e+@CLAS12 Meeting Notes

04/15/2020

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The regular weekly meeting is now scheduled on every Wednesday at 10 am JLab time.

List of tasks & assignments

i) Identification/review of issues with operating Hall B beam line with positrons (**Eugene**)
There is no issue on the beam diagnostic side. A write-up, to be provided by the accelerator team, will serve to elaborate a text for the proposal. The remaining issue is the shielding configuration with respect to possible different background environment. This needs iv) input.

ii) Identification/review of issues with operating CLAS12 with positrons for comparison with electrons
See v).

iii) Identification/review of the different source of systematic errors in the comparison of electron and positron cross section
See v).

iv) Characterization of the electron/positron background environment (**Latifa**)
The infrastructure to run full simulations is ready but manpower is temporarily missing. At minima, the comparison between the angular distributions of Møller and Bhabha scattering should help to assess the background conditions and impact. Similar evaluation can also be done for positron annihilation. Extended simulations will be done at the latest before the PAC defense to confirm/correct simple evaluation from the angular distributions.

v) Definition of an electron and positron calibration experiment + ii) + iii) (**Volker**)
(see slides attached)
The ii), iii) and v) items gathers all together in the discussion. Systematics effects are generated by the fact that electrons and positrons are not detected by the exact same piece of the detector if only the torus field is changed. This can be corrected if the solenoid field is also changed, but protons will then be detected in another part of the central detector. These effects can be investigated and measured with elastic scattering at small Q_2, using a lower beam energy. While it is not the goal to have extensive simulations of these effects for the proposal, it is necessary to evaluate their magnitude and develop the strategy to address them experimentally. An important source of information with respect to systematics can possibly be found in the TPE documentation. This experiment was much strongly concerned than DVCS by electron/positron systematics: small 2-photons effects are here replaced by a large charge asymmetry signal.

vi) Modifications of the Møller polarimeter to operate in Bhabha scattering mode (**Brian/Eric**)
Modifications are essentially hardware. A small write up needs to be included into the proposal.

vii) Generation of DVCS quasi-data considering approved DVCS measurements with CLAS12 and expected positron measurements with the same luminosity than electrons (**FX**)
To progress soon. The generation of charge asymmetry observables will be performed with a Fast MC, which is realistic enough for the needs of this proposal.

viii) Extraction of D-term from expected data and evaluation of the impact of unpolarized positron beams (**FX**)
The D-term extraction will directly follow observables generation.

ix) Extraction of the CFF from expected data and evaluation of the impact of unpolarized and polarized positron beams (**Silvia**)
The point was made that inconsistencies in the generation of experimental observables may affect the extraction of CFF in a biased way. This issue could not be fully addressed during the meeting and needs further discussion since the impact of positron measurements on GPD physics must be clearly assessed in the proposal.

x) Evaluation of the impact of the beam momentum spread and emittance on experimental observables (**Eric**)
(see slides attached)
The beam emittance is the only beam parameter predicted to change when using the secondary positron beam. This can be controlled to some extent and the impact on the measurement can also be calibrated by doing measurements with the secondary electron beam also produced at the positron production target.

xi) Proposal deadlines: 4/20 (abstract), 5/4 (proposal to CLAS Review Committee), 5/18 (CLAS Review Committee feedback), 5/25 (CLAS Review Committee recommendation), 6/1 (proposal submission) (**All**)
The skeleton of the proposal is in progress and will be posted soon on overleaf. Starting from there and the LOI, we should build an elaborated draft for 5/4. A draft abstract will circulate by the end of Thursday 4/16, and should be finalized for 4/20.
The main physics argument is about charge asymmetries which do not require polarized positrons. However, polarized beams can be delivered at no expense of intensity for CLAS12, such that they can be used at no cost to investigate the potential impact of twist-3 effects.
Considering the time separating RG-A from a potential positron experiment, it seems more appropriate to take data with both electron and positron beams for a better control of systematics.

