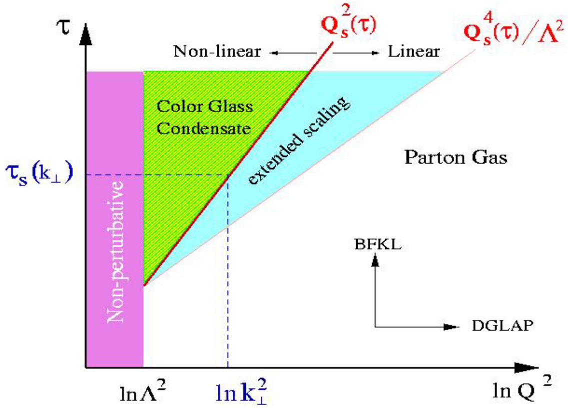
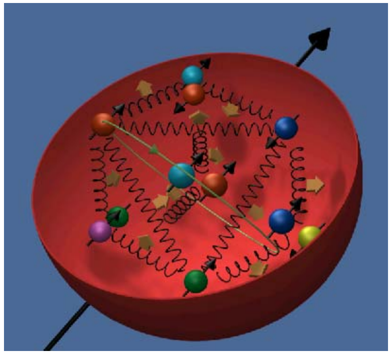
STAR Multi-Year Beam Use Request For

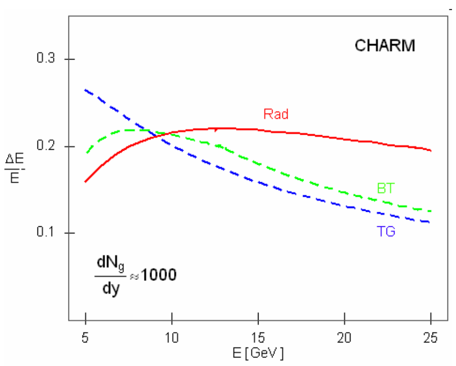
Run 8



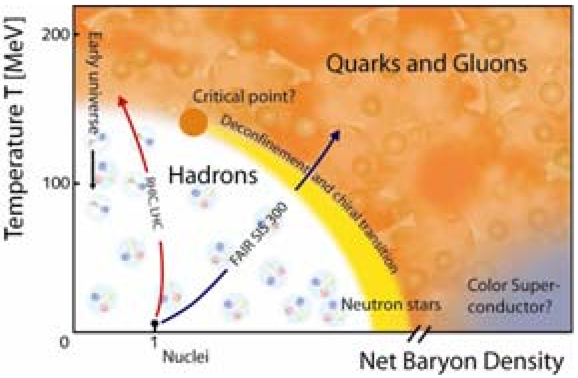
Runs 8 & 9



Run 9



Run 10



Tim Hallman for the STAR Collaboration

Brookhaven National Laboratory
March 29-30, 2007

Beam Use Proposal Run 8 – Run 10

Run	Energy	System	Goal
8	$\sqrt{s_{NN}}$ = 200 GeV $\sqrt{s}$ = 200 GeV $\sqrt{s}$ = 200 GeV $\sqrt{s}$ = 500 GeV	d + Au $p_{\rightarrow}\, p_{\rightarrow}$, $p_{\uparrow}\, p_{\uparrow}$ $p_{\uparrow}\, p_{\uparrow}$ pp	(10 + 2 weeks) 30/60 nb^{-1} sampled* (~12 + 2 weeks) ~ 3 days pp2pp Commissioning**
9	$\sqrt{s_{NN}}$ = 200 GeV $\sqrt{s}$ = 200 GeV $\sqrt{s}$ = 200 GeV $\sqrt{s}$ = 500 GeV	Au + Au $p_{\rightarrow}\, p_{\rightarrow}$, $p_{\uparrow}\, p_{\uparrow}$ $p_{\rightarrow}\, p_{\rightarrow}$ pp	(8 + 2 weeks) (~14 + 2 weeks) ~ 3 days pp2pp Commissioning**
10	Low $\sqrt{s_{NN}}$ $\sqrt{s}$ = 500 GeV	Au + Au $P_{\rightarrow} P_{\rightarrow}$	12 + 3 weeks 8 + 3 weeks

* First number with slow detectors, second number with fast detectors

** Contingent on achieving primary physics goals early

The "big picture" physics goals of the proposed program are:

Run 8 Definitive results on the saturation scale for the gluon distribution in relativistic heavy nuclei

Decisive test of gluon saturation as the origin of particle suppression at forward pseudo-rapidity

First significant measurement of the x dependence of gluon polarization in the proton, $\Delta G(x)$; new insight into transverse spin/motion preferences of quarks/gluon

Qualitative advance in study of pp elastic scattering

Measurements that will provide qualitatively new insights into the properties of

the nucleon

the nucleus

dense QCD matter

Physics Driving Proposal for Run 8

Definitive results on the saturation scale for the gluon distribution in relativistic heavy nuclei

Decisive test of gluon saturation as the origin of particle suppression at forward η

First significant measurement of the x dependence of gluon polarization in the proton, ΔG(x); new insight into transverse spin/motion preferences for quarks/gluon

Qualitative advance in study of pp elastic scattering

Measurements at RHIC in Run 8 which address these questions can result in a sea change in our understanding of the initial conditions in RHIC (LHC) HI collisions and the helicity preference of gluons in the proton as a function of momentum fraction

Enabling Developments

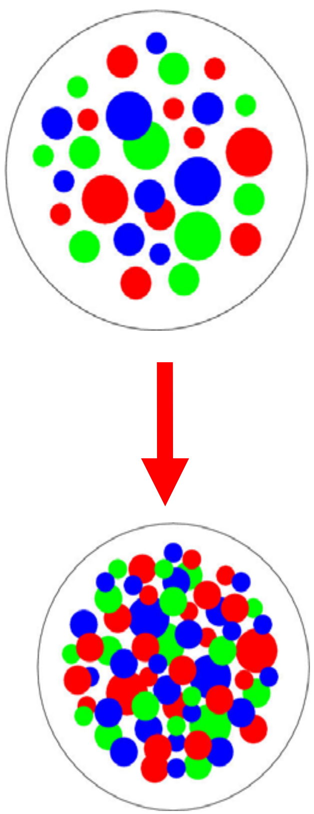
The STAR Forward Meson Spectrometer (FMS) will be fully commissioned (and producing physics) prior to Run 8

No extraordinary assumptions about machine capability beyond what C-AD has projected or already achieved are necessary

The science driving d+Au running

Definitive results on the saturation scale for the gluon distribution in relativistic heavy nuclei

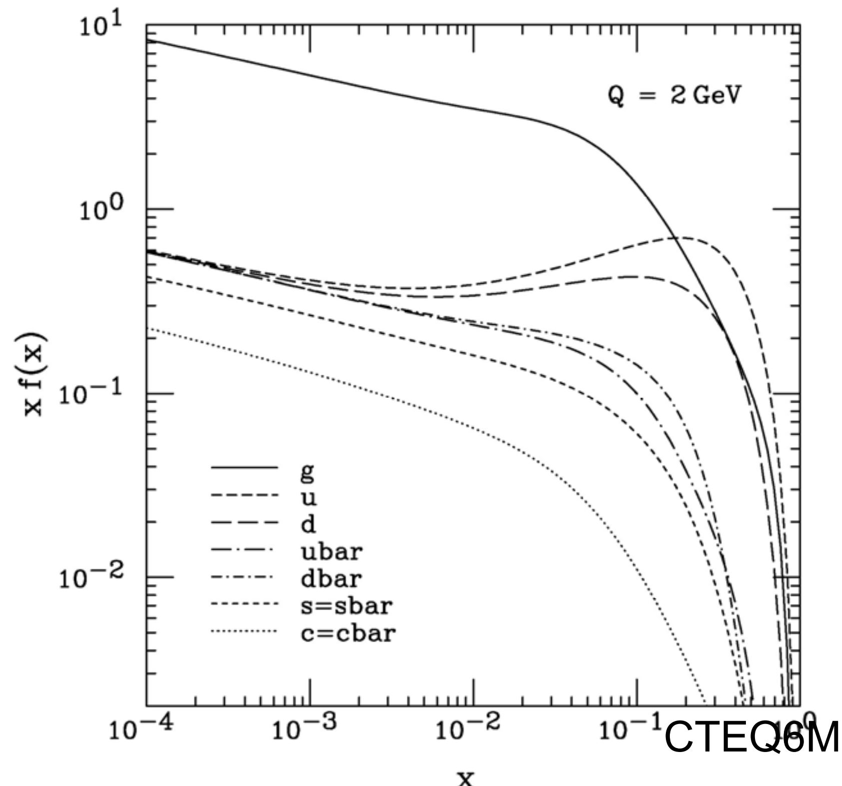
Decisive test of gluon saturation as the origin of particle suppression at forward pseudorapidity



Mid Rapidity

$$x \sim \frac{2 p_T}{\sqrt{s}} e^{-y}$$

Forward Rapidity



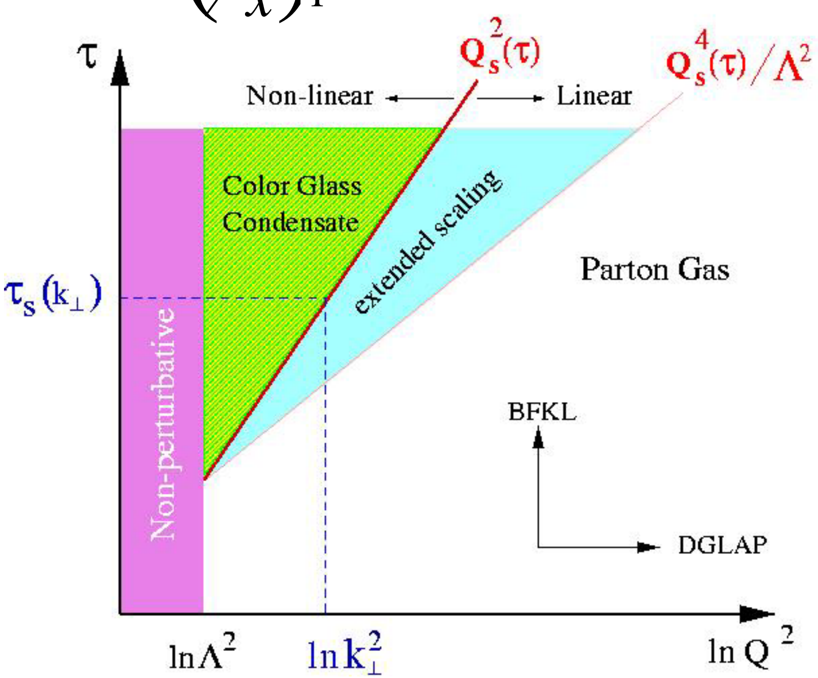
Gluon density can't grow forever.

Saturation must set in at forward rapidity when gluons start to overlap.

STAR

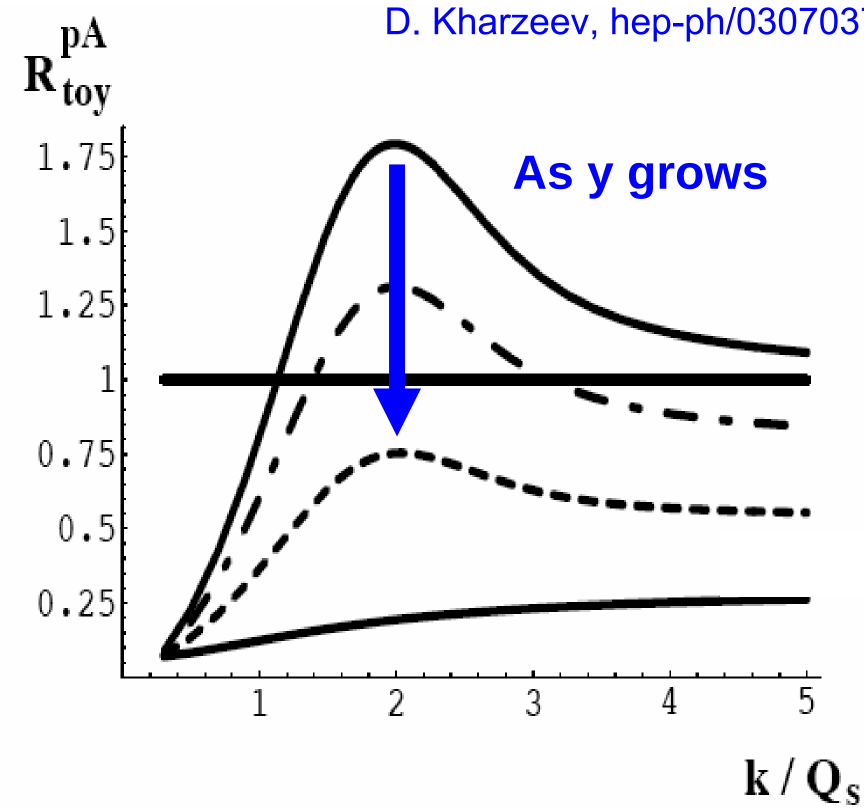
Expectations for a Color Glass Condensate

$\tau = \ln\left(\frac{1}{x}\right)$ τ related to rapidity of produced hadrons.



Iancu and Venugopalan, hep-ph/0303204

D. Kharzeev, hep-ph/0307037



Is there evidence for **gluon saturation at RHIC energies**?

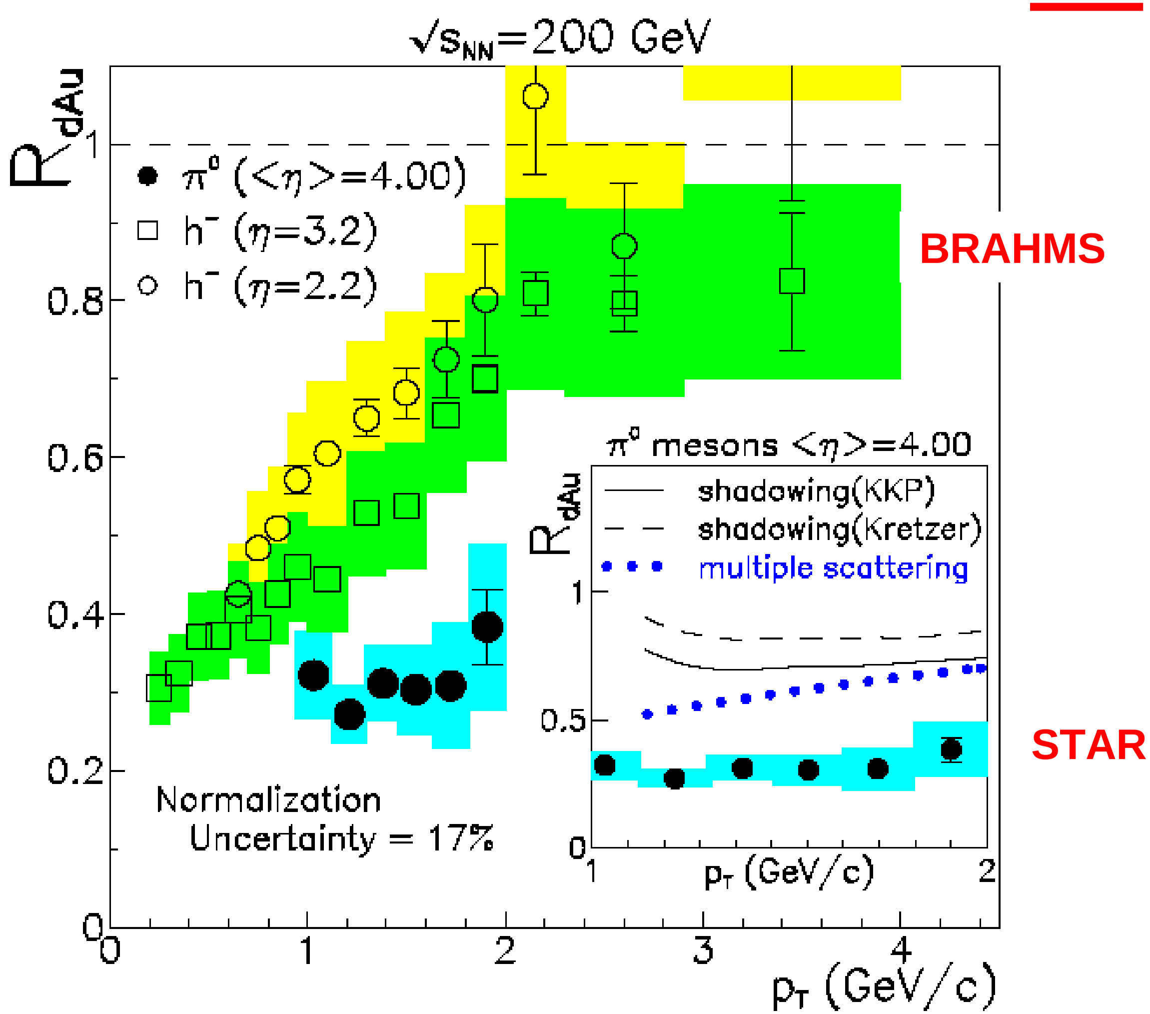
BROOKHAVEN NATIONAL LABORATORY

Office of Science U.S. DEPARTMENT OF ENERGY

η dependence of R_{dAu} at RHIC

PRL 97, 152302

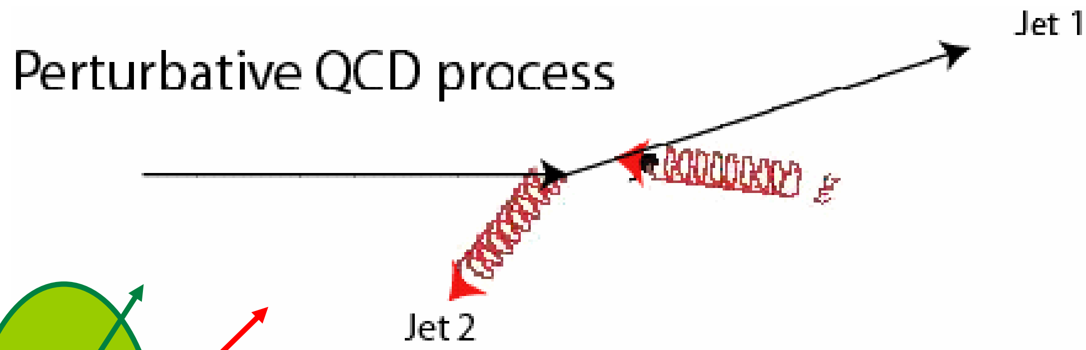
$$R_{dAu} = \frac{1}{2*197}\frac{\sigma_{dAu}}{\sigma_{pp}}$$



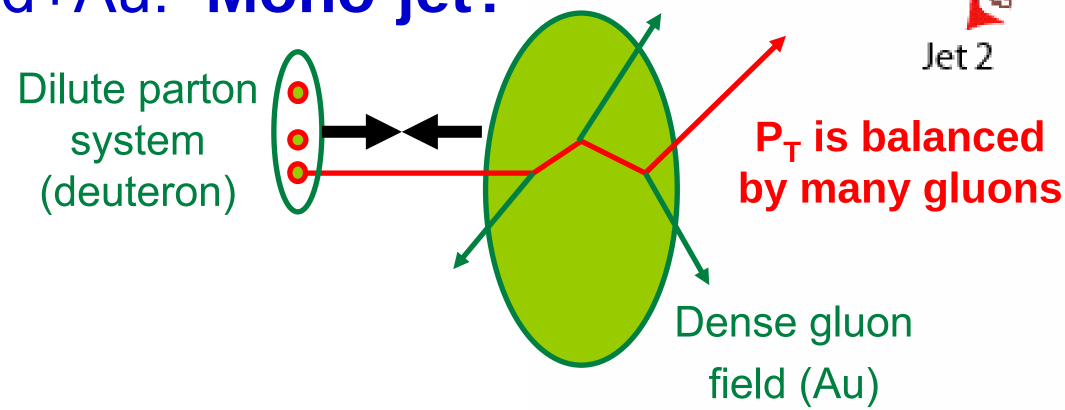
- Observe significant rapidity dependence, similar to expectations from the saturation framework.
- pQCD calculations significantly over predict R_{dAu}.

