Quark Matter
Torino, Italy
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Antideuteron Yield and Coalescence Implications at the AGS

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for the E864 Collaboration

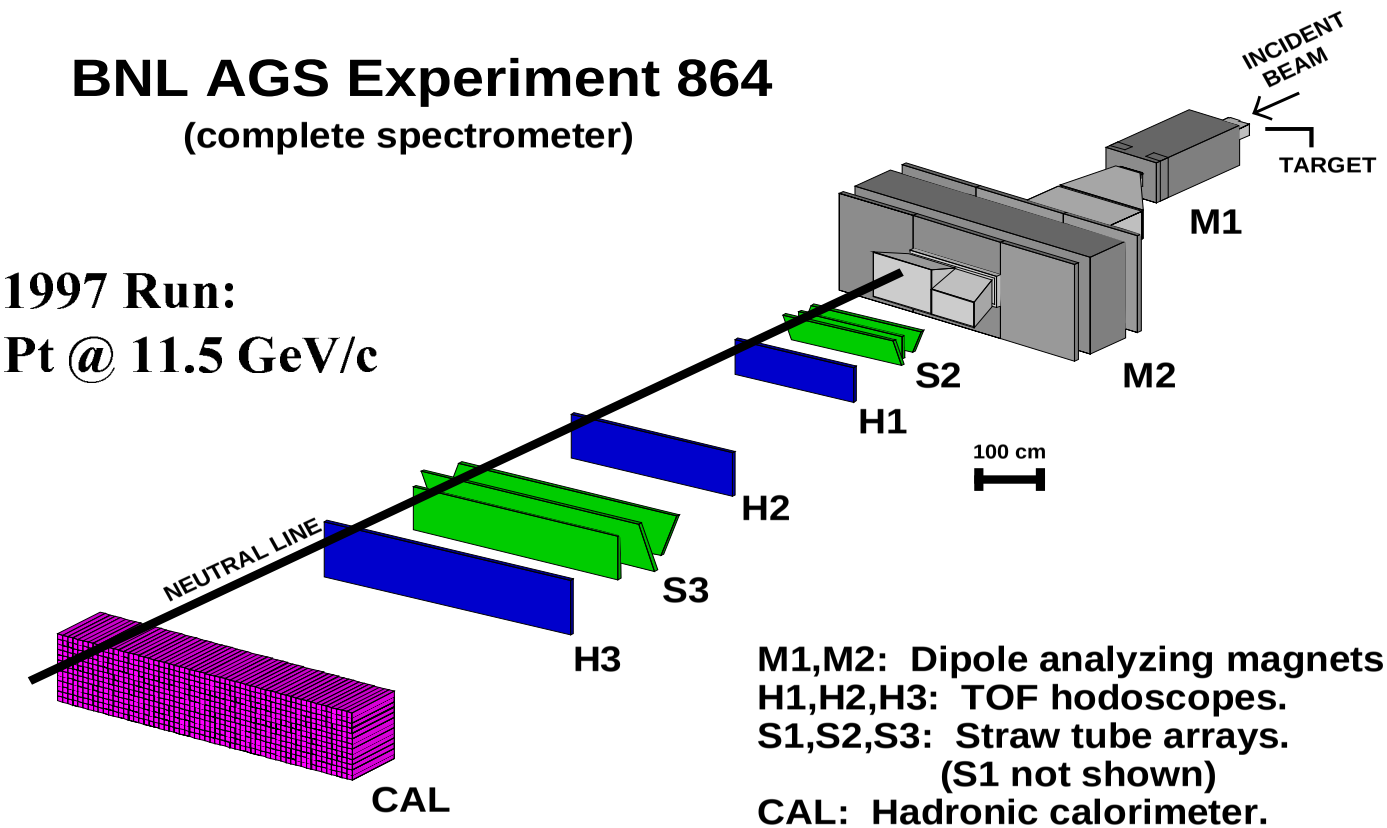
E864 Experiment at the AGS *(A3 line)*

BNL AGS Experiment 864

(complete spectrometer)

1996-1997 Run:

