

ePIC – Far Backward Overview

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ePIC Collaboration Meeting

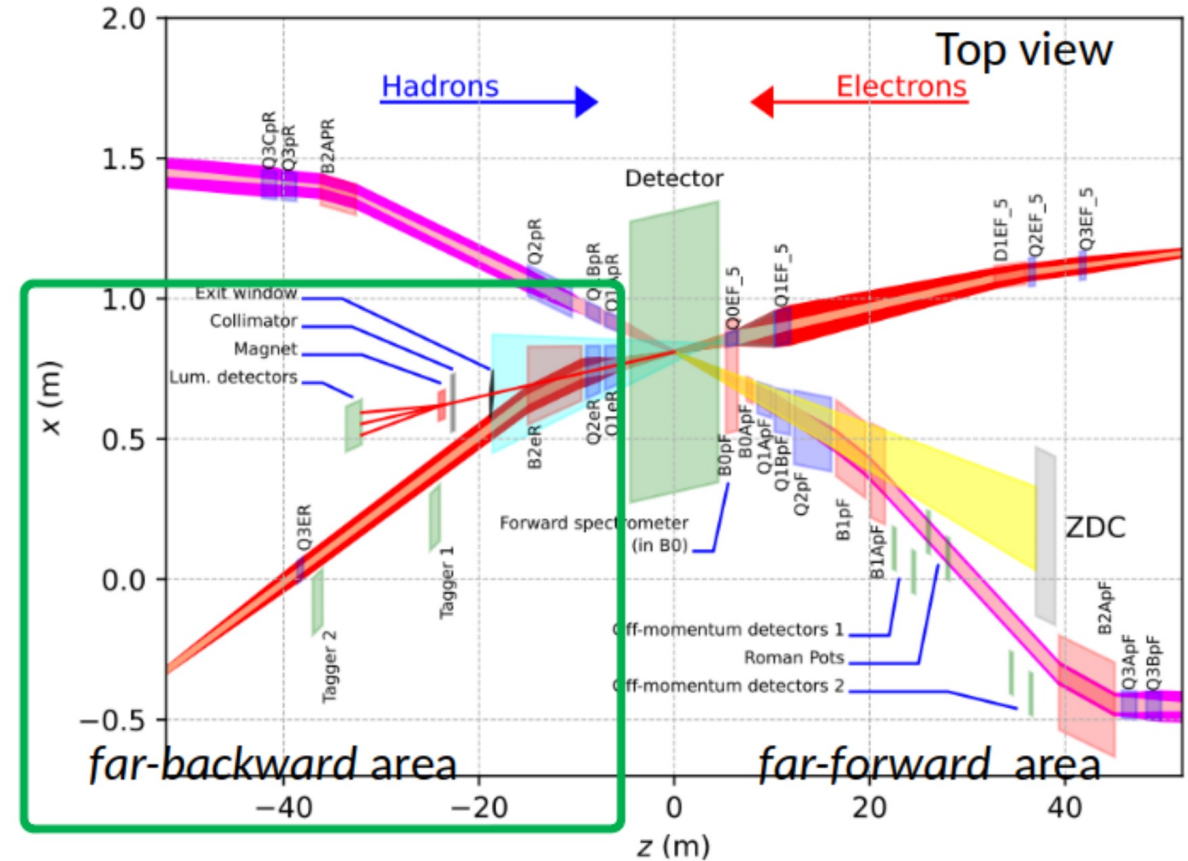
Far Backward WG:

Instrumentation along the outgoing electrons

Regular meetings* are on Thursday 10 am ET

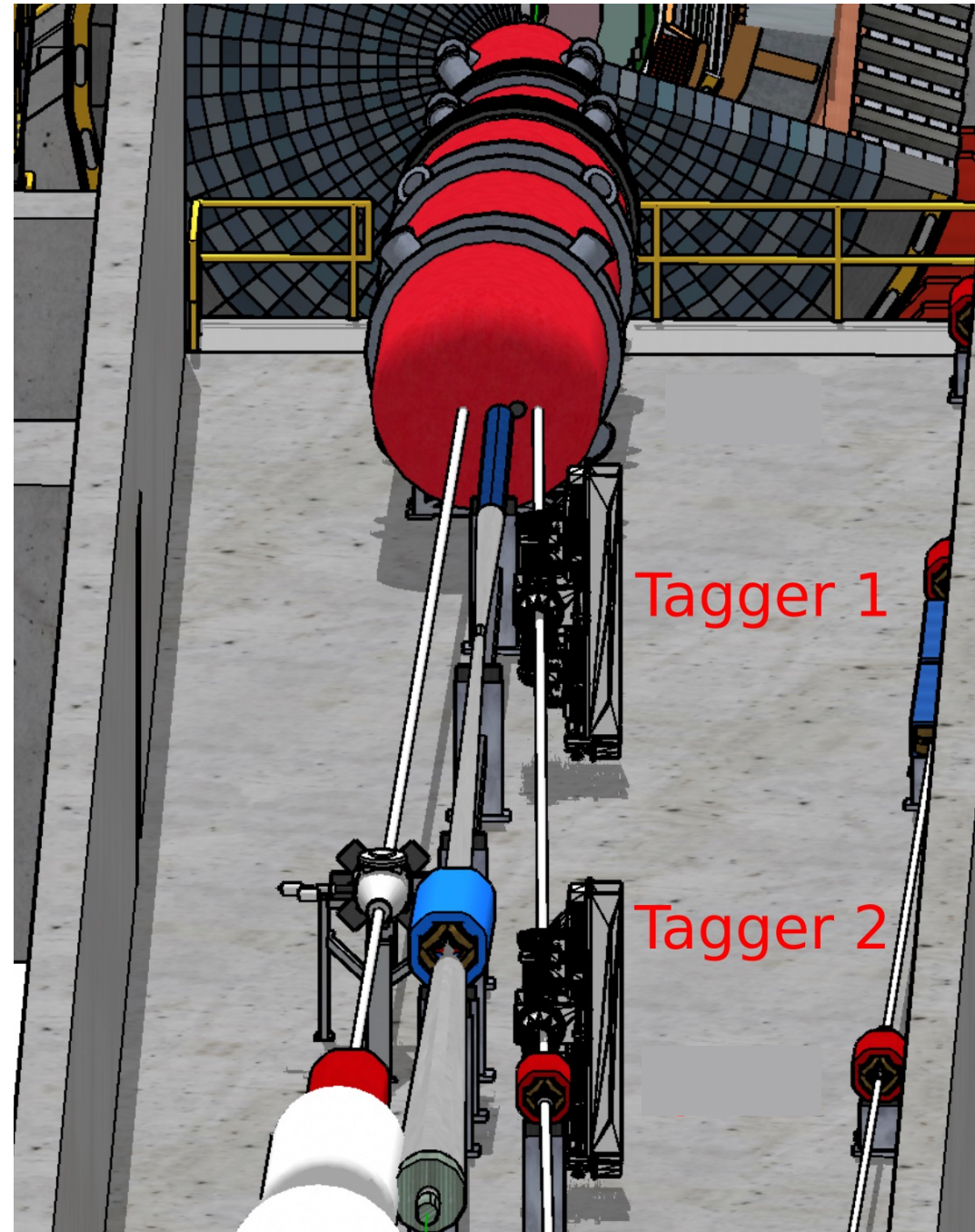
Our mailing list:

<https://lists.bnl.gov/mailman/listinfo/eic-projdet-farback-l>



Far Backward instrumentation

- Luminosity monitors
- Low Q^2 tagger

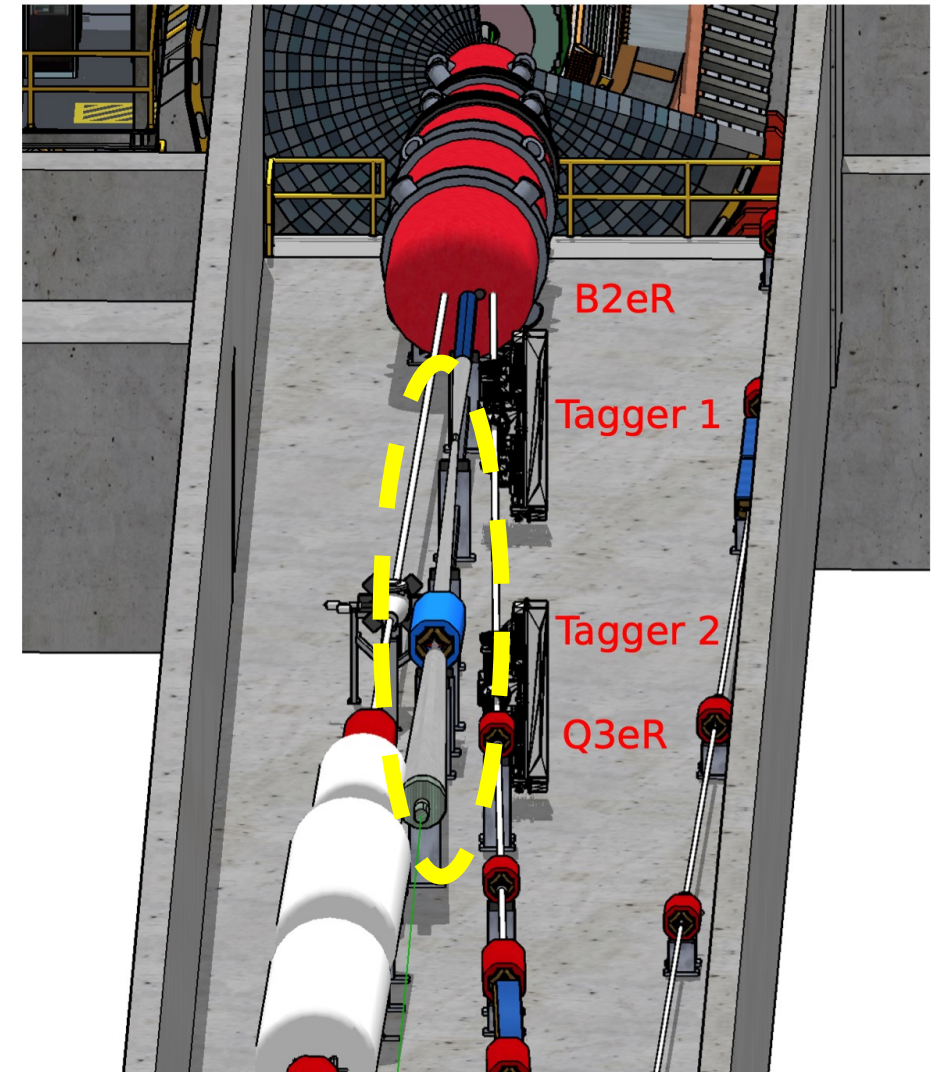


Luminosity Monitors

The luminosity measurement provides the required normalization for all physics studies.

