First Studies of Long Range Correlations in PbPb 158 AGeV Collisions in NA49 Experiment

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Abstract

We present the 1st results of 158 AGeV PbPb collisions data analysis based on the study of long range correlations. "Long range" here means that we study correlations between various observables (multiplicity and mean transverse momentum) measured in two rapidity windows sufficiently separated. This is the major difference compared to other conventional correlation studies. Correlations obtained in our case might be a signature of processes different from the HBT correlations, resonance decays, back-to-back short range correlations, mini-jets and jet decays.

1. Introduction

The total number of events used in the analysis is 60 000 (10 000 for each of 6 classes of centrality).

Rapidity and transverse momentum (Pt) distributions of charged particles, products of PbPb collisions measured by NA49, were used for the selection of regions of interest for the further correlation analysis. Two criteria were used:

i. uniformity of NA49 acceptance for Pt measurements in a given window
ii. desirable separation of windows in the rapidity space

Two rapidity windows relevant to the NA49 experiment were chosen and defined (in c.m.s.) as "backward" (0.0-0.5) and "forward" (1.0-2.0). The following 2D histograms were plotted accumulating all events data for every event: multiplicity (n) and mean Pt for charged particles measured in the "backward" window vs. n and Pt for the "forward" window.

The following long range correlation functions defined using data for “backward” and “forward” rapidity windows were obtained event-by-event in line with our proposals (NA49 collaboration meeting, GSI, December 2002, report by G.Feofilov): <n>-n, <Pt>-Pt and <Pt>-n.

The mean values here (<>)correspond to the values averaged in a given window over all events.

The long range correlations were studied as a function of collision centrality using 6 classes defined by EVeto data of NA49 zero degree calorimeter.

Plots of long range correlation coefficients vs. centrality classes are presented.

In analysis the 00M data production was used. And the following cuts were done:

Event-cuts

	1-st class	**2-nd class**	**3-rd class**	**4-th class**	**5-th class**	**6-th class**
Iflag	0	0	0	0	0	0
VertexX	-0.2 – 0.1	-0.2 – 0.1	-0.2 – 0.1	-0.2 – 0.1	-0.2 – 0.1	-0.2 – 0.1
VettexY	-0.1 – 0.2	-0.1 – 0.2	-0.1 – 0.2	-0.1 – 0.2	-0.1 – 0.2	-0.1 – 0.2
VertexZ	-579.2 – -578.65	-579.2 – -578.65	-579.2 – -578.65	-579.2 – -578.65	-579.2 – -578.65	-579.2 – -578.65
Multiplicity	800 – 1500	700 – 1300	400 – 1200	200 – 900	100 – 700	10 – 500
Eveto	0 – 9250	9250 – 14670	14670 – 21190	21190 – 26080	26080 – 29340	29340 – 36000

Track-Cuts

Iflag	0
Zfitst	< 200
NMP	> 30
NFP/NMP	0.5 - 1.1
$\mathbf{b_x}$	-2 – 2
$\mathbf{b_y}$	-1 – 1
Pt	0.005 – 2.5

