Updates on Run12 π^0 – jet A_{LL}

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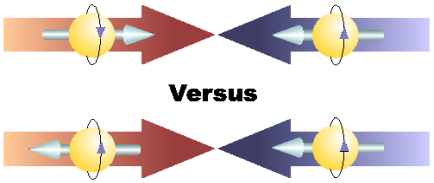


Outline

- Updated variable binning
- Updated signal yield estimation method
- Updated asymmetry results

Main updates

- The variable bin widths are adjusted (wider).

- The signal yield estimation method is updated:
  (1) fix the signal and background shapes in each bin by fitting the 4-spin-state combined spectrum;
  (2) then only fit the signal and background normalization for each bin.

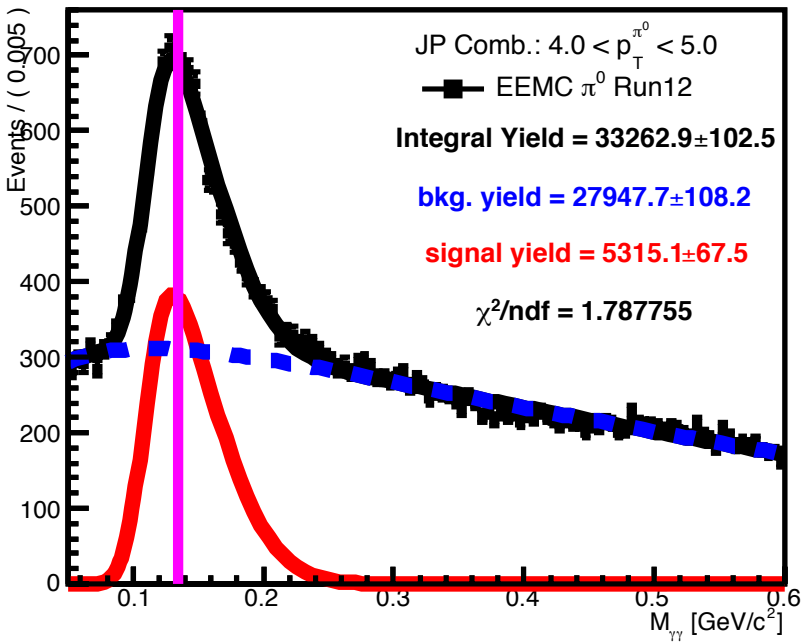
- In the last results (June 27), constraints on the signal fraction were set during fitting for several bins (which could cause the absence of fluctuations of the asymmetries).

Asymmetry Analysis -- variable re-binning

```
const Double_t mPi0PTbins_rebin[8]={ 4.0, 5.0, 6.0, 8.0, 10.0, 12.0, 16.0, 36.0};

const Double_t mJetPTbins_rebin[8] = {7.1, 9.9, 13.8, 19.2, 26.8, 37.3, 51.9, 100.0};

const Double_t mPi0JetMassbins_rebin[7] = {17.0, 24.0, 35.0, 50.0, 72.0, 100.0, 200.0};

const Double_t mX1bins_rebin[6] = { 0.07, 0.10, 0.15, 0.23, 0.35, 0.53};

const Double_t mX2bins_rebin[6] = { 0.01, 0.02, 0.04, 0.06, 0.12, 0.24};
```

Asymmetry Analysis – signal yield estimation method update

$\Sigma P_B P_Y (N^{++} + N^{--})$



The invariant mass spectrum (weighted by relative luminosities and beam polarizations), are fitted to estimate signal yield for each kinematic variable bin, respectively.

$$sig(x):\ k \times e^{\frac{-(x-\mu)^2}{2\sigma^2}} \times [1 + \mathrm{Erf}(\frac{a(x-\mu)}{\sqrt{2}\sigma})]$$

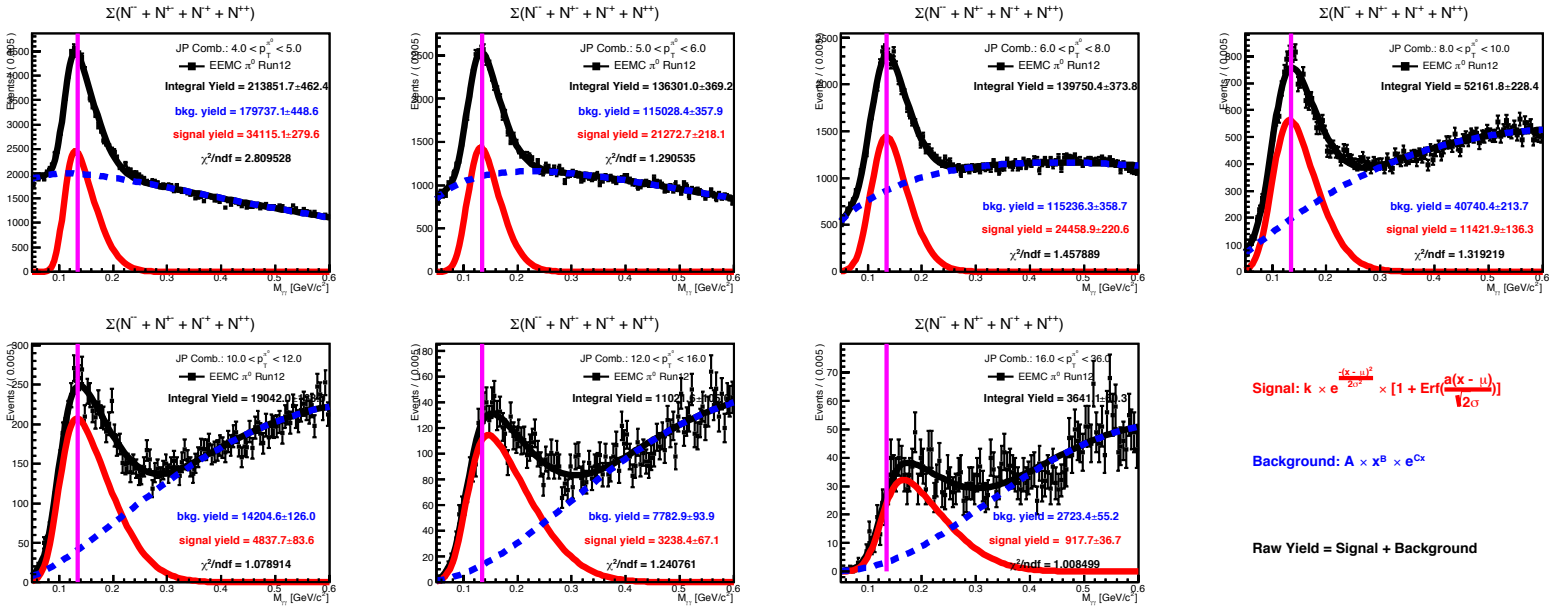
$$bkg(x):\ A \times x^B \times e^{Cx}$$

$$model(x) = \frac{n_{sig}}{n_{sig}+n_{bkg}} * sig(x) + \frac{n_{bkg}}{n_{sig}+n_{bkg}} * bkg(x)$$

$$n_{raw} * model(x) = n_{sig} * sig(x) + n_{bkg} * bkg(x)$$

- The **raw yield** (n_{raw})of π^0-jet are well fitted by *model(x)*, in which the signal shape was described by **skewed Gaussian function** *sig(x)*, and background shape was fitted by **Gamma function** *bkg(x)*;
- The shapes of *sig(x)* and *bkg(x)* were determined by fitting the spectrum summed over spin states.
- ***Signal yield*** **(n_{sig})** and **background yield (n_{bkg})** are estimated by fitting over [0.05, 0.6] GeV/c^2 with the fixed *sig(x)* and *bkg(x)* shapes, according $n_{raw} * model(x) = n_{sig} * sig(x) + n_{bkg} * bkg(x)$
- Signal (background) asymmetries, A_{LL}^{S} (A_{LL}^{B}), are calculated by the fitted normalization n_{sig} (n_{bkg}).

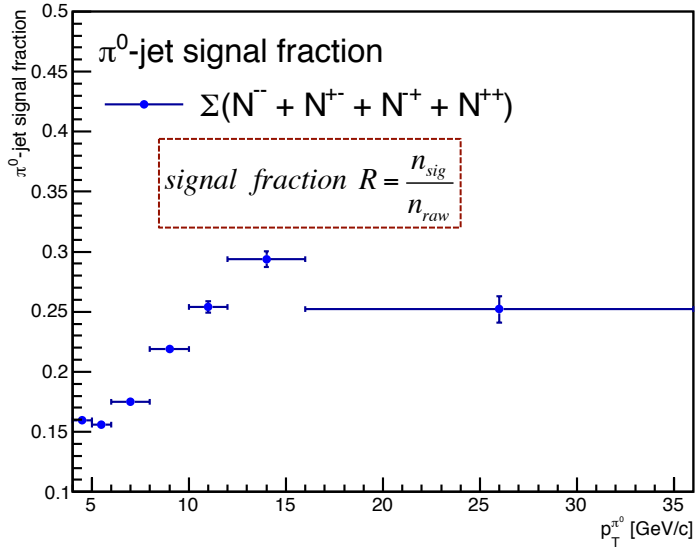
Asymmetry Analysis – determine *sig(x)* & bkg(x) shapes for π^0 p_T bins

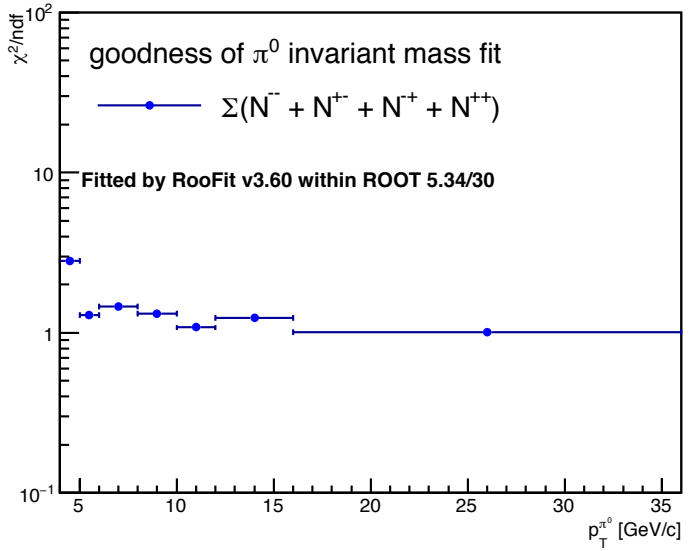


Signal: $k \times e^{\frac{-(x-\mu)^2}{2\sigma^2}} \times [1 + Erf(\frac{a(x-\mu)}{\sqrt{2}\sigma})]$

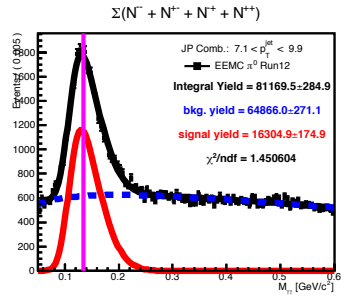
Background: $A \times x^B \times e^{Cx}$

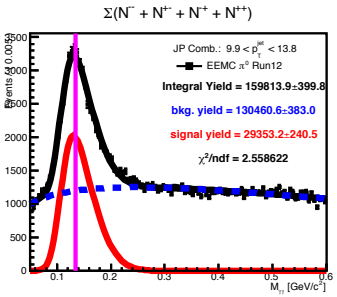
Raw Yield = Signal + Background

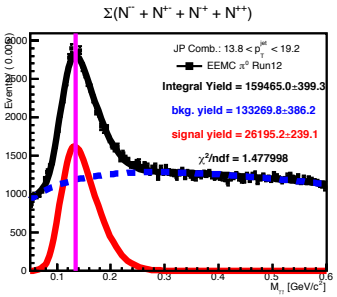


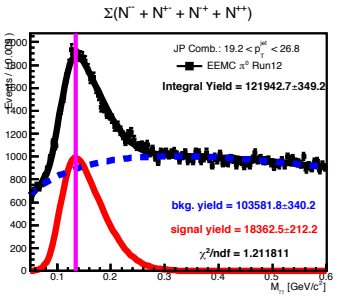


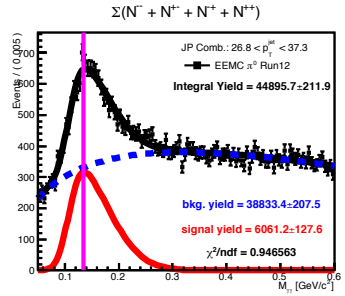
Asymmetry Analysis – determine *sig(x)* & bkg(x) shapes for jet p_T bins

