Directed flow and Elliptic flow in 22.4 GeV CuCu collisions

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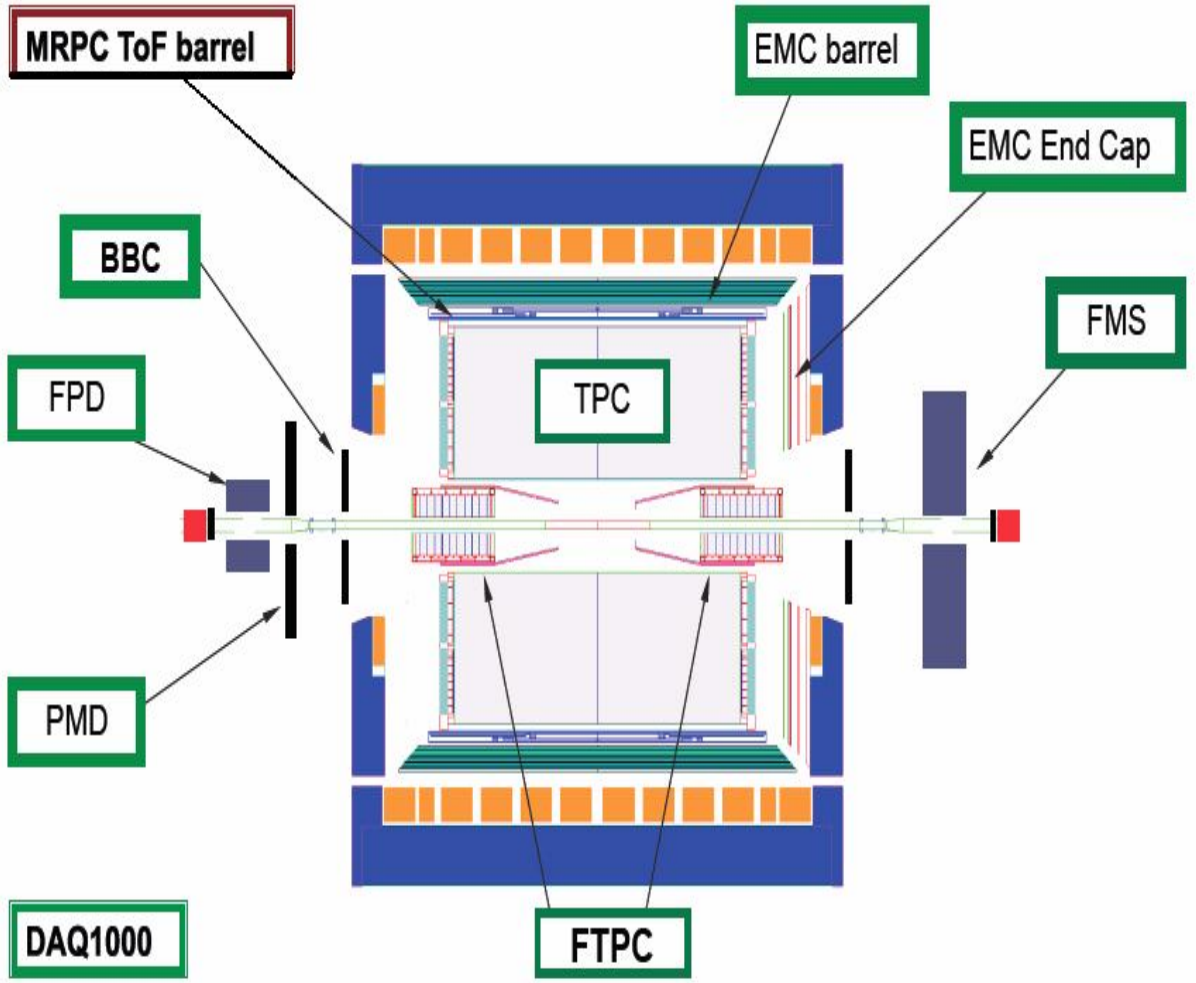
APS April Meeting@Washington D.C .Feb/15/2010

Outline

- Introduction
- Data-set and Cuts
- Event Plane Reconstruction
- Results
- Summary

STAR Detector

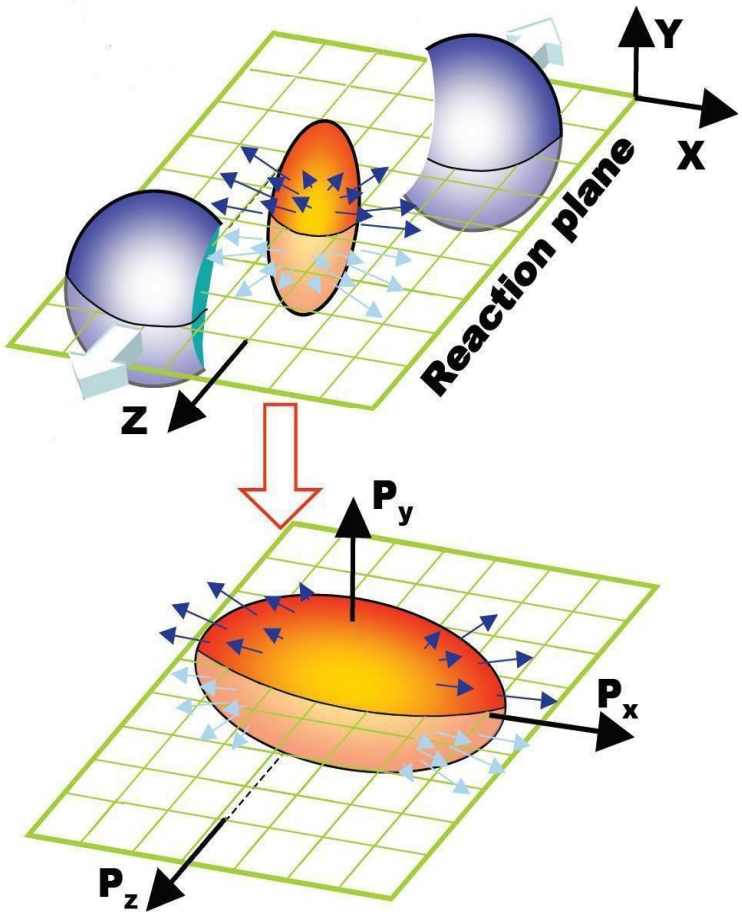


Full azimuthal particle identification!

Introduction

Anisotropic flow: Anisotropy of the azimuthal distribution of particles with respect to the reaction plane: Fourier expansion of the particle's azimuthal distribution with respect to the reaction plane is given by:

$$E\frac{d^3N}{d^3p} = \frac{1}{2\pi}\frac{d^2N}{p_t dp_t dy}\left(1+\sum_{n=1}^{\infty}2v_n\cos(n(\phi-\Psi_r))\right)$$



Coordinate-Space Anisotropy

$$v_n = \langle\cos(n(\phi-\Psi_r))\rangle$$

$$\phi = \tan^{-1}\left(\frac{p_x}{p_y}\right)$$

Momentum-Space Anisotropy

Directed flow is quantified by the first harmonic (v_1)

Elliptic flow is quantified by second harmonic(v_2)

Data: 22 GeV CuCu Collisions(year 2005)

