Preliminary Results For η/η' Photoproduction Cross Sections between 3 and 6 GeV at the Gluex Experiment

Mahmoud Kamel

FIU FLORIDA INTERNATIONAL UNIVERSITY

GLUEX

Jefferson Lab

Introduction

Gluex is searching for photoproduced exotic mesons and their production mechanisms.

A simple start is to look at the photoproduction of regular mesons like η/η'.

Comparing the differential cross sections with the previous measurements help to understand our detector efficiency and flux determinations.

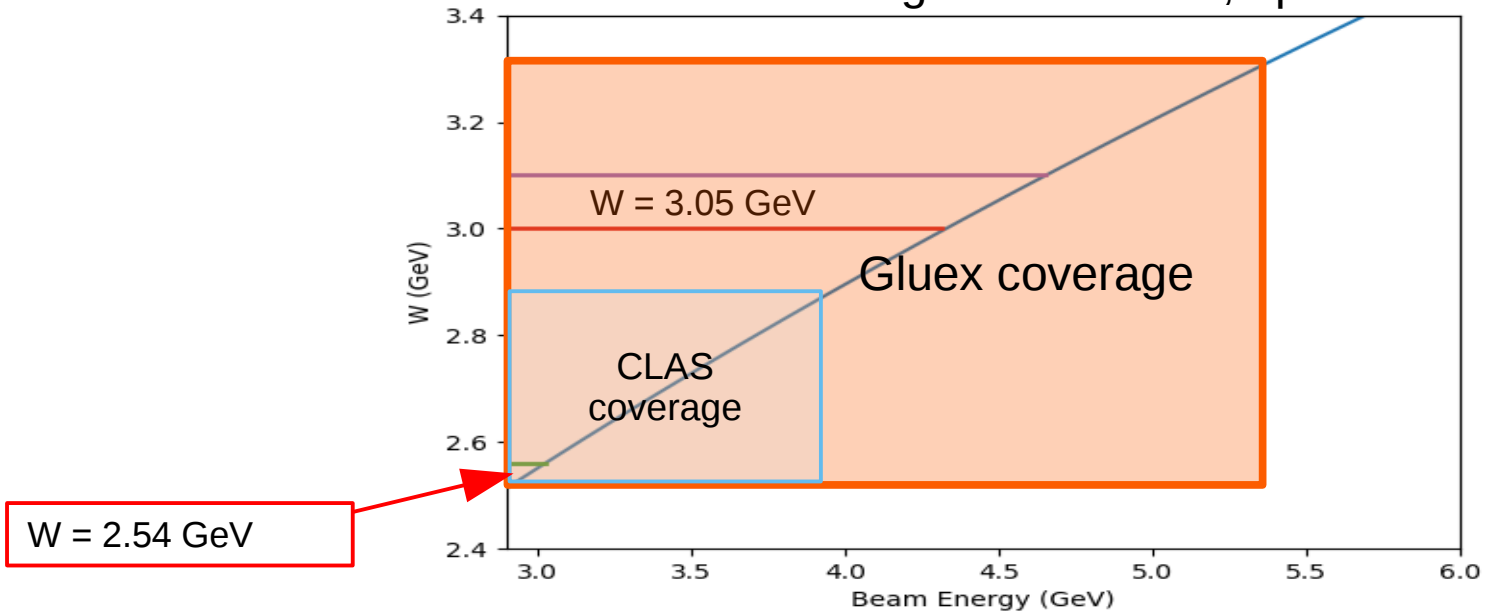
The differential cross sections of photoproduced η meson will be compared to previously published CLAS data 2009, and recent EtaMAID2018 model. Differential cross section of η' is limited by statistics using the same binning as η.

Energy Binning

Published data measured the differential cross section up to center of mass energy W = 2.84 GeV.

This particular set of Gluex data will extend the measurements up to W =3.3 GeV.

12 center of mass energy bins (40 MeV wide) are used starting from 2.52 GeV and up to 3 GeV.
3 more bins of 100 MeV wide are used starting from 3.0 GeV, up to 3.3 GeV.



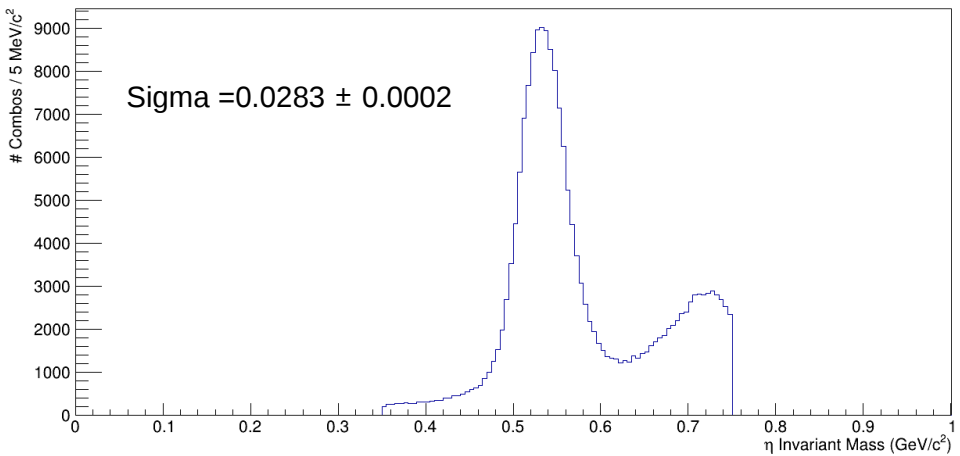
Data Selection

All final state particles are reconstructed in the Gluex. The Studied reactions for this work are:

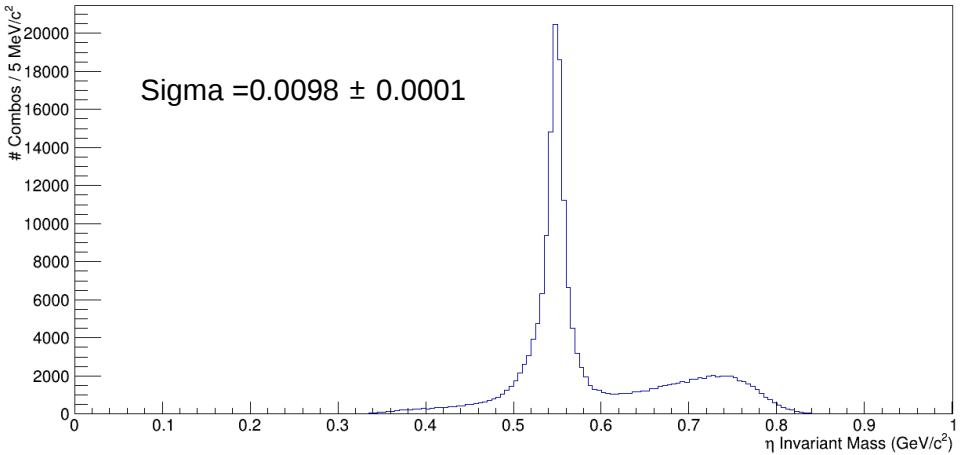
$\gamma + p \longrightarrow \eta + p, \quad \eta \longrightarrow \gamma\gamma$ and $\gamma + p \longrightarrow \eta' + p, \quad \eta' \longrightarrow \pi^+ \pi^- \gamma$

Kinematic fitting (KinFit) technique is applied conserving energy, and momentum. The mass spectrum for η invariant mass is shown.

