Lumi Spectrometer Tracker Pointing Resolution

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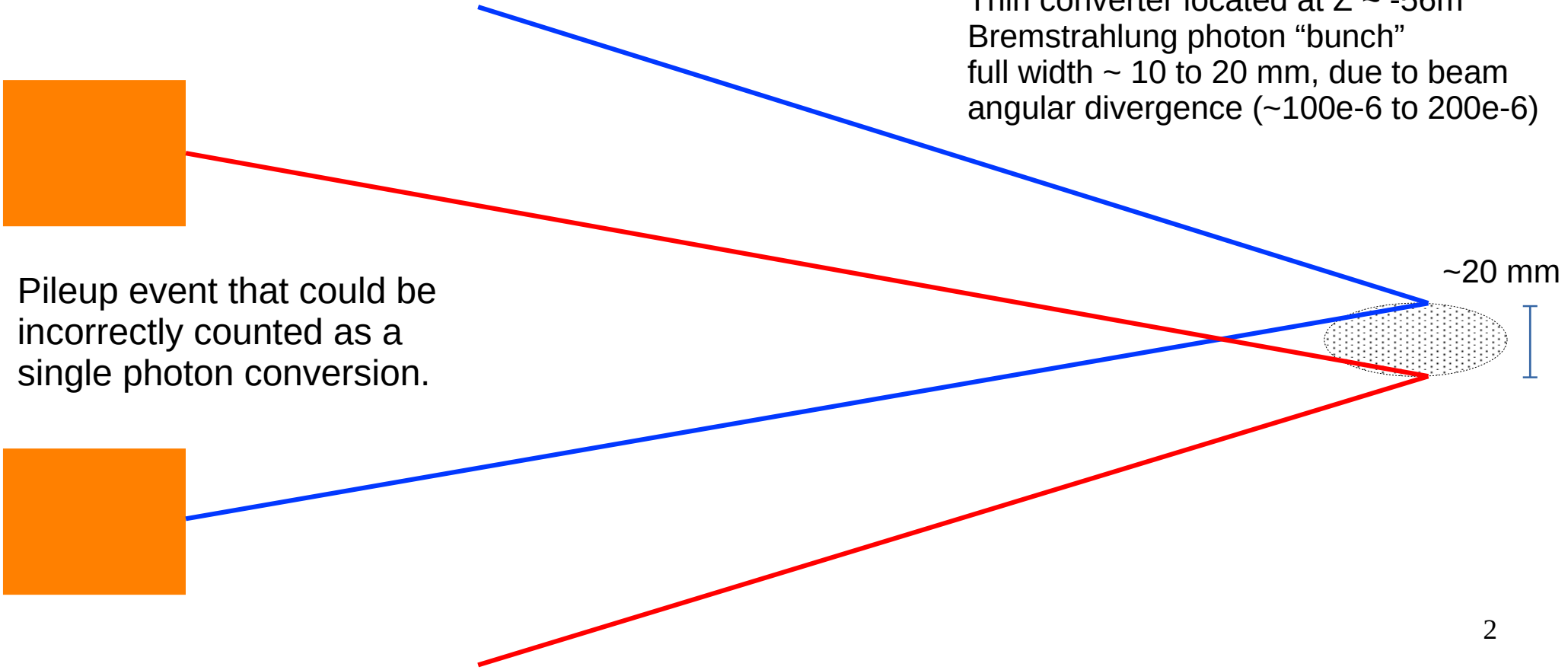
The trackers may help with pileup



