# Measurements of J/ with PHENIX Muon Arms in 2003 p+p Collisions

for the PHENIX Collaboration

2003

2003 9 11

# Content

1. Physics motivation

2. PHENIX Muon Arms

3. Detector Performance

4. J/ψ Mass

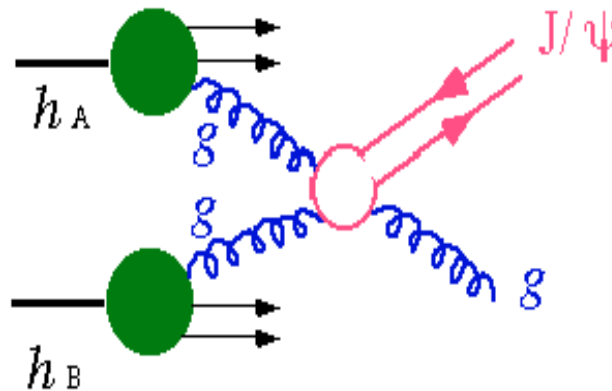5. J/ψ Polarization

6. Summary

# Physics Motivation

Spin Structure of Proton

$$\frac{(\sigma_{++}^{J/\psi}) - (\sigma_{+-}^{J/\psi})}{(\sigma_{++}^{J/\psi}) + (\sigma_{+-}^{J/\psi})} = \mathrm{A}_{\mathrm{LL}}^{\mathrm{J/\psi}} = \frac{\Delta g(x_1)}{g(x_1)} \times \frac{\Delta g(x_2)}{g(x_2)} \times a_{LL}^{g+g \to J/\psi}$$

There is theoretical ambiguity for J/ production mechanism

Versus

$h_A$

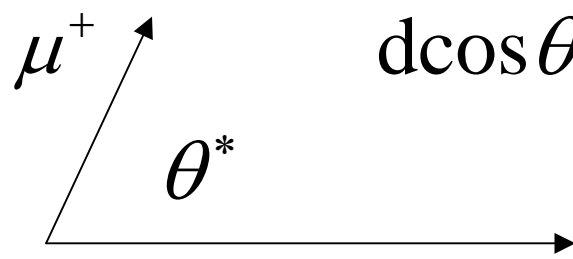$h_B$

$g$

$g$

$g$

J/ψ

Cross section for J/ production, J/ Polarization

# J/ Polarization

There are three J/ production models.

<span style="color:red">Color Singlet Model (CSM)</span>     > 0 Transverse
<span style="color:red">Color Evaporation Model ( CEM)</span>    = 0 Unpolarized
<span style="color:red">Color Octet Model (COM)</span>     < 0 Longitudinal

$$\frac{\mathrm{d}\sigma}{\mathrm{dcos}\,\theta^*} \sim 1 + \lambda \cos^2 \theta^*$$
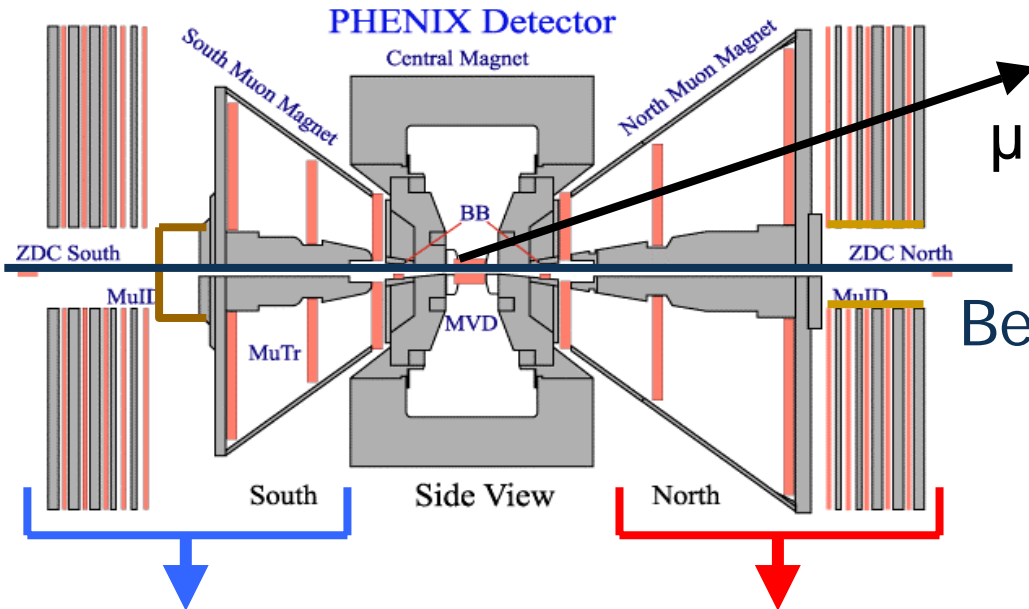
$\mu^+$

$\theta^*$

* is the angle between the μ⁺ in the J/ rest frame and J/ momentum direction.

