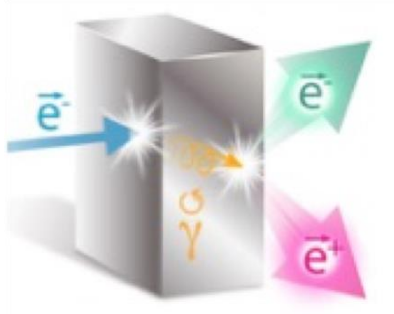
Update on PR12+23-008

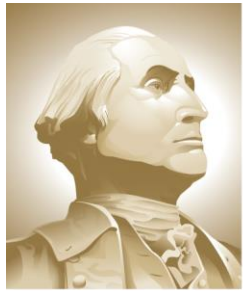
"A Direct Measurement of Hard Two-Photon Exchange with Electrons and Positrons at CLAS12"

Axel Schmidt

Positron Working Group Annual Meeting

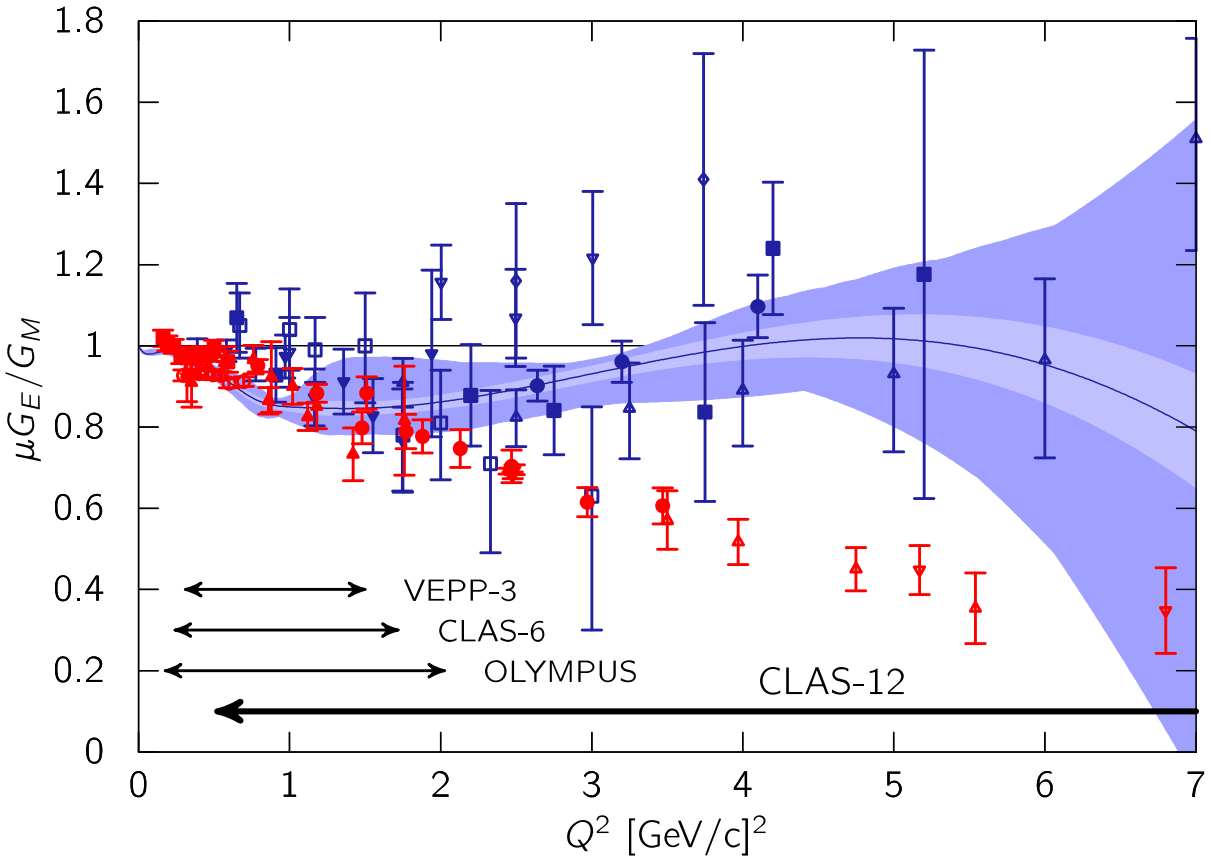
March 24, 2025





THE GEORGE WASHINGTON UNIVERSITY
WASHINGTON, DC

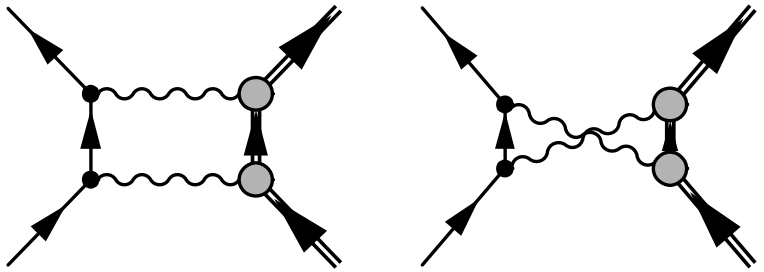
Is hard two-photon exchange responsible for the proton form factor discrepancy?



