

GBP – MC Update

Kyle Fleck, Niall Cavanagh & Gianluca Sarri

22/10/21

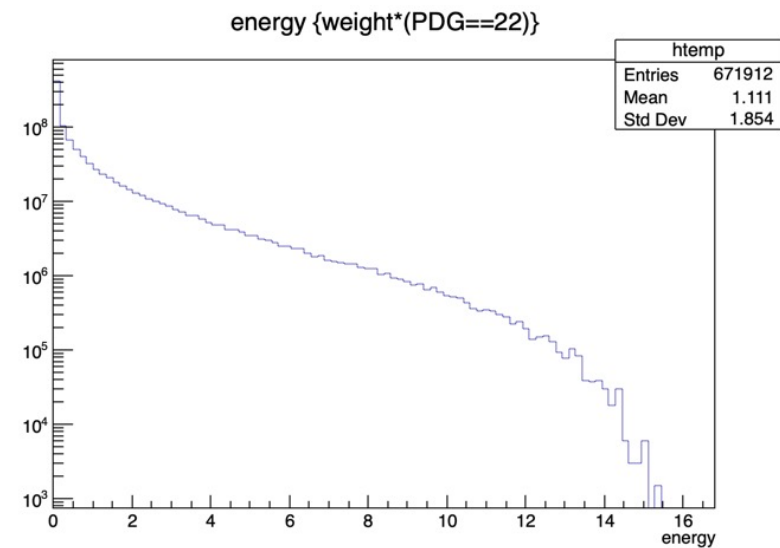
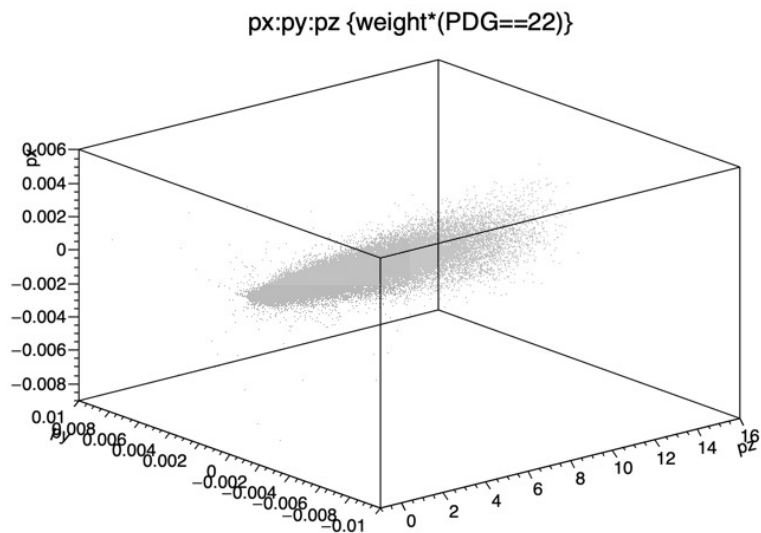
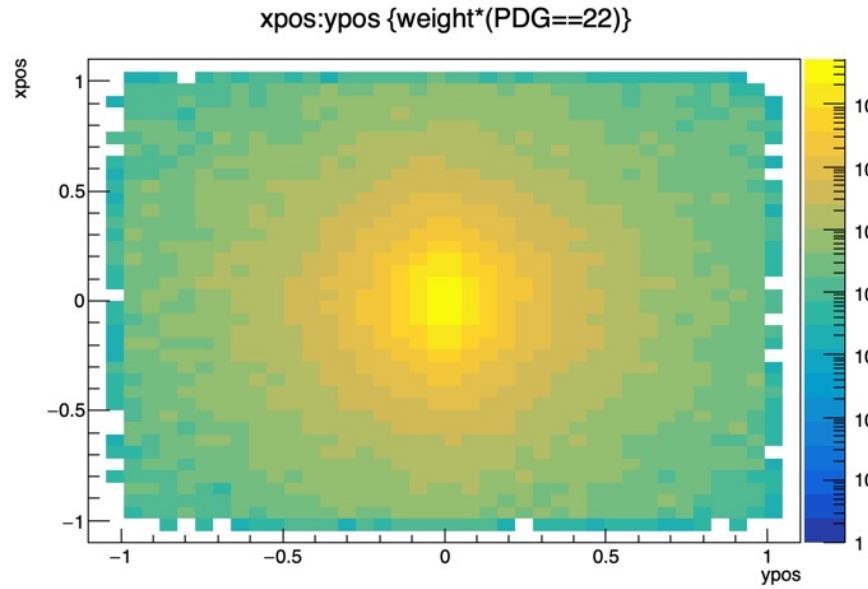
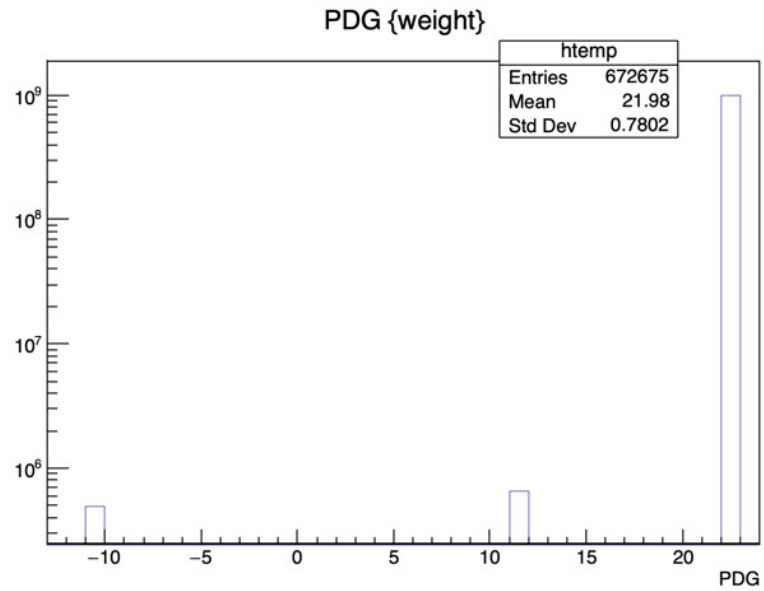
FLUKA – Tracks Information

