J/Ψ production in p+p and Au+Au @ 200 GeV as seen by the PHENIX experiment at RHIC

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Topics in Heavy-Ions Collisions
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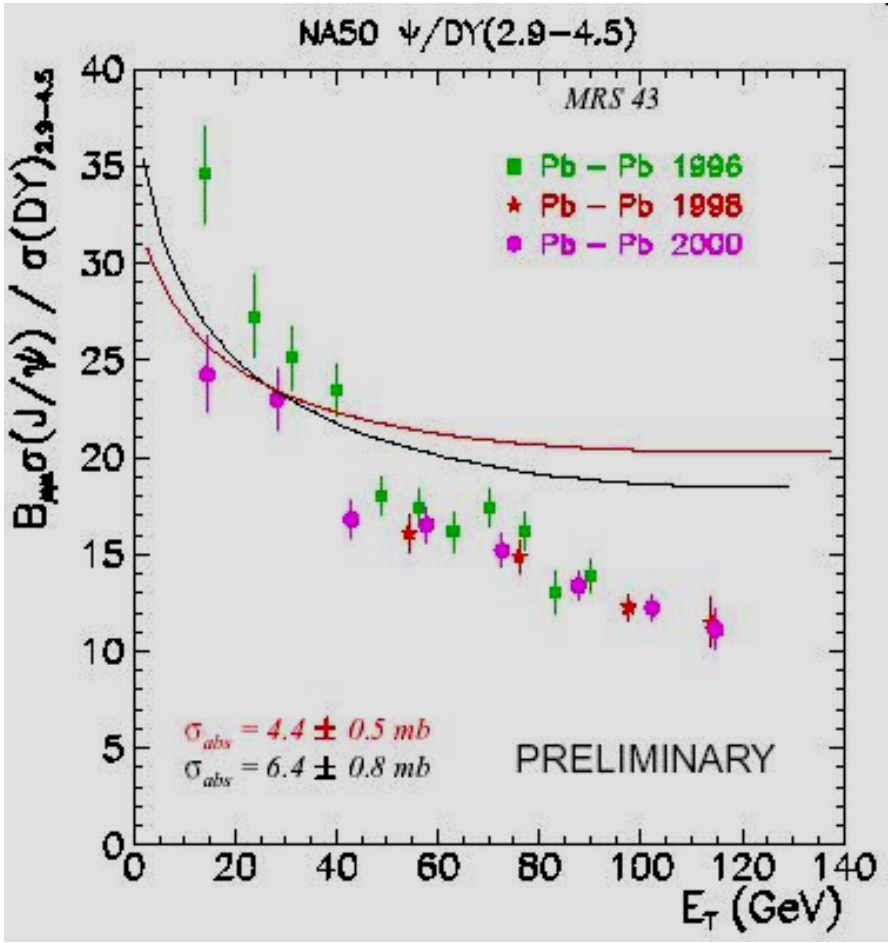
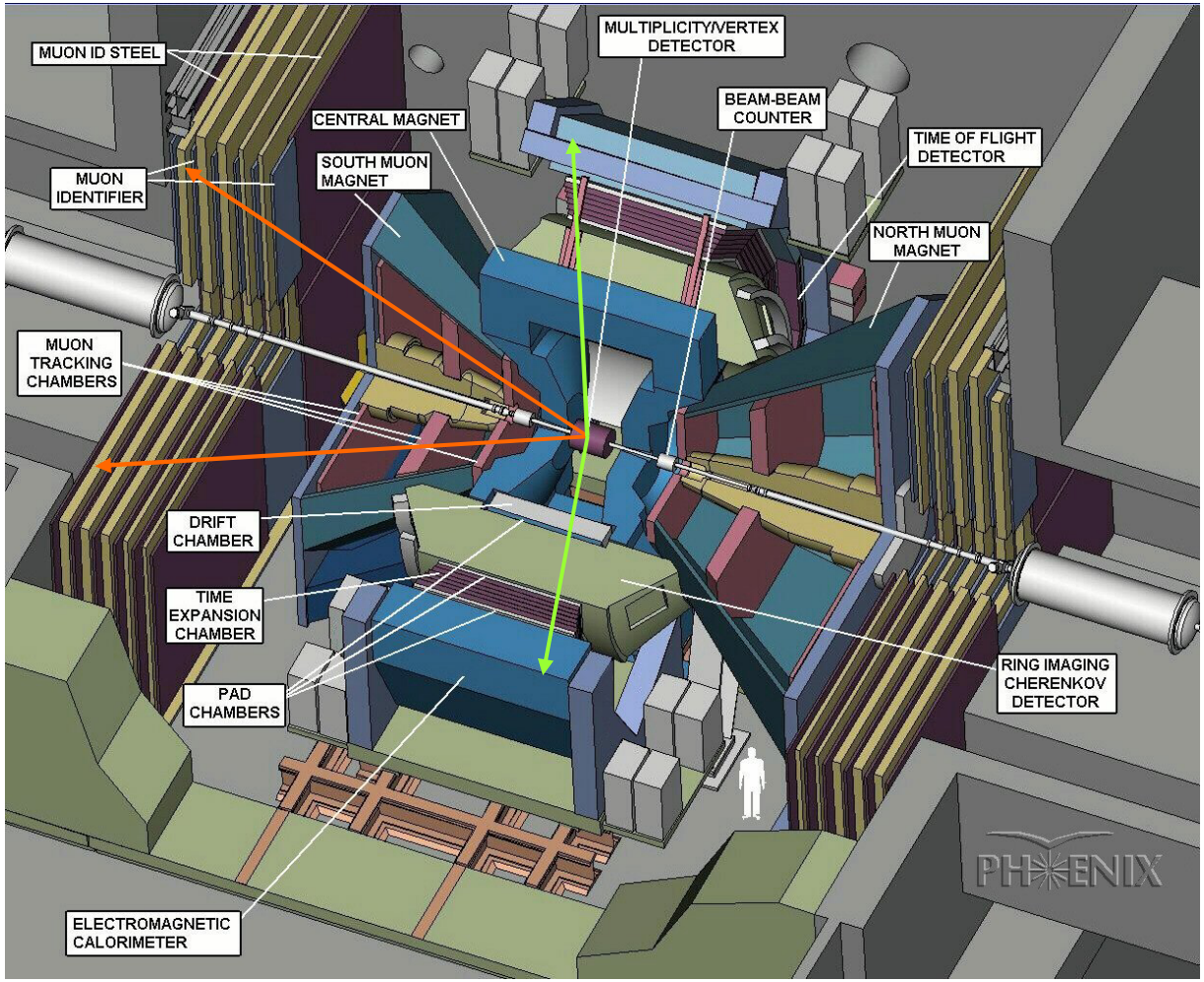
Physics motivation

