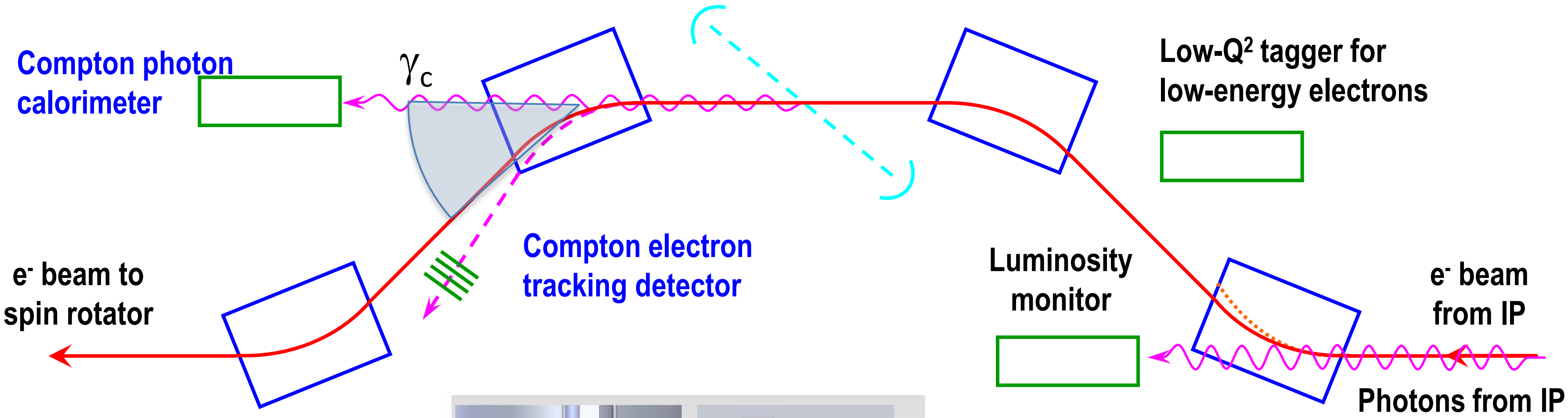
eRD15
Compton electron detector R&D

EIC R&D meeting

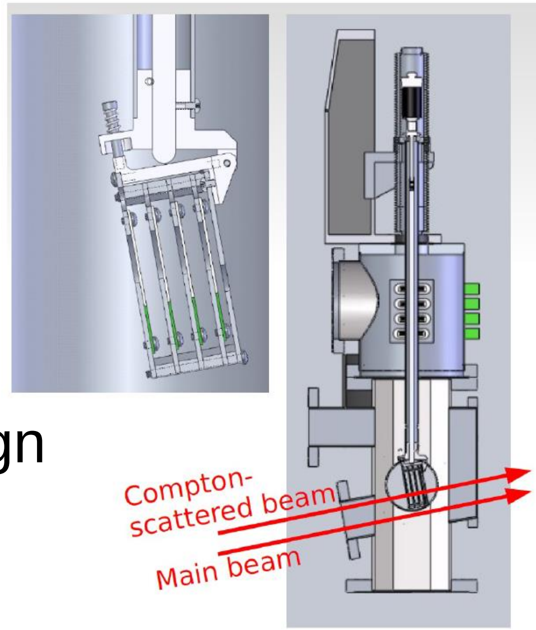
July 27th 2018

Alexandre Camsonne

Compton electron detector

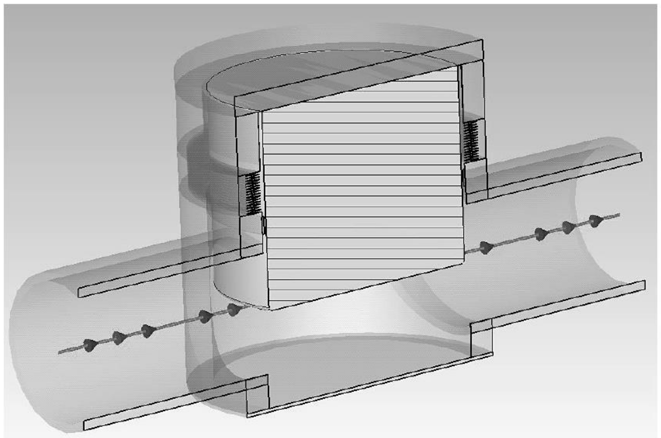


Electron detector not in direct view of synchrotron fan



Existing Hall C design

TOTEM Roman Pot



eRD15 : Compton electron detector R&D

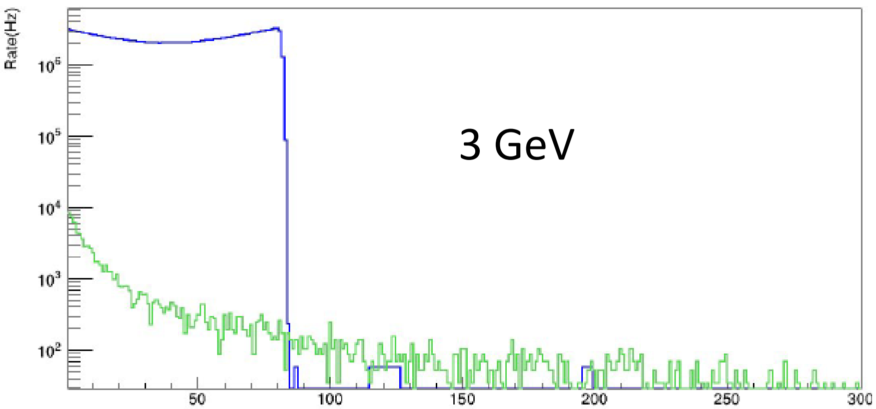
- Requirement
  - 1% or better electron polarization measurement
  - Best measurement Compton electron detector at SLD (~0.5%)
- Deliverables
  - Simulation to determine signal to background for JLEIC baseline Roman Pot and expected accuracy

