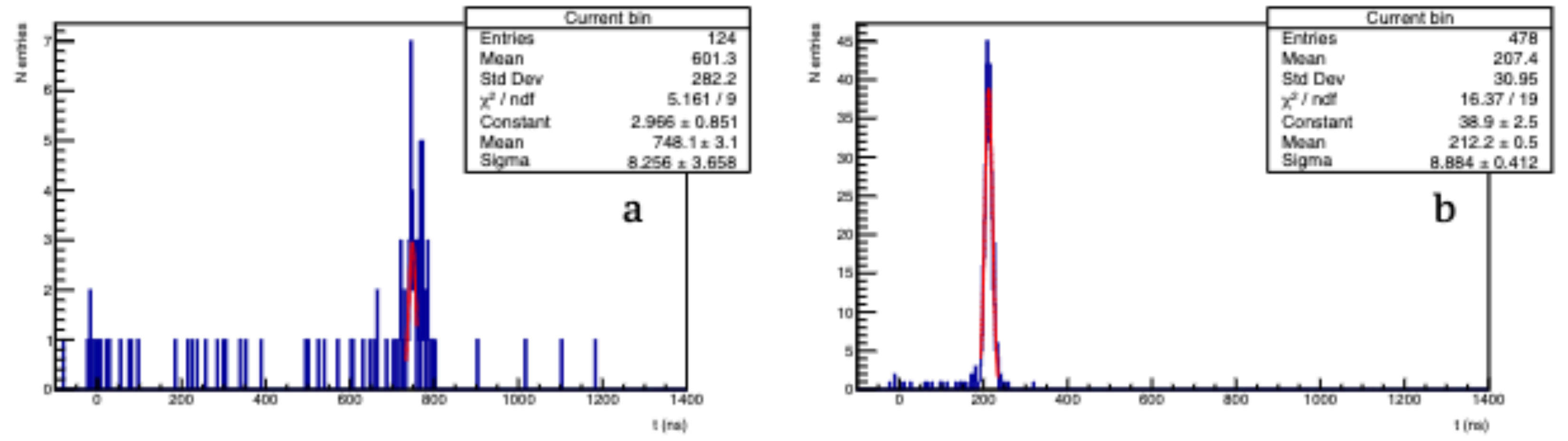


Figure 35: Drift time distributions for a straw tube with wire eccentricity of 0.19 mm obtained for different Y slices. The slices of 100 µm width are centred at $Y = -8.95$ mm (a) and $Y = 4.65$ mm (b). The fitted Gaussian distributions are shown with red curves.

described with a normal distribution. The width of this distribution can be estimated as

$$\sigma = \frac{\sigma_t}{\left|\frac{dF(Y)}{dY}\right|} = \frac{\sigma_t}{|F'|} \tag{14}$$

where the uncertainty $\delta\sigma$ is defined by the time resolution error $\delta\sigma_t$:

$$(\delta\sigma)^2 = \left[\frac{\partial\sigma}{\partial\sigma_t}\right]^2 \cdot (\delta\sigma_t)^2 + \left[\frac{\partial\sigma}{\partial F'}\right]^2 \cdot (\delta F')^2 = \left(\frac{1}{F'}\right)^2 \cdot (\delta\sigma_t)^2 + \left(-\frac{\sigma_t}{F'^2}\right)^2 \cdot (\delta F')^2. \tag{15}$$

The derivative F' was estimated numerically for every slice Y_i using the obtained $T = F(Y)$ dependence. In order to minimize fluctuations, while keeping the variation of Y small, four neighboring slices were used for the derivative calculation:

$$F'_i = \frac{T_{i+2} - T_{i-2}}{4Y_w}, \tag{16}$$

where Y_w is the width of Y_{tr} slices. The corresponding uncertainty was evaluated as

$$\delta F'_i = \frac{\sqrt{(\delta T_{i+2})^2 + (\delta T_{i-2})^2}}{4Y_w}. \tag{17}$$

The resulting spatial resolutions as a function of the Y_{tr} coordinate are shown in Figure 37 for the short straw tube with the wire eccentricities of 0.02 mm, 1.10 mm and 1.97 mm. As was the case for the other methods, the spatial resolution exhibits plateaus of about 100 µm at each side of the straw and raises around the anode wire.

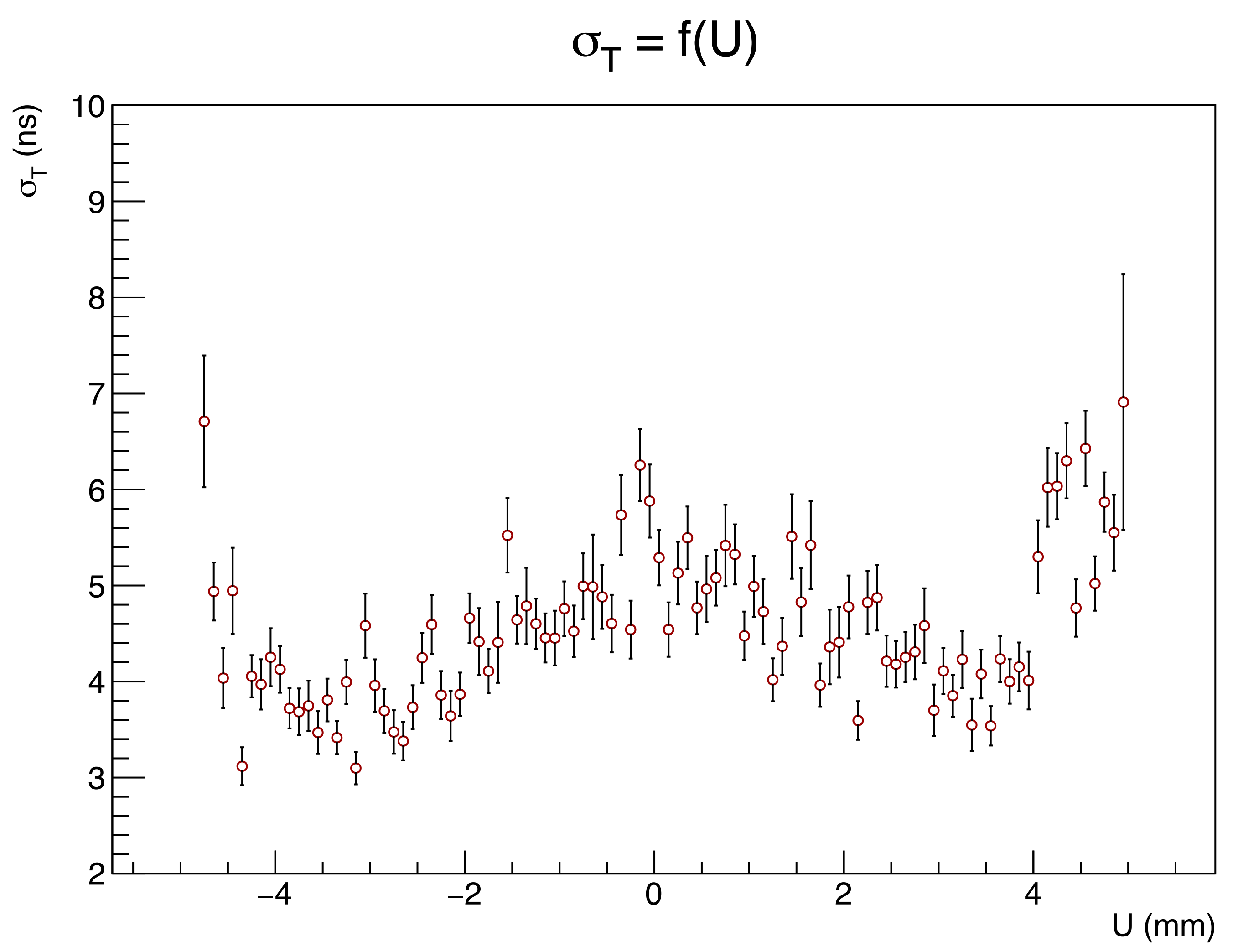
The analysis was performed for all data sets measured with the short straw tube for different applied tube offsets. The results are shown and discussed in 6.3.

