PHENIX

PHENIX Beam Use Proposal for Run-7 and Beyond

W.A. Zajc
for the PHENIX Collaboration

(this talk available at
http://www.phenix.bnl.gov/phenix/WWW/publish/zajc/sp/presentations/RBUP06/)

Outline

- Status
  - Collaboration
  - Experiment
  - Physics
  - Run-6 achievements
- Proposal
  - Inputs
  - Request
  - Discussion
- Issues

Status

PHENIX Chronology

- PHENIX has an excellent track record of
  - Performing major installations and/or upgrades in each shutdown

while

  - Maintaining scientific productivity

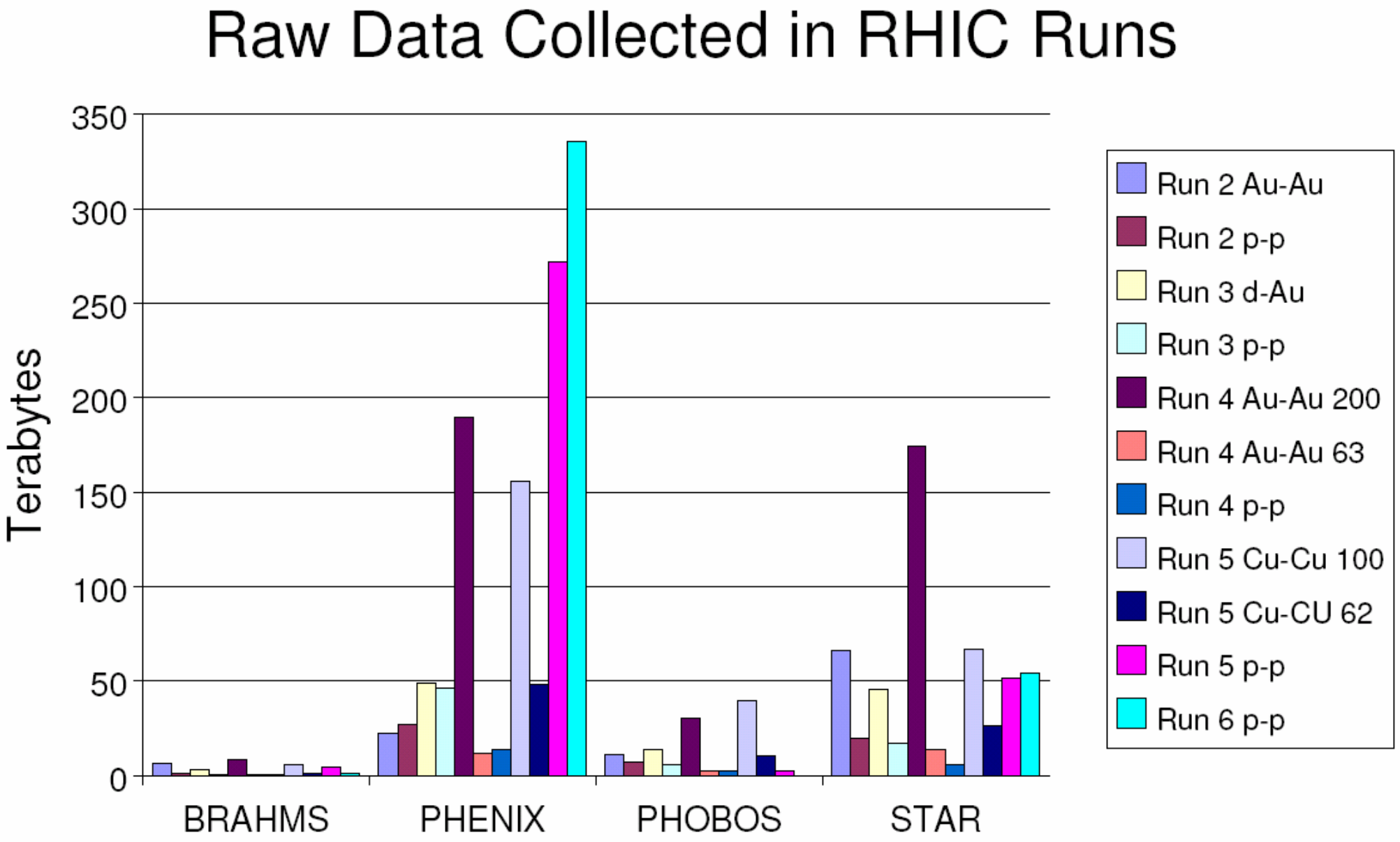
- See Back-up slides for complete chronology
  - (Most material there provided courtesy of Ed O'Brien, PHENIX Operations Manager)

Run-1 to Run-6 Capsule History

Run	Year	Species	$s^{1/2}$ [GeV]	$\int Ldt$	N_{Tot}	p-p Equivalent	Data Size
01	2000	Au+Au	130	1 μb^{-1}	10M	0.04 pb^{-1}	3 TB
02	2001/2002	Au+Au	200	24 μb^{-1}	170M	1.0 pb^{-1}	10 TB
		p+p	200	0.15 pb^{-1}	3.7G	0.15 pb^{-1}	20 TB
03	2002/2003	d+Au	200	2.74 nb^{-1}	5.5G	1.1 pb^{-1}	46 TB
		p+p	200	0.35 pb^{-1}	6.6G	0.35 pb^{-1}	35 TB
04	2003/2004	Au+Au	200	241 μb^{-1}	1.5G	10.0 pb^{-1}	270 TB
		Au+Au	62	9 μb^{-1}	58M	0.36 pb^{-1}	10 TB
05	2004/2005	Cu+Cu	200	3 nb^{-1}	8.6G	11.9 pb^{-1}	173 TB
		Cu+Cu	62	0.19 nb^{-1}	0.6G	0.8 pb^{-1}	48 TB
		Cu+Cu	22.5	2.7 μb^{-1}	9M	0.01 pb^{-1}	1 TB
		p+p	200	3.8 pb^{-1}	85B	3.8 pb^{-1}	270 TB
06	2006	p+p	200	10.7 pb^{-1}	230B	10.7 pb^{-1}	310 TB
		p+p	62	0.1 pb^{-1}	28B	0.1 pb^{-1}	25 TB

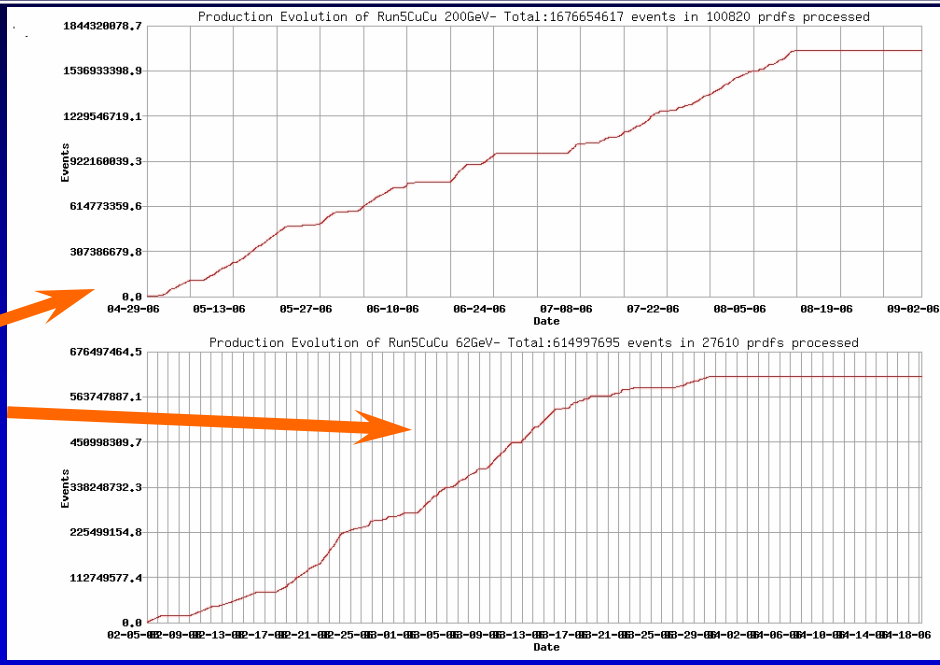
Total Data Volumes

- Plot courtesy of Tom Throwe (RCF)



PHENIX Data Production

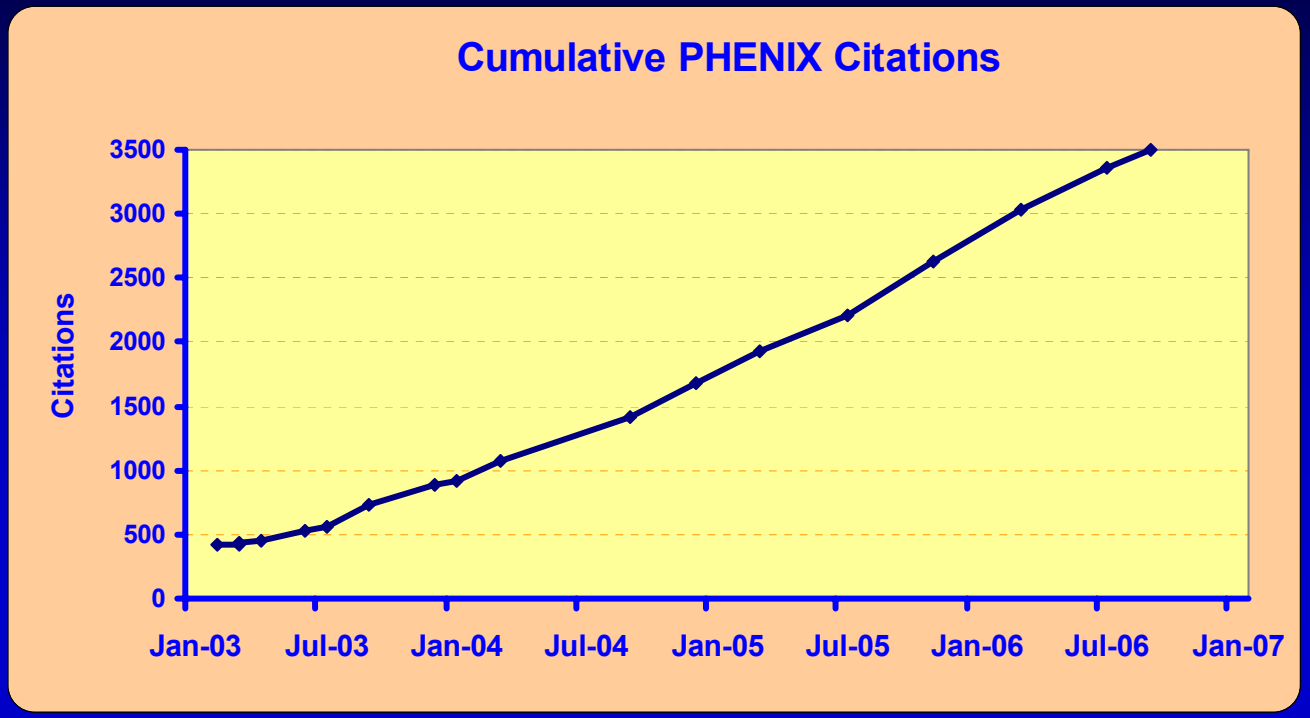
- **PHENIX making effective use of collaboration resources to stay ahead of the incoming data:**
  - **Run-5**
    - Cu+Cu 200 GeV at RCF
      - May to August, 2006, 1.7G events in 4 months
    - Cu+Cu 62.4 GeV at PHENIX 1008 farm
      - Feb to March , 2006 0.6G events in 2 months
    - Cu+Cu 22.5 GeV at PHENIX 1008 farm
      - A few days to process 9M events
    - p+p 200 GeV at PHENIX CC-J in Japan
      - In final clean-up phase, essentially complete
      - All pp data (270 TB) shipped via network to CC-J during Run-5
    - Level-2 stream produced in quasi-real time at ORNL
  - **Run-6**
    - p+p 62 GeV at PHENIX 1008 farm
      - Complete
    - p+p 200 GeV at PHENIX 1008 farm
      - Production for transverse polarization underway
    - p+p 200 GeV at PHENIX CC-J in Japan
      - Production for longitudinal polarization about to start
    - Level-2 stream produced in quasi-real time at Vanderbilt
  - **Simulation at Vanderbilt, LLNL, New Mexico (all results archived at RCF)**



☞ *Production for **all** PHENIX data-sets completed by start of Run-7*

Publication Summary

- Since 2001:
  - 31 PRL's
  - 11 Phys. Rev. C
  - 3 Phys. Rev. D
  - 1 Phys. Lett. B
  - 1 Nucl. Phys. A (White Paper)
- ~ 3500 citations



- Most-cited paper from RHIC:
  - "*Suppression of hadrons with large transverse momentum in central Au+Au collisions at* $\sqrt{s_{NN}}$ *= 130 GeV*",
    K. Adcox *et al.* , Phys.Rev.Lett. 88:022301 (2002), nucl-ex/0109003
- 12 other papers with > 100 citations

Collaboration, 2006

14 Countries; 68 Institutions; 550 Participants*

University of São Paulo, São Paulo, Brazil
Academia Sinica, Taipei 11529, China
China Institute of Atomic Energy (CIAE), Beijing, P. R. China
Peking University, Beijing, P. R. China
Charles University, Faculty of Mathematics and Physics, Ke Karlovu 3, 12116 Prague, Czech
Czech Technical University, Faculty of Nuclear Sciences and Physical Engineering, Brehova
Republic
Institute of Physics, Academy of Sciences of the Czech Republic, Na Slovance 2, 182 21 Prag
University of Jyvaskyla, P.O.Box 35, FI-40014 Jyvaskyla, Finland
Laboratoire de Physique Corpusculaire (LPC), Universite de Clermont-Ferrand, F-63170 Aubi
France
Dapnia, CEA Saclay, Bat. 703, F-91191 Gif-sur-Yvette, France
IPN-Orsay, Universite Paris Sud, CNRS-IN2P3, BP1, F-91406 Orsay, France
Laboratoire Leprince-Ringuet, Ecole Polytechnique, CNRS-IN2P3, Route de Saclay, F-91128 P
SUBATECH, Ecòle des Mines at Nantes, F-44307 Nantes, France
University of Muenster, Muenster, Germany
KFKI Research Institute for Particle and Nuclear Physics at the Hungarian Academy of Scien
Budapest, Hungary
Debrecen University, Debrecen, Hungary
Eövös Loránd University (ELTE), Budapest, Hungary
Banaras Hindu University, Banaras, India
Bhabha Atomic Research Centre (BARC), Bombay, India
Weizmann Institute, Rehovot 76100, Israel
Center for Nuclear Study (CNS-Tokyo), University of Tokyo, Tanashi, Tokyo 188, Japan
Hiroshima University, Higashi-Hiroshima 739, Japan
KEK - High Energy Accelerator Research Organization, 1-1 Oho, Tsukuba, Ibaraki 305-0801, Japan
Kyoto University, Kyoto, Japan
Nagasaki Institute of Applied Science, Nagasaki-shi, Nagasaki, Japan
RIKEN, The Institute of Physical and Chemical Research, Wako, Saitama 351-0198, Japan
RIKEN – BNL Research Center, Japan, located at BNL
Physics Department, Rikkyo University, 3-34-1 Nishi-Ikebukuro, Toshima, Tokyo 171-8501, Japan
Tokyo Institute of Technology, Oh-okayama, Meguro, Tokyo 152-8551, Japan
University of Tsukuba, 1-1-1 Tennodai, Tsukuba-shi Ibaraki-ken 305-8577, Japan
Waseda University, Tokyo, Japan
Cyclotron Application Laboratory, KAERI, Seoul, South Korea
Ewha Womans University, Seoul, Korea
Kangnung National University, Kangnung 210-702, South Korea
Korea University, Seoul 136-701, Korea
Myong Ji University, Yongin City 449-728, Korea
System Electronics Laboratory, Seoul National University, Seoul, South Korea
Yonsei University, Seoul 120-749, Korea
IHEP (Protvino), State Research Center of Russian Federation , Protvino 142281, Russia
Joint Institute for Nuclear Research (JINR-Dubna), Dubna, Russia
Kurchatov Institute, Moscow, Russia
PNPI, Petersburg Nuclear Physics Institute, Gatchina, Leningrad region 188300, Russia
Skobeltsyn Institute of Nuclear Physics, Lomonosov Moscow State University, Vorob'evy Gory, Moscow 119992, Russia
Saint-Petersburg State Polytechnical Univiversity , Politechnicheskayastr, 29, St. Petersburg 195251, Russia
Lund University, Lund, Sweden

Abilene Christian University, Abilene, Texas, USA
Brookhaven National Laboratory (BNL), Chemistry Dept., Upton, NY 11973, USA
Brookhaven National Laboratory (BNL), Collider Accelerator Dept., Upton, NY 11973, USA
Brookhaven National Laboratory (BNL), Physics Dept., Upton, NY 11973, USA
University of California - Riverside (UCR), Riverside, CA 92521, USA
University of Colorado, Boulder, CO, USA
Columbia University, Nevis Laboratories, Irvington, NY 10533, USA
Florida Institute of Technology, Melbourne, FL 32901, USA
Florida State University (FSU), Tallahassee, FL 32306, USA
Georgia State University (GSU), Atlanta, GA 30303, USA
University of Illinois Urbana-Champaign, Urbana-Champaign, IL, USA
Iowa State University (ISU) and Ames Laboratory, Ames, IA 50011, USA
Los Alamos National Laboratory (LANL), Los Alamos, NM 87545, USA
Lawrence Livermore National Laboratory (LLNL), Livermore, CA 94550, USA
University of Maryland, College Park, MD 20742, USA
Department of Physics, University of Massachusetts, Amherst, MA 01003-9337, USA
Old Dominion University, Norfolk, VA 23529, USA
University of New Mexico, Albuquerque, New Mexico, USA
New Mexico State University, Las Cruces, New Mexico, USA
Department of Chemistry, State University of New York at Stony Brook (USB), Stony Brook, NY
USA
Department of Physics and Astronomy, State University of New York at Stony Brook (USB), Sto
Brook, NY 11794, USA
Oak Ridge National Laboratory (ORNL), Oak Ridge, TN 37831, USA
University of Tennessee (UT), Knoxville, TN 37996, USA
Vanderbilt University, Nashville, TN 37235, USA

*as of July 2006
and growing

Collaboration Status

- Healthy
  - Wide-ranging participation in
    - Data analysis
    - Shift support (~300 individuals in Run-6 !)
    - Upgrades program
- Continued growth:

Year	Institutions	Nations	Participants
2001	53	11	420
2003	57	12	460
2005	62	13	550

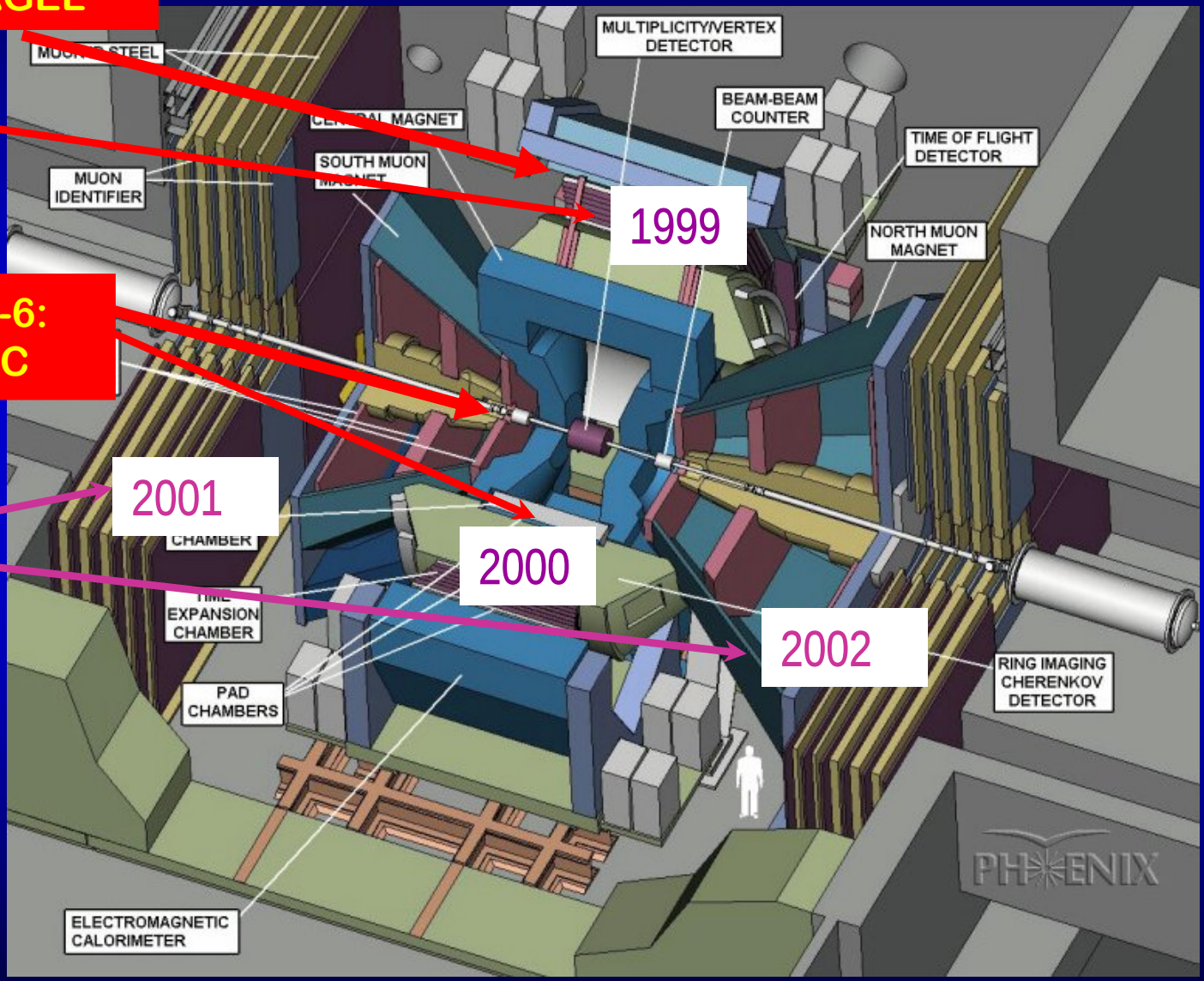
- Recent Additions
  - Jyvaskyla University (Finland)
  - University of Maryland
  - Ehwa Women's University (Korea)
  - Muhlenberg College

(Partial) Listing of Awards

- Presidential Early Career Awards for Scientists and Engineers
  - V. Cianciolo (ORNL)
  - S. Mioduszewski (BNL)
- Outstanding Junior Investigator (DOE)
  - J. Nagle (Colorado)
  - J. Velkovska (Vanderbilt)
- Sloan Fellowship
  - J. Nagle (Colorado)
- RHIC/AGS Thesis Award
  - J. Burward-Hoy (Stony Brook)
  - H. Sato (Kyoto)
  - C. Klein-Boesing (Muenster)
  - A. Sickles (Stony Brook)
- Sambamurti Award
  - J. Mitchell (BNL)
  - S. Mioduszewski (BNL)
- Gertrude Goldhaber Memorial Award
  - A. Sickles (SUNY-Stony Brook)
- Luise Meyer-Schutzmeister Memorial Award
  - C. Aidala (Columbia)
- “Best Young Researcher”, Westfaelische Wilhelms-University of Muenster
  - K. Reygers (Muenster)
- Intel Science Talent Finalist
  - B. Huang (Longwood High School; Advisor: Prof. T. Hemmick, SUNY-Stony Brook)
- Fulbright
  - Alumni Initiative Award, T. Csorgo (KFKI)
  - Visiting Student Research Award, M. Csanad (ELTE)
  - Visiting Student Research Award, R. Vertesi (Debrecen)
  - Senior Researcher/Lecturer, B. Cole (Columbia)
- JPS Distinguished Young Researcher
  - T. Chujo (Vanderbilt)

