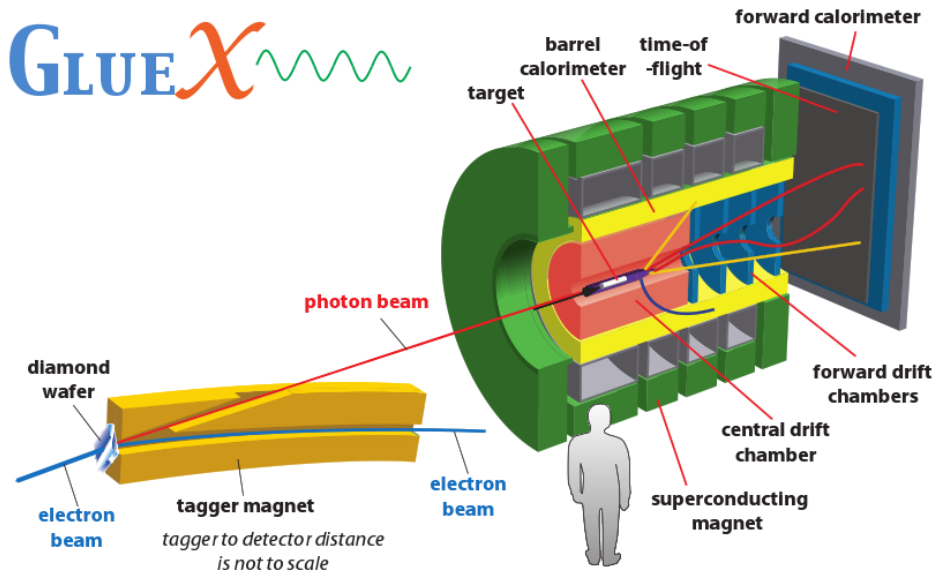


Polarized Photoproduction of Hybrid Mesons

with **GLUEX** 



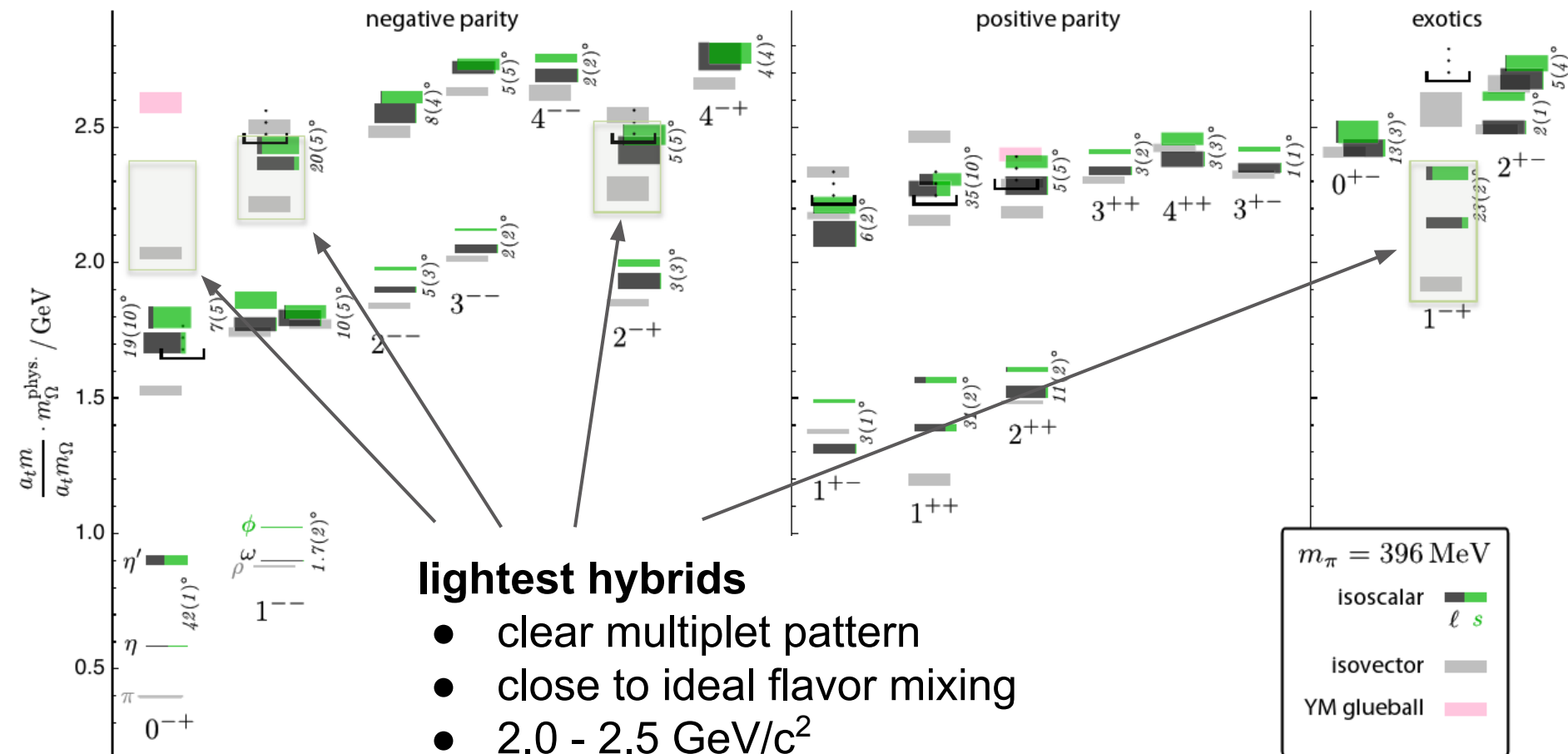
Richard Jones, University of Connecticut
representing
the GlueX collaboration

