

# *Beam Charge Asymmetries for Deeply Virtual Compton Scattering on the Proton at CLAS12*

V. Burkert<sup>1\*</sup>, L. Elouadrhiri<sup>1\*</sup>, F.-X. Girod<sup>3\*</sup>, J. Grames<sup>1</sup>, S. Niccolai<sup>2\*</sup>, E. Pasyuk<sup>1</sup>,  
B. Raue<sup>4</sup>, E. Voutier<sup>2\*</sup> ...

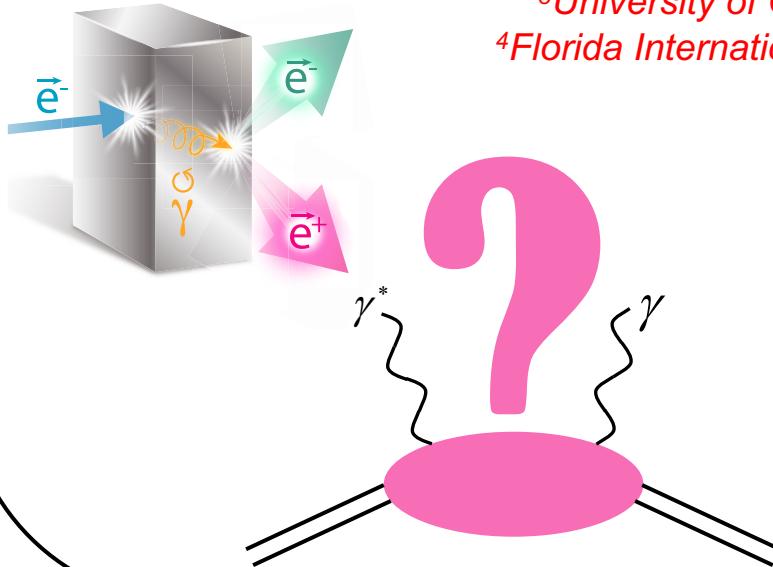
<sup>1</sup>*Thomas Jefferson National Accelerator Facility, Newport News, VA, USA*

<sup>2</sup>*Université Paris Saclay, IJCLab, Orsay, France*

<sup>3</sup>*University of Connecticut, Storrs, CT, USA*

<sup>4</sup>*Florida International University, Miami, FL, USA*

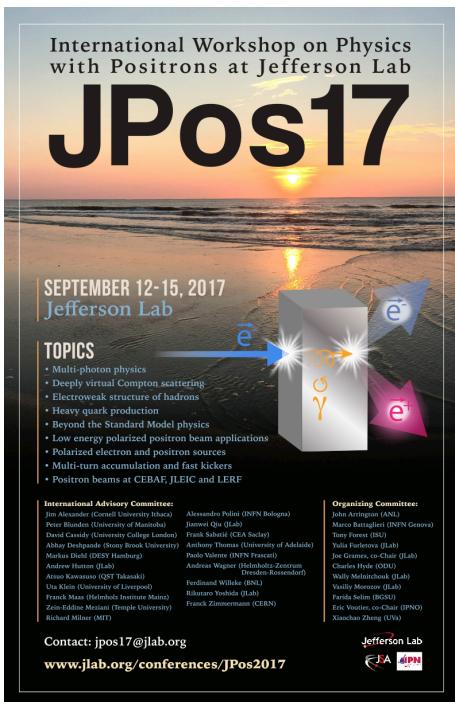
...



- (i) Physics motivations
- (ii) Proposed measurements
- (iii) Polarized positron beam production
- (iv) Positron beam in Hall B
- (v) Control of systematics
- (vi) Beam time request
- (vii) e<sup>+</sup>@JLab White Paper

## JPos17

Proc. of the International Workshop on Physics with Positrons at Jefferson Lab, J. Grames and E. Voutier Edts. AIP Conf. Proc. 1970 (2018)



Volume 1970

 Conference collection

International Workshop on Physics with Positrons at Jefferson Lab



Newport News, VA, USA  
12-15 September 2017

Editors  
Joseph Grames and Eric Voutier

AIP | Conference Proceedings

[proceedings.aip.org](http://proceedings.aip.org)

<https://aip.scitation.org/toc/apc/1970/1?size=all&expanded=1970>

**LOI12-18-004**

J. Grames, E. Voutier et al. Jefferson Lab LOI12-18-004 (2018), arXiv:1906.09419

Letter-of-Intent to PAC46  
LOI12-18-004

## Physics with Positron Beams at Jefferson Lab 12 GeV

Andrei Afanasev<sup>29</sup>, Ibrahim Albayak<sup>2</sup>, Salma Alzabi<sup>2</sup>,  
Moskov Amaryan<sup>21</sup>, Anisala AAngel<sup>13,28</sup>, John Annand<sup>24</sup>,  
Todd Averett<sup>2</sup>, Michael Avakian<sup>1</sup>, Michael Avakian<sup>1</sup>,  
Vincenzo Bellini<sup>11</sup>, Vladimir Berdnikov<sup>27</sup>, Jan Bernauer<sup>3</sup>,  
Angela Biselli<sup>11</sup>, Marie Bize<sup>27</sup>, Bill Briscoe<sup>1</sup>, Volker Burkert<sup>1</sup>,  
Alexander Butbul<sup>1</sup>, Antonio Calaprice<sup>1</sup>, Lawrence Camacho<sup>2</sup>,  
Marco Carnignotto<sup>1</sup>, Lucien Causse<sup>1</sup>, Andrea Celentano<sup>6</sup>,  
Pierre Chatagnon<sup>1</sup>, Giuseppe Ciaullo<sup>1,28</sup>, Marco Contalbrigo<sup>17</sup>,  
Donald Day<sup>2</sup>, Marisa Della Volpe<sup>1</sup>, Stefan Diehl<sup>1</sup>,  
Bilal Elouadrhiri<sup>1</sup>, Stephan Egerer<sup>1</sup>, Dipankar Dutta<sup>27</sup>,  
Mathieu Ehrhart<sup>1</sup>, Latifa Elouadrhiri<sup>1</sup>, Rui Ent<sup>1</sup>,  
Ishara Fernando<sup>11</sup>, Alessandra Filippi<sup>1</sup>, Yalla Furman<sup>1</sup>,  
Hayeon Gao<sup>1</sup>, Sabat Gasparian<sup>1</sup>, David Gaskell<sup>1</sup>,  
Frédéric Georges<sup>1</sup>, Frédéric Gérard<sup>1</sup>, Jeanne Grammes<sup>1</sup>,  
Chao Gu<sup>19</sup>, Michel Guida<sup>2</sup>, David Hamilton<sup>1</sup>, Douglas Hassel<sup>1</sup>,  
Douglas Higinbotham<sup>1</sup>, Mostafa Hoballah<sup>1</sup>, Tanja Horwitz<sup>1</sup>,  
Cesare Kalogeris<sup>1</sup>, Antonios Karavidas<sup>1</sup>, Gregorio Keltz<sup>1</sup>,  
Mitchell Kerner<sup>1</sup>, Paul King<sup>23</sup>, Edward Kinney<sup>9</sup>, Ho-San Ko<sup>2</sup>,  
Michael Kohl<sup>11</sup>, Valery Kubrakov<sup>1</sup>, Lucilla Lanza<sup>1,29</sup>,  
Paul Laskaris<sup>1</sup>, Dongmei Li<sup>1</sup>, Simon Lister<sup>17</sup>,  
Juliette Mameni<sup>1</sup>, Donnella Marchand<sup>1</sup>, Pete Markowitz<sup>13</sup>,  
Luca Marsicano<sup>6,5</sup>, Malek Mazouz<sup>11</sup>, Michael McCaughan<sup>1</sup>,  
Bryan McKinnon<sup>14</sup>, Mila Mihovilovic<sup>26</sup>, Richard Milner<sup>1</sup>,