- In *AA* collisions :
  - Quarkonia production expected to be modified in a Quark Gluon Plasma
  - Anomalous suppression seen at CERN →
- In *pA* (or *dA*) collisions :
  - Normal nuclear effects (Shadowing, Cronin, …)
  - Baseline for *AA*
- In *pp* collisions :
  - Cross section
  - Production mechanisms
  - Baseline for *pA* and *AA*



(NA50 from Quark Matter 2002)

How does PHENIX see the J/Ψ ?



$J/\Psi \rightarrow e^+e^-$
identified in RICH and EMCal

- $|\eta| < 0.35$
- $p > 0.2$ GeV

$J/\Psi \rightarrow \mu^+\mu^-$
identified in two forward spectrometers

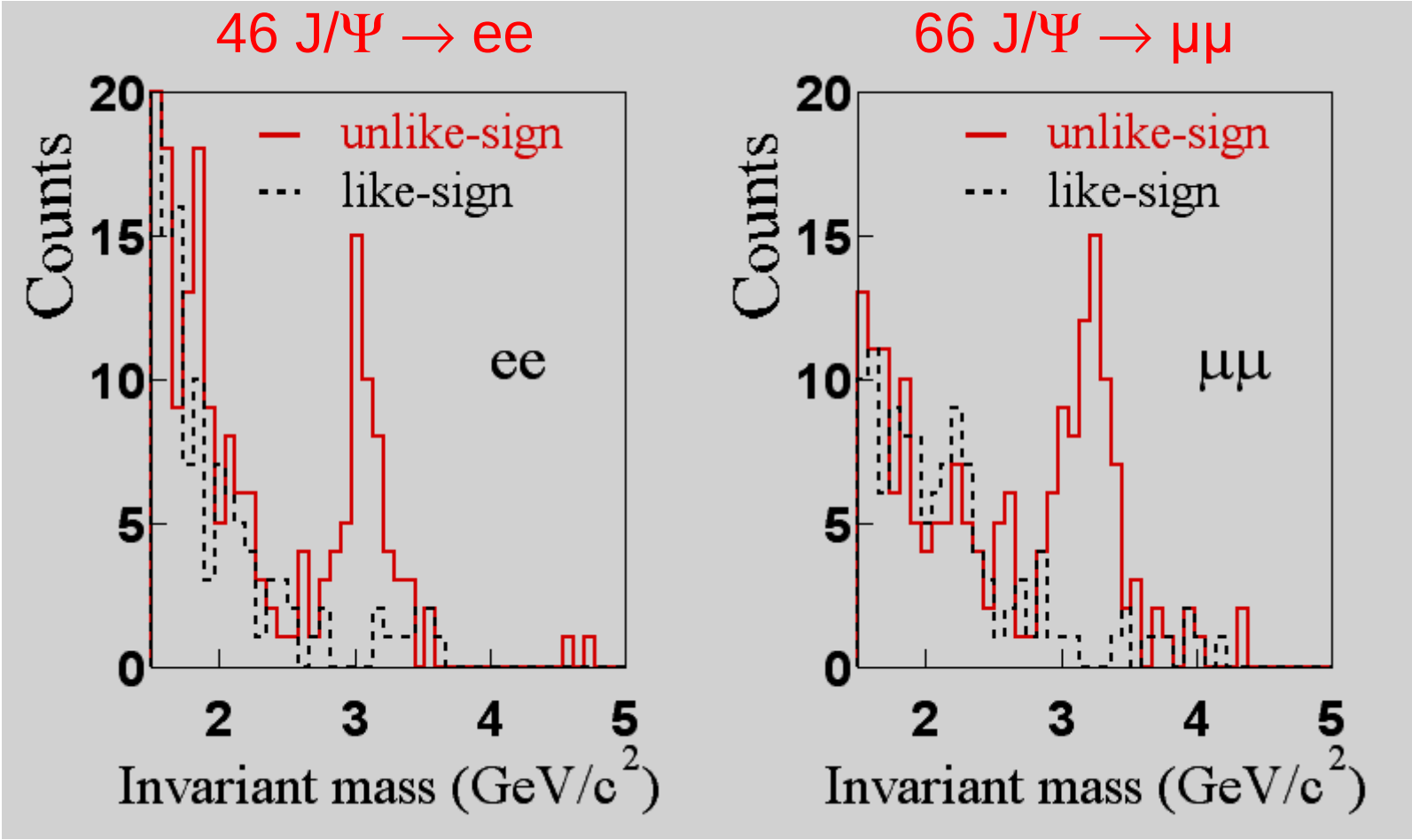
- $\pi/\mu \sim 10^{-4}$
- $1.2 < |\eta| < 2.4$
- $p > 2$ GeV

Centrality and vertex given by global detectors

RHIC run history (and outline)

Year	Species	Energy	Luminosity	Detectors
2000	Au-Au	130 GeV	1 μb^{-1}	Central (electrons)
2001/2002	2. Au-Au	200 GeV	24 μb^{-1}	Central + 1 muon arm
	1. p-p	200 GeV	0,15 pb^{-1}	
2002/2003	3. d-Au	200 GeV	2,74 μb^{-1}	Central + 2 muon arms
	p-p	200 GeV	0,35 pb^{-1}	
2003/2004	Au-Au	200 GeV	? ? ?	! ready !