Outline

- the GlueX experiment
 - the GlueX photon beam
 - polarization production and measurement
 - utility of linear polarization in PWA
 - other physics with polarized beam
 - GlueX status and outlook
-

the light meson spectrum (LQCD)

Fig. 4 from Dudek et al., Phys.Rev.D 83, 111502(R) (2011)



the GlueX experiment

- focus on $n\bar{n}$ exotic mesons

$$\begin{aligned} \pi_1 &\rightarrow \pi b_1, \pi f_1, \pi \rho, \eta a_1, \pi \eta' \\ \eta_1 &\rightarrow \pi(1300)\pi, a_1\pi, \eta f_1, \eta \eta' \end{aligned}$$

$$\begin{aligned} b_2 &\rightarrow f_1\rho, a_1\pi, h_1\pi, b_1\eta, \omega\pi, a_2\pi, \rho\eta \\ h_2 &\rightarrow b_1\pi, \rho\pi, \omega\eta, f_1\omega \end{aligned}$$

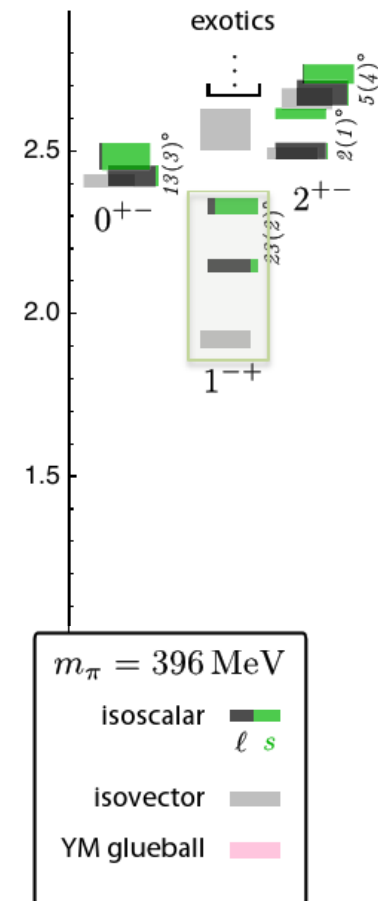
$$\begin{aligned} b_0 &\rightarrow \pi(1300)\pi, h_1\pi, f_1\rho, b_1\eta \\ h_0 &\rightarrow b_1\pi, h_1\eta \end{aligned}$$

- $s\bar{s}$ exotics with PID upgrade

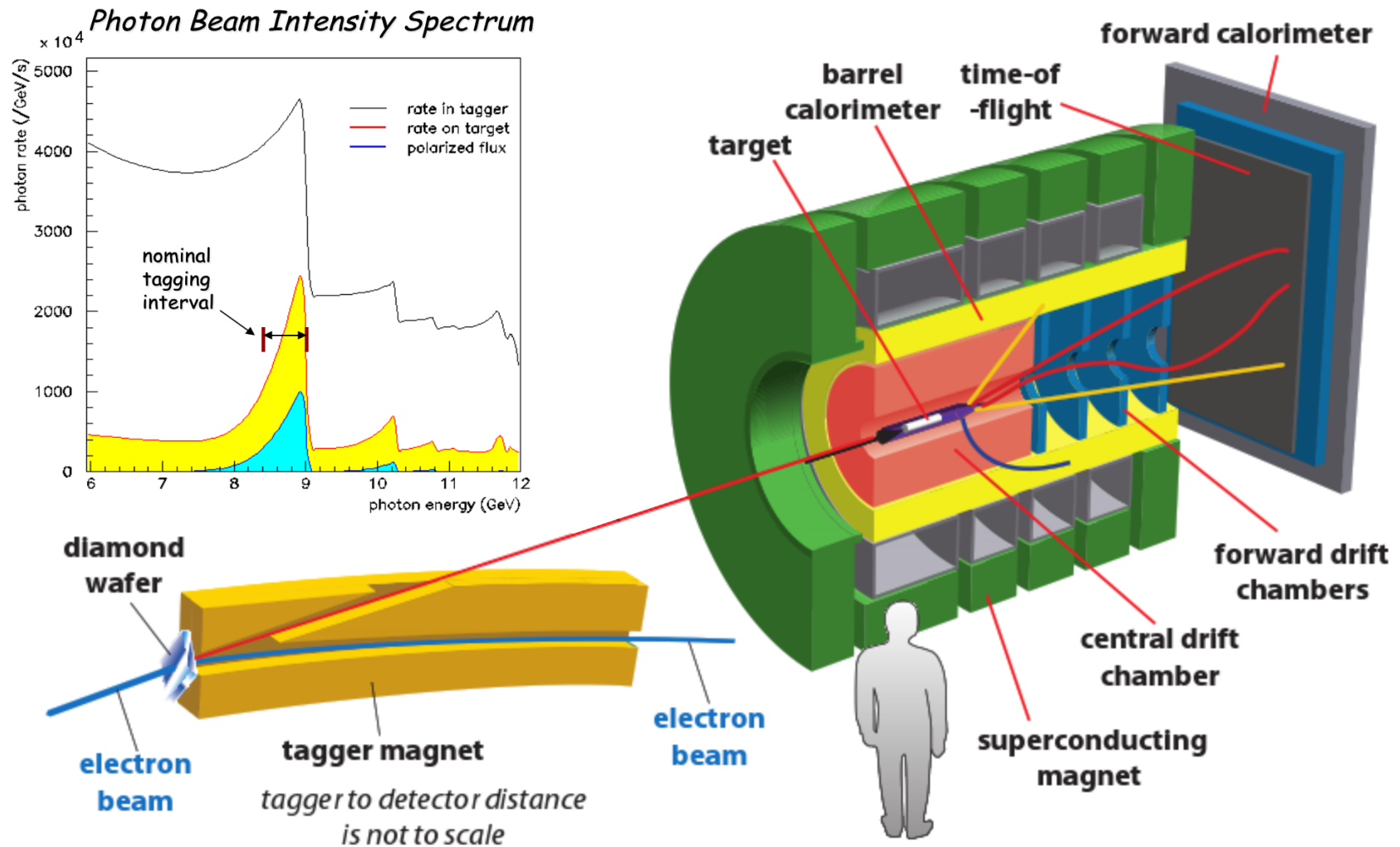
$$\eta_1' \rightarrow KK^*, K^*K^*, KK_1, \omega\phi$$