Correlations, a definitive test: the difference between p+p and d+Au

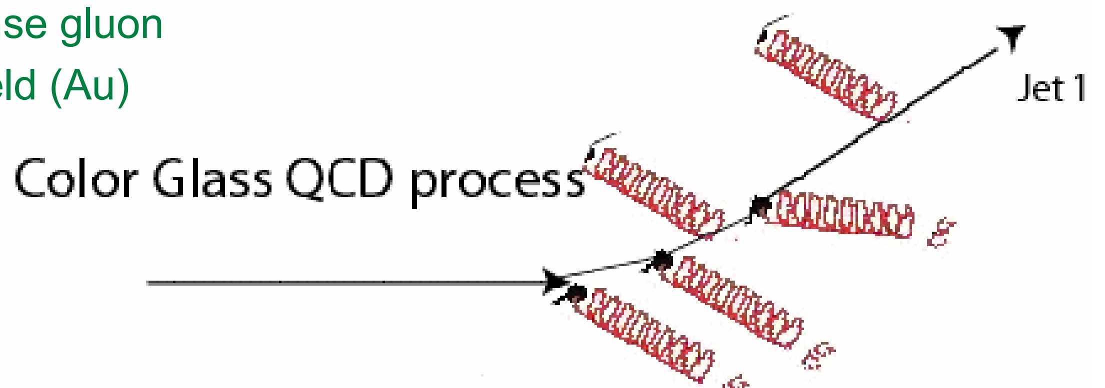
p+p: **Di-jet**



d+Au: **Mono-jet?**



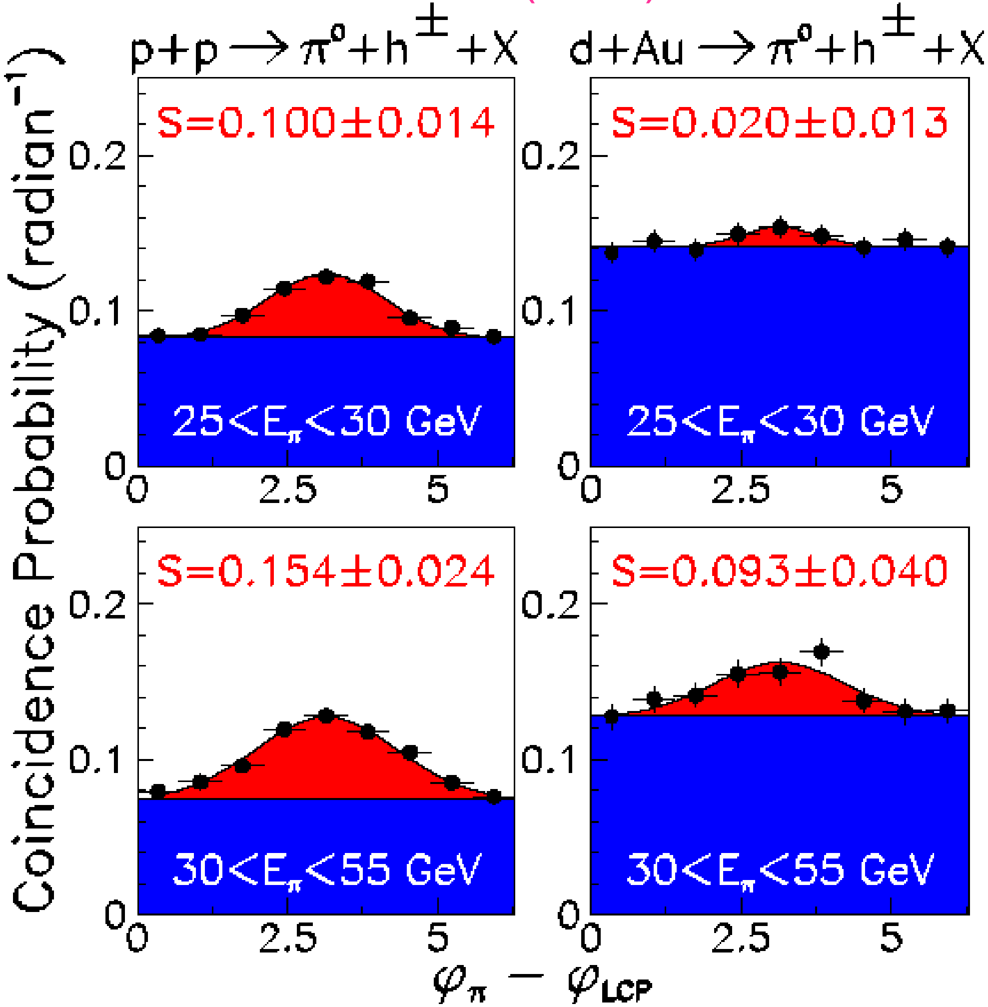
Kharzeev, Levin, McLerran gives physics picture (NPA748, 627)



Color glass condensate predicts that the back-to-back correlation from p+p should be suppressed

An initial glimpse: correlations in d+Au

PRL 97, 152302 (2006)



<$p_{T,\pi}$> ~ 1.0 GeV/c

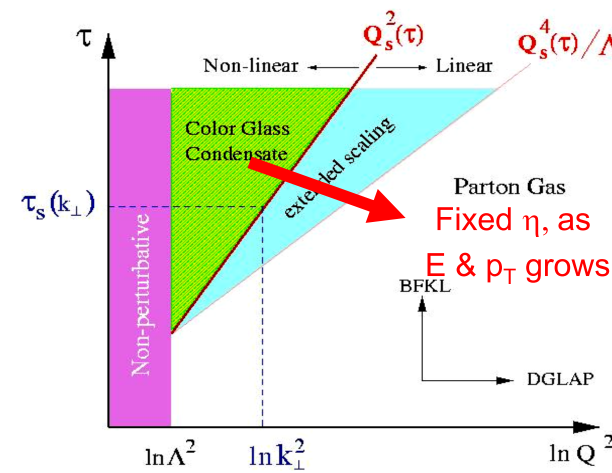
<$p_{T,\pi}$> ~ 1.3 GeV/c

π^0: |<η>| = 4.0

$h^{\pm}$: |η| < 0.75; p_T > 0.5 GeV/c

- are suppressed at small <x_F> and <$p_{T,\pi}$>

consistent with CGC picture

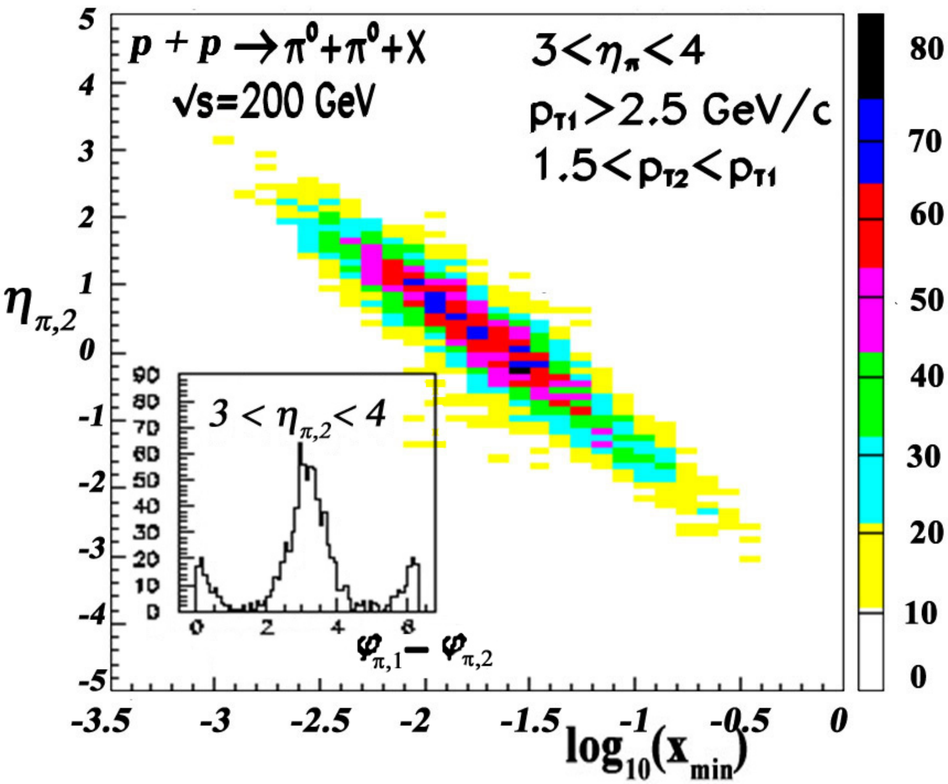


- are similar in d+Au and p+p at larger <x_F> and <$p_{T,\pi}$>

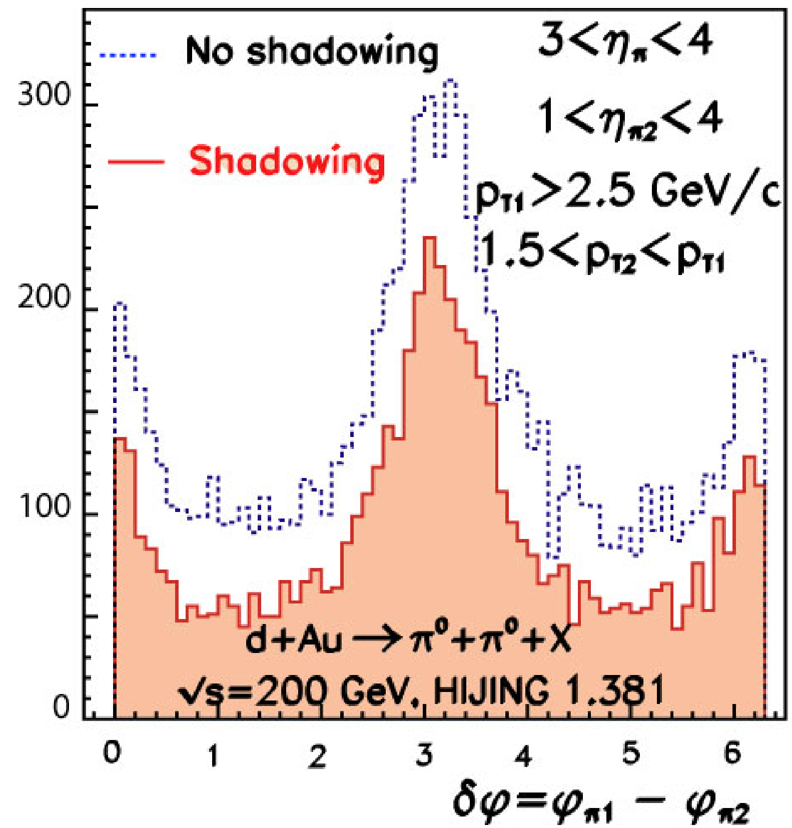
As expected by HIJING

p+p and d+Au → $\pi^0+\pi^0$+X correlations with forward π^0

p+p in PYTHIA



d+Au in HIJING hep-ex/0502040



Conventional shadowing will **change yield, but not coincidence structure**.

Coherent effects such as CGC evolution will **change the structure**.

Sensitive to **x_g ~ 10^{-3} in pQCD** scenario; **few x 10^{-4} in CGC** scenario.

World-wide interest in this science? QM06 abstracts…

CGC, Full 3-D Hydro, and Hadronic Cascade

Hyrano, Heinz, Kharzeev, Lacey, Nara

Jet Tomographic Tests of the CGC Initial State at RHIC and LHC

Adil, Gyulassy

Forward Nuclear Modification Form Factor in Au-Au and Cu-Cu Collisions at $\sqrt{s_{NN}}$ = 62.4 GeV

Larsen

Centrality Dependence of Charge Hadron Spectra pT at Forward Rapidities in Cu-Cu Collisions at $\sqrt{s_{NN}}$ = 200

Bekele

System Size and Rapidity Dependence of the Nuclear Modification Factor

Karabowicz

Does the Cronin Peak Disappear?

Barnaf, L'evaia, Papp, Fai, Cole

Are Jets Quenched in Cold Nuclei?

Vitev

Identified Particle Nuclear Modification Factors at Rapidity = 2-3.8 in Au-Au Collisions at s_{NN} = 200 GeV

Ristea

World-wide interest in this science? QM06 abstracts…

Nuclear-Induced Particle Suppression at Large XF at RHIC
Lee

Heavy Flavor Production in pA Collisions with the MV + BK Framework
Fujii, Gelis, Venugopalan

Multiplicity Fluctuations in Cu-Cu and Au-Au Collisions at RHIC
Wo'zniak

Are there Mono-jets in High Energy Proton-Nucleus Collisions
Borghini, Gelis

Energy Dependence of Nuclear Suppression in the Fragmentation Region
Tywoniuk, Arsene, Bravina, Kaidalov, Zabrodin

QQbar Production in pA Collisions at RHIC and the LHC
Albacete, Kovchegov, Tuchin

Identified Hadron Production in d+Au and p+p Collisions at RHIC
Yang

Probing small-x gluons and large-x quarks: jet-like correlations between forward and mid-rapidity in pp, d+Au, and Au-Au Collisions from STAR
Molnara

World-wide interest in this science? QM06 abstracts…

Nuclear Modification to parton Evolution and onset of parton saturation

Kang, Qiu

Early Time Evolution of High Energy Heavy Ion Collisions

Fries, Kapusta, Li

Multiplicity Fluctuations in Cu-Cu and Au-Au Collisions at RHIC

Wo’zniak

Probing partonic distribution functions in nucleons and nuclei with Forward Calorimeters in the PHENIX Experiment at RHIC

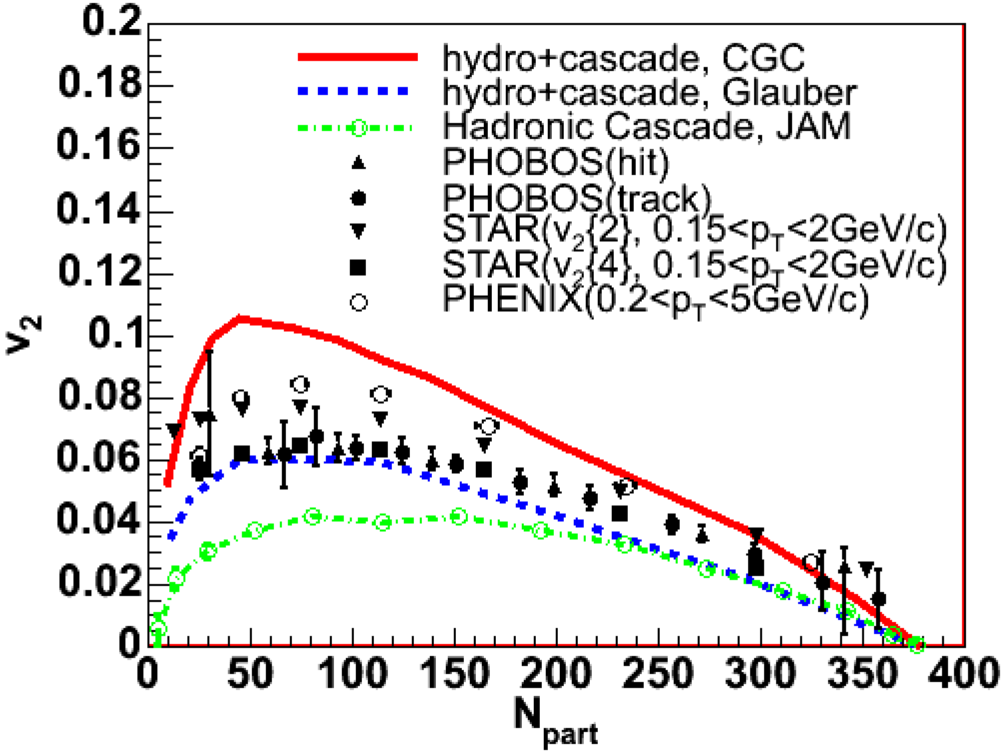
Kistenev

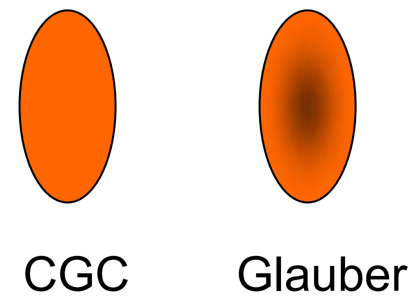
Low-x QCD with CMS at CERN-LHC

This is <u>discovery physics</u> of broad interest to the programs at RHIC and the LHC

Another urgent d+Au question: v_2 and the hydro limit--Glauber vs Color Glass Condensate

Hirano et al, PLB 636, 299





CGC: Treats the nucleus as a saturated gluon field

Effects initial eccentricity of the overlap zone

- Do we have Glauber matter distribution + perfect liquid, or Color Glass Condensate distribution + viscous matter?
- Understanding the initial state is **crucial to understand what we are seeing in the final state**

The short summary:

It is time to stop guessing. The proposed d+Au run will:

- Determine the saturation scale for the gluon distribution in heavy nuclei
- Provide a decisive test of gluon saturation as the origin of particle suppression at forward pseudorapidity
- Provide an important reference for the D, B meson studies in Au+Au

This research is compelling to:

Understand the initial state conditions for relativistic heavy nuclei at RHIC and confirm our understanding of multiplicities and rapidity dependence

Understand how thermalization appears to be established so quickly at RHIC

Understand whether we have really reached the hydro limit for v_2

Understand mid-rapidity particle production at the LHC in the future

STAR

Status of STAR Forward Meson Spectrometer upgrad

Some materials (Pb glass, tubes & original configuration not available on necessary time scale

