Υ production in U+U collisions at the STAR experiment

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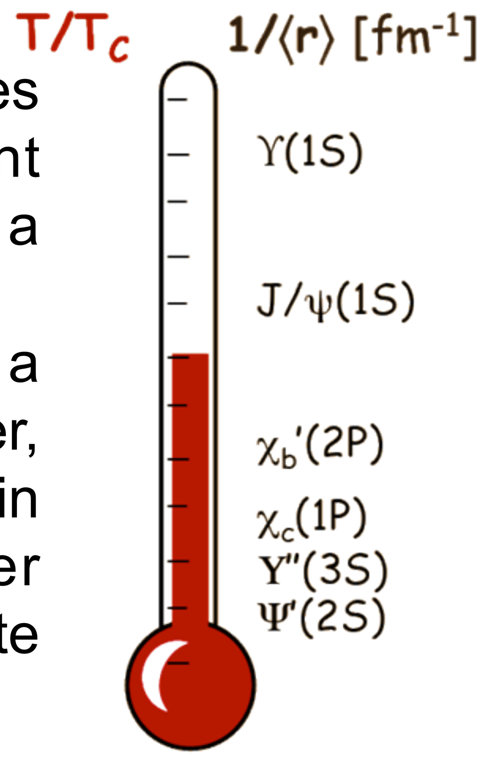
Motivation

Quarkonium as an sQGP thermometer

- Due to Debye-screening, Quarkonium states are expected to dissociate at different temperatures in the sQGP, providing a “thermometer” for the medium [1].
- J/ψ suppression was suggested to be a smoking gun signature for QGP [2]. However, effects such as quark pair recombination (in the plasma) and feed-down, co-mover absorption (in the hadronic phase) complicate the interpretation of J/ψ measurements



