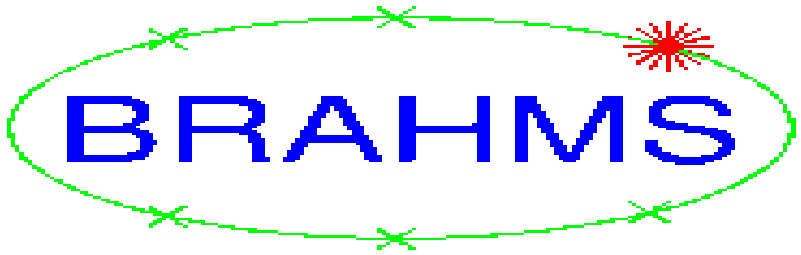

Results from First RHIC run

QM 2001

January 15, 2001

F.Videbœk

Physics Department

Brookhaven National Laboratory

For the **BRAHMS** Collaboration

BRAHMS Collaboration

Brookhaven National Laboratory, USA

Fysisk Institutt, University of Oslo Norway

IReS, Université Louis Pasteur, Strasbourg, France

Jagellonian University, Cracow, Poland

Johns Hopkins University, Baltimore, USA

New York University, USA

Niels Bohr Institute, University of Copenhagen, Denmark

Texas A&M University, College Station. USA

University of Bucharest, Romania

University of Kansas, USA.

University of Bergen, Norway

I.G. Bearden[7], D. Beavis[1], Y. Blyakhman[6], J.Brzychczyk,B. Budick[6], H. Bøggild[7], C. Chasman[1], P. Christiansen[7], J.Cibor, R.Debbe[1], J. J. Gaardhøje[7], K.Grotowski,J. I. Jordre[10], F. Jundt[3], K. Hagel[11], O. Hansen[7], H.Heiselberg, A. Holm[7], C. Holm[7], A.K. Holme[2], H. Ito[9], E. Jacobsen[7], A. Jipa[8], C. E. Jørgensen[7], E. J. Kim[5], T.Kreutgel, T. Kozik[4T],T.M.Larsen, J. H. Lee[1], Y. K.Lee[5], G. Løvhøjden[2], Z. Majka[4], A. Makeev[11], B. McBreen[1], M. Murray[11], J. Natowitz[11], B.S.Nielsen[7], K. Olchanski[1], D. Ouerdane[7], R.Planeta. F. Rami[3], D. Roerich[10], B. Samset[2], S. Sanders[9], R.A.Scheetz[1], I. S. Sgura[8],Z.Sosin, P. Stazel[4,7,] T.S. Tveter[2], F.Videbæk[1], R. Wada[11] and A.Wieloch

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BRAHMS

Overview of presentation

- Physics Goals of BRAHMS and the Millennium (2000) Run - AuAu at $\sqrt{s_{nn}} = 130$ GeV
- Spectrometer Performance
- Event Selection
  - Tiles,Beam Counters, ZDC and Silicon
- Global Observables
  - $dN/d\eta$ from TPC track counting
- Baryon and Meson Ratios
  - Mid-Rapidity and Forward Rapidities (y~2-3)
  - Comparisons to models and SPS data.

Brahms presentations and posters at QM2001

- Particles ratios at forward and mid-rapidities I.G.Bearden;RHIC particle RatiosParallel session III- Friday.
- dN/dη from global detectors H.Ito P- 181
- Mid-rapidity particle identification and spectra,J HLee P-182
- Electromagnetic cross section. M.Murray. P-174
- TPC tracking performance P.Christiansen Instrumentation P-209
- Vertex Determination in Brahms B.Samset Instrumentation P-227

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BRAHMS

BRAMS Physics Goals

The RHIC experimental program addresses the physics of Hot and Dense Matter and non-perturbative QCD.

As part of the RHIC program BRAHMS has a special and complementary role, and studies in particular

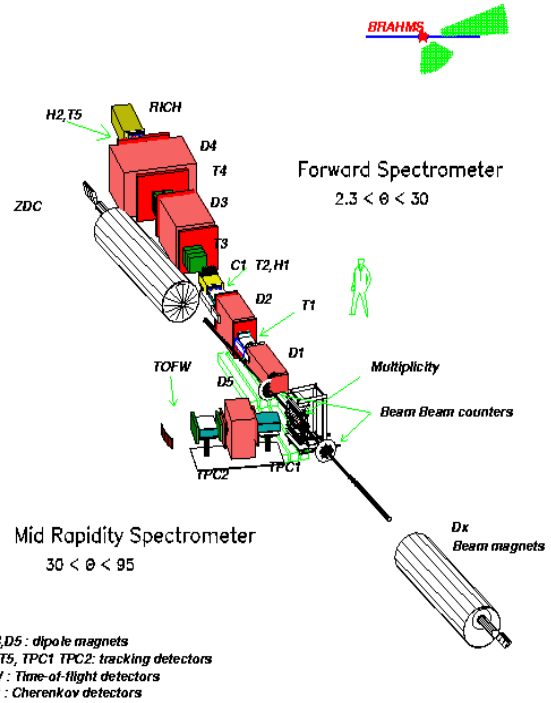
- Reaction Mechanism and dynamics
- Baryon Stopping.
- Particle production

Through measurements of

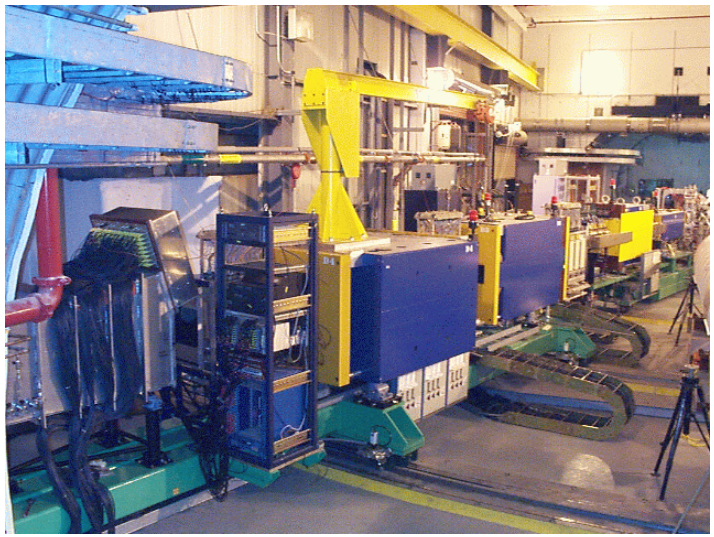
- p, K, π identified over wide range of rapidity, $0 < |y| < 4$ and $0.2 < pt < \sim 3$GeV/c (central and fragmentation region) vs centrality with high precision. First run only covers a small part of the landscape.

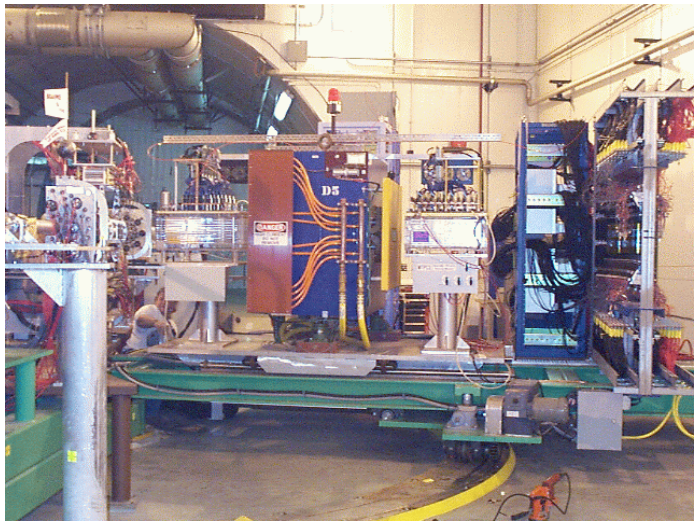
Perspective View of Brahms

Experiment open during RHIC Tours tomorrow at BNL.



