

Brahms

RHIC Beam Use Proposal

HE/NP PAC

September 27, 2001

Brookhaven National Laboratory, USA

Fysisk Institutt, University of Oslo Norway.

IReS, Université Louis Pasteur, Strasbourg, France .

Jagellonian University, Krakow, Poland.

Institute of Nuclear Physics, Krakow, Poland

Johns Hopkins University, Baltimore, USA.

New York University, USA.

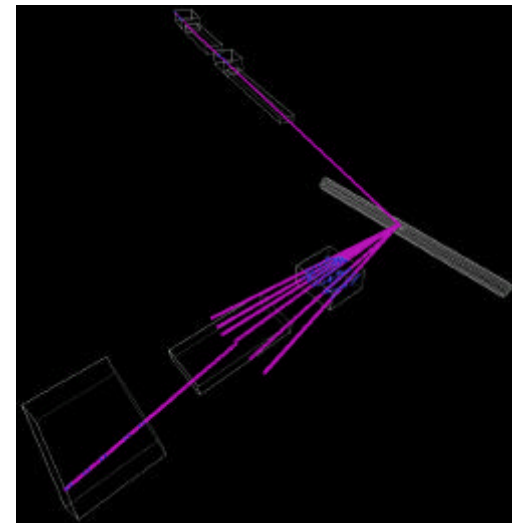
Niels Bohr Institute, University of
Copenhagen, Denmark

University of Bucharest, Romania.

University of Kansas, USA.

University of Bergen, Norway.

Texas A&M University, College Station, USA



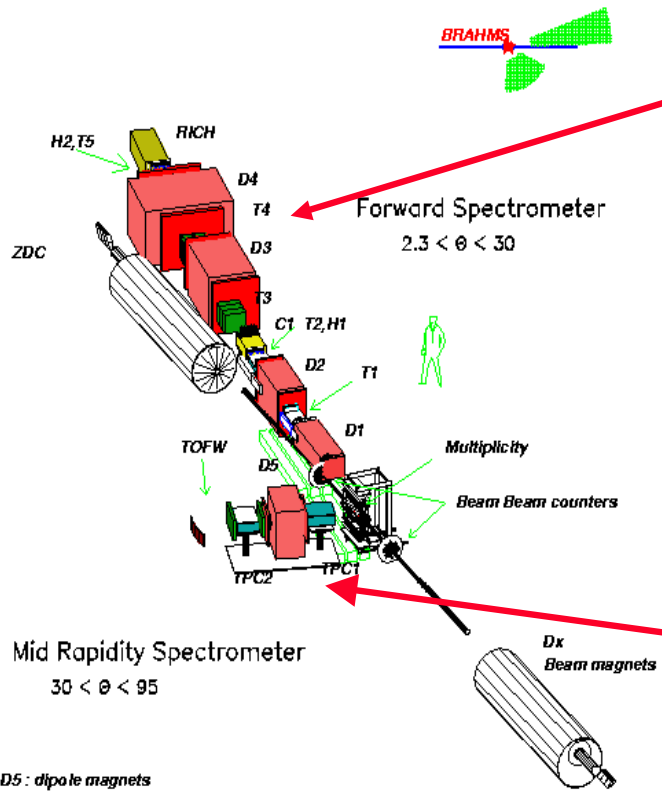
Overview of presentation

- Introduction
- Summary of Run-1 (2000)
- Run-2 (FY2001/02)
 - Detector completions
 - Accomplishment so far and expectations for data collection and analysis in ongoing run.
- Beam Requests for possible Run-2 extension.
 - ✍ Au-Au completions at $\sqrt{s_{NN}}=200$ GeV
 - ✍ Lighter system at $\sqrt{s_{NN}}=200$ GeV (preferential Si/S)
 - Au-Au at lower energy. $\sqrt{s_{NN}}=130$ GeV.
 - Comment on pp running

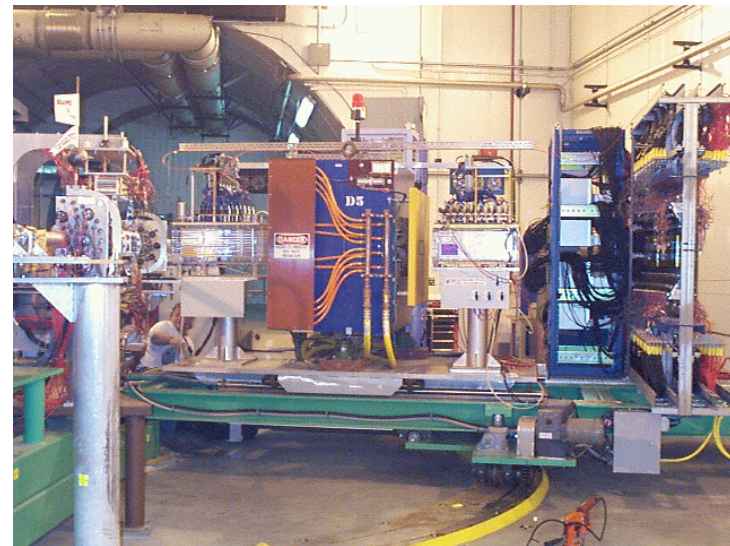
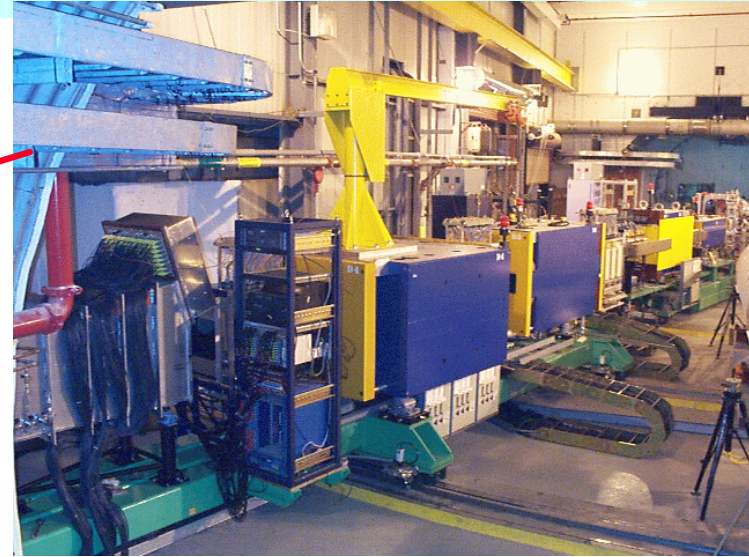
Place in RHIC program

