BALANCE FUNCTION - DRAFT 1

PROPOSED TITLE

“CENTRALITY DEPENDENCE OF THE BALANCE FUNCTION IN Pb + Pb COLLISIONS AT 158 AGeV AT THE CERN SPS (NA49)”

University of Athens group
OUTLINE

INTRODUCTION
  - Balance Function Method

EXPERIMENTAL SETUP

DATA ANALYSIS
  - Data Sets
  - Event And Track Selection
  - Systematic Errors

RESULTS

DISCUSSION

SUMMARY
INTRODUCTION

Introduction on the experimental signals of QGP.

The Balance Function method

Motivation
Definition - Formula - Explanation of terms
Properties of the width \( \rightarrow \) could signal delayed hadronization
Properties of the B.F.

Width independent on the multiplicity and net charge.
Width depends on the number of correlations.
EXPERIMENTAL SETUP

- Description of the setup (TPCs, TOFs, Calorimeters)
- Description of targets (Pb, p)
- BPDs and triggers
- Centrality selection → Veto calorimeter
## DATA SETS

- Description of data sets (number of events, polarity, reconstruction date)
- Description of the NA49 centrality classes (table with information about: Centrality Class - Number Of Events - E_o Range - N_w - b range)

<table>
<thead>
<tr>
<th>Interaction</th>
<th>Number of events</th>
<th>E_o range [GeV]</th>
<th>&lt;Nw&gt;</th>
<th>b range [fm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>p + p</td>
<td>1M</td>
<td></td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Pb + Pb (Veto 6)</td>
<td>300K</td>
<td>29340 - 40000</td>
<td>42</td>
<td>10.2 - ...</td>
</tr>
<tr>
<td>Pb + Pb (Veto 5)</td>
<td>110K</td>
<td>26080 - 29340</td>
<td>88</td>
<td>9.1 - 10.2</td>
</tr>
<tr>
<td>Pb + Pb (Veto 4)</td>
<td>88K</td>
<td>21190 - 26080</td>
<td>134</td>
<td>7.4 - 9.1</td>
</tr>
<tr>
<td>Pb + Pb (Veto 3)</td>
<td>75K</td>
<td>14670 - 21190</td>
<td>204</td>
<td>5.4 - 7.4</td>
</tr>
<tr>
<td>Pb + Pb (Veto 2)</td>
<td>100K</td>
<td>9250 - 14670</td>
<td>281</td>
<td>3.4 - 5.4</td>
</tr>
<tr>
<td>Pb + Pb (Veto 1)</td>
<td>100K</td>
<td>0 - 9250</td>
<td>352</td>
<td>0 - 3.4</td>
</tr>
</tbody>
</table>
EVENT AND TRACK SELECTION

- Description of cuts on event level ($V_x$, $V_y$, $V_z$).
- Description of cuts on track level ($b_x$, $b_y$, $N_{\text{points}}$, $N_{\text{points}}/N_{\text{max points}}$).
- Description of acceptance curves (reference to Jacek).
- Phase space analyzed.
**SYSTEMATIC ERRORS**

- Varying $\Delta z$.
- Varying $b_x$.
- Varying $b_y$.
- Different data sets.
RESULTS
### RESULTS (cont.)

<table>
<thead>
<tr>
<th>Interaction</th>
<th>W (Real data)</th>
<th>W (Shuffled data)</th>
</tr>
</thead>
<tbody>
<tr>
<td>p + p</td>
<td>0.772 ± 0.007</td>
<td>0.793 ± 0.002</td>
</tr>
<tr>
<td>Pb + Pb (6)</td>
<td>0.714 ± 0.020</td>
<td>0.812 ± 0.005</td>
</tr>
<tr>
<td>Pb + Pb (5)</td>
<td>0.704 ± 0.021</td>
<td>0.795 ± 0.005</td>
</tr>
<tr>
<td>Pb + Pb (4)</td>
<td>0.677 ± 0.019</td>
<td>0.806 ± 0.005</td>
</tr>
<tr>
<td>Pb + Pb (3)</td>
<td>0.653 ± 0.019</td>
<td>0.812 ± 0.005</td>
</tr>
<tr>
<td>Pb + Pb (2)</td>
<td>0.602 ± 0.012</td>
<td>0.803 ± 0.003</td>
</tr>
<tr>
<td>Pb + Pb (1)</td>
<td>0.595 ± 0.012</td>
<td>0.806 ± 0.004</td>
</tr>
</tbody>
</table>

#### Balance Function - pp@158 GeV

![Graph showing balance function for pp collisions at 158 GeV with data points for real and shuffled data.](image)
The results show that:

- The width of the B.F. takes its maximum value for p + p interactions.
- The width decreases with increasing centrality in Pb + Pb collisions.
- The B.F. for mixed events goes to zero for all the bins of $\Delta n$, due to the removal of global charge conservation.
- The B.F. for shuffled events is constantly broader than the one for real events.
### DISCUSSION

#### Interaction Table

<table>
<thead>
<tr>
<th>Interaction</th>
<th>W (Set 1)</th>
<th>W (Set 2)</th>
<th>W (Set 3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>p + p</td>
<td>-</td>
<td>-</td>
<td>0.772 ± 0.007</td>
</tr>
<tr>
<td>Pb + Pb (6)</td>
<td>0.714 ± 0.020</td>
<td>0.714 ± 0.019</td>
<td>0.723 ± 0.022</td>
</tr>
<tr>
<td>Pb + Pb (5)</td>
<td>0.704 ± 0.021</td>
<td>0.710 ± 0.015</td>
<td>0.692 ± 0.018</td>
</tr>
<tr>
<td>Pb + Pb (4)</td>
<td>0.677 ± 0.019</td>
<td>0.683 ± 0.019</td>
<td>0.672 ± 0.020</td>
</tr>
<tr>
<td>Pb + Pb (3)</td>
<td>0.653 ± 0.019</td>
<td>0.666 ± 0.019</td>
<td>0.660 ± 0.020</td>
</tr>
<tr>
<td>Pb + Pb (2)</td>
<td>0.602 ± 0.012</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Pb + Pb (1)</td>
<td>0.595 ± 0.012</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

#### Centrality Dependence

![Centrality Dependence Graph](image)

- PbPb@158 AGeV - 00N DST
- PbPb@158 AGeV - 00M DST
- PbPb@158 AGeV - 01J DST
- pp@158 GeV - 00R DST
- PbPb@158 AGeV - Shuffled data
- pp@158 GeV - Shuffled data
DISCUSSION (cont.)

NA49 data show a strong centrality dependence of the order of (17 ± 3)%.

STAR data show also a strong centrality dependence of the order of (14 ± 2)%. 

SUMMARY

- Analysis of centrality selected Pb + Pb @ 158 AGeV and p + p @ 158 GeV collisions using the Balance Function.

- B.F. could give us insight about the time of hadronization.

Results show that:
- The width of the B.F. takes its maximum value for p + p interactions.
- The width of the B.F. for shuffled events doesn't show any sign of centrality dependence.
- The width decreases with increasing centrality in Pb + Pb interactions.
- STAR experiment shows the same trend.
Hijing events + Acceptance filter - Centrality dependence study.

Will be ready soon.

This draft can be found in the directory:

/afs/cern.ch/user/p/pchrista/group/BalanceFunction/draft1.ps

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