Direct-Photon A_N

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Asymmetry Calculation

Direct-Photon Yields (from ppg136, eq. 7):

$$N_{dir}^{iso} = N_{incl}^{iso} - (n_{\pi^0}^{iso} + R\,N_{\pi^0}^{iso}) - A^{iso}(1+R)\,N_{\pi^0}^{iso}$$

$$N_{dir}^{iso} = \underbrace{(N_{incl}^{iso} - n_{\pi^0}^{iso})}_{N_{incl}} - \underbrace{[R + A^{iso}(1+R)]\,N_{\pi^0}^{iso}}_{N_{bkgr}}$$

$n_{\pi^0}^{iso}$ Photons which have a partner photon reconstructed in the EMCal acceptance.

$N_{\pi^0}^{iso}$ Photons which satisfy the isolation criteria if the partner photon is masked out.

$$A_N = \frac{1}{P}\langle f(\varphi)\rangle \frac{(N^{\uparrow\uparrow} + R_1 N^{\uparrow\downarrow}) - (R_2 N^{\downarrow\uparrow} + R_3 N^{\downarrow\downarrow})}{(N^{\uparrow\uparrow} + R_1 N^{\uparrow\downarrow}) + (R_2 N^{\downarrow\uparrow} + R_3 N^{\downarrow\downarrow})}$$

$$R_1 = \frac{L^{\uparrow\uparrow}}{L^{\uparrow\downarrow}}, \quad R_2 = \frac{L^{\uparrow\uparrow}}{L^{\downarrow\uparrow}}, \quad R_3 = \frac{L^{\uparrow\uparrow}}{L^{\downarrow\downarrow}}$$

$$\langle f(\varphi)\rangle = \langle|\sin(\varphi)|\rangle^{-1} = \frac{N}{\sum_{i=0}^{N}|\sin(\varphi)|}$$

NOTE: φ is measure from polarization axis.

Physics Asymmetry:

$$A_N = \frac{A_N^{incl} - r\,A_N^{bkgr}}{1-r}$$

$$\delta A_N = \frac{\sqrt{(\delta A_N^{incl})^2 + r^2(\delta A_N^{bkgr})^2}}{1-r}$$

$$r = \frac{N_{bkgr}}{N_{incl}} = [R + A^{iso}(1+R)]\frac{N_{\pi^0}^{iso}}{N_{incl}^{iso} - n_{\pi^0}^{iso}}$$

Cuts

> The analysis follows the same method established in ppg136.
> Direct photon candidates are tagged using isolation cut.
> PDST for the analysis were produces using AnalysisTaxi 256.

Mainly the cuts used are the same as those used for cross-section measurement.

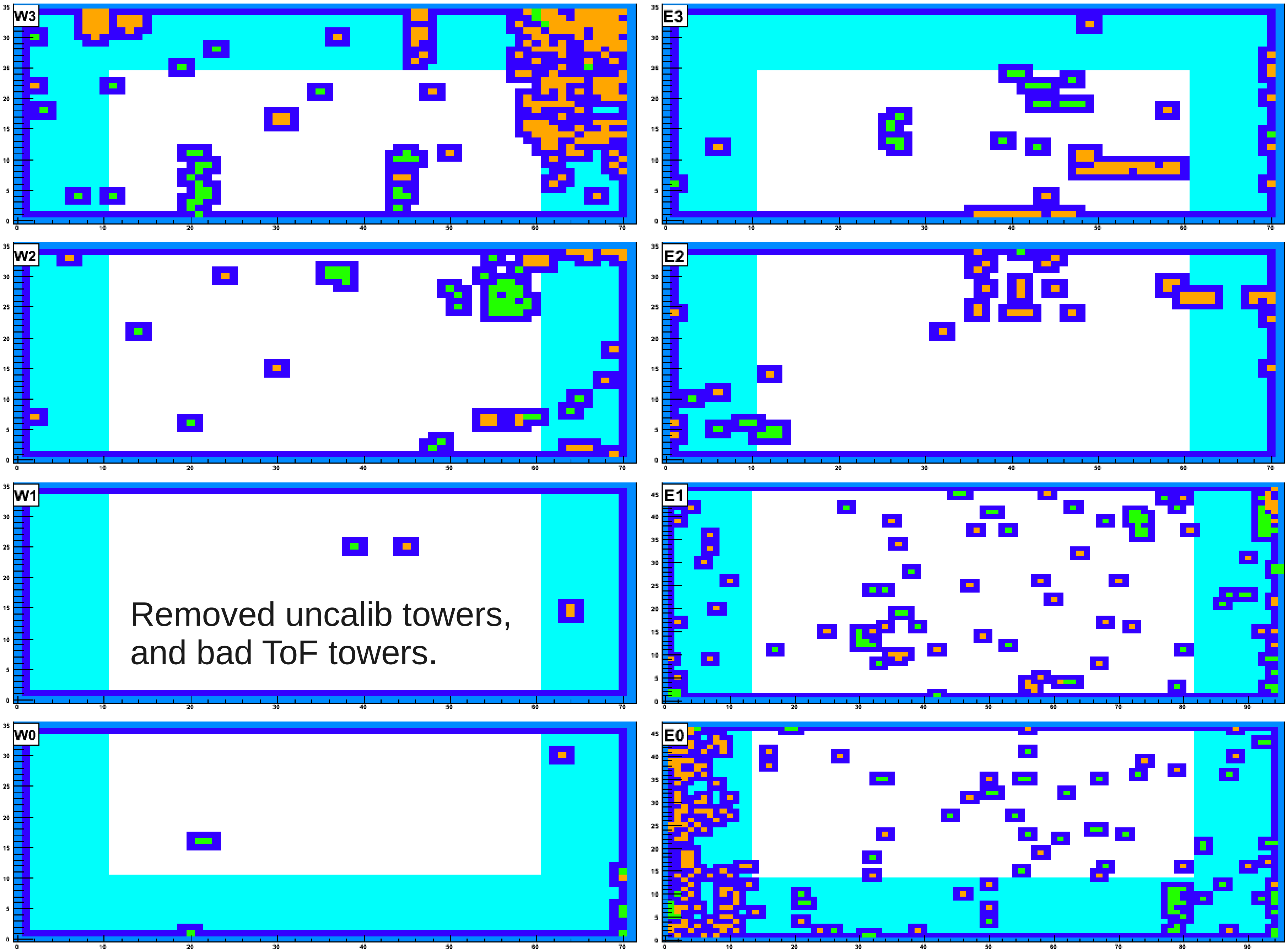
Photons:

- Shower shape cut. (prob > 0.02)
- Minimum Energy: 0.5 GeV for partner photons; 0.15 for Econe calculation
- ToF: -5 to 10
- ERT is required.
- Charge Veto (by comparing TowerID of photon cluster to TowerIDs of Tracks)

Tracks (for Econe calculation)

