Run12 A_{LL} measurements with Forward π^0 – Barrel Jet Correlation

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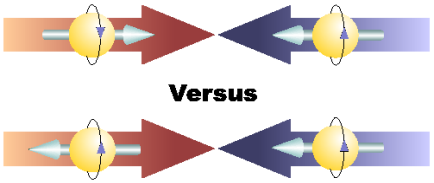


Outline

- Dataset introduction
- Analysis cuts
- Variable definitions
- Preliminary asymmetry results
- Discussion and next to do

Dataset introduction

Dataset: **2012 pp longitudinal at √s=510 GeV**

Reconstructed EEMC trees location (~2.6 T): **/star/u/ypwang/disk05/Run12Pi0s_EEMC**
Reconstructed jet trees location: **/star/data05/scratch/zchang/Run12Jets_new**
/star/data05/scratch/zchang/Run12Jets_new_new

Macros/scripts for EEMC Tree production (TSIU algorithm used):

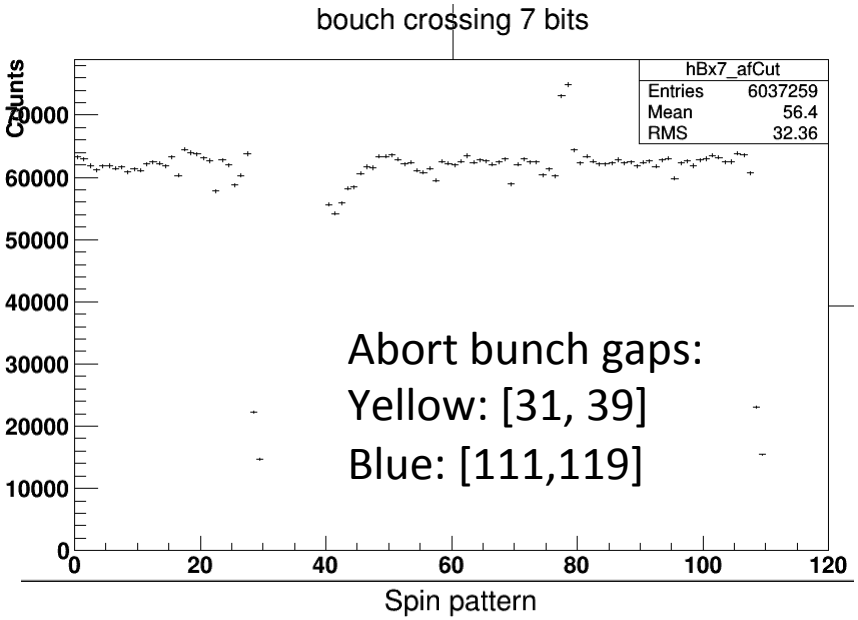
- scripts: **/star/u/ypwang/disk03/pi0Trees3/submitBatch1.sh && submitBatch2and3.sh**
- schedulers: **/star/u/ypwang/disk03/pi0Trees3/scheduler**
- macros: **/star/u/ypwang/disk03/pi0Trees3/macros**

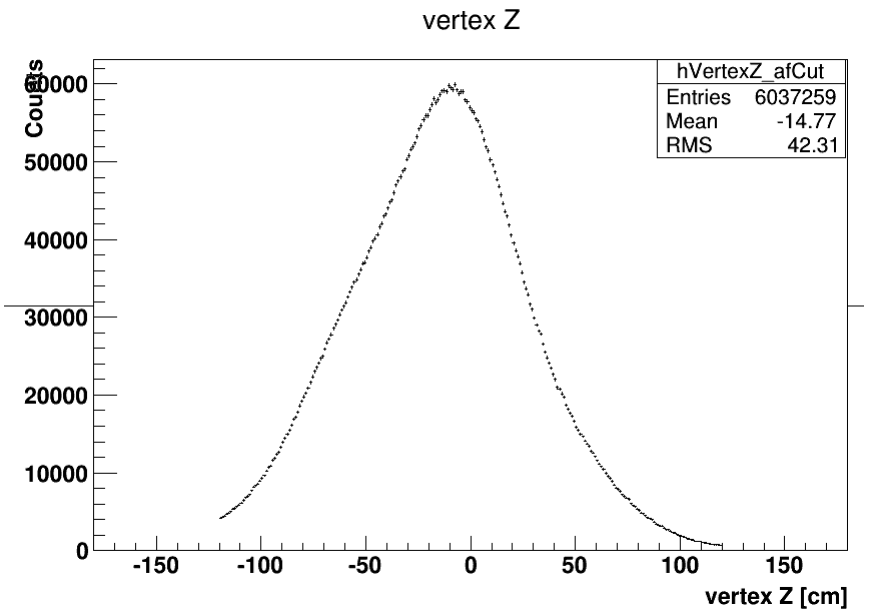
Run number list (491 runs): **/star/u/ypwang/disk03/pi0Trees3/runNumber_final.list**
Obtained from Run12 jet tree production (Zilong).

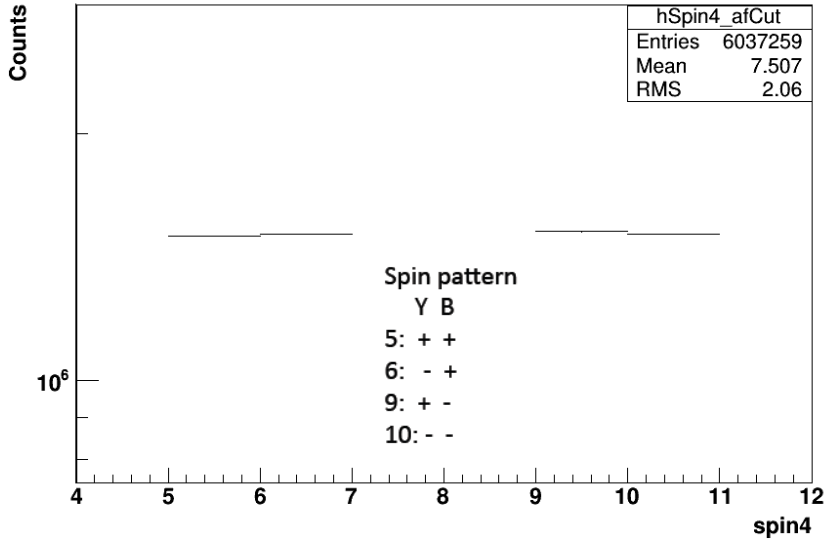
Analysis codes can be found on the path:
http://www.star.bnl.gov/cgi-bin/protected/cvsweb.cgi/offline/users/ypwang/pi0JetAna/

π^0 – jet QA plots can be found:
http://www4.rcf.bnl.gov/~ypwang/pi0JetAna/pi0JetQA/

