Hard Probes Highlight

A. Baldisseri
Irfu/SPhN, CEA Saclay

Disclaimer

- «Only exceptionally good results» => Highly biased
- More experimental than theoretical (LHC startup)
- More LHC than RHIC
- More Pb-Pb than p-p
- Topics covered
  - Jets, Photons, High p_T Hadrons
  - Heavy Flavors & Quarkonia

Goal: Trigger your interest

(more details at http://qm2011.in2p3.fr)

Heavy Flavors Highlights

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Open Heavy Flavors

Dainese (ALICE)

Heavy quarks as medium probes: Energy Loss

A puzzle at RHIC

q: colour triplet

u,d,s: m~0, C_R=4/3
(difficult to tag at LHC)

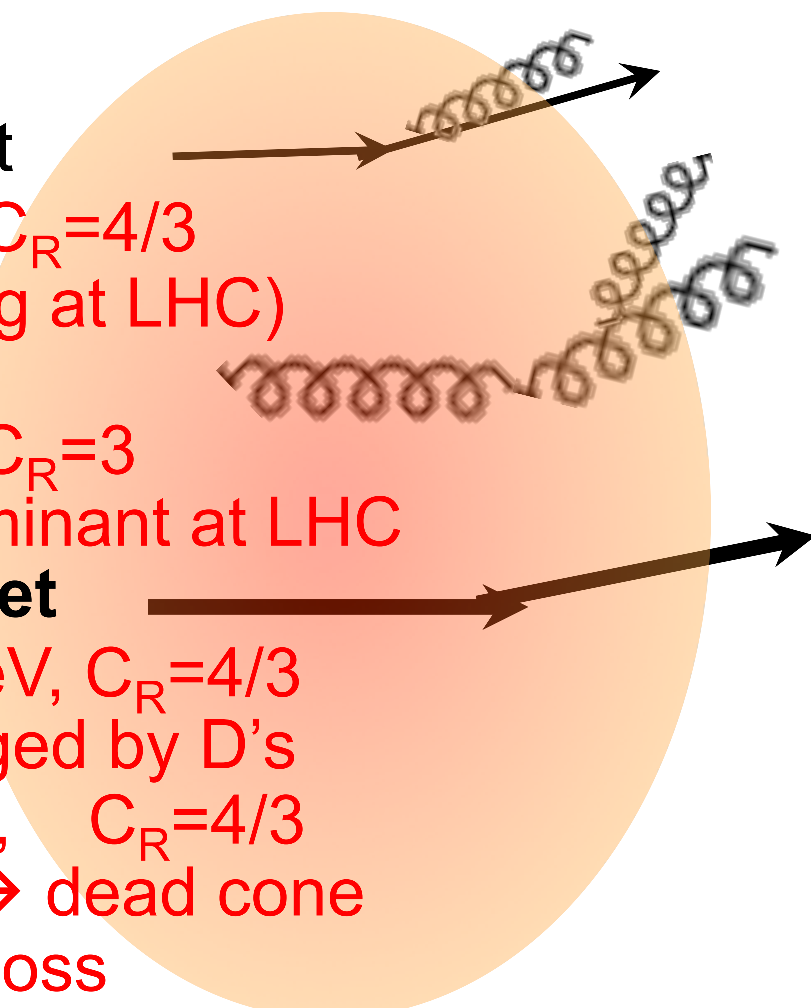
g: colour octet

g: m=0, C_R=3
> E loss, dominant at LHC

Q: colour triplet

c: m~1.5 GeV, C_R=4/3
small m, tagged by D's

b: m~5 GeV, C_R=4/3
large mass → dead cone
→ < E loss



'Quark Matter'

courtesy D.d'Enterria

Parton Energy Loss by

- medium-induced gluon radiation
- collisions with medium gluons

$$\Delta E(\varepsilon_{medium}; C_R, m, L)$$

pred: $\Delta E_g > \Delta E_{c \approx q} > \Delta E_b$

→ $R_{AA}^{\pi} < R_{AA}^{D} < R_{AA}^{B}$

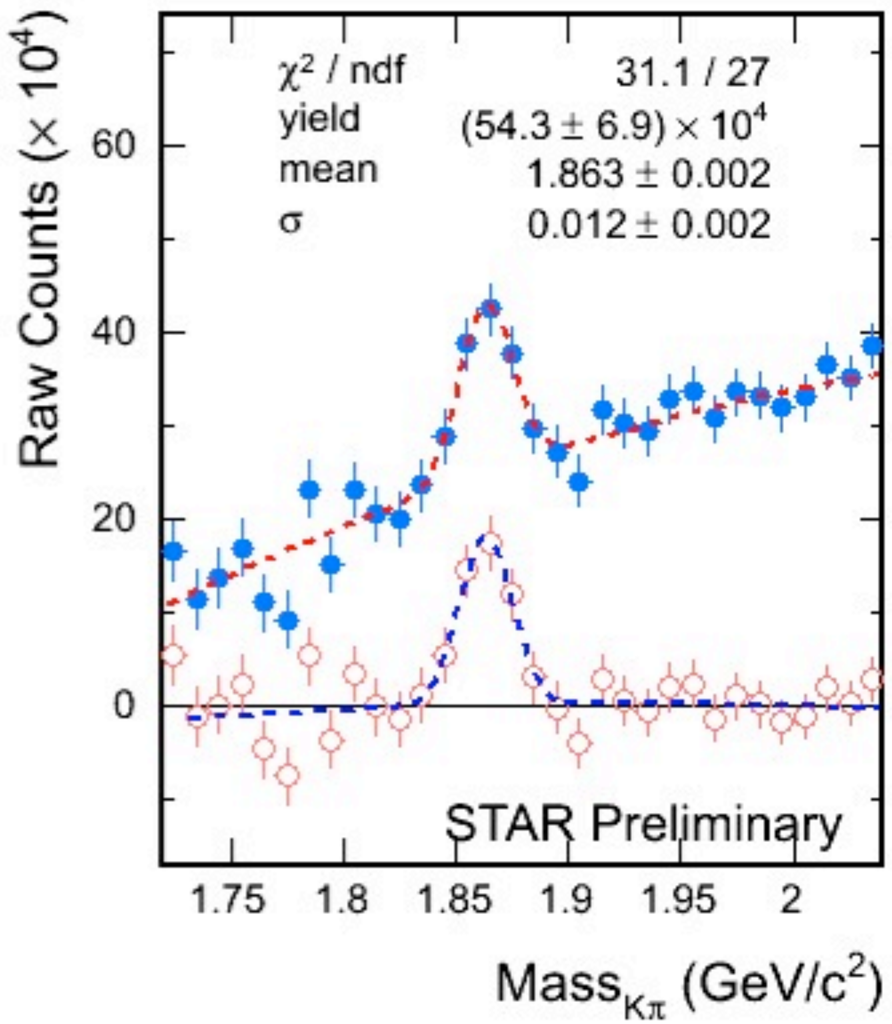
$$R_{AA}(p_t) = \frac{1}{\langle T_{AA} \rangle} \frac{dN_{AA}/dp_t}{d\sigma_{pp}/dp_t}$$

See e.g.:
Dokshitzer and Kharzeev, PLB 519 (2001) 199. Armesto, Salgado, Wiedemann, PRD 69 (2004) 114003.
Djordjevic, Gyulassy, Horowitz, Wicks, NPA 783 (2007) 493.

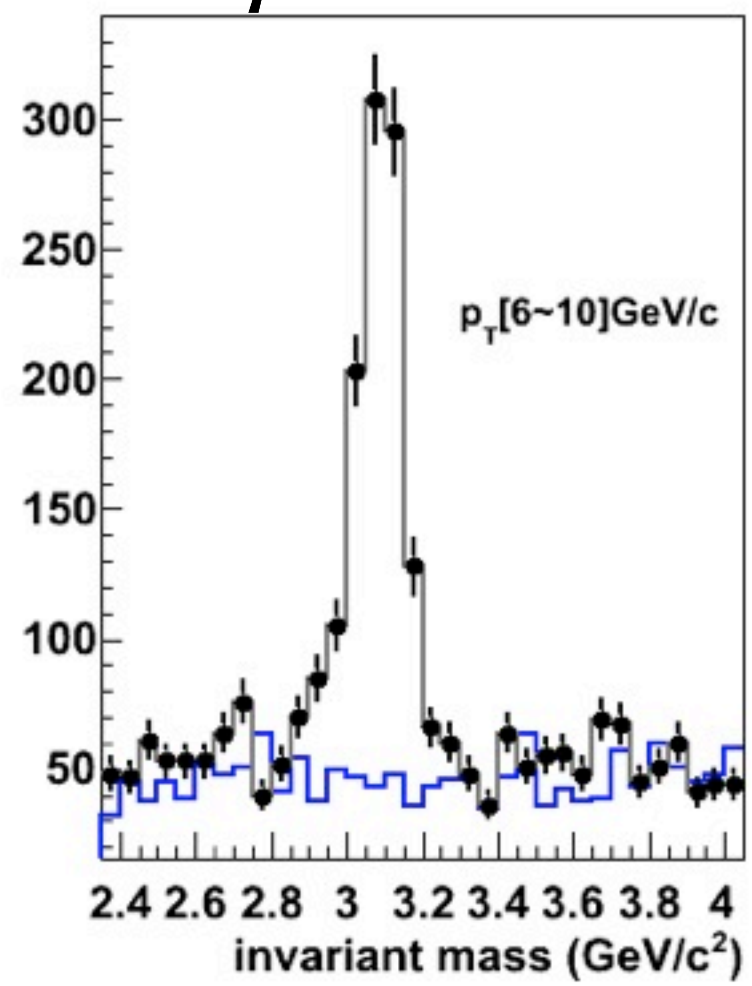
STAR capability for heavy flavors

Masui (STAR)

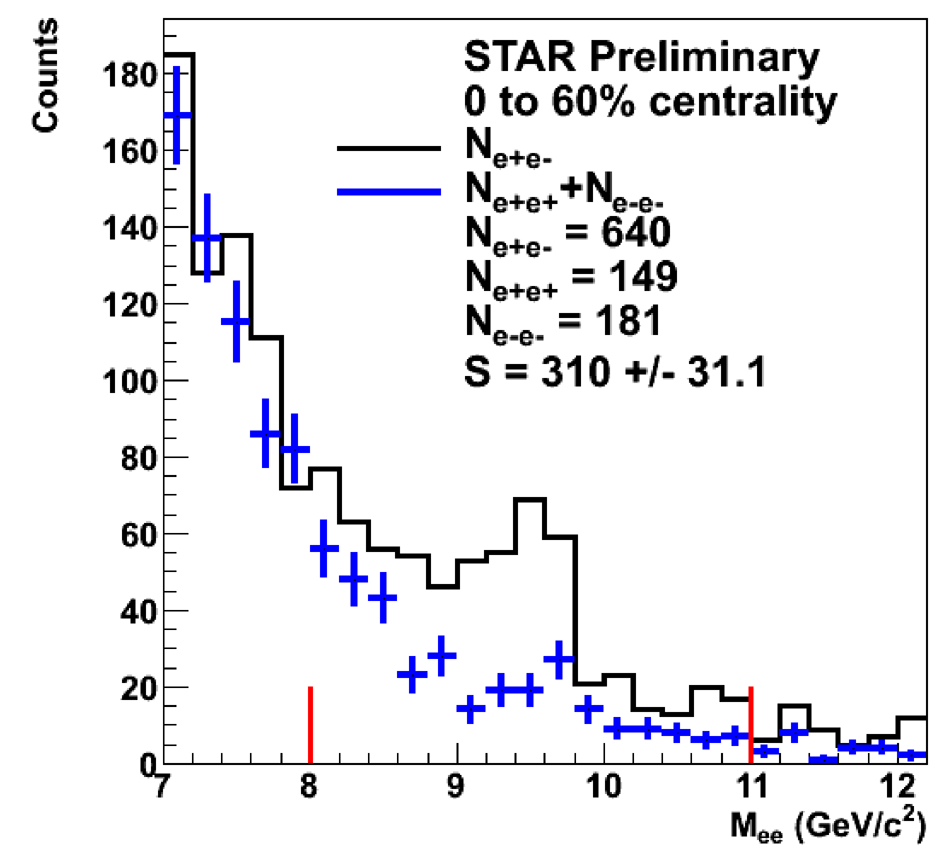
$D^0 \rightarrow K^- \pi^+$



$J/\psi \rightarrow e^+ e^-$



$\Upsilon \rightarrow e^+ e^-$



- Clear signal for D^0 mesons, J/ψ and Υ in Au + Au collisions

p+p -> HF + X at mid rapidity

Da Silva (STAR)

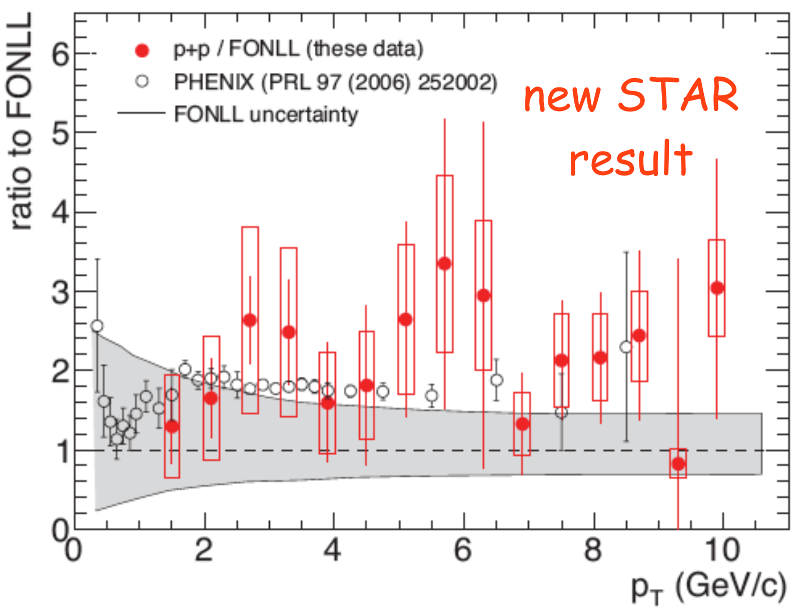
- long paper with analysis details of the p+p and Au+Au submitted

arXiv:1005.1627v2

Heavy Quark Production in $p+p$ and Energy Loss and Flow of Heavy Quarks in Au+Au Collisions at $\sqrt{s_{NN}} = 200$ GeV

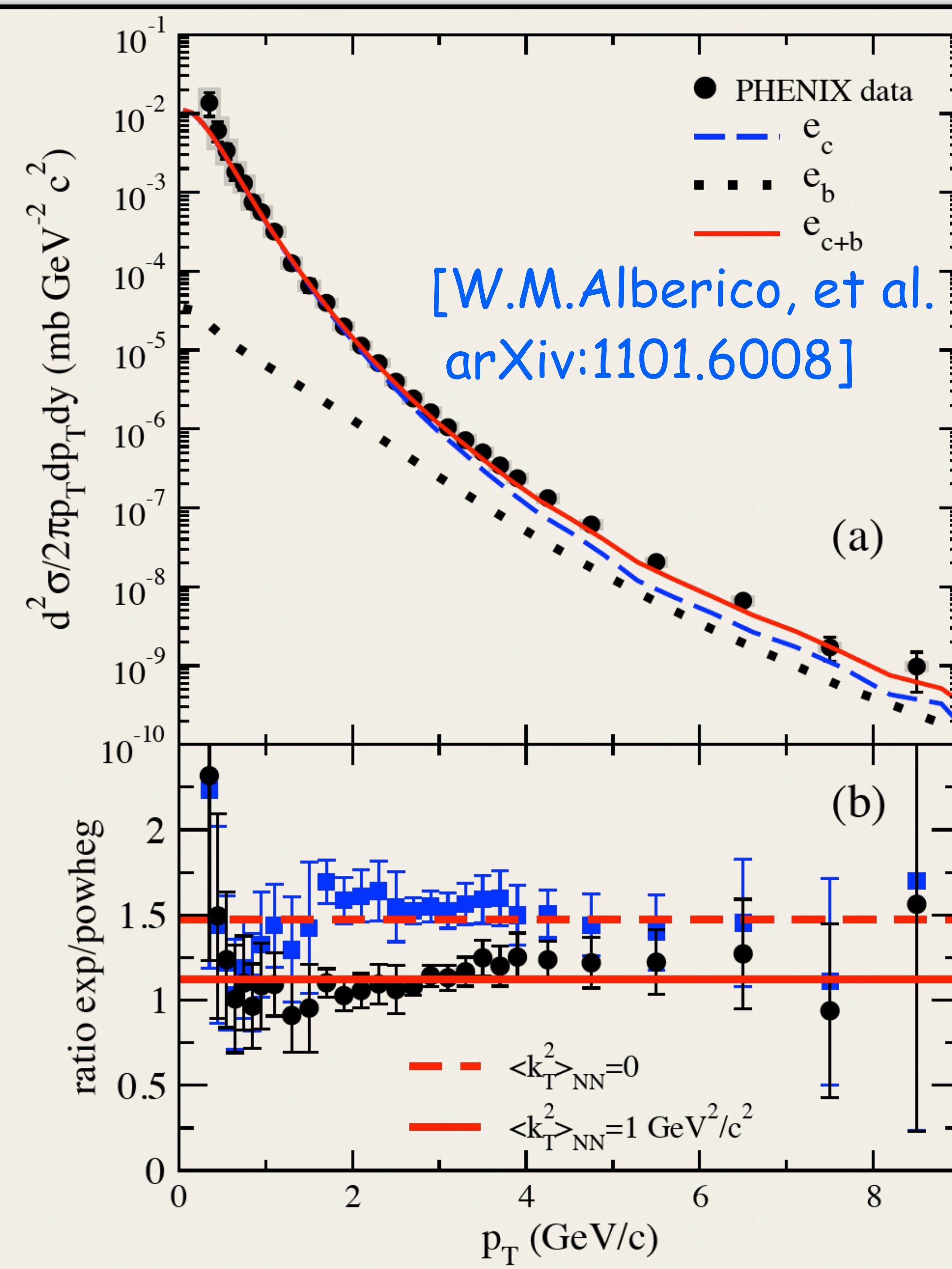
A. Adare,[9] S. Afanasiev,[23] C. Aidala,[10] N.N. Ajitanand,[50] Y. Akiba,[44,45] H. Al-Bataineh,[39] J. Alexander,[50] A. Al-Jamel,[39] K. Aoki,[29,44] L. Aphecetche,[52] R. Armendariz,[39] S.H. Aronson,[4] J. Asai,[45] E.T. Atomssa,[30] R. Averbeck,[51] T.C. Awes,[40] B. Azmoun,[4] V. Babintsev,[19] G. Baksay,[15] L. Baksay,[15] A. Baldisseri,[12] K.N. Barish,[5] P.D. Barnes,[32] B. Bassalleck,[38] S. Bathe,[5] S. Batsouli,[10,40] V. Baublis,[43] F. Bauer,[5] A. Bazilevsky,[4] S. Belikov,[4,22,*] R. Bennett,[51] Y. Berdnikov,[47] A.A. Bickley,[9] M.T. Bjorndal,[10] J.G. Boissevain,[32] H. Borel,[12]

- long standing discrepancy resolved



[PRL98:192301,2007, Erratum-ibid.106:159902,2011]

- working towards the extension at high p_T [Matt Durham's talk this afternoon]



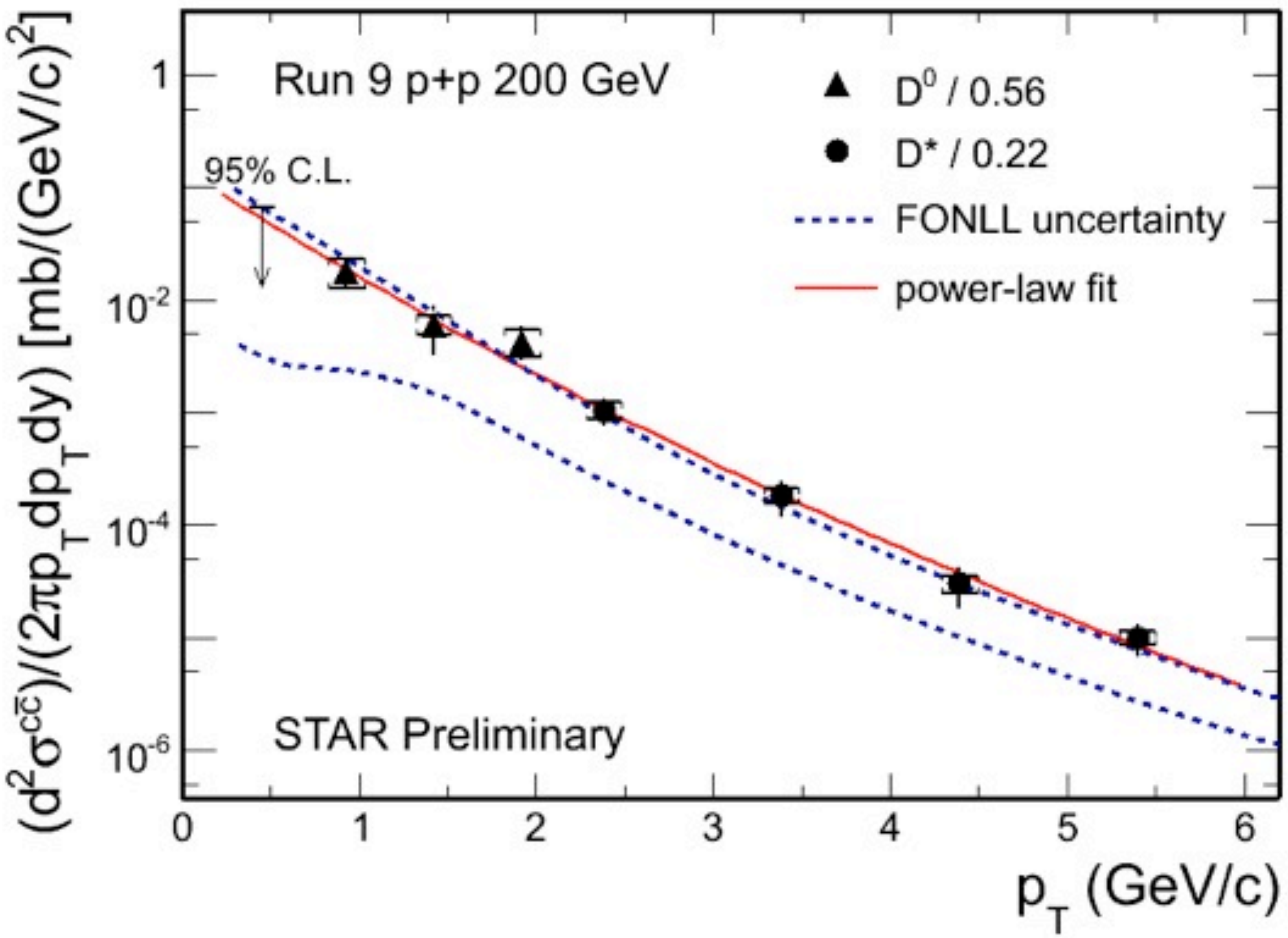
- NLO HF calculation with $\langle k_T \rangle^2 = 1 GeV^2/c^2$ matches our experimental result

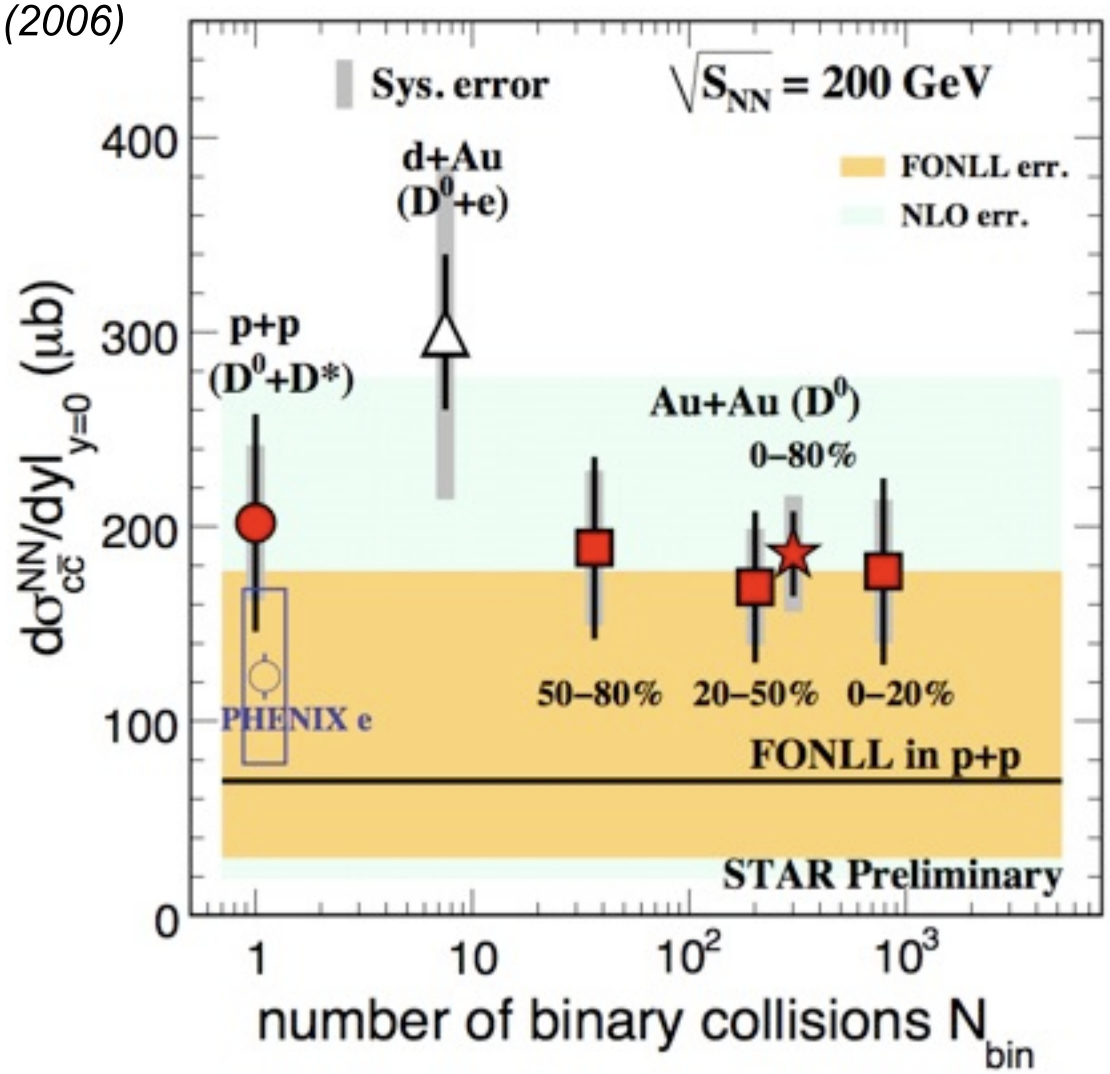
Charm cross section

Masui (STAR)

*FONLL: M. Cacciari et al, **PRL95**, 122001 (2005)*
*NLO: R. Vogt, **EPJ. ST 155**, 213 (2008)*
*d+Au: STAR, **PRL94**, 062301 (2005), electron: PHENIX, **PRL97**, 252002 (2006)*

Yifei Zhang, Fri/27 16:00

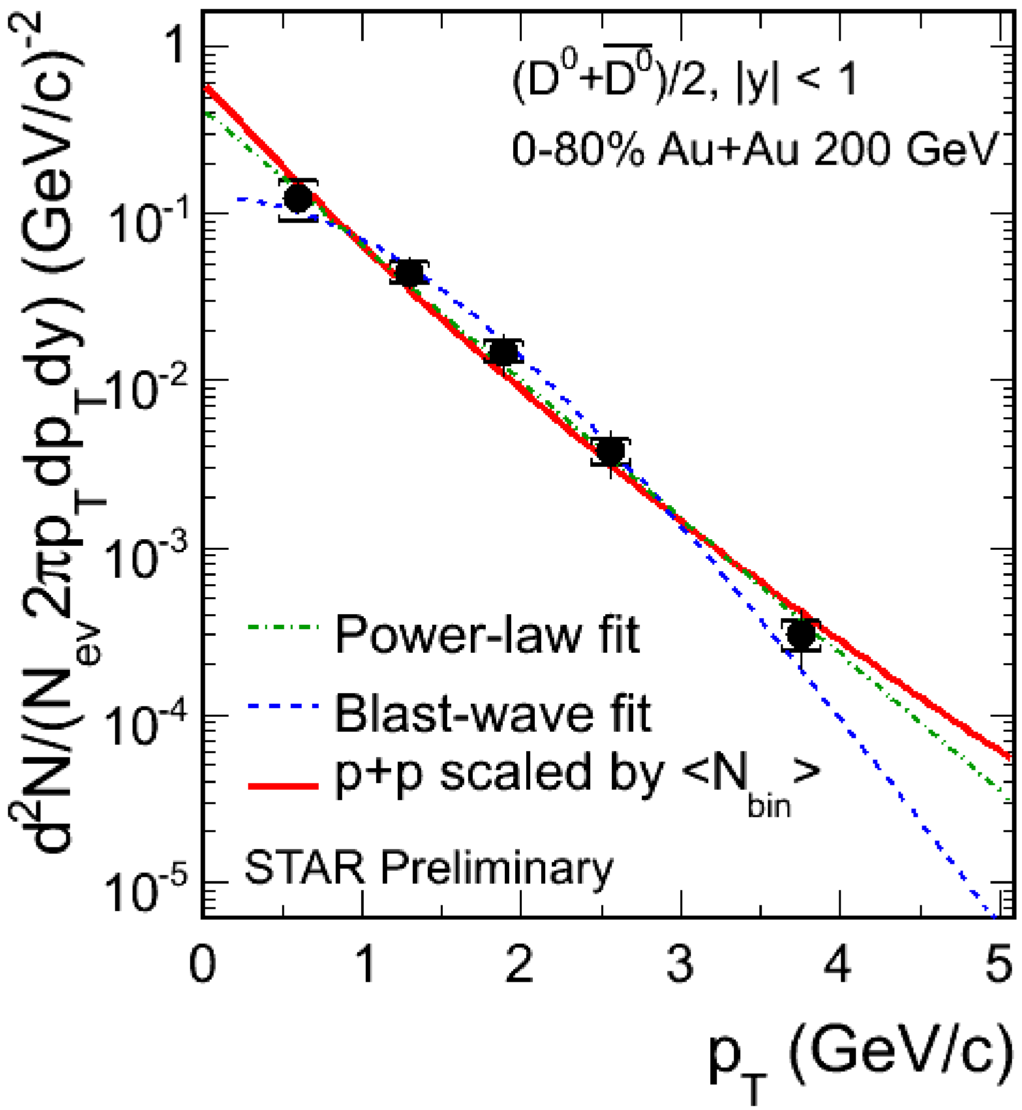




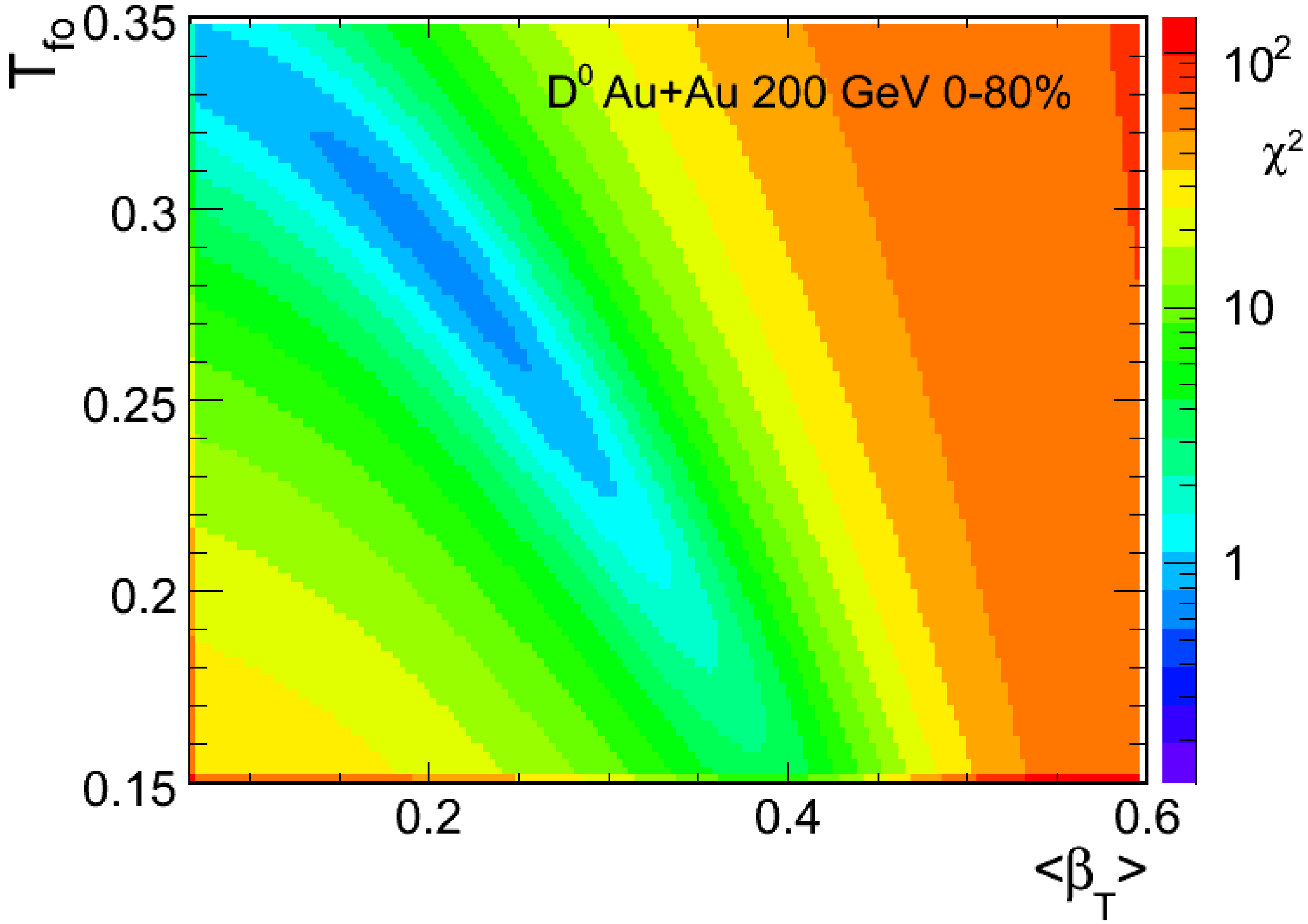
- Charm cross section is consistent with upper bound of FONLL calculation in p+p
- Charm cross section follows number of binary collision scaling

➡ Charm quarks are mostly produced by initial hard scattering

D^0 R_{AA} vs p_T



BW (πKp): B. I. Abelev, et al., Phys. Rev. C 79 (2009) 34909.



D^0 Au+Au 0-80% divided by p+p with $\langle N_{bin} \rangle$ scaled.

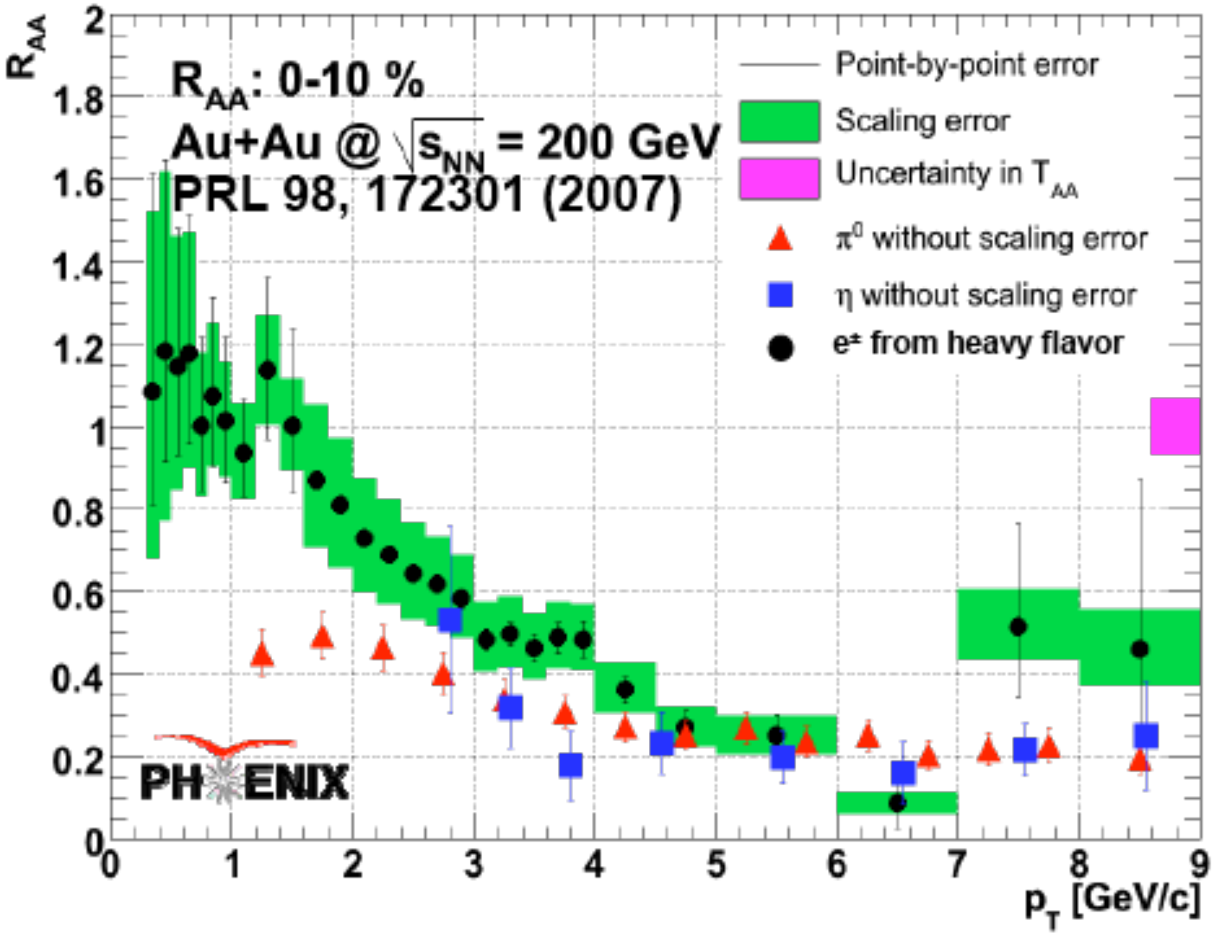
No obvious suppression at $p_T < 3$ GeV/c.

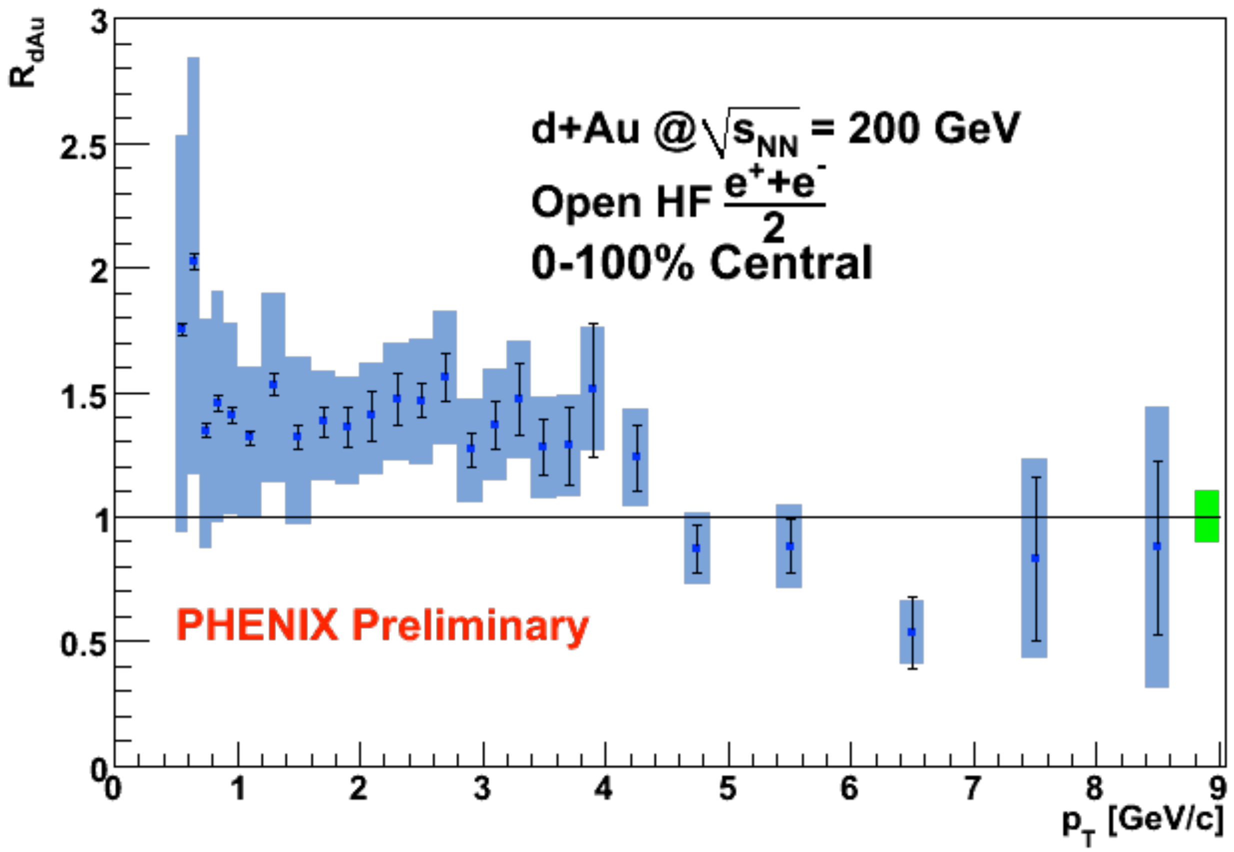
Blast-wave predictions with light hadron parameters are different from data.

