IP6 Compton

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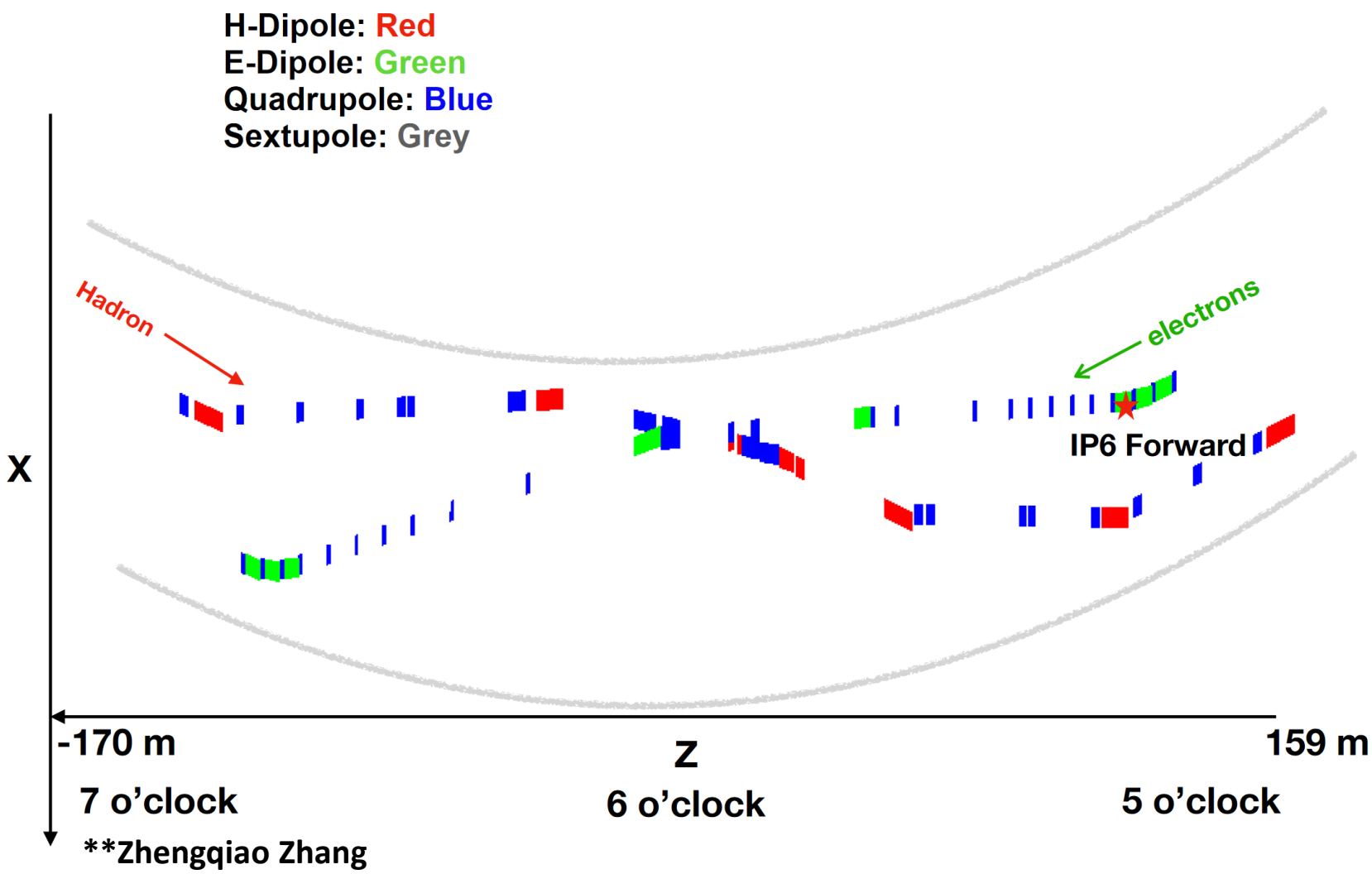
IP6 polarimeter location and magnet layout



- The only place that was deemed useable for the Compton was near to IP6 right before the last horizontal bend
- The photon detector would be ~31.6 m downstream
- The electron detector will be about 9m downstream in front of a quad
- The polarization direction at the Compton will not be 100% longitudinal providing an additional challenge for the measurement

