Amplitude analysis of GlueX $(p\eta'\pi^0)$ data

Florida International University 2020

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Using mass constrained data for η and π^0 and Q-factor signal-background separation

1. Fitting only data for γ polarization plane angle relative to horizontal of 0^{o} :

2. Fit intensity with different wave sets:
   - $S_0, P_{0,1}, D_{0,1,2}$ ε=$+1$
   - $S_0, P_{0,1}, D_{0,1,2}$ ε=±1

3. Invariant mass bin size of 75 MeV/c^2, momentum transfer bin size of 0.6 $(GeV/c)^2$

Plot acceptance uncorrected results

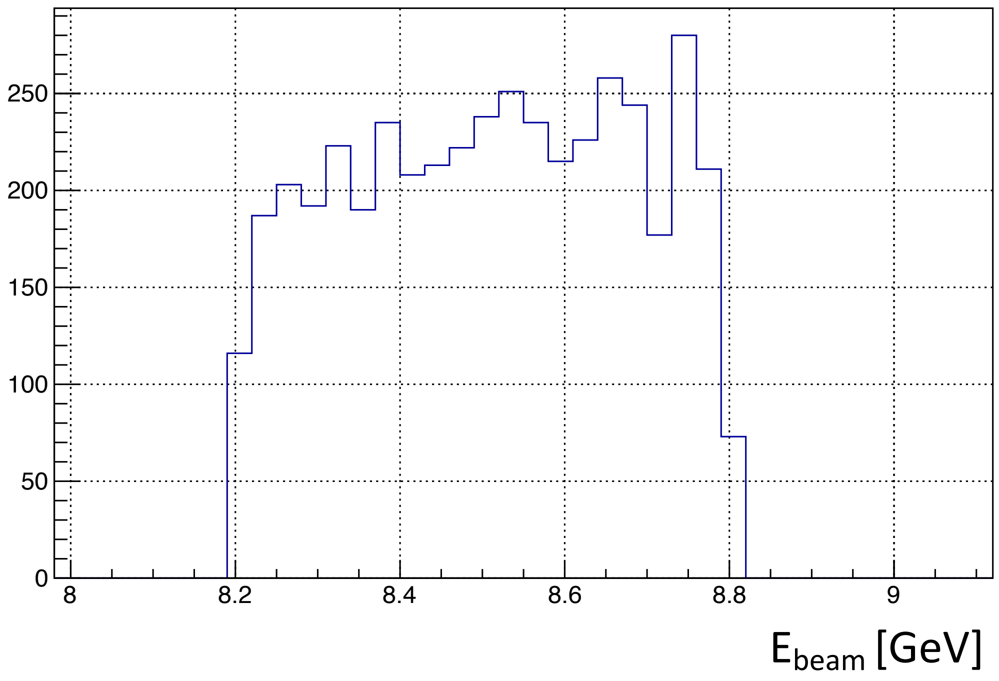
4397 GlueX ($p\eta'\pi^0$) events for 0^o polarization

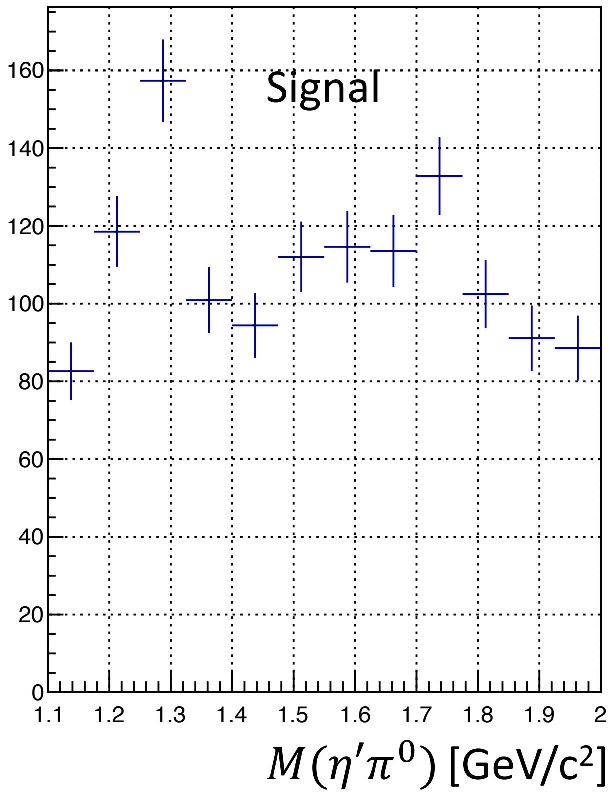
0 Deg.
$P_\gamma = 0.3519$

Signal-Background separation using Probabilistic Weighing Method

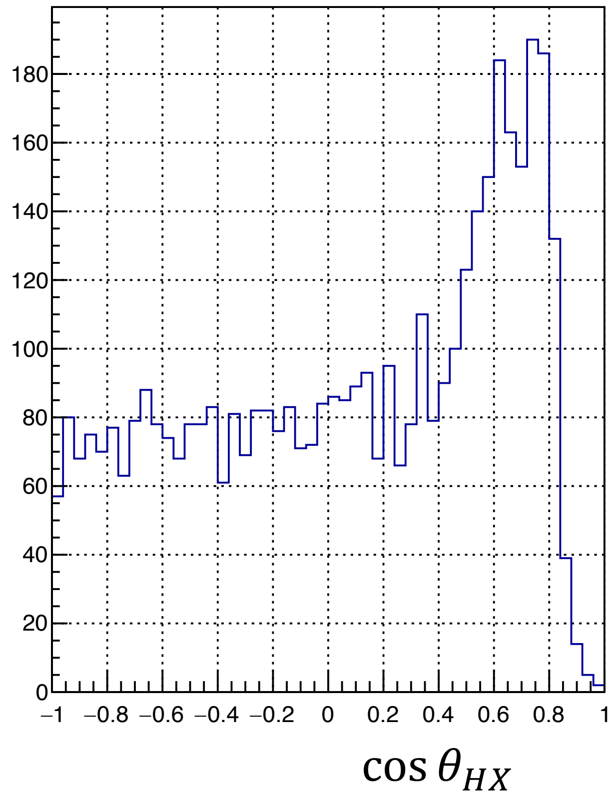
Reaction $\gamma p \rightarrow p\eta'\pi^0$

