Transverse Corrections

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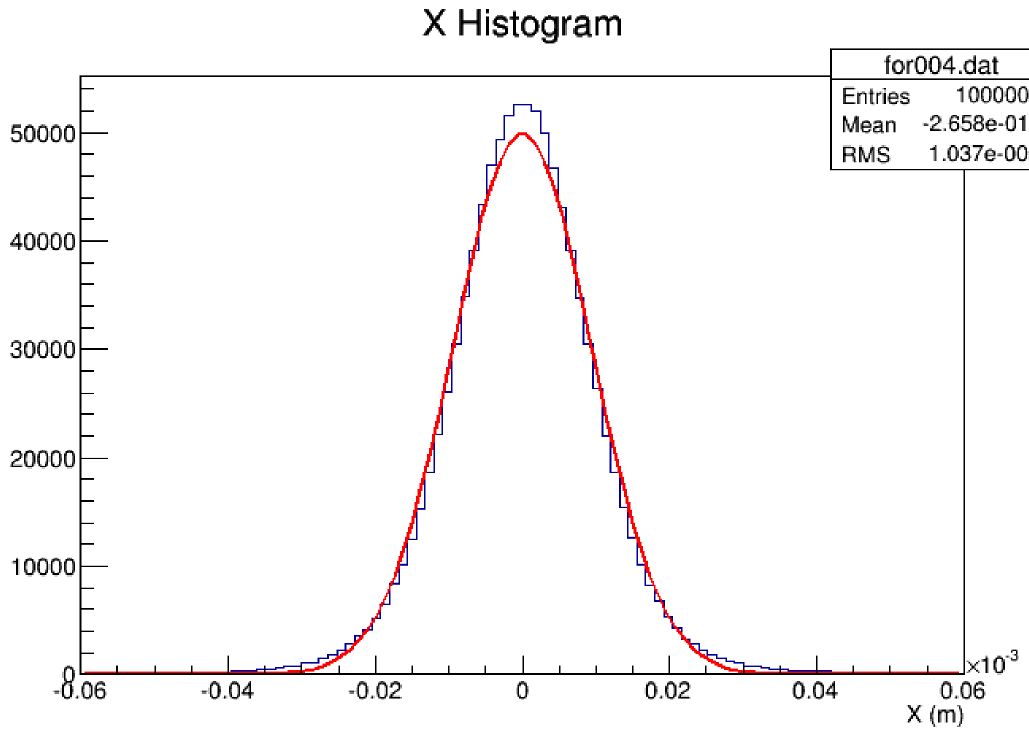
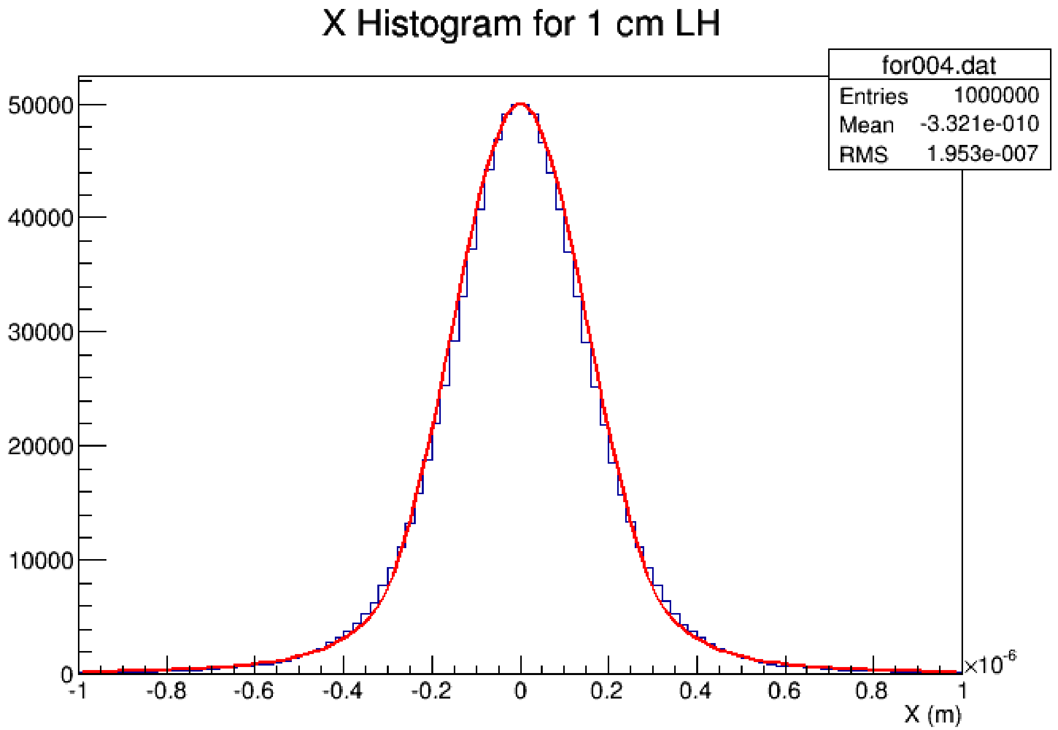
Problem #1:
Fitting Transverse Coordinates