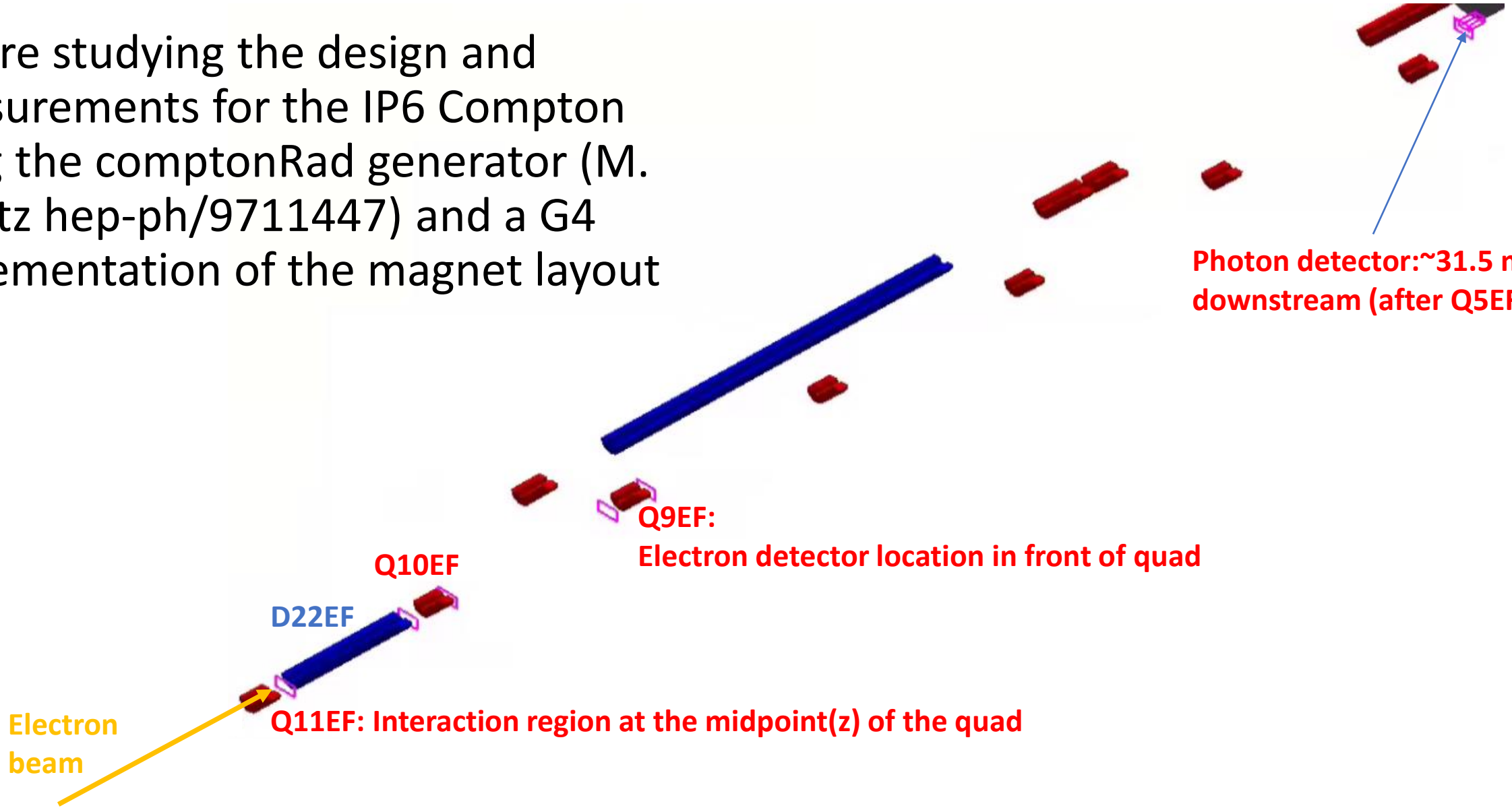
	polarization at Compton IP	
Beam energy [GeV]	Longitudinal [%]	Horizontal [%]
5	97.6	21.6
10	90.7	42.2
18	70.8	70.6

$$S_T = \sqrt{S_L^2 + S_H^2 + S_V^2}$$

Simulations

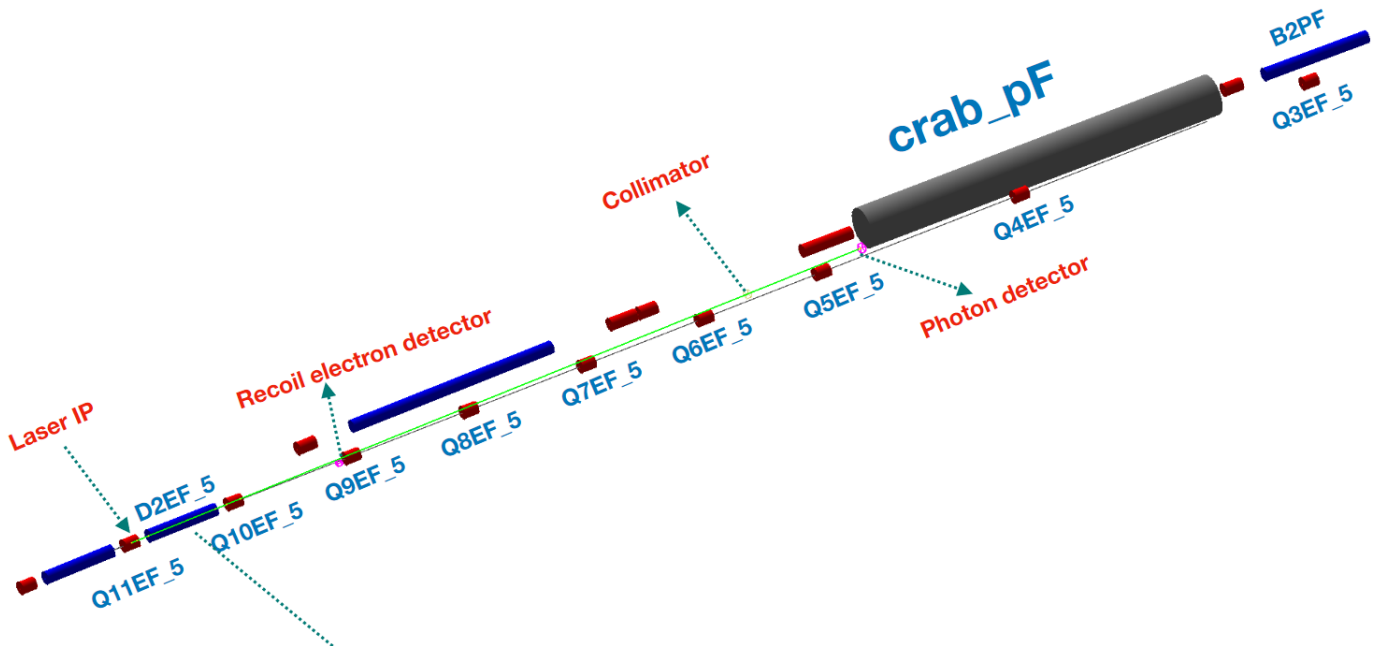
https://github.com/eic/compton
https://gitlab.com/eic/mceg/comptonRad