- The Brahms experiment has unique capabilities in terms of precise momentum determination and particle ID.
- The forward spectrometer (FS) covers a rapidity range up to about 4 , and a large momentum and transverse momentum range
- The excellent Particle Identification (PID) in Mid-Rapidity Spectrometer (MRS) complements measurements by other RHIC detectors, and allows for comparisons to higher rapidities.

Perspective View of BRAHMS Spectrometer



*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*



BRAHMS Physics Goals

Soft Physics

- Reaction Mechanism and dynamics.
- Baryon Stopping (transparency, plateau)
- Thermalization, expansion and freeze-out.

Hard processes

- Mini-jet production systematic; rapidity dependence ($p_t > 2 \text{ GeV}/c$ p, K, ?).
- Comparison of p_t spectra at $\eta \sim 0$ and $\eta \sim 3$ in pp, pA and AA.

BRAHMS Measurements and Methods

Measurements

- p, K, ? identified in wide range of rapidity, $0 < |y| < 4$ and $0.2 < p_t < \sim 3\text{GeV}/c$ (central and fragmentation region).
- Measure p_t spectra as function of centrality, collision and cm energy.
- HBT & Heavier clusters (d,t, ^3He)

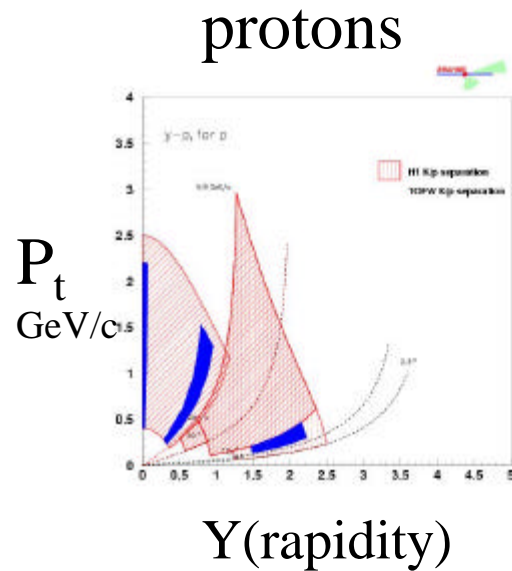
Method

- High precision momentum determination, and Particle Identification in small solid angle spectrometer.
- Large dynamic range in accepted momenta, and angle.

Run-1 Accomplishments

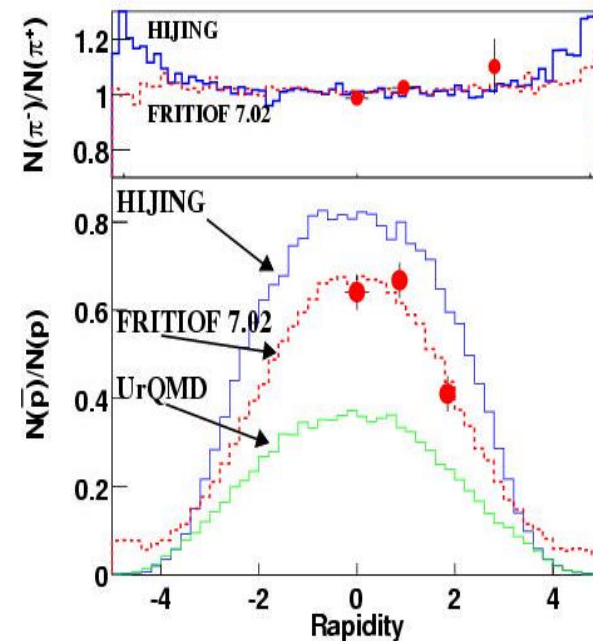
- Run Usage
 - Commissioning of detector systems (Global detector, MRS, and FFS tracking)
 - Physics data taking during ~2 weeks end August 2000.
- Issues
 - Wide vertex distributions and machine background gave limited statistics for useful events.
- Physics Results
 - Global charged particle distributions. (Submitted PLB August 14 2001, nucl-ex 0108015)
 - Identified charged hadron ratios. (PRL 87, 112305 (2001))

P-bar/p p_t and rapidity dependence from ? $s_{NN} = 130$ GeV



P-bar/P rapidity dependence
is a consequence of interplay
between Stopping and particle
production. No models so far
reproduce both this dependence and
 dN/dy $y \sim 0$

