Polarization Update

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Jefferson Lab

Vector meson angular distributions

$$\Sigma_h^\phi = 2\rho_{1-1}^0 \qquad\qquad \Sigma_h^b = 2\rho_{11}^1 + \rho_{00}^1$$

$$W_h^L(\phi, \Phi) = \frac{1}{2\pi}\left[1 - 2\left(\rho_{1-1}^0\right)\cos 2\phi - P_\gamma\left(2\rho_{11}^1 + \rho_{00}^1\right)\cos 2\Phi\right.$$
$$\left. + P_\gamma\left(\rho_{1-1}^1 - \mathrm{Im}\rho_{1-1}^2\right)\cos 2\left(\Phi - \phi\right) + P_\gamma\left(\rho_{1-1}^1 + \mathrm{Im}\rho_{1-1}^2\right)\cos 2\left(\Phi + \phi\right)\right]$$

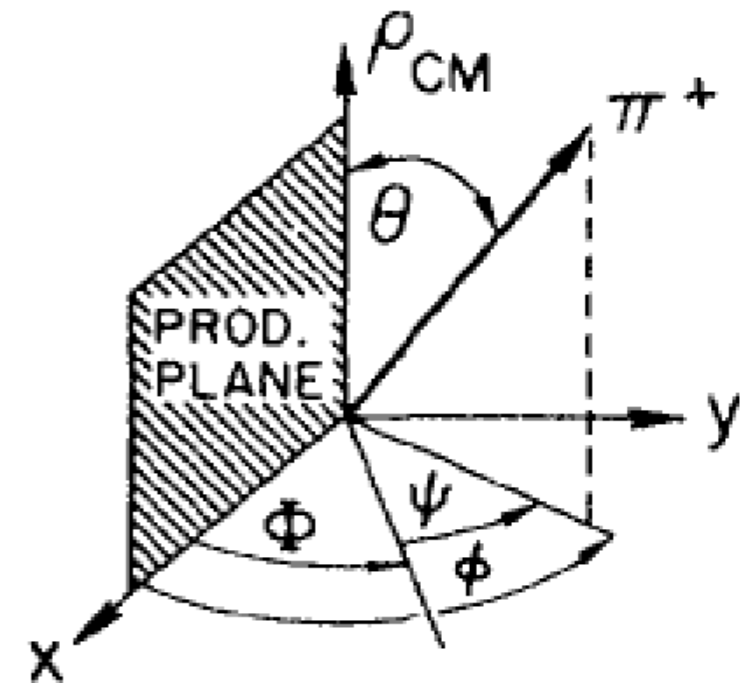$$\Sigma_h^d = \left(\rho_{1-1}^1 - \mathrm{Im}\rho_{1-1}^2\right) \qquad\qquad \Sigma_h^e = \left(\rho_{1-1}^1 + \mathrm{Im}\rho_{1-1}^2\right)$$

✳ Integrate angular distributions over θ

✳ The simplified model I've been using in previous studies to extract the polarization values assumes

$$\rho_{1-1}^1 = -\mathrm{Im}\rho_{1-1}^2 = 0.5$$

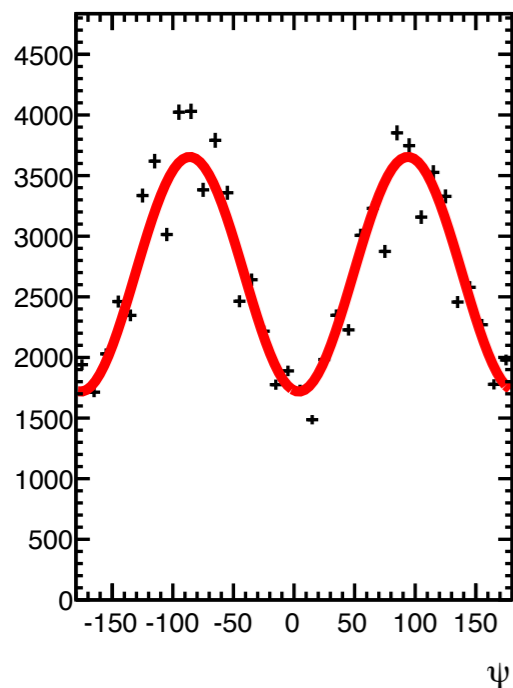$$\Sigma_h^d = \Sigma = 1 \qquad\qquad \Sigma_h^e = 0$$

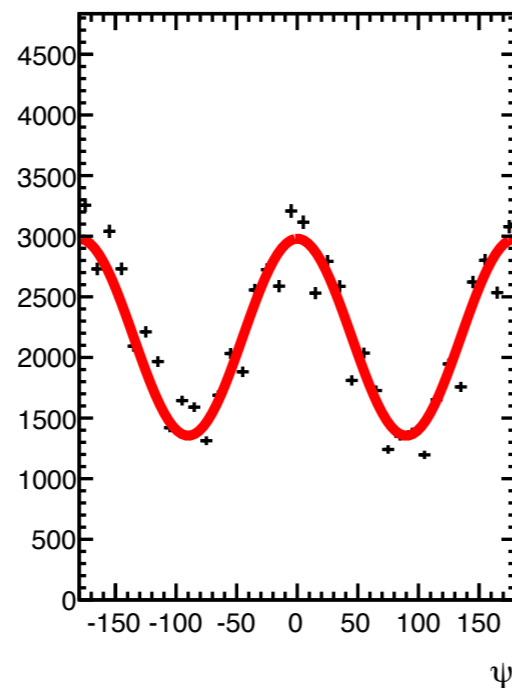✳ And all other SDMEs are small enough to be neglected, consistent with old SLAC data

Nominal Σ asymmetry

$$W_h^L(\phi, \Phi) = \frac{1}{2\pi} \left[1 - \boxed{P_\gamma \Sigma_h^d \cos 2 (\Phi - \phi)} - P_\gamma \Sigma_h^e \cos 2 (\Phi + \phi) \right]$$
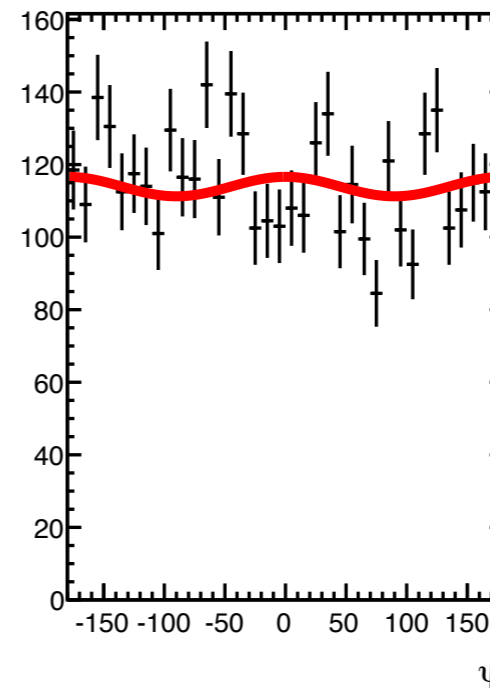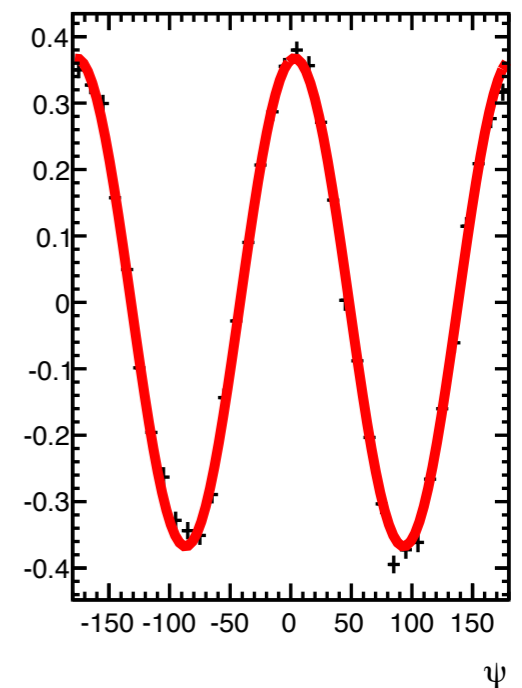
PERP

PARA

Amorphous

$$\frac{N_\parallel - N_\perp}{N_\parallel + N_\perp}$$
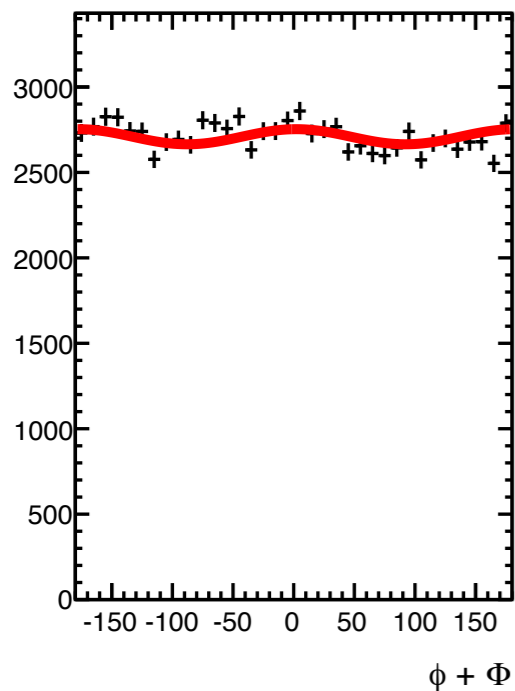

