Update of Electron Polarimeter

- Time requirement
- Recoil electron detection

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Time Requirements

- The Sokolov-Ternov effect will depolarize these electron bunches with a time constant of 30 min (at the highest energy of 18 GeV).
- In order to maintain high spin polarization (all 290 bunches), each of the bunches is replaced every six minutes.
- The polarization lifetime is larger at 10 GeV and 5 GeV and the bunch replacement rate can be reduced by a factor of at least five.

Time Requirements

$$L = f_b N_e N_\gamma G$$

Geometric factor:

$$G = \frac{1 + \beta cos\theta}{2\pi\sqrt{\sigma_y^2 + \sigma_{\gamma y}^2}\sqrt{\sigma_x^2(\beta + cos\theta)^2 + \sigma_{\gamma x}^2(1 + \beta cos\theta)^2 + (\sigma_z^2 + \sigma_{\gamma z}^2)sin^2\theta}}$$

$f_b = 2.2852 \times 10^7; Ne = 6.2 \times 10^{10}; N_\gamma = 2.84974 \times 10^{12};$

$\sigma_{\gamma x} = 0.1mm; \sigma_{\gamma y} = 0.1mm; \sigma_{\gamma z} = 1.3mm;$

$\sigma_z = 10mm; \sigma_x = \sqrt{\epsilon_x \beta_x}, \beta_x = 10m; \beta_y = 50m;$

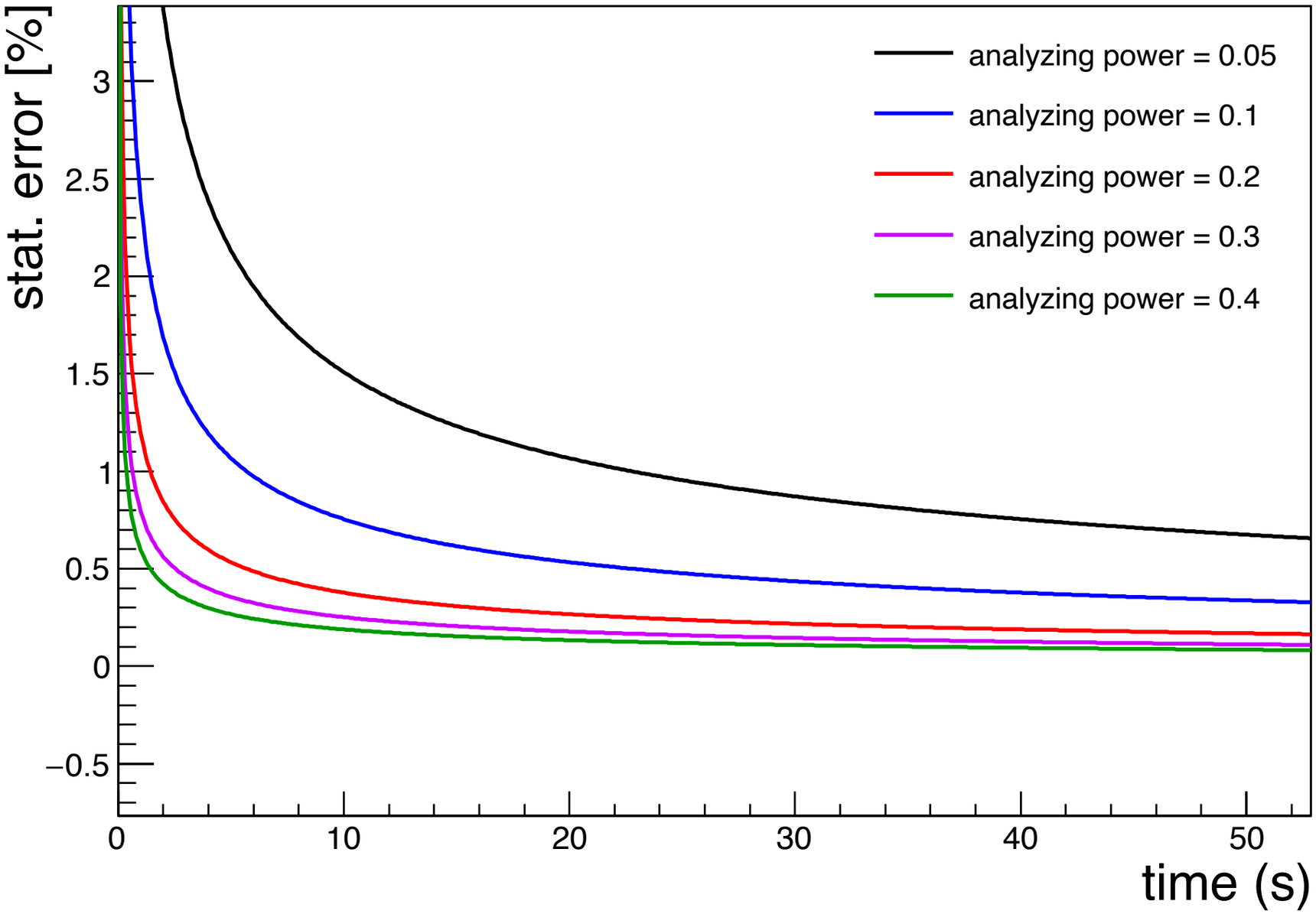
$\delta P_e \approx \frac{1}{A\sqrt{N}}; N = time * L * \sigma_{Compton} * 0.8 * f_b/290;$

