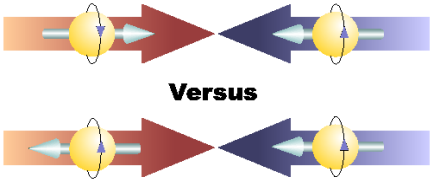
Updates on Run12 π^0 – jet A_{LL}

Yaping Wang (CCNU)
Zhenyu Ye (UIC)



Outline

- Systematics estimation
- Investigations on large background false asymmetries

Asymmetry Results – A_{LL} systematics estimations

Systematics sources:

- Propagated uncertainty from relative luminosity, δR_3
- Propagated uncertainty from single spin asymmetries (SSA) offset (δA_L^Y, δA_L^B, δA_{LL}^{LS}, δA_{LL}^{US})
- Propagated uncertainty from fit function shape

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

Asymmetry Results – systematics propagated from R_3

- Systematics due to relative luminosity uncertainty, δR_3

- The uncertainty of double spin asymmetry can be estimated as below way [1]

$$\delta A_{LL} \cong \frac{1}{P_B P_Y} \cdot \frac{\delta R_3}{2R_3}$$

Here we take the deduced systematic uncertainty of $\delta R/2R \approx \pm 0.0004$ [1], and assume $P_B = P_Y = 0.55$. Then $\delta A_{LL} \approx \pm 0.0013$.

For a conservative estimate, we use ±0.0015 in this result.

[1] James Hayes-Wehle, Joe Seele, Hal Spinka, Bernd Surrow, PSN0570: Relative Luminosity Analysis for run9 pp 200 GeV Running, Nov. 25, 2012. http://drupal.star.bnl.gov/STAR/starnotes/private/psn0570

Asymmetry Results – systematics propagated from SSA

- Systematics due to single spin asymmetries offset (δA_L^Y, or δA_L^B, or δA_{LL}^{LS}, or δA_{LL}^{US})

Following the same way as Suvarna's Dijet analysis to estimate systematics due to SSA offset from zero: https://drupal.star.bnl.gov/STAR/system/files/SSA_Systematics_0.pdf

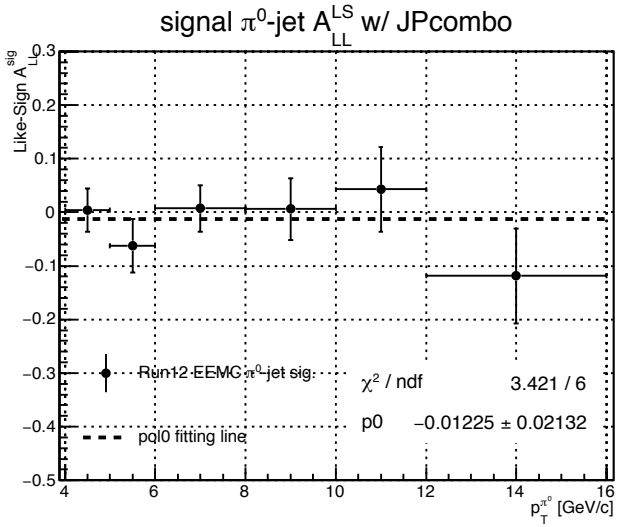
Suvarna's talk at SPIN PWG meeting on Jan. 18, 2016

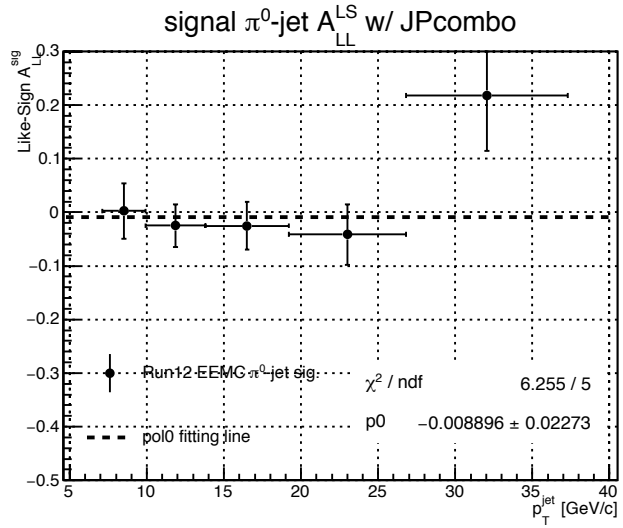
Incorporating the Single Spin Asymmetries offset as a systematic error

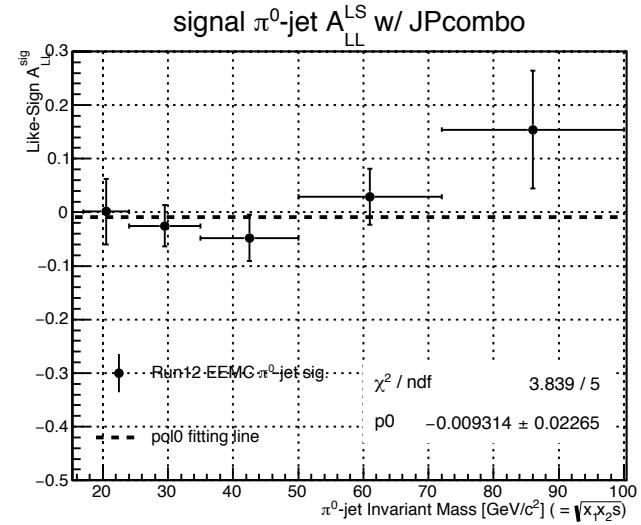
- False Asymmetries : https://drupal.star.bnl.gov/STAR/system/files/Spin_Nov2_0.pdf
- Trying to find a way to quantify the offset of Single Spin Asymmetries from zero as a systematic error into A_{LL}
  - Systematic error due to R_3 is 0.0004
  - Assume any systematic offset from zero in the SSA arises from contributions to the dijet yields in one and only one spin state
  - Since the asymmetries in A_{LS}, A_B and A_Y are all negative, it is natural to assign the effect to the spin state with spin bit 10 (N_{10} or N^{++})
  - Encapsulate the modification of N_{10} by a multiplicative factor **f** and then use this in the definition of A_{LS} , to extract **f**
  - We make the assumption that the relative luminosities are "correct", since there is already an error associated with them, and so the multiplicative **f** is not included in the yields used to extract the relative luminosities

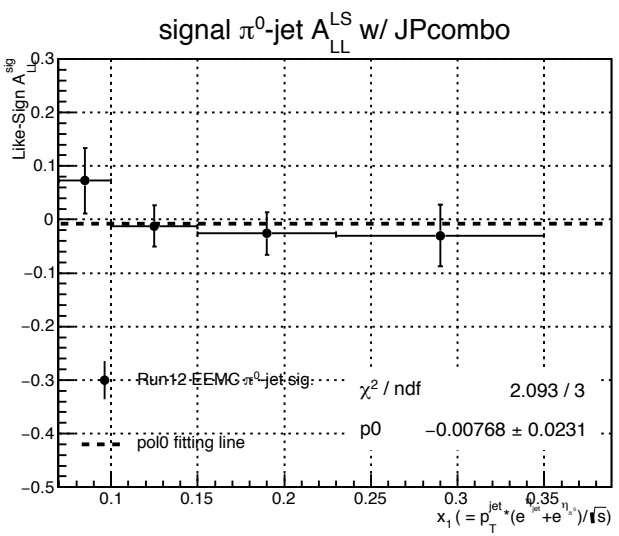
In this study, the uncertainties from SSA were calculated from A_{LL}^{LS} (due to reasonable signal and background asymmetries)

