Contents

A Case for *Plausible* consistency between FMS Eta AN and FPD Eta An.

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Overview

The purpose of this note is to make the case that the measurement of a large Eta single transverse spin asymmetry that is observed in Run 6 data with the FPD is not contradicted by the Run 8 transverse data set with the FMS.

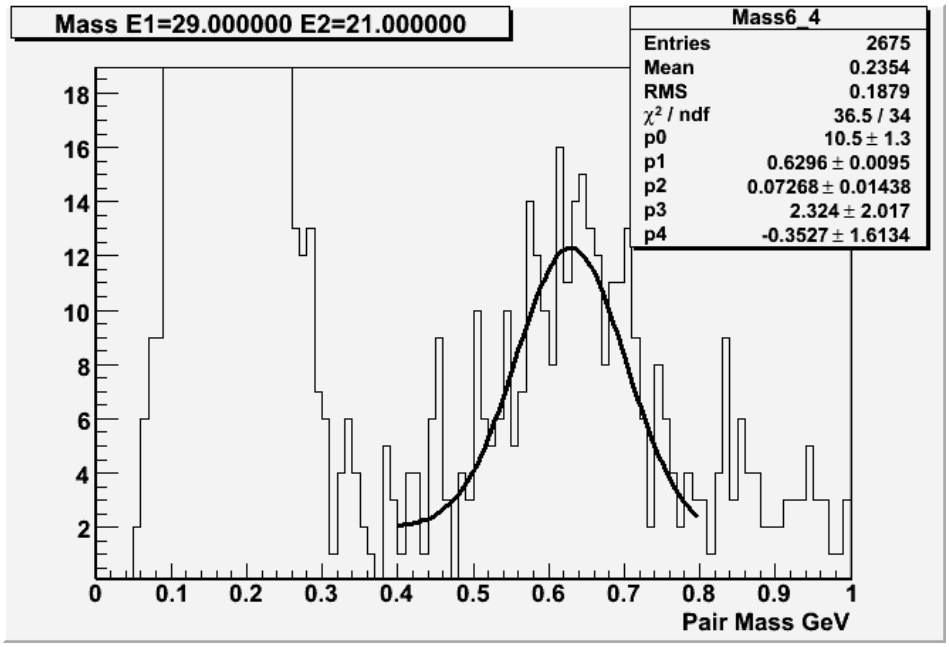
The Run 8 transverse polarization data was calibrated for Spin 2008 presentations. Using this calibration, the results showing singles spin asymmetries have been presented.

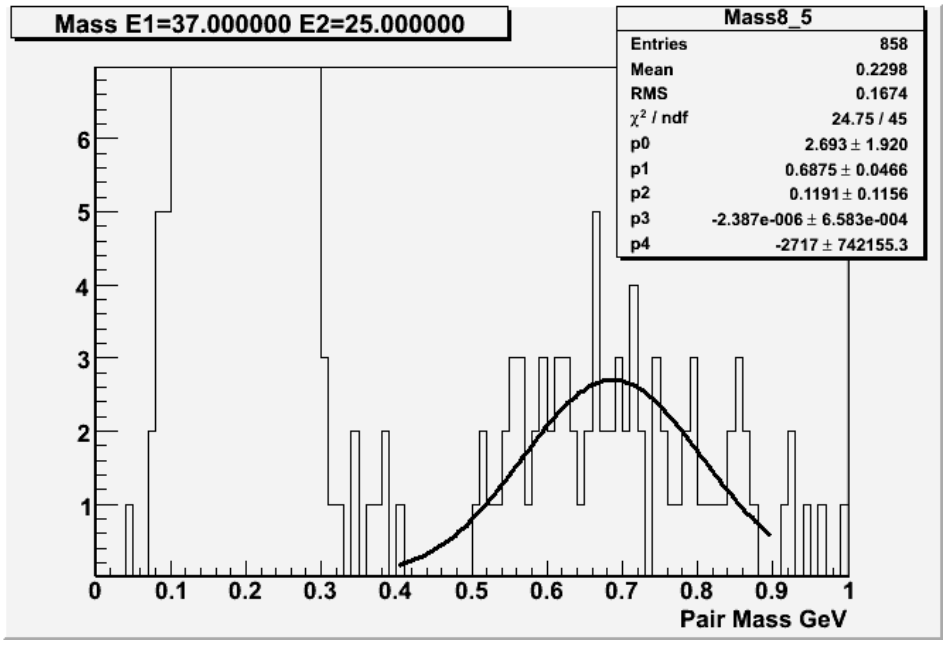
I argue that because of the wide range of channel–by-channel gain variations, many of the channels of the FMS do not contribute to the trigger until very large energy. Those channels that don't significantly contribute to the data set seem to not be well calibrated. This leads to a significant shift in Pi0 and Eta mass peaks for energies of 50 GeV or more. It is not yet clear how to correct the energy for these high energy events but it is likely that new calibration methods will need to be developed.

