

RHIC S&T Review

July 22, 2009

Experiment Operations

T. Ludlam

- Status of detector upgrades**
- BNL management oversight of upgrades**
- RCF status**
- Reorganization of research groups**
- eRHIC Science Task Force**

Upgrades to PHENIX and STAR

An on-going program of R&D and construction to add capabilities needed for RHIC II science goals with enhanced luminosity

- ❑ Improved rate capability and trigger sensitivity for rare probes
- ❑ Precision vertex trackers for open charm and beauty
- ❑ W measurements in 500 GeV pp collision
- ❑ Low-mass e^+e^- continuum (PHENIX)
- ❑ Muon capability for STAR; Forward calorimetry for PHENIX

Funding for this array of small projects comes from...

- | | |
|--|---------|
| • RHIC program R&D and capital equipment funds | \$10.5M |
| • DOE MIE project funds | \$23.9M |
| • NSF funds | \$ 2.5M |
| • Contributions from non-U.S. collaborators
Japan, China, France... | \$ 9.5M |

The overall effort is captured in BNL's "Mid Term Plan" for RHIC.

The total cost is ~\$50M.

There has been a great deal of progress during the past year, as well as a much-improved budget climate.

The Upgrade Projects

PHENIX:

- **Hadron Blind Detector: HBD** Remove Dalitz and conversion pairs in low mass e^+e^-
- **Silicon Vertex Trackers: VTX, FVTX** Open Charm and Beauty; photon-jet correlations
- **Muon Trigger: Mu Tr FEE, RPC** W^\pm measurements in 500 GeV p-p
- **Forward Calorimeter: FOCAL** A development effort: forward π^0, γ in spin and d-A

STAR:

- **High-rate data acquisition: DAQ 1000** KiloHertz rates with near-zero trigger dead time
- **Time of flight barrel: TOF** Complete coverage of TPC, using MRPC technology
- **Forward Meson Spectrometer: FMS** Forward π^0, γ in spin and d-A
- **Forward GEM Tracker: FGT** W^\pm measurements in 500 GeV p-p
- **Heavy Flavor Tracker: HFT** Direct reconstruction of charm and beauty decays
- **Muon Telescope Detector: MTD** A development effort: Muon tracking at mid-rapidity

VTX, FVTX, TOF are DOE Major Item of Equipment (MIE) projects < \$5M

HFT is on track to become MIE project < \$20M

All others are funded from RHIC Capital Equipment budget < \$2M

(or non-DOE funds)

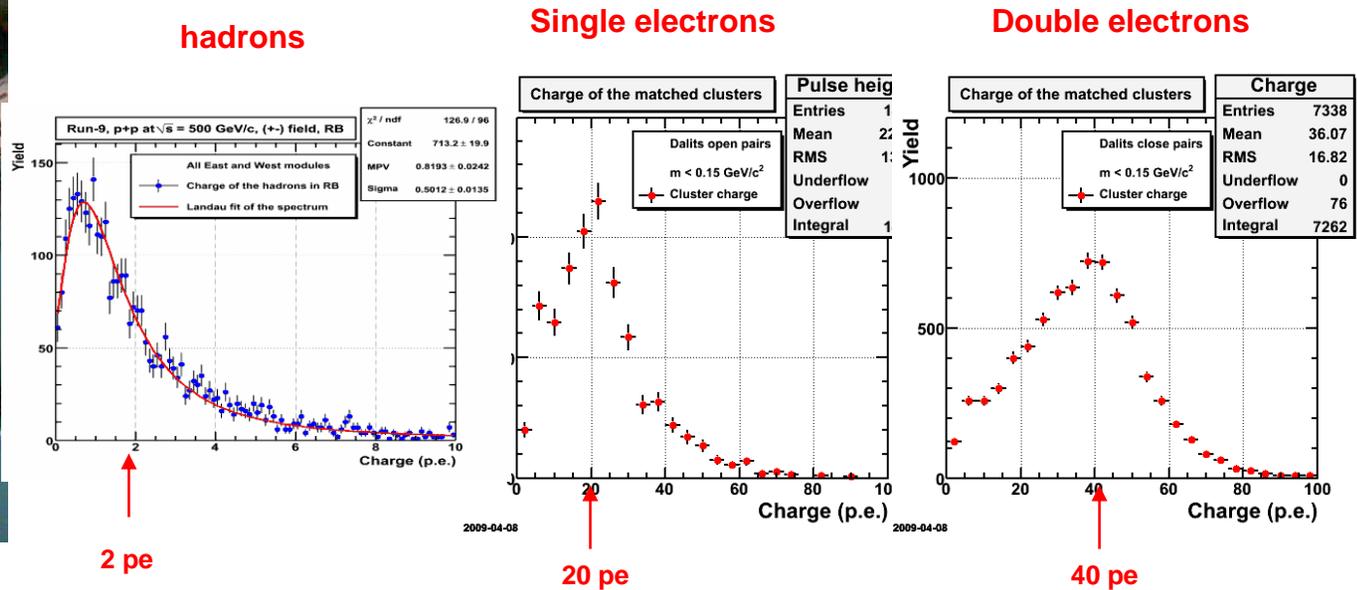
} Different requirements
for DOE project
management

Ed O'Brien will give a detailed status report in tomorrow's Breakout Session.

