Extended Far-Backward region in DD4hep

- Beamline magnets and beam pipes added in DD4hep out to Z = -75 m.

- Will aid in placement-optimization studies of luminosity detectors in DD4hep.

- Locations and dimensions of magnets were extracted from an engineers drawing (obtained by Bill Schmidke and Elke). The extracted parameters are only accurate to ~1 cm and can be made more precise later with more detailed drawings.

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Dec 1st 2022

View of Far-Bwd Region

Several items need to be placed:

1) Sweeper magnet
2) Thin converter
3) Pair spectrometer magnet
4) Tracking planes
5) Pair spectrometer

Distance between red lines is 1 m.

Not enough room in this Z range!

Z= -45 m

Z= -18 m
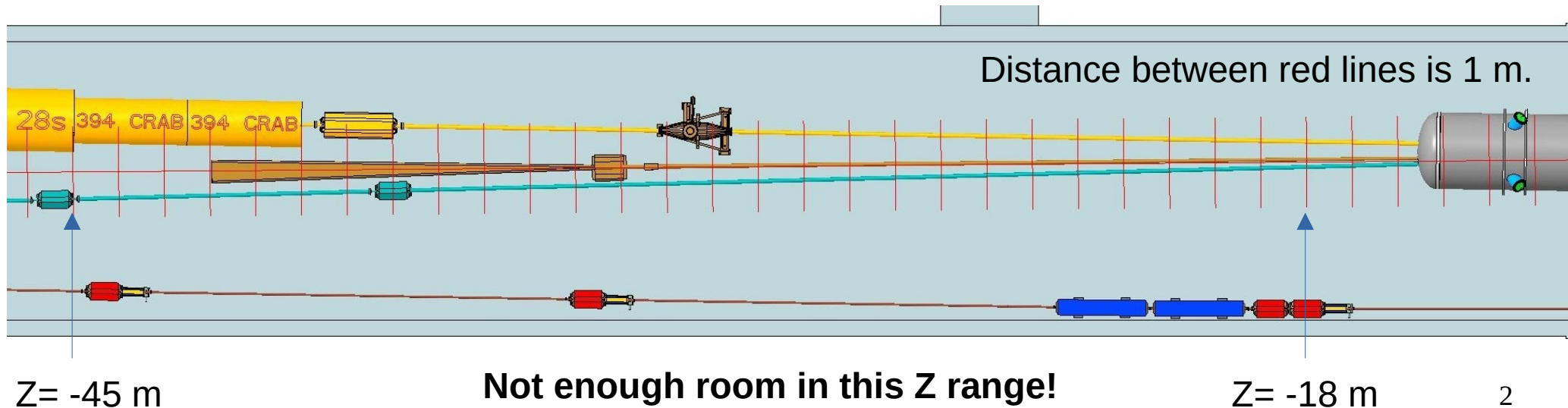
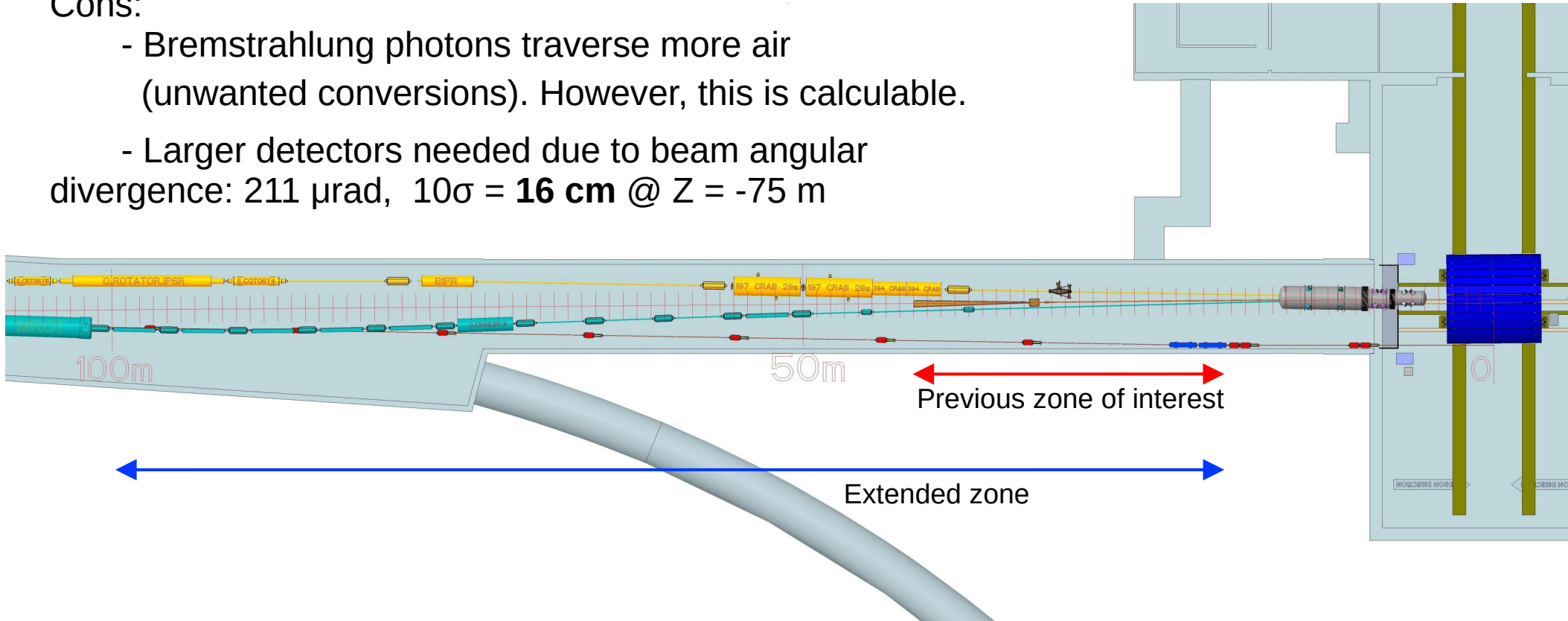# Extended View of Far-Bwd Region