Au + Pt @ 11.5 GeV/c

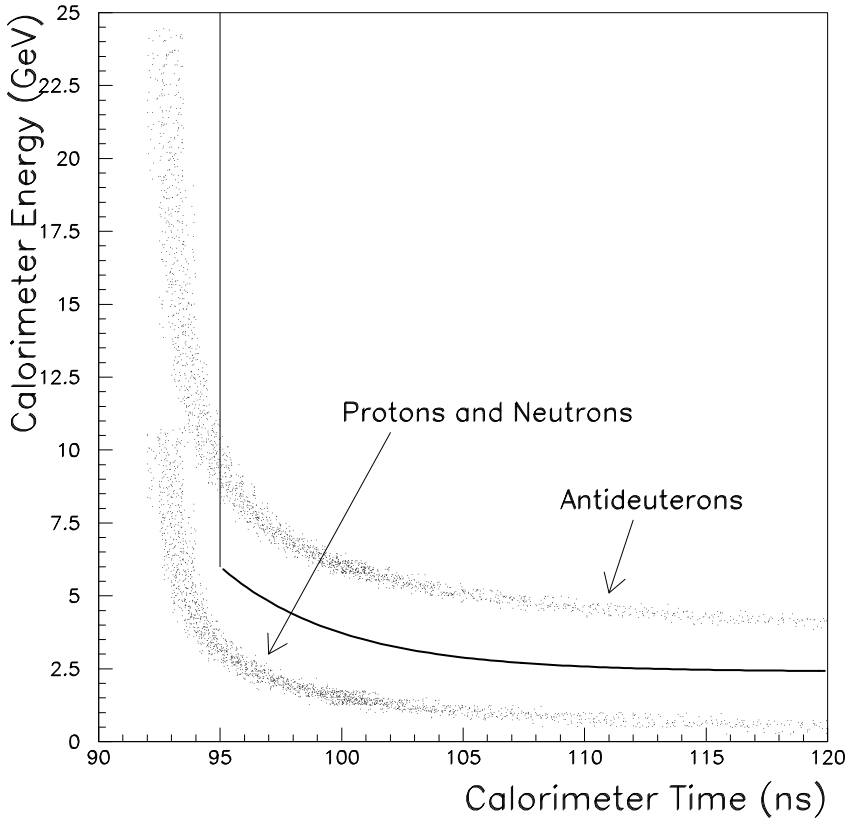


M1,M2: Dipole analyzing magnets.
H1,H2,H3: TOF hodoscopes.
S1,S2,S3: Straw tube arrays.
(S1 not shown)
CAL: Hadronic calorimeter.
Downstream vacuum chamber not shown.

J.K.Pope October 1, 1996

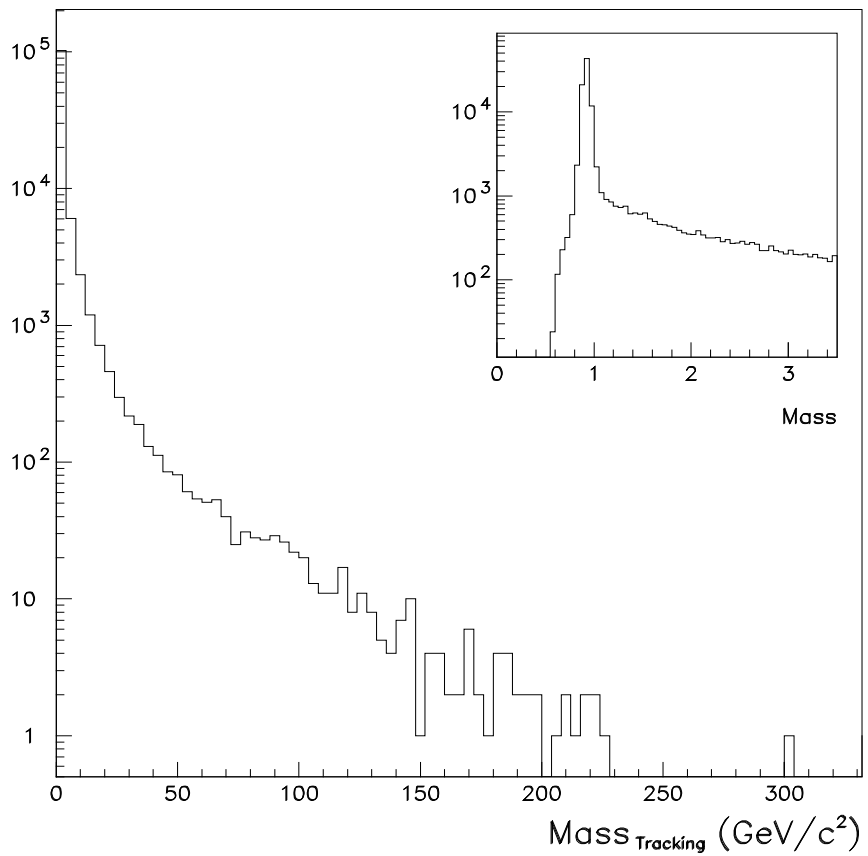
Late-Energy Trigger (LET)