=> D^0 freeze out earlier than light hadrons.

Understanding HF R_{AuAu}

Da Silva (STAR)





- can cold nuclear matter effects explain the large suppression seen in Au+Au collisions?

- new preliminary measurement of electrons from HF decays in d+Au collisions answers this question, NO!

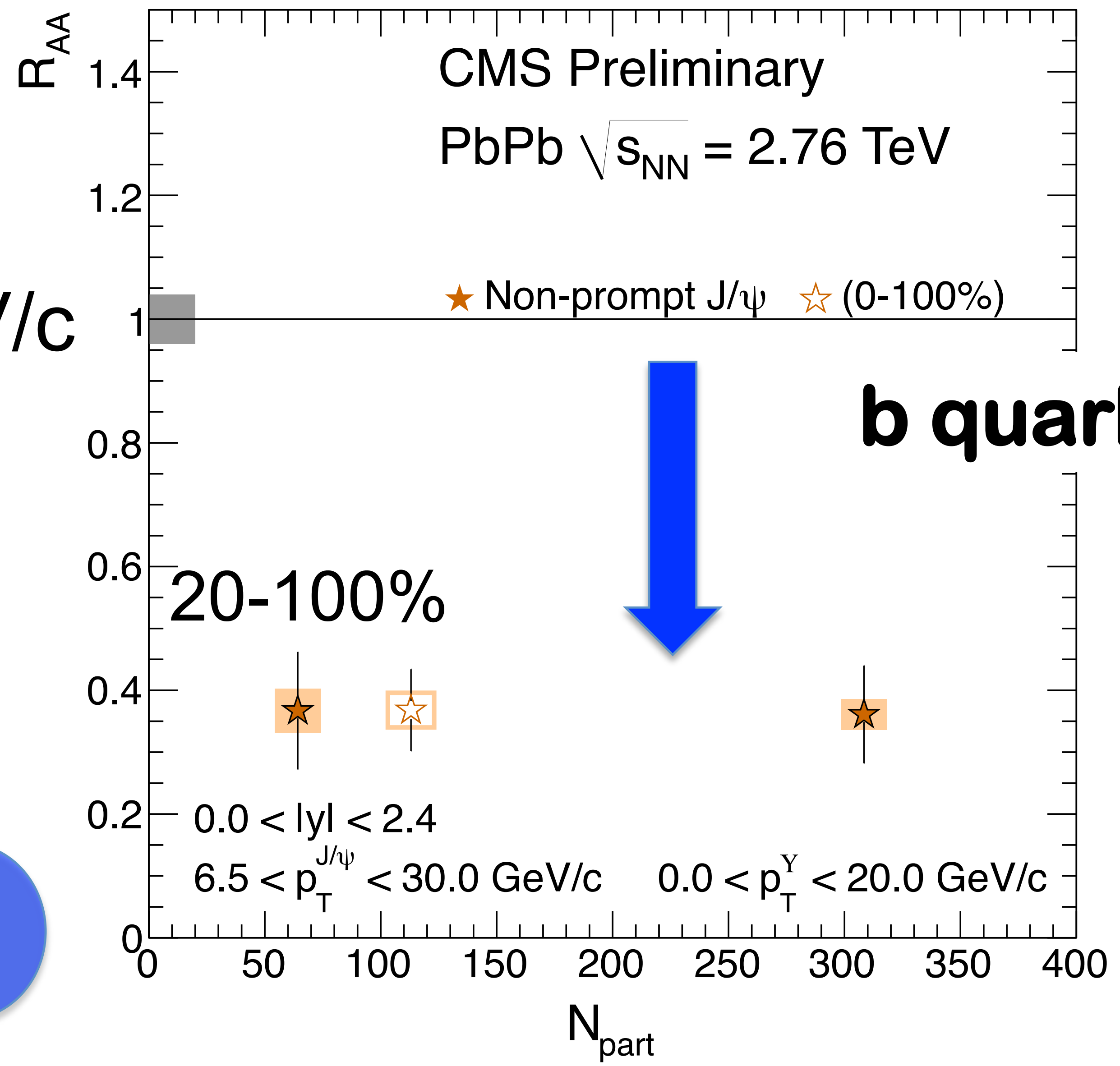
[Matt Durham's talk this afternoon]

First B → J/ψ R_{AA}

Silvestre (CMS)

PbPb $\sqrt{s_{NN}}$=2.76 TeV

$p_T^{J/\psi} > 6.5$ GeV/c



b quark energy loss ?

Minimum bias R_{AA} = 0.37 ± 0.07 ± 0.03

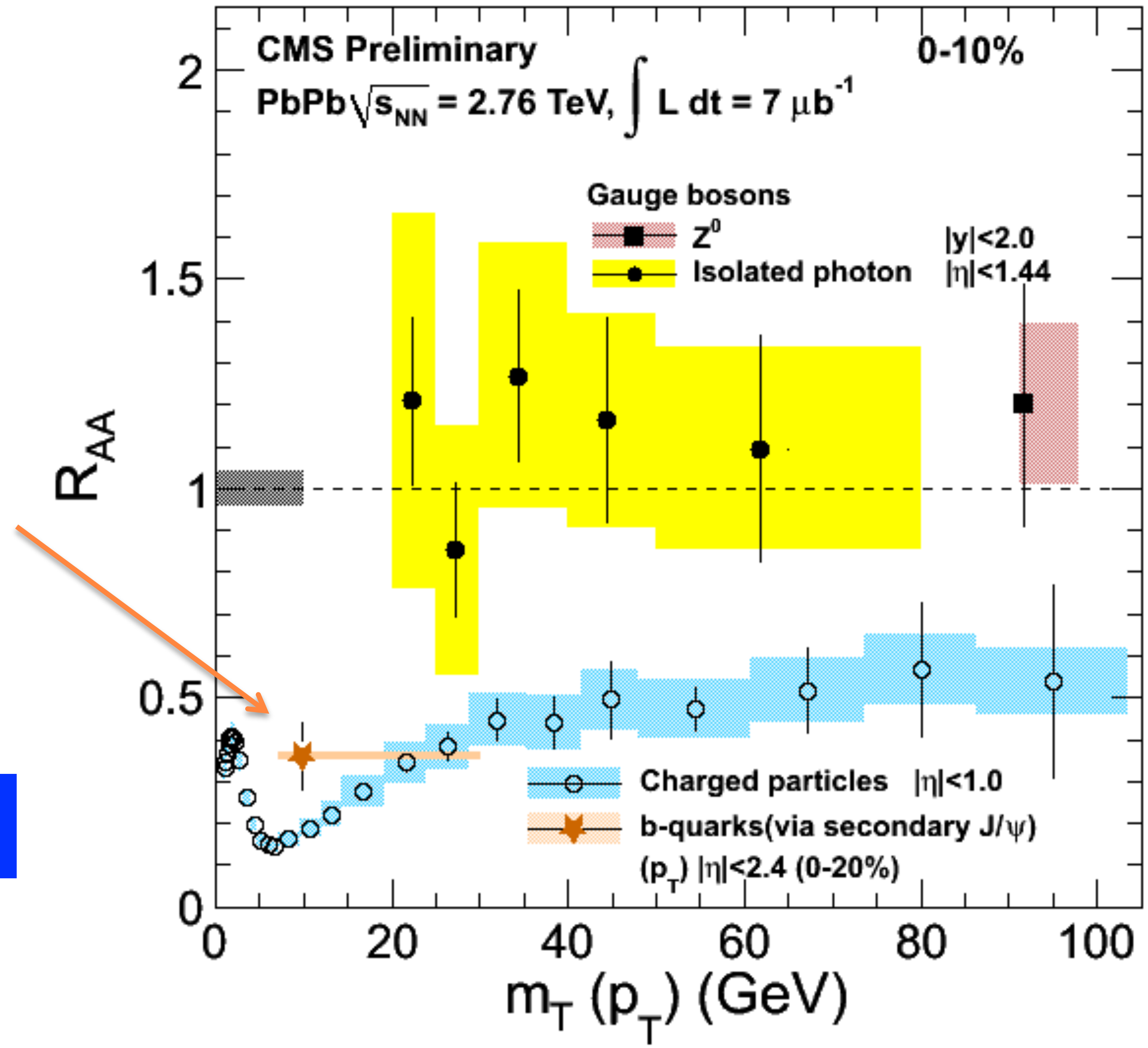
Central 0-20% R_{AA} = 0.36 ± 0.08 ± 0.03

High p_T Suppression

Silvestre (CMS)

PbPb

$\sqrt{s_{NN}}$=2.76 TeV



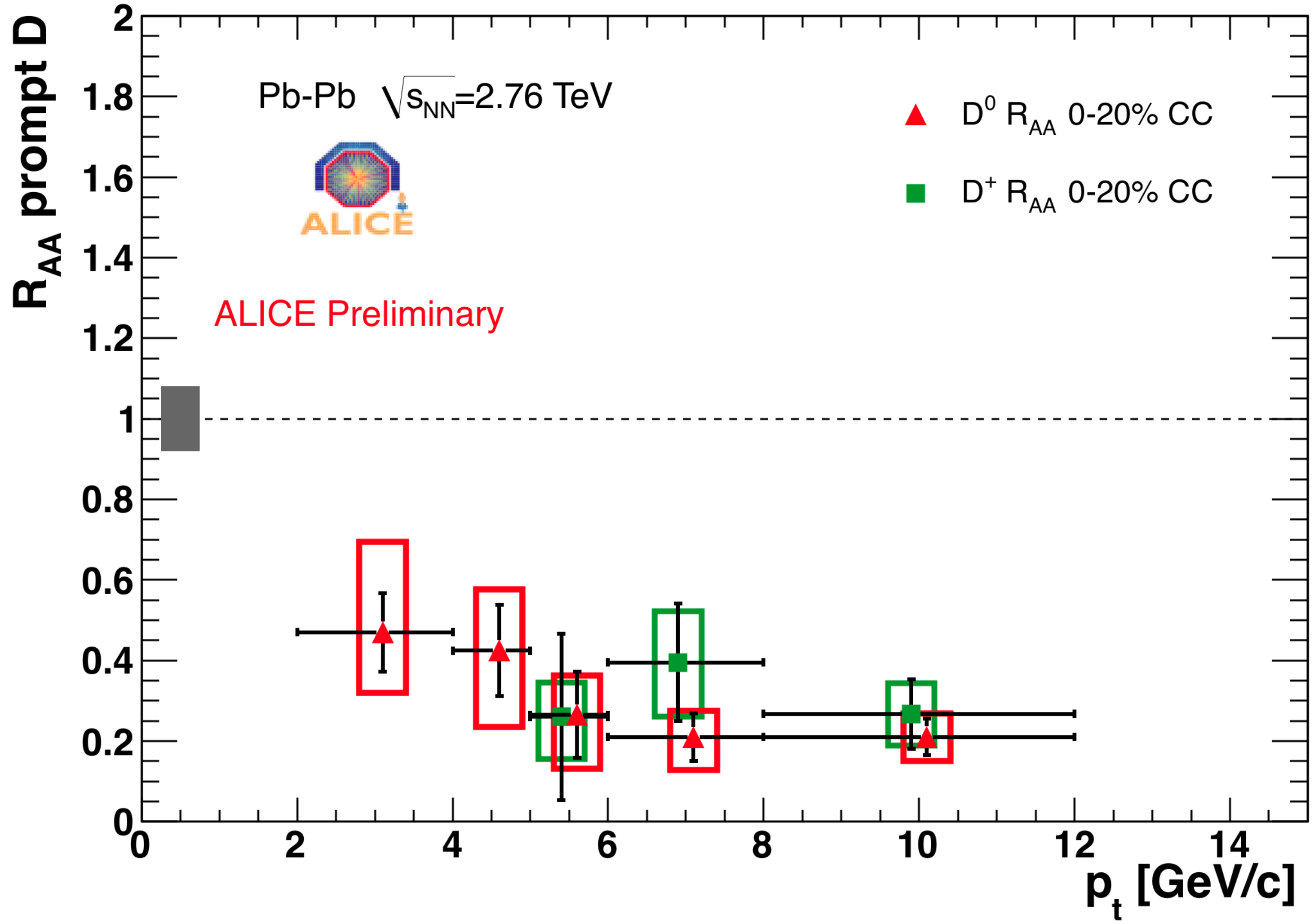
Yen-Jie Lee (Wed. 9h)

B→J/ψ at the p_T of the J/ψ

Same level of suppression as hadrons

Dainese (ALICE)

The D meson R_{AA} (0-20%)

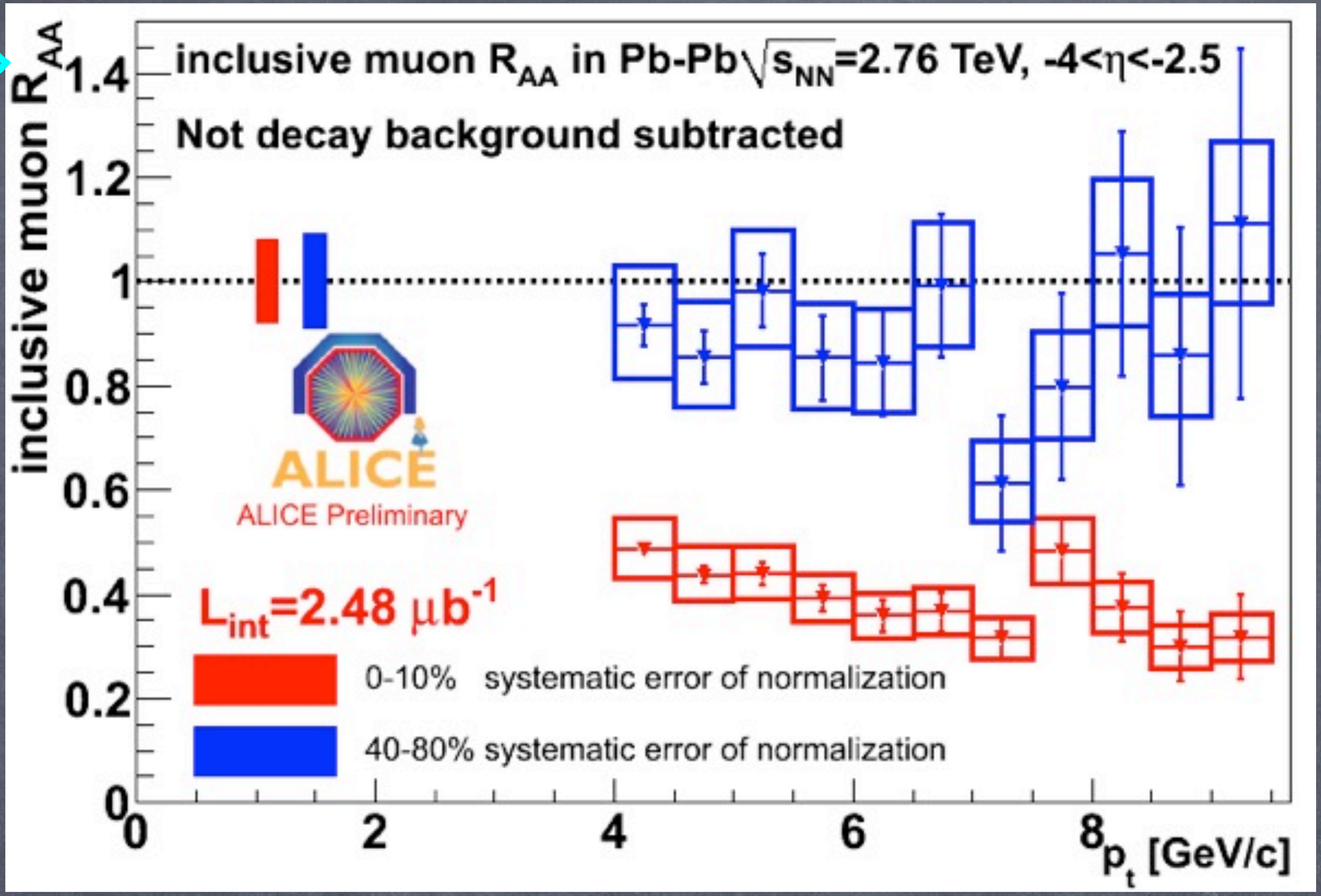


- Suppression for charm is a factor 4-5 above 5 GeV/*c*

Inclusive Muon R_{AA}

Zhang (ALICE)

80% rich in HF



40-80%

0-10%

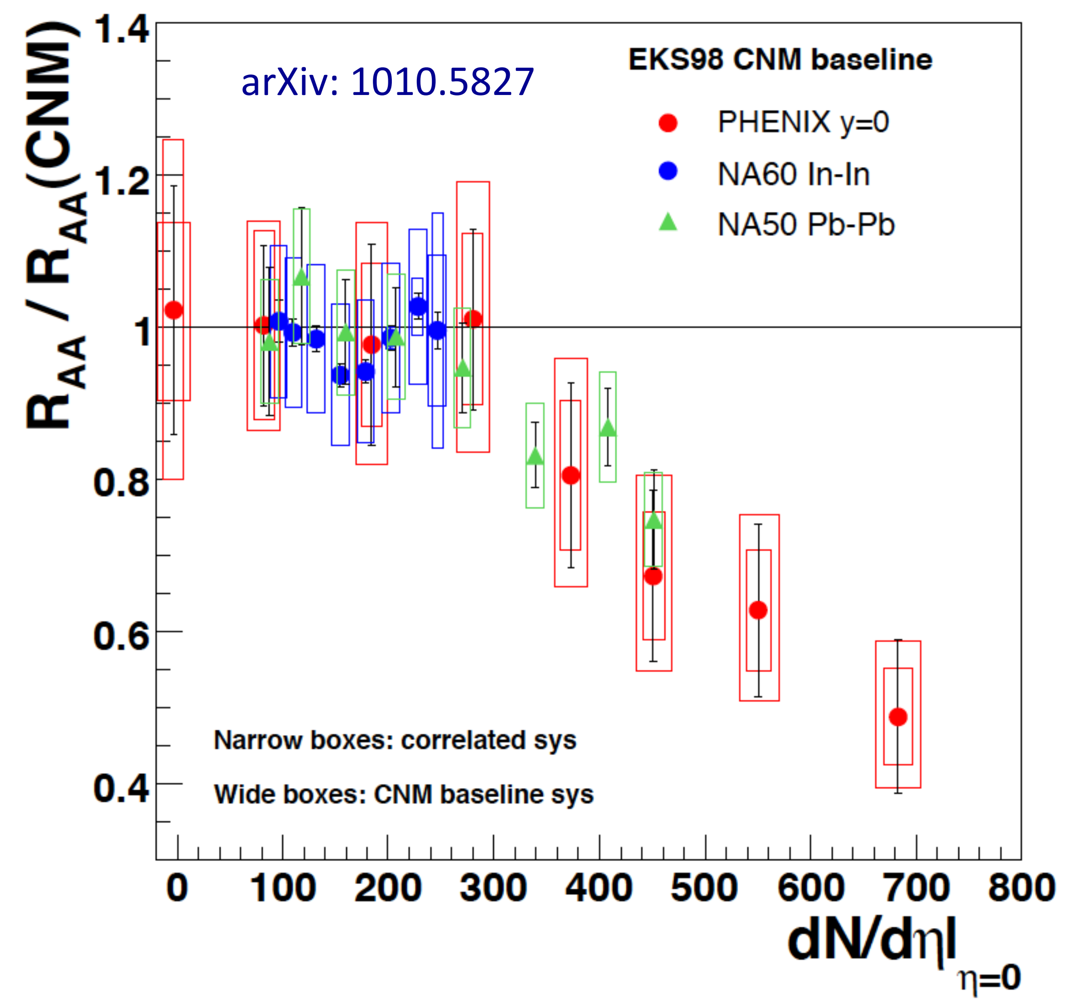
- systematic uncertainty from pp and Pb-Pb data and scaling factor;
- systematic uncertainty on normalization includes uncertainty on T_{AA} and the 7% uncertainty on cross section in pp collisions;
- centrality dependence of tracking efficiency is not included (<1%);
- suppression observed in central collisions, no strong p_t dependence.

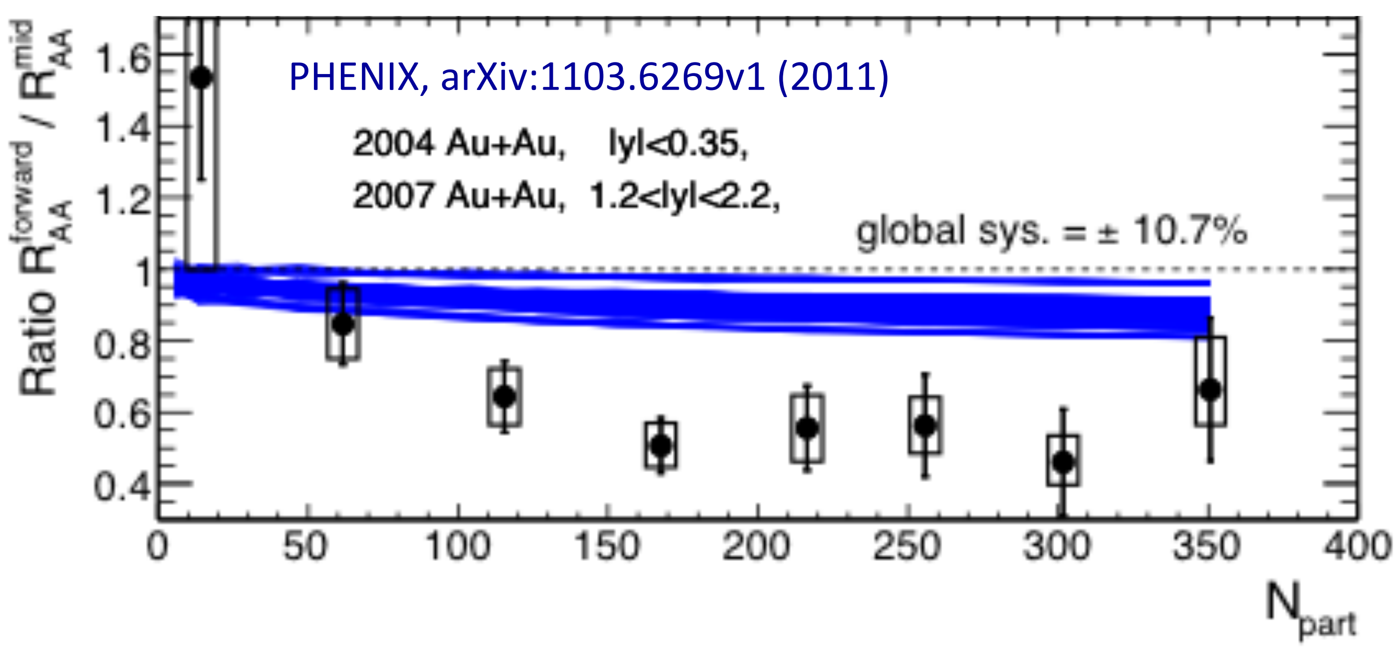
Quarkonia

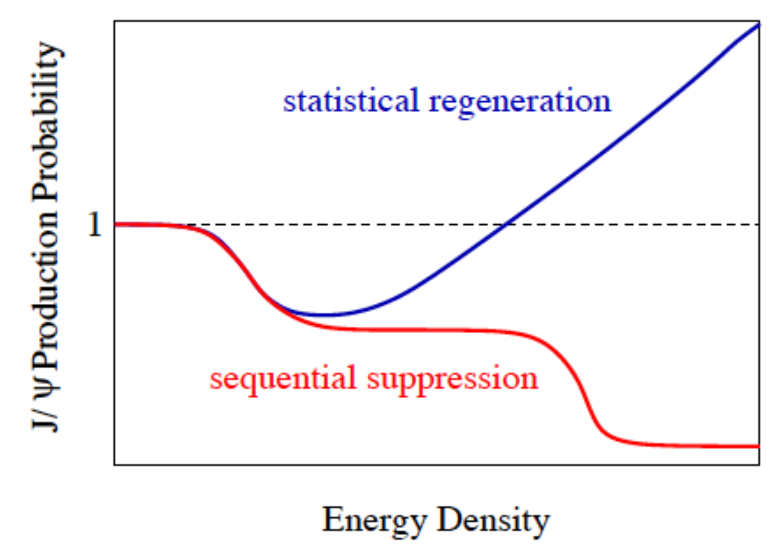
Motivations

Pillot (ALICE)

- J/ψ measurement: probe of deconfinement
- Puzzles:
  - Suppression above cold nuclear matter effects is not so large at RHIC. Does quarkonium regeneration play a role?
  - RHIC measures higher suppression at forward than at central rapidities

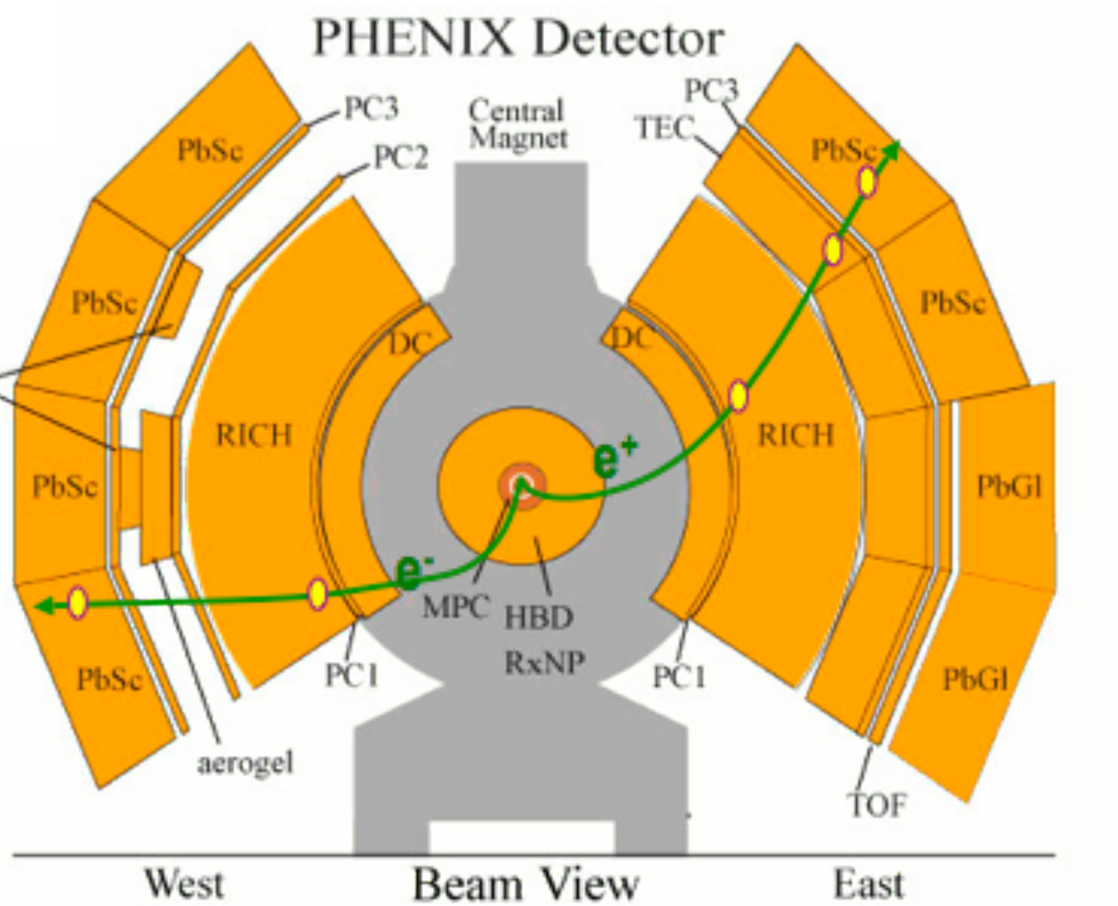


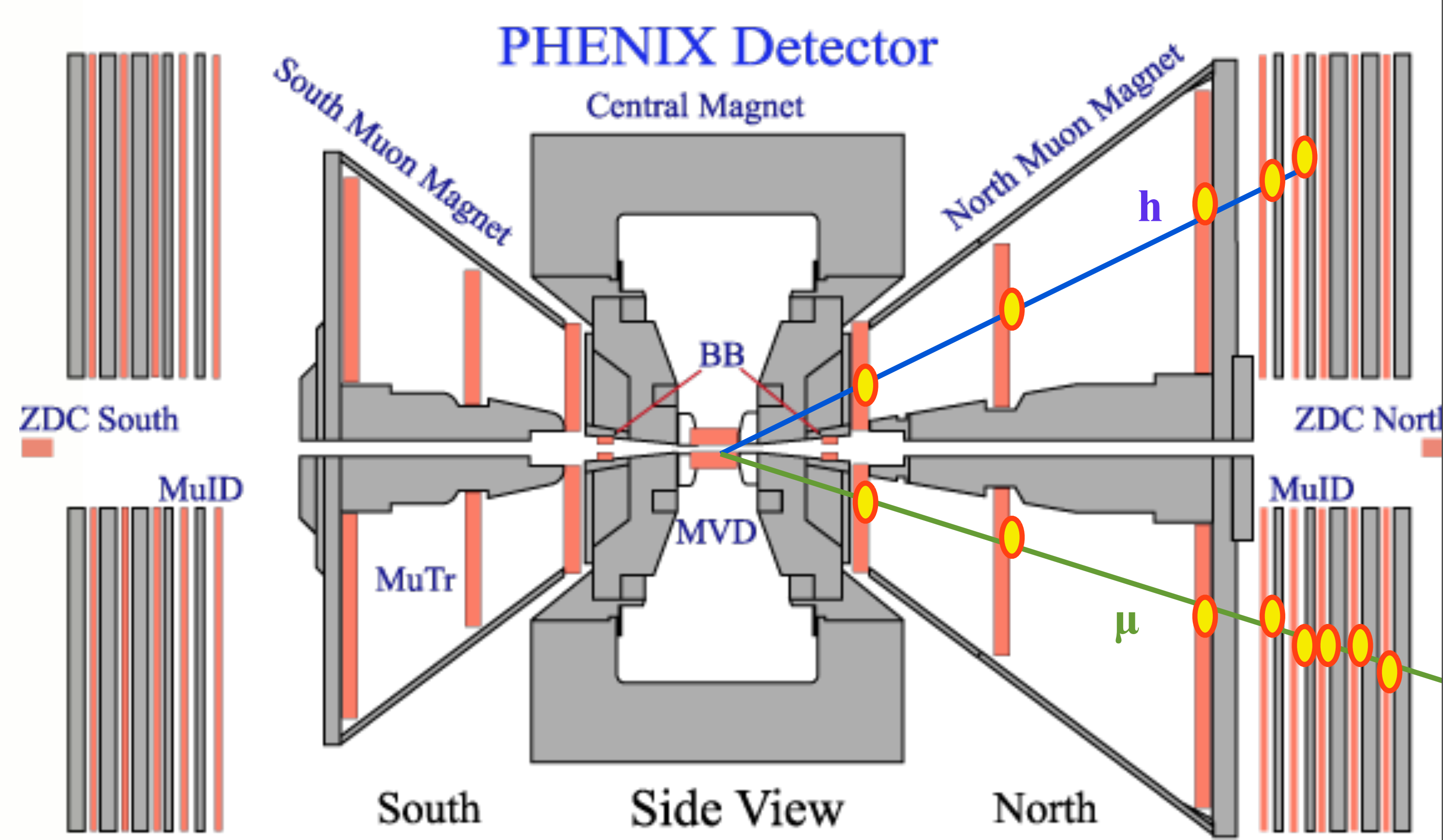




→ Need measurement at central and forward rapidities in higher energy collisions

Da Silva (PHENIX)





$|y|<0.35$ $\Delta\Phi = 2 \times \pi/2$

$1.2<|y|<2.2$ $\Delta\Phi = 2\pi$

Measures leptonic decays of heavy flavor and quarkonia

Results in p+p, d+Au, Cu+Cu and Au+Au at $s^{1/2}=200$

in forward and mid rapidities

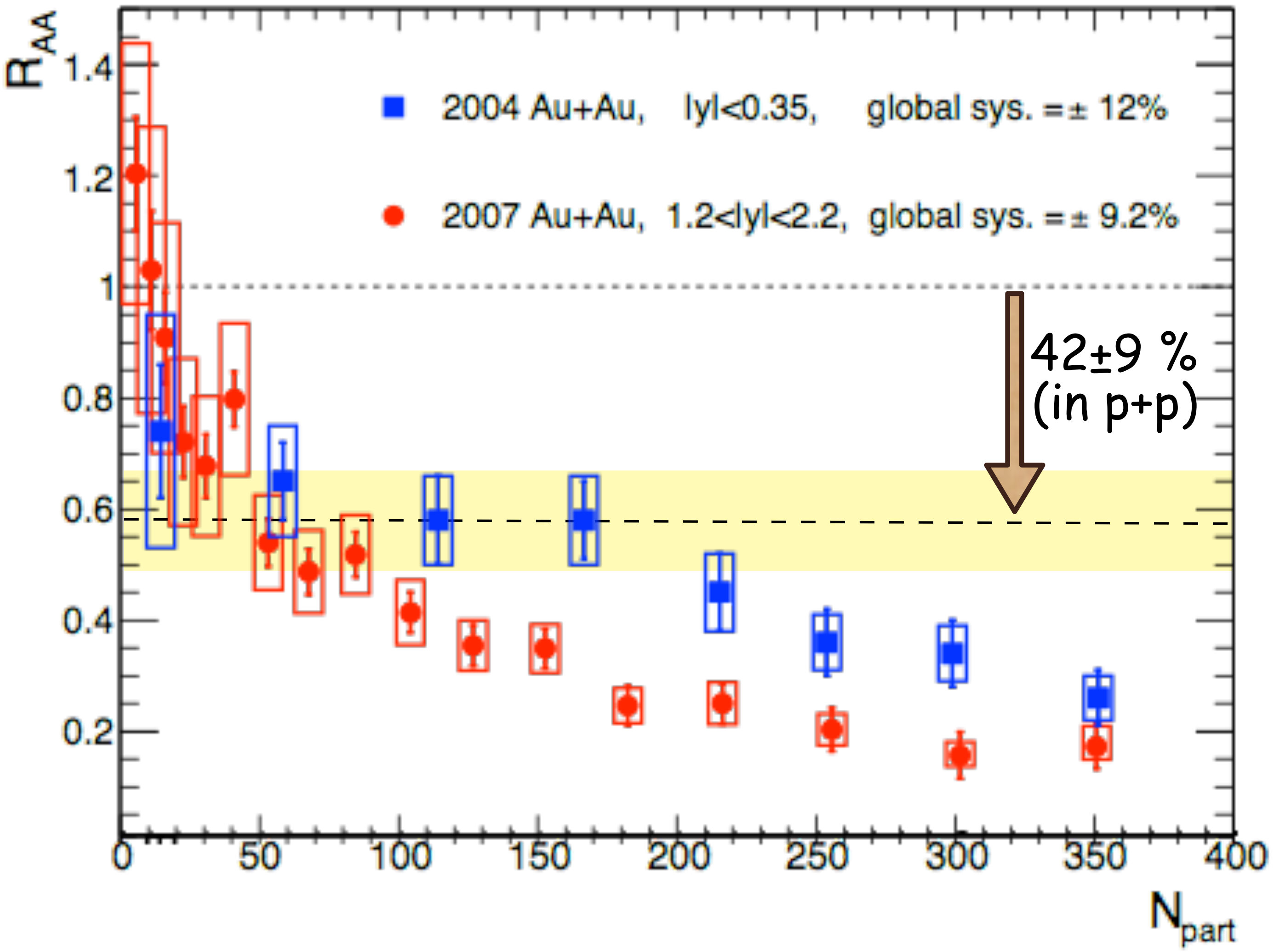
open heavy flavor->leptons, J/ψ, ψ', χ_c, Υ(1S,2S,3S)

PHENIX

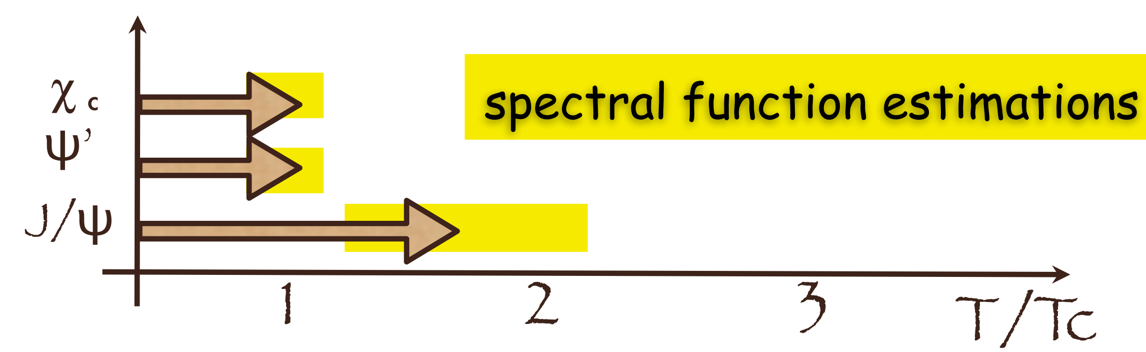
Trying to understand J/ψ suppression in Au+Au collisions...

Da Silva (PHENIX)

[arXiv:1103.6269v1]



- Tc ~ 170 MeV
- inverse slope of thermal photons measured by PHENIX is 221±28MeV [PRL104, 132301 (2010)]
- hydro models fitted to the thermal photon data suggest T_{init} ~300-600 MeV
- who survives?