J/ Momentum direction

<span style="color:red">J/ polarization can distinguish these models</span>

2003  9  11

4

# PHENIX Muon Arms

### North Muon Arm became operation in 2003 Run



μ

Muon Tracker (MuTr)
   Measurement of momentum

Muon Identifier (MuID)
   Muon identification
   Trigger Counter

Geometry Acceptance
   North : 1.2 <  < 2.4
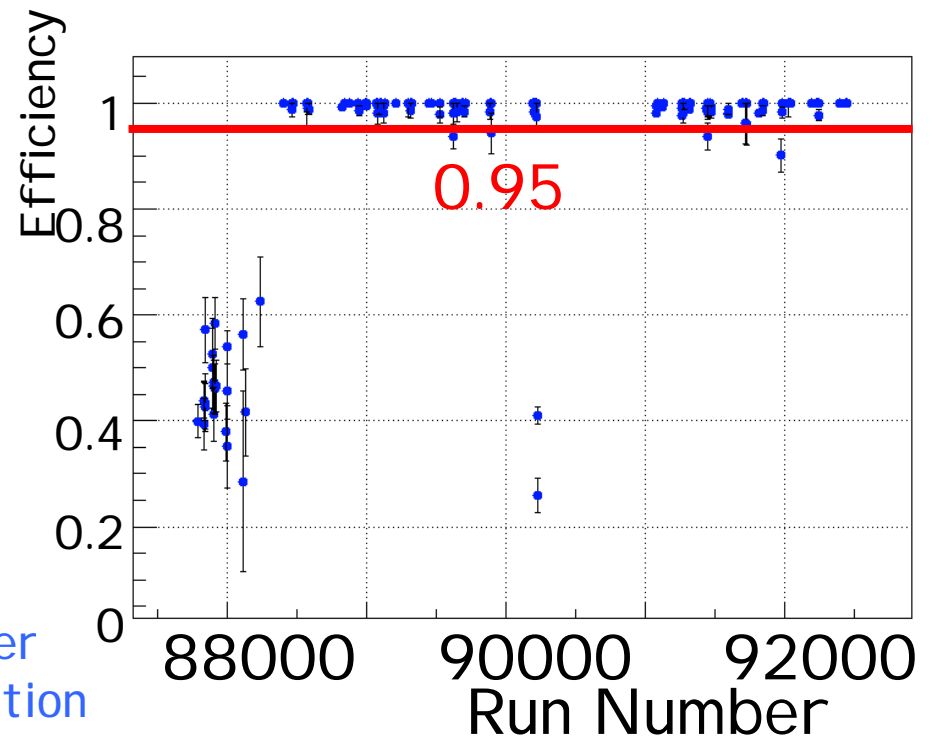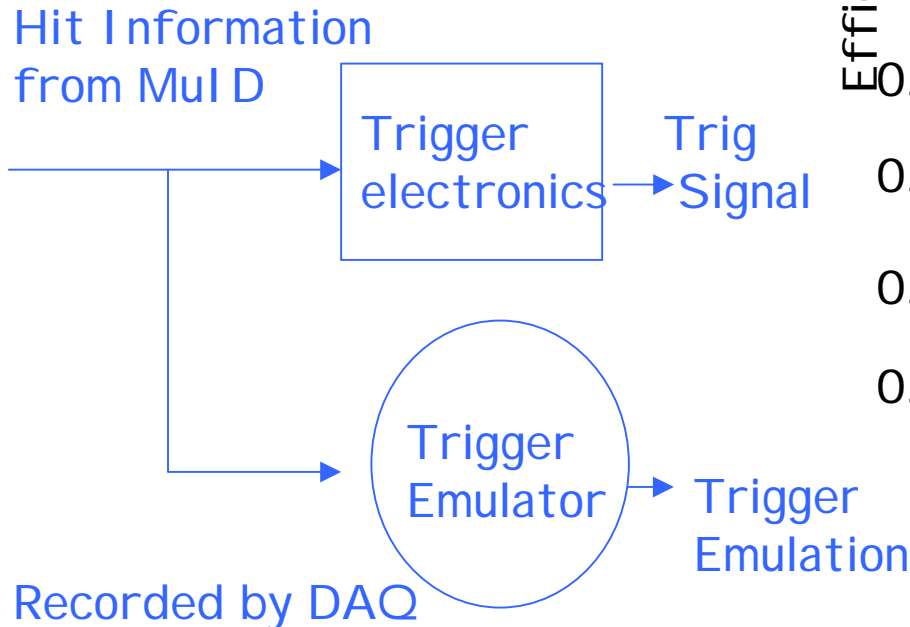   South:  -2.2<  <-1.2
Muon range cut off ~ 2GeV/c

South Muon Arm
2001~

North Muon Arm:
2002~

$\sqrt{s} = 200\,\text{GeV}$   Proton-Proton Collision

Longitudinal Polarization
   average 27%

# Muon Trigger by MuID

MuID is divided by 4("Quadrant")

Coincidences in z direction
at each Quadrant make muon
road for trigger signal.

z direction

Quadrant

Quadrant

Quadrant

Horizontal

Vertical

Look Up
Table

Muon Trigger signal
• single muon
•dimuon

# Trigger Circuit Efficiency

Hit Information
from MuID

Trigger
electronics → Trig
Signal
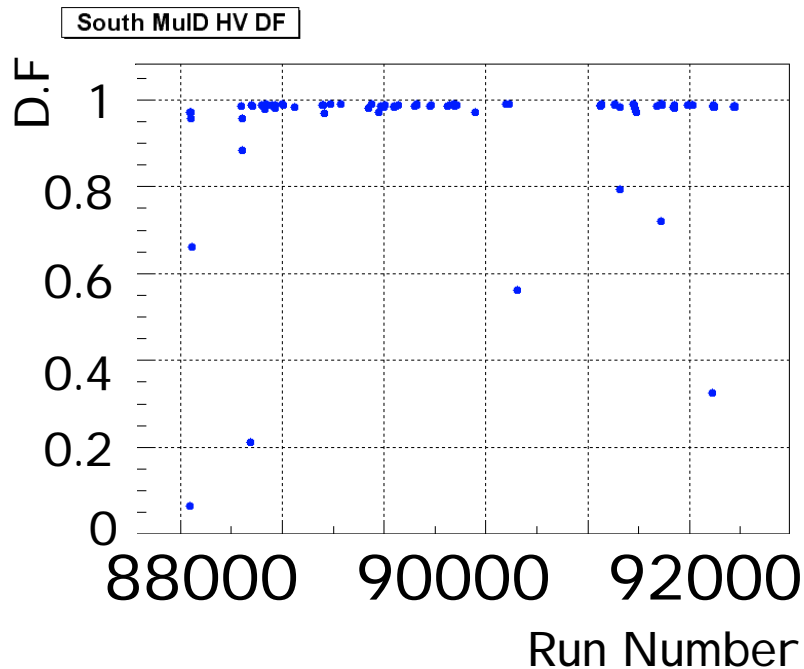
Trigger
Emulator → Trigger
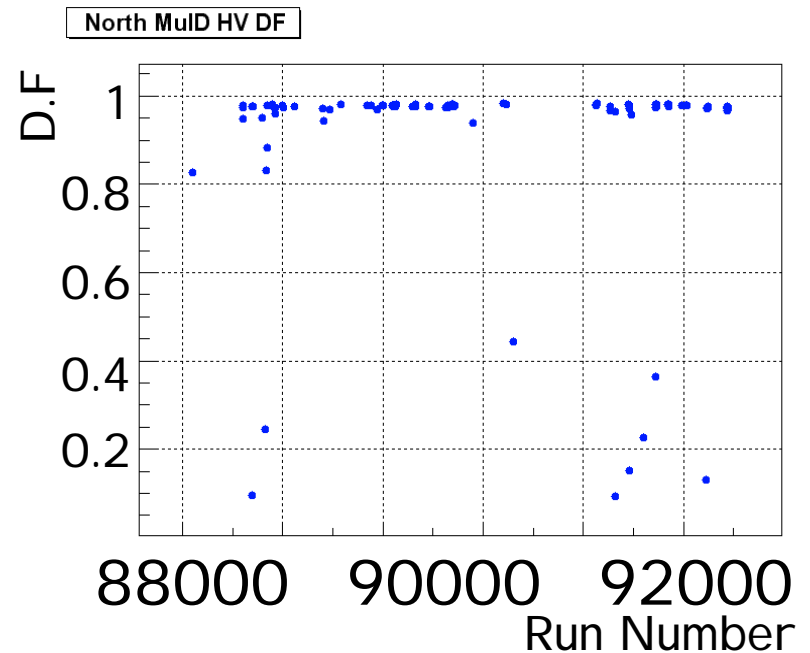Emulation