Positron/Electron Asymmetry in DVCS

CLAS12

DVCS kinematics:

$e^- p \rightarrow e^- p \gamma$

$e^+ p \rightarrow e^+ p \gamma$

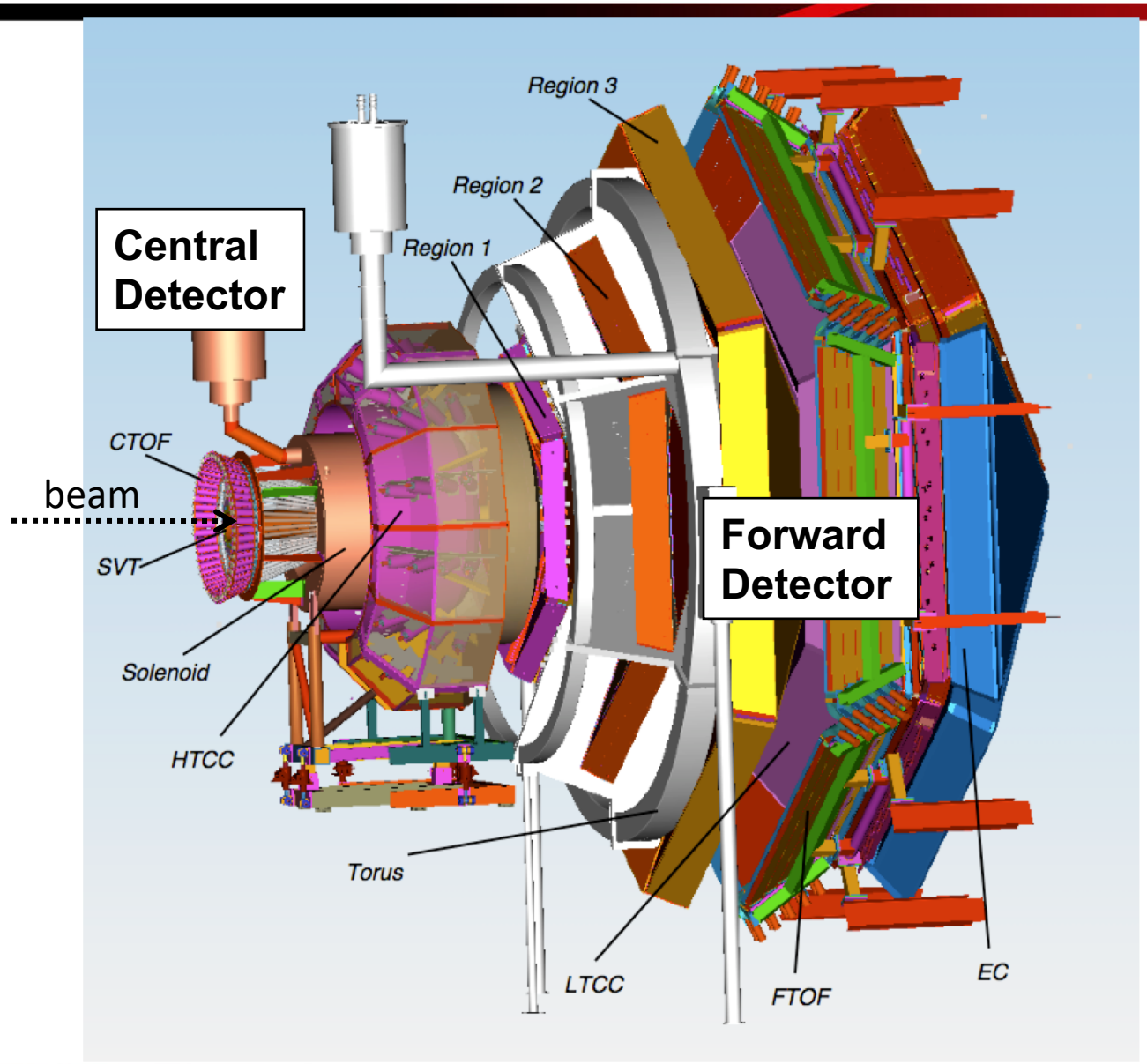
e^-/e^+ scattered to small angles detected in CLAS12 FD