Schedule

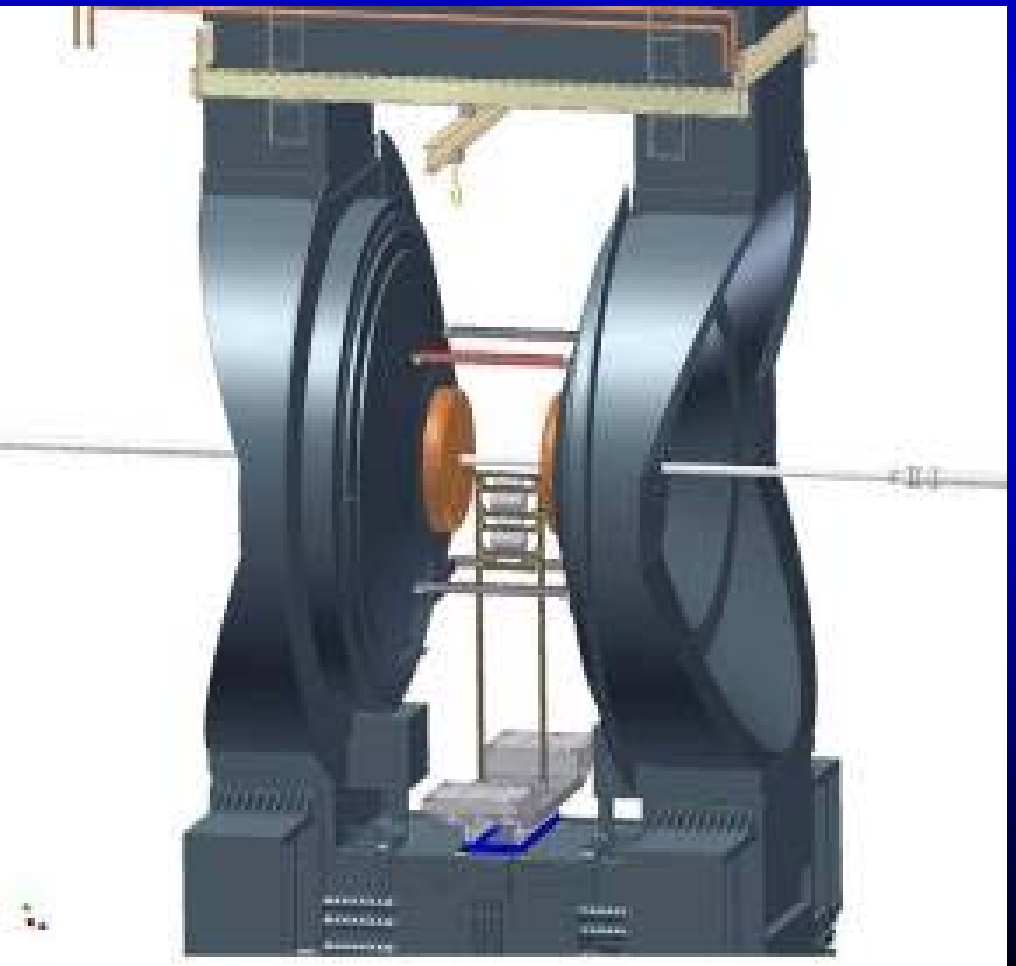
- 2 central spectrometers
- 2 forward spectrometers
- Forward detectors
  - Triggering
  - Centrality
  - Local polarimetry
  - Luminosity monitoring

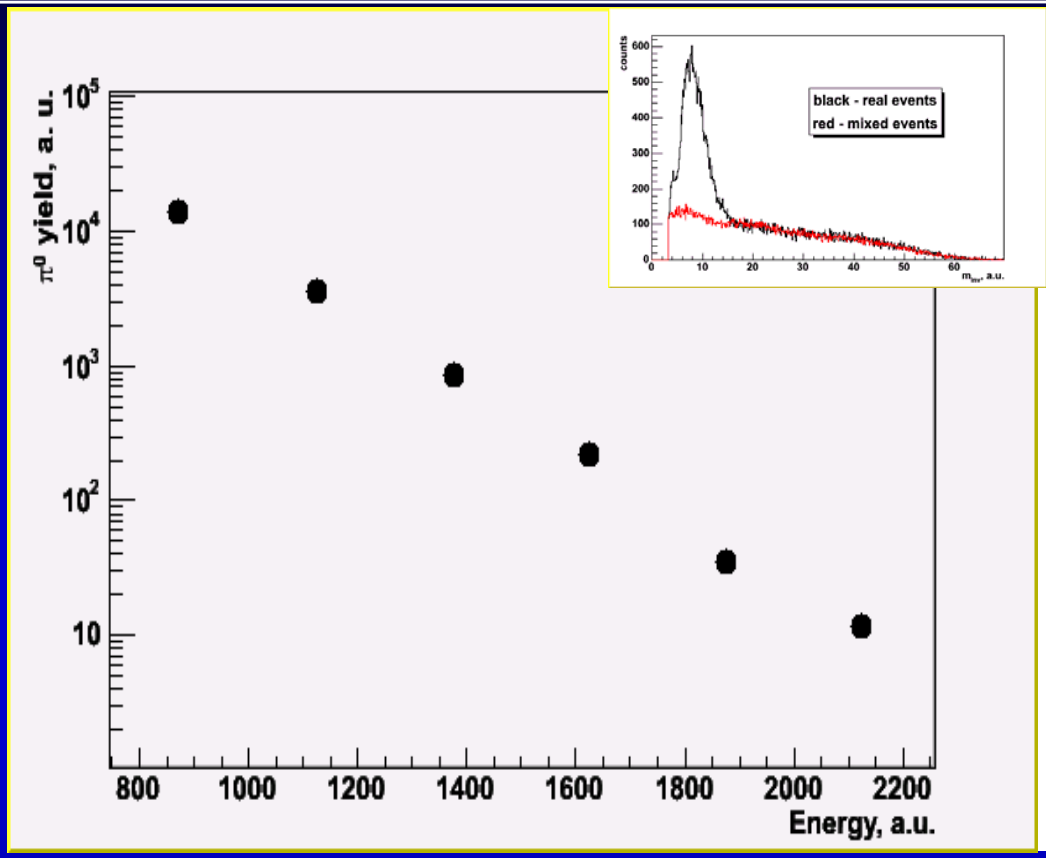


A past, present and future tribute to the incredible skills of the PHENIX 1008 Engineering and Technical Staff !

New Additions for Run-6

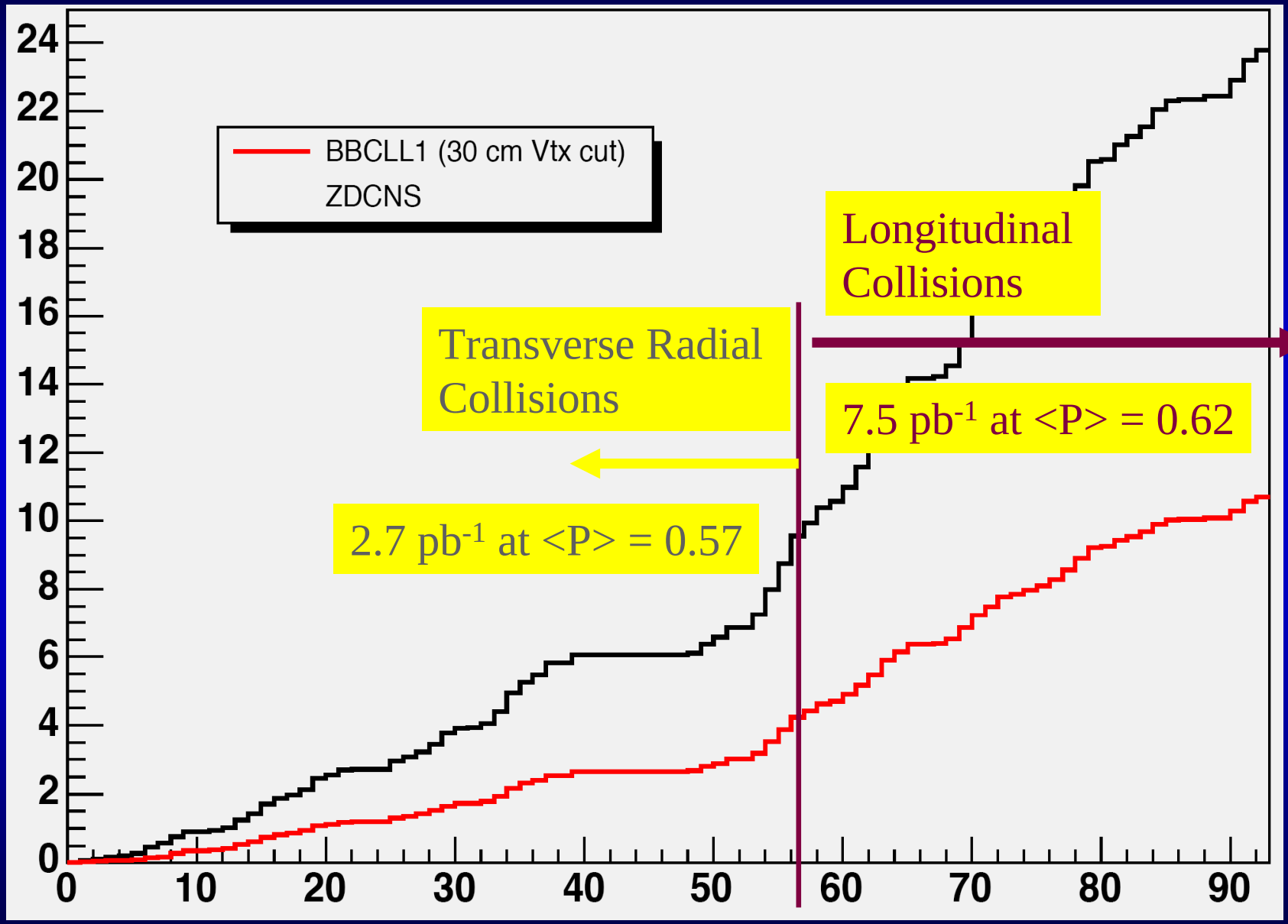
- Radiation tests of strip-pixel samples



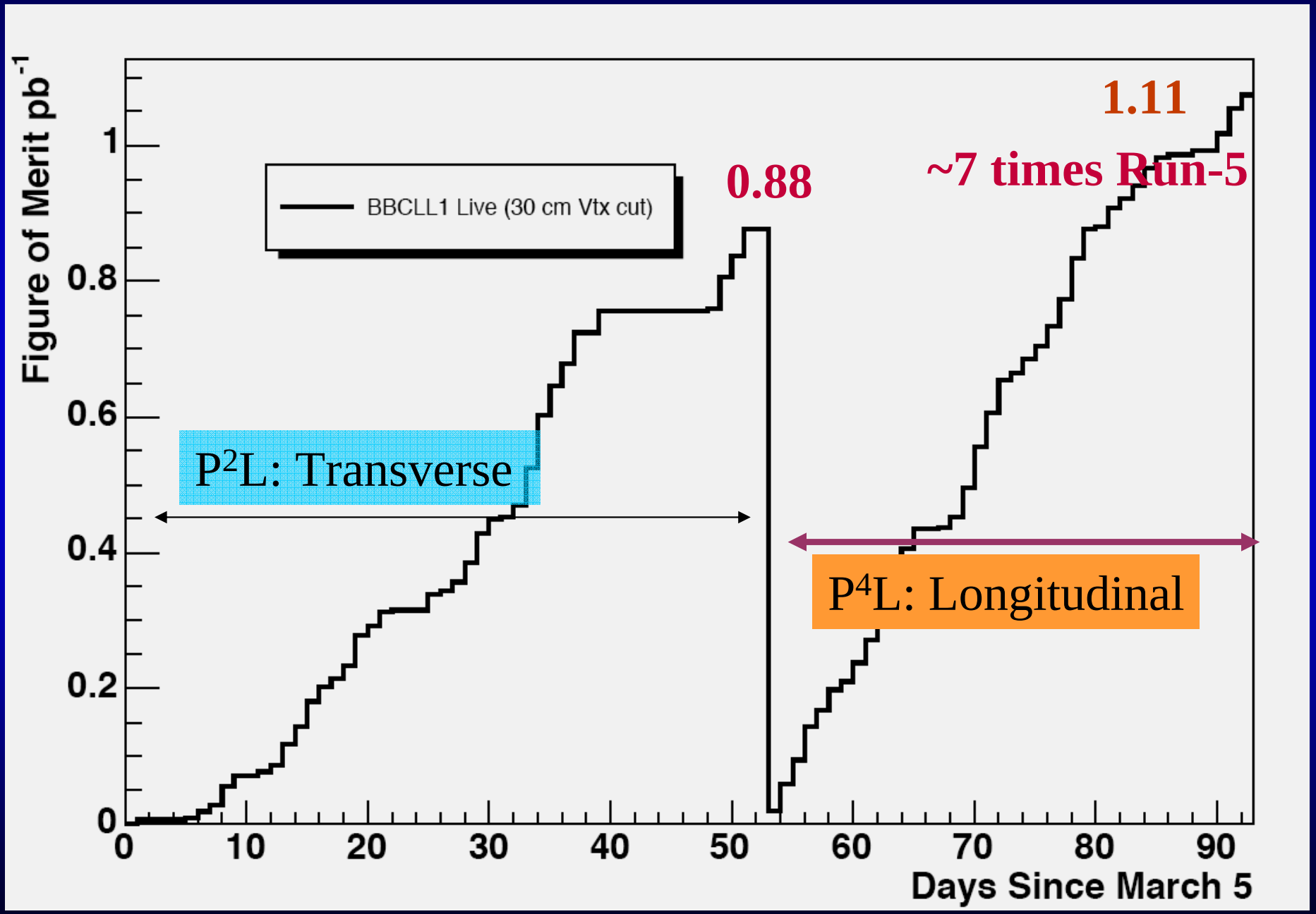


- Muon Piston Calorimeter (MPC)
  - 192 $PbW0_4$ crystals
  - APD read out w. EmCal FEM's

Run-6 Accumulations

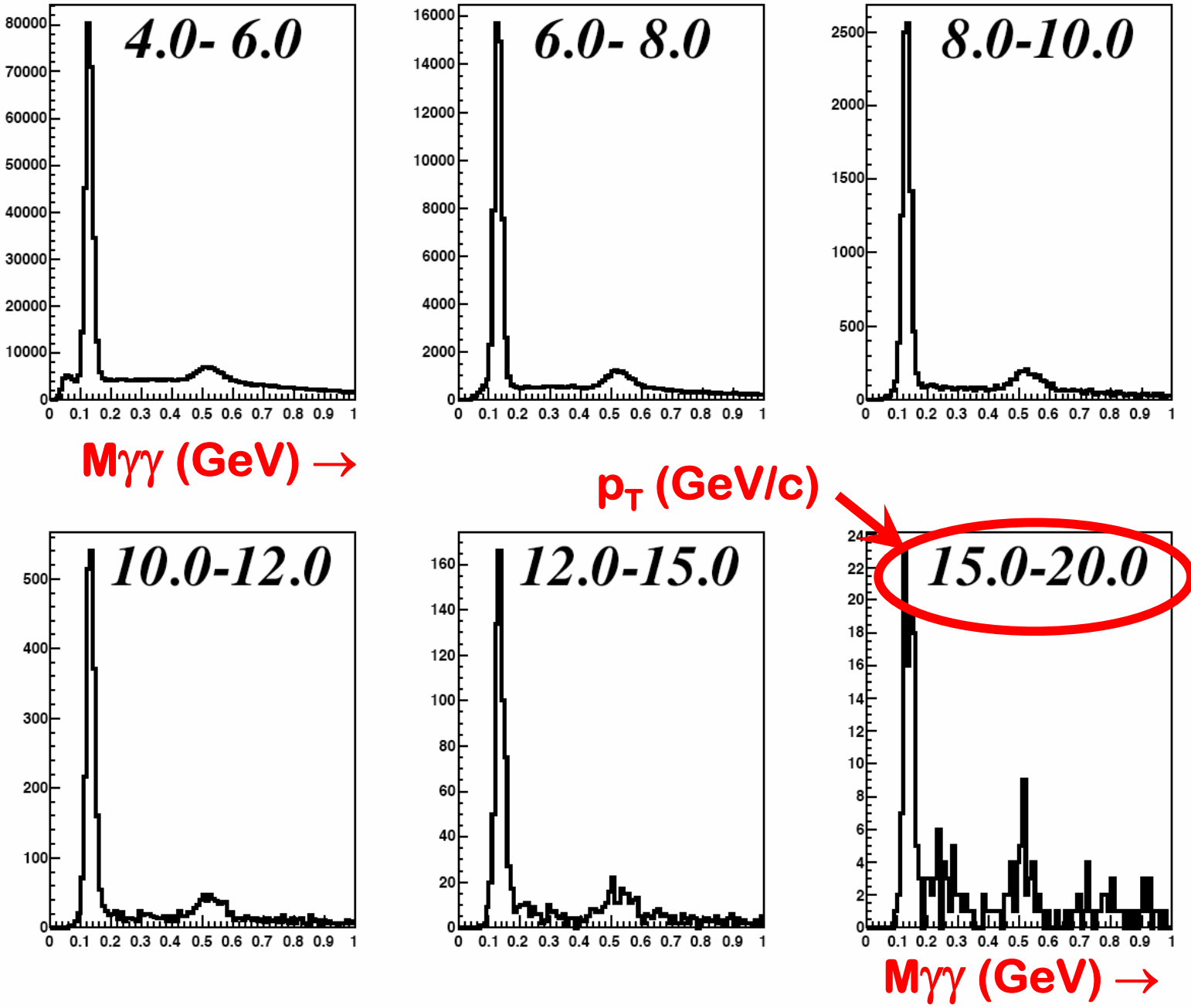


Run-6: Figure of Merit



Run-6 Data Quality

- Level 2 filter:
  - $\pi^0 \rightarrow \gamma\gamma$,
  - $\eta^0 \rightarrow \gamma\gamma$
- Clear η peak seen out to ~20 GeV/c
- Obtained in quasi real-time production on Vanderbilt farm



PHENIX

Proposal

Run Request

RUN	SPECIES	$\sqrt{s_{NN}}$ (GeV)	PHYSICS WEEKS	$\int L\,dt$ (recorded)	p+p Equivalent
7	p+p	200	10	32 pb^{-1}	32 pb^{-1}
	Au+Au	200	15	1.1 nb^{-1}	44 pb^{-1}
8	d+Au	200	15	58 nb^{-1}	23 pb^{-1}
	p+p	200	10	52 pb^{-1}	52 pb^{-1}
9	Au+Au	TBD	25-M		
	p+p	500	M		
10	U+U?	200	25-N		
	p+p	500	N		

Also: Section 5.1.3 of Proposal: "endorse potential C-A D requests for further development of 500 GeV polarized proton running."

Input to the Run Request

- PHENIX Physics Goals
- PHENIX Upgrades Schedule
- Collider-Accelerator Dept. Guidance
- External Constraints
  - Competitive measurements
  - Funding agency/community expectations
  - Consequences of Run-6 funding challenge

Consequences of Run-6

- Our present Beam Use Proposal is the logical adjustment to the loss of Au+Au running in Run-6
  - From last year:
  - Our desire to accumulate a factor of 10 increase in Au+Au data with an upgraded PHENIX remains unchanged
  - Our commitment to annual development of polarization and luminosity remains unchanged
  - Our desire for timely development of 500 GeV running remains unchanged

Run Request Summary Table

Table 2: The PHENIX Beam Use Proposal for Runs 6-10.

RUN	SPECIES	$\sqrt{s_{NN}}$ (GeV)	PHYSICS WEEKS	$\int \mathcal{L}dt$ (recorded)	p+p Equivalent
6	Au+Au	200	13	1 nb^{-1}	40 pb^{-1}
	p+p	200	4	7 pb^{-1}	7 pb^{-1}
	p+p	62.4	2	0.6 pb^{-1}	0.6 pb^{-1}
	p+p	22.5	0.5	4 nb^{-1}	4 nb^{-1}
	p+p	500	1	NA	NA
7	d+Au	200	10	28 nb^{-1}	11 pb^{-1}
	p+p	200	15	57 pb^{-1}	57 pb^{-1}
8	Au+Au	200	15	1.5 nb^{-1}	60 pb^{-1}
	p+p	200	10	52 pb^{-1}	52 pb^{-1}
9	TBD	200	10		
	p+p	200	5	22 pb^{-1}	22 pb^{-1}
	p+p	500	10		
10	U+U?	200	15		
	p+p	500	10		

- *This plan developed after careful consideration of alternative proposals*

PHENIX Physics Goals

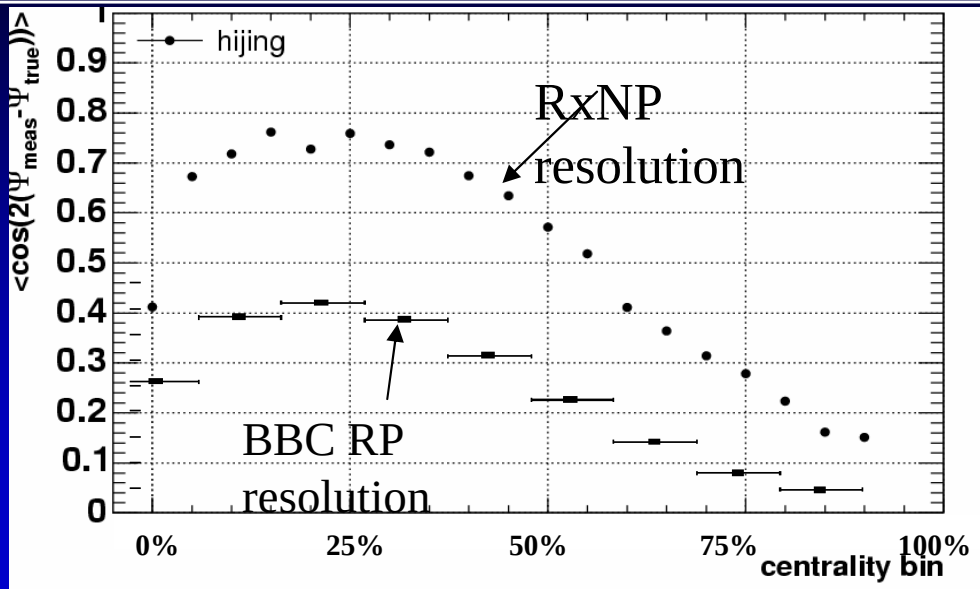
- Extend the quantitative investigation of the new state of matter formed in RHIC collisions.
- Extend the quantitative investigation of cold nuclear matter effects in heavy nuclei
- Extend the measurement of spin structure functions in polarized proton collisions

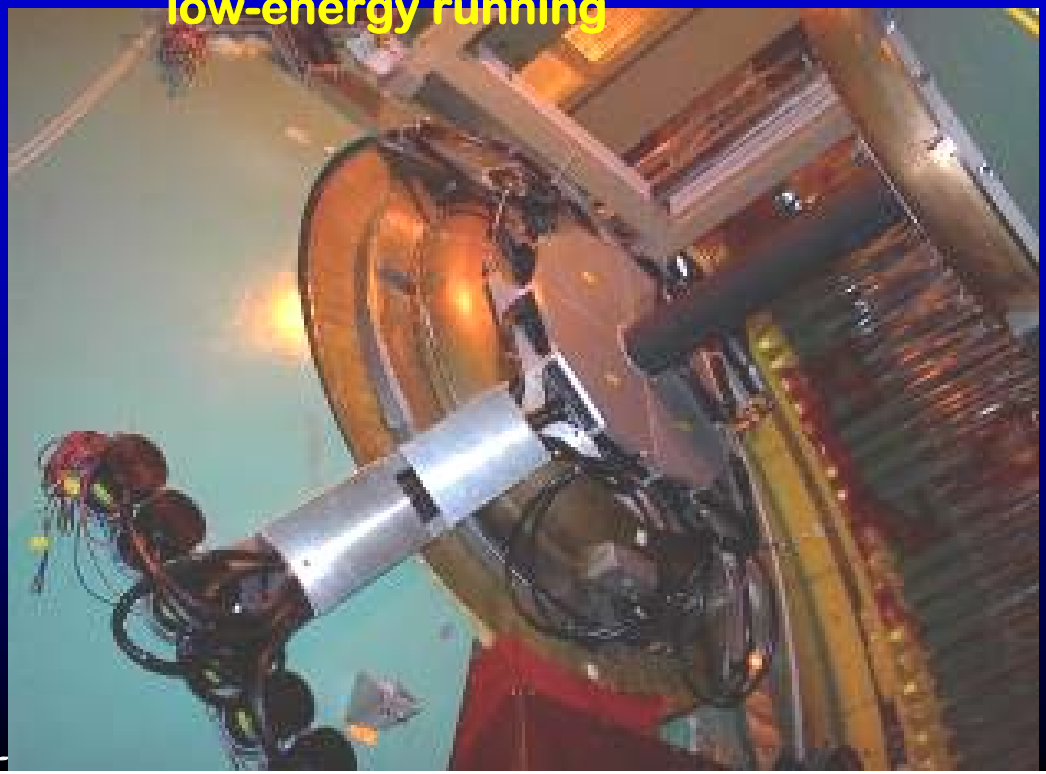
- "Extend" ≡
  - Sensitivity in rare channels
  - Exploration of new channels via upgrades
- Undertake this program in a way that
  - maintains roughly comparable sensitivities in p+p, d+A, A+A year-by-year in same detector configuration
  - takes advantage of ongoing upgrades program

