Multiplicity dependent J/ψ and ψ(2S) production in pp collisions

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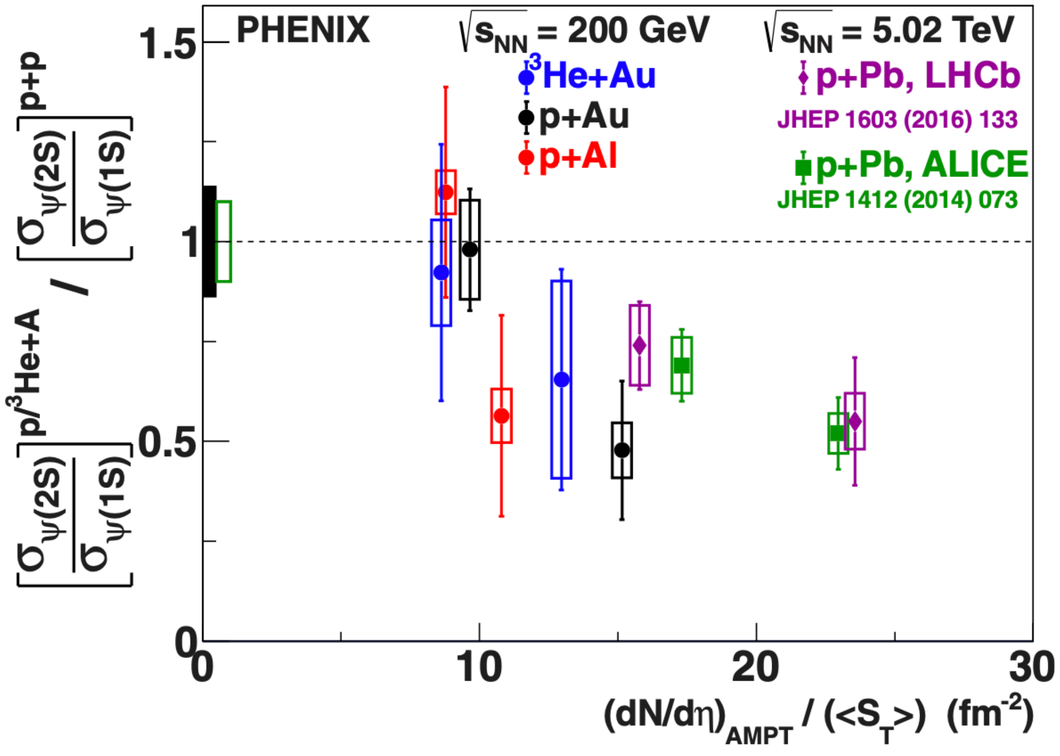
1. Introduction

- Quarkonia production in small collision systems like pA collisions, J/ψ and $\psi(2S)$ ratio decreases as multiplicity increases.
- Decreasing of the ratio can be explained by comover effects.
- The comover effect is that quarkonia are broken by interactions with the comover hadron.
- One way to study comover effect is to measure quarkonia with the same quark contents but different binding energy, like J/ψ and $\psi(2S)$.

