PHENIX J/Ψ Measurements

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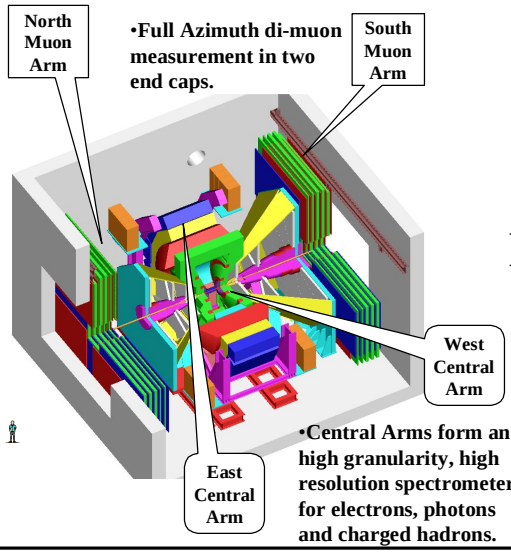
OUTLINE

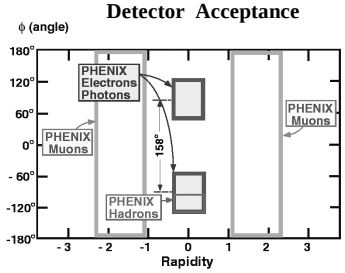
- **PHENIX Detector**
  - **★Electron Measurement**
  - **★Muon Measurement**
- **Dilepton Spectra**
- **Vector Meson Measurement**
- **Expected Rates**
- **Conclusions**

The PHENIX Detector



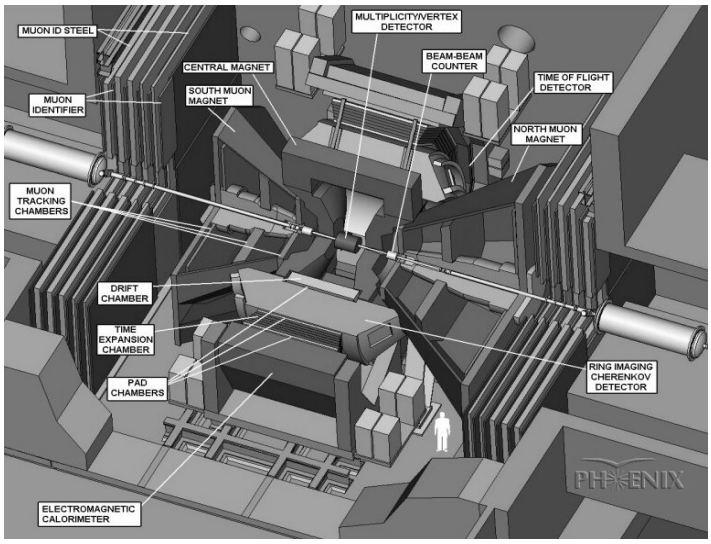
- **Full Azimuth di-muon measurement in two end caps.**
- **Central Arms form an high granularity, high resolution spectrometer for electrons, photons and charged hadrons.**

Detector Acceptance



PHENIX numbers:
445 Collaborators in 10 Countries (44 Institutions)

The Detector



Central Arm Tracking Chambers

Drift Chambers (DC)

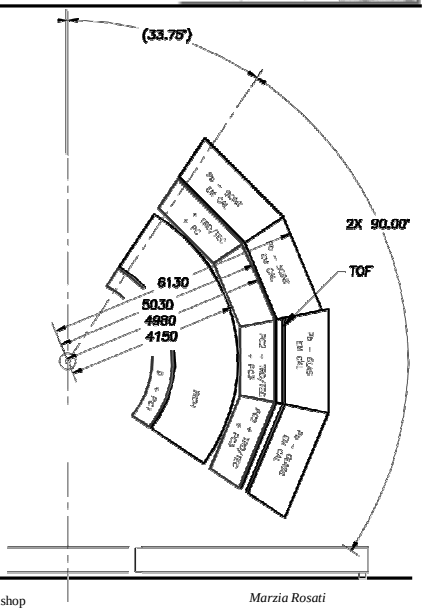
- ★ **Low Mass multi-wire focussing drift chambers oriented to provide high resolution P_T measurements**

Pixel Pad Chambers (PC)