$$\psi = \Phi - \phi$$

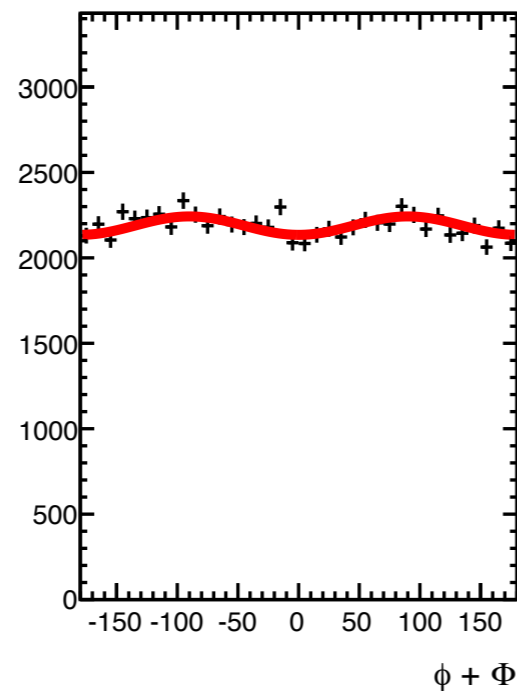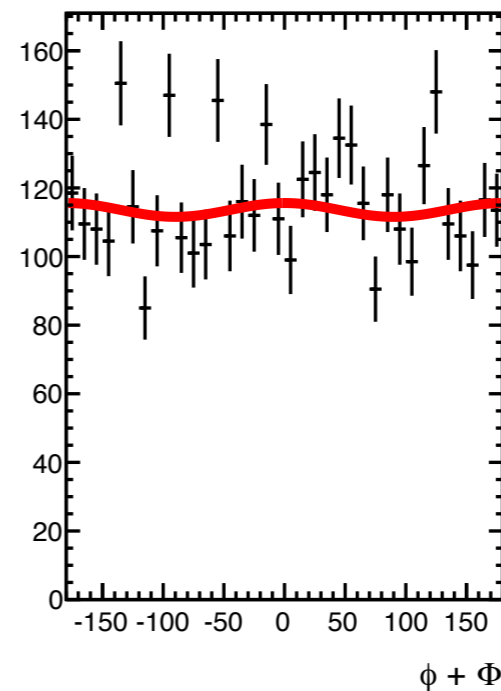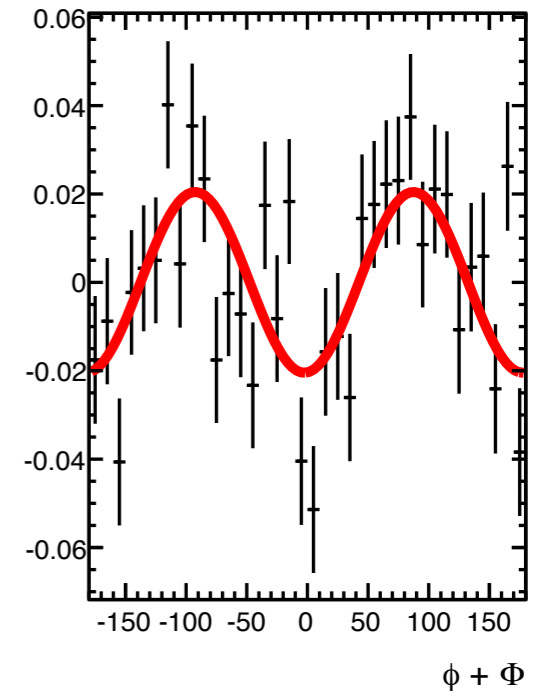$$P\Sigma_h^d$$

Run 11366-11555: 8.4 < E$_\gamma$ < 9 GeV

New asymmetry term

$$W_h^L(\phi, \Phi) = \frac{1}{2\pi} \left[1 - P_\gamma \Sigma_h^d \cos 2(\Phi - \phi) - \boxed{P_\gamma \Sigma_h^e \cos 2(\Phi + \phi)} \right]$$

PERP

PARA

Amorphous

$$\frac{N_\| - N_\perp}{N_\| + N_\perp}$$

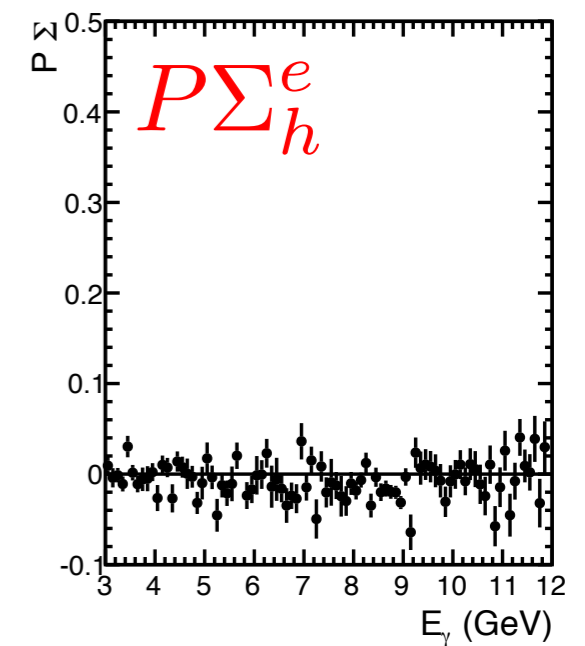$$P\Sigma_h^e \sim -0.02$$

Run 11366-11555: 8.4 < E_γ < 9 GeV

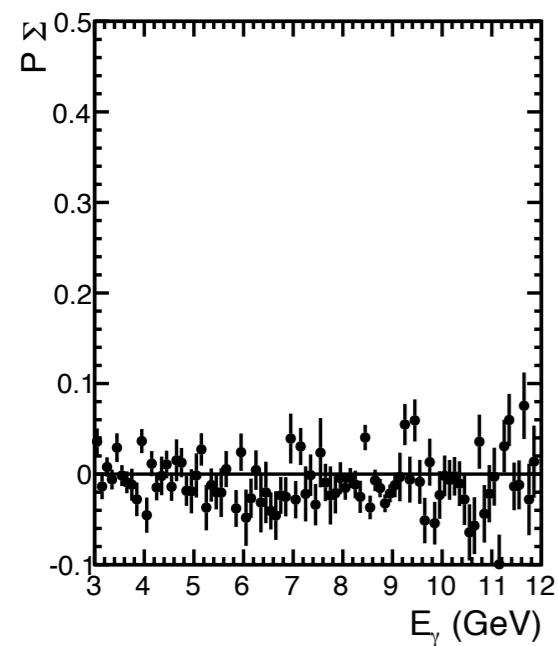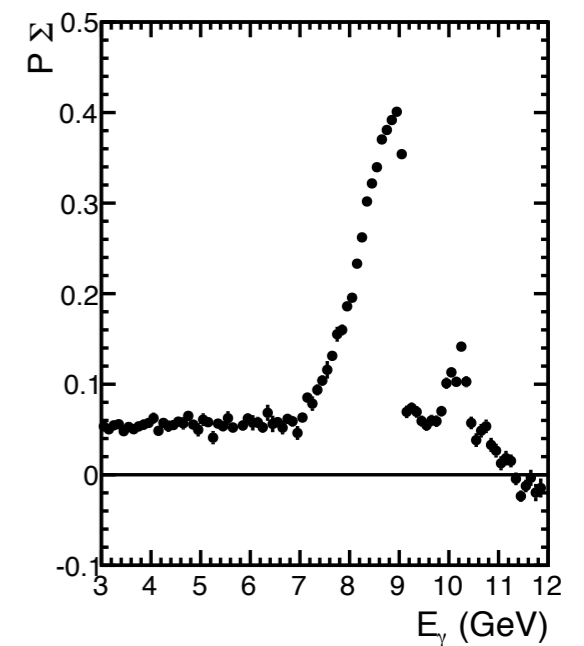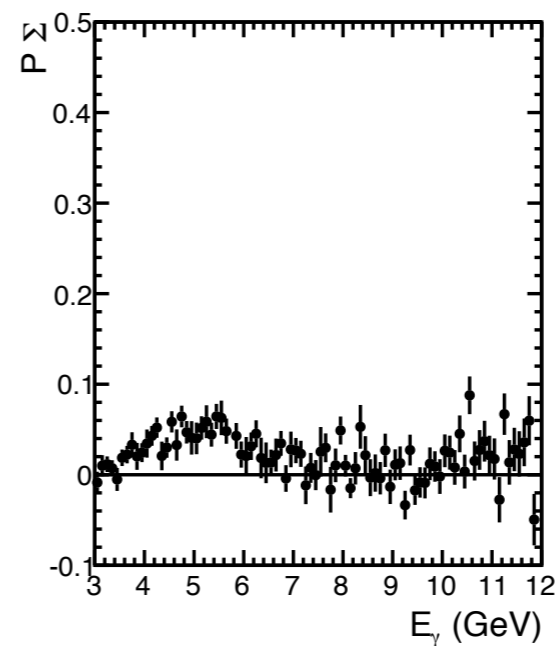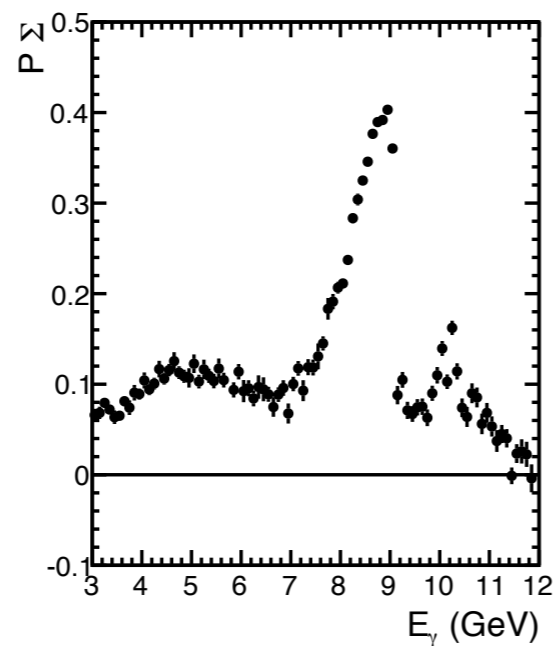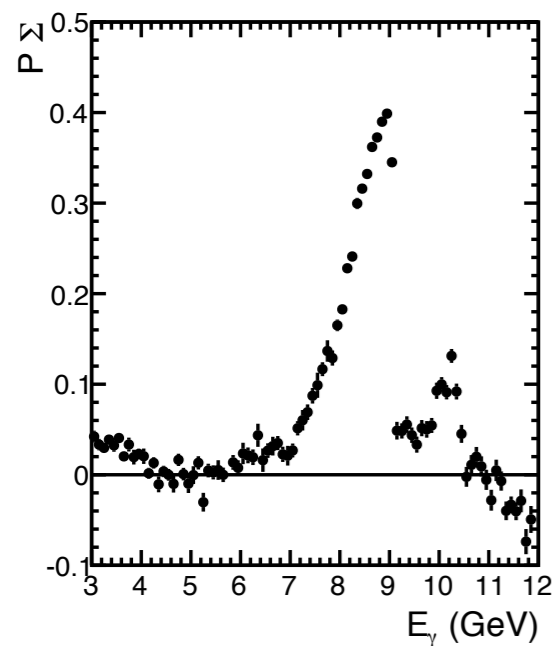# ρ asymmetries: Runs 11366-11555