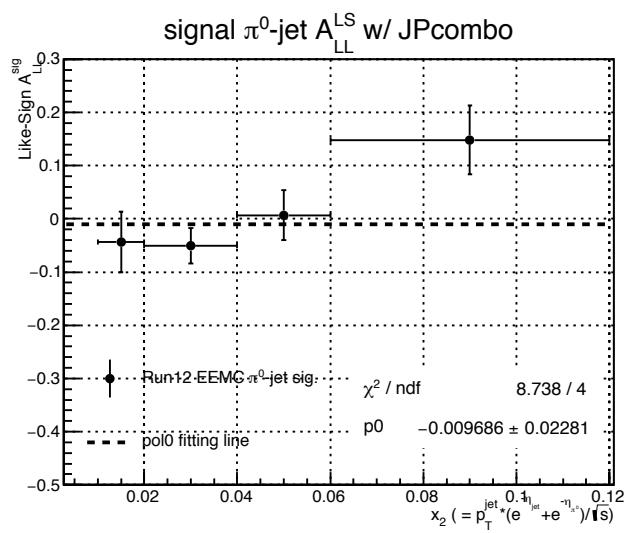
Asymmetry Results – systematics propagated from SSA





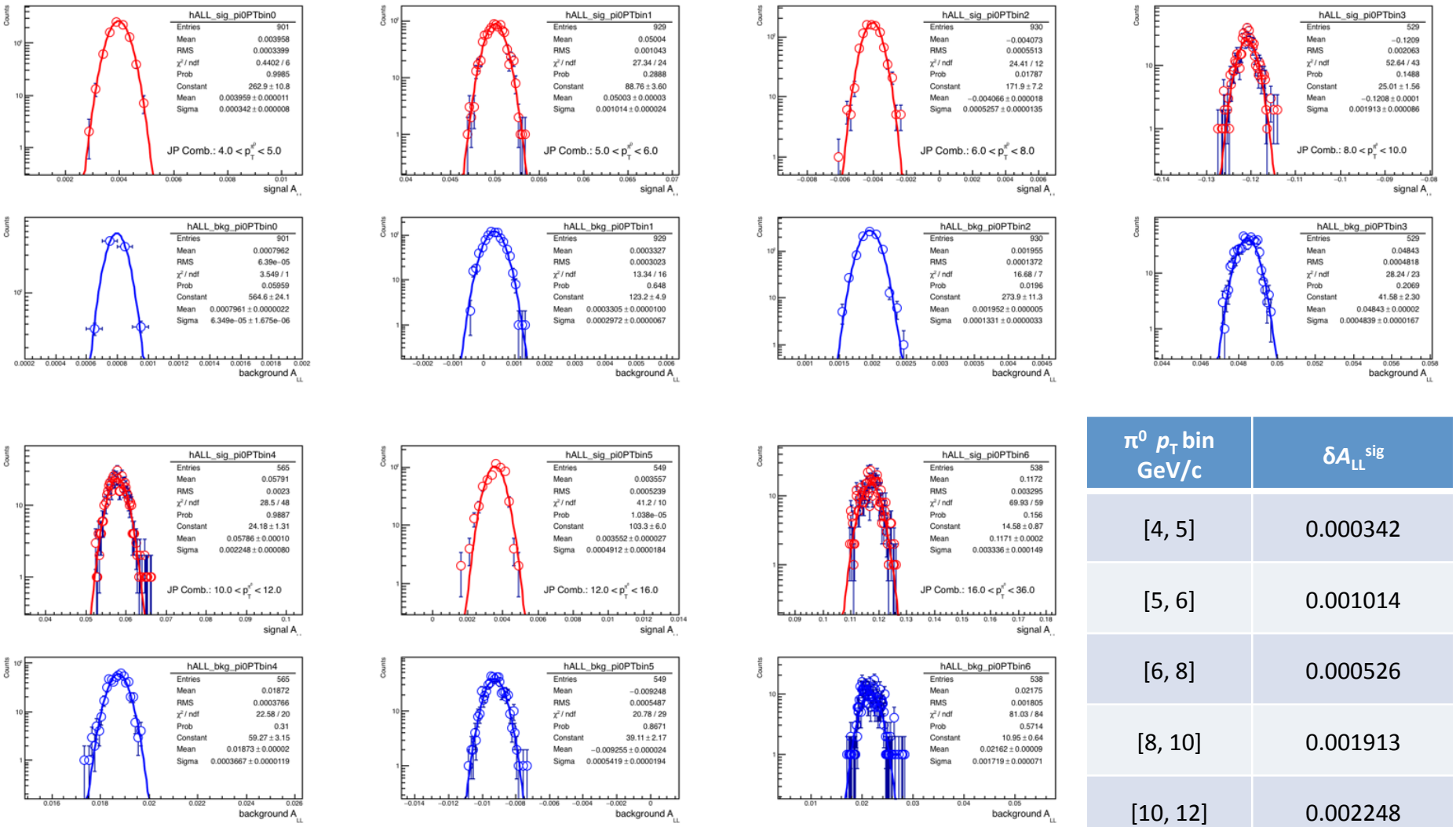






variable	δA_{LL} from SSA
π^0 p_T	0.006148
jet p_T	0.004460
x_1	0.003849
x_2	0.004857
inv. mass	0.004670

