EVENT PLANE DETERMINATION
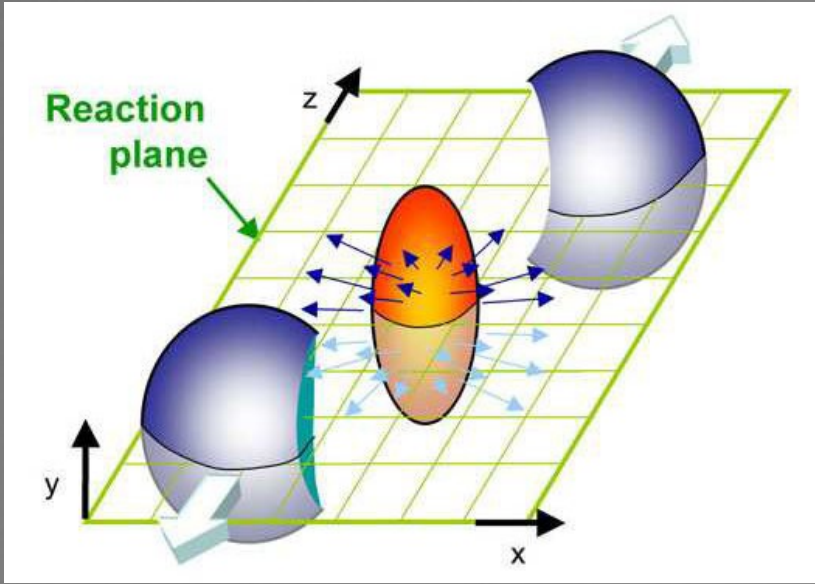
Anjali Sharma
Dr.M.M.Aggarwal and Prof.A.K.Bhati
(PANJAB UNIVERSITY,CHANDIGARH)

ALICE-INDIA COLLABORATION MEETING
MARCH 15-17,2017
VECC,KOLKATA

Outline :

- WHAT IS REACTION PLANE / EVENT PLANE

- OUR PROBLEM

- CORRECTION METHODS

- RESULTS

- SUMMARY

Anjali Sharma

Theory :

- **REACTION PLANE (RP)** - Plane formed by IMPACT PARAMETER VECTOR "b" and the collision axis. (For central collision i.e. b=0, RP can't be defined)
- In practice, we can not find RP but can only approximate and this approximated RP is known as EVENT PLANE .
- Event Flow Vector "Q_n" and Event Plane Angle ψ_n from the n-th harmonics are defined as :

$$Q_n \sin(n\Psi_n) = Y_n = \sum_i w_i \sin(n\phi_n) \qquad\qquad Q_n \cos(n\Psi_n) = X_n = \sum_i w_i \cos(n\phi_i)$$

$$\Psi_n = \frac{\left(\arctan\left(\dfrac{\sum\limits_i w_i \sin(n\phi_n)}{\sum\limits_i w_i \cos(n\phi_n)}\right)\right)}{n}$$

Where w_i is weights and ϕ_n is particle's azimuthal angle.

Anjali Sharma

Schematic Diagram of Reaction Plane :
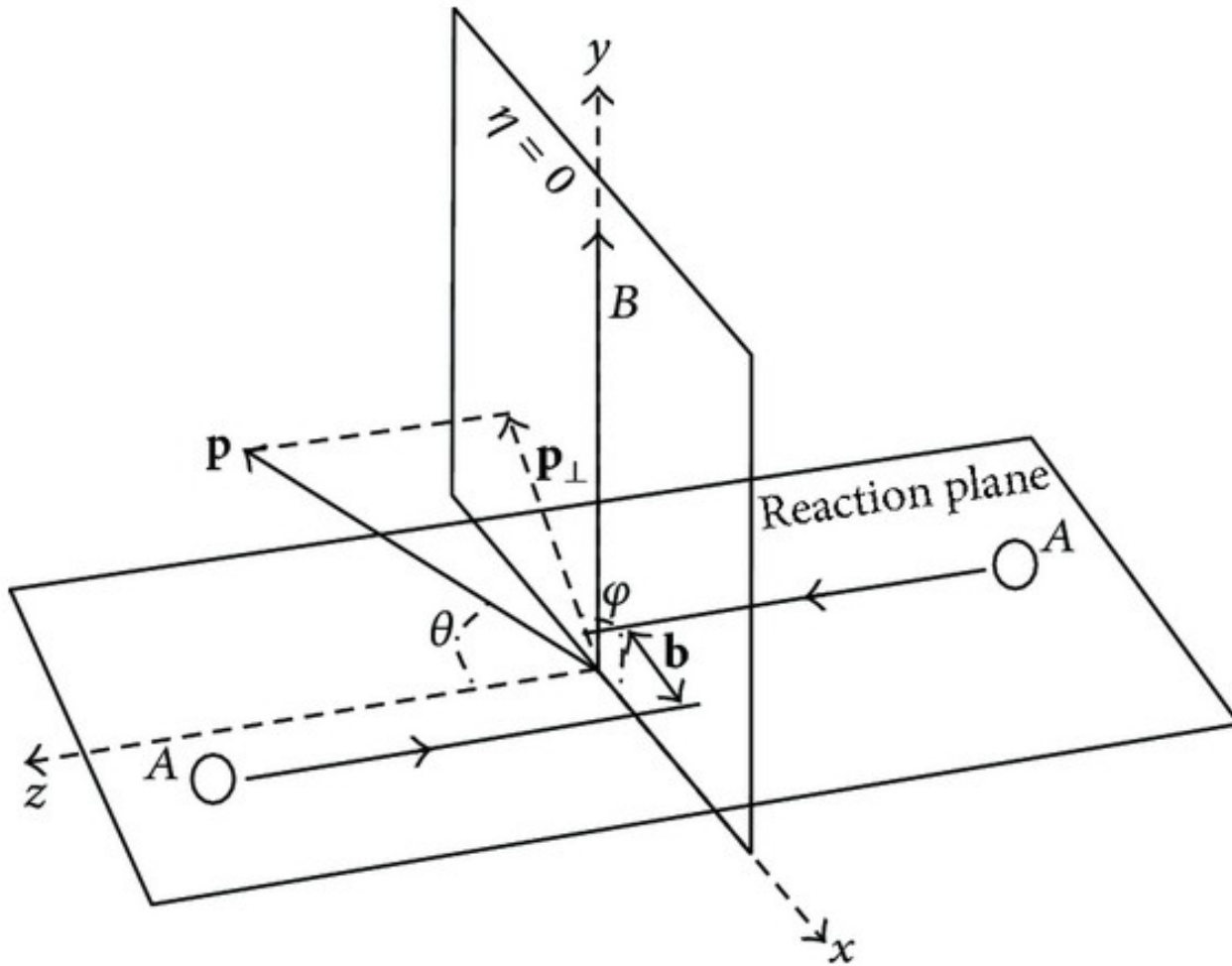
For the detectors with Perfect azimuthal acceptance i.e.

$$0 \leq \phi \leq 2\pi$$

Reaction plane is isotropic.

