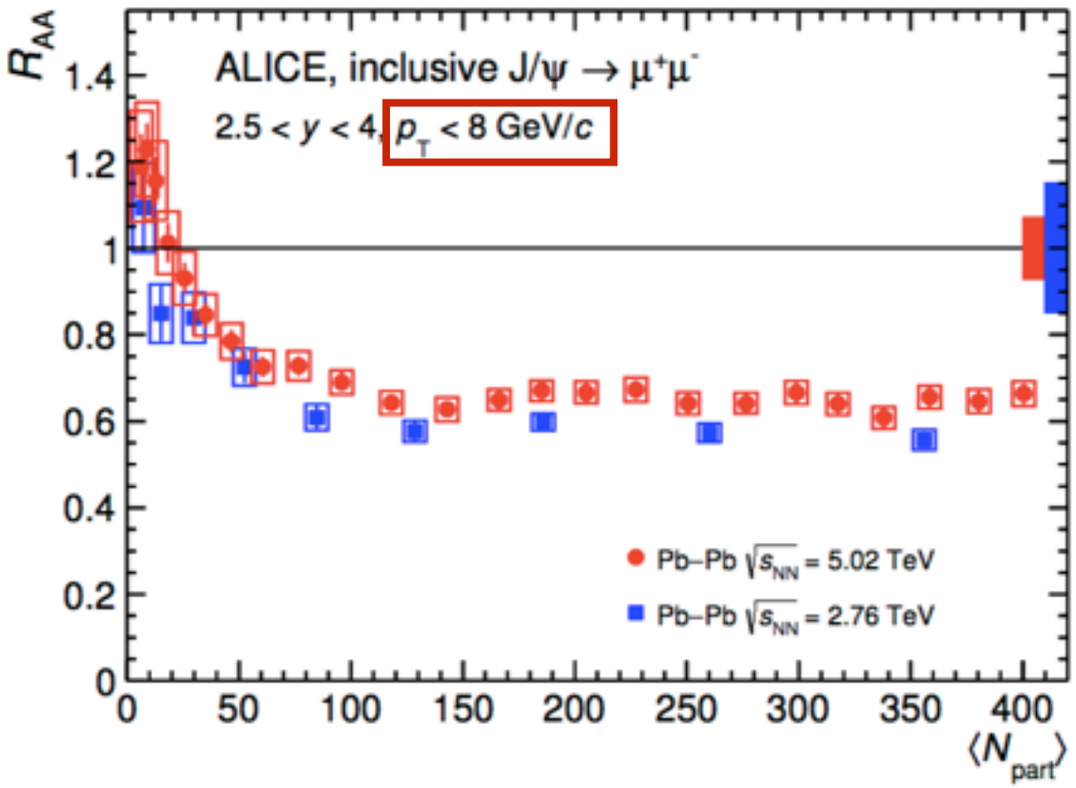
Charmonia from SQM 2016

Songkyo Lee

dilepton meeting
6th July 2016

ALICE

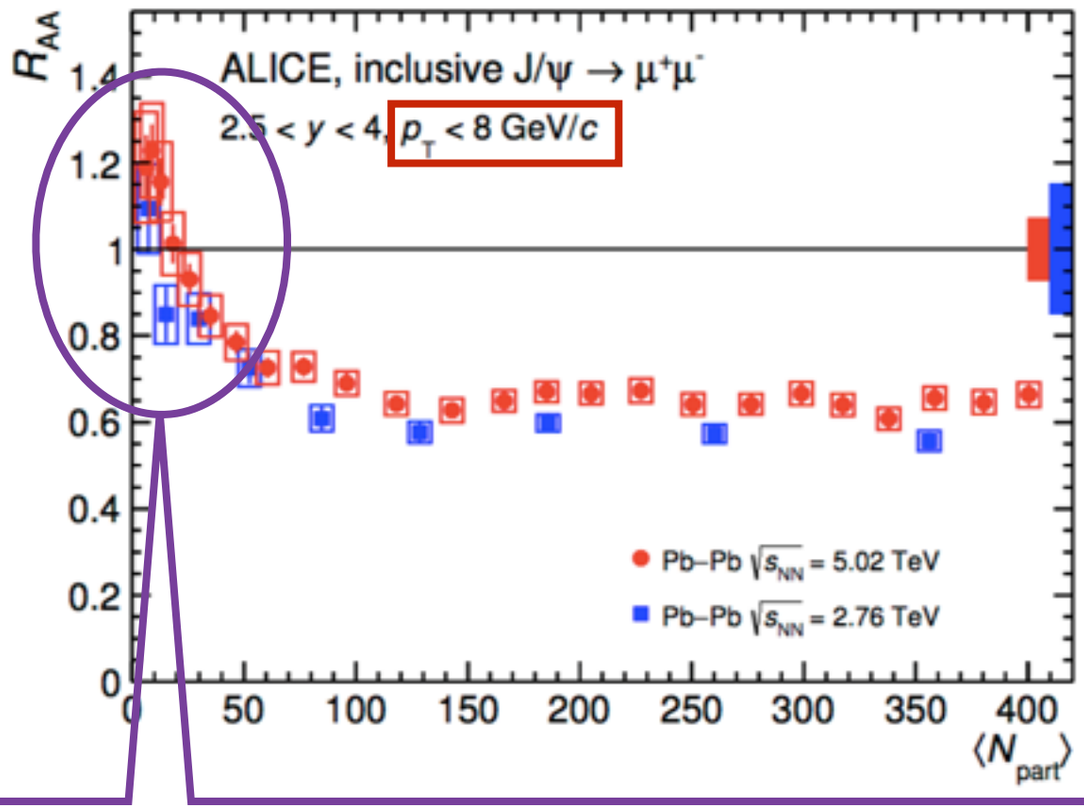
- J/ψ in PbPb @ 5 TeV - Paper submitted (http://arxiv.org/abs/1202.1383)

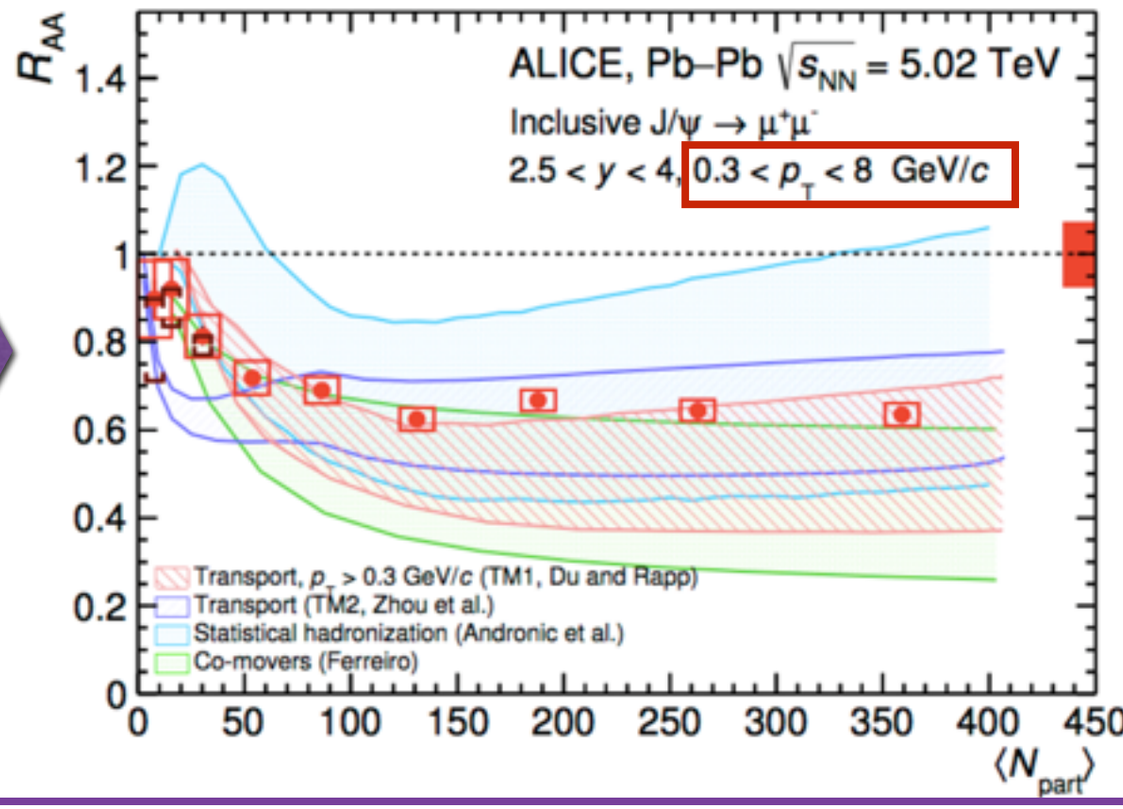


- finer binning than 2.76 TeV
- Similar trends (slightly higher)
  - 5.02 TeV $R_{AA}^{0\text{-}90\%}$ = 0.66 ± 0.01(stat) ± 0.05(syst)
  - 2.76 TeV $R_{AA}^{0\text{-}90\%}$ = 0.58 ± 0.01(stat) ± 0.09(syst)

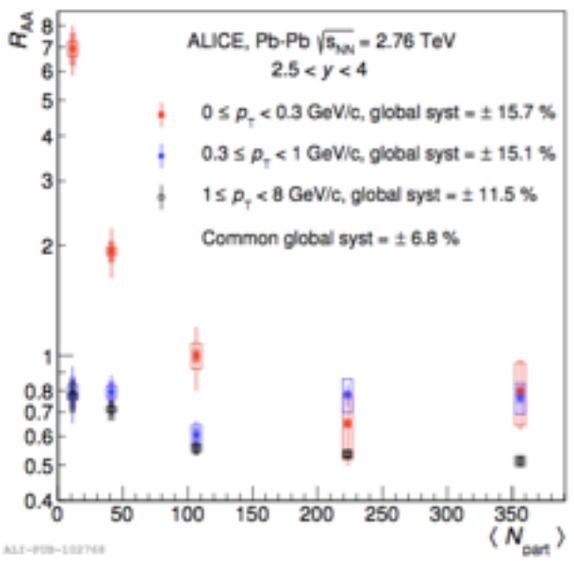
ALICE

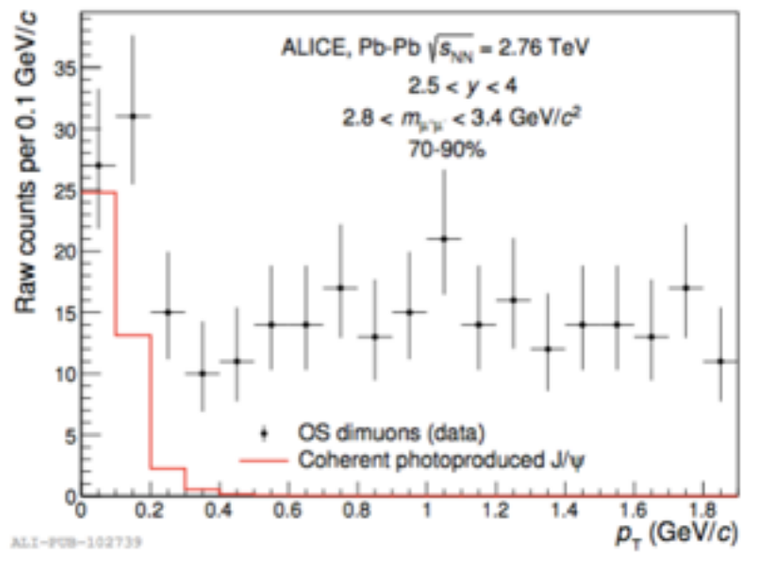
- J/ψ in PbPb @ 5 TeV - Paper submitted (http://arxiv.org/abs/1202.1383)