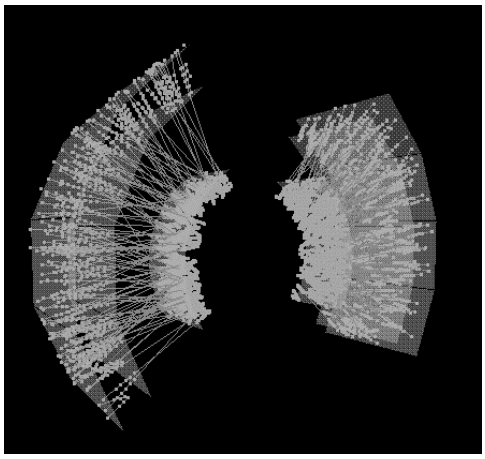
- ★ **Non projective chambers providing three-dimensional position measurements to aid pattern recognition and measure P_Z/P_T and provide information to second level trigger**

Time Expansion Chambers (TEC)

- ★ **Provide tracking in front of the Electromagnetic Calorimeter and aid in global pattern recognition**



Tracking Detector Performance



Drift Chamber

- ★ **position resolution of 150 μm in r-ϕ and 2 mm in z**
- ★ **2 track separation is 1.5 mm**

Pixel Pad Chamber

- ★ **3-d space point with accuracy of 3-8mm (PC1-3)**

Time Expansion Chamber

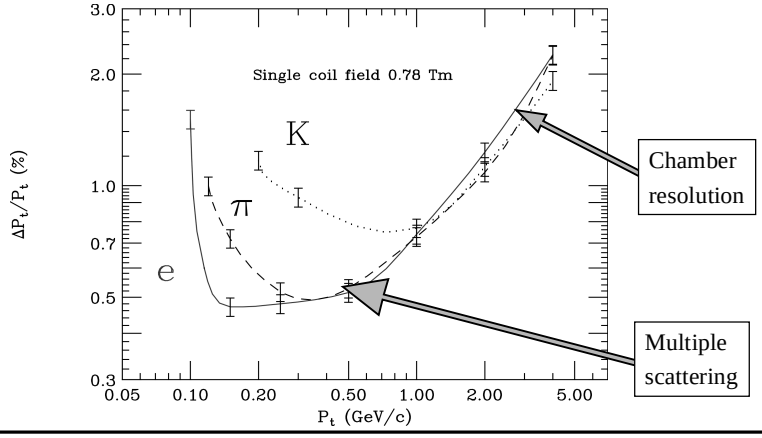
- ★ **single point track resolution of 200-250μm in the r-ϕ direction**
- ★ **2track separation of 5mm for tracks normal to the detector**

Using DC, PC and TEC, the trajectory can be reconstructed.for all charged particles within the Central Arm acceptance

Electron Momentum Resolution

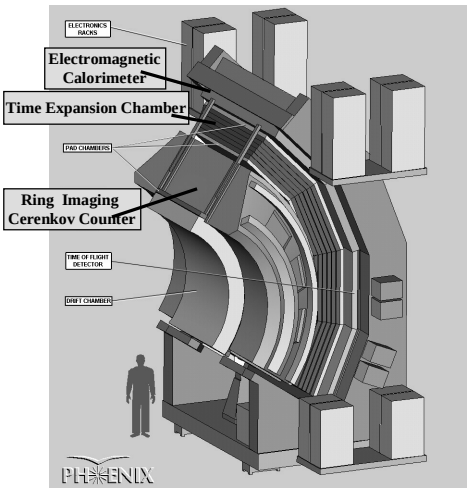
Combining the information on trajectory and magnetic field, particle momenta are determined