Rosenbluth
- Litt '70
- Berger '71
- Bartel '73
- Andivahis '94
- Walker '94
- Christy '04
- Qattan '05

Bernauer '13

Polarized
- Gayou '01
- Punjabi '05
- Jones '06
- Zhan '11
- Crawford '07
- Puckett '12
- Puckett '17



Two-Photon Exchange

(only partially treated in standard radiative corrections)

E12+23-008: Compare e^+p and e^-p elastic scattering at CLAS12

J. C. Bernauer, V. D. Burkert, E. Cline, I. Korover, **A. Schmidt**, N. Santiesteban, T. Kutz

- 55 PAC days in Hall B
- Alternating e^+, e^- beams
  - 2.2, 4.4., 6.6 GeV, at 1 μA
- Liquid H_2 target, 10^{35} cm^{-2} s^{-1} luminosity
- Measure $R_{2\gamma} = \sigma_{e^+p}/\sigma_{e^-p}$
  - Coincidence of both $e^{\pm}$ and p
  - Measure all combinations of magnet polarities to reduce systematics.

Jefferson Lab

Stony Brook University

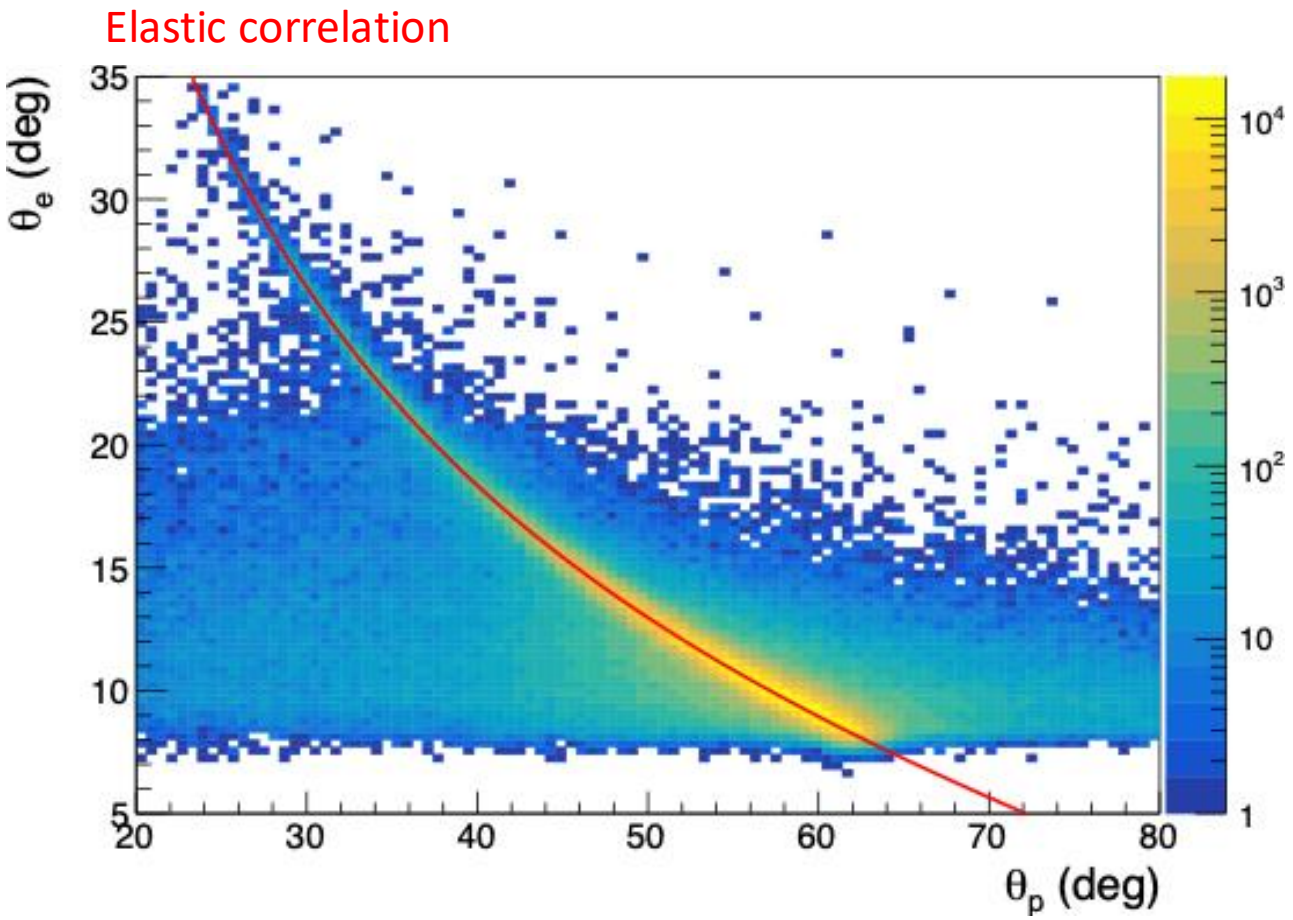
JG|U JOHANNES GUTENBERG UNIVERSITÄT MAINZ