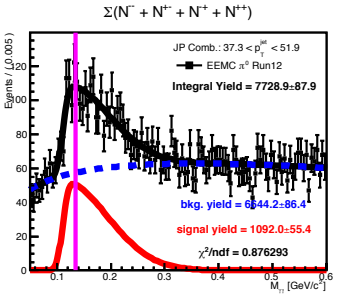


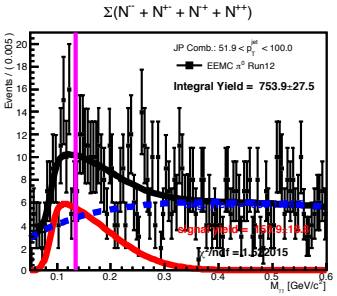








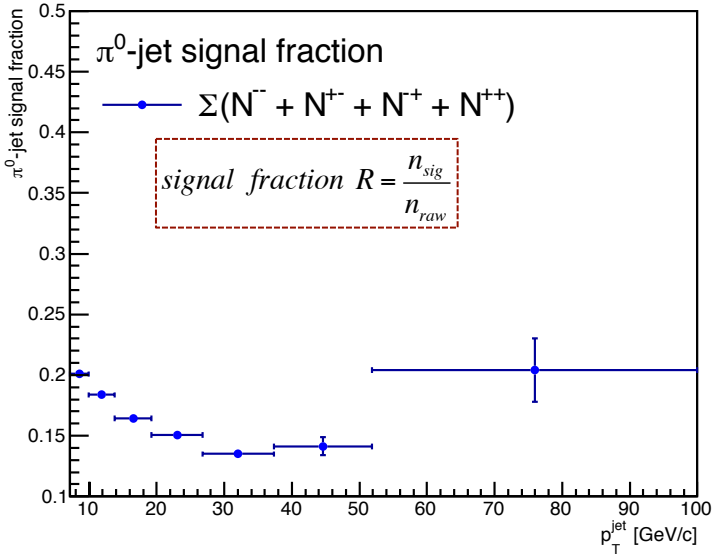


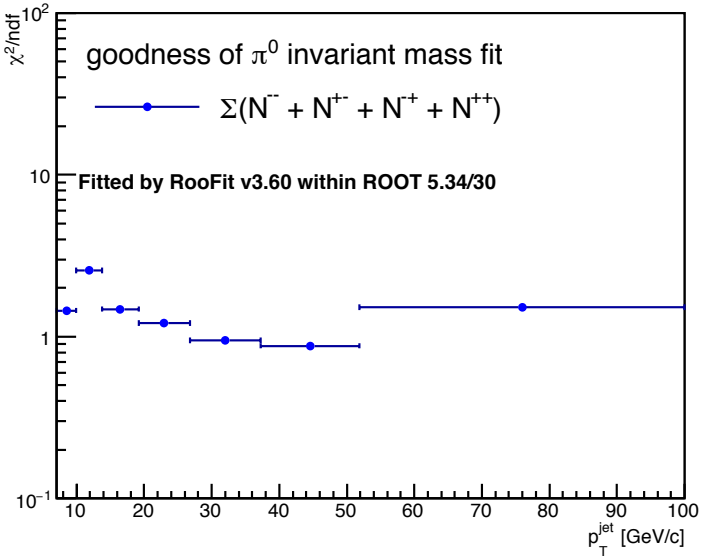


Signal: $k \times e^{\frac{-(x-\mu)^2}{2\sigma^2}} \times [1 + Erf(\frac{a(x-\mu)}{\sqrt{2}\sigma})]$

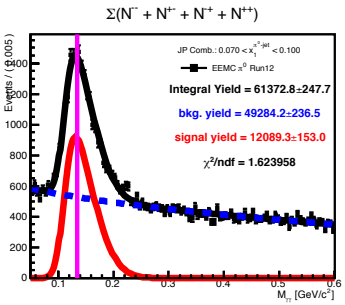
Background: $A \times x^B \times e^{Cx}$

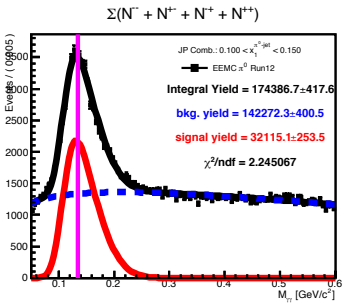
Raw Yield = Signal + Background

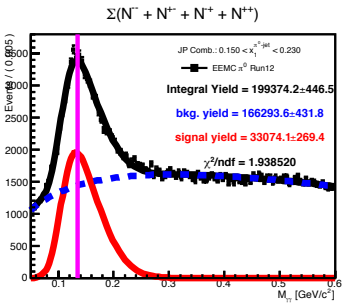


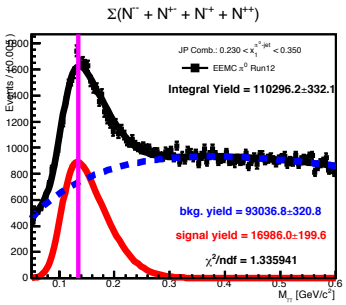


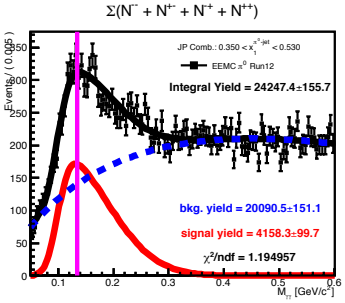
Asymmetry Analysis – determine *sig(x)* & bkg(x) shapes for x_1 bins







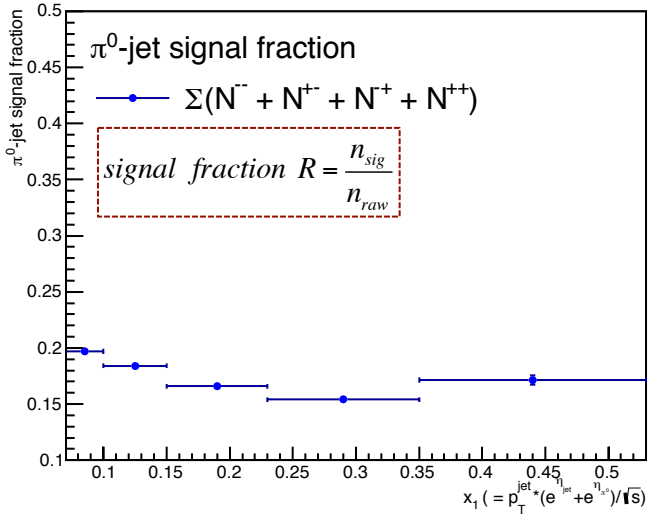


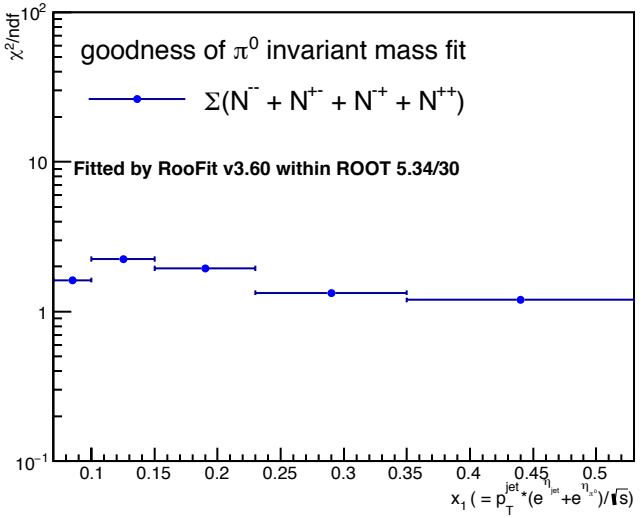


Signal: $k \times e^{\frac{-(x-\mu)^2}{2\sigma^2}} \times [1 + \mathrm{Erf}(\frac{a(x-\mu)}{\sqrt{2}\sigma})]$

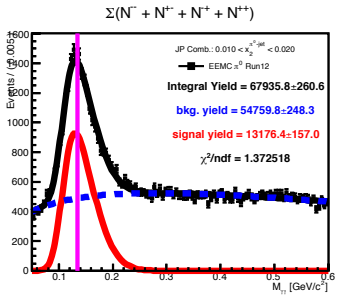
Background: $A \times x^B \times e^{Cx}$

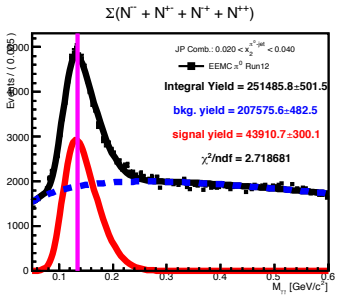
Raw Yield = Signal + Background

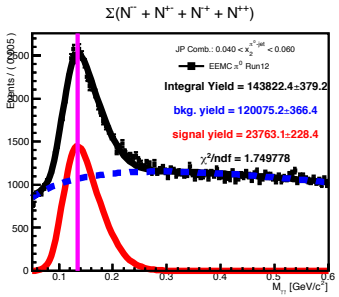


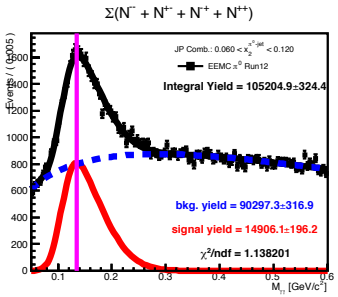


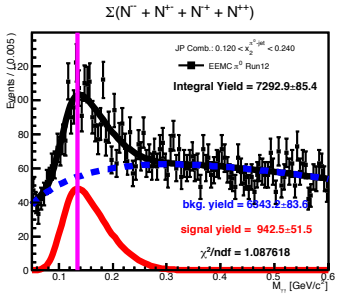
Asymmetry Analysis – determine *sig(x)* & bkg(x) shapes for x_2 bins







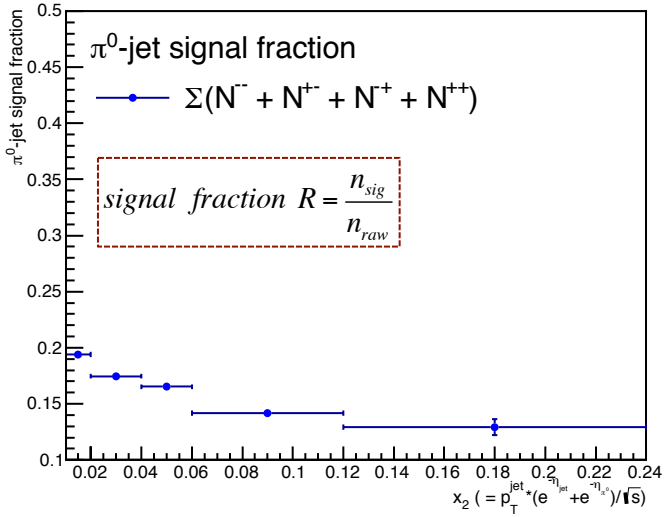


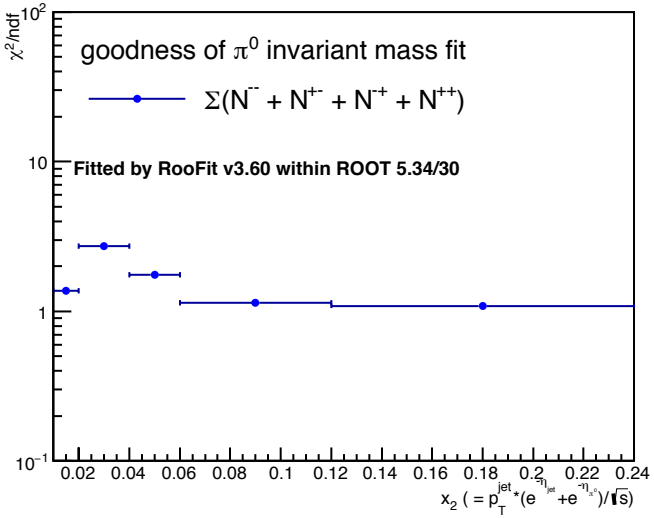


Signal: $k \times e^{\frac{-(x-\mu)^2}{2\sigma^2}} \times [1 + Erf(\frac{a(x-\mu)}{\sqrt{2}\sigma})]$

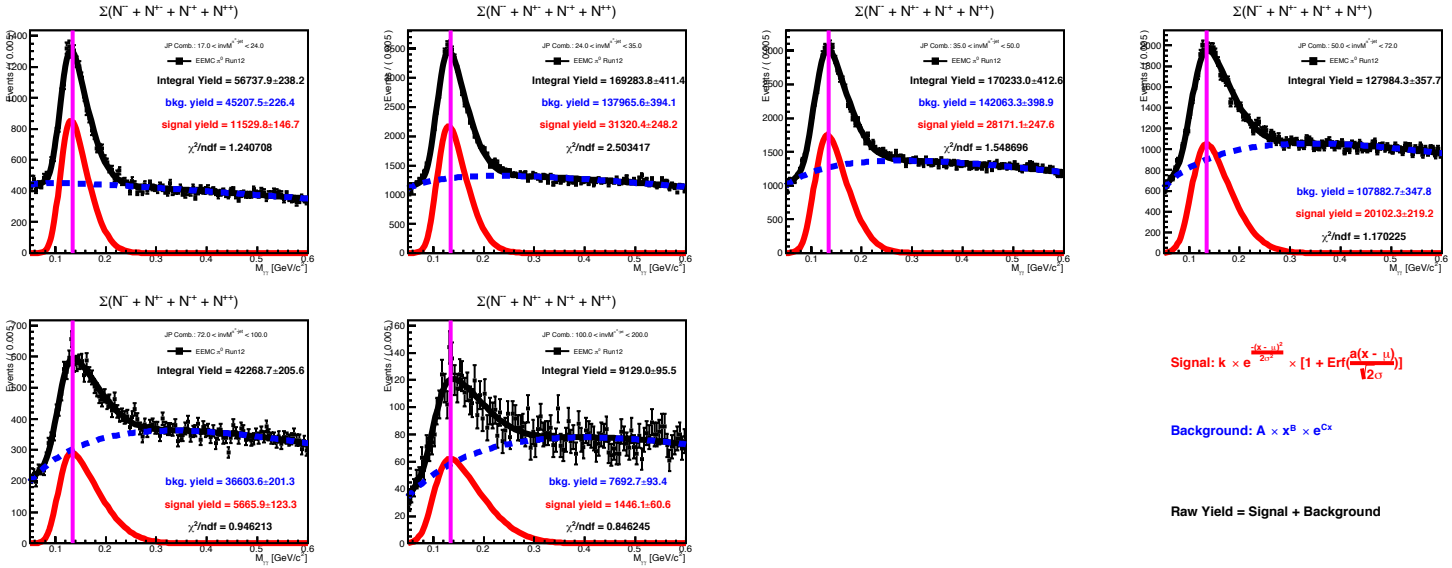
Background: $A \times x^B \times e^{Cx}$