- PC3 or EMC matching
- Track quality > 3
- Track pt <15

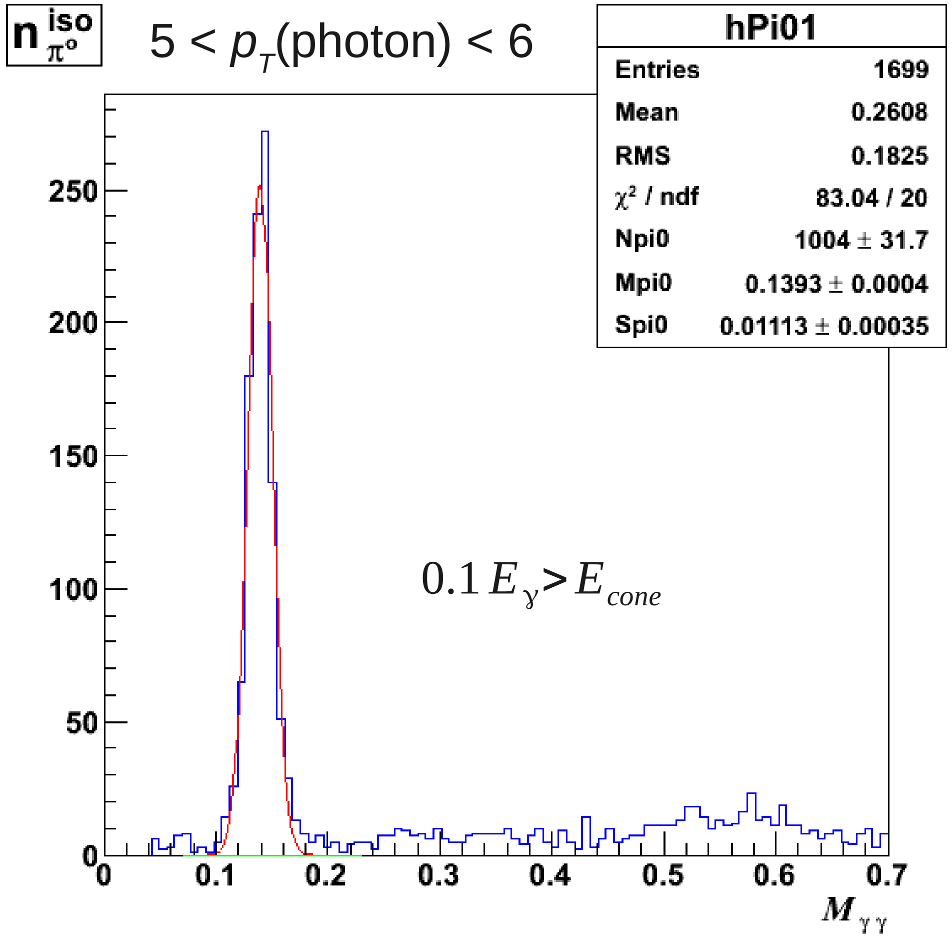
EMCal warn map

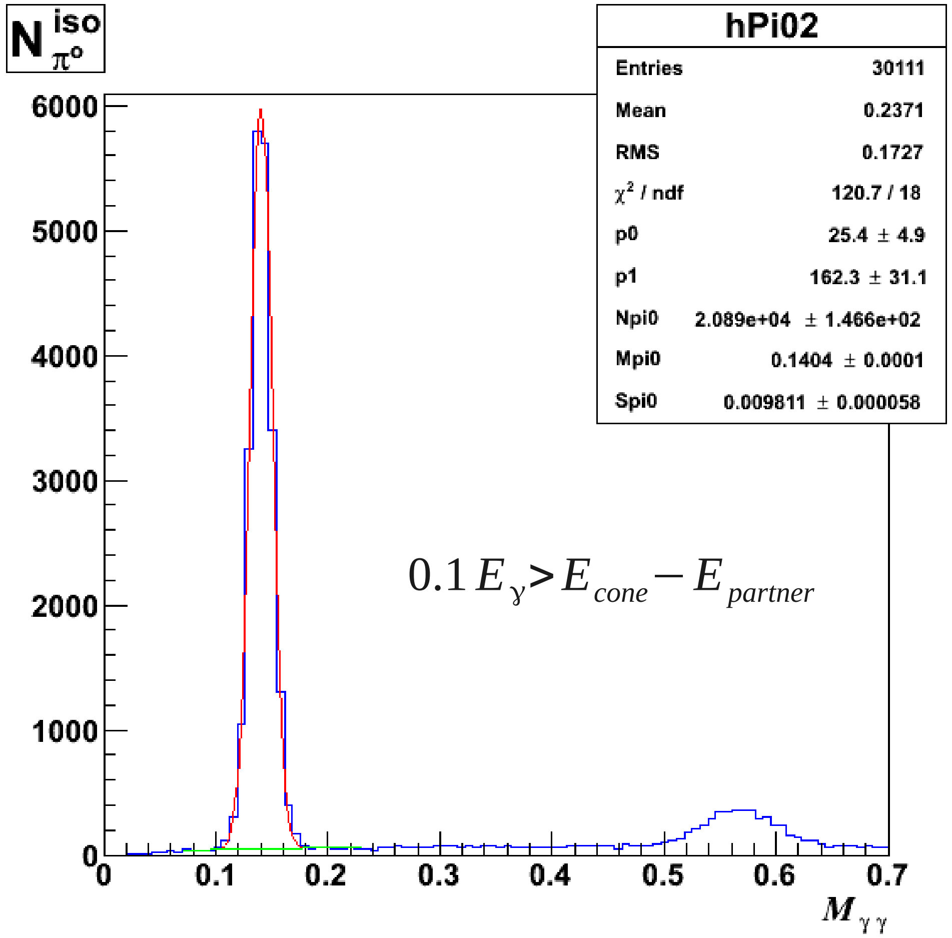


Removed uncalib towers, and bad ToF towers.

Photon from pi0 decay

$$N_{dir}^{iso} = (N_{incl}^{iso} - n_{\pi^0}^{iso}) - [R + A^{iso}(1+R)] N_{\pi^0}^{iso}$$





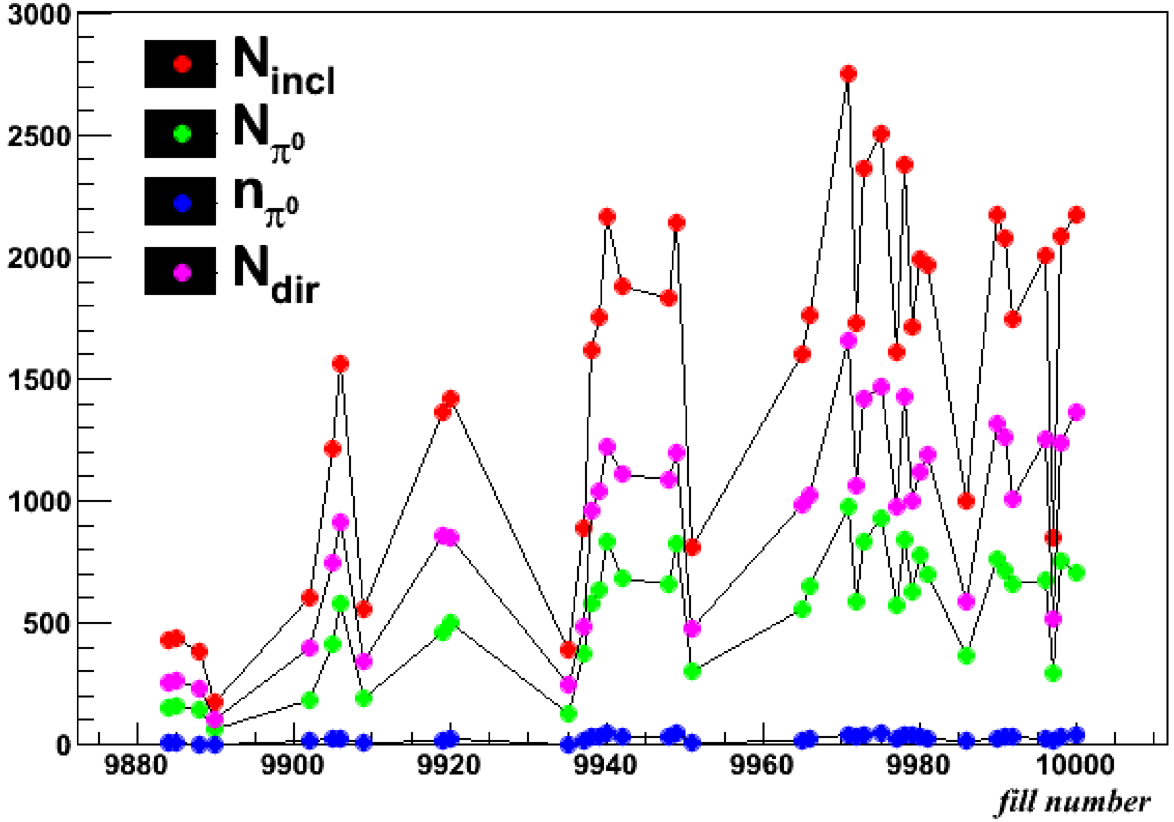
I'm subtracting the combinatoric background using average of counts in the two side bands (above and below mass peak).