- very low p_T J/ψ excess
- presumably originated from photon-production
- p_T > 0.3 GeV cut applied to reduce these contributions

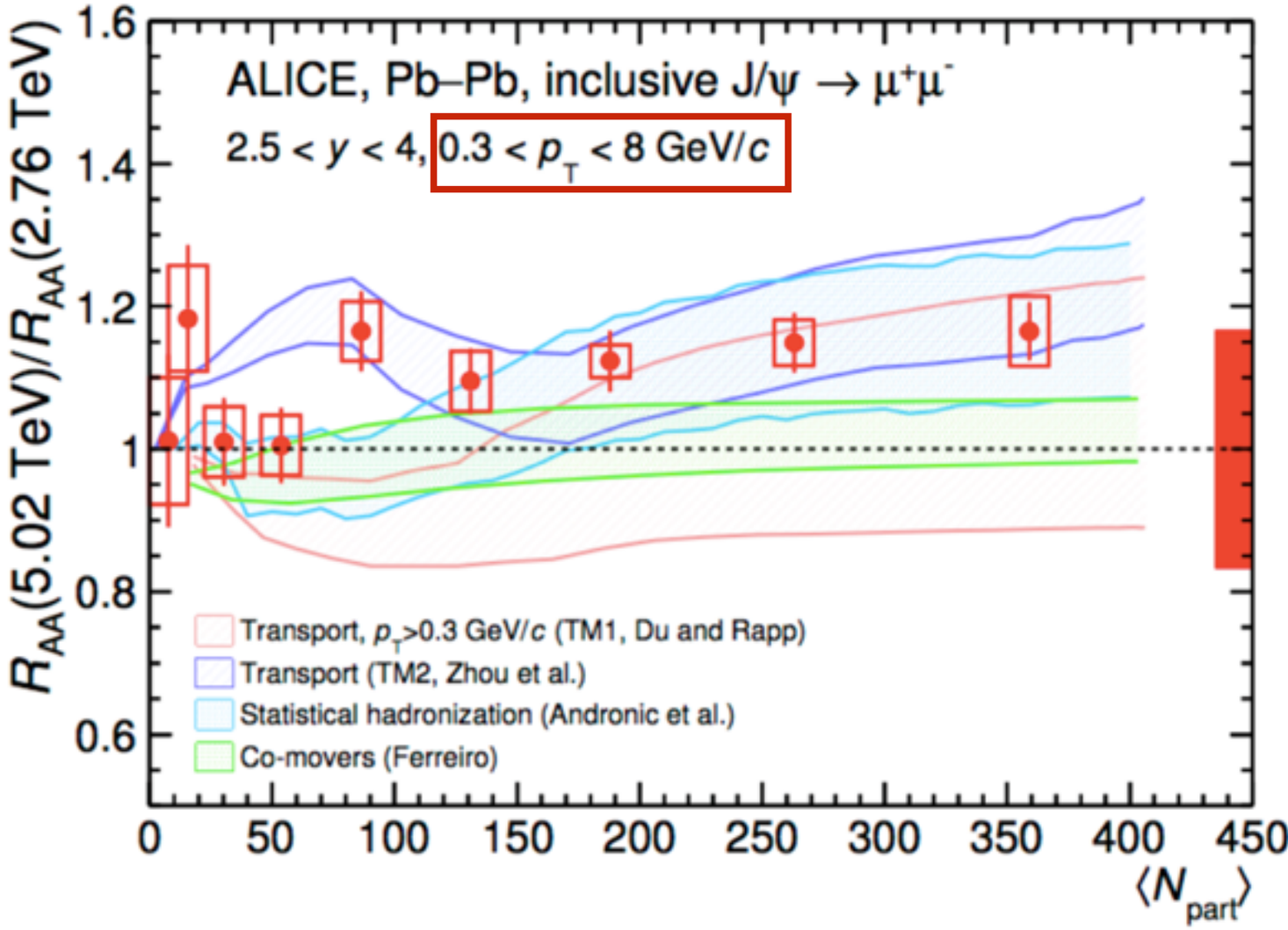




ALICE

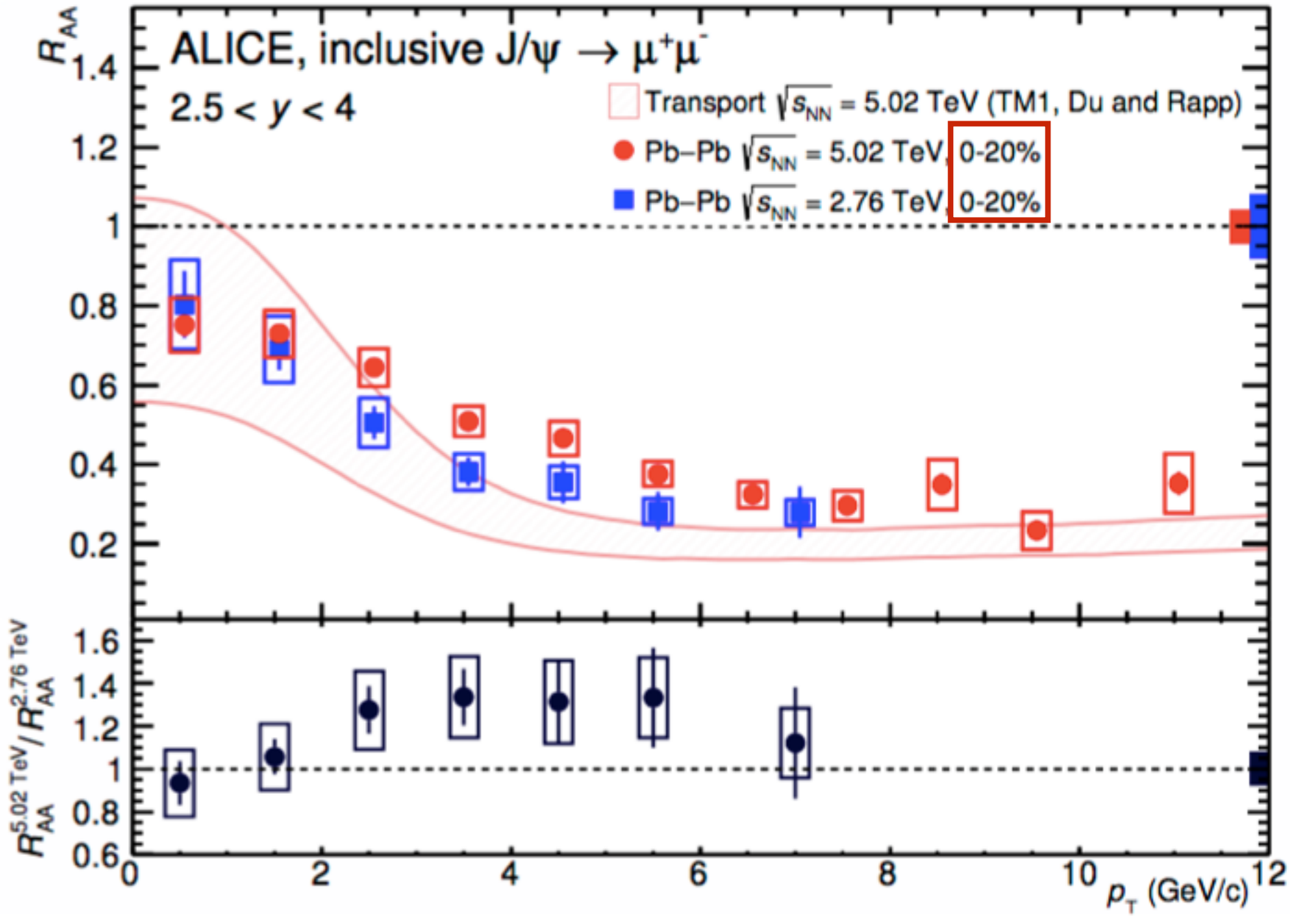
- 5.02 TeV / 2.76 TeV
- Competition between suppression vs regeneration
- Regeneration more dominant?

$$r^{0-10\%} = 1.17 \pm 0.04(\text{stat}) \pm 0.20(\text{syst})$$



- Transport : rate equation of suppression and regeneration by/in the QGP
- Statistical hadronization : all J/ψ produced by statistical hadronization at the QGP phase boundary
- Co-movers : suppression by the co-moving partonic medium + regeneration

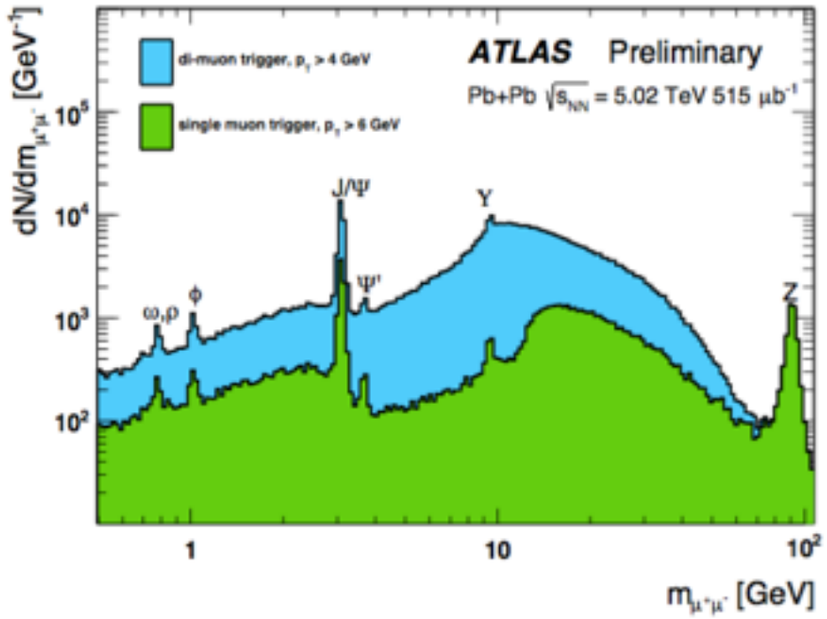
ALICE

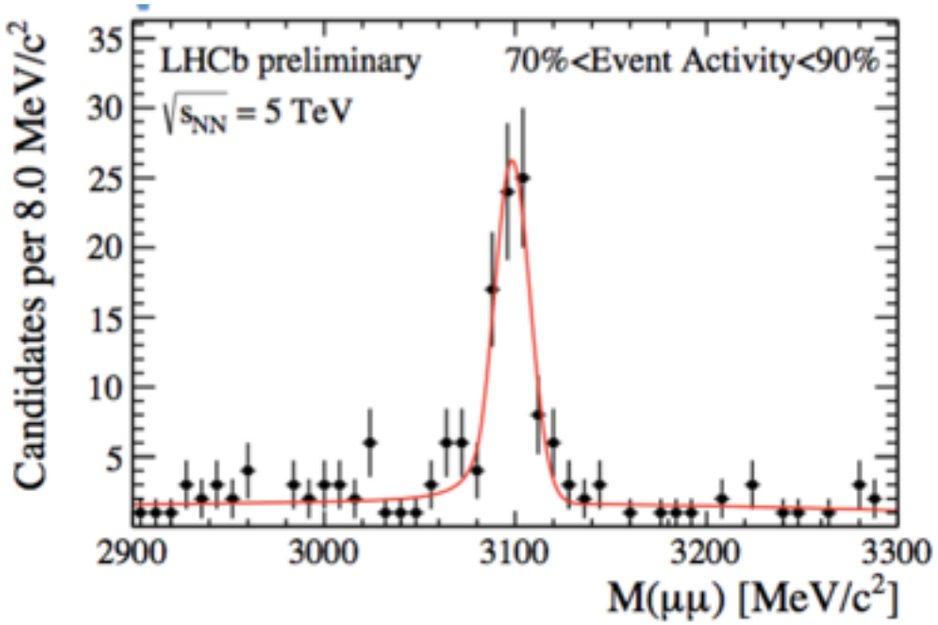


- Hint for an increase with $\sqrt{s_{NN}}$ at p_T = 2 - 6 GeV
- Regeneration & radial flow effects?