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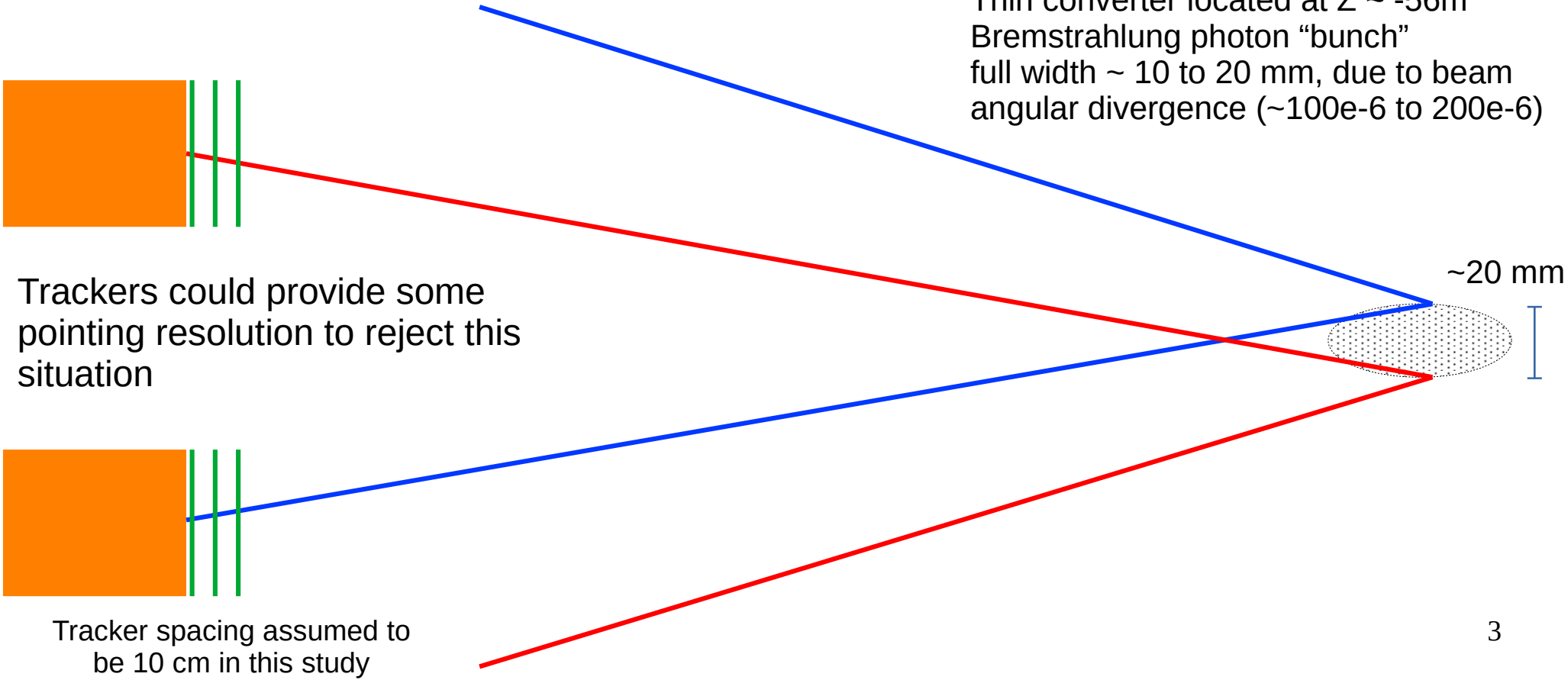


Tracking

Least-squares linear regression formula for N tracking planes with arbitrary spacing in z.

$$\tan\theta_y = \frac{N\sum z_i y_i - \sum z_i \sum y_i}{N\sum z_i^2 - (\sum z_i)^2}$$

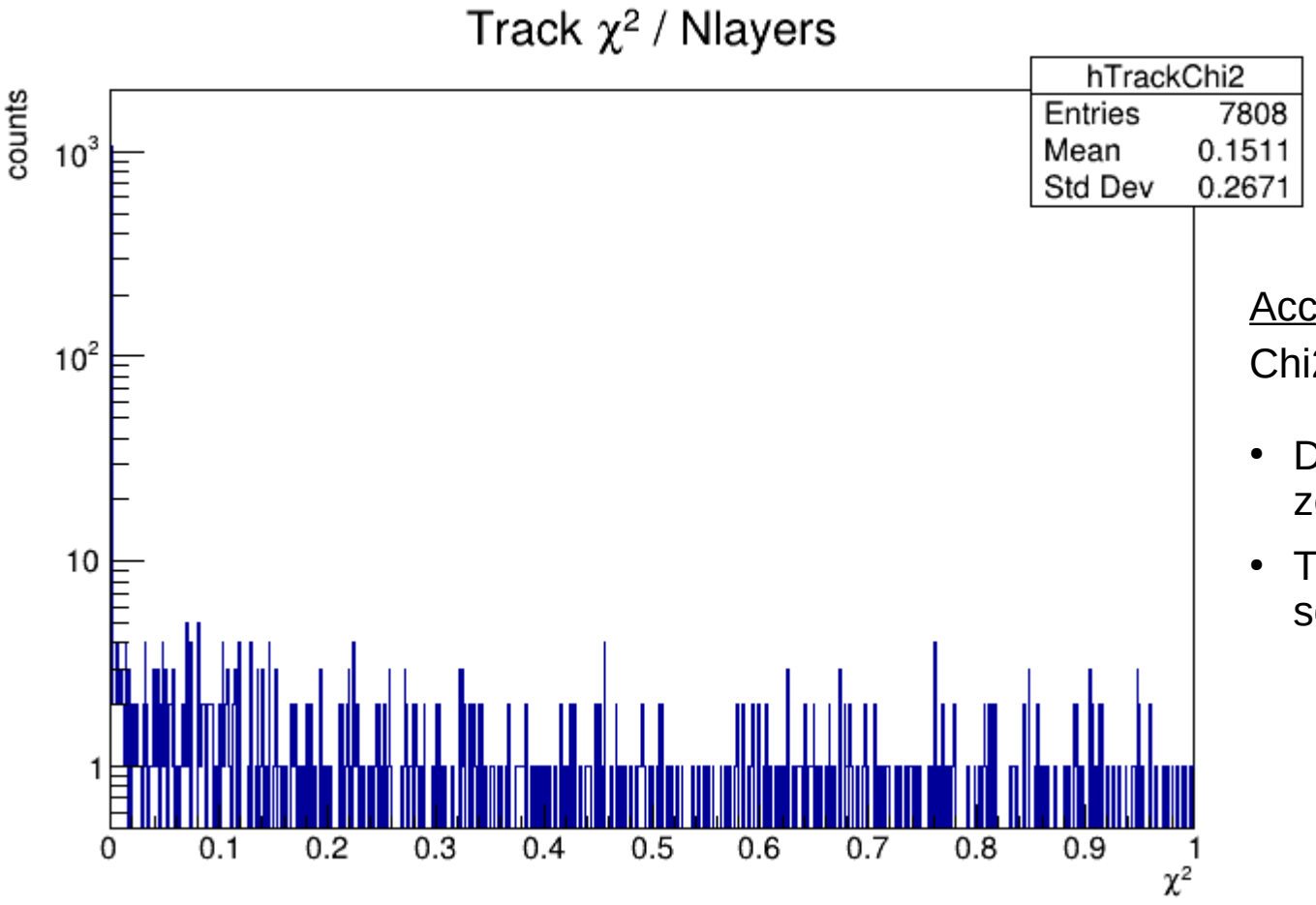
- Same equation to find other slope, θ_x ($y_i \rightarrow x_i$).
- We consider N = 3 tracking planes.
- A reduced Chi2 is formed in the usual way: sum of squared differences

