

BRAHMS Heavy Ion Group

Science and Technology Review of RHIC

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Outline of presentation

- o **Manpower and current support**
- o **Science and priorities**
- o **Accomplishments**
- o **Plans**
- o **Issues**

Manpower and current support

Scientific Staff

- F. Videbaek (Group Leader)
- C. Chasman
- D. Beavis (Project Manager)
- J.H. Lee
- R. Debbe
- H. Ito (post Doc.)

Technical Staff

- E. Baker (mech. Tech.)
- J. Hammond (el. Tech.)
- M. Echmalian (1/2 time sec.)
- R. A. Scheetz (engineer, also involved in STAR DAQ design)

Even though the group is small, we continue to be the driving force within the BRAHMS Collaboration.

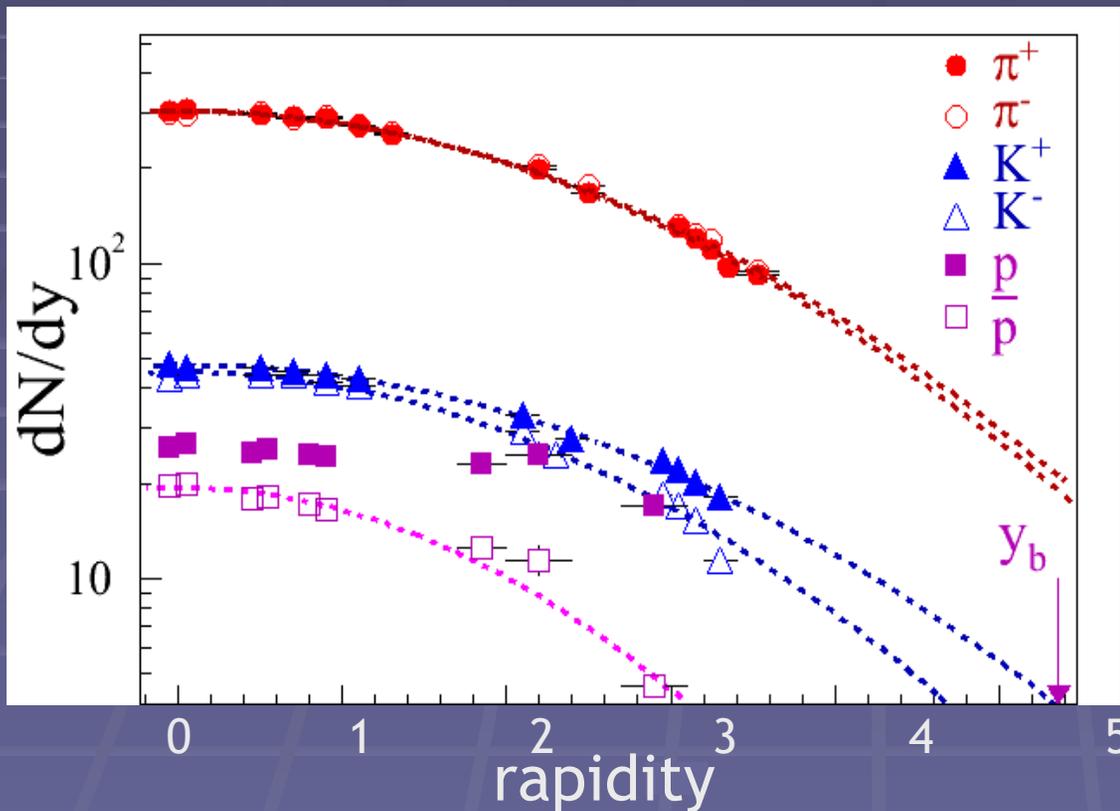
This is mainly because of the right mixture of our expertise both in hardware and physics analysis.

Our responsibilities within BRAHMS

- F. Videbaek Spokesperson
- D. Beavis Project Manager
- JH. Lee 2005 run Coordinator
- H. Ito DAQ
- R. Debbe Cherenkov detectors and TPCs
- D. Beavis Time-of-flight detectors
- F. Videbaek Trigger
- F. Videbaek, C. Chasman, JH Lee, H Ito, R. Debbe Data analysis

Science and priorities: Initial program

Our program was centered on the detailed **survey of particle production** in heavy ion collisions at RHIC. We have been delivering results of that program:



75% of the system energy goes into particle production.

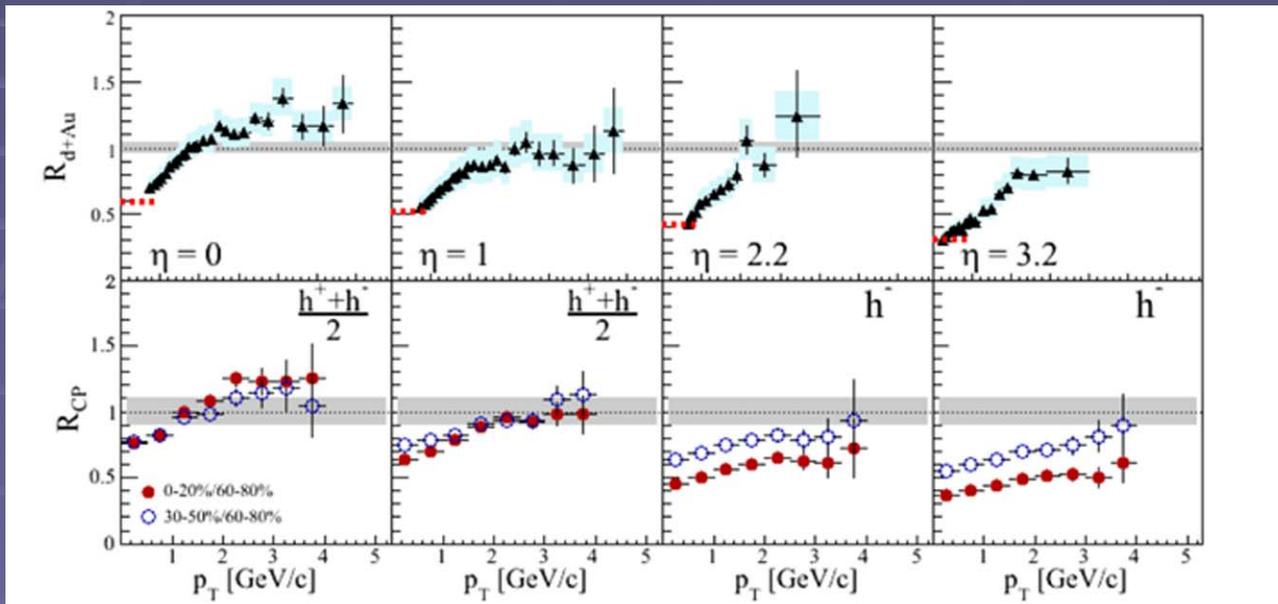
We consider this a detailed snapshot of RHIC physics. Effects of many new phenomena end up in this distributions.