- Reconfigured FLUKA to output tracks information into ROOT Ttree
- Ttree contains:
 - PDG (electron = 11, positron = -11, photon = 22, other = 0)
 - Plane (upstream profiler = 0, downstream profiler = 1)
 - (X,Y,Z) (location of boundary crossing relative to plane; cm)
 - (px, py, pz) (momentum components of track, GeV/c²)
 - Energy (GeV)
 - Weight

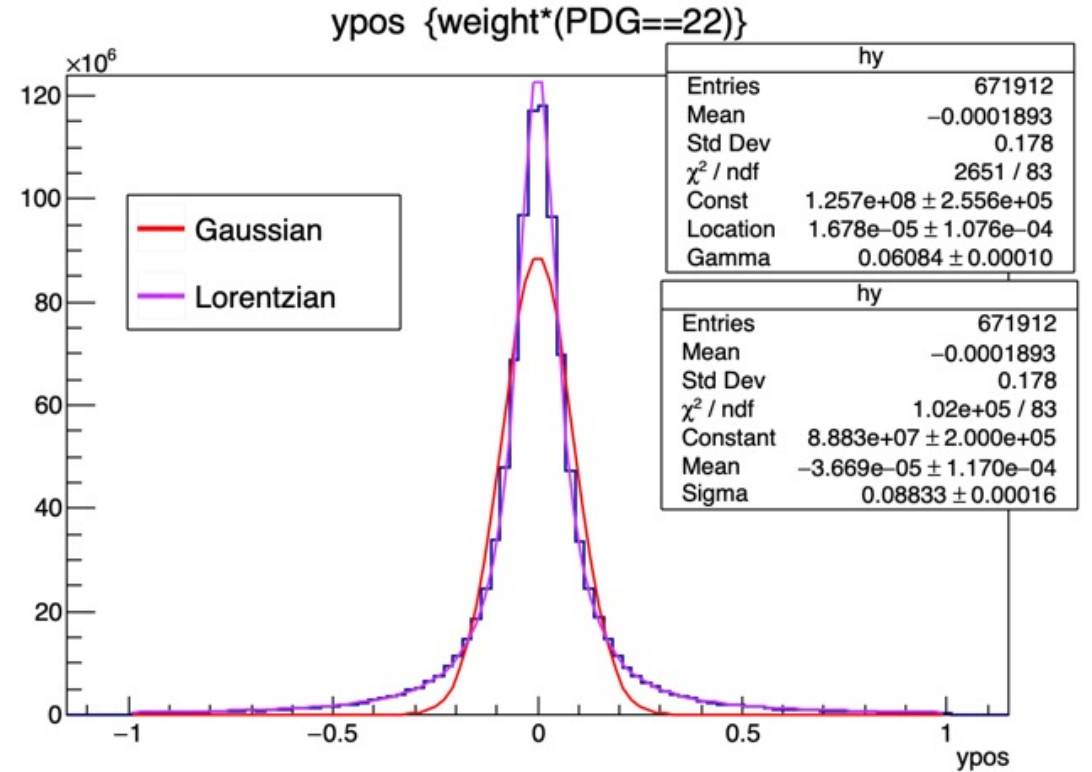
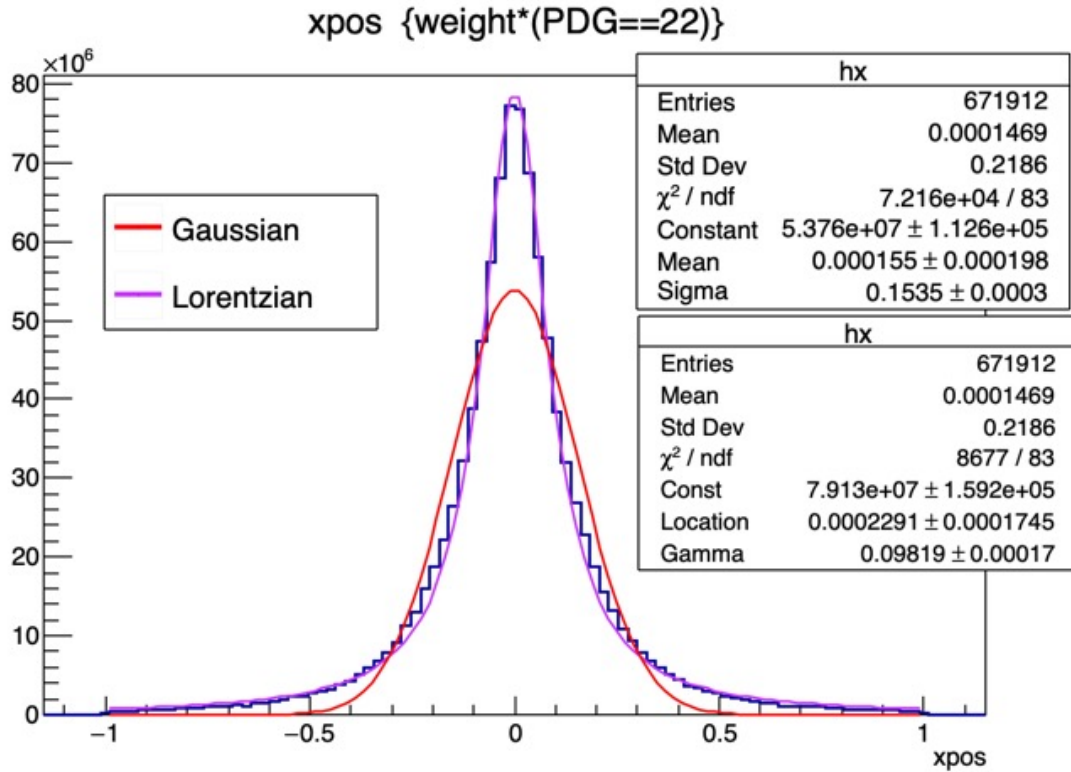
```
*****
*Tree   :Tracks   : Tracks
*Entries : 465812 : Total =      33639715 bytes File Size = 21589065 *
*       :         : Tree compression factor = 1.56
*****
*Br    0 :PDG      : PDG/I
*Entries : 465812 : Total Size= 1868973 bytes File Size = 41210 *
*Baskets : 59 : Basket Size= 32000 bytes Compression= 45.32 *
*.....*
*Br    1 :plane    : plane/I
*Entries : 465812 : Total Size= 1869099 bytes File Size = 14426 *
*Baskets : 59 : Basket Size= 32000 bytes Compression= 129.46 *
*.....*
*Br    2 :xpos     : xpos/D
*Entries : 465812 : Total Size= 3737686 bytes File Size = 3563710 *
*Baskets : 117 : Basket Size= 32000 bytes Compression= 1.05 *
*.....*
*Br    3 :ypos     : ypos/D
