

NPP Program Advisory Committee
June 15, 2009

Status Report on Detector Upgrades

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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, which is constantly evolving. 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.

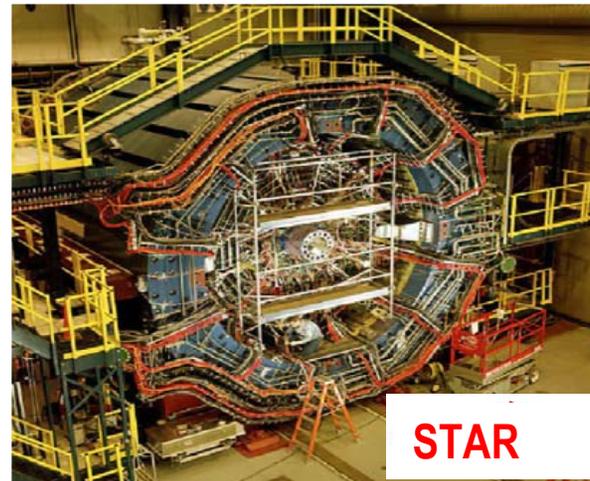
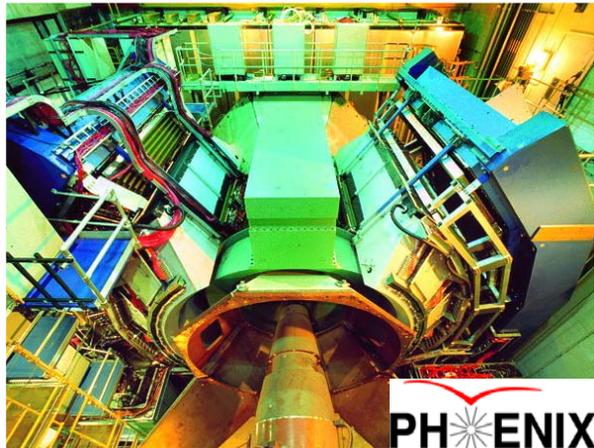
The Upgrade Projects

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

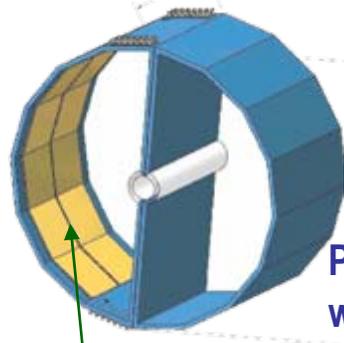
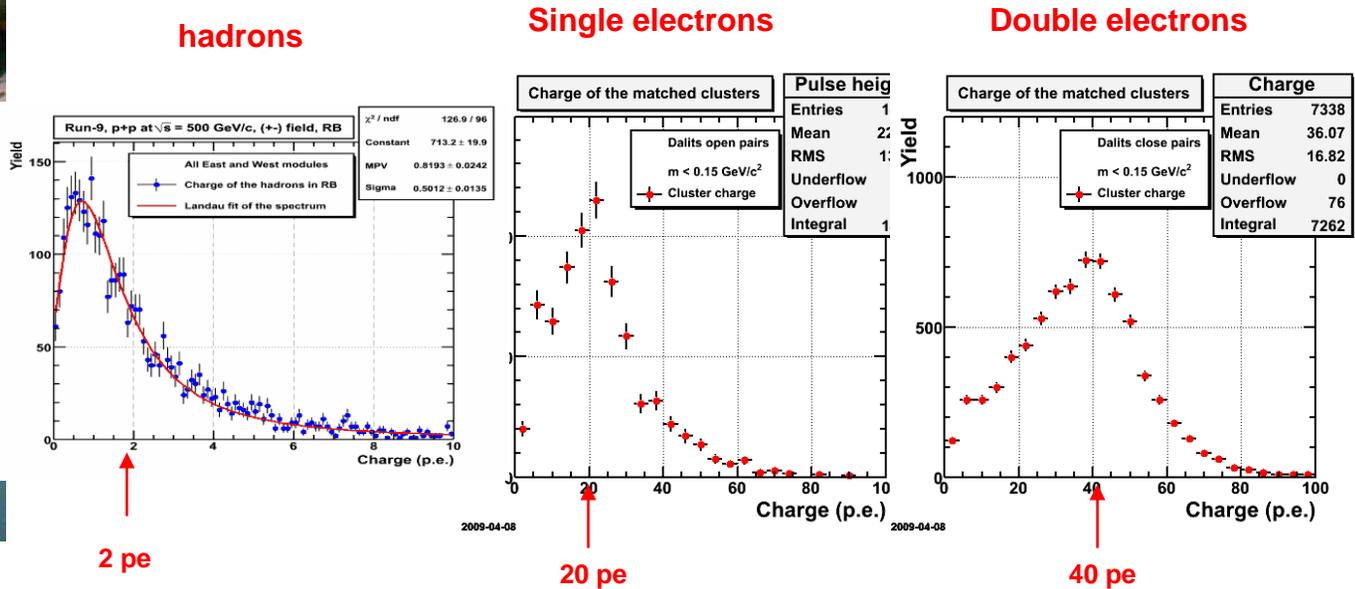
STAR:

- **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



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.



Proximity focused Cherenkov counter with CF_4 radiator

CsI photocathode on triple GEM layers

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

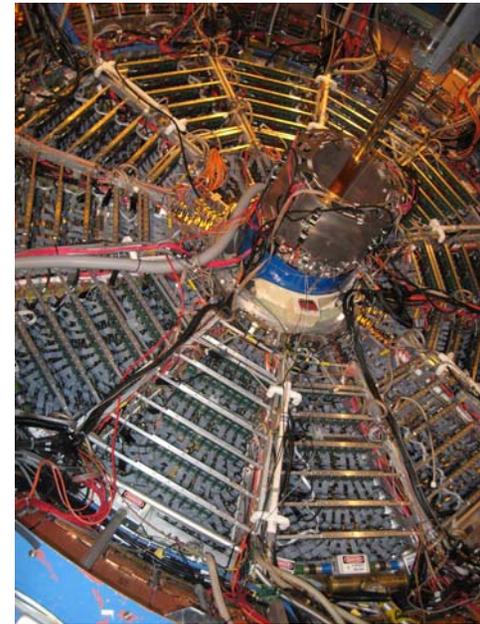
Operational in Runs 9 & 10;
Removed for VTX in Run 11

STAR DAQ 1000

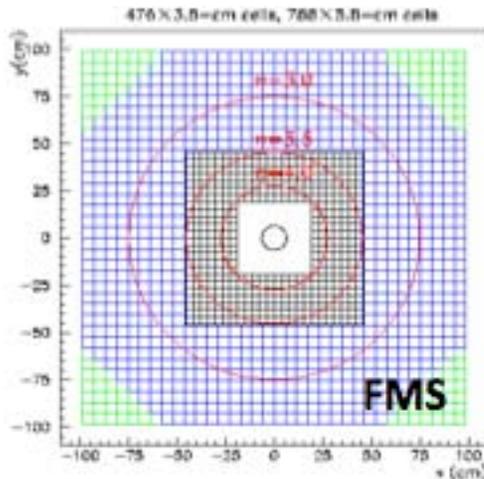
New TPC electronics, cables, fibers, LV, and readout computers installed and operational in Run 9.

