Feasibility study of J/ψ measurement in 30 GeV/c p+Au collision

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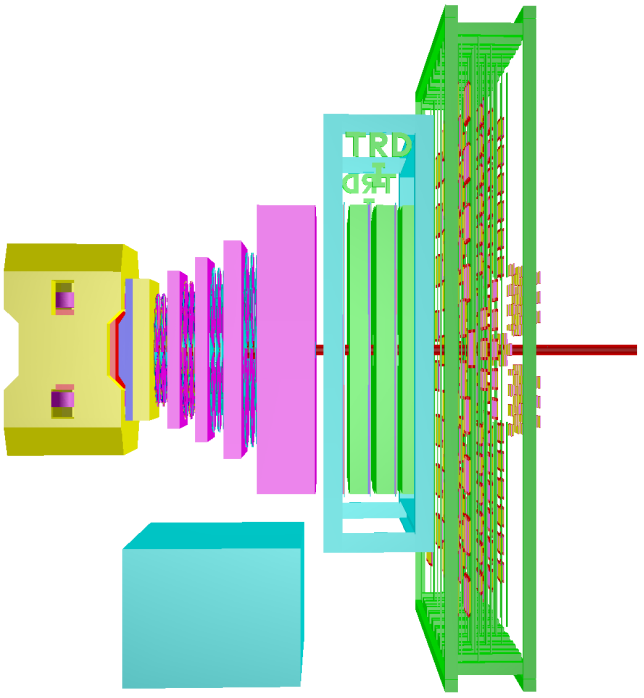
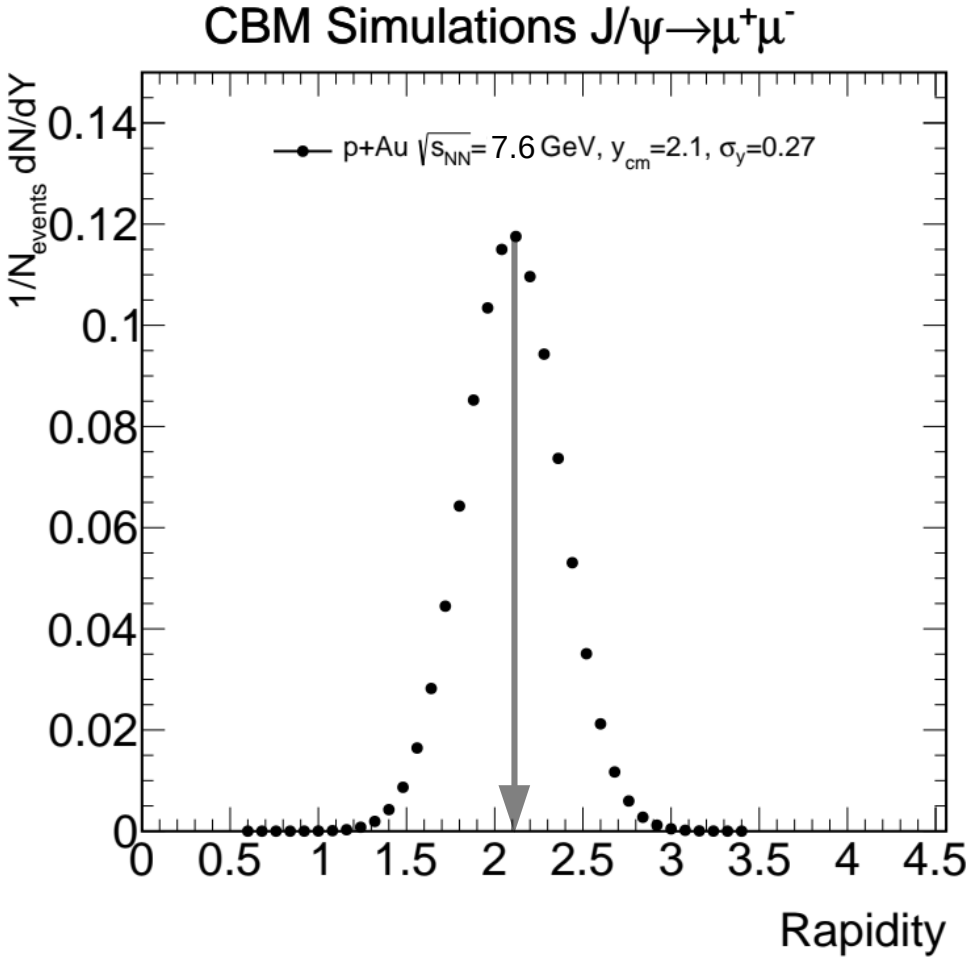
Simulation details

