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Jefferson Lab
Thomas Jefferson National Accelerator Facility

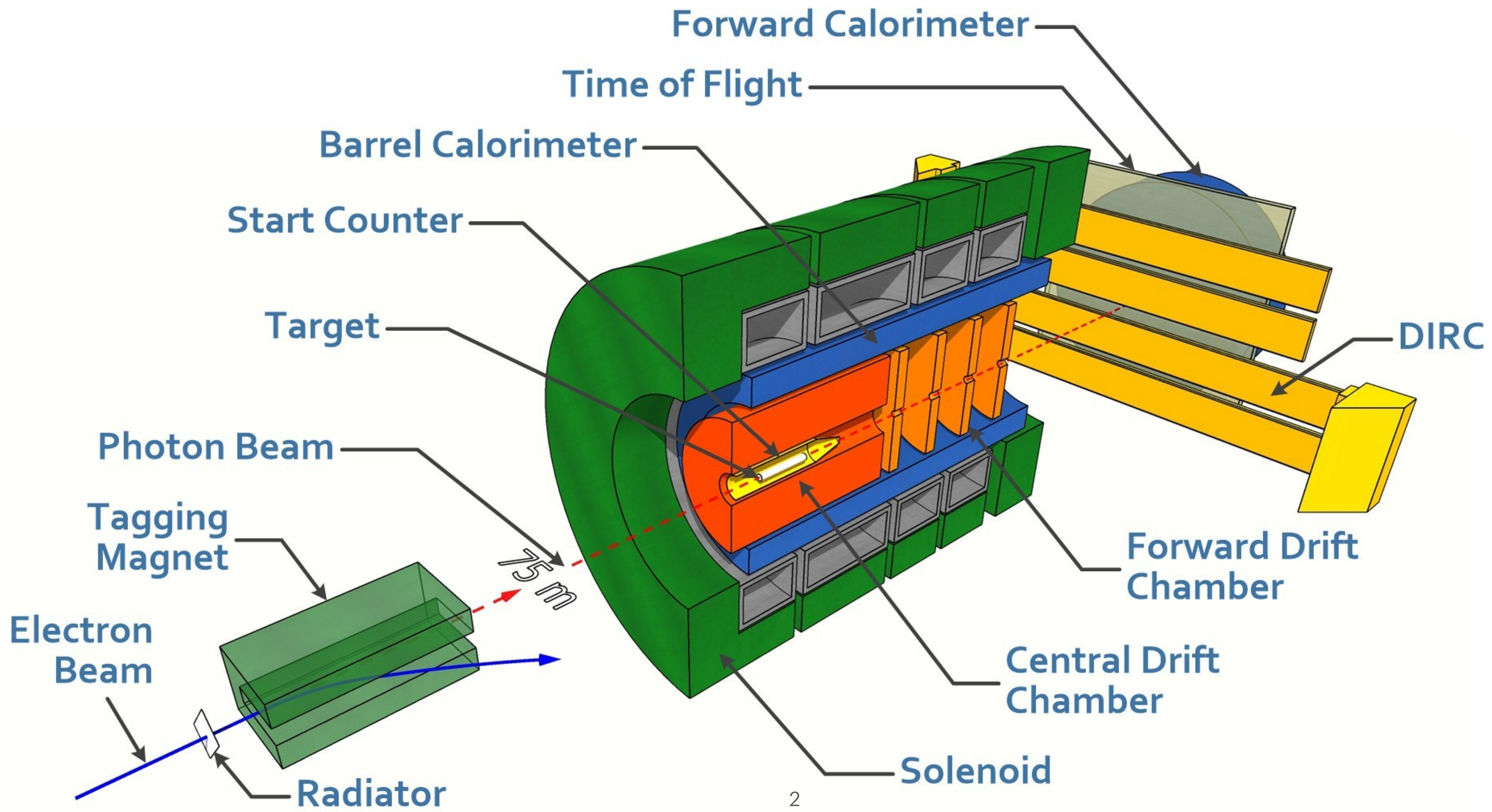
Hall D Highlights

JLUO Satellite Meeting

Olga Cortés Becerra 4/3/2024

GlueX Spectrometer

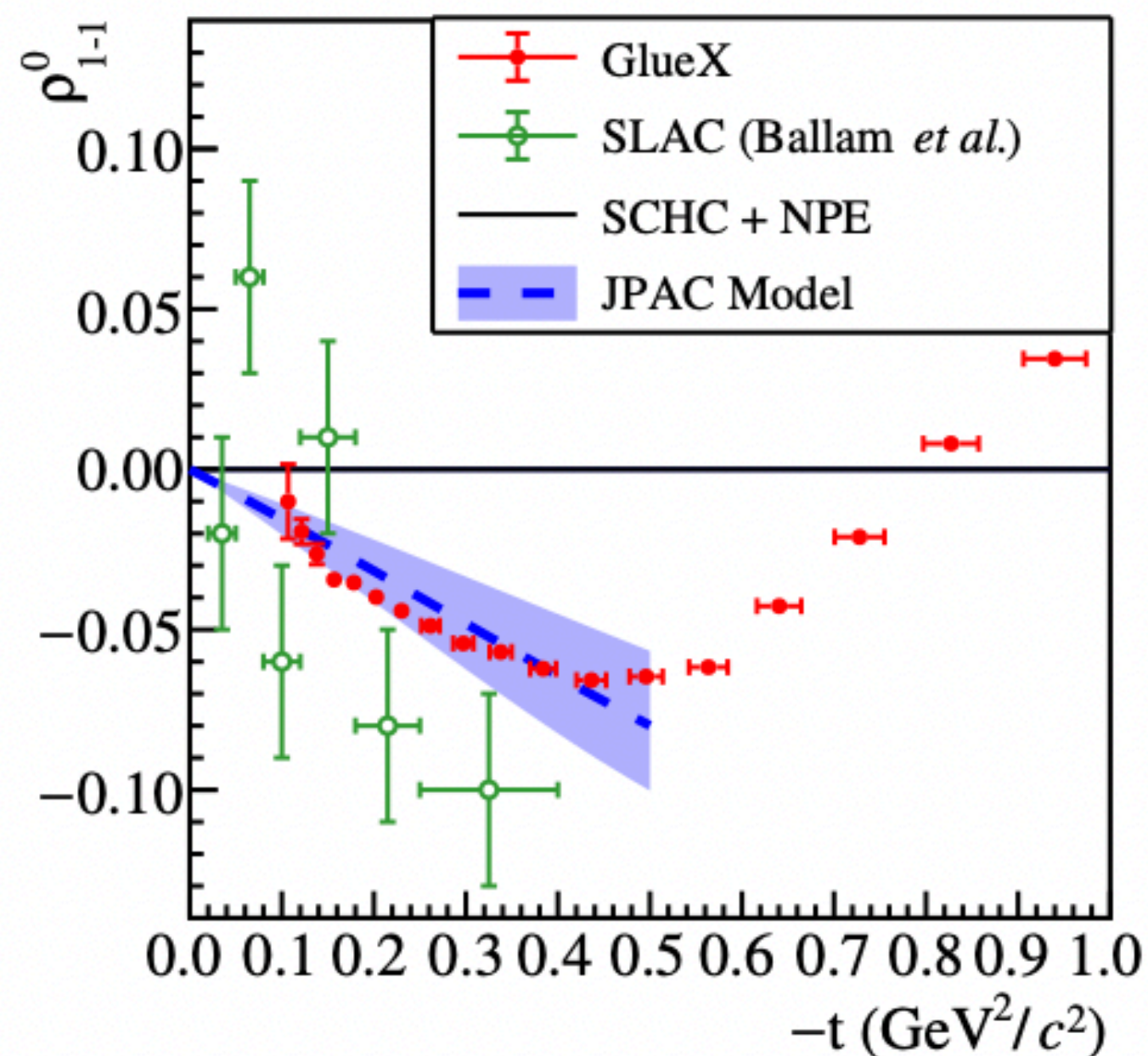
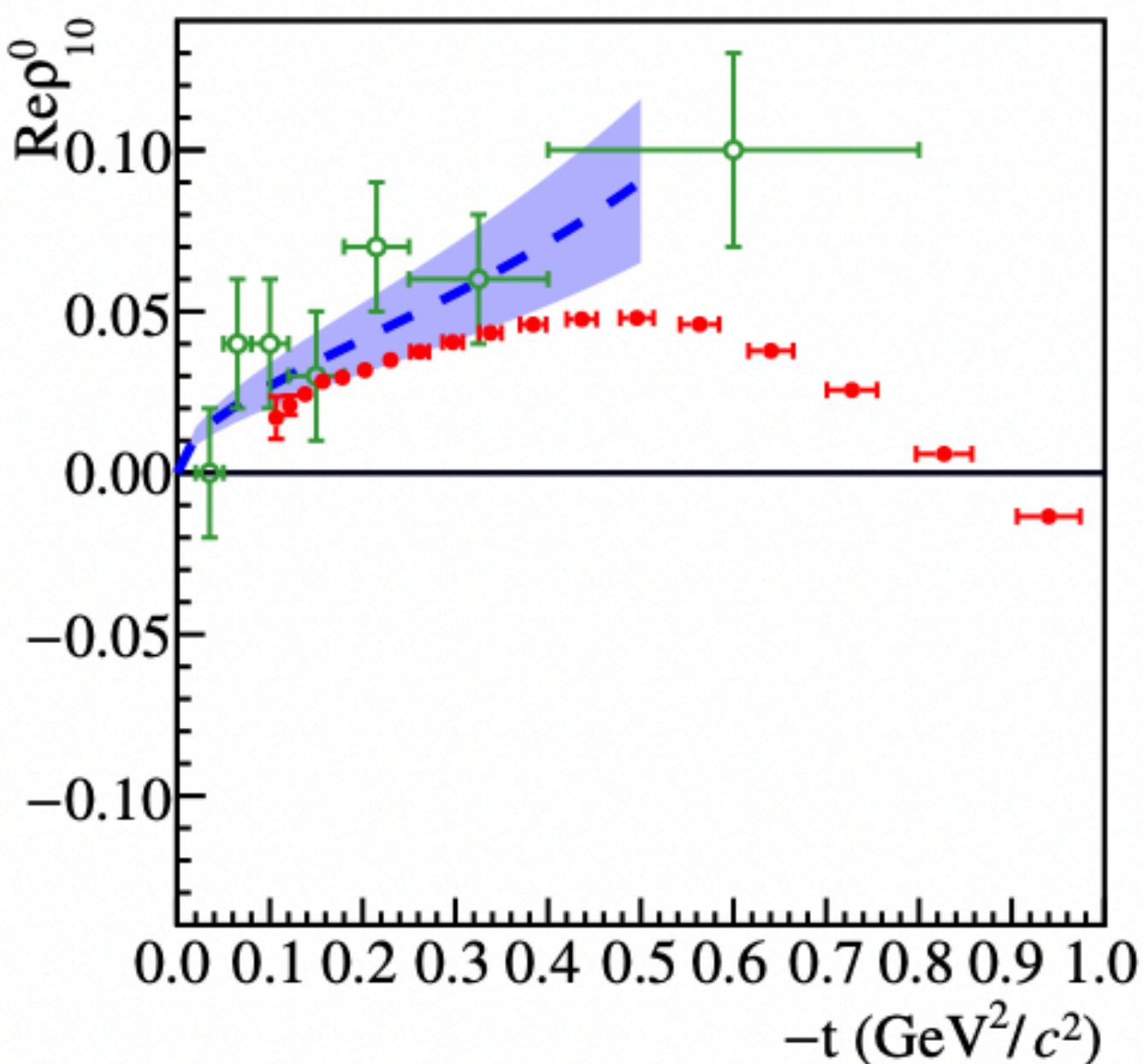
Hall D: The Photoproduction Hall



1. GlueX

General Goal: high-intensity polarized photoproduction experiment that explores up to above the $c\bar{c}$ threshold