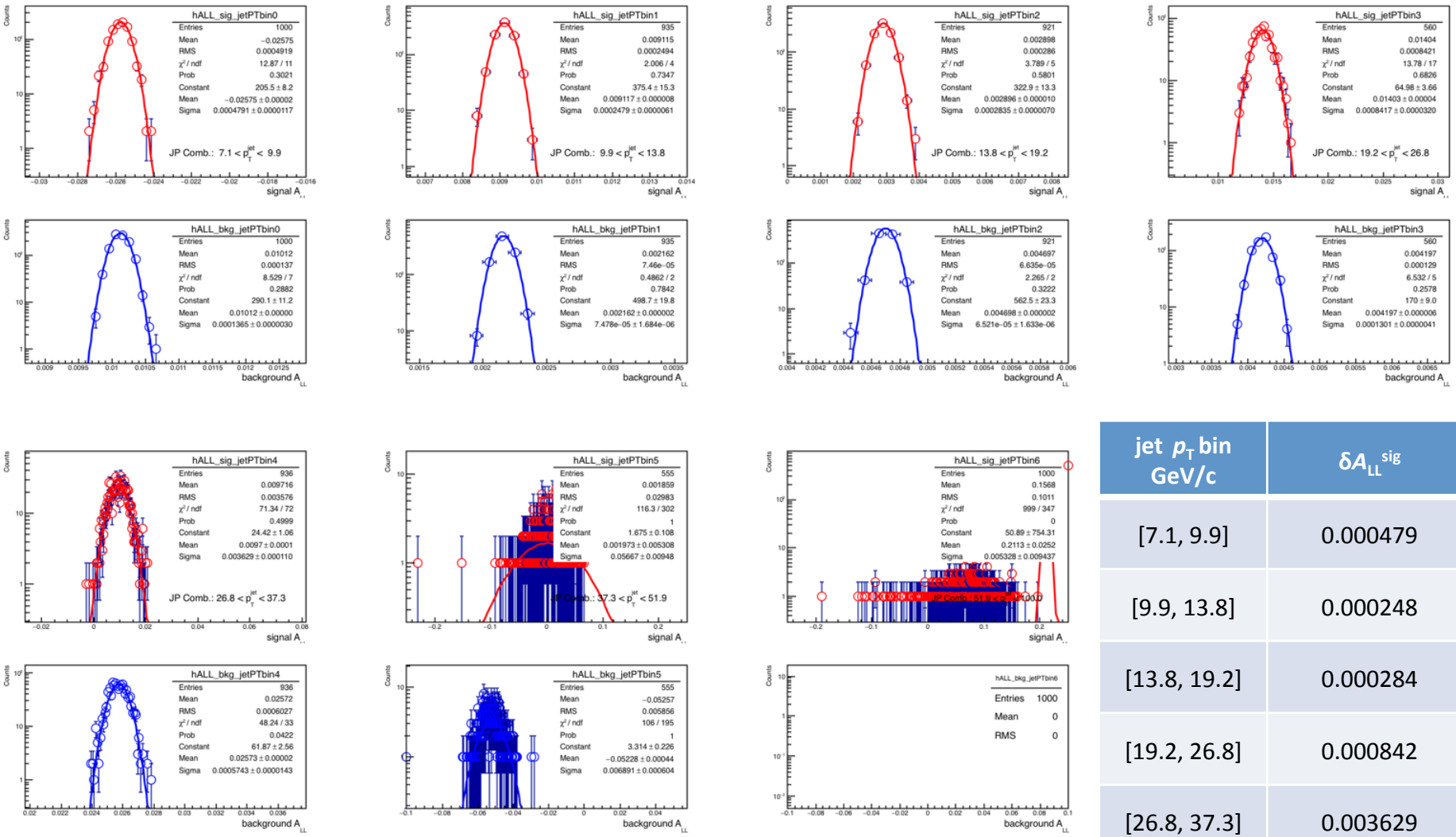
Asymmetry Results – systematics propagated from fit function shape



π^0 p_T bin GeV/c	δA_{LL}^{sig}
[4, 5]	0.000342
[5, 6]	0.001014
[6, 8]	0.000526
[8, 10]	0.001913
[10, 12]	0.002248
[12, 16]	0.000491

- Asymmetries distribution calculated by n_{sig} and n_{bkg} from fitting with slightly deviated function shape.

Asymmetry Results – systematics propagated from fit function shape



jet p_T bin GeV/c	δA_{LL}^{sig}
[7.1, 9.9]	0.000479
[9.9, 13.8]	0.000248
[13.8, 19.2]	0.000284
[19.2, 26.8]	0.000842
[26.8, 37.3]	0.003629

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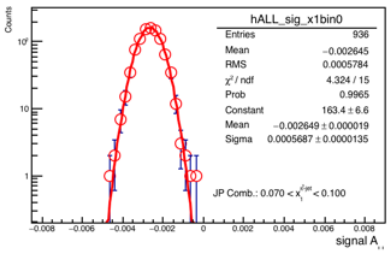
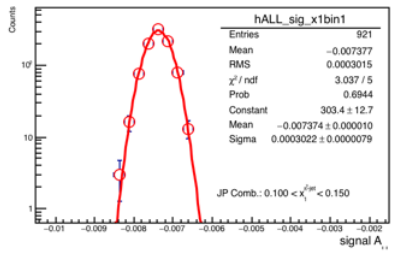
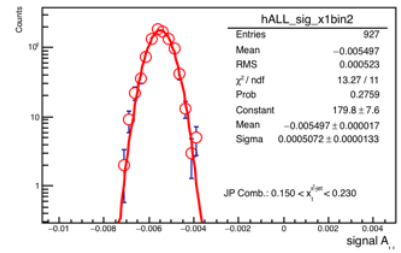
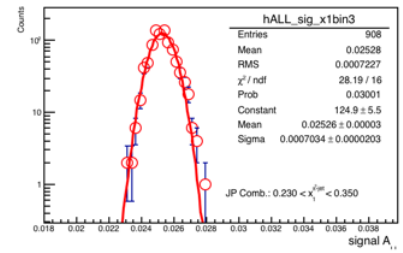
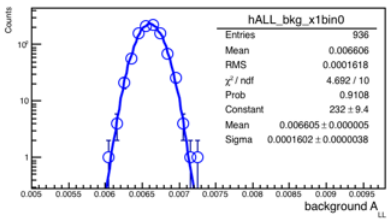
Asymmetry Results – systematics propagated from fit function shape

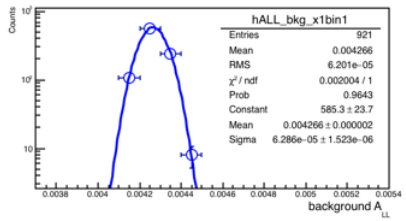


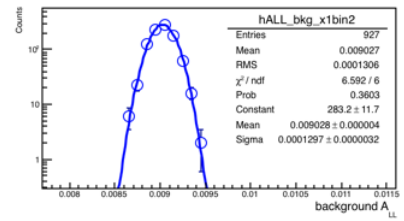


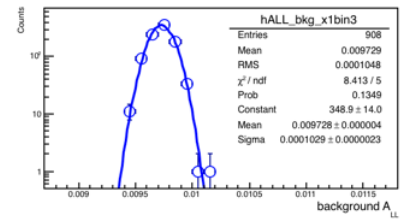


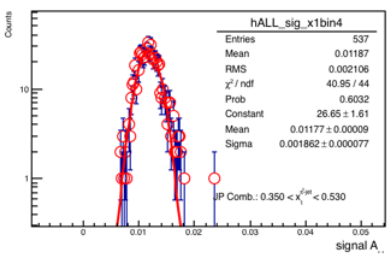


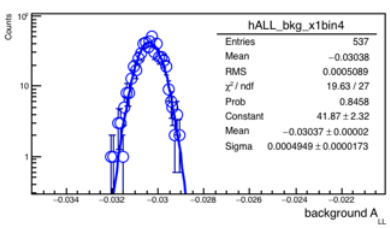








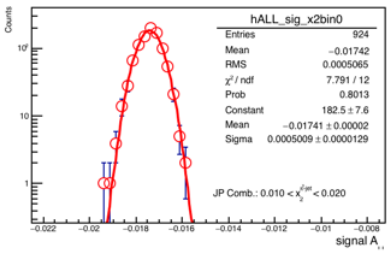


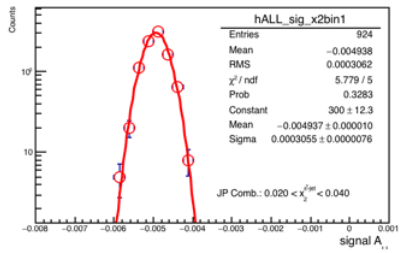


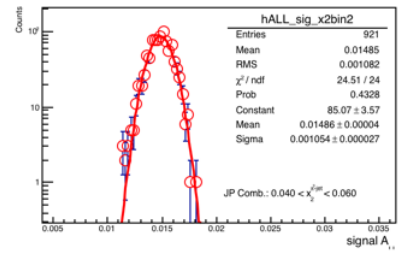
x_1 bin	δA_{LL}^{sig}
[0.07, 0.10]	0.000569
[0.10, 0.15]	0.000302
[0.15, 0.23]	0.000507
[0.23, 0.35]	0.000703
[0.35, 0.53]	0.001862