- Level 2 trigger: Selects events with high mass candidates using energy & time measurements in the E864 calorimeter



Charge Z=-1 Spectrum

- Significant scattering background
- Tail of antiprotons just below antideuteron mass



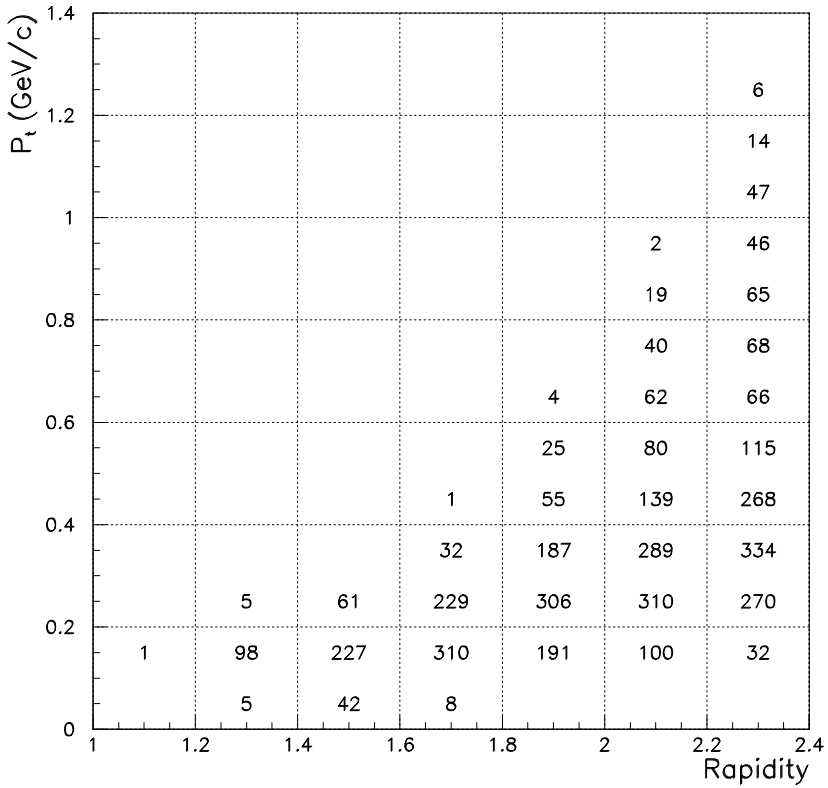
Antideuteron Acceptance

$$\frac{d^2N}{dy\,dp_t} \propto p_t\, e^{-2p_t/\langle p_t\rangle} e^{-(y-y_{cm})^2/2\sigma_y^2}$$