$\gg \Delta P_t/P_t = 1\%$ at 2. GeV/c

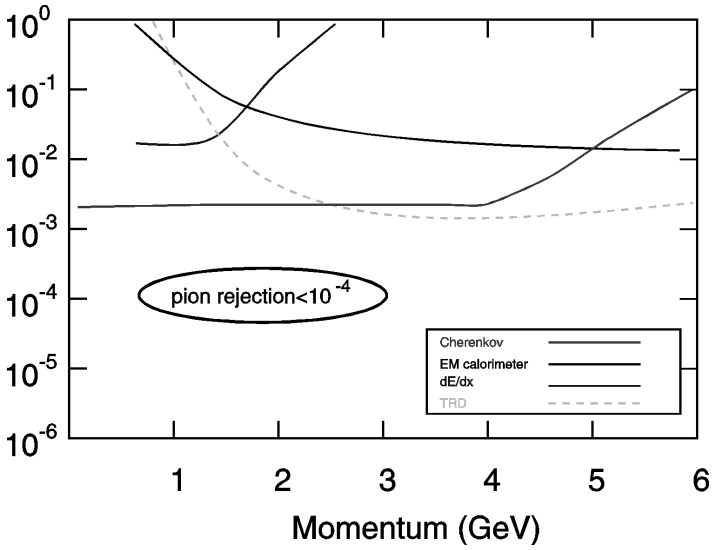


Central Arm Electron Identification

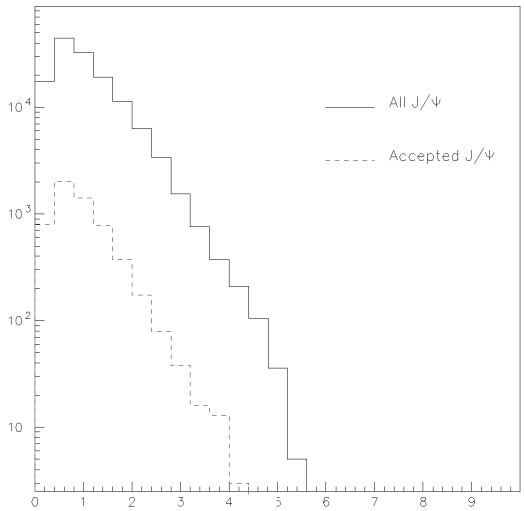
- **Electromagnetic Calorimeters**
  High Resolution, high granularity detector provide electron identification $\pi/e < 10^{-2}$ for momentum > 1.5 GeV/c
- **Time Expansion Chamber**
  dE/dx measurement allowing π/e separation at 1 GeV/c of $<10^{-2}$ with P10 gas and 4 planes instrumented and $2x10^{-3}$ with Xe gas and 6 planes instrumented .
- **Ring Imaging Cherenkov Detector**
  π/e separation < 10^{-4} for a single charged pion with momentum <4GeV/c.
  Electron efficiency > 90% up to 4GeV/c.



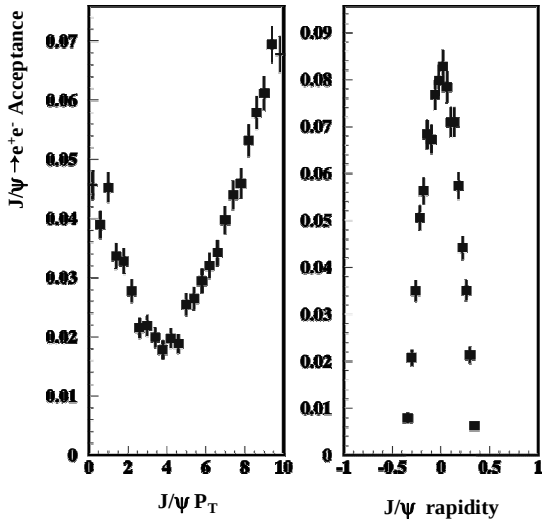
PHENIX π Rejection



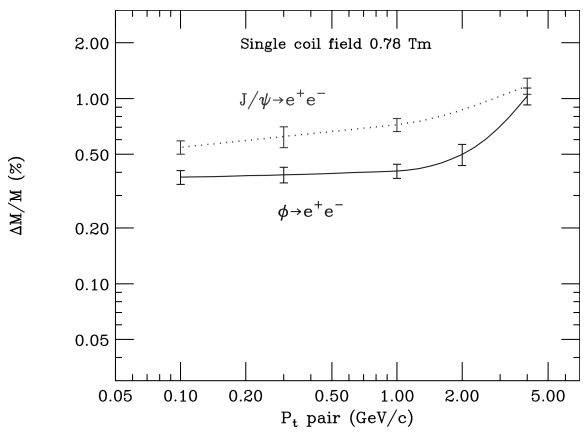
$J/\psi \rightarrow e^+e^-$ Transverse Momentum



$J/\psi \rightarrow e^+e^-$ Acceptance vs P_T and rapidity

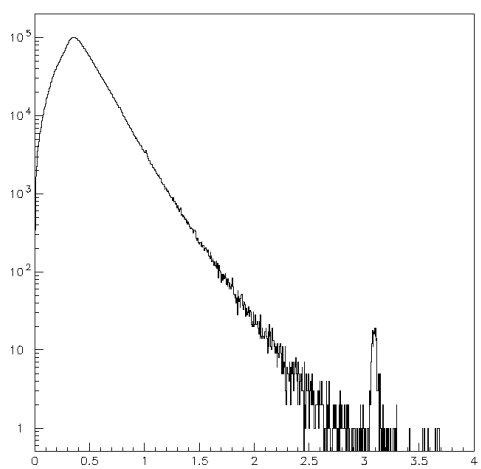


$J/\psi \rightarrow e^+e^-$ Invariant Mass Resolution



J/ψ Mass Resolution is $\cong$ 20 Mev/c^2 and shows a weak dependence on the p_T of the electron pair