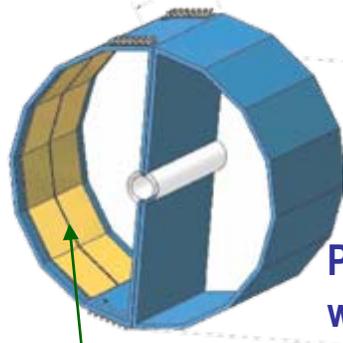
I will give a brief update here.

PHENIX Hadron Blind Detector

HV discharge problem and damage to GEM surfaces found in FY 2007 engineering run have been corrected and repaired. Excellent performance in FY 2009 run.



Electrons from Dalitz pairs in the mass region below 150 MeV.



Proximity focused Cherenkov counter with CF_4 radiator

CsI photocathode on triple GEM layers

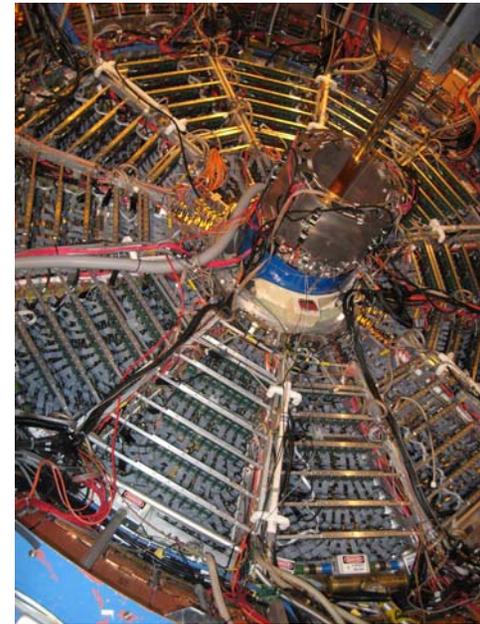
**Operational in Runs 9 & 10;
To be removed for VTX in Run 11**

STAR DAQ 1000

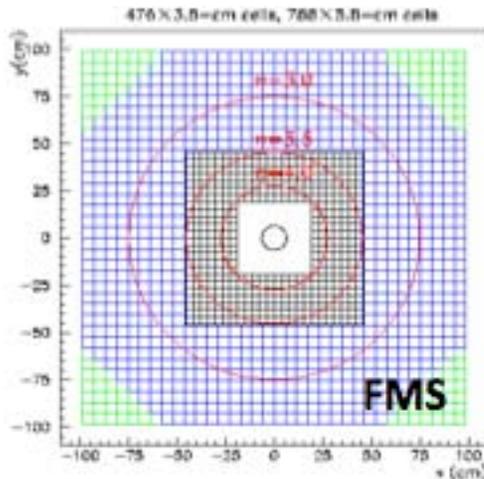
New TPC electronics, cables, fibers, LV, and readout computers installed and operational in Run 9.

Measured deadtime $\sim 1\%$ for TPC readout rate of 500 Hz.

STAR is now a high-rate detector for RHIC II.