$$\chi^2/N = \sum_i (\vec{L}_i - \vec{H}_i)^2/N$$

Position of point on the extracted Line

Position of Tracker Hit

Tracks with hits from secondaries

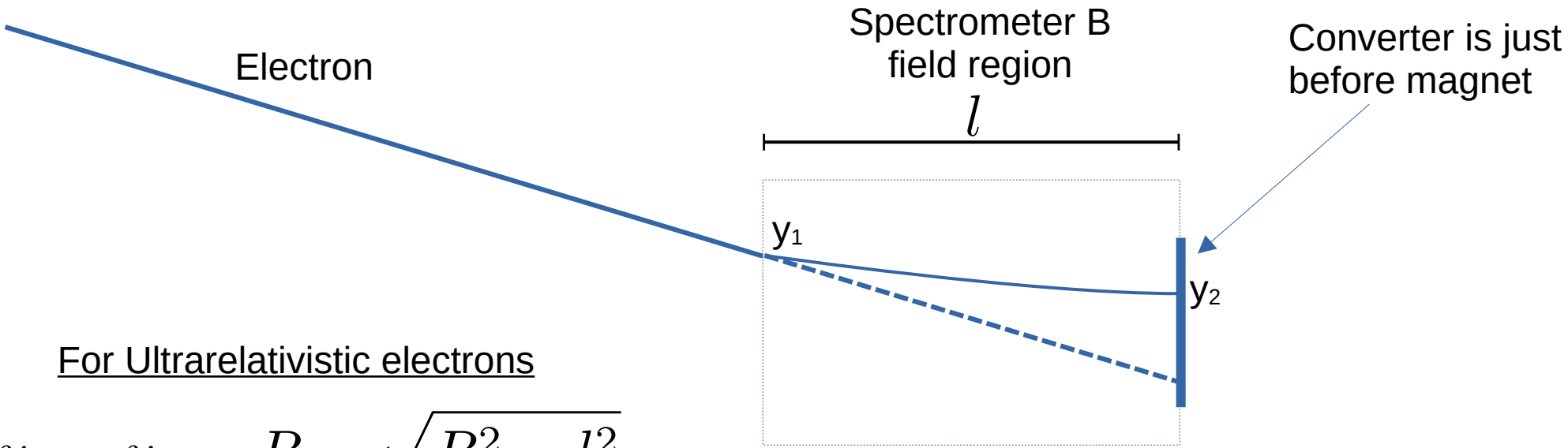


Accepted tracks:

Chi2/Nlayers < 0.01

- Desired tracks shown as spike near zero.
- The rest are from tracks with hits from secondary particles.