PERP **PARA** **Amorphous** **PERP+PARA**

$$P\Sigma_h^d$$

$$P\Sigma_h^e$$
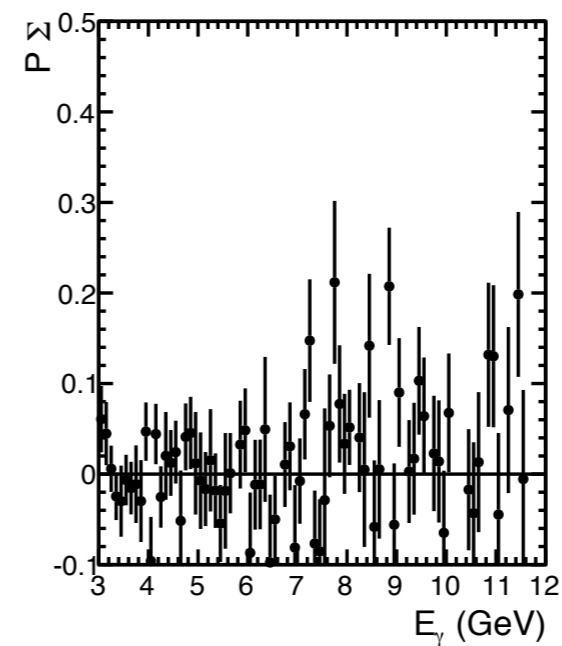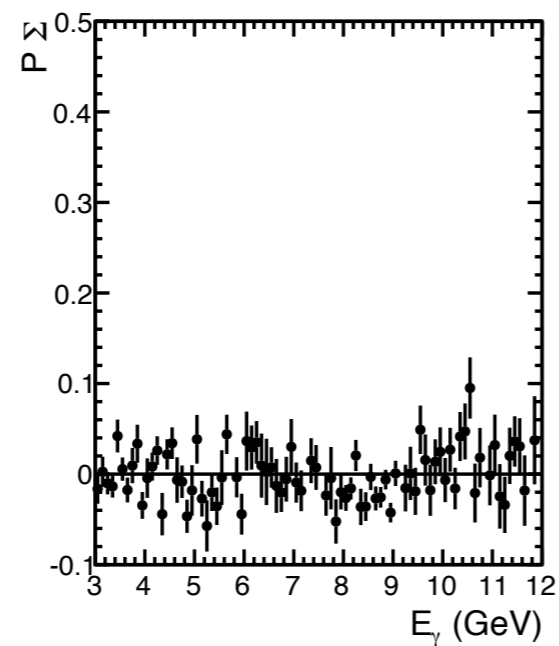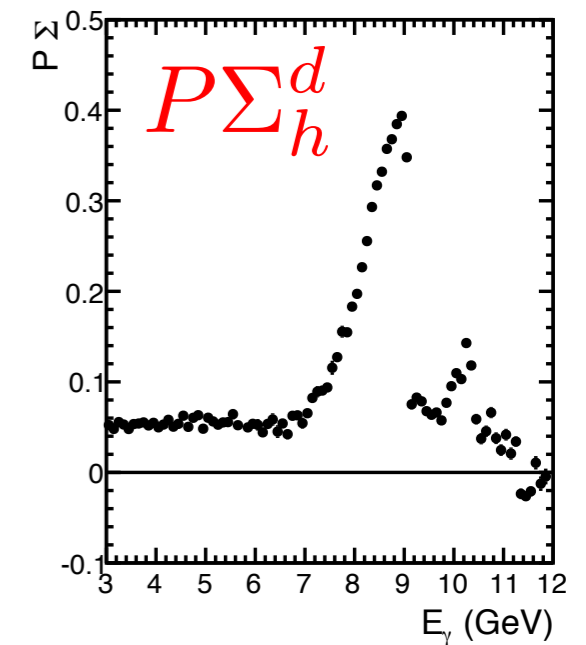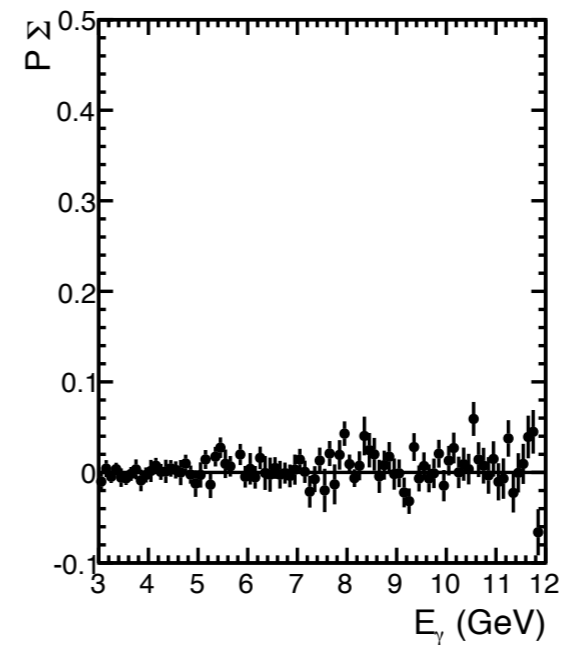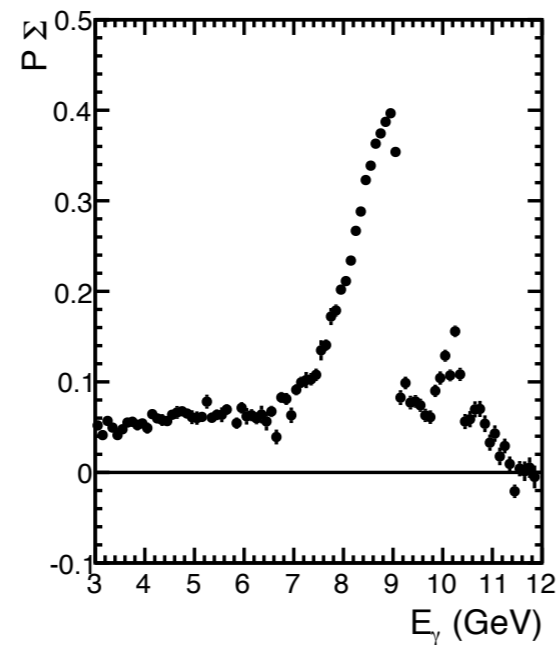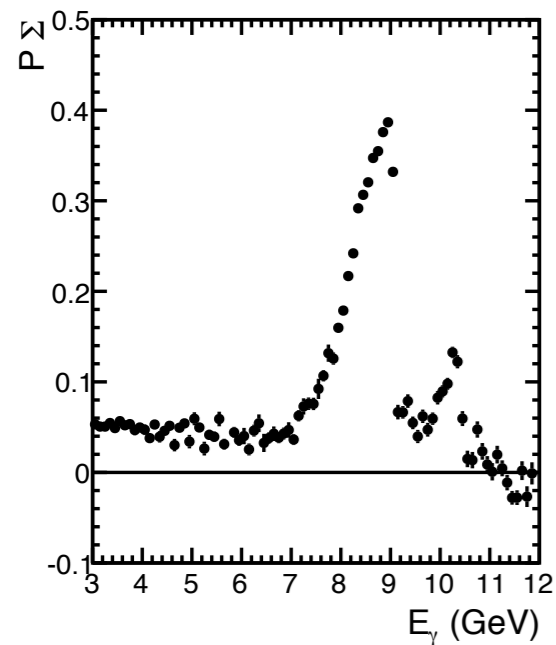
$$W_h^L(\phi, \Phi) \;=\; \frac{1}{2\pi}\left[\, 1 \;-\; P_\gamma\,\Sigma_h^d\,\cos 2\,(\Phi - \phi) \;-\; P_\gamma\,\Sigma_h^e\,\cos 2\,(\Phi + \phi)\,\right]$$

ρ asymmetries: cut comparison

Nominal Cuts
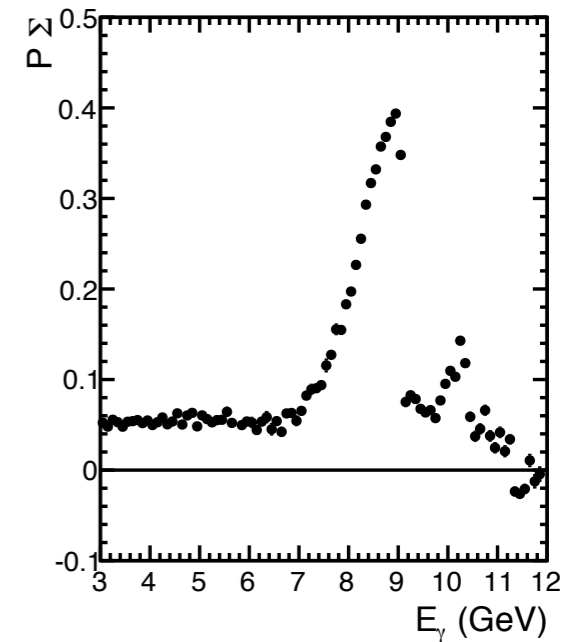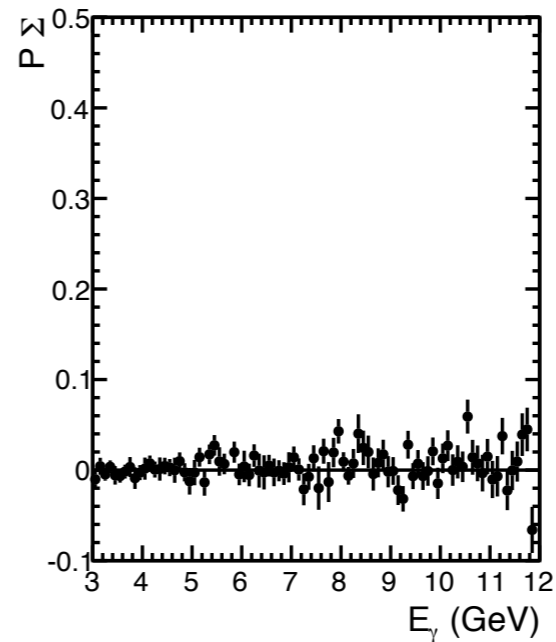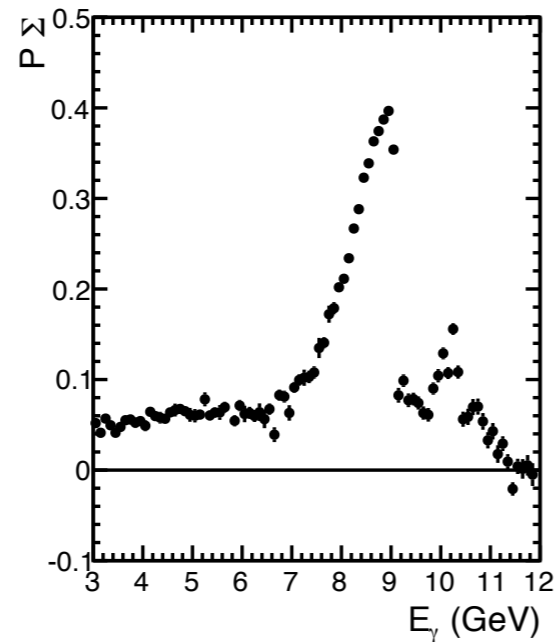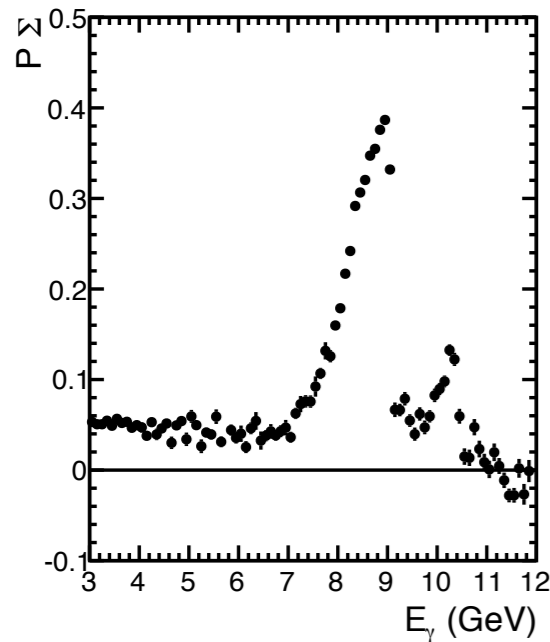
KinFit CL > 0.01

