J/ψ suppression and elliptic flow in $\sqrt{s_{NN}}$ = 200 GeV Au+Au collisions at the mid rapidity region of PHENIX

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Outline

- Introduction
- Experimental Setup
  - Remote data reconstruction
  - Electron identification
- Measurement of J/ψ suppression
  - Signal counting
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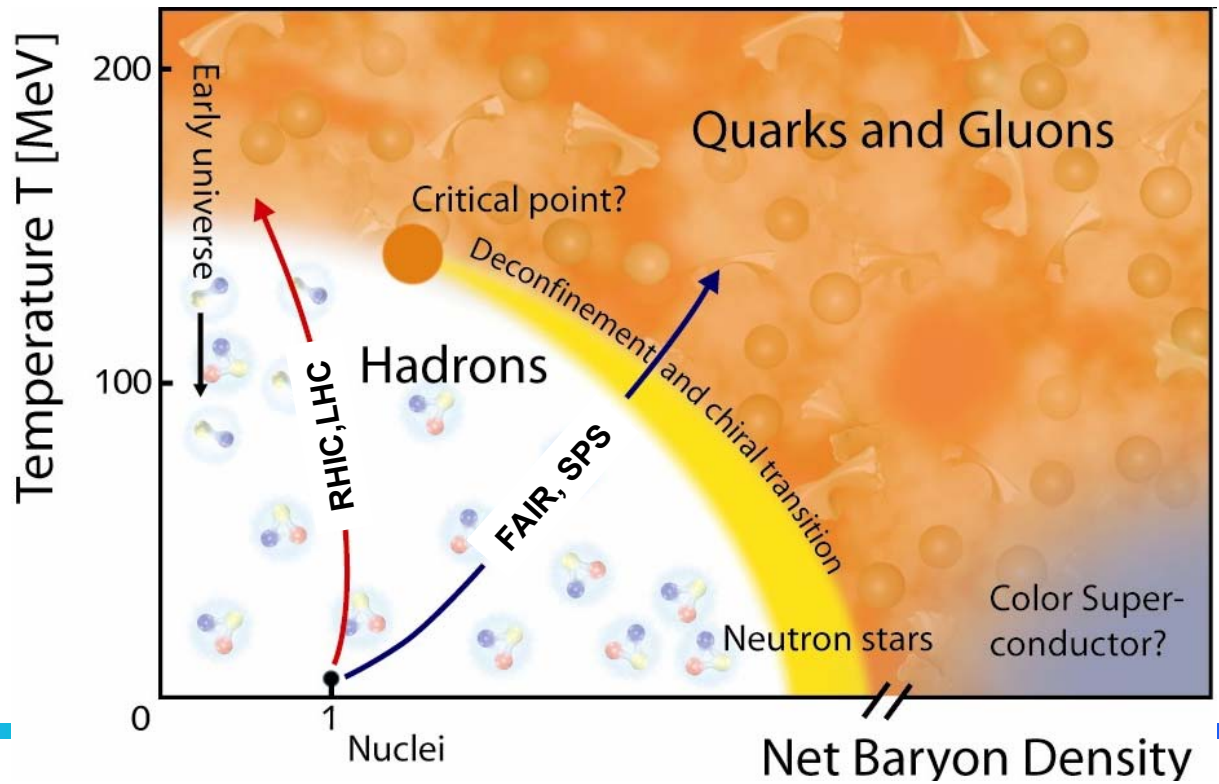
- Measurement of J/ψ elliptic flow
  - Method
  - Results
- Conclusion

Introduction

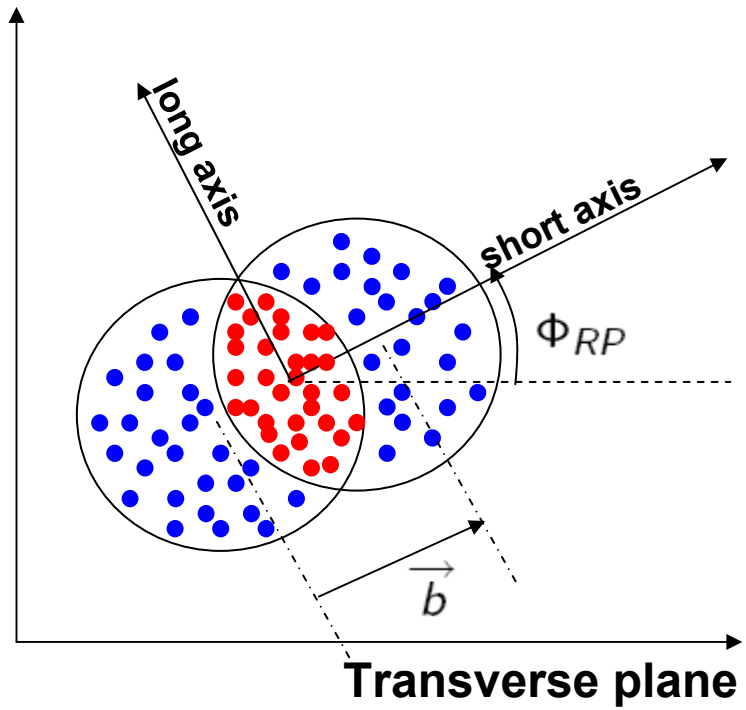
Quark Gluon Plasma

- QGP: A deconfined state of quarks and gluons
  - Extreme temperature or net baryon density
    - Heavy ion collisions: only possible laboratory tool to achieve these conditions
  - Transformation of a confined hadronic medium to a state of QGP
    - Rapid cross over at low baryonic density
    - Second order phase transition at high baryonic density



Heavy ion collision

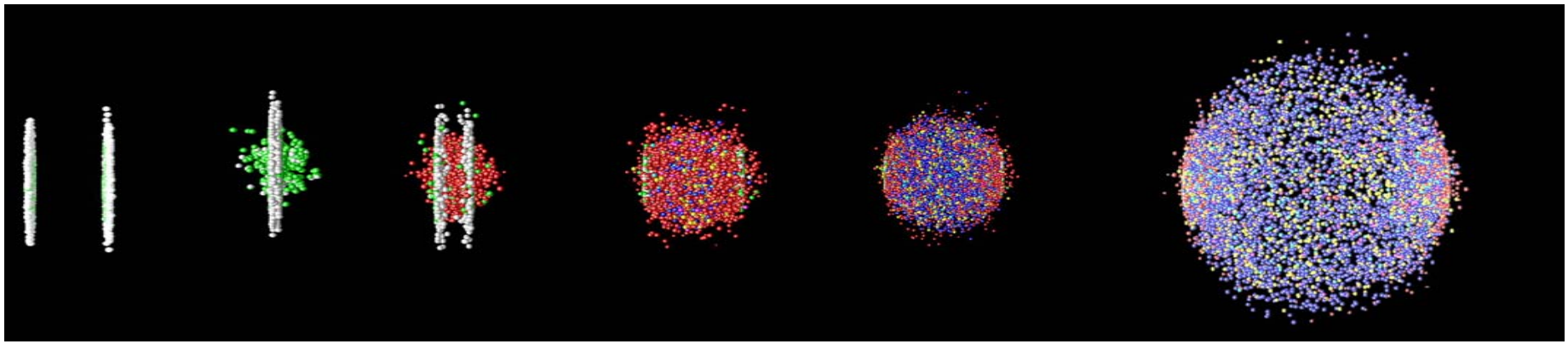
- Impact parameter
- Orientation
  - Reaction plane: ($\vec{b}$, z)
  - How is the collision region oriented?
- Magnitude
  - How close are the centers of the colliding nuclei?
  - Centrality, energy density



- Participant and spectator nucleons
  - N_{part}: number of nucleons undergoing inelastic collisions
  - N_{coll}: number of binary inelastic N–N collisions

Evolution of a heavy ion collision

- Chronology of a collision
  - Typical orders of magnitude at top RHIC energy (200 GeV)
  - Source: modeling, hydrodynamics

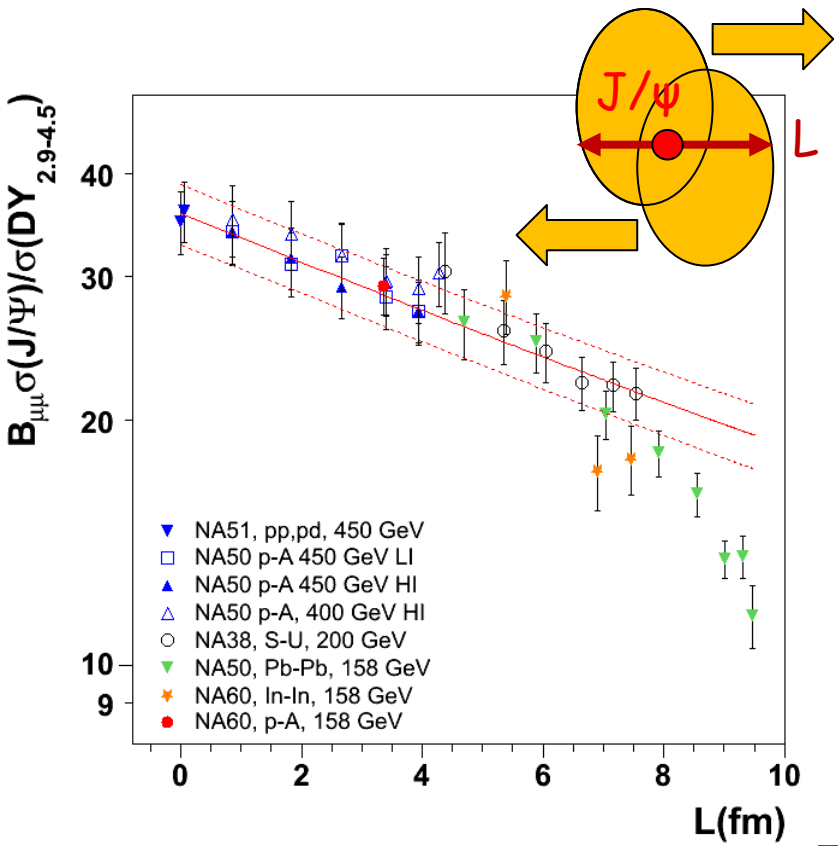


~0.13 fm/c	0.6-1 fm/c	~0.7 fm/c	4-6 fm/c
Crossing	**Thermalization**	**Formation**	**Hadronization**

- J/ψs are ideal probes because
  - Formed very early in the collision through hard processes
  - Have a much longer life time than the medium (2000 fm/c)

Probing QGP with J/ψ

- A bit of history …
  - J/ψ suppressed in heavy ion collisions due to color screening if Quark Gluon Plasma is formed (Matsui & Satz PL B178 (1986) 416)
  - Experiments at CERN SPS measured J/ψ suppression in many systems
- Anomalous suppression
  - J/ψ yield compared to Drell-Yan, which is insensitive to QGP
  - Suppression shows a universal scaling as a function of L for all systems except central heavy-heavy collisions
  - At RHIC, this phenomenon is studied at up to ~10x higher collision energy.



Experimental setup

The RHIC collider

- Heavy ion and polarized proton colliding machine
  - Four systems
    - p+p, d+Au, Cu+Cu, Au+Au
  - Wide range of energies:
    - 9.2 GeV up to 500 GeV
  - Top CM energy of 200 GeV in Au+Au
    - SPS: 17 GeV (Pb+Pb)
    - LHC: 5.5 TeV (Pb+Pb)

PHENIX J/ψ measurement

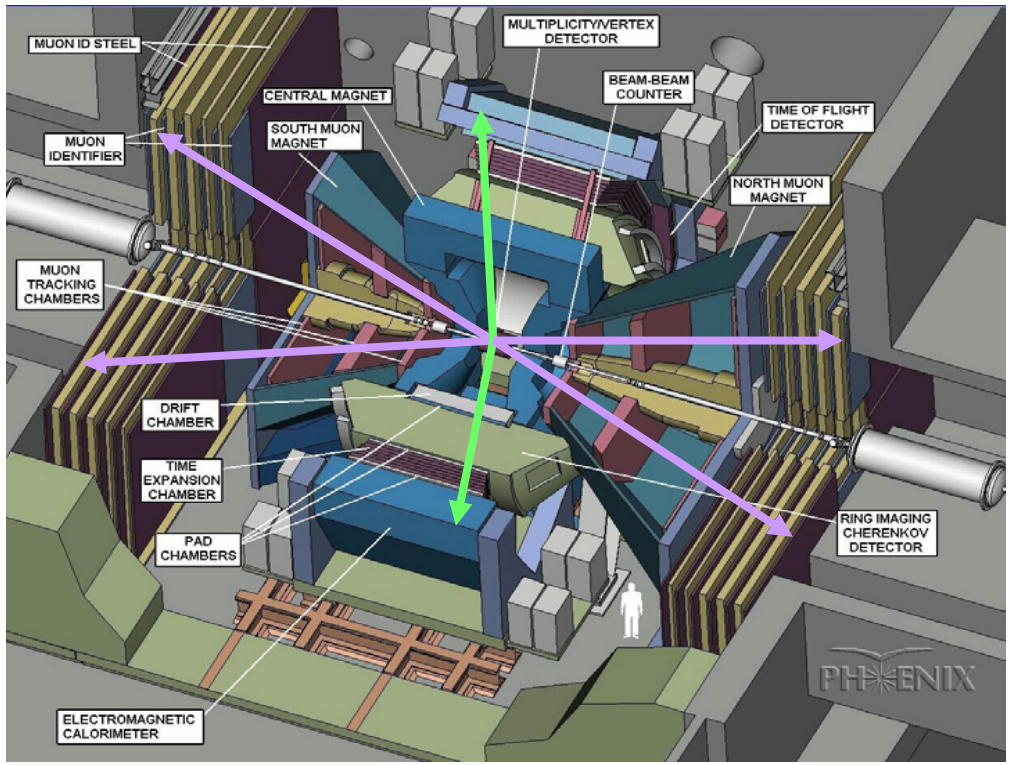
Central Arms:

Hadrons, photons, electrons

- J/$\psi \rightarrow e^+e^-$
- $|\eta| < 0.35$
- $p_e > 0.2$ GeV/c
- $\Delta\phi = \pi$ (2 arms x $\pi/2$)

Muon Arms:

- J/$\psi \rightarrow \mu^+\mu^-$
- $1.2 < |\eta| < 2.2$
- $p_\mu > 2$ GeV/c
- $\Delta\phi = 2\pi$



Global detectors:

Beam-Beam Counter (BBC)

Reaction Plane Detector (RxNP)

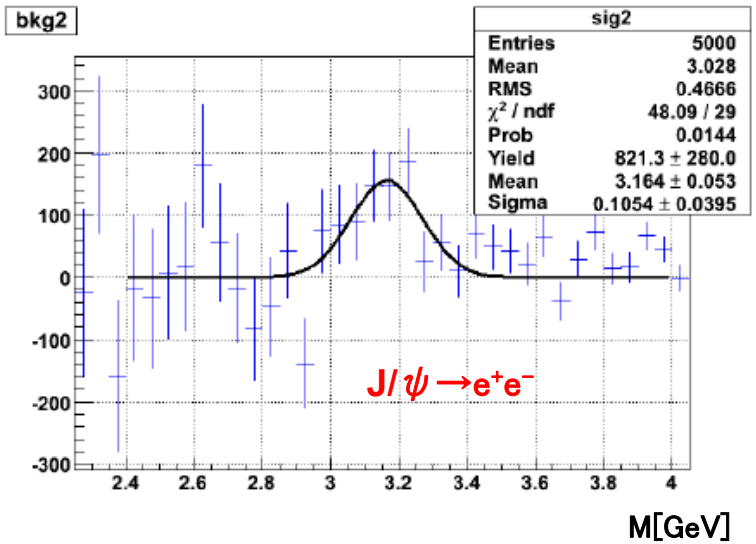
PHENIX J/ψ measurements summary

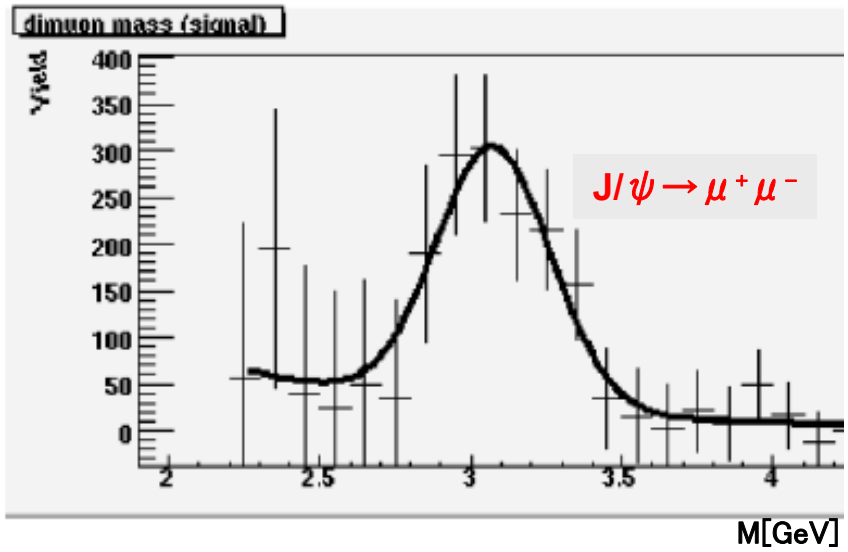
RHIC year	Species	$\sqrt{s_{NN}}$[GeV]	$\int$Ldt	J/ψ counts (|y|<0.35)	J/ψ counts (1.2<|y|<2.2)	Reference
2001	Au+Au	130	$1\mu b^{-1}$			
2002	Au+Au	200	$24\mu b^{-1}$	~13		
	p+p	200	$0.15pb^{-1}$	46	66	PRC69, 014901(2004)
2003	d+Au	200	$2.74nb^{-1}$	360	1200	PRL92, 051802(2004)
	p+p	200	$0.35pb^{-1}$	130	450	PRL96, 012304(2006)
2004	Au+Au	200	$241\mu b^{-1}$	1000	4500	PRL98, 232301(2007)
	Au+Au	63	$9\mu b^{-1}$			
	p+p	200	$350nb^{-1}$			
2005	Cu+Cu	200	$3nb^{-1}$	2000	9000	PRL101, 122301(2008)
	Cu+Cu	62	$0.19\mu b^{-1}$		~146	
	Cu+Cu	22.5	$2.7\mu b^{-1}$			
	p+p	200	$3.8pb^{-1}$	1500	8000	PRL98, 232002(2007)
2006	p+p	200	$10.7pb^{-1}$	~2300	~27000	
	p+p	62	$0.1pb^{-1}$			
2007	Au+Au	200	$800\mu b^{-1}$	~3400	~20000	
2008	d+Au	200	$80nb^{-1}$	~4400	~57000	
	p+p	200				

Data reconstruction

Remote data reconstruction and analysis

- 2007 run high level trigger filtered data
  - Filtered raw data ~ 70 TB, reconstructed data ~10 TB
  - Data taking at RHIC and reconstruction at CCIN2P3 (French computing farm)





  - Useful exercise as an almost 'real time' monitoring of the data quality
  - di-muon fast analysis:
    - Used for J/Ψ elliptic flow measurement (Thesis of C. Silvestre)
  - di-electron fast analysis:
    - Low lvl2 trigger efficiency (50%) was revealed by the online analysis
    - Caused by low efficiency in the PC outer tracker layer which is used in the trigger algorithm
    - Reconstructed data was not used for this analysis because of low efficiency

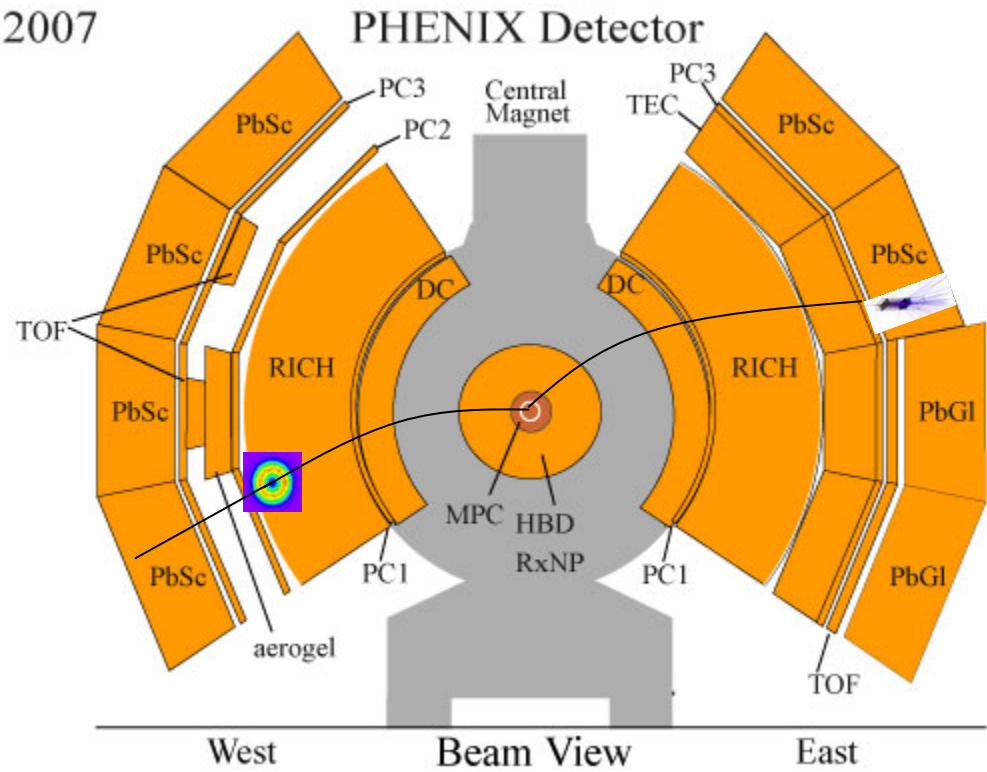
Electron identification

PHENIX Central Arm

- Tracking detectors
  - Drift Chamber, Pad Chamber
- Identification
  - RICH, Čerenkov rings
    - Momentum threshold for Čerenkov emission:

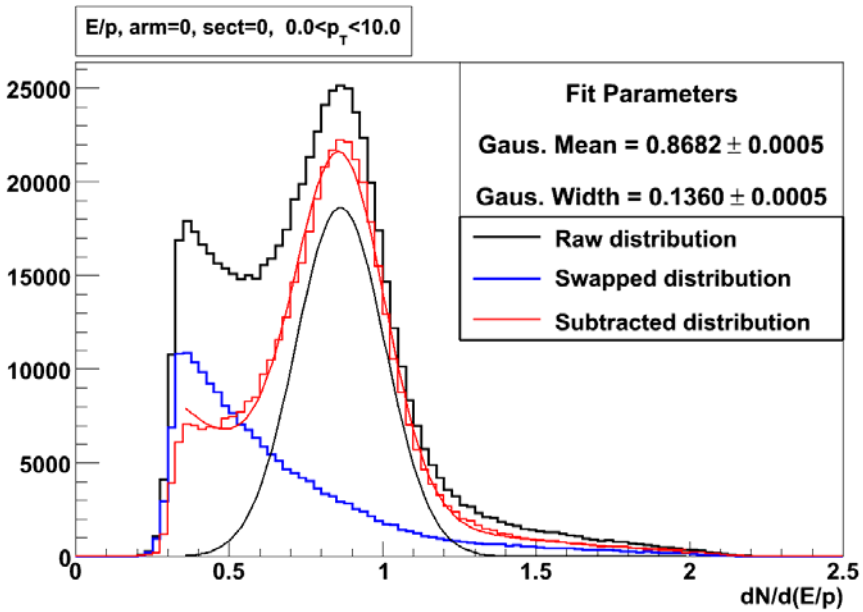
      electrons: p_{thr} = 0.2 GeV/c

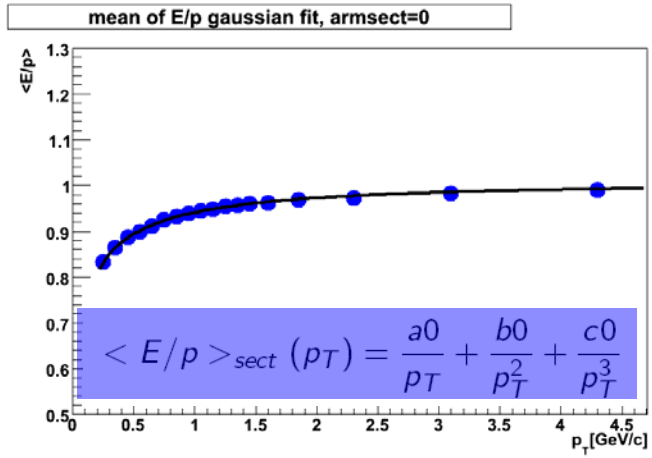
      pions: p_{thr} = 4.8 GeV/c
    - Spatial matching of track projections to center of Čerenkov rings
  - EMCal (8 sectors)
    - Spatial matching of track projections to shower
    - E-p comparison

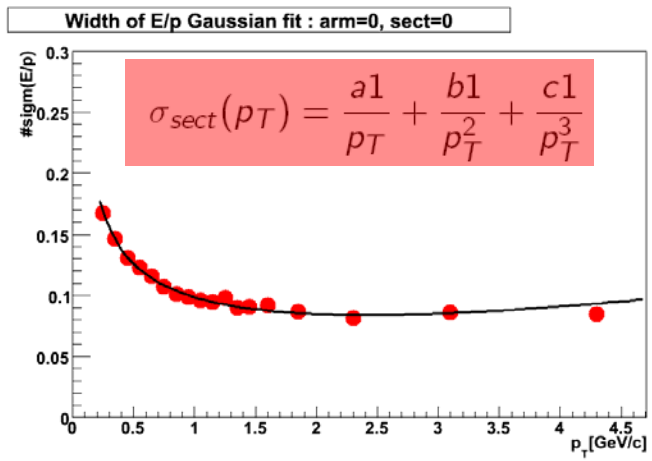


Raw identification parameters need to be tuned before use in analysis

Energy/momentum tuning







Tracks associated with RICH rings

Random coincidence of $\pi^{\pm}$ with RICH rings

Subtracted electron peak centered at E/p ~ 1

Gaussian fit (center and width dependent on p_T)

$$dep(E, \vec{p}, sect) = \frac{< E/p >_{sect}(p_T) - E/p}{\sigma_{sect}(p_T)}$$

Unlike E/p, "dep" has no sector/momentum dependence

Measurement of J/ψ suppression

How the J/ψ suppression is quantified?

- Nuclear modification factor

$$R_{AA}(cent) = \frac{Y_{AA}(cent)}{N_{coll}(cent)\,Y_{pp}}$$

- For the p+p yield, the year 2005 data set is used
  - $Y_{pp} = (B_{e+e-} \times d\sigma_{J/\psi}/dy = 44.3 \pm 1.4\text{stat} \pm 5.1\text{sys nb})/\sigma_{pp,inel} = 1.1\text{x}10^{6}$
- The AA yield is expressed as:

$$Y_{AA}(cent) = \frac{1}{\Delta y} \times \frac{N^{AA}_{J/\psi}(cent)|_{y=0}}{N_{evt}(cent)} \times \frac{1}{A\varepsilon \times \varepsilon(cent)}$$

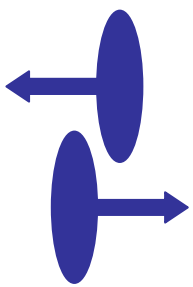
(1) (2) (3)

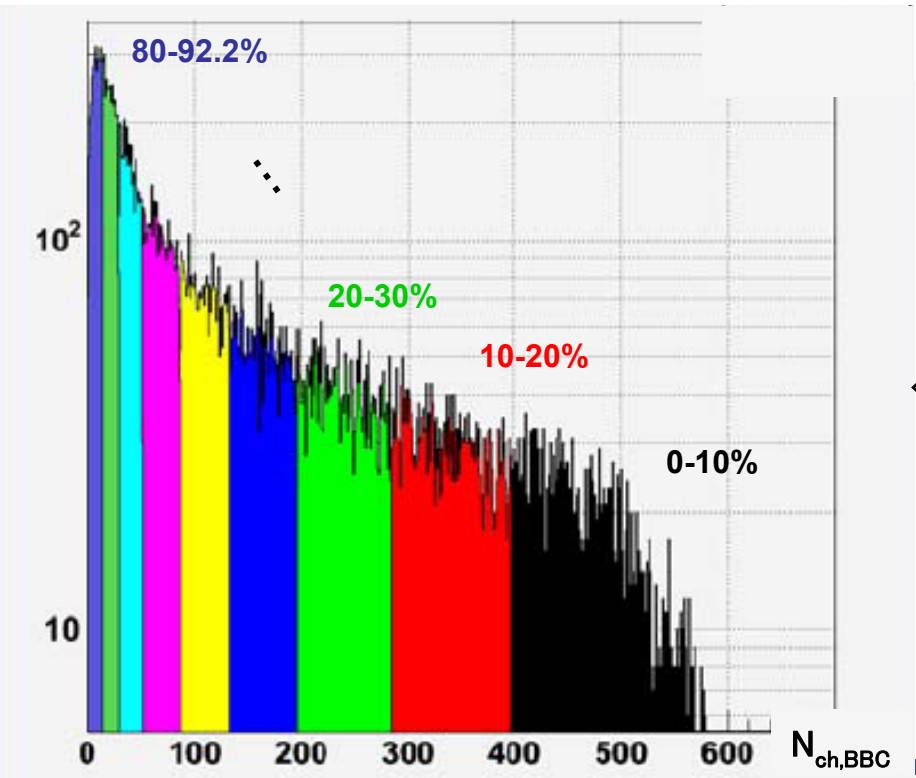
  - Number of events used in the analysis (N_{evt}) : ~2.9x10^{9}
  - (1), (2) and (3) will be discussed shortly

Determining Centrality

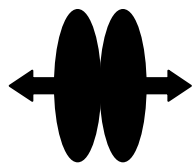
- Dividing total cross section according to centrality
  - BBC: detection of very forward moving charged particles
  - Response increases monotonously with centrality
  - Geometric model (Glauber) is used to calculate $\langle N_{part} \rangle$ & $\langle N_{coll} \rangle$
  - Minimum Bias (MB): No centrality selection

Most peripheral
80 – 92.2%
$\langle N_{part} \rangle = 6.3 \pm 1.2$
$\langle N_{coll} \rangle = 4.9 \pm 1.2$





Most central
0 – 10 %
$\langle N_{part} \rangle = 325.2 \pm 3.3$
$\langle N_{coll} \rangle = 955.4 \pm 93.6$

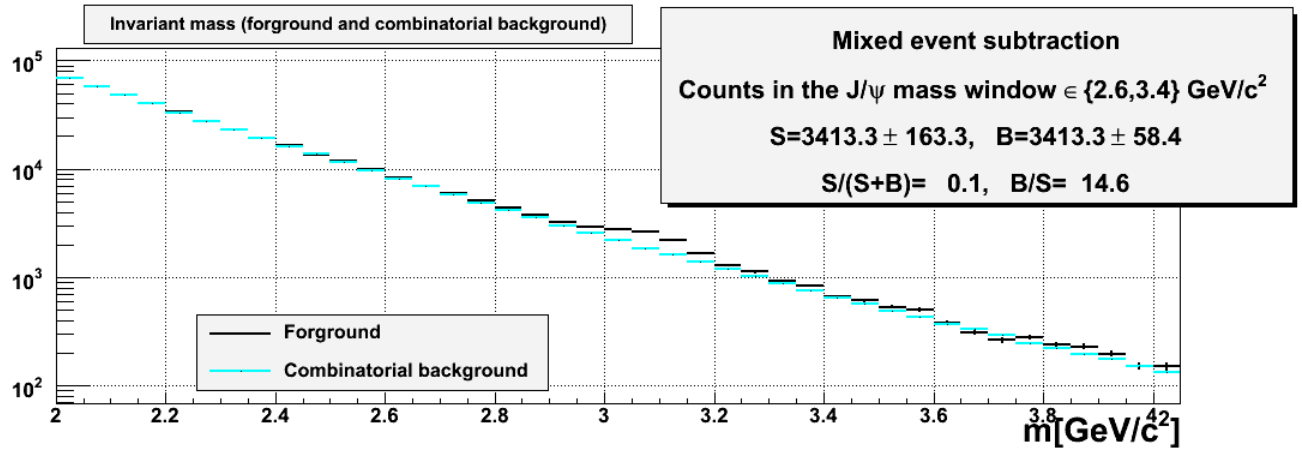


Measurement of J/ψ suppression

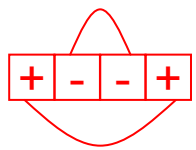
- Signal counting: $N^{AA}_{J/\psi}(cent)|_{y=0}$

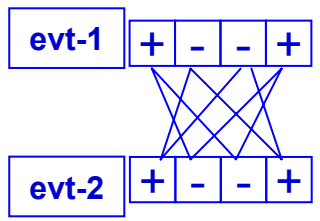
Signal counting (1/2)

- Unlike sign electron-positron pair mass spectrum



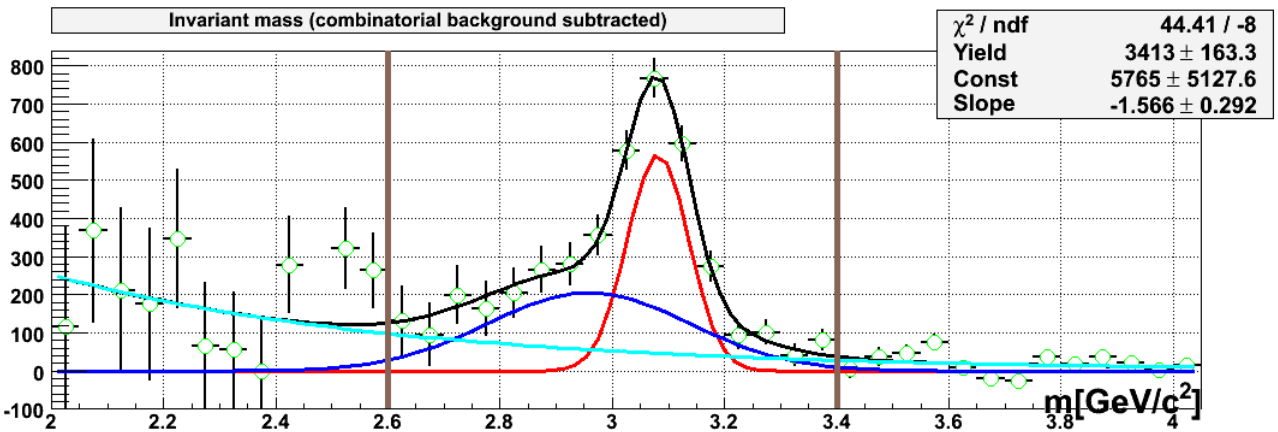
- Reproducing the combinatorial background
  - Like sign pairs in the same event
    - A priori uncorrelated
    - Limited statistics
  - Unlike sign pairs from different events
    - Necessarily uncorrelated
    - Statistics can be made as high as needed (requires normalization)
    - Cautions: Events with similar characteristics (vertex position, centrality…)
    - Control correctness by comparing same event like sign pair spectra





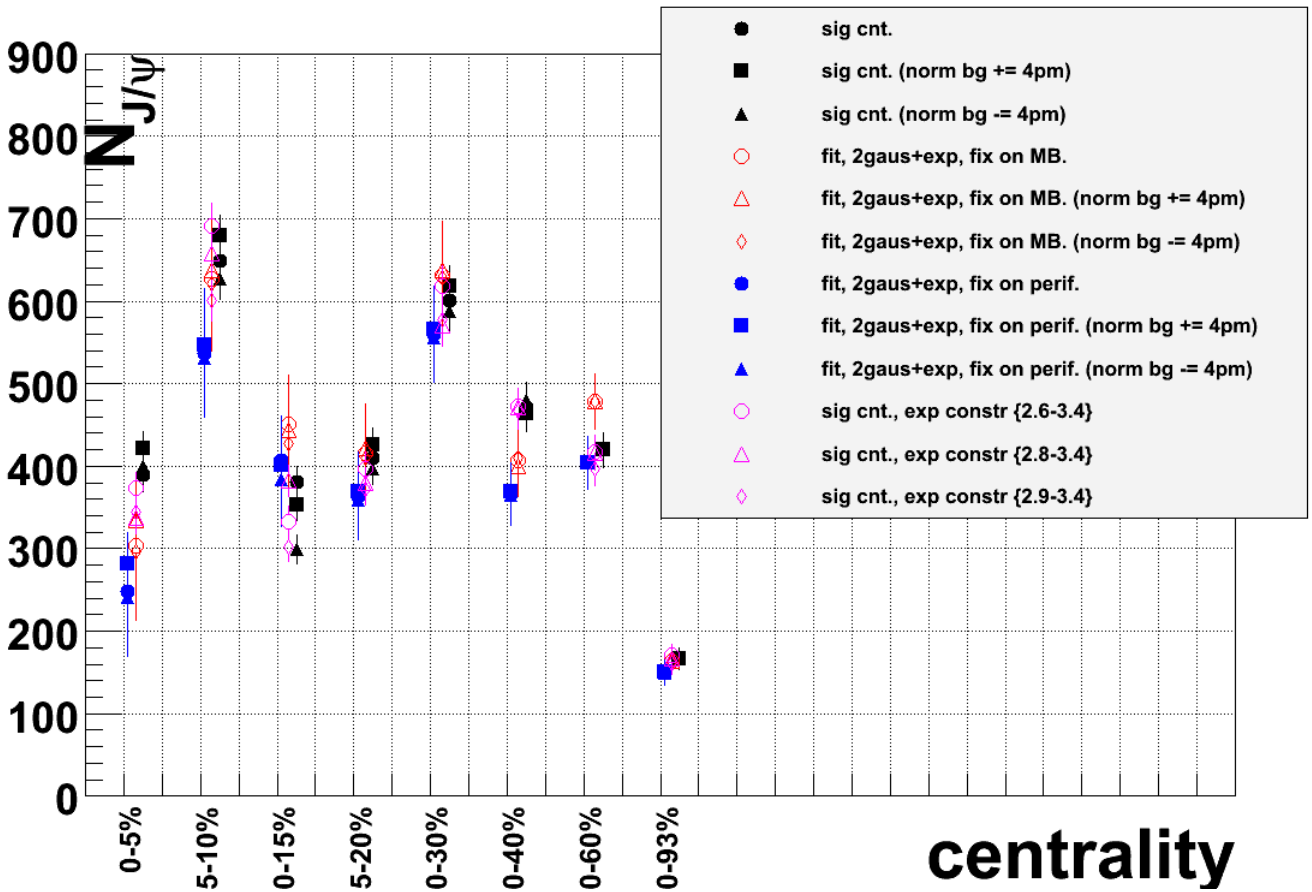
Signal counting (2/2)

- Central method: Simple histogram integration
  - Counting window: 2.6 – 3.4
  - Accounting for residual background + correlated (physics) background
- Systematics: varying signal counting methods
  - Fitting: Double Gaussian + Exponential
    - 2nd Gaussian accounts for a radiative mass tail and/or low resolution tracks
    - Fix parameters from free fits to MB and peripheral events



Signal counting systematics

- Dispersion of signal counts



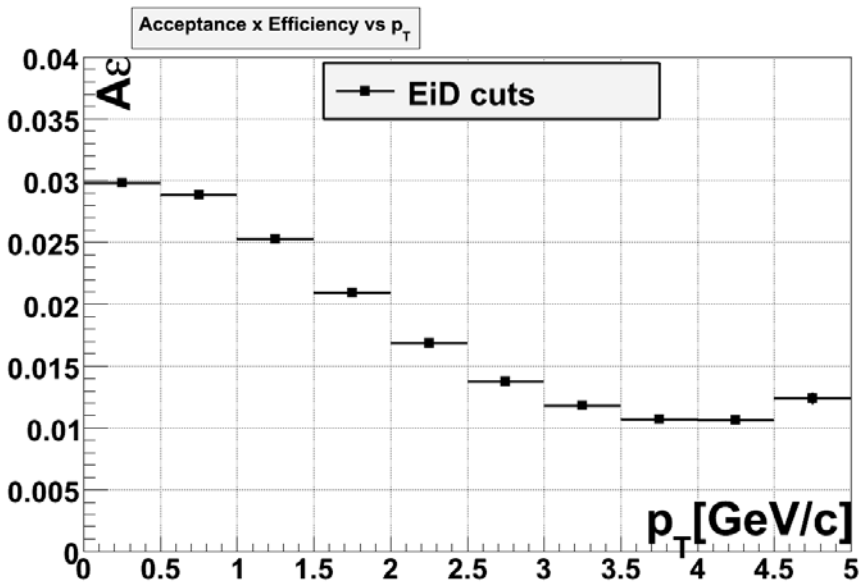
Measurement of J/ψ suppression

- Signal counting
- Efficiency corrections: $A\varepsilon$ and $\varepsilon(cent)$

Acceptance and reconstruction efficiency

- Calculated through the relation:

$$A\varepsilon(p_T) = \frac{N^{rec}_{J/\psi}(p_{T,rec})}{N^{gen}_{J/\psi}(p_{T,gen})}$$

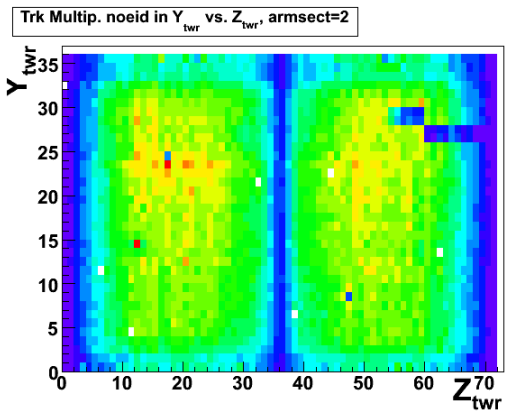


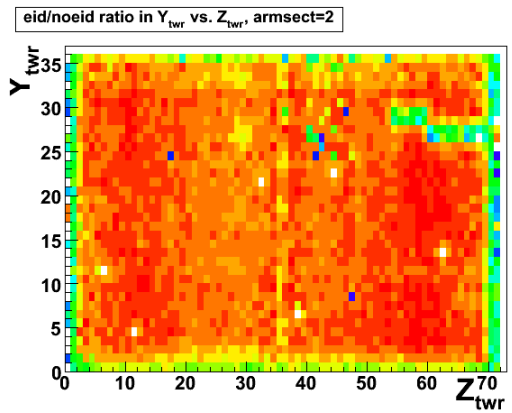
- Realistic input J/ψ p_T, rapidity and vertex distributions are used
- Detector inefficiency is accounted for by removing inefficient areas at analysis level, both in data and in simulation: Fiducial cuts method

Illustration with the EMCal

- Identification of inefficient towers
  - Calculate tower by tower ratio ($R_{el/tr}$) of electron track to unidentified track multiplicity
  - Apply a lower cut on the distribution of $R_{el/tr}$ to remove towers that have low efficiency

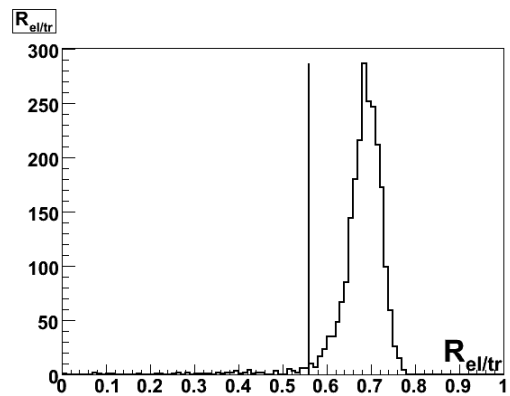
Unidentified tracks

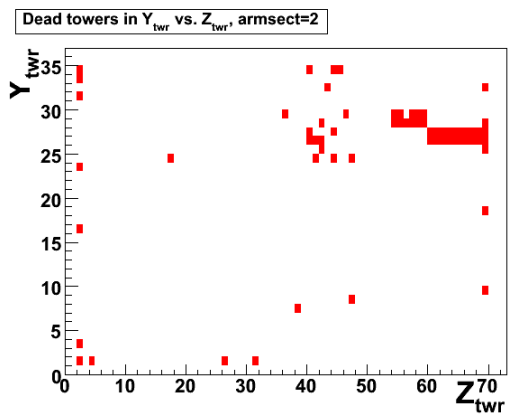




$R_{el/tr}$ vs. tower coordinate

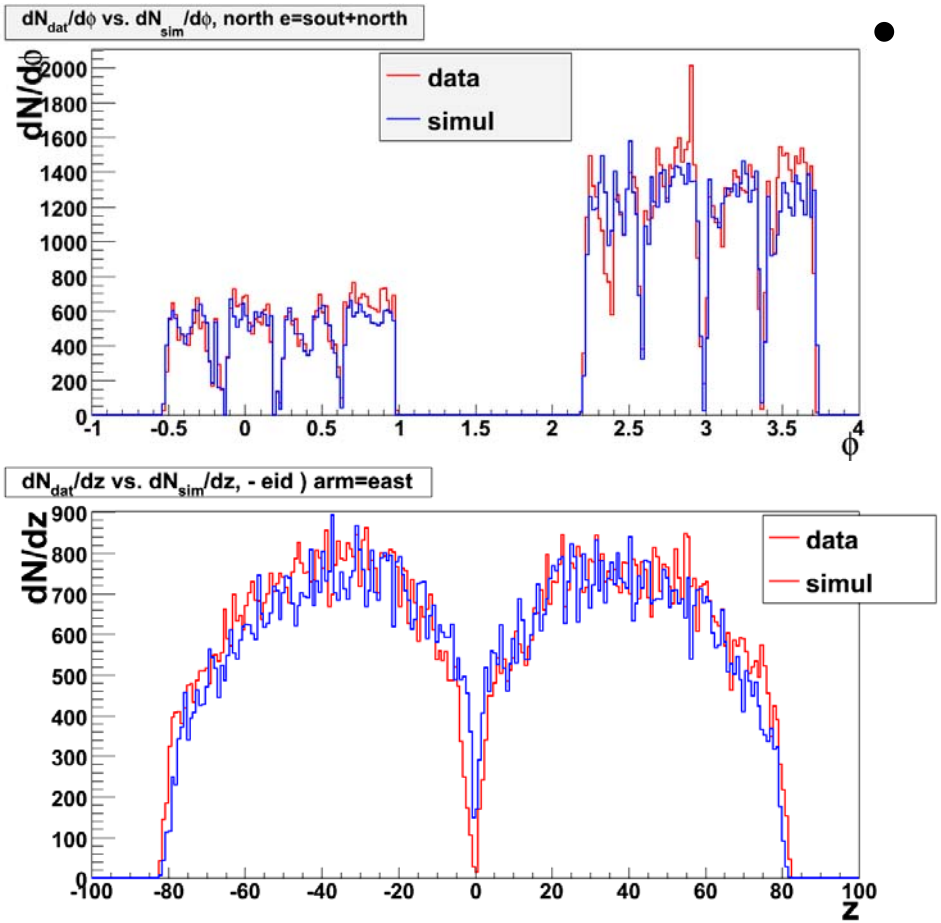
$R_{el/tr}$ distribution





Inefficient towers

Cross checking the fiducial cuts



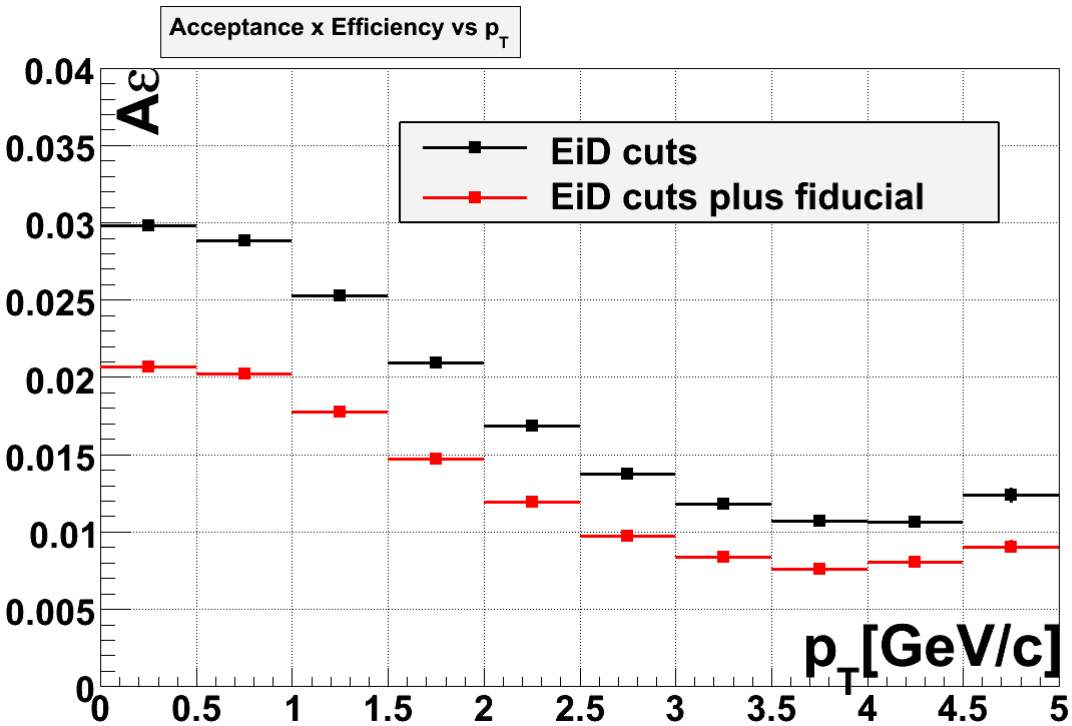
- Method
  - Simulate single electrons with a realistic p_T distribution
  - Compare the ϕ and z distributions in data and simulation:
    - ϕ = azimuth
    - z = position along beam axis (z)

    at the tracker radius
  - The systematics due to this mismatch can be accounted for through

$$err_{syst} = \frac{\sum |dN_{sim} - dN_{dat}|}{\sum \frac{1}{2} \times (dN_{sim} + dN_{dat})} \approx 11.5\%$$

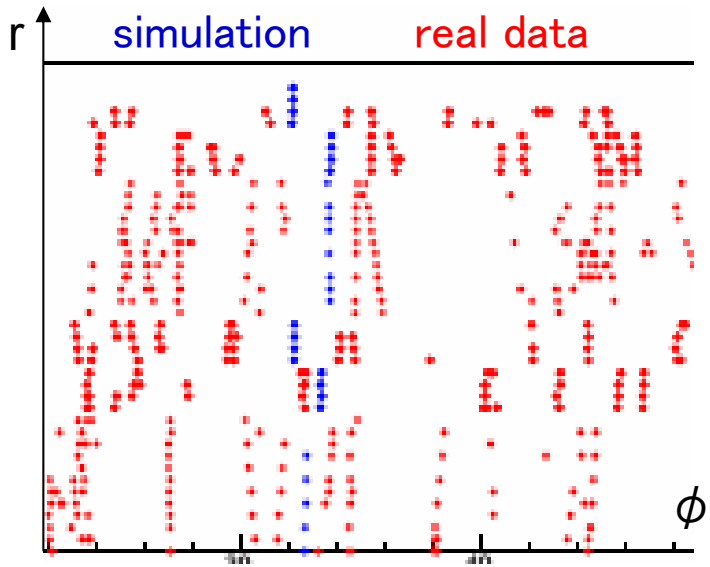
Final correction

- p_T integrated Aε = (1.535 ± 0.003)%
  - Application of fiducial cuts drops J/ψ acceptance by ~40%
  - In real data, the loss of signal is ~20%

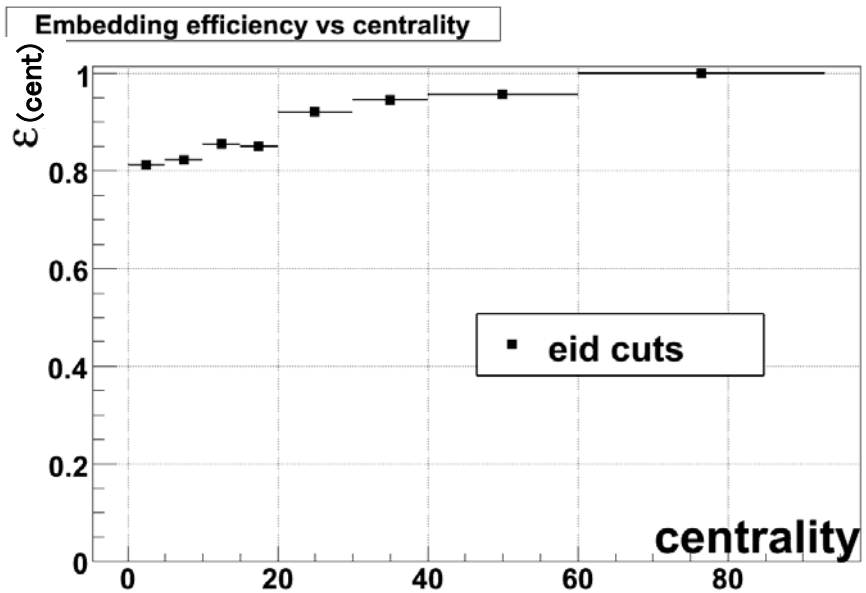


Centrality dependent efficiency

- Aim: characterize reconstruction efficiency loss due to high multiplicity
  - Merge hits from simulated $e^+e^- \leftarrow J/\psi$ into hits from real data events
  - Reconstruct merged hits using standard reconstruction software
  - Embedding efficiency $\varepsilon(cent)$: Fractional loss of J/ψ



Longitudinal projection of hits in a section of the drift chamber volume

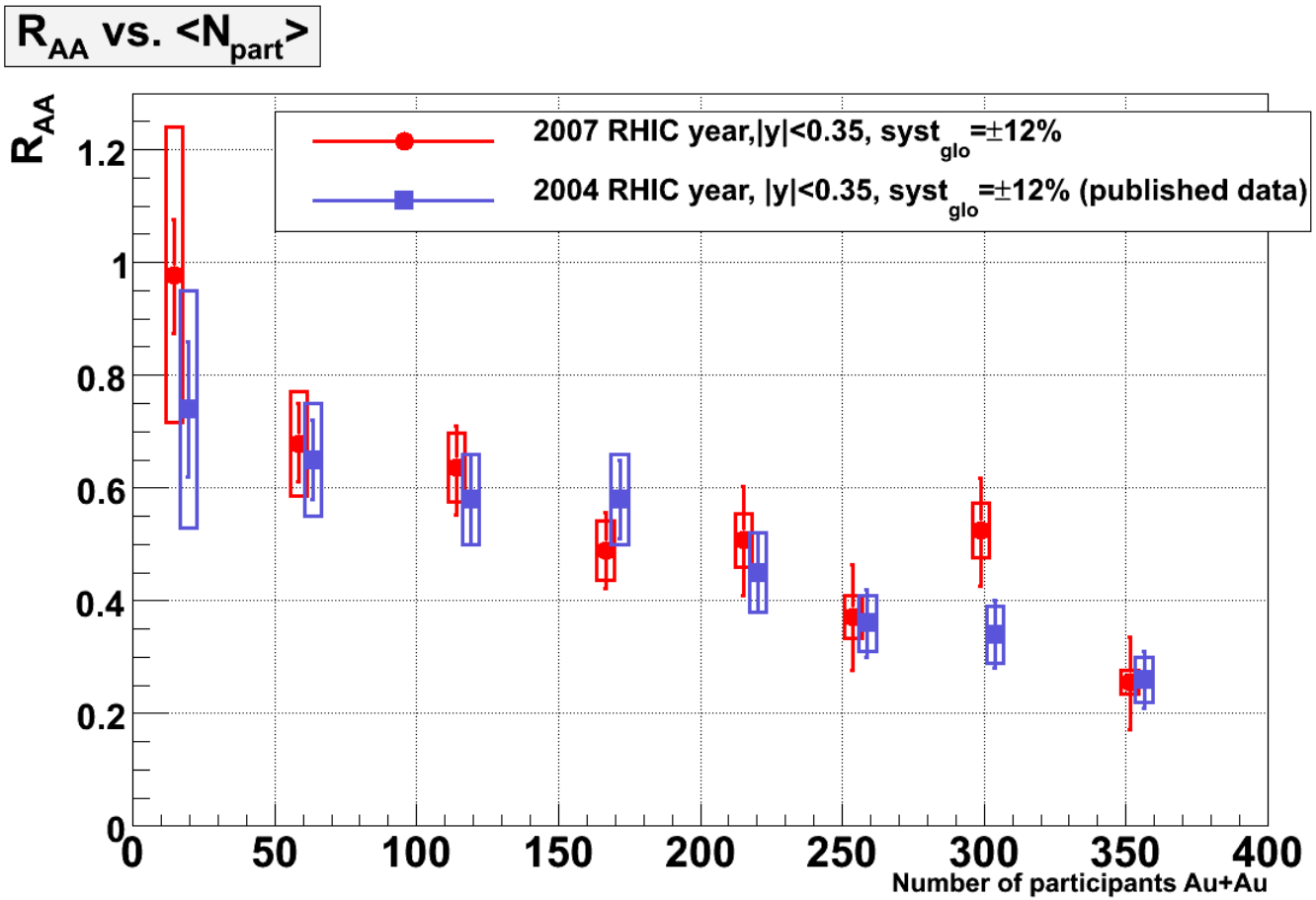


Measurement of J/ψ suppression

- Signal counting
- Efficiency correction
- Results

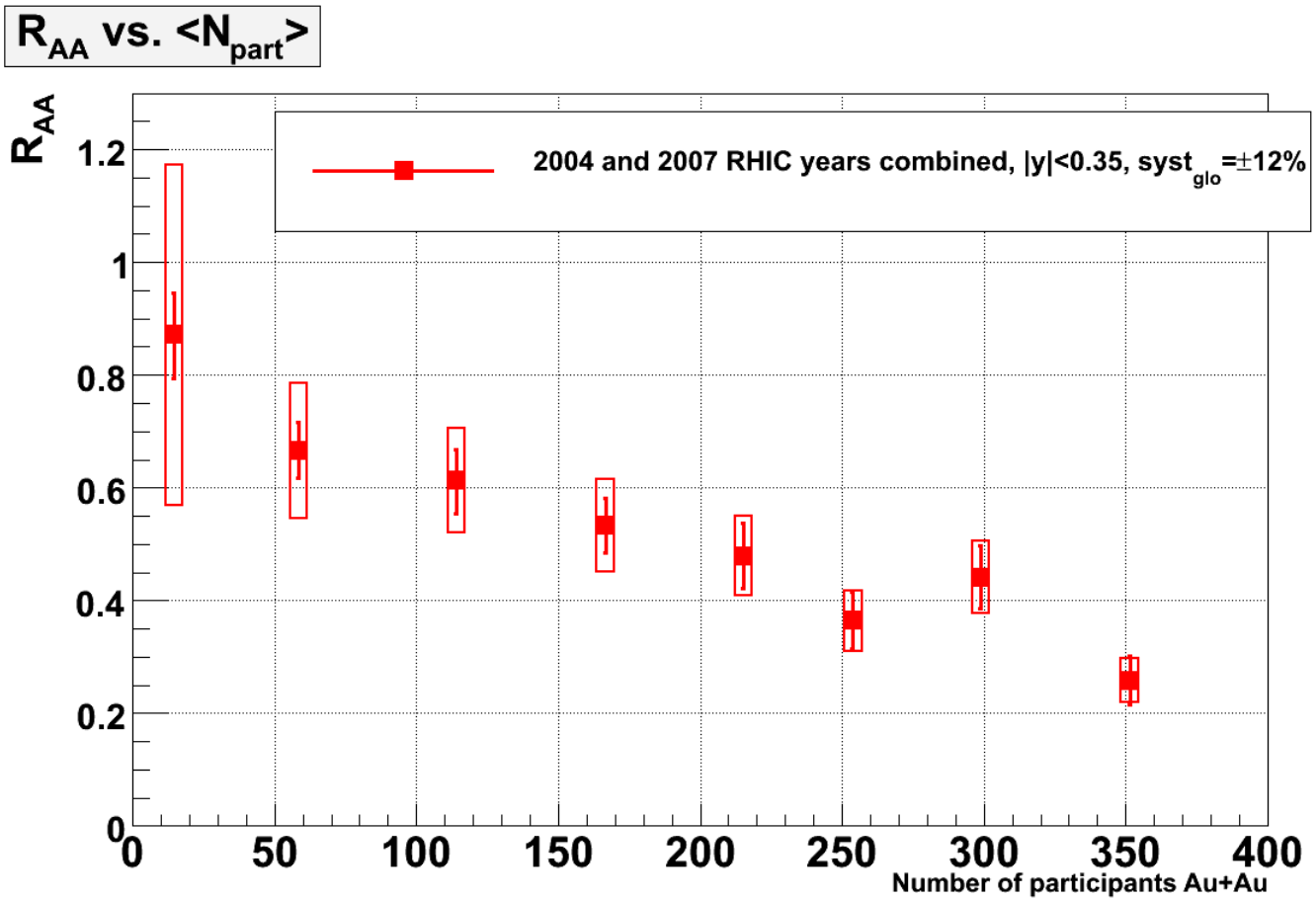
R_{AA} result

- Comparison to result from the 2004 run data set



R_{AA} result

- Average with result from the 2004 data set

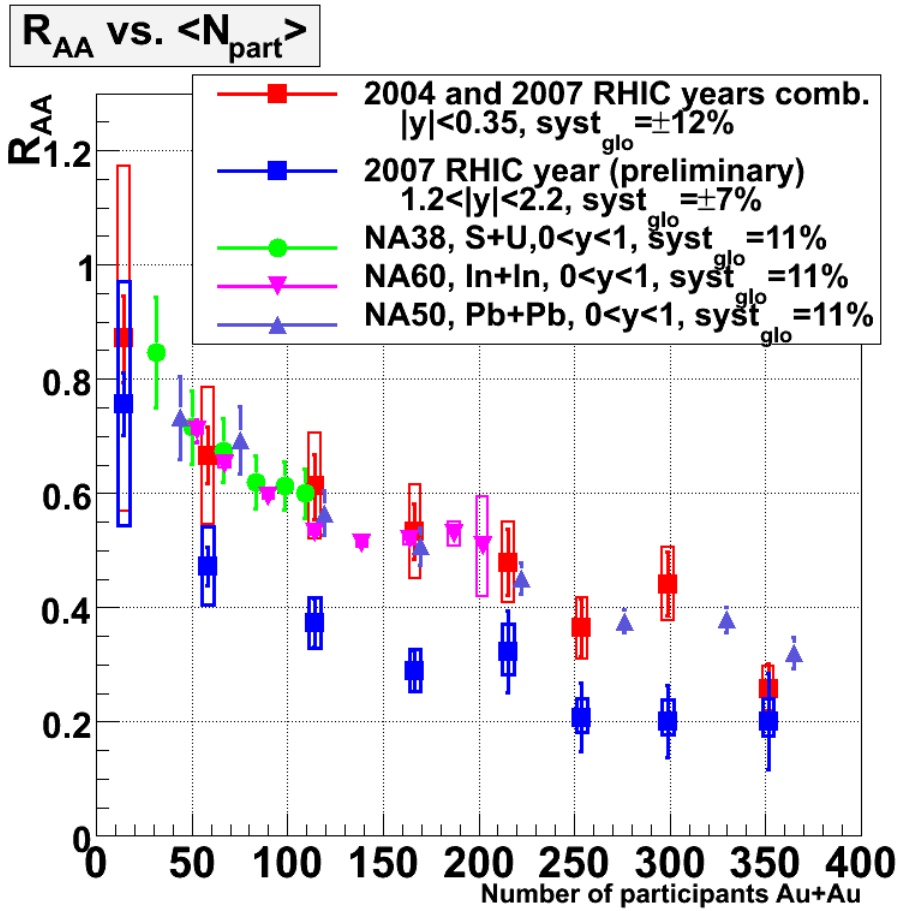


Two surprises

- Comparison to SPS
  - R_{AA} (RHIC, (|y|<.35) ≈ R_{AA} (SPS)
  - Not what's expected from

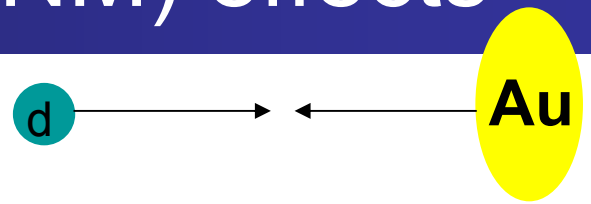
    $\varepsilon_{SPS} < \varepsilon_{RHIC}$
- Rapidity dependence
  - R_{AA} (1.2<|y|<2.2) < R_{AA} (|y|<.35)
  - Not expected from

    $\varepsilon_{1.2<|y|<2.2} < \varepsilon_{|y|<.35}$
  - Challenge to most "local density" based suppression models that successfully described SPS results



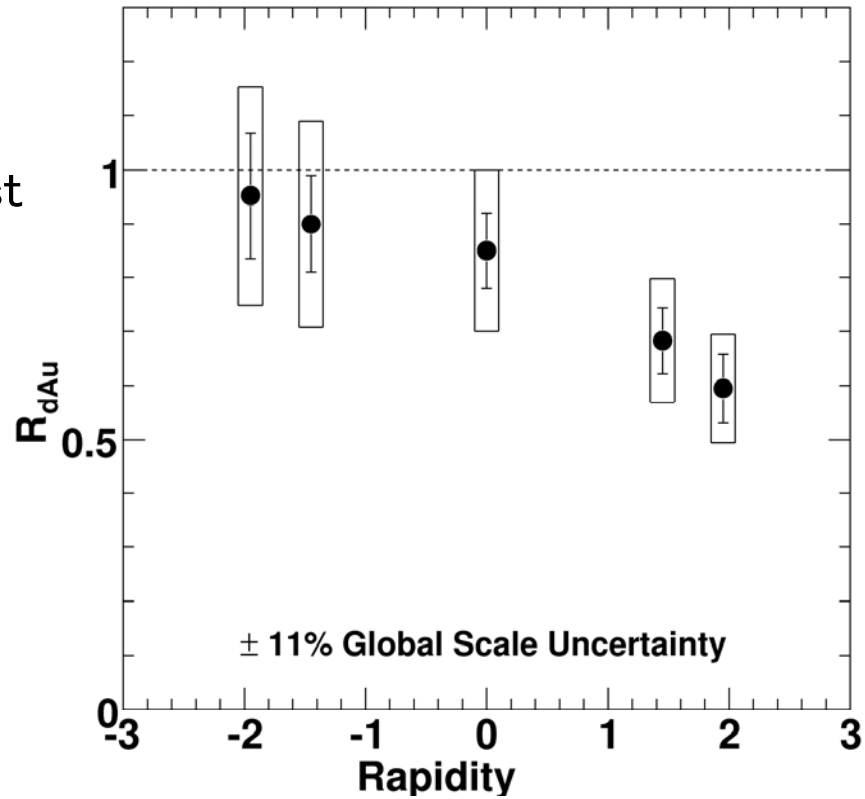
Reminder: Normal nuclear matter effects play a role at SPS!
How about at RHIC?

Cold nuclear matter (CNM) effects



- J/ψ suppression in d+Au:
  - Light–Heavy system => No QGP related effect
  - However suppression is seen, at least at forward rapidity.
  - This suppression can only be caused by CNM effects such as
    - Shadowing (modification of PDF)
    - Absorption/breakup
    - Initial state (gluon) scattering

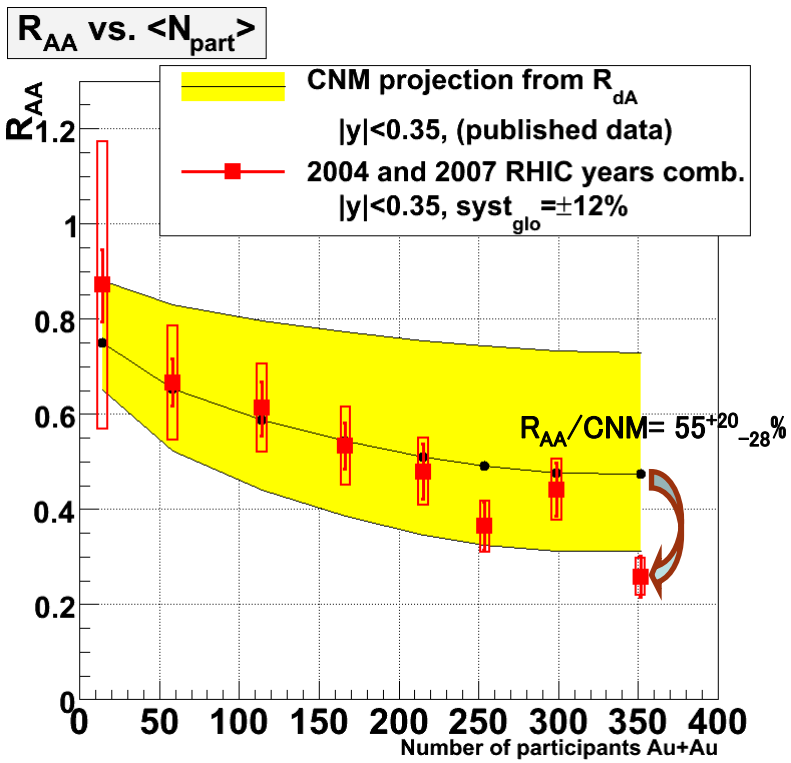
    which play a role towards the suppression in AA collisions as well.

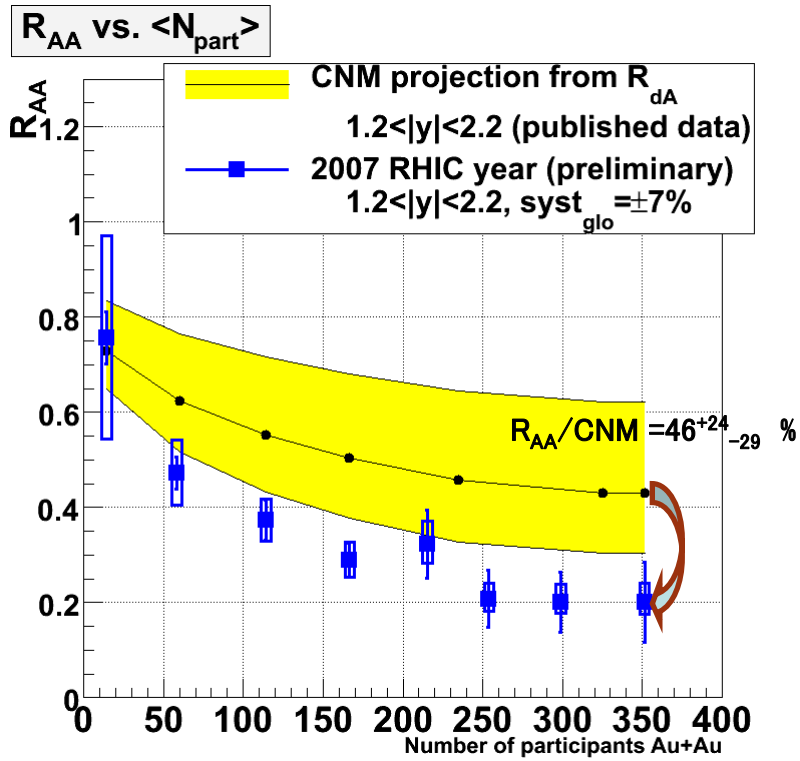


  - **Extrapolation of R_{dA} to R_{AA} : Estimate of extent of suppression in the absence of QGP formation**

Data driven extrapolation from d+Au

- Comparison of R_{AA} to a projection of CNM effects from R_{dAu} with minimal model dependence

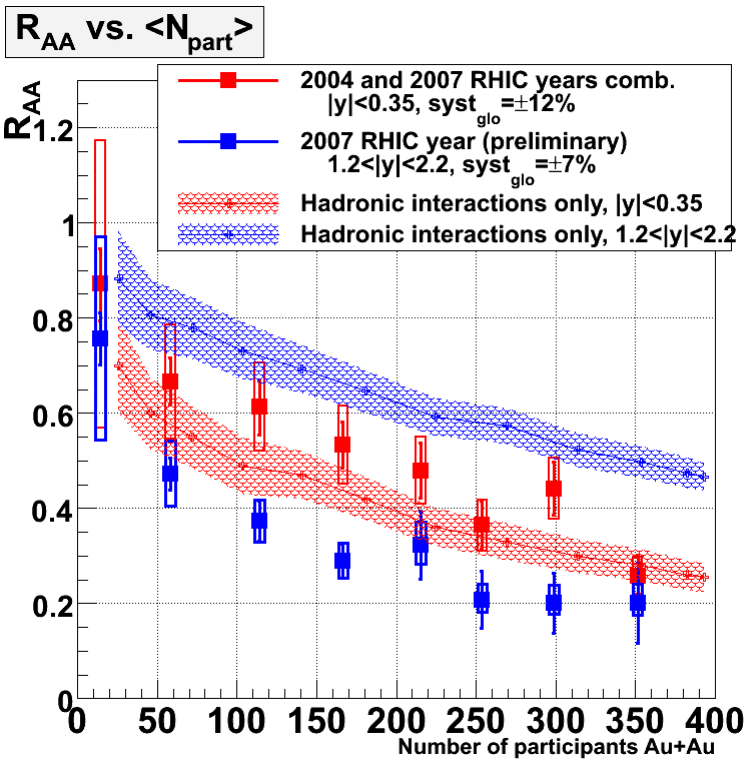


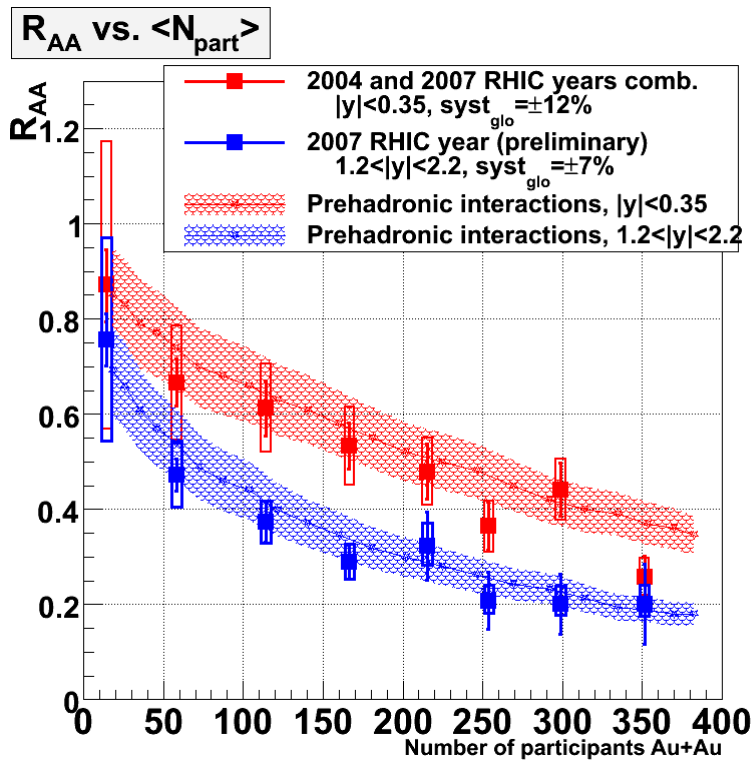


Uncertainty on CNM projection doesn't allow to exclude the same anomalous suppression at forward and mid rapidities.

Another possible explanation: regeneration

- Why regeneration could explain rapidity trend?
  - Uncorrelated c and $\bar{c}$ quarks coalesce at hadronization
  - At mid rapidity, more charm quarks => enhance J/ψ yield



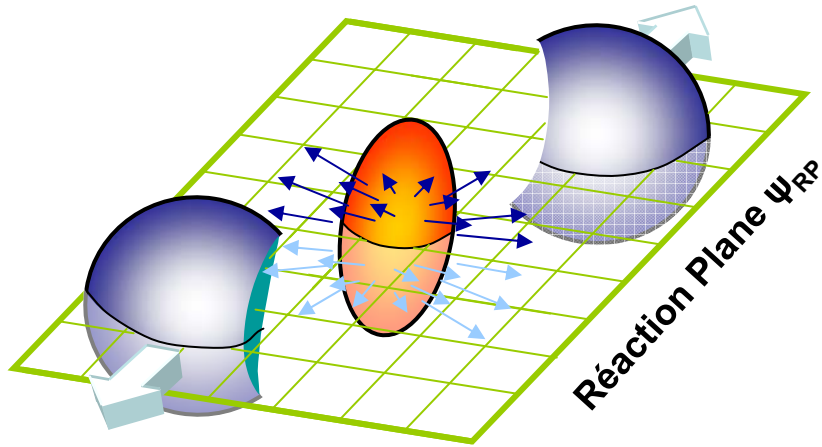


Models have a strong dependence on the production rate of heavy quarks in AA collisions which is poorly constrained.

Measuring J/ψ elliptic flow

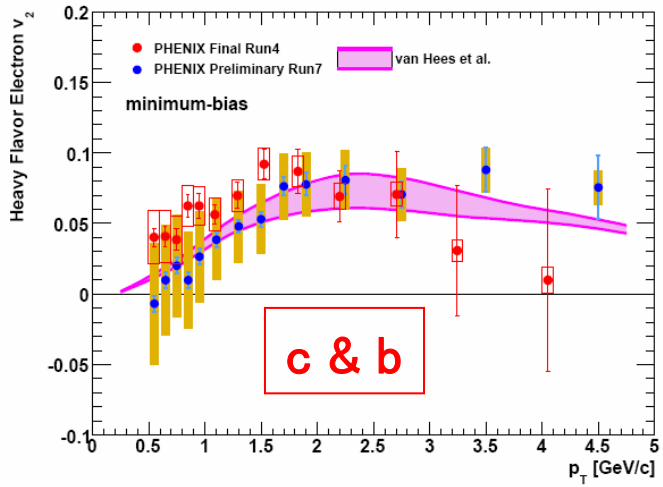
Testing regeneration with J/ψ elliptic flow

- Elliptic flow
  - In non central collisions, almond shaped interaction region results in a pressure gradient
  - More particles are emitted 'in plane' than 'out of plane'
  - Magnitude measured by v_2



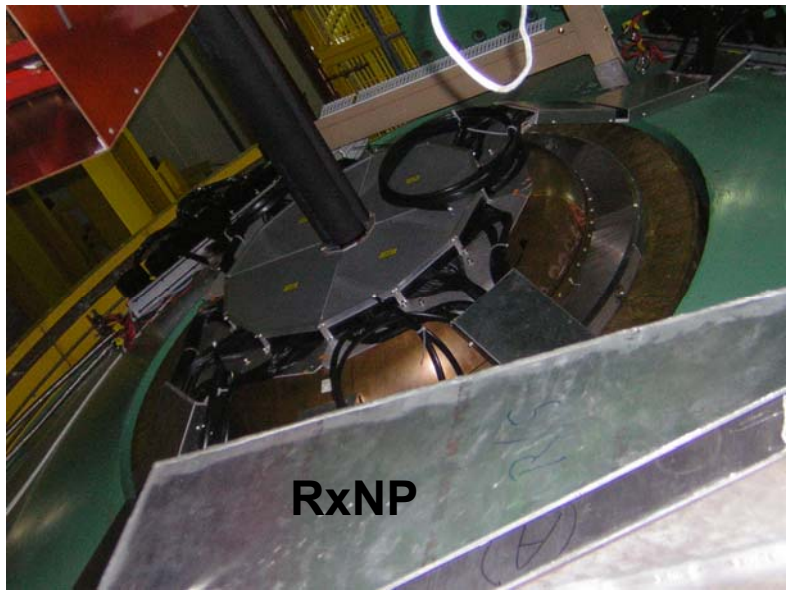
$$\frac{dN}{d(\phi - \Phi_{RP})} = A\left(1 + 2v_2 \cos\left(2(\phi - \Phi_{RP})\right) + \cdots\right)$$

- J/ψ elliptic flow as a test of regeneration
  - Electrons from open c and b semileptonic decays show large nonzero elliptic flow
  - J/ψ regenerated from c quarks should inherit their flow



Determining reaction plane (RP) angle

- Reaction Plane Detector
  - Newly installed for year 2007
  - One in each arm
  - Plastic scintillator detector
    - $1 < \eta < 2.8$
    - 2(r)x12(ϕ) sector
    - Active volume thickness 2 cm
    - Preceded by a 2 cm photon converter
  - Measures the energy deposit by charged secondaries in each sector



  - The weighted average of the azimuthal positions of the sectors:

$$(X, Y) = \left(\sum_i wt_i \times \cos(n \times \phi_i), \sum_i wt_i \times \sin(n \times \phi_i)\right)$$

i=sector, wt_i=ADC reading,
ϕ_i=azimuthal position,
n=harmonic (2 for elliptic flow)

- Other RP angle measuring devices: BBC, MPC

RP angle resolution correction

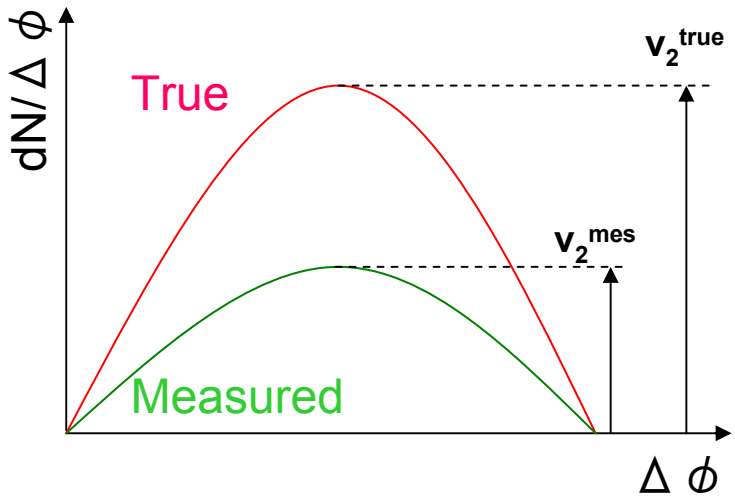
- Finite resolution RP angle
  - Washes out the anisotropy in particle yield and reduces the apparent v_2 with respect to its true value
  - The true and measured elliptic flows are related by

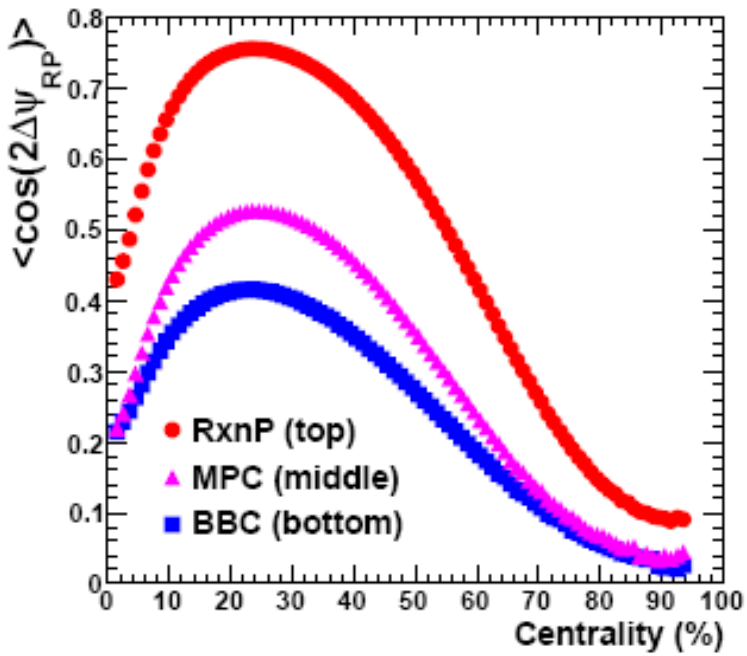
$$v_2^{mes} = v_2^{true}\sigma_{RP}$$

where the correction factor is

$$\sigma_{RP} = < \cos\left(2(\Phi_{RP}^{A} - \Phi_{RP}^{B})\right) >$$

  - Φ_{RP}^{A} and Φ_{RP}^{B} are measured by two equivalent sized independent sub samples of the same event (north and south arm RP detectors)





Signal Counting in Δφ

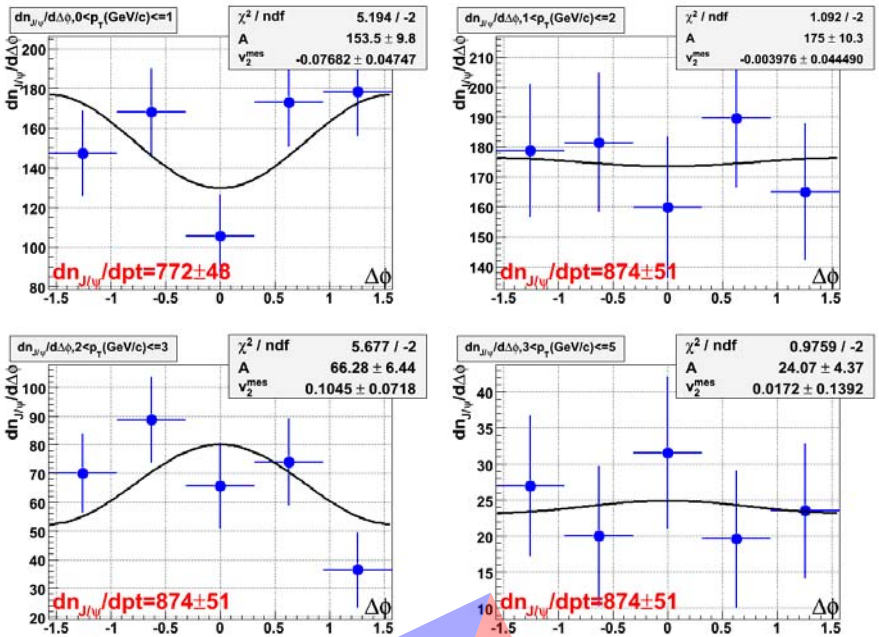
- Three methods
  - Fitting (subtraction) method
    - Signal counting in $\Delta\phi$ and p_T bins.
    - 5 bins from $-\pi/2$ to $\pi/2$
    - Fit the $\Delta\phi$ dependence with

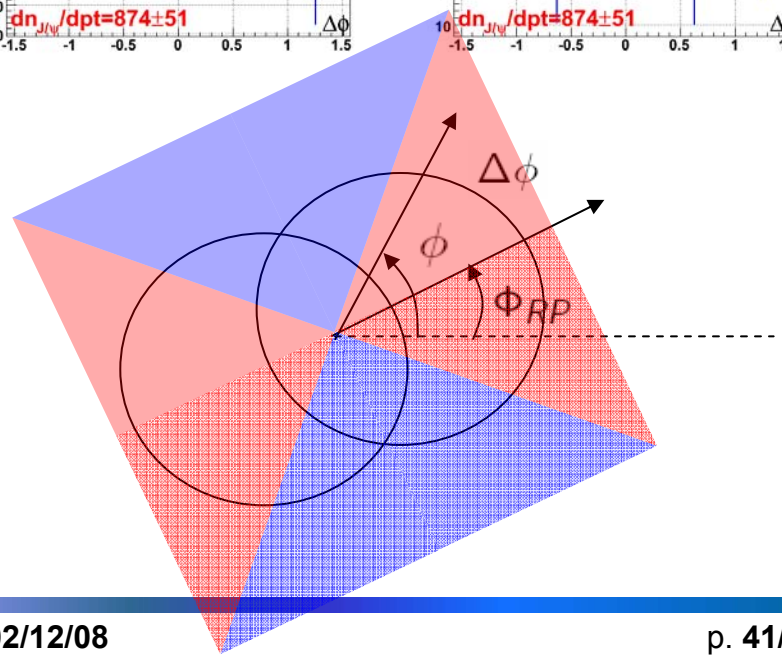
$$[A](1 + 2v_2 \cos(2 \times \Delta\phi))$$

  - Ratio method
    - In plane (N_{in}) and out of plane (N_{out})

$$v_2 = \frac{\pi}{4} \times \frac{N_{in} - N_{out}}{N_{in} + N_{out}}$$

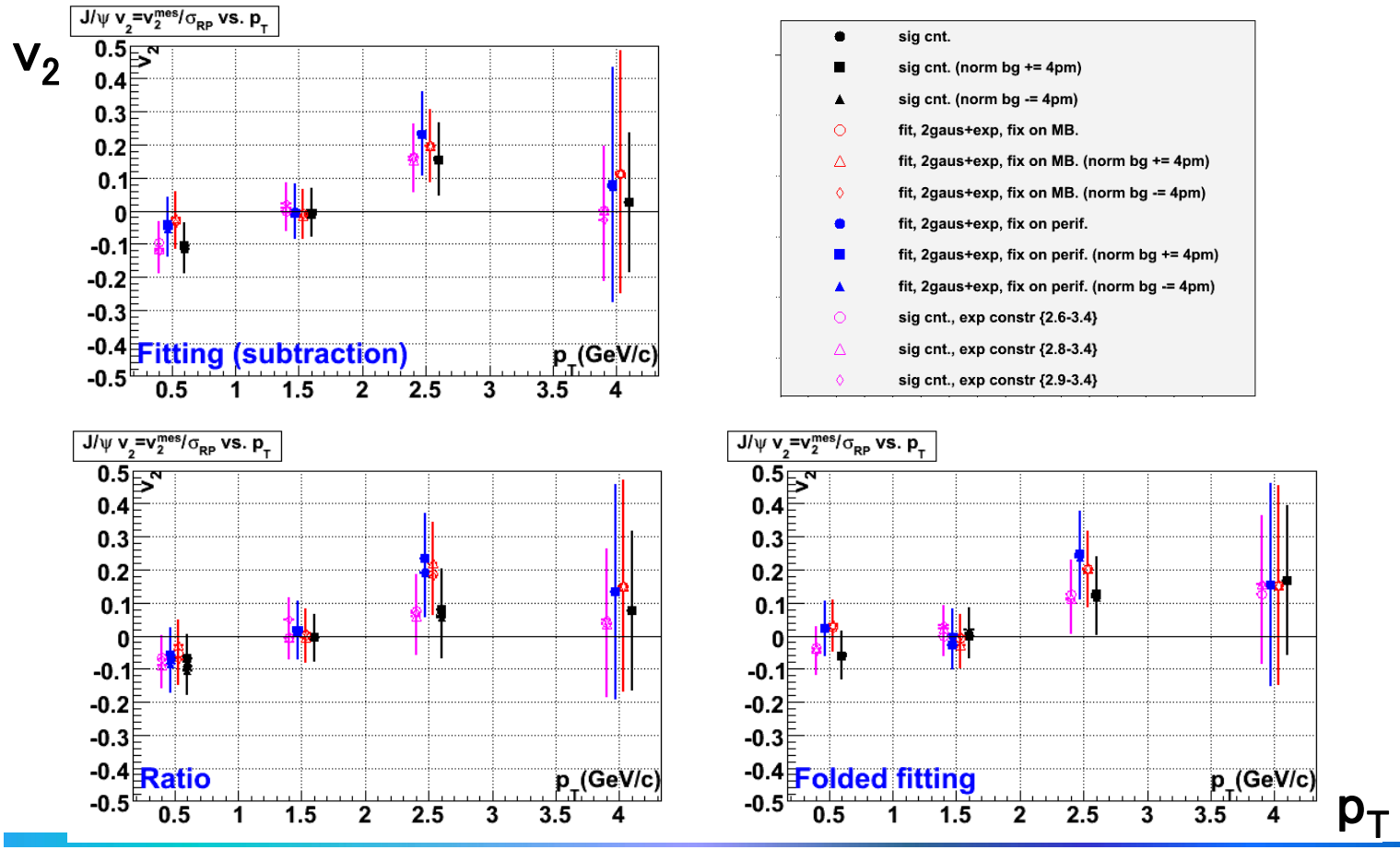
    - More statistics in each bin
  - Folded fitting method
    - Exploits the symmetry of v_2 fit eq.
    - Fold $\Delta\phi$ around 0





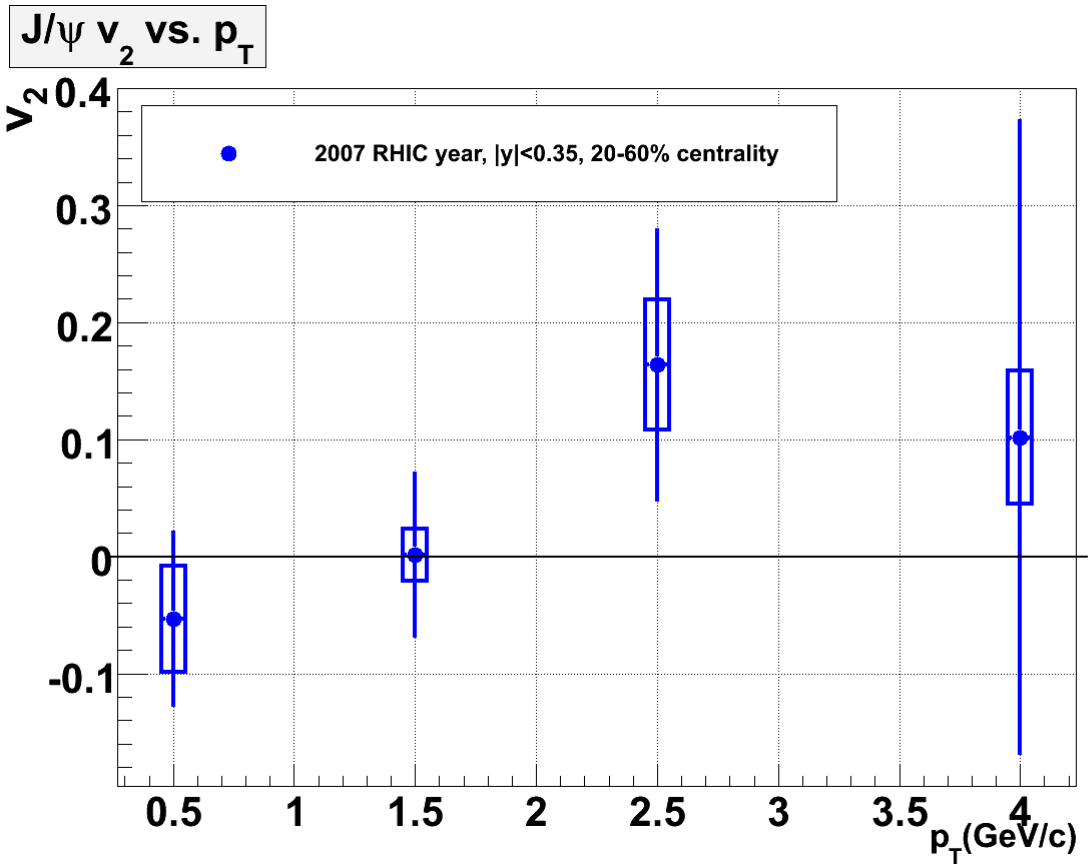
Systematics of v_2

- Multiple signal/raw v_2 extraction methods
  - Central value: average of all results while varying the method
  - Systematical error: RMS of the results



J/ψ v_2 result

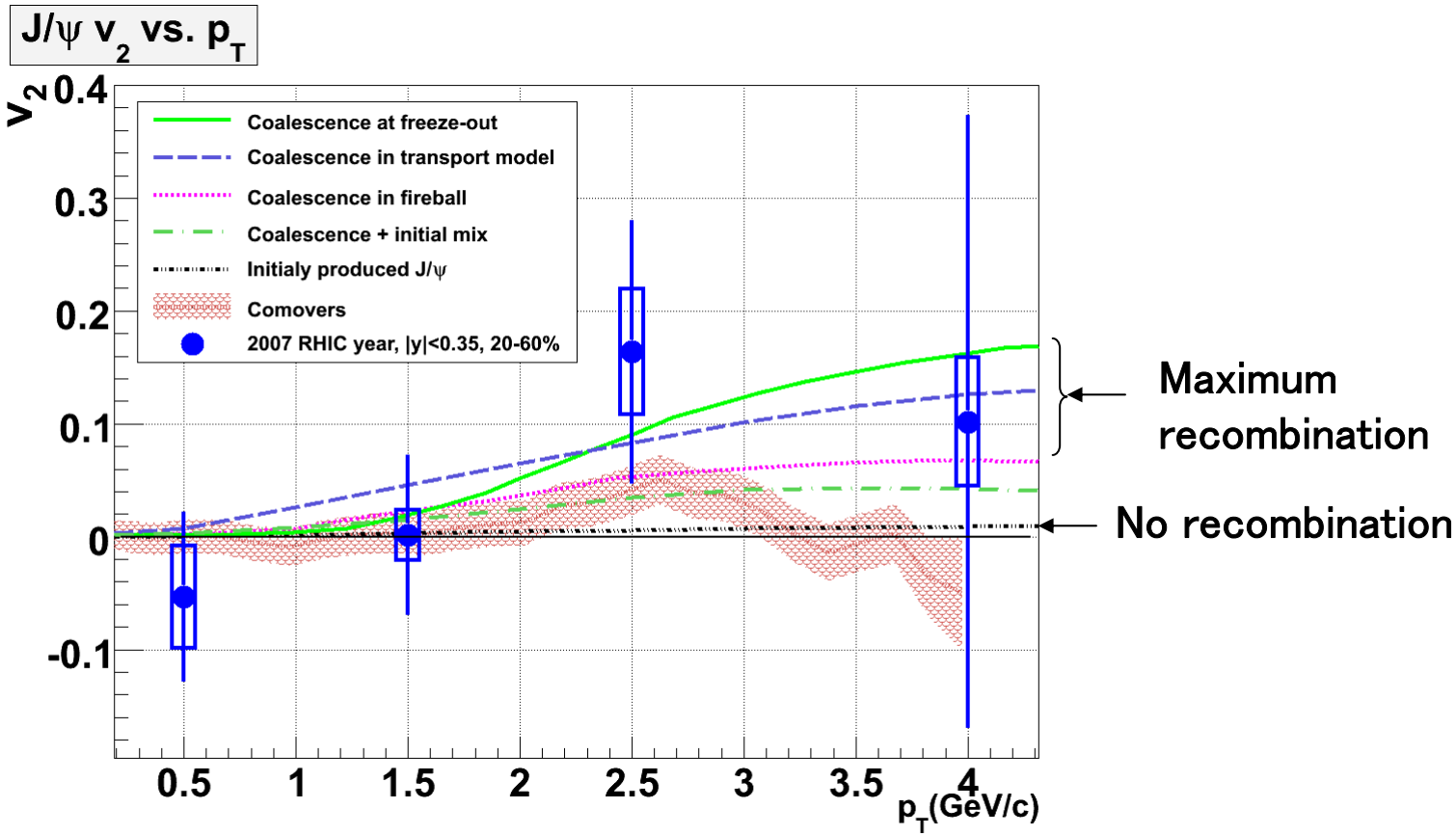
J/ψ elliptic flow vs. p_T



p_T integrated v_2 = (0.68±4.85)% @ |y|<.35

J/ψ elliptic flow vs. p_T

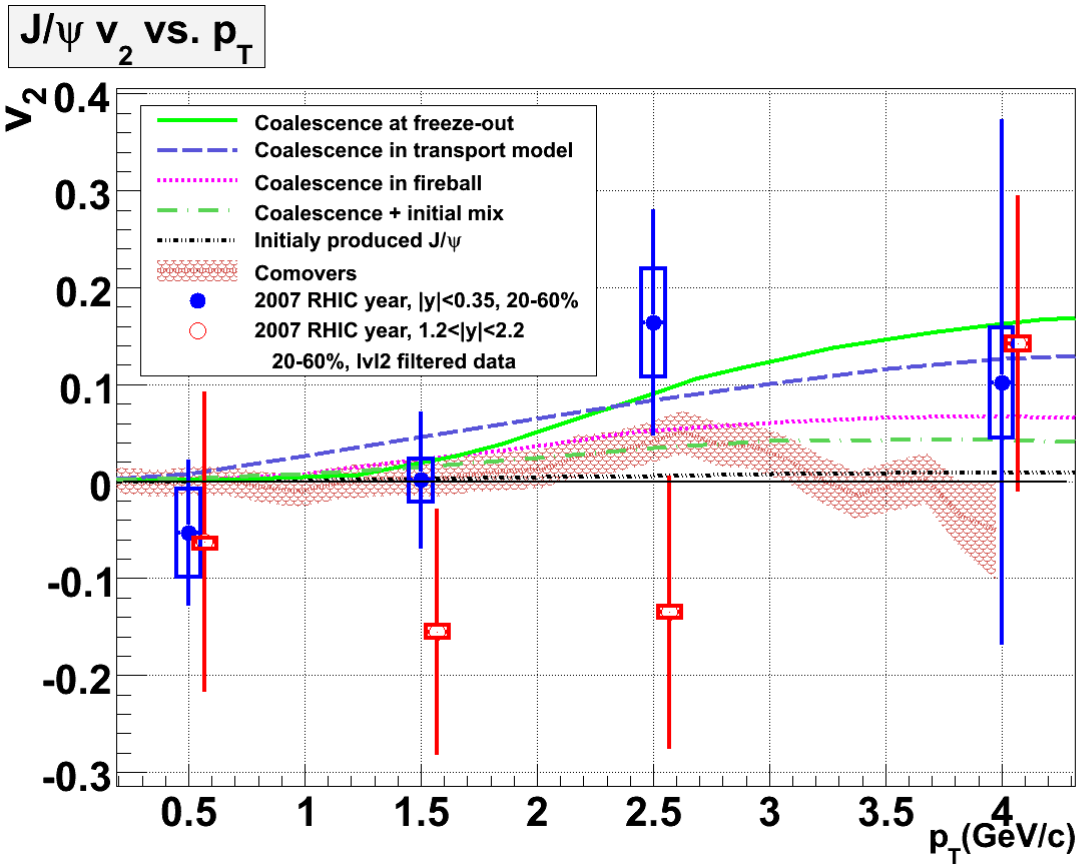
- Comparison to model predictions



pT integrated v2 = (0.68±4.85)% @ |y|<.35

J/ψ elliptic flow vs. p_T

- Comparison to forward rapidity measurement



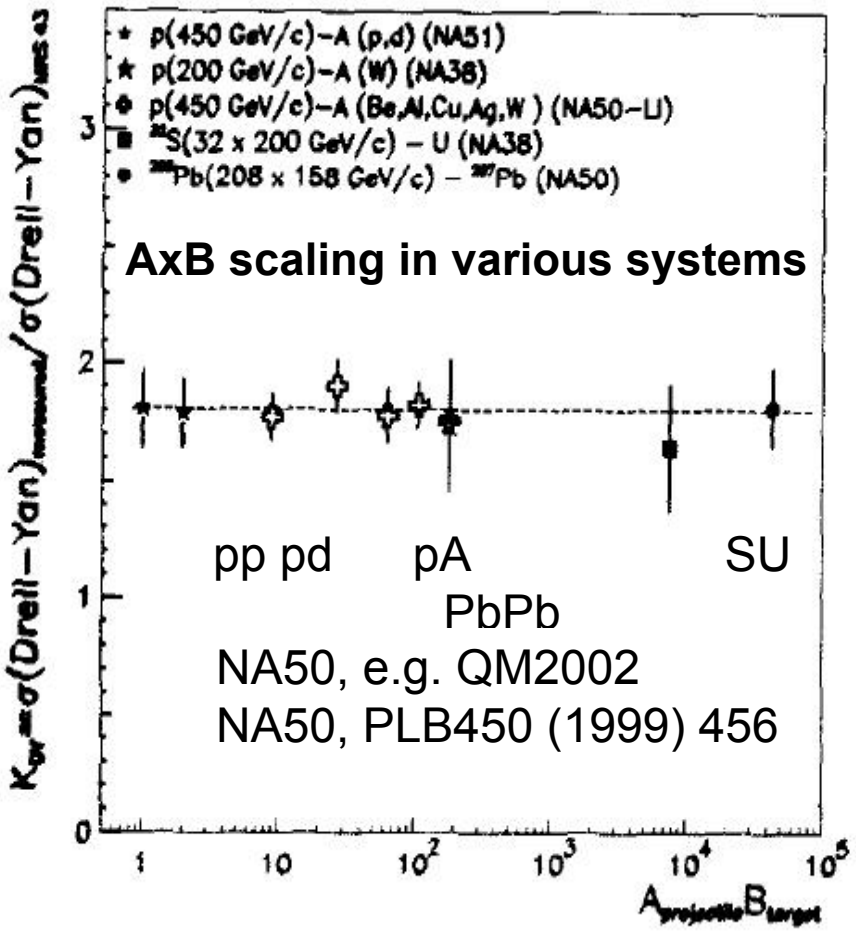
p_T integrated v_2 = (0.68±4.85)% @ |y|<.35 and (−9.3 ± 9.2)% @ −1.2<|y|<1.2

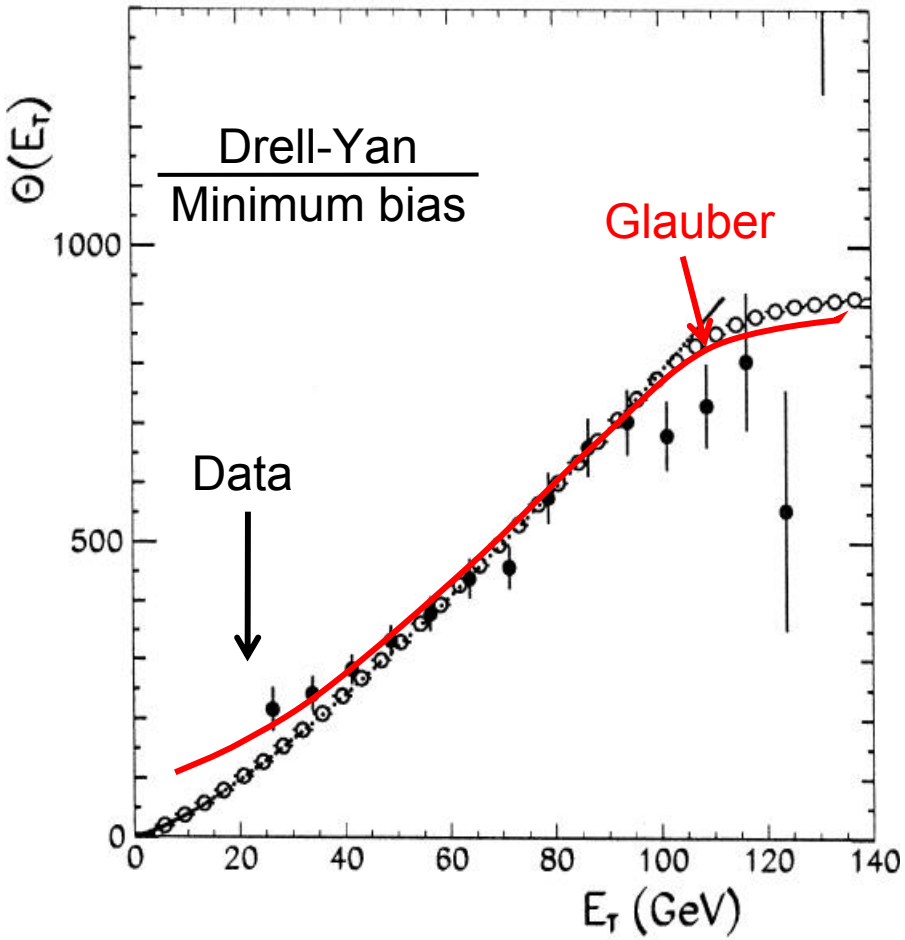
Conclusion and outlook

- Suppression
  - The analysis of the new 2007 RHIC year data set confirms the already measured J/ψ nuclear modification factor:
    - The uncertainty on the cold nuclear matter effects impedes interpretation.
    - The rapidity dependence suggests regeneration could be at play.
    - Elliptic flow is a possible test of regeneration.
- Elliptic flow
  - A J/ψ elliptic flow measurement result is shown:
    - The result in its current state does not allow to distinguish between models.
    - It can be seen as a demonstration of feasibility.
- The future
  - Higher statistics and upgrades (Silicon Vertex Detector)
  - More precise constraint on cold nuclear matter effects
  - Measurement of other quarkonium states

Backup

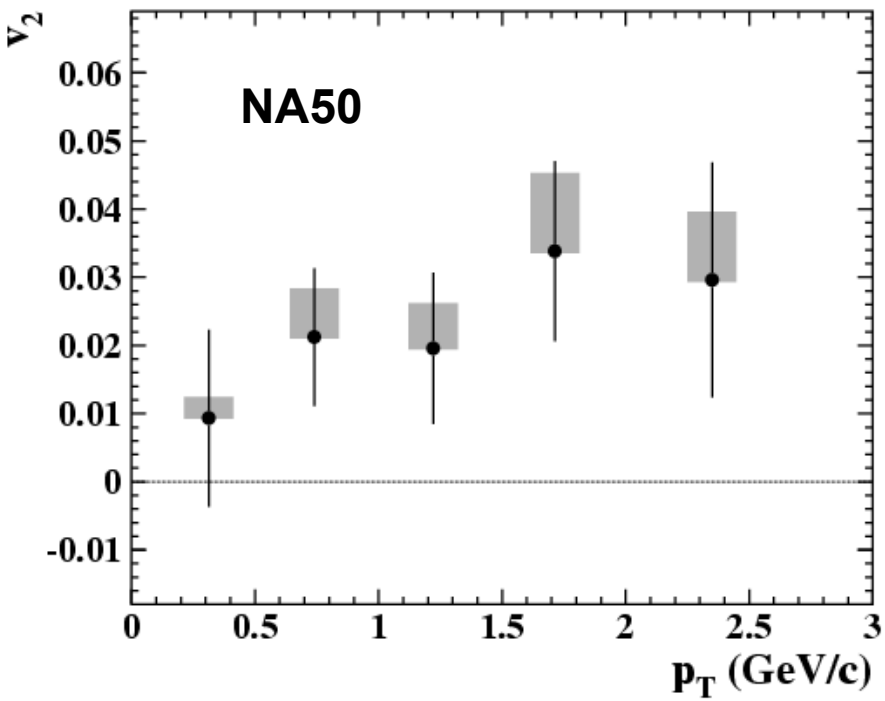
N_{coll} scaling of Drell-Yan at SPS

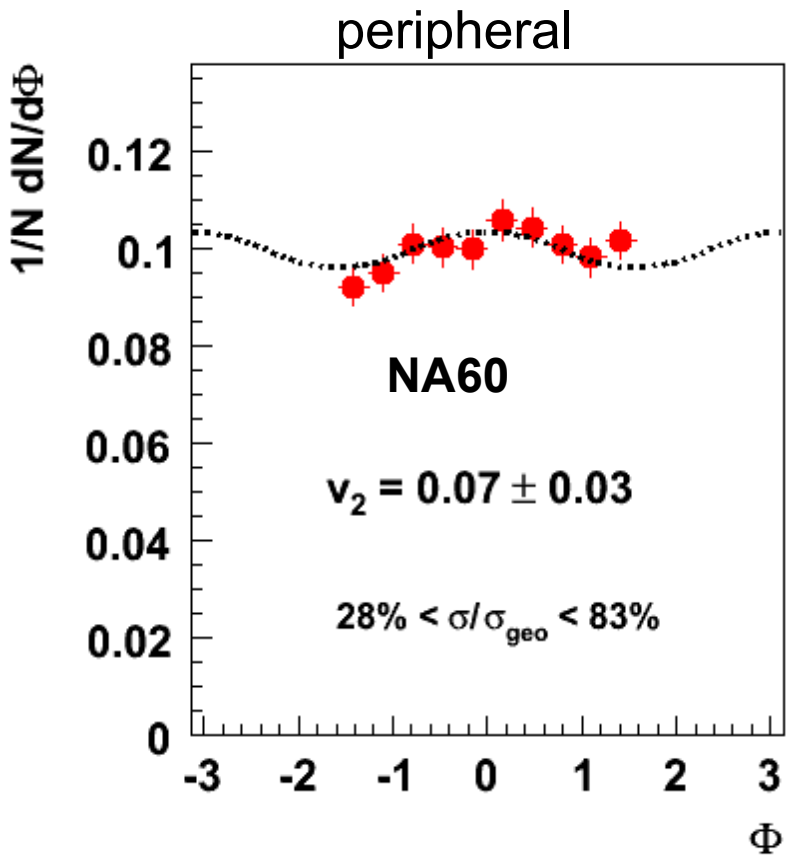




Neither cold nor hot modifications
Quark (anti)shadowing must be small
It is a good reference for charmonia

J/ψ flow at SPS





- A non zero flow is observed at SPS
  - Impossible to explain in terms of recombination, since the open charm yield per collision is low.

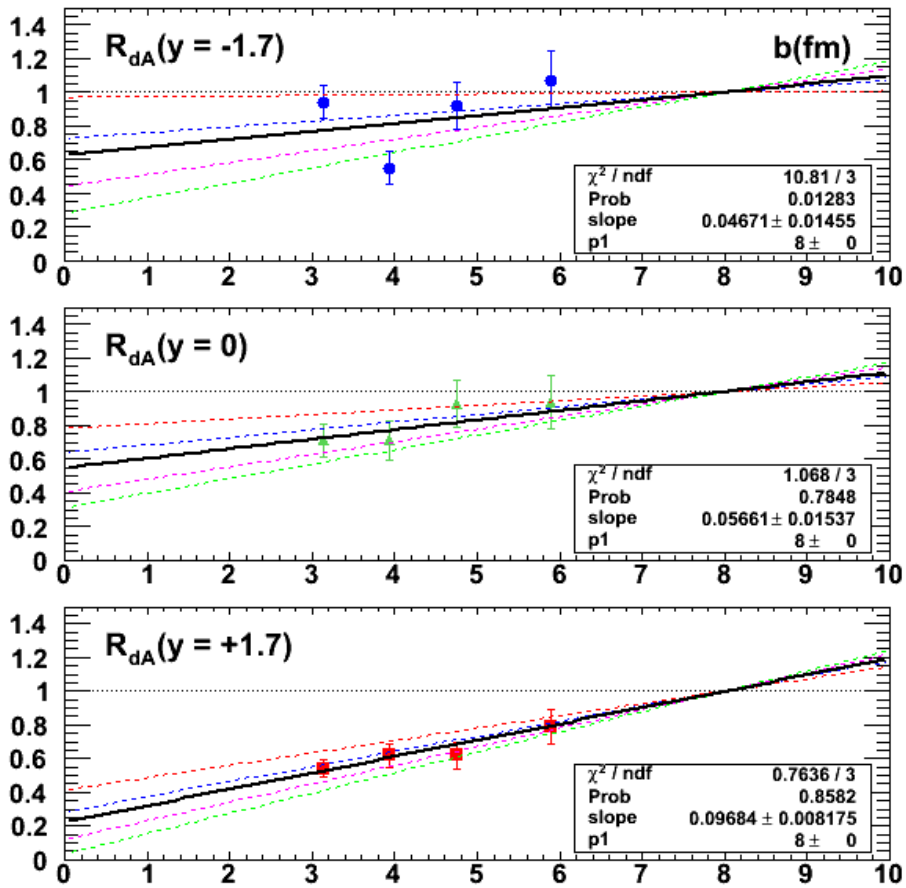
Extrapolating R_{dA} to R_{AA}

- The idea
  - Infer the y and b dependence of $R_{dA}(y,b)$ by fitting assumed functions to the measured points
  - Implement AA collisions with a given impact parameter range
  - For each AA collision, construct the average

    Σ [$R_{dA}(-y,b_{i1})$ x $R_{dA}(+y,b_{i2})$] / N_{coll}

    to evaluate R_{AA}^{CNM}
  - This factorization is true at least for shadowing and absorption which follow the J/ psi production follows

    ~ pdf1 x pdf2 x exp $-\rho\ \sigma$(L1+L2)



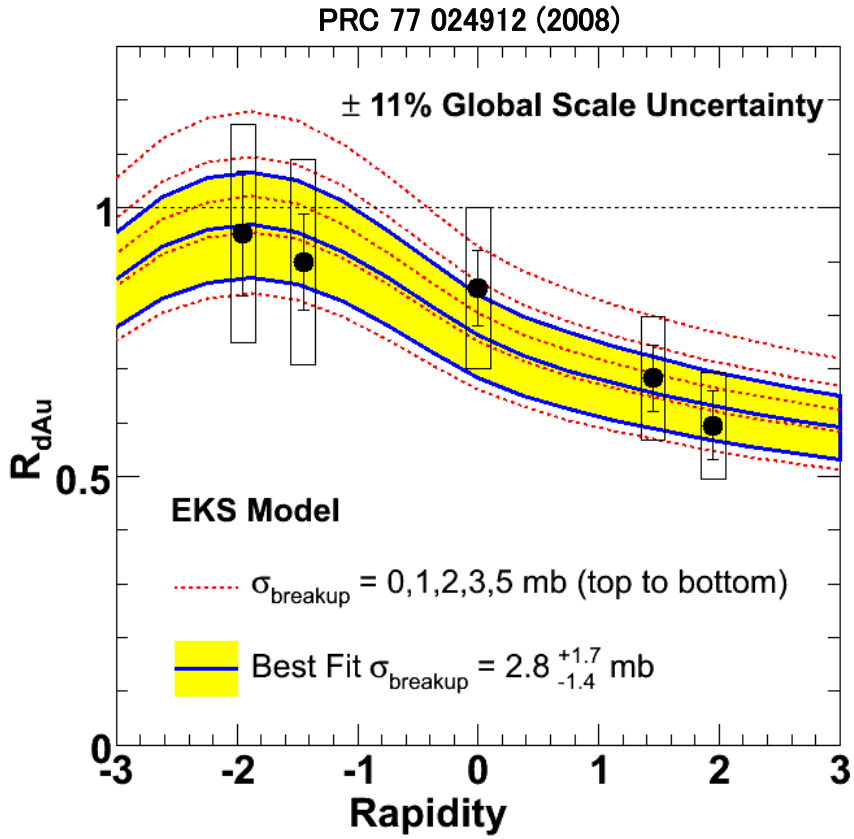
RGdC, QM06, JPG35 (2008) 104023
PHENIX, PRC 77, 024912 (2008)

Breakup cross-section

- Extraction method
  - Rapidity dependence of R_{dAu} calculated (*) assuming a shadowing model EKS (**) or NDSG (#)
  - Any additional suppression is accounted for by a single free parameter : break up cross-section ($\sigma_{breakup}$)
    - EKS => $\sigma_{breakup} = 2.8\ ^{+1.7}_{-1.4}$ mb
    - NDSG => $\sigma_{breakup} = 2.2\ ^{+1.6}_{-1.5}$ mb
  - Compatible with SPS (##):

    $\sigma_{abs} = 4.2 \pm 0.5$ mb

    (Anti shadowing effect not taken into account in SPS calculation)



(*) R. Vogt, PRC, 71 054902 (2005)

(**) K.J. Eskola et al., Nucl. Phys. A 696, 729 (2001)

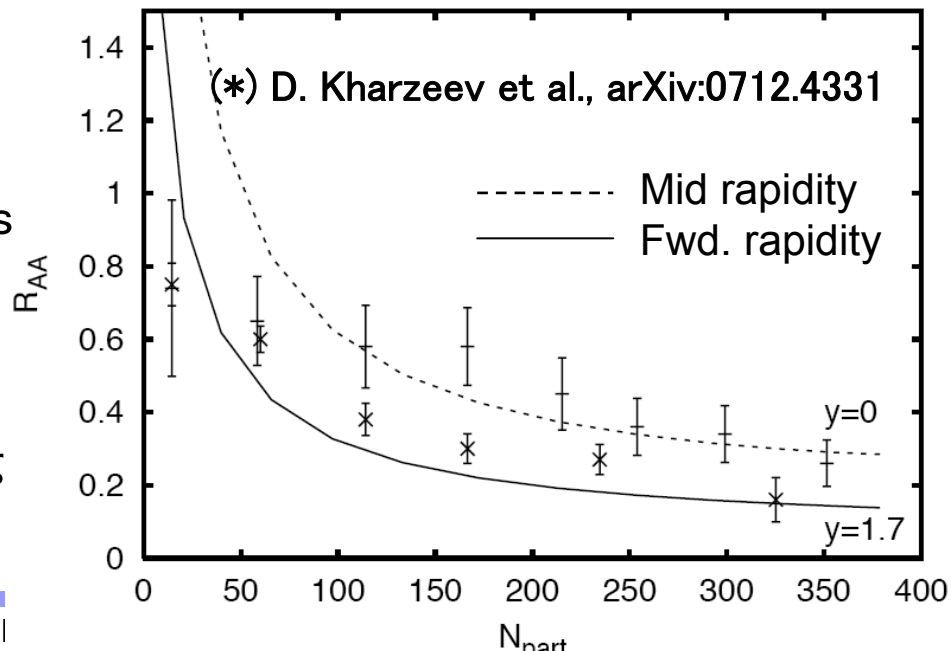
(#) D. deFlorian et al., PRD, 69 074028 (2004)

(##) B. Alessandro et al., Euro. Phys. J. C48, 329 (2006)

Yet another possible explanation

- Lattice QCD results suggest :
  - No J/ψ suppression for T as high as 2.1Tc ($\gtrsim$ 10GeV/fm3)
  - ψ' and χc start melting at around 1.1Tc (attained both at RHIC & SPS)
  - Suppression seen at RHIC & SPS may be only the feed down part
  - This explains RHIC/SPS similarity
- Color Glass Condensate
  - Charmed meson calculations based on CGC give higher mid rapidity yields
  - Latest prediction(*) confirms this trend for J/ψ. Initial state effects can explain the forward/mid tendency
  - This calculation succeeds in reproducing data without involving any 'hot nuclear matter' effects.

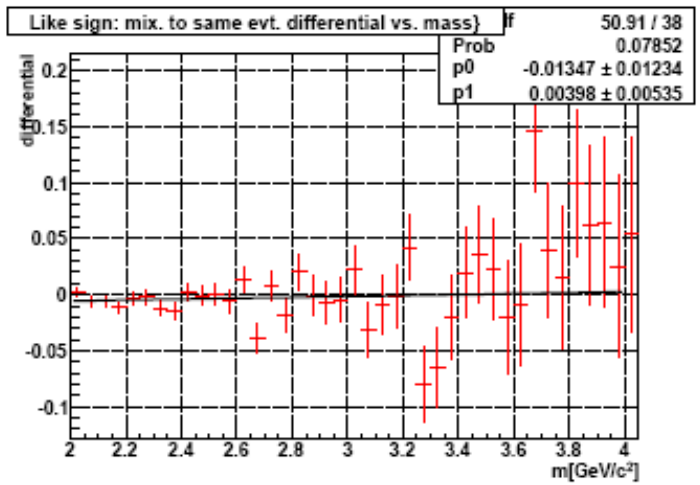
state	$J/\psi(1S)$	$\chi_c(1P)$	$\psi'(2S)$	$\Upsilon(1S)$	$\chi_b(1P)$	$\Upsilon(2S)$	$\chi_b(2P)$	$\Upsilon(3S)$
T_d/T_c	2.10	1.16	1.12	>4.0	1.76	1.60	1.19	1.17

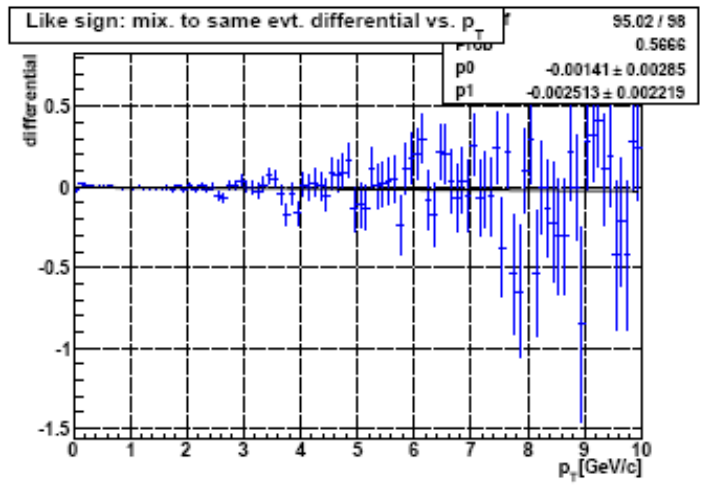


Cross checking the mixed event bkg.

Mixing cross check: like sign differentials vs. mass and p_T

- The like sign distribution differentials, $\frac{n^{like}_{same} - n^{like}_{mix}}{n^{like}_{mix}}$, where $n^{like} = n^{++} + n^{--}$ were plotted versus mass and p_T
- These ratios are flat within the errors (p1 = slope).





Conservatively, the slope of the differential vs. mass (0.4%) is used to vary the mixed event background normalization factor once up and once down, and the resulting signal counts are added to the systematical error estimation.

Acceptance systematics (1/2)

The systematical error is estimated using in the following way.

- The area covered by the difference between the two distributions (Data and MC) is normalized by their average integral:

$$err_{syst} = \frac{\sum_{bins} |dN_{sim} - dN_{dat}|}{\sum_{bins} 1/2 * (dN_{sim} + dN_{dat})}$$

- This formula has a bin size dependence (increases with decreasing bin size)
- The systematics is thus plotted as a function of the bin size (figs next slide), and then fitted with a p0 in the region where the bin size dependence is small
- The argument behind this is that when the bin size is small, statistical fluctuations dominate the systematics evaluated by the above relation. When statistics starts to be dominated by systematic effects, the variation slows

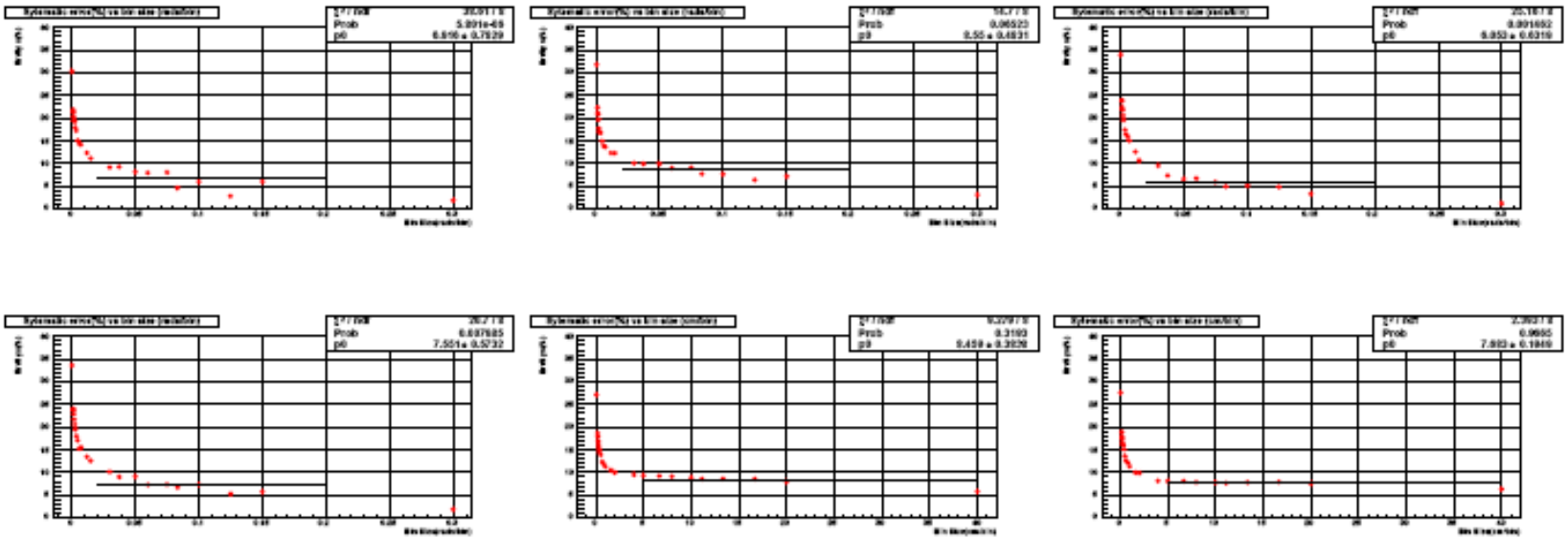
Acceptance systematics (2/2)

The systematics is estimated separately for phi and zed

- phi: electrons east arm $(\delta_\phi e_e)$, electrons west arm $(\delta_\phi e_w)$, positrons east $(\delta_\phi p_e)$ and positrons west $(\delta_\phi p_w)$
- zed: electrons $(\delta_{zed} e)$ and positrons $(\delta_\phi e_w)$

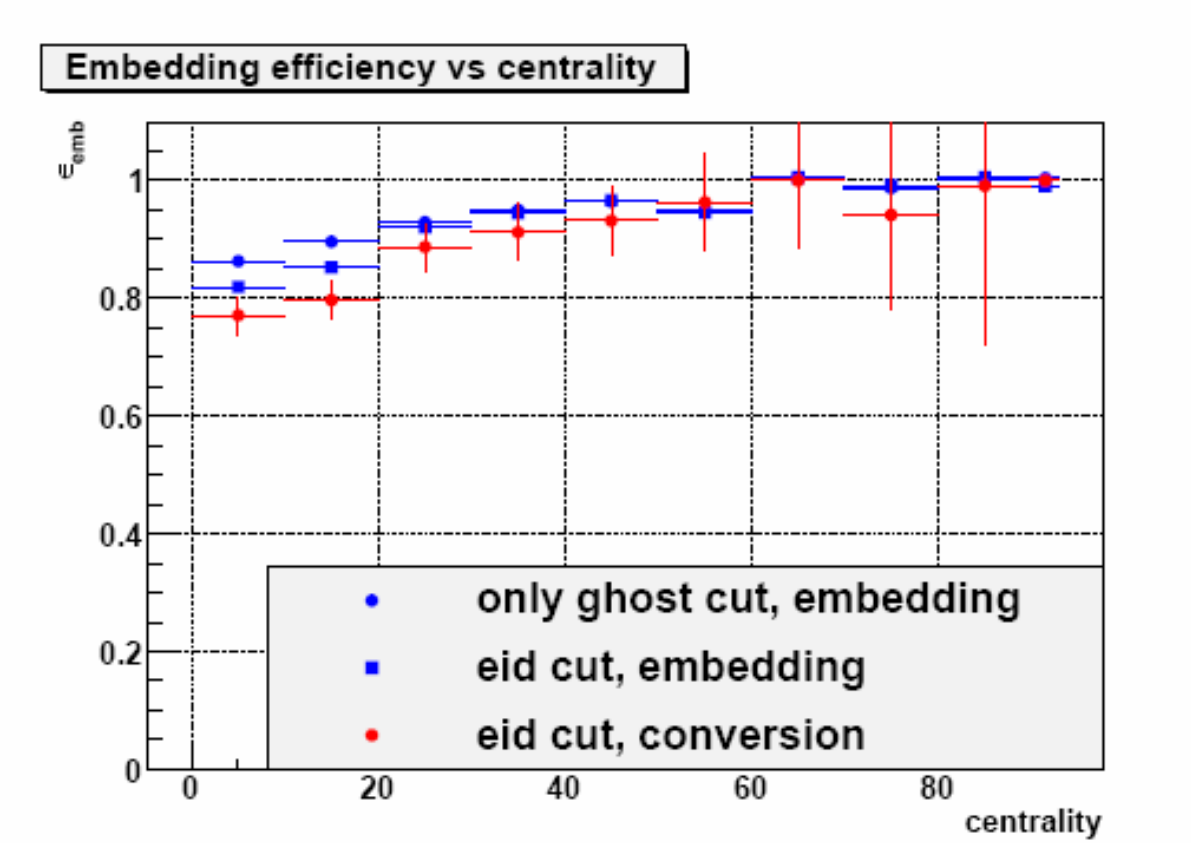
$$\delta_\phi(J/\psi) = \frac{(\delta_\phi e_w \oplus \delta_\phi p_e) + (\delta_\phi e_e \oplus \delta_\phi p_w)}{2.} = 10.4\%$$

$$\delta_{zed}(J/\psi) = \delta_{zed} e \oplus \delta_{zed} p = 11.5\%$$



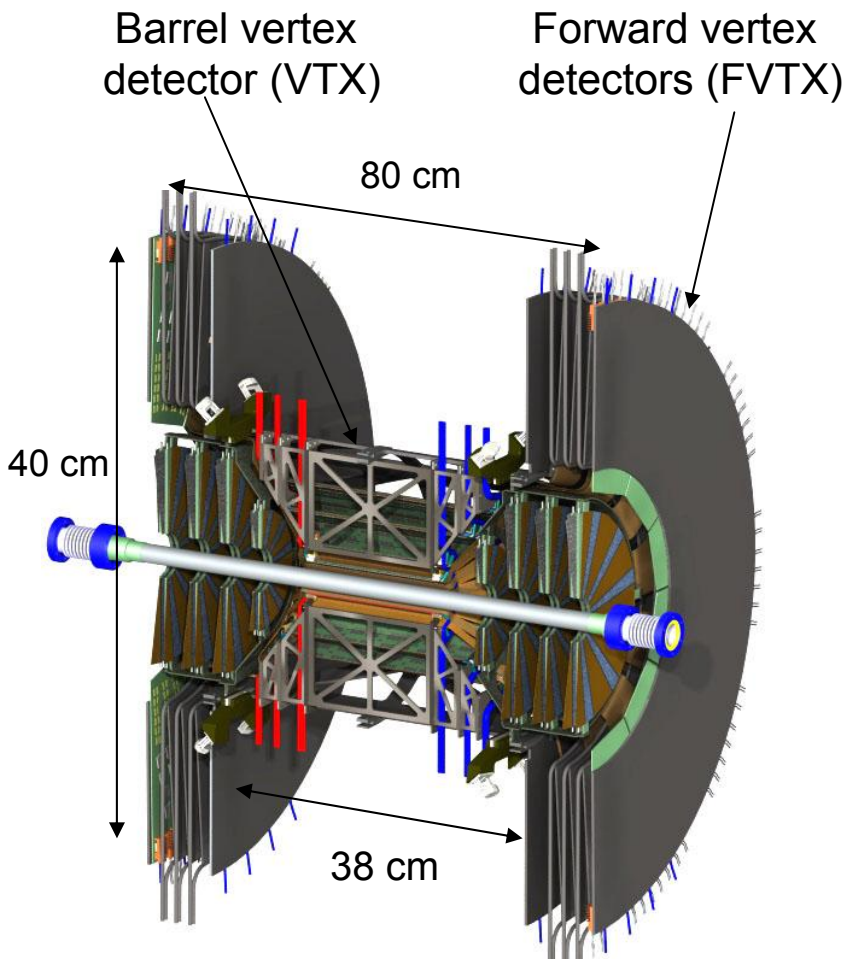
Crosschecking embedding efficiency

- Conversion method is a data driven method

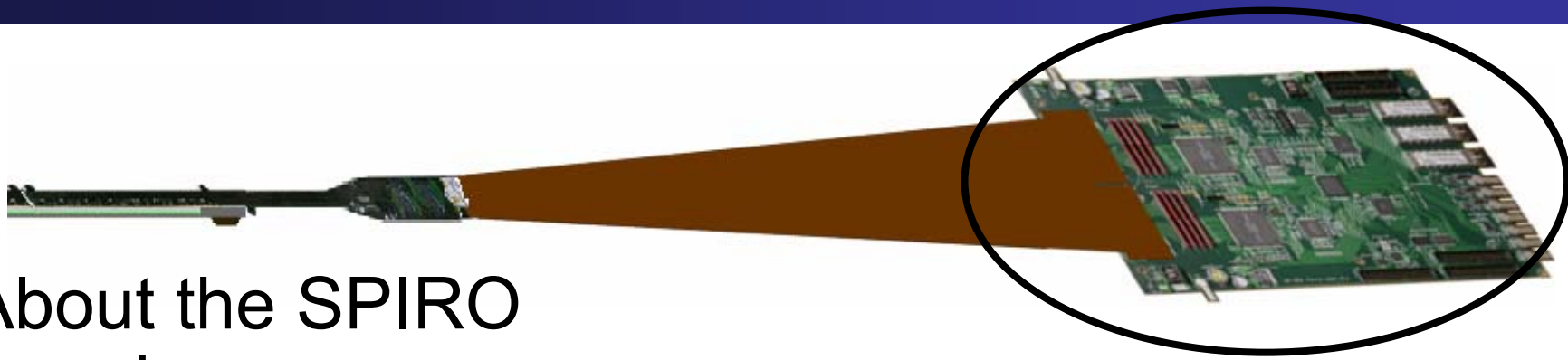


Looking forward…

- Silicon Vertex upgrade
  - 2 pixel + 2 strip layers at mid rap.
    - Full azimuthal coverage
  - 4 strip layers at forward rapidity
  - Central arm
    - Main improvement is expected in open HF. Need to insure quarkonium measurement not affected through multiple scatterings of electrons
  - Muon arm
    - The FVTX is expected to improve resolution sufficiently to enable J/ψ–ψ' separation
- Involved in pixel part:
  - Chip based on 32x256, 450x50μm^2 pixel hybrid ALICE–LHCb sensors (with analog readout)
  - Readout: SPIRO (next slide)



Silicon Pixel Interface Read Out (SPIRO)



- About the SPIRO board
  - Each SPIRO board reads a half ladder (8 sensor chips) @10MHz
  - 65536 channels
  - SPIRO formats data and aligns data on a more precise clock
  - Optical transformation using a GOL chip driving a transceiver
  - In the other direction, it brings PHENIX clock & commands to sensor chips.
  - This card was developped and is being produced by our group

- Contributions
  - When test bench was laid out, I did some programming of the testing software framework with the help of lab engineers.
  - Also did simulation study of how much J/ψ measurement would be afffected, w/o considering hits from VTX. (Just material budget effect). Result was reported in Proposal.

Data reconstruction work

- 2007 run high level trigger filtered data
  - Filtered raw data ~ 70 TB (~30k file segments), reconstructed data ~10 TB
  - Data taking at RHIC and reconstruction at CCIN2P3 (French computing farm)