Science and priorities: Present direction

Our high rapidity results from d+Au collisions have rekindled the interest in **Forward Physics at RHIC**.

Together with the Npart dependence of multiplicity distributions our d+Au results are considered as an indication of the onset of saturation in the small-x components of the Au wave function.

Some of the measured effects at RHIC may be determined by the initial state of the system



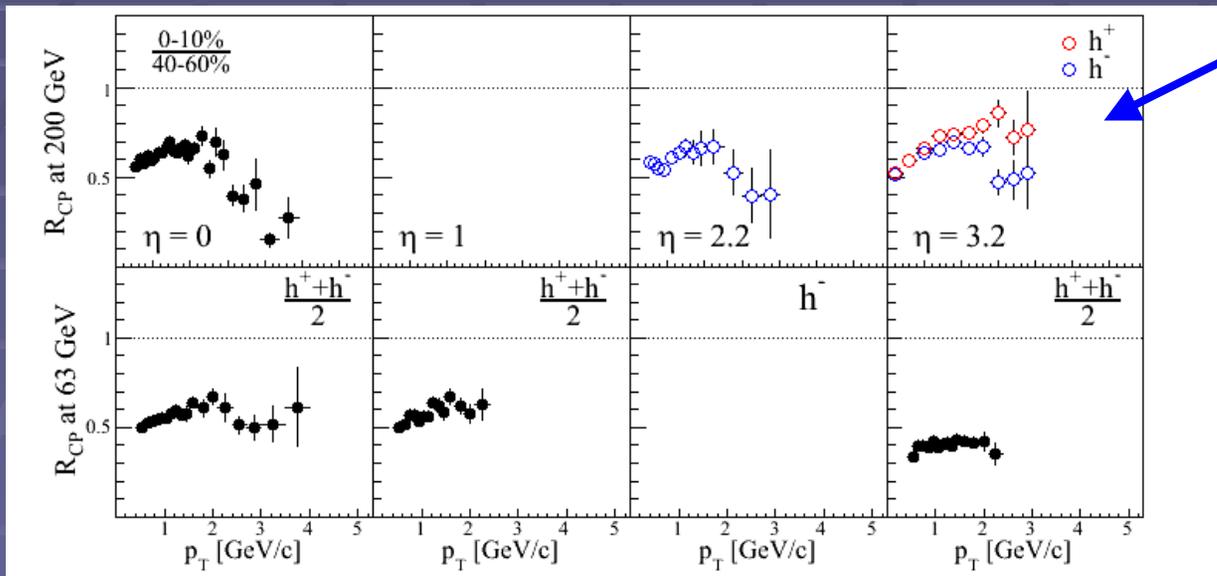
Rapidity and centrality dep. of part. prod. in d+Au compared to p+p.

Science and priorities: A+A at high y

The group priorities have shifted to studies at the highest rapidity. In particular, our group is pioneering the analysis of Au+Au data at $y \sim 3$

We consider the small change of the R_{CP} factor as function of y as puzzle for energy loss models.

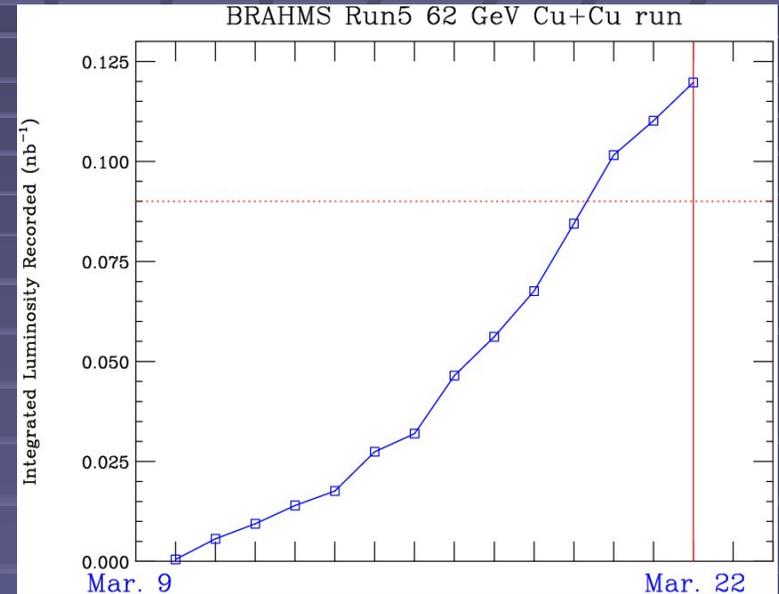
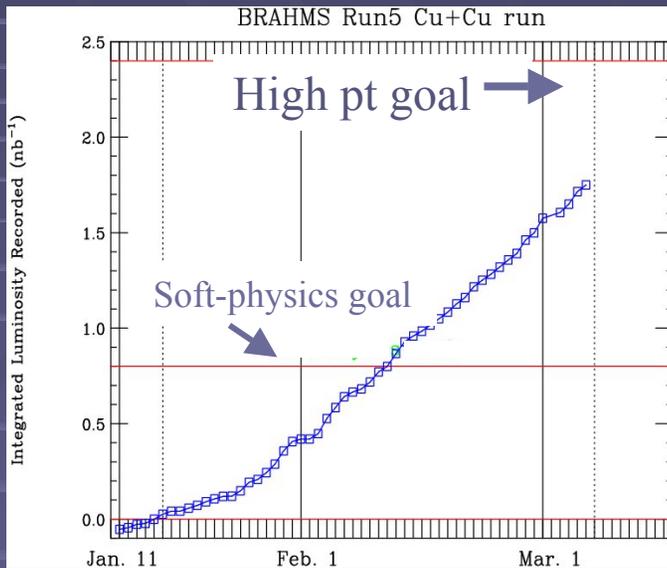
Au+Au 200 GeV



We think that the addition of reaction-plane information could disentangle this result from trivial phase-space effects.

