# Extraction of polarized moments for generated $(p\eta'\pi^0)$ data with GlueX acceptance

Florida International University 2020

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# Generated 5*10⁶ $(p\eta'\pi^0)$events with AmpTools

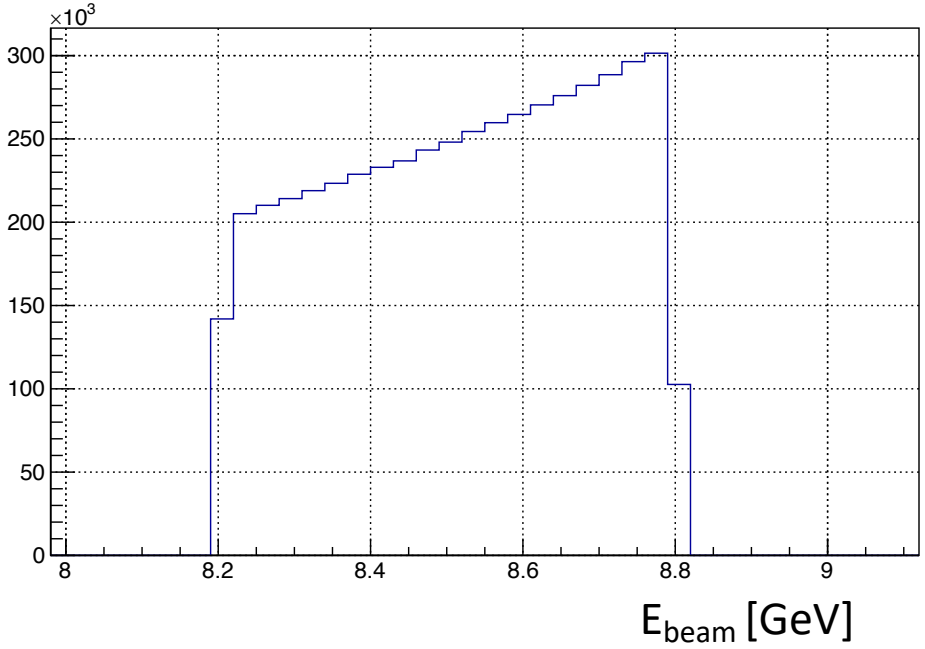
Generated amplitudes are

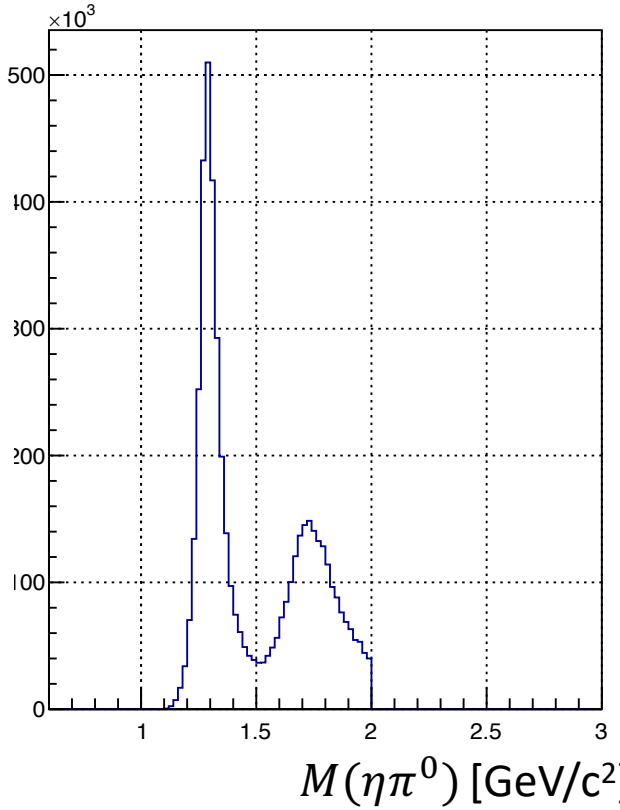
- P1/$\pi_1$(1600 MeV) (exotic)
- D/$a_2$ (1320 MeV)
- D/$a_2$' (1700 MeV)

| J | M | ε | Real | Imaginary | BW Mass | BW Width |
|---|---|---|---|---|---|---|
| 1 | 0,1 | +1 | 70 | 70 | 1.564 | 0.492 |
| 2 | 0,1,2 | +1 | 350 | 350 | 1.306 | 0.114 |
| 2 | 0,1,2 | +1 | 150 | 150 | 1.722 | 0.247 |

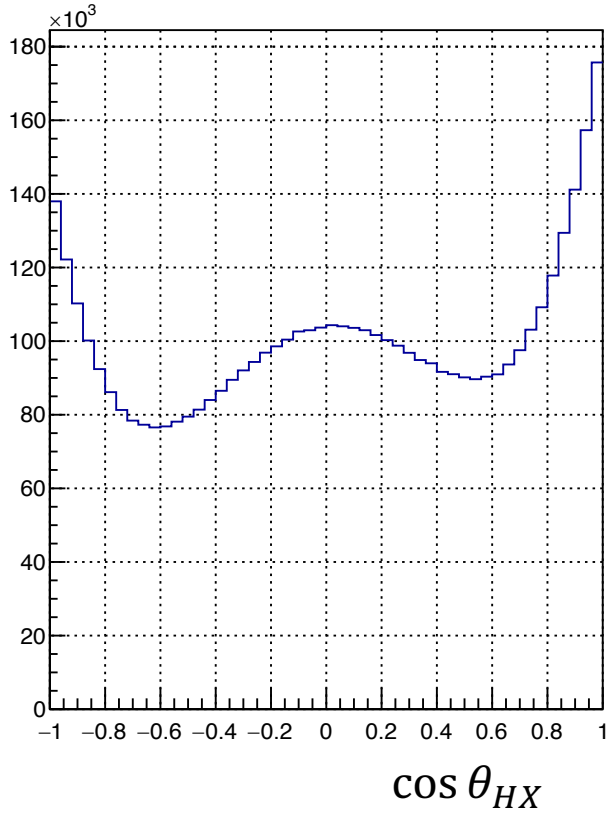
$\Phi$=1.77 Deg.

$P_\gamma$ =0.3




cosθ



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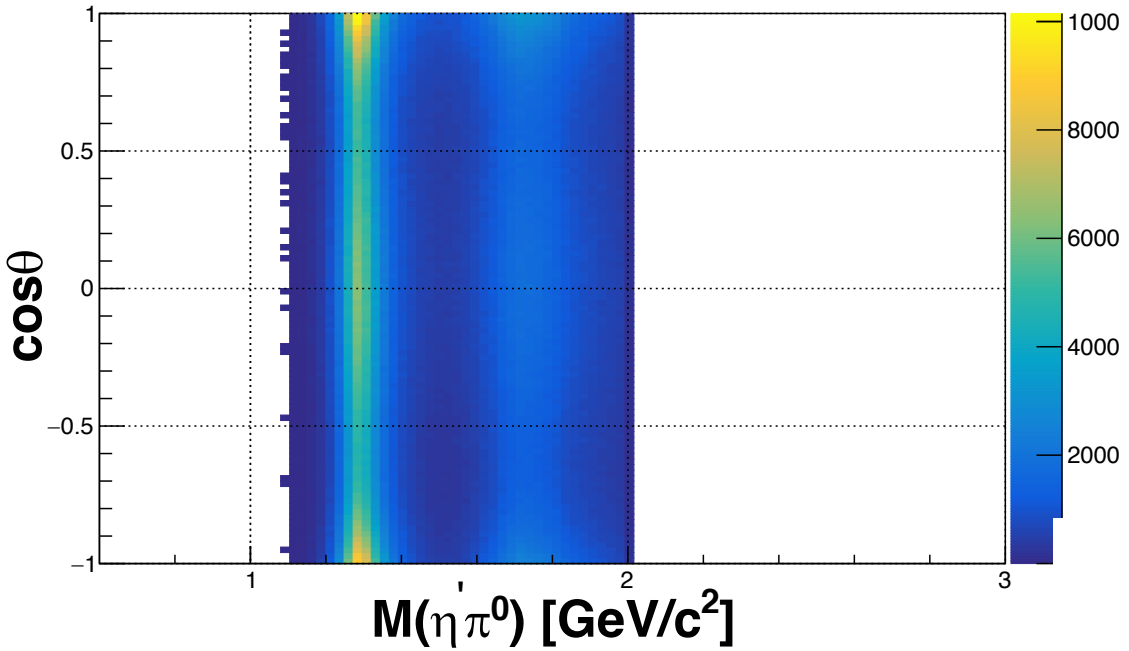


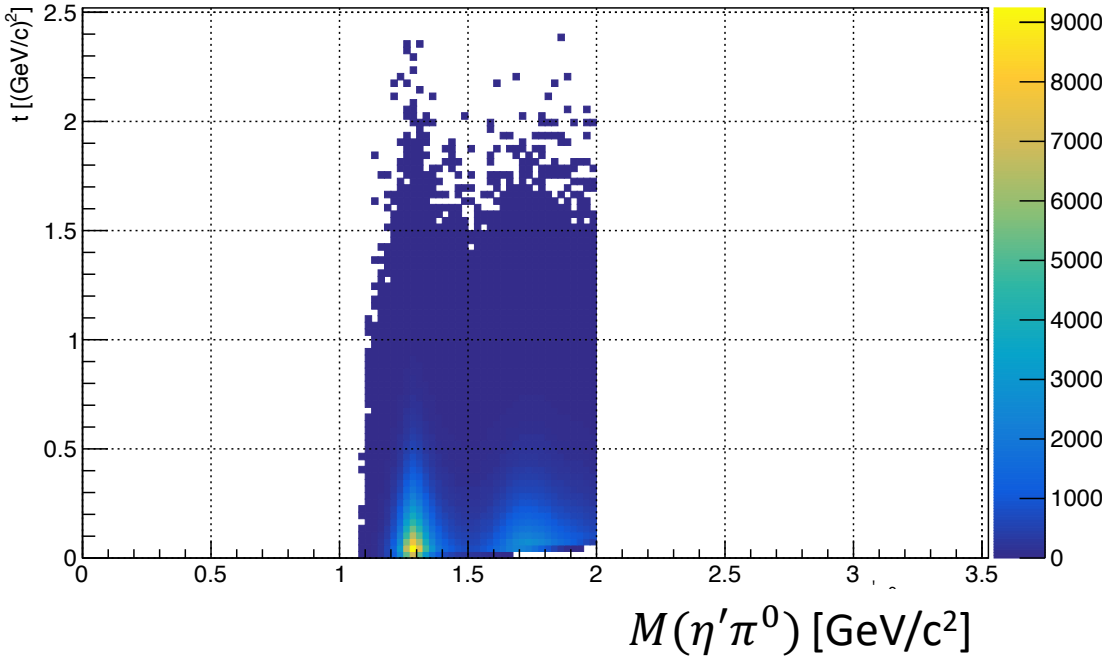


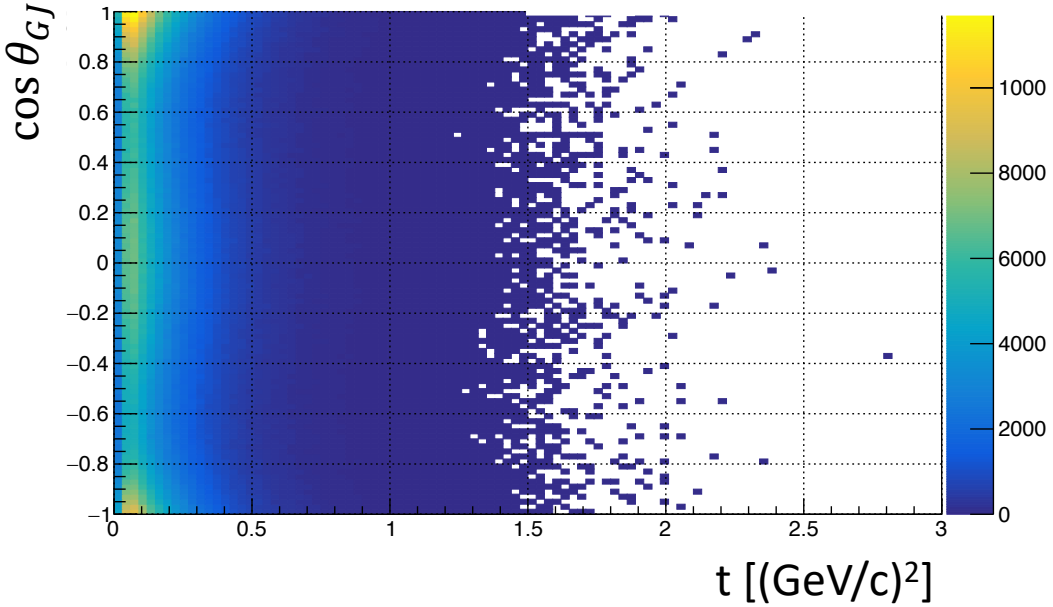

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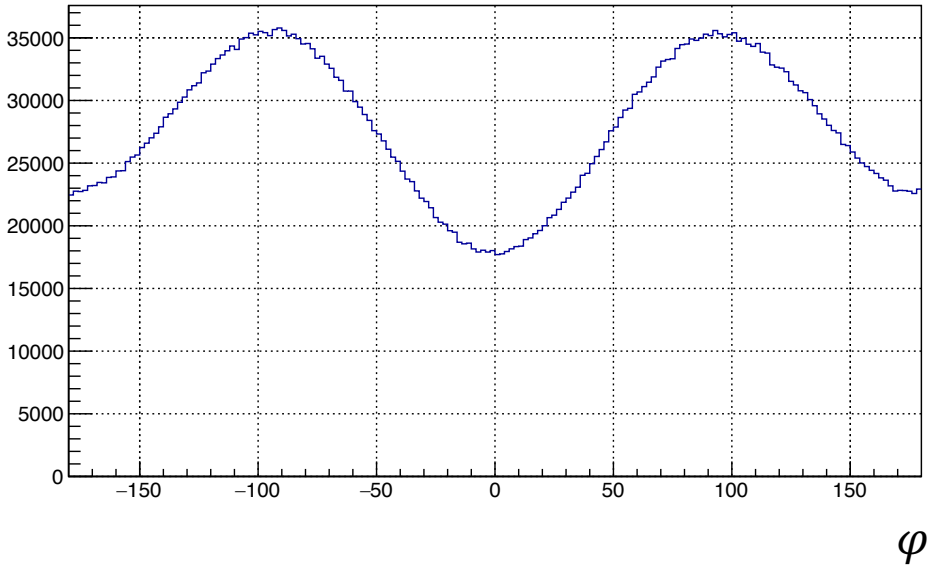
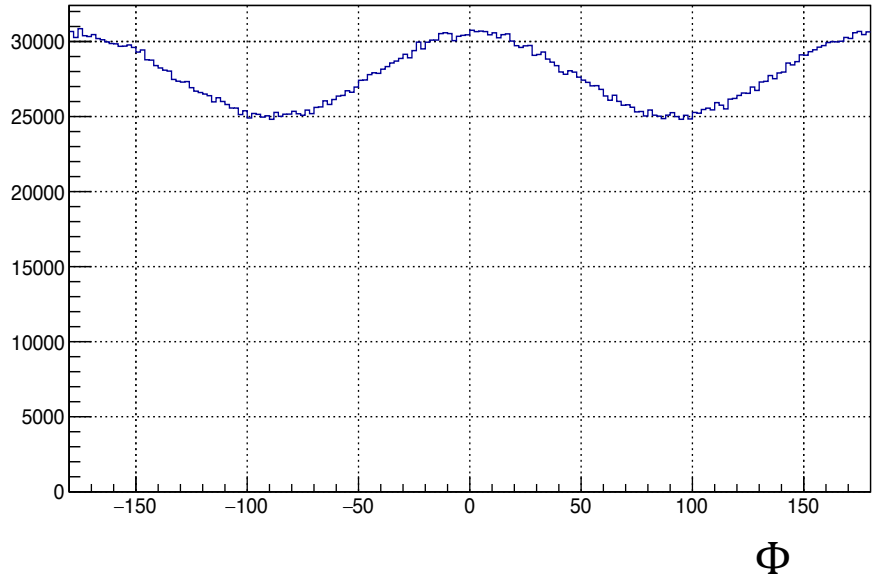
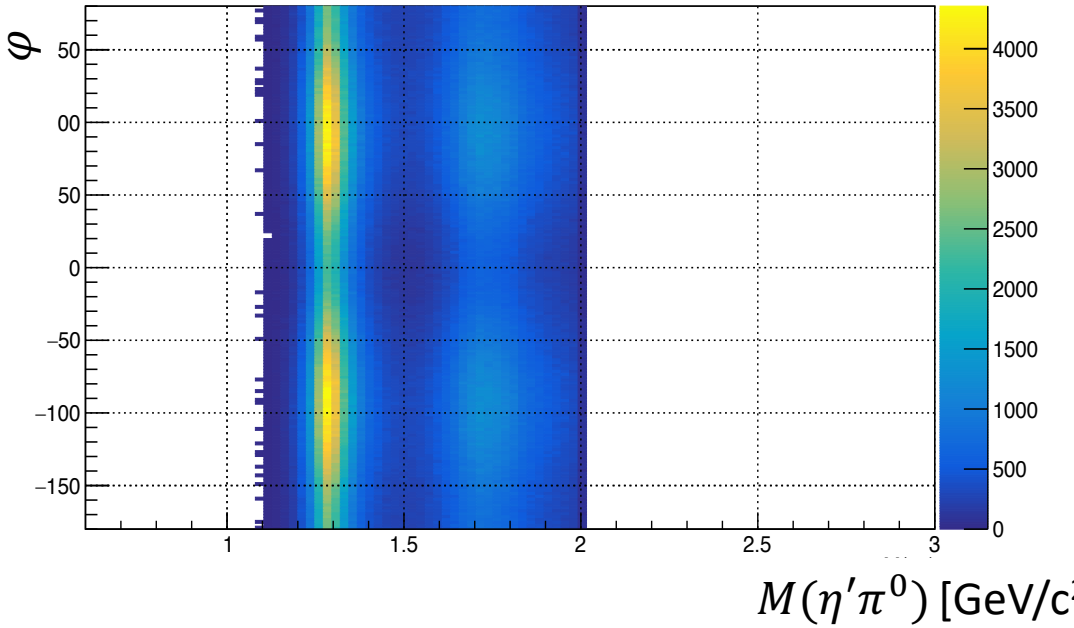
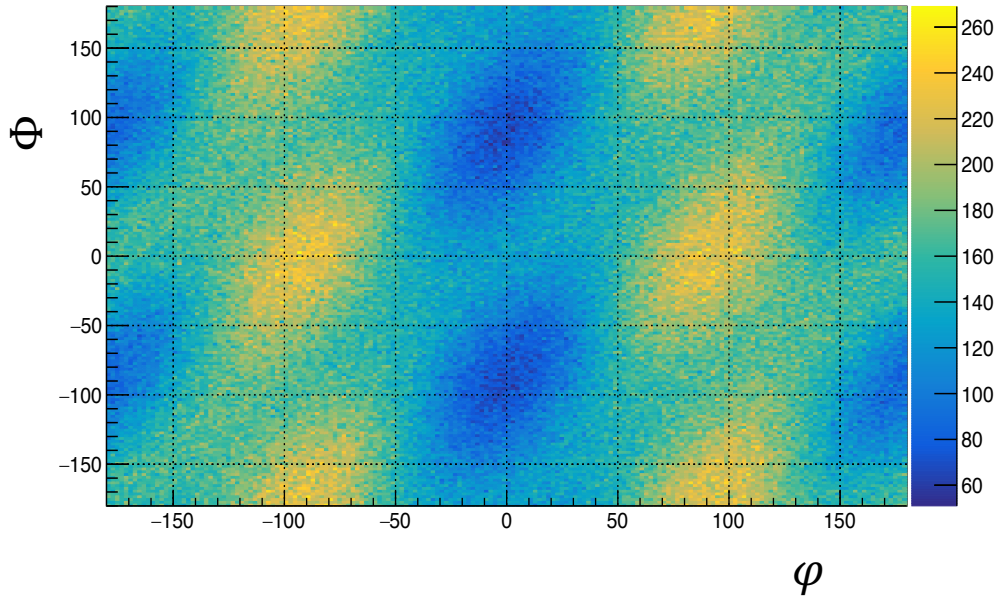