SDME $\vec{\gamma}p \rightarrow p\rho(770)$ at $E_\gamma = 8.2 - 8.8$ GeV



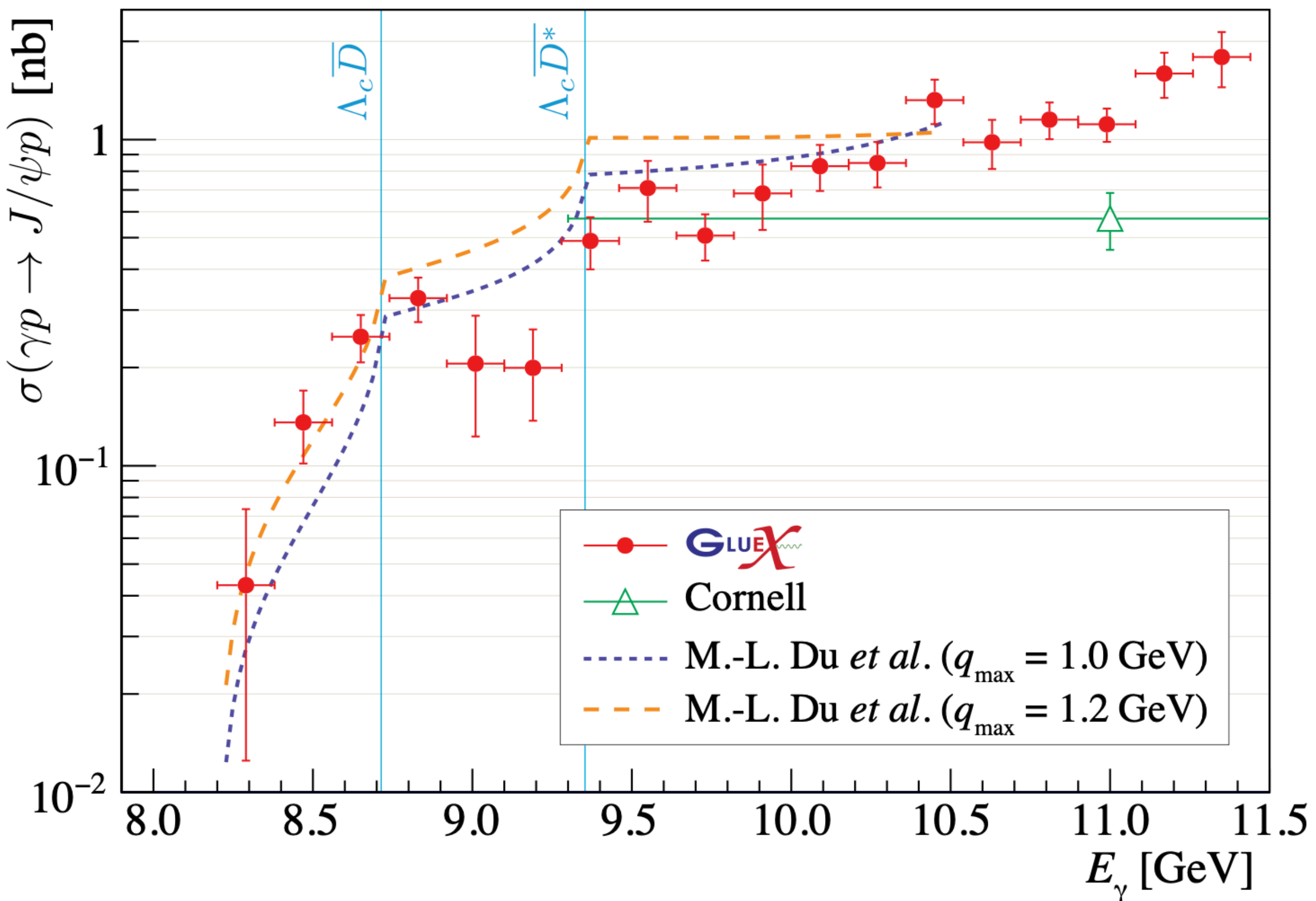
Phys. Rev. C **108**, 055204 (2023)

- Statistical precision exceeds previous experiments at this energy range
- Polarized SDMEs describe the polarization transfer from the beam photon to the ρ meson
- JPAC model valid in the region $-t < m_\rho^2$
- As $t \rightarrow 0$, SDMEs are expected to be consistent with s – channel helicity conservation and natural parity exchange

Future SDMEs results:

- Under internal review $\vec{\gamma}p \rightarrow \pi^- \Delta^{++}(1232)$

J/ψ photoproduction cross section near threshold

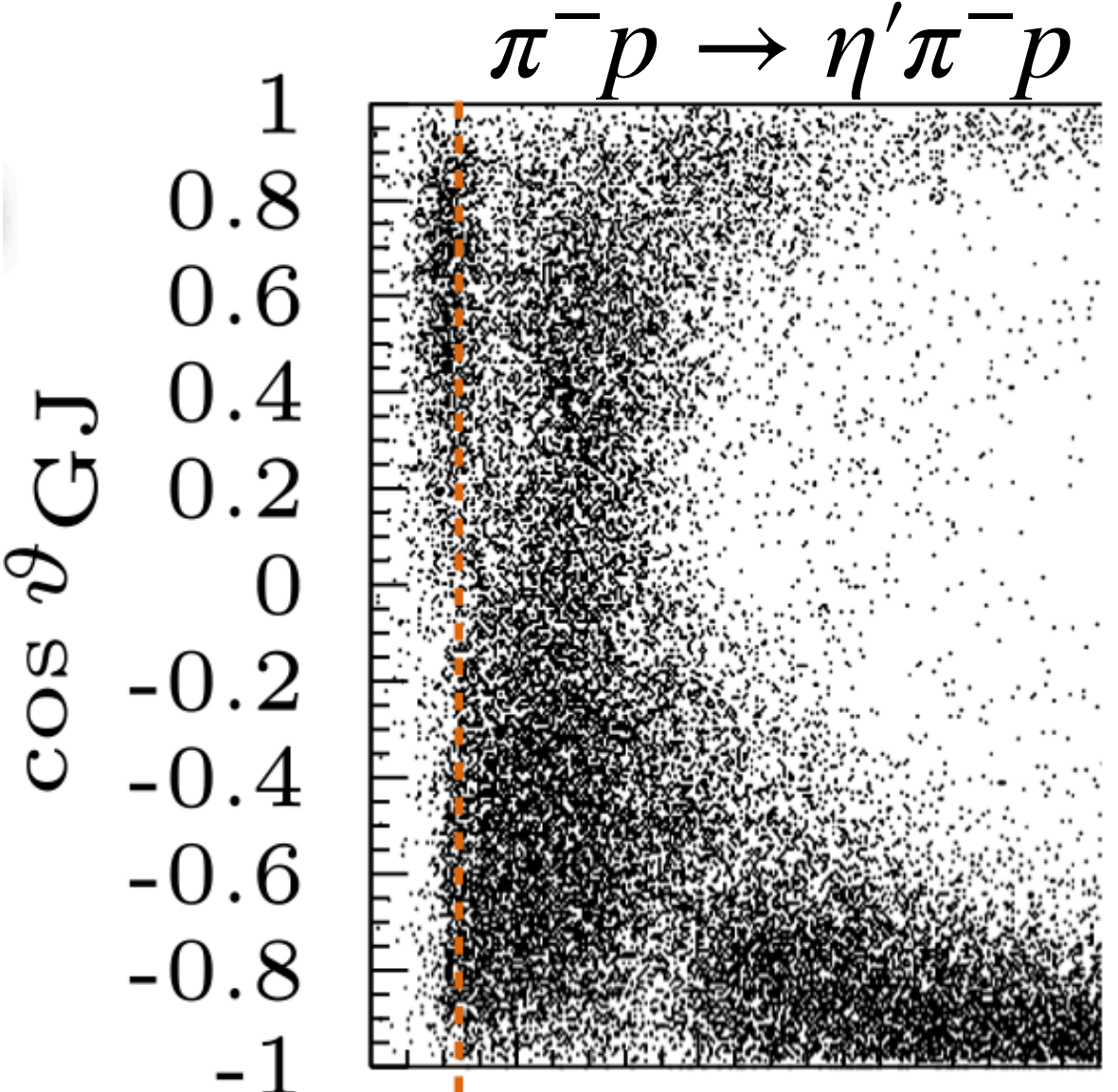


Phys. Rev. C **108**, 025201 (2023)

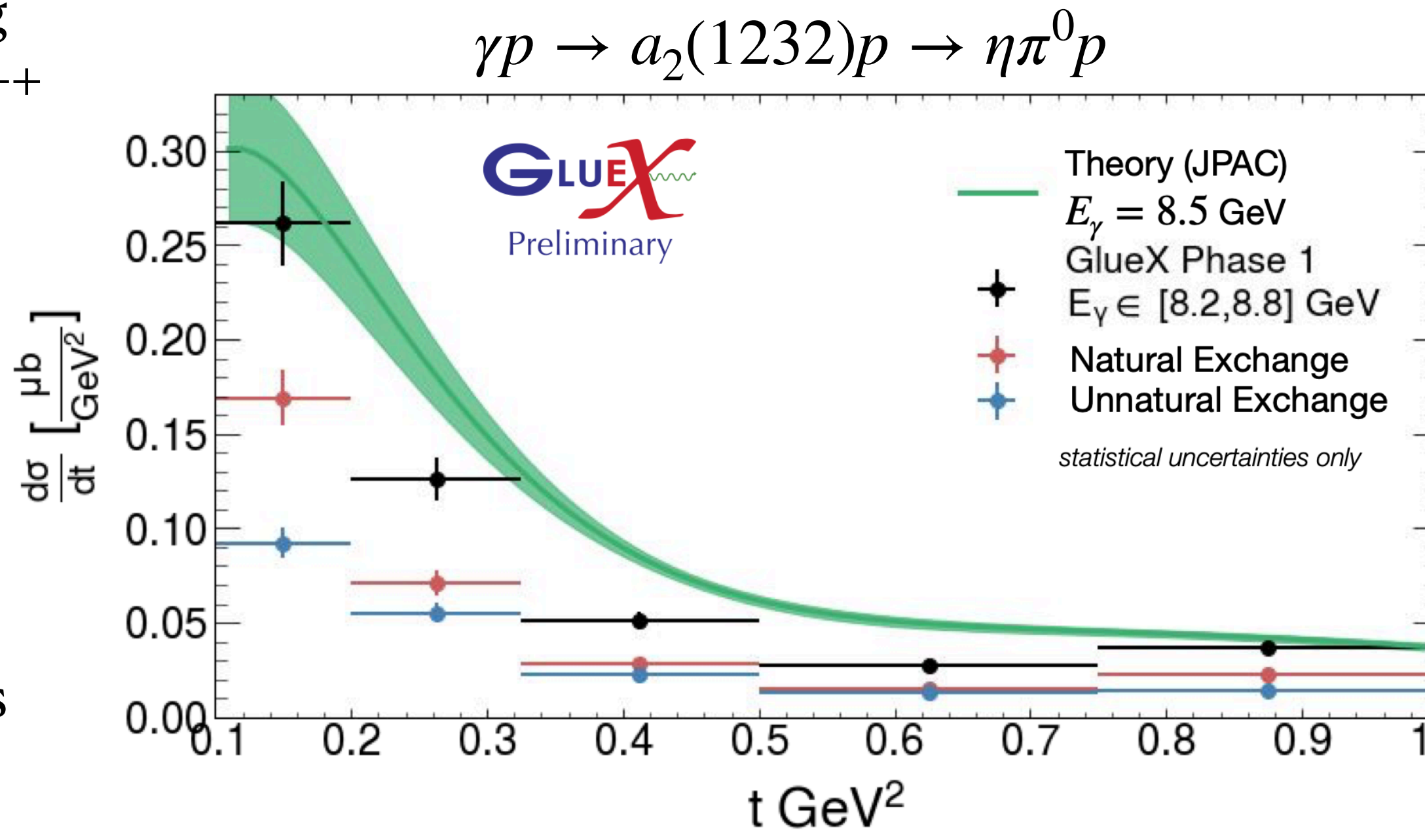
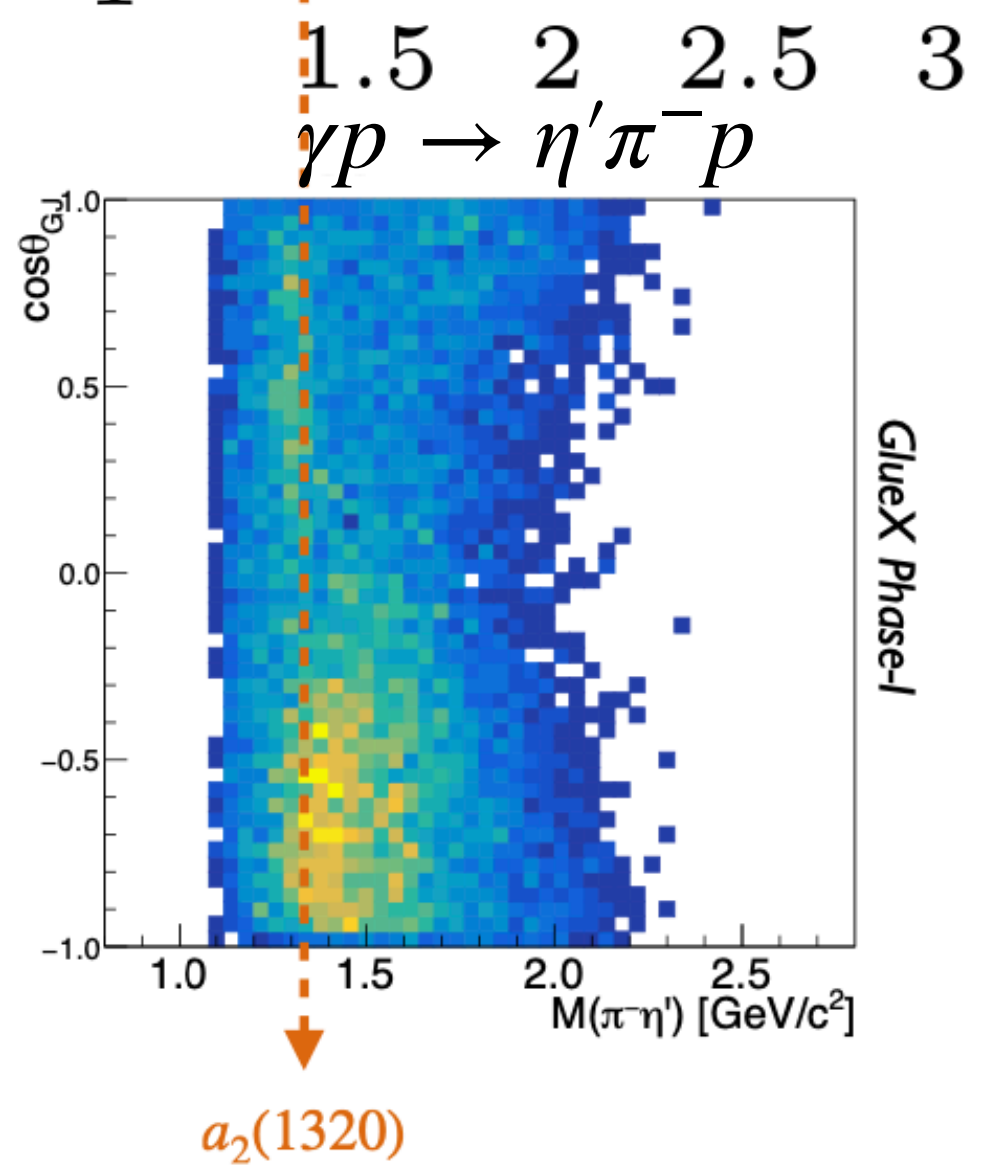
- Editor's suggestion
- Structures at open charm thresholds
- Understanding the production mechanism is fundamental to interpretation
 - There is evidence for multiple production methods
- New results used in three different papers:
 - JPAC, Phys. Rev. D **108**, 5, 054018 (2023)
 - Guo et al, Phys. Rev. D **108**, 034000 (2023)
 - Strakovsky et al, Phys. Rev. D **108**, 1, 015202 (2023)
 - And many others! (over 200 citations between the two J/ψ papers)