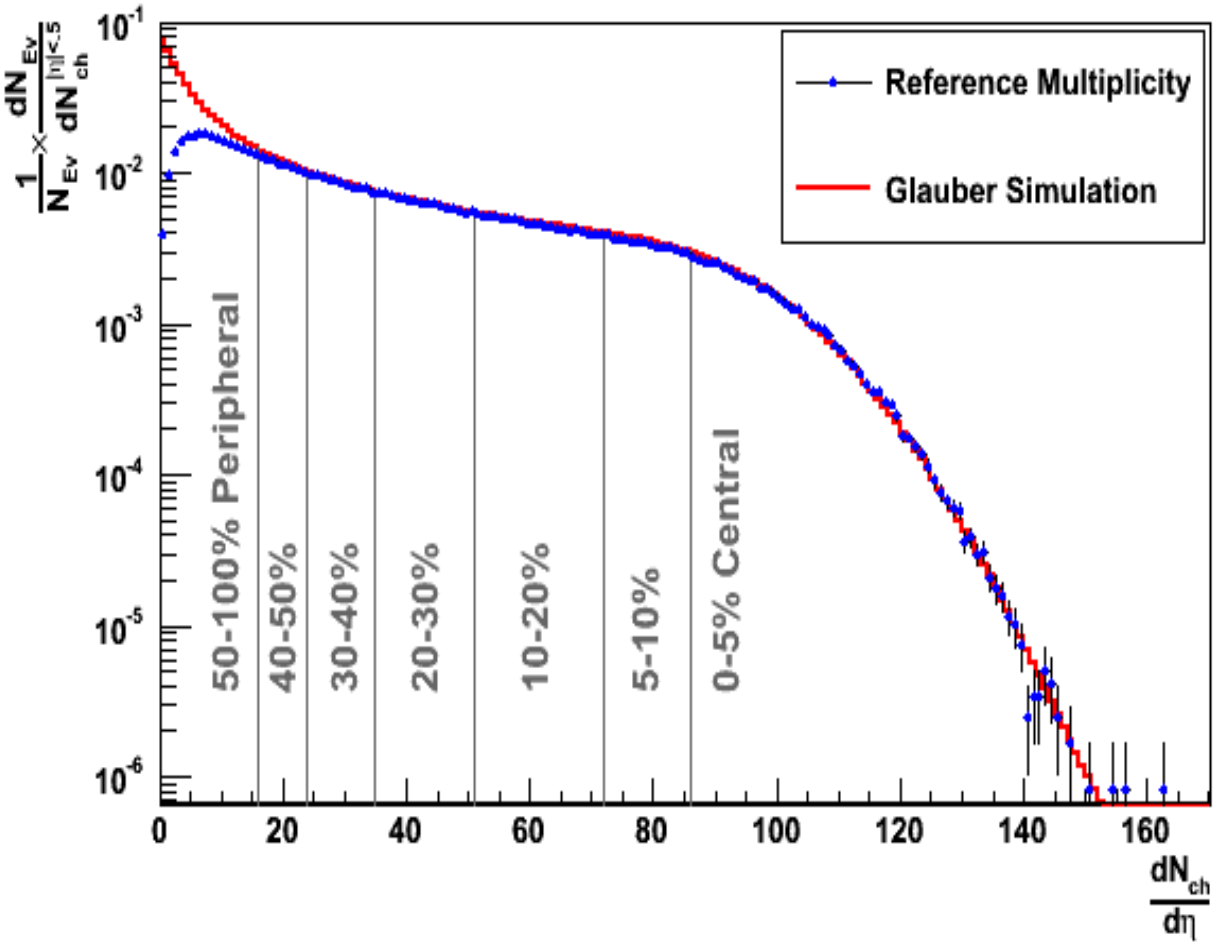
The Cu+Cu 22 GeV Dataset was taken during run 5 from Mar 22 -24th

Cuts for event:

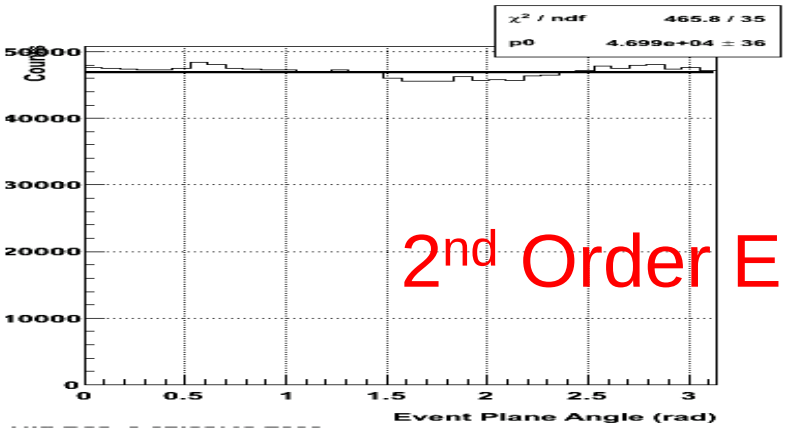
|Vx|,|Vy| < 1.0
Sqrt(vx2+vy2)<1.0
|Vz|<30.0
Mult>10
BBCAdc<120
Centrality 0-60%

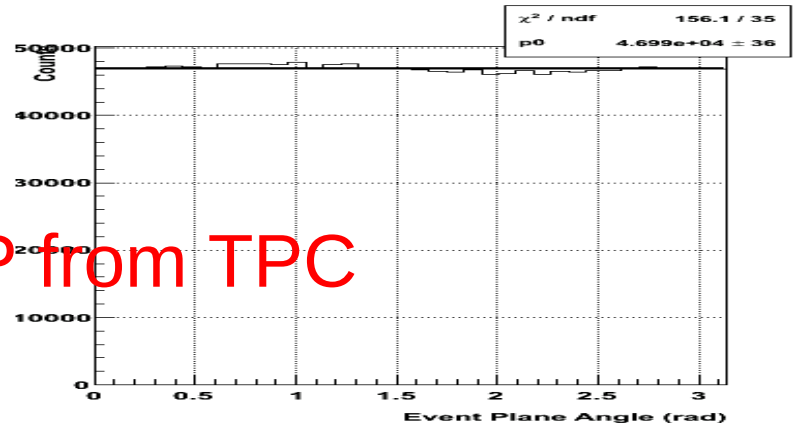
Cuts for track:

Pt(TPC&FTPC) 0.15,2.0
FitPts(TPC) 15,50
FitPts(FTPC) 5,11
DCA global(FTPC) <1.0
Eta(TPC) <|1.2|
Eta(FTPC)<|2.5-4.0|