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

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

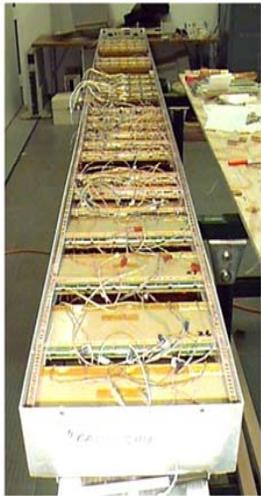
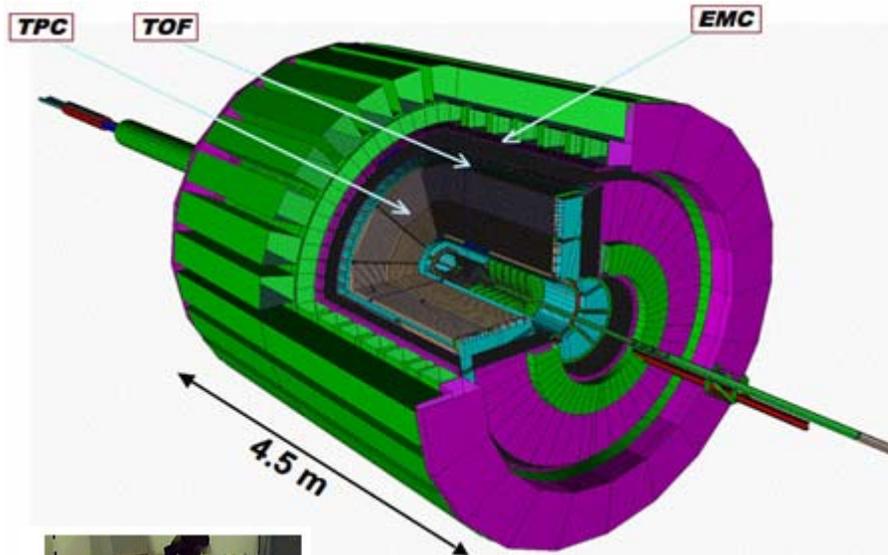


