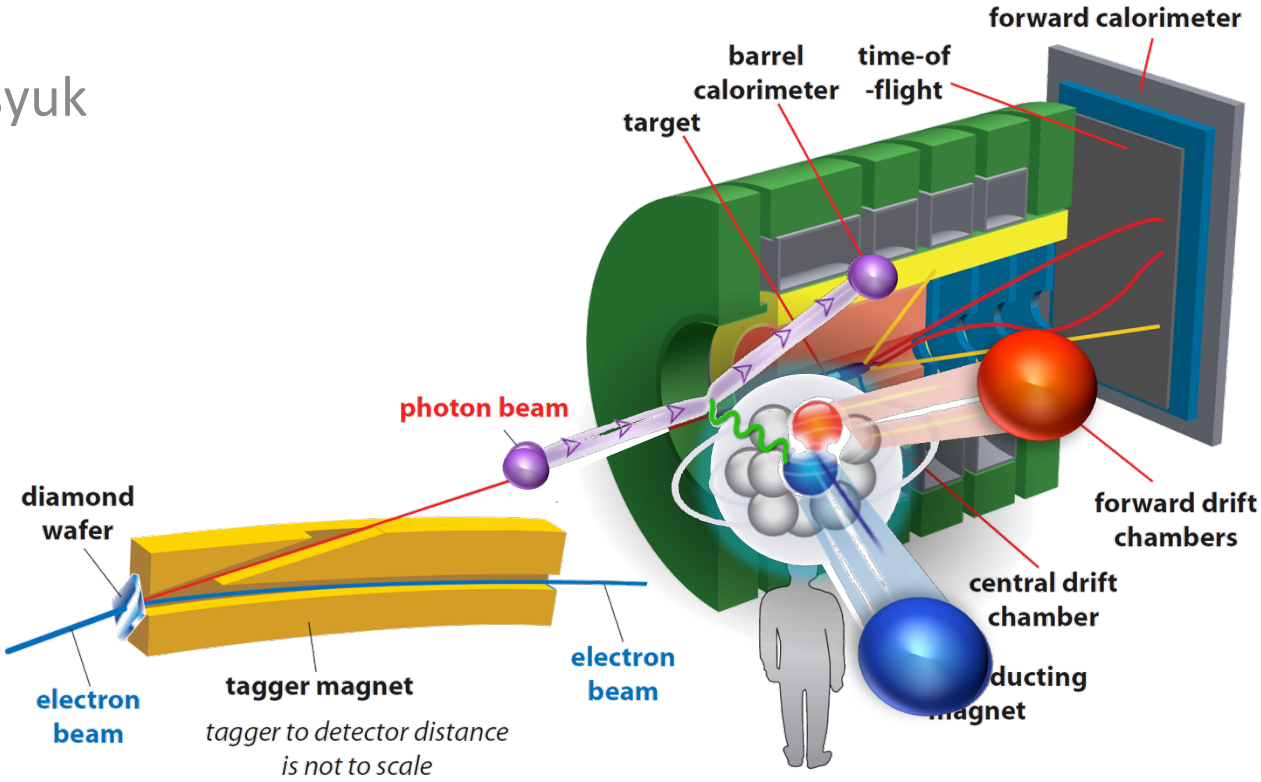
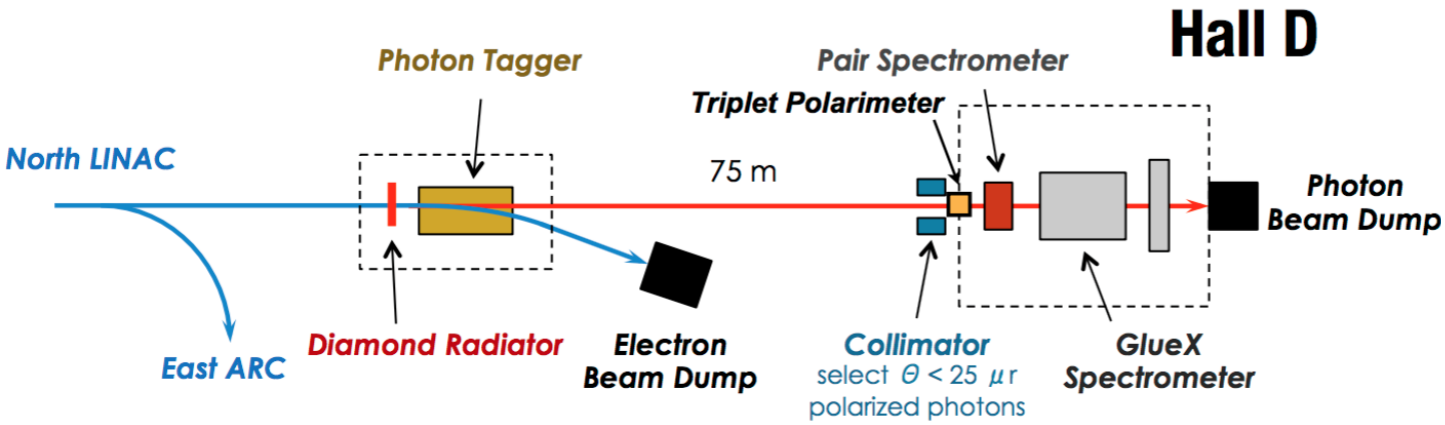
Short Range Correlations at GLUEX

