J/Ψ Signal Extraction In Pb-Pb collisions at $\sqrt{s_{NN}}$=5.36 TeV In RUN 3 With ALICE at LHC

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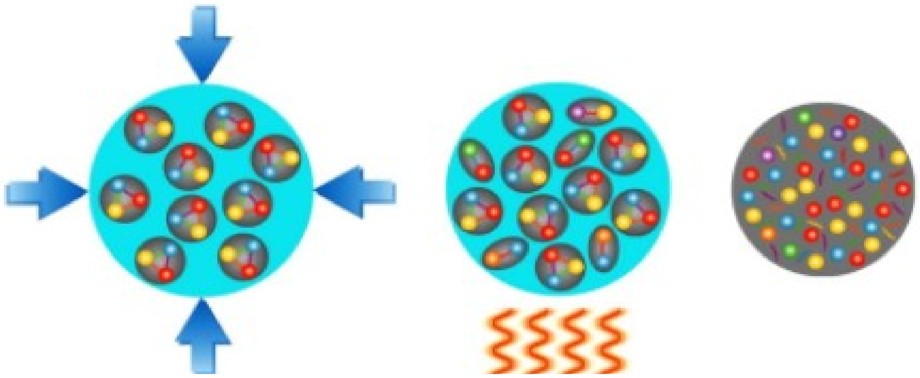
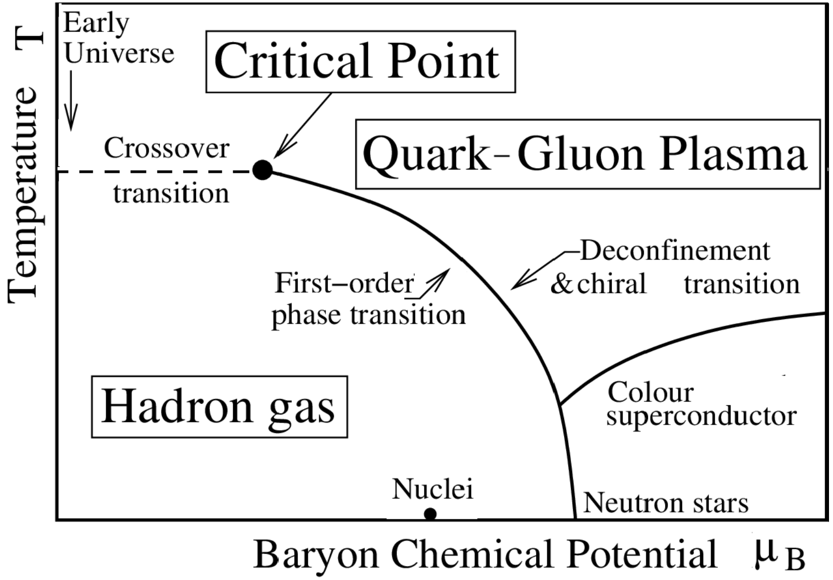
Outline Of This Talk:

- Introduction:QGP and Relativistic Heavy Ion Collision
- Physics Motivation
- ALICE Detector to detect J/Ψ at forward rapidity:Muon Spectrometer
- Data sample and Analysis Procedure in O2 framework
- Signal Extraction from raw dimuon data:Direct Fit
- Integrated and differential (in p_T) analysis
- Summary and Outlook

Quark Gluon Plasma

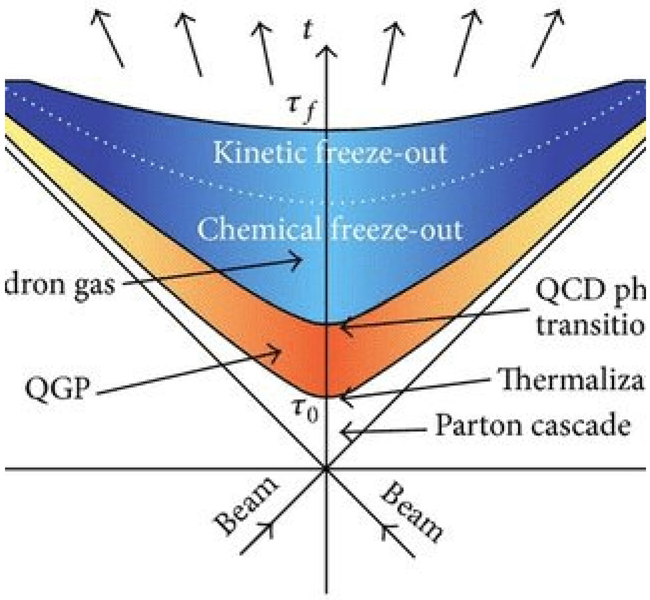
- Deconfined medium consisting of quark and gluons in local thermal equilibrium.
- Created either by heating or applying huge amount of pressure to the normal nuclear matter.