$\theta = 3mrad; \sigma_{Compton} = 400mb;$

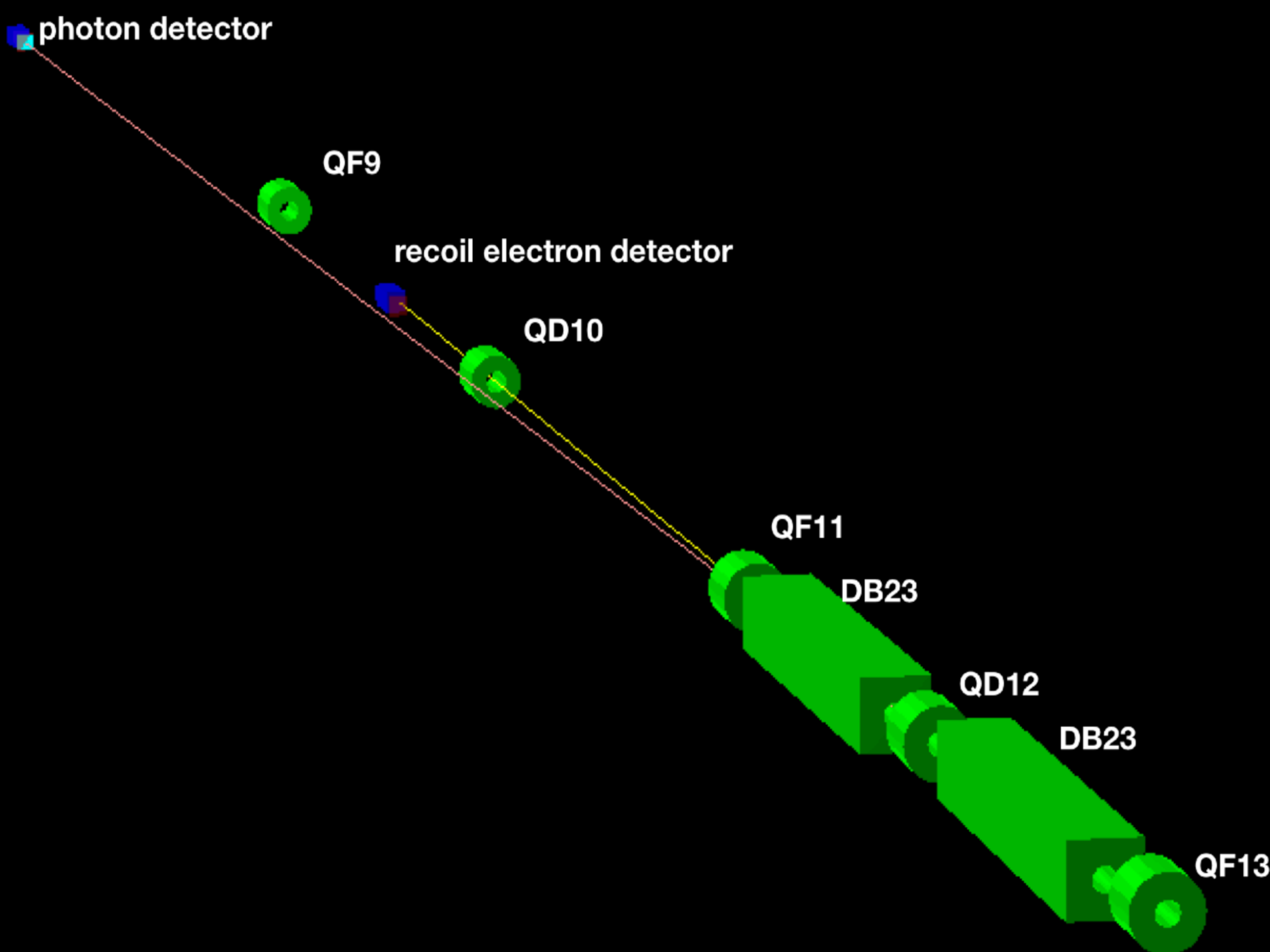
Laser power: 10W

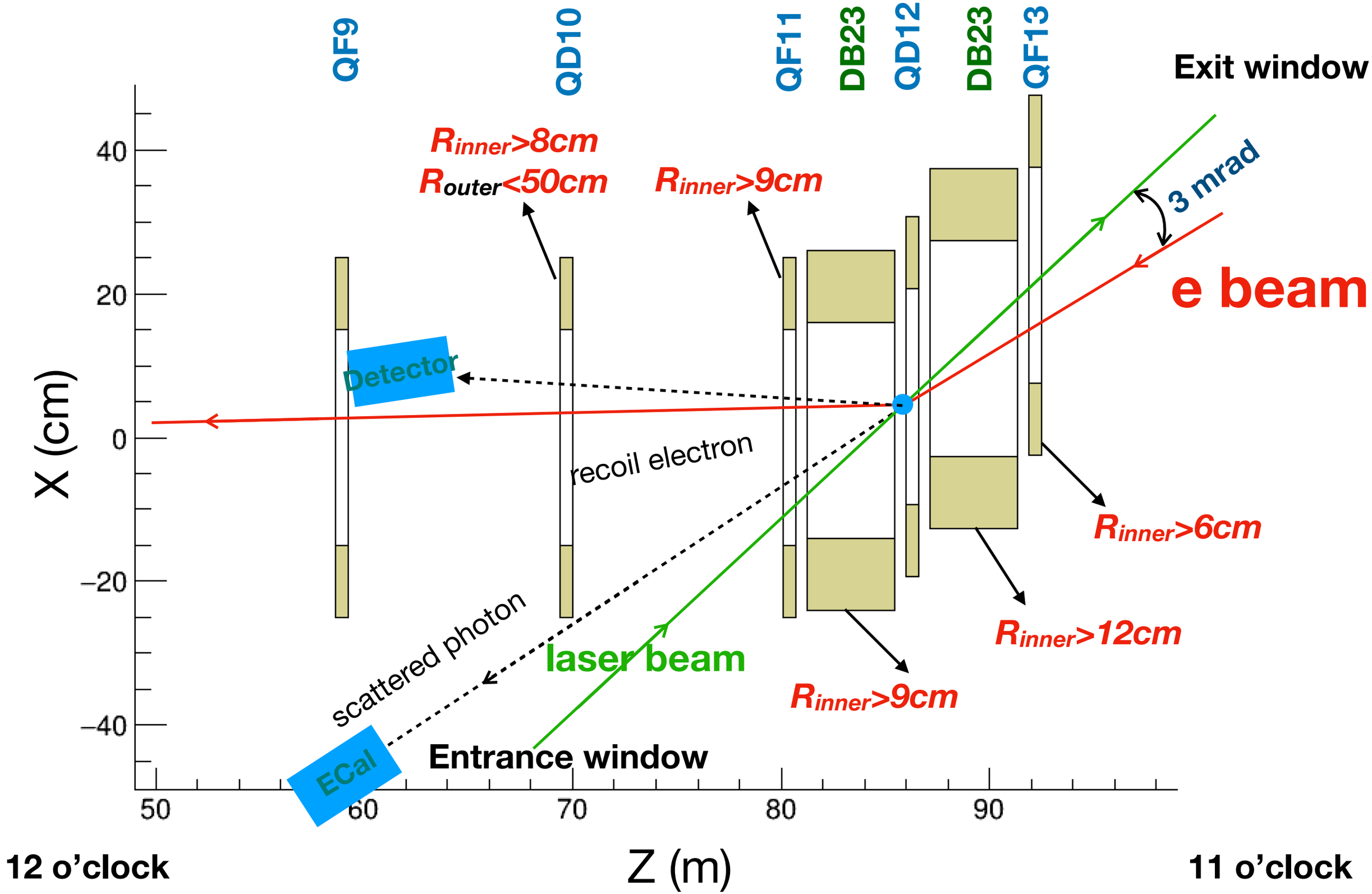
Species	proton	electron
Energy [GeV]	275	18
CM energy [GeV]	140.7	
Bunch intensity [10^{10}]	20.5	6.2
No. of bunches	290	
Beam current [A]	0.74	0.227
RMS norm. emit., h/v [μm]	4.6/0.75	845/72
RMS emittance, h/v [nm]	16/2.6	24/2.0
β^*, h/v [cm]]	90/4.0	59/5.0
IP RMS beam size, h/v [μm]	119/10	
K_x	11.8	
RMS $\Delta\theta$, h/v [μrad]	132/253	202/202
BB parameter, h/v [10^{-3}]	3/2	100/100
RMS long. emittance [10^{-3}, eV·sec]	36	
RMS bunch length [cm]	6	0.9
RMS $\Delta p/p$ [10^{-4}]	6.8	10.9
Max. space charge	0.006	neglig.
Piwinski angle [rad]	5.6	0.8
Long. IBS time [h]	2.1	
Transv. IBS time [h]	2	
Hourglass factor H	0.86	
Luminosity [10^{33}cm^{-2}sec^{-1}]	1.65	