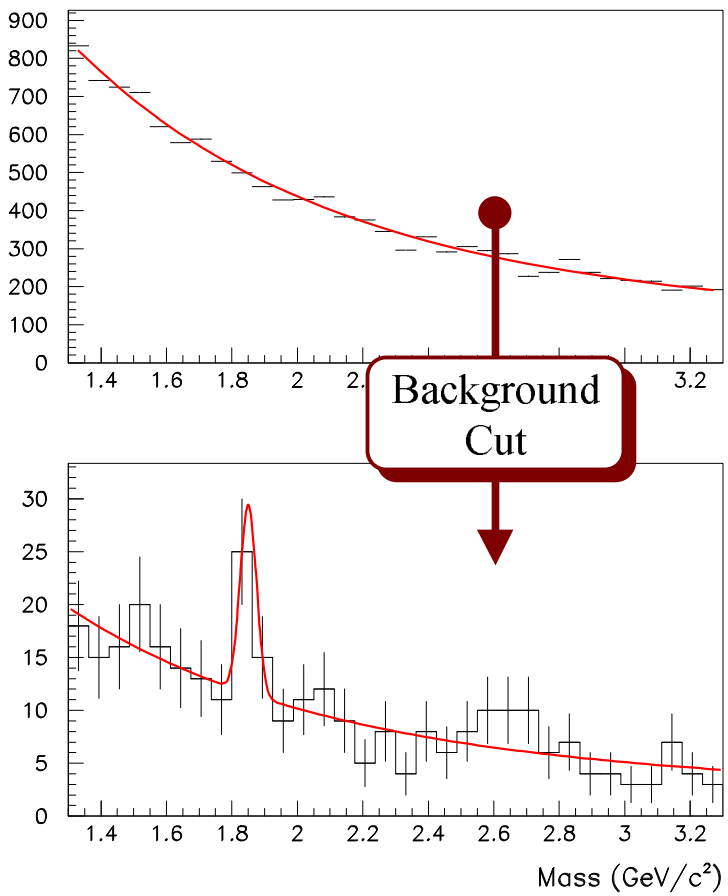
$\langle p_t \rangle = 1.0$ GeV/c

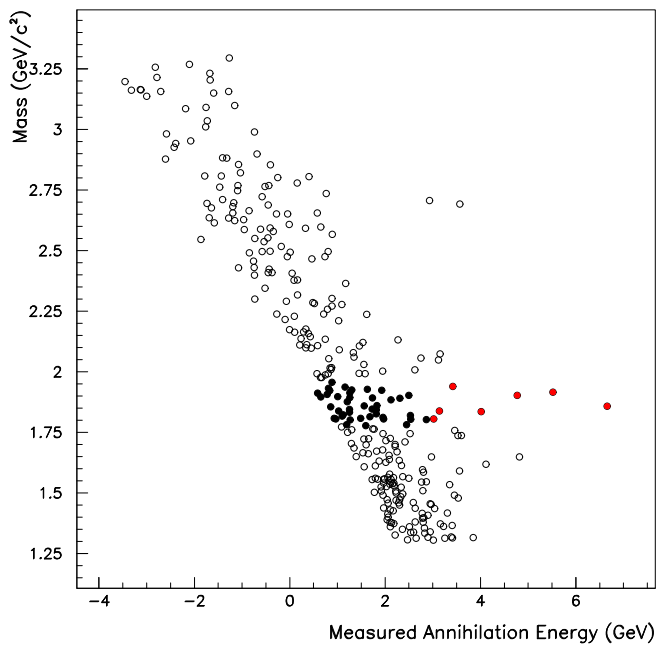
$\sigma_y = 0.5$

$y_{cm} = 1.6$



Z=-1, 1.8<y<2.2 Spectrum

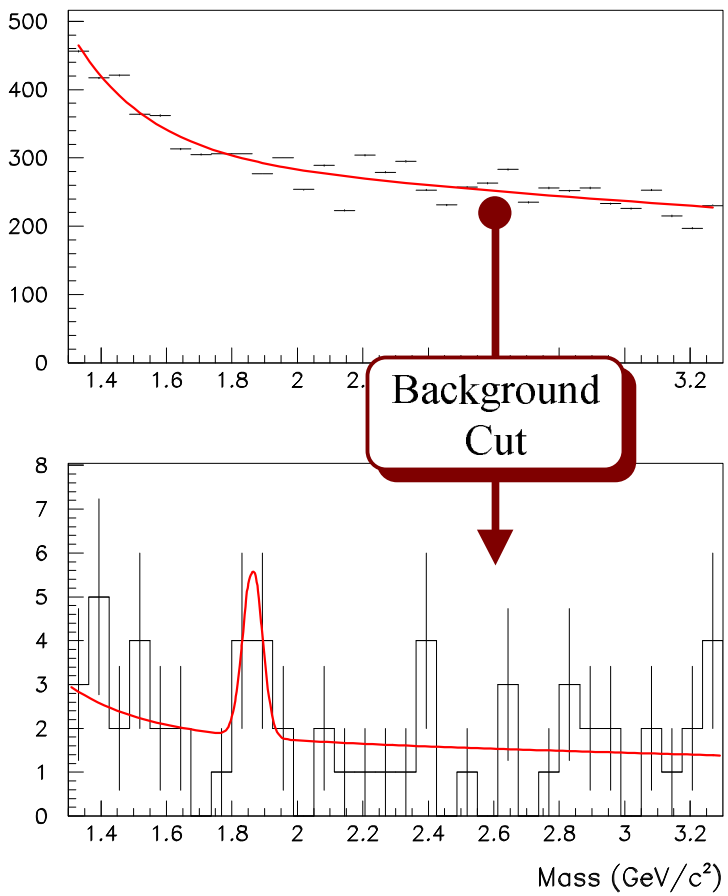


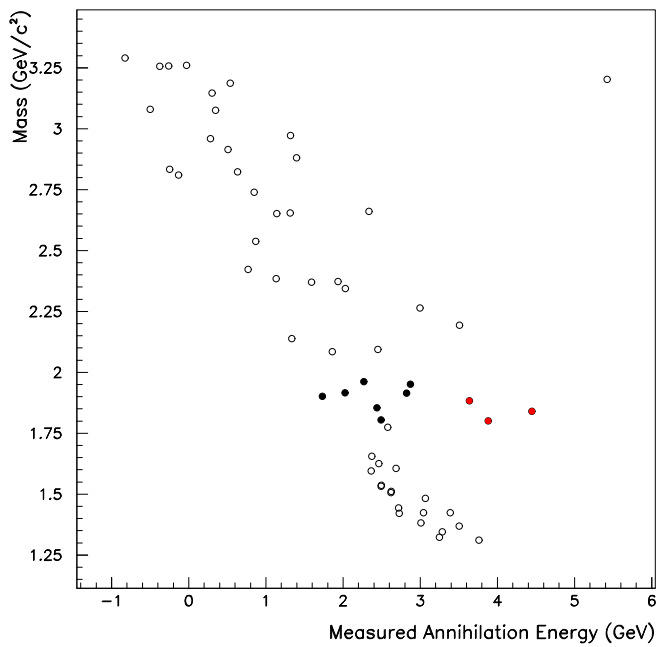


$N_{observed} = 17.6 +/- 7.5$

$N_{backgnd} = 34.1 +/- 5.8 +/- 2.3$

Z=-1, 1.4<y<1.8 Spectrum





$N_{observed} = 4.6 +/- 3.3$