Arthur Merchant<sup>1</sup>, Hantje Merscheneck<sup>4</sup>, Aram Movsisyan<sup>17</sup>,  
Carlo Mulas Campbell<sup>1</sup>, Pawel Nadel-Turonski<sup>1</sup>,  
Mazio De Natale<sup>28</sup>, Jannin Nazeer<sup>14</sup>, Silvia Niccolai<sup>2</sup>,  
Gabriel Niculescu<sup>20</sup>, Rainer Novotny<sup>32</sup>, Luciano Pappalardo<sup>7,31</sup>,  
Rafayel Parunichenko<sup>1</sup>, Eugene Pasyuk<sup>1</sup>, Tanvi Patel<sup>14</sup>,  
Iman Pegaz<sup>1</sup>, Antonio Perini<sup>1</sup>, Michael Pivovarov<sup>1</sup>,  
Nunzio Randazzo<sup>1</sup>, Mohamed Rashid<sup>24</sup>, Malina Rathmeyer<sup>14</sup>,  
Alessandro Rizzo<sup>1,24</sup>, Julie Rosche<sup>1</sup>, Oscar Roncero<sup>1</sup>,  
Aviel Schechter<sup>1</sup>, Mira Shabotova<sup>1</sup>, Youn Soo Shin<sup>1</sup>,  
Sam Sorensen<sup>1</sup>, Daniel Stavinschi<sup>1</sup>, Alexander Strumovsky<sup>1</sup>,  
Nikolai Spaventa<sup>1</sup>, Stepan Stepanyan<sup>1</sup>, Igor Strumovsky<sup>1</sup>,  
Vardan Tadevosyan<sup>1</sup>, Michael Tiefenbacher<sup>1</sup>, Richard Trotta<sup>27</sup>,  
Raffaella De Vita<sup>1</sup>, Hakan Voskanyan<sup>1</sup>, Eric Voutier<sup>1</sup>,  
Rong Wang<sup>1</sup>, Bozheng Xia<sup>1</sup>, Stepan Stepanyan<sup>1</sup>,  
Shengyong Zhao<sup>1</sup>, Simon Zhamkochyan<sup>1</sup>, Lingling Zhang<sup>37</sup>,  
Xiaochao Zheng<sup>1</sup>, Carl Zorn<sup>1</sup>.

<sup>1</sup>Thomas Jefferson National Accelerator Facility, Newport News, VA, USA  
<sup>2</sup>Université Paris Saclay, IJCLab, Orsay, France  
<sup>3</sup>Stony Brook University, Stony Brook, NY, USA  
<sup>4</sup>University of Connecticut, Storrs, CT, USA  
<sup>5</sup>The George Washington University, Washington, DC, USA  
<sup>6</sup>Istituto Nazionale di Fisica Nucleare, Genova, Italia  
<sup>7</sup>Università di Genova, Genova, Italia  
<sup>8</sup>Argonne National Laboratory, Argonne, IL, USA  
<sup>9</sup>University of Connecticut, CT, USA

...

**"These measurements all have significant physics interest. The proposers should carefully evaluate feasibility and present the best case possible in a future proposal."**

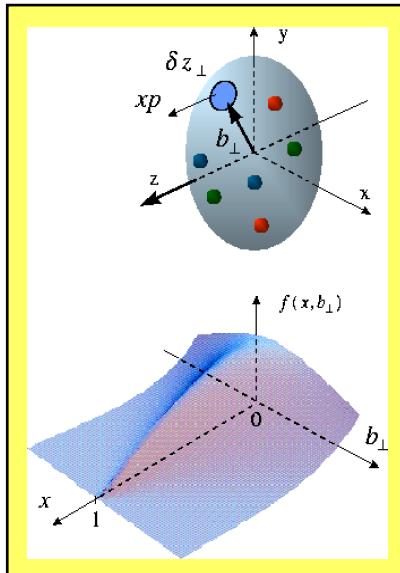
<sup>10</sup>Palo University  
114 Chapel Drive, Durham, NC 27708, USA  
<sup>11</sup>François D'Exaust, Université de Montréal  
1875 N Brossard Blvd., Burnaby, BC V5S 2C6, Canada  
<sup>12</sup>Berkeley University  
1873 N Beacons Blvd., Berkeley, CA 94720, USA  
<sup>13</sup>Florida International University  
11200 SW 8th St, Miami, FL 33199, USA  
<sup>14</sup>Florida Institute of Technology  
100 University Boulevard, Melbourne, FL 32906, USA  
<sup>15</sup>Institut National de Physique Nucléaire  
Sciences de la Matière, Paris-Saclay  
91191 Gif-sur-Yvette, France  
<sup>16</sup>Istituto Nazionale di Fisica Nucleare  
Via Santa Sofia, 64 - 00123 Roma, Italia  
<sup>17</sup>Joint Institute for Nuclear Research  
Russia, Dubna  
Via Serego 1, 20131 Milano, Italy  
<sup>18</sup>Istituto Nazionale di Fisica Nucleare  
Sezione di Roma, I-00193 Roma, Italia  
<sup>19</sup>Istituto Nazionale di Fisica Nucleare  
Via P. Giuria, 1 - 10133 Torino, Italia  
<sup>20</sup>James Madison University  
800 North Fairfax Street, Harrisonburg, VA 22807, USA  
<sup>21</sup>Massachusetts State University  
B.S. Harlan Library, Box 1000, Springfield, MA 01149, USA  
<sup>22</sup>North Carolina A&T State University  
1605 E Market Street, Greensboro, NC 27411, USA  
<sup>23</sup>Athena, OR 97530, USA  
<sup>24</sup>Old Dominion University  
5110 University Boulevard, Norfolk, VA 23508, USA  
<sup>25</sup>Humboldt State University  
180 North Mad River Road, Arcata, CA 95521, USA  
<sup>26</sup>Université de Sherbrooke  
1650 Avenue Provost, Sherbrooke, PQ J1M 1Z3, Canada  
<sup>27</sup>Université de Montréal  
114 Chapel Drive, Burnaby, BC V5S 2C6, Canada  
<sup>28</sup>Université de Paris  
75231 Paris Cedex 05, France  
<sup>29</sup>Universität Regensburg  
93040 Regensburg, Germany  
<sup>30</sup>University of Alberta  
Edmonton, AB T6G 2E8, Canada  
<sup>31</sup>University of Birmingham  
Birmingham, B15 2TT, United Kingdom  
<sup>32</sup>University of Manitoba  
60 Chancellors Circle, Winnipeg, MB, Canada  
<sup>33</sup>University of New Hampshire  
100 Main Street, Durham, NH 03824, USA  
<sup>34</sup>University of Virginia  
382 McCormick Rd, Charlottesville, VA 22904, USA  
<sup>35</sup>Universitat de València  
Avda. del Cid, 5 - 46130 Valencia, Spain  
<sup>36</sup>Yale University  
325 Prospect Street, New Haven, CT 06511, USA  
<sup>37</sup>A. Aboimov National Laboratory  
Yerevan Physics Institute  
Aboimov Building, 21, 375006, Armenia  
<sup>38</sup>A. Akhiezer Institute  
Pionovskiy Prospekt, 11, 197000, Russia