D1,D2,D3,D4,D5 : dipole magnets
T1,T2,T3,T4,T5, TPC1 TPC2: tracking detectors
H1,H2,TOFW : Time-of-flight detectors
RICH, GASC : Cherenkov detectors





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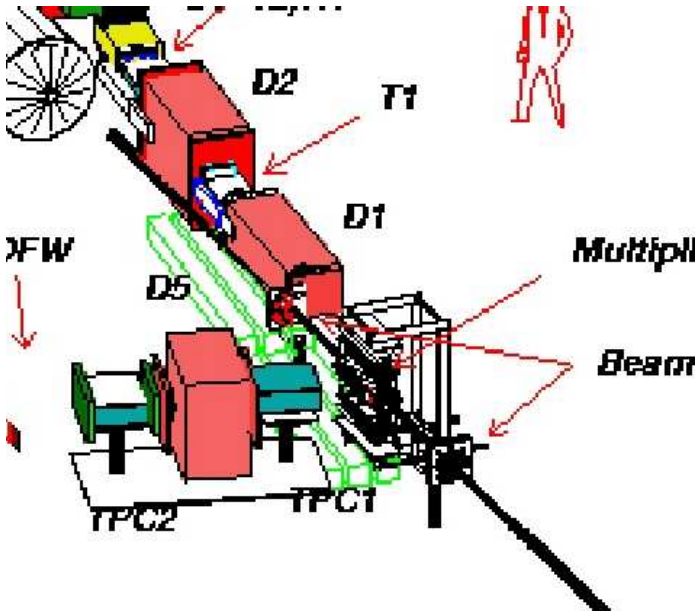
Detector Configurations Used in Data Presented



Forward Spectrometer

Θ=**4.0** [5,8 and 12]

tracking and momentum determination by **T1-T2, D2**

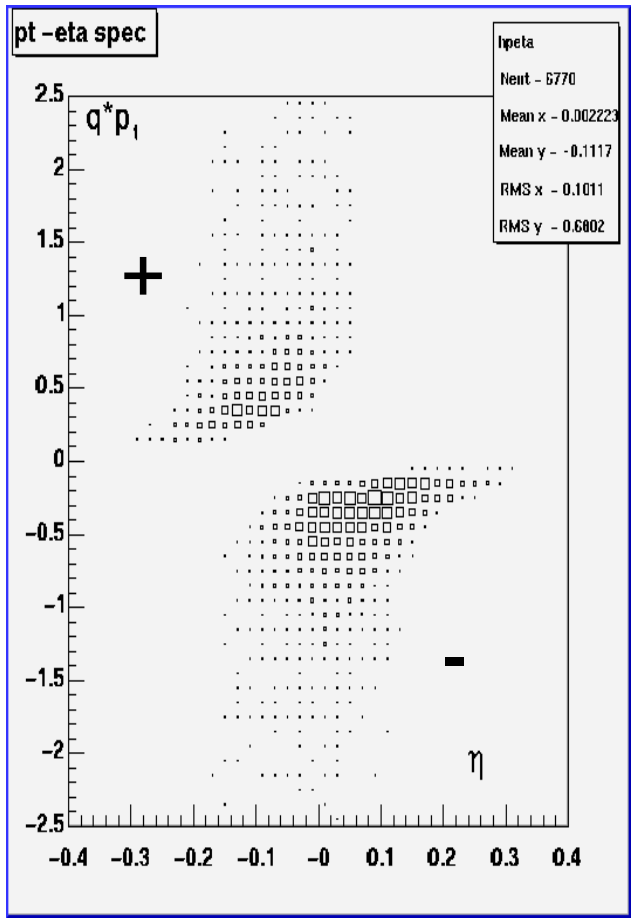
PID: **TOF-H1** (K/p < 4.5 GeV/c)

Mid-Rapidity Spectrometer

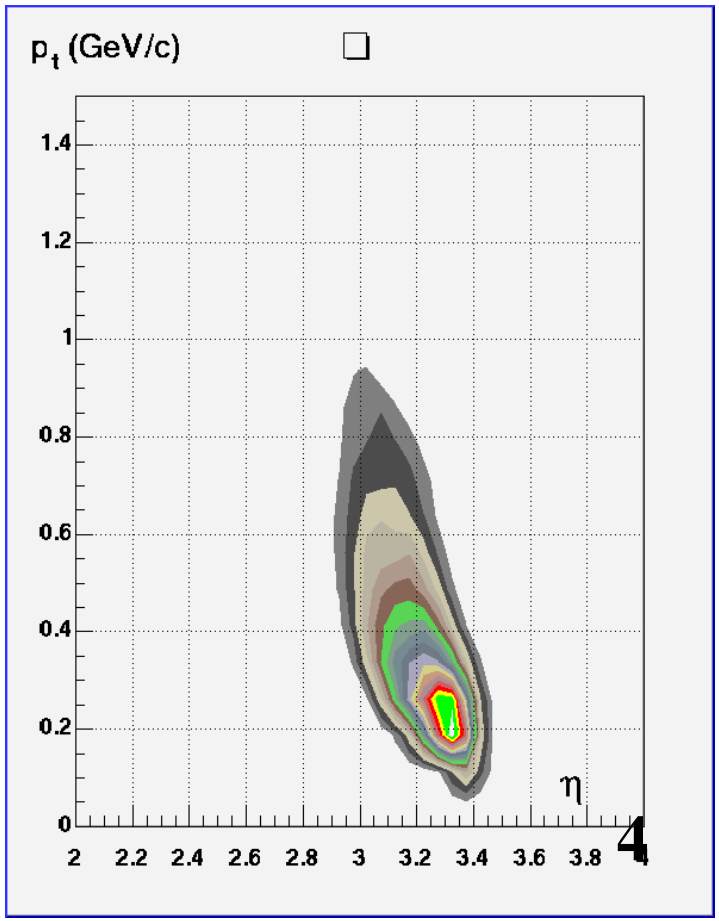
Θ=**90** [60,45 and 40]

- Tracking and Momentum determination, **TPM1, TPM2 and D5.**
- PID **TOFW** (π /K < 1.5, K/p < 2.2 GeV/c with 3σ cut). One charge sign measurements.

Acceptance of all charged tracks (p_t–η)



90 setting.



4 degree setting

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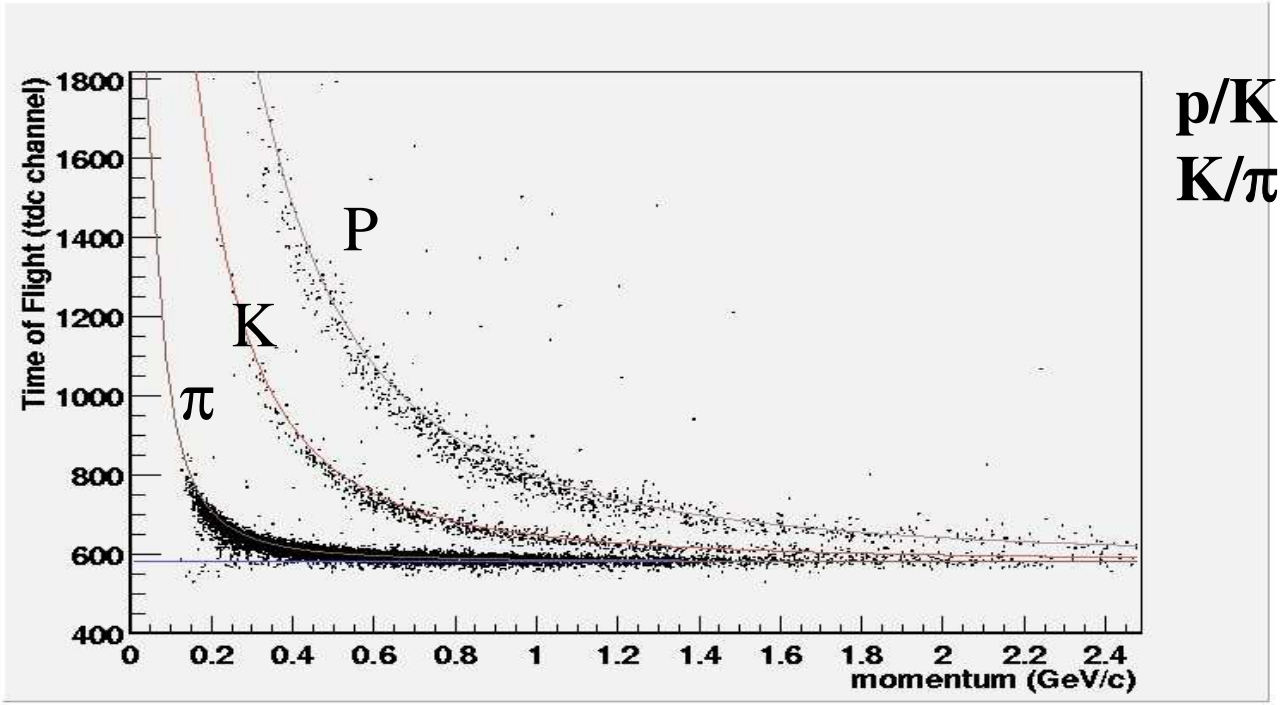
TOF PID separation

