

Overview of RHIC Experiments and Accelerator

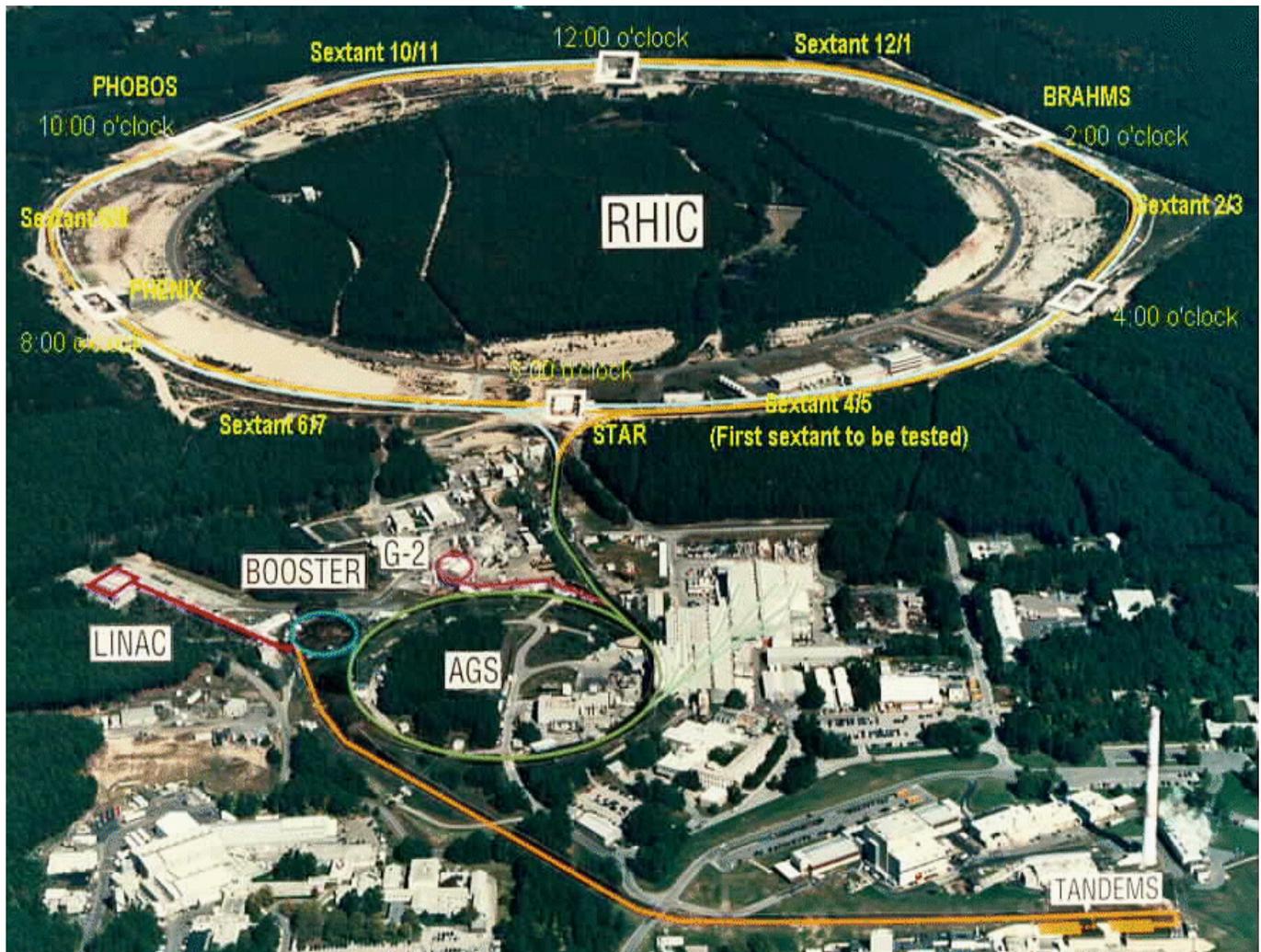
Michael J. Bennett
Los Alamos National Lab

DNP RHIC Workshop

October 28, 1998

Thanks to:
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Thomas, Flemming Videbaek,
Sebastian White and Bill Zajc

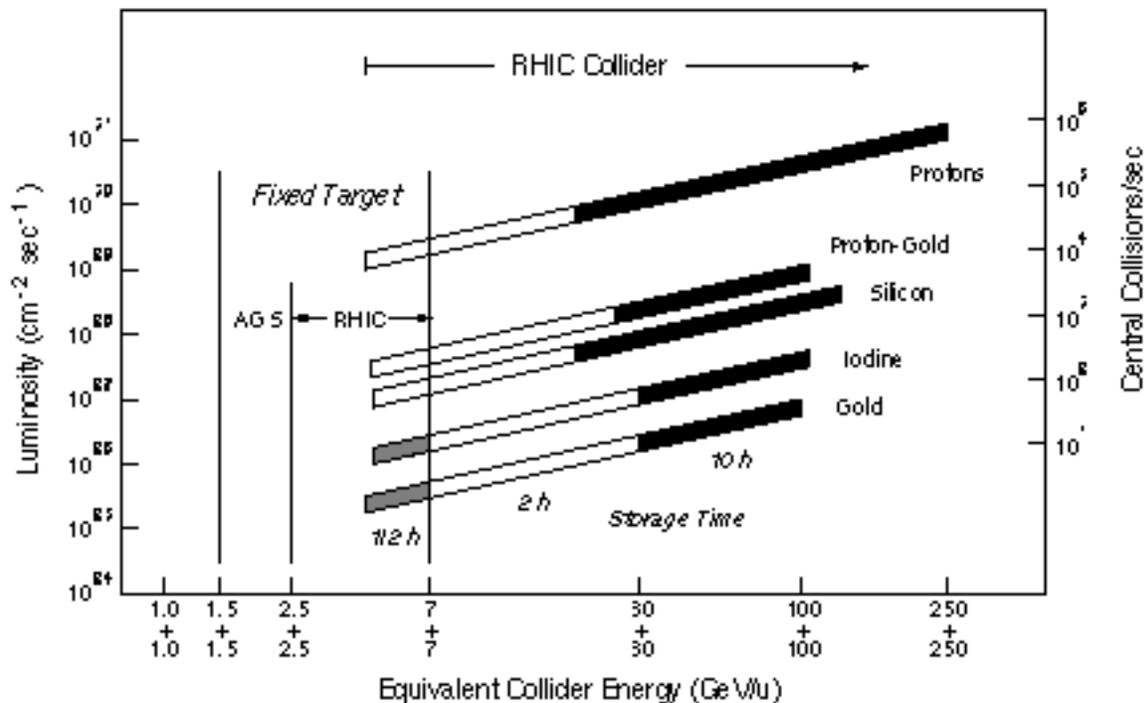
The RHIC Accelerator Ring



- Two concentric superconducting magnet rings
- 3.8 km circumference
- 6 interaction regions

RHIC--A Versatile Accelerator

- Heavy Ion Program
 - Vary Species
 - Vary Beam Energy
- p-A Program
- Polarized Protons
 - Spin Program



Beam Lines at RHIC Injection



RHIC RF Cavity



RHIC Experimental Program

Very diverse field

Charged hadrons, neutral hadrons, global properties, photons, electrons, muons

Requires complementary experiments

Ability to tie experiments together

Some overlap

Common elements

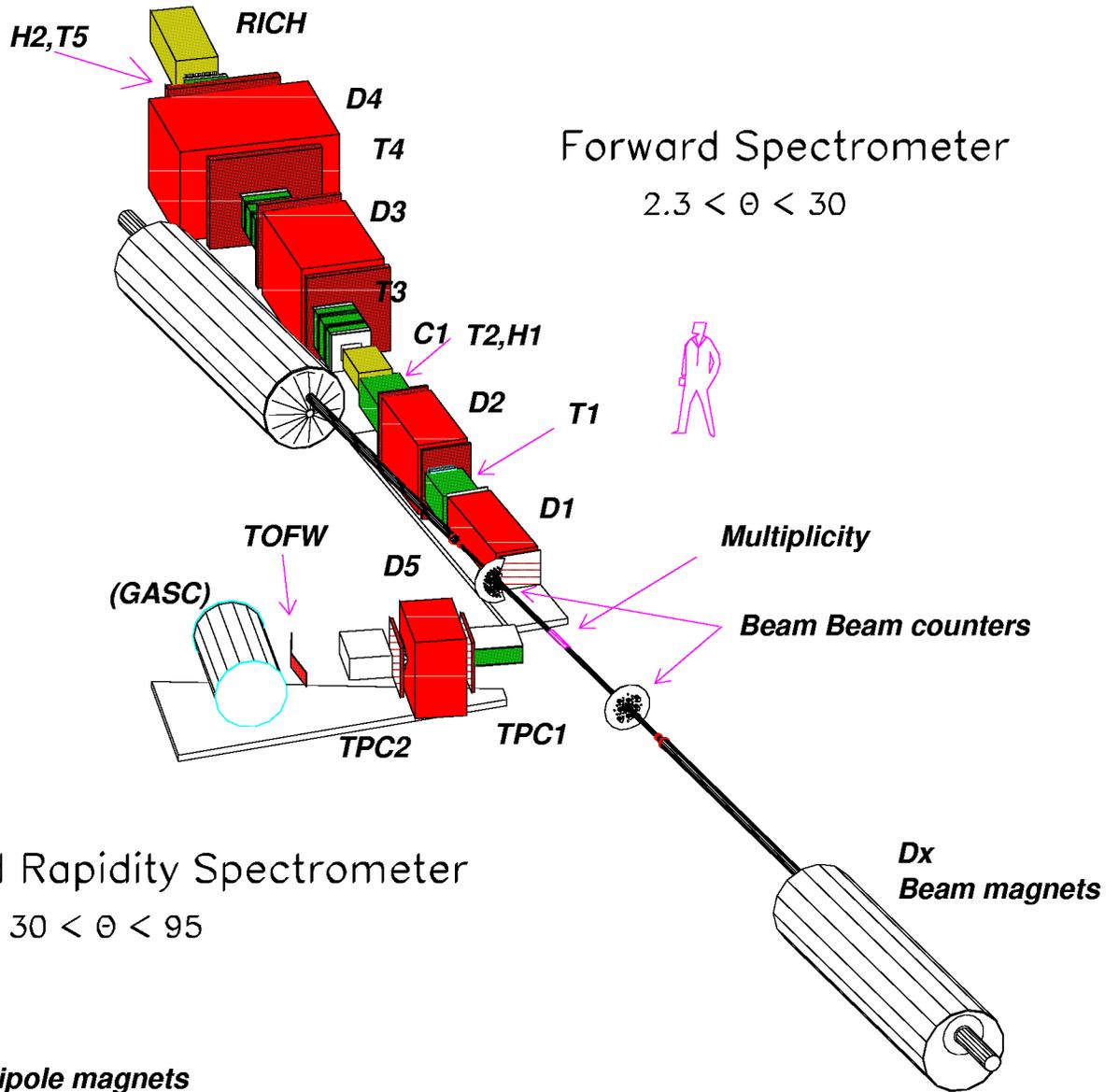
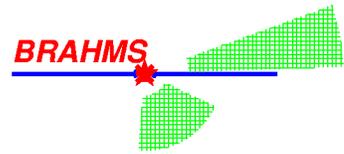
Zero Degree Calorimeters

Two large, multipurpose experiments:

STAR, PHENIX

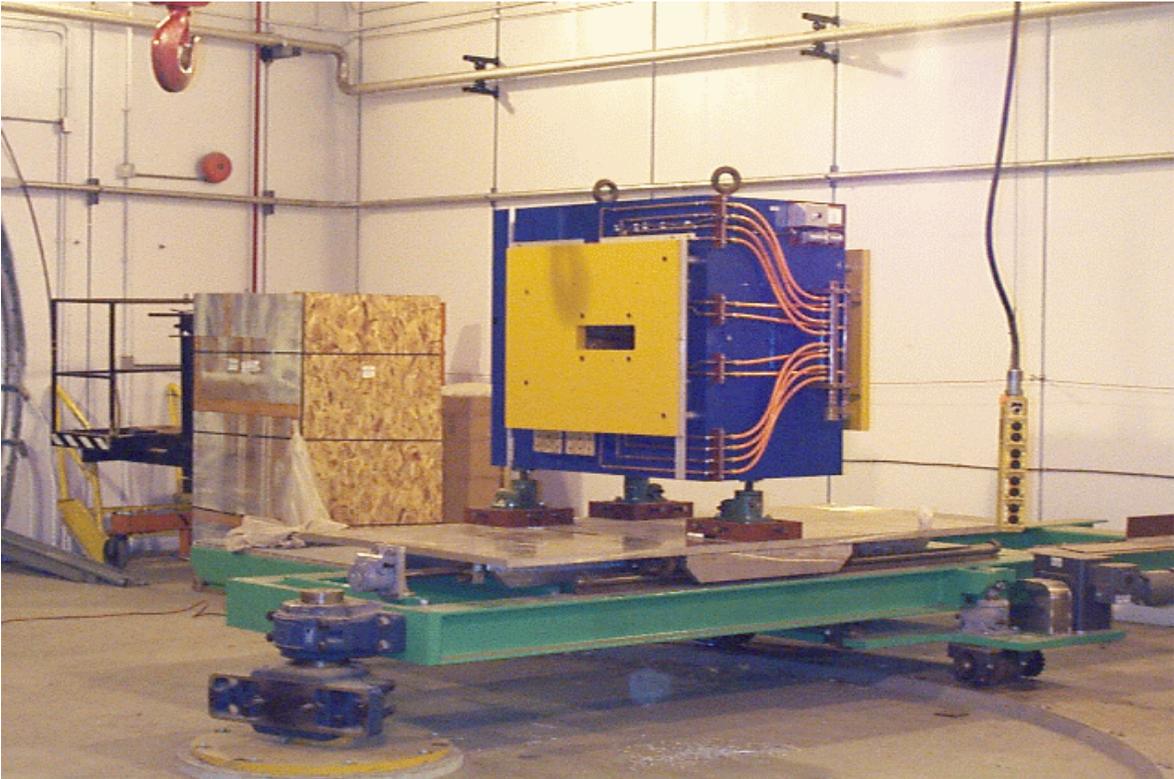
Two smaller, more focused experiments:

PHOBOS, BRAHMS

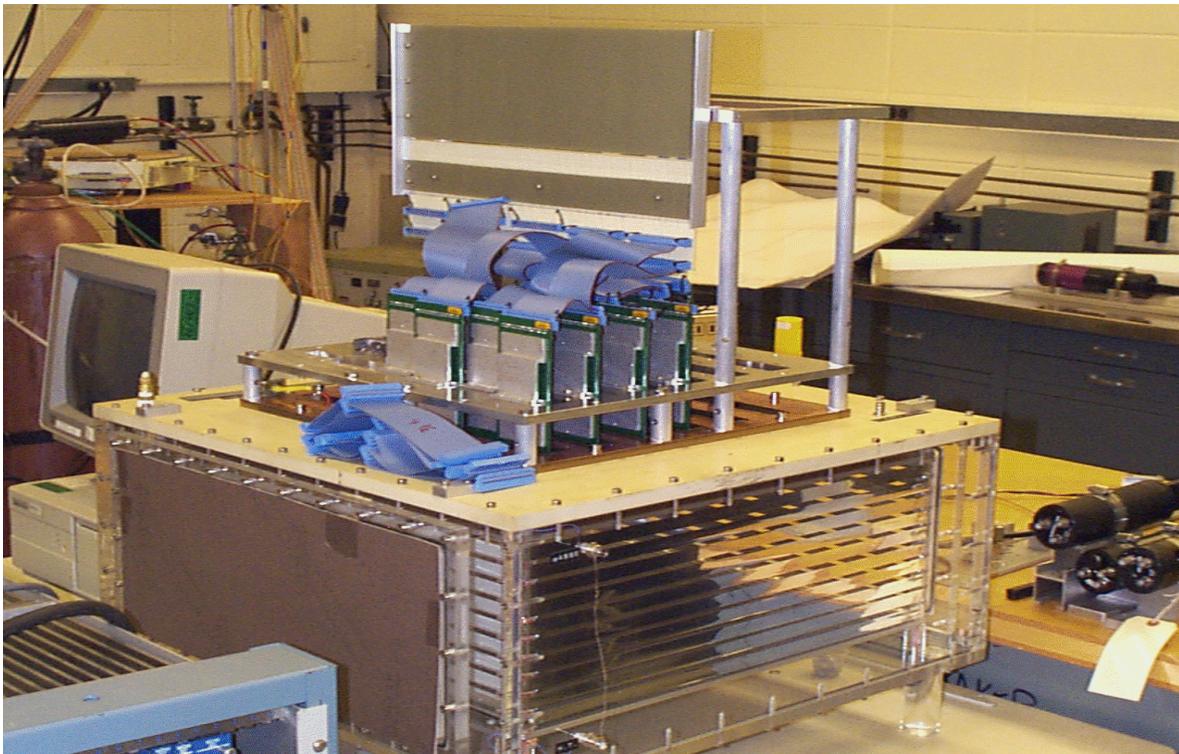


- D1, D2, D3, D4, D5 : dipole magnets**
- T1, T2, T3, T4, T5, TPC1 TPC2: tracking detectors**
- H1, H2, TOFW : Time-of-flight detectors**
- RICH, GASC : Cherenkov detectors**

Dipole Magnet on Mid-Rapidity Platform



TPC1 for Mid-Rapidity Spectrometer



BRAHMS Experimental Area



Strengths of BRAHMS

- Good Particle ID at "edges" of phase space

Investigate QGP in fragmentation region

- Pion Interferometry at high rapidity, p_t
- Ability to investigate mini-jets ($p_t > 2 \text{ GeV}/c$)
- High rate ($\sim 250 \text{ events}/\text{sec}$)

Flexible spectrometer trigger to select events of interest

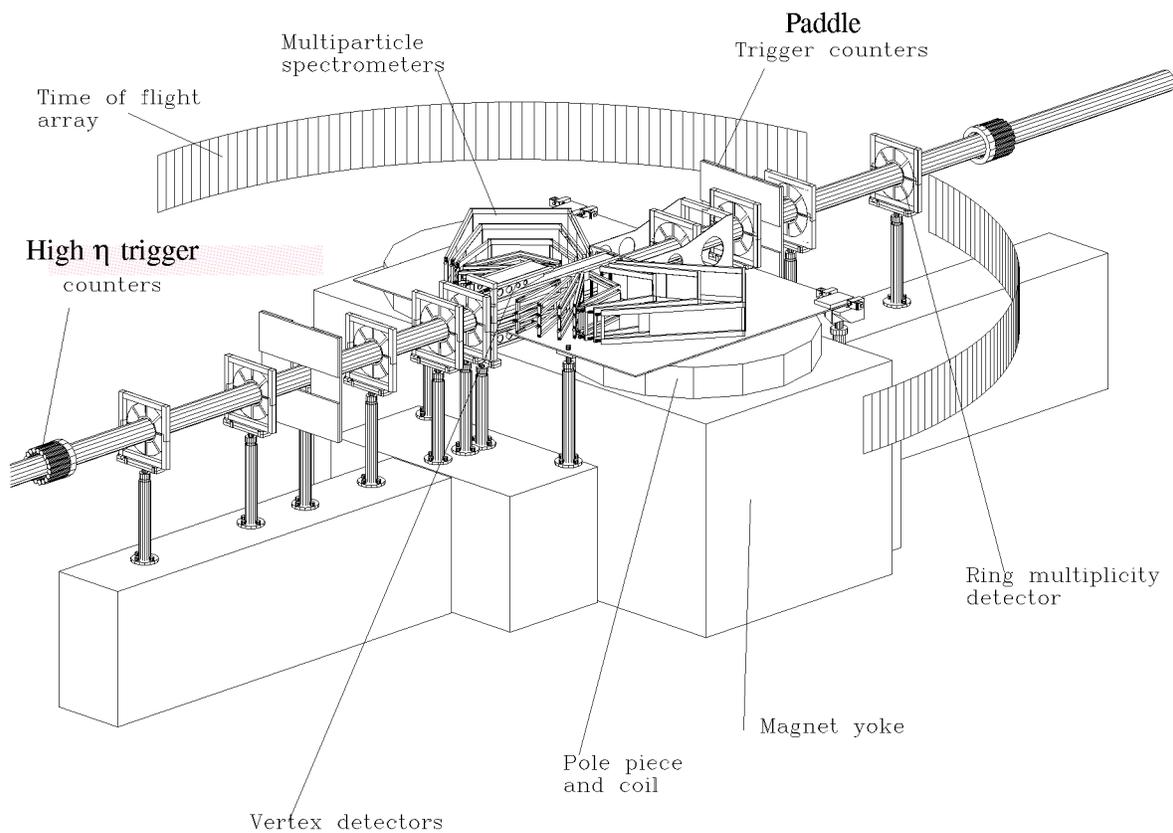


Figure 1. The PHOBOS detector.

The PHOBOS beam pipe, multiplicity and vertex detectors, spectrometer arms, lower half of the magnet, and a schematic TOF detector.