η'-> $\pi^+\pi^-\eta$, $\eta \rightarrow \gamma\gamma$



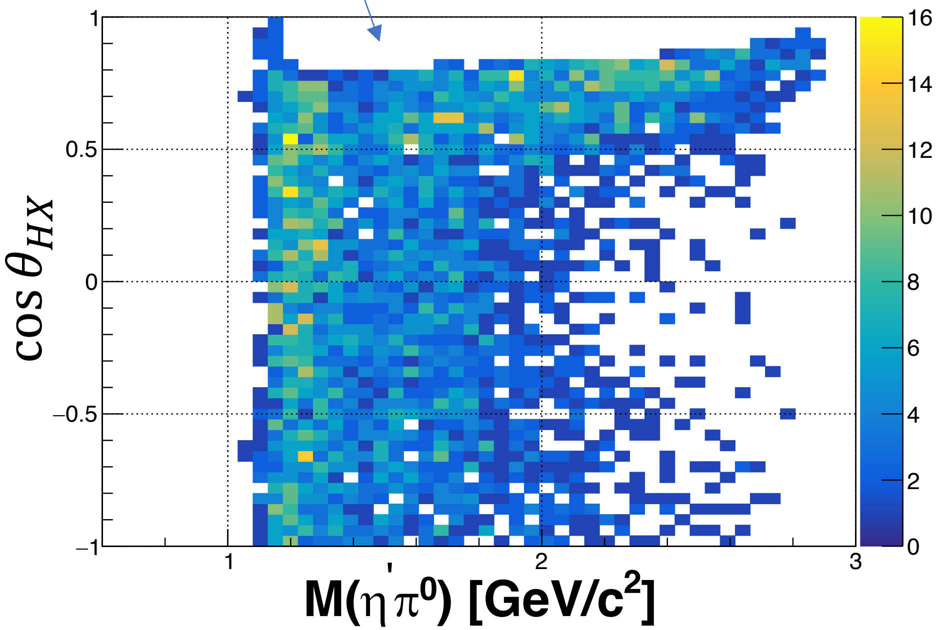


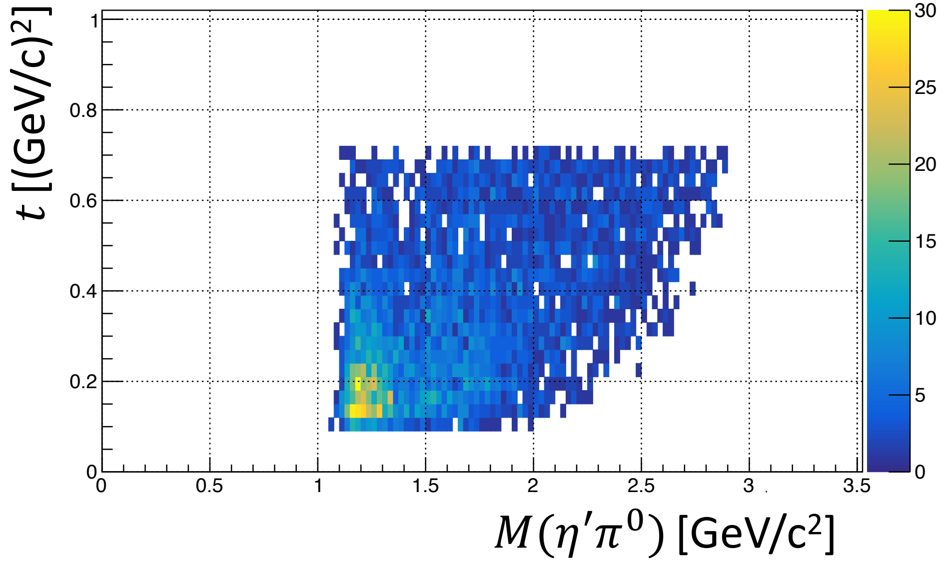
cosθ

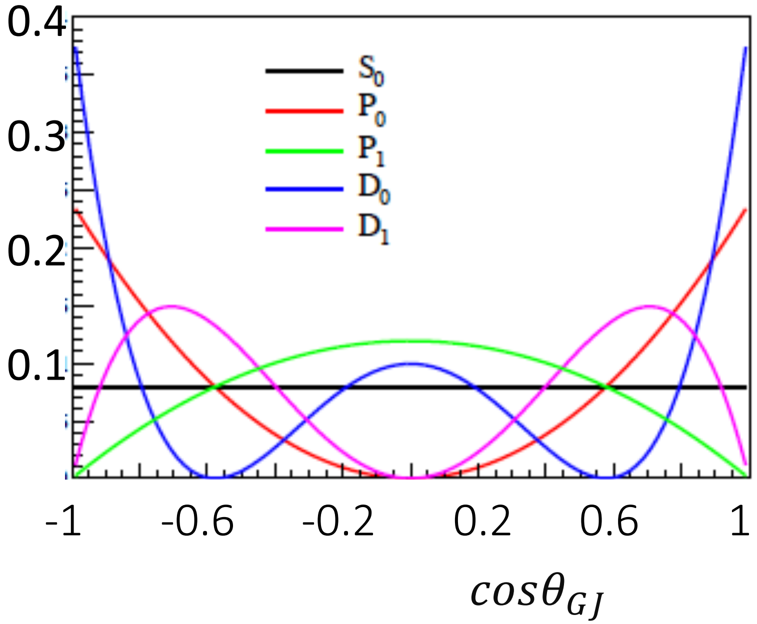


4397 GlueX ($p\eta'\pi^0$) events for 0^o polarization

Δ^+ rejection($0.0\ GeV/c^2 < M_{\pi^0 p} < 1.4\ GeV/c^2$)







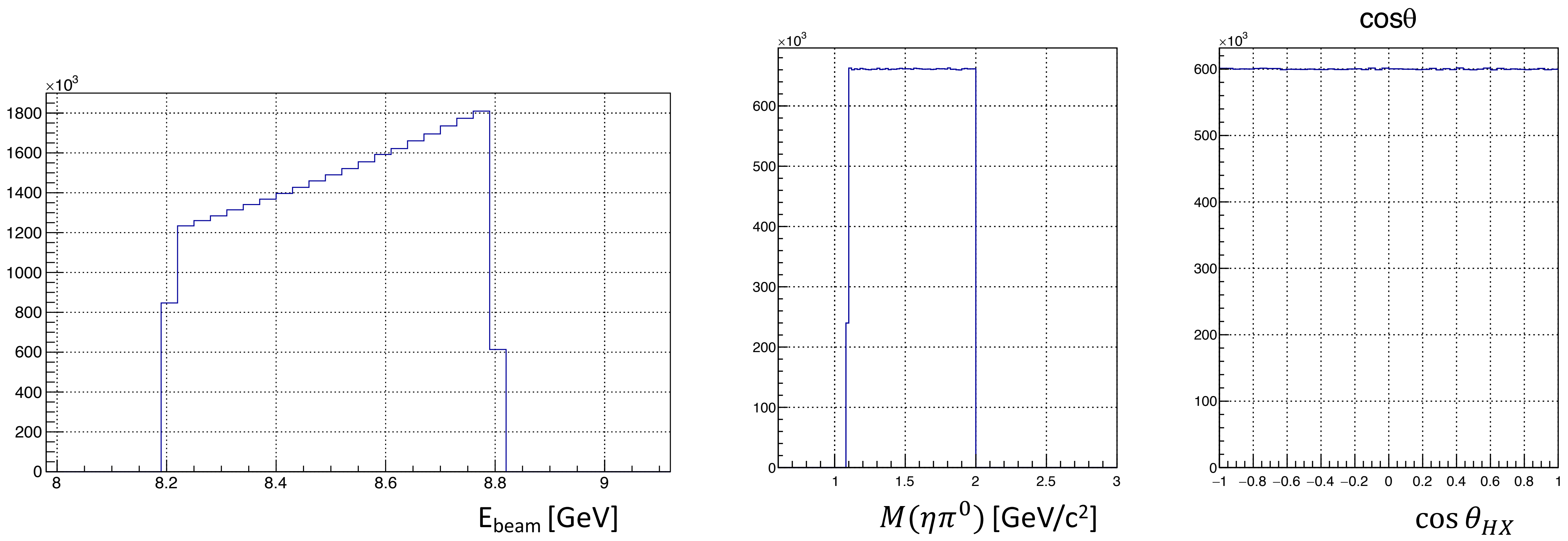
Fit in M and t bins