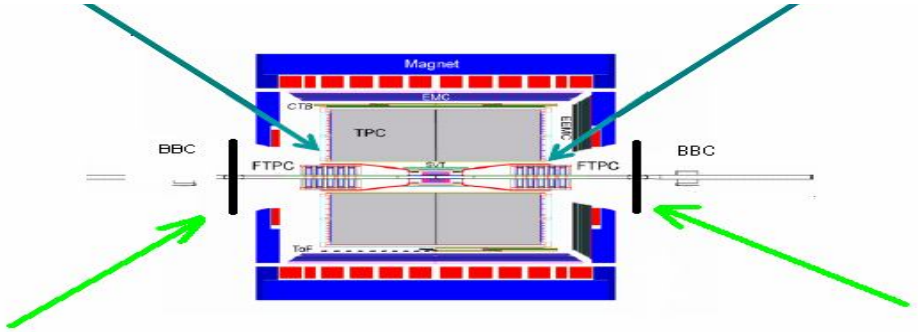


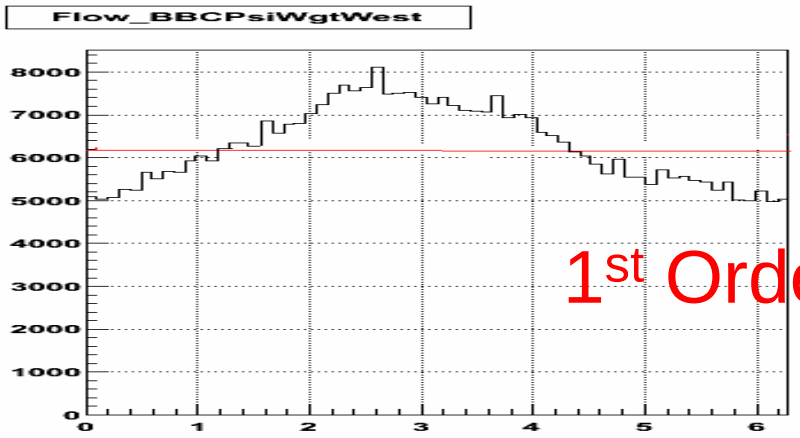
Event Plane

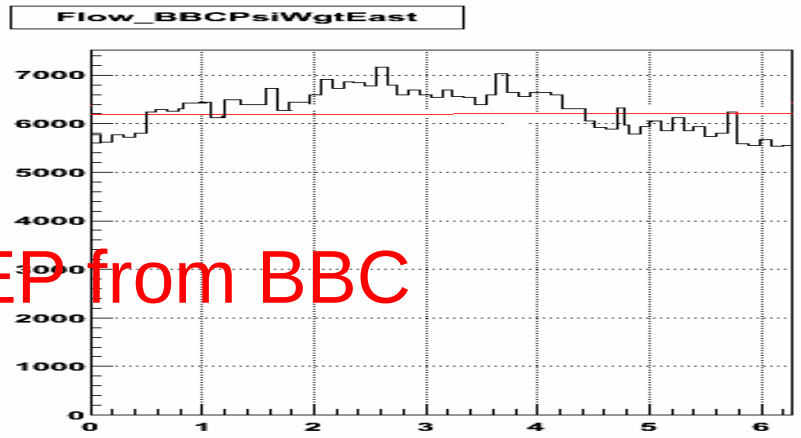




2nd Order EP from TPC



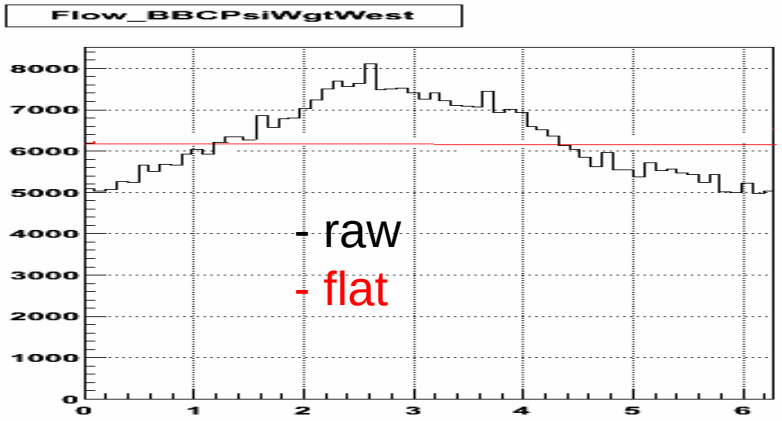


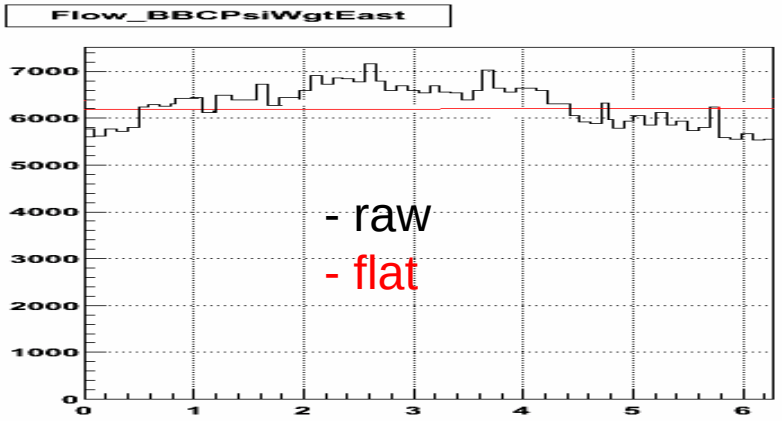


1st Order EP from BBC

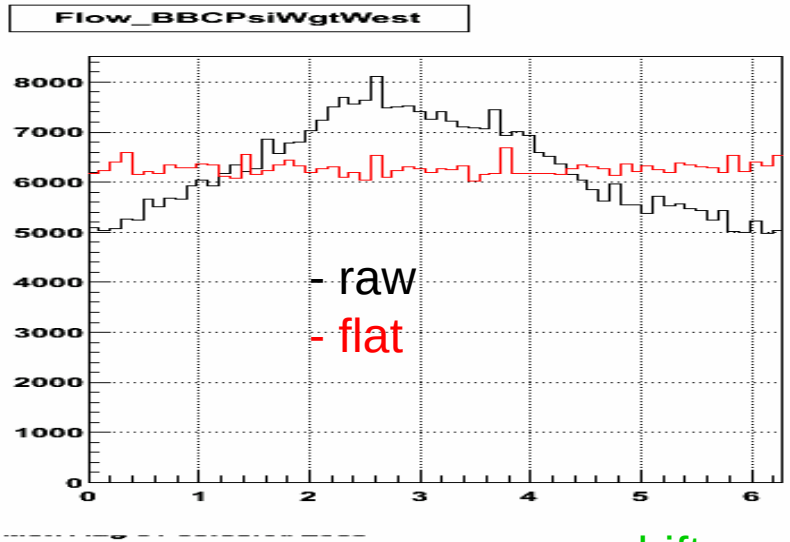
BBC Event Plane

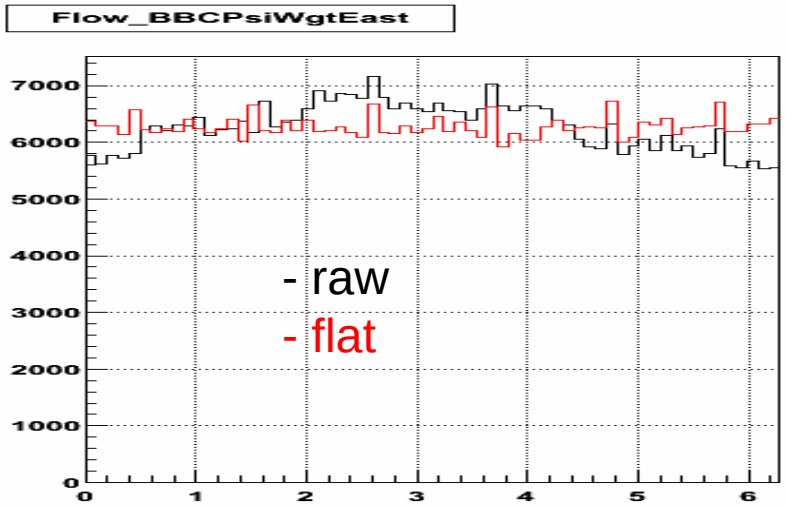
We have used psi weight method and shift method [J.Barrette et al Phys.Rev.C56(1997)3254] to make the event plane distribution flat.





