Centrality, $N_{part}$ & $N_{collision}$ at BRAHMS

H. Ito
University of Kansas
For the BRAHMS Collaboration
Why do we want $N_{\text{part}}$?

- Comparison of P-P, P-A, and A-A?
- Comparison of Different Centrality?

What is the concern about using $N_{\text{part}}$?
- No Direct Measurement
- Is there any indirect measurement (ZDC, etc)?
- If not measured, are there any model dependencies?

Can we live without $N_{\text{part}}$?
- For comparison of P-P, P-A & A-A, we can compare the most central collisions.
What Is Measured?

We can measure charged particle multiplicities.

\[ N_{\text{charge}} \text{ in } -4.7 < \eta < 4.7 \]
What we have done with $N_{\text{part}}$ up to now?

Using experimental centrality and comparing with the model calculation, we got $N_{\text{part}}$ for our event selections.
How we calculated $N_{\text{part}}$.

- Measure charged particle multiplicities by **Silicon and Tile**

Assuming centrality and multiplicity have a linear correlation, select events by slicing the corrected multiplicity distribution vertically.

- Correct for missing fraction of the cross section and background events with small multiplicity by **Tile only**.
- Correct anomalous background events by **Silicon and Tile**.

By knowing the centrality, use Monte Carlo simulation to get corresponding $N_{\text{part}}$. 
Event Selection for Minimum Bias

- ZDC is very close to 100% efficient.
  - Not efficient at the most central events.
- Beam Beam (BB) is only about 75% efficient.
  - Not efficient at the peripheral events.

Although the correlated events by BB and ZDC can be used to select only real collision events, it is not used for minimum bias selection.
Multiplicity and Centrality Cut

Event selection is done by slicing multiplicity distribution vertically.
Efficiency for Minimum Bias Events

Efficiency of the Tile getting hit in minimum bias event is about 99% in the Monte Carlo simulation.
How to get the fraction of missing cross section?

Measured multiplicity distribution by Tile

Using Hijing with GEANT, estimate how many events we should have for very small multiplicity events.

\[
\frac{\sum \text{Event}_{M=0...4}}{\sum \text{Event}_{M=0...200}} \approx 0.1 \rightarrow 10\%
\]
Centrality Selection in Monte Carlo

Multiplicity measured by Silicon and Tile is used to select centrality.
Wounded Nucleon Calculation

\[ \sigma_{NN} = 40 \text{mb}, \ a = 0.54 \text{ fm} \]

<table>
<thead>
<tr>
<th>Centrality</th>
<th>( N_{\text{part}}(WN) )</th>
<th>( N_{\text{collision}}(WN) )</th>
<th>( N_{\text{part}}(\text{Hijing}) )</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-5</td>
<td>346</td>
<td>873</td>
<td>352</td>
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<tr>
<td>5-10</td>
<td>293</td>
<td>708</td>
<td>299</td>
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<td>10-20</td>
<td>228</td>
<td>516</td>
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<tr>
<td>20-30</td>
<td>164</td>
<td>333</td>
<td>165</td>
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<tr>
<td>30-40</td>
<td>114</td>
<td>206</td>
<td>114</td>
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<tr>
<td>40-50</td>
<td>76</td>
<td>118</td>
<td>75</td>
</tr>
</tbody>
</table>
Measured Neutron by ZDC

Very Few Neutrons ???

50 % Central
Correlation of Tile and Silicon multiplicity
Correlation of BB and Silicon-Tile multiplicity
$N_{\text{part}}, N_{\text{collision}}$ and Impact Parameter

$N_{\text{NN}} = 40\text{mb}, a = 0.54\ \text{fm}$