LUMI detector **size** considerations

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Det1 Far-backward Mtg.
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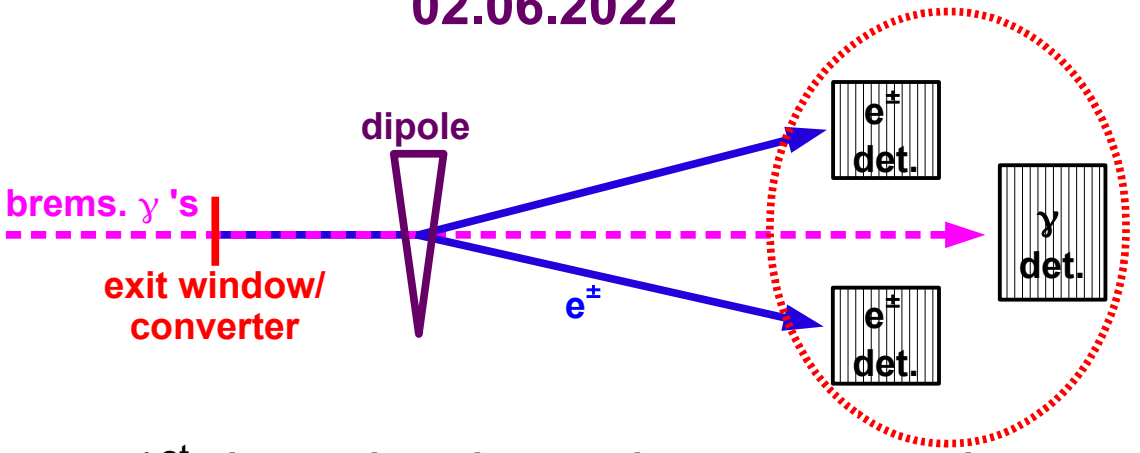
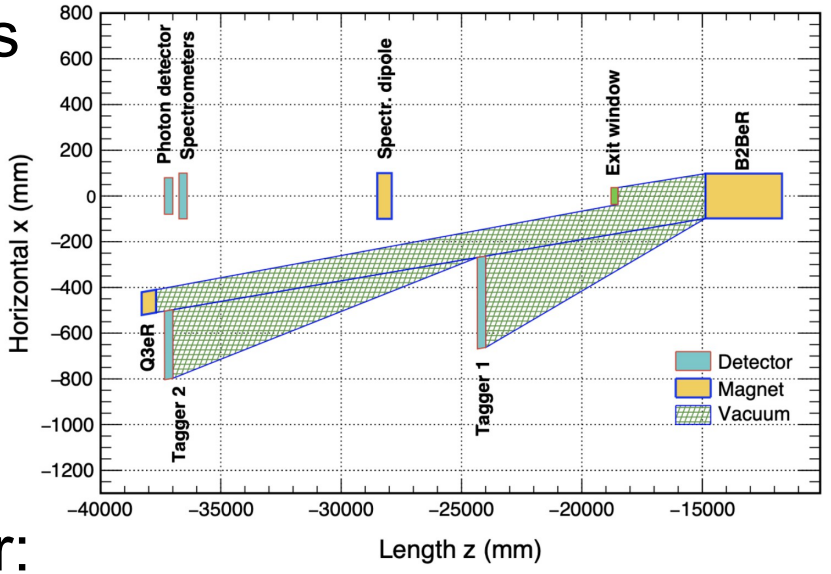


- Some 1st thoughts based on constraints:
  - component locations in tunnel (Z = …)
  - photon (electron) beam divergences
- Based on some parameters (e.g. CDR), some may be out of date, need updates
- Intended to start discussion, evolve with input / suggestions / updates
- Only overall detector sizes considered here, e.g. segmentation needs more discussion: rates, technologies, ...

