Quarkonium – hadron correlations

Quarkonium production vs event activity

Daniel Kikoła

ETC*, Trento 2016

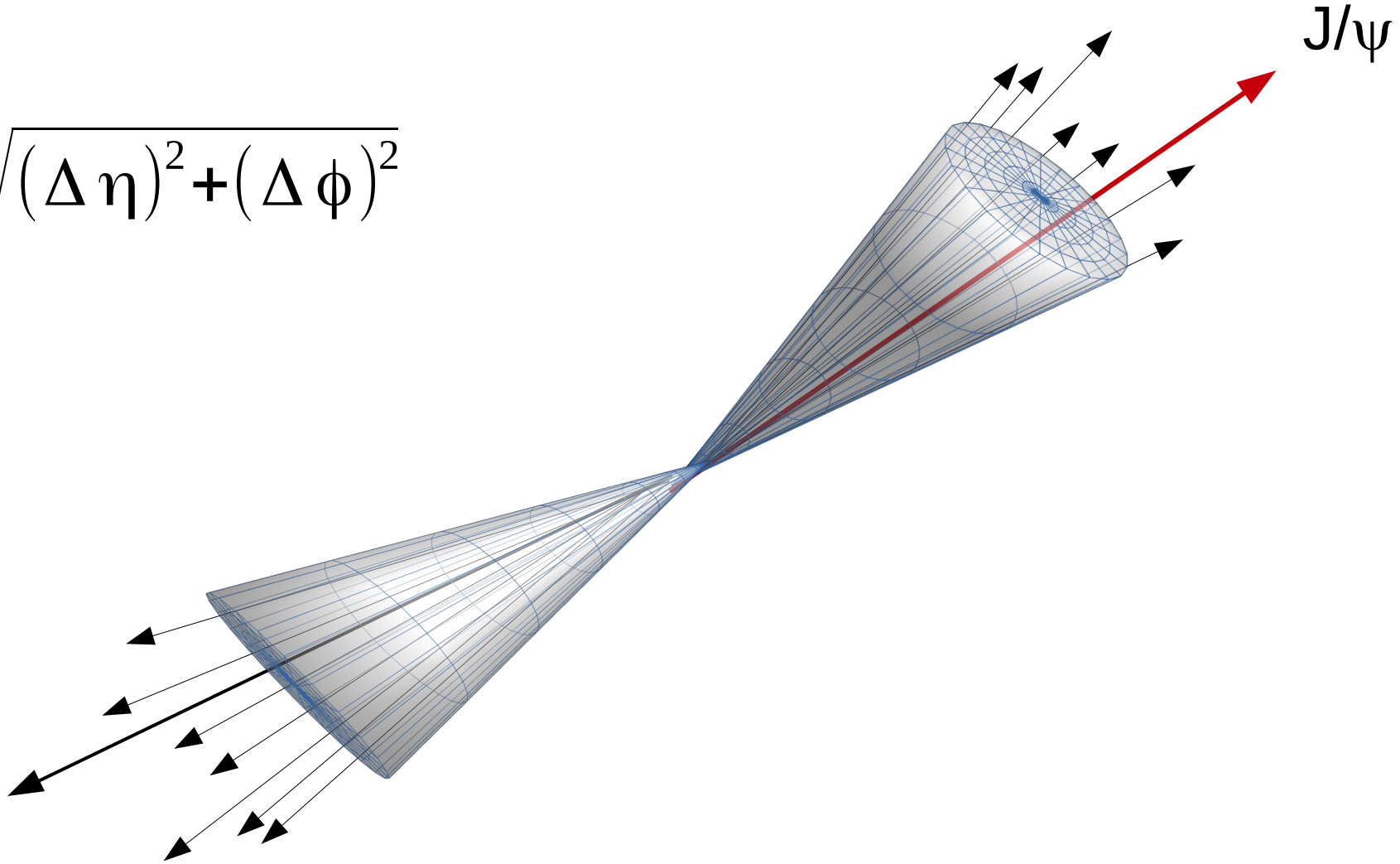
Faculty of Physics, Warsaw University of Technology

Quarkonium – hadron correlations

$$\Delta\phi = \phi^{J/\psi} - \phi^{hadron}$$

or

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



Quarkonium – hadron correlations

- J/ψ – hadron $\Delta\phi$ (or $\Delta\eta$) correlations
  - B $\rightarrow$ J/ψ vs prompt J/ψ production