As illustration is shown the Particle Identification achieved
In Mid-Rapidity Spectrometer



p/K to 2.2 GeV/c
K/π to 1.5 GeV/c

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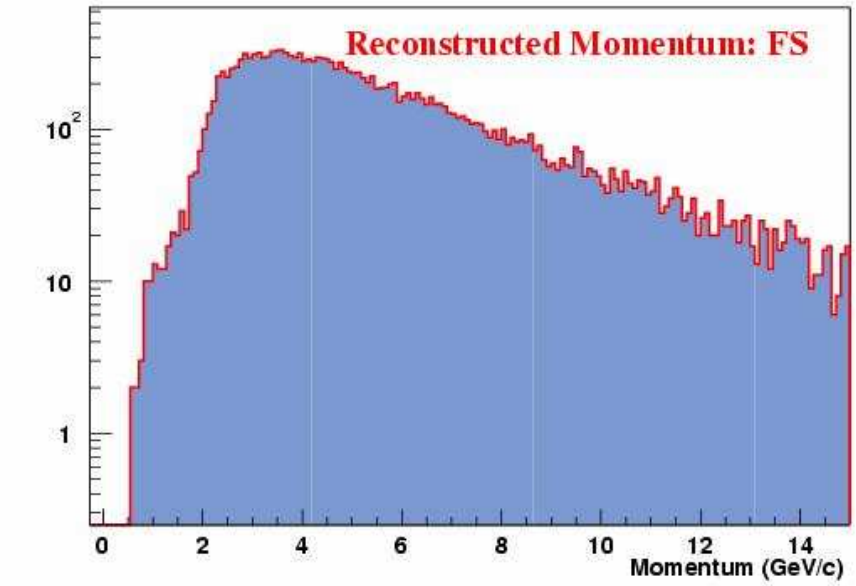
Particle spectra.

- Large momentum coverage in FS.

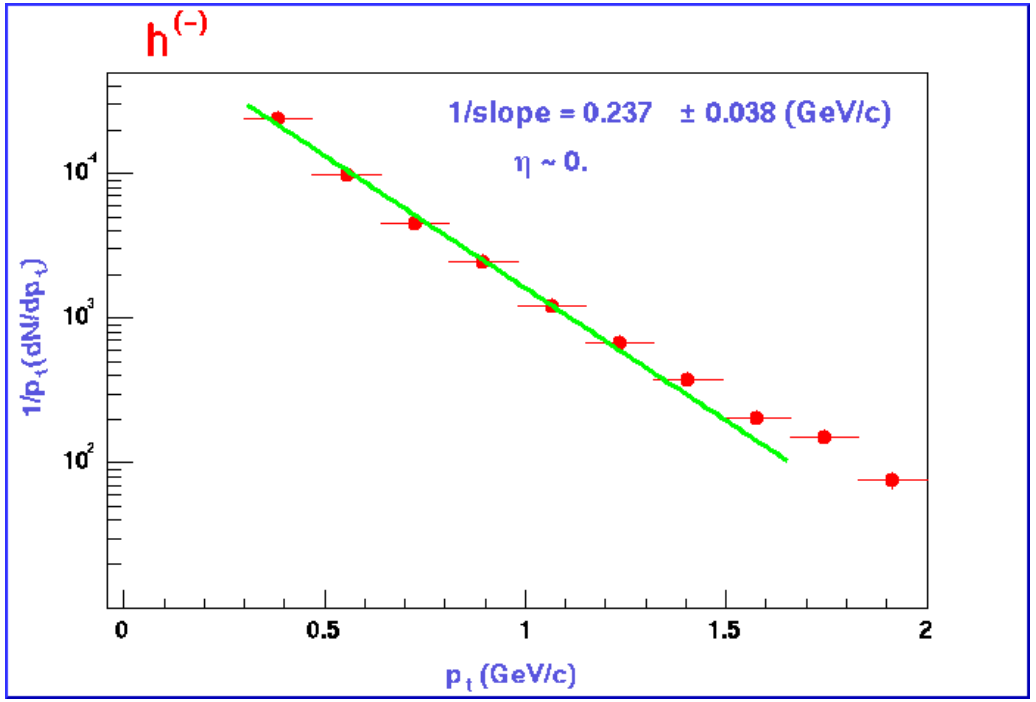


Charged Hadron Spectra

The vertex distribution, and the geometry in MRS implies a complicated acceptance for spectra; an acceptance that cancels out for particle ratio

Acceptance corrected h(-) spectra at η~0.

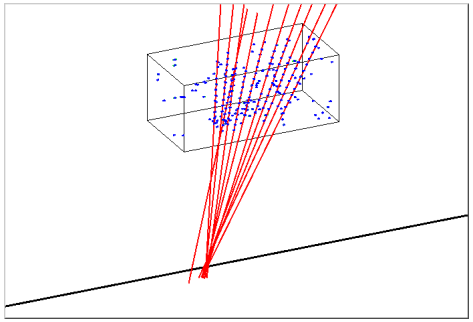
The shape is as expected showing the increasing importance of hard scattering.



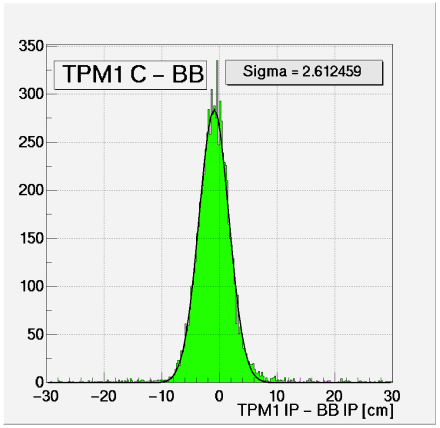
Event Selection

- For background rejection events are selected by requiring timing signals from BB, ZDC consistent with collisions.
- A vertex is calculated from the difference in timing signals.
- Events are required to have at least one hit in tiles. This rejects the very peripheral electromagnetic dissociation of the nuclei.
- For event selection, for good track selection, and for TOF measurements the interaction point must be known with good accuracy.

Vertex Determination in BRAHMS



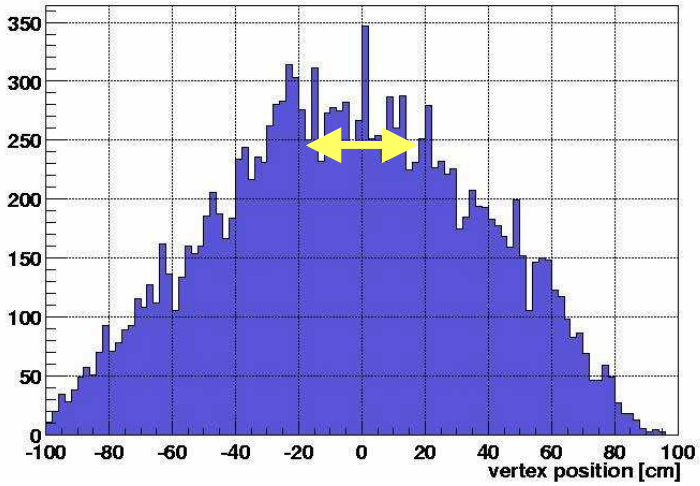
Comparison of found collision vertex using BB timing information andTPM1 tracking



σ(BB)~2.6cm.

Vertex distribution of accepted tracks in TPM1.

Accepted region ~30cm



•Only events from a selected narrow range, dependent on analysis, are accepted – rejecting at times up to 90% of all recorded data.