Specific Goal: contribute to the search for and understanding of exotic hybrid mesons

π_1 Search status



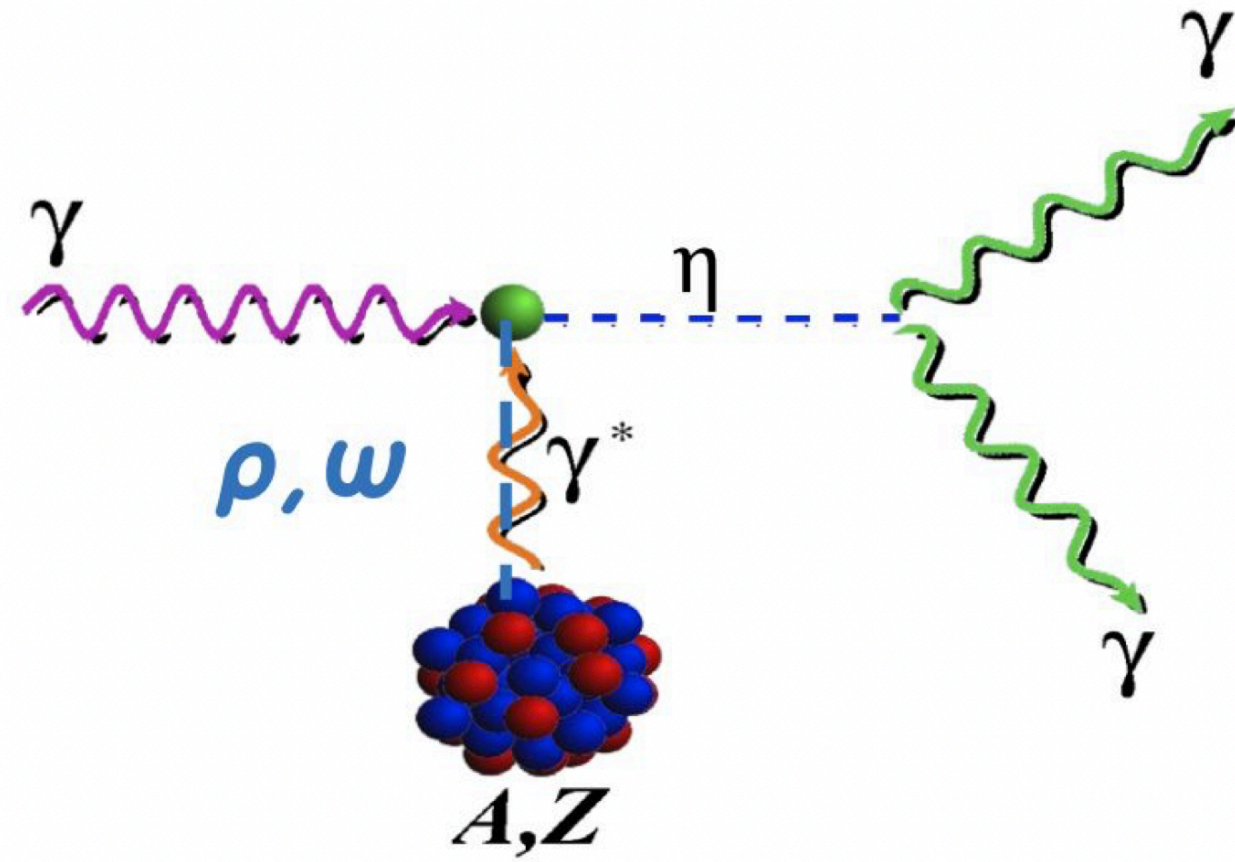
- hadspec Lattice QCD predictions, along with GlueX data, indicate $\gamma p \rightarrow \eta' \pi^- \Delta^{++}$ as the most promising channel
- $\eta' \pi^-$ decay distribution similar with COMPASS
 - JPAC interpretation of COMPASS data: interference between a_2 and exotic π_1
- Forward/backward asymmetry indicates interference between even and odd (exotic) partial waves
- Understanding a_2 production mechanism is fundamental for the search of π_1



Future π_1 results:

- Under internal review: π_1 upper limit from $\omega \pi \pi$

2. PrimeX-eta Experiment



Standard GlueX Detector

- Aluminum radiator: Unpolarized photon beam
- Compton Calorimeter: Detection of Forward angle particles
- Solenoid: on/off. $E_e = 10.04, 11.16,$ and 11.5 GeV

