e-Beam divergence / LUMI aperture considerations

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Det1 Far-backward Mtg.
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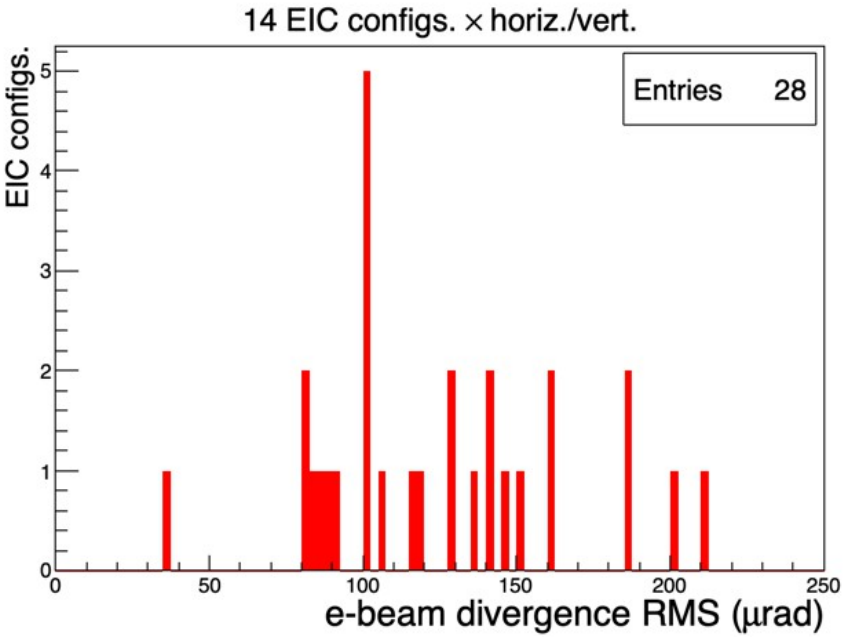
Some points here already discussed Far-Backward meeting 02.06.22*

- Electron beam angular divergence from CDR Tables 3.3-3.5:
  Need to measure divergence:
- Correct for photons lost outside aperture:
  - need adequate aperture to measure x,y distribution (some n×RMS)
  - adequate resolution to measure RMS
- Diagnostic for collider ops (emittance)