Recorded by DAQ

Efficiency

0.95

Run Number

$$\text{Trigger Circuit Efficiency} = \frac{\#(\text{Trig Signal} \cap \text{Trigger Emulation})}{\#\text{Trigger Emulation}}$$
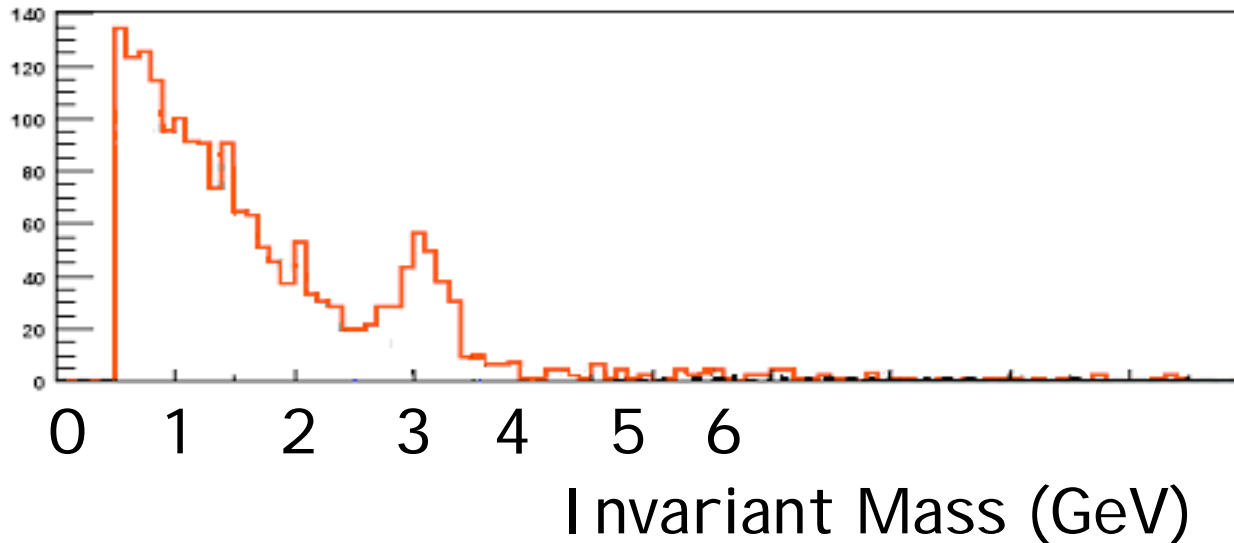
using Minimum Bias events

# MuID HV Status

South MuID HV DF

North MuID HV DF

South MuID

North MuID

$$\text{Duty Fraction} = \frac{\int (\# \text{ of live HV channel}) \, dt}{\int (\# \text{ of HV channel}) \, dt}$$