Before KinFit



After KinFit

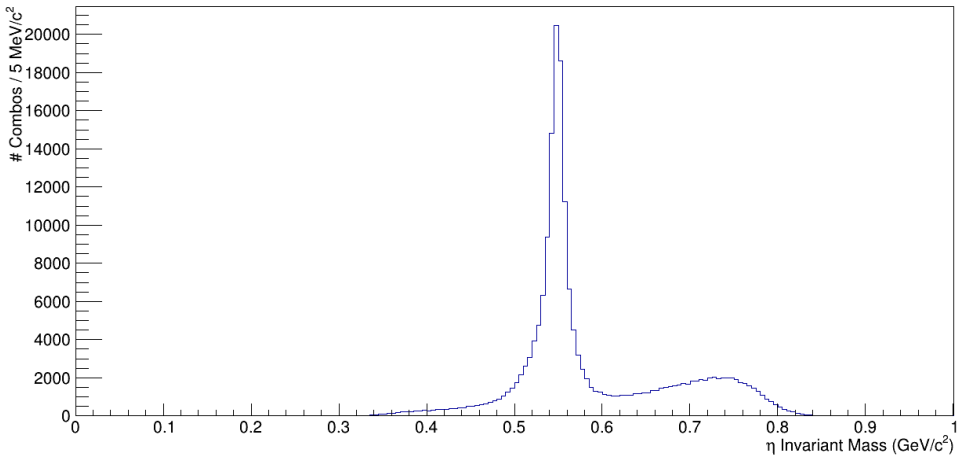


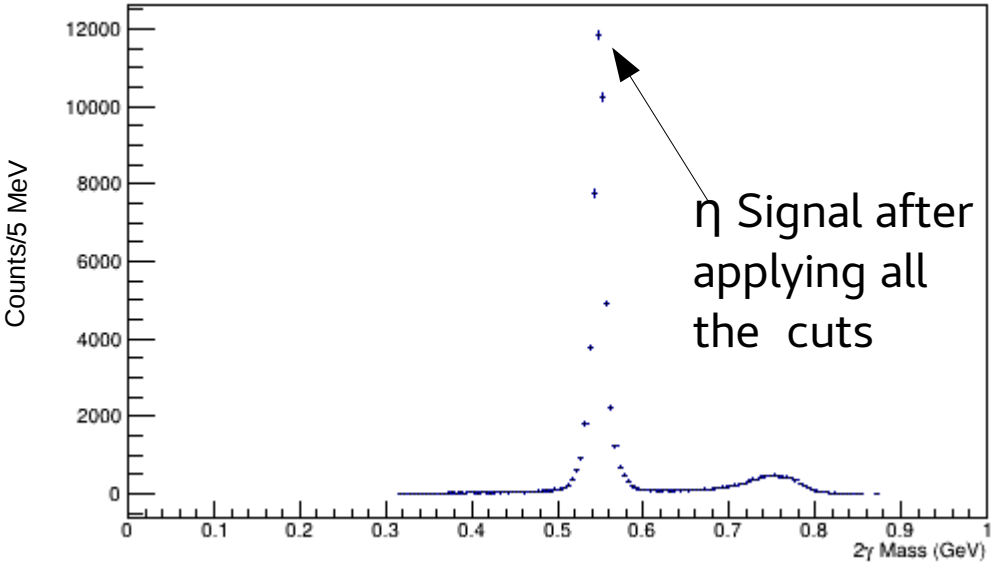
Data Selection

Apply vertex radial cut > 1 cm and vertex z cut: 50 – 80 cm.

Missing mass squared cut of ± 0.025 GeV^2

Missing energy cut of ± 0.6 GeV for η and ± 0.8 GeV for η'





Differential cross section is given by

$$\frac{d\sigma}{dcos\theta^{\eta}_{cm}} = \frac{A_T}{\Gamma(W)\rho_T L_T N_A} \frac{Y(W,\theta^{\eta}_{cm})}{\Delta cos\theta^{\eta}_{cm} ACC(W,\theta^{\eta}_{cm})} \frac{1}{BF(\eta\to\gamma\gamma)}$$

ρ_T : Target density.
L_T : Target Length.
A_T : Target atomic weight.
$\Gamma(W)$: Flux.
$Y(W, \theta^{\eta}_{cm})$: Raw yield
$ACC(W, \theta^{\eta}_{cm})$: Acceptance.
$BF(\eta \to \gamma\gamma)$: Branching fraction.
θ^{η}_{cm} : Production polar angle

Yield Extraction

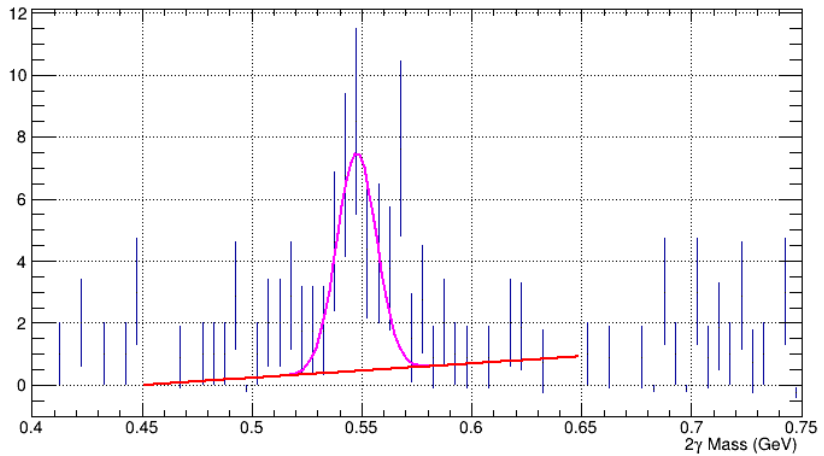
Selected example of the fits to extract the yield.

