Efficiency of the tagger fixed array

Effects of

- Gaps between counters
- Collimation of electrons by magnet aperture

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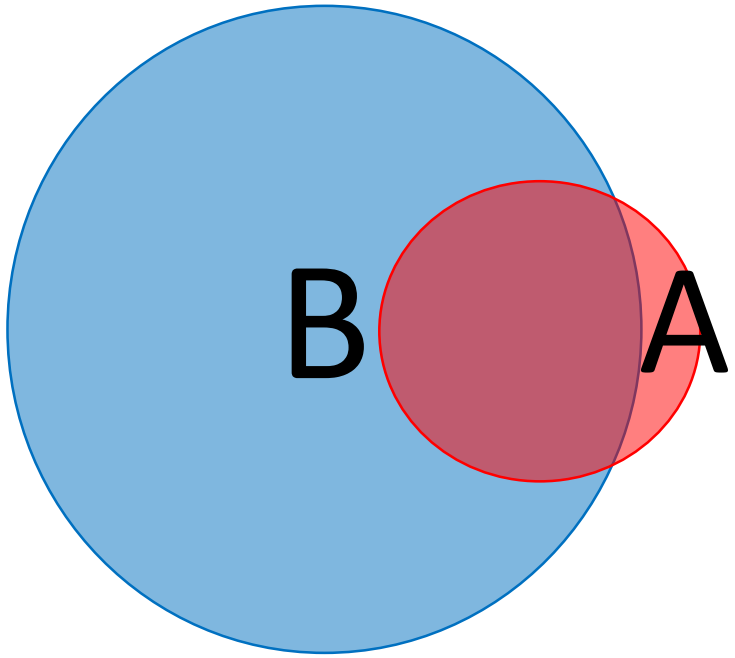
Tagger ratios



For each photon energy bin:

N(A) = events with photon through collimator

N(B) = events with detected electron in tagger

N(A·B) = events with collimated tagged photon

Ratio 1 = N(A·B)/N(B) (≈ 50% for 5 mm collimator)

Common name: “tagger efficiency”, ”tagging ratio”

Proposed name: photon ratio, ε_γ

Use: Normalization using tagger counts

Ratio 2 = N(A·B)/N(A) (≈ 90%)

Common name: (none)

Proposed name: electron ratio, ε_e

Use: Normalization using pair spectrometer

Tagger ratios → Tagged photon flux

Method 1: Use ε_γ = N(collimated photons · tag)/N(tag)

Measure N_{tag}

Incident tagged photons = $\varepsilon_\gamma \ N_{tag}$

Method 2: Use ε_e = N(collimated photons · tag)/N(collimated photons)

Measure N_{PS}

Incident tagged photons = $\varepsilon_e \ N_{PS} / f_{PS}$

where f_{PS} = (pair converter fraction)·(P.S. efficiency)

Effects contributing to electron ratio ε_γ:

- Gaps between fixed-array counters (next slides)