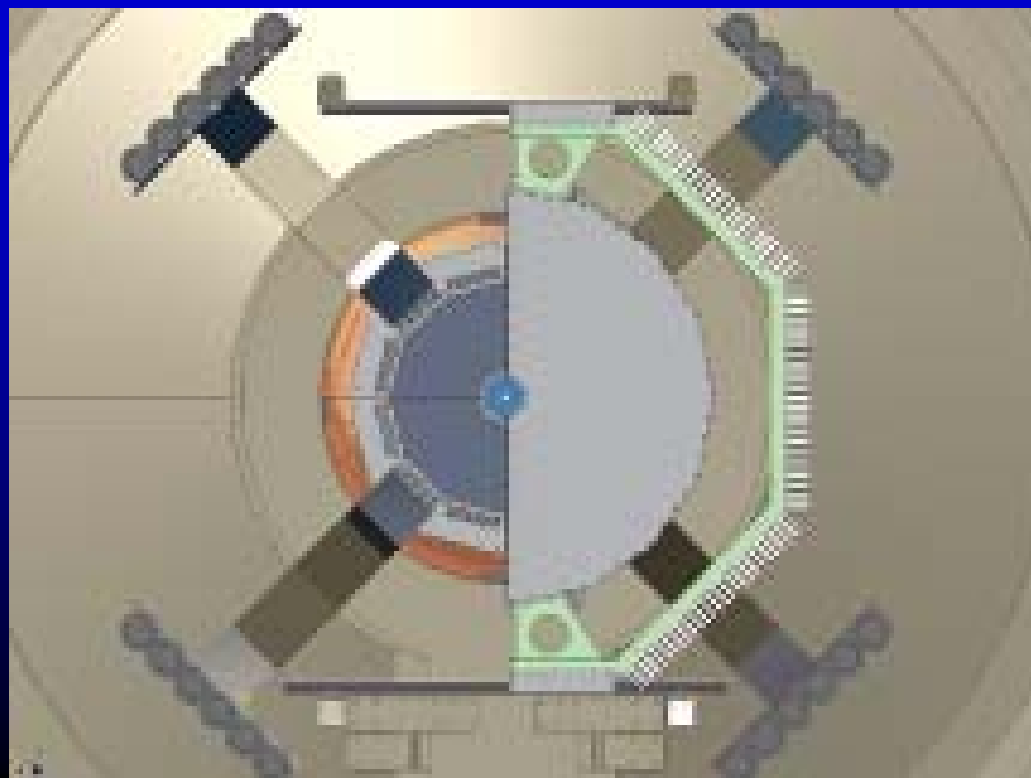
☞ *The proposed program implements these goals*

Reaction Plane Detector

- Goal: to improve resolution on reaction plane
  - Factor of 2 in resolution equivalent to increasing statistics by factor of 4
  - Essential, e.g., for v_2 (J/Ψ)
- Now installed for Run-7
  - 48 Scintillator paddles with lead converter at $1<|\eta|<3$ for reaction plane measurement
  - In future: trigger counter for low-energy running

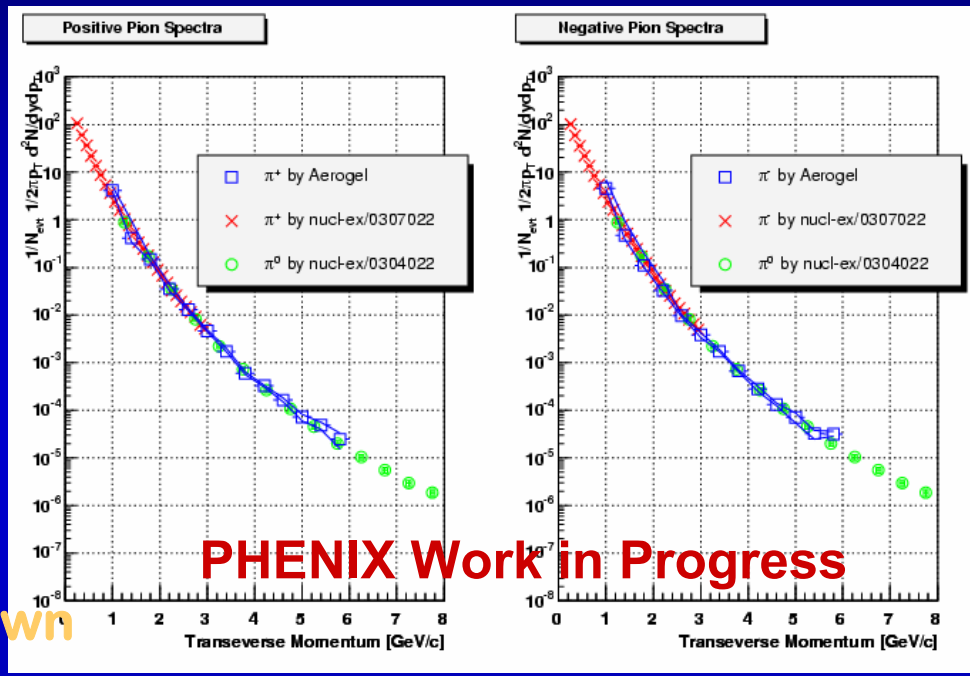


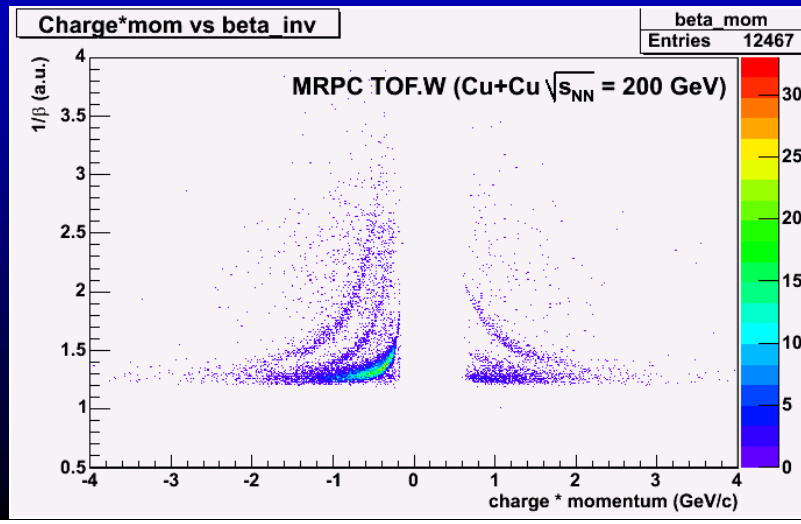




AGEL + TOF-W

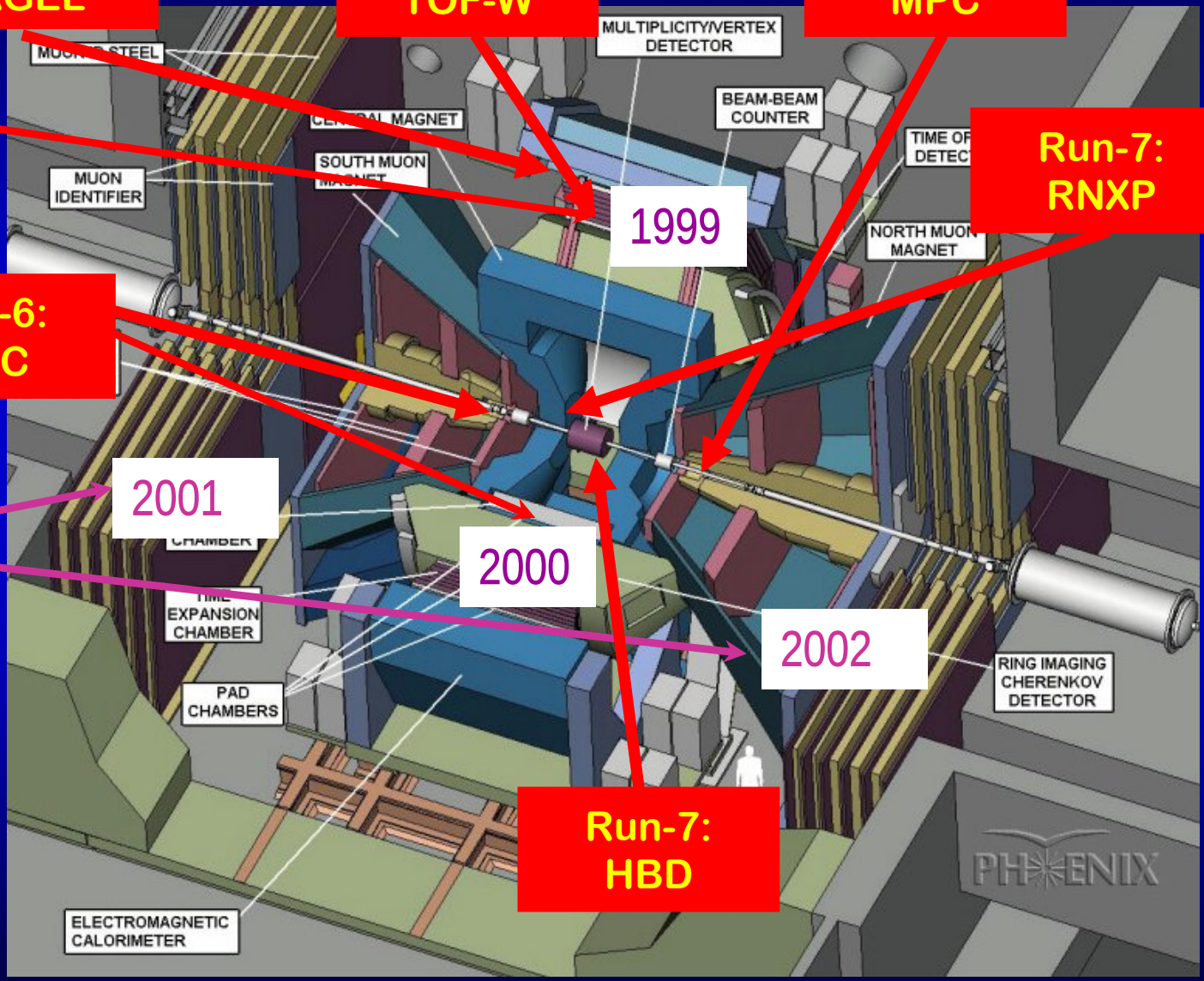
- From PHENIX Decadal Plan: "An aerogel and time-of-flight system to provide complete π/K/p separation for momenta up to ~10 GeV/c."
- Status
  - Aerogel
    - completely installed
    - first physics results now available
  - TOF-W ('Time-Of-Flight-West')
    - Prototypes tested in Run-5
    - System installed in current shutdown
    - Partial funding: J. Velkovska (Vanderbilt) OJI





Upgrades Schedule (I)

- 2 central spectrometers
- 2 forward spectrometers
- Forward detectors
  - Triggering
  - Centrality
  - Local polarimetry
  - Luminosity monitoring



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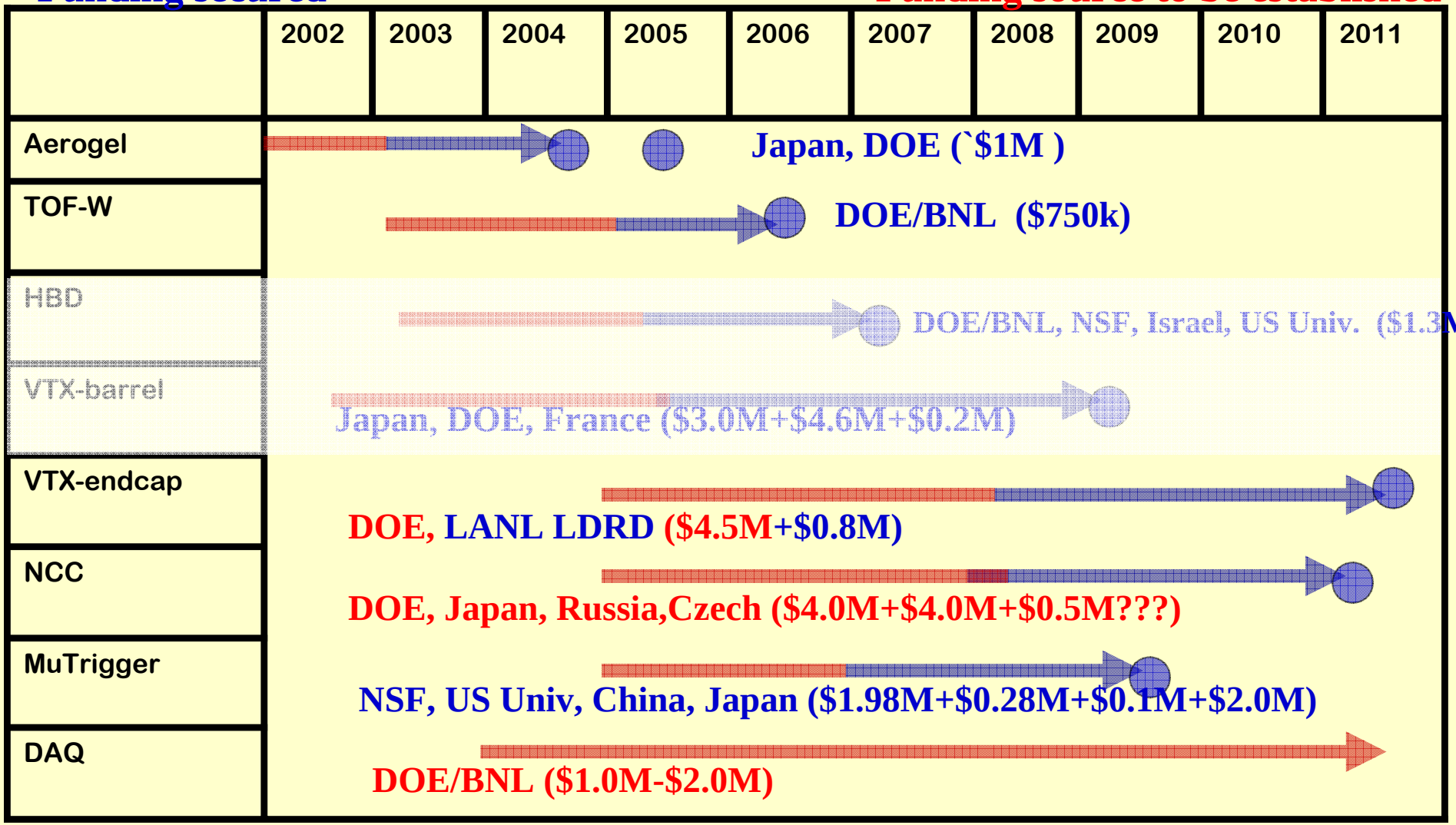
Upgrades Schedule (II)

Funding secured — **Funding source to be established**



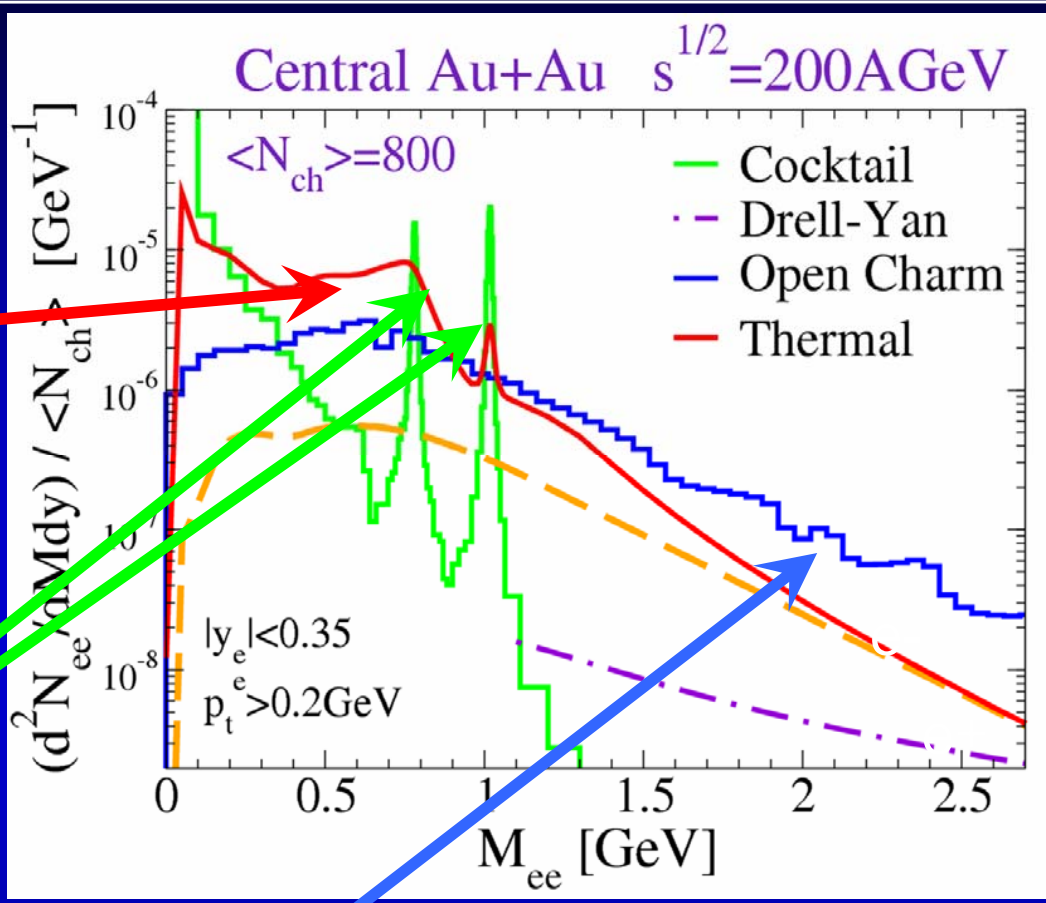
R&D Phase — Construction Phase — Ready for Data

Upgrades Schedule (III)

- Most relevant to our request:
- There is an interplay between
  - The current availability of the HBD (Runs 7, 8, 9)
  - The planned installation of the Si-VTX (Run-10)
- Accordingly:
  - We have developed a proposal that
    - Insures exposure of the HBD to (at least) 200 GeV p+p, Au+Au and d+Au
    - In a sequence designed to maximize success of this program of measurements
    - That retains option of exploring lower-energy collisions in Run-9
  - This program provides earliest possible access to the physics of low-mass dileptons in Au+Au collisions at RHIC energies
  - While maintaining progress towards our goals in other channels and other systems in Runs 7, 8 and 9.

Physics from the HBD

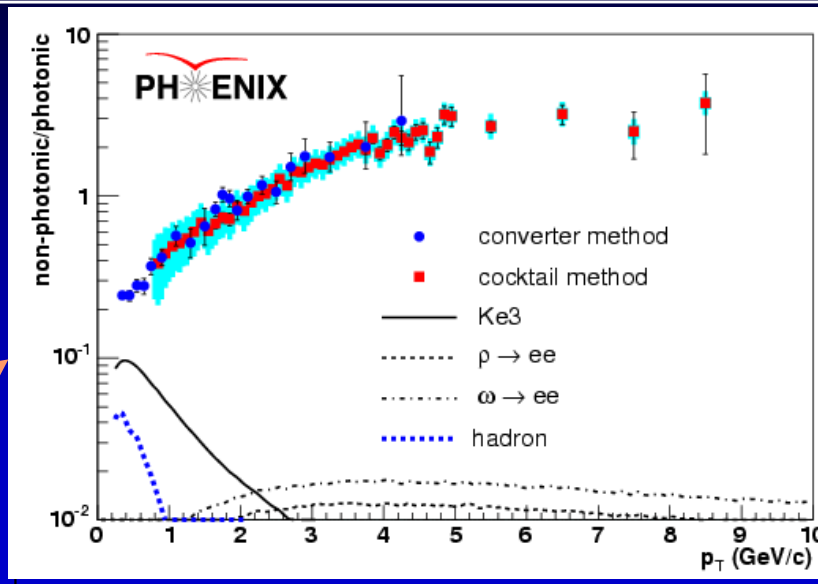
- The spectrum of low-mass e+e- pairs is sensitive to
  - Thermal radiation from plasma: $\gamma^* \rightarrow$ e+e-
  - Medium modifications of vector mesons
    - Broadening
    - Mass shifts
    - Predicted by chiral symmetry restoration
    - Observed via $(\rho,\omega,\phi) \rightarrow$ e+e-
  - Open charm
    - In some sense a "background"
    - From semi-leptonic decays of D's.



R. Rapp nucl-th/0204003

Current Electron Capabilities

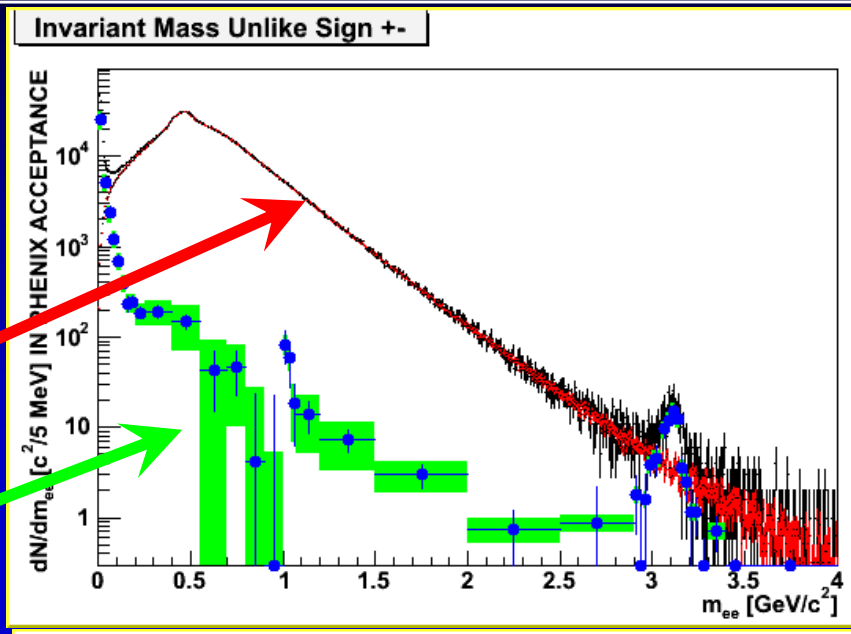
- PHENIX has *superb* capabilities to
  - Identify electrons
    - Tracking, RICH, EmCal
  - Identify signal electrons
    - Very low material budget in aperture
    - "Converter" runs used to measure/check/verify/extend assumptions of "cocktail" subtraction
- Provides outstanding measurements of "non-photonic" electrons
  - "Measurement of high-p_T Single Electrons from Heavy-Flavor Decays in p+p Collisions at $\sqrt{s}$ = 200 GeV" , submitted to PRL, Preprint: hep-ex/0609010

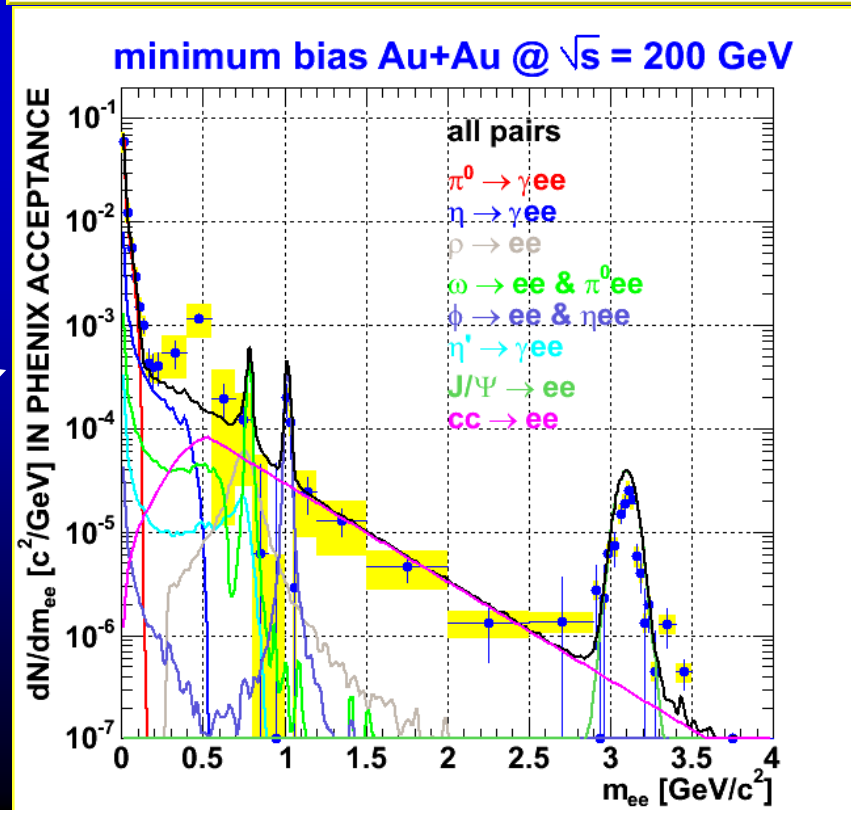


Agreement within errors with FONLL pQCD

Current *Di*-Electron Capabilities

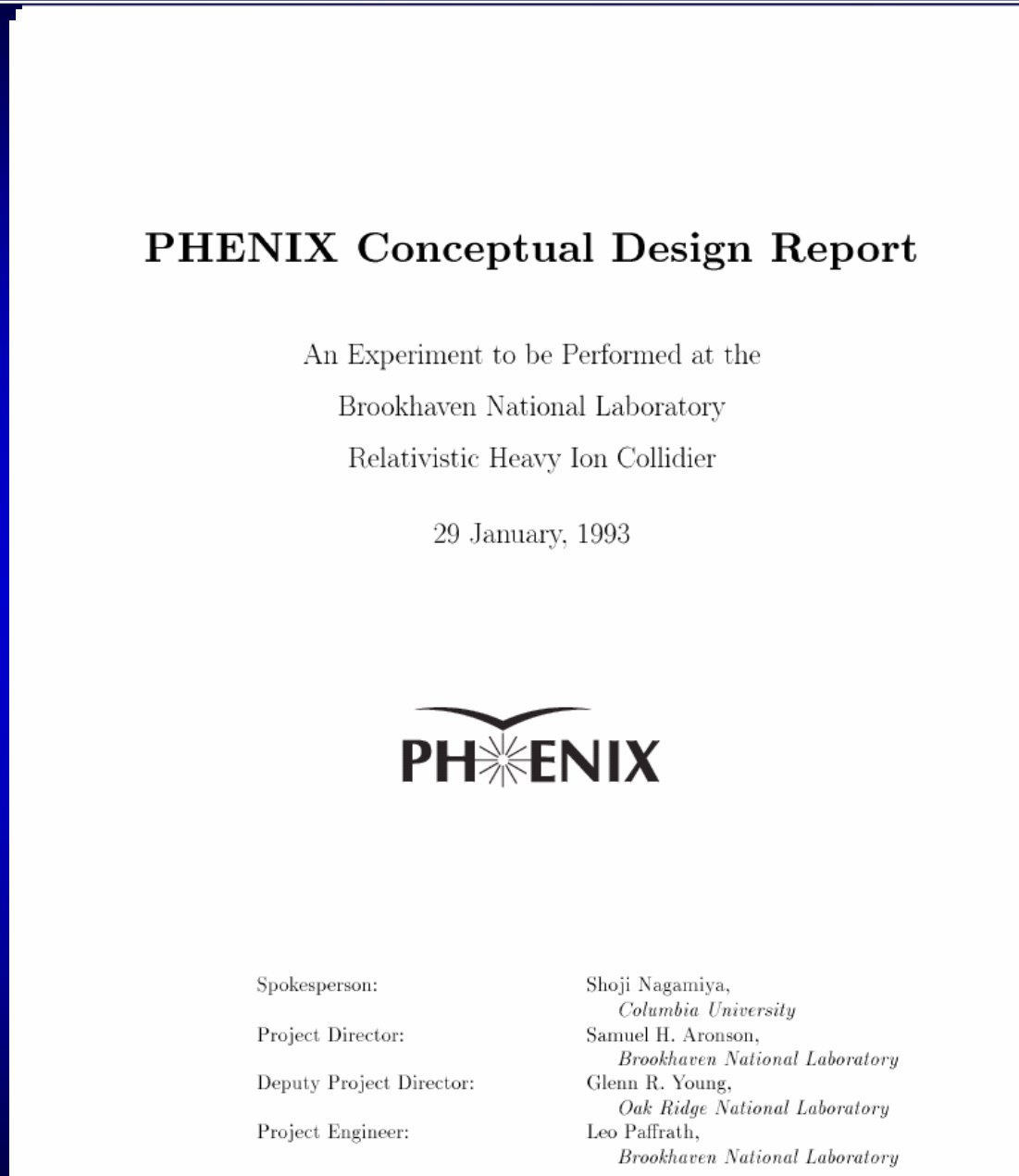
- Again, ***superb*** electron identification
- Also: ***Superb*** control on subtraction of combinatoric background
  - Four different methods agree within 0.3%
  - But, systematic errors dominated by subtraction of *huge* combinatoric background
- Results in only a modest proof-of-principle, even when using full Run-4 Au+Au data set:
- ***The HBD will improve our S/B by a factor of ~100***





