Primakoff photoproduction of η-mesons in the PrimEx experiment at Jefferson Lab

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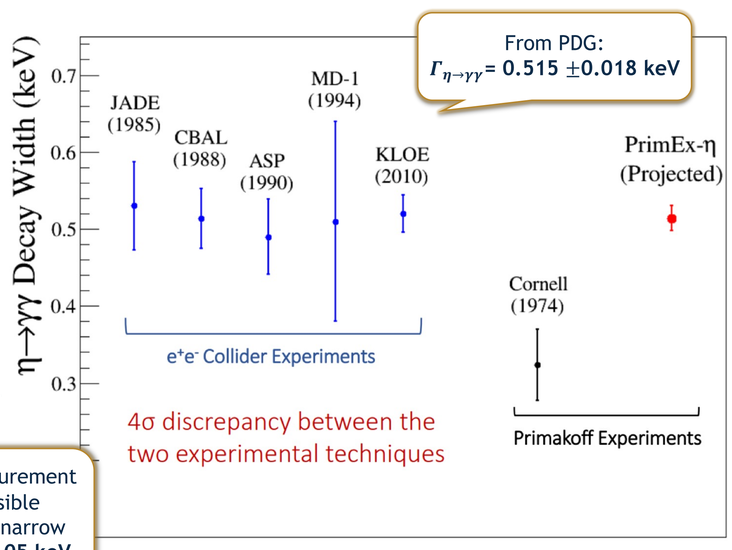
INTRODUCTION

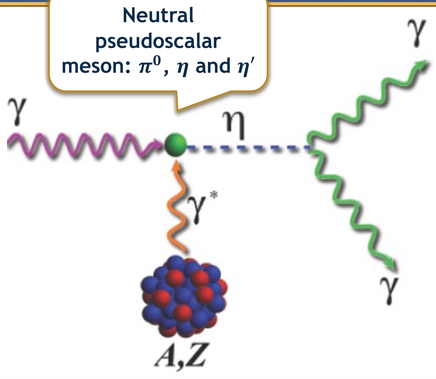
The PrimEx experiment at Hall-D focuses on **extracting the two-photon radiative decay width of eta (η) mesons ($\Gamma_{\eta\to\gamma\gamma}$)** via the Primakoff Effect.

This is a **high precision measurement** which provides input to:

- Ratio of light quark masses (m_u, m_d)
- Mixing angle between $\eta - \eta'$
- Improvement to other partial decay widths of η



THE PRIMAKOFF EFFECT



Production of mesons due to the interaction of a real photon with the Coulomb field of a nucleus

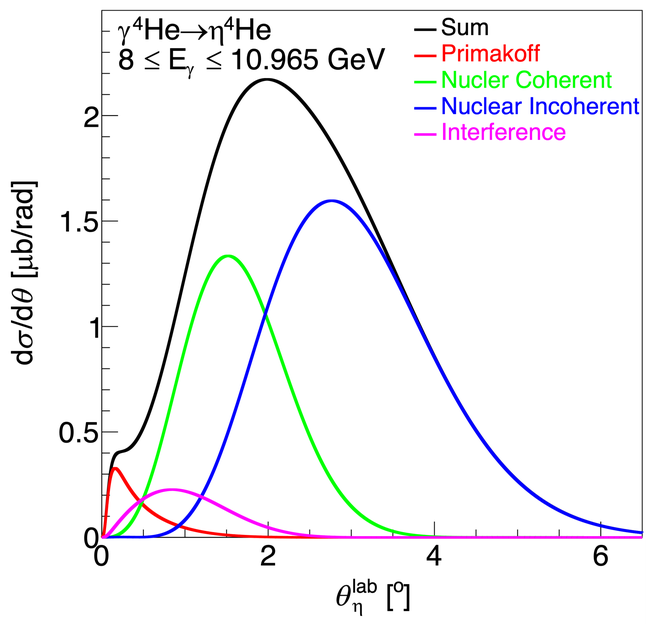
Henry Primakoff

THEORETICAL MODEL

The extraction of the radiative decay width is **Model dependent**

$$\frac{d\sigma}{d\Omega} = \frac{d\sigma_P}{d\Omega} + \frac{d\sigma_C}{d\Omega} + \frac{d\sigma_I}{d\Omega} + 2\cdot\sqrt{\frac{d\sigma_p}{d\Omega}\cdot\frac{d\sigma_C}{d\Omega}}\cos\phi$$