  Gaps mainly result from shifting second counter plane

  from 13 cm to 18 cm

- Collimation of electrons by the magnet poles

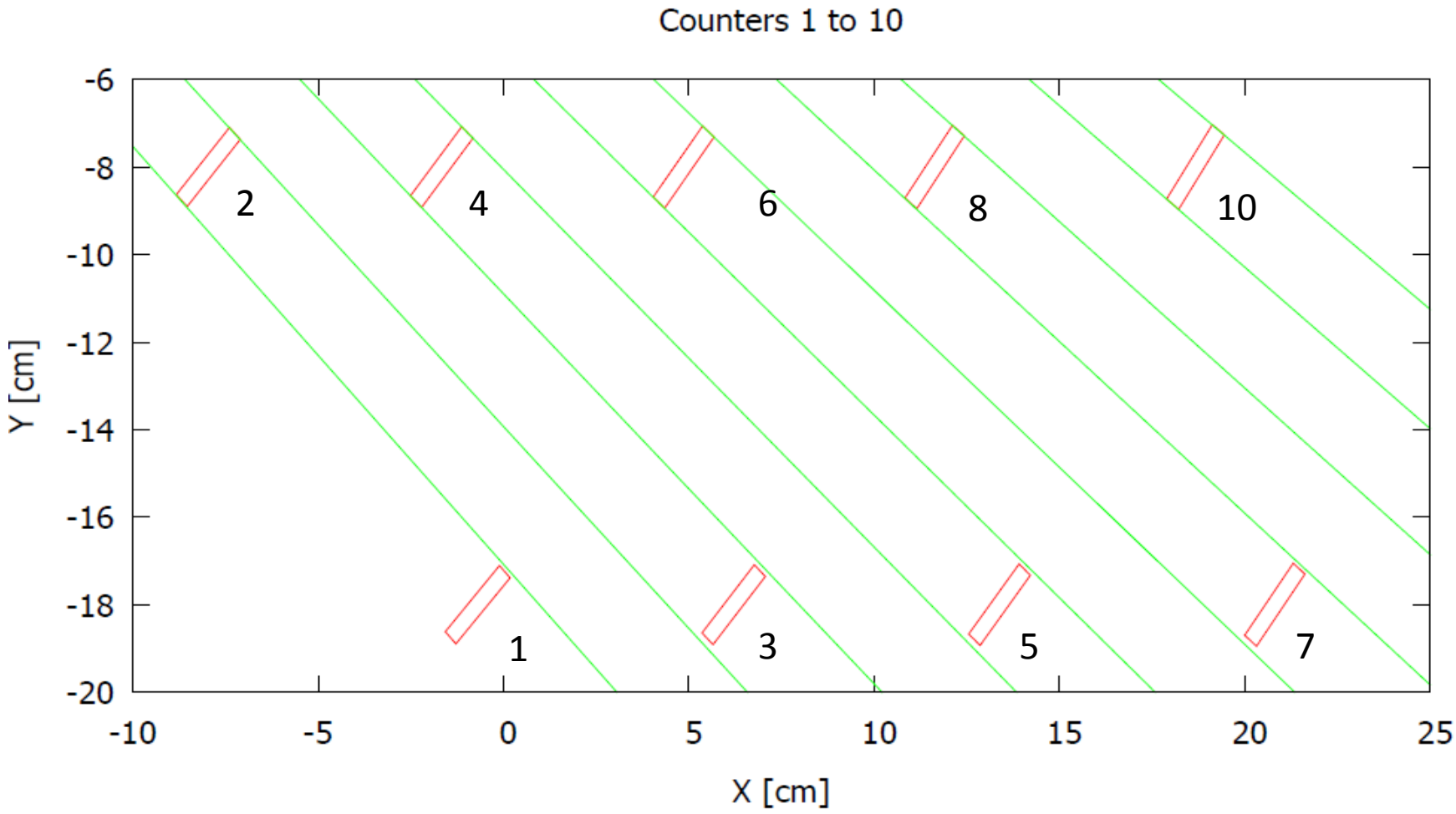
  Depends on angular distributions and size of photon collimator