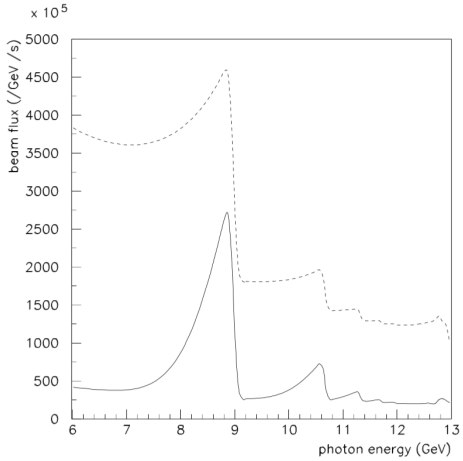
Maria Patsyuk



Quantitative challenges in EMC and SRC Research and Data-Mining, Dec. 2-5 2016

Hall D beam line and detector

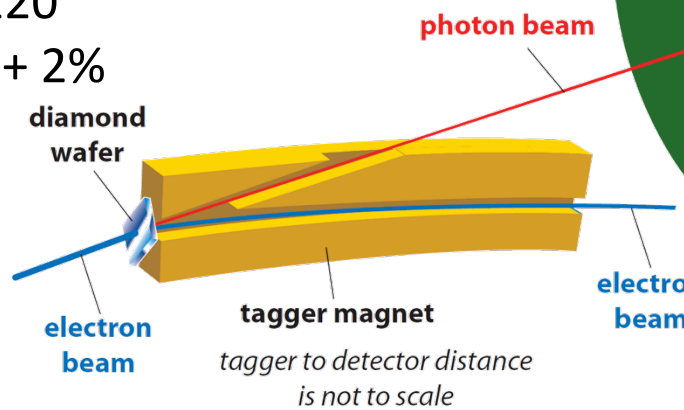