Photon Yields

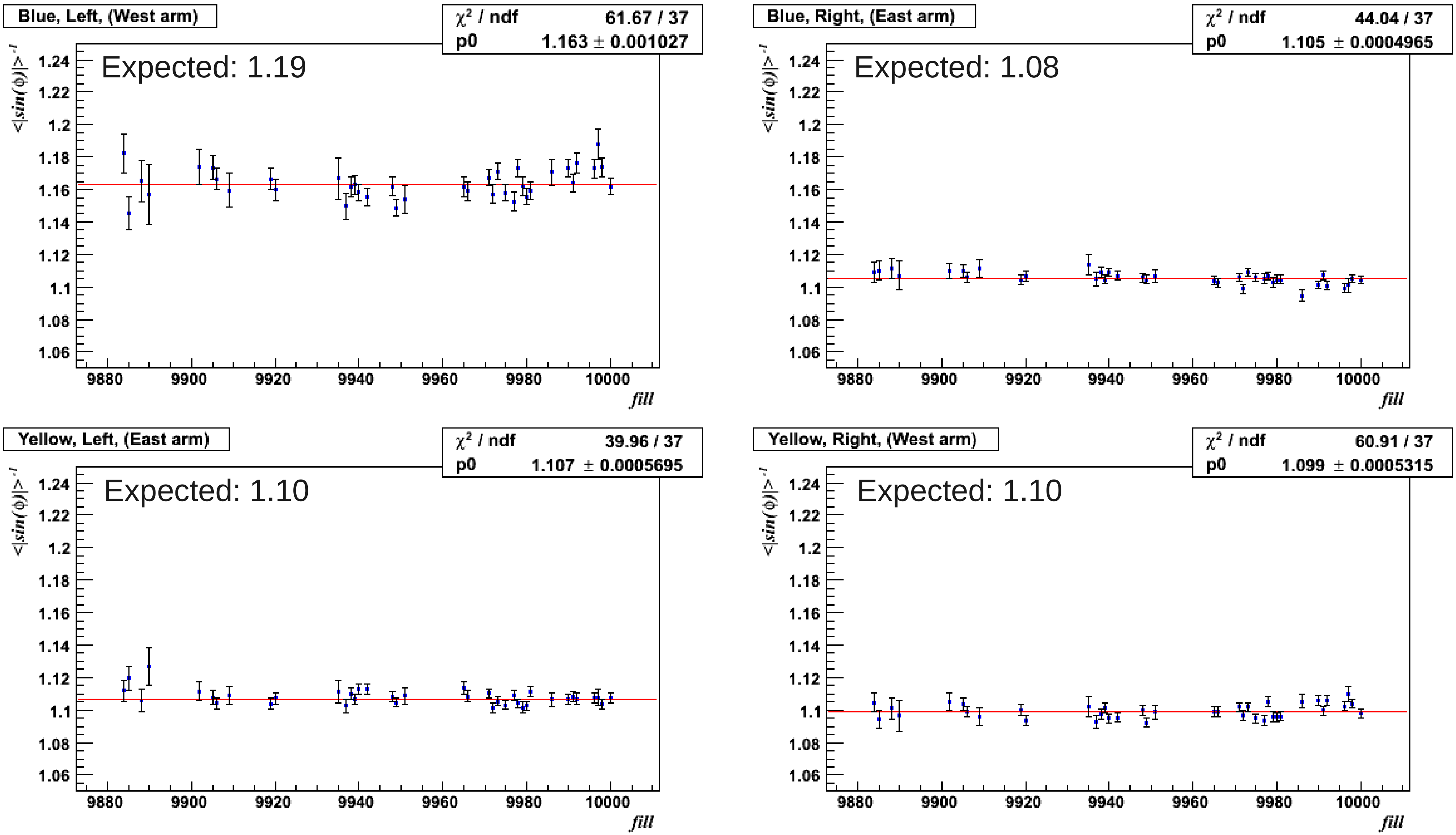
$$N_{dir}^{iso} = \left(N_{incl}^{iso} - n_{\pi^0}^{iso}\right) - R\,N_{\pi^0}^{iso}$$