1.1-2 GeV/c^2 12 bins

0.1-0.7 (GeV/c)^2 1 bin

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

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



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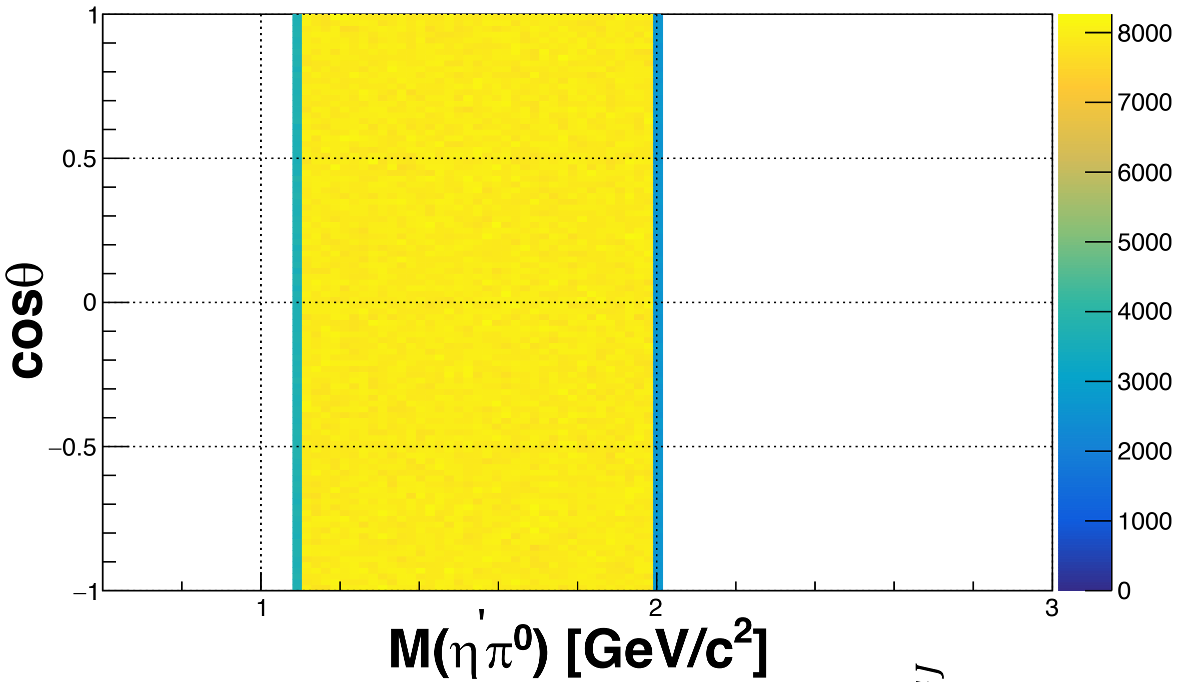
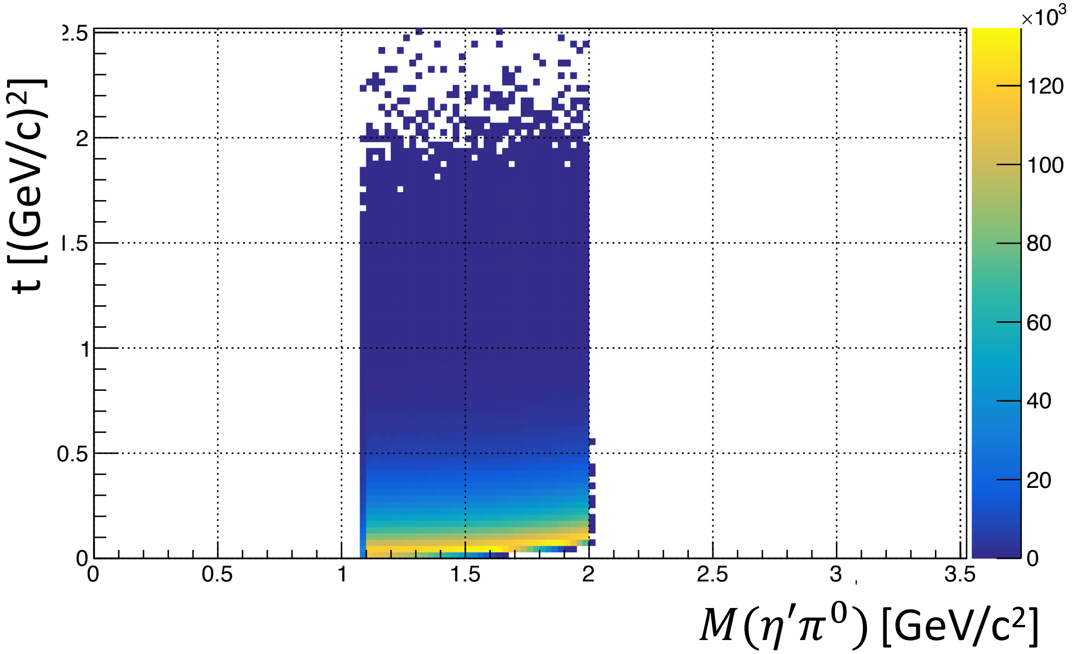
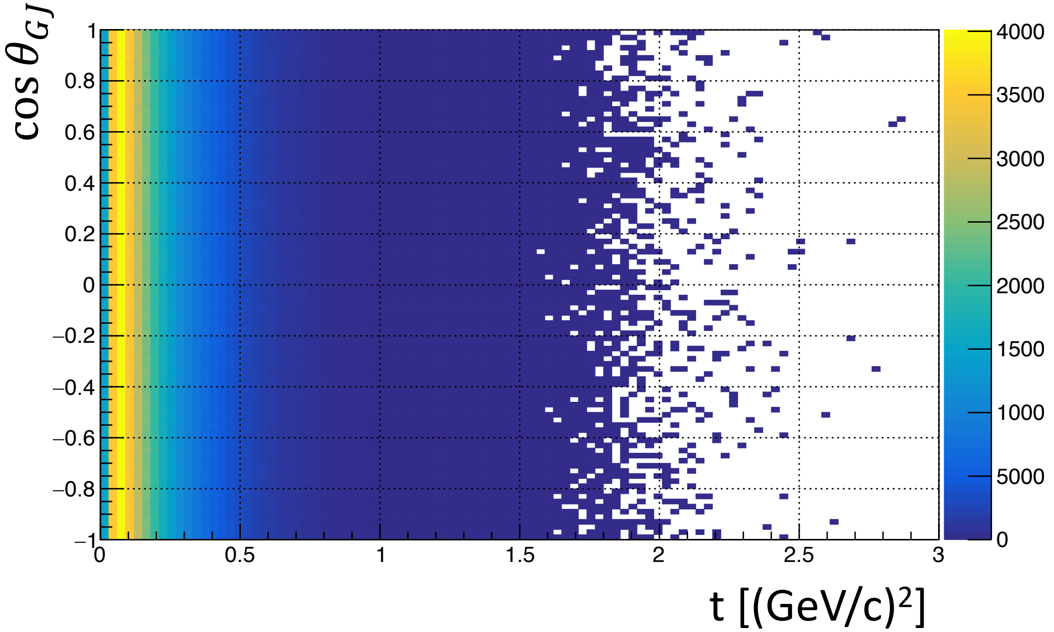
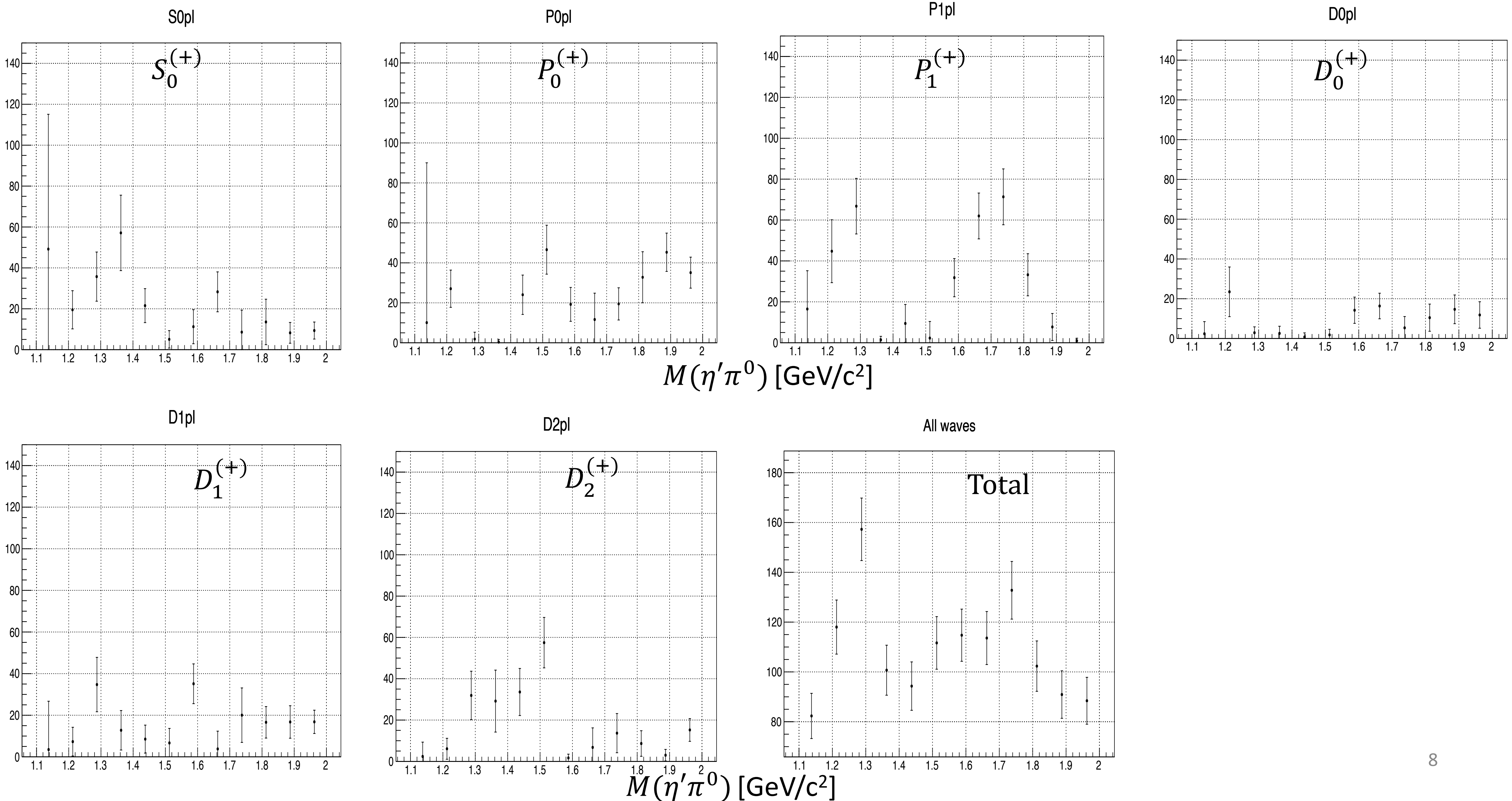