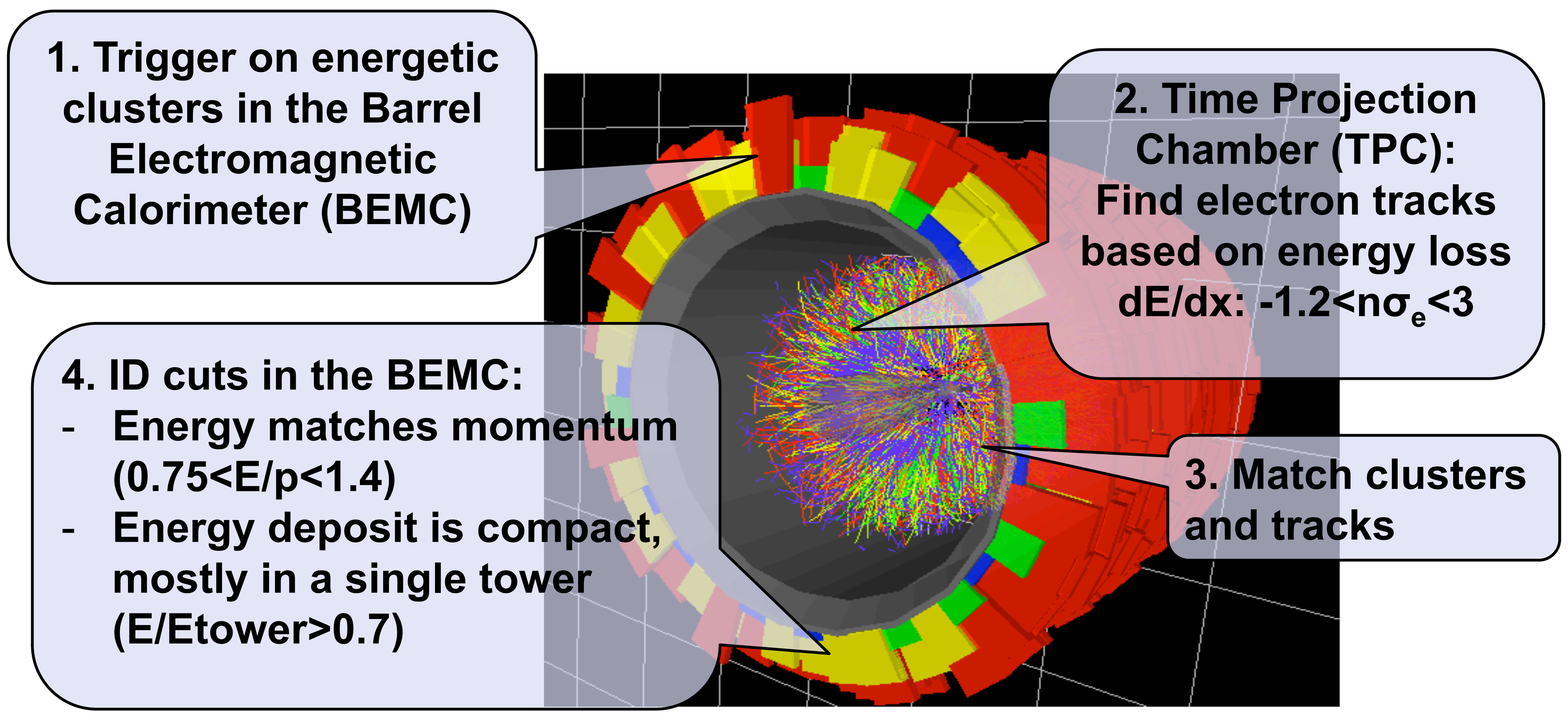
Upsilons in RHIC: a cleaner probe

- Recombination and co-mover absorption are negligible at RHIC energies.
- Central 193 GeV U+U collisions provide the highest energy density at RHIC, where the strongest suppression of Υ states are expected.
- Models with different formalisms and assumptions, however, give different predictions. Two popular examples are Refs. [3,4]. Precise data are needed to constrain the models.

Measurement

Experiment: Solenoidal Tracker at RHIC

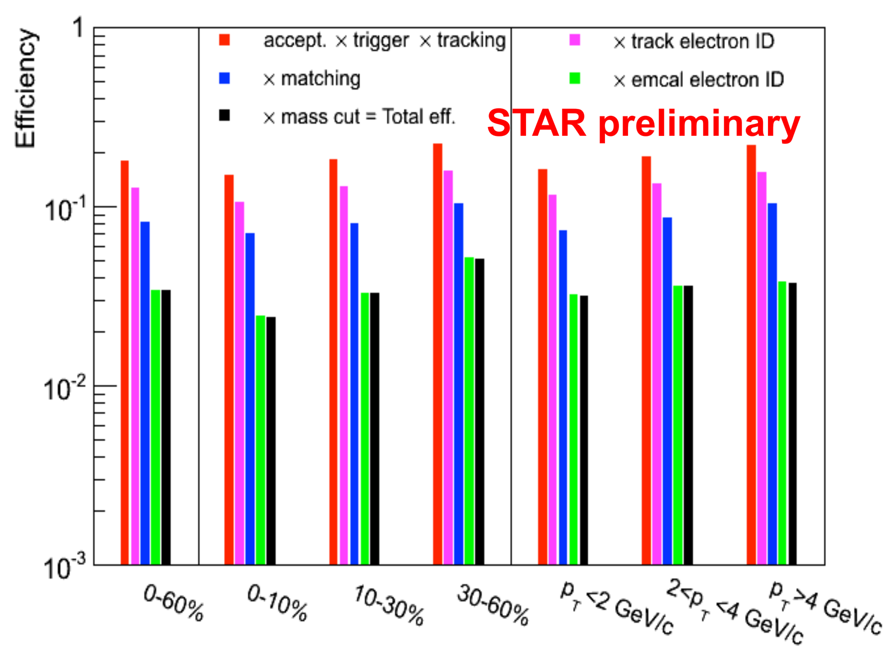
- Reconstruction in the the dielectron channel $\Upsilon \rightarrow e^+e^-$ (BR~2%) at mid-rapidity (|y|<1.0), in 3 centrality and p_T bins.
- The Upsilon is not abundant: identification and background rejection is a challenge.



- 15M events (263 μb^{-1} integrated luminosity) processed; 2296 e^+e^- pairs with a reconstructed invariant mass m_{ee}>5 GeV remain after selection. Most of them are background from several sources: combinatorial pairs (random correlation), Drell-Yan (DY) electrons, pairs from open $b\bar{b}$ production (BB).