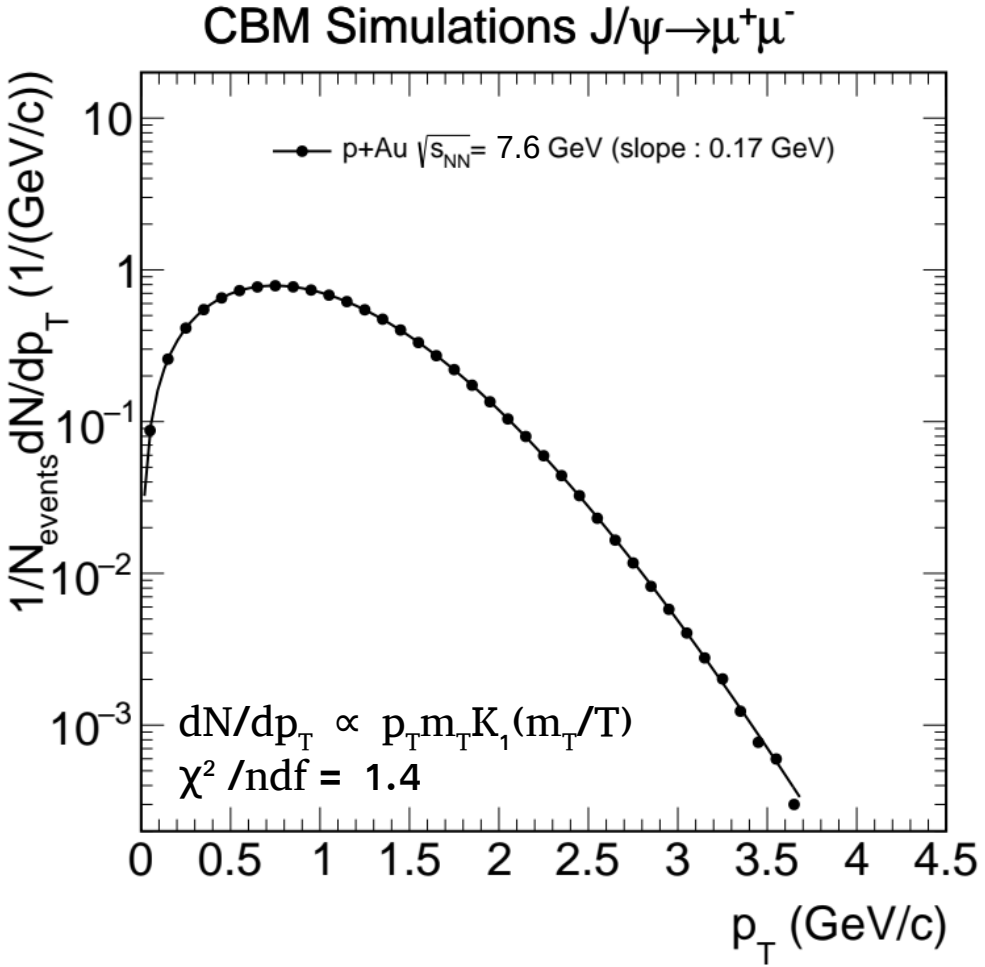
- **CBMROOT** : APR20 (Release)
- **Setup** : sis100_muon_jpsi
- **Active detectors** : STS + MUCH + TRD + TOF
- **System** : p+Au @ 30 GeV/c (central)
- **Input** :
  - **Signal** : J/ψ -> μ^+ μ^- (PLUTO)
  - **Background** : UrQMD
- **No of events** : 10M (background)
  5M (signal)
- **Transport engine** : GEANT3
- **File path** :
  - **Input** : PLUTO, UrQMD
  - **Reconstructed** : REC001_M (UrQMD), REC002_M (Embedded)



sis100_muon_jpsi_setup

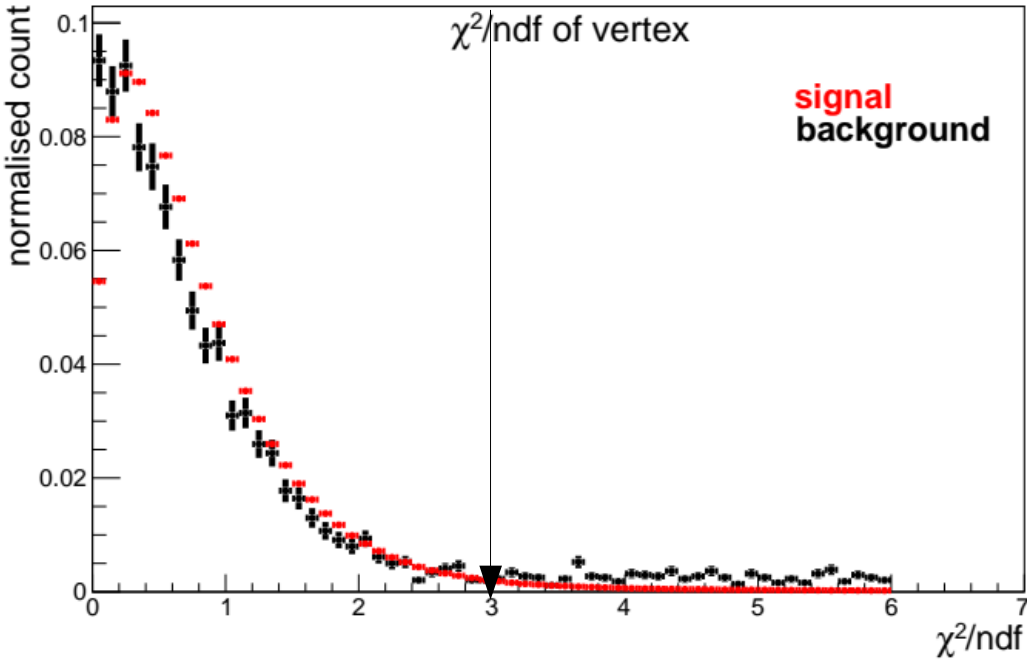
Input (Y-p_T distribution)