TEL AVIV UNIVERSITY

GW

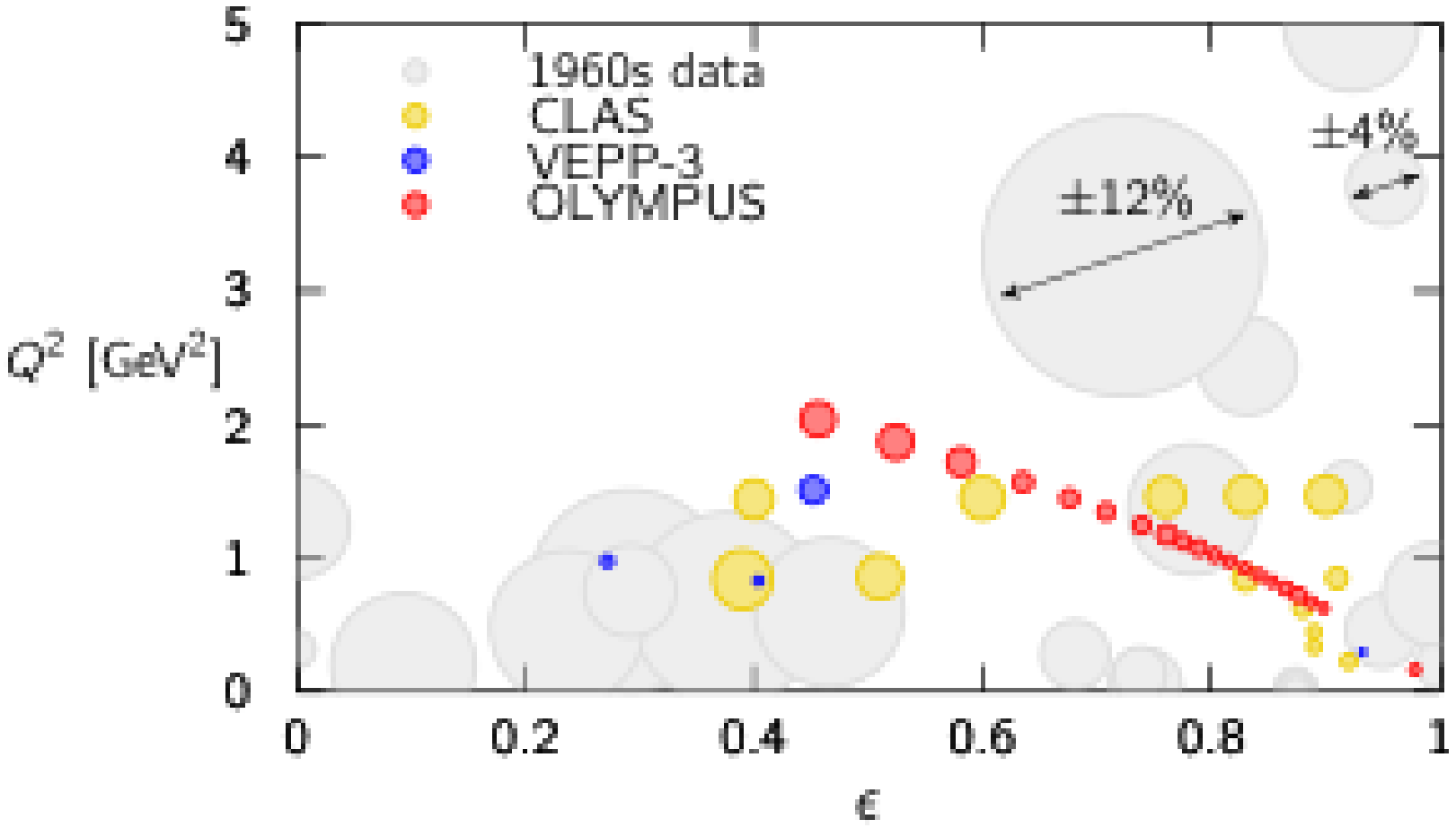
University of New Hampshire

E12+23-008: Compare e^+p and e^-p elastic scattering at CLAS12

