Feasibility Studies of Low-mass Mesons Identification for the CBM Project

Radoslaw Karabowicz
Hot Matter Physics Department, Institute of Physics, Jagiellonian University
Krakow’s group in the CBM collaboration:

entered the CBM project on Nov. 15, 2002 and consists of:
Jerzy Cibor, Zbigniew Majka, Pawel Staszel, Pawel Szostak, R. K.

Goals:
- Find expected working conditions of the silicon tracking detector (hit densities, radiation dose)
- Assess the possibility of detection of light vector mesons via $e^+e^-$ decay channel

Tools:
- **UrQMD** event generator (10$^4$ central Au+Au events @ 25 GeV/u)
- **Pluto** event generator (10$^6$ light vector mesons decays)
- **Geant4** transport code (simulation of the detector)
Compressed Baryonic Matter

CBM experiment and STS
Light vector mesons in central Au+Au collisions at 25 GeV/u

<table>
<thead>
<tr>
<th>PARTICLE</th>
<th>PARTICLES/EVENT</th>
<th>e+e- BR. RATIO</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\omega$</td>
<td>10</td>
<td>$7.15 \times 10^{-5}$</td>
</tr>
<tr>
<td>$\rho$</td>
<td>10</td>
<td>$4.48 \times 10^{-5}$</td>
</tr>
<tr>
<td>$\phi$</td>
<td>1</td>
<td>$3.00 \times 10^{-4}$</td>
</tr>
</tbody>
</table>

$\omega \rightarrow \pi^0 e^+ e^-$ Dalitz decay channel: $5.90 \times 10^{-4}$

Particle multiplicities:

$N_{\text{ALL}} = 1582$
$N_{\text{CH}} = 944$
Signal and background comparison
Signal and background comparison
Signal and Background Comparison
Hit densities

Station 1
hit density:
- total
- primaries
- electrons
- positrons

Station 7
hit density:
- total
- primaries
- electrons
- positrons

P-G meeting
Radoslaw Karabowicz
Warszawa, 24 XI 2003
Collision rate, 
radiation Vector 

DAMAGE

IN NUMBERS:

- about $10^7$ Au+Au collisions per second,
- multiplicity of charged particles will be about $10^3$ in central Au+Au collision (on average ~ 250),
- the inner parts of the first silicon tracking station will be exposed to about $10^7$ hits per mm$^2$ per second, that is $10^{12}$ hits/mm$^2$/week,
- radiation damages in the Si detector (displacement of atoms in the crystal lattice) was calculated – for inner parts of the first STS the displacement damage cross section $D$ exceeds 60 MeV·mb in one central event (per week $D \equiv 10^{13}$ MeV·mb)

{A. Vasilescu (INPE Bucharest) and G. Lindstroem (University of Hamburg), displacement damage in silicon, on-line compilation}.
Extraction of the $e^+e^-$ signal from light vector mesons decays

- Triggers

(selection of interesting events, i.e. Those with light vector mesons)

To select the events with mesons decays
Extraction of the e+e− signal from light vector mesons decays

- Triggers
  (selection of interesting events, i.e., those with light vector mesons)

- Cuts
  (rejection of e+e− from other processes)
  - Vertex cut
  - Opening angle cut
  - P_T cut

- All pairs coming from low-mass vector mesons originate in the collision vertex, thus all the particles that do not come from this point can be rejected

- Electron-positron pairs from ω Dalitz decay have relatively small opening angle, so pairs with small opening angle can be rejected

- Pairs from gamma conversion have small transversive momenta, so pairs with small transverse momenta can be rejected
Extraction of the $e^+e^-$ Signal from Light Vector Mesons Decays

10^6 events, trigger Efficiency = 100%, cuts applied

- Triggers
  (Selection of interesting events, i.e. Those with light vector mesons)

- Cuts
  (Rejection of $e^+e^-$ from other processes)
  - Vertex cut
  - Opening angle cut
  - $p_T$ cut

- Combinatorics
  (Extraction of the real signal)

P-G meeting  Radoslaw Karabowicz  Warszawa, 24 XI 2003
In progress

• Magnetic field + tracking

• Investigation and optimization of different cuts

• Realistic detector – efficiencies, misidentifications