It's Been There All Along

- The need for the HBD to investigate these physics channels was clearly anticipated in the PHENIX **Conceptual Design Report** :
  - "A method of identifying and tracking both members of such a pair before curling up in the field would greatly enhance our ability to suppress this background and improve our study of low mass dielectrons The proposed upgrade is a hadron-blind tracker based on Cherenkov signals"
- Still the case…



PHENIX Conceptual Design Report

An Experiment to be Performed at the

Brookhaven National Laboratory

Relativistic Heavy Ion Collidier

29 January, 1993

PHENIX

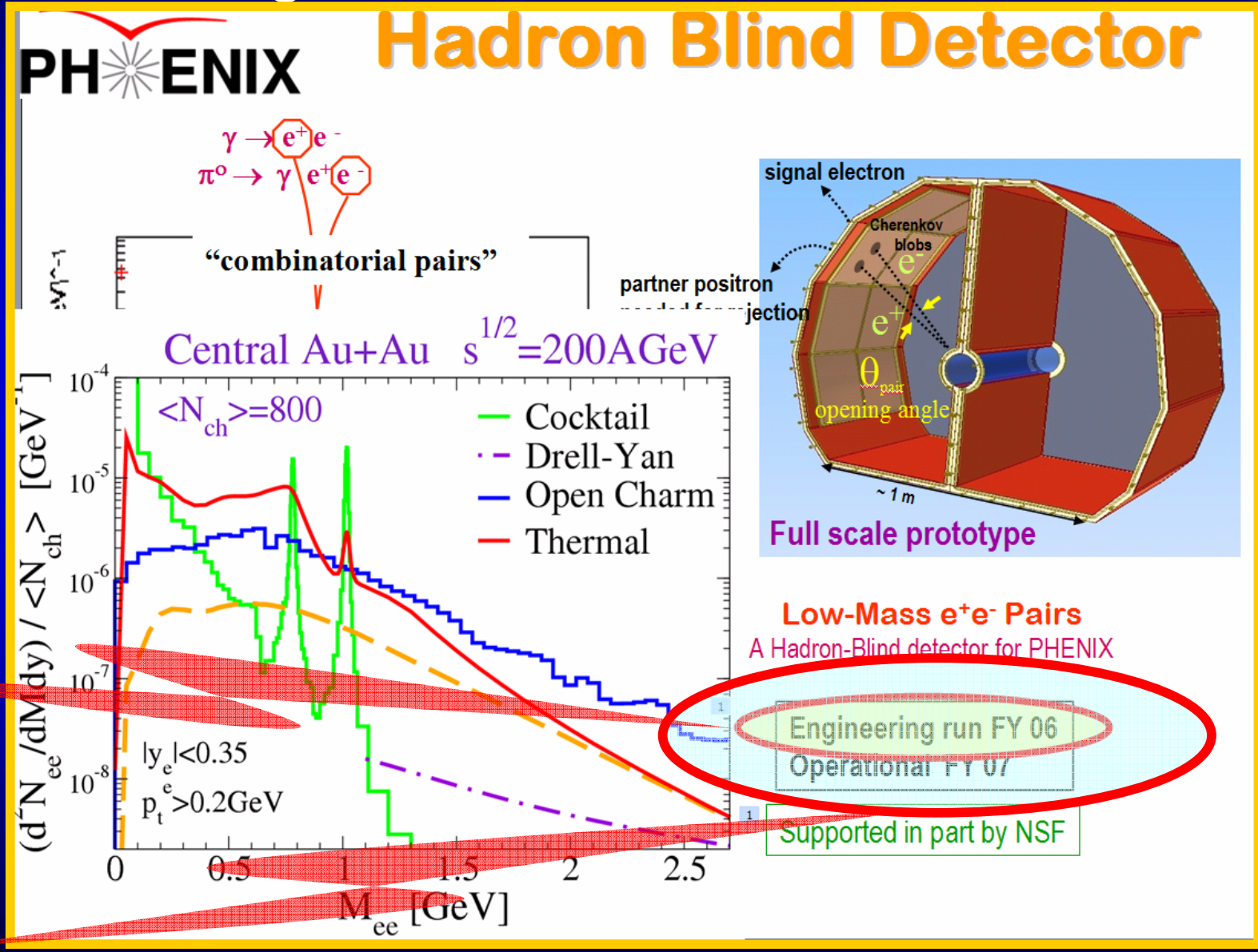
Spokesperson:	Shoji Nagamiya, *Columbia University*
Project Director:	Samuel H. Aronson, *Brookhaven National Laboratory*
Deputy Project Director:	Glenn R. Young, *Oak Ridge National Laboratory*
Project Engineer:	Leo Paffrath, *Brookhaven National Laboratory*

From Last Year's PAC Presentation

- In spite of the challenge of Run-6…

- We preserved this
- And will maintain this schedule

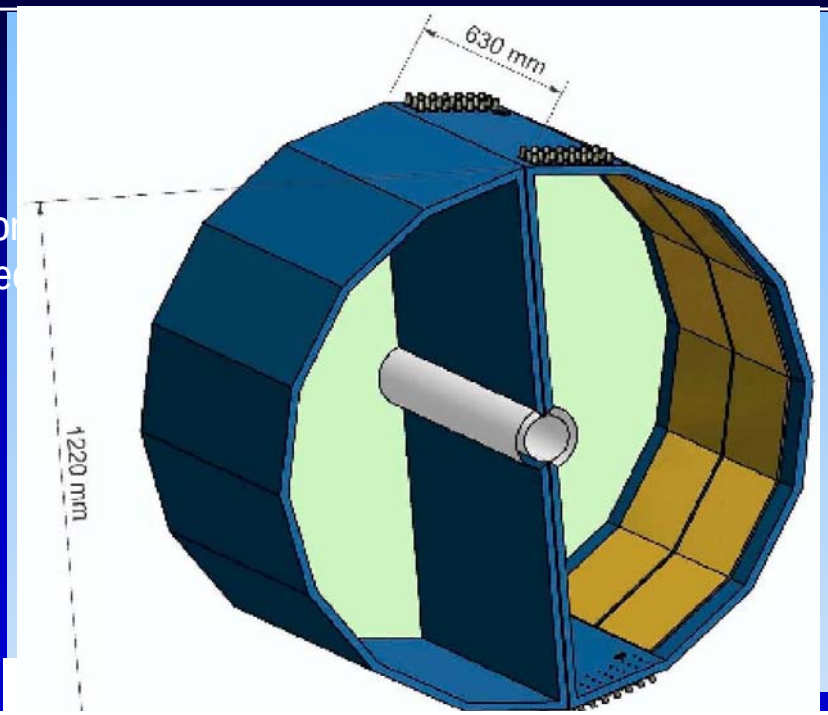
Hadron Blind Detector

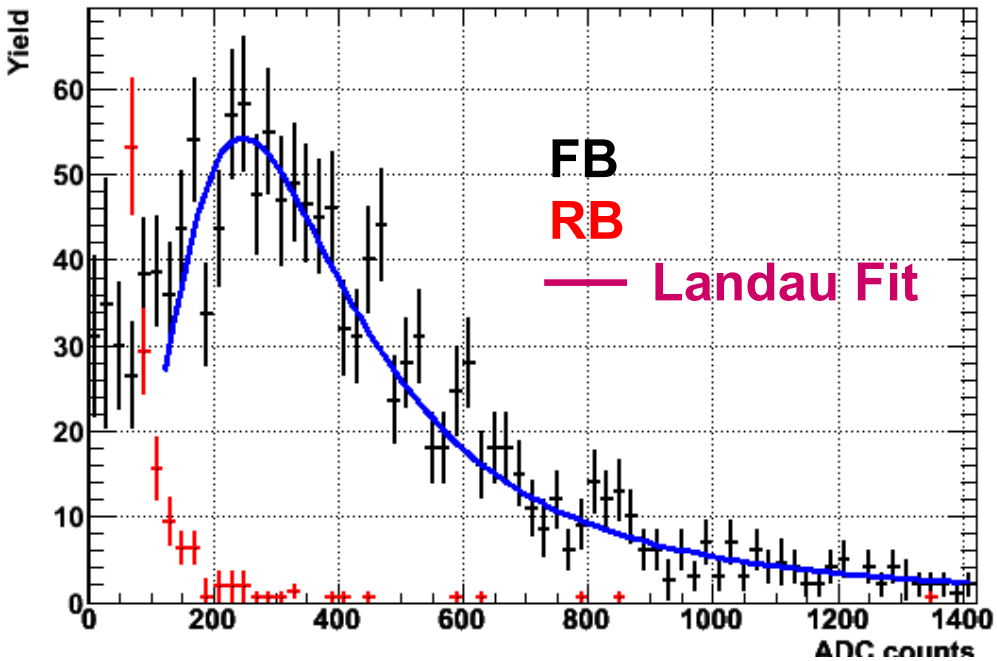


Hadron-Blind Detector (HBD)

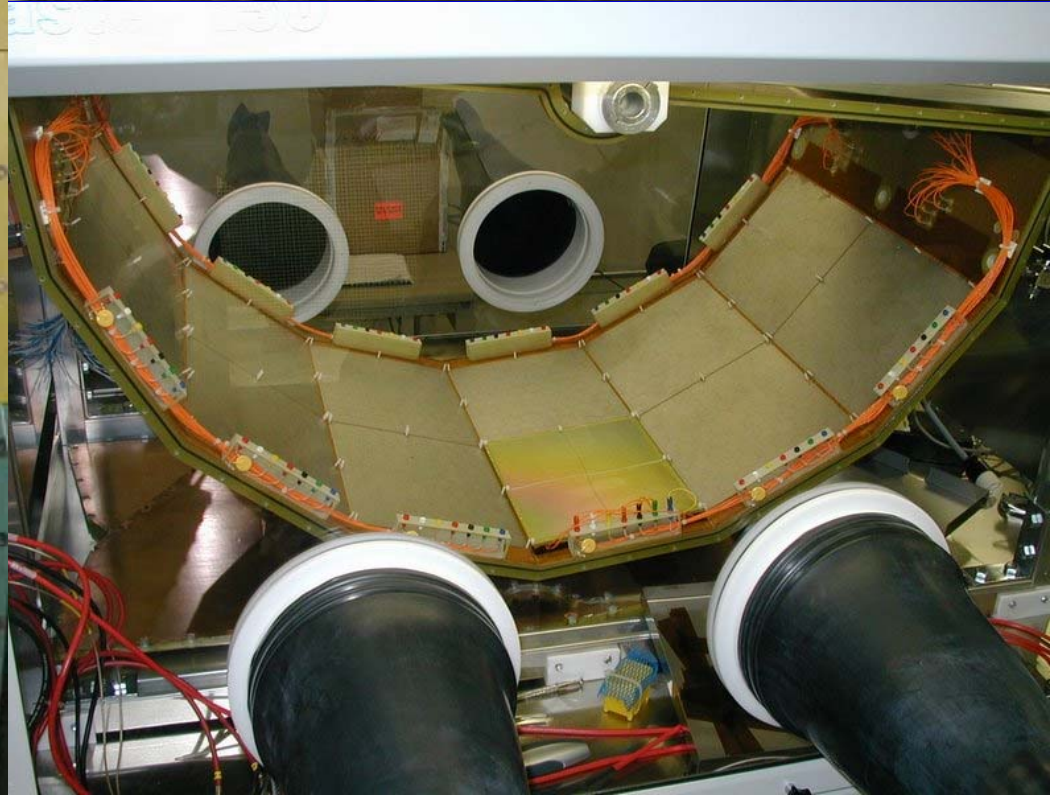
- "A hadron-blind detector to detect and track electrons near the vertex."
- Dalitz rejection via opening angle
  - Identify electrons in field free region
  - Veto signal electrons with partner
- HBD: a novel detector concept:
  - windowless CF_4 Cherenkov detector
  - 50 cm radiator length
  - CsI reflective photocathode
  - Triple GEM with pad readout
- Construction/prototype(!) /installation 2005/2006
- Funding: DOE + $250K (NSF) + $100K (Weizmann) + $57K (SUNY-SB)

partner positron
needed for reje



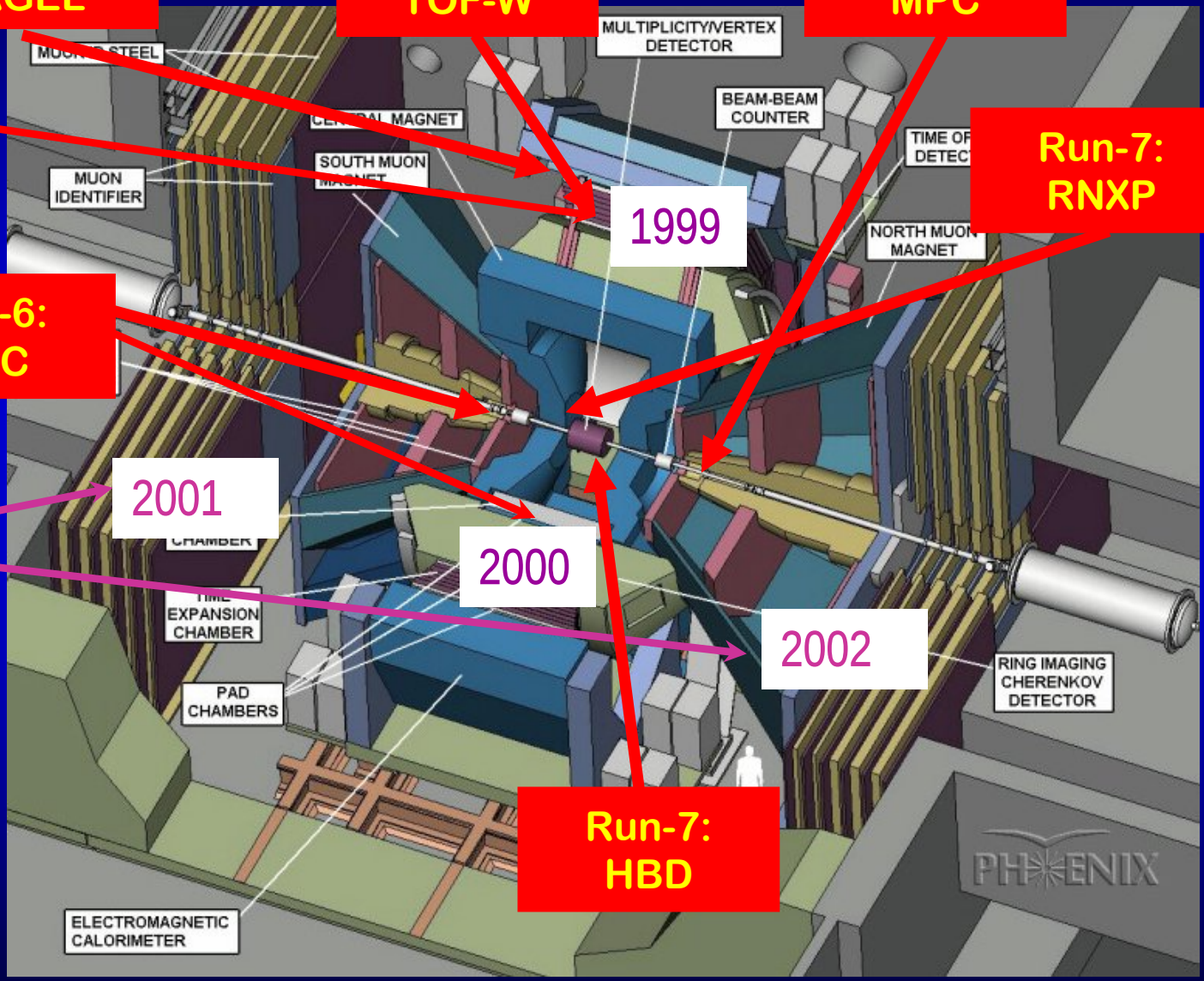


The HBD Becomes Real



Upgrades Schedule (I)

- 2 central spectrometers
- 2 forward spectrometers
- Forward detectors
  - Triggering
  - Centrality
  - Local polarimetry
  - Luminosity monitoring



A past, present and future tribute to the incredible skills of the PHENIX 1008 Engineering and Technical Staff !

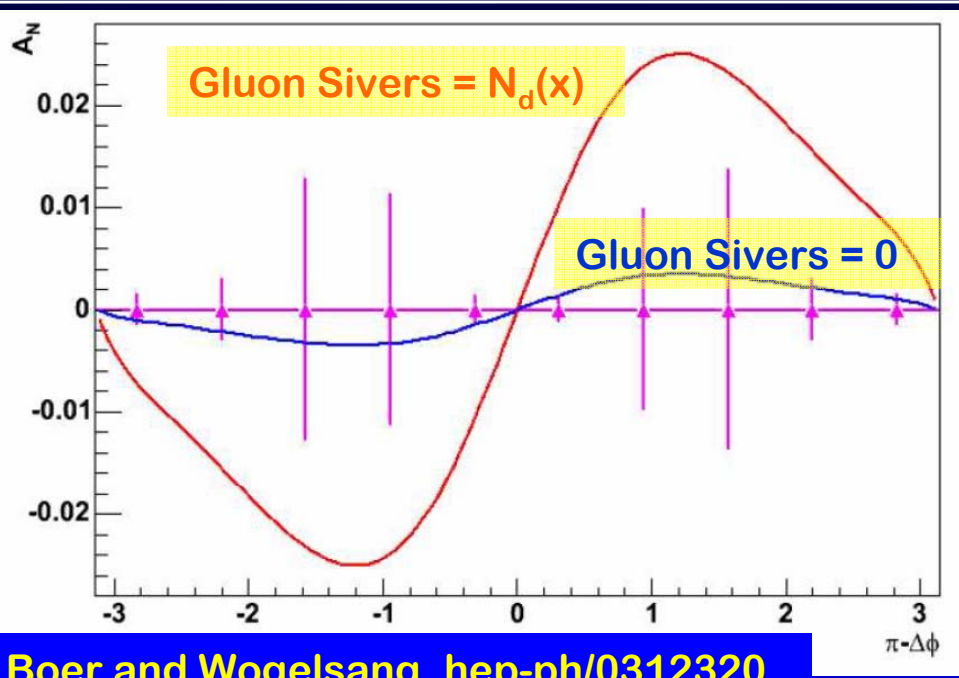
Run-7 Request (Au+Au)

- 15 weeks Au+Au at $\sqrt{s_{NN}}$ = 200 GeV
  - Consistent with our (deferred) request from last year for an order-of-magnitude increase in Au+Au integrated luminosity over a 2-3 year period.
    - Run-4 Au+Au: 241 μb^{-1} recorded
    - Run-7 Au+Au: 1100 μb^{-1} recorded
  - Will provide new physics
    - Low mass electron pairs
    - V_2 (J/Ψ)
    - V_2 (γ)
  - Will extend existing physics
    - PID range for high p_T particles and jet pairs (TOF-W)
    - V_2(e) (RXNP)
    - Jet tomography, away-side shape
    - (List extends well of this slide)
  - ☞ *Provided we begin the Au+Au run with an operating and fully-commissioned HBD .*

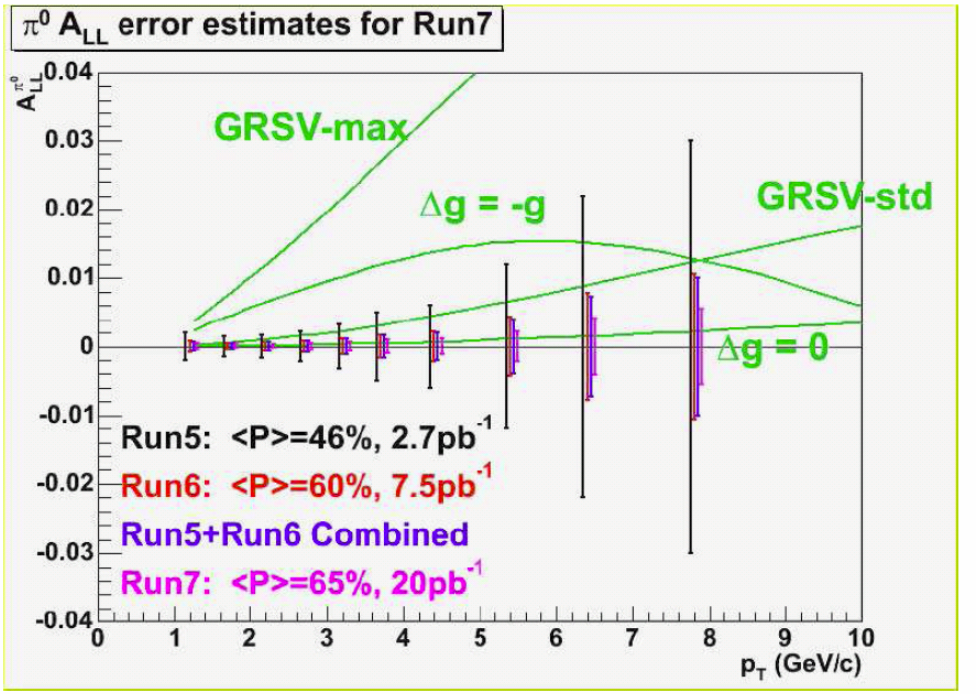
PHENIX Run Coordinator for Run-7: M. Leitch (LANL)

Run-7 Request (p+p)

- 10 weeks p+p at $\sqrt{s}$ = 200 GeV
  - Consistent with our interest in maintaining progress towards spin goals via yearly periods of polarized proton running.
- Breakdown:
  - 2.5 weeks transverse to constrain gluon Sivers function via A_N measurements for single and di-hadrons
    - Run-6: 2.7 pb^{-1} recorded
    - Run-7: 6.0 pb^{-1} recorded
  - 7.5 weeks longitudinal to constrain ΔG through A_{LL} for inclusive hadron production
    - Run-6: 7.5 pb^{-1} recorded
    - Run-7: 20 pb^{-1} recorded
- Factors of 2-3 improvement over Run-6, with additional detectors (MPC-South *and* MPC-North)



Boer and Wogelsang, hep-ph/0312320



Run-7 Request (Order)

- The new physics program made possible by the HBD is focused on heavy ion collisions
  - Combinatoric background/signal ~ multiplicity
- The "massless" aperture of PHENIX for all electron physics is being replaced by an "active mass"
  - It's crucial for the Au+Au run to have that mass "active", that is, fully commissioned
- It is therefore essential that the HBD be fully operative at the start of the Au+Au run

☞ *These considerations lead us to request starting Run-7 with polarized protons*