Fitting Transverse Coordinates: “Gaussians”

Last time:



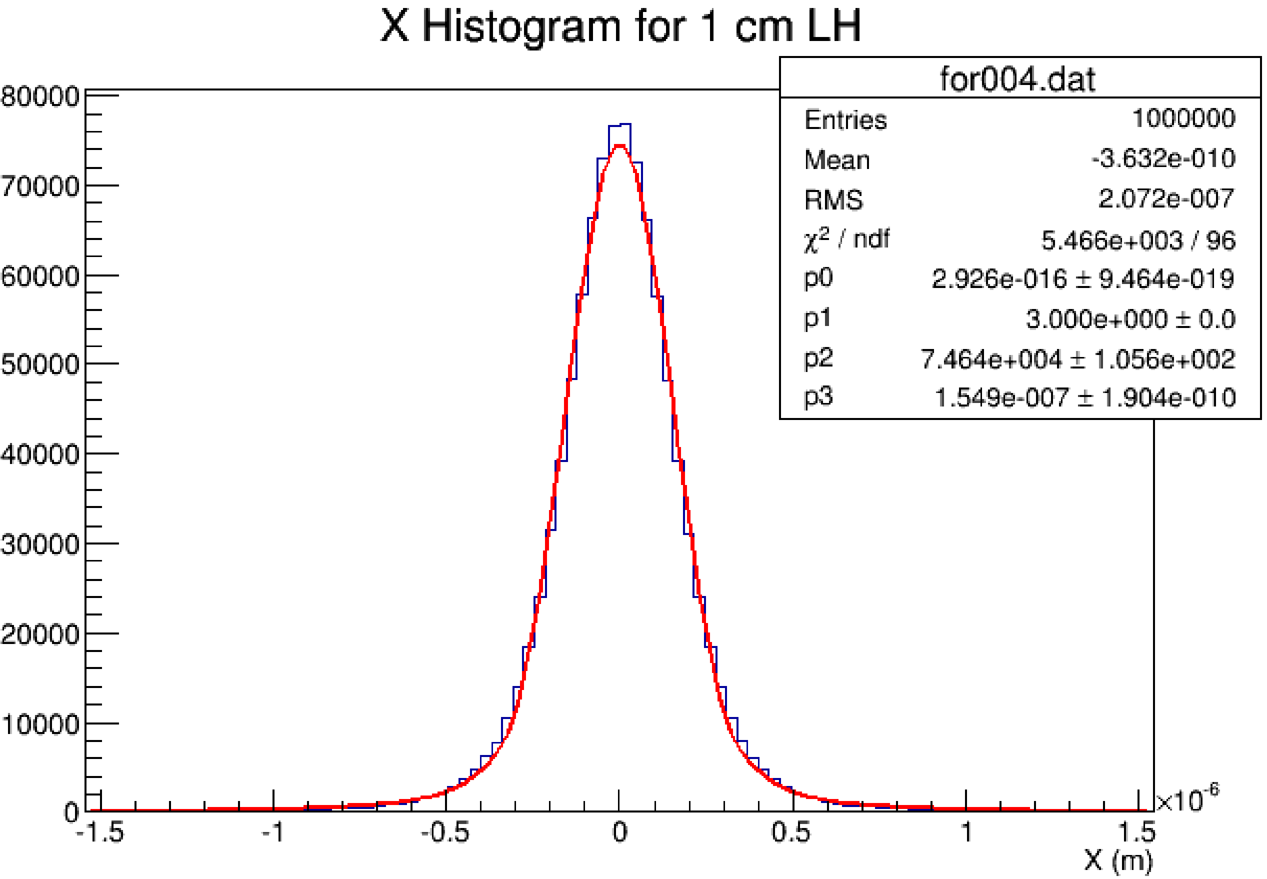
This time:



Right plot manually fixed:
amplitude = max_bin (=50,000)

Fitting Transverse Coordinates: Function

- This time:



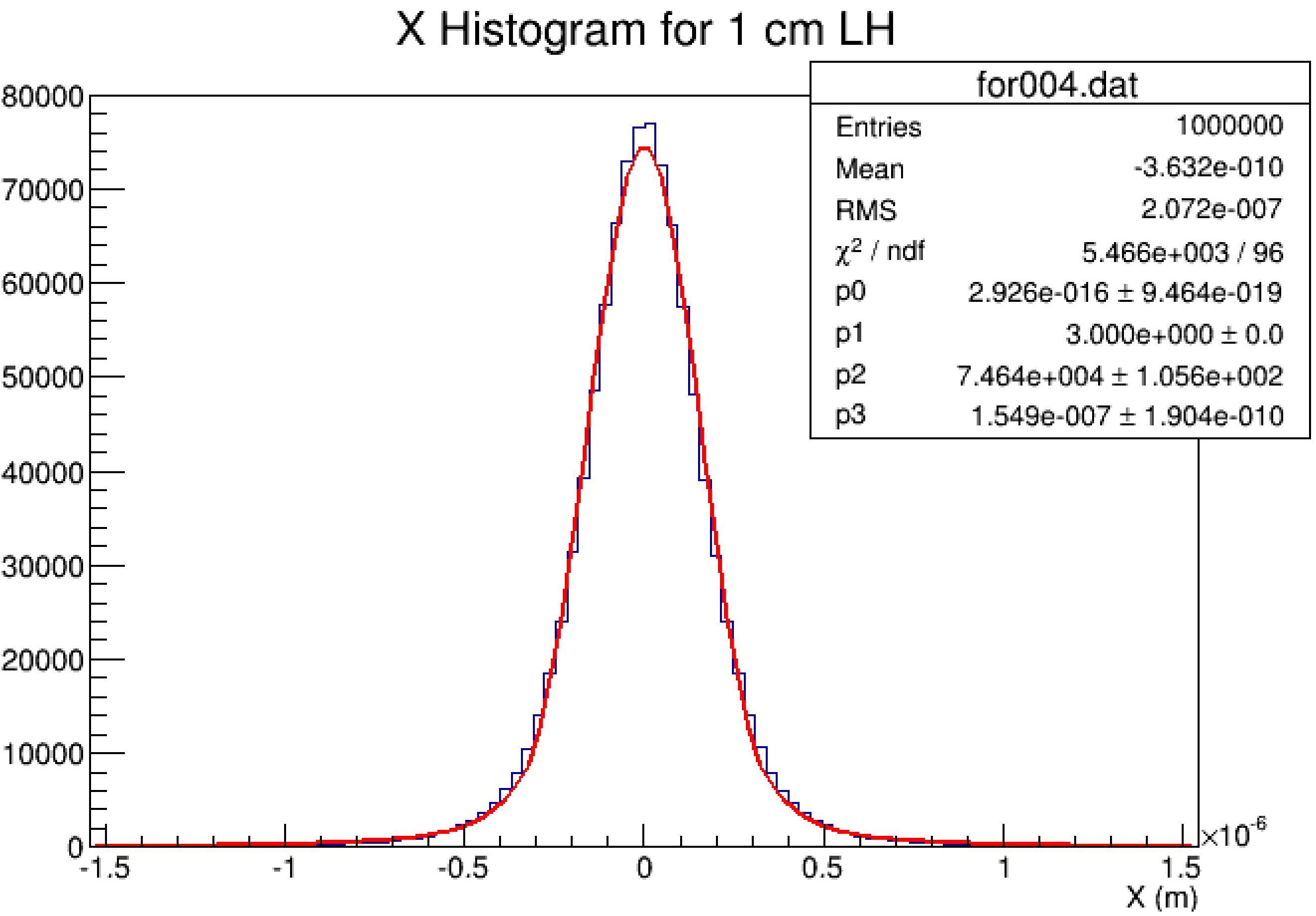
The difference is the piecewise fit:

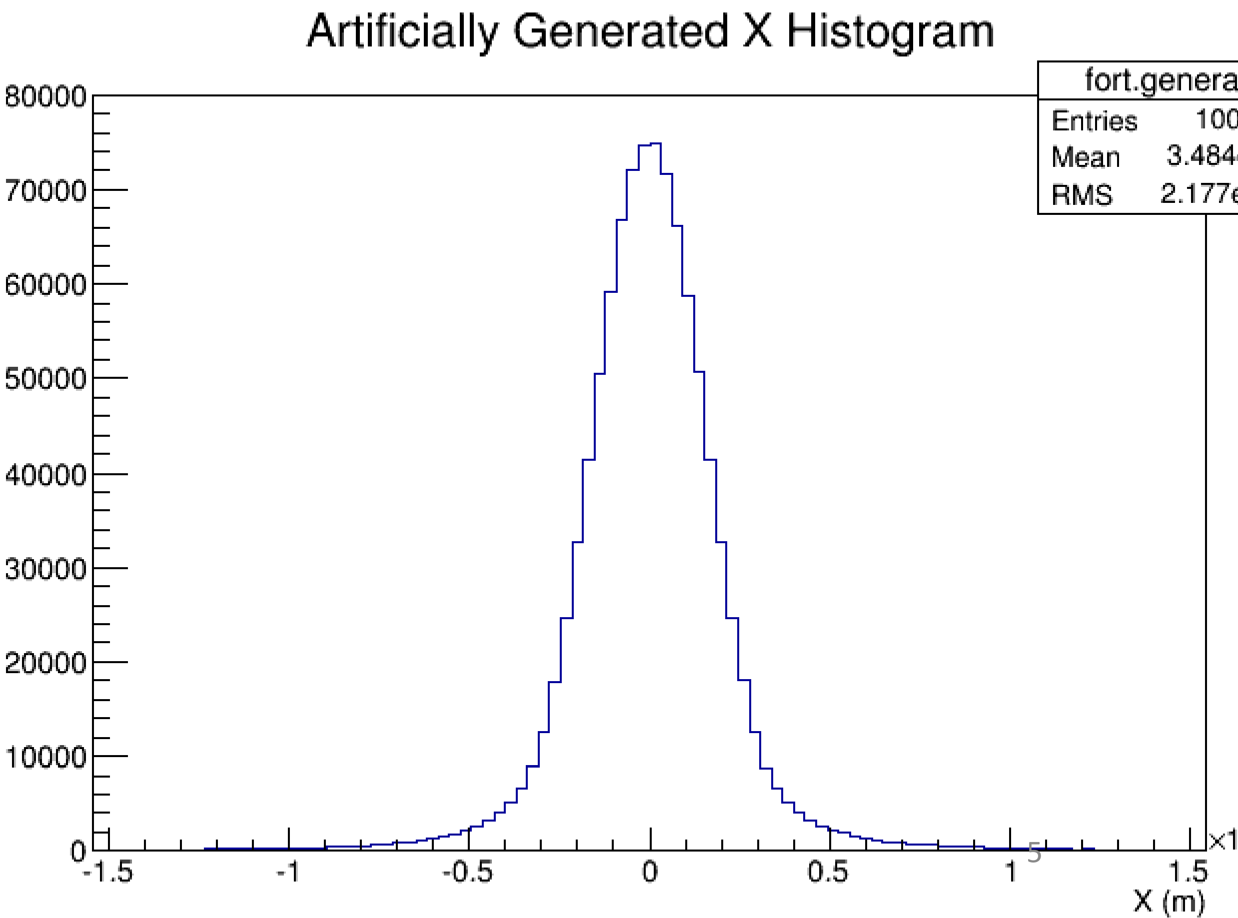
$$f(x) = \begin{cases} -\dfrac{[0]}{x^{[1]}}, & x < -x_0 \\ [2] * Gaus(x, 0, [3]), & -x_0 < x < x_0 \\ \dfrac{[0]}{x^{[1]}}, & x_0 < x \end{cases}$$

$$x_0 = 2 * [3] \approx 0.3\ \mu m$$

Fitting Transverse Coordinates: RNG

- Right-hand plot has slightly smaller peak, can fix manually





Fitting Transverse Coordinates: Theory

Angular Distribution

The quantity $u = cos\theta$ is sampled according to a model function $g(u)$. The shape of this function has been chosen such that Eqs. 7.32 and 7.33 are satisfied. The functional form of g is

$$g(u) = p[qg_1(u) + (1-q)g_3(u)] + (1-p)g_2(u) \tag{7.47}$$

where $0 \leq p, q \leq 1$, and the g_i are simple functions of $u = cos\theta$, normalized over the range $u \in [-1,\ 1]$. The functions g_i have been chosen as

$$g_1(u) = C_1 \quad e^{-a(1-u)} \qquad\qquad -1 \leq u_0 \leq u \leq 1 \tag{7.48}$$

$$g_2(u) = C_2 \quad \frac{1}{(b-u)^d} \qquad\qquad -1 \leq u \leq u_0 \leq 1 \tag{7.49}$$