Gaussian + Linear Background

Not accounting for systematic errors in the current analysis

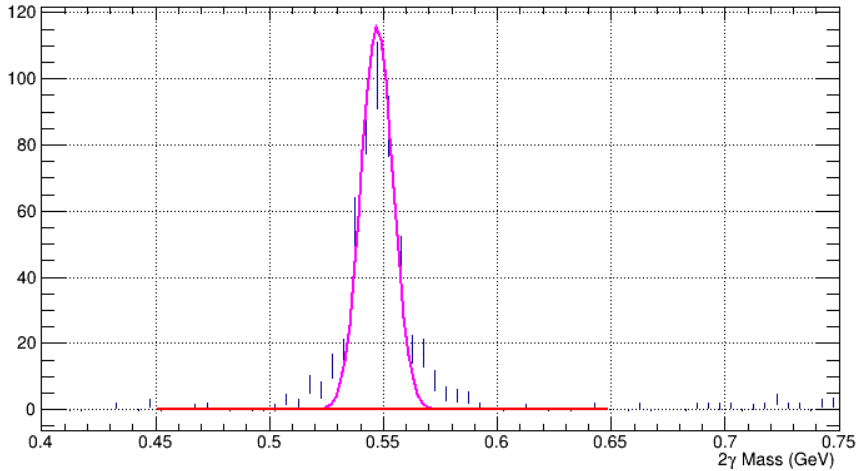
W = 2.54 GeV

-0.4 <= Cos ϴ < -0.2



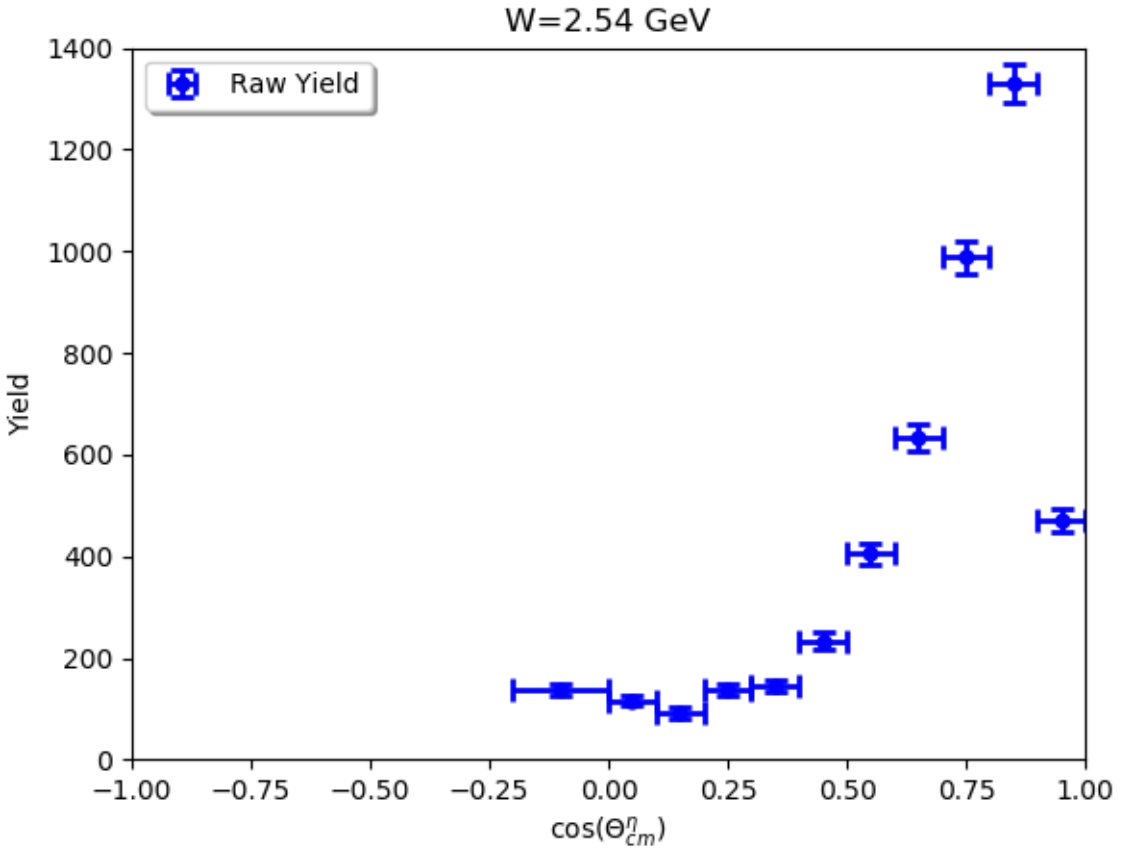
Low statistics bins are not currently shown

0.5 <= Cos ϴ <0.6



Signal fit needs more improvement

Raw Yield



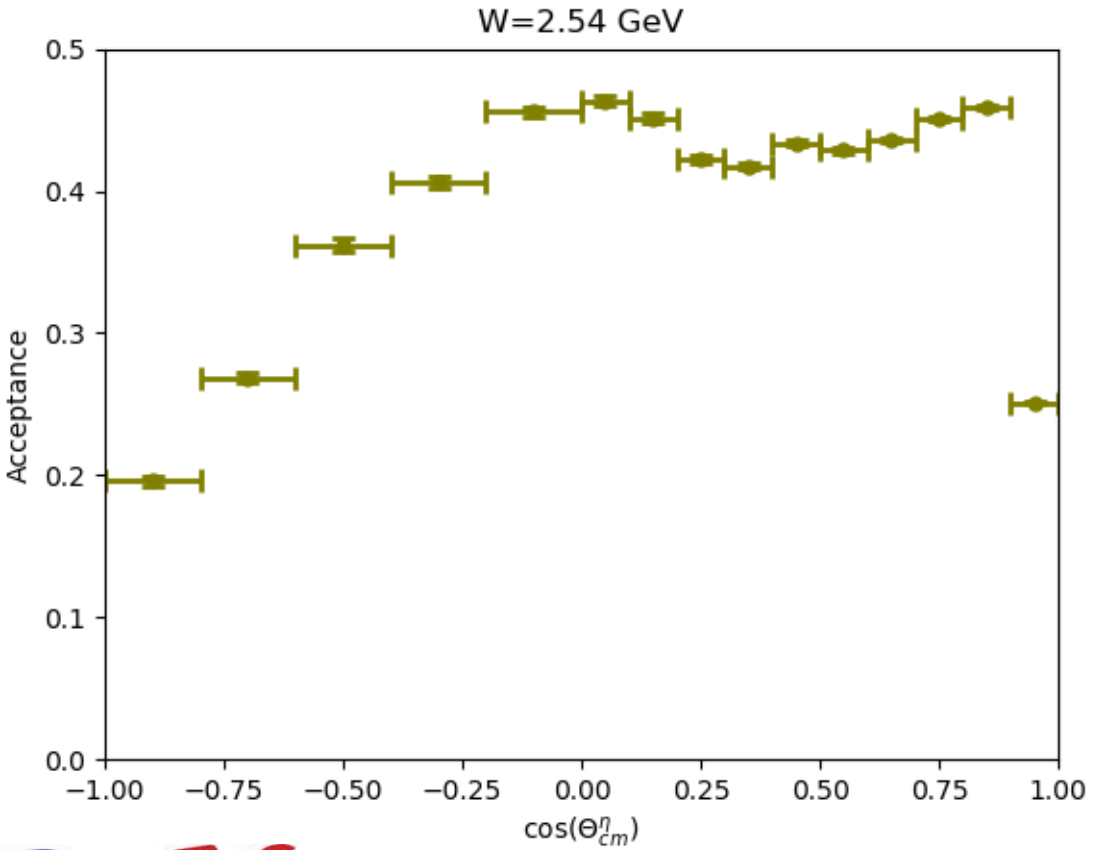
Most of the backward bins are statistically limited (not shown)

Acceptance

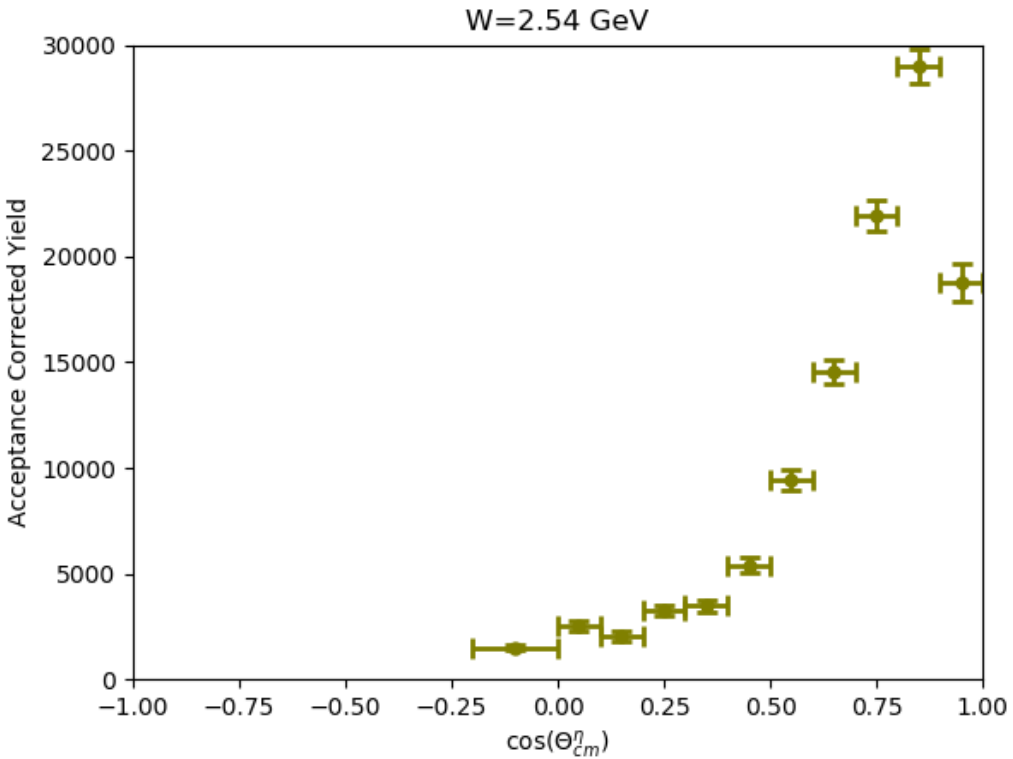
Acceptance is calculated using MC sample generated by standard Gluex generator for exclusive η photoproduction with Regge Model.