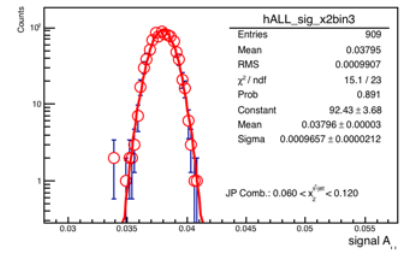
- Asymmetries distribution calculated by n_{sig} and n_{bkg} from fitting with slightly deviated function shape.

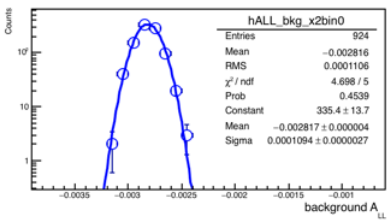
Asymmetry Results – systematics propagated from fit function shape

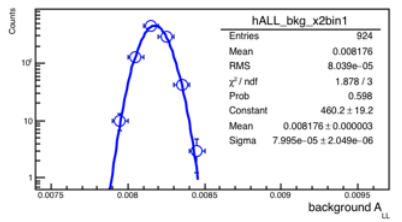


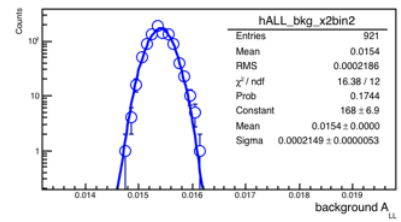


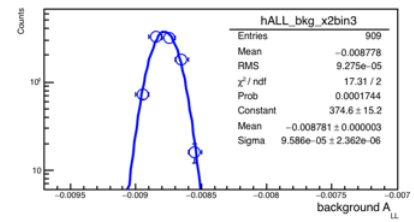


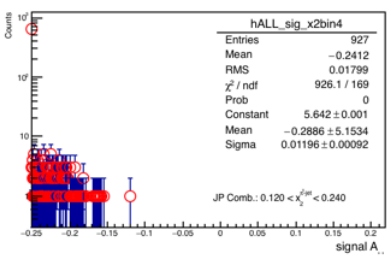


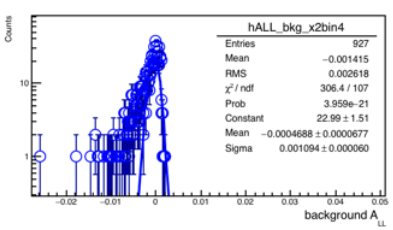








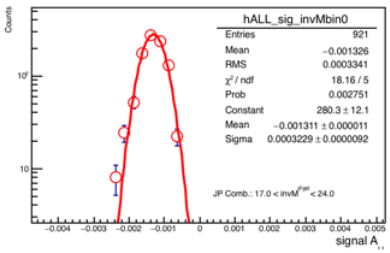


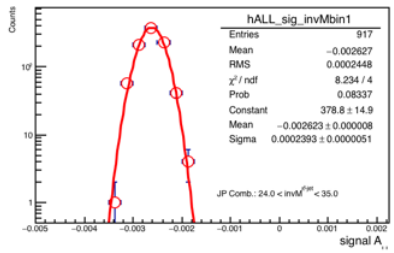


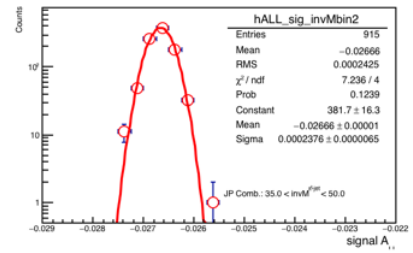
x_2 bin	δA_{LL}^{sig}
[0.01, 0.02]	0.000501
[0.02, 0.04]	0.000306
[0.04, 0.06]	0.001054
[0.06, 0.12]	0.000966

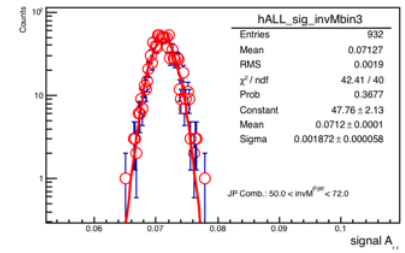
- Asymmetries distribution calculated by n_{sig} and n_{bkg} from fitting with slightly deviated function shape.

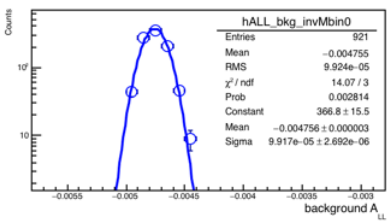
Asymmetry Results – systematics propagated from fit function shape

