$\beta^* \ \frac{dL}{dz}$ Simulation

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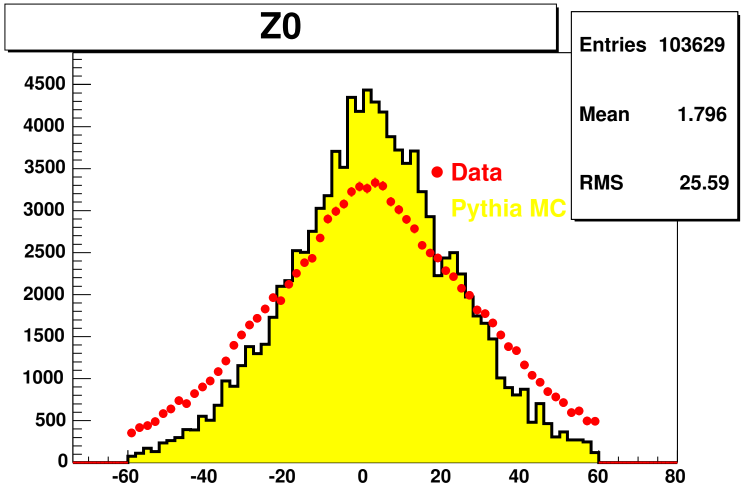
Problems with the Current $\beta^* \frac{dL}{dz}$ Simulation

- The location of the peak of the generated distribution does not match data.
- The width of the generated distribution is too narrow w.r.t. data.
- The generated distribution is distorted due to bugs in the implementation of the MC method used (von Neumann).
- The track parameter z0 data / simulation comparison from the Simulation Validation page:



Problems, Continued ...

- The $\frac{dL}{dz}$ model only allows one β^* and z_{min} parameter:

$$\frac{dL}{dz} \propto \frac{e^{\frac{-(z-z_0)^2}{2\sigma_z^2}}}{1+\frac{(z-z_{min})^2}{\beta^{*2}}}$$

- According to studies done by Stan Lai, et al (CDF 6492), we actually have a β^* and z_{min} for both x and y; currently, the x and y values are averaged for each parameter.
  - This is okay for β^*:
    $\beta_x^* = 38.6 \pm 2.5$ cm
    $\beta_y^* = 38.0 \pm 3.0$ cm.
  - This is NOT okay for z_{min}:
    $z_{min,x} = 12.1 \pm 0.7$ cm
    $z_{min,y} = -9.2 \pm 1.7$ cm.

Solutions

- MC method is understood and ready for implementation (sans distortions)
- Parameter issues
- In order to accomodate two z_{min} parameters, we need a different $\frac{dL}{dz}$ model:

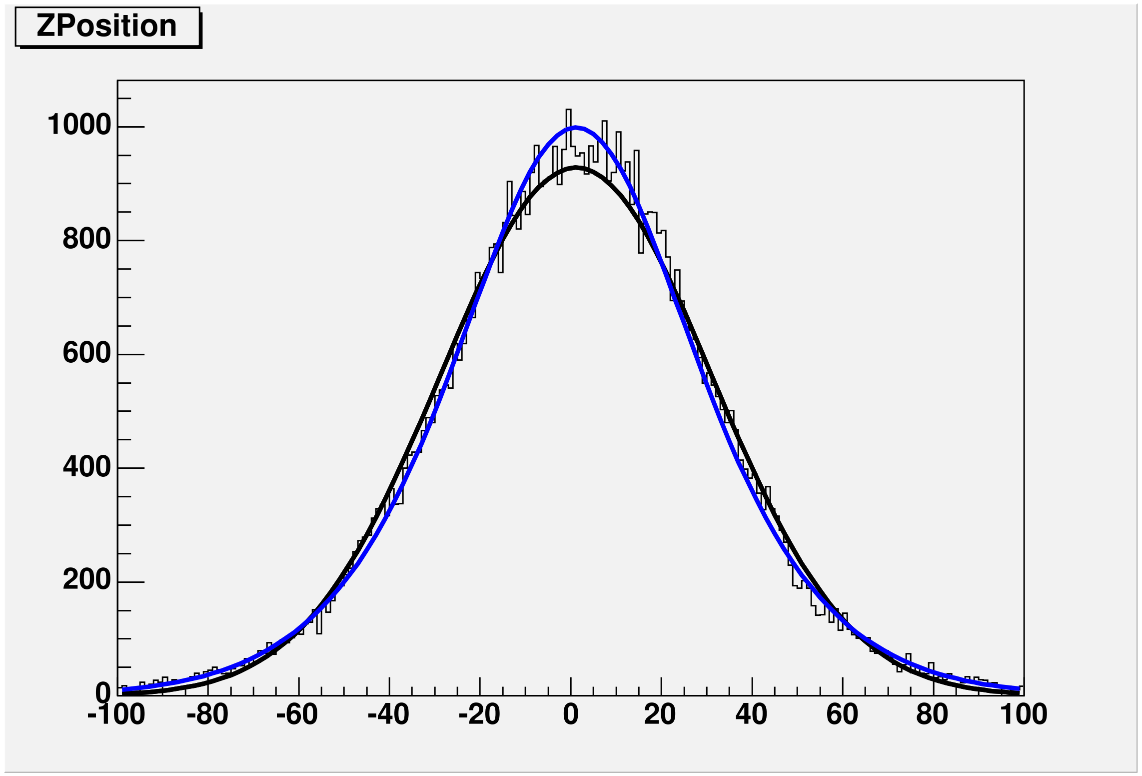
$$\frac{dL}{dz} \propto \frac{e^{\frac{-(z-z_0)^2}{2\sigma_z^2}}}{\sqrt{(1+\frac{(z-z_{min,x})^2}{\beta^{*2}})(1+\frac{(z-z_{min,y})^2}{\beta^{*2}})}}$$