The response of the Gluex detector is simulated with geant3.

Acceptance = reconstructed signal / thrown sample.

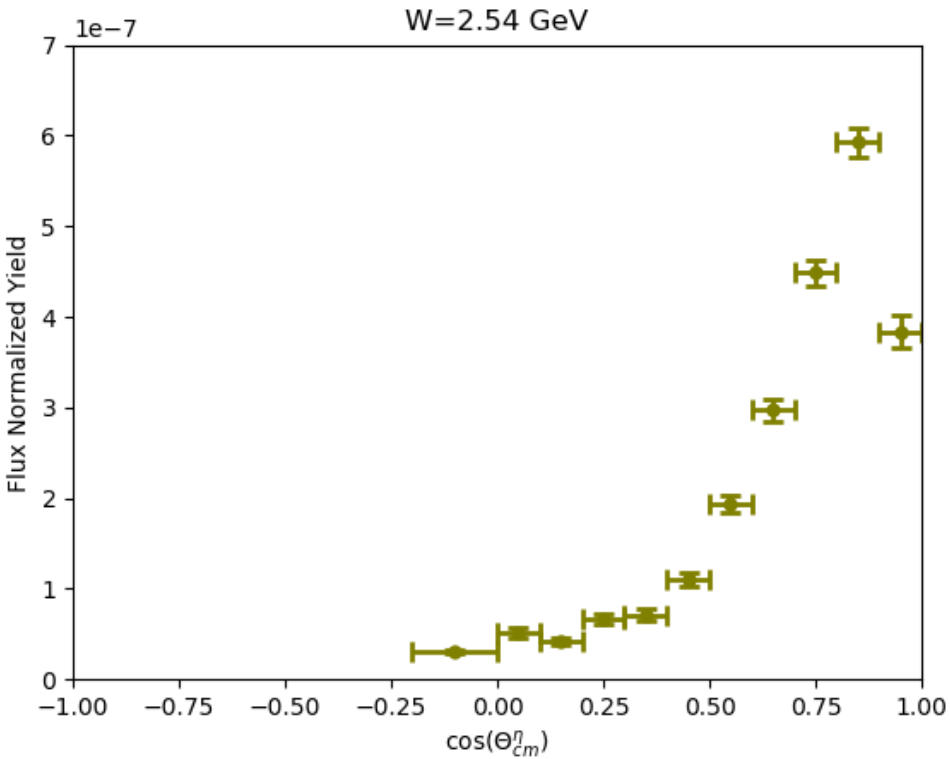


Acceptance Corrected Yield



Raw Yield/ Acceptance

Flux Normalized Yield



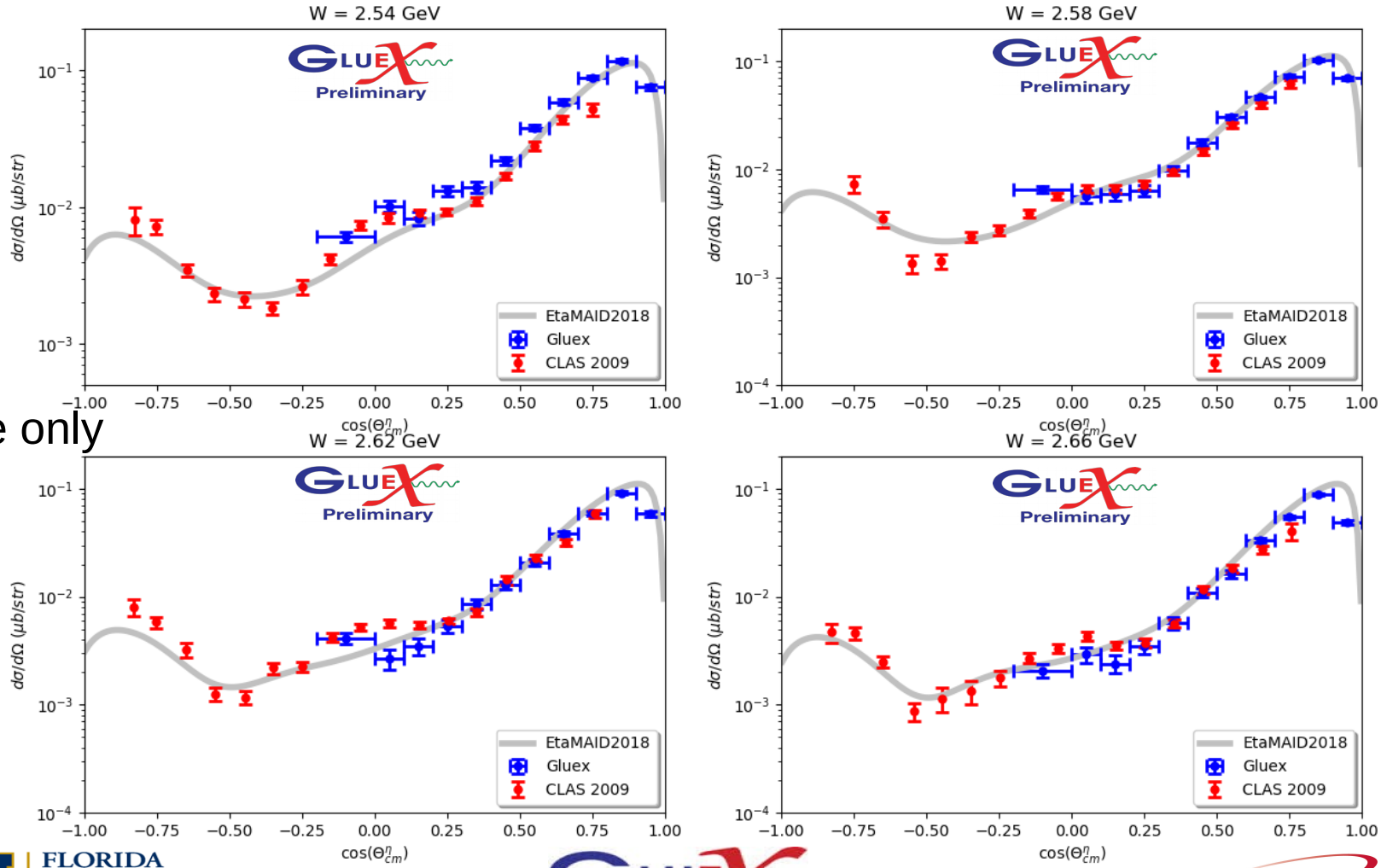
Raw Yield/ (Acceptance*Flux)