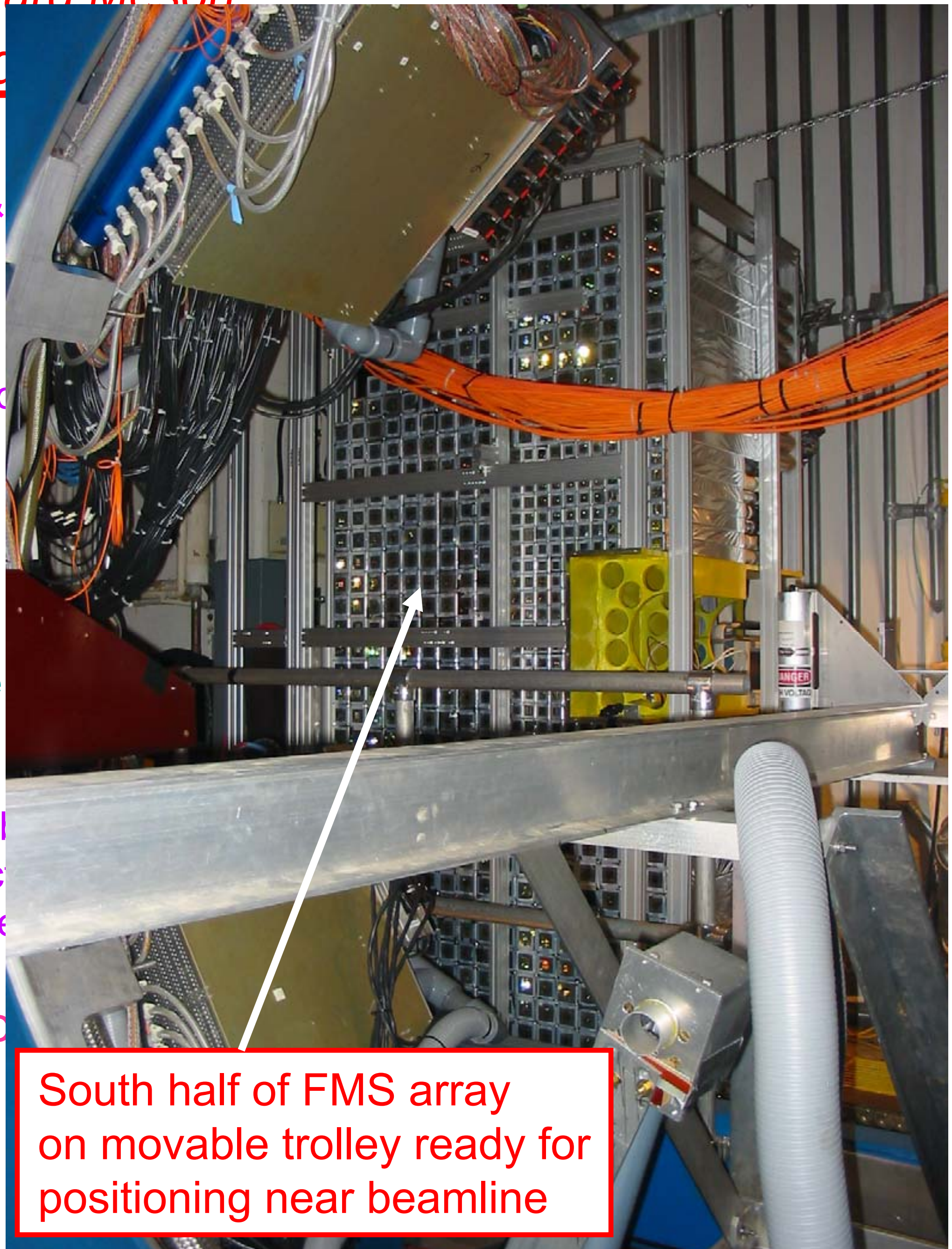
Construction of revised configuratio complete

PMT base construction carried out Penn State

Sizeable student team (5 graduate undergraduate) "in harness"

Readout electronics in final asseml at Space Science Lab; camac elec utilized for initial shake-down in inte

FMS commissioned and pro physics in Run 7



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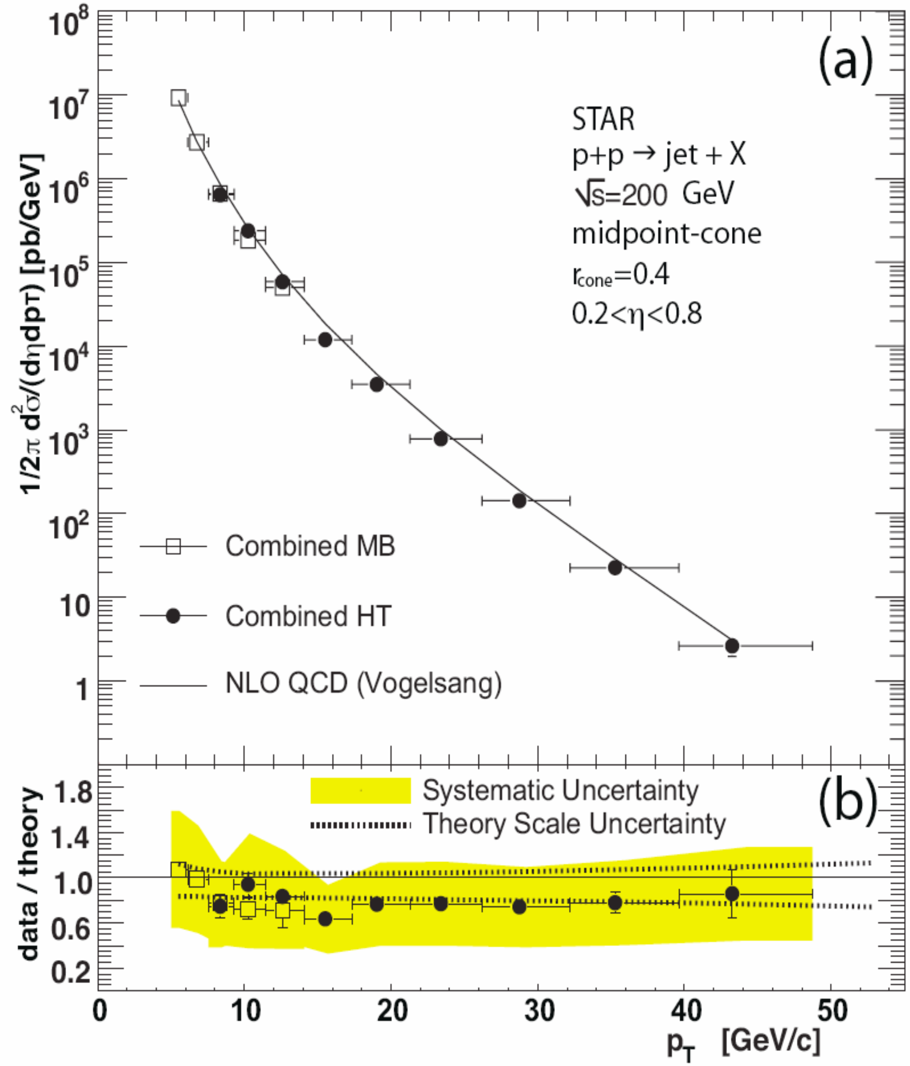
STAR longitudinal spin program - Results

First inclusive jet cross section result at RHIC

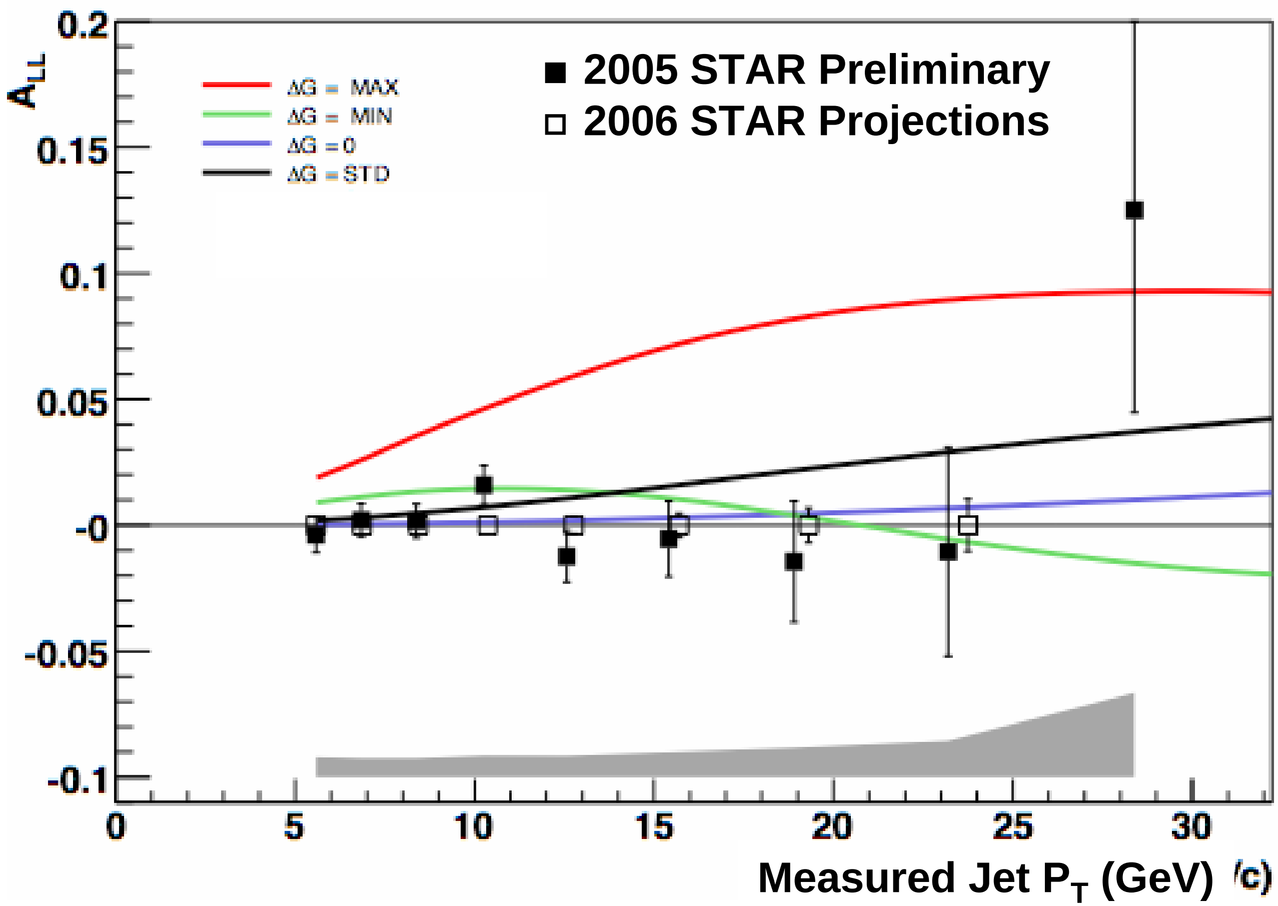
- 2003+2004 p+p runs
  - Sampled luminosity: ~0.16 pb^{-1}
  - Good agreement between MB and HT data
  - Good agreement with NLO over 7 orders of magnitude
  - Agreement with NLO calculation within systematic uncertainty

PRL 97, 252001 (2006)



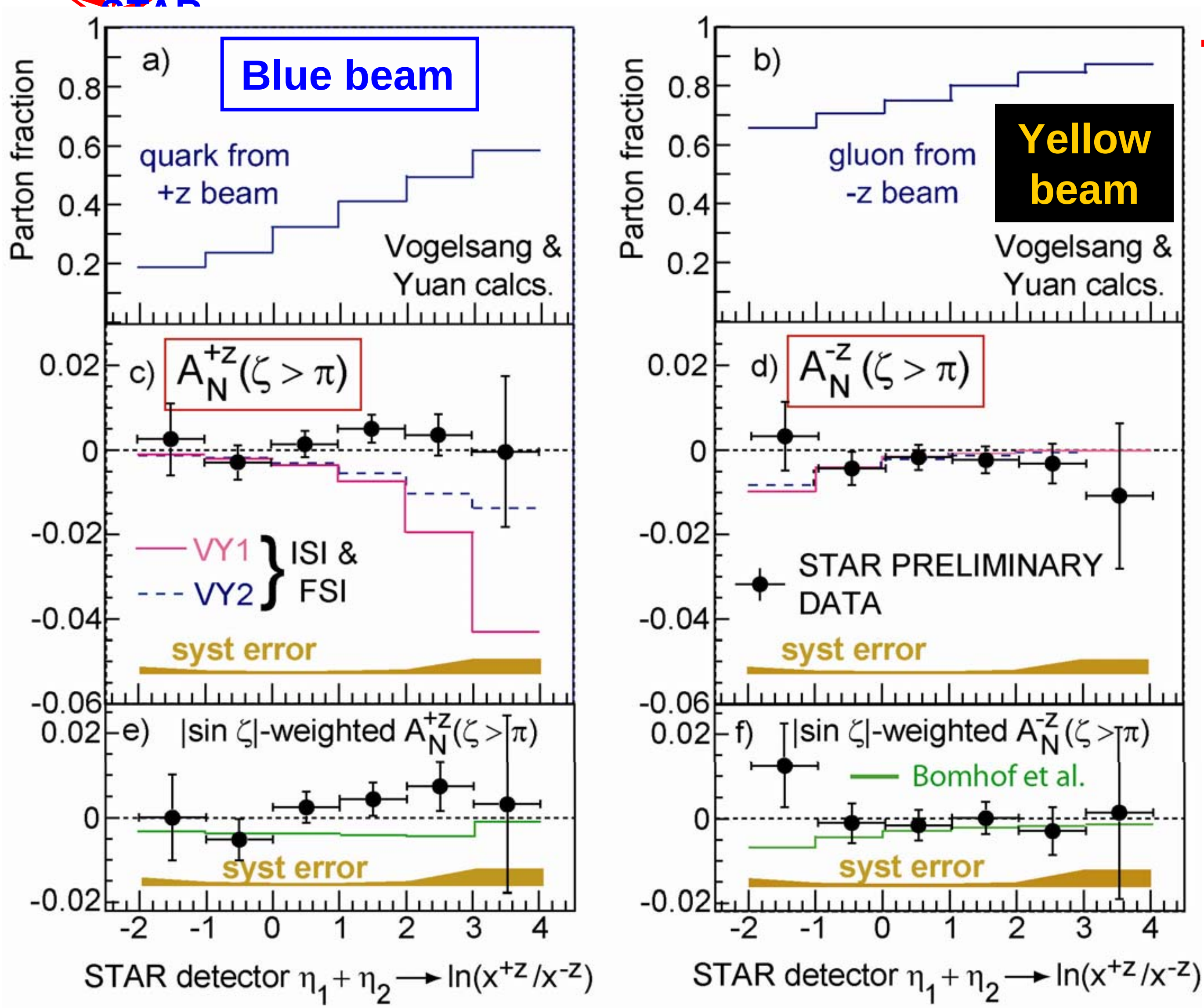
Hallman, BNL PAC, 3/29/2006

A_{LL} published (Run 3+4), preliminary (Run 5), and projected Run 6 results on inclusive jet production in p+p collisions at $\sqrt{s}$ =200GeV



These results will place a world-class constraint on gluon polarization in the proton, ΔG

Run 6 Di-Jet Sivers Results vs. Jet Pseudorapidity Sum



STAR Preliminary

First shown at Spin'06

- ***A_N of di-jet acoplanarity is sensitive to spin-dependent transverse motion preferences – Sivers effect***

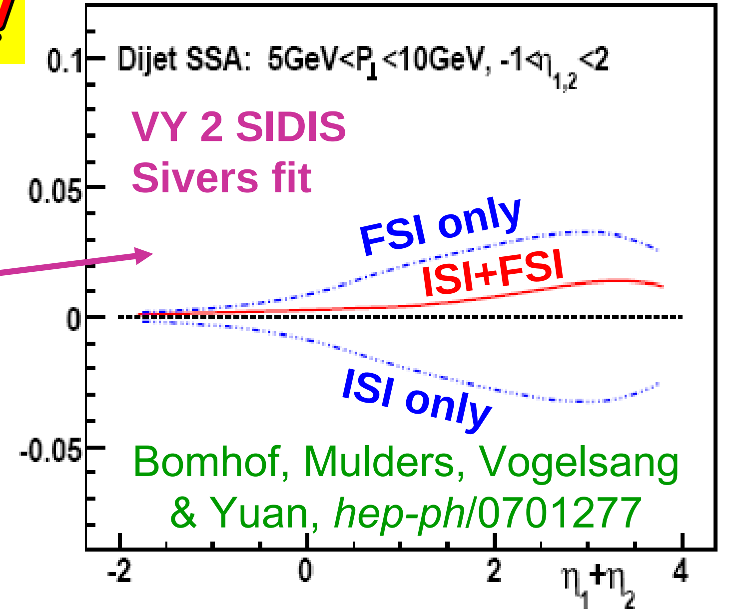
STAR A_N all consistent with zero ⇒ both net high-*x* parton and low-*x* gluon Sivers effects ~10x smaller in $\vec{p}p \rightarrow$ di-jets than SIDIS quark Sivers asym.!

Theory of Transverse SSA Developing Very Rapidly!

Di-jet SSA Post-dictions shrinking!

Bacchetta, Bomhof, Mulders & Pijlman **[PRD 72, 034030 (2005)]** ***deduce gauge link structure for pp → jets, hadrons:***

$\Rightarrow A_N(\text{ISI+FSI}) \approx -0.5\, A_N(\text{ISI})$

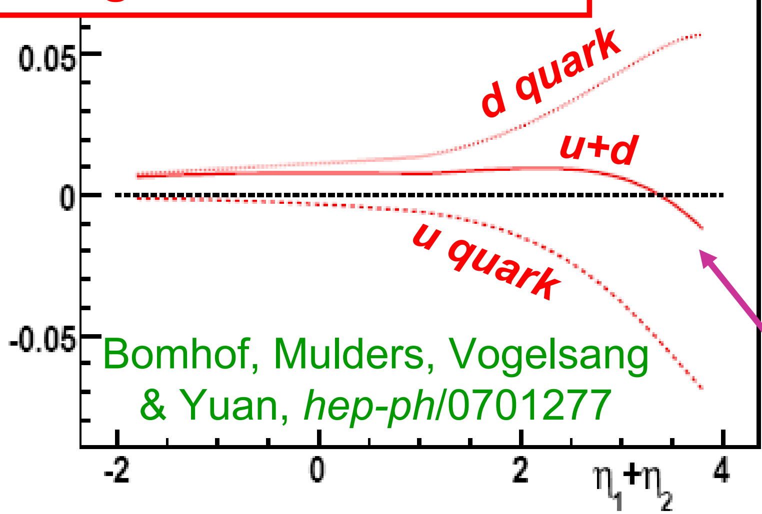


⇒ Gauge links more robust for SSA weighted by $\sum p_T$ for 2 jets, or |sin ζ|

Sivers fcns. from twist-3 qg correl'n

adron

Possible test: flavor dependence of leading charged hadrons



Ji, Qiu, Vogelsang & Yuan **[PRL 97, 082002 (2006)]** ***show strong overlap between Sivers effects & twist-3 quark-gluon (Qiu-Sterman) correlations:***

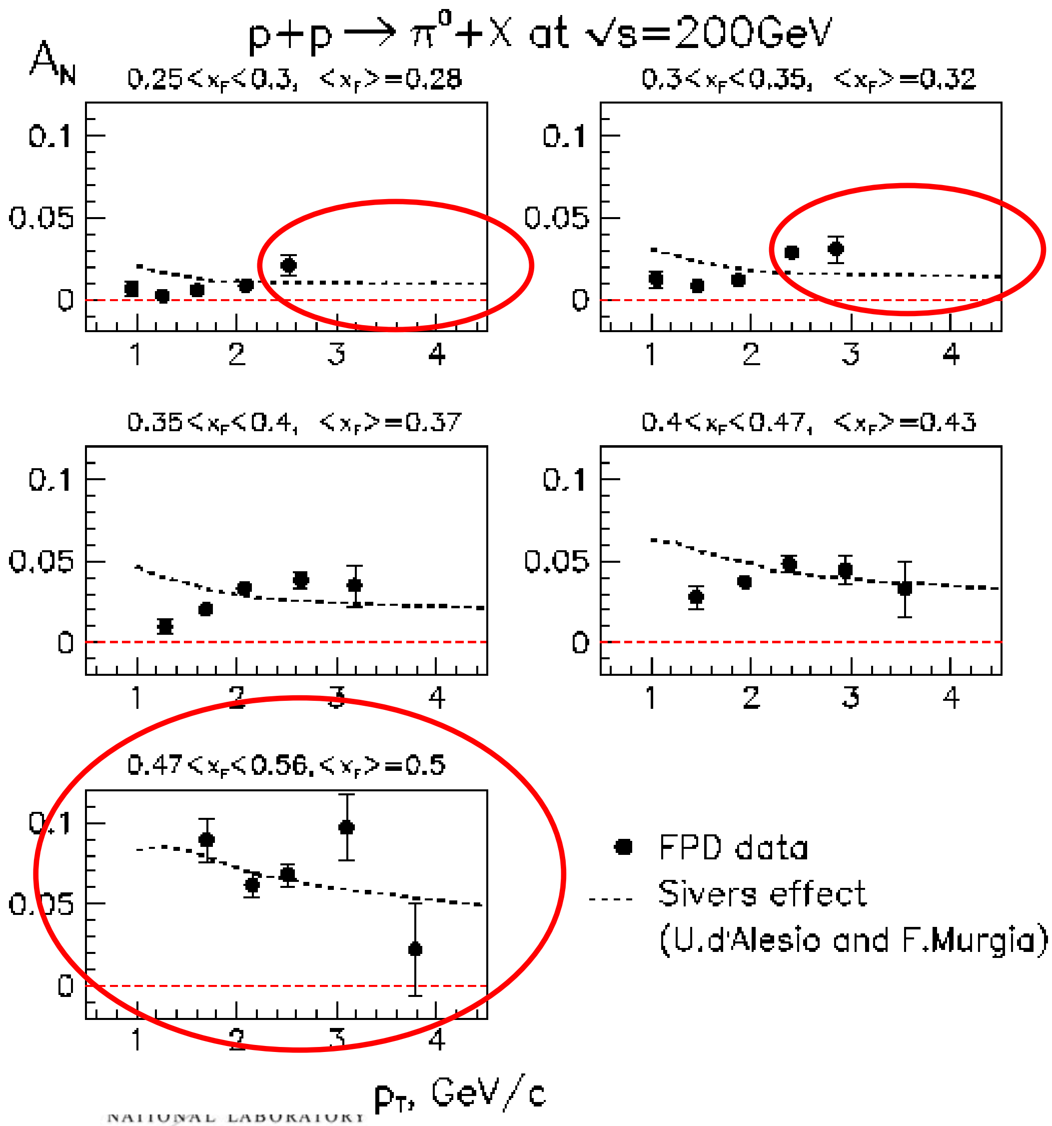
⇒ twist-3 fits to $A_N(\vec{p}+p \to$ fwd. h) can constrain Sivers fcn. moment relevant to weighted di-jet SSA