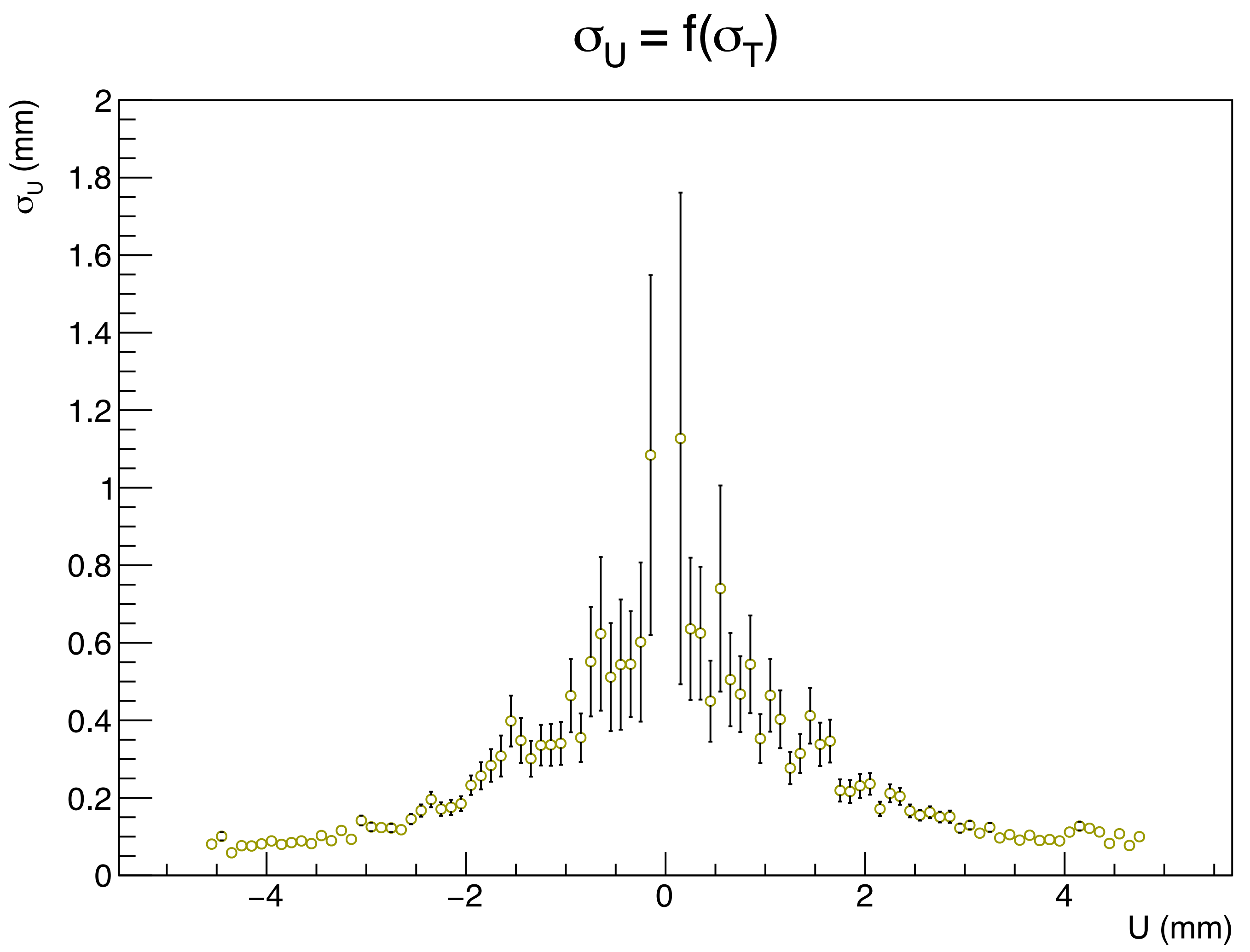
Method Description (pol2)

- For the every 100μm R bin from the R(T) TH2 get the T point according to the maximum of the distribution.
- Fit or interpolate the extracted T vs R distribution with pol2
- Build distributions of residuals Y – Ytr versus Y for the straw tube, where Y is the value from the inverse V-shape function and Ytr is the extrapolated coordinate
- Slice the data in Y bins and fit the 1-dimensional distributions of residuals by Gaussian