Correction for B field deflection



For Ultrarelativistic electrons

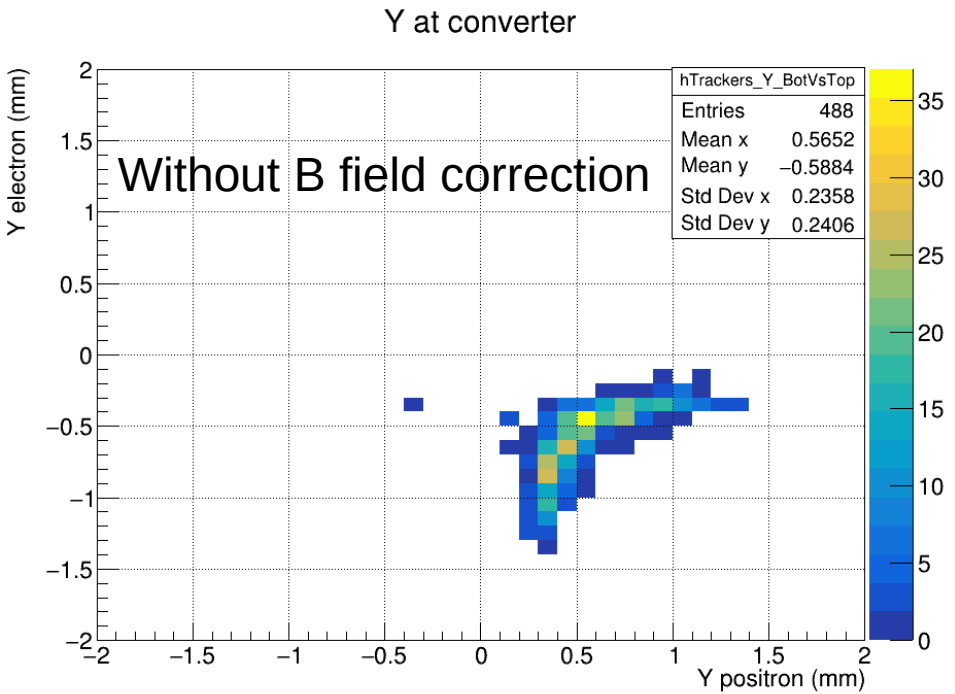
$$y_2 - y_1 = R - \sqrt{R^2 - l^2}$$

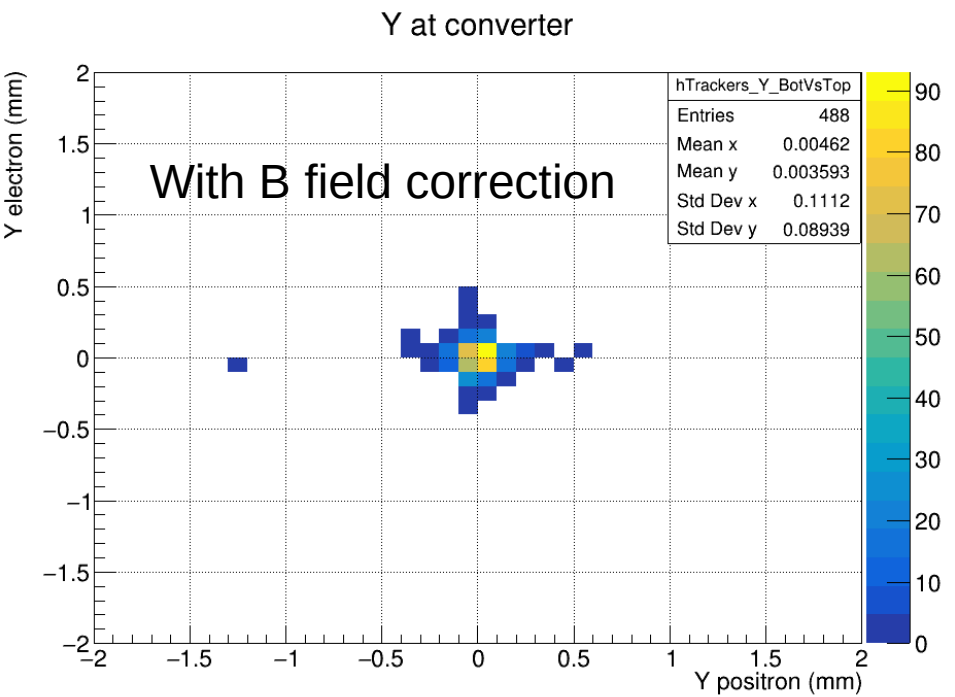
$$R = \frac{E}{c\,e\,B}$$

R: Cyclotron radius
E: electron energy
c: speed of light
e: electron charge
B: magnetic field