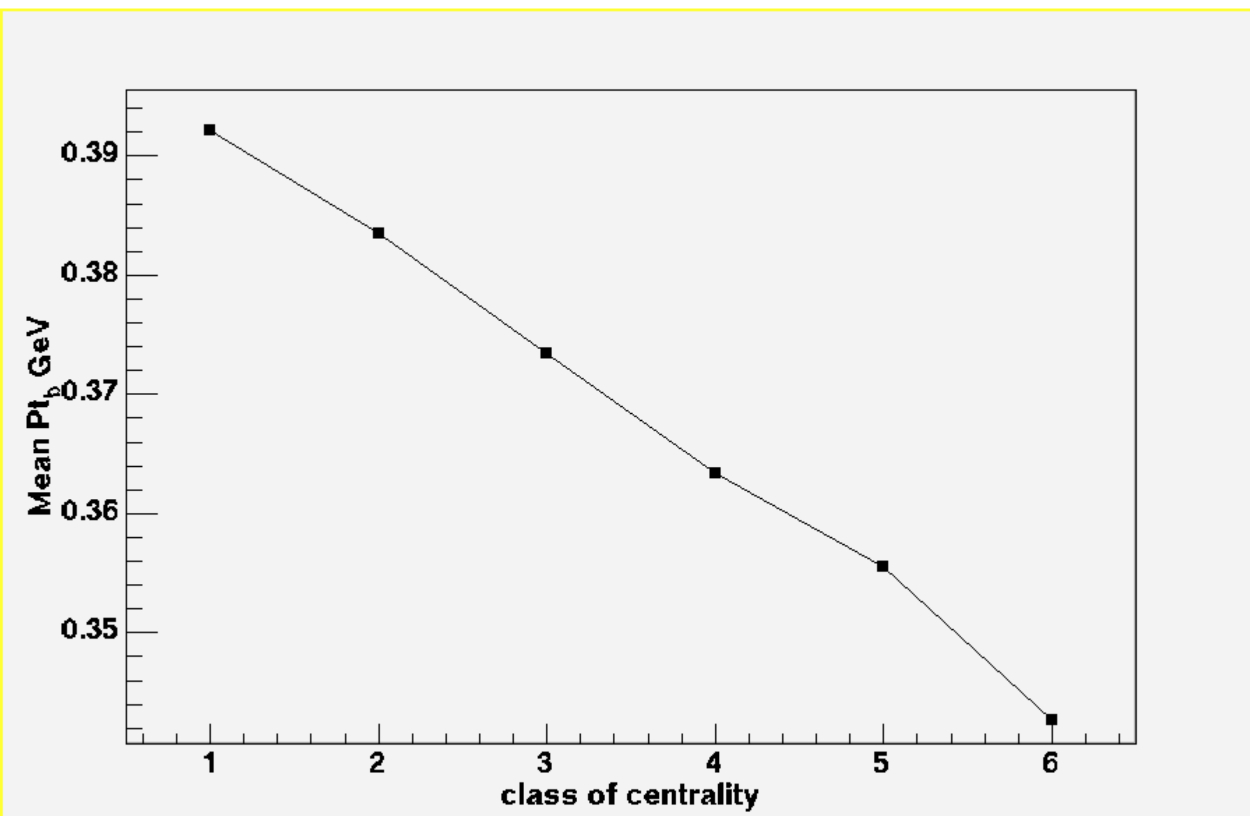
The following centrality classes were used:

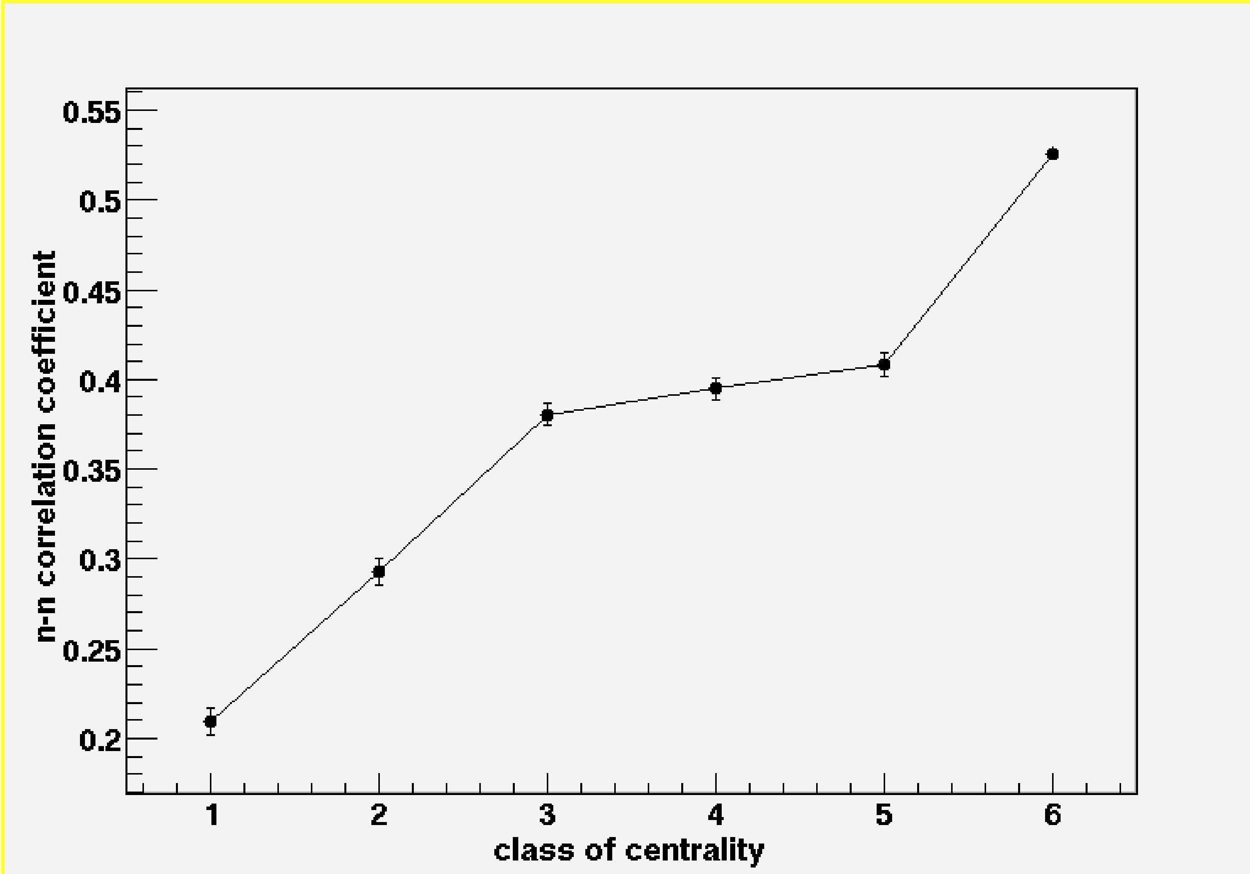
I. < 5%,
II. 5%-12.5%,
III. 12.5%-23.5%,
IV. 23.5%-33.5%,
V. 33.5%-43.5%,
VI. > 43.5%

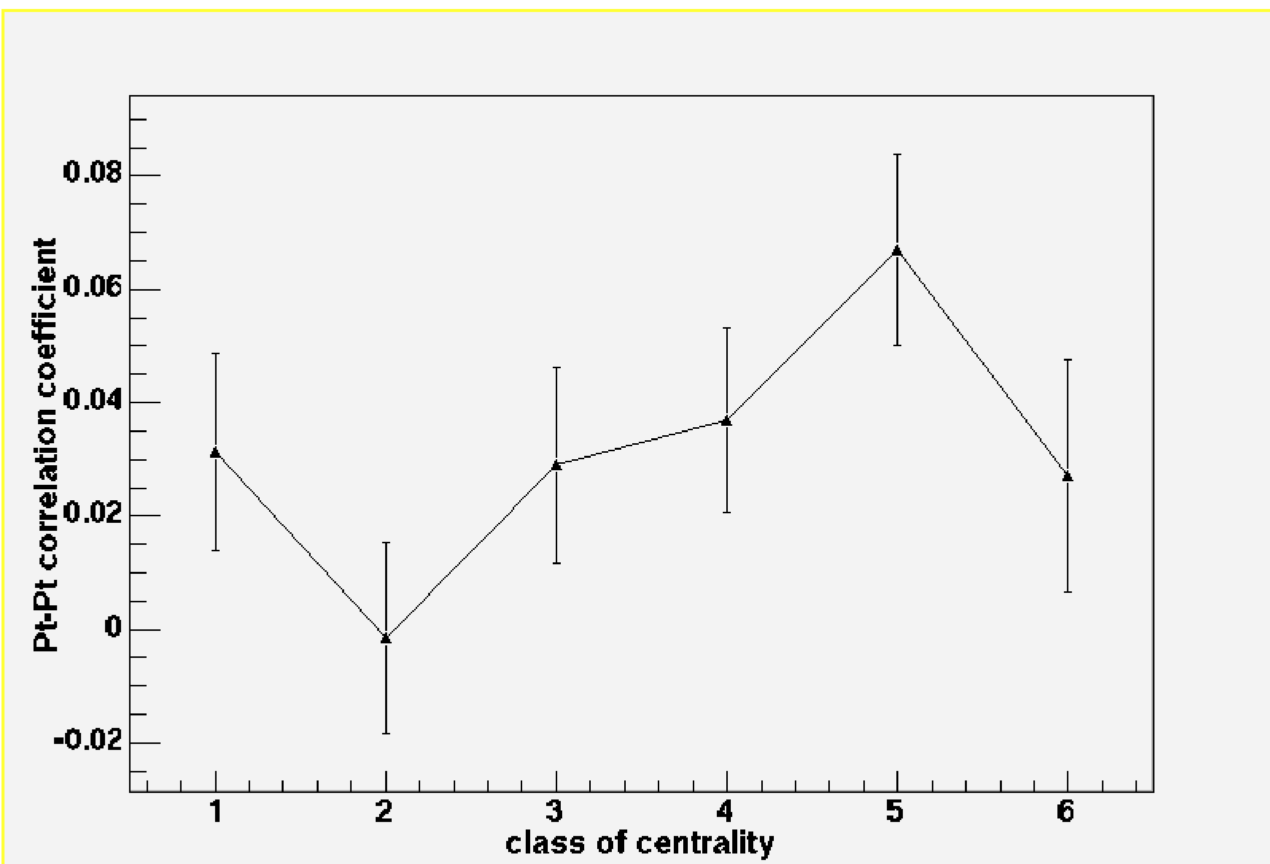
All plots here were obtained by the object-oriented data analysis framework ROOT. Both 2D histograms and profile histograms with default errors calculations were obtained for: <n>-n, <Pt>-Pt and <Pt>-n correlations. Correlation coefficients for each centrality class were obtained by fitting profile histograms using linear approximation. In a given examples only points with good statistics were taken into consideration when fitting a profile histogram, while the points of poor statistics were discarded. Polynomial coefficients with error bars were automatically calculated and represented in each profile histogram as p0 and p1.