- Efficiency of tagger counters

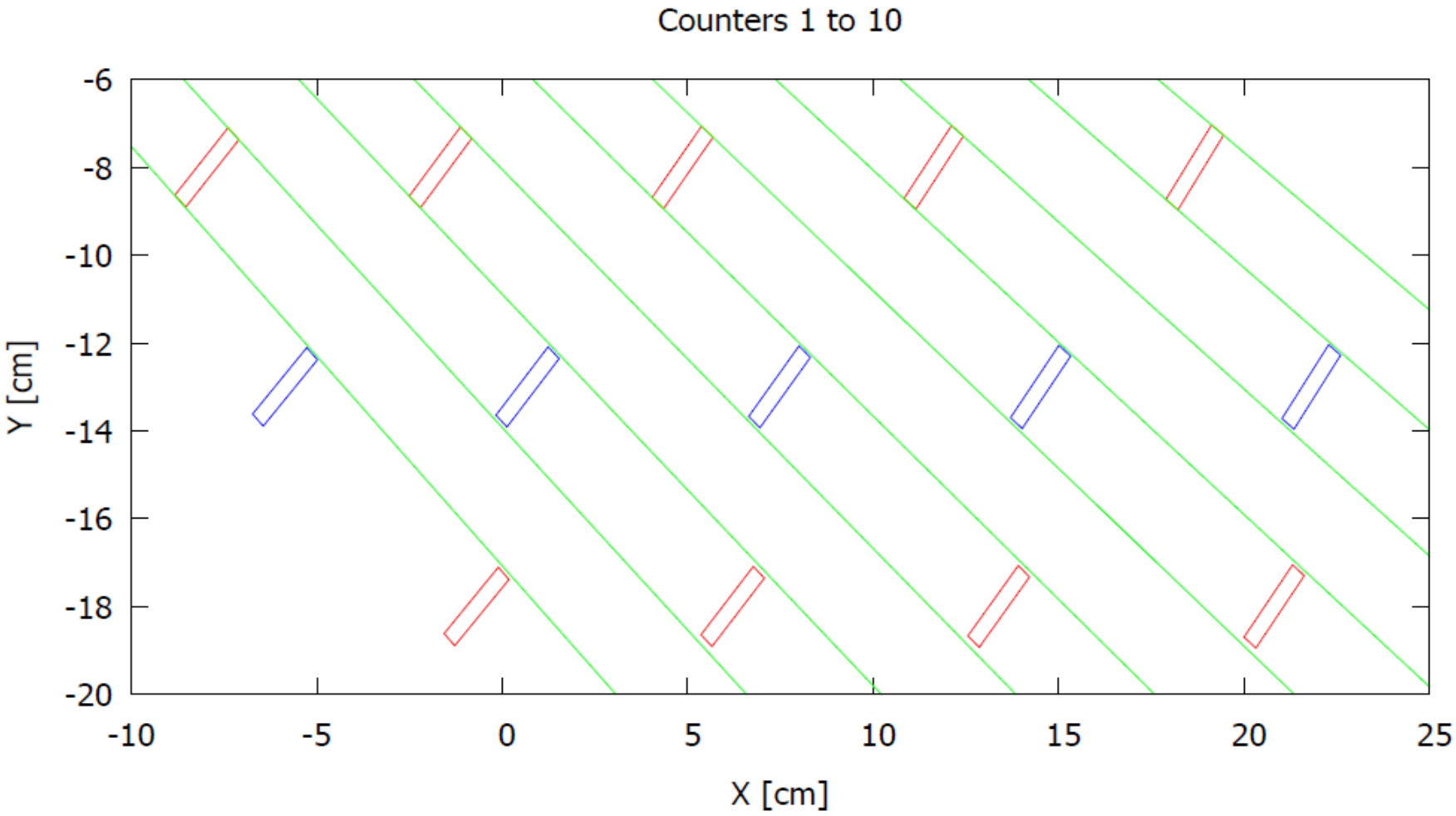
  e.g. N. Sparks's high voltage tests at last beam meeting

Counters 1-10 (11.6-11.8 GeV):