Published in PRL 87, 112305 (2001)



Detector Configuration Changes for run-2

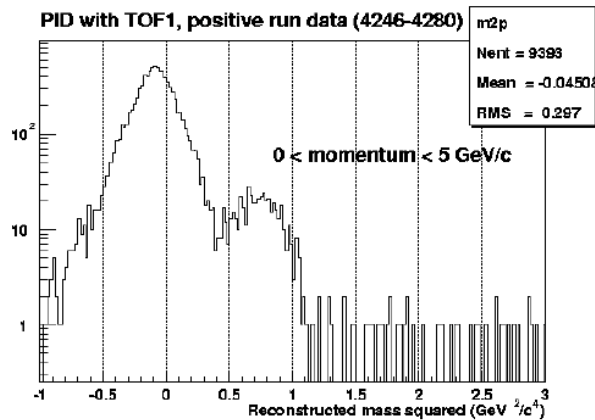
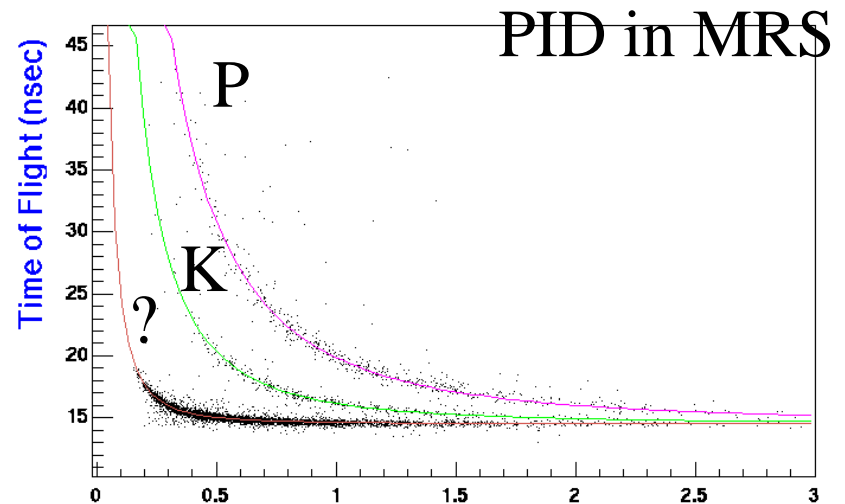
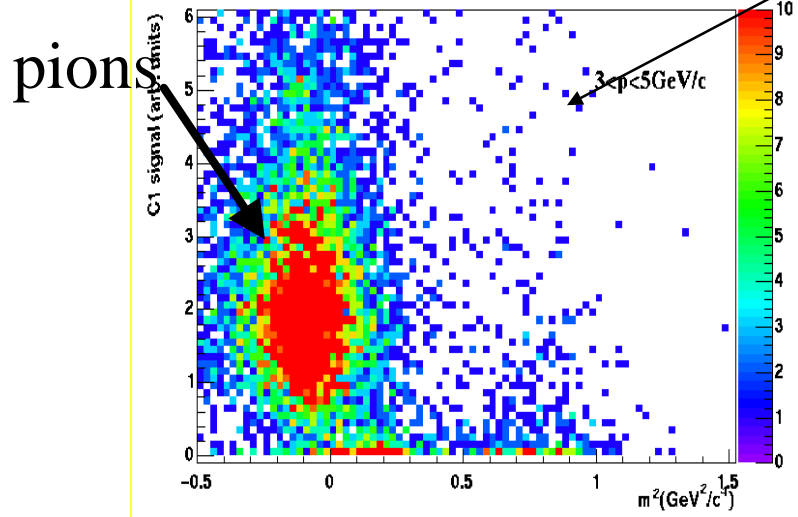
- Thanks to CA-D the addition of A/C substation completed – can operate magnets at full field.
- The TOFW was extended to full (+-) coverage. Calibration slats and fibers added.
- TPM1 readout plane was rebuild at BNL. (changed pitch and wire distribution).
- The Gating grid system was commissioned for all detector and significant noise reduction achieved.
- The BFS DCs were instrumented with readout electronic, checkout, integrated into DAQ.

Run-2 Progress

- Physics data taking is now into week 6 of the Au-Au run
- Achievements
 - Detectors has been commissioned including adjustments, fixes; The entire Spectrometer system is now functional
 - Data taken before physics running has been used extensively for calibrations and software development
- Higher level triggers for the higher luminosity have been developed
 - Centrality trigger (Central barrel – can select down to 20%)
 - Vertex selection (based on ZDC - +/-20cm selection)
- Data taking is in routine mode.
- Concerns about beam background (near DX-D0). Contributions to DC currents, and hodoscope rates.