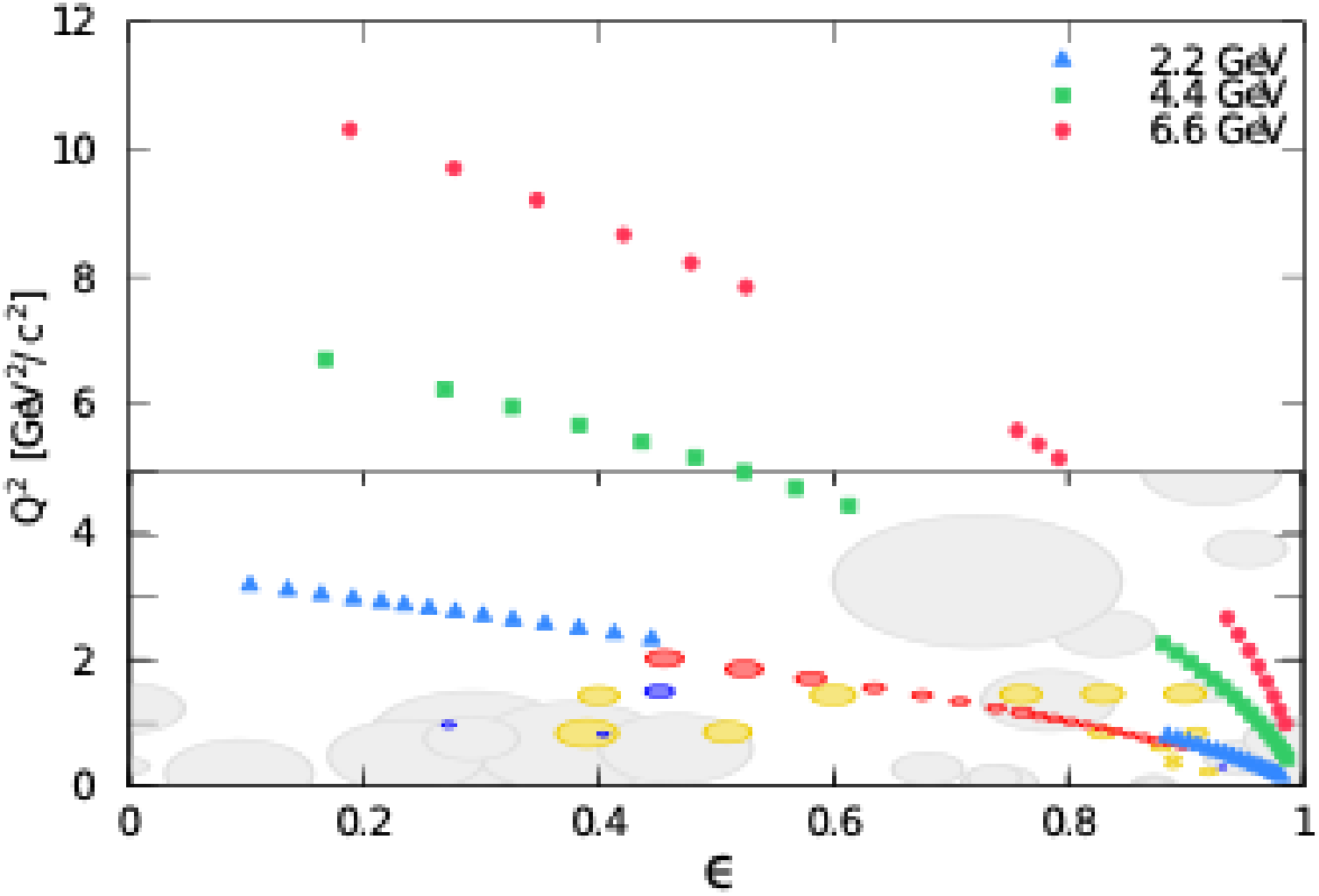


6 GeV electron data from CLAS12 Run Group M

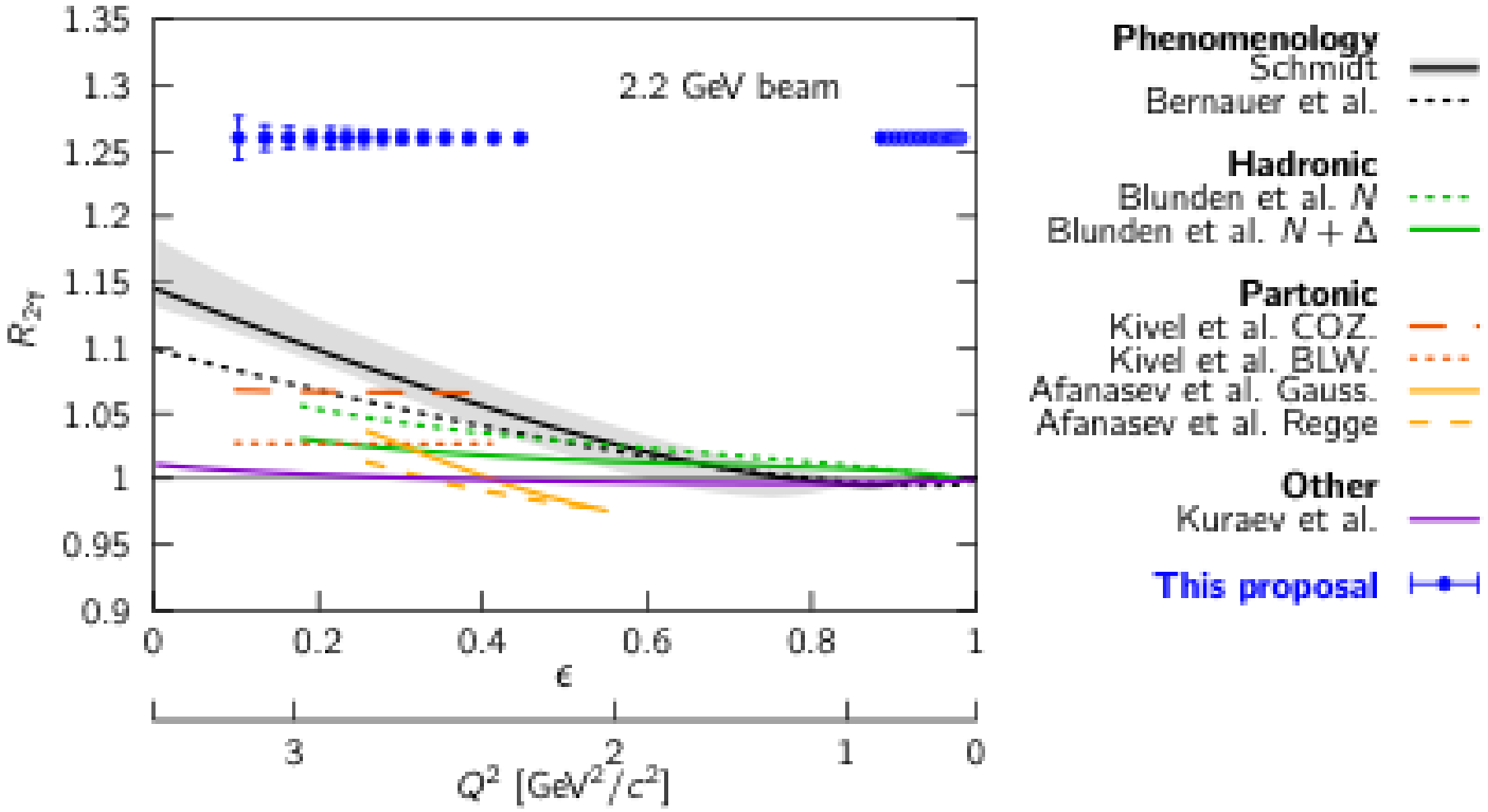