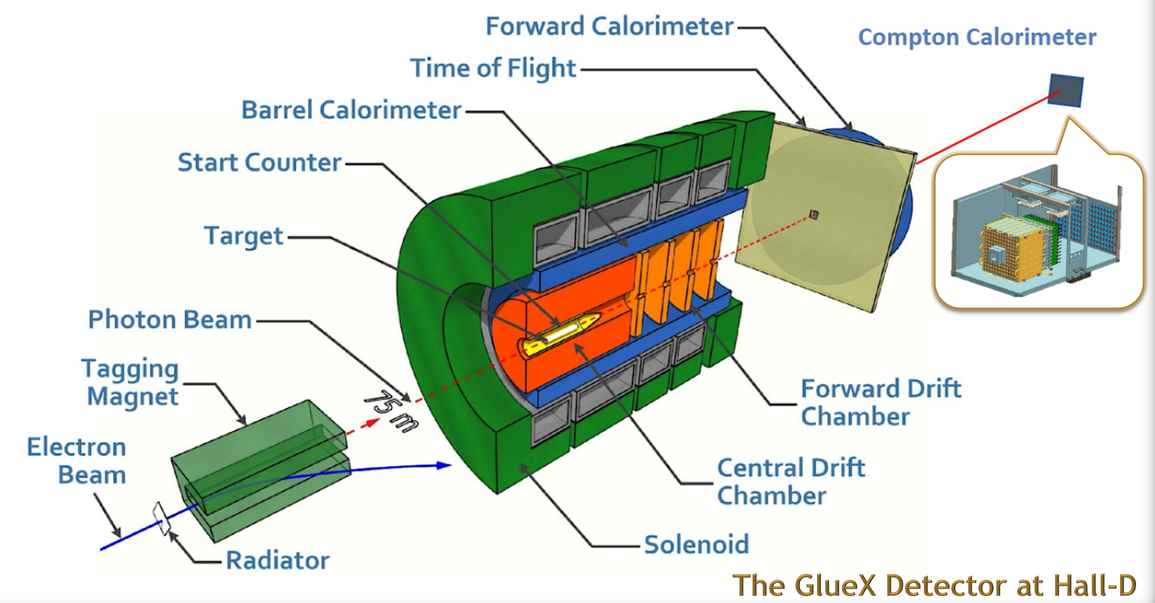
$$\frac{d\sigma_P}{d\Omega} = \Gamma_{\gamma\gamma}\ \frac{8\alpha Z^2}{m_\eta^3}\frac{\beta^3 E^4}{Q^4}\,|F_{e.m.}(Q)|^2\sin^2\theta_\eta^{lab}$$



Take away:

- Higher energy beam E^4 → Higher Primakoff cross section peak
- Z^2 dependence → Liquid helium target (meaning increased by 4)
- Primakoff cross section peak at very small angle → very forward kinematics (coherent events)