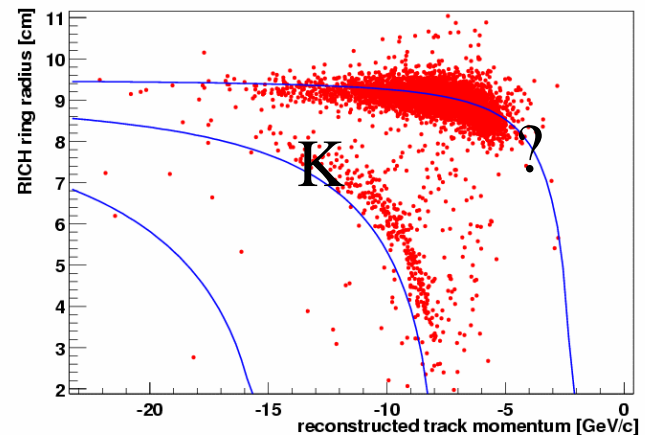
Performance of Spectrometers in on-going run

Cherenkov (C1) vs H1 PID

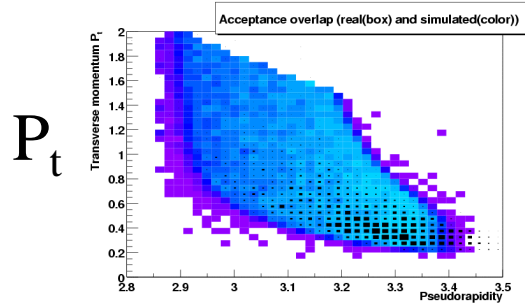


Mass²

RICH - response

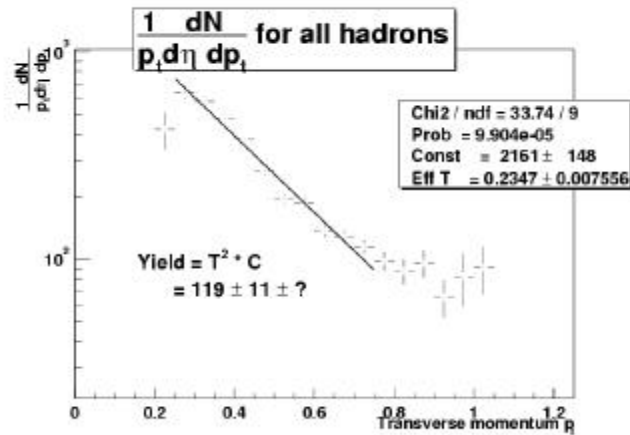


Spectra..

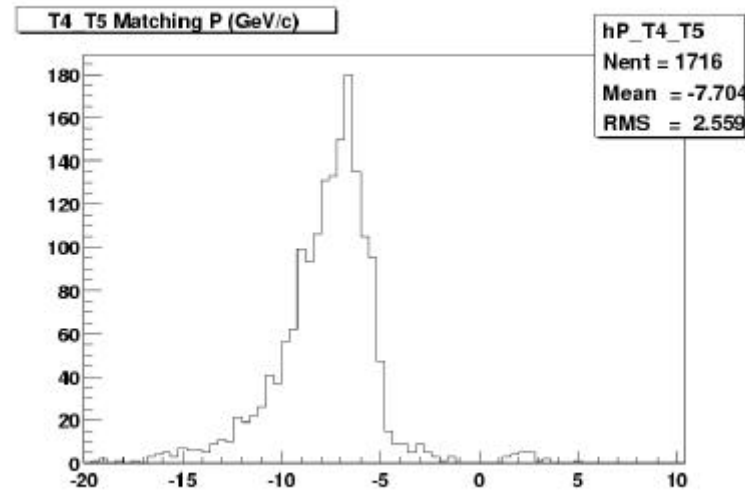
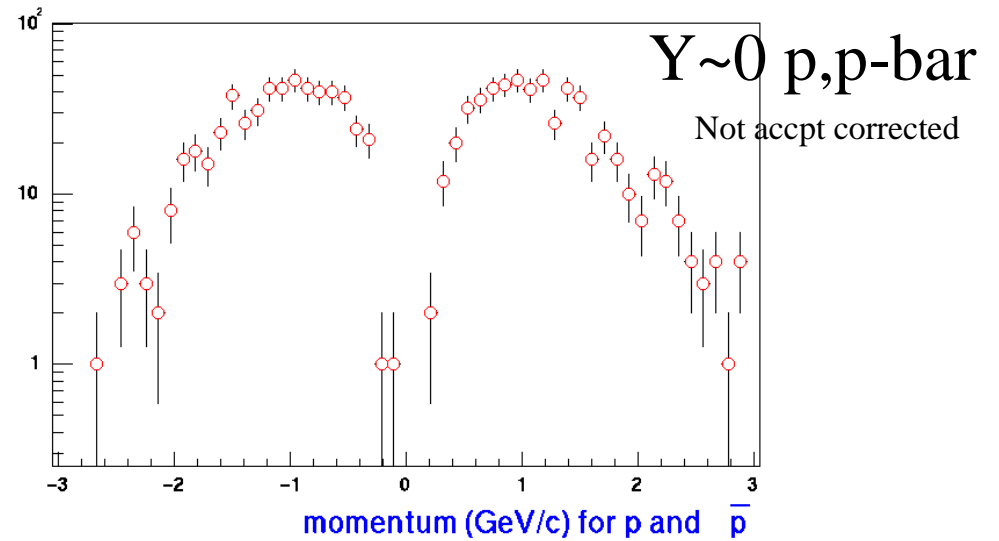


?