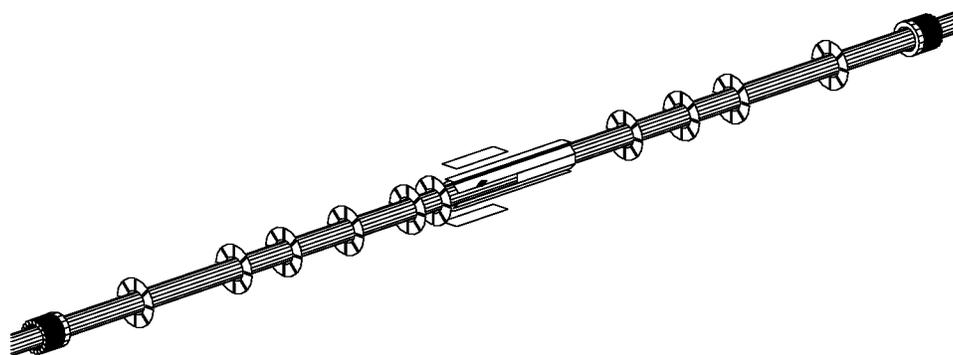
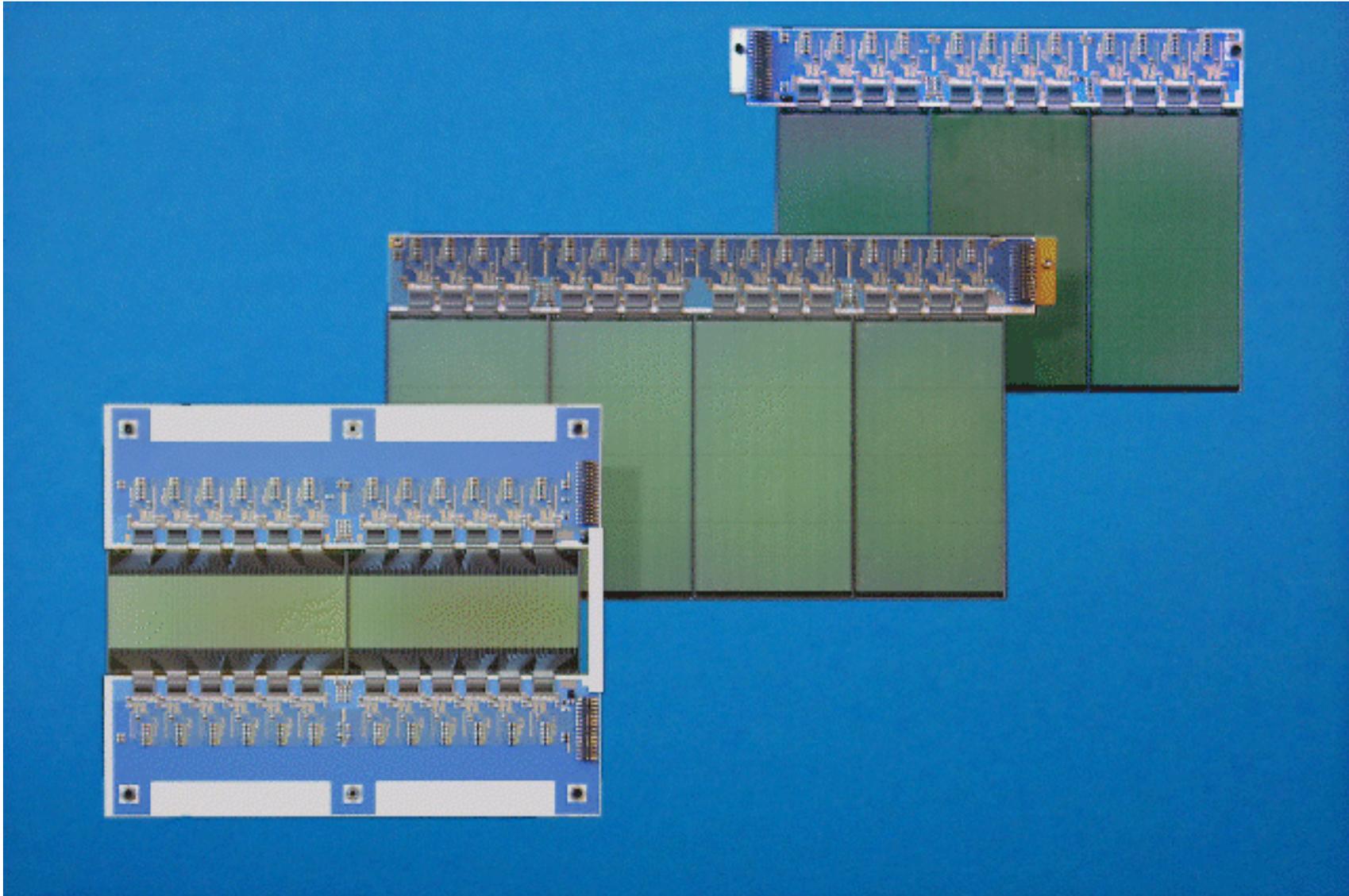


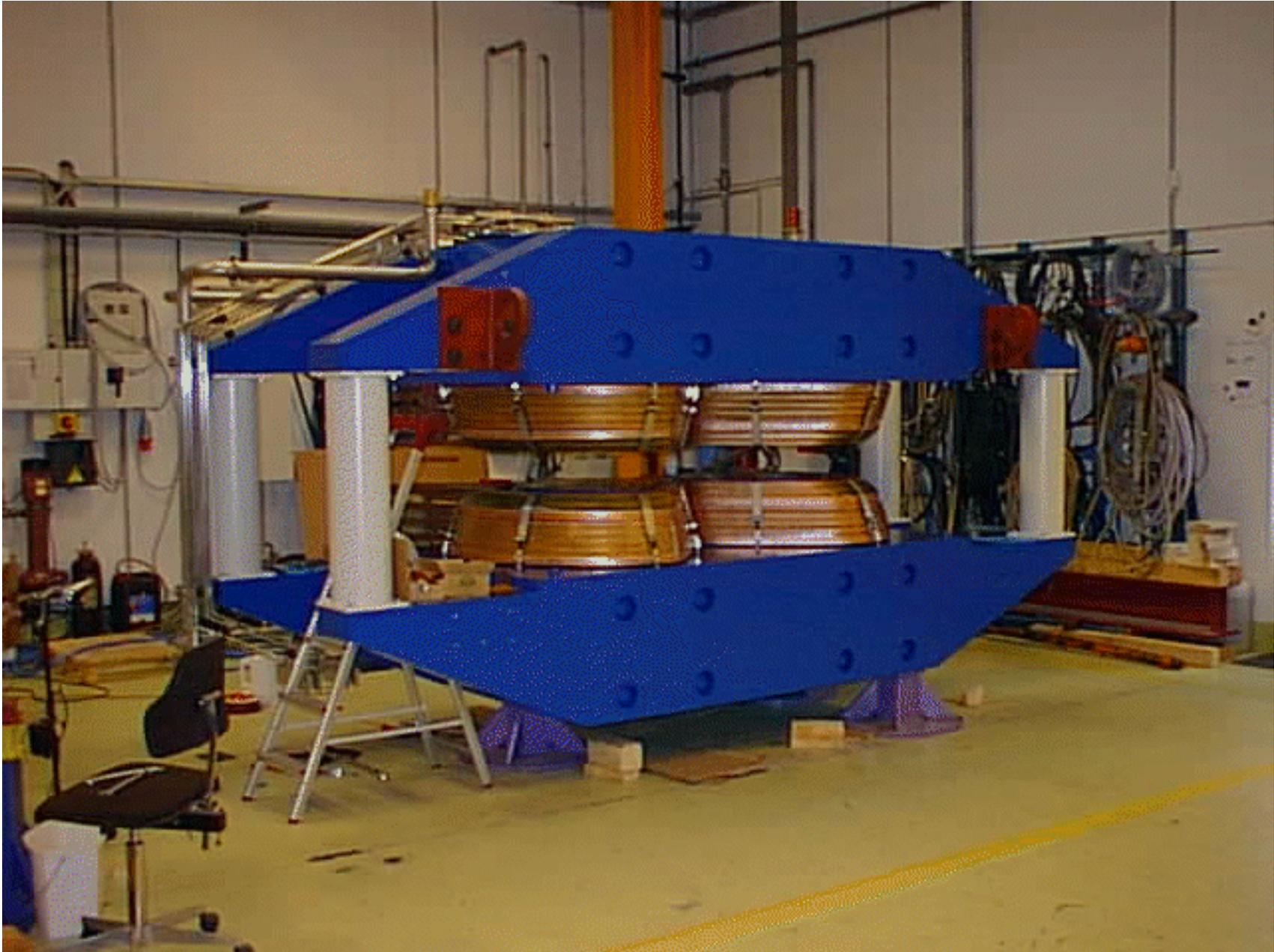
Figure 2. The PHOBOS multiplicity detector.

The PHOBOS beam pipe, multiplicity ring and barrel detectors, and vertex detector.