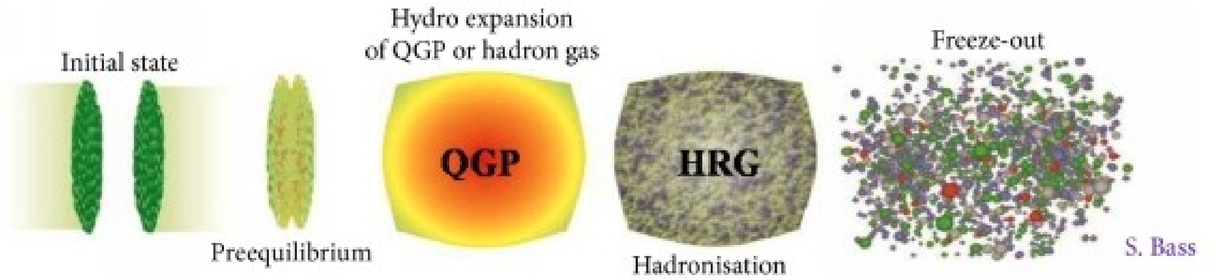




Relativistic Heavy Ion Collision

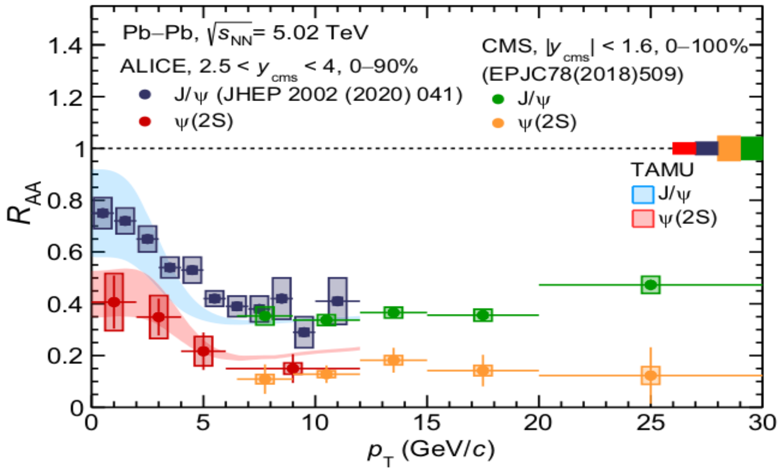
- Heavy ions are accelerated to very high energy and collide with each other at LHC RHIC to form QGP medium at laboratory .





Physics Motivation

- Quarkonia is a bound state of heavy quark and anti-quark which are stable under strong decay.
- Quarkonia is very good probe to study QGP produced in relativistic heavy ion collisions.
- Due to high mass, formed at early stage of the collisions and witness entire evolution.
- Carry important thermodynamical properties of the early phases of the collision.
- To study R_{AA} at different p_T bins with RUN3 data for Pb-Pb system.



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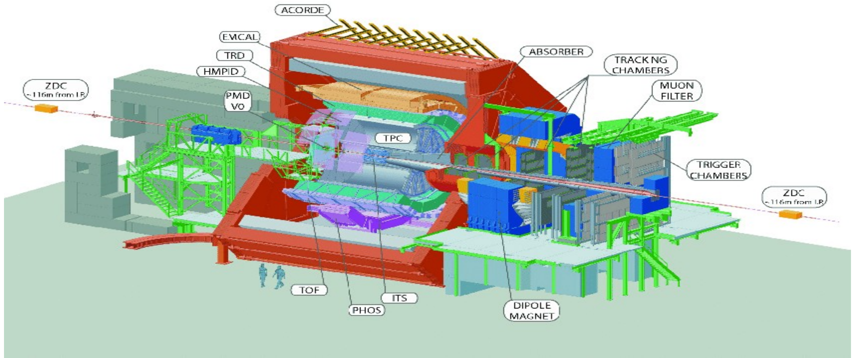
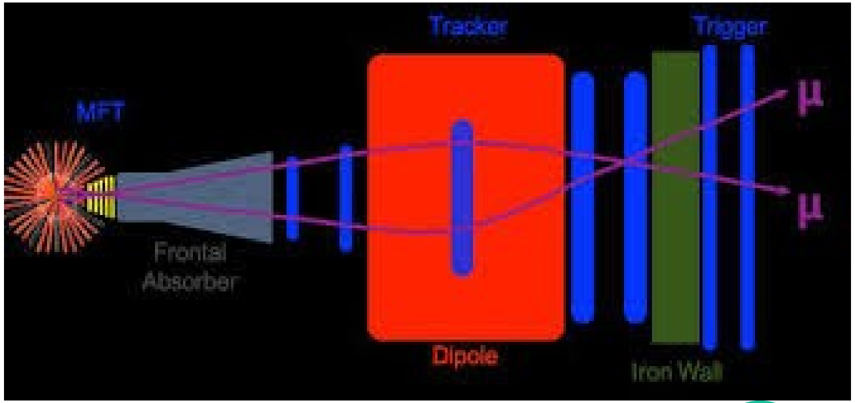
ALICE detector to detect J/Ψ: Muon Spectrometer