photon yields

5 < p_T(photon) < 6

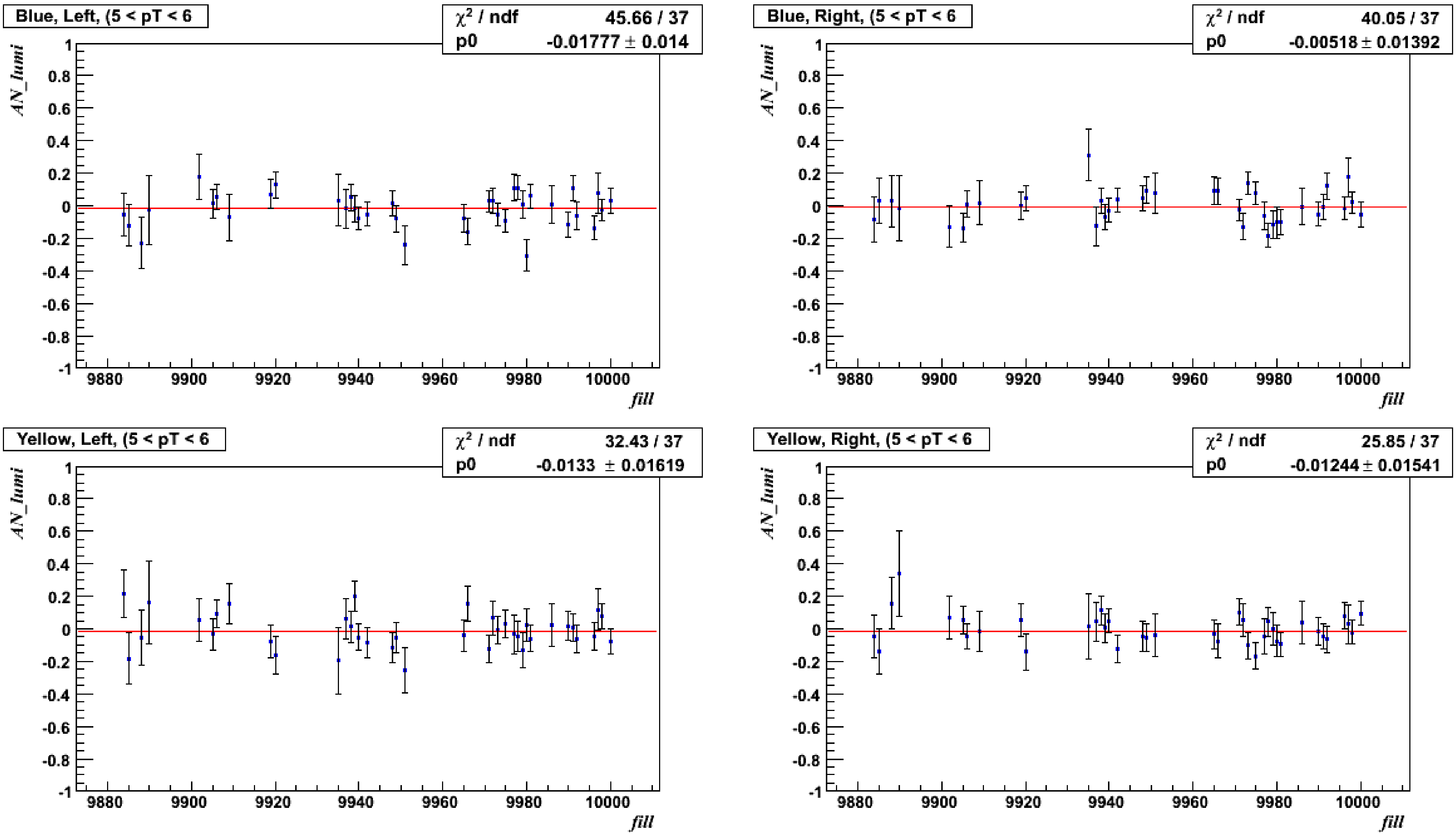


Acceptance Function

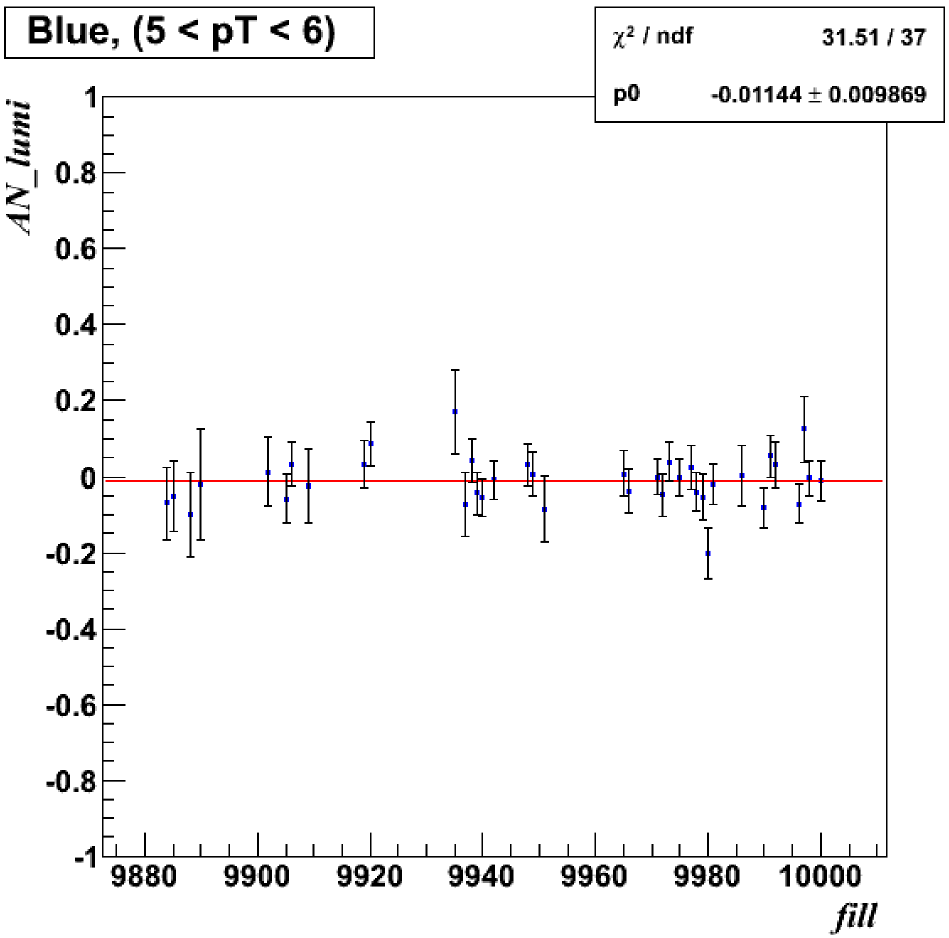


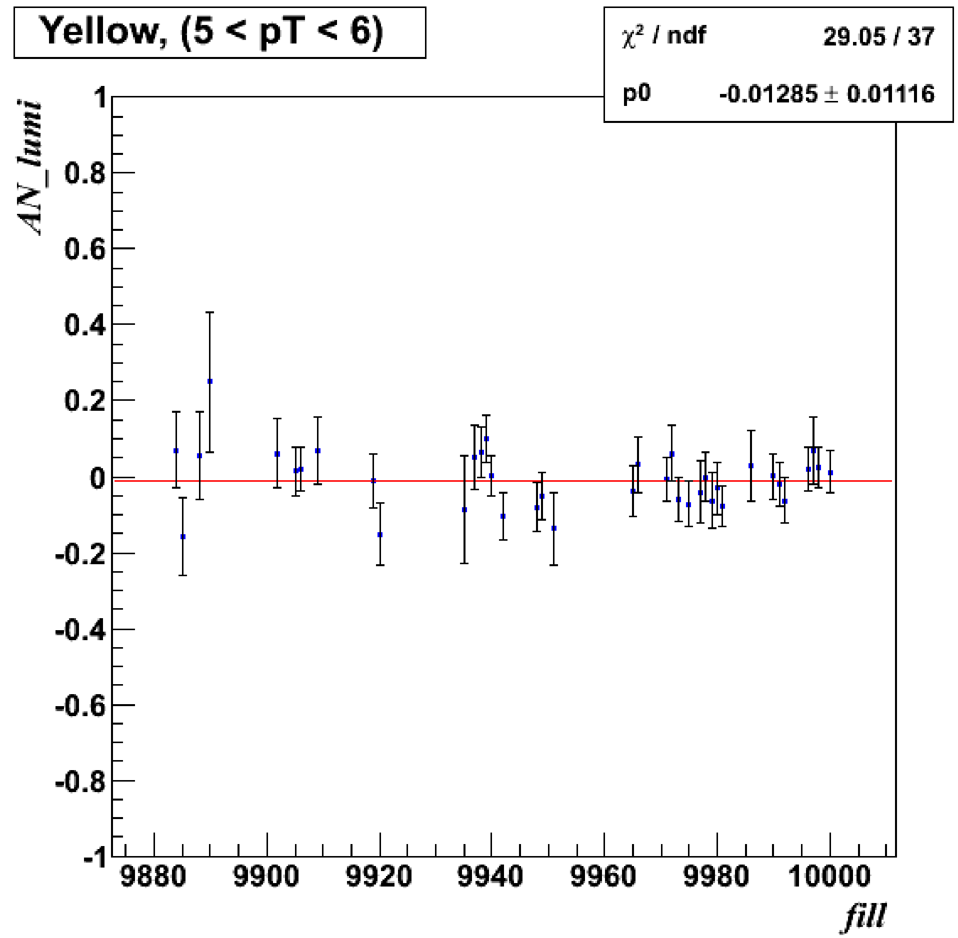
Φ is measure from beam polarization direction. I've taken into account the shift in blue beam pol direction. 0.24 rad. For these plots: 5 < pT(photons) < 15.

$$A_N^{incl} = \frac{1}{P} \langle f(\varphi) \rangle \frac{(N^{\uparrow\uparrow} + R_1 N^{\uparrow\downarrow}) - (R_2 N^{\downarrow\uparrow} + R_3 N^{\downarrow\downarrow})}{(N^{\uparrow\uparrow} + R_1 N^{\uparrow\downarrow}) + (R_2 N^{\downarrow\uparrow} + R_3 N^{\downarrow\downarrow})}$$