STAR Forward Meson Spectrometer



- 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

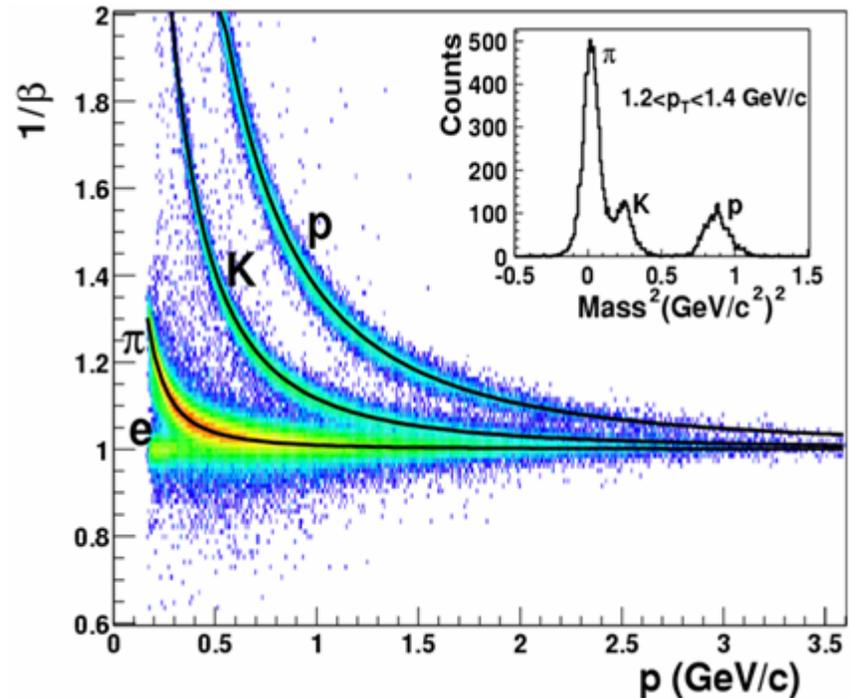


Run 9 Results:
 $\sigma_t = 80$ ps

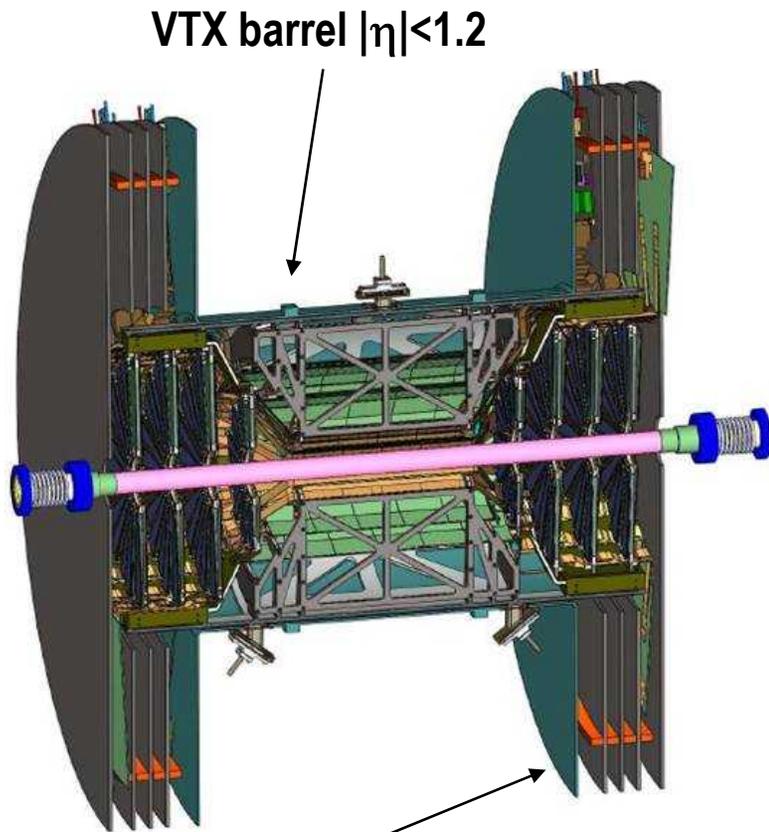
90/120 trays installed in Run 9

Remainder are complete and ready to install for Run 10.

Successful completion of first RHIC II MIE project.



PHENIX Silicon Vertex Trackers



VTX barrel $|\eta| < 1.2$

FVTX endcaps
 $1.2 < |\eta| < 2.7$

New 4 cm dia Be beam pipe is
under construction

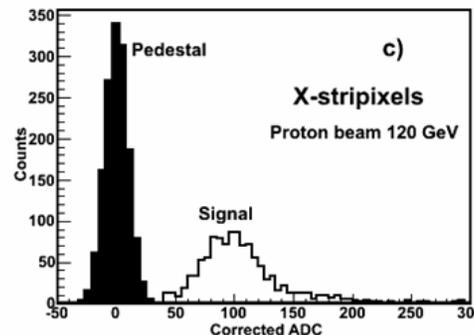
VTX Barrel:

- 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.

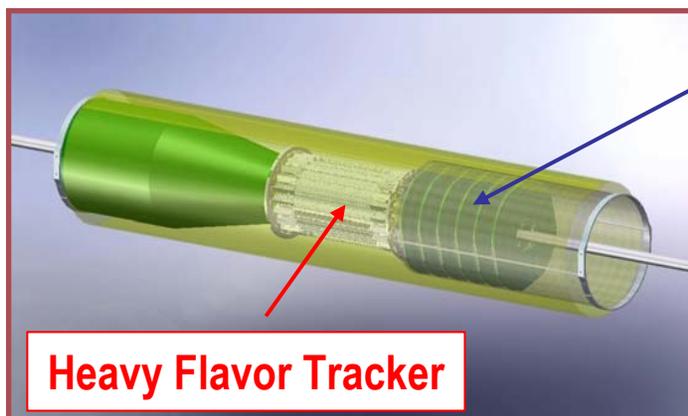
FVTX Endcaps:

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

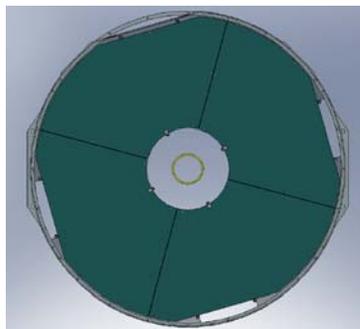
Strip-pixels in FNAL
test beam Aug 2008



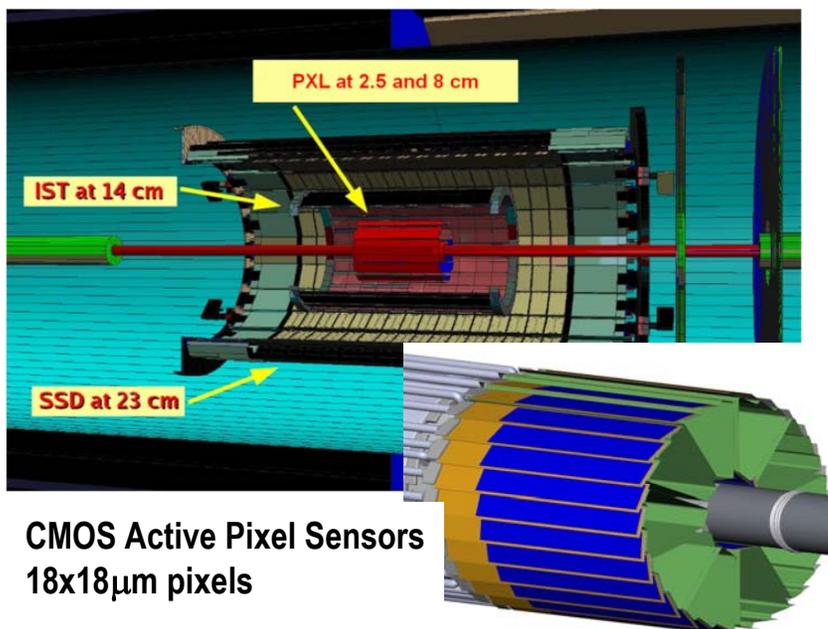
New STAR Inner Tracking Detectors



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

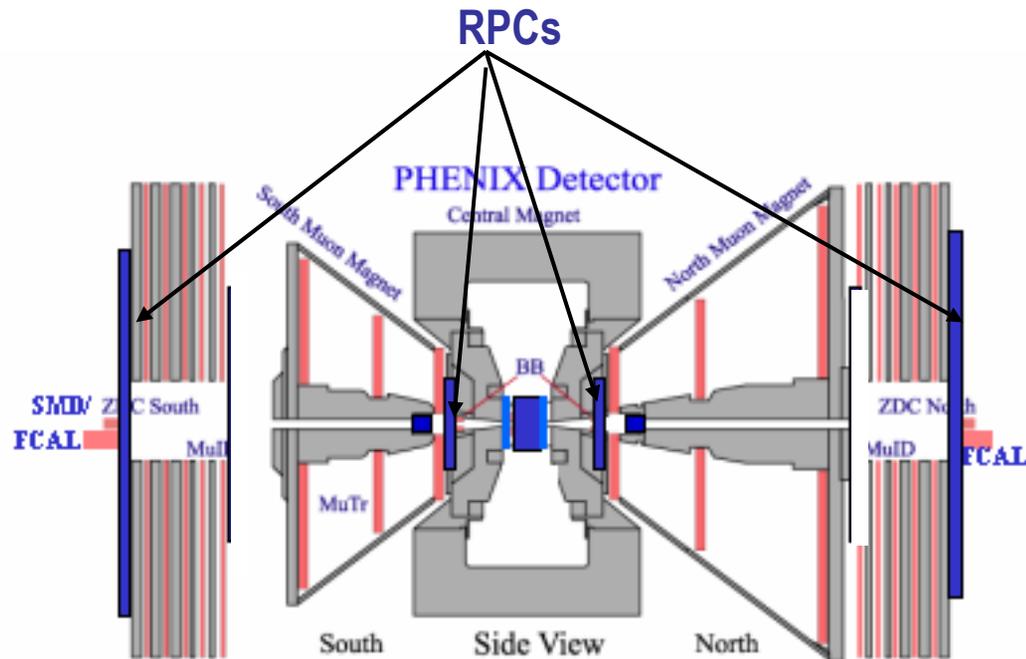
- CD-0 “mission need” established: total project cost ~\$17M
- Project management team is in place.
- Preparing for CD-1 technical review this fall; FY 2010 Pres. Budget has \$1.4 M funding
- **Physics readiness expected in 2014**

PHENIX Muon Trigger

Initially 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.