<sup>1</sup>Contact person: J. Grames (grames@jlab.org), E. Voutier (voutier@jlab.org)

## Parton Imaging

D. Müller, D. Robaschik, B. Geyer, F.M. Dittes, J. Horejsi, FP 42 (1994) 101   X. Ji, PRD 55 (1997) 7114   A. Radyushkin, PRD 56 (1997) 5524

- **GPDs parameterize the partonic structure of hadrons and offer the unprecedented possibility to access the spatial distribution of partons.**



**GPDs encode the correlations between partons** and contain information about the dynamics of the system like the **angular momentum** or the **distribution of the strong forces** experienced by quarks and gluons inside hadrons.

X. Ji, PRL 78 (1997) 610

M. Polyakov, PL B555 (2003) 57

M. Burkardt, PRD 62 (2000) 071503   M. Diehl, EPJC 25 (2002) 223

**GPDs can be interpreted as a distribution in the transverse plane of partons carrying some fraction of the longitudinal momentum of the nucleon.**

A new light  
on hadron  
structure

## $\mathcal{N}(e,e'\gamma N)$ Differential Cross Section

M. Diehl at the CLAS12 European Workshop, Genova, February 25-28, 2009

$$\sigma(eN \rightarrow eN\gamma) = \left| \text{DVCS} + \text{Bethe-Heitler (BH)} \right|^2$$

$$\sigma_{P0}^e = \sigma_{BH} + \sigma_{DVCS} + P_1 \tilde{\sigma}_{DVCS} + e_1 (\sigma_{INT} + P_1 \tilde{\sigma}_{INT})$$

Electron  
observables

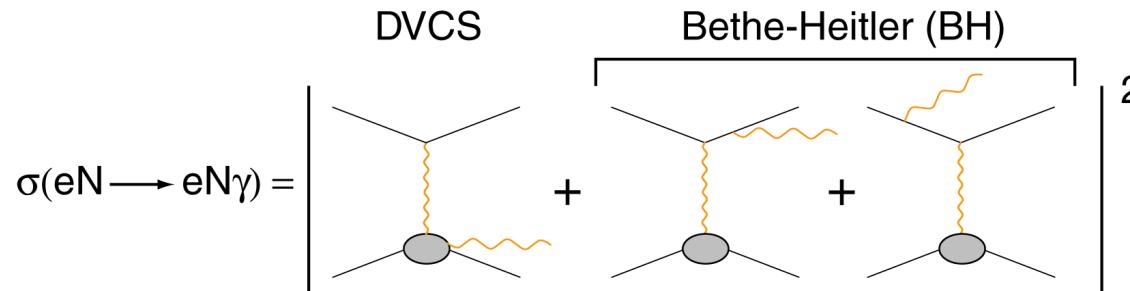
$$\begin{aligned}\sigma_{00}^- &= \sigma_{BH} + \sigma_{DVCS} - \sigma_{INT} \\ \sigma_{+0}^- - \sigma_{-0}^- &= 2 \tilde{\sigma}_{DVCS} - 2 \tilde{\sigma}_{INT}\end{aligned}$$

Electron & positron  
observables

$$\begin{aligned}\sigma_{00}^+ - \sigma_{00}^- &= 2 \sigma_{INT} \\ [\sigma_{+0}^+ - \sigma_{-0}^+] - [\sigma_{+0}^- - \sigma_{-0}^-] &= [\sigma_{+0}^+ - \sigma_{+0}^-] - [\sigma_{-0}^+ - \sigma_{-0}^-] = 4 \tilde{\sigma}_{INT}\end{aligned}$$

## $\mathcal{N}(e, e'\gamma N)$ Differential Cross Section

M. Diehl at the CLAS12 European Workshop, Genova, February 25-28, 2009



$$\sigma_{P0}^e = \sigma_{BH} + \sigma_{DVCS} + P_1 \tilde{\sigma}_{DVCS} + e_1 (\sigma_{INT} + P_1 \tilde{\sigma}_{INT})$$

Electron  
observables

$$\begin{aligned}\sigma_{00}^- &= \sigma_{BH} + \sigma_{DVCS} - \sigma_{INT} \\ \sigma_{+0}^- - \sigma_{-0}^- &= 2 \tilde{\sigma}_{DVCS} - 2 \tilde{\sigma}_{INT}\end{aligned}$$

Electron & positron  
observables

$$\begin{aligned}\sigma_{00}^+ - \sigma_{00}^- &= 2 \sigma_{INT} \\ [\sigma_{+0}^+ - \sigma_{-0}^+] - [\sigma_{+0}^- - \sigma_{-0}^-] &= [\sigma_{+0}^+ - \sigma_{+0}^-] - [\sigma_{-0}^+ - \sigma_{-0}^-] = 4 \tilde{\sigma}_{INT}\end{aligned}$$

Polarized electrons and positrons allow to **separate** the unknown amplitudes of the cross section for electro-production of photons.

## Nucleon Internal Pressure

V. Burkert, L. Elouadrhiri, F.-X. Girod, Nature 557 (2018) 396    M.V. Polyakov, P. Schweitzer, Int. J. Mod. Phys. A33 (2018) 1830025  
 K. Kumerički, Nature 570 (2019) E1

$$\int_{-1}^1 x H(x, \xi, t) dx = M_2(t) + \frac{4}{5} \xi^2 d_1(t)$$

The 2<sup>nd</sup> order **Mellin moment** of GPDs allow to access the pressure distribution inside hadrons through the **skewness dependency** of GPDs... (**DDVCS**).