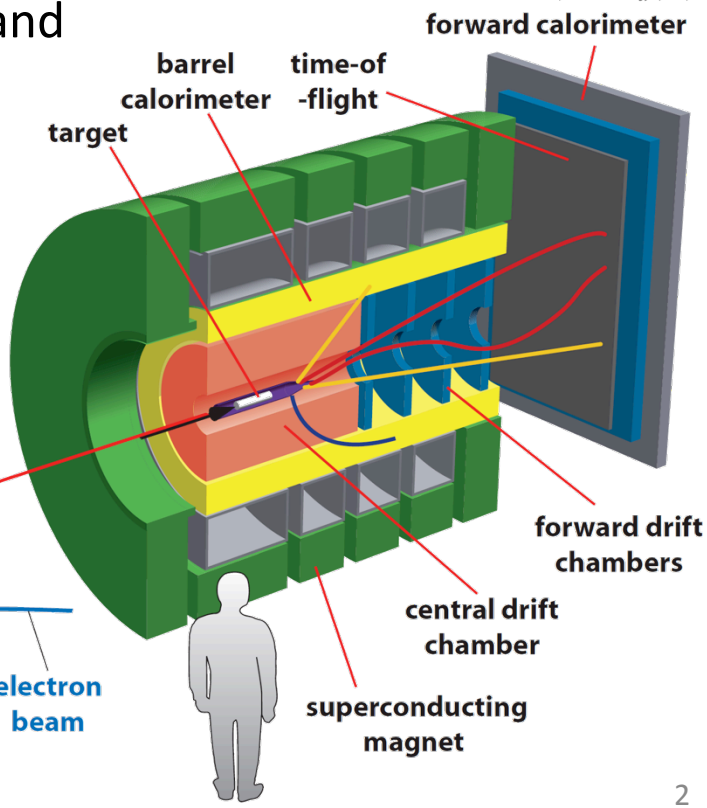


12 GeV electrons up to 2.2 μA hit a diamond radiator and produce linearly polarized bremsstrahlung photons

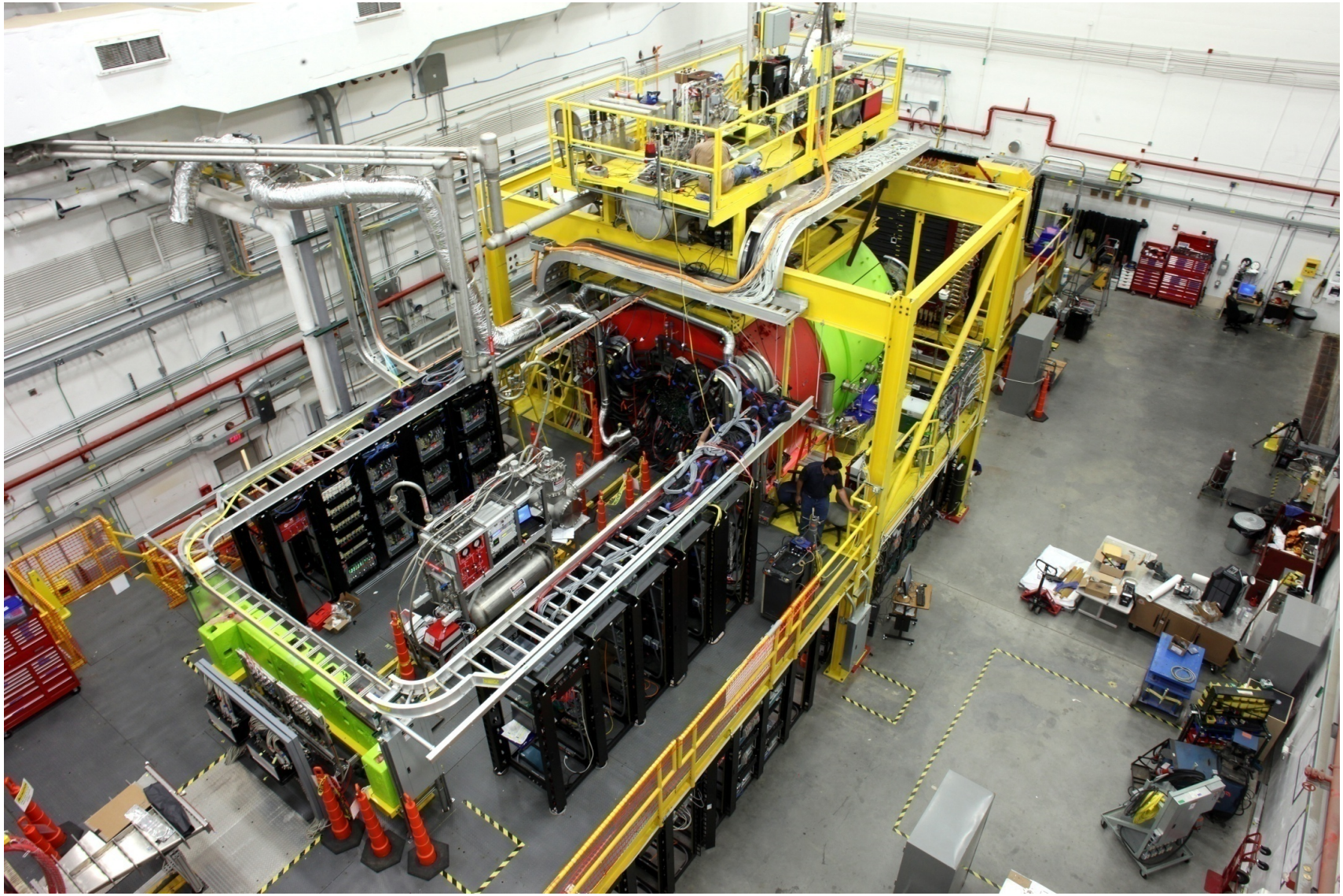
Intensity: 10^8 γ/s in coherent peak Eγ=8.4-9 GeV