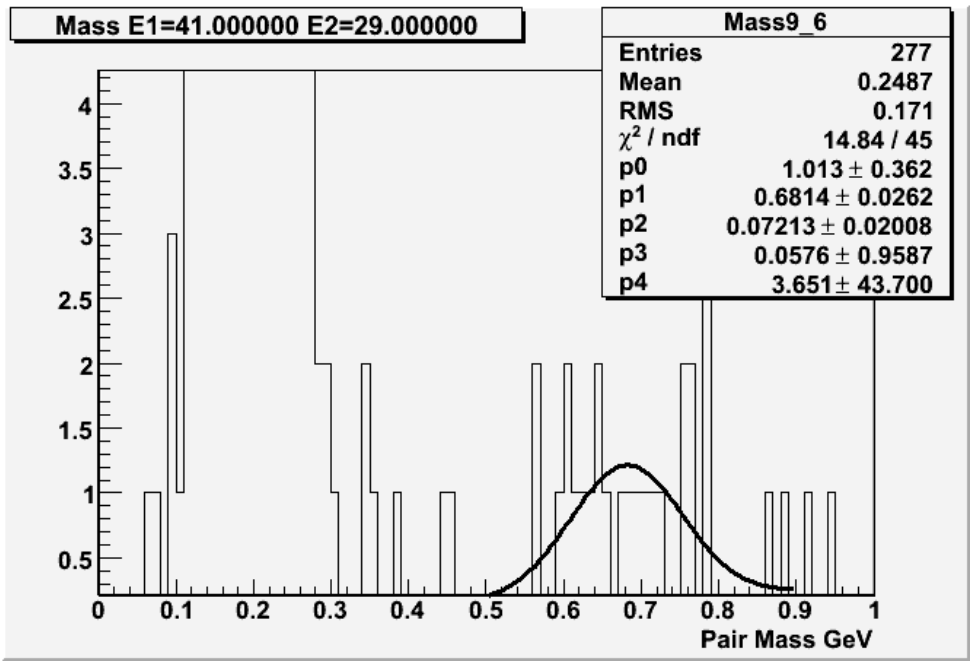
FMS Eta Peak for various E1,E2 bins.

The following plots represent two photon events that are selected to have reconstructed energies of E1 $\pm$ 2GeV and E2 $\pm$ 2GeV as shown. The fits are to a Gaussian + Line.

$$FitForm = p_0 e^{\left(-\frac{(x-p_1)^2}{2\ p_2^2}\right)} + p_3(1+p_4 x)$$







Thus, for the FMS Run 8 data, the high energy event pairs reconstruct to show the Eta peak at mass that is up to 1.25 times the nominal mass of .55 GeV. Exactly what this implies for the energy correction is not clear.

However, when we select high energy Eta candidates, the energy is likely to be lower than the energy than we nominally measure. Because the measured Eta asymmetry seen in Run 6 data seems to be varying rapidly with energy it will be difficult to compare Run 6 and Run 8 data.

If we make the dangerous assumption the Eta mass shift is proportional to the energy shift, then

$$@\,50GeV : E \to (0.87)E \sim 44GeV$$
$$@\,62GeV : E \to (0.80)E \sim 50GeV$$
$$@\,70GeV : E \to (0.80)E \sim 57\,GeV$$

Conclusion

If we select events that reconstruct to energies in a high energy Energy range like **73 GeV to 83 GeV:**

1) The true distribution of actual energies is not yet fully understood!

2) A naïve estimate of the **actual energy range may be as low as ~ 58 GeV to ~66 GeV**

FMS Data for PseudoRapidity 3.5<Y<3.8.

The following 3 plots characterize the FMS data for the rapidity range $3.5 < Y < 3.8$

