Study of the systematics in determining the symmetry plane for Bi-Bi collisions at $\sqrt{S_{NN}}$ 9.2 GeV in the DCM-QGSM-SMM model

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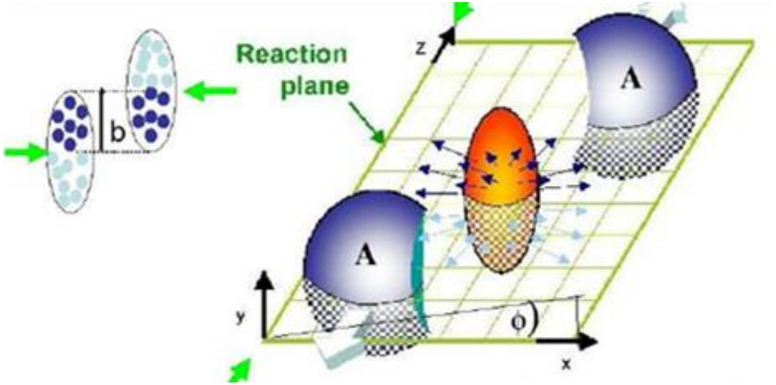
Collective anisotropic flow

The spatial asymmetry of the energy distribution at the initial moment of the collision of nuclei is transformed, through the strong interaction, into the momentum anisotropy of the produced particles

Fourier series expansion of particle distribution in azimuthal angle with respect to the reaction plane angle

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



The expansion coefficients:

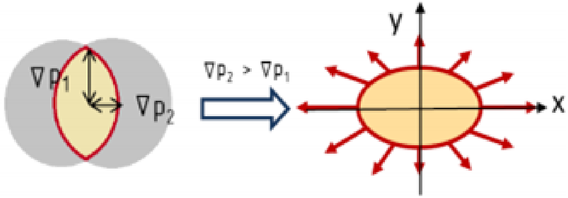
$$v_n = \langle \cos(n(\phi - \Psi_{RP})) \rangle$$

In the experiment, we can get the event plane angle Φ_n , relative it:

$$v_n = \frac{\langle \cos n(\phi - \Phi_n) \rangle}{R_n}$$

R_n — Resolution of Φ_n
for the reaction plane angle Ψ_{RP}:

$$R_n = \langle \cos n(\Phi_n - \Psi_{RP}) \rangle$$



Scalar product method

Each particle with an azimuthal angle ϕ is assigned a vector u:

$$u_n = x_n + iy_n = \cos(n\phi) + i\sin(n\phi) = exp(in\phi)$$

The sum of these vectors determines the Q-vector of the event

$$Q_n = \sum u_n = \sum(\cos n\phi + i\sin n\phi) = X_n + iY_n = |Q_n|exp(in\Psi^n_{EP})$$

Event-averaged correlation of u-vectors with Q-vector depends on v_n

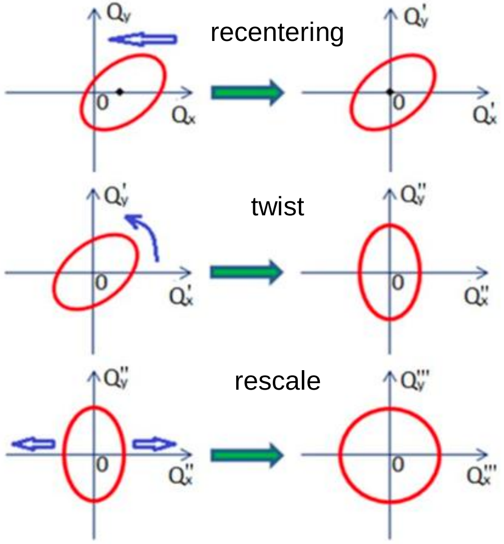
$$\langle u_n Q_n\rangle = \langle x_n X_n\rangle + \langle y_n Y_n\rangle = \int_0^{2\pi} \frac{d\Psi_{RP}}{2\pi} \langle u_n\rangle_{\Psi_{RP}} \langle Q_n\rangle_{\Psi_{RP}} = v_n V_n$$

$$\langle Q^a_n Q^b_n\rangle = \frac{1}{4} V^2_n$$

$$v_n = \frac{\langle x_n X_n\rangle}{\sqrt{2\langle X^a_n X^b_n\rangle}} = \frac{\langle y_n Y_n\rangle}{\sqrt{2\langle Y^a_n Y^b_n\rangle}}$$

a,b - sub-events

Corrections for non-uniform acceptance



The QnAnalysis package

Motivation:

•Decoupling configuration from implementation

•Persistency of analysis setup

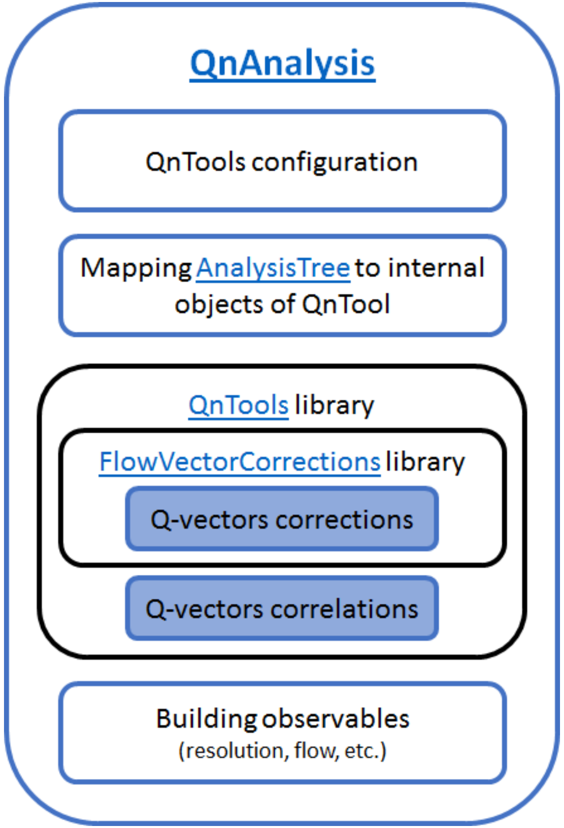
•Co-existence of different setups (easy systematics study)

•Unification of analysis methods

•Self-descriptiveness of the analysis results

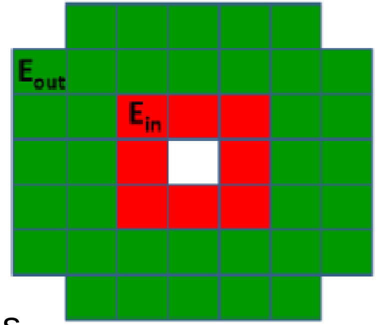
QnAnalysis requirements:
•ROOT ver. ≧ 6.20 (with MathMore library)
•C++17 compatible compiler
•CMake ver. ≧ 3.13
Can be easily installed on NICA cluster using ROOT and CMake modules

Git repository:
https://github.com/HeavyIonAnalysis/QnAnalysis



FHCal’s role in scalar product method

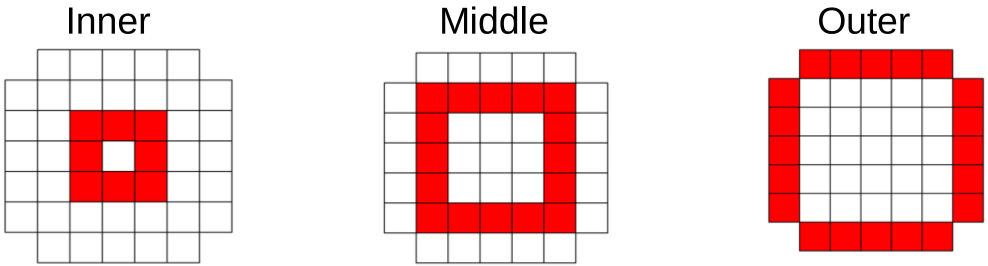
FHCal is used to form Q-vectors of sub-events according to the angular distribution of spectator energy in modules:



$$Q_{n,x} = \sum_i w_i \cos(n\phi_i) \quad Q_{n,y} = \sum_i w_i \sin(n\phi_i)$$

ϕ_i —azimuthal angle of modules № i in FHCal, w_i — energy in module

Sub-events can be formed by Right(South) and Left(North) FHCal and also by the rings of FHCal modules