Still waiting raw data from Dosbol

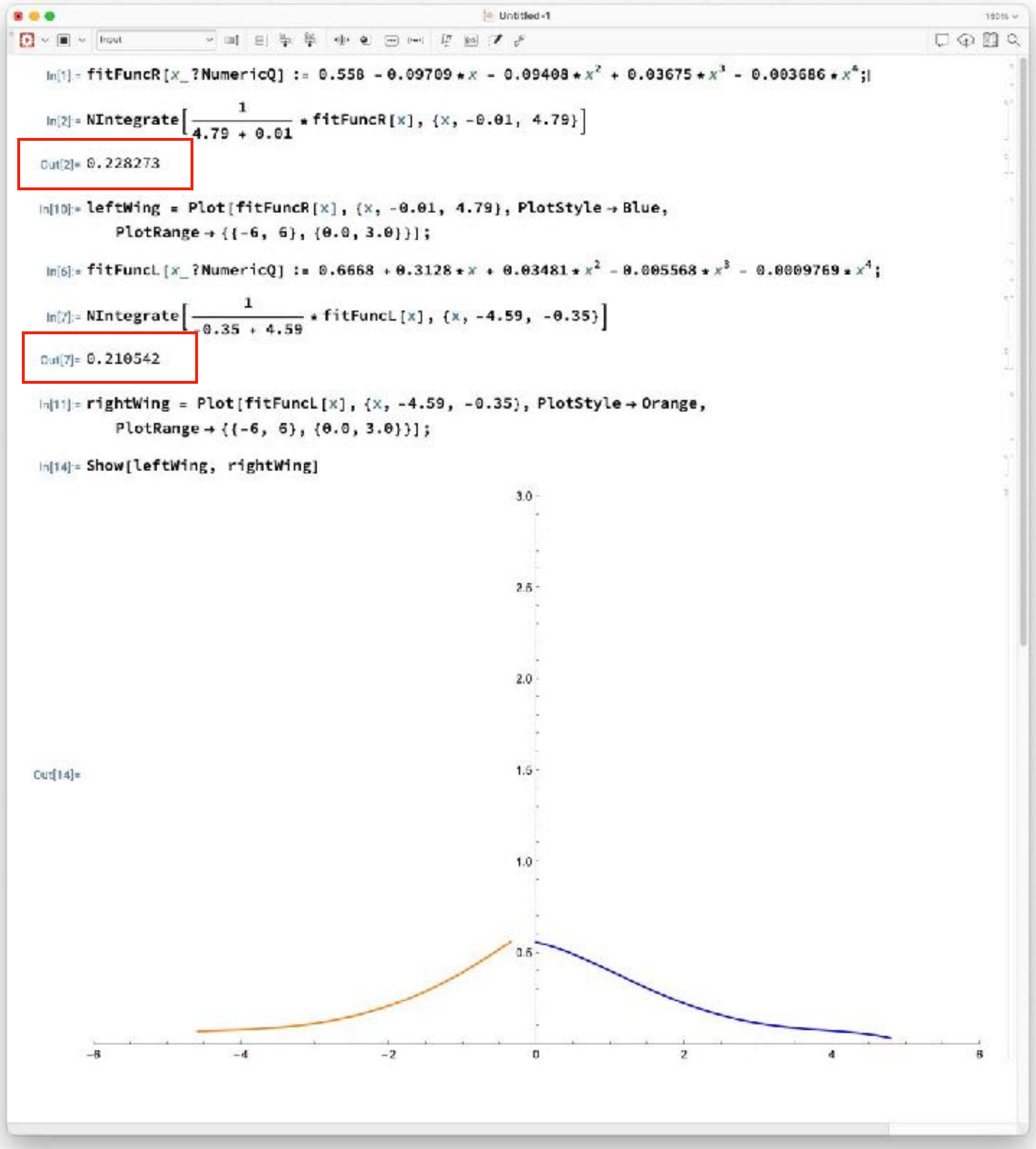
Spatial Resolution Estimation for NA62 data





using weighted mean:

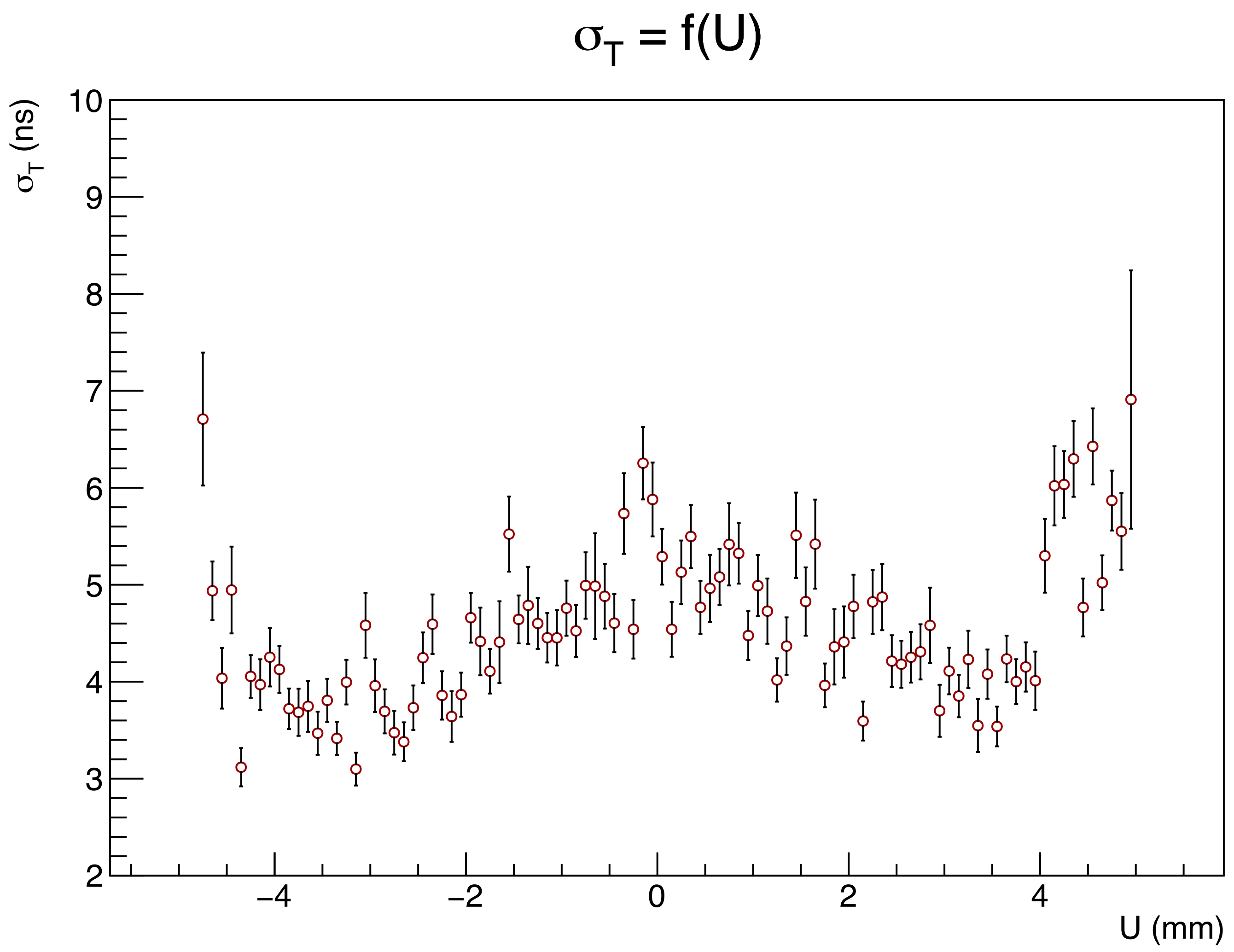
Resolution: (0.099975 +/- 0.00113005) mm

