GBP – MC Update

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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

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

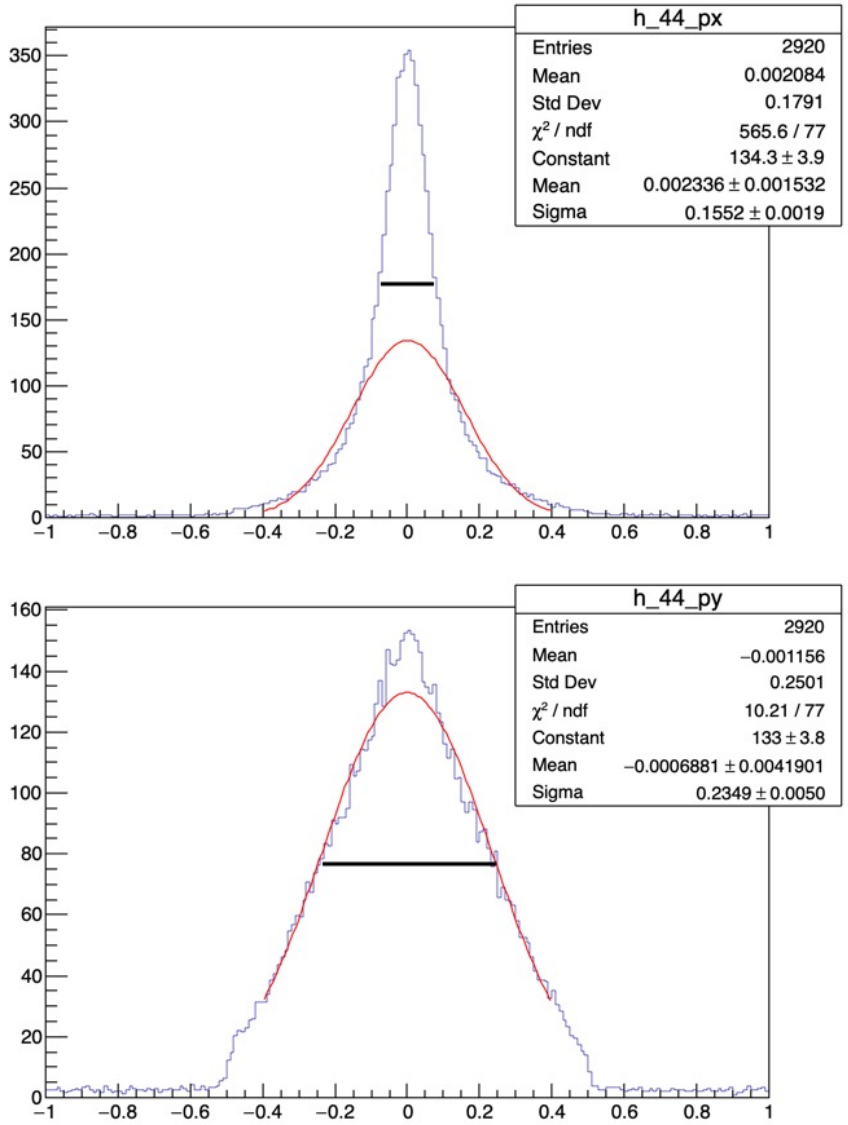
Variance of Profile

- 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 ξ = 5.0 with enlarged laser waist 40 μm