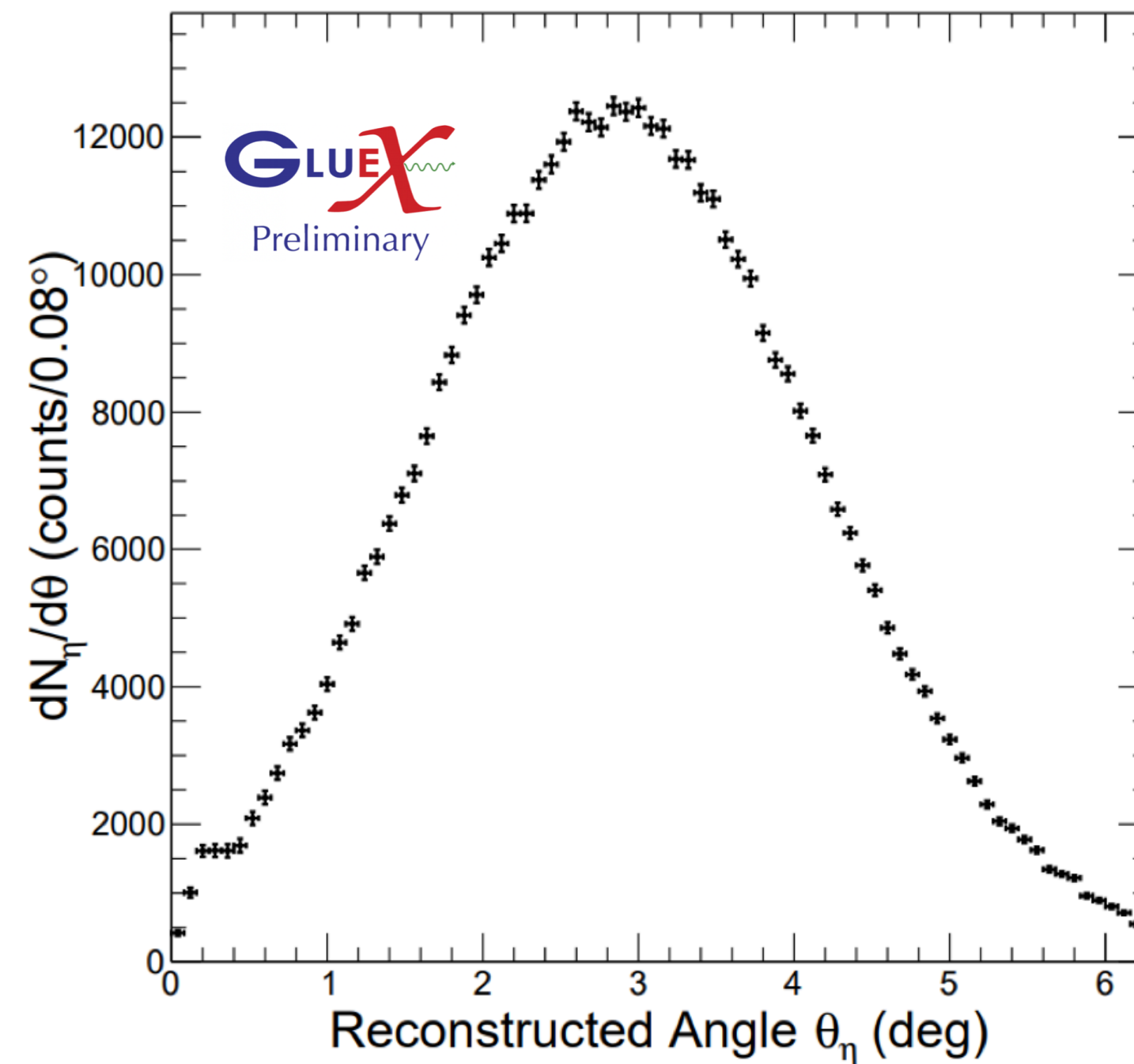
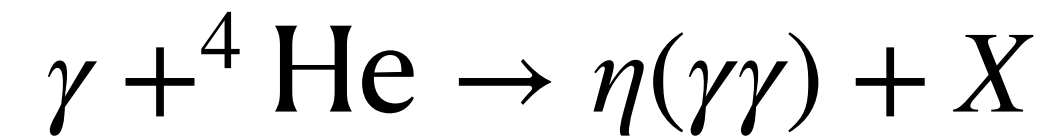
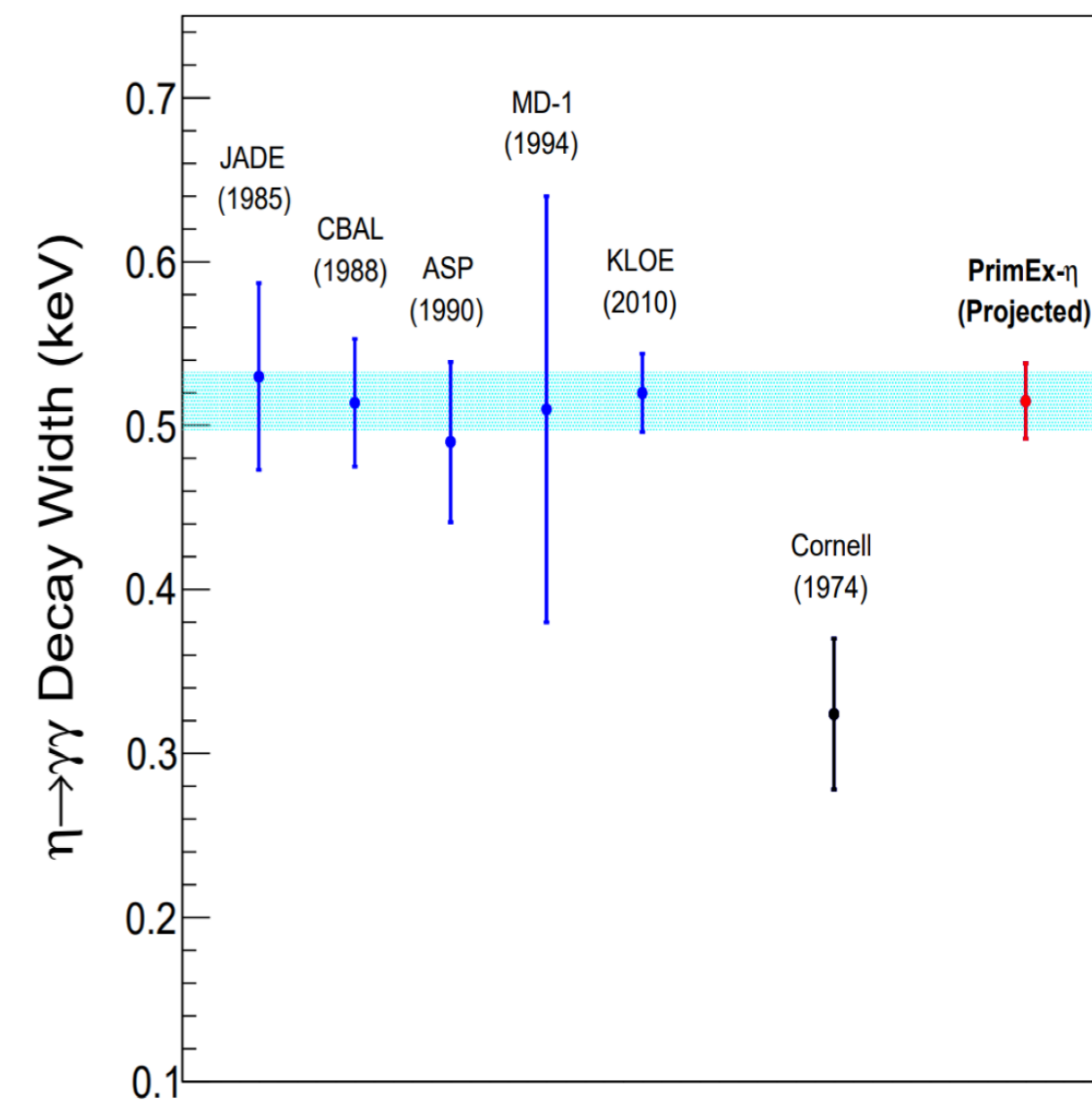
Target

- Liquid ^4He target: well-known nuclear form factor and Primakoff cross section $\sim Z^2$

Compton scattering off atomic electron used as reference channel

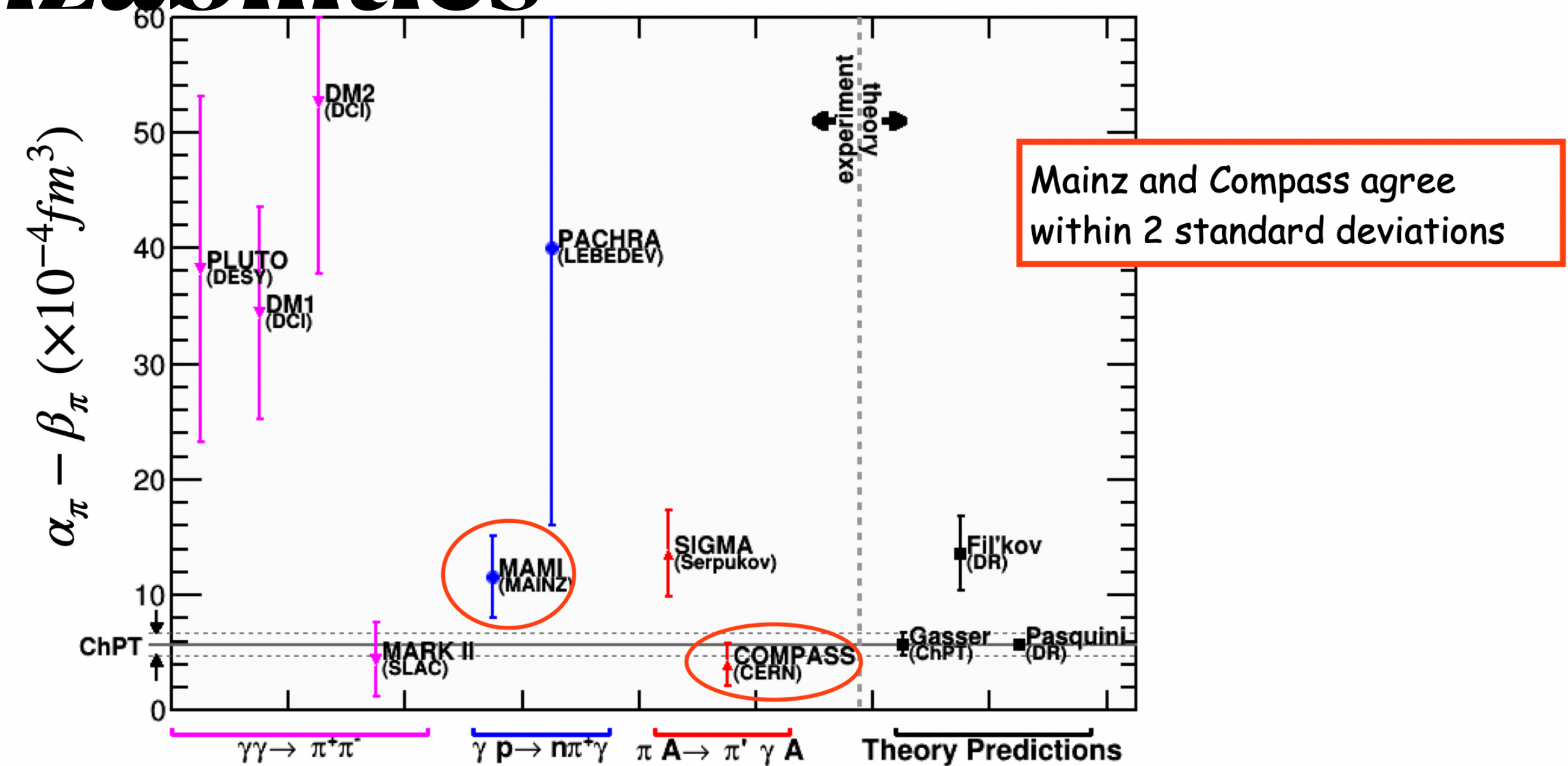
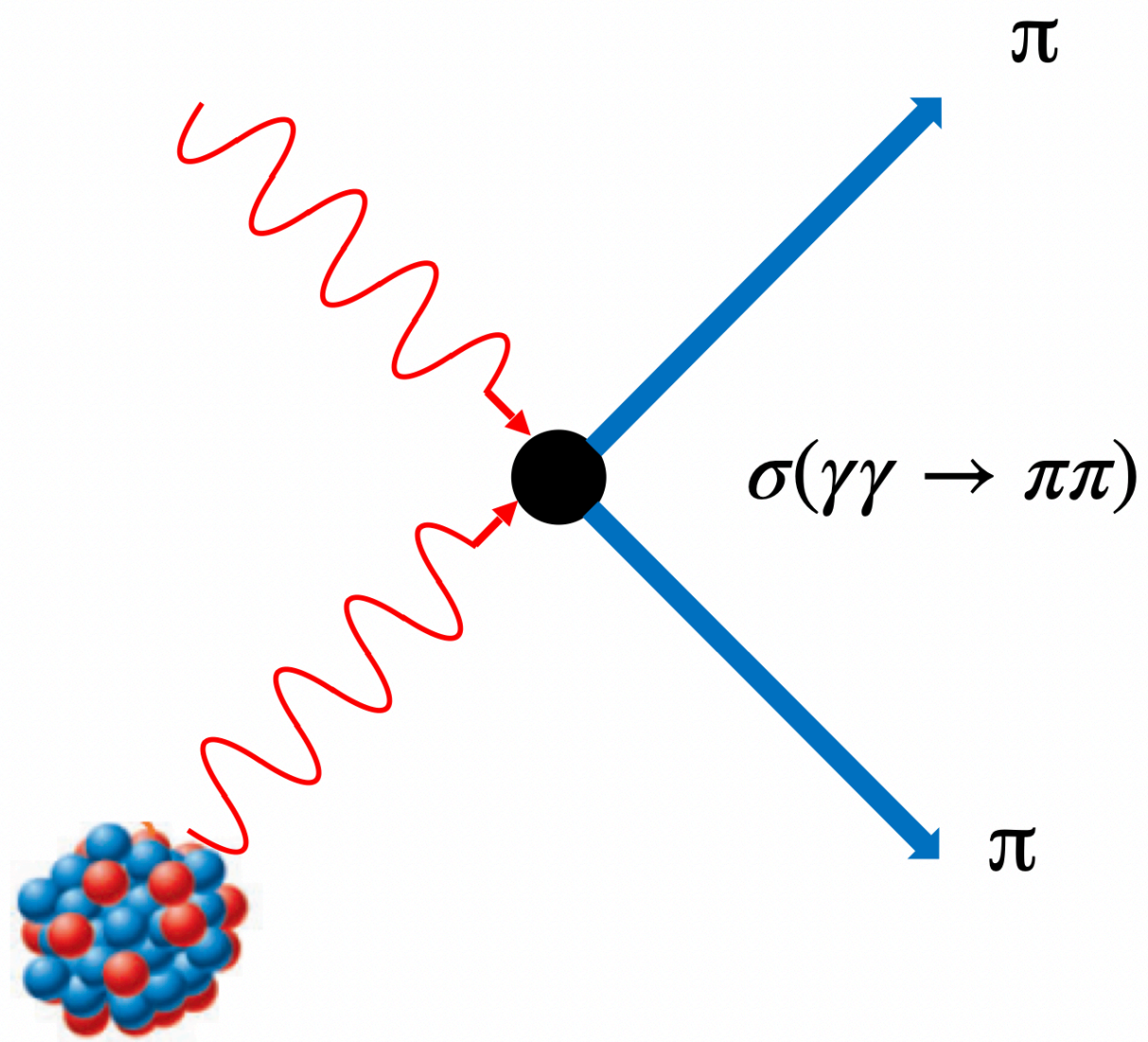
Future results:

- Under internal review Total Compton Scattering Cross Section



Plot courtesy A. Smith

3. CPP: Charged pion polarizabilities



Standard GlueX Detector:

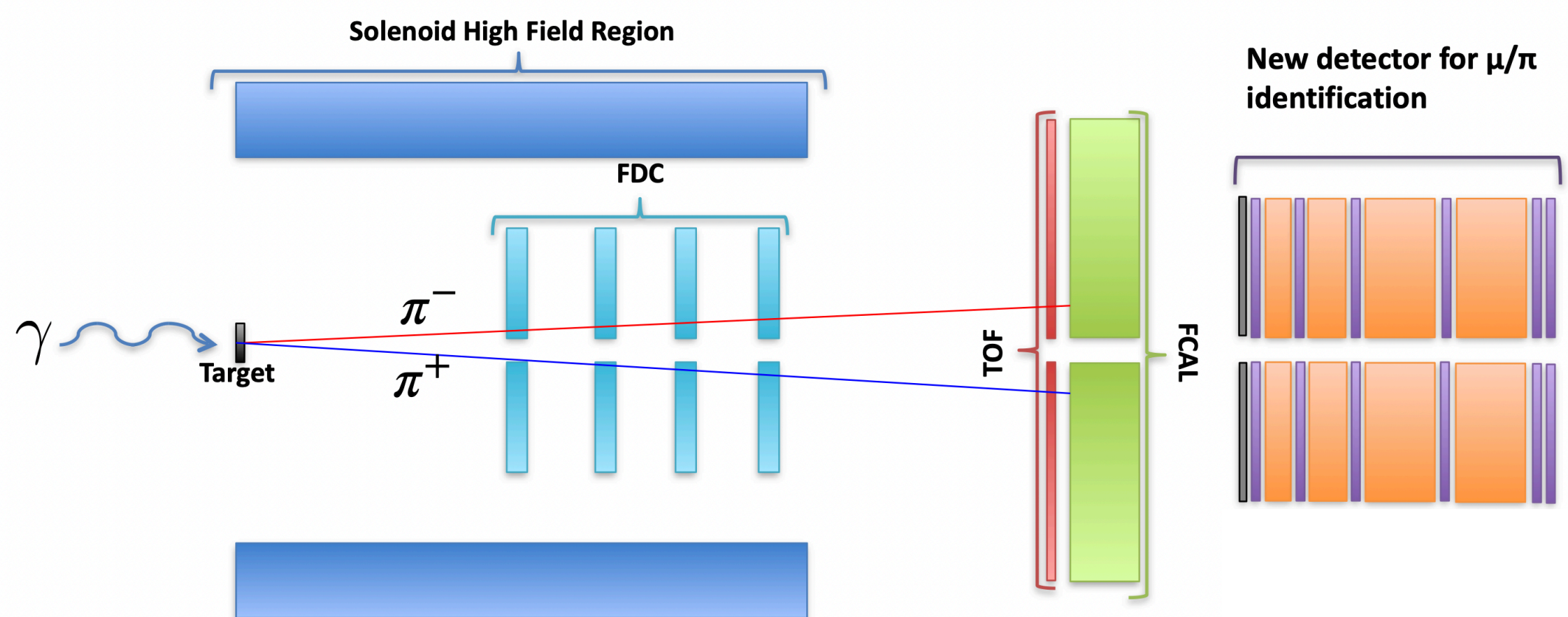
- Muon Detector
- Beam: 30 nA current, coherent peak Energy 4.5 – 6 GeV

Target

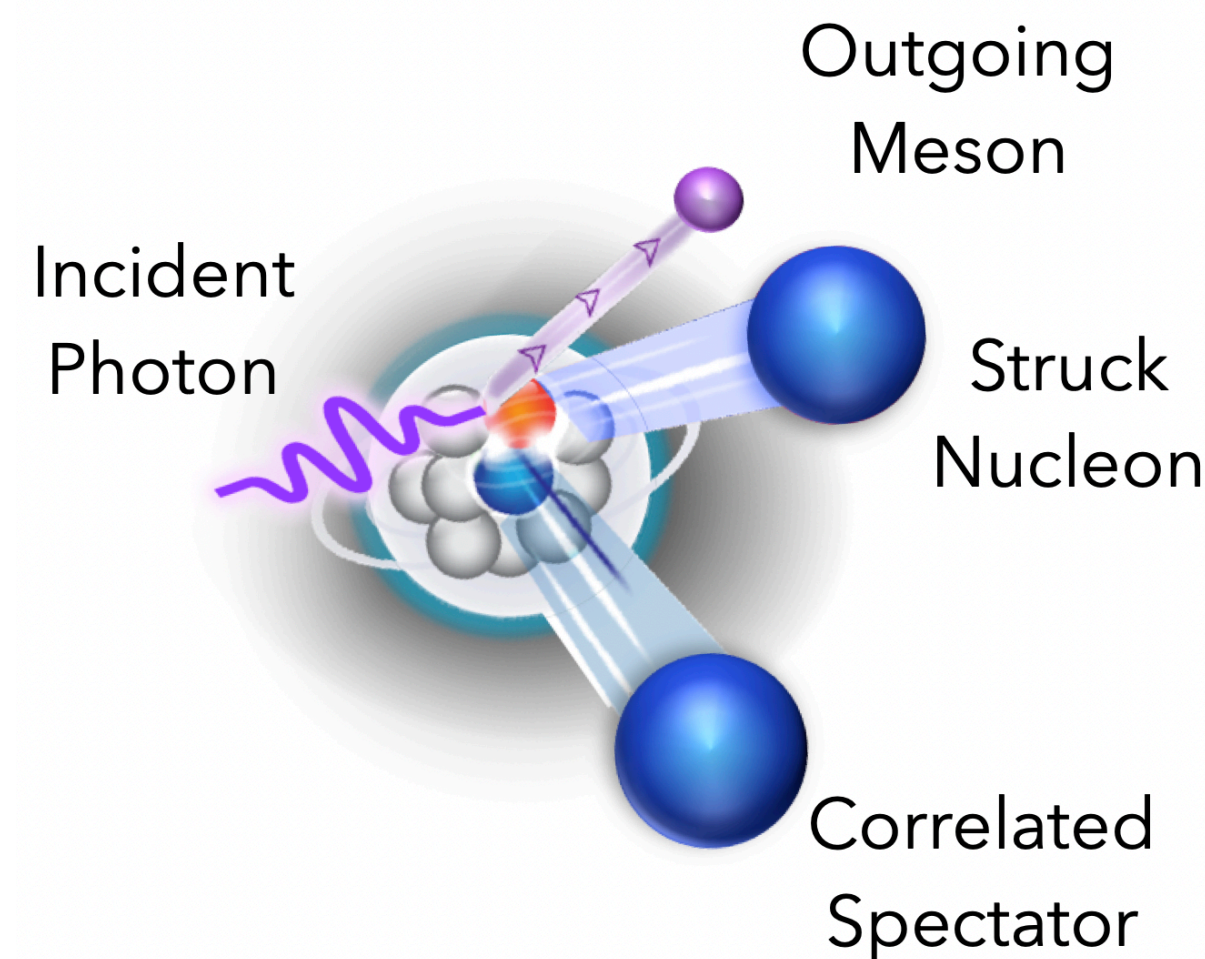
- Pb208, 0.03 cm, shifted upstream

STATUS:

Data collection and Calibration done. Ready for full scale reconstruction!



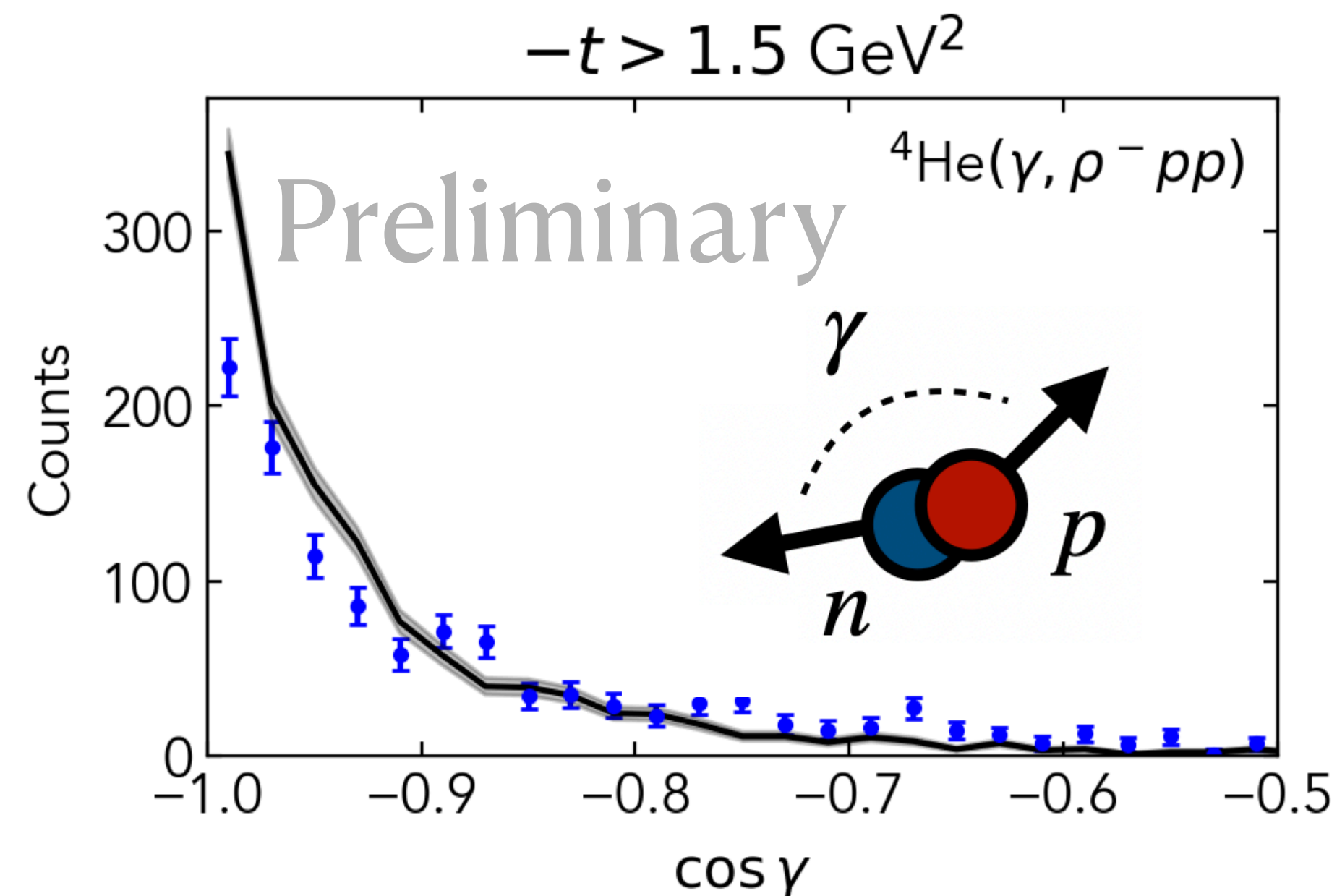
4. SRC: Short Range Correlation at Hall D Plots courtesy J. Pybus