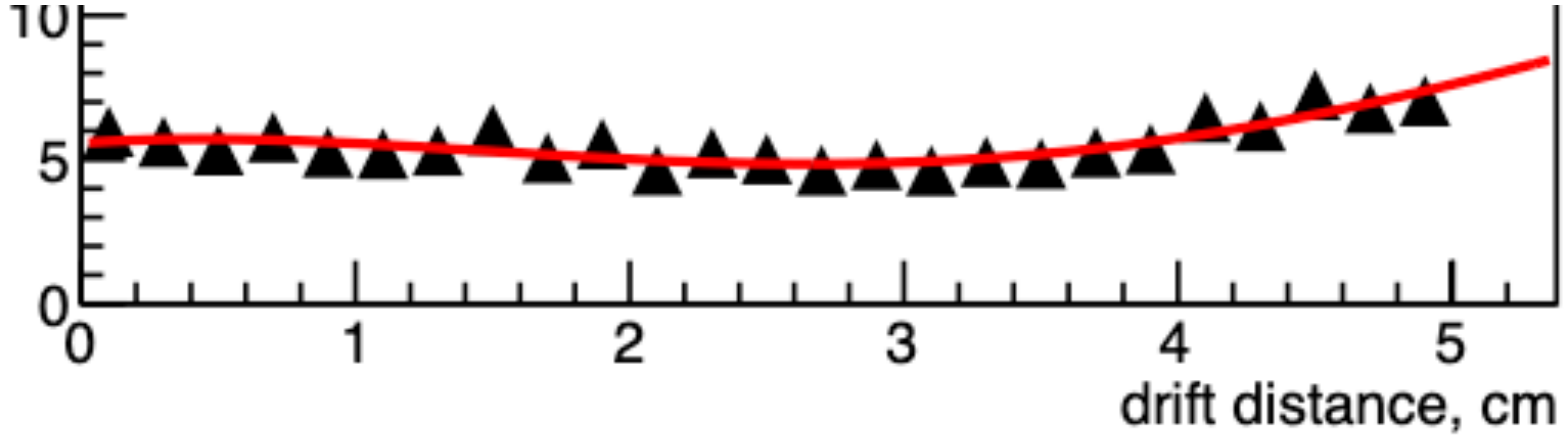


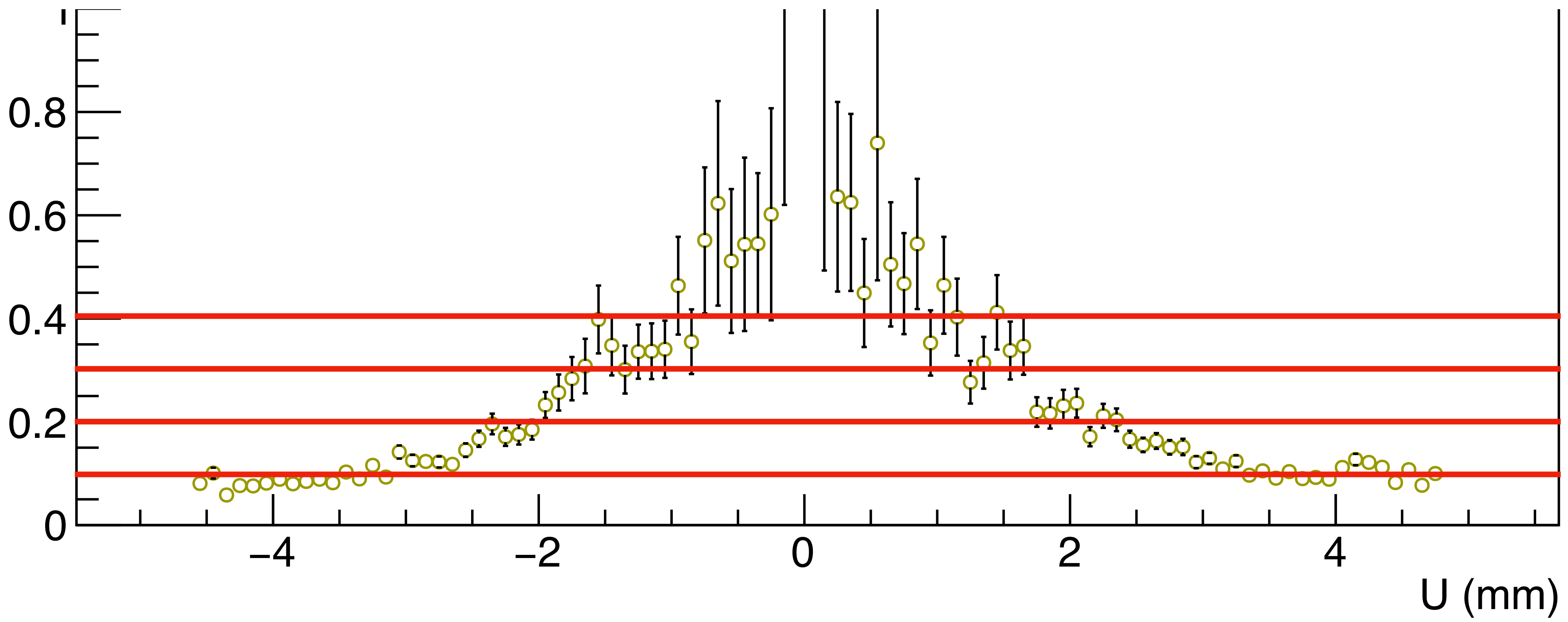
Fitting the $\sigma_U = f(\sigma_T)$ with pol4 and find the average as

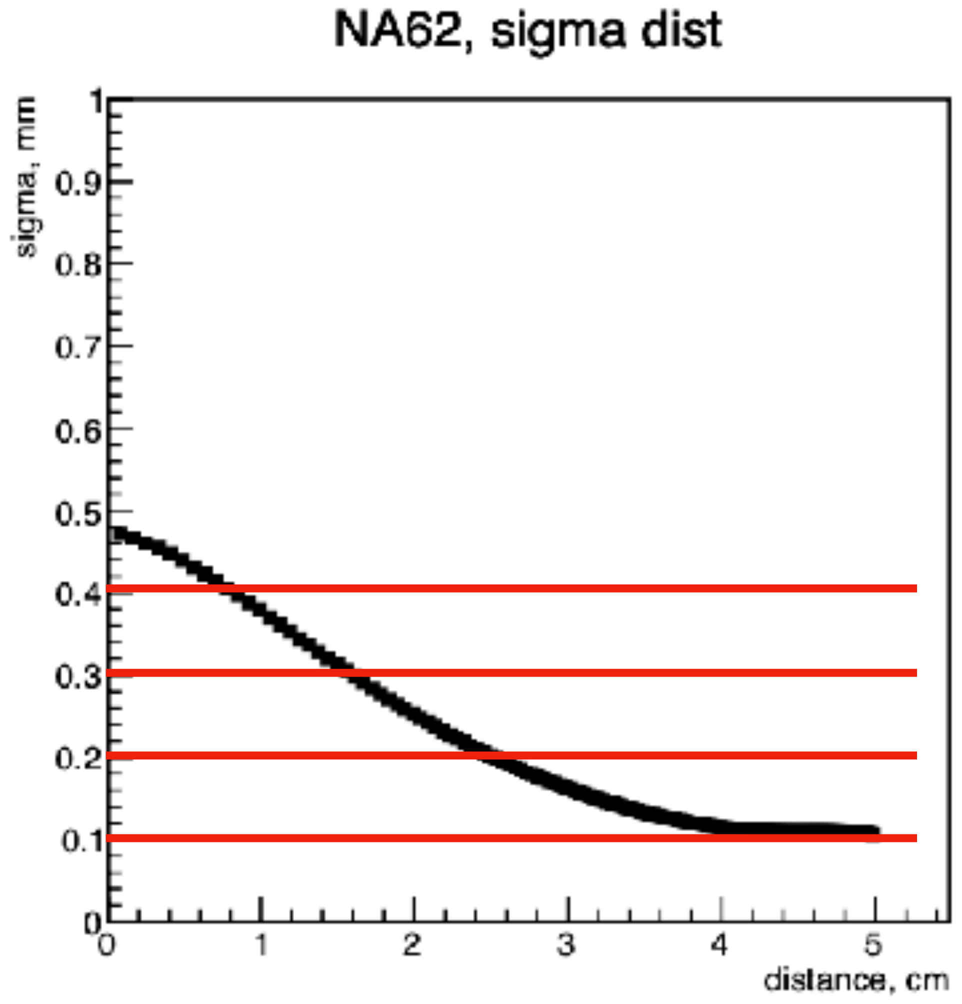
$$\bar{f} = \frac{1}{b-a}\int_a^b f(x)dx$$

