Acceptance study

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1. 03/19/25 Effect of analyzer magnetic field strength in acceptance

Motivation

Luminosity is obtained from the equation

$$L_{\text{inst}} = \frac{R}{fA\sigma} \qquad (10)$$

Imprecise knowledge of A creates the largest uncertainty in the measurement.

The acceptance of the luminosity system depends primarily on two issues:

1. Obstacles upstream of the entry to the luminosity system that remove photons from the edges of the bremsstrahlung beam;
2. The fraction of the converted pairs in which both electrons are accepted into the fiducial areas of the calorimeters.

doi:10.1016/j.nima.2006.06.049

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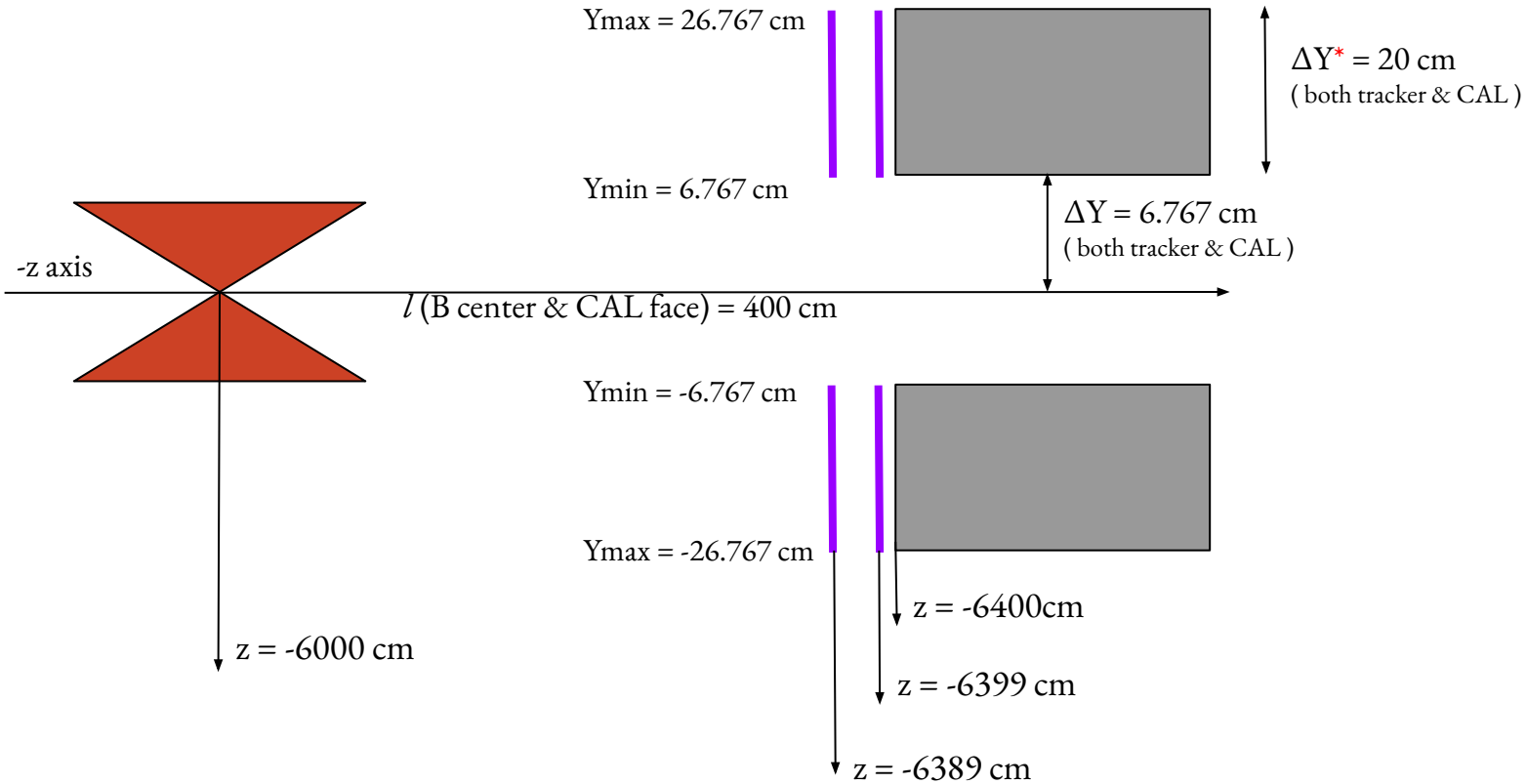
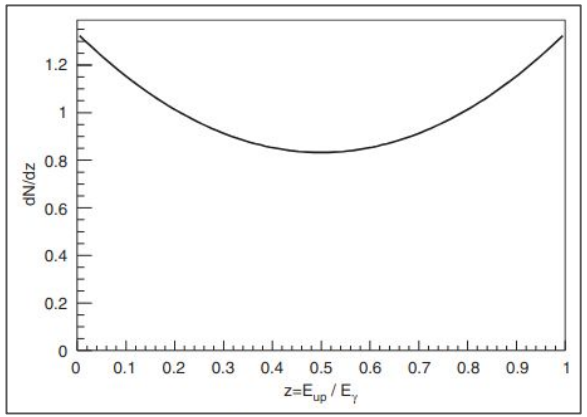
Design details for simulations study