- Absolute cross sections.
- Combine different running periods.
- Relative luminosity of the different bunch crossings.

Accuracy of the order of 1% is required
(or relative luminosity exceeding 10^{-4} precision)



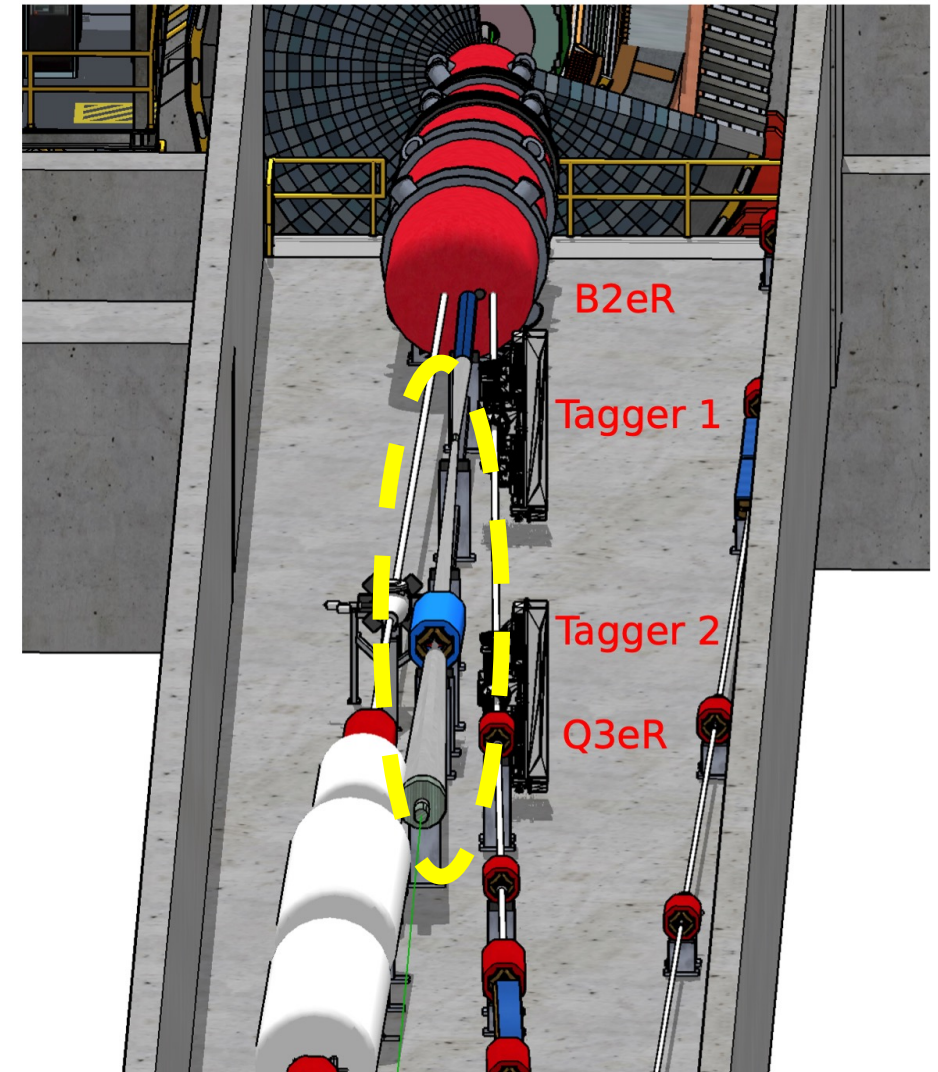
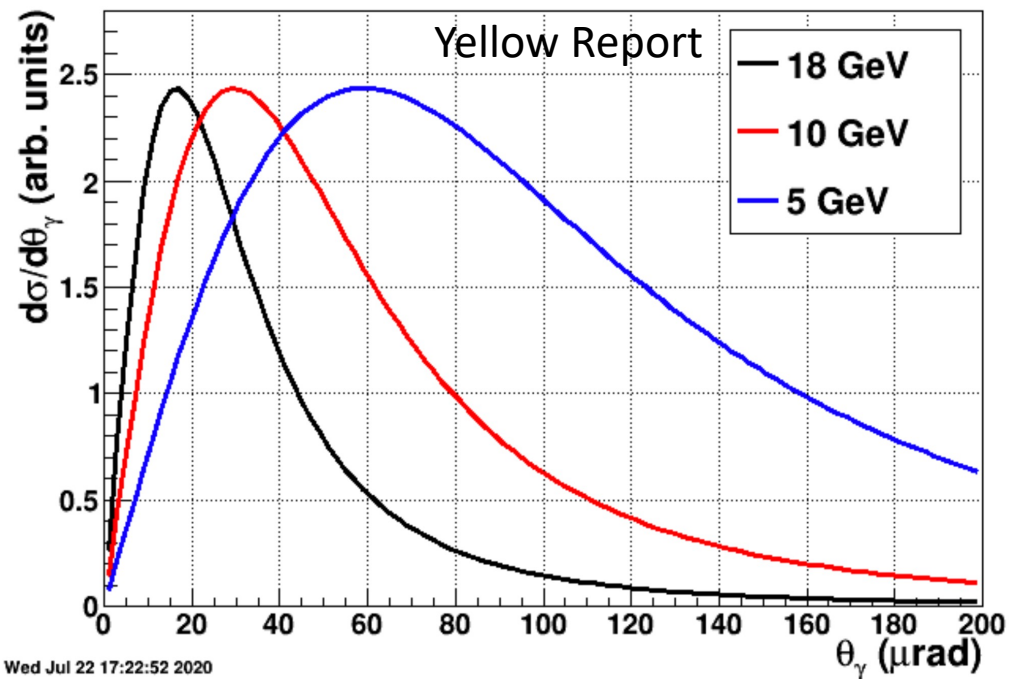
Luminosity Monitors