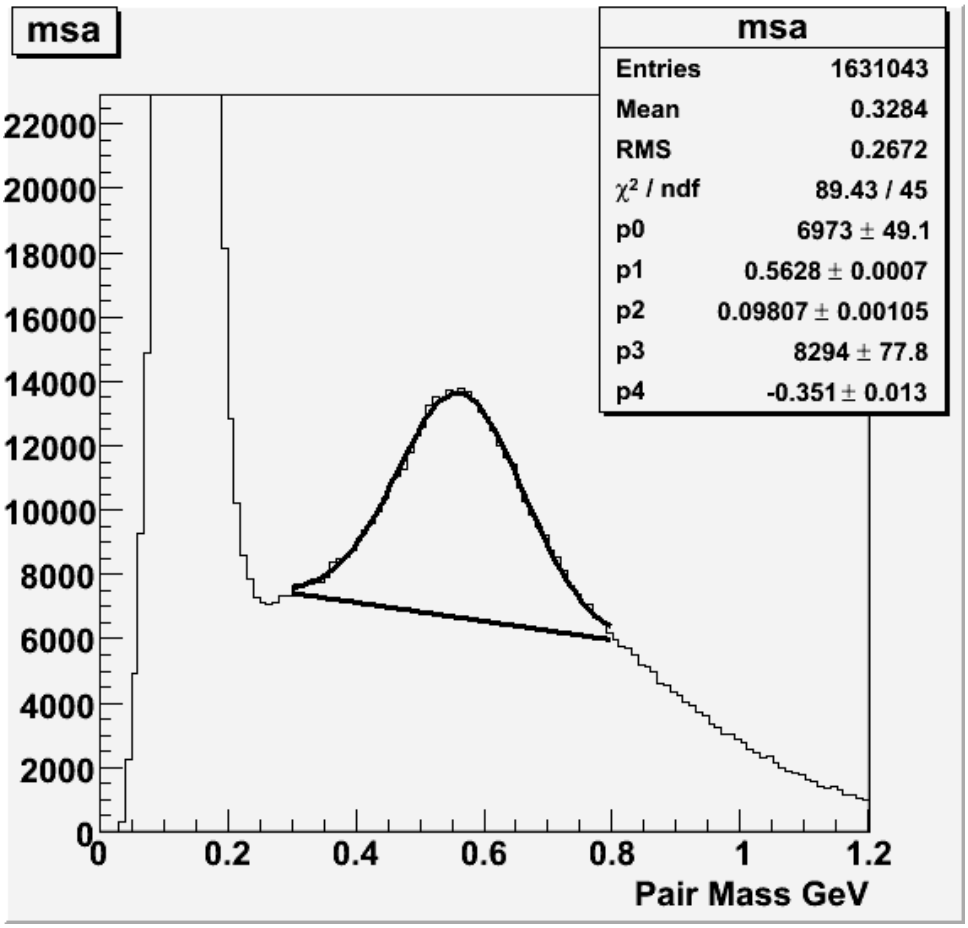


Figure 1: The Mass Distribution for Events in the range 3.5<Y<3.8 and pair energy>30 GeV. Note that the Mass peak is within 1 or 2 % of the nominal Eta Mass. For these data, the average pair Energy is about 39 GeV.

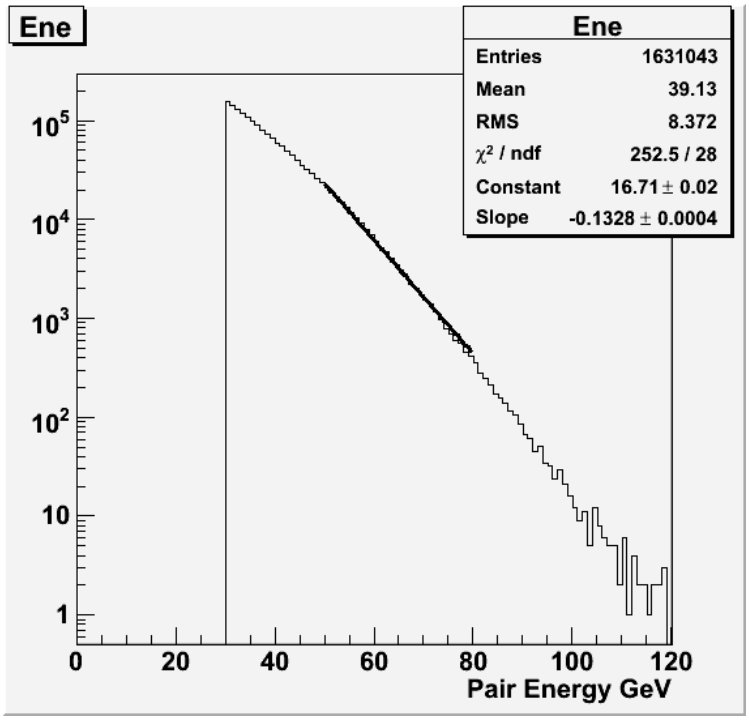


Figure 2: The FMS pair energy distribution for events with 3.5<Y<3.8. Note that the exponential fit to the energy dependence differs significantly from that measured in the FPD at this rapidity region (Figure 4 for FPD Distribution). The FMS data is drawn to higher energy than the FPD data with the magnitude of the slop of .13 in the FMS and .22 in the FPD.