Pros of placing detectors farther backward:
- More space to place our magnets & detectors

Cons:
- Bremstrahlung photons traverse more air
  (unwanted conversions). However, this is calculable.

- Larger detectors needed due to beam angular divergence: 211 µrad, 10σ = **16 cm** @ Z = -75 m

Previous zone of interest

Extended zone

Region near Crab cavities
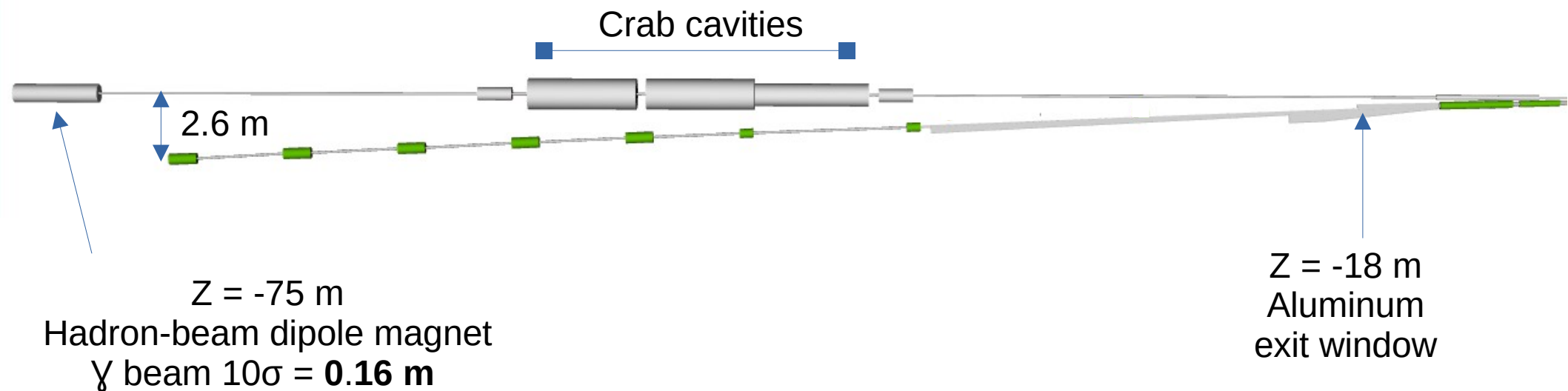
First question: Where in Z can the sweeper magnet be given the choice of |**B**|?
Given the width of ZEUS spectrometer magnet (~50cm, see last slide)
|Z| > 25 m (However a μ metal might be needed to shield the e- pipe)