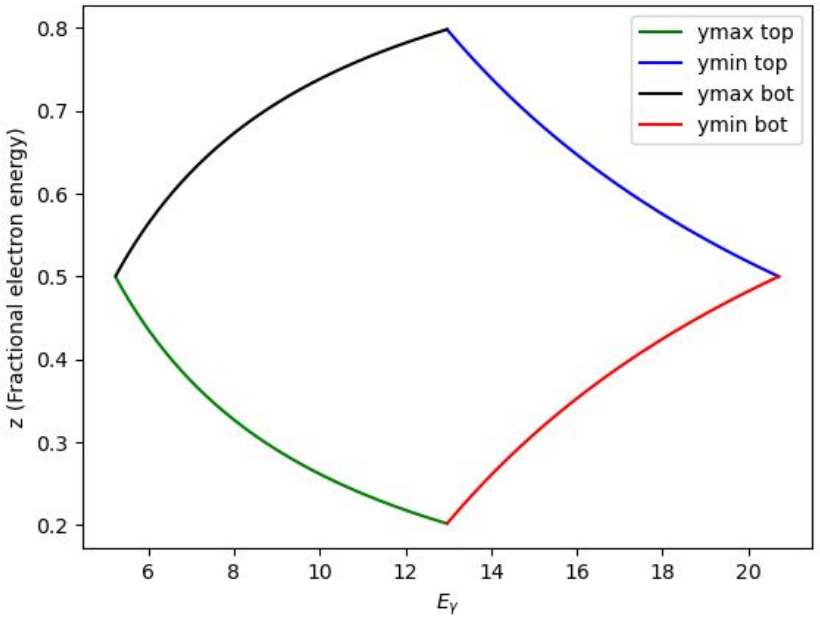


*The dimensions change based on the specific calorimeter design.

Accepted photon range in PS detectors



$$zE_\gamma = \frac{\ell p_T}{y_{up}} \qquad (1-z)E_\gamma = \frac{\ell p_T}{y_{dn}}$$



