High-t Meson Photoproduction: Experimental Capabilities

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Workshop on Probing Small-Size Configurations in High-t Photo/Electroproduction
Jefferson Lab
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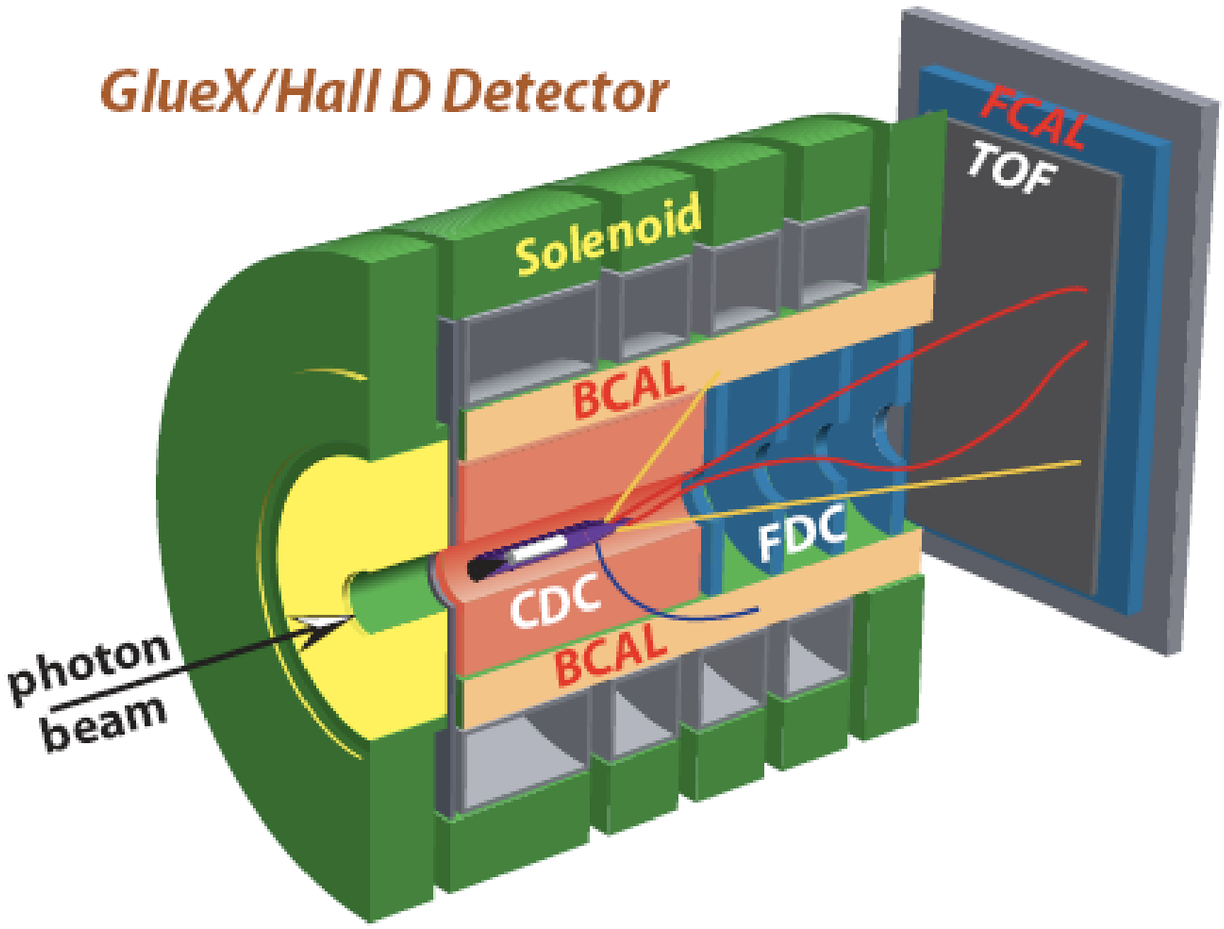
Outline

- The CLAS12 and GlueX detectors.
- Kinematics.
- What can be done with CLAS12 and GlueX.
- Detector Capabilities for polarization measurements.