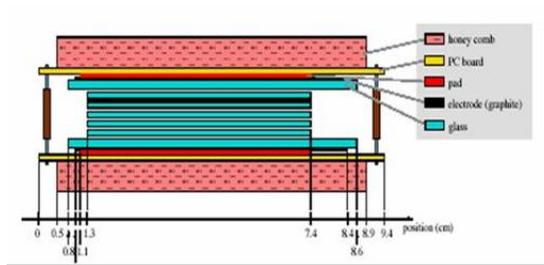
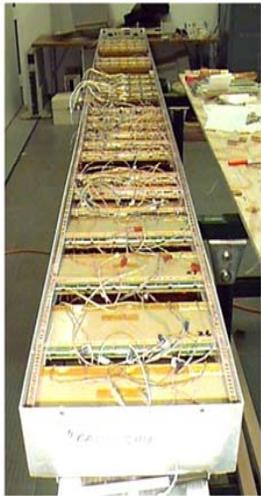
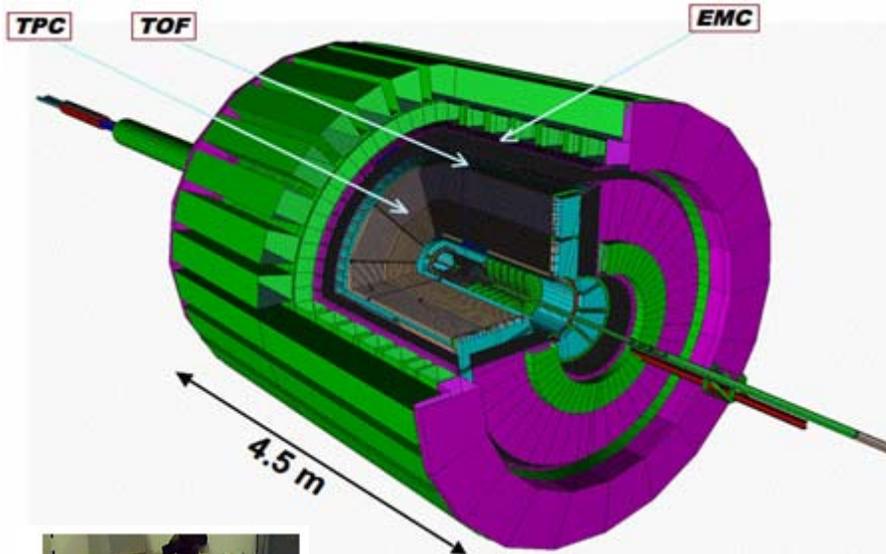


STAR Forward Meson Spectrometer



- Pb glass array: $2.5 < \eta < 4.0$
- Took d-Au and p-p data, Run 8 and Run 9: forward π^0 and γ correlations with hadrons in TPC.
- Not yet fully tuned as fast trigger.