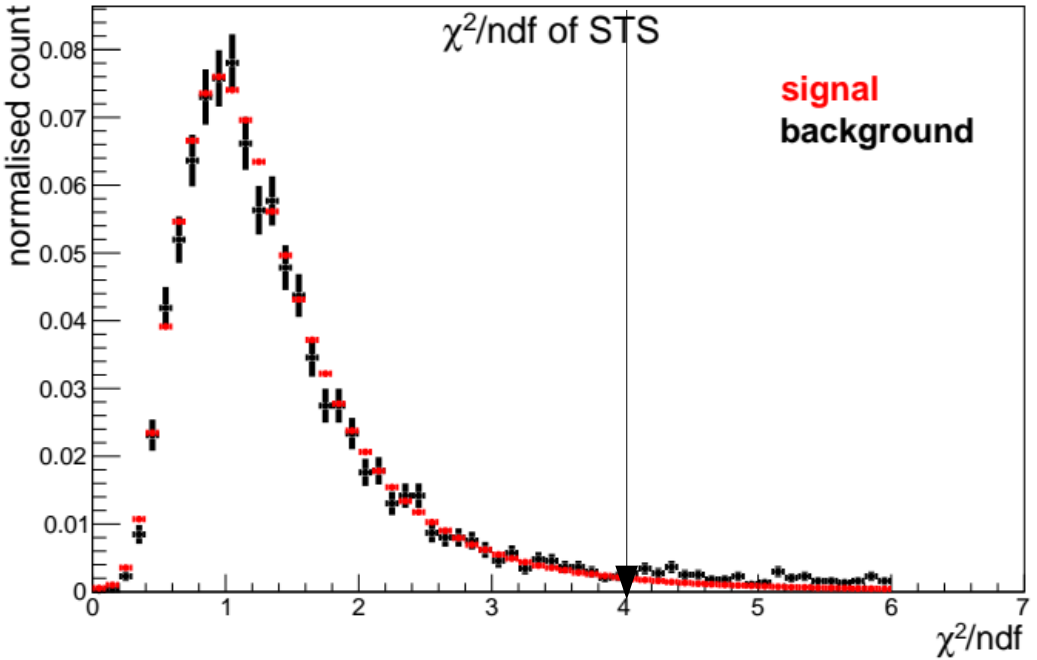




PLUTO (J/ψ -> μ^+ μ^- @ 30 GeV)

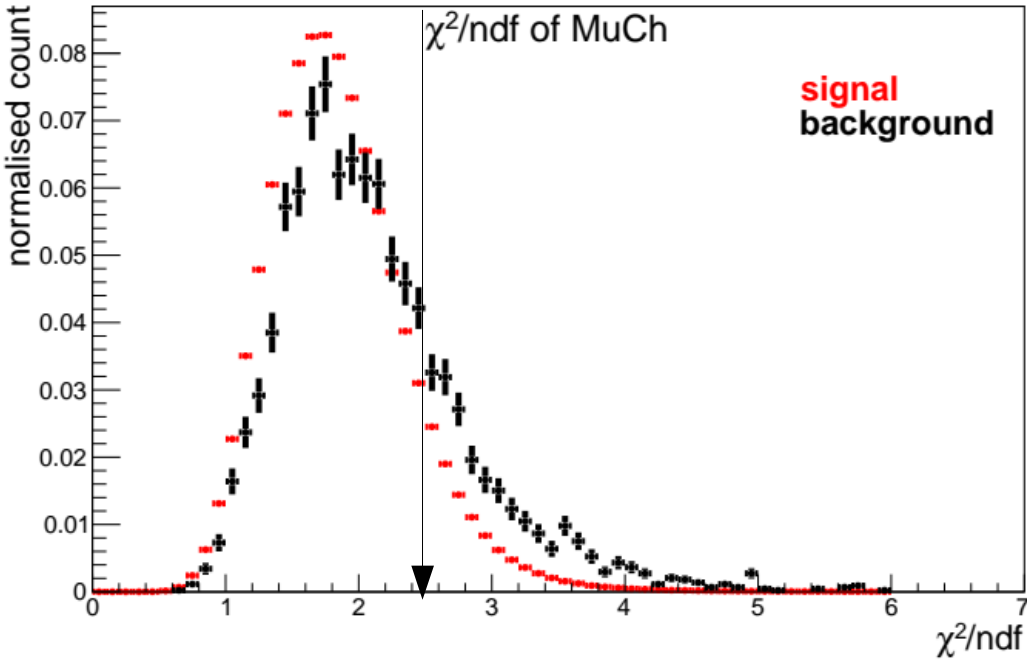
Distribution of Track parameters

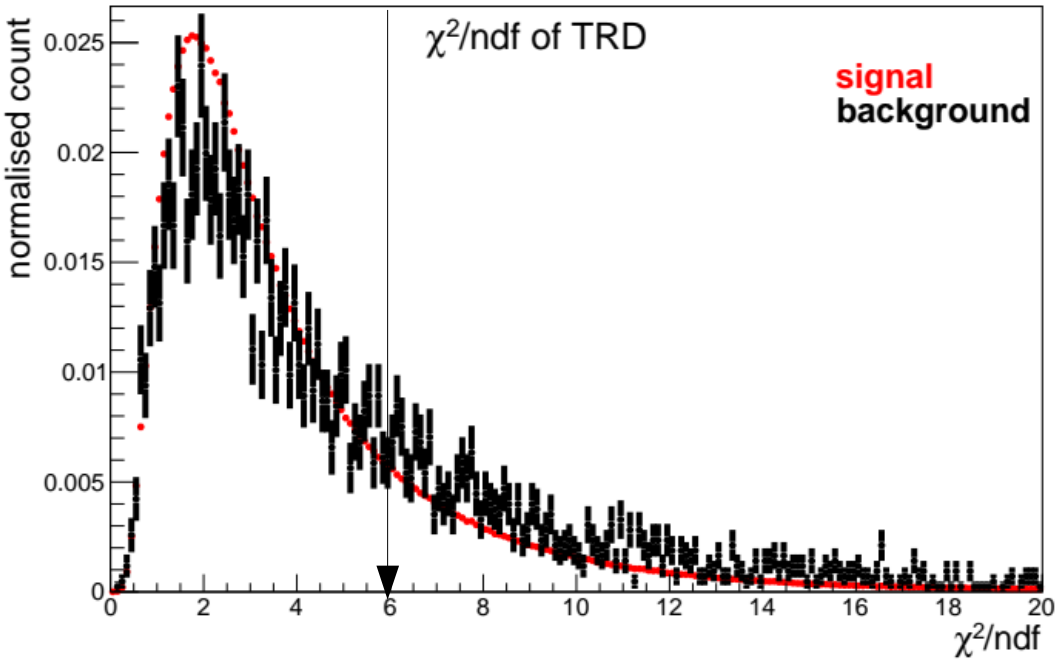




- Signals tracks are extracted from embedded (PLUTO+UrQMD) set of events using GeantProcessId( )=KPPrimay and pdg=±13
- Background tracks are extracted from pure UrQMD set of events