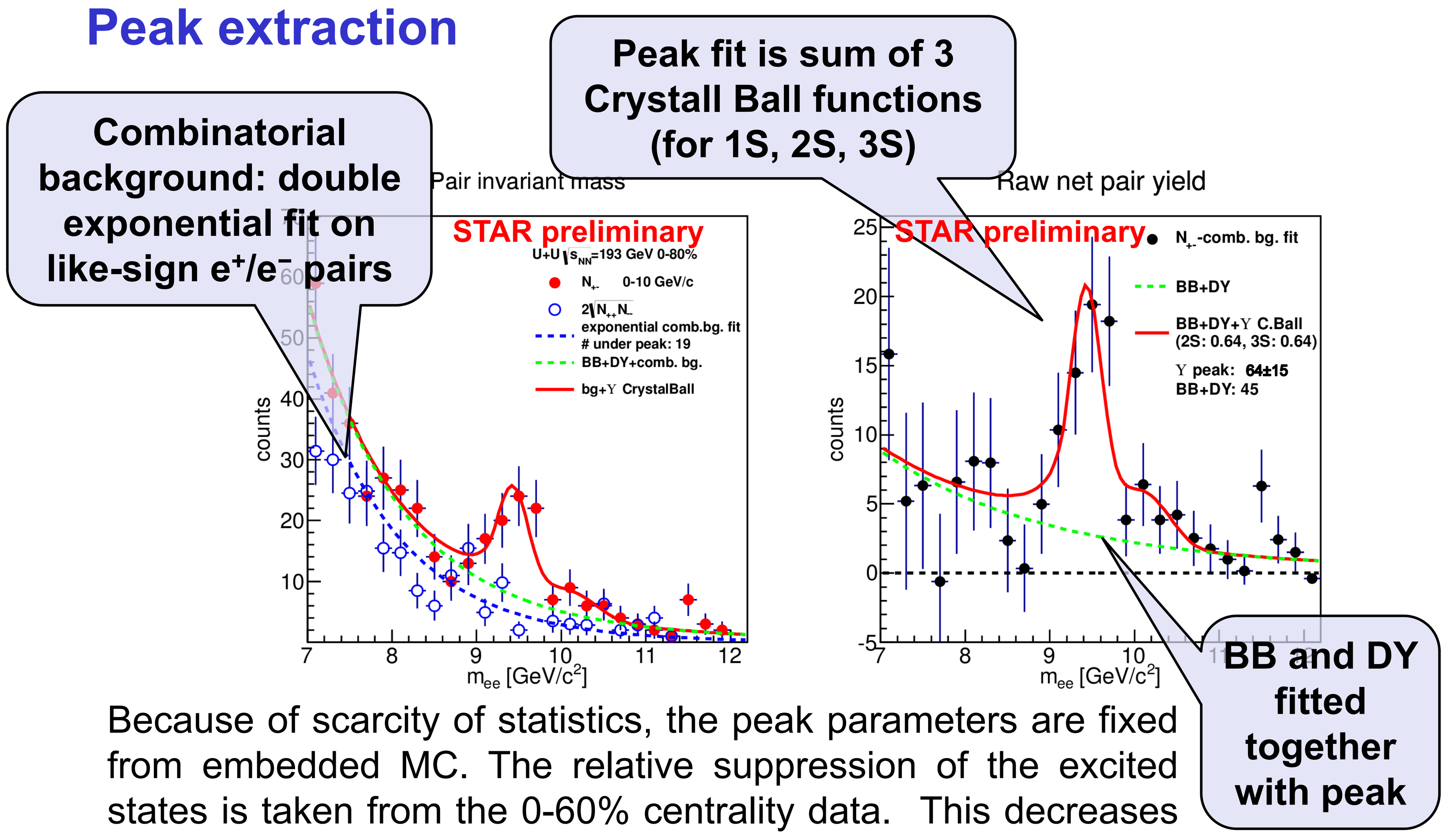
Acceptance and efficiency

- Geometrical acceptance, trigger, tracking, matching and cluster compactness cut efficiencies are from embedded simulation.
- E/p and dE/dx efficiencies are calculated using single identified electron samples.
- Around 2-3% of the Υ are reconstructed.



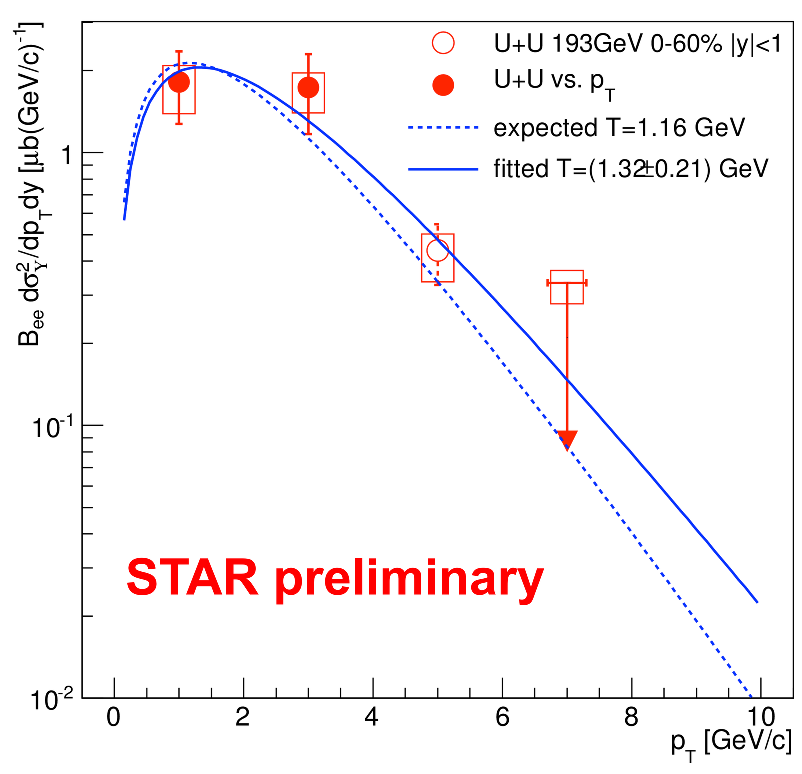
Upsilon yield

Peak extraction



Because of scarcity of statistics, the peak parameters are fixed from embedded MC. The relative suppression of the excited states is taken from the 0-60% centrality data. This decreases random fluctuation, but shows up in the systematics.

Spectrum and x-section



Fit function is $f(p_T) = \frac{p_T}{\exp(p_T/T+1)}$.

The expected value for T is extrapolated from ISR, CDF and CMS measurements

Υ cross section (STAR preliminary)

U+U 193 GeV, 0-60% centrality

$$B_{ee}\left.\frac{d\sigma^{\Upsilon}_{AA}}{dy}\right|_{|y|<1} = (4.37 \pm 1.09\,_{\text{stat.}}\;{}^{+0.65}_{-1.01}\,_{\text{syst}})\ \mu b$$

Major systematic uncertainties (%) (STAR preliminary)

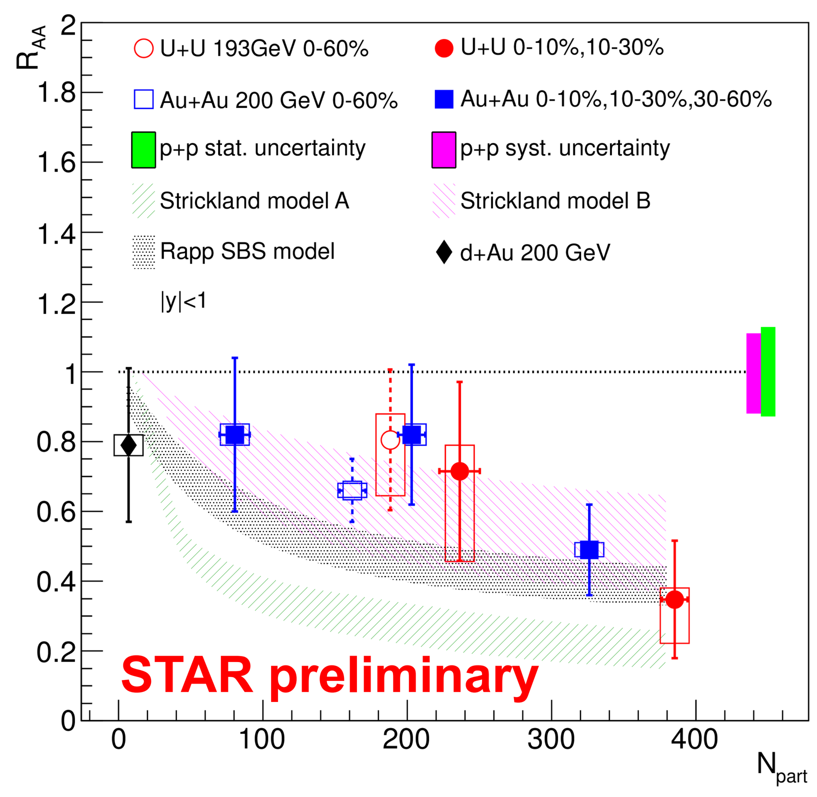
Geometrical acceptance	+1.7 -3.0
Trigger efficiency	+1.1 -3.6
Tracking efficiency	11.8
TPC electron identification	+4.0 -6.4
TPC-BEMC matching	5.4
BEMC electron identification	5.9
Embedding p_T and y shapes	2.1
Signal extraction	+4.8 -18

Nuclear modification factor

- Nuclear modification factor (R_{AA}) compares the corrected yield in A+A collisions to that in p+p, scaled by the number of binary collisions.

$$R^{\Upsilon}_{AA} = \frac{1}{\langle N_{coll}\rangle}\frac{N^{\Upsilon}_{AA}\varepsilon^{-1}_{AA}}{N^{\Upsilon}_{pp}\varepsilon^{-1}_{pp}}$$

Yield in current measurement; Acceptance x Efficiency; from the Glauber model; Reference yield



Conclusion

- As expected, data trend towards stronger suppression of Υ(1S+2S+3S) with higher number of participants
- This indicates an increased dissociation of the Υ states with energy density
- Potential model ‘A’ of Ref. [3], based on heavy quark free energy, is disfavored

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References:
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[2] T. Matsui, H. Satz, Phys.Lett. B178, 416 (1986)
[3] M. Strickland, D. Bazow, Nucl.Phys. A879, 25 (2012)
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