η Differential Cross Sections

L. Tiator et al., ArXiv:1807.04525v2 [nucl-th] 7 DEC 2018.

Williams et al. DOI:https://doi.org/10.1103/PhysRevC.80.045213, 2009

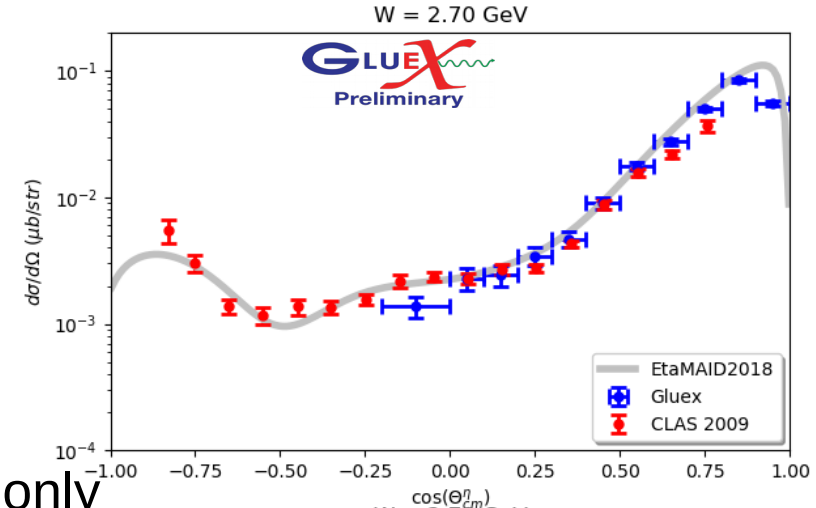
Errors are only statistical

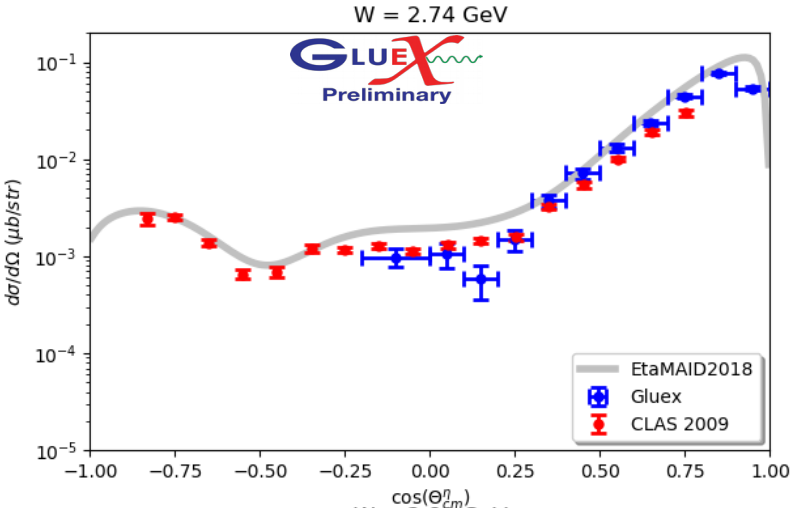


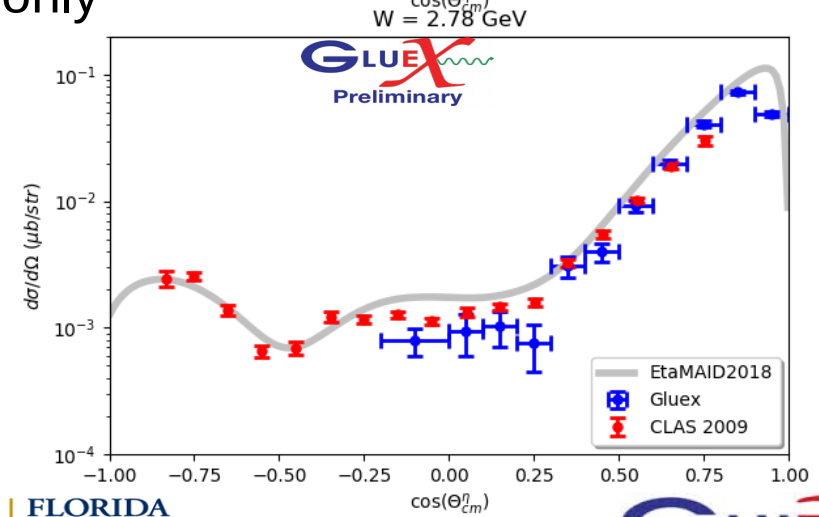
η Differential Cross Sections

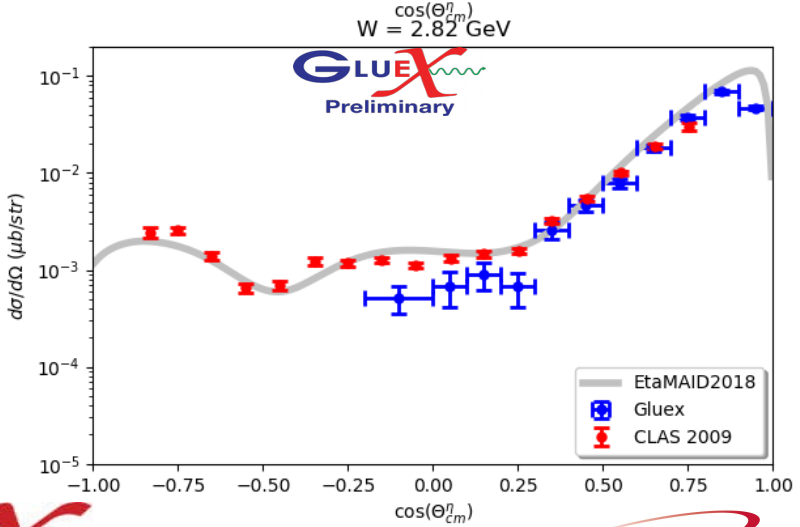
CLAS' intervals: 50 Mev wide centered at 2.705 GeV, and 90 MeV wide centered at 2.795 GeV.