STAR MRPC Time-of-flight barrel

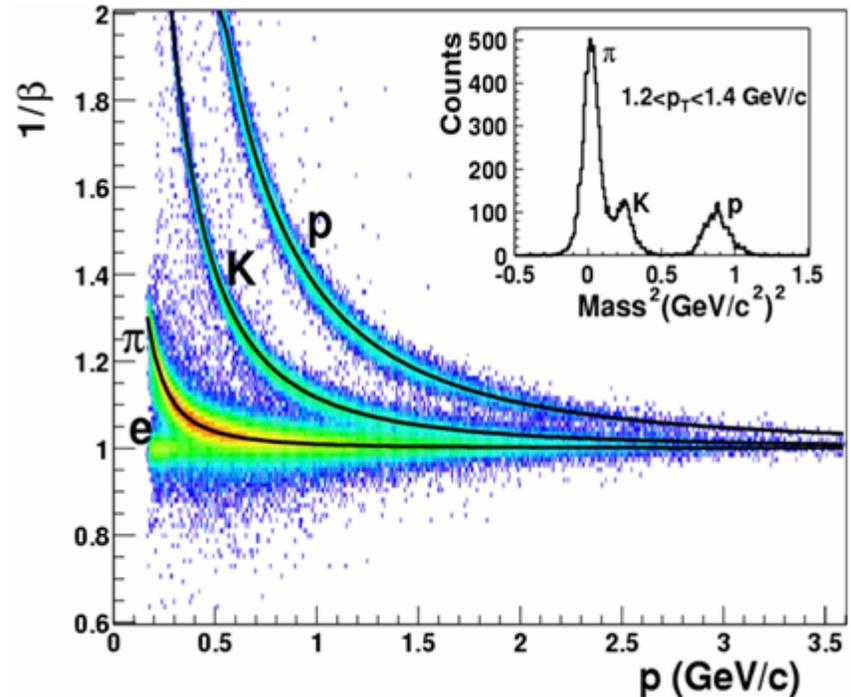


90/120 trays installed in Run 9

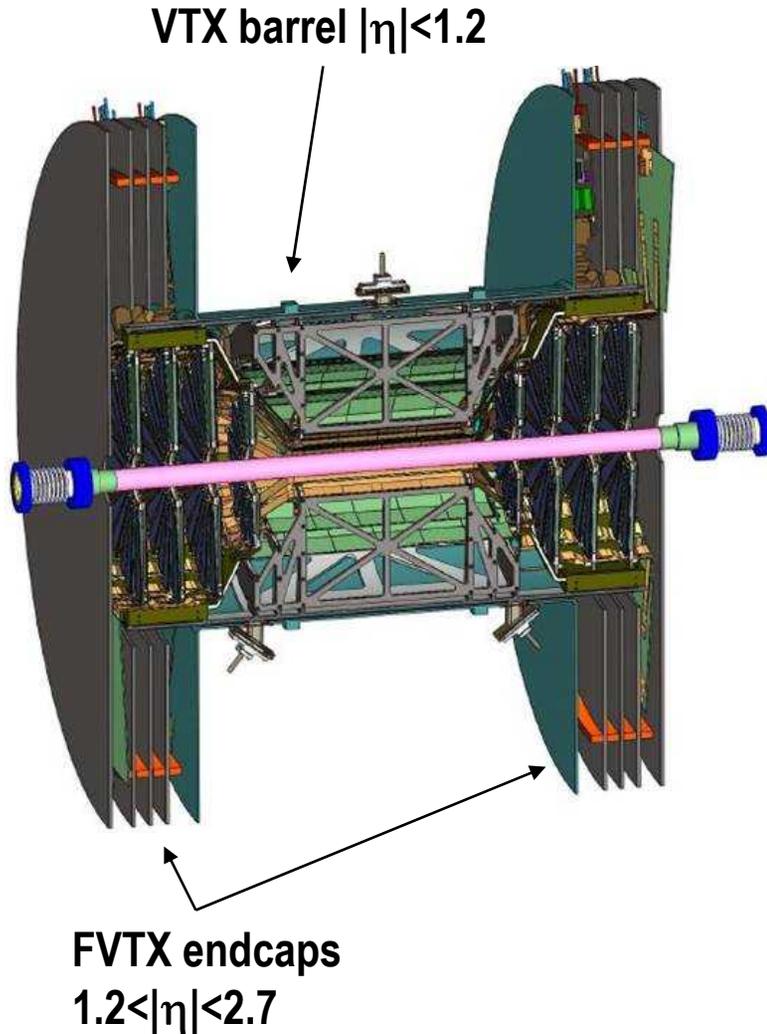
Remainder are complete and ready to install for Run 10.

Run 9 Results: $\sigma_t = 80$ ps

Successful completion of first RHIC II MIE project.



PHENIX Silicon Vertex Trackers



New 4 cm dia Be beam pipe is under construction

VTX Barrel:

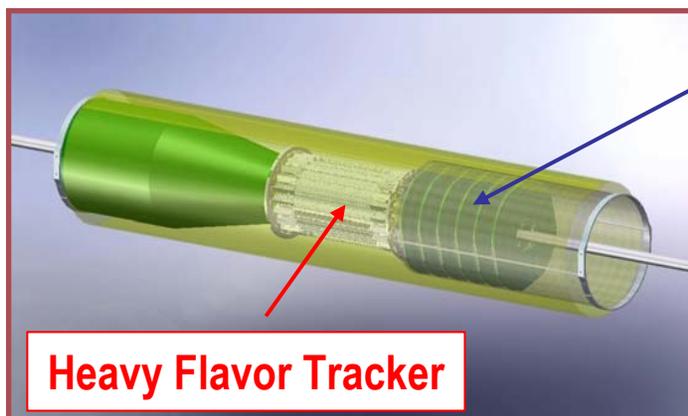
- Two pixel layers (Japan), two strip-pixel layers
- One year ago, significant technical problems arose with the strip-pixel Read Out Card.
- A review earlier this month showed this problem under control
- Project back on track for installation next year, ready for operation in Run 11.

FVTX Endcaps:

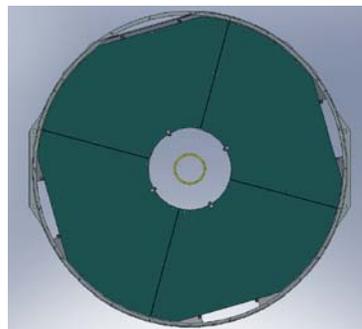
- Each endcap is 4 layers of Si “mini-strips”
- Modified BTeV electronics
- Project started ~1 year ago; on track for installation for Run 12.

Both projects have received ARRA funds, and are now fully funded– reducing cost and schedule risk.