⇒ Kouvaris et al. **[PRD 74, 114013 (2006)]** ***fits give nearly complete u vs. d cancellation in weighted di-jet SSA***

Forward π^0 $A_N(p_T)$ for bins in x_F

STAR

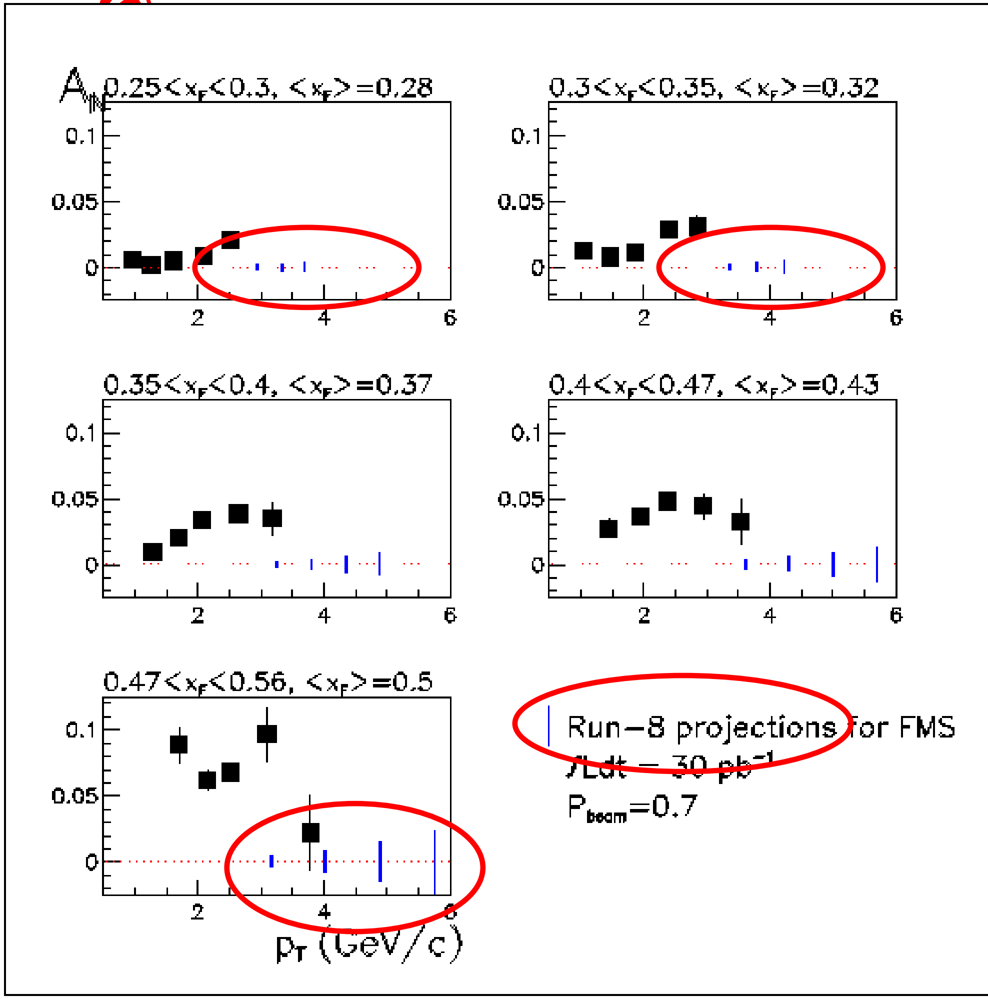
***STAR* Preliminary, first shown at Spin'06**



- Combined data from three runs at $<\eta>$=3.3, 3.7 and 4.0
- In each x_F bin, $<x_F>$ does not significantly change with p_T
- A_N increases with p_T in each bin at least up to ~2.5 GeV/c, well into the regime where pQCD describes the cross section
- But model calculations had expected A_N to fall with p_T throughout this region
- Higher precision and extended kinematic coverage will help elucidate the underlying dynamics

STAR

Transverse spin in Runs 8+9



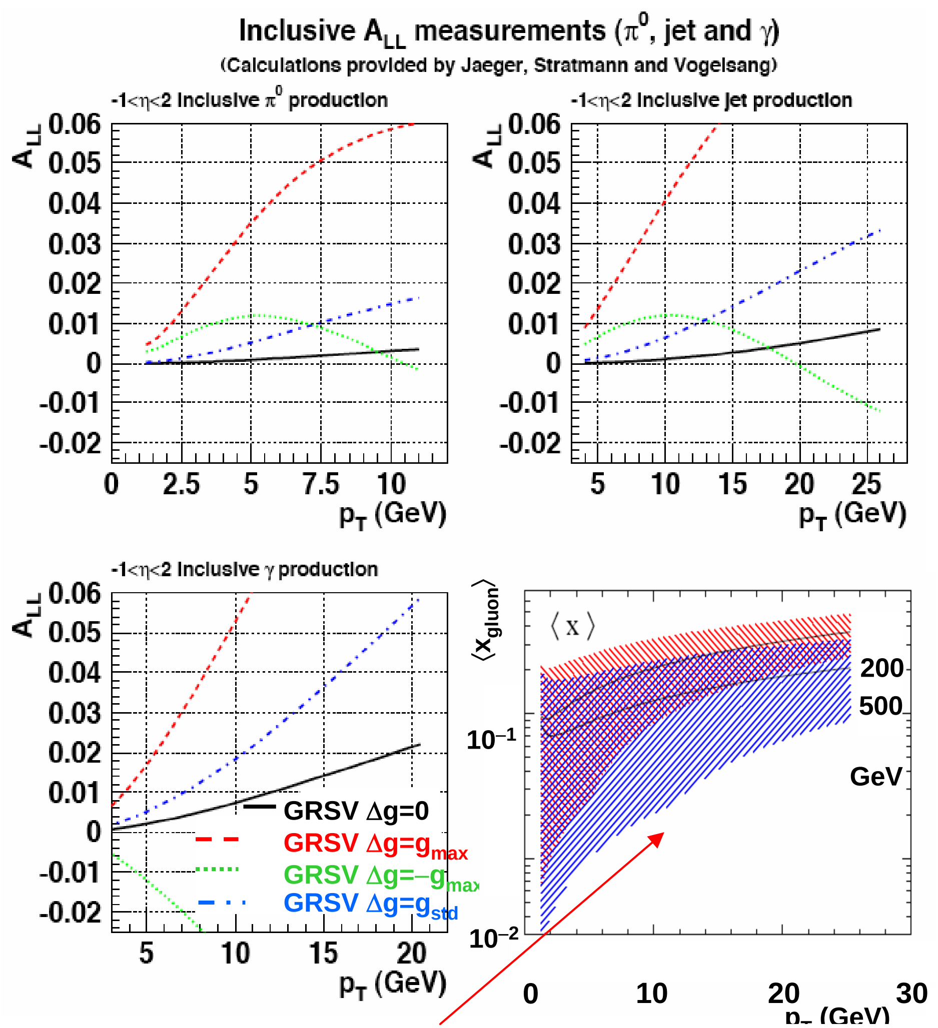
FMS will provide a dramatic improvement in precision over existing results

Additional physics with the FMS:

- Spin-dependent near-side correlations (π^0–π^0)
  ⇒ separation of Sivers and Collins effects
- Spin-dependent away-side correlations (π^0-jet)
  ⇒ isolation of Sivers effect
- Embark on spin-dependent inclusive γ and γ+jet

Concurrent measurements will explore the leading charged particle dependence of the di-jet Sivers effect to isolate *u* and *d* quark contributions

Why it is essential to map the x dependence of ΔG



NLO pQCD predictions for inclusive jet, π^0 and direct photon production. The upper two frames and the lower left frame show A_{LL} within the STAR calorimeter acceptance as a function of p_T under different assumptions for the underlying polarized gluon distribution.

The lower right frame shows the gluon x-ranges contributing to inclusive π^0 production in p+p collisions at $\sqrt{s} = 200$ and 500 GeV, with solid curves indicating the mean contributing x-values, and the shaded bands indicating the rms spread of contributing x-values.

Inclusive measures which do not resolve the parton kinematics only weakly constrain the range of x_{gluon} which contributes to the observed asymmetry.

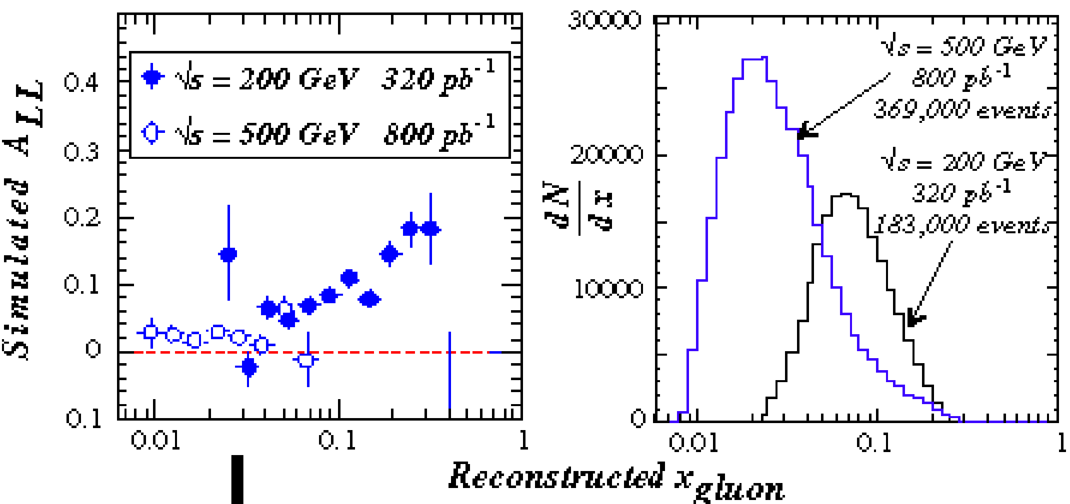
Makes interpretation sensitive to model assumptions about shape of *ΔG(x)*

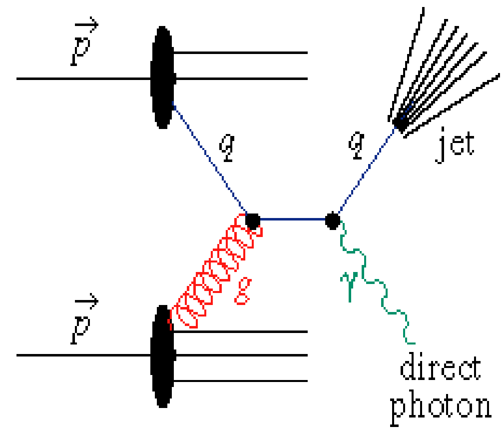
STAR Sensitivity to $\Delta G(x)$

STAR's wide acceptance = Coincident detection of γ and away-side jet direction

→ Determination of initial-state partonic kinematics.

$\vec{p}\,\vec{p} \rightarrow \gamma + jet + X$





200 and 500GeV

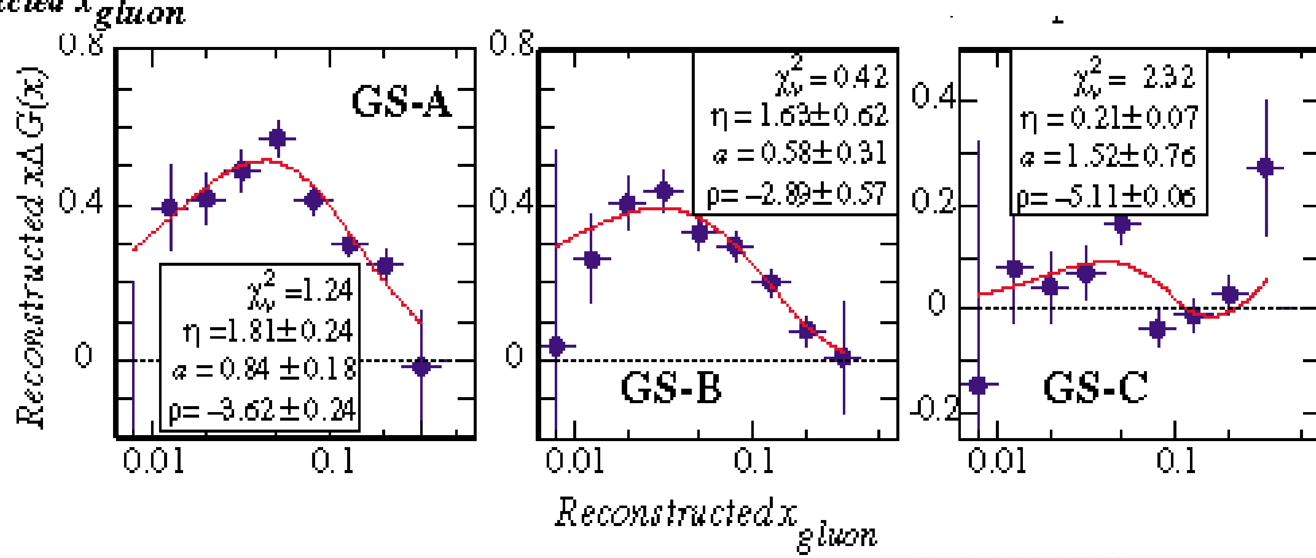
Going to forward rapidity

Better sensitivity

Wider x range

to determine integral

$$\Delta G\,(Q^2) = \int_0^1 \Delta G(x, Q^2)\,dx$$

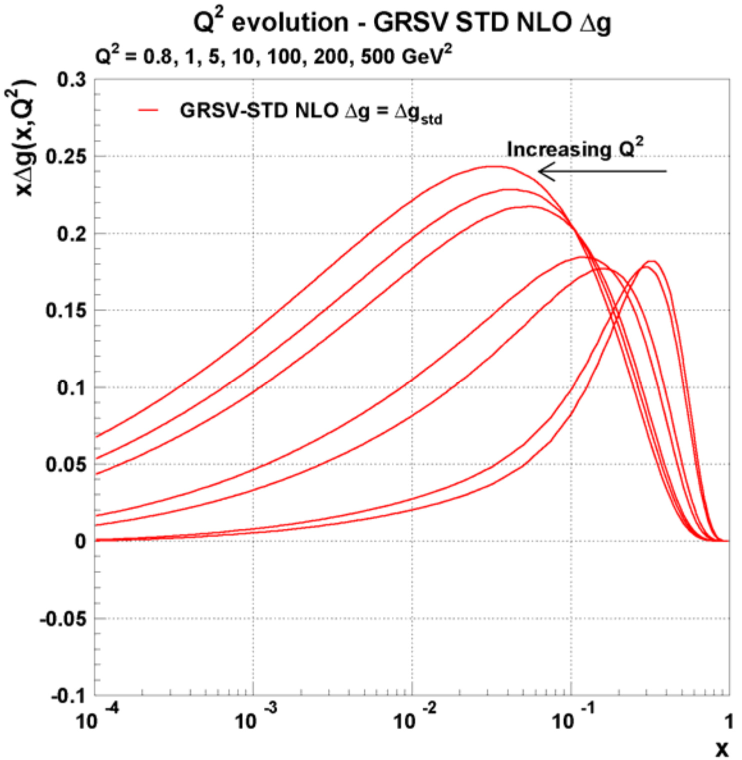


U.S. DEPARTMENT OF ENERGY

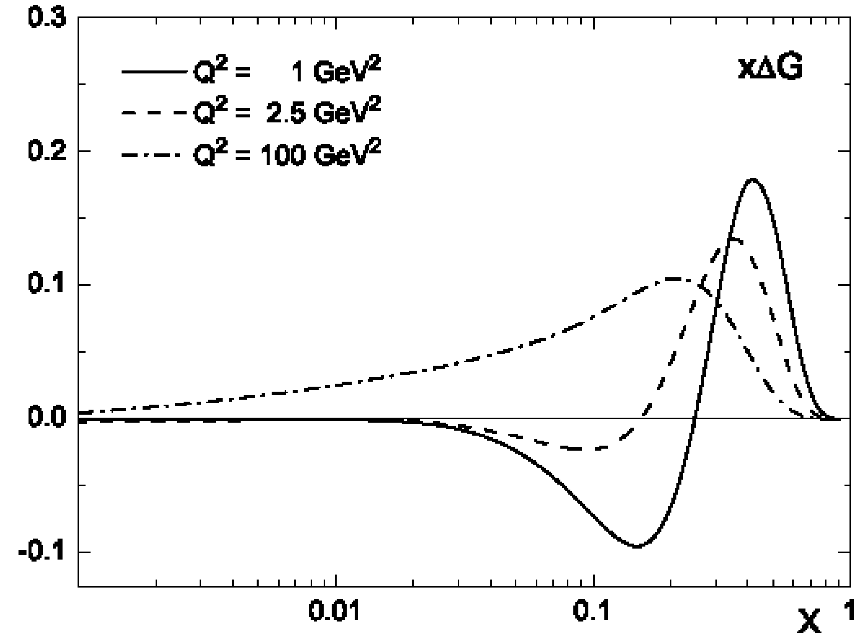
Interpreting $\Delta g(x)$ measurements

Evolution for two recent global fits

GRSV STD



Leader et al, hep-ph/0612360, "oscillating in sign solution"



- Overlapping measurements for the same *x* at different energies
- **Important cross-check of the entire theoretical framework**
- For example, polarized gluon distribution experiences significant evolution with Q^2
- Need detailed studies at both 200 and 500 GeV

Work ongoing in preparation for Run 8

Technical issues that are being quantitatively assessed for realistic detector performance in the analysis of 2006 data and related simulations:

(1) What levels of γ retention and $\pi 0$ rejection can be attained to optimize signal/background for photon-jet coincidences?

(2) How low in *pT* can direct photons be identified in the presence of a growing π^0 background?

(3) Does low-mass background seen to date in $\pi 0$ reconstructions in STAR constitute an additional background for direct photon analyses?

(4) Is an L2 coincidence trigger for γ-jet desirable, or will it enhance background more than signal?