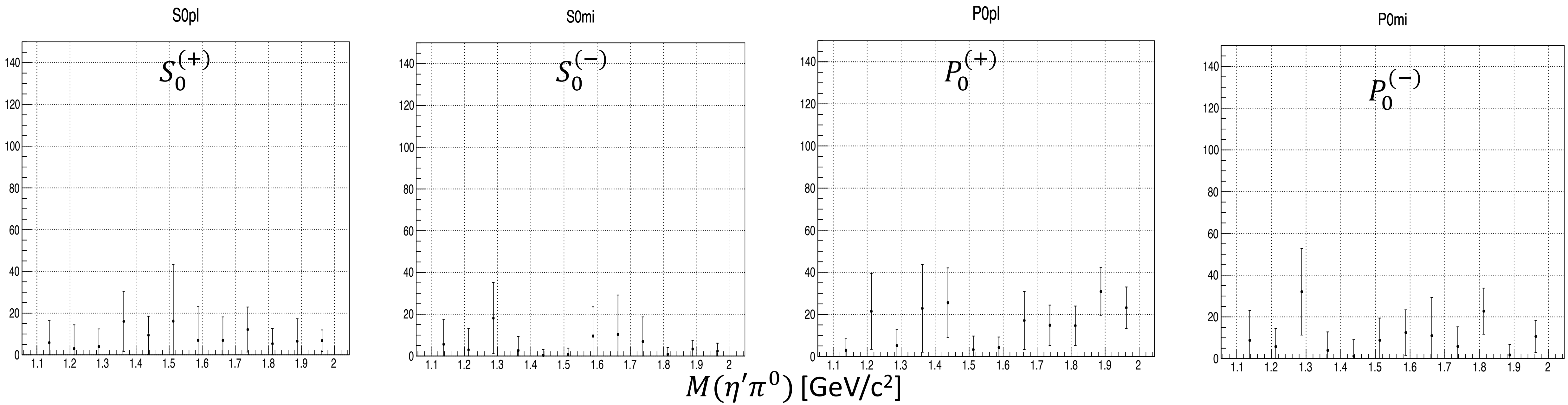


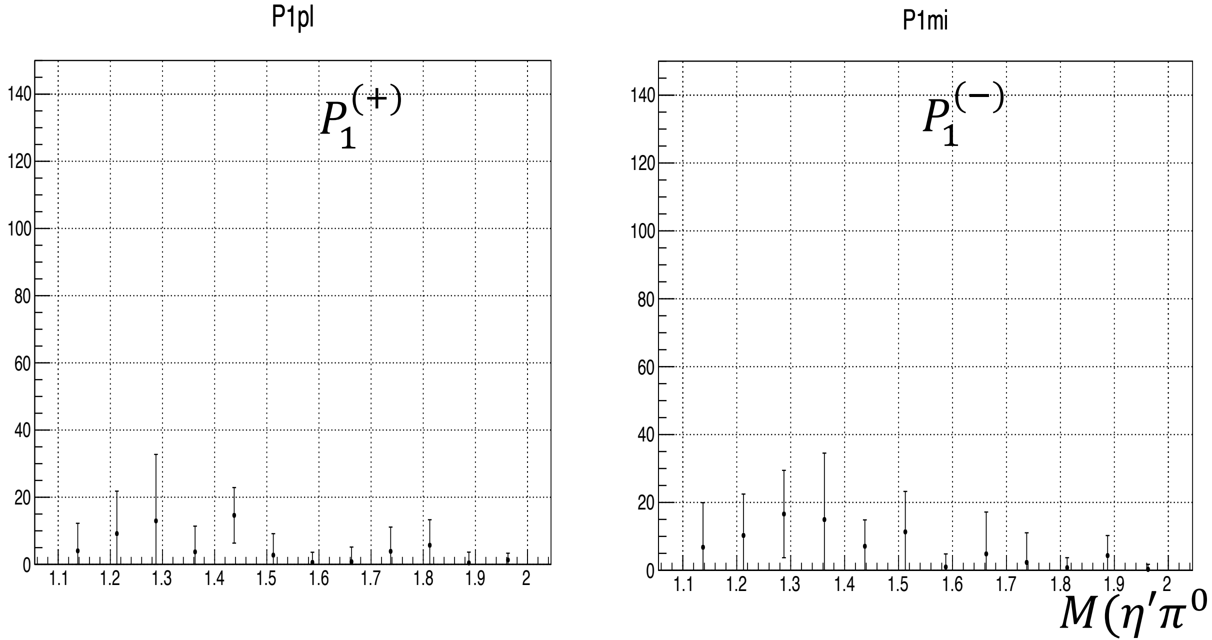


Fit with $S_0, P_{0,1}, D_{0,1,2}$ ε=+1

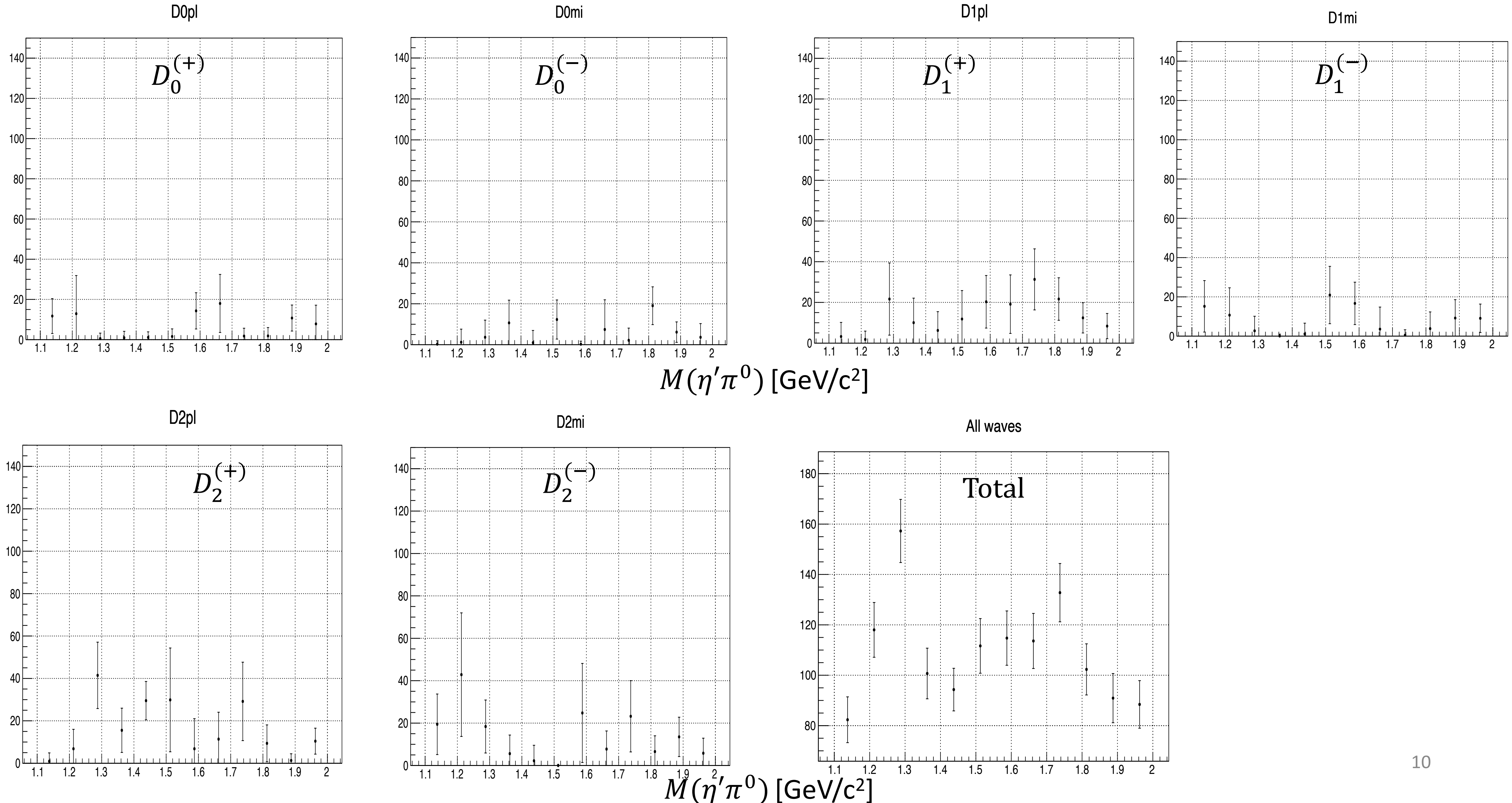


Fit with $S_0, P_{0,1}, D_{0,1,2}$ ε=±1





Fit with $S_0, P_{0,1}, D_{0,1,2}$ ε=± 1



1. Fitting entire GlueX phase 1 data (except fall 2018) for four γ polarization plane angles relative to horizontal (0, 45, 90, 135^o) + amorphous data using loop statement in AmpTools

2. Fit intensity with different wave sets:
   - $S_0, P_{0,1}, D_{0,1,2}$ ε=$+1$
   - $S_0, P_{0,1}, D_{0,1,2}$ ε=±1
   - $S_0, P_{0,\pm1}, D_{0,\pm1,\pm2}$ ε=±1

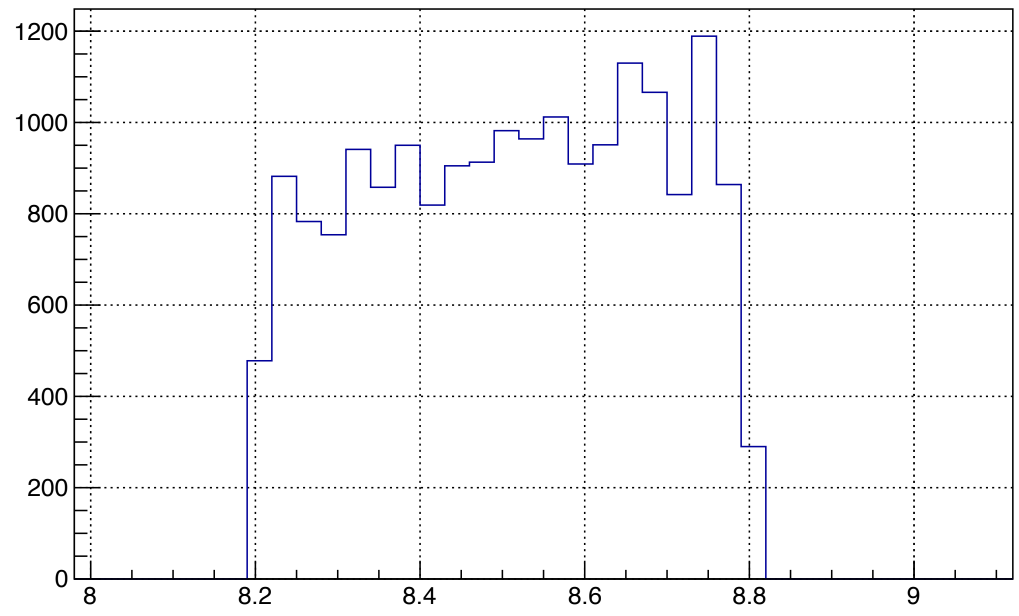
3. Invariant mass bin size of 75 MeV/c^2, momentum transfer bin size of 0.6 $(\mathrm{GeV}/c)^2$

Plot acceptance uncorrected results

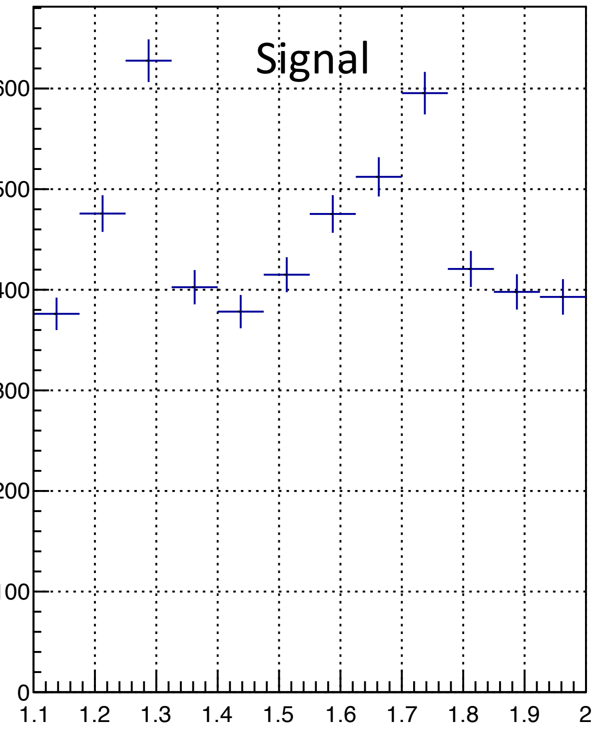
18482 GlueX ($p\eta'\pi^0$) events for 4 γ polarization plane angles relative to horizontal (0, 45, 90, 135^o) + amorphous data

0 Deg. $P_\gamma = 0.3519$
45 Deg. $P_\gamma = 0.3374$
90 Deg. $P_\gamma = 0.3303$
135 Deg. $P_\gamma = 0.3375$
Amorphous $P_\gamma = 0.00001$

Signal-Background separation using Probabilistic Weighing Method
Reaction $\gamma p \to p\eta'\pi^0$
η'-> $\pi^+\pi^-\eta$, $\eta \to \gamma\gamma$

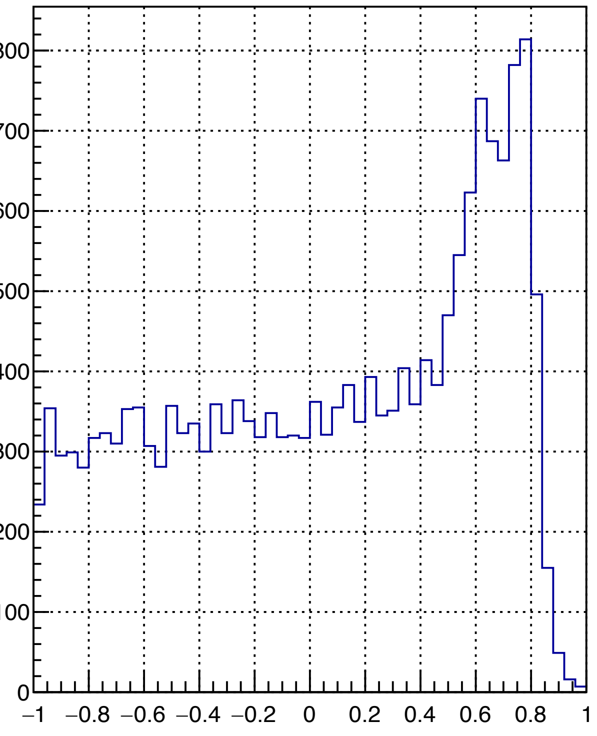


E_{beam} [GeV]



$M(\eta'\pi^0)$ [GeV/c²]