Beam divergence → det. size

- Electron beam divergence:
  max. from CDR tables 211 μrad (for high div. 275×10)
- Dominates photon angular spread
  small contribution from Brems. process
- Lumi detectors sit @ Z = ~37 m
  spread σ~0.8 cm
- Pick a number: want up to ±5(10)σ of
  angular divergence
- Then need 8(16) cm transverse size for:
  - photon calorimeter horizontal & vertical
  - spectrometer calorimeter horizontal (non-bend);
    vertical (bend) plane other considerations, later
- Further define w/ collimator (next slide)

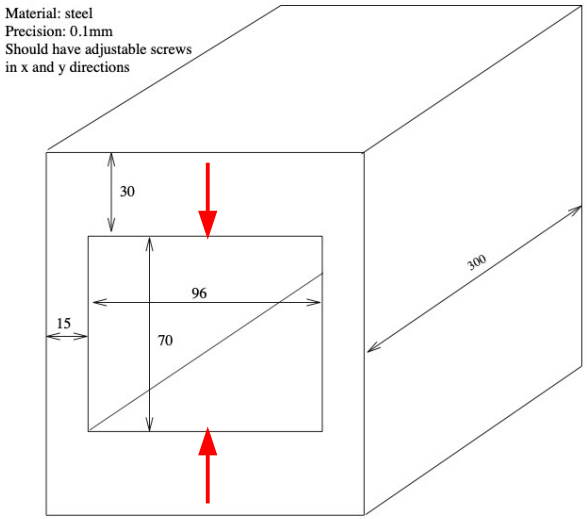


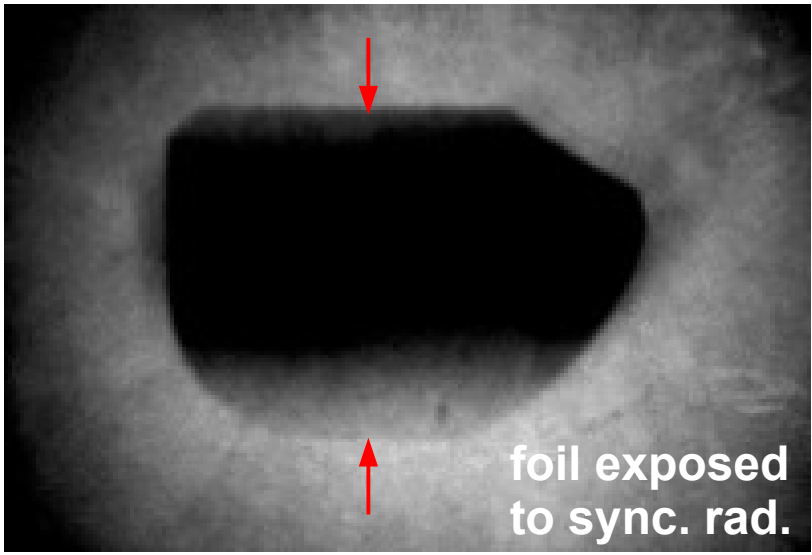
Need to check:

- Contribution of Brems. process to divergence (Jarda's GETaLM)
- This is around some design 0° of e beam; how much will
  this vary for beam tuning, optimization etc.?

Collimator: aperture definition

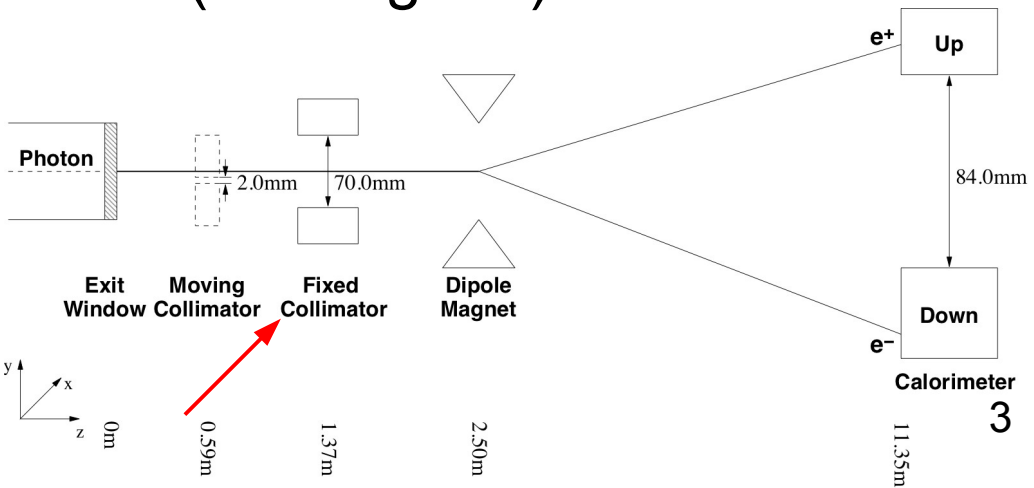
- It would be good to define photon aperture with collimator
  e.g. ZEUS @ HERA:





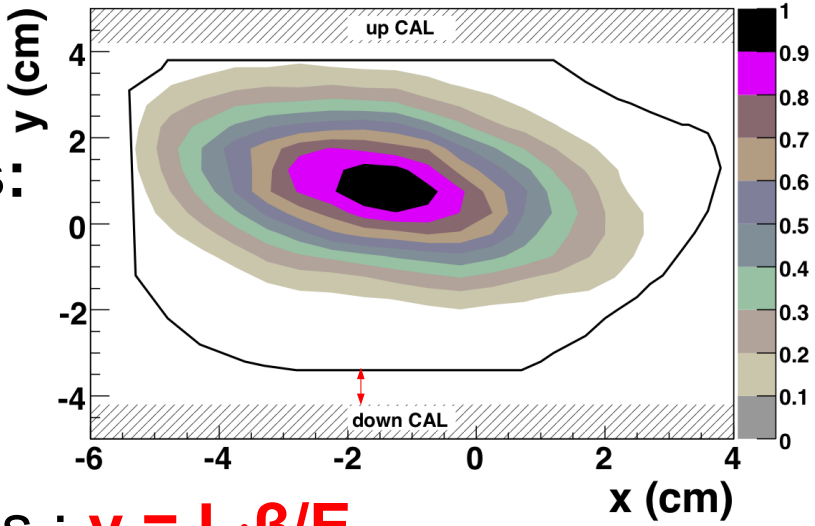
- Collimator defined top/bottom of aperture
  HERA elements → irregular sides; complicated acceptance correction
- Simpler @ EIC? Need to check.
  Good to define more regular aperture (rectangular)

- Location: before spec. dipole
  (or immediately after)
  gap size scaled with Z
- Make detector sizes consistent
  w/ aperture (slightly larger)

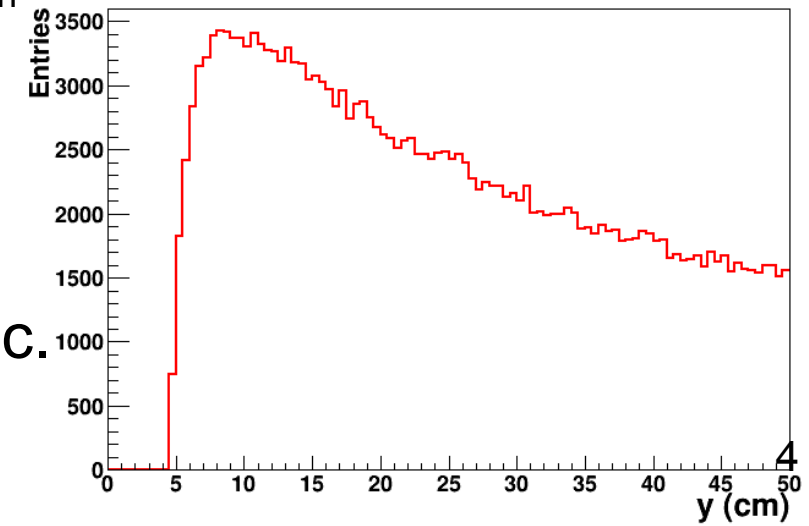


Spec. calorim. vertical location

- **No direct (unconverted) brems. photons should hit the spectrometer calorimeters:** stay outside defined vert. aperture,
  e.g. ZEUS:



- Converted *e* energy E, deflection @ calorims.: **$y = L \cdot \beta / E$**
  where: L = dipole→cal. distance, e.g. L=9m in EIC diagrams
  $\beta = 0.3 \cdot \int B \cdot dL$, e.g. ZEUS B=0.5T, L=0.6m, β=90 MeV
- Maximum *e* energy is beam energy □ minimum y deflection
  for E_e=18 GeV, above e.g. params., y_{min} = 4.5 cm
- Vertical position endpoint:

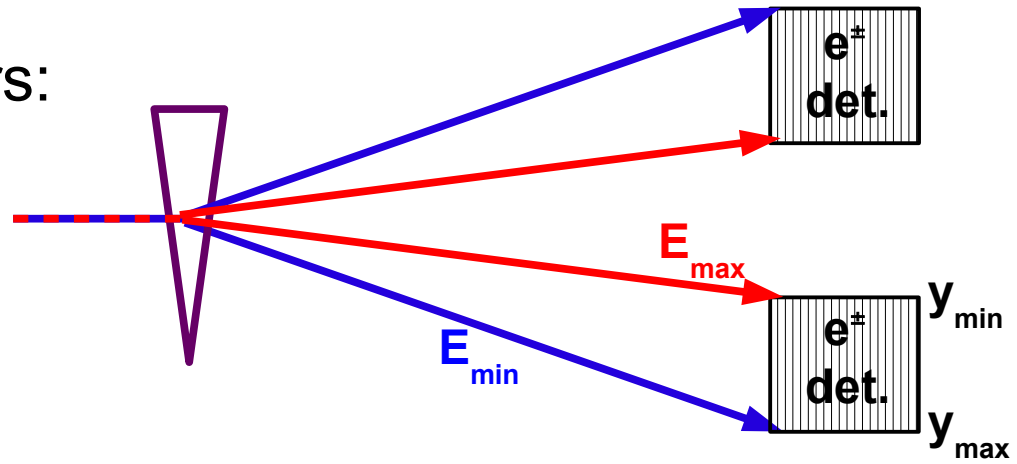


- Sharp edge is powerful calibration tool, sensitive to many params.
- Would be good to access this inside spec. calorimeters & trackers acceptance (maybe special runs high B, etc.)

Spec. det. vertical sizes

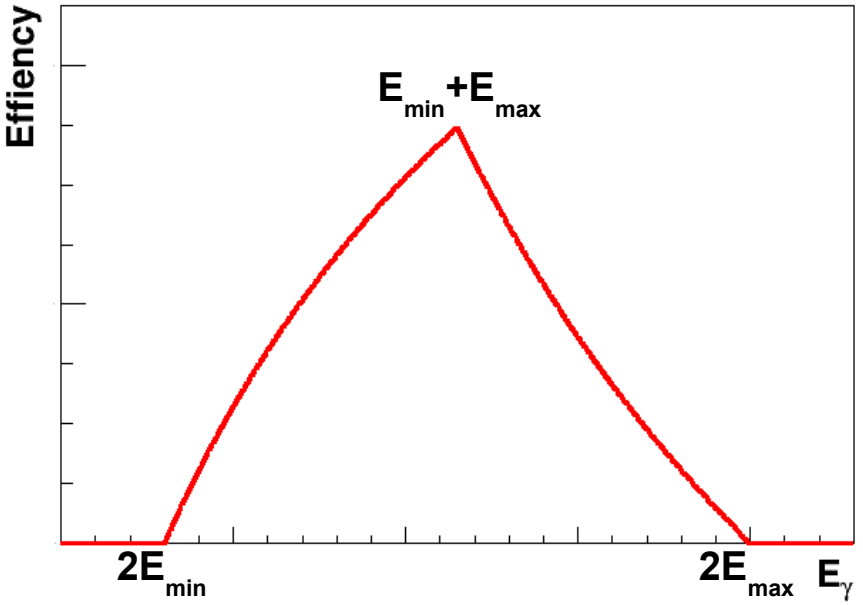
- Min. / max. vertical range of detectors:
  y_{min} / y_{max}

- Determine max. / min. $e^{\pm}$ energies:
  $E_{max} = L \cdot \beta / y_{min}$ $E_{min} = L \cdot \beta / y_{max}$



- This defines range of photon energies E_{γ} which can make up/down detector coincidences:

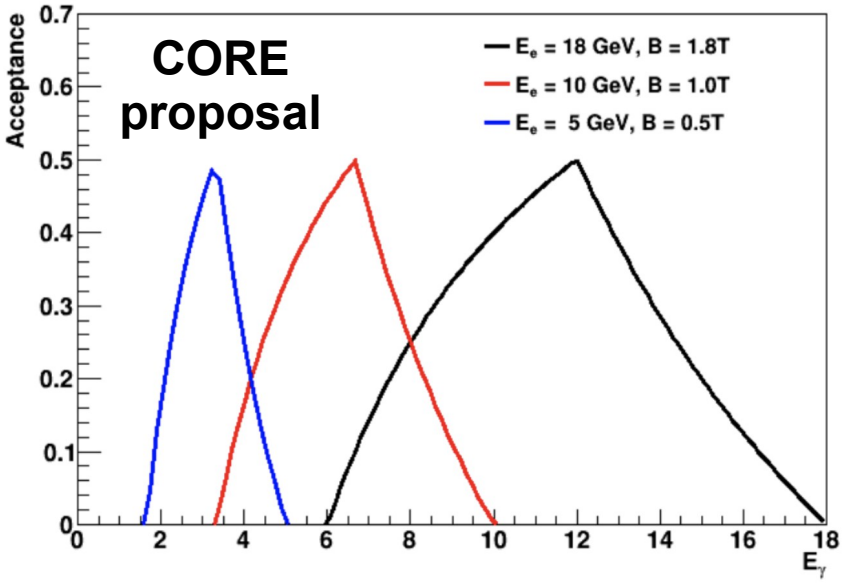
  (shown for symmetric up/down det.)