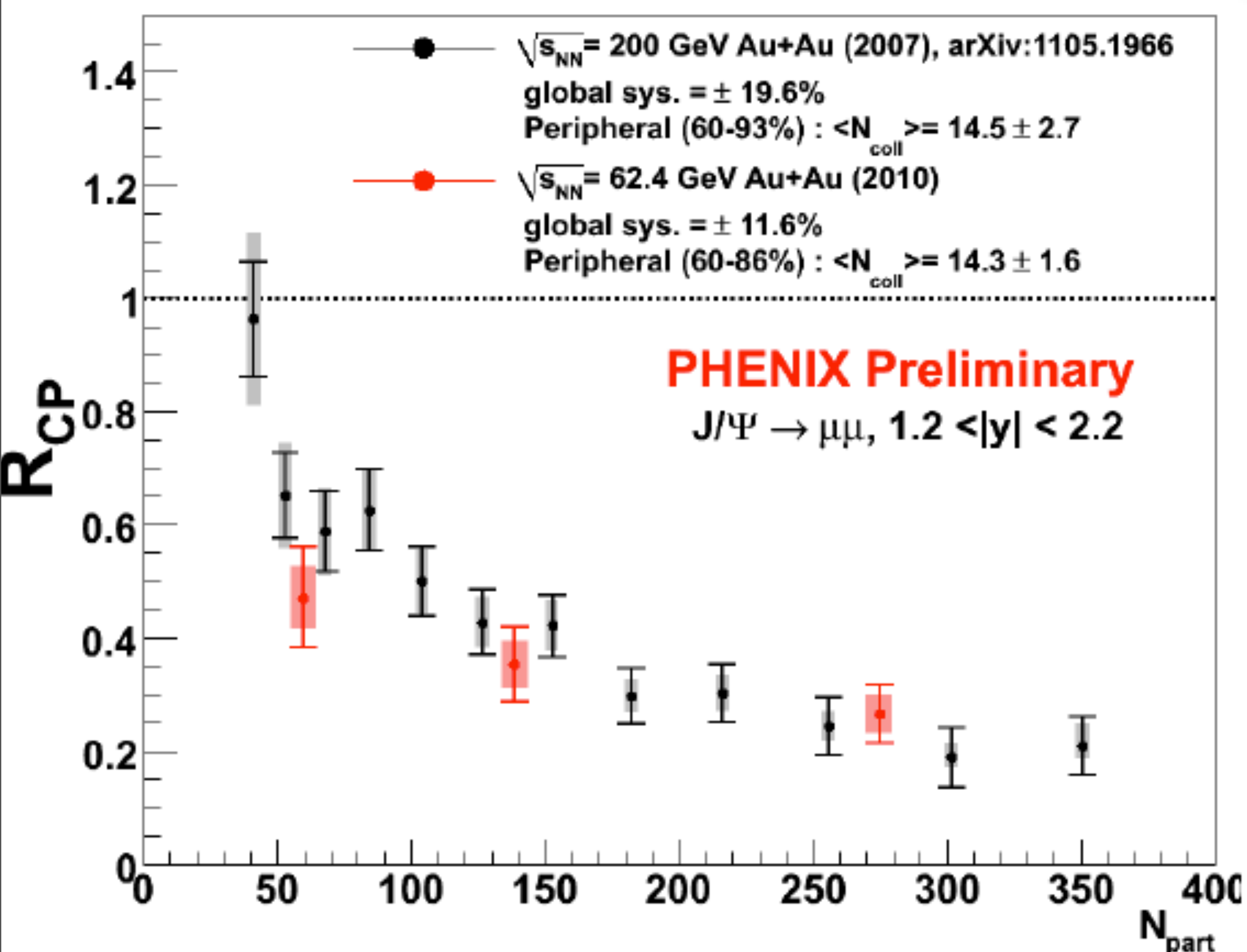


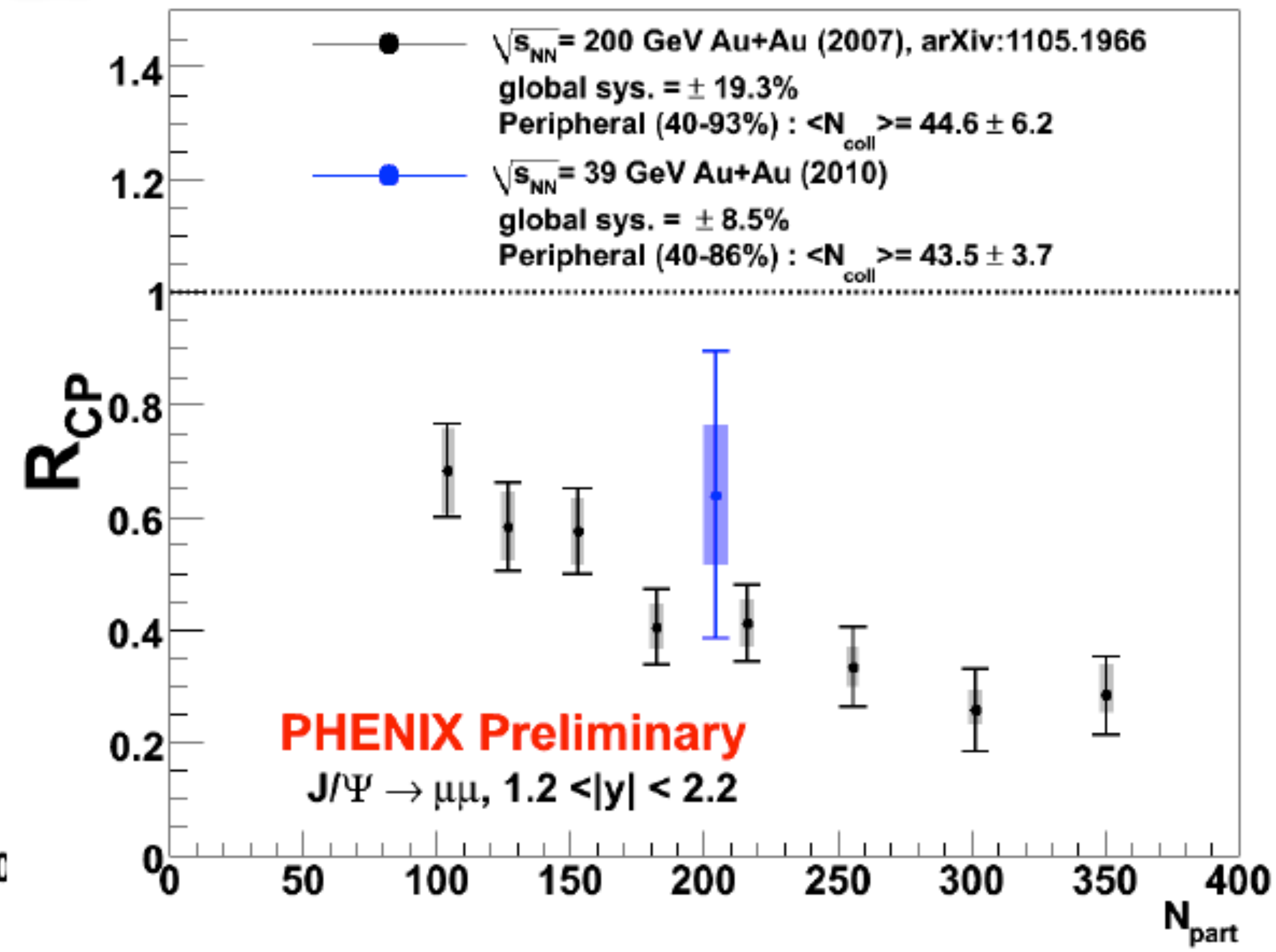
Cold matter effects not included

- if J/ψ from ψ' and χ_c fully suppressed R_{AA} drops to 0.6

J/ψ in lower energy Au+Au collisions

Da Silva (PHENIX)



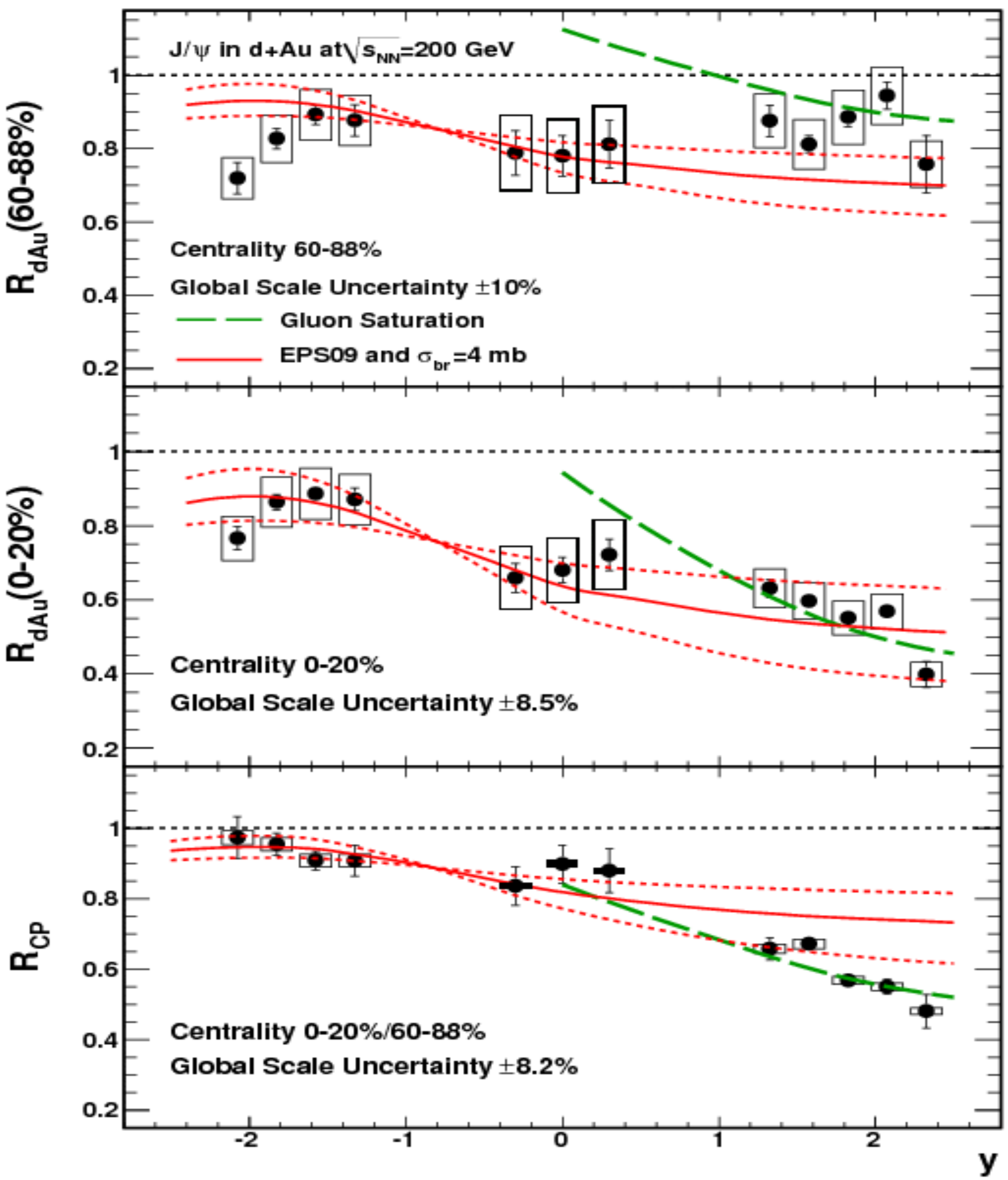


- energy comparison: same detector, rapidity range and centrality
- no p+p reference at 62 GeV and 39 GeV, using yield relative to peripheral events (Rcp)
- suppression similar in all energies given the current uncertainties
- **but**, CNM effects expected to be different

[presented on Tuesday by Abhisek Sen]

J/ψ suppression in d+Au

Sen (PHENIX)



- (Solid red curves) A reasonable agreement with EPS09 nPDF + σ_{br} = 4 mb for central collisions but not peripheral.
- (Dashed green line) CGC calculations can't reproduce mid-rapidity. (Nucl. Phys. A 770(2006) 40)

What about R_{CP} ?

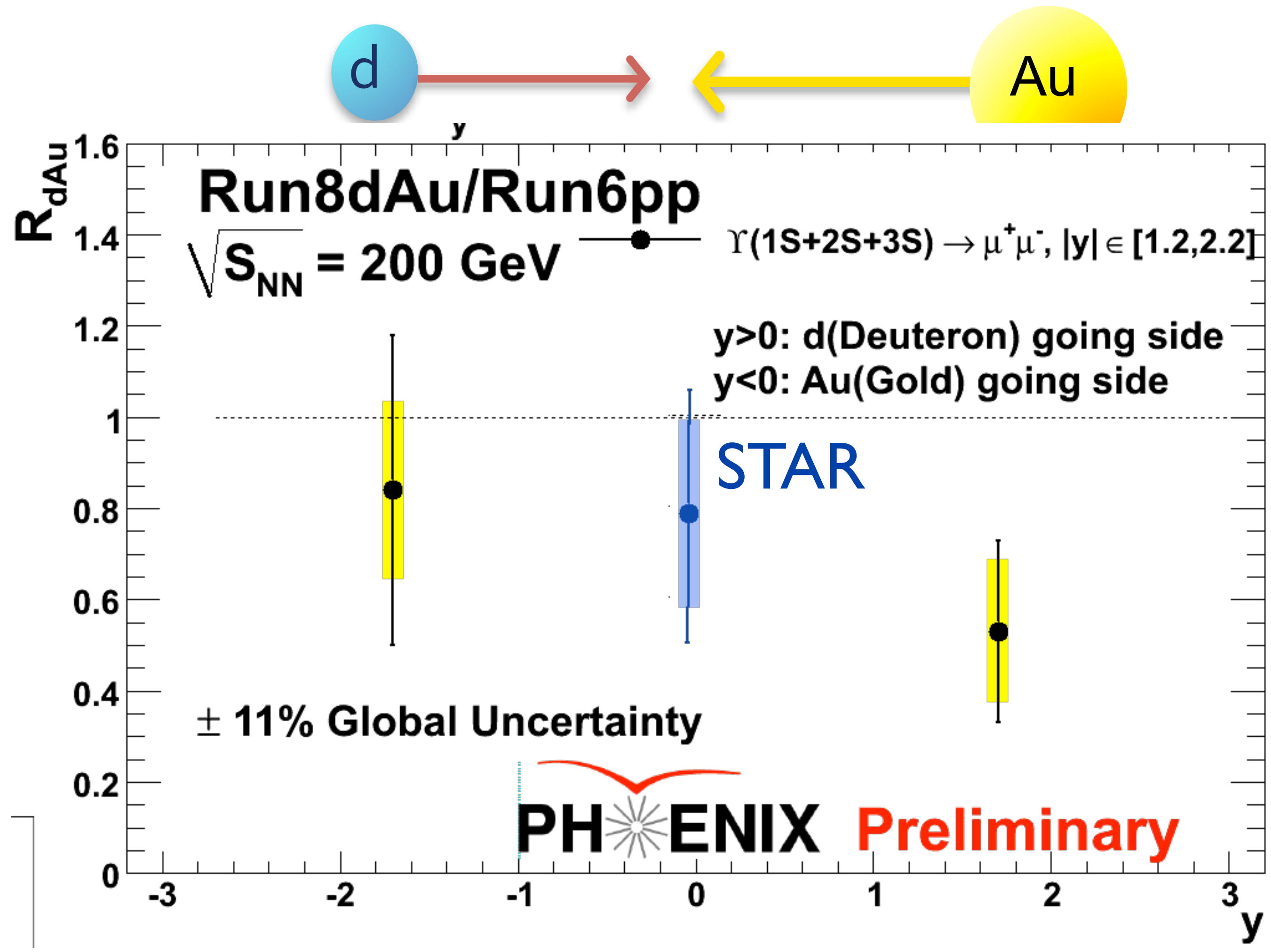
EPS09 with assumed linear thickness dependence fails to describe centrality dependence of forward rapidity region.

arxiv:1010.1246

Sen (PHENIX)

New PHENIX Υ results

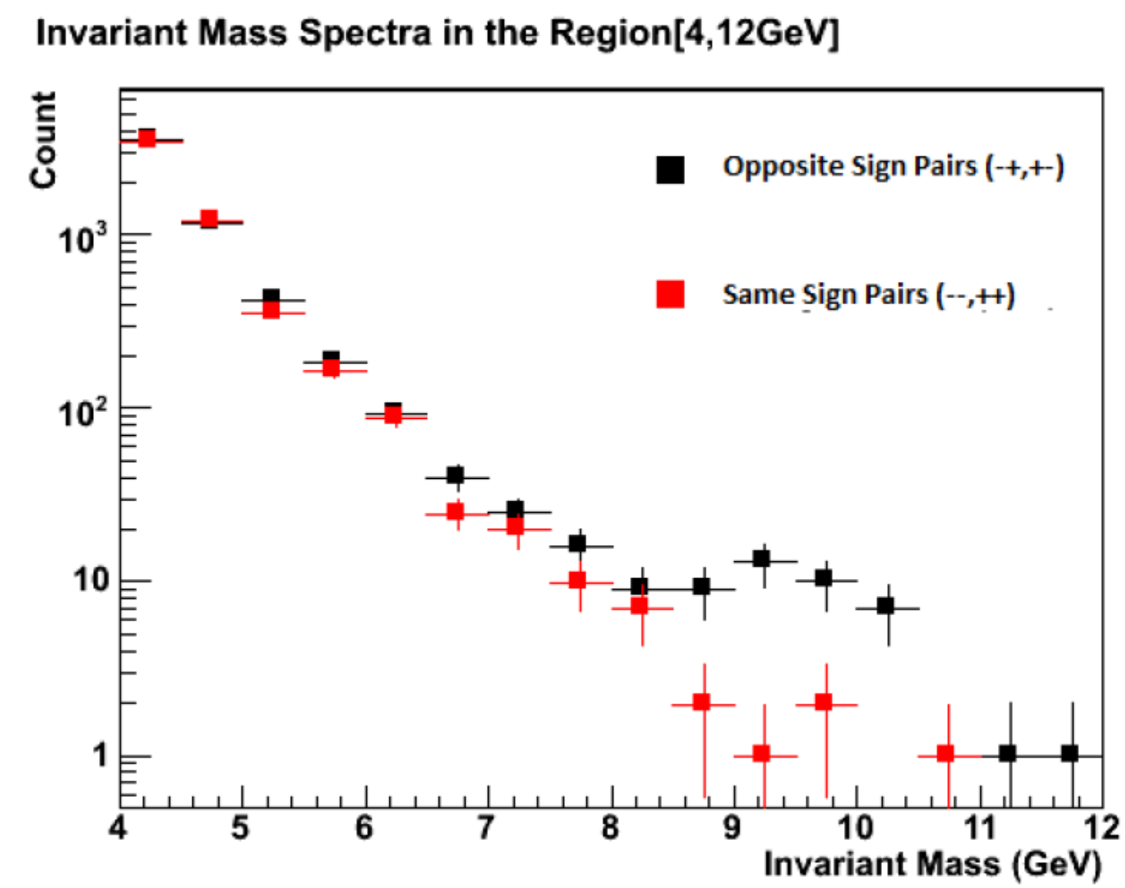
d+Au



Coming soon R_{dAu} at mid-rapidity

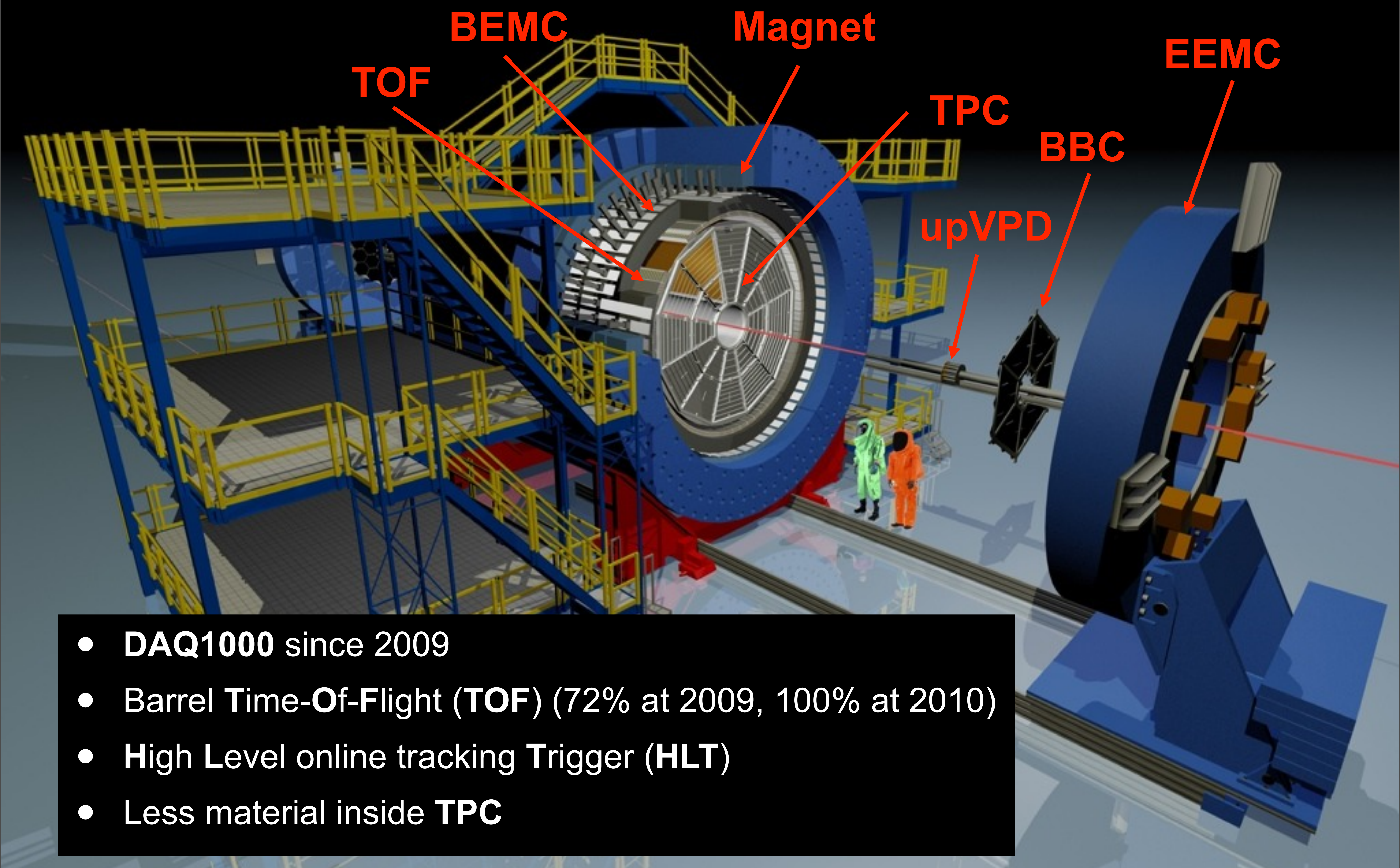
First measurement of CNM effects in Υ production at RHIC.

Au+Au



R_{AA} Coming soon!

STAR experiment



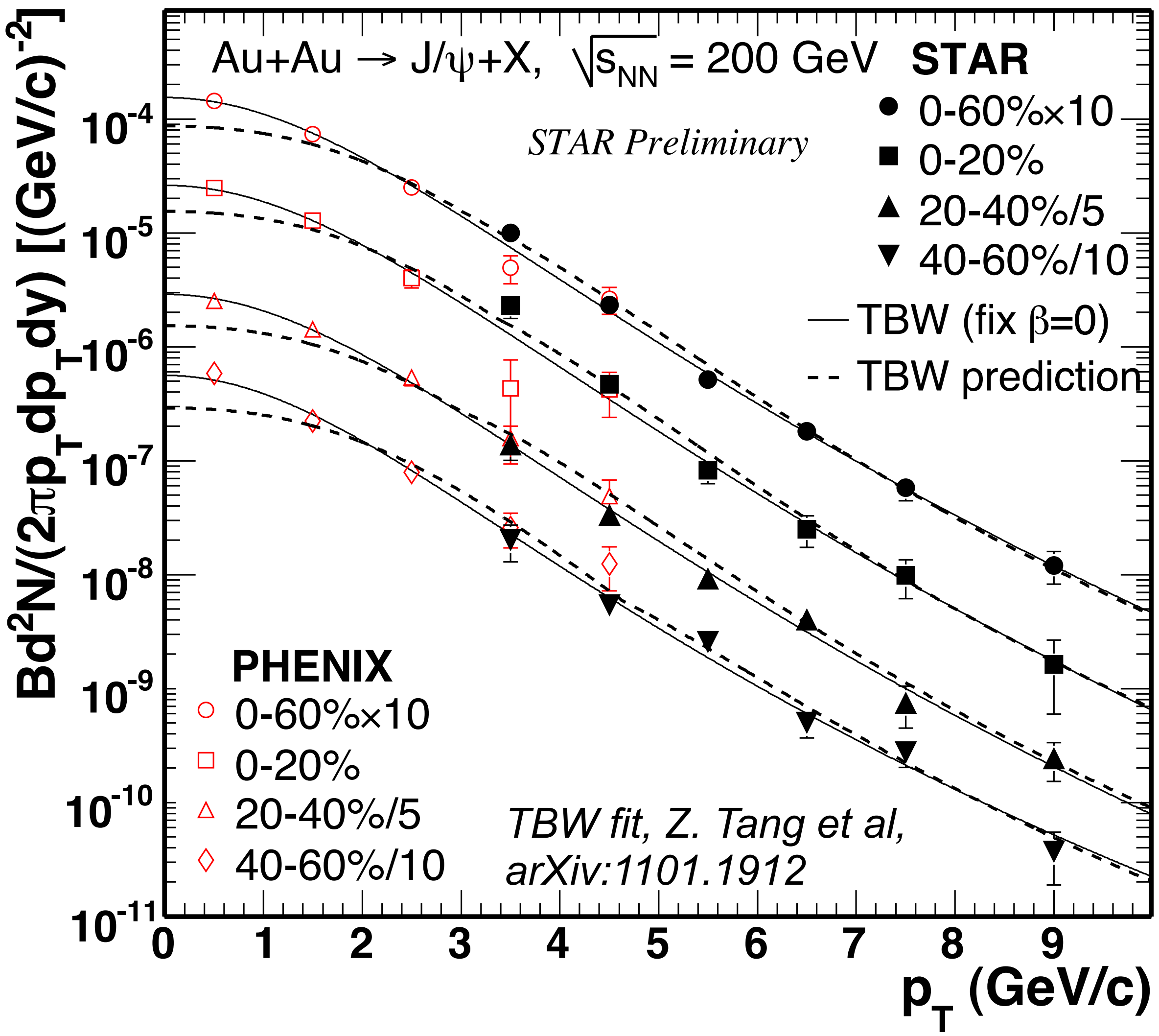
- **DAQ1000** since 2009
- Barrel **T**ime-**O**f-**F**light (**TOF**) (72% at 2009, 100% at 2010)
- **H**igh **L**evel online tracking **T**rigger (**HLT**)
- Less material inside **TPC**

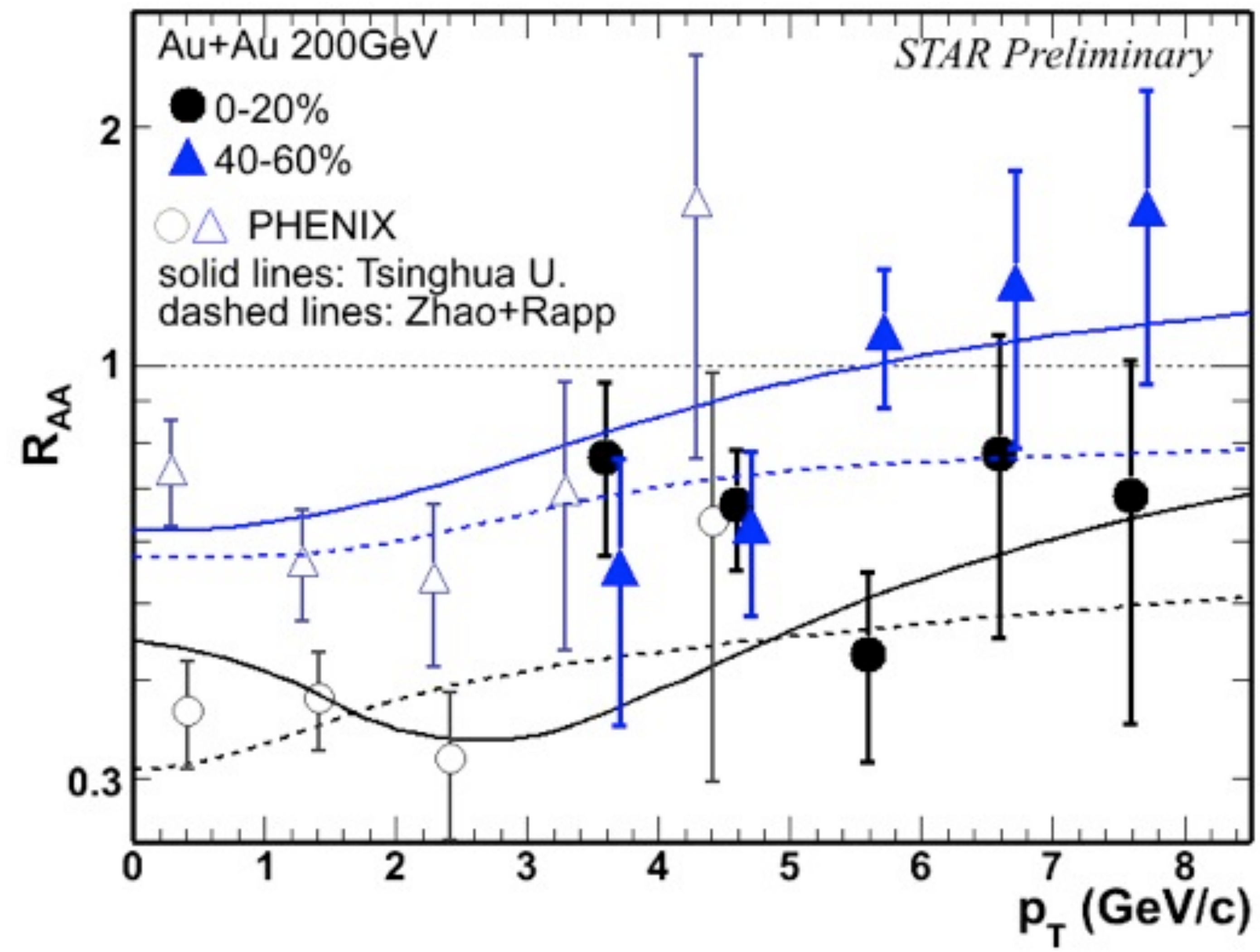
J/ψ spectra & R_{AA}

Masui (STAR)

Zebo Tang, Tue/24 15:40

*STAR CuCu: **PRC80**, 041902(R) (2009), PHENIX: **PRL98**, 232301 (2007)*
*Y. Liu et al, **PLB678**, 72 (2009) and private comminication*
*X. Zhao and R. Rapp, **PRC82**, 064905(2010) and private communication*





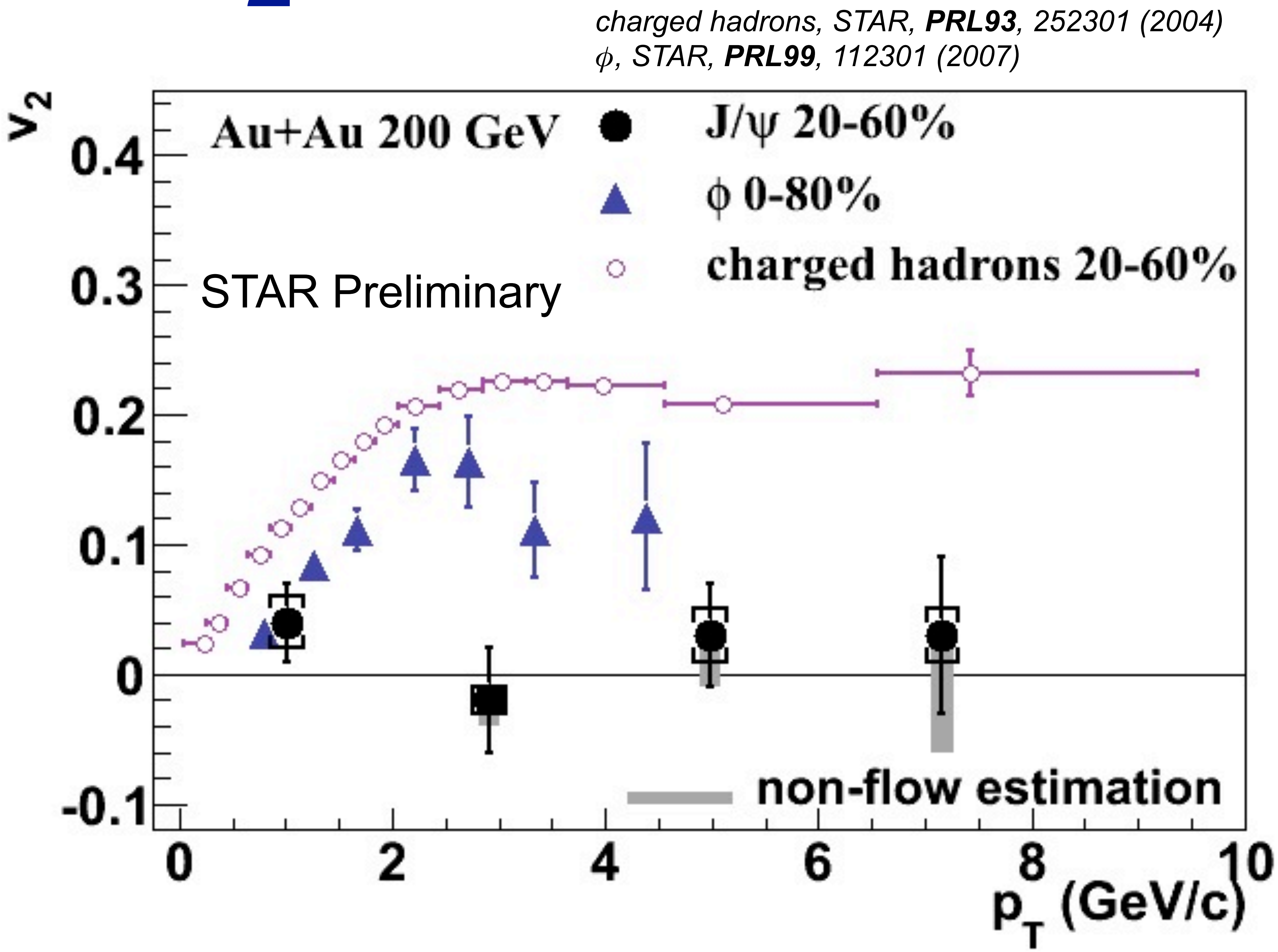
- Extend *J/ψ* spectra up to 10 GeV/c
- High p_T ($p_T > 5$ GeV/c) *J/ψ* suppression at central collisions

J/Ψ v_2

Masui (STAR)

Hao Qiu, poster board 60, Thu/26

Zebo Tang, Tue/24 15:40



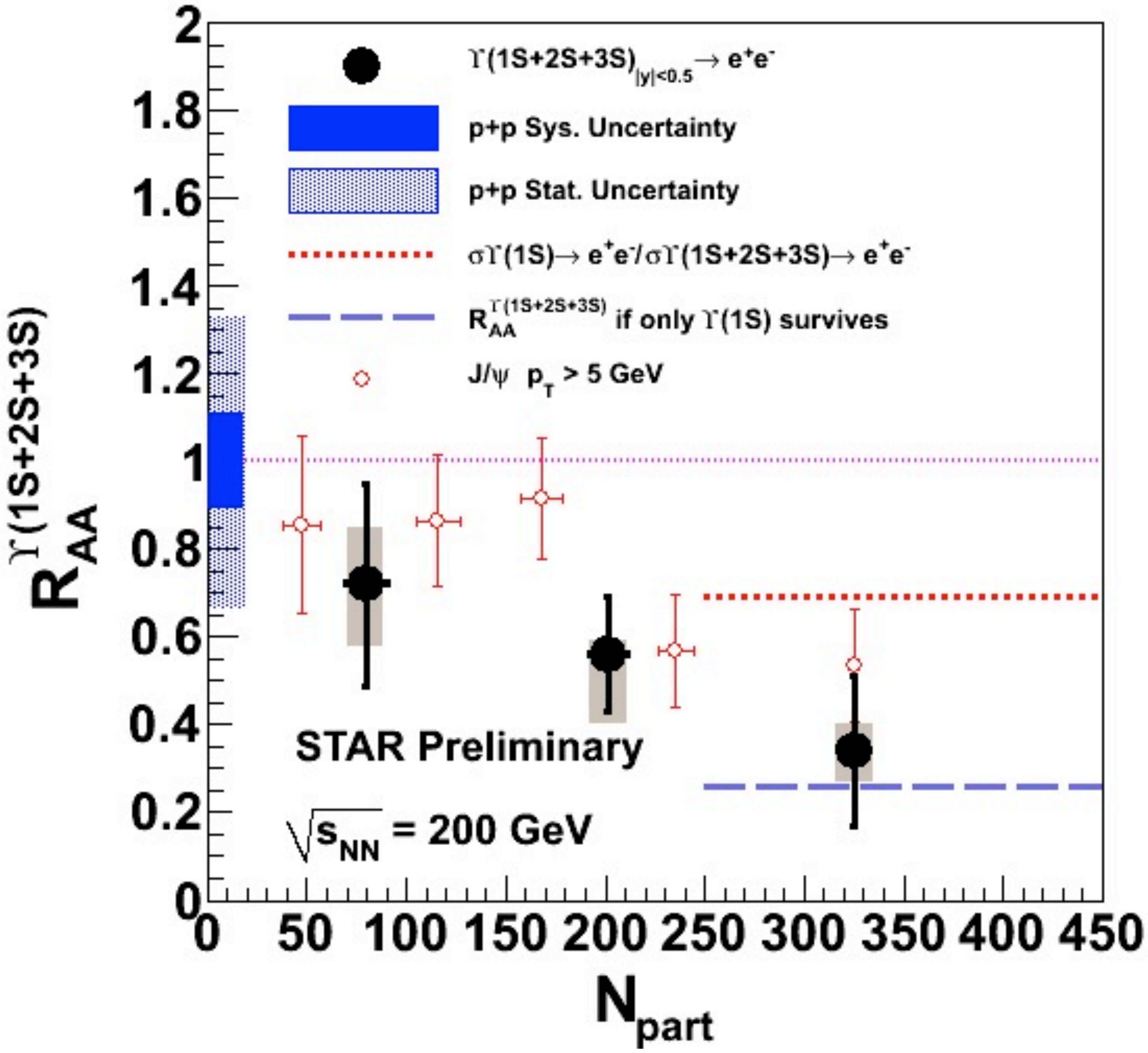
- *J/ψ* v_2 ~ 0 up to p_T ~ 8 GeV/c in mid-central 20-60%

➡ Disfavors coalescence from thermalized charm quarks

ϒ R_{AA}

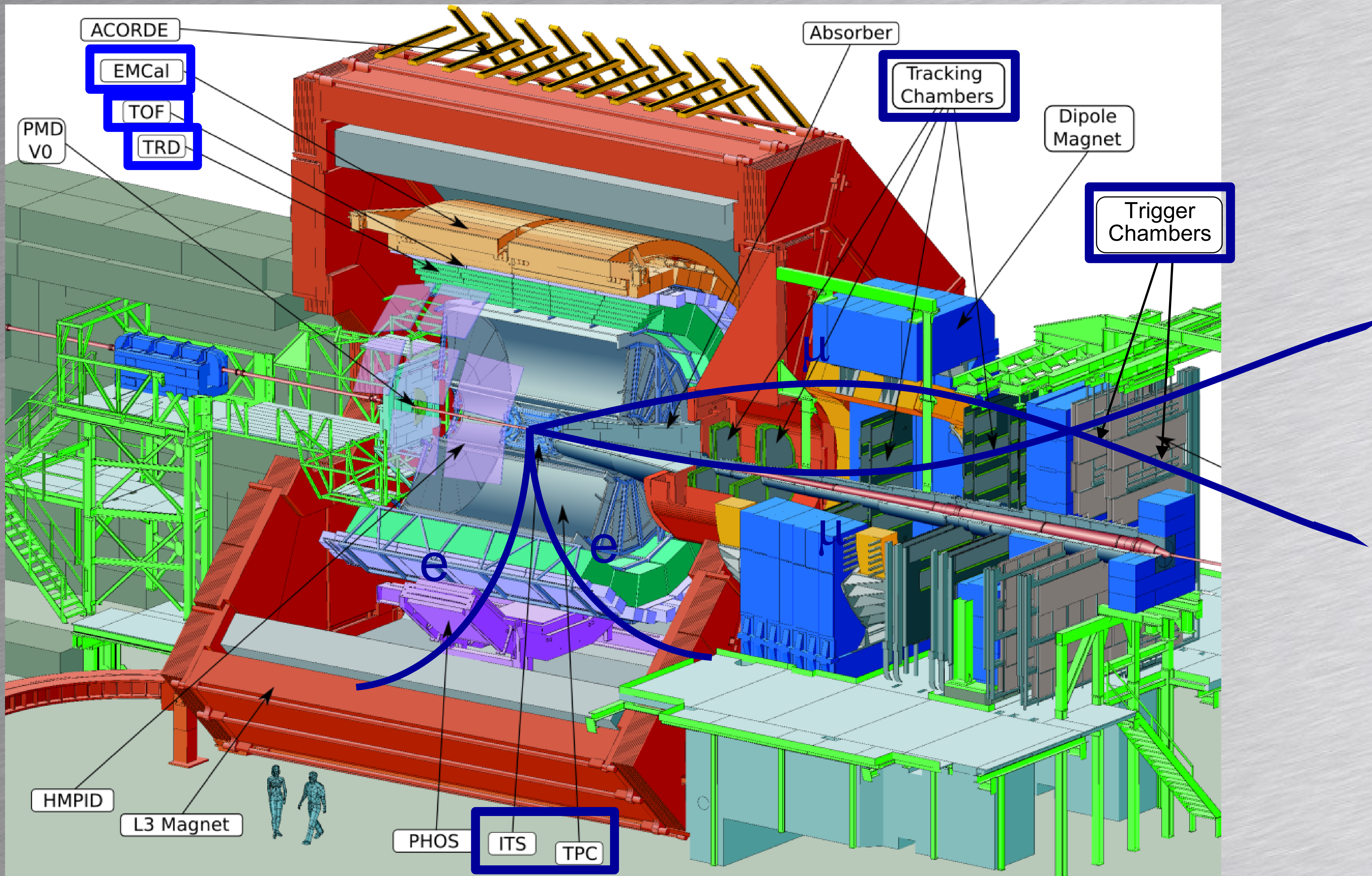
Masui (STAR)

Rosi Reed, poster board 48, Thu/26



- ϒ(1S+2S+3S) suppression at central collisions
  - Similar suppression with high p_T J/ψ
- First measurement of ϒ suppression
- Statistical uncertainty will be improved by more than a factor of 2
  - × 3 in p+p 2009
  - × 2 in Au+Au 2011

Quarkonium measurements



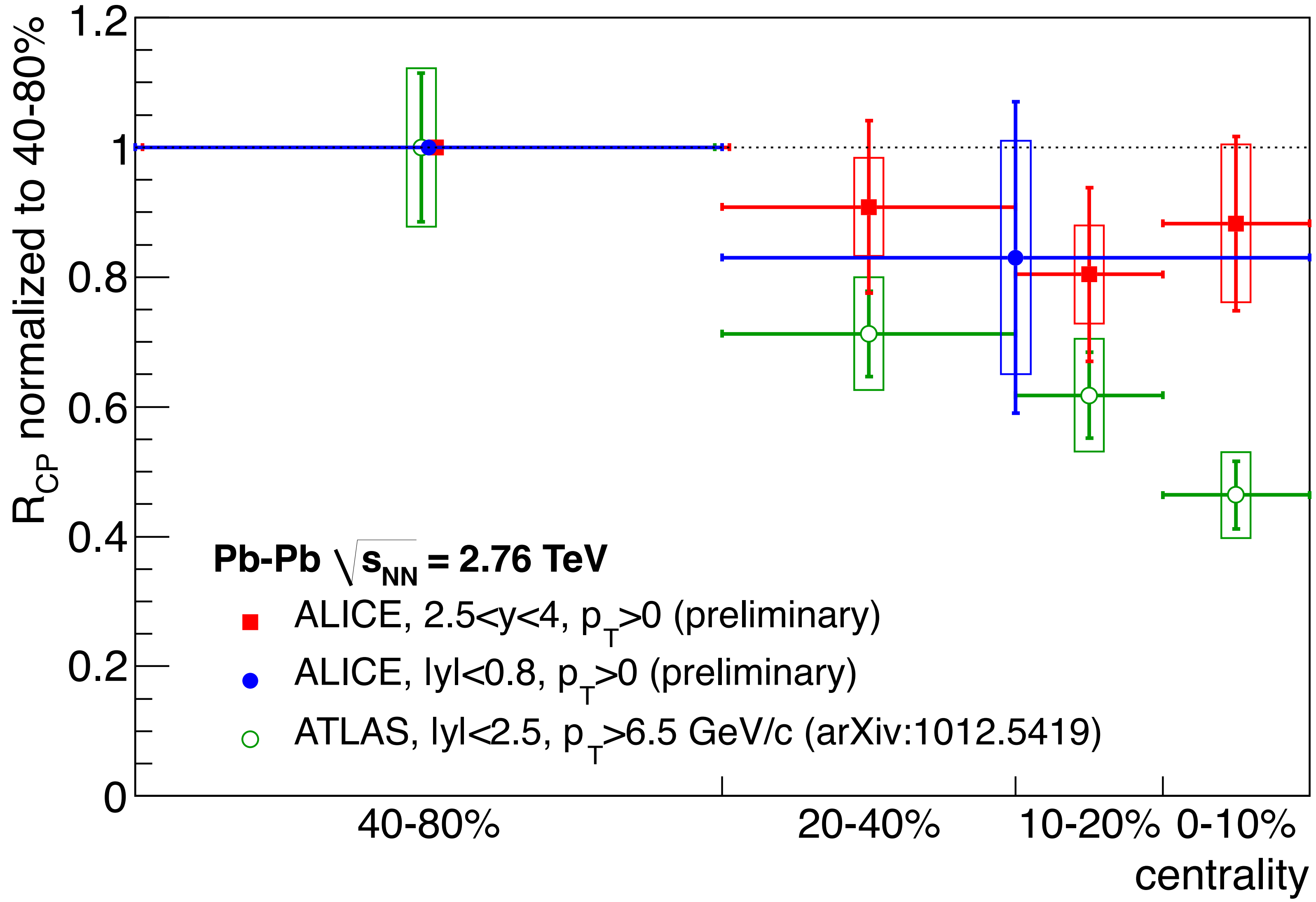
Down to p_T=0

|y|<0.9: ➔e^+e^-, J/ψ🡐B, e-trig & **2.5<y<4.0**: ➔$\mu^+\mu^-$, μ-trig.