Effective detection of multi-particle final states
Uniform acceptance: 1° - 120°
Resolution: $\sigma_E/E \sim 6\%/\sqrt{E} + 2\%$
$\sigma_p/p \sim 2\text{-}5\ \%$

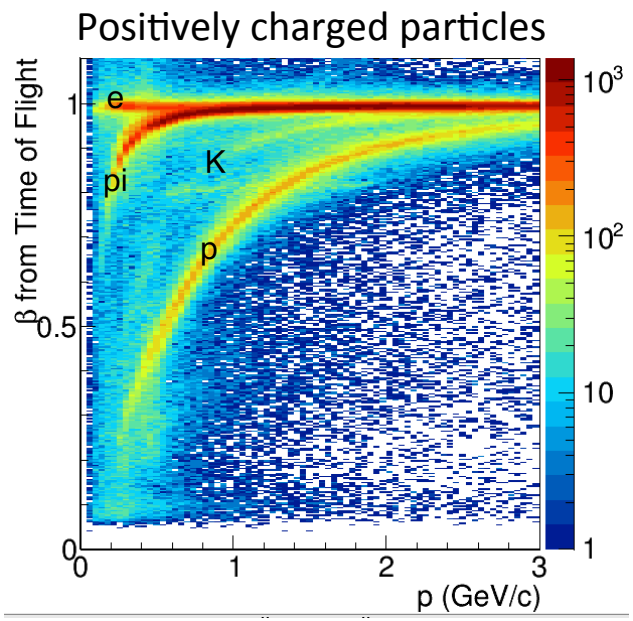


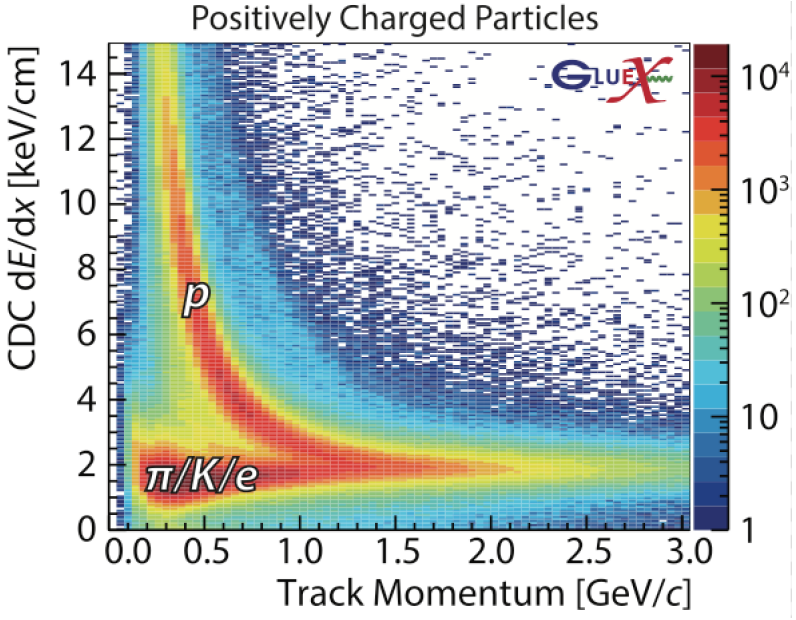


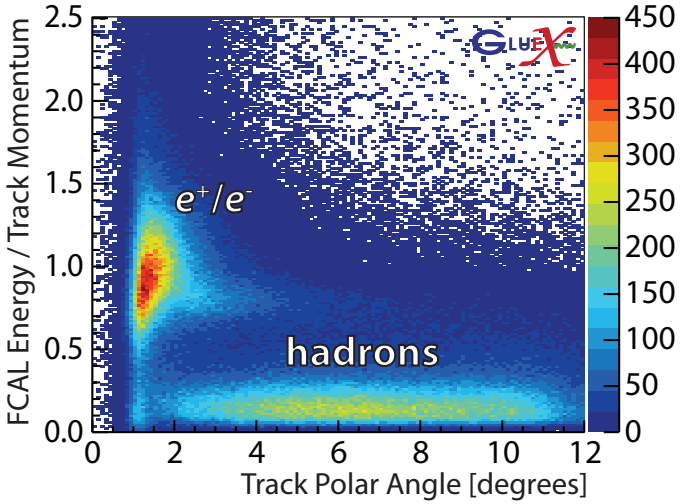
GlueX in Hall D



Particle identification







Why GlueX?

Photon beam:

- complements the set of different probes
- interact with neutron leading to charged final state ($\gamma\, n \longrightarrow \pi^-\, p$)
- hard reactions