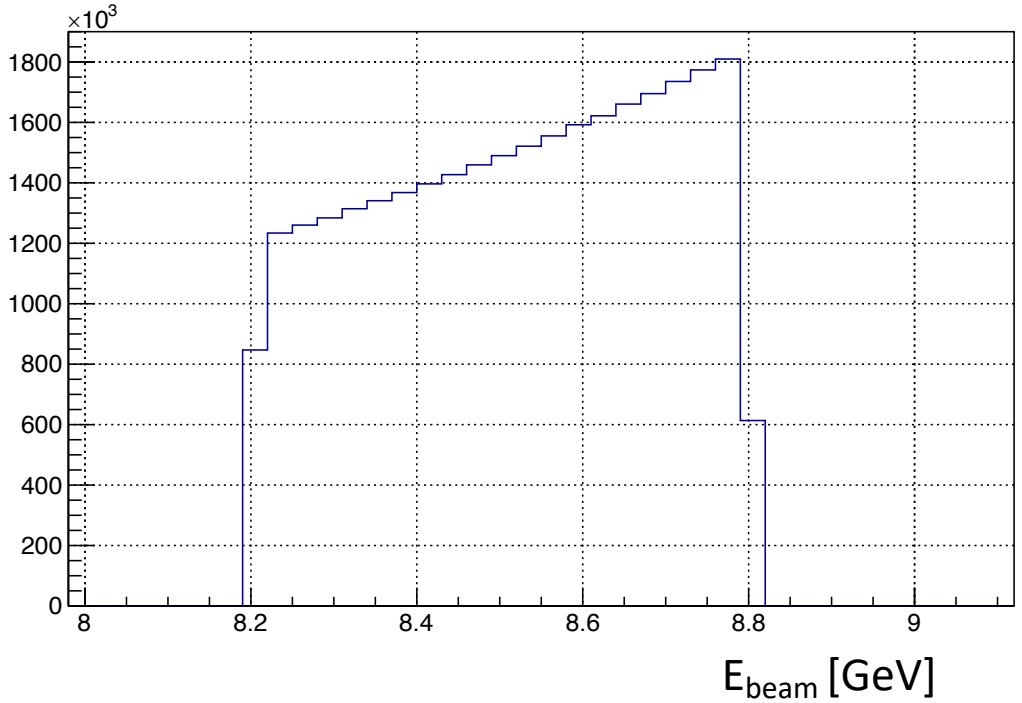



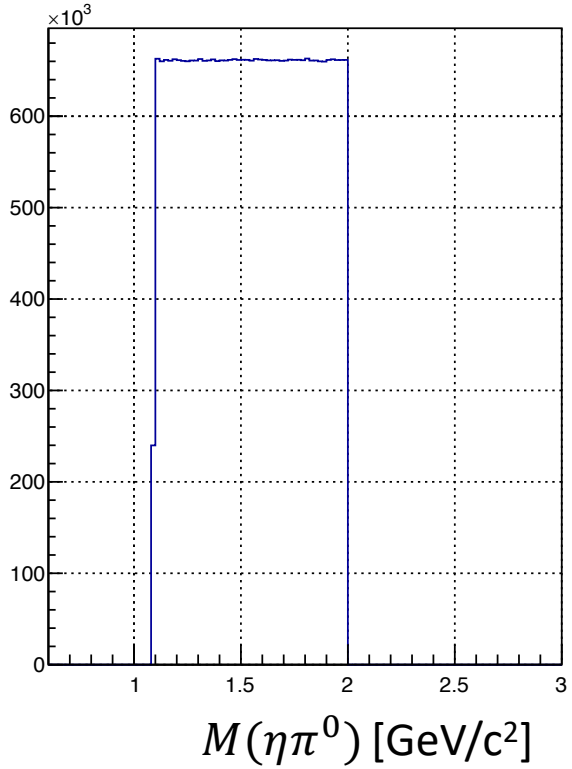



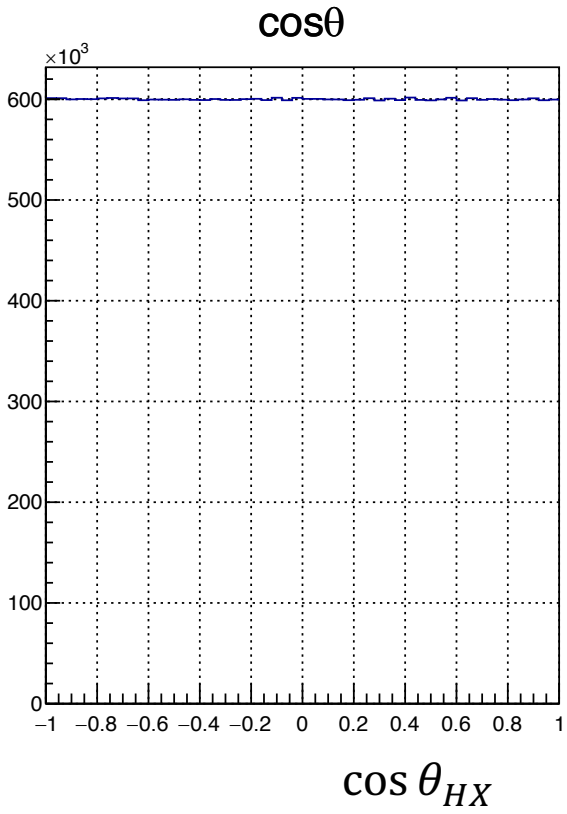



# Generated 30*10⁶ ($p\eta'\pi^0$) flat events with AmpTools

- Flat in $\cos\theta_{GJ}$
- Flat in $M(\eta\pi^0)$



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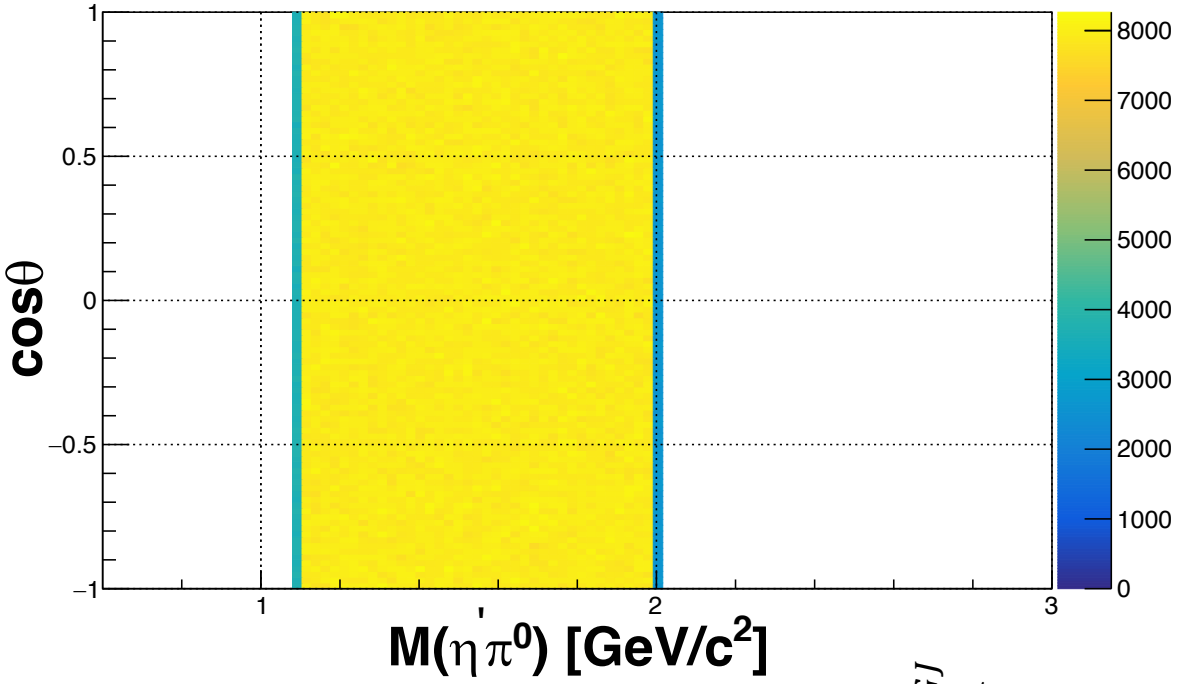
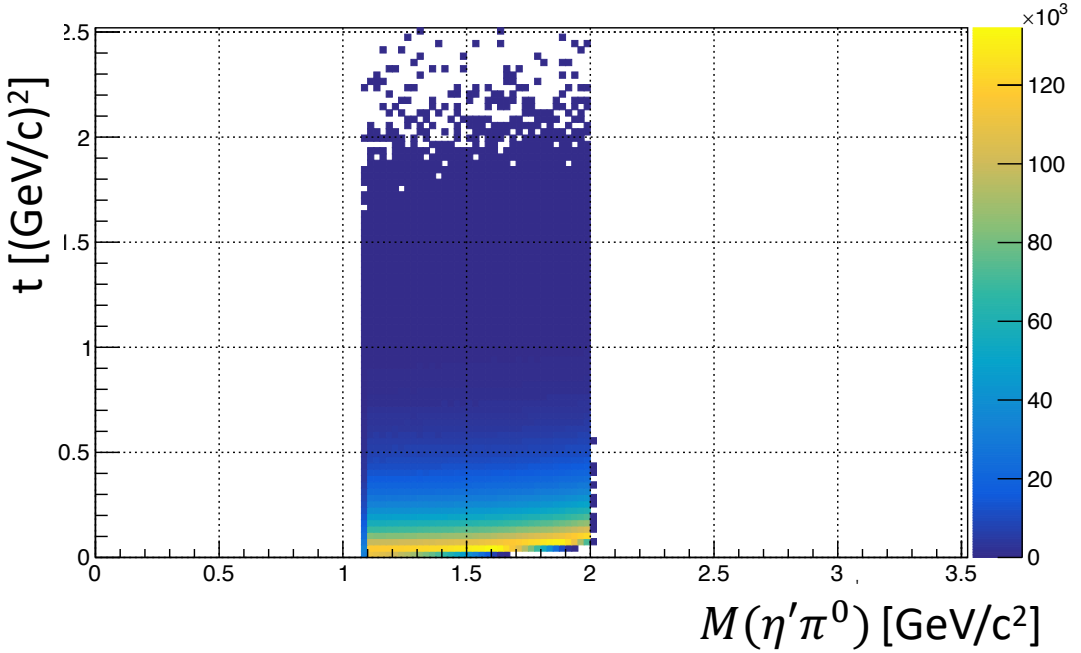
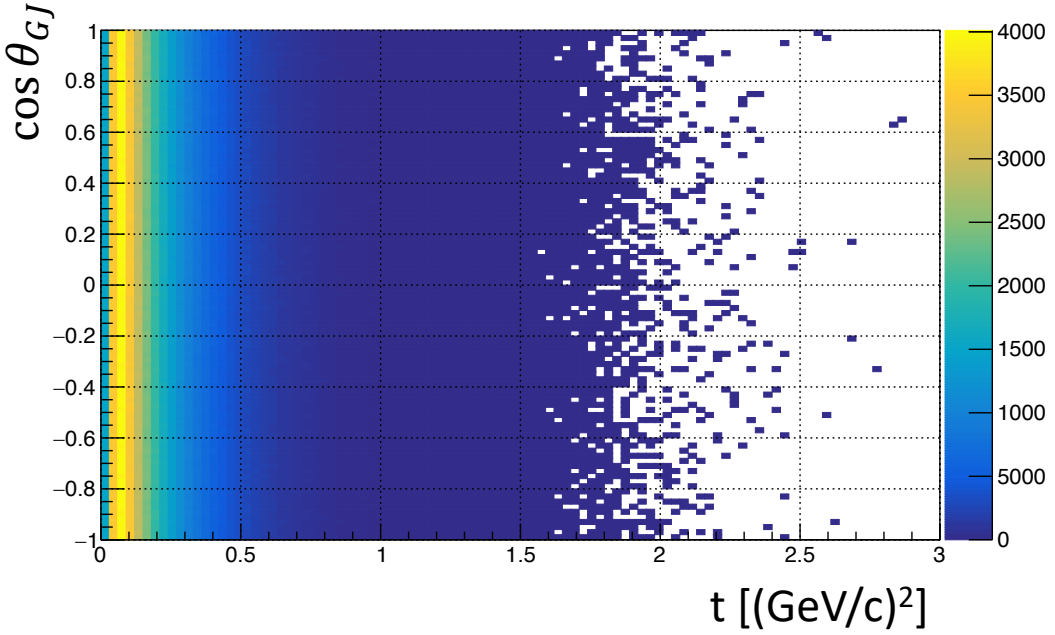
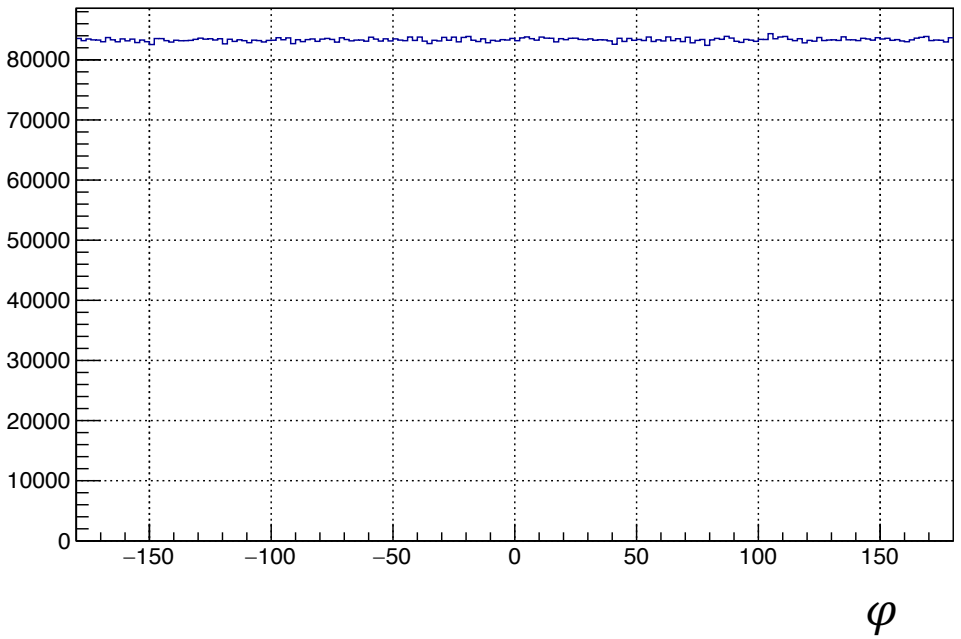
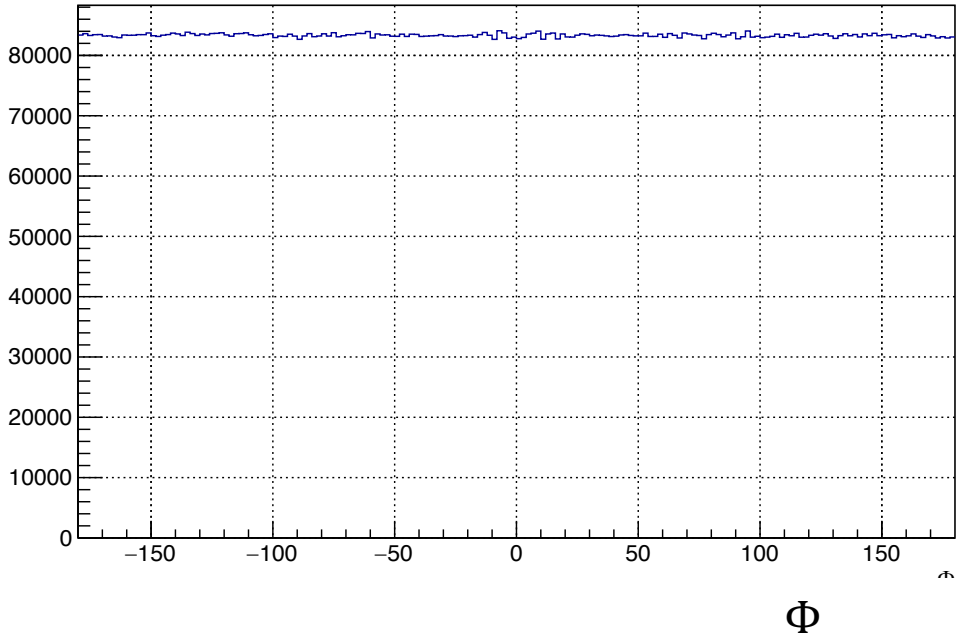


# Generated 30*10$^6$ ($p\eta'\pi^0$) flat events with AmpTools



# Analysis strategy

1. Assume perfect acceptance and fit intensity to extract partial waves and calculate moments (generated moments).
2. Compare to the moments extracted with the GlueX acceptance

- Process generated data through GlueX detector to have the effect of acceptance on it
- Process reconstructed events through analysis code to apply particle identification cuts
- Repeat the steps for generated flat (in M and angles) MC sample to obtain accepted MC sample. Both MC samples are used in MC integration of Intensity in Amptools.