Accomplishments: Data collection

We had a very successful 2005 run:



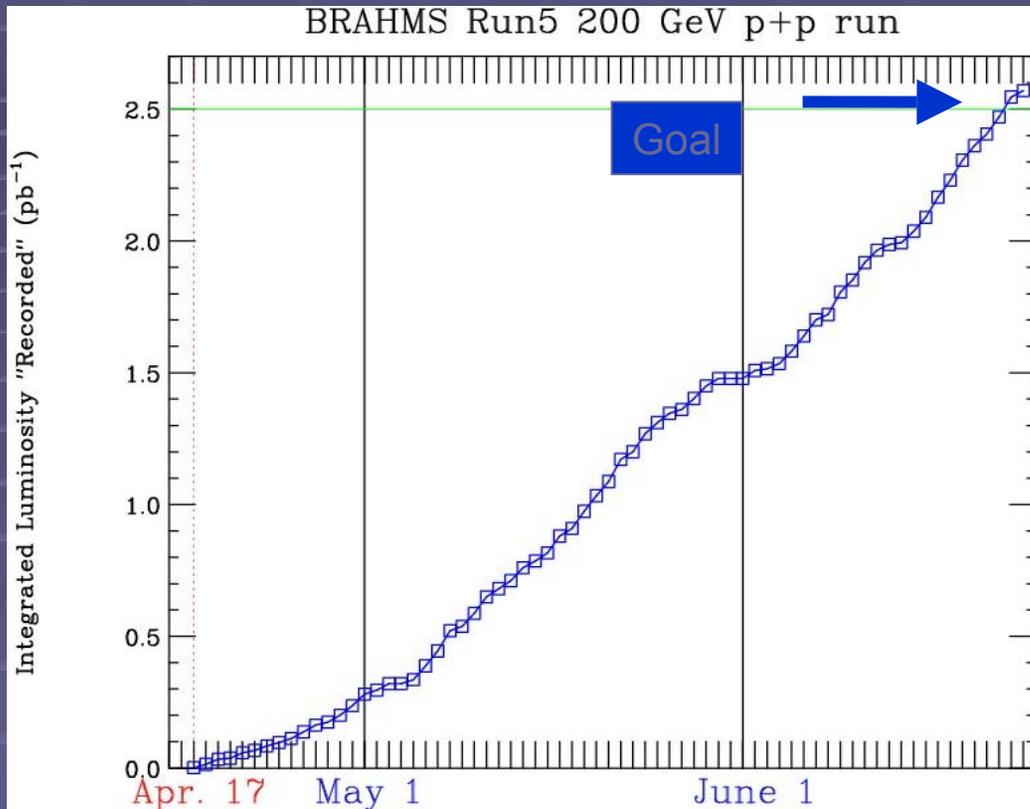
•200 GeV Cu-Cu

- ~1.75 nb^{-1} Cu+Cu 200 GeV recorded
- 56M MRS 103M FFS Triggers collected
- ~75% of the Goal Achieved

•62 GeV Cu-Cu

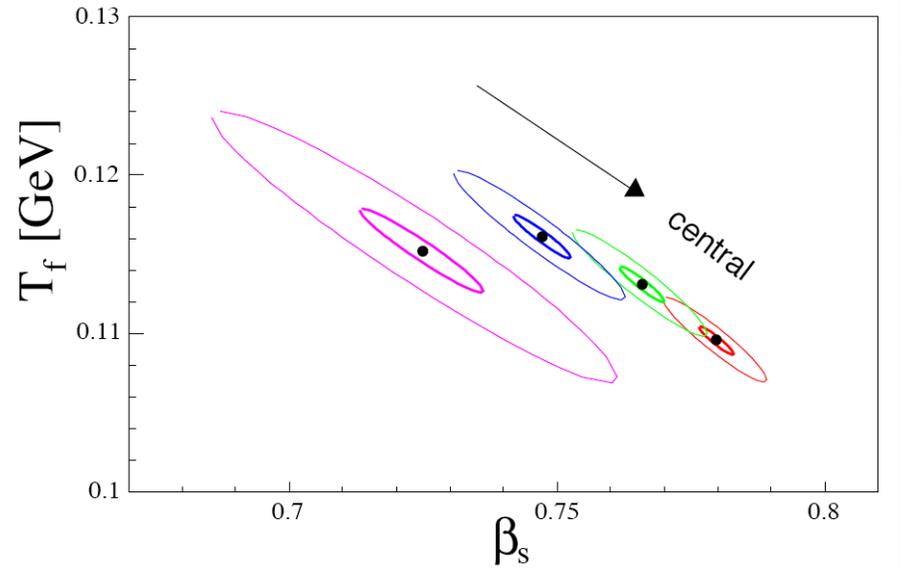
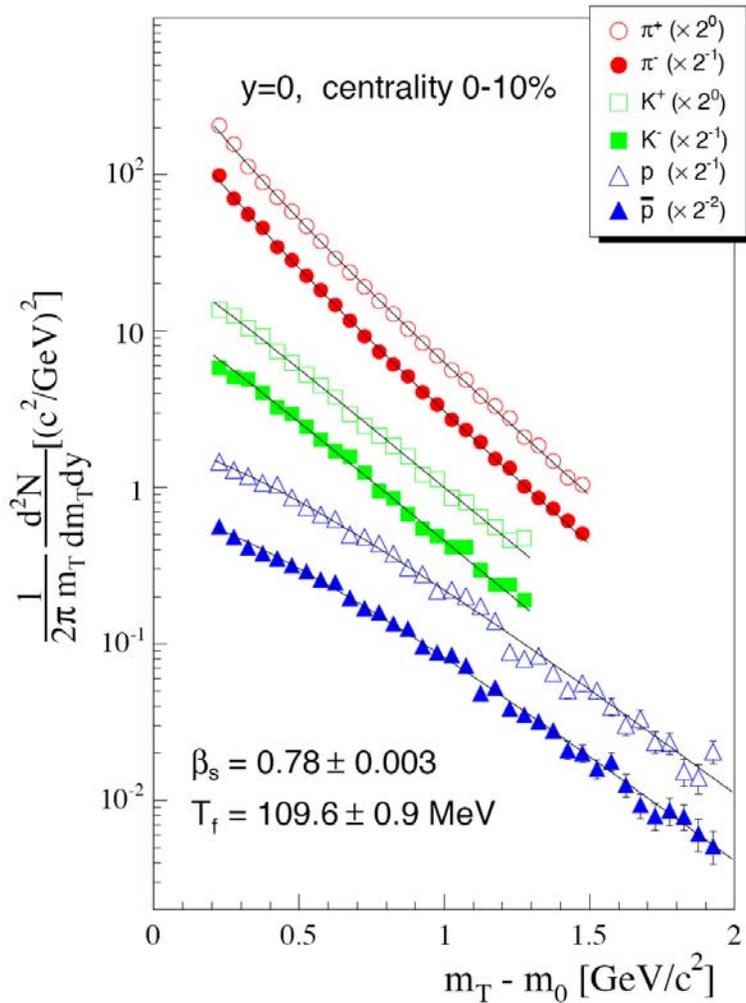
- Total 120 μb^{-1} Recorded
- 18M MRS triggers, 5.5M FS triggers collected
- Achieved the luminosity goal for physics