Spatial Resolution Estimation for NA62 data (vs Artem)





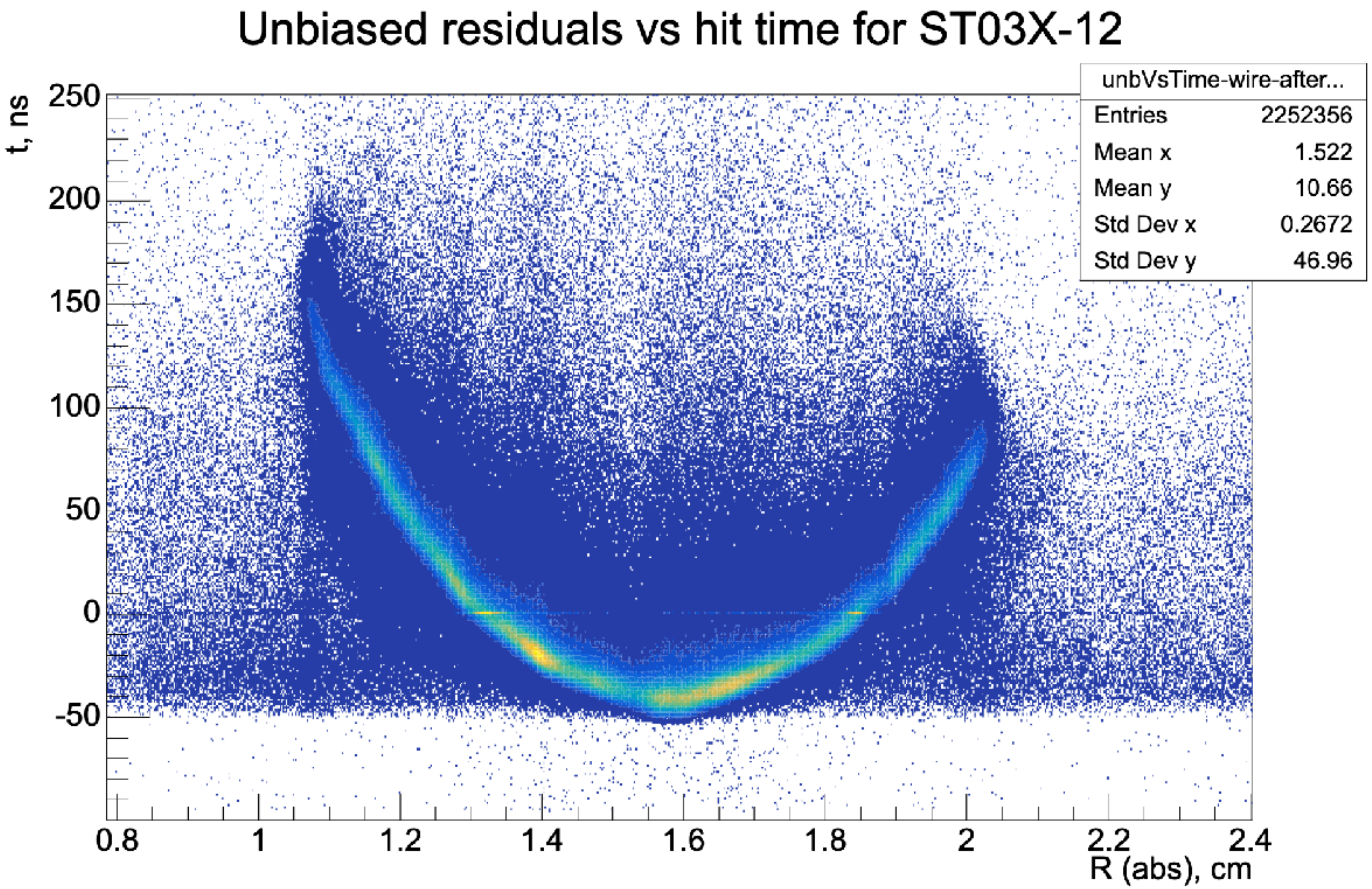




Binning tests

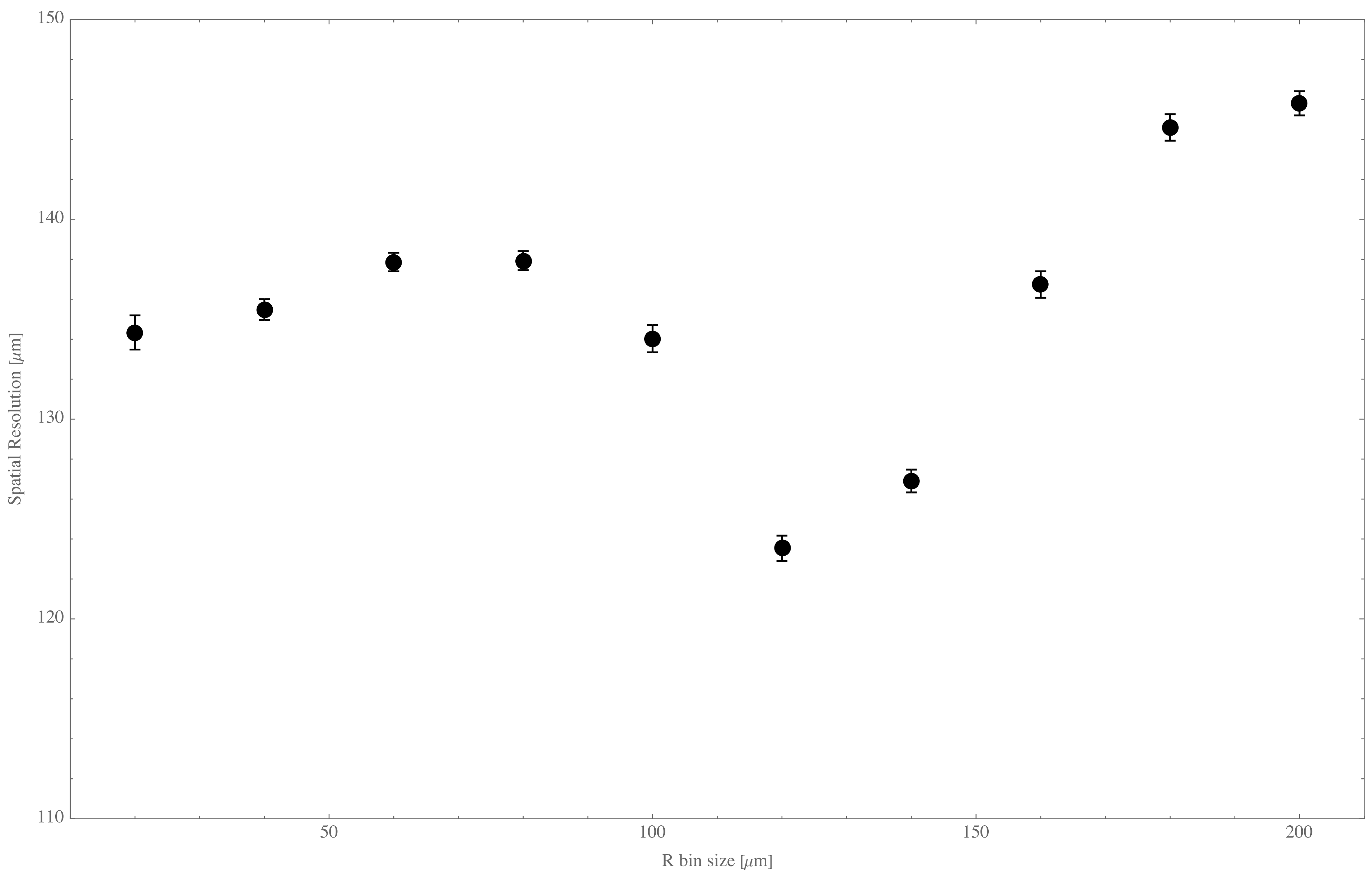
Thanks to Dima!