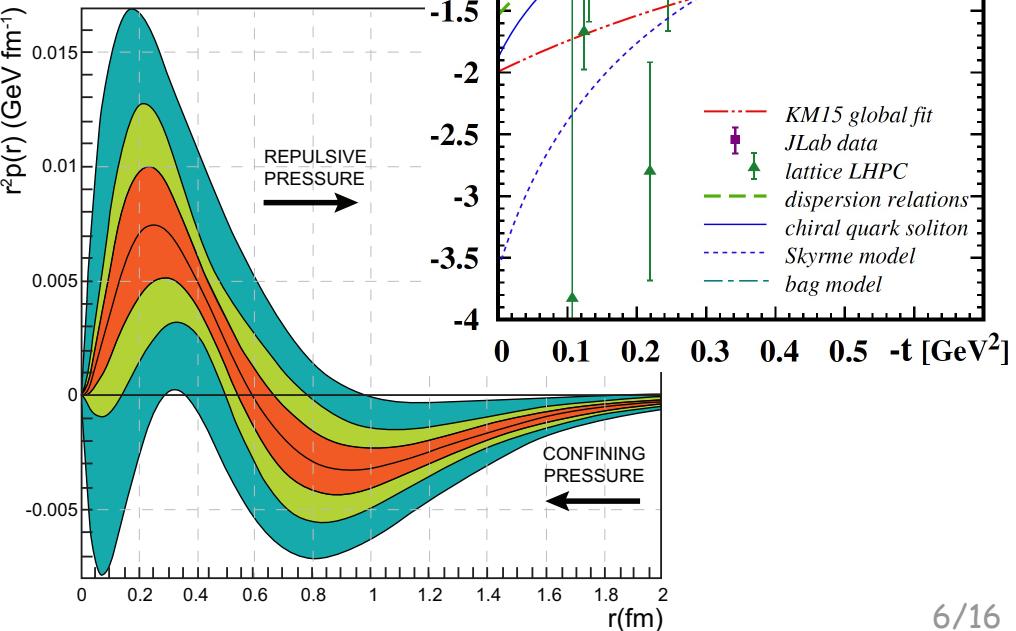
CFF

$$\mathcal{H}(\xi, t) = \int_{-1}^1 \left[ \frac{1}{\xi - x - i\epsilon} - \frac{1}{\xi + x - i\epsilon} \right] H(x, \xi, t) dx$$

$$\Re e[\mathcal{H}(\xi, t)] \stackrel{\text{LO}}{=} D(t) + \mathcal{P} \left\{ \int_{-1}^1 \left[ \frac{1}{\xi - x} - \frac{1}{\xi + x} \right] \Im m[\mathcal{H}(x, t)] dx \right\}$$

$$D(t) = \frac{1}{2} \int_{-1}^1 \frac{D(z, t)}{1 - z} dz$$

$$D(z, t) = (1 - z^2) [d_1(t) C_1^{3/2}(z) + \dots]$$



## Nucleon Internal Pressure

V. Burkert, L. Elouadrhiri, F.-X. Girod, Nature 557 (2018) 396    M.V. Polyakov, P. Schweitzer, Int. J. Mod. Phys. A33 (2018) 1830025  
 K. Kumerički, Nature 570 (2019) E1

$$\int_{-1}^1 x H(x, \xi, t) dx = M_2(t) + \frac{4}{5} \xi^2 d_1(t)$$

The 2<sup>nd</sup> order **Mellin moment** of GPDs allow to access the pressure distribution inside hadrons through the **skewness dependency** of GPDs... (**DDVCS**).

CFF

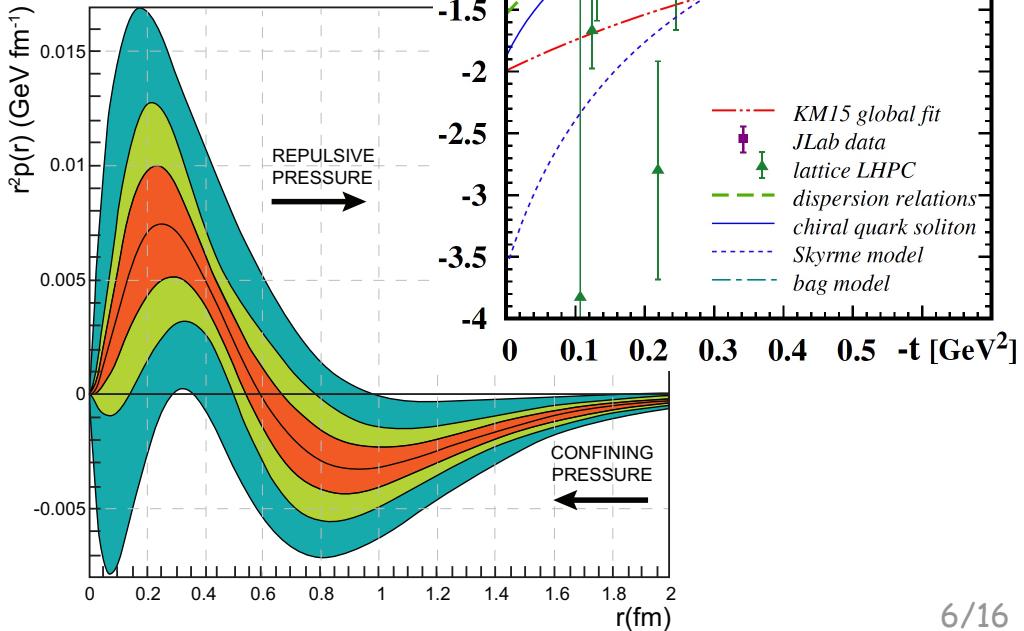
$$\mathcal{H}(\xi, t) = \int_{-1}^1 \left[ \frac{1}{\xi - x - i\epsilon} - \frac{1}{\xi + x - i\epsilon} \right] H(x, \xi, t) dx$$

$$\Re e[\mathcal{H}(\xi, t)] \stackrel{\text{LO}}{=} D(t) + \mathcal{P} \left\{ \int_{-1}^1 \left[ \frac{1}{\xi - x} - \frac{1}{\xi + x} \right] \Im m[\mathcal{H}(x, t)] dx \right\}$$

$$D(t) = \frac{1}{2} \int_{-1}^1 \frac{D(z, t)}{1-z} dz$$

$$D(z, t) = (1 - z^2) [d_1(t) C_1^{3/2}(z) + \dots]$$

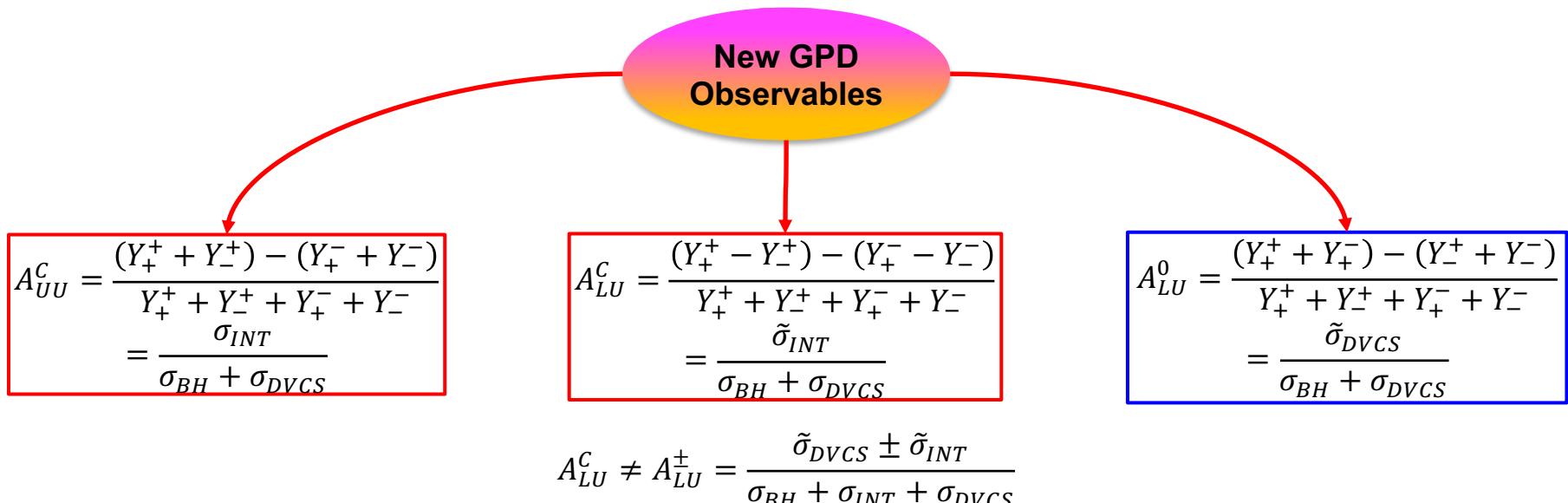
Real part of Compton form factors  
( $\sigma_{\text{INT}}$ )