Accomplishments: Data collection



- $\sim 2.57 \text{ pb}^{-1}$ recorded (April 17th – June 24th)
- $\sim 2.57/2.5 = 103\%$ of the goal achieved
- Calculated by min-bias trigger covering $\sim 70\%$ of pp inelastic cross-section
- Goal Assumed:
 - Recorded/Delivered ~ 0.5
 - Blue Polarization = 45%

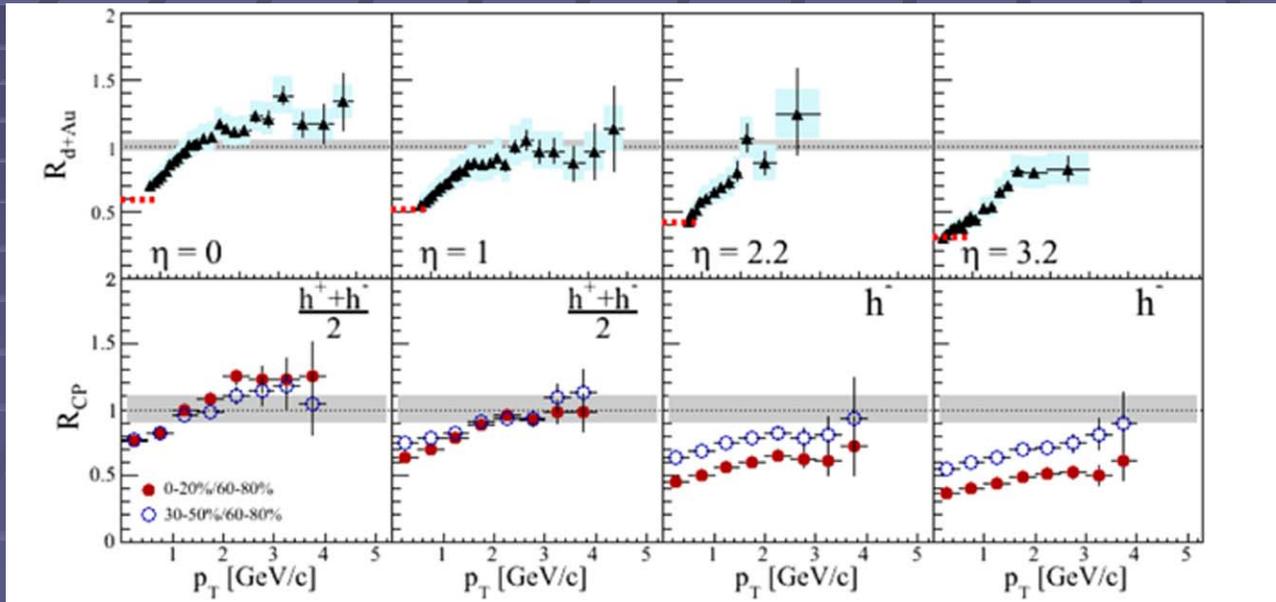
BNL Data Analysis accomplishments: Radial Flow



Studied particle production around mid-rapidity as function of centrality. In particular, we extracted parameters of “radial flow”

Phys. Rev. C (in print)

BNL Data Analysis accomplishments: Evolution of R_{dAu} with rapidity and centrality