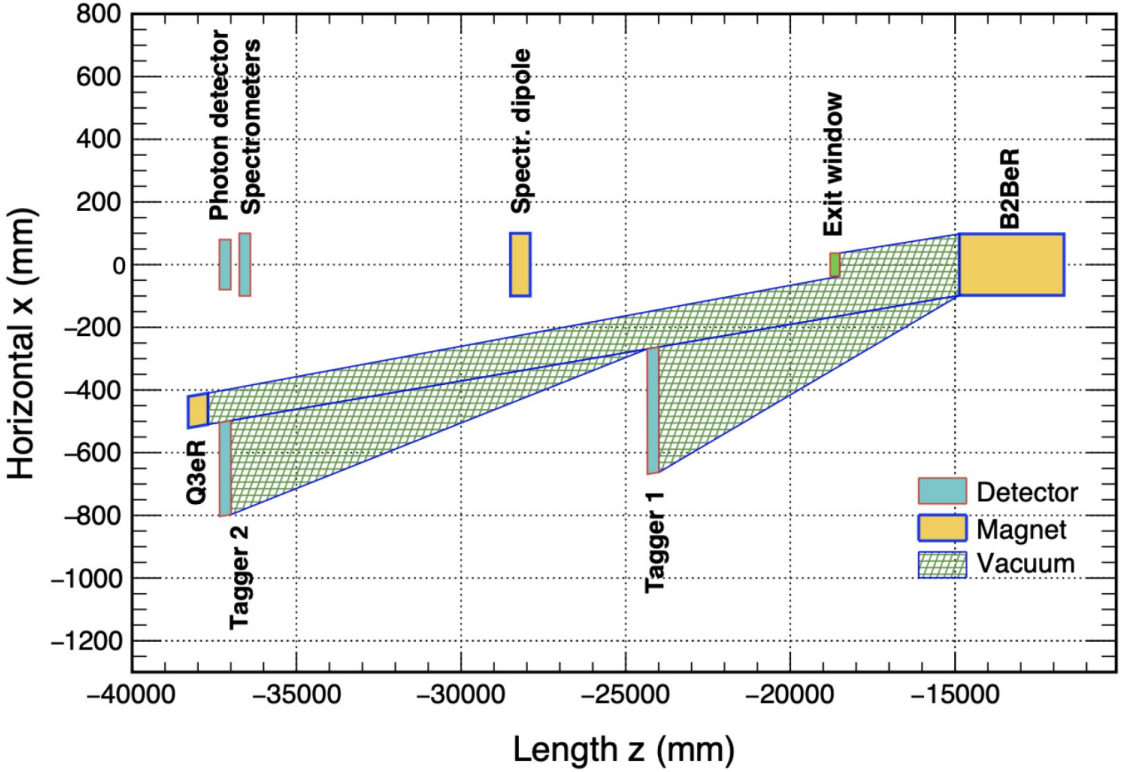


- Min. aperture driven by largest divergence: 275(p)×10(e) GeV
- Use for estimates: **RMS 211 μrad**
- Detector resolution driven by smallest divergence: 110(Au)×18(e) GeV
- Use for estimates: **RMS 37 μrad**

*https://indico.bnl.gov/event/15873/contributions/64537/attachments/41268/69137/Det1_FarBack_02.06.22.pdf

LUMI system layout

- Hope to develop/improve LUMI vacuum system soon*
- For now take baseline config. from CDR:

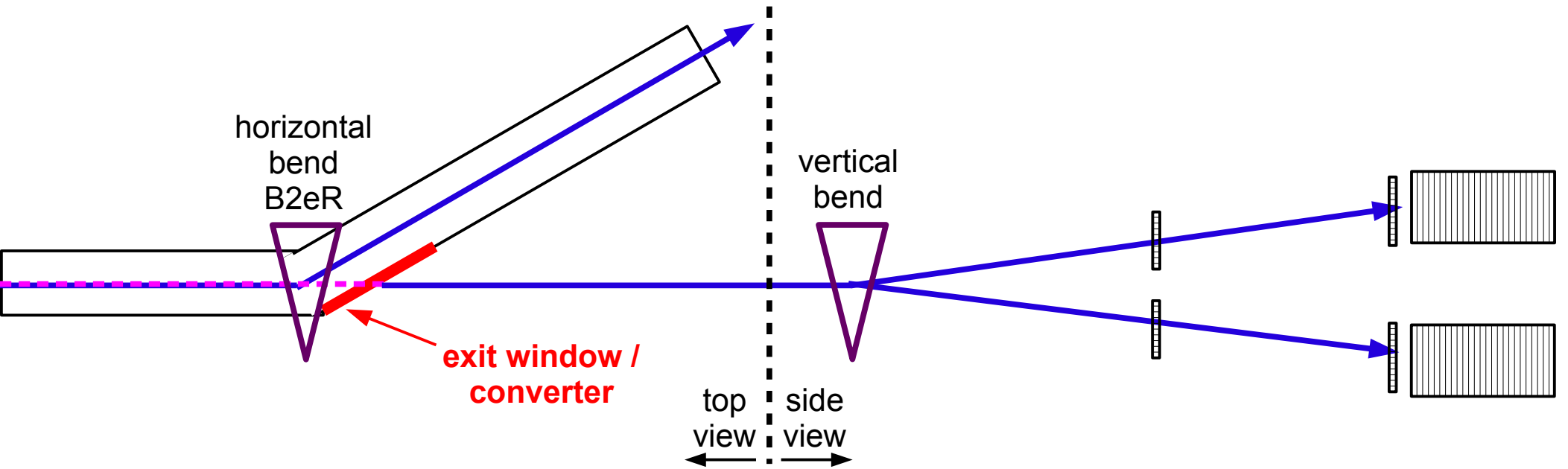


- Consider photon RMS spread at:

	exit window	spec. dipole	LUMI detectors
D	19 m	28 m	37 m
max. RMS	0.4 cm	0.6 cm	0.8 cm
min. RMS	0.07 cm	0.1 cm	0.14 cm