## Beam Charge Asymmetries

Using polarized electron and positron beams, we are proposing to measure

- The unpolarized beam charge asymmetry  $A_{UU}^C$ , which is sensitive to the **CFF real part**
- The polarized beam charge asymmetry  $A_{LU}^C$ , which is sensitive to the **CFF imaginary part**
- The charge averaged beam spin asymmetry  $A_{LU}^0$ , which is sensitive to **higher twist effects**



$Y_{\pm P^\pm}^{e\pm} = \frac{N_\pm^\pm}{Q_\pm^\pm}$  is the beam polarization and accumulated charge normalized yield.

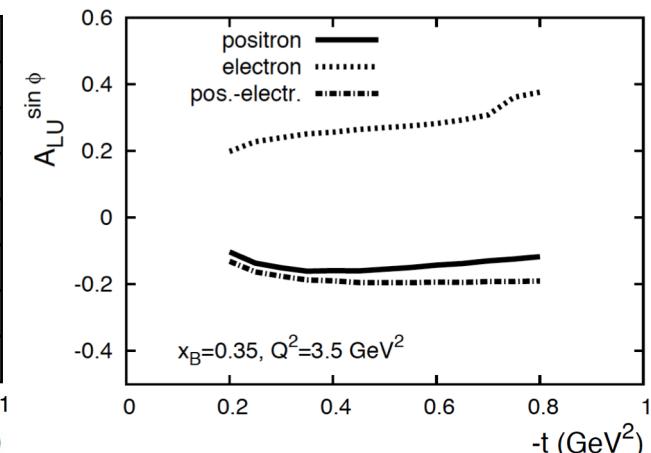
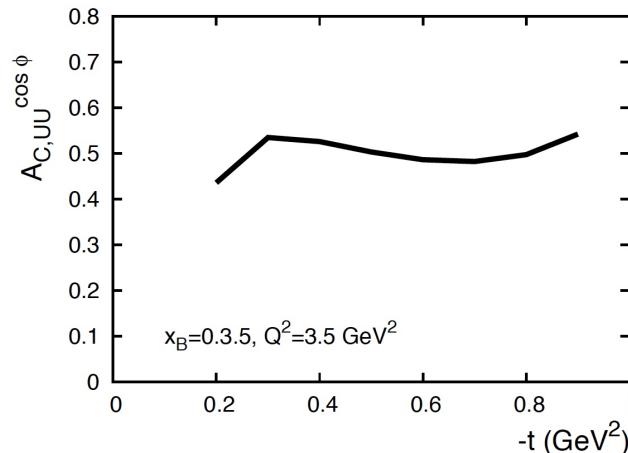
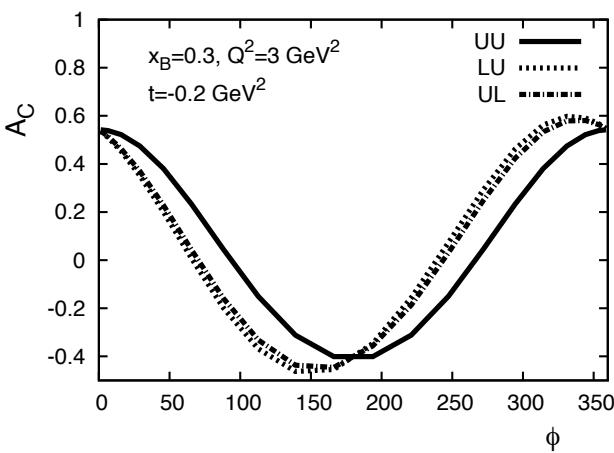
## Experimental Observables

H. Avakian, V. Burkert, V. Guzey, JPos09, AIP 1160 (2009) 43

$$CFF \propto F_1 \mathcal{H} + \frac{x_B}{2 - x_B} (F_1 + F_2) \tilde{\mathcal{H}} - \frac{t}{4M^2} F_2 \mathcal{E}$$

Dominant contribution at twist-2 approximation

- Experimental observables are evaluated assuming GPD **H** and **E** dominance, within a **dual parameterization** approach.

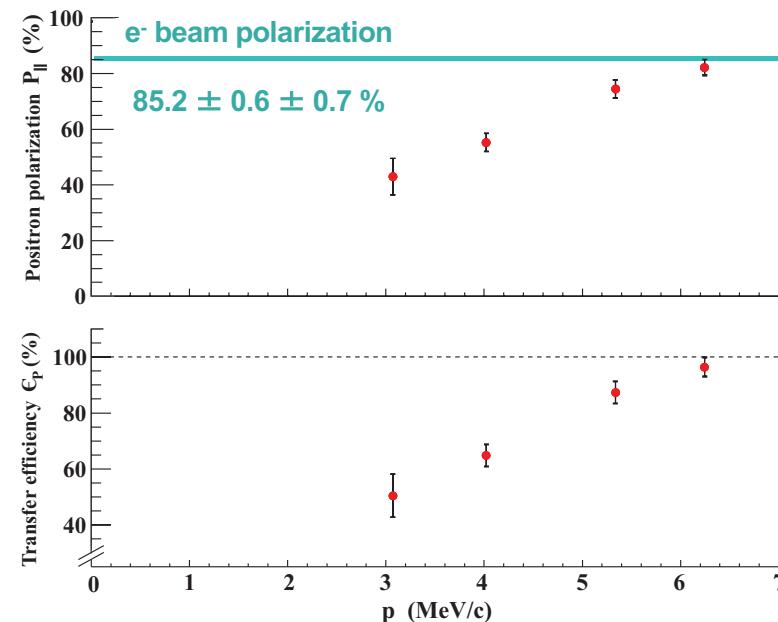
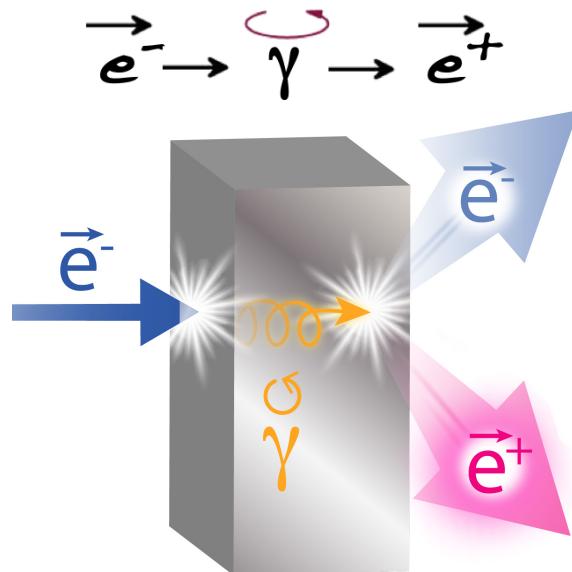


Beam charge asymmetries with large amplitudes are predicted.