Analysis cuts – event cuts



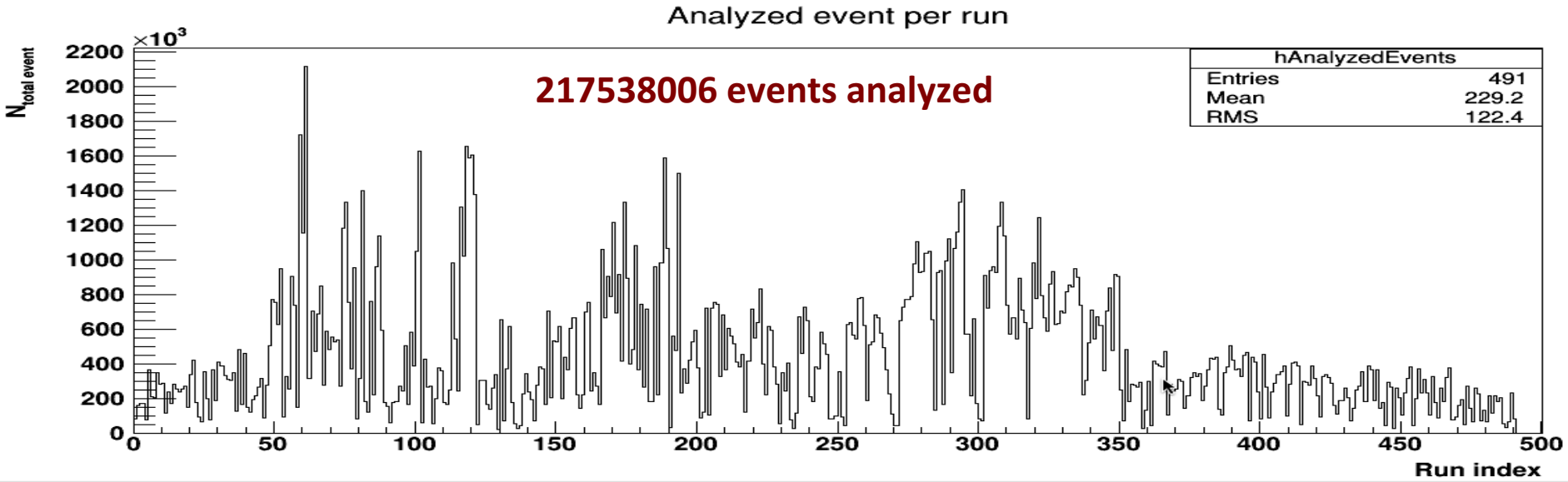




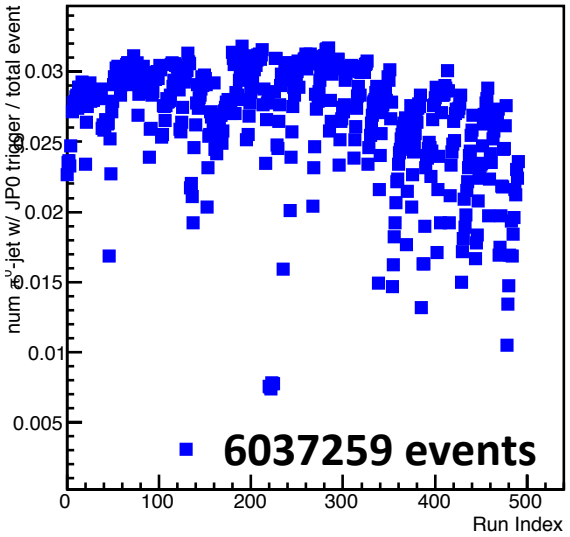
Event selection:

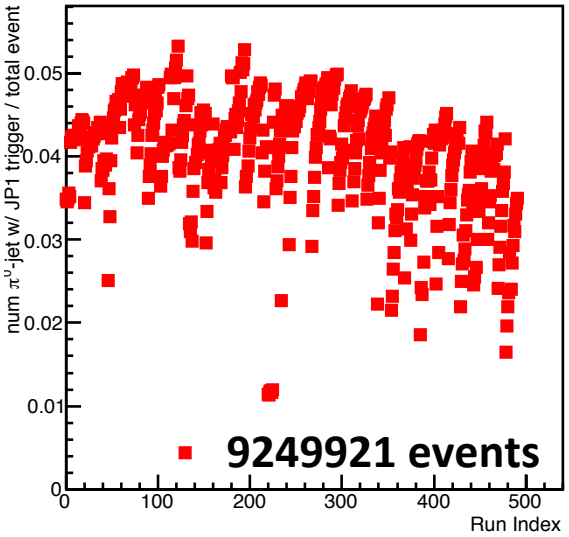
- At least one barrel jet ($|\eta|<1.0$) and one forward π^0 ($0.8<\eta<2.0$) found
- $|vZ| < 120$ cm
- Highest rank vertex required , Rank()>0

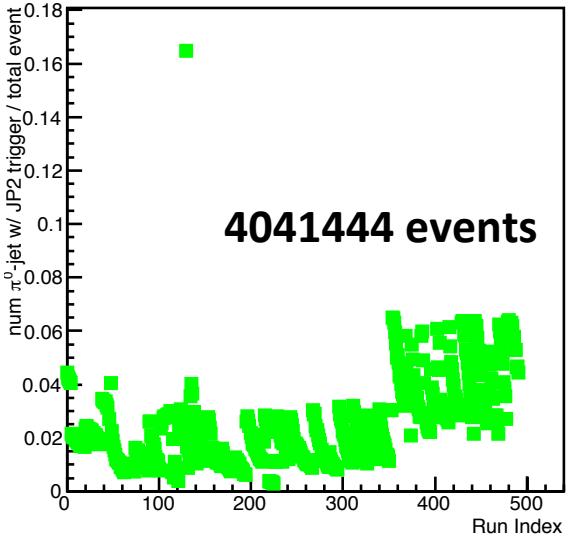
Analysis cuts – event cuts



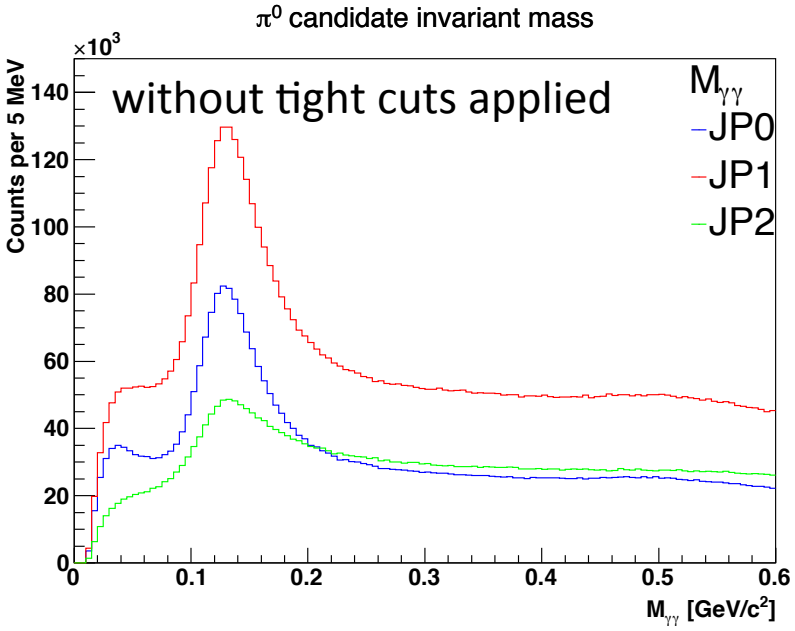
Ratio of JP0/JP1/JP2 triggered π^0-jet event to the total analyzed events:

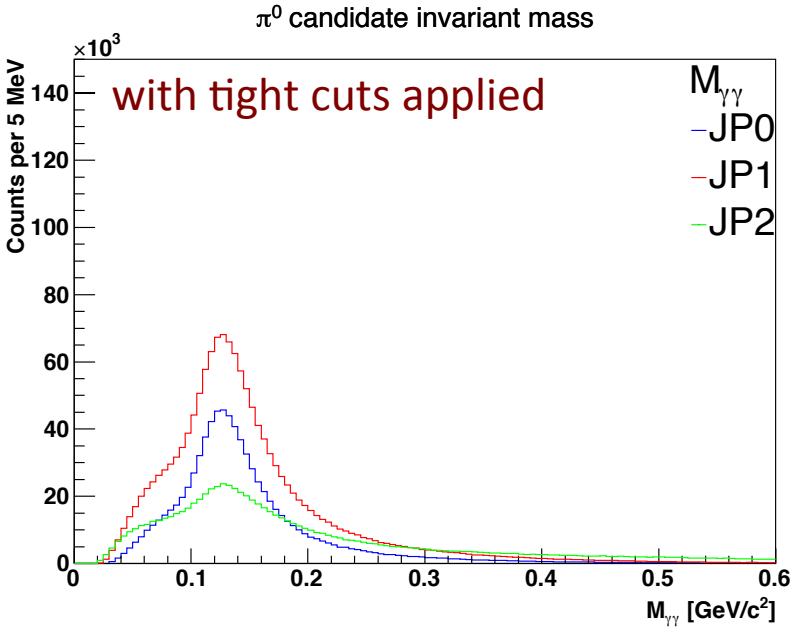






Analysis cuts – π^0 cuts



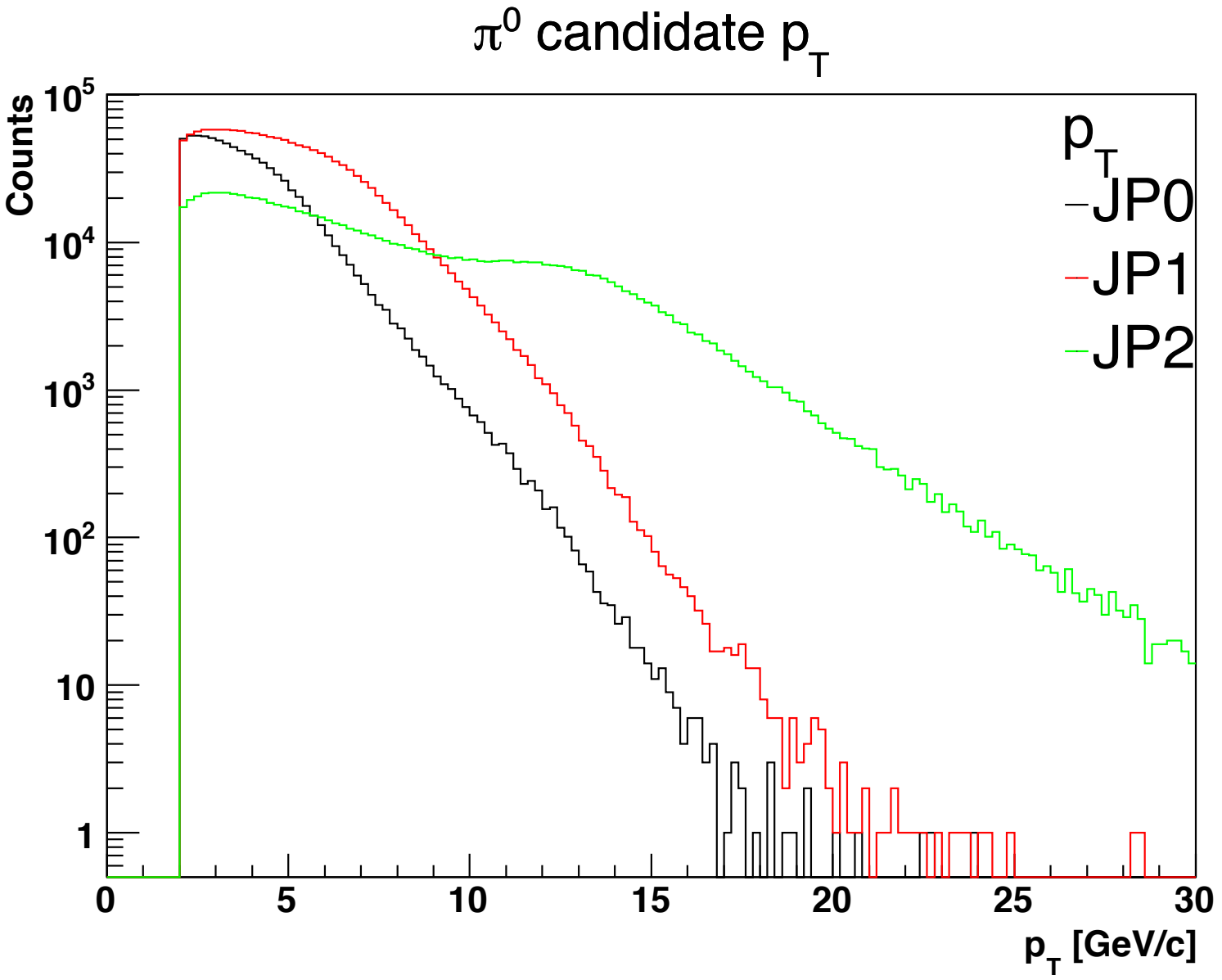


- Hardware and software trigger conditions applied
  - ✦If(JP2 hardware & JP2 software) JP2 π^0
  - ✦If(JP1 hardware & JP1 software) JP1 π^0
  - ✦If(JP0 hardware & JP0 software) JP0 π^0
- π^0 p_T: > 2.0 GeV/c
- π^0 mass: (0, 0.6)
- π^0 physics eta: (1.086, 2.0)
- Decayed photon eta: (1.11, 1.96)
- Decayed photon 1 energy: > 2.0 GeV
- Decayed photon 2 energy: > 1.5 GeV

Tight cuts:

- Preshower energy for each photon: < 40 MeV
- SMD relative energy threshold for each photon $(E_{cluster1/2u}+E_{cluster1/2v})/E_{tower1/2}$: > 0.008
- Photons opening angle (degree): (0.2, 3.0)
- Photons distance on EEMC plane (cm): (4.0, 20.0)
- Photons difference in eta (absolute value): < 0.15

Analysis cuts – π^0 cuts



Analysis cuts – jet cuts

- Jet p_T > 5.0 GeV/c
- Jet physics eta: (-0.9, 0.9)
- Jet detector eta: (-0.7, 0.9)
- R_t < 0.95
- Using Anti-k_T algorithm with cone size R = 0.6
- Sum track p_T > 0.5 GeV/c
- Hardware, software and geometric trigger conditions applied
- Triggers (threshold: JP0 5.4 GeV/c, JP1 7.3 GeV/c, JP2 14.4 GeV/c):

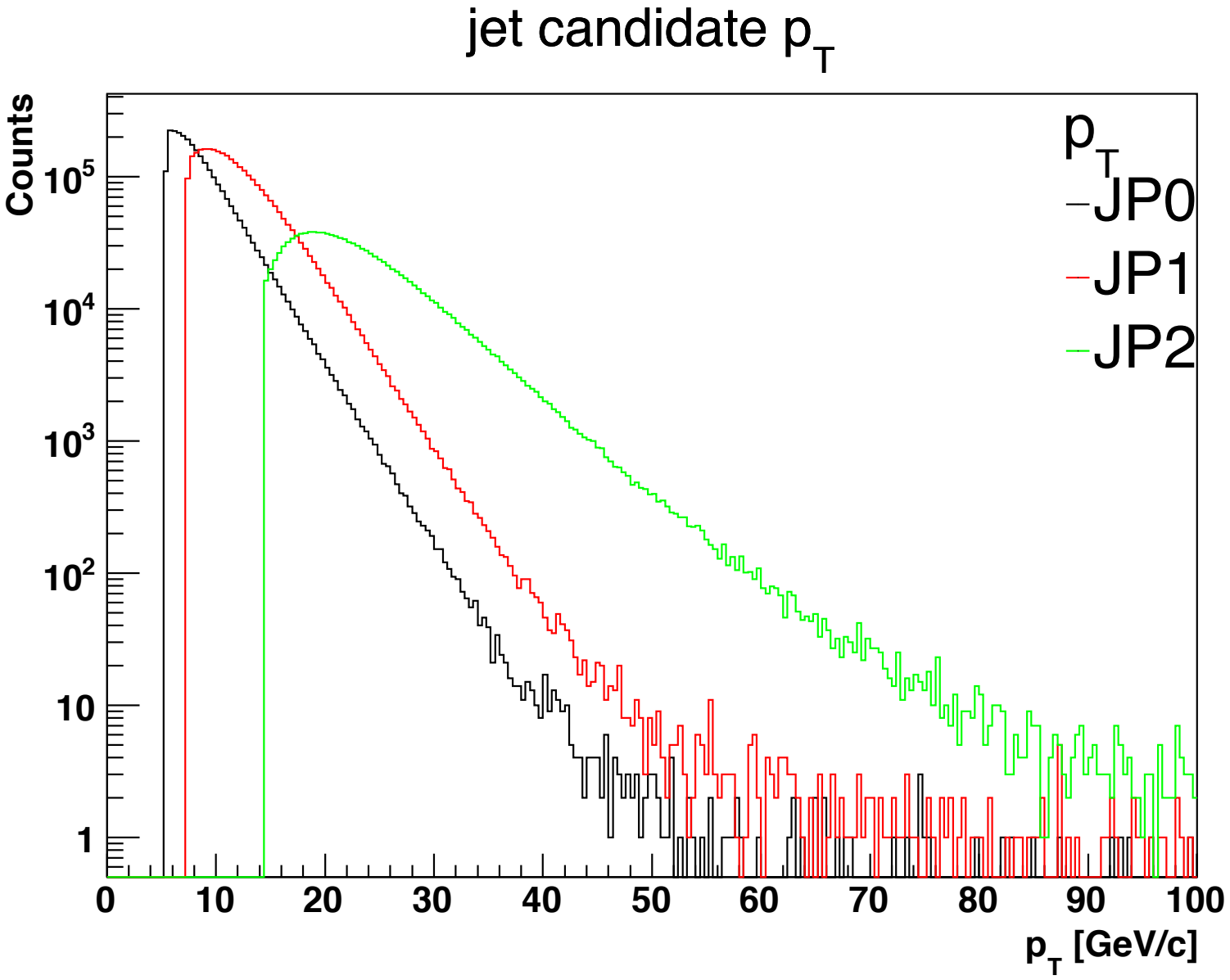
★If(JP2 hardware & JP2 software & geometric match JP2 & pT>14.4) JP2 jet