$N_{backgnd} = 5.4 +/- 2.3 +/- 0.7$

Invariant Yields

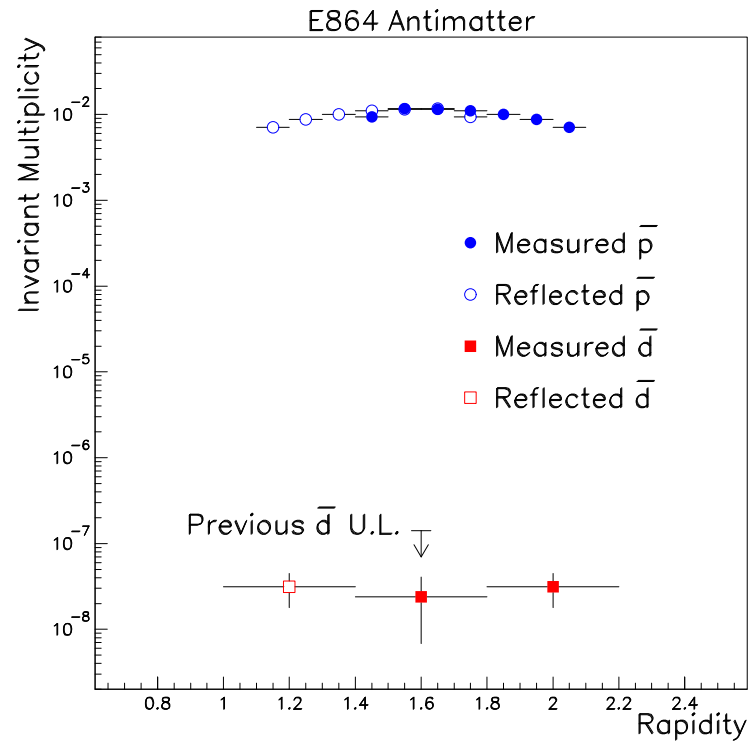
$$\frac{1}{2\pi P_t}\frac{d^2N}{dy\,dp_t} = \frac{1}{2\pi P_t}\frac{1}{\Delta y\,\Delta p}\frac{N_{observed}}{N_{sampled}}\frac{1}{\varepsilon}$$

- $N_{sampled} = 1.38 \times 10^{10}$
  (10% central collisions)

	$\frac{1}{2\pi P_t}\frac{d^2N}{dy\,dp_t}$
1.8<y<2.2	**(3.1 +/- 1.4) x 10^{-8}**
1.4<y<1.8	**(2.4 +/- 1.7) x 10^{-8}**