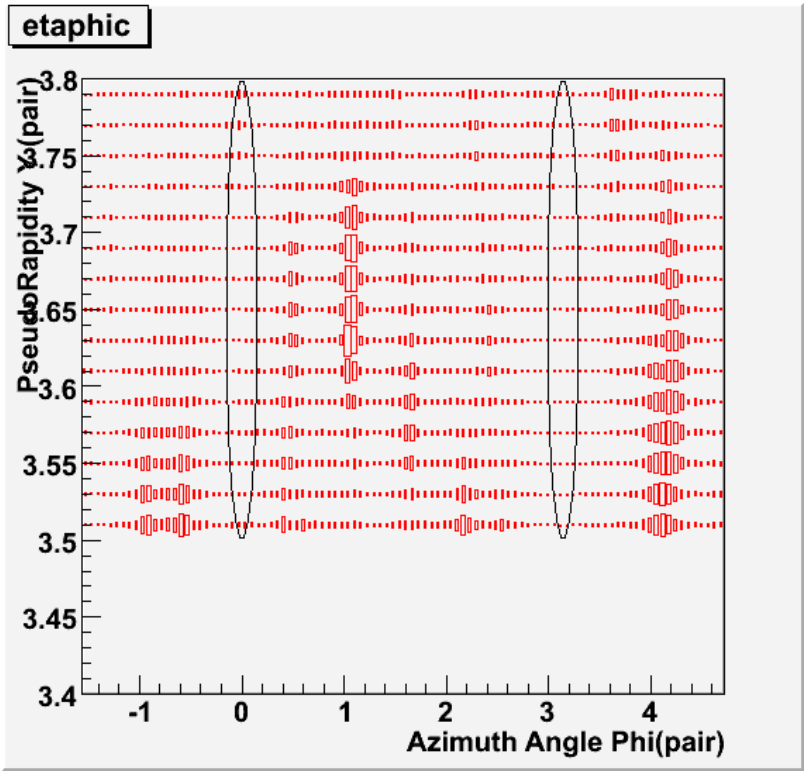


Figure 3: The Y vs. Phi distribution for events shown in Figure 2 and Figure 3. The circles shown indicate the "CenterCut" used in the Run 6 FPD analysis. Note that in the FMS the trigger rate is suppressed in the "CenterCut" region.

Review of Run 6 FPD Result

The following plots represent the Eta signal from the Run 6 FPD during the transverse run with application of the following cuts:

1. Two Photons in one FPD module.
2. CenterCut $\sqrt{(Y-3.65)^2+(\tan(\phi))^2}<0.15$
3. $Z\equiv\left|\frac{E_1-E_2}{E_1+E_2}\right|$<0.8

