Coulomb effects in relativistic heavy ion collisions from CBM experiment

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Introduction

The observed assimetry in the number of charged pions at AGS and SPS was interpreted as an effect of Coulomb interaction between the produced pions and the positive charge from reaction partners.

At lower energies, the nuclei are fully stopped and expands relatively slowly in all directions ➔ the total charge stays together sufficient time to significantly accelerate or decelerated the produced charged pions (interaction between charged pions and net charge of protons changes the transverse momentum of pions with the Coulomb "kick", pc).

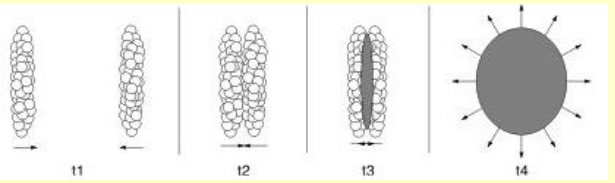
$$\frac{\pi^-}{\pi^+} = \left\langle \frac{\pi^-}{\pi^+} \right\rangle \frac{p_\perp + p_c}{p_\perp - p_c} \exp\left(\frac{m_\perp^- - m_\perp^+}{T}\right) \qquad m_\perp^\pm = \sqrt{m^2 + (p_\perp \pm p_c)^2}.$$

AGS data ➔Au+Au at 11.6 AGeV ➔pc ~ 20MeV [1]

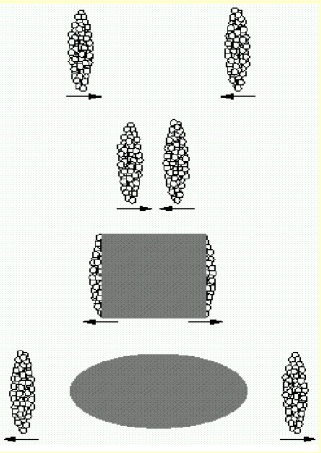
SPS data ➔Pb+Pb at 158AGeV ➔pc ~ 10 MeV [1]

At higher energies, the colliding nuclei are no longer stopped, the system expands faster in longitudinal direction (a higher degree of transparency) ➔ a smaller Coulomb effect.

Stopping

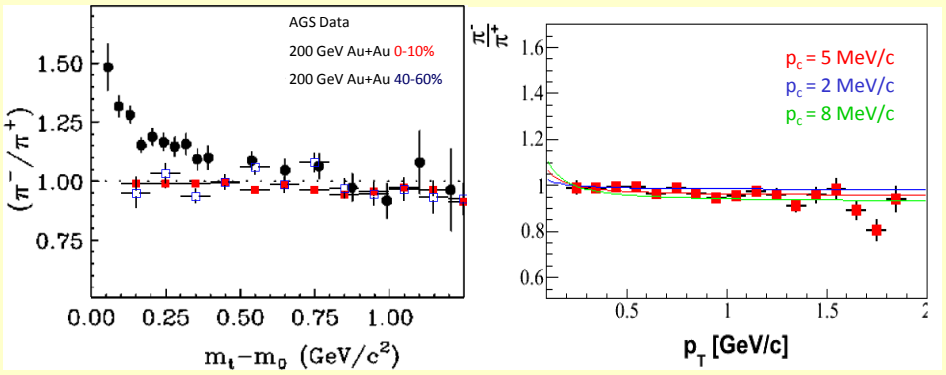


Transparency



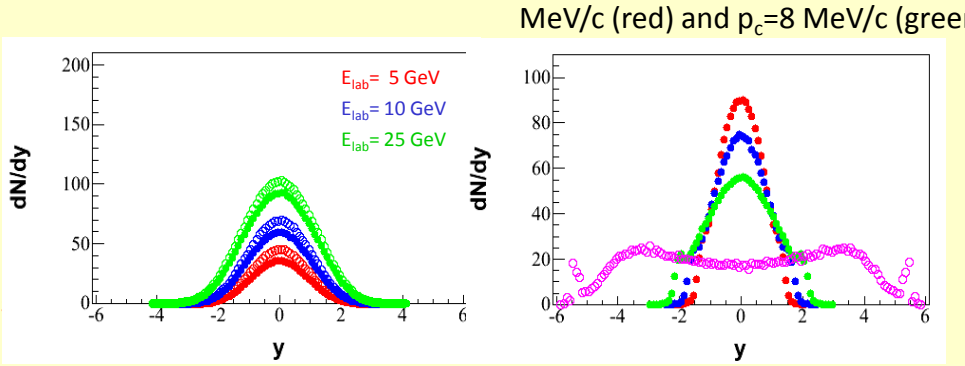
Experimental results vs. Code Simulations

Different behaviors for charged pion ratios at very low transverse momentum.



Left: AGS Au+Au at 11.6 AGeV/c (full symbols) [2] and BRAHMS Au+Au at 200 GeV [4] (red for 0-10% centrality, blue symbols for 40-60% centrality).

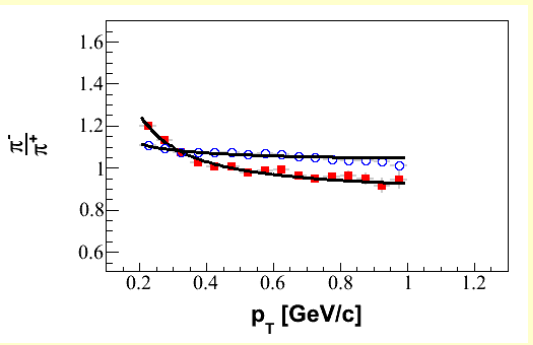
Right: Charged pion ratio produced in 0-10% Au+Au collisions at 200 GeV [4] as a function of transverse momentum. The lines are the calculations using the relation (1) for p_c=2 MeV/c (blue), p_c=5 MeV/c (red) and p_c=8 MeV/c (green).



Left: Rapidity distributions for positive pions (full symbols) and negative pions (open symbols) in Au+Au collisions at 5 GeV, 10 GeV and 25 GeV beam energies, simulated with UrQMD code [3].

Right: Rapidity distributions for protons obtained in Au+Au collisions at 5 GeV, 10 GeV, 25 GeV beam energies and sqrt(s_{NN})=200 GeV (magenta), simulated with UrQMD code.

Charged pion ratio produced in Au+Au collisions at 10 GeV (red points) and 25 GeV beam energy (blue points) , simulated with AMPT code [5] as a function of transverse momentum. The lines are the fits using the relation (1) ➔ pc ~ 25 MeV/c (Au+Au at 10GeV), pc~9 MeV/c (Au+Au at 25GeV).



Conclusions:

Negligible Coulomb effects in Au+Au collisions at RHIC energies. At CBM-FAIR energies, the Coulomb interaction has to be taken into account.

Bibliography:

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