$\theta_{e-} = 6^o – 35^o$ / θ_{e+} $6^o – 35^o$

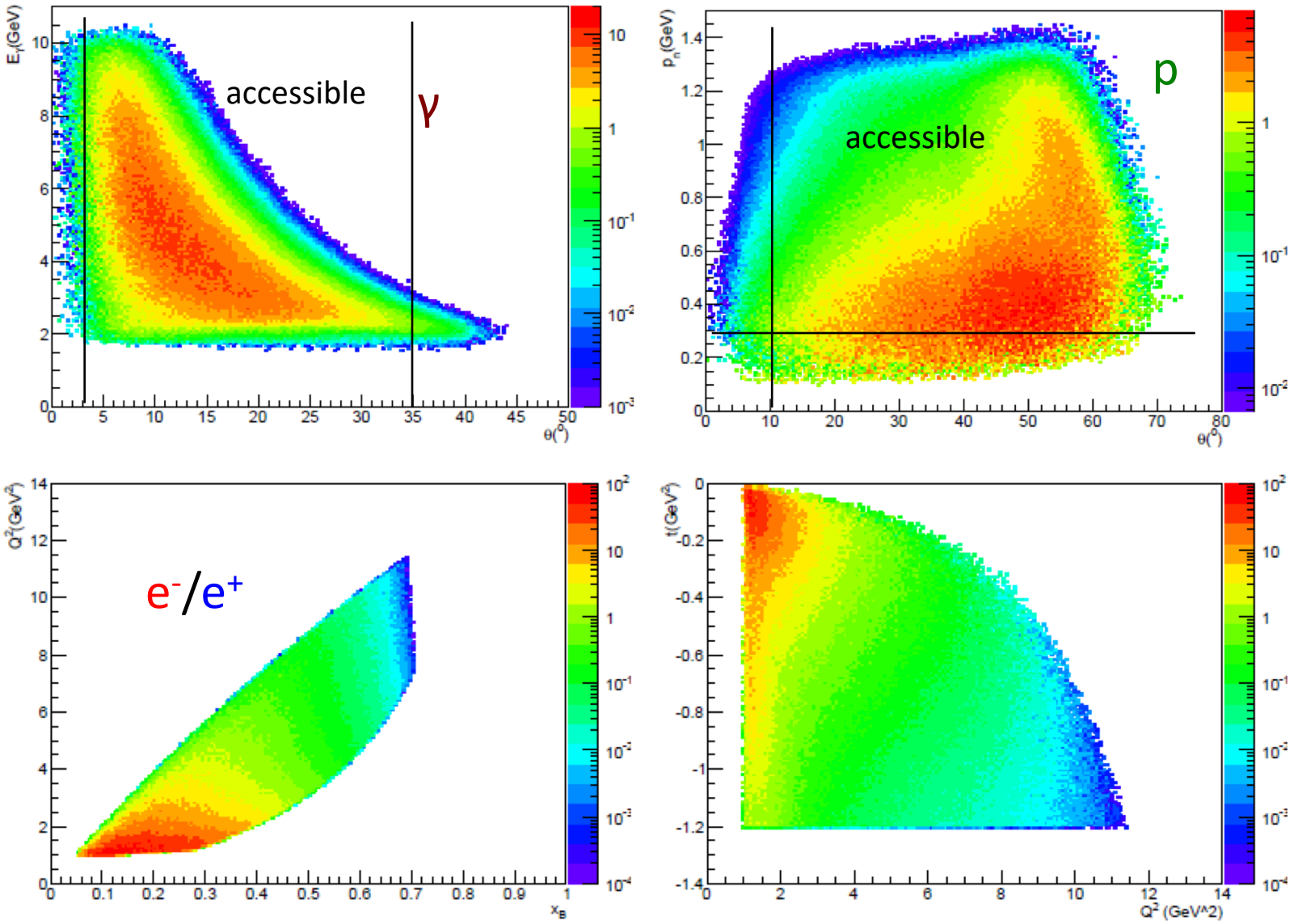
(reverse Torus field)