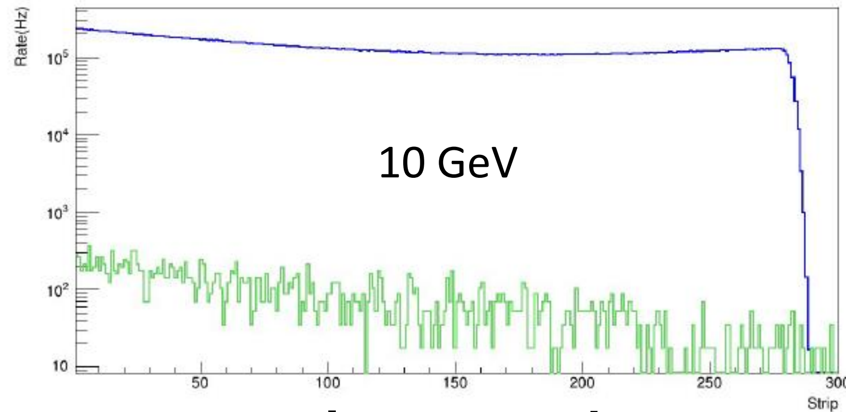
Deliverable estimate for FY 2019

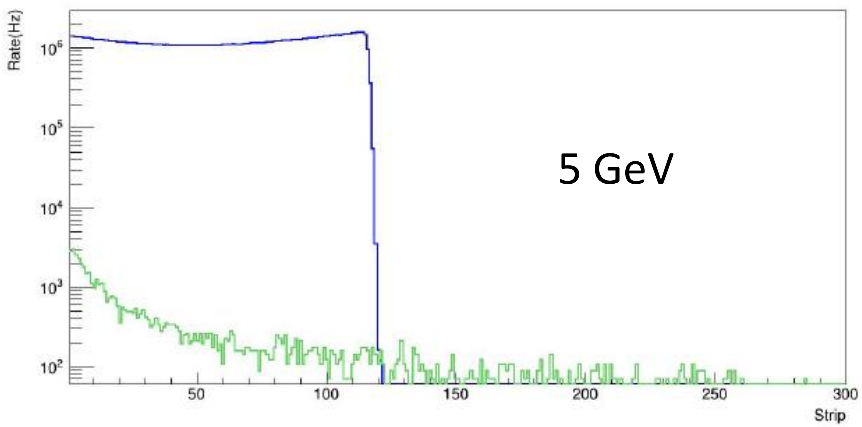
- Simulation
  - Implement beam pipe in magnet
  - More cross check with old simulation
  - Full simulation with Interaction Region and beam pipe
  - Run simulation large scale on batch farm will full setup
  - Halo modelling
  - Model beam laser interaction
  - Implement polarization extraction analysis
  - Study of systematics and optimization of the setup
  - Realistic Roman Pot Geometry
  - Synchrotron radiation study, detector response to synchrotron photons