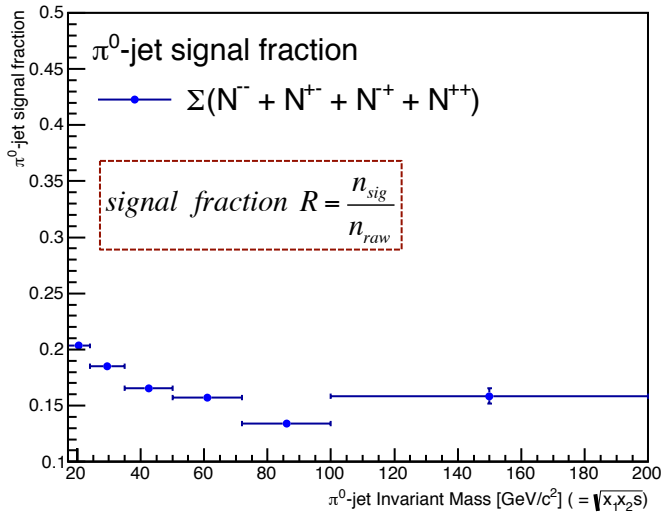
Raw Yield = Signal + Background

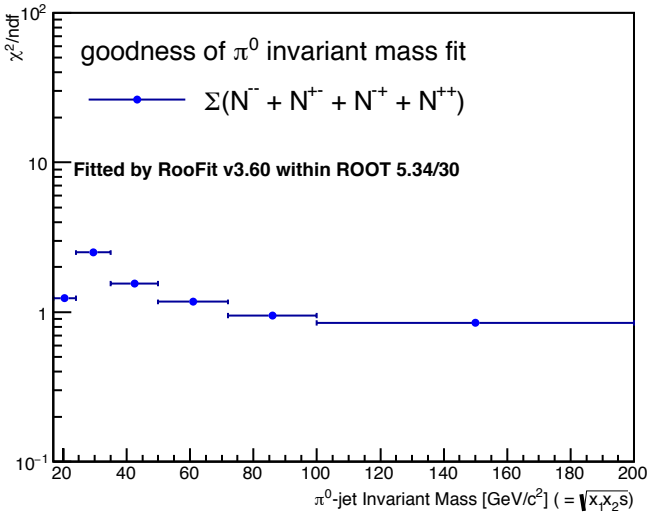




Asymmetry Analysis – determine *sig(x)* & bkg(x) shapes for *inv. mass* bins



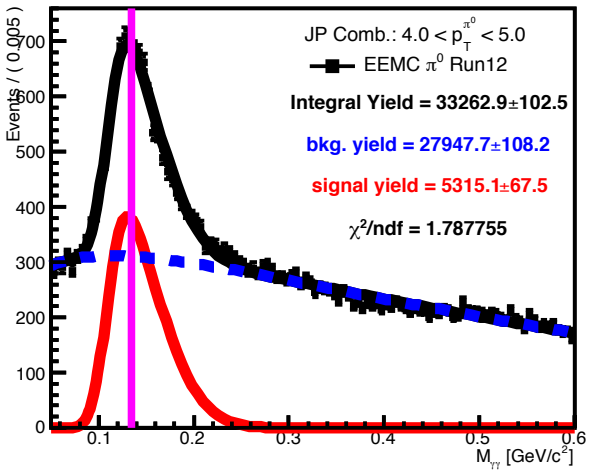




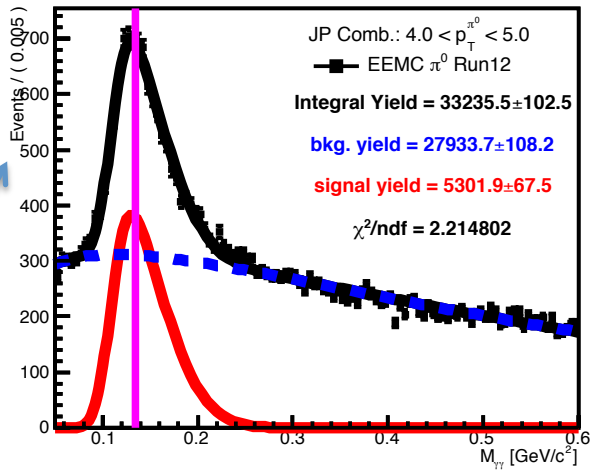
Asymmetry Analysis – Calculate the signal asymmetry A_{LL}

- Using the fixed signal and background shapes, *sig(x)* and *bkg(x)*, then only fit the signal and background normalization (n_{sig} and n_{bkg}) for each bin (taking the A_{LL} in π^0 p_T bin [4.0,5.0] for an example).

$\Sigma P_B P_Y (N^{++} + N^{--})$

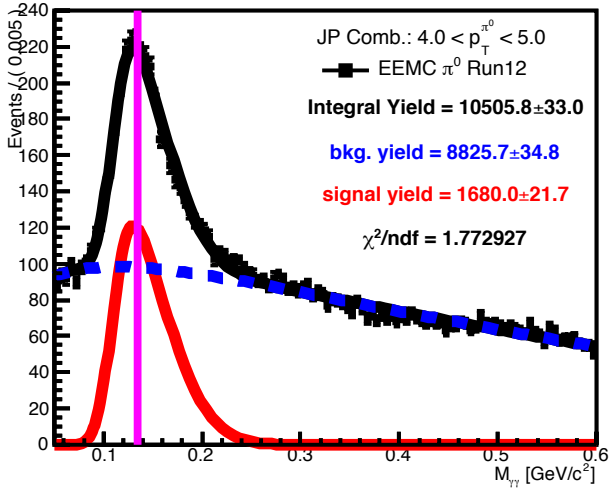


$\Sigma P_B P_Y R_3 (N^{+-} + N^{-+})$

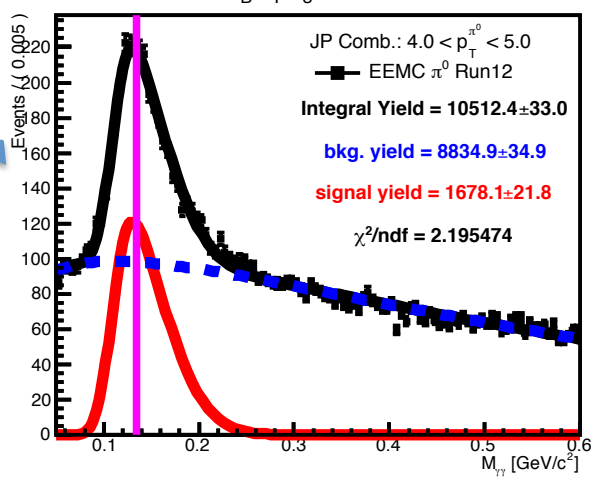


$$A_{LL} = \frac{\sum P_Y P_B [(N^{++} + N^{--}) - R_3 (N^{+-} + N^{-+})]}{\sum P_Y^2 P_B^2 [(N^{++} + N^{--}) + R_3 (N^{+-} + N^{-+})]}$$

$\Sigma P_B^2 P_Y^2 (N^{++} + N^{--})$



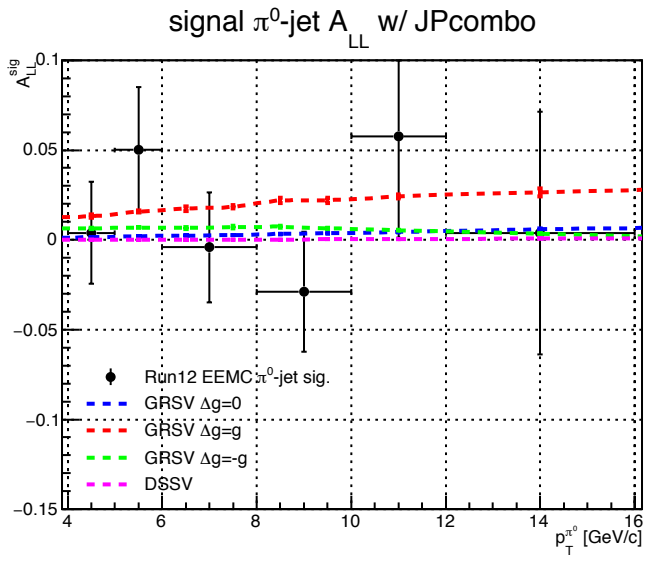
$\Sigma P_B^2 P_Y^2 R_3 (N^{+-} + N^{-+})$

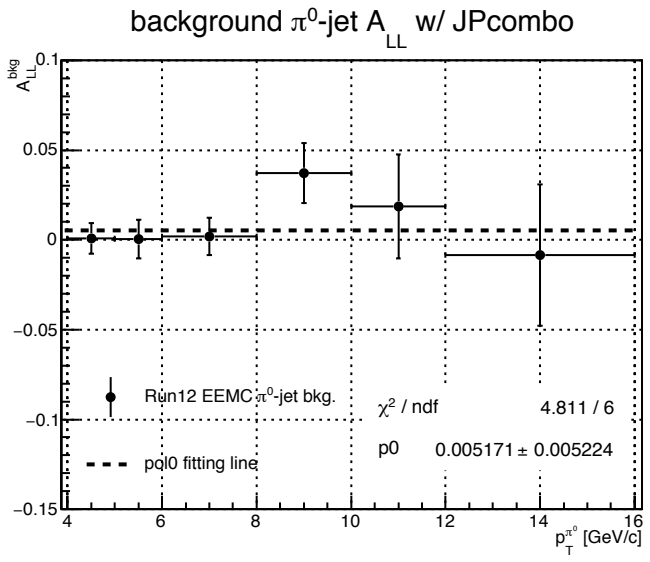


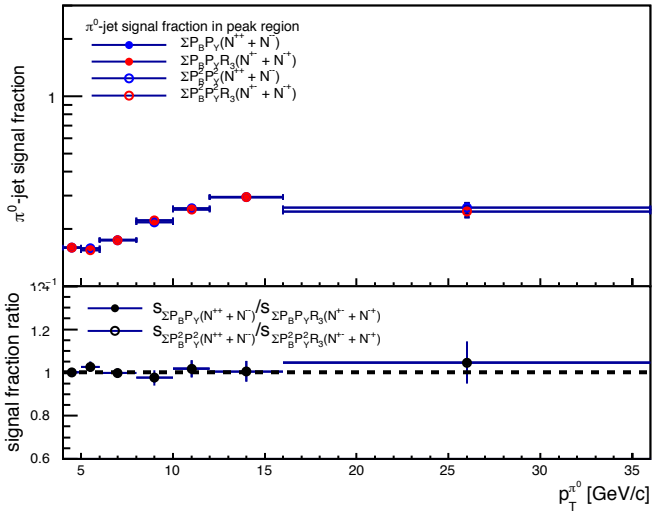
Note: correlations between numerator and denominator was not considered yet, and will be take into account (could reduce the statistical uncertainties).

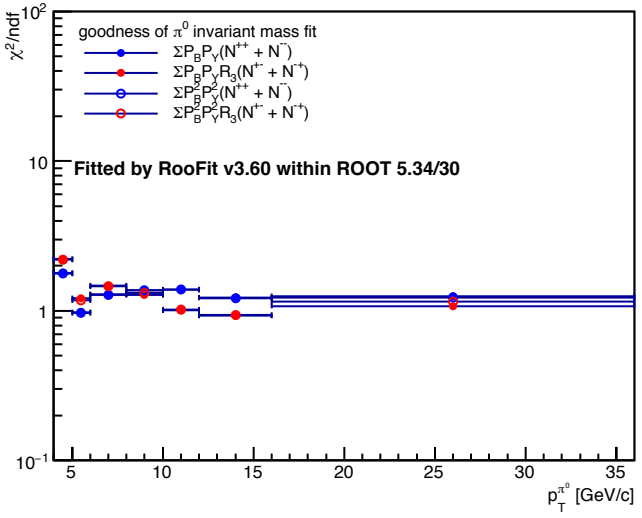
Asymmetry Results -- Updated longitudinal double asymmetry, A_{LL}

Longitudinal double asymmetry, A_{LL}^{Sig} (left) and A_{LL}^{Bkg} (right), as a function of π^0 p_T :