Spec. det. vertical sizes

- The E_γ coincidence range scales with dipole strength B:

- But the ratio of endpoints is fixed:
  $E_{max}/E_{min} = y_{max}/y_{min}$



  - To maximize flexibility, maximize E_{max}/E_{min} range
    maximize y_{max}/y_{min} range
  - E_{max}, y_{min} fixed by constraints discussed slide 4
  - Minimize $E_{min} \Rightarrow$ maximize y_{max}
  - Build detectors with max. vertical span practical (extreme: to the tunnel floor/ceiling)
  - A given analysis may prefer smaller E_{max}/E_{min} range: you don't have to use the entire detector

Key points

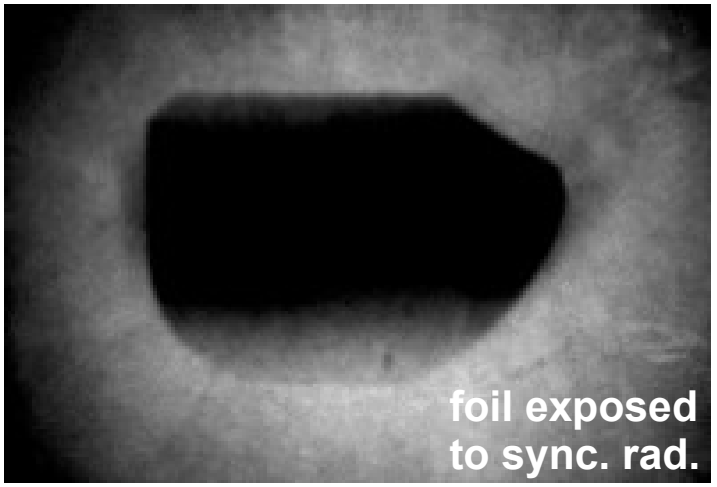
- LUMI detector transverse acceptance
  for Nσ photon beam divergence
  Need to check:
  - (e-beam divergence)$\oplus$(Brems. angular spread)
  - EIC e-beam steering variation
- Collimator to define photon aperture
- Spectrometer detector inner edge:
  - outside direct (unconverted) photon aperture
  - able to detect endpoint $e^{\pm}$
  both aided by maximizing dipole $\rightarrow$ detector distance
- Maximum practical spec. detector vertical size

Focused here on spec. calorimeters, similar considerations for spec. tracking (extra slide)