Simulation results

– Signal to background different energies

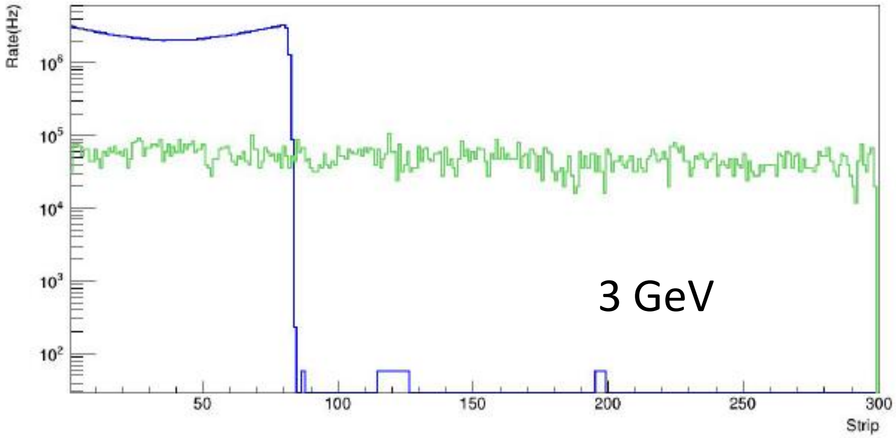


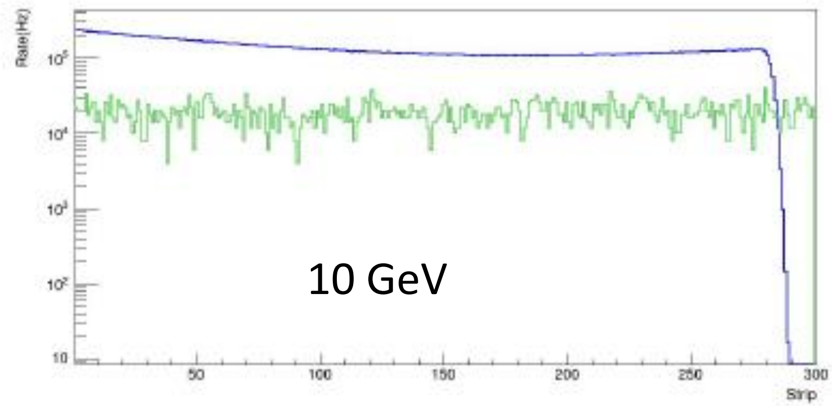


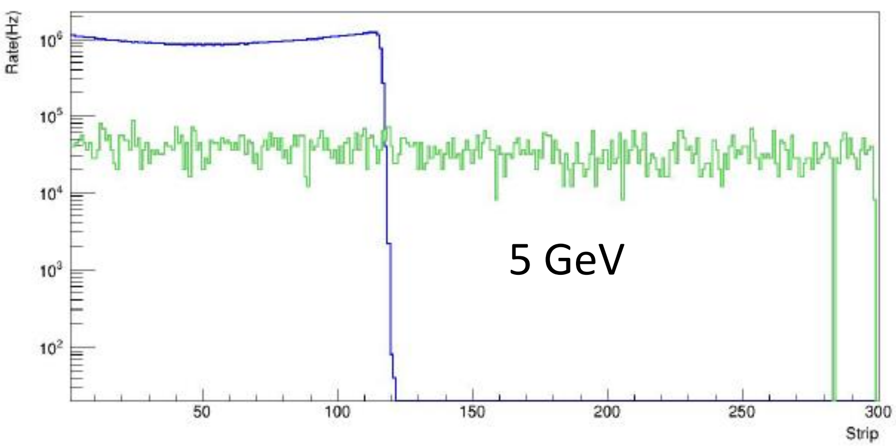


- 1 A electron beam
- 10^{-9} torr
- 10 W CW laser
- Bremsstrahlung is ok at all energies

