Measurement of χ_c -> J/Ψ + γ in dAu collisions at PHENIX/RHIC

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for the PHENIX Collaboration

Motivation

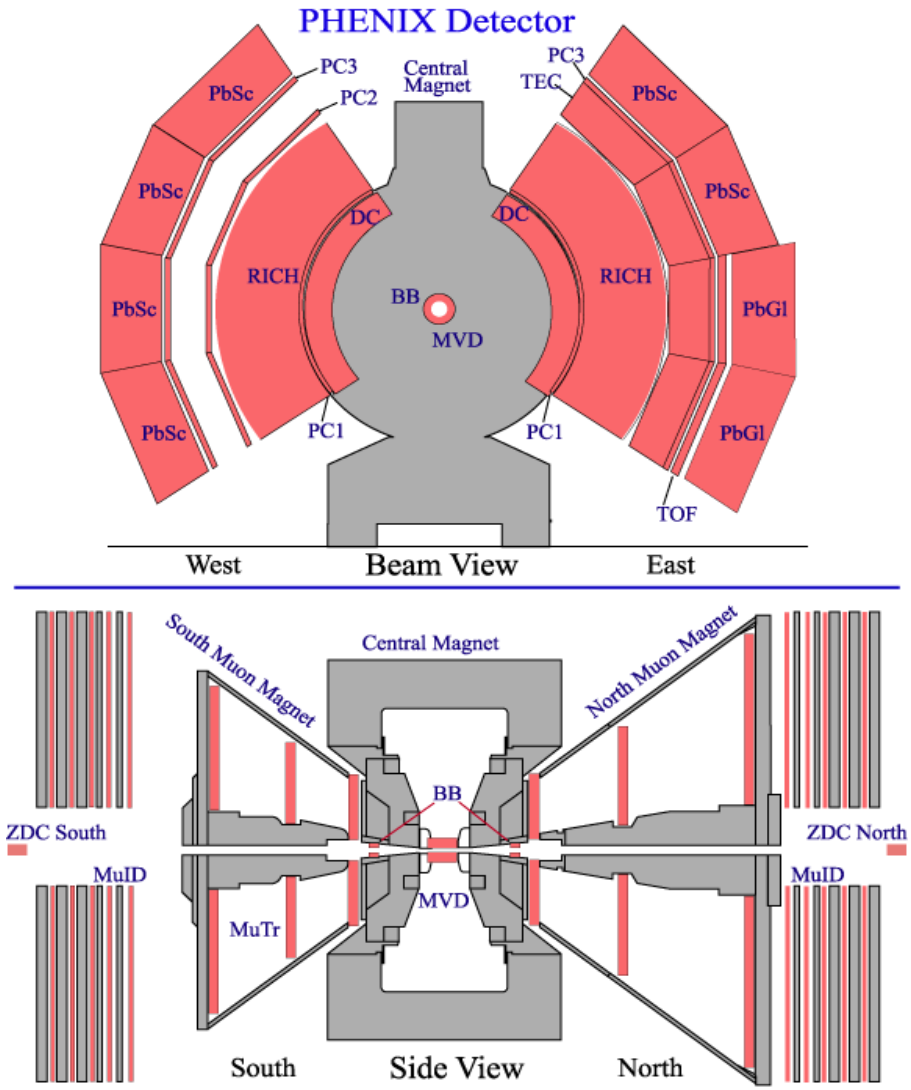
If quark- gluon plasma (QGP) is formed in relativistic heavy ion collisions, color screening will lead to suppression of charmonium production (*T. Matsui, H. Satz, Phys. Lett. B178(1986)416*). A promising signal of QGP formation.

More recent studies predict increased J/Ψ production at RHIC due to recombination (*R.L. Thews et al, Phys. Rev. C63(2001)054905*)

It is important to measure simulataneously several charmonium states, e.g. J/Ψ and χ_c to find out which models of charmonium production work best.

dAu collisions, along with pp, provide a baseline for understanding J/Ψ and χ_c production in AuAu.

The PHENIX Experiment



The PHENIX experiment at RHIC has the unique ability to measure both J/Ψ and χ_c in relativistic heavy ion collisions.

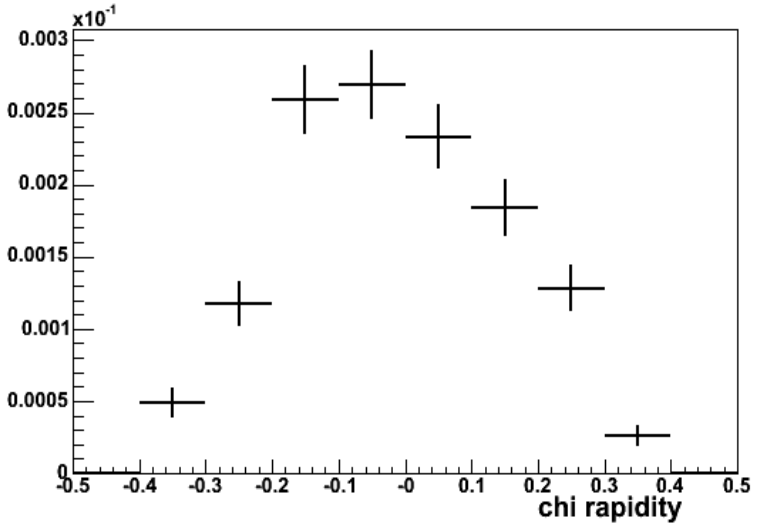
Charged particle tracking and the momentum measurement by the Drift Chamber.

Electron identification in Ring Imaging Cherenkov Detector and Electromagnetic Calorimeter (EMCal).

Photon Identification in EMCal

Muon tracking and identification in Muon Arms.

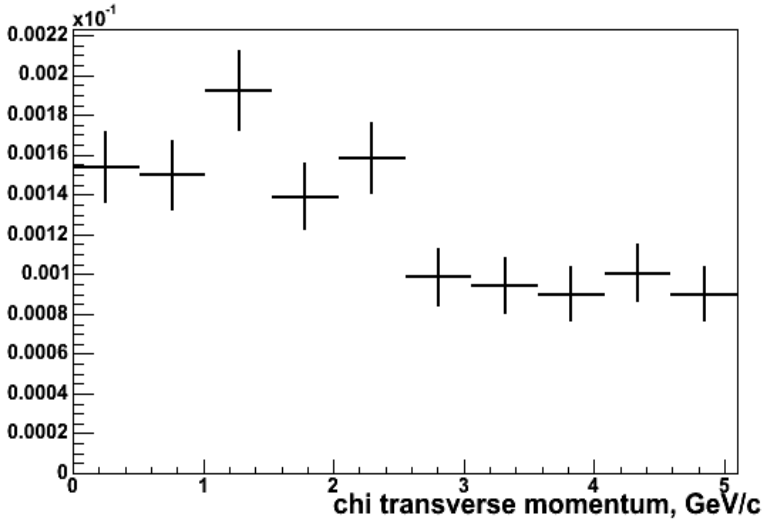
Acceptance for χ_c -> γ + J/Ψ -> e^+e^-

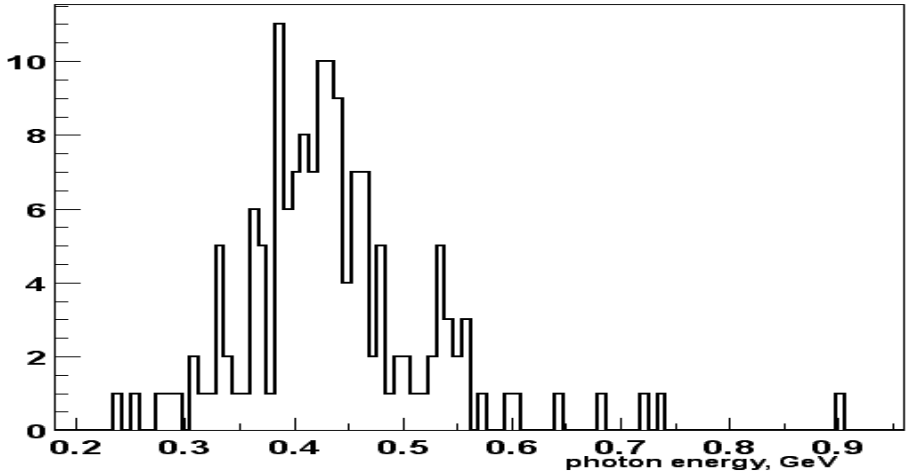


To calculate χ_c acceptance, a simulation using single χ_c was performed. Acceptance vs rapidity and tranverse momentum is shown at left.

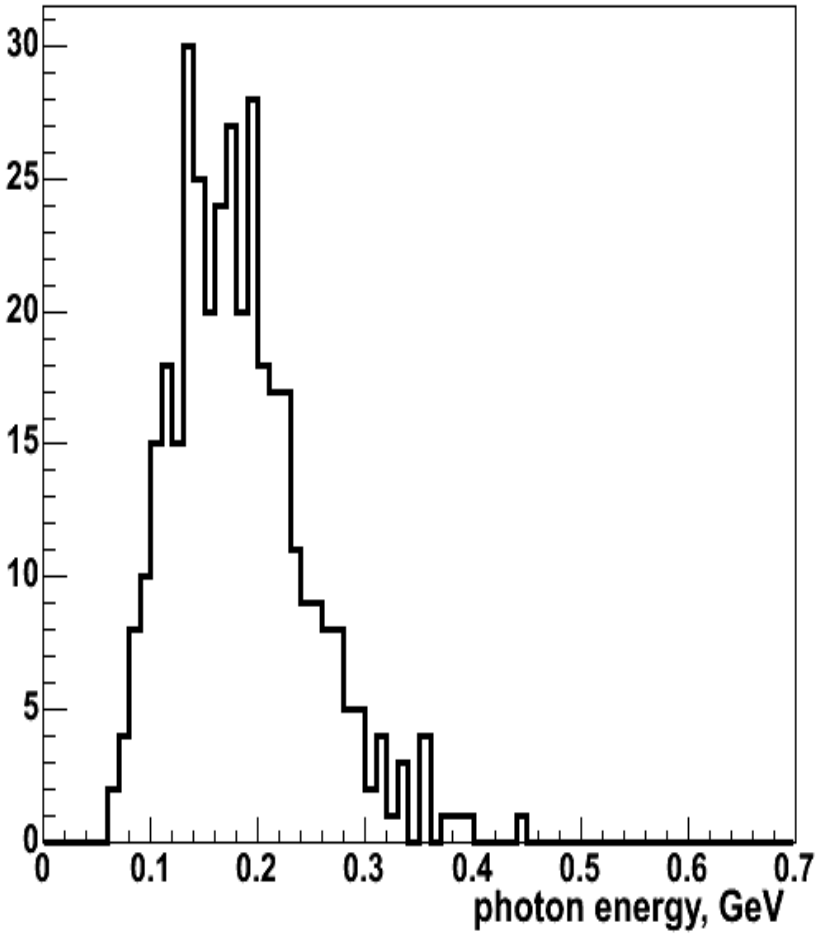
If J/Ψ is detected in the Phenix Central Arms, the probability to detect the photon is 11%

Note low photon energy shown in the plot below.





Acceptance for $\chi_c \rightarrow \gamma + J/\Psi \rightarrow \mu^+\mu^-$

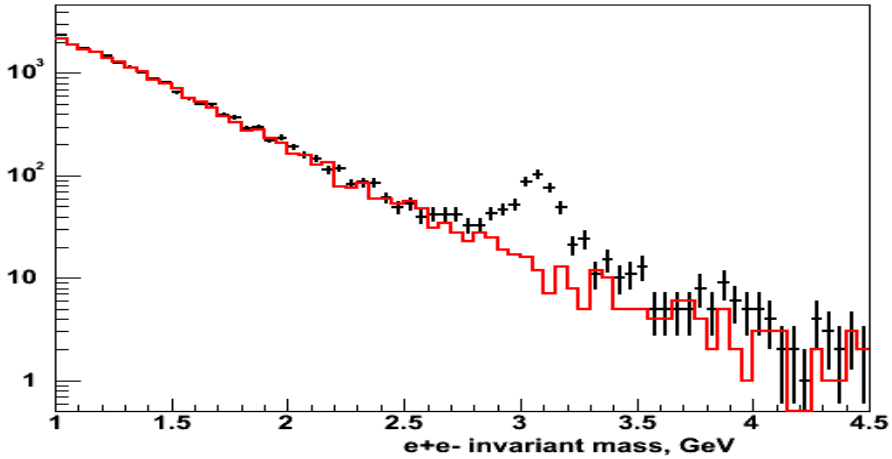


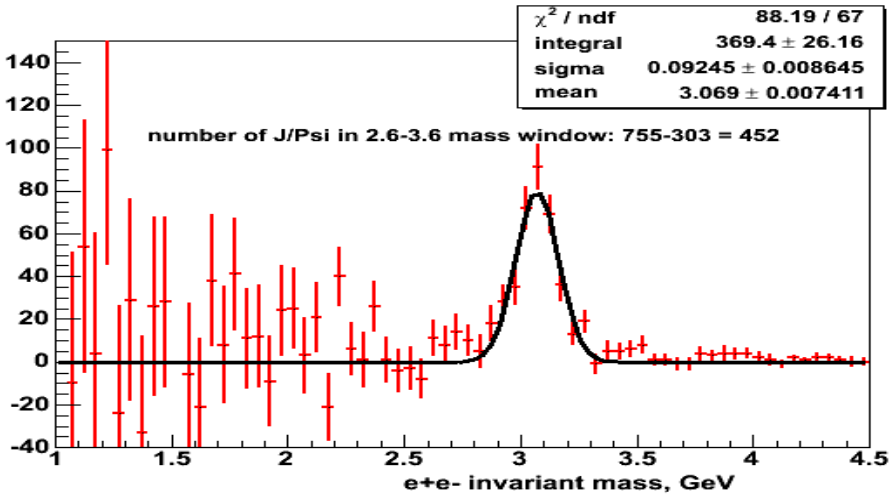
In case of J/Psi decaying to μ+μ–, the probablility to detect the photon in Central Arms, while muons are detected in Muon Arms is 2.5%.

Expected number of reconstruced J/Ψ in Muon Arms is ~4 times more than in Central Arms, which makes the expected number of reconstructed χ_c in this channel comparable to e+e- channel.

However, the photon energy is very low, which makes χ_c measurement in Muon Arms practically impossible.

Expected number of reconstructed χ_c

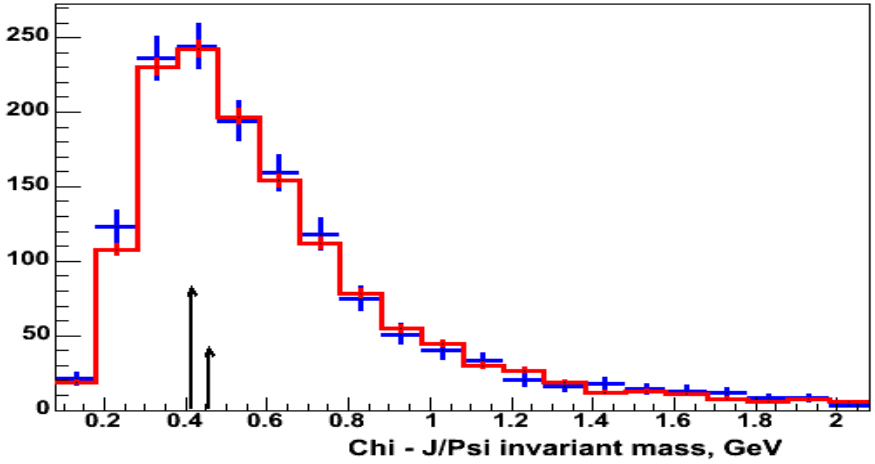


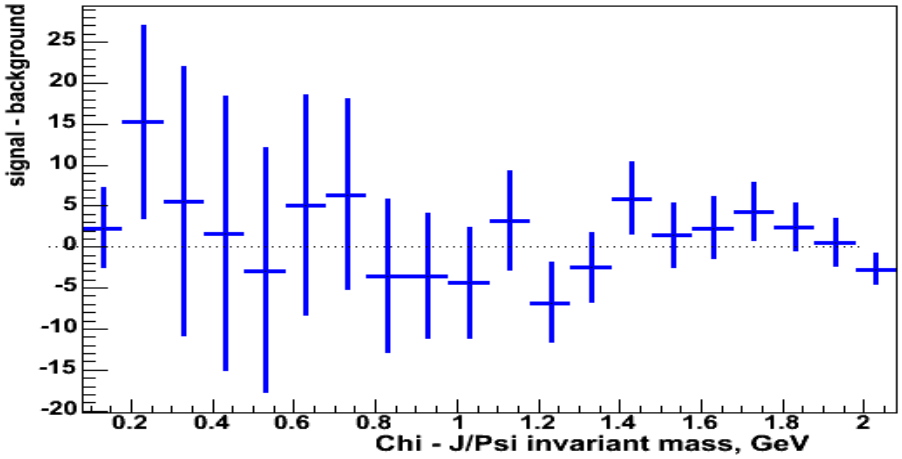


Total number of reconstructed J/Ψ in run3 dAu is ~450. e+e- inveriant mass distribution is shown in the plots at left. Red histogram shown same sign background. In the bottom plot background is subtracted.

Assuming that 40% of J/Ψ come from χ_c, and 11% acceptance, total expected number of reconstructed χ_c is ~20.

χ_c -> J/Ψ + γ in the data



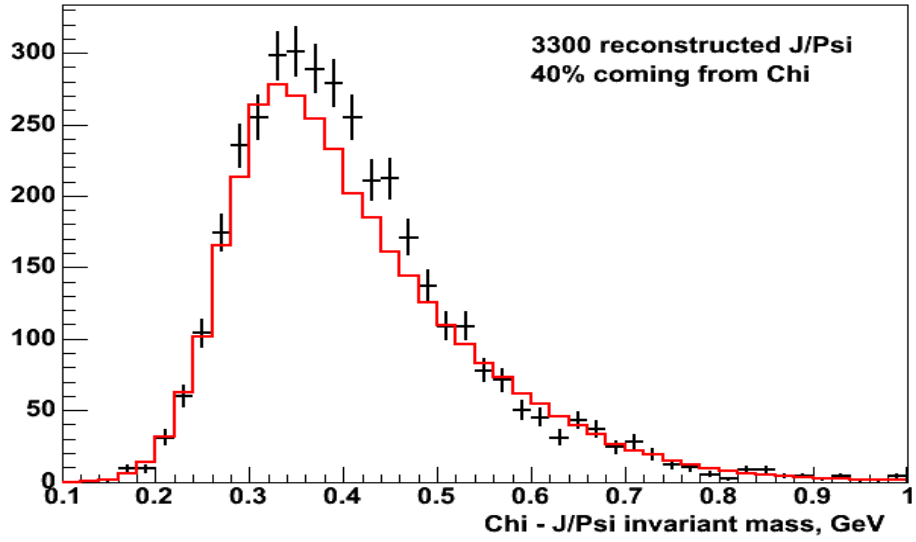


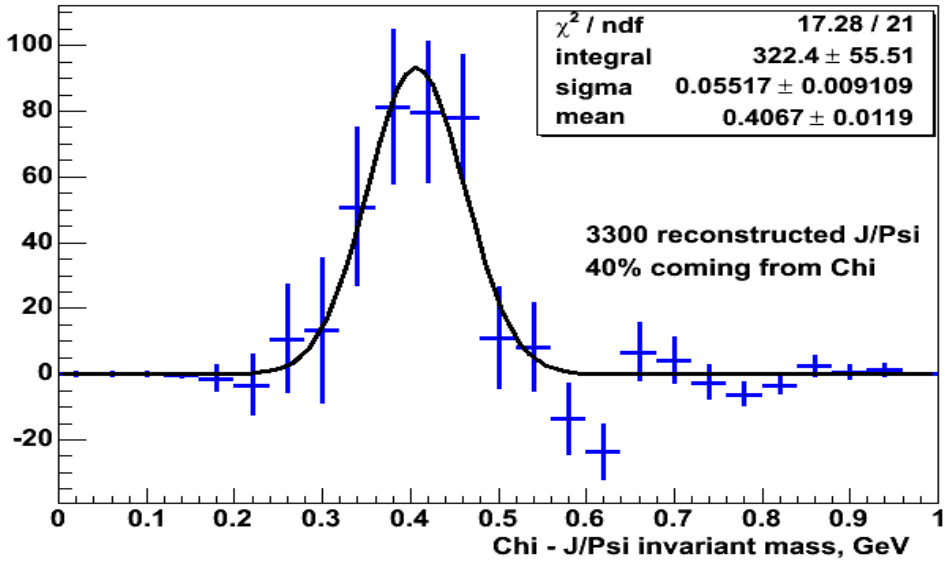
The plot shows χ_C - J/Ψ invariant mass distribution for all run3 dAu data. ~20 χ_C are expected in this plot.

Red histogram shows combinatorial background calculated using mixed events method.

The width of χ_C peak is expected to be ~50 MeV (from EMCal resolution and full scale simulations).

Full scale simulation (1)





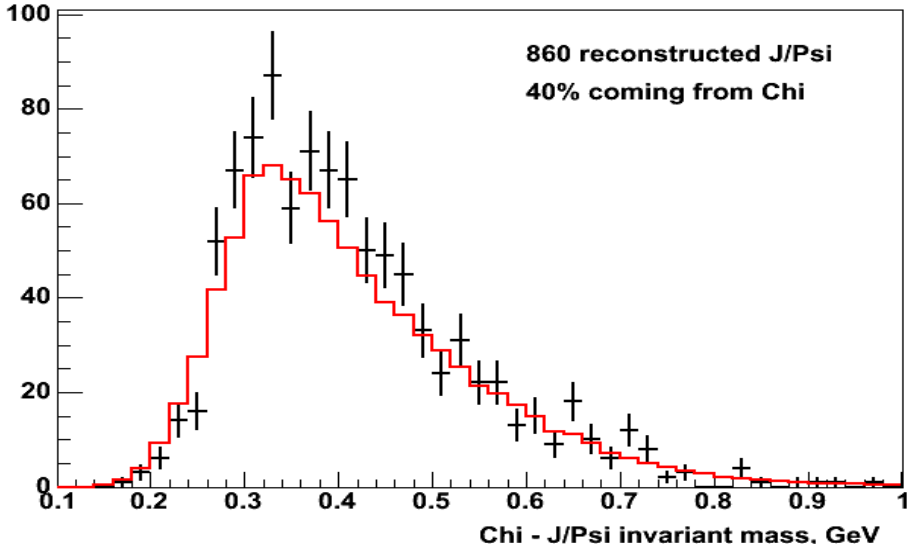
To determine statistics necessary for reliable χ_C measurement, single J/Ψ and χ_C were merged with simulated dAu events, and complete data analysis was performed.

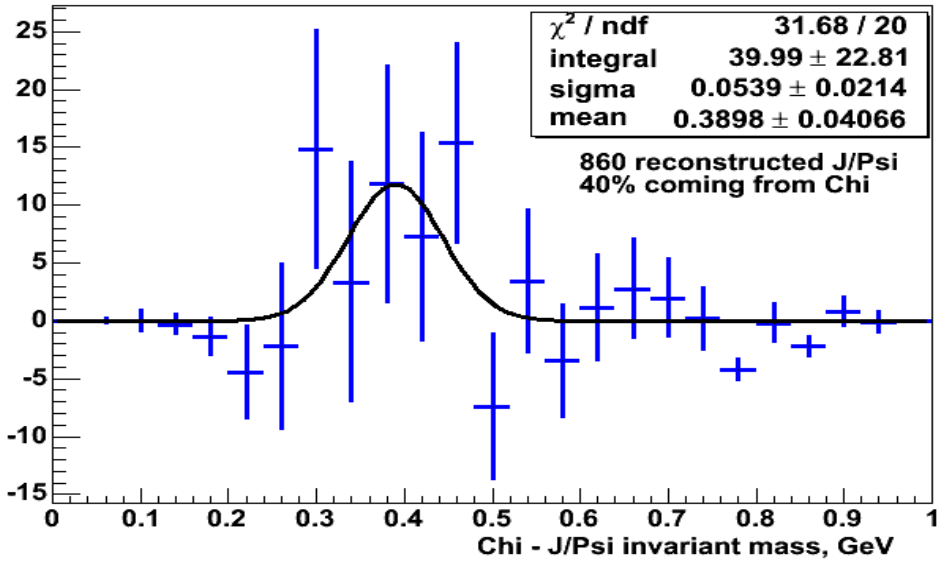
40% of events with merged χ_C were added to 60% of events with merged J/Ψ

Red histogram in the top plot shows combinatorial background calculated using mixed events method. Background was normalized at the tail of the distribution (mass>0.55 GeV).

3300 J/Ψ were reconstructed in this plot. Eight times more than run3 dAu statistics.

Full scale simulation (2)





860 J/Ψ were reconstructed in this plot. This is two times more than run3 dAu statistics.

Conclusions

Results of a search for χ_c meson in dAu collisions at sqrt(s_{NN})=200 GeV were presented.

No signal was observed with statistical accuracy of +- 20 counts. Expected number of χ_c in run3 dAu data is ~20 assuming that 40% of J/Ψ come from χ_c

After systematic error estimation an upper limit on the fraction of J/Ψ coming from χ_c will be calculated.