Results

Estimations of a0 from profiler LP simulation data

Experimental Parameters

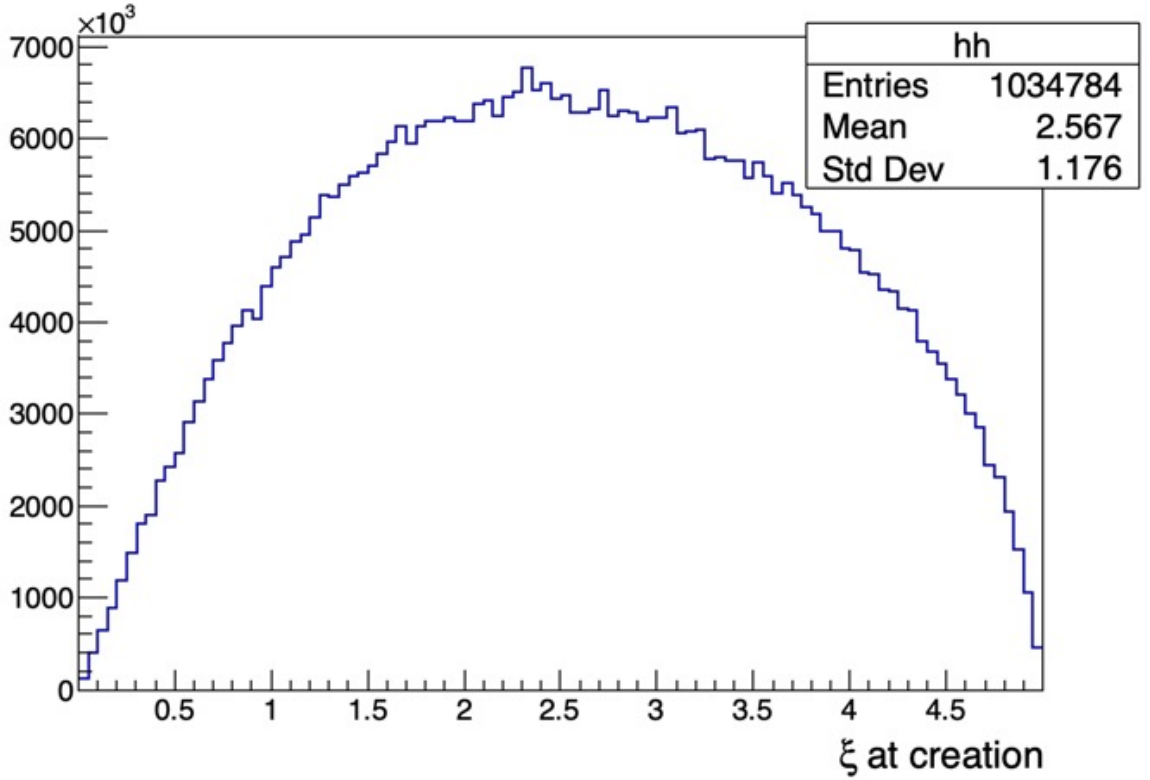
electron beam radius	5	um
impact parameter	0	um
crossing angle	17.2	deg
initial energy	16.5	GeV
laser energy	1.2	J
wavelength	0.8	um
fwhm duration	30	fs
detector distance	1150	cm

Simulation Results

simulation a0	**5**	**7**	**10**		**5**	**7**	**10**		**5**	**7**	**10**	
laser waist	**20**	**20**	**20**	**um**	**40**	**40**	**40**	**um**	**6.690429**	**4.778878**	**3.345215**	**um**
mean final energy	13.431	12.213	10.477	GeV	13.096	11.742	9.582	GeV	14.567	14.242	13.832	GeV
mean final energy error	0.03	0.03	0.03	GeV	0.03	0.04	0.04	GeV	0.03	0.04	0.05	GeV
field correction factor	0.91	0.91	0.91		0.97	0.97	0.97		0.77	0.74	0.73	
Standard deviation of data												
parallel std deviation	0.149	0.177	0.236	cm	0.154	0.188	0.25	cm	0.133	0.147	0.169	cm
perp std deviation	0.127	0.135	0.17	cm	0.129	0.142	0.179	cm	0.121	0.125	0.137	cm
a0	4.34	6.003	7.97		4.883	6.75	8.633		2.68	3.58	4.43	
a0 error	0.03472	0.048024	0.06376	0	0.039064	0.054	0.069064		0.02144	0.02864	0.03544	
% diff	13.2	14.24286	20.3		2.34	3.571429	13.67		46.4	48.85714	55.7	
FWHM of data												
parallel FWHM	0.152081	0.204844	0.270022		0.170704	0.217259	0.316578	cm	0.111733	0.1257	0.1257	cm
perp FWHM	0.085352	0.085352	0.091559		0.079144	0.085352	0.093111	cm	0.072937	0.072937	0.085352	cm
parallel std deviation	0.098	0.132	0.174		0.11	0.14	0.204	cm	0.072	0.081	0.081	cm
perp std deviation	0.055	0.055	0.059		0.051	0.055	0.06	cm	0.047	0.047	0.055	cm
a0	4.432	6.268	7.95		5.663	6.97	9.576		2.656	3.031	2.611	
a0 error	0.004	0.002	0.002		0.003	0.002	0.001		0.006	0.004	0.006	
% diff	11.36	10.45714	20.5		-13.26	0.428571	4.24		46.88	56.7	73.89	
Gaussian Fit												
parallel std deviation	0.151	0.168						cm	0.152	0.154	0.17	cm
perp std deviation	0.149	0.15						cm	0.149	0.149	0.151	cm
a0												
a0 error												

Realistic Laser Spot Sizes

- For the realistic simulation settings, laser spot size is close to less than electron beam radius (for ξ = 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 ξ = 5, peak ξ is ~2.5 – close to value determined from profile



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