Errors are only statistical







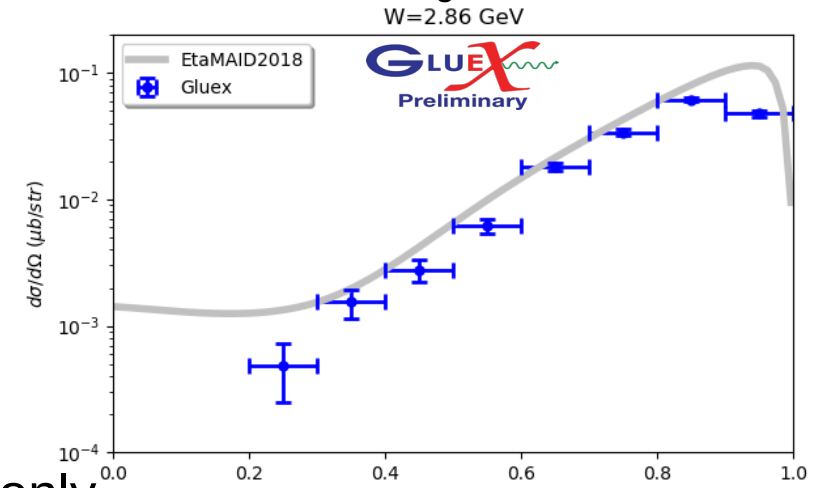


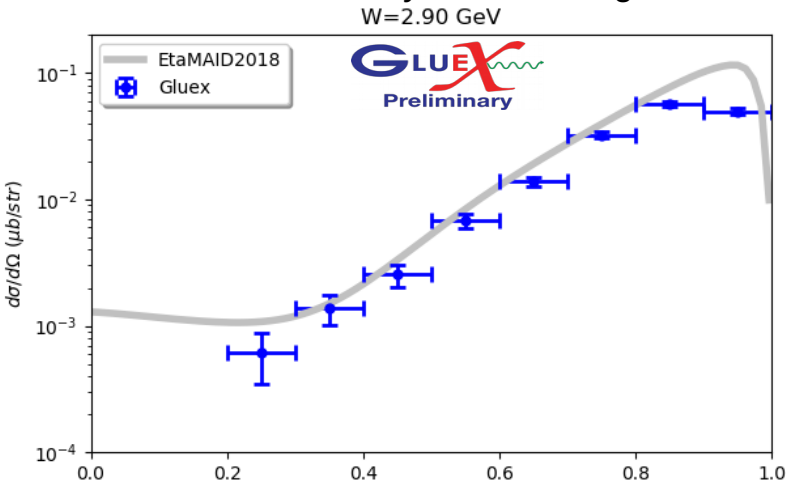
η Differential Cross Sections

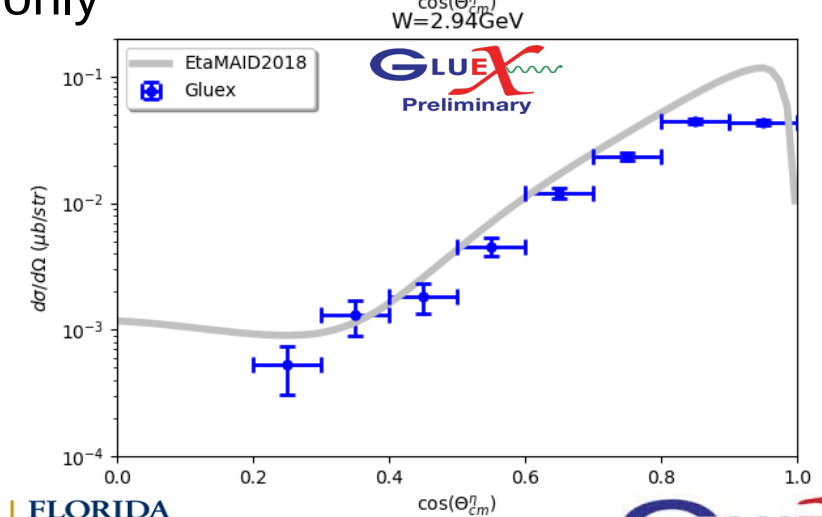
No previous measurements in these W ranges.

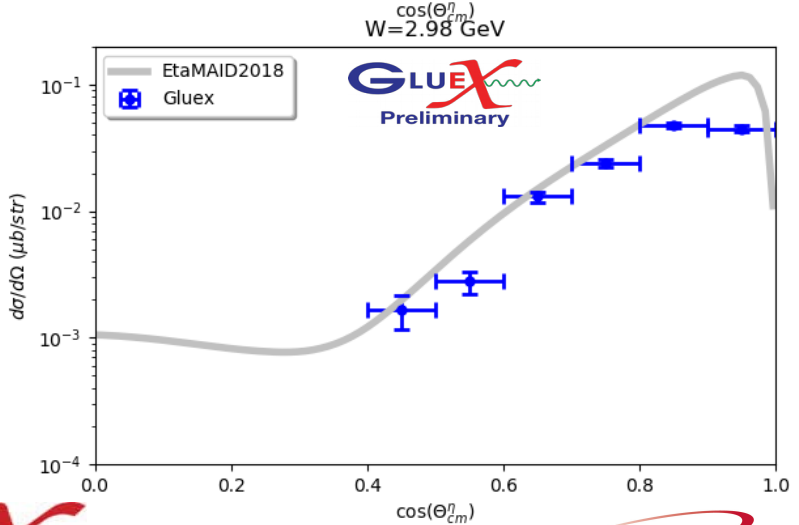
Only Forward Angles shown.

