Two-particle correlations in azimuthal angle and pseudorapidity in Be+Be collisions at SPS energies

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Introduction

Two-particle correlations in azimuthal angle and pseudorapidity were studied for inelastic Be+Be interactions at five beam momenta: $19A$, $30A$, $40A$, $75A$ and $150A$ GeV/c. Correlations are derived from the distributions of the difference in pseudo-rapidity and azimuthal angle between two particles in the same event.
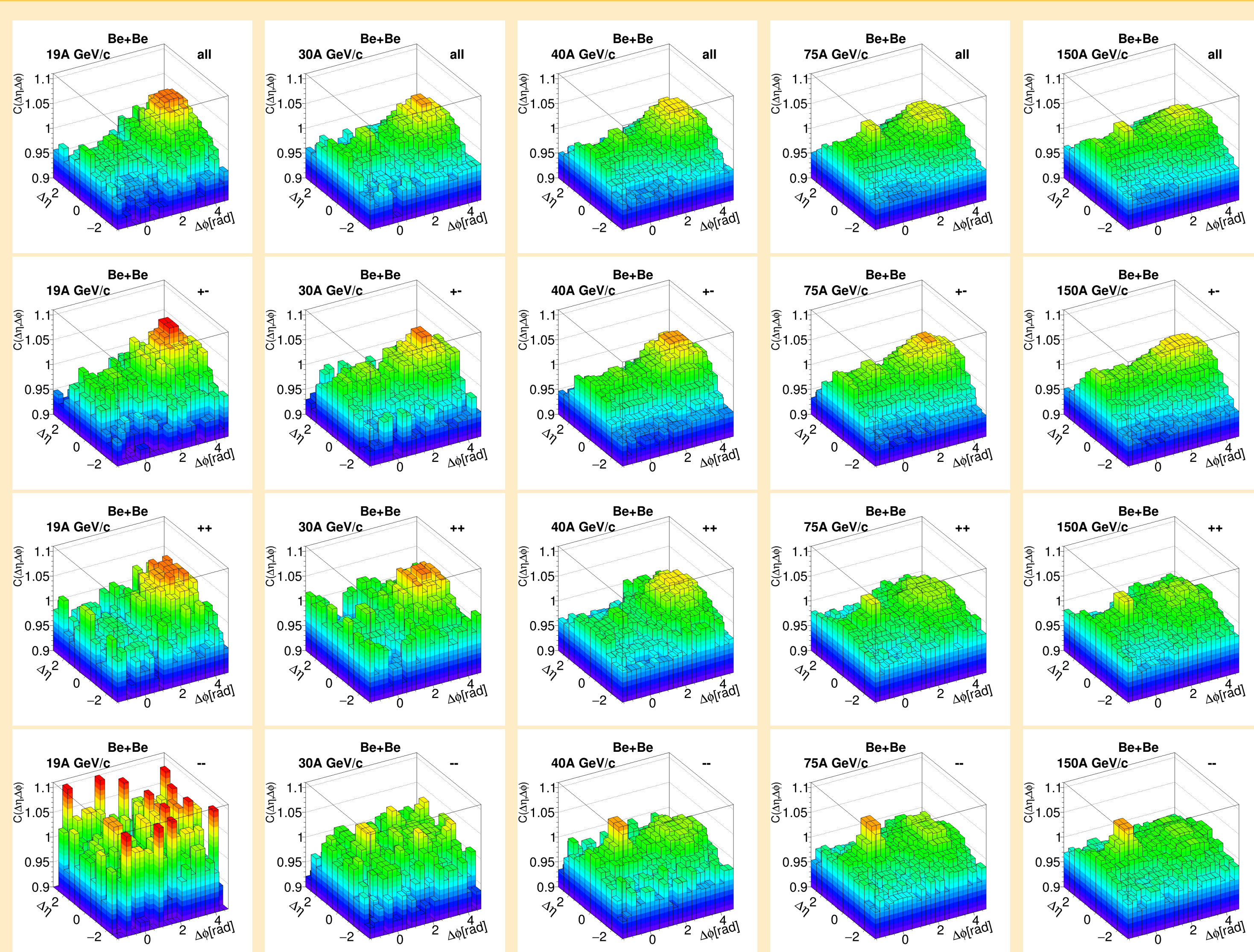
$$\Delta\eta = |\eta_1 - \eta_2|; \qquad \Delta\phi = |\phi_1 - \phi_2|$$
$$C(\Delta\eta, \Delta\phi) = \frac{N_{bkg}^{pairs}}{N_{signal}^{pairs}} \frac{S(\Delta\eta, \Delta\phi)}{B(\Delta\eta, \Delta\phi)};$$
$$S(\Delta\eta, \Delta\phi) = \frac{d^2 N^{signal}}{d\Delta\eta d\Delta\phi}; \quad B(\Delta\eta, \Delta\phi) = \frac{d^2 N^{bkg}}{d\Delta\eta d\Delta\phi}$$

