Υ measurements in p+p collisions at √s = 500 GeV with the STAR experiment

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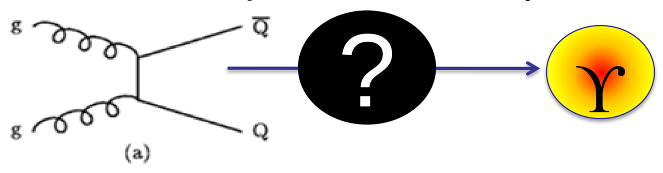
Abstract

Studies of quarkonium production in heavy-ion collisions can provide insight into thermodynamic properties of the quark-gluon plasma (QGP). Suppression of Υ states is expected at a sufficiently high temperature in the QGP and can be measured using the nuclear modification factor R_{AA}. Measurements of p_T spectra for separate Υ states in p+p collisions provide constraints for models of the quarkonium production, which is an important factor in the interpretation of the heavy-ion results. In addition, high quality data from p+p collisions at √s = 500 GeV can be used as a baseline for R_{AA} as a function of p_T in Au+Au collisions at √s = 200 GeV, after rescaling to lower energy. Also, studies of ratios of Υ states as a function of event multiplicity may help better understand the interactions with hadronic co-movers, because the higher states have larger geometrical sizes and thus should have larger cross section for such interactions compared to Υ(1S).

In this poster, we will focus on experimental aspects of Υ measurements in p+p collisions at √s = 500 GeV with the STAR experiment. Furthermore, the prospects of Υ measurements with the newly installed Muon Telescope Detector (MTD) will be discussed.

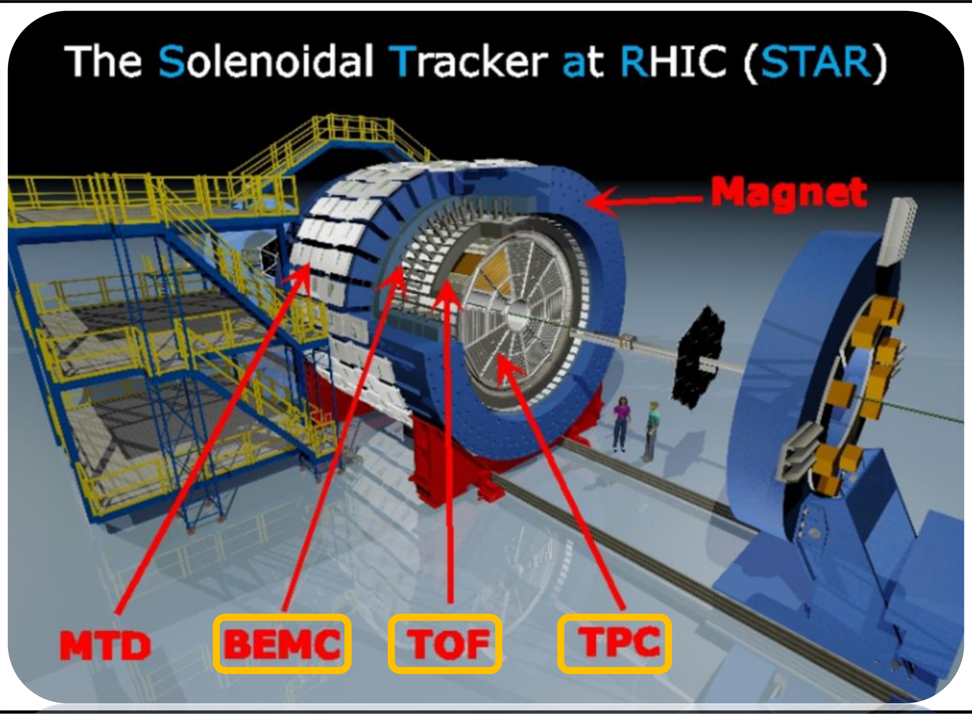
1. Motivation

- Υ mesons provide a clean probe of QGP, but production mechanism and cold nuclear matter effects (CNM) are not well known → Measurements of p_T spectrum and multiplicity dependence of the production help to constrain the models.