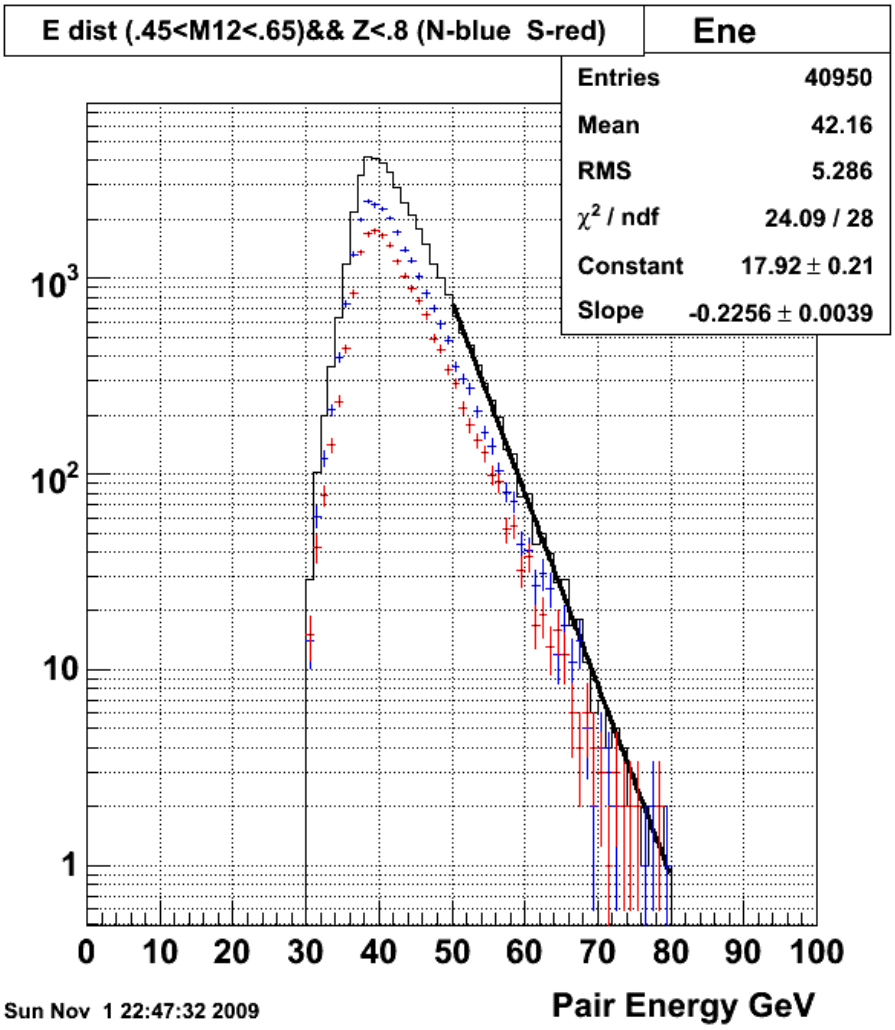


Figure 4: The Energy dependence of selected Eta candidates. Blue/Red indicates the contribution from the North/South FPD modules. The fitted exponential slope of -.22 GeV^{-1} is consistent with an invariant cross section shape of $\frac{(1-x)^5}{p_T^{\,6}}$.

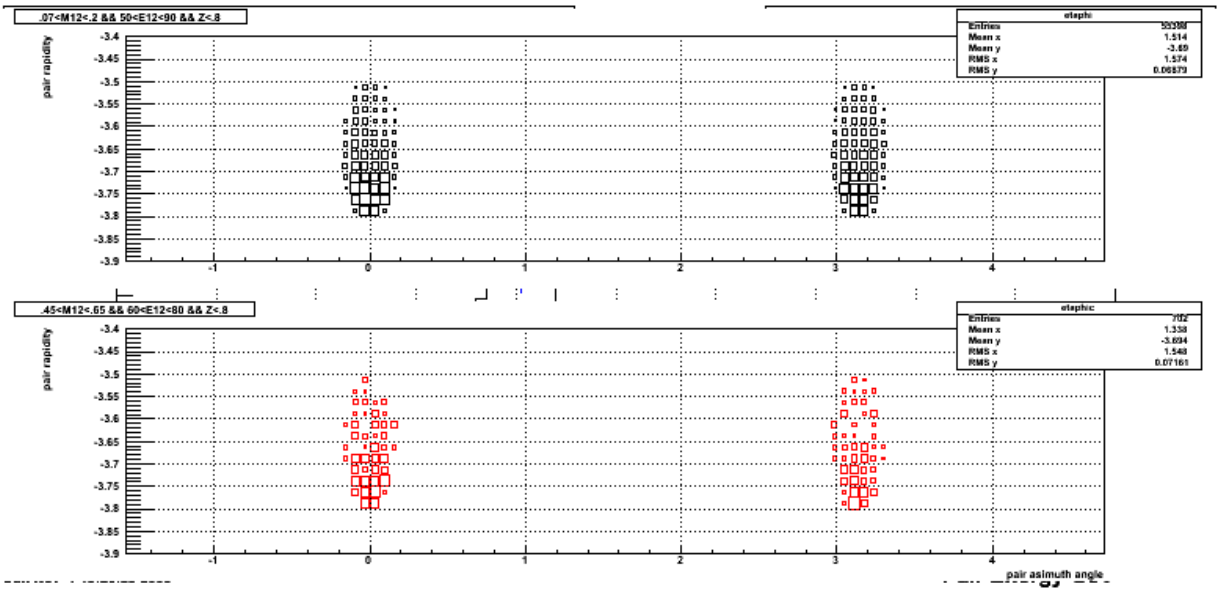


Figure 5: The Pair rapidity vs Phi distribution is shown for
(Upper Black): The pion peak 0.07 GeV<M<0.2 GeV with 50GeV<E<90GeV.
(Lower Red): The Eta peak 0.45<M<.65 with 60 GeV< E < 80 GeV.