Run-7 Order

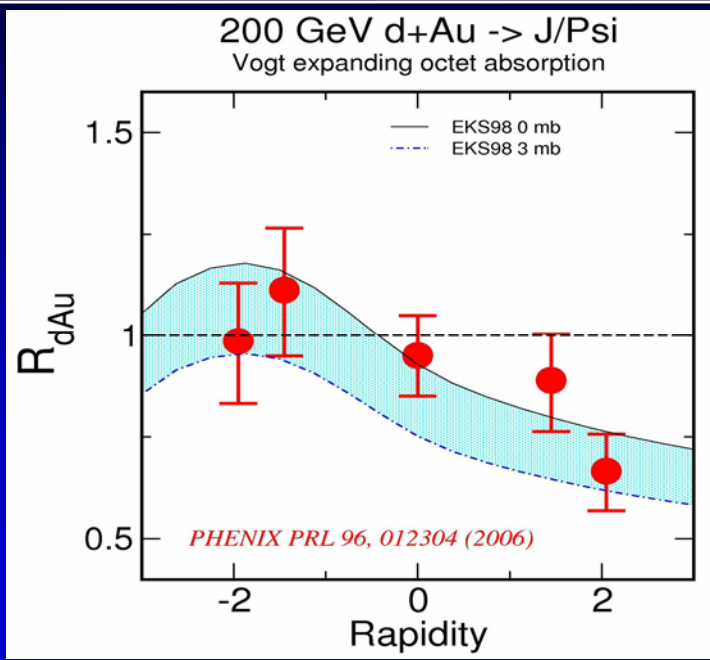
- Exacerbating factors
  - It is not yet clear of various improvements for p+p running will be available at run start
    - New quadrupole configuration in AGS
    - New sextapole configuration in RHIC
    - h=120 RF
  - The proton running will not be able to take advantage of AGS optimization for protons "behind" Au+Au stores in RHIC
- Ameliorating factors
  - We have just completed a "long" very successful p+p run
  - The start-up appears likely to be further delayed
  - The requested sequence maximizes probability for success in a compelling and unexplored sector at RHIC
    - Physics impact
    - Programmatic impact: NSAC performance measure for 2010: "Measure e^+e^- production in the mass range $500 \leq m_{e+e-} \leq 1000$ MeV/c^2 in $\sqrt{s_{NN}}$= 200 GeV collisions. "

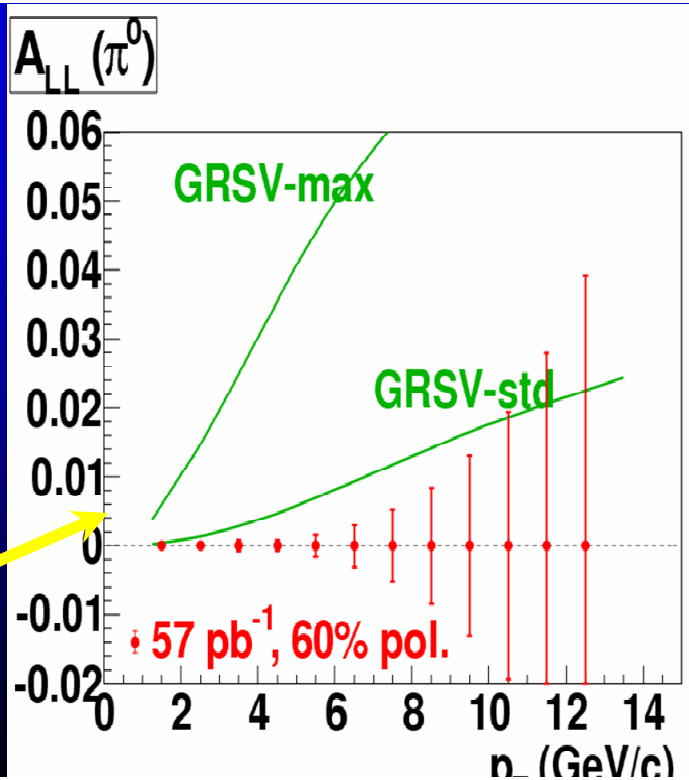
NSAC Performance Measures

- RHIC program of sufficient breadth that it encompasses two broad categories in the NSAC Performance Measures :
  - Physics of High Density and Hot Hadronic Matter:
    - ✓2005 Measure J/ψ production in Au+Au at $\sqrt{s_{NN}}$ = 200 GeV.
    - ✓2005 Measure flow and spectra of multiply-strange baryons in Au+Au at $\sqrt{s_{NN}}$ = 200 GeV.
    - ✓2007 Measure high transverse momentum jet systematics vs. $\sqrt{s_{NN}}$ up to 200 GeV and vs. system size up to Au+Au.
    - 2009 Perform realistic three-dimensional numerical simulations to describe the medium and the conditions required by the collective flow measured at RHIC
    - ✓2010 Measure the energy and system size dependence of J/ψ production over the range of ions and energies available at RHIC.
    - ✓2010 Measure e^+e^- production in the mass range $500 \le m_{e+e-} \le 1000$ MeV/c^2 in $\sqrt{s_{NN}}$= 200 GeV collisions.
    - 2010 Complete realistic calculations of jet production in a high density medium for comparison with experiment.
    - ✓2012 Determine gluon densities at low *x* in cold nuclei via p+Au or d+Au collisions
  - Hadronic Physics
    - ✓2008 Make measurements of spin carried by the glue in the proton with polarized proton-proton collisions at center of mass energy $\sqrt{s}$ = 200 GeV.
    - ✓2013 Measure flavor-identified q and q contributions to the spin of the proton via the longitudinal-spin asymmetry of W production.

Run-8 Request

- 15 weeks of d+Au at $\sqrt{s_{NN}}$ = 200 GeV
  - Given expected advances in integrated p+p luminosity, existing Run-3 d+Au data set becomes limiting factor in making precision statements about (small) nuclear modifications.
    - Run-3: 2.7 nb^{-1}
    - Run-8: 58 nb^{-1}
- 10 weeks of polarized p+p at $\sqrt{s}$ = 200 GeV
  - Longitudinal polarization
  - Factor of ~7 improvement in integrated luminosity
    - Run-6: 7.5 pb^{-1}
    - Run-8: 52 pb^{-1}
  - Assumed polarization of 70%
    - ➡ order-of-magnitude improvement in figure of merit

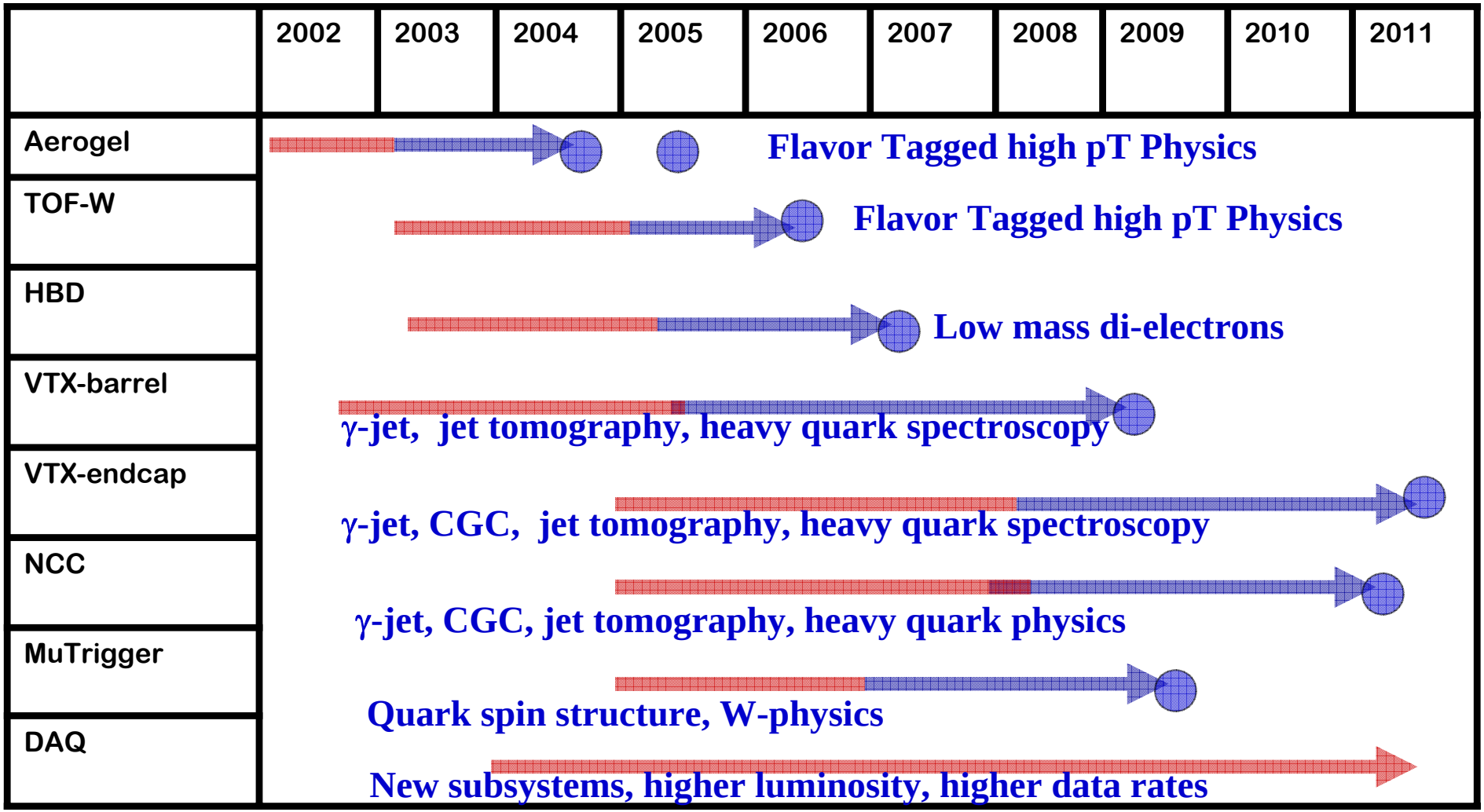




Run-9 Request

- 25 – M weeks of Au+Au at $\sqrt{s_{NN}}$ = ? GeV
  - Painfully aware of difficulties in long-term projections
  - Equally aware of
    - Need for integrated planning with upgrades schedule
    - Physics potential for low-energy running at RHIC
  - Allocation of full versus low-energy running will be contingent upon (then-analyzed) Run-7 Au+Au data at 200 GeV
- M weeks of polarized p+p at $\sqrt{s}$ = 500 GeV
  - This too a contingent request
  - Based upon
    - Cumulative value of Runs 3-8 integrated luminosity for polarized protons at 200 GeV
    - Progress towards 500 GeV commissioning
    - Upgrades schedule

Future (Compelling) Physics



The Upgraded PHENIX Detector

Charged Particle Tracking:

- Drift Chamber
- Pad Chamber
- Time Expansion Chamber/TRD
- Cathode Strip Chambers(Mu Tracking)
- Forward Muon Trigger Detector
- Si Vertex Tracking Detector- Barrel (Pixel + Strips)
- Si Vertex Endcap (mini-strips)

Particle ID:

- Time of Flight
- Ring Imaging Cerenkov Counter
- TEC/TRD
- Muon ID (PDT's)
- Aerogel Cerenkov Counter
- Multi-Resistive Plate Chamber Time of Flight
- Hadron Blind Detector

Calorimetry:

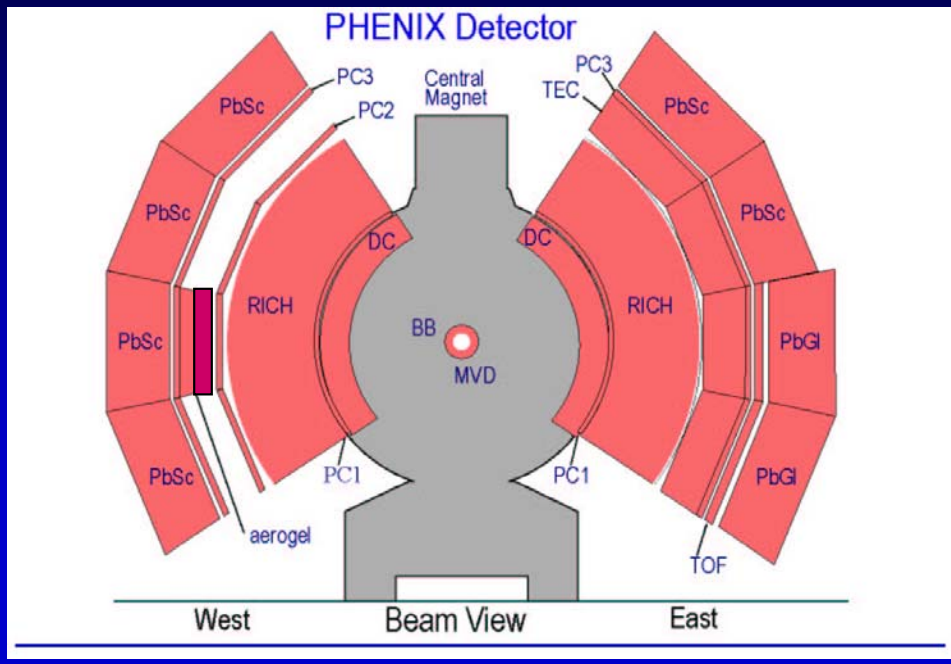
- Pb Scintillator
- Pb Glass
- Nose Cone Calorimeter
- Muon Piston Calorimeter

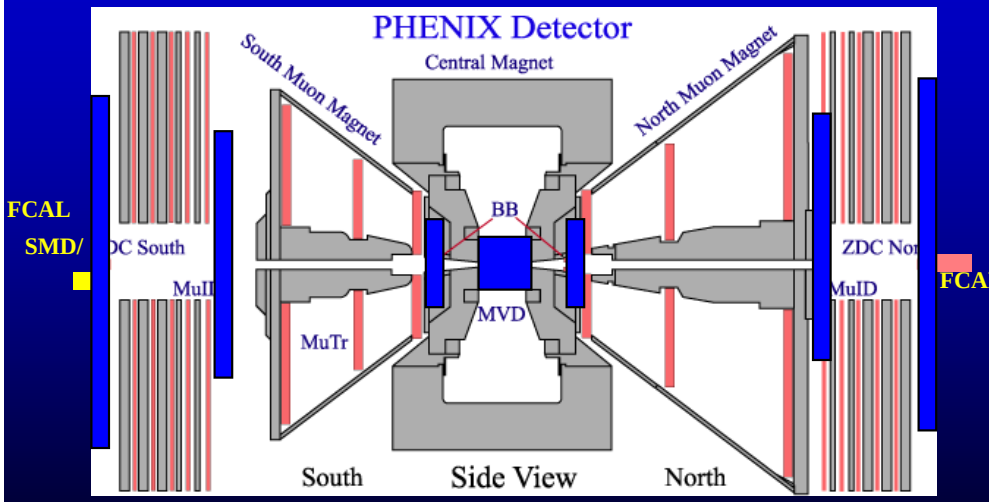
Event Characterization:

- Beam-Beam Counter
- Zero Degree Calorimeter/Shower Max Detector
- Reaction Plane Detector
- Forward Calorimeter

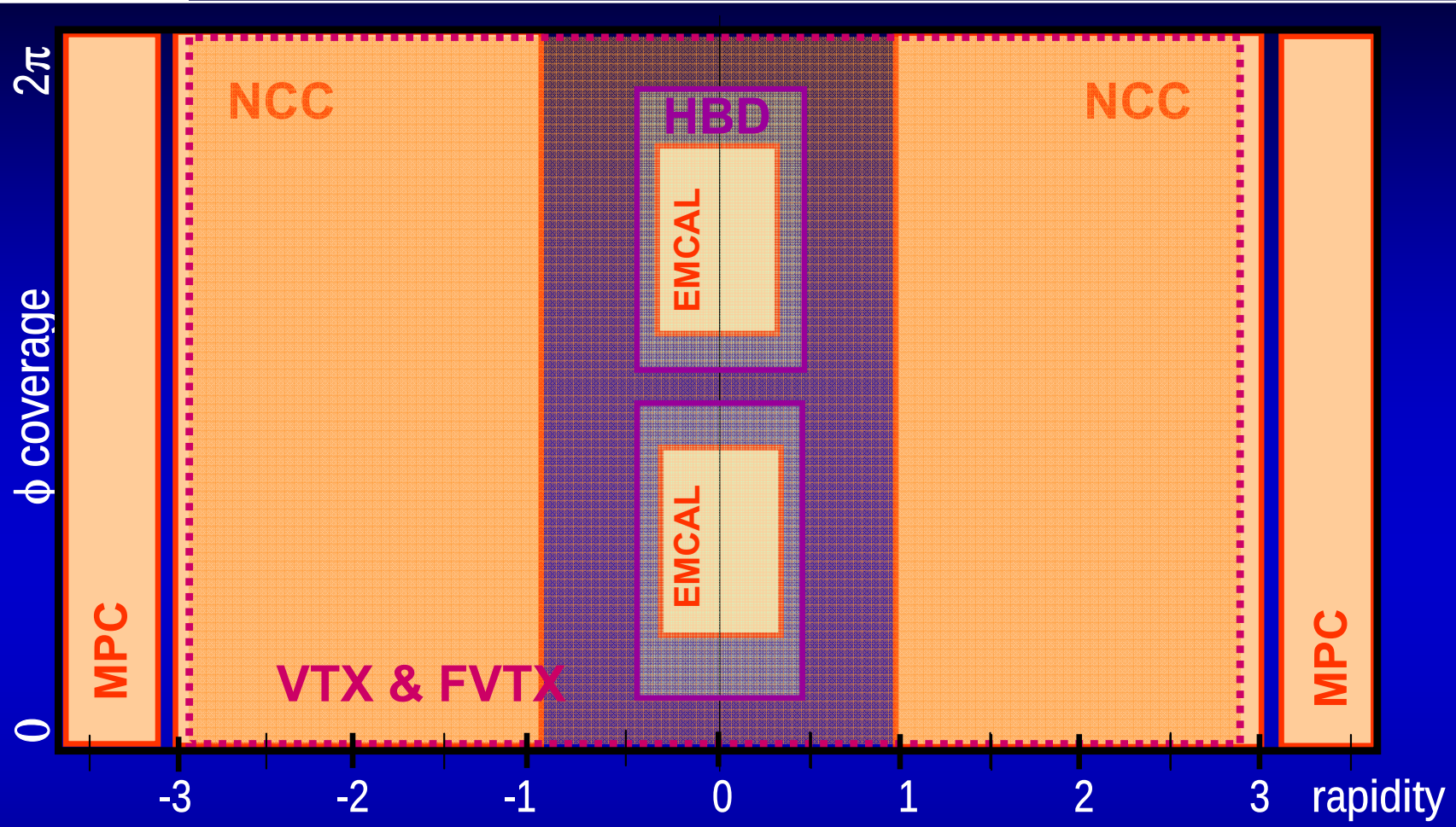
Data Acquisition:

- DAQ Upgrade





Future Acceptance for Hard Probes



(i) π^0 and direct γ with combination of all electromagnetic calorimeters
(ii) heavy flavor with precision vertex tracking with silicon detectors
combine (i)&(ii) for jet tomography with γ-jet

(iii) low mass dilepton measurements with HBD + PHENIX central arms

PHENIX view of RHIC Upgrade Plans

Near term: Base line

Medium term: first upgrades

Long term: full detector and RHIC upgrades

2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018

Analysis of data on tape

Near term detector upgrades of PHENIX
TOF-W, HBD, VTX , μTrig

Commissioning

40x design luminosity for Au-Au via electron cooling

PHENIX upgrades

Long term upgrades
FVTX, NCC, ...

RHIC luminosity upgrade

RHIC baseline program

Au+Au ~ 250 μb^{-1} at 200 GeV
Species scan at 200 GeV
Au+Au energy scan
Polarized protons ≥ 150 nb^{-1}

Extended program with 1st detector upgrades:

Au+Au ~ 1.5 nb^{-1} at 200 GeV
Polarized p at 500 GeV
(start p+A program)

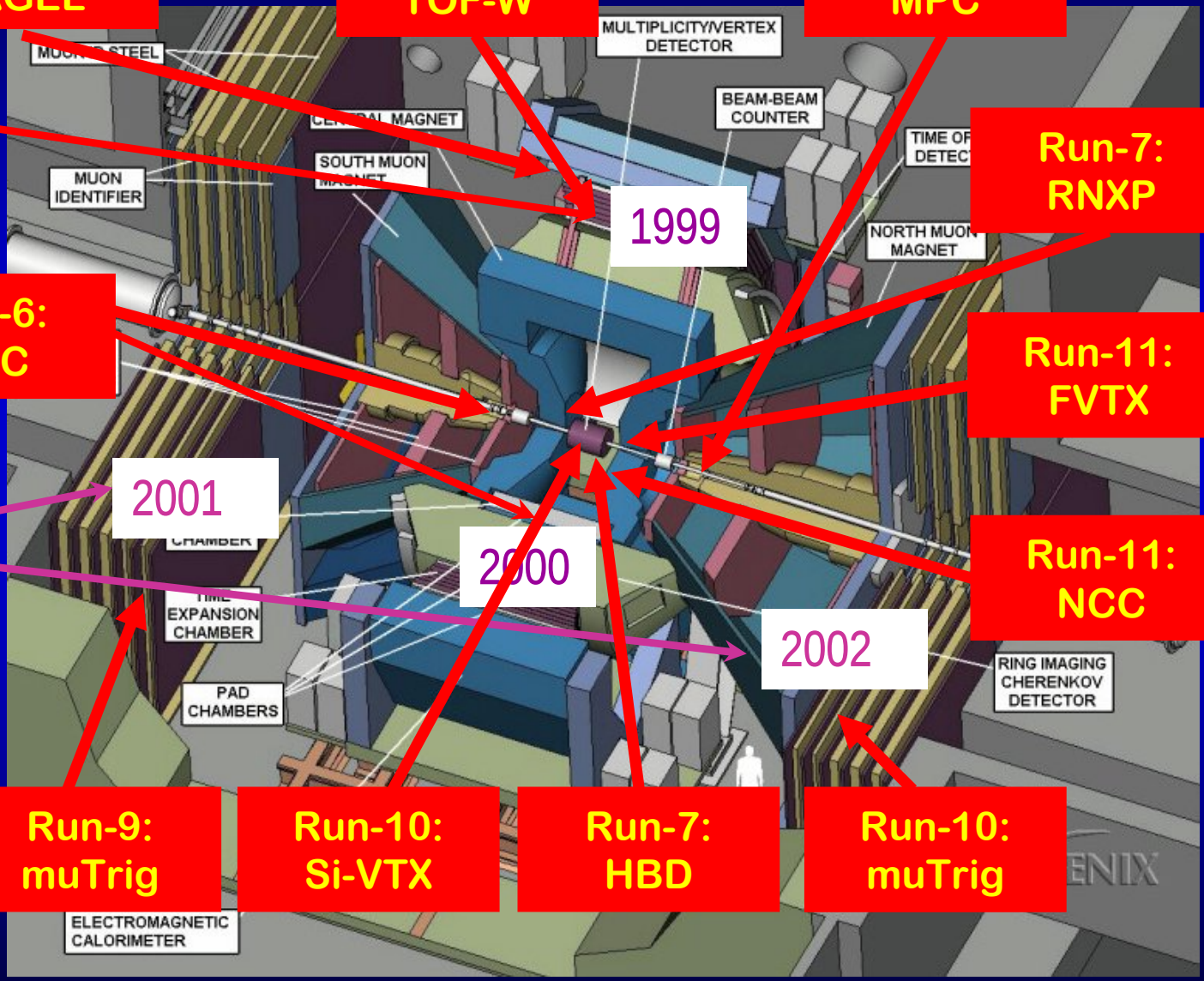
Full utilization of RHIC opportunities:

Studies of QGP with rare probes:
jet tomography, open flavor,
J/ψ, ψ', χc, ϒ(1s), ϒ(2s), ϒ(3s)

Complete spin physics program
p+A physics

Schedule

- 2 central spectrometers
- 2 forward spectrometers
- Forward detectors
  - Triggering
  - Centrality
  - Local polarimetry
  - Luminosity monitoring



A past, present and future tribute to the incredible skills of the PHENIX 1008 Engineering and Technical Staff !