Second question: Where in Z can the spectrometer magnet be given the choice of |**B**|?
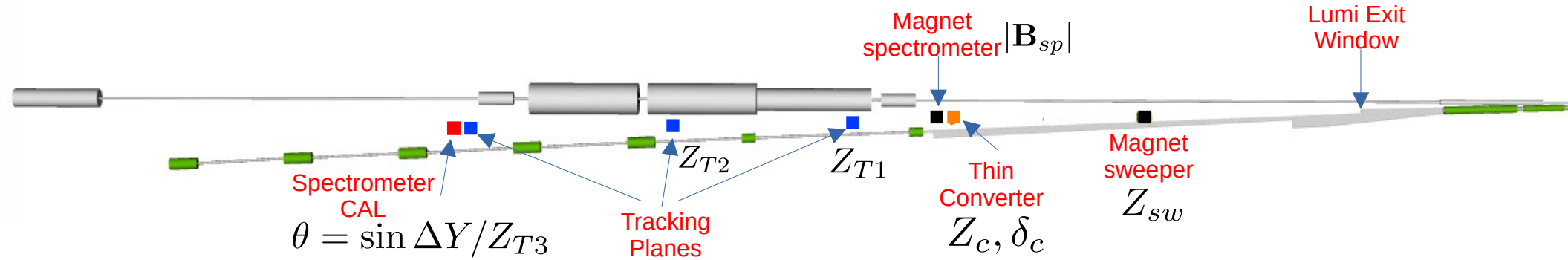Can it be near the CRABs/Quads/Dipoles?
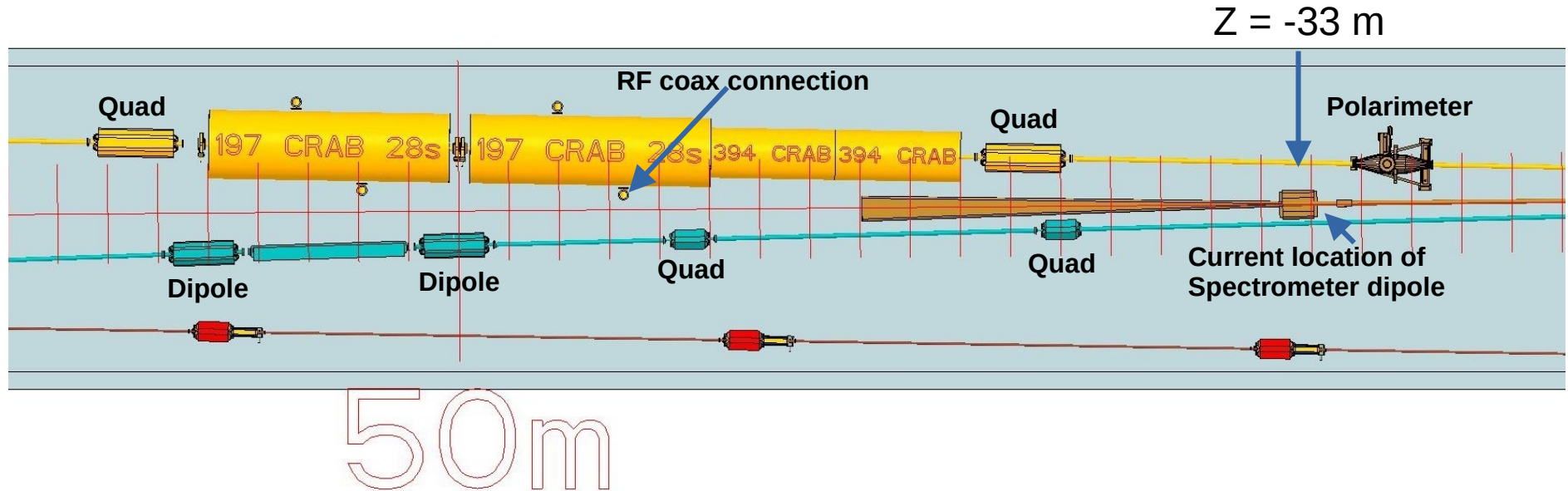
New DD4hep implementation

Beam magnets and pipes in Far-bwd region in DD4hep has been extended to Z=-75 m (Pull Request submitted).