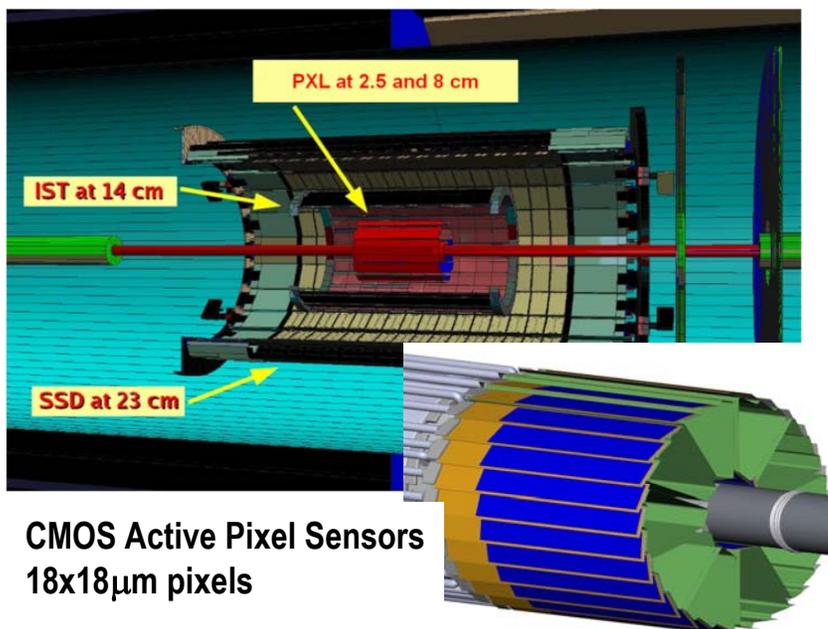
New STAR Inner Tracking Detectors



FGT: Six layers of triple GEM detectors



Forward Gem Tracker: Successful development of full-size GEM foils (SBIR).
On track for operation in Run 12.



Heavy Flavor Tracker

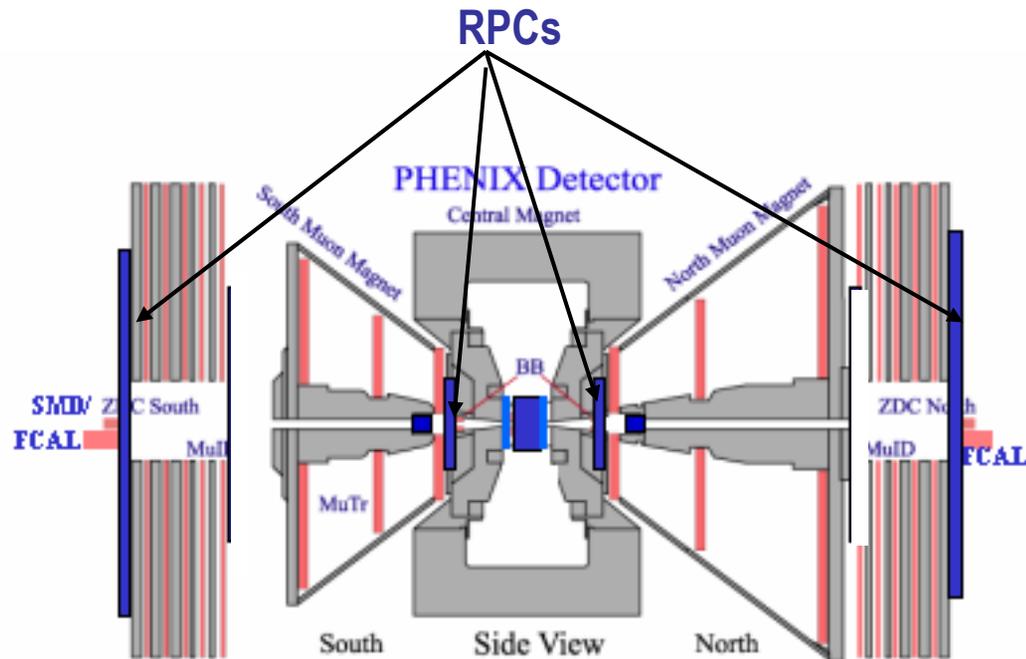
- CD-0 “mission need” established: total project cost ~\$17M
- Project management team is in place.
- Preparing for CD-1 technical review this fall; FY 2010 Pres. Budget has \$1.4 M funding
- **Physics readiness expected in 2014**

PHENIX Muon Trigger

Initiated as an NSF funded project:

Add Resistive Plate Chambers to the muon arms, and LVL1 trigger electronics to muon tracking chambers.

Cost growth in RPCs led to a change of scope: NSF is funding 4 stations of RPCs, and Japanese collaborators are providing LVL1 trigger electronics.



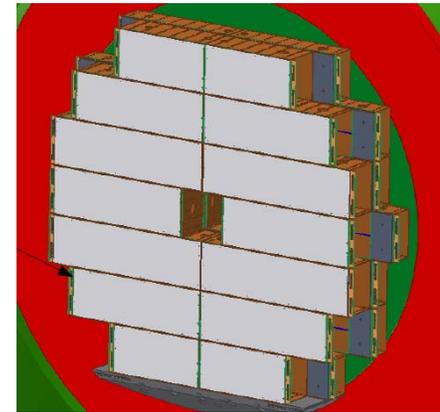
RPC sectors in 2 planes, plus first MuTrig electronics successfully tested in Run 9.