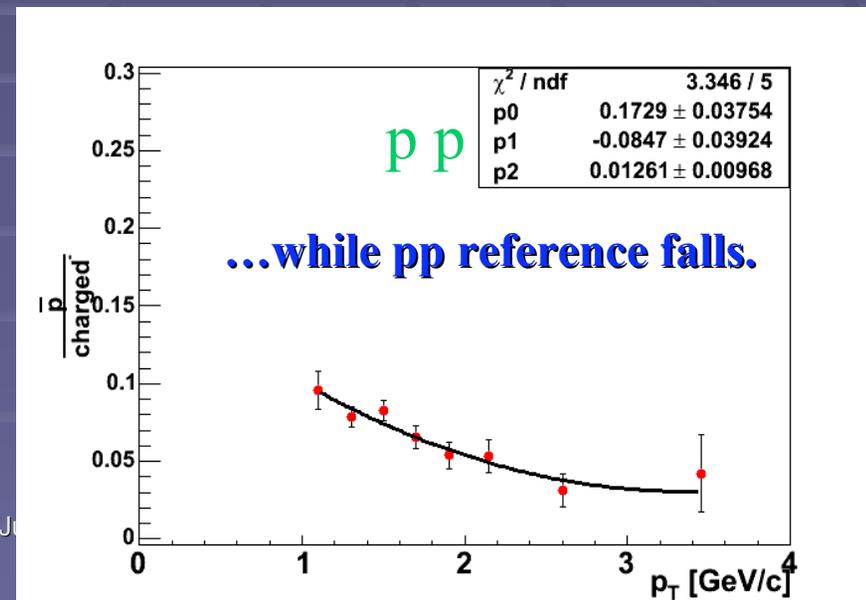
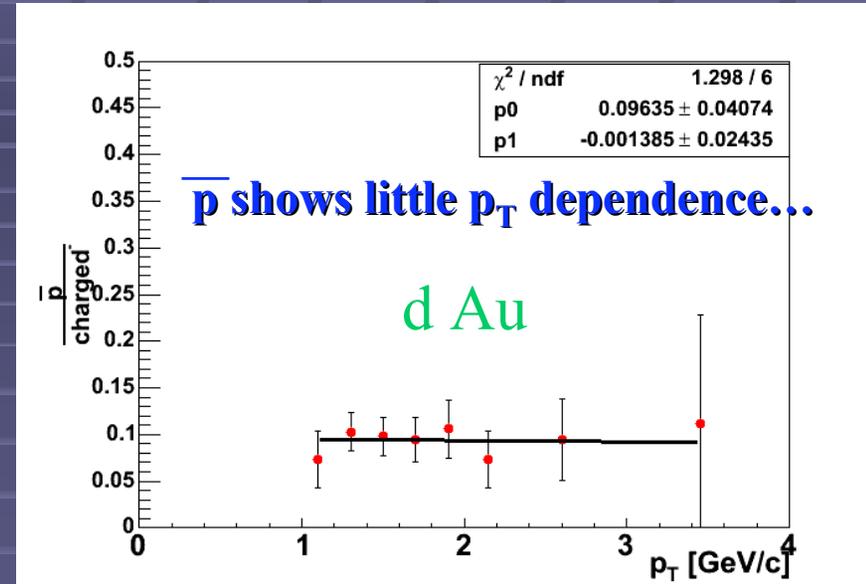
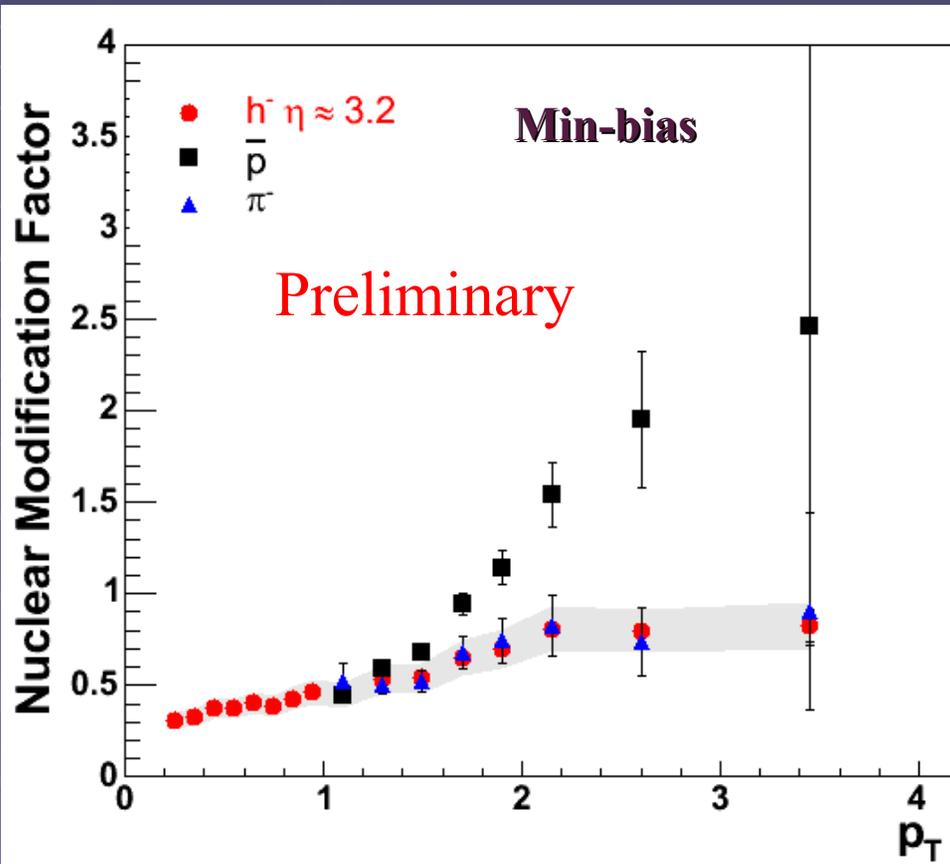
Our analysis of d+Au collisions from run 3 as function of rapidity and centrality has generated strong interest: **74 citations**

In contrast with a naïve extension of Cronin enhancement to higher rapidities and centralities, the data shows a suppression that has been identified as the onset of the Color Glass Condensate in the Au wave function at RHIC energies.

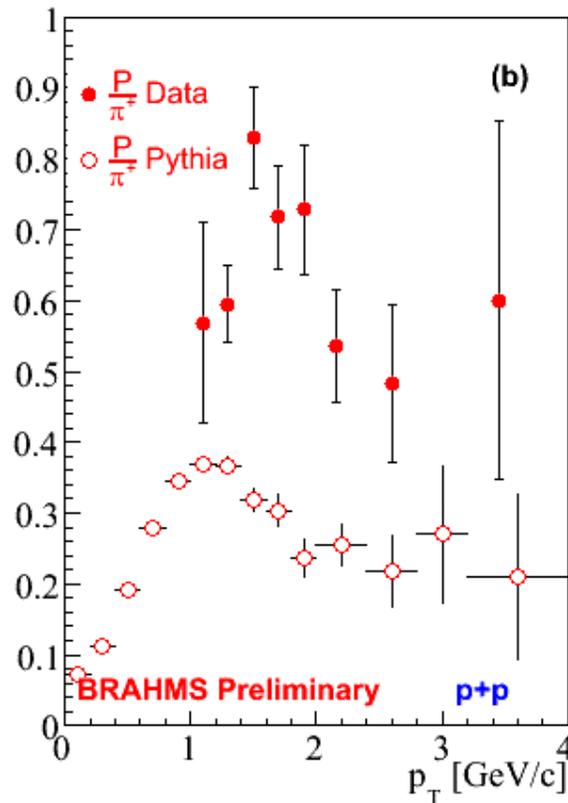
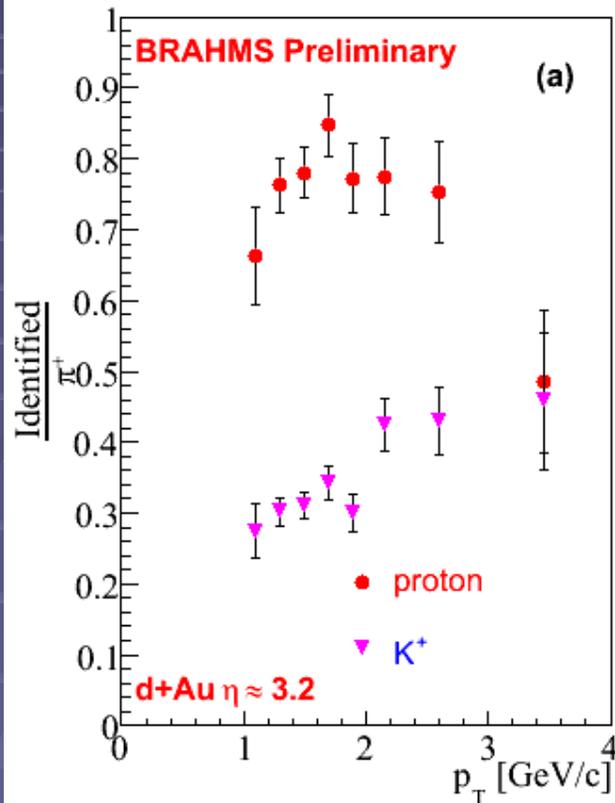
PRL 93, 242303(2004)

BNL Data analysis: d+Au collisions

Our group continues leading the analysis of d+Au data: include PID, centrality, finalize spectra.