$$h_2' \rightarrow KK^*, K^*K^*, KK_1, KK_2^*, \eta\phi$$

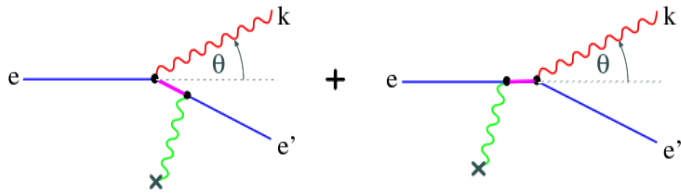
$$h_0' \rightarrow KK_1, f_0(980)\phi$$



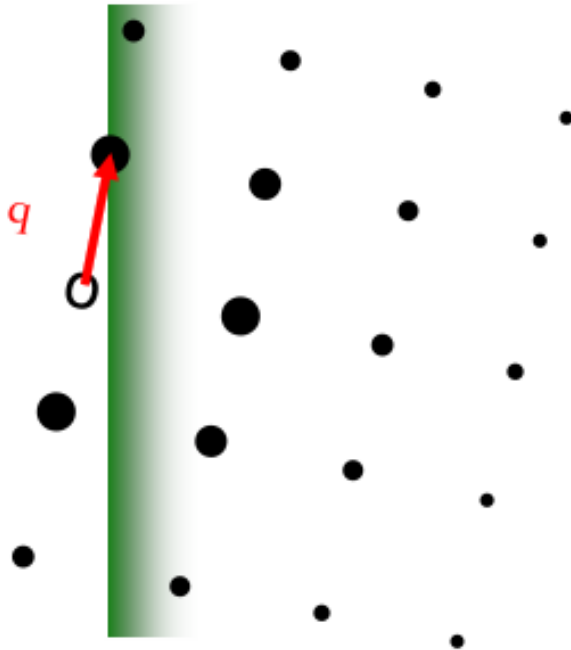
the GlueX experiment



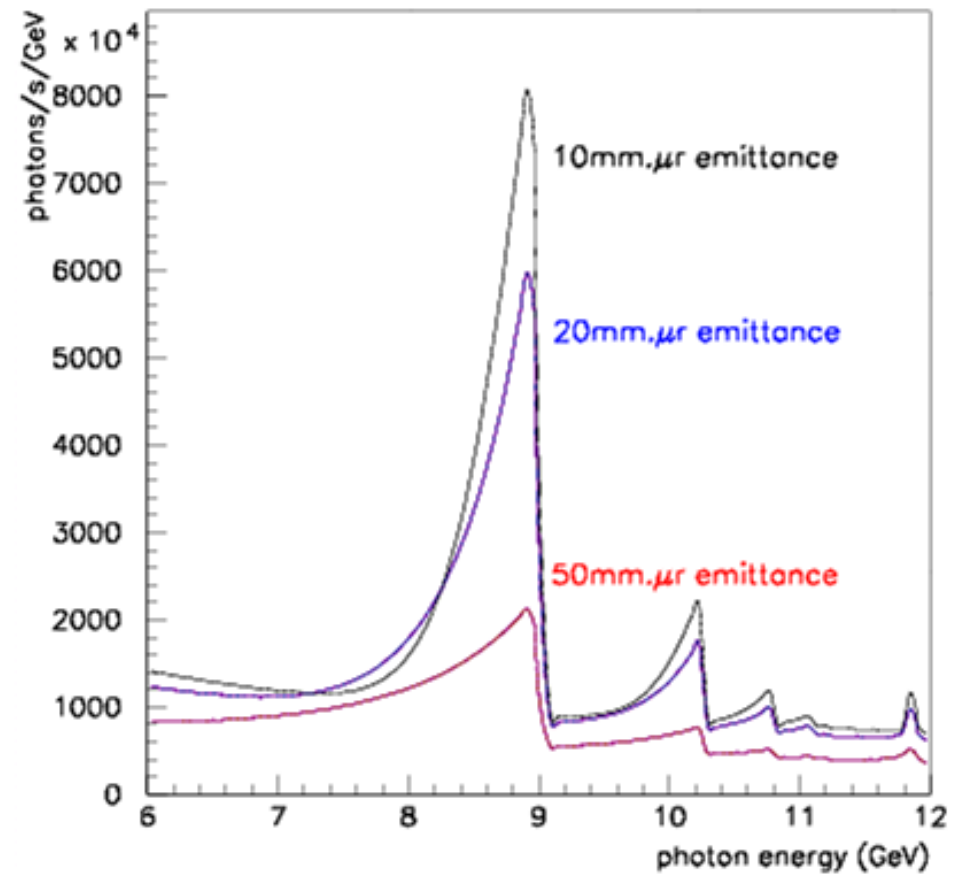
polarized photon source



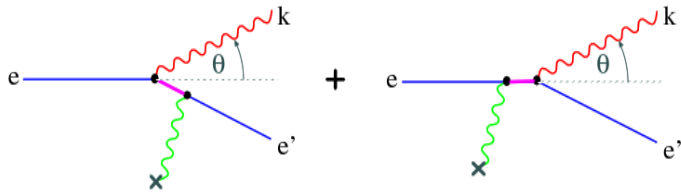
bremsstrahlung in an oriented crystal target