Event and track cuts were chosen to select the 5% most violent collisions with particles produced in strong and EM processes within the NA61/SHINE acceptance.
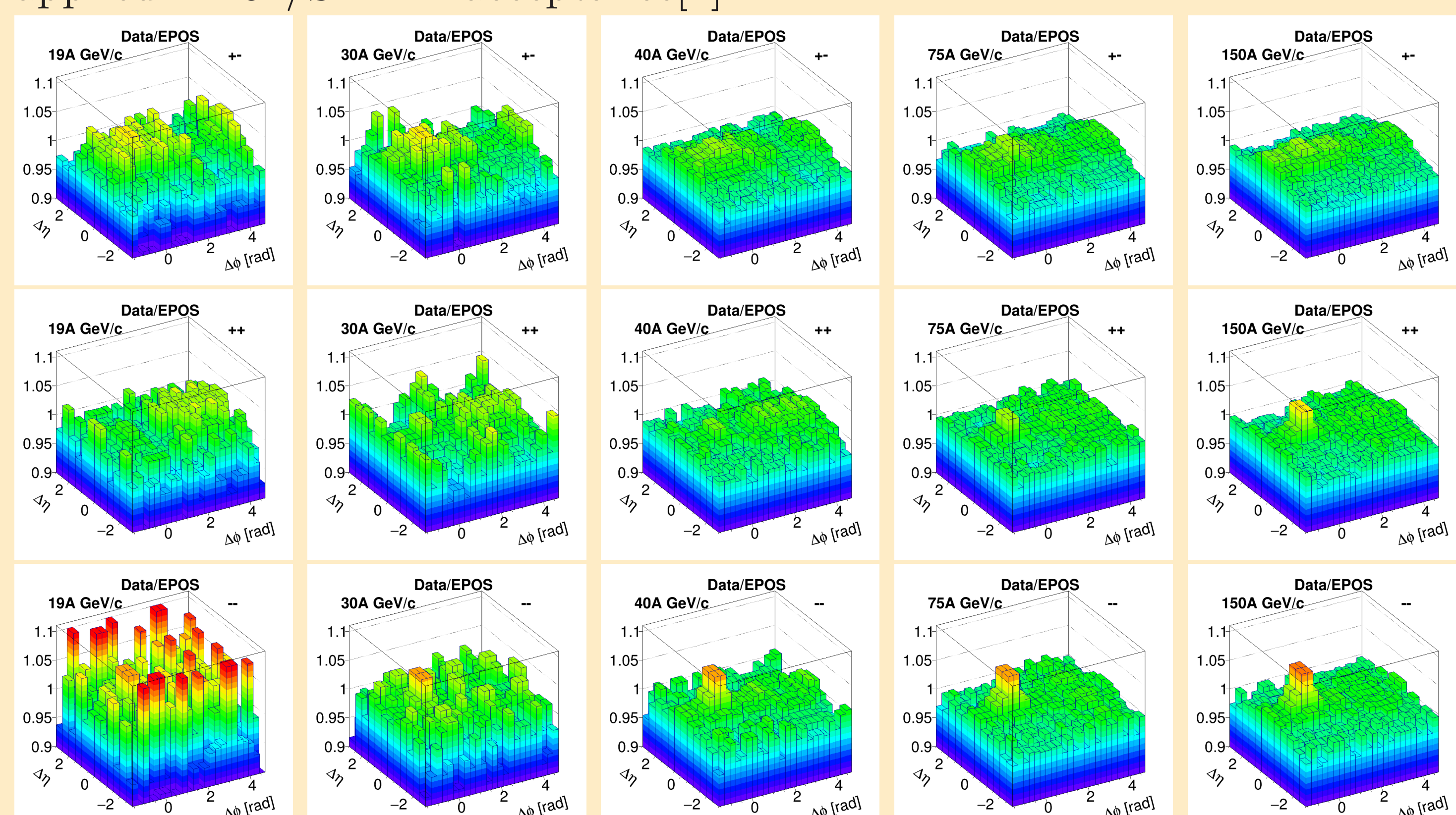
Results

Two main structures are visible: a maximum at $(\Delta\eta, \Delta\phi) = (0, \pi)$ probably due to resonance decays and momentum conservation; a small maximum at $(0,0)$ which, for unlike-charge pairs its most probable source is Coulomb attraction, while in like-charge pairs it is probably due to quantum statistics. A difference in its height between pairs of positively and negatively charged particles can be observed. Correlations for pairs of positively charged particles is an interplay of two effects: enhancement for bosons and suppression for fermions, while correlations of negatively charged particles have no significant admixture of fermions.