$$g_3(u) = C_3 \qquad\qquad -1 \leq u \leq 1 \tag{7.50}$$

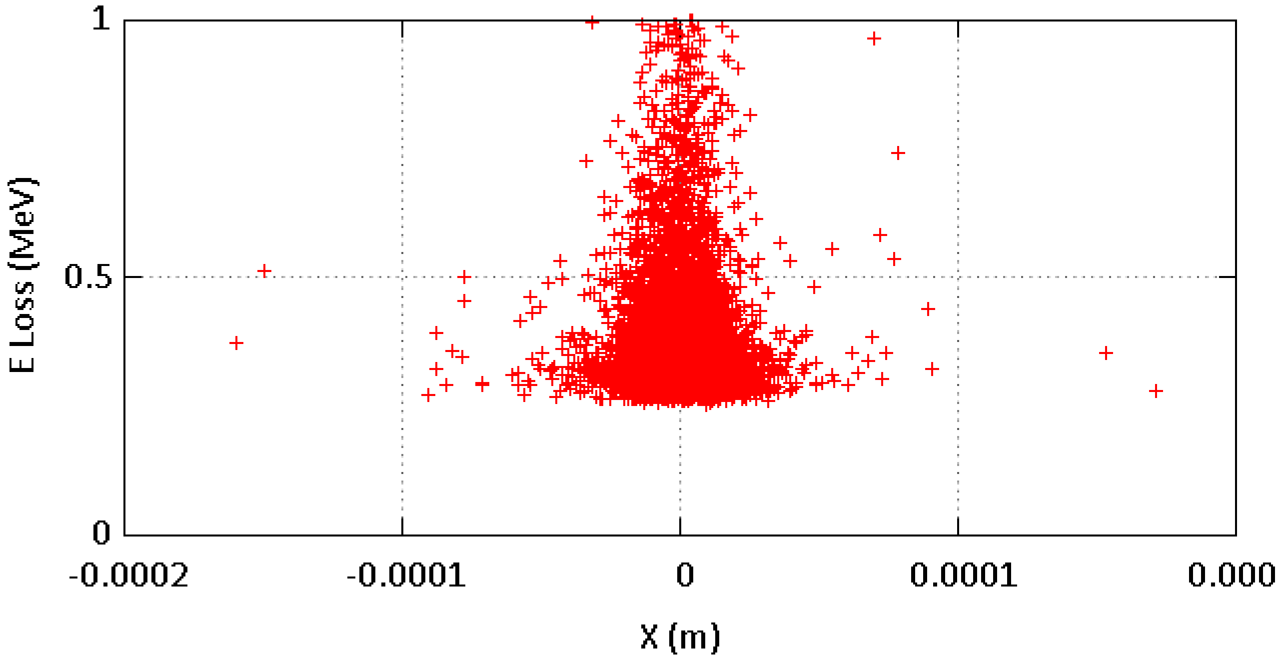
where $a > 0$, $b > 0$, $d > 0$ and u_0 are model parameters, and the C_i are normalization constants. It is worth noting that for small scattering angles, θ, $g_1(u)$ is nearly Gaussian ($exp(-\theta^2/2\theta_0^2)$) if $\theta_0^2 \approx 1/a$, while $g_2(u)$ has a Rutherford-like tail for large θ, if $b \approx 1$ and d is not far from 2 .

Problem #2:
Parameter Coupling

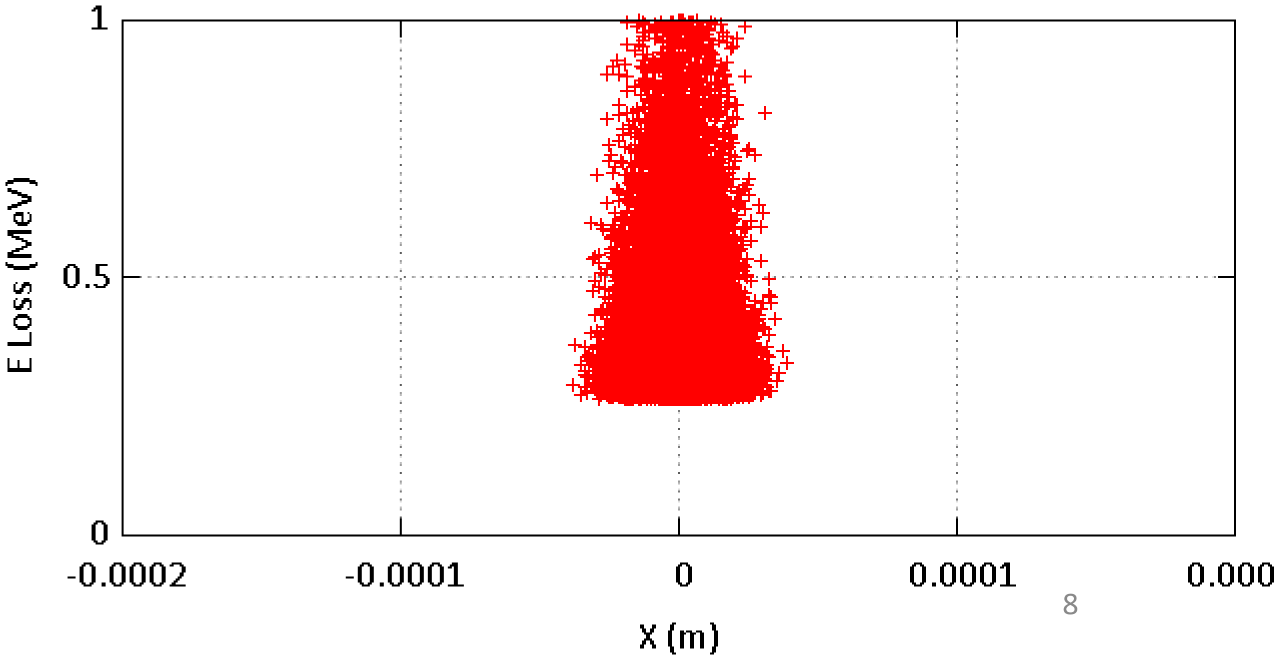
Parameter Coupling: Energy Loss

- Energy loss appears independent of transverse coordinates (looks like Gaussian vs. Landau).
- Tails of Gaussian (X axis) get us in trouble, should be Rutherfordian