# Cuts applied on reconstructed data (Rupeshes analysis cuts)

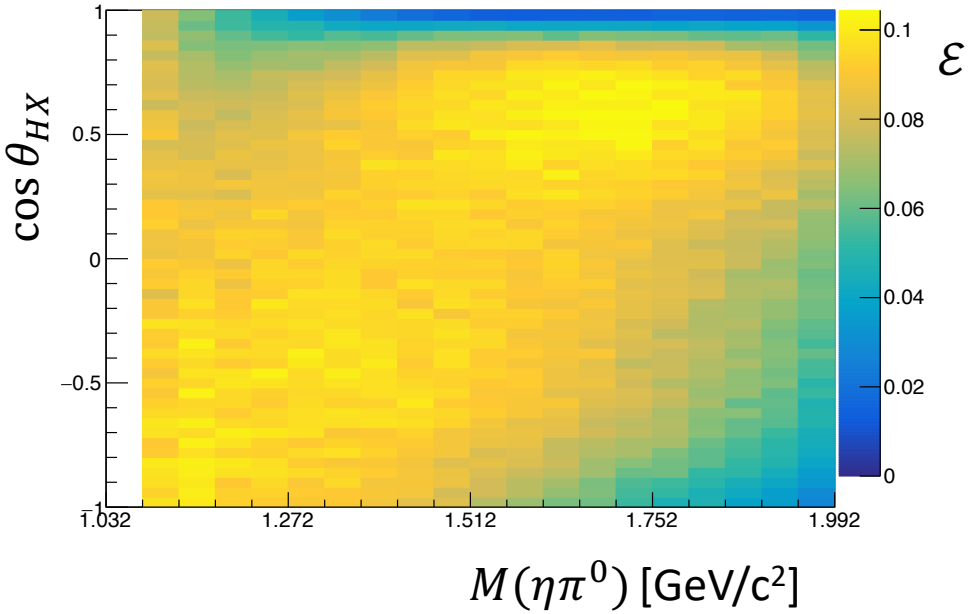
1. Kinfit confidence level cut
2. Check if combo has already been used with all the particles in it
3. Missing mass squared, coherent beam energy and timing selection (select prompt peak)
4. Reject major $\pi^0\ \pi^0$ events
5. Select eta and pi0 mass region in the $M_{\gamma\gamma}$
6. Select $\eta'$ mass window in the $M_{\pi^+\pi^-\eta}$

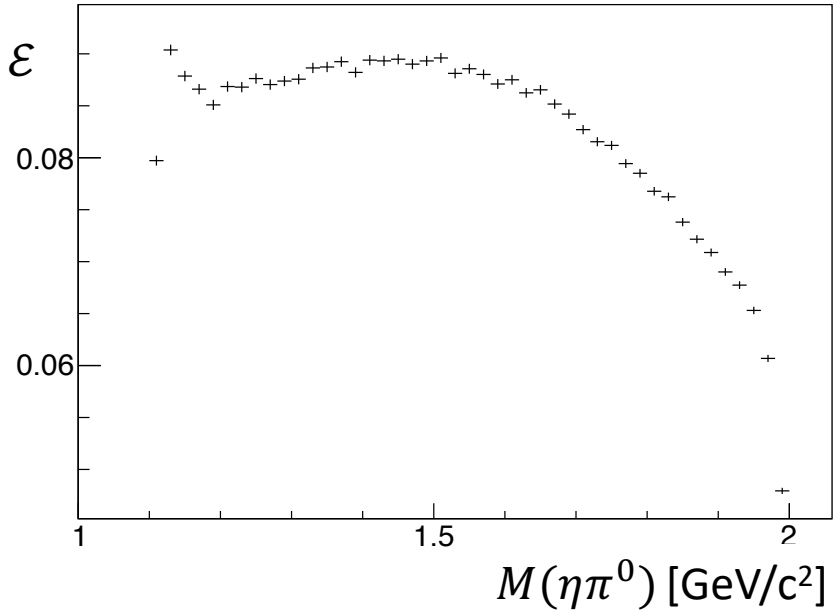
# Acceptance with flat data

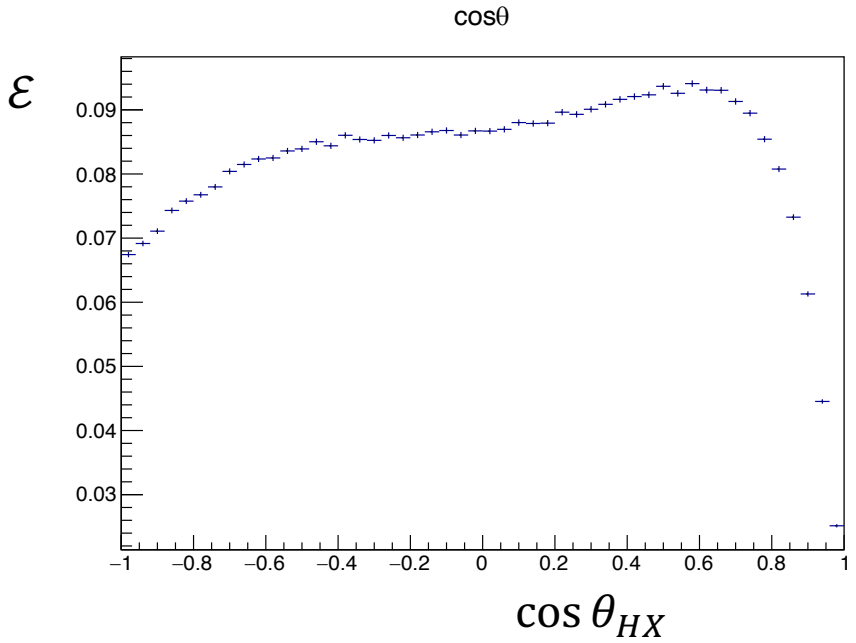
1. Generate data and pass through the GlueX detector to study acceptance ($\mathcal{E}$)
2. Turning off all decay channels of final state particles but that of interest ($\eta'$-> $\pi^+\pi^-\eta$ (~42.6%), $\eta \rightarrow \gamma\gamma$(~39.4%)) to obtain correct acceptance for the reaction $\gamma p \rightarrow p\eta'\pi^0$
   - Have generated 5*$10^6$ events
   - ~8.5% got reconstructed and have passed analysis cuts (have used Rupeshes analysis code)

# Acceptance with flat data for -t>0.1 (GeV/c)$^2$ with uncertainties

We select -t>0.1 (GeV/c)$^2$ to cut events, where p had such low –t , that it couldn't get out of the target.

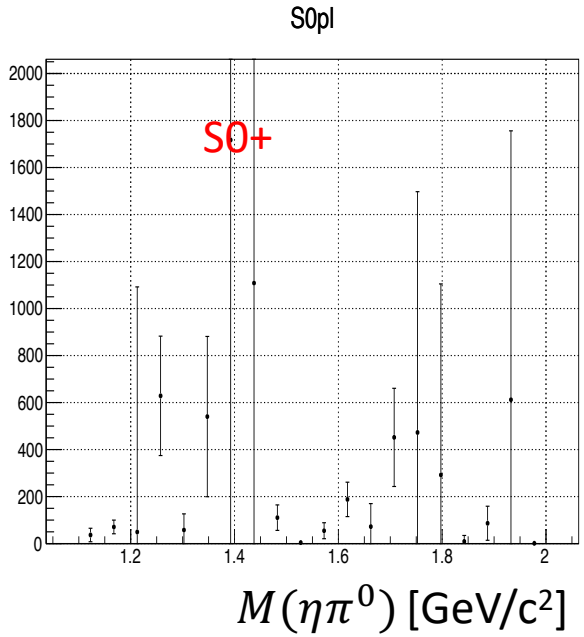


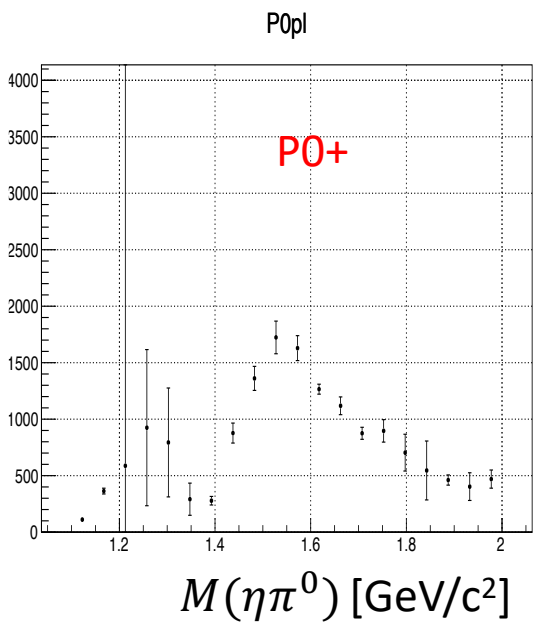



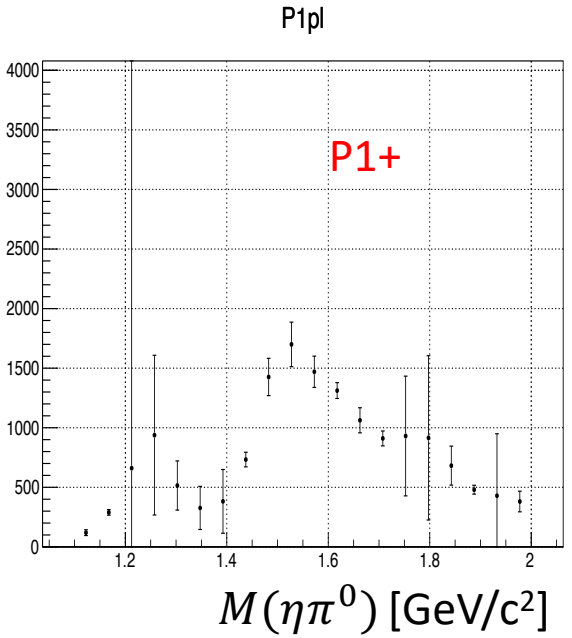



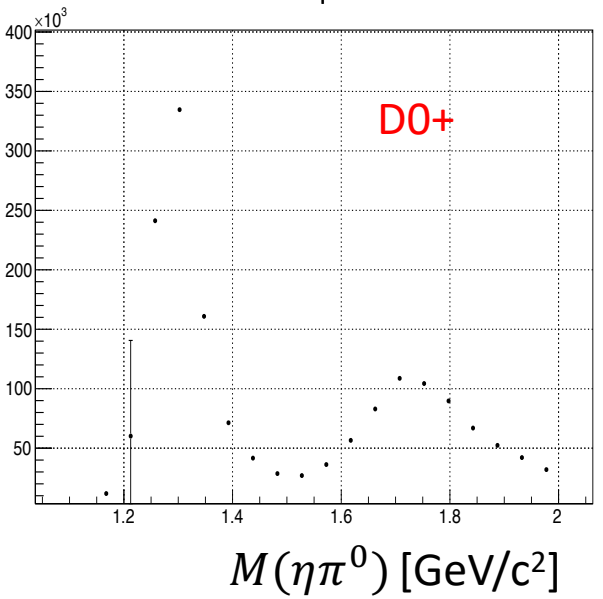
# Fit results for generated data

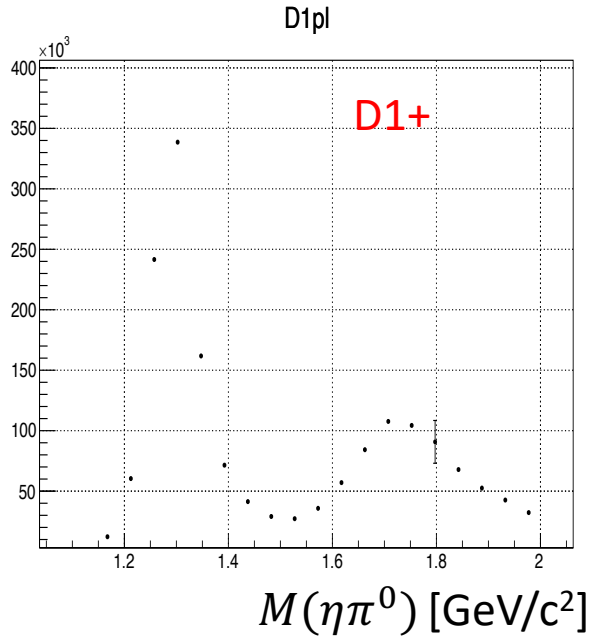
Fitting with amplitude set: S0+, P0+, P1+, D0+, D1+, D2+.

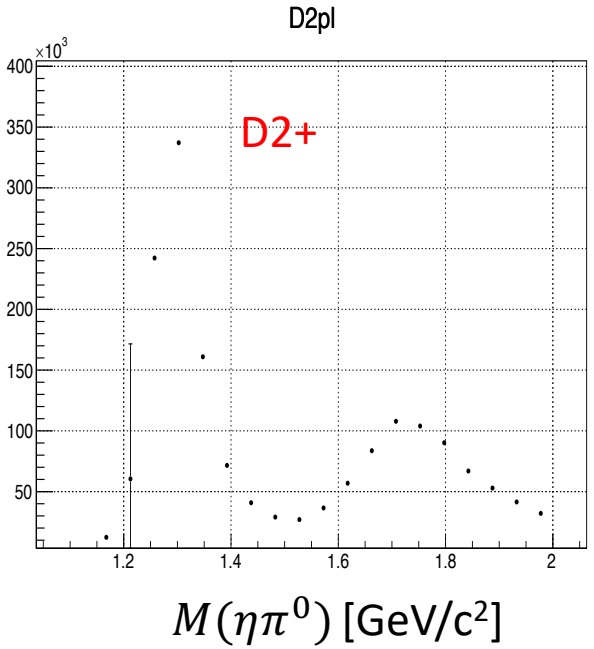


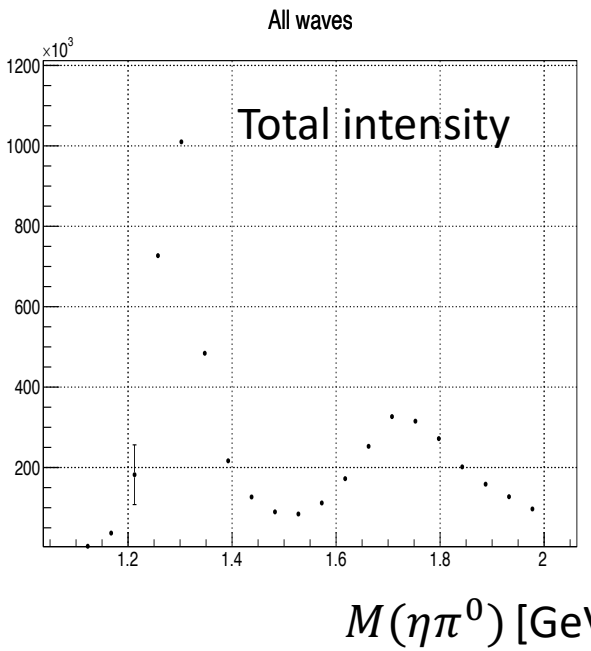



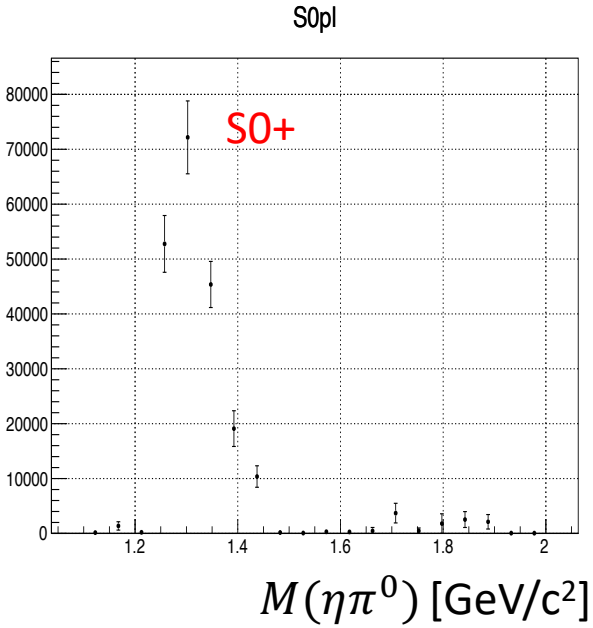



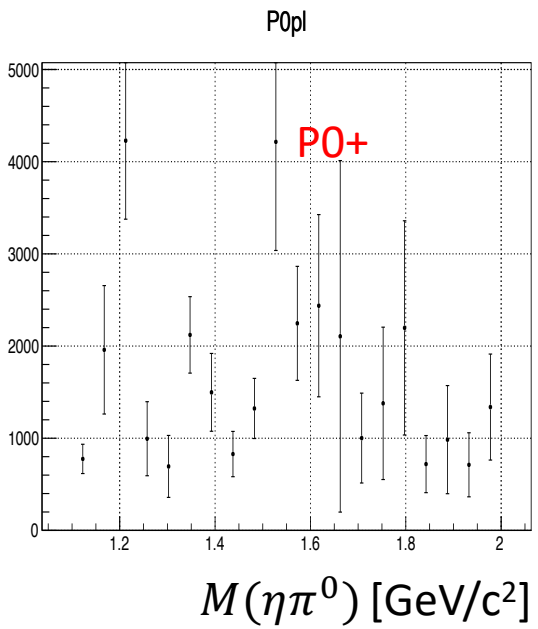



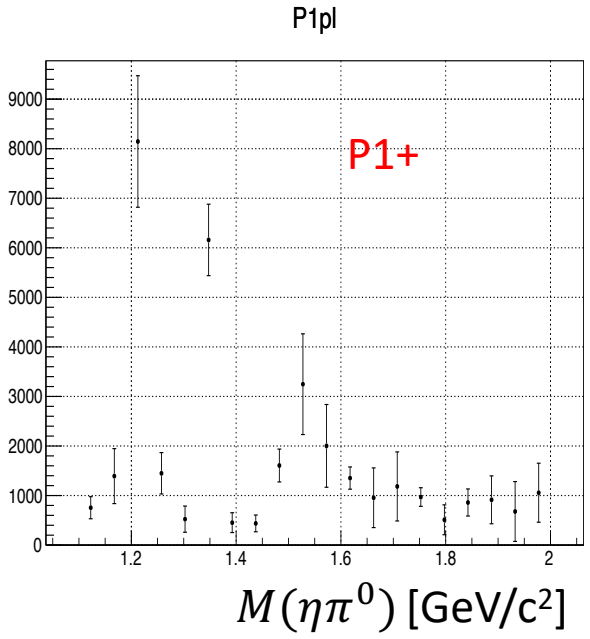

$$\frac{I(a_2)}{I(\pi_1)} \approx 350 \quad \frac{I(a'_2)}{I(\pi_1)} \approx 100$$

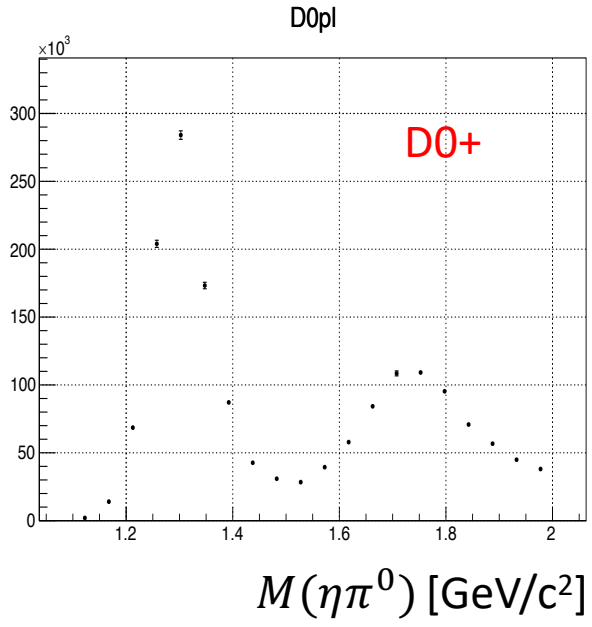
# Fit with GlueX acceptance

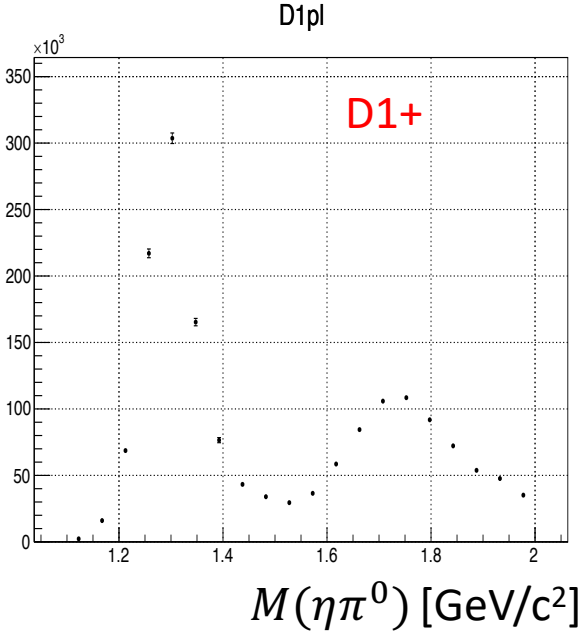
Fitting with amplitude set: S0+, P0+, P1+, D0+, D1+, D2+.