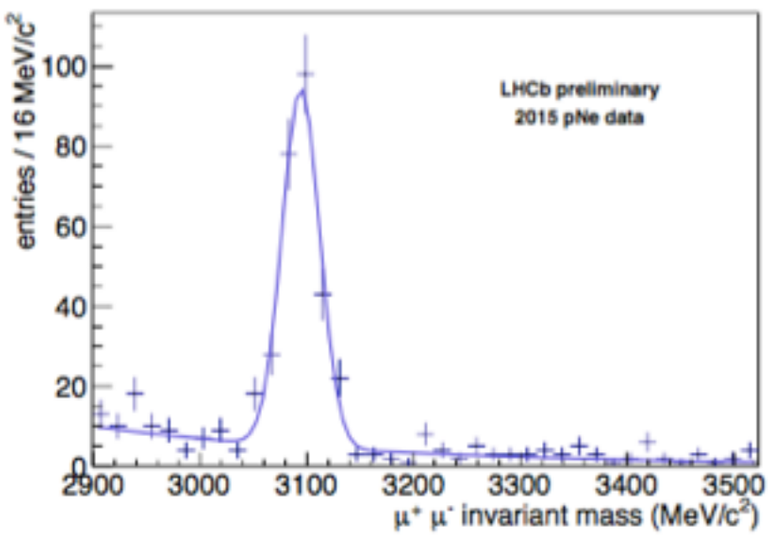
Other LHC experiments

- No new results from ATLAS and LHCb yet





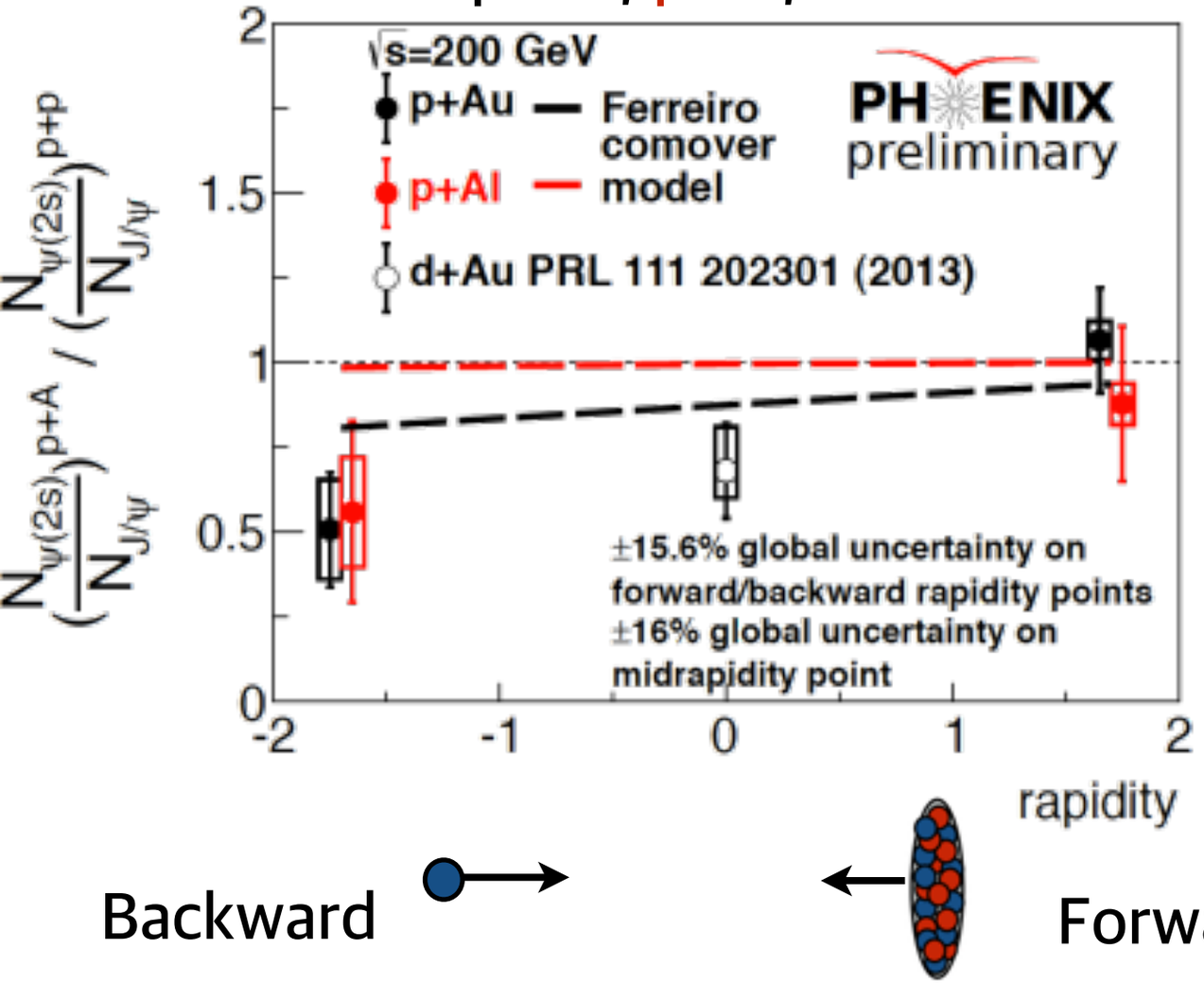
- LHCb also working on..
  - photo-production
  - fixed target p-[He,Ne,Ar] e.g. @ 110 GeV