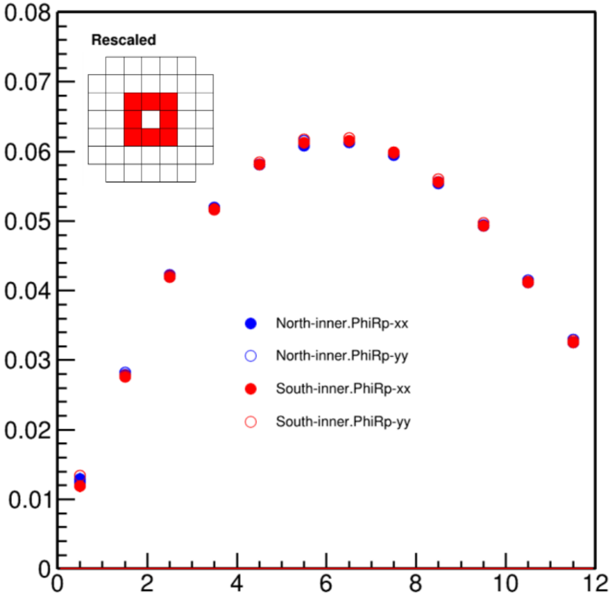
When studying correlations, the following values is also considered:

$$\frac{1}{2}R_n^T = \langle X_n^{a,b} X_{RP} \rangle = \langle Y_n^{a,b} Y_{RP} \rangle; R_n^T - TrueResolution$$

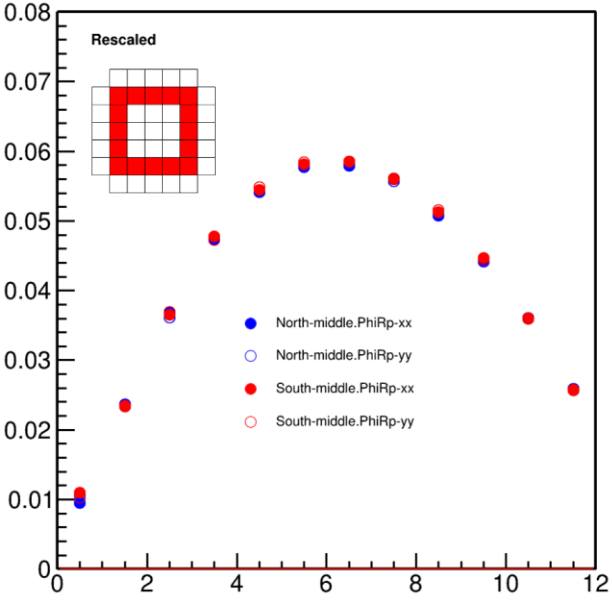
$$\frac{1}{2}R_n^2 = \langle X_n^a X_n^b \rangle = \langle Y_n^a Y_n^b \rangle; R_n - RecoResolution$$

