J/Ψ measurement in d-Au interactions at $\sqrt{s_{NN}}$ = 200 GeV

Physics Motivation

- J/Ψ production, gluon shadowing.

Run-3 d-Au (2003)

- luminosity, expectations.

State of the analysis

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J/Ψ Production

p-p : study of production mechanism and cross sections

- Color evaporation model, Color singlet model, Color octet model
- Polarization, Rapidity dependence (electron and muon channels)
- Production of J/Ψ, Ψ',.. states
- Base line for pA and AA

p(d)-A : study of "normal nuclear effect": shadowing and energy loss

- Nuclear dependence of $\sigma(J/\Psi)$: A^{α} or σ_{abs} (nuclear absorption)
- Base line for AA

A-A : study of "medium effect" in high density matter

- J/Ψ suppression : signature of QGP (Matsui/Satz)
- J/Ψ formation by c quark coalescence at RHIC/LHC ?

Comparisons between various collision species are very important.

Studies done via both dielectron and dimuon channels in PHENIX.

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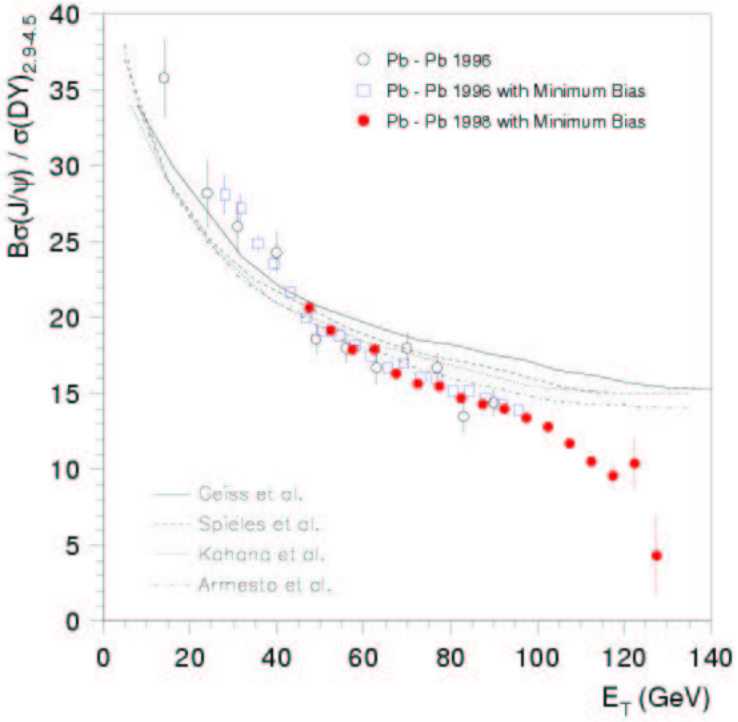
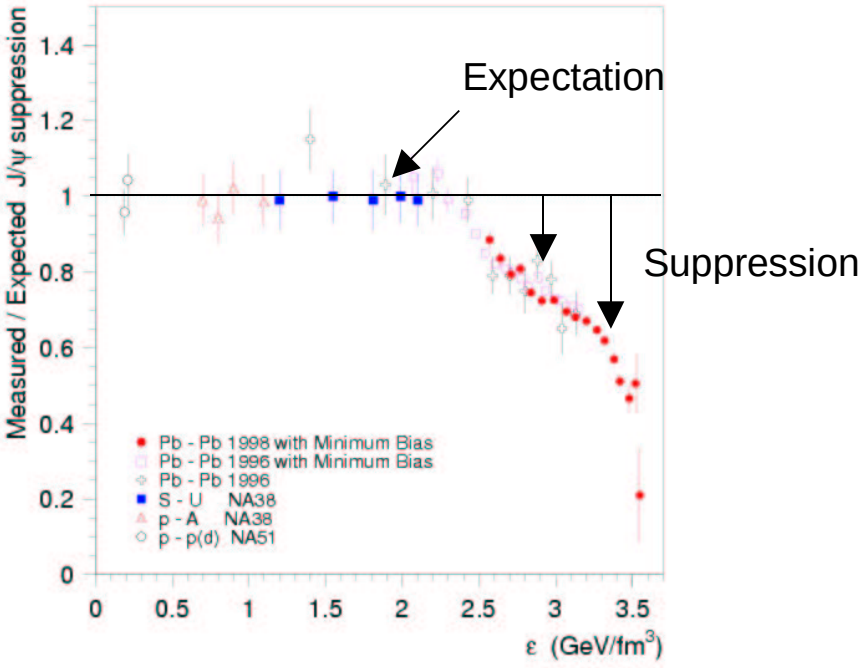
Observation at CERN (NA50)



J/Ψ normalized to
Drell-Yan vs “Centrality”

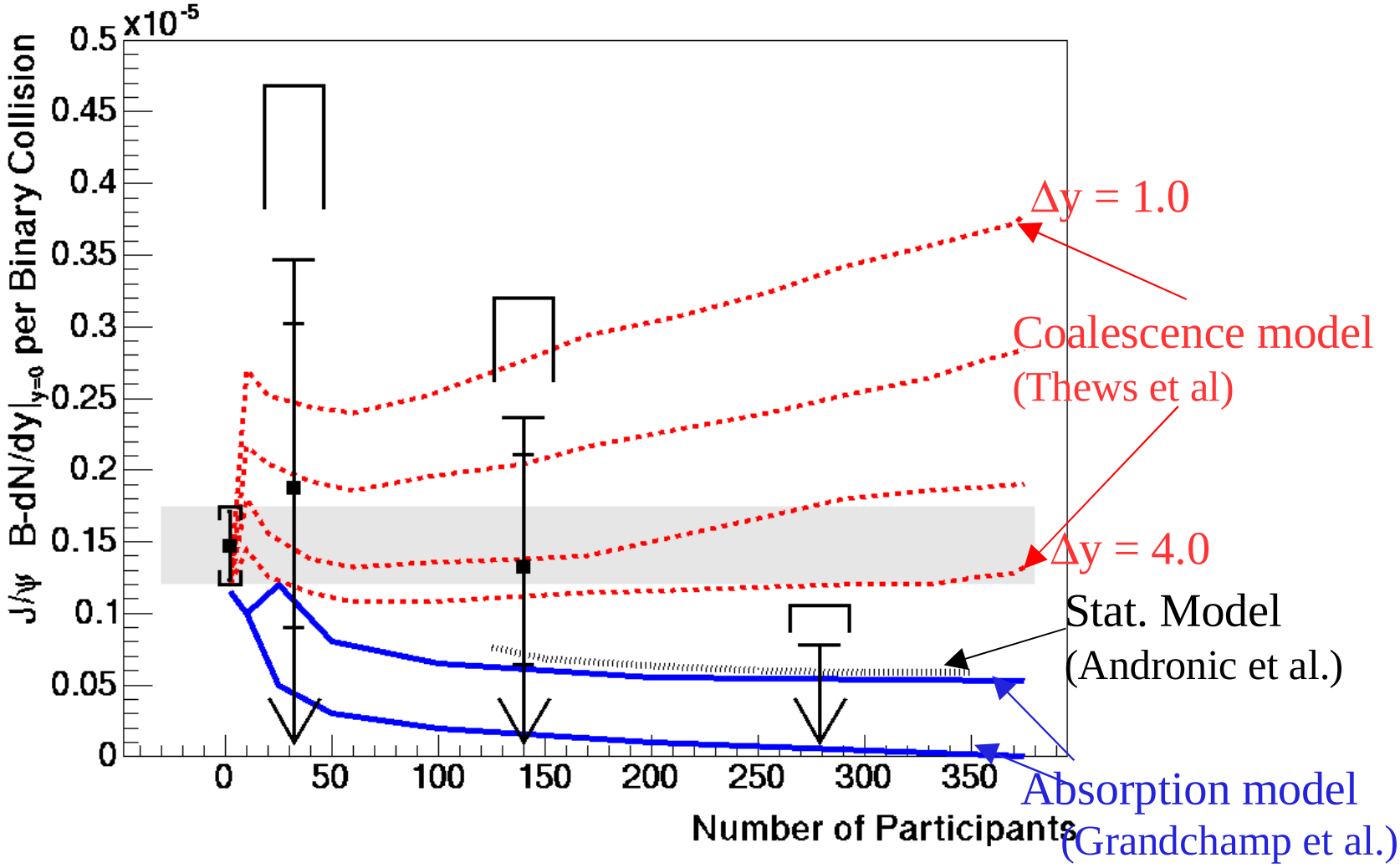
NOTE: D-Y is not the optimal normalization, closed/open charm is better.

Pb-Pb collisions show suppression in excess of "normal" nuclear suppression



NA50, Phys. Lett. B477 (2000) 28.

Run-2 Au-Au Di-electron result



Disfavor models with enhancement relative to binary collision scaling.
Cannot discriminate between models that lead to suppression relative to binary collision scaling.

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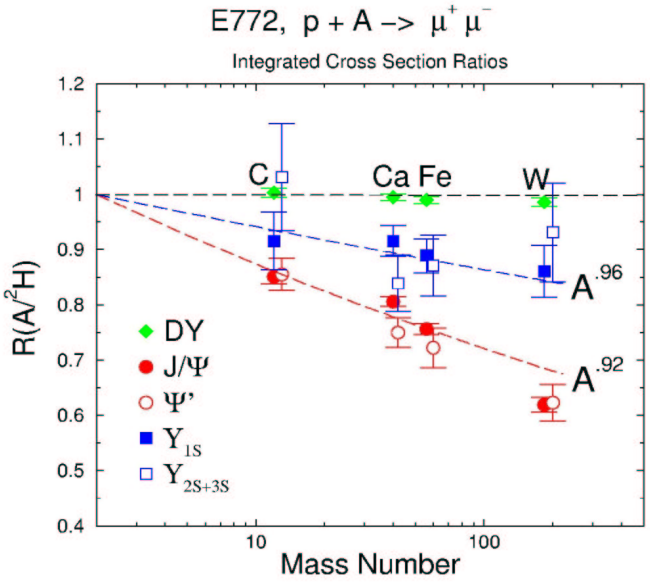
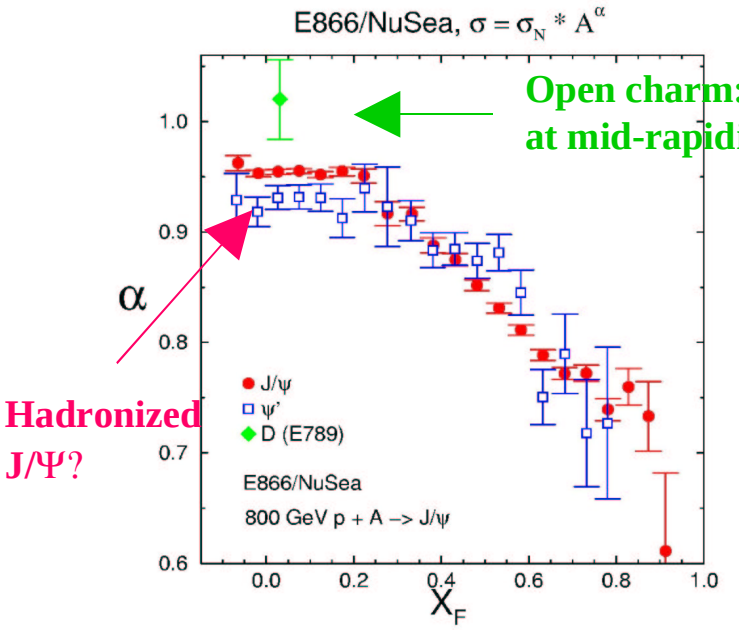
J/Ψ Suppression





Open charm: no A-dep at mid-rapidity

Hadronized J/Ψ?

J/Ψ suppression – an effective signature of Quark-Gluon Plasma (QGP) formation?

Color screening in a QGP would destroy $c\bar{c}$ pairs before they can hadronize into charmonium

But ordinary nuclear effects also absorb or modify J/Ψ's

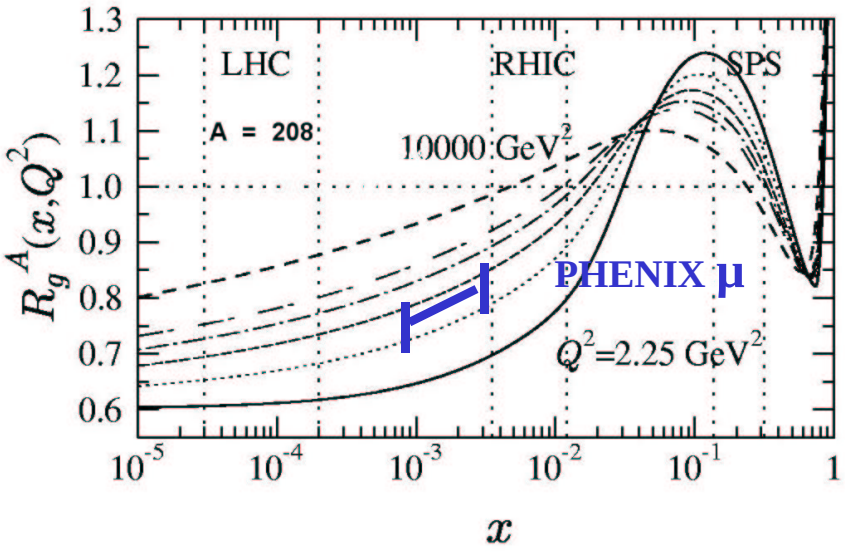
We need a comprehensive understanding of open charm and charmonium production

Gluon Shadowing

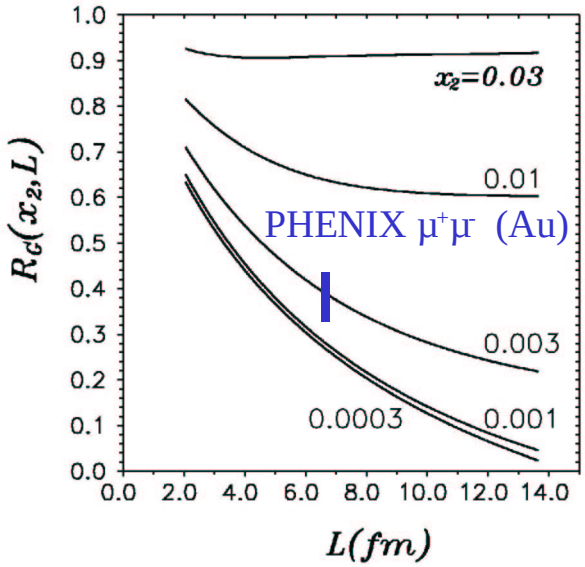
$R(x,Q^2,A) \equiv f_i^A(x,Q^2) / [A\, f_i^N(x,Q^2)] < 1$ ➔

Shadowing (partons recombining) resulting in e.g. lower J/Ψ yields..

Eskola, Kolhinen, Vogt hep-ph/0104124



Kopeliovich, Tarasov, & Hufner hep-ph/0104256



Gluon shadowing effects for nuclei, for the relevant x and Q^2 regions for the PHENIX muon arms, have large uncertainties. Kopeliovich et al., predict approx. a factor of 2 lower R_g values than Eskola et al.

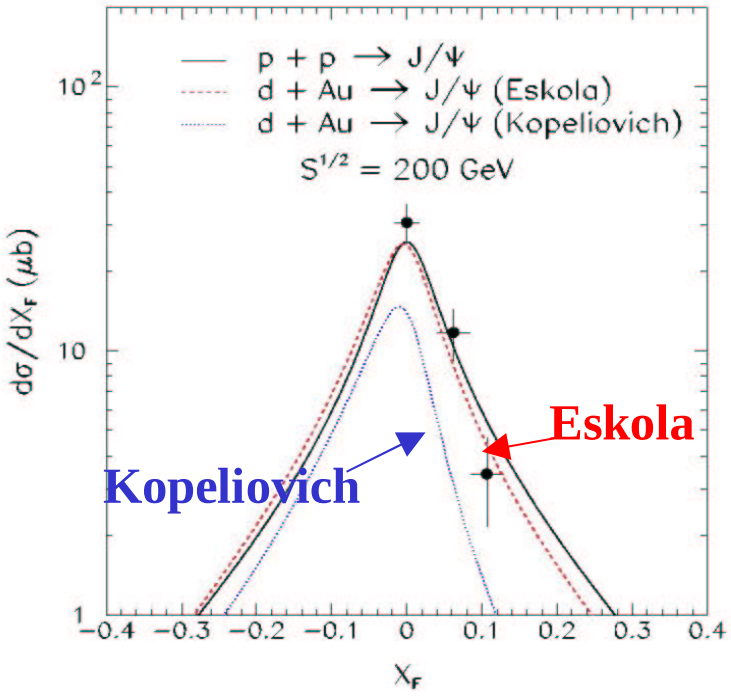
Kinematics

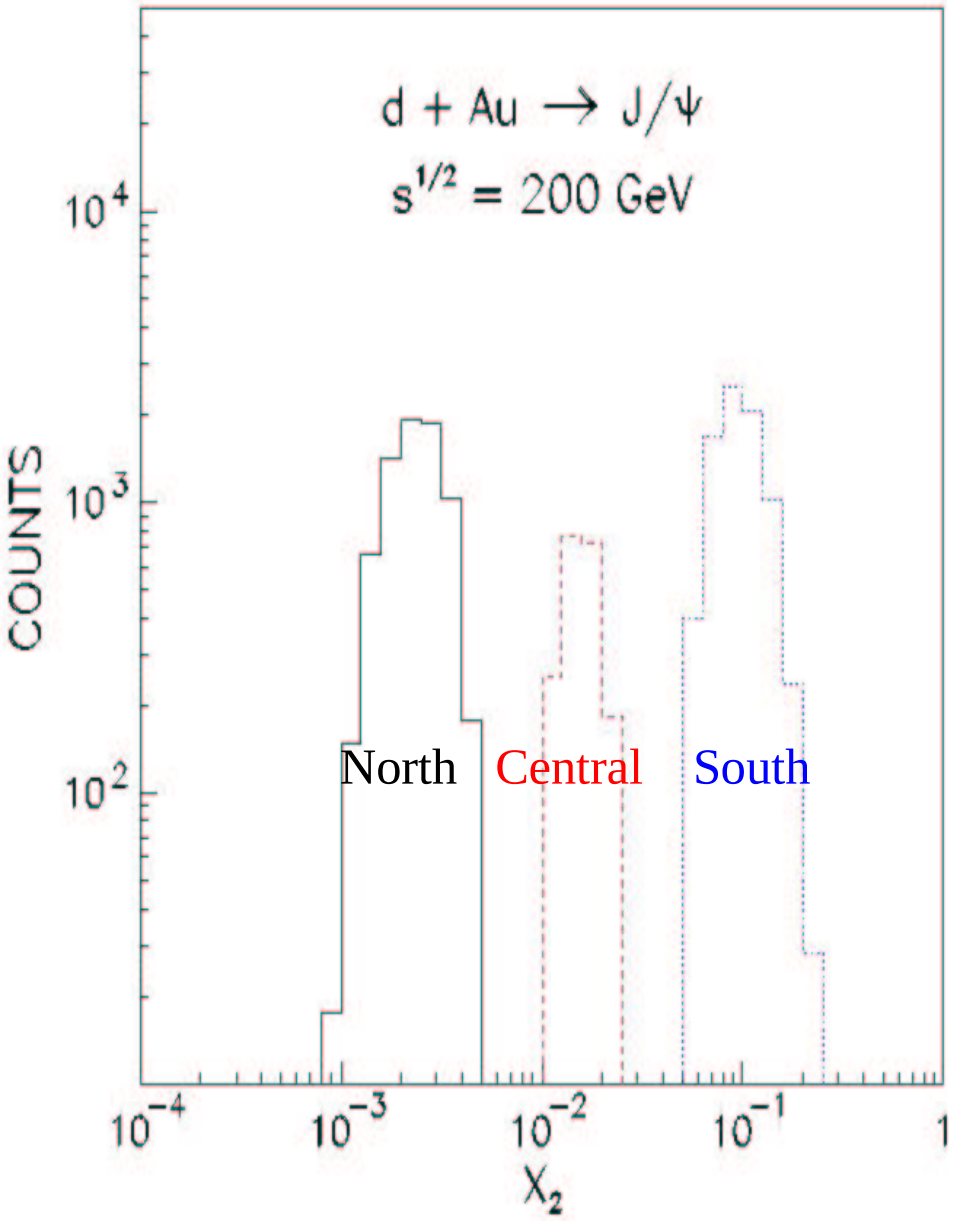
$x_F = 2*p_z/\mathrm{sqrt}(s)$.

$\tau = m^2/s$,

$x_1 = 1/2*(x_F+\mathrm{sqrt}(x_F^2+4*\tau))$;

$x_2 = x_1 - x_F$





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Luminosity / Expectations

$N_{J/\Psi} = N_{BBC} / \sigma_{BBC} * \sigma_{J/\Psi} * B.R. * Acc * Eff.$

- N_{BBC} = 5.5 G events; σ_{BBC} ~= 2.6 *0.88 b; B.R. ~= 0.06

- $\sigma_{J/\Psi}$ ~= 0.8 mb(?); (α ~= 0.92 scaling from pp)

Acc * Eff ~= 0.0226 (N.B.: both arms, not with real MUID tube eff.)

=> $N_{J/\Psi}$ ~= 2.6 k (somewhat optimistic estimate)

Number of J/Ψ's expected from the ~ 2.7 nb^{-1} d-Au run (w/o shadowing)

~ 1000/arm for $\mu^+\mu^-$

~ 400 for e^+e^-

p-p run may give ~ 300/arm J/Ψ's for $\mu^+\mu^-$.

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Analysis Strategy

Goal - result by QM 2004: dAu/pp vs y, centrality, pT, cos(theta)

So far, used level-1 trigger filtered data samples

- d-Au deep-deep – done, ¼ of total data
- p-p deep-shallow – ¼ done

Analyze to nDst's

- d-Au done at CCF

Trigger efficiency : BLT and MUID tube eff.

MC acceptance & efficiency calculations

- Dead HV channel, scratched strips (all in database)
- Folds in reconstruction efficiency

Centrality dependence - Jane

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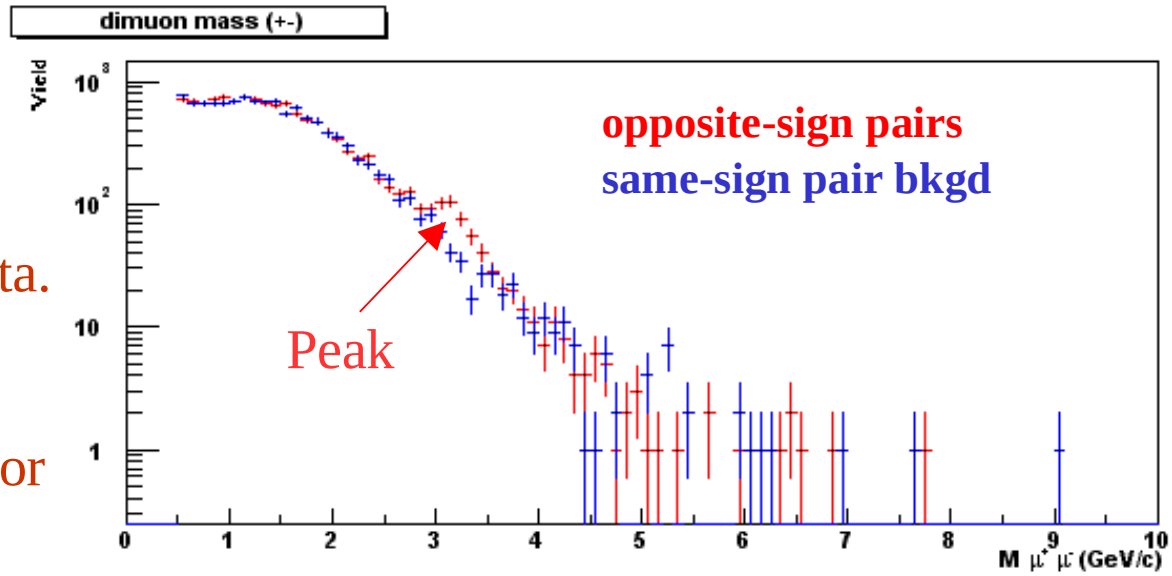
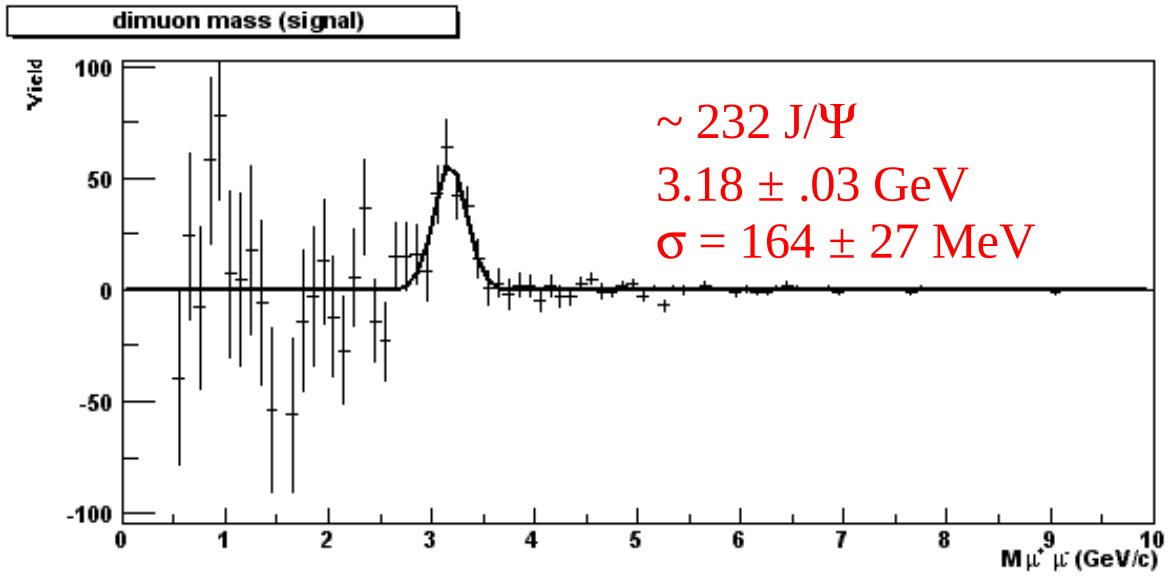
Run-3 dAu : South muon arm

Analyzed a subset of the data.

Expect of the order of a factor of four improvement of the statistics when the whole d-Au run is included.





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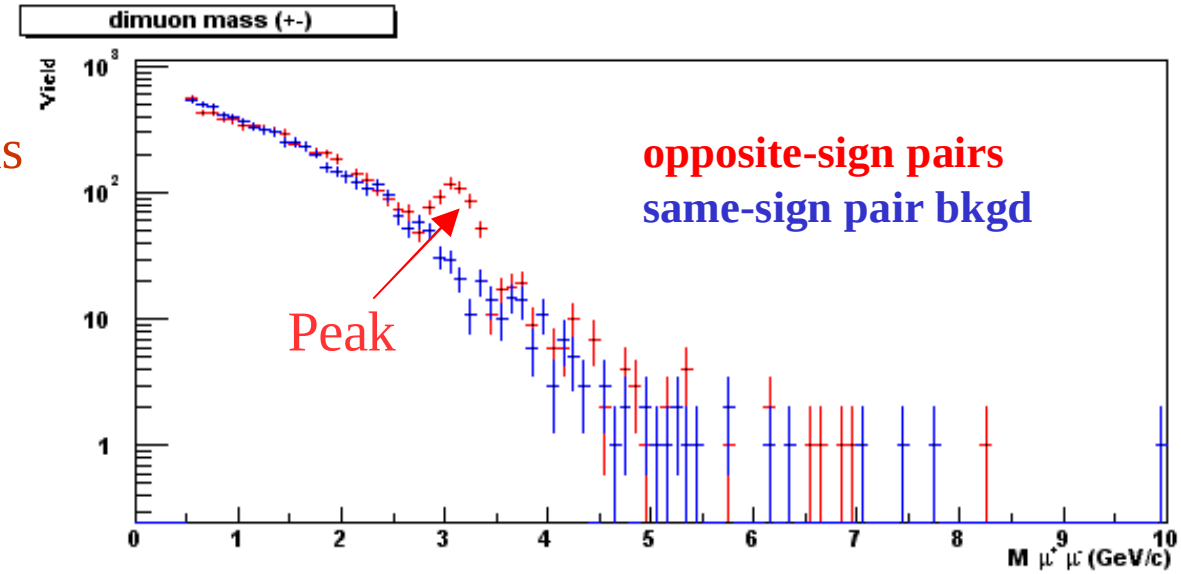
$M_{\mu+\mu-}$ (GeV/c^2)

Run-3 dAu : North muon arm

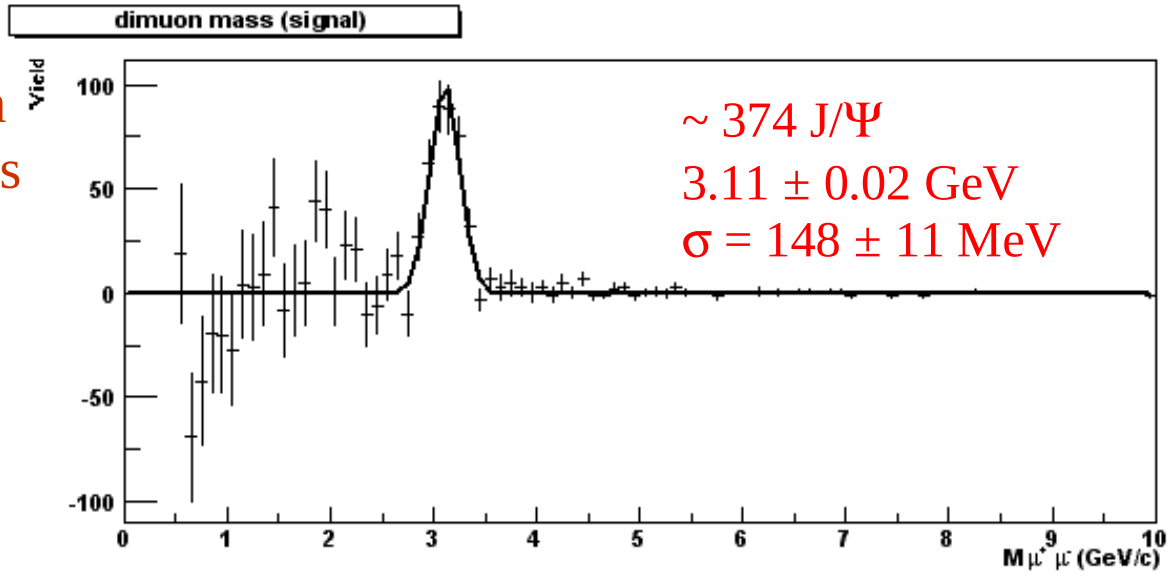
Newly installed arm : works great!

Note: a different data sample, no corrections for detector & trigger eff. or acceptance.



Direct comparisons between the yield in the arms are thus meaningless for now.

But hopefully not for too long..