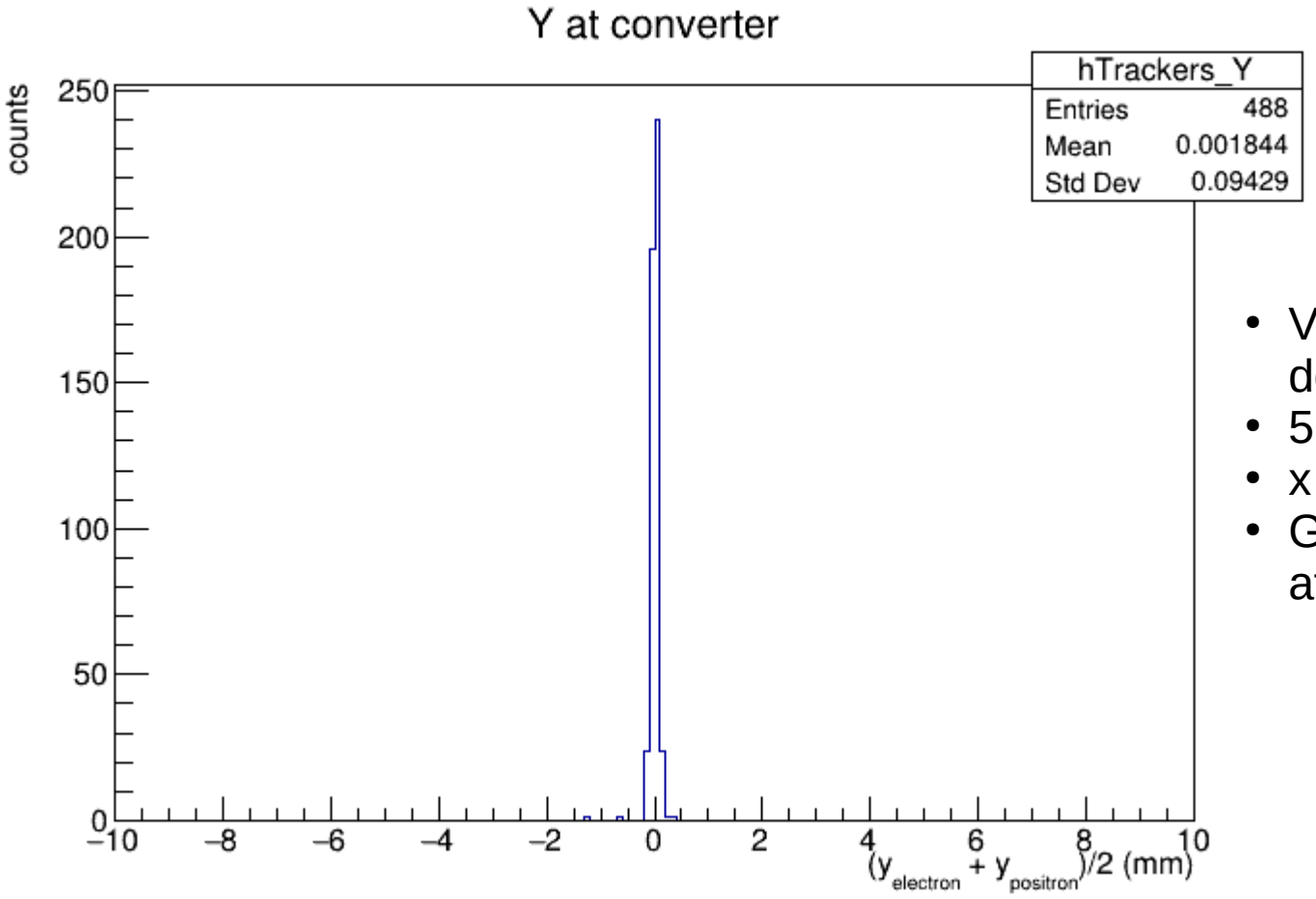
With and without deflection correction

- Converted photons of 18 GeV (e- e+) generated at center of converter (X=0, Y=0) and ran through simulation.
- Ideal case with Vacuum everywhere and ultra-small Si pixels (5 microns), 0.3 mm thick.
- Tracks reconstructed with trackers and projected back to converter location