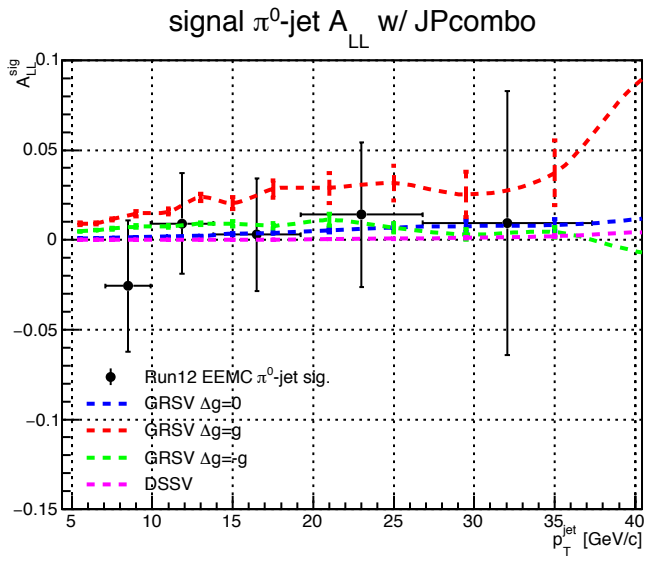


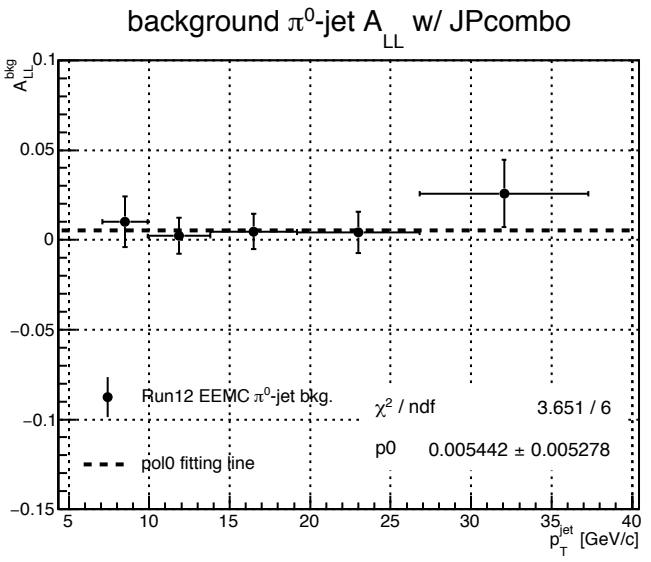


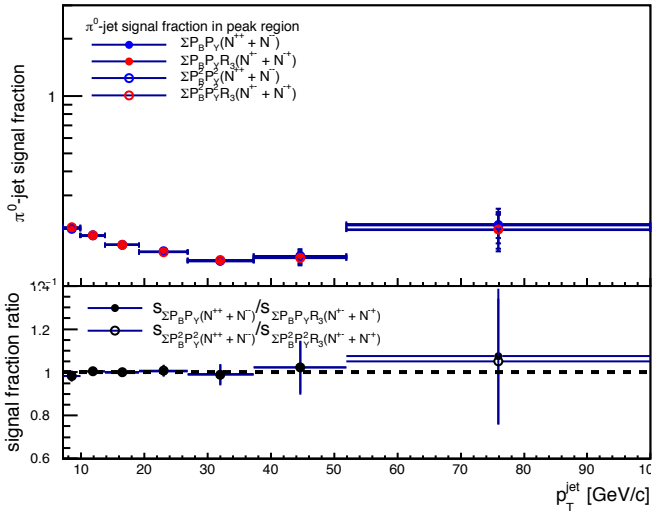


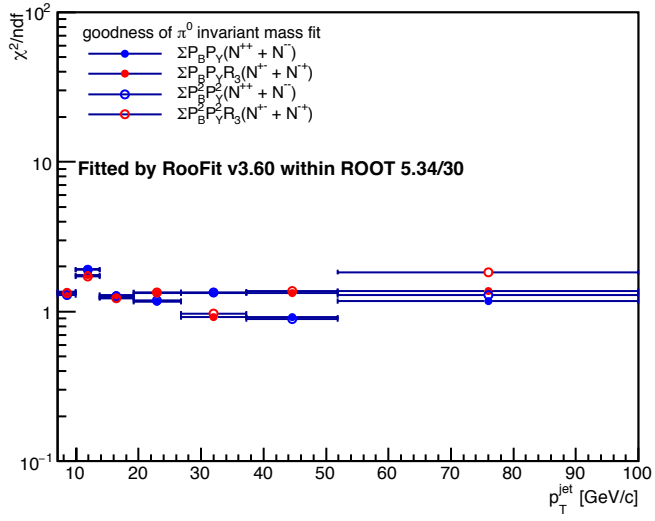
Asymmetry Results -- Updated longitudinal double asymmetry, A_{LL}

Longitudinal double asymmetry, A_{LL}^{Sig} (left) and A_{LL}^{Bkg} (right), as a function of jet p_T :



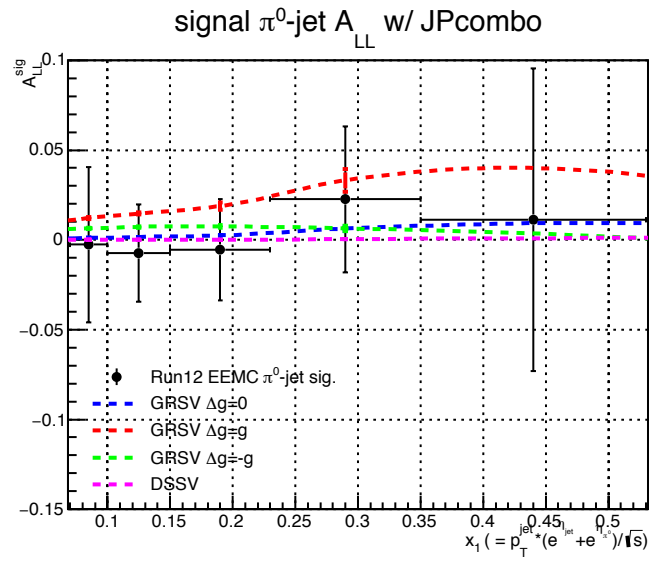


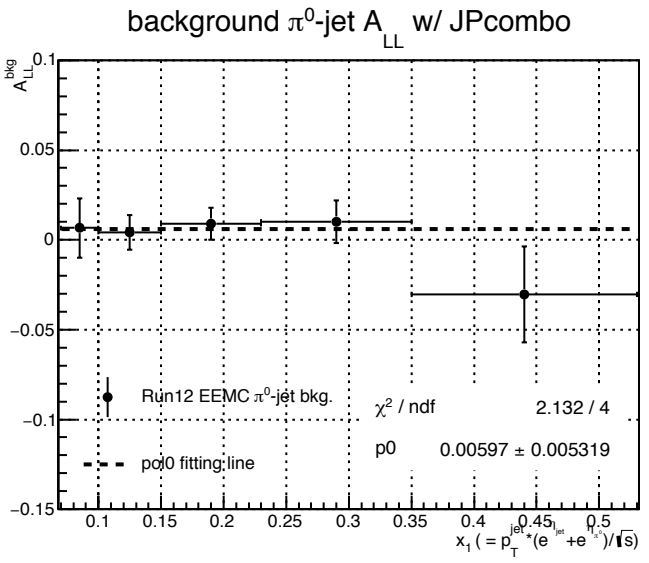


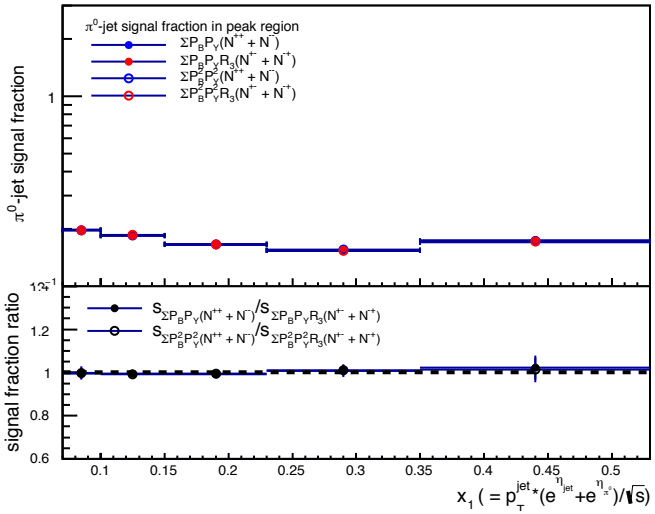


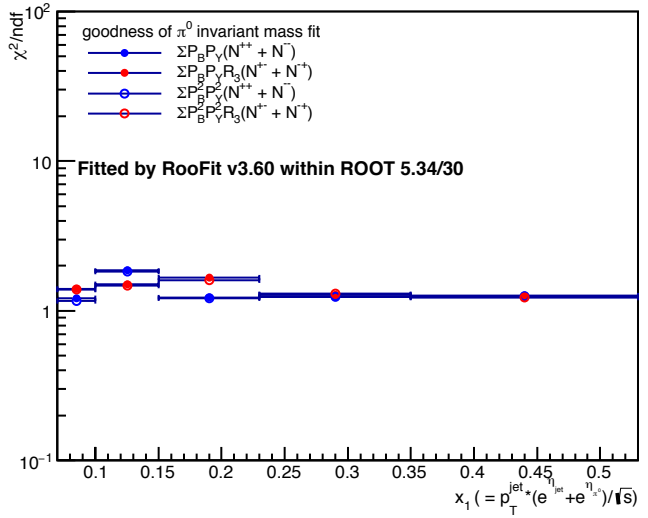
Asymmetry Results -- Updated longitudinal double asymmetry, A_{LL}

Longitudinal double asymmetry, A_{LL}^{Sig} (left) and A_{LL}^{Bkg} (right), as a function of π^0-jet x_1 :



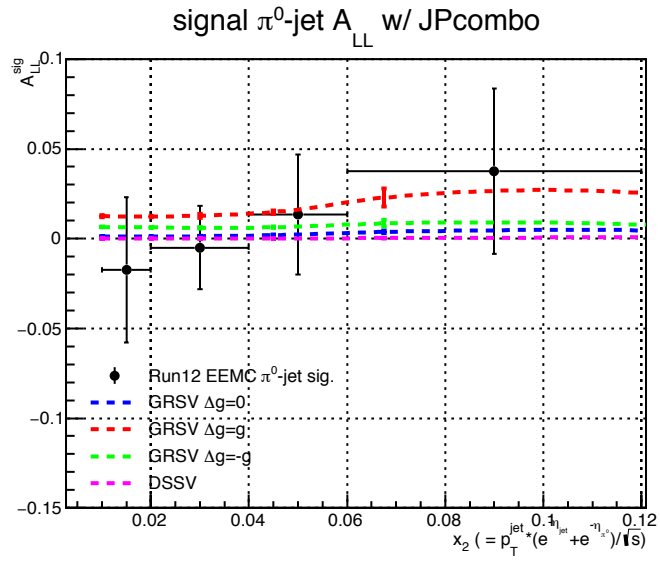


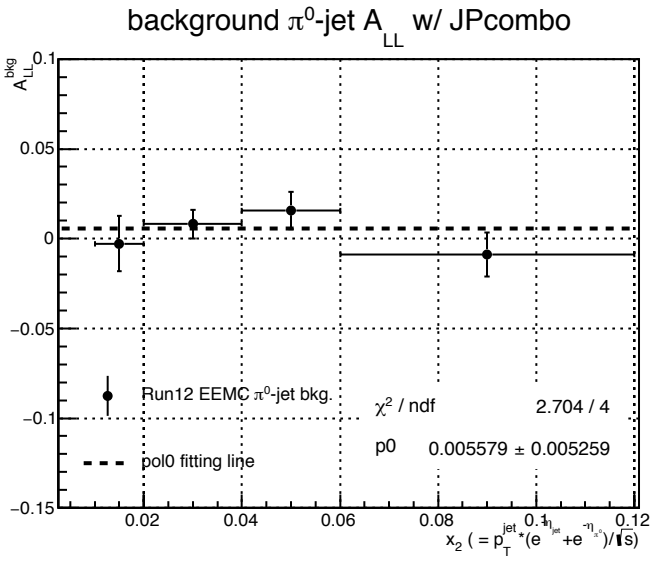


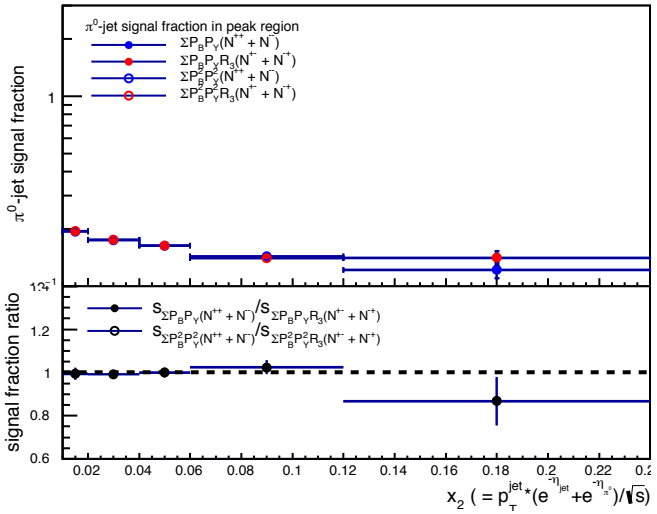


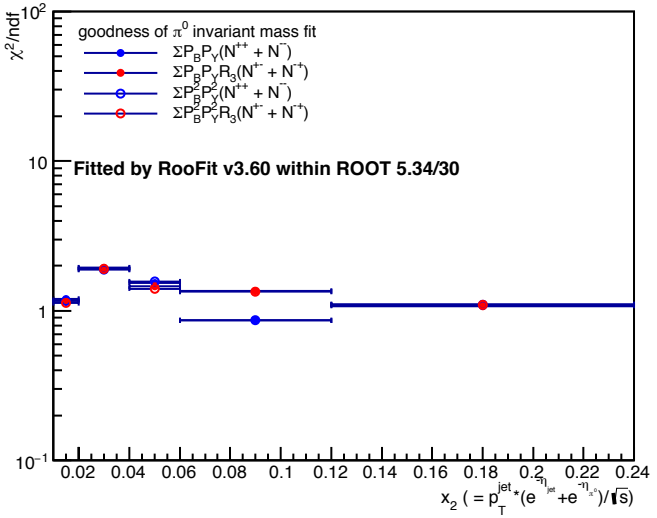
Asymmetry Results -- Updated longitudinal double asymmetry, A_{LL}