Proton in full CLAS12 CD/FD

$\theta_p = 10 - 70^o$

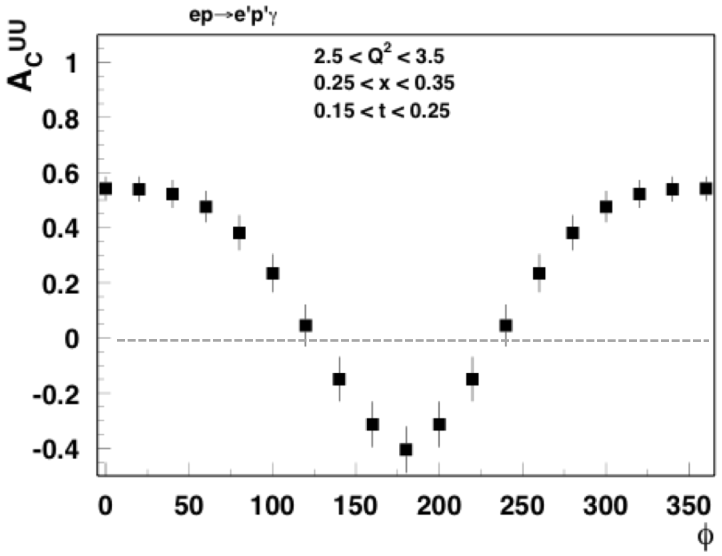


DVCS kinematics $E_{e+/e-}$ = 11 GeV

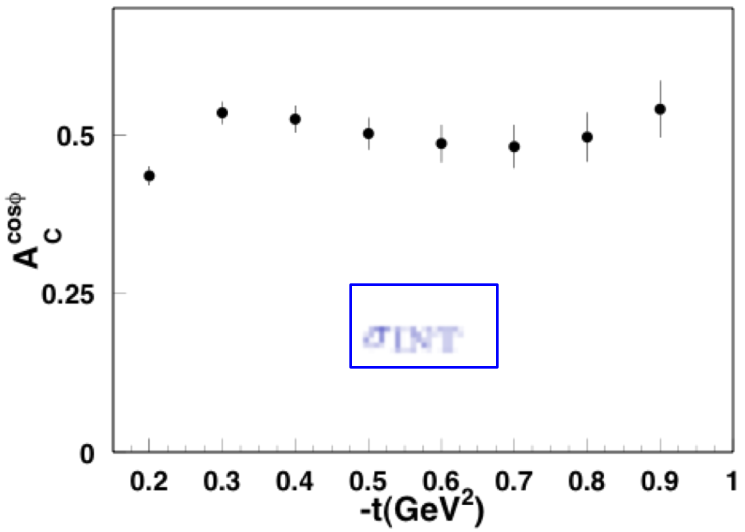


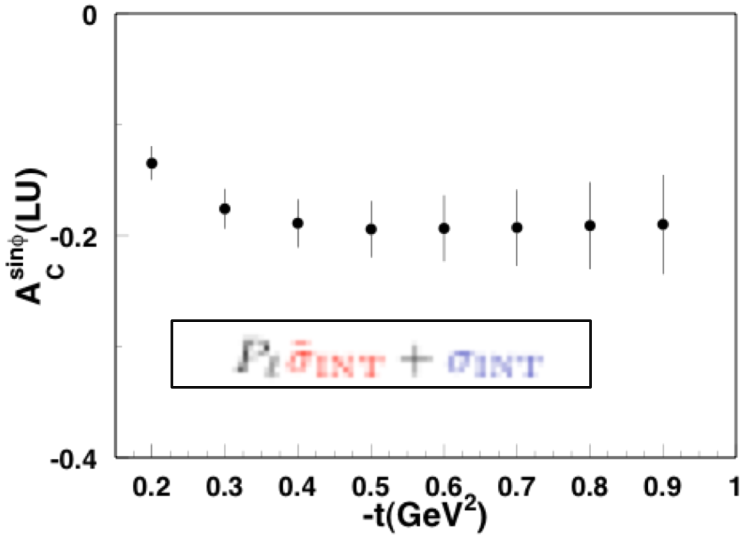
Charge Asymmetries are large

Positrons: L = $2\times10^{34}cm^{-2}s^{-1}$; P=0.6
Electrons: L = $10^{35}cm^{-2}s^{-1}$; P=0.8
E=11 GeV, 1000hrs.