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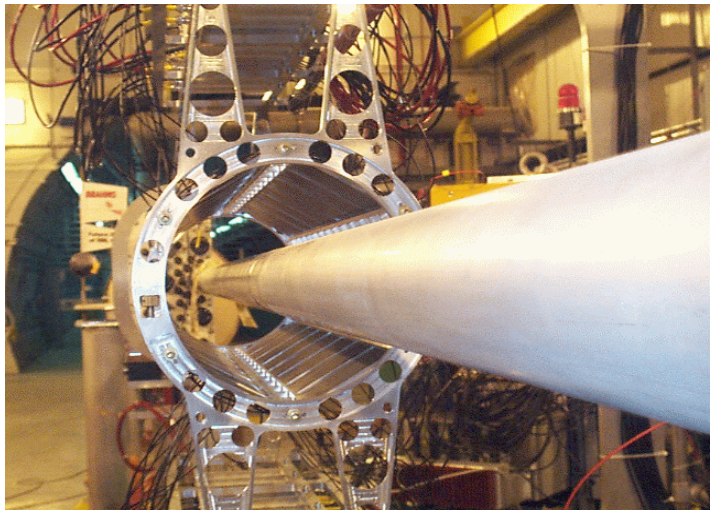
Multiplicity Selection

Centrality Detector consisting of

- 38 segments of 12*12 cm scintillator tiles
- coverage $-2.0 < \eta < 2.0$
- Phi coverage ~70%

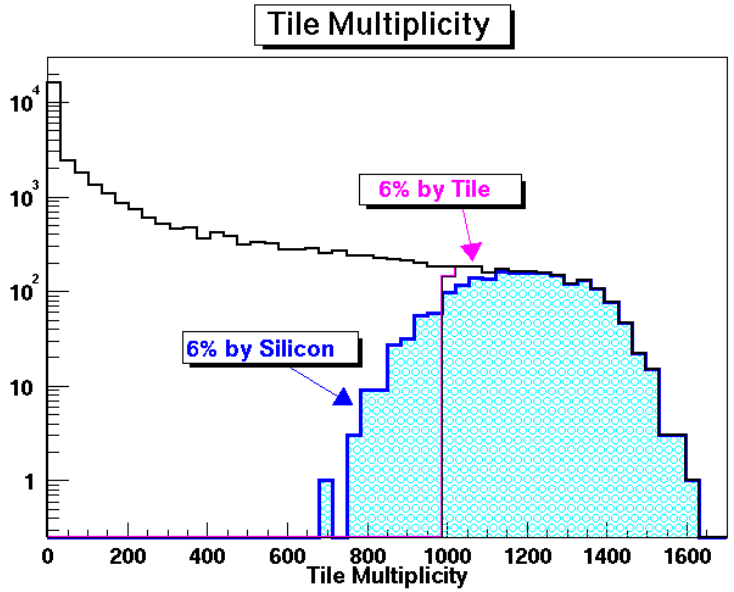
- Large linear Dynamic Range (1-100 hits), but no single hit resolution.
- Detectors using dE measurements to extract multiplicities are subjects to significant corrections for absolute yields.



Centrality Measure using Tiles.

Multiplicity is evaluated from dE measurement includes secondary particle contribution. Secondaries ~30-40% depending on vertex position. N ~ Σ dE/<dE>.

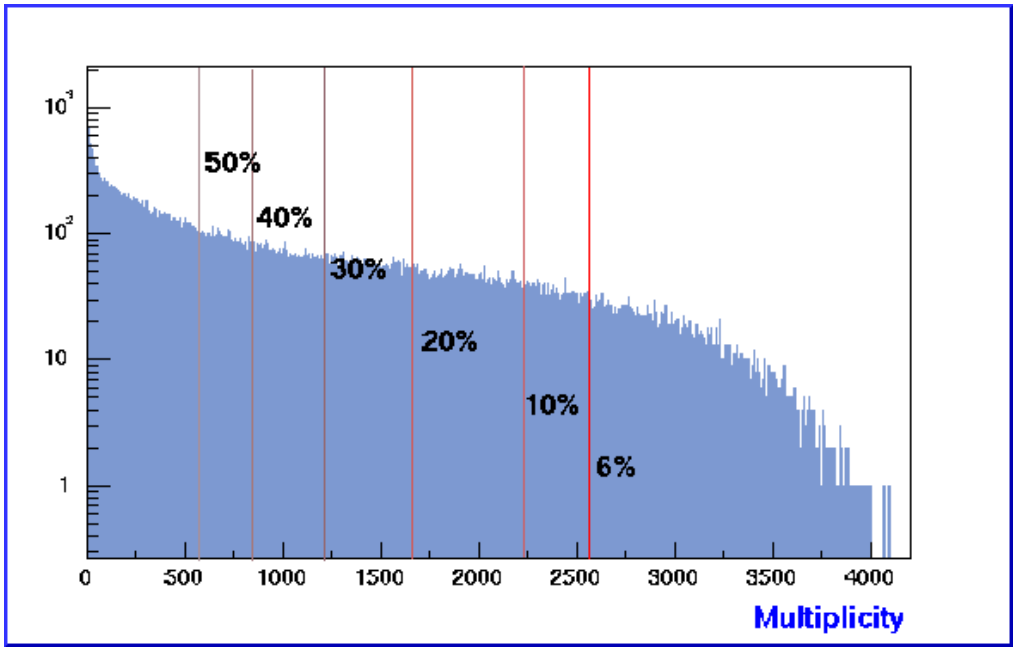
- The interaction vertex is calculated event-by-event and angle corrections applied, as well as solid-angle correction to yield an 'energy sum' proportional to multiplicity. This centrality measure correlates well to other detectors.



Centrality Selection Distributions

Centrality cuts has been employed for subsequent analysis.

The percentage fraction is of the 97% of nuclear cross section (7.2 b). Min bias cross section requires just one hit in any tile in addition to valid ZDC correlation.



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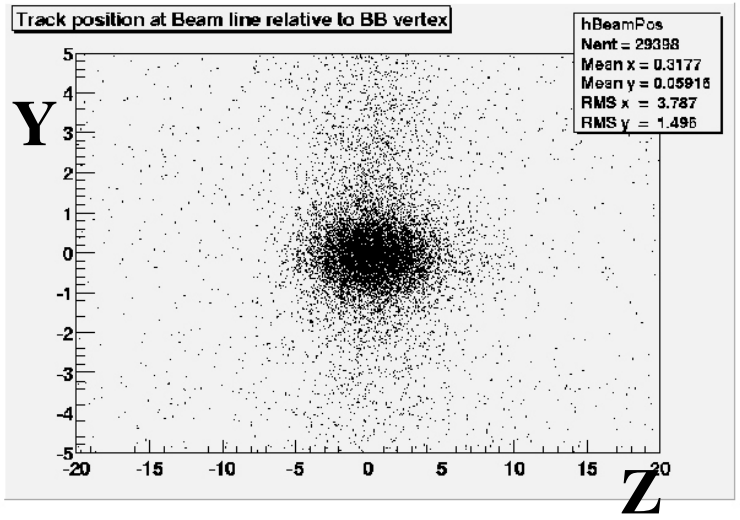
Centrality Dependent dN/dη from tracking.

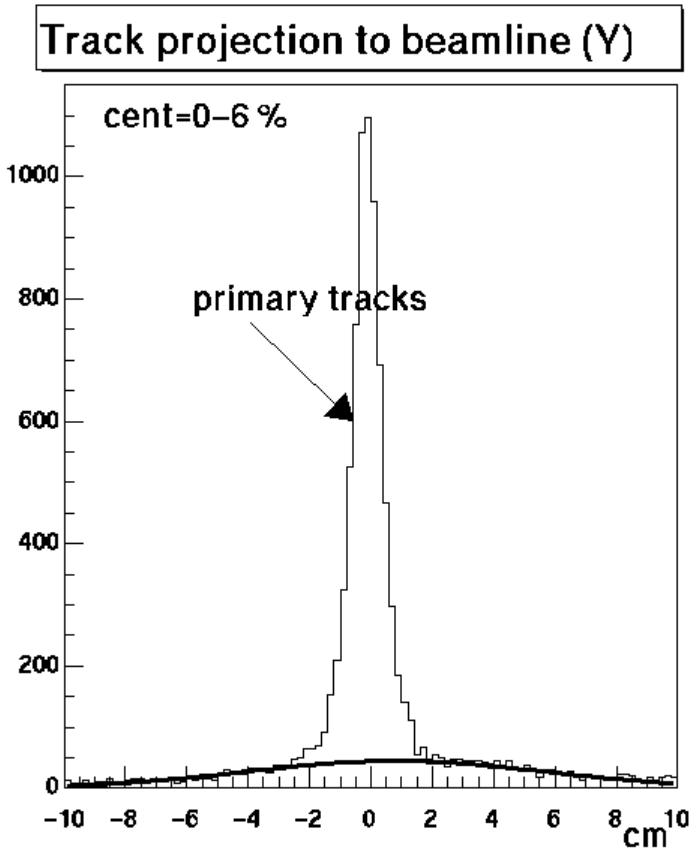
The TPC at 90 degrees is used for these measurements