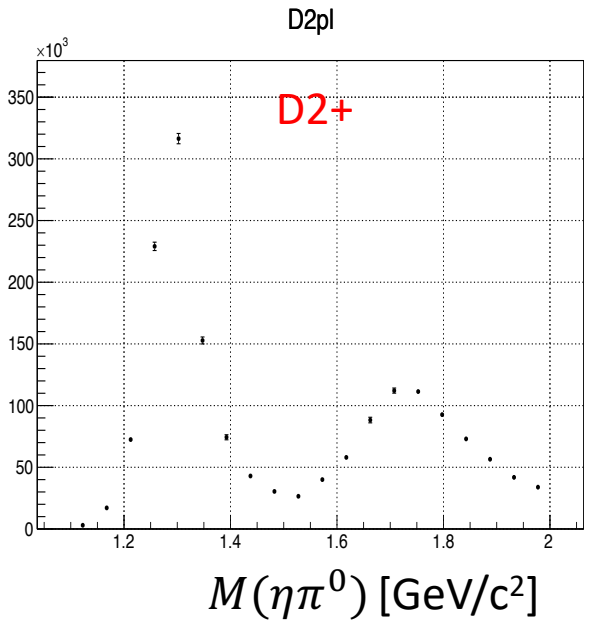


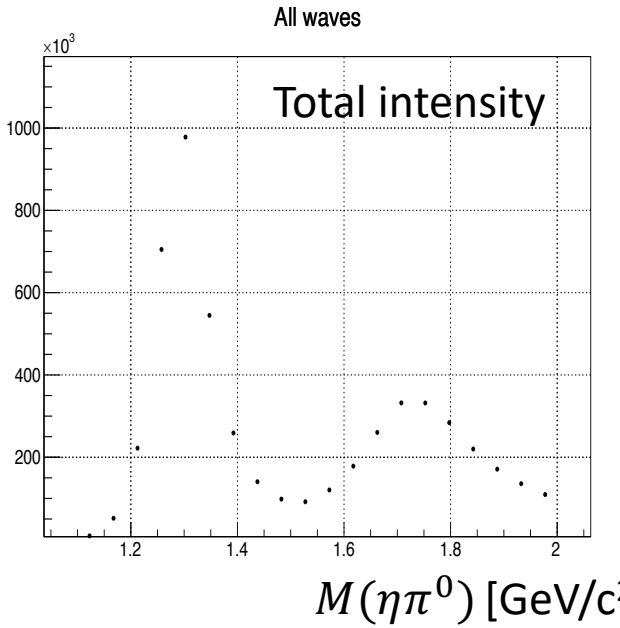



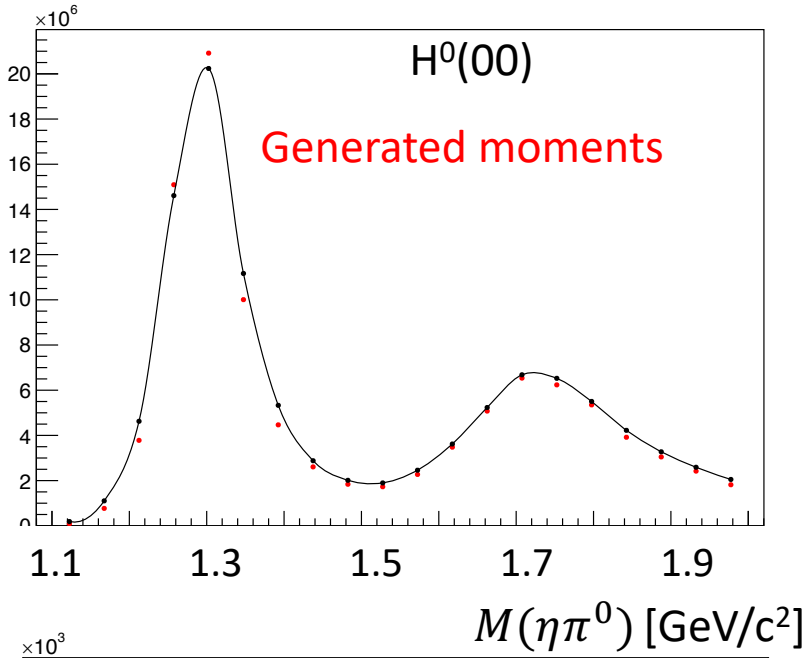



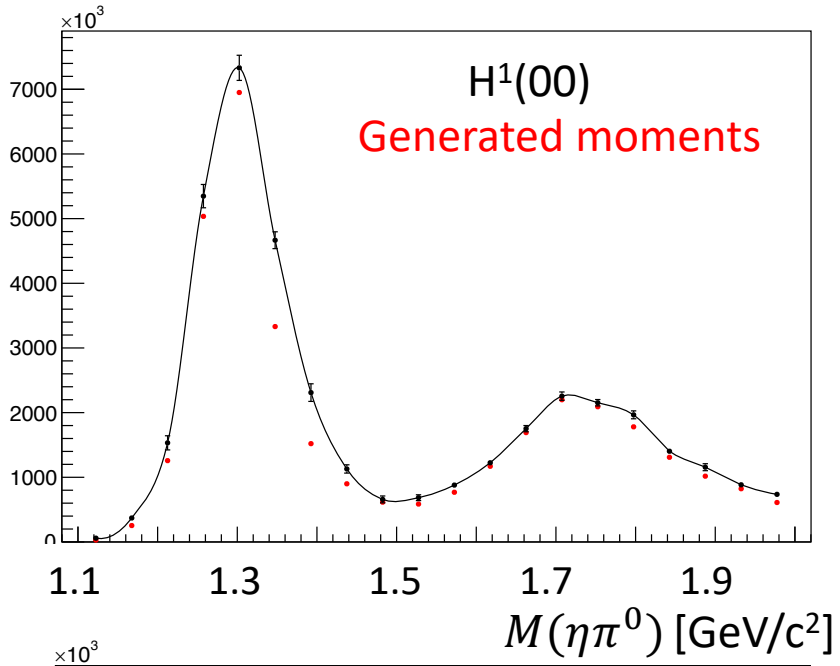



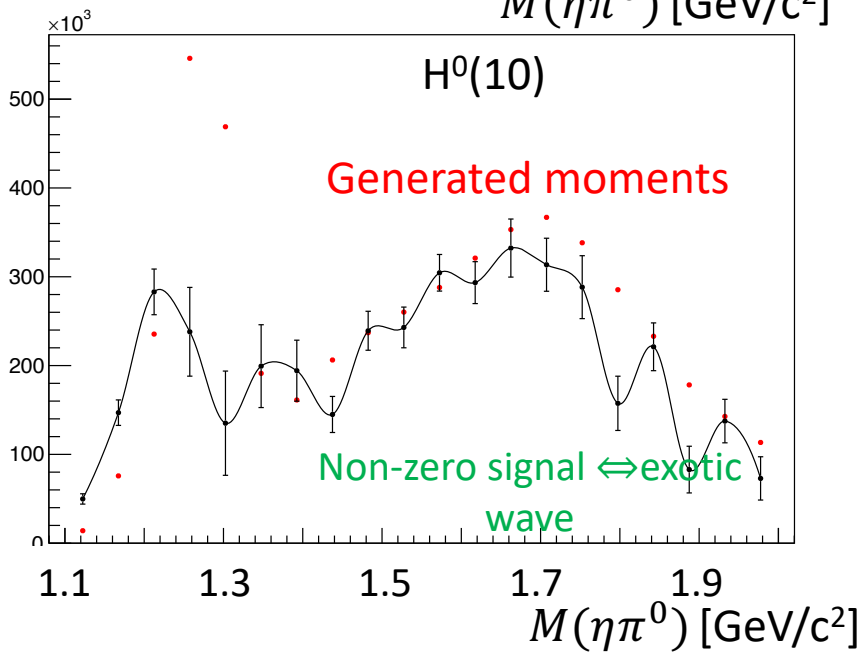
# Polarized moments calculated with partial waves and GlueX acceptance don't agree with generated moments

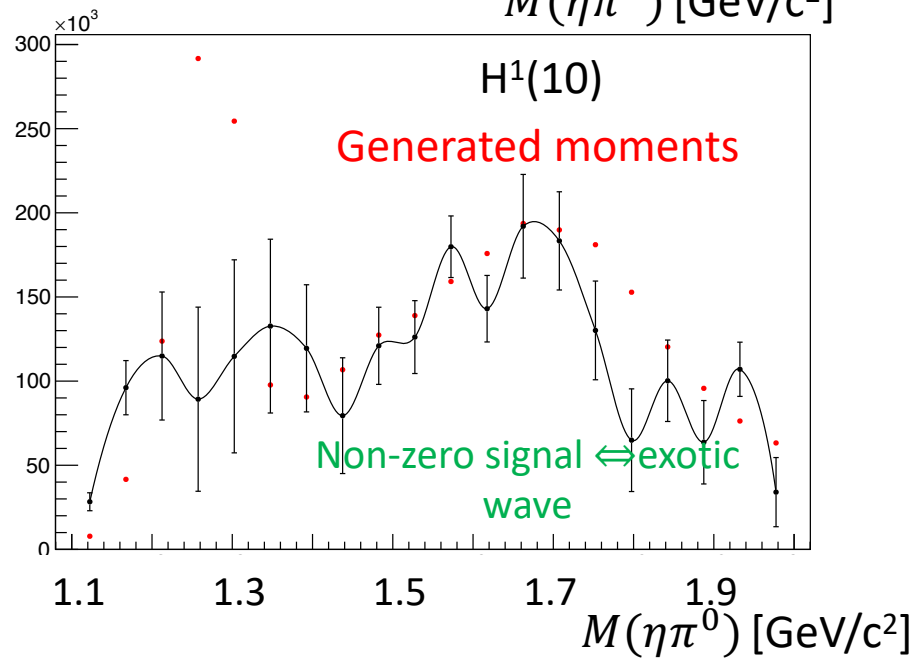
Uncertainties from bootstrapping

$0<t<0.3$ (GeV/c)$^2$



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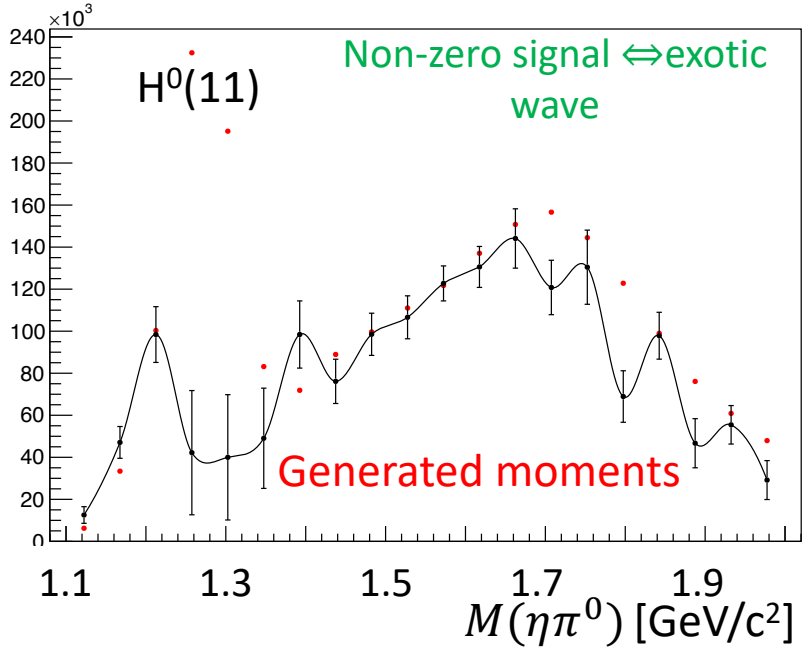