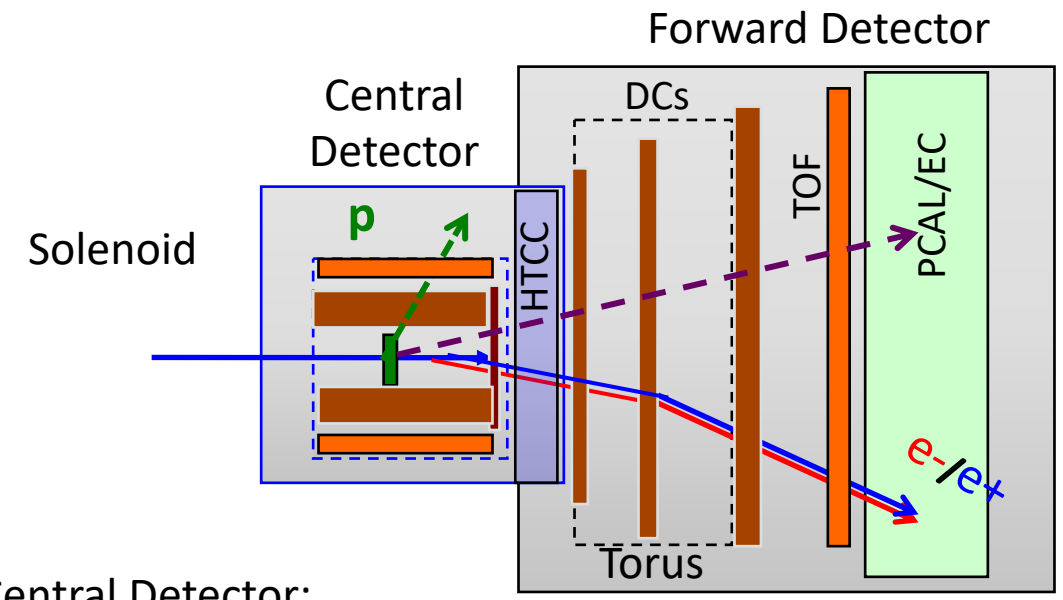
Dual model: V. Guzey (2009)