(5) How efficiently, and with what bias in extracted four-momenta, can jets be reconstructed beyond the barrel EMC region, despite the services gap (η=0.98 – 1.08) and rapidly decreasing TPC tracking performance?

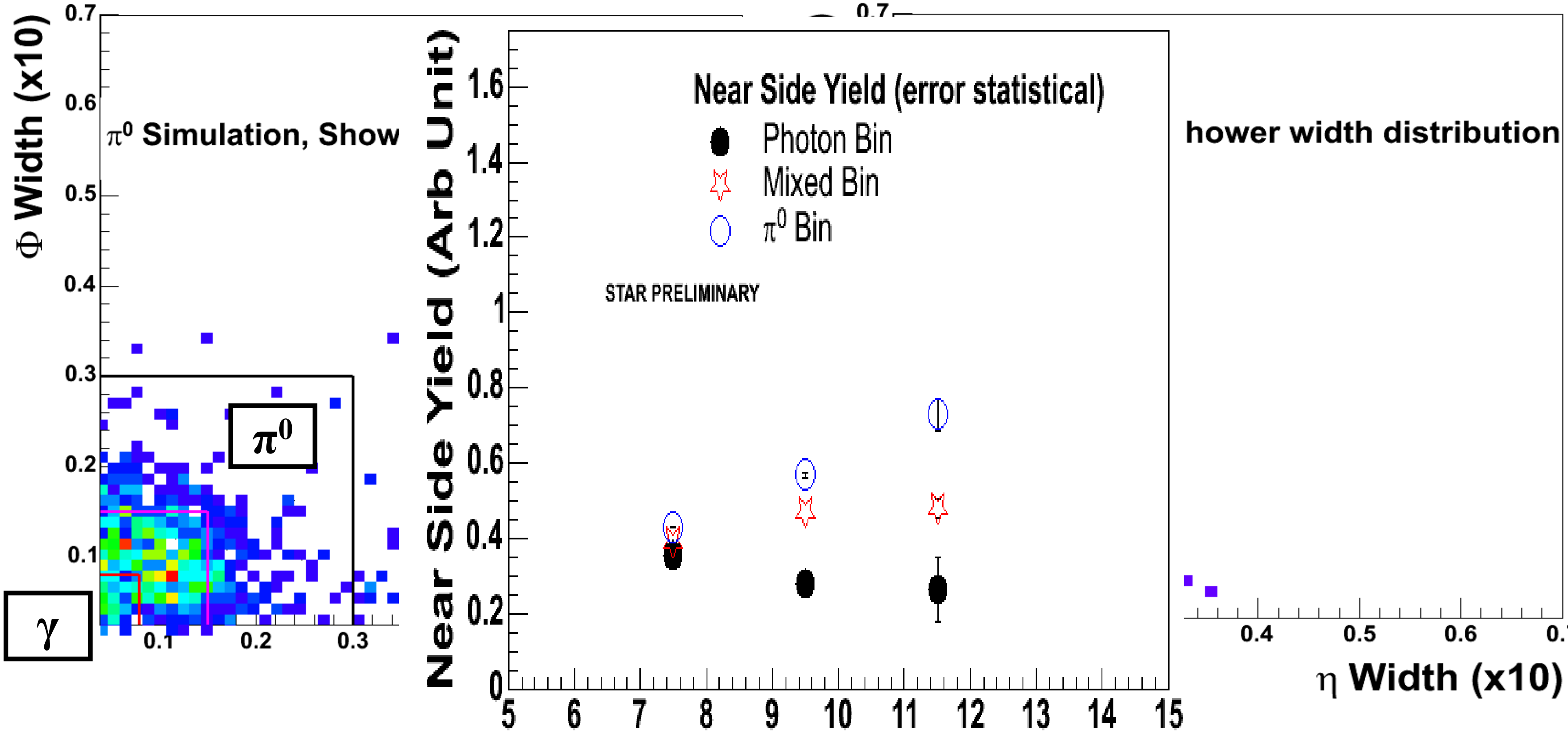
(6) What trigger biases on contributing partonic processes and *x*-ranges are imposed by the 2006 di-jet trigger?

(7) What bandwidth trade-off between di-jet and gamma+jet optimizes ability to constrain ΔG(x)?

By the time of Run 8, STAR will have answers for several of these questions, --and gained considerable insight for the rest.

Example: progress toward direct γ identification in p+p

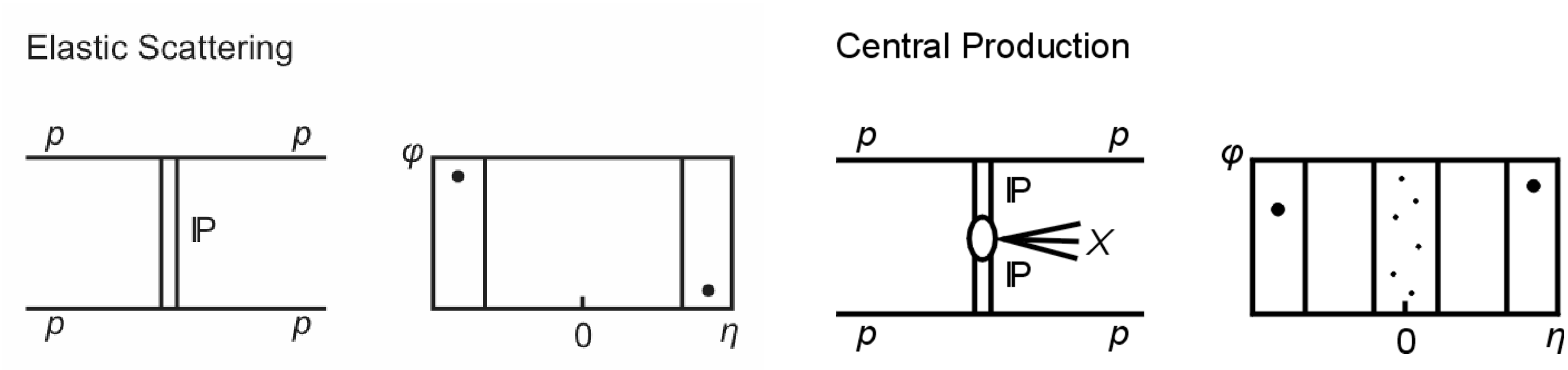
S Chattopadhyay, QM06



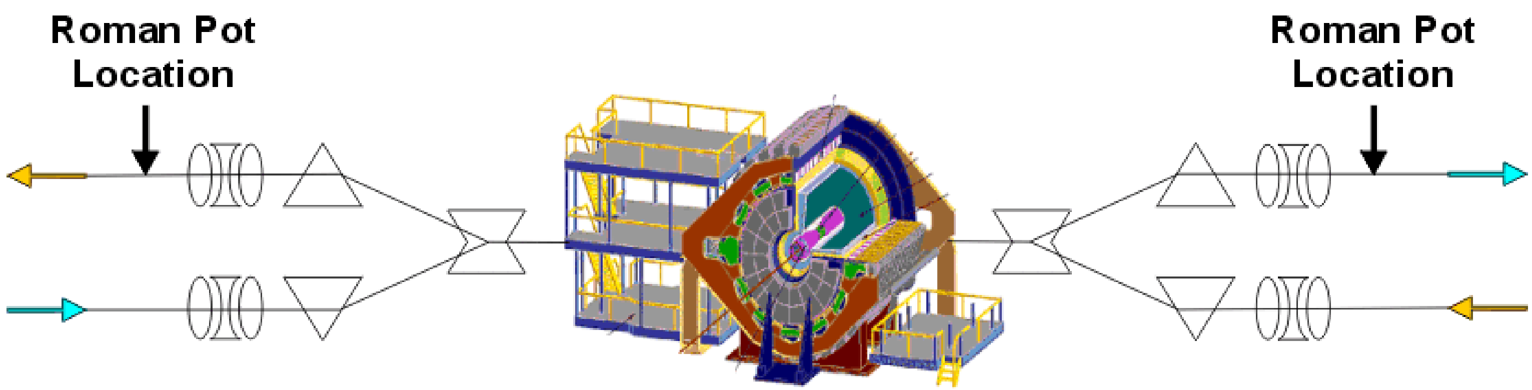
- Select π^0 and … p) … ıower shape profiles in the … ınimal (±0.075 by ±0.075) charged …
- Examine the resulting near-side two-particle correlation strength to infer the purity of the γ sample.

Very encouraging, but we still have much to do!

Physics with Tagged Forward Protons at STAR



Need detectors to tag forward protons and detector with good acceptance and particle ID to measure central system



The Roman pots of the pp2pp experiment in the STAR interaction region, with the arrows indicating proposed location. At each location one Roman Pot station is horizontal and one vertical.

Plan for Run 8 and Expected Performance

With a dedicated run including setup and about 40 hrs of data taking:

1. Elastic scattering:
   - 100% acceptance for elastic scattering for $0.003 < |t| < 0.024$;
   - 20×10^6 elastic events: $\Delta b=0.31\ (\mathrm{GeV}/c)^{-2}$, $\Delta\rho=0.01$, $\Delta\sigma_{tot}$ = 2-3 mb;
   - In four t subintervals we shall have 5×10^6 events in each resulting in corresponding errors $\delta A_n=0.0017$, $\delta A_{nn}=\delta A_{ss}=0.003$.

2. DPE process in Phase I: With luminosity $3\times10^{29}\ \mathrm{cm}^{-2}\mathrm{sec}^{-1}$ we estimate:
   - About $4\cdot10^6$ events with the proton tag, proton in either pot, of the order of the ISR experiment.
   - $4.5\cdot10^5$ DPE events with fully reconstructed proton momentum.

The Physics Driving Run 9

- Qualitative advance in the study of resonances including both their hadronic and leptonic decays
- Extended precision in measurement of correlations of hadrons with non-photonic electrons from D, B semi-leptonic decays
- Completion of initial map at $\sqrt{s}$ = 200 GeV of the x dependence of gluon polarization in the proton, $\Delta G(x)$

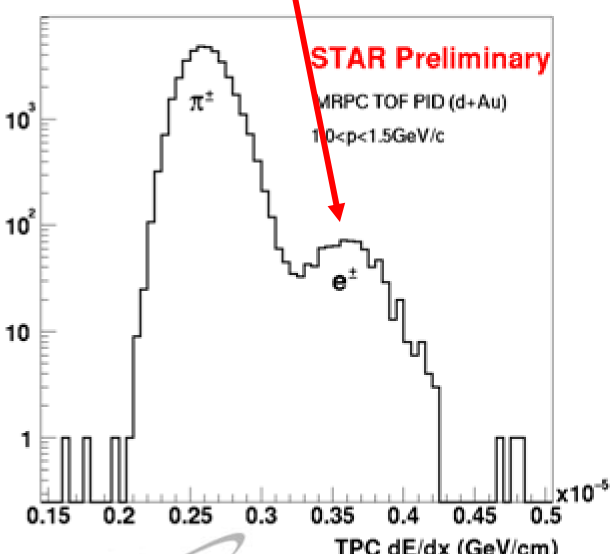
In addition to the completed FMS, significant implementation of DAQ1000 and the STAR TOF barrel are expected to be available in Run 9. These upgrades will provide a qualitative advance in STAR detector capability for heavy ion studies.

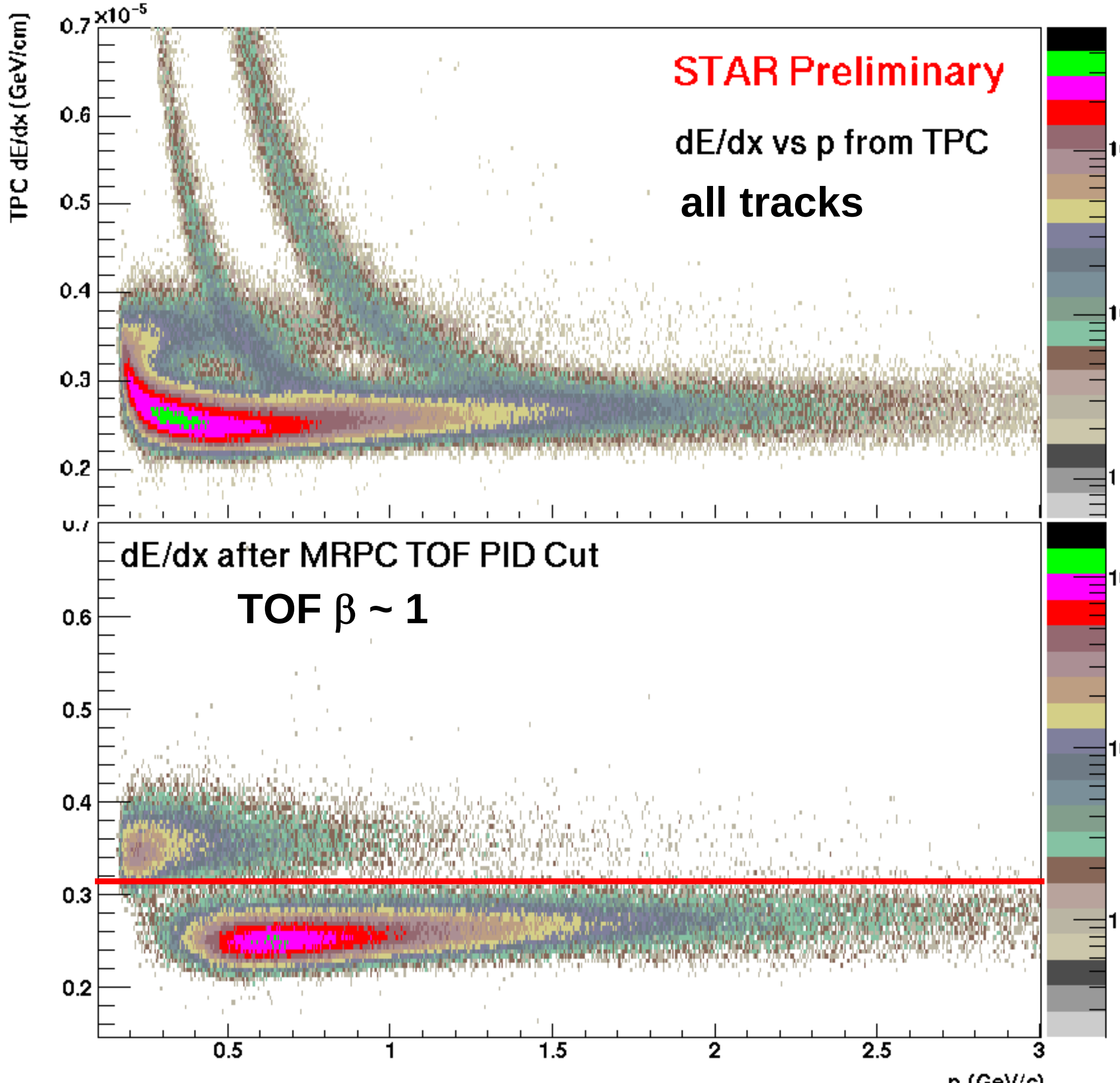
The STAR SVT+SSD will be removed prior to Run 9 → minimal mass interior to the STAR TPC inner field cage

The STAR Forward GEM Tracker will not be available for Run 9 making $\sqrt{s}$ = 500 GeV running for $W^{\pm}$ studies much, much less efficient than in Run 10

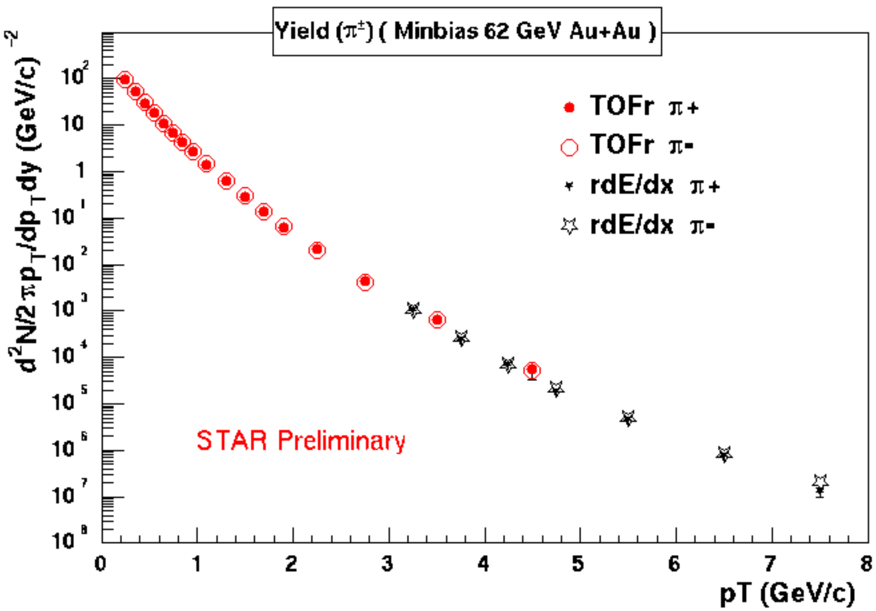
A new physics horizon in STAR provided by the TOF upgrade: electrons at intermediate p_T

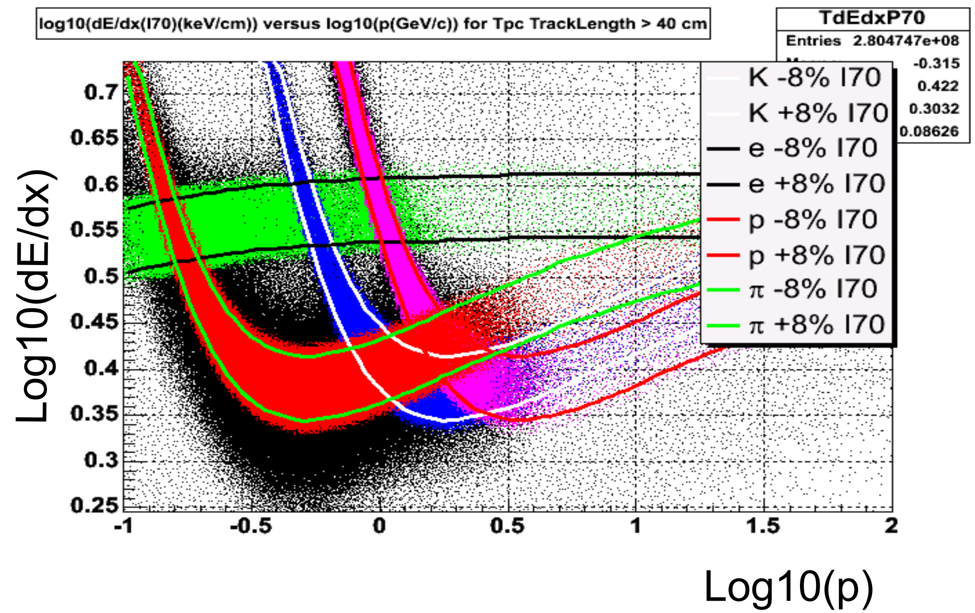
One entirely new physics horizon opened in STAR by the TOF upgrade..
- charmonium
- open charm
- vector mesons





Extending STAR Particle ID





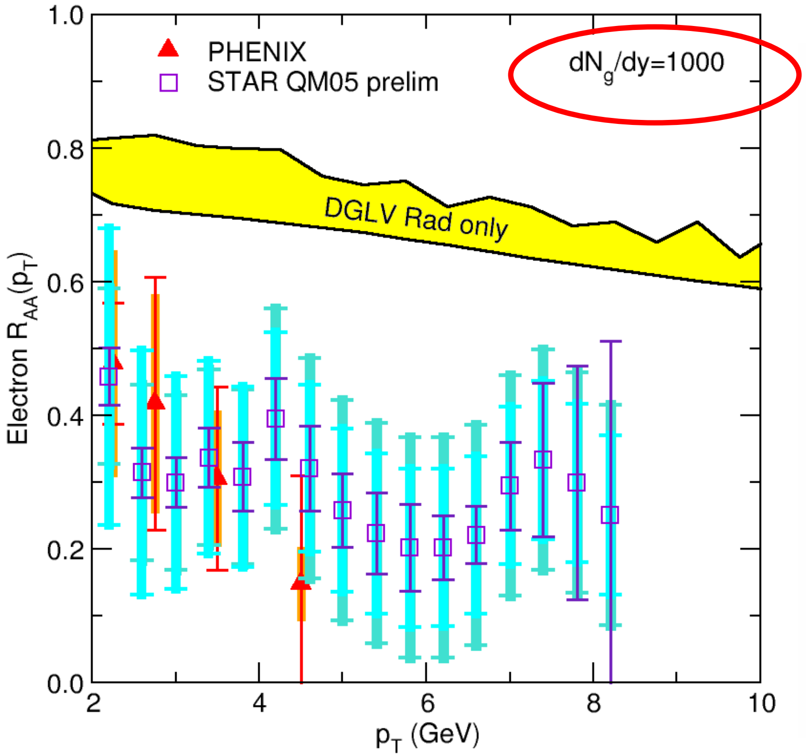
Methods paper submitted to NIM A, nucl-ex/0505026.