Muon Trigger to be installed in stages. Fully operational for Run 12

Emerging Development Projects: not yet formally proposed

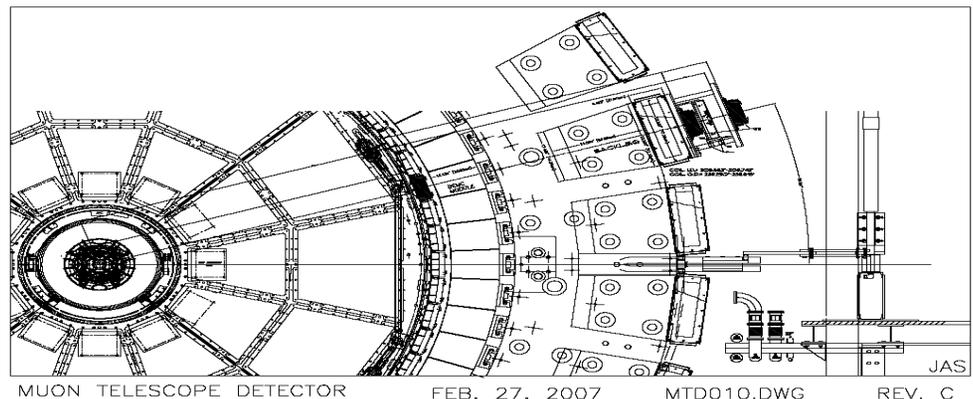
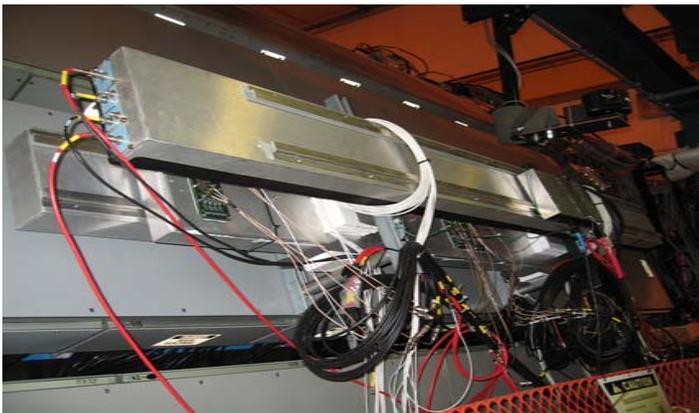
PHENIX Forward Calorimeter: $1 < \eta < 3$

- Tungsten absorber with Si readout
- Similar technology as previous Nose Cone Calorimeter, which was not funded by DOE.
- Present effort aims for reduced cost and scope
- Focus on p-p and d-A physics.



STAR Muon Telescope Detector: muon tracking at mid-rapidity

- Use STAR magnet flux return bars as hadron filter
- Use enlarged version of MRPC developed for TOF to detect penetrating muons
- Prototypes tested in Runs 8 and 9.



Forecasts for RHIC Upgrades

Machine:

- Stochastic cooling luminosity upgrade **Run 12**
- EBIS [U + U] **Run 11**

Forward detectors: W^\pm decay

- PHENIX Muon Trigger – full installation **Run 12**
Partial implementation beginning Run 10
- STAR Forward GEM Tracker **Run 12**

Particle and photon ID:

- PHENIX Hadron Blind Detector **Run 10**
Operational in Run 9
- STAR Time of Flight **Run 10**
~3/4 installed for Run 9

Vertex detectors:

- PHENIX VTX **Run 11**
- PHENIX FVTX **Run 12**
- STAR HFT **Run 14**
Possible partial installation Run 12

Mid Term Plan

Current DOE funding plan for detector upgrades and RHIC computing

June 09 update: FY 2006-2008 as spent.; 09Approp.; 2010Pres.

	FY 2006A	FY 2007A	FY 2008A	FY 2009A	FY 2010P	FY 2011	FY 2012	FY 2013	FY 2014	
R&D funds										
PHENIX HBD	0.10									0.10
PHENIX MIEs	0.30	0.45	0.16							0.91
PHENIX DAQ	0.10	0.05	0.26	0.40	0.60	0.20	0.25			1.86
STAR Tracking	0.50	0.32	0.70	0.80	0.40	0.20	0.25			3.17
Generic Det. R&D	0.00				0.20	0.80	1.00	1.50	1.50	5.00
Total R&D	1.00	0.82	1.12	1.20	1.20	1.20	1.50	1.50	1.50	11.04
Exp. Capital										
PHENIX HBD/TOFW	0.40	0.10								0.50
STAR FMS	0.20	0.20								0.40
STAR DAQ1000	0.90	0.35	0.65	0.00						1.90
STAR FGT			0.20	0.75	0.90	0.00				1.85
PHENIX FoCal*					0.30	0.80	0.70			1.80
Exp. Infrastr.	0.60	0.35	0.45	0.75	0.80	1.00	0.85	0.85	0.85	6.50
RCF	1.30	1.70	1.70	2.00	2.50	3.00	3.00	3.00	3.00	21.20
Total Capital	3.40	2.70	3.00	3.50	4.50	4.80	4.55	3.85	3.85	34.15
MIEs										
STAR TOF	2.40	2.40								4.80
PHENIX VTX		1.60	2.00	1.10						4.70
PHENIX FVTX			0.70	4.20	0.00					4.90
STAR HFT**					1.40	2.65	5.40	5.60	0.25	15.30
Total MIE	2.40	4.00	2.70	5.30	1.40	2.65	5.40	5.60	0.25	23.85