psi weight method

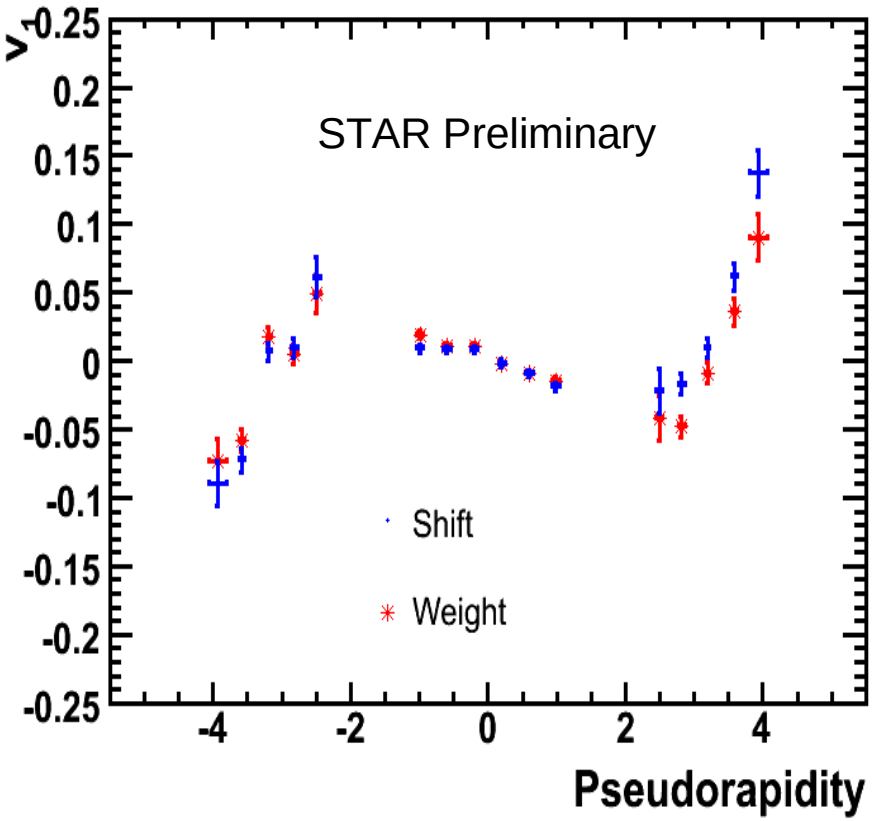




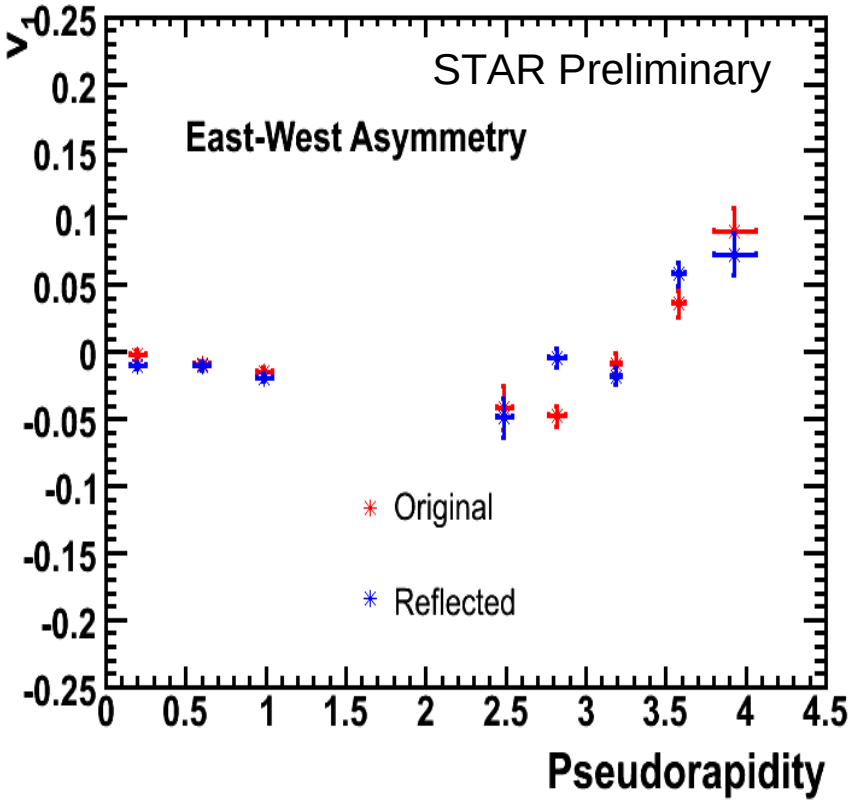
shift correction method

Directed Flow v1(η) at 22GeV CuCu

We use east BBC event plane to calculate v1 in west and west BBC event plane to calculate v1 at east in FTPC eta[2.5-4.0] coverage region and full event plane in TPC eta[1.2-1.2] coverage



BBC EP Resolution~15%

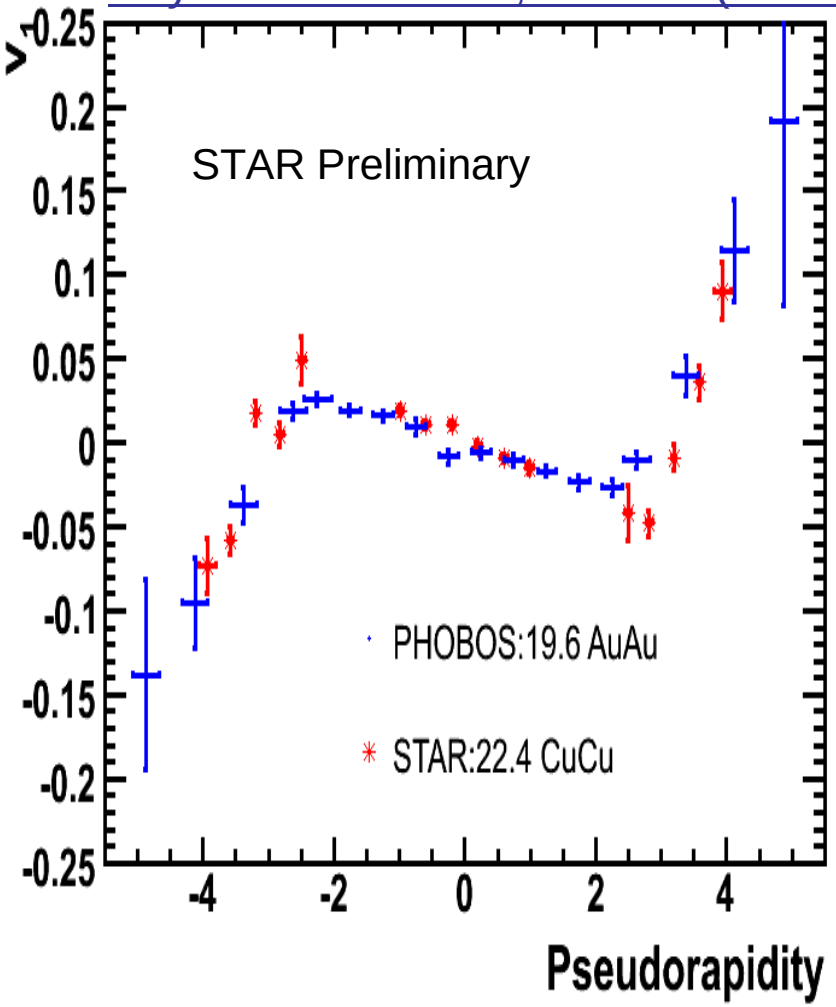


Asymmetry is within stat. error

Comparison with Other Energies

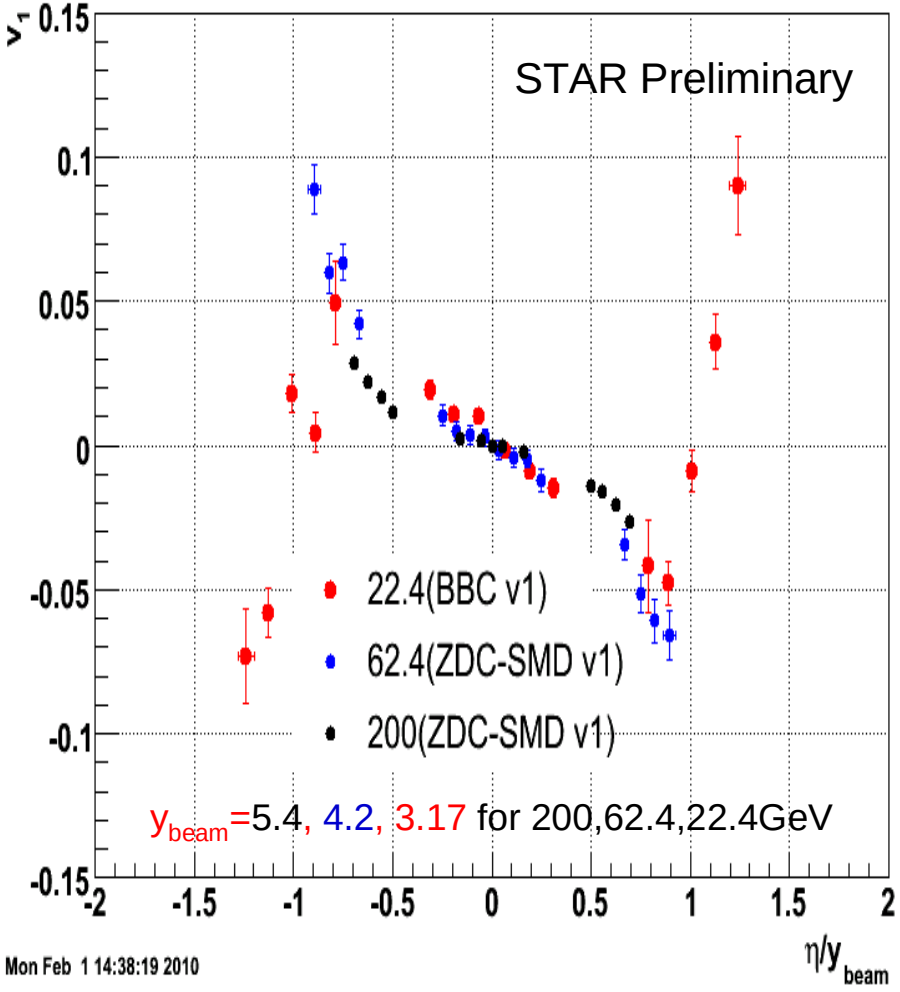
Comparison with PHOBOS

Phys. Rev. Lett. 97, 012301 (2006)