- Reconstructed tracks are selected within a fiducial area of 24*12 cm**2 at 95 cm.
- Tracks are projected to beam and distance to vertex is analyzed.
- This is done as function of centrality determined by tiles for cuts in range 0-50% of centrality



Track projection Distribution

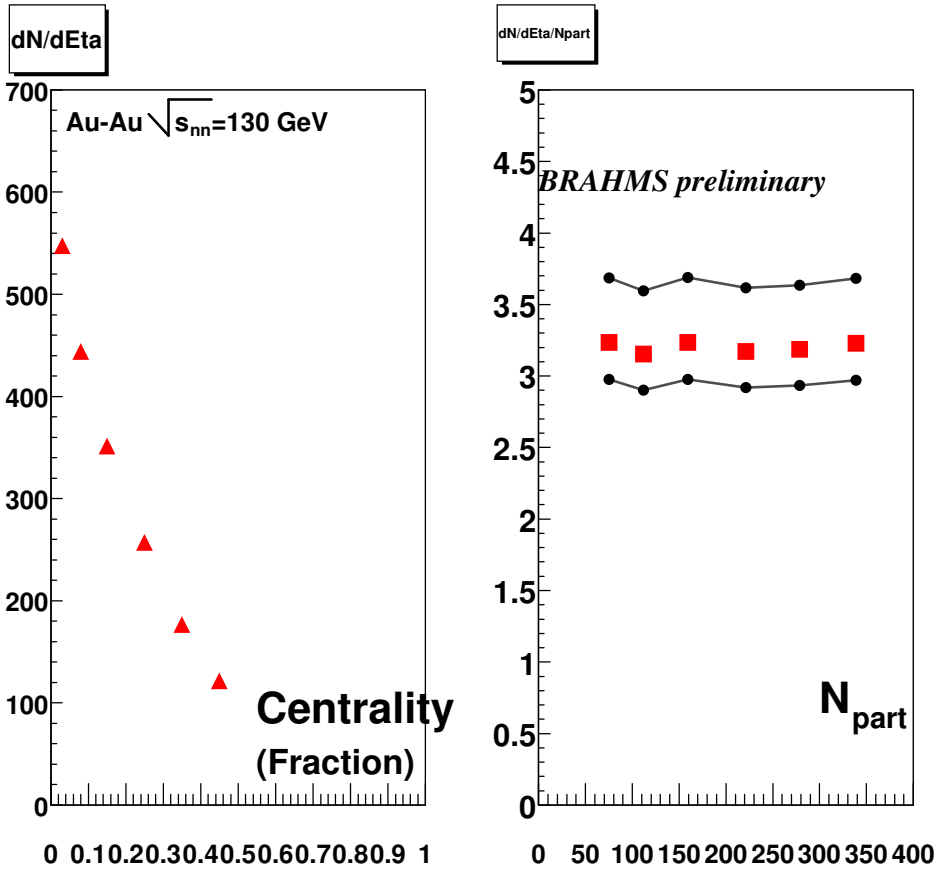
Cuts and Selection



The average number of tracks is deduced from such distributions. The shape of background is confirmed by Geant simulations.

Converted to dN/dη applying solid angle correction and a multiplicity dependent tracking efficiency correction of 1.10-1.22

dN/dη(charged) result



The value obtained for the most central 0-6% bin is

545±6(stat)+(60) (syst)
- (30)

The centrality dependence on dN/dη per participant pair is weak.

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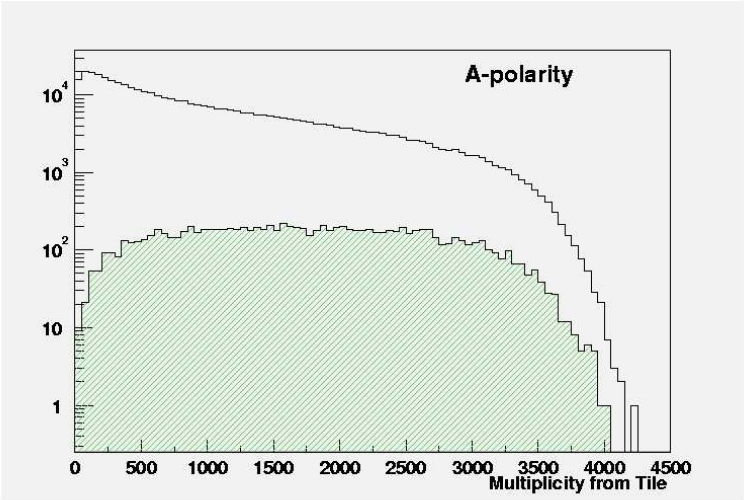
Hadron Ratios from MRS Spectrometer. (η~0)

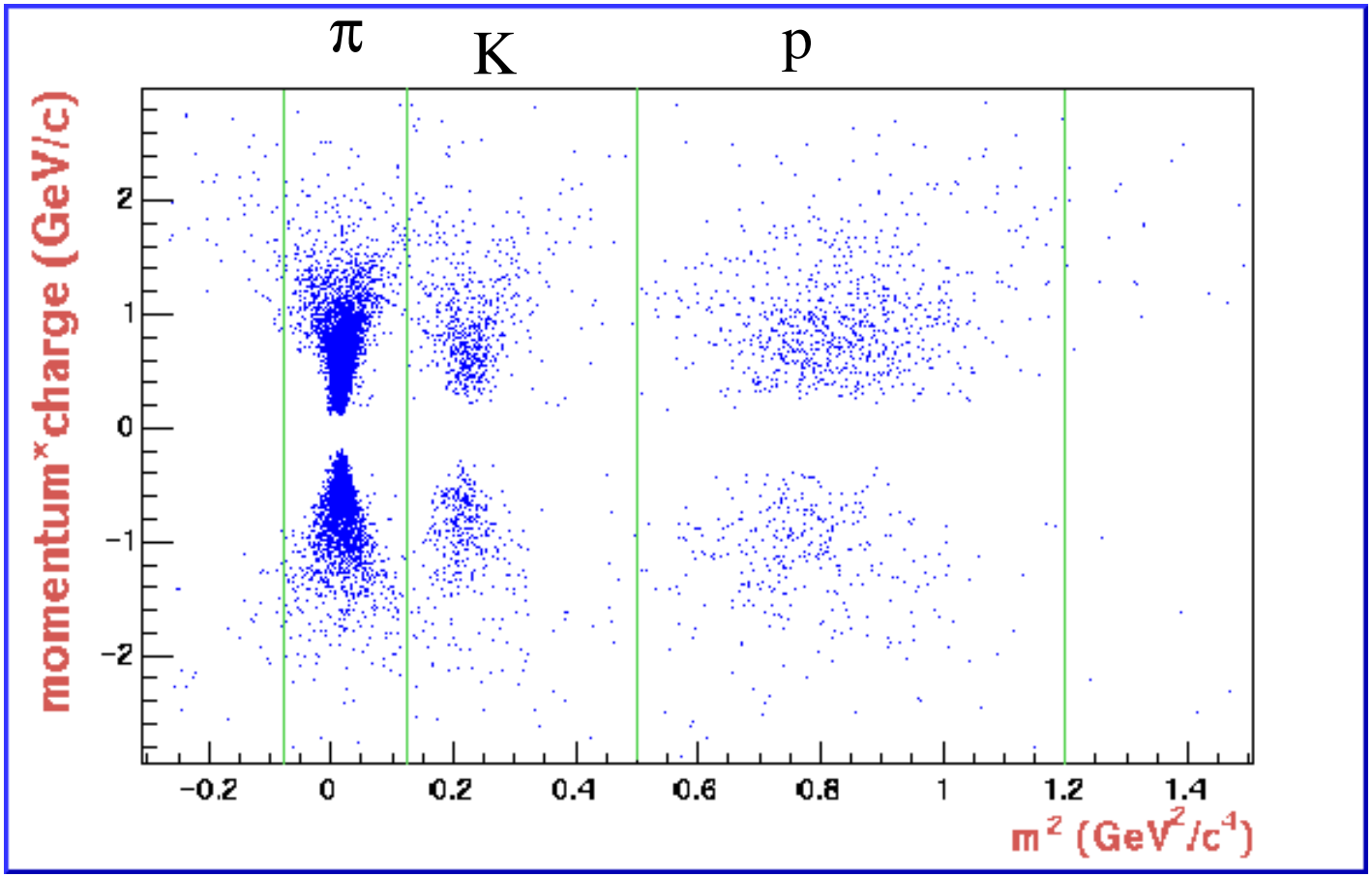
More Data and discussion in I.G.Bearden's talk On Friday Afternoon (Parallel session)

- Data sample for this analysis consists of 420K events A-polarity (p) and 691K events (p-bar) using the 90 deg spectrometer settings.
- The centrality selection by requiring at least one identified track correspond to a average centrality of 18% .