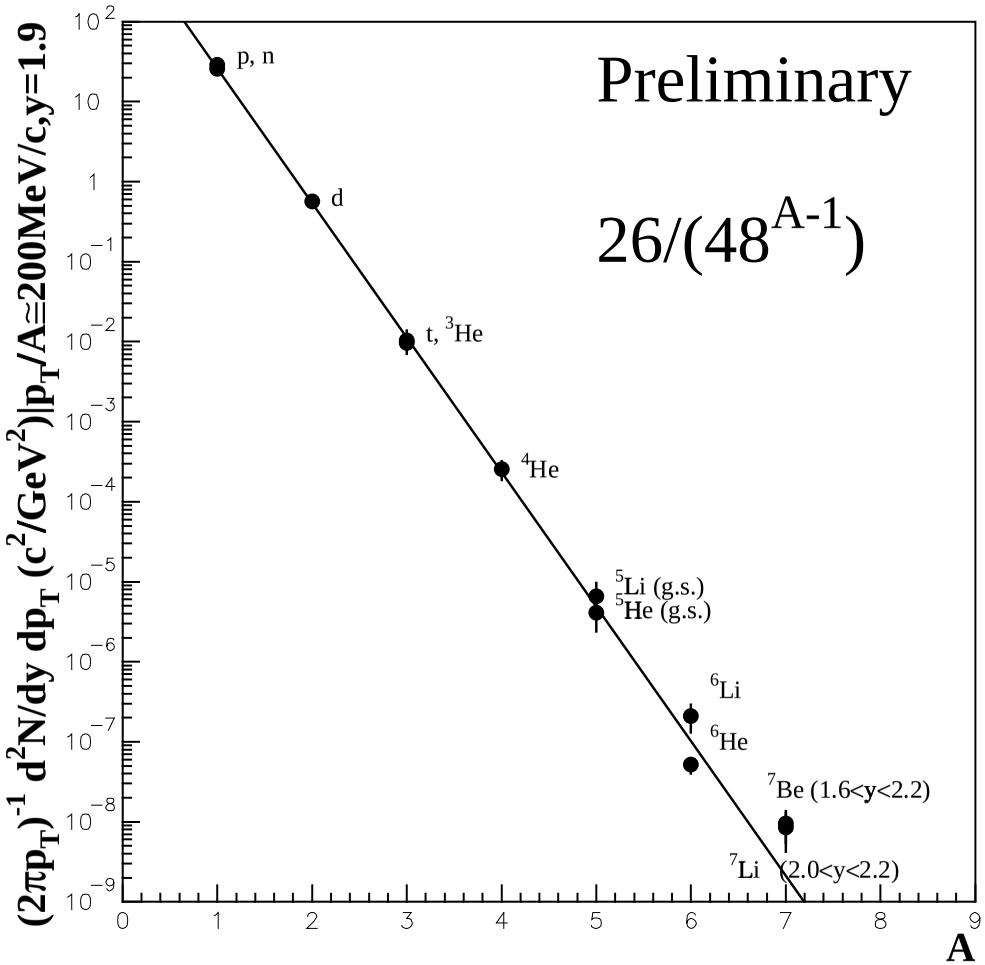
$GeV^{-2}\,c^2$

(statistical errors only)



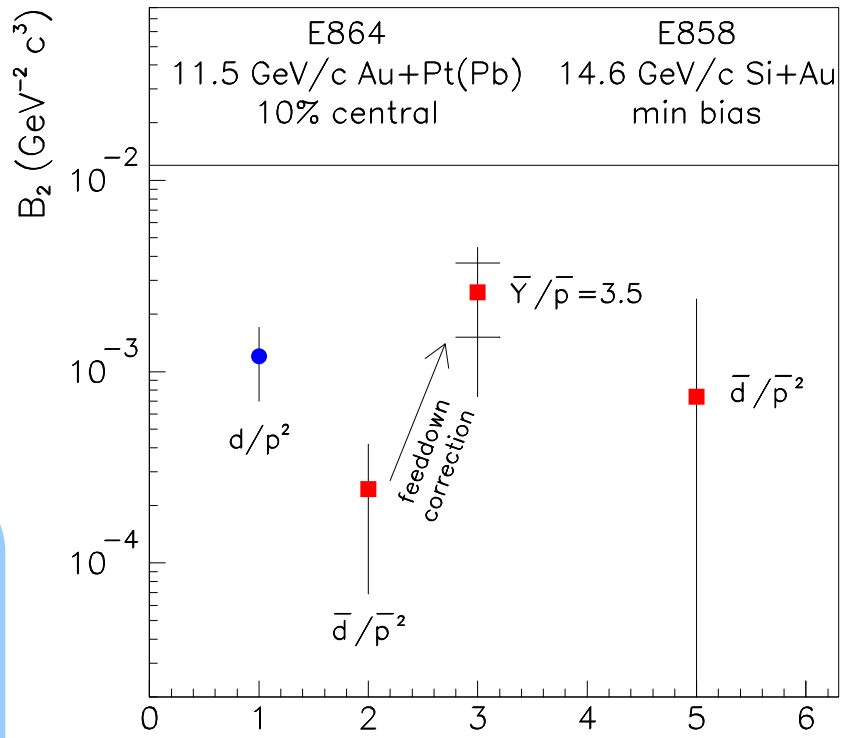
E864 Light Nuclei Yields

- Strong evidence for coalescence: exponential form to light nuclei yields as a function of A