- In ALICE J/Ψ detected via dilepton
  |y| <0.9: J/Ψ ⟶ e^+e^-
  2.5 <y <4.0: J/Ψ ⟶ $\mu^+\mu^-$



- Muon Spectrometer has four components

  1. Hadron Absorber
  2. Dipole Magnet (B ~ 0.7 T)
  3. Tracking Chamber
  4. Trigger System



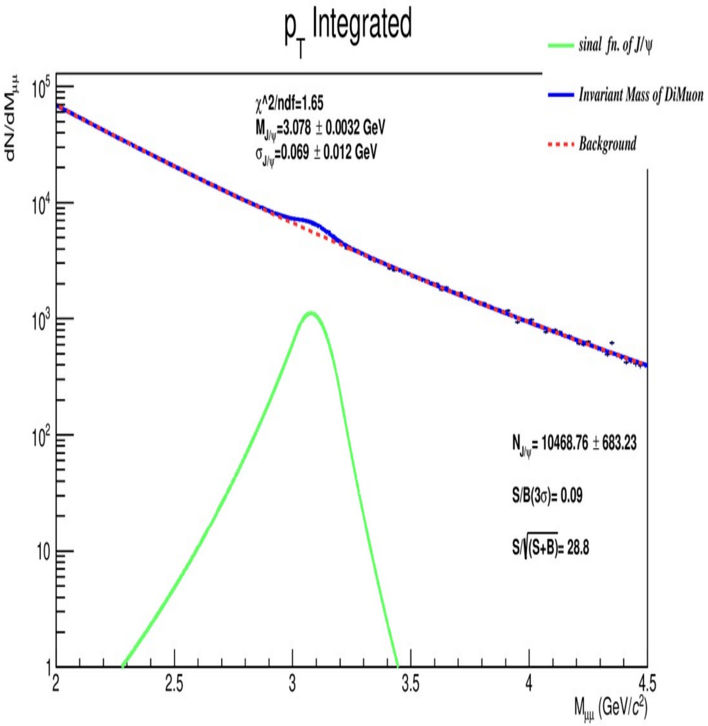
- Pseudorapidity coverage: $2.5<\eta<4$
- Spatial Resolution: 1 cm
- Time Resolution : 2 ns

Data sample And Analysis Procedure

- The Data set chosen: LHC23zzh_pass2_small
- Analysis Work Flow: O2-analysis-dq-table-reader
- Physics Selection
- Event Selection:eventStandardSel8NoTFBorder
  $|Vz| < 10$ cm, centrality : FT0C

- Same event pairing with opposite sign muons(OS)
- Standard muon track selection cuts applied:
  - → 2 muon matching trigger
  - → $17.6 < R_{abs} < 89.5$ cm
  - → single muon $p_T > 0.5$ GeV/c
  - → $-4 < \eta_\mu < -2.5$
  - → $2.5 < y_\mu < 4$
  - → $0 < p_T < 12$ GeV/c
- Note: Full statistics of LHC23zzh is yet to be recovered, analysis will been redone

Signal Extraction(direct fit): p_T integrated



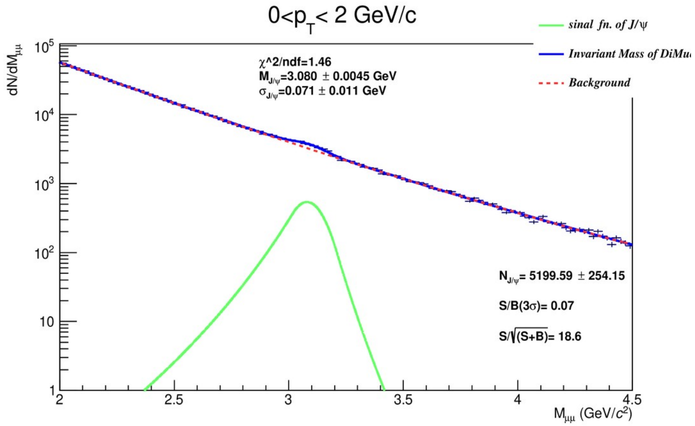
- Signal functions : Double Crystal Ball(CB2)

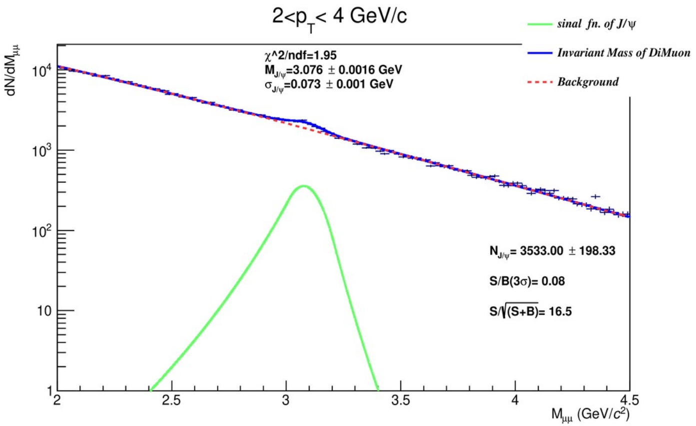
- Background functions :Variable With Gaussian(VWG)
- J/Ψ mass positions(PDG) and width(MC)

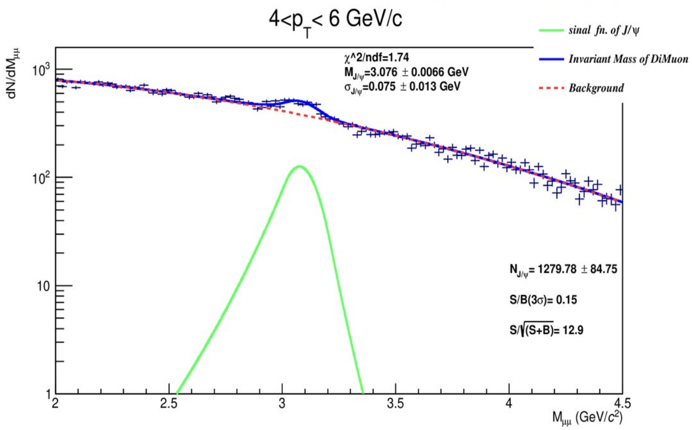
- Fitting range: $2 < M_{\mu\mu} < 4.5$ GeV/c^2
- Tail parameters: MC embedding tails and pp 13 TeV tails from data

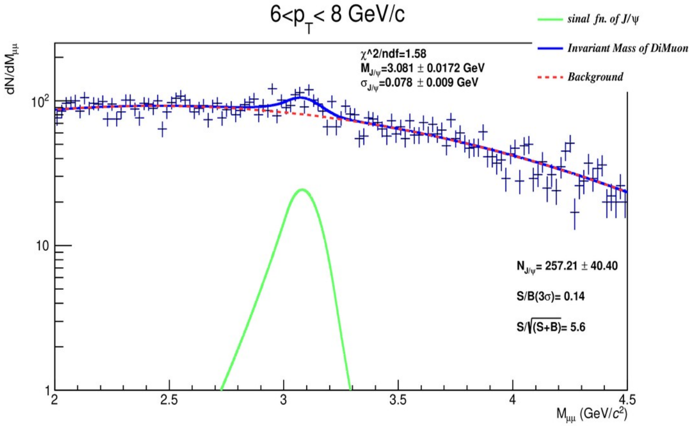
- 1/6 th of the total data volume analyzed