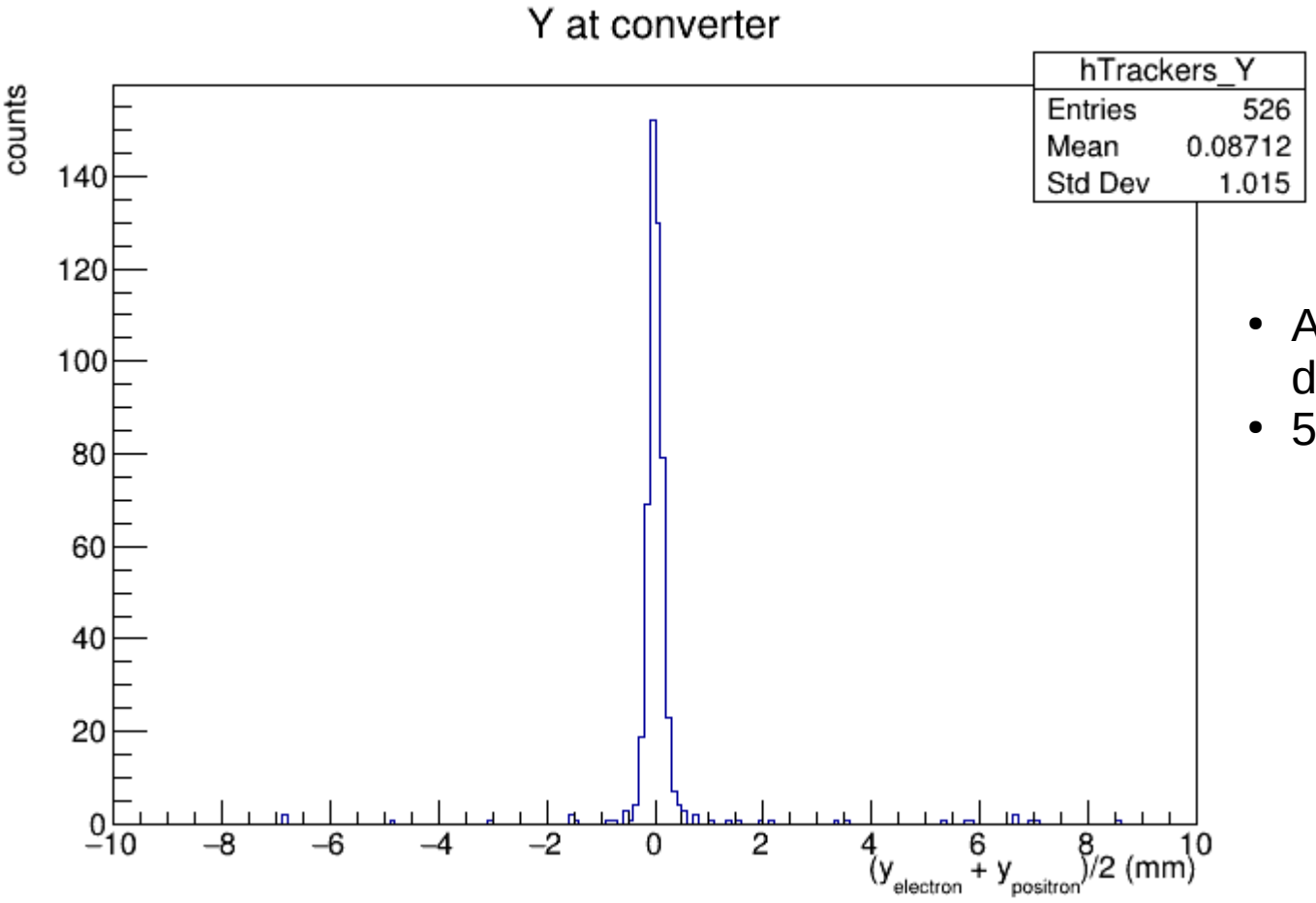
Ideal scenario: Vacuum & 5 μm pixels



$$y_\gamma = \frac{y_{electron} + y_{positron}}{2}$$

- Vacuum “filled” in between all detectors.
- 5 micron pixel size.
- x distribution looks similar
- Generated photon conversion is at y = 0.