- We are studying the design and measurements for the IP6 Compton using the comptonRad generator (M. Swartz hep-ph/9711447) and a G4 implementation of the magnet layout

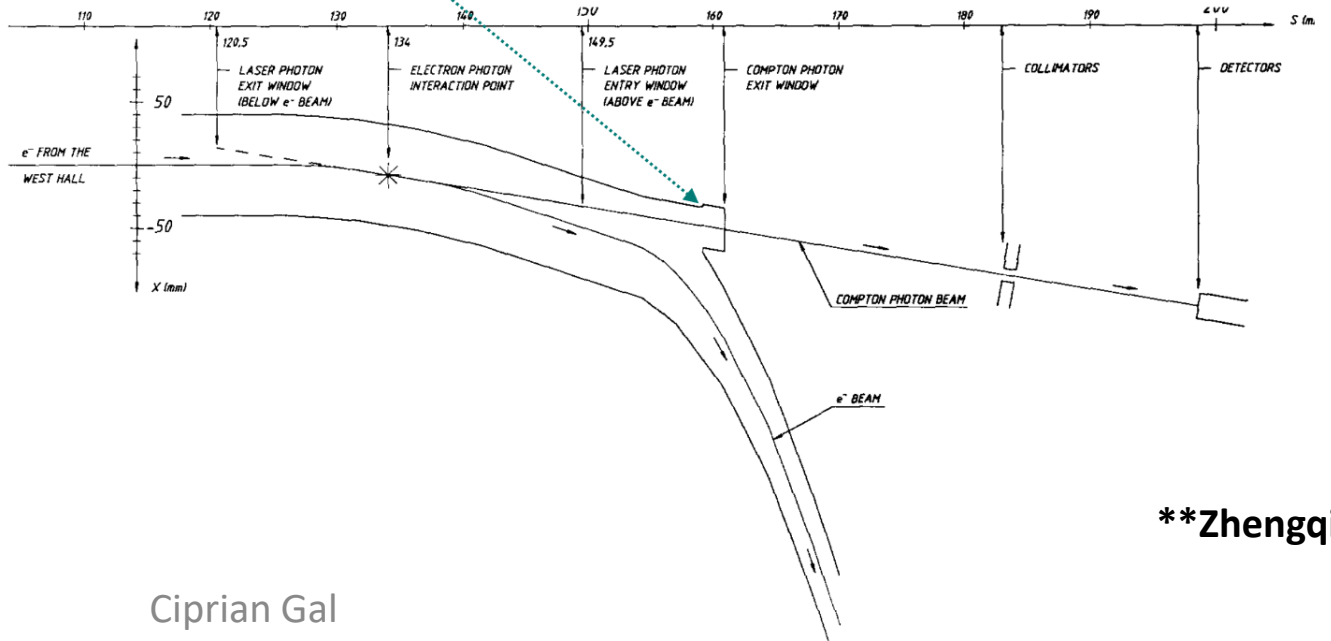


IP6 Compton layout

- A special construction for the dipole (somewhat similar to HERA) will need to integrate a vacuum window for the backscattered photons
  - Simulations suggest that a Beryllium exit window (up to a thickness of 1.5mm) would allow for very little loss in the backscattered photon flux
- For the electron a 0.5mm thickness pipe shows ~15% loss in signal