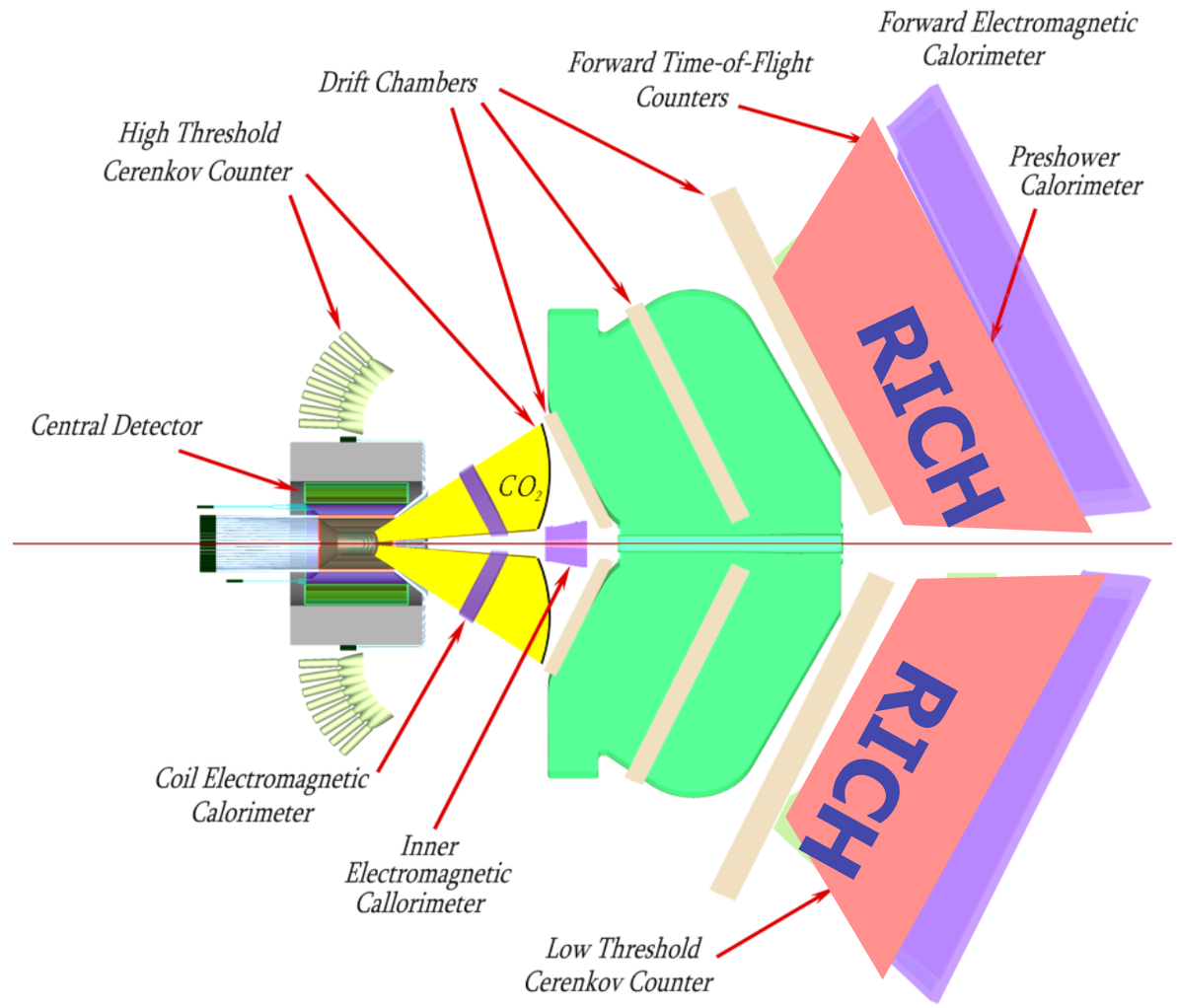
The Detectors



Limited Resolution

Limited PID

Uniform Acceptance



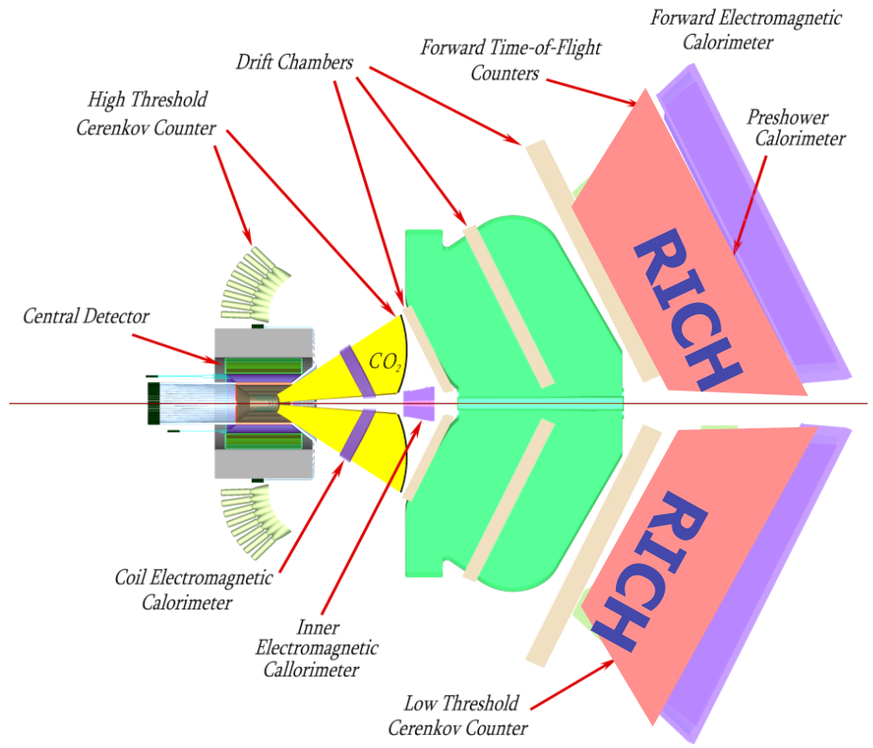
Good Resolution

Good PID

Non-Uniform Acceptance

Detector Capabilities in Hall B: CLAS12

- General
  - 11 GeV polarized electron beam
  - Luminosity: 10^{35} $cm^{-2}s^{-2}$
- Forward Detector (toroidal spectrometer)
  - Angular Acceptance: 5° - 35°
  - Momentum Resolution: 0.5% - 1% for 5 GeV track
  - Angular Resolution: 1 mrad for the electron track