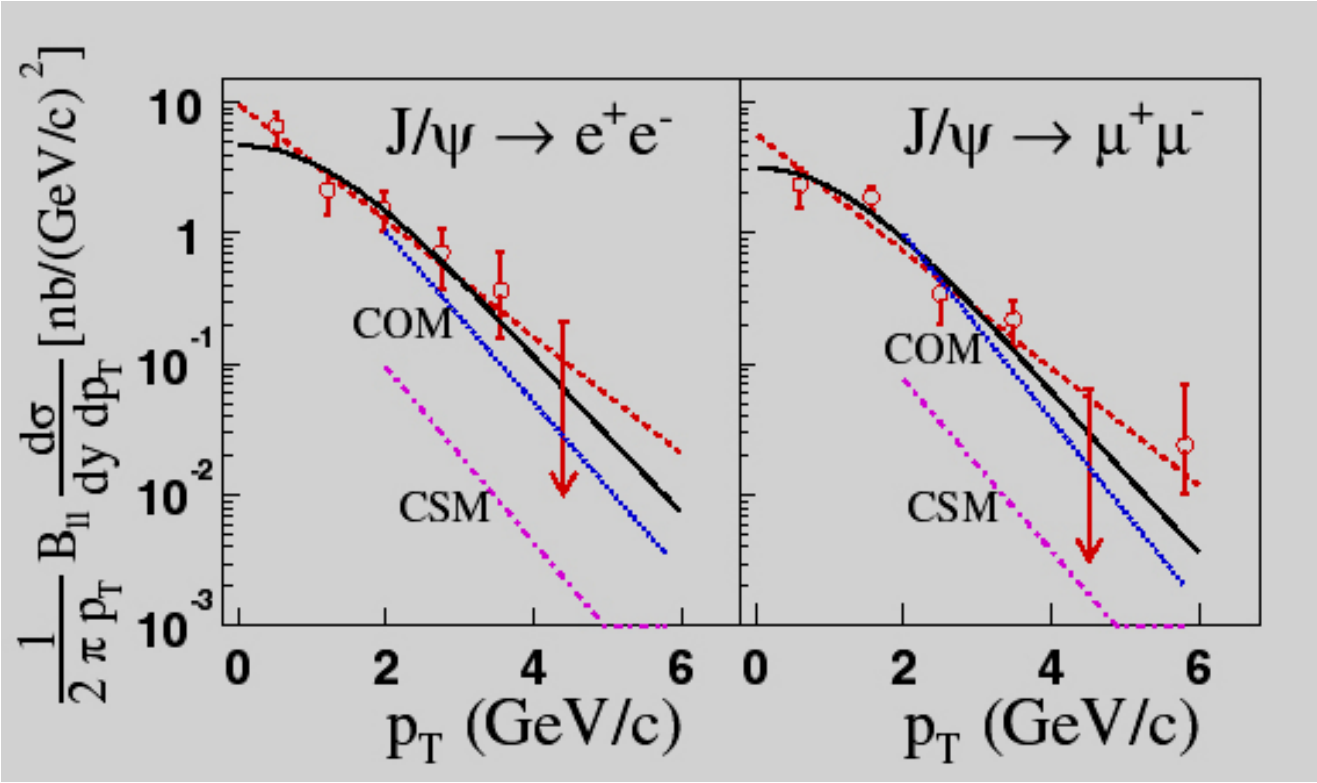
J/Ψ statistics in p + p



Resolutions agree with expectations

σ_{ee} ~ 110 MeV $\sigma_{\mu\mu}$ ~ 160 MeV

J/Ψ transverse momentum



Color Singlet Model

Color Octet Model

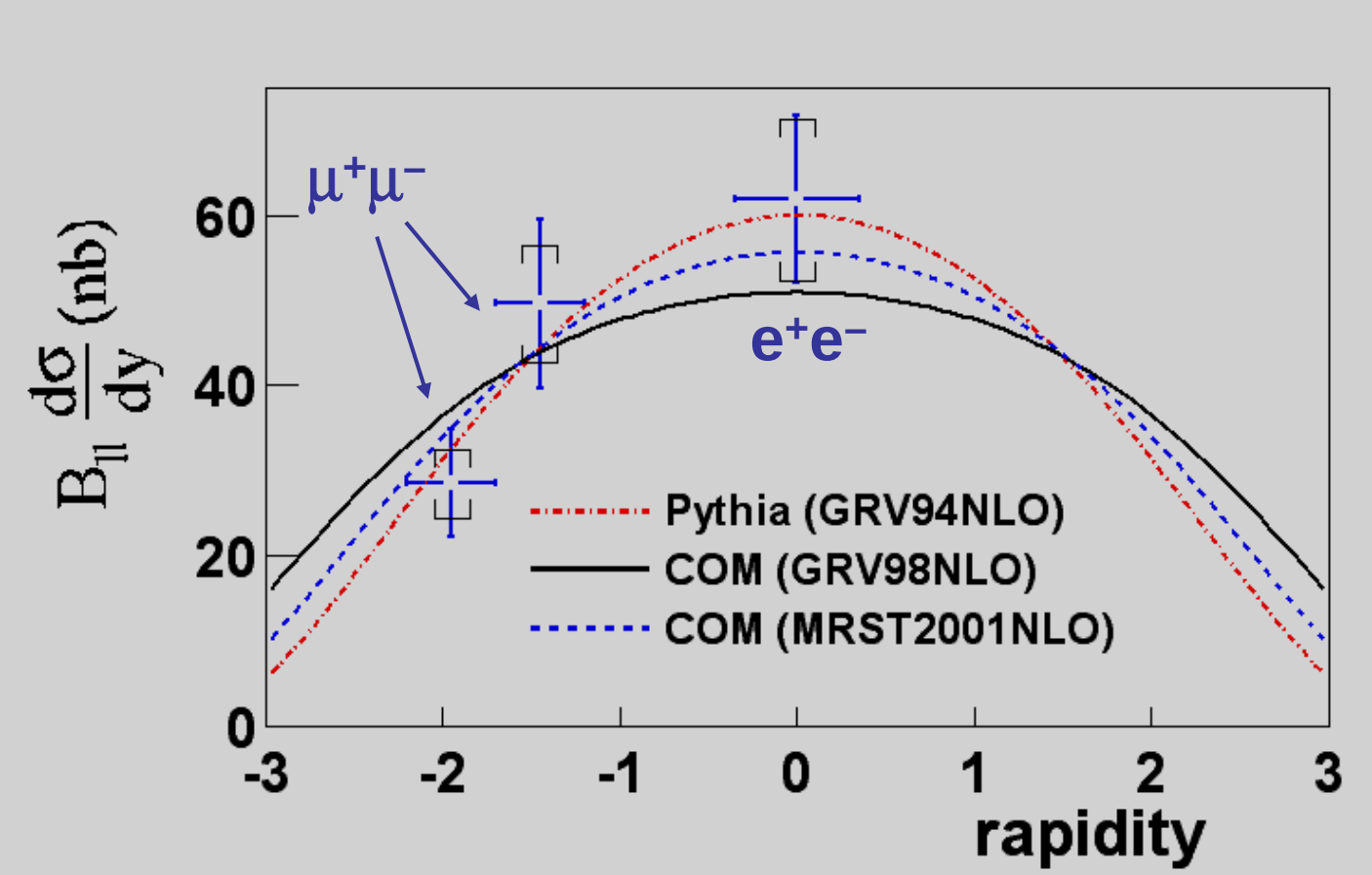
(from Nayak et al. hep/ph 0302095)