Exit window



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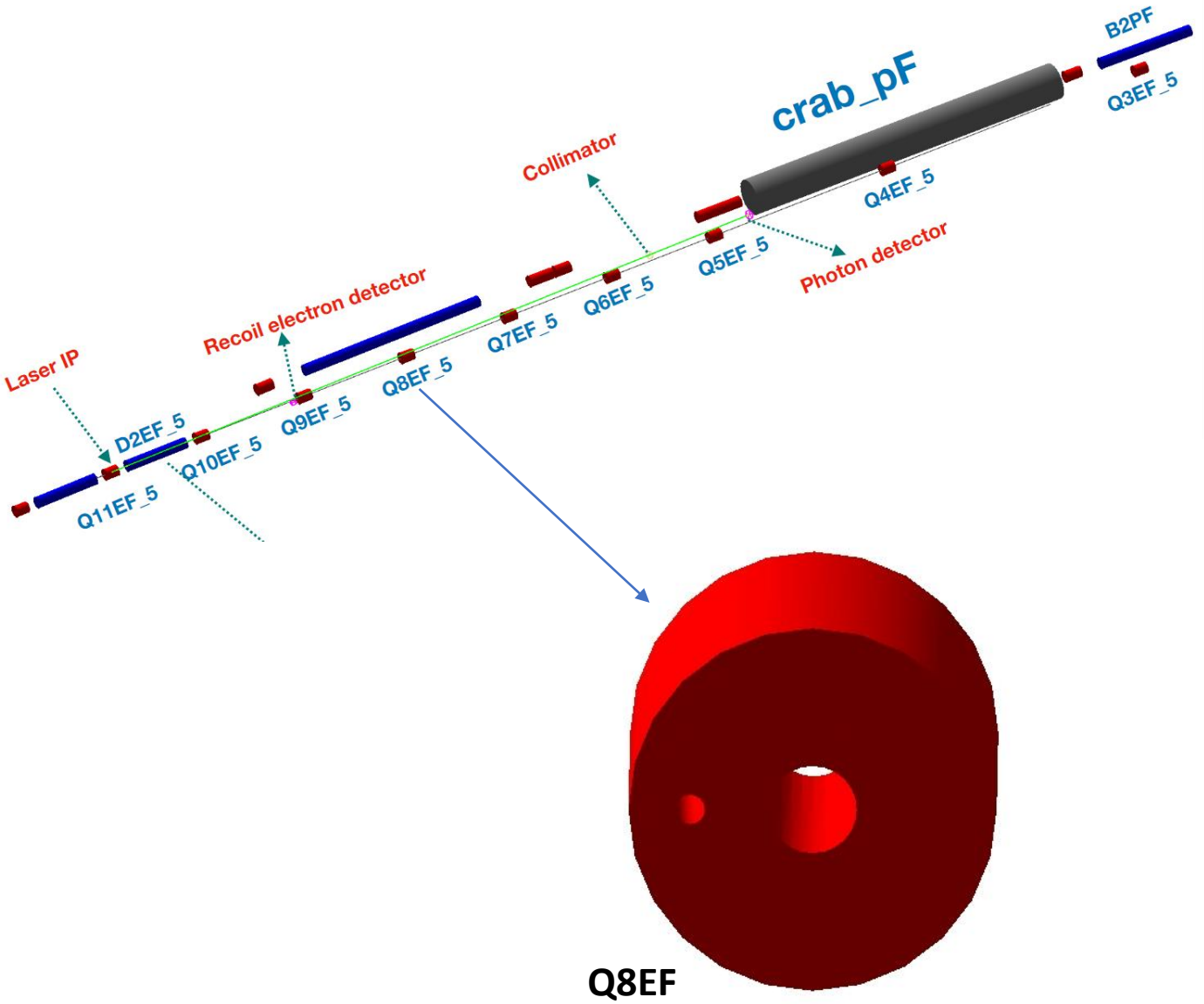
- Due to the tight beamline constraints the backscattered photons will need to travel through the quadrupole magnets before being detected