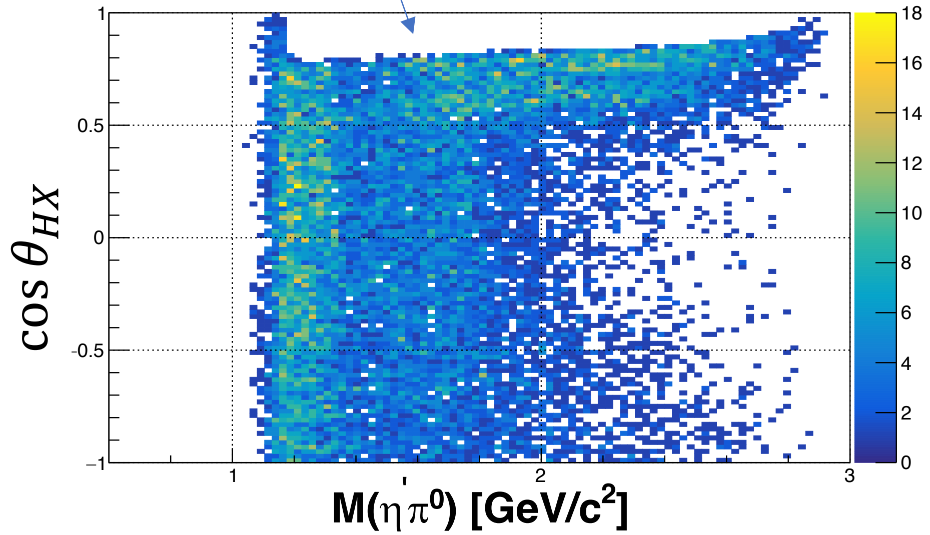
cosθ

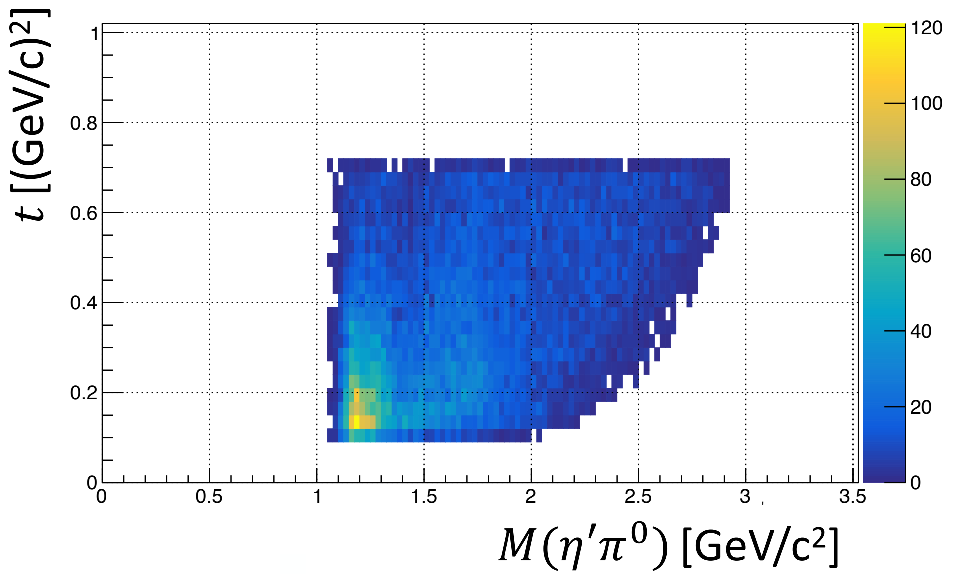


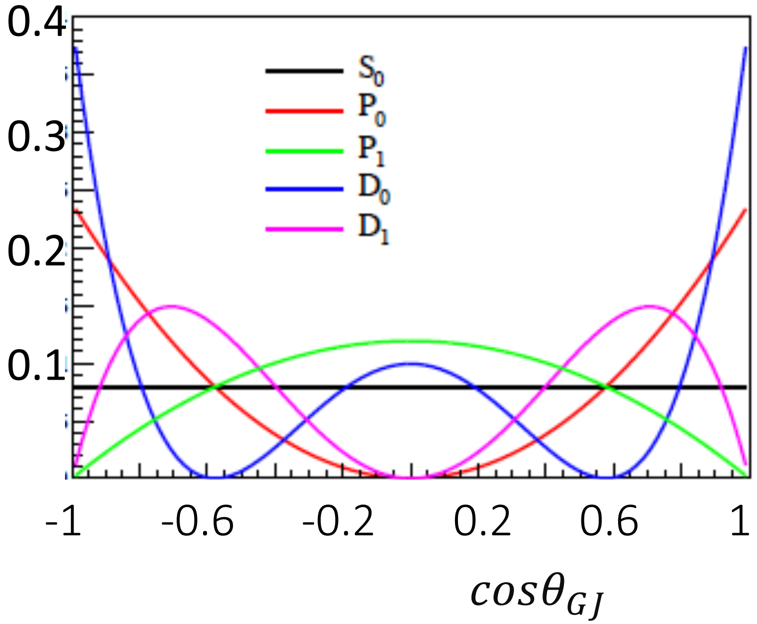
$\cos\theta_{HX}$

18482 GlueX ($p\eta'\pi^0$) events for 4 γ polarization plane angles relative to horizontal (0, 45, 90, 135^o) + amorphous data

Δ^+ rejection(0.0 GeV/c^2 < $M_{\pi^0 p}$ < 1.4 GeV/c^2)