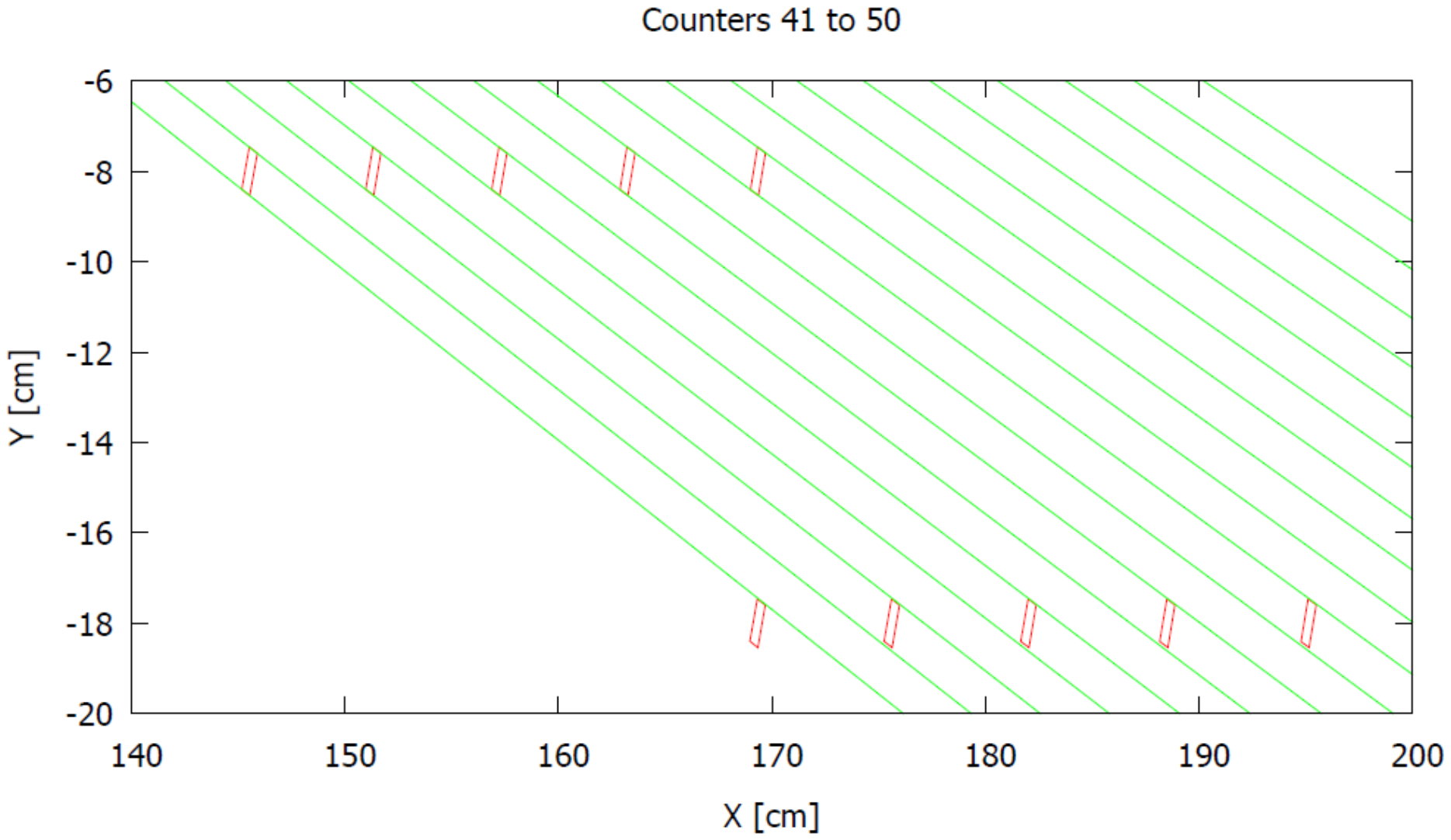
Green lines show the bounding 0-angle electron trajectories for each front-plane counter (Y=-8 cm).
Back-plane (Y=-18 cm) counters do not fill the region between trajectories.



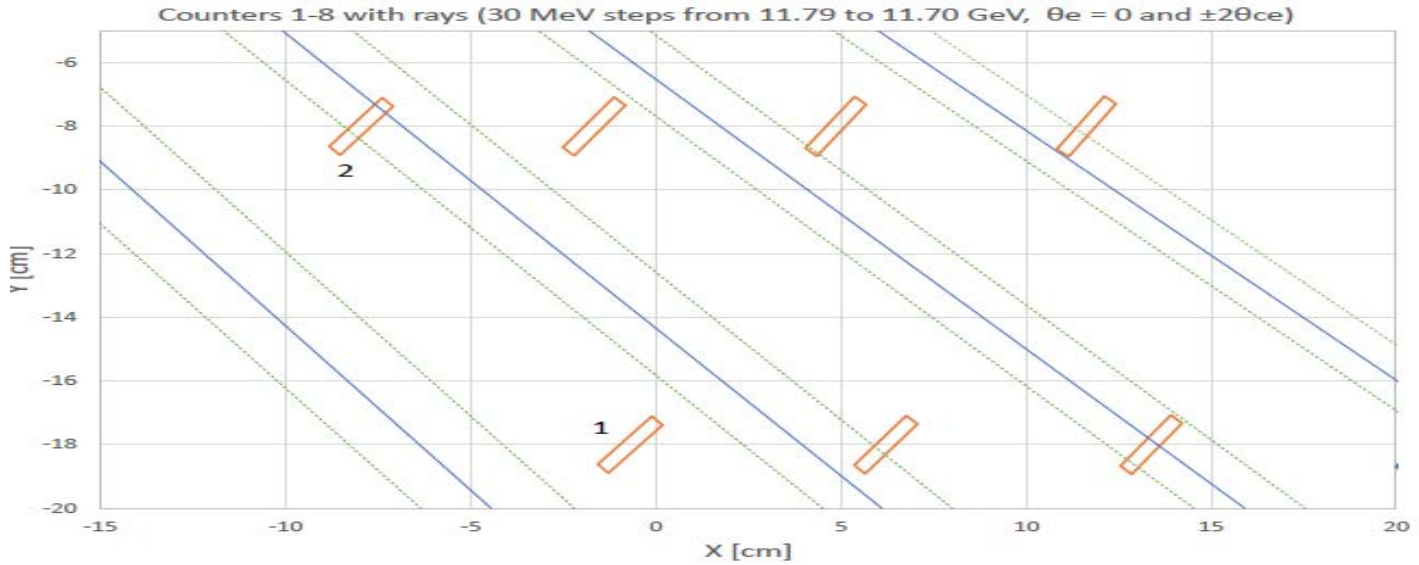
The reason:
Counters were originally designed to be placed at Y = -8 cm and -13 cm.
Bill Crahen moved the back-plane to -18 cm without adjusting counter widths or front-plane positions.
Blue boxes show the intended counter positions.