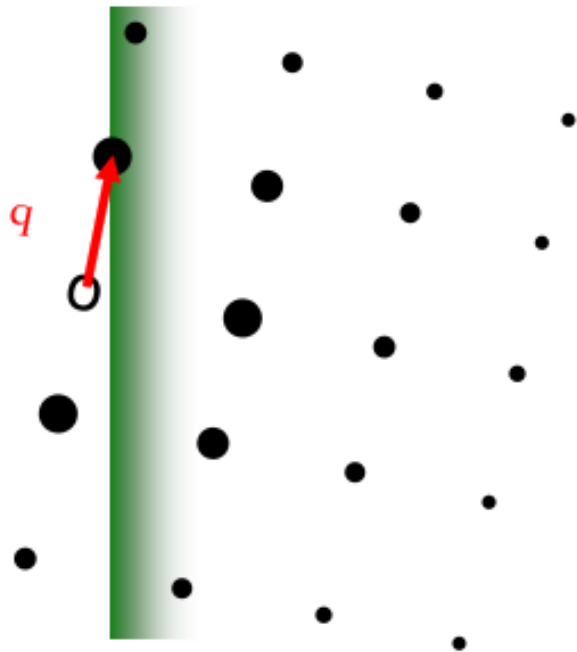
effect of electron beam emittance



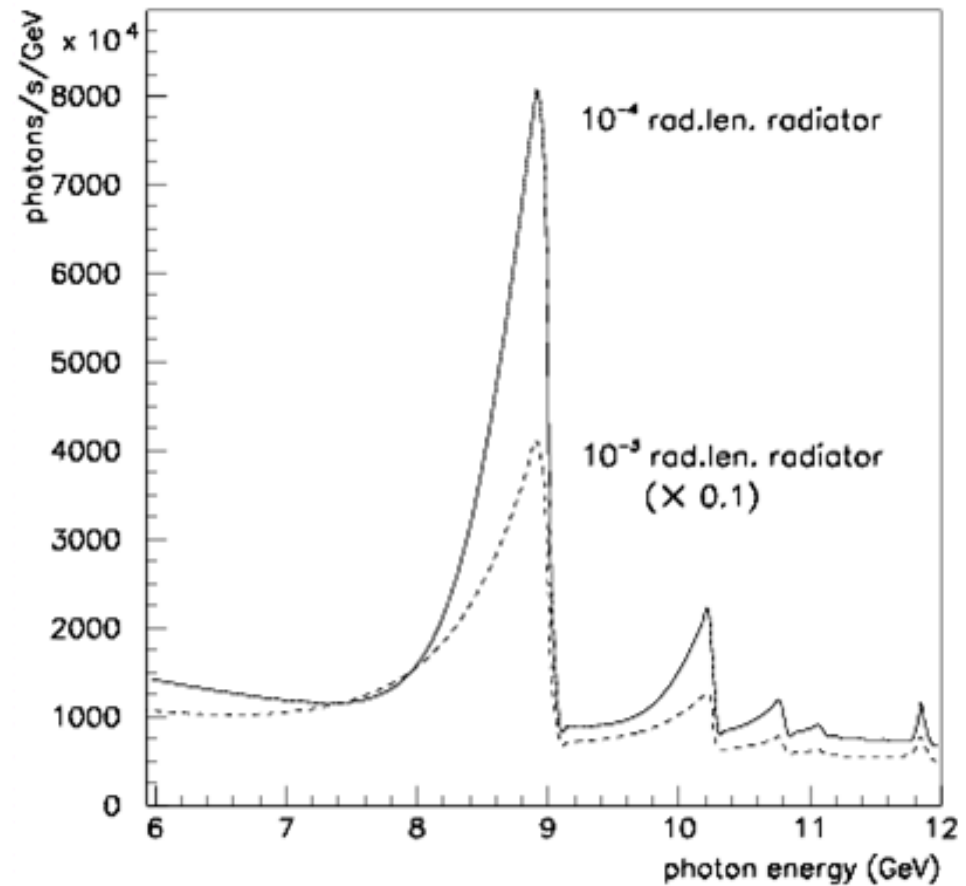
polarized photon source



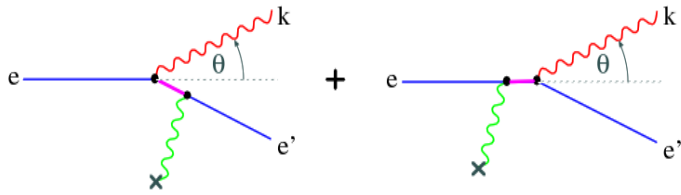
bremsstrahlung in an oriented crystal target