PERP **PARA** **Amorphous** **PERP+PARA**
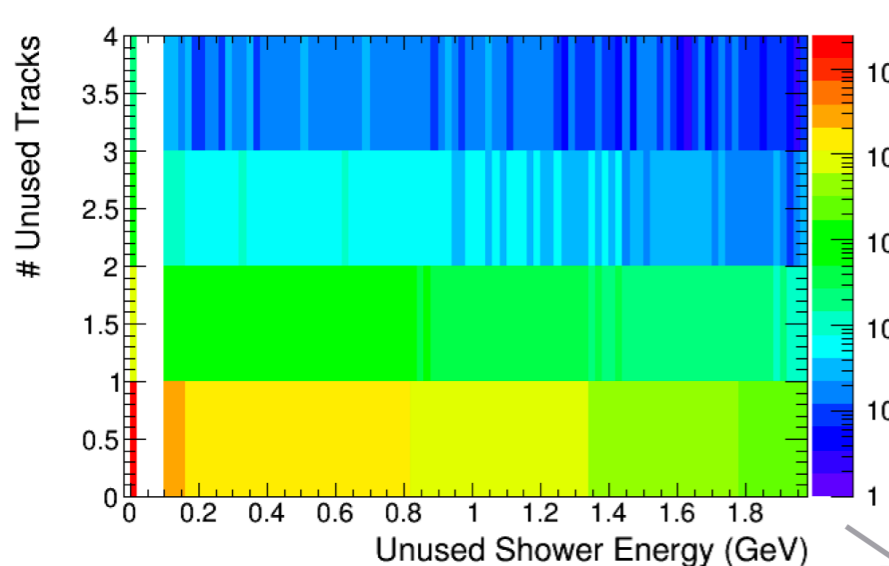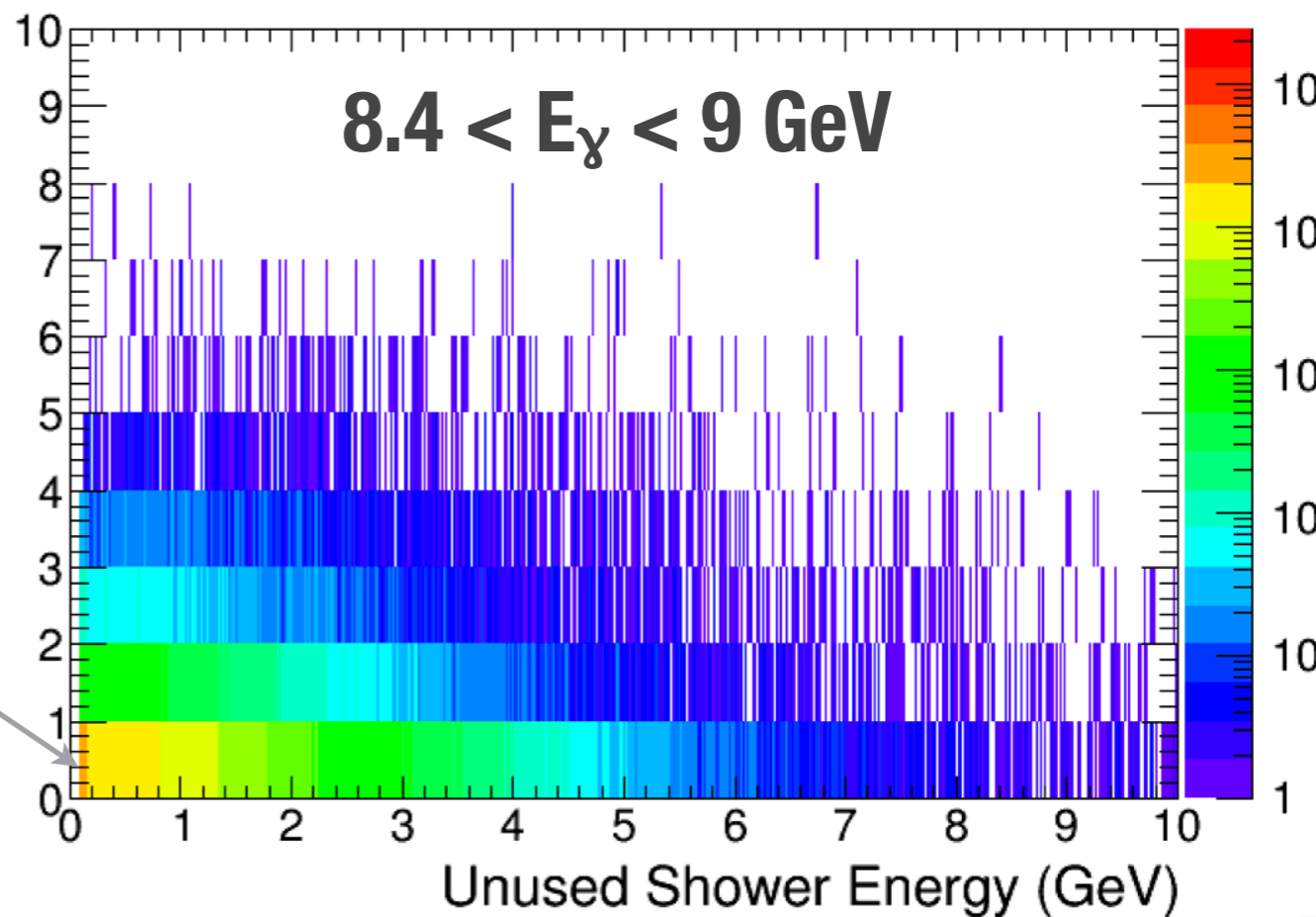
Tighter exclusivity cuts

Mike Staib

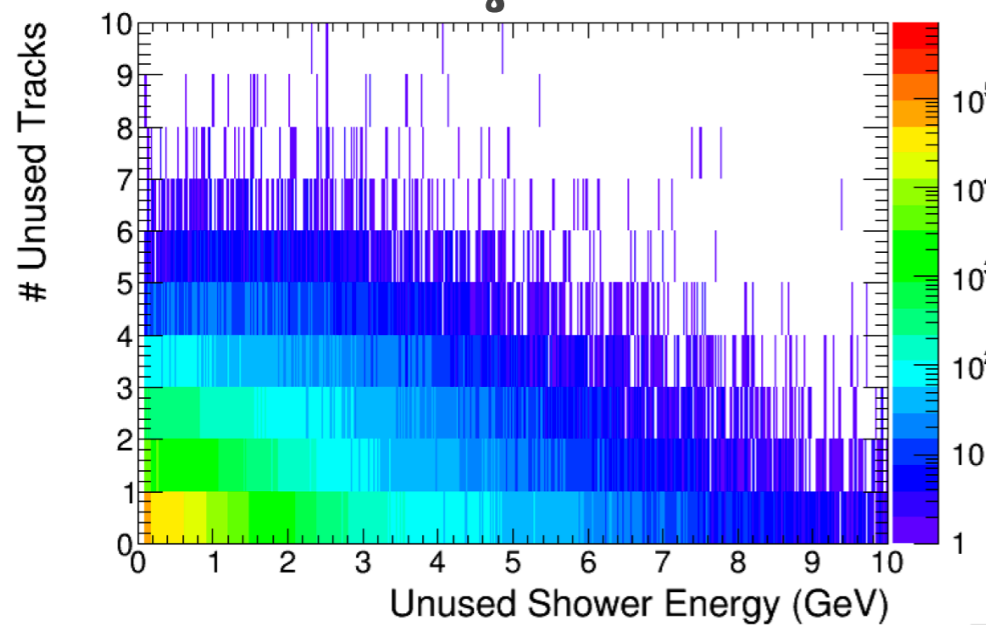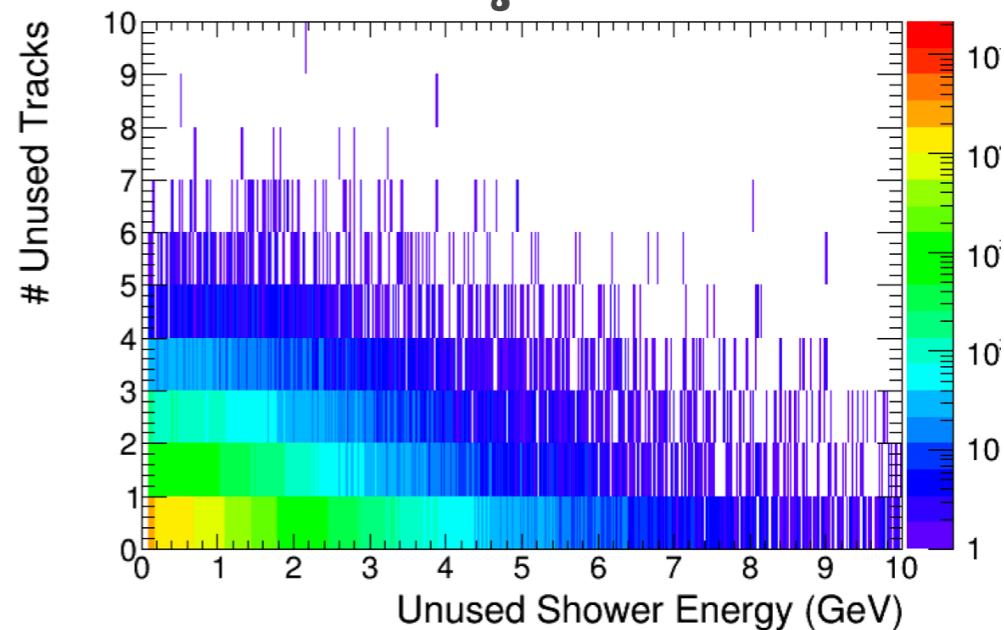**Select more "exclusive" events by requiring no unused tracks or showers**