Results to 12 GeV in Au+Au

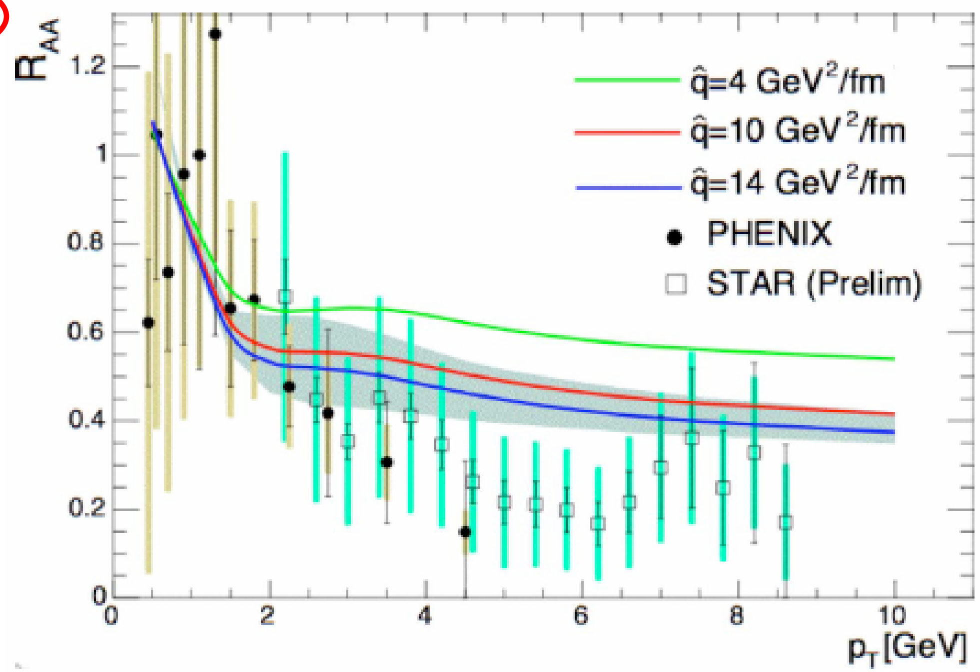
- TPC:
  - Pion: 0-~0.6GeV/c
  - Kaon: 0.2-~0.6GeV/c
  - Proton: 0.2-~1 GeV/c
- TOF:
  - Pion: 0.2-~1.6GeV/c
  - Kaon: 0.2-~1.6GeV/c
  - Proton: 0.2-~3 GeV/c
- TPC+TOF:
  - Pion: 0.-~10 GeV/c
  - Kaon: 0.2-~3GeV/c
  - Proton: 0.2-~? GeV/c

Heavy flavor suppression via b,c → e+X

S.Wicks et al., nucl-th/0512076



Armesto et al., Phys.Lett.B637:362-366,2006



R_{AA}(non-photonic electrons) ~ 0.2 ~ $R_{AA}(\pi^0)$!!

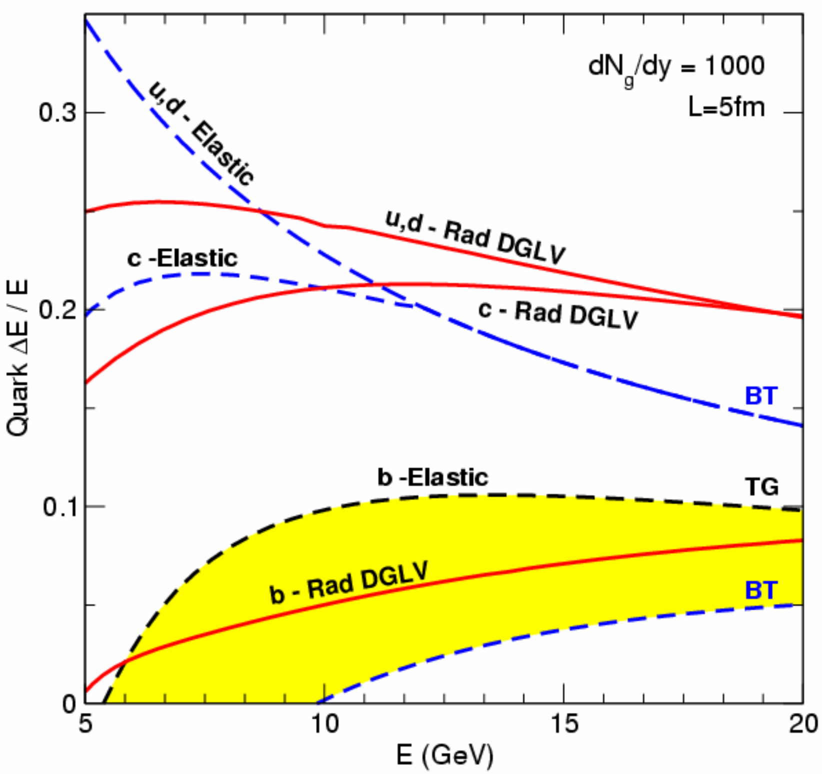
Gluon density/qhat constrained by light quark supression+entropy density (multiplicity)

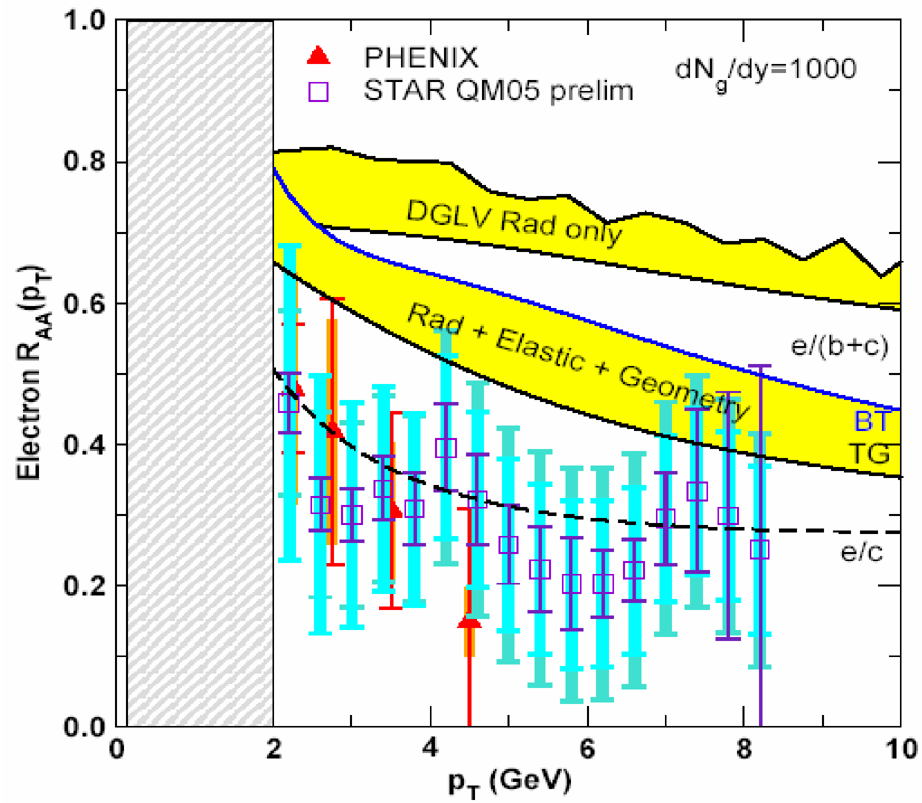
⇒ under-predicts electron suppression

⇒ charm vs beauty? elastic energy loss? …?

Elastic (collisional) energy loss revisited

S.Wicks et al., nucl-th/0512076





Elastic ΔE comparable to Radiative ΔE – not negligible

Elastic ΔE important even for light quarks

⇒ revisit energy density estimates?

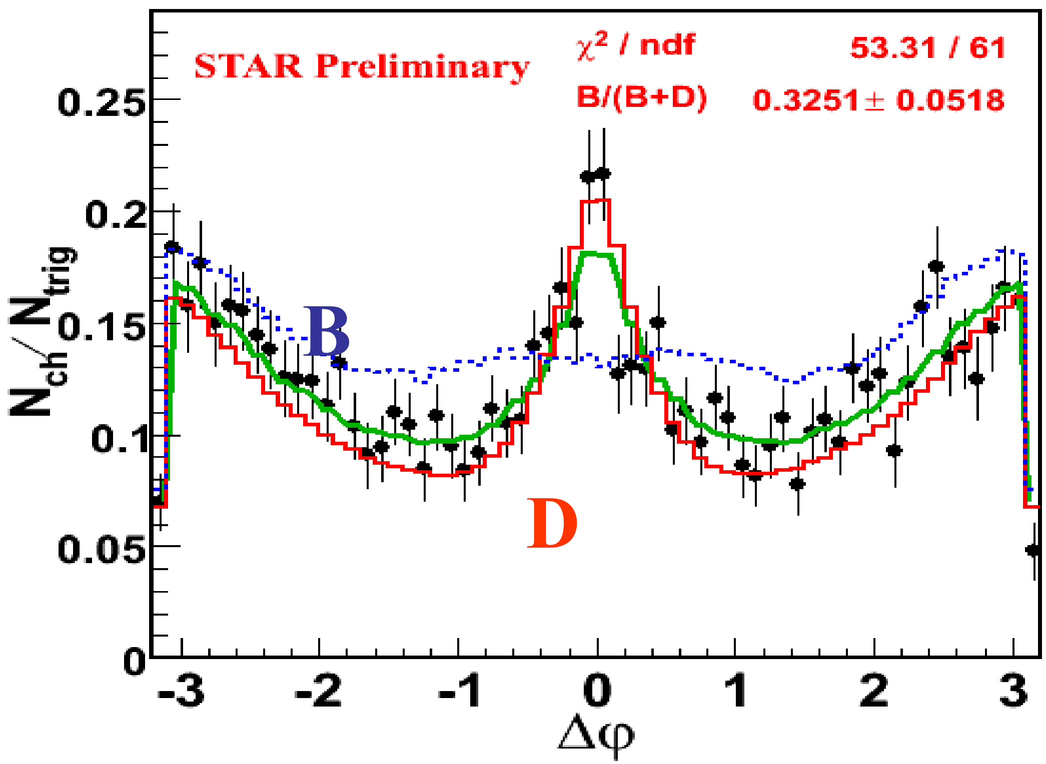
What's the Real c and b Contribution to NPE's ?

- Measure azimuthal correlations between electron and charged hadron (e-h correlations)
- Measure electron from charm contribution at p_T>3 GeV/c through $D^0 \rightarrow e^+ K^- X$ (e-K correlations)
- Measure azimuthal correlations of electron and charm mesons (e-D^0 correlations)

These studies significantly enhanced by the near-zero mass configuration and enhanced PID (from TOF) available in Run 9

Using PYTHIA Curves to Fit Data Points

2.5 < P_T(trig) < 3.5 GeV/c, P_T(asso) > 0.3 GeV/c

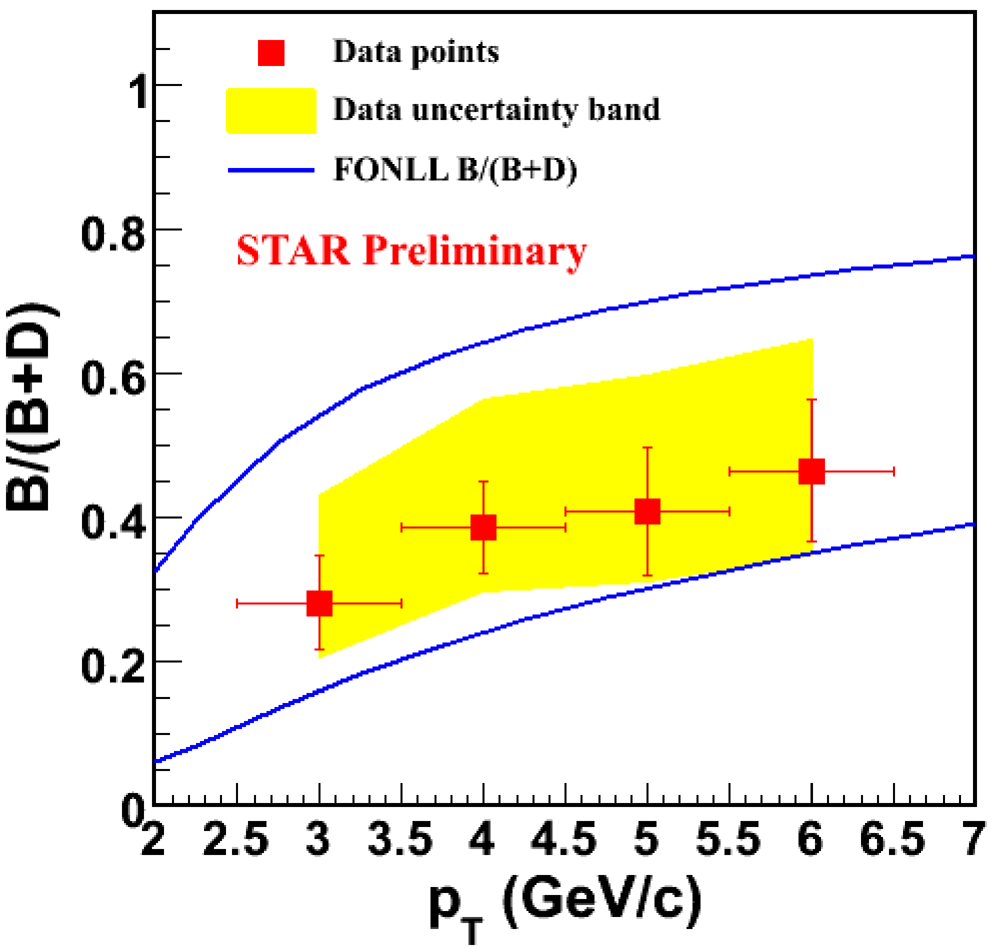


Fit function: R*PYTHIA_B+(1-R)*PYTHIA_D

R is B contribution, i.e. B/(B+D), as a parameter in fit function.

X.Y. Lin, QM2006

Preliminary Results: B Contribution in p+p vs. p_T

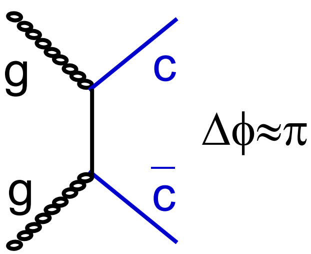


- Data uncertainty includes statistical errors and systematic uncertainties from:
  - photonic background reconstruction efficiency (*dominant*).
  - difference introduced by different fit functions.
- Preliminary data is within the range that FONLL calculation predicts.
- Non-zero B contribution is observed.

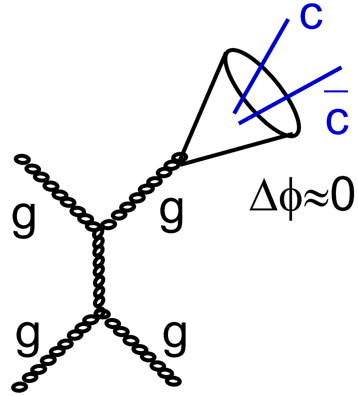
X.Y. Lin, QM2006

Electron Tagged Correlations

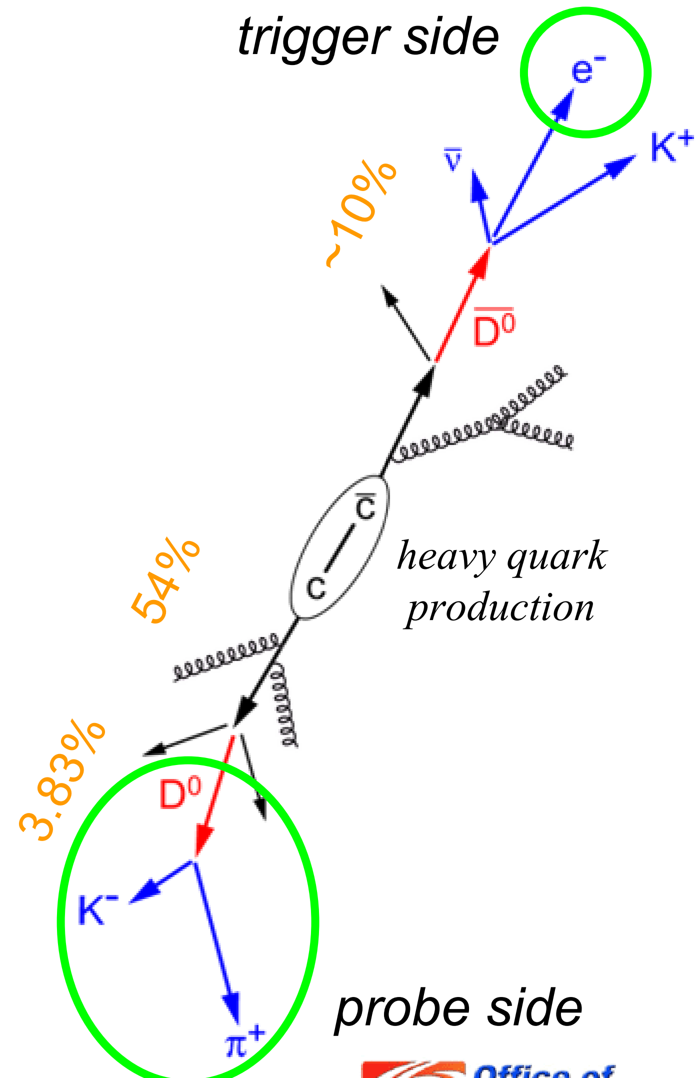
- Experimental approach
  - non-photonic electrons from semi-leptonic charm decays are used to trigger on c-cbar pairs
  - back-2-back D^0 mesons are reconstructed via their hadronic decay channel (probe)
- Underlying production mechanism can be identified using second charm particle