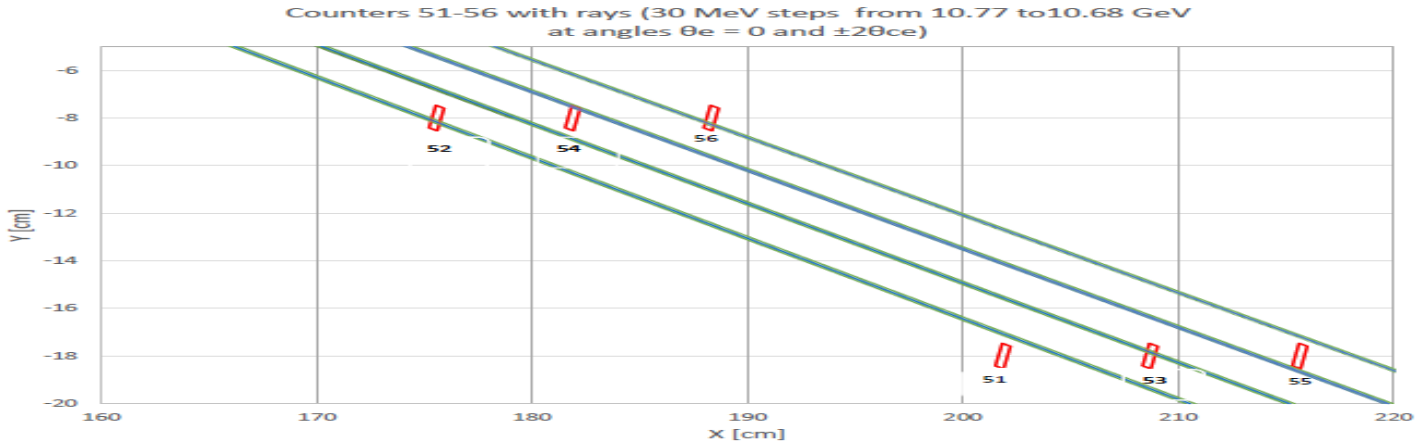
For Counters 41-50 ($E\gamma \approx 11$ GeV), effect is similar:



Counter energy boundaries were calculated using zero-angle electrons.
How important is the bremsstrahlung electron angular distribution? Plot rays for $\theta_e = 0$ and $\pm 2\theta_{ce}$.