- Each of the Υ states (1S, 2S, 3S) has different dissociation temperature (due to different binding energy) and can have different interaction cross section with hadrons (due to different size) → Separate measurements for each of the states vs. event multiplicity could help understand this effect

2. STAR experimental setup



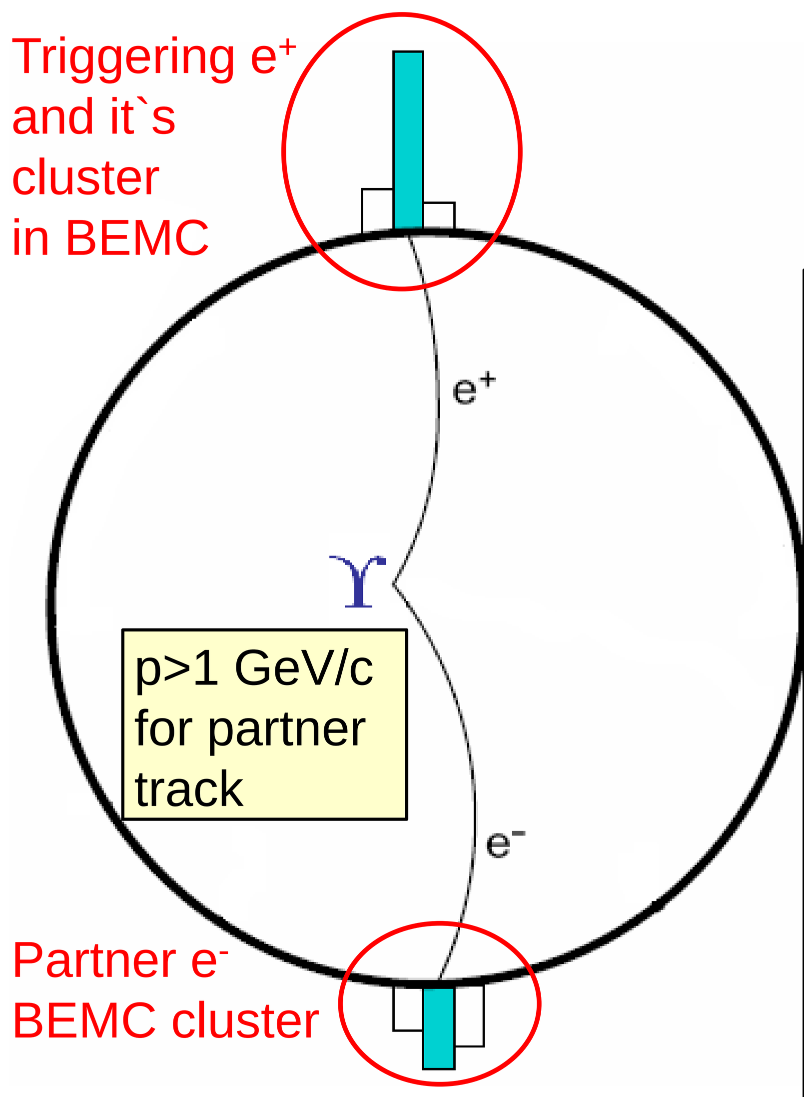
Acceptance	
|η|<1	0<φ<2π

Detectors used in this analysis:
- **Time projection Chamber (TPC)** for tracking and particle identification
- **Time of Flight (TOF)** for measuring particle multiplicity
- **Barrel Electromagnetic Calorimeter (BEMC)** for electron identification and triggering

3. Upsilon measurement

Dielectron channel

$\Upsilon \to e^+e^-$ (BR = 2.38±0.11) [1]



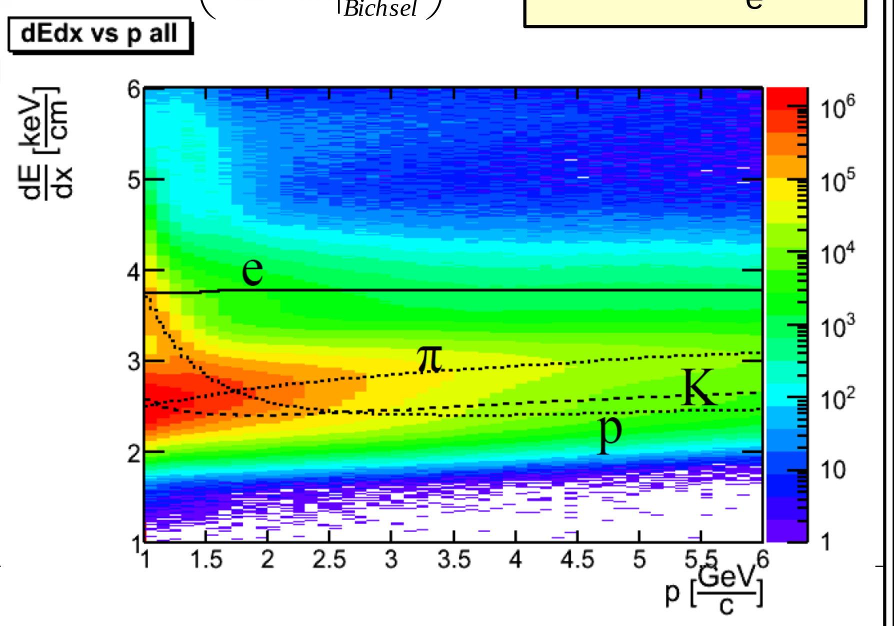
- Measurements are done in dielectron channel.
- The data are collected by triggering on high energy tower in **BEMC**.
- Dataset: 164M **BEMC** triggered, high tower events from p+p 500 GeV → $L_{int} \approx 21.5\ pb^{-1}$

Electrons are identified in **TPC** via normalized dE/dx:

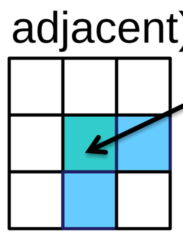
$$n\sigma_e = \ln\left(\frac{dE/dx_e}{dE/dx|_{Bichsel}}\right)/\sigma$$

TPC e

$-1.2<n\sigma_e<3$



Electrons are identified in **BEMC** by reconstructing clusters (hit tower+2 adjacent) pointed by TPC tracks