## Polarized Electrons for Polarized Positrons

(PEPPo Collaboration) D. Abbott et al. , PRL 116 (2016) 214801

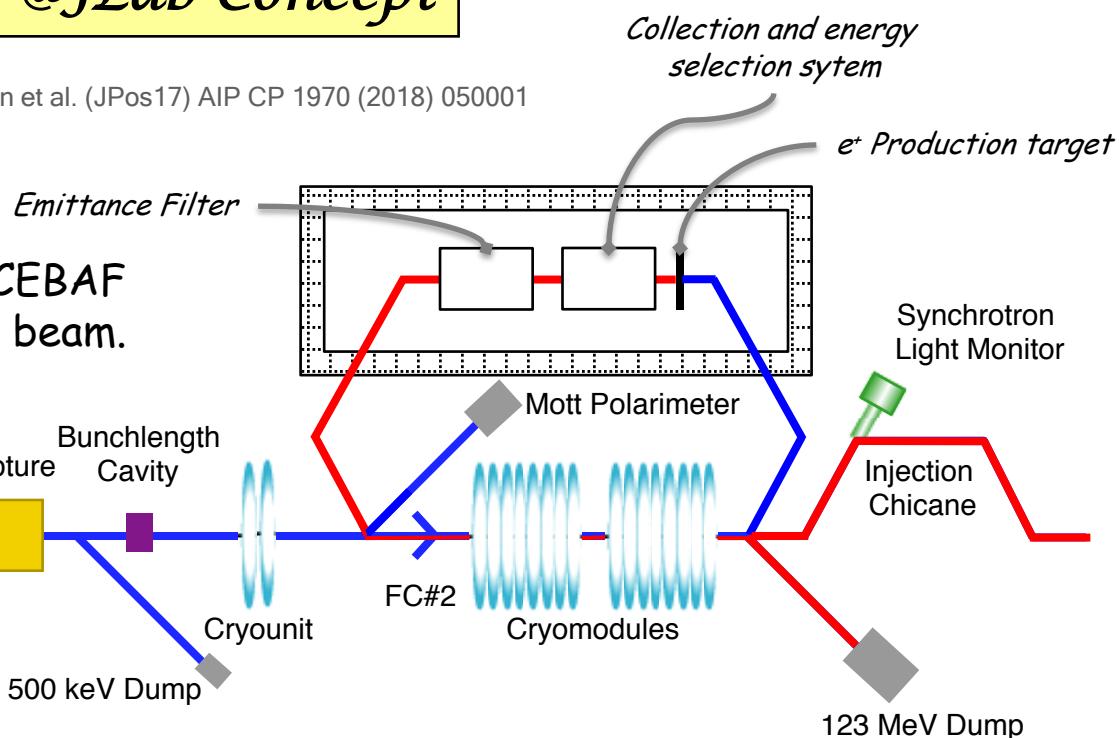
- PEPPo demonstrated **efficient polarization transfer** from 8.2 MeV/c electrons to **positrons**, expanding polarized positron capabilities **from GeV to MeV accelerators**.



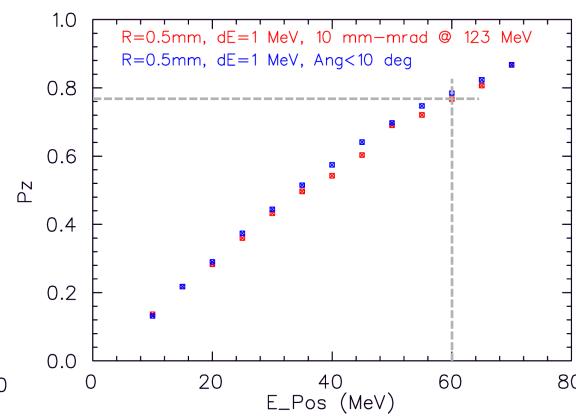
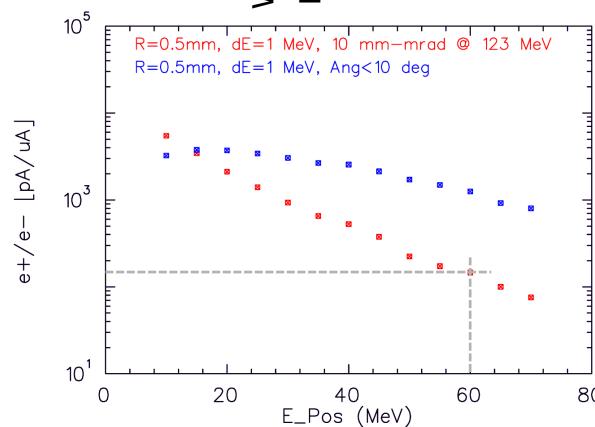
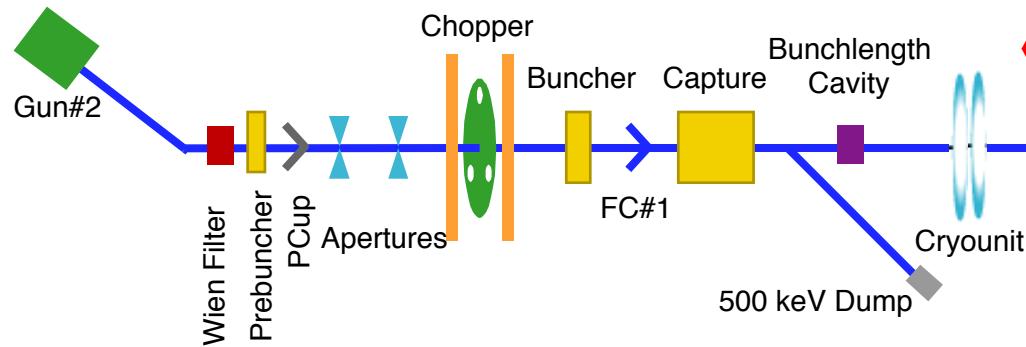
The PEPPo technique can achieve up to **100% transfer** of the electron.