COM contribution is dominant, as for high p_T J/Ψ @ Tevatron

Phenomenological + exponential fits of dimuon and dielectron data give mean p_T :

<pT> = 1.80 ± 0.23 (stat) ± 0.16 (sys) GeV/c

J/Ψ cross section



Results consistent with shapes from various models and PDF.

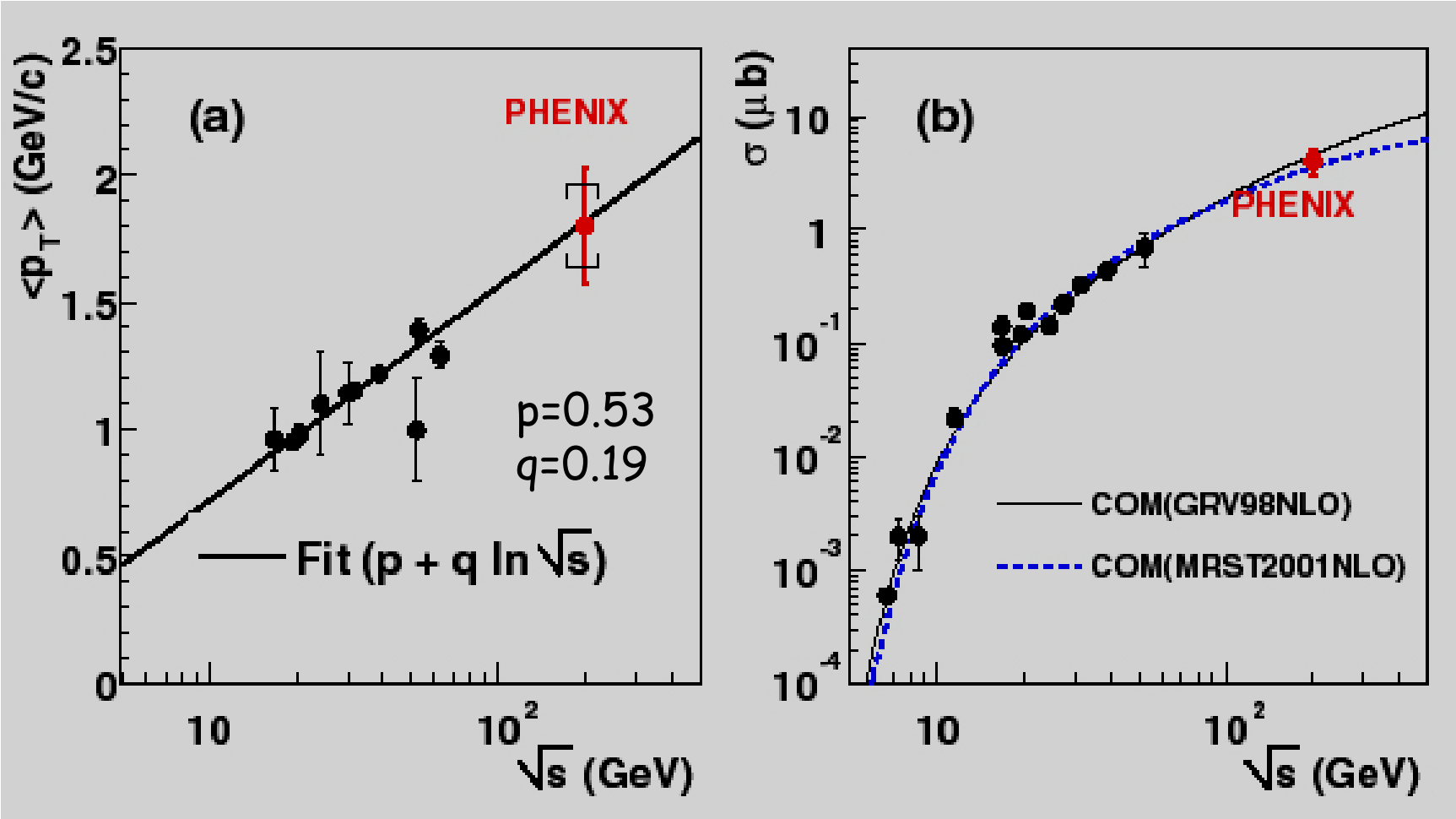
Take the PYTHIA shape to extract our cross-section

Error from absolute normalization

Integrated cross-section :