Halo contribution for apertures







- 1 cm aperture
- S/B still around 10
- 10 W CW laser no need for aperture unless need more power with cavity

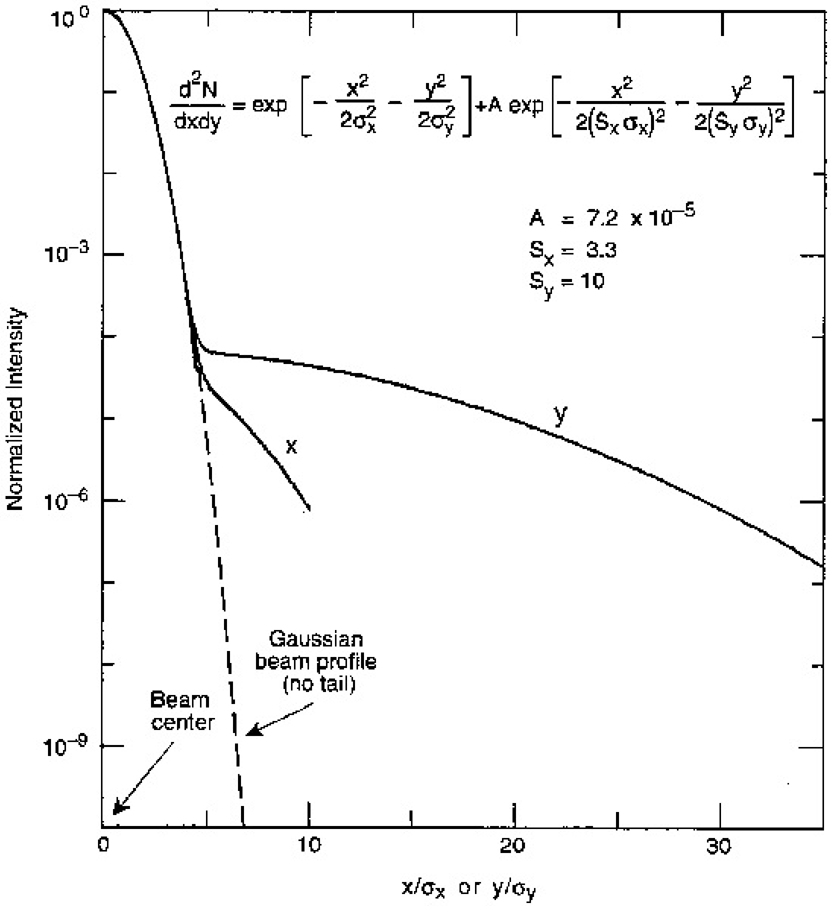
Beam halo modelling

Both GEANT3 and GEANT4 simulations uses description of beam halo from PEPII design report[1].