Longitudinal double asymmetry, A_{LL}^{Sig} (left) and A_{LL}^{Bkg} (right), as a function of π^0-jet x_2 :



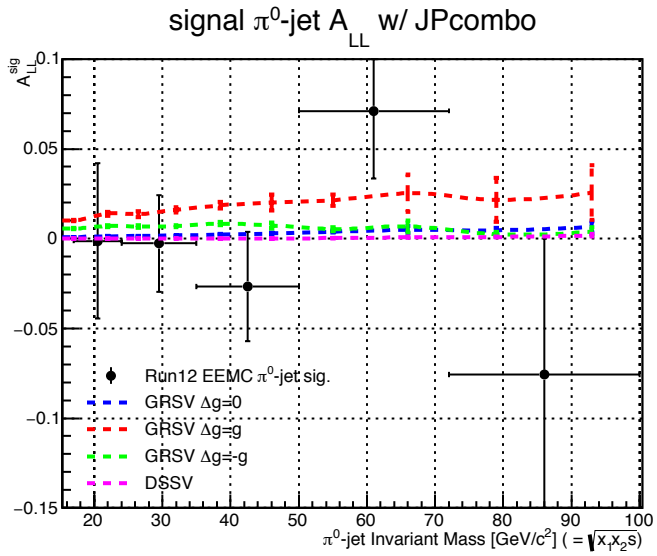


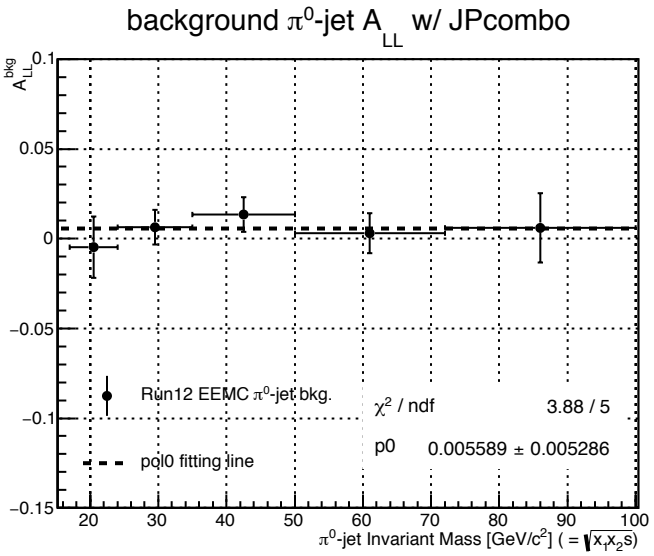


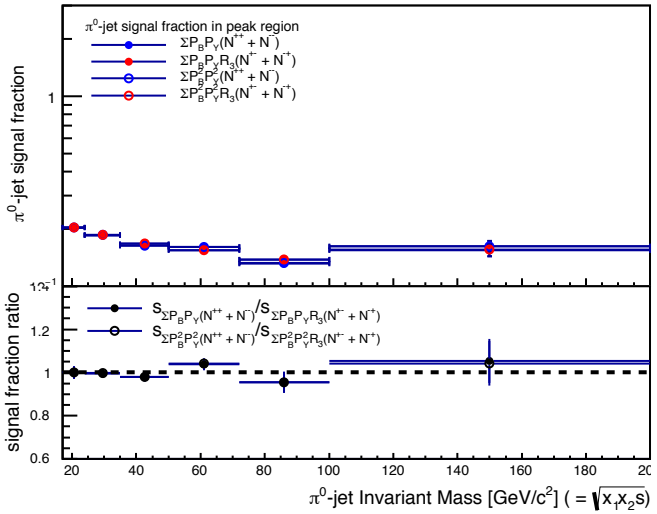


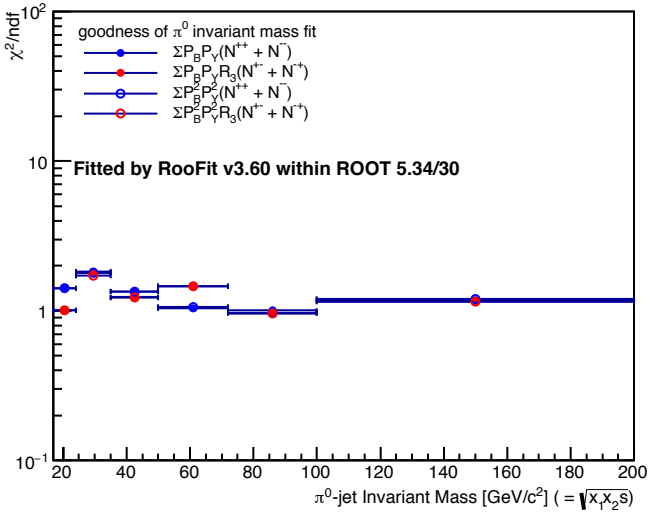
Asymmetry Results -- Updated longitudinal double asymmetry, A_{LL}

Longitudinal double asymmetry, A_{LL}^{Sig} (left) and A_{LL}^{Bkg} (right), as a function of π^0-jet *inv. Mass*:



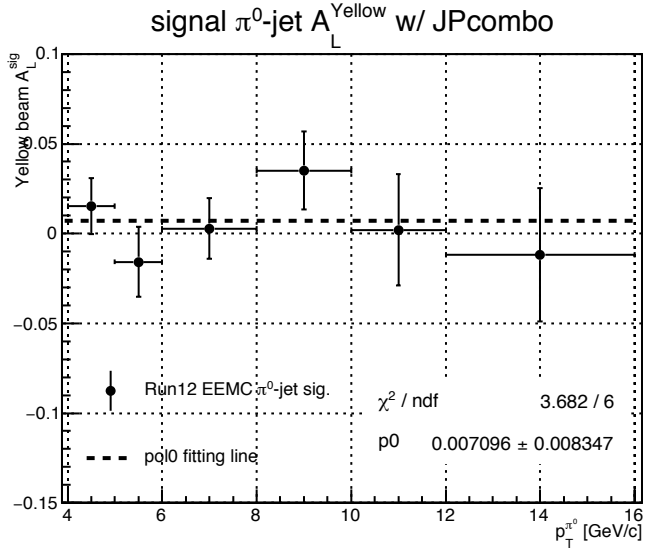


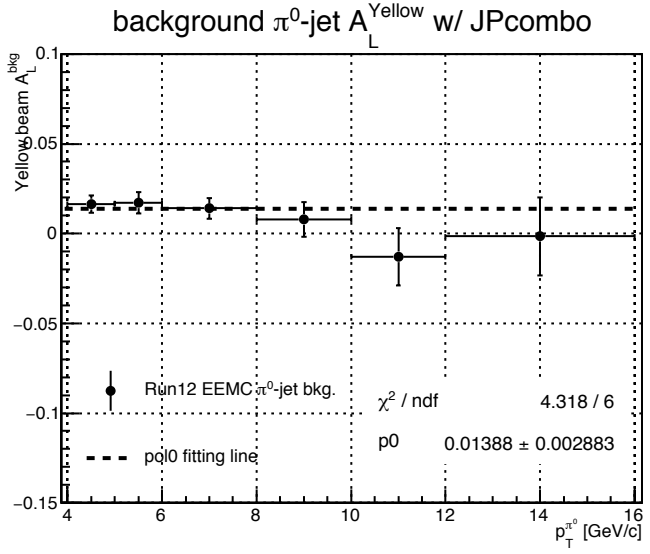


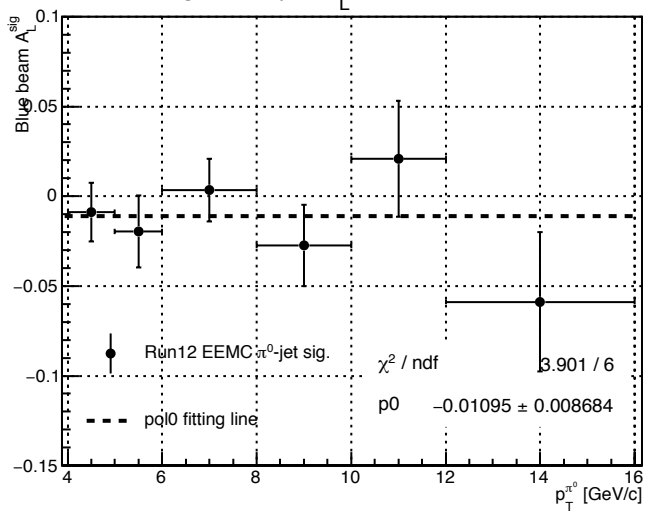


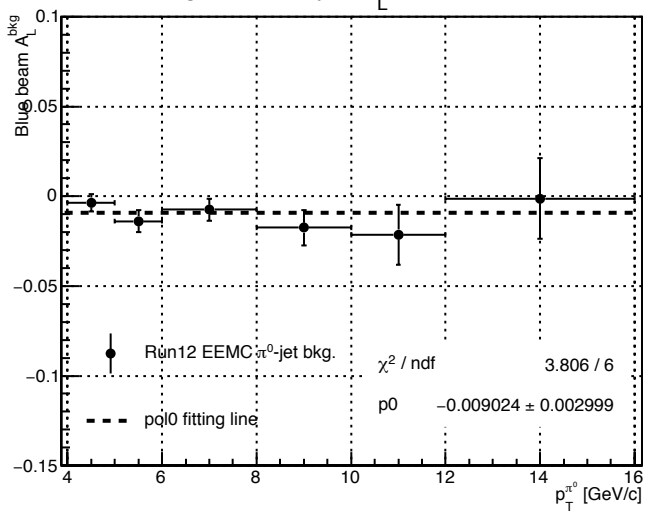
Asymmetry Results – Updated single asymmetries, A_L^Y, A_L^B

π^0 p_T bins



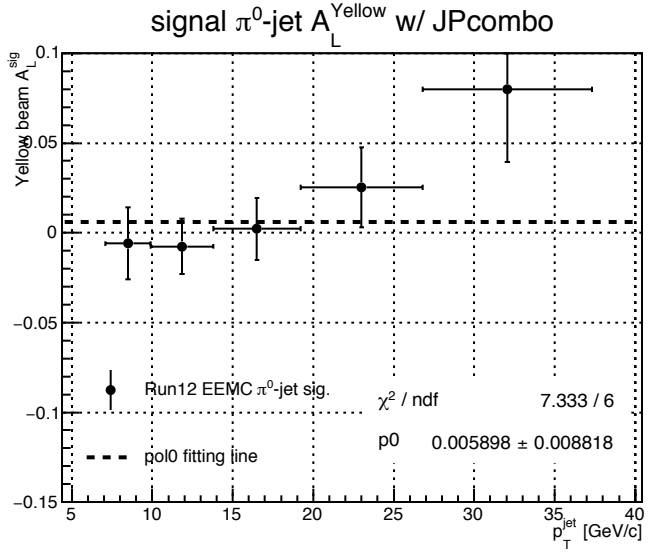


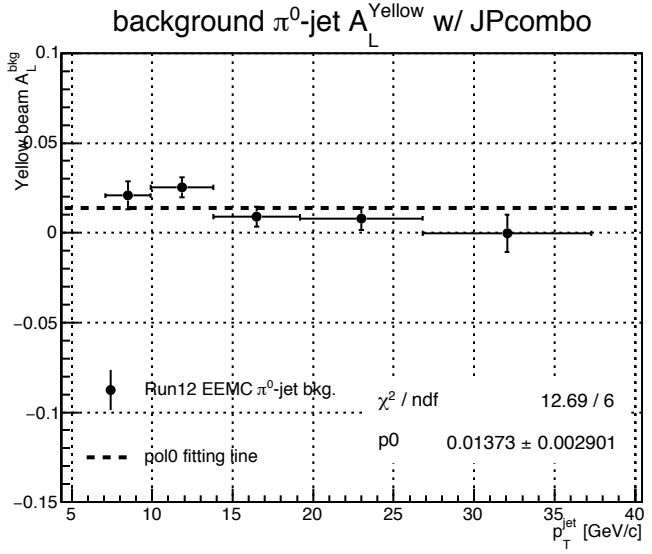


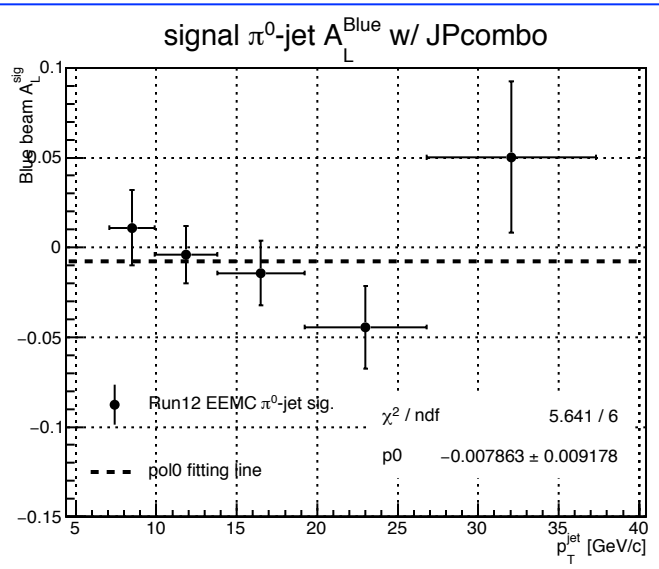


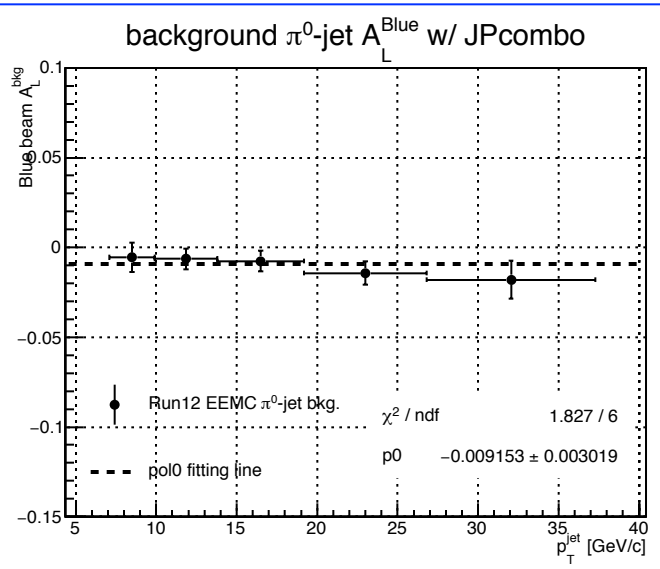
Asymmetry Results – Updated single asymmetries, A_L^Y, A_L^B