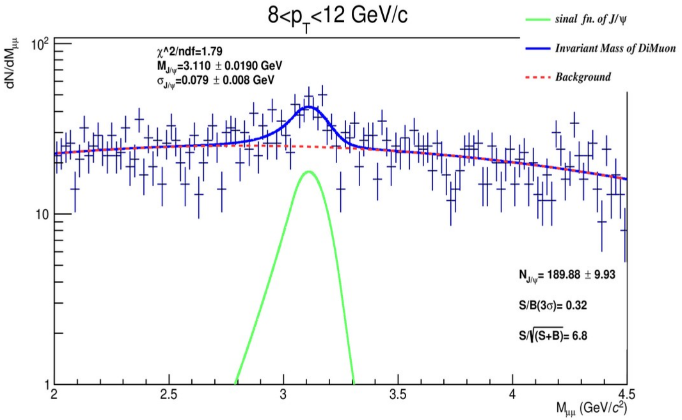
Signal Extraction in p_T bins





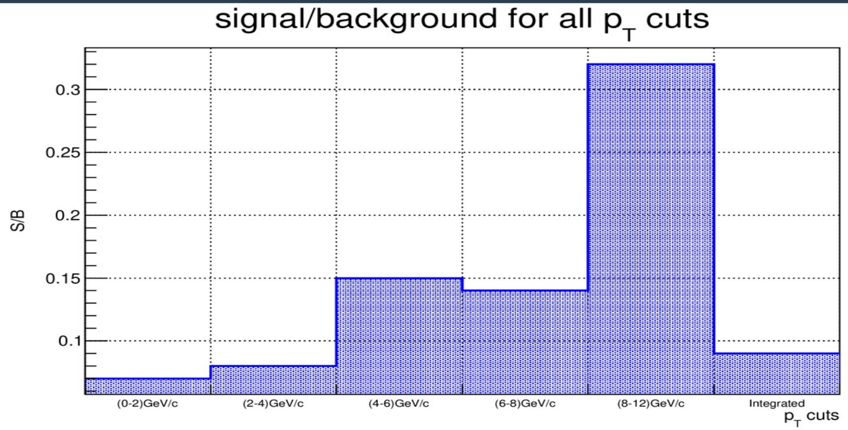




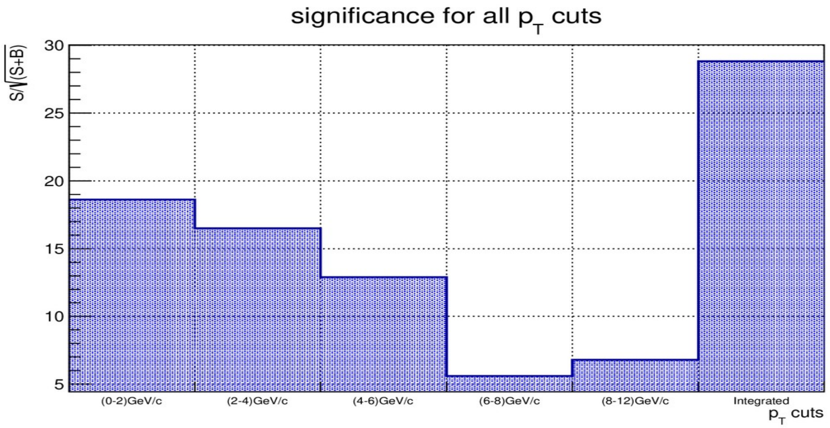


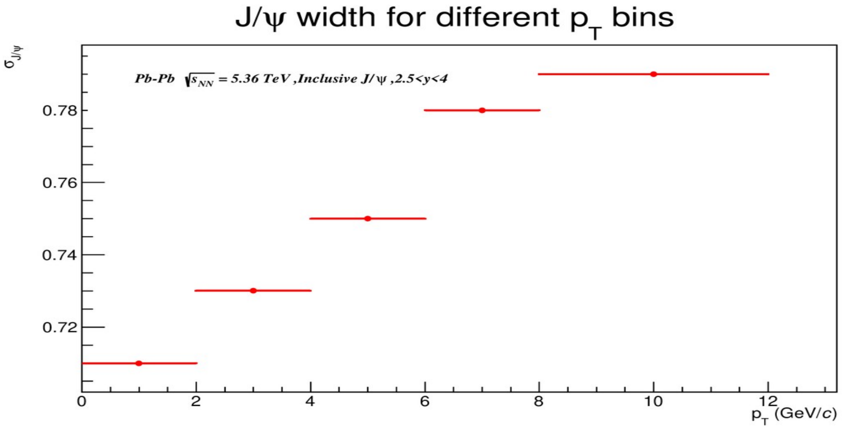
- Due to very low statistics p_T>8 GeV/c fitting is not good

Fitting characteristics value :different p_T bins



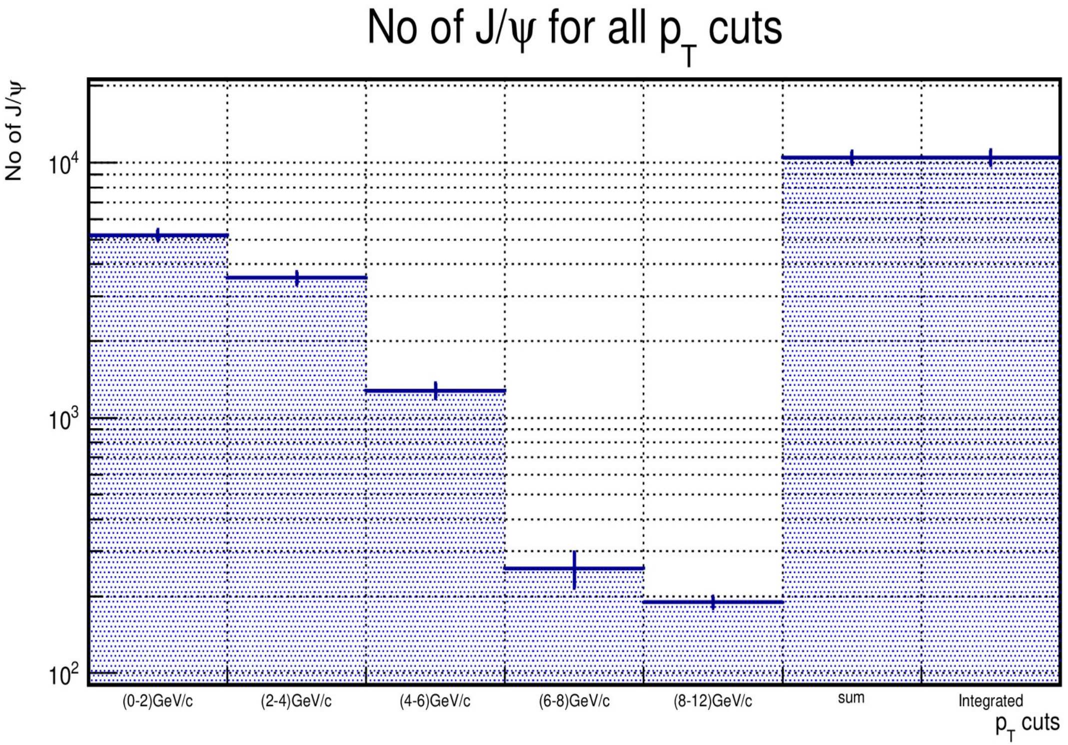
- Signal extracted by fitting a set of large volume data.
- In the spectrum contribution from backgro-und(huge)and the signal resonance peak.
- S/B increase for higher p_T bins
- Significance of fitting decrease for higher p_T bins



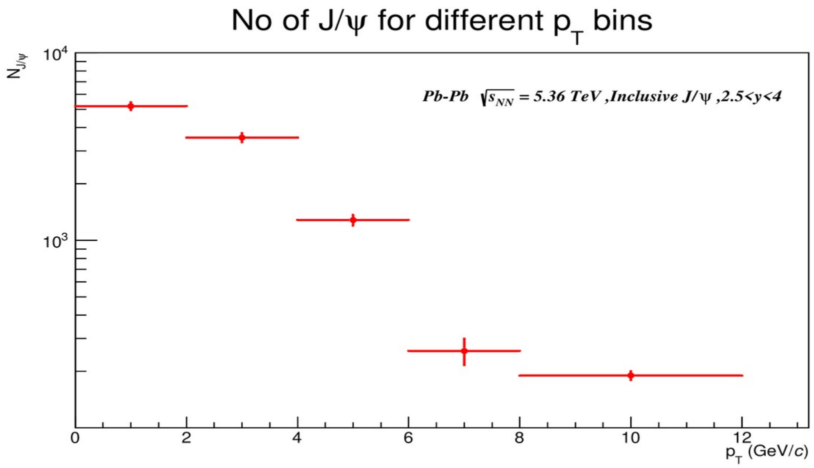


J/Ψ in RUN 3: consistency checks

- The number of J/Ψ reported below for all p_T bins and sum over for all p_T bins and the total number obtained by fiiting the p_T integrated spectra



- The difference between J/Ψ counts value obtained from the sum of all p_T bins differs from the integrated spectrum by less than ~0.2%



Summary And Outlook

- From the invariant mass spectrum of dimuon pairs J/Ψ signal extracted and the no of J/Ψ is obtained in the latest O2 Analysis framework.

- Integrated as well as in differential p_T bins invariant mass spectrum presented.

List to do:

- When full statistics recovered ,same thing will be redone.
- Background substraction , acceptance*efficiency correction ,systematic correction yet to be done.
- Extraction of mass pole and width for full sample data.

- Then some J/Ψ related physics problem (like. R_{AA}, flow,polarization etc.) can be looked over with the higher volume data of RUN3.

Thank You

Backup Slides

– signal shape: double Crystal Ball function (CB2) :

$$f(x;N,\bar{x},\sigma,t_1,t_2,p_1,p_2) = N \cdot \begin{cases} A \cdot (B-t)^{-p_1} & ,t \le t_1 \\ \exp\left(-\frac{1}{2}t^2\right) & ,t_1 < t < t_2 \\ C \cdot (D+t)^{-p_2} & ,t \ge t_2 \end{cases}$$

where

$$t = \frac{x-\bar{x}}{\sigma}$$

$$A = \left(\frac{p_1}{|t_1|}\right)^{p_1} \cdot \exp\left(-\frac{|t_1|^2}{2}\right)$$

$$B = \frac{p_1}{|t_1|} - |t_1|$$

$$C = \left(\frac{p_2}{|t_2|}\right)^{p_2} \cdot \exp\left(-\frac{|t_2|^2}{2}\right)$$

$$D = \frac{p_2}{|t_2|} - |t_2|$$

– background shapes: variable Width Gaussian (VWG) :

$$f(x;N,\bar{x},A,B) = N \cdot \exp\left(-\frac{(x-\bar{x}^2}{2\sigma_{VWG}^2}\right)$$

where

$$\sigma_{VWG} = A + B \cdot \frac{x-\bar{x}}{\bar{x}}$$

- Old tails:
  α_1=0.883 → t1
  n_1=9.940 → p1
  α_2=1.832 → t2
  n_2=15.323 → p2