Comparison with ALICE at mid-rapidity

Pillot (ALICE)

Inclusive J/ψ R_{CP} can be also measured in ALICE at mid-rapidity in the dielectron channel

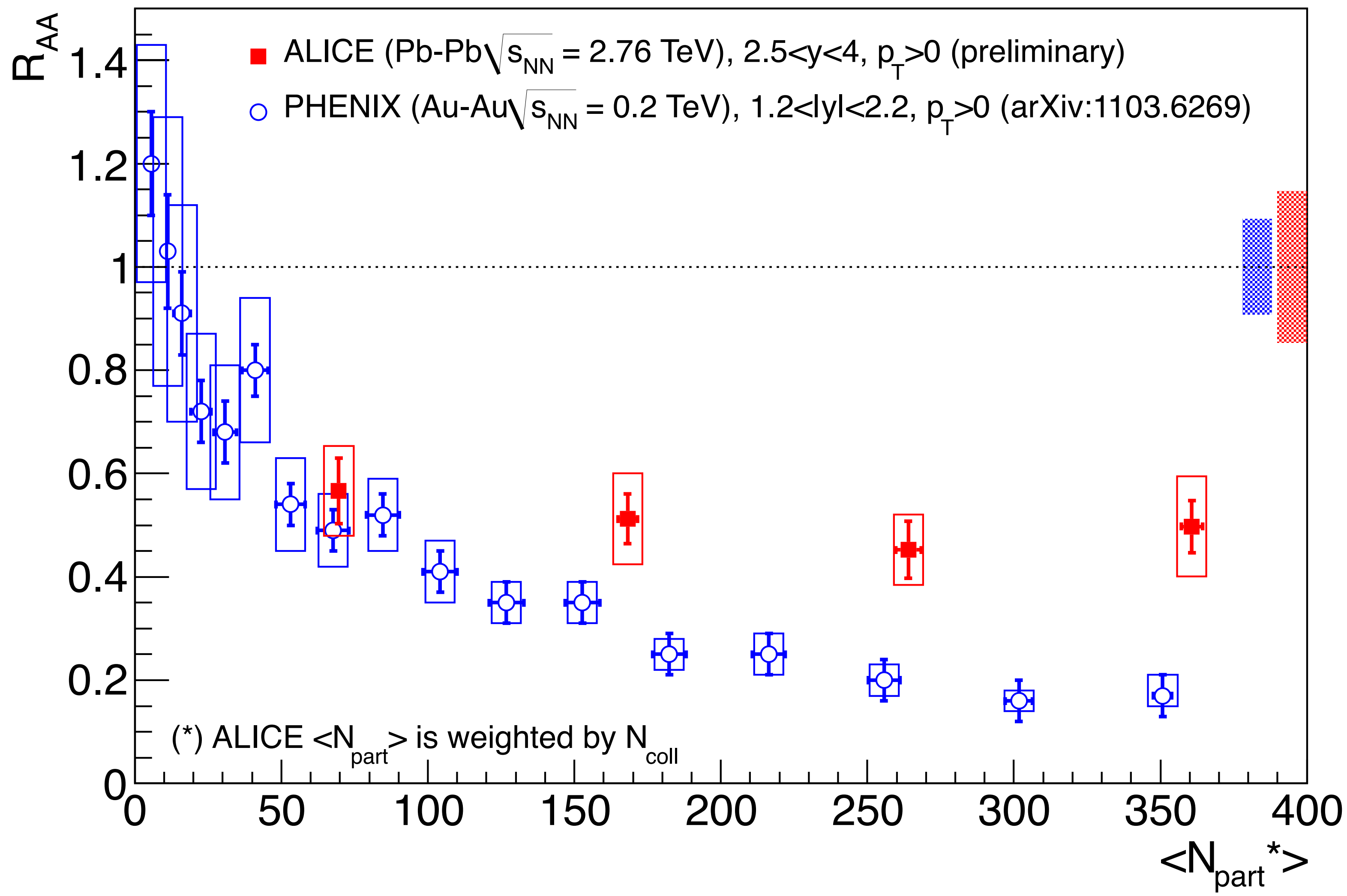


Very challenging analysis… error bars are still large

→ poster of J. Book and J. Wiechula (#75)

Comparison with PHENIX

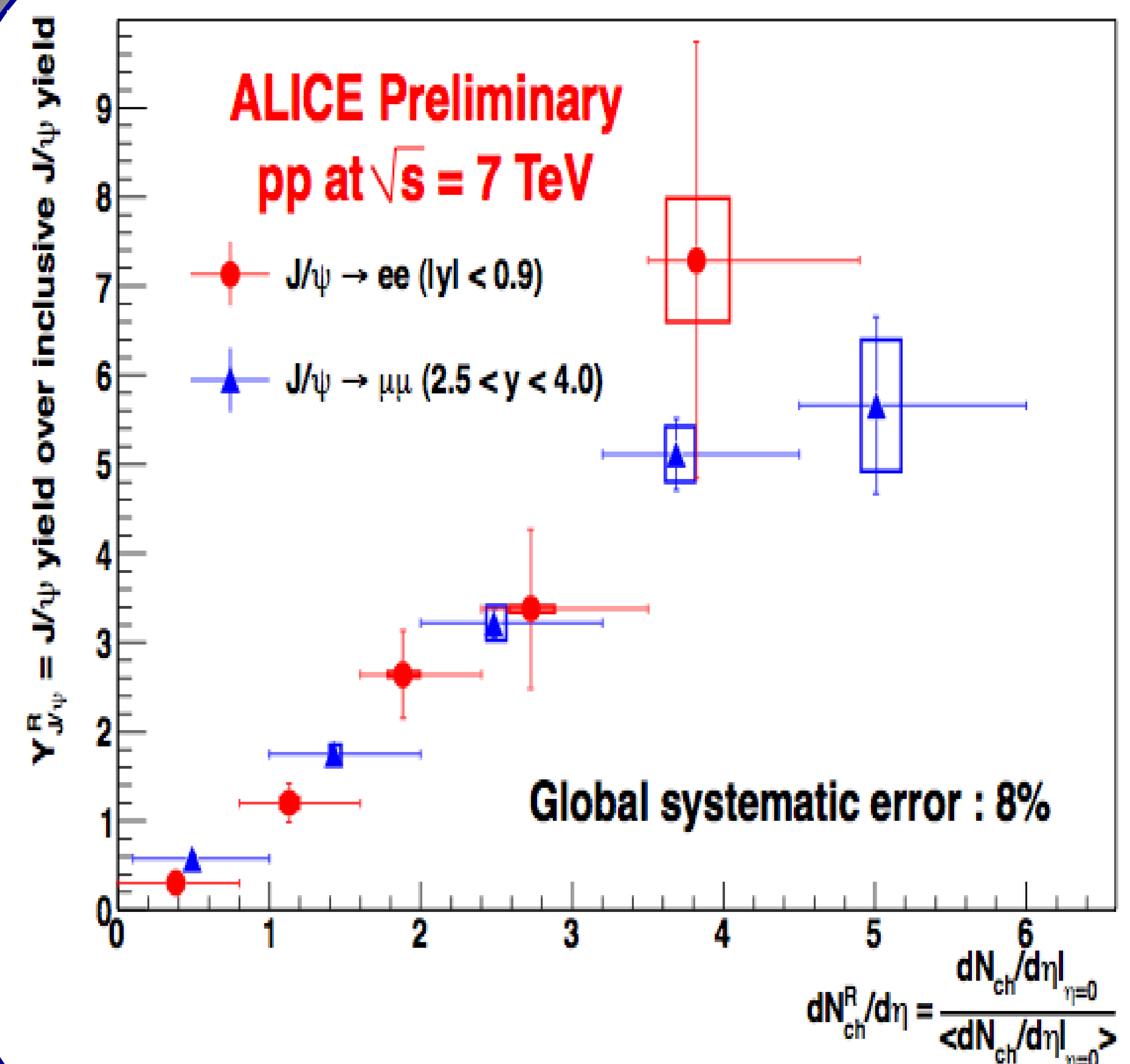
Given the size of our centrality bins, and in order to ease the comparison with PHENIX, the calculation of $\langle N_{part} \rangle$ for ALICE has been weighted by N_{coll}

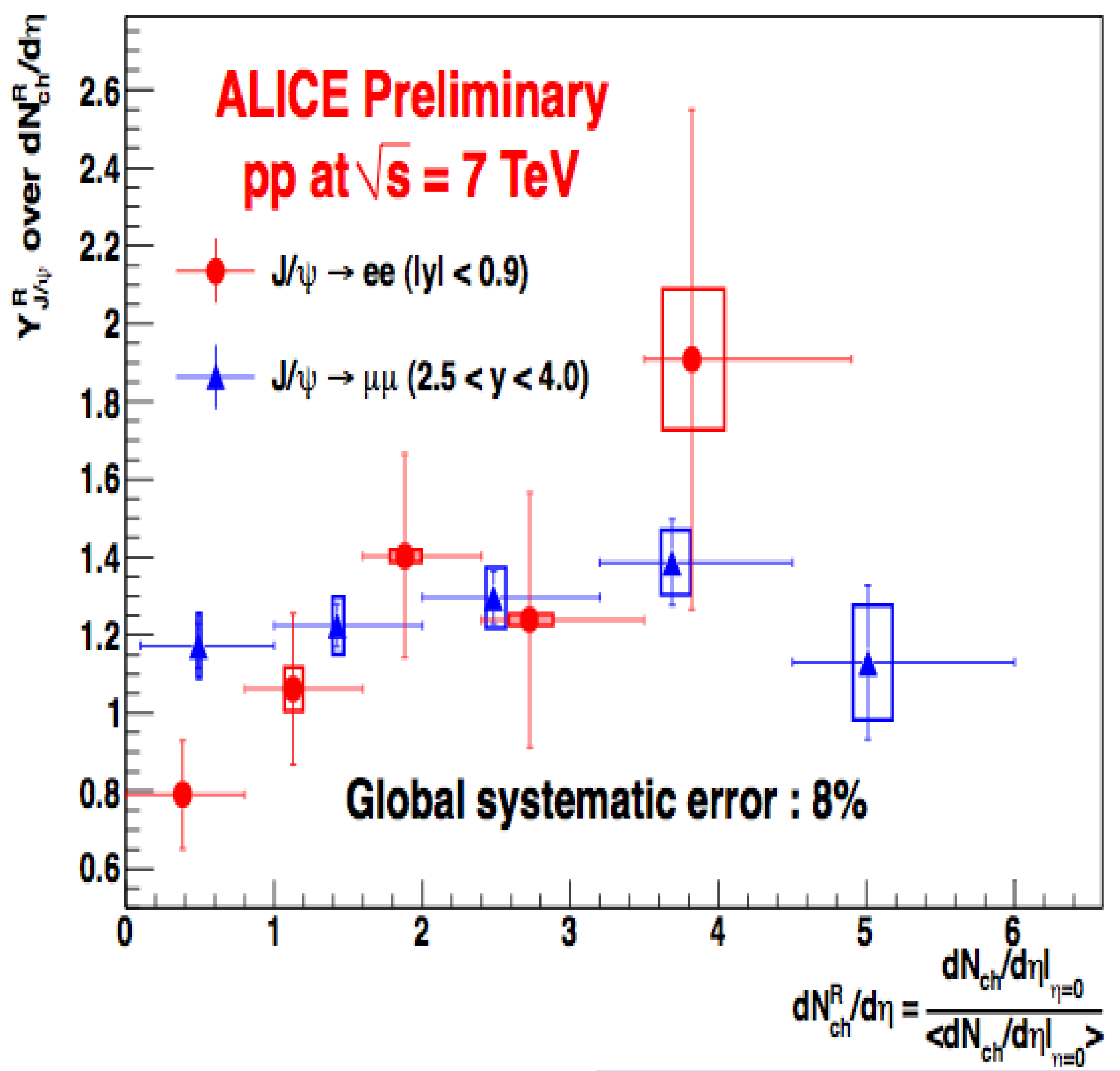


→ J/ψ R_{AA} in central collisions is larger at LHC in 2.5<y<4 than at RHIC in 1.2<|y|<2.2

J/ψ in high mult. pp events

Relative J/ψ yield: yield in multiplicity bin (|η|<1.6) over the yield per inelastic pp collision.





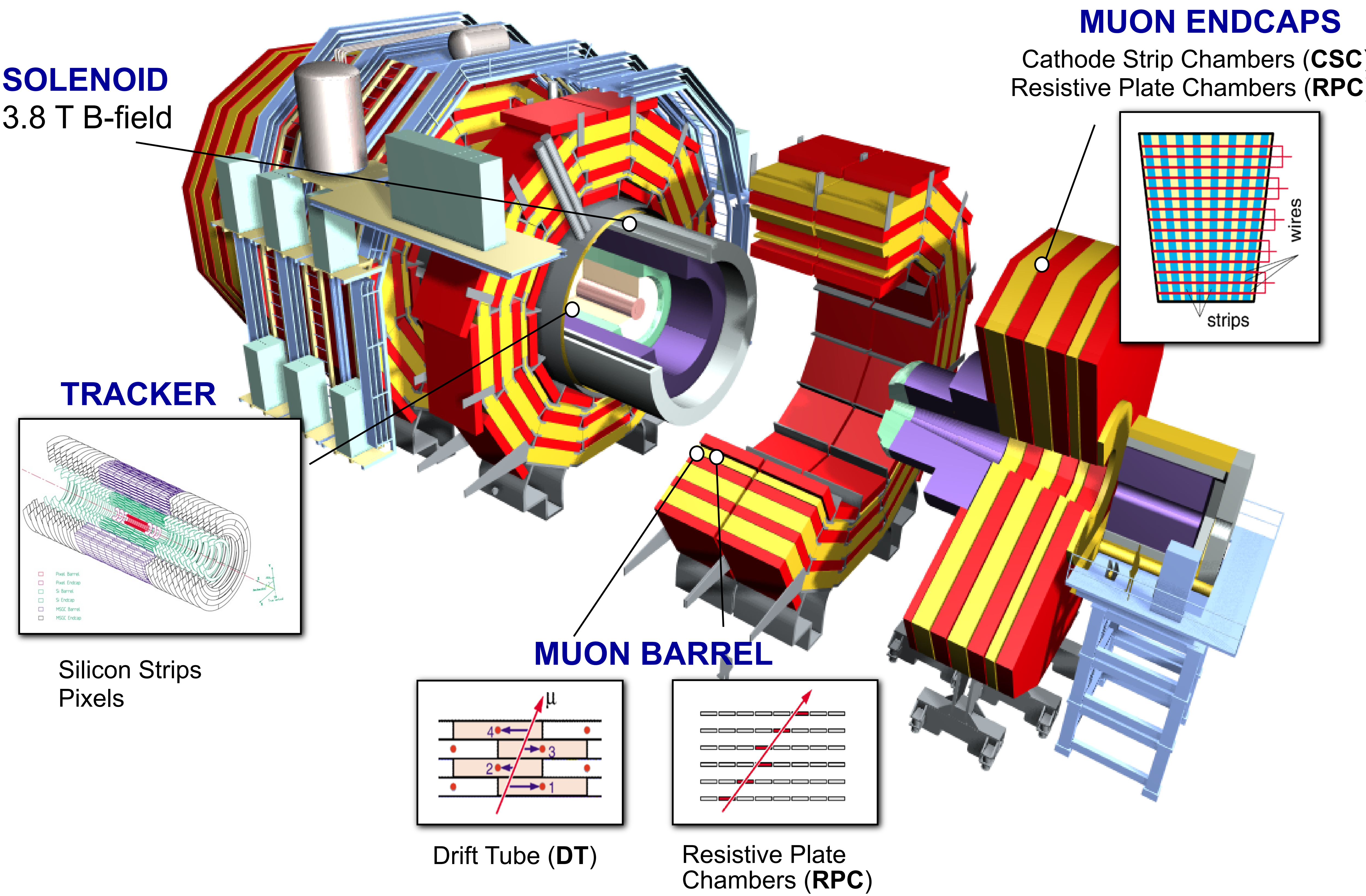
Poster #76 of F. Kramer & Poster #78 of M. Lenhardt

S. Porteboeuf & R. Granier, arXiv:1012.0719v1 (2011)

Linear increase of J/ψ yield with charged particle density.

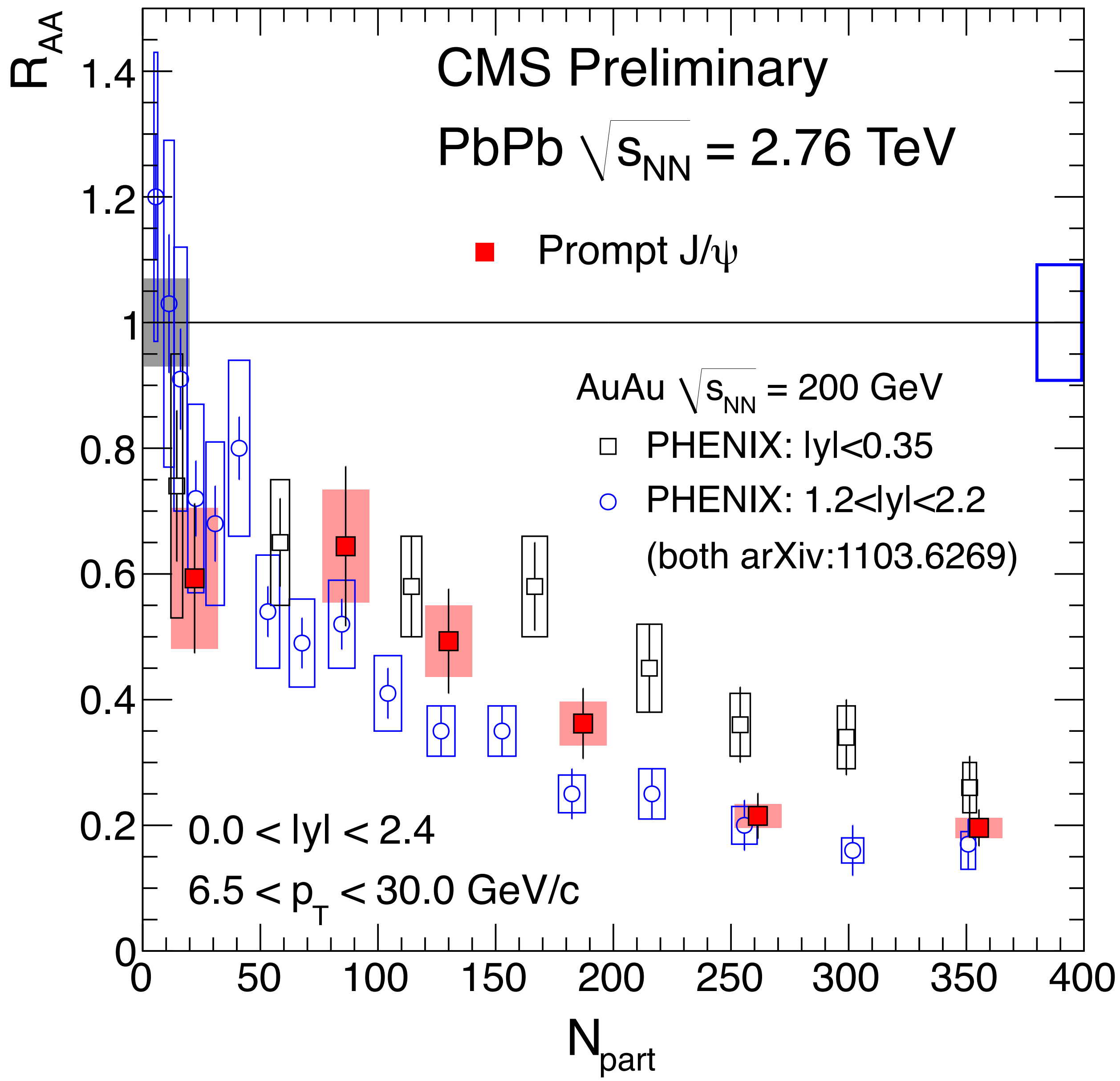
Compact Muon Solenoid

Silvestre (CMS)



Nuclear Modification Factor

Dahms (CMS)



PHENIX data: arXiv:1103.6269

Comparison to J/ψ in AuAu collisions at $\sqrt{s_{NN}}$ = 200 GeV

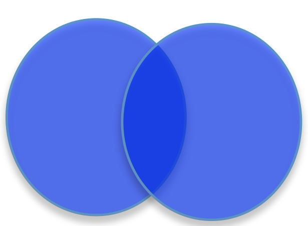
- Measured at much lower p_T
- Surprising qualitative agreement in centrality dependence
- Suppression in the most central collisions seems the same

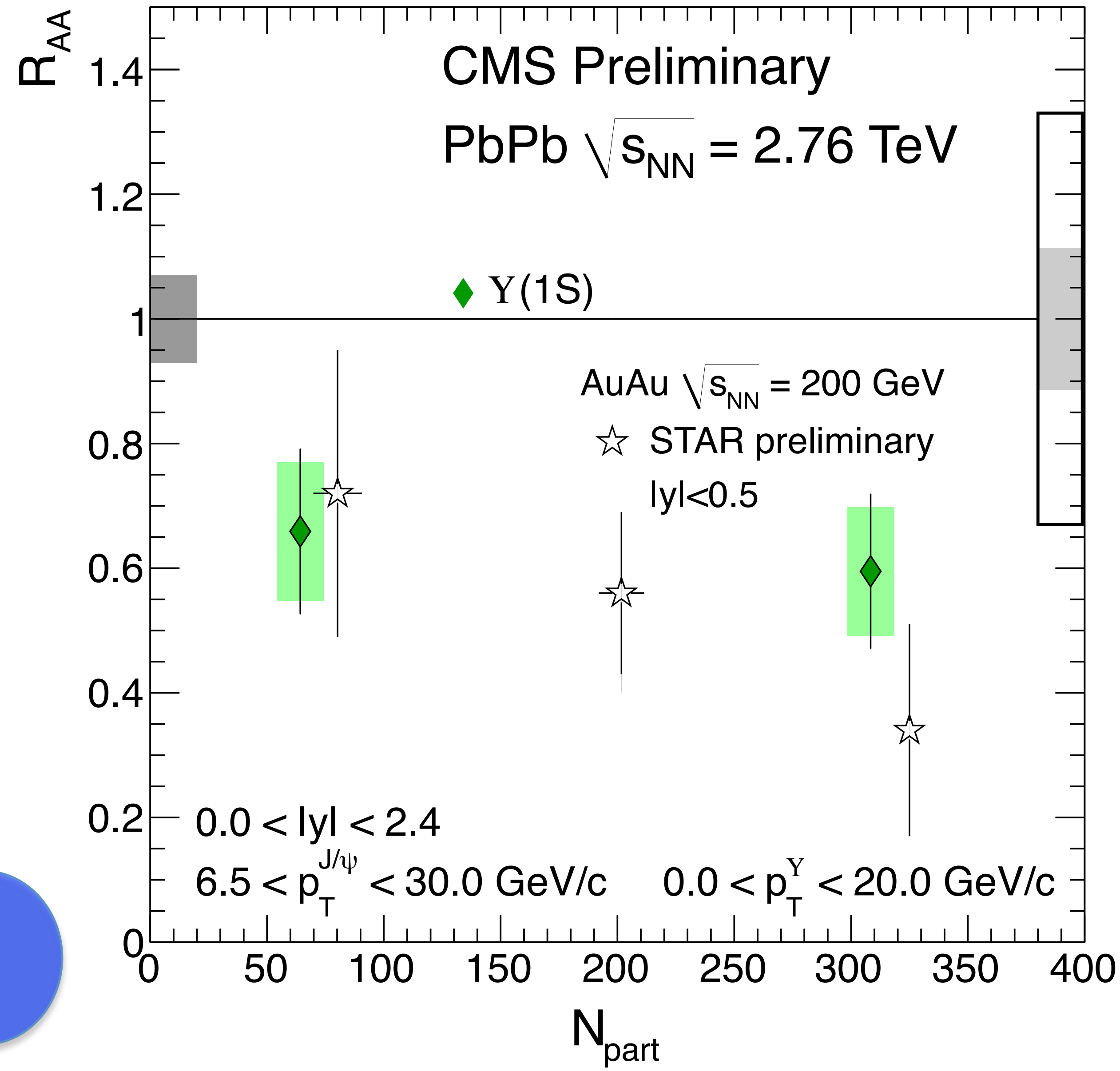
Υ(1S) R_{AA}

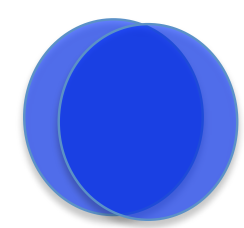
Silvestre (CMS)

PbPb

$\sqrt{s_{NN}}$=2.76 TeV







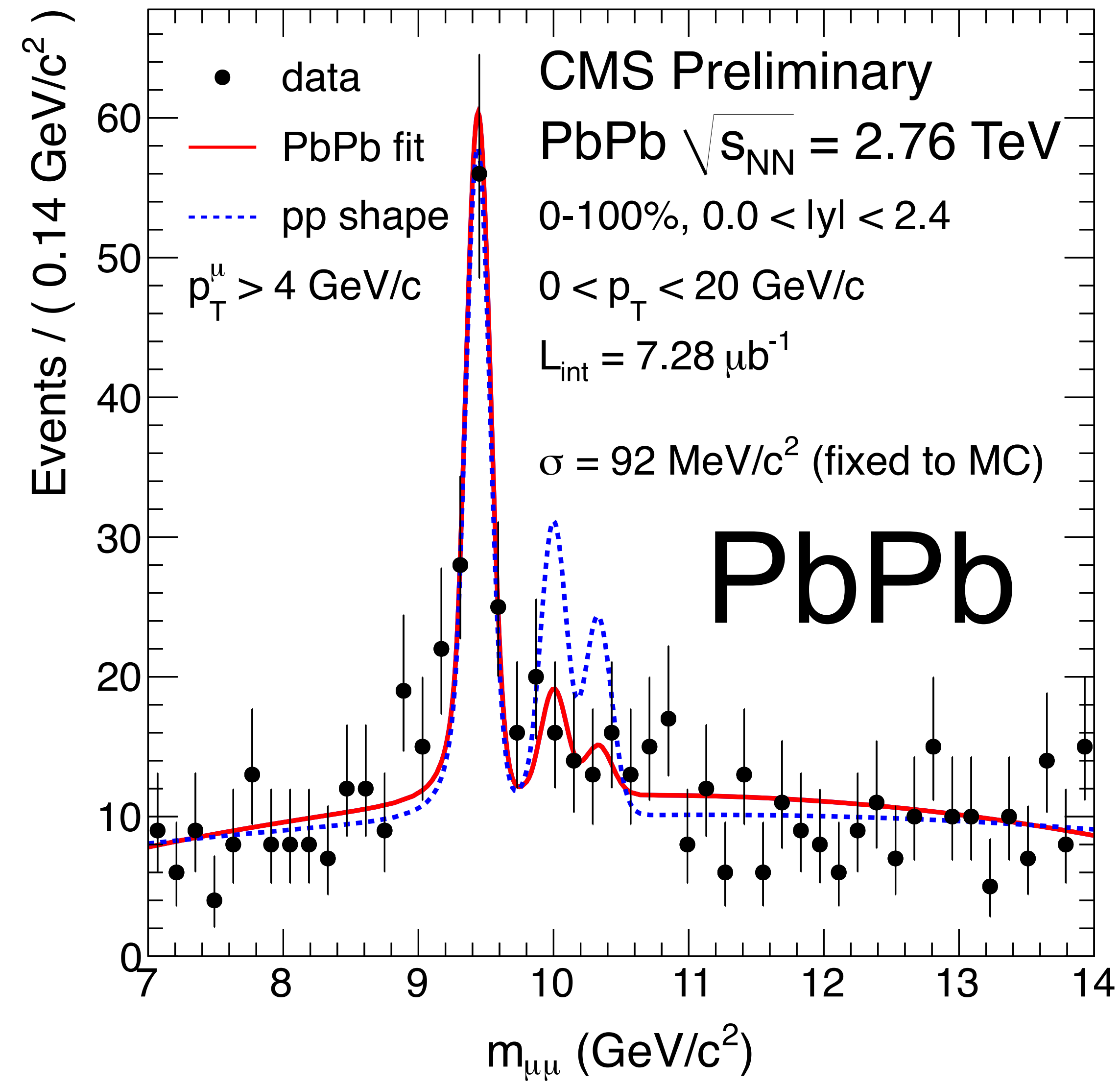
- **Comparison with STAR**
  - CMS Υ(1S) R_{AA}(0-100) = 0.62 ± 0.11 ± 0.10
  - STAR Υ(1+2+3S) R_{AA}(0-60) = 0.56 ± 0.11 $^{+0.02}_{-0.10}$

R. Reed (poster)

Silvestre (CMS)

Υ(2S+3S) Suppression PbPb $\sqrt{s_{NN}}$=2.76 TeV

$$\frac{\Upsilon(2S+3S)/\Upsilon(1S)|_{PbPb}}{\Upsilon(2S+3S)/\Upsilon(1S)|_{pp}}$$



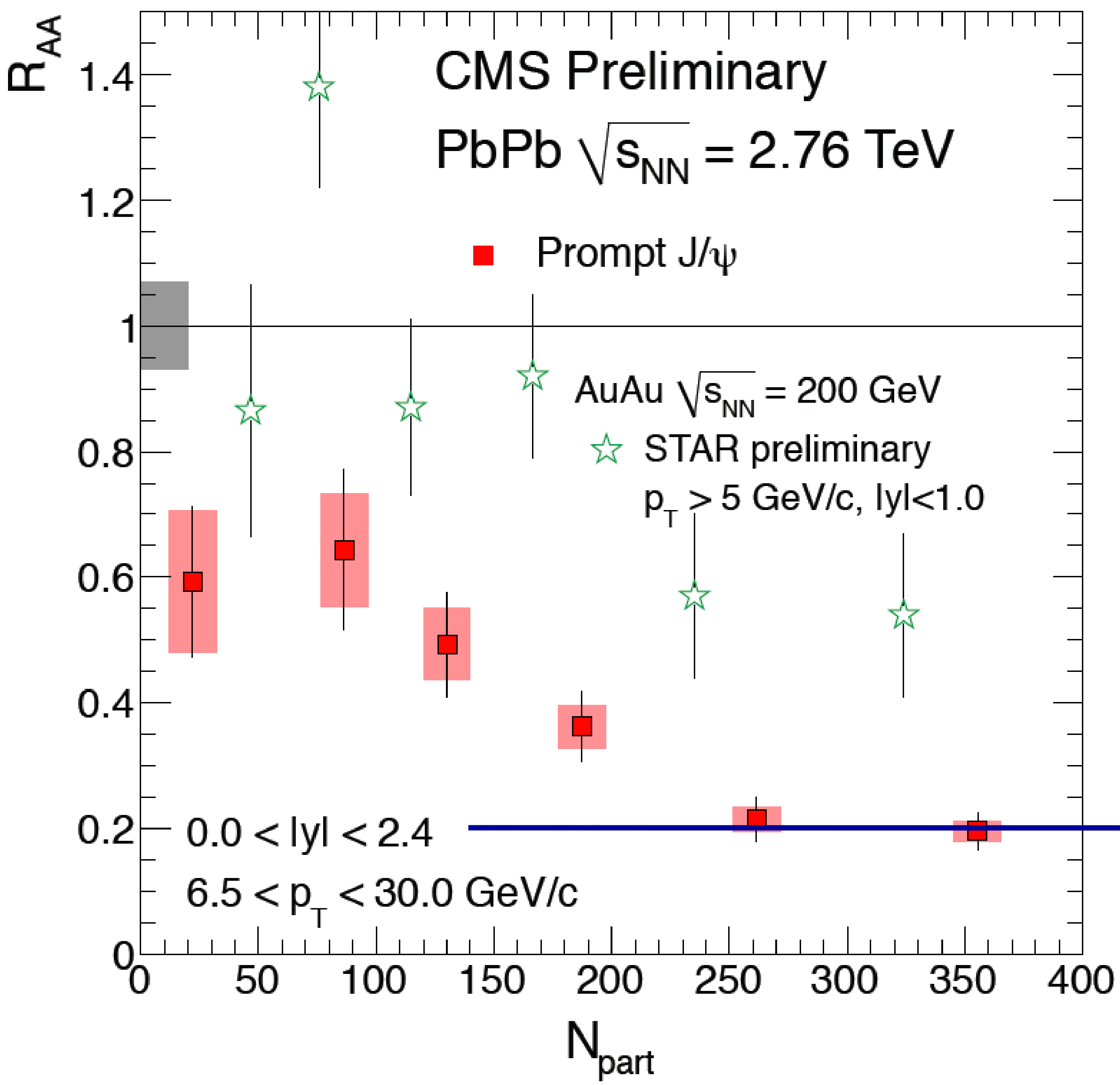
- **Pros of a double ratio**
  - Acceptance cancels
  - Efficiency cancels
- **Potential differences**
  - Remaining systematics 9%, from line shapes

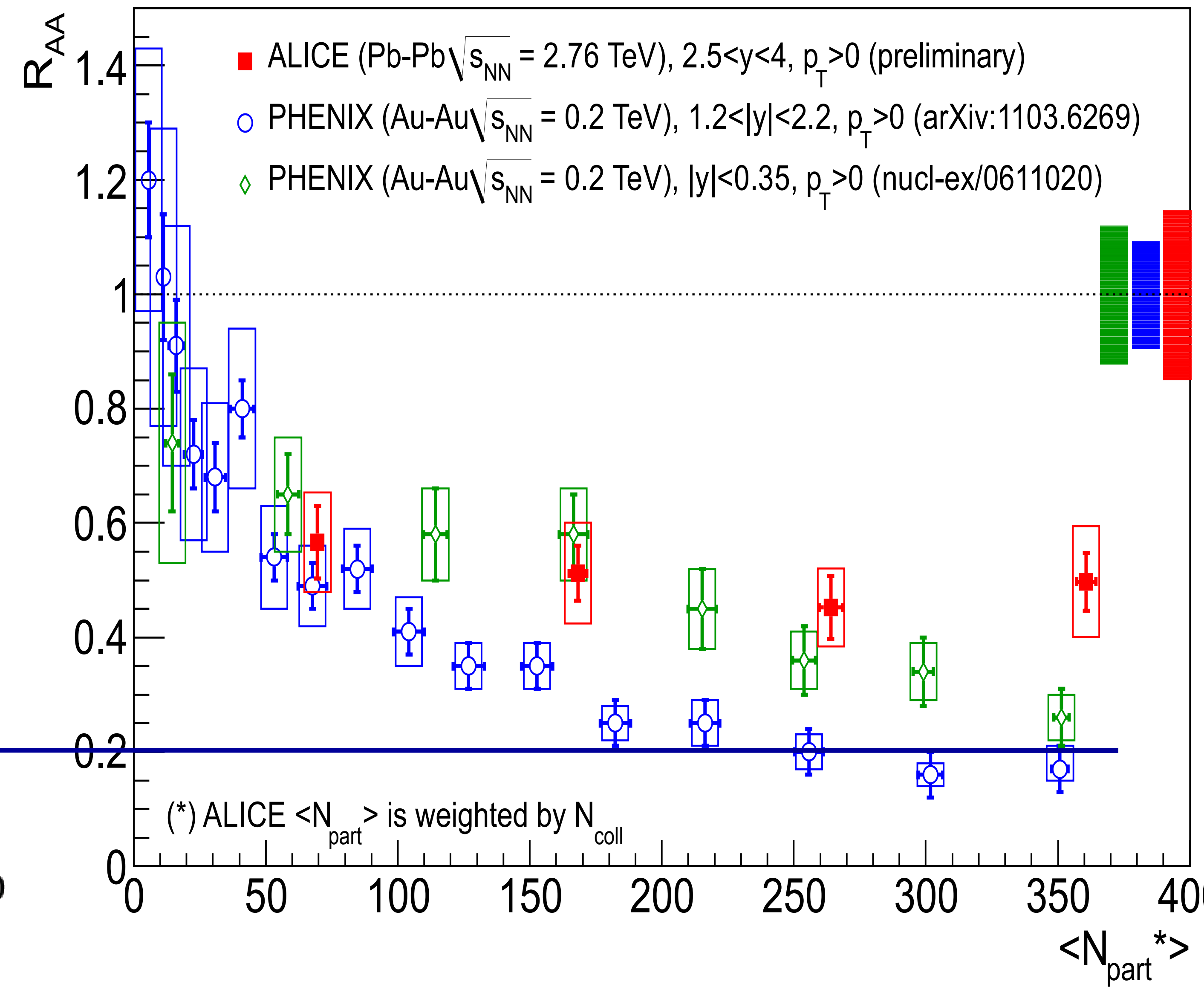
$$\frac{\Upsilon(2S+3S)/\Upsilon(1S)|_{PbPb}}{\Upsilon(2S+3S)/\Upsilon(1S)|_{pp}} = 0.31^{+0.19}_{-0.15} \pm 0.03$$

arXiv : 1105.4894
Submitted to PRL

Hypothesis: no suppression ⇒ p-value 1%
Significance of the suppression 2.4 σ

LHC/RHIC comparison





STAR (p_T>5 GeV) versus CMS (6.5<p_T<30 GeV)

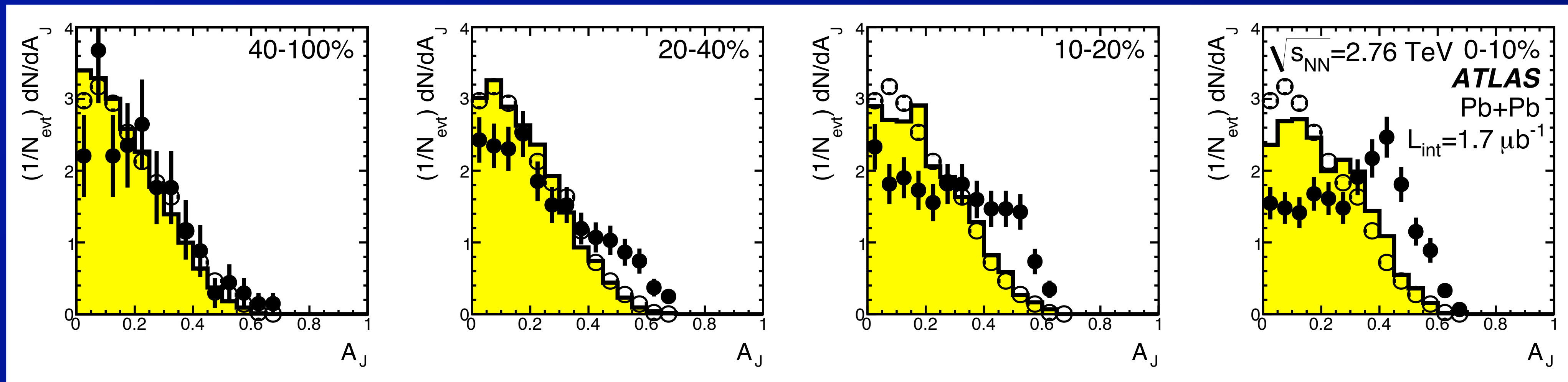
PHENIX (p_T>0 GeV) versus ALICE (p_T>0 GeV)

Caveat: Different beam energy and rapidity coverage;
$dN_{ch}/d\eta(N_{part})^{LHC} \sim 2.1 \times dN_{ch}/d\eta(N_{part})^{RHIC}$ (A. Toia talk).