Halo flux is about 0.25% of total beam flux

Backgrounds due to halo can contribute in two locations

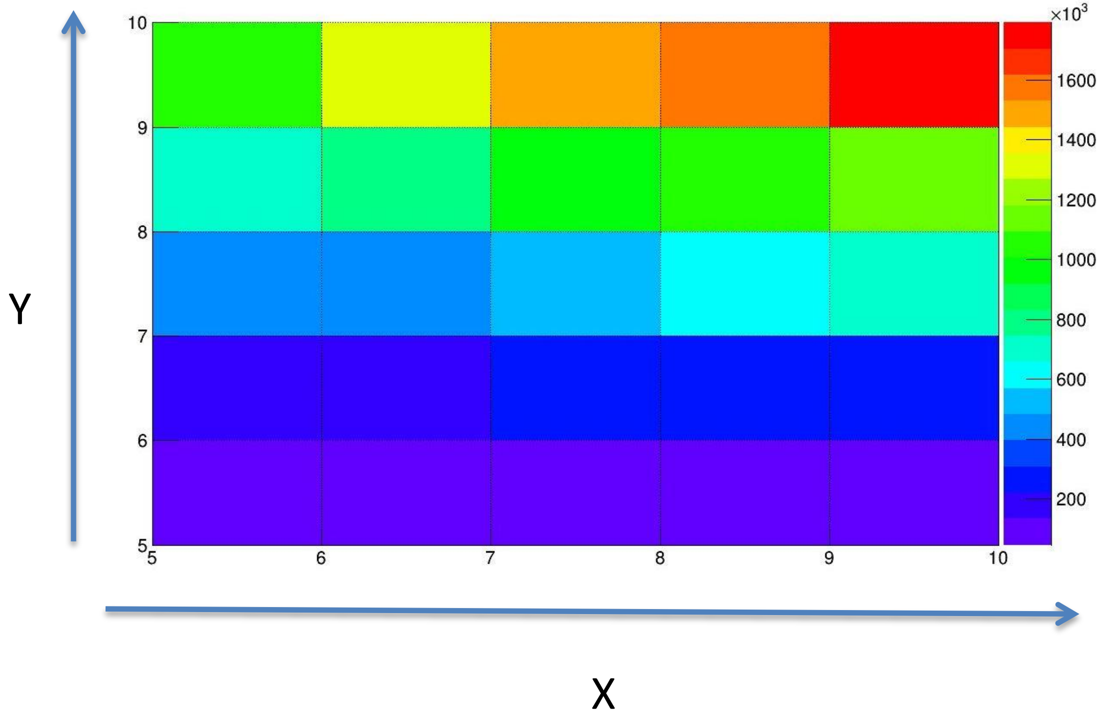
Interactions with cavity apertures
Direct strike of electron detector



Halo induced background

Halo contributions from the IP due to apertures, were studies over both energies.
Rates are at an acceptable level and easily controllable be varying the aperture size.
The more pertinent problem is halo interacting with the detector directly.

Halo in the detector is a potential problem if the width is not controlled (worst case 1.6 MHz). More accurate estimations of potential values are possible once we are provided with estimated beam properties



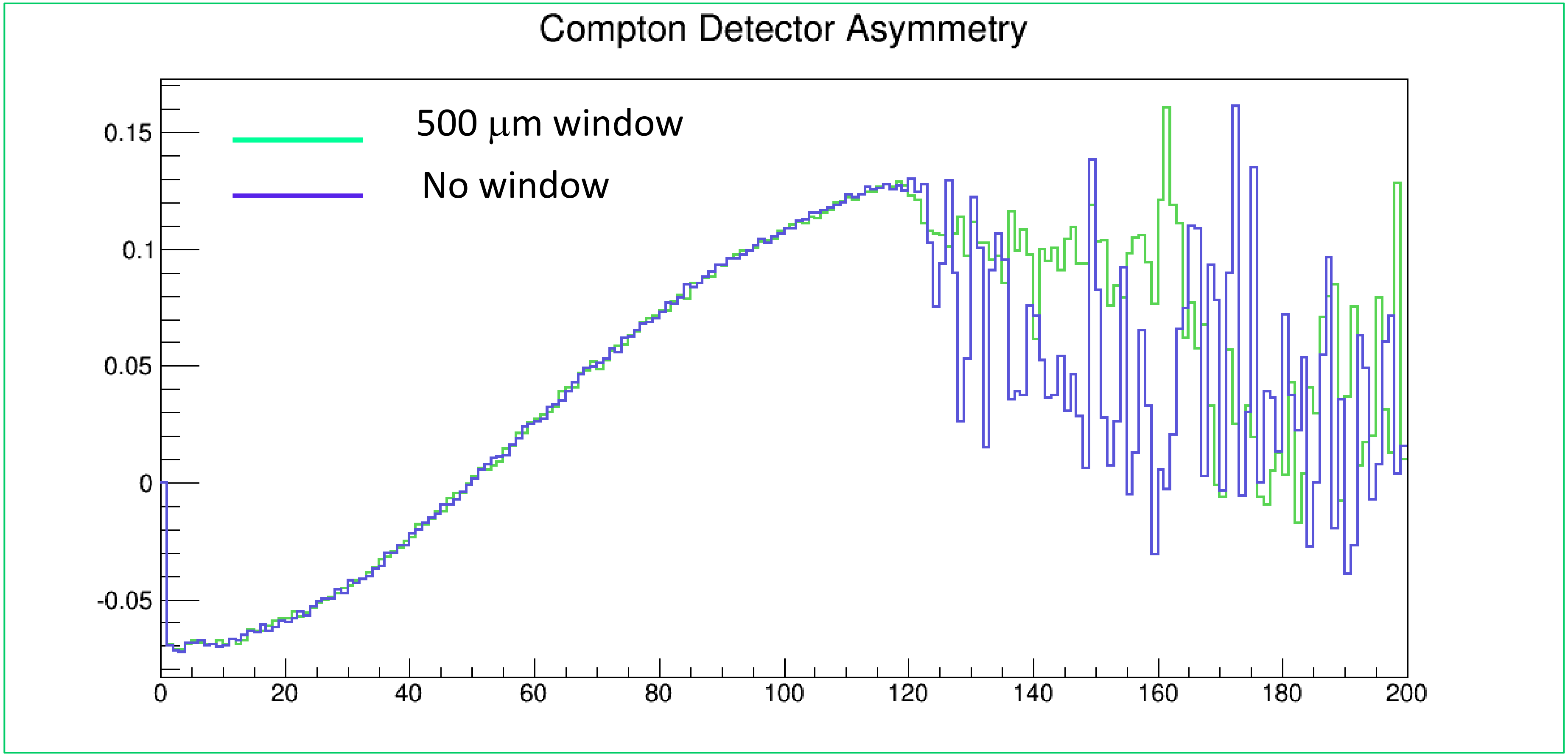
Detector rate for different combinations of the halo
Multipliers. Rates are for halo at the detector.