PHOBOS Silicon Pad Detectors

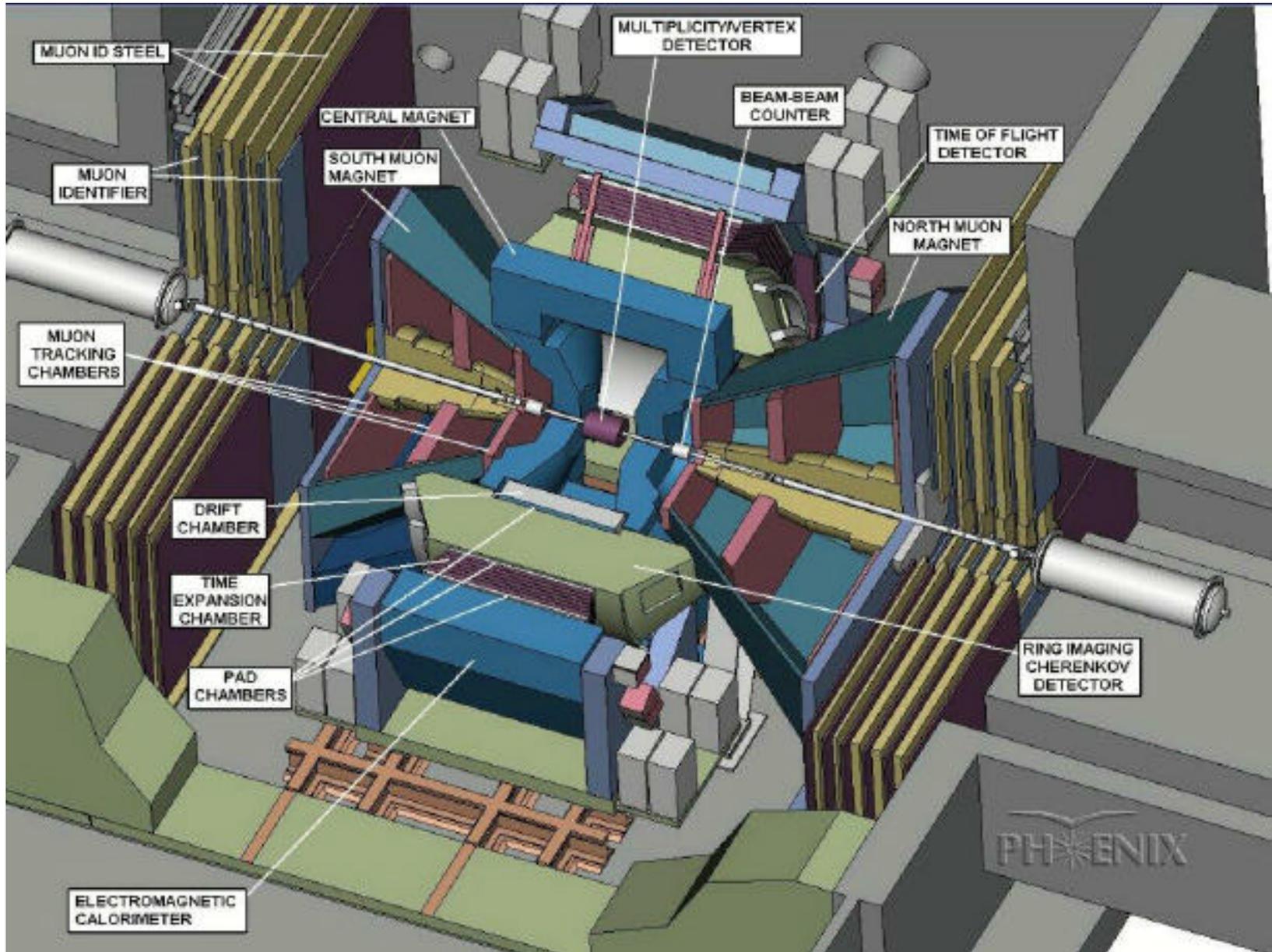


PHOBOS Spectrometer Magnet in Experimental Hall

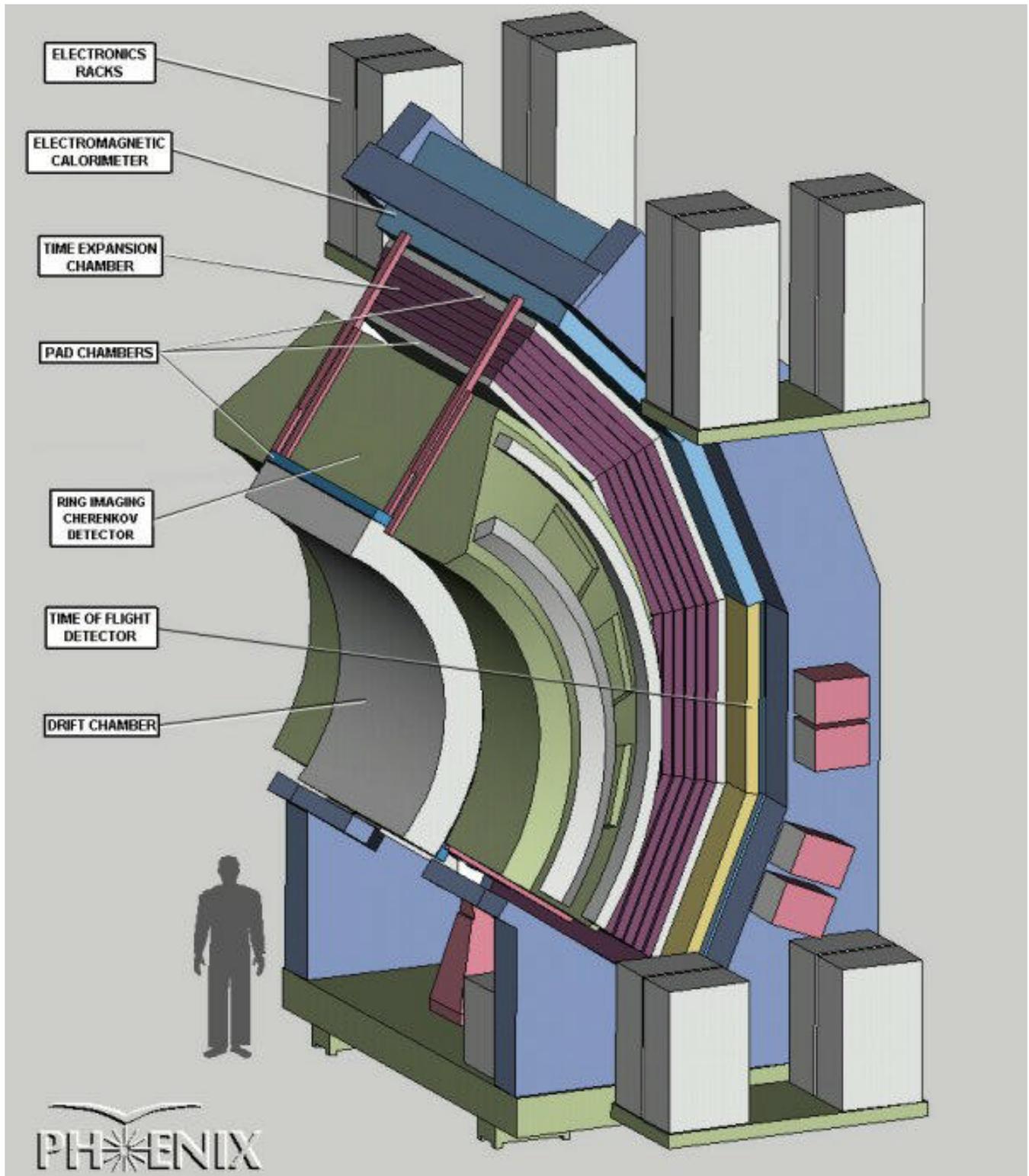


Strengths of PHOBOS

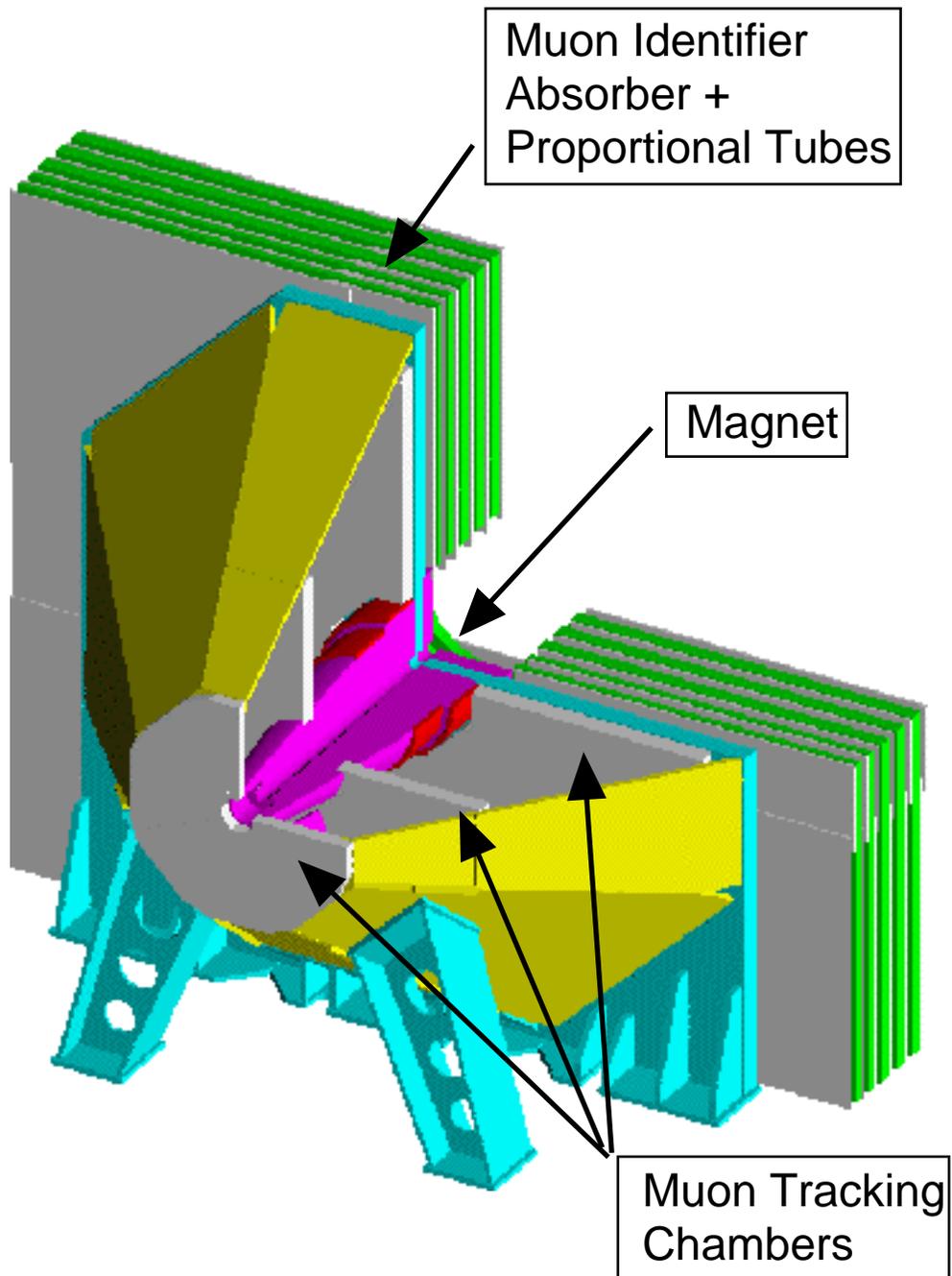
- Charged Particle Multiplicity
 - Virtually all Phase Space
 - Very high granularity
 - Sensitive to fluctuations
- Identified Particle Spectra
 - Down to very low p_t
 - Interesting region for \rightarrow KK, pion interferometry
- Very high event rate
 - Can run at 600 events/sec, equivalent to all minimum bias Au+Au at full RHIC luminosity