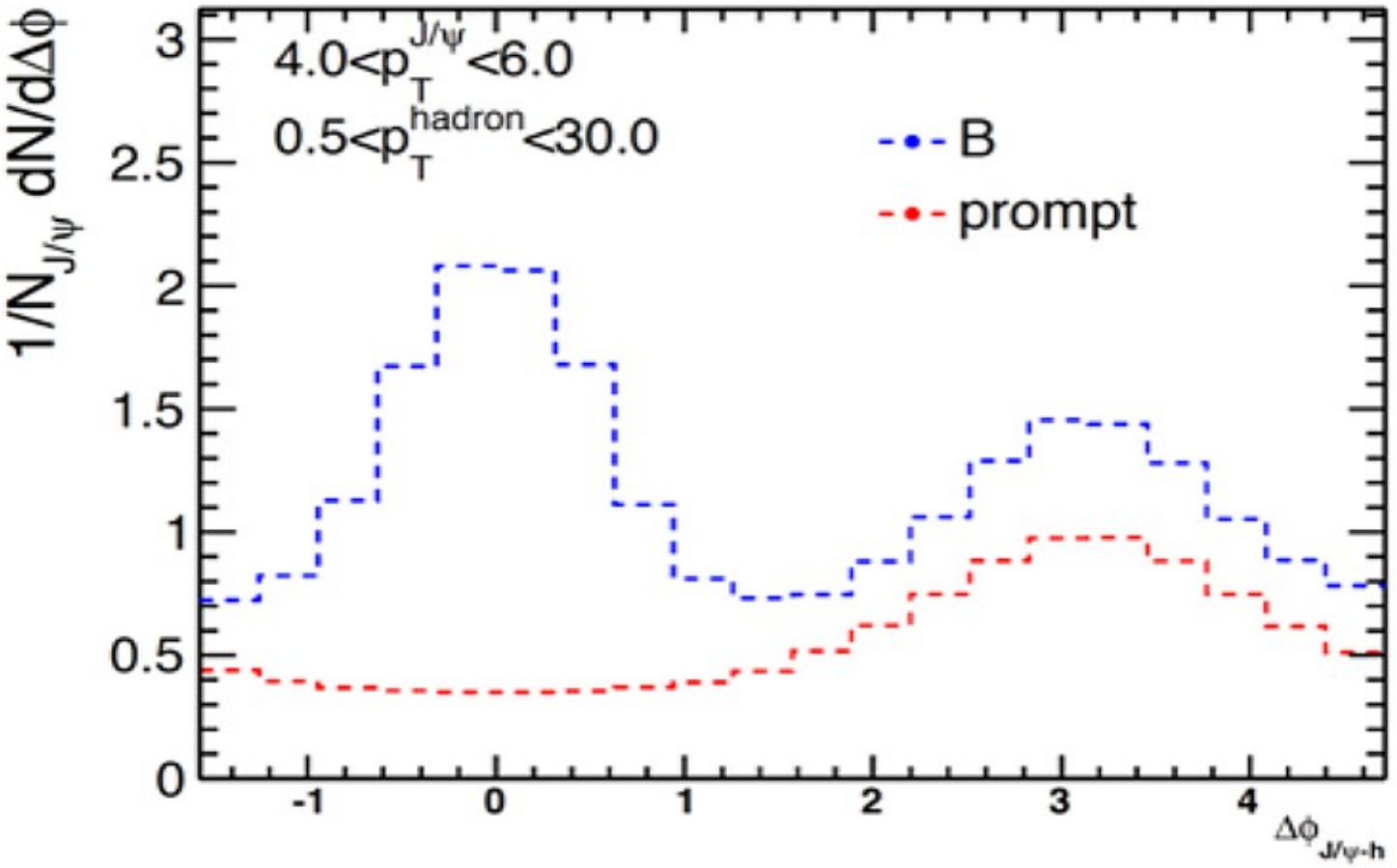
- Υ – hadron $\Delta\phi$ ($\Delta\eta$) correlations
  - Production mechanism:

    color singlet vs **high gluon radiation color octet**

    Can be done also for prompt J/ψ

Quarkonium – hadron correlations

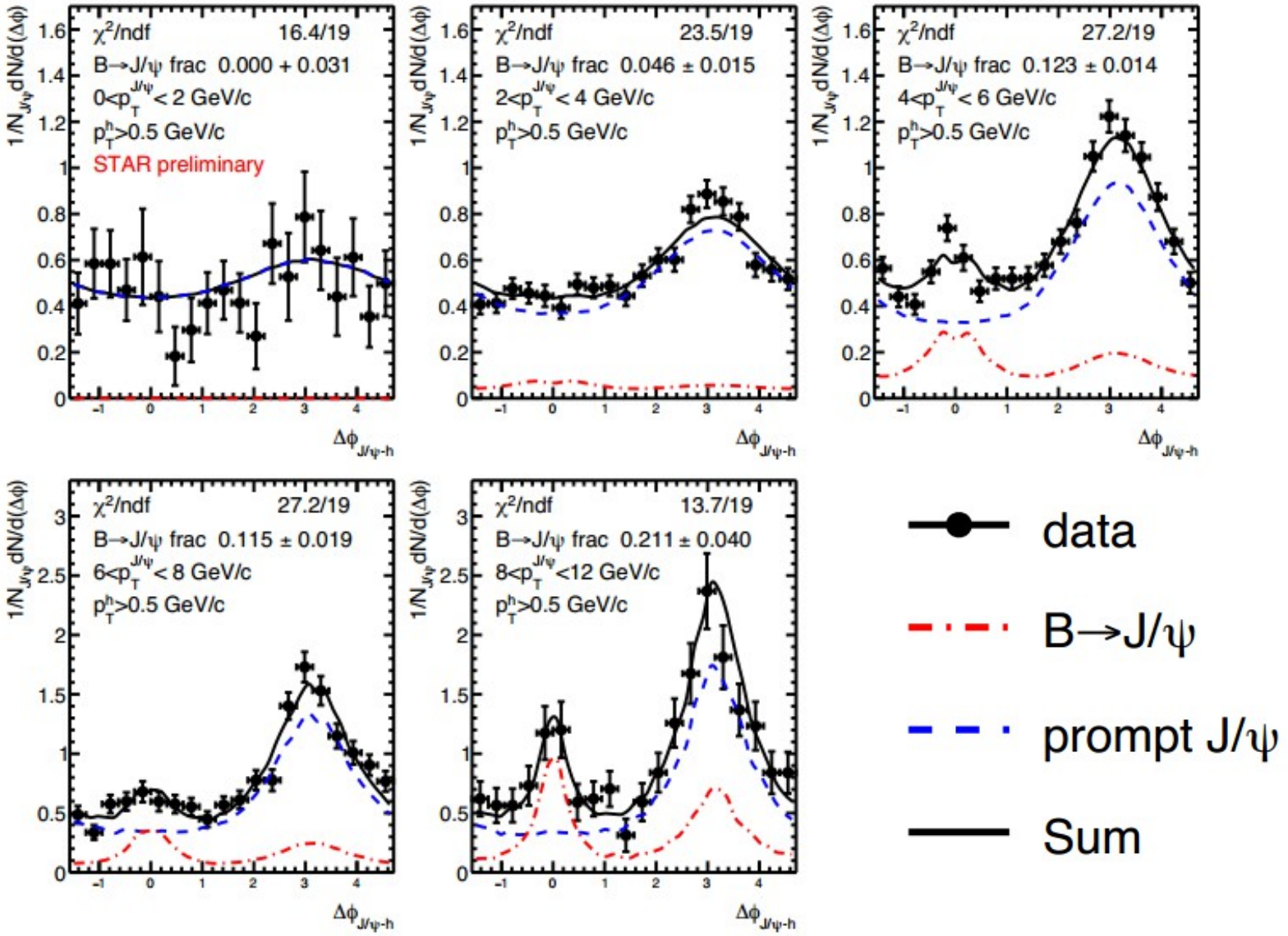
- J/ψ – hadron Δϕ (or Δη) correlations
  - B → J/ψ vs prompt production