8.4 < E_γ < 9 GeV

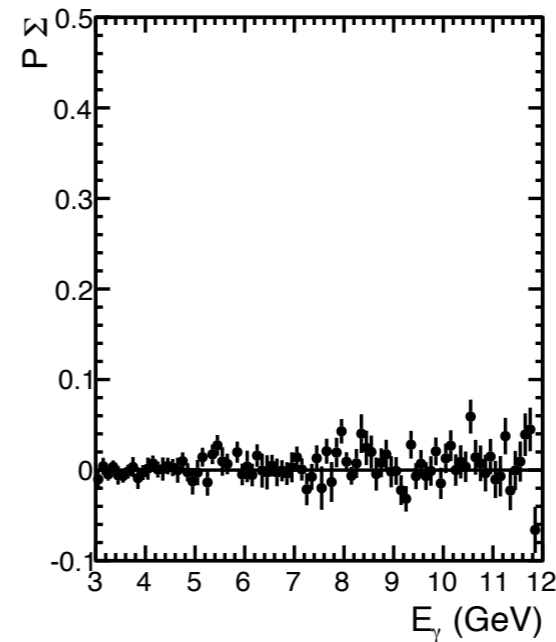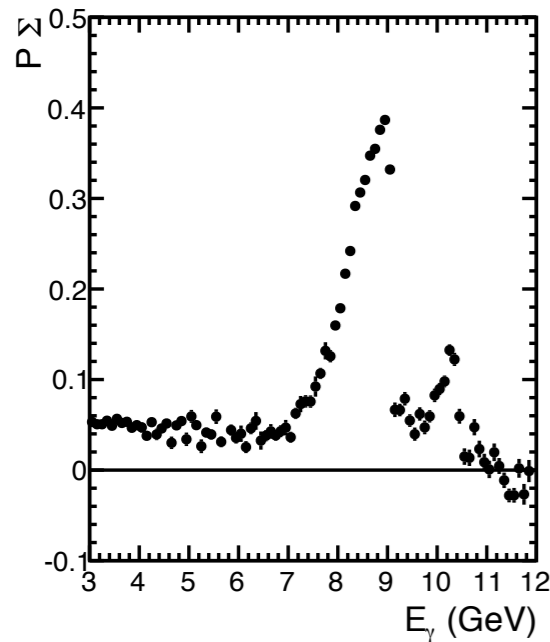3 < E_γ < 5 GeV
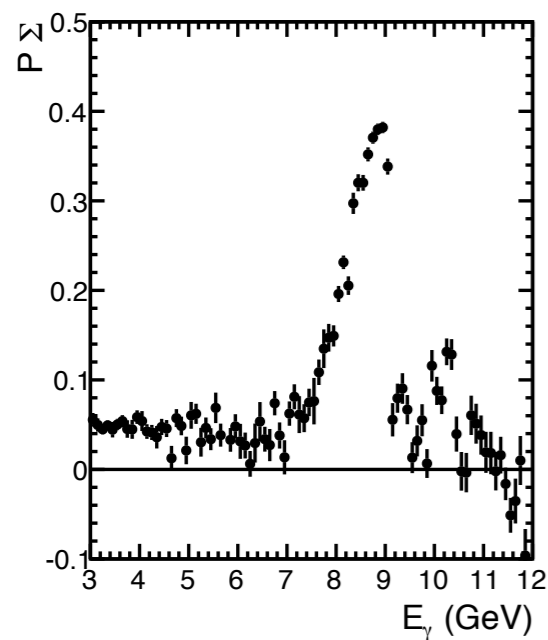
5 < E_γ < 7 GeV

ρ asymmetries: cut comparison

Mike Staib
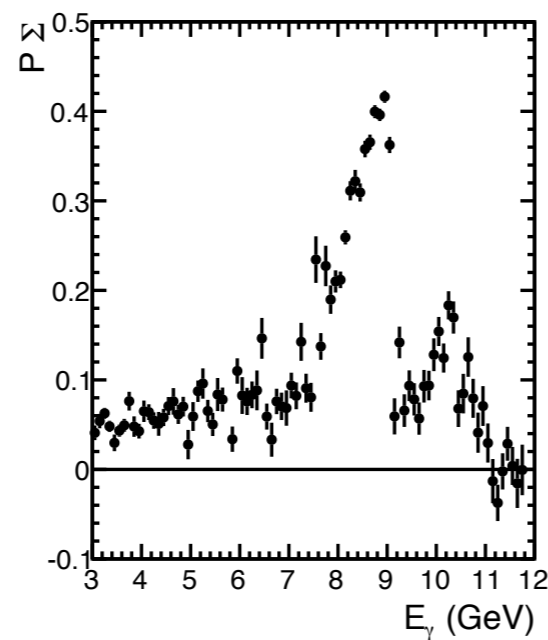
Nominal Cuts
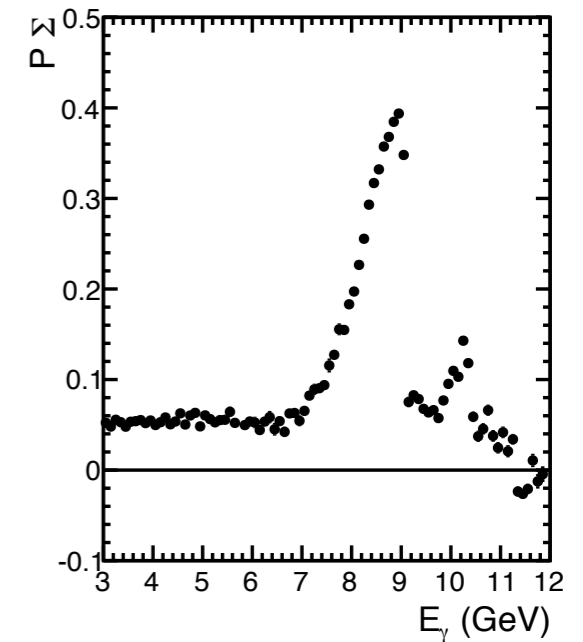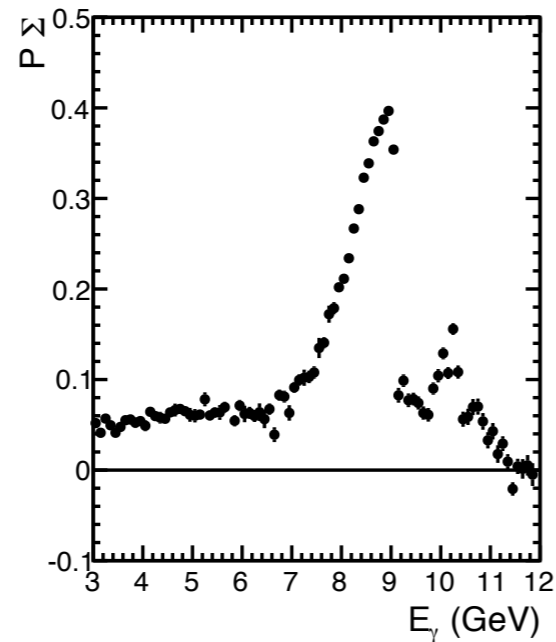
No additional tracks or showers
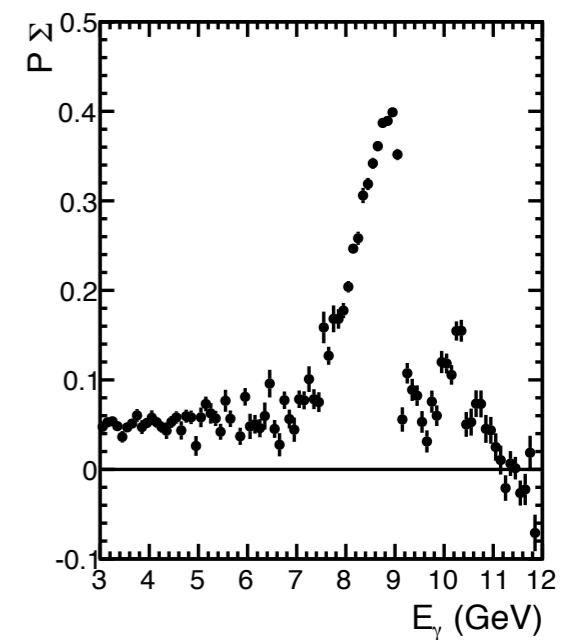

PERP   **PARA**   **Amorphous**   **PERP+PARA**
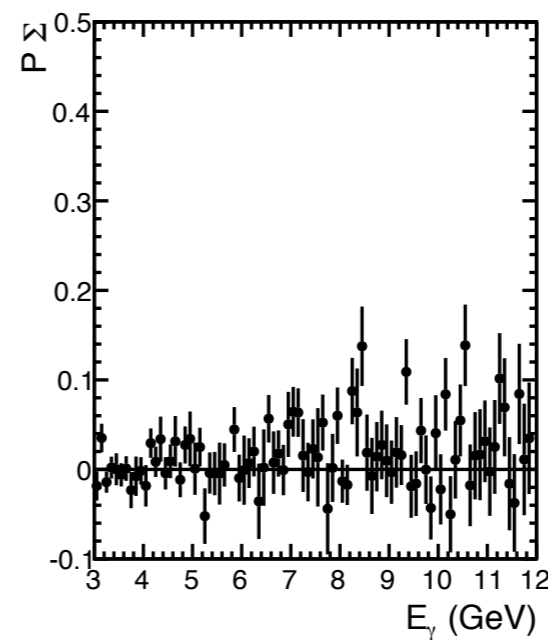
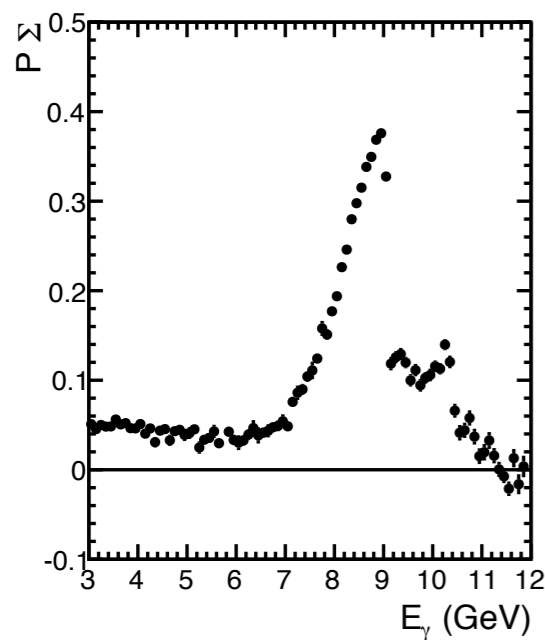# ρ asymmetries: "best" combo