Jets, Photons, High p_T hadrons (@LHC)

Di-jet Asymmetry

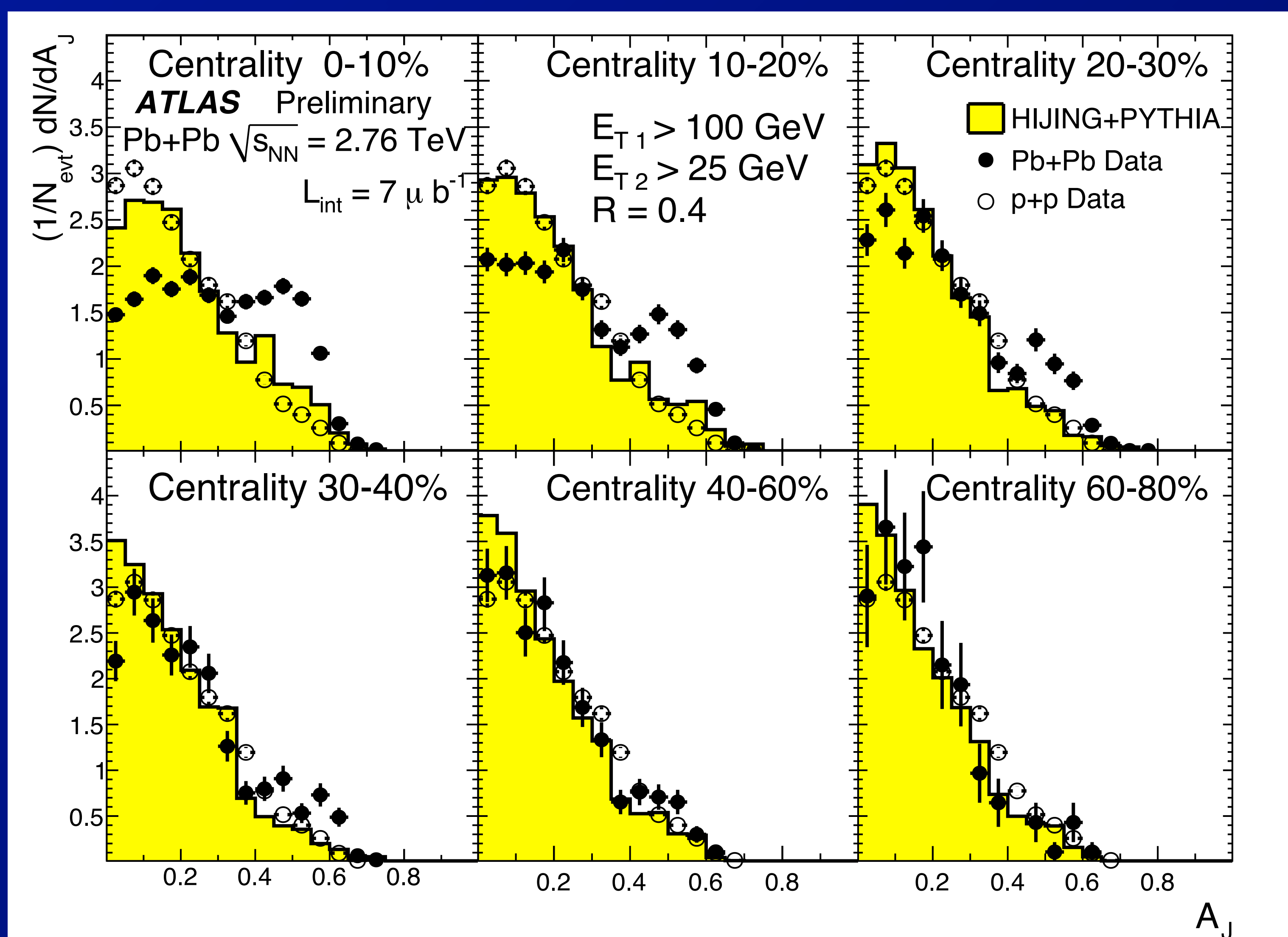
Cole (ATLAS)



2010 PRL results

R = 0.4, E_{T1} > 100 GeV, E_{T2} > 25 GeV

$$A_J \equiv \frac{E_{T1} - E_{T2}}{E_{T2} + E_{T1}}$$

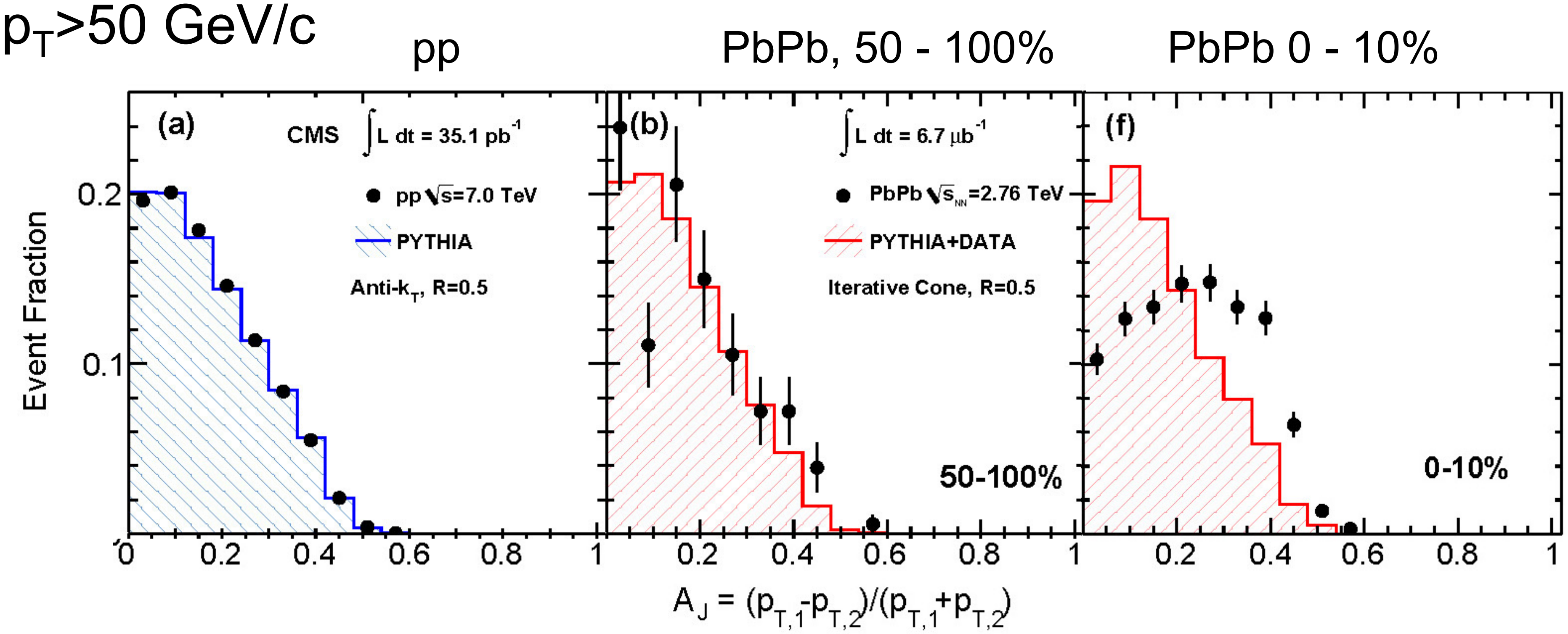


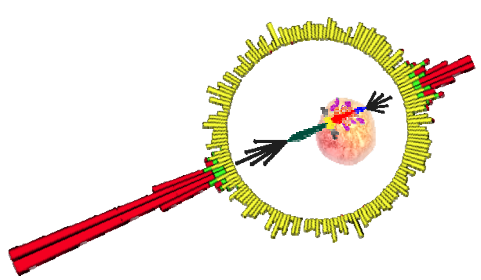
- **Update:**
  - Full statistics
  - Iteration step in background estimation
  - Correction for flow in underlying event
  - MC down to 35 GeV

Jet quenching via large dijet energy imbalance

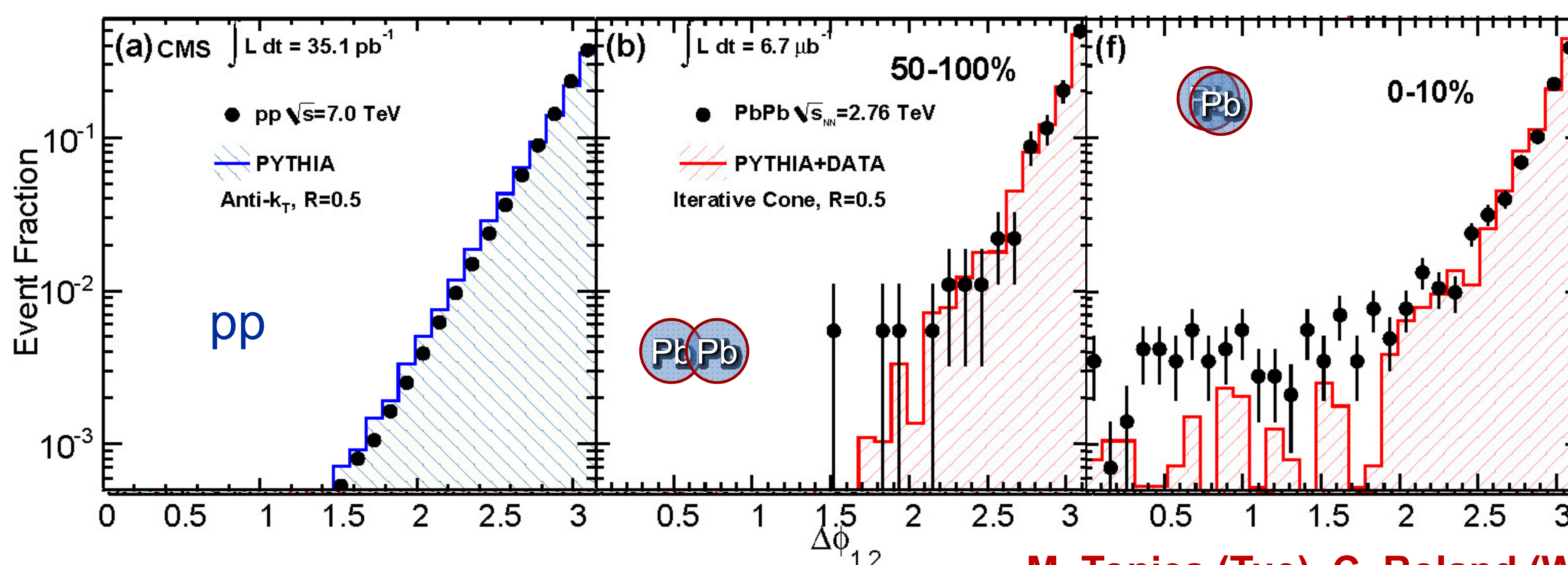
- Dijets, calorimeters only
  - Leading p_T>120 GeV/c
  - Sub-leading p_T>50 GeV/c

p_T imbalance, increasing with centrality





Back-to-back Δϕ~π for all centralities



arXiv:1102.1957

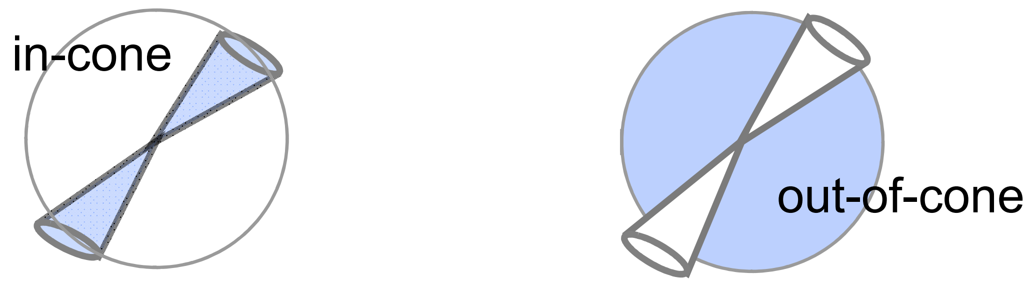
M. Tonjes (Tue), C. Roland (Wed)

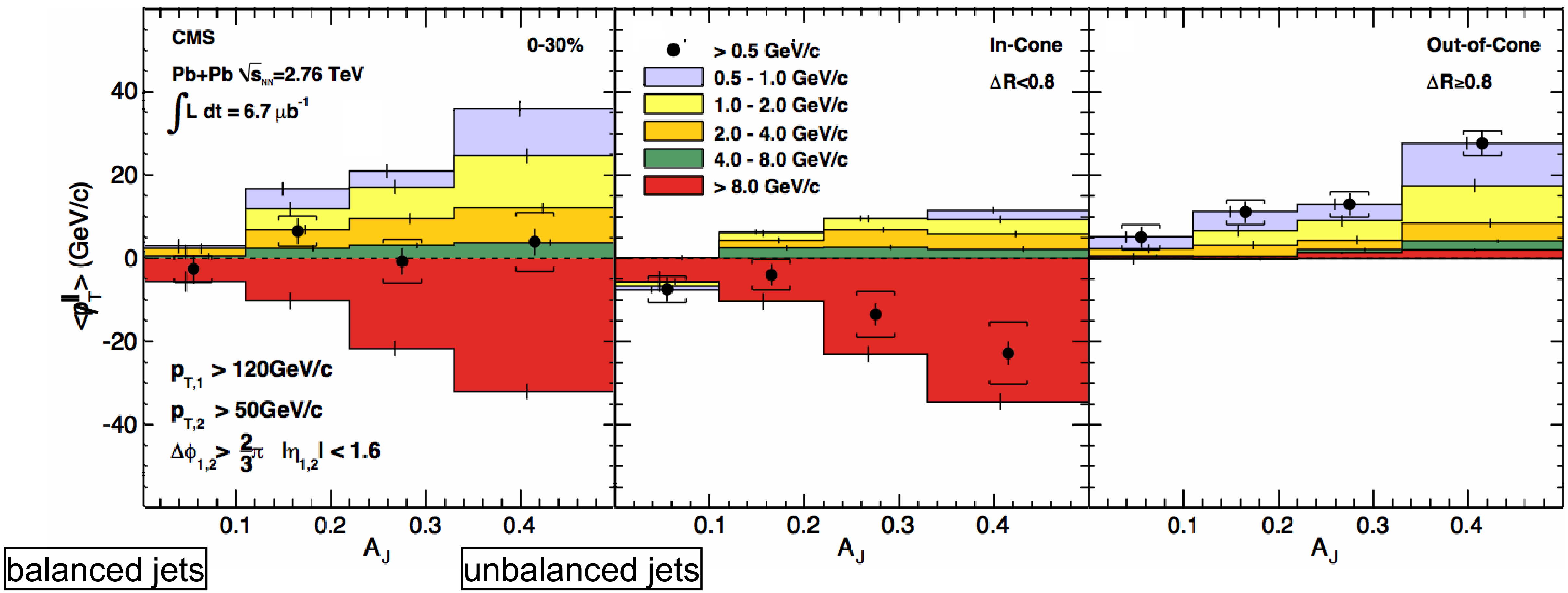
Where is the energy? spread out low p_T particles

Wyslouch (CMS)

$$\not{p}_T^{\parallel} = \sum_{\text{Tracks}} -p_T^{\text{Track}} \cos\left(\phi_{\text{Track}} - \phi_{\text{Leading Jet}}\right)$$

0-30% Central PbPb





Low p_T, full acceptance
Momentum is balanced

In-cone large momentum imbalance at high p_T
Consistent with calorimetry

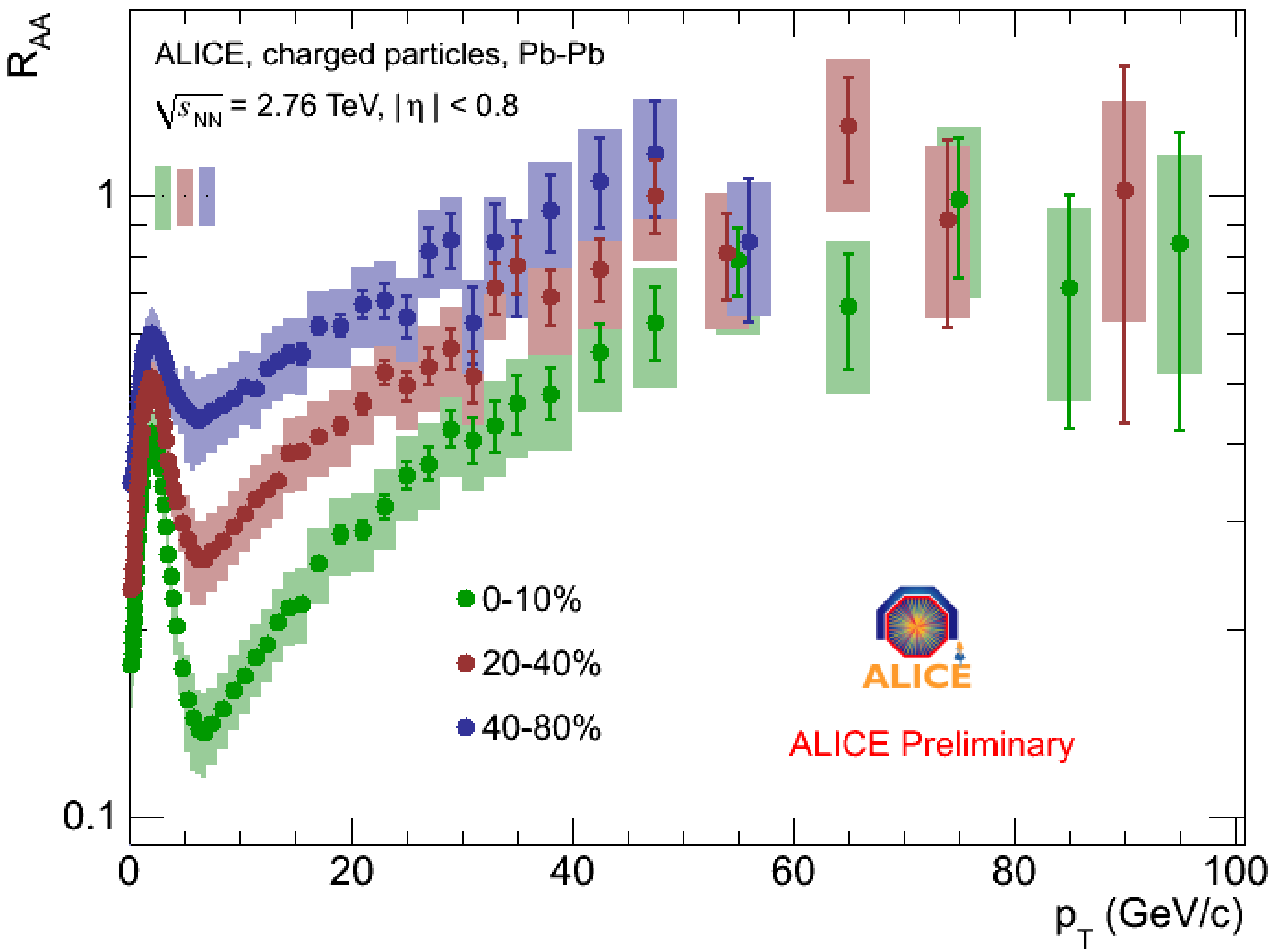
Out-off-cone low p_T particles balance the complete event

arXiv:1102.1957

M. Tonjes (Tue), C. Roland (Wed)

charged particle R_{AA}

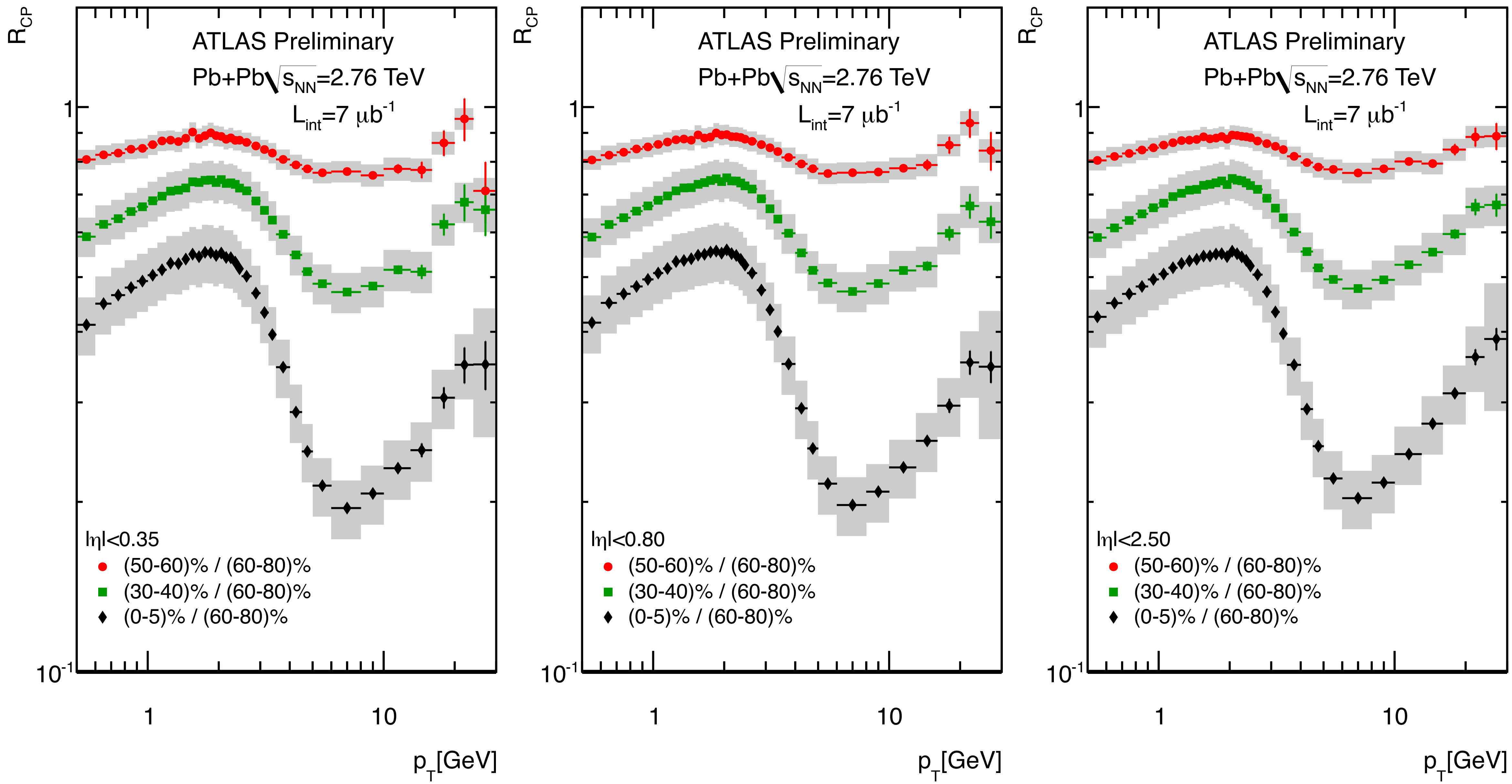
Appelshäuser (ALICE)



- pronounced centrality dependence below p_T = 50 GeV/c
- minimum at $p_T \approx$ 6-7 GeV/c
- strong rise in 6 < p_T < 50 GeV/c
- no significant centrality and p_T dependence at p_T > 50 GeV/c

Steinberg (ATLAS)

Charged particle RCP



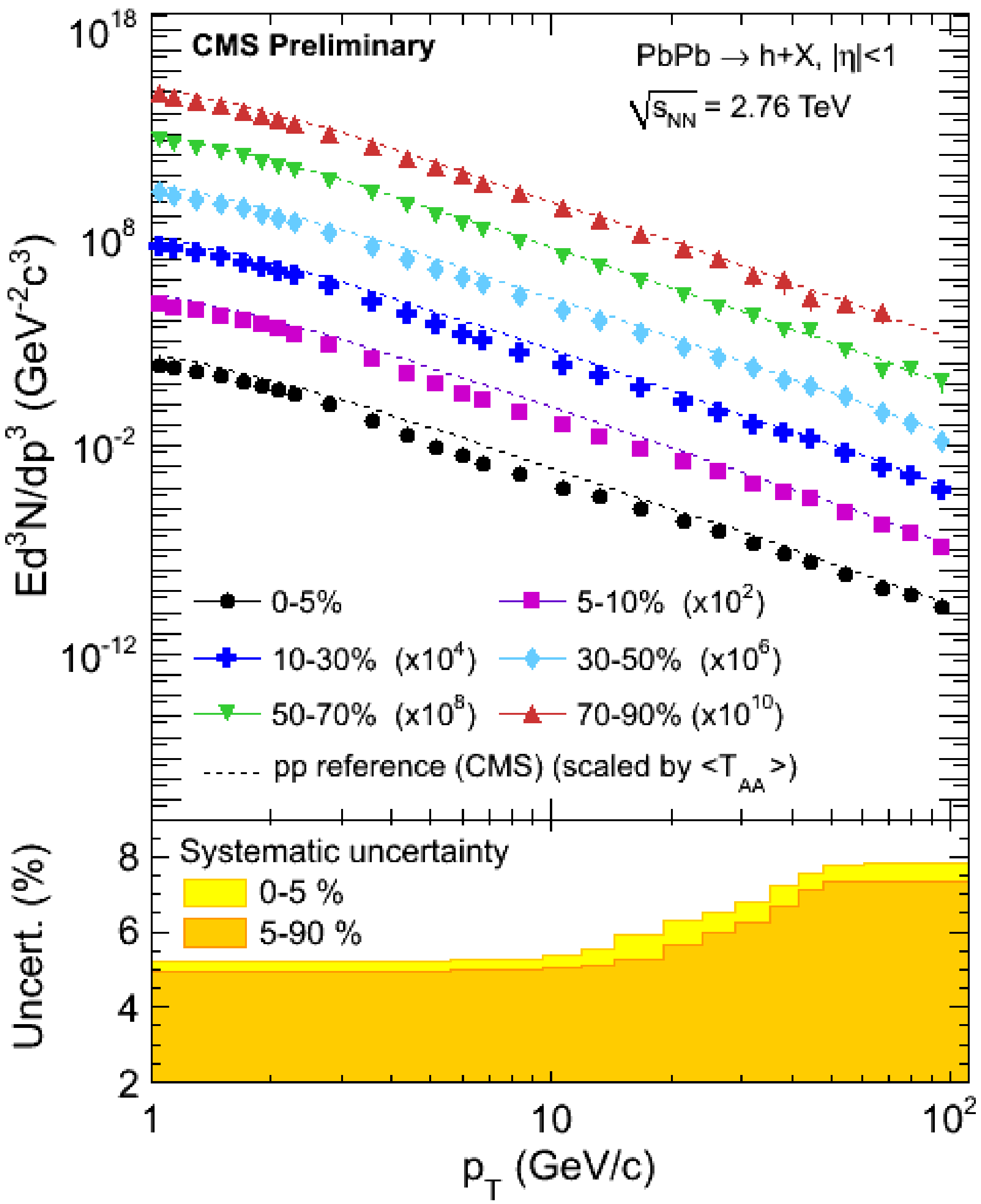
Strong suppression seen in more central events via charged RCP

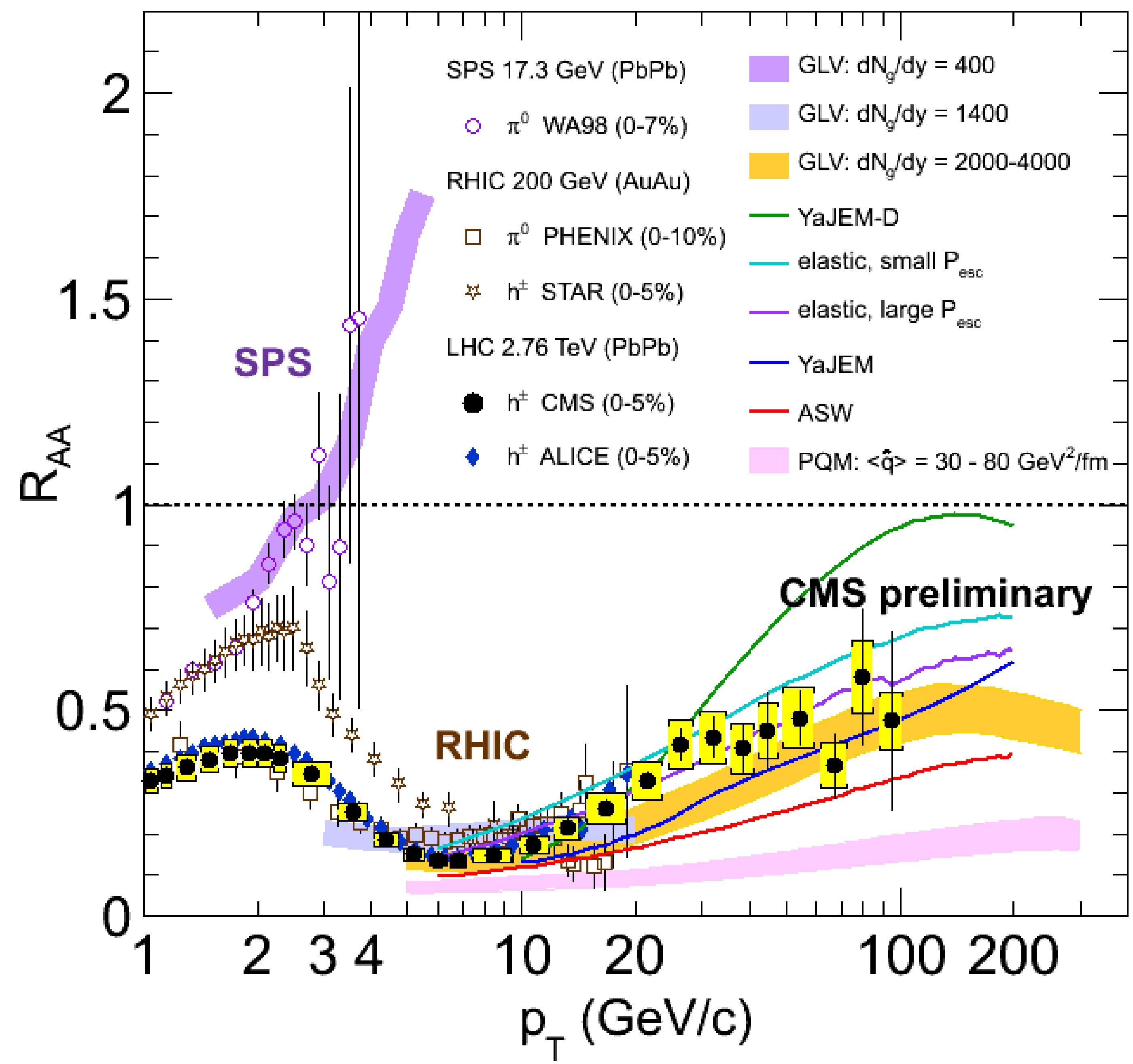
No η dependence observed

for details, see talk by Sasha Milov (3:20pm Thurs.)

High p_T charged hadron suppression

- Measuring charged tracks up to p_T~100 GeV/c
- Using jet triggers to enhance statistics at high p_T

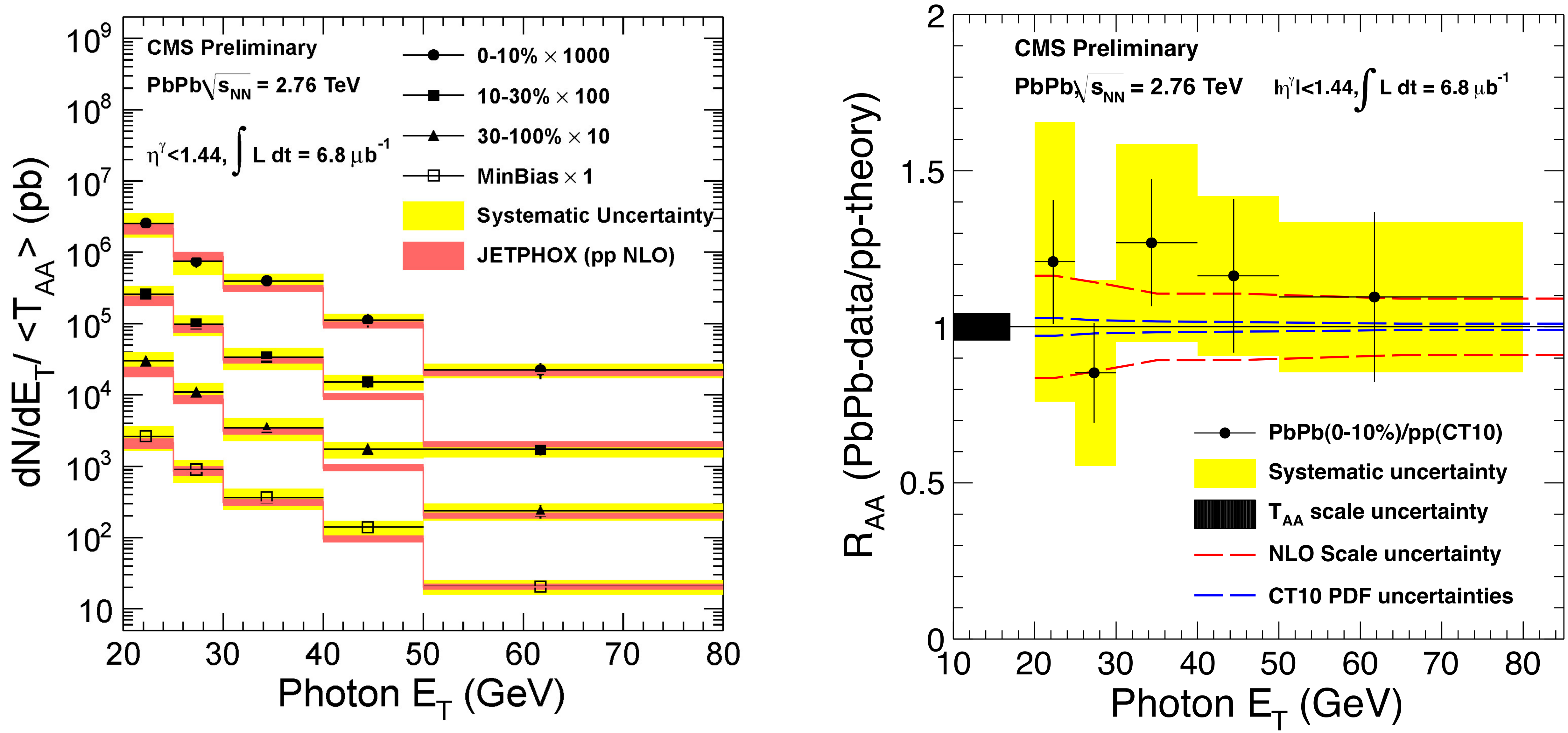




Y-J Lee (Wed) A. Yoon (Thu)

Unsuppressed isolated high p_T photons

Wyslouch (CMS)



Confirmation of collisional scaling

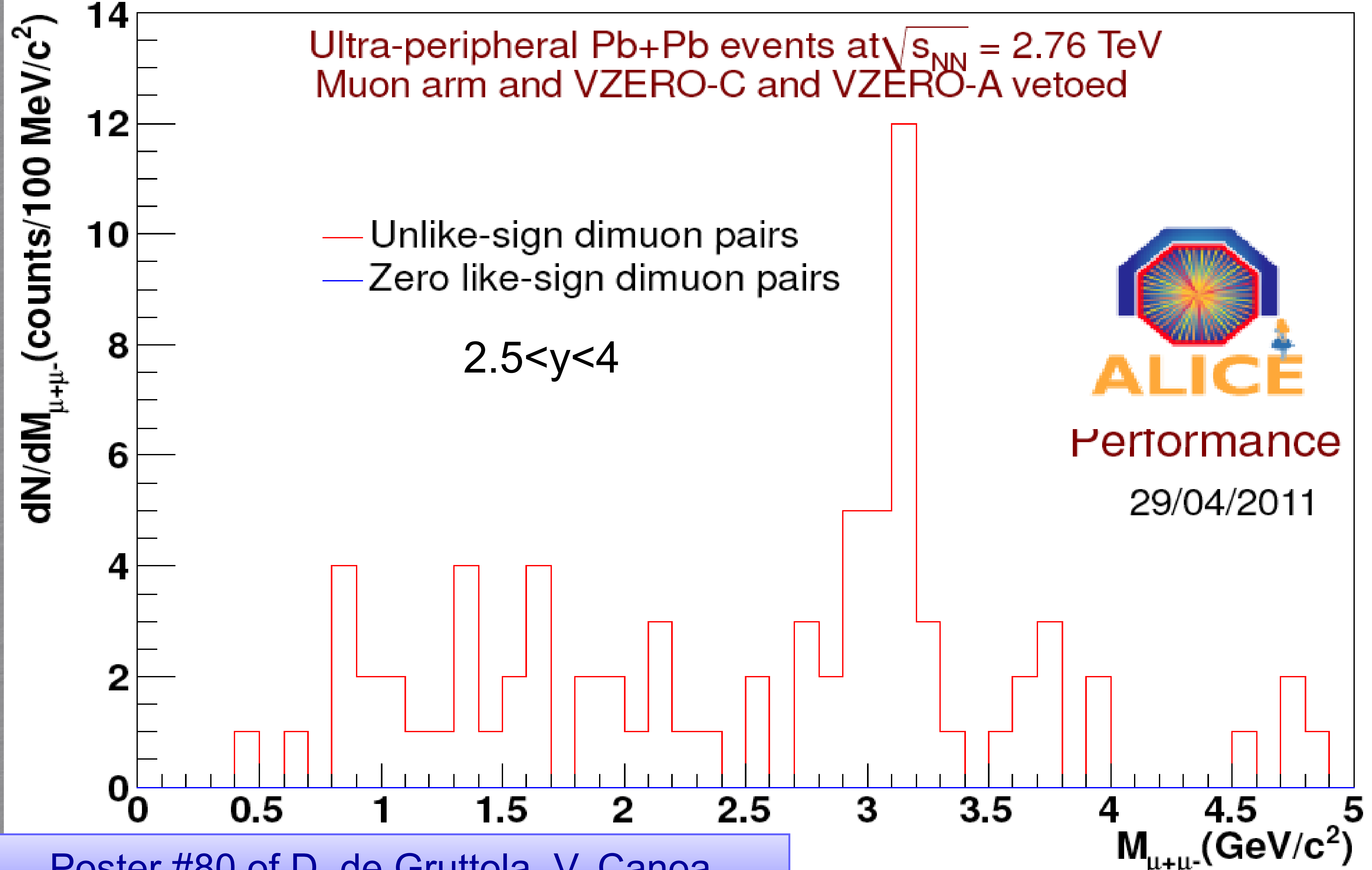
No nuclear modifications seen

Y-J Lee (Thu), Y Kim (Fri)

Exotica

J/ψ signals in Pb-Pb

From Pb-Pb UPC



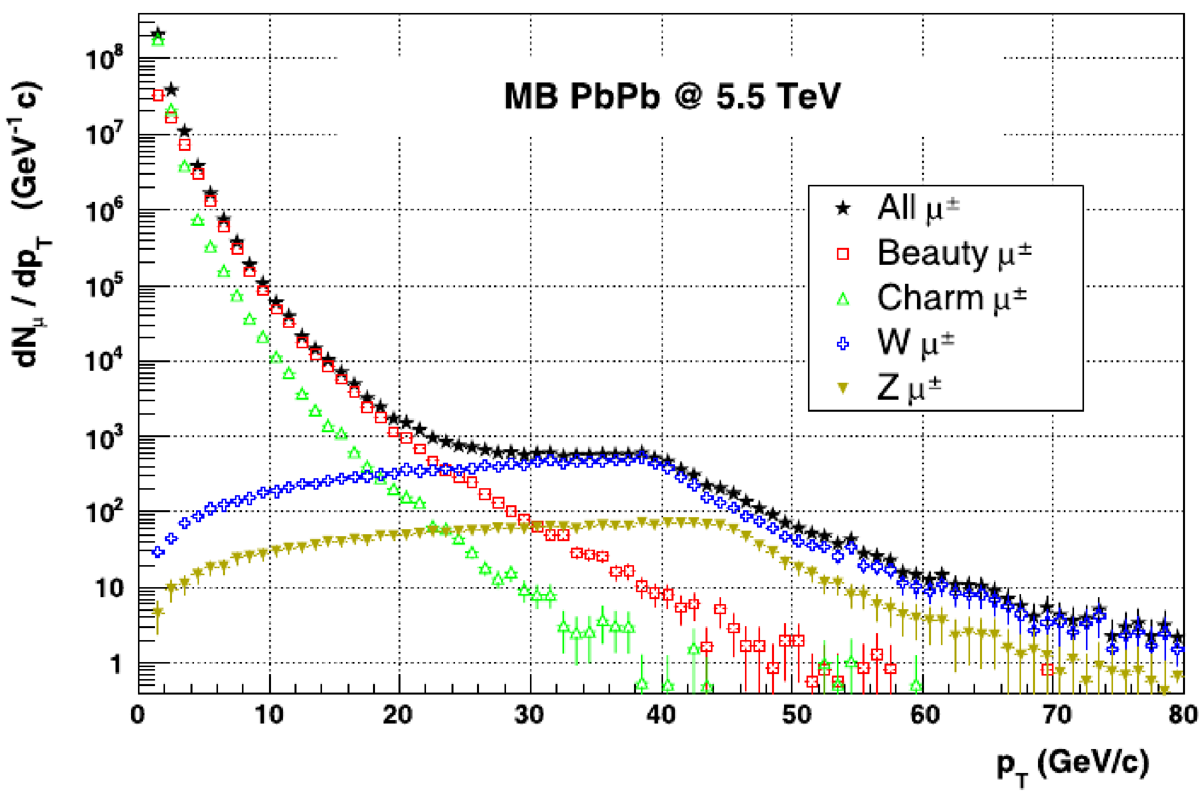
Poster #80 of D. de Gruttola, V. Canoa

Poster #75 of J. Book, J. Wiechula

J/ψ signal seen in PbPb central collisions in ALICE.