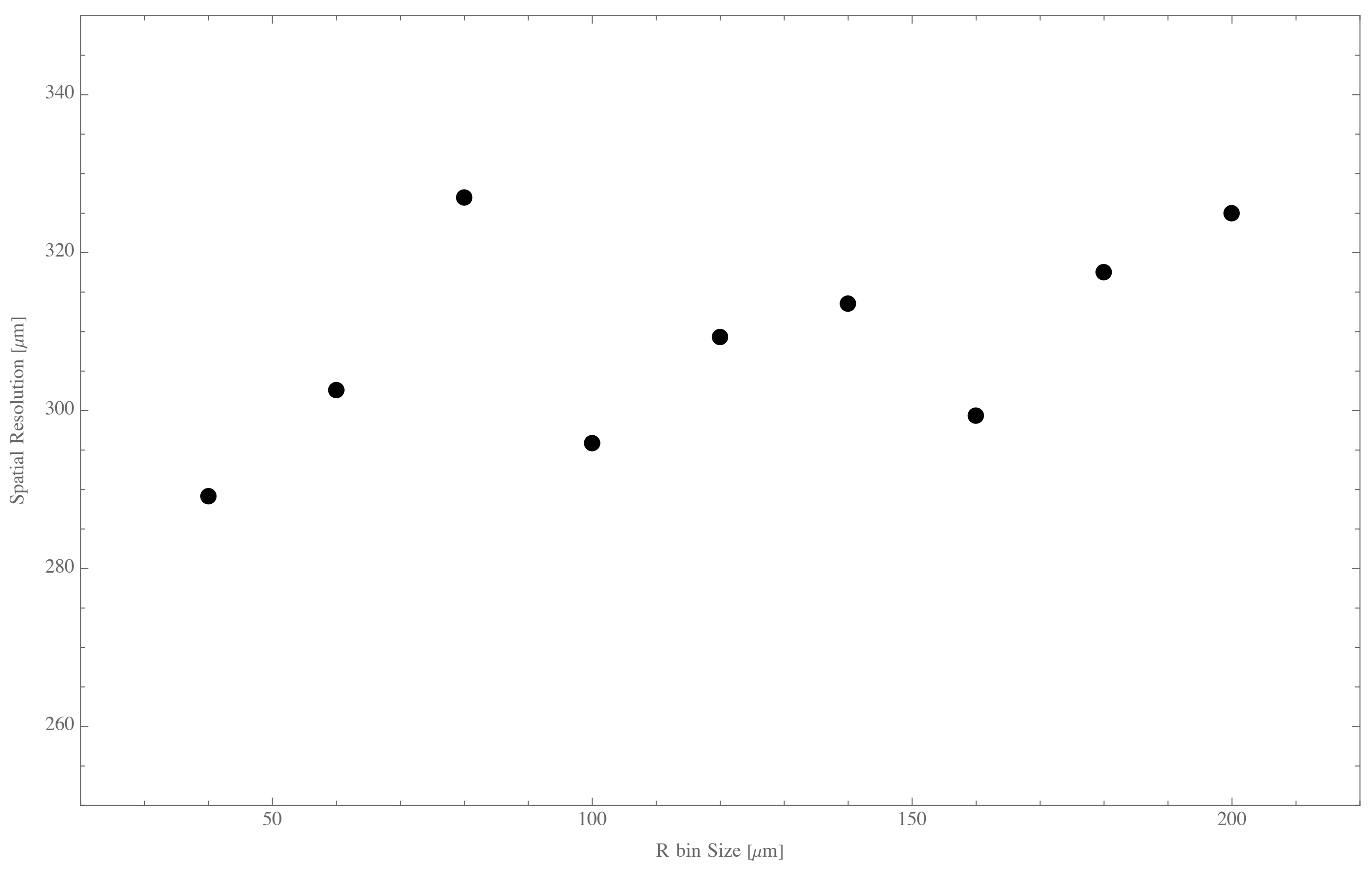
R bin = 20 μm



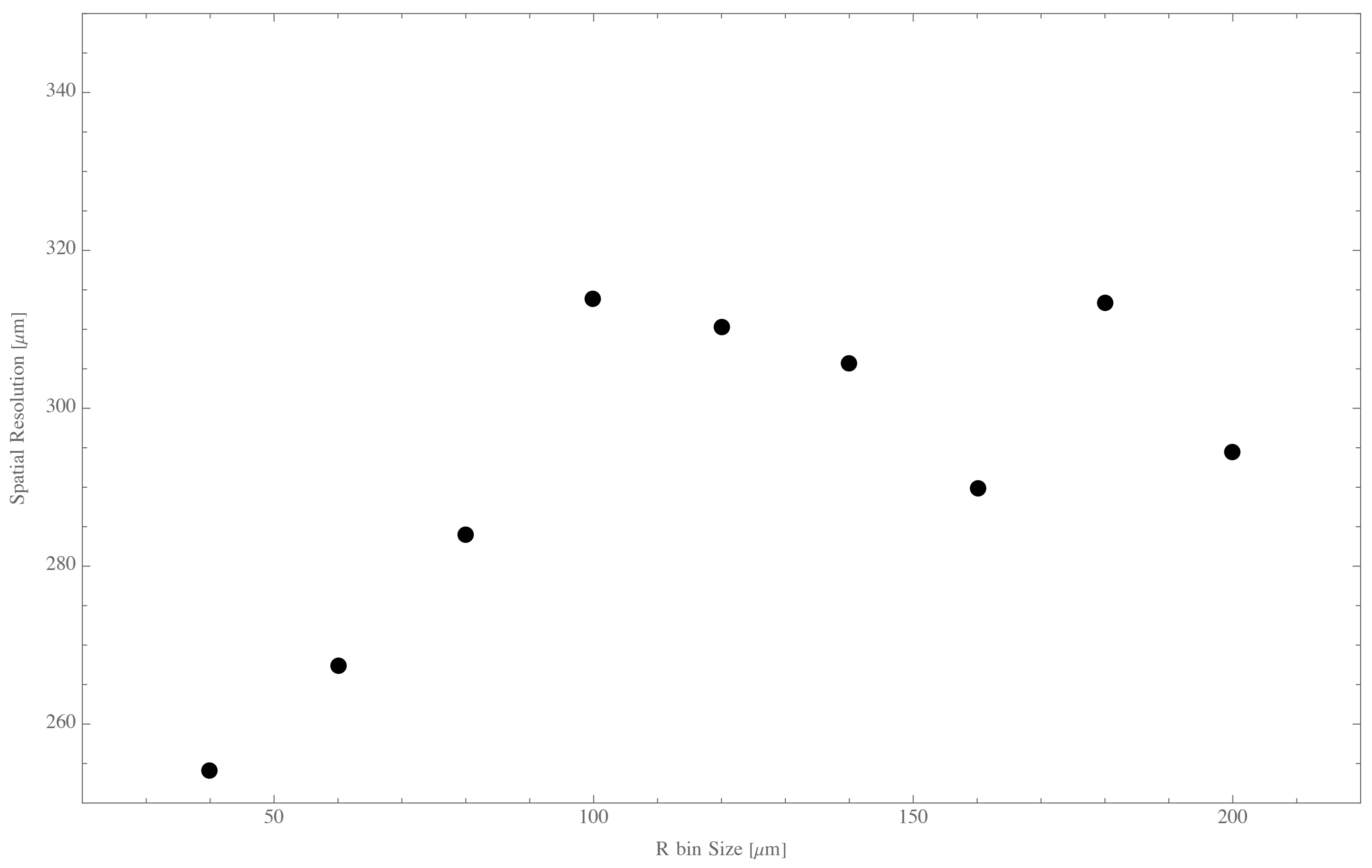
- Do the scan of bin size dependance
- Bin size from 40 to 200 with 20 μm step
- Both methods were used (weighted mean and pol4 integration)

Binning tests





Right wing



Left wing

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ToyMC