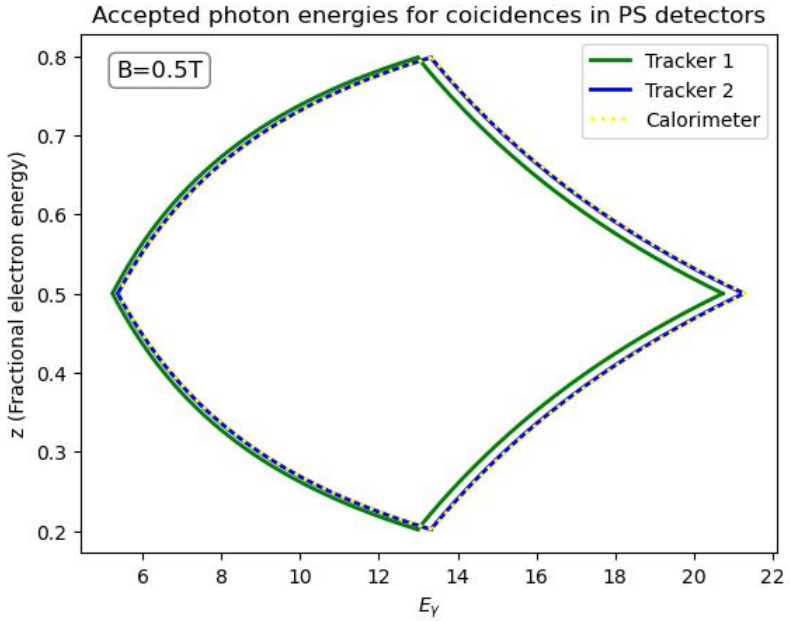
l : 3.89 m

p_T : 0.18 GeV/c

y_{up}(max) : 26.76cm y_{up}(min) :6.767cm

y_{dn}(max) : 26.76 y_{dn}(min) :6.767cm

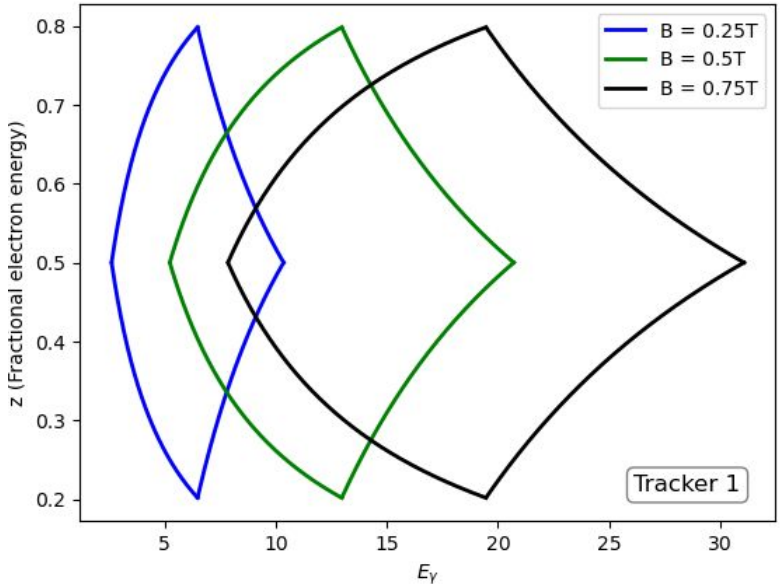
Accepted photon range in PS detectors



ΔZ (tracker2 & CAL) = 1 cm
ΔZ (tracker1 & tracker2) = 10 cm

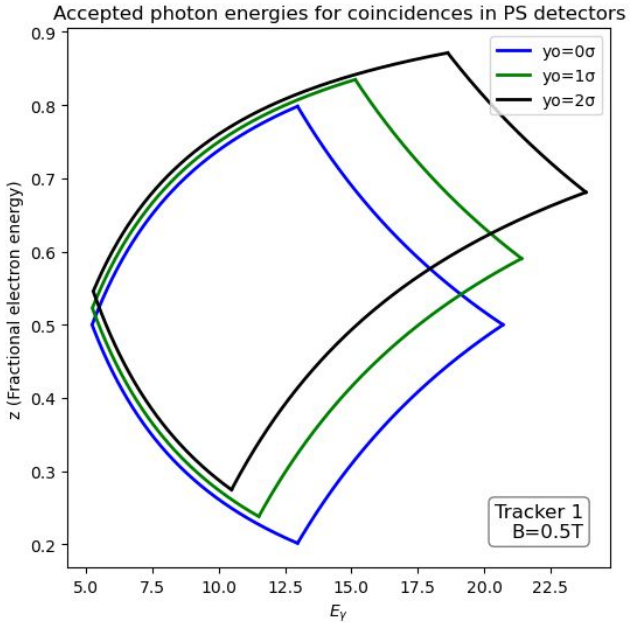
- No significant change in photon acceptance with trackers.
- Next slides will include acceptance study with tracker 1.