Bremsstrahlung:

$$ep \rightarrow e \gamma p$$

$$eAu \rightarrow e \gamma Au$$

- The cross section is precisely known from QED
- Large cross section peaked for photons at small angles



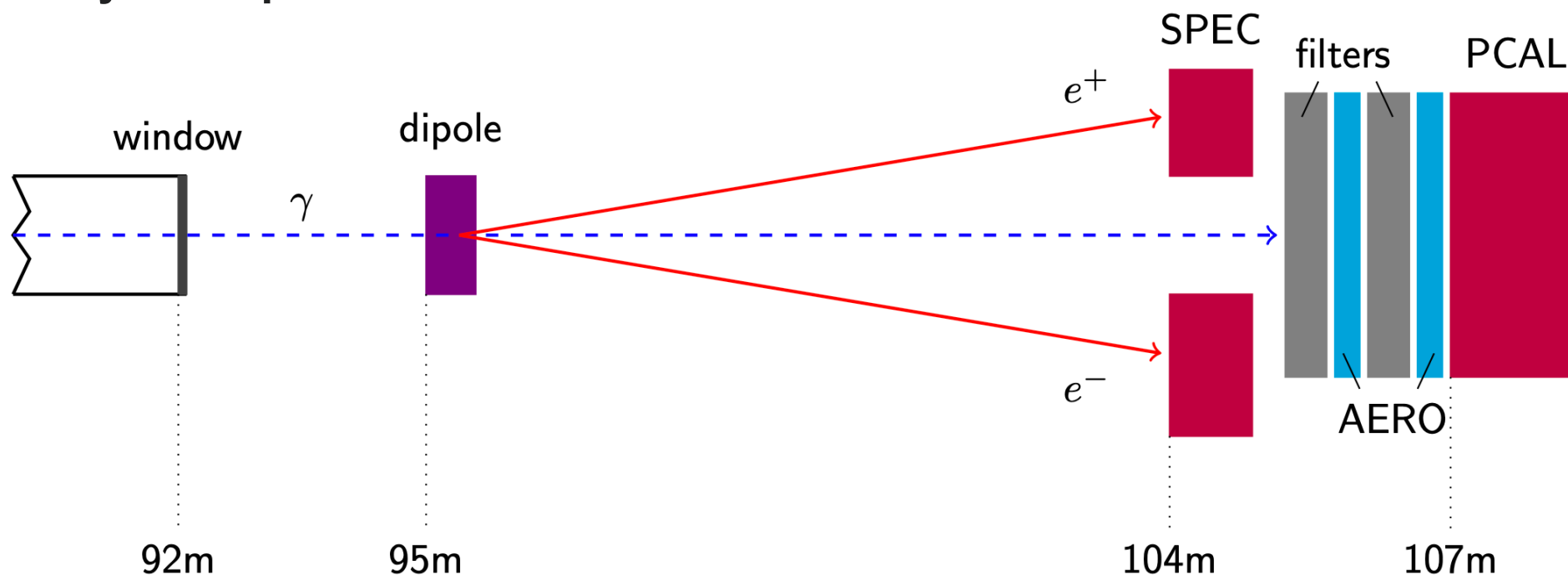
Luminosity monitors

Multiple subsystems:

❖ **Luminosity Direct Photon Detector**

HERA II [arXiv:1306.1391](https://arxiv.org/abs/1306.1391)