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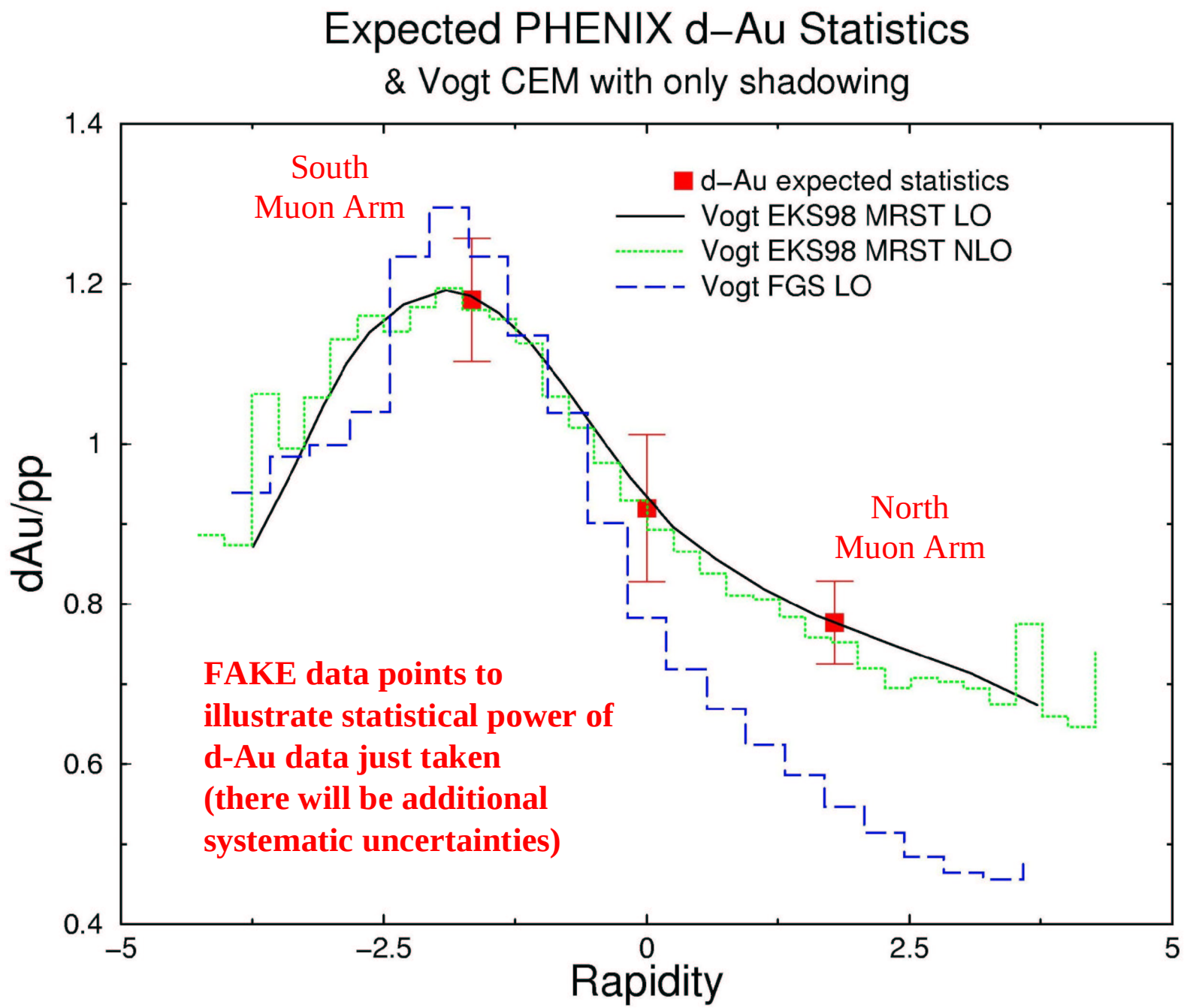
$M_{\mu+\mu-}$ (GeV/c^2)


Expected PHENIX d–Au Statistics
& Vogt CEM with only shadowing
South
Muon Arm
North
Muon Arm
d–Au expected statistics
Vogt EKS98 MRST LO
Vogt EKS98 MRST NLO
Vogt FGS LO
FAKE data points to
illustrate statistical power of
d-Au data just taken
(there will be additional
systematic uncertainties)
dAu/pp
Rapidity
1.4
1.2
1
0.8
0.6
0.4
–5
–2.5
0
2.5
5

Summary and Outlook

First d-Au run recently completed. More substantial J/Ψ yields than previously seen at RHIC were obtained.

- Should give us more understanding about e.g. gluon shadowing
- Baseline for comparisons with the upcoming high statistics Au-Au run

Done first analysis iterations online and uncovered/improved various things along the way.

- Now ready for the official d-Au pass (about to start). Data size ~ 50 Tb..

A lot of analysis tools and procedures are in place and progress is on track. We are coordinating remaining tasks with a weekly short analysis meeting.