E12+23-008: Compare e^+p and e^-p elastic scattering at CLAS12



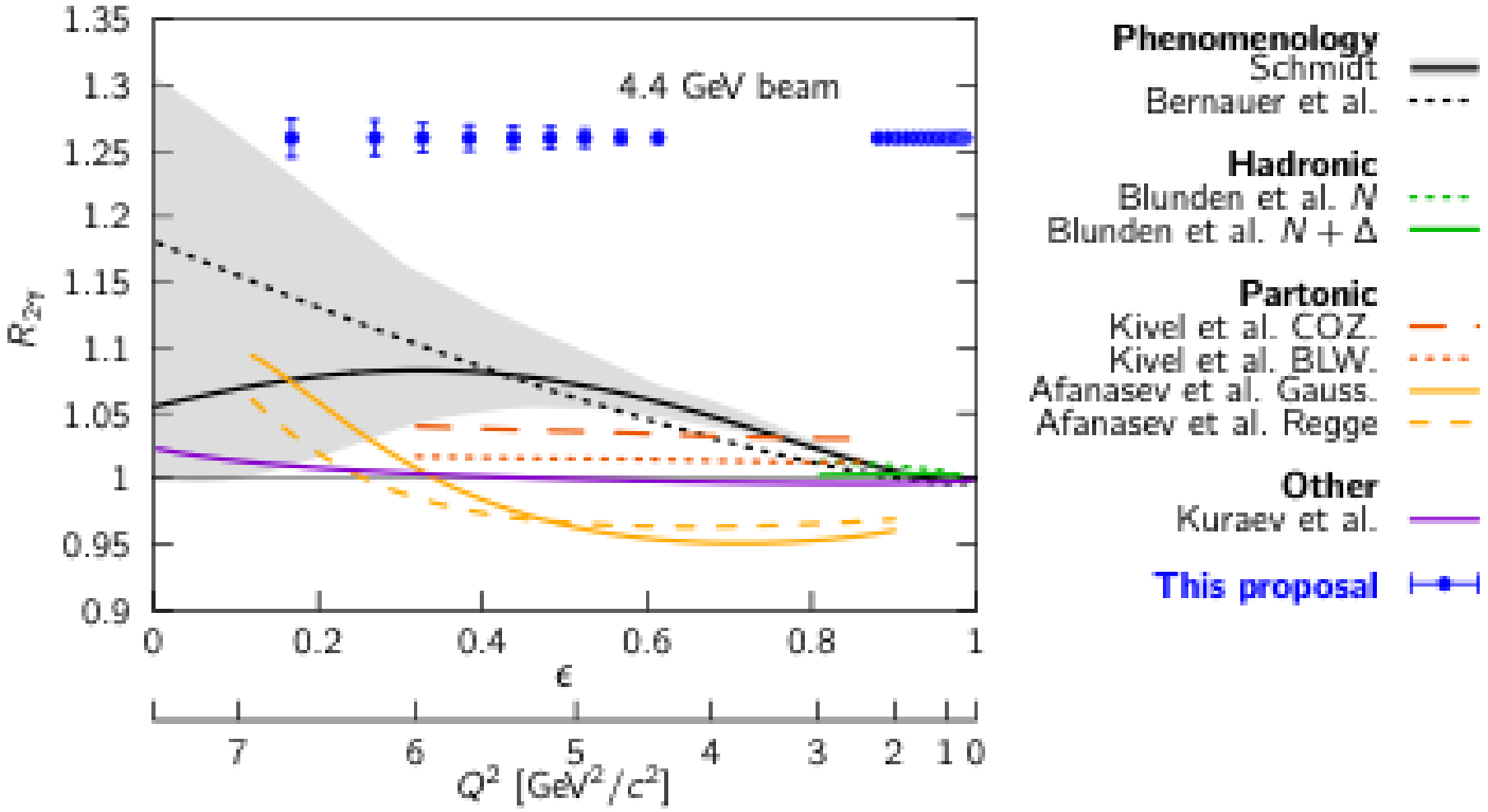
E12+23-008: Compare e^+p and e^-p elastic scattering at CLAS12