X vs. Energy Loss (1 cm)

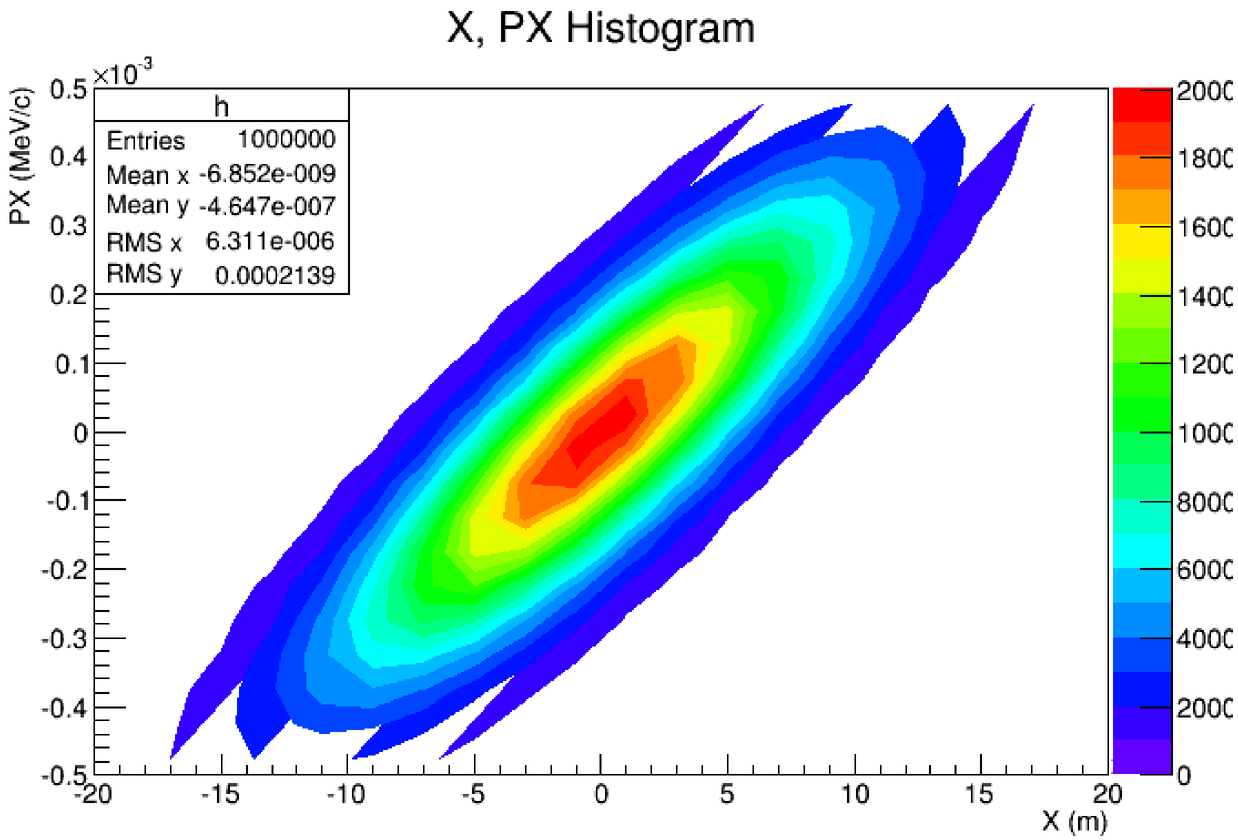


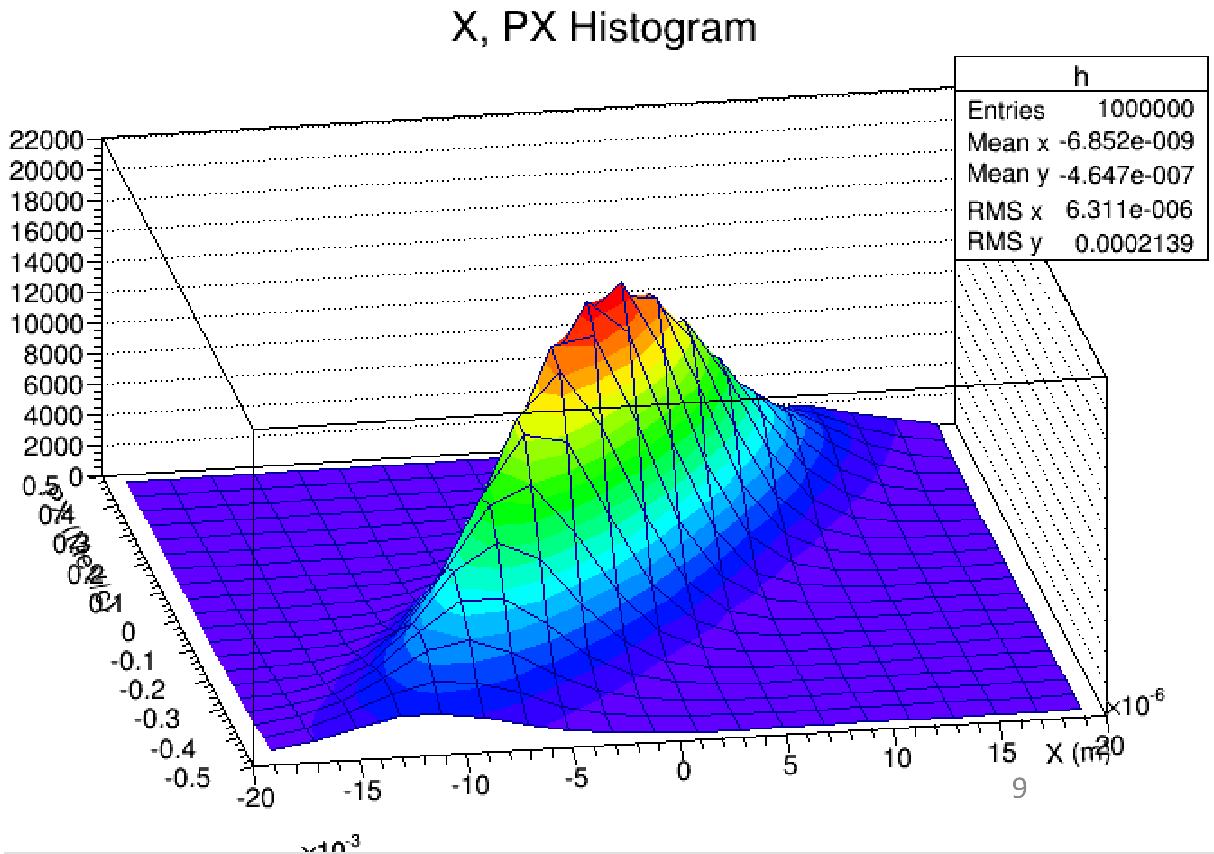
Generated Gaussian vs. Landau



Parameter Coupling: X, PX Histogram

- Histograms for 1M particles through 1 cm