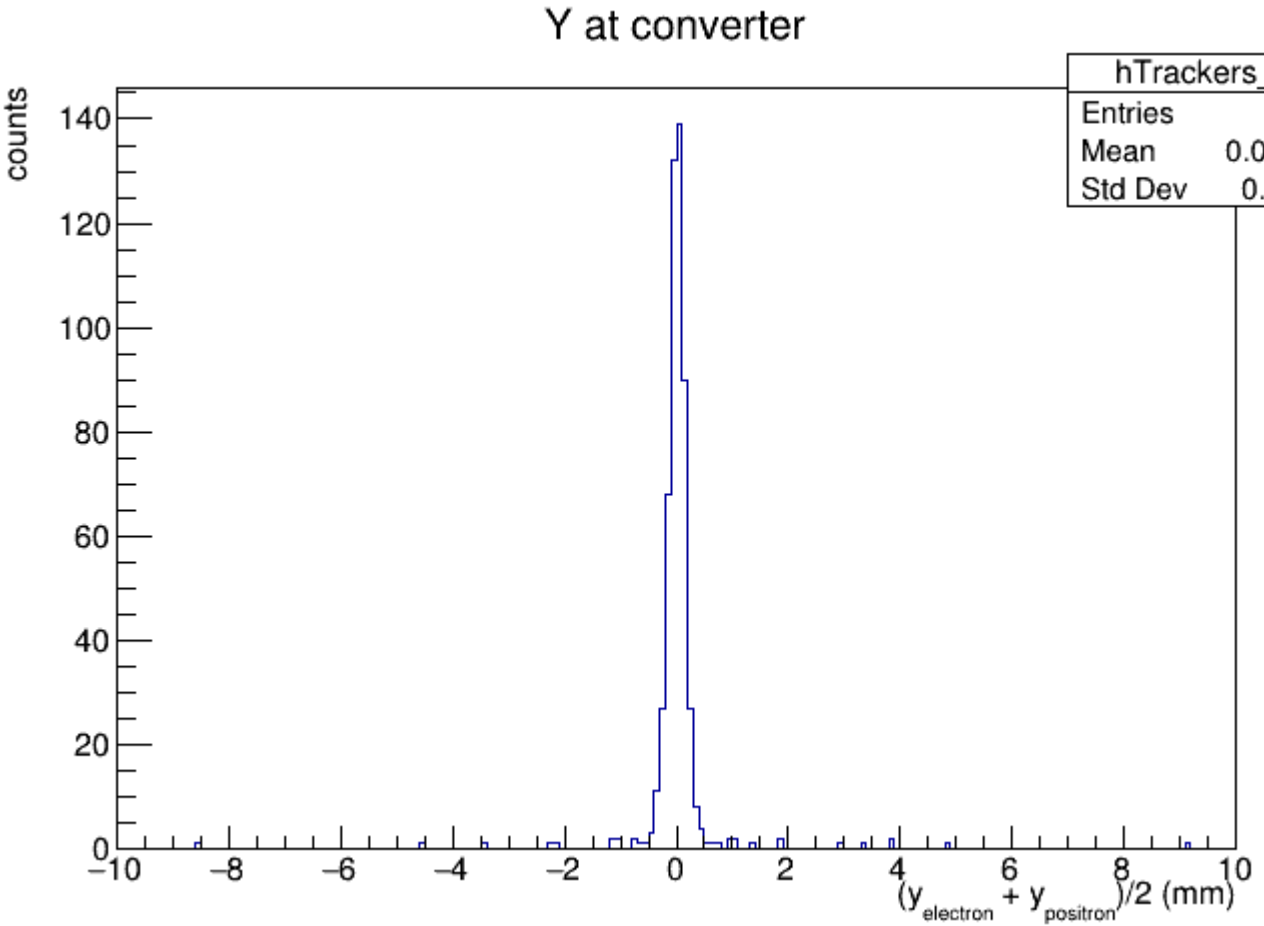
Air & 5 μm tracker pixels



$$y_\gamma = \frac{y_{electron} + y_{positron}}{2}$$

- Air filled in between all detectors.
- 5 micron pixel size.