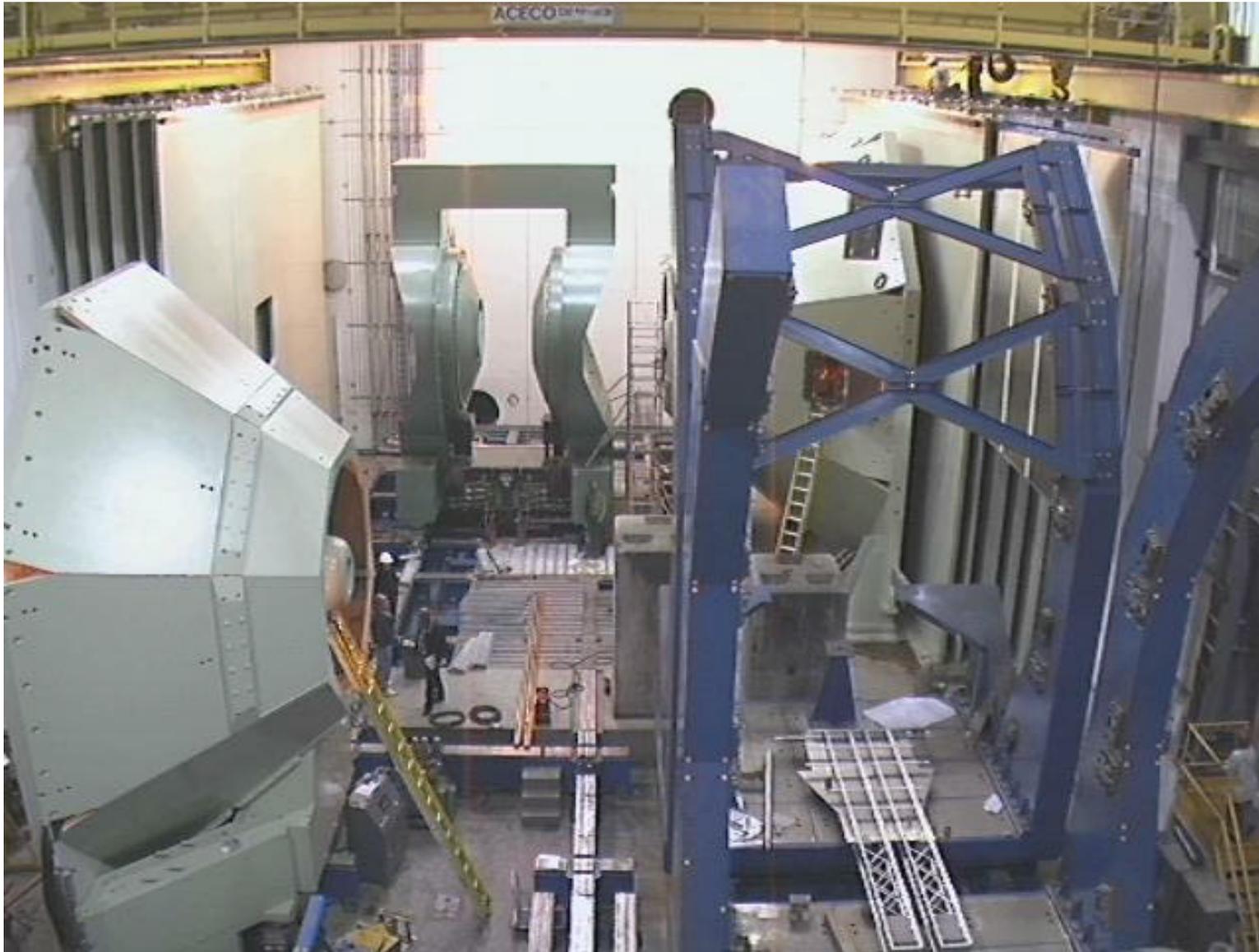
Central Arm Tracking Detectors



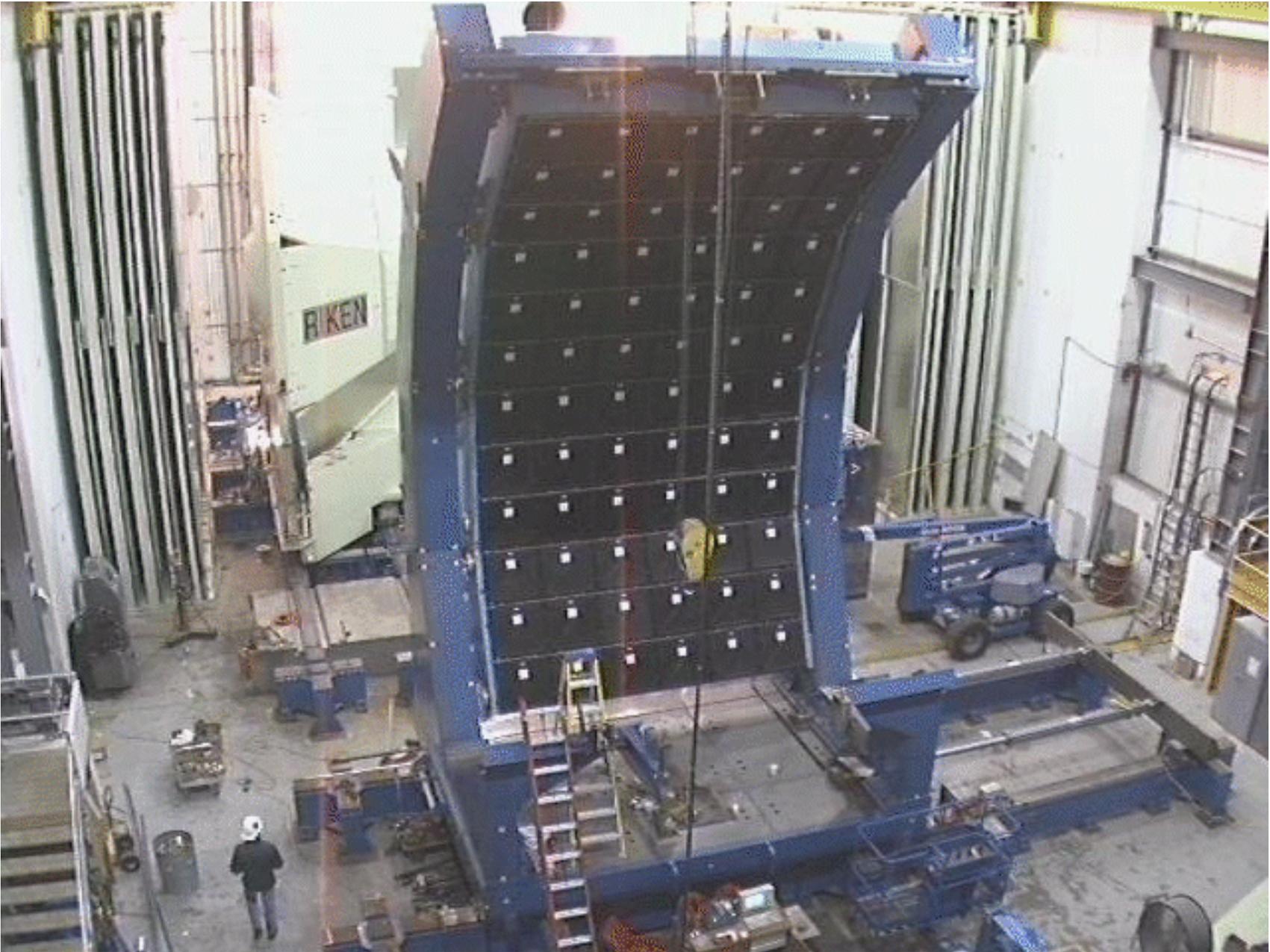
Muon Arm Detectors



Installation of Muon ID Panels into PHENIX Main Facility Hall



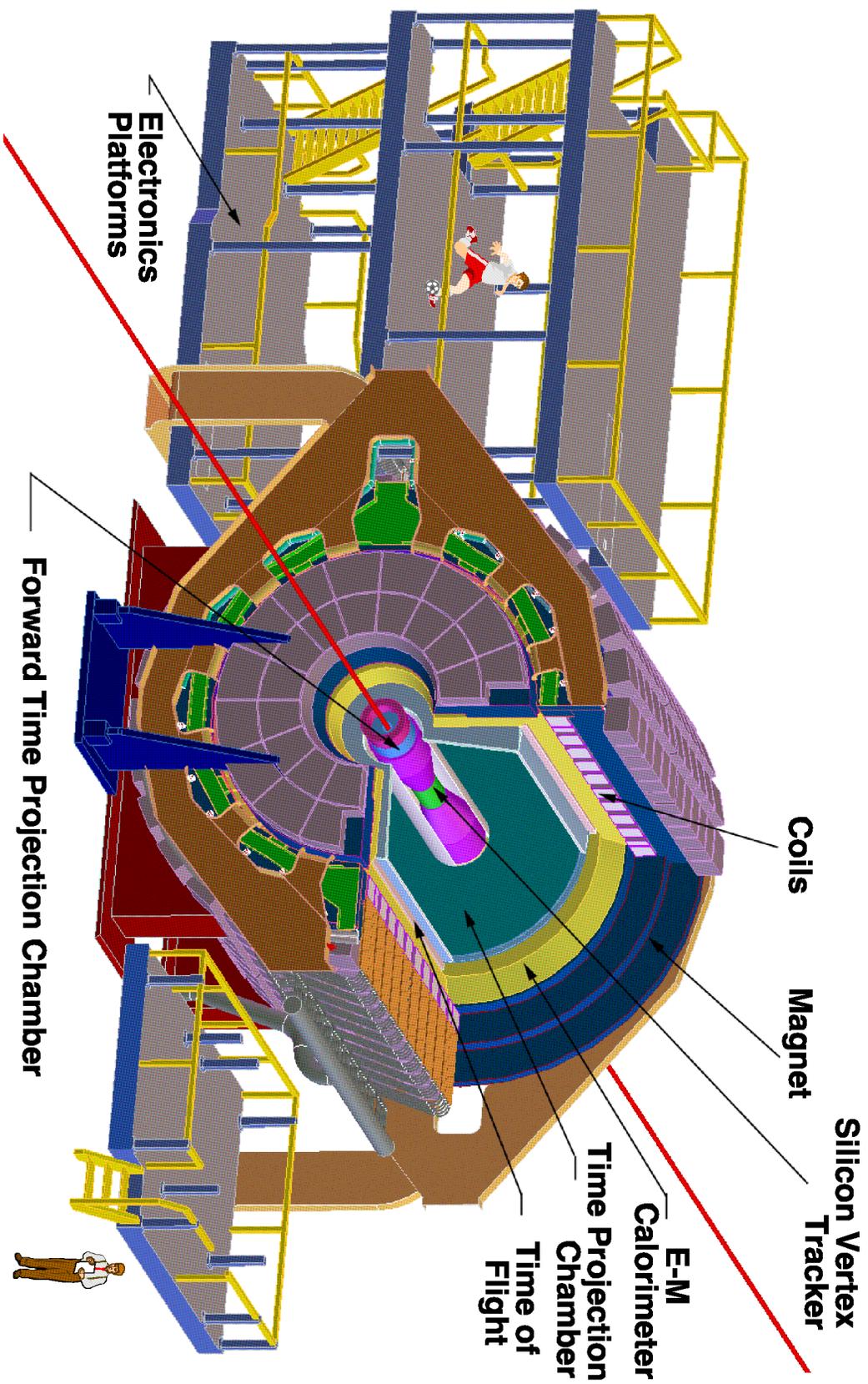
PHENIX EMCAL modules fully installed on west arm



Strengths of PHENIX

- Simultaneous measurement of:
 - Charged particle mult. over wide range
 - Identified hadron spectra
 - Electrons
 - Photons
 - Muons
- High Energy Cutoff on photons, electrons
 - Jet Quenching
- Ability to investigate:
 - J/ψ , ψ' , suppression
 - Vector Meson Mass Shifts
 - Open Charm
 - Drell-Yan
- High rate, sensitive to rare processes
 - 125 central Au+Au/sec

The STAR Detector at RHIC



As the engineers designed it

The TPC Arrives at BNL

Nov. 6th, 1997



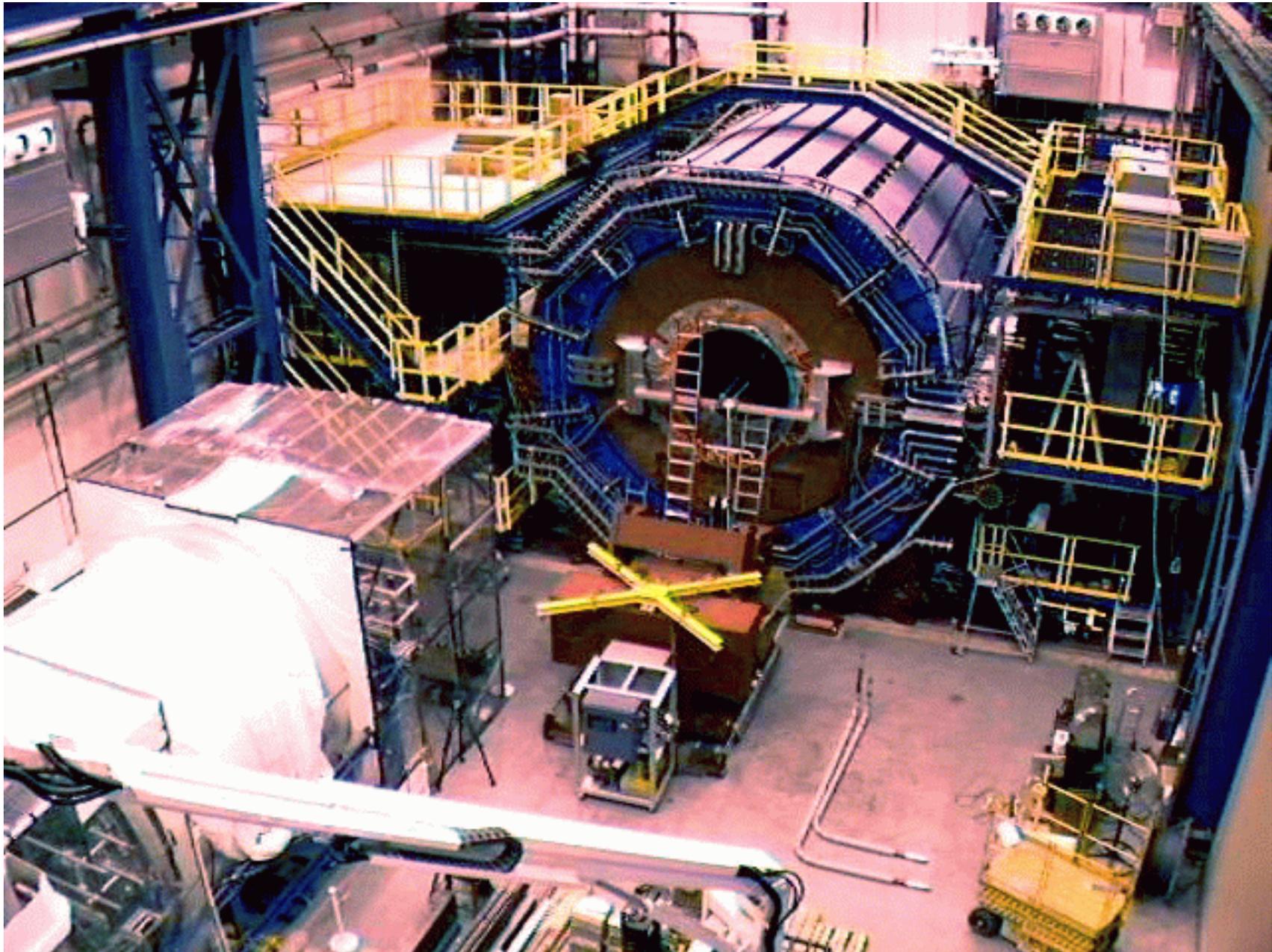
T.K. Shea

- Photos
- Documentation
- Physics

[http://
www.rhic.bnl.gov/
star/starlib/doc/
www/star.html](http://www.rhic.bnl.gov/star/starlib/doc/www/star.html)