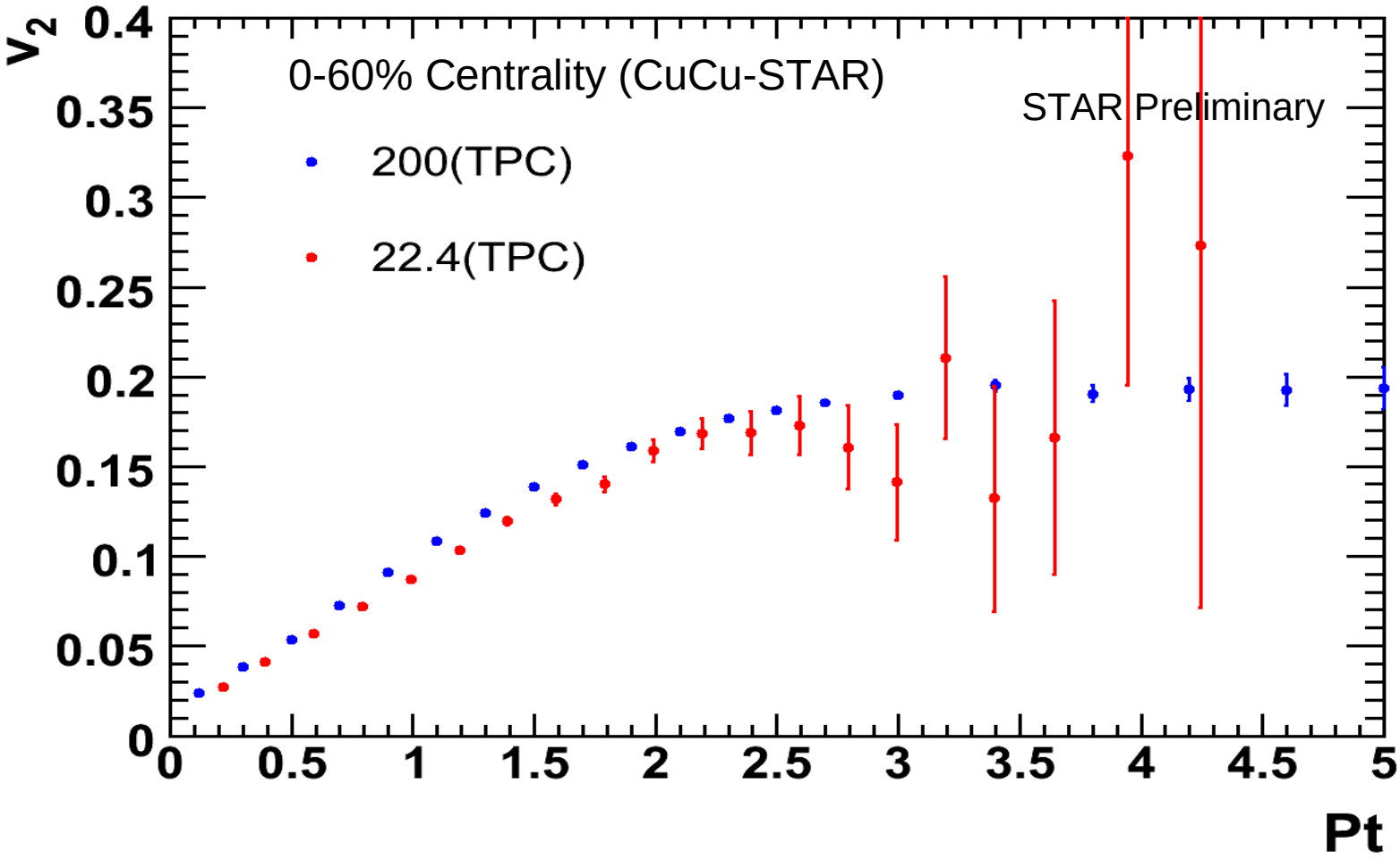
Comparison with STAR

Phys. Rev. Lett. **101** (2008) 252301



Elliptic Flow v_2(pt) at 22 GeV CuCu Collisions

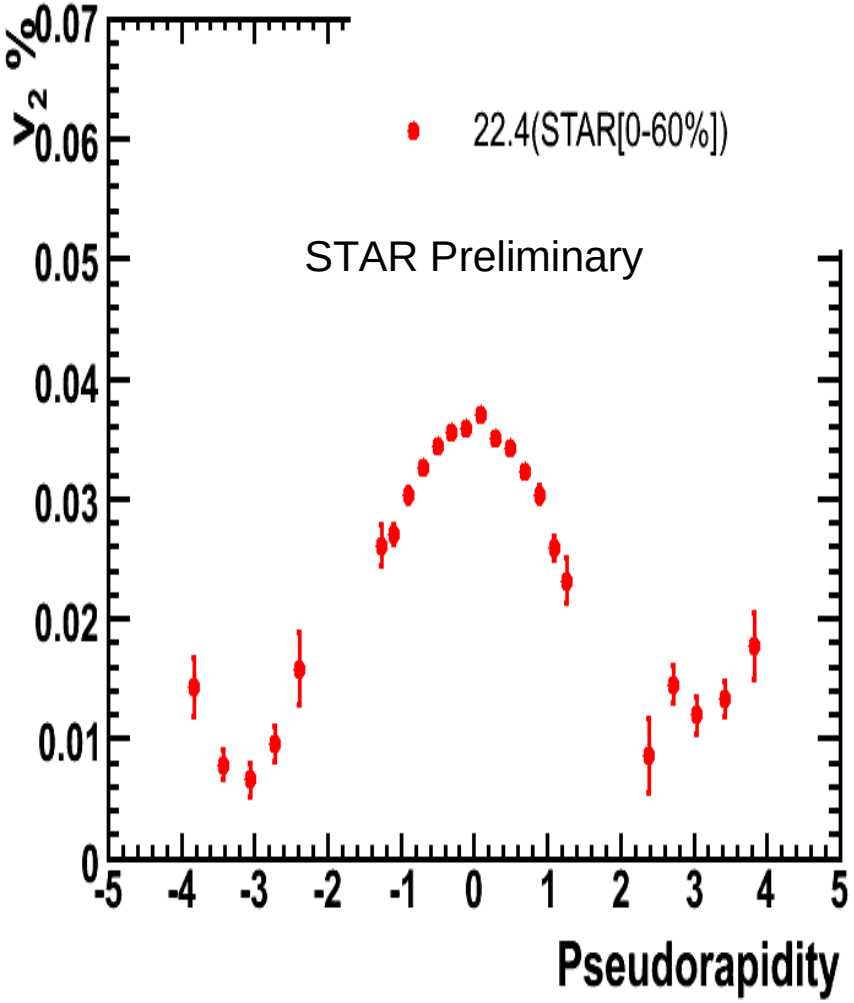
arXiv:1001.5052



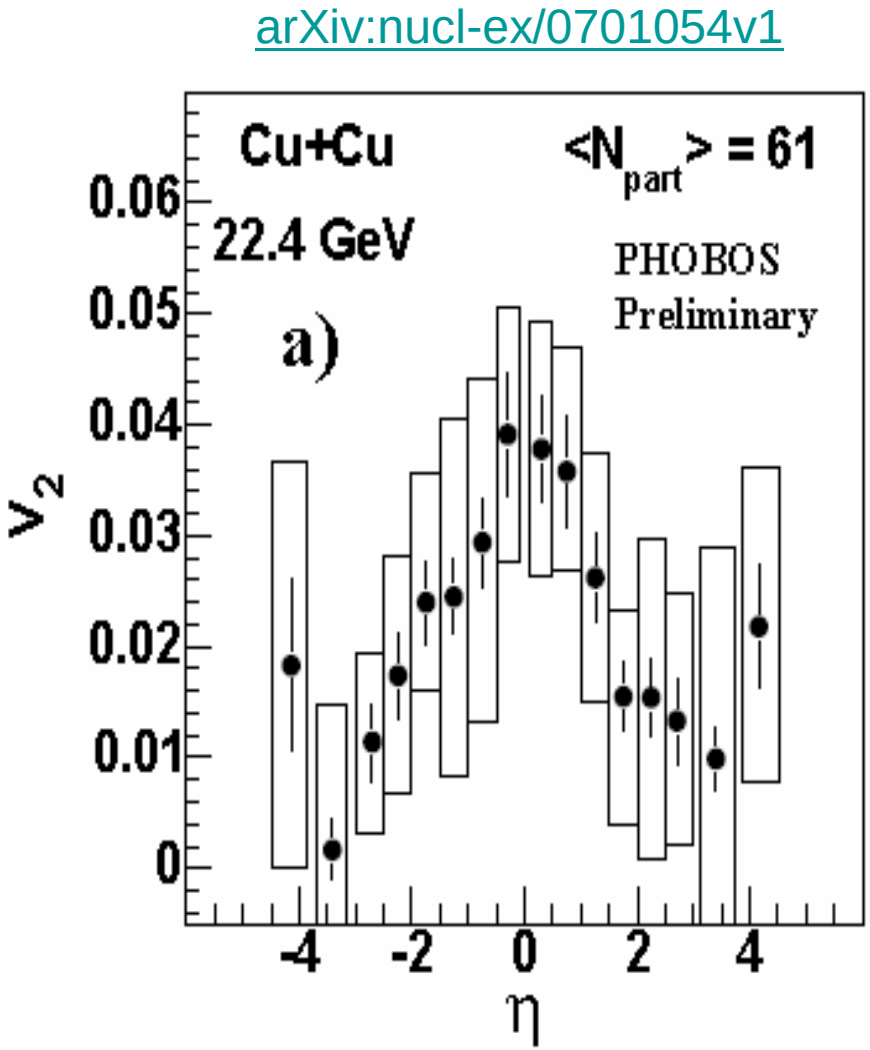
Elliptic Flow $v_2(\eta)$ at 22 GeV CuCu Collisions

0-60% Centrality

0-40% Centrality



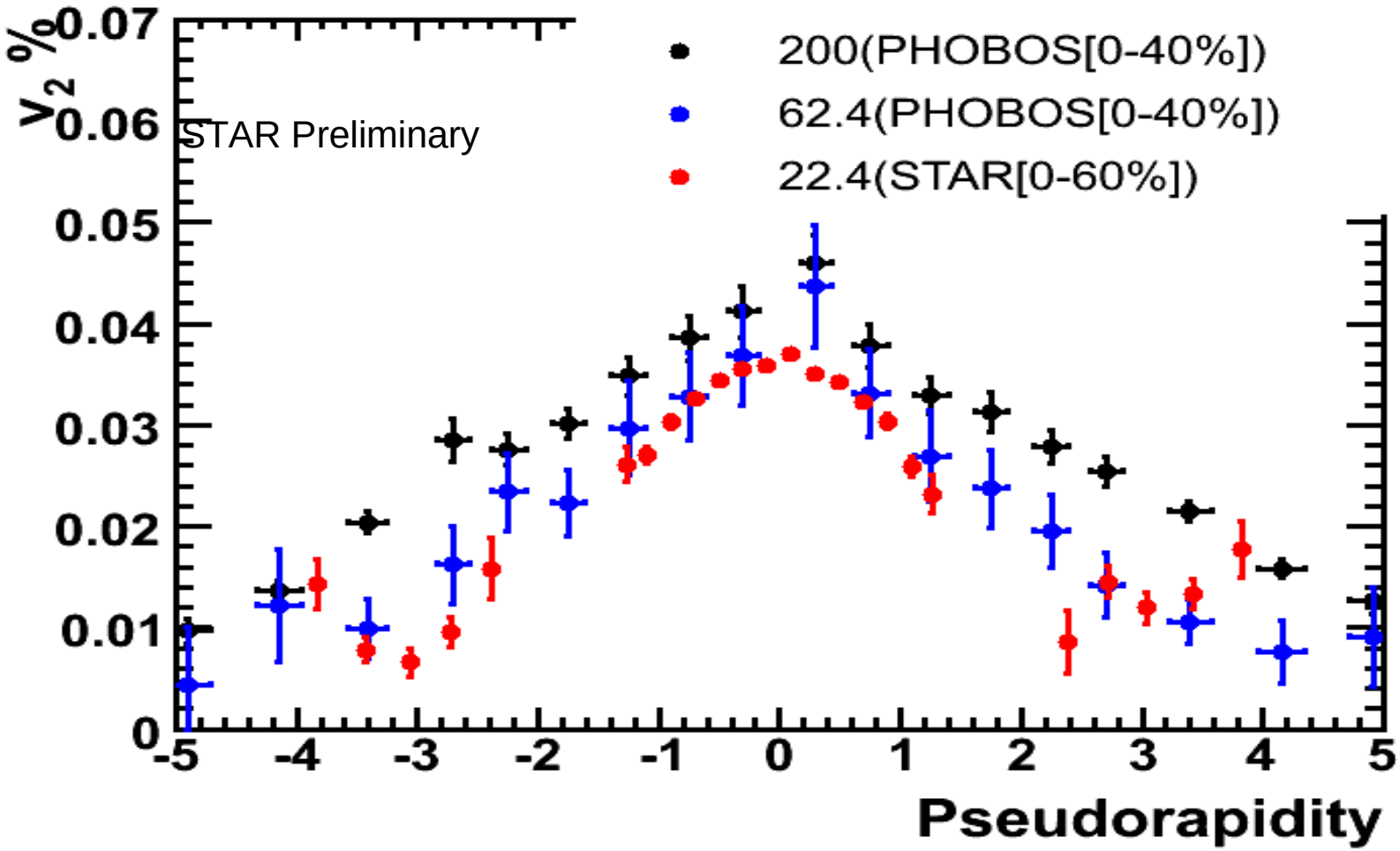
arXiv:nucl-ex/0701054v1



Comparison with Other Energies

Comparing with PHOBOS(CuCu)

Phys. Rev. Lett. 98, 242302 (2007)

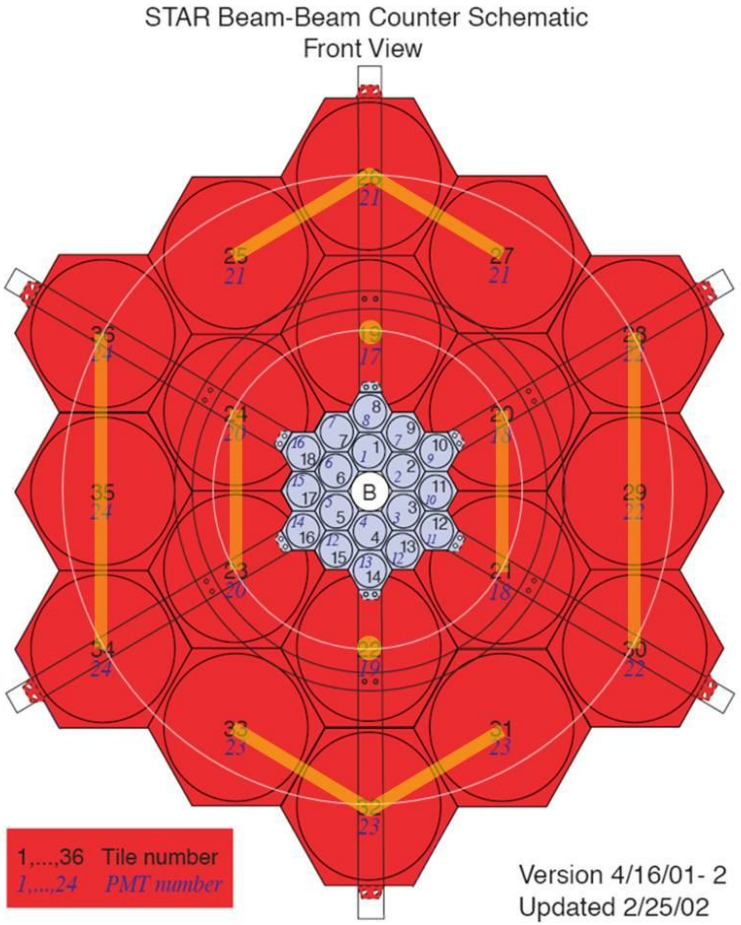


Summary

- We present the first measurement of charged particle directed flow $v_1(\eta)$ in CuCu collisions at 22.4 GeV using BBC event plane.
- Directed flow $v_1(\eta)$ in 22.4GeV CuCu is similar to 19.6GeV AuAu collisions and we observe nice scaling behavior for different energies.
- We present the first STAR results for v2(η) and v2(pt) with TPC Event plane at 22.4GeV CuCu.
- Elliptic flow v2(pt) in 22.4 GeV CuCu collisions follows the similar trend with CuCu 200GeV collisions.
- Elliptic flow v2(η) in 22.4GeV CuCu collision is consistent with the PHOBOS result at 22.4GeV CuCu and we observe the incident energy dependence of v2(η) .