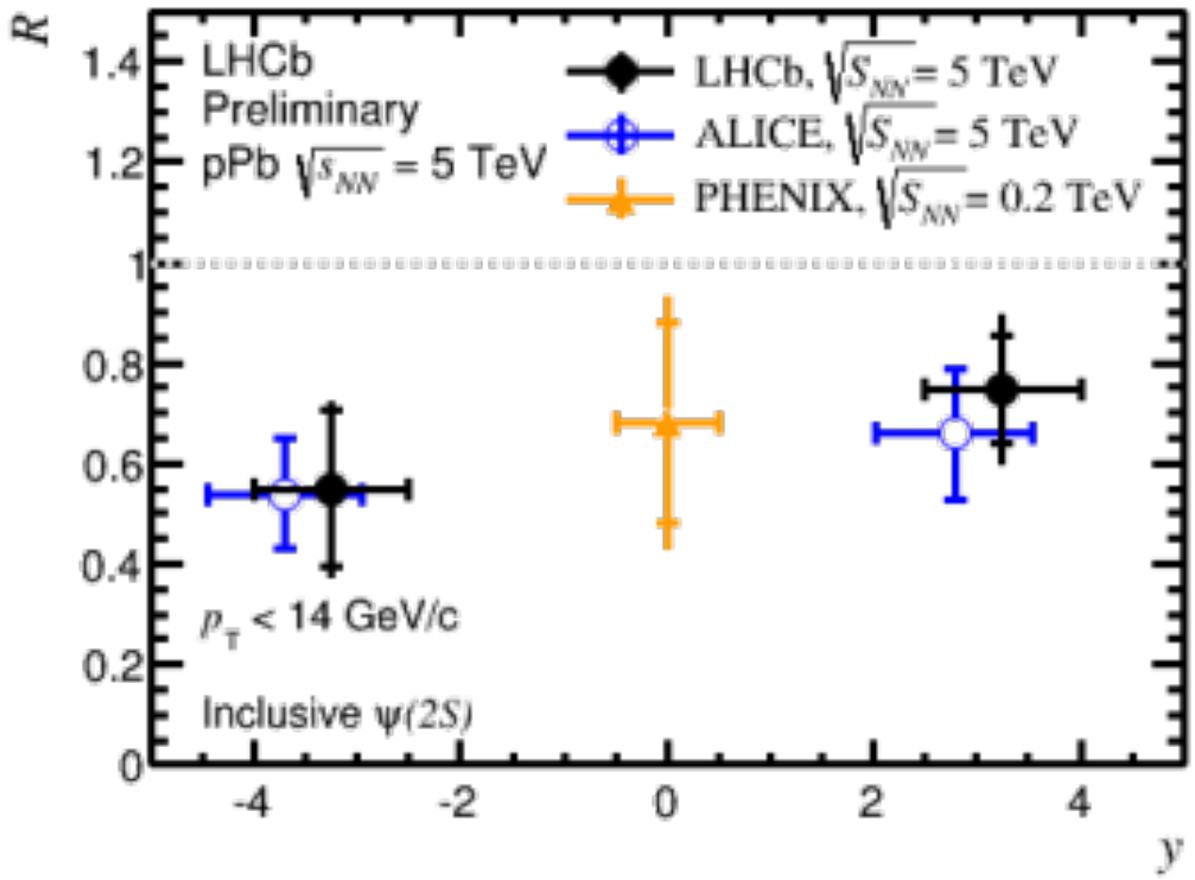
PHENIX

- Double ratio [ψ(2S) / J/ψ] in p-Al @ 200 GeV

RHIC : p+Au, p+Al, d+Au

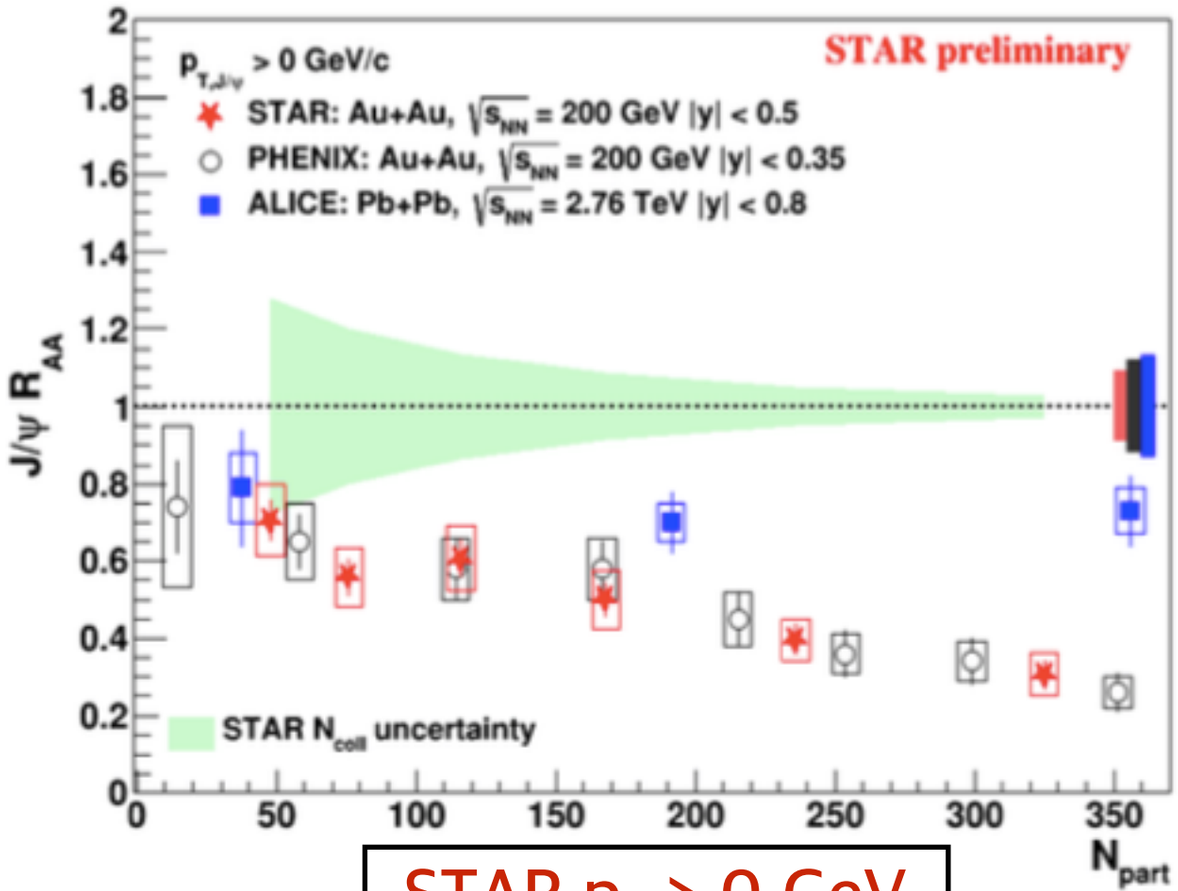


RHIC : d+Au, LHC : p+Pb

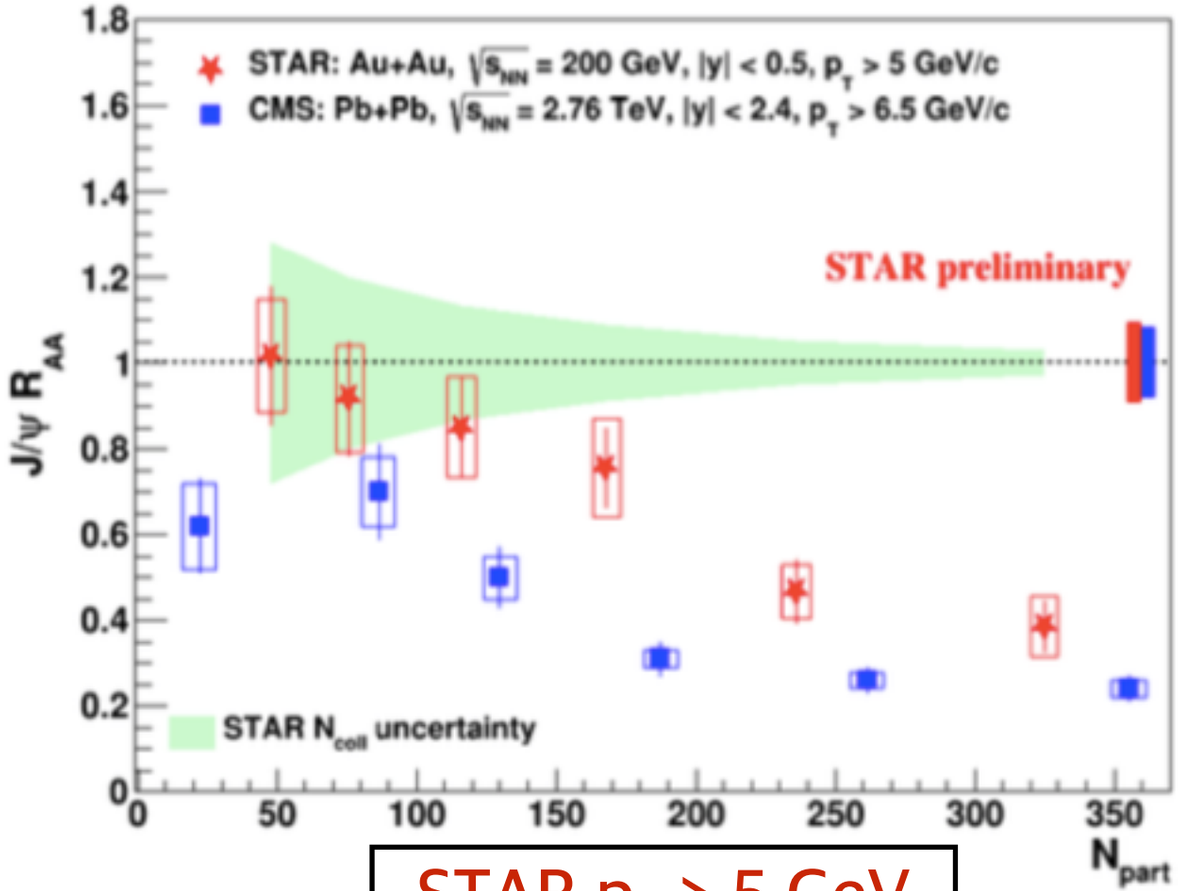


- Hint for stronger suppression at backward
- Co-mover model qualitatively agrees with data

STAR



STAR p_T > 0 GeV



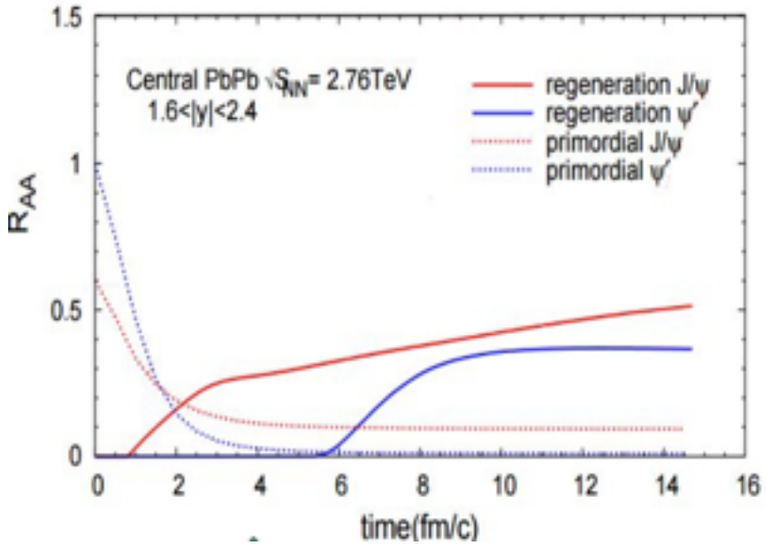
STAR p_T > 5 GeV

- STAR: new, independent measurement at |y|<0.5 via muon channel
- Confirms existing picture:
  - Low-p_T J/ψ at the LHC are less suppressed than at RHIC, extra source
  - High-p_T J/ψ at the LHC are more suppressed than at RHIC, more dissociation

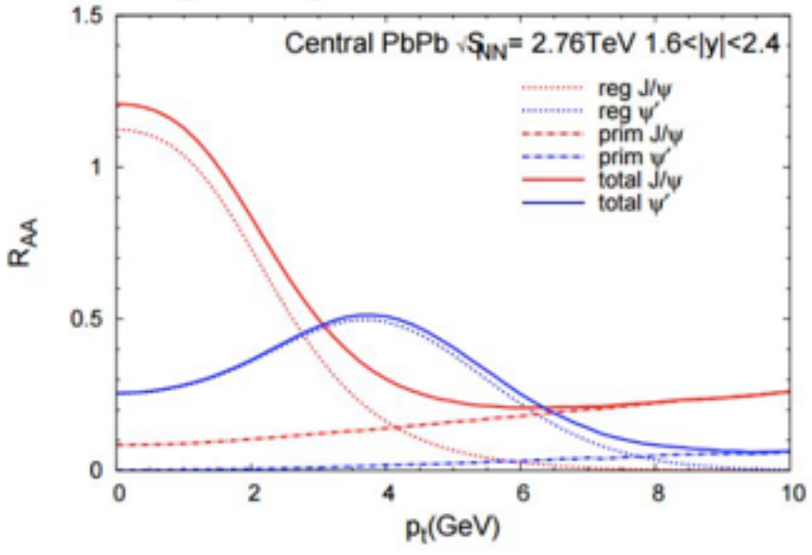
Transport approch

- Xiaojian Due, Tuesday

RAA time evolution

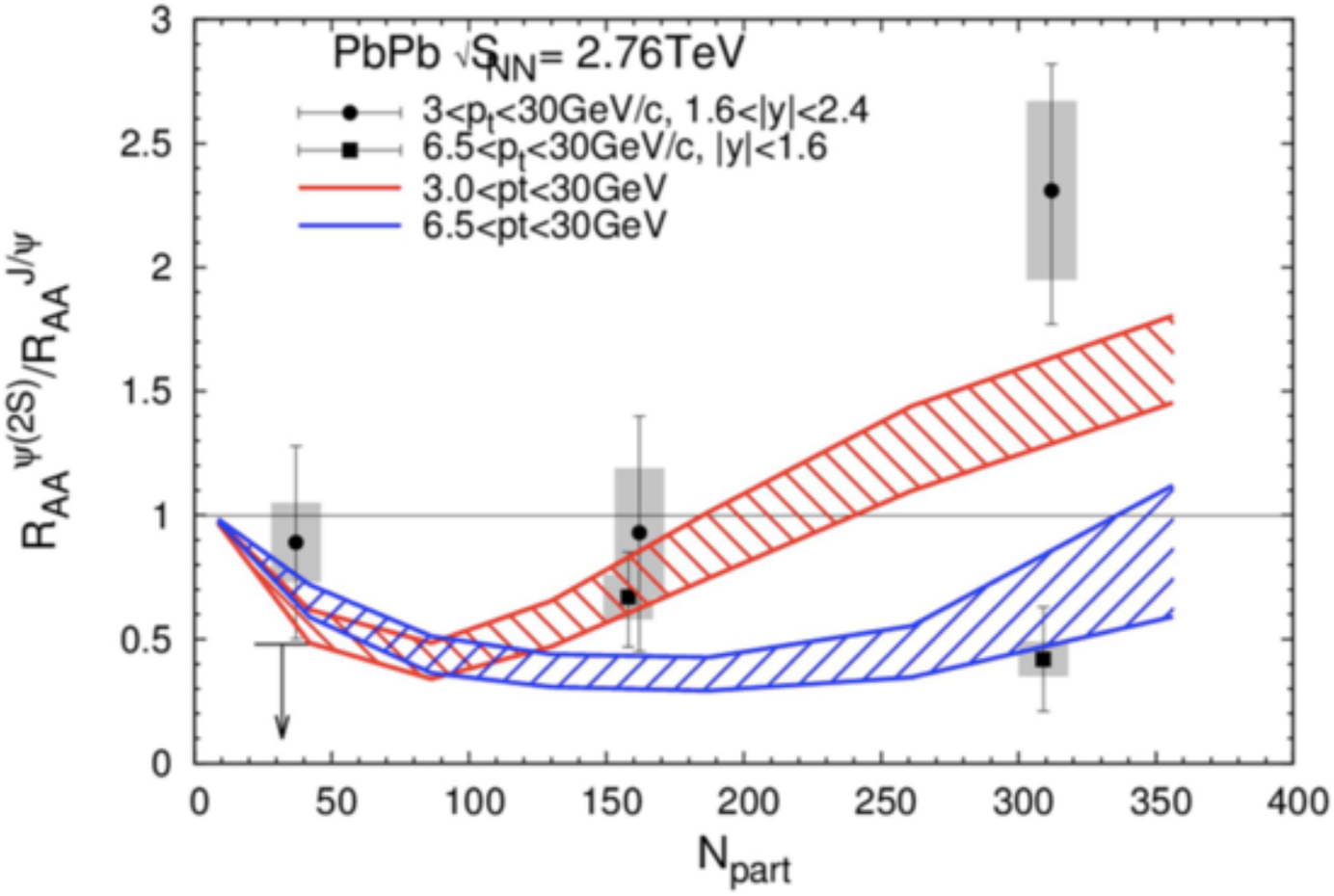


p_T dependent RAA



- ψ(2S) regenerated later than J/ψ
- flow pushes ψ(2S) to higher p_T

Rate Equation+Fireball Approach



- plan to provide prediction for our 5.02 TeV results (~ before the end of summer)