jet p_T bins



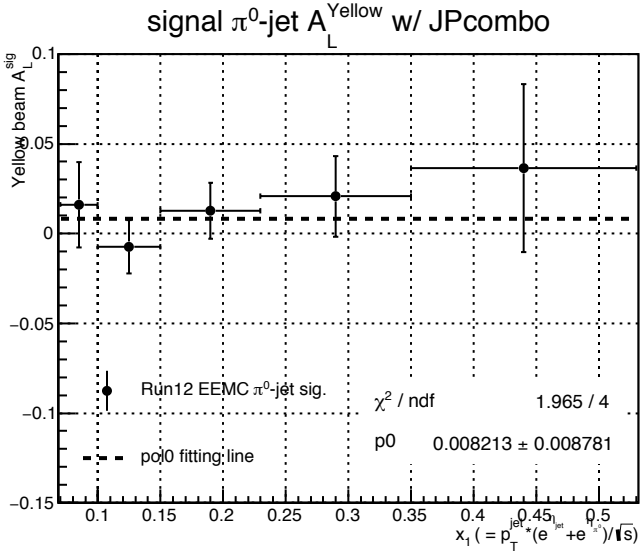


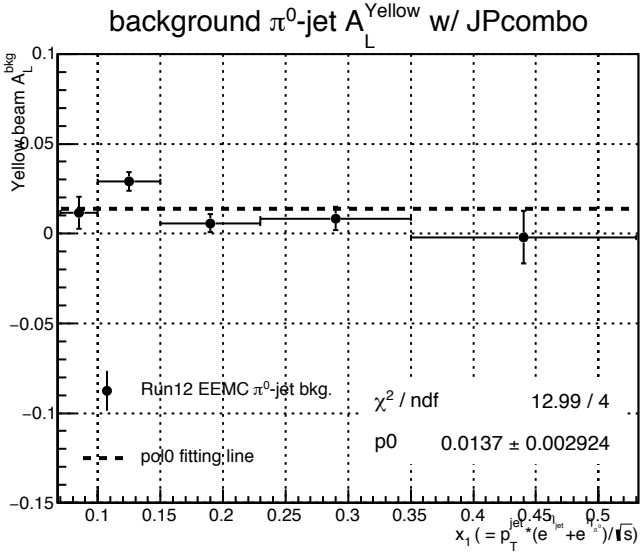


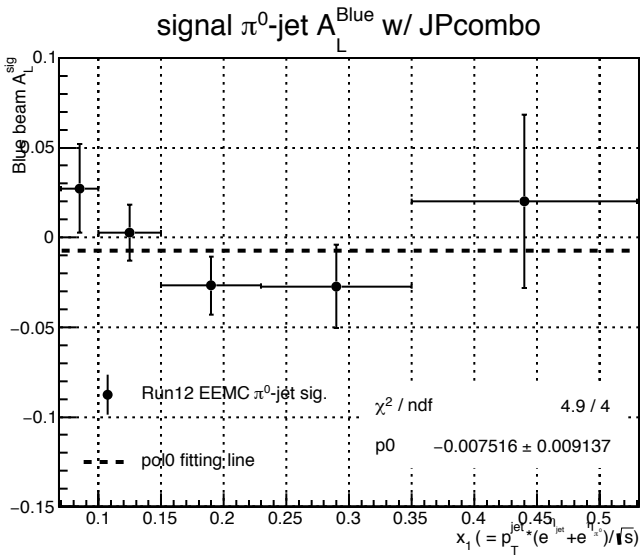


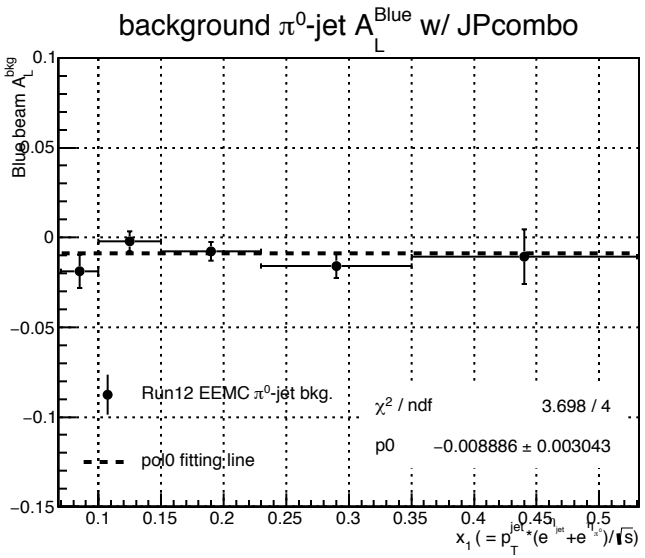
Asymmetry Results – Updated single asymmetries, A_L^Y, A_L^B

x_1 bins



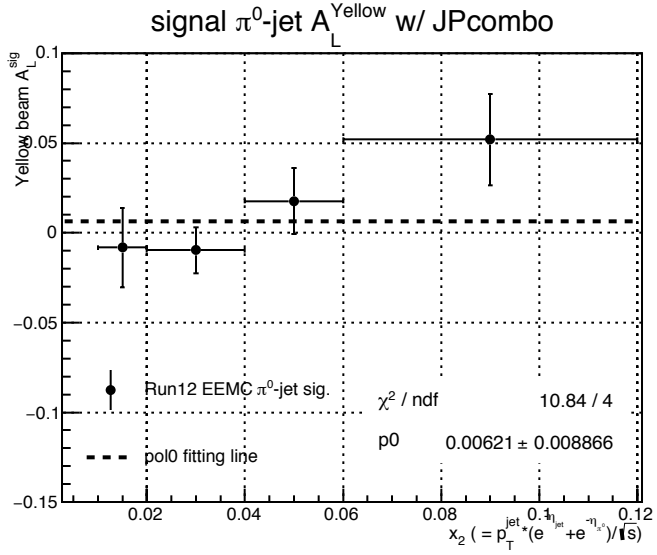


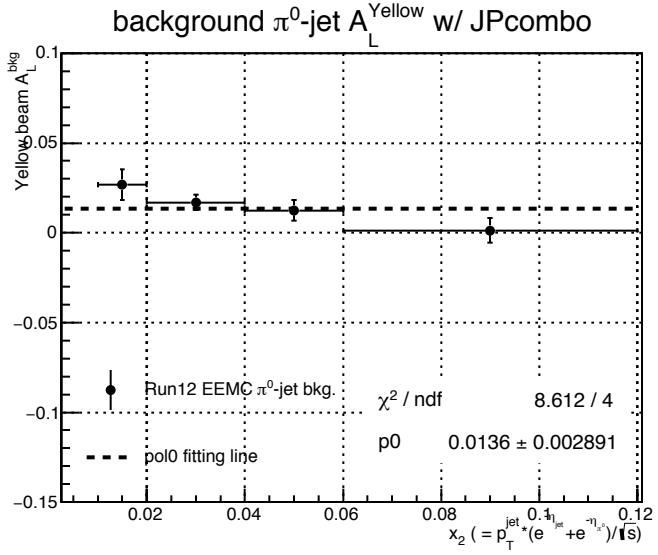


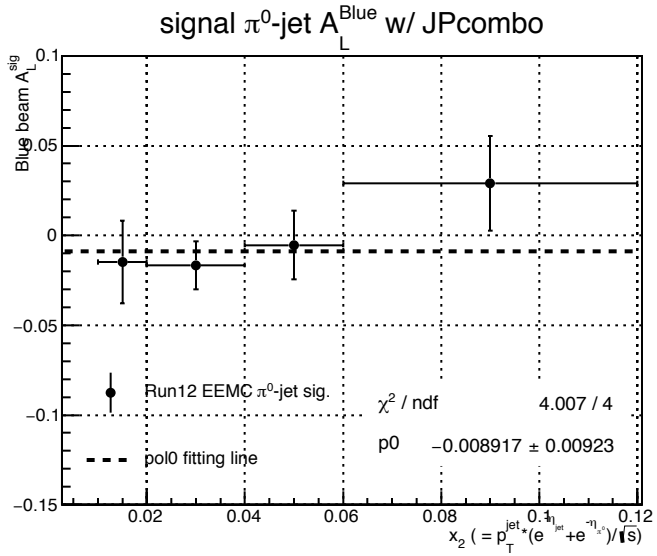


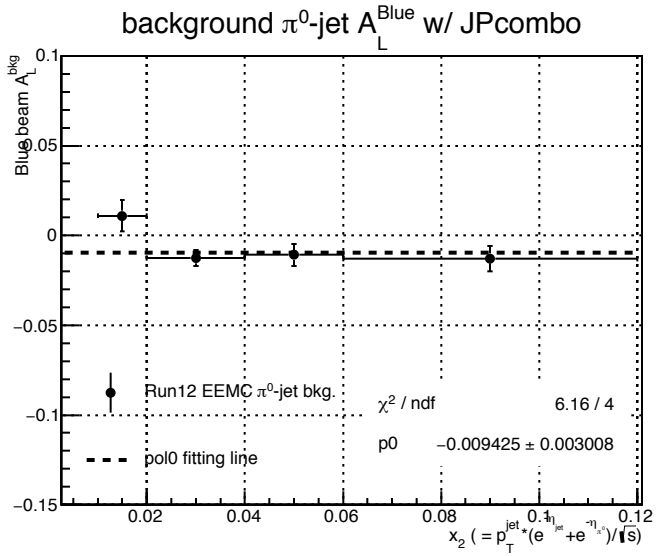
Asymmetry Results – Updated single asymmetries, A_L^Y, A_L^B