Coalescence Factor: $\overline{B}_2$

- E864 has measured antiproton production over $1.4 < y < 1.6$: 1.0×10^{-2} GeV^{-2} c^2
- $\bar{d}/\bar{p}^2 = \overline{B}_2$



$\overline{B}_2 = (2.4 +/- 1.7) \times 10^{-4}$

$\overline{Y}/\overline{p} = 3.5$ =>

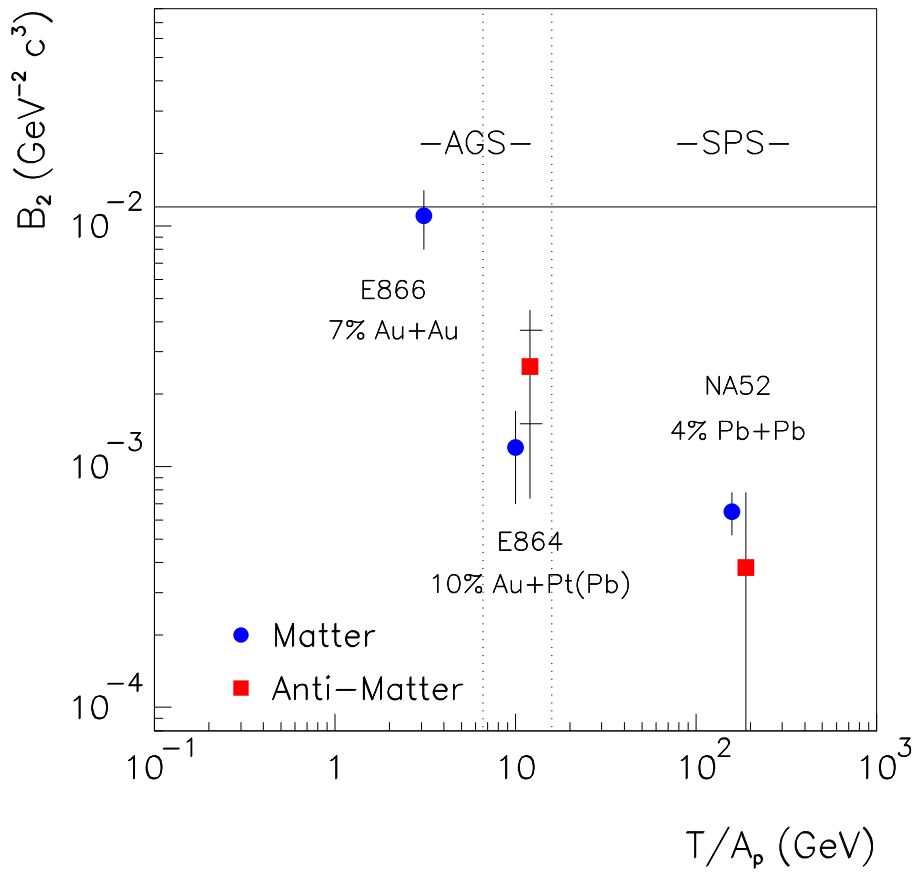
$\overline{B}_2 = (2.6 +/- 1.9) \times 10^{-3}$ GeV^{-2} c^3

(statistical errors only)

$\overline{B}_2$ Comparison

- Compare collisions with similar numbers of participant nucleons (hundreds!)

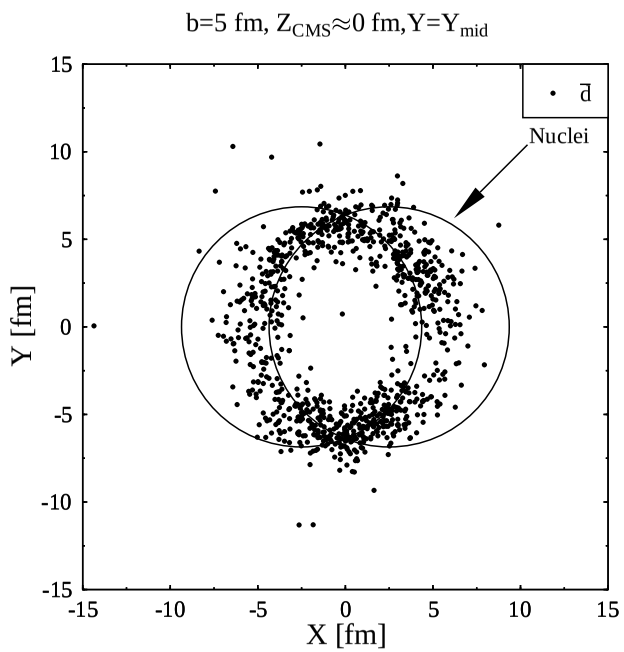
No evidence that $\overline{B}_2$ does not follow B_2