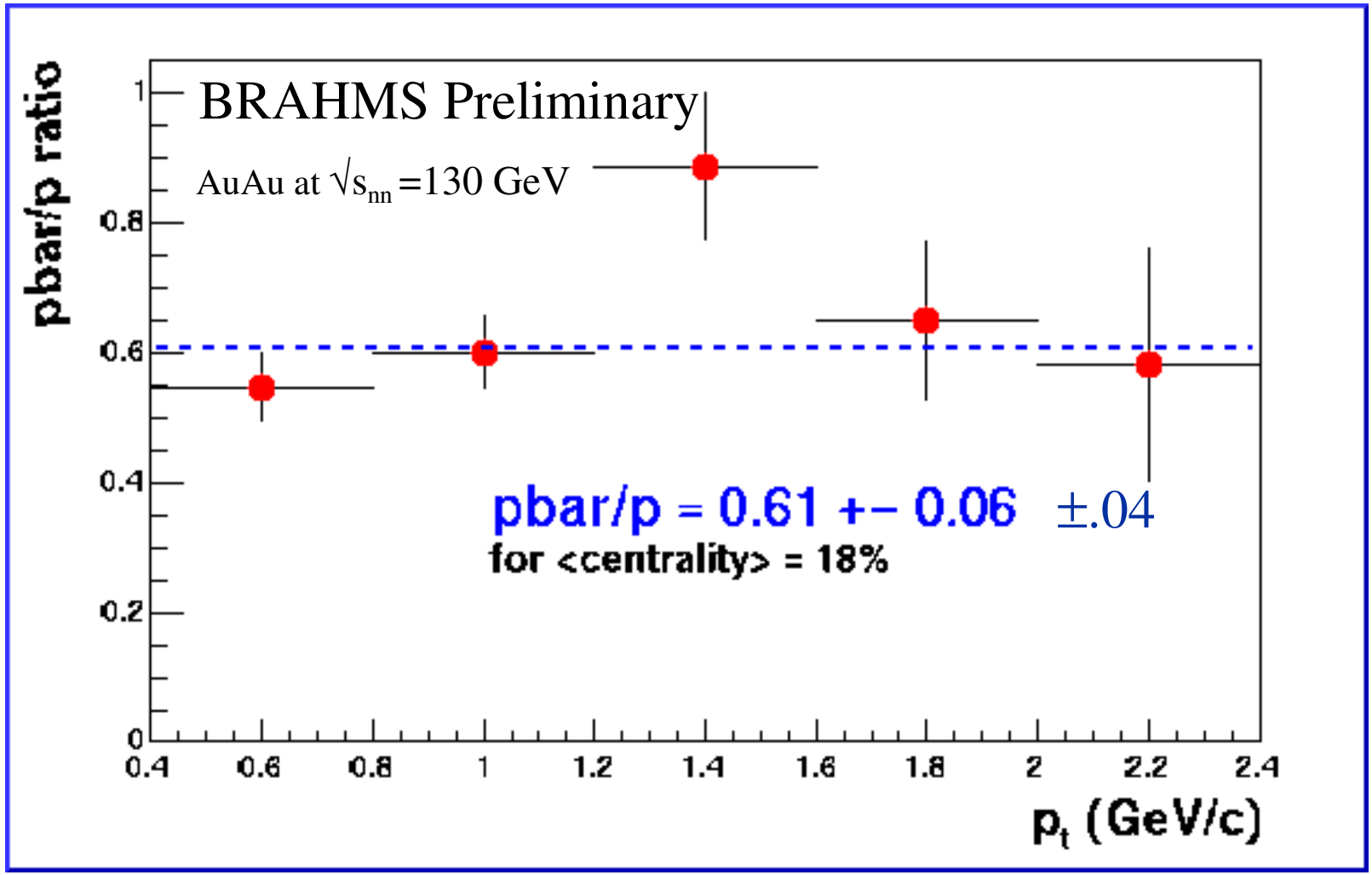


P vs. Mass^2

A-polarity data i.e. positive particles favoured



$\bar{p}/p$ at $\eta \sim 0$



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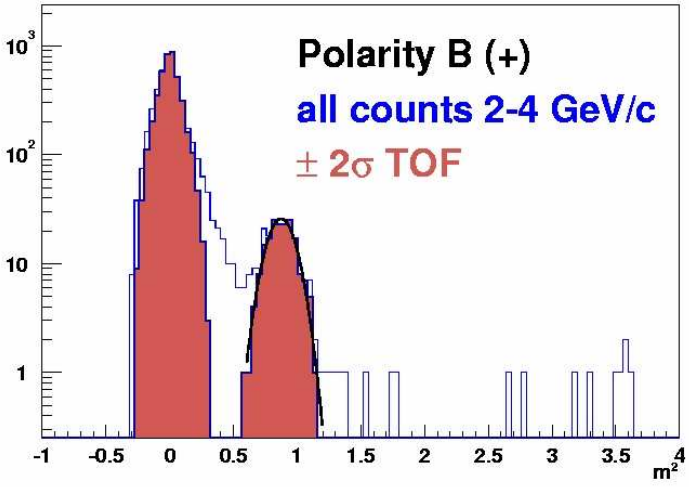
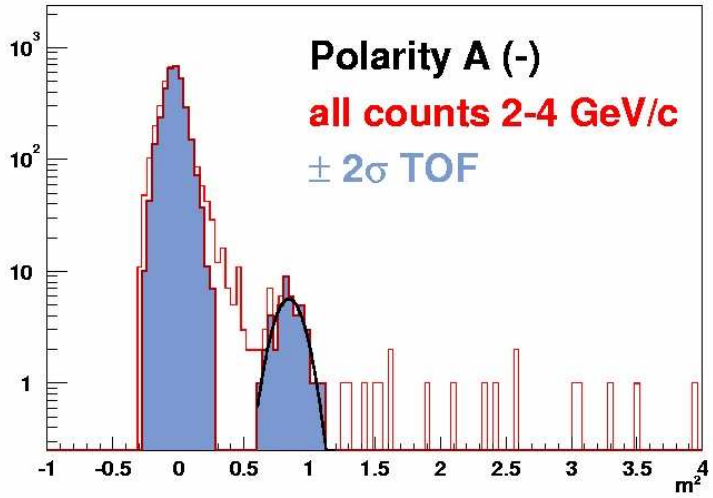
Hadron Ratios from FS Spectrometer. (η~3)

- The data set is from physics run of 260K events for (p-bars) and 270K events for (p).
- The vertex is restricted to ±35 cm.
- The overall time of flight resolution is 120 psec in this analysis. The flight path is corrected for vertex position.
- Only TOF is used for PID in this analysis.

Forward Spectrometer P, P-bar data extraction

The momentum region 2-4 GeV/c has more than 2 sigma separation between K and P.
A 2 sigma region around p/p-bar is selected, for yield determination.





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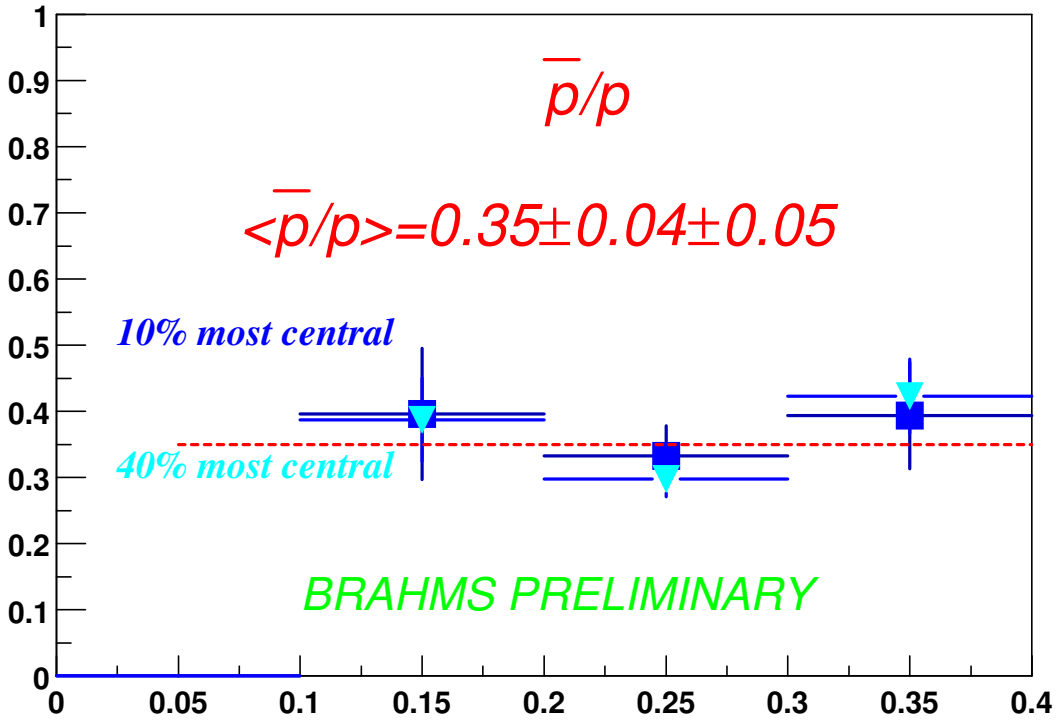
p-bar/p ratio at η~3