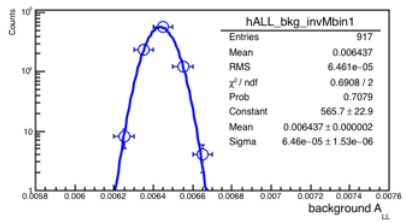


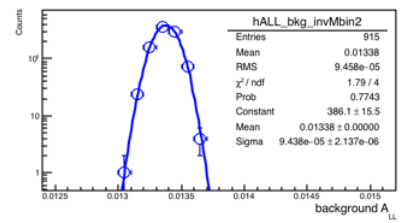


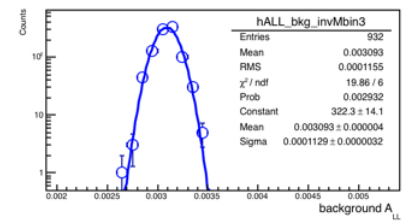


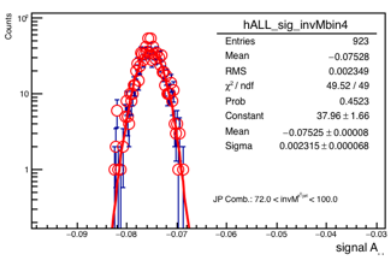


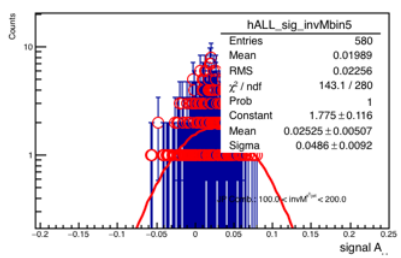


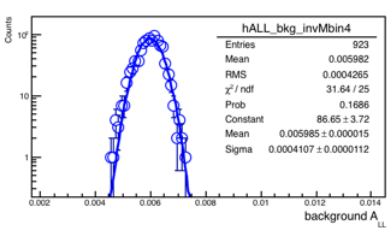


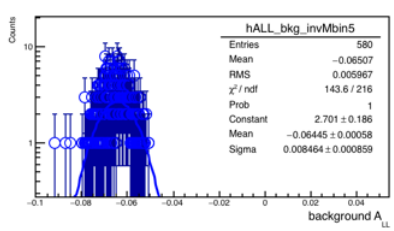








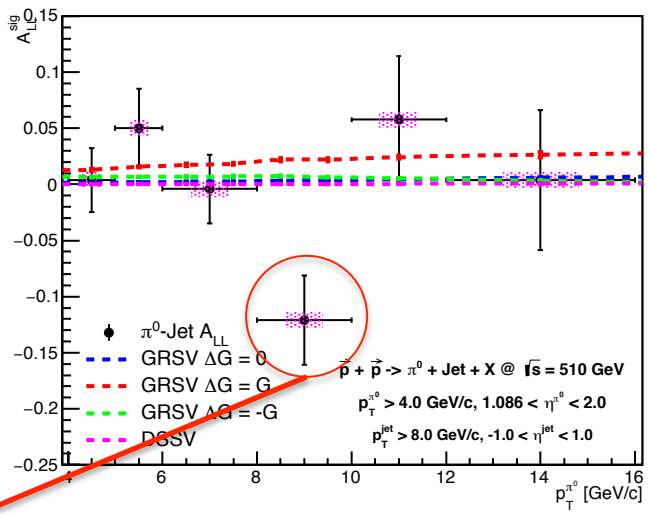


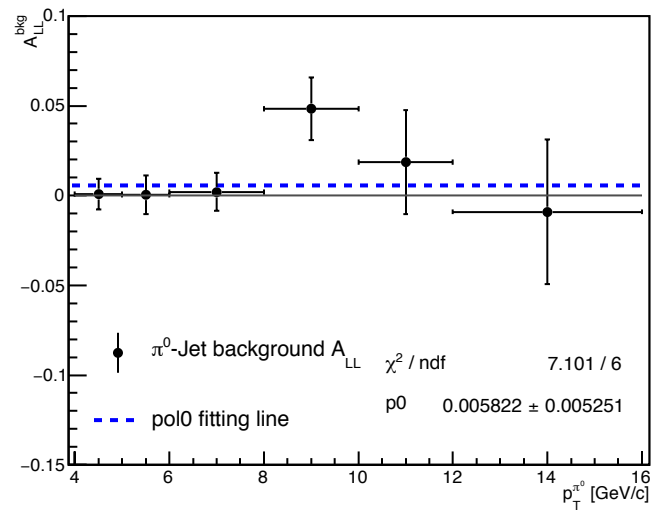


Inv mass bin GeV/c²	δA_{LL}^{sig}
[17, 24]	0.000323
[24, 35]	0.000239
[35, 50]	0.000238
[50, 72]	0.001872
[72, 100]	0.002315

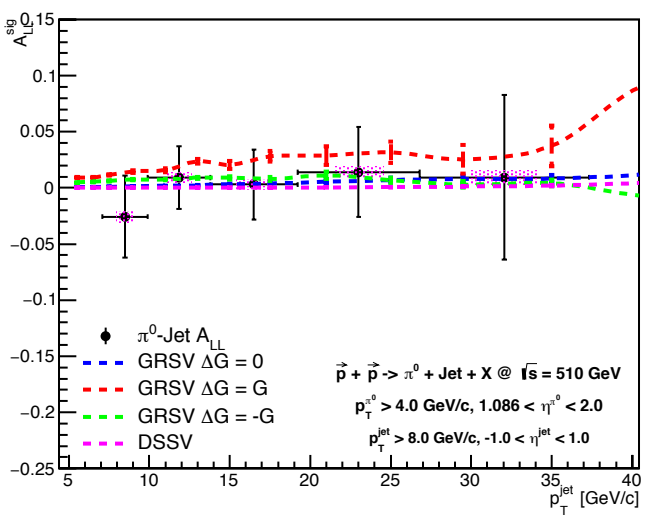
- Asymmetries distribution calculated by n_{sig} and n_{bkg} from fitting with slightly deviated function shape.

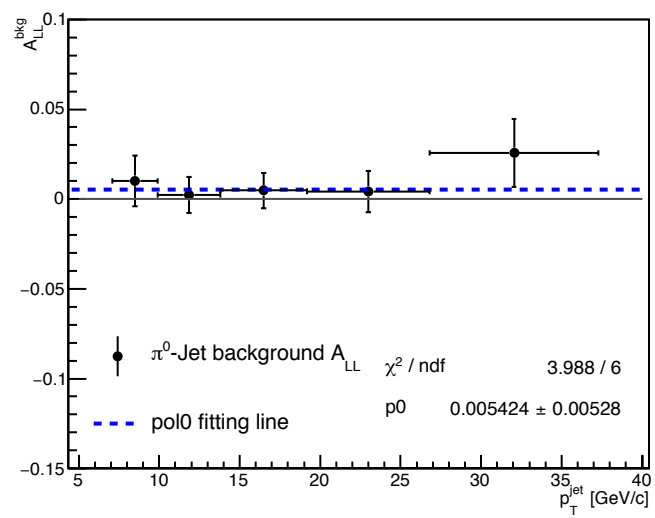
Asymmetry Results – Longitudinal double asymmetries , A_{LL}



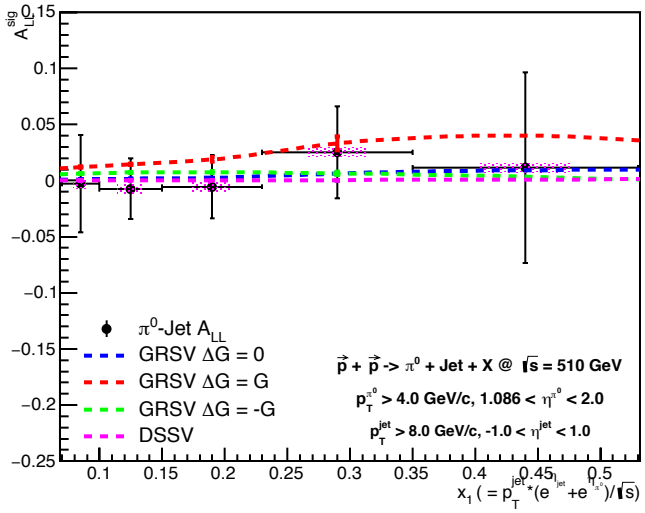


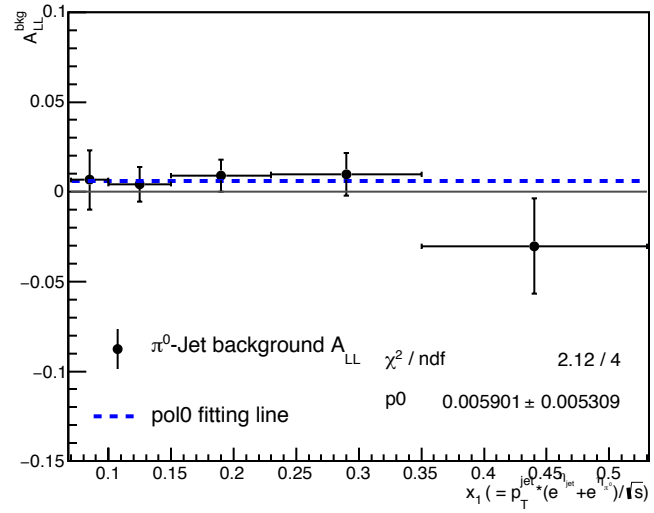
The point drops down compared to the result shown in the collaboration meeting, due to a bug was found in plotting macro (the parameter limit was set for the n_{sig} during fit for this bin).