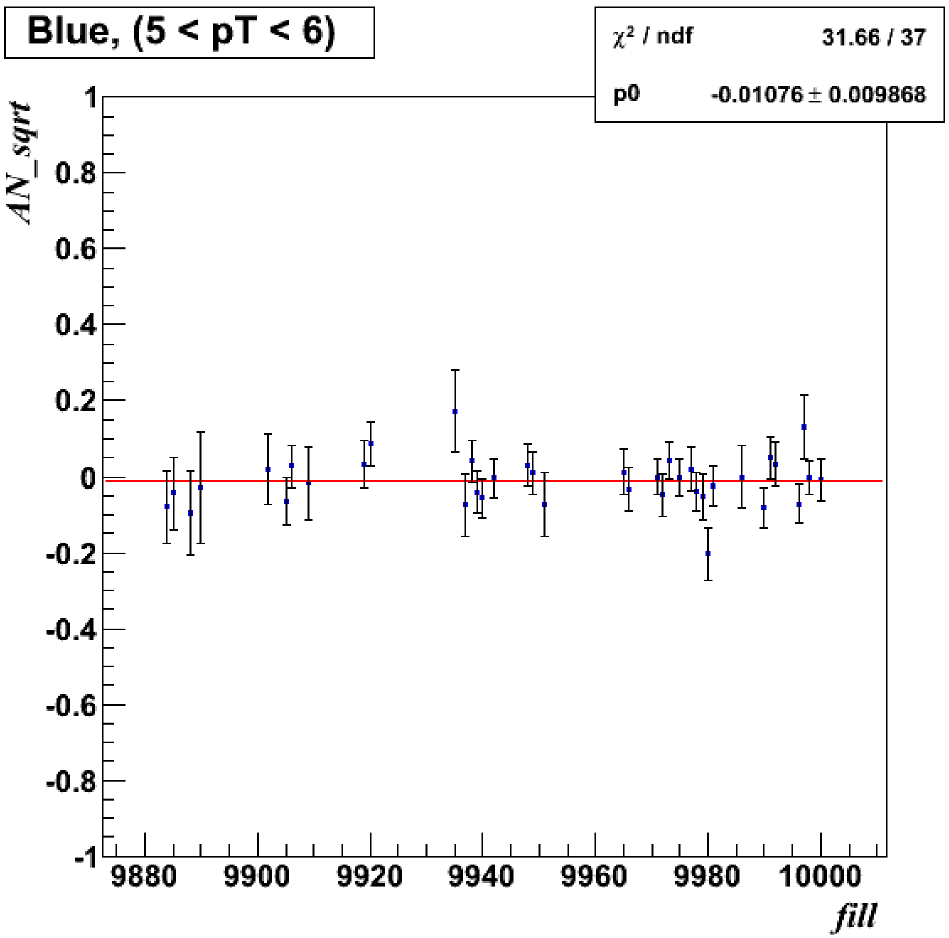


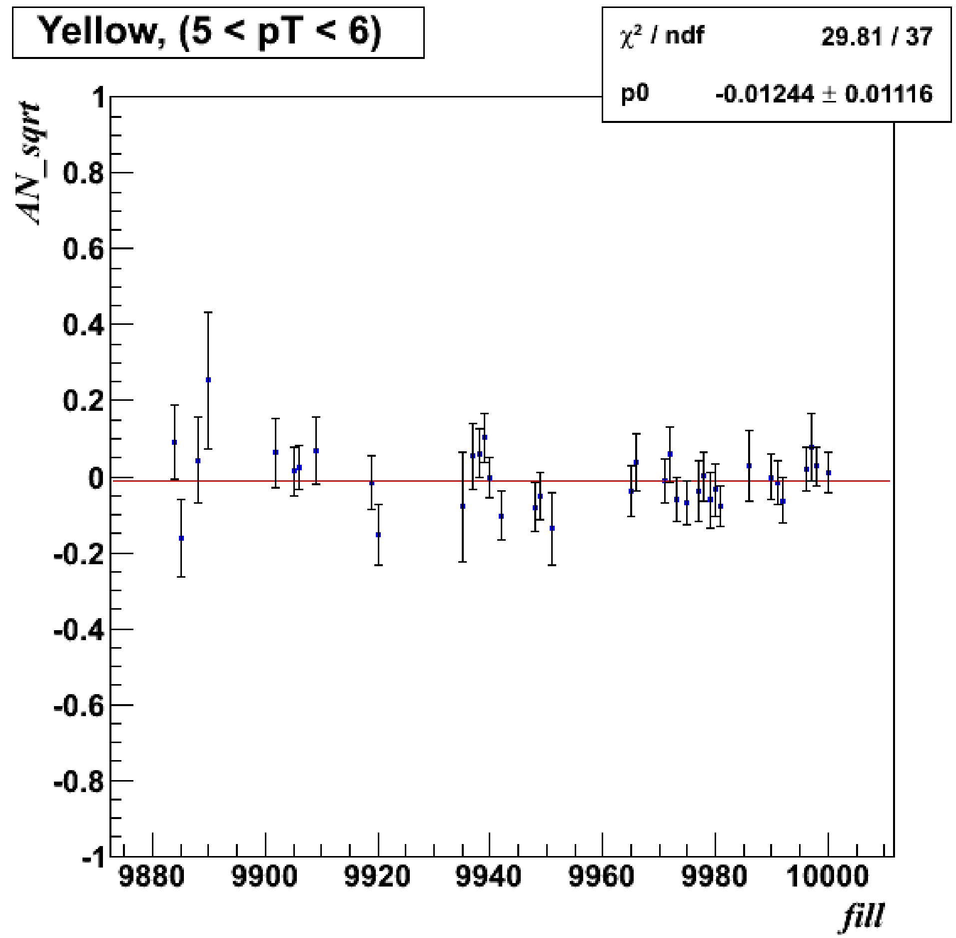
$$A_N^{incl} = \frac{1}{P} \langle f(\varphi) \rangle \frac{(N^{\uparrow\uparrow} + R_1 N^{\uparrow\downarrow}) - (R_2 N^{\downarrow\uparrow} + R_3 N^{\downarrow\downarrow})}{(N^{\uparrow\uparrow} + R_1 N^{\uparrow\downarrow}) + (R_2 N^{\downarrow\uparrow} + R_3 N^{\downarrow\downarrow})}$$



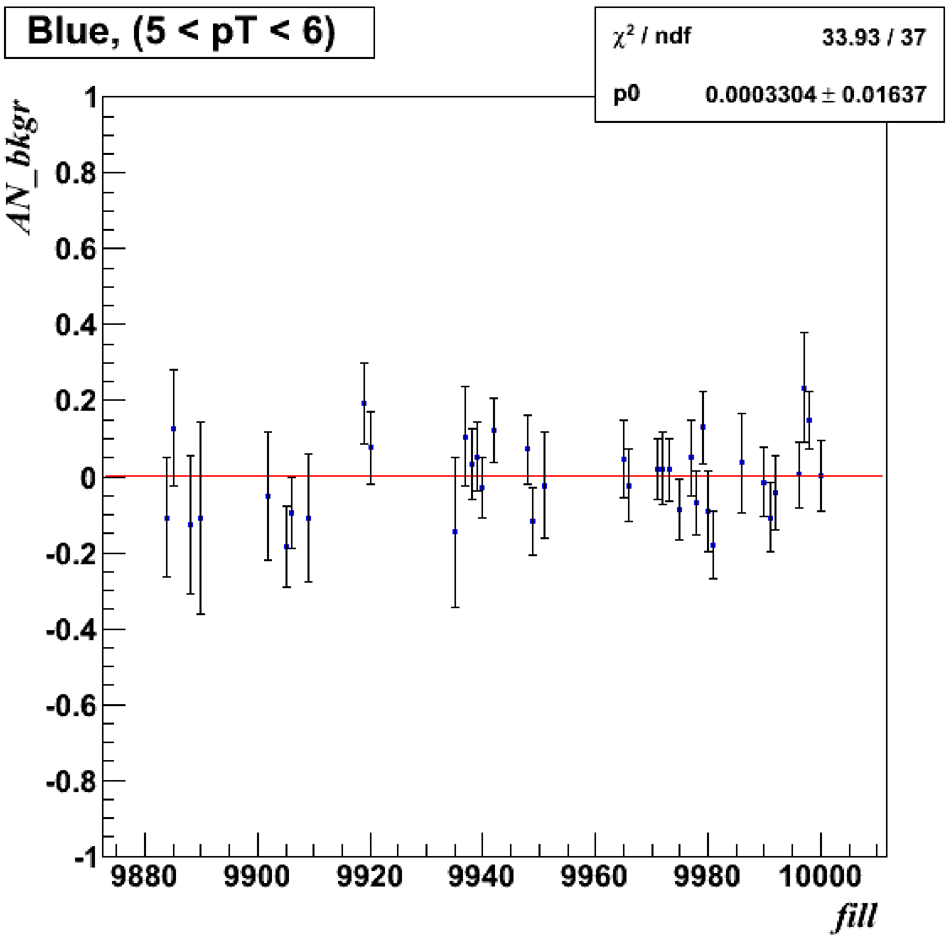


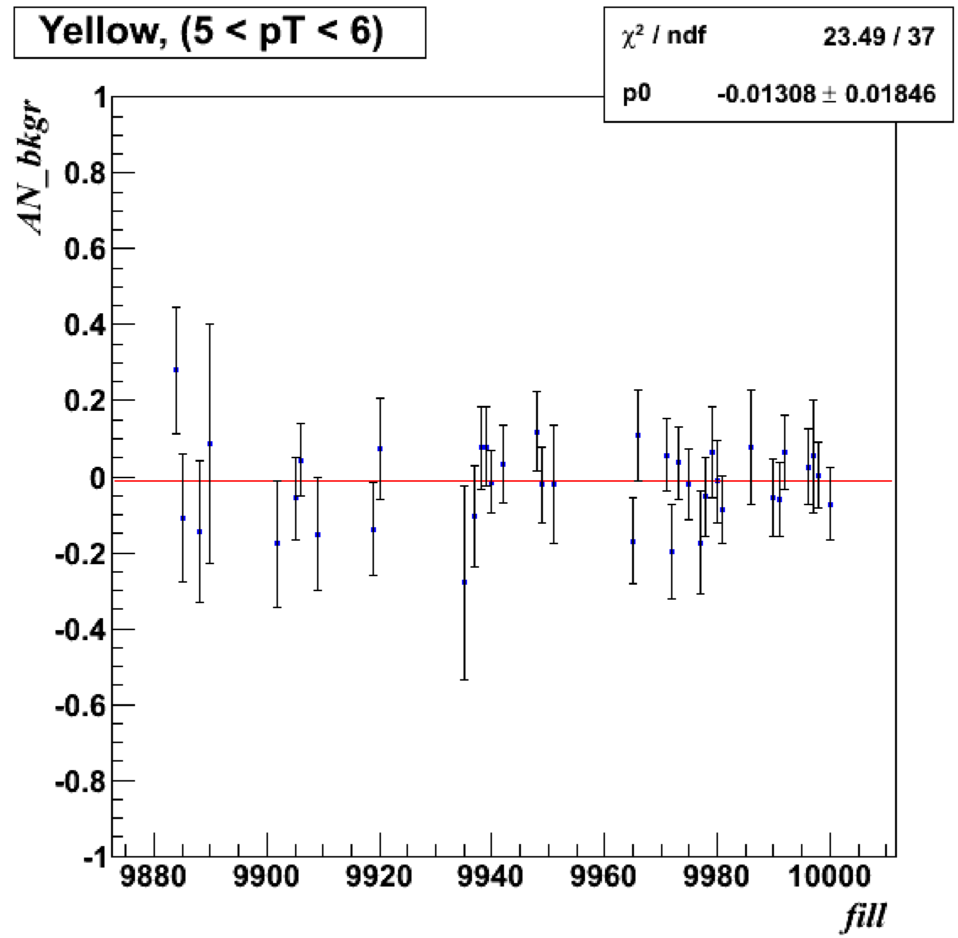
$$A_N^{incl} = \frac{1}{P} \langle f(\varphi) \rangle \frac{\sqrt{N_L^{\uparrow} N_R^{\downarrow}} - \sqrt{N_L^{\downarrow} N_R^{\uparrow}}}{\sqrt{N_L^{\uparrow} N_R^{\downarrow}} + \sqrt{N_L^{\downarrow} N_R^{\uparrow}}}$$