* Pending review and approval

** Pending final science approval

Full funding in FY 09 via ARRA funds

BNL oversight and management of the upgrade projects

Recommendations from last year's RHIC S&T Review:

- *BNL should strengthen collaboration management with experienced technical and project management expertise in order to implement the planned suite of detector upgrade projects. BNL should present progress at the 2009 RHIC S&T review.*
- *BNL should adopt a methodology to improve monitoring and consulting on detector upgrade projects sufficient to ensure progress on the needed aggressive timelines. BNL should document the methodology and present the same at the 2009 RHIC S&T review.*

In response, we have taken the following steps...

- Vigdor, Ludlam, and O'Brien have worked with the PHENIX and STAR collaboration management teams to get them more directly involved in monitoring the upgrade projects, and taking corrective action on the part of the collaboration where necessary.
- BNL project planning experts Kerry Mirabella and Bob VanWormer (C-AD), and Bob Ernst (Physics) provide oversight and assistance to the project managers of the upgrades, for cost/schedule/contingency management.
- A uniform set of procedures has been put in place for initiating, tracking, and reviewing all of the upgrade projects, including those that do not fall into the DOE MIE category.

Ed O'Brien will discuss this methodology in detail in tomorrow's Breakout session.

Recent and upcoming annual reviews of upgrade projects

These reviews are conducted by Technical Advisory Committees (outside consultants) convened by BNL in cooperation with DOE.

Project	Date	Dates for Upcoming Reviews
STAR TOF	8/2008	8/2009 (Project Completion)
PHENIX VTX	6/2009	6/2010
PHENIX FVTX	11/2008	11/2009
STAR FGT	7/2008	Fall 2009
PHENIX MuTrg	9/2008	Fall 2009
STAR HFT	2/2008	Sept/Oct 2009 (CD-1 review)
PHENIX FOCAL (Not yet approved. A science case and project scope review is being planned)		Fall 2009

RHIC Computing Facility

Studies based on projections for data-taking at RHIC II luminosity with upgraded detectors showed that the annual investment in RCF equipment should grow to \$3.0M in 2010.

Detailed 5-year STAR computing plan, submitted January 2009, includes large-scale data transfer to KISTI (Korea). Mock data exercise has demonstrated the capability.

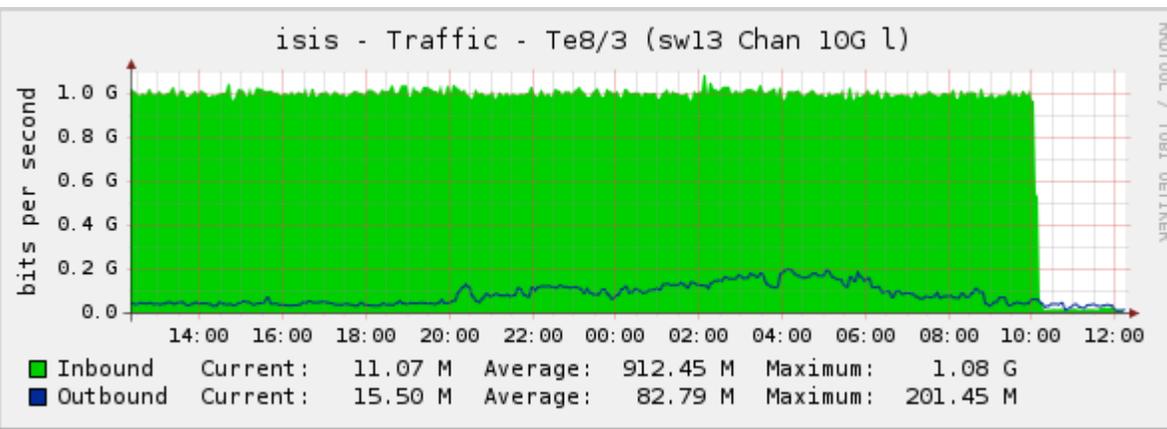
Computing infrastructure (space, power, cooling) is a long term issue for RHIC & ATLAS computing facilities.

Data Transfer and processing from all four experiments.