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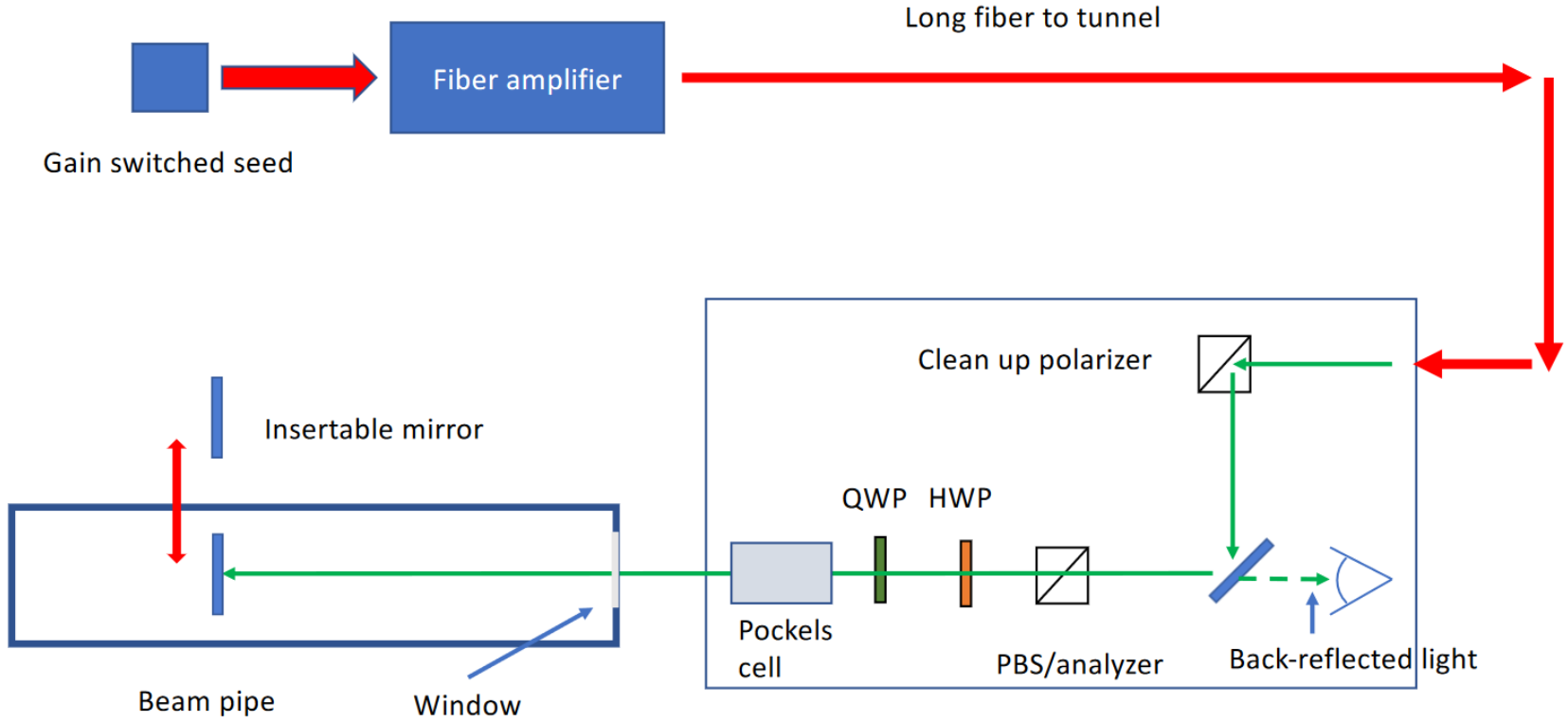
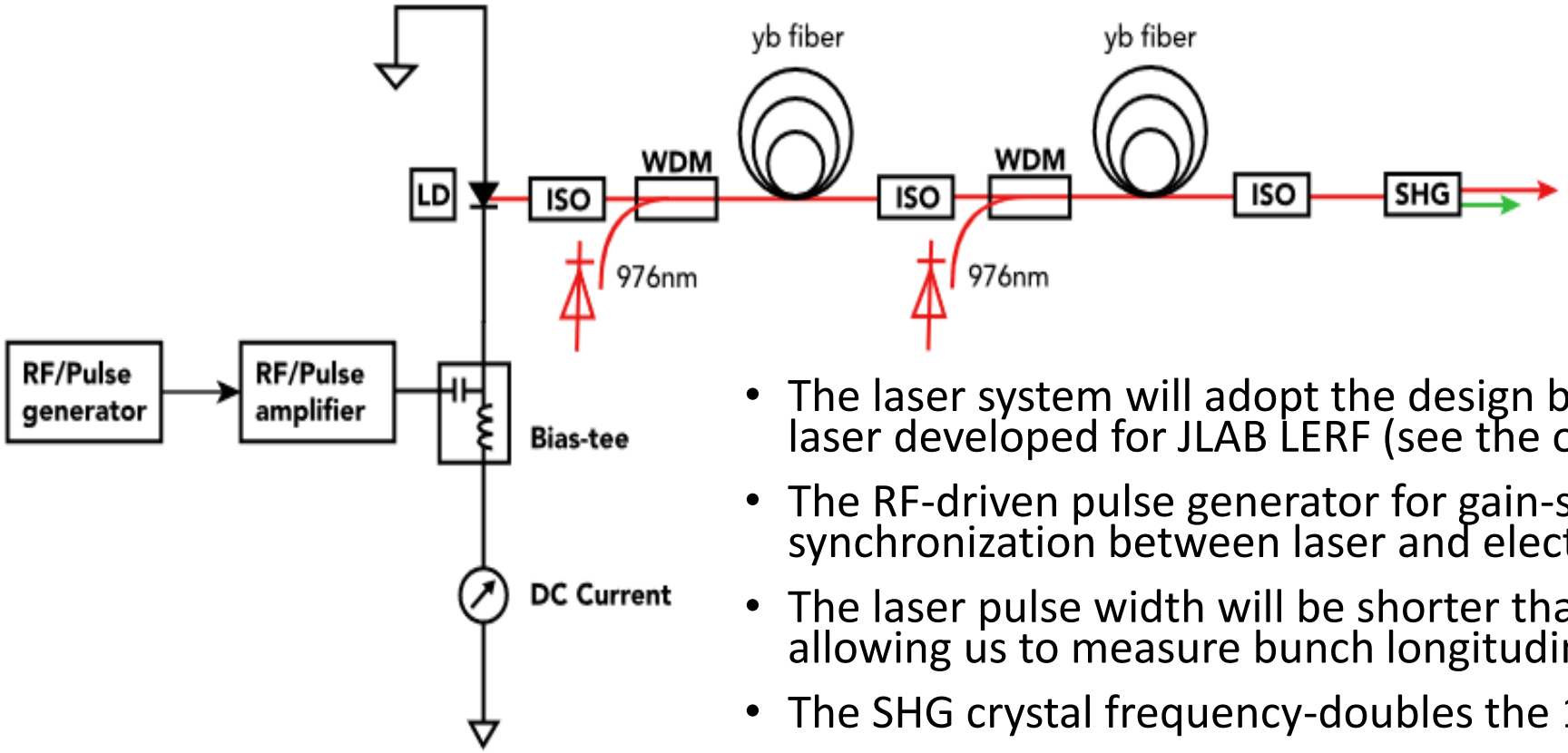
Compton laser system