Distribution of Track parameters





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Multiplicity estimation (general consideration)

The number of J/ψ produced can be calculated as,

$N_{J/\psi}^{prod} = \mathscr{L} \times \sigma_{pA}^{J/\psi}$, where $\mathscr{L}$ is the luminosity and $\sigma_{pA}^{J/\psi}$ is the J/ψ production cross-section in p+A collision

Luminosity can be calculated as,

$\mathscr{L} = N_{inc}^{total} \times N_{target}$, where N_{inc}^{total} is the number of incoming protons and N_{target} is the number of nuclei in the target

$N_{target} = \frac{N_A \times \rho \times l_{eff}}{A}$, where N_A is the Avogadro's number, ρ is the density of the target material, l_{eff} is the effective length and A is the mass number of the target

$l_{eff} = \frac{\lambda_I}{\rho}[1 - e^{-\frac{L}{\lambda_I/\rho}}]$, where λ_I is the interaction length and L is the thickness of the target

Ref: C. Lourenço et al., NA60 Note 2001-6

Estimation of production cross-section

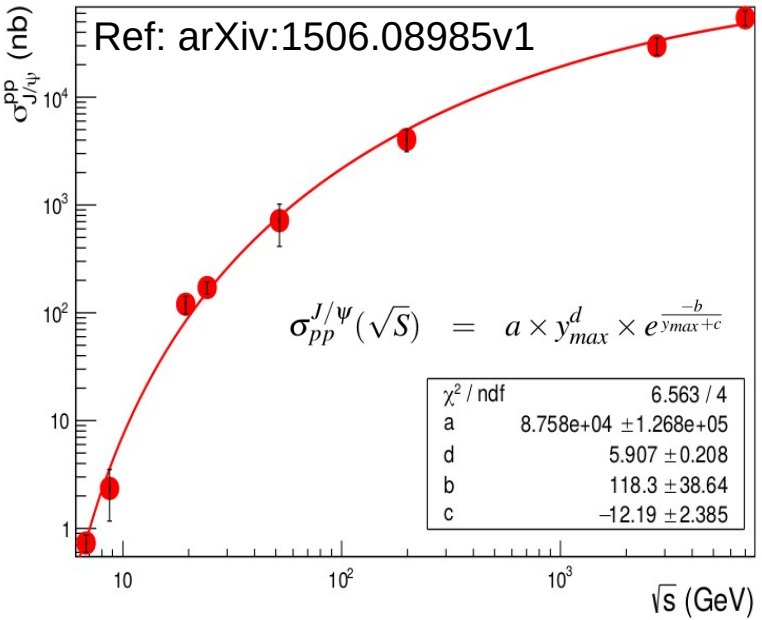
The J/ψ production cross-section can be estimated using the following relations,

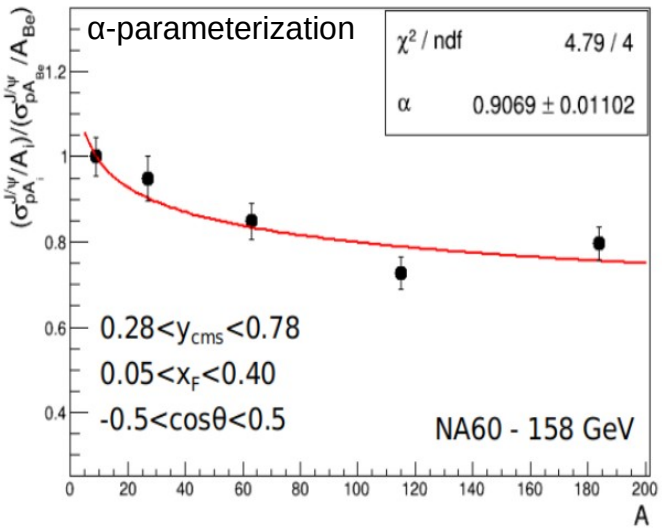
α-parameterization

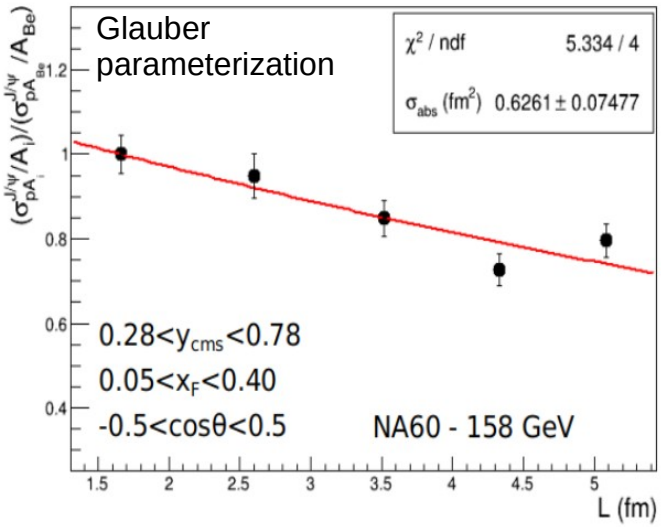
$$\sigma_{pA}^{J/\psi} = \sigma_{pp}^{J/\psi} \times A^{\alpha} \quad \text{---------- (1)}$$