=>How about the **smallest collision system?**



PhysRevC.95.034904

2. PHENIX detector

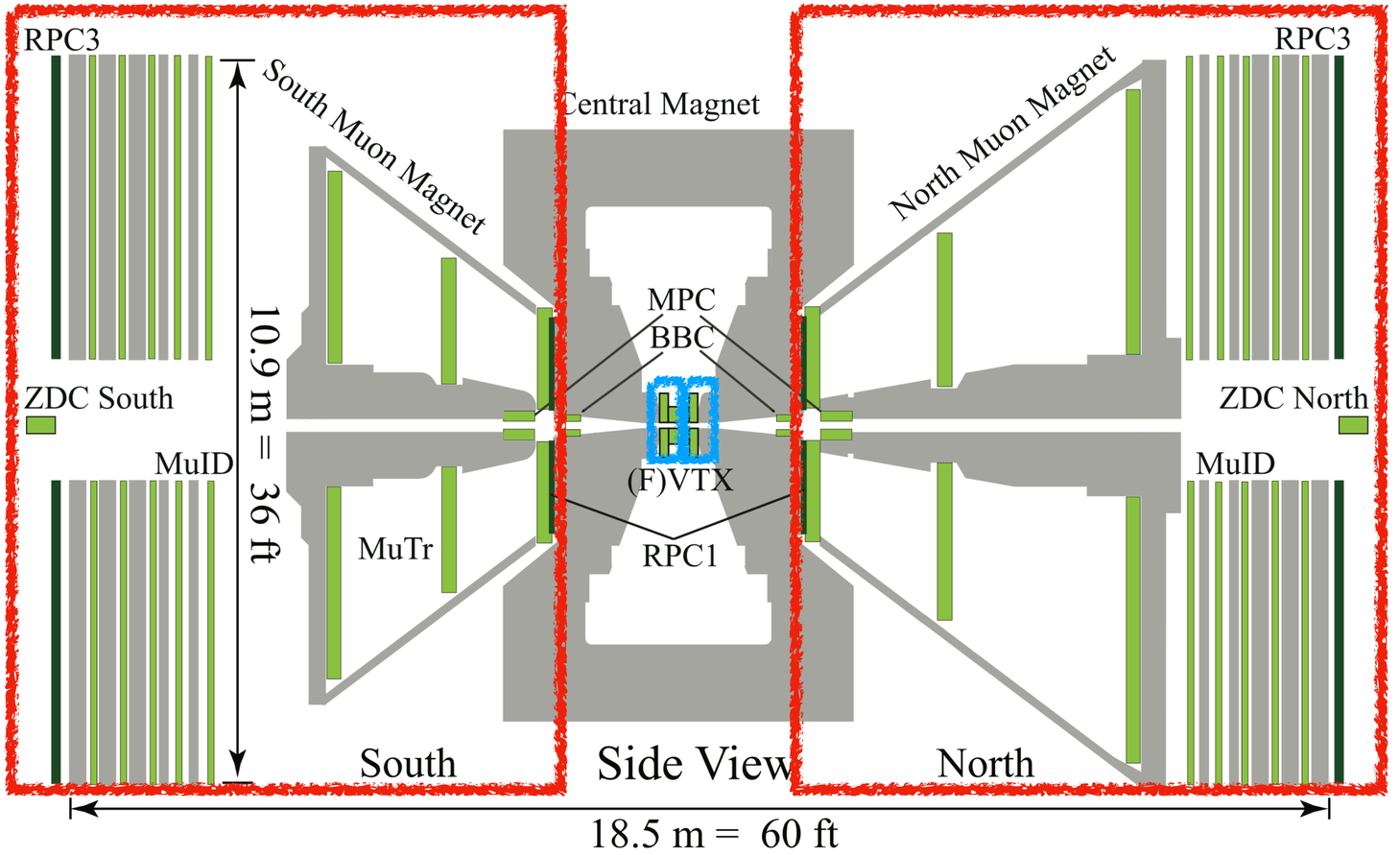
- Two muon arms in PHENIX.

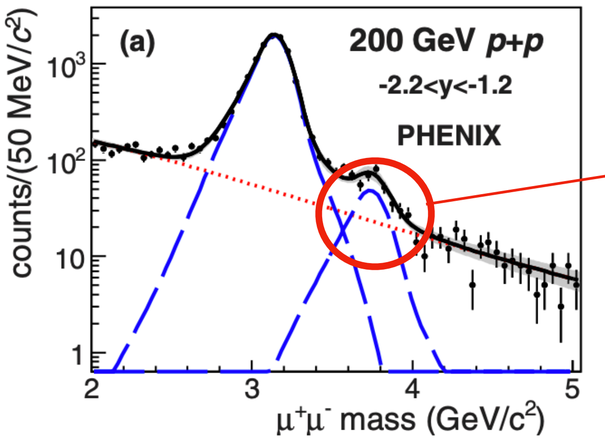
  - South arm: -2.2 $\leq \eta \leq$ -1.2
  - North arm: 1.2 $\leq \eta \leq$ 2.4
  - FVTX rapidity: 1.2 $\leq |\eta| \leq$ 2.2
  - J/ψ rapidity: 1.2 $\leq |y| \leq$ 2.2

- MuID is used to identify muon.

- MuTr find muon tracks and measure momentum.

- Matching muon arm tracks and FVTX(Forward silicon vertex tracker) tracks to improve mass resolution.
  (Without FVTX can't measure psi(2S))





$\psi(2S)$

PhysRevC.95.034904

2. PHENIX detector

- Multiplicity can be calculated by various detectors.

- Ideally, using J/ψ going direction of the FVTX detector may maximize physics effects related to multiplicity.