Due to finite acceptance of detectors, Anisotropy in an Event Plane occurs.

To remove the anisotropy, Two different methods are used.

Anjali Sharma

Methods of Correction :

*Phys.Rev. C56 (1997) 3254-3264

Anjali Sharma

Methods of Correction (contd.) :

SECOND METHOD[#]: Estimation of REACTION PLANE can be obtained from EVENT FLOW VECTOR Q_n which is $Q_n = \sum_{EP} u_n$ where "u_n" is a unit vector defined as

$$u_n = x_n + i\, y_n \equiv \cos(n\phi) + i\sin(n\phi)$$

Due to imperfect azimuthal acceptance of detector, absolute value of "u_n" does not remain unity. To make "u_n" unity, three step process is as follows:

1. RE-CENTERING: For correcting the shift of u_n -vector due to non-zero values of averaged cosine and sine functions, we do re-centering procedure as:

$$x_n' = x_n - \overline{c}_n \qquad\qquad y_n' = y_n - \overline{s}_n$$

Where $c_n = \cos(n\phi)$ and $s_n = \sin(n\phi)$

Anjali Sharma

Methods of Correction :

2. <u>Re-Twisting</u> : Twisting due to irregularity in shape of detector can be corrected by following procedure

$$x'' = \frac{x' - \lambda_{2n}^{S-} \cdot y'}{1 - \lambda_{2n}^{S-} \cdot \lambda_{2n}^{S+}}$$

$$y'' = \frac{y' - \lambda_{2n}^{S+} \cdot x'}{1 - \lambda_{2n}^{S-} \cdot \lambda_{2n}^{S+}}$$

Where smallness parameter λ is defined as $\lambda_{2n}^{S\pm} = \frac{\overline{S_{2n}}}{a_{2n}^{\pm}}$

3. <u>Re-Scaling</u> : After applying above two corrections,re-scaling is done by dividing corrected "x" and "y" by acceptance coefficient

$$x''' = \frac{x''_n}{a_{2n}^{+}}$$

$$y''' = \frac{y''_n}{a_{2n}^{-}}$$

Where acceptance coefficient is defined as $\quad a_{2n}^{\pm} = 1 \pm \overline{c_{2n}}$

Anjali Sharma

Data Sets used :

We have studied these two methods on 3 different DATA SETS.

HIJING

System: Pb-Pb @ 2.76 TeV
Centrality: 40-50%
Analyzed charged particles with and
without detector effect where in
"WITH DETECTOR EFFECT"
we exclude
$45^0 < \phi < 55^0$

TPC

System: Pb-Pb @ 2.76 TeV
Data Set: LHC10h, ESD pass2
Vertex : -10 < Vz < 10 cm
Centrality: 40-50%
Eta: $\eta < |0.8|$
Pt: > 0.2 GeV

PMD

System: Pb-Pb @ 2.76 TeV
Data Set: LHC10h, ESD pass2
Vertex : -10 < Vz < 10 cm
Centrality: 40-50%
Eta: $2.3 < \eta < 3.5$
Adc > 432 and ncell >1
36 < Adc <= 432

Anjali Sharma

Results(first method) HIJING :