3.99 ± 0.61 (stat) ± 0.58 (sys) ± 0.40(abs) µb

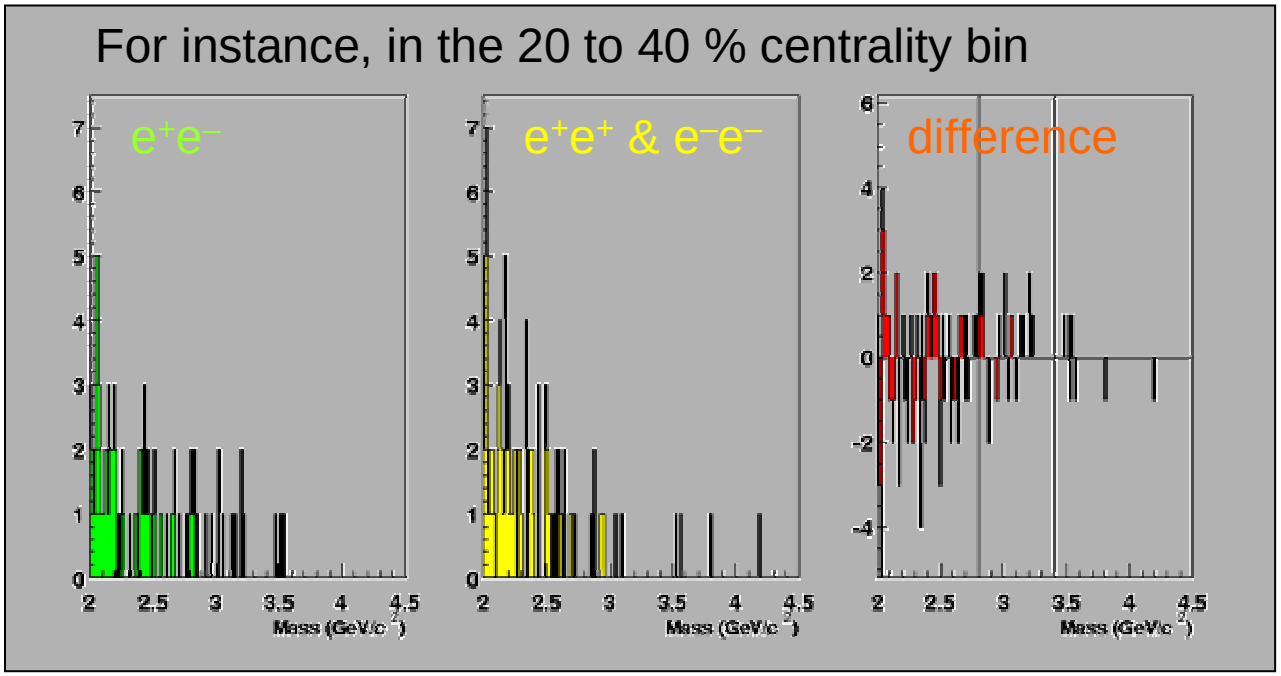
Running with energy



Cross section well described by Color Octet Model

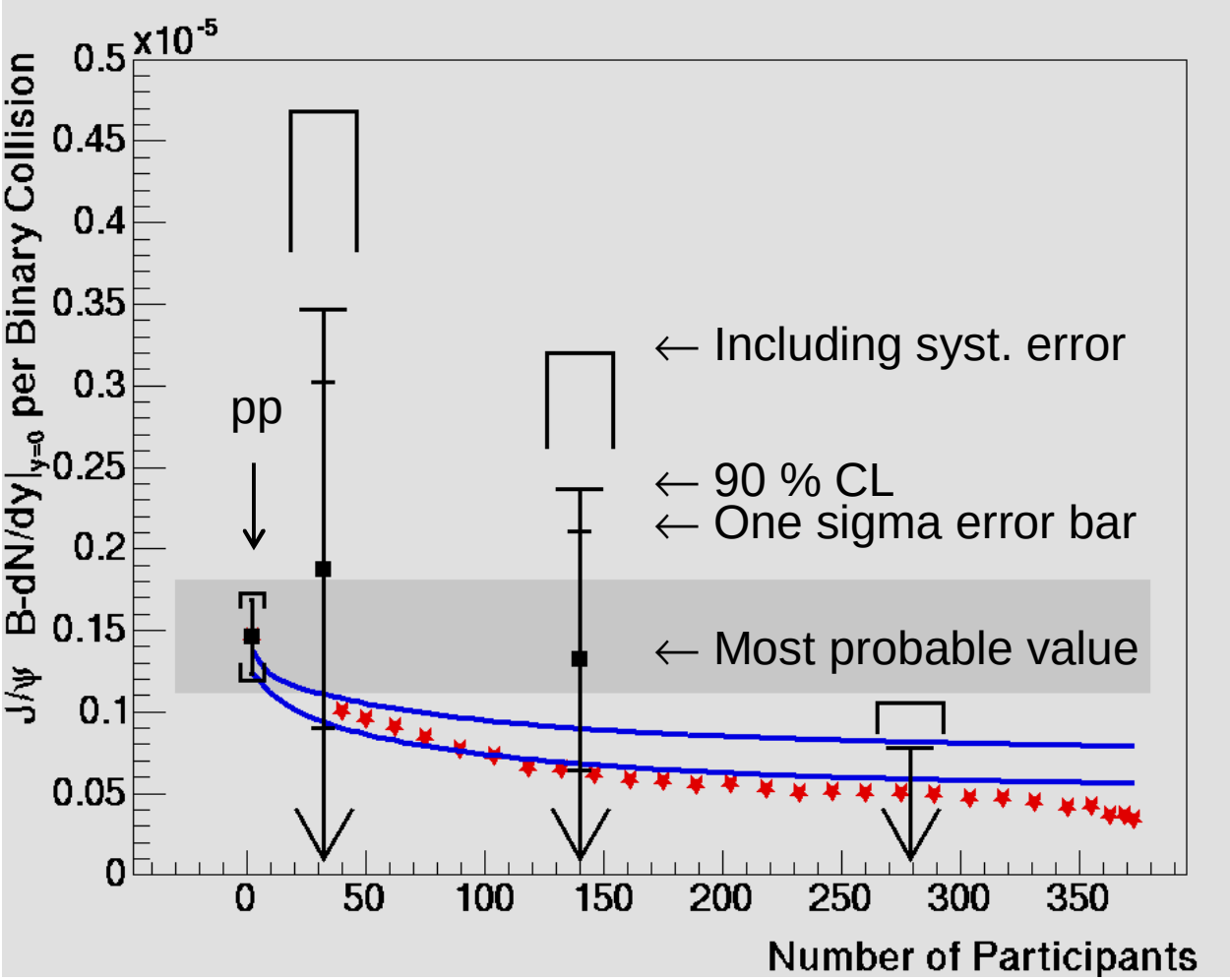
J/Ψ statistics in Au+Au

- Di-muon statistics are marginal
  - One arm only, being commissioned…
- A few di-electron candidates
  - Divided in 3 centrality bins (0-20%, 20-40%, 40-90%)



- Very low statistics !
- Extract signal expectation value from like sign and unlike sign likelihood distribs

J/Ψ versus centrality



No event in most central bin.