❖ **Luminosity Pair Spectrometer**



HERA II reached about 1.7% in systematic uncertainty

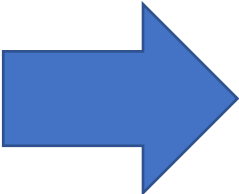
Luminosity monitors

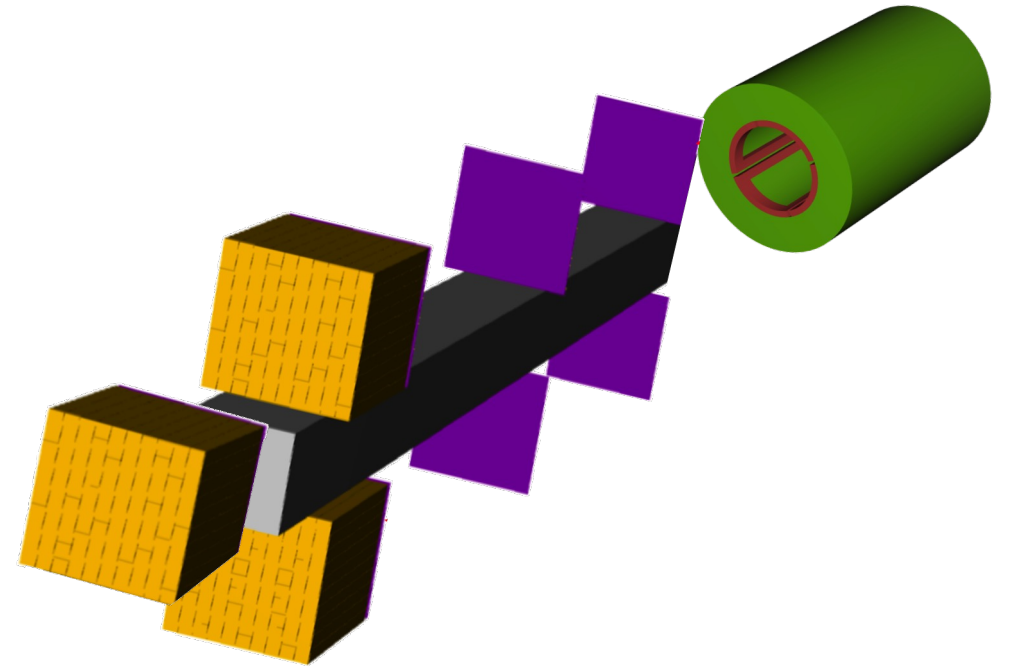
EIC expected luminosity of $10^{33} \text{ cm}^{-2} \text{ s}^{-1}$

Higher event rate and higher synchrotron radiation.

Proton polarization $\sigma_{brem} = \sigma_o(1 + aP_eP_p)$

(limited by the precision of the polarization measurement)

- 
- High energy resolution.
 - Segmentation of calorimeters.
 - Adding tracking layers for pair spectrometer.
 - Cross calibration with Low Q^2 taggers.
(Tagging bremsstrahlung electrons and counting corresponding photons in the photon detectors.)

