

SPIN ASYMMETRIES IN HARD EXCLUSIVE MESON ELECTROPRODUCTION AT JLAB-CLAS

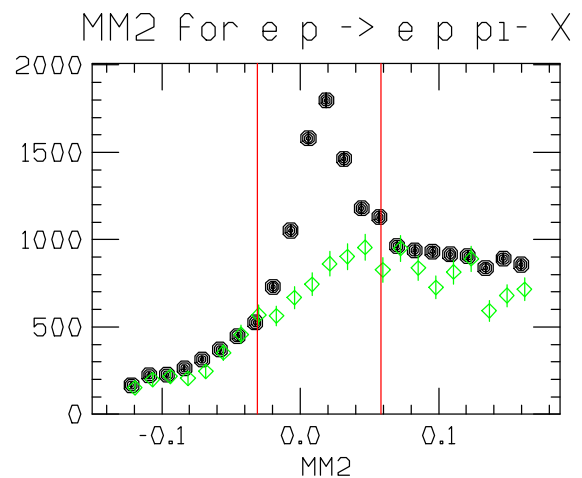
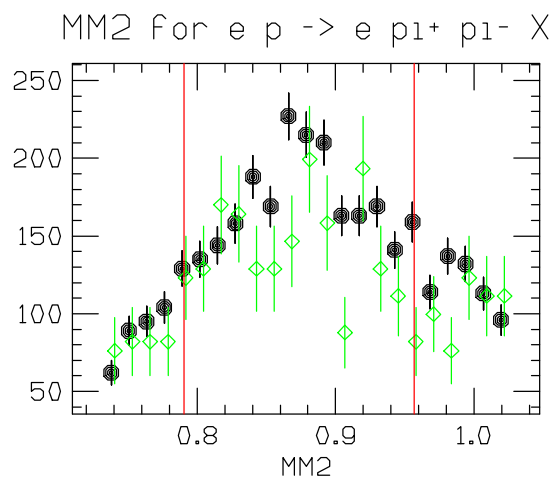
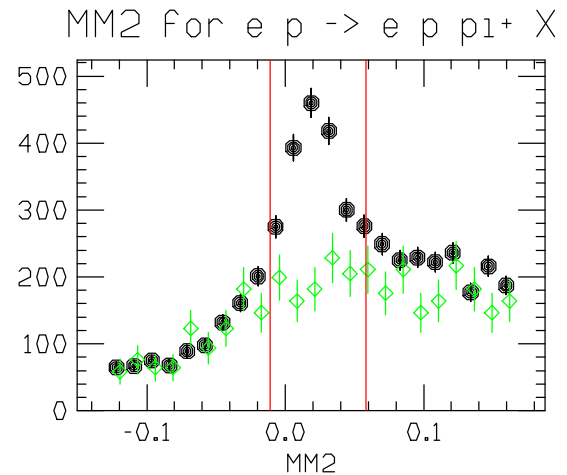
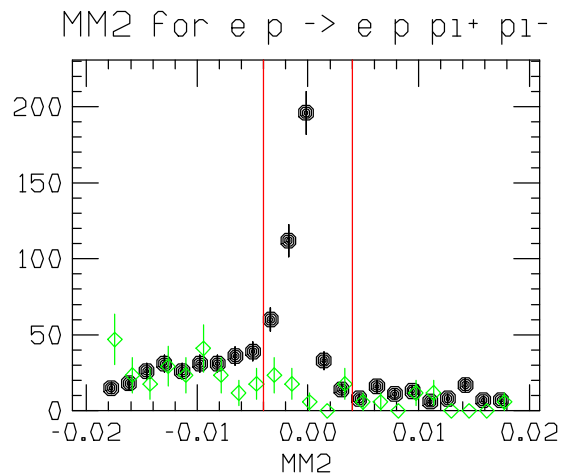
- Focus on reaction mechanism
- Spin degrees of freedom good at distinguishing for example reggeon and Pomeron exchange.
- In limit of pure GPD handbag description, spin asymmetries with longitudinally polarized target and beam all predicted to be zero.
- Preliminary investigation of η , ρ , and ω electroproduction from protons in NH_3 , $E = 5.7$ GeV in CLAS Eg1b.
- Select $W > 1.8$ GeV to minimize resonance contributions.