- Central Detector (solenoid magnet): moderate momentum baryon detection
  - Angular Acceptance: 35° - 125°
  - Momentum Resolution: 5% for 1 GeV track
  - Angular Resolution: 5 - 10 mrad
  - Momentum Range: 0.3 - 1.3 GeV/c



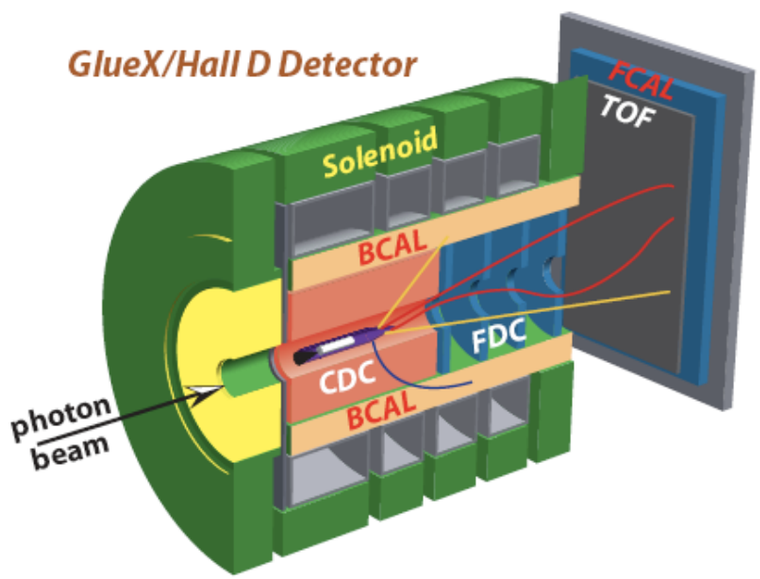
Detector Capabilities in Hall B: CLAS12

- Particle Identification with base equipment

CLAS12 PID Forward Detectors	πK			πp			Kp		
	p<2.6	2.6<p<5	p>5	p<2.6	2.6<p<5	p>5	p<2.6	2.6<p<5	p>5
FTOF	✓	✓		✓	✓		✓	✓	
LTCC		✓	✓		✓	✓			
HTCC			✓			✓			