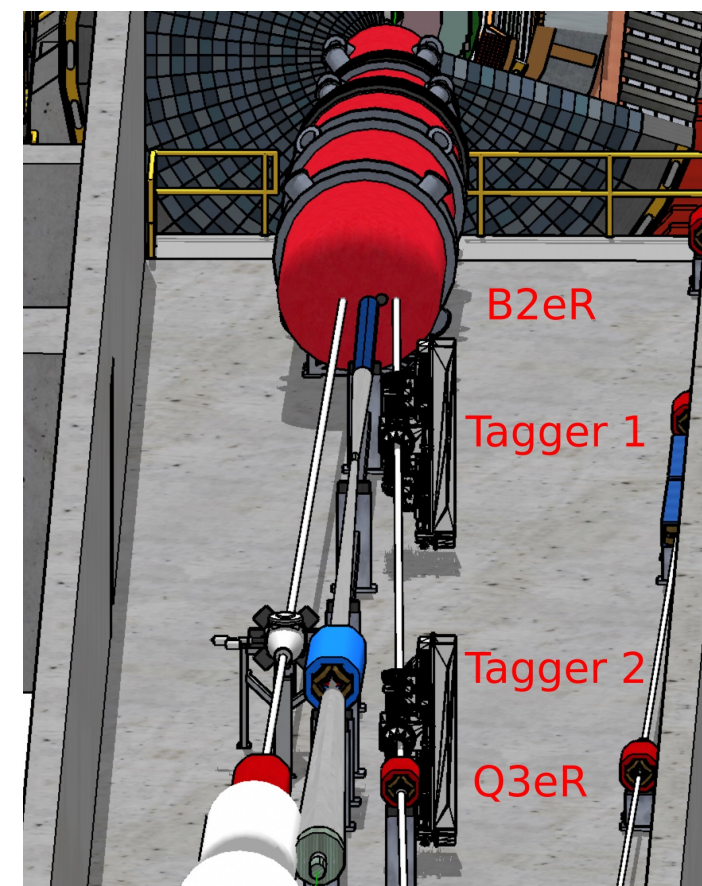
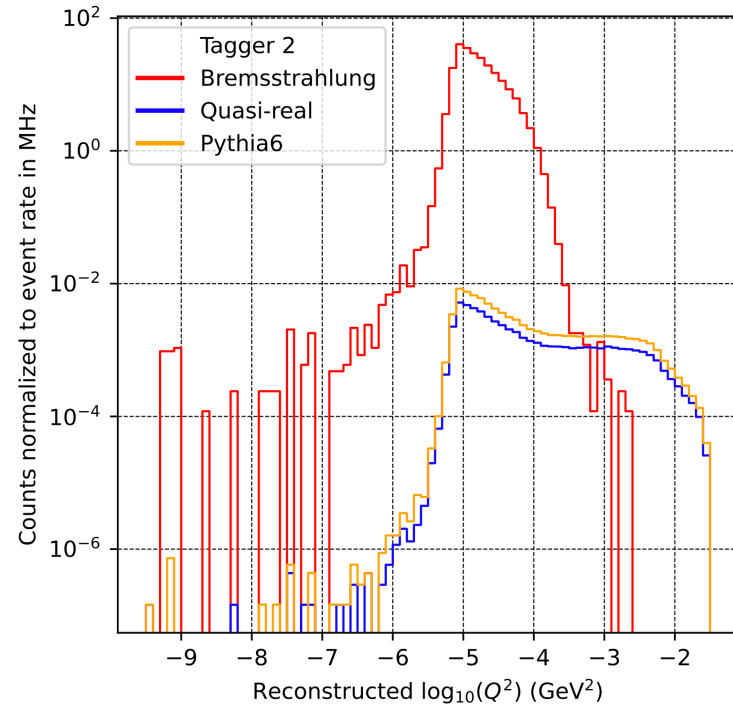
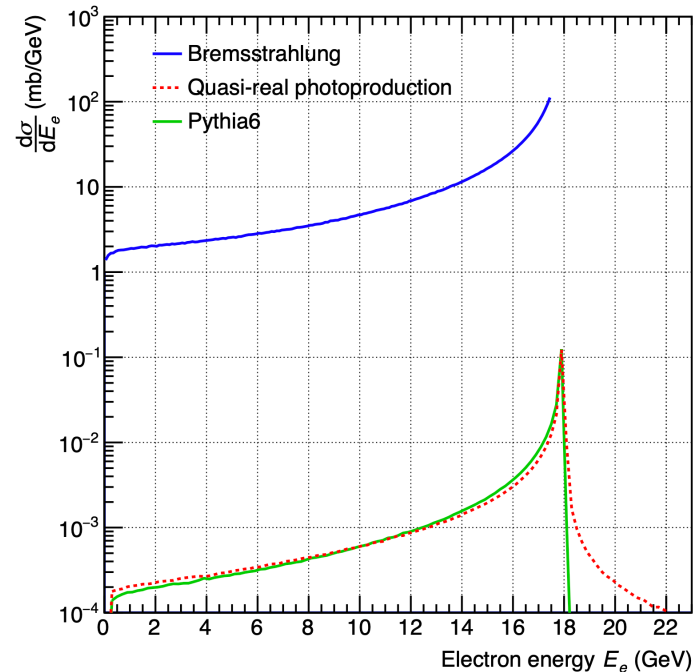


See talks by: Jae Nam for Direct photon detector.
Dhevan Gangadharan for pair spectrometers

Low Q^2 taggers

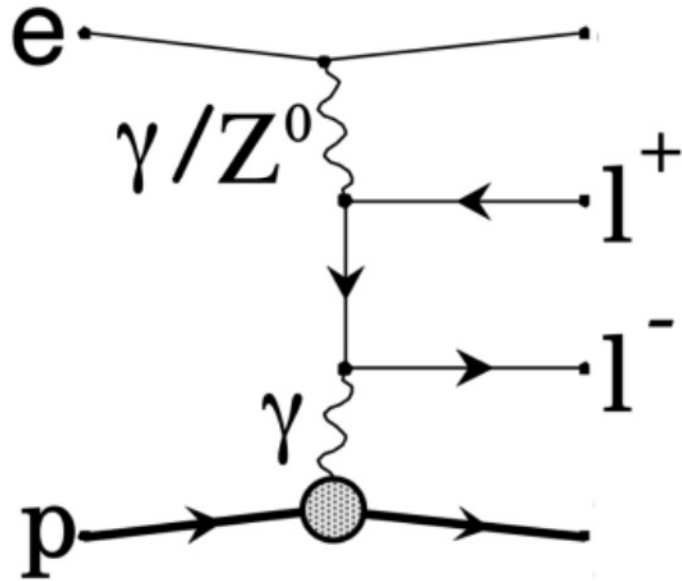
Two stations: Tagger 1 and 2 are placed along the outgoing electron beam

- Important for quasi real photoproduction.



Clean photoproduction signal can be taken over a limited region of $10^{-3} \lesssim Q^2 \lesssim 10^{-1} (\text{GeV}/c)^2$

Dilepton production



- Far-backward taggers detect scattered electrons, $\pi - \theta_e < 10$ mrad
- Scattered proton is detected in far-forward, $\theta_p < 6$ mrad
- All lepton pairs, e^\pm , μ^\pm and τ^\pm can reach central detector.

