Experience from analyzing pp collisions in ALICE

Konstantin Mikhaylov

ITEP, Moscow
Simulations: software and input

- **Aliroot v4-14-Rev-01, AliFemto from svn/trunk**
- **PDC2007: PYTHIA pp 14 TeV**
  (the pp events simulated at the request of the V0 group with no ITS refit requirement: /alice/sim/PDC_07/LHC07f/1600*)

- **AliRoot local analysis** (~2*10^6 events)
  - 1D π^+π^+ correlations
  - 0.1 < P_T < 1.0 GeV/c
  - Standard cut on splitting-merging
  - Influence of Vz, Multiplicity, Particle collection on the correlation function

- **Pythia direct analysis** (read galice.root ~7*10^5 events)
  - 1D π^+π^+ correlations
  - 0.1 < P_T < 1.0 GeV/c, |η|<1
\( \pi \pi \ r_0 = 1 \text{fm Model (Blue), Experimental (red)} \)

### NumFakepippipqinvcf

- **Entries**: 2.742262e+07
- **Mean**: 0.2168
- **RMS**: 0.1456

### Numqinvcf

- **Entries**: 2766551
- **Mean**: 0.2452
- **RMS**: 0.1456
- **\( \chi^2 / \text{ndf} \)**: 46.32 / 46
- **\( r_1 \)**: 1.012 ± 0.088
- **\( \lambda_1 \)**: 0.05525 ± 0.00742
- **\( r_2 \)**: 5.64 ± 1.33
- **\( \lambda_2 \)**: 0.1404 ± 0.0646

![Graph showing \( Q_{\text{inv}} \) vs. \( \pi \pi \) data for model and experimental results.](image-url)
**PYTHIA direct events**

**π⁺π⁺ correlation function**

Cuts:
- \(0.1 < P_T < 1.0 \text{ GeV/c}\)
- \(-1. < \eta < +1.\)

**CF=Real/Mixed**

Energy and Momentum Conservation-Induced Correlations:
- Due to energy-momentum conservation probability of two particle emitted at same direction is smaller than in opposite direction

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No correlations at small Q

**K.Mikhaylov, ITEP**

AliFemto Meeting. 04-11-2008
We created correlations which did not exist in PYTHIA.
CF was fitted with superposition of two Gaussian.
Artificial CF with direct pions and pions from resonances?

Does it come from mixing procedure?
Vz: ALIFEMTO and PYTHIA

Vertex position in z

EvVertZcutPass

Entries 1821205
Mean -0.004667
RMS 5.235
$\chi^2 / \text{ndf}$ 2341 / 147
Constant 2.736e+04 ± 25
Mean -0.005834 ± 0.004036
Sigma 5.323 ± 0.003

Pythia: Z-vertex pi+

Entries 610115
Mean 0.02362
RMS 6.001
$\chi^2 / \text{ndf}$ 539.4 / 28
Constant 1.749e+04 ± 45
Mean 0.03213 ± 0.01178
Sigma 5.723 ± 0.010

Reconstruction?
Acceptance for mixed events

TPC size is equal 2.5m
Collision point distribution is Gaussian with sigma ~5.5cm
Does it important for correlation function (mixing)?

Blue is real pair with Z=0 (both particles are in acceptance).
Red is mixed pair with different Z! = 0 (one is in acceptance and other is out of acceptance due to inefficiency close to edge of TPC).
We create the correlation!

Solution: mix only events which have a very similar z-vertex position!
CFs for different Vz

We can calculate correlation functions for different Z-vertex regions:

- Divide Vz onto three regions with approximately same statistics
  - Vz < -2.5 cm
  - -2.5 < Vz < 2.5 cm
  - Vz > 2.5 cm

- Divide Vz by two regions around Vz=0
  - -5.0 < Vz < 0.0 cm
  - 0.0 < Vz < 5.0 cm

And add correlation functions from different regions according:

\[ CF_{TOTAL} = \sum_{bin} (CF_1 * w_1 + CF_2 * w_2 + CF_3 * w_3) / (w_1 + w_2 + w_3) \]  \hspace{1cm} (1),

where \( w = 1/N \)

\[ \Delta CF_{TOTAL} = 1/\sqrt{N_1 + N_2 + N_3} \]  \hspace{1cm} (2)
$V_z <- 2.5, |V_z| < 2.5, V_z > 2.5 \text{ cm}$