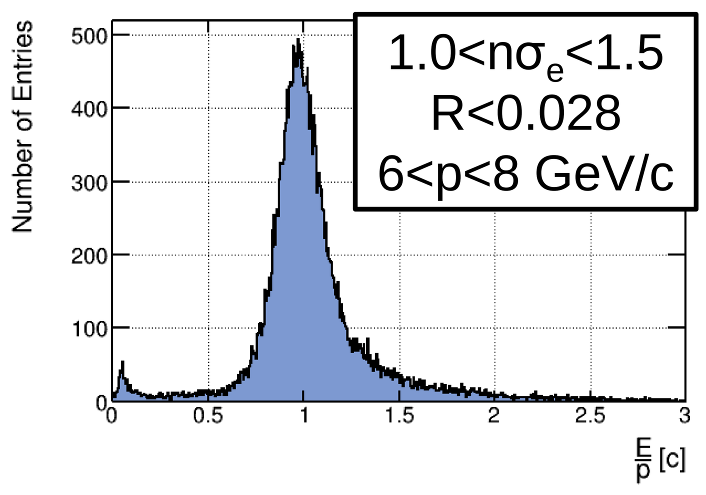


Distance between track projection and center of a cluster

$$R = \sqrt{\Delta\eta^2 + \Delta\phi^2}$$

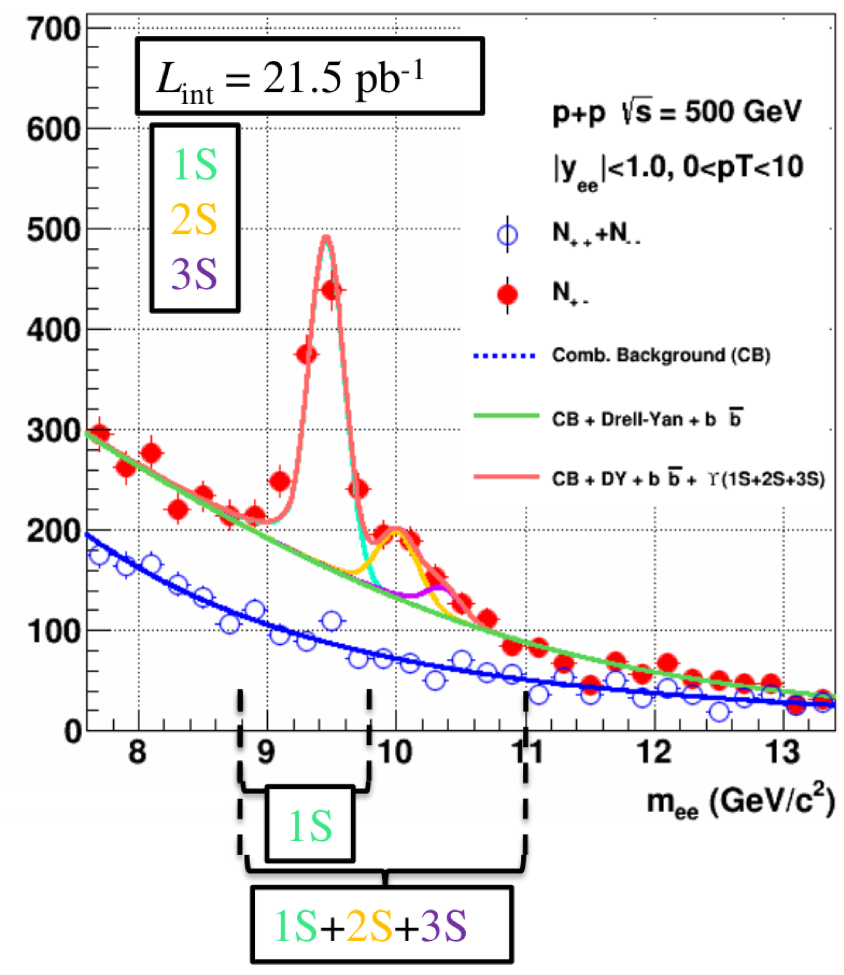
BEMC e

$E_{tow}/E_{clu}>0.5$
$0.55<E_{clu}/pc<1.45$
$R<0.028$

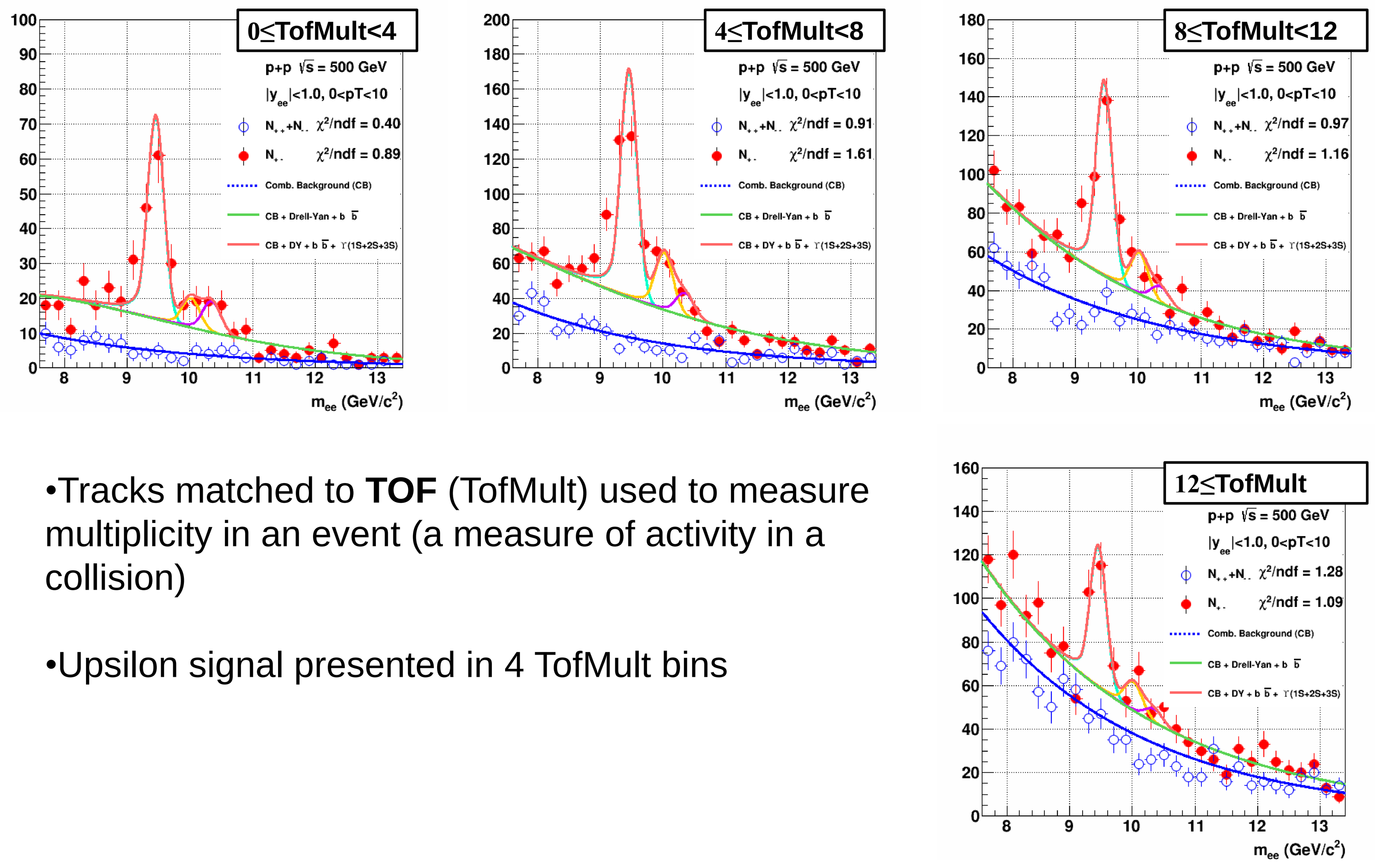


4. Upsilon signal

- Υ signal is reconstructed from e^+e^- pairs
- Signal lineshape for 1S,2S,3S states from MC simulation and backgrounds are fitted simultaneously to like-sign and unlike-sign pairs
- Largest signal measured by STAR to date → high precision results
- Estimation of Drell-Yan [2] and $b\bar{b}$ cross sections possible in the future

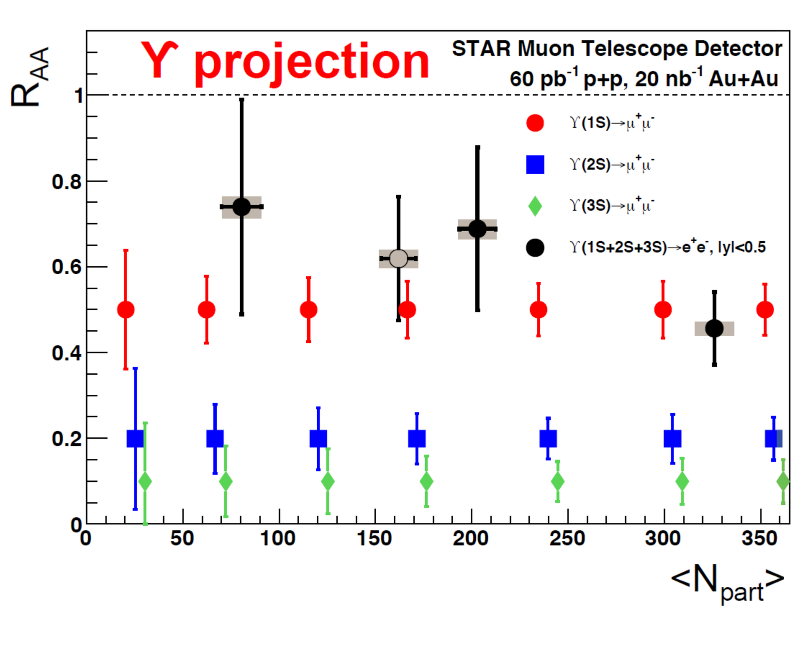


5. Event activity studies



- Tracks matched to **TOF** (TofMult) used to measure multiplicity in an event (a measure of activity in a collision)
- Upsilon signal presented in 4 TofMult bins

6. Prospects for Υ measurements



- New **Muon Telescope Detector (MTD)** installed in 2014
- Makes measurements in dimuon channel possible $\Upsilon \to \mu^+\mu^-$ (BR = 2.48±0.05) [1] with clean signal
- It will allow separation of 1S, 2S and 3S states
- Precision measurements of R_{AA}

7. Summary

- Presented Υ measurements in p+p collisions at √s = 500 GeV
- Signal presented in 4 TofMult bins („event activity")

[1] K.A. Olive et al. (Particle Data Group), Chin. Phys. C, 38, 090001 (2014)
[2] Sidney D. Drell and Tung-Mow Yan, Phys. Rev. Lett. 25, 316 (1970)
[3] Phys.Lett. B735 (2014) 127
[4] S. Chatrchyan; et al. (CMS Collaboration) JHEP 04 (2014) 103 arXiv:1312.6300v3

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The STAR Collaboration: http://drupal.star.bnl.gov/STAR/presentations

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