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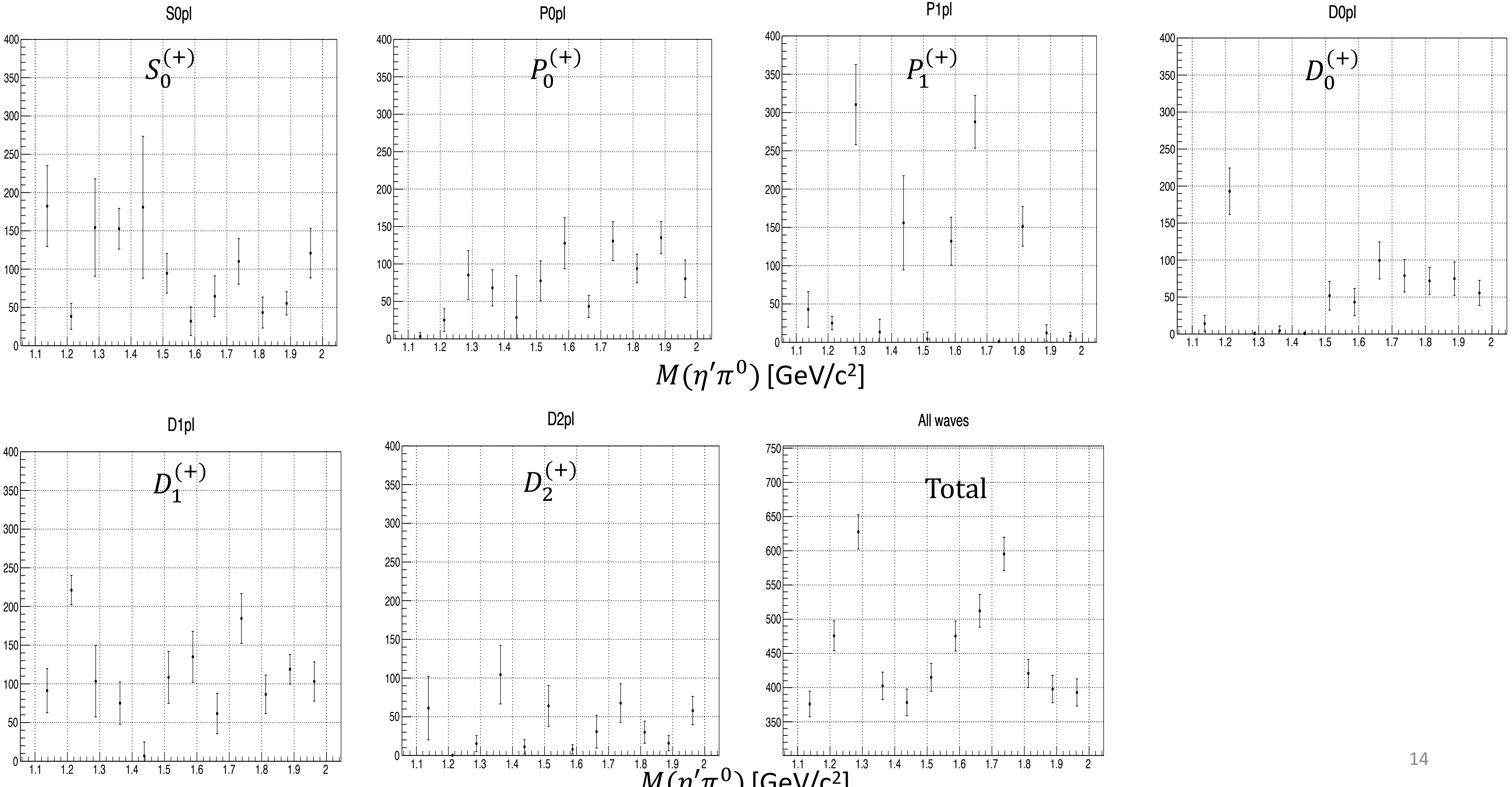
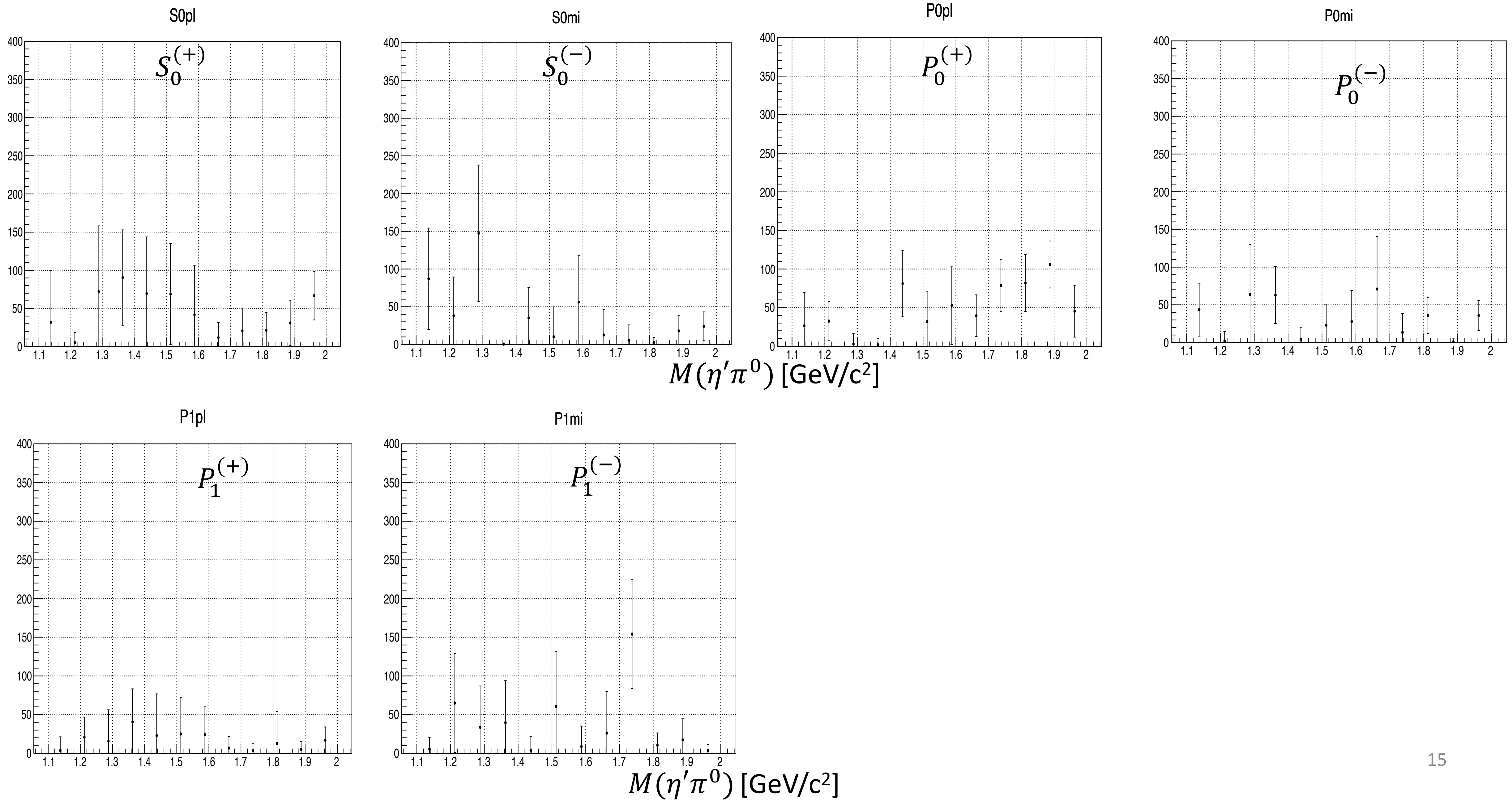
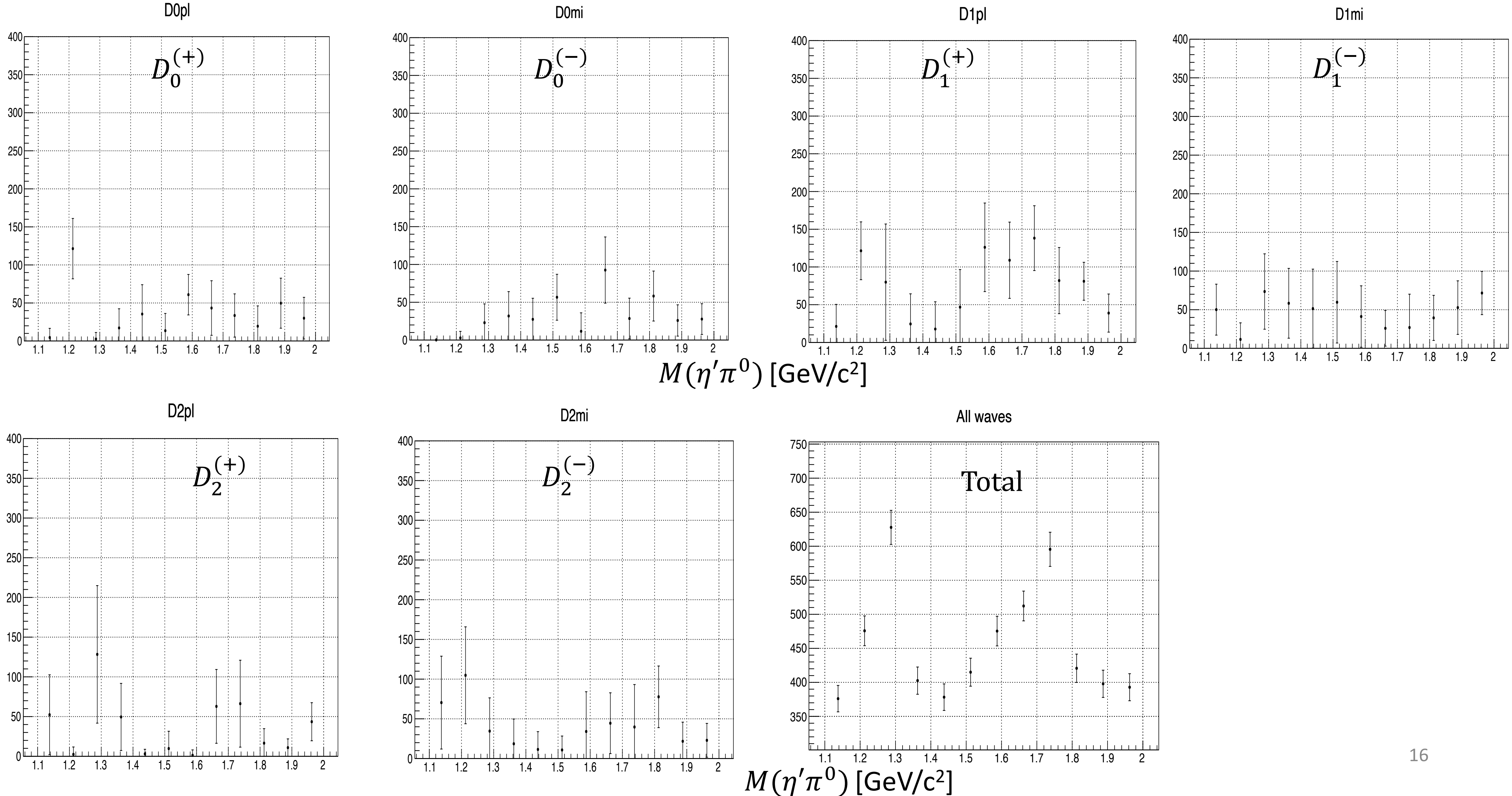