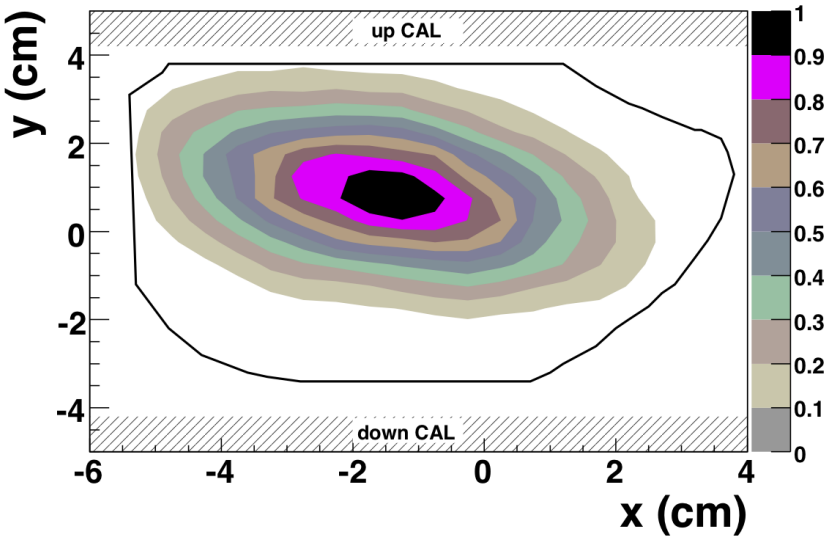
Extras

ZEUS aperture

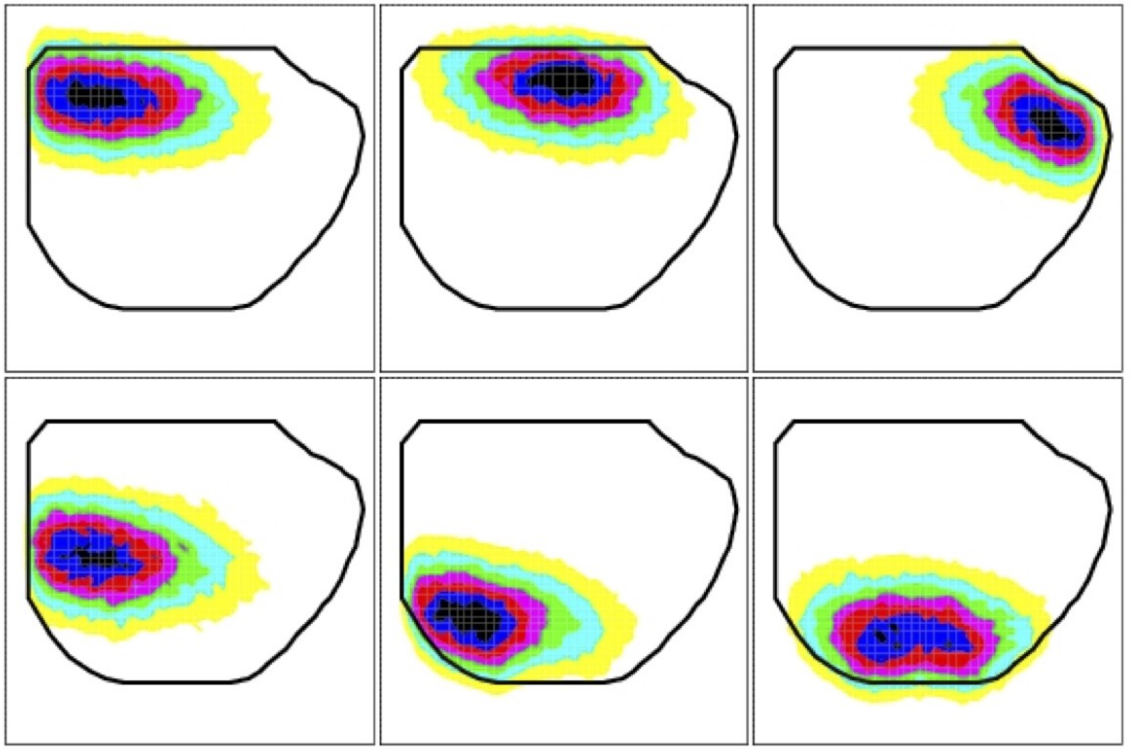
- Shadow outline measured:



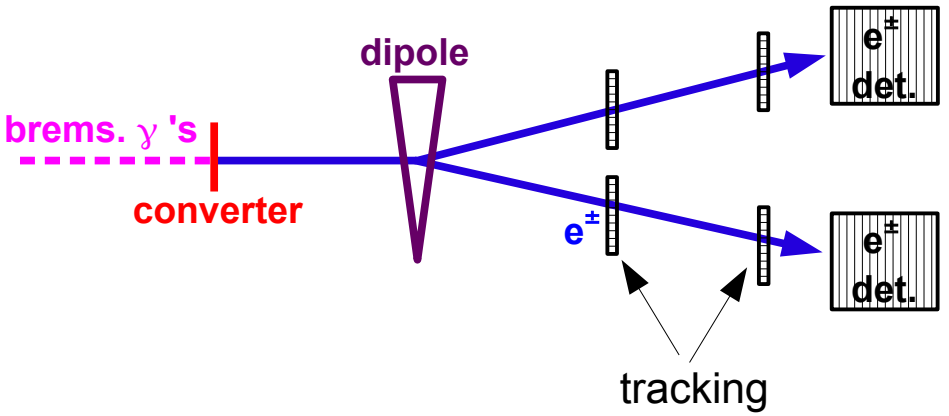
- Implemented in MC, compare data:



- Edges probed with extreme e-beam tilts:



Pair spectrometer tracking



- Transverse size considerations for tracking planes similar to calorimeters
- Transverse size limits scale ∝ Z(dipole→detector)