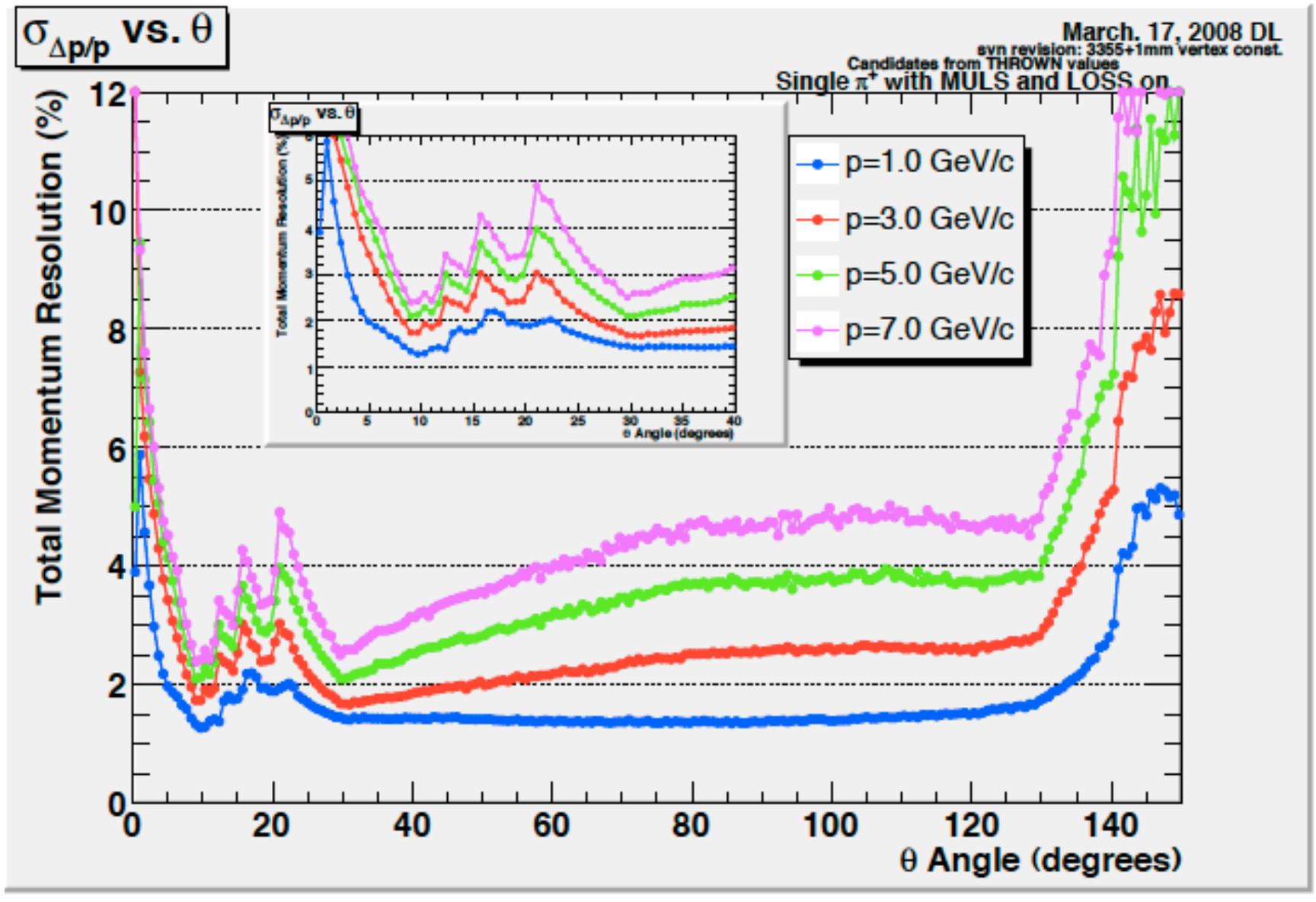
Detector Capabilities in Hall D: GlueX

- General
  - 9 GeV tagged photon beam
  - Linear beam polarization ~40%
  - Photon flux: 10^8 photons/s at 9 GeV coherent edge
  - optimized for 3 or more pions in final state
  - Angular Acceptance for photons: 1° - 126.4°
  - Angular Acceptance for charged particles: 1° - 150°
  - Momentum Acceptance for charged particles: up to ~ 7 GeV/c
  - Momentum Thresholds
    - pions: 0.15 GeV/c
    - kaons: 0.15 - 0.22 GeV/c
    - protons: 0.25 - 0.33 GeV/c
  - Particle ID
    - capability to separate pions/protons
    - limited capability to identify kaons