WITHOUT DETECTOR EFFECT

WITH DETECTOR EFFECT

Anjali Sharma
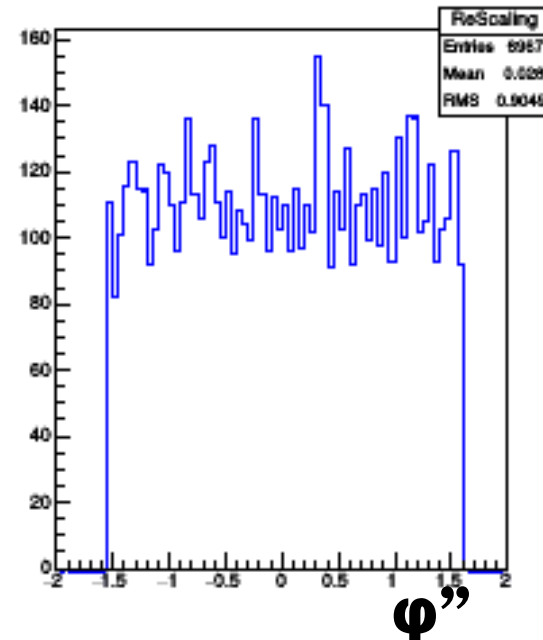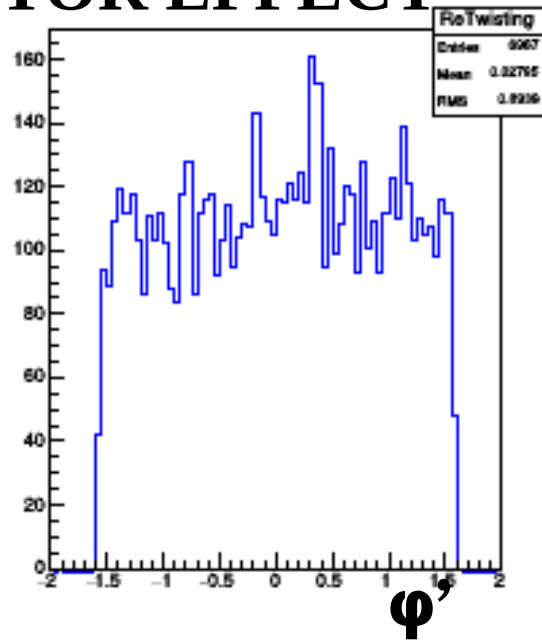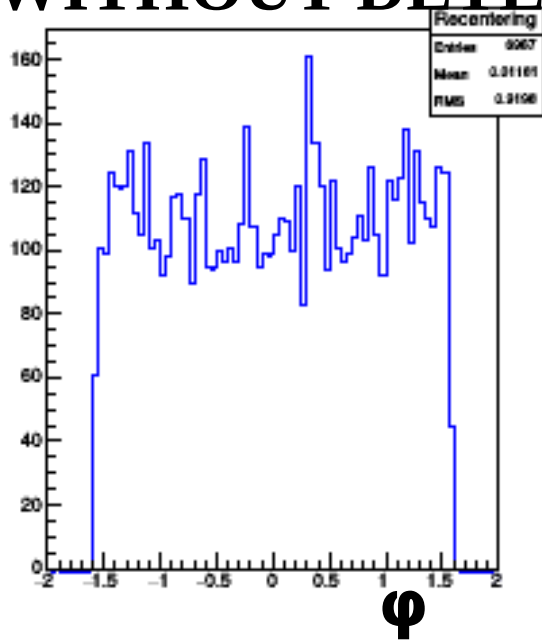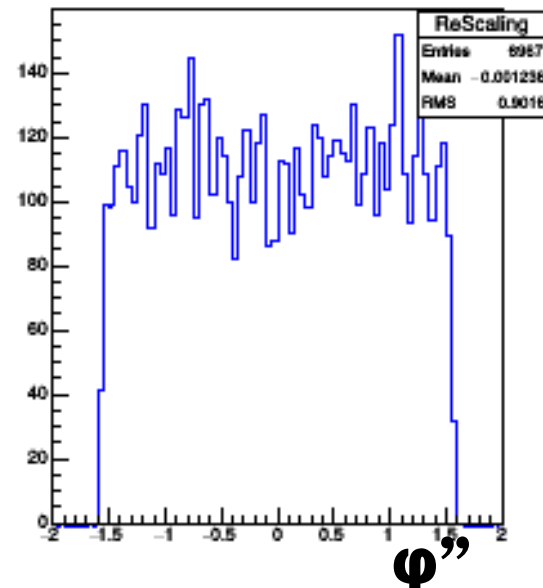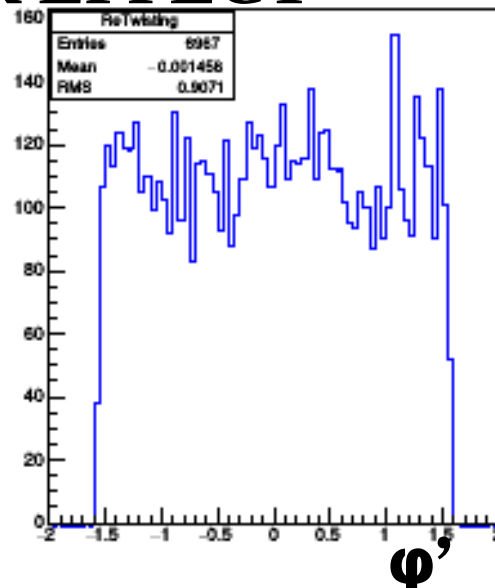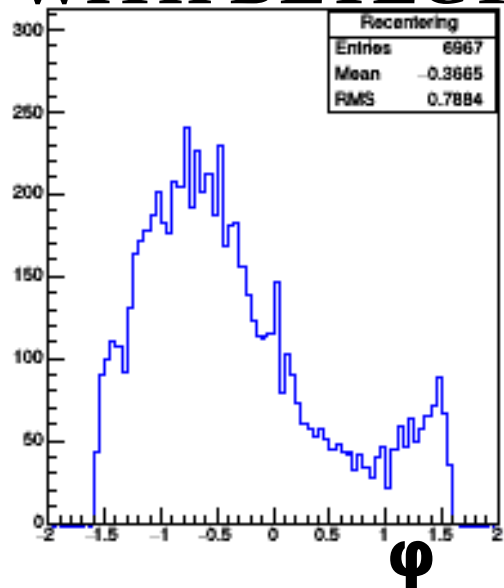
Results (second method) HIJING:
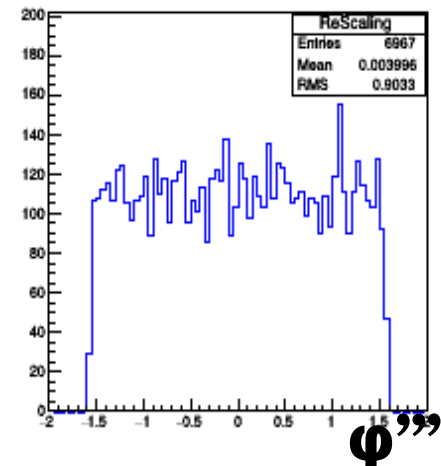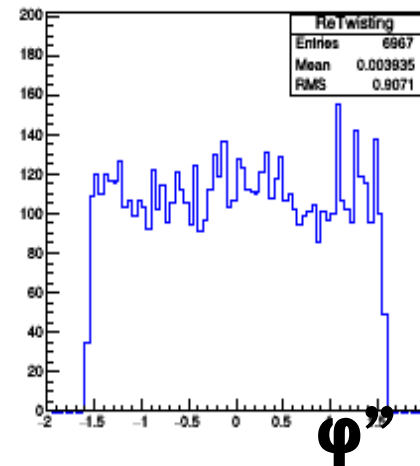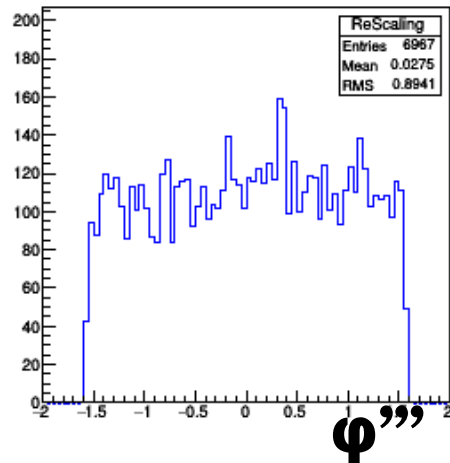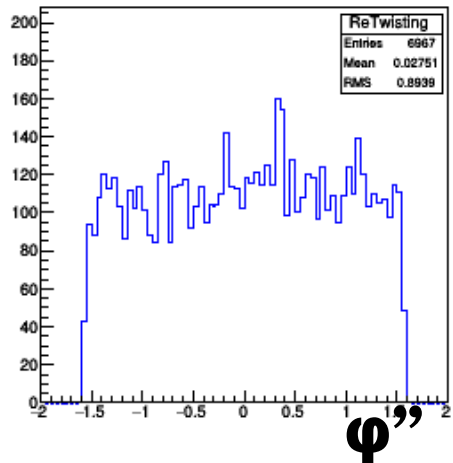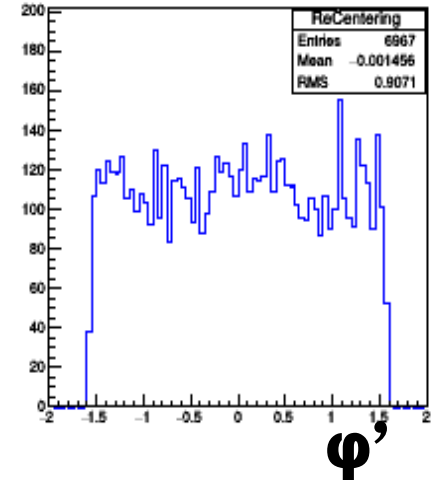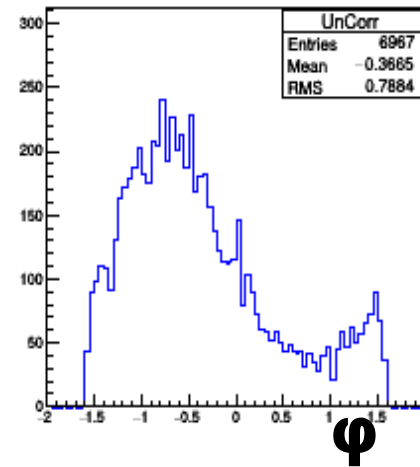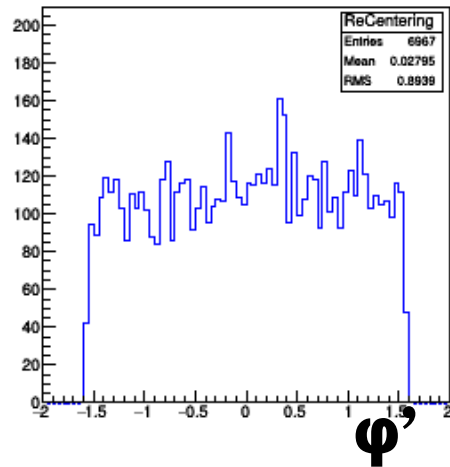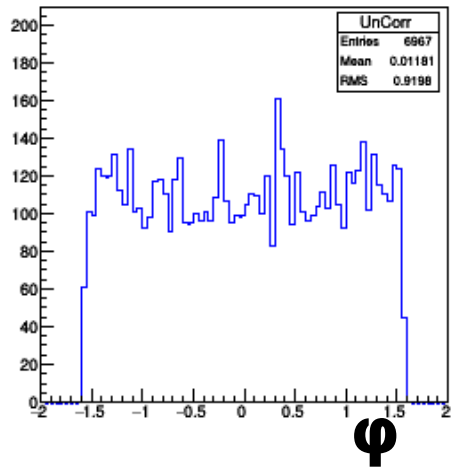
w/o detector effect