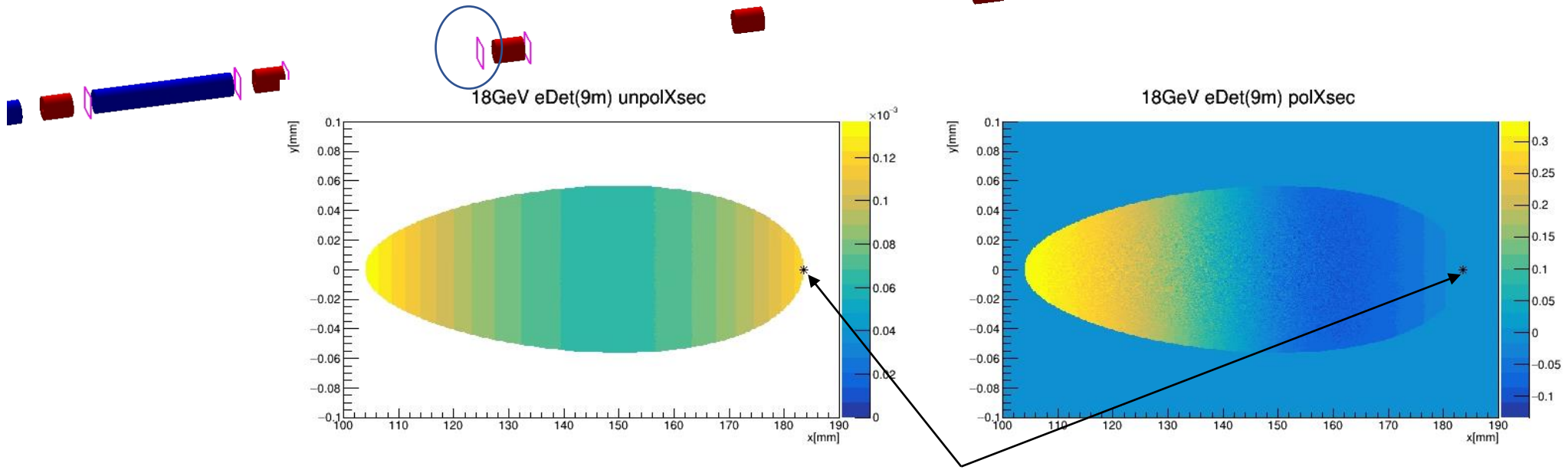
- The initial laser system design uses most of the design features highlighted in the previous Compton polarimeter implementations
  - As was before we need the laser system to be away from potential fatal radiation fields inside the tunnel (we plan to evaluate the use of high power laser fiber)
- The vacuum resident insertable mirror will be needed in order to be able to monitor the DOCP at the interaction point

Laser with gain-switched seed

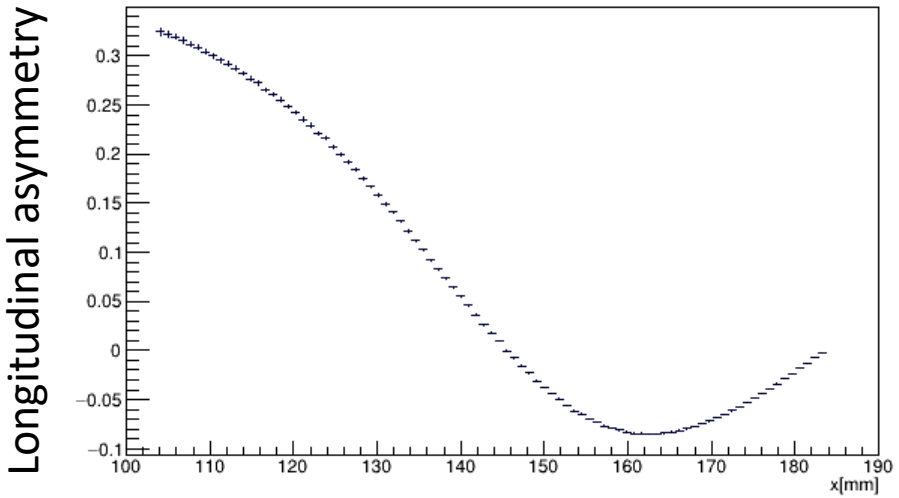


- The laser system will adopt the design based on the photocathode drive laser developed for JLAB LERF (see the optical scheme)
- The RF-driven pulse generator for gain-switching provides direct synchronization between laser and electron bunches
- The laser pulse width will be shorter than the electron bunch (potentially allowing us to measure bunch longitudinal polarization profile)
- The SHG crystal frequency-doubles the 1064nm light to 532nm
- The system has proven to be very reliable and in operation at JLAB LERF but still needs to be proven to work at the high power needed for the EIC Compton
- Construction and characterization of lower power prototype has been funded from the EIC R&D eRD26 effort
  - Should be completed by mid Fall

Scattered electron distribution (18 GeV)