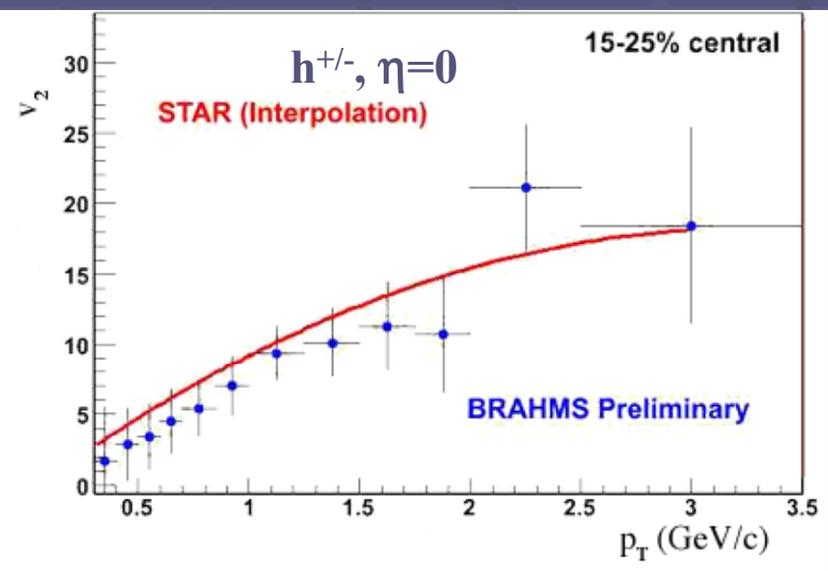
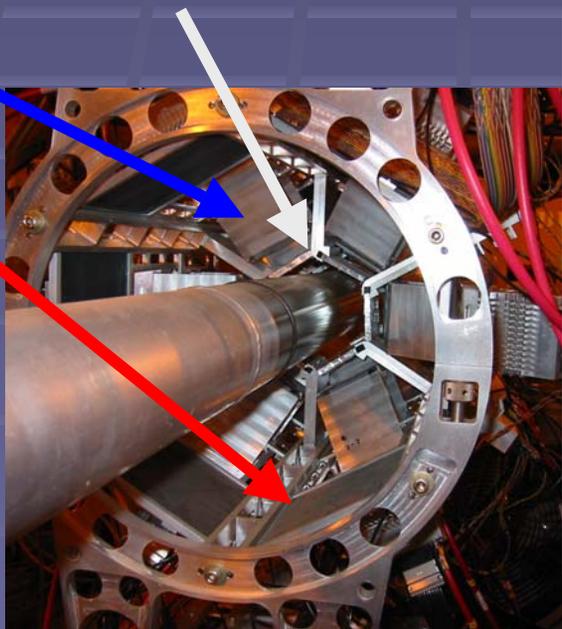
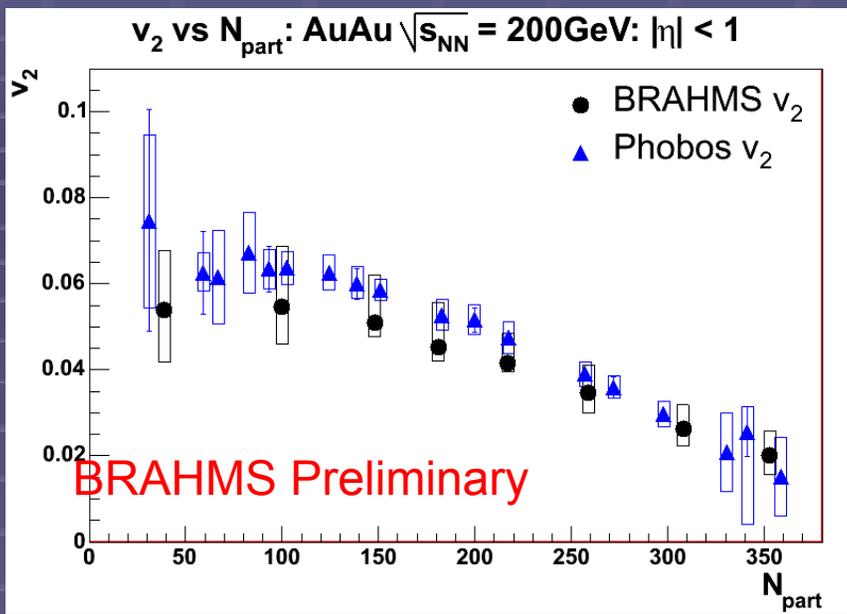
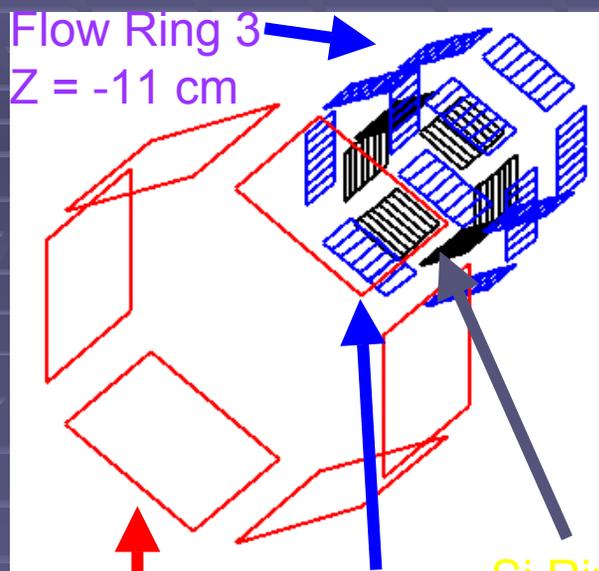
BNL Data analysis: Baryons at high rapidity



We have measured an unexpectedly large number of protons with high p_T at $y \sim 3$.

This may be a handle on fragmentation functions.

BNL Data analysis: Azimuthal Flow

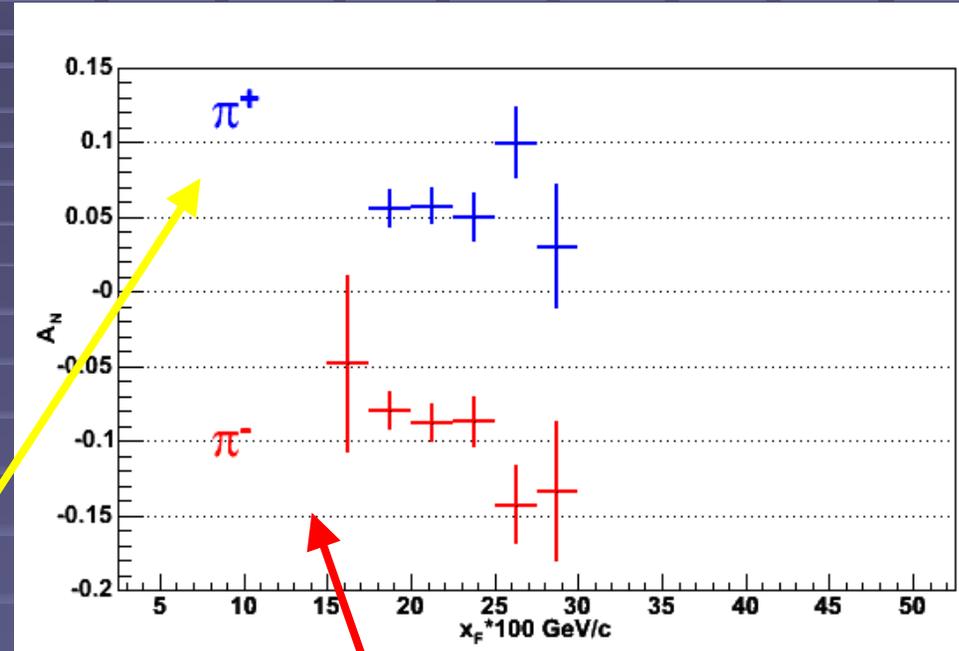


Identified particle $v_2(p_T)$ over an extended η range, $0 < \eta < 3.2$, will be presented at QM2005...

BNL Data analysis: Transverse Single- Spin

Asymmetries

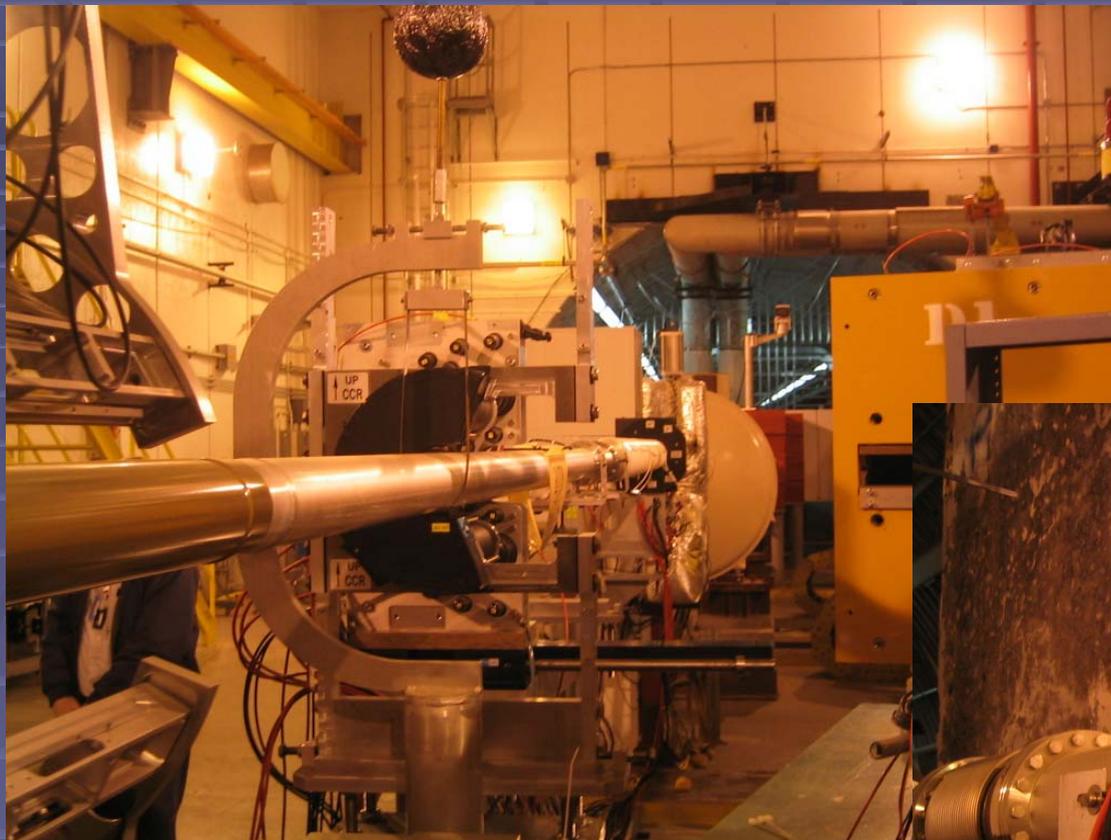
POLARIZATION WAS
~42% FOR π^+
MEASUREMENTS AND
~38% FOR π^- .
SYSTEMATIC SCALE
ERROR ON P ~ 20-30%.
WILL IMPROVE FINAL
FINAL ANALYSIS OF
CNI AND GAS JET
DATA.



$$A_N = +0.05 \pm 0.005 \pm [0.015] \text{ in} \\ 0.17 < x_F < 0.32$$

$$A_N = -0.08 \pm 0.005 \pm [0.02] \text{ in} \\ 0.17 < x_F < 0.32$$

Hardware improvements: CC counters

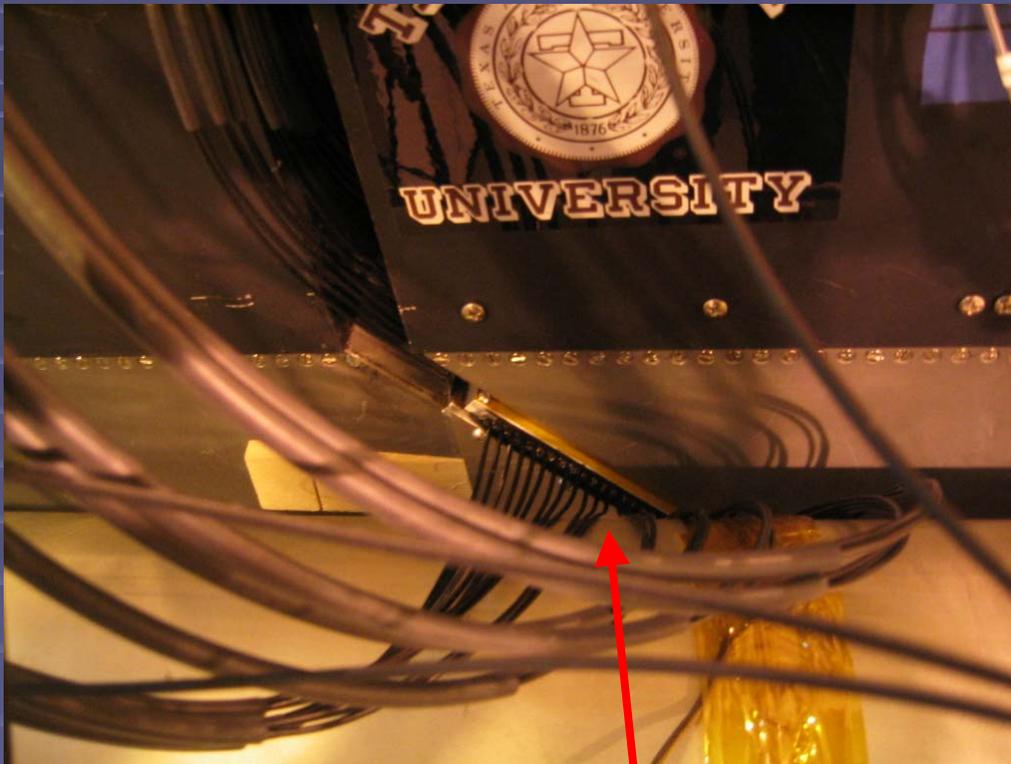


Minimum bias trigger, timing and vertex definition with Cherenkov radiation based detectors.

Improved the p+p collision definition from ~ 5 cm to 1.5 cm.



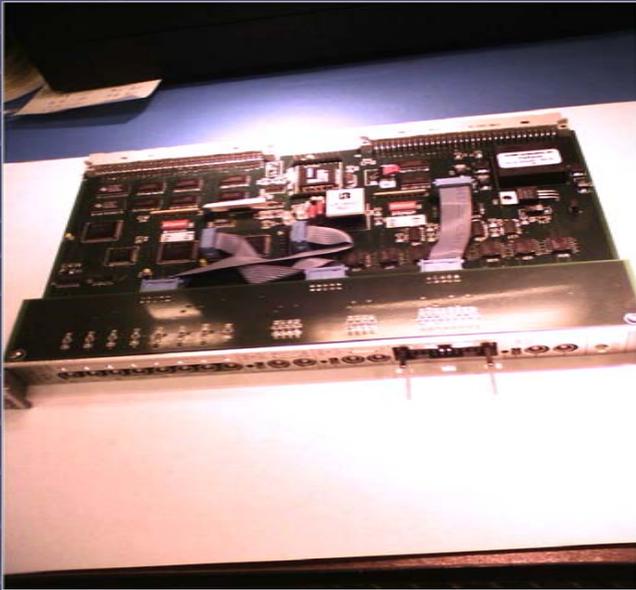
Hardware improvements: Shower maximum detector for ZDC's



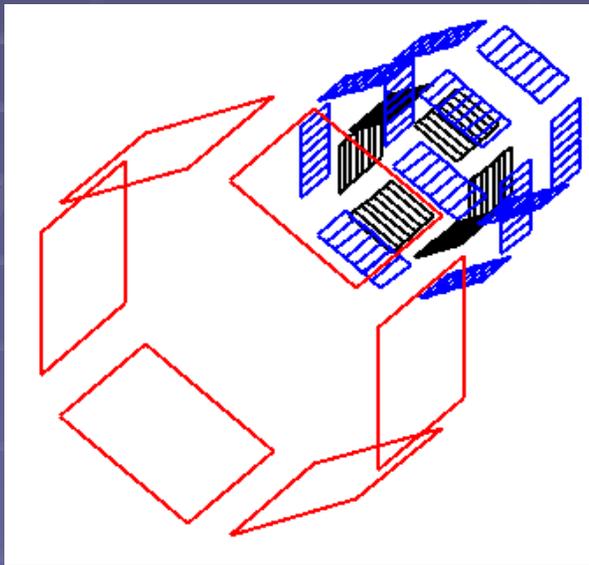
10X9 scintillators read with wls fibers and multi-anode PMTs

These detectors are installed in both ZDC systems, can measure (a yet unexplained) asymmetry in the neutron distribution depending on the polarization of the beam. They may also measure the reaction plane in A+A collisions.

Hardware improvements:



VME time delay boards: 8 channel
Programmable logic with range: 0 –
127 nsec in 0.5 nsec intervals. Built
12 modules and installed them in
BRAHMS Trigger.



Rearrangement of the Si
multiplicity detector in
order to get azimuthal
segmentation to measure
the reaction plane in A+A
collisions.

Plans: Data analysis

- Au+Au 200 GeV at forward rapidity
- Azimuthal flow in Au+Au.
- Continue analysis of d+Au data.
- Data processing for run 5 data
- Spin asymmetries.
- Analyze particle production in p+p at all rapidities.

Plans: Experimental

If the next RHIC run will concentrate on polarized p+p our first order priority would be to use our resources to analyze the already collected data.

But we want to reserve the ability to change our immediate plans if we find that some data is missing, or new physics can be accessed with further measurements.

If the community decides to continue the scan with lighter species or lower energies, we would like to participate.

Plans: Experimental cont.

Our group is spearheading an effort to collect additional d+Au data with some modification to our existing setup and possibly with the addition of one module of the ALICE PHOS detector.

We believe that by extending our d+Au measurements to $p_T \sim 5$ GeV/c we will be able to differentiate better between initial or final state descriptions of the data.

At the same time we plan to modify our MRS spectrometer to be able to measure identified spectra at backward rapidities ($\eta \sim -1.5$).

Plans: Experimental cont.

Our group is working on a document that outlines the physics reach of our plans for a new d+Au run. Our intension is to pursue this work to a LOI for an upcoming PAC.

Issues

We strongly argue for d+Au in run 7 because we foresee problems in keeping the collaboration together for a longer time period.

We need more people (Post. Docs) to analyze data.

We need appropriate funding for operations and research for the program we are planning to propose.