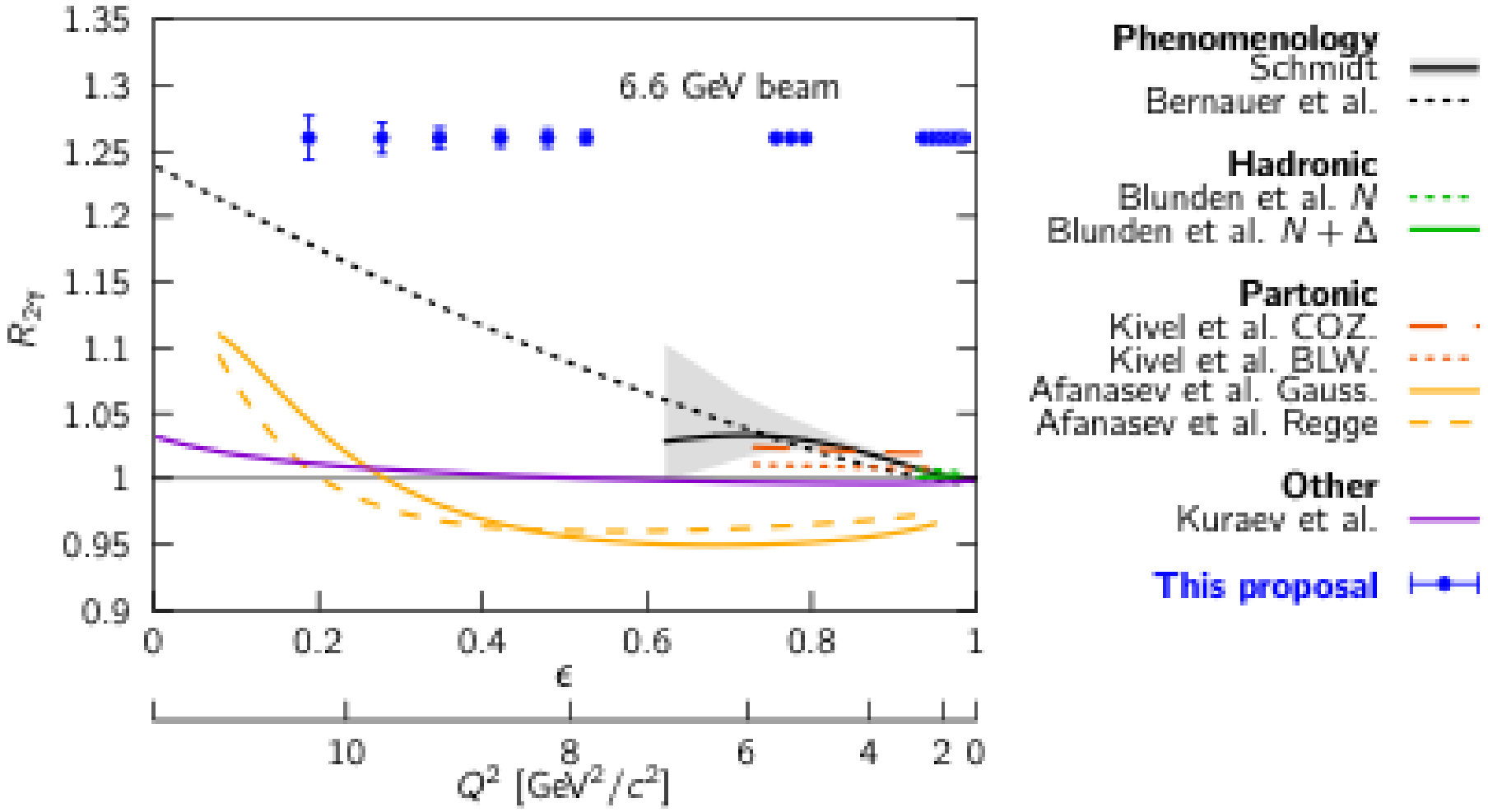
Expected reach at 2.2 GeV (1.3 days)



