

BNL-65375

CONF-971231-- RECEIVED

MAY 11 1993

Centrality and Collision System Dependence of Antiproton Production
from p+A to Au+Au Collisions at AGS Energies

OSTI

H. Sako, for the E802 Collaboration

BNL-UCBerkeley-UCRiverside-Columbia-INS(Tokyo)-Kyoto-LLNL-Maryland-MIT-
Tokyo-Tsukuba-Yonsei

L. Ahle⁷, Y. Akiba⁵, K. Ashktorab¹, M. D. Baker⁷, D. Beavis¹, H. C. Britt⁶, J. Chang³,
C. Chasman¹, Z. Chen¹, Y. Y. Chu¹, V. Cianciolo¹³, B. A. Cole¹⁴, H. J. Crawford²,
J. B. Cumming¹, R. Debbe¹, J. C. Dunlop⁷, W. Eldredge³, J. Engelage², S. -Y. Fung³,
E. Garcia¹¹, S. Gushue¹, H. Hamagaki¹², L. Hansen⁶, R. S. Hayano¹⁵, G. Heintzelman⁷,
E. Judd², J. Kang¹⁰, E. -J. Kim¹⁰, A. Kumagai⁹, K. Kurita⁹, J. -H. Lee¹, J. Luke⁶,
Y. Miake⁹, A. Mignerey¹¹, B. Moskowit¹, M. Moulson¹⁴, C. Muentz¹, S. Nagamiya⁴,
M. N. Namboodiri⁶, C. A. Ogilvie⁷, J. Olness¹, L. P. Remsberg¹, H. Sako⁹,
T. C. Sangster⁶, R. Seto³, J. Shea¹¹, K. Shigaki¹, R. Soltz⁶, S. G. Steadman⁷,
G. S. F. Stephans⁷, M. J. Tannenbaum¹, J. H. Thomas¹, S. Ueno-Hayashi⁹, F. Videbæk¹,
F. Wang¹⁴, Y. Wu¹⁴, H. Xiang³, G. H. Xu³, K. Yagi⁹, H. Yao⁷, W. A. Zajc¹⁴, F. Zhu¹

¹ Brookhaven National Laboratory, Upton, NY 11973² University of California, Space Sciences Laboratory, Berkeley, CA 94720³ University of California, Riverside, CA 92507⁴ High Energy Accel. Res. Organization (KEK), Oho, Tsukuba, Ibaraki 305, Japan⁵ High Energy Accel. Res. Organization (KEK), Tanashi-branch, Midoricho, Tanashi,
Tokyo 188, Japan⁶ Lawrence Livermore National Laboratory, Livermore, CA 94550⁷ Massachusetts Institute of Technology, Cambridge, MA 02139⁸ Department of Physics, University of Tokyo, Tokyo 113, Japan⁹ University of Tsukuba, Tsukuba, Ibaraki 305, Japan¹⁰ Yonsei University, Seoul 120-749, Korea¹¹ University of Maryland, College Park, MD 20742¹² Center for Nuclear Study, School of Science, University of Tokyo, Midoricho, Tanashi,
Tokyo 188, Japan¹³ Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831¹⁴ Columbia University, New York 10027 and Nevis Laboratories, Irvington, New York
10533¹⁵ University of Tokyo, Tokyo 113, Japan

Antiproton production in 11.7 A-GeV/c Au+Au collisions over a wide transverse-mass coverage was studied in the AGS-E866. The inverse slope parameter increases rapidly as a function of centrality. Antiproton yields in Si+A and Au+Au collisions are consistent with

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

MASTER
DTIC QUALITY INSPECTED 1

19980529 052

the scaling with the $2/3$ power of the number of participant nucleons. Transverse-mass spectra are similar to those of protons from peripheral to central Au+Au collisions.