Counter 1-8
11.79-11.70 GeV



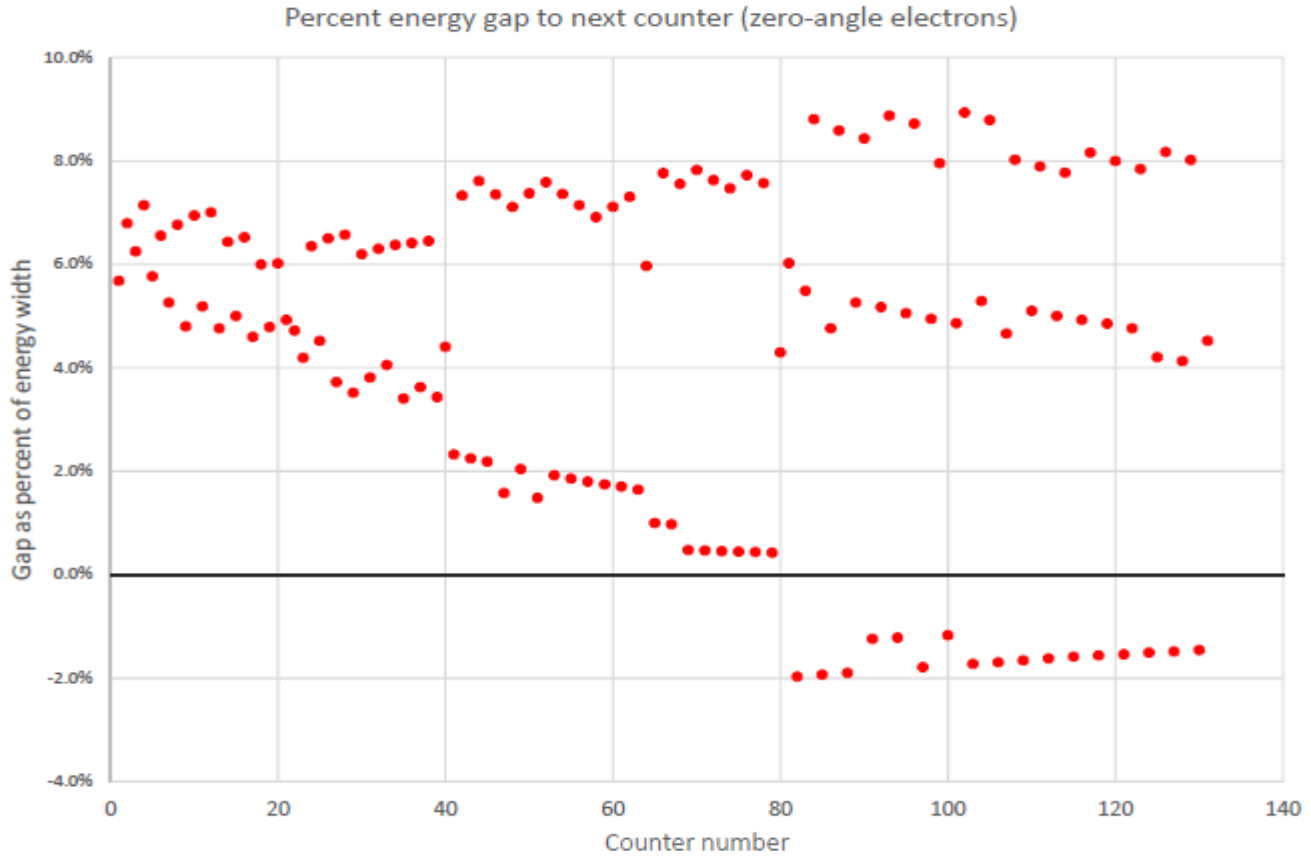
Counter 52-56
10.77 – 10.68 GeV

Plot of **energy gaps** between counters for **0-angle electrons** only.

Gap sizes alternate between front-plane and back-plane counters because of the method used to displace the counters. Gaps give typical inefficiency ≈ 5%.

Note that for Counters 80-131 there are 3 planes of counters (-8, -13, -18 cm).