Photo Feb. 2009

5000 sq. ft. building addition for RACF:
BNL and OHEP funds



1 Gigabit/sec to KISTI
Computing Facility via
ESnet/GLORIAD/KREOnet2

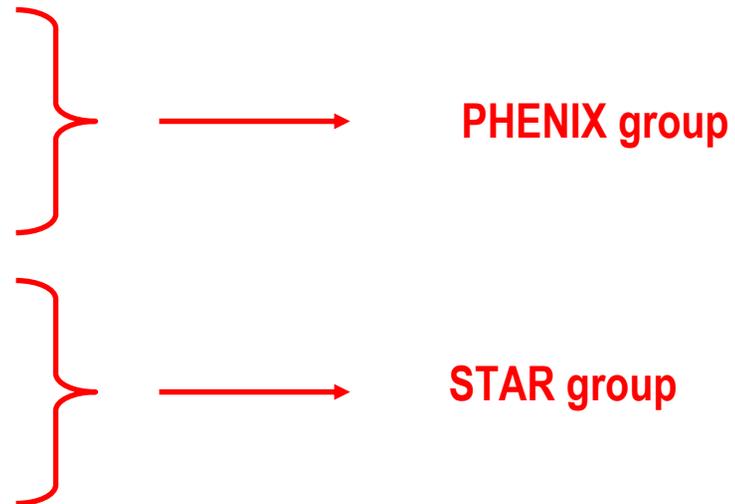
New Directions for the Heavy Ion Research group (HIRG)

- ❑ BRAHMS and PHOBOS: Wrapping up their analysis
- ❑ Members of the HIRG group have taken on significant roles in PHENIX and STAR upgrades
- ❑ Proposed growth in ATLAS Heavy Ion effort will not occur.
Continue ~2.5 FTE ATLAS Heavy ions through first data.

HIRG group reassignments:

R. Nouicer [PHENIX VTX]
P. Steinberg [ATLAS HI, co-convener]
M. Baker [ATLAS HI]
J. Jia [PHENIX, Stony Brk. Joint appt.]

R. Debbe [STAR upgrades]
J-H Lee [STAR pp2pp]
D. Beavis [STAR TPC & HFT; Daya Bay]
F. Videbaek [HIRG leader; STAR HFT]



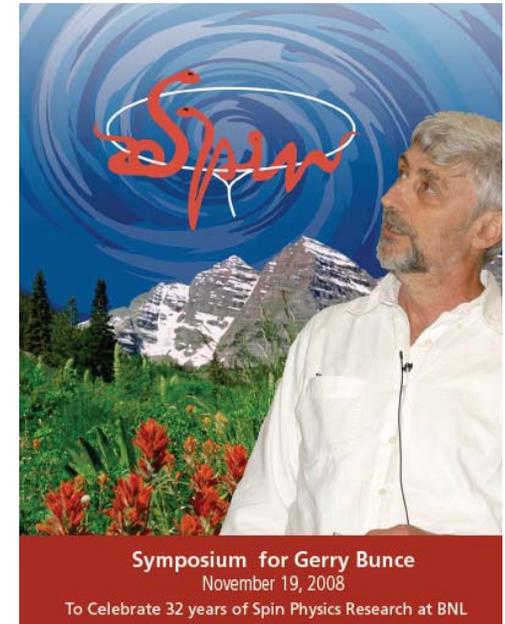
A Major Change in RHIC Spin Leadership

Gerry Bunce retired from BNL in September 2008

- BNL Spin Group Leader
- Leader of the global RHIC Spin Collaboration
- Experimental Head of Riken-BNL Research Center

Elke Aschenauer joined BNL in March 2009

- New BNL Spin Group Leader
- Former Spokesperson: Hermes at HERA
- Former JLab Hall D group leader
- A major participant in the Electron Ion Collider effort



Expanded RHIC Spin/ EIC Science effort

❑ Medium Energy Spin Group

PHENIX Physics: Aschenauer (Spin group leader), Bazilevsky

STAR Physics: Bland, Ogawa, Gordon, Guryn (.5)

Polarimetry: Morozov, Atoian (.5), Gill (.5)

7.5 FTE

+ 2.5 additional FTE proposed in FY09-FY10

Yousef Makdisi will discuss RHIC polarimetry in tomorrow's breakout session

❑ Establish EIC Science Task Force

- Science program and detector design: Readiness for 2012 LRP
- Specific goals and manpower commitments

Details in Elke Aschenauer's talk later today

BNL EIC Task Force: eRHIC Physics Working Group Participants

Participants matrixed from existing groups (~5 FTE)

E. Aschenauer/ T. Ullrich

W. Vogelsang
M. Lamont
J. Dunlop
W. Guryan
J.H. Lee
R. Debbe
P. Nevski
P. Steinberg
E. Kistenev

2 Hires (PD)

Other key players

A. Deshpande
R. Venugopalan } EIC Collaboration

V. Litvinenko
V. Ptitsin } BNL Accelerator group

The Task Force has its own budget for travel and visitors

Physics Department Organization

March 1, 2009