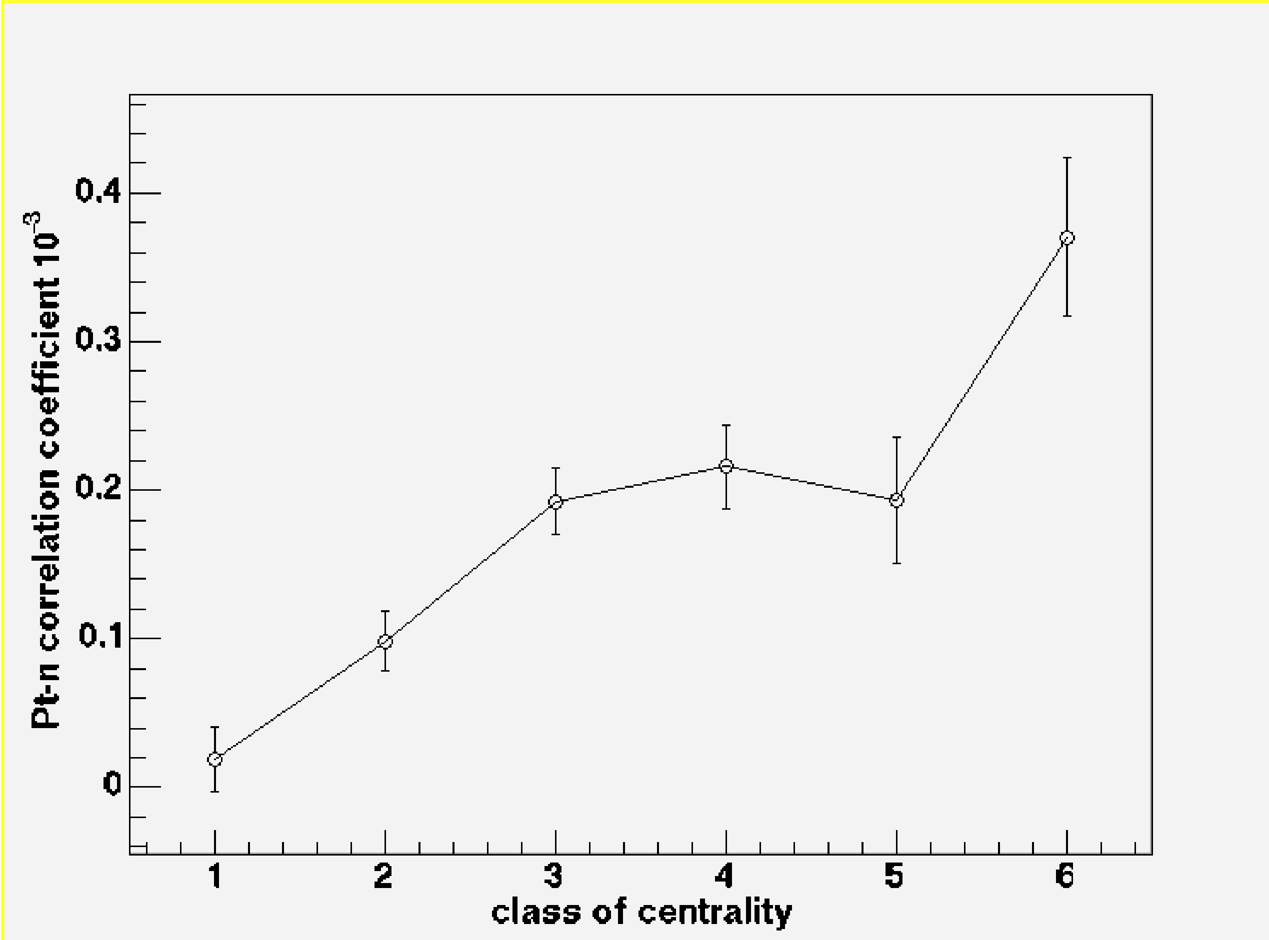
2. Results

1. Strong <n>-n long range correlations were obtained for all centrality classes as was expected. Monotonous increase of n correlation coefficient is observed towards the peripheral collisions (from 0.2 to about 0.5)
2. Mean Pt values obtained in the "backward" window vary with the increase of the impact parameter (going from 0.39 GeV/c in the central region(class I) down to 0.345 GeV/c in the peripheral region, class VI) . At the same time mean Pt values in the “forward” window vary slowly.
3. <Pt>-Pt correlations are small (as it was expected) for all centrality regions except the class V where some slight increase is visible.
4. <Pt>-n correlations show a noticeable rise in the peripheral region in qualitative agreement with our early predictions done for PbPb at LHC energies (Beta rises from 19 ± 21 (10^{-6}) in the central region to the value 370 ± 50 (10^{-6}) for the class VI). Beta here is defined in units of: *10^{-6}[GeV].




0.55
0.5
0.45
0.4
0.35
0.3
0.25
0.2
n-n correlation coefficient
1
2
3
4
5
6
class of centrality


0.08
0.06
0.04
0.02
0
-0.02
Pt-Pt correlation coefficient
1
2
3
4
5
6
class of centrality



COMMENT: Compare: Our estimate in PSM-1 of Beta**)** for <Pt>-n correlations in the peripheral region 10-15fm for PbPb at 6ATeV gives about 450 ± 50 (10^{-6}).

3. Conclusions

1. Three types of long range correlations were observed for NA49 data on PbPb collisions at 158 AGeV (Event-by-event analysis of: <n>-n, <Pt>-Pt and <Pt>-n correlations using data from different rapidity windows)
2. <Pt>-n correlations appear to be the most interesting for further studies as it was predicted previously. They exhibit a non-monotonous behavior of the correlation coefficient in the peripheral region in the case of PbPb collisions in agreement with our early predictions (done for LHC energies[1]).
3. The immediate plans for the future include:
    i. continuation of data analysis for lighter nuclei (SS collisions)
    ii. inclusion of fluctuations analysis (fluctuations of multiplicity and Pt) for the same data samples used in correlations study

iii. model simulations (Parton String Model, PSM-1 code[2]) for PbPb at the collision energy of 158 AGeV

References

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2. N.S. Amelin, N. Armesto, C. Pajares, D. Sousa Monte Carlo model for nuclear collisions from SPS to LHC energies Eur.J.Phys.,C22, (2001) 149;