- Taken from CDF 6327 and CDF 7324
- Width and peak location **must** be determined from data via a 2 parameter (z_0, σ_z) fit to the z vertex distribution, fixing the average β^*, $z_{min,x}$ and $z_{min,y}$.

Example Fits

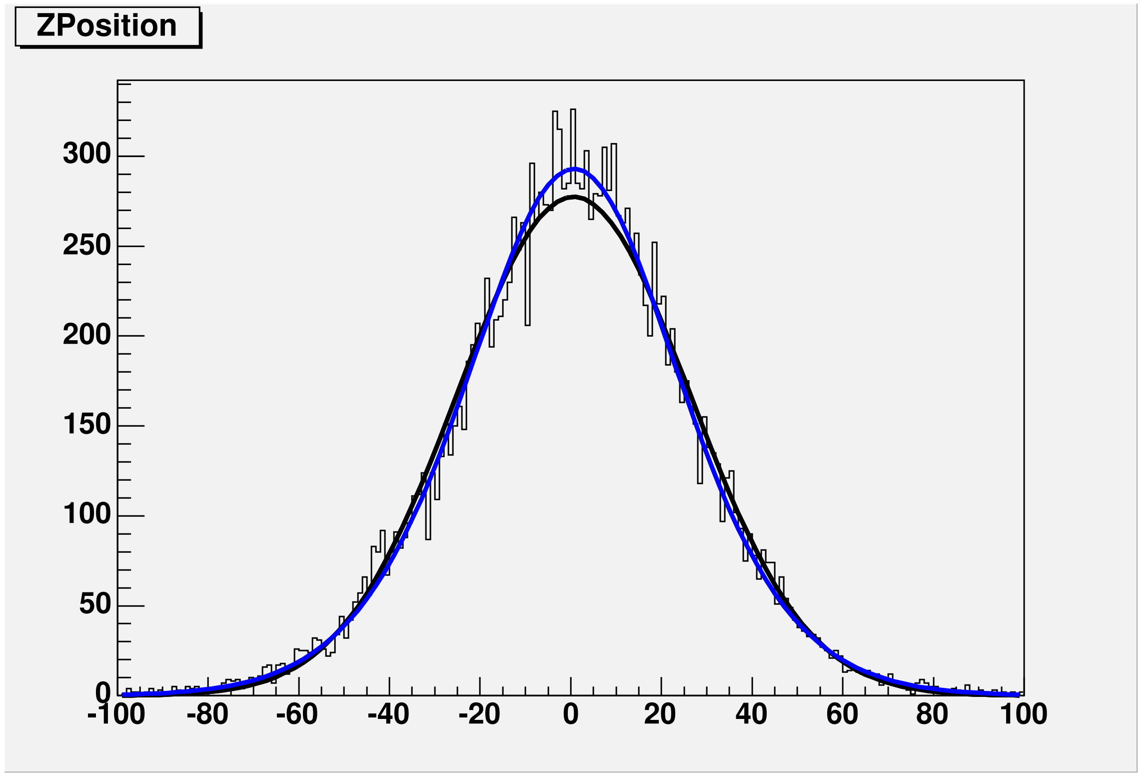
- All histograms taken from the standard DQM repository on fcdfdata033 (5.3.1 production pass), gmbs0d or 0e data
  - Histogram path: ZVertexValidationModule/ZPosition
- All runs are in v7.0 of the DQM good run list (1,1,1,1)
- Gaussian fits are in **Black**, $\beta^* \frac{dL}{dz}$ are in **Blue**