★If(JP1 hardware & JP1 software & geometric match JP1 & pT>7.3) JP1 jet

★If(JP0 hardware & JP0 software & geometric match JP0 & pT>5.4) JP0 jet

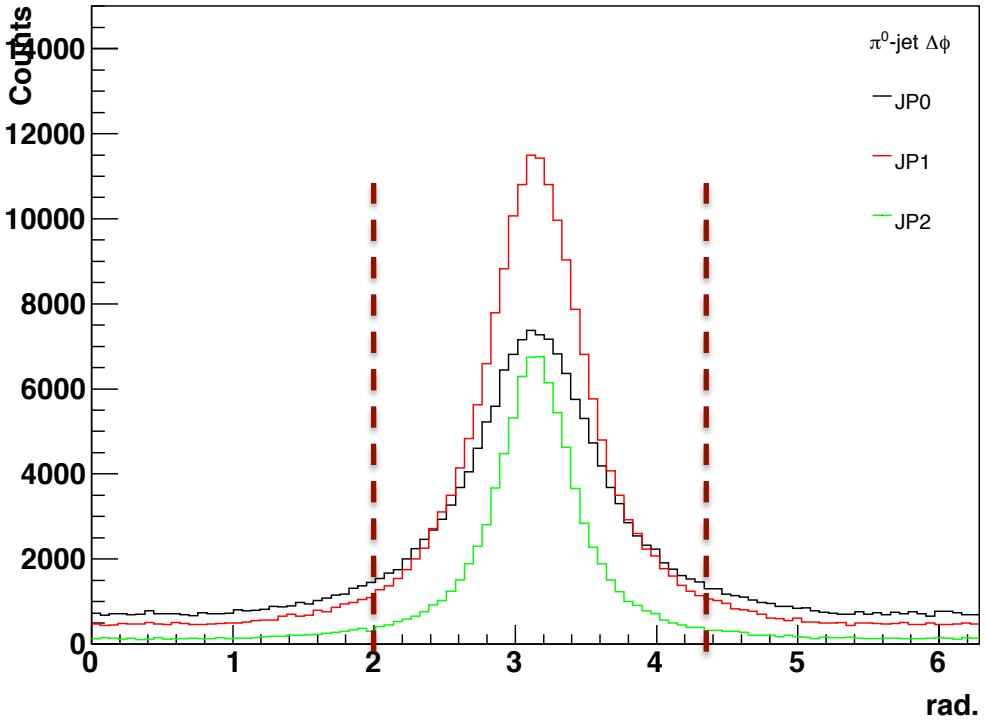
* The geometric match jet patch codes are from Grant Webb's Dijet codes

Analysis cuts – jet cuts



Analysis cuts – π^0 -jet coincidence cuts

- Asymmetric p_T cut: $p_T^{\pi 0} > 2.0$ GeV/c, $p_T^{jet} > 5.0$ GeV/c
- Only use leading π^0 to match a barrel jet (the higher p_T jet holds the pairing priority)
- $\Delta\phi > 2.0$ (a forward π^0 opposite a barrel jet)
- Signal π^0 mass region: (0.08, 0.2) GeV/c^2
- Trigger match:
  - ★ If(JP2 π^0 & JP2 jet) JP2 π^0–jet
  - ★ If(JP1 π^0 & JP1 jet) JP1 π^0–jet
  - ★ If(JP0 π^0 & JP0 jet) JP0 π^0–jet



Variable definitions

A_{LL} was measured as a function of jet or π^0 p_T.
To better determine Δg, A_{LL} as a function of x or z are used.

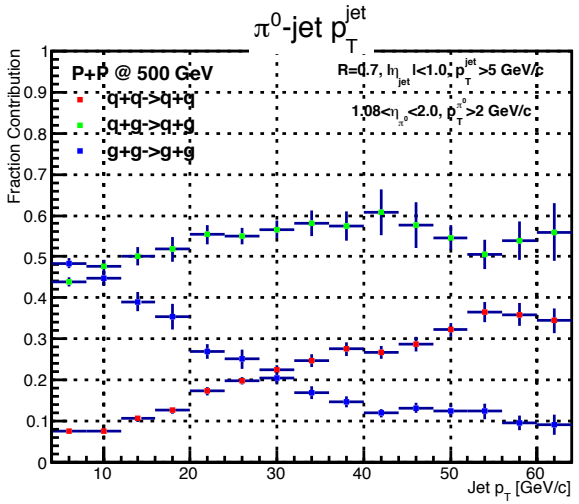
Variable definitions:

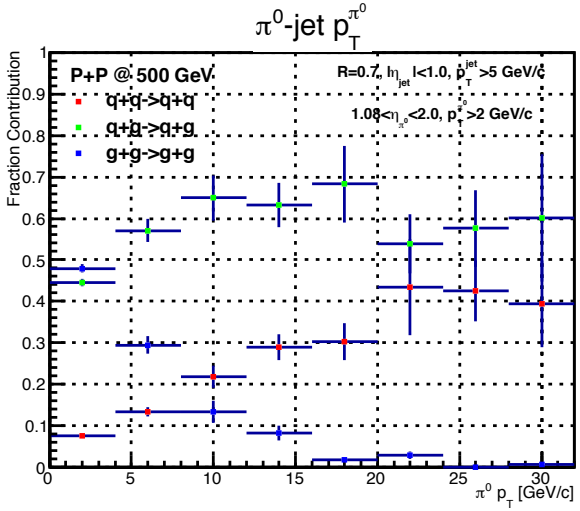
$$z = \frac{p_T^{\pi^0}}{p_T^{jet}},$$

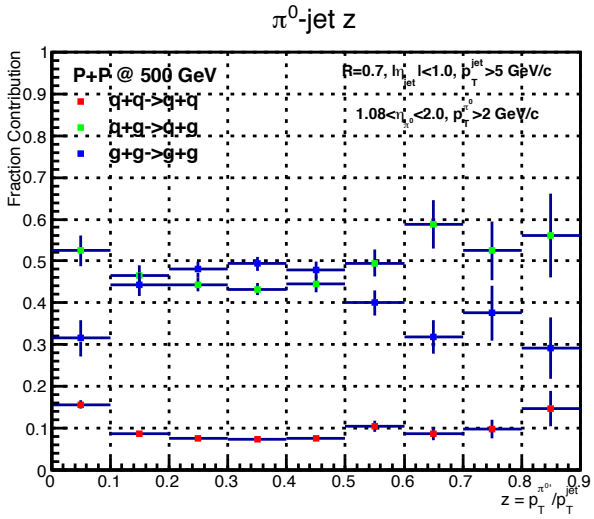
$$x_1 = \frac{p_T^{jet}}{\sqrt{s}}(e^{\eta_{jet}} + e^{\eta_{\pi^0}}), \quad x_2 = \frac{p_T^{jet}}{\sqrt{s}}(e^{-\eta_{jet}} + e^{-\eta_{\pi^0}})$$

$$invM_{\pi^0-jet} = \sqrt{x_1 x_2 s}.$$

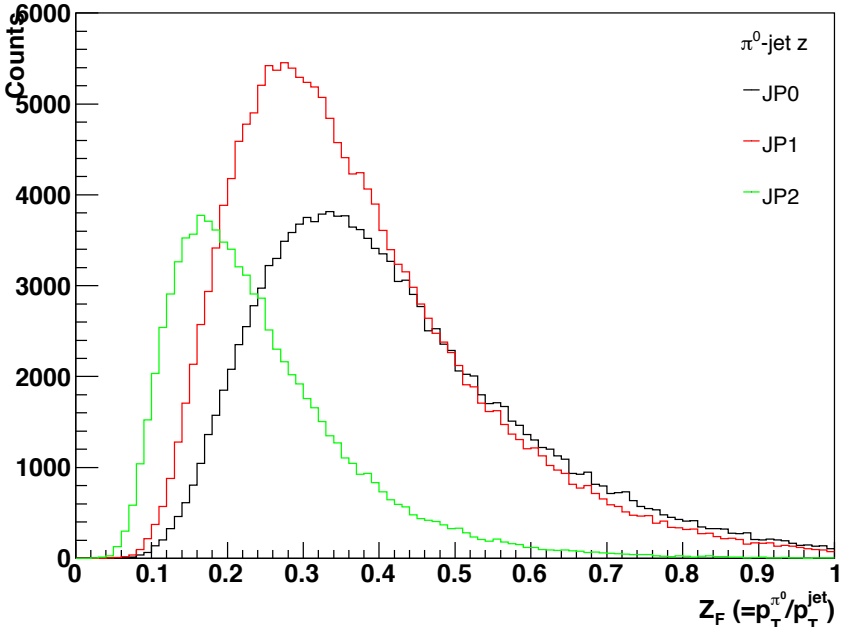
Pythia simulation: sub-process fraction as a function of pT and z:

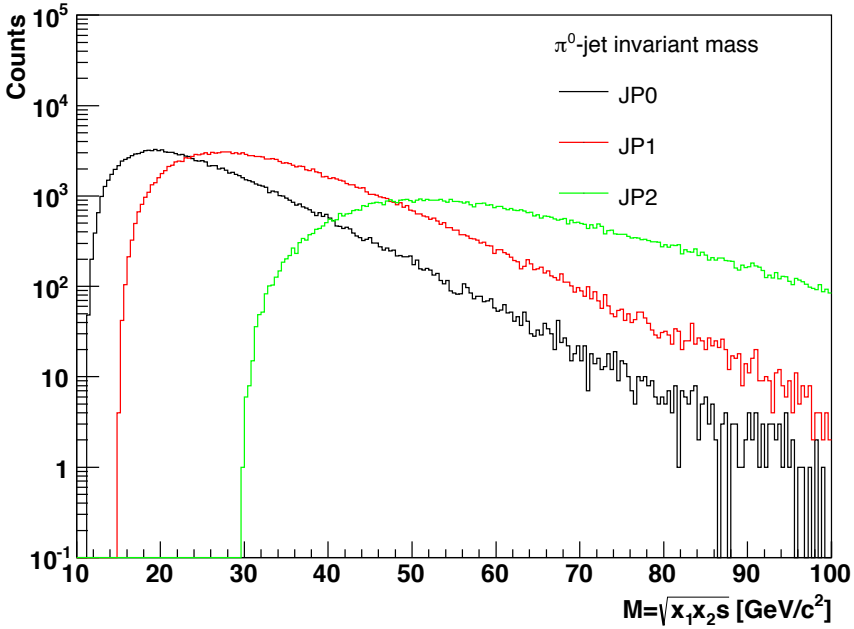


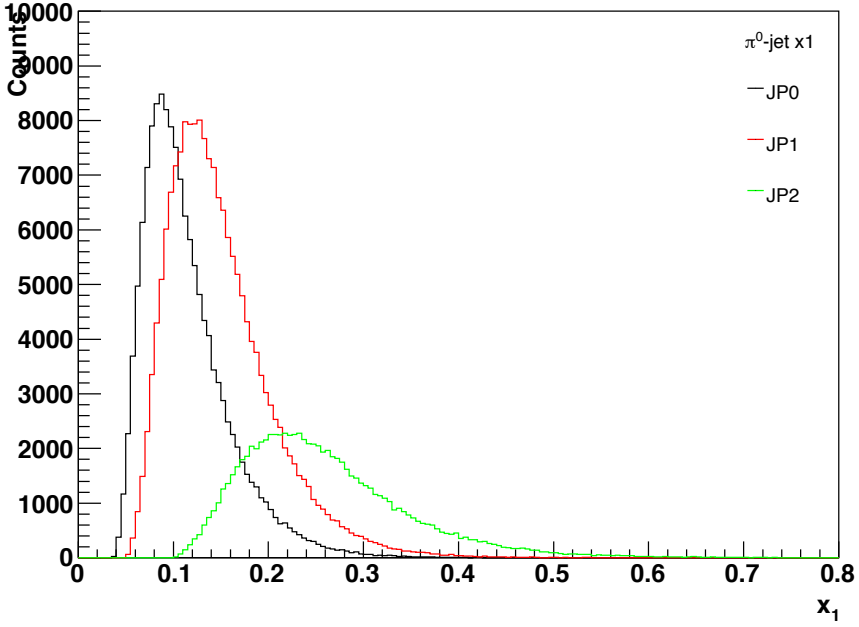


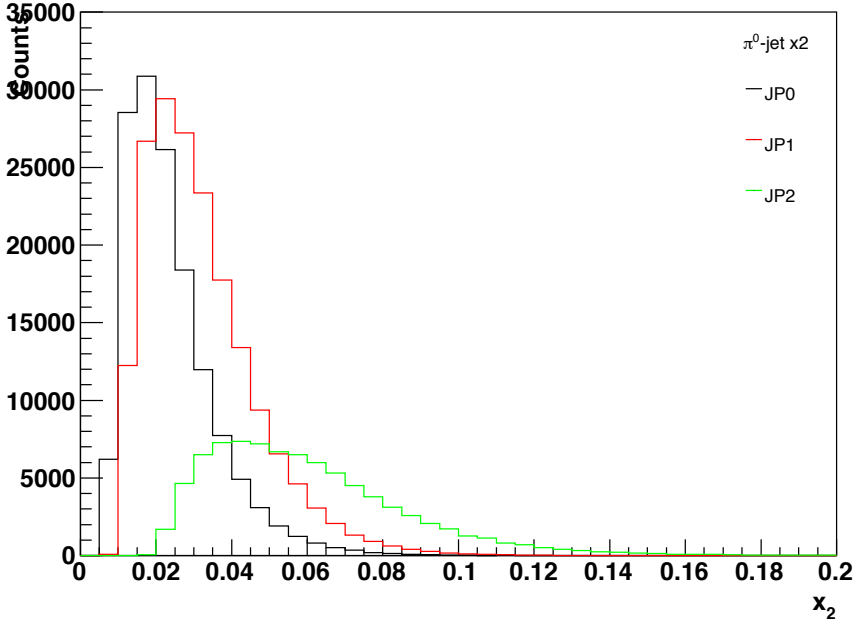


Variable distributions from Run12 data









Variable binning

```
const Int_t nPi0PTbins = 13; //20% resolution
const Double_t mPi0PTbins[nPi0PTbins + 1] = { 2.0, 3.0, 4.0, 5.0, 6.0, 7.0, 8.4, 10.0, 12.0, 14.4, 17.3, 20.7,
25.0, 30.0};

const Int_t nJetPTbins = 15; // jet pT bin 18% resolutions
const Double_t mJetPTbins[nJetPTbins + 1] = {5.0, 6.0, 7.1, 8.4, 9.9, 11.7, 13.8, 16.3, 19.2, 22.7, 26.8,
31.6, 37.3, 44.0, 51.9, 61.2};

const Int_t nPi0JetMassbins = 13; //20% resolution
const Double_t mPi0JetMassbins[nPi0JetMassbins+1] = {10.0, 12.0, 14.4, 17.3, 20.7, 24.9, 29.9, 35.9,
43.0, 51.7, 62.0, 74.4, 89.3, 100.0};

const Int_t nZbins = 7; // z 150% resolution
const Double_t mZbins[nZbins+1] = { 0.06, 0.09, 0.135, 0.20, 0.30, 0.45, 0.675, 1.0};

const Int_t nXbins = 8; // x1/x2 150% resolution
const Double_t mX1bins[nXbins+1] = { 0.025, 0.045, 0.070, 0.100, 0.150, 0.230, 0.35, 0.53, 0.8};
const Double_t mX2bins[nXbins+1] = { 0.005, 0.010, 0.015, 0.023, 0.035, 0.053, 0.08, 0.12, 0.2};
```

Asymmetry results – Asymmetries

Longitudinal double spin asymmetries:

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

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

Longitudinal single-spin asymmetries:

$$A_L^Y = \frac{\sum P_Y [(N^{++} + N^{+-}) - R_1 (N^{--} + N^{-+})]}{\sum P_Y^2 [(N^{++} + N^{+-}) + R_1 (N^{--} + N^{-+})]}$$

$$A_L^B = \frac{\sum P_B [(N^{++} + N^{-+}) - R_2 (N^{--} + N^{+-})]}{\sum P_B^2 [(N^{++} + N^{-+}) + R_2 (N^{--} + N^{+-})]}$$