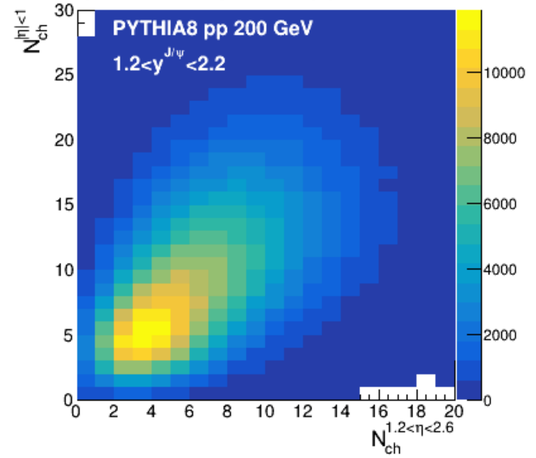
- But, if using only one of the detectors for calculating multiplicity then, the statistic is not enough.

==> Then, which combination of detectors is better to use for calculating multiplicity?

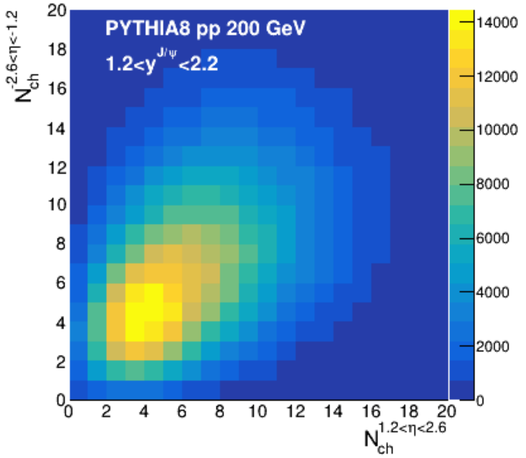
==>Let's find out which combination of detectors can be used in PYTHIA8!

MC Data

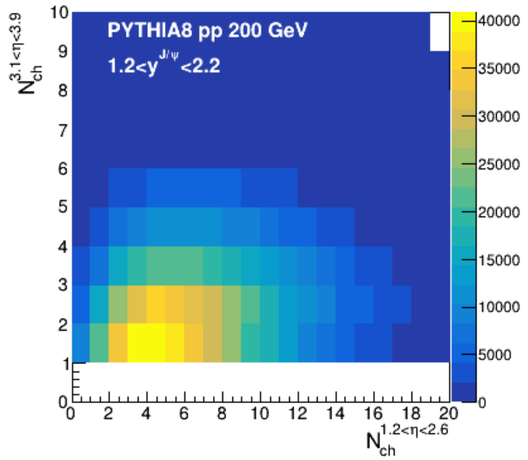
VTX(Mid rapidity) vs North



South FVTX vs North



BBC vs North



Through the PYTHIA8 study, we decided to use FVTX North, FVTX South, and VTX for the multiplicity calculation

3. Analysis procedure

PHENIX pp data set
$\sqrt{s} = 200GeV$

J/ψ and $\psi(2S)$ candidates

Multiplicity classification

Run QA, Dimuon selection

Calculate multiplicity in N_{Tracks} / $< N_{Tracks}\, in\, MB >$.
But, N_{Tracks} have primary vertex dependency.

=> Corrected by using $< N_{Tracks}\, in\, MB >$ value at each primary vertex position!

Calculate the ratio between J/ψ and $\psi(2S)$

Compare with PYTHIA8 results and other results

Fitting for correlated background, invariant mass, extract J/ψ and $\psi(2S)$ yields.

We are here!