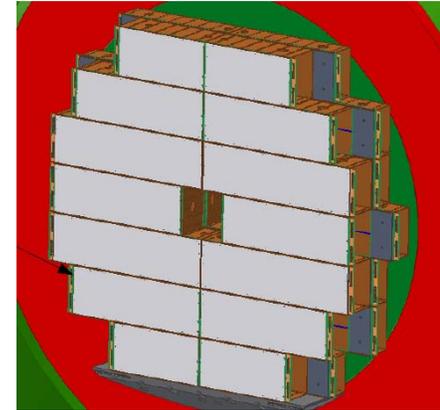
RPC sectors in 2 planes, plus first MuTrig electronics successfully tested in Run 9.

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

Emerging Development Projects

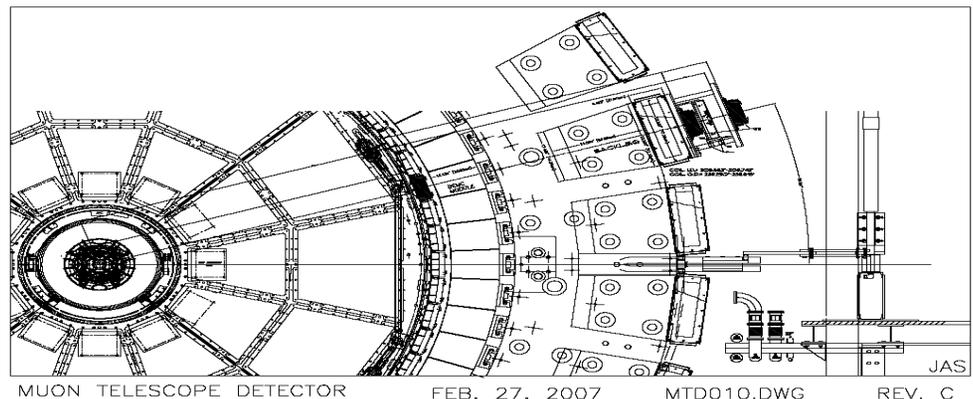
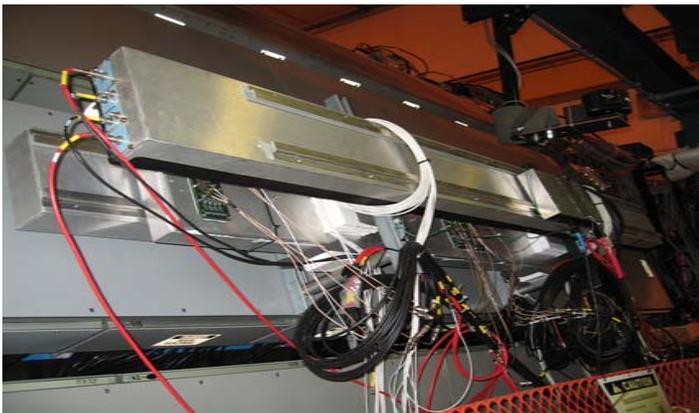
PHENIX Forward Calorimeter: $1 < \eta < 3$

- 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.