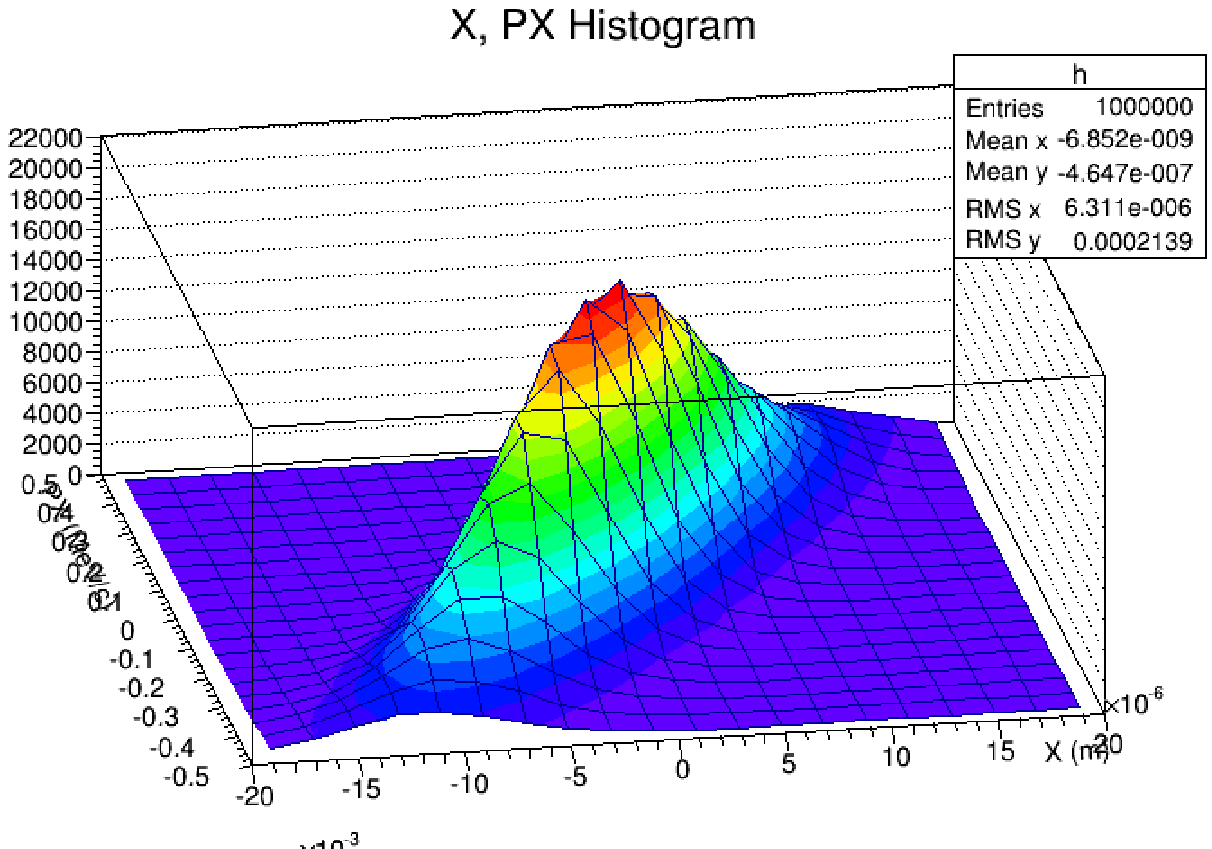


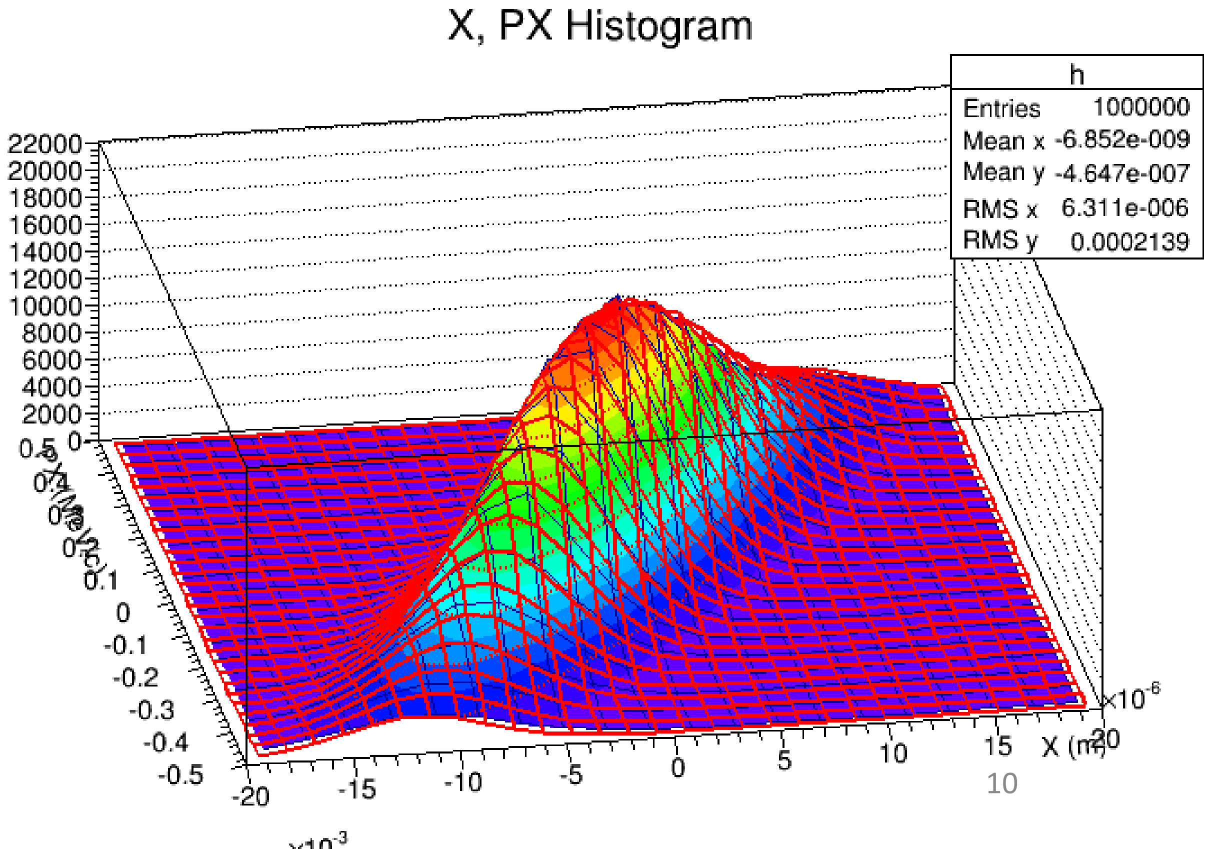


Parameter Coupling: Fit ($\chi^2 = 9943$)

- Fit with bivariate Gaussian:

$$f(x,y) = Exp\left[-\frac{x^2}{\sigma_x^2} + \frac{2\rho xy}{\sigma_x\sigma_y} - \frac{y^2}{\sigma_y^2}\right]/2\pi\sigma_x\sigma_y\sqrt{1-\rho^2}$$





Parameter Coupling: Tails

- Bivariate Gaussian fit was windowed at X ϵ [-2,2]E-5, PX ϵ [-5,5]E-4