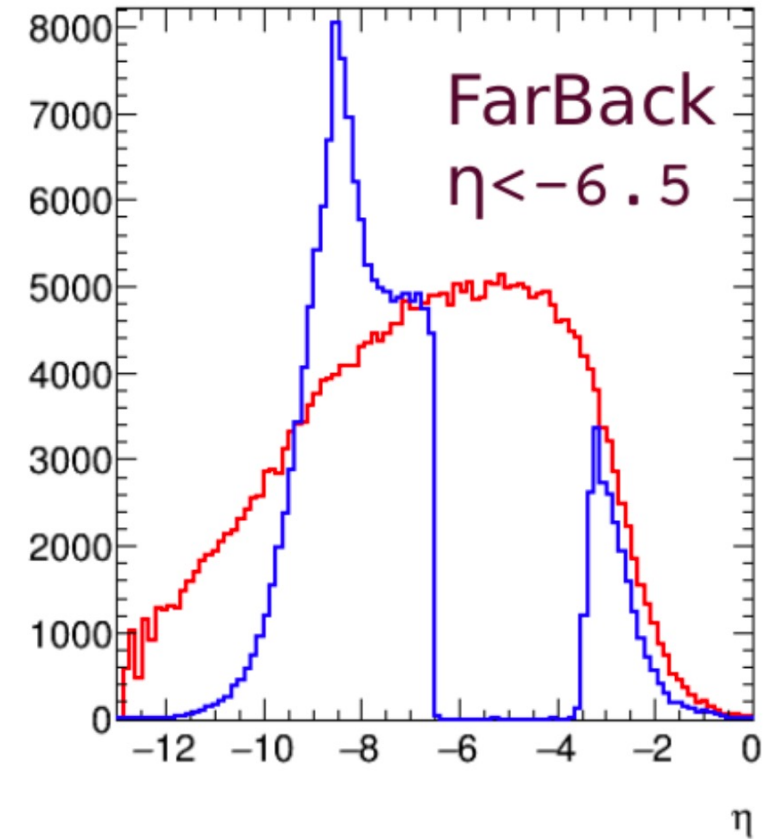
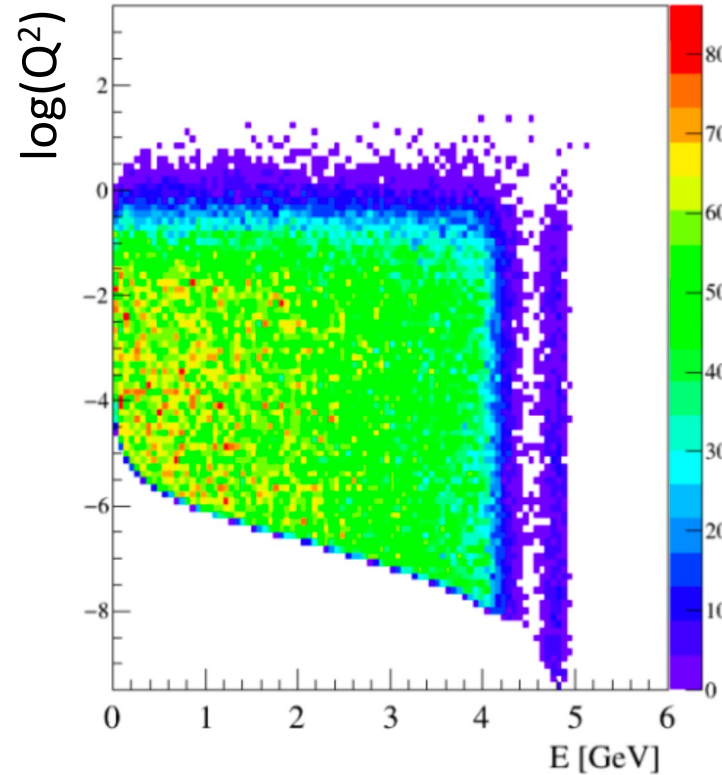
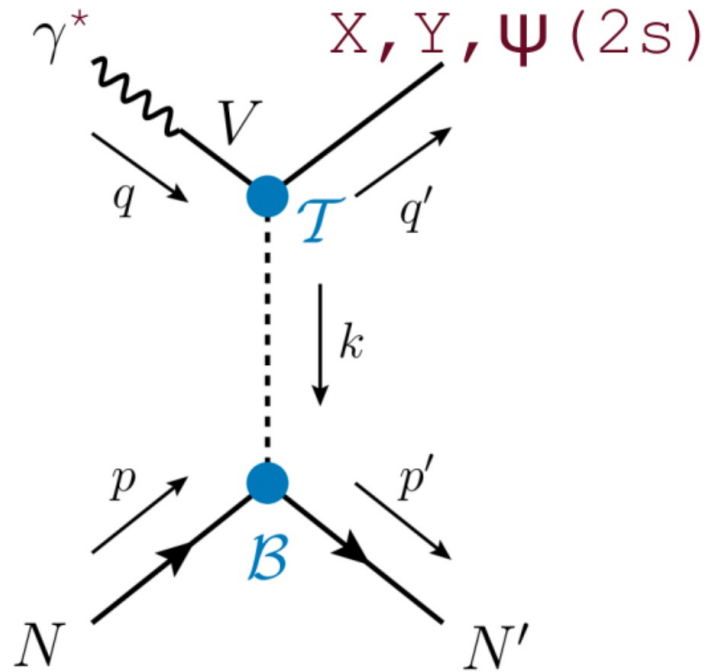
Can be a background for J/ψ or Υ production.