RHIC Upgrades Timeline

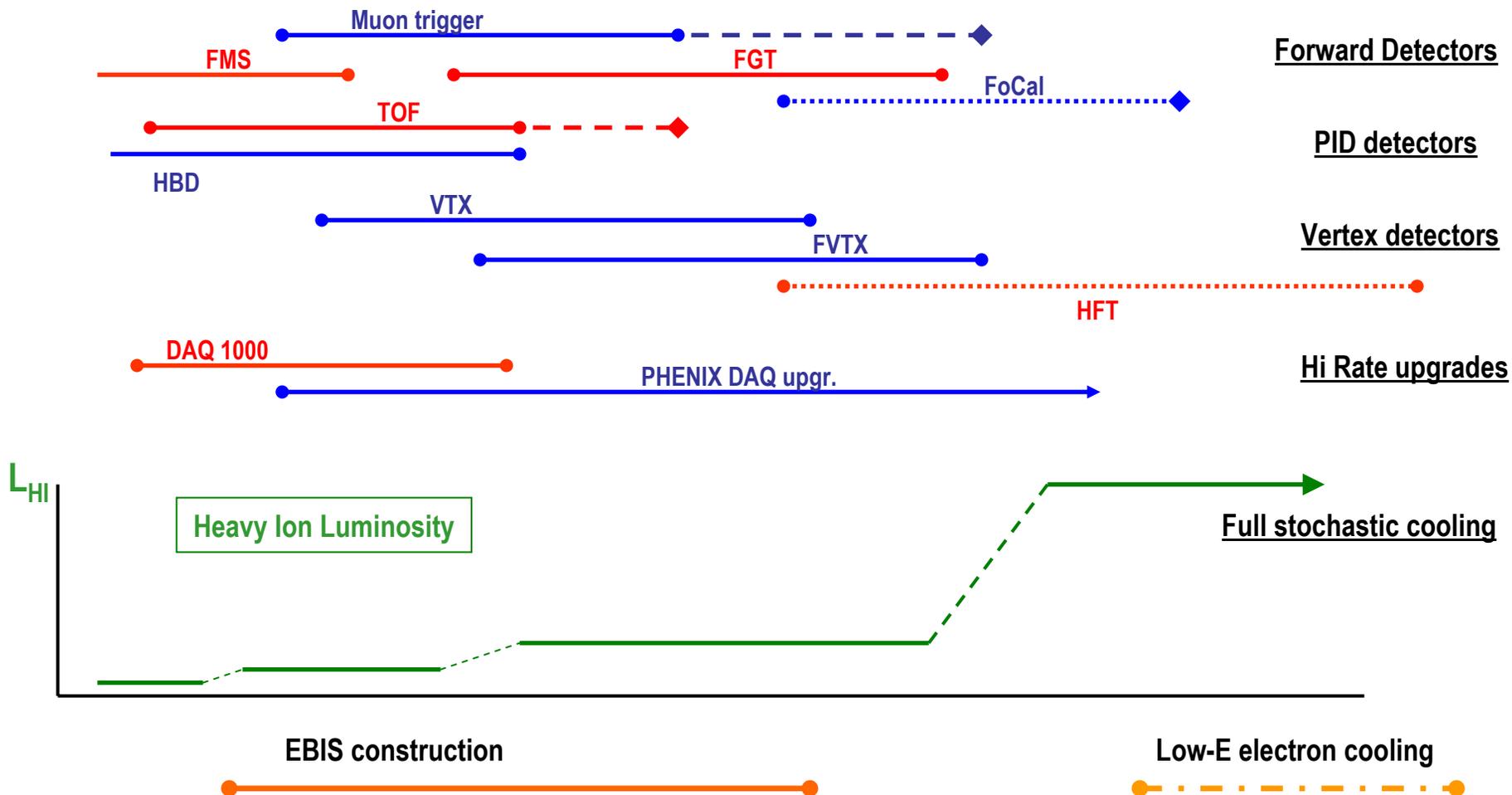
PHENIX

STAR

FY 2006	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
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Au-Au, d-Au, Ion scans
pp 200 GeV; pp 500 GeV development

Critical pt. scan; high statistics Au-Au; U-U
500 GeV spin runs: W measurement



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

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