Principle behind *W* identification

- $W \to \mu\nu$ needs missing energy term to be reconstructed, which is unreliable in a Pb+Pb environment.

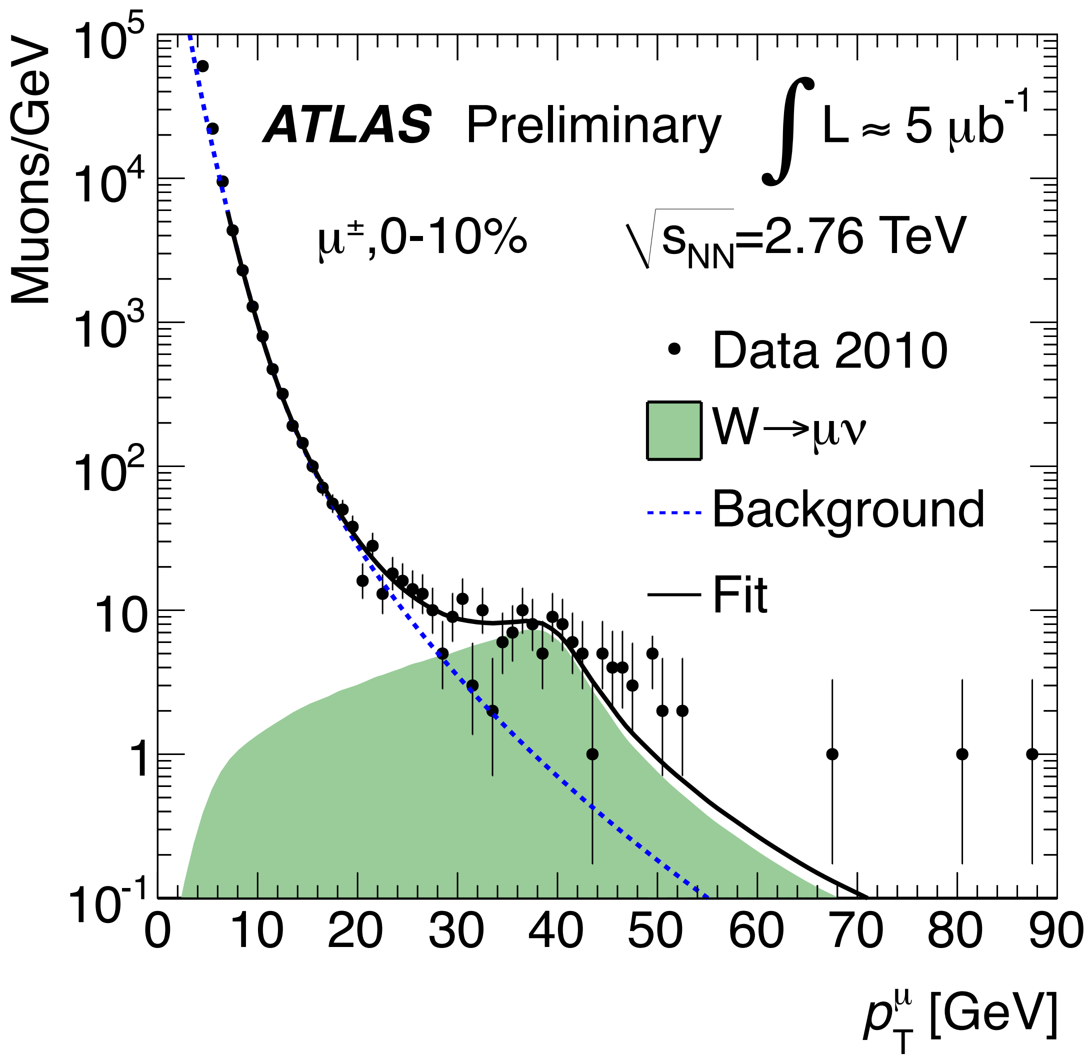


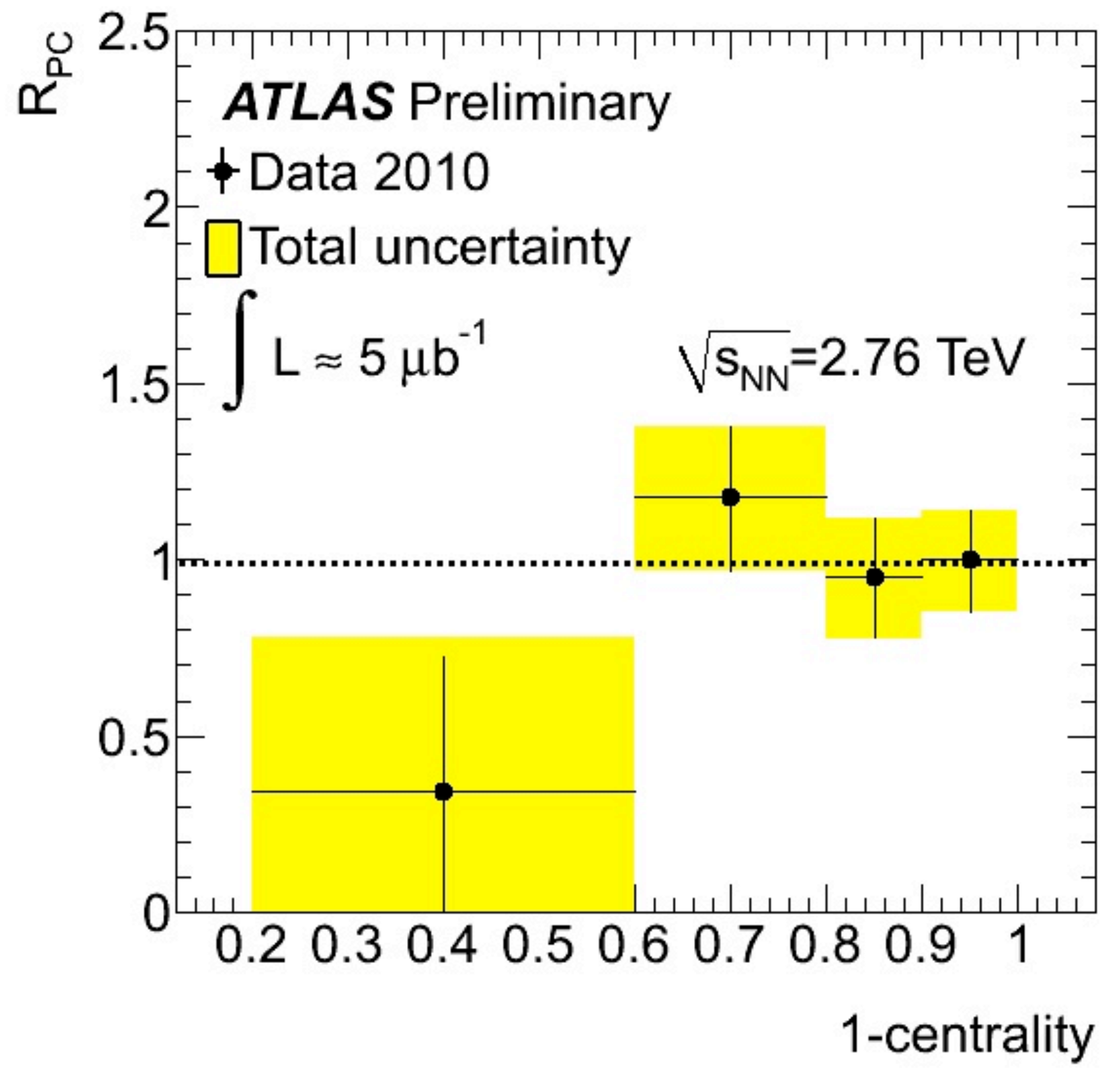
Electroweak boson detection in the ALICE muon spectrometer
Z. Conesa del Valle for the ALICE Collaboration
Eur. Phys J. C 49, 149-154 (2007)

- Muons from *W* are in average more energetic than muons from QCD processes.
- At high transverse momenta, the two dominating sources of single muons are *b*-quark decays and *W* decays.
- The muons from *W* creates a "shoulder" in the p_T spectrum.
- The amplitude of the shoulder gives the number of $W \to \mu\nu$ in the dataset.

Steinberg (ATLAS)

Hard probes: N_{coll} scaling from $W^{\pm}$ production





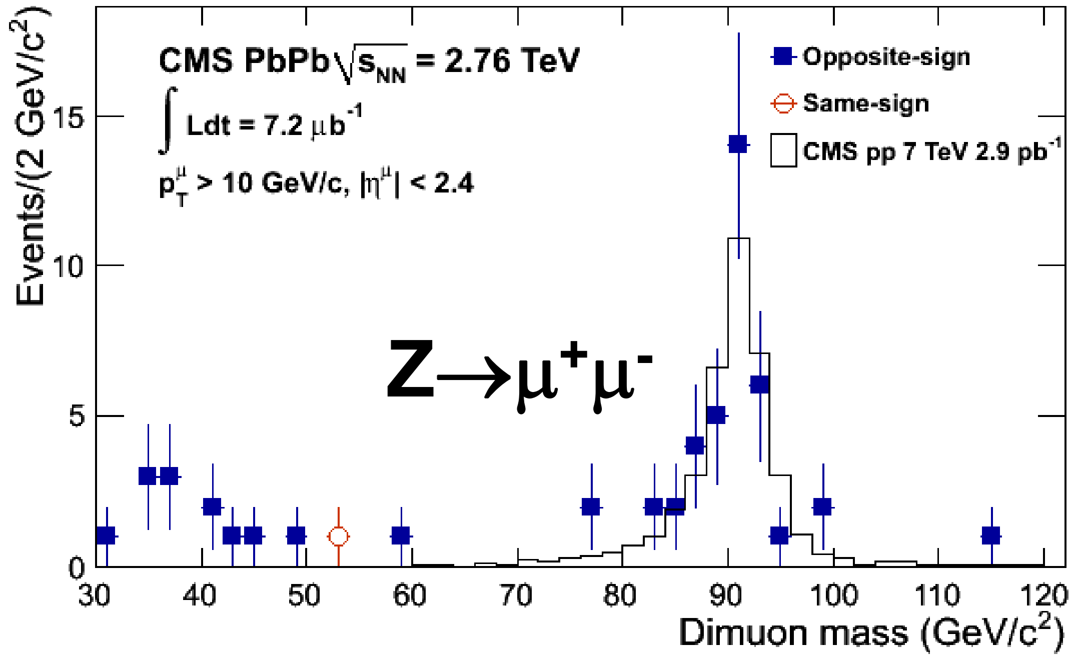
W yields extracted using an empirical fit to single muon spectra: heavy flavor (adapted from p+p) and simulated PYTHIA $W^{\pm}$ template

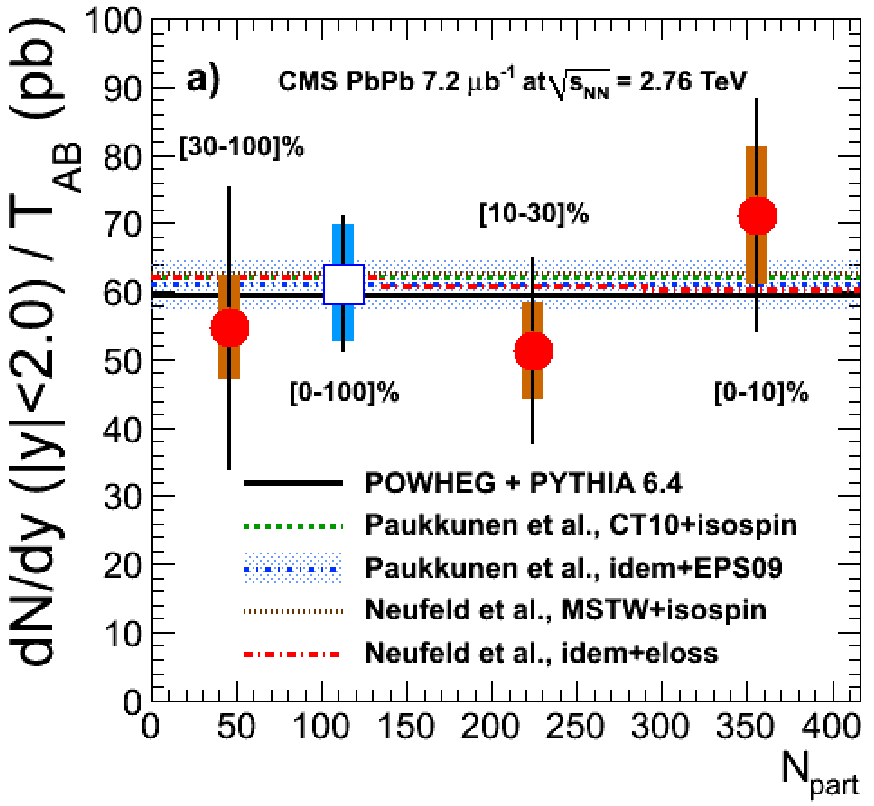
Pinned to most central events (R_{PC}), N_{coll} scaling observed.

for details, see talk by Rikard Sandström (3:20pm Thurs)

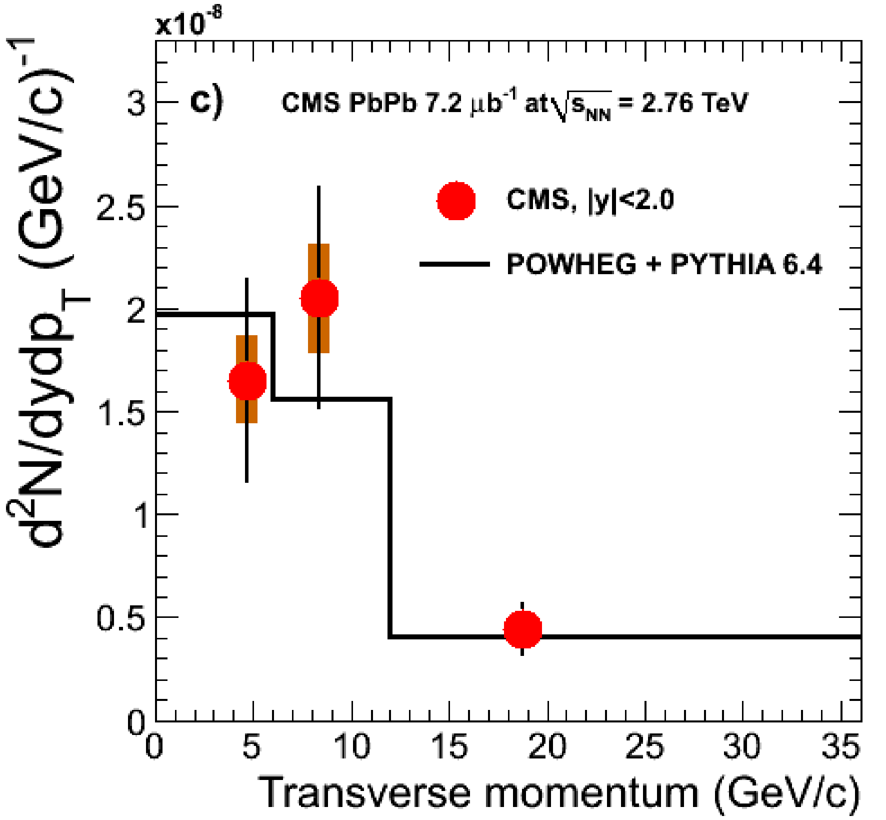
Wyslouch (CMS)

Z bosons show collisional scaling





No significant dependence on centrality



p_T dependence consistent with pp

arXiv:1102.5435 accepted by PRL

J Robles (Thu)

Conclusion

- Very rich QM edition with the first Pb-Pb LHC run
- QGP@LHC looks like a «perfect» liquid (similar to RHIC)
- Jet quenching
- Hadron suppression as a function of P_T
- Open charm and beauty suppression @ LHC
- Charmonia @ LHC
  - J/Psi : Less suppressed that RHIC => recombination could play a role
  - Upsilon: Suppression observed (CMS/STAR)

More work needed for the interpretation
Theoreticians/Experimentalists

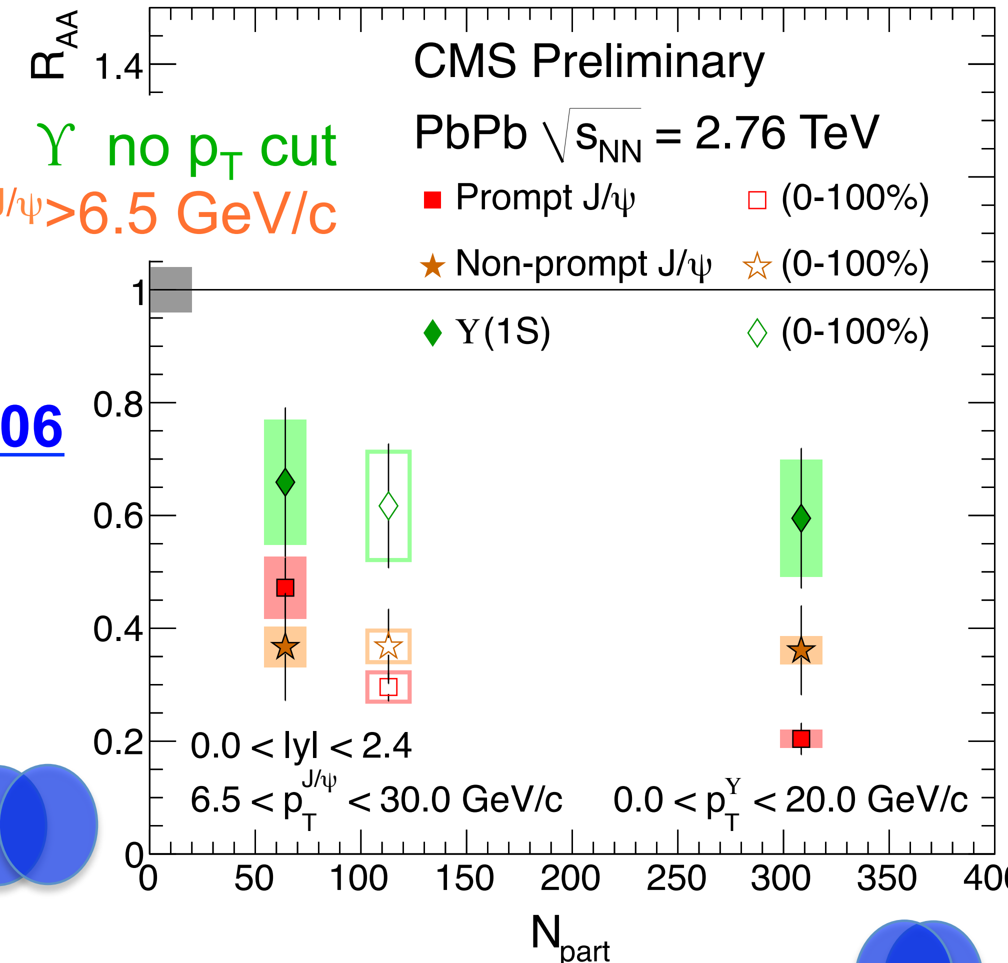
Backup

Silvestre (CMS)

Quarkonia Production with CMS

- **First non-prompt J/ψ in HI**
  - b-quark energy loss

PAS CMS HIN-10-006



- Prompt J/ψ
  significantly **suppressed**

- ϒ(2S)+ϒ(3S) **excited states suppressed**
  - Consistent with 40% ϒ(1S) suppression

arXiv : 1105.4894
Submitted to PRL

Sequential melting accessible with CMS resolution

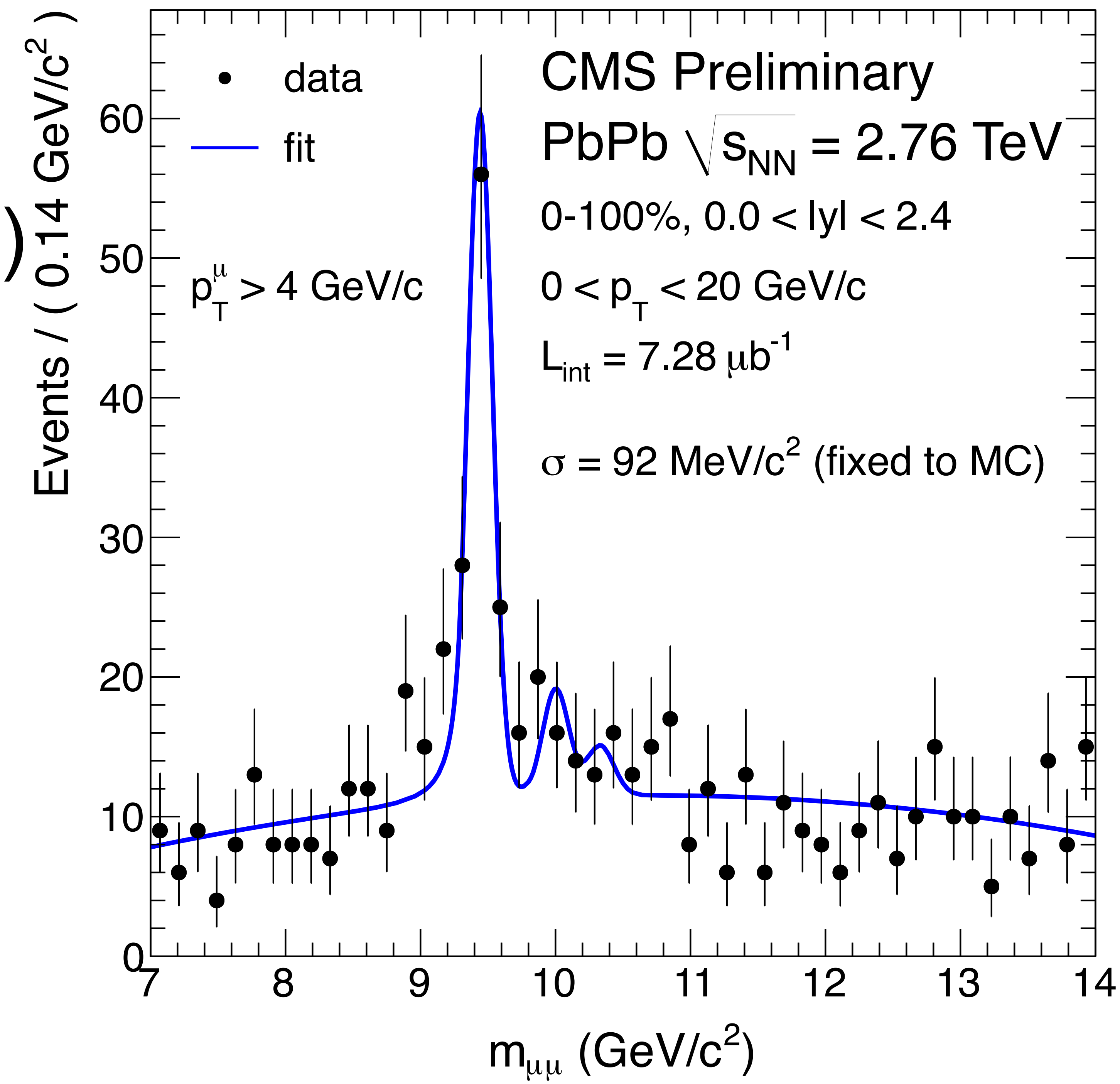
Silvestre (CMS)

ϒ States

PbPb
$\sqrt{s_{NN}}$=2.76 TeV

86 ± 12 ϒ(1S)

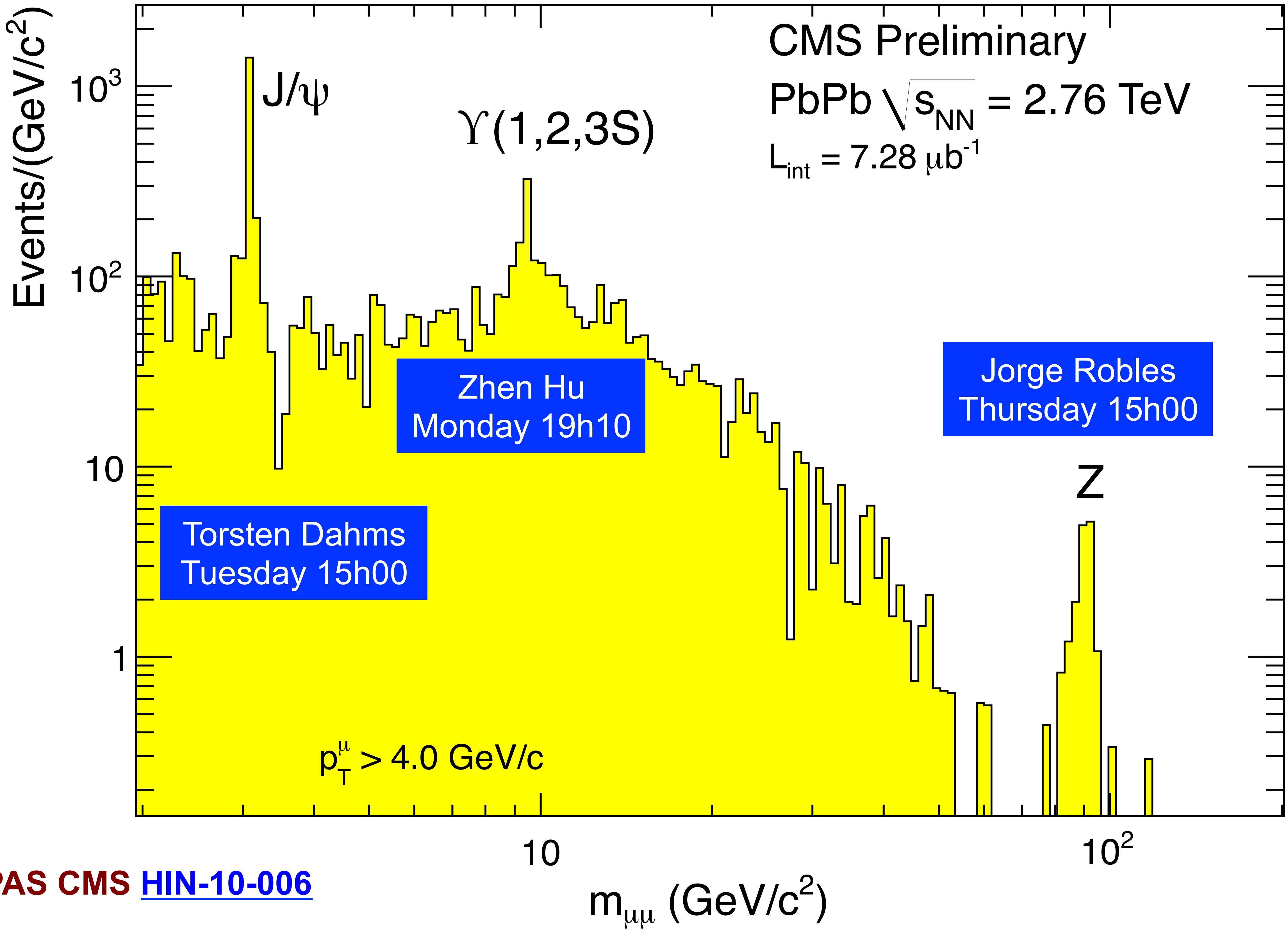
$p_T^{\mu} > 4$ GeV/c



Zhen Hu
(Mon. 19h10)

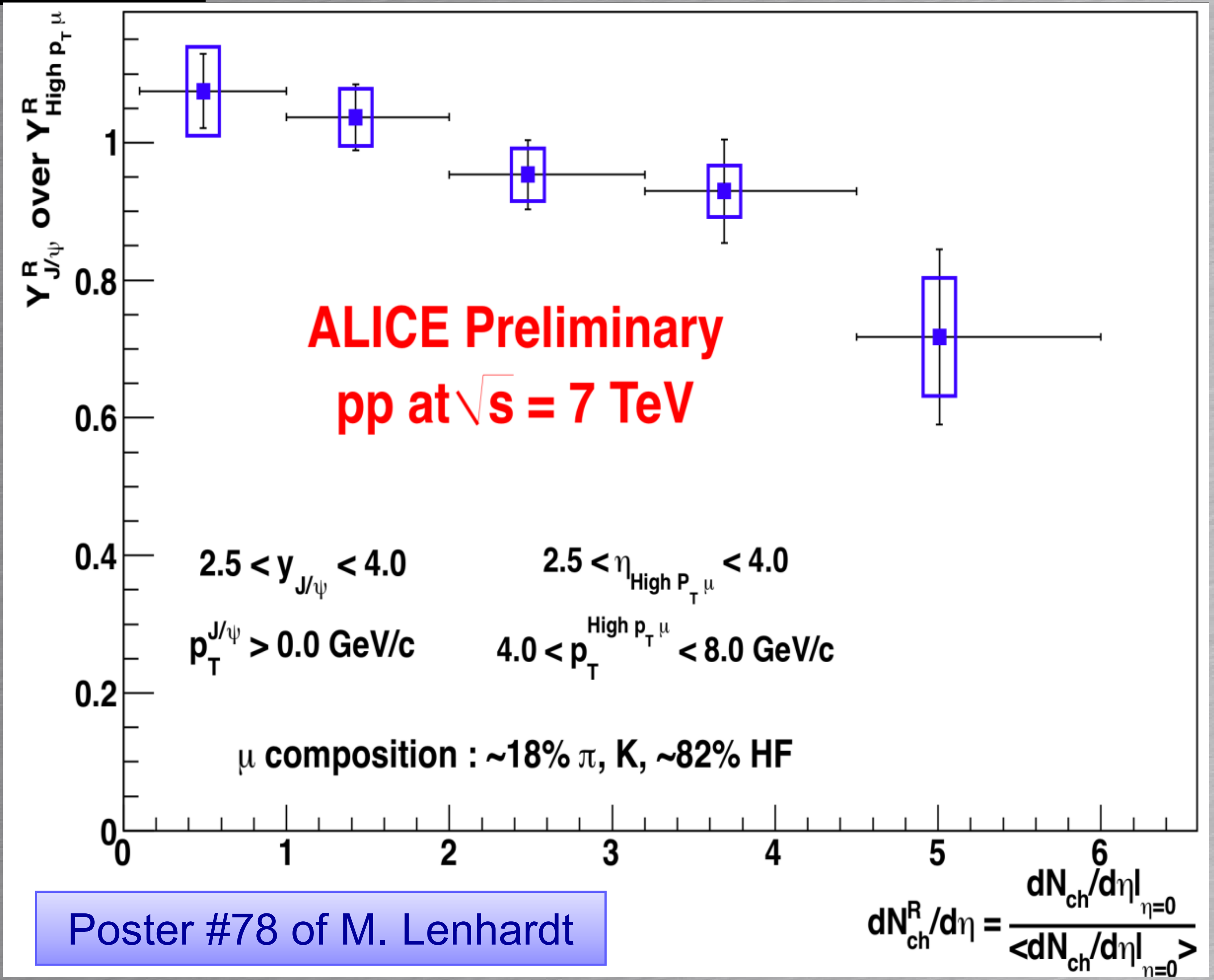
Di-muons by CMS in PbPb

Silvestre (CMS)



PAS CMS HIN-10-006

J/ψ versus high p_T muons



Poster #78 of M. Lenhardt

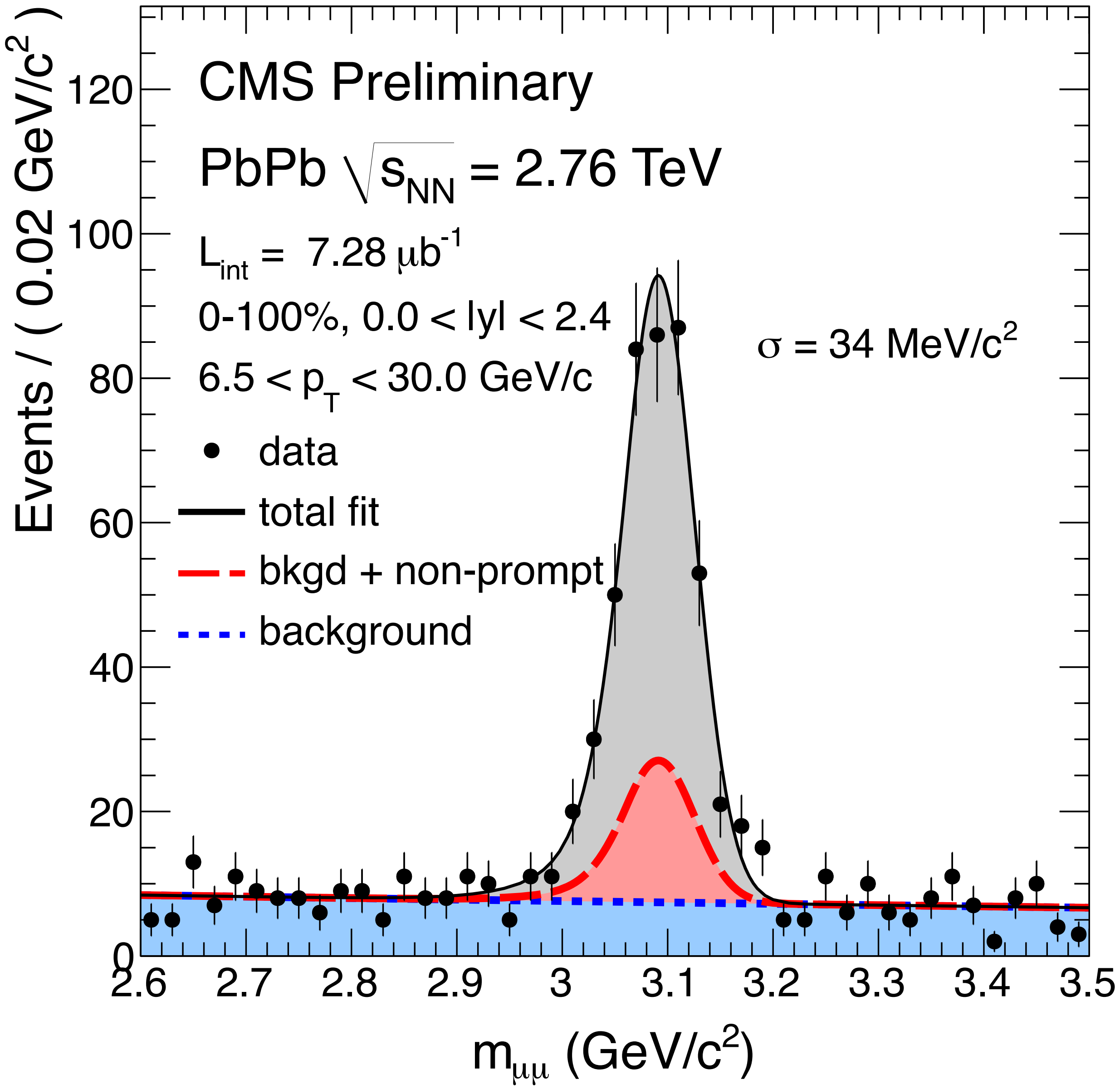
- ✓ High p_T muon ($4<p_T<8$ GeV/c);
- ✓ About ~18% π,K (decays), ~82% HF (~50%-c, ~50%-b);

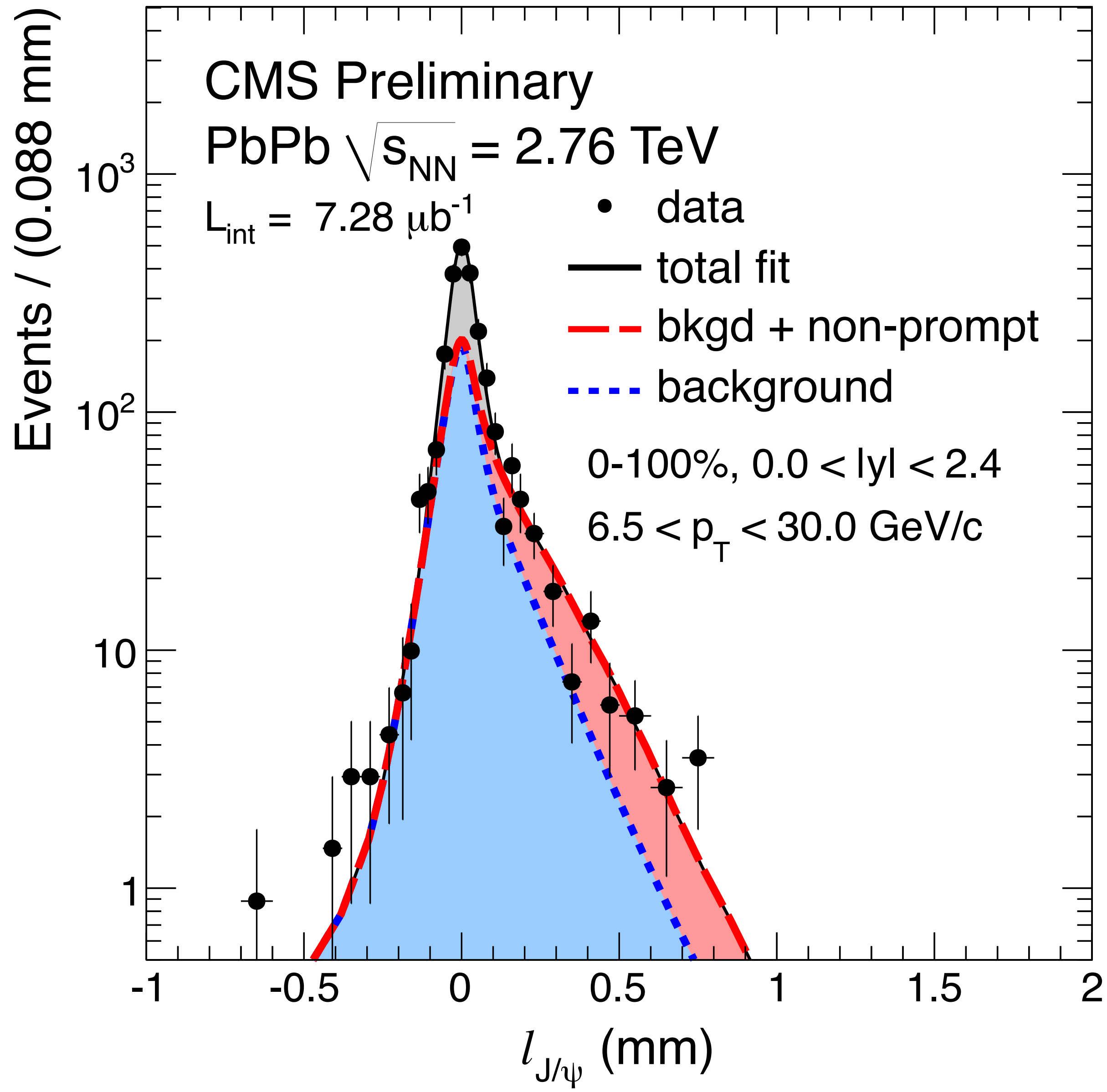
Talk of X. Zhang on Mon May 23rd 5:50 pm

Understanding multi-partonic interactions in pp collisions. Different behaviours between J/ψ and high p_T muon. Many interpretations are possible.