## $e^+@JLab$ Concept

L. Cardman et al. (JPos17) AIP CP 1970 (2018) 050001



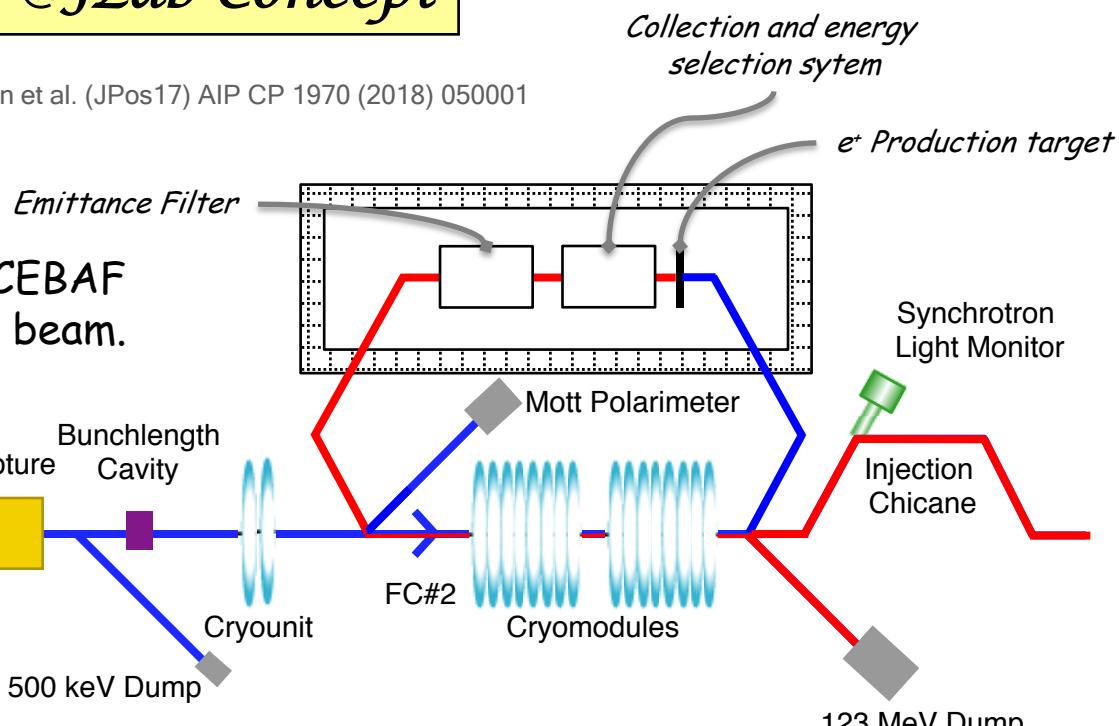
➤ Positrons would be created at the CEBAF injector, using the **123 MeV** electron beam.



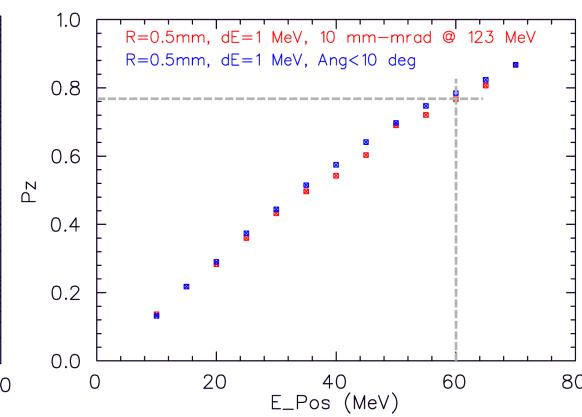
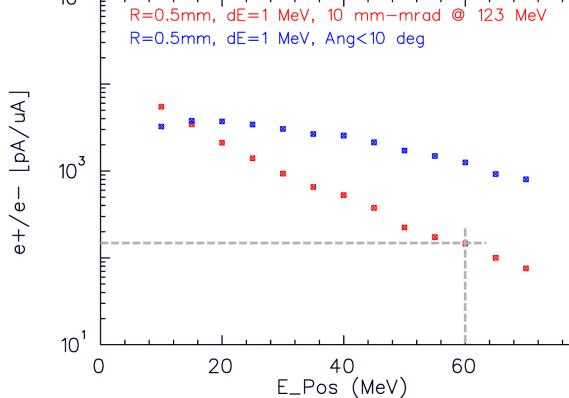
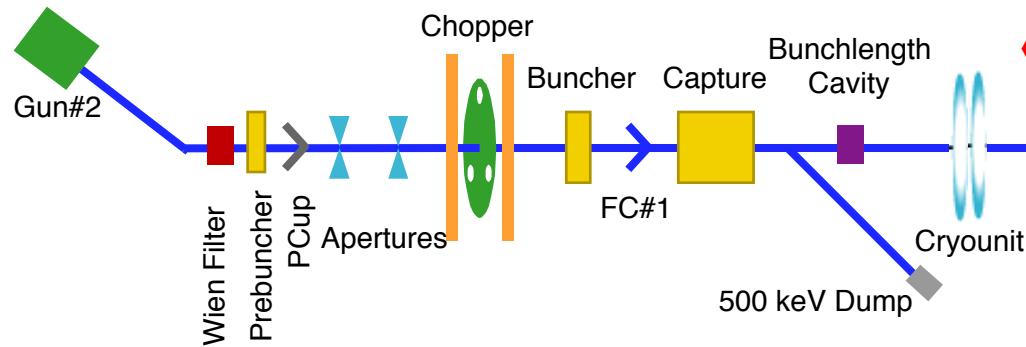
- ✓ Selecting **60 MeV** positrons maximizes the FoM ( $P_{e^+} \approx 75\% P_{e^-}$ ,  $I \approx 100 \text{ nA}$ )
- ✓ Selecting **6 MeV** positrons maximizes the flux ( $I > 1 \mu\text{A}$ )

## $e^+@JLab$ Concept

L. Cardman et al. (JPos17) AIP CP 1970 (2018) 050001



➤ Positrons would be created at the CEBAF injector, using the **123 MeV** electron beam.



✓ Selecting **60 MeV** maximizes  $+/-$  ( $P_{e^+} \approx 75\%$ )  
✓ 4 pC @ 250 MHz beam power on a thick target  
123 kW beam power on **MeV** positrons maximizes the flux ( $I > 1 \mu\text{A}$ )

## *e<sup>+</sup> Beam Induced Modifications*

### **Beam transport and characterization**

- There is **no difference** between electron and positron beam transport in Hall B beam line
- Beam diagnostic should be operated *in principle*
- *Møller to Bhabha polarimeter*

*On-going reflexion of experts*

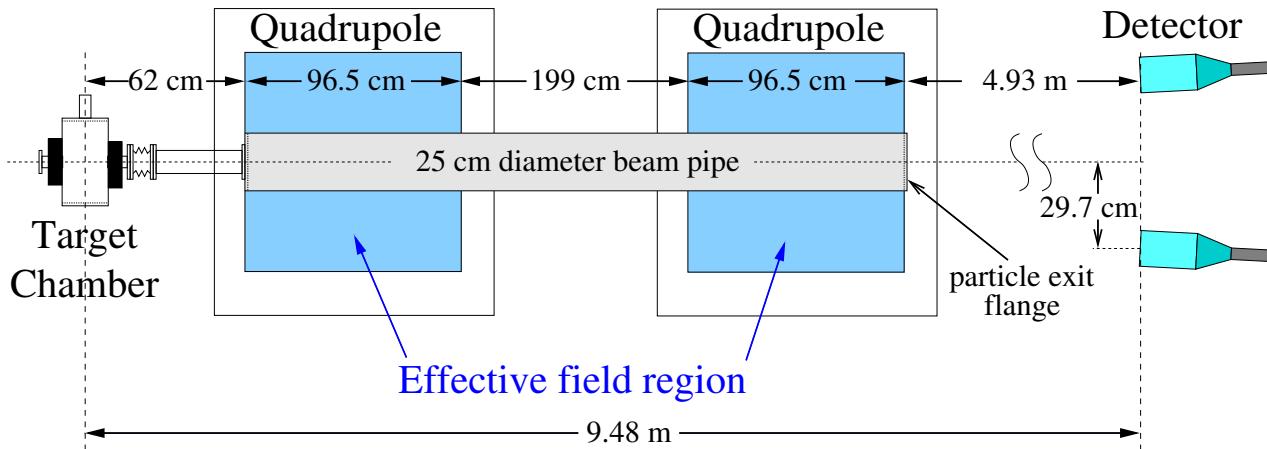
### **Beam related background in CLAS12**

- **Bhabha** and **Møller** scattering have different angular distributions: from similar to **much smaller** as c.m. angle increases
- Positron **annihilation** is an additional background process

*Simulations in progress*

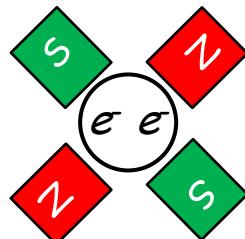
## Møller to Bhabha Polarimeter

TOP VIEW



Bhabha asymmetry is identical to Møller, and cross sections similar magnitude at 90°c.m.