Back Up Slides

BBC Geometry

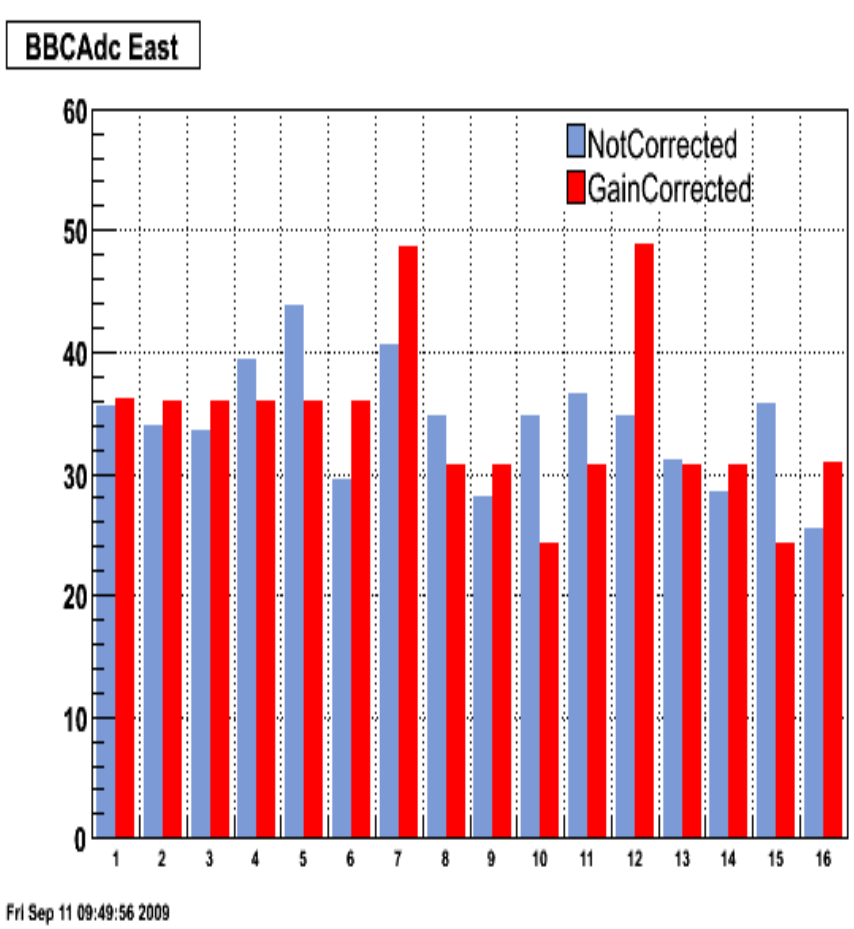


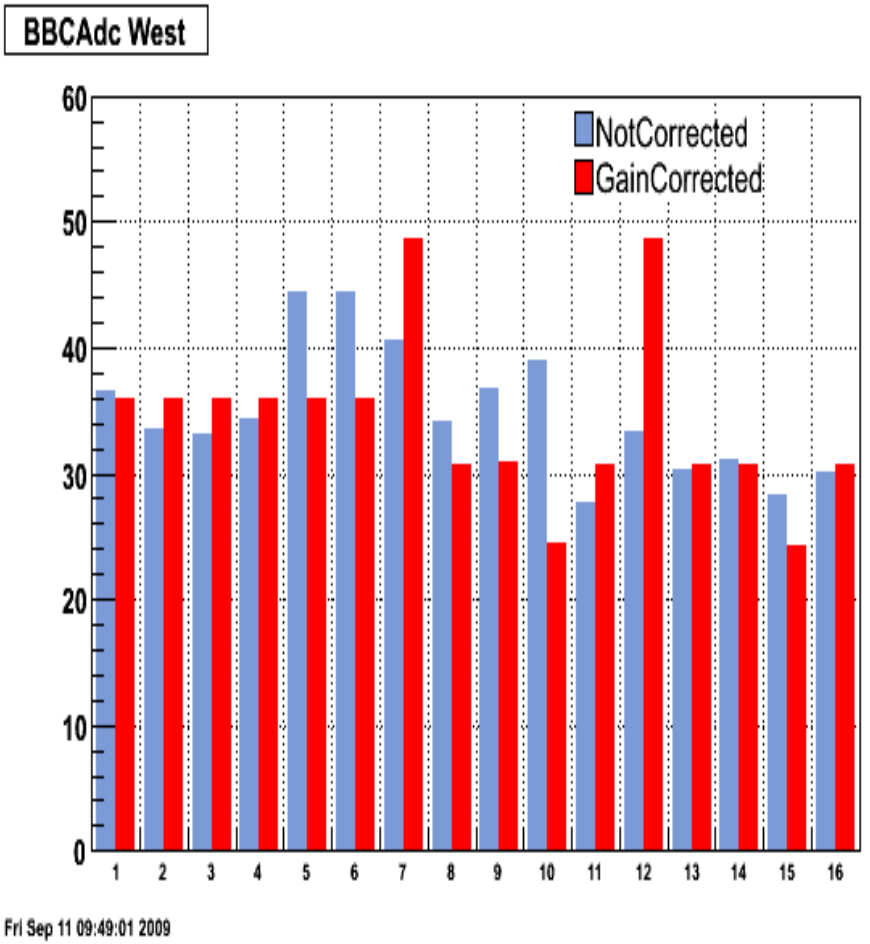
- Nearly circular Geometrical Shape.
- About 3.7m from the IR center.
- 2.2<|η|<5.2.
- 4 rings with 36 tiles on each side.
- 18 small tiles in inner two rings.
- 18 big tiles in outer two rings.
- 24 PMTs read the 36 tiles/side; linked tiles are mostly in outer rings.
- Find the 1st-order Event Plane at Low Beam Energies, following the mode of the ZDC- SMD at higher energies
- Less non-flow than other methods based on FTPC/TPC

Gain correction

We have made channel-by-channel gain correction assuming that each channel at the same radius from the center of the beam pipe should be hit by same number of particles.

Channel by channel gain correction





BBC Event Plane

$Q \cos\Psi_0 = X = \sum w_i \cos\Phi_i$

$Q \sin\Psi_0 = Y = \sum w_i \sin\Phi_i$

$$\tan(\psi_0) = \frac{\sum w_i \sin(\varphi_i)}{\sum w_i \cos(\varphi_i)} \qquad w_i = \frac{BBCadc_i}{\sum BBCadc_i}$$

$$v_1 = \frac{v_{obs}}{Res} \qquad v_{obs} = \langle \cos(\theta - \Psi_0) \rangle$$

$$Res = \langle \cos(\psi_0 - \psi_R) \rangle = C\sqrt{\langle \cos(\psi^E - \psi^W) \rangle}$$

Ψ_0 : Event plane angle

Φ_i : Azimuthal angle of center of the BBC tile. Where multiple tiles are connected to same PMT, Φ_i corresponds to the center of gravity of the tile combination.

θ :azimuthal angle of the particle.