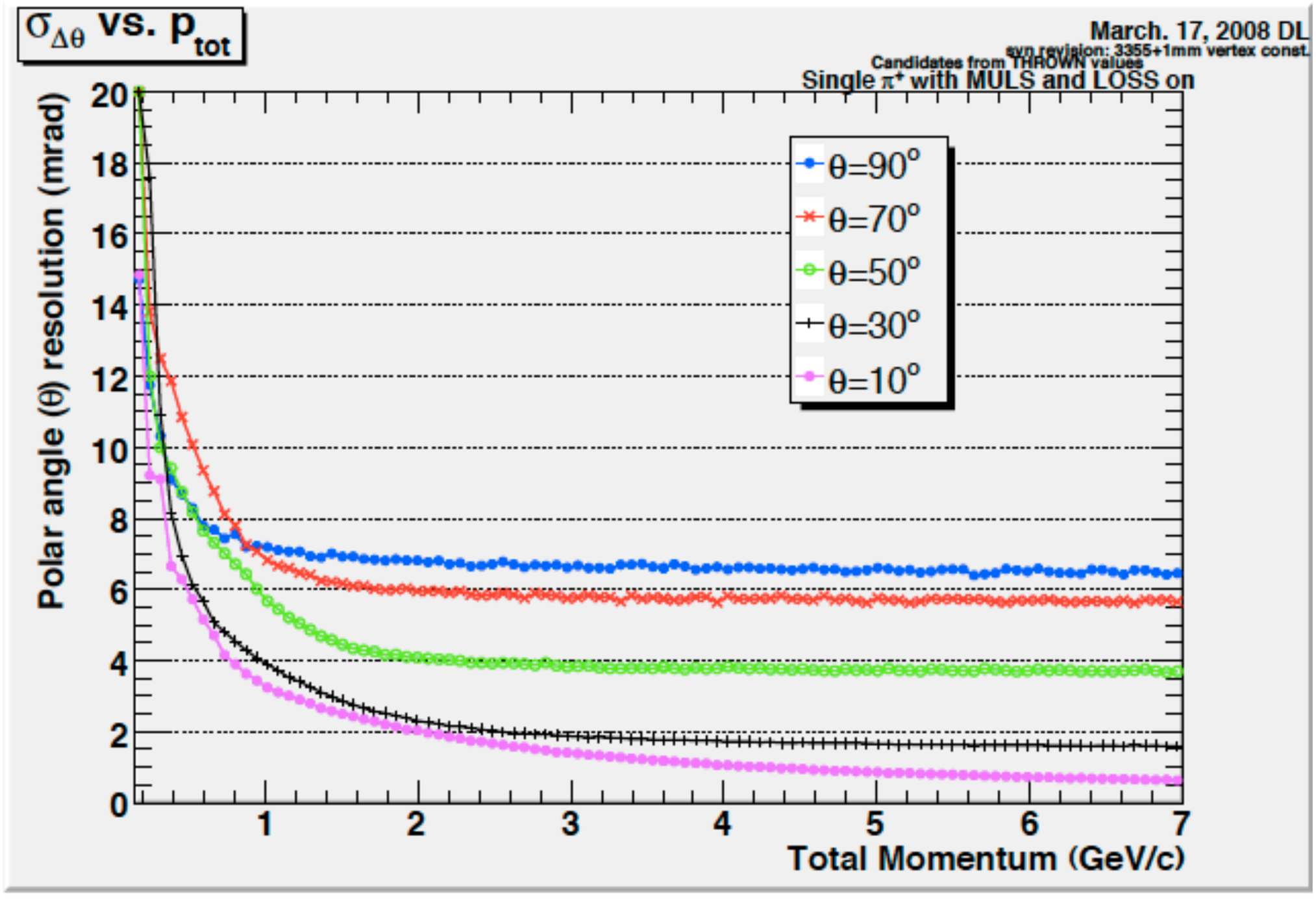
Detector Capabilities in Hall D: GlueX

- Momentum Resolution



Detector Capabilities in Hall D: GlueX

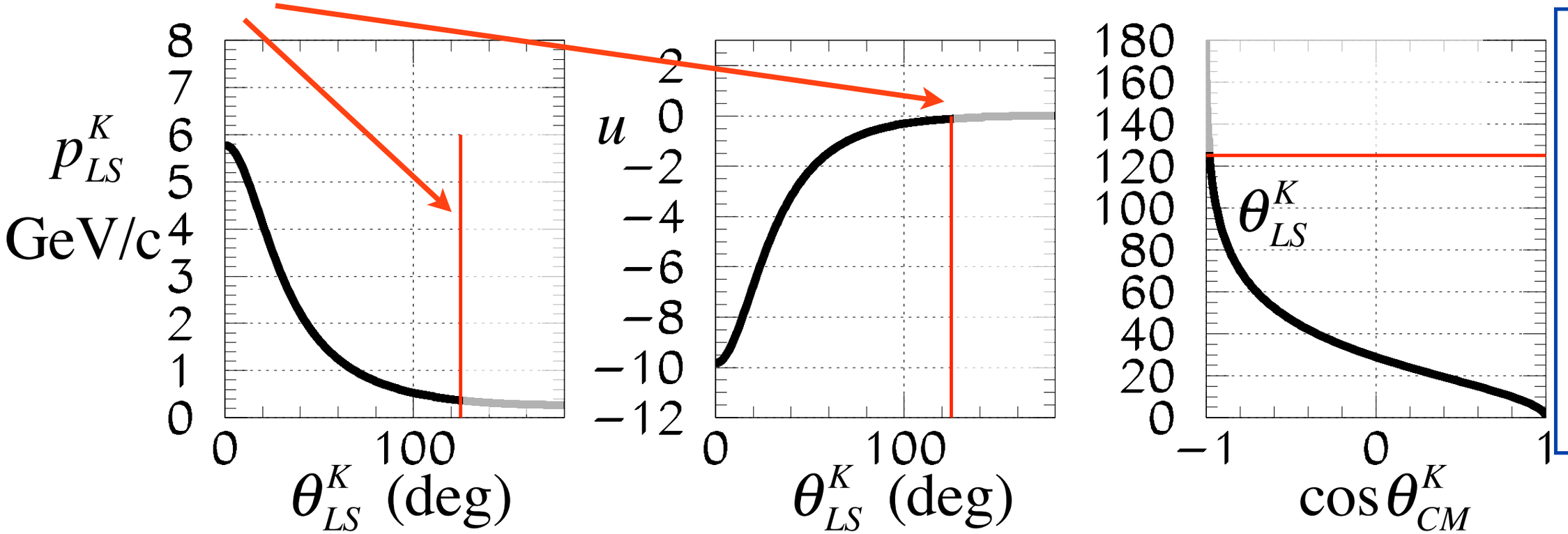
- Polar-angle Resolution



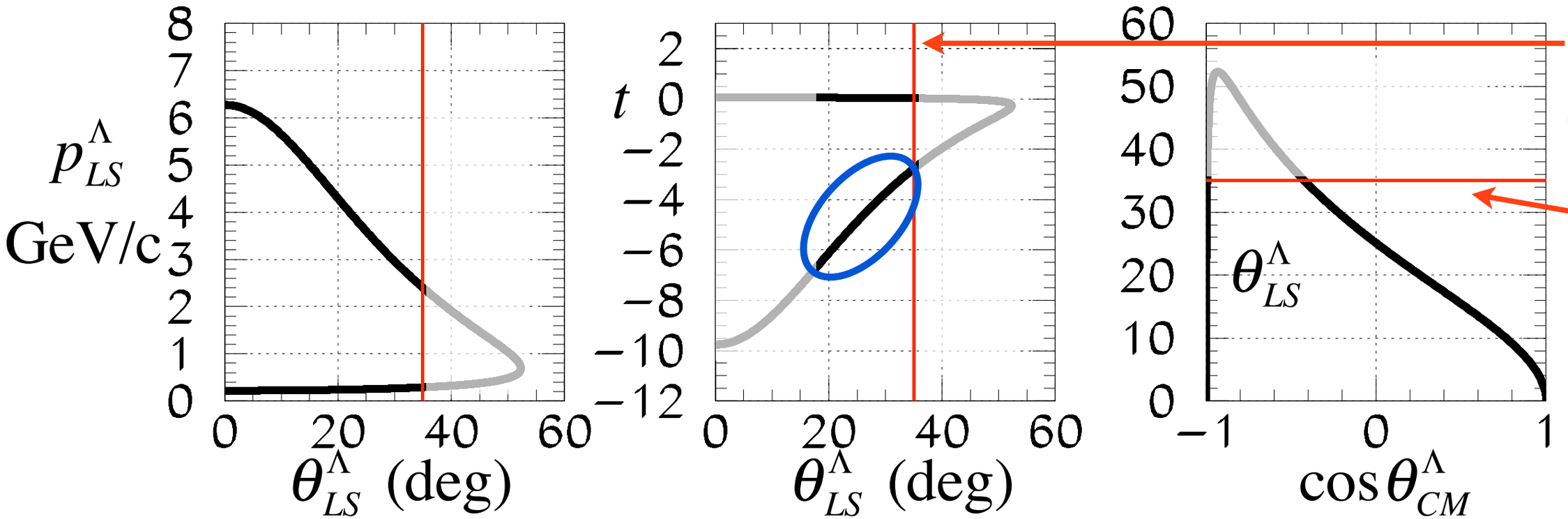
Kinematics

$$\gamma p \to K^+ \Lambda \text{ at } E_\gamma = 6 \text{ GeV}$$

Backward-angle limit of CLAS12



Simultaneous detection of K and Λ in Forward Detector

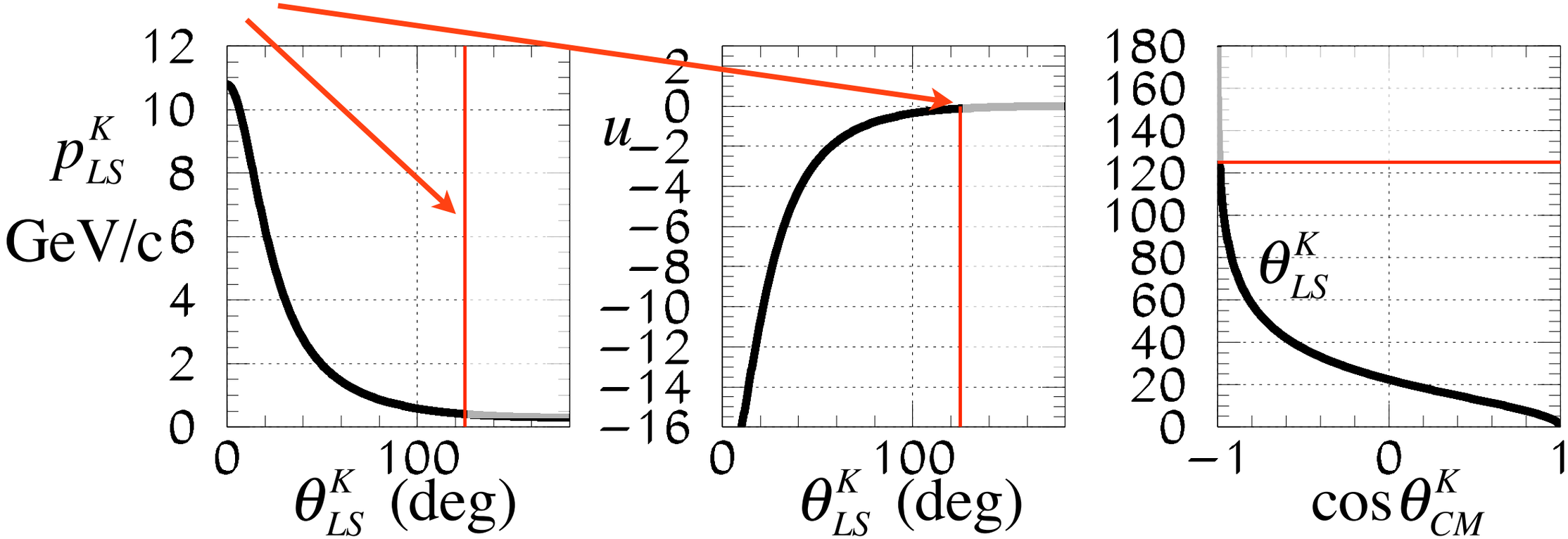


Forward Detector limit of CLAS12

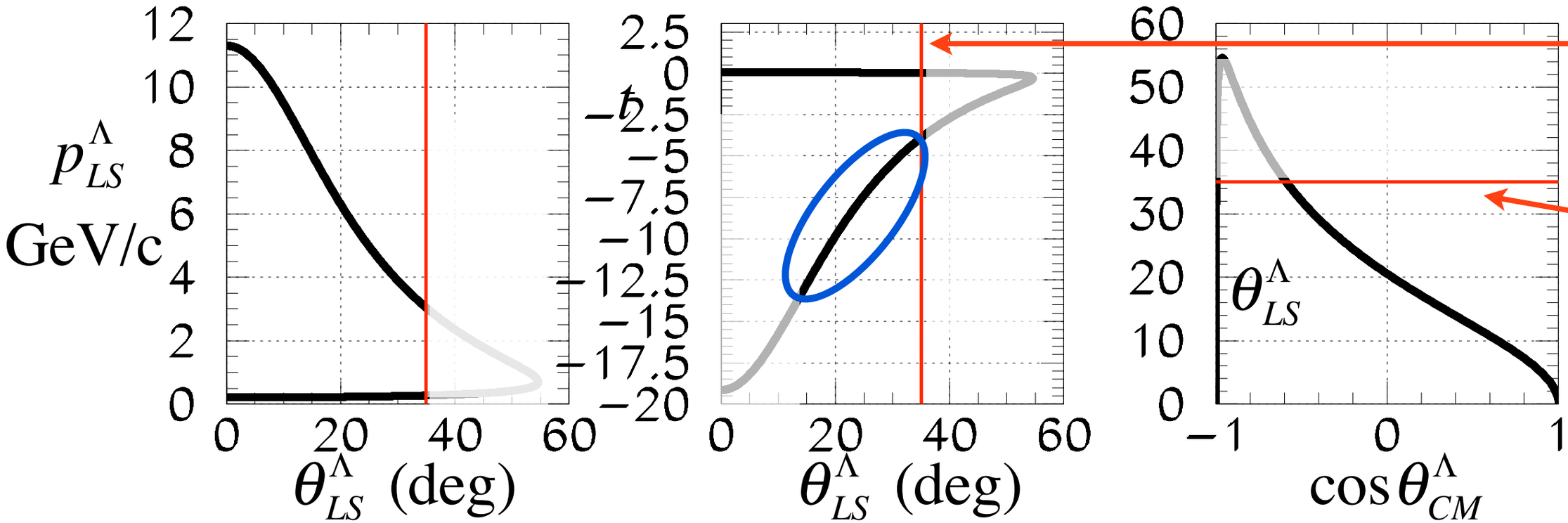
Kinematics

$$\gamma p \to K^+ \Lambda \text{ at } E_\gamma = 11 \text{ GeV}$$

Backward-angle limit of CLAS12



Simultaneous detection of K and Λ in Forward Detector



Forward Detector limit of CLAS12

CLAS Capabilities for measuring

$$\gamma p \rightarrow K^{+}\Lambda \text{ at } E_{\gamma} = 6 - 11 \text{ GeV}$$

