RIKEN Accel. Prog. Rep. **35** (2002)

Measurement of π^0 Production in p+p and Au+Au Collisions at $\sqrt{s_{NN}} = 200GeV$

H. Torii, A. Bazilevsky, B. Fox, Y. Goto, and K. Okada for the PHENIX Collaboration

In this paper, two independent but strongly related topics are discussed. One is about a testing ground of the perturbative quantum chromodynamics (pQCD) theory and the other is the medium effect in heavy ion collisions, the suppression of particle production at high p_T which is predicted as a Quark Gluon Plasma (QGP) signature[1)]. In the first part, we will prove that our measurements in p+p collisions can be described by the pQCD theory. Next, we will compare the measured medium effect in Au+Au collisions with the p+p data. This study used PHENIX electromagnetic calorimeters, which have an azimuthal coverage of $90° + 90°$ and a pseudorapidity coverage of ± 0.35. The data were collected during the p+p and Au+Au runs in 2001–2002 at RHIC.

In Fig. 1, our results of π^0 production in the p+p data are compared with next-to-leading order (NLO) pQCD calculations[2)]. The calculations have been performed with the same renormalization and factorization scales of p_T by using the CTEQ6M[3)] set of parton distribution functions and two sets of fragmentation functions: "Kniehl-Kramer-Pötter" (KKP)[4)] and "Kretzer"[5)]. The calculation with the former agrees with our data better than that with the latter. These two sets differ mainly in that the gluon-to-pion fragmentation function, D_g^π, is greater in the KKP set. This difference is exhibited primarily at low p_T because of the dominance of gluon-gluon interactions. We conclude that the π^0 production in p+p collisions in this energy region are described well by the pQCD calculation.

In Au+Au collisions, we quantify the medium effects with the nuclear modification factor given by the ratio of the measured Au+Au invariant yields to the NN-collision-scaled p+p invariant yields: $R_{AA} = \frac{d^2 N^{\pi^0}_{AuAu}}{N^{evt}_{AuAu} dp_T dy} / (\langle N_{coll} \rangle \times \frac{d^2 \sigma^{\pi^0}_{pp}}{\sigma^{inel}_{pp} dp_T dy})$, where $\langle N_{coll} \rangle$ is the average nucleon-nucleon collision estimated by the Glauber model. $R_{AA}(p_T)$ measures the deviation of AA data from an incoherent superposition of NN collisions. Fig. 2 shows R_{AA} as a function of p_T measured in the 0-10% central and 80-92% peripheral Au+Au collisions. Within errors, the peripheral collisions behave similarly to a superposition of NN collisions. The R_{AA} values for the central collisions, however, are notably below unity, as observed at 130 GeV[6)], and in contrast to the enhanced high p_T π^0 production ($R_{AA} > 1$) observed at CERN-SPS energies[7)].

In summary, we have discovered significant suppression of the π^0 production in the central Au+Au collisions compared to an incoherent superposition of NN collisions. This observation is consistent with the theoretical model, jet quenching, predicted as a QGP signature[1)].

† Condensed from Phys. Rev. Lett. 91, (2003) 072301 and from Phys. Rev. Lett. 91, (2003) 241803

References

1) X. N. Wang et al.: Phys. Rev. **D44**, 3501 (1991).
2) F. Aversa et al.: Nucl. Phys. **B327**, 105 (1989), private communication with W. Vogelsang.
3) J. Pumplin et al. [CTEQ Collaboration]: J. High Energy Phys. **0207**, 012 (2002).
4) B.A. Kniehl et al.: Nucl. Phys. **B597**, 337 (2001).
5) S. Kretzer: Phys. Rev. **D62**, 054001 (2000).
6) K. Adcox et al.[PHENIX Collaboration]: Phys. Rev. Lett. **88**, 022301 (2002).
7) M.M. Aggarwal et al.[WA98 Collaboration]: Eur. Phys. J. **C23**, 225 (2002).

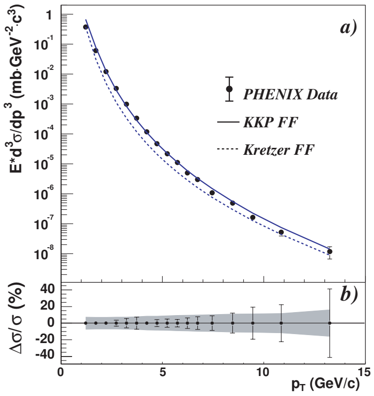

Fig. 1. a) Invariant differential cross section for inclusive π° production in p+p collisions and the results of NLO pQCD calculations[2–5)]. See the text for details. b) The relative statistical (point) and point-to-point systematic (band) errors.

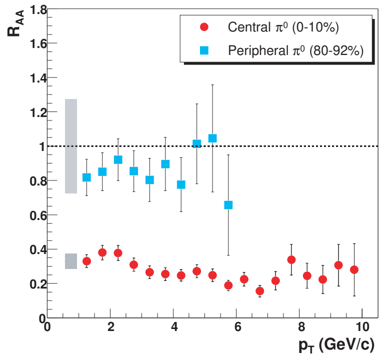

Fig. 2. Nuclear modification factor $R_{AA}(p_T)$ in central and peripheral Au+Au collisions. Error bars include statistic and systematic errors. Shaded bands represent the quadratic sum of fractional uncertainties in Glauber calculation and π^0 yield normalization.