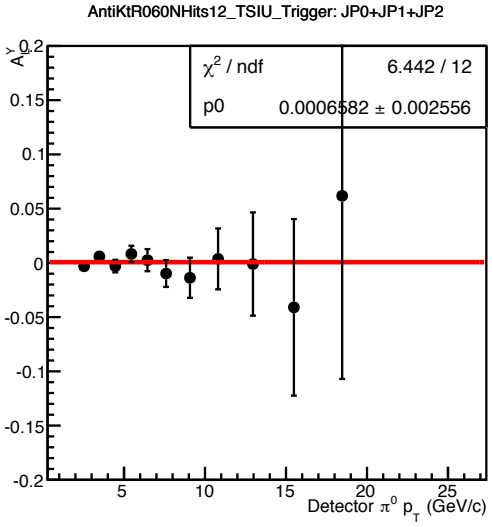
Like-sign/Unlike-sign asymmetry:

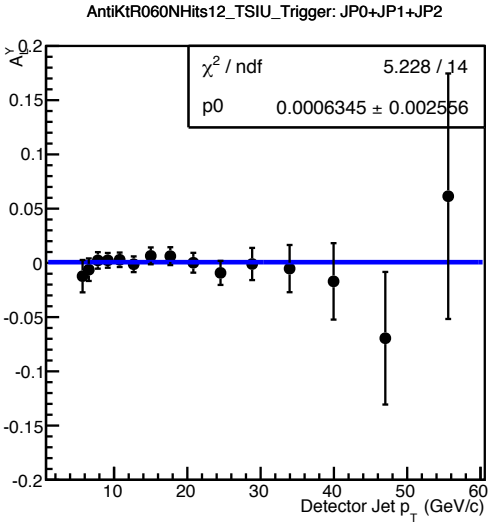
$$A_{LL}^{ls} = \frac{\sum P_Y P_B (N^{++} - R_4 N^{--})}{\sum P_Y^2 P_B^2 (N^{++} + R_4 N^{--})}$$

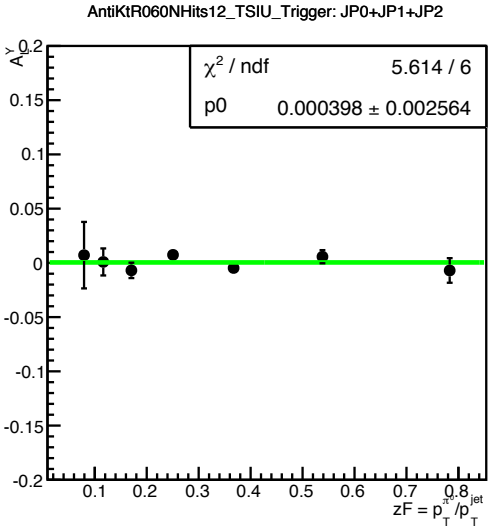
$$A_{LL}^{us} = \frac{\sum P_Y P_B (R_6 N^{+-} - R_5 N^{-+})}{\sum P_Y^2 P_B^2 (R_6 N^{+-} + R_5 N^{-+})}$$

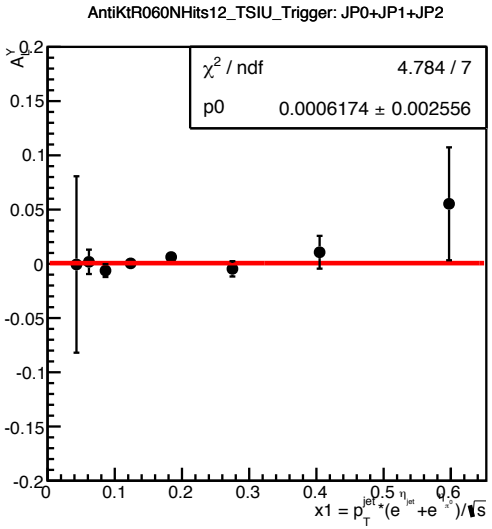
Asymmetry results – False asymmetries

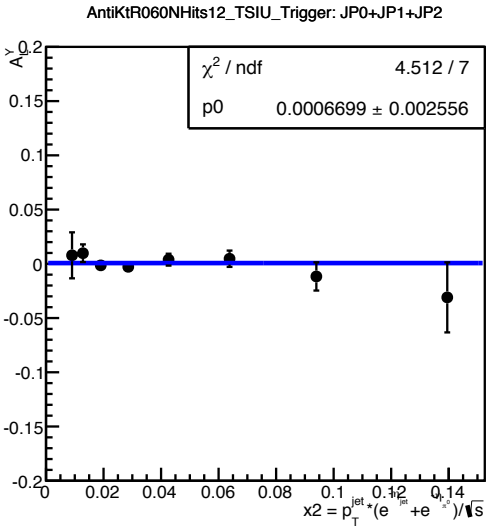
Longitudinal single-spin asymmetries (Yellow beam): combined triggers