Expected reach at 4.4 GeV (4 days)



Expected reach at 6.6 GeV (44 days)



Next steps

1. Trigger design
   - We'll need to build a forward-proton elastic trigger
   - No updates since PAC, work still to be done.

2. Radiative corrections
   - Received question during PAC Q&A about systematics from RCs
   - Working now to
     - Consolidate/document RC approaches from the OLYMPUS era
     - Studying the impact of different approaches
     - Study systematics for CLAS12 positron measurement

OLYMPUS used a custom radiative event generator, developed from Mainz A1.

Standard SIMC Approach

- Radiation is fully “peaked”
- No interference between brems. diagrams
- Effective beam energy is updated after initial-state radiation.

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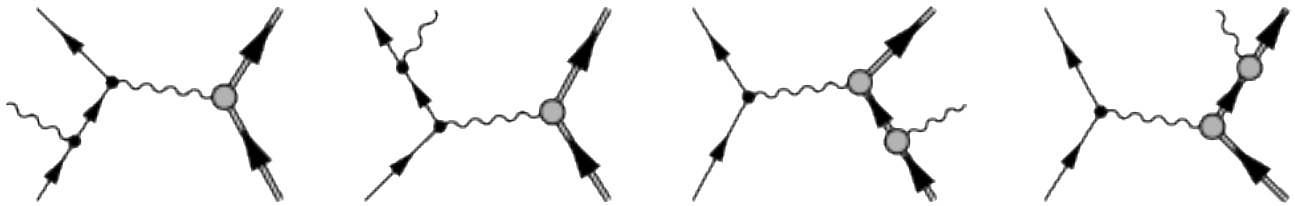
OLYMPUS Generator Approach

- Radiation emitted in all directions
- Full complex amplitude of brems. diagrams preserved.
- A single radiated photon can be both initial- and final-state.

$$d\sigma \sim$$



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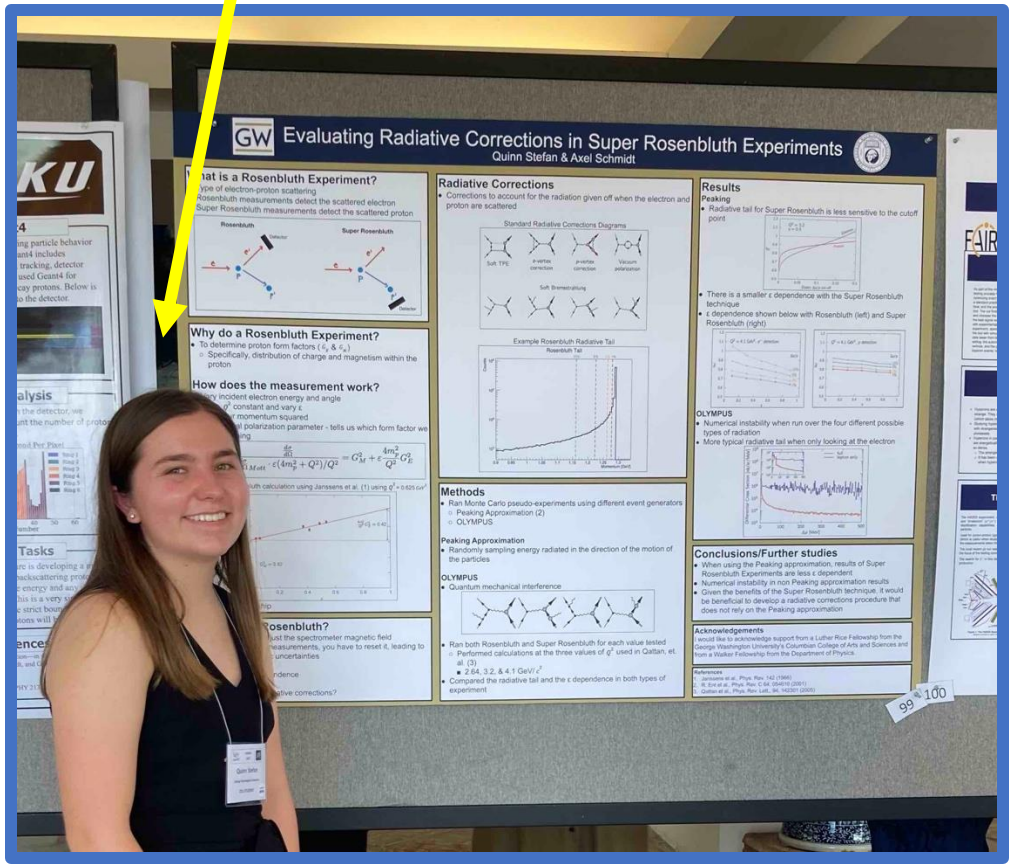
Next goals