Statistical uncertainties do not exceed 1% of the correlation magnitude while systematic uncertainties were estimated to be up to 2%.

Comparison with EPOS

The corrected results were compared to the results from EPOS1.99 with applied NA61/SHINE acceptance[1].

EPOS reproduces data qualitatively well except of Coulomb peak or quantum statistics peak at $(\Delta\eta, \Delta\phi) = (0, 0)$.

Comparison with p+p results

Be+Be results corrected for detector effects were compared to already published results from a similar analysis in p+p system [2]. Be+Be results below are in p+p scale.
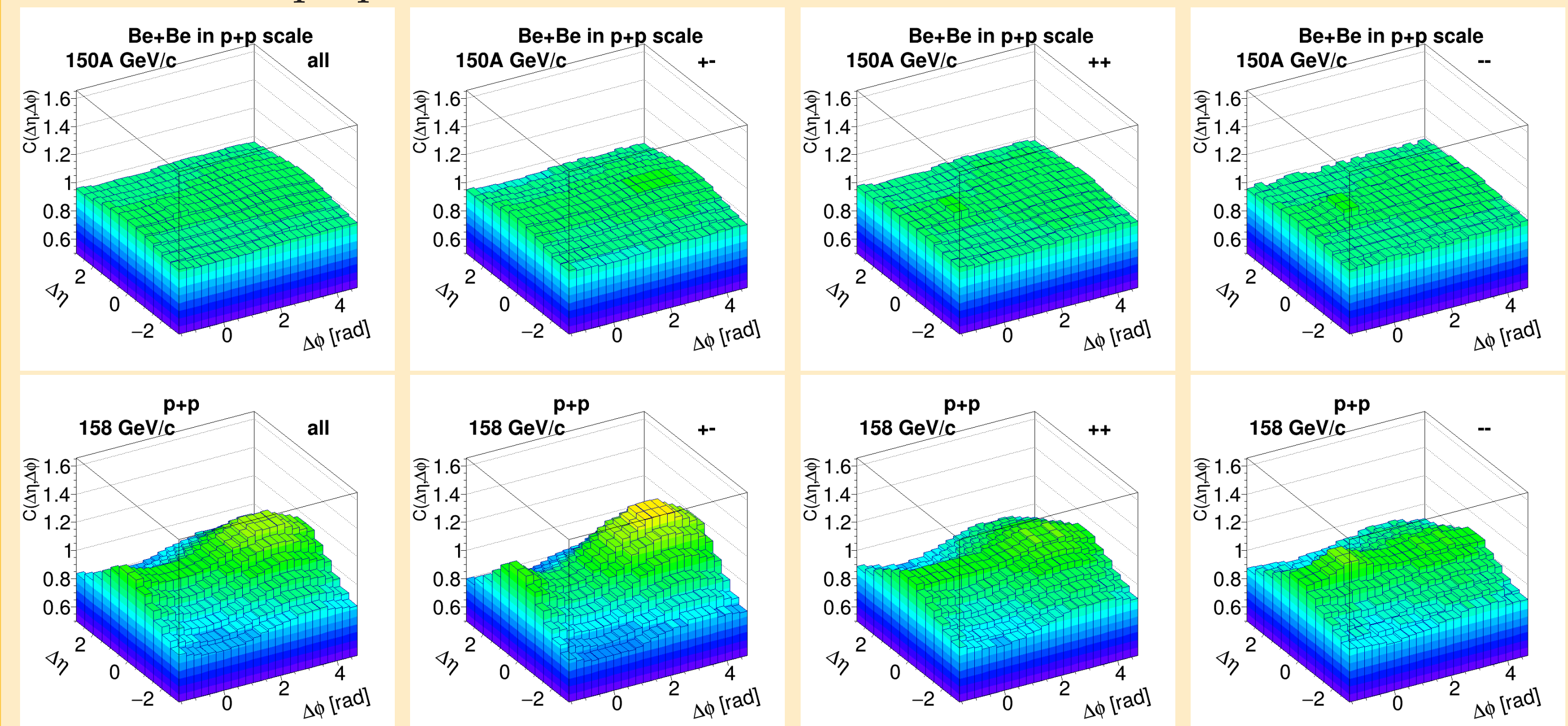
Correlation results of Be+Be are about 30% weaker than the results of p+p due to higher combinatorial background, while the mean multiplicity in the Be+Be events is about 4-5 times higher than in p+p events at the similar beam momentum.