Glauber parameterization

$$\frac{\sigma_{pA}^{J/\psi}}{A} = \sigma_{pp}^{J/\psi} exp(-\sigma_{abs}\rho L) \quad \text{---------- (2)}$$





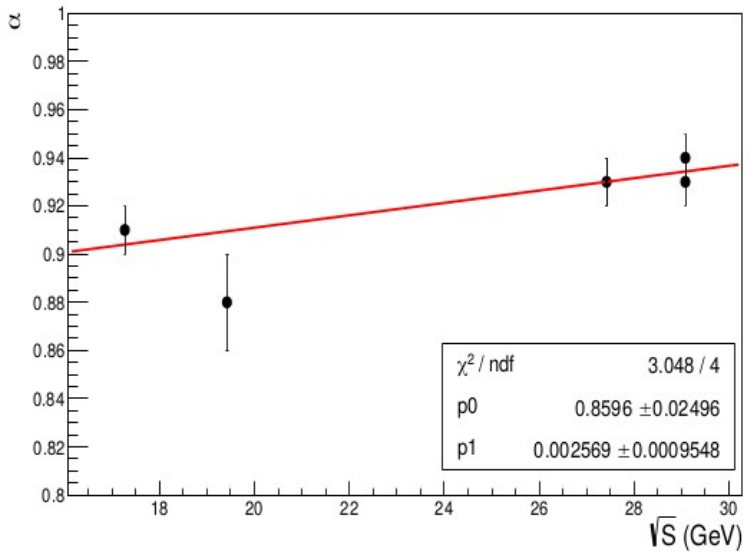


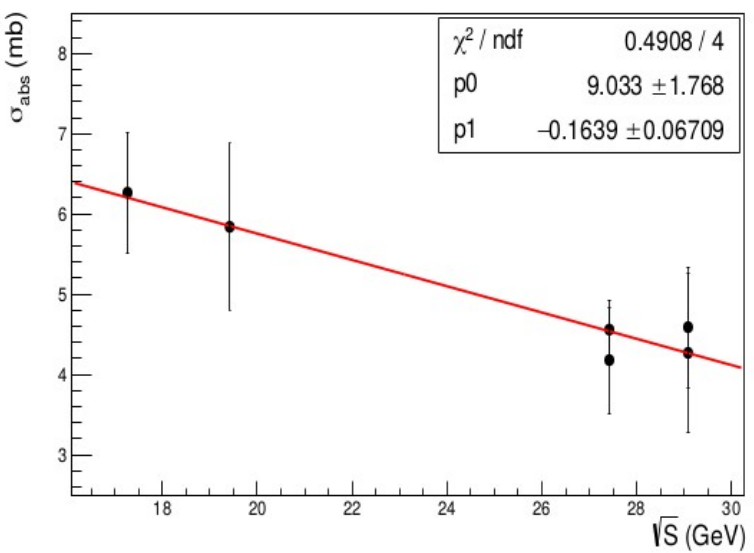
Multiplicity estimation

Experiment	$\sqrt{S}$ (GeV)	α	σ_{abs} (mb)
NA38	19.42	0.88 ± 0.02	5.84 ± 1.04
NA60	17.27	0.91 ± 0.01	6.26 ± 0.75
NA60	27.42	0.93 ± 0.02	4.18 ± 0.66
NA50	27.42	0.93 ± 0.01	4.56 ± 0.36
NA50 (HI)	29.08	0.93 ± 0.01	4.59 ± 0.75
NA50 (LI)	29.08	0.94 ± 0.01	4.27 ± 0.99

Ref:

- **Phys. Lett. B225, 459 (1991)**
- **Phys. Lett. B410, 337 (1997)**
- **Euro. J.Phys 48 329 (2006)**
- **Phys. Lett. B 706 263 (2012)**

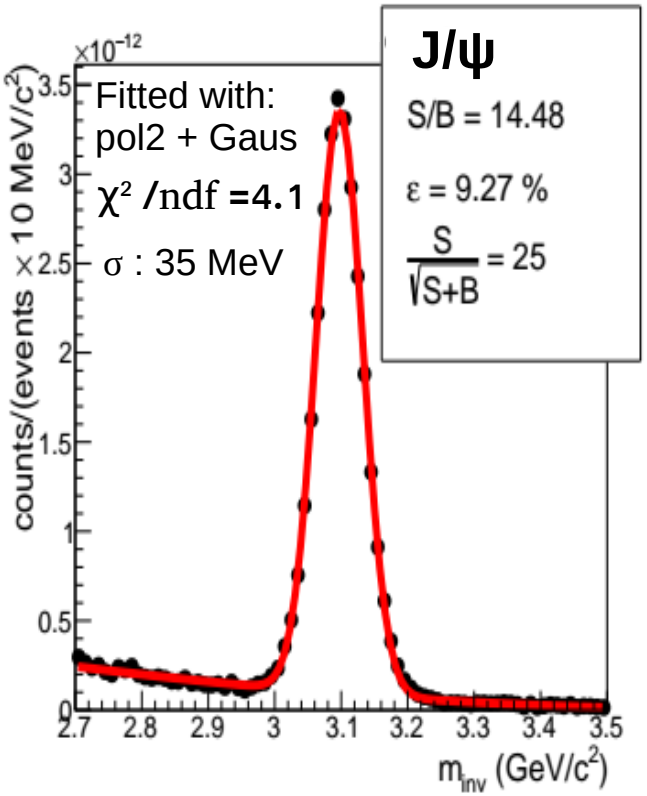




Fitted with a 1st order polynomial

Invariant mass distribution

Multiplicity : 5.13 x 10^{-8}



Cuts:

N of STS hits ≥ 7

N of MUCH hits ≥ 11

N of TRD hits ≥ 3

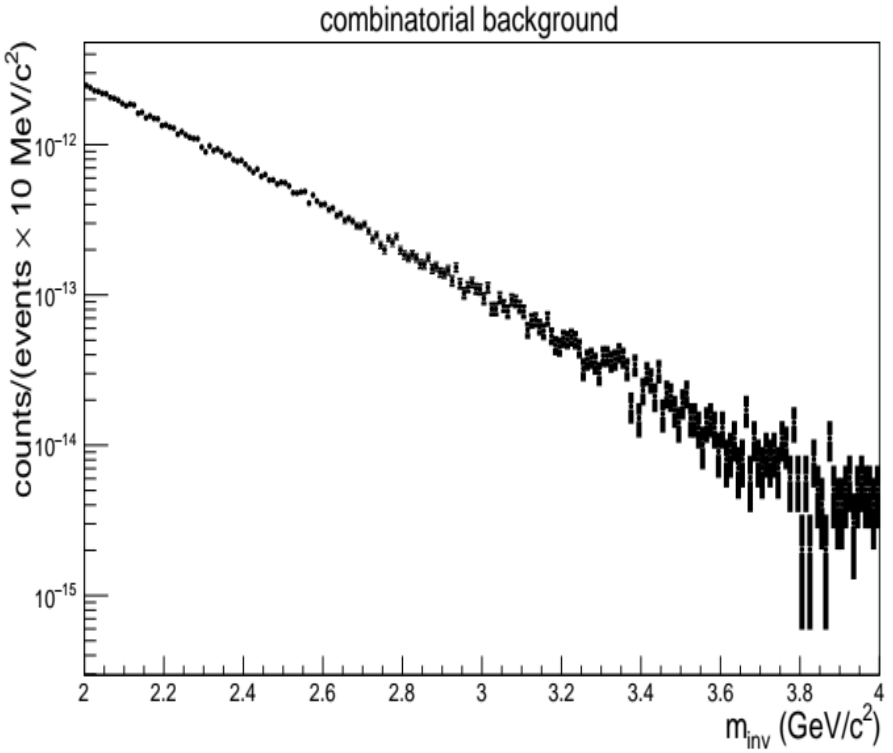
N of TOF hits ≥ 1

$\chi^2_{vertex} \leq 3.0$

$\chi^2_{STS} \leq 4.0$

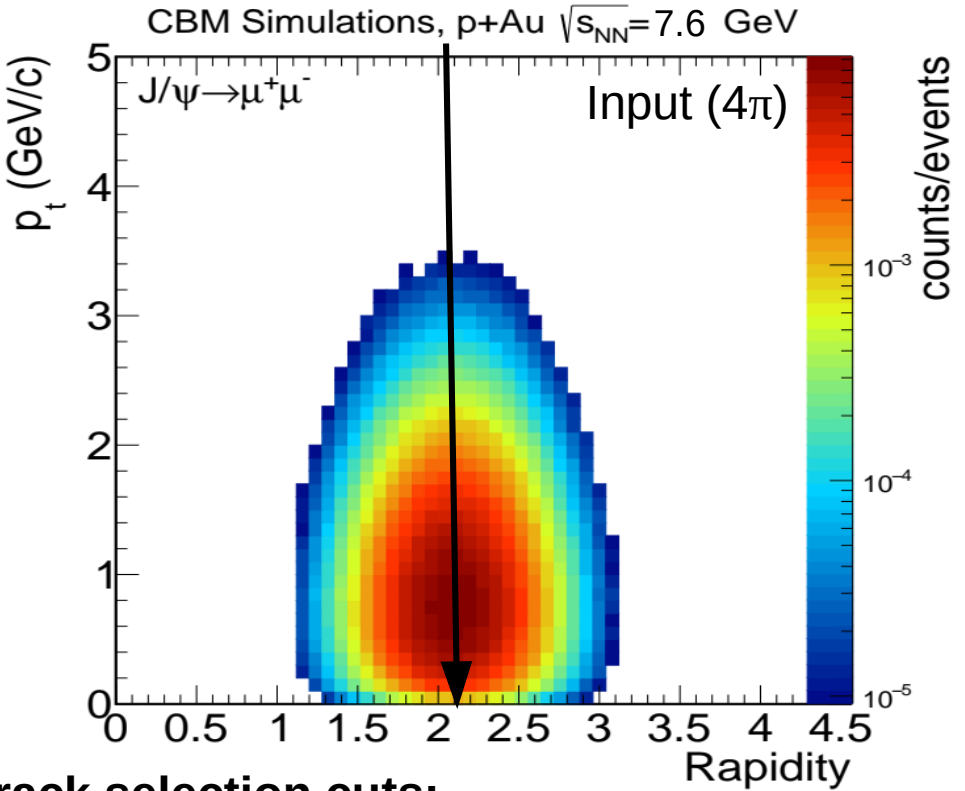
$\chi^2_{MUCH} \leq 2.5$

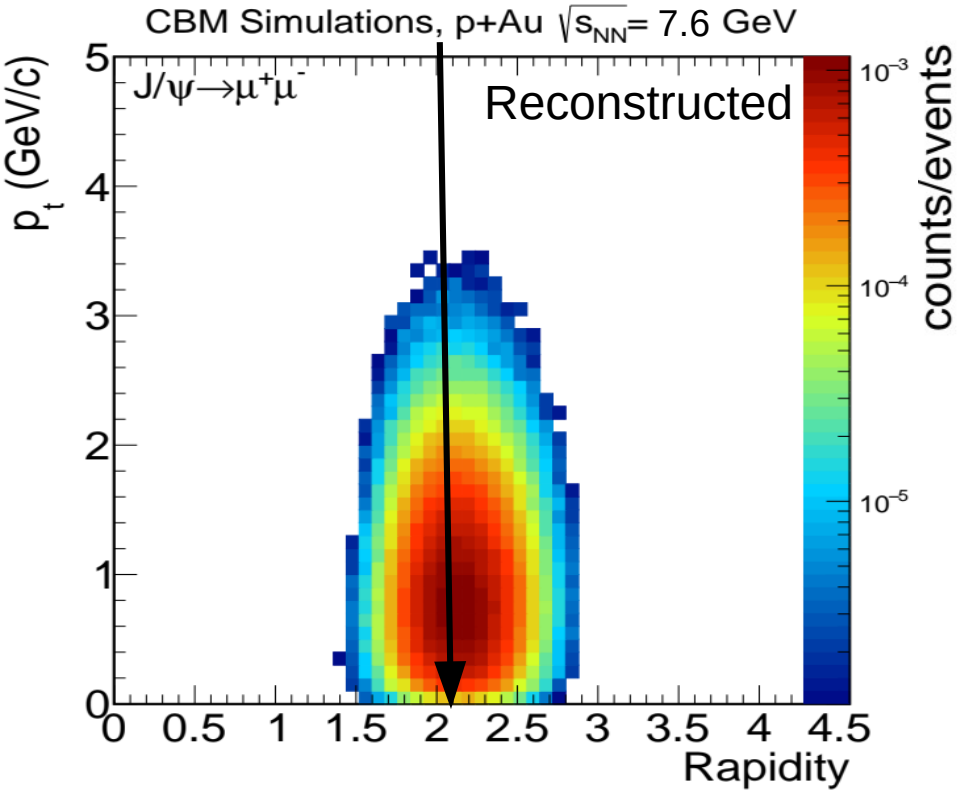
$\chi^2_{TRD} \leq 6.0$



Large fluctuation in the higher mass region of the combinatorial background