FS accpt, spectra



P_t (GeV/c)



P (GeV/c)

Data Taking for Run-2

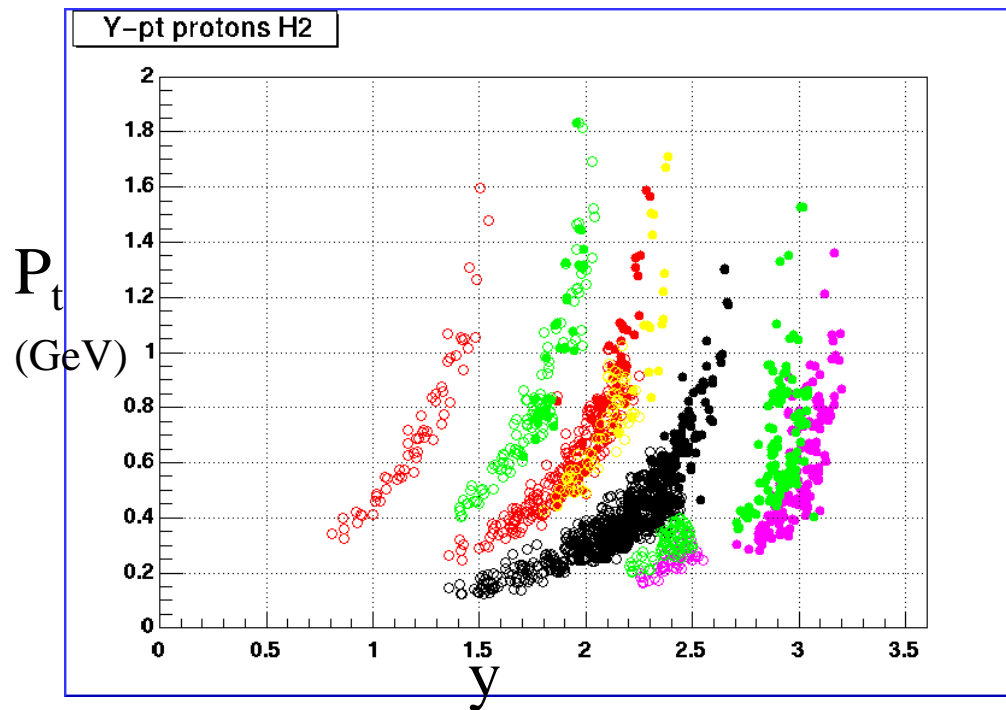
Angle	Fields	Interaction Recorded (M)	Data-taking hours
4	1/5 A,B	9.2	112
4	1/3 A,B	3.0	38
8	1/5 A,B	5.2	71
3	1/3 A	2.2	24
90	2 A,B	20	160
90	4 A,B	5	44
40	3 A,B	5	40

- Data hours/week ~ 45. Corresponding to Brahms uptime of >80% of delivered beam.
- Is about 8% of goal for run-2.
- The measurements consists of multiple angle and field setting for an average of 5-10 μb^{-1} recorded with a goal of $\sim 150 \mu\text{b}^{-1}$
- Goal to complete significant part of the baseline AuAu program as per 2000 RBUP with measurements from $y=0$ to 3.5 and $p_t \sim .2 \rightarrow 1.5 \text{ GeV}/c$.
 - Unlikely, we can complete the higher p_t measurements at $y \sim 2, 3$.

Acceptance for run-settings

The small solid angle necessitates many measurements to obtain detailed $dN/dydp_t$ for identified particles.

Protons (expected for angular settings 2.5 3 4 8 12 20 deg)



Beam Request

- Run-2 extension (8 weeks ?)
 - ✍ Complete the Au-Au measurements (4-6 weeks)
 - ✍ Supplement on-going measurements.
 - ✍ Perform the high statistics runs at large p_t with the FS, the HBT measurements in FS, MRS, as well as heavier fragments studies.
 - Perform a survey at the highest energy for a lighter system (Si/S or alternate Cu) (4 weeks).
 - A shorter period with Au-Au at lower energy ,130 GeV, to supplement data already taken
 - Comparison runs with pp; transverse polarization measurements

Follow up on specific issue that will emerge from the analysis in run-2.

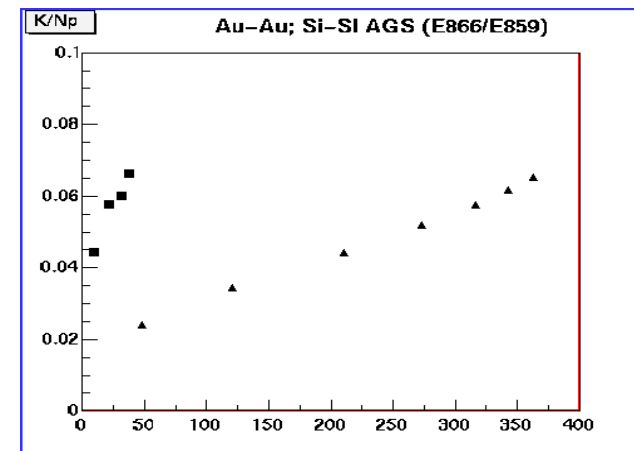
Au-Au at 200 GeV

- Completion of on-going program
 - Measurements at the highest possible energy is crucial to explore high density matter. The experiment has a duty to explore this in detail before moving on to systematic studies of changes with ions and/or energy
 - Understanding of spectra at intermediate to high p_t is emerging as an important aspect of the RHIC HI program.
 - We request sufficient time to do complete such a program. The precise amount will clearly depend on the progress in the next 6 weeks.
 - Additionally we want to perform sets of measurements of HBT (MRS and FS) as well as heavy clusters in FS.