EXCLUSIVE ρ^0 ELECTROPRODUCTION

- Process is large part of total cross section at high W , low $-t'$, low Q^2 .
- Can be described in terms of Reggeon exchange at lower W , (model of Kochelev et al.) possibly changing to Pomeron exchange at higher W (model of Ivanov et al.)
- GVMD prediction of Fraas is $A_1(\rho) \approx 2A_1^i/(1 + (A_1^i)^2)$, where A_1^i is for inclusive electron scattering (valid at high Q^2).
- Double spin asymmetry interesting to distinguish (Pomeron exchange gives $A_1 = 0$, Reggeon gives $A_1 > 0$).
- HERMES found $A_1 = 0.23 \pm 0.14$ at $\langle W \rangle = 4.9$ GeV, $\langle Q^2 \rangle = 1.8$ GeV², and $\langle -t' \rangle = 0.15$ GeV² for proton target.
- CLAS kinematics probe lower W region. Used $Q^2 > 0.5$ GeV², $1.75 < W < 3$ GeV, $-t' < 0.4$ GeV² (beam energy fixed at 5.7 GeV). Non-diffractive production will be important.

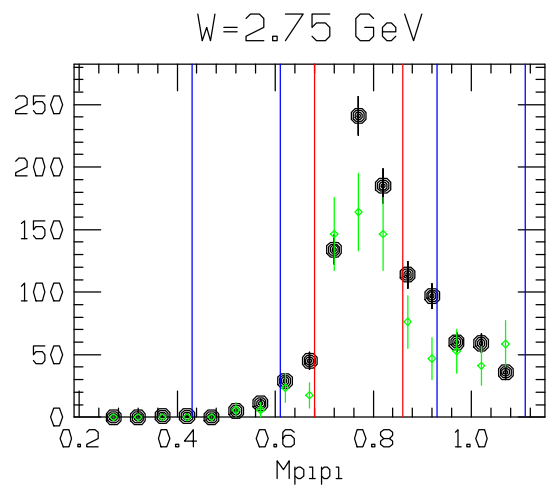
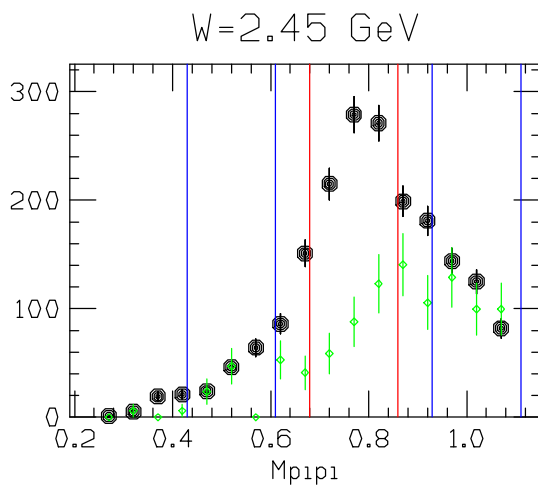
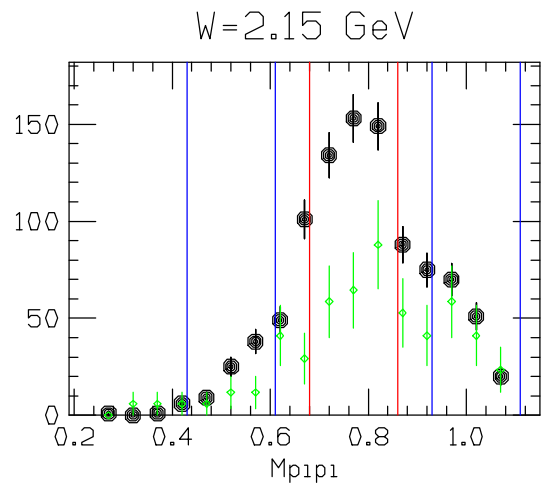
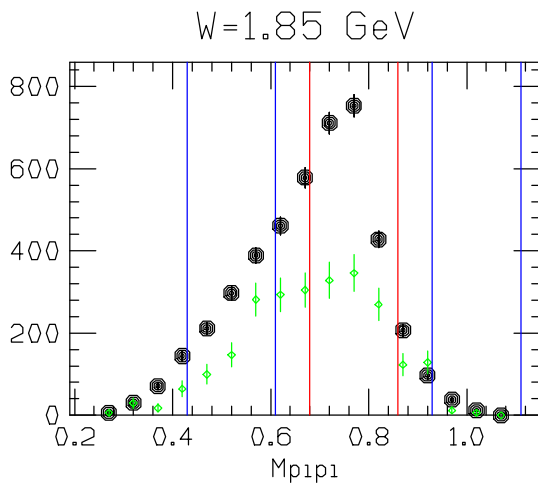
$ep \rightarrow ep\pi^+\pi^-$ EVENT SELECTION

- Selected events where all final state particles detected, or one particle missing.
- Cuts on missing mass reduce N background (green), especially when all particles detected.
- Plots are for one typical bin in W , Q^2 , and $-t'$, and torus polarity.