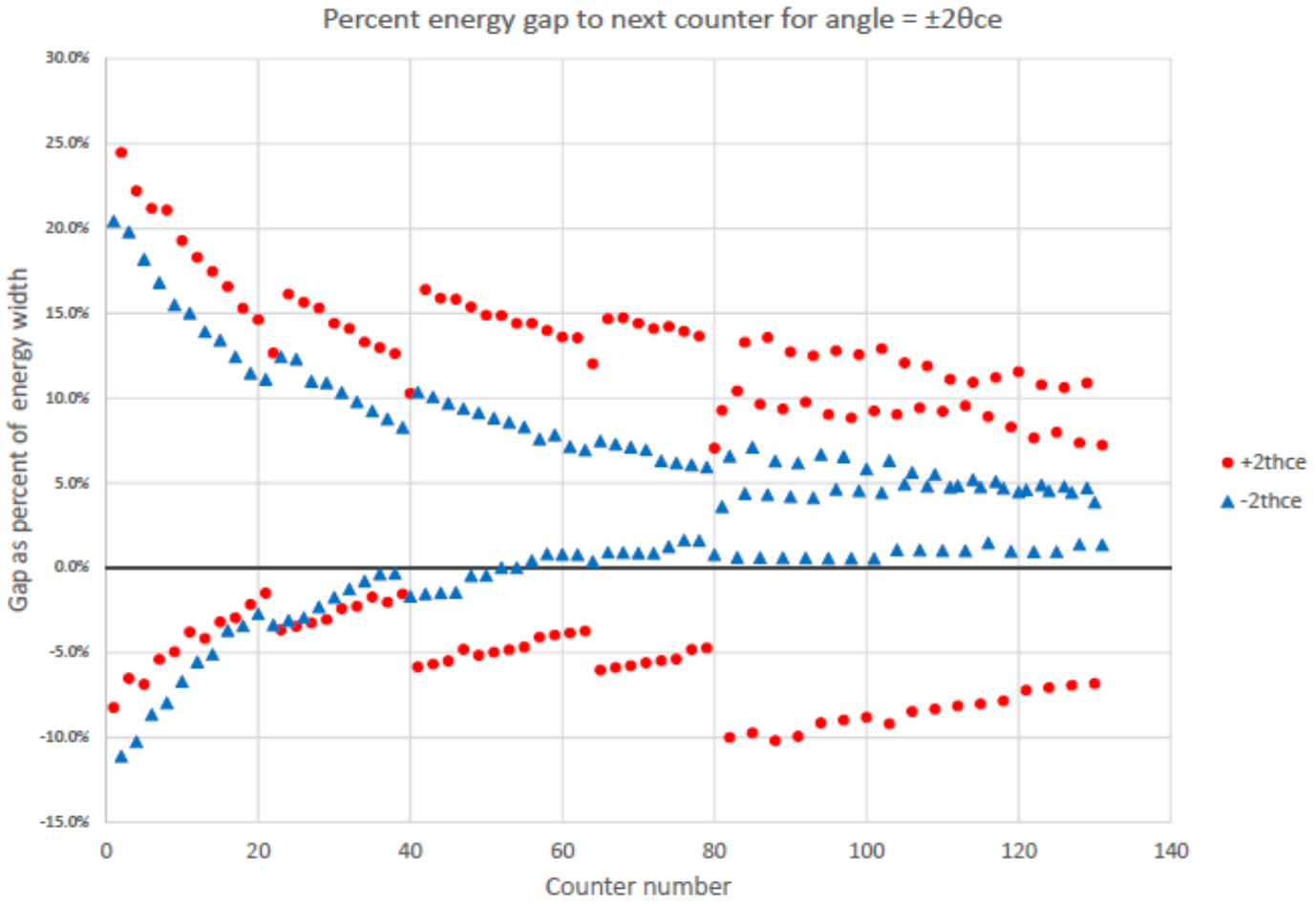
“Negative gap” = overlap (2 counters in coincidence)



Energy gaps for $\theta = \pm 2\theta_{ce}$ which contains most of the angular distribution.

$$\theta_{ce} = (m_e/E_0)\, E_\gamma /(E_0 - E_\gamma)$$

Gaps and overlaps are larger, but not dramatically so.