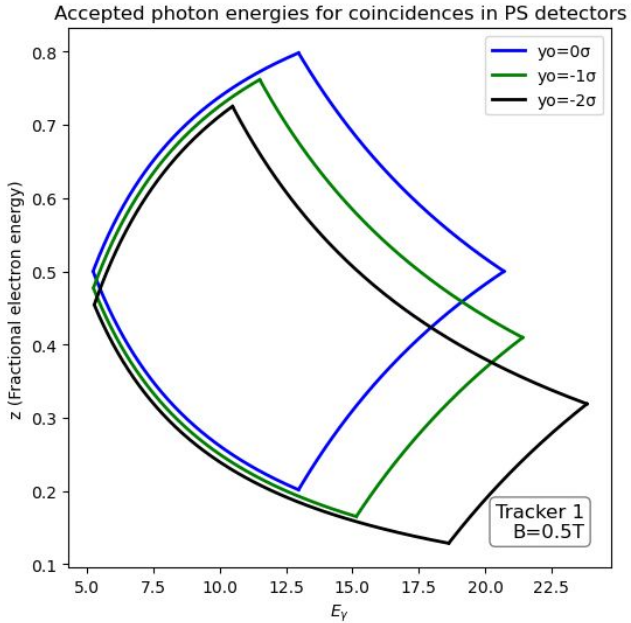
Accepted photon range in PS detectors for different magnetic field strength



- Accepted photon width increases with B.
- B 0.75 T doesn't seem optimal for EIC electron beam energies.

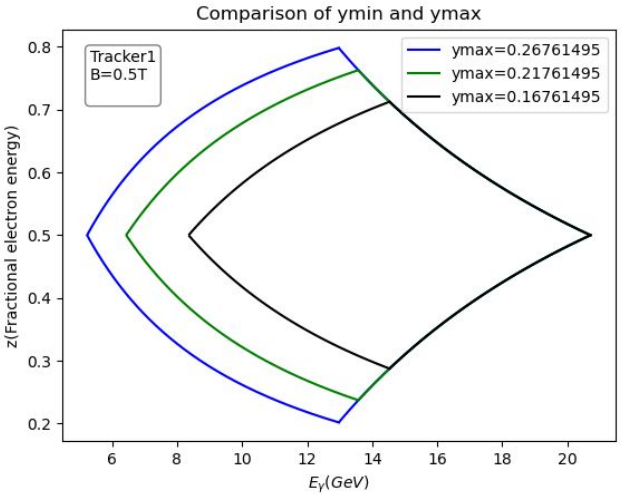
Accepted photon range in PS detectors for different photon vertex offset



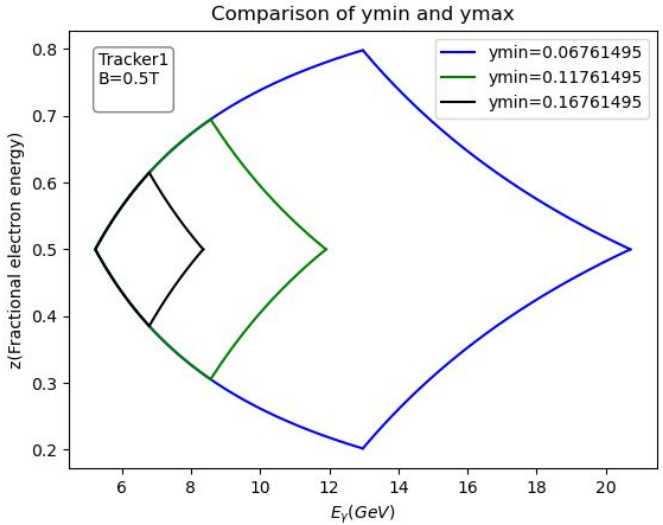


- Added a gaussian distribution to the beam (sigma=1.2238cm)
- The area of the curves is conserved. (Area=0.12765)