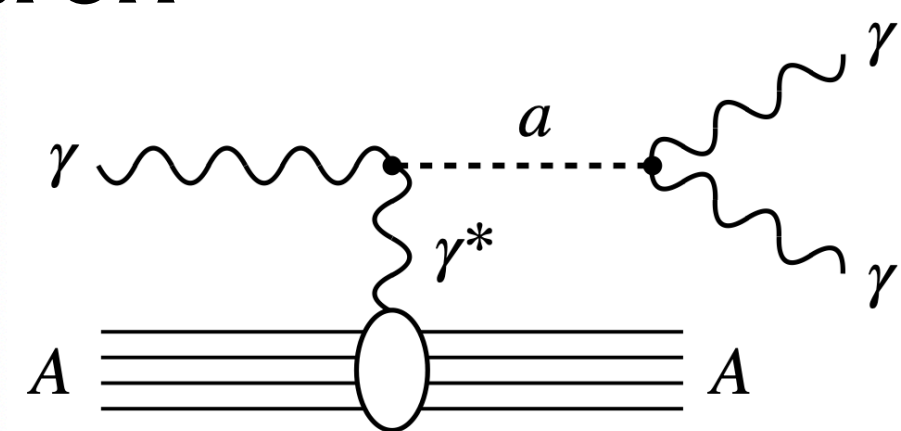
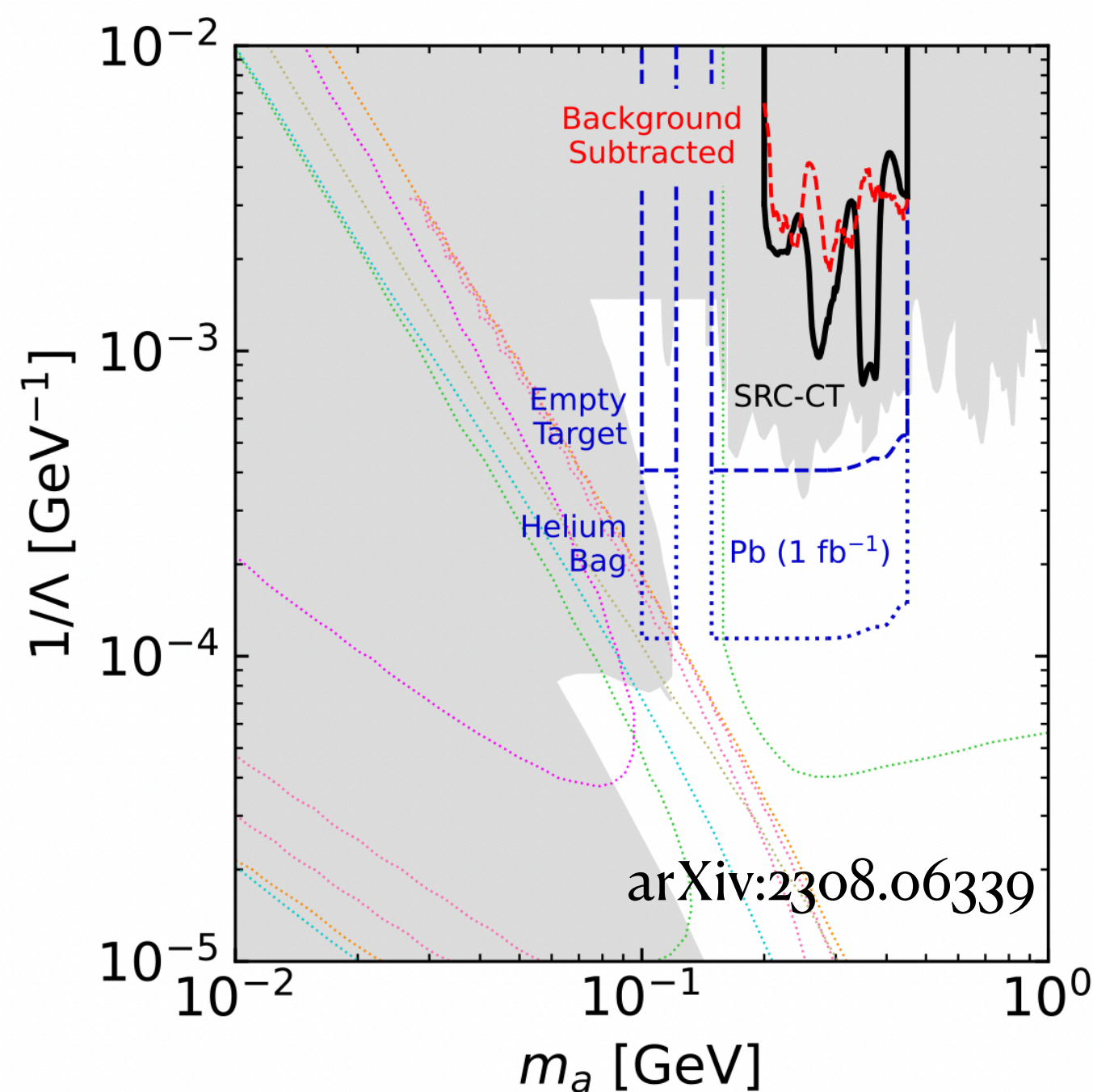
Standard GlueX Detector

Target:

- ${}^2\text{H}, {}^4\text{He}, {}^{12}\text{C}$

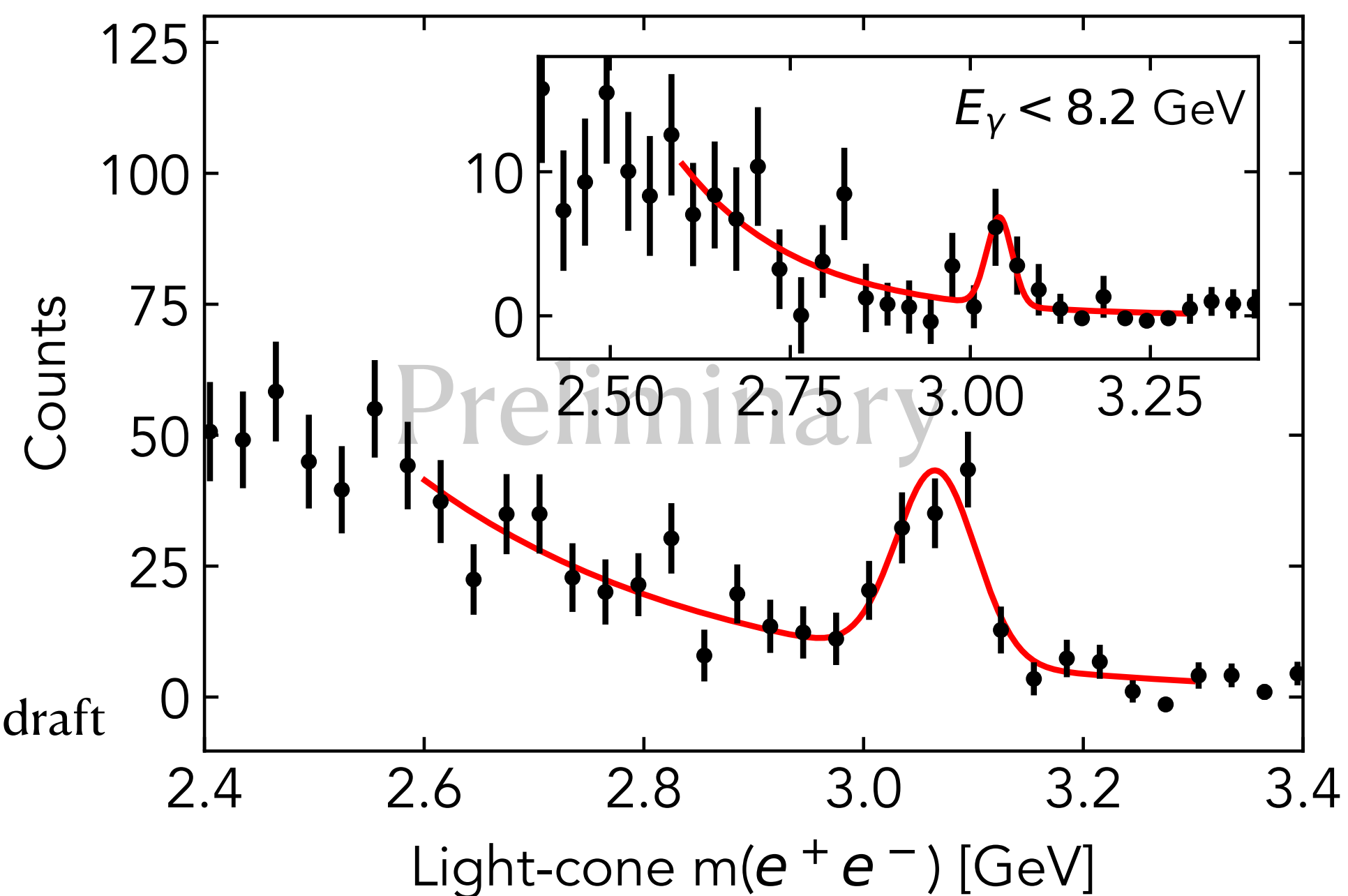


ALP Search



$(\gamma, J/\psi p)$

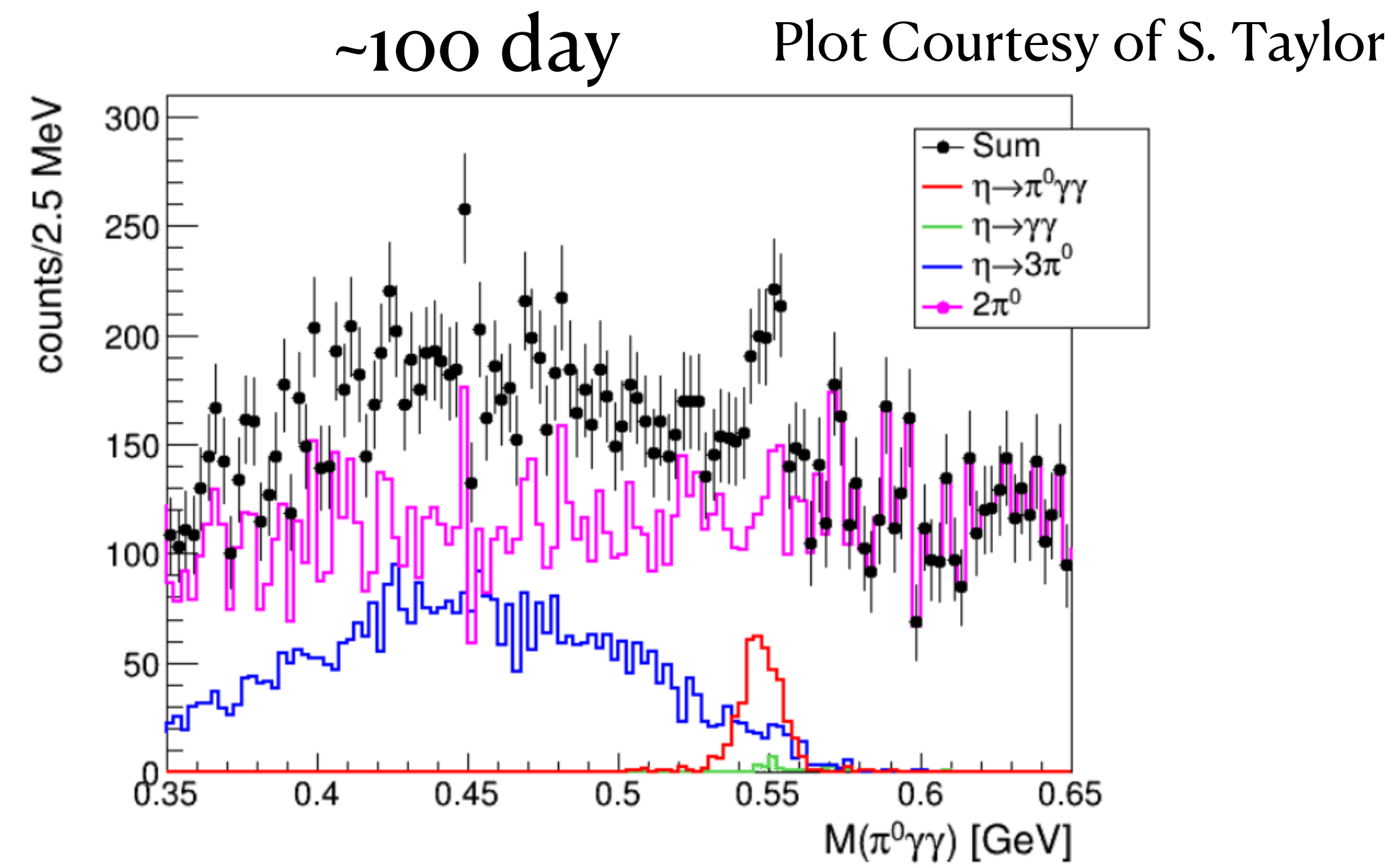
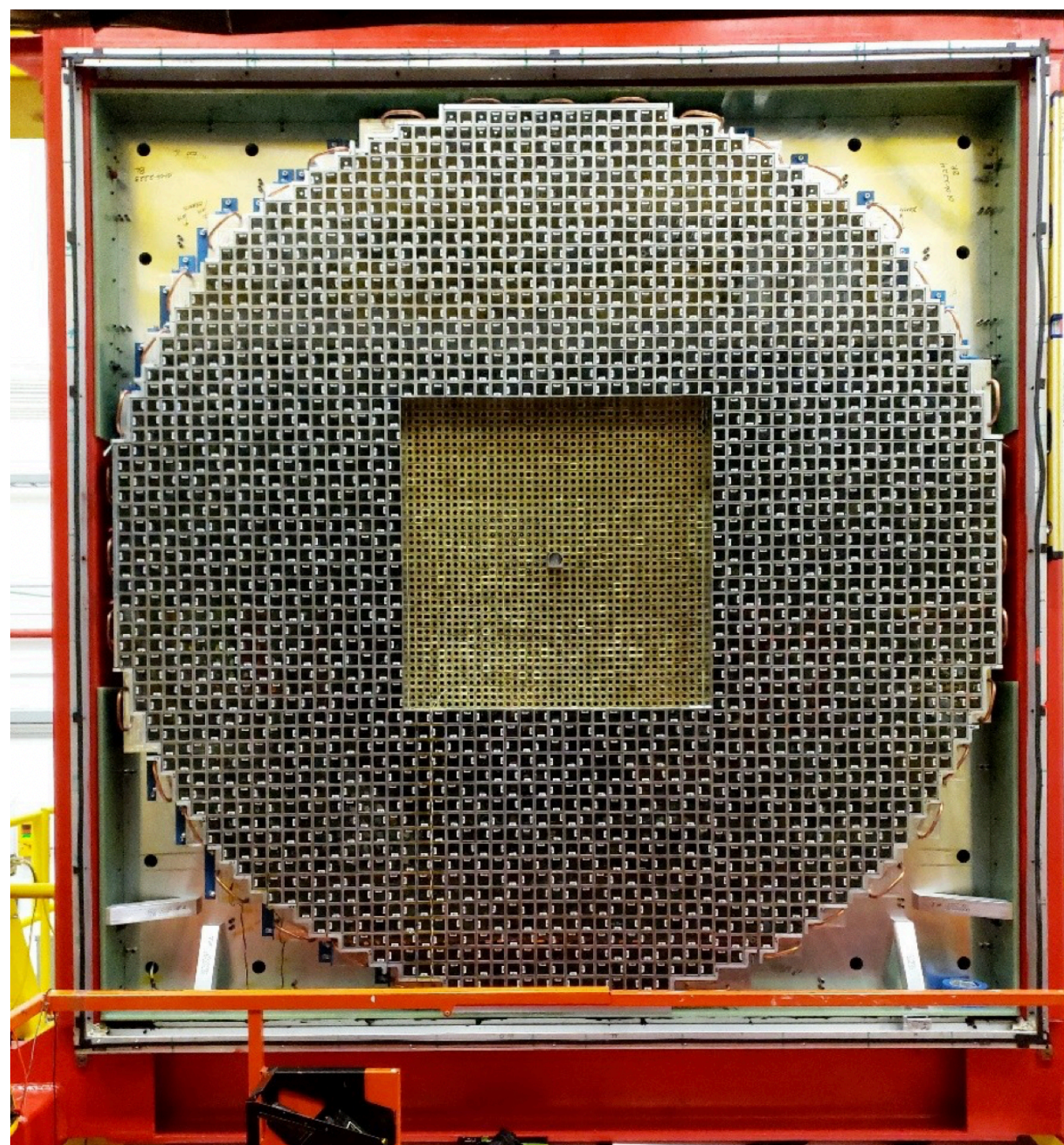
Paper draft