DETECTOR SET UP

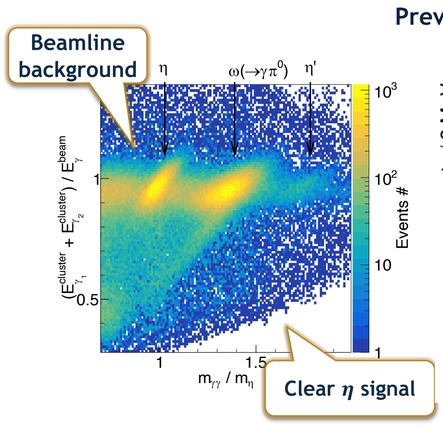


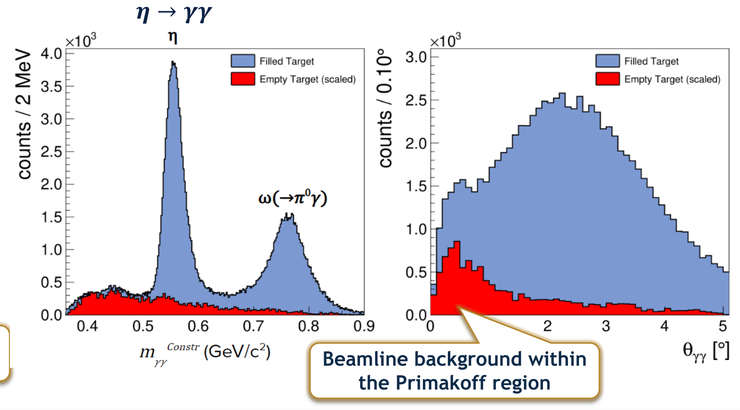
The GlueX Detector at Hall-D

RESULTS FROM PHASE I & II

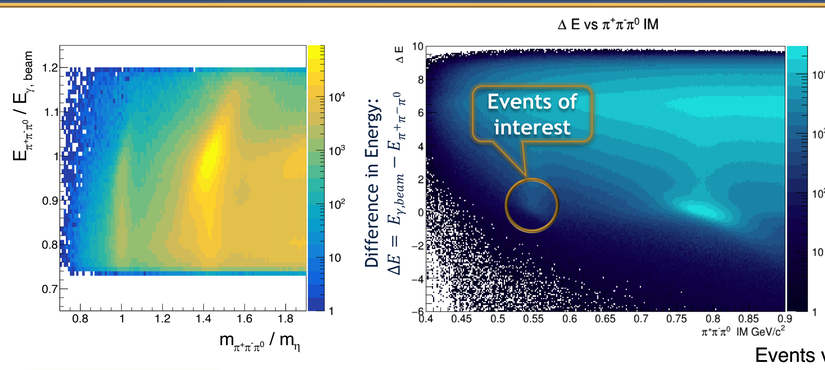
Previous results from Phase I and II:

$\eta \to \gamma\gamma$





PRELIMINARY RESULTS FROM SRC DATA



Decay channels of interest:

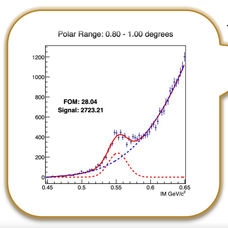
$\eta \to \gamma\gamma$

$\eta \to \pi^0\pi^0\pi^0$

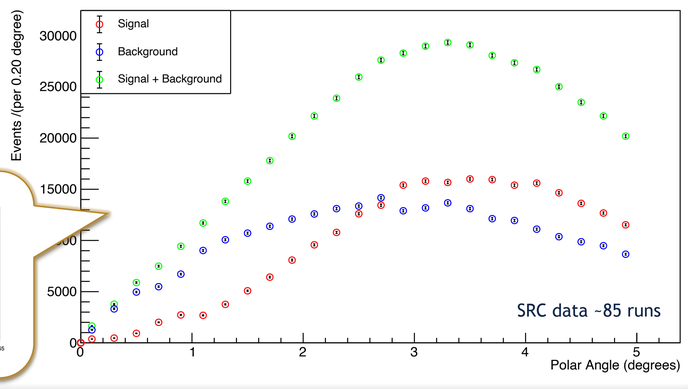
$\eta \to \pi^+\pi^-\pi^0$

Selection Criteria:

$E_{beam} > 8$ GeV
$0.10 < m_{\pi^0} < 0.16$ GeV
$-1.6 < \Delta E < 2.1$ GeV
Projection of pion pos.($\hat{z}$):
$45 < \Delta L < 85$ cm
Vertex ($\hat{z}$):
$50 < \Delta L < 80$ cm
Vertex radial($\hat{r}$):
$r < 1$ cm



Events vs. Polar Angle



SUMMARY & OUTLOOK

Phase I & II data has beamline background
Phase III data will allow analysis of charged decay channel with vertex tracking
Phase III data expected to be reconstructed this summer
Meanwhile, used reconstructed SRC data to develop analysis. SRC is not optimal for eta detection

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