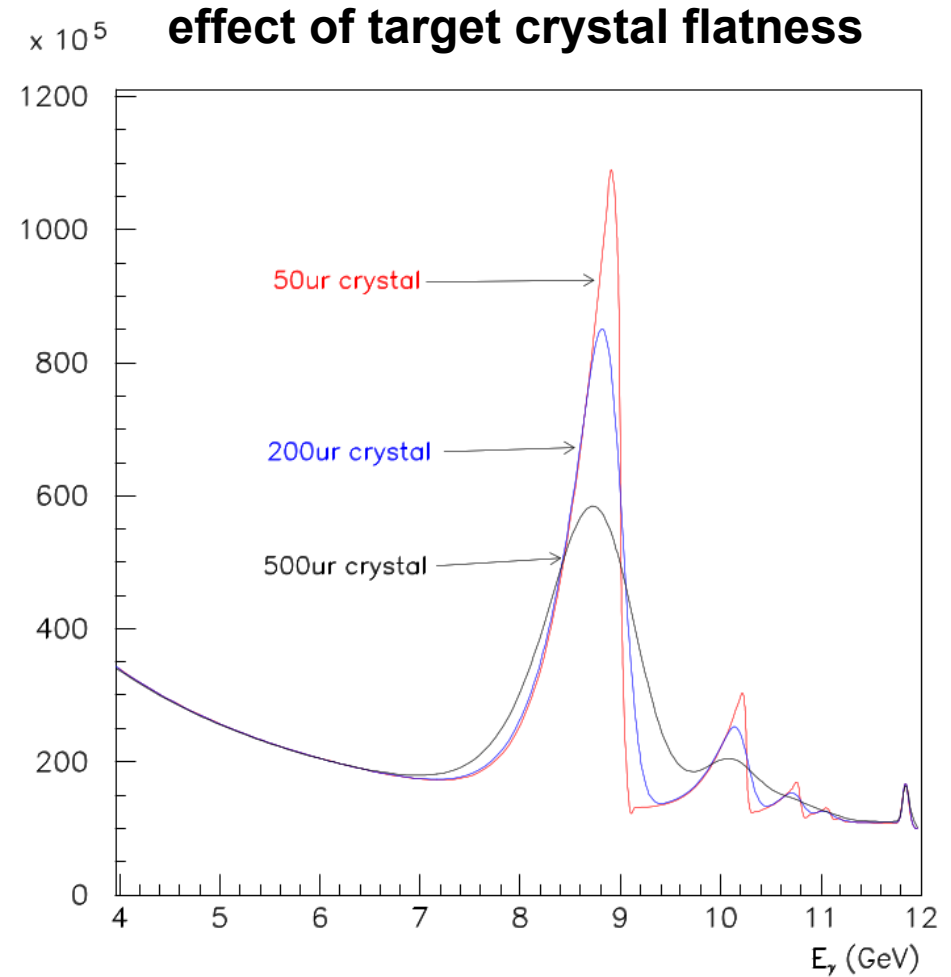
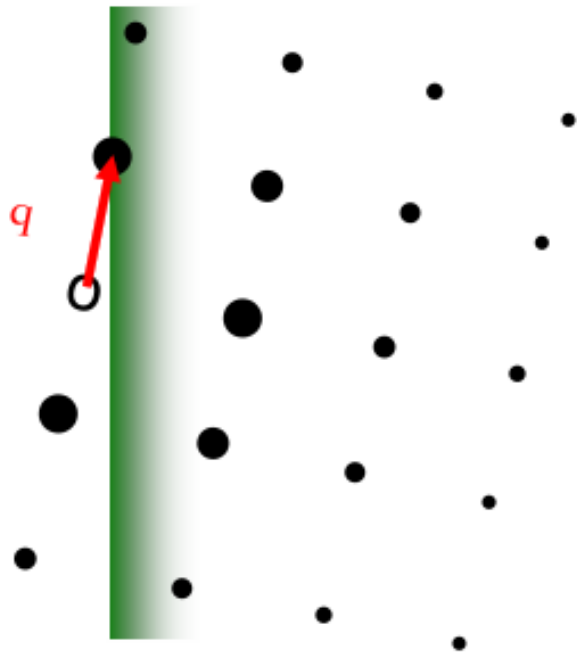
effect of target crystal