*Far-Backward meeting 28.04.22 slides 9-11:
https://indico.bnl.gov/event/15498/contributions/62844/attachments/40717/68031/Det1_FarBack_28.04.22.pdf

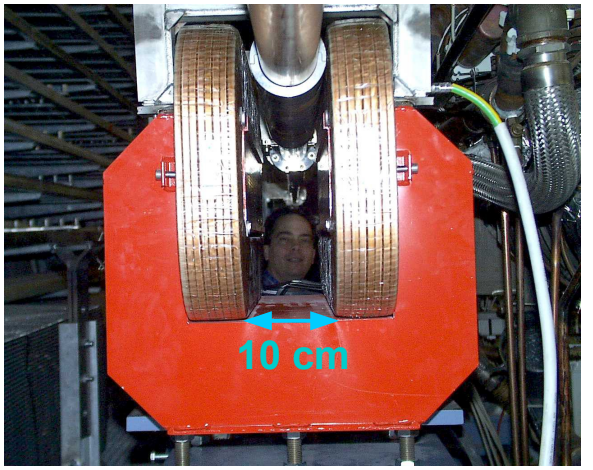
Exit window



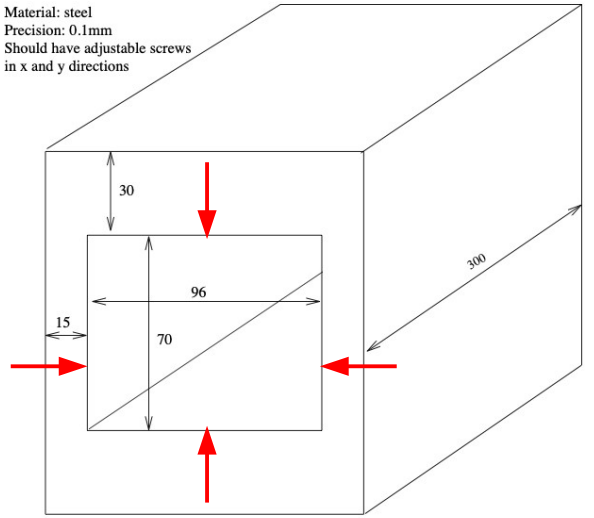
- @ 19 m: max. photon RMS size 4 mm
- If want ±10 σ acceptance:
  need window transverse sizes 8×8 cm
- Beam pipe tilt w.r.t. photon direction:
  much longer in horizontal directions
- Details in a YR Far-Forward/Backward W.G. presentation (Jarda)
  (links on EICUG web page seem to have been lost)
- Similar size requirements for alternative vacuum system designs

Spectrometer dipole

- @ 28 m: max. photon RMS size 6 mm
- Compare to dipole gap; ZEUS 10 cm:
- Take ZEUS dipole as baseline model
  nominal B 0.5 T × 0.6 m, Δp_T = 90 MeV



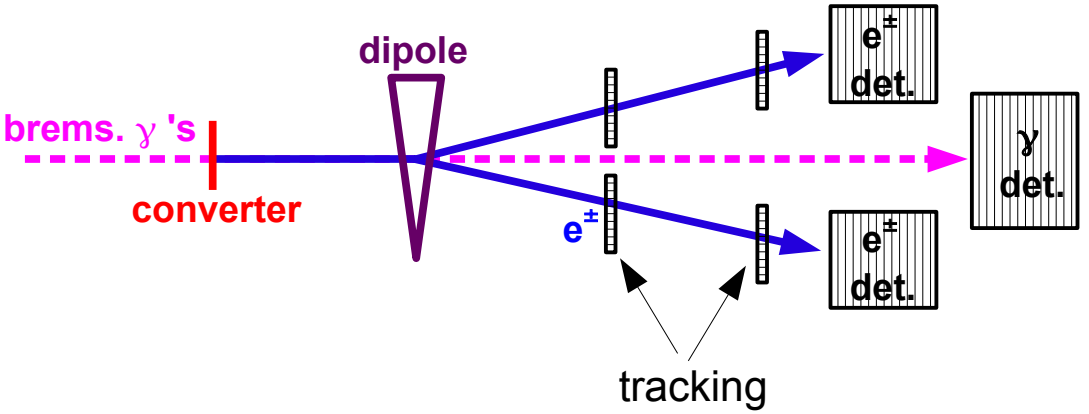
- ZEUS had collimator upstream of dipole:



- Horizontal gap 9.6 cm
  - shield dipole coils from direct photons
  - ±8 σ acceptance, adequate measure X-profile
- Vertical gap 7 cm
  - shield spec. detectors from direct photons
  - ±6 σ acceptance, adequate measure Y-profile
- Take as baseline model

- For min. e-divergence, photon RMS size 1 mm
- Aperture size 35-48 σ;
  negligible acceptance correction **if beam is centered**

LUMI detector sizes

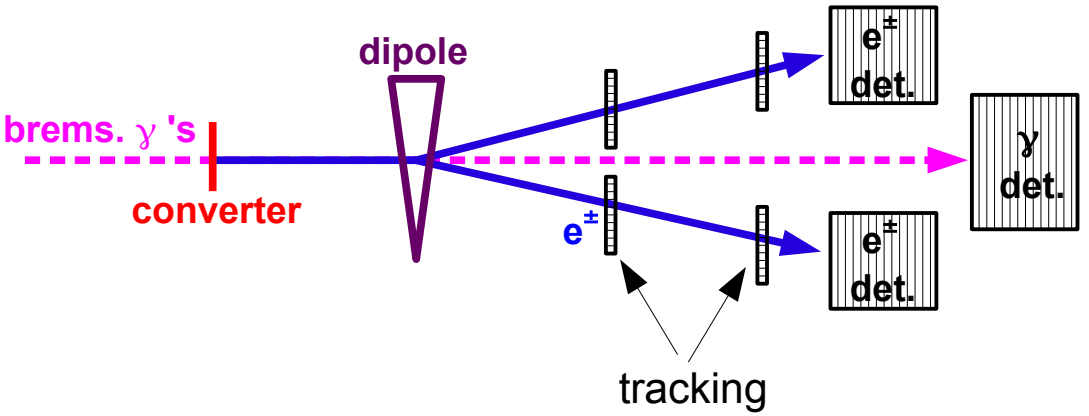


- Collimator aperture @ 28 m projects to detectors @ 37 m:
  12.7(h) × 9.3(v) cm
- Minimum active area γ-det.
- Minimum horizontal size $e^{\pm}$-det.
- Minimum vertical gap between $e^{\pm}$-det.
- Aperture at tracking detectors scales with Z
  from dipole: 9.6(h) × 7(v) cm
  to calorims.: 12.7(h) × 9.3(v) cm

- Spec. detector vertical sizes, spacing discussed previously*:
  - max. vertical span practical, extreme: to the tunnel floor/ceiling
  - highest energy $e^{\pm}$ (18 GeV) land inside detector

*Far-Backward meeting 02.06.22 slides 4-6:
https://indico.bnl.gov/event/15873/contributions/64537/attachments/41268/69137/Det1_FarBack_02.06.22.pdf

LUMI detector resolutions



- e-beam RMS at calorimeters: min./max. 1.4/8 mm
- RMS at tracking detectors scales with Z
  from dipole: min./max. 1/6 mm
  to calorims.: min./max. 1.4/8 mm

Measuring smallest e-beam divergence challenging: 1-1.4 mm

- Not so important for acceptance correction
  (small beam RMS in large aperture, 10's of σ)
- But is important diagnostic for collider operation
  (e-beam emittance)

Summary

- Here just took some baseline ideas for layout
- Estimated rough numbers for detector parameters
- Will evolve as design matures...

- Yulia has already implemented model of ZEUS dipole: