$J/\psi \rightarrow e^{+}e^{-}$ Measurements in Au+Au collisions at $\sqrt{S_{NN}}$ = 200 GeV at RHIC-PHENIX

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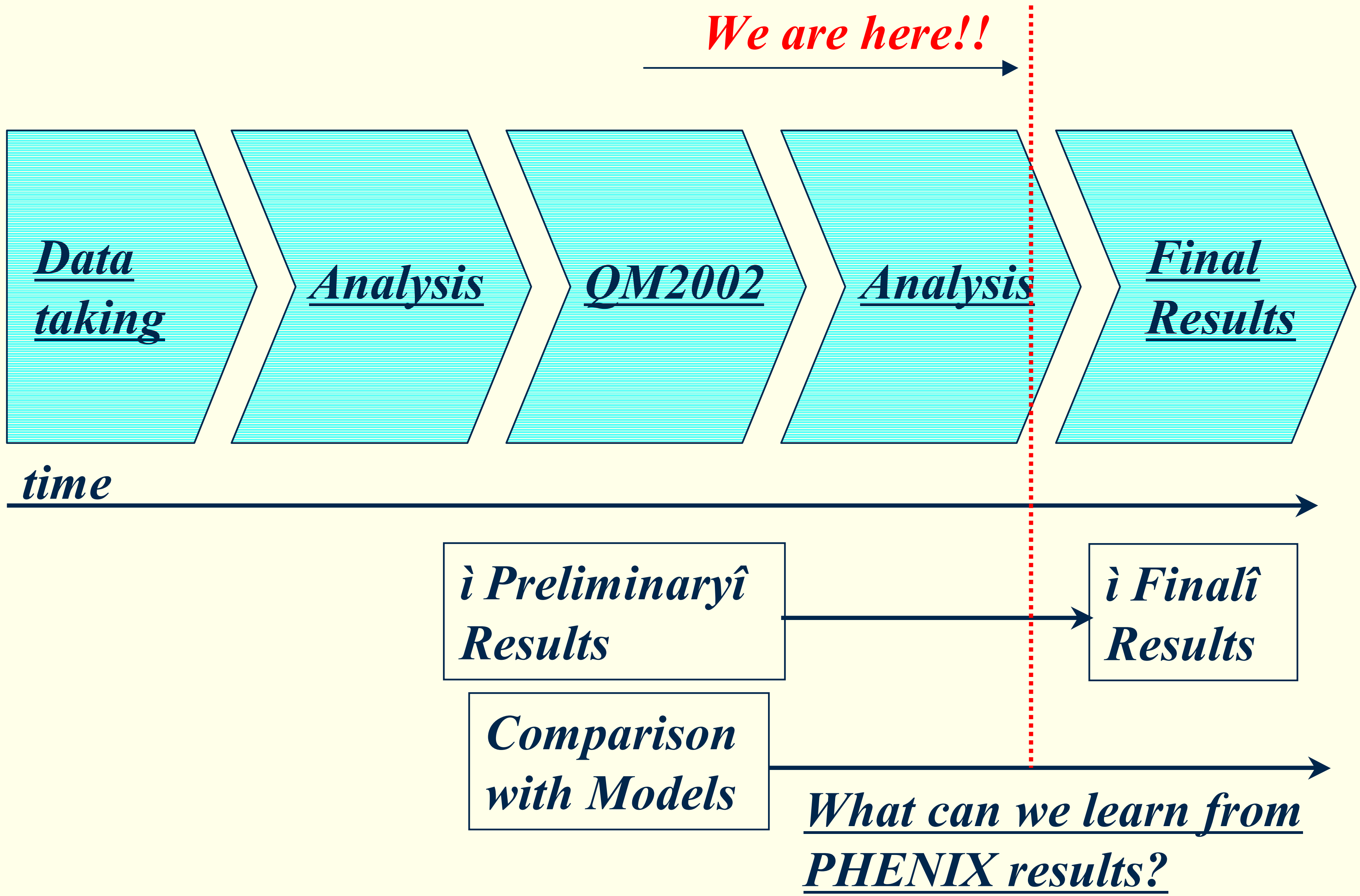
for the PHENIX collaboration

At Spring JPS Meeting

- OUTLINE -

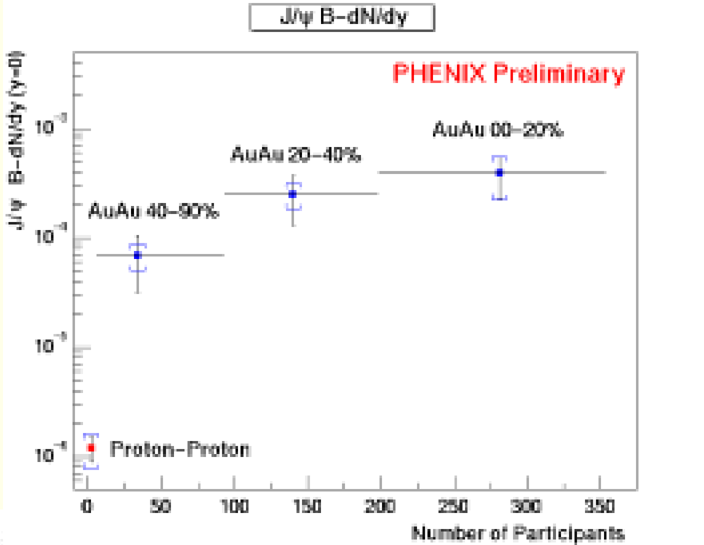
ïQM results & theorists effort
ïAfter QM
ïLevel-2 Trigger
ïCombinatorial background
ïAcceptance Fluctuation
ïEid & centralit dependence
ïTowards final results
ïsummary

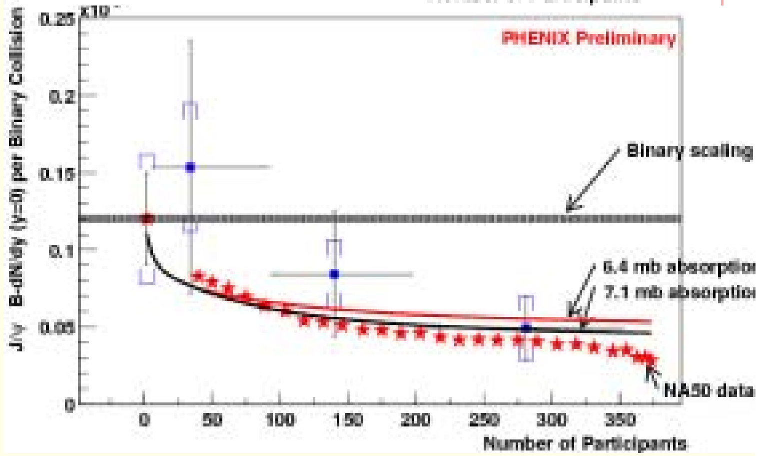
Where are we?

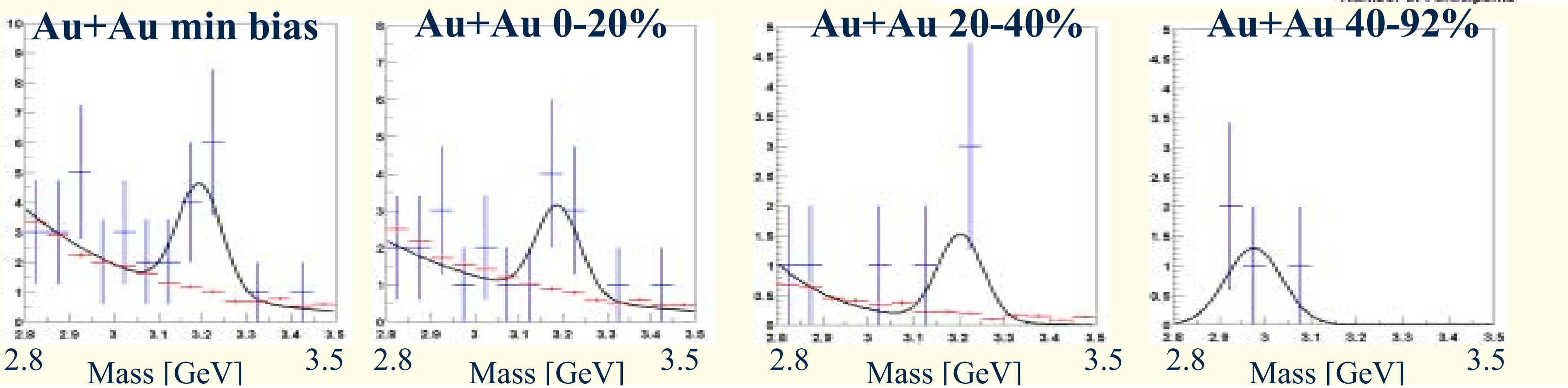

We are here!!
Data taking
Analysis
QM2002
Analysis
Final Results
time
ì Preliminaryî Results
ì Finalî Results
Comparison with Models
What can we learn from PHENIX results?

QM results & Effort of theorists

- QM2002 Preliminary results
  - J/ψ peak and dN/dy (per binary collision) are presented
- Theorists attempt to understand the results
  - R.L.Thews : coalescence calculation
  - Rapp : comparison with QGP formation, recombination
  - E.L.Bratkovskaya : nucl-th/0301083
- Hard to determine the model parameter
  - Data gives the constrain on extreme model ?



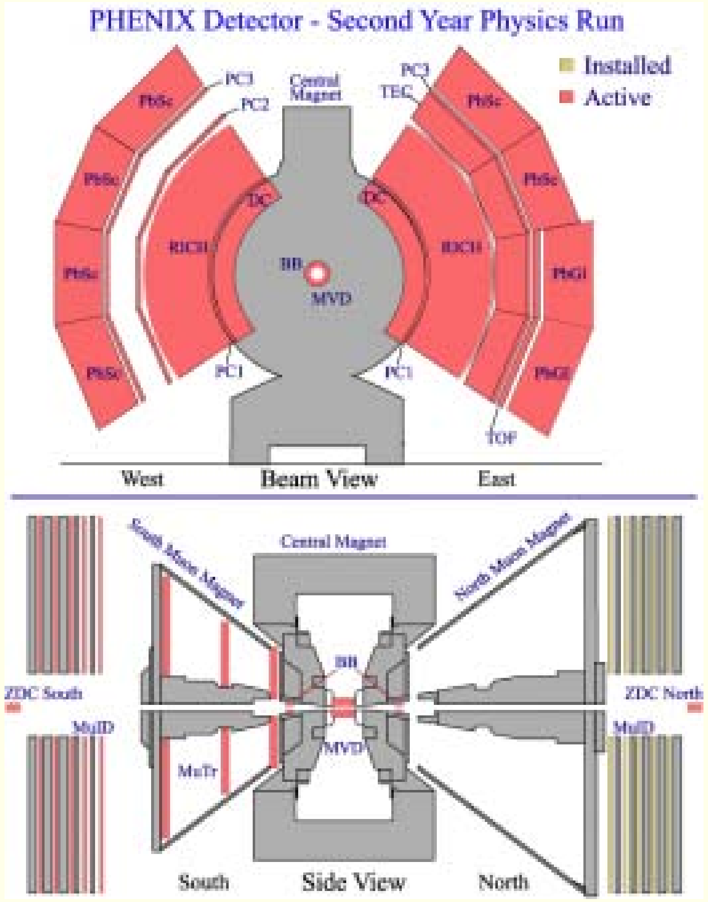




After QM

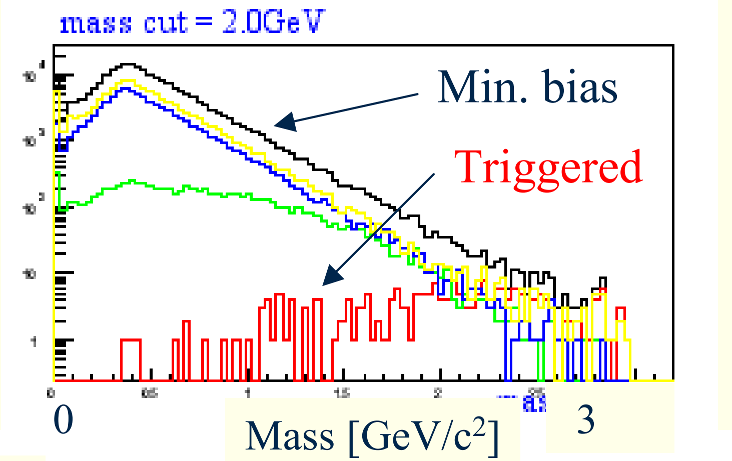
- Re-analysis of $J/\psi \rightarrow e^+e^-$ measurements in PHENIX Run2 Au+Au collisions, in order to publish the final results .
- **Double** the event statistics
  - Min-bias : **25.9 M** events (QM analysis) : N_{mb}
  - LVL2 trigger : **24.9 M** events (**new**) $N_{lvl2sample}, \varepsilon_{lvl2}$
- **Consistency check** of analysis procedure
- Acceptance& EID & Embedding recheck: $\varepsilon_{acc}, \varepsilon_{eff}, \varepsilon_{embed}$
- Initial pT distribution of J/ψ
  - Input from Run2 p+p result in PHENIX
- Counting J/ψ : $N_{J/\psi}$
  - Careful statistical treatment
- Formula to determine dN/dy of J/ψ

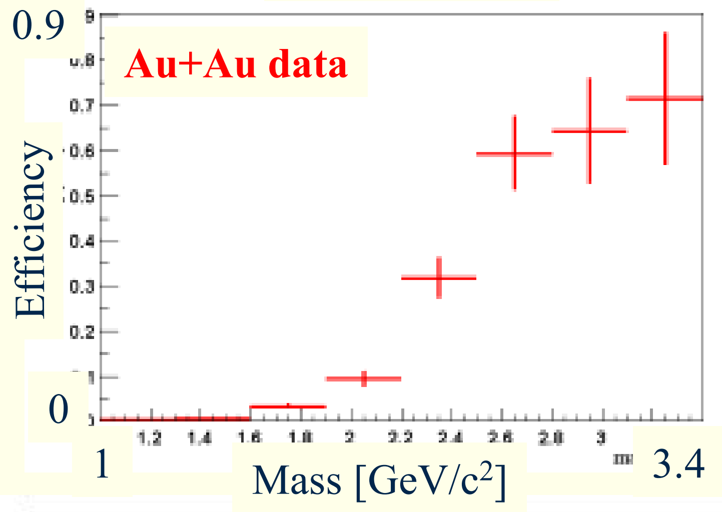
$$B\frac{dN}{dy} = \frac{N_{J/\psi}}{N_{mb} + \epsilon_{lvl2} \times N_{lvl2\_sample}} \times \frac{1}{dy} \times \frac{1}{\epsilon_{acc} \times \epsilon_{eff} \times \epsilon_{run-run} \times \epsilon_{embed}}$$

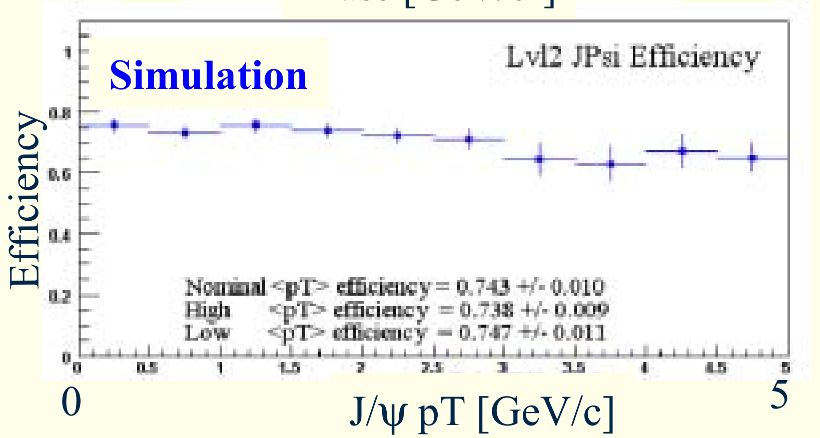


Level-2 Trigger

- LVL2 trigger algorithm in PHENIX
  - Makes ì rare event triggerî
    - Calculate invariant mass of electron pair
    - Set threshold to m >2.0(2.2) GeV/c^2
- Sampled **24.9 M** events → statistics become double
- Trigger efficiency evaluation
  - **Simulation**
    - Applied trigger algorithm to single J/y simulation. Check pT, z-vertex, and rapidity dependence.
  - **Real data (both Au+Au and p+p)**
    - Using lvl2 trigger bit in ì minimum bias sampleî
    - limited statistics → used for tuning of the simulation and consistency check.
- Final correction factor
  - ε_{lvl2} **: 0.743±0.01(stat) ± 0.02(sys)**
    - **Au+Au data : 0.750 ± 0.153**
    - **p+p data : 0.73 ± 0.10**

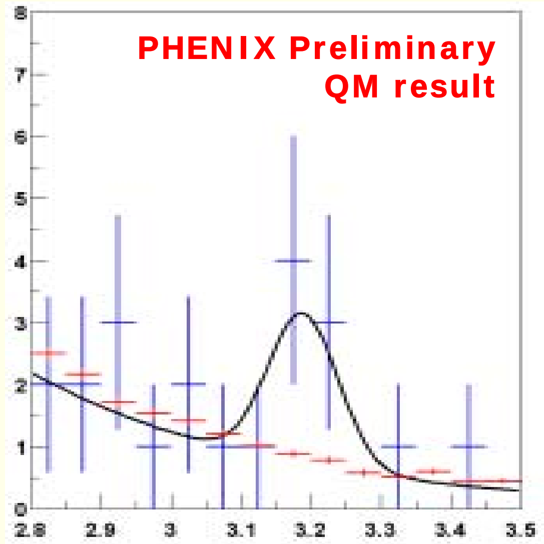




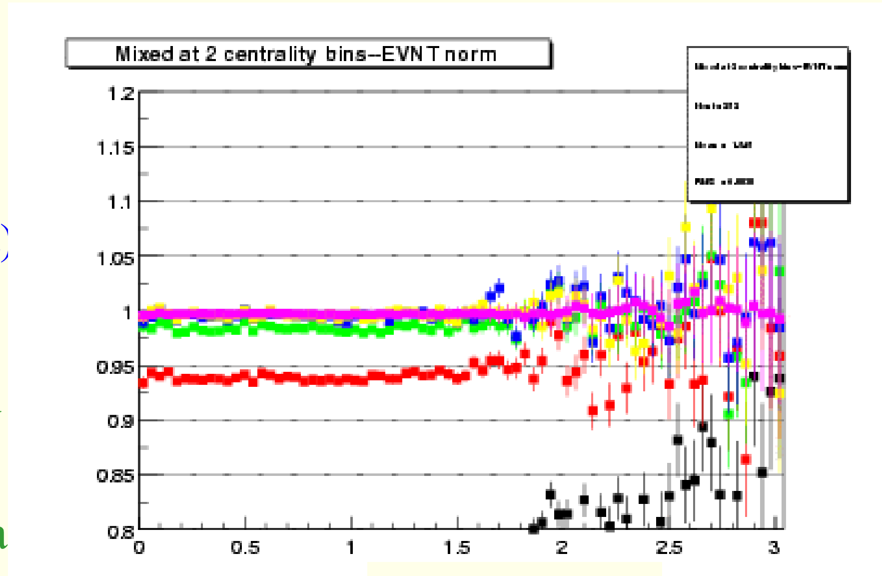


Combinatorial Background Evaluation

- Critical issue of counting J/ψ → Understanding of combinatorial background
- Three method for consistency check
  - **Fit with Exponential + Gauss**
  - **Like-sign pair**
    - Use same event
    - Absolute normalization, poor statistics
  - **Event Mixing**
    - Use different N event having similar event characteristics
    - Normalization, event grouping (edge effect) high statistics
- Comparison between two method
  - Spectrum from mixed event normalized by like-sign pair (different centrality binning)
  - Our best understanding about combinatorial background



Mass [GeV/c^2]



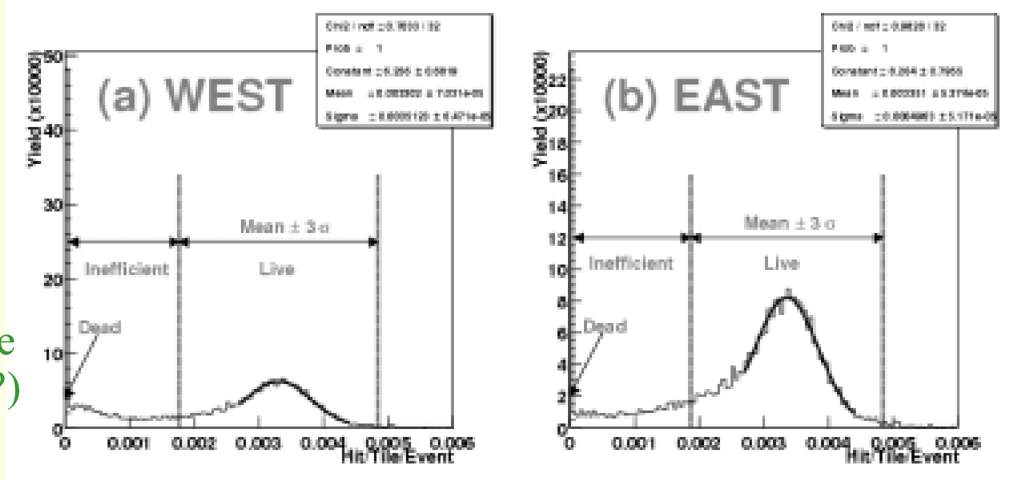
Mass [GeV/c^2]

Run-to-Run Fluctuation of Acceptance

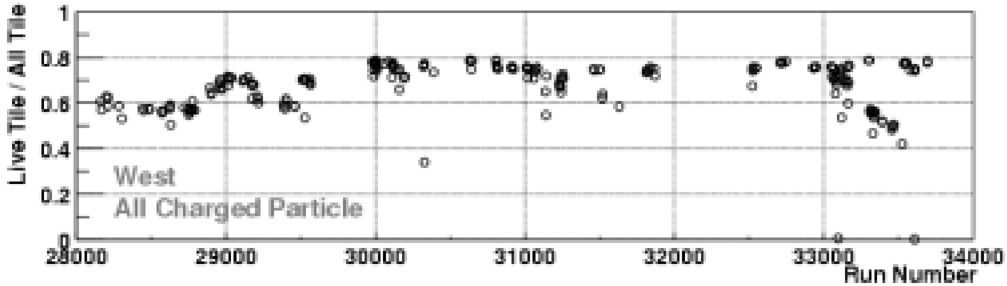
- Electron acceptance and efficiency is evaluated using simulation
- There are two source of ambiguity
  - How well the simulation data represent the real data ? (what is included in simulation?)
    - only drift chamber ì always dead areaî
    - Real/Sim is evaluated as **W =0.755±0.004(stat)±0.005(sys)**
  - Relative fluctuation of detector acceptance
- Consistency check using different procedure
  - Detector hit occupancy
  - Electron yield
- Calculation

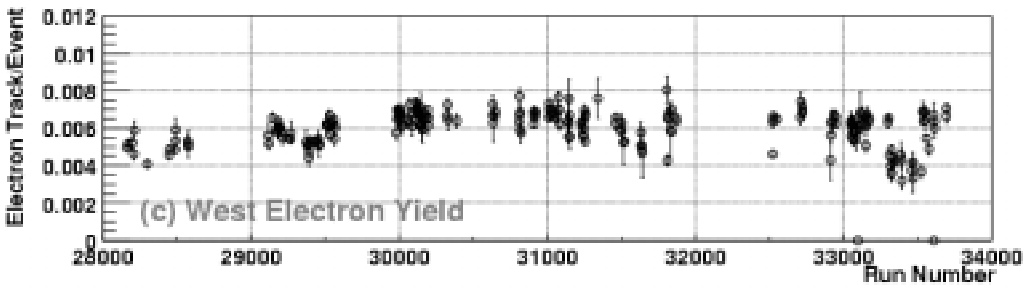
$$\epsilon_{run-run} = \frac{\sum \epsilon^{i}_{run} N^{i}_{MB}}{\sum N^{i}_{MB}} \times W$$

- Final correction factor:
  - $\varepsilon_{run-run}$: **0.702±0.005(stat) + 0.021(sys)-0.025(sys)**



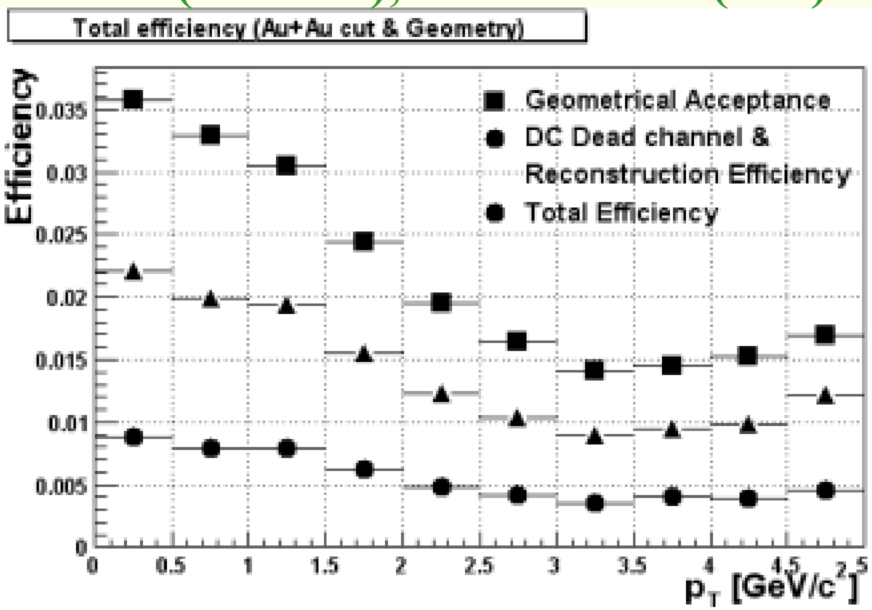
Drift chamber hit occupancy in unit area

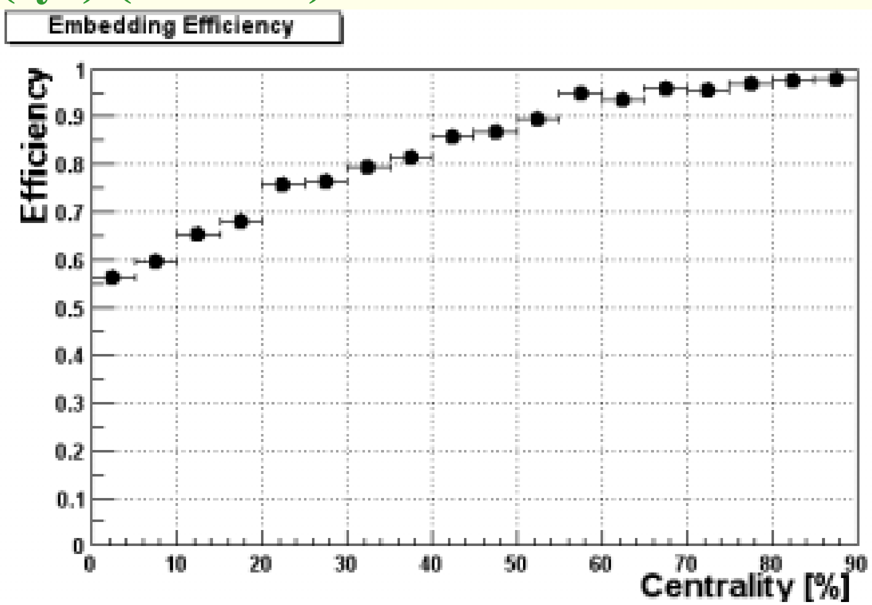




Electron Identification & Centrality Dependence

- Simulation: single J/ψ(acceptance, efficiency) and single J/ψ + real data (embedding)
- Single J/ψ efficiency is evaluated to reflect the applied electron identification cut, counting range of J/ψ, and detector dead area
  - Input from J/ψ pT distribution from run2 p+p results
  - **$\varepsilon_{acc} \times_{,} \varepsilon_{eff}$: 0.0061 ±0.001(stat) ±0.0011(sys)**
- Centrality dependence is updated from QM value.
  - **ε_{embed} :0.608±0.0004(stat) ± 0.06(sys) (0-20%) , 0.778±0.0010(stat)± 0.08(sys) (20-40%), 0.903±0.0008(stat) ±0.09(sys) (40-90%)**





Number of J/ψ & Toward Final Result

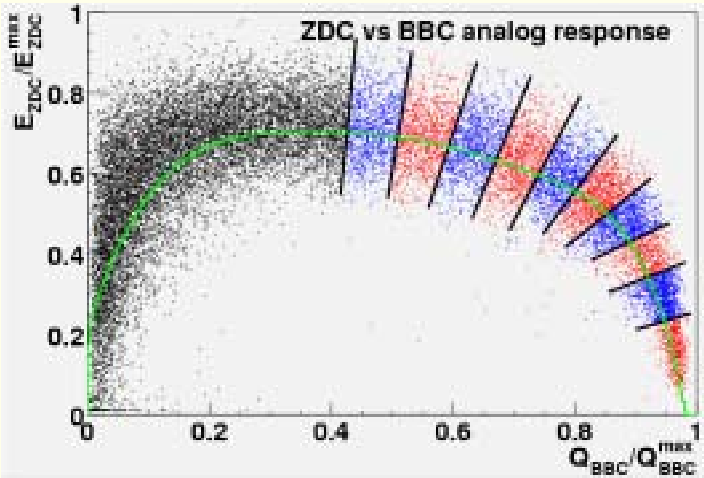
- Evaluation of Number of J/ψ
  - The most important part of analysis
  - Count using invariant mass distribution
    - Foreground and background
  - Limited statistics of Run2 data
    - Consistency check using different counting method
    - Exact treatment of (foreground ñ background) to determine statistical error in number of J/ψ
- After completing to get the number of J/ψ
  - dN/dy (per binary) as a function of centrality are produced and compared with models.

Summary

- **The analysis for final result is ongoing**
  - Level 2 triggered sample makes the statistics about 50M. Trigger efficiency study is done except small systematics evaluation.
  - Double check of both analysis procedure and correction values are performed
  - J/ψ count is not shown today. But the spectrum is in the final form
- **The results will be published soon**
  - Further constrain on extreme model (enhance model) such as coalescence model and statistical production model.
- **Our goal is to record x40 data in Run-4 (end of this year)**

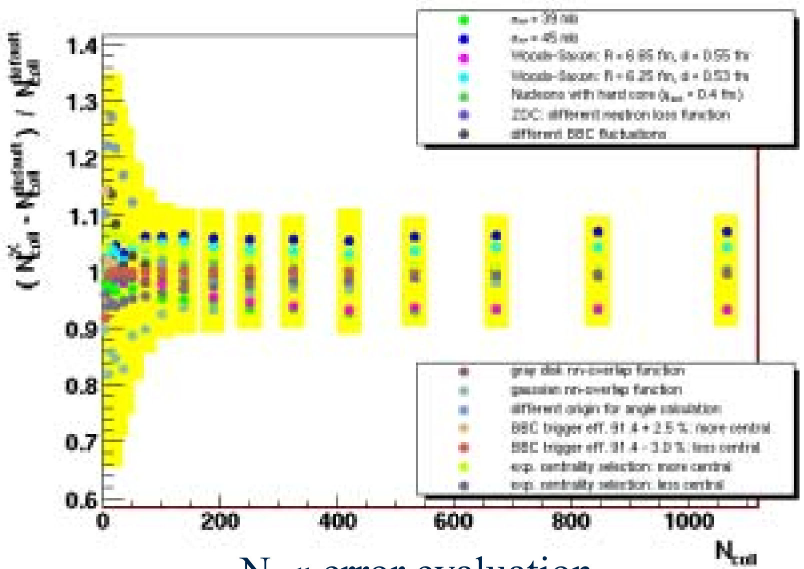
Centrality Determination & N_{coll}, N_{part}

- Centrality is determined by using the correlation between BBC and ZDC

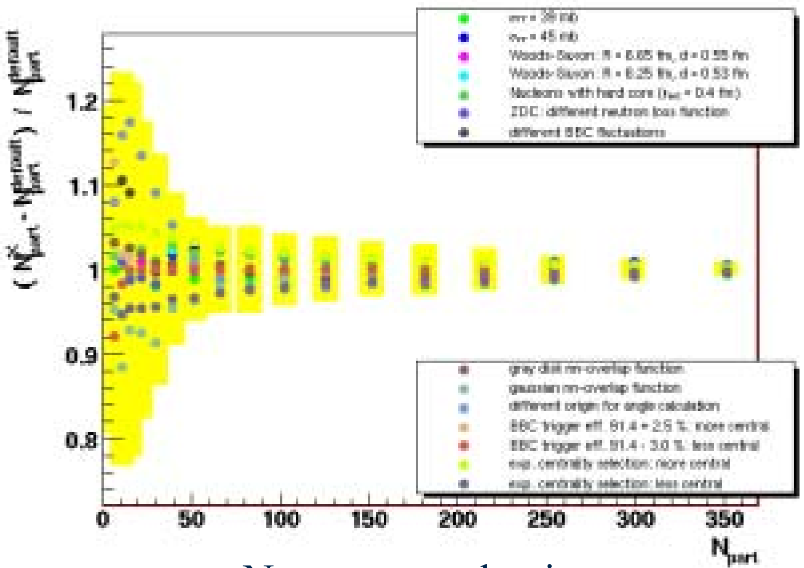


- N_{coll} and N_{part} are derived using Glauber MC calculation

class	Npart	sys	Ncoll	sys	T_{AB}	sys.	b	sys.	ecc.	sys.
0- 10 %	325.2	3.3	955.4	93.6	22.75	1.56	3.2	0.2	0.057	0.008
10- 20 %	234.6	4.7	602.6	59.3	14.35	1.00	5.7	0.3	0.161	0.021
20- 30 %	166.6	5.4	373.8	39.6	8.90	0.72	7.4	0.3	0.241	0.026
30- 40 %	114.2	4.4	219.8	22.6	5.23	0.44	8.7	0.4	0.301	0.028
40- 50 %	74.4	3.8	120.3	13.7	2.86	0.28	9.9	0.4	0.348	0.042
50- 60 %	45.5	3.3	61.0	9.9	1.45	0.23	11.0	0.4	0.377	0.058
60- 70 %	25.7	3.8	28.5	7.6	0.68	0.18	11.9	0.5	0.398	0.053
70- 92 %	9.5	1.9	8.3	2.4	0.20	0.06	13.5	0.5	0.317	0.084

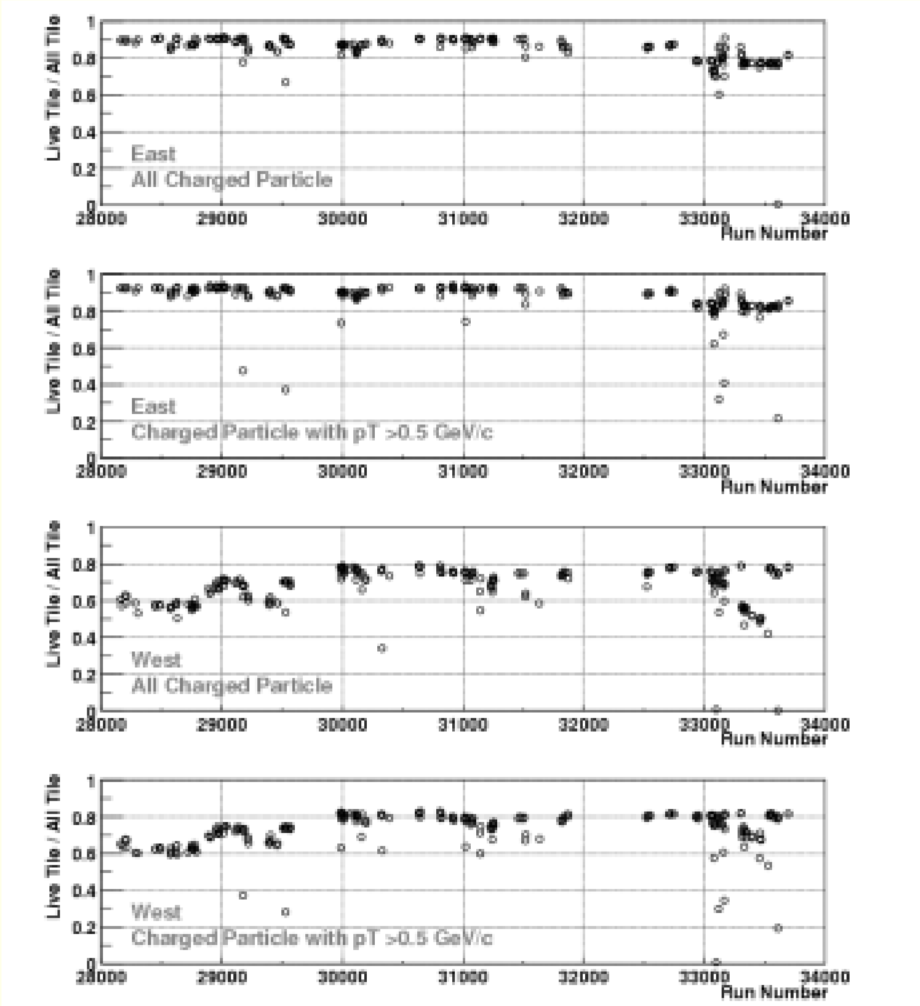


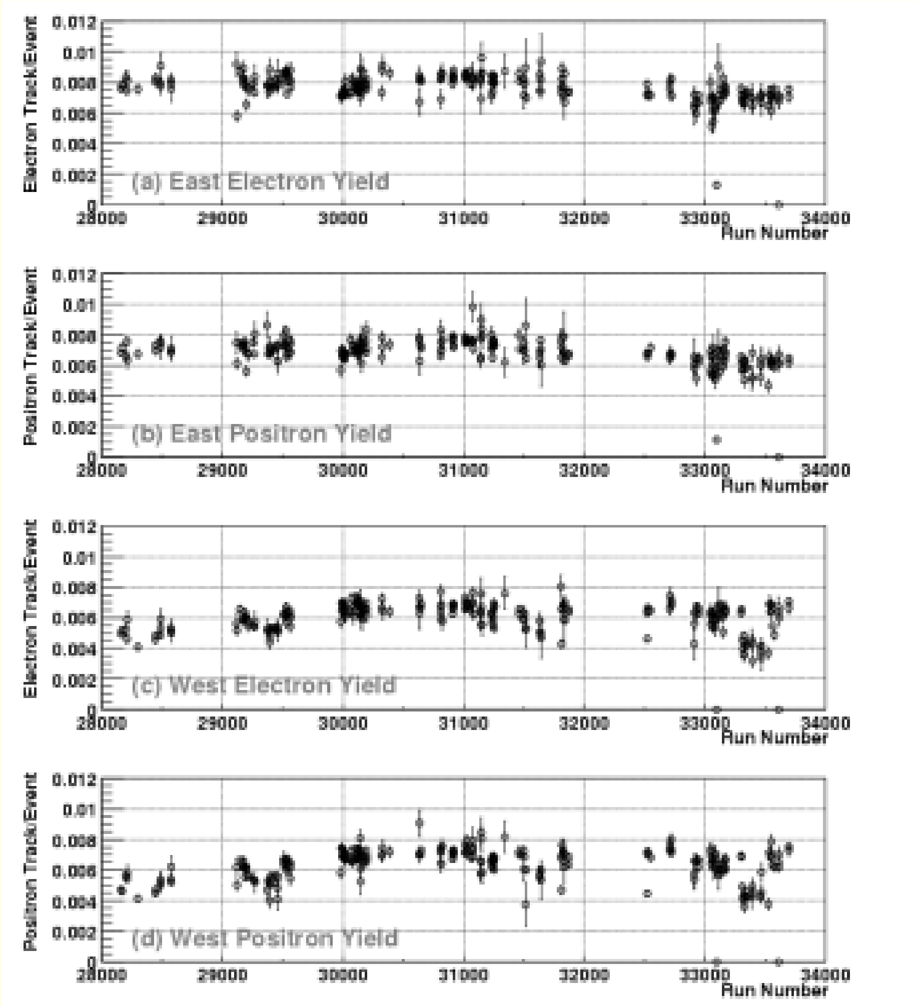
N_{coll} error evaluation



N_{part} error evaluation

Backup 1


Live Tile / All Tile
East
All Charged Particle
East
Charged Particle with pT >0.5 GeV/c
West
All Charged Particle
West
Charged Particle with pT >0.5 GeV/c
Run Number


Electron Track/Event
(a) East Electron Yield
Positron Track/Event
(b) East Positron Yield
Electron Track/Event
(c) West Electron Yield
Positron Track/Event
(d) West Positron Yield
Run Number

Backup 2

- Number of e+e- in 100 event with poisson fit