While comparing correlation structures in both systems, the away-side enhancement is qualitatively similar. However, the evolution of $(0,0)$ region between the systems is quite striking. This is visualized by calculating the ratio: $(C^{BeBe} - 1)/(C^{pp} - 1)$, where C functions of both systems were normalized to the maxima in their away-side regions.
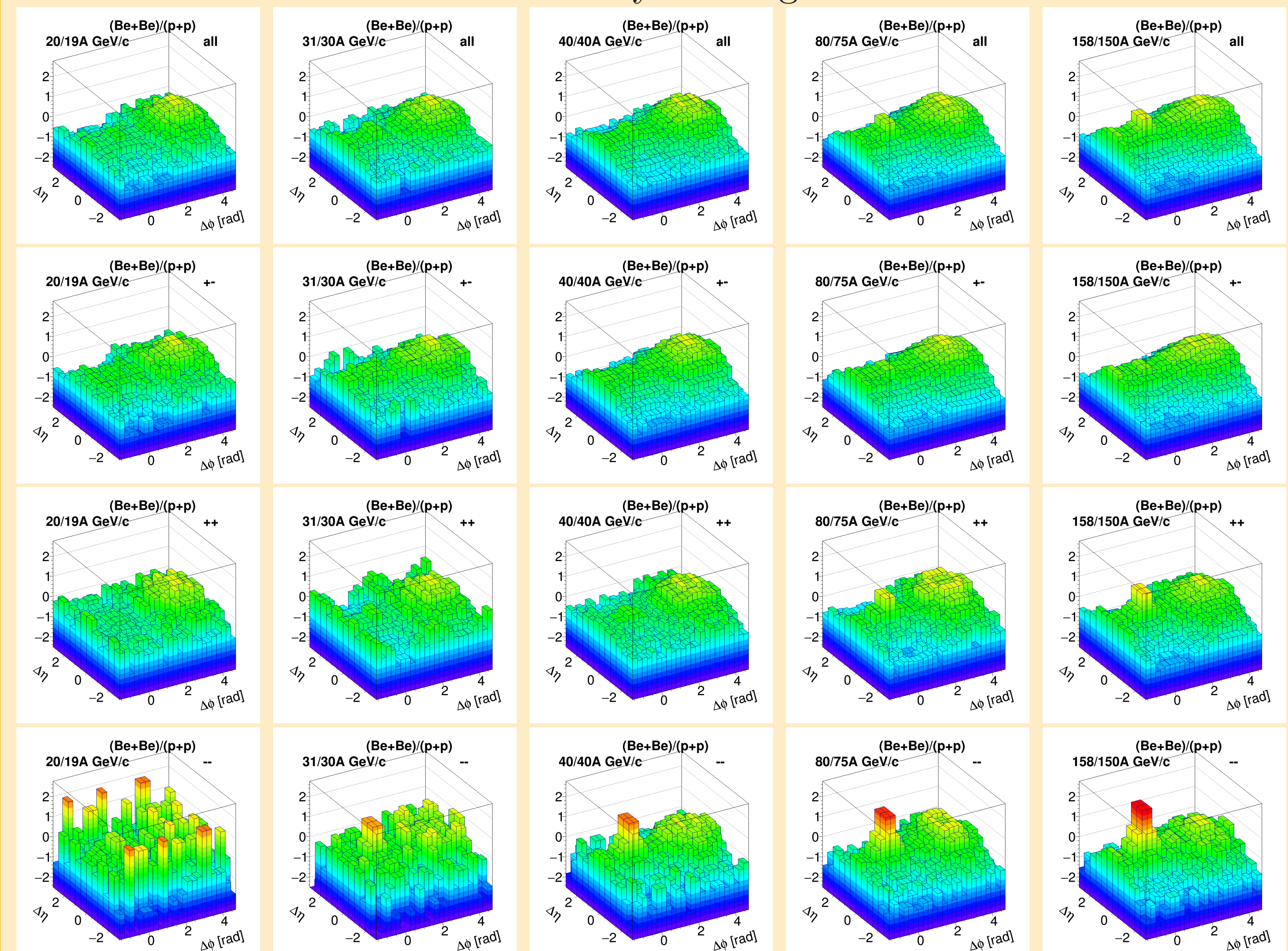
The ratio plots show that $(0,0)$ region grows stronger in Be+Be with increasing beam momentum.

Conclusions

Corrected results of Be+Be two-particle correlations in $\Delta\eta\Delta\phi$ were presented. Two main structures are visible: away-side enhancement due to momentum conservation and resonance decays; near-side peak which is probably an effect of Coulomb attraction in unlike-sign pairs of particles and quantum statistics in like-sign pairs of particles. The comparison of the results were compared to EPOS results. The model reproduces data well with exception of $(0,0)$ region. The comparison to already published p+p results was done as well and found an increase of quantum statistics contribution in higher beam momenta in Be+Be.

References

[1] The NA61/SHINE detector acceptance definition, https://edms.cern.ch/document/1700774/1.

[2] A. Aduszkiewicz *et al.* [NA61/SHINE Collaboration], Eur. Phys. J. C **77** (2017) no.9, 626 [arXiv:1705.08206 [nucl-ex]].