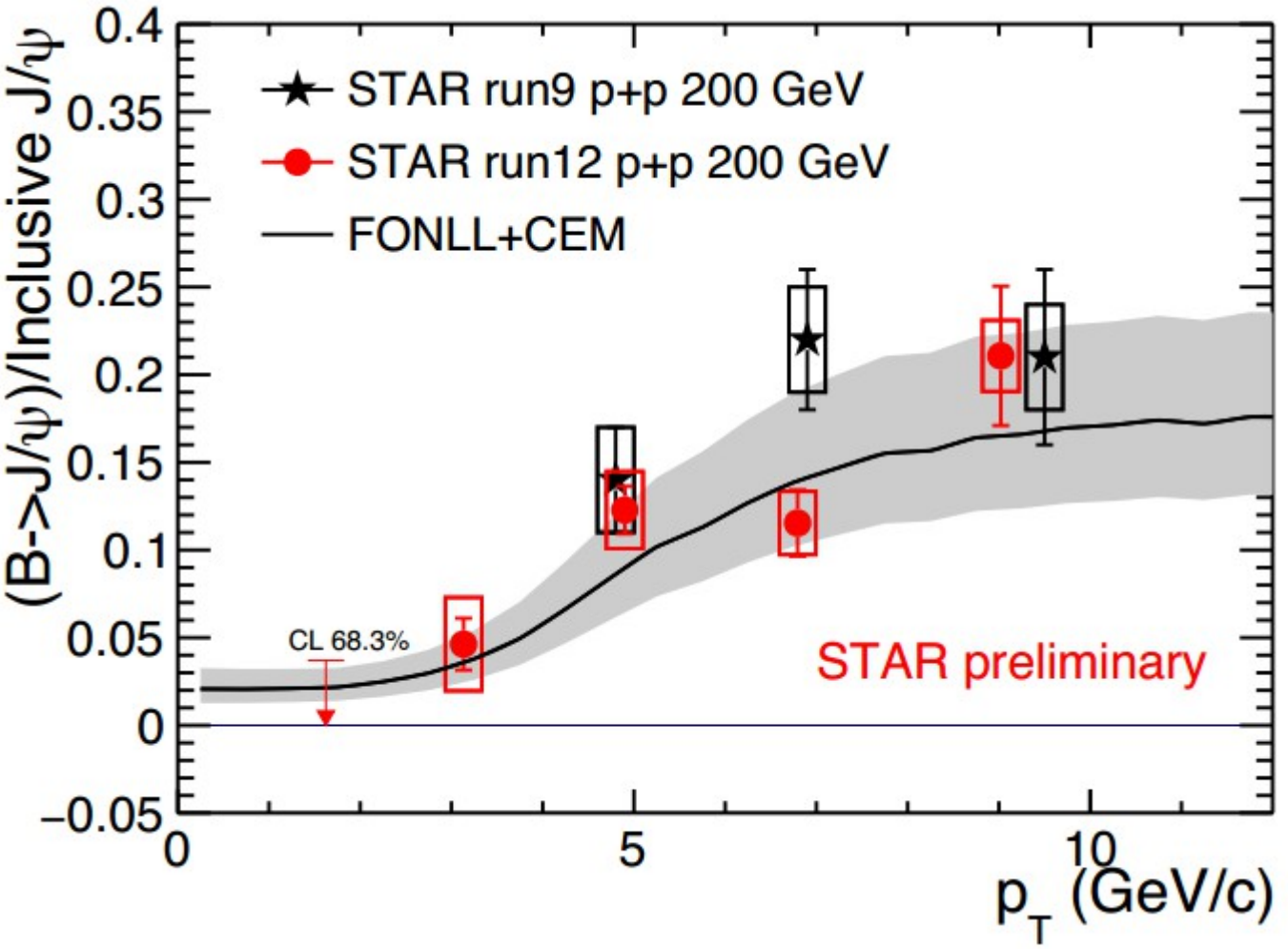
Pythia 8
p+p 200 GeV

p+p 200 GeV

$$Data = p[1] * p[0] * B \rightarrow J/\Psi + p[1] * (1 - p[0]) * Prompt\ J/\Psi$$

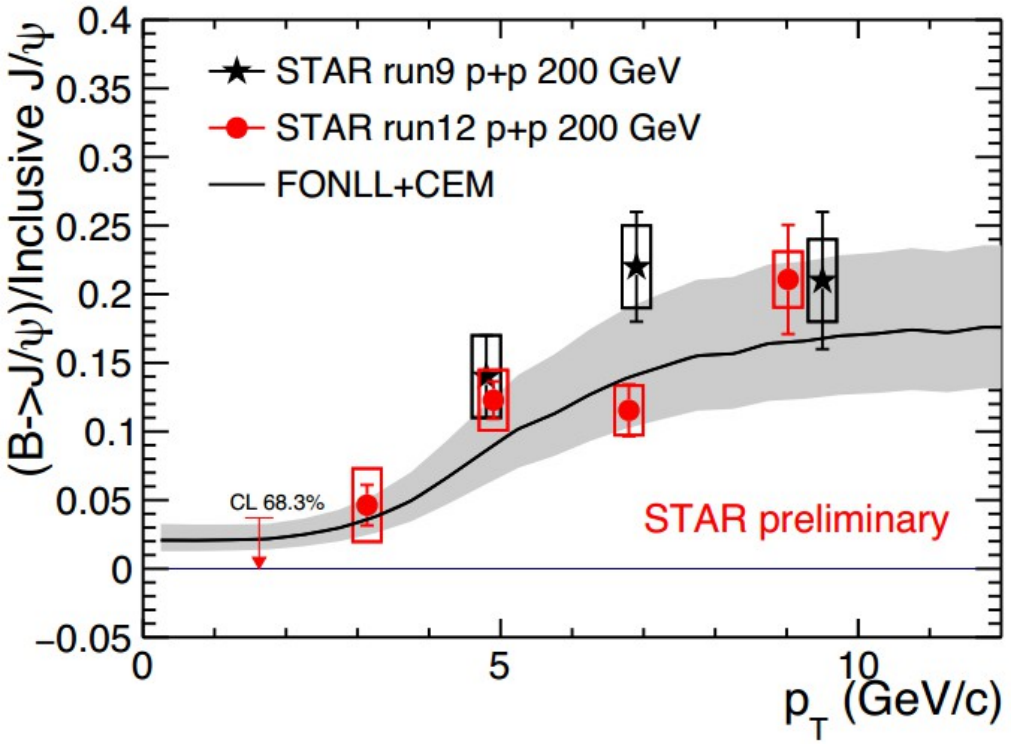


Non-prompt J/ψ

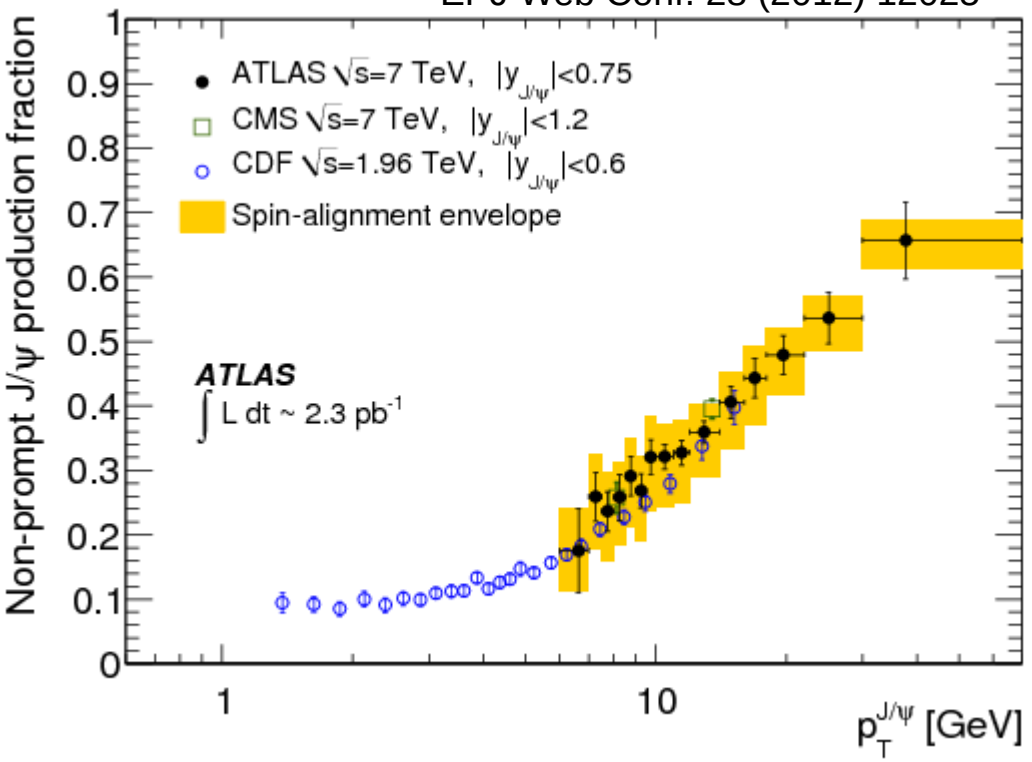


FONLL+CEM: R. Vogt private comunication, M. Cacciari, P. Nason, R. Vogt 2005 PRL 95 122001
STAR Run 9: PLB 722 (2013) 55

Non-prompt J/ψ



EPJ Web Conf. 28 (2012) 12025

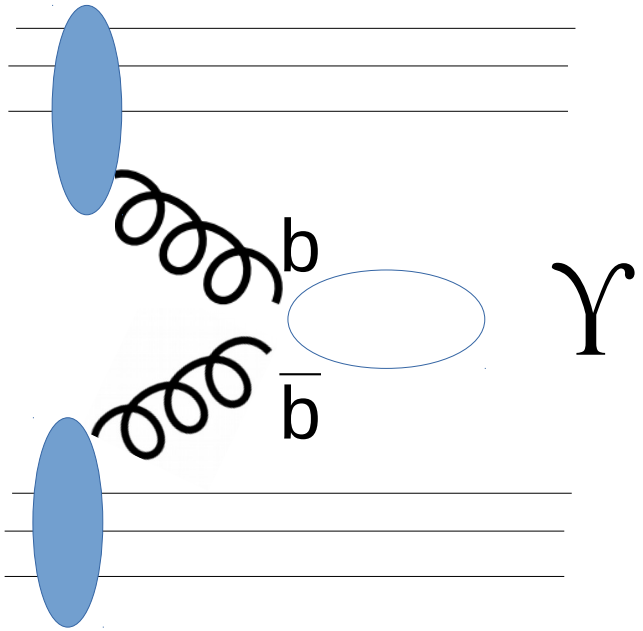


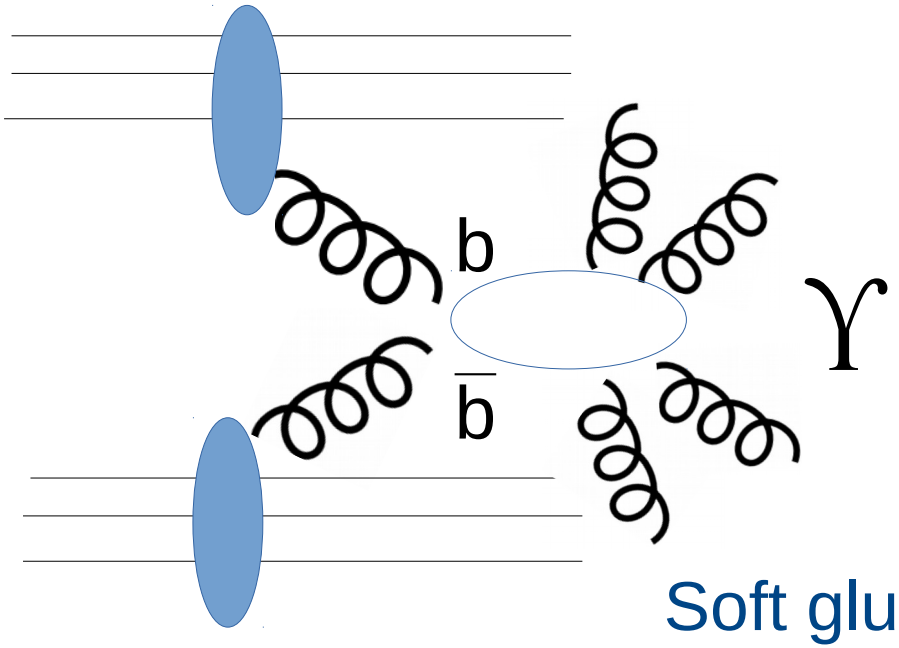
Quarkonium – hadron correlations

- Υ – hadron $\Delta\phi$ ($\Delta\eta$) correlations
  - Production mechanism:

    color singlet vs **high gluon radiation color octet**

Color octet high radiation scenario





Soft gluons

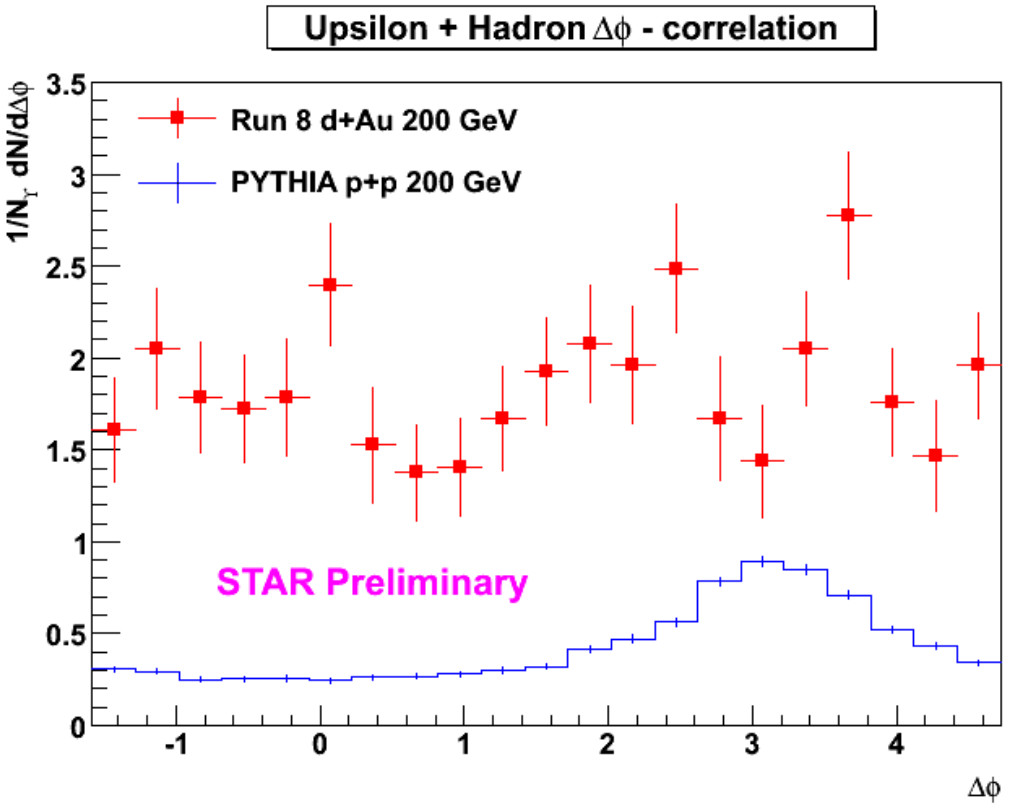
Color Singlet vs Color Octet

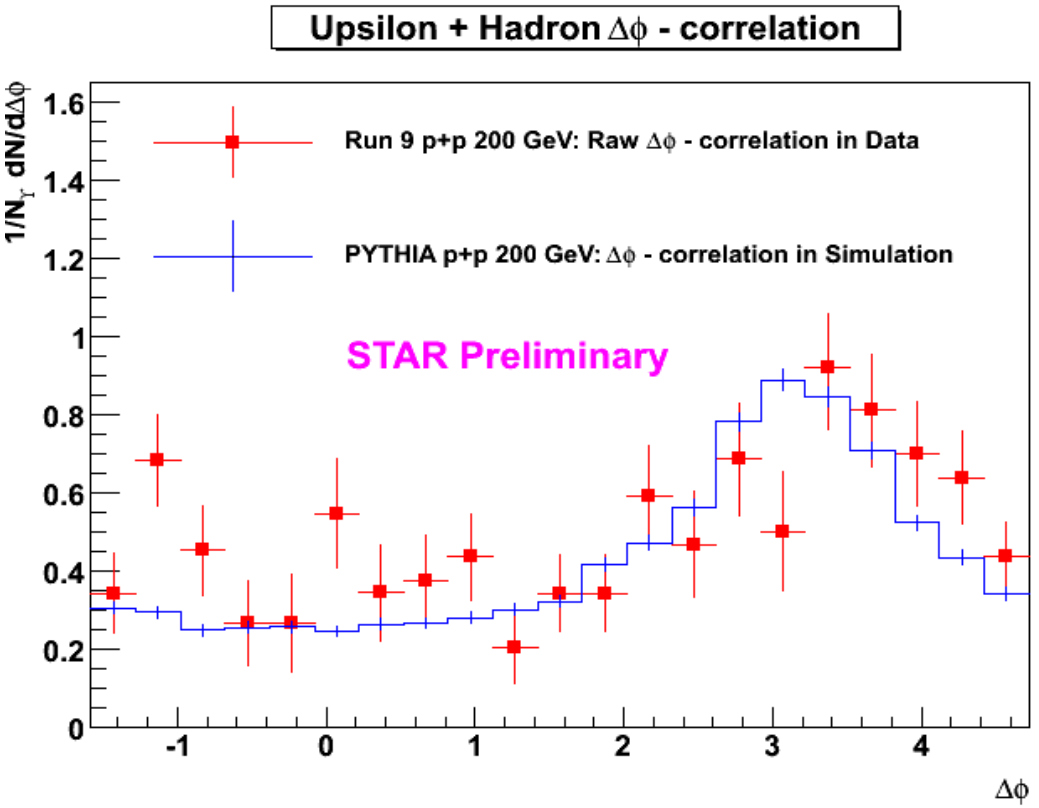
(high gluon radiation case)

→ difference in particle production around Υ

(Kraan, arXiv:0807.3123)

Υ – hadron $\Delta\phi$ correlations





$\Delta\phi$ - correlation is not corrected for efficiency and acceptance

No significant correlation in d+Au 200 GeV

Correlation in p+p 200 GeV consistent with PYTHIA

Production vs event activity

Why?

Production vs event activity

- Test for production models

- Issue: model has to reproduce soft and hard processes in the same time

Production vs event activity

- Hadronic to partonic matter transition in a small system?