Strip size optimization

Strip Size	Energy (GeV)	Polarization	χ^2/NDF
240 μm	3	-97.02 $\pm$ 0.67	1.02
480 μm	3	-97.97 $\pm$ 0.64	1.09
1200 μm	3	-97.43 $\pm$ 0.65	2.29
2400 μm	3	-96.01 $\pm$ 0.62	4.83
2880 μm	3	-95.25 $\pm$ 0.60	6.01
4800 μm	3	-96.20 $\pm$ 0.64	7.45
240 μm	5	-97.69 $\pm$ 0.58	0.88
480 μm	5	-97.48 $\pm$ 0.58	0.83
1200 μm	5	-97.53 $\pm$ 0.59	0.97
2400 μm	5	-97.41 $\pm$ 0.59	1.02
2880 μm	5	-97.17 $\pm$ 0.59	1.23
4800 μm	5	-96.68 $\pm$ 0.60	2.29
240 μm	10	-97.19 $\pm$ 0.24	1.08
480 μm	10	-97.94 $\pm$ 0.23	1.37
1200 μm	10	-97.79 $\pm$ 0.23	1.36
2400 μm	10	-97.70 $\pm$ 0.23	3.73
2880 μm	10	-97.71 $\pm$ 0.26	4.31
4800 μm	10	-97.65 $\pm$ 0.23	7.96

- strip size can be divided by 5
- 40 strips detectors sufficient for 1% accuracy
- small correction at 3 GeV