Live on the Web

STAR Magnet, TPC, and Electronics Platforms



Strengths of STAR

- Simultaneous measurement of:
 - Charged particle mult. over wide range
 - Identified hadrons over wide range
 - Photons
- Ability to reconstruct decays of short-lived particles ($c \sim \text{few cm}$)
 - Strangeness, multiply strange baryons
 - K_s^0 interferometry
- High energy photon cutoff
 - Jet quenching
- Excellent event-by-event capability
 - sensitive to fluctuations in:
 - particle ratios, phase space distributions
 - isospin, particle mean p_t ...

Zero-Degree Calorimeters

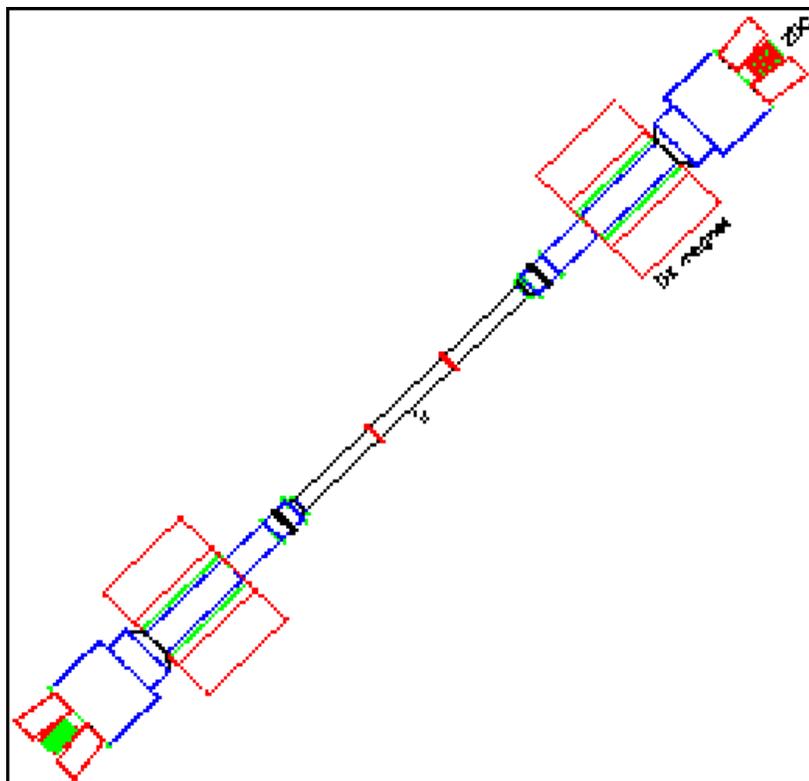
Group represents all RHIC Experiments

Provide Common Measure of Centrality

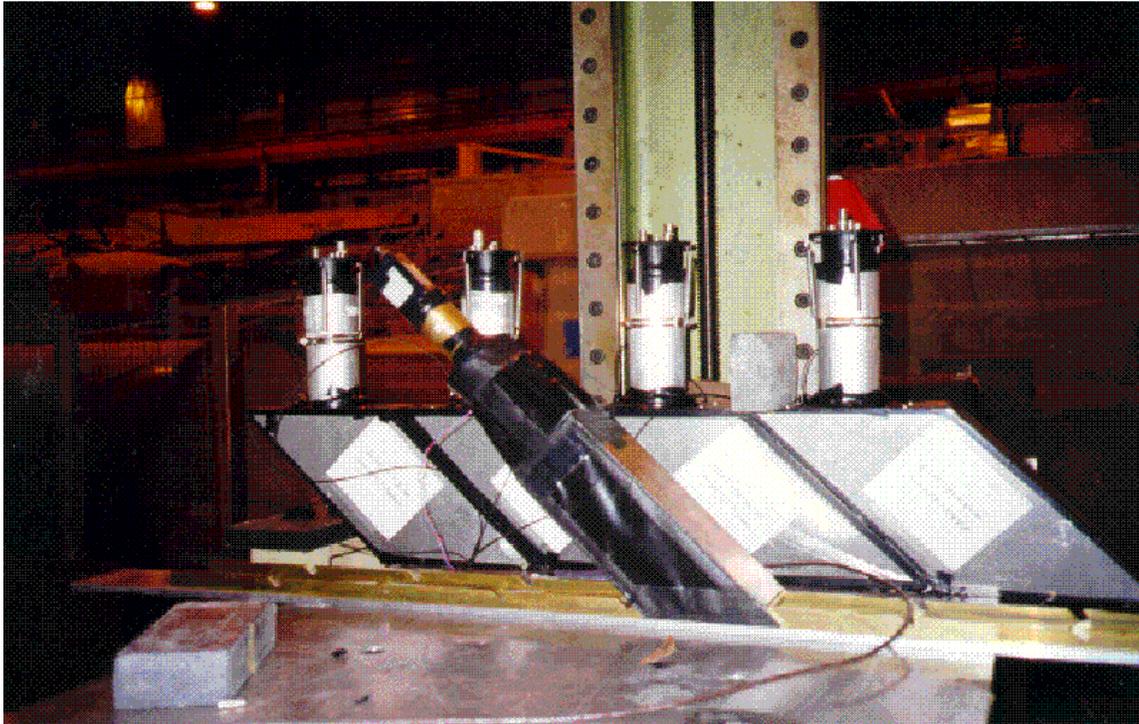
Eight calorimeters of identical design

Measure spectator neutrons

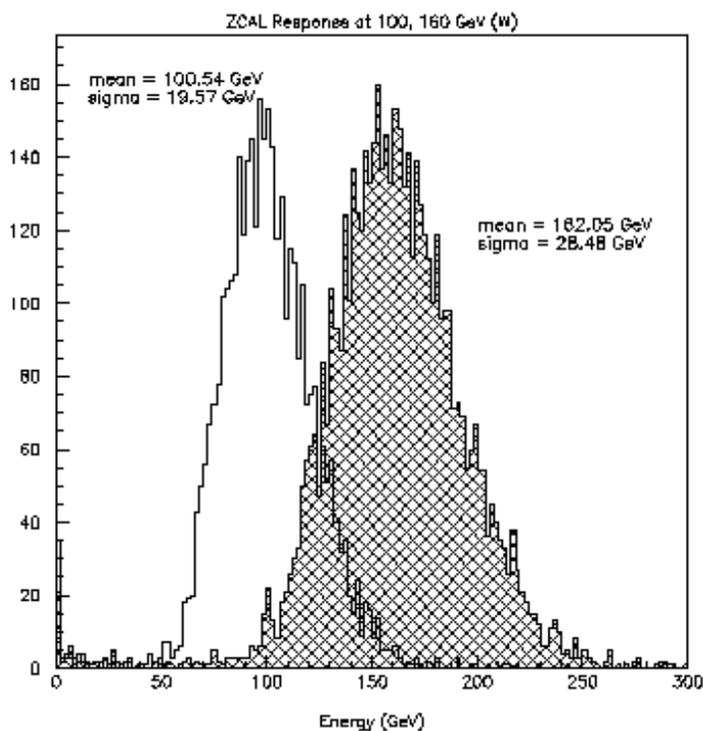
Cross-calibrate on single neutron peak
from Coulomb dissociation



ZDC Test at SPS



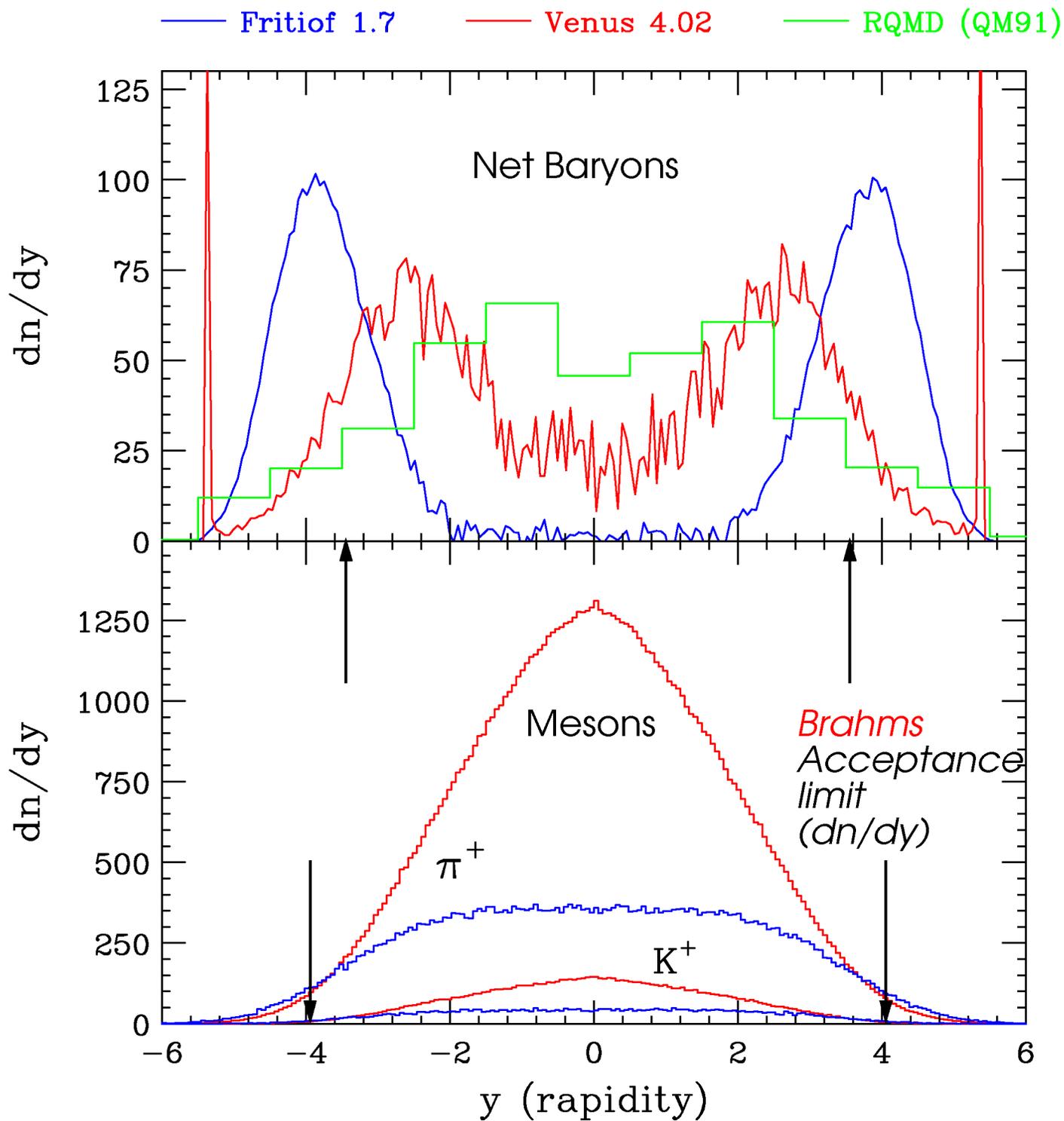
Tungsten / Cerenkov fiber sandwich design