1. Introduction

Antiproton (\bar{p}) production in heavy ion collisions reflects subtle interplay between initial production and absorption by nucleons. Because the AGS energies ($10 - 20$ A · GeV/c) are close to the \bar{p} production threshold, \bar{p} may be sensitive to cooperative processes such as QGP [1] and hadronic multi-step processes [2]. On the other hand, \bar{p} has been proposed as a probe of baryon density due to large $N\bar{N}$ annihilation cross sections [3]. Cascade models [4–6] predict the maximum baryon density reaches about 10 times the normal nucleus density in central Au+Au collisions, where the strong \bar{p} absorption is expected. In this paper, we show systematic studies of \bar{p} production from p+A to Au+Au collisions.

2. Analysis in AGS-E866 Experiment

The AGS-E866 experiment is aimed at studies of particle production in $10 - 12$ A · GeV/c Au+Au collisions as a function of centrality. The experimental setup is described elsewhere [7,8]. In this analysis, data taken in 1994 in the Forward Spectrometer are used. Centrality is defined with the zero-degree calorimeter (ZCAL). The kinematic coverage for \bar{p} is $1.0 < y < 2.2$ and $0 < m_t - m_p < 1.2$ [GeV/c²], where y , m_t , and m_p denote rapidity, transverse mass, and \bar{p} mass, respectively. About 800 \bar{p} candidates were extracted out of about 15 million minimum-bias collisions.

3. Results

Fig. 1 shows m_t spectra in minimum-bias events. Kinematic reflections of the spectra in each rapidity are consistent within statistical uncertainties. E886 [9] and E878 [10] results at $p_t \simeq 0$ agree with our data. Fig. 2 shows m_t spectra in $1.0 < y < 2.2$ in centrality windows of 0 – 8 %, 8 – 23 %, 23 – 38 %, and 38 – 77 % (zero corresponds to most central). Inverse slope parameters increase rapidly as a function of centrality from 0.18 to 0.28 GeV/c². E864 [11] and E878 [10] data at $p_t \simeq 0$ agree with our data except for in the most centrality window, where the E864 point is 4 times larger than the E878 point, and the exponential extrapolation of our data comes between them. It is an open question whether this is due to acceptance difference of the \bar{p} decaying from $\bar{\Lambda}$. The acceptance in our spectrometer is estimated to be 42 % including the branching ratio of 64 %.

Fig. 3 shows comparison of dN/dy among p+A [12], Si+Al and Si+Au data [13] at 14.6 A · GeV/c in $y_{NN} - 0.6 < y < y_{NN}$ and Au+Au data at 11.7 A · GeV/c in $|y - y_{NN}| < 0.6$ as a function of the number of participants (N_{part}). The N_{part} was calculated with FRITIOF 1.7 [14]. A beam energy correction factor of 0.47 is applied to p+A and Si+A data. Si+A and Au+Au data are consistent with the $N_{part}^{2/3}$ scaling.

These data are compared with RQMD (solid line) and the first collision model (dashed line). RQMD calculations are from Ref. [15] for p+A and were done with version 2.3 for Si+A and 2.1 for Au+Au. In RQMD, initial \bar{p} production is enhanced by multi-step processes and free $N\bar{N}$ annihilation cross sections are used. The first collision model gives \bar{p} yields as $dN/dy = dN/dy_{p+p} \cdot N_f$, where dN/dy_{p+p} is dN/dy in p+p collisions, and N_f

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

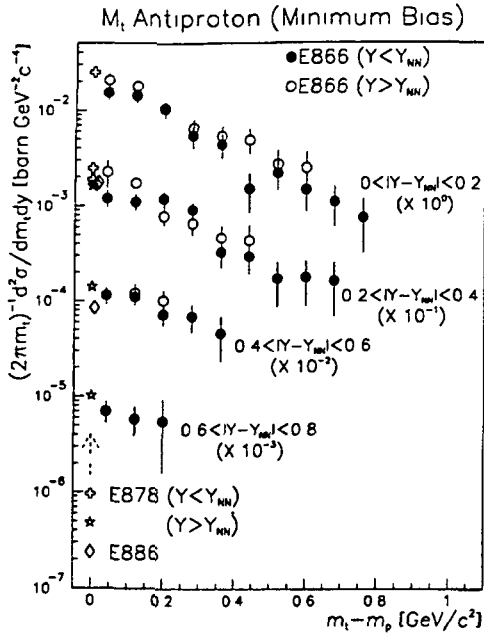


Figure 1. Transverse-mass spectra in minimum bias events. See text for details.

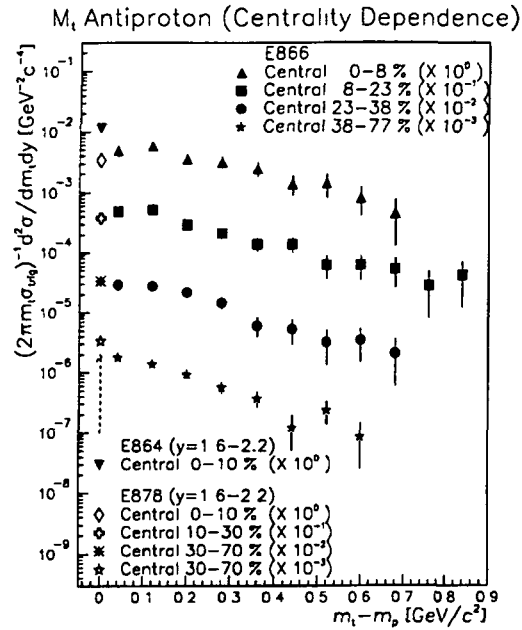


Figure 2. Transverse-mass spectra in centrality dependence. See text for details.

is the number of binary collisions between unstruck nucleons. No absorption is assumed. Both models reproduce p+A data, and the scaling of $N_{part}^{2/3}$ from Si+A to Au+Au data.

In Fig. 4, m_t spectra are compared with those of protons. For all centrality windows, their shapes appear similar, but more data are needed for a quantitative evaluation.

4. Conclusions and Outlook

E866 measured \bar{p} production in Au+Au collisions at 11.7 A·GeV/c in wide transverse mass coverage. The dN/dy from Si+A to Au+Au collisions scales with $N_{part}^{2/3}$. Both RQMD and the first collision model reproduce the global system dependence of \bar{p} yields. However, by construction, the latter cannot reproduce the rapid development of the inverse slope parameter with centrality in Au+Au collisions. This observation implies that it is important to investigate m_t spectra to explore \bar{p} production mechanisms. The m_t spectra of \bar{p} are similar to those of the proton from peripheral to central Au+Au events, and this will be investigated in more detail with a larger data sample in 1995, as well as the data in E866's large angle spectrometer, Henry Higgins.

This work is supported by the U.S. Department of Energy under contracts with BNL (DE-AC02-98CH10836), Columbia University (DE-FG02-86-ER40281), LLNL (W-7045-ENG-48), MIT (DE-AC02-76ER03069), UC Riverside (DE-FG03-86ER40271), by NASA (NGR-05-003-513), under contract with University of California, by Ministry of Education and KOSEF (951-0202-032-2) in Korea, and by the Ministry of Education, Science, Sports, and Culture of Japan.

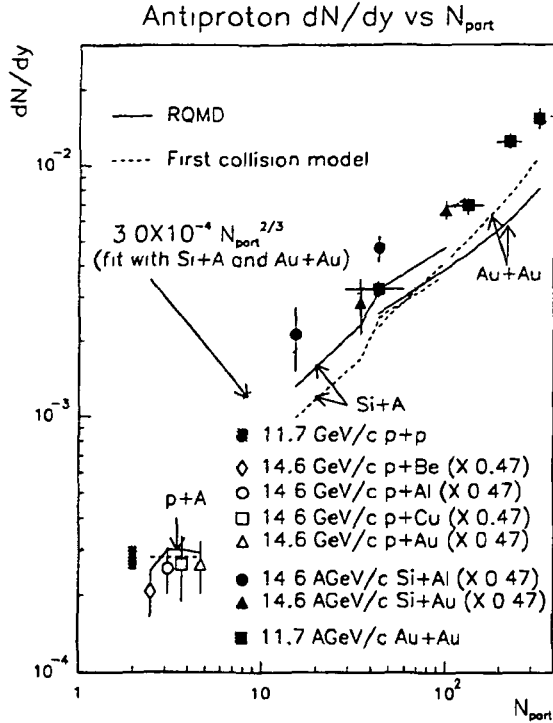


Figure 3. The dN/dy in p+A, Si+A and Au+Au collisions as a function of N_{part} . See text for details.

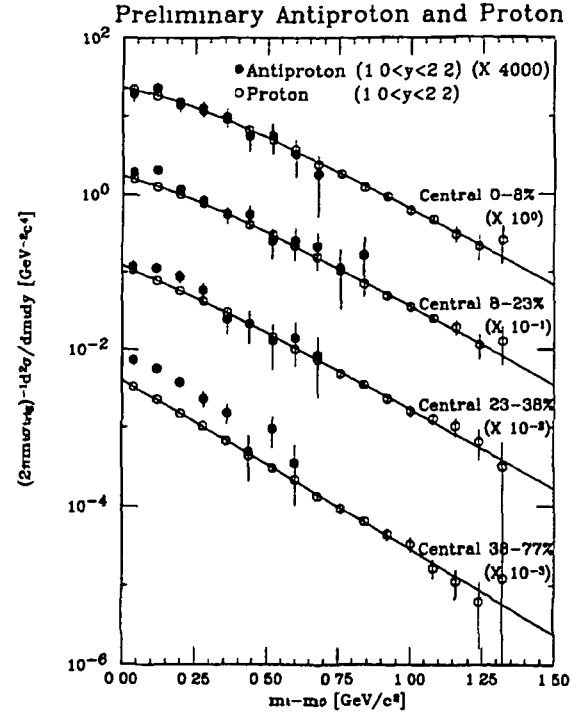


Figure 4. Comparison of m_t spectra between \bar{p} (scaled by 4000) and the proton in Au+Au collisions. See text for details.

REFERENCES

1. K. S. Lee *et al.*, Phys. Rev. **C37** (1988) 1452; D. H. Rischke *et al.*, Phys. Rev. **D41** (1990) 111; T. DeGrand, Phys. Rev. **D30** (1984) 2001.
2. A. Jahns *et al.*, Z. Phys. **A341** (1992) 243; A. Jahns *et al.*, Phys. Rev. Lett. **68** (1992) 2895.
3. S. Gavin *et al.*, Phys. Lett. **B234** (1990) 175.
4. H. Sorge *et al.*, Phys. Lett. **B243** (1990) 7.
5. Y. Pang *et al.*, Phys. Rev. Lett. **68** (1992) 2743.
6. B. A. Li and C. M. Ko, Phys. Rev. **C52** (1993) 2037.
7. L. Ahle *et al.*, Nucl. Phys. **A610** (1996) 139c.
8. L. Ahle *et al.*, To be published in Phys. Rev. C: Rapid Communications (1998).
9. G. E. Diebold *et al.*, Phys. Rev. **C48** (1993) 2984.
10. D. Beavis *et al.*, Phys. Rev. Lett. **75** (1995) 3633; D. Beavis *et al.*, Phys. Rev. **C56** (1997) 1521.
11. T. A. Armstrong *et al.*, Phys. Rev. Lett. **79** (1997) 3351.
12. T. Abbott *et al.*, Phys. Rev. **C47** (1993) R1351.
13. T. Abbott *et al.*, Phys. Lett. **B271** (1991) 447.
14. B. Nilsson-Almqvist *et al.*, Com. Phys. Comm. **43** (1987) 387.
15. A. Jahns *et al.*, Phys. Lett. **B308** (1993) 11.

M98004992



Report Number (14) BNL--65375
CONF-971231--

Publ. Date (11) 199712

Sponsor Code (18) DOE/ER; NASA; KOME; KOS EF; JAMESC, XF

UC Category (19) UC-414; UC-006; UC-000; UC-000; UC-000; DOE/ER

DOE