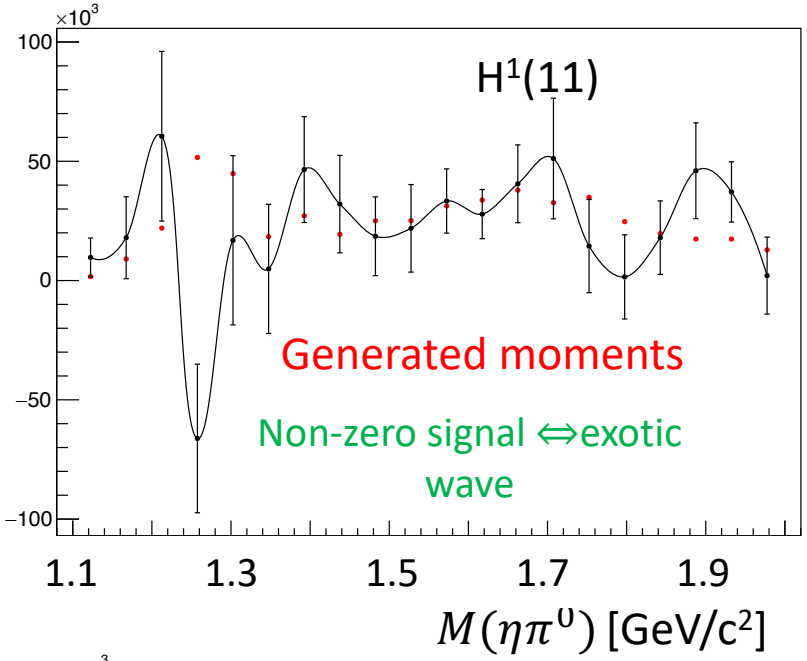


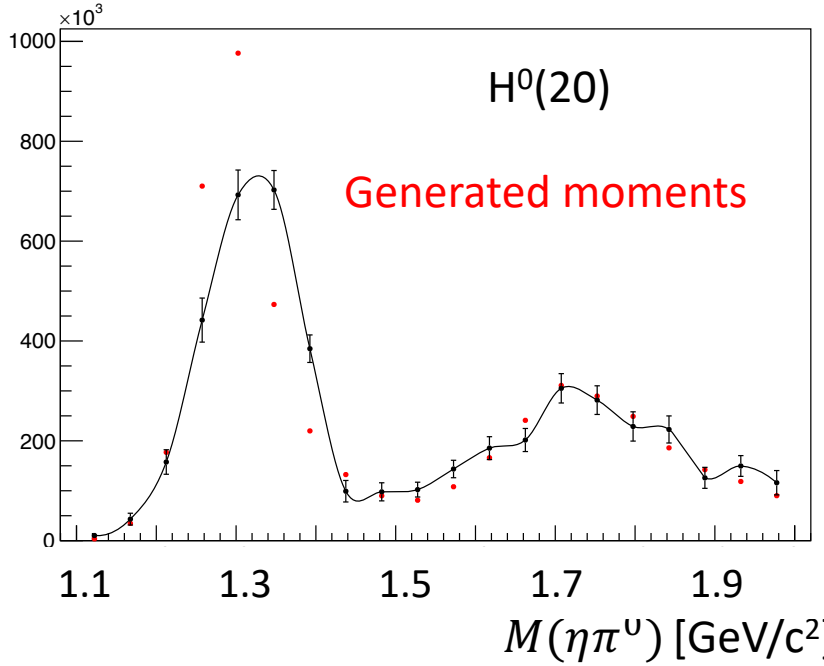


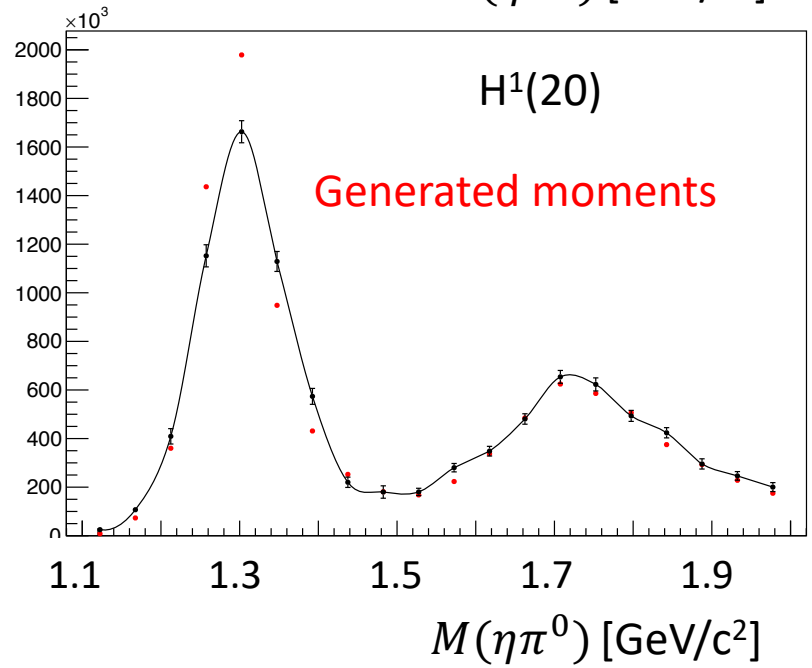

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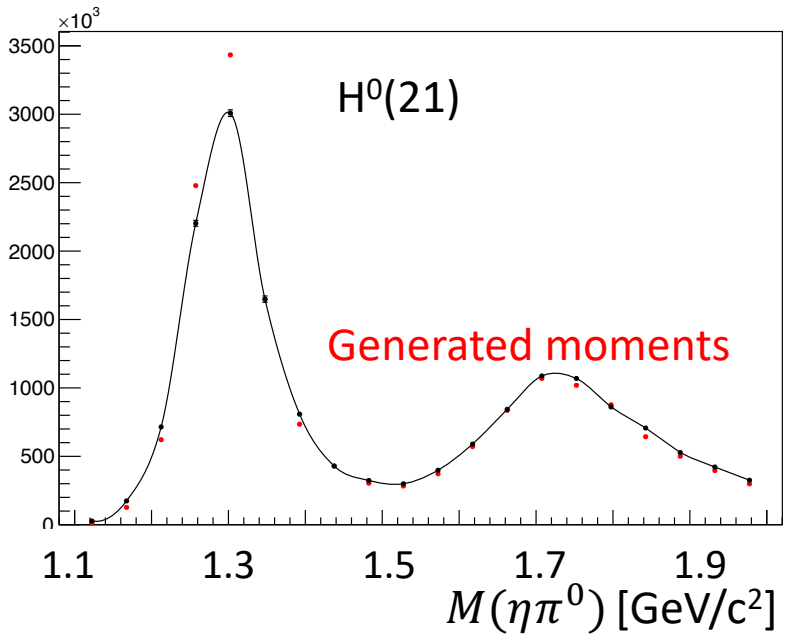
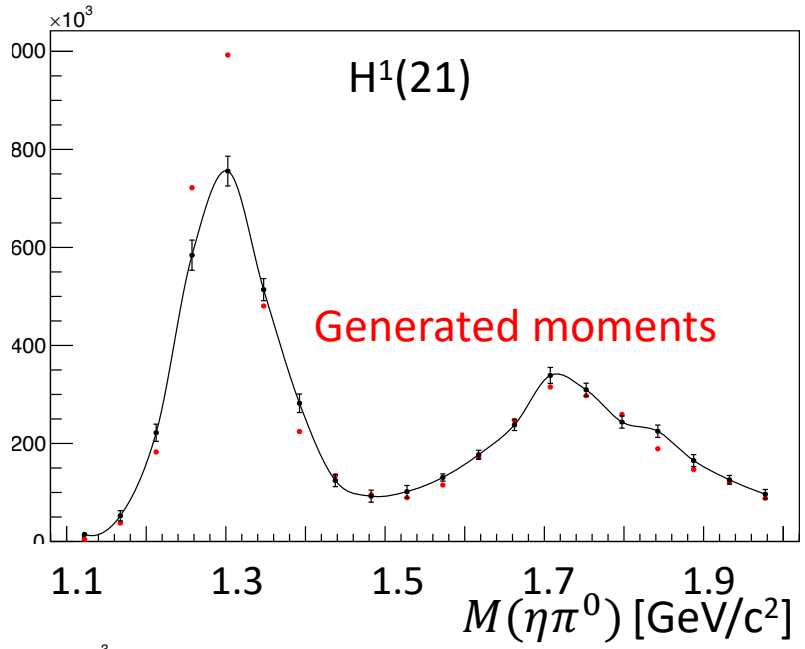
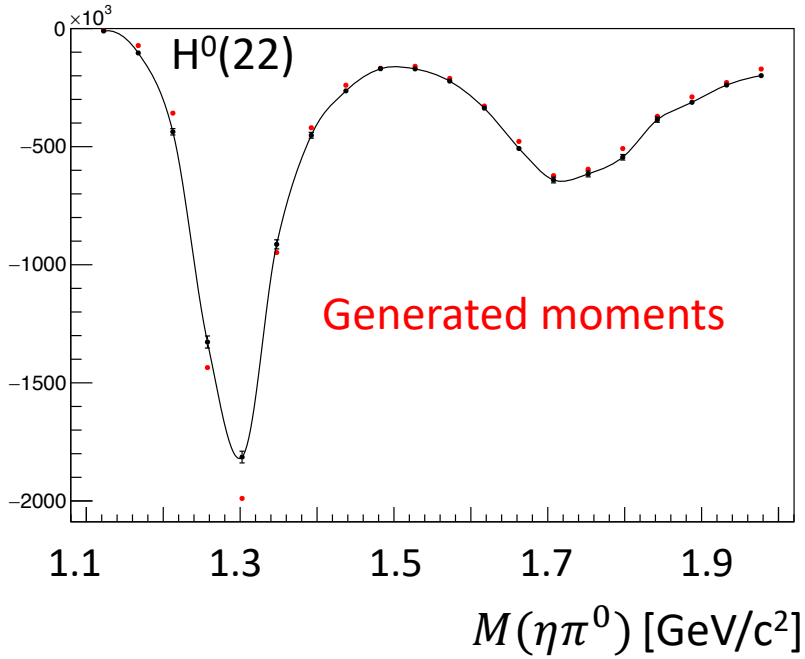
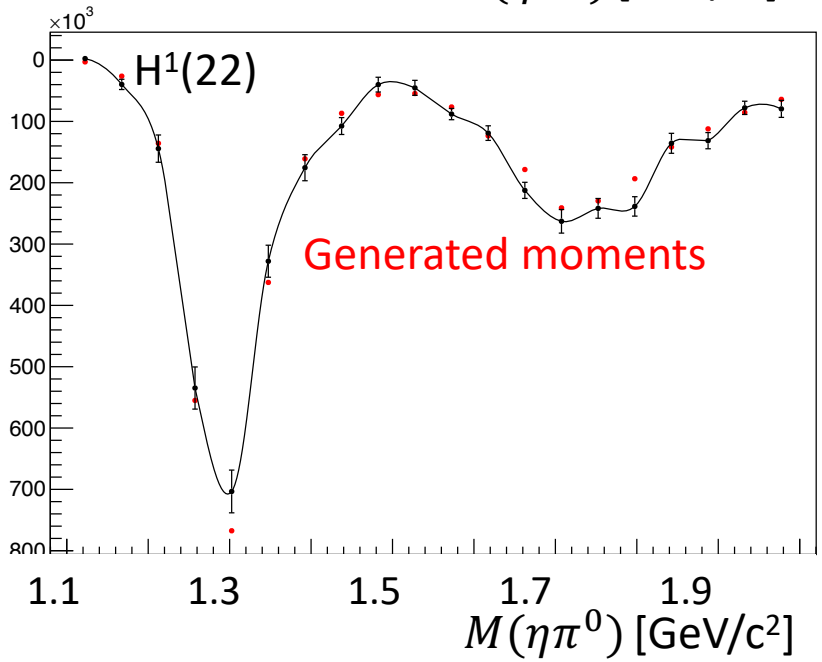


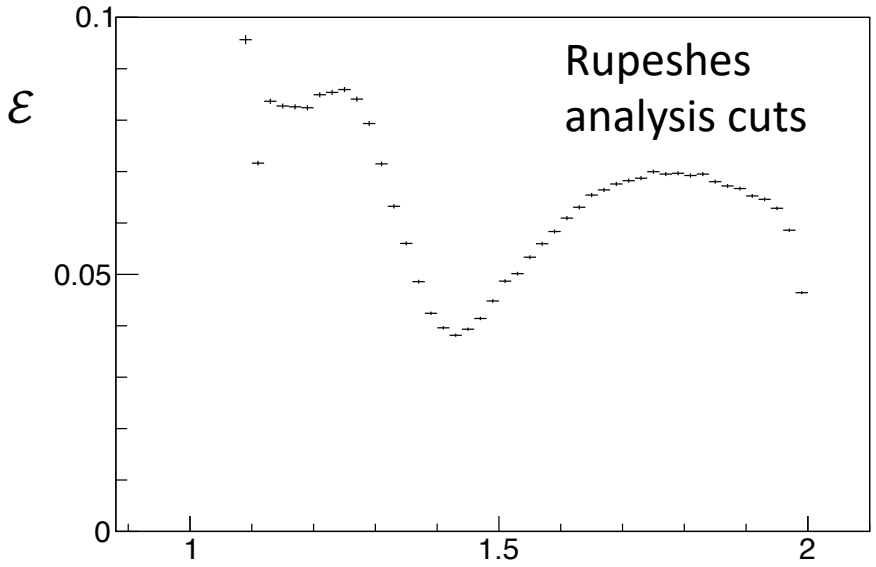



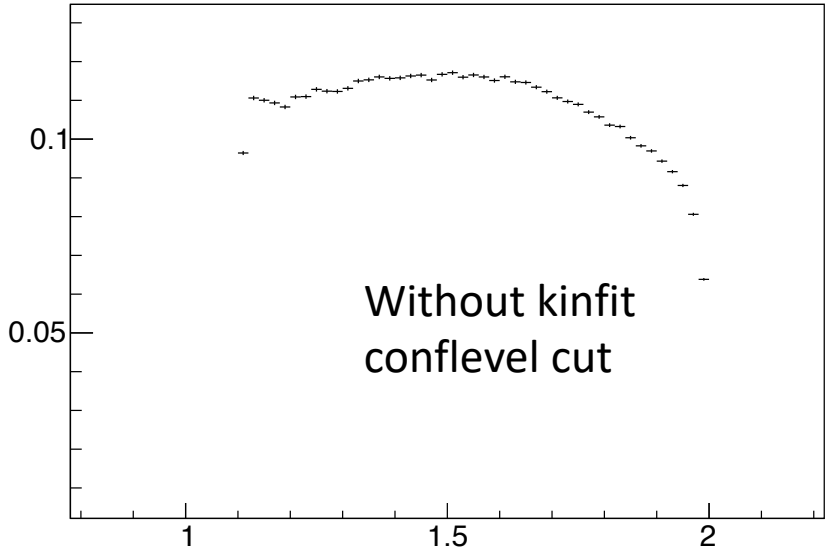



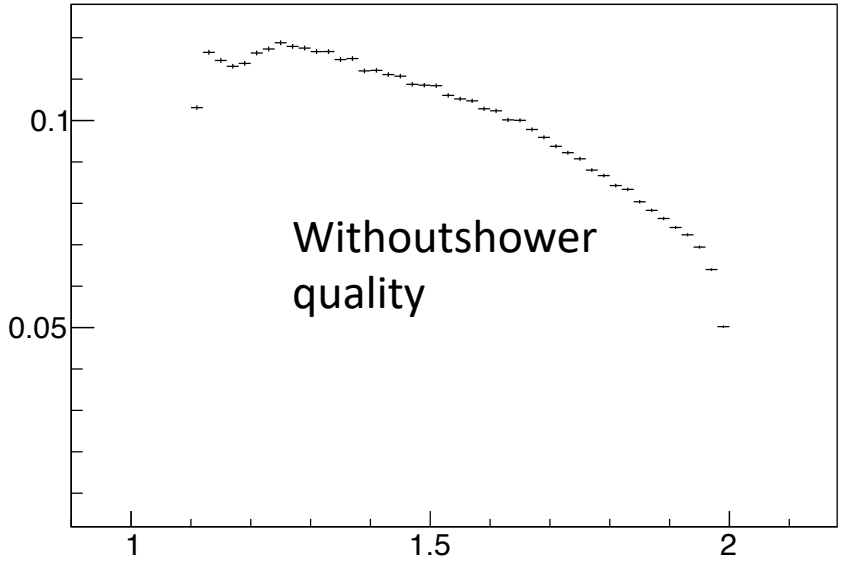
Repeating previous analysis now using generated 4-vectors for reconstructed data both in obtaining the acceptance and in fitting (there is no $2\pi^0$ and $\omega$ cut on reconstructed data) to understand discrepancy between the moments at M~1.3 for $H^0(11)$

# Acceptance with flat data for 0.1<-t<1 (GeV/c)$^2$ with uncertainties

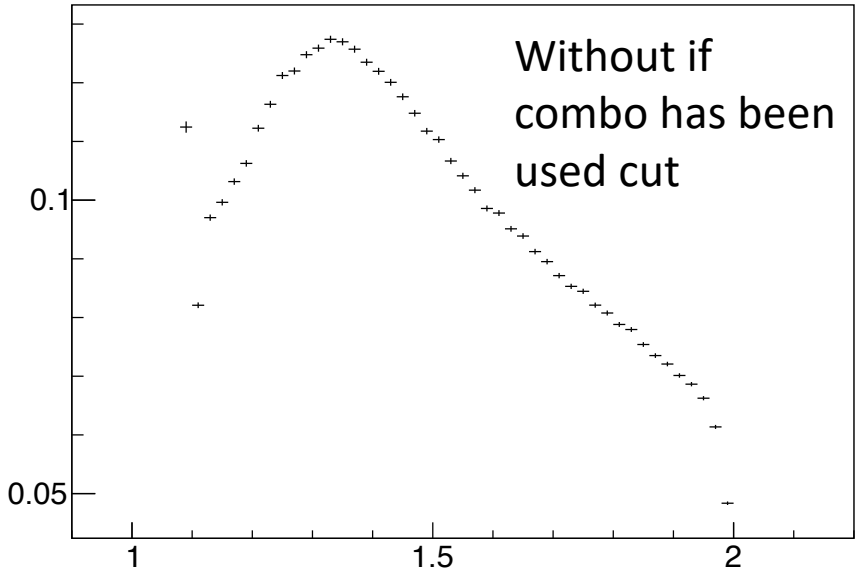
We select -t>0.1 (GeV/c)$^2$ to cut events, where p had such low –t , that it couldn't get out of the target.




$M(\eta'\pi^0)$ [GeV/c$^2$]



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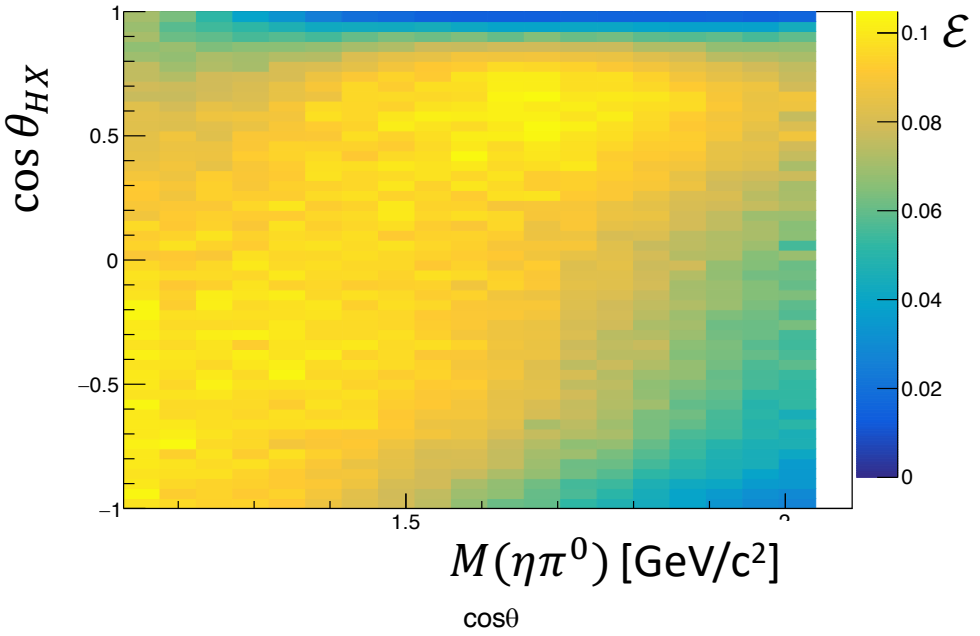
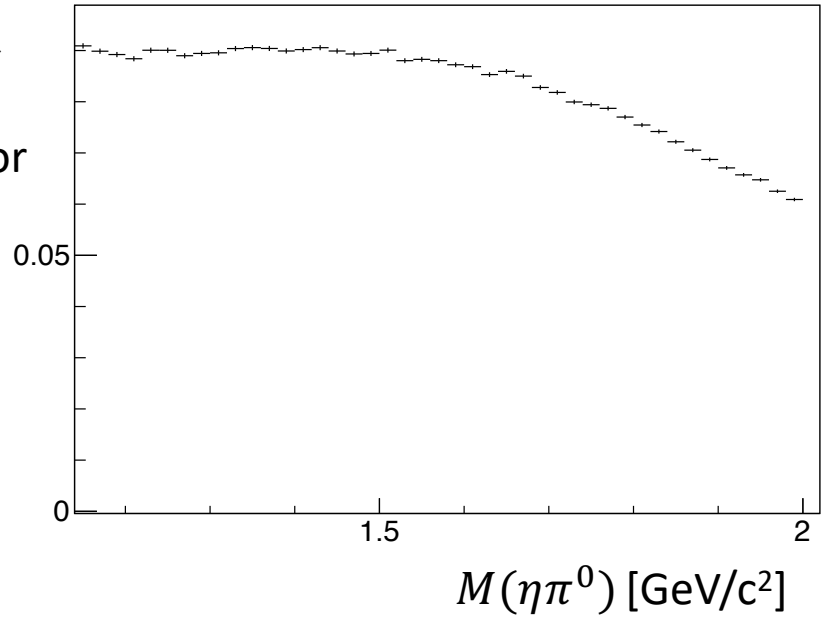
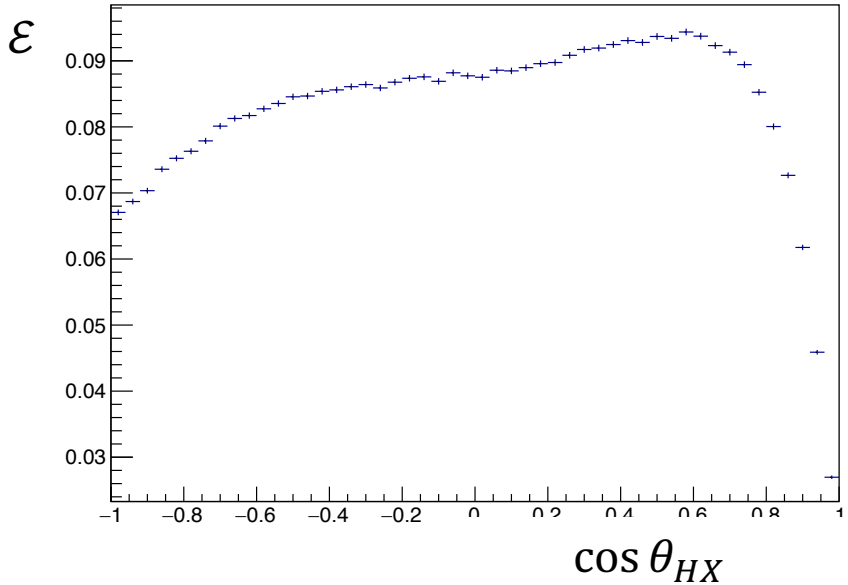