Table Reader output:different p_T bins spectra

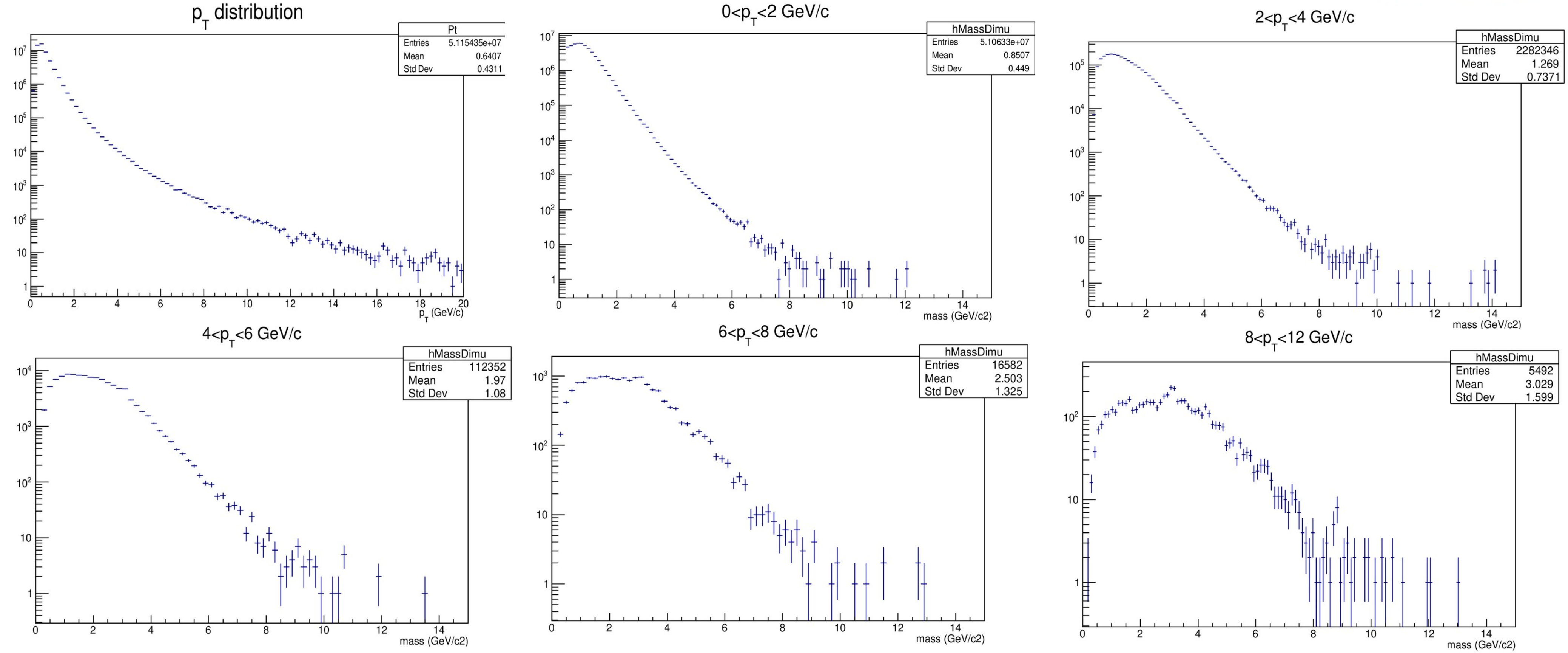
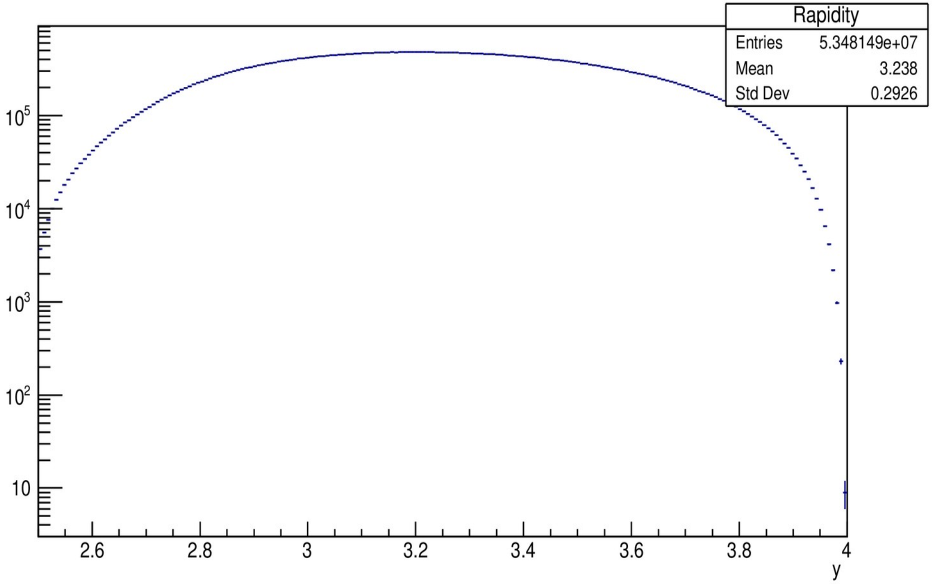
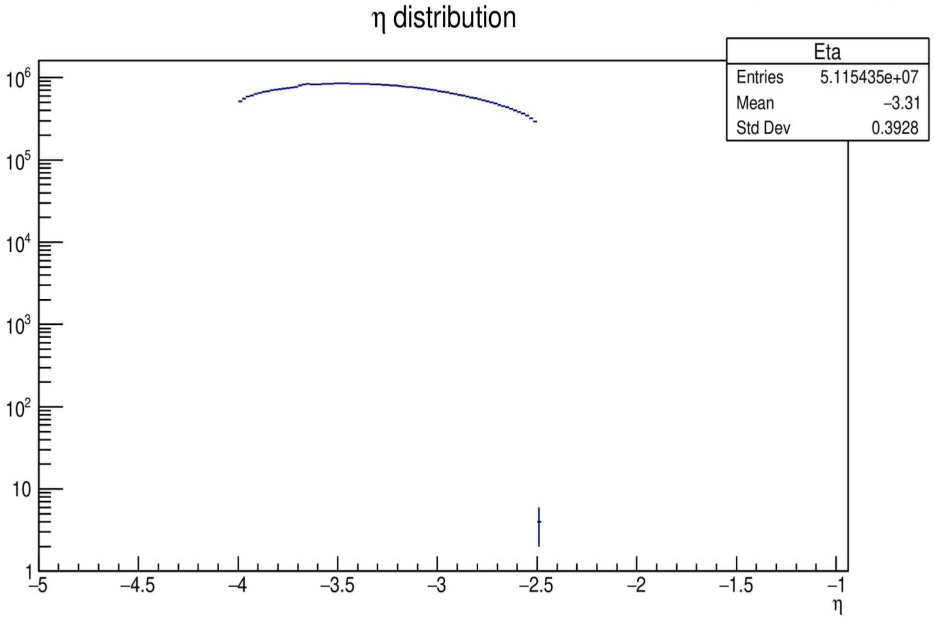