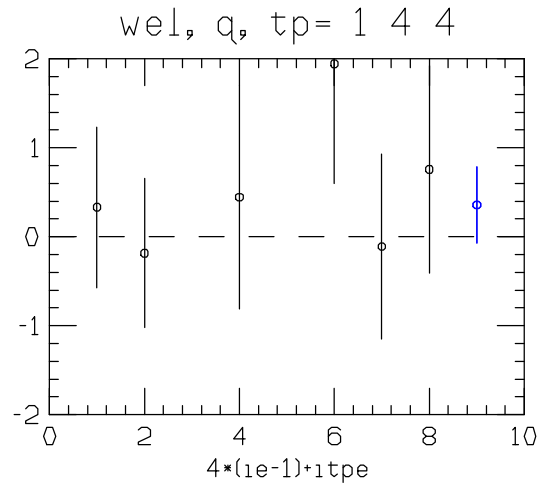
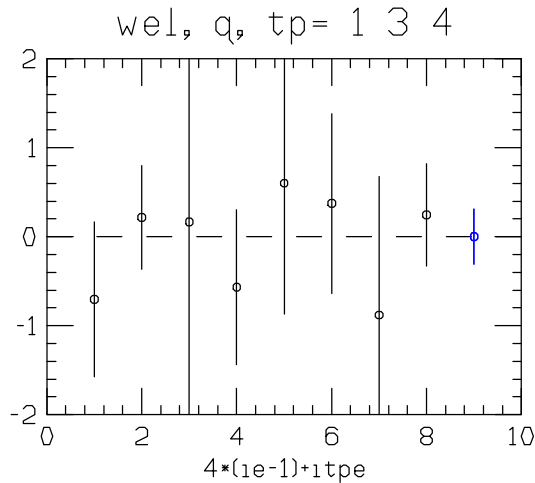
$ep \rightarrow ep\rho$ EVENT SELECTION

- Selected $\pi^+\pi^-$ final state for four event topologies as described above, then ρ events selected with cuts shown by red lines for representative ep missing mass spectra for four W bins.
- Dilution and asymmetry from non- ρ events made using events within green lines (net correction to A_1 close to zero on average).