Crab cavities

2.6 m

Z = -75 m
Hadron-beam dipole magnet
Ɏ beam 10σ = **0.16 m**

Z = -18 m
Aluminum
exit window

Spectrometer Placement Parameters

Possible approach to determine placement parameters

1) Magnet sweeper:
   - B field should be as large as possible to "sweep" unwanted electrons away quickly. Place as close to the Lumi exit window as possible accounting for the effect of stray fields impacting the beams. This sets $\mathbf{B}_{sw}$ & Z_{sw}.
2) Thin converter:
   - Place converter after unwanted electrons have been swept far enough away. This sets Z_c.
   - Thickness, δc, to be determined from simulation studies (study desired conversion rate in ep & eA, and minimize multiple scattering).
3) Magnet spectrometer:
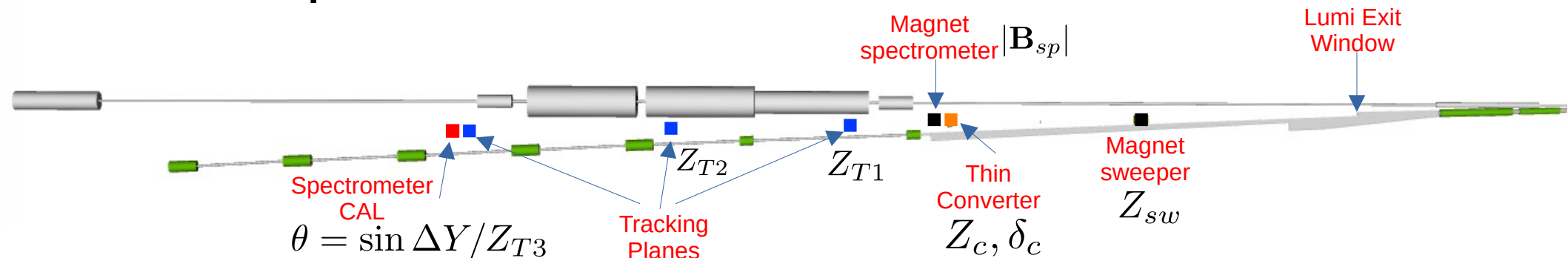   - $\mathbf{B}_{sp}$ determined by the chosen part of the Bremstrahlung energy spectrum to sample at the CAL.
   - This also sets θ.
   - Luminosity can be determined from any sampled E interval.
4) Tracking planes:
   - Z_{T1}, Z_{T2}, & Z_{T3} determined from simulation studies.
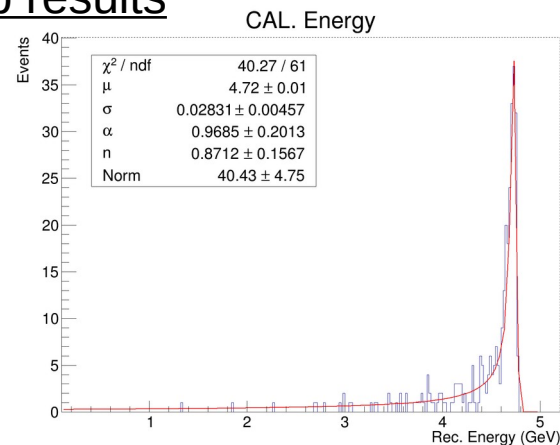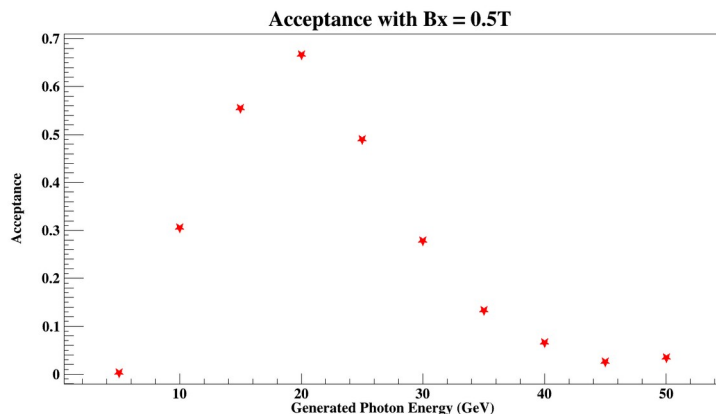5) Spectrometer CAL to be placed right behind Z_{T3}.