with detector effect

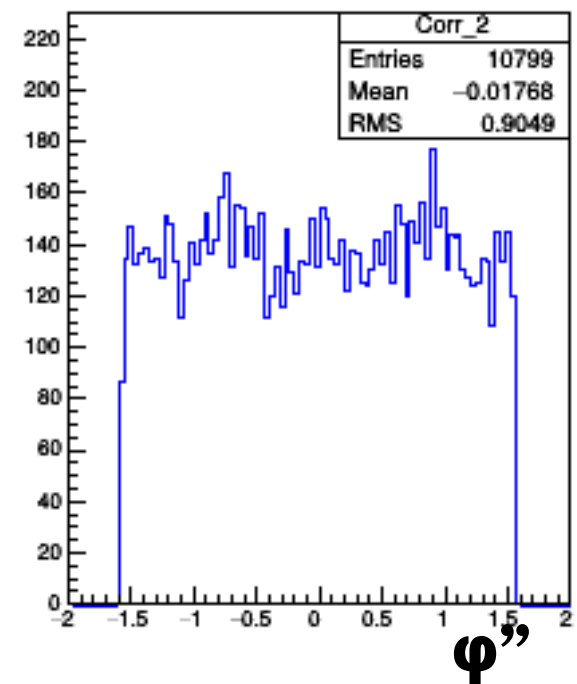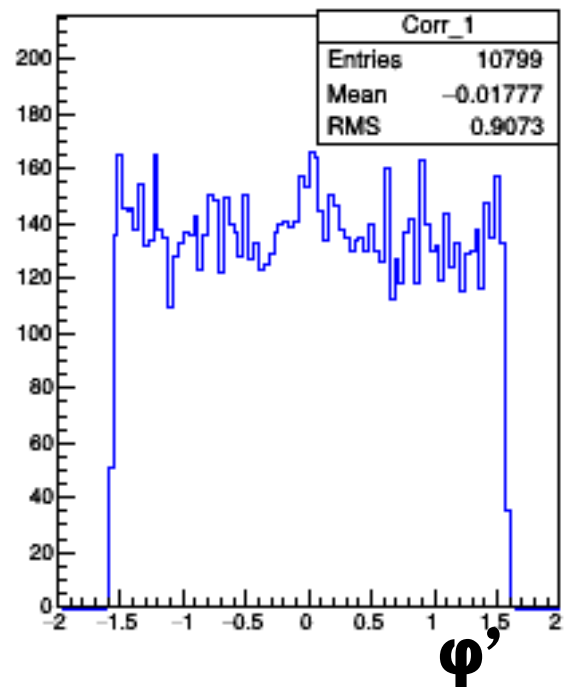Anjali Sharma