Light Ion Collisions

The second request is for measurements with a lighter projectile. When considering the number of participants in the reaction such a light system gets access to a region (low number of #participants) that cannot easily be measured by peripheral Au-Au collisions. These measurements should be done at the same energy as Au-Au i.e. $\sqrt{s_{NN}}=200$ GeV. For this system the focus will be on central collisions where trigger and global detectors will be fully efficient. Our preference is S or /S since lower energy data exists from SPS and AGS

Cu would be acceptable as ion species; there are no lower energy data but the ‘overlap’ with N_{part} is larger with the Au-Au system.



Lower energy running

- The multiplicity data from RHIC at 56, 130 and 200 GeV show only a logarithmic dependence in overall particle production. This is somewhat disappointing, but emphasizes the need for detailed studies of AA reactions, and in our opinion demonstrates the importance of the highest energy.
- Despite this we believe it useful to have a good survey at lower energy. The preference of the collaboration is to add to the 130 GeV data.

pp Running in Run-2

- Commissioning of detector system
 - Comparison to pp as a reference for AA will be useful.
 - Implement the common in-elasticity detectors shared with pp2pp.
 - Spectrometers need time-start counter for spectrometers for TOF PID. Resource limited for implementing this, but could be achieved for FS, certainly not for MRS.
- Exploring possibilities for a spin program (high x_F , transverse polarization) for transversity measurements with the RHIC spin group. This could be initiated in Run-2 with the one week of $\sim 1.5 \text{ pb}^{-1}$, but will require a longer period for high statistics later.

Summary

Strategic points of request

- Au Au at $\sqrt{s_{NN}} = 200$ GeV to complete and extend Run-2 primary goal
- Light ion system at $\sqrt{s_{NN}} = 200$ GeV
- Au-Au at lower collider energy
- Extended pp,p(d)A running will be most beneficial to Brahm's following a shutdown period. [somewhat pending experience from December run-period].

BRAHMS Collaboration

Brookhaven National Laboratory¹, USA

Fysisk Institutt², University of Oslo Norway.

IREs, Université Louis Pasteur³, Strasbourg, France .

Jagellonian University⁴, Krakow, Poland.

Institute of Nuclear Physics, Krakow, Poland

Johns Hopkins University, Baltimore, USA.

New York University⁶, USA.

Niels Bohr Institute⁷, University of Copenhagen, Denmark

University of Bucharest⁸, Romania.

University of Kansas, USA.

University of Bergen, Norway.

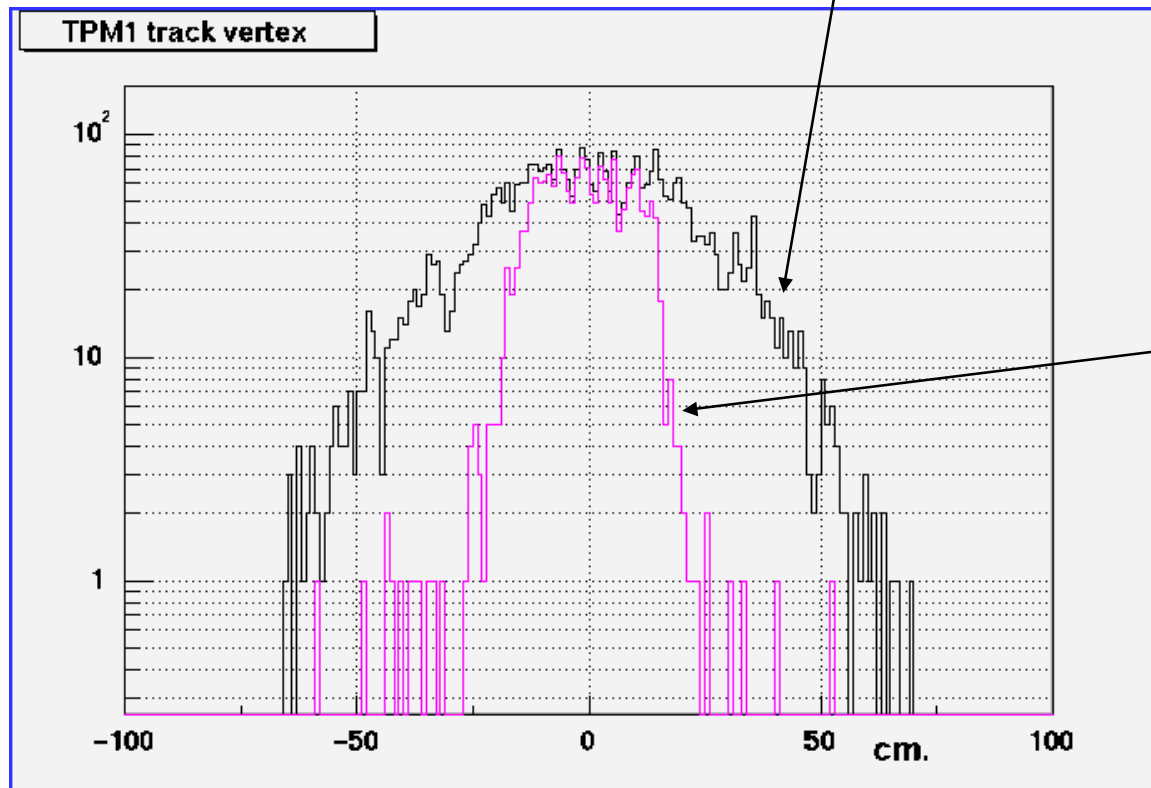
Texas A&M University, College Station, USA