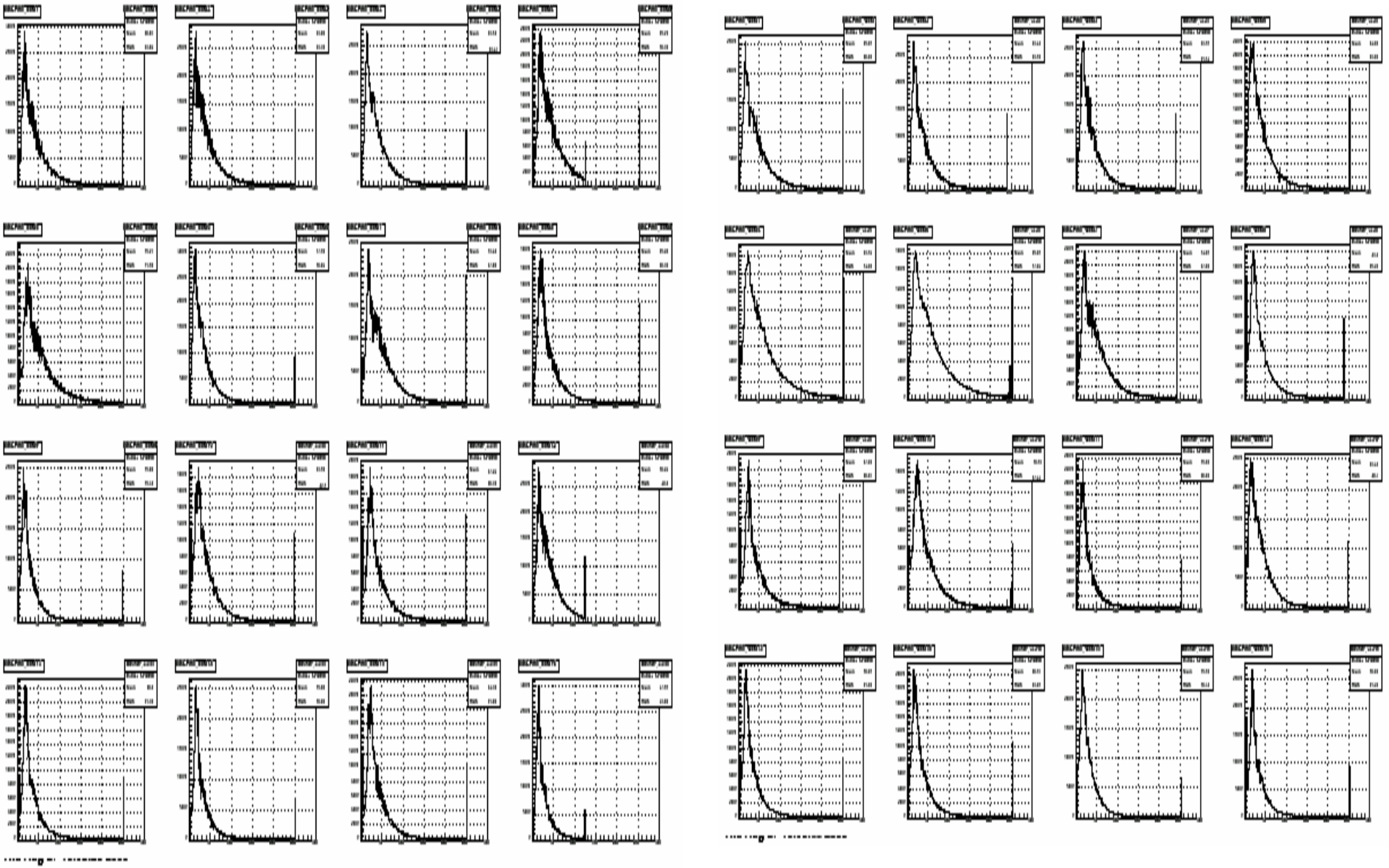
C : Conversion factor [A.M. Poskanzerer and S.A.Voloshin,1998]

Shift Correction Formula:

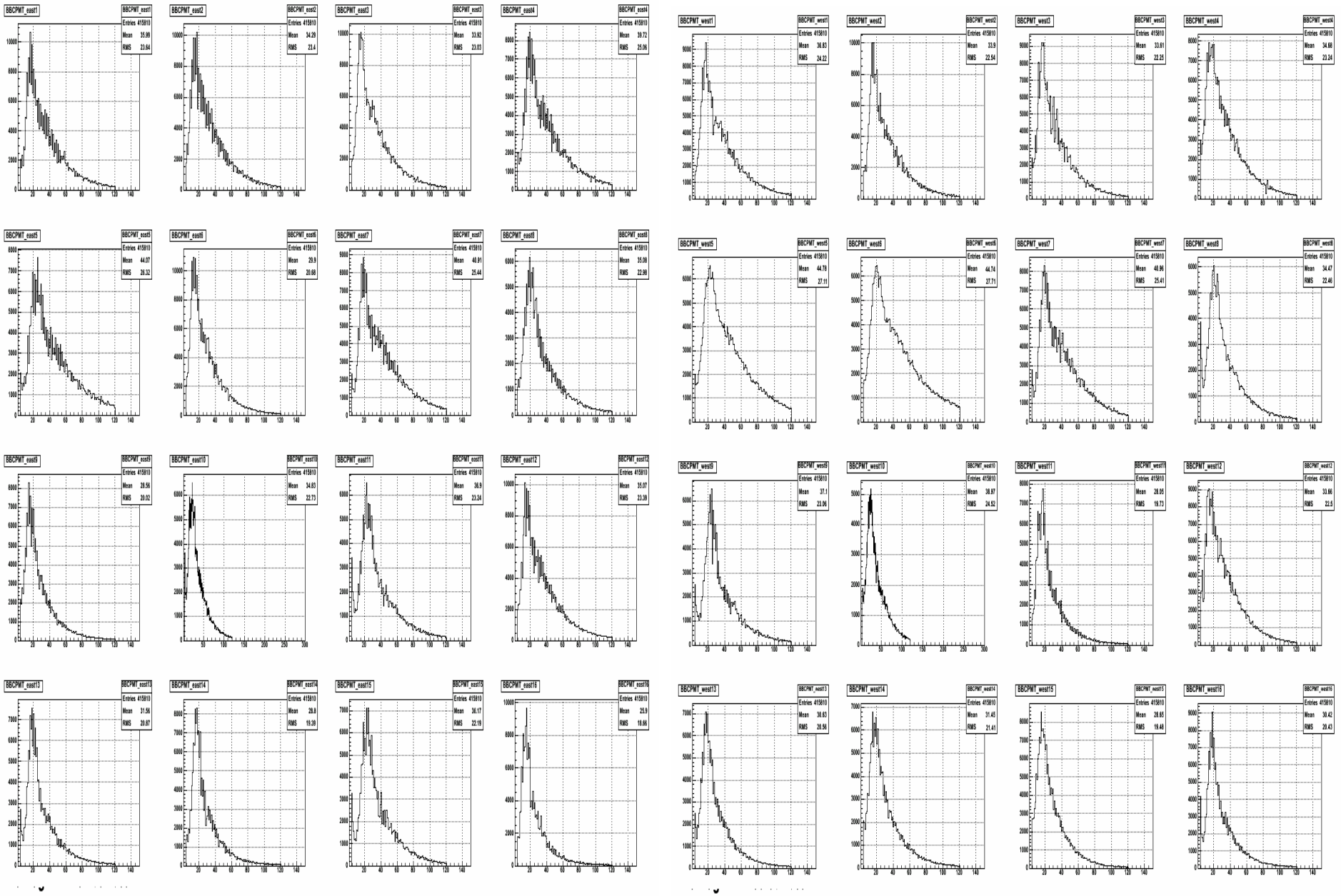
$$\Psi_1' = \Psi_1 + \sum_n \frac{2}{n}(-\langle \sin n\Psi_1 \rangle \cos n\Psi_1 + \langle \cos n\Psi_1 \rangle \sin n\Psi_1)$$

J.Barrette et al. Phys. Rev. C56 (1997)3254

Raw BBC Adc Distribution



BBC Adc Distribution after BBCAdc cut (Events with BBCAdc<120)



BBC Adc distribution after gain correction