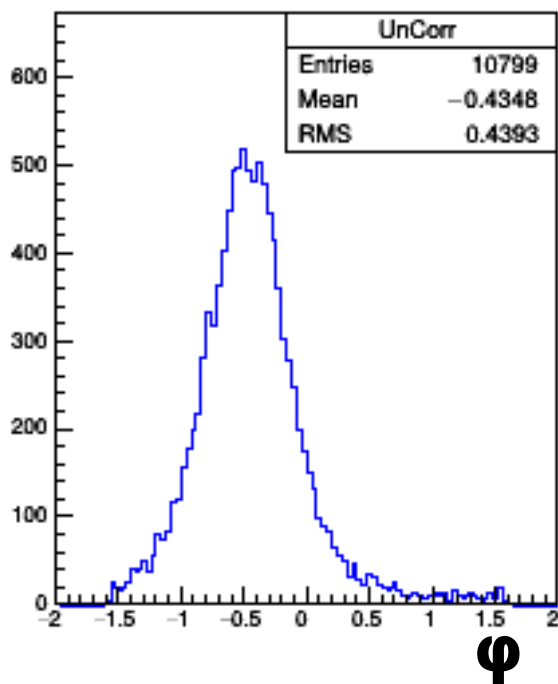# Results from TPC : (first method)
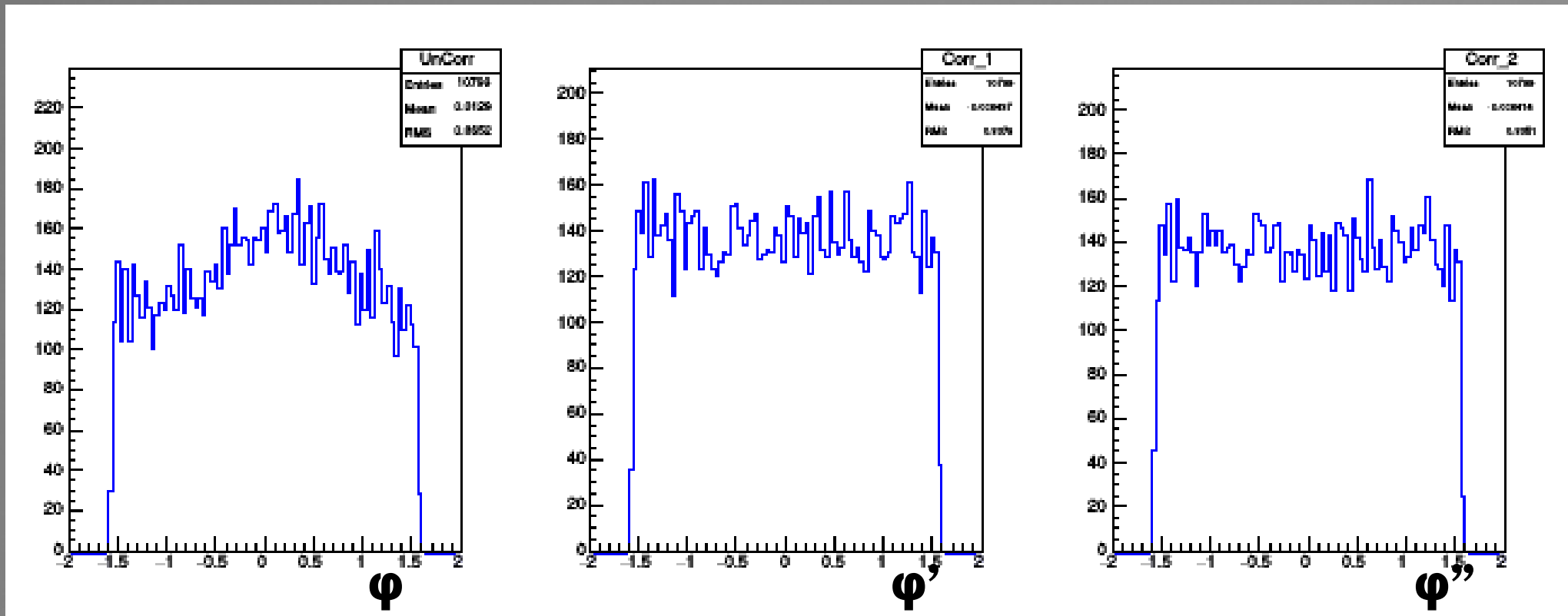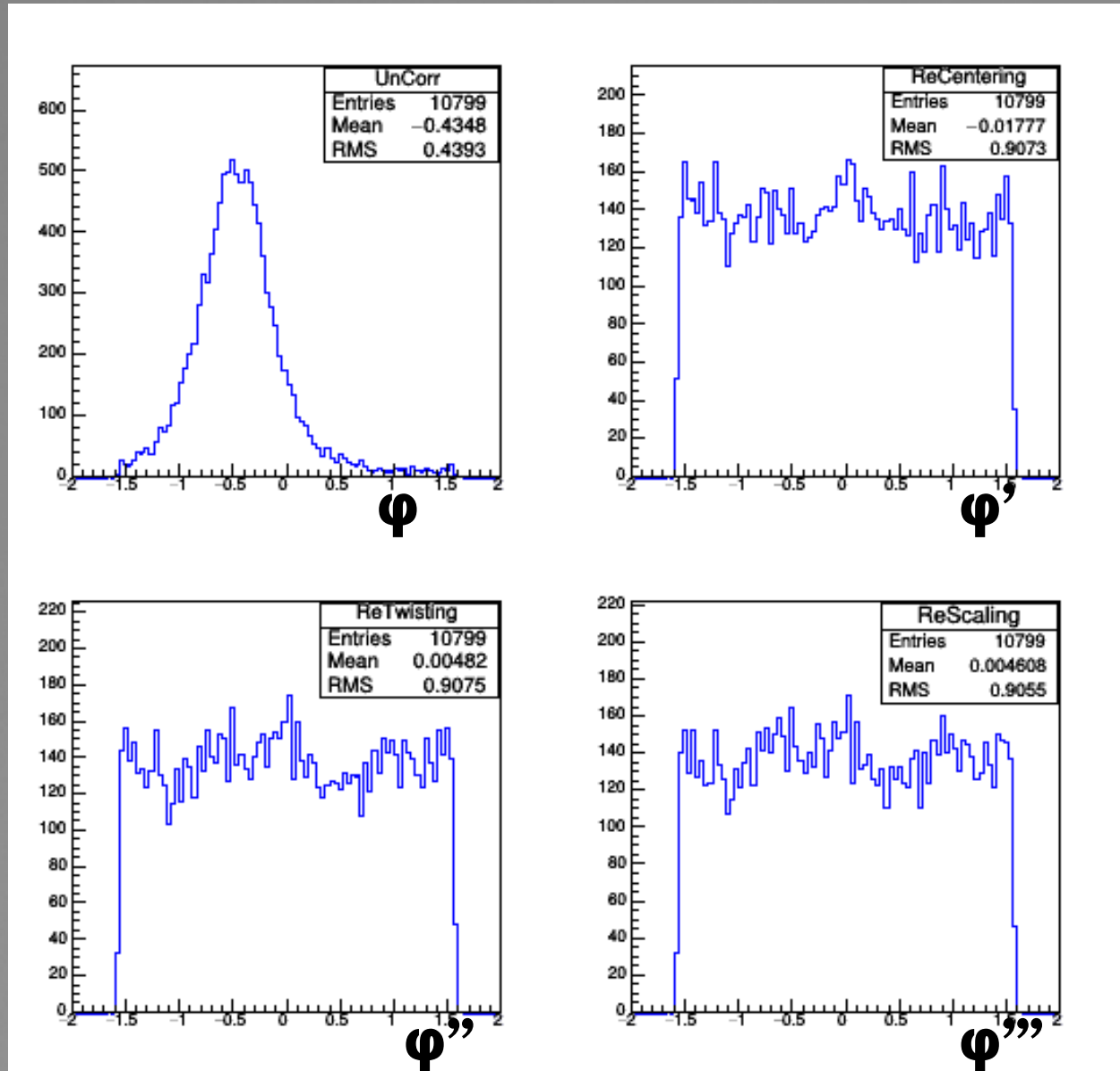
Results from TPC : (second method)
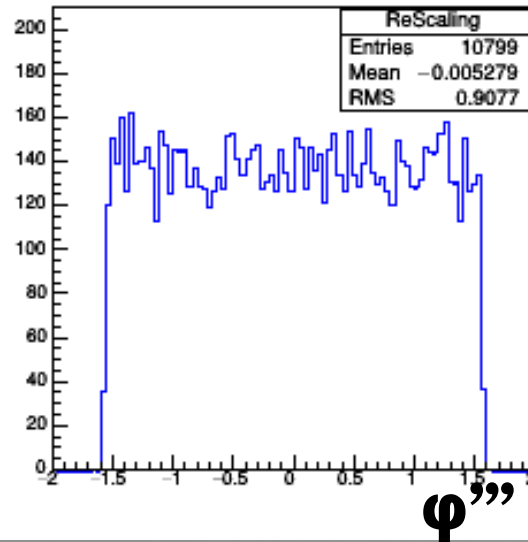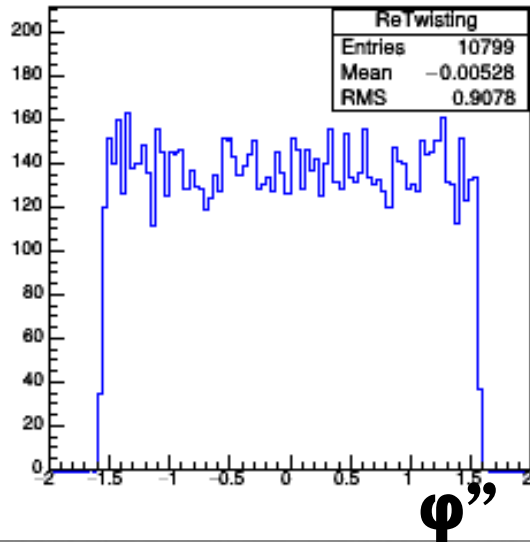