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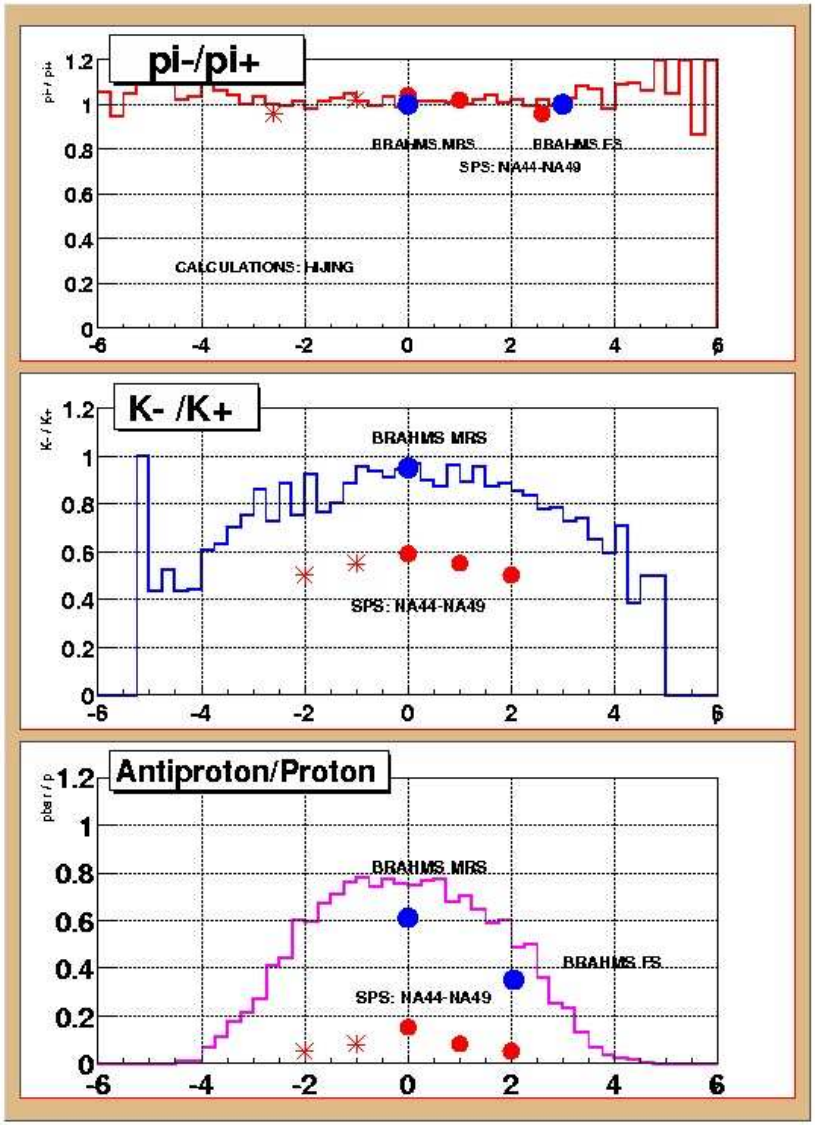
Summary of Result

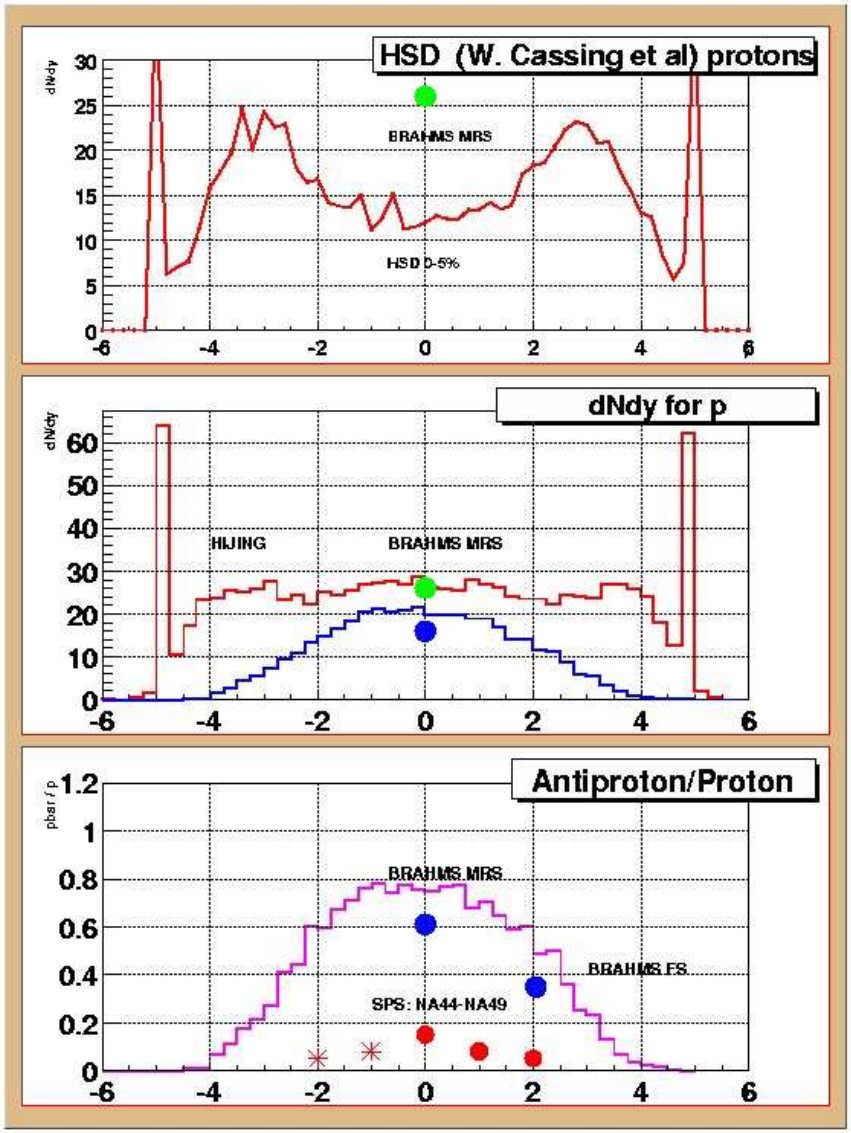
- The p-bar/p ratios is independent of centrality and pt.
- P-bar/P= 0.61 ± 0.06(stat) ±0.04(syst) at eta=0;
  .4<pt<2.2 GeV/c
- P-bar/P= 0.35+ ±0.04(stat) ±0.05(syst) at $\eta \sim 3$; .2<pt<.4 GeV/c

Using the charged particle $dN/d\eta$ at 0-6% and measured particle ratio it is estimated that $N(p) \sim 23\text{-}27$ at $\eta=0$, and thus a net proton density of Δ (p-pbar) ~ 8-11.



The yields are compared to predictions by Hijing. The SPS data values from NA44, NA49 are plotted as reference.

The η~3 measurement converted to y using the accepted mean pt.



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Summary

The first year of RHIC running has yield a first set of good quality data yielded hadronic spectra at a few rapidities.