Measurement with μ^\pm pairs is sensitive to proton charge radius.

Opportunity for data-driven calibrations with two-photon exclusive process.

Process is implemented in GRAPE generator (arXiv:hep-ph/0012029)

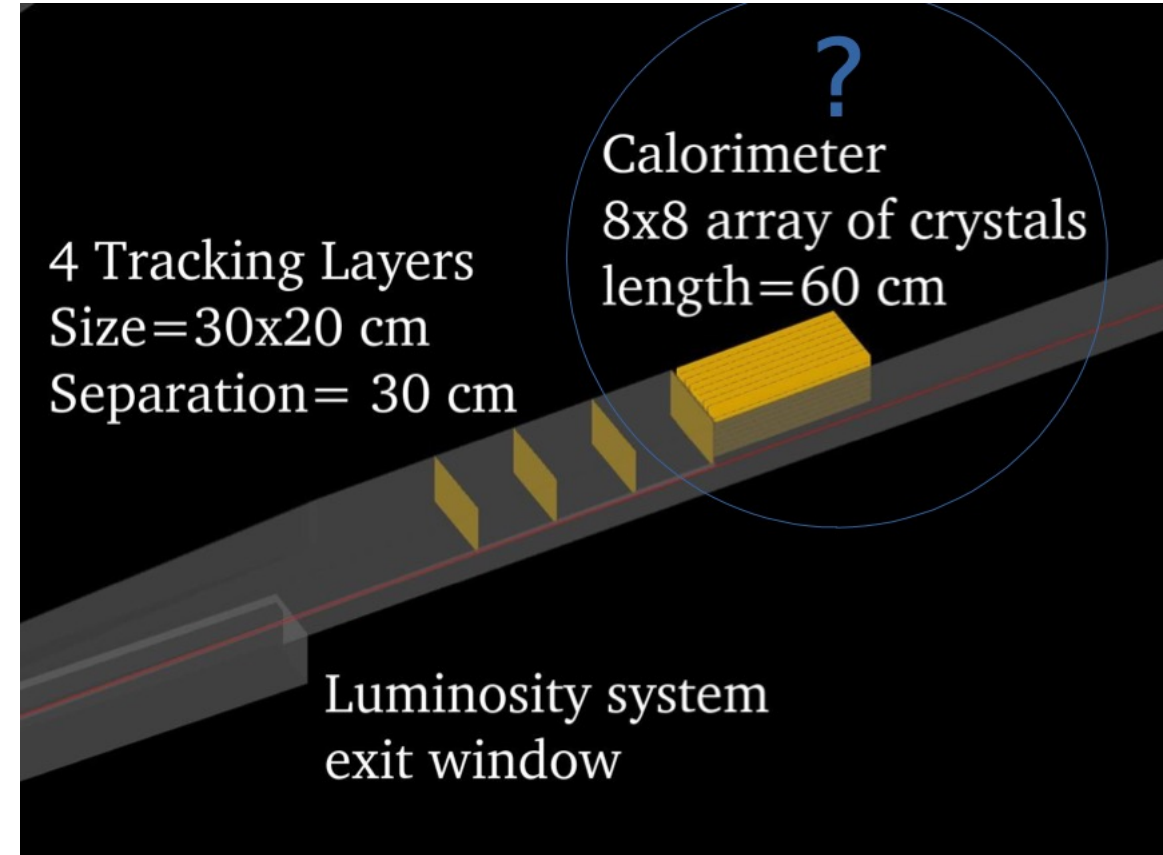
Meson spectroscopy



- Final states of $J/\psi + \pi^+\pi^- +$ scattered e and nucleons, events both at low Q^2 and low t .
- The integrated luminosities expected for the EIC, provide the opportunity to study rare exclusive processes not accessible at HERA.

Low Q^2 tagger – detector concept

- Each tagger will consist from tracking layers.
- Calorimeter under consideration.
- Ideally detector will be in primary vacuum.
- Reference design based on tracker outside vacuum.
- Different configurations/combinations considered.



Detailed studies presented by: Simon Gardner

Technologies for Far Backward detectors

- Good timing and short integration time is needed to identify each bunch crossing.
- Large data rates and volumes in DAQ, also should provide online machine performance.

Trackers

- Multiple particles from the same bunch crossing.
- Small pixel pitch for track separation MAPS or AC-LGAD for sensors.
- Suitable ASIC for timing capability (Timepix4).

Calorimeters

- Performance stability over the run
- Homogeneous bars of PbWO_4 Sampling W/ScFi, quartz fibers or W-Si.
- Readout by fast PMTs or SiPM.

Contribution from out of project funding

Luminosity Monitors ~ 1M\$

Low Q2 taggers ~ 1 M\$

UK: UKRI/STFC (Glasgow and York group).



Poland: MEiN (Ministry of Education and Science)



Ministerstwo
Edukacji i Nauki

Czech Republic: GACR (The Czech Science
Foundation).



Thank you