Prompt vs. non-prompt J/ψ in PbPb

Dahms (CMS)



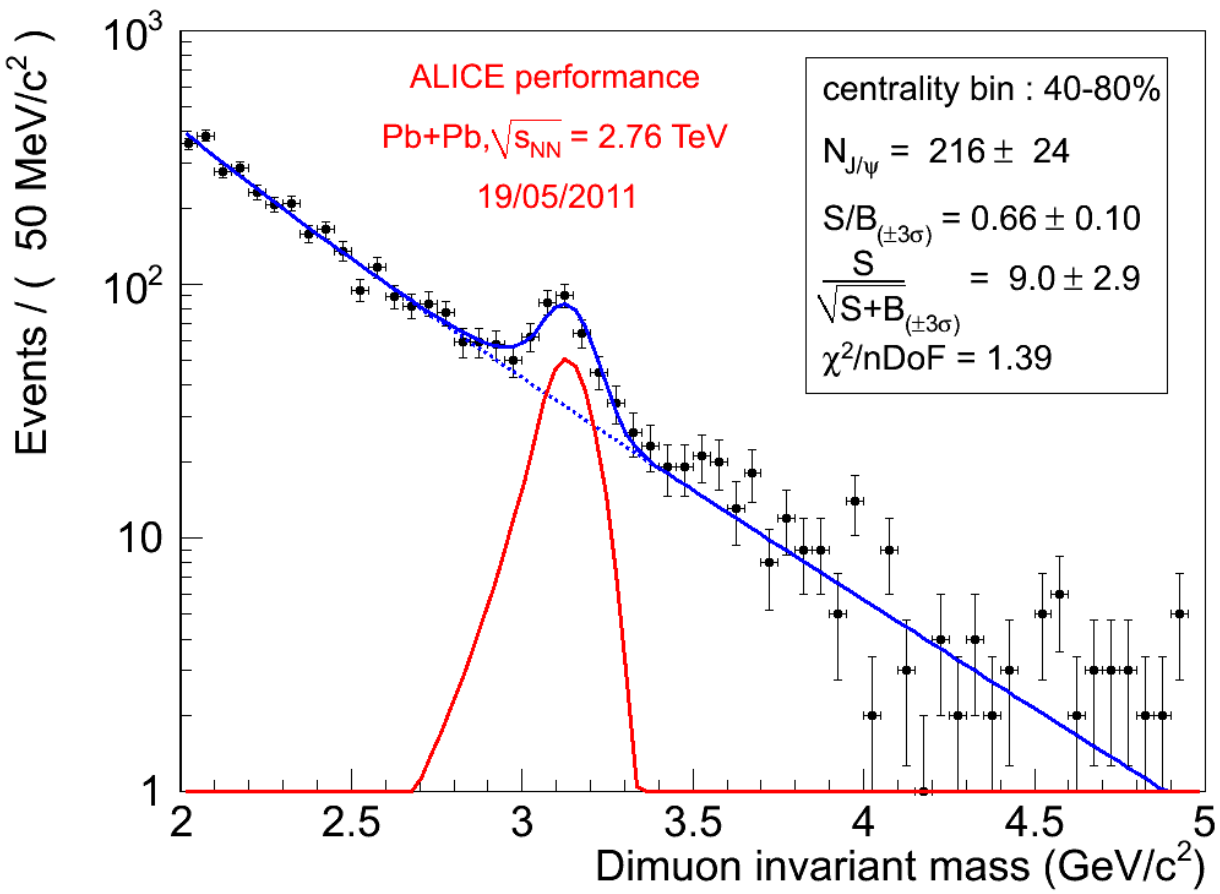


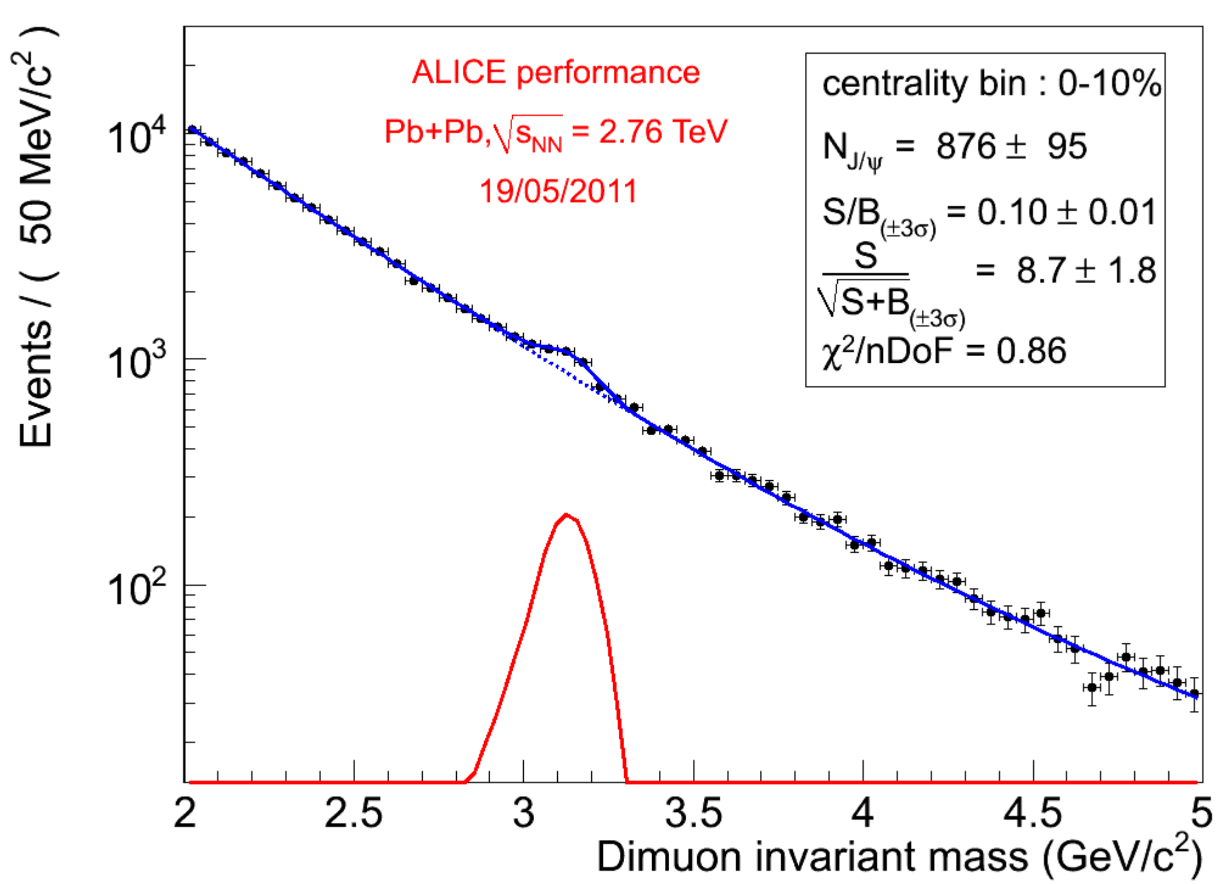
First time that prompt and non-prompt J/ψ have been separated in heavy ion collisions

Signal extraction (1)

Fit the mass distribution in the range [2, 5] GeV/c^2:

- Background: a sum of 2 exponentials
- Signal: a Crystal Ball (CB) function with 1 or 2 tails
  - Shape fixed for the 4 centrality bins
  - Several parameterization (tails/position/width) tested

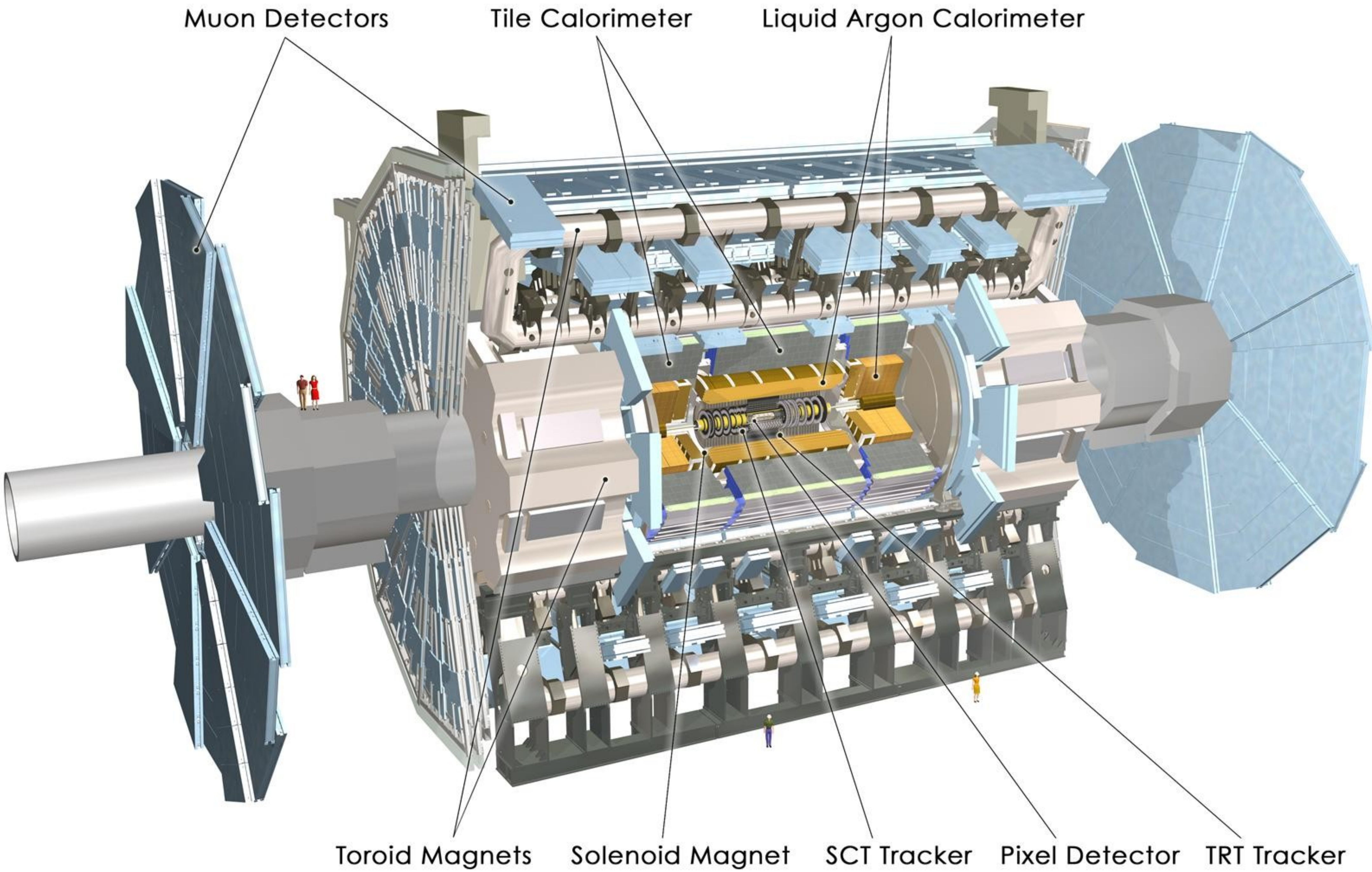




On the plots: J/ψ curve alone (red), background (dash, blue) and the sum (blue)

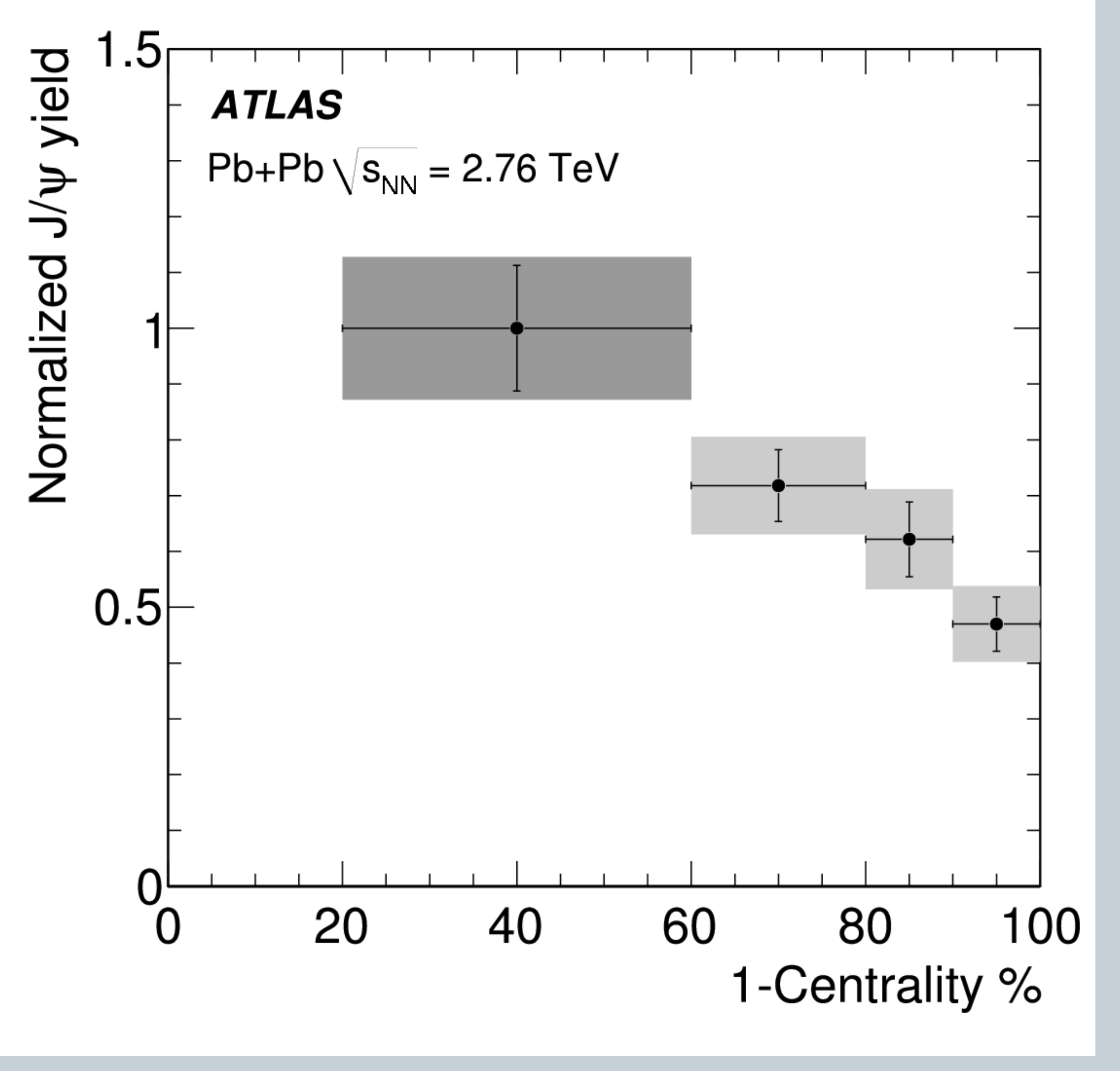
R. Sandström (ATLAS)

The ATLAS detector



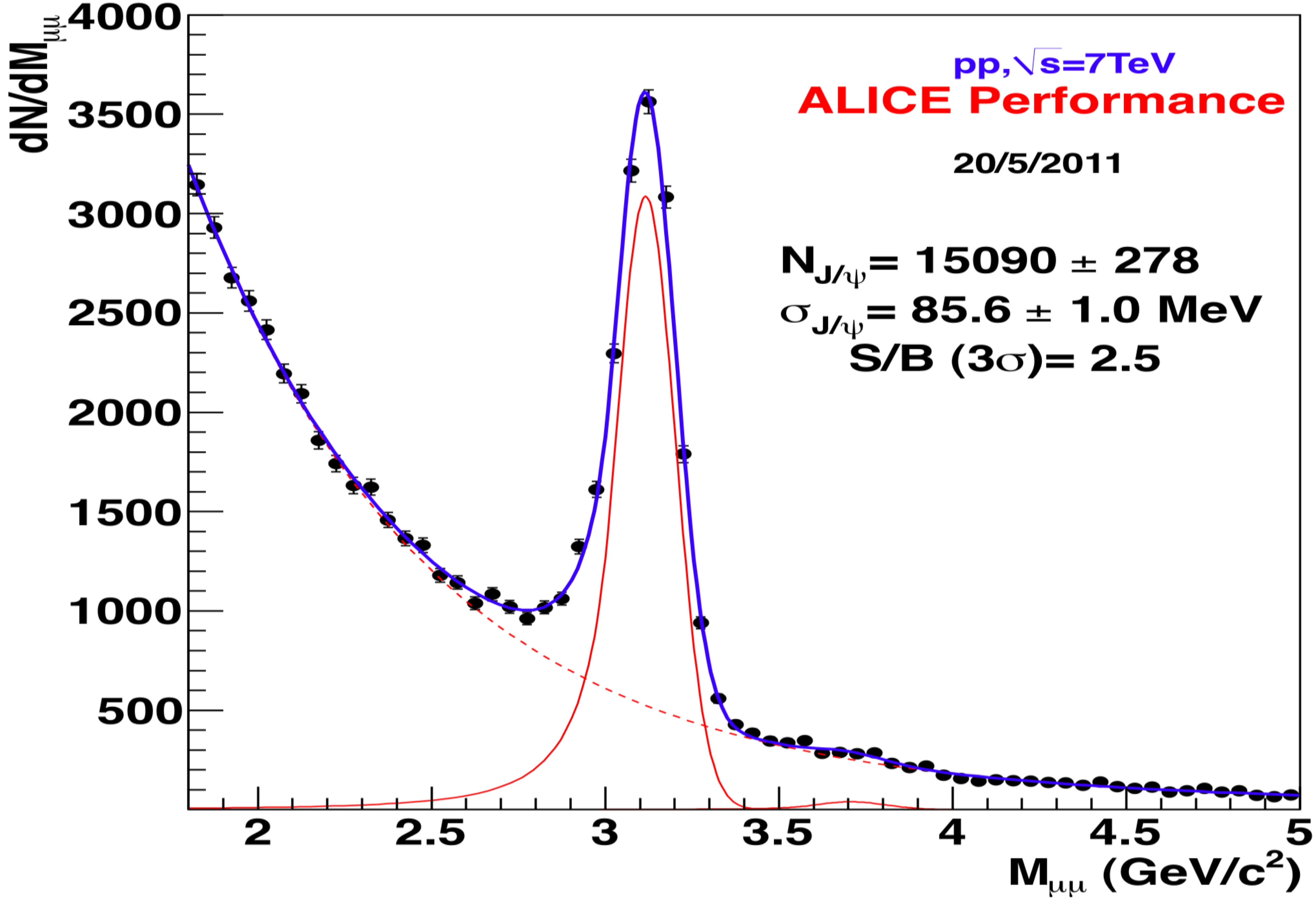
R_{CP}: J/ψ suppression

- Finally: The J/ψ yield is normalized to the R_{coll} in each centrality bin and divided by the peripheral yield.
  - Uncertainties on R_{coll} is included as a systematic.
  - The dark point is by definition 1, the uncertainties on the yield are not propagated to the other points.
- We observe a centrality dependent suppression of the J/ψ yield.
  - Probability of no suppression: $p(\chi^2, ndof)$ = 0.11%. (including systematics in χ^2)
- ATLAS vs PHENIX:
  - Similar result when integrating PHENIX result over p_T despite different momentum ranges.



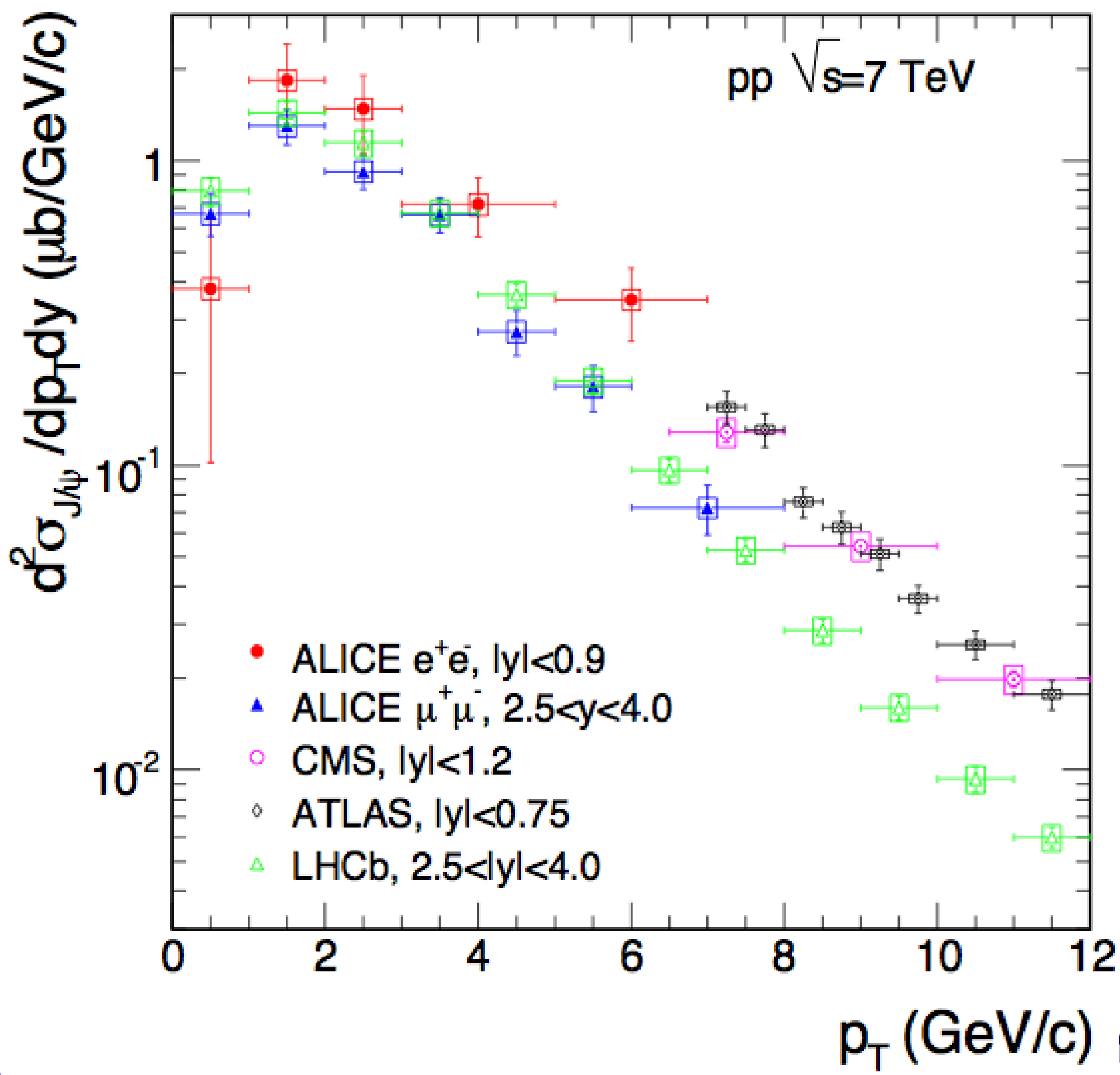
Vertical error bars: statistical uncertainty
Shaded regions: stat.&systematic uncertainties

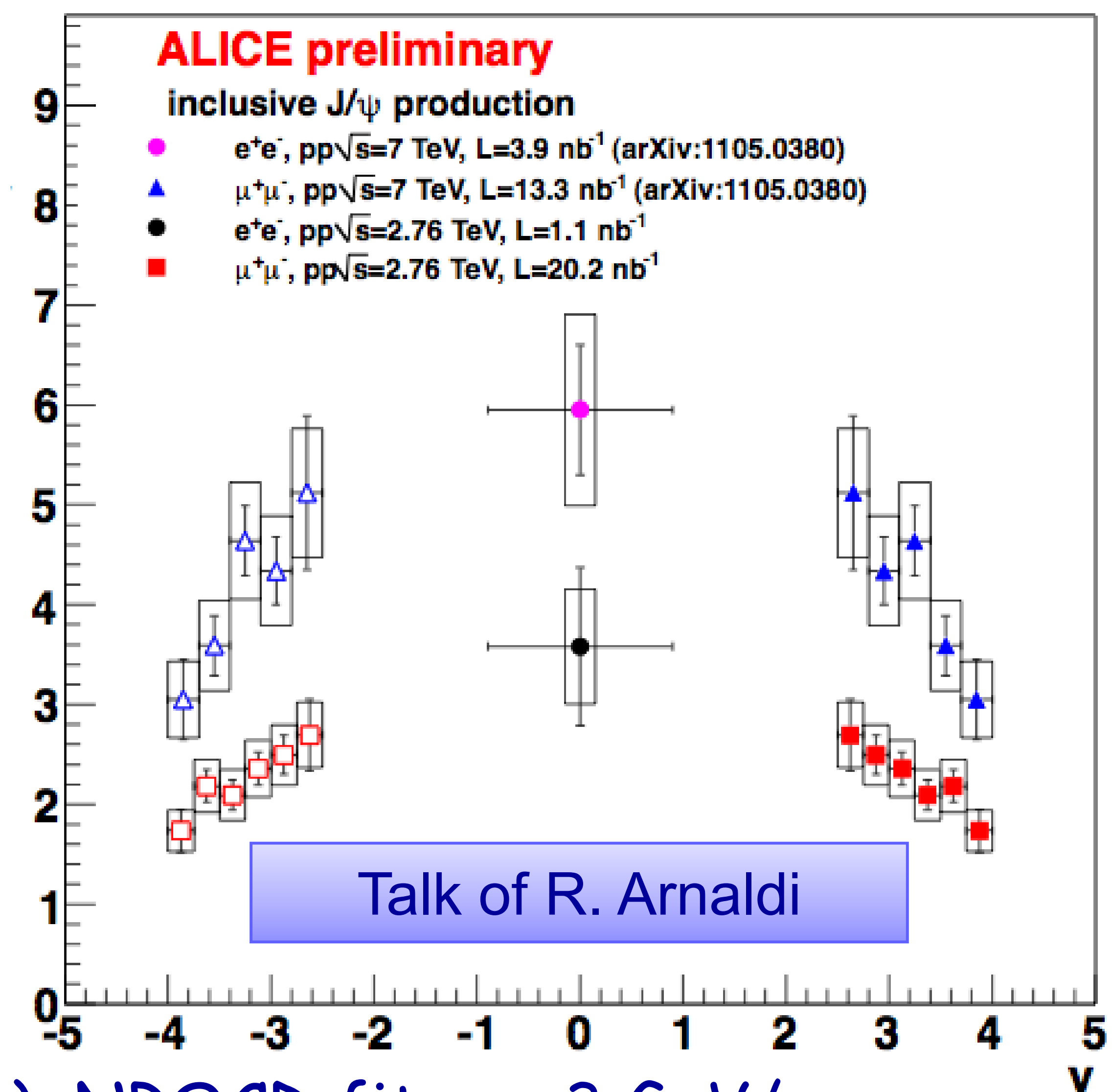
Quarkonium Signals in pp



J/ψ, $\mu^+\mu^-$, e^+e^-, 2.76 & 7 TeV, integrated, (p_T, y), pol., $dN_{ch}/d\eta$

$\sigma_{J/\psi}$ and p_T-y distributions



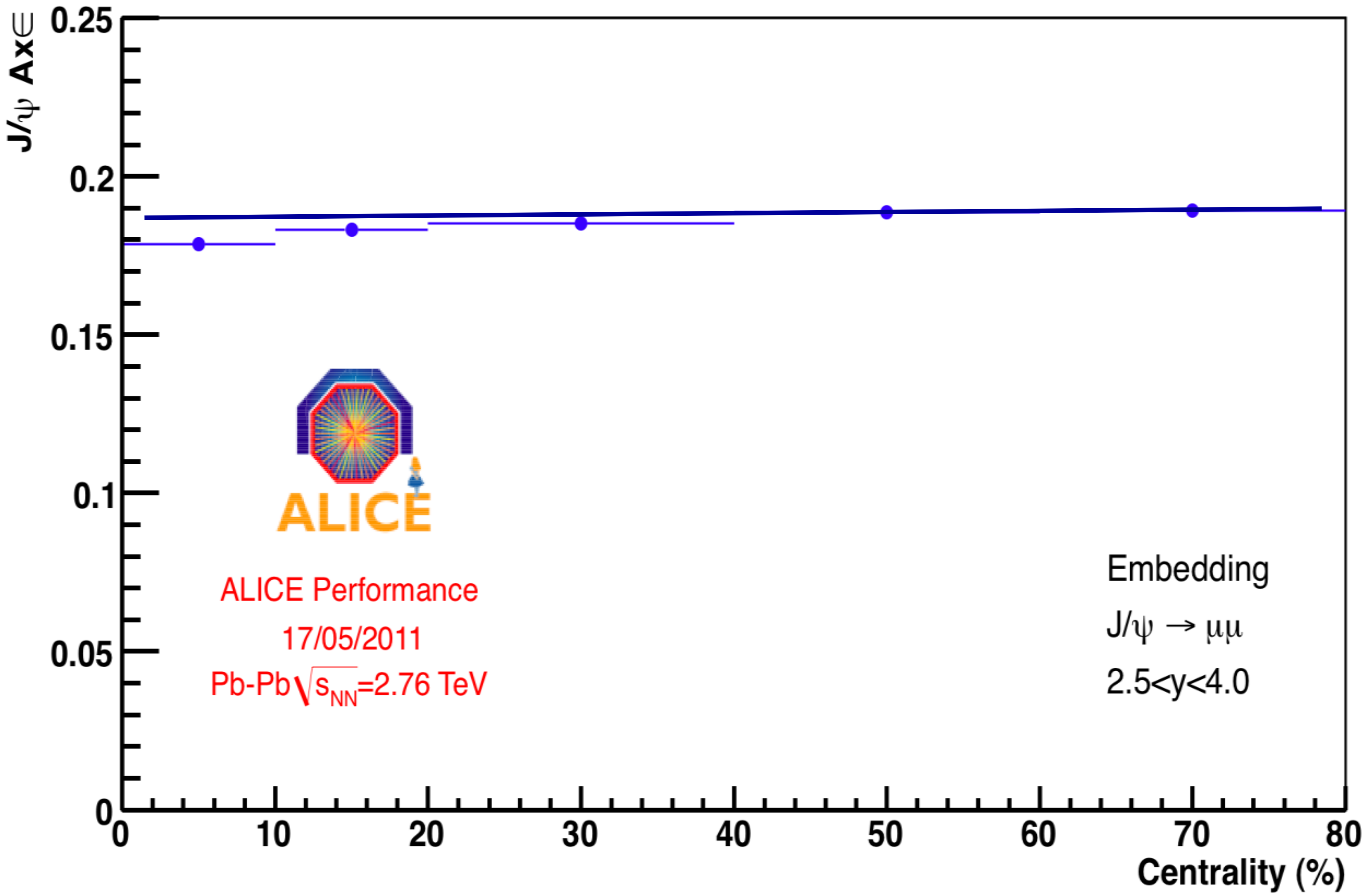


rs), NRQCD fits p_T>3 GeV/c

A factor 13(μ-tri), 3(MB) more in pp at 7 TeV run 2010.

Efficiency in Pb-Pb

Embedding J/ψ signal in real Pb-Pb events.



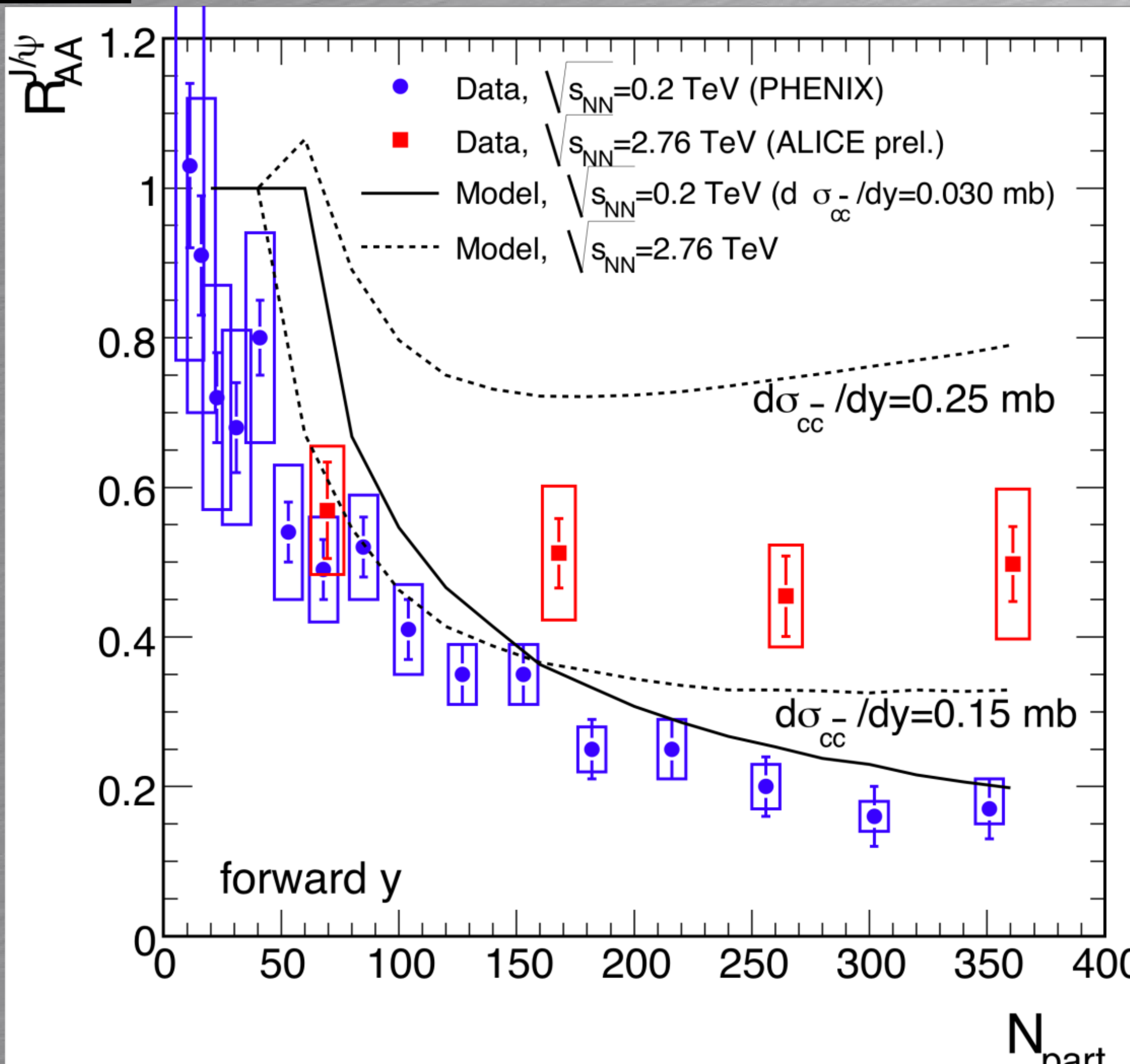
J/ψ signal from interpolation studies

Poster #53 of M. Gagliardi

Poster #58 of A. Lardeux, L. Valencia

Only 4% efficiency loss in the most central collisions;
In agreement with measured tracking efficiency loss from data.

Statistical Hadronization

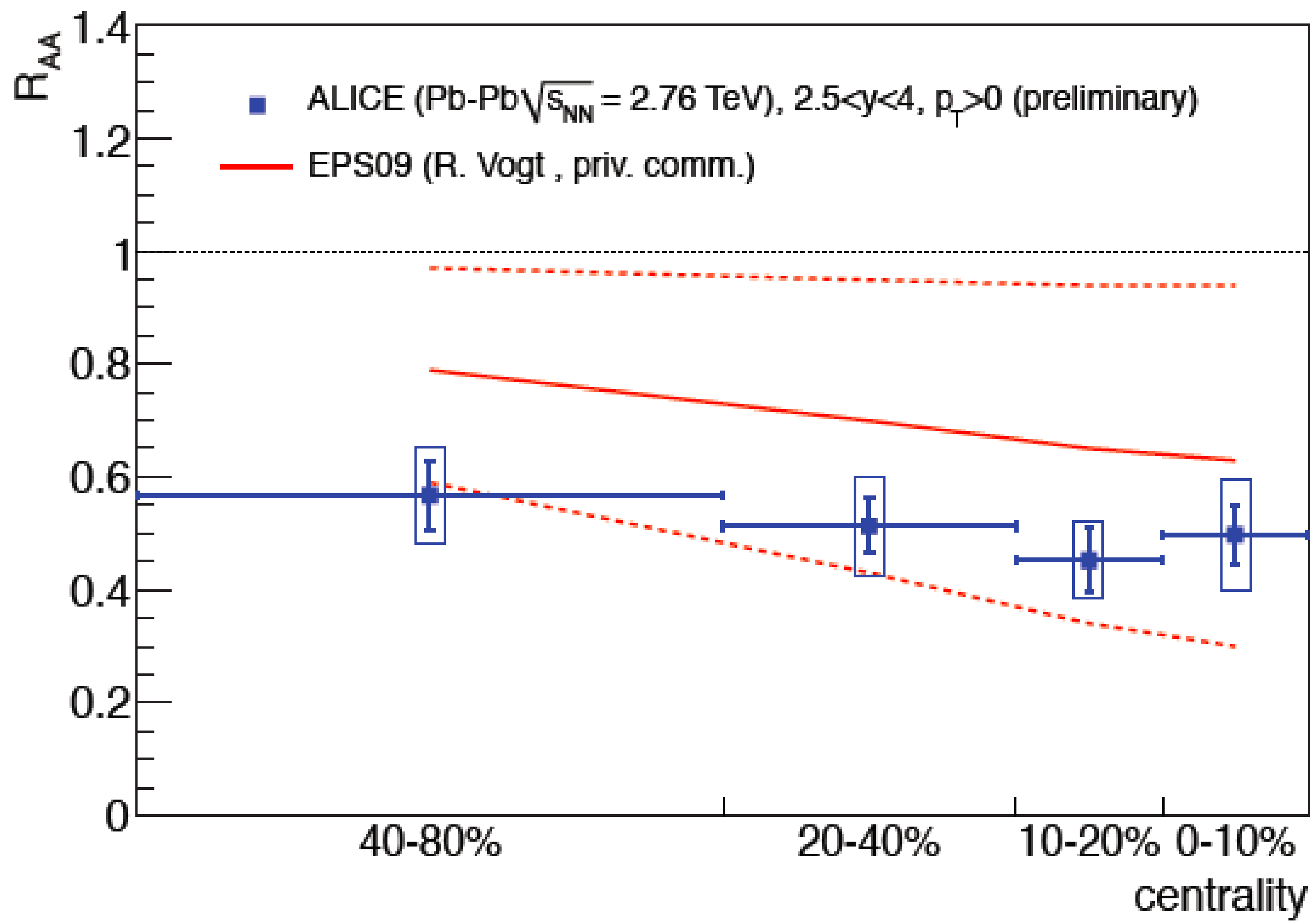


Talk of A. Andronic on Mon May 23rd

PBM & JS, PLB490, 196 (2000); A.A. et al., PLB571, 36 (2003)

Comparison with EPS09

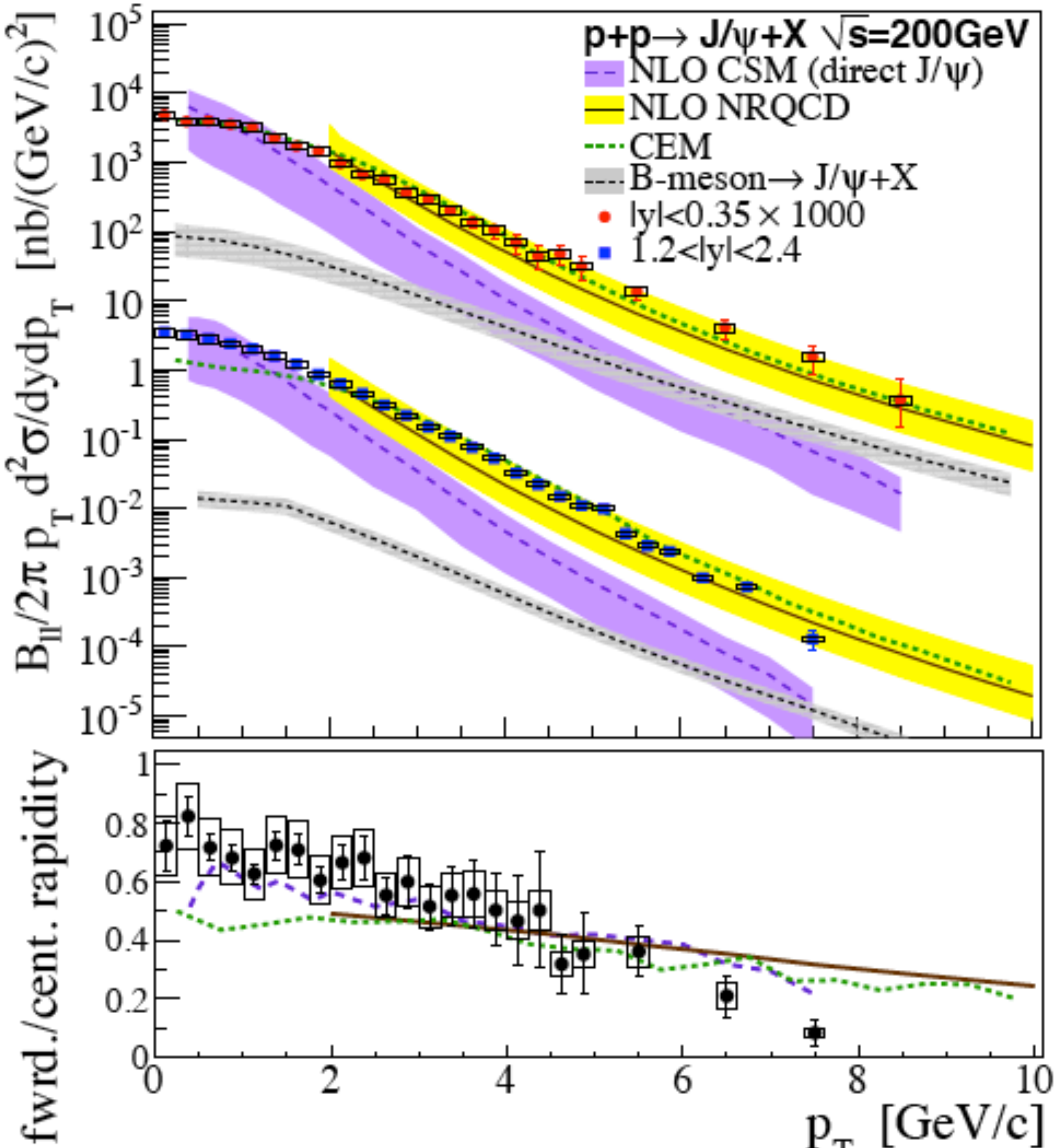
K.J.Eskola *et al.*, JHEP 0904:065, 2009
R. Vogt, Phys.Rev.C81:044903, 2010