x_2 bins



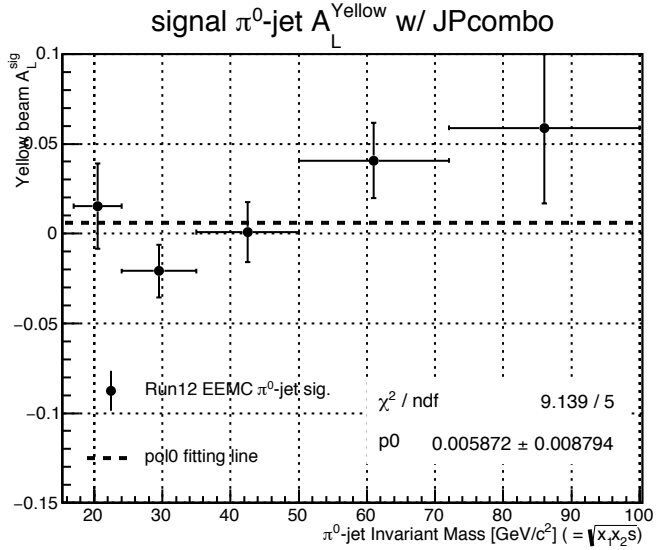


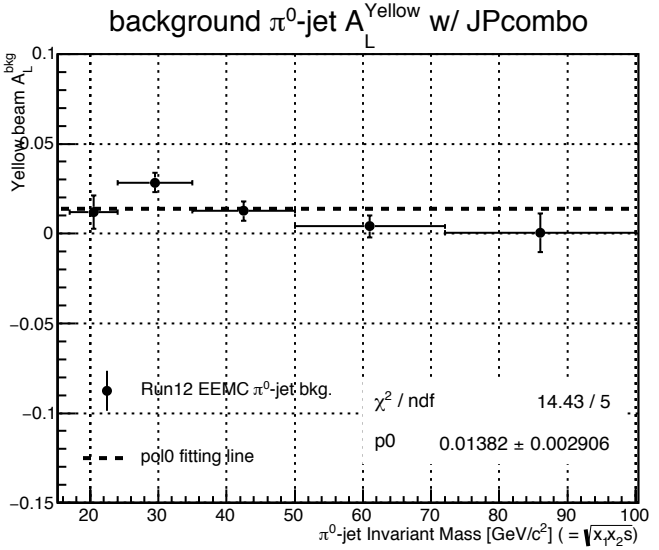


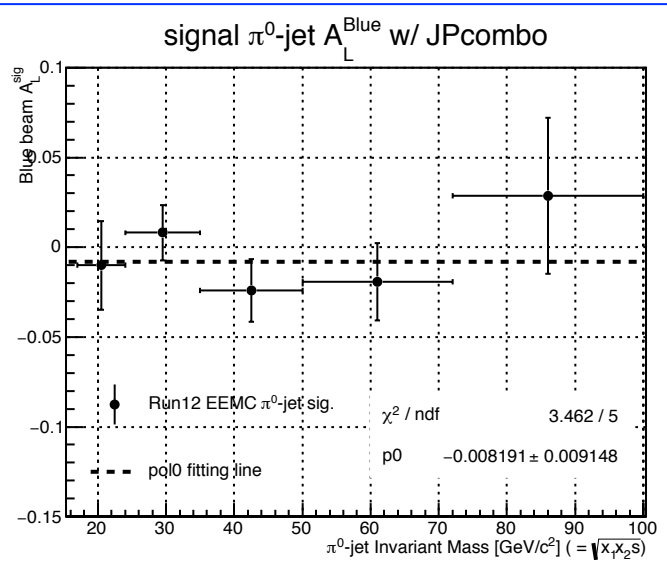


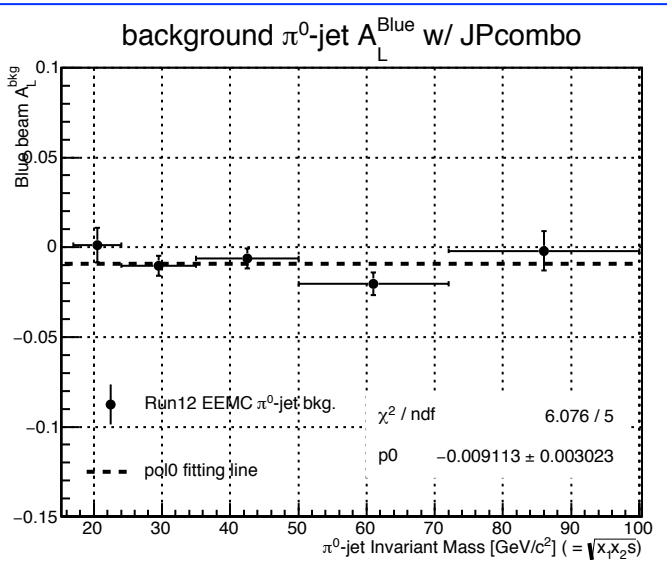
Asymmetry Results – Updated single asymmetries, A_L^Y, A_L^B

inv. mass bins



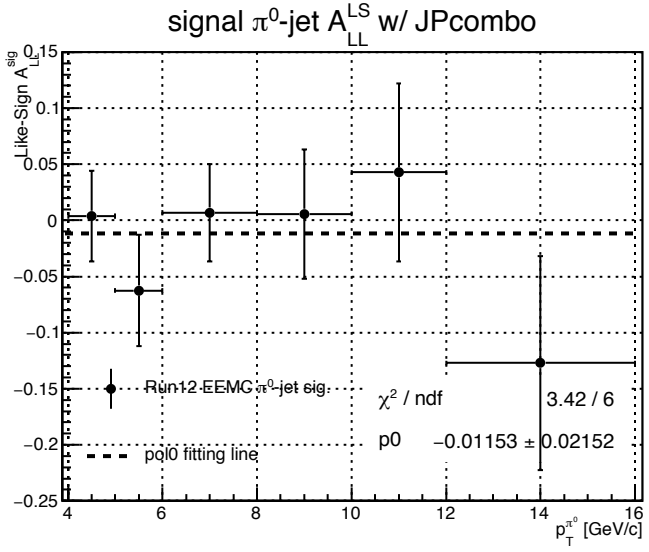


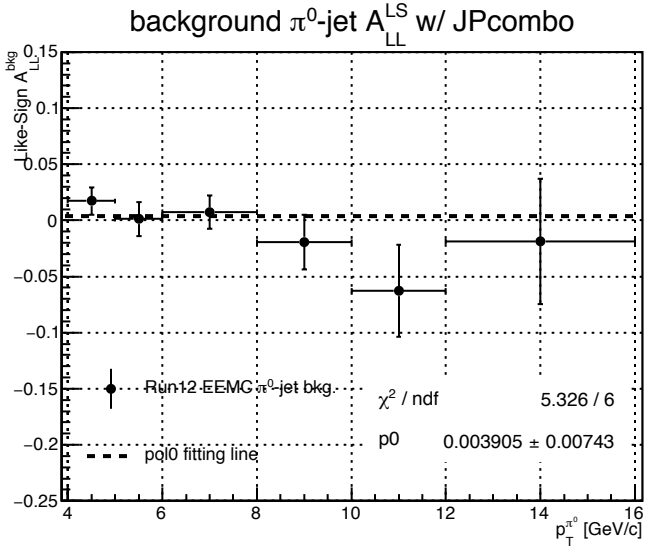


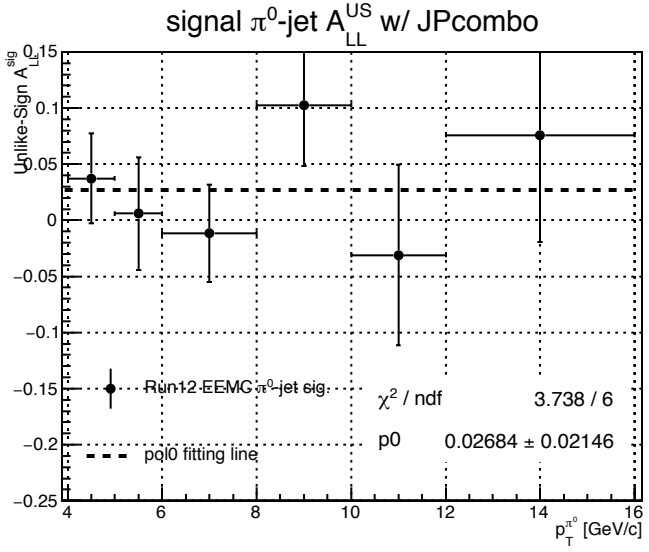


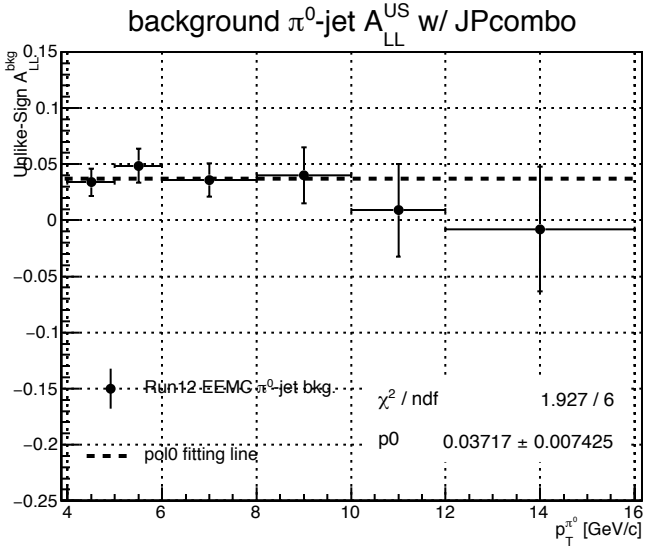
Asymmetry Results – Updated false asymmetries, A_{LL}^{LS}, A_{LL}^{US}

π^0 p_T bins



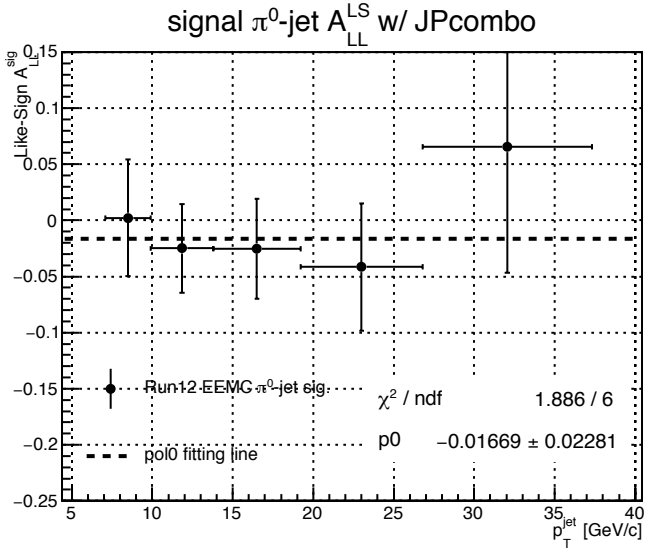


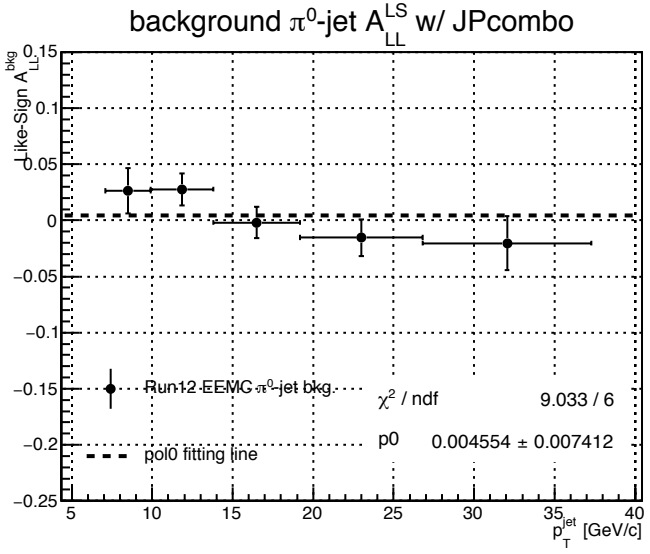


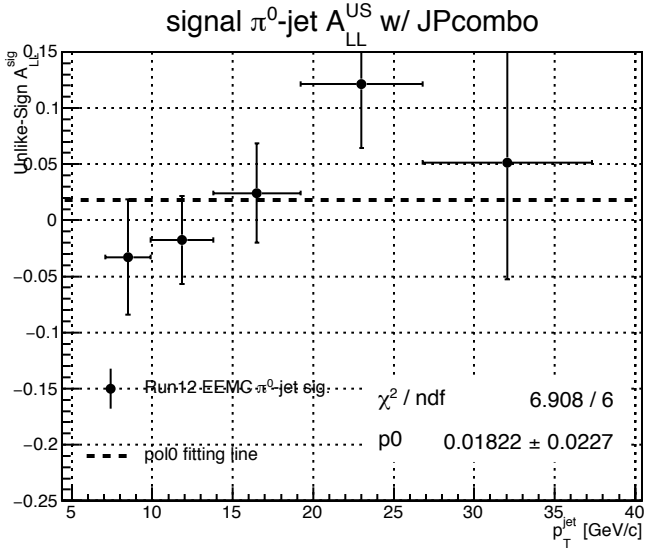


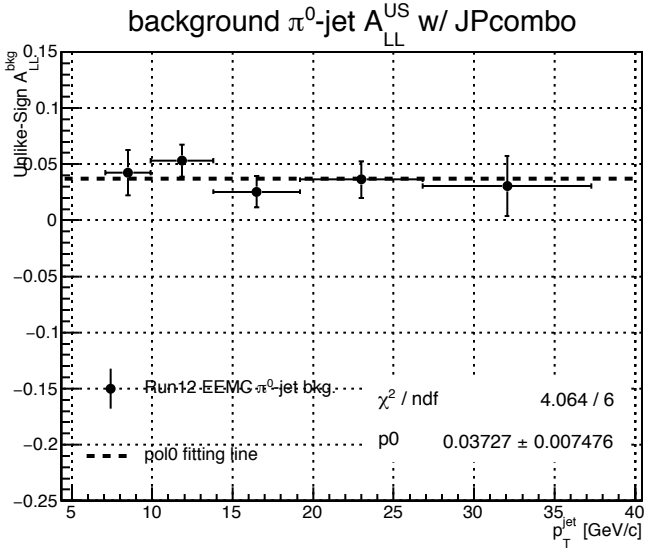
Asymmetry Results – Updated false asymmetries, A_{LL}^{LS}, A_{LL}^{US}