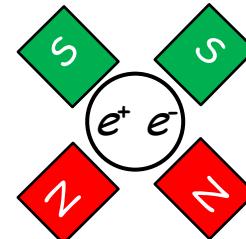
The transition of the Møller polarimeter into a Bhabha polarimeter requires to rewire the quads into dipoles.



view downstream

- Loss of half the coincidences
- Potential background issues from cross-over events

*In principle possible...*



in bending mode

B. Raué

## Beam Related Systematics

Y. Roblin at the International Workshop on Physics with Positrons at Jefferson Lab, Newport News, September 12-15, 2017

- Despite much larger momentum dispersion and emittance at the source,  $e^+$  and  $e^-$  beams have the same  $\delta p/p$  at target, with an emittance **2-3 times larger**.

### Transverse Emittance\* and Energy Spread†

Area	$\delta p/p$ [ $\times 10^{-3}$ ]	$\epsilon_x$ [nm]	$\epsilon_y$ [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

### 12GeV config

Damping

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

Sync. Rad.

\* Emittances are geometric

† Quantities are rms

### Transverse Emittance\* and Energy Spread†

Area	$\delta p/p$ [ $\times 10^{-3}$ ]	$\epsilon_x$ [nm]	$\epsilon_y$ [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	9.4	6.8
MYAAT01	0.18	9.13	6.19

### Positrons

Damping

Sync. Rad.

\* Emittances are geometric

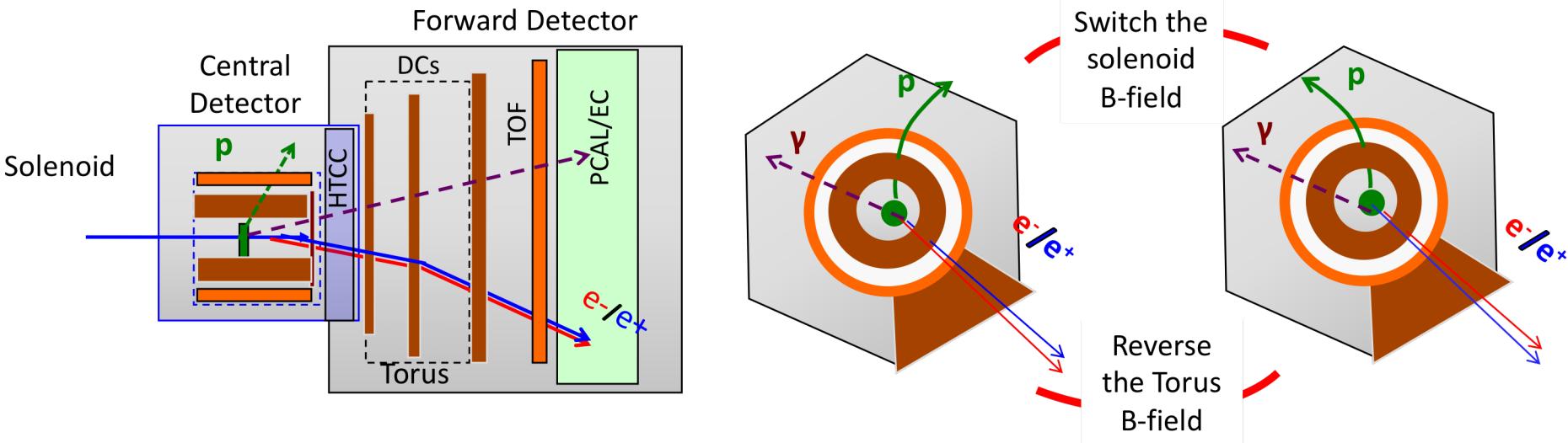
† Quantities are rms

Courtesy Yves Roblin

- Select the electron from the  $e^+e^-$ -pair produced at the source to investigate these possible effects or perform the physics measurement.

## Detector Related Systematics

- Potential false asymmetries may occur between due to  $e^-$  and  $e^+$  from same vertex and kinematics passing through different part of the detector shifted in  $\phi$  in a sector.



### Two possible remedies

V. Burkert

- **Switch** the **solenoid field** to reveals false asymmetries in FD, which may creates false asymmetries in proton tracking.
- **Measure**, simultaneously to DVCS, **elastic scattering** cross sections for  $e^-$  and  $e^+$  at low  $Q^2$  where  $2\gamma$ -effects are small.

**BCA @ CLAS12**

Purpose	Beam	Energy (GeV)	Polarization (%)	Luminosity ( $\text{cm}^{-2} \cdot \text{s}^{-1}$ )	Time (d)
Commissionning / Calibration	$e^+ / e^-$	11	60 (> 40)	$10^{35}$	4
p-DVCS	$e^-$				38
	$e^+$				38
<i>Total</i>					<b>80</b>

- We propose to run for **80 days** equally shared between polarized positron and electron beams, including:  
 commissionning of « new » equipment,  
 specific **systematics calibration** measurements,  
 DVCS physics data taking off the proton.

- Projections of experimental measurements
- **Impact** of positron measurements on **CFF** extraction
- **Impact** of positron measurements on **D-term** determination

**Work in progress...**

## JLab Positron Working Group

[https://wiki.jlab.org/pwgwiki/index.php/E%2B\\_White\\_Paper\\_Sub-Group](https://wiki.jlab.org/pwgwiki/index.php/E%2B_White_Paper_Sub-Group)

- The JLab Positron Working Group is developing a **White Paper** intenting to describe the full extent of a **Physics Program** with **Positron beams** at **JLab**.

*Full information available here*

### Four Physics Sub-Groups

- Deeply Virtual Compton Scattering (Silvia Niccolai, [niccolai@ipno.in2p3.fr](mailto:niccolai@ipno.in2p3.fr))
- Two-Photon Exchange Physics (Axel Schmidt, [schmidta@jlab.org](mailto:schmidta@jlab.org))
- Physics Beyond the Standard Model (Marco Battaglieri, [battagli@jlab.org](mailto:battagli@jlab.org))
- Other Topics (Douglas Higinbotham, [doug@jlab.org](mailto:doug@jlab.org))

### Revised Time Table

First draft of each contribution: **May 11th**.

Final contribution: **June 1st**.

First draft of the White Paper: June 15th.

Final Positron White Paper: **June 29th**.

Contact the convener of your physics sub-group  
for any contribution to the  
**e<sup>+</sup>@JLab White Paper**

*Template files available here*

<https://ipnshare.in2p3.fr/owncloud/index.php/s/BdDZ2NHS2qSV4jZ/download>