Comparison of changing ymin and ymax

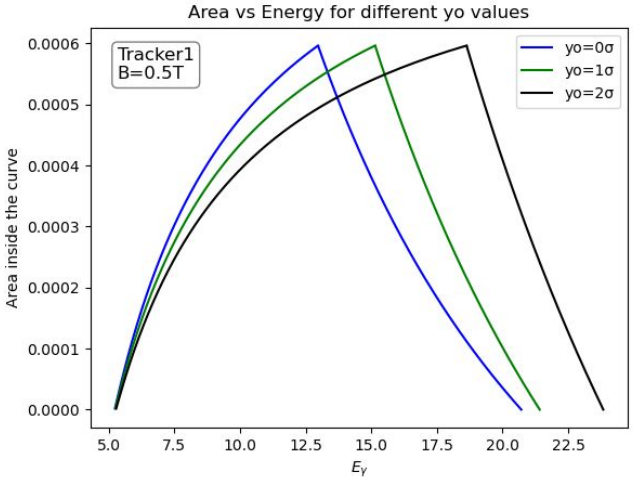


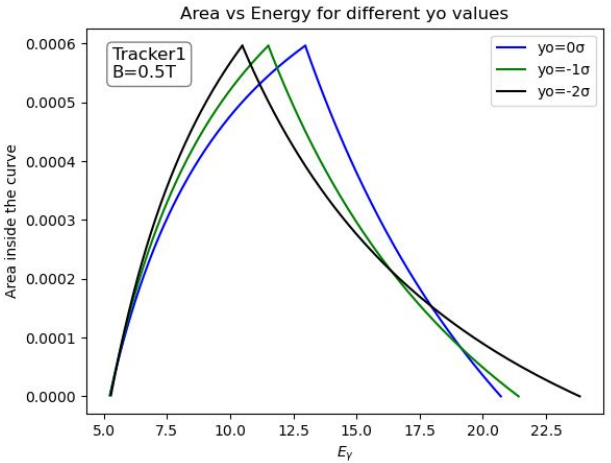
- Keep ymin fixed and change ymax.



- Keep ymax fixed and change ymin.

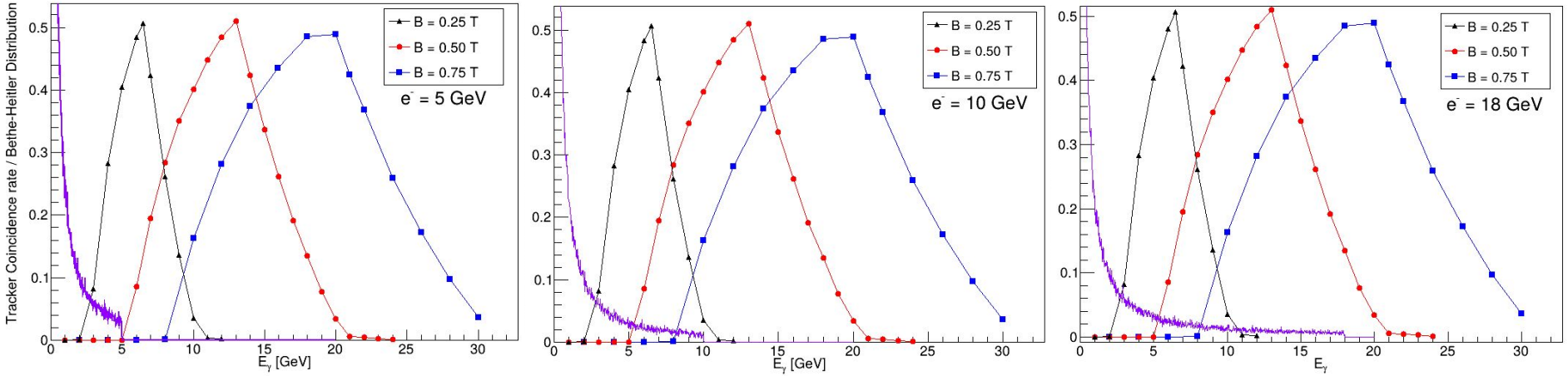
Accepted photon range in PS detectors for different magnetic field strength





- The peak of the curves inside the curve is the same.
- The peak moves left or right according to the sigma.

Acceptance for different magnetic field and EIC e^- beam energies



- Magenta curve is the Bremsstrahlung spectra.

- With current location and size of trackers,
  - B = 0.25 T, seems optimal choice for all e^- beam energy.
  - B = 0.5 T, detectors should be shifted vertically upwards to include 5 GeV beam.
  - B = 0.75 T, not an optimal choice. [require too much vertical displacement, limited vertical space in tunnel.]

Open Questions & Expert Insights Needed

- ➔ What optimal B should we choose to operate the luminosity detector for all electron beam energies 0.25 T or 0.5 T ?

- ➔ Is there any room for vertical displacement of PS detectors ?
  - ♦ This will shift the accepted photon range for 0.5 T to lower energies.
  - ♦ 0.5 T has the benefit of wider width and if shifted will cover whole BH spectra.

- ➔ What should be the next steps to see acceptance effect on ePIC PS luminosity detector.

Thank
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