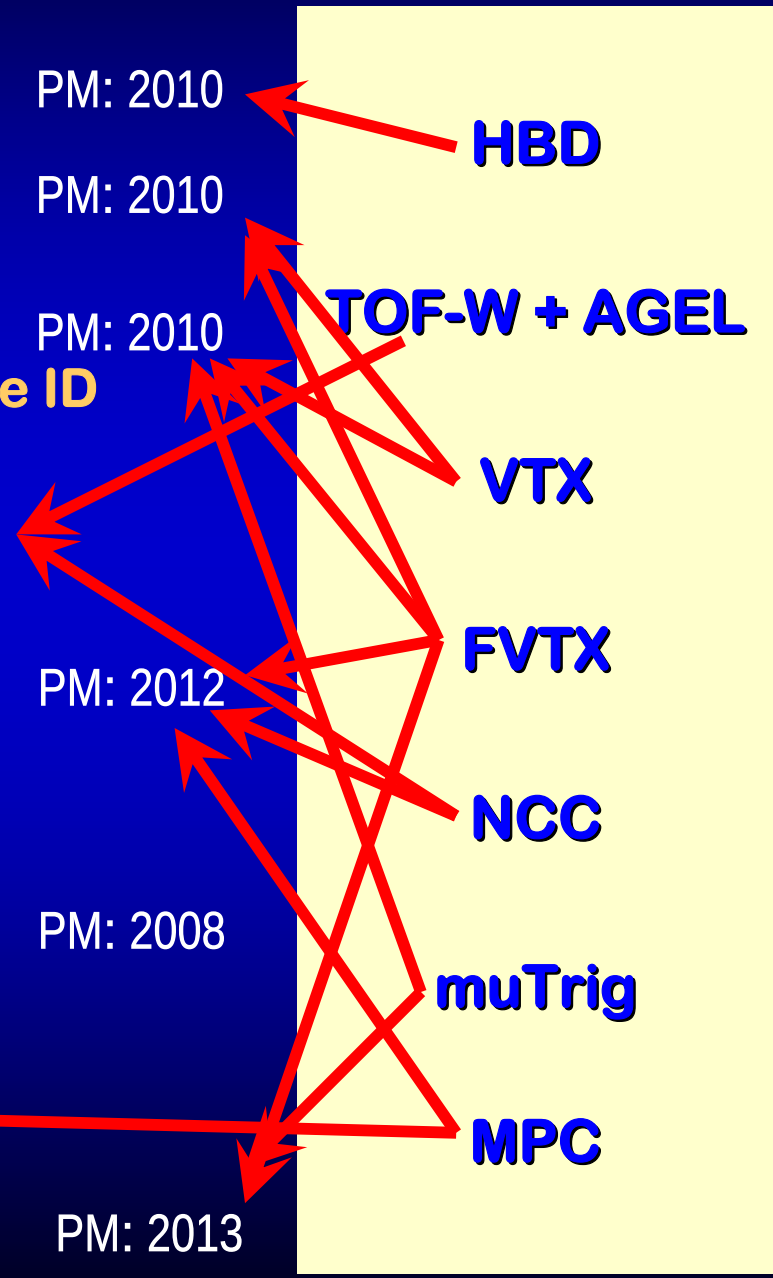
Looking Ahead

- For Run-7 and beyond, various PHENIX upgrades become (or are already) available:
  - Hadron Blind Detector
  - Si-VTX
  - Muon trigger
  - Nose Cone Calorimeter
  - FVTX

- These greatly extend our physics reach, and make re-visiting various canonical systems very attractive
- NSAC guidance:
  "Invest in near-term detector upgrades of the two large experiments, PHENIX and STAR, to take full advantage of the existing accelerator capabilities."

NSAC Performance Measures

- **Heavy Ion:**
  - **e-pair mass spectrum**
    - "Hadron Blind" Dalitz pair rejection — PM: 2010
  - **Open charm measurements in AA**
    - High Resolution vertex detection — PM: 2010
  - **Charmonium Spectroscopy**
    - High luminosity; precision vertex, particle ID — PM: 2010
  - **Jet Tomography**
    - High luminosity; increased acceptance; enhanced particle ID
  - **Gluon shadowing; low-x in d-Au**
    - particle detection at forward rapidity — PM: 2012
- **Spin:**
  - **Complete initial ΔG/G measurement**
    - No upgrades needed — PM: 2008
  - **Transverse spin measurements**
    - Forward particle measurement
  - **W measurements at 500 GeV**
    - Forward tracking/triggering in PHENIX — PM: 2013



*DOE performance milestones set by NSAC

Issues

We Can't Go On Meeting Like This

- Recent PAC dates
  - 05-Nov-05
  - 12-Sep-06
  - (This my 9th presentation to the PAC on behalf of PHENIX)
- My comments on these late dates (and the resulting impasse between the collaborations):
  - Ollie: *"Well, here's another nice mess you've gotten me into."*
  - We have met the enemy, and he is us

A Modest Proposal

- Integrate the PAC meeting with the C-A D retreat
  - Typically held 2-3 weeks after end of run
  - Complete analysis of run performance of all accelerator systems
  - Presentations on data-taking performance and associated interface issues by Run Coordinator from each collaboration
- This would obviously provide maximal
  - Understanding of shutdown issues, schedule affecting both C-A D and collaborations
  - Time for reaction to PAC guidance
- Would further propose more “discussion centered” rather than “presentation centered” approach as appropriate for a retreat

Summary

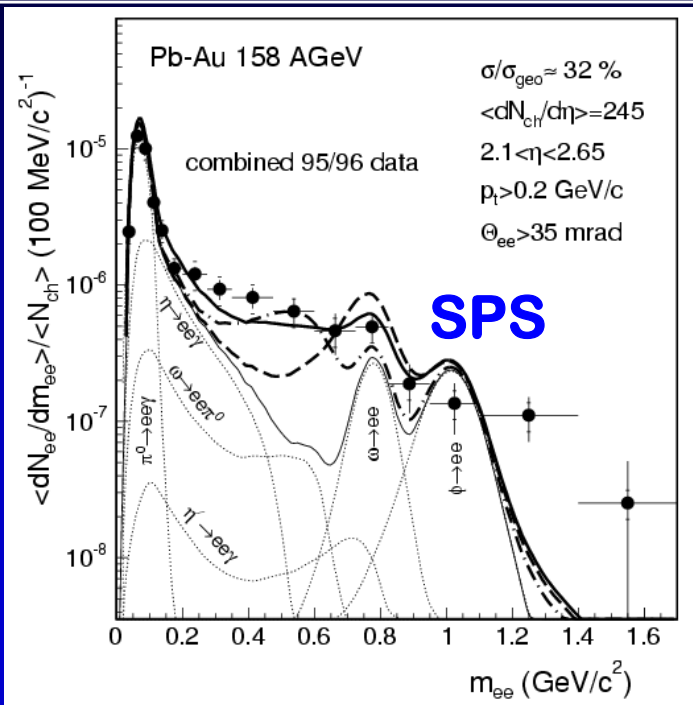
- PHENIX successes in Runs 1-6 have paralleled the (*extraordinary!*) successes of the accelerator
- Ongoing, productive enterprise engaged in timely publication of an extraordinarily broad spectrum of results (Au+Au, p+p, d+Au)
- Proposed upgrades will
  - Open new channels for investigation
  - Extend investigation of rare processes to address fundamental questions in heavy ion physics
  - Extend demonstrated spin physics capabilities to higher p_T and to new channels

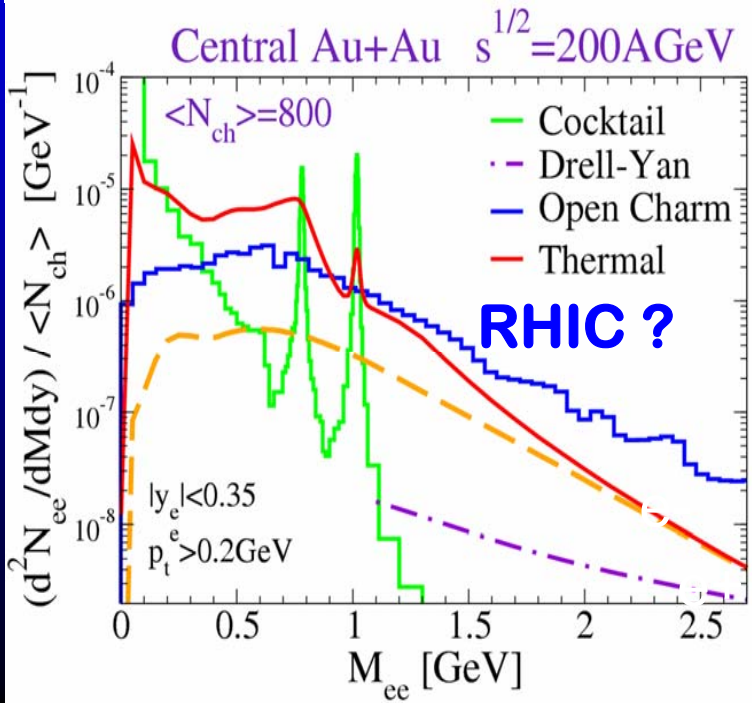
☞ *Plans provide for a program of continued discovery and extended precision for the next decade*

In Closing

- The matter created at RHIC is spectacularly different from that at the SPS
  - Full development of (perfect fluid) hydrodynamic flow
  - Jet quenching
  - Modification of away-side jet shape
- It is essential that we investigate as yet unexplored channels (low-mass pairs, virtual photons) to further characterize this matter
- *While* maintaining steady progress towards understanding the proton spin
- *While* increasing the precision in studies of cold nuclear matter effects

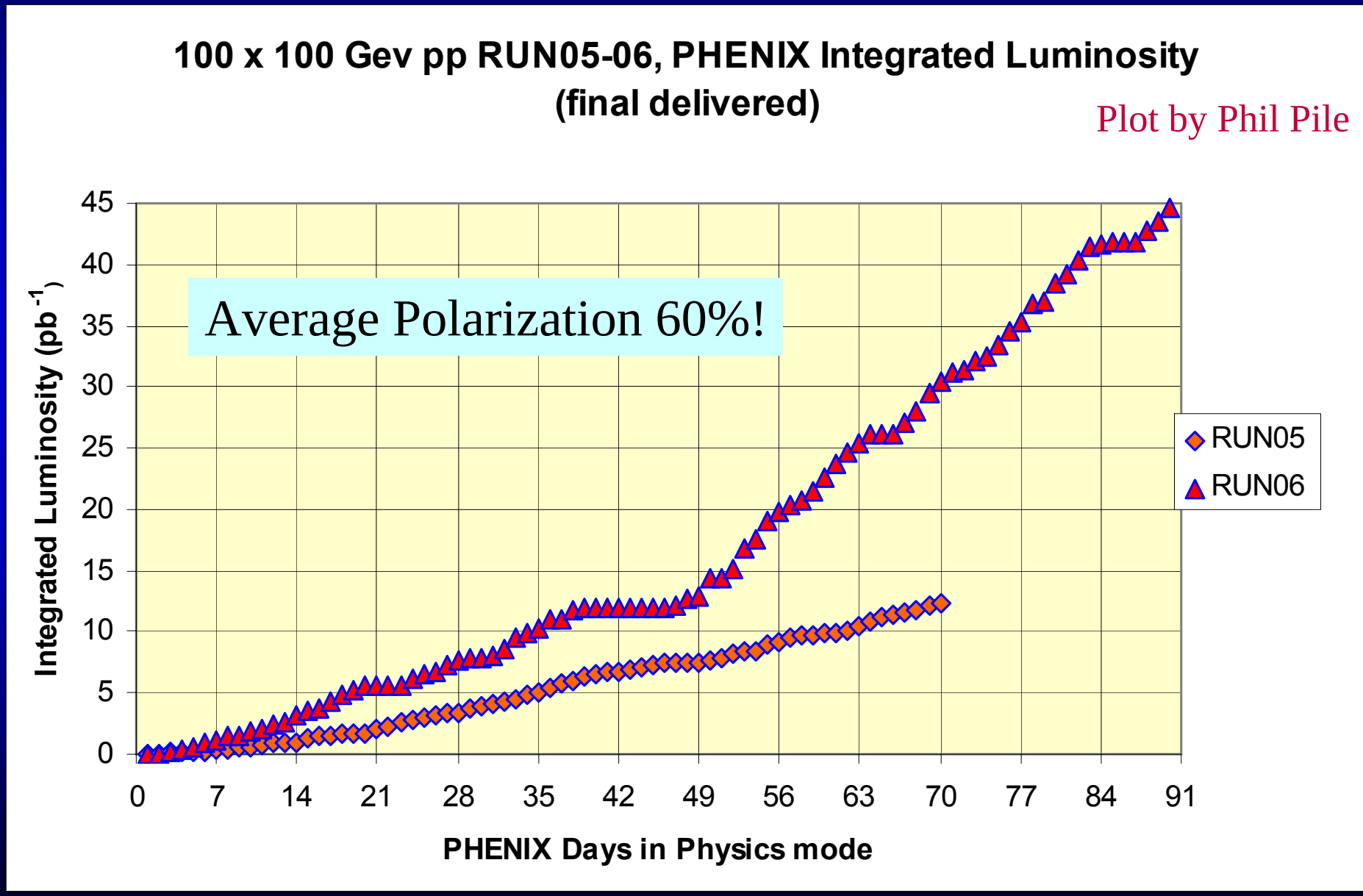
☞ ***The proposed program from PHENIX is a coherent, time-ordered approach towards systematically achieving these goals.***





Back-up

RHIC Luminosity Run-6 vs. Run-5



HBD Commissioning

- Note: All estimates absolute minimum times
- Note again: All estimates absolute minimum times
- Plan:
  - Assume electronics will be available well before run
  - Complete prior to beam
    - noise studies
    - pedestal studies
    - integration into PHENIX DAQ
    - (eventually) also zero suppression
  - Initial set-up:
    - detector timing and HV adjustment of 24 modules for operation at gain of 10^4 Min 2d
    - - detailed calibration at the pad level Min 6d
      - based on the test beam we will need at least 1d data taking with B=0 and forward bias + at least 2 d for data analysis
      - Repeat with Same reversed bias - This should provide a quantitative determination of the figure of merit N_0 as well as the separation between single and double electron hits
  - studies
    - +- field configuration; full, 0.95, 0.90 compensating
    - data taking and analysis Min 4d
- Absolute minimum cumulative time is 2 weeks, could easily be twice this

PHENIX Students (I)

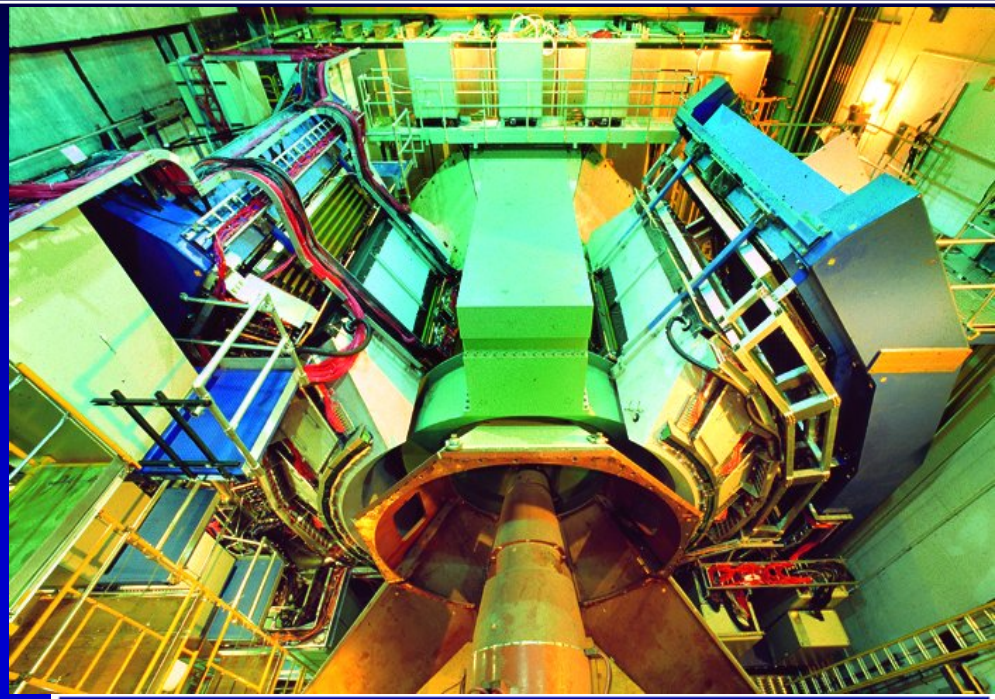
Given Name	Family Name	Thesis Topic	Completion Date	Institution	Adviser	Second Adviser	Other Institution	PWG
Andrew	Adare	Jet Physics in 200 GeV Cu+Cu Collisions		University of Colorado	Nagle			Photon/Hard
Christine	Aidala	Measurement of A_N and A_{LL} through Neutral and Charged Pions	2005	Columbia University	Cole			Spin
Hisham	Albataineh	Measurment of A_N for transverse single-spin from 62.4GeV and 200GeV		New Mexico State University	Papavassiliou	Liu		Spin
Ahmed	Al-Jamel	J/psi production properties from polarized proton-proton collisions at 200 GeV	2004	New Mexico State University	Papavassiliou			Spin
Raul	Armendariz	Run-4 Au-Au		New Mexico State University	Pate			Heavy/Light
Stefan	Bathe	Momentum Fluctuations and Production of Neutral Mesons in Ultra-Relativistic Heavy Ion Collisions	2002	University of Muenster	Santo			Photon/Hard
Robert	Bennett	Longitudinal Double spin asymmetry of Photon Production in Polarized Protons at 200 GeV		SUNY-Stony Brook (Physics)	Deshpande			Spin
Kieran	Boyle	Longitudinal Double Spin Asymmetry of pi0 Production in Polarized Protons at 200 GeV		SUNY-Stony Brook (Physics)	Deshpande			Spin
Henner	Buesching	Azimuthal Photon Correlations in Ultra-relativistic p+A, Pb+Pb and Au+Au Reactions	2002	University of Muenster	Santo			Photon/Hard
Jane	Burward-Hoy	Transverse Momentum Distributions of Hadrons Produced in Au+Au Collisions at 130 GeV Measured by the PHENIX experiment at RHIC BNL	2001	SUNY-Stony Brook (Physics)	Jacak			Global/Hadron
Sergey	Butsyk	Charm production in 200-GeV p+p collisions	2005	SUNY-Stony Brook (Physics)				
Sarah	Campbell	Low mass di-electrons from Cu+Cu Collisions		SUNY-Stony Brook (Physics)	Hemmick			Heavy/Light
Xavier	Camard			SUBATECH				
Mickey	Chiu	Angular Correlations in High p_T Particle Production in Au-Au Collisons at RHIC	2004	Columbia University	Zajc	Nagle	Colorado	Photon/Hard
Christopher	Cleven	Heavy Flavor Production and the Reaction Plane in Heavy Ion Collisions at RHIC		Georgia State University	He			Heavy/Light
Yann	Cobigo	Production de J/Psi dans les collisions proton-proton et deuton-or à 200 GeV dans le centre de masse nucléon-nucléon	2004	Dapnia/Saclay	Gosset			Heavy/Light
Paul	Constantin	Extraction of jet properties from two-particle azimuthal correlations in pp and AuAu collisions at $\sqrt{s_{NN}}$ = 200 GeV	2004	Iowa State University	Lajoie			Photon/Hard
Kushal	Das	J/Psi Production Measured via e+e- decays in Au-Au Collisions at RHIC		Florida State University	Frawley			Heavy/Light
Cesar Luiz	da Silva	Study of Vector Mesons with the PHENIX Detector		University of Sao Paulo	Dietzsch	Rosati	Iowa State	Heavy/Light
Torsten	Dahms	Measurement of Photons via Conversion Pairs with the PHENIX Experiment at RHIC	2005	SUNY-Stony Brook (Physics)	Drees			(Master's Thesis)
Alan	Dion	Heavy Flavor Production (via e-mu?)		SUNY-Stony Brook (Physics)	Averbeck			Heavy/Light
Lesley	D'Orazio			University of Maryland	Mignery			
Rickard	du Rietz	Deuteron and anti-deuteron production in $\sqrt{s_{NN}}$=200 GeV AuAu Collisions at RHIC	2002	Lund University	Gustafsson			Heavy/Light
Karim	El Chenawi	A High Resolution Tracking System for High Energy Heavy-Ion Experiments	1998	Lund University	Gustafsson			(Master's Thesis)
Jamil	Egdemir	Nuclear Modification Factor in Semi-leptonic Heavy Flavor decays in 200 GeV Au+Au Collisions		SUNY-Stony Brook (Physics)	Averbeck			Heavy/Light
Tatia	Engelmore			Columbia University	Cole			Photon/Hard
Akitomo	Enokizono	Space-time evolution of hot and dense matter probed by Bose-Einstein correlation in Au+Au collisions at $\sqrt{s_{NN}}$ = 200 GeV	2004	Hiroshima University	Sugitate			Global/Hadron
Tahsina	Ferdousi	Measurement of Charged Particle Multiplicity with the Multiplicity and Vertex Detector at the PHENIX Detector at RHIC	2002	UC-Riverside	Seto			(Master's Thesis)
Justin	Frantz	Direct Photon Shine: Direct Photon and π^0 Production in $\sqrt{s_{NN}}$ = 200 GeV Au-Au Collisions	2004	Columbia University	Cole	Nagle	Colorado	Photon/Hard
Yoshi	Fukao	Double spin asymmetry in pi0 production in p+p collisions		Kyoto University	Saito			Spin
Sebastien	Gadrat	Etude de la production de charme ouvert et de Drell-Yan dans les collisions p+p avec PHENIX à RHIC	2005	Clermont-Ferrand	Roche			Heavy/Light
Irakli	Garishvili	Open Charm in Cu+Cu at 200 GeV		University of Tennessee	Read	Sorensen		Heavy/Light
Andrew	Glenn	Single Muon Production and Implications for Charm in √sNN = 200 GeV Au+Au Collisions	2005	University of Tennessee	Sorensen	Read		
Nathan	Grau	Jet correlations from p+p, d+Au and Au+Au collisions	2005	Iowa State University	Ogilvie			Photon/Hard
Taku	Gunji	J/psi -> e+e- measurements in Au-Au Collisions at RHIC-PHENIX		CNS-Tokyo	Hamagaki			Heavy/Light
Takashi	Hachiya			Hiroshima University	Sugitate			
Ahmed	Hadj Henni	Direct Photons in p+p Collisions at 200 GeV		SUBATECH	Delagrange			Photon/Hard
Ali	Hanks			Columbia University	Cole			Photon/Hard
Eva	Haslum	Event-by-event fluctuations in relativistic heavy-ion collisions		Lund University	Gustafsson	Oskarsson		Global/Hadron
Robert	Hobbs	Measuring the Partonic Orbital Angular Momentum in the Proton from Two Particle Azimuthal Correlations at PHENIX in Run3pp	2006	University of New Mexico	Fields			Spin
Wolf	Holzmann		2006	SUNY-Stony Brook (Chemistry)	Lacey			Photon/Hard
Andrew	Hoover	The PHENIX Muon Spectrometer and J/psi Production in √s=200 GeV proton-proton collisions at RHIC	2003	New Mexico State University	Pate			Heavy/Light
Takuma	Horaguchi	Direct photon production in polarized proton-proton collisions at PHENIX		Tokyo Institute of Technology	Shibata			Spin
Donald	Hornback	Open Charm in p+p Collisions at 200 GeV		University of Tennessee	Read	Sorensen		Heavy/Light
TadaAki	Isobe	Direct Photon and pi0 Production in 200 GeV Au+Au Collisions		CNS-Tokyo	Hamagaki			Photon/Hard
Michael	Issah			SUNY-Stony Brook (Chemistry)	Lacey			Photon/Hard
Wooyoung	Jang			University of Korea				
Jiangyong	Jia	High-pT Charged Hadron Suppression in Au-Au Collisions at $\sqrt{s_{NN}}$ = 200 GeV	2003	SUNY-Stony Brook (Physics)	Drees			Photon/Hard
Jiamin	Jin	Direct photon Jet Physics in 200GeV/c Au+Au Collisions		Columbia University	Cole			Photon/Hard
Soichiro	Kametani	Measurement of J/Psi Production in the e+e- Channel in d+Au collisions at $\sqrt{s_{NN}}$ = 200GeV		CNS-Tokyo	Hamagaki			Heavy/Light
Nobuyuki	Kamihara	J/Psi formation and decay in polarized proton-proton collisions at PHENIX		Tokyo Institute of Technology	Shibata			Spin

PHENIX Students (II)