Time Requirements



$\beta_x = 10m; \beta_y = 50m;$


photon detector
QF9
recoil electron detector
QD10
QF11
DB23
QD12
DB23
QF13


QF9
QD10
QF11
DB23
QD12
DB23
QF13
Exit window
R_{inner}>8cm
R_{outer}<50cm
R_{inner}>9cm
3 mrad
e beam
Detector
recoil electron
R_{inner}>6cm
R_{inner}>12cm
R_{inner}>9cm
scattered photon
laser beam
ECal
Entrance window
X (cm)
40
20
0
−20
−40
50
60
70
80
90
Z (m)
12 o'clock
11 o'clock

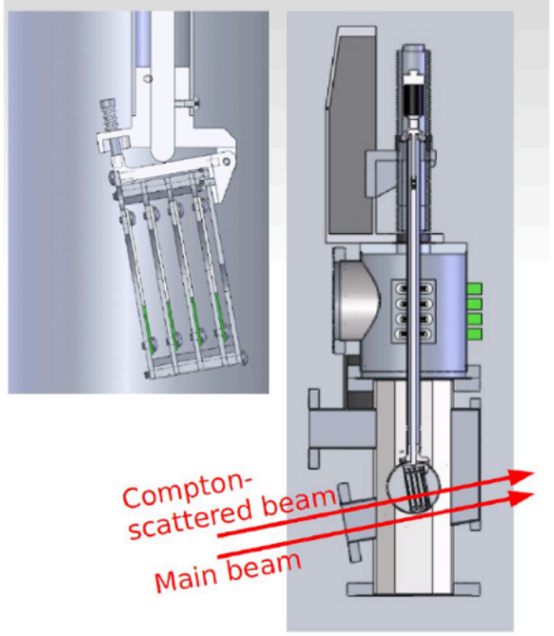
Roman Pot for electron detection?