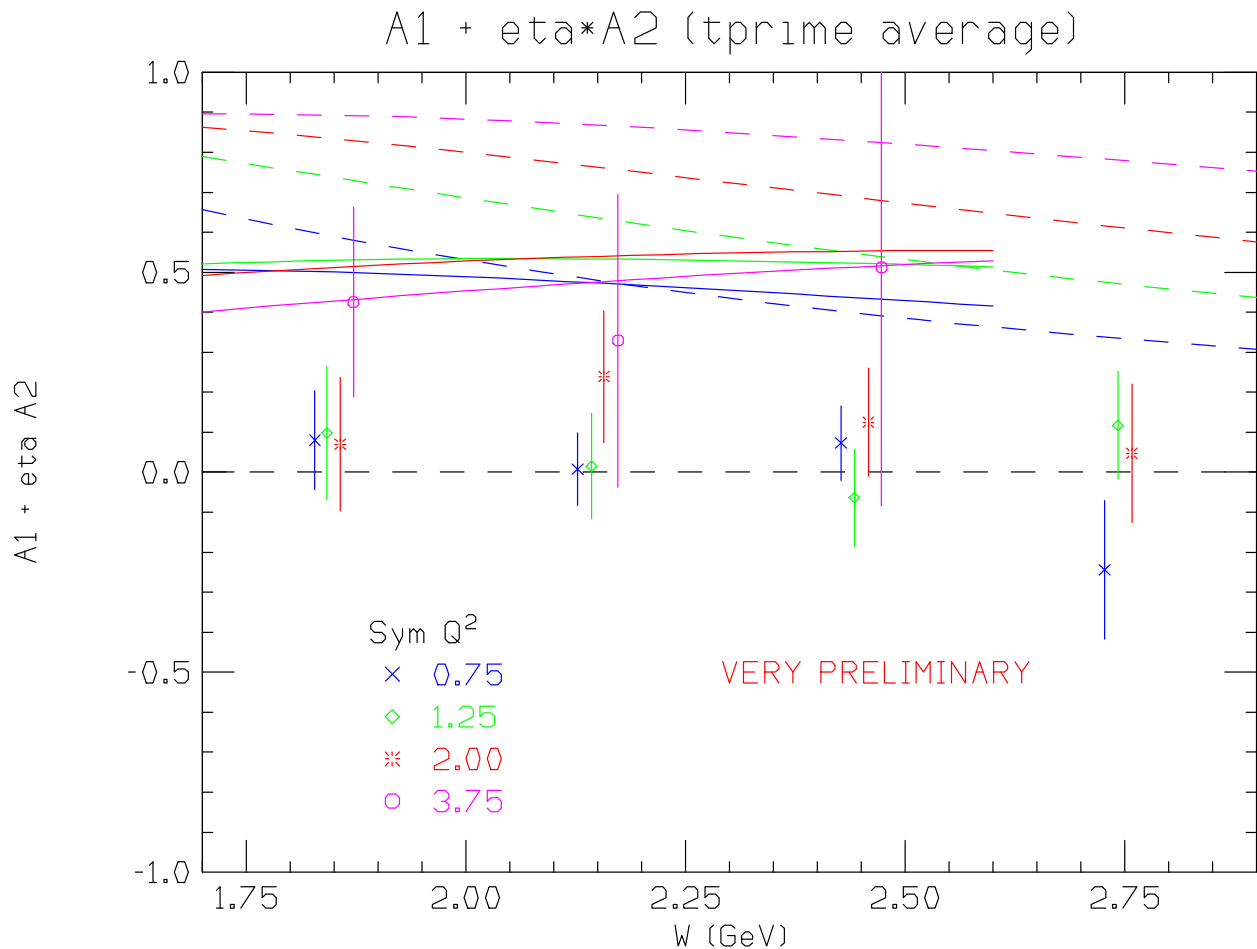
$ep \rightarrow ep\rho$ DOUBLE SPIN ASYMMETRY

- Double spin asymmetry formed in each kinematic bin for each event topology and torus polarity.
- Converted to $A_1 + \eta A_2$ using HERMES parameterization $R = \sigma_L/\sigma_T = 0.35(Q^2/0.59)^{0.62}$
- $A_1 + \eta A_2$ then averaged over event topology and torus polarity.



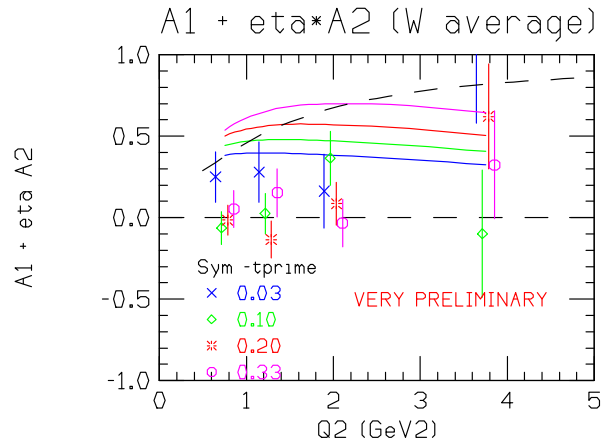
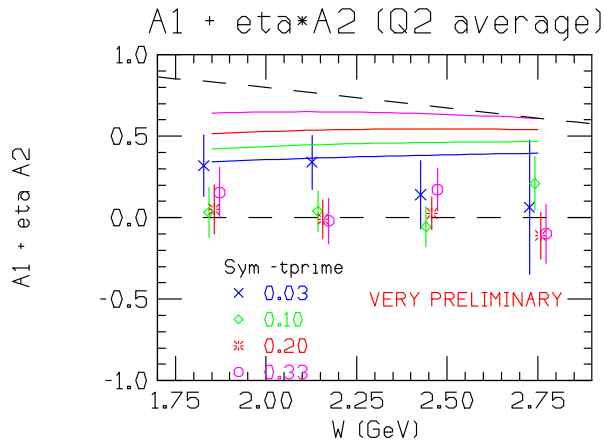
$$ep \rightarrow epp \rho A_1 + \eta A_2$$