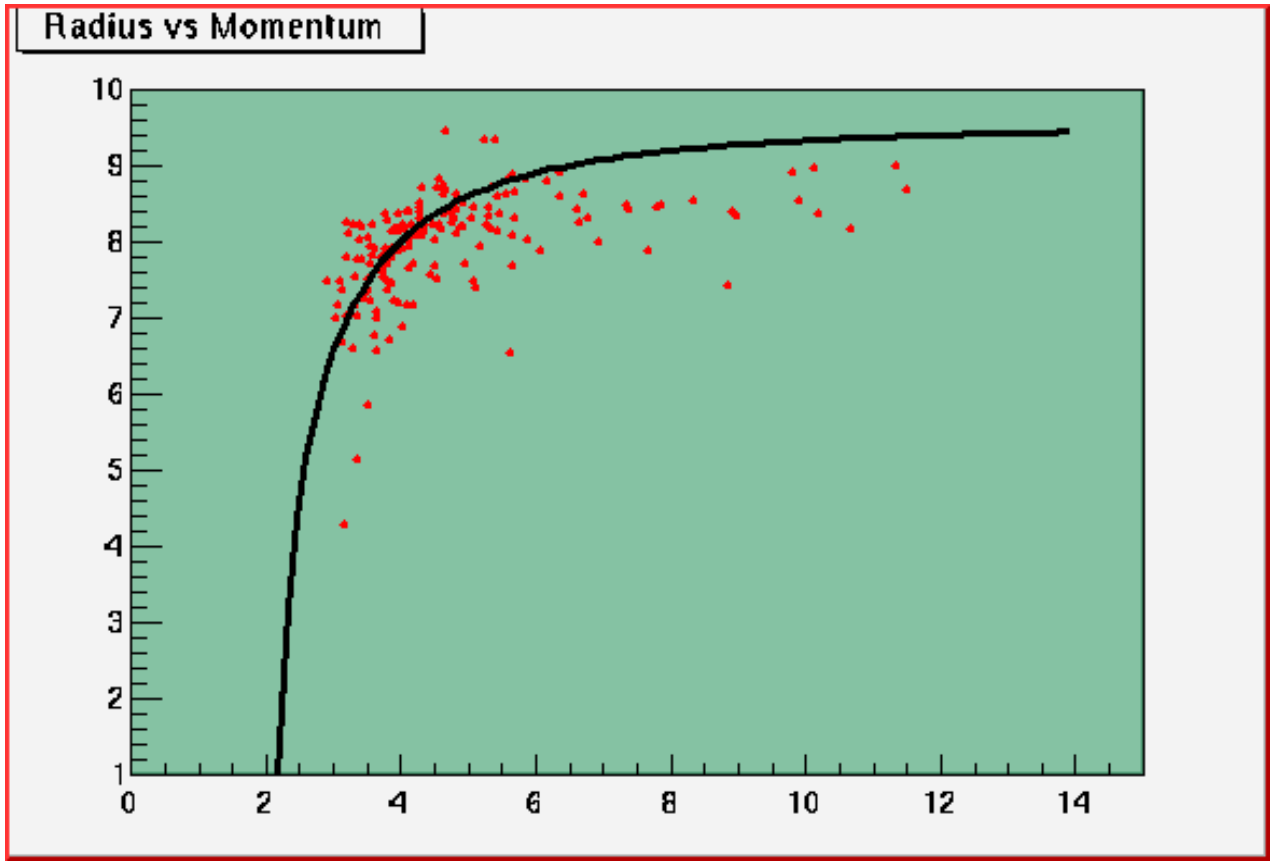
The main results presented here are

- Particle ratios determined at η ~0 and 3.
- pbar/p ~0.61 ±0.06 and 0.35 ±0.05 independent of pt and centrality
- π+/ π-, K+/K- ~1at η ~0
- Charge particle density $dN/d\eta$ ~ 545 ± 6 ± 60 for most central 0-6% collisions.
- The the Au Au reaction at $\sqrt{s_{nn}}$ 130 GeV still exhibit a net baryon yield at mid-rapidity.

Aux. Slides

- The next set of slides shows the good performance of the RHIC detector that will be crucial for next years run.

Radius of single rings vs momentum measured in Forward Spectrometer

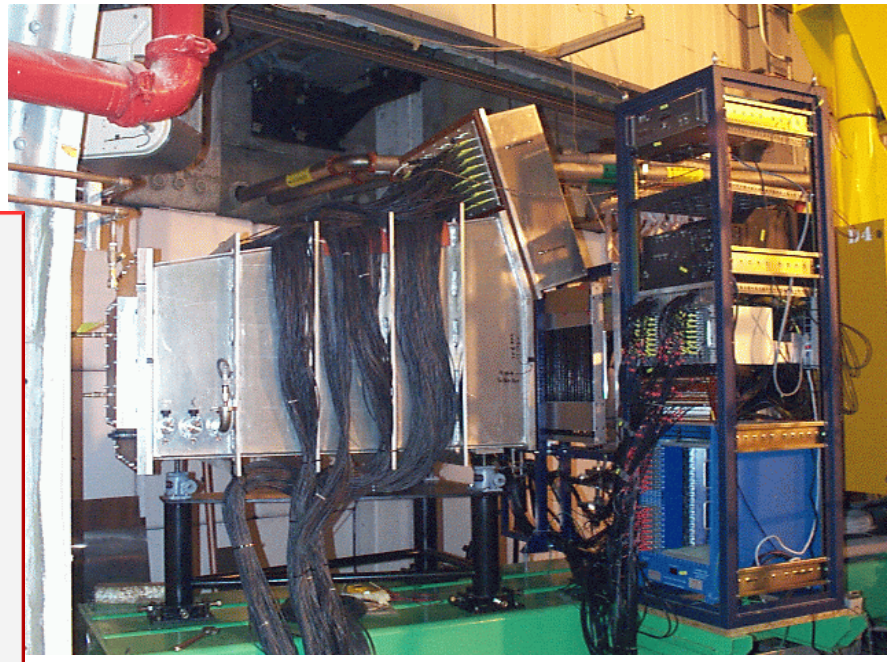


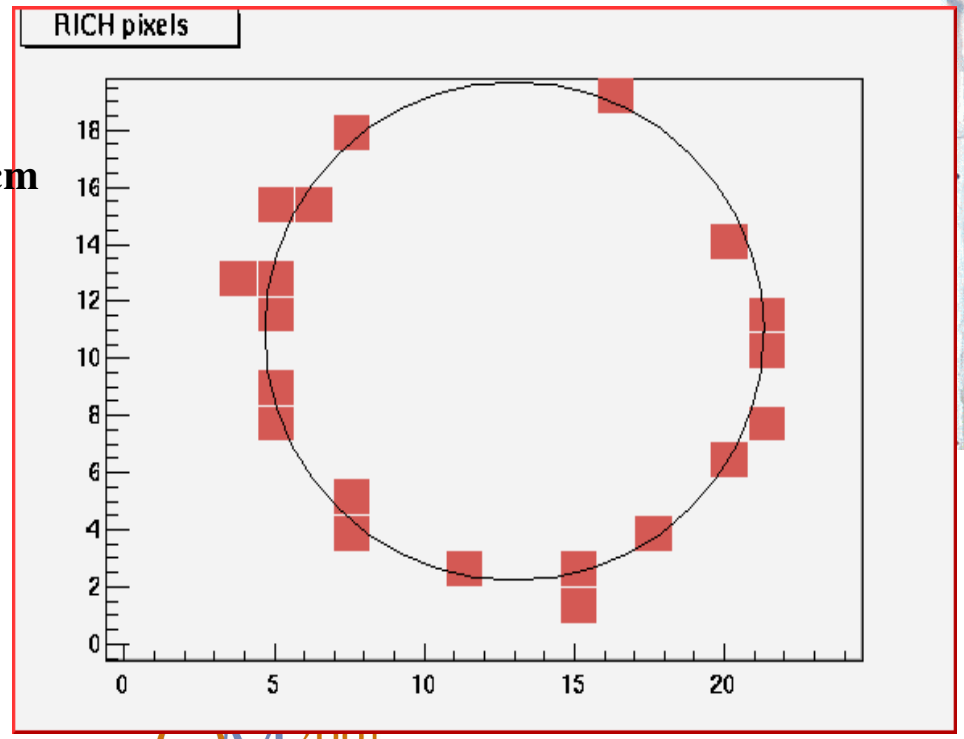
BRAHMS Ring Imaging Cherenkov detector

1.25 atm of C4 F10 and

C5 F12 mixture

Measured index of refraction: n = 1.00203





Average # of p.e : 20

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