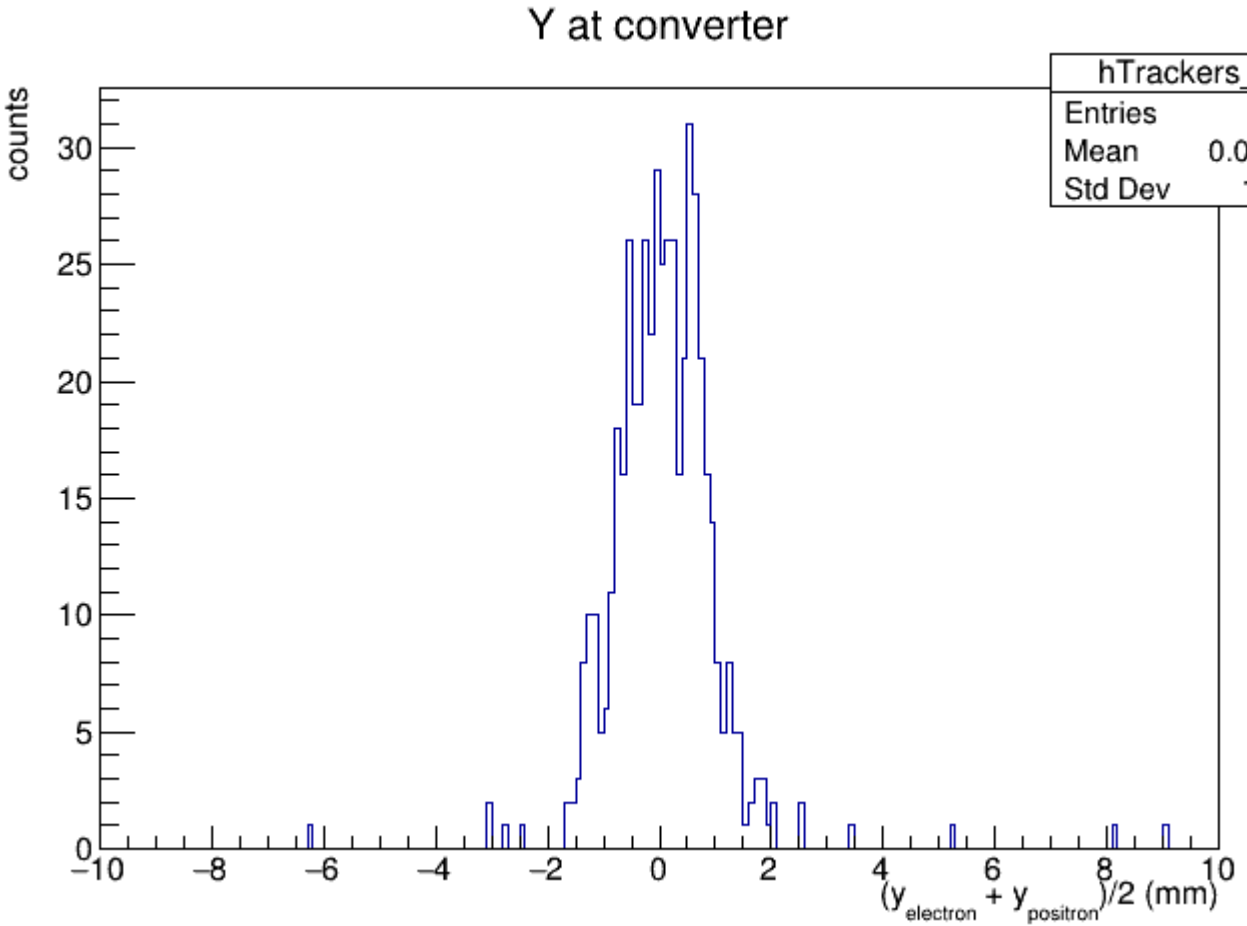
Air & 50 μm tracker pixels



$$y_\gamma = \frac{y_{electron} + y_{positron}}{2}$$

- Air filled in between all detectors.
- 50 micron pixel size

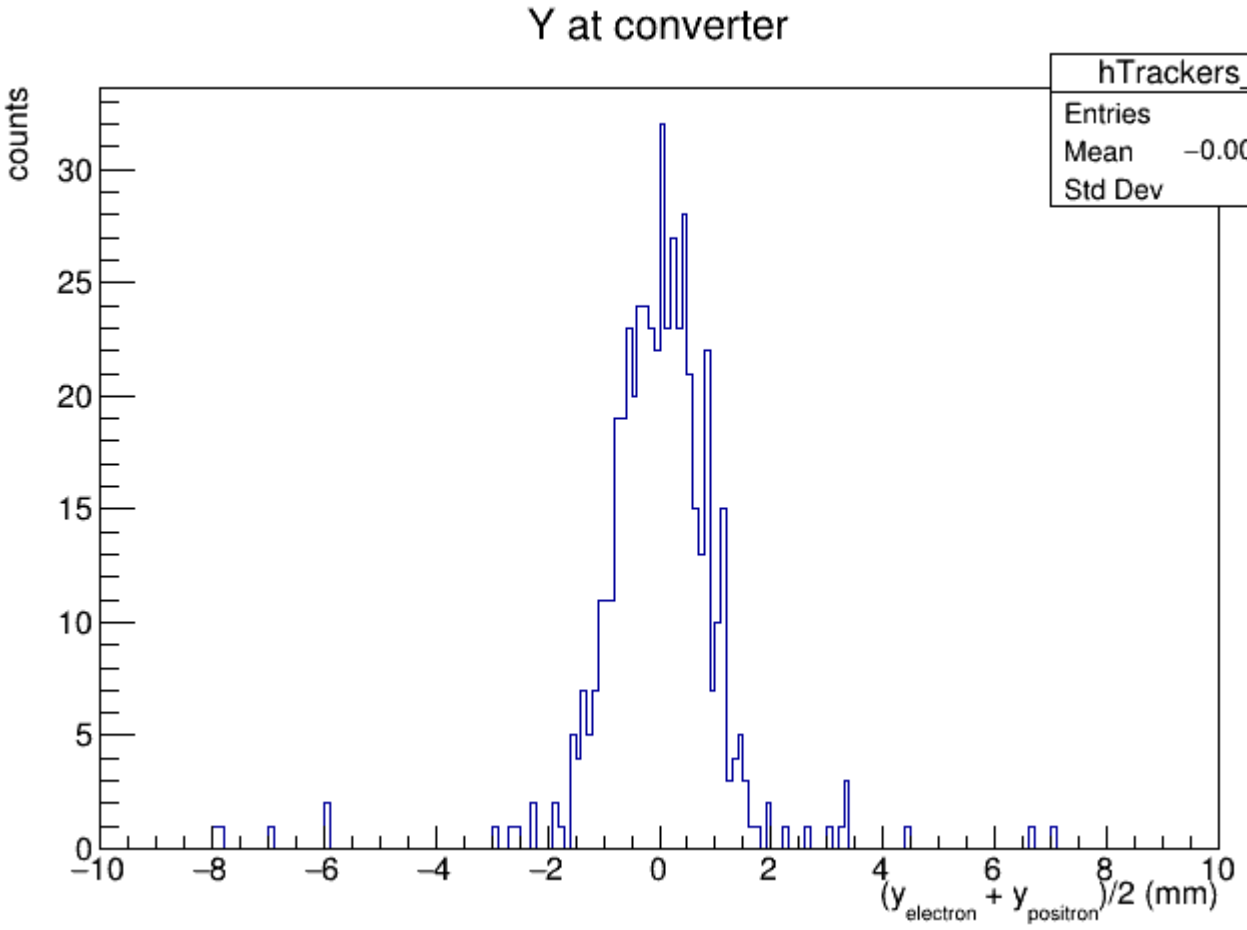
Air & 500 μm tracker pixels



$$y_\gamma = \frac{y_{electron} + y_{positron}}{2}$$

- Air filled in between all detectors
- 500 micron pixel size
- Angles of center-hitting tracks ~169/9000 = 0.018 rad
- Angular error due to nearby pixel misfire ~ 0.5/200 = 0.0025

Air & 500 μm tracker pixels + 0.14 mm Cu layer: ACLGAD



$$y_\gamma = \frac{y_{electron} + y_{positron}}{2}$$

- Air filled in between all detectors.
- 500 micron pixel size
- 0.14 mm Cu layer added behind Si sensor to approximate ASICs and cooling material. This approximates an ACLGAD.

Summary

- Bremstrahlung photon beam will be as large as 20 mm at Z = -56 m, mainly due to the electron beam's angular divergence.
- We can use this macroscopic size to our advantage in suppressing pileup photons.
- Preliminary studies of the Lumi spectrometer tracker's pointing resolution suggest that a value of ~ 1 mm is achievable.
- Precise measurements of the electron beam profile might be beneficial to the machine and ePIC.

Next Steps

- Cross check this finding with multi photon events (pileup).
- Further optimizations can be made:
  - Multiple scattering in air reduced if we shorten the spectrometer and increase B * dL
- Determine which kind of Si sensor will be needed for the trackers.