Proton beam test
results shown

NA49 heavy ion
test results in
EPJ A2, 383

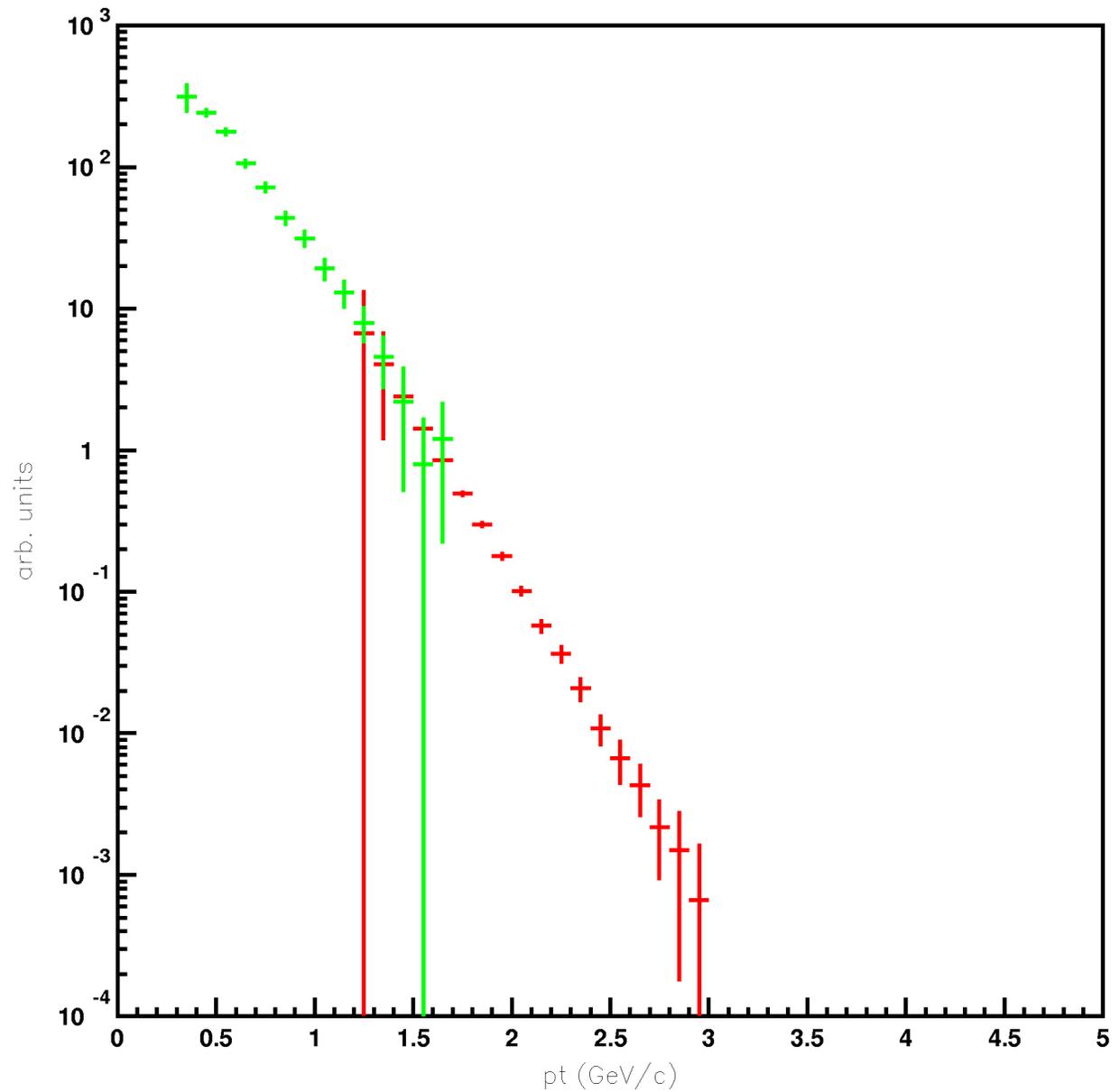
Central Au + Au at RHIC



High p_t measurements

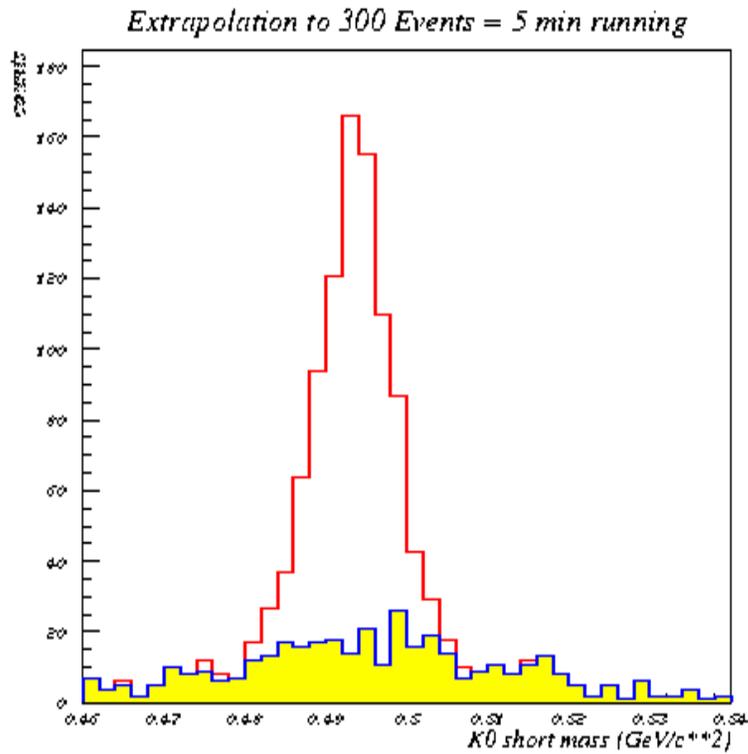
Example of quality of spectrum of π^+ at $y=2.4$. The measurement can be done for central Au+Au collisions in about 1 week in 2 settings of magnetic fields.

Extensions to $p_t \approx 6$ GeV/c with Δp_t of .5 GeV/c can be done in another week.

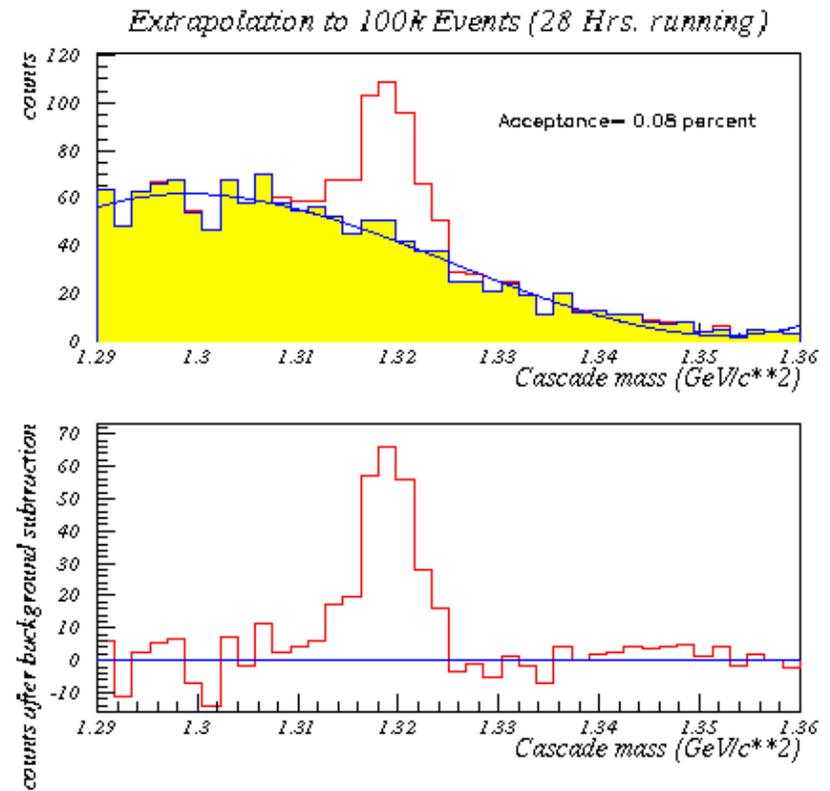


STAR Reconstruction of Short-Lived Hadrons

Using SVT and TPC...