$$A_N^{bkgr} = \frac{1}{P} \langle f(\varphi) \rangle \frac{(N^{\uparrow\uparrow} + R_1 N^{\uparrow\downarrow}) - (R_2 N^{\downarrow\uparrow} + R_3 N^{\downarrow\downarrow})}{(N^{\uparrow\uparrow} + R_1 N^{\uparrow\downarrow}) + (R_2 N^{\downarrow\uparrow} + R_3 N^{\downarrow\downarrow})}$$





Pi0 miss ratio: *R*

Implemented Single particle Monte Carlo

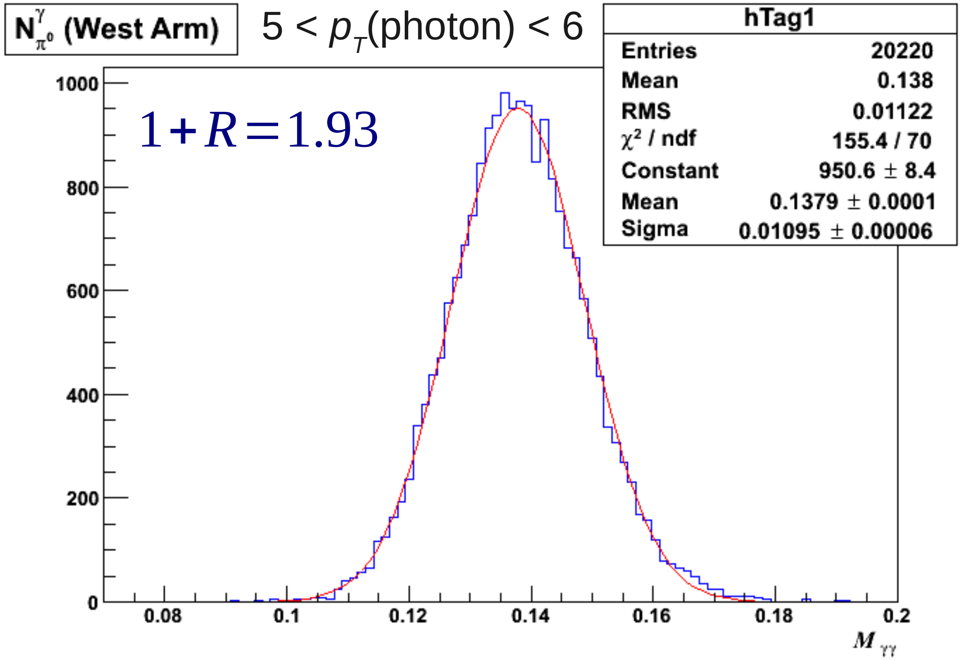
$$R = \frac{N_{\pi^0}^{1\,tag}}{N_{\pi^0}^{2\,tag}} = \frac{N_{\pi^0}^{\gamma} - N_{\pi^0}^{2\,tag}}{N_{\pi^0}^{2\,tag}}$$

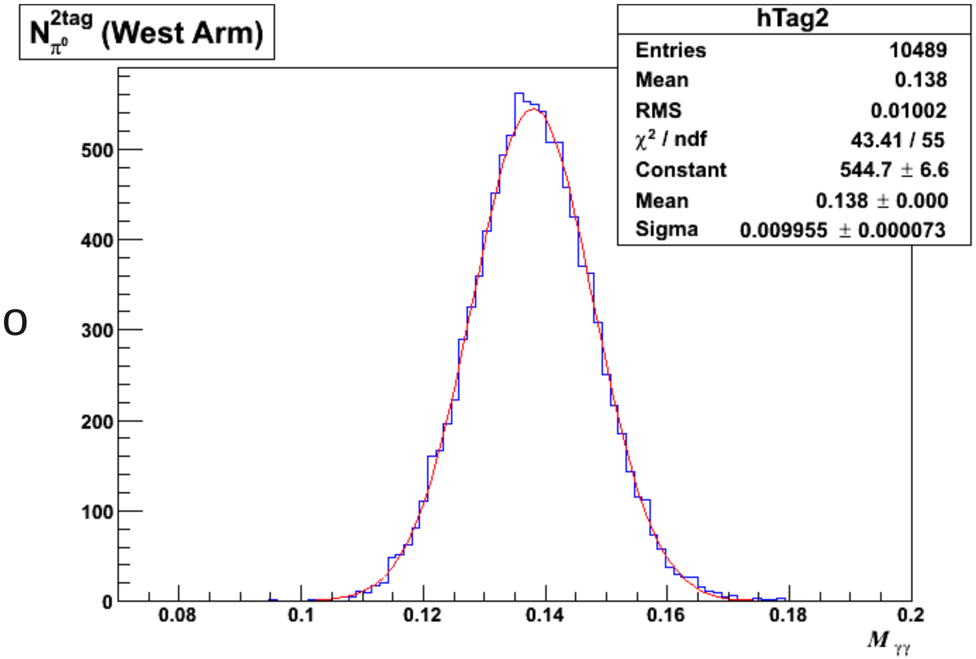
$N_{\pi^0}^{1\,tag}$ no. of pi0s where one photon falls inside active region (excluding guard veto), and 2nd photon is missed.

$N_{\pi^0}^{2\,tag}$ no. of pi0s where both photons are detected.

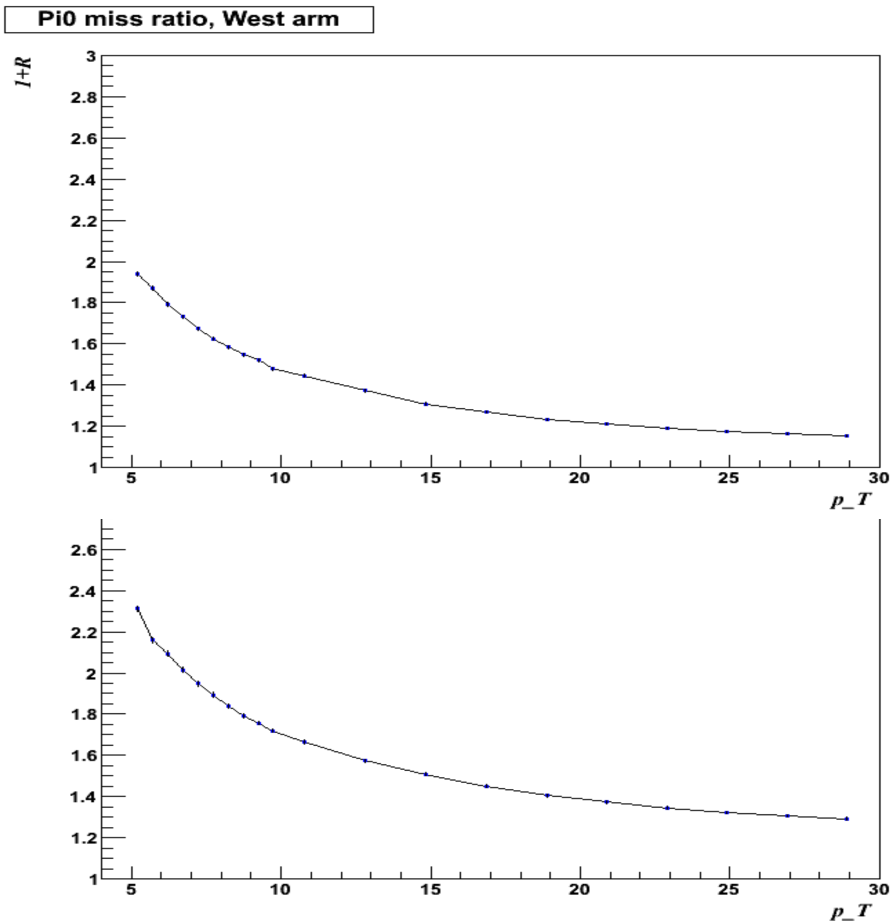
$N_{\pi^0}^{\gamma}$ no. of pi0s where one photon falls inside active region (excluding guard veto), regardless of what happens to the 2nd one.