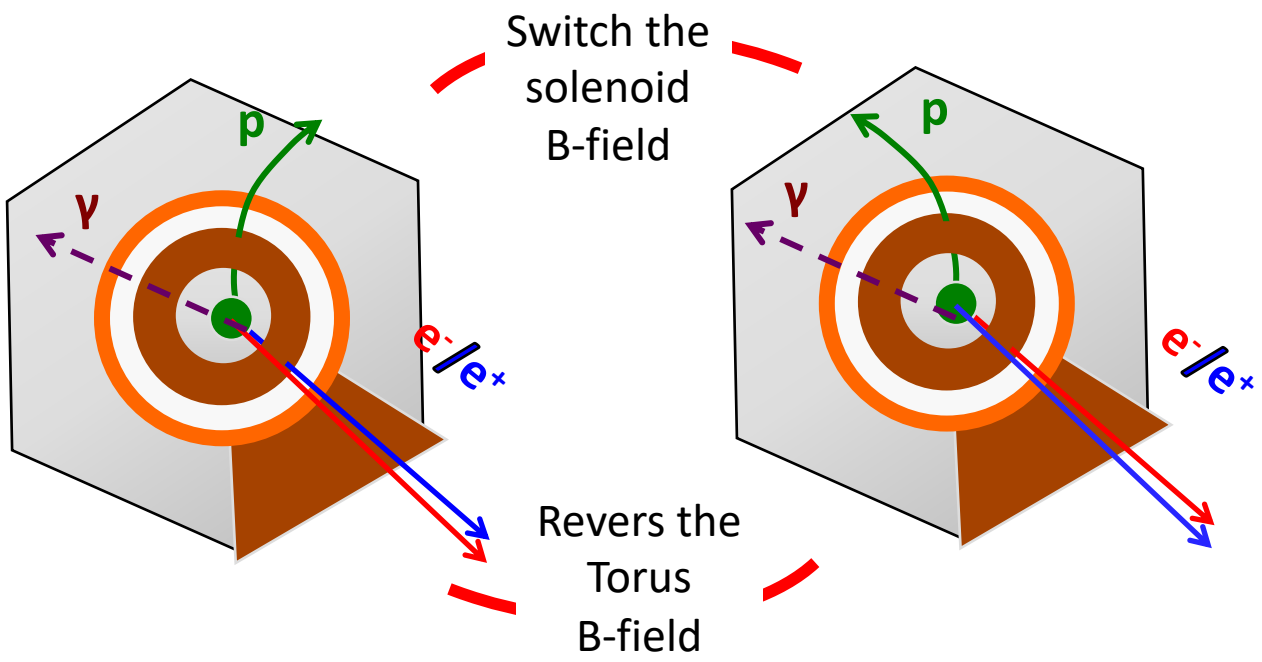




Charge asymmetries $A_c = e^+-e^-/e^++e^-$ in VCS are large and show strong azimuthal modulations. They can be measured with good accuracy.

CLAS12 e^+p/e^-p experiment (generic)





Central Detector:
- Charged particle tracking in solenoid field
- Polar angle range θ = 35 - 125°
- Azimuthal angle range Δϕ= 360°
- Particle ID by TOF for p < 1.2 GeV/c

Forward Detector:
- Charged particle tracking in Torus field
- Polar angle range θ = 6 - 35°
- Azimuthal angle range (0.6 – 0.9)x2π
- e^+/e^- ID in HTCC & ECAL

Potential false asymmetry due to e- and e+ with same vertex kinematics pass through different part of the forward detector shifted in phi in sector.

Two possible remedies:

1) Switch solenoid B-field => reveals false asymmetry in FD. May create create asymmetries in proton tracking.

2) Measure elastic scattering cross sections for e- and e+ at low enough Q^2 where 2-γ effects small. This is measured simultaneous with the DVCS process.

Positron/Electron Beam comparison

From Y. Roblin @ JPos17

Transverse Emittance* and Energy Spread†

12GeV config

Area	δp/p [x10^{-3}]	ε_x [nm]	ε_y [nm]
Chicane	0.5	4.00	4.00
Arc 1	0.05	0.41	0.41
Arc 2	0.03	0.26	0.23
Arc 3	0.035	0.22	0.21
Arc 4	0.044	0.21	0.24
Arc 5	0.060	0.33	0.25
Arc 6	0.090	0.58	0.31
Arc 7	0.104	0.79	0.44
Arc 8	0.133	1.21	0.57
Arc 9	0.167	2.09	0.64
Arc 10	0.194	2.97	0.95
Hall D	0.18	2.70	1.03

Damping

e- beam is dominated by synch. rad at 12GeV

Sync. Rad.

* Emittances are geometric
† Quantities are rms

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Y. Roblin, JPOS17 workshop, 12-15 Sept 2017

Transverse Emittance* and Energy Spread†

Positrons

Area	δp/p [x10^{-3}]	ε_x [nm]	ε_y [nm]
Chicane	10	500	500
Arc 1	1	50	50
Arc 2	0.53	26.8	26.6
Arc 3	0.36	19	18.6
Arc 4	0.27	14.5	13.8
Arc 5	0.22	12	11.2
Arc 6	0.19	10	9.5
Arc 7	0.17	8.9	8.35
Arc 8	0.16	8.36	7.38
Arc 9	0.16	8.4	6.8
MYAAT01	0.18	9.13	6.19

Damping

Sync. Rad.

* Emittances are geometric
† Quantities are rms

Courtesy Yves Roblin

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- Beam momentum spread is controled by Arcs, not the source.
- Beam emittance is about 5 times worth for positrons than for electrons.