- γp scattering ($\sigma \sim s^{-7}$) selects mostly forward going high momentum protons in nucleus (SRC)

Good neutron detection efficiency:

- probe nn SRC-pairs
- role of protons vs. neutrons in a nucleus
- map transition between mean field and SRC

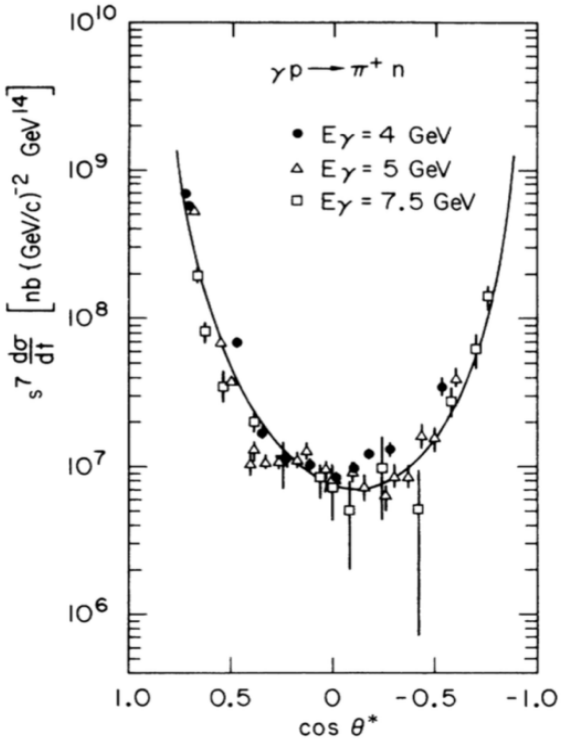


FIG. 6. $s^7 d\sigma/dt$ versus $\cos\theta^*$ for the reaction $\gamma p \to \pi^+ n$. The solid line shows the empirical function $(1-z)^{-5}(1+z)^{-4}$ where $(z = \cos\theta^*)$, which is an empirical fit to the angular distribution.