Upsilon SQM

Chad Flores

July 6 , 2016

Interesting Talks

Experiment

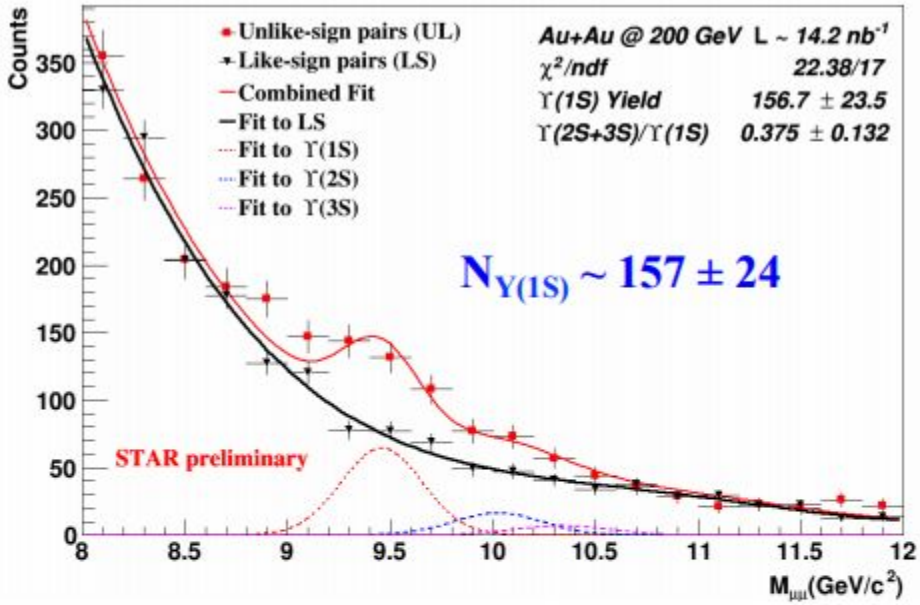
- ALICE Heavy Flavor Overview - Javier Castillo LINK
- STAR Quarkonia Measurements - Takahito Todoroki LINK
- Quarkonia Experimental Overview - Torsten Dahms LINK
- ATLAS Vector Boson and Charmonium - Will Brooks LINK

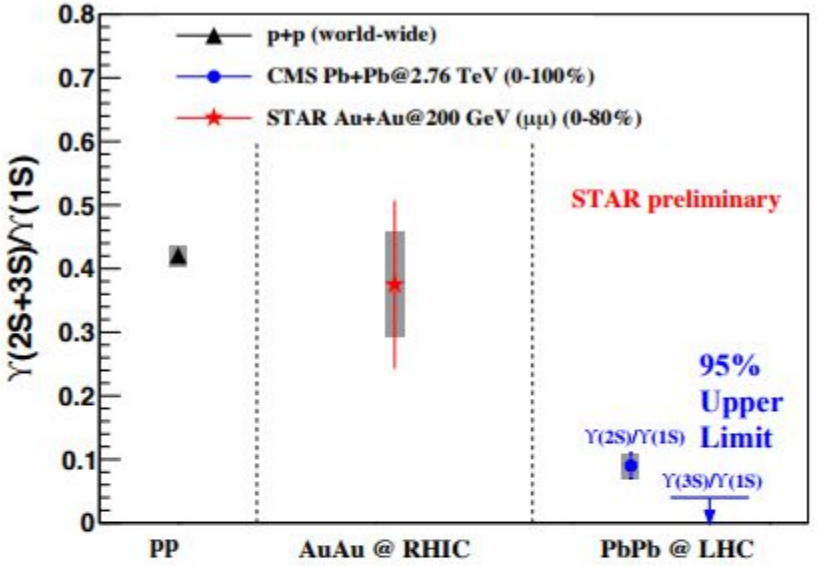
Interesting Theory

- Heavy Quarkonium Transport - Kai Zhou LINK
- Semi-Realistic Dynamical Bottomonium Suppression - Gossiaux et al. LINK

STAR - Upsilons via dimuons!

- STAR Quarkonia Measurements - Takahito Todoroki LINK





World-wide PRC 88(2013) 067901
CMS : PRL 109(2012) 222301
CMS : JHEP 04 (2014) 103

- **Signs of Υ(2S+3S) from the di-muon channel**
  - Challenging for di-electron channel due to Bremsstrahlung
- Hint of less melting of Υ(2S+3S) at RHIC than at LHC

pp reference at 5.02 TeV

- pPb and NEW PbPb results use extrapolated pp data!!

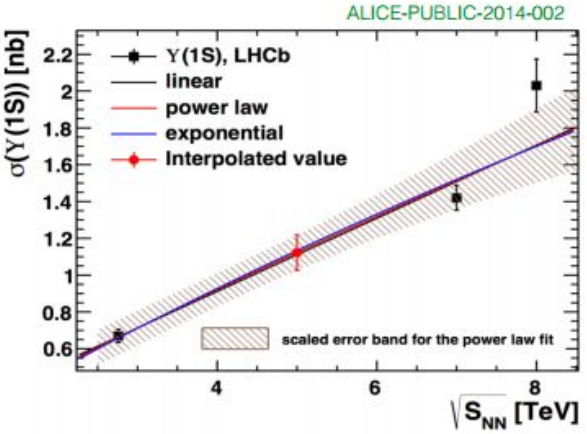
Extrapolation method (not enough statistics in pp data at 5.02 TeV)

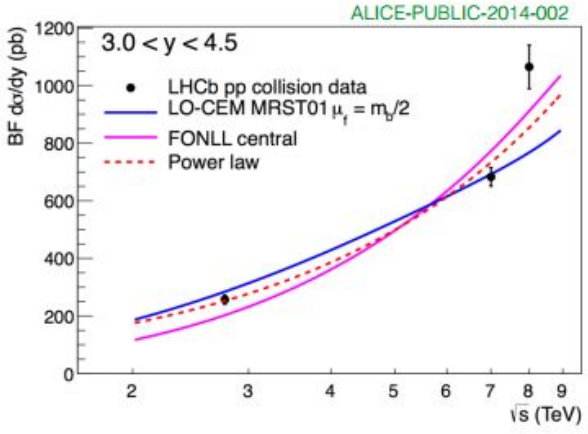
Based on fits to LHCb data with different shapes:

- two-parameter functions: linear, power law and exponential,
- a Leading Order Color Evaporation Model (LO-CEM) calculation,
- the energy and rapidity dependence of the total $\sigma_{b\bar{b}}$ cross section, computed in the FONLL approach with the CTEQ6.6 set of parton distribution functions.

Both R_{pPb} and R_{AA} computations reported in this talk are based on this σ_{pp} interpolation

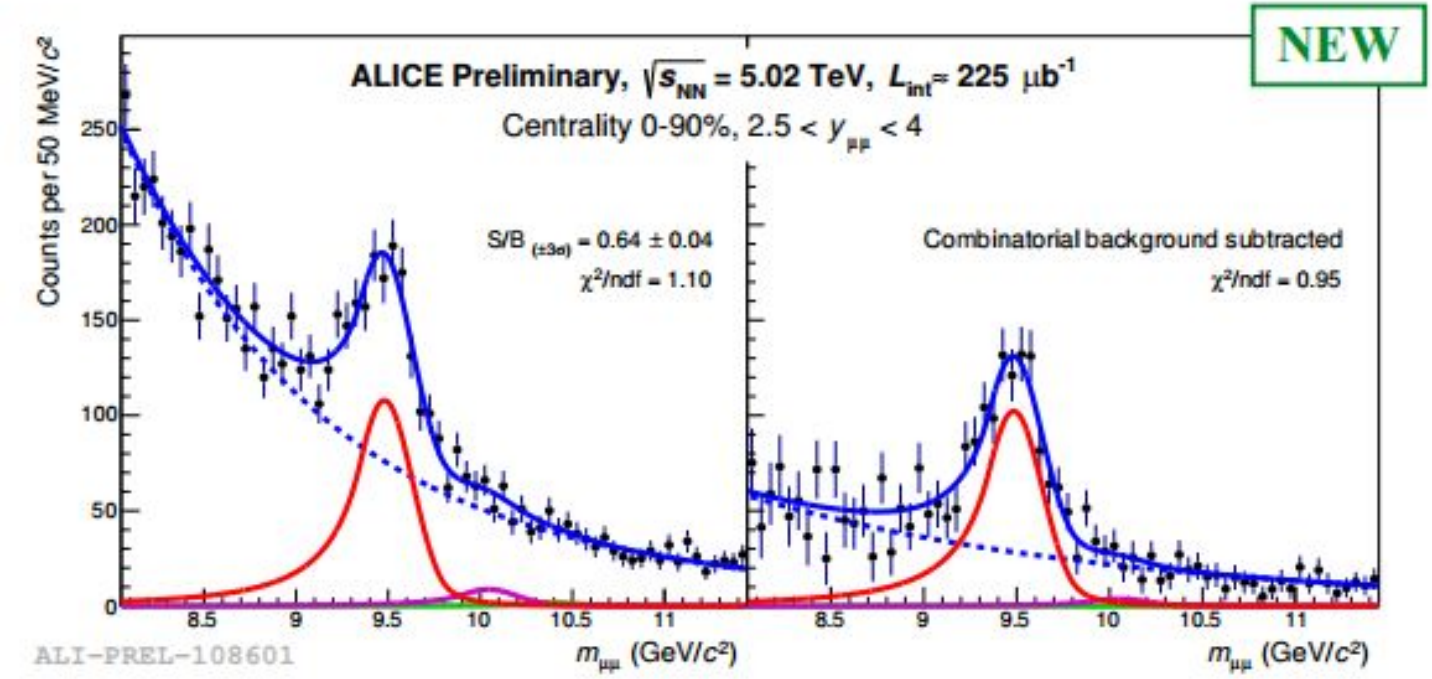
→ $\sigma_{\Upsilon(1S)}$ **(pp@5.02 TeV, 2.5 < *y* <4) = 1.14 ± 0.10 (syst) nb**