Compton asymmetry with window



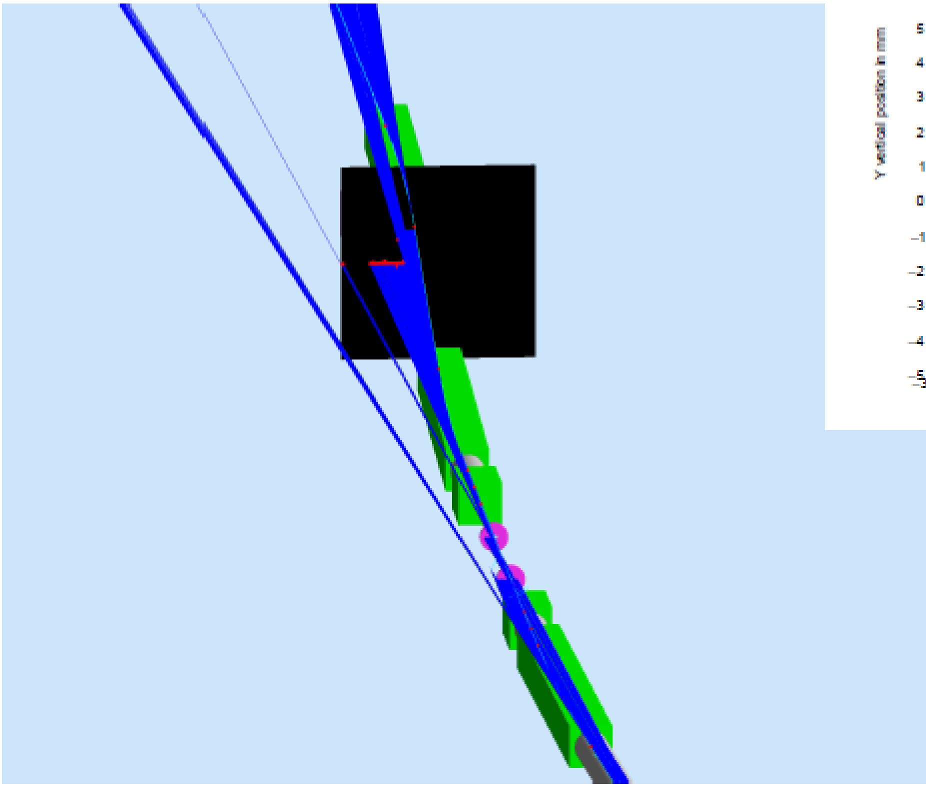
- Higher statistics MC comparison

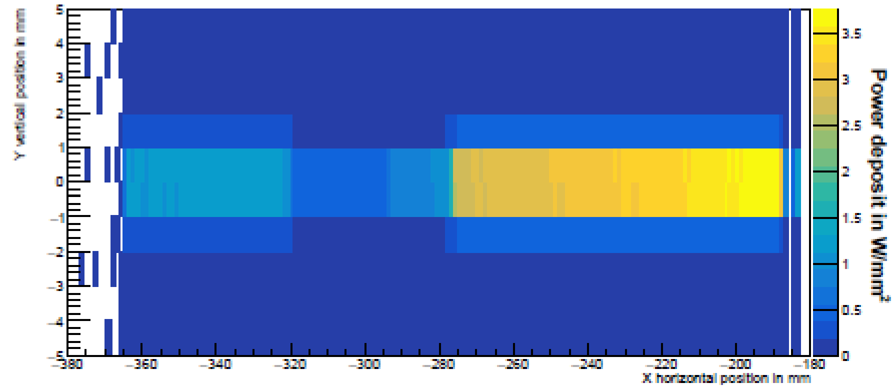
Effect of RP window

Energy	Thickness	Polarization	Error
3	50	-97.02	+/-0.67
3	500	-96.60	+/-0.90
3	1000	-95.82	+/-0.81
5	50	-97.69	+/- 0.58
5	500	-96.59	+/- 0.79
5	1000	-96.68	+/- 0.50
10	50	-97.19	+/- 0.17
10	500	-97.19	+/- 0.24
10	1000	-97.02	+/- 0.20

- polarization correction at 3 and 5 GeV due to thickness
- consistent with input polarization of 97% within 1% error bar

GEMC synchrotron





- Synchrotron process in GEMC thanks to Catherin Ploen (eRD21)
- preliminary synchrotron radiation with GEMC, needs to be crosscheck
- cross-check and high statistics later from Mike Sullivan code

Future work

- Summary report and NIM paper
- Generator and polarization analysis documentation
- Roman pot geometry from TOTEM
- High statistics synchrotron with EGCS
- Synchrotron beam induced background with Molflow (collaboration with eRD21)

Conclusions

- Electron detector background from Bremsstrahlung and halo are ok at 3,5 and 10 GeV
- Detector segmentation can go down to 40 strips
- Halo need to be limited for background and direct strike
- Vacuum window induce a small correction at lower energy, OK at 1% level (need more work for better)
- Preliminary test synchrotron in simulation
- Collaboration with eRD21 and Michael Sullivan for beam induced background
- Need formal agreement with TOTEM to get real geometry
- Generator and analysis tools to study polarization accuracy thanks to Joshua Hoskins

Backup

- Better than 1% ?
- Use HOM shield with slit and one plane in vacuum