*Entries : 465812 : Total Size= 3737686 bytes File Size = 3564368 *
*Baskets : 117 : Basket Size= 32000 bytes Compression= 1.05 *
*.....*
*Br    4 :zpos     : zpos/D
*Entries : 465812 : Total Size= 3737686 bytes File Size = 28629 *
*Baskets : 117 : Basket Size= 32000 bytes Compression= 130.46 *
*.....*
*Br    5 :px       : px/D
*Entries : 465812 : Total Size= 3737444 bytes File Size = 3610262 *
*Baskets : 117 : Basket Size= 32000 bytes Compression= 1.03 *
*.....*
*Br    6 :py       : py/D
*Entries : 465812 : Total Size= 3737444 bytes File Size = 3608140 *
*Baskets : 117 : Basket Size= 32000 bytes Compression= 1.04 *
*.....*
*Br    7 :pz       : pz/D
*Entries : 465812 : Total Size= 3737444 bytes File Size = 3558400 *
*Baskets : 117 : Basket Size= 32000 bytes Compression= 1.05 *
*.....*
*Br    8 :energy   : energy/D
*Entries : 465812 : Total Size= 3737928 bytes File Size = 3558039 *
*Baskets : 117 : Basket Size= 32000 bytes Compression= 1.05 *
*.....*
*Br    9 :weight   : weight/D
*Entries : 465812 : Total Size= 3737928 bytes File Size = 33536 *
*Baskets : 117 : Basket Size= 32000 bytes Compression= 111.38 *
*.....*
```

