Transverse momentum fluctuations –
 system size dependence
 (status of the draft)

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Plan of the draft

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1. Introduction

- The main goals of event-by-event physics
- Dynamical fluctuations
- The subject of this paper – system size dependence of transverse momentum fluctuations
2. Measures of fluctuations

- Distribution of mean (per event) transverse momenta $M(p_T)$ for data and mixed events
- $\phi_{p_T}$ correlation measure
- Two-particle correlation plots $(x_1, x_2)$
3. Experimental Set-up

- TPCs
- Different beam definitions (counters) and target arrangements (p+p, C+C, Si+Si and Pb+Pb)
- VCAL

Figure 1
4. Data selection and analysis

4.1 Data sets

<table>
<thead>
<tr>
<th>Collision Type</th>
<th>No. of events</th>
<th>$\sigma/\sigma_{tot}$</th>
<th>$\langle N_W \rangle$</th>
<th>$b$ range [fm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>p+p</td>
<td>570 000</td>
<td>0.9</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>C+C</td>
<td>33 000</td>
<td>0.153</td>
<td>13.9</td>
<td>0 - 2.0</td>
</tr>
<tr>
<td>Si+Si</td>
<td>63 000</td>
<td>0.122</td>
<td>37</td>
<td>0 - 2.6</td>
</tr>
<tr>
<td>Pb+Pb(6)</td>
<td>117 000</td>
<td>0.57</td>
<td>42</td>
<td>10.2 -</td>
</tr>
<tr>
<td>Pb+Pb(5)</td>
<td>59 000</td>
<td>0.10</td>
<td>88</td>
<td>9.1 - 10.2</td>
</tr>
<tr>
<td>Pb+Pb(4)</td>
<td>68 000</td>
<td>0.10</td>
<td>134</td>
<td>7.4 - 9.1</td>
</tr>
<tr>
<td>Pb+Pb(3)</td>
<td>68 000</td>
<td>0.11</td>
<td>204</td>
<td>5.4 - 7.4</td>
</tr>
<tr>
<td>Pb+Pb(2)</td>
<td>45 000</td>
<td>0.075</td>
<td>281</td>
<td>3.4 - 5.4</td>
</tr>
<tr>
<td>Pb+Pb(1)</td>
<td>180 000</td>
<td>0.05</td>
<td>352</td>
<td>0 - 3.4</td>
</tr>
</tbody>
</table>

Table 1: Data sets used in analysis. Listed for p+p, C+C, Si+Si and six centralities of Pb+Pb collisions at 158 AGeV are: number of events, $\sigma/\sigma_{tot}$ - the fraction of the total inelastic cross section, $\langle N_W \rangle$ - the mean number of wounded nucleons, $b$ - impact parameter.

<table>
<thead>
<tr>
<th>$v_*$</th>
<th>$A_{[GeV]}$</th>
<th>$B_{[GeV]}$</th>
<th>$C_{[deg \times GeV]}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.9 - 4.1</td>
<td>0</td>
<td>0.3</td>
<td>6500</td>
</tr>
</tbody>
</table>

Table 1
4.2 Event and particle selection

* vertex cuts
* track cuts (bx, by, nmp, np/nmp)
* \(4.0 < y_\pi < 5.5\)
* \(0.005 < p_T < 1.5 \text{ GeV/c}\)
* geometrical acceptance (\(p_T\) versus azimuthal angle)

Table 2

Figure 2
4.3 Corrections and systematic error estimates

* influence of non-target interactions
* influence of non-vertex tracks

Figure 3

Figure 4
4.3 Corrections and systematic error estimates
* losses of tracks due to reconstruction inefficiency and track selection cuts
* limited two track resolution effect

Figure 5

Figure 6
5. Results

![Graphs and data tables related to experimental results.]

Figure 7

Table 3: Measured inclusive and event-by-event parameters for accepted particles. \( \langle N \rangle \), \( \sigma(N) \), \( p_T \) and \( \sigma(p_T) \) values are not corrected for acceptance. \( \phi_{p_T} \) values are corrected for limited two track resolution. The systematic error of \( \phi_{p_T} \) is smaller than 1.6 MeV/c.
5. Results

Figure 8

Figure 9
6. Discussion

- HIJING model with NA49 acceptance and kinematical cuts
- No significant centrality dependence

Figure 10
6. Discussion

- Low $\Phi_{pT}$ values for $p+p$ (data and HIJING)

- Structure for two-particle correlation plot ($p+p$) -> what is the origin?

Figure 11
6. Discussion

- a) p+p data
- b) HIJING model
- c) random generator with $M(p_T)$ versus N dependence
- d) fluctuation of the inverse slope parameter (10.5%)
6. Discussion

- HIJING model for p+p and C+C interactions
- Dilution effect from the higher number of particle pairs
6. Discussion

- Model with inverse slope parameter fluctuations for central Pb+Pb
  - a) $\sigma(T)/T = 2.6\%$
  - b) $\sigma(T)/T = 5.3\%$
  - c) $\sigma(T)/T = 10.5\%$
  - d) Pb+Pb data

Figure 14
6. Discussion

- $\sigma(T)/T < 1\%$

**Figure 15**

- $\Phi_{p_{T}}$ [MeV/c]
- $\sigma(T)/T$ [%]
- $<T> = 190$ MeV

'temperature' fluctuations

**Pb+Pb (5%)**
6. Discussion

- **STAR**
  - Central Au+Au at $\sqrt{s} = 130$ GeV
  - $M(p_T)$ distribution 20% wider than corresponding Gamma distribution
  - Saddle shaped structure for two-particle correlation plot
  - $\phi_{p_T}$ about 25 MeV/c for midrapidity

- **PHENIX**
  - Central Au+Au at $\sqrt{s} = 130$ GeV
  - No effect for $M(p_T)$ and $\phi_{p_T}$
  - The reason: limited azimuthal angle, limited pseudorapidity, lower $p_T$ cut = 0.2 GeV/c
6. Discussion

- **NA22**
  - Elementary interactions at 250 AGeV
  - $\phi_{pT}$ dependence on the rapidity region
  - Confirmation of our low fluctuations for forward hemisphere
  - $\phi_{pT}$ for midrapidity above 25 MeV/c

- **CERES**
  - Pb+Au at 158 AGeV
  - $\phi_{pT}$ at midrapidity = 7.8 ± 0.9 MeV/c
7. Summary

- Event-by-event fluctuations for p+p, C+C, Si+Si and Pb+Pb at 158 AGeV
- FORWARD rapidity region only
- $M(p_T)$, $\phi_{pT}$ and two-particle correlation plots
- Dynamical fluctuations small, system size dependence
- Two-particle correlation plot for p+p data shows a structure connected with $M(p_T)$ versus N correlation
- A small effect of the Bose-Einstein correlations for central Pb+Pb collisions
- HIJING model reproduces two-particle correlation plots but no $\phi_{pT}$ versus centrality dependence