EMCal warn map is implemented in monte carlo

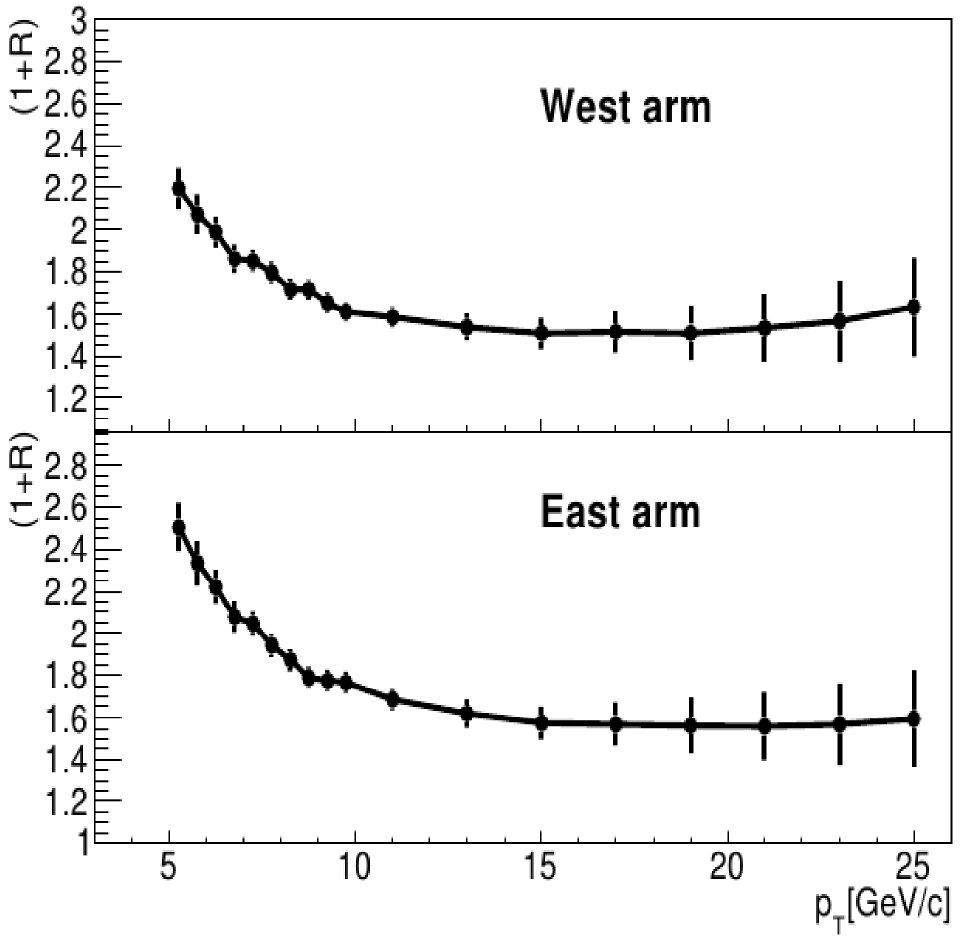




Pi0 miss ratio: *R*

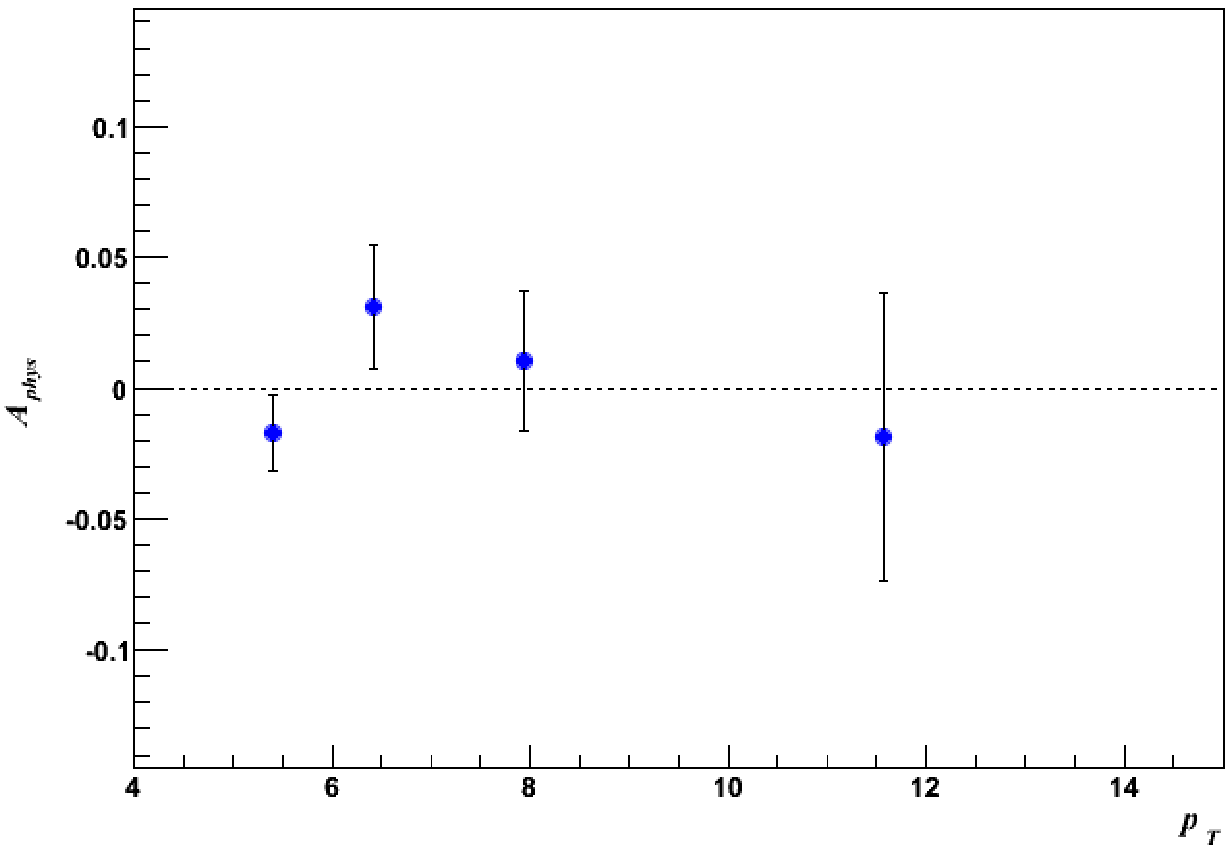


PHENIX Direct-Photon Xsection paper (2012)



After ~13 GeV, effect of photon merging become significant.
I haven't implement shower merging in my monte carlo yet.

Physics Asymmetry



Hadronic background (other than pi0) is not subtracted yet.