Example Results

Ptarmigan_10.0_0_tracks.root
1.09 BX



Profile Distributions



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Determination of ξ

- From Blackburn et. al. 2020 (PRAB), model independent formula for normalized laser intensity is

$$\xi^2 = 4\sqrt{2} \beta \langle \gamma_i \rangle \langle \gamma_f \rangle (\sigma_{\parallel}^2 - \sigma_{\perp}^2)$$

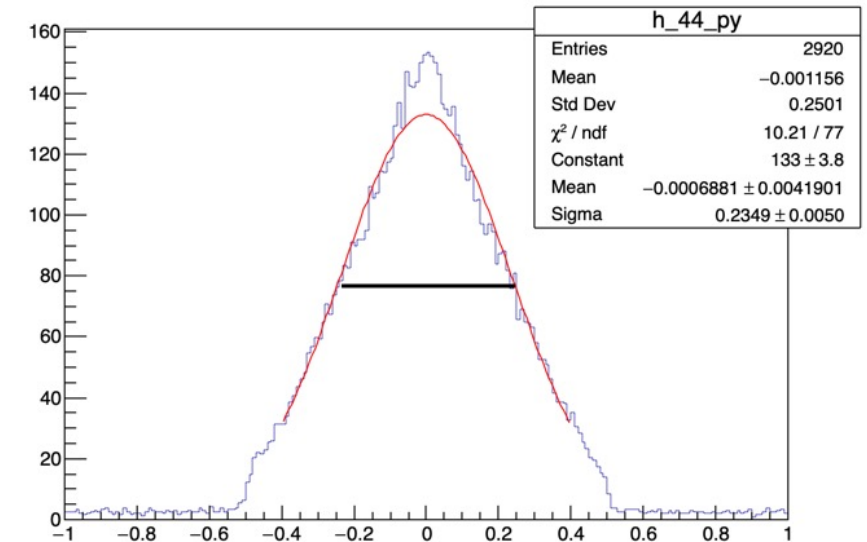
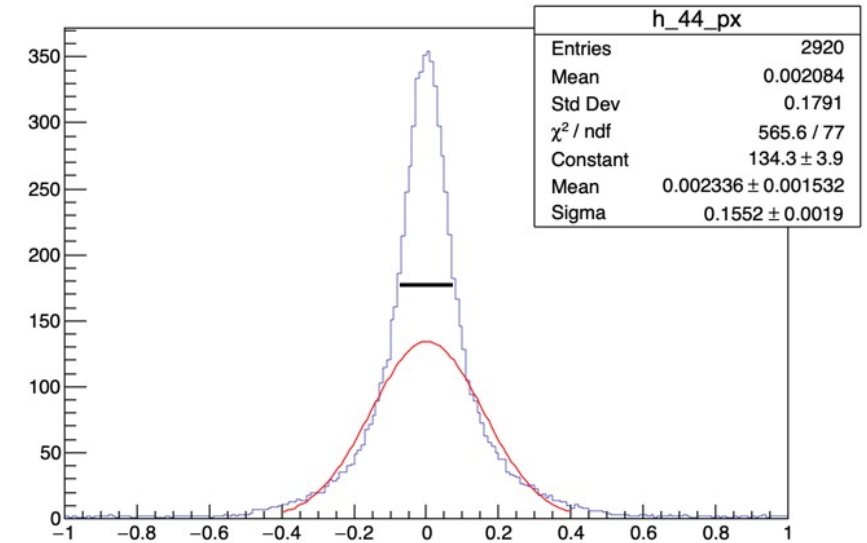
- Depends on difference in the variance of the angular profile of the gamma profile
- The average final Lorentz factor accounts for the physics of the interaction
- Error in ξ can be calculated by

