Vol. 35 (2004) ACTA PHYSICA POLONICA B No 1

LEARNING FROM RHIC DATA WITH DPMJET-III*

F.W. Bopp, J. Ranft

Fachbereich Physik, Universität Siegen
D-57068 Siegen, Germany

R. Engel

Institut für Kernphysik, Forschungszentrum Karlsruhe,
Postfach 3640, D-76021 Karlsruhe, Germany

and S. Roesler

CERN, Geneva, Switzerland

(Received November 13, 2003)

The dual parton model event generator Dpmjet-III is compared to some selected data from the RHIC collider. The aim is to find out, which features of the two-component dual parton model have to be modified in such collisions.

PACS numbers: 12.38.Mh, 13.85.Hd, 13.85.Ni

The Dpmjet-III code system [1,2] is a MC event generator implementing Gribov–Glauber theory for collisions involving nuclei, for all elementary collisions it uses the DPM as implemented in Phojet [3,4]. Dpmjet-III is unique in its wide range of application simulating hadron-hadron, hadron–nucleus, nucleus–nucleus, photon–hadron, photon–photon and photon–nucleus interactions.

The groups at Lisboa [5] and Santiago de Compostela [6] were the first to point out, that the multiplicities measured at RHIC are significantly lower than predicted by conventional multi-string models. A new mechanism is needed to lower the multiplicity in situations with a very high density of produced hadrons like in central nucleus–nucleus collisions. The percolation

* Presented at the XXXIII International Symposium on Multiparticle Dynamics, Kraków, Poland, September 5–11, 2003.

and fusion of strings, the building blocks of the multi-string models is one such mechanism [7,8]. The result of chain percolation expressed in the most simple way is a decrease of the multiplicity and an increase of the average transverse momenta. Using the original DPMJET-III with needed baryon stopping we are able to confirm: there is indeed a new mechanism required to reduce N_{ch} and $dN_{\mathrm{ch}}/d\eta|_{\eta=0}$ in situations with a produced very dense hadronic system. Therefore, percolation and chain fusion is introduced into DPMJET-III.

We consider only the percolation and fusion of soft chains, these are chains where the transverse momenta of both chain ends is below a certain cut-off $p_{\perp}^{\mathrm{fusion}} = 2$ GeV/c. The condition of percolation is, that the chains L and K overlap in transverse space. We allow fusion of the chains for $R_{L-K} \leq R^{\mathrm{fusion}} = 0.75$ fm. The chains in DPMJET are fragmented using the Lund code JETSET as available inside the PYTHIA code [9]. Only the fragmentation of color triplet-antitriplet chains is available in JETSET, however fusing two arbitrary chains could result in chains with other colors. Therefore at the moment we select only chains for fusion, which again result in triplet-antitriplet chains. An example for the fusion of two chains is: *(i)* A q_1–$\bar{q}_2$ plus a q_3–$\bar{q}_4$ chain become a q_1q_3–$\bar{q}_2\bar{q}_4$ chain. An example for the fusion of three chain is: *(ii)* A q_3–q_1q_2 plus a q_4–$\bar{q}_1$ plus a $\bar{q}_3$–q_5 chain become a q_4–q_2q_5 chain. In reaction *(i)* we observe new diquark and anti-diquark chain ends. In the fragmentation of these chains we expect baryon-antibaryon production anywhere in the rapidity region of the collision. Therefore, *(i)* helps to shift the antibaryon to baryon ratio of the model into the direction as observed in the RHIC experiments.

In Fig. 1 we present the pseudorapidity distribution of charged particles in Au–Au collisions at 130 GeV as obtained from DPMJET-III with fusion. In the central region $\eta = 0.0$ we have data from three RHIC experiments. The data from PHENIX [11] are the highest and we have adjusted the amount of percolation in such a way, that we get agreement to the PHENIX [11] data. BRAHMS [10] gives more data points not only in the central region, these points and also the points from PHOBOS [12] are below the PHENIX [11] points and with this also below the points from the model.

In Fig. 2 we compare the π^0 transverse momentum distribution in p–p collisions at $\sqrt{s} = 200$ GeV from PHENIX [13] to PHOJET and find excellent agreement up to transverse momenta of about $p_{\perp} = 10$ GeV/c.

Several RHIC experiments (see for instance [14]) find in d-Au collisions at large $p_{\perp}$ a nearly perfect collision scaling for π^0 production. (Collision scaling means $R_{AA} \approx 1.0$.) The R_{AA} ratios are defined as follows:

$$R_{AA} = \frac{\frac{d^2N^{A-A}}{dp_{\perp}d\eta}}{N_{\mathrm{binary}}^{A-A}\frac{d^2N^{N-N}}{dp_{\perp}d\eta}}\,. \tag{1}$$