Modifications of nucleon structure in nuclei

Exp. evidence: EMC effect → bound nucleon ≠ free nucleon

Explanations: a) all nucleons are modified by the mean field

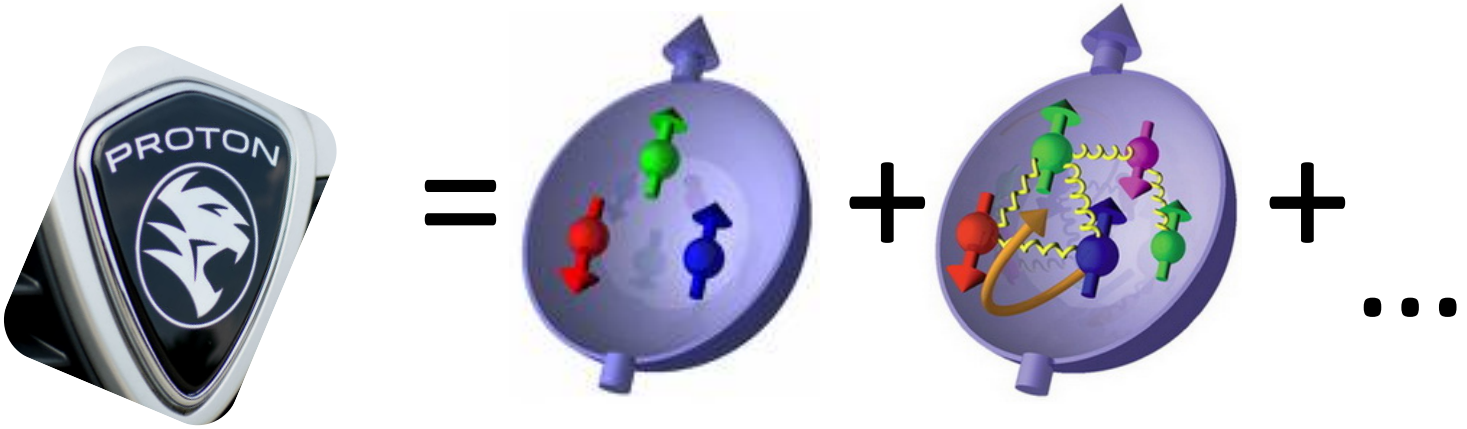
b) only high momentum nucleons ≠ free nucleons

Novel observable:

Compare branching ratios (BR) when scattering off quasi-free/ bound nucleon for reactions:

Exclusive Proton Reactions	Exclusive Neutron Reactions
$\gamma + p \rightarrow \pi^0 + p$	$\gamma + n \rightarrow \pi^- + p$
$\gamma + p \rightarrow \pi^- + \Delta^{++}$	$\gamma + n \rightarrow \pi^- + \Delta^{++}$
$\gamma + p \rightarrow \rho^0 + p$	$\gamma + n \rightarrow \rho^- + p$
$\gamma + p \rightarrow K^+ + \Lambda^0$	$\gamma + n \rightarrow K^0 + \Lambda^0$
$\gamma + p \rightarrow K^+ + \Sigma^0$	$\gamma + n \rightarrow K^0 + \Sigma^0$
$\gamma + p \rightarrow \omega + p$	x
$\gamma + p \rightarrow \phi + p$	x
…	…