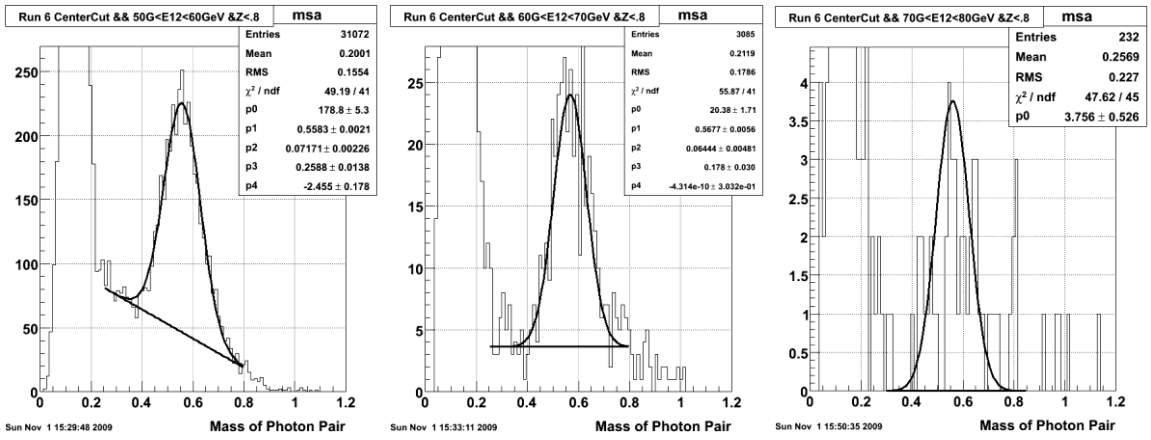


Figure 6: FPD Mass distribution for Centercut events,Z<.8 in 3 energy bins.

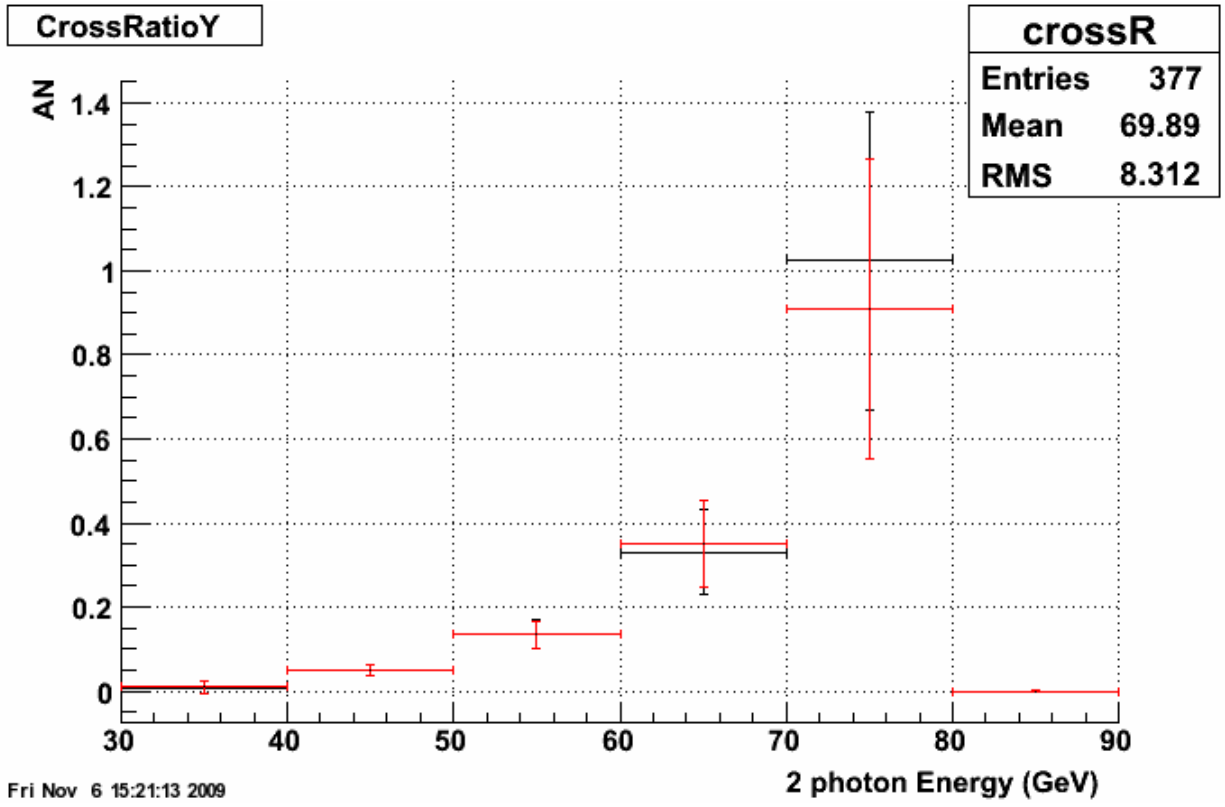


Figure 7: FPD Eta Asymmetry (using Polarization = 0.6), CenterCut, .45 GeV< M<.65 GeV and Z<0.8. The black points represent Cross ratio asymmetries and the red points represent simple single spin asymmetry.