ALICE

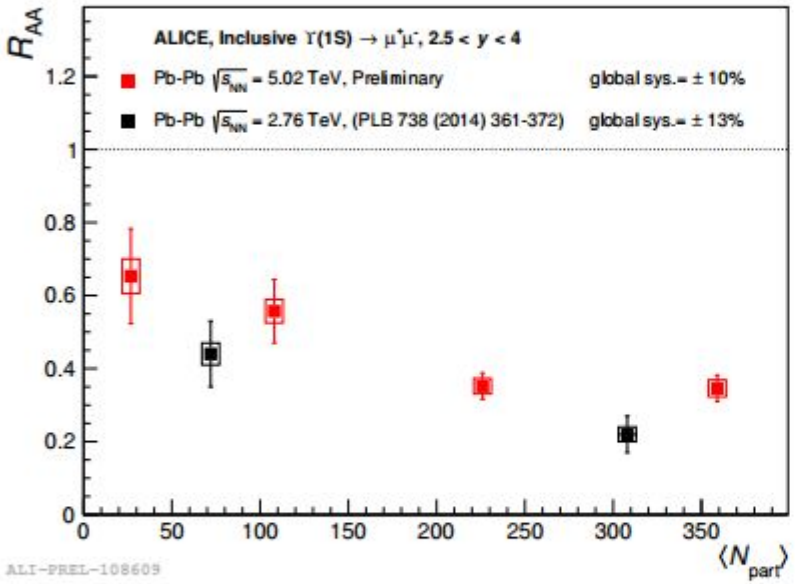
- Upsilon production
  - Talk by Antoine Lardeux - [LinkTalk]

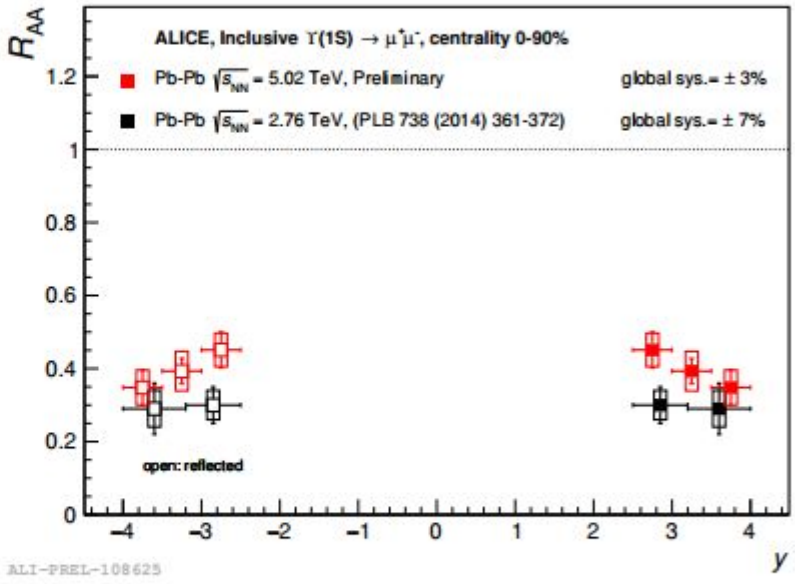


ALICE

Collision energy comparison:

NEW

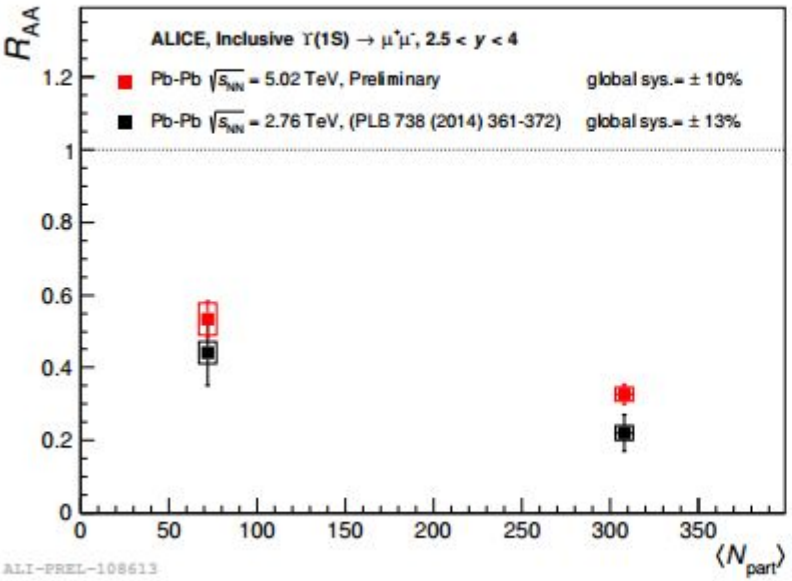


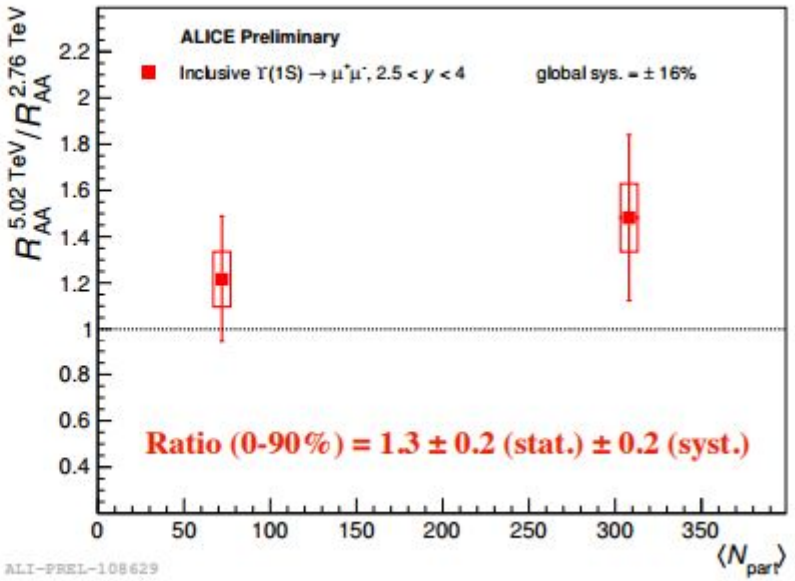


R_{AA} (5.02 TeV, 0-90%) = 0.40 ± 0.03 (stat.) ± 0.04 (syst.)

R_{AA} (2.76 TeV, 0-90%) = 0.30 ± 0.05 (stat.) ± 0.04 (syst.)