Using generated P4 for reconstructed data



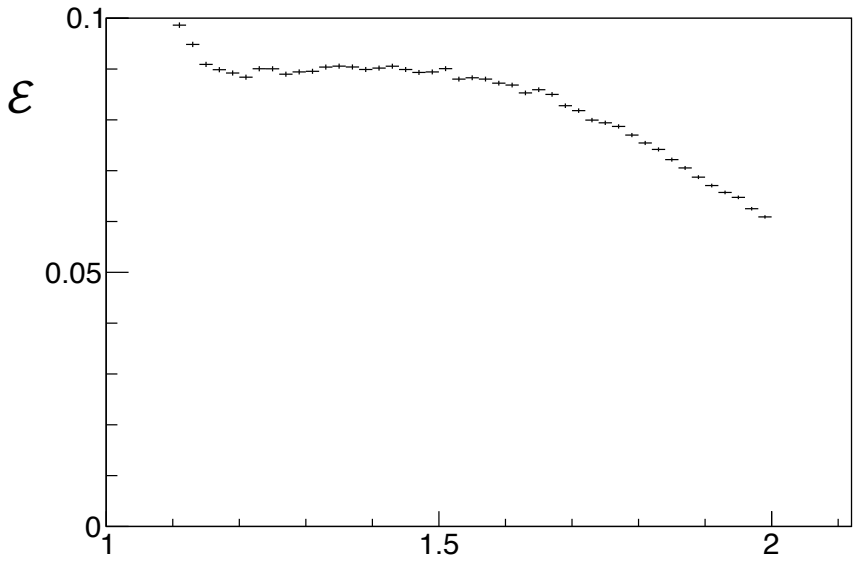

cosθ



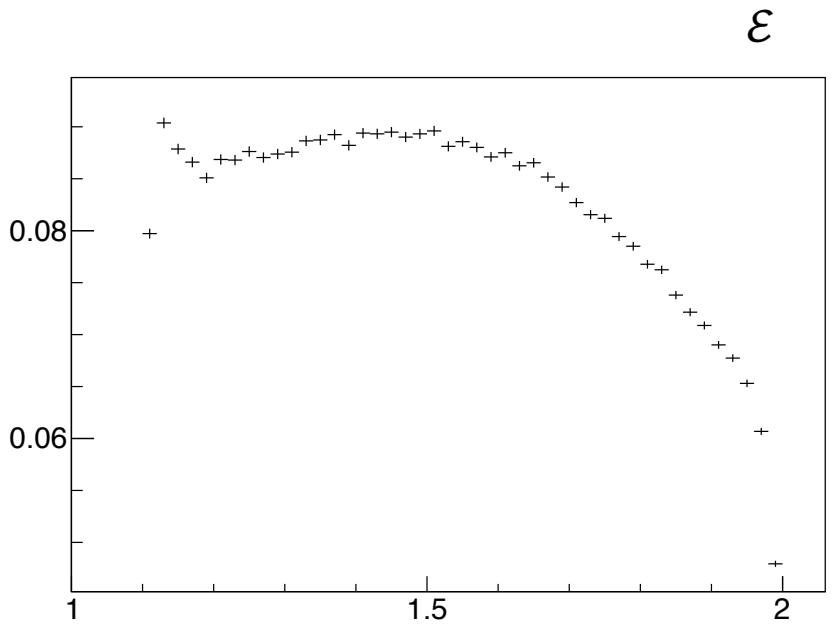
# Acceptance with flat data for 0.1<-t<1 (GeV/c)$^2$ with uncertainties

We select -t>0.1 (GeV/c)$^2$ to cut events, where p had such low –t , that it couldn't get out of the target.

Using generated P4 for reconstructed data



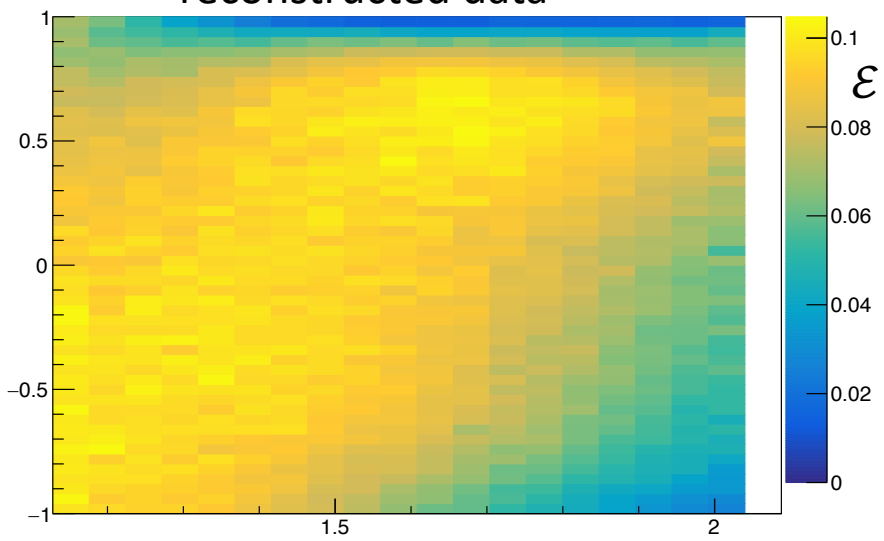

Using reconstructed P4 for reconstructed data



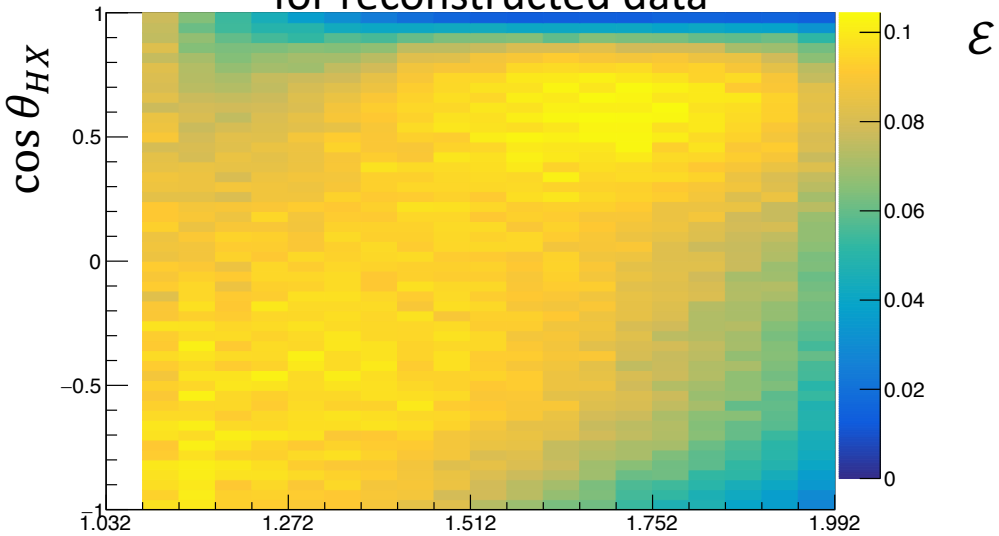
# Acceptance with flat data for 0.1<-t<1 (GeV/c)$^2$ with uncertainties

We select -t>0.1 (GeV/c)$^2$ to cut events, where p had such low –t , that it couldn't get out of the target.

Using generated P4 for reconstructed data

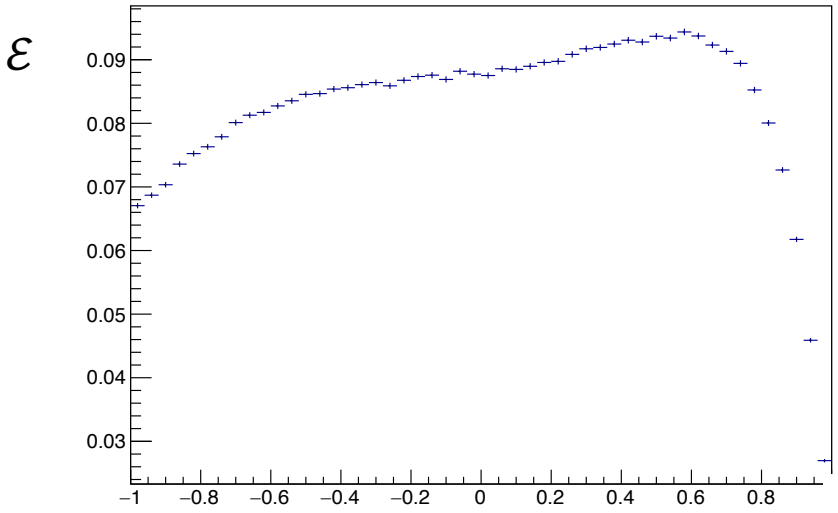



Using reconstructed P4 for reconstructed data

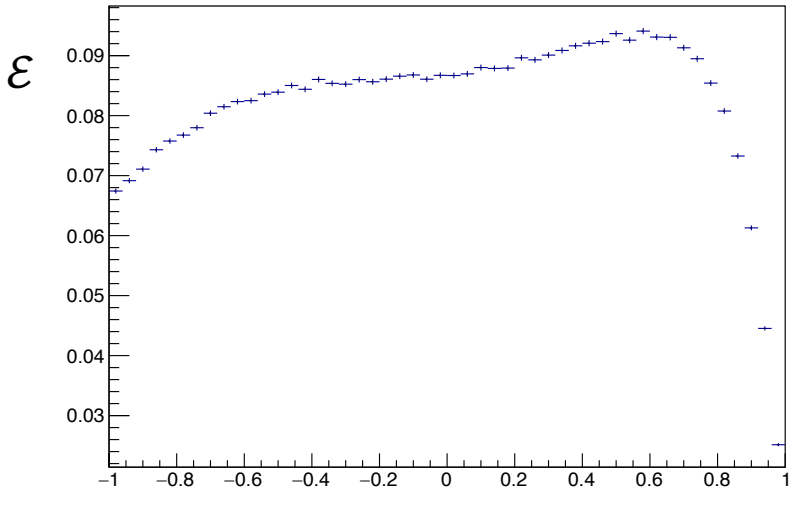



$M(\eta'\pi^0)$ [GeV/c²]

cosθ



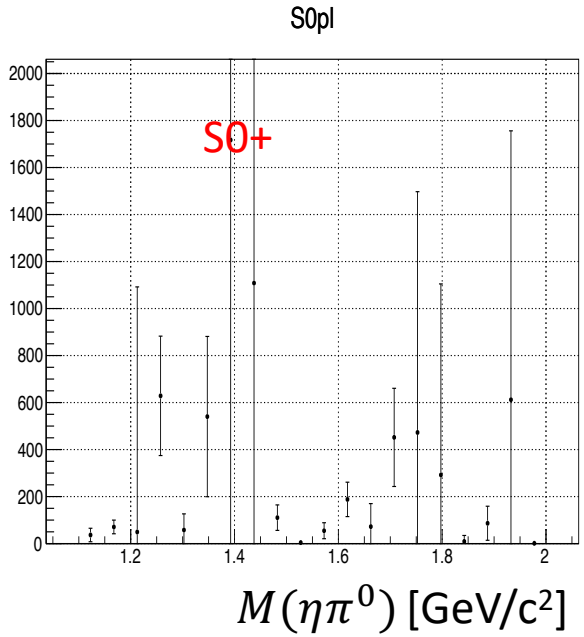

cosθ

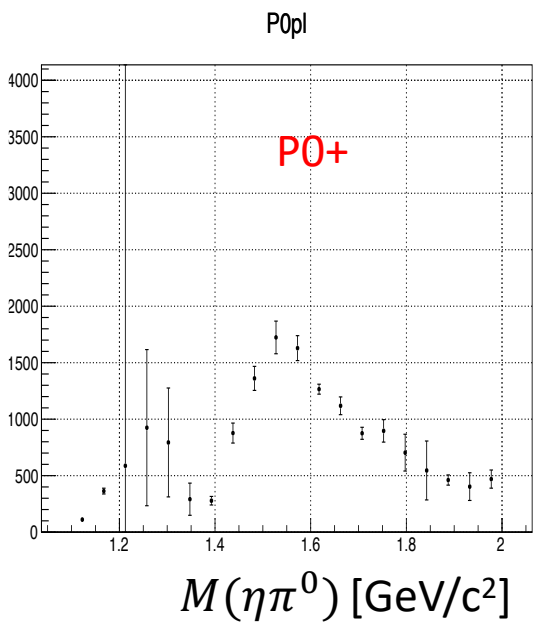


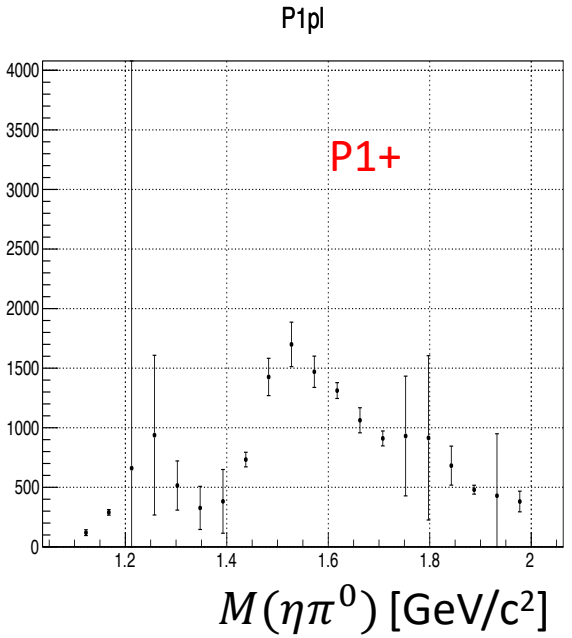

$\cos\theta_{HX}$

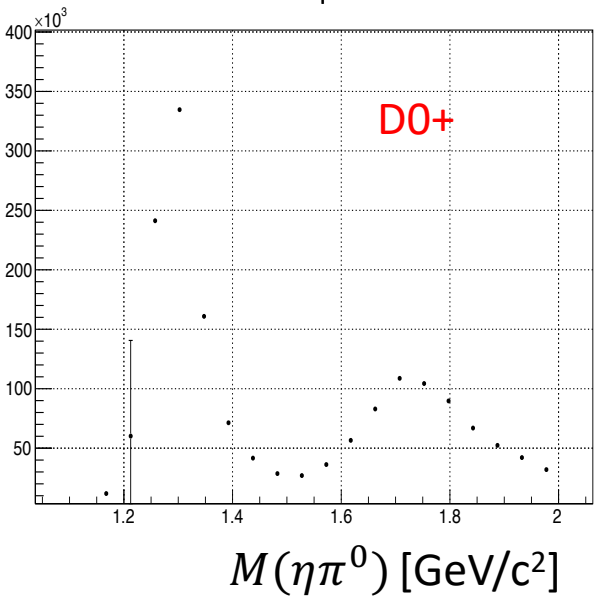
# Fit results for generated data

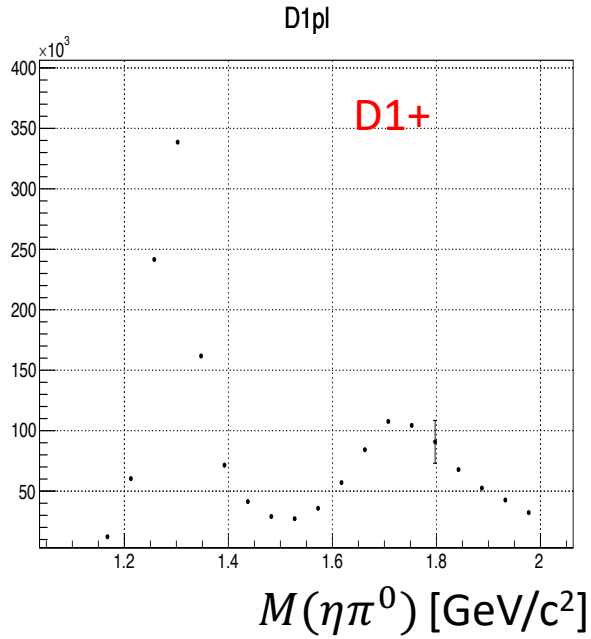
Fitting with amplitude set: S0+, P0+, P1+, D0+, D1+, D2+.