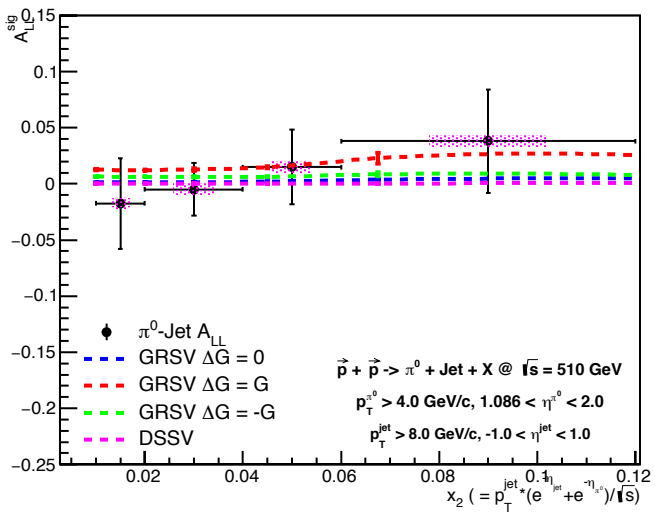


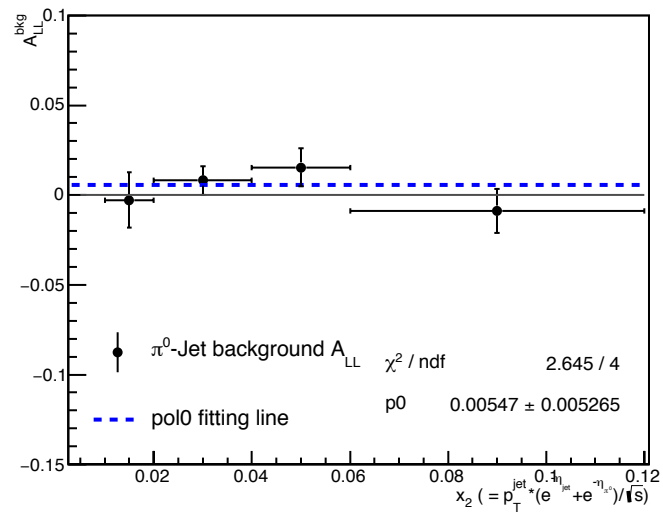


Asymmetry Results – Longitudinal double asymmetries , A_{LL}

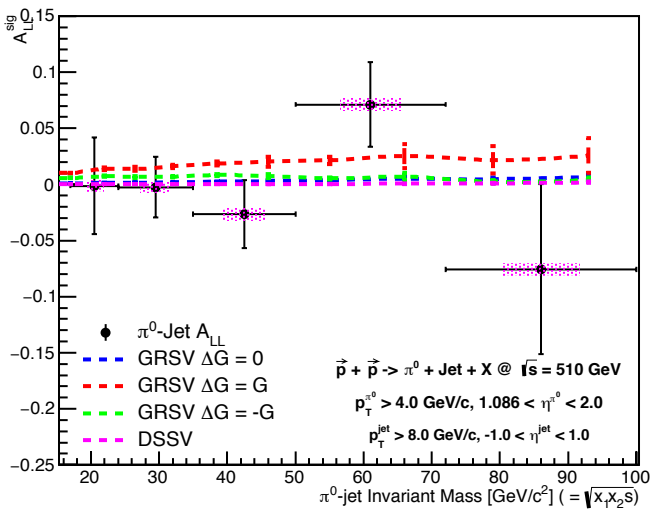


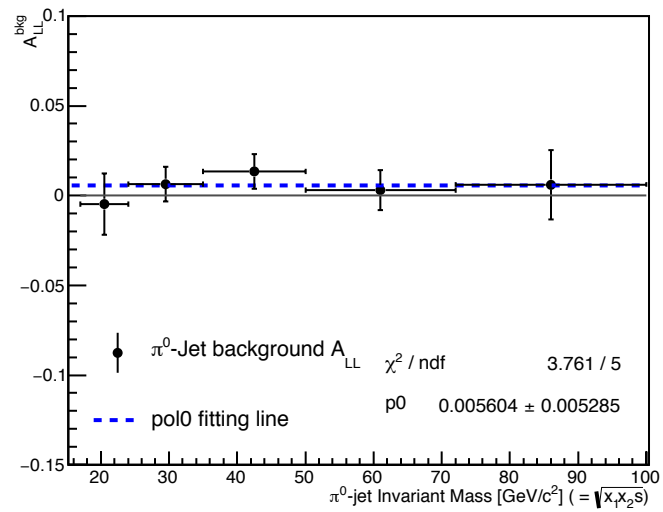






Asymmetry Results – Longitudinal double asymmetries , A_{LL}





Deviation from zero in the constant fit

BKG Asymmetry	π^0 p_T	Jet p_T	x_1	x_2	Inv. mass
A_L^B	2.99	3.03	2.95	3.13	3.01
A_L^Y	4.81	4.73	4.70	4.69	4.76
A_{LL}^{LS}	0.54	0.51	0.67	0.35	0.51
A_{LL}^{US}	4.99	5.00	4.90	5.02	4.97
Combined triggers (JP0 + JP1 + JP2), Anti-Kt R=0.6					

- Large false asymmetries of background were found in A_L^B, A_L^Y, and A_{LL}^{US}.

Asymmetry Results – Check large false asymmetries in background

- Then we try to check the large background false asymmetry dependence on the anti-kt cone size (R = 0.6 → R = 0.5)

Issues: (1) the π^0 pico trees (pp200 DBs were used for EEMC) reconstructed for the π^0-jet analysis were gone from /star/data05 disk in couple of months ago.