Run 154654



- Gaussian Fit: χ^2 / ndf = 709 / 197; prob 0
  μ = 1.16 $\pm$ 4.57
  σ = 30.0 $\pm$ 9.53e-2
- $\beta^* \frac{dL}{dz}$ fit: χ^2 / ndf = 359 / 197; prob 1.44e-12
  σ_z = 44.2 $\pm$ 2.35e-1
  z_0 = 7.13 $\pm$ 2.44e-1

Run 185962



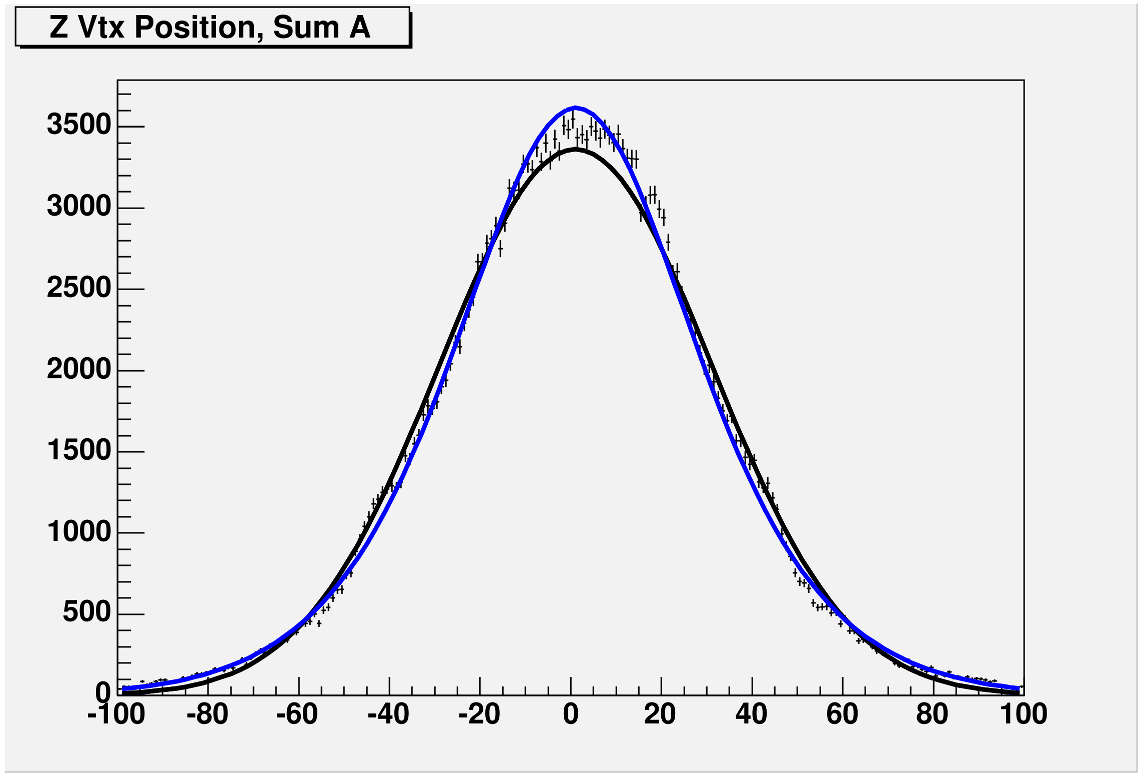
- Gaussian Fit: χ^2 / ndf $=$ 307 / 195; prob 2.26e-7
  $\mu =$ 6.21e-1 $\pm$ 1.93e-1
  $\sigma =$ 25.6 $\pm$ 1.52e-1

- $\beta^* \frac{dL}{dz}$ fit: χ^2 / ndf $=$ 256 / 195; prob 2.30e-3
  $\sigma_z =$ 33.9 $\pm$ 2.86e-1
  $z_0 =$ -2.51e-1 $\pm$ 3.36e-1

$\frac{dL}{dz}$ Model Performance for Individual Runs

Run	Gaussian χ^2/ndf	$\beta^* \frac{dL}{dz}$ χ^2/ndf
153416	504 / 197	290 / 197
154208	379 / 197	265 / 197
154654	709 / 197	359 / 197
155129	342 / 197	269 / 197
155130	673 / 197	330 / 197
156103	408 / 197	301 / 197
184444	150 / 154	334 / 154
184957	247 / 192	185 / 192
185260	582 / 197	342 / 197
185377	504 / 197	297 / 197
185962	307 / 195	256 / 195
186598	774 / 197	329 / 197