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where the uncertainty $\delta\sigma$ is defined by the time resolution error $\delta\sigma_t$:

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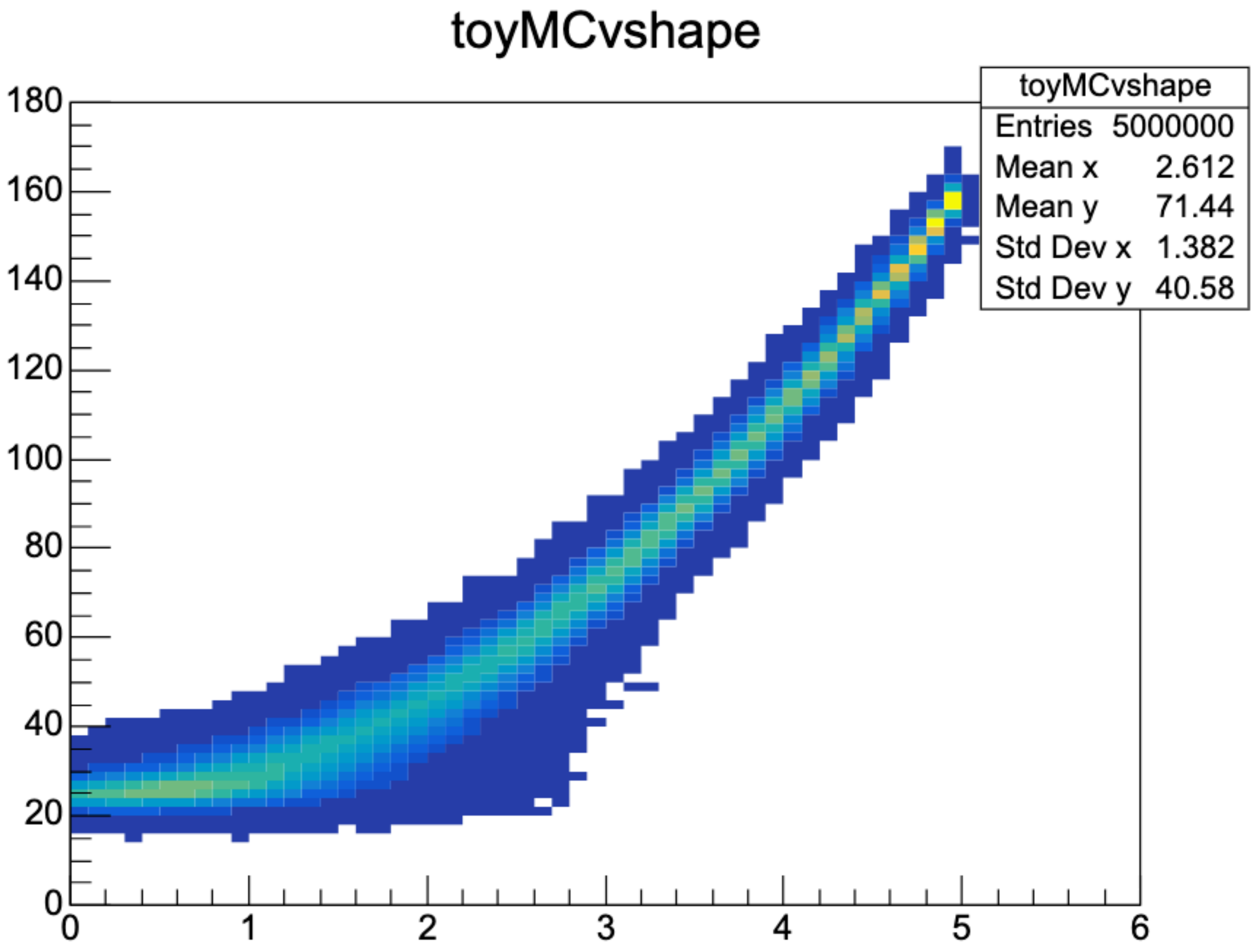
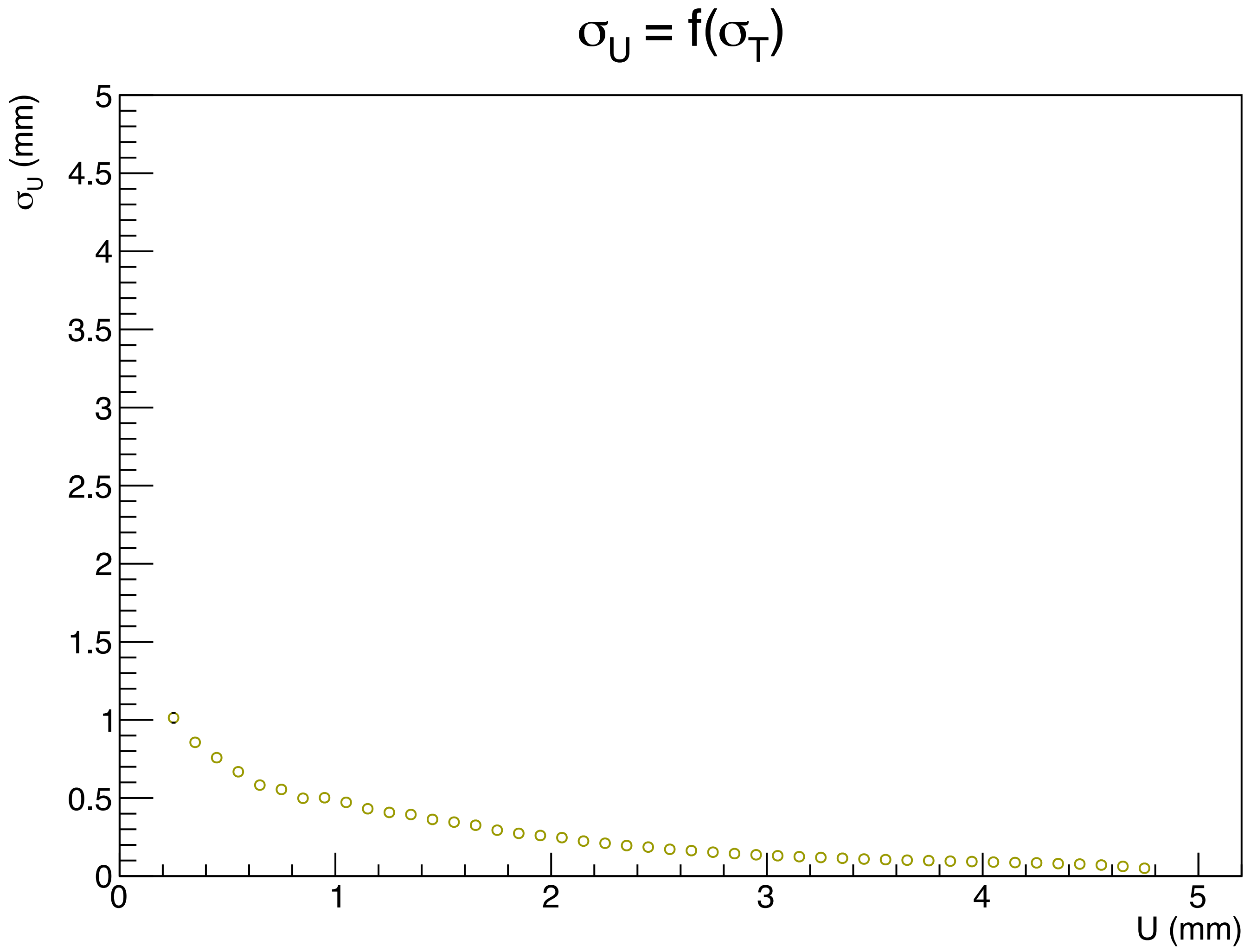
Where should we use the information about the scint Resolution?