- Plot shows $A_1 + \eta A_2$ averaged over $0 < -t' < 0.4 \text{ GeV}^2$. Values are close to GPD prediction of zero (slightly positive on average).
- Data below Fraas prediction (dashed curves) and Regge model of Kochelev et al. (solid curves). Also below J.M. Laget model (not shown).



$$ep \rightarrow ep\rho A_1 + \eta A_2$$

- Also examined $(W, -t')$ dependence averaged over Q^2 (left) and $(Q^2, -t')$ dependence averaged over W . Possible trend for larger $A_1 + \eta A_2$ at larger Q^2 .
- No obvious ϕ dependence to $A_1 + \eta A_2$ observed (no plot yet).

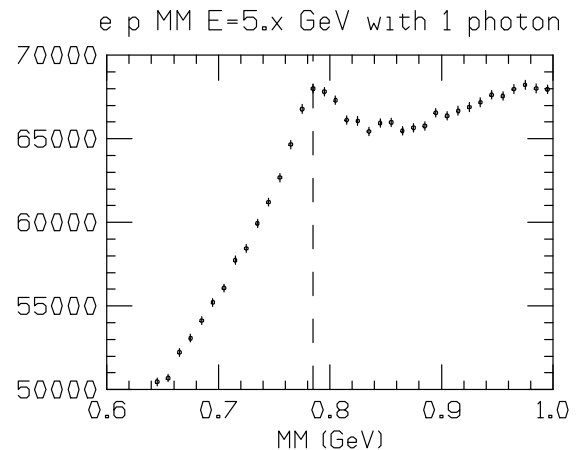
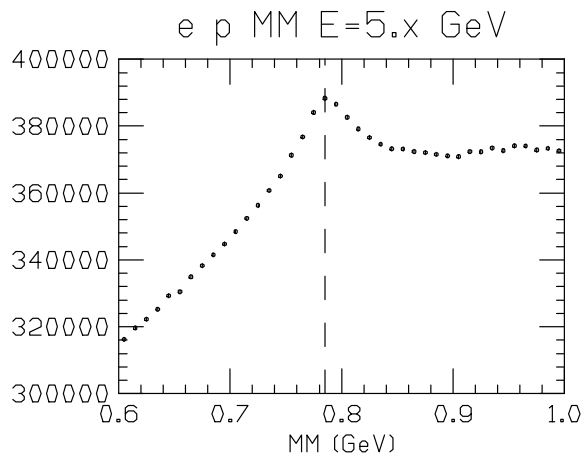


EXCLUSIVE ω ELECTROPRODUCTION

- Couples weakly to resonances, except perhaps near threshold.
- J.M. Laget model predicts A_{LL} much smaller than for ρ . Good test of reaction mechanisms.
- Narrow width (8 MeV) is key to identification, as decay is mostly to $\pi^+\pi^-\pi^0$, for which full detection in CLAS has negligible probability.
- Found best topology is simply detection of e, p , given huge background from N in NH₃ target.
- Other topologies tried included extra photon detected, and $\pi^+\pi^-$ detected with MM equal to π^0 .

$ep \rightarrow ep(\omega)$ MM Spectra

- Plot shows ep MM spectra. Omega peak clearly visible above large background.
- Averaged over all kinematics, error on A_{LL} will be about 0.03. Laget model predicts about 0.15, so small enough to distinguish from GPD prediction of zero, and to take a crude look at W , Q^2 , t , ϕ dependence (averaged in each case over other variables).