Compton Electron Detector R&D Project

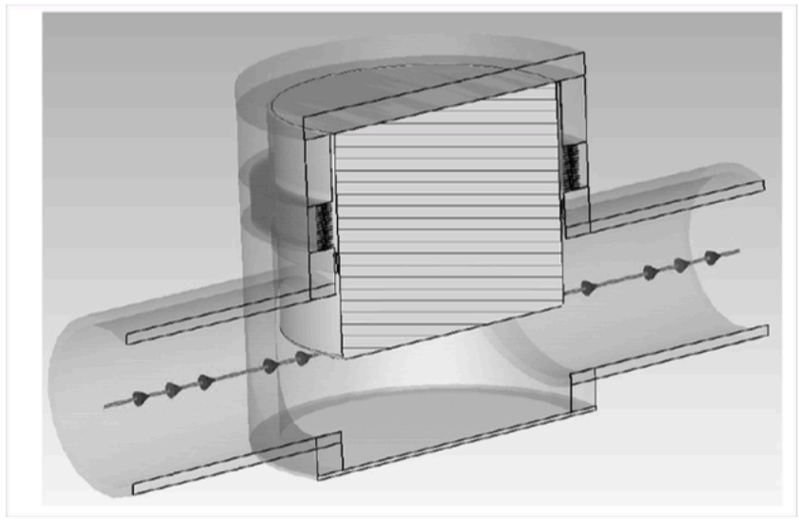
EIC Detector R&D Project for development of electron detection scheme for Compton polarimetry (A. Camsonne, J. Hoskins, et. al.)

→ Default design based on diamond strip detectors similar to those used in Hall C at JLab, but placed in Roman Pot rather than beam vacuum

→ Simulations targeted at understanding backgrounds and studying achievable precision