$$\frac{\delta \xi}{\xi} = \frac{1}{2} \sqrt{\left(\frac{\delta \langle \gamma_f \rangle}{\langle \gamma_f \rangle}\right)^2 + \frac{4(\sigma_{\parallel}^2 + \sigma_{\perp}^2) \delta \sigma^2}{(\sigma_{\parallel}^2 - \sigma_{\perp}^2)^2}}$$

Variance of Profile

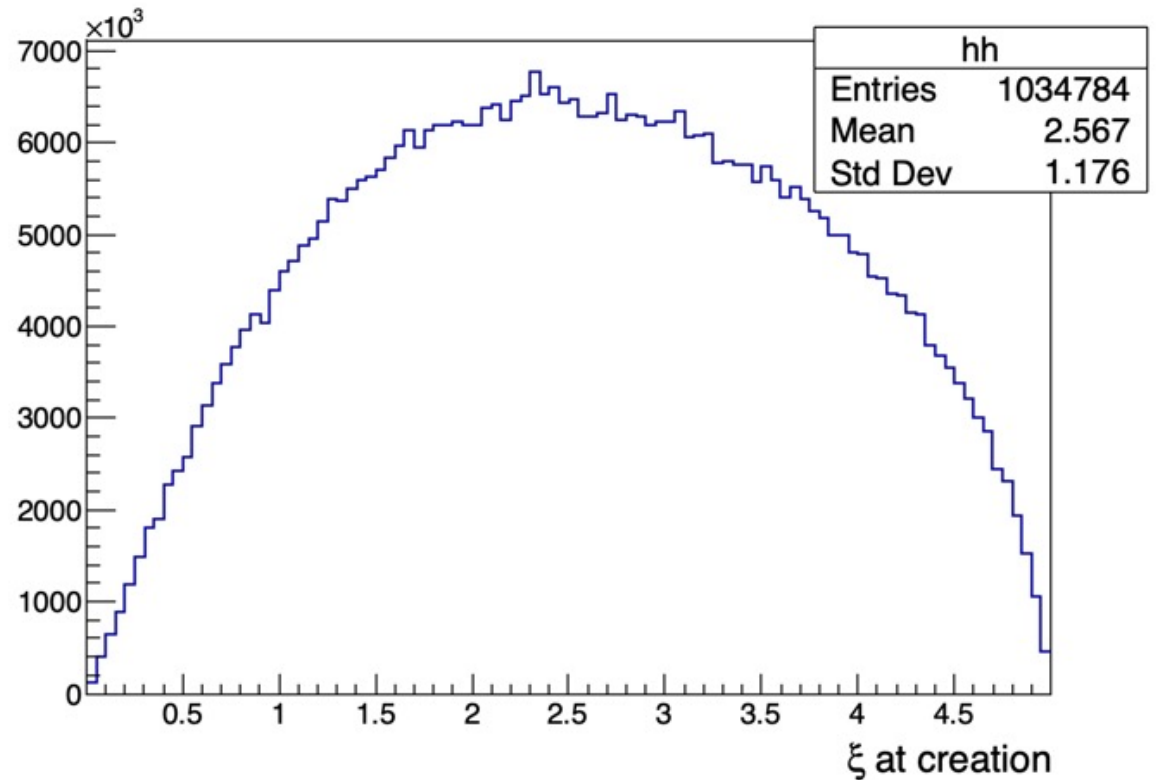
- Variance (standard deviation) of profile needed to calculate ξ
- Three methods used:
 - Using standard deviation of profile data
 - Calculate FWHM of profile data
$$FWHM = 2\sigma\sqrt{2 \ln 2}$$
 - Apply Gaussian fit and used standard deviation of fit
- Second approach seems to work best

X and Y profiles for $\xi = 5.0$ with enlarged laser waist $40 \mu\text{m}$



Realistic Laser Spot Sizes

- For the realistic simulation settings, laser spot size is close to less than electron beam radius (for $\xi = 7$ and 10)
- Not all electrons will 'see' the same value of ξ at interaction
- The gamma profile will not reflect the maximum ξ value
- Histogram shows for $\xi = 5$, peak ξ is ~ 2.5 – close to value determined from profile



Histogram of the ξ value seen at the creation of each photon.