jet p_T bins



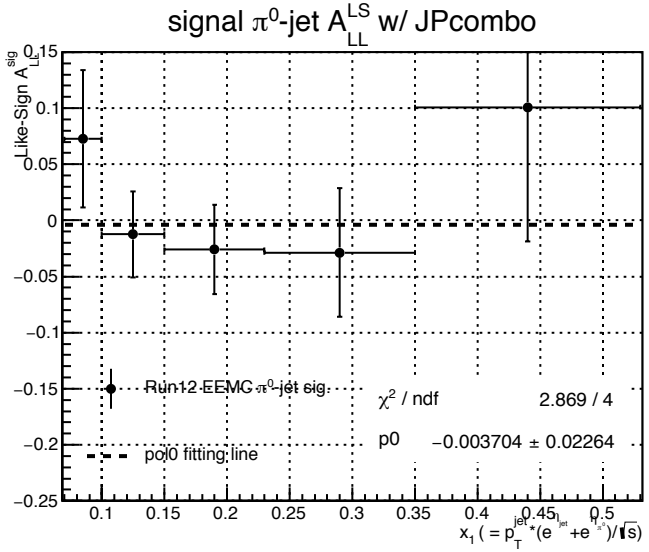


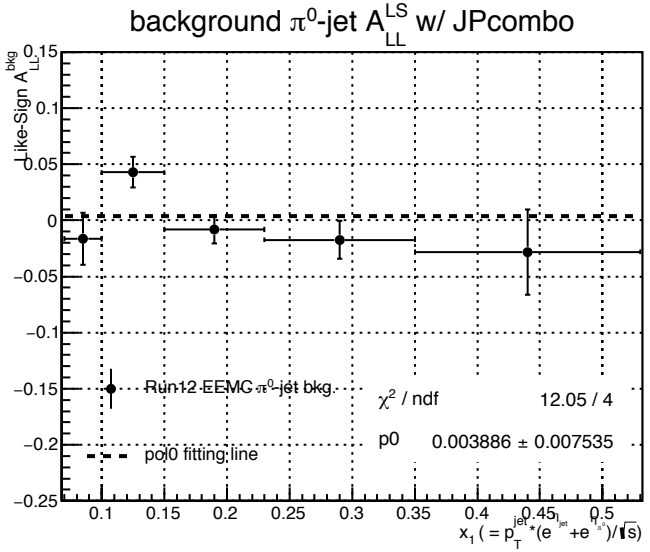


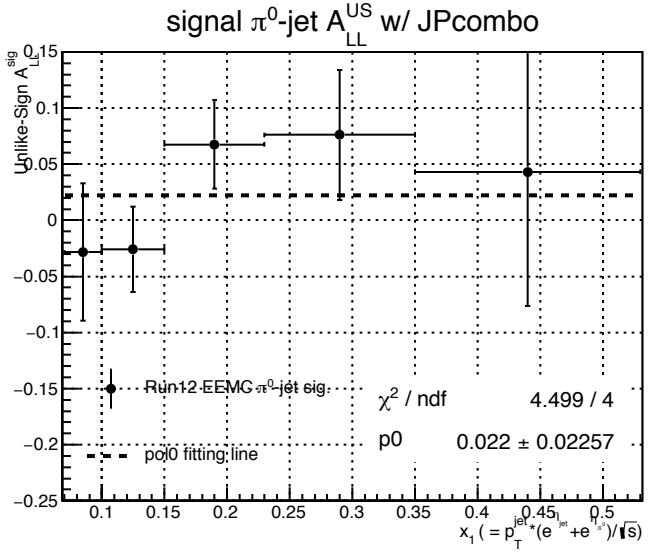


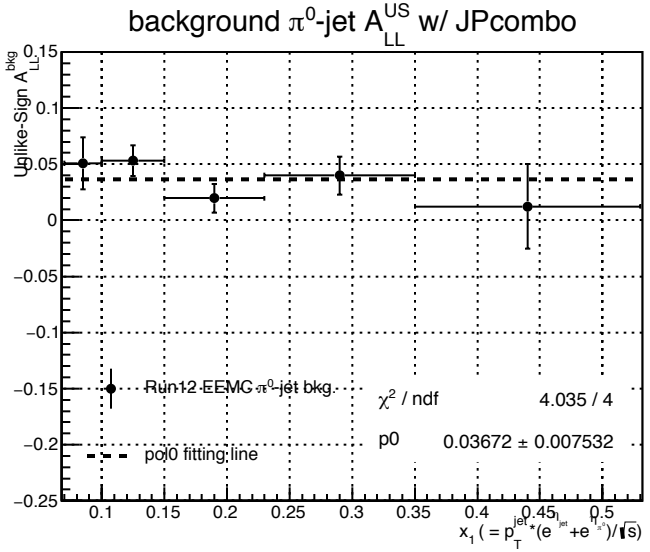
Asymmetry Results – Updated false asymmetries, A_{LL}^{LS}, A_{LL}^{US}

x_1 bins



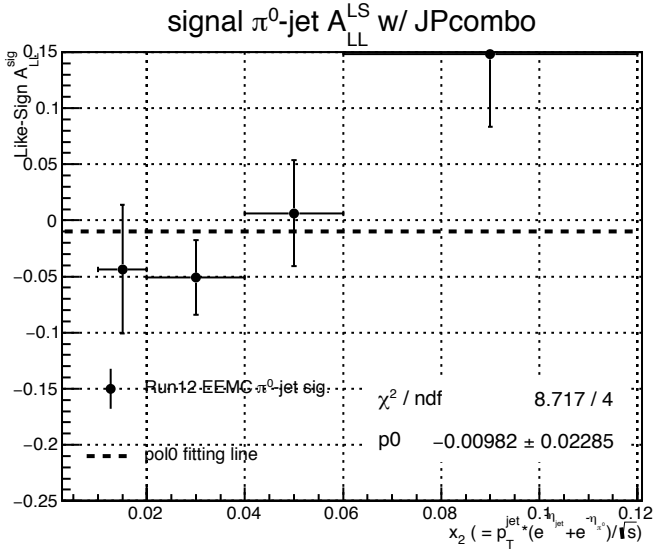


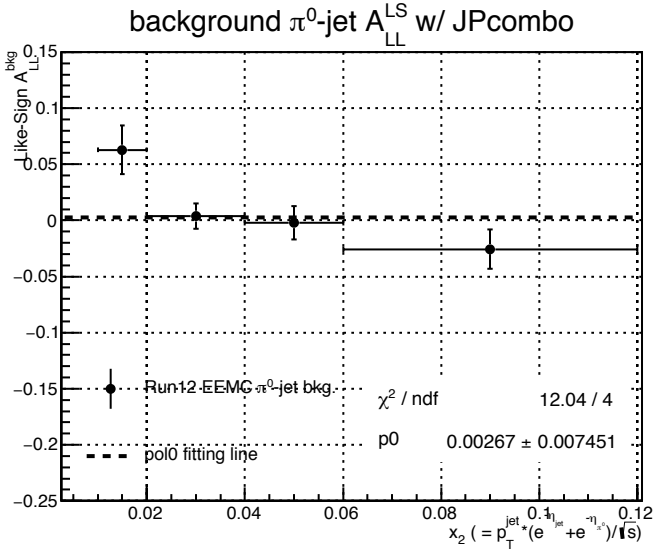


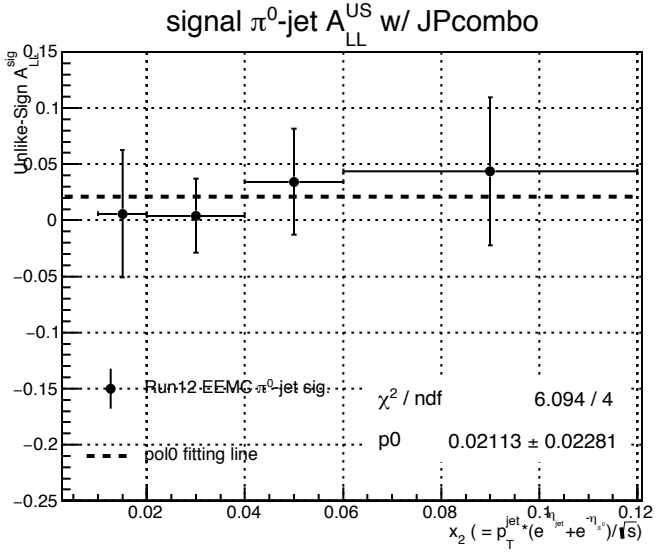


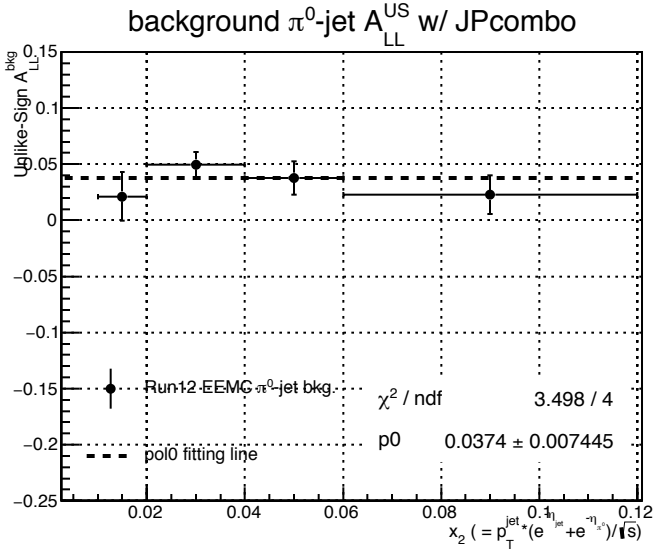
Asymmetry Results – Updated false asymmetries, A_{LL}^{LS}, A_{LL}^{US}

x_2 bins

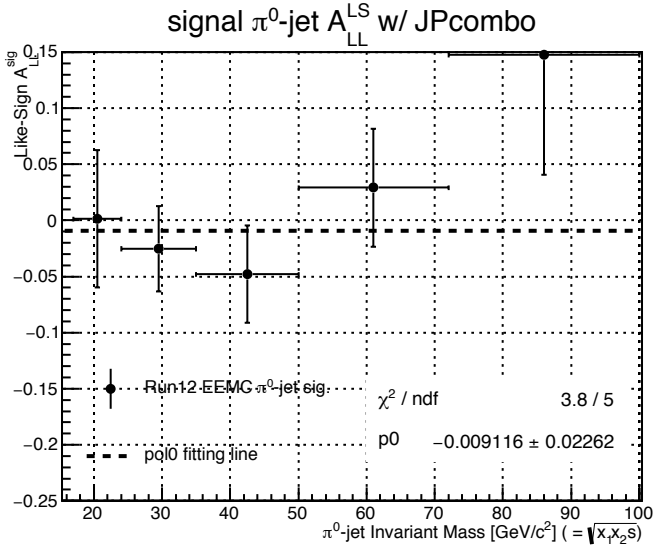


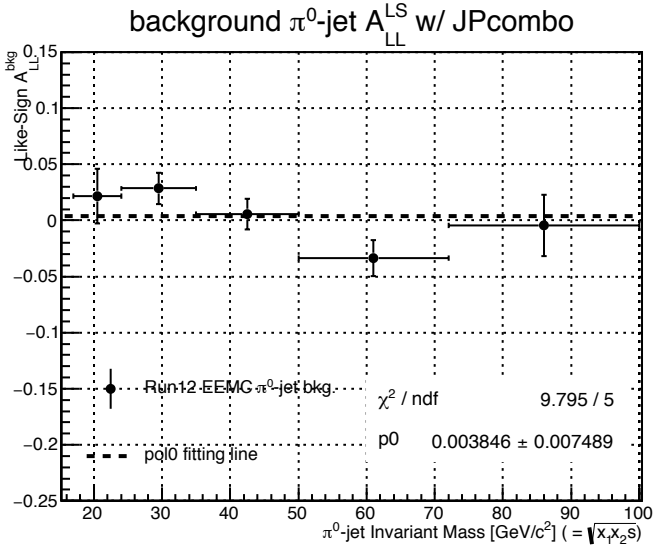


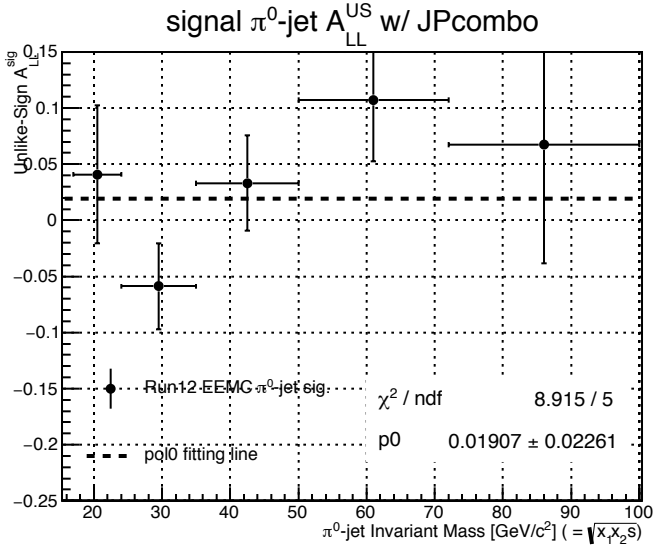


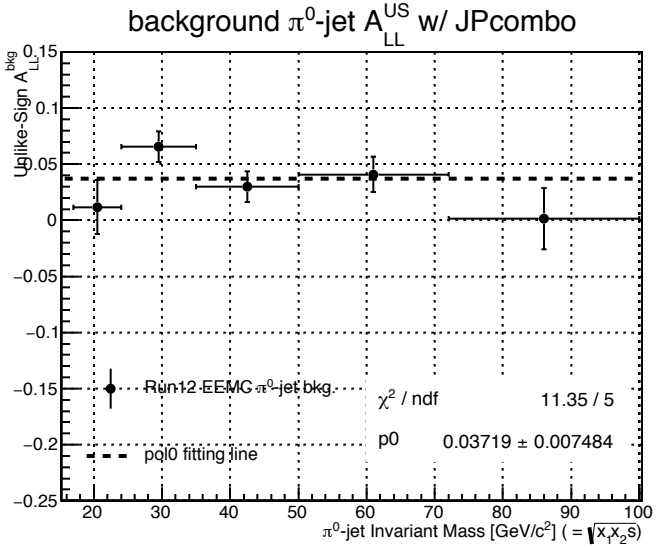


Asymmetry Results – Updated false asymmetries, A_{LL}^{LS}, A_{LL}^{US} inv. mass bins









Next to do

- Re-estimate the systematic uncertainties, …