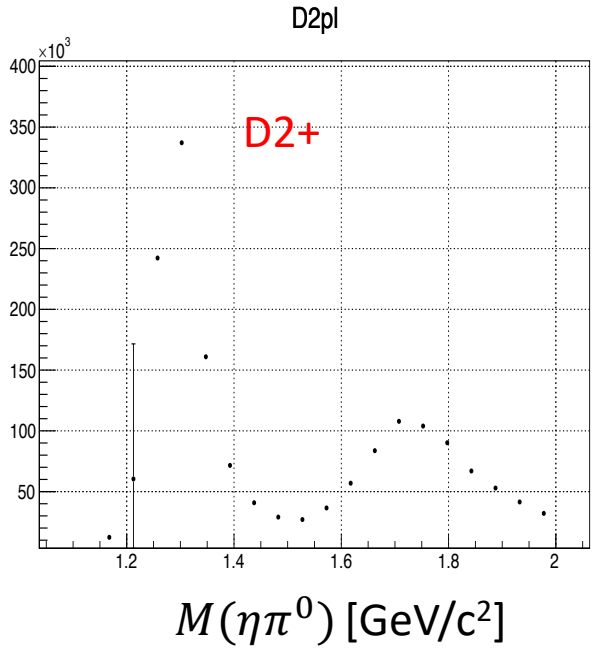


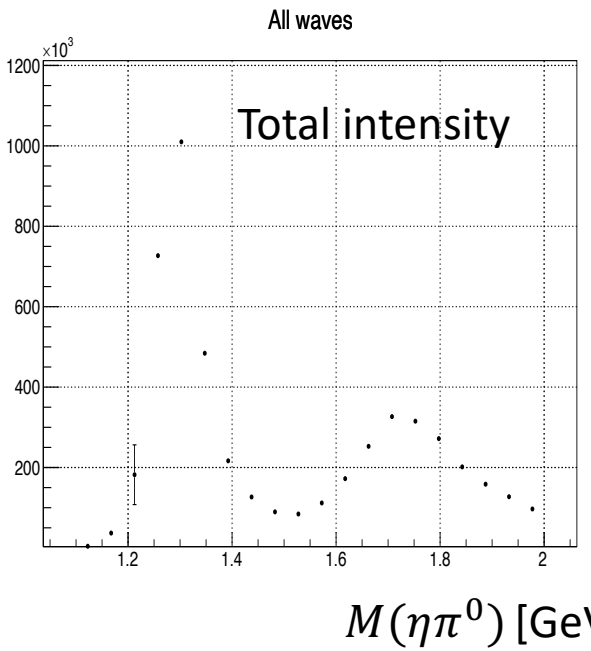



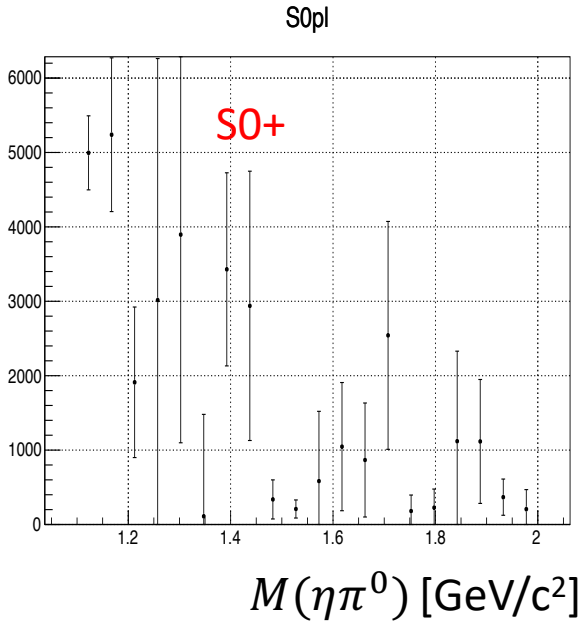



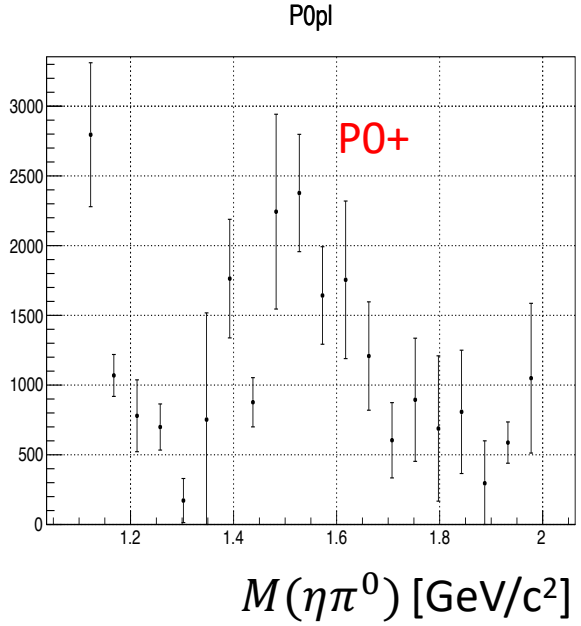



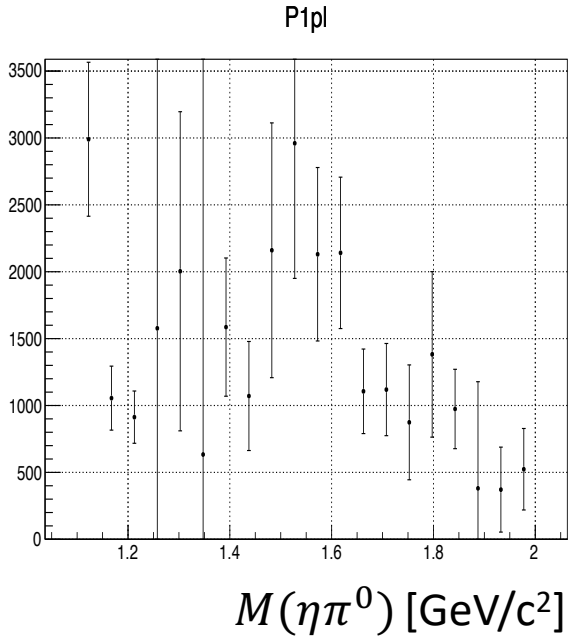

$$\frac{I(a_2)}{I(\pi_1)} \approx 350 \quad \frac{I(a'_2)}{I(\pi_1)} \approx 100$$

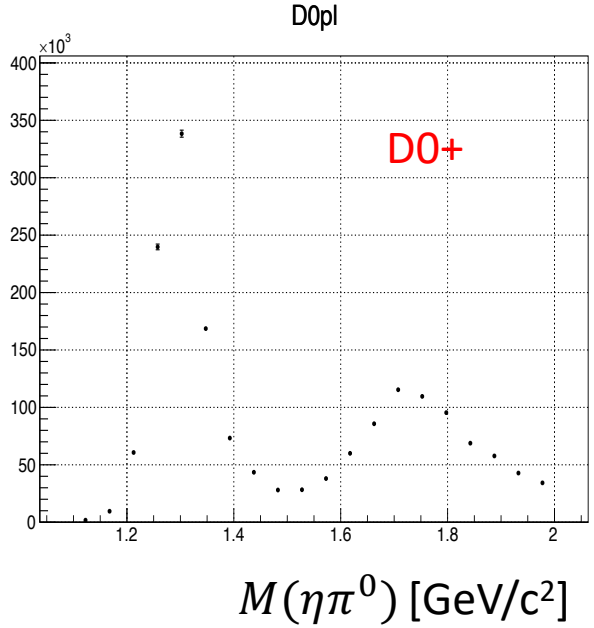
# Fit with GlueX acceptance

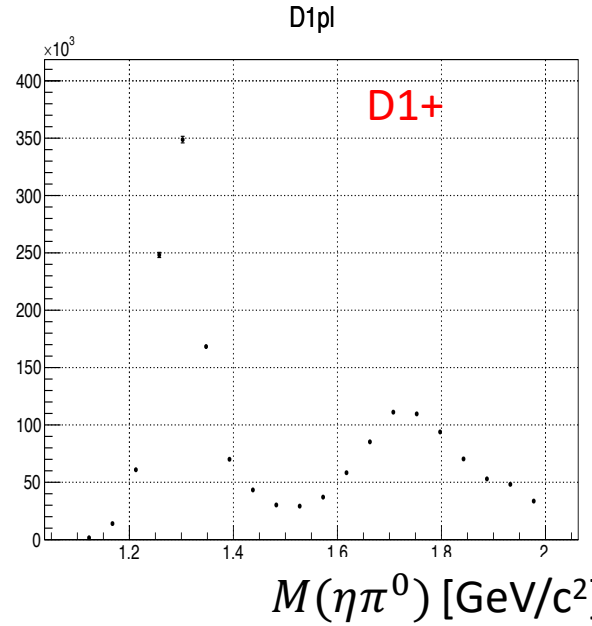
Fitting with amplitude set: S0+, P0+, P1+, D0+, D1+, D2+.

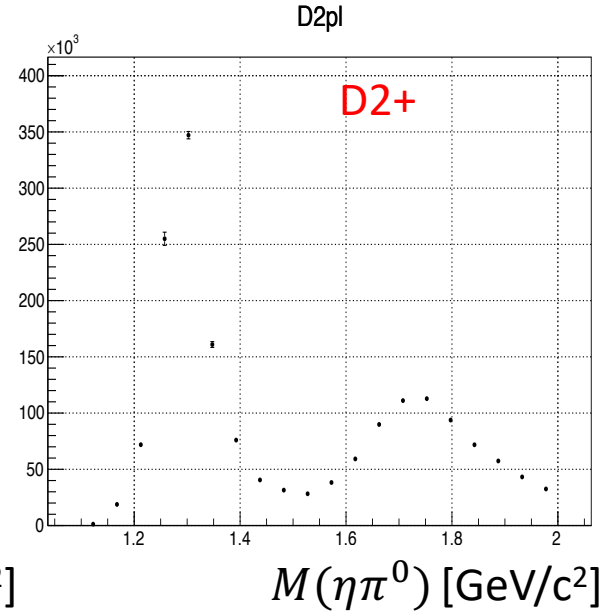


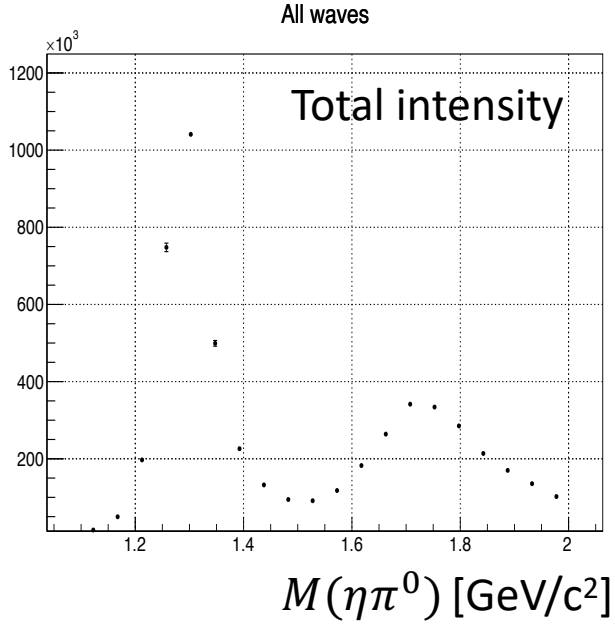



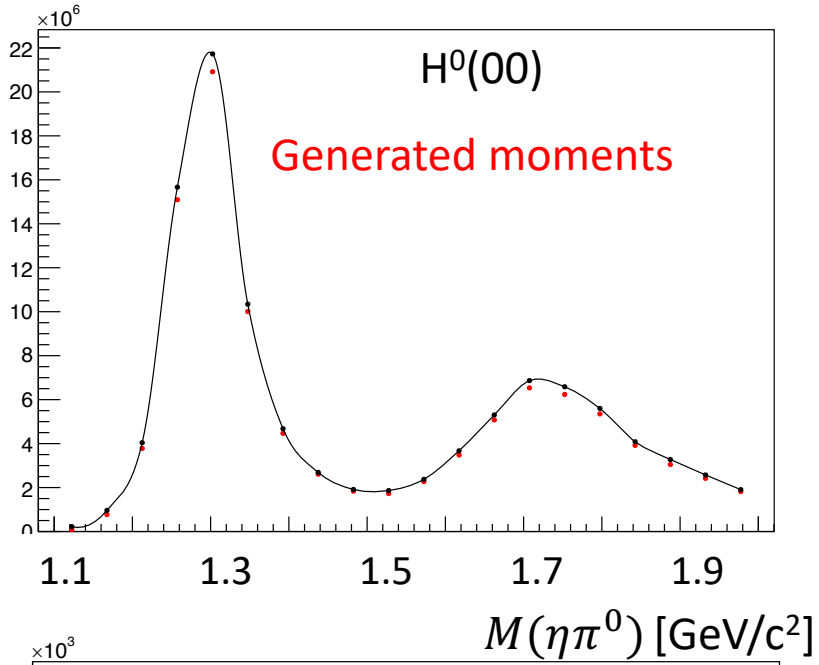



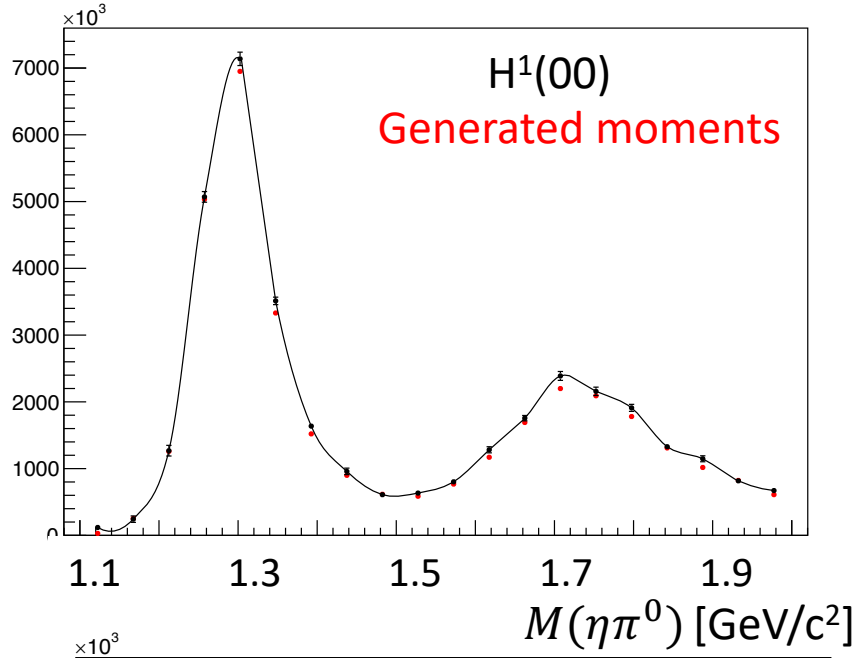



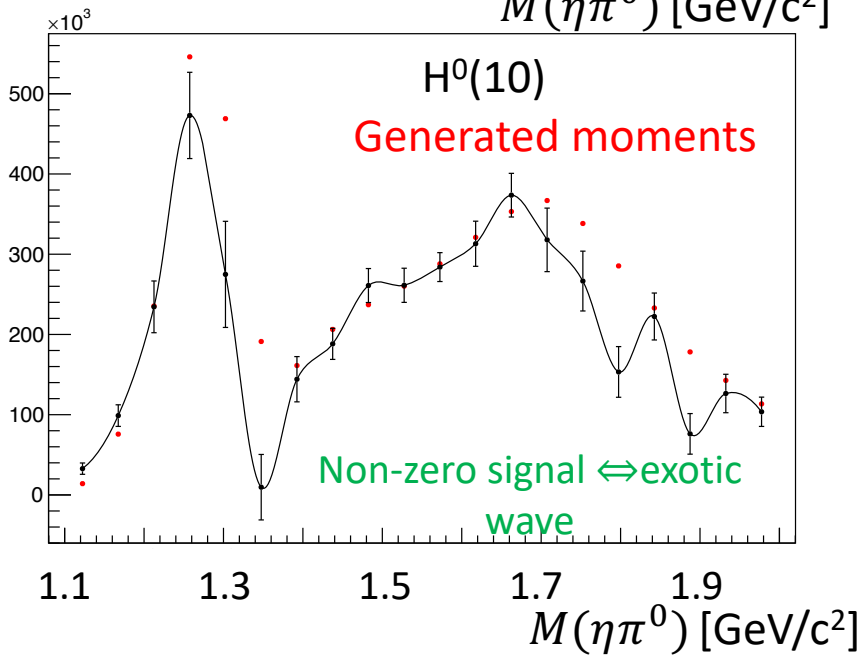
# Polarized moments calculated with partial waves and GlueX acceptance don't agree with generated moments