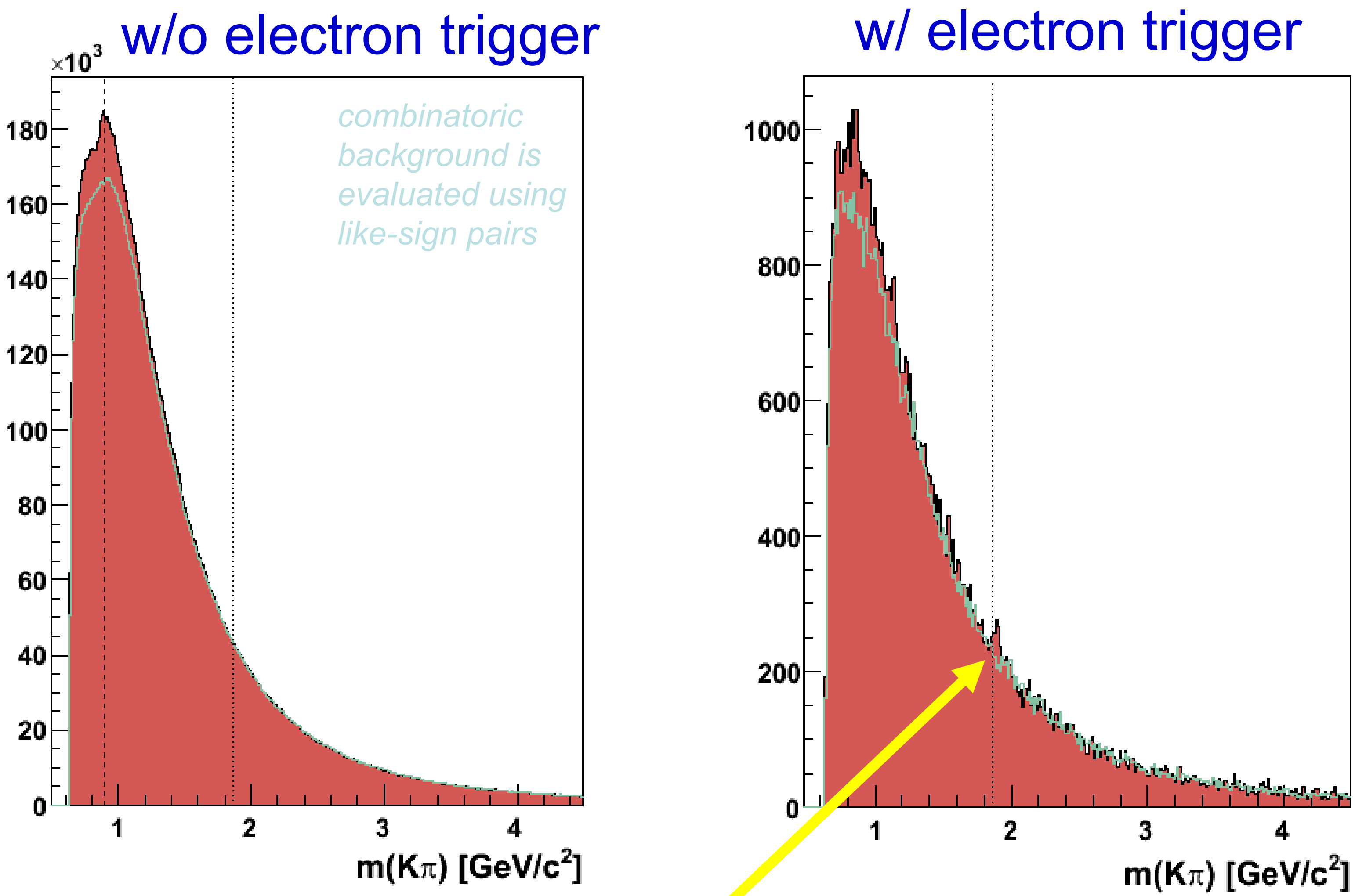
flavor creation



gluon splitting/fragmentation



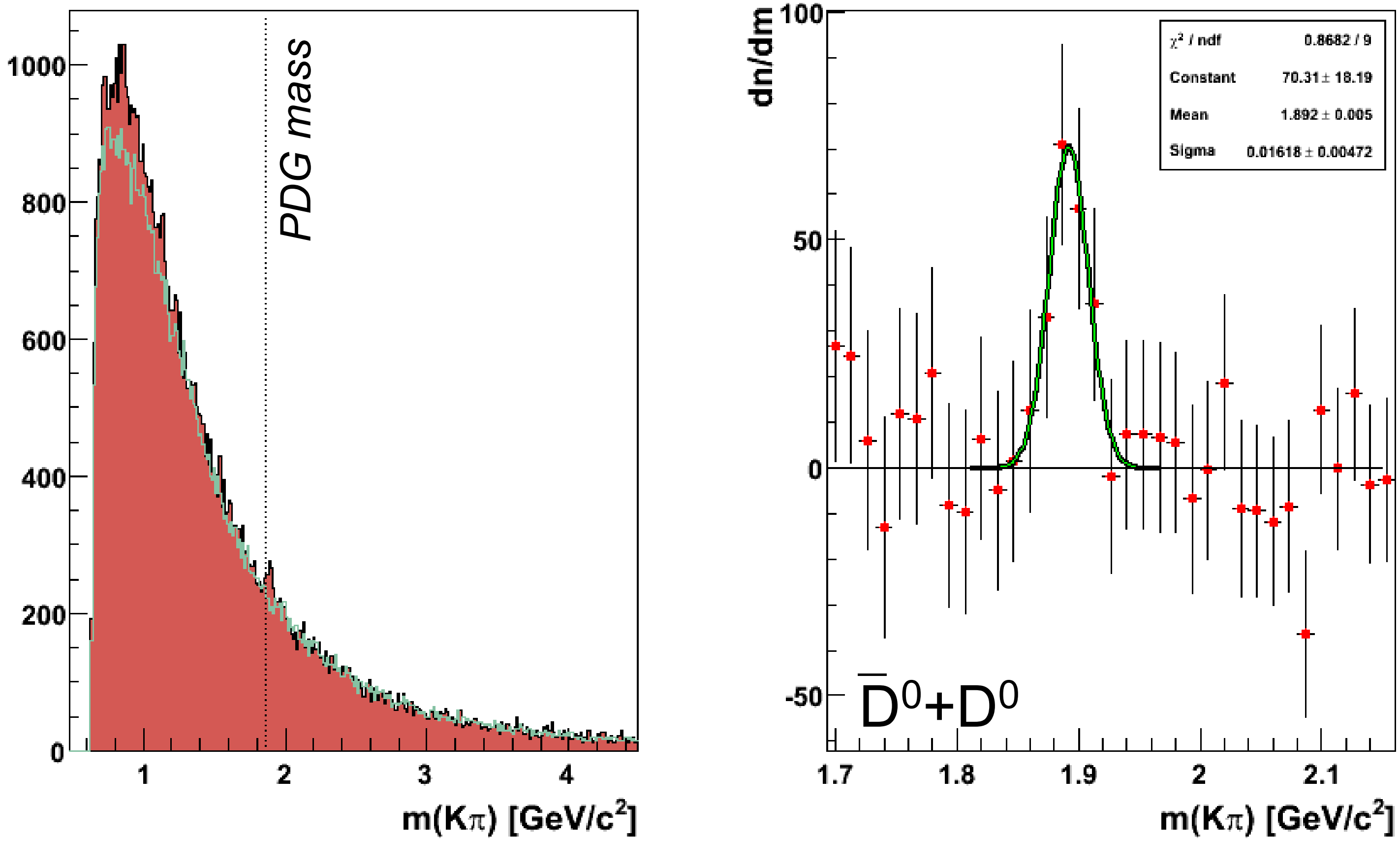
(Kπ) Invariant Mass Distribution



Clear D^0 signal w/o background subtraction

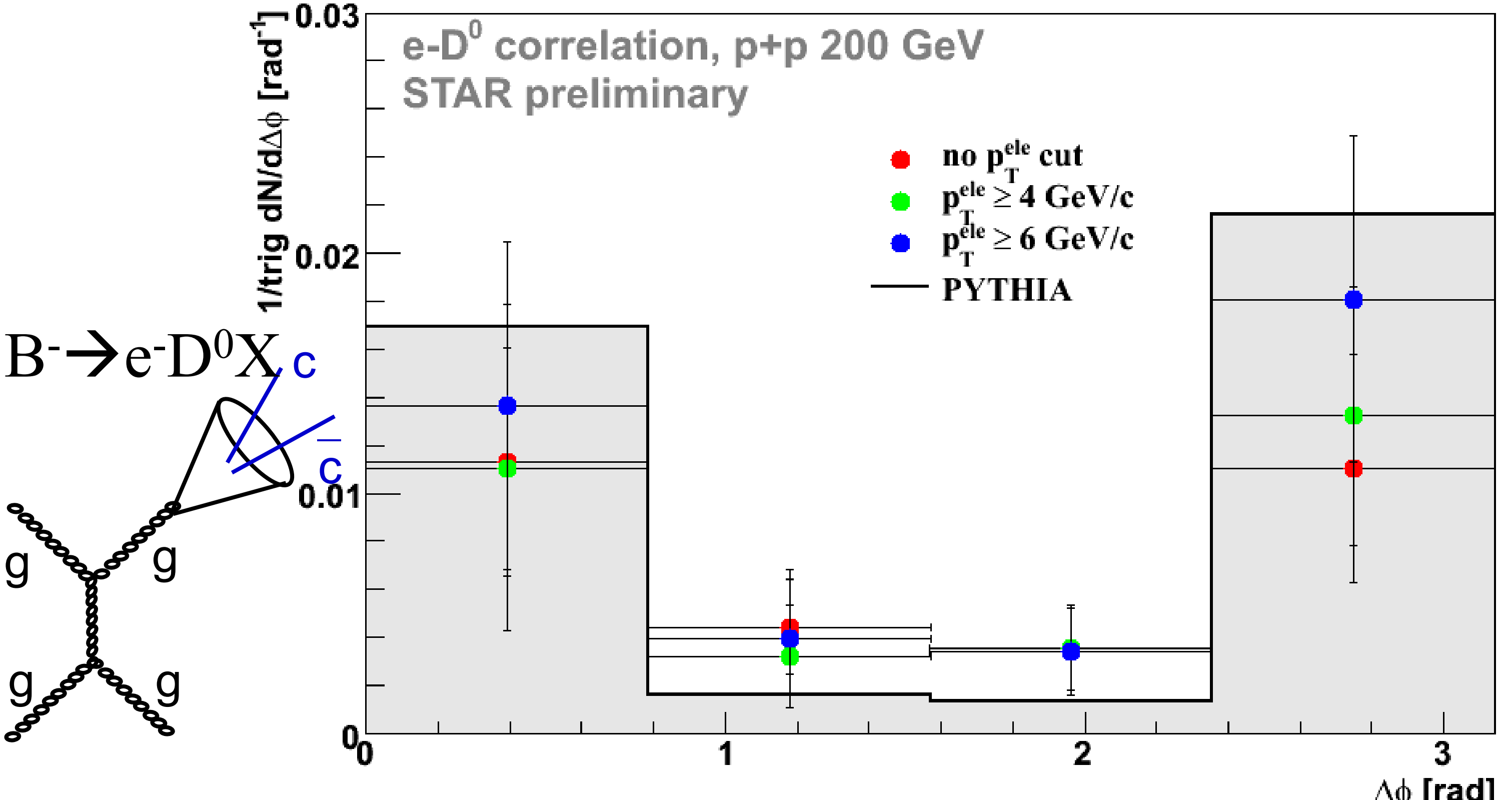
STAR

D^0 Mesons in p+p Collisions

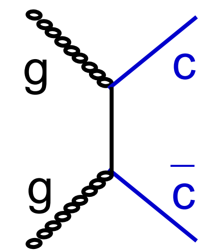


- S/B = 1/7 (~1/600 in d+Au w/o trigger) → factor ~100 better
- Significance = 3.7
- Peak content ~200

e^{-}-D^{0} Azimuthal Correlation Distribution



like-sign (e,K) pairs



statistical errors only

First heavy flavor pair correlation measurement at RHIC!!

Data analysis and simulation are going on to interpret the signal observed.

The Physics Driving Run 10

- Definitive results on the existence/location of the QCD Critical Point
- Continuation of $\Delta G(x)$ map below $x_{BJ} \sim 0.03$
- First measurement of flavor dependence of sea quark / anti-quark polarization in the proton

The above polarized proton goals anticipate the first significant run for spin physics at $\sqrt{s}$ = 500 GeV in Run 10

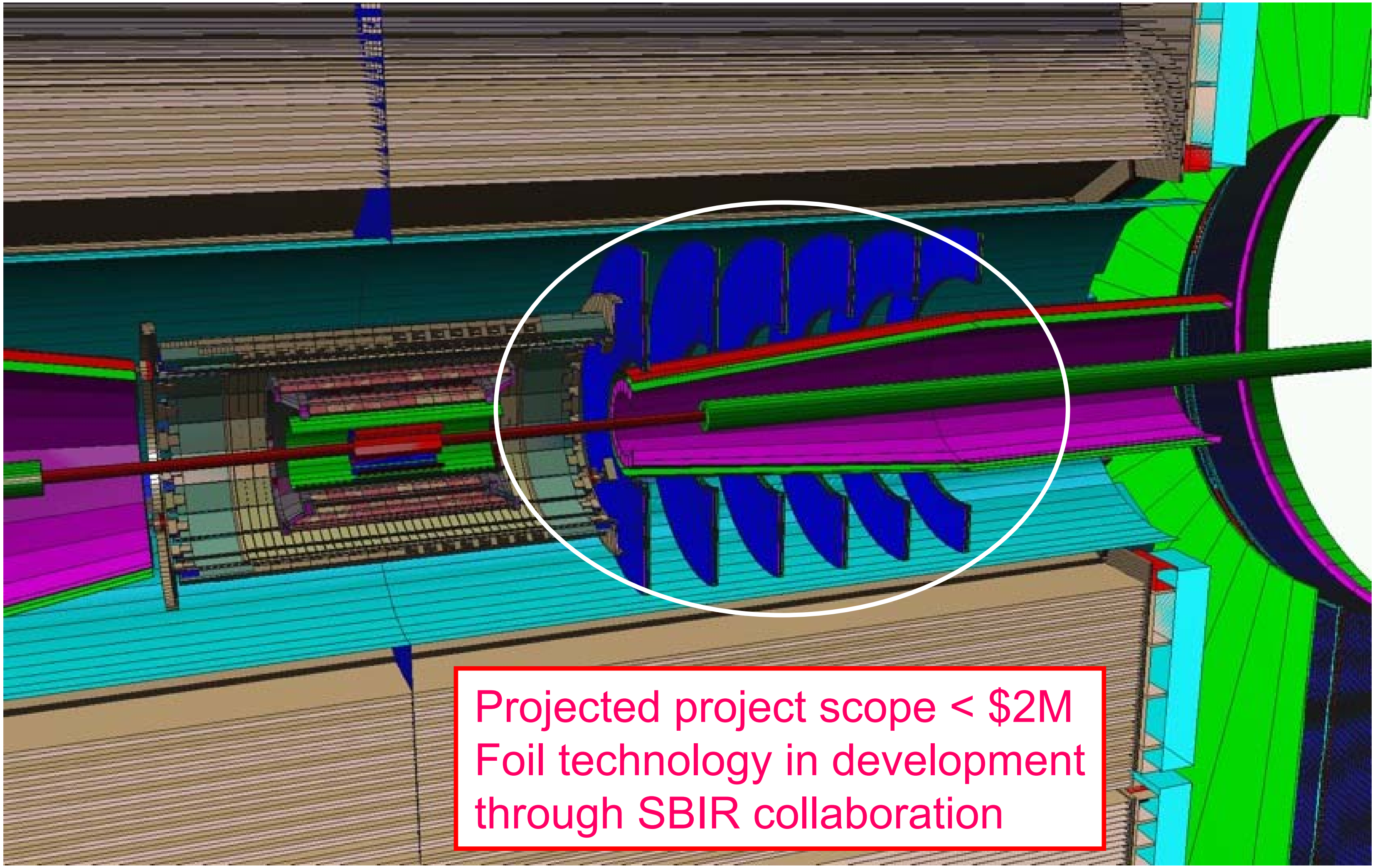
In addition to the completed FMS, The STAR DAQ1000 upgrade, the full TOF barrel and the Forward GEM Tracker are expected to be complete in time for Run 10.

The completed TOF barrel is crucial for the QCD critical point search

The Forward GEM Tracker is crucial for studying $W^{\pm}$ decays

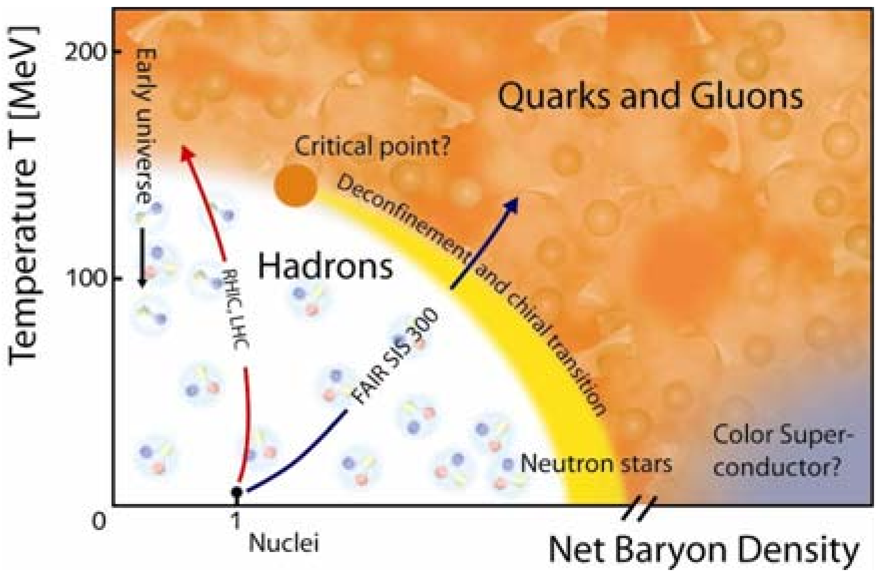
"Serious" $\sqrt{s}$ = 500 GeV commissioning time required prior to this run

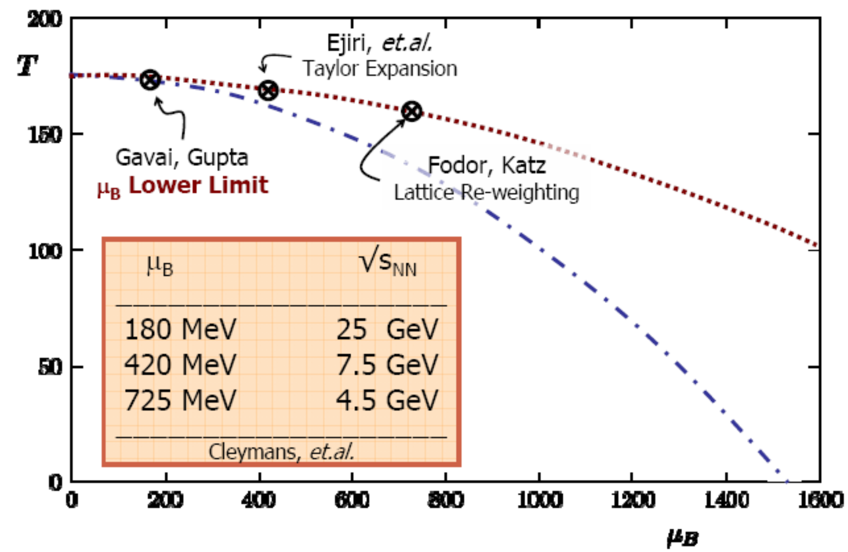
Forward GEM Tracker



Layout of the Forward GEM Tracker, consisting of six triple-GEM detector disks

Does a QCD Critical Point Exist? If so, where?