Summary

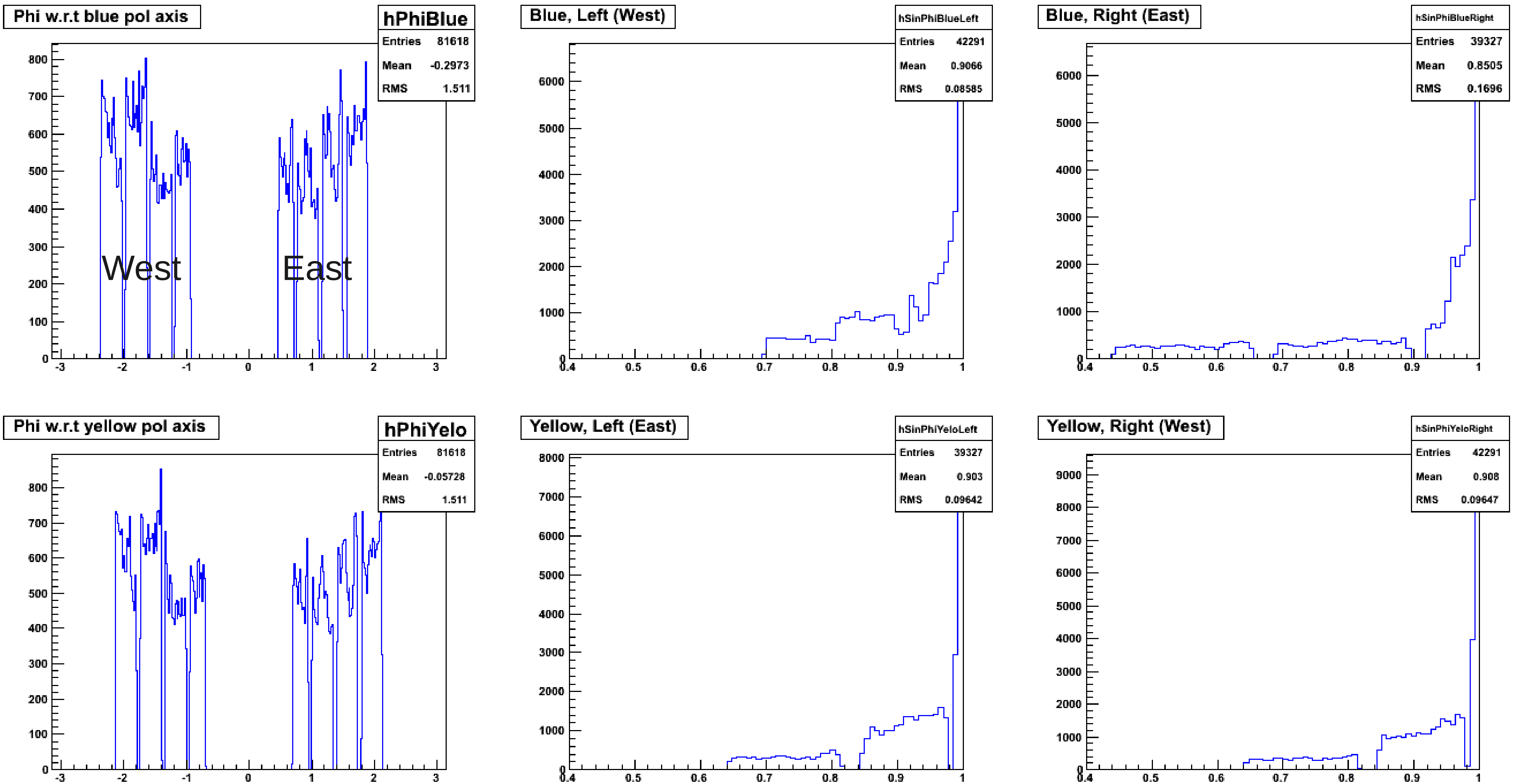
- Run QA is done.
- Spin QA is done.
- EMCal warn map is determined.

- Inclusive and background asymmetries are calculated.

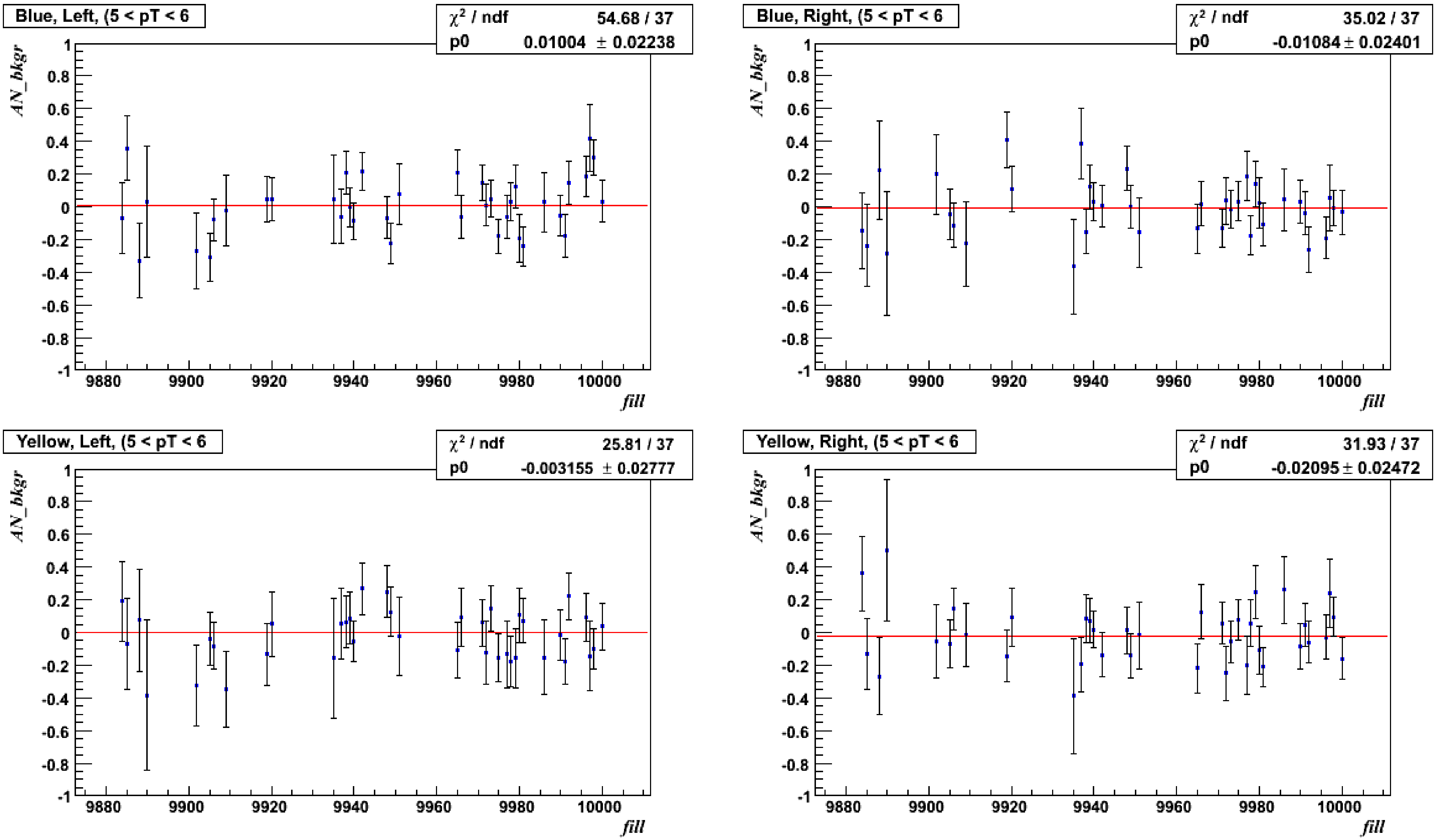
- Need to implement shower profile in MC to correctly estimate R.
- A^{iso} needs to be calculated.
- Bunch shuffling.

Backup

φ and $|\sin(\varphi)|$



$$A_N^{bkgr} = \frac{1}{P} \langle f(\varphi) \rangle \frac{(N^{\uparrow\uparrow} + R_1 N^{\uparrow\downarrow}) - (R_2 N^{\downarrow\uparrow} + R_3 N^{\downarrow\downarrow})}{(N^{\uparrow\uparrow} + R_1 N^{\uparrow\downarrow}) + (R_2 N^{\downarrow\uparrow} + R_3 N^{\downarrow\downarrow})}$$



Archeology of A^{iso}

From PHENIX AN460 (Table 3)

Particle	Production ratio	Branching ratio	γ ratio $(=A_0 - 1)$
η/π^0	0.45 ± 0.1	$\frac{Br(\eta \to 2\gamma)}{Br(\pi^0 \to 2\gamma)} = 39.4/98.8$	0.18 ± 0.04
ω/π^0	1.0 ± 0.3	$\frac{Br(\omega \to \pi^0\gamma)}{Br(\pi^0 \to 2\gamma)} \times \frac{1}{2} = 8.9/98.8 * 1/2$	0.045 ± 0.014
η'/π^0	0.25 ± 0.08	$\frac{Br(\eta' \to 2\gamma)}{Br(\pi^0 \to 2\gamma)} = 2.1/98.8$	0.0053 ± 0.0017
Sum	-	-	0.23 ± 0.05

PHENIX Eta cross section paper measured 0.51 +/- 0.01

Modified to 0.237 in Kensuke's code