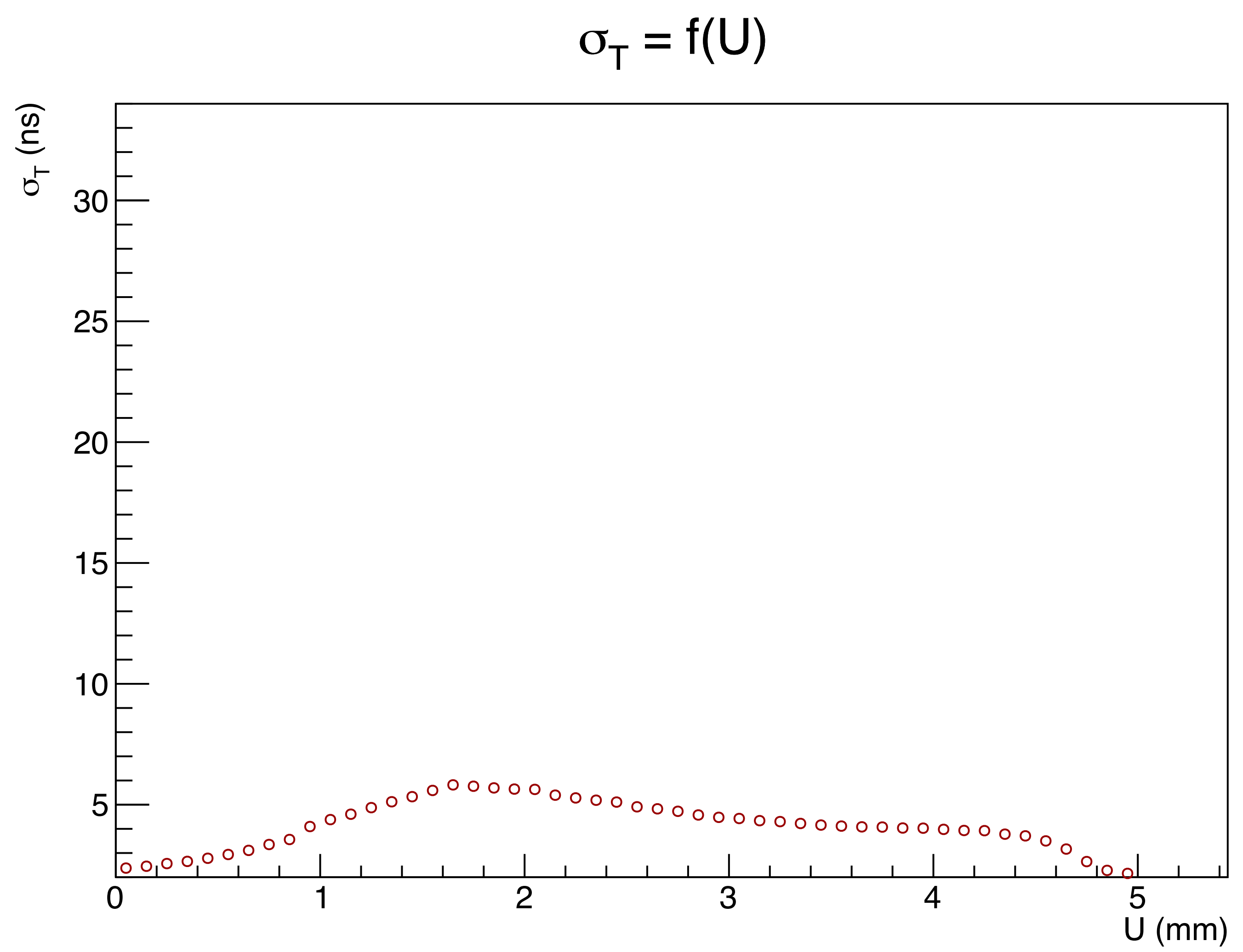
Do the toyMC:

- Find T as F(R) = pol2(R)
- Smear the T with Gaussian where sigma = 2 ns
- Smear the R with Gaussian where sigma = pol4(R)

ToyMC


toyMCvshape
toyMCvshape
Entries 5000000
Mean x 2.612
Mean y 71.44
Std Dev x 1.382
Std Dev y 40.58


$\sigma_U = f(\sigma_T)$
σ_U (mm)
U (mm)


$\sigma_T = f(U)$
σ_T (ns)
U (mm)

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