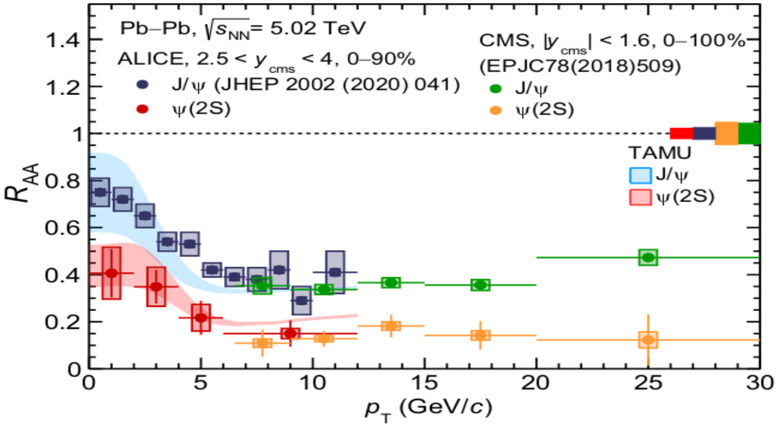
Table reader output: η & rapidity





Also J/Ψ signal checked for different p_T threshold cut and other cuts (MCH-MID,MCH-MFT,pDCA 10sigma etc)

Motivation



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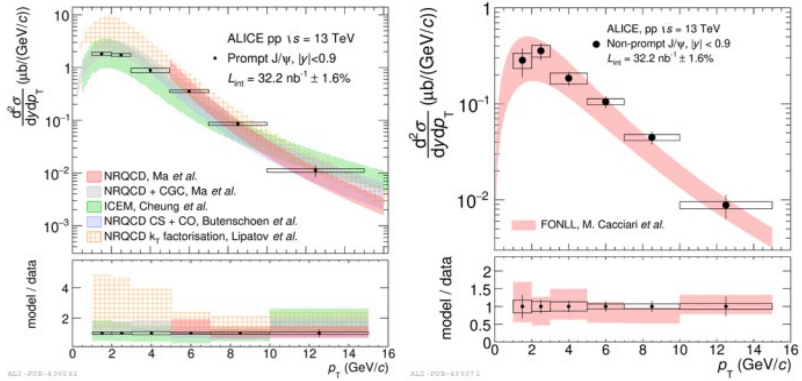

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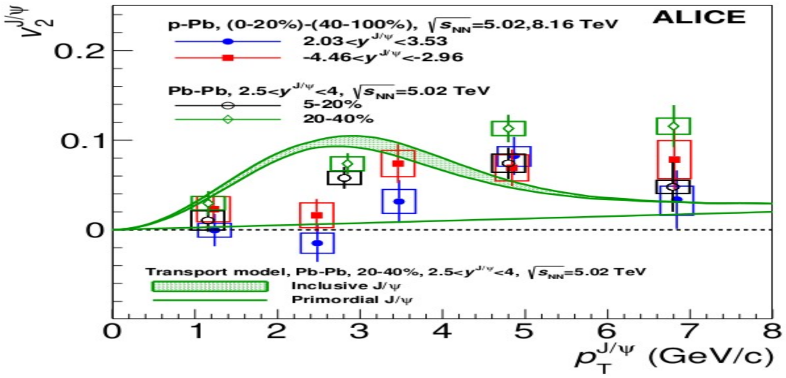

ALICE Collaboration, Phys. Lett. B 780, 7–20 (2018)