μ_B	$\sqrt{s_{NN}}$
180 MeV	25 GeV
420 MeV	7.5 GeV
725 MeV	4.5 GeV

Available results from LQCD suggest that at non-vanishing chemical potential, as the temperature of dense hadronic matter increases it should undergo a rapid transition from a hadron resonance gas to a quark-gluon plasma signaled by a sudden change in the equation of state. As the baryon chemical potential is increased, the fluctuations on the cross-over line increase dramatically suggesting the existence of a critical point in the phase diagram.

The location of the QCD Critical Point, if it exists, remains a matter for experiment

STAR Capabilities for QCD Critical Point Study

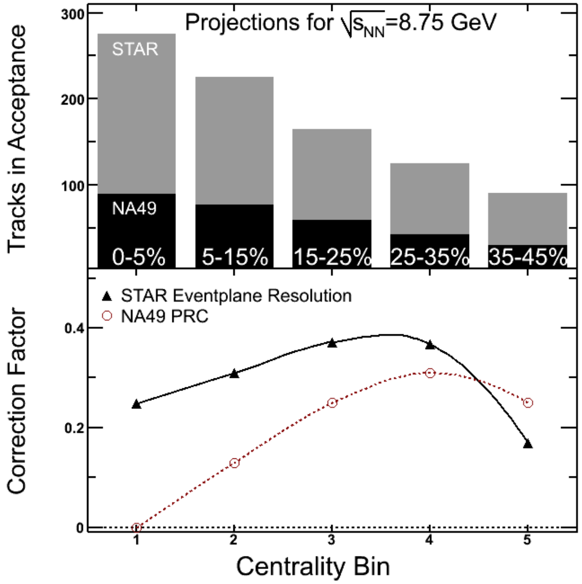
Because of its 2π acceptance and excellent PID (with complete TOF by Run 10) STAR is an ideal detector this study.

Triggering efficiently appears feasible

impact parameter	AuAu @ 5 GeV BBC Inner	AuAu @ 5 GeV BBC Outer	AuAu @ 8.75 GeV BBC Inner	AuAu @ 8.75 GeV BBC Outer
b<0	5	27	12	54
3<b<6	11	30	21	57
6<b<9	22	35	39	40

Particle hit multiplicities in the STAR Beam-Beam counters for low $\sqrt{s_{NN}}$ Au+Au running

Low luminosity and beam background will still present challenges



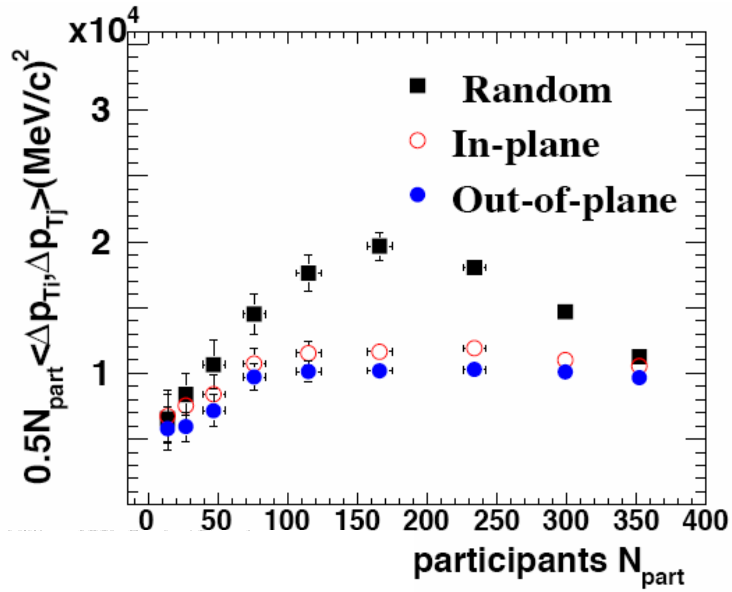
Simulation of the event plane resolution in STAR vs NA49 for comparable centrality bins ($\sqrt{s_{NN}}$ = 8.75 GeV Au+Au (Pb+Pb)).

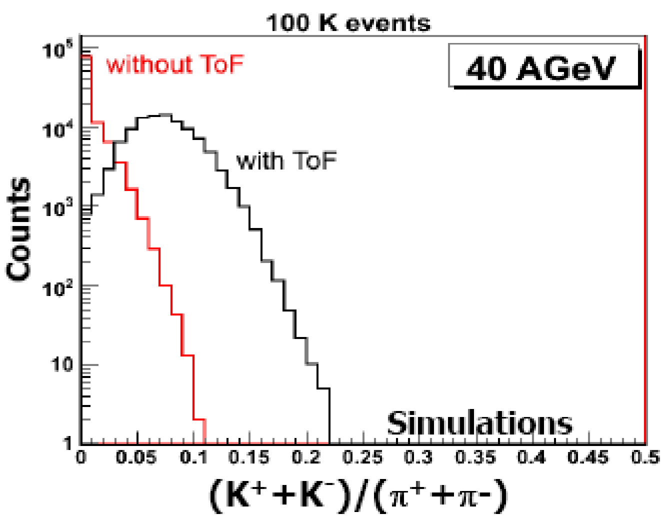
Large 2π acceptance important for these studies

Importance of acceptance and PID

Contribution of elliptic flow to the apparent magnitude of <ΔpTiΔpTj > fluctuations for particles within

- 45 degrees of the event plane (red),
- 45 degrees of the out-of-plane direction (blue),
- a detector with partial angular coverage when the event plane is unknown (black). (Fluctuations are overestimated because the event plane is fluctuating randomly in, out, and within the acceptance.)





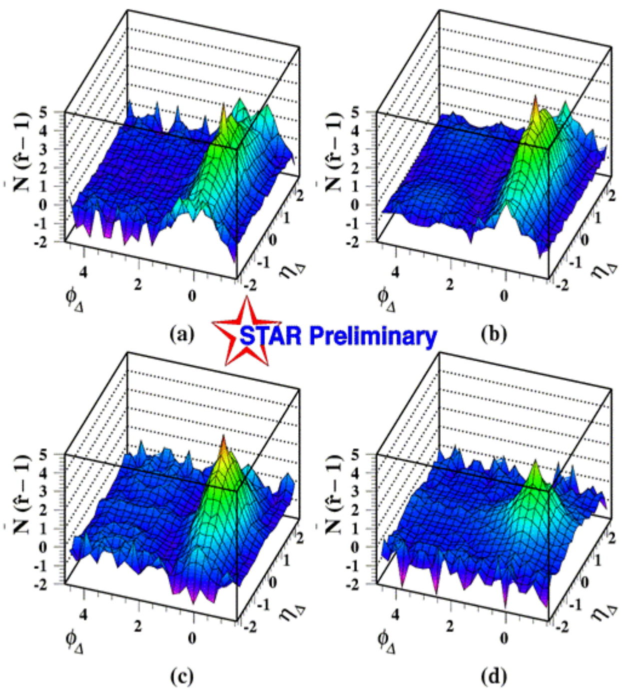
Study, based on 100,000 simulated events of the statistical and systematic uncertainties with and without the PID capability of the STAR TOF

Full Barrel TOF is Crucial

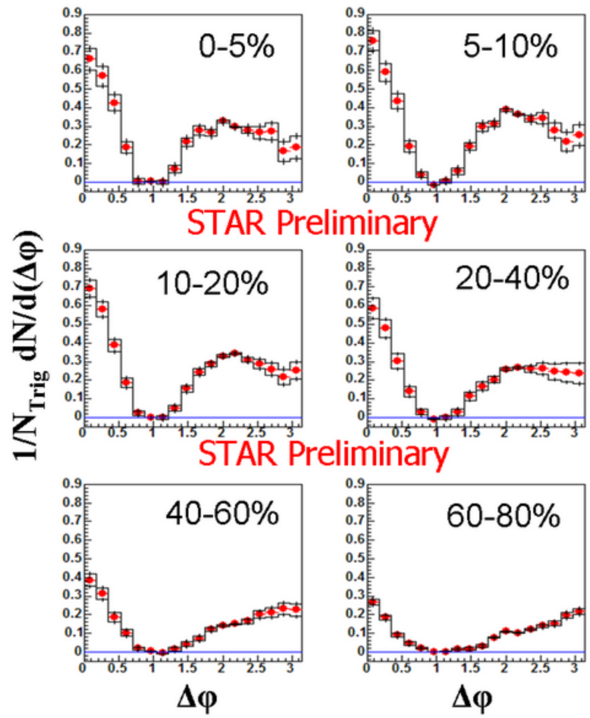
Misidentification of only 1% leading to a swapping of pions for kaons reduces the width of the observed k/pi fluctuation distribution by 10%. A misidentification of 2% leads to a reduction in width of 20%.

Upgraded Detector Capability in Run 10

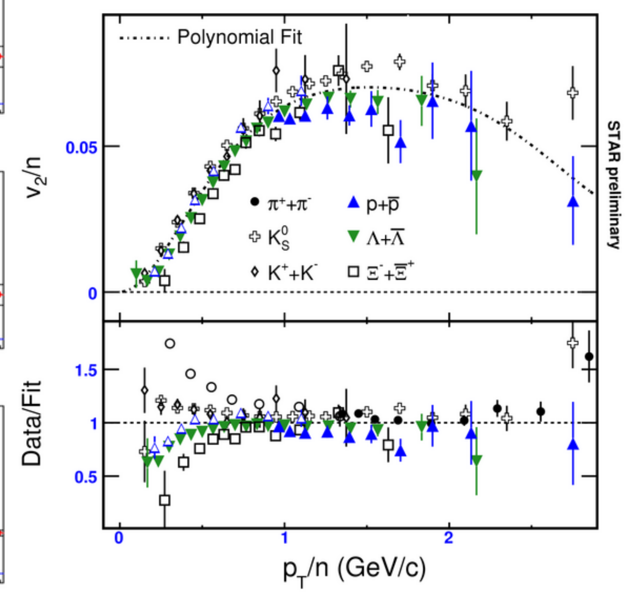
Two particle correlations at low p_T



Two (3) particle correlations at intermediate p_T



Constituent-quark-scaled v_2 at intermediate p_T



Further examples of the types of measurements which will make a major advance with the combination of upgraded PID capability and increased DAQ throughput in Run 10

BROOKHAVEN NATIONAL LABORATORY

Office of Science U.S. DEPARTMENT OF ENERGY

Conclusions

- The STAR Collaboration strongly believes the proposed plan will provide for qualitative advances in our understanding of the nucleon, the nucleus, and dense QCD matter in a way that makes maximal use of RHIC beams and STAR/RHIC capability as it develops

- STAR maintains this is an optimal plan for maximizing the scientific impact and discovery potential in the next 3 years

- The completion of the initial $\Delta G(x)$ map at $\sqrt{s}$ = 200 GeV before moving on to $\sqrt{s}$ = 500 GeV is <u>important</u> to allow sufficient statistics to elucidate the Q^2 evolution between these energies, and to make efficient use of the higher energy once the Forward GEM Tracker has been installed.

The STAR Collaboration: 45 Institutions, 12 countries, ~ 500 Scientists and Engineers

U.S. Labs:
Argonne, Lawrence Berkeley, and Brookhaven National Labs

U.S. Universities:
UC Berkeley, UC Davis, UCLA, Carnegie Mellon, Creighton, CCNY, Indiana, Kent State, MSU, Ohio State, Penn State, Purdue, Rice, Texas A&M, UT Austin, Washington, Wayne State, Valparaiso, Yale, MIT

Brazil:
Universidade de Sao Paolo

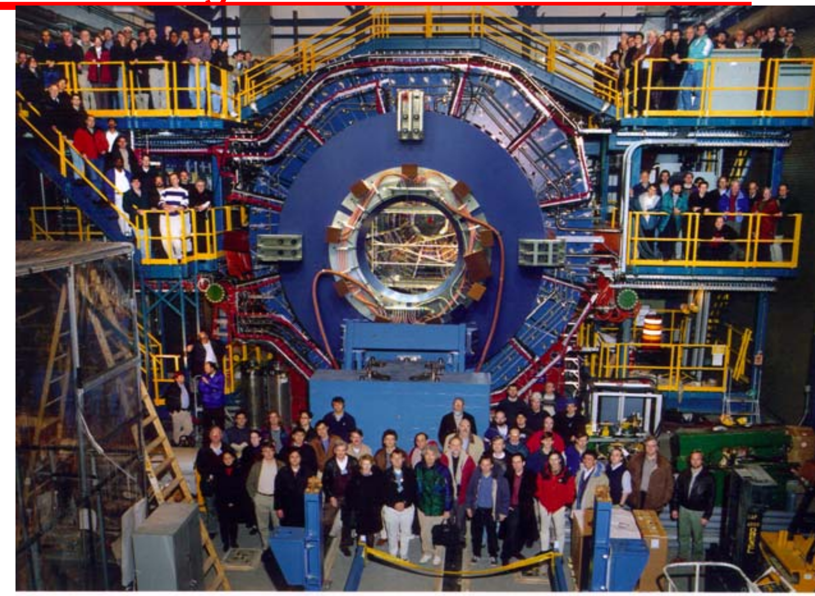
China:
IHEP - Beijing, IPP - Wuhan, USTC, Tsinghua, SINR, IMP Lanzhou

Croatia:
Zagreb University

Czech Republic:
Institute of Nuclear Physics

Englan
Un

France:
Ins
SU



India:
Bhubaneswar, Jammu, IIT-Mumbai, Panjab, Rajasthan, VECC

Netherlands:
NIKHEF

Poland:

HEP –

Pusan National University

New members from BRAHMS

New members from pp2pp

Status of STAR: a growing list of degree recipients

STAR

96 advanced degrees to students at 28 institutions awarded on STAR research

Max-Planck-Institut
2005 Frank Simon, PhD
2004 Joern Putschke, PhD
2003 Maierbeck Peter, Dipl.
2002 Markus Oldenburg, PhD
2000 Holm Huemmler, PhD
2000 Tobias Eggert, Dipl.
1998 Rainer Marstaller, Dipl.
1997 Michael Konrad, PhD
1997 Xaver Bittl, Dipl.

Michigan State University
2002 Marguerite Tonjes, PhD

Ohio State University
2004 Selemon Bekele, PhD
2004 M. Lopez-Noriega, PhD
2003 Randy Wells, PhD
2002 Robert Willson, PhD

Purdue University
2003 Timothy Herston, M.S.
2002 Alex Cardenas, PhD
2006 Levente Molnar, PhD

Rice University
2001 Martin DeMello, M.S.

USTC China
2005 Xin Dong, PhD
2004 Shengli Huang, PhD
2004 Lijuan Ruan, PhD

IOP, Bhubaneswar
2006 D. Misra, Ph.D.
2006 A. Dubey, Ph.D.

SUBATECH
2005 Magali Estienne, PhD
2004 Gael Renault, PhD
2003 Ludovic Gaudichet, PhD
2002 Javier Castillo, PhD
2000 Fabrice Retiere, PhD
2000 Walter Pinganaud, PhD

University of Texas - Austin
2004 Aya Ishihara, PhD
2004 Yiqun Wang, PhD
2003 Bum Choi, PhD
2002 Curtis Lansdell, PhD

Warsaw University of Technology
2004 Adam Kisiel, PhD
2004 Zbigniew Chajecki, M.S.

University of Washington
2002 Jeff Reid, PhD

Institute of Particle Physics
2005 Zhixu Liu, PhD
2002 Jinghua Fu, PhD

Yale University
2006 Sevil Salur, PhD
2004 Jon Gans, PhD
2003 Haibin Zhang, PhD
2003 Michael Miller, PhD
2002 Matthew Horsley, PhD
2001 Manuel Calderon, PhD

SINAP
2006 GuoliangMa, Ph.D.

University of Bern
2005 Mark Heinz, PhD

University of Birmingham
2005 John Adams, PhD
2002 Matthew Lamont, PhD

UC – Los Angeles
2006 Jingguo Ma, PhD
2006 Johan Gonzalez, PhD
2006 Weijiang Dong, PhD
2005 Dylan Thein, PhD
2005 Jeff Wood, PhD
2005 Hai Jiang, PhD
2003 Yu Chen, PhD
2003 Paul Sorensen, PhD
2002 Hui Long, PhD
2001 Eugene Yamamoto, PhD

Univ. –Sao Paulo
1998 Jun Takahashi, Ph.D.

Carnegie Mellon University
2003 Christopher Kunz, PhD

Creighton University
2003 Steve Gronstal, M.S.
2003 Nil Warnasooriya, M.S.
2003 Sarah Parks, M.S.
1999 Jie Lin, M.S.
1998 Quinn Jones, M.S.
1996 John Meier, M.S.
1995 Jeffrey Gross, M.S.
2006 Michael Swanger, M.S.

Texas A&M
2006Thomas Henry

Wayne State University
2005 Ying Guo, PhD
2005 Alexander Stolpovsky, PhD
2006 Ahmed Hamed, Ph.D.

Nucl. Physics Inst., Prague
2002 Petr Chaloupka, M.S.
2004 Michal Bystersky, M.S.
2006 Jan Kapitan, M.S.

UC - Davis
2002 Ian Johnson, PhD
2005 Roppon Picha, Ph.D.
2006 Mike Anderson, Ph.D.

University of Frankfurt
2006 Thorsten Kollegger, PhD
2003 Dominik Flierl, PhD
2003 Jens Berger, PhD
2003 Clemens Adler, PhD
2003 Christof Struck, PhD
1998 Jens Berger, Dipl.
1998 Clemens Adler, Dipl.
2006 Wetzler, Alexander, Ph.D

Reserches Sub. Strasbourg
2004 Julien Faivre, PhD
2002 Boris Hippolyte, PhD
2001 Christophe Suire, PhD
2006 Speltz, Jeff, Ph.D

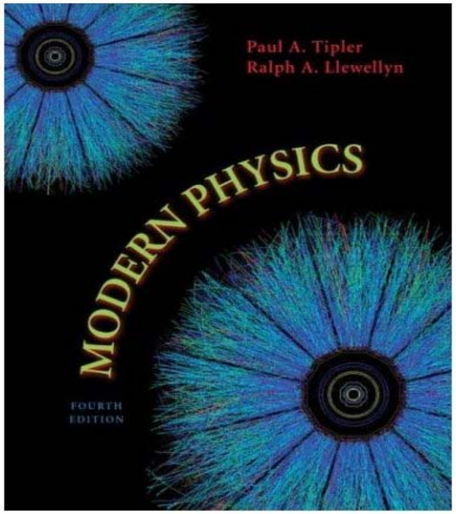
Kent State University
2005 Camelia Mironov, PhD
2005 Gang Wang, PhD
2003 Ben Norman, PhD
2002 Wensheng Deng, PhD
2002 Aihong Tang, PhD

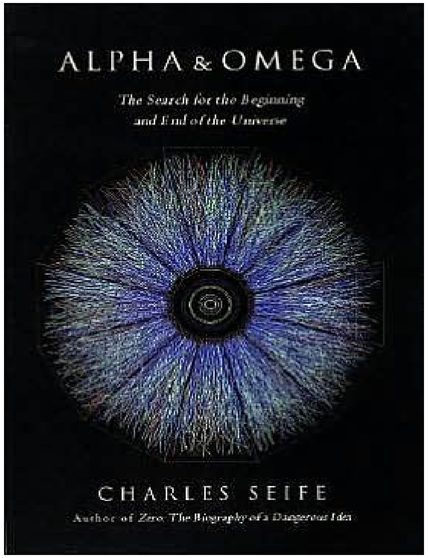
LBNL
2003 Vladimir Morozov, PhD

Blue = awarded since July 2005

Status of STAR: a growing publication record

- **39** Physical Review Letters
- **27** Physical Review C
- **10** Physics Letters B / J. Physics G / Nuclear Physics A /PRD
- 4,690 Citations
- 11 "Very well known" (topcite) Papers with >100, < 250 citations
- 5 "Famous" Papers with >250, < 500 citations





Visibility which is impacting the popular image of modern physics