Correlation of Q-vectors in FHCal's rings with reaction plane angle PhiRp

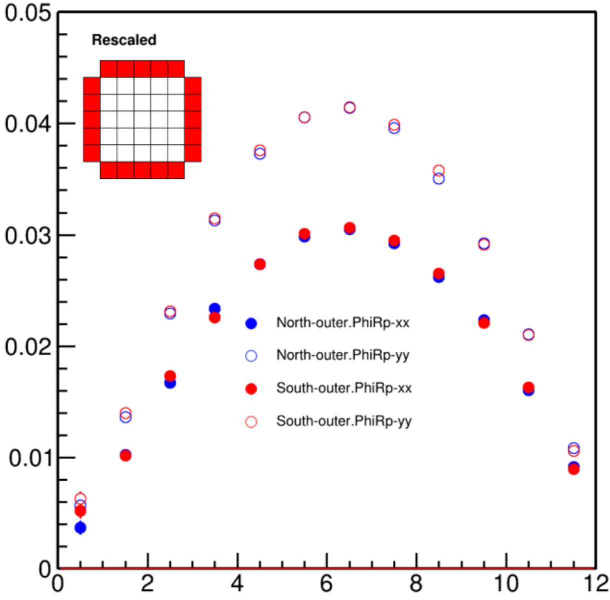
Inner ring



Middle ring



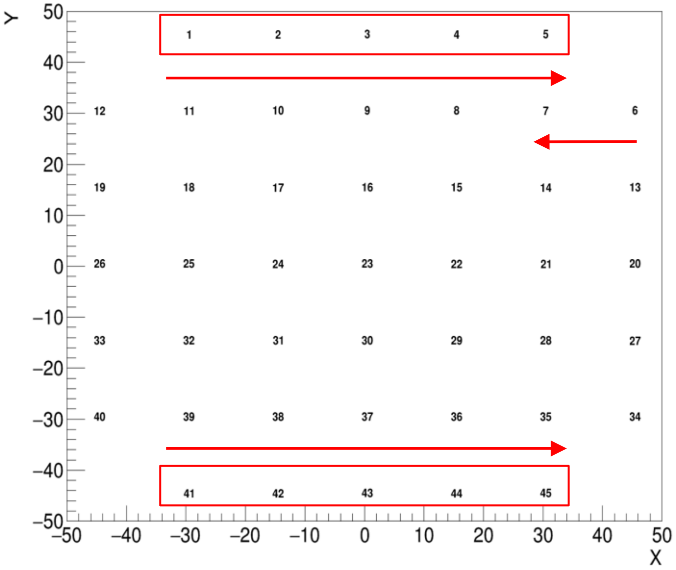
Outer ring



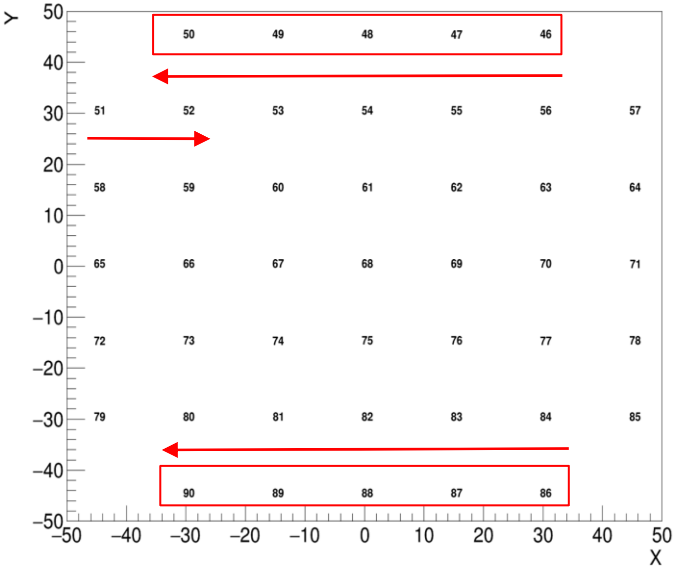
XX and YY components diverge for outer ring

FHCal Module numbering

Left



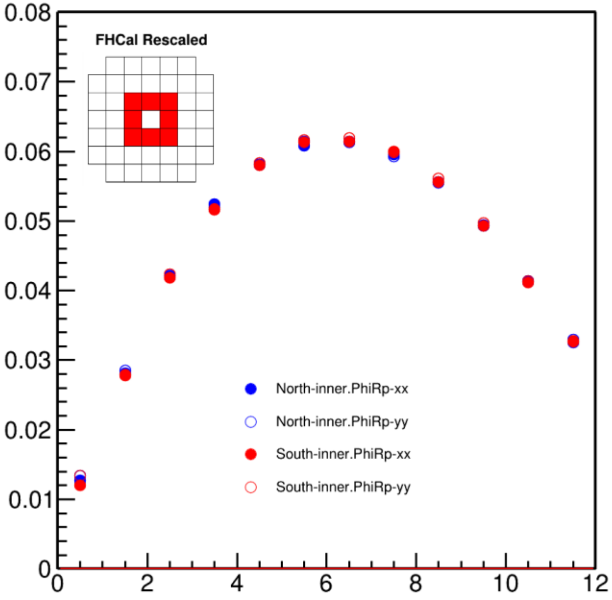
Right



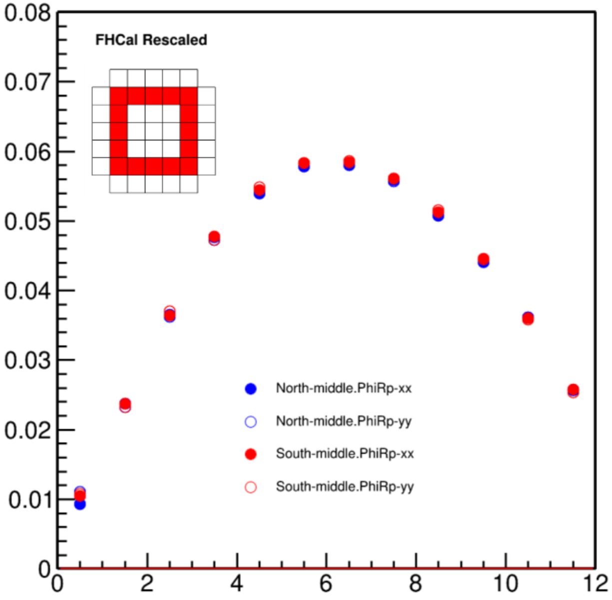
The first and last lines are numbered in the wrong direction. Can we obtain module coordinates from MPDROOT?