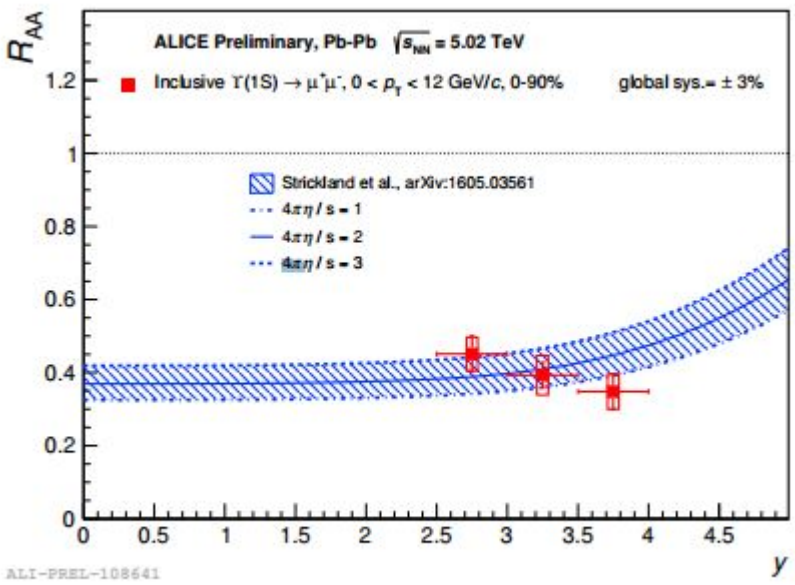
ALICE

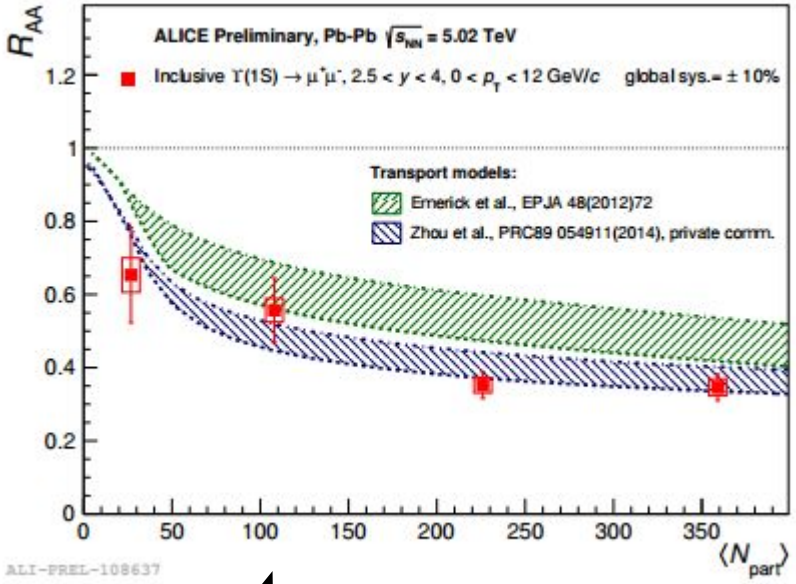




Results are compatible within uncertainties

ALICE - Comparison with models



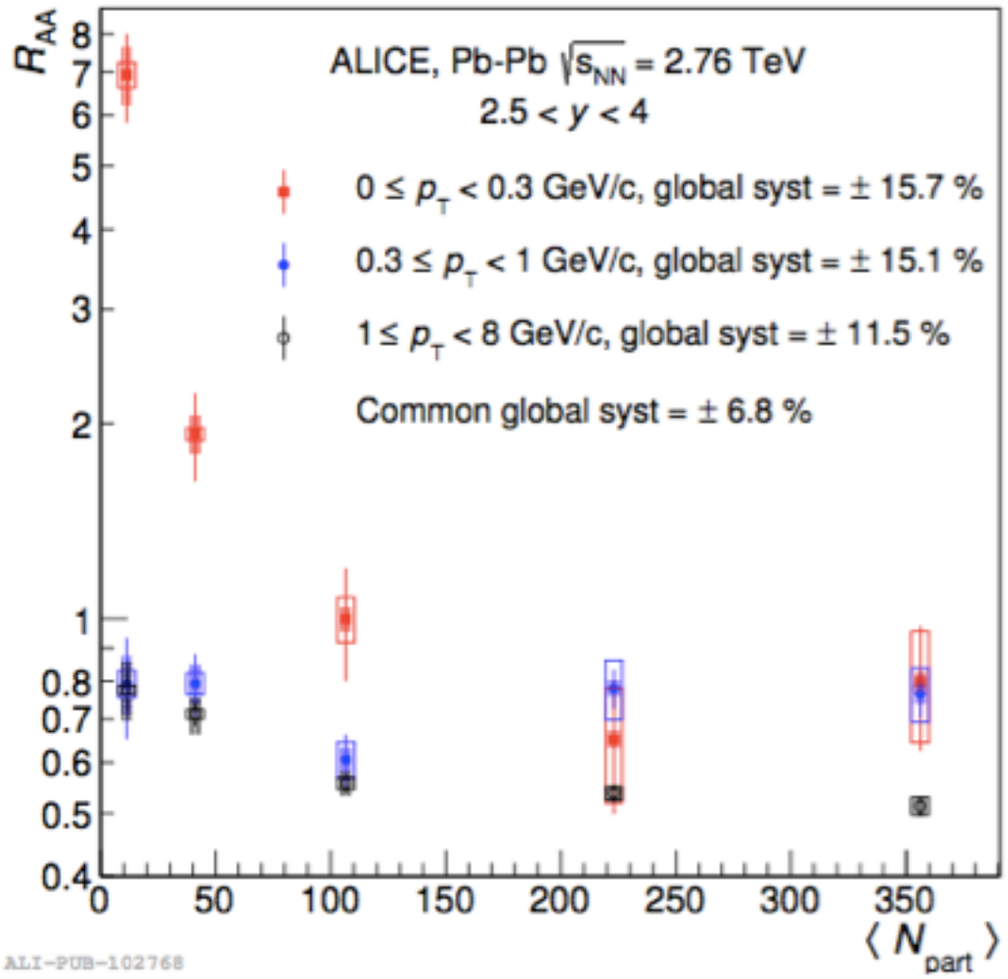


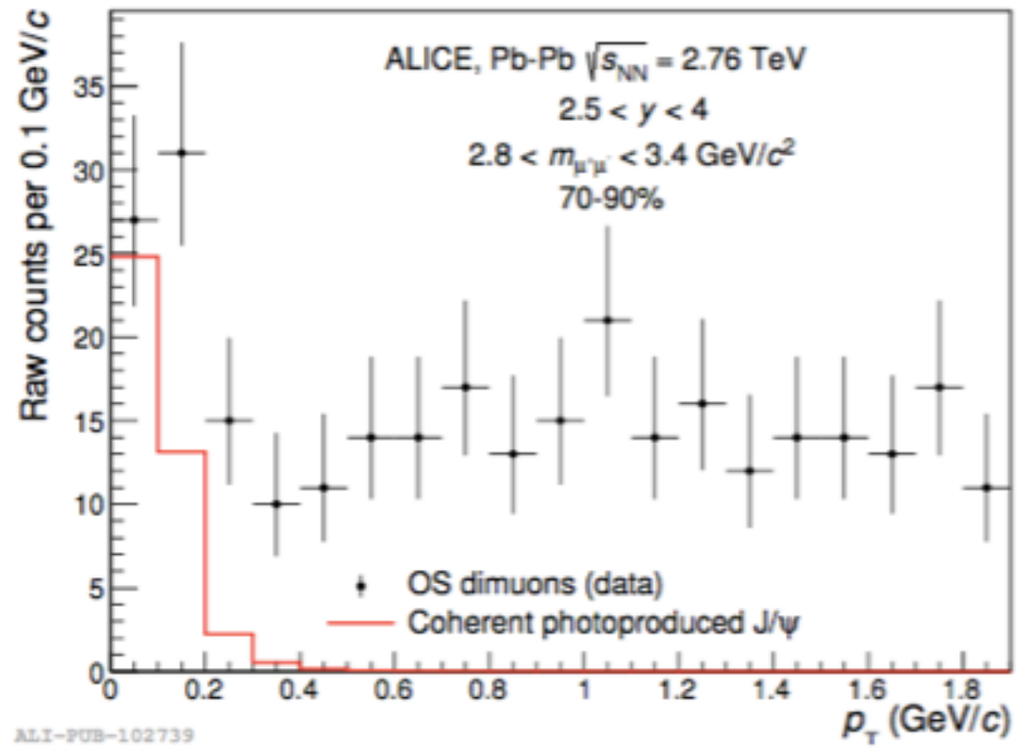
No strong indication of direct Υ(1S) suppression in most central collisions (considering a suppression of ~30% from feed-down and ~30% from CNM effects)

back up

ALICE

- Very-low-p_T J/ψ excess
  - Seen in peripheral Pb-Pb collisions at 2.76 TeV
  - Presumably of EM origin

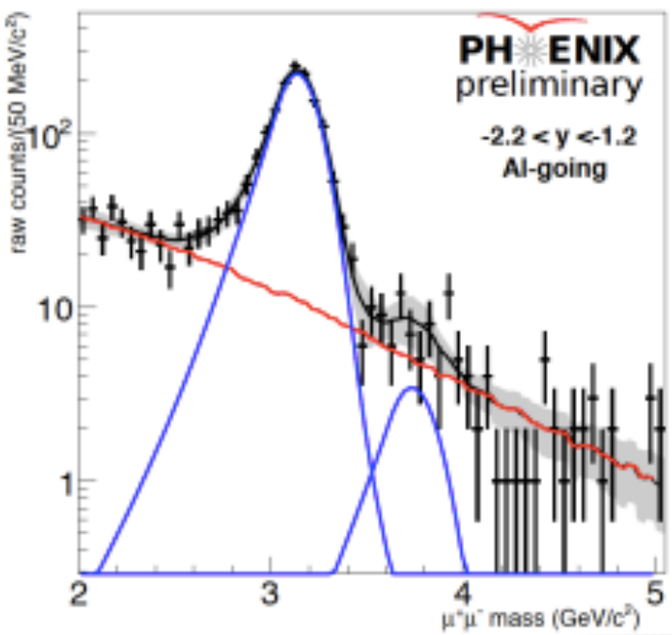




  - Due to the very specific origin and kinematics, photo-produced J/ψ could become an useful probe of the QGP
  - In the mean time, it constitutes a "contamination" to the hadronic R_{AA}
    - Apply a cut p_T > 0.3 GeV to reduce photo-production contribution