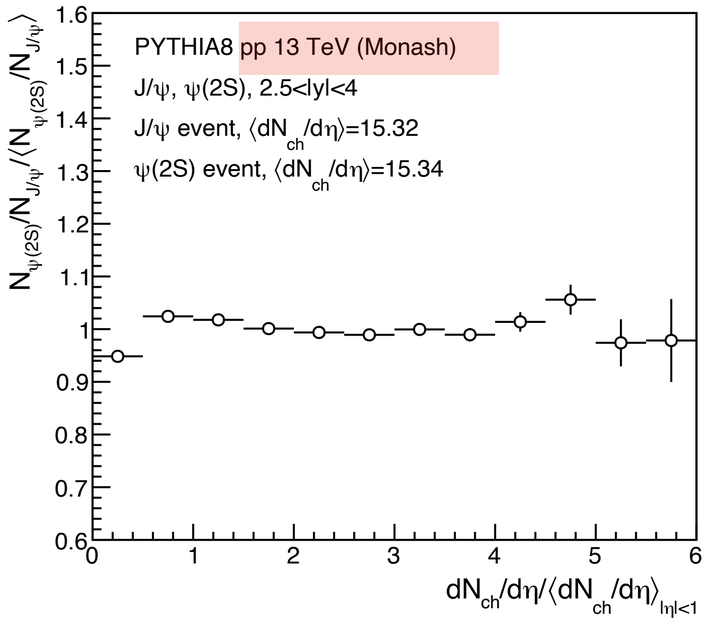
Systematic error study

4. MC Study

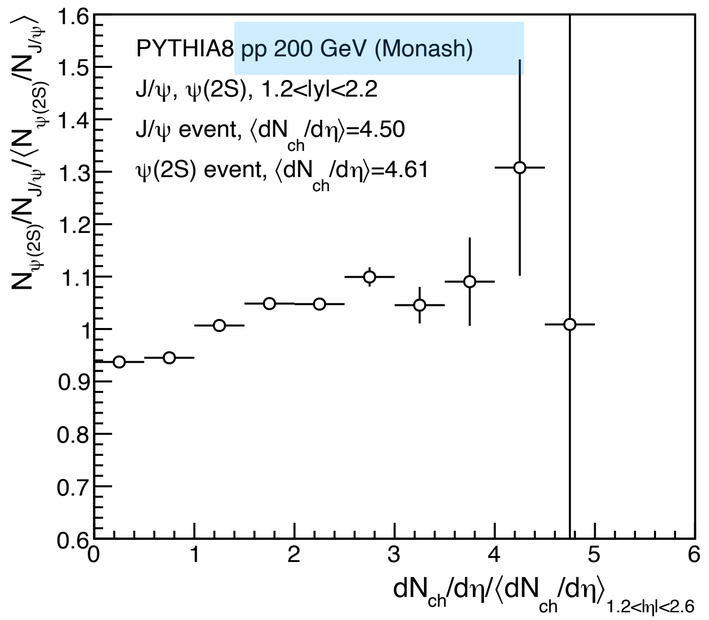
1. A different trend in double ratio as a function of multiplicity at Monash tune is seen with the different center of mass energy.
2. PYTHIA8 **Monash tune** and **Detroit tune** at 200 GeV show the opposite ratio trend.

   ==> Compare with real data would be interesting!