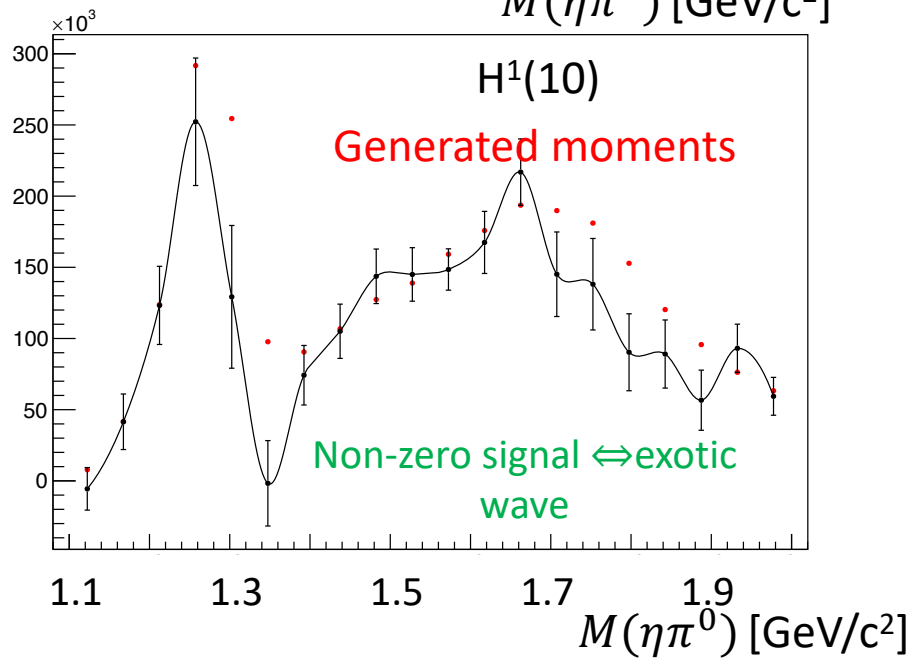
Uncertainties from bootstrapping

$0<t<0.3$ (GeV/c)$^2$



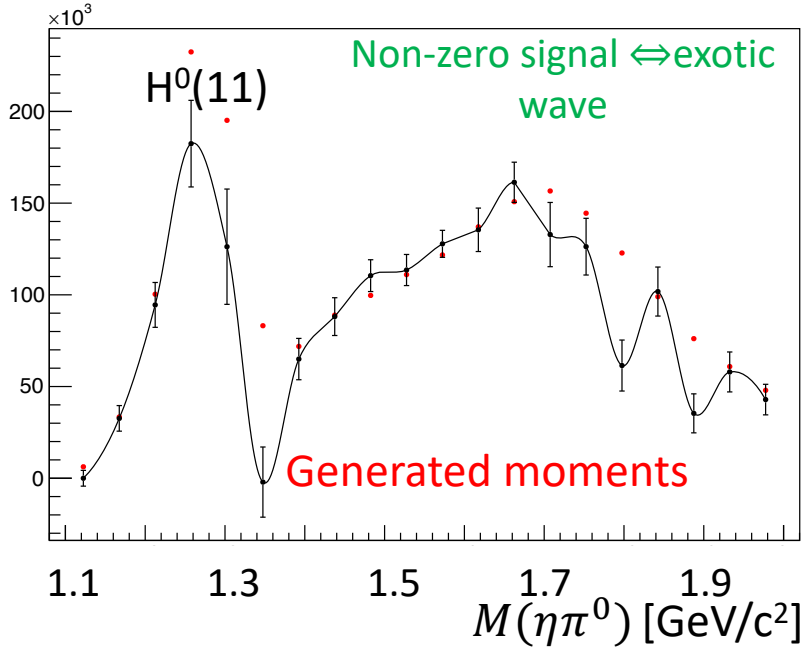



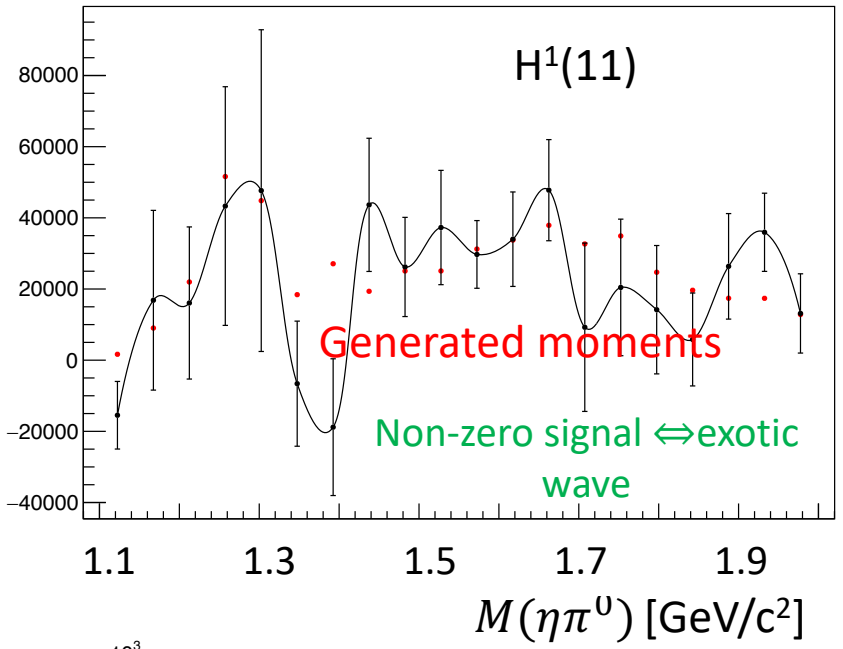



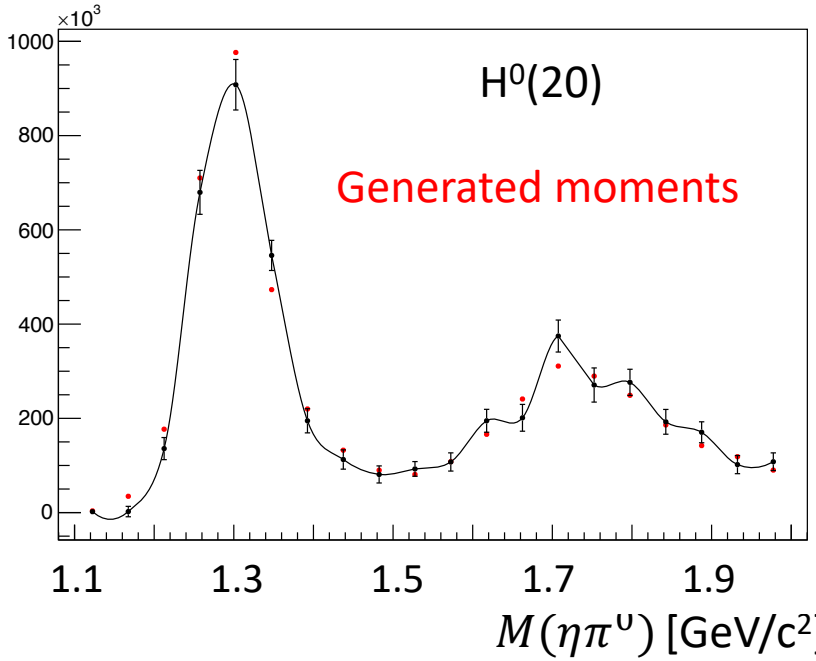
# Polarized moments calculated with partial waves and GlueX acceptance don't agree with generated moments

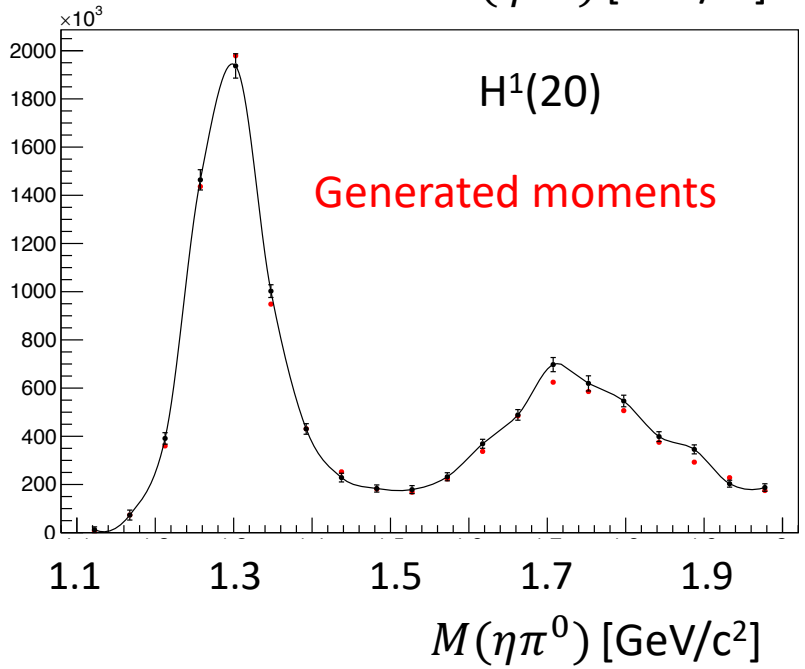
Uncertainties from bootstrapping

$0<t<0.3$ (GeV/c)$^2$



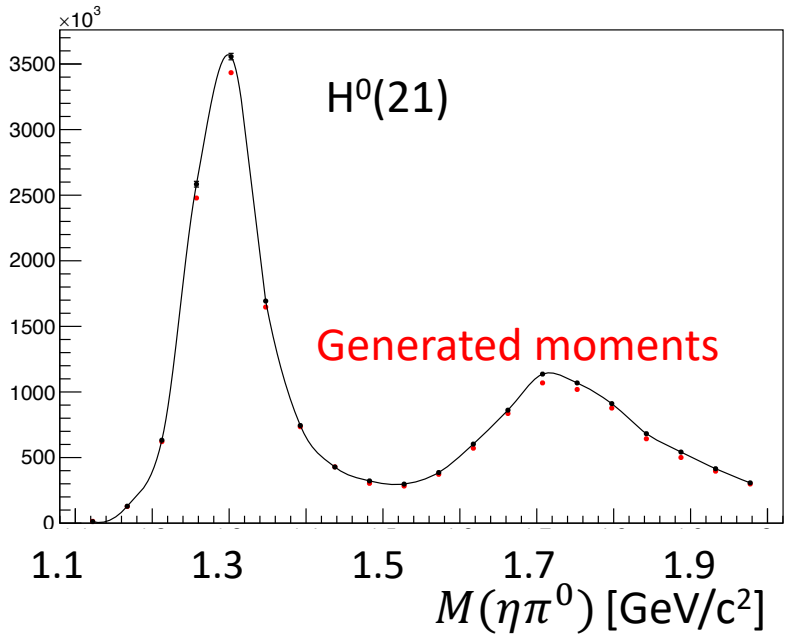



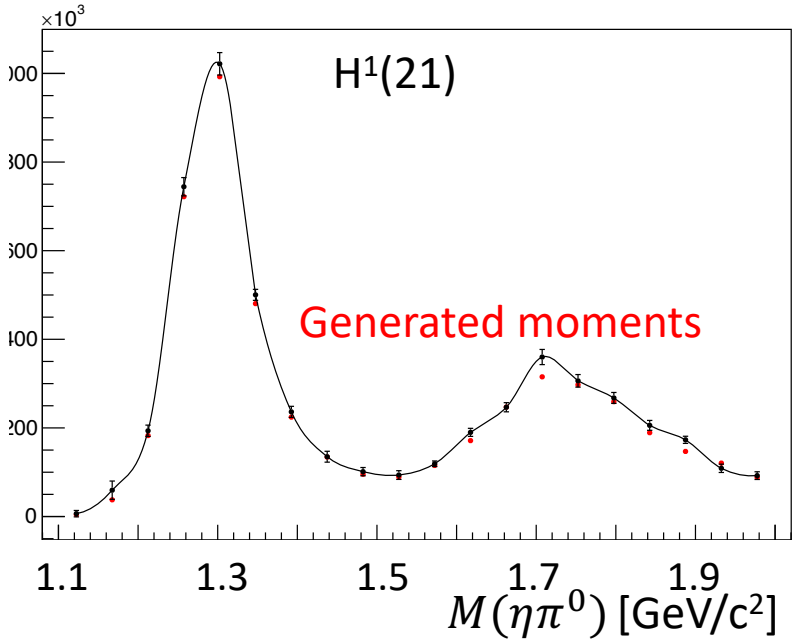



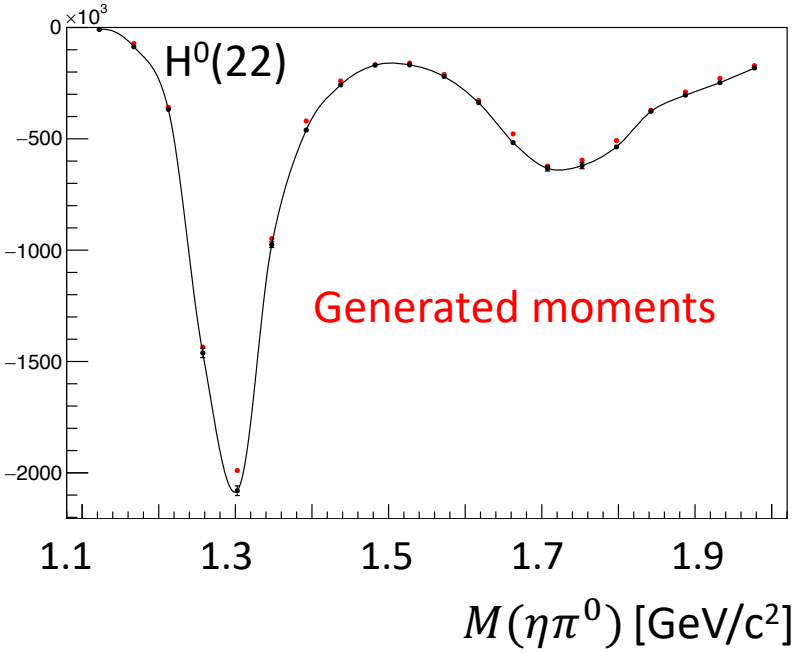
Polarized moments calculated with partial waves and GlueX acceptance don't agree with generated moments

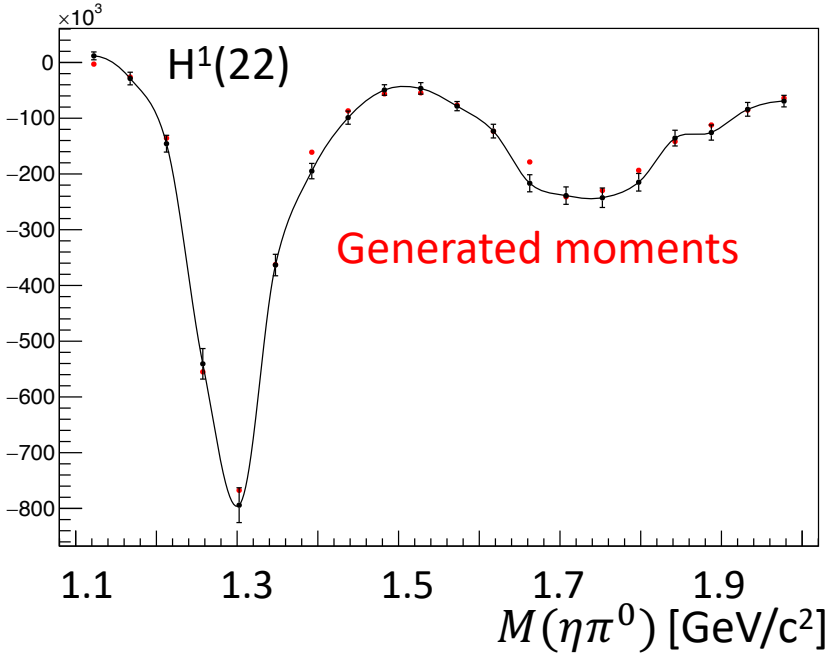
Uncertainties from bootstrapping

$0<t<0.3$ (GeV/c)$^2$



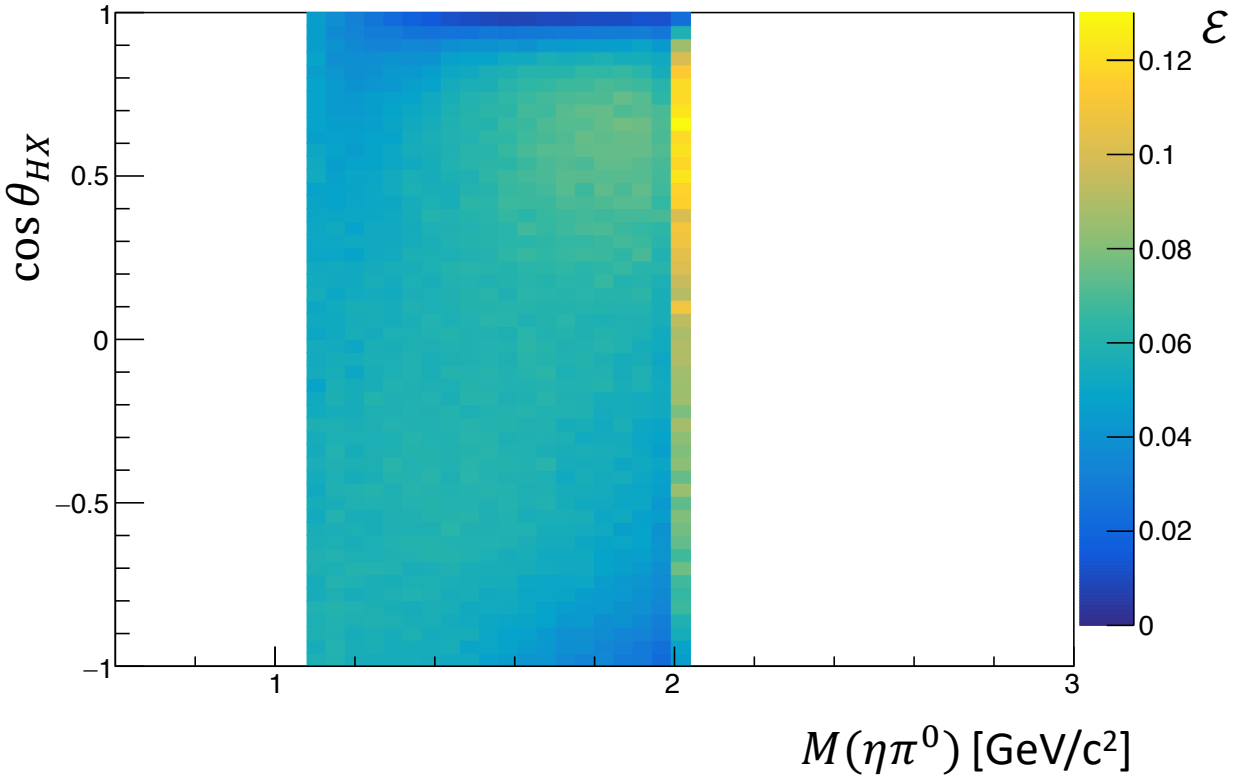



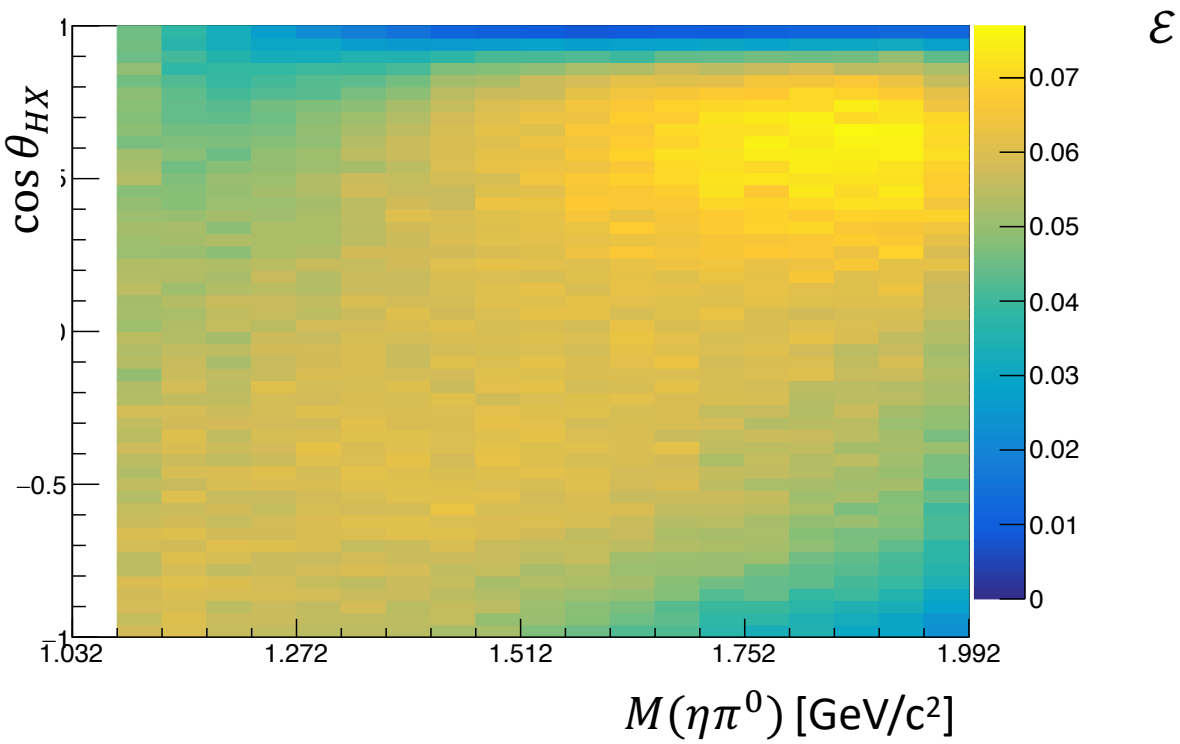



# Summary

- The polarized moments extracted with GlueX acceptance agree with generated moments within bootstrapping uncertainties.
- Though the small intensity, interference with even waves gives a strong exotic signal in odd L moments.
- The spiky structure seen in the acceptance at lower M is due to resolution difference between generated and accepted data and wrong reconstructed combos.

# Acceptance with generated flat MC



# Acceptance with generated flat MC