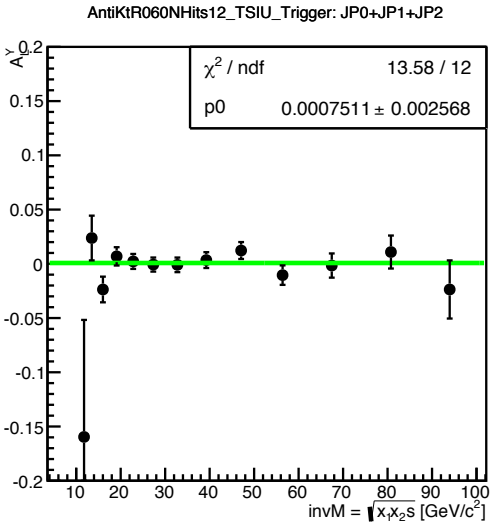






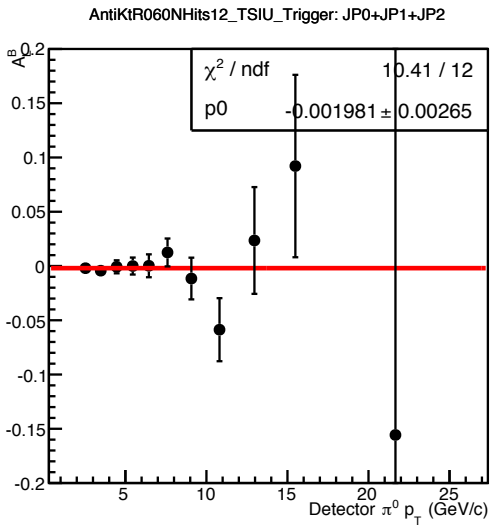


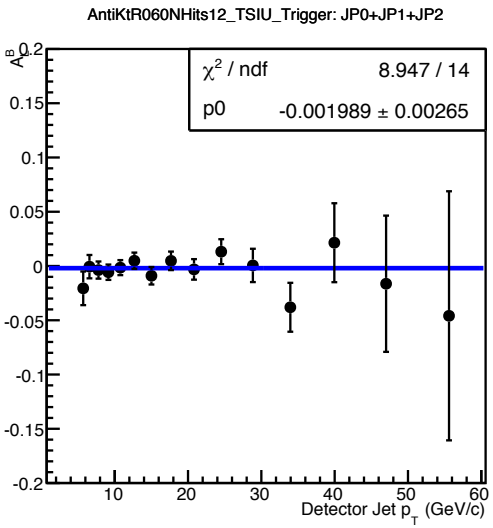


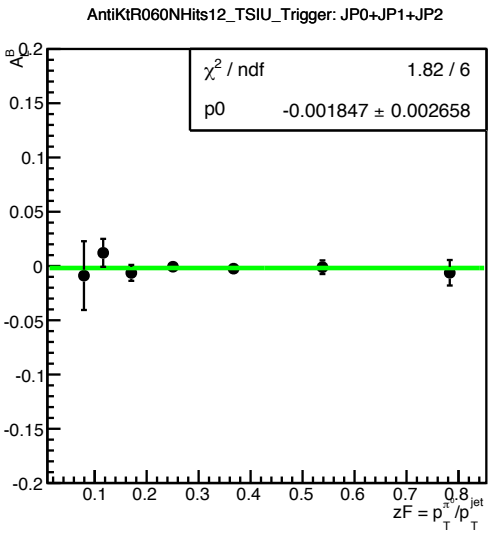


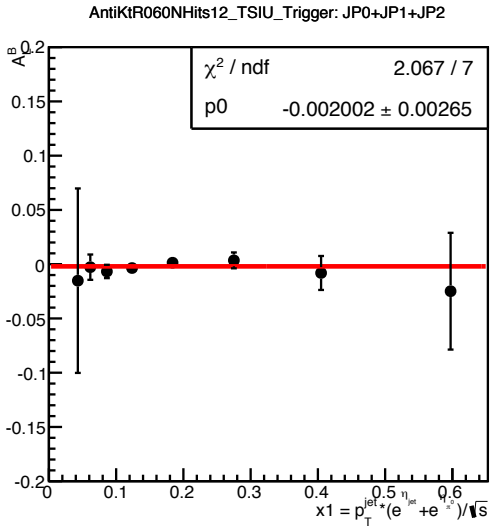
Asymmetry results – False asymmetries

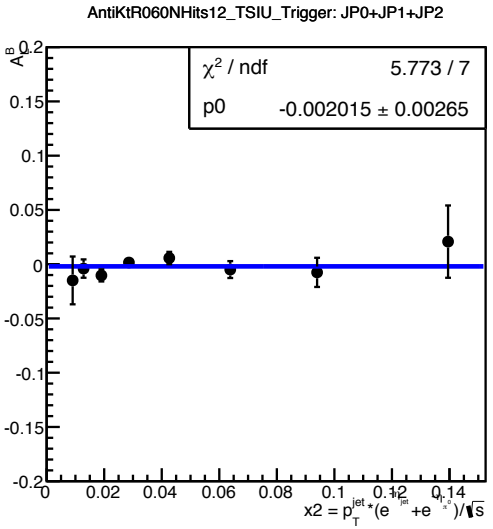
Longitudinal single-spin asymmetries (Blue beam): combined triggers