5. JEF: JLab $\eta^{(\prime)}$ Factory

Goal:

- Detect decays of η and η' , particularly neutral rare decays:
 - Search for sub-GeV hidden bosons
 - Directly constrain CVPC new physics
 - Precision test of low-energy QCD
 - Improve quark mass ratio via $\eta \rightarrow 3\pi$



Calorimeter upgrade to lead-tungstate modules status:

- All modules were installed (October 2023)
- Working on the LMS (70% installed)
- Electronics and cable installation (End of July)
- Data taking: tentatively by October 2024

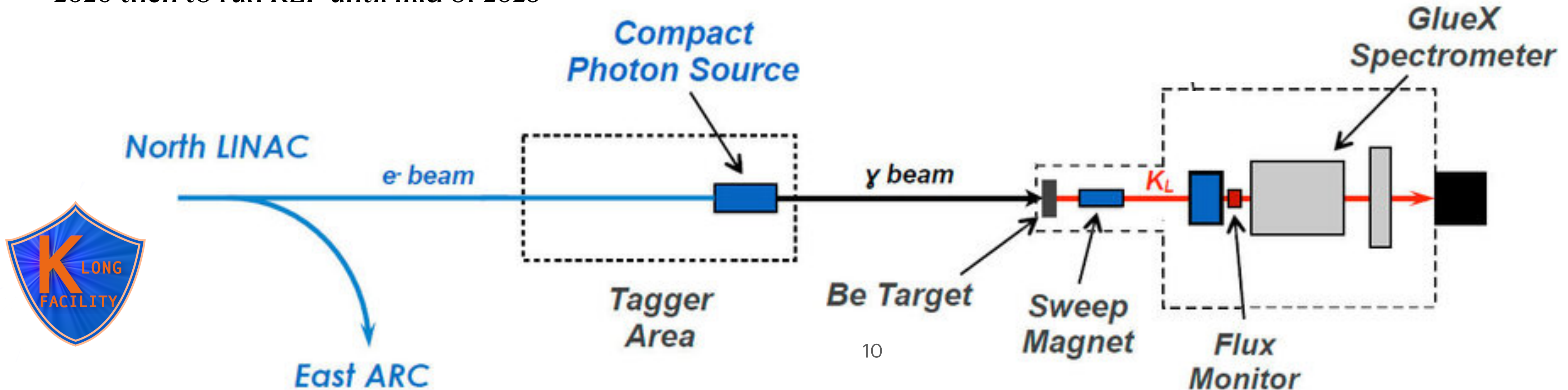
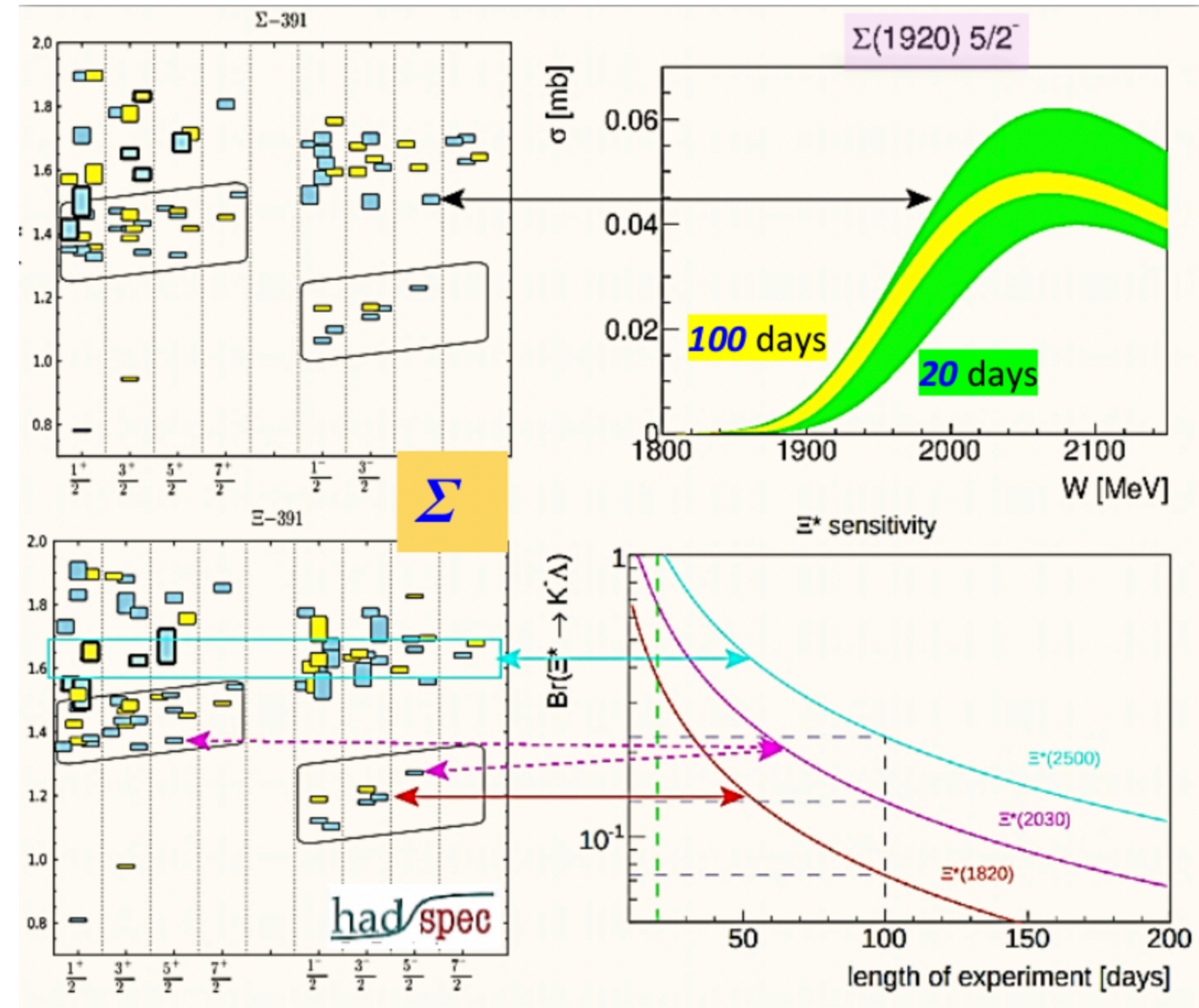
6. KLF: K-Long Facility

Goal:

- First hadronic facility at JLab
- Hyperon Spectroscopy: Λ^* , Σ^* , Ξ^* , Ω^*
- Strange meson Spectroscopy by studying $\pi - K$ interaction (κ search)
- Dark matter search

Status

- Conceptual designs for all beam line components, working on the engineering designs for them (mostly CPS)
- Injector compatibility of KLF and Möller calculated, tests to be completed by the end of current run
- The installation of the KLF is planned for Spring 2025 - Spring 2026 then to run KLF until mid of 2028



Take aways

Status of 6 experiments at Hall D: very interesting and diverse physics happening

- GlueX
 - Recent published results: SDME $\vec{\gamma}p \rightarrow p\rho(770)$, Cross section photoproduction of J/ψ
 - In the making: π_1 search progress in understanding a_2 (interferometer of π_1) production
- PrimEx-eta
 - Under internal review: Total Compton Scattering Cross Section
 - In the making: differential cross section of $\gamma + {}^4\text{He} \rightarrow \eta(\gamma\gamma) + X$
- CPP/NPP
 - Finished: Calibration
 - Next step: Full scale reconstruction
- SRC
 - Under peer review: ALP search
 - In the making: Paper draft for subthreshold J/ψ production, first clear evidence of SRC in photoproduction ${}^4\text{He}(\gamma, \rho^- pp)$
- JEF
 - Finished module installation
 - In the making: LMS installation (70%)
- KLF
 - Finished: Conceptual designs for all beam line components and KLF/ Möller compatibility study
 - In the making: Engineering designs for CPS
- GlueX
 - Olga Cortes (GWU): [Session Mo8.2](#)
 - Tolga Erbora (FIU): [Session Mo8.3](#)
 - Churamani Paudel (FIU): [Session Mo8.6](#)
- PrimEx-eta
 - Andrew Smith (JLab): [Session Mo8.1](#)
 - Vladimir Berdnikov (JLab): [Session Ho6.3](#)
- SRC
 - Jackson Pybus (MIT): [Session D17.5](#)
 - Phoebe Sharp (GWU): [Session J17.5](#)
 - Bhesha Devkota (MSU): [Session Po3.6](#)
 - Bo Yu (Duke): [Session So3.6](#)
- JEF
 - Alexander Somov (JLab): [Session Ho6.1](#)
 - Igal Jaegle (JLab): [Session Ho6.4](#)
 - Liping Gan (UNCW): [Session Mo8.4](#)
 - Simon Taylor (JLab): [Session Ho6.5](#)
- KLF
 - Moskov Amarian(ODU): [Session So3.3](#)