- Working with J. C. Bernauer to get our paper on the generator written and submitted.
- Package the code in a standalone version, and make public.
- Continue to develop…

Studying the peaking approximation in Super-Rosenbluth measurements.

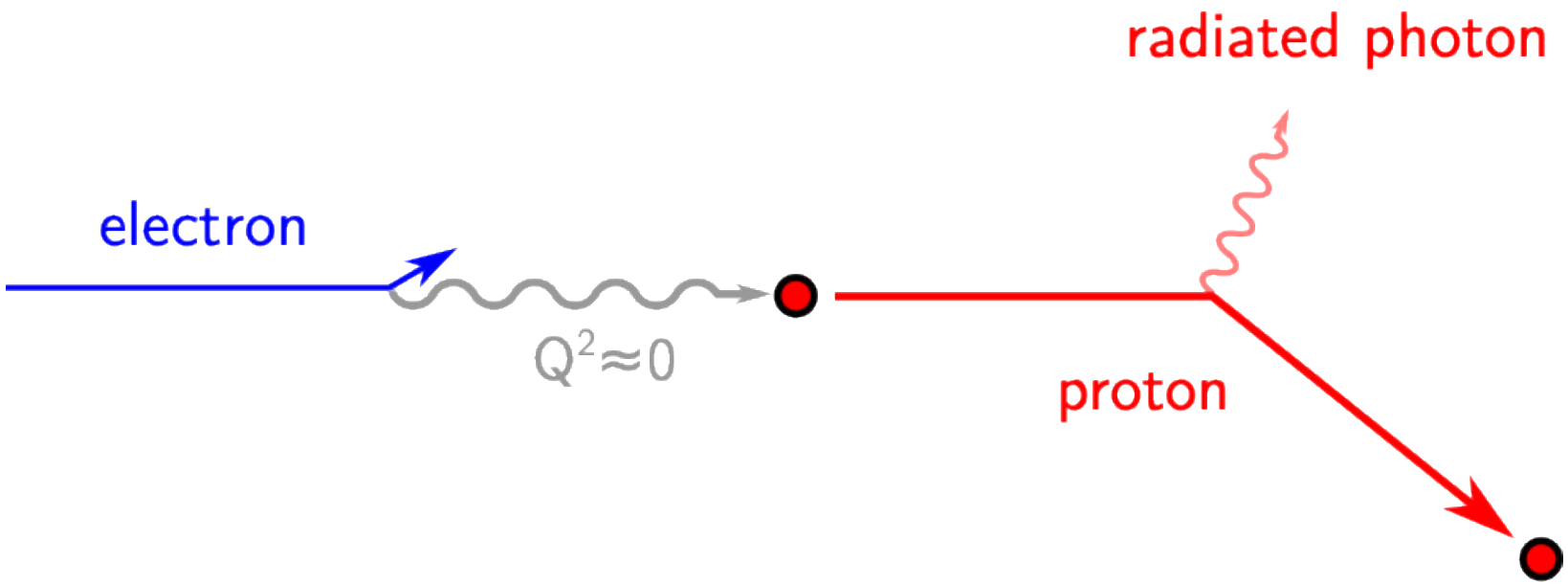
[Quinn Stefan, Axel Schmidt, Eur. Phys. J. A 60, p. 229 (2024)]



- Compare RCs in a Super-Rosenbluth configuration in peaking and OLYMPUS approaches.
- Within the peaking approximation, Super-Rosenbluth technique has more favorable RCs than traditional Rosenbluth technique.
- However, there can be a large contribution from non-peaked radiation!

Studying the peaking approximation in Super-Rosenbluth measurements.

Quinn Stefan, Axel Schmidt, Eur. Phys. J. A 60, p. 229 (2024)



Conclusions

- Work to be done after PAC
  - Trigger design ----> Work still to be done
  - Radiative corrections ----> Underway
- Next tasks
  - Publish OLYMPUS Radiative Generator paper
  - Package generator code for public release
  - Improve and add features
    - Off-shell / Compton Form Factors
  - Study impact on systematics
- Help out theory with new electron observables ---> see talk on Wed.