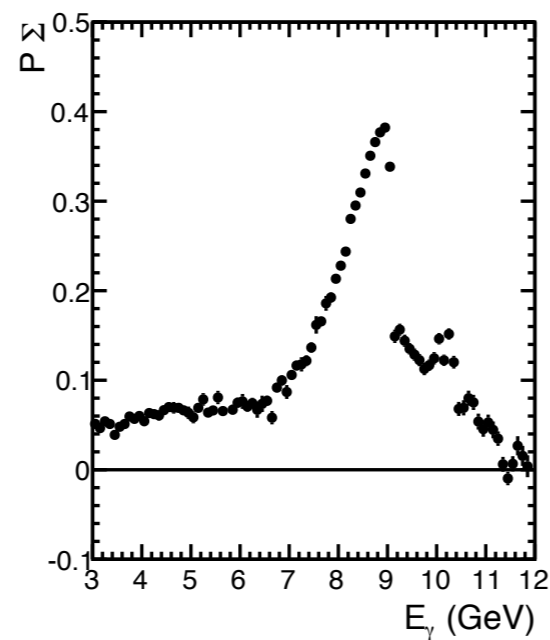**Paul Mattione**

**Instead of dealing with accidentals,
just choose the "best" combo in the event**

Here "best" means Missing Energy closest to 0
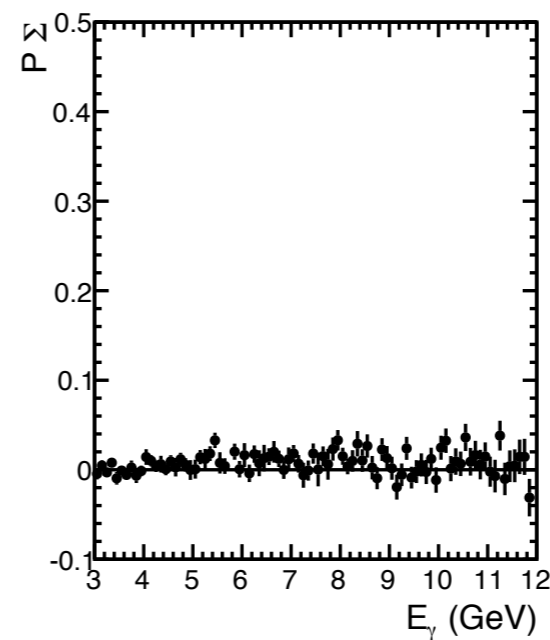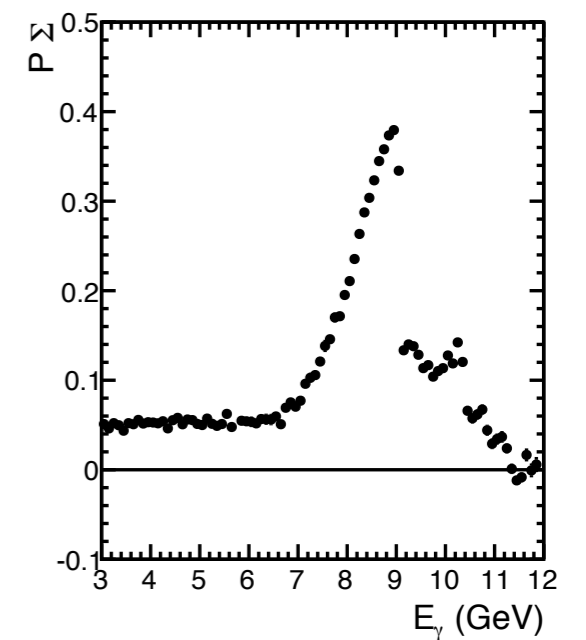

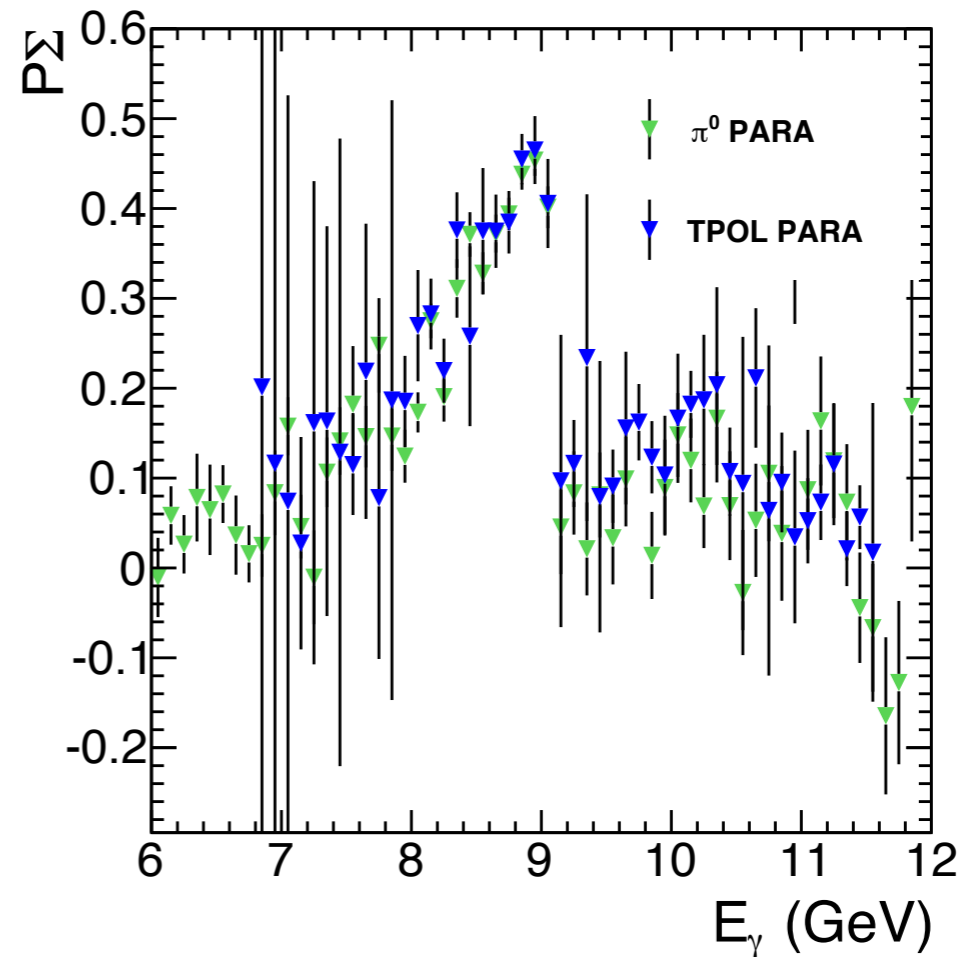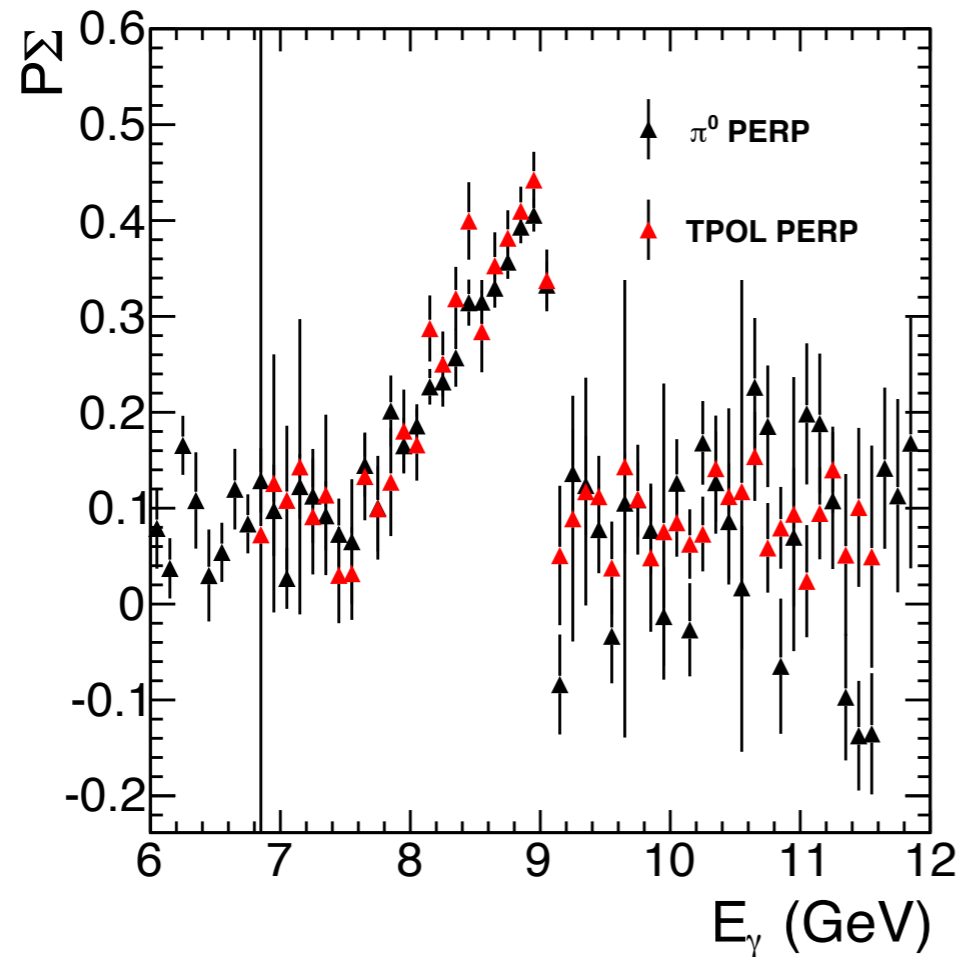**PERP**   **PARA**   **Amorphous**   **PERP+PARA**

Comparison of TPOL and π⁰


* Latest TPOL values from Mike Dugger (preliminary)

* Currently running more triplet MC to provide finer binning in beam energy

Summary

✳ Small contribution to ρ angular distributions from cos $2(\Phi+\phi)$ term. Indicating $\Sigma_\rho < 1$ as expected from previous data

✳ Several systematic checks on event selection, etc. which all show ~5% asymmetry at low energy

✳ Comparison of π^0 asymmetry with TPOL polarization show good agreement in coherent peak

✳ Propose to move forward with TPOL polarization values for user analyses (limited to the coherent peak region) after more TPOL MC statistics are complete

Backup

ρ selection

$$\gamma p \to \pi^+ \pi^- p$$
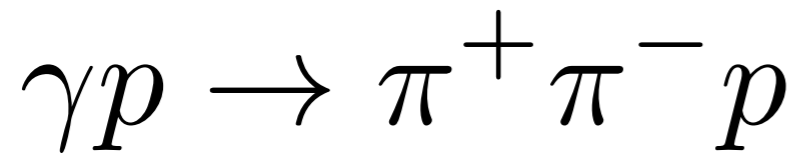
* No kinematic fit