- Issue: volume is small,

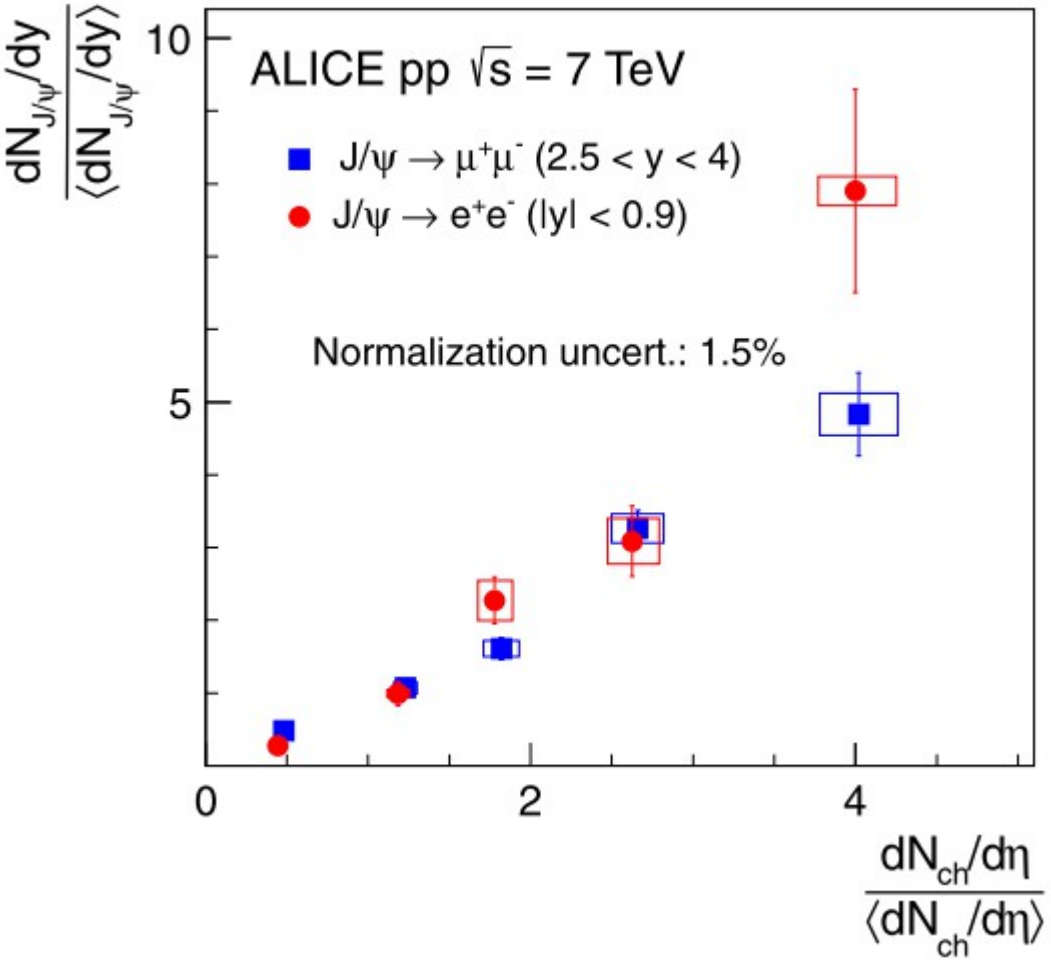
  partonic ≠ Quark-Gluon Plasma (probably)

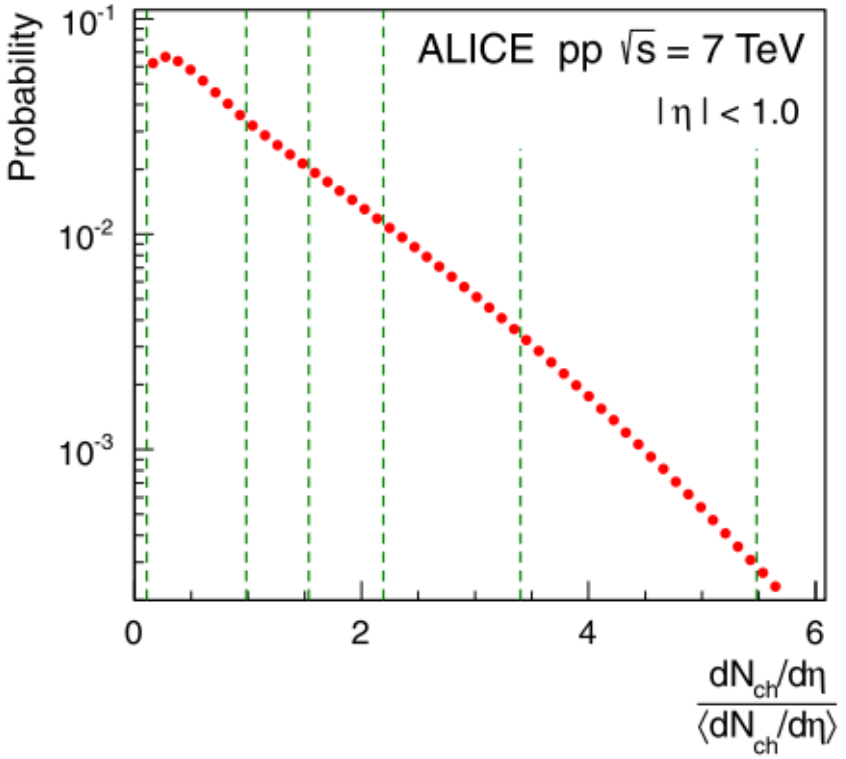
Production vs event activity

- Handle on interaction with hadronic co-movers using Υ(nS)/Υ(1S)

- Issue: how to separate change in the production cross section from co-mover suppression?

J/ψ yield vs event activity at LHC