Errors are only statistical

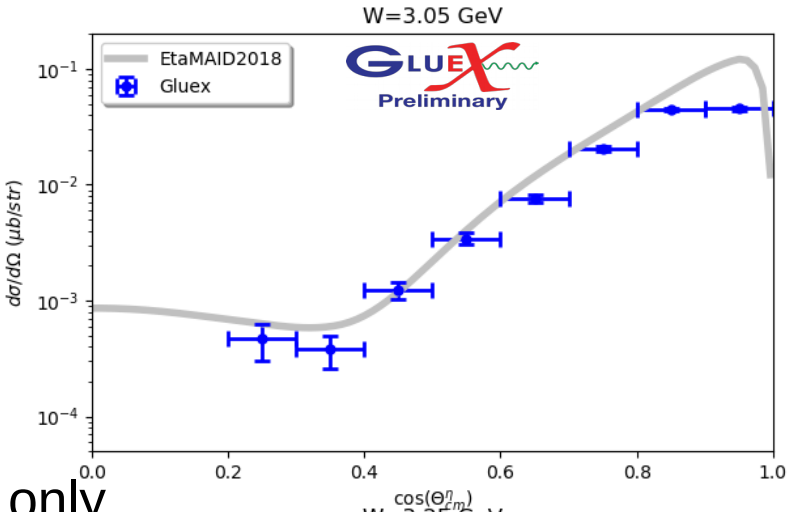


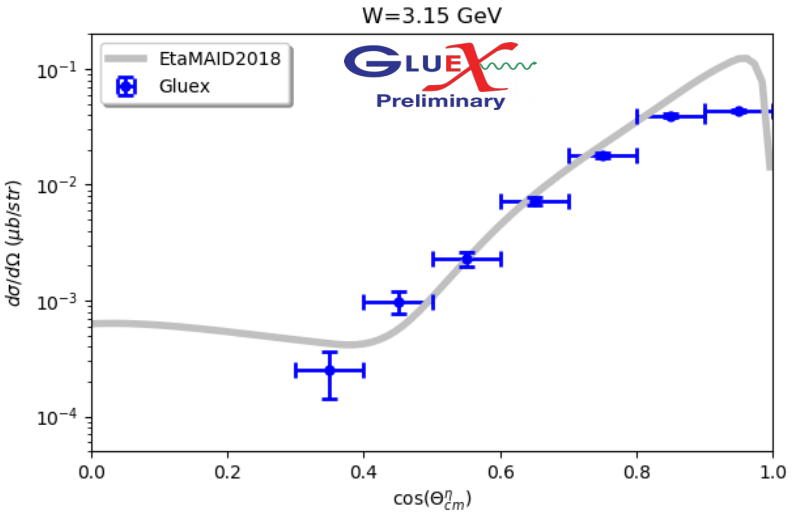


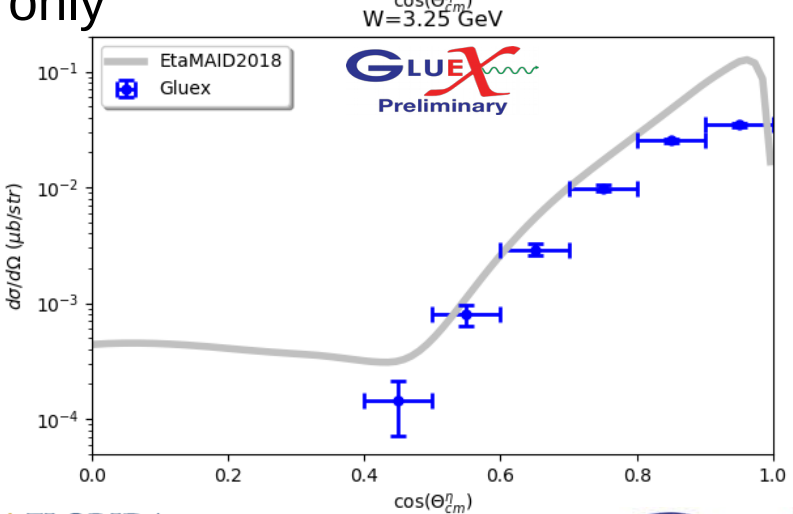




η Differential Cross Sections





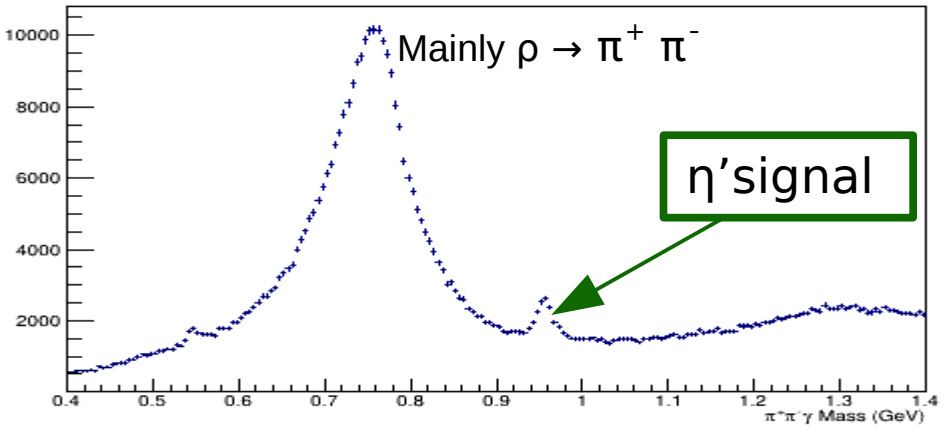


Errors are only statistical

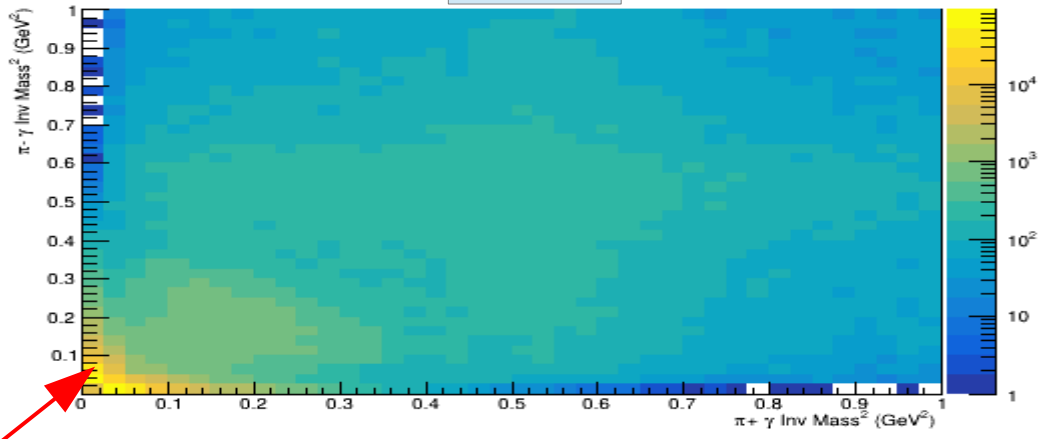
No Published data in these W ranges.

The new data could constrain the photo-production mechanism at high energies

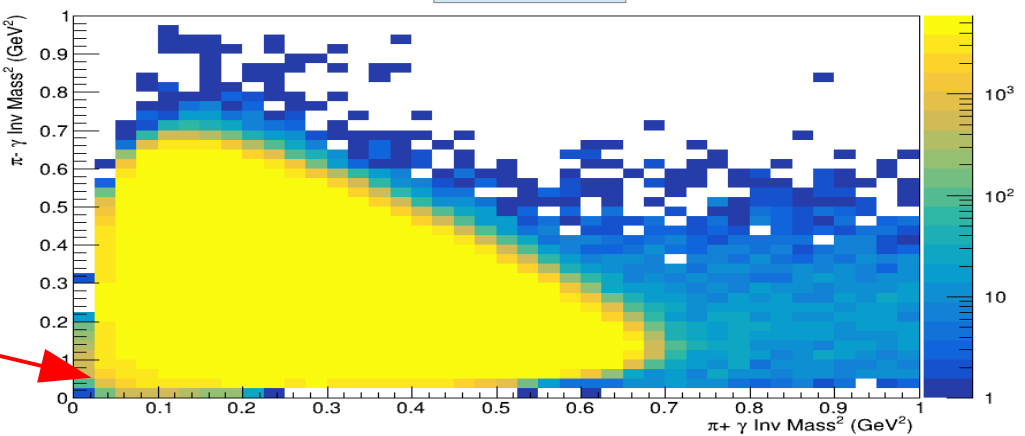
$\gamma + p \longrightarrow \eta' + p\,, \quad \eta' \longrightarrow \pi^+ \pi^- \gamma$



Data



SIM

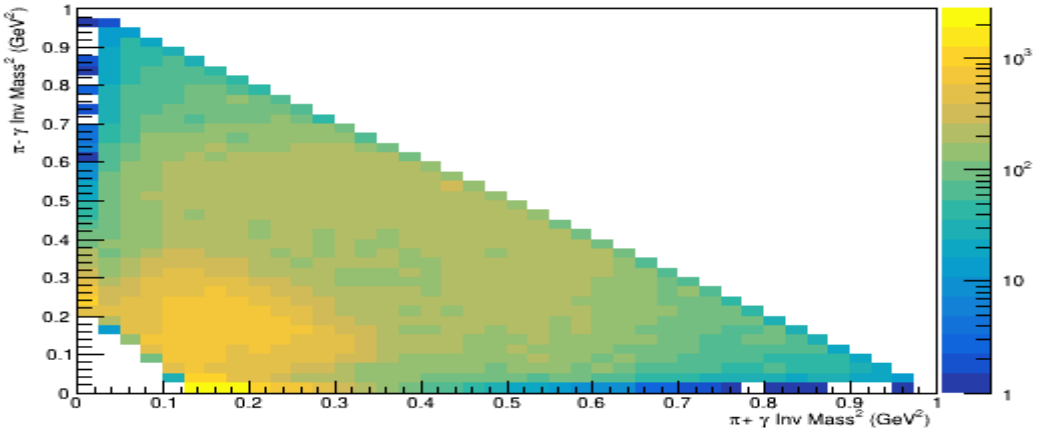


Split-off of pions produces false photon signal in the calorimeter.

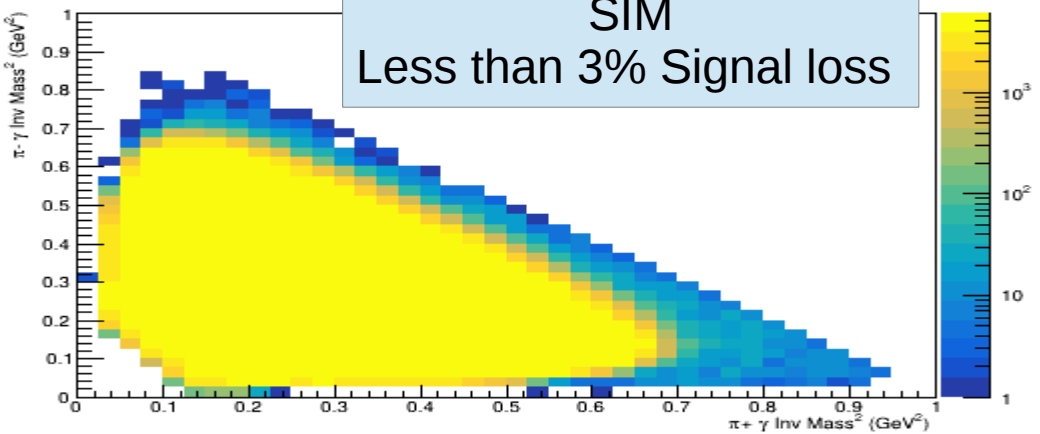
Generating MC with exclusive η' photoproduction