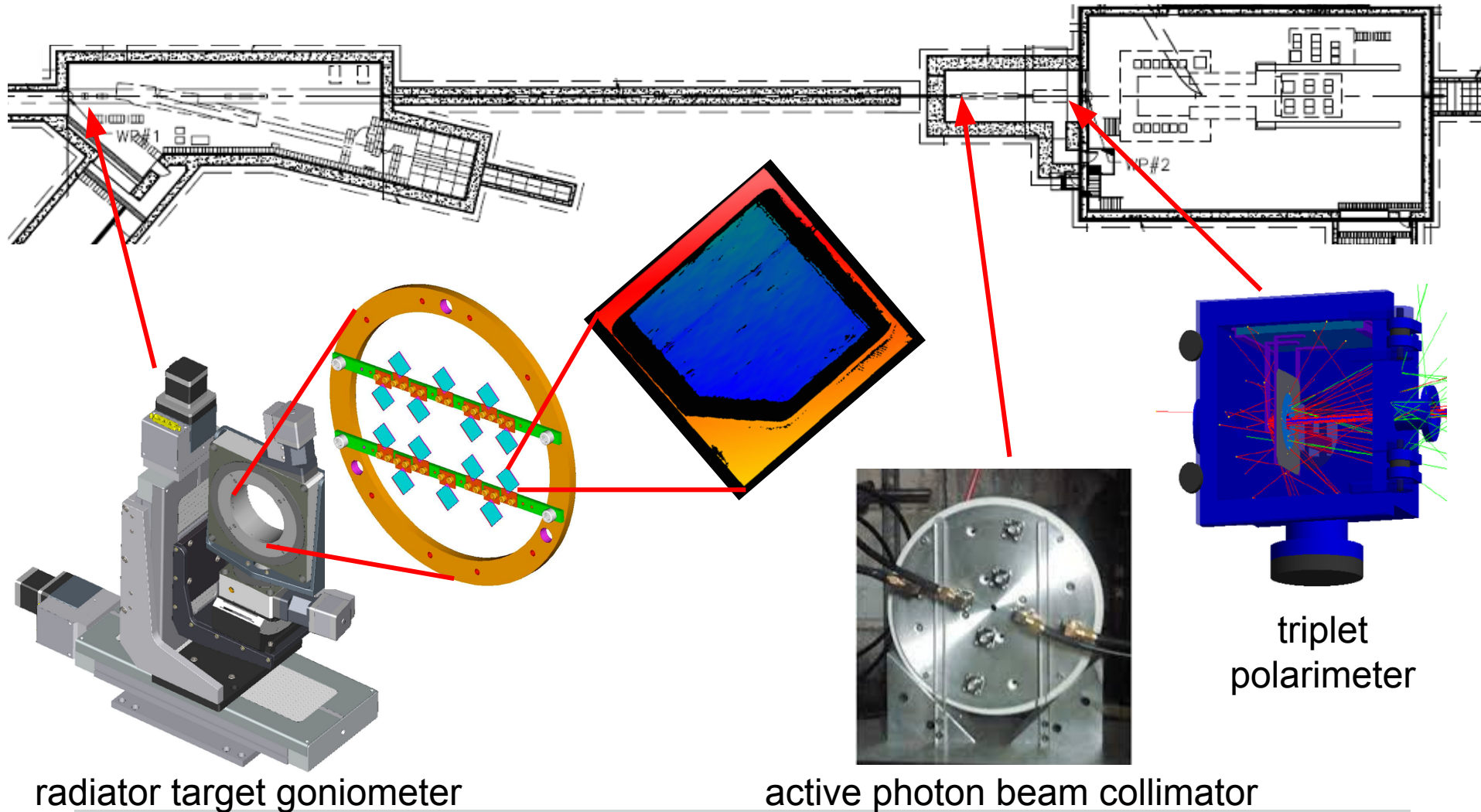
polarized photon source



bremsstrahlung in an oriented crystal target

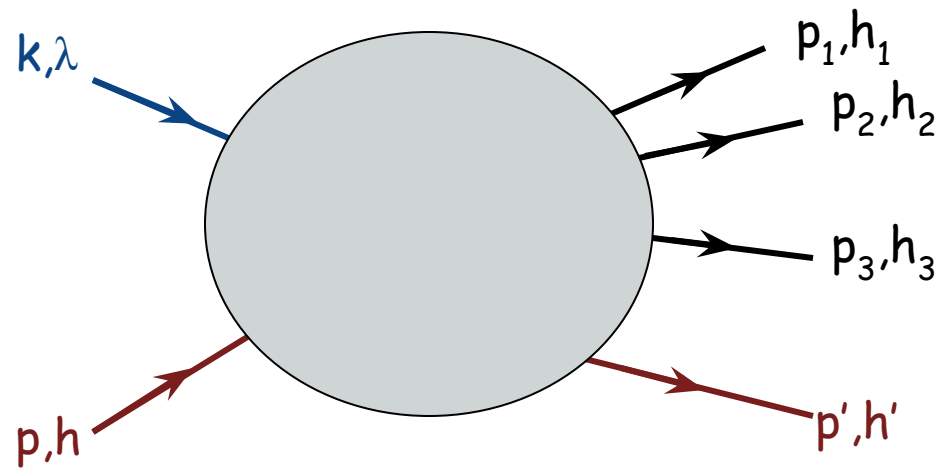


polarized photon beam complex



polarization in t-channel PWA

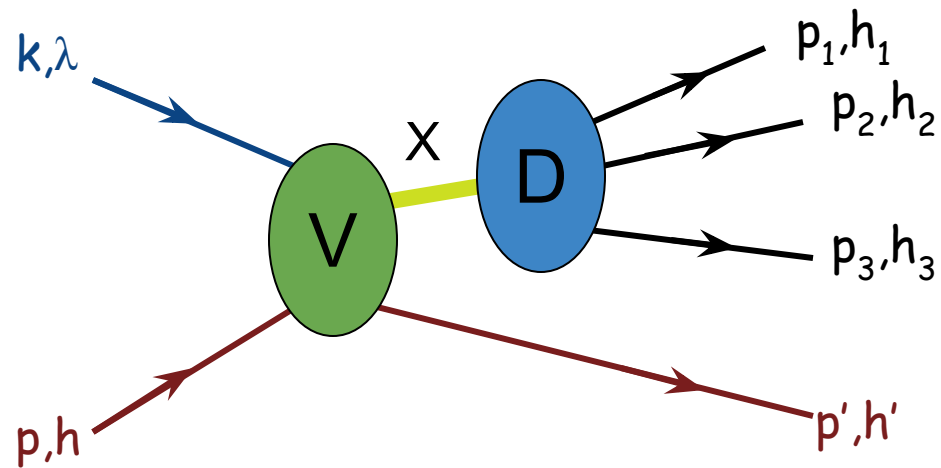
- Consider some general photoproduction reaction



- Focus on process $\gamma p \rightarrow B + M$
-

polarization in PWA

- Focus on process $\gamma p \rightarrow B + X$



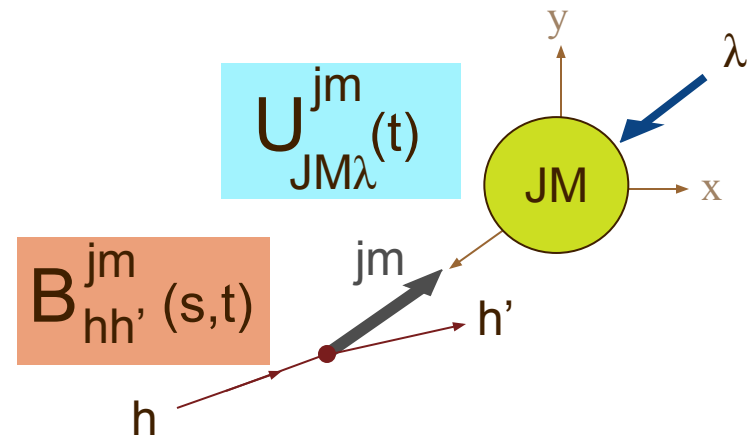
$$d\sigma_{\lambda} = \left| \sum_{J,M} V_{\lambda,h,h'}^{J,M}(s,t) D_{M,h_1\dots}^J(\Omega) \right|^2 d^n \Omega$$