Given Name	Family Name	Thesis Topic	Completion Date	Institution	Adviser	Second Adviser	Other Institution	PWG
Young Gook	Kim	PHENIX Event Characterization Using Charged Particle Multiplicities measured with the MVD		Yonsei University	Kang			Global/Hadron
Dong Jo	Kim	J/Ψ Production in d+Au and p+p Collisions as √s=200 GeV	2004	Yonsei University	Kang			Heavy/Light
Akio	Kiyomichi	Study of Identified Hadron Spectra and Yields at Mid-rapidity in $\sqrt{s_{NN}}$ = 200 GeV Au+Au Collisions	2005	University of Tsukuba	Miake			Global/Hadron
Christian	Klein-Bösing	Production of Neutral Pions and Direct Photons in Ultra-Relativistic Au+Au Collisions	2005	University of Muenster	Santo			Photon/Hard
Ryota	Kohara	J/psi Suppression Mechanism		Hiroshima University	Sugitate			Heavy/Light
Dmitri	Kotchetgov	Study of chiral symmetry restoration in relativistic heavy-ion collisions at RHIC		UC-Riverside	Seto			
Alexander	Kozlov	(Electron Pairs)		Weizmann Institute	Tserruya			Heavy/Light
MinJung	Kweon	J/Psi Production in Au+Au Collision at RHIC	2005	Korea University	Hong			Heavy/Light
Yue Shi	Lai			Columbia University	Cole			Photon/Hard
KwangBok	Lee			Korea University	Hong			Heavy/Light
Hiroshi	Masui	Elliptic Flow of Identified Hadrons in Au+Au and Cu+Cu Collisions at RHIC		University of Tsukuba	Miake	Esumi		Global/Hadron
Felice	Matathias	Identified Particle Production in p+p and d+Au Collisions at RHIC Energies	2004	SUNY-Stony Brook (Physics)	Hemmick			
Takashi	Matsumoto	Measurements of production cross section of J/psi in $\sqrt{s_{NN}}$ = 200 GeV Au+Au reactions at RHIC		CNS-Tokyo	Hamagaki			Heavy/Light
Alexander	Milov	Particle production in heavy ion collisions at RHIC energies	2002	Weizmann Institute	Tserruya			Global/Hadron
Astrid	Morreale	Measurement of Longitudinal Double Spin Asymmetry through Charged Pions		UC-Riverside	Barish			Spin
Mohammed	Muniruzzman	> Asymmetry through Charged Pions	2003	UC-Riverside	Seto			Heavy/Light
Tomoaki	Nakamura			Hiroshima University	Sugitate			
Jason	Newby	J/Psi Production in Heavy Ions at RHIC using PHENIX muon arms	2003	University of Tennessee	Sorensen	Read		Heavy/Light
Paul	Nilsson	Experimental studies of particle production in ultra-relativistic heavy ion collisions	2001	Lund University	Oskarsson	Gustafsson		Global/Hadron
Susumu	Oda	Measurement of Vector Mesons in the e+e- Channel in Cu+Cu Collisions		CNS-Tokyo	Hamagaki			Heavy/Light
Ken	Oyama	Pizero production in Au+Au Collisions at $\sqrt{s_{NN}}$ = 130 GeV	2002	CNS-Tokyo	Hamagaki			Photon/Hard
WooJin	Park	Open Charm Production in Au-Au Collisions at RHIC		University of Korea	Hong			Heavy/Light
Hua	Pei			Iowa State University	Ogilvie			Photon/Hard
Hai	Qu	Quarkonium Polarization Measurement at RHIC		Georgia State University	He			Heavy/Light
Anuj	Purwar	Study of Initial and Final State Effects in Ultrarelativistic Heavy Ion Collisions Using Hadronic Probes	2004	SUNY-Stony Brook (Physics)	Hemmick			Global/Hadron
Andry	Rakotozafindrabe	J/Ψ Production in Cu+Cu Collisions		Laboratoire **L**eprince-**R**inguet	Fleuret			Heavy/Light
Yuriy	Riabov	Measurement of the spectral shape of light mesons produced in relativistic ion collisions through hadron decay modes		PNPI	Samsonov	Milov	SUNY-Stony Brook (Physics)	Heavy/Light
Eric	Richardson			University of Maryland	Mignery			
Sarah	Rosendahl	Resonance studies in Heavy Ion collisions at RHIC		Lund University	Nystrand	Stenlund		Global/Hadron
Sang Su	Ryu	Fluctuations in the Charged Particle Multiplicity Distributions		Yonsei University	Kang			Heavy/Light
Shingo	Sakai	Azimuthal anisotropy of heavy flavor electrons in Au+Au collisions at 200 GeV		University of Tsukuba	Miake	Esumi		Heavy/Light
Hiroki	Sato	J/psi Production in p+p Collisions at sqrt(s) = 200 GeV	2003	Kyoto University	Imai			Heavy/Light
Baldo	Sahlmueller	Spectra of pi0's, eta's and direct photons in 200 GeV Au+Au Collisions		University of Muenster	Wessels			Photon/Hard
Joeseph	Seele	Cross section and A_{LL} for η production in polarized p+p collisions at 200 GeV		University of Colorado	Kinney	Nagle		Spin
Anne	Sickles	Azimuthal Correlation and Conditional Yield Measurements in √sNN=200GeV in Au+Au, d+Au and p+p Collisions at RHIC	2005	SUNY-Stony Brook (Physics)	Jacak			Photon/Hard
David	Silvermyr	Aspects of Hadron Production in High-Energy Heavy-Ion Collisions	2001	Lund University	Stenlund	Gustafsson		Global/Hadron
Catherine	Silvestre	J/Psi Production in Au+Au Collision at RHIC		Saclay (CEA)	Pereira	Gonin		Heavy/Light
Steven	Skutnik	A scalable analytic model for single event upsets in radiation-hardened field programmable gate arrays in the PHENIX interaction region	2005	Iowa State University	Lajoie			(Master's Thesis)
Mikhail	Stepanov	Charm production in 200-GeV polarized p-p collisions		New Mexico State University	Papavassiliou			Spin
Peter	Tarjan			Debrecen University	David			Photon/Hard
Manabu	Togawa	Single Transverse-spin asymmetry in forward neutron production in p+p collisions at 200 GeV and 410 GeV		Kyoto University	Saito			Spin
Hisayuki	Torii	Midrapidity Neutral-Pion Production in Proton-Proton Collisions at √s = 200GeV	2003	Kyoto University	Imai			Photon/Hard
Vi-Nham	Tram	Etude de la production du J/psi dans les collisions or-or à 200 GeV par paire de nucléons dans l'expérience PHENIX	2006	Laboratoire **L**eprince-**R**inguet	Drapier	Fleuret		Heavy/Light
Yuji	Tsuchimoto			Hiroshima University	Sugitate	Homma		
Thomas	Svensson	Tracking Chambers with 2-Dimensional Readout for the PHENIX Experiment at RHIC	1999	Lund University	Oskarsson	Stenlund		
Henrik	Tydesjo	Net charge fluctuations in AuAu collisions at RHIC	2004	Lund University	Oskarsson			Global/Hadron
Eric	Vazquez			Columbia University	Cole			Photon/Hard
Matthew	Wysocki	Quarkonia in Au+Au and Cu+Cu Collisions at 200 GeV		University of Colorado	Nagle			Heavy/Light
Oliver	Zaudtke	Pi0- and direct photon spectra from 200 GeV Au-Au and pp-data		University of Muenster	Wessels	Reygers		Photon/Hard
Chun	Zhang	Nuclear Modification Factor for Hadrons at Forward and Backward Rapidities in Deuteron+Gold Collisions at √sNN = 200 GeV	2004	Columbia University	Zajc	Nagle	Colorado	Heavy/Light
Xiaopeng	Zong			Iowa State University	Rosati			Heavy/Light

The PHENIX Detector

- Detector Redundancy
- Fine Granularity, Mass Resolution
- High Data Rate
- Good Particle ID
- Limited Acceptance



Charged Particle Tracking:

- Drift Chamber
- Pad Chamber
- Time Expansion Chamber/TRD
- Cathode Strip Chambers(Mu Tracking)

Particle ID:

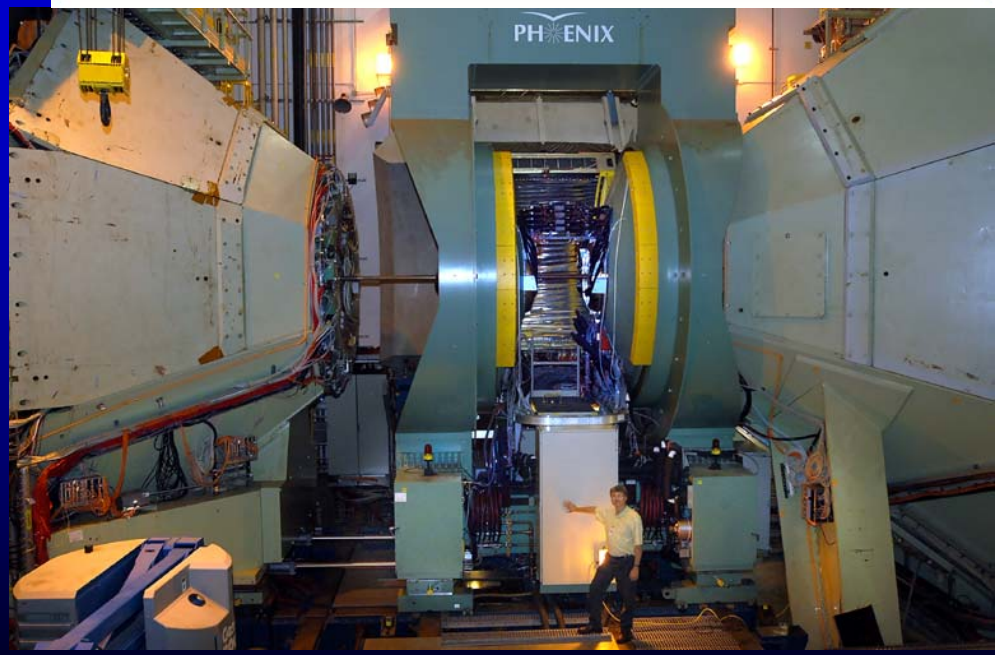
- Time of Flight
- Ring Imaging Cerenkov Counter
- TEC/TRD
- Muon ID (PDT's)
- Aerogel Cerenkov Counter

Calorimetry:

- Pb Scintillator
- Pb Glass

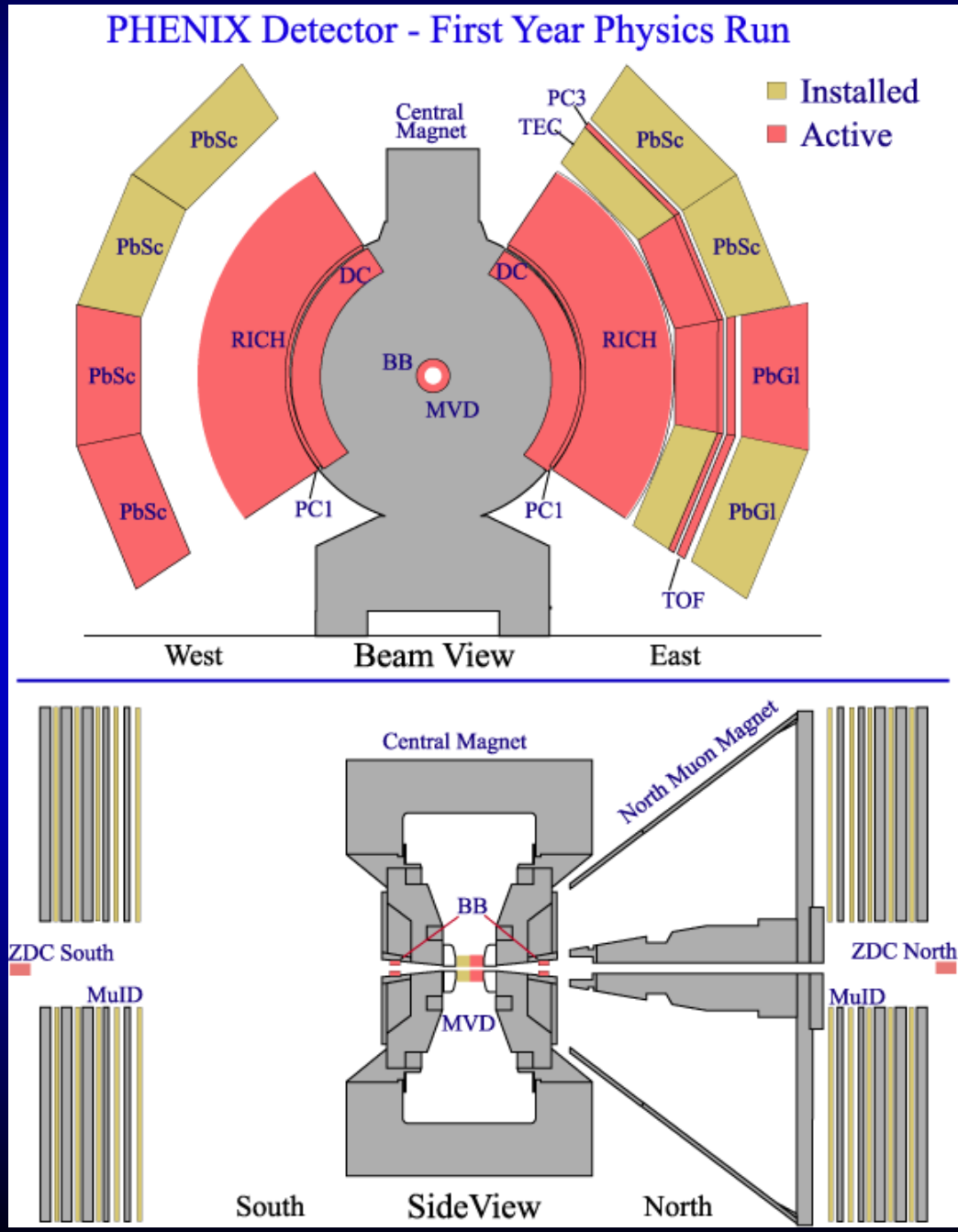
Event Characterization:

- Multiplicity Vertex Detector (Si Strip,Pad)
- Beam-Beam Counter
- Zero Degree Calorimeter/Shower Max Detector
- Forward Calorimeter



Run-1 Configuration

- Two central arms
  - Mechanically ~complete
  - Roughly half of aperture instrumented
- Global detectors
  - Zero-degree Calorimeters (ZDCs)
  - Beam-Beam Counters (BBCs)
  - Multiplicity and Vertex Detector (MVD, engineering run)

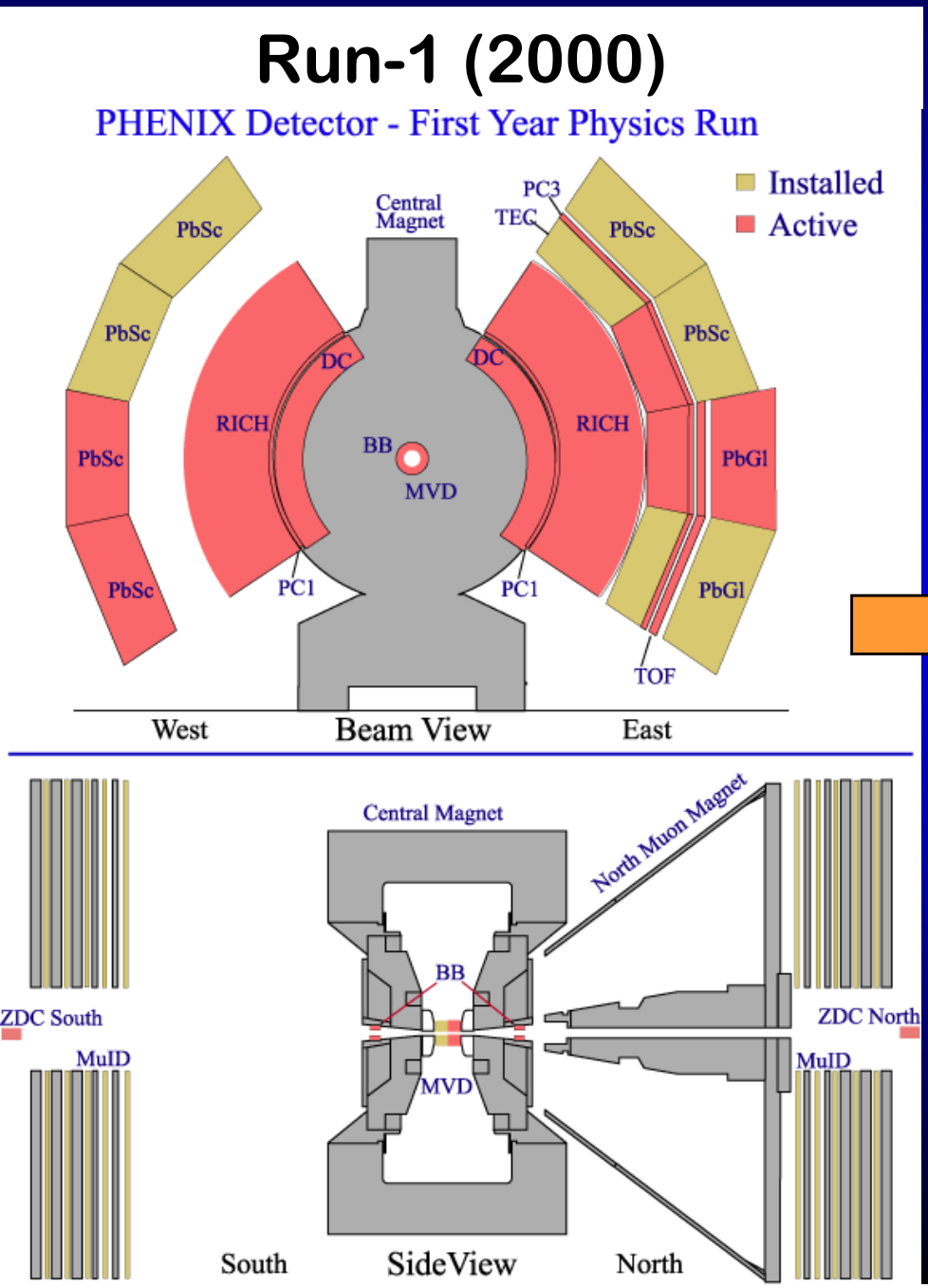


Run-1 Publications

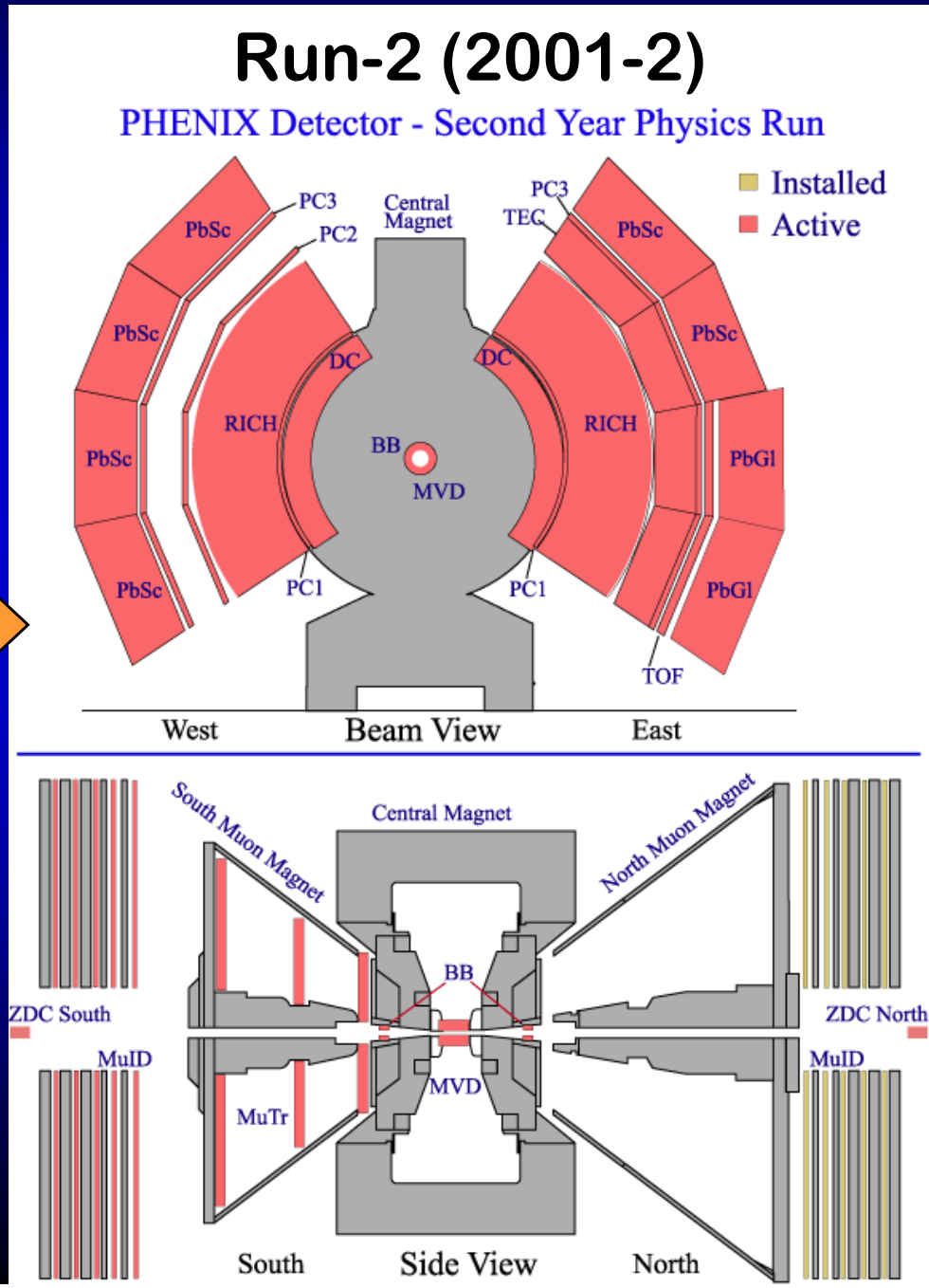
- "Centrality dependence of charged particle multiplicity in Au-Au collisions at $\sqrt{s_{NN}}$ = 130 GeV", PRL 86 (2001) 3500
- "Measurement of the midrapidity transverse energy distribution from $\sqrt{s_{NN}}$ = 130 GeV Au-Au collisions at RHIC", PRL 87 (2001) 052301
- "Suppression of hadrons with large transverse momentum in central Au-Au collisions at $\sqrt{s_{NN}}$ = 130 GeV", PRL 88, 022301 (2002).
- "Centrality dependence of $\pi^{+/-}$, $K^{+/-}$, p and pbar production at RHIC," PRL 88, 242301 (2002).
- "Transverse mass dependence of the two-pion correlation for Au+Au collisions at $\sqrt{s_{NN}}$ = 130 GeV", PRL 88, 192302 (2002)
- "Measurement of single electrons and implications for charm production in Au+Au collisions at $\sqrt{s_{NN}}$ = 130 GeV", PRL 88, 192303 (2002)
- "Net Charge Fluctuations in Au+Au Interactions at $\sqrt{s_{NN}}$ = 130 GeV," PRL. 89, 082301 (2002)
- "Event-by event fluctuations in Mean p_T and mean e_T in sqrt(s_NN) = 130GeV Au+Au Collisions" Phys. Rev. C66, 024901 (2002)
- "Flow Measurements via Two-particle Azimuthal Correlations in Au + Au Collisions at $\sqrt{s_{NN}}$ = 130 GeV" , PRL 89, 212301 (2002)
- "Measurement of the lambda and lambda^bar particles in Au+Au Collisions at $\sqrt{s_{NN}}$ =130 GeV", PRL 89, 092302 (2002)
- "Centrality Dependence of the High pT Charged Hadron Suppression in Au+Au collisions at $\sqrt{s_{NN}}$ = 130 GeV", Phys. Lett. B561, 82 (2003)
- "Single Identified Hadron Spectra from $\sqrt{s_{NN}}$ = 130 GeV Au+Au Collisions", to appear in Physical Review C, nucl-ex/0307010

From Run-1 to Run-2

Run-1 (2000)



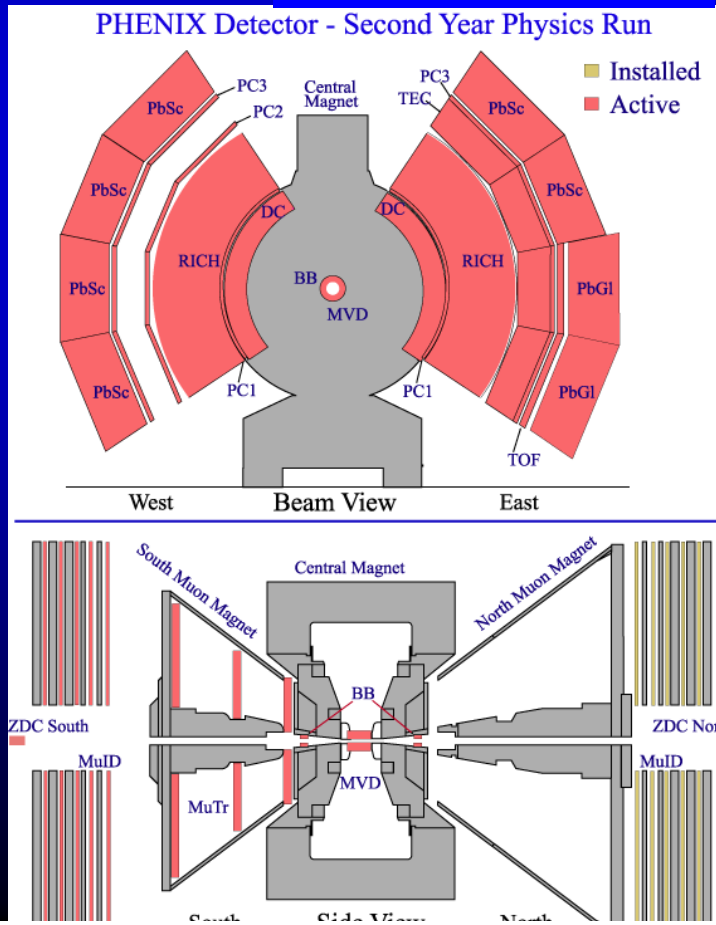
Run-2 (2001-2)



Work in 2001 Shutdown

- Construction, installation and commissioning of South Muon Spectrometer
- Install and commission PC2, PC3 in West carriage
- Install and commission 5 sectors EMCal electronics
- Install and commission 2 sectors TEC electronics
- Commissioning and operation of MVD (Silicon Vertex)
- Commissioning and operation of PHENIX Event Builder
- Commissioning and operation of PHENIX Level2 Trigger
- Completion of RICH electronics
- Major servicing of Drift Chamber East