- $V_z < -2.5 \text{ cm}$
  - Entries: 711949
  - Mean: 0.2468
  - RMS: 0.1449

- $|V_z| < 2.5 \text{ cm}$
  - Entries: 711949
  - Mean: 0.2468
  - RMS: 0.1449

- $V_z > +2.5 \text{ cm}$
  - Entries: 715640
  - Mean: 0.2471
  - RMS: 0.145

- $\sum$ of 3 CFs
- Simple Analysis
-5 < Vz < 0 cm

0 < Vz < -5 cm

\[ -5 < Vz < 0 \text{ cm} \]

\[ 0 < Vz < -5 \text{ cm} \]

\[ \sum \text{ of 2 CFs} \]

\[ \text{Simple Analysis} \]

\[ \sum \text{ of 2 CFs} \]

\[ |Vz| < 2.5 \text{ cm} \]
//#### Old ####

//Simple Analysis:
AliFemtoSimpleAnalysis* an = new AliFemtoSimpleAnalysis();

//#### New: STAR Z-vertex and multiplicity mixing procedure####

//With z-vertex mixing:
AliFemtoVertexMultAnalysis *an =
    new AliFemtoVertexMultAnalysis(NbinsVz, -15.6, 15.6, NbinsMulti, 2, 100);
an->SetNumEventsToMix(10); //Number of events to mix
an->SetMinSizePartCollection(2); //Minimum number of particles in event after all cuts

//Test with different cut parameters

//#1 NbinsVz=20 ,NbinsMulti=1
//#2 NbinsVz=1, NbinsMulti=10
//#3 Combined : NbinsVz=20 and NbinsMulti=10
Vz and Multiplicity mixing

Vz-, Mult-mixing

- Simple Analysis
- NbinsVz=1, NbinsMulti=10
- NbinsVz=20, NbinsMulti=1
- NbinsVz=20, NbinsMulti=10

Q_{INV}, GeV/c
Vz, Multiplicity, and $|Vz|<2.5\text{cm}$

<table>
<thead>
<tr>
<th>z1m10</th>
<th>$\chi^2 / \text{ndf}$ 83.84 / 48</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$p0$ 1.044 ± 0.003</td>
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<tr>
<td></td>
<td>$p1$ -0.1077 ± 0.0098</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>z20m1</th>
<th>$\chi^2 / \text{ndf}$ 55.32 / 48</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$p0$ 1.023 ± 0.003</td>
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<tr>
<td></td>
<td>$p1$ -0.05344 ± 0.00974</td>
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<tr>
<th>z20m10</th>
<th>$\chi^2 / \text{ndf}$ 51.38 / 48</th>
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<tbody>
<tr>
<td></td>
<td>$p0$ 1.029 ± 0.003</td>
</tr>
<tr>
<td></td>
<td>$p1$ -0.06713 ± 0.00976</td>
</tr>
</tbody>
</table>

|z1m1 $|Vz|<2.5\text{cm}$| $\chi^2 / \text{ndf}$ 54.22 / 48 |
|--------|----------------------------------|
|        | $p0$ 1.024 ± 0.005 |
|        | $p1$ -0.06178 ± 0.01569 |

|NbinsVz=1, NbinsMulti=10| \(NbinsVz=20, NbinsMulti=1\) |

|NbinsVz=20, NbinsMulti=10| \(NbinsVz=1, NbinsMulti=10\), \(|Vz|<2.5\text{cm}\)|
Conclusion and To Do

• Only events with at least two particle (pions) should be taken into analysis
• $V_z$, multiplicity mixing procedure is very important
• $V_z$ mixing is most important in case of pp collision at 14TeV
• May be problem with Multiplicity mixing?

After a lot of studies we still have a slope in the CF ($CF \sim 1.02 - 0.05*Q$)

• To be studied multiplicity cut ($m > 3, m > 4, m > 5,...$)
• To be studied rapidity cut (-1 < $y$ < 0, 0 < $y$ < +1)
• We need additional monitors (histograms):
  • Multiplicity
  • TPC efficiency: 2D plot rapidity vs $V_z$