Correlation of Q-vectors in FHCal's rings with reaction plane angle PhiRp

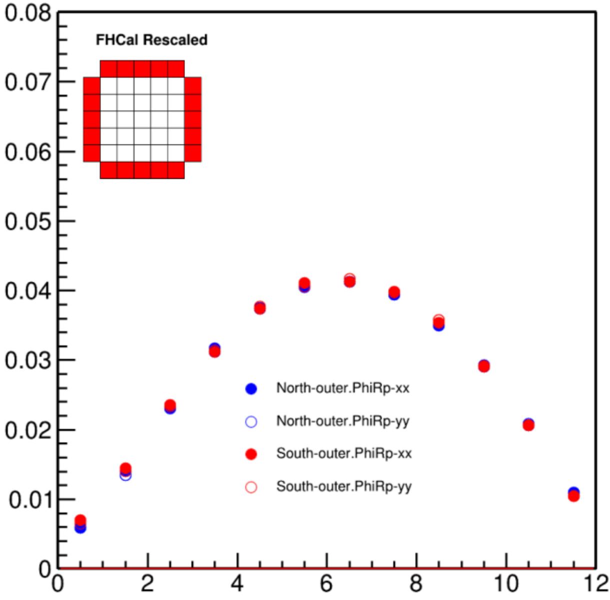
Inner ring



Middle ring

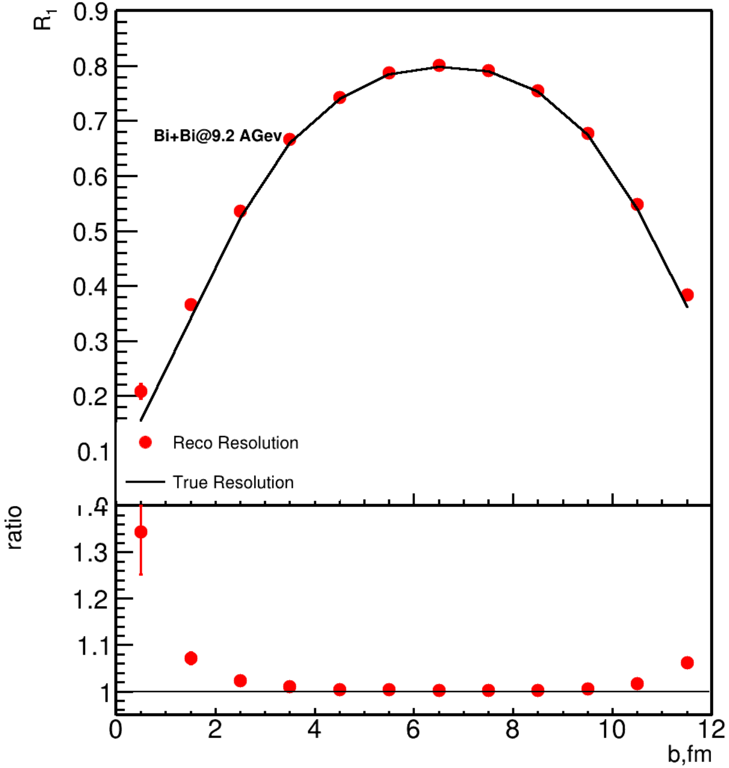


Outer ring



Ratio of True Resolution and Reco Resolution

$$R_1 = \langle \cos(\Phi_1 - \Psi_{RP}) \rangle$$



- good agreement for mid-central collisions
- necessary to study difference for central collisions

Summary

- An error was detected in the calculation of FHCal module coordinates
- Two sub-events method is applicable to calculate first harmonic Resolution for mid-central collisions
- It is necessary to study difference for central collisions
- Three sub-events method is needed to study further

Thanks for your attention!