Run-2 PHENIX



Run-2 Publications

- "Suppressed π^0 Production at Large Transverse Momentum in Central Au+Au Collisions at $\sqrt{s_{NN}}$ = 200 GeV" , Phys. Rev. Lett. 91, 072301 (2003)
- "Scaling Properties of Proton and Anti-proton Production in $\sqrt{s_{NN}}$ = 200 GeV Au+Au Collisions“, Phys. Rev. Lett 91, 172301 (2003).
- "J/Ψ Production in Au-Au Collisions at $\sqrt{s_{NN}}$ =200 GeV at the Relativistic Heavy Ion Collider", Phys. Rev. C 69, 014901 (2004).
- "Elliptic Flow of Identified Hadrons in Au+Au Collisions at $\sqrt{s_{NN}}$ = 200 GeV" , Phys.Rev.Lett. 91 (2003) 182301
- "Midrapidity Neutral Pion Production in Proton-Proton Collisions at $\sqrt{s}$ = 200 GeV“, Phys. Rev. Lett. 91, 241803 (2003)
- "Identified Charged Particle Spectra and Yields in Au-Au Collisions at $\sqrt{s_{NN}}$= 200 GeV", Phys. Rev. C 69, 034909 (2004)
- "J/Ψ production from proton-proton collisions at $\sqrt{s}$ = 200 GeV“, Phys. Rev. Lett. 92, 051802 (2004)
- "High-pt Charged Hadron Suppression in Au+Au Collisions at $\sqrt{s_{NN}}$ = 200 Gev”, Phys. Rev. C 69, 034910 (2004)
- "Measurement of Non-Random Event-by-Event Average Transverse Momentum Fluctuations in $\sqrt{s_{NN}}$ =200 GeV Au+Au Collisions" , S.S. Adler et al., Phys. Rev. Lett. 93, 092301 (2004),
- "Bose-Einstein Correlations of Charged Pion Pairs in Au+Au Collisions at $\sqrt{s_{NN}}$ =200 GeV" to appear in PRL, nucl-ex/0401003
- "Deuteron and anti-deuteron production in Au+Au collisions at \sqrt{s} = 200 GeV" , submitted to PRL June 1, 2004, Preprint: nucl-ex/0406004
- "Identified Leading Particle Correlations in Au+Au and d+Au collisions at $\sqrt{s_{NN}}$ =200 GeV" , submitted to PRL Aug. 7, 2004, nucl-ex/0408007

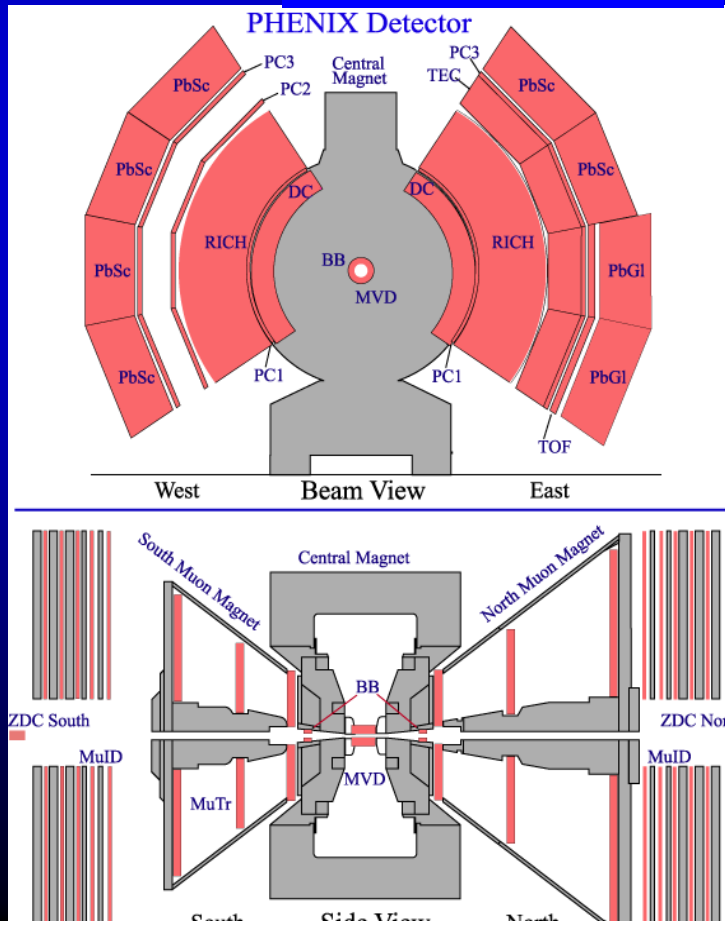
Also contains Run-3 d+Au data

Work in 2002 Shutdown

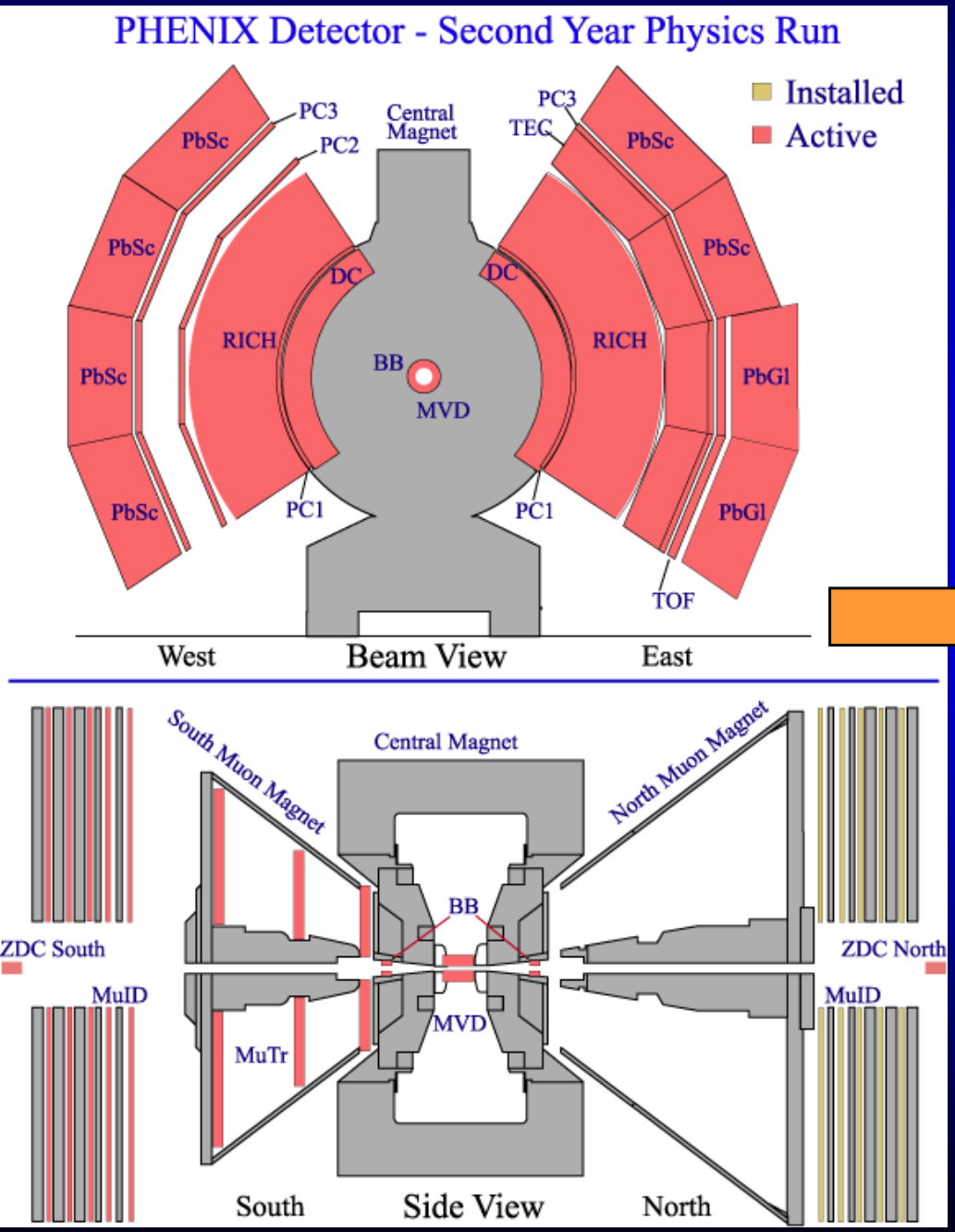
- MuTrk South Spectrometer removal, service and reinstallation
- MuTrk North Spectrometer prep, installation & commissioning
- MuID shielding installation in MuID cutout N&S
- Installation of TRD radiator packs in Time Expansion Chamber
- Install Central Magnet inner coils
- Replace temporary access scaffold with permanent access system
- Modify Central Magnet nosecones
- Install new BBC rack. Move electronics and recable
- Addition of Two Forward Calorimeter for d-A running
- Upgrade to PHENIX safety systems
- Installation of all electronics for Muon North spectrometer arm muTracking + MuID
- Installation of 2 additional planes of electronics for Time Expansion Chamber
- Upgrades to LVL1 Trigger system (NTC, ZDC, EMCal/RICH, MuID)

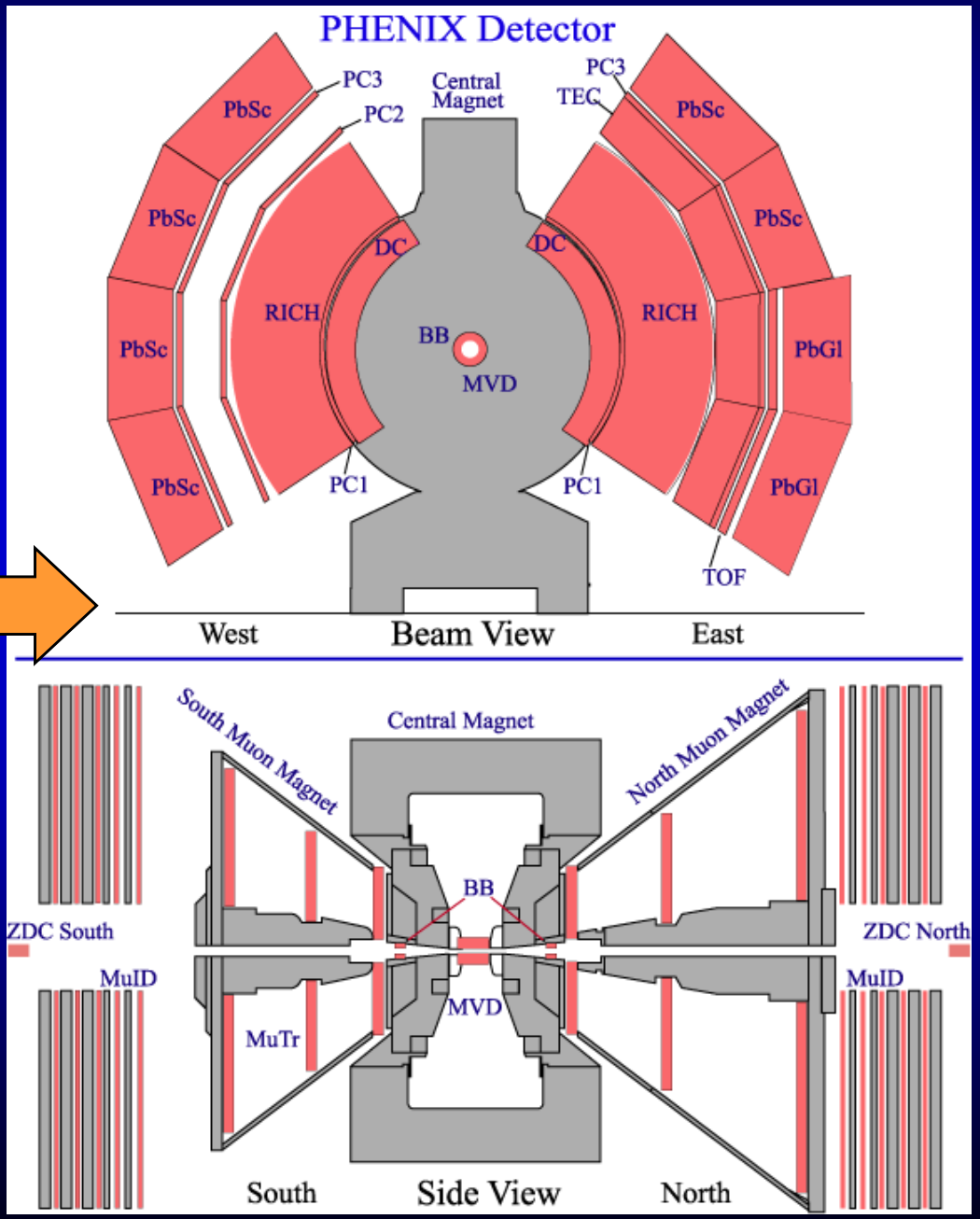
PHENIX baseline detector was declared COMPLETE at the beginning of Run-3

Run-3 PHENIX



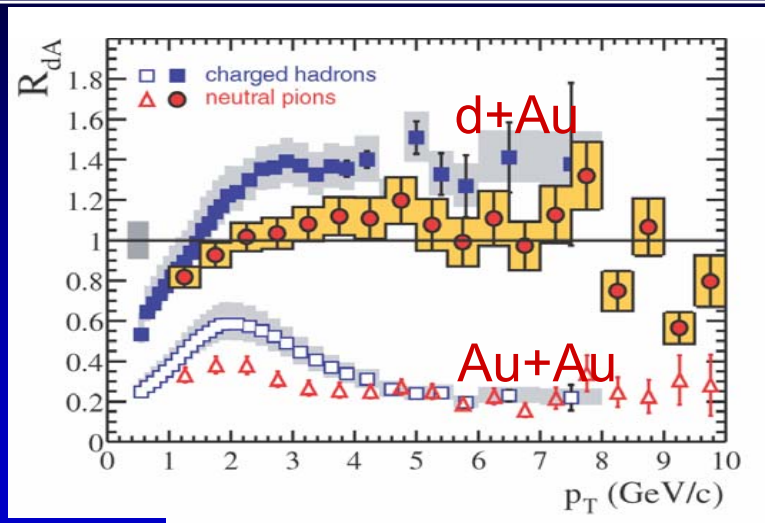
Run-3 and Beyond



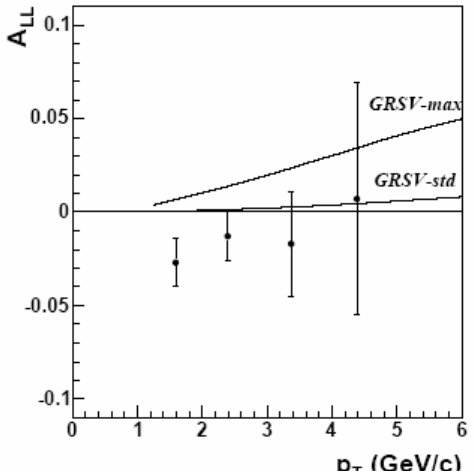


Run-3 Publications

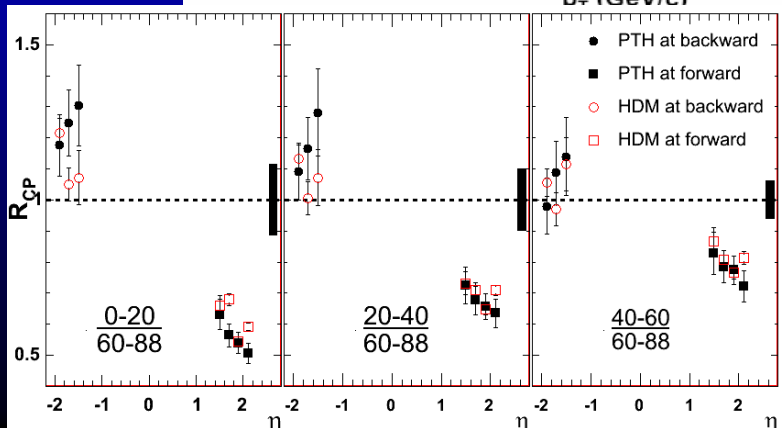
- "Absence of Suppression in Particle Production at Large Transverse Momentum in $\sqrt{s_{NN}}$ = 200 GeV d+Au Collisions",
  PRL 91, 072303 (2003)
  - ☞ PID-ed particles (π^0's) out to the highest p_T's PHENIX's unique contribution to June '03 "press event"



- "Double Helicity Asymmetry in Inclusive Mid-Rapidity neutral pion Production for Polarized p+p Collisions at sqrt(s)=200 GeV "
  Phys. Rev. Lett. 93, 202002 (2004)
  - ☞ First measurement of A_{LL} at RHIC.



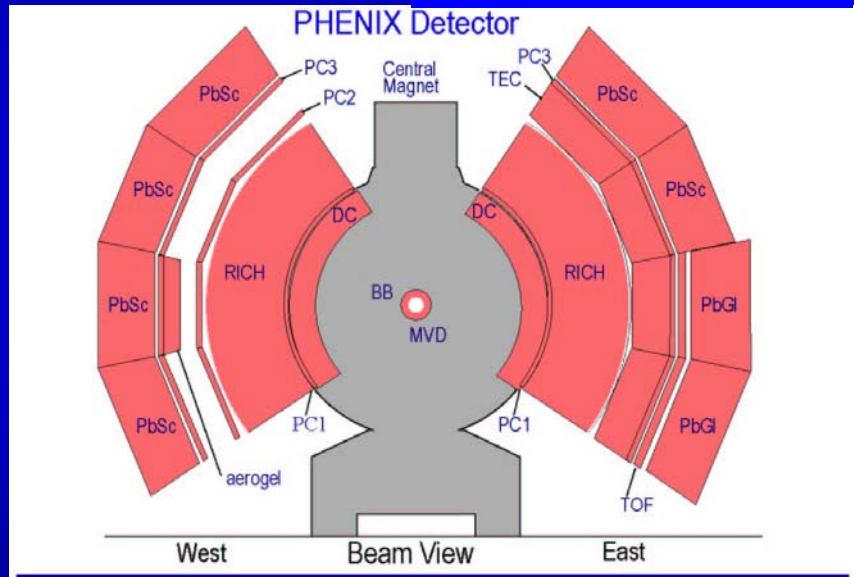
- "Nuclear Modification Factors for Hadrons At Forward and Backward Rapidities in Deuteron-Gold Collisions at √sNN = 200 GeV"
  Phys. Rev. Lett. 94, 082302
  - ☞ Clever extension of PHENIX hadron capabilities to the muon arms

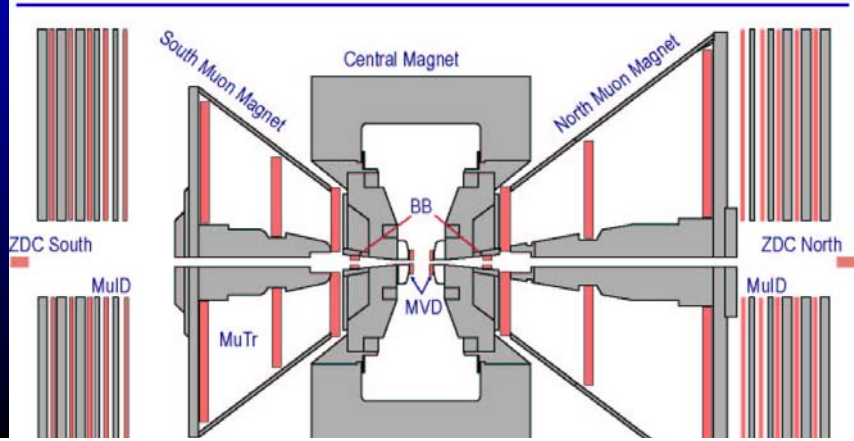


Work in 2003 Shutdown

- Reinstall Photon Shields
- Muon N&S Servicing
- Complete and commission TRD Xenon system
- West Carriage platforms for Aerogel
- Installation of Aerogel ½ sector
- Complete Inner Coil buswork
- Magnet mapping with Inner Coil
- New MuTracking Gas System
- New IR air conditioning
- Improve IR Rack cooling water
- Improve shielding in the tunnel for Muon Arms
- General Detector Maintenance
- Electronics Maintenance
- Improve TEC LV situation
- Replace Drift Chamber East dc/dc converters
- Fab MuID N LL1 boards
- Finish configuration of gigabit Ethernet EvB switch
- More LVL2 code development
- Fix Pad Chamber Multi-event buffering
- Change Databases (Objy to PostgreSQL)
- Complete installation of TEC/TRD electronics
- Complete ERT/MuID S LL1
- Fab Smart Partitioner Modules for MuTracking

Run-4 PHENIX





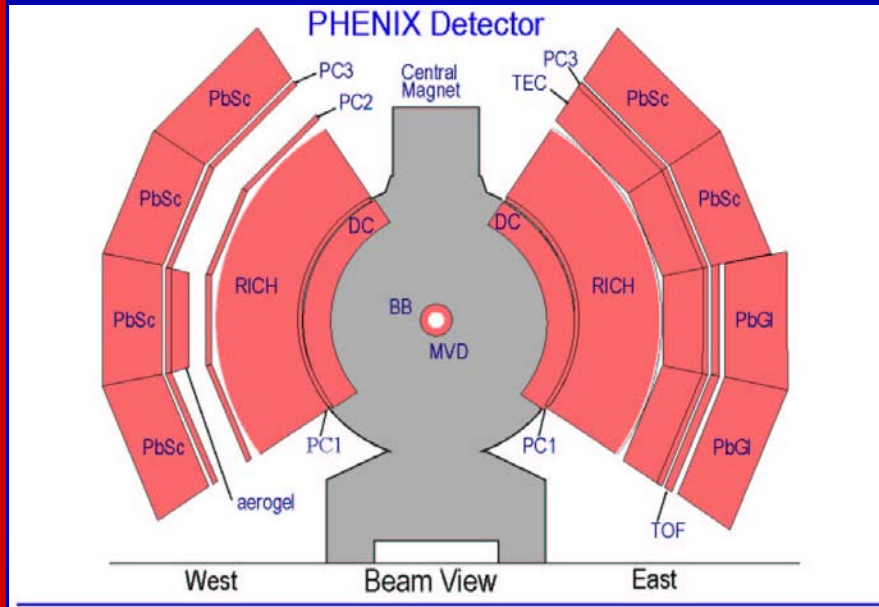
Work in 2004 Shutdown

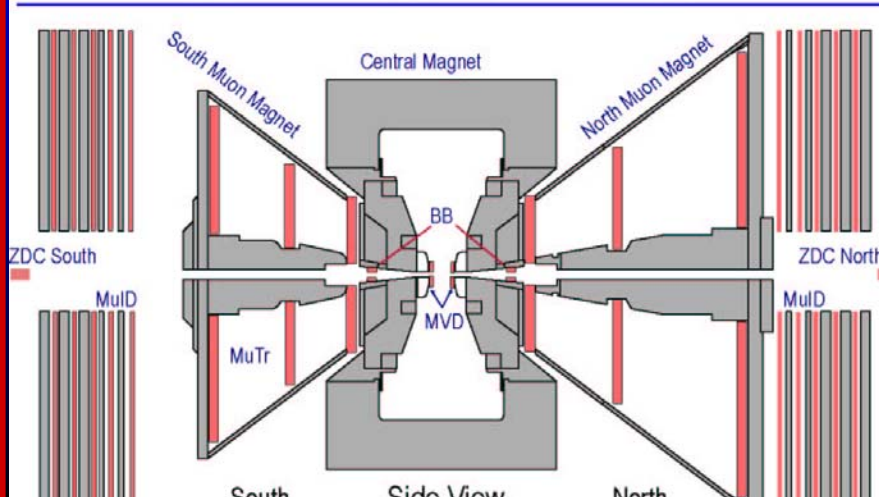
- General maintenance on PHENIX subsystems
- 2nd ½ of Aerogel Sector completed and installed
- Drift Chamber E Window repair
- DC W dc-dc converter replacement
- Magnet mapping
- Lots of Gas system work
- Extra Tunnel Shielding for Muon Arms
- Fix Multi-event buffering (MuTracker, EMCal)
- Improve FEM Data Formatting (MuTracking, EMCal)
- LL1 trigger work (MuID, ERT)
- EvB improvements (convert to LINUX)
- Implement 4X data buffering capability in 1008 (32 TB)
- TOF-W prototype installed in West Arm
- New Scalers for pp running

Built, install Summer 05

Work in 2005 Shutdown

- New Aerogel ½-sector completed and installed
- Multi-event buffering for MuTracking, EMCal implemented
- Event Builder converted to Linux , plus other improvements.
- With DAQ & EvB improvements expect 5+ kHz event recording rate (Data rate max 1 GB/s uncompressed).
- 32 TB additional buffering capacity in 1008.
  - Increase bufferboxes from 4 to 6
- New maps of the magnetic field
- Tests of TOF-West prototype
- Gas system improvements for MuID, TRD
- Additional tunnel shielding for Muon Arms
- LL1 working for MuID and ERT
- Improvements to PHENIX Safety system
- New Scalers available for pp run





Work in 2006 Shutdown

- General maintenance on PHENIX subsystems
- Install accesses to bridge rack platform on central magnet flux return
- Prepare new electronics racks for bridge platform
- Install and commission Time of Flight-West(TOF-W) Detector
- Install and commission Reaction Plane(RXNP) Detector
- Install and commission Hadron Blind Detector (HBD)
- Install and commission Muon Piston Calorimeter-N (MPC-N)
- Add recirculation to HBD gas system
- Prepare HBD, TOF-W, RXNP, MPC-N racks for detector electronics
- Remove, maintain and reinstall BBC
- Drift Chamber- W repair
- Muon Piston Calorimeter-South maintenance
- Upgrades to Safety Systems (480 VAC trip)
- Improve central region detector access
- Prepare General IR infrastructure for future upgrades