* 50 < Vertex Z < 78 cm

* $|t_{beam} - t_p| < 2.004$

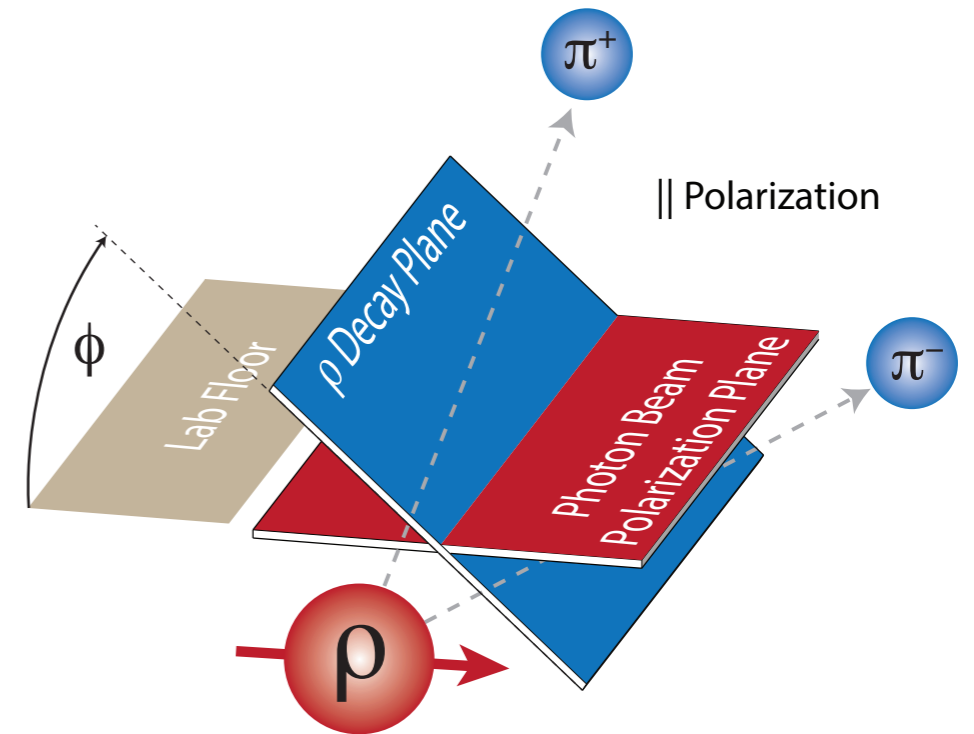* Proton dE/dx

* |MM2| < 0.02

* Missing Energy

* $0.6 < M_{\pi\pi} < 0.88$
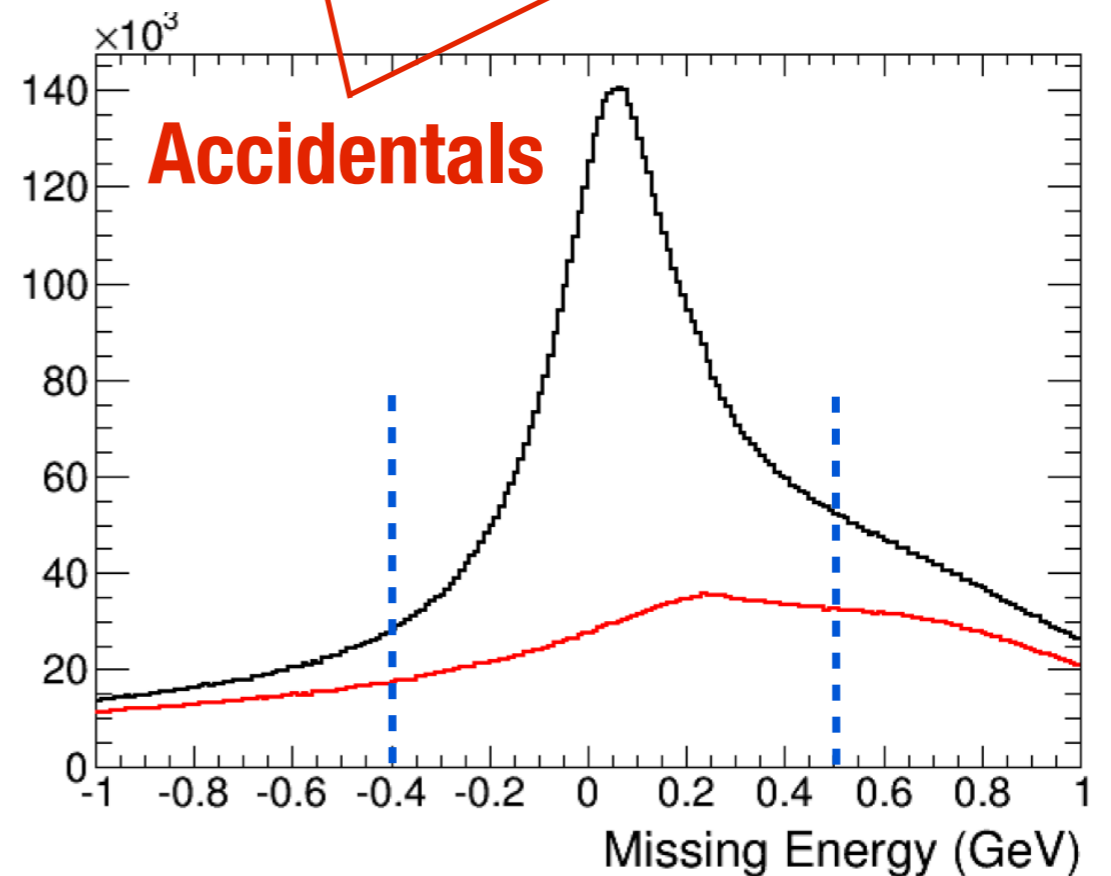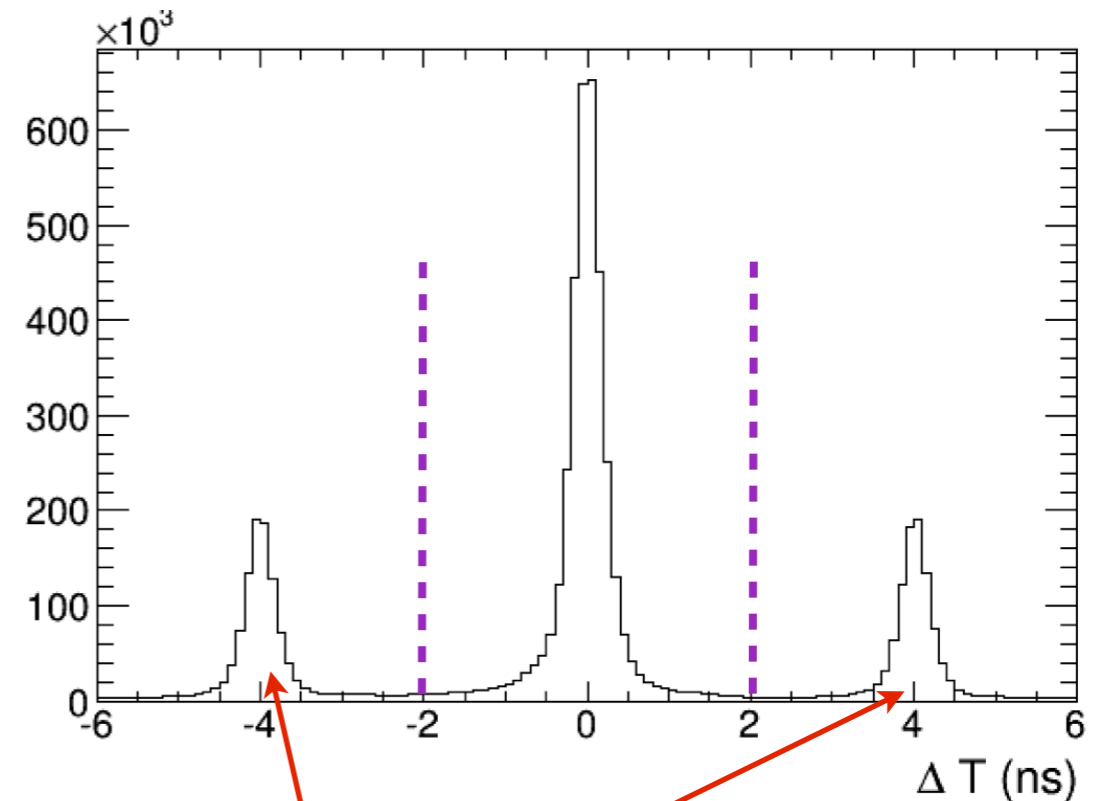
Accidentals

ρ asymmetry: method

* Subtract accidentals from φ-dependent yield

* Fit to PERP and PARA yields separately

* Fit to asymmetry to cancel acceptance effects

* Measure both in bins of E_γ (next slide)

|| Polarization

$$\frac{N_{||} - N_{\perp}}{N_{||} + N_{\perp}}$$

Run 11366-11555: 3 < E_γ < 5 GeV

PERP

PARA

Amorphous

$$d\sigma_\perp \sim 1 - P_\perp \Sigma \cdot cos2\phi \qquad d\sigma_{||} \sim 1 + P_{||} \Sigma \cdot cos2\phi$$