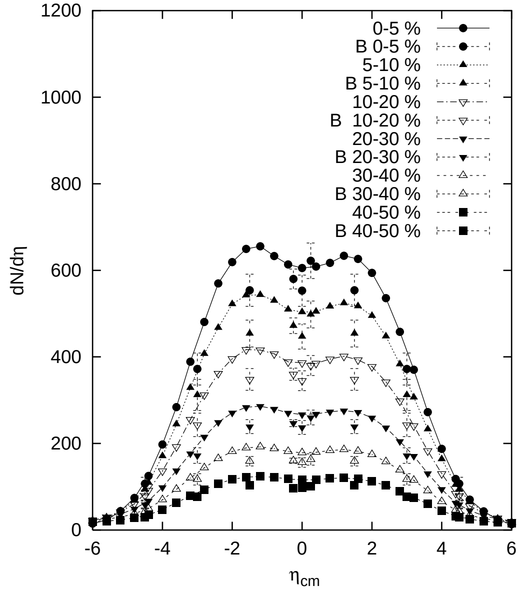

Fig. 1. Pseudorapidity distributions of charged hadrons in Au–Au collisions at $\sqrt{(s_{NN})} = 130$ GeV for centralities 0–5 % up to 40–50 %. The points with rather small error bars are from the DPMJET-III Monte Carlo with chain fusion as described in the text. The data points (with a B in the label) are from the BRAHMS Collaboration [10], except the points drawn at $\eta = 0.25$, which are from PHENIX for $\eta = 0.0$ [11], and the points drawn at $\eta = -0.25$, which are from PHOBOS for $\eta = 0.0$ [12].

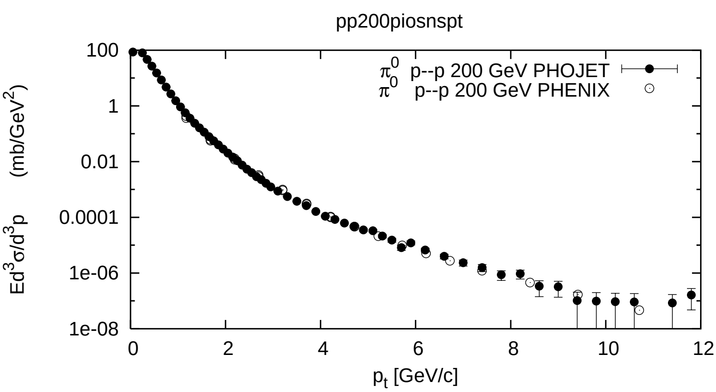

Fig. 2. Transverse momentum distributions of π^0-mesons produced in $\sqrt{(s)} = 200$ GeV p–p collisions. The results of PHOJET are compared to preliminary experimental data from the PHENIX Collaboration [13].

Here $N_{\rm binary}^{A-A}$ is the number of binary Glauber collisions in the nucleus–nucleus collision A–A. Dpmjet-III in its original form gave for π^0 production in d+Au collisions strong deviations from collision scaling ($R_{AA} \approx 0.5$ at large $p_\perp$). The reason for this was in the iteration procedure to implement the multiple collisions in Dpmjet, some soft and hard collisions were rejected by this iteration procedure. Using a changed iteration procedure it was possible to obtain a nearly perfect collision scaling, see Fig. 3.

The rate of new experimental results from RHIC is impressive. We will have to continue for quite some time in our program to learn from these data for Dpmjet. Further topics to be presented elsewhere which could not be covered within the space of this contribution include R_{AA} ratios in central Au–Au collisions and elliptic flow in Dpmjet.

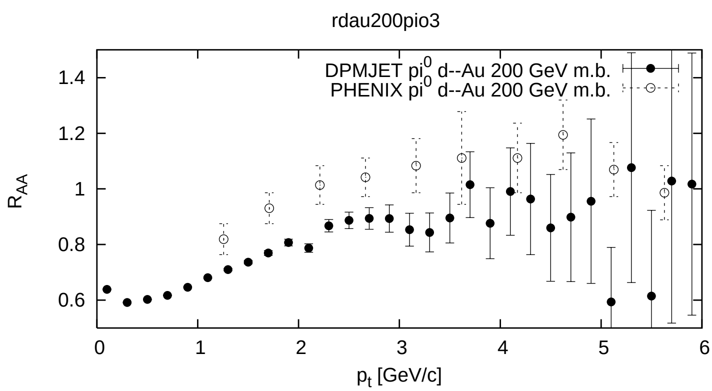

Fig. 3. R_{AA} ratio of π^0-mesons produced in $\sqrt(s) = 200$ GeV d–Au collisions. The results of the modified Dpmjet are compared to experimental data from the PHENIX Collaboration [14].

REFERENCES

[1] S. Roesler, R. Engel, J. Ranft, Proceedings of ICRC 2001, Copernicus Ges., (2001).

[2] S. Roesler, R. Engel, J. Ranft, `hep-ph/0012252`.

[3] R. Engel, *Z. Phys.* **C66**, 203 (1995).

[4] R. Engel, J. Ranft, *Phys. Rev.* **D54**, 4244 (1996).

[5] J. Dias de Deus, R. Ugoccioni, *Phys. Lett.* **B491**, 253 (2000).

[6] M. Braun, F. del Moral, C. Pajares, *Phys. Rev.* **C65**, 024907 (2002).

[7] M.A. Braun, C. Pajares, J. Ranft, *Int. J. Mod. Phys.* **A14**, 2689 (1999).

[8] M. Braun, C. Pajares, *Eur. Phys. J.* **C16**, 359 (2000).

[9] T. Sjöstrand, CERN Report CERN-TH.7112/93.

[10] I.G. Bearden *et al.*, BRAHMS Collaboration, *Phys. Lett.* **B523**, 227 (2001).

[11] K. Adcox *et al.*, PHENIX Collaboration, *Phys. Rev. Lett.* **86**, 3500 (2001).

[12] B.B. Back *et al.*, PHOBOS Collaboration, *Phys. Rev.* **C65**, 061901 (2002).

[13] S.S. Adler *et al.*, PHENIX Collaboration, `hep-ex/0304038`.

[14] A.A. Adler *et al.*, PHENIX Collaboration, *Phys. Rev. Lett.* **91**, 072303 (2003).