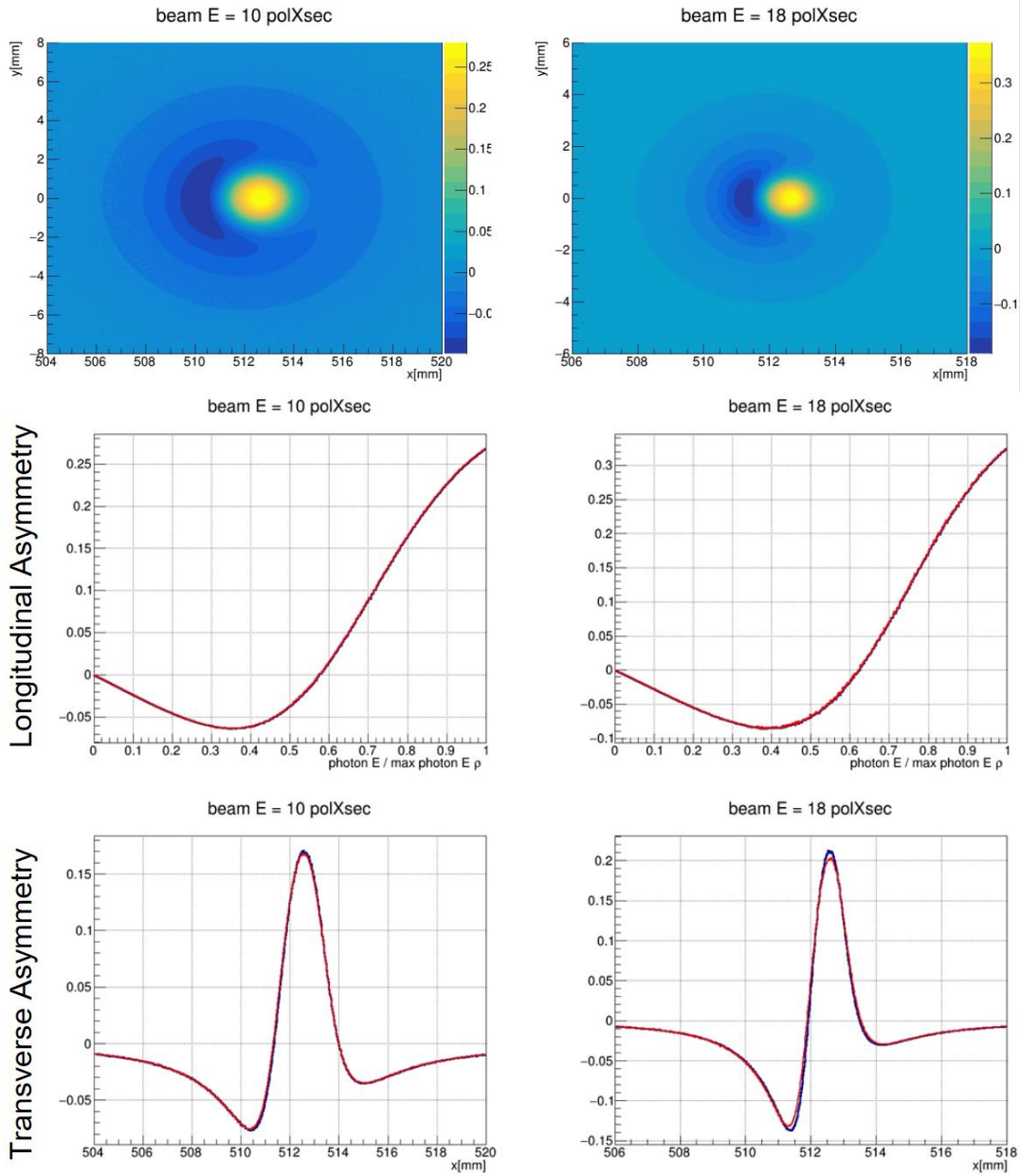
Un-scattered beam



- While the beam has both transverse and longitudinal components the electron measurements will only be sensitive to the longitudinal component
- The energy dependence of the asymmetry is converted to a position dependence due to the dipole after the interaction point
- We expect that with a horizontal resolution of 0.4mm (or better) we should be able to obtain a good measurement
- At 5 GeV we need to be able to detect electrons 8-10 mm away from the electron beam (this is approximately 20 sigma)