Dielectron invariant mass



e^+e^- Invariant Mass (GeV/c^2)

work done by Y. Akiba

18 M Au+Au Central collisions

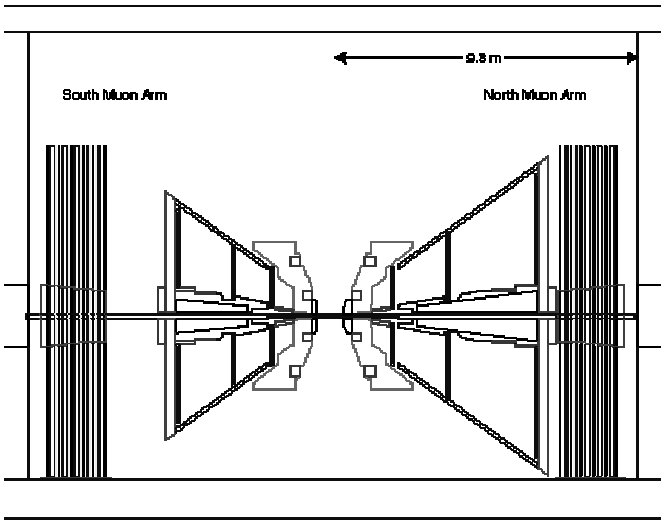
1/2 week with full Luminosity of RHIC

Events are fully simulated using Geant

Main source of background are Dalitz decays and photon conversions.

An anomalous suppression factor of 0.5 was assumed.

Muon Arms



Muon Tracking and Muon ID Detectors

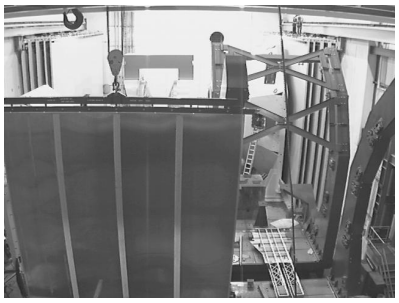
Muon Tracking

3 stations of 3 cathode strip chambers (CSC)

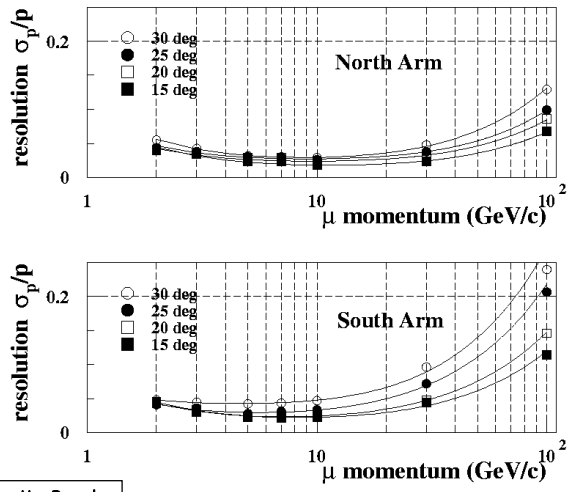
- one fine cathode plane, $\sigma \sim 100\ \mu m$
- one coarse cathode plane at a stereo angle of 22.5 degrees
- anode plane which is perpendicular to the fine cathode plane

Muon ID

- 6 walls of steel absorber interleaved with layers of Iarocci proportional tubes
- Low energy muon threshold of ~2.2 GeV
- $\pi/\mu \sim 10^{-4}$
- **Already installed!**