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Spectrometer Placement Parameters

Lumi Exit Window

Magnet spectrometer $|\mathbf{B}_{sp}|$

Spectrometer CAL

$\theta = \sin \Delta Y / Z_{T3}$

Tracking Planes

Z_{T2}

Z_{T1}

Thin Converter

Z_c, δ_c

Magnet sweeper

Z_{sw}

Metrics to use for optimization:

1) Acceptance in spectrometer CAL
2) Energy resolution obtained from CAL
3) Energy resolution obtained from Trackers

Recent DD4hep results

Acceptance with Bx = 0.5T

CAL. Energy

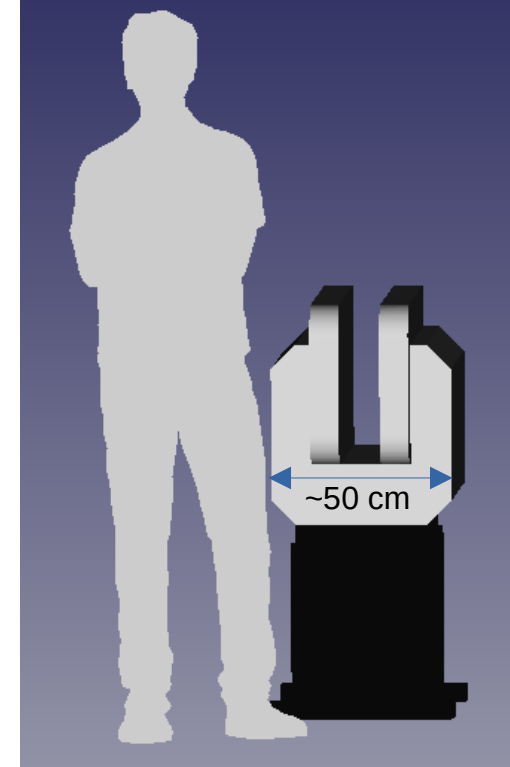|	
χ² / ndf	40.27 / 61
μ	4.72 ± 0.01
σ	0.02831 ± 0.00457
α	0.9685 ± 0.2013
n	0.8712 ± 0.1567
Norm	40.43 ± 4.75

Realistic dipole magnet for pair spectrometer

Current design in DD4hep.
Cylindrical, like the beam-line magnets.
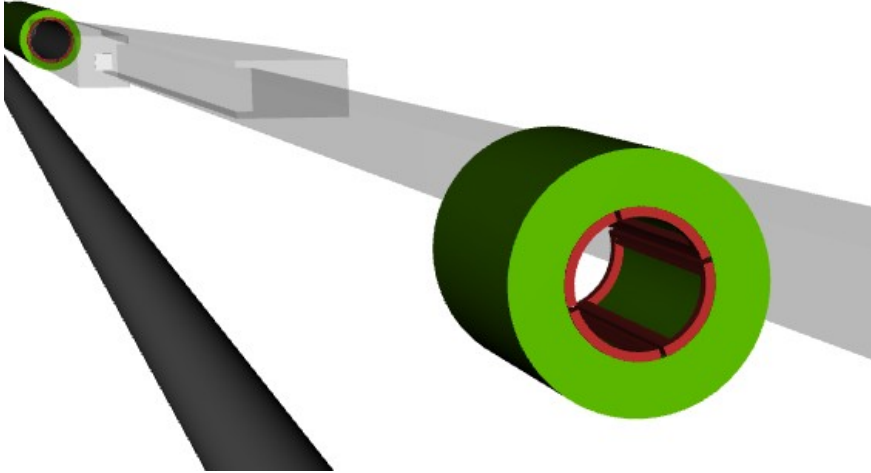
ZEUS design

CAD
drawing
obtained
from Yulia

~50 cm

ZEUS design soon to be implemented in DD4hep