$$\frac{N_{||} - N_{\perp}}{N_{||} + N_{\perp}} = P\Sigma cos2\phi$$

π^0 asymmetry: method

* Subtract accidentals from φ-dependent yield

* Fit to PERP and PARA yields separately

* Fit to asymmetry to cancel acceptance effects
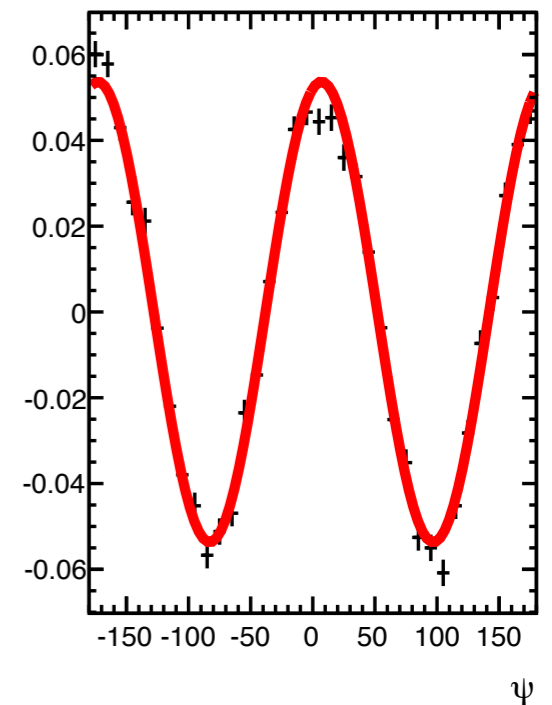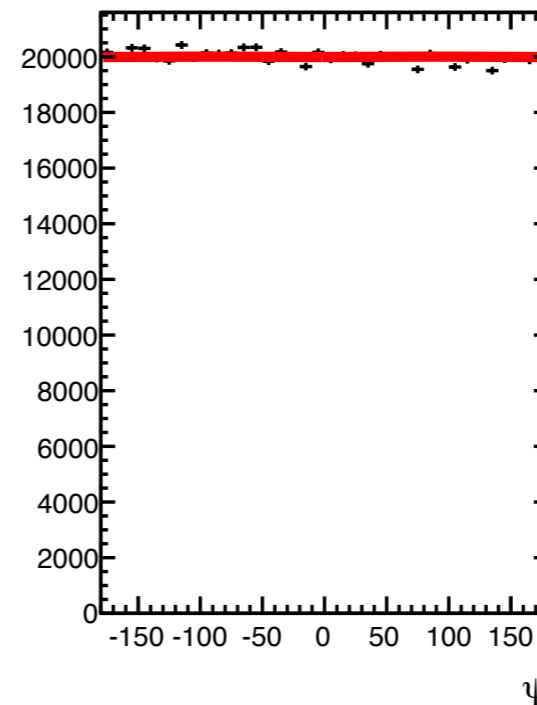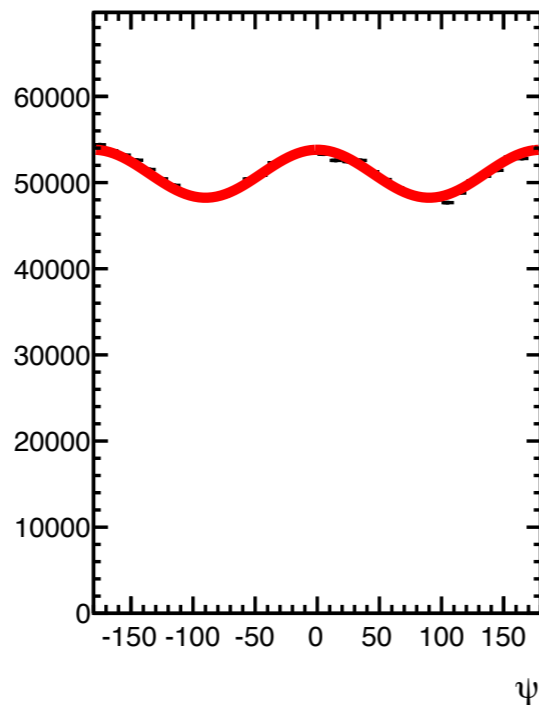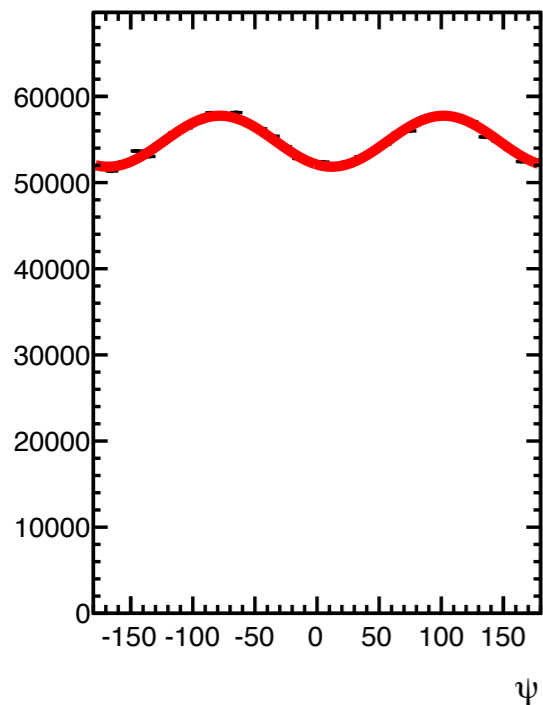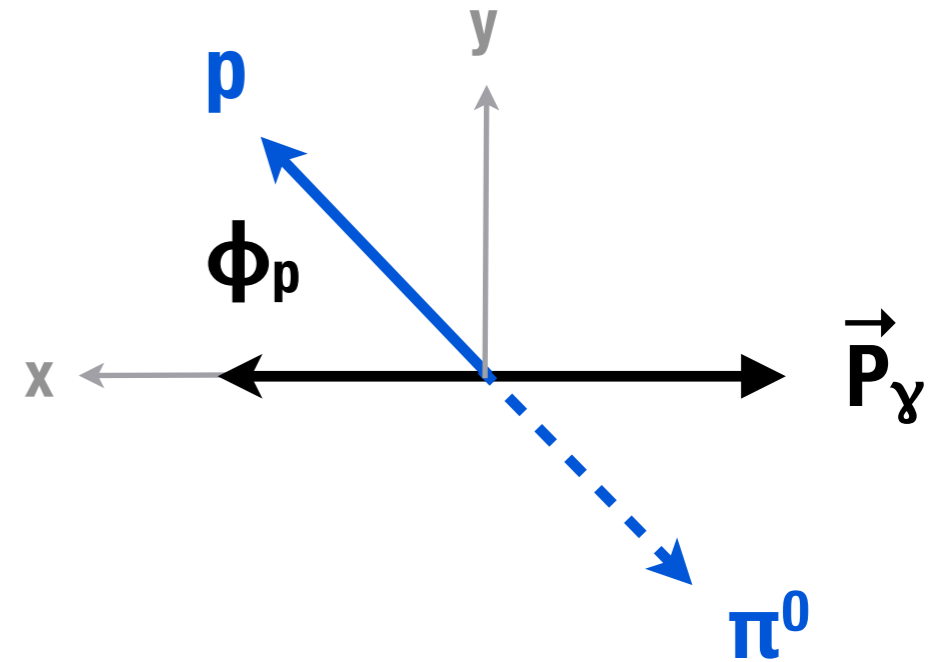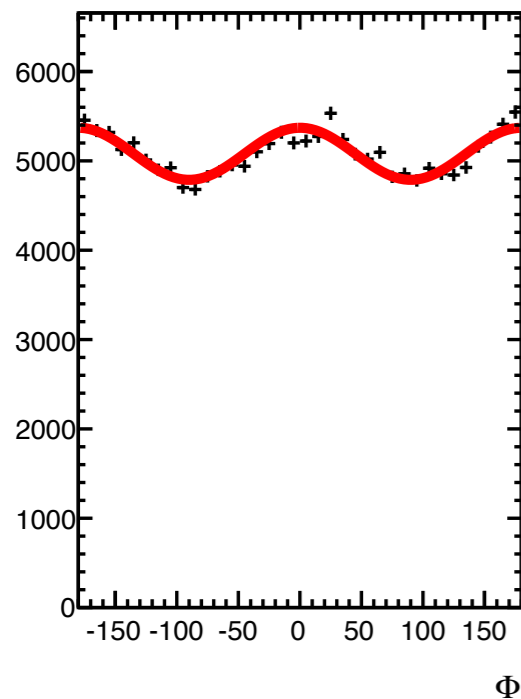
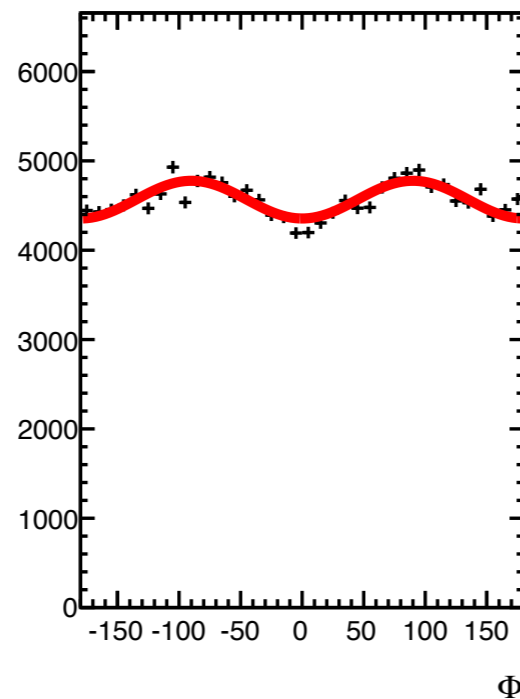* Measure both in bins of E_γ (next slide)
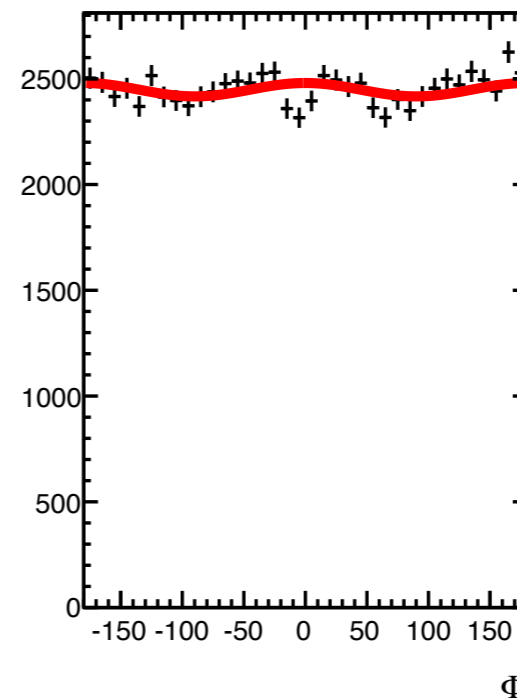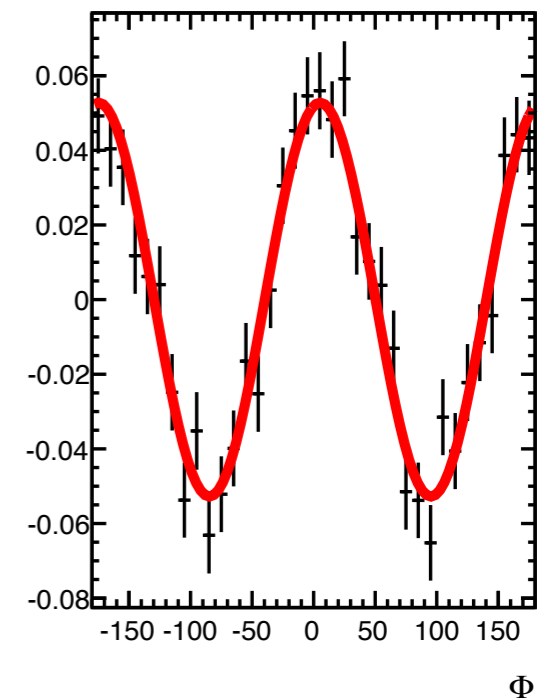
Run 11366-11555: 3 < E_γ < 5 GeV

$$\frac{N_\perp - N_\parallel}{N_\perp + N_\parallel}$$

PERP   **PARA**   **Amorphous**

$$d\sigma_\parallel \sim 1 - P_\parallel \Sigma \cdot cos2\phi \qquad d\sigma_\perp \sim 1 + P_\perp \Sigma \cdot cos2\phi$$

$$\frac{N_\perp - N_\parallel}{N_\perp + N_\parallel} = P\Sigma cos(2\phi)$$

Comparison of accidentals

Runs 11366-11555

Runs 11569-11663