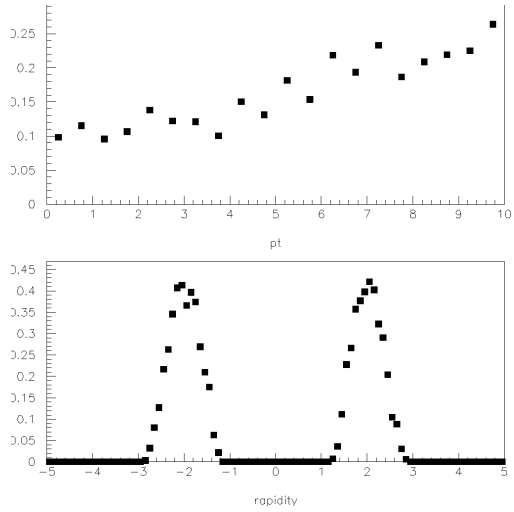


Muon Arm Momentum Resolution

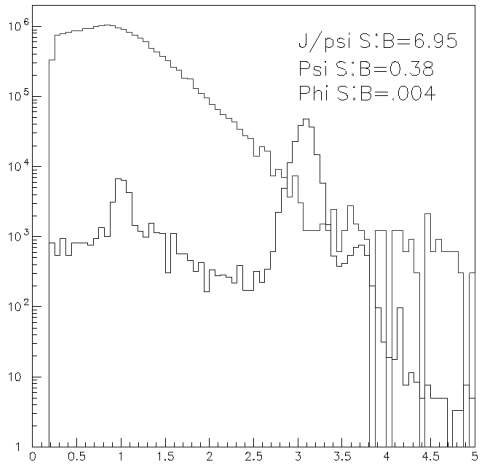


work done by M. Brooks

$J/\psi \rightarrow \mu^+\mu^-$ Acceptance vs P_T and rapidity



J/ψ —> $\mu^+\mu^-$ Invariant Mass



$\mu^+ \mu^-$ Invariant Mass (Gev/c^2)

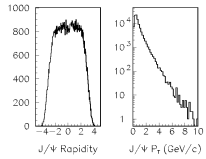
work done by M. Brooks

Drell Yan
Charm Production
Vector Mesons

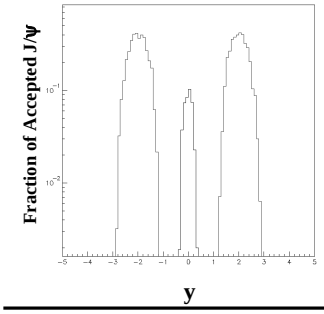
background

1 RHIC year at design luminosity Minimum Bias NO ANOMALOUS SUPPRESSION is included

Detector Acceptance for J/ψ → dileptons



Using the p-N cross section predictions as calculated at NLO for the transverse momentum and rapidity distribution we calculate the acceptance, that is the percentage of J/ψ which have both leptons going through the detector



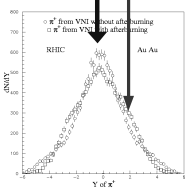
For J/ψ →$\mu^+\mu^-$

$$\frac{N_{J/\psi}(accepted)}{N_{J/\psi}(total)} = 8.6\%$$

For J/ψ →e^+e^-

$$\frac{N_{J/\psi}(accepted)}{N_{J/\psi}(total)} = 0.75\%$$

VNI Model π+ Rapidity nucl-th/9705041



J/ψ Invariant Mass Resolution and Acceptances

Particle	Mass Resolution (MeV/c^2)	Acceptance (%)
J/ψ→μμ	105	8.6
ψ'→μμ	105	8.6
Υ→μμ	180	8.3
ψ→ee	20	0.75
ψ' →ee	20	0.75

Estimate of J/ψ Integrated Yield in one Year of RHIC

Assuming there is **no anomalous J/ψ suppression** we can calculate an upper limit to the J/ ψ Integrated Yield.

$$\sigma_{AA\to J/\psi} BR = A^{2\alpha}\sigma_{pN\to J/\psi} BR = 3.3mb \quad \text{with} \quad \begin{cases} BR\ \sigma_{pN\to J/\psi} = 185nb \\ \alpha = 0.92 \end{cases}$$

We estimate one year of running for 8 months corresponds to 10^7 seconds, to account for detector and accelerator down time(50%). Using the RHIC design luminosity L= 2x 10^{26} cm^{-2} s^{-1}.Then the total number of J/ψ produced is:

$$N_{J/\psi}(total) = 6.3\times10^6 events$$

Within the PHENIX acceptance we have:

Particle	Dimuon Decay	Dielectron Decay
J/ψ	530k	53K
ψ'	9k	0.9k
Υ	0.8k	

Conclusions

- **Within one year of RHIC running at full luminosity we will have data sample of size comparable to NA50 for J/ψ**
- **PHENIX has capabilities of measuring several charmonium states**
- **RHIC will allow pp, pA, AA collisions therefore we will be able to make a systematic study of charmonium and bottonomium production providing STRINGENT CONSTRAINTS on production/suppression theoretical models.**

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