$\eta' \longrightarrow \pi^+ \pi^- \gamma$

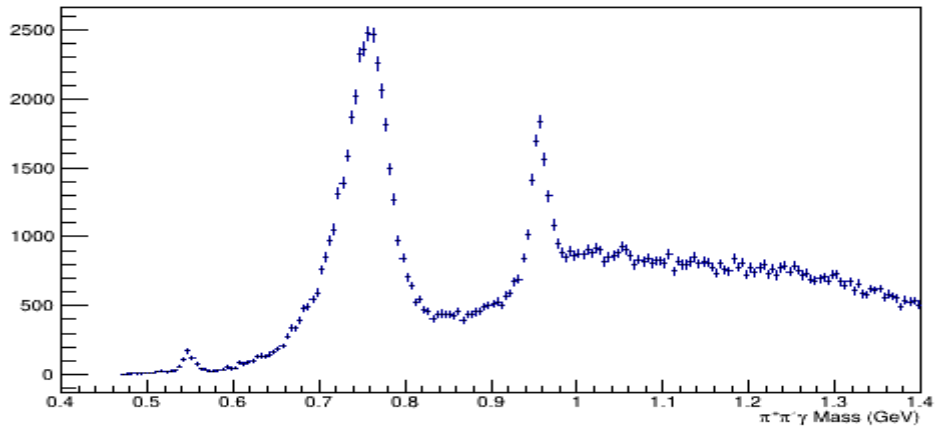
Data



SIM
Less than 3% Signal loss

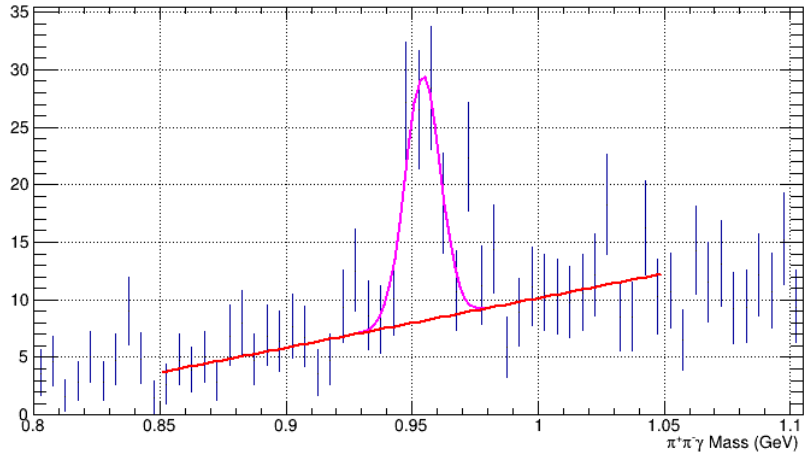


Data



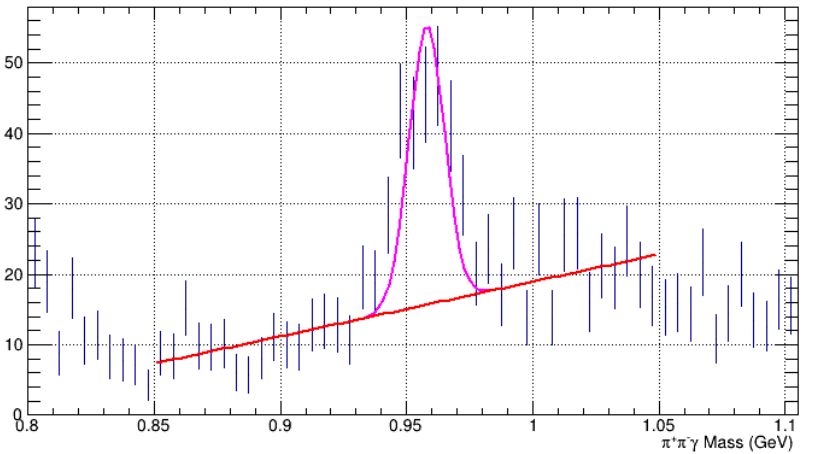
$\eta' \longrightarrow \pi^+ \pi^- \gamma$

0.4 <= Cos ϴ < 0.6

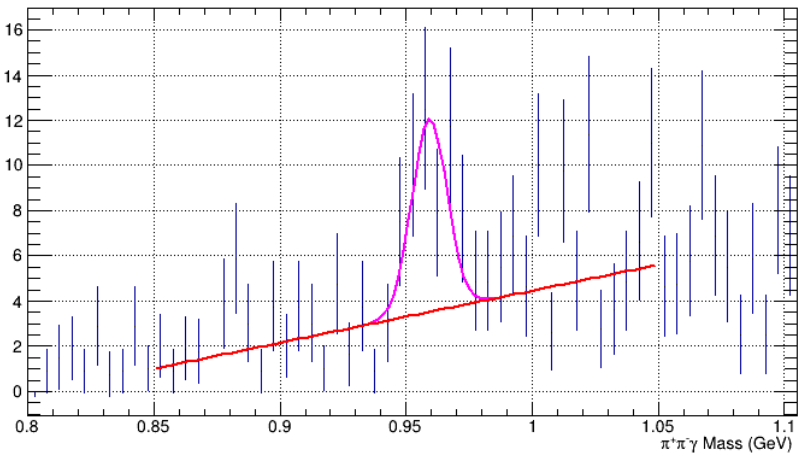


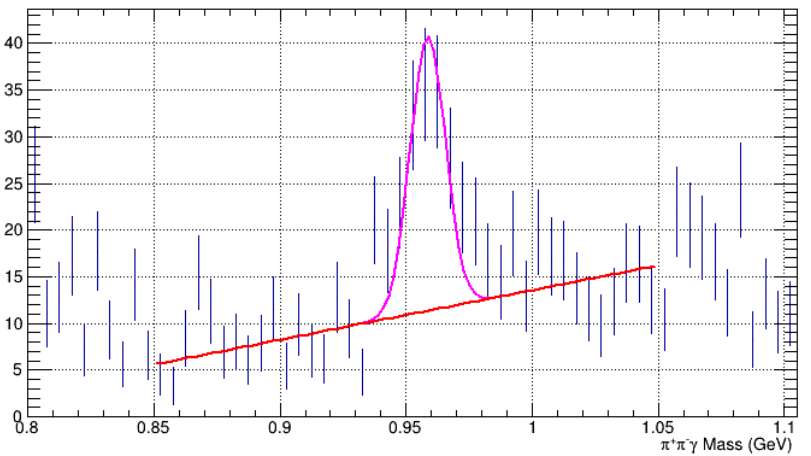
W = 2.54 GeV

0.8 <= Cos ϴ < 0.9



W = 2.70 GeV





Summary And Future Work

Differential cross section for η is in agreement within 15 -25 % of previously published data, and roughly following the shape of the EtaMAID model in the new W bins. In the forward direction the model deviates from data with increasing W.

Differential cross section agreement with previous measurements provide better understanding of the detector efficiency and flux normalization.

The new data can improve our understanding of the production mechanisms at high energies.

Systematic studies for η and continue analyzing η' channel with wider binning.

This work is supported in part by the Department of Energy Contract DESC0013620

Back Up Slides

EtaMAID2018 Model
Isobar model consists of

Background:	Born	Regge					
Resonances:	S11(1535)	S11(1650)	S11(1895)	P11(1440)	P11(1710)	P11(1880)	P11(2100)
	P13(1720)	P13(1900)	D13(1520)	D13(1700)	D13(1875)	D13(2120)	
	D15(1675)	D15(2060)	F15(1680)	F15(1860)	F15(2000)		
	F17(1990)	G17(2190)	G19(2250)				