Modifications of nucleon structure in nuclei

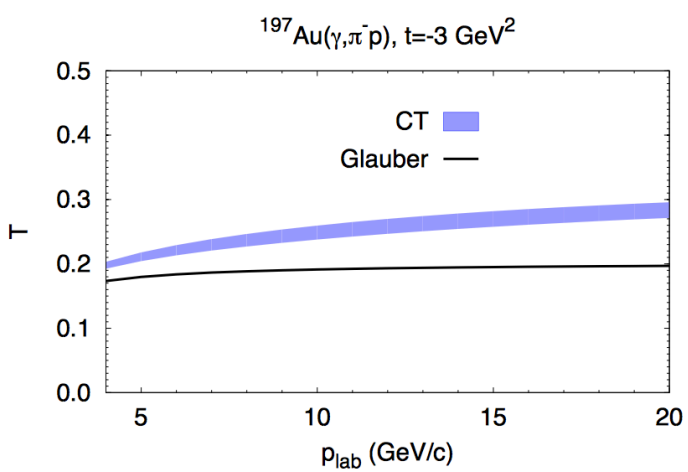


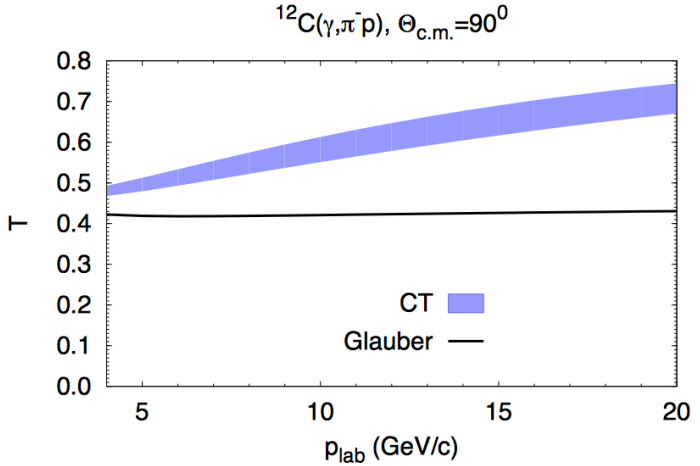
Different Fock states absorb γ differently → variation in Fock state decomposition for protons from different nuclei:

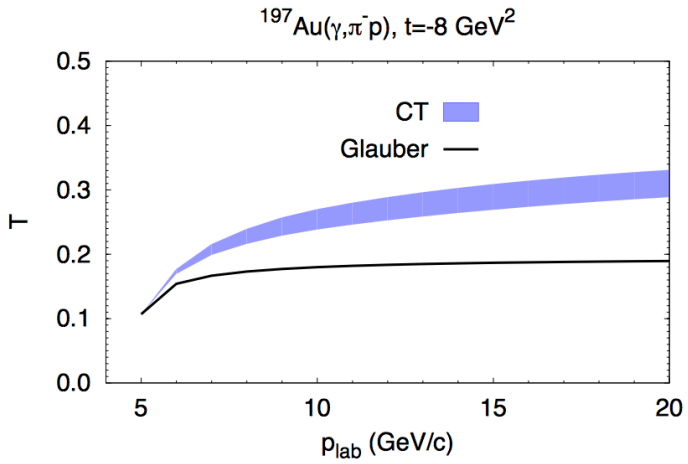
^{2}H, ^{4}He, ^{12}C, (^{27}Al), ^{28}Si, **^{40}Ca, ^{48}Ca, ^{54}Fe**, ^{93}Nb, ^{208}Pb

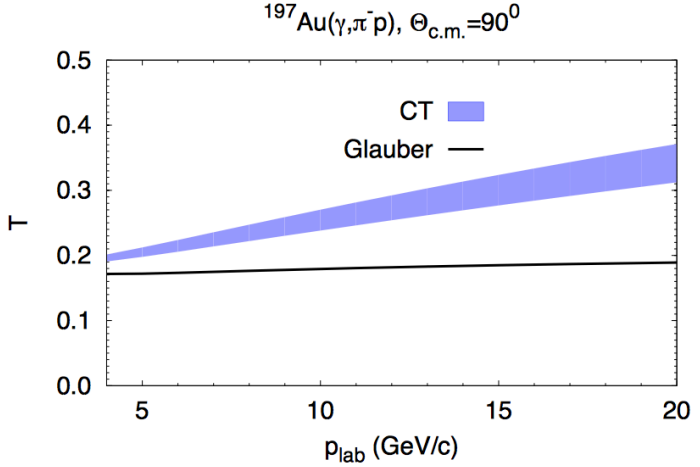
Nuclear transparency

For GlueX kinematical conditions nuclear attenuation deviates from the Glauber calculation:









A. Larionov and M. Strikman, Phys. Lett. B **760**, 753 (2016)

Outlook

- GlueX experiment has a unique beam for SRC studies and a spectrometer with good efficiency for detecting charged particles and neutrons

- SRC physics program (LOI submitted to PAC 44) includes:
  - Search for SRC pairs
  - (Color) transparency studies
  - In medium modifications of nucleon structure

- Simulation studies are needed

Backup

Reactions

Exclusive Proton Reactions	Exclusive Neutron Reactions
$\gamma + p \rightarrow \pi^0 + p$	$\gamma + n \rightarrow \pi^- + p$
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$\gamma + p \rightarrow K^+ + \Sigma^0$	$\gamma + n \rightarrow K^0 + \Sigma^0$
$\gamma + p \rightarrow \omega + p$	x
$\gamma + p \rightarrow \phi + p$	x
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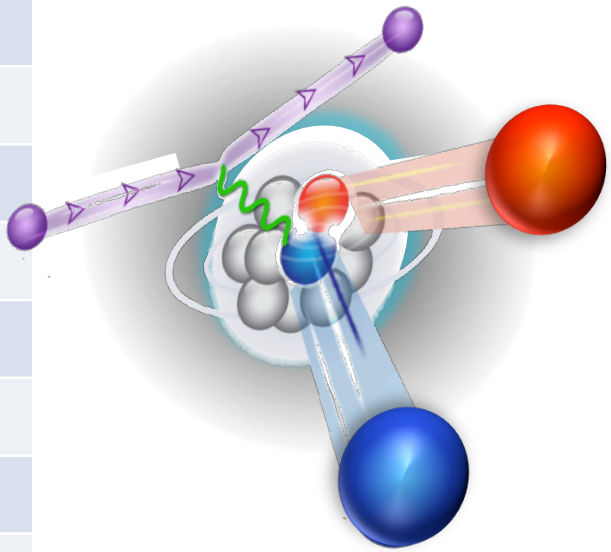

A set of thin foil targets:

^{2}H, ^{4}He, ^{12}C, (^{27}Al), ^{28}Si, **^{40}Ca, ^{48}Ca, ^{54}Fe**, ^{93}Nb, ^{208}Pb

Modifications of nucleon structure in nuclei

A proton can be described using Fock states:

- *FREE*

$$\left|proton\right\rangle = \alpha_{PLC}\left|PLC\right\rangle + \alpha_{3qg}\left|3q+g\right\rangle ... + \alpha_{3q\pi}\left|3q+\pi\right\rangle + \alpha \left| \ \right\rangle$$

- *BOUND*

$$\left|proton^{*}\right\rangle = \alpha^{*}{}_{PLC}\left|PLC\right\rangle + \alpha^{*}{}_{3qg}\left|3q+g\right\rangle ... + \alpha^{*}{}_{3q\pi}\left|3q+\pi\right\rangle + \alpha^{*}\left| \ \right\rangle$$

- *SRC*

$$\left|proton^{SRC}\right\rangle = \alpha^{SRC}{}_{PLC}\left|PLC\right\rangle + \alpha^{SRC}{}_{3qg}\left|3q+g\right\rangle ... + \alpha^{SRC}{}_{3q\pi}\left|3q+\pi\right\rangle + \alpha^{SRC}\left| \ \right\rangle$$

<u>Novel observable:</u>

Compare branching ratios (BR) when scattering off quasi-free/bound nucleon for a set of reactions

Get an idea about relative contribution of different Fock states for quasi-free/bound nucleon