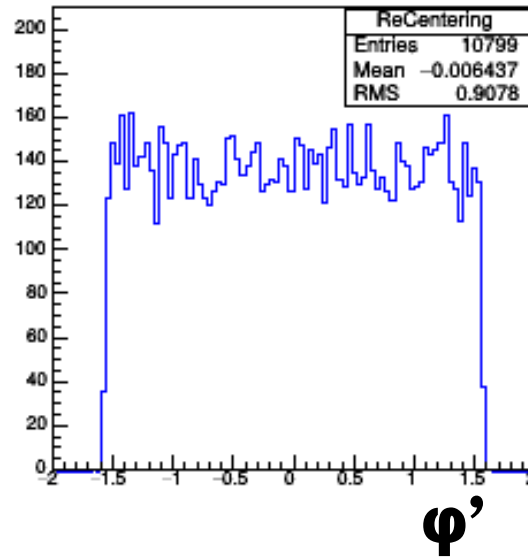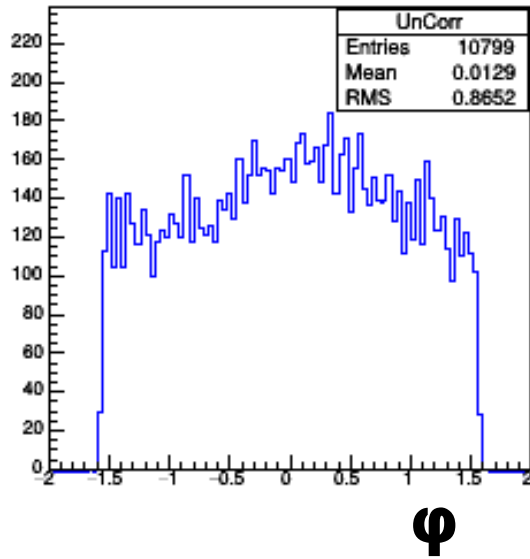
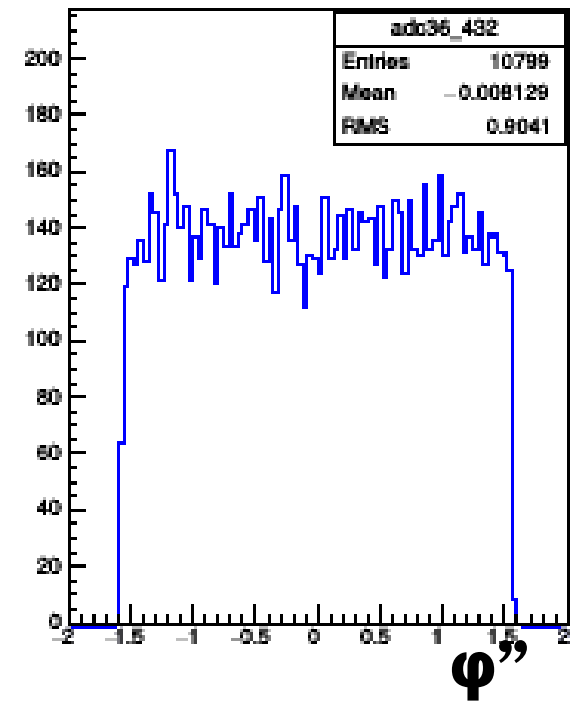# Results from PMD : (first method)
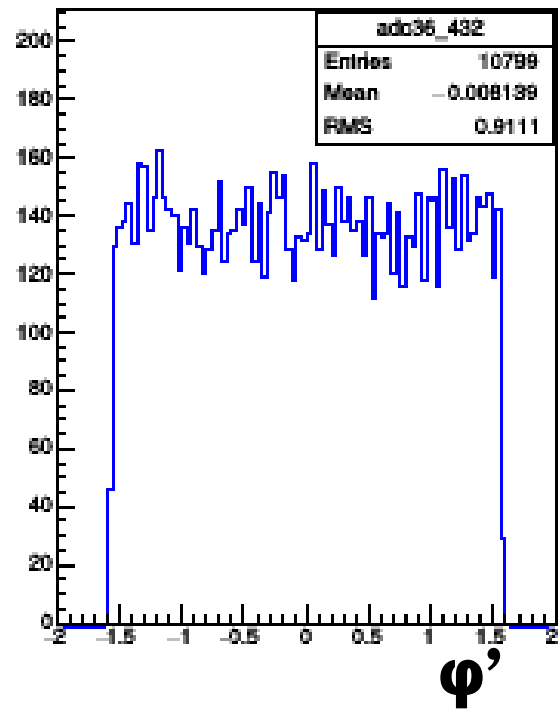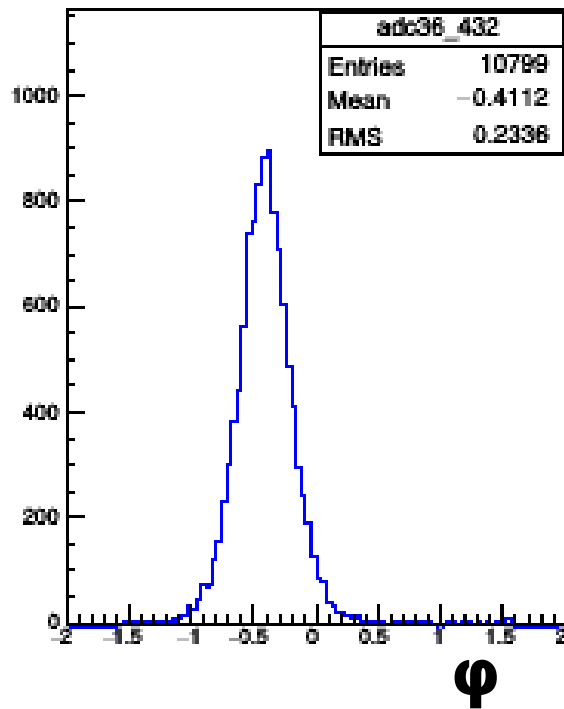
With MipCut adc > 432 and ncell >1