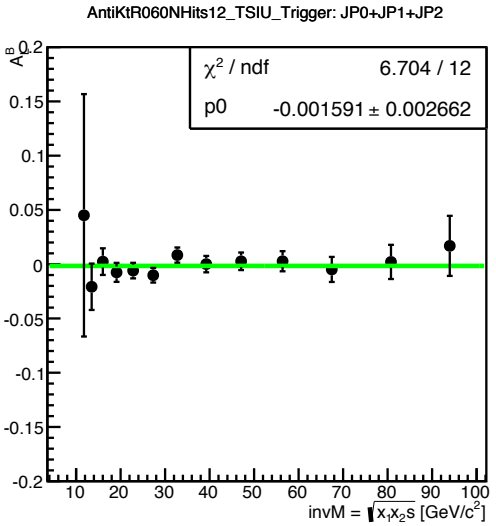






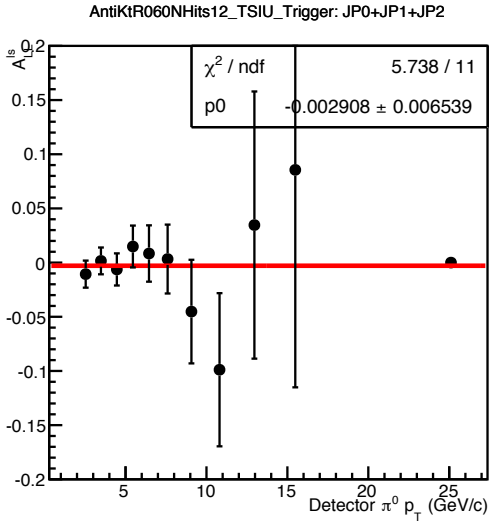


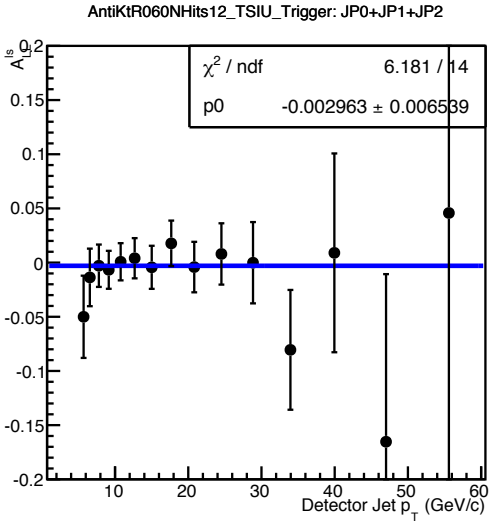


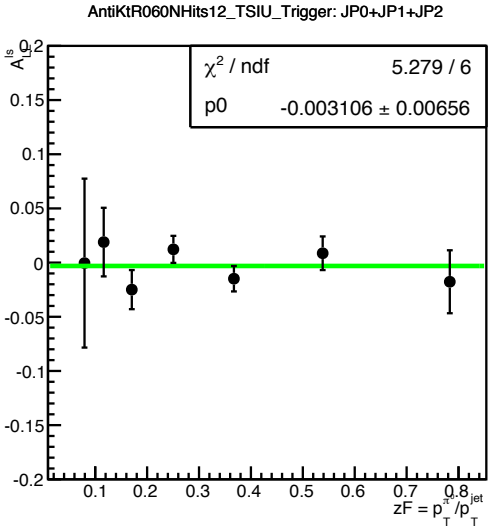


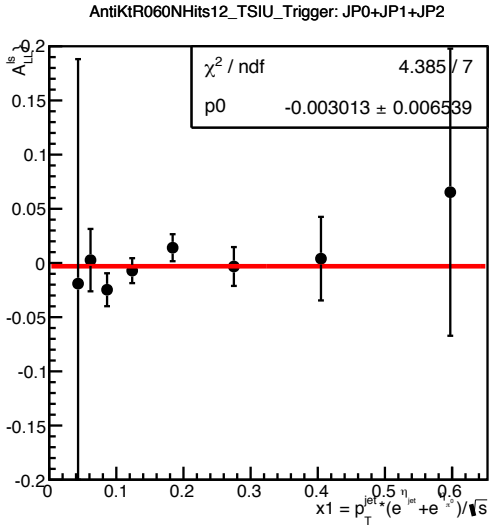
Asymmetry results – False asymmetries

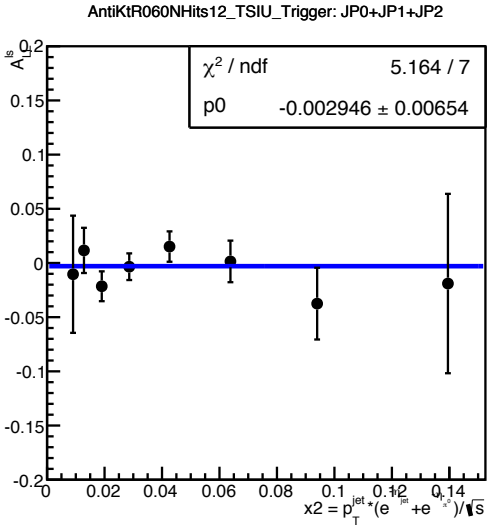
Like-sign asymmetry: combined triggers

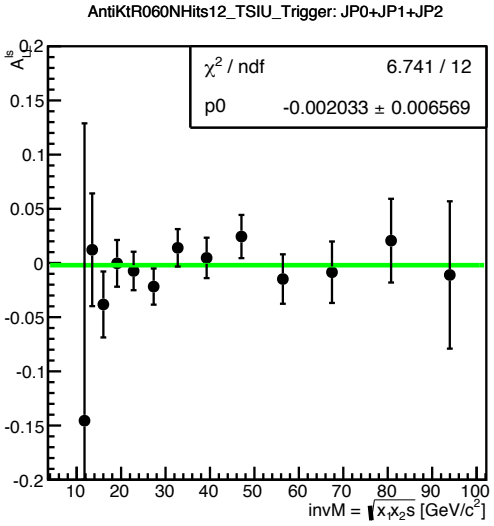






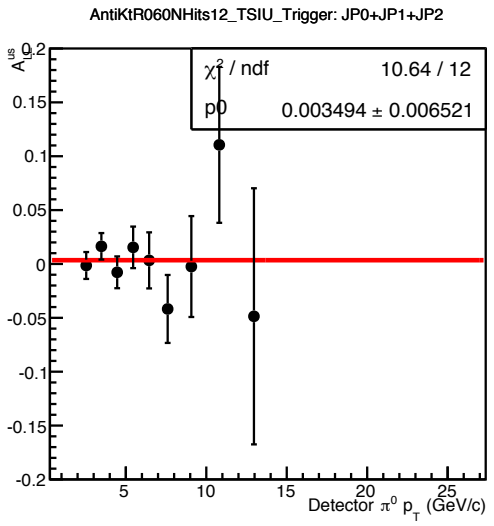


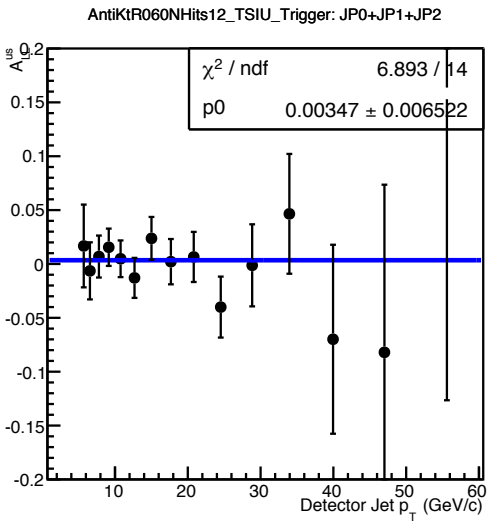


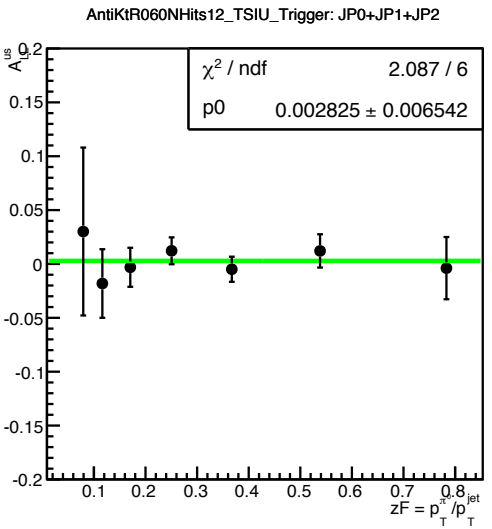


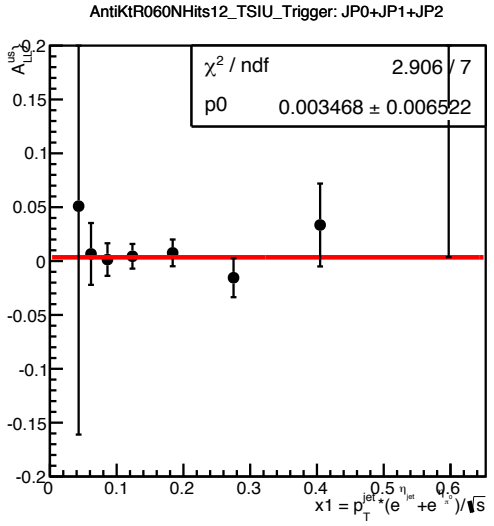
Asymmetry results – False asymmetries

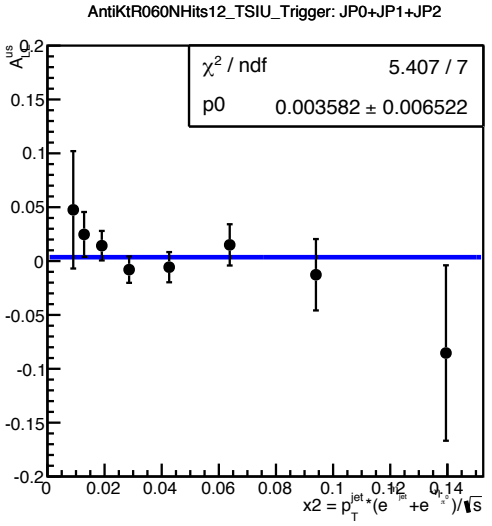
Unlike-sign asymmetry: combined triggers

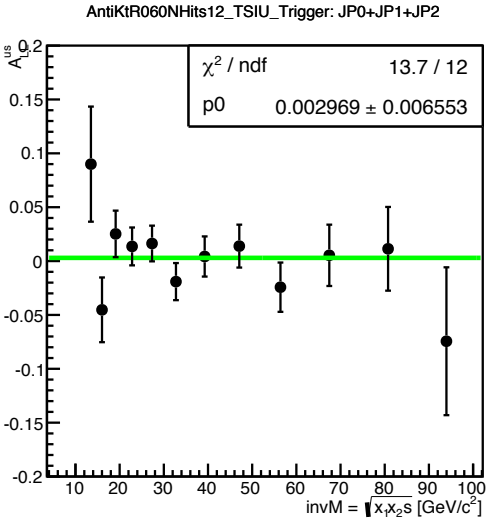






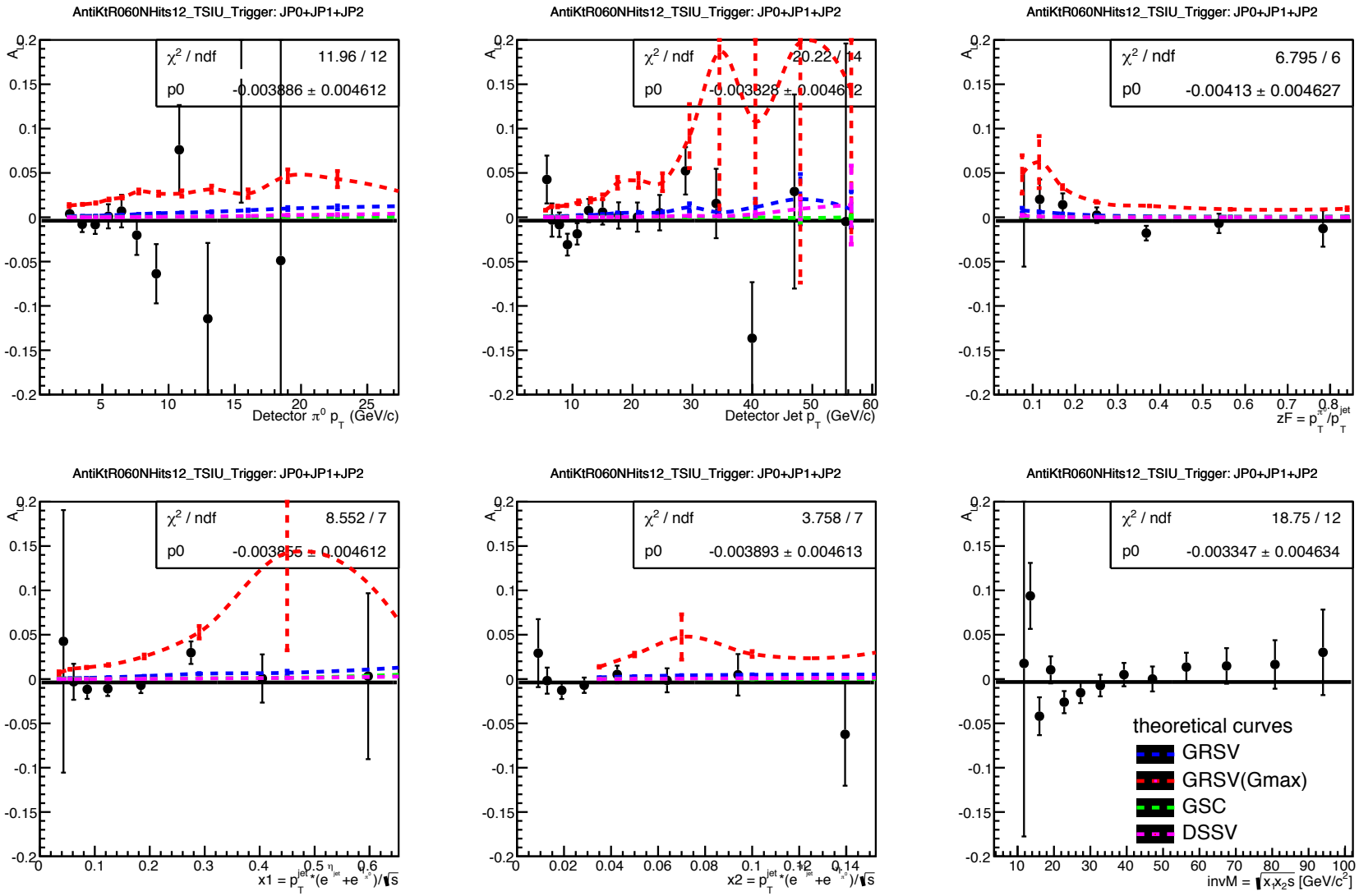






Asymmetry results – Longitudinal double spin asymmetry

Theoretical A_{LL} curves* are calculated to compare with data:



* Daniel de Florian, Phys. Rev. D79:114014,2009, arXiv:0904.4402v2

Discussion and Next To Do

Discussion:

Comments and suggestion are welcome

Next to do:

(1) Optimizing π^0 cuts to get clean π^0s

(2) Systematic errors

(3) …

Thanks for your attention!