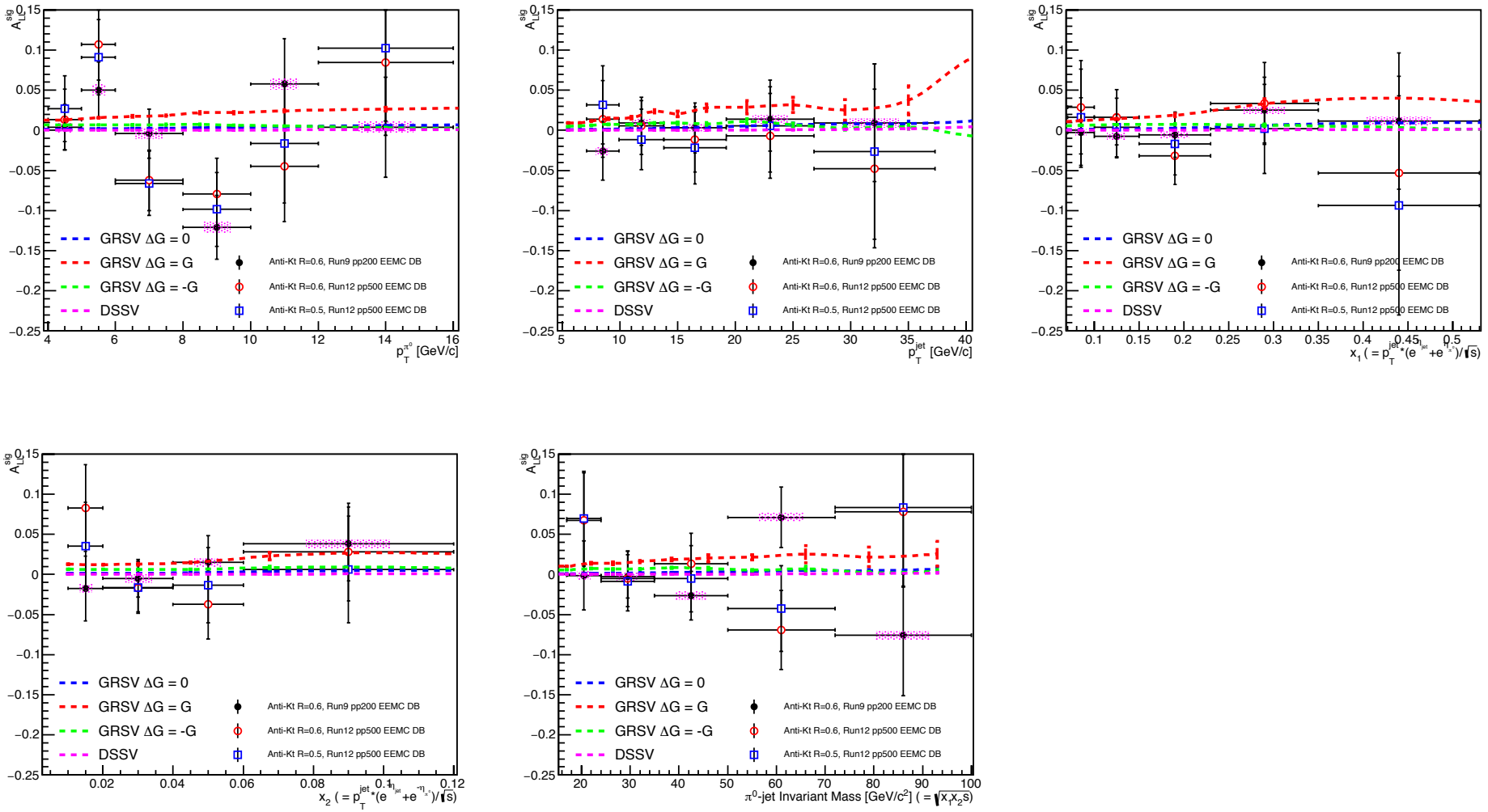
(2) Couple of weeks were spent after the Collaboration meeting to transferred MuDst trees of 100 runs (Run 12 pp500) from HPSS to RCF for π^0 pico tree reproduction. This is about one fourth statistics of the pi0-jet analysis (this reproduction uses the latest updated pp510 EEMC DBs).

The reproduced π^0 pico trees can be found (run 13077067 ~ 13085047):

RCF: /star/u/ypwang/disk01/pi0Trees3/output

Asymmetry Results – Longitudinal double asymmetries , A_{LL}

- A_{LL} dependence on Anti-Kt cone size (R=0.6 and 0.5) and EEMC DB (pp200 and run12 pp510).



Asymmetry Results – Blue beam single spin asymmetries, A_L^B

- Signal A_L^B dependence on Anti-Kt cone size (R=0.6 and 0.5) and EEMC DB (pp200 and run12 pp510).

signal A_L^B	R=0.6, old EEMC DB (359 runs)		R=0.6, new EEMC DB (100 runs)		R=0.5, new EEMC DB (100 runs)	
	value	Deviation from zero	value	Deviation from zero	value	Deviation from zero
π^0 p_T	-0.0113 ± 0.008602	1.31	-0.00297 ± 0.0108	0.28	-0.002416± 0.01147	0.21
jet p_T	-0.007947± 0.009174	0.87	-0.004886± 0.01185	0.41	-0.005555± 0.01267	0.44
x_1	-0.007428± 0.009157	0.81	-0.00719 ± 0.0117	0.61	-0.008128± 0.0125	0.65
x_2	-0.00884 ± 0.009215	0.96	-0.005243± 0.01194	0.44	-0.006333± 0.01274	0.50
Inv. mass	-0.008214± 0.009148	0.90	-0.005395± 0.01177	0.46	-0.005872± 0.01255	0.47

Asymmetry Results – Blue beam single spin asymmetries, A_L^B

- Background A_L^B dependence on Anti-Kt cone size (R=0.6 and 0.5) and EEMC DB (pp200 and run12 pp510).

background A_L^B	R=0.6, old EEMC DB (359 runs)		R=0.6, new EEMC DB (100 runs)		R=0.5, new EEMC DB (100 runs)	
	value	Deviation from zero	value	Deviation from zero	value	Deviation from zero
π^0 p_T	-0.008978± 0.003003	2.99	0.01161 ± 0.005667	2.05	0.008663± 0.005961	1.45
jet p_T	-0.00914 ± 0.003019	3.03	0.01135 ± 0.005663	2.00	0.008690± 0.00595	1.46
x_1	-0.008924± 0.003026	2.95	0.01231 ± 0.005713	2.15	0.009936± 0.006007	1.65
x_2	-0.00944 ± 0.003012	3.13	0.01134 ± 0.005637	2.01	0.008747± 0.005929	1.48
Inv. mass	-0.009105± 0.003023	3.01	0.01161 ± 0.005676	2.05	0.008934± 0.005968	1.50

Asymmetry Results – Yellow beam single spin asymmetries, A_L^Y

- Signal A_L^Y dependence on Anti-Kt cone size (R=0.6 and 0.5) and EEMC DB (pp200 and run12 pp510).

signal A_L^Y	R=0.6, old EEMC DB (359 runs)		R=0.6, new EEMC DB (100 runs)		R=0.5, new EEMC DB (100 runs)	
	value	Deviation from zero	value	Deviation from zero	value	Deviation from zero
π^0 p_T	0.007065 ± 0.008268	0.85	-0.01198 ± 0.01054	1.14	-0.009909± 0.01119	0.89
jet p_T	0.005930 ± 0.008814	0.67	-0.01487 ± 0.01156	1.29	-0.01108 ± 0.01235	0.90
x_1	0.008087± 0.0088	0.92	-0.01221 ± 0.01142	1.07	-0.008838± 0.0122	0.72
x_2	0.006245± 0.008851	0.71	-0.01509 ± 0.01164	1.30	-0.01116 ± 0.01242	0.90
Inv. mass	0.00582 ± 0.008794	0.66	-0.01456 ± 0.01148	1.27	-0.01087 ± 0.01225	0.87

Asymmetry Results – Yellow beam single spin asymmetries, A_L^Y

- Background A_L^Y dependence on Anti-Kt cone size (R=0.6 and 0.5) and EEMC DB (pp200 and run12 pp510).