Needs to increase the statistics!!!

Y-p_T distribution of muon pairs





Track selection cuts:

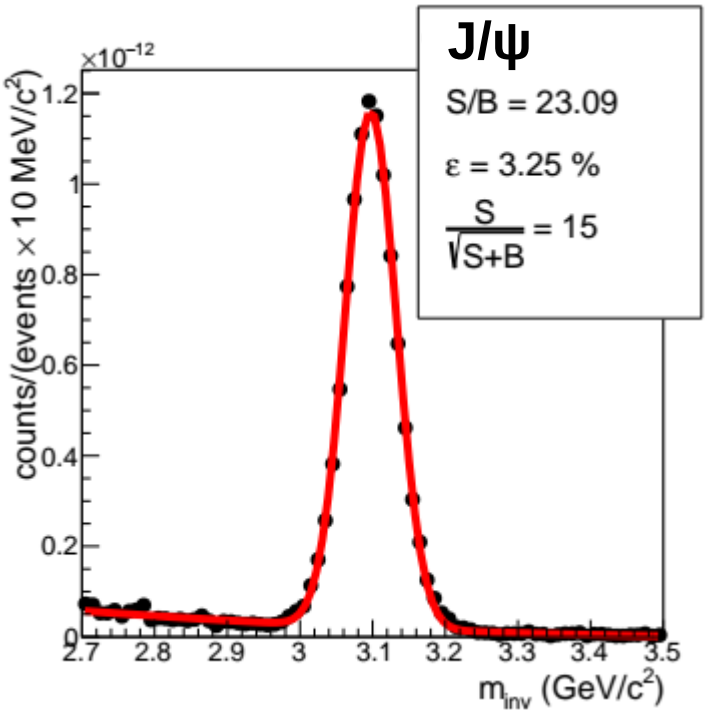
Accepted tracks: STS hit ≥ 7; MuCh hit ≥ 11; TRD hit ≥ 3; TOF hit ≥ 1

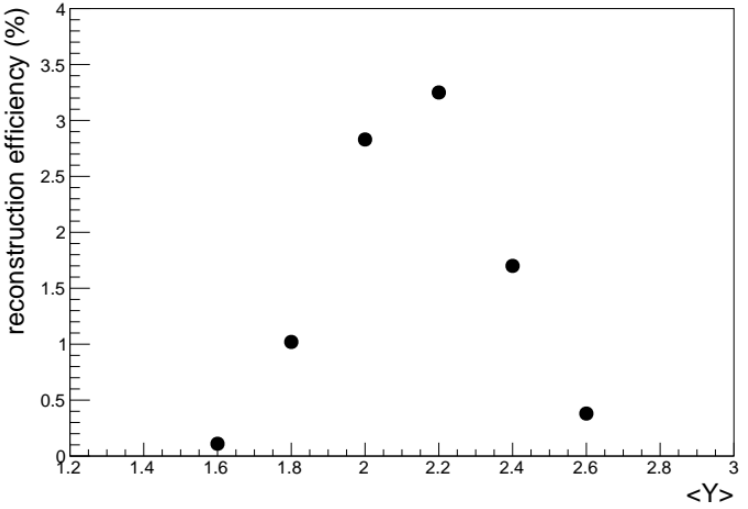
Reconstructed tracks: $\chi^2_{VERTEX} \leq 3.0$; $\chi^2_{STS} \leq 4.0$; $\chi^2_{MuCh} \leq 2.5$; $\chi^2_{TRD} \leq 6.0$