Results from PMD : (second method)

with MipCut adc > 432
and ncell >1

Results from PMD : (first method)

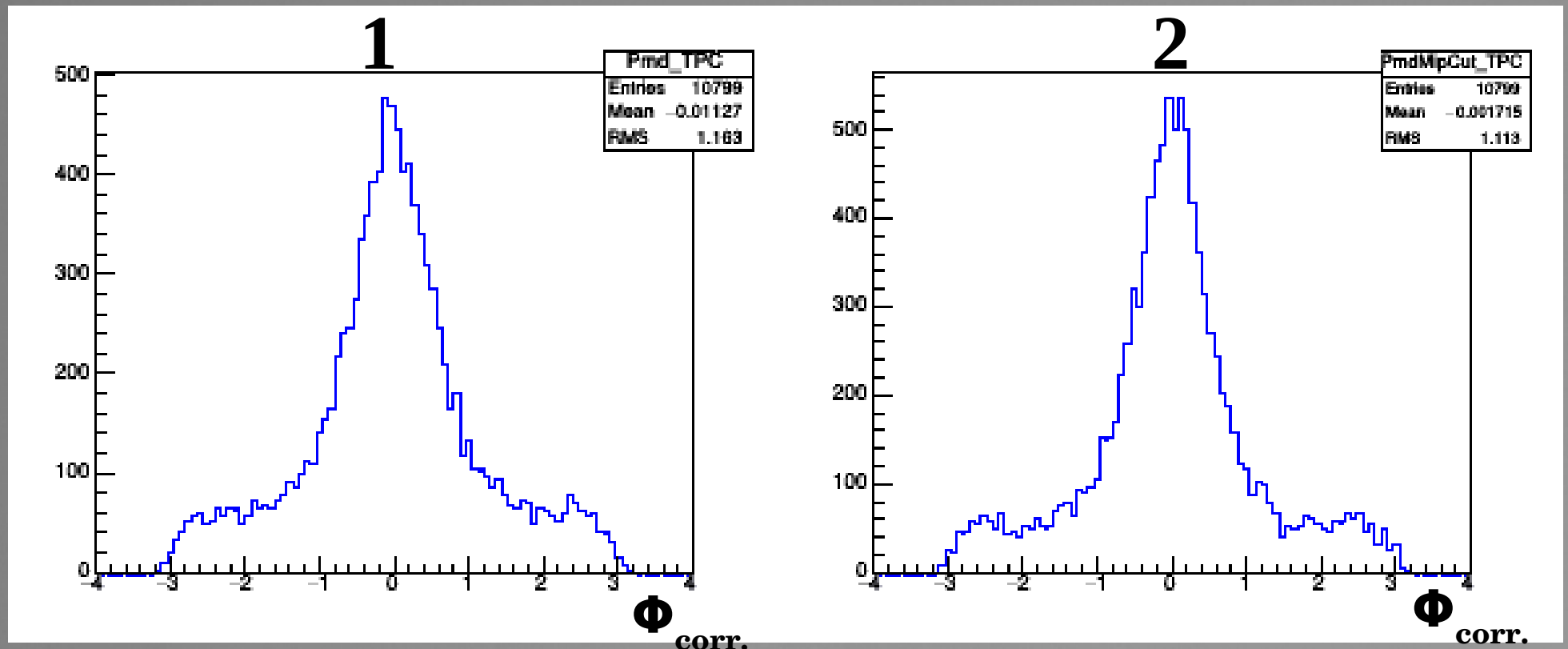with MipCut: 36 < adc <= 432

Results from PMD : (second method)

with MipCut:

36 < adc <= 432

Anjali Sharma
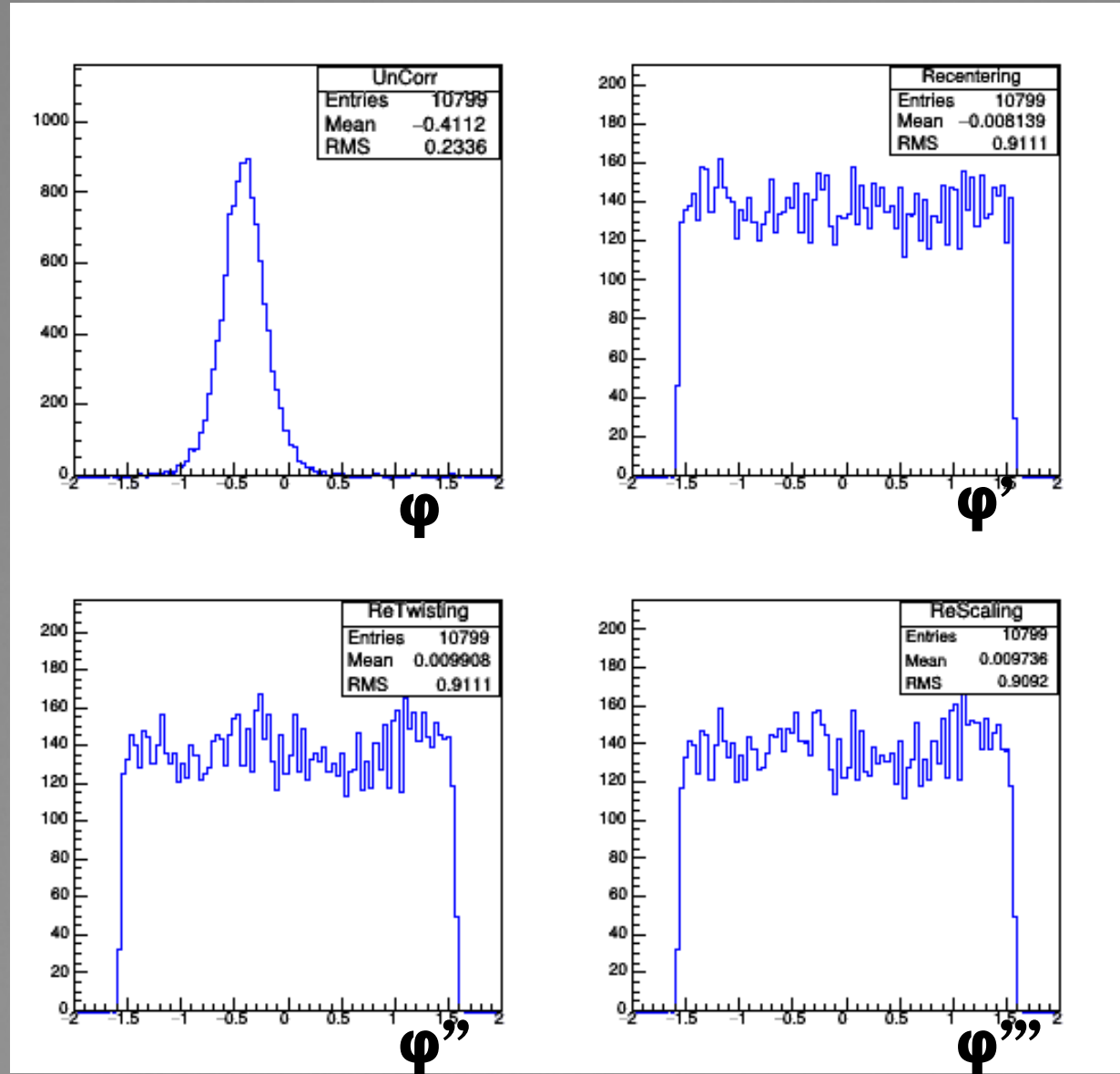
Results :

1. Difference Plot between corrected TPC event plane and corrected PMD PHOTON-LIKE event plane.

2. Difference Plot between corrected TPC event plane and corrected PMD HADRON-LIKE event plane.

Anjali Sharma

Summary and Future Plans :

◆ For an event-by-event study of various properties of QGP i.e., Flow, Chiral Magnetic Effect (CME) etc, the "isotropic Event Plane" is main ingredient.

◆ Event plane from different detectors (PMD and TPC) along with HIJING event plane has been studied and observed no matching between them, which needs the corrections.

◆ These methods work in nice way to improve the flatness of Event plane but upto 2nd order only.

➢ Flatness of event plane will be done for V0 and ZDC detectors also.
➢ The correlation will also be studied for corrected event planes.

THANKS

Anjali Sharma