$\frac{dL}{dz}$ Model Performance for Multiple Runs - A

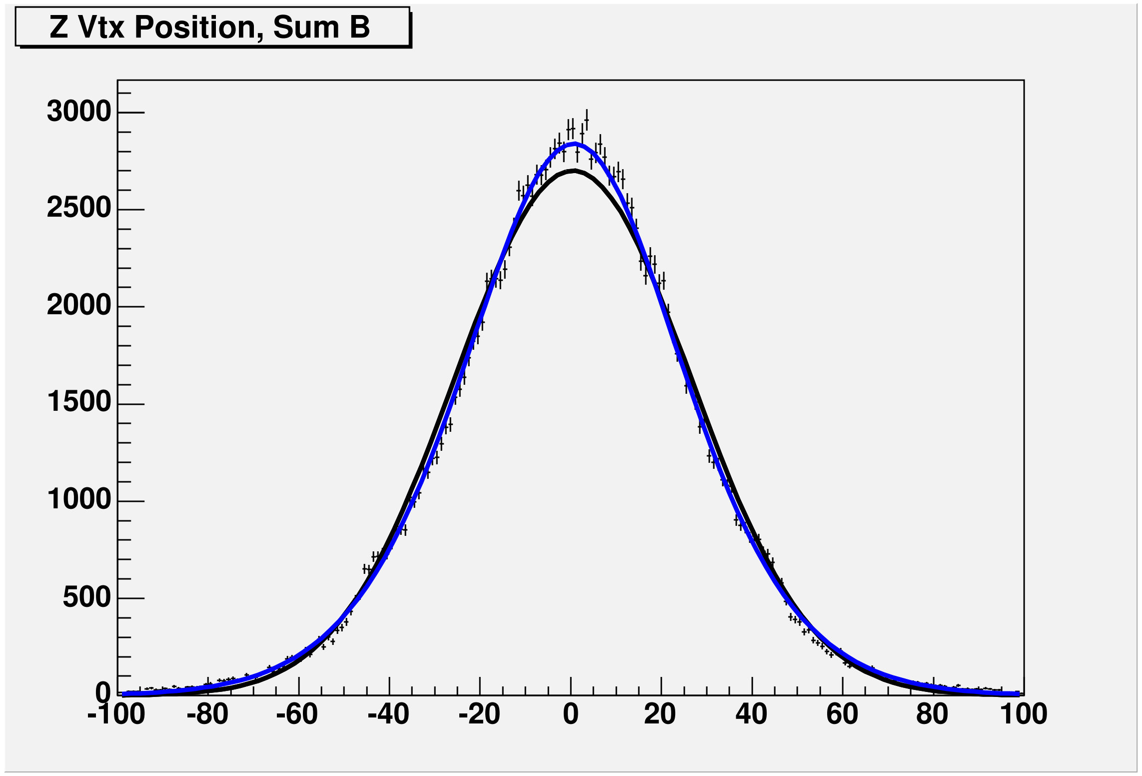


- Runs: 153416, 154208, 154654, 155129, 155130, 156103

- Gaussian Fit: χ^2 / ndf = 2218 / 197; prob 0
  μ = 1.07 $\pm$ 6.00e-2
  σ = 30.0 $\pm$ 5.03e-2

- $\beta^* \frac{dL}{dz}$ fit: χ^2 / ndf = 835 / 197; prob 0
  σ_z = 44.3 $\pm$ 1.25e-1
  z_0 = 5.89e-1 $\pm$ 1.29e-1

$\frac{dL}{dz}$ Model Performance for Multiple Runs - B



- Runs: 185377, 186598, 185260, 184957, 185962, 184444
- Gaussian Fit: χ^2 / ndf = 1824 / 197; prob 0
  μ = 4.82e-1 $\pm$ 6.21e-2
  σ = 26.0 $\pm$ 5.19e-2

- $\beta^* \frac{dL}{dz}$ fit: χ^2 / ndf $=$ 651 / 197; prob 0
  σ_z $=$ 35.3 $\pm$ 1.04e-1
  z_0 $=$ -3.86e-1 $\pm$ 1.12e-1

Summary

- The current implementation of the $\beta^* \frac{dL}{dz}$ function in simulation has major bugs
- These bugs have solutions, but a new $\beta^* \frac{dL}{dz}$ function is required
- The parameters for this new function need to be determined from data
- The new function definitely performs better than a Gaussian fit for the run range covered in CDF 6492 (pre COT compromised period)