EXCLUSIVE η ELECTROPRODUCTION

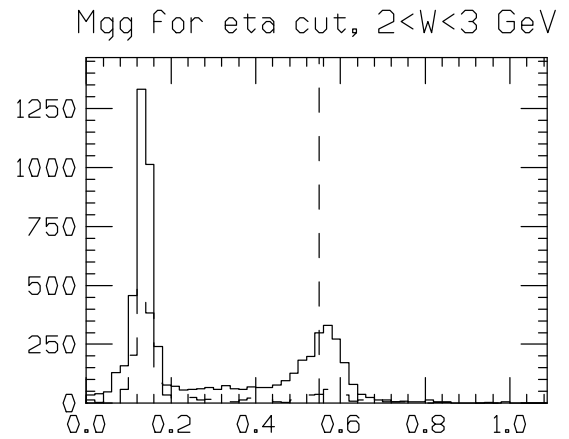
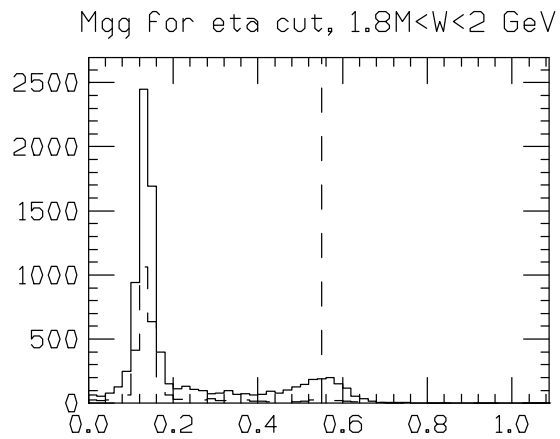
- Mainly couples to $S_{11}(1535)$, higher mass S_{11} resonances ($I = 0$ pseudoscalar)
- Spin-averaged cross section strongly peaked near 1.53 GeV, secondary peak visible near 1.7 GeV
- For spin-1/2 resonances, $A_1=1$. Good way to search for higher mass spin-1/2 resonances.

$ep \rightarrow ep\eta$ EVENT SELECTION

- For $W < 1.8$ GeV, sufficient to detect scattered electron, recoil proton, and 1 photon.
- For $W > 2$ GeV, found need to detect two photons (from $\eta \rightarrow \gamma\gamma$) to see signal above huge background.
- Used standard PID cuts for electron, proton, and the two photons.
- Require missing momentum of $ep\gamma\gamma$ system to be near zero (within 0.2 GeV for P_x and P_y , 0.26 GeV for P_z).

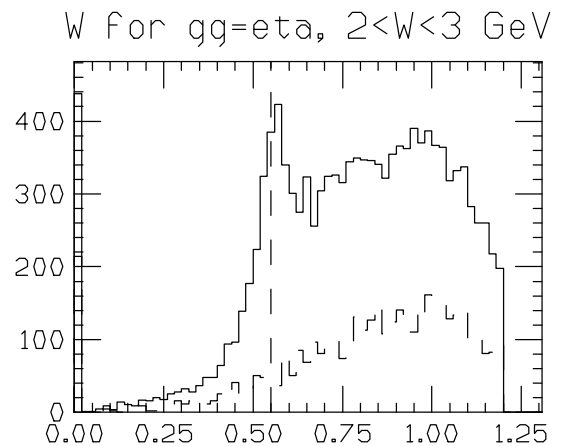
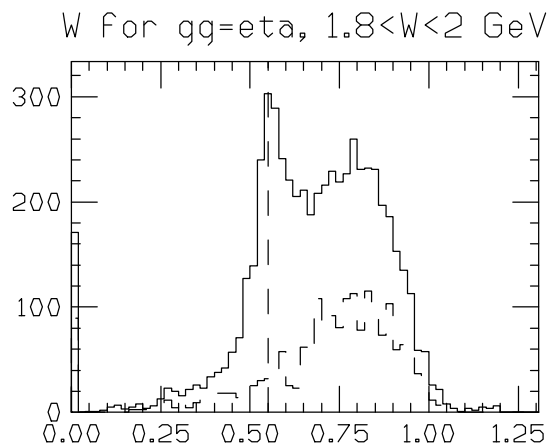
$ep \rightarrow ep\eta$ EVENT SELECTION

- Plotted is $\gamma\gamma$ invariant mass for events with ep missing mass within 0.05 GeV of η mass.
- Clear peak seen at η mass. Bigger peak also visible at π^0 mass.



$ep \rightarrow ep\eta$ MASS SPECTRUM

- Plot shows ep missing with cut on $\gamma\gamma$ mass within 0.06 GeV of η mass.
- Clear peak at η mass seen for NH3 (solid histo).
- Background from C (scaled to same luminosity at NH3) is relatively small and has no η peak
- Expect A_{LL} can be determined with accuracy of about 0.06, averaged over Q^2 and decay angles (work in progress).



OUTLOOK

- Look at A_{UL} , A_{LL} , A_{LU} versus ϕ for ρ .
- Obtain final spin asymmetries for η , ω
- Can extend study to π^0 and $f_2(1280)$
- Adding 4.2 GeV to all analyses
- Compare to J.M. Laget model
- Will obtain approximately 3 to 5 times smaller errors with upcoming Eg1-IC experiment.
- Any graduate students interested for thesis topic?