Run 8 FMS result for 3.5<Y<3.8 and 73 GeV<E<83 GeV and Z<0.8

Note, while we select the range 73 GeV<E<83 GeV, it is likely that the actual range is lower, perhaps 58 GeV<E<66 GeV.

In this range of rapidity and energy, we plot the simple asymmetry AN as a function of azimuthal angle phi for the two photon pair. Data are selected to have mass .45<M<.65. Note that this mass cut while nominal for the Eta meson selects the lower half of the mass peak. It is possible that the upper half of the mass peak is more contaminated with low energy events.

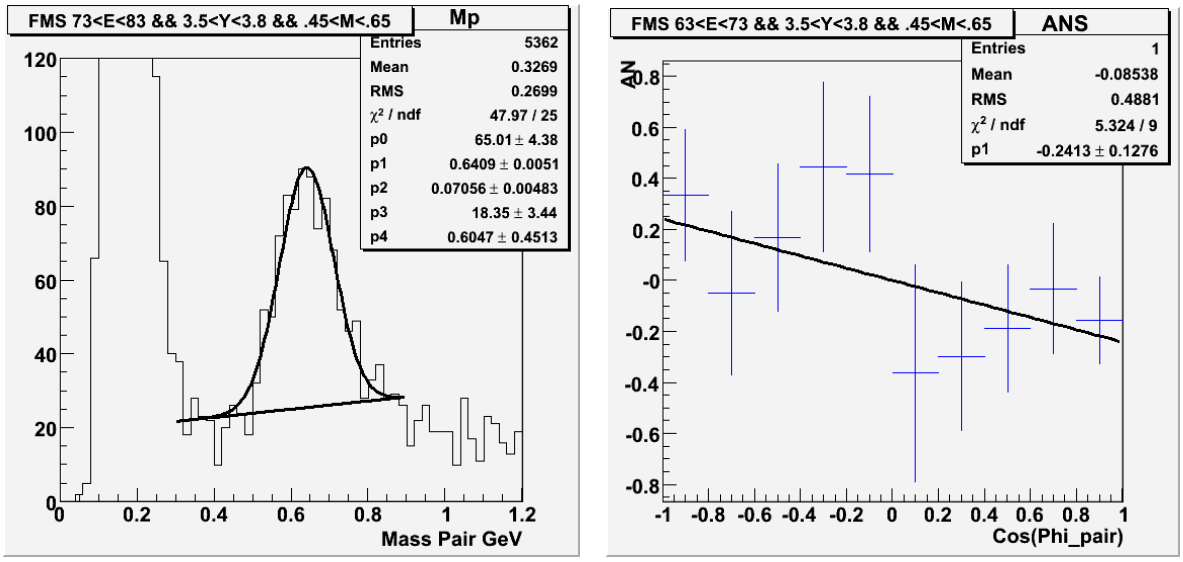


Figure 8: The fit on the right is to the form f(Cos(phi))=p1*cos(Phi). The asymmetry AN is calculated with an assumption of polarization = 50%. The slope p1 is thus the asymmetry. We also note that for the mass cut indicated, about 1/3 of the events appear to be background to the Eta meson. The conclusion is that the asymmetry AN ~ 0.24 +/- .13 with a signal/(signal+background) ratio of about 2/3. If this asymmetry is measured at an actual energy of about 60 GeV, this result is consistent with the FPD result of Figure 7.

It should be noted that to compare this result with the Run 6 FPD result, there are two important differences.

- In the FMS, the energy scale is uncertain for high energy events.
- The Z distributions that result from the FMS Run 8 trigger is essentially the compliment of what is measured in the FPD. The Z distribution of FMS events in this energy and mass range are shown in Figure 9. The background is greater for large Z events. In contrast, for the FPD, the acceptance for Eta mesons is primarily at Z<.5.

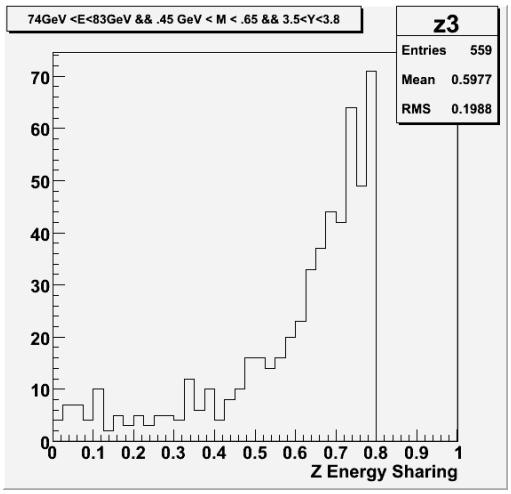


Figure 9: The Z distribution for events in the energy range 74<E<83 GeV and .45<Mass<.65.