background A_L^Y	R=0.6, old EEMC DB (359 runs)		R=0.6, new EEMC DB (100 runs)		R=0.5, new EEMC DB (100 runs)	
	value	Deviation from zero	value	Deviation from zero	value	Deviation from zero
π^0 p_T	0.0139 ± 0.002887	4.81	0.01347 ± 0.005546	2.43	0.01169 ± 0.005833	2.00
jet p_T	0.01374 ± 0.002902	4.73	0.01317 ± 0.005541	2.38	0.0112 ± 0.005825	1.92
x_1	0.01371 ±0.002919	4.70	0.01334 ± 0.00559	2.39	0.0116 ± 0.005881	1.97
x_2	0.01359 ± 0.002895	4.69	0.01293 ± 0.005516	2.34	0.01101 ± 0.005805	1.90
Inv. mass	0.01383 ± 0.002906	4.76	0.01313 ± 0.005554	2.36	0.01067 ± 0.005843	1.83

Asymmetry Results – Like-sign single spin asymmetries, A_{LL}^{LS}

- Signal A_{LL}^{LS} dependence on Anti-Kt cone size (R=0.6 and 0.5) and EEMC DB (pp200 and run12 pp510).

signal A_{LL}^{LS}	R=0.6, old EEMC DB (359 runs)		R=0.6, new EEMC DB (100 runs)		R=0.5, new EEMC DB (100 runs)	
	value	Deviation from zero	value	Deviation from zero	value	Deviation from zero
π^0 p_T	-0.01225 ± 0.02132	0.57	-0.02711 ± 0.02722	1.00	-0.02344 ± 0.02894	0.81
jet p_T	-0.008896± 0.02273	0.39	-0.04005 ± 0.02967	1.35	-0.03344 ± 0.03174	1.05
x_1	-0.00768 ± 0.0231	0.33	-0.03881 ± 0.02927	1.33	-0.03419 ± 0.03135	1.09
x_2	-0.009686± 0.02281	0.42	-0.04015 ± 0.02989	1.34	-0.0352 ± 0.03191	1.10
Inv. mass	-0.009314± 0.02265	0.41	-0.04011 ± 0.02944	1.36	-0.03381 ± 0.03142	1.08

Asymmetry Results – Like-sign single spin asymmetries, A_{LL}^{LS}

- Background A_{LL}^{LS} dependence on Anti-Kt cone size (R=0.6 and 0.5) and EEMC DB (pp200 and run12 pp510).

background A_{LL}^{LS}	R=0.6, old EEMC DB (359 runs)		R=0.6, new EEMC DB (100 runs)		R=0.5, new EEMC DB (100 runs)	
	value	Deviation from zero	value	Deviation from zero	value	Deviation from zero
π^0 p_T	0.004015 ± 0.007441	0.54	0.04368 ± 0.01425	3.07	0.03511 ± 0.01499	2.34
jet p_T	0.003851 ± 0.007482	0.51	0.04368 ± 0.01422	3.07	0.03483 ± 0.01494	2.33
x_1	0.005137 ± 0.007673	0.67	0.04568 ± 0.01434	3.19	0.03804 ± 0.01508	2.52
x_2	0.002646 ± 0.00746	0.35	0.04284 ± 0.01415	3.03	0.03471 ± 0.01488	2.33
Inv. mass	0.00381 ± 0.007487	0.51	0.04394 ± 0.01425	3.08	0.03456 ± 0.01498	2.31

Asymmetry Results – Unlike-sign single spin asymmetries, A_{LL}^{US}

- Signal A_{LL}^{US} dependence on Anti-Kt cone size (R=0.6 and 0.5) and EEMC DB (pp200 and run12 pp510).

signal A_{LL}^{US}	R=0.6, old EEMC DB (359 runs)		R=0.6, new EEMC DB (100 runs)		R=0.5, new EEMC DB (100 runs)	
	value	Deviation from zero	value	Deviation from zero	value	Deviation from zero
π^0 p_T	0.02748 ± 0.02126	1.29	-0.02507 ± 0.02656	0.94	-0.02434 ± 0.02829	0.86
jet p_T	0.01833 ± 0.02269	0.81	-0.02805 ±0.02918	0.96	-0.02041 ± 0.03112	0.66
x_1	0.02165 ± 0.02262	0.96	-0.01819 ± 0.02881	0.63	-0.01189 ± 0.0307	0.39
x_2	0.0211 ± 0.02277	0.93	-0.02721 ± 0.02935	0.93	-0.01931 ± 0.03127	0.62
Inv. mass	0.01902 ± 0.02261	0.84	-0.02507 ± 0.02895	0.87	-0.01797 ± 0.03085	0.58

Asymmetry Results – Unlike-sign single spin asymmetries, A_{LL}^{US}

- Background A_{LL}^{US} dependence on Anti-Kt cone size (R=0.6 and 0.5) and EEMC DB (pp200 and run12 pp510).

background A_{LL}^{US}	R=0.6, old EEMC DB (359 runs)		R=0.6, new EEMC DB (100 runs)		R=0.5, new EEMC DB (100 runs)	
	value	Deviation from zero	value	Deviation from zero	value	Deviation from zero
π^0 p_T	0.0371 ± 0.007434	5.03	-0.005464± 0.01405	0.39	-0.003366± 0.0148	0.23
jet p_T	0.03728 ± 0.007477	4.99	-0.00509 ± 0.01404	0.36	-0.004278± 0.01476	0.29
x_1	0.0368 ± 0.007516	4.90	-0.007112± 0.01415	0.50	-0.00583 ± 0.0149	0.39
x_2	0.03741 ± 0.007454	5.02	-0.005844± 0.01397	0.42	-0.004838± 0.0147	0.33
Inv. mass	0.03719 ± 0.007483	4.97	-0.006026± 0.01406	0.43	-0.005827± 0.0148	0.39

Asymmetry Results – Check large false asymmetries in background

Additional check:

BKG A_{LL}^{US}	
Kinematics cuts	π^0 p_T
π^0 $p_T > 4$, Jet $p_T > 8$, $\lvert\Delta\phi\rvert > 2.0$	4.99 (= 0.0371/0.007434)
π^0 $p_T > 4$, Jet $p_T > 10$, $\lvert\Delta\phi\rvert > 2.0$	4.43 (= 0.03562/0.008039)
π^0 $p_T > 4$, Jet $p_T > 10$, $\lvert\Delta\phi\rvert > 2.54$	3.97 (= 0.03389/0.00854)
Combined triggers (JP0 + JP1 + JP2), Anti-Kt R = 0.6	

- The deviation become less as the more restrict analysis cuts were set.

Summary

- The methods of systematics estimation were proposed;
- Large false asymmetries of background were investigated, and found:
  - The asymmetries show difference while using the pp200 EEMC DB or run12 pp510 EEMC DB;
  - The new populated pp510 EEMC DB benefits π^0-jet statistics (much better background suppression).
  - The anti-Kt R=0.5 algorithm could reduce the false asymmetries compared to R=0.6.
- Request S&C to transfer run12 pp510 MuDst files to RCF for π^0 picoDst reproduction, and the π^0 picoDst reproduction can be finished in one week once the MuDst available.

Thanks for your attention!