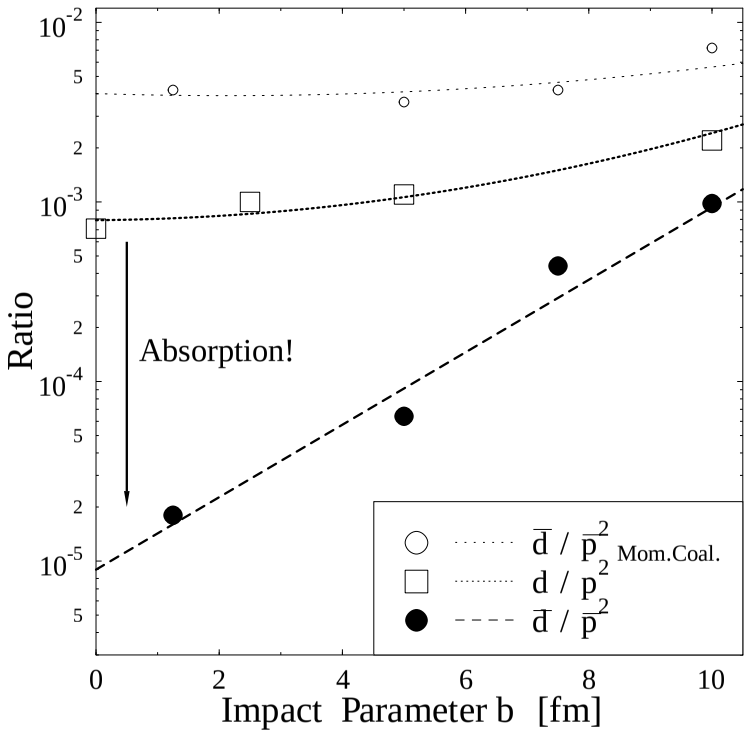


Antimatter Absorption

Predictions for 10.7 GeV/c Au + Au (RQMD)

(free space annihilation)





M. Bleicher *et al.* (1995) nucl-th/9506009

Thermal Model

- Volume, Radii: $\bar{B}_2 = \frac{1}{2\, m_p V}(2\pi\hbar)^3$ ← N.R., Boltzmann, spin incl.

$V \cong 4200\ \mathrm{fm}^3$ $\xrightarrow[\text{correction}]{\text{feeddown}}$ $V \cong 400\ \mathrm{fm}^3$

$R_{therm} \cong 10.0$ fm $\qquad R_{therm} \cong 4.5$ fm

E864,E866 deuteron extracted $R_{rms} \cong$ 5-7 fm , here $R_{rms(SY)} \cong$ 13 or 6 fm

- Temperature:

$d/\bar{d}$ => $\mu_B/kT \cong 4.15$

$p/\bar{p}$ => $\mu_B/kT \cong 3.85$ $\xrightarrow[\text{correction}]{\text{feeddown}}$ $p/\bar{p}$ => $\mu_B/kT \cong 5.05$

$\bar{d}/\bar{p}$ => $kT \cong 100 - 110$ MeV $\qquad \cong 120 - 140$ MeV

Summary

- Antideuteron signal observed:
  - Invariant yields:
    - $1.8 < y < 2.2$: **(3.1 +/- 1.4) x 10^{-8}** $GeV^{-2}\ c^2$
    - $1.4 < y < 1.8$: **(2.4 +/- 1.7) x 10^{-8}** $GeV^{-2}\ c^2$
- $\overline{B}_2$ measured ($1.4 < y < 1.8$):
    - **(2.4 +/- 1.7) x 10^{-4}** $GeV^2\ c^{-3}$

      Feeddown correction ($\overline{Y}/\overline{p} = 3.5$):
    - **(2.6 +/- 1.9) x 10^{-3}** $GeV^2\ c^{-3}$
  - Within one order of magnitude of B_2
    - $\overline{B}_2$ may not depend so strongly on absorption