- If shadowing is considered, it could even lead to an enhancement of the J/ψ in central Pb-Pb with respect to cold nuclear matter effects
- Large uncertainties for shadowing prediction, p-A is then imperative at LHC

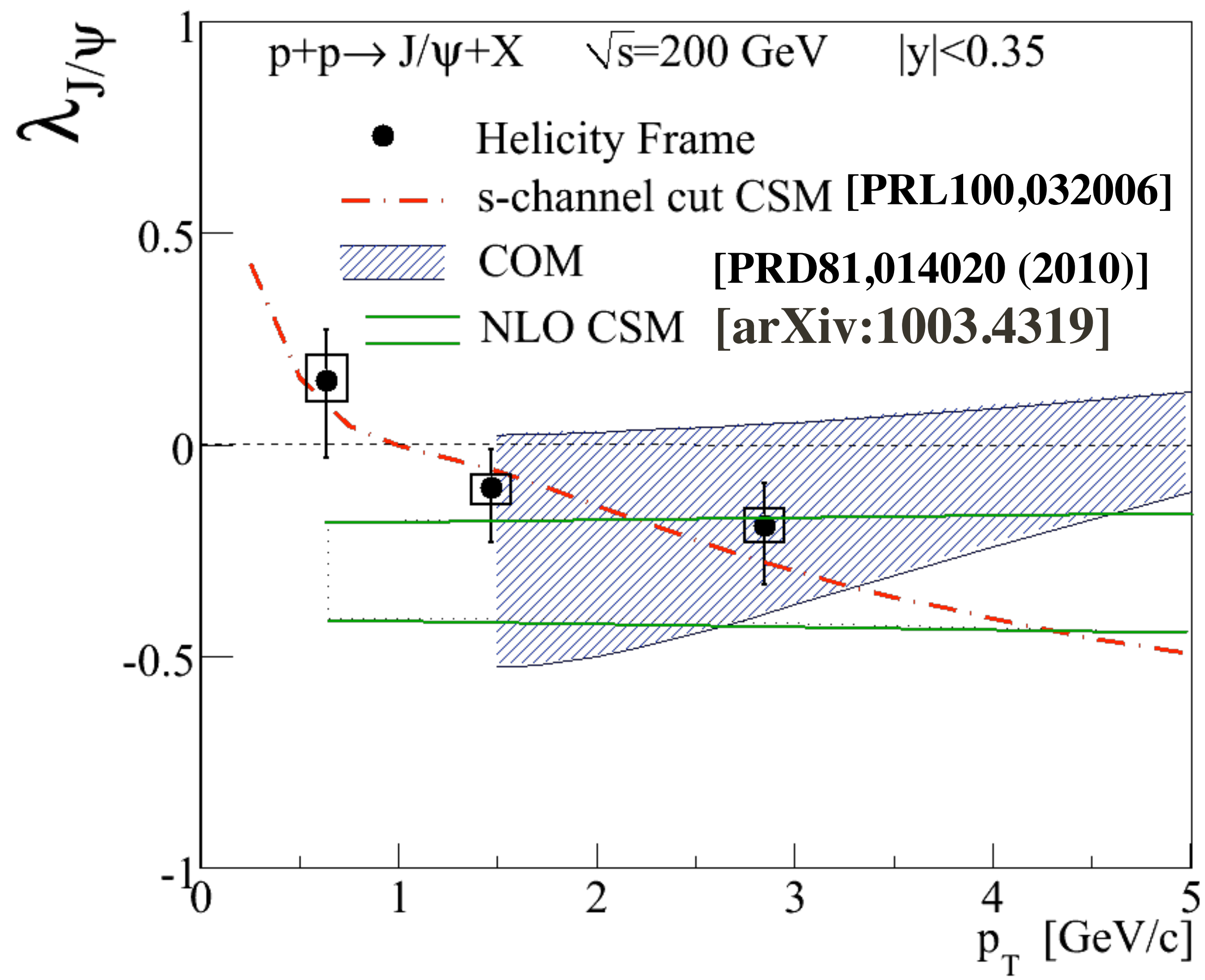
J/ψ Production Mechanism

[arXiv:1105.1966]



- only models with color octet formation describe the data
- J/ψ polarization measured to be small

[PRD82,012001 (2010)]



- new measurement of J/ψ yield in the mid and forward rapidities

- color octet state may cross part of the nuclear matter as a pre-resonant state

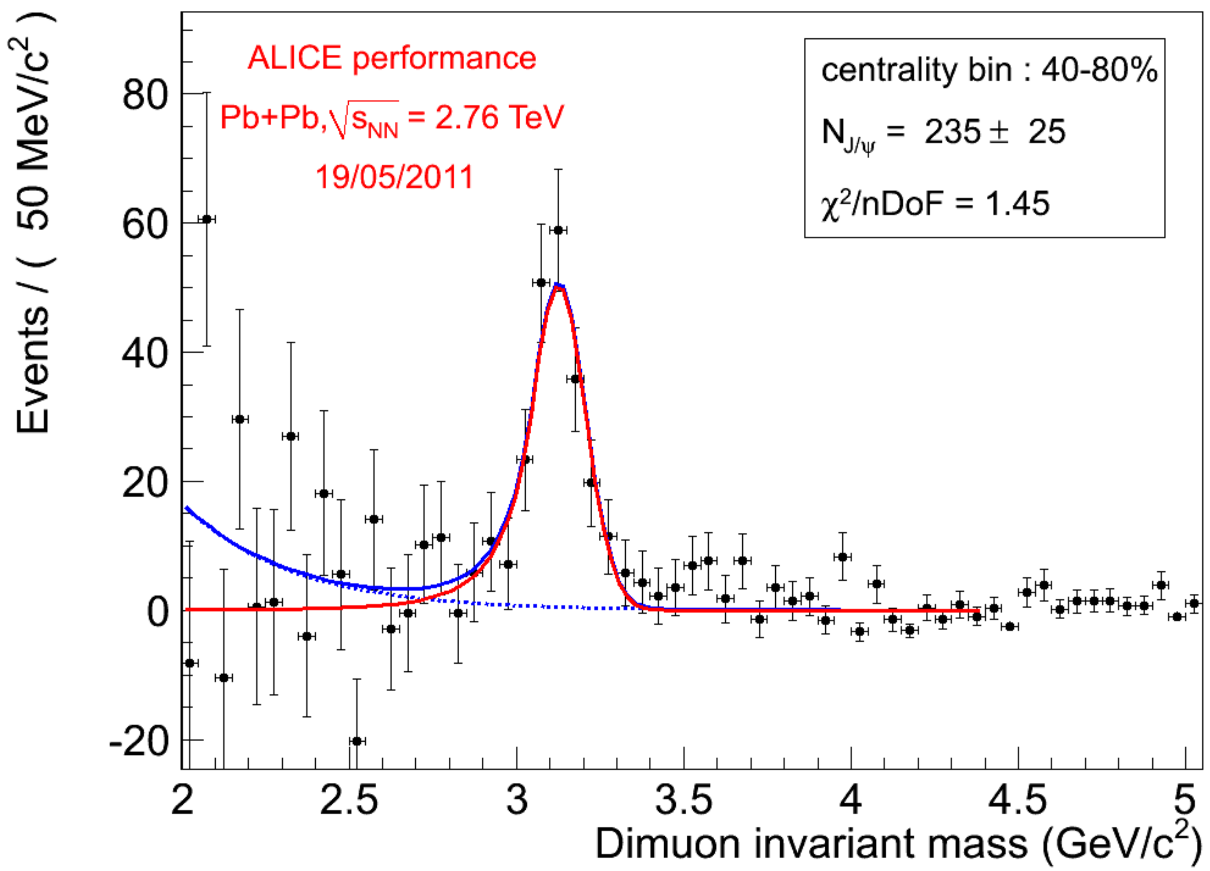
Signal extraction (2)

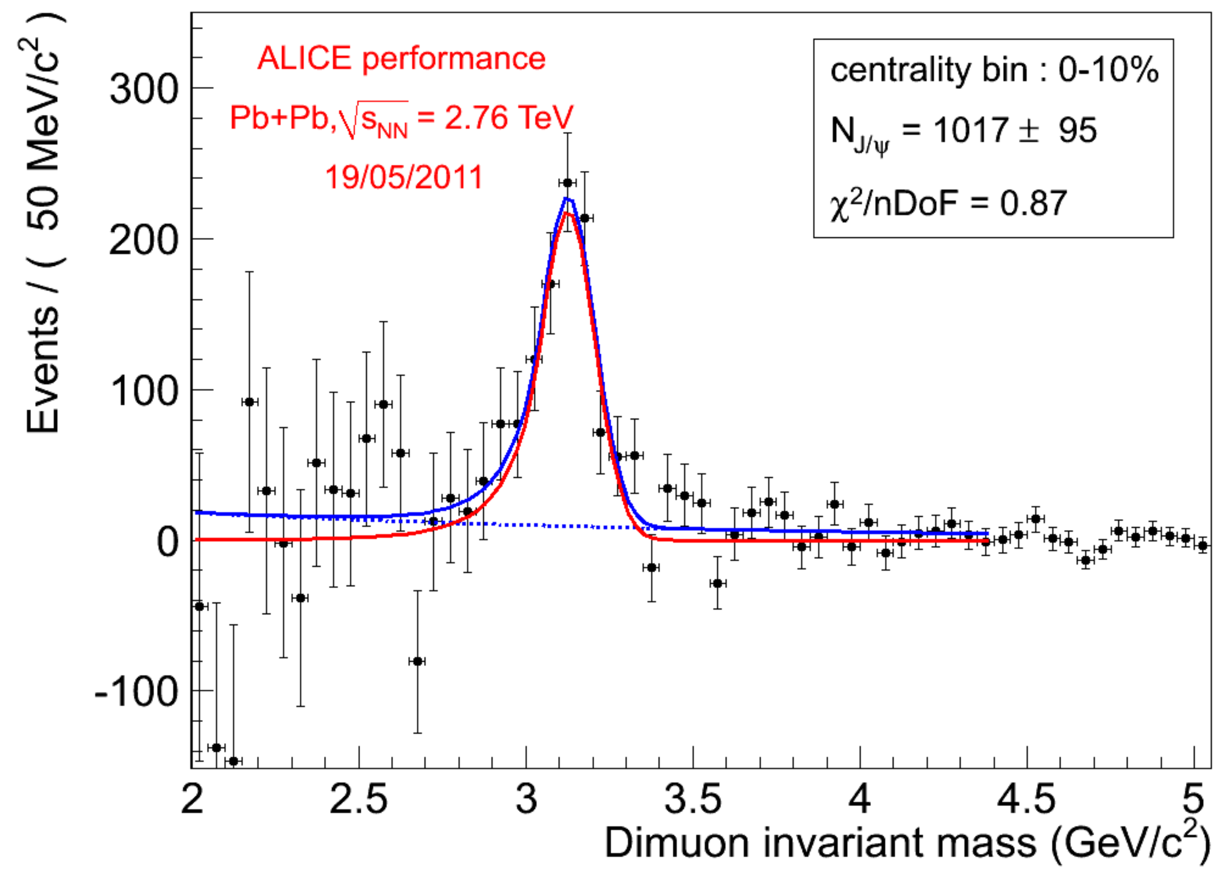
Subtract the background using event mixing technique:

- Mixed pair invariant mass distribution normalized to data in [1.5, 2.5] GeV/c^2

Fit the background subtracted mass distribution in the range [2, 4.5] GeV/c^2:

- Residual background: an exponential or a straight line
- Signal: the various CB shapes used in the first method





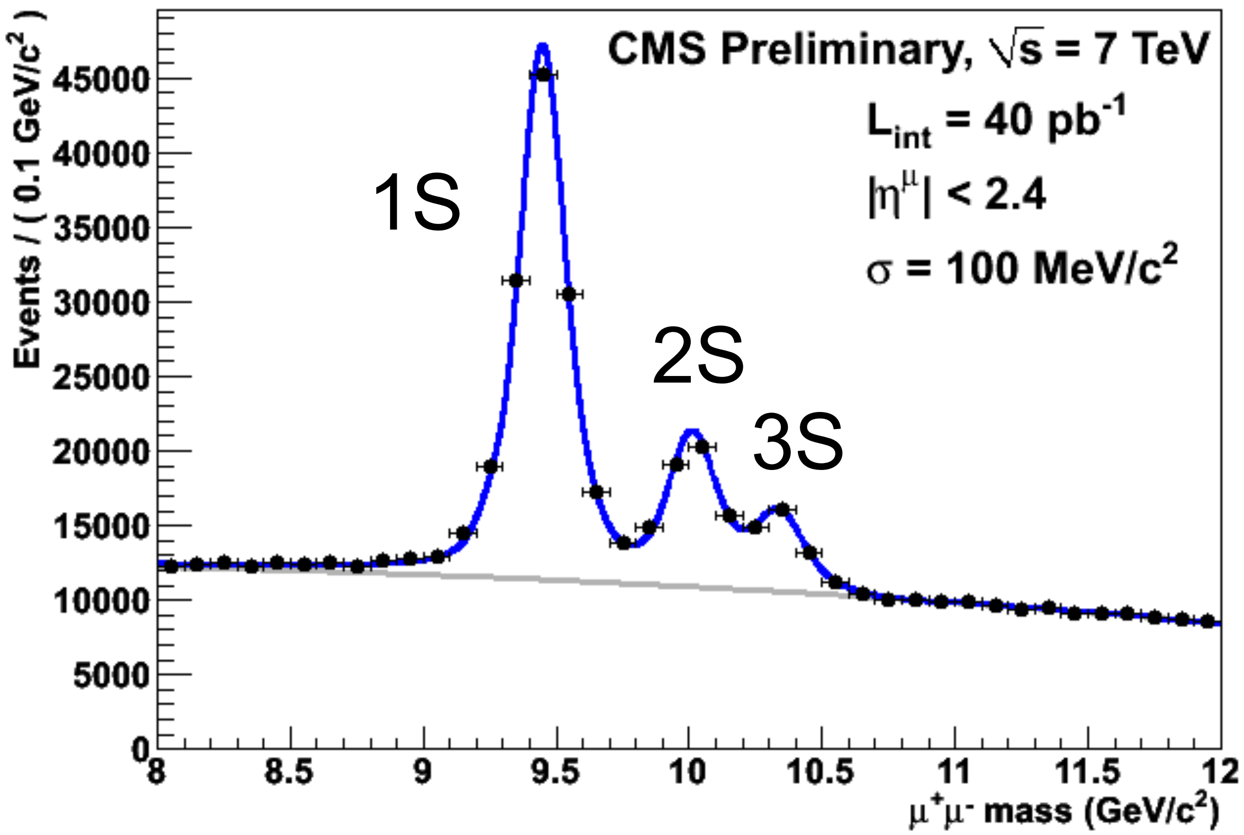
On the plots: J/ψ curve alone (red), background (dash, blue) and the sum (blue)

→ Results obtained with different techniques combined to extract <$N_{J/\psi}$> and systematics

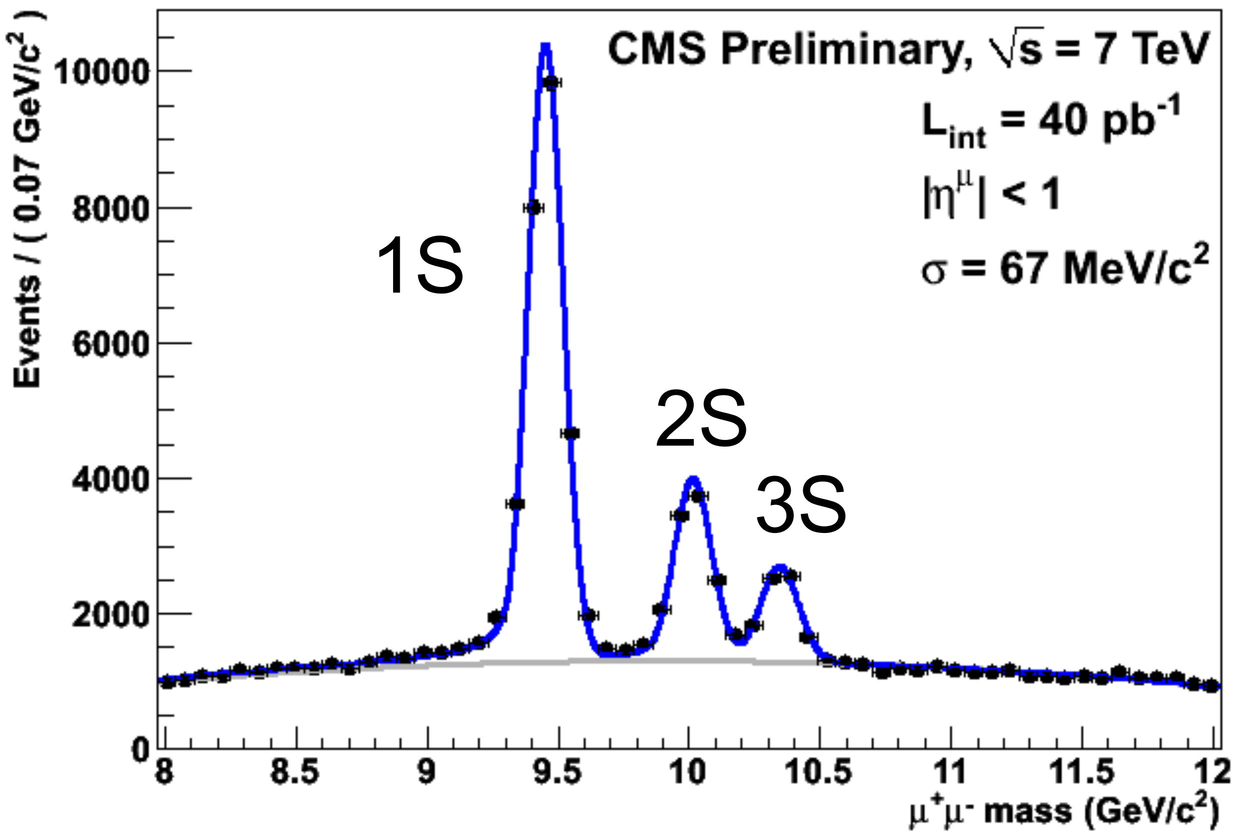
Υ States

pp $\sqrt{s}$=7 TeV

$|\eta^{\mu}| < 2.4$
σ = 100 MeV/c^2



$|\eta^{\mu}| < 1$
σ = 67 MeV/c^2

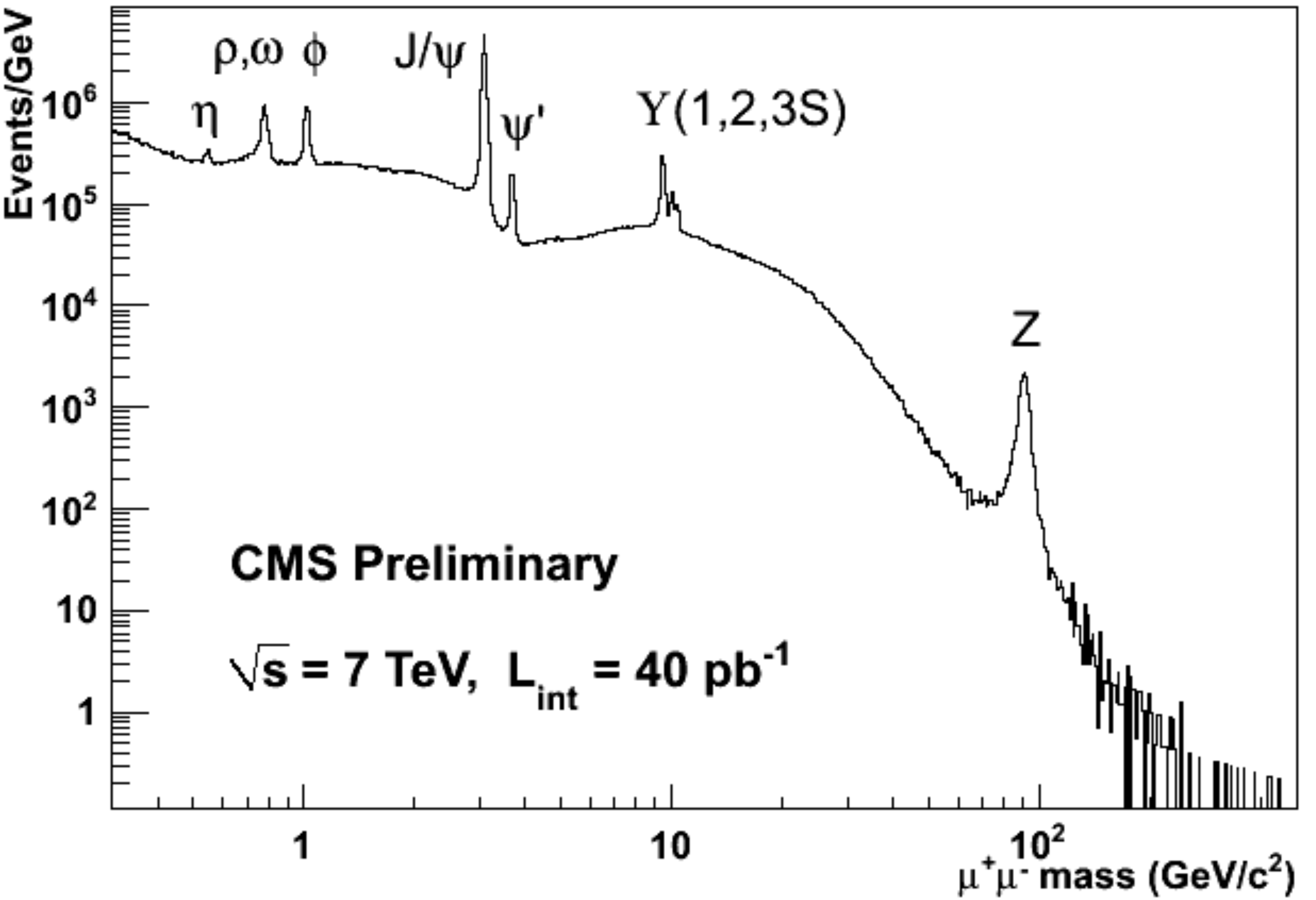


- **Very good dimuon mass resolution**

  → separation of the 3 Υ states

Di-muons from CMS pp $\sqrt{s}$=7 TeV

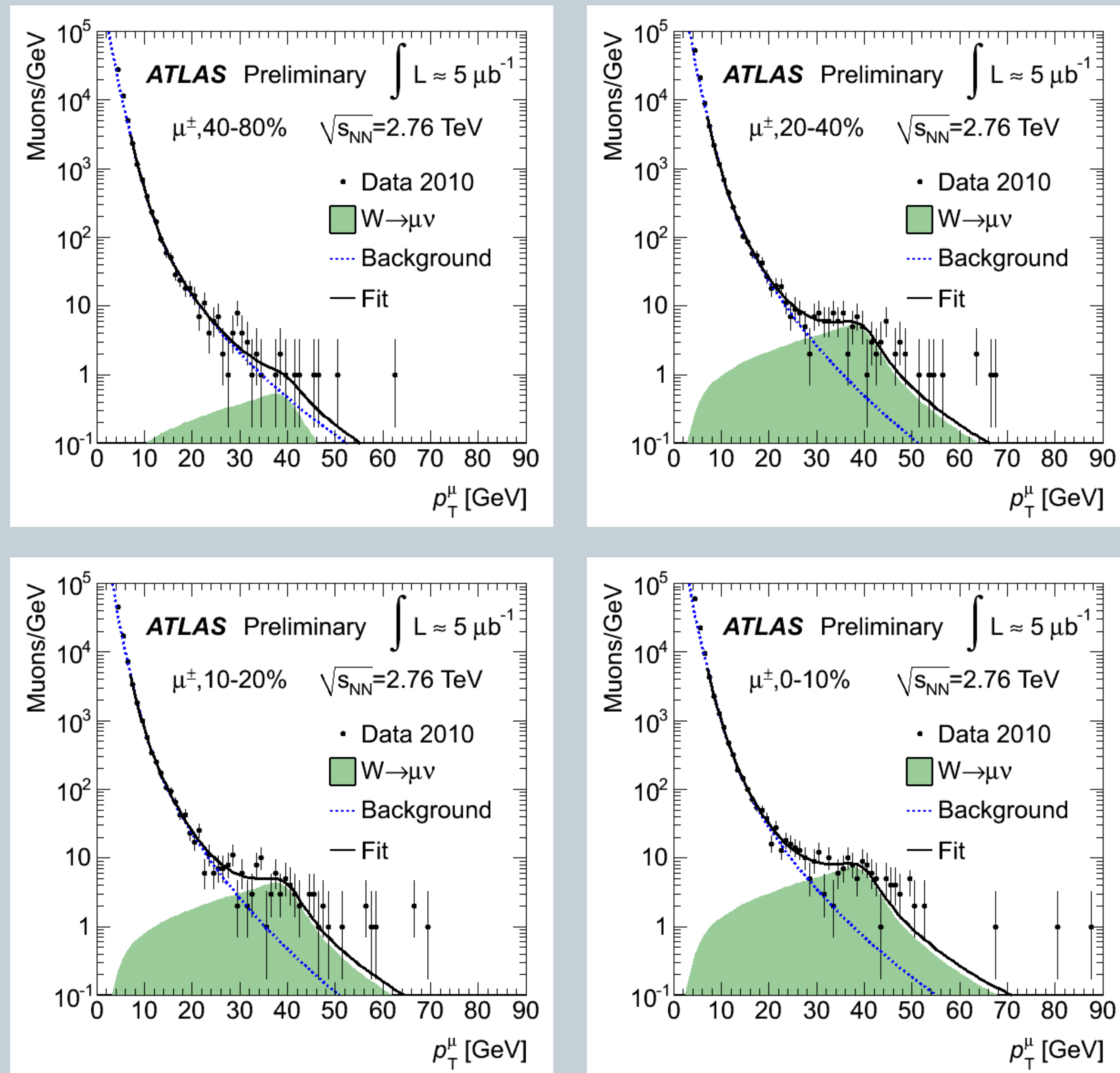
Silvestre (CMS)



Number of *W* per centrality bin

- Divide Pb+Pb dataset in subsets of centrality, and fit each subset independently.
  - The peripheral subset suffers from low statistics, but the other three allow more precise measurement of *W* than *Z* bosons.

Centrality	N_W^{fit}
40-80%	12^{+13}_{-12}
20-40%	118^{+17}_{-24}
10-20%	97^{+16}_{-18}
0-10%	165^{+23}_{-25}
W (all)	399^{+36}_{-38}

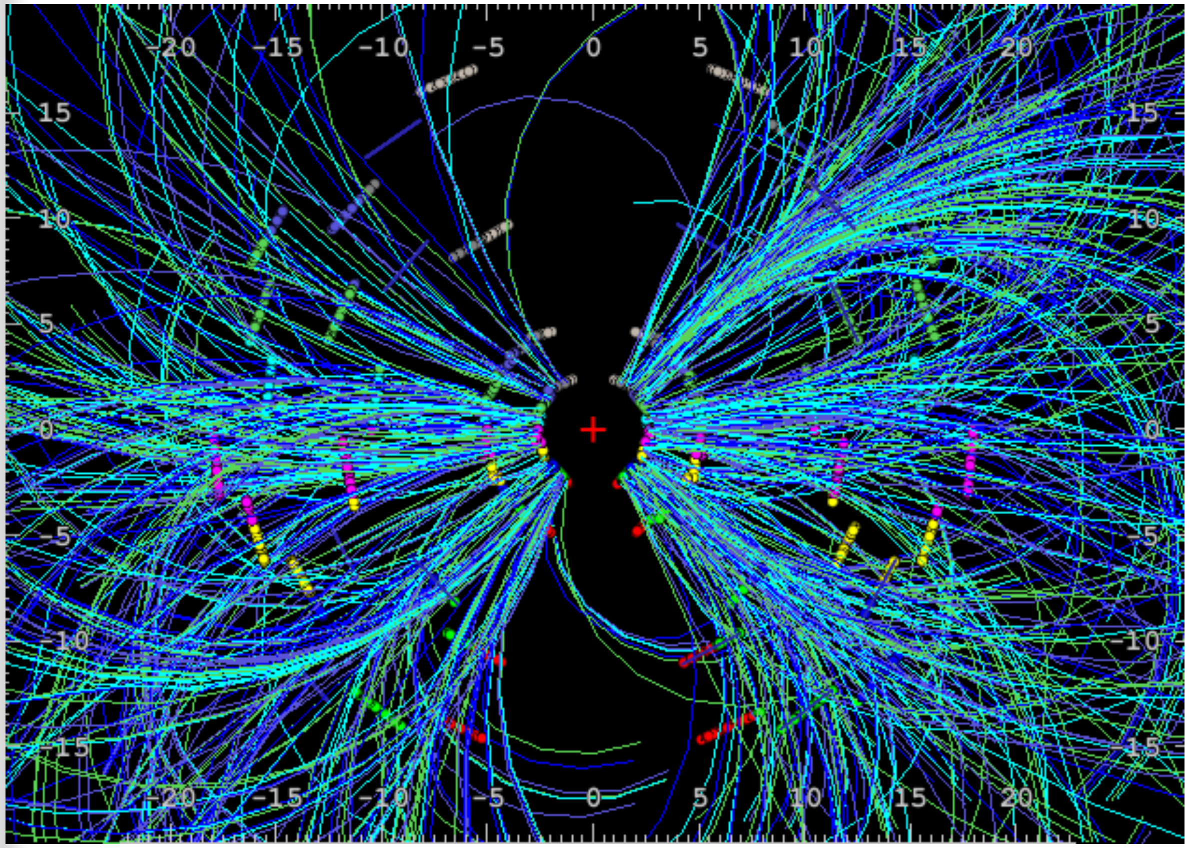


Vertex detectors

Da Silva (PHENIX)

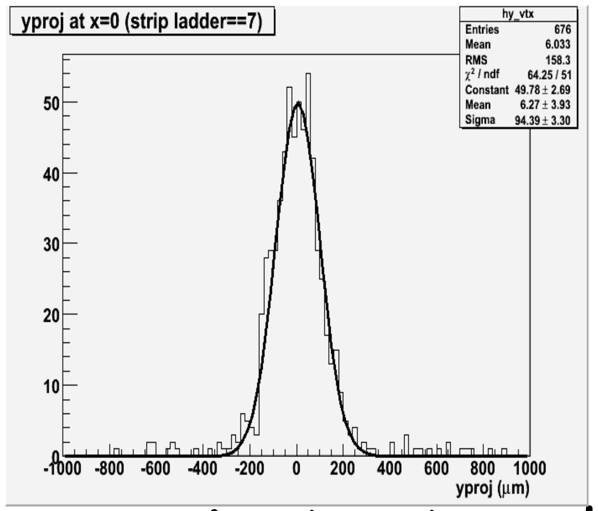
- large reduction of backgrounds → smaller systematics
- c/b separation through displaced vertices

VTX |y|<1



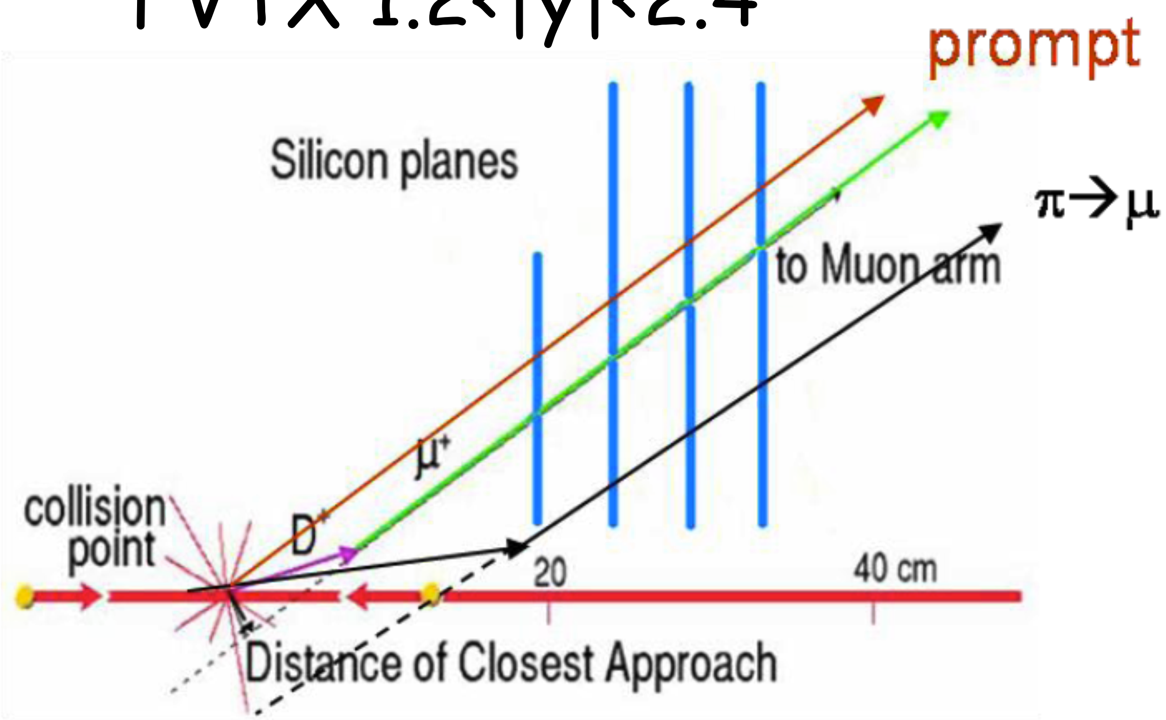
beam profile

$\sigma \sim 100\,\mu m$



- taking data right now in Au+Au collisions

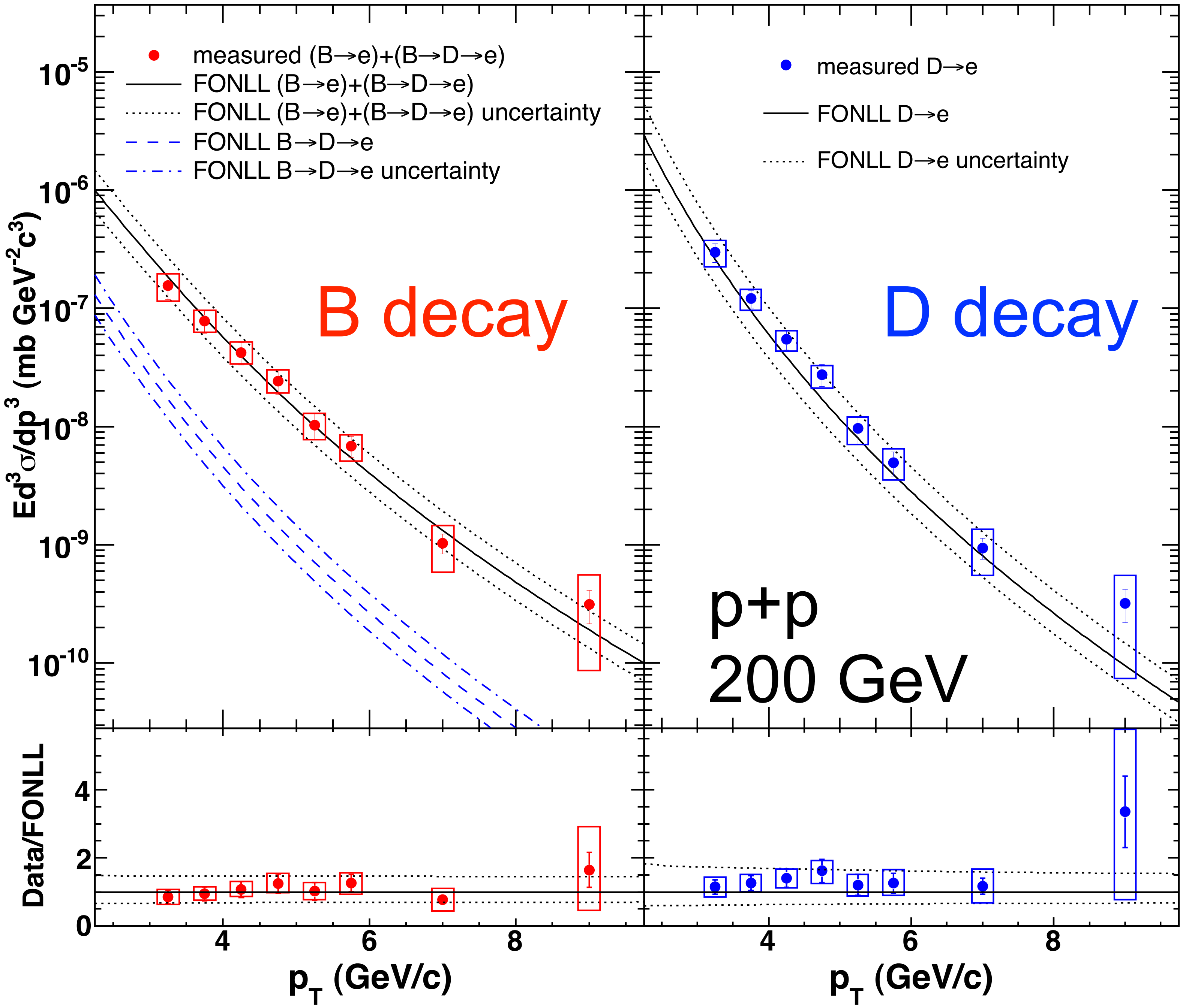
FVTX 1.2<|y|<2.4



- will also improve mass resolution allowing ψ' measurements at forward rapidity
- starting in 2012 run

Bottom cross section

Masui (STAR)



Xin Li, poster board 44, Thu/26

Wenqin Xu, Mon/23 17:30

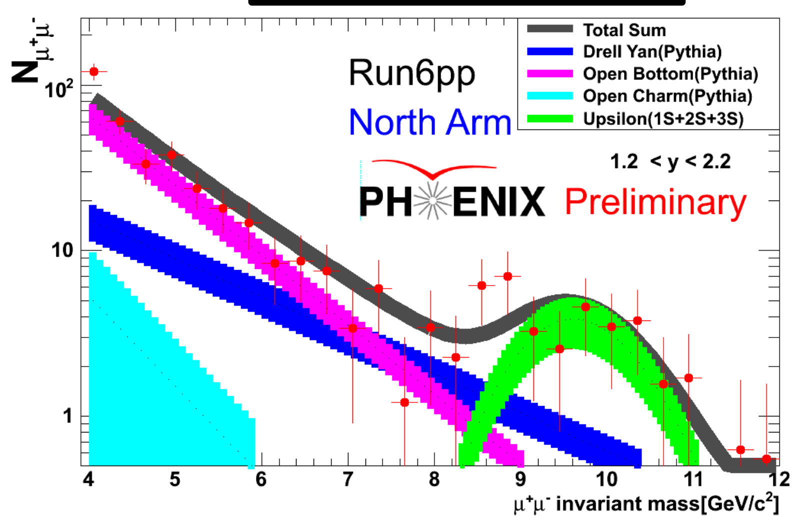
*STAR, **PRD83**, 052006 (2011)*
*FONLL, M. Cacciari et al, **PRL95**, 122001 (2005)*
M. Cacciari, R. Vogt, private communication

- Disentangle B decay contribution to non-photonic electron
- Bottom decay electrons consistent with FONLL calculation

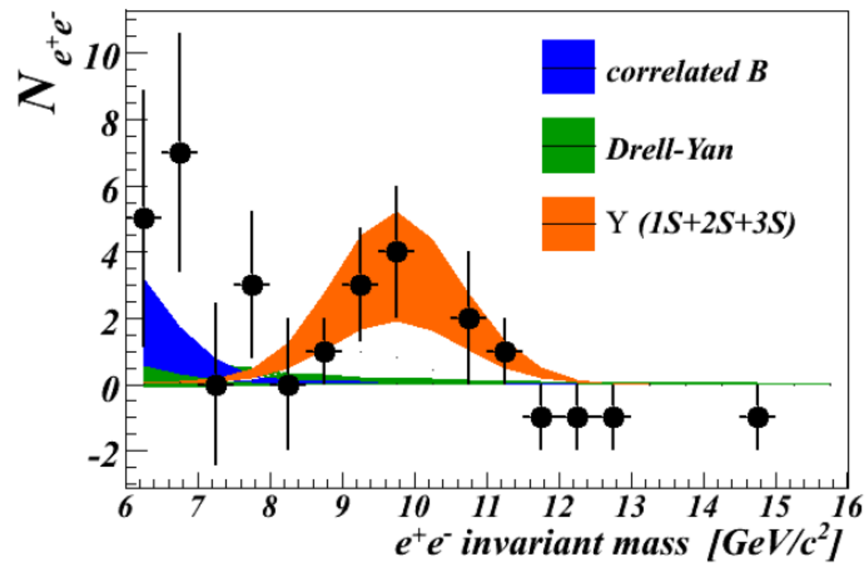
Sen (PHENIX)

Υ's in p+p collisions at 200 GeV

-2.2 < y <-1.2



|y|<0.35



1.2 < |y| <2.2