Run 8 FMS result for 3.5<Y<3.8 and 83 GeV<E<103 GeV and Z<0.8

This part of the energy distribution most likely again maps to lower energy, perhaps to the 70-80 GeV region?

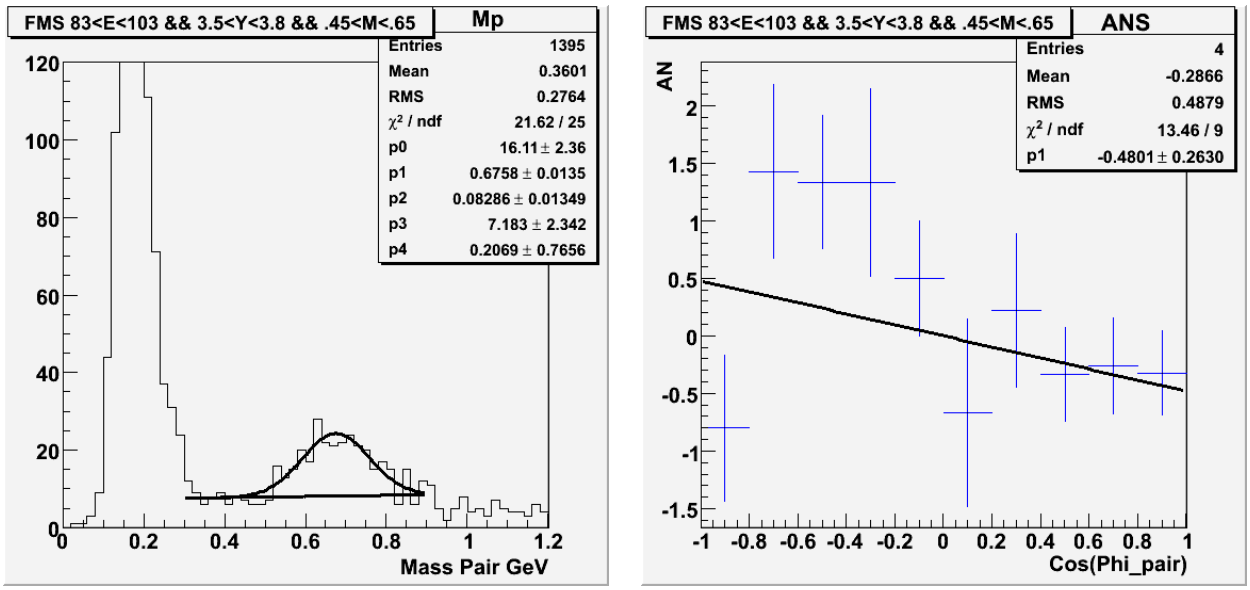


Figure 10: The fit on the right is to the form f(Cos(phi))=p1*cos(Phi). The asymmetry AN is calculated with an assumption of polarization = 50%. The slope p1 is thus the asymmetry. We also note that for the mass cut indicated, about 1/3 of the events appear to be background to the Eta meson. The conclusion is that the asymmetry AN ~ 0.48 +/- .26 with a signal/(signal+background) ratio of about 2/3. If this asymmetry is measured at an actual energy of about 75 GeV, this result is consistent with the FPD result of Figure 7.

Conclusion: Plausible Consistency between FPD and FMS.

So in conclusion, the FMS Eta meson peak has been seen in the Run 8 FMS. At large pair energy there is some evidence of large single spin asymmetries in the FMS. From the FPD data, we see an apparent rapid change of AN with energy. Because of unanswered questions about the energy calibration in the high energy region, we cannot make a definitive statement about the energy dependence of AN at this time.

- We measure AN in the same rapidity range as was used in the FPD CenterCut but over a fully expanded azimuthal angle phi region.
- Data are consistent with large asymmetries at large energies.
- The energy of the selected data is large but somewhat uncertain.
- In an energy range which may be around 60 GeV, FMS data favors an asymmetry of about 24%+/- 13% , which could increase to as much as about 35% if background is considered.
- In an energy range which may be around 75 GeV, FMS data favors an asymmetry of about 48%+/-26%. Again this could rise if background is taken into account.
- Because of the Z acceptance differences, background is likely greater for FMS data.

While there are many questions about analysis of the FMS data, there appears to be nothing that would clearly contradict the FPD result.