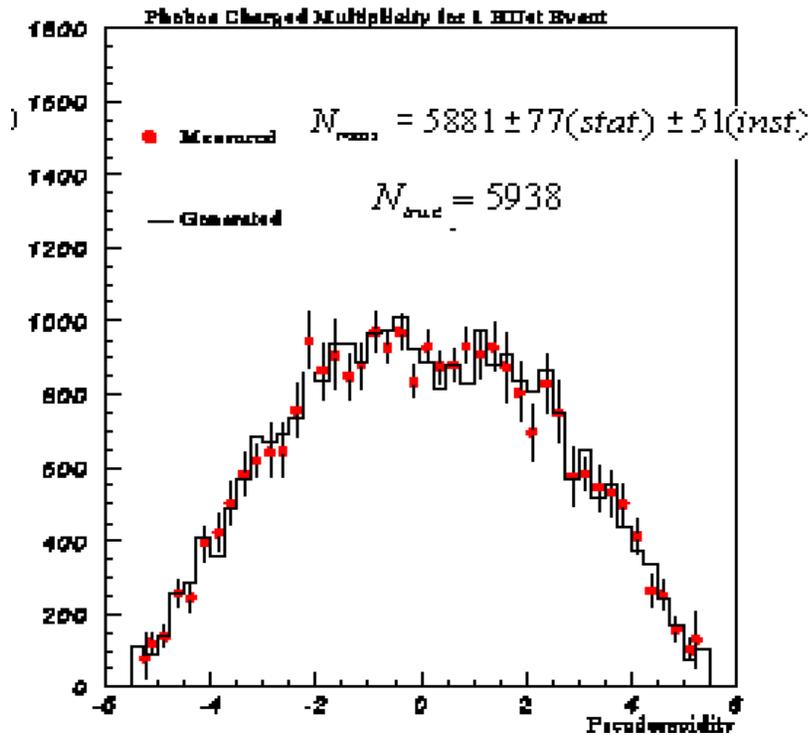
K^0_{short} reconstruction



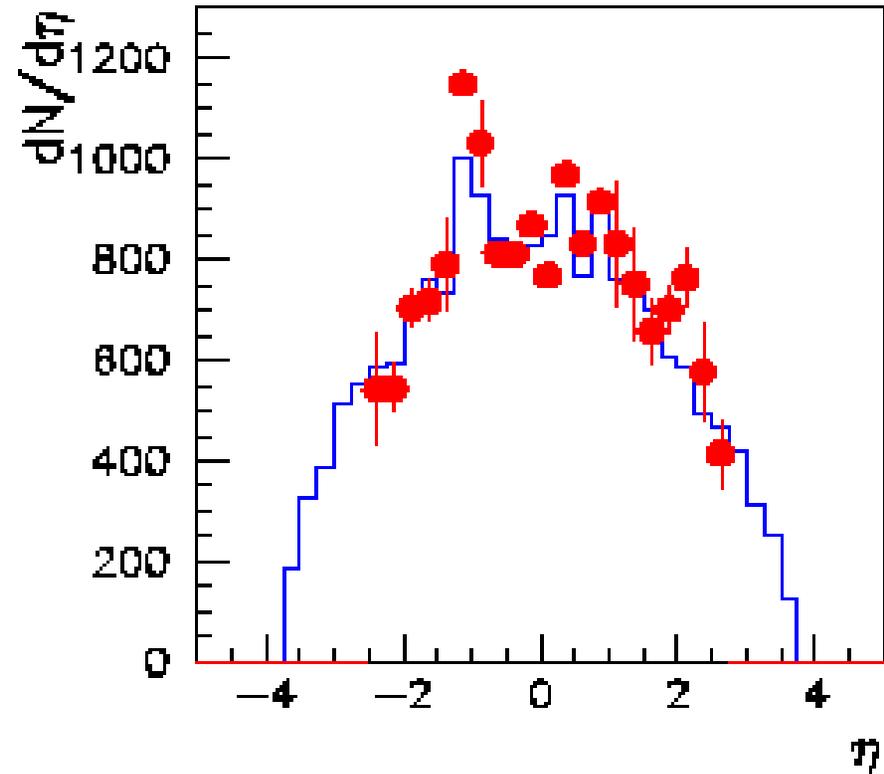
→ reconstruction

Charged Particle Multiplicity---Event-by-Event

PHOBOS



PHENIX

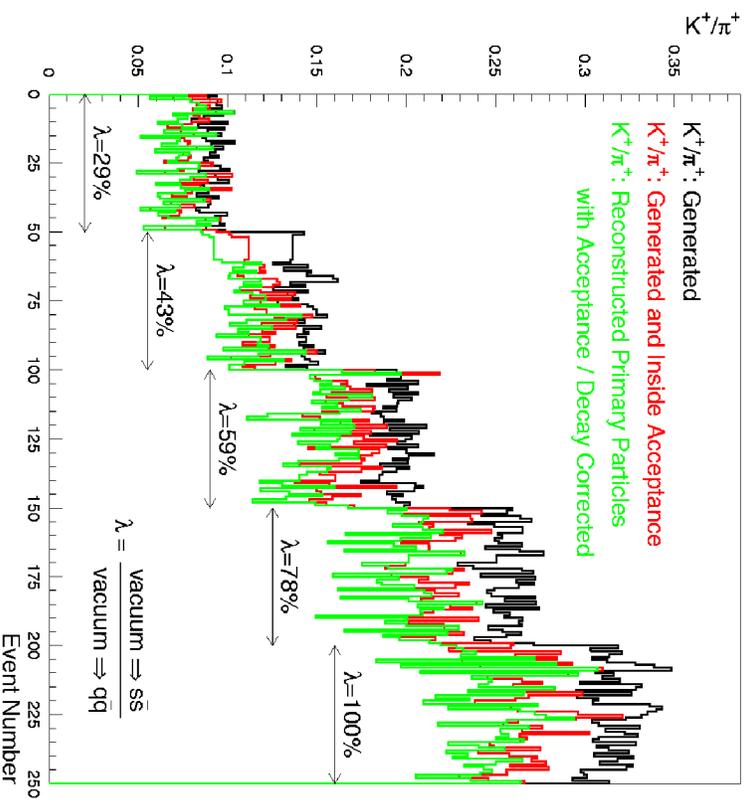


STAR also has capability to measure dN/d
event-by-event...

Simulations: Physics Performance



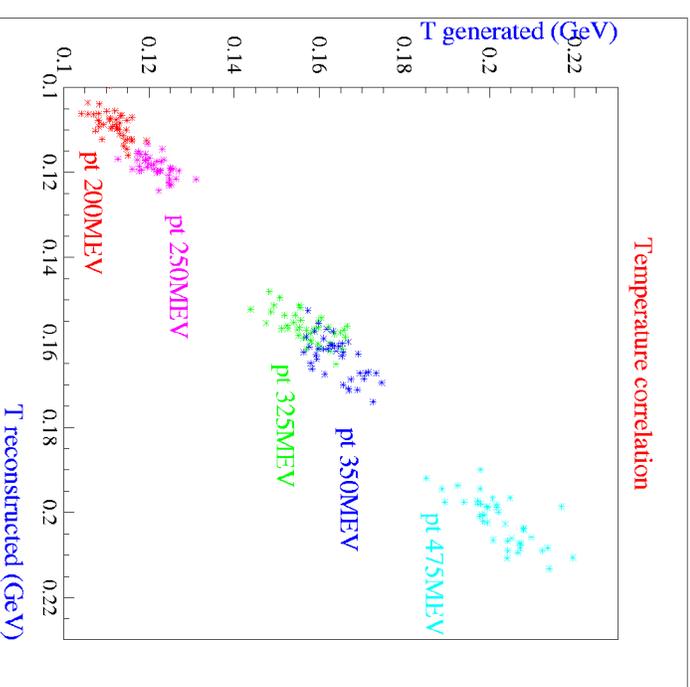
hijet events



F.Q. Wang

Reconstructed K/π ratios

Reconstructed physics signals: event by event

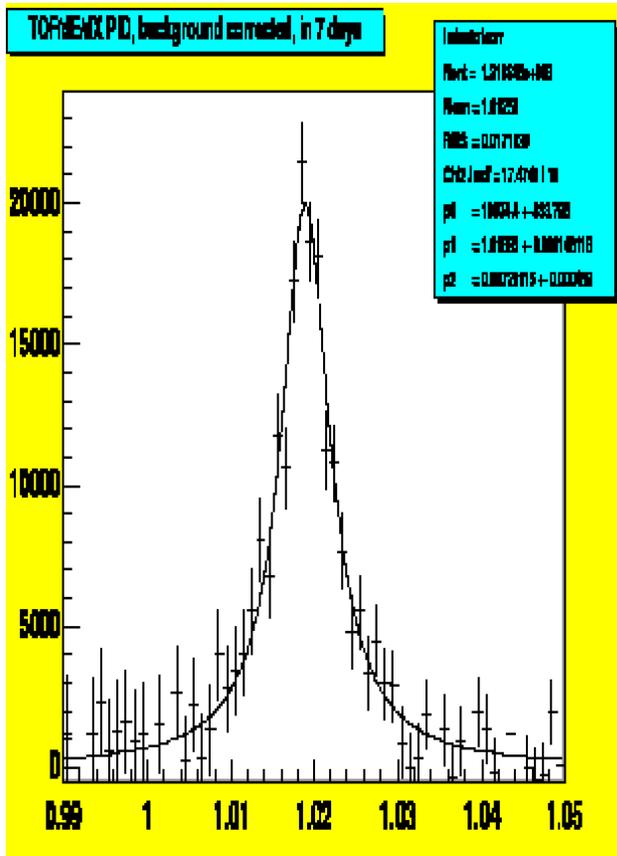


I. Sakrejda

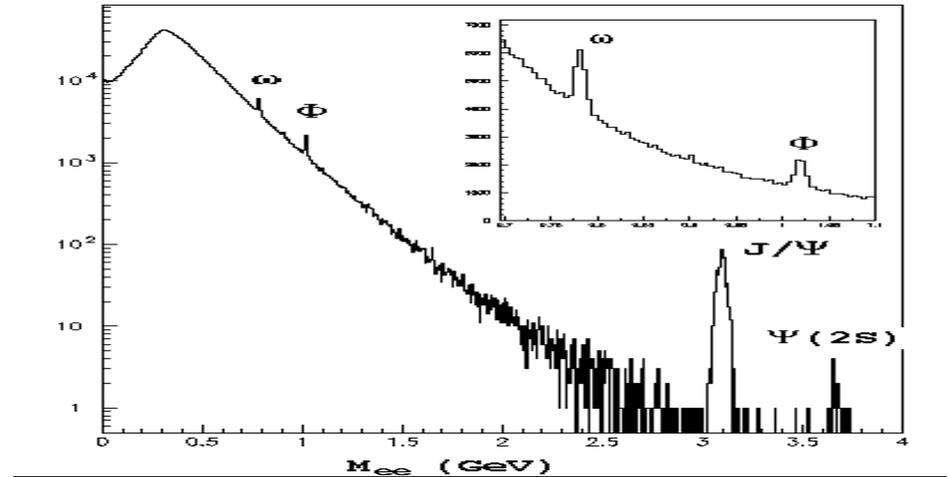
Reconstructed slope parameters

Chiral Symmetry Restoration: Physics

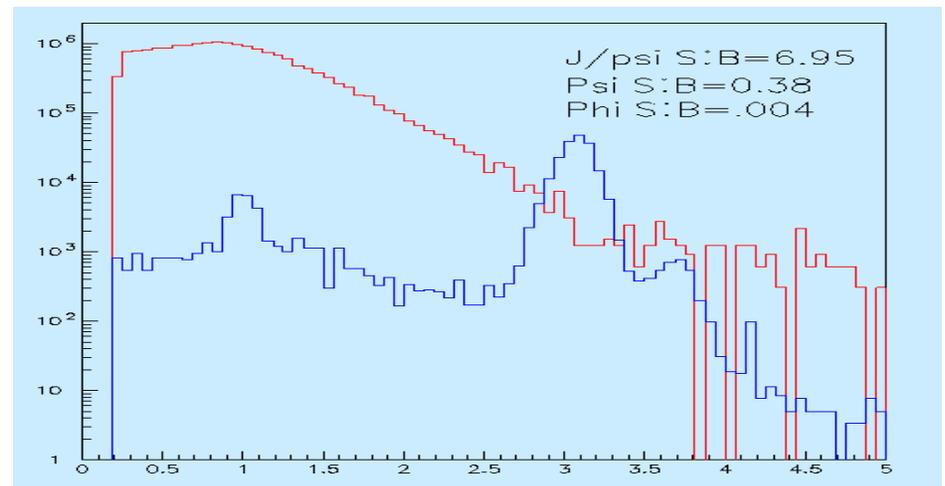
Mass shifts, Branching Ratio



PHOBOS K⁺K⁻



PHENIX e⁺e⁻



PHENIX μ⁺μ⁻

Summary

Taken as a whole, the RHIC Accelerator and Experimental Program will

- Perform vigorous p-A and Spin physics program
- Investigate high energy nuclear physics over wide range of energy density by:
 - varying size of colliding systems
 - varying beam energy
 - measuring and selecting event centrality
- Study essentially all of the **MANY** proposed QGP Signature Processes
 - Good overlap and complementarity between Experiments
 - Direct way to compare results between Experiments