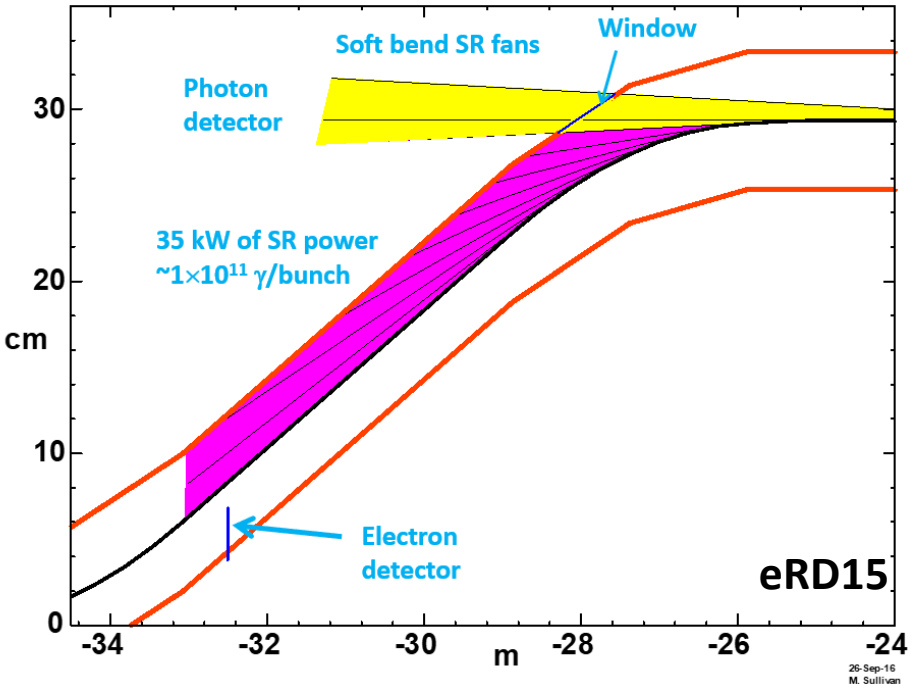
Backscattered photon impact

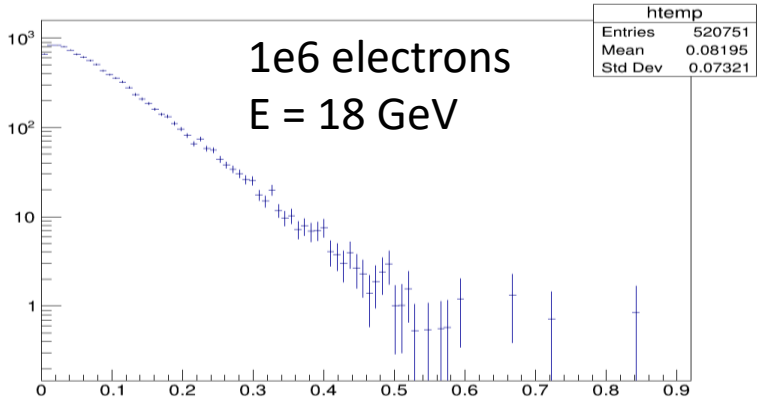
- The photon detection will give us both the longitudinal and transverse components
  - The longitudinal will be dependent on the photon energy (calorimetry measurement) – PbWO4 seems a perfect candidate
  - The transverse will be position dependent
- The transverse component determination will be the limiting factor in terms of time (generally will take about 2 times longer to accumulate statistics to reach the same precision as the longitudinal)
  - Still we expect to be able to reach 1% precision with one bunch in less than 1 minute
  - Similar segmentation as the electron detector will allow us to extract the transverse component without large systematic detector effects

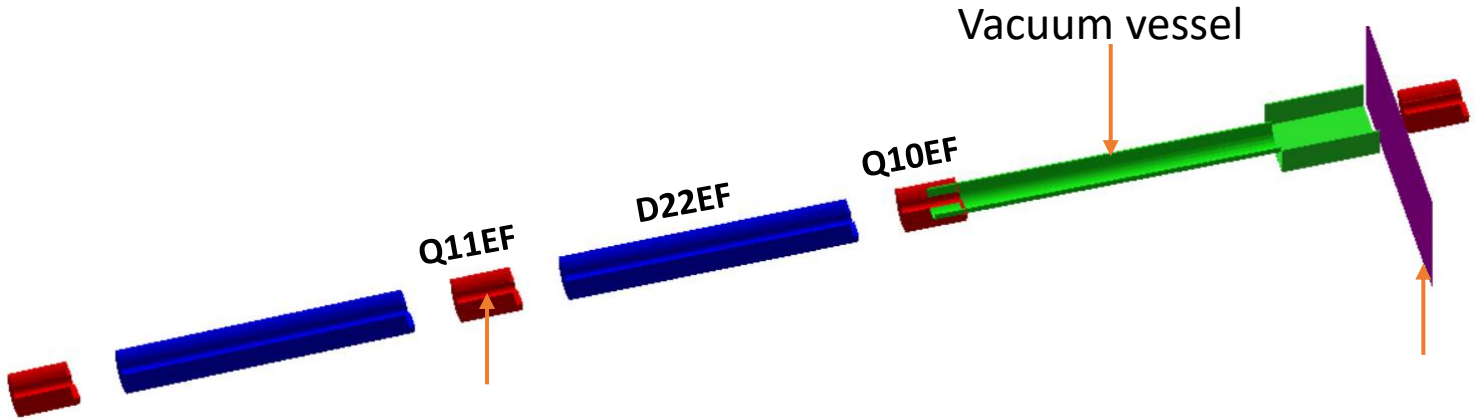


Background studies

- M. Sullivan found that (in the JLEIC setup) the electron detector would get a significant amount of background at 7 and 10 GeV (with the expectation that it would be worse are higher energies
- We have added a rudimentary stainless steel pipe and box upstream of the electron detector location
- We have cross checked that the synchrotron spectrum provided by G4 is consistent with analytical calculations for a simpler set up
- The initial simulation doesn't show a significant amount of 1-bounce photons, but further cross checks will be made (including comparing our results to engineering calculations of power depositions on the beam pipe)







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Conclusions and next steps

- The Compton at IP6 will be the most challenging high precision polarimetry measurement ever attempted
- The initial feasibility studies show that the pulsed laser design will give enough luminosity to reach 1% statistical precision during the lifetime of the electron bunches at all energies
- Initial detector requirements point to standard technology being sufficient for our needs
- Detailed design of beamline will be needed in the near future (to address things like impedances)
- Background studies will be crucial moving forward