I. G. Bearden⁷, D. Beavis¹, C. Besliu⁸, Y. Blyakhman⁶, J. Brzychczyk, B. Budick⁶, H. Bøggild⁷, C. Chasman¹, C.H. Christensen⁷, P. Christiansen⁷, J. Cibor, R. Debbé¹, J. J. Gaardhøje⁷, K. Grotowski, J. I. Jordre¹⁰, F. Jundt³, K. Hagel¹¹, O. Hansen⁷, A. Holm⁷, C. Holm⁷, A.K. Holme², H. Ito⁹, E. Jacobsen⁷, A. Jipa⁸, C. E. Jørgensen⁷, E. J. Kim⁵, T. Keutgen, T. Kozik⁴, J. H. Lee¹, Y. K. Lee⁵, G. Løvbjerg², T.M. Larsen, Z. Majka⁴, A. Makeev¹¹, B. McBreen¹, M. Murray¹¹, J. Natowitz¹¹, B.S. Nielsen⁷, K. Olchanski¹, D. Ouerdane⁷, R. Planeta, F. Rami³, D. Roerich¹⁰, B. Samset², S. Sanders⁹, R.A. Sheetz¹, Z. Sosin, P. Stazel^{4,7}, T.S. Tveter², F. Videbæk¹, R. Wada¹¹, A. Wieloch and I. S. Zgura⁸.

Vertex Selection

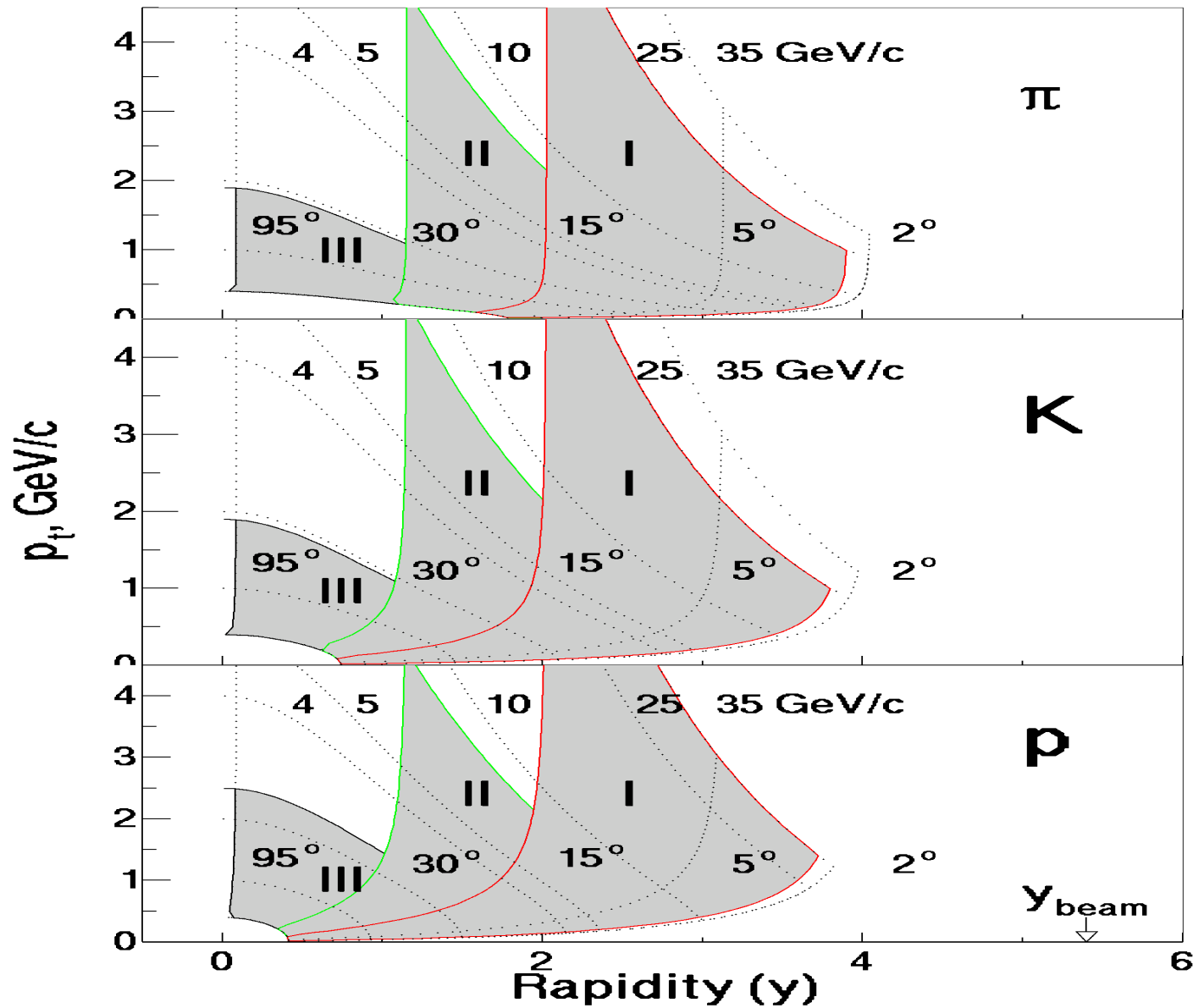
Trigger based on 'fast precise
Overlap from ZDC CFD timing