Select more than 30 minutes Run

# J/ψ Mass

First Detection J/ψ with North Muon Arm
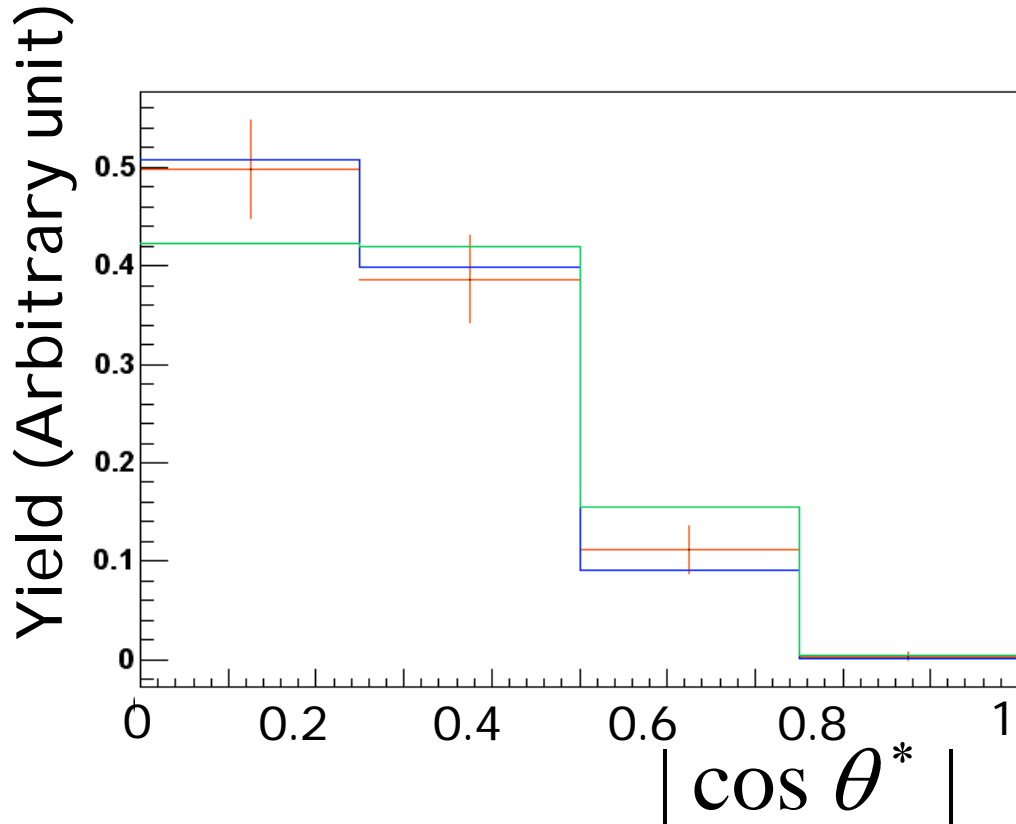


Invariant Mass (GeV)

Data Sample: Dimuon Trigger
Integrated Luminosity: 143 $nb^{-1}$ (~50% of run3pp (350 $nb^{-1}$))
Dimuon sample : 3M
J/ψ : ~ 227 J/ψ's

Expected number of J/ψ : 600 (North and South)

# How can we determine J/ψ Polarization?



= 1 Transverse
= 0 Unpolarized
= -1 Longitudinal

Pt(J/ψ) > 2 GeV/c
Using Pt(J/ψ) distribution by Run2
GRV94

$$\frac{\mathrm{d}\sigma}{\mathrm{d}\cos\theta^*} \sim 1 + \lambda\cos^2\theta^*$$

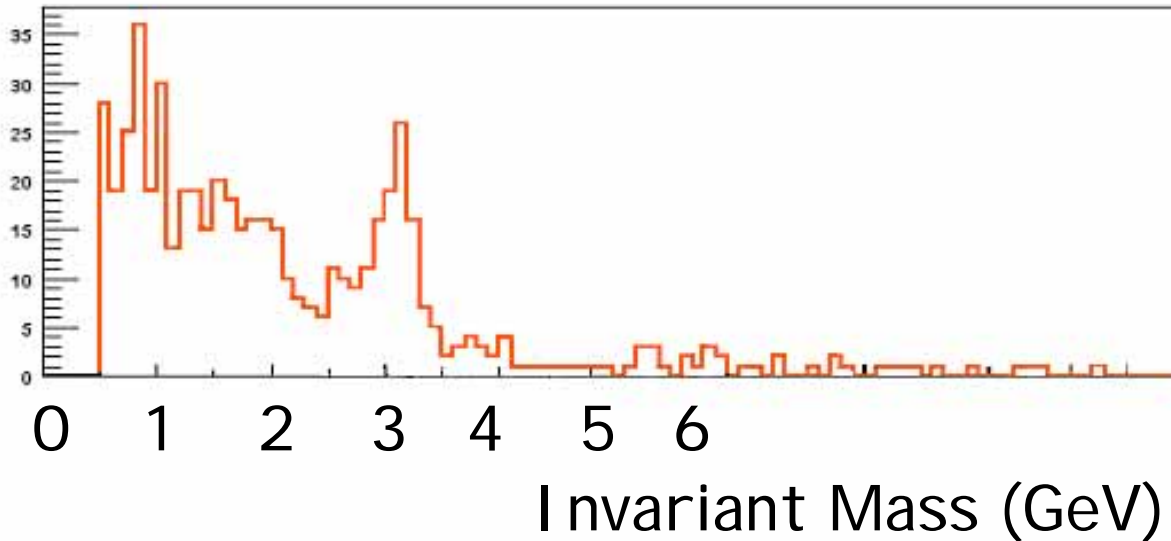J/ψ number for evaluating error: 200 (Pt(J/ψ)>2Gev/c)

# Summary

- PHENIX took polarized proton-proton collision data at $\sqrt{s}$ = 200 GeV with 350 $nb^{-1}$ integrated luminosity in 2003 Run.

- North Muon Arm was newly installed in 2003 Run.

- Muon Trigger at both Arms were working well.

- $J/\psi$ was measured with both Muon Arms.

- We confirm $J/\psi$ Polarization is measurable.

# J/ψ Mass

South Arm

Invariant Mass (GeV)

Data Sample: Dimuon sample
Integrated Luminosity: 143 nb$^{-1}$ (65% of run3pp)
Dimuon sample : 1M
J/ψ : ~ 98 J/ψ's