Measurements are compatible with zero within 2σ.

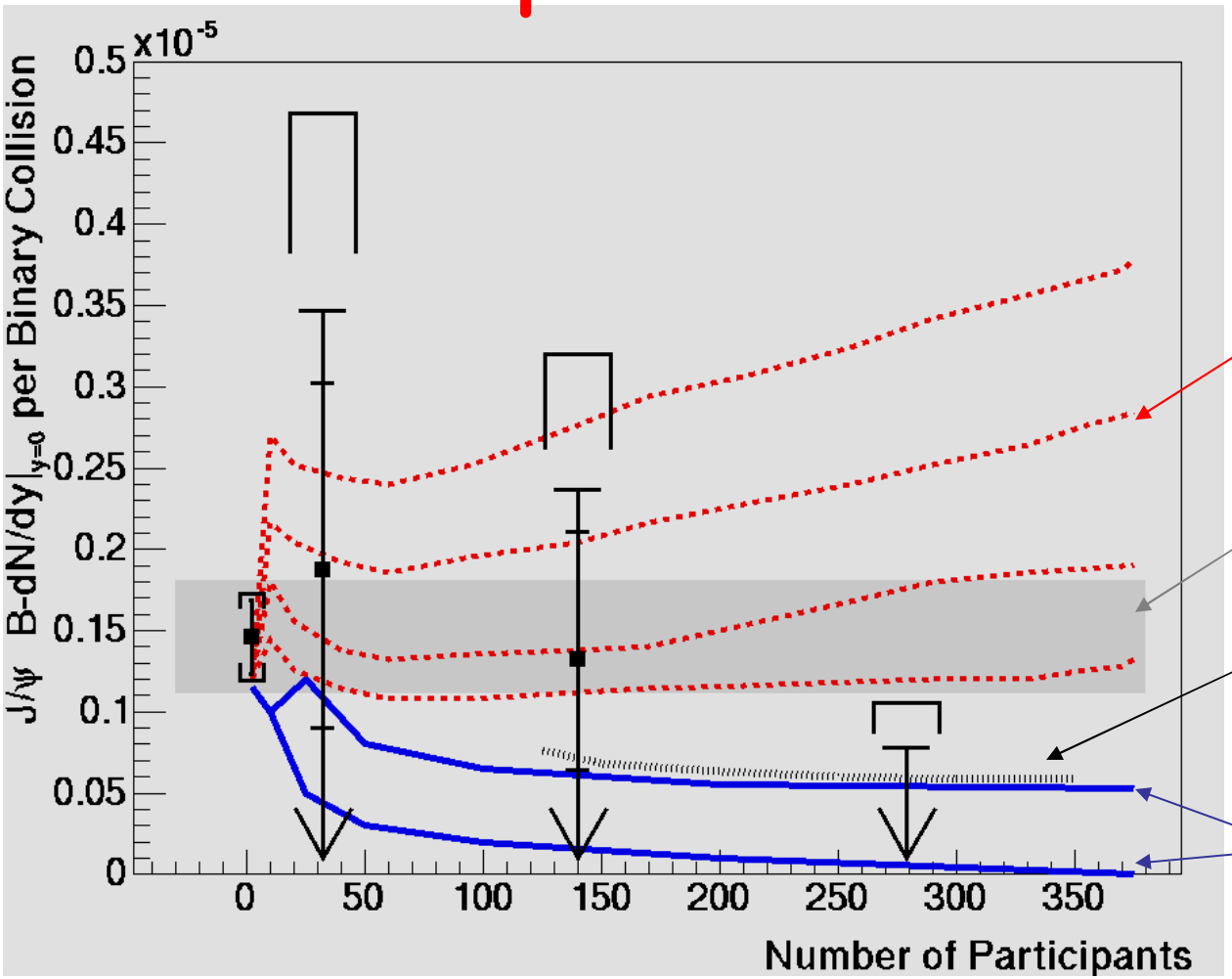
← Binary scaling

← Nuclear absorption 4.4 and 7.1 mb

★ NA50 points normalized to pp for shape comparison

Available as nucl-ex/0305030, submitted to Phys. Rev. C

Comparison with models



Coalescence model
(Thews et al)
PRC63,054905 (2001)
T=400 MeV and
Δy from 1 to 4

Binary scaling

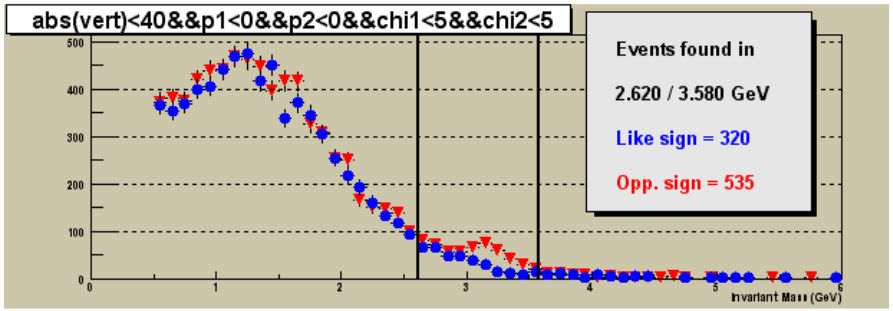
Statistical model
(Andronic et al)
nucl/th 0303036