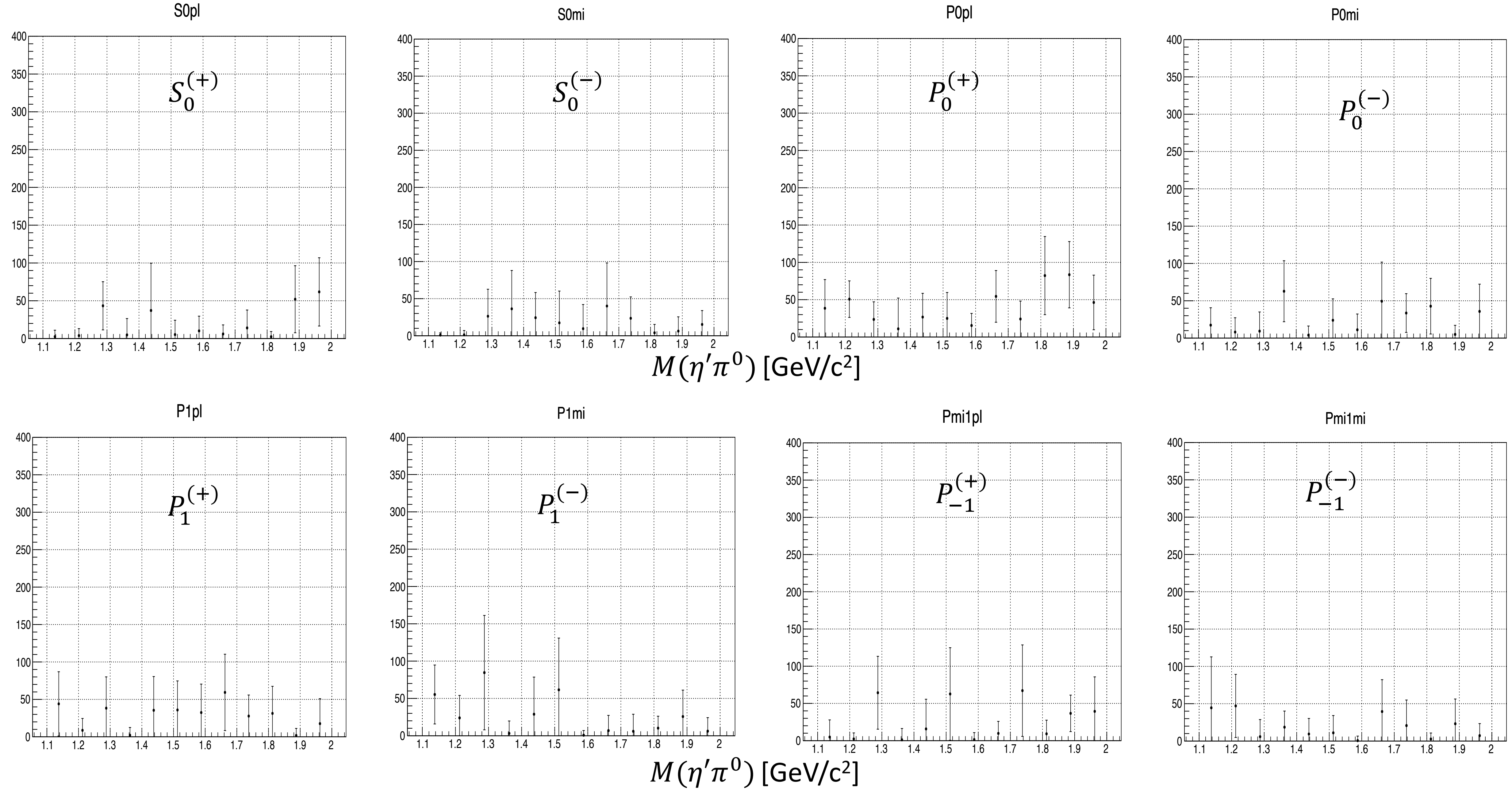
Fit with $S_0, P_{0,1}, D_{0,1,2}$ ε=±1



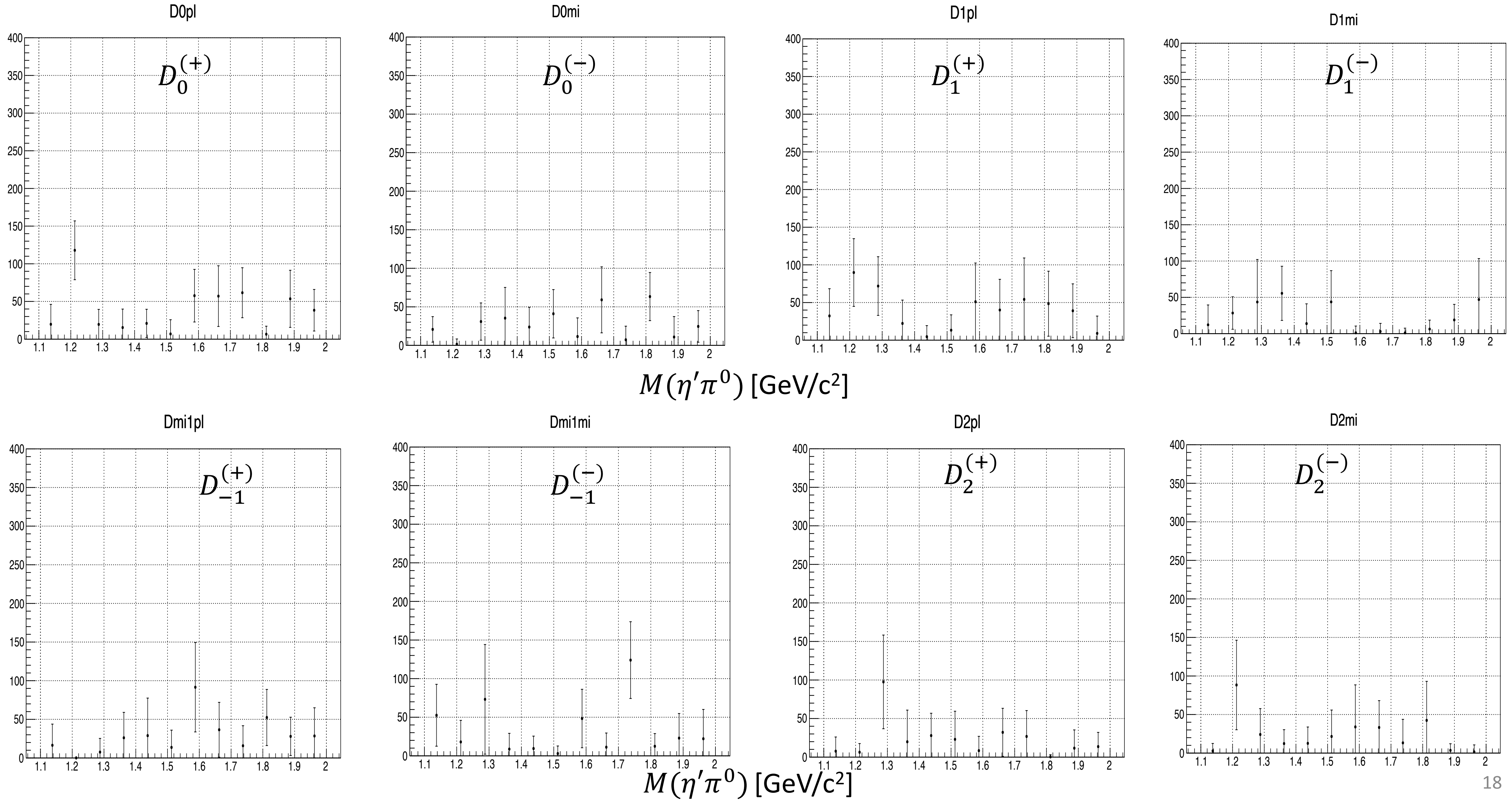
Fit with $S_0, P_{0,1}, D_{0,1,2}$ ε=± 1



Fit with $S_0, P_{0,\pm1}, D_{0,\pm1,\pm2}$ ε=$\pm$1



Fit with $S_0, P_{0,\pm1}, D_{0,\pm1,\pm2}$ ε=±1



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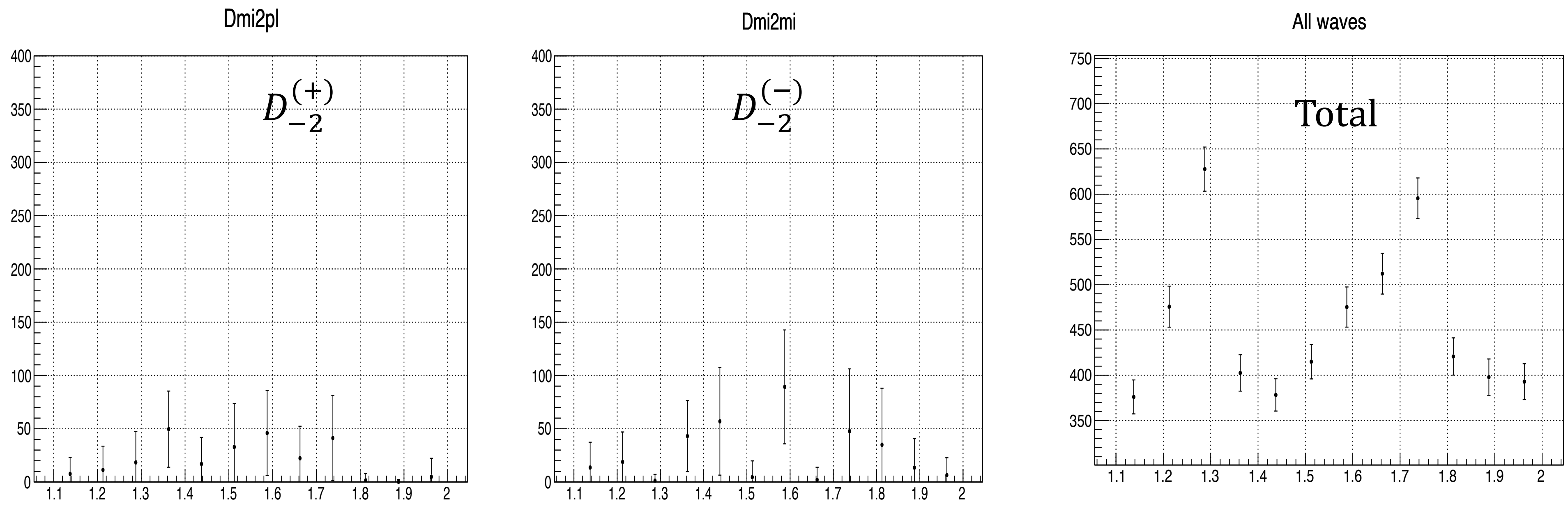
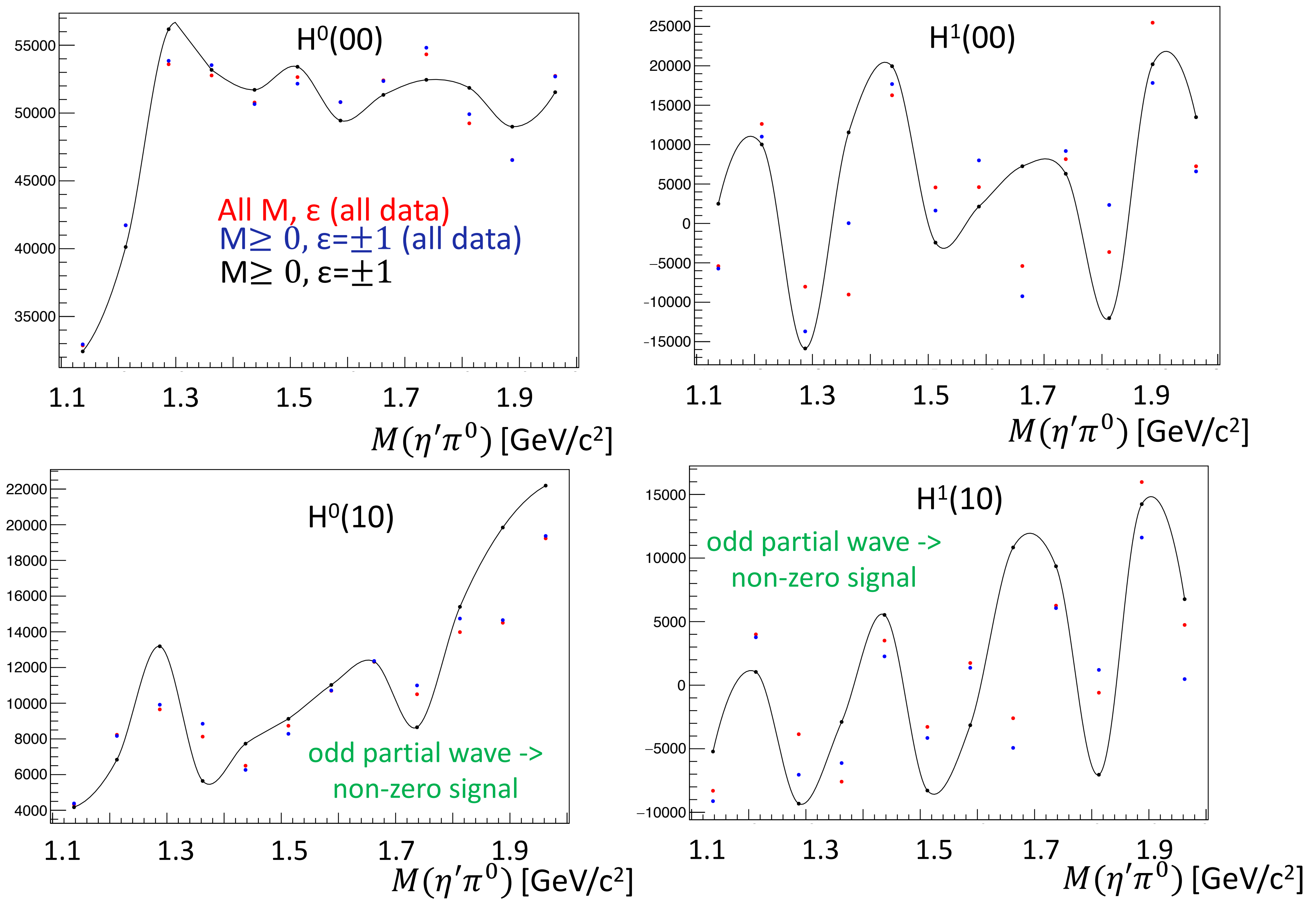