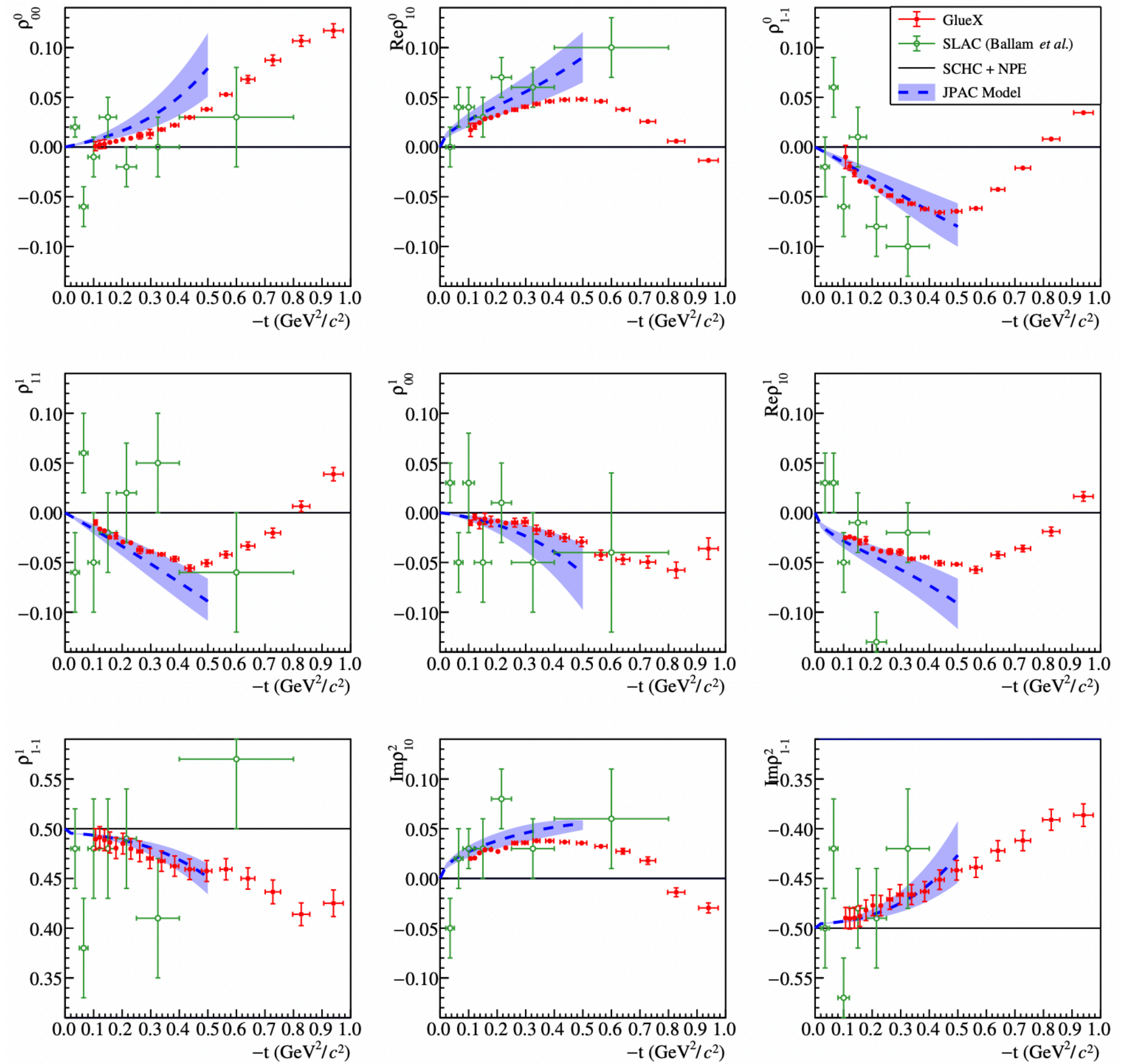


Thank you! Questions?

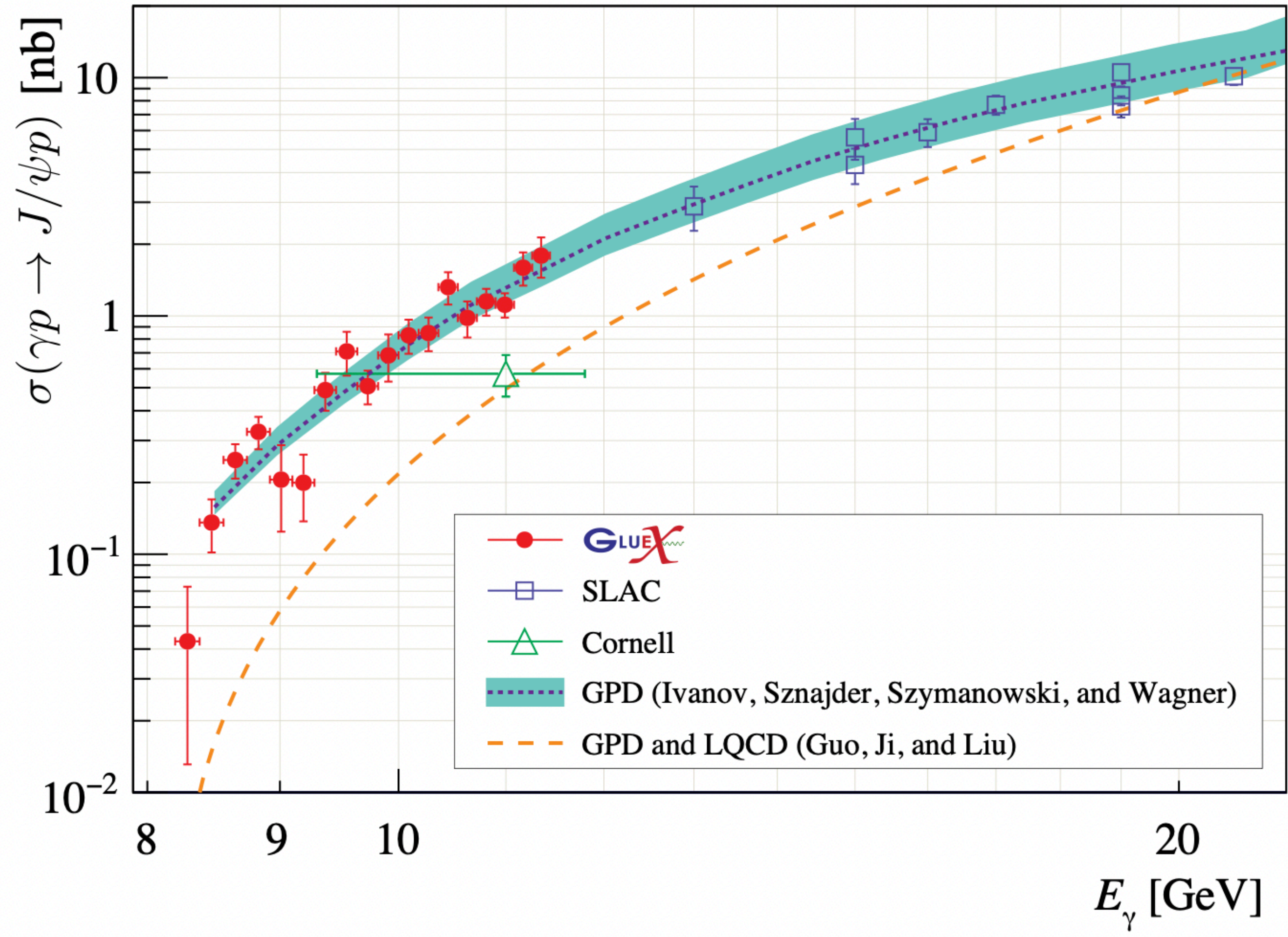
GlueX acknowledges the support of several funding agencies and computing facilities:
<http://gluex.org/thanks>

Backup slides

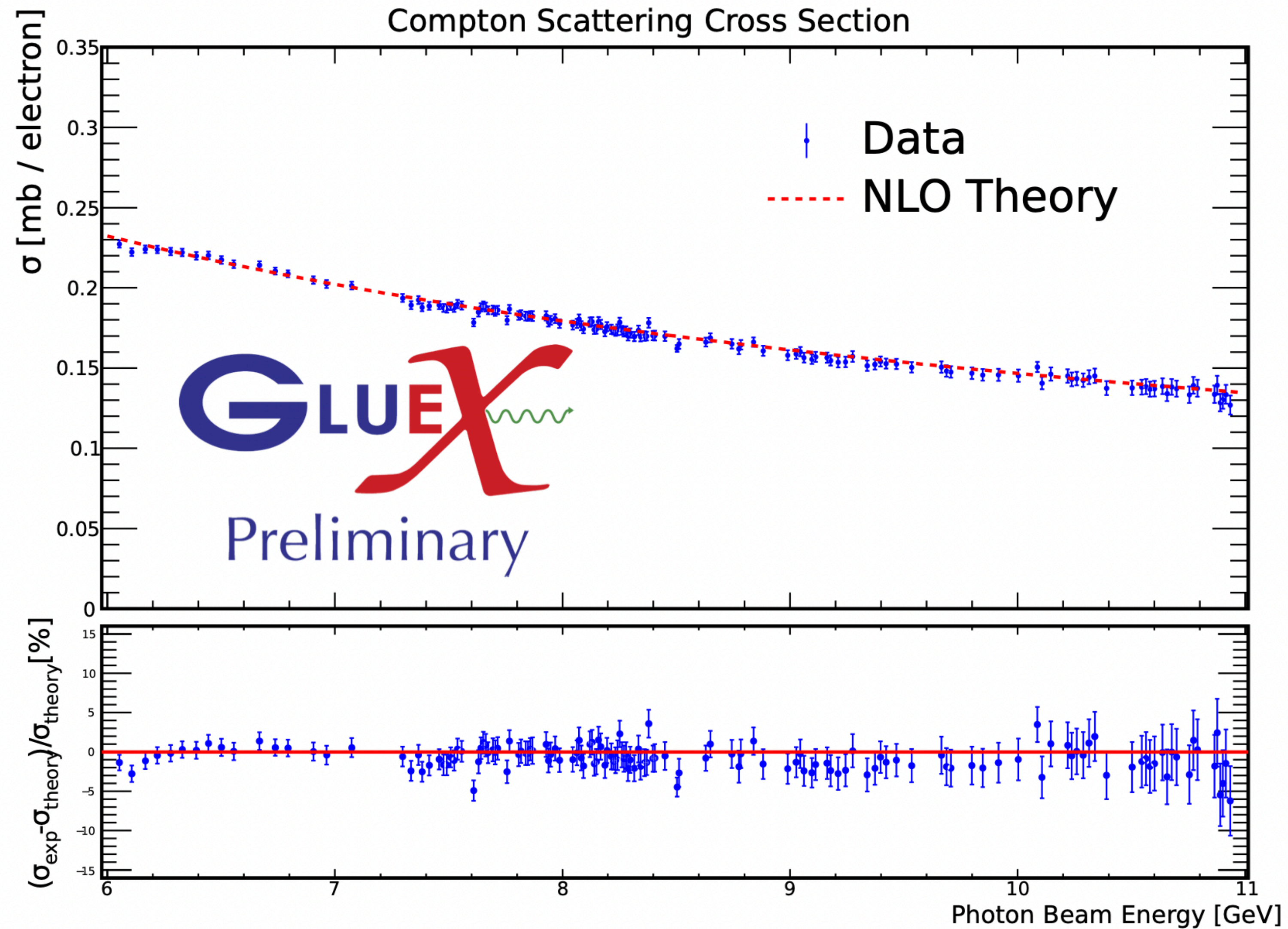
GlueX SDME



GlueX



PrimeX Compton Scattering



KLF