Track z-projection from all
events



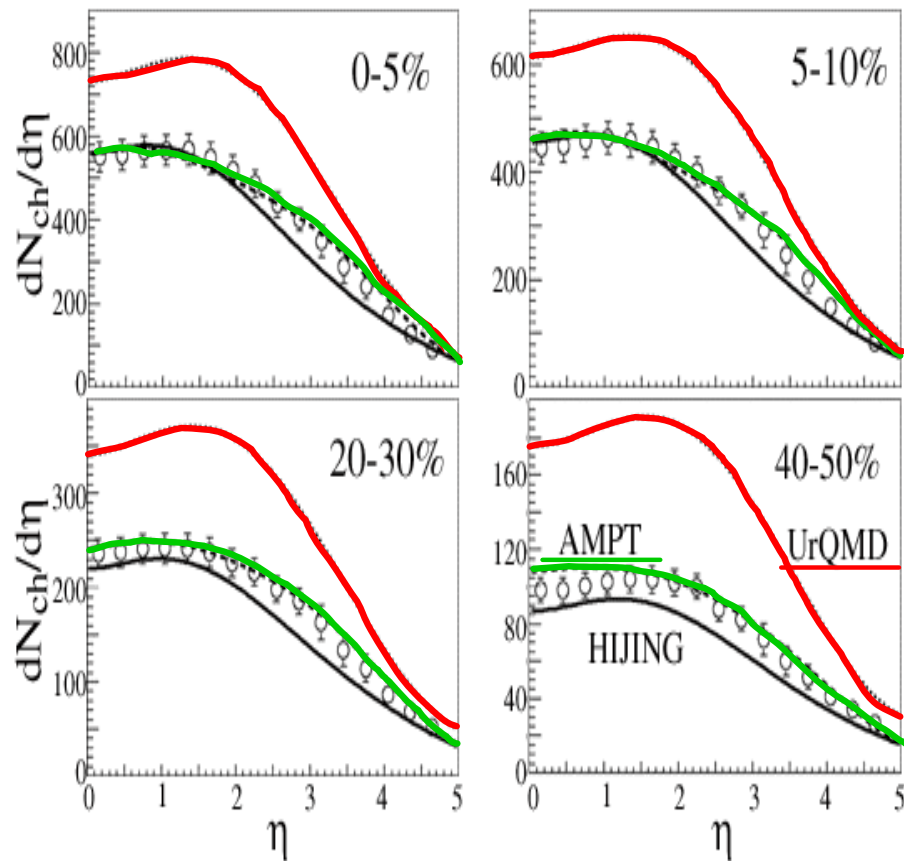
Tracks from
events with trig.

Brahms Over acceptance for identified hadrons



Charged Hadron Multiplicity ($dN_{ch}/d\eta$) at $\sqrt{s_{NN}} = 130 \text{ GeV}$

Combining 4 detector systems

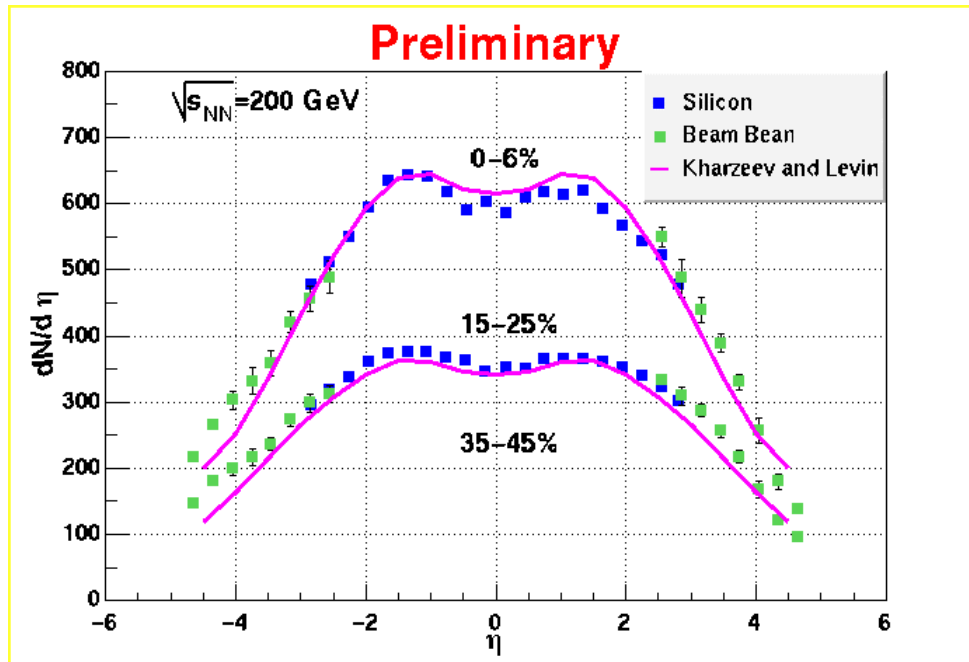


- Plastic Scintillator Tile + Silicon ($2 < \eta < 2$)
- Beam-Beam Counter ($2 < |\eta| < 4$)
- ~ 550 at $y = 0$
- Consistent with measurements using tracks in TPC at $y = 0$
- Data \sim HIJING at near Mid-rapidity while data $>$ HIJING at $2 < \eta < 4$

Submitted PLB
August 14 2001

Global measurements ? $s_{NN} = 200$ GeV

The first analysis of the global properties is underway.
Very preliminary $dN/d\eta$ distributions using BBC and Si-det only (already shown at RHIC/AGS users meeting.)



A small increase ($\sim 10\%$) at
 $\eta \sim 0$
Slightly wider $dN/d\eta$?
distribution than at 130 GeV.