$M(\eta'\pi^0)$ [GeV/c²]

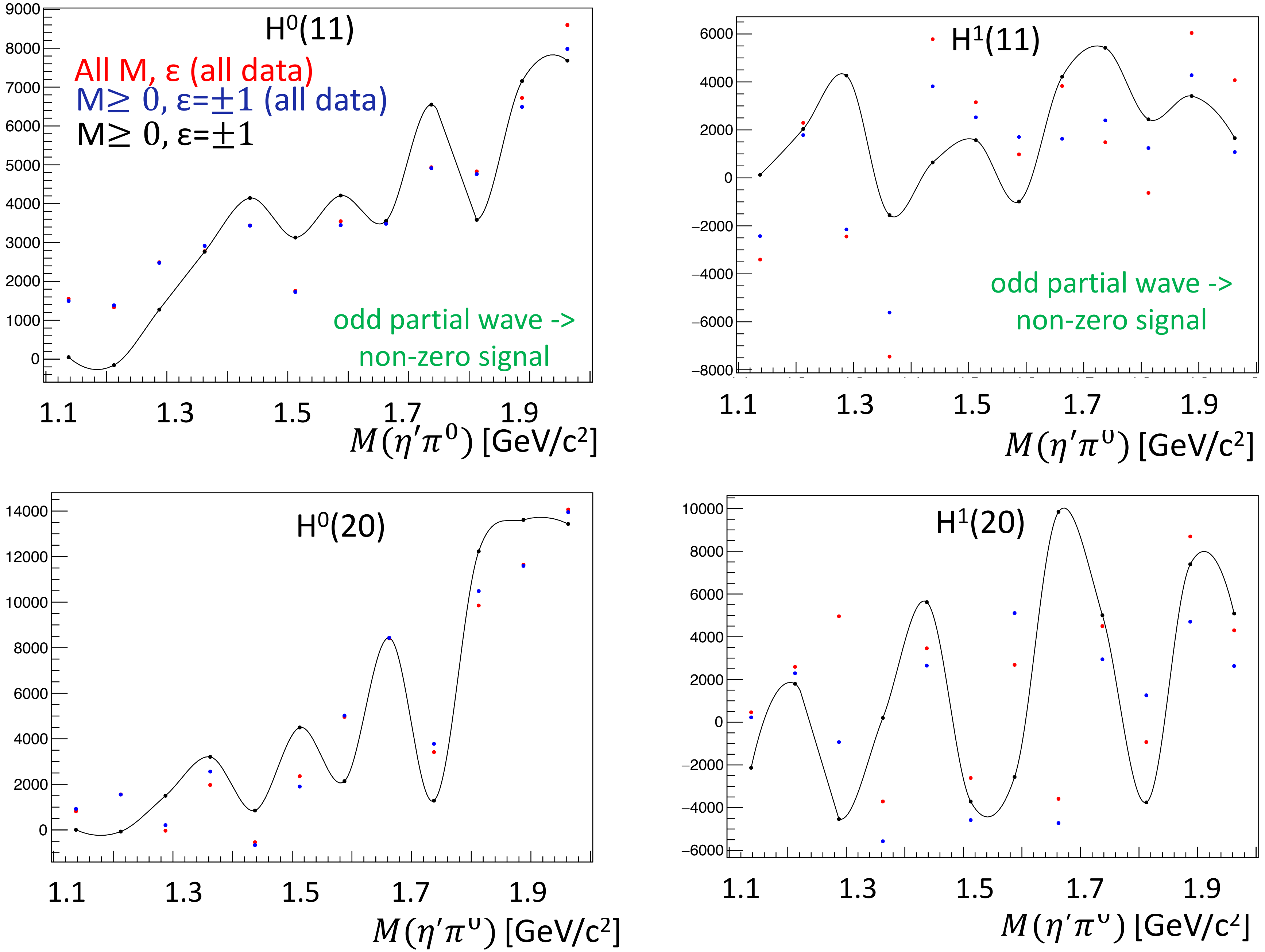
Comparison of moments from different fit results

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



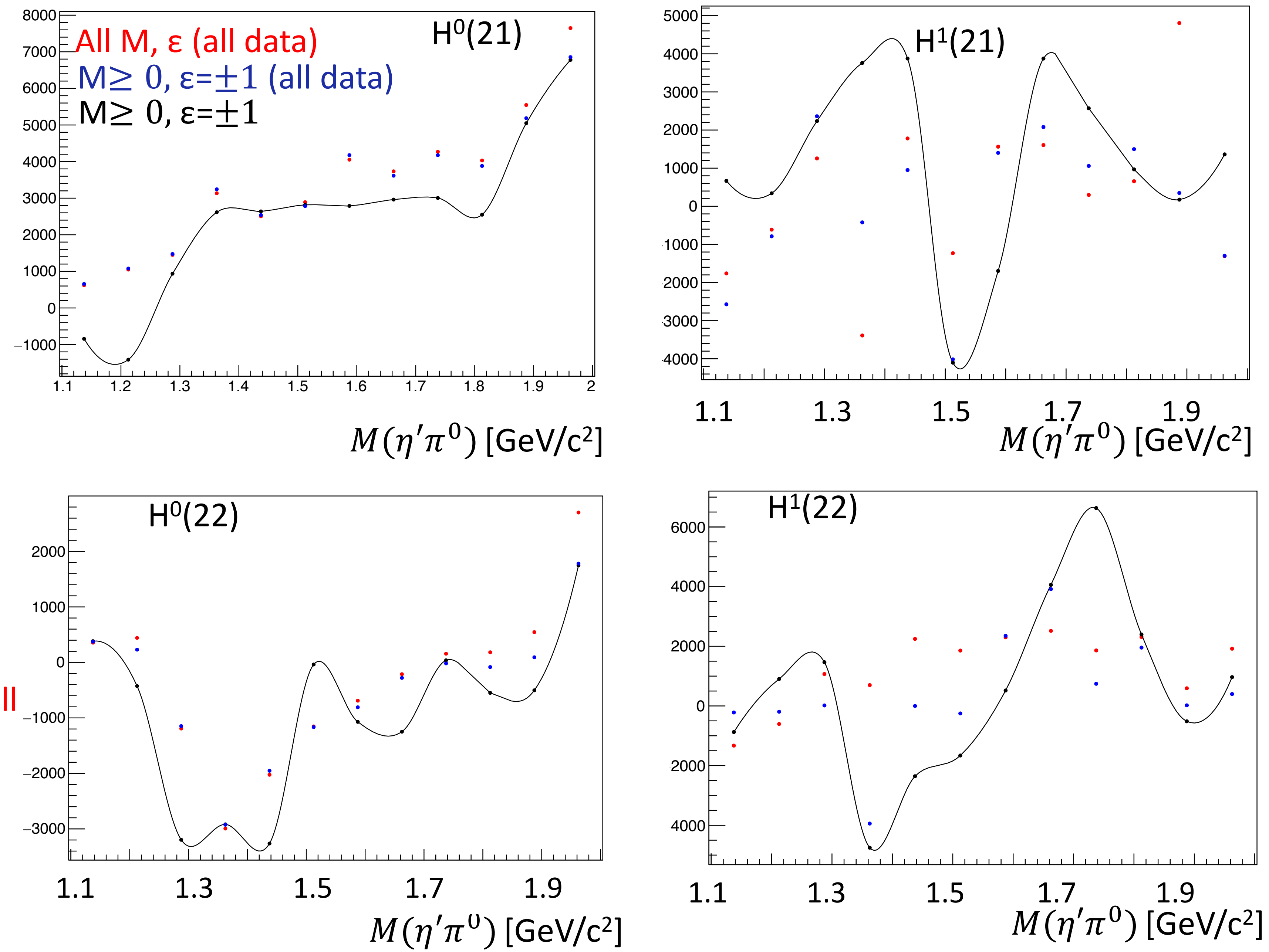
Comparison of moments from different fit results

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



Comparison of moments from different fit results

$0<t<0.3\ (\mathrm{GeV}/c)^2$



Moments from fit results with all M, ε (all data) agree with moments from fit with M≥ 0, ε=±1 (all data)

Summary

- Have used new loop statement to fit data for different polarization angles together
- Can improve fitting using more than 100 fits with randomized initial parameters, to choose good starting parameters
- Improve Q-factor signal-background separation
- Use different generated and accepted MC data files when fitting data corresponding to different polarizations
- Change the bin size?
- Compare the obtained moments to the ones obtained by weighting each event by corresponding intensity as defined in Mathiew et al.

$$H^0(LM) = \frac{P_\gamma}{2} \int_\circ I(\Omega, \Phi)\, d^L_{M0}(\theta) \cos M\phi,$$

$$H^1(LM) = \int_\circ I(\Omega, \Phi)\, d^L_{M0}(\theta) \cos M\phi \, \cos 2\Phi,$$

$$\operatorname{Im} H^2(LM) = -\int_\circ I(\Omega, \Phi)\, d^L_{M0}(\theta) \sin M\phi \, \sin 2\Phi,$$

$$\text{with } \int_\circ = (1/\pi P_\gamma) \int_0^\pi \sin\theta \mathrm{d}\theta \int_0^{2\pi} \mathrm{d}\phi \int_0^{2\pi} \mathrm{d}\Phi$$