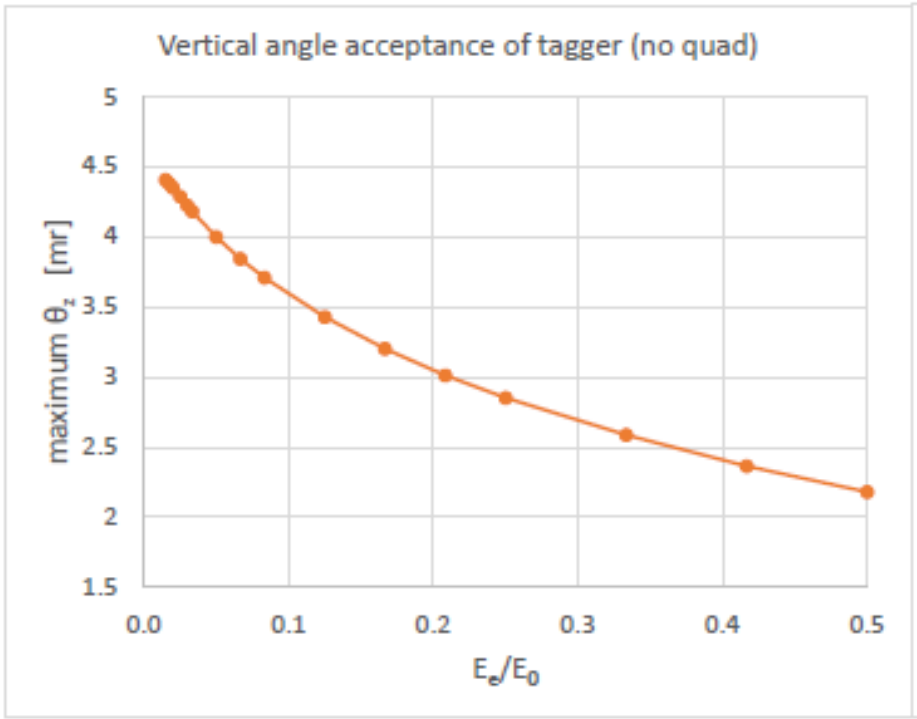
Another effect: vertical acceptance of tagger magnet gap (no quad)

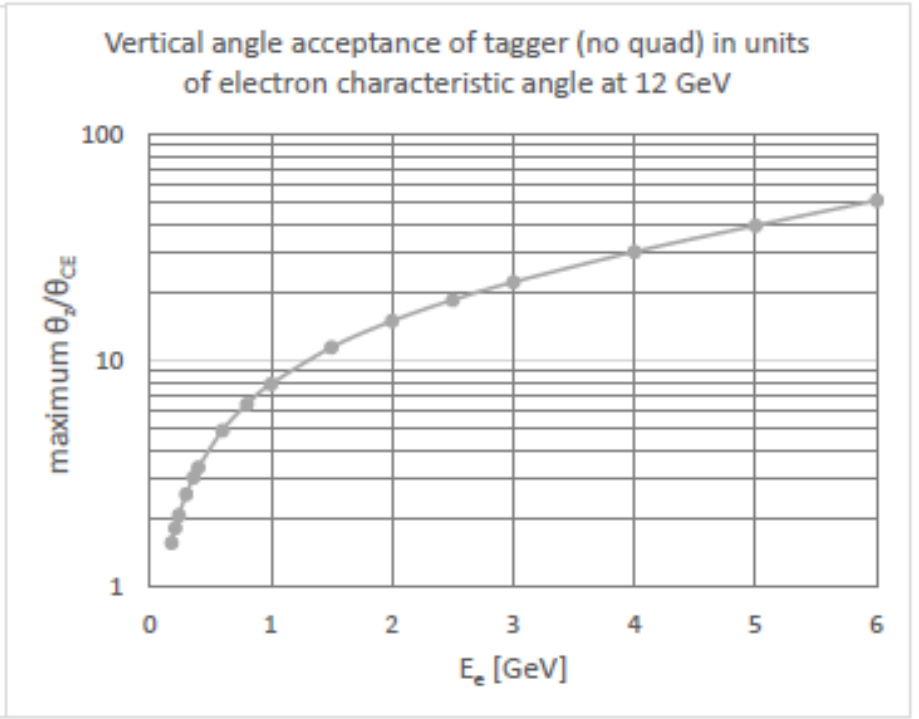
Trace rays through tagger magnet, and find vertical angle for which z = 15 mm at the exit chamfer.

Left figure: $\Theta_{z\,max}$ decreases rapidly with E_e/E_0 (independent of E_0), but …

Right figure: $\Theta_{z\,max} / \Theta_{ce}$ increases rapidly with E_e

At 12 GeV, only for the first few counters is $\Theta_{z\,max} < 3\,\Theta_{ce}$





Estimate of fraction of electrons blocked by magnet gap (no quad)

Depends on 3 parameters: $E_e/E_{0,}$ $\Theta_{z\ max}/\Theta_{ce}$ and $\Theta_{\gamma\ max}/\Theta_c$

Interpolate/extrapolate from old (1998) bremsstrahlung integrations performed for Hall B:
(Caution: not very confident about the accuracy of these numbers – use for trends only.)