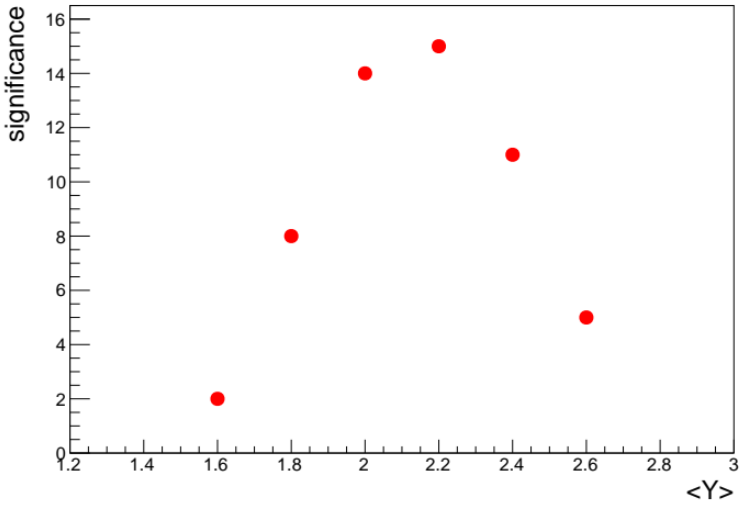
Good mid-rapidity coverage

Differential study (p_T inclusive)

$2.1 < Y \leq 2.3$







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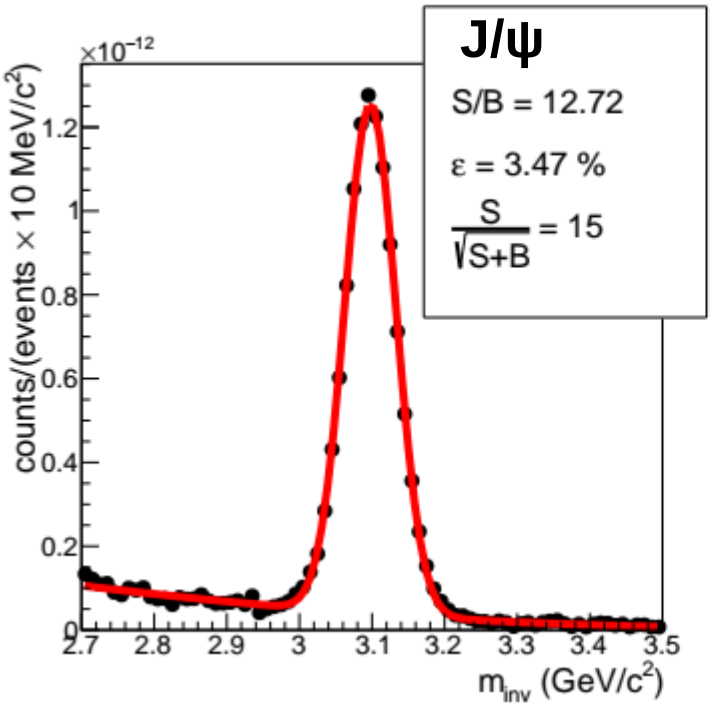
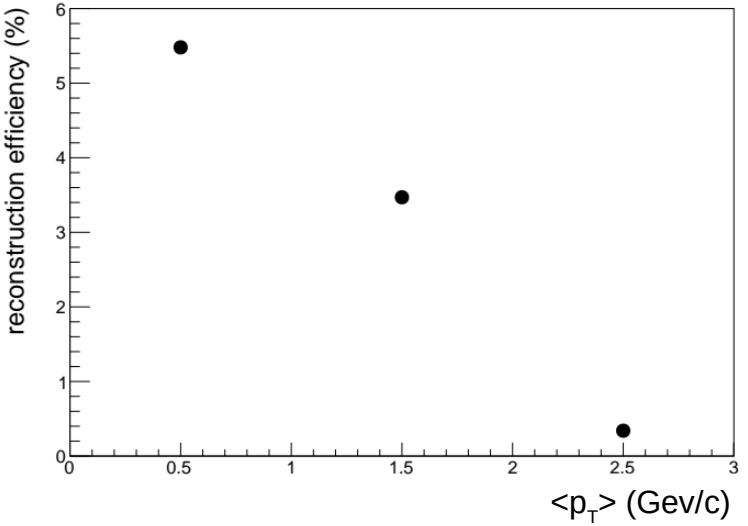
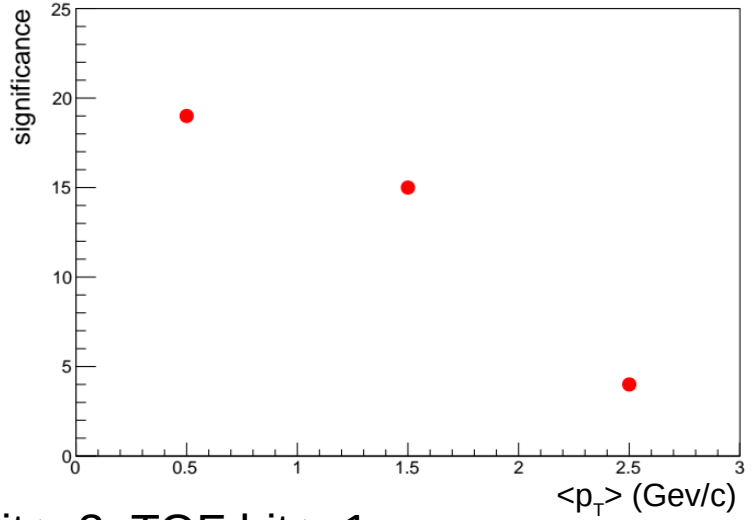
Differential study (Y inclusive)

$1.0 < p_T \leq 2.0$ GeV/c







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Summary

- Large fluctuation in the higher mass region of the combinatorial background
- Good reconstruction efficiency and significance value is obtained
- α-parameterization and ρL-parameterization are used to estimate the J/ψ production cross-section in p+Au collision

Future plans

- Investigation of the shape of the combinatorial background using different techniques (e.g. mixed event, like-sign method etc)
- Acceptance and efficiency correction
- With different transport engine and event generators (e.g. DCM-QGSM)

THANK YOU