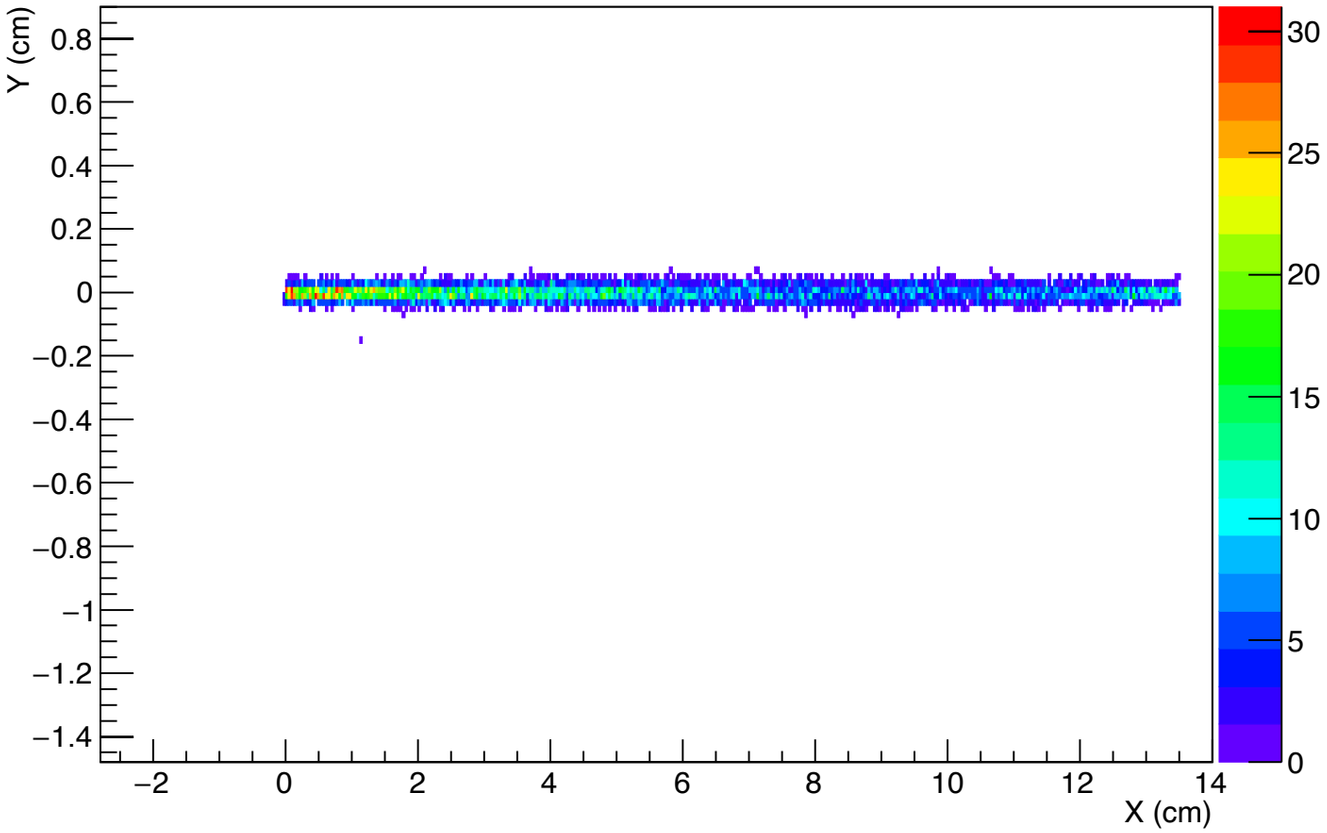


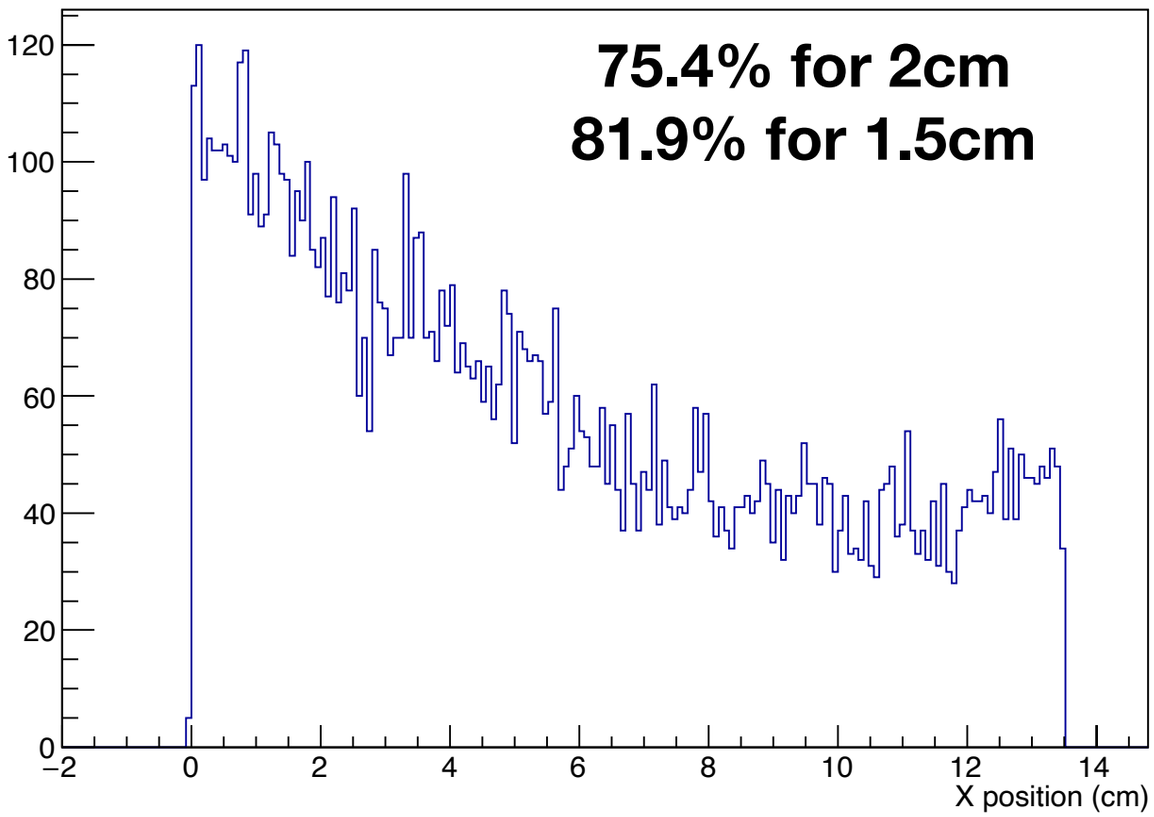
TOTEM Roman Pot



Recoil electron positon

Beam parameters for recoil electron detector:
BetaX = 40m; emittanceX = 24nm;
SigmaX = 970 um;
15*sigmaX = 1.45 cm;





Wiki Page for EIC Polarimetry

https://wiki.bnl.gov/eic/index.php/Polarimetry

Thanks!