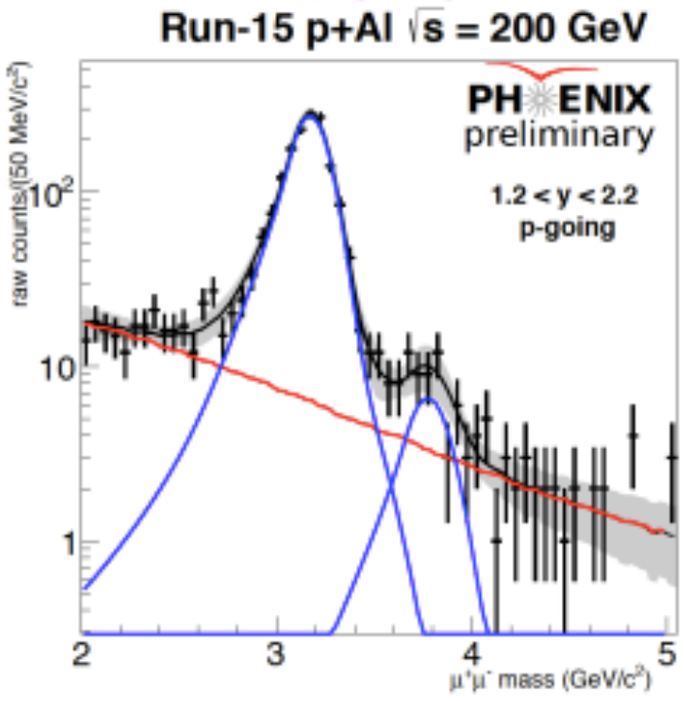
PHENIX

Backward: Al-going direction

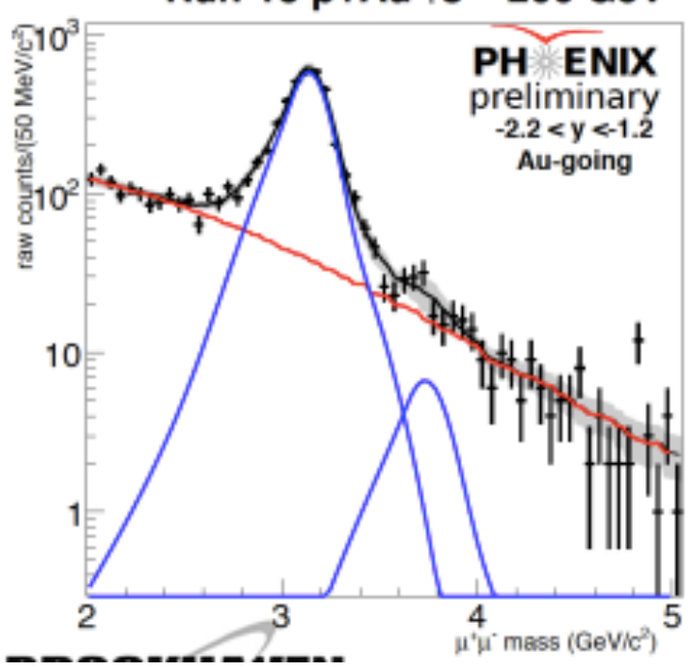


central collision

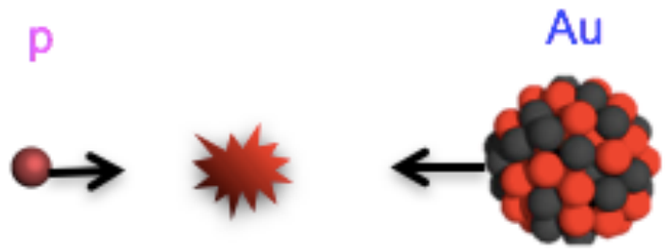
Forward: p-going direction



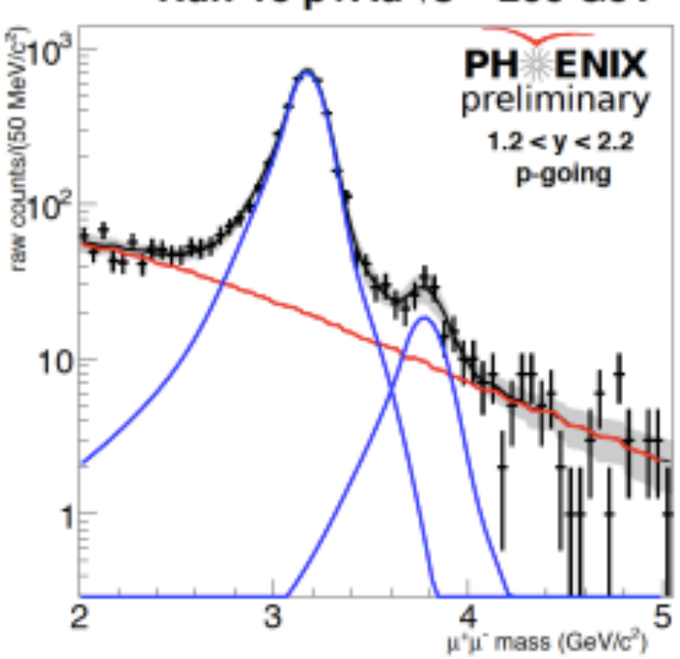
Backward: Au-going direction



central collision

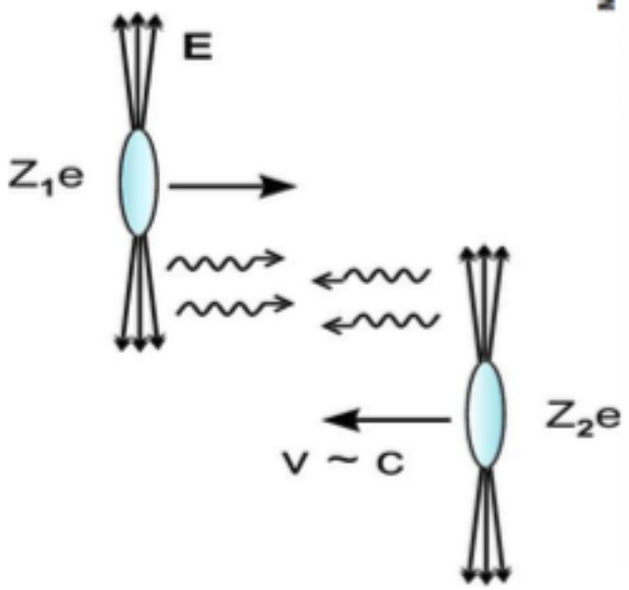


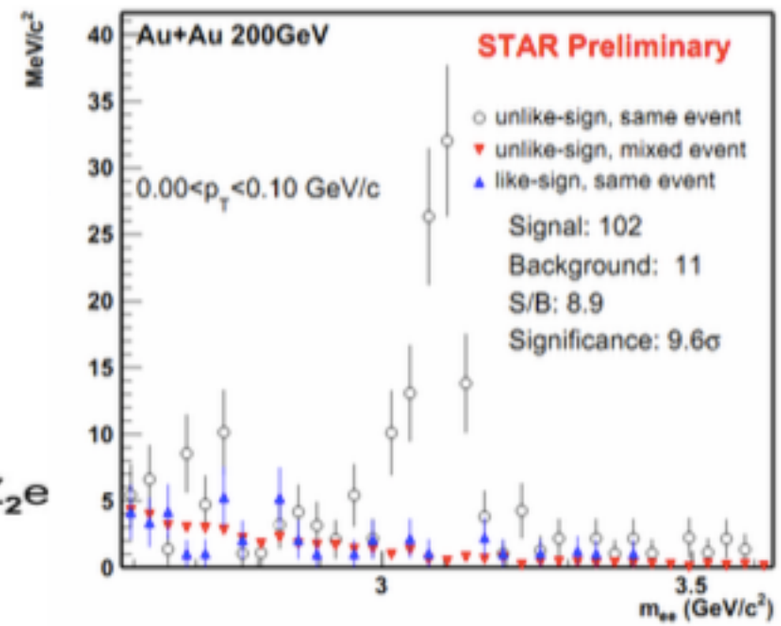
Forward: p-going direction

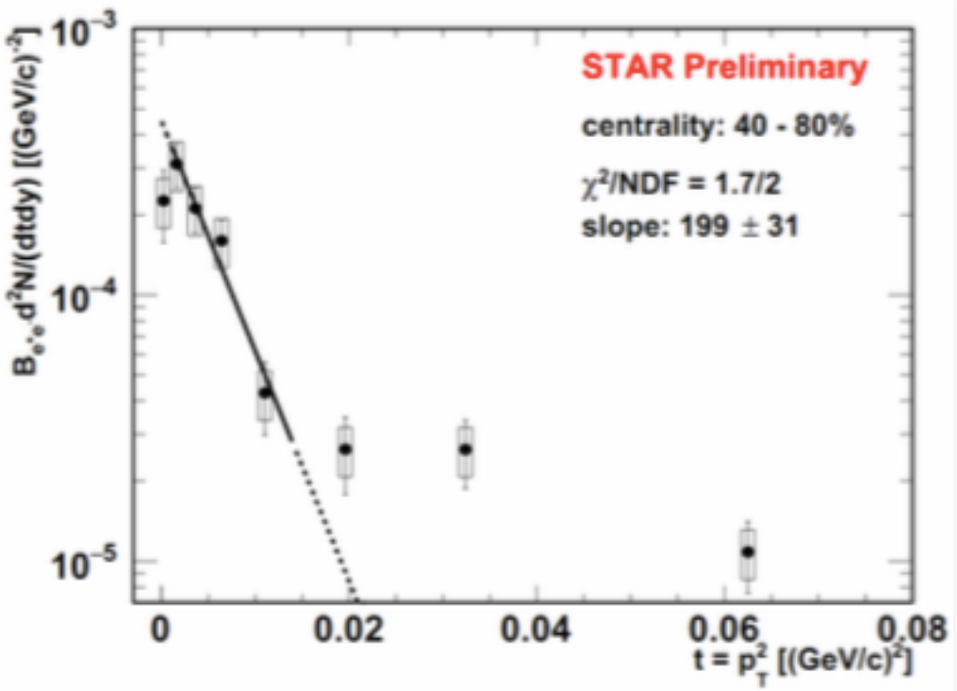


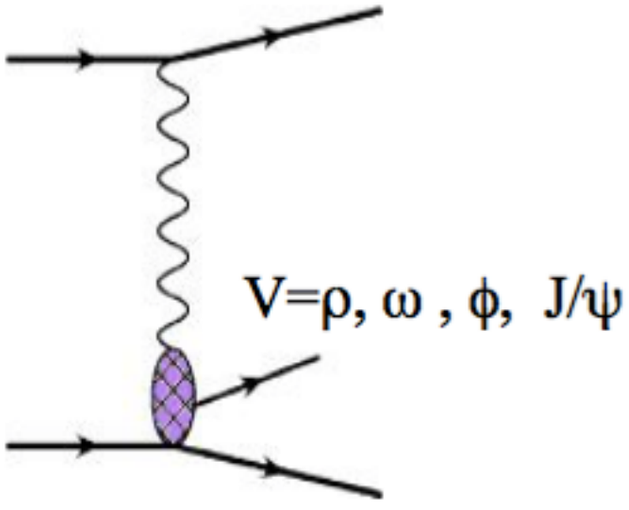
STAR

W. Zha June 28







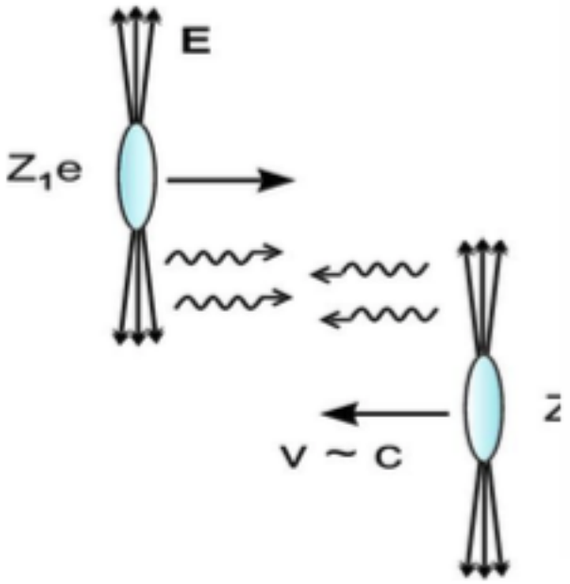


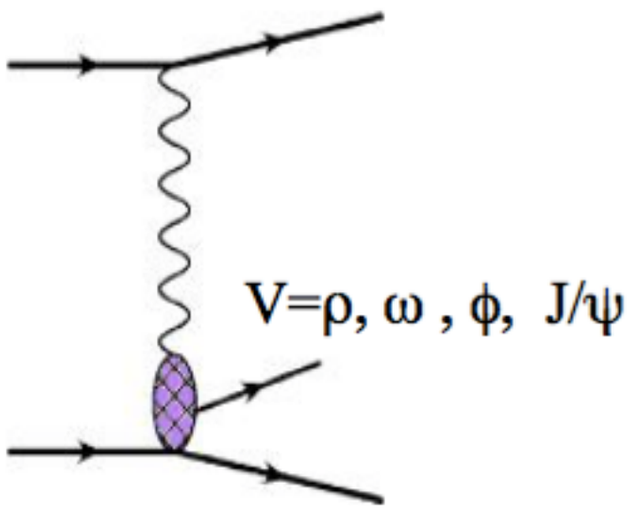
Photon-nucleus interactions

- Coherent and incoherent photoproduction of ρ mesons observed in Ultra-Peripheral Collisions (UPC)
- Observe excess of very low p_T J/ψ in peripheral collisions with features consistent with coherent photoproduction
  - Similar slope as UPC: 199 ±31(GeV/c)$^{-2}$
    UPC in STARLIGHT: 196 (GeV/c)$^{-2}$

STAR

W. Zha June 28





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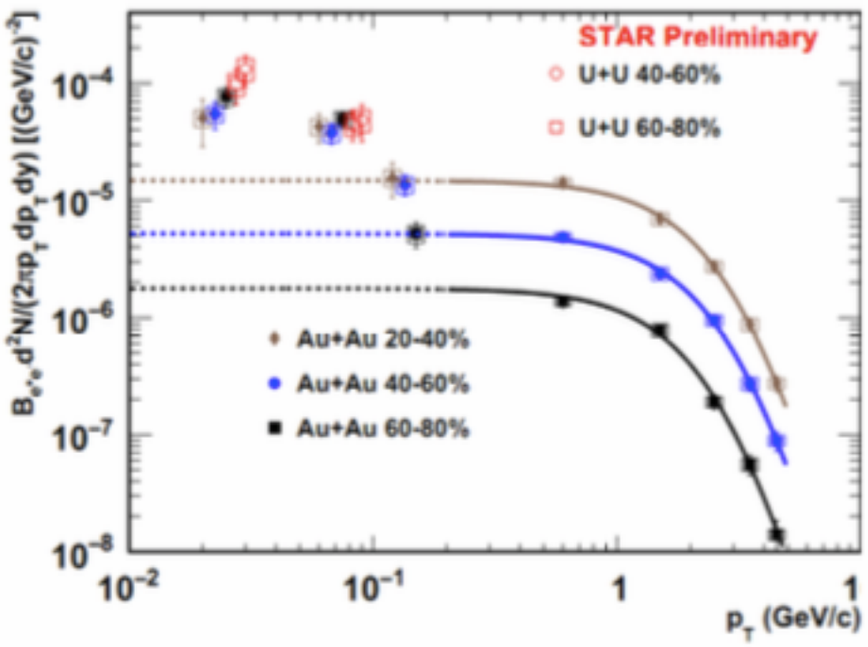

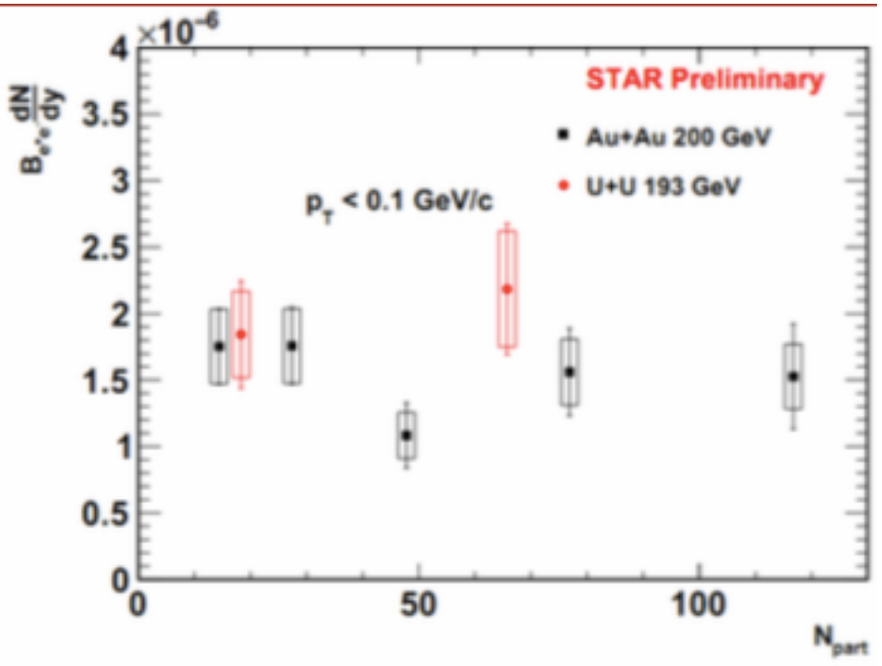

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- Observe excess of very low p_T J/ψ in peripheral collisions with features consistent with coherent photoproduction
  - Similar slope as UPC: 199 ±31(GeV/c)$^{-2}$
    UPC in STARLIGHT: 196 (GeV/c)$^{-2}$
  - Production cross-section independent of centrality

A challenge for theory but a new opportunity for QGP studies?