- At 6 GeV: both outgoing particles can be detected in coincidence in the forward detector with basic equipment. Accessible t range: -3 $(GeV/c)^2$ to -7 $(GeV/c)^2$
- At 11 GeV: Coincidence measurement is fully possible only if RICH detector is available for pion/kaon/proton separation in the momentum range 3 - 8 GeV/c.
- At 11 GeV: Lambda momentum varies from 3 to 11 GeV/c. May be possible to detect Lambda's over full range. Accessible t range: -4 $(GeV/c)^2$ to -13. $(GeV/c)^2$. Photon detection will be needed if only Lambda is detected.
- Forward Tagger
  - Quasi-real photons: Q^2 = 0.01 - 0.3 $(GeV/c)^2$
  - Photon energies: 6.5 - 10.5 GeV
  - Linear Polarization: 70% - 10%.
  - Photon Flux: 5×10^8 photons/s integrated flux over full tagged energy range

GlueX Capabilities for measuring

$$\gamma p \to K^+\Lambda \text{ at } E_\gamma = 6-11 \text{ GeV}$$

- Good photon energy resolution
- Linear polarization
- $Q^2 = 0$

- Better forward acceptance than CLAS12, but poorer resolution for high momentum particles.
- Do not need to detect all the final-state particles. Analysis can be done when only Lambda is identified.
- If RICH is installed, the final-state kaon can be identified as well - strong background reduction.

Capabilities for polarization measurements

- Hall D: coherent bremsstrahlung, up to 9 GeV (40% linear polarization at 9 GeV)
- Hall B: quasi-real photoproduction, $Q^2 < 0.3$ $(GeV/c)^2$ (10% - 70% linear polarization over tagged photon energy range)
- Hall B: circular photon polarization measurement is possible for fully exclusive final states, where all the final-state particles are detected and the photon beam energy is reconstructed
- Polarized targets: linearly polarized target planned for Hall B.

Summary and Perspectives

- The CLAS12 and GlueX provide complementary capabilities for measuring high-t real-photoproduction processes.
- CLAS12 provides better resolution and particle ID, but limited and non-uniform acceptance.
- GlueX provides tagged photon beam, larger acceptance coverage and uniform acceptance, but poorer resolutions. Kaons are not well identified. Optimized for multi-pion final states.
- Experiments with linearly polarized photons are possible with both setups.
- The CLAS12 offers a possibility for circularly polarized measurement for fully exclusive final states.
- Depending on the final state of interest, complementary measurements can be done with both detectors.

The END