- Factorize into **production** and **decay** amplitudes

polarization in PWA

- Focus on **production** amplitude $V_{\lambda,h,h'}^{J,M}(s,t)$
- Decompose into a sum over t-channel exchanges j,m

$$V_{\lambda,h,h'}^{J,M} = \sum_{jm} B_{hh'}^{jm}(s,t) U_{JM\lambda}^{jm}(t)$$



polarization in PWA

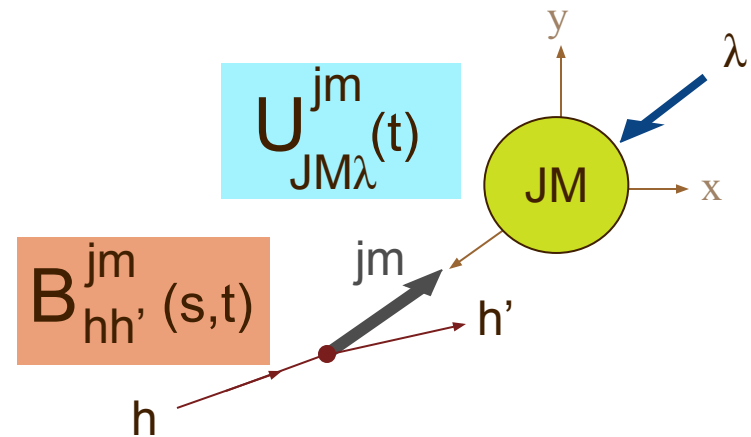
- Focus on **production** amplitude $V_{\lambda,h,h'}^{J,M}(s,t)$
- Decompose into a sum over t-channel exchanges j,m

$$V_{\lambda,h,h'}^{J,M} = \sum_{jm} B_{h,h'}^{j,m} U_{J,M,\lambda}^{j,m}$$

- Define reflectivity $r = \pm 1$

$$B_{h,h'}^{j,m,r} = B_{h,h'}^{j,m} + r n_j (-1)^m B_{h,h'}^{j,-m}$$

$$U_{J,M,\epsilon}^{j,m} = U_{J,M,\lambda}^{j,m} + \epsilon (-1)^\lambda U_{J,M,-\lambda}^{j,m}$$



polarization in PWA

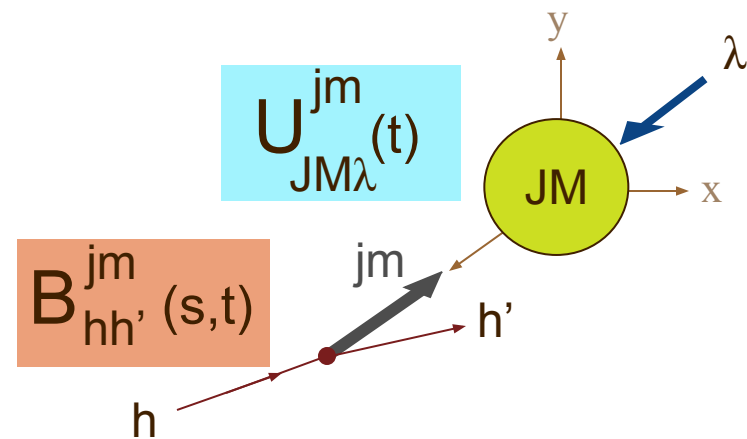
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$$U_{J,M,\epsilon}^{j,m} = U_{J,M,\lambda}^{j,m} + \epsilon (-1)^\lambda U_{J,M,-\lambda}^{j,m}$$



- Exploit parity conservation: definite ϵ instead of λ

$$V_{h,h',\epsilon}^{J,M,r} = \sum_{jm} \left(B_{h,h'}^{j,m} U_{J,M,\epsilon}^{j,m} + r n_J (-1)^M B_{h,h'}^{j,m} U_{J,-M,\epsilon}^{j,m} \right) = \sum_{jm} B_{h,h'}^{j,m,r,\epsilon} U_{J,M,\epsilon}^{j,m}$$

polarization in PWA

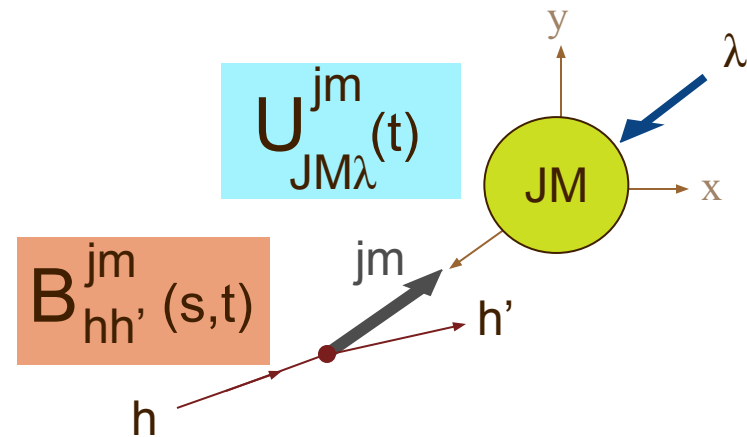
- Focus on **production** amplitude $V_{\lambda,h,h'}^{J,M}(s,t)$
- Decompose into a sum over t-channel exchanges j,m

$$V_{\lambda,h,h'}^{J,M} = \sum_{jm} B_{h,h'}^{j,m} U_{J,M,\lambda}^{j,m}$$

- Define reflectivity $r = \pm 1$

$$B_{h,h'}^{j,m,r} = B_{h,h'}^{j,m} + r n_j (-1)^m B_{h,h'}^{j,-m}$$

$$U_{J,M,\epsilon}^{j,m} = U_{J,M,\lambda}^{j,m} + \epsilon (-1)^\lambda U_{J,M,-\lambda}^{j,m}$$