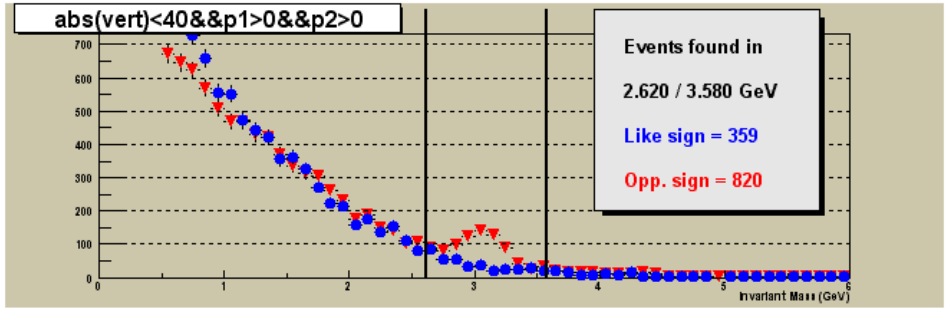
Absorption model
(Grandchamp et al)
NP A709, 415 (2001)

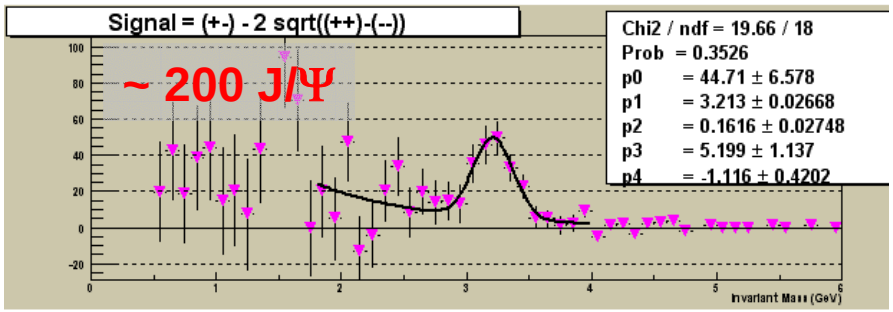
- Cannot distinguish between suppression models
- Disfavor strong enhancement wrt to binary scaling

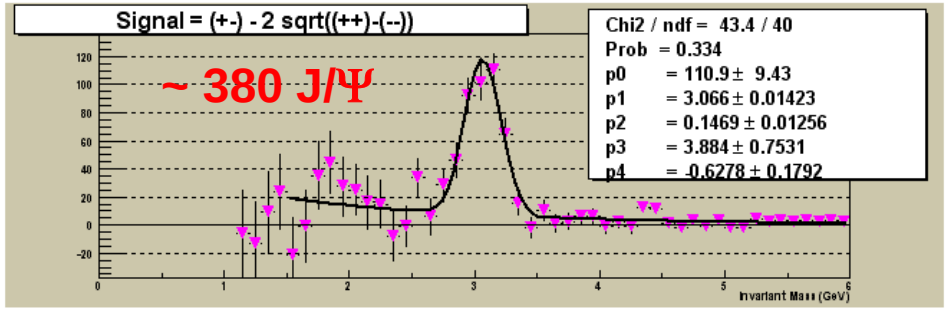
J/Ψ in Deuteron + Gold

- Two muon arms fully commisioned !
- A partial analysis from subsets of data :









- Please, don't compare numbers !
  - Different cuts, no acceptance and efficiency corrections applied ! Analysis in progress…

Last run outcomes

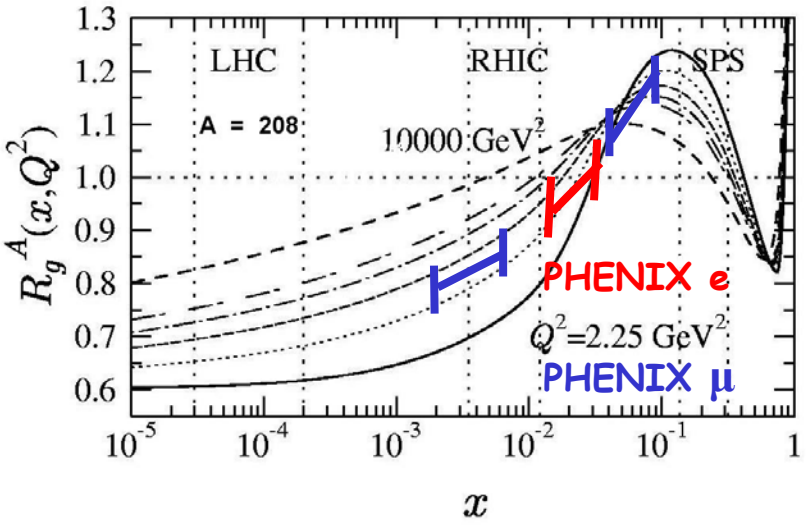
d+Au expected statistics :

~ 1000 J/Ψ per muon arm

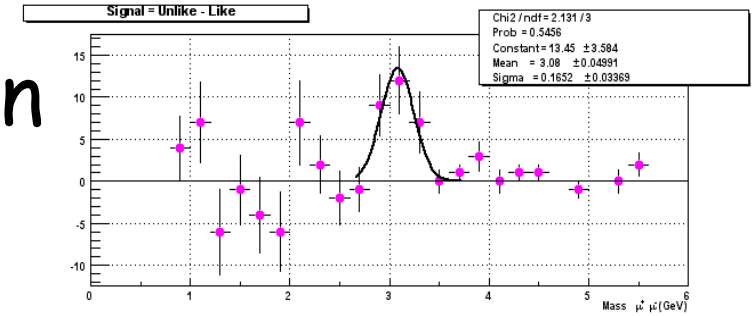
~ 400 J/Ψ in dielectron

Will give us valuable information about gluon shadowing.

Eskola, Kolhinen, Vogt
hep-ph/0104124



New p+p run should contain a few hundred J/Ψ.