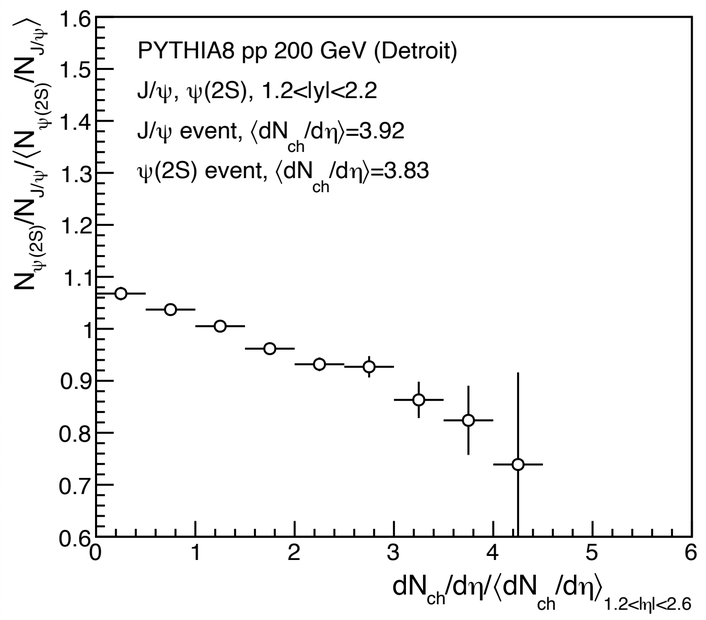
Monash, ALICE acceptance, pp 13 TeV



Monash, PHENIX acceptance, pp 200 GeV



Detroit, PHENIX acceptance, pp 200 GeV



Comparsion of different center of mass energy at Monash tune

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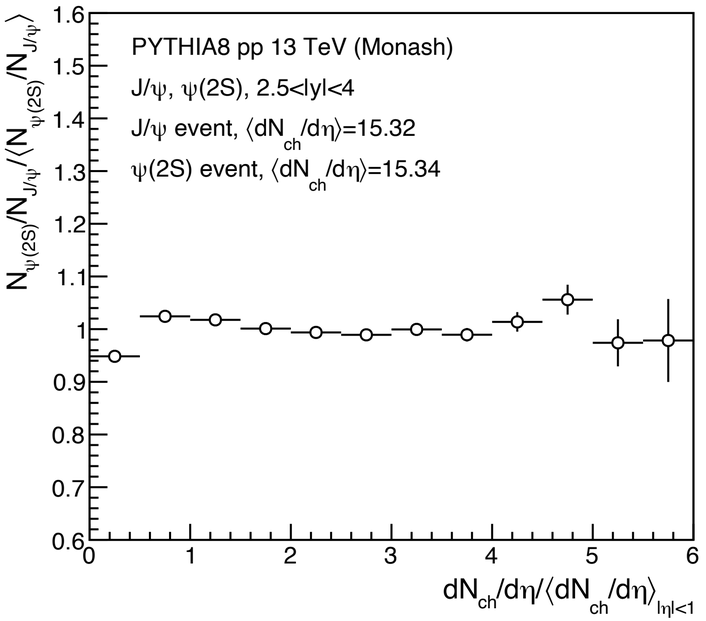
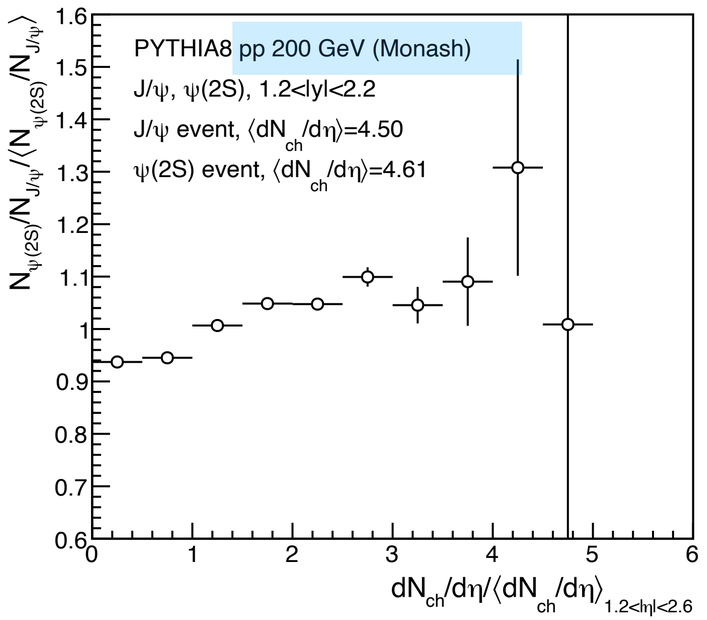
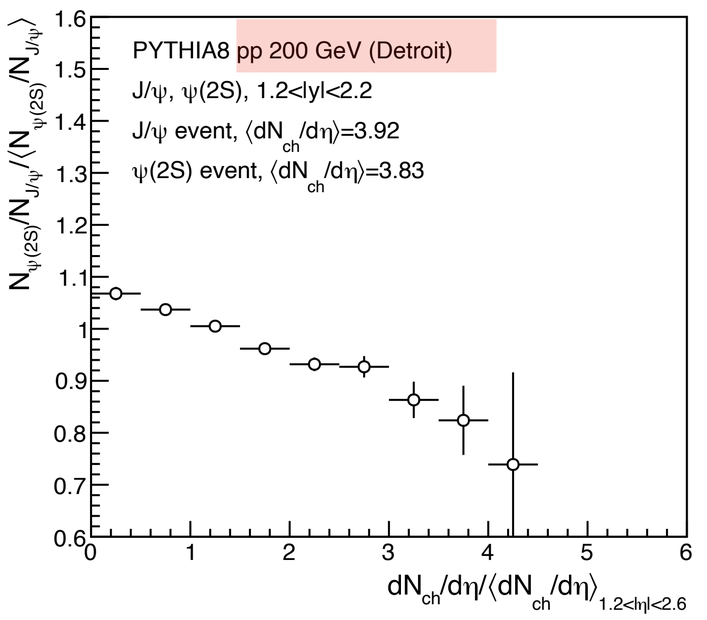


Monash, PHENIX acceptance, pp 200 GeV



Detroit, PHENIX acceptance, pp 200 GeV



Comparison of Monash tune and Detroit tune at 200GeV

5. Summary & plan

Summary

1. Analyzing PHENIX pp data at $\sqrt{s} = 200\,GeV$ for J/ψ and $\psi(2S)$ ratio.
2. The decreasing ratio with increasing multiplicity is shown at all kinds of pA collisions in data analysis.

   => Motivation for this analysis.
3. Analyzing PYTHIA8 to calculate multiplicity to select the combination of detectors.
4. PYTHIA8 Monash tune and Detroit tune are showing an opposite ratio trend in 200 GeV.

Plan

1. The systematic study will be finished.
2. Our data will be able to be compared to the various PYTHIA8 tunes.