- Exploit parity conservation: definite ϵ instead of λ

$$V_{h,h',\epsilon}^{J,M,r} = \sum_{jm} \left(B_{h,h'}^{j,m} U_{J,M,\epsilon}^{j,m} + r n_j (-1)^M B_{h,h'}^{j,m} U_{J,-M,\epsilon}^{j,m} \right) = \sum_{jm} B_{h,h'}^{j,m,r,\epsilon} U_{J,M,\epsilon}^{j,m}$$

only one B contributes, either $n_j = +1$ or -1 , selected by ϵ

GlueX status and outlook

- First commissioning run: Oct. 17 - Nov. 15, 2014
 - 10 GeV electrons to tagger dump
 - amorphous radiators 3×10^{-5} - 3×10^{-4} radiation lengths
 - commission active collimator, pair spectrometer, tagging counters
 - commission GlueX detector with 2.5 - 9.8 GeV photons
 - Second commissioning run: April, 2015
 - still at 10 GeV endpoint energy
 - commission diamond radiators, goniometer
 - collect test data with triplet polarimeter
 - small-diameter collimator with fast-feedback stabilization
 - Later in 2015, assuming adequate funding
 - **first physics data collected with 7 GeV polarized beam!**
-

acknowledgements

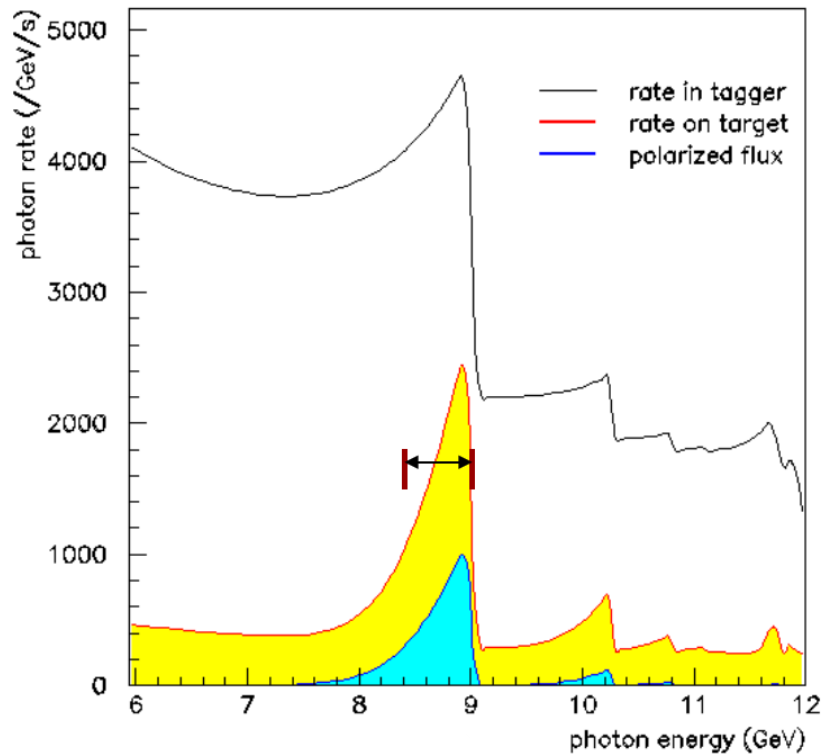


This work was supported by the U.S. National Science Foundation under grant 1207857, and by the U.S. Dept. of Energy under grant STTR #DE-SC-0004190.

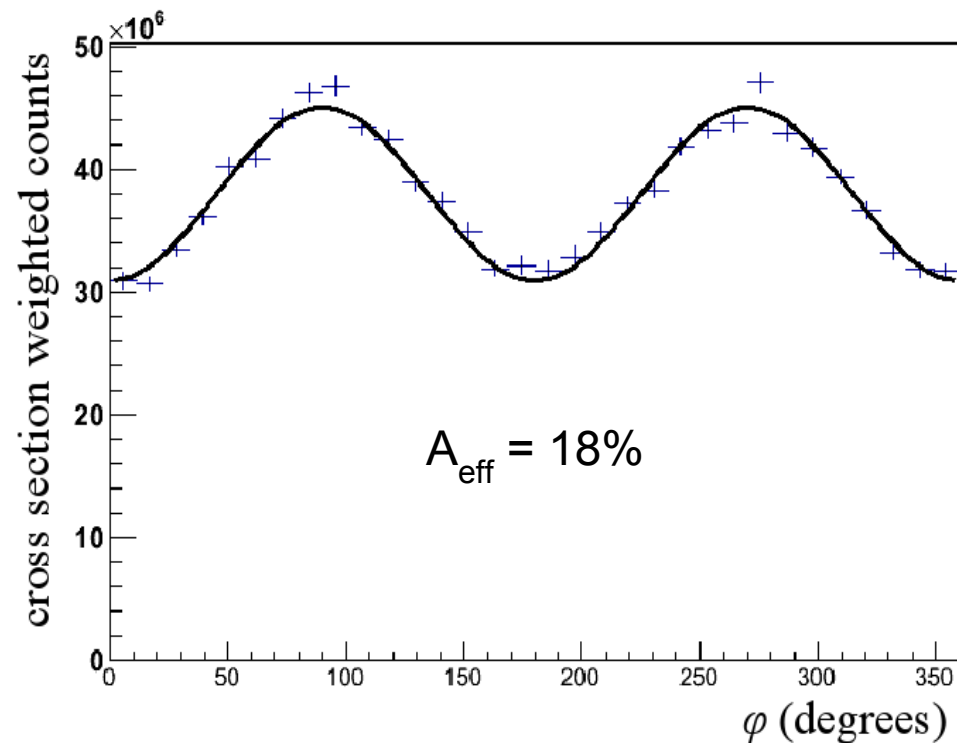
photon beam polarimetry

➤ 2 methods to measure linear polarization $p(E)$

1. beam spectrum shape analysis (CBSA)



2. triplet production azimuthal asymmetry



other physics with polarized beam

Primakoff production