Conclusions

- p+p : J/Ψ cross section measured

  3.99 ± 0.61 (stat) ± 0.58 (sys) ± 0.40(abs) μb

  (to be submitted to PRL soon)

- Au+Au : High J/Ψ enhancement is disfavored.
  - We need more statistics !
- d+Au : Promissing statistics for gluon shadowing investigation…
- Au+Au run 4 should allow us to probe J/Ψ anomalous suppression !
  - ~ Maybe 350 μb^{-1} effective luminosity
  - ~ 3000 $J/\Psi \rightarrow \mu\mu$ and 600 $J/\Psi \rightarrow ee$ (if not suppressed)

PHENIX

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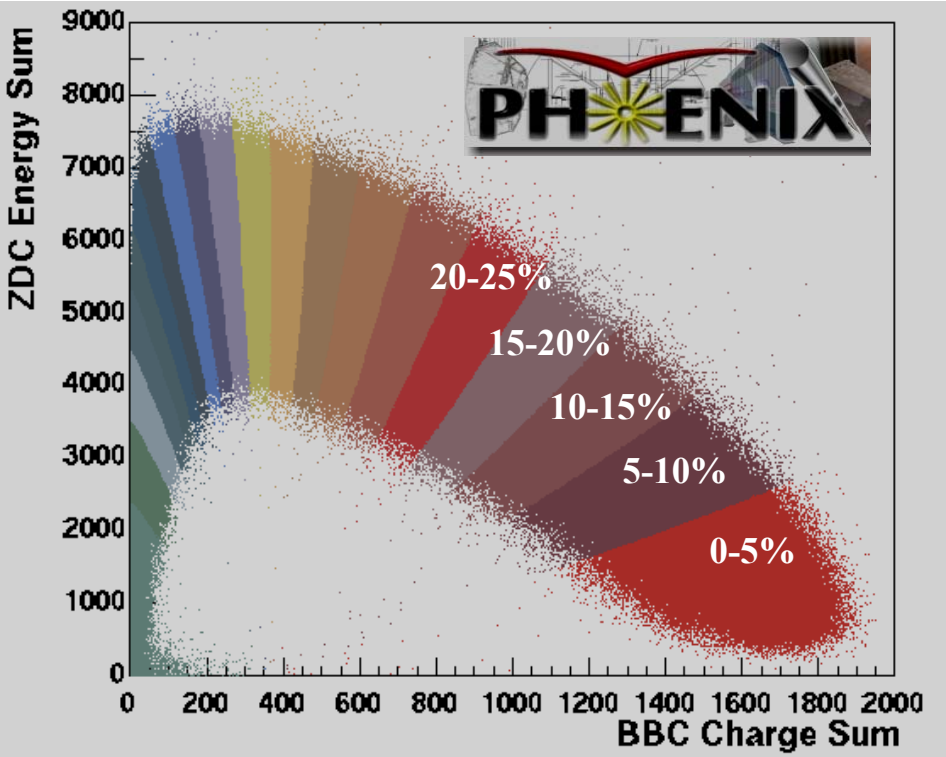
*as of July 2002

Spare slides

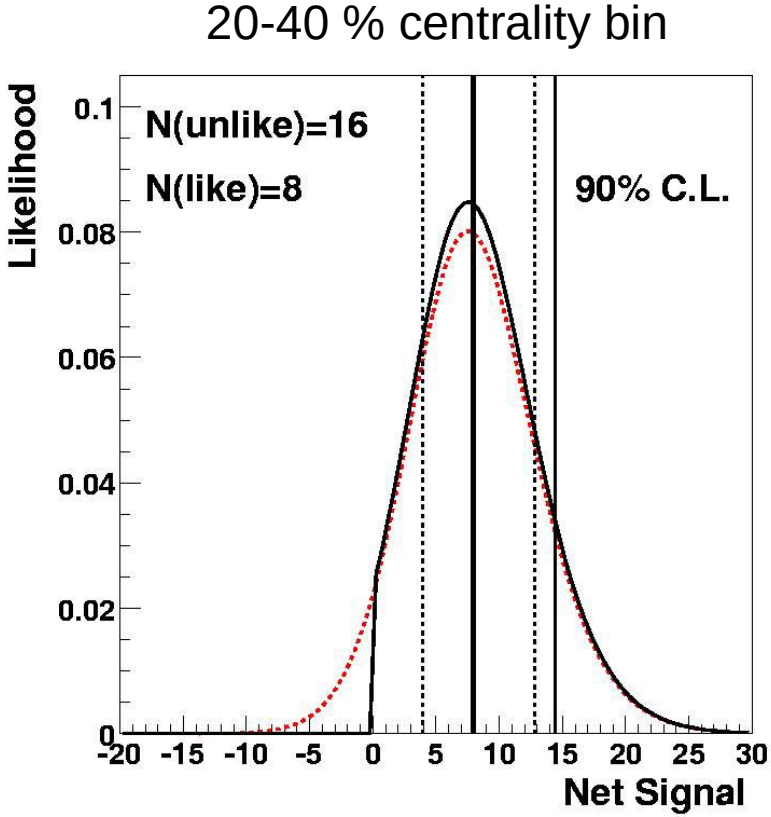
Au+Au centrality



Centrality	N_{part}	N_{bin}
0-20 %	279	779
20-40 %	140	296
40-90 %	32	45
0-90 %	111	263

Au+Au signal determination

- Signal likelihood distribution from
  - Unlike sign and
  - like sign counts
- Renormalize to correct for unphysical negative values.
- Other contributions :
  - J/Ψ from B decay : 1 to 4 %
  - Open charm : 0.02 to 0.1 signal events



Au+Au yields

$B\ dN/dy|_{y=0}\ (x10^{-4})$

Centrality	Most likely value	90% C.L.U.L.
0-20 %	No counts	6.08 + 1.56 (sys)
20-40 %	$4.00\ ^{+2.34\ +1.36}_{-2.01\ -1.60}$	7.19 + 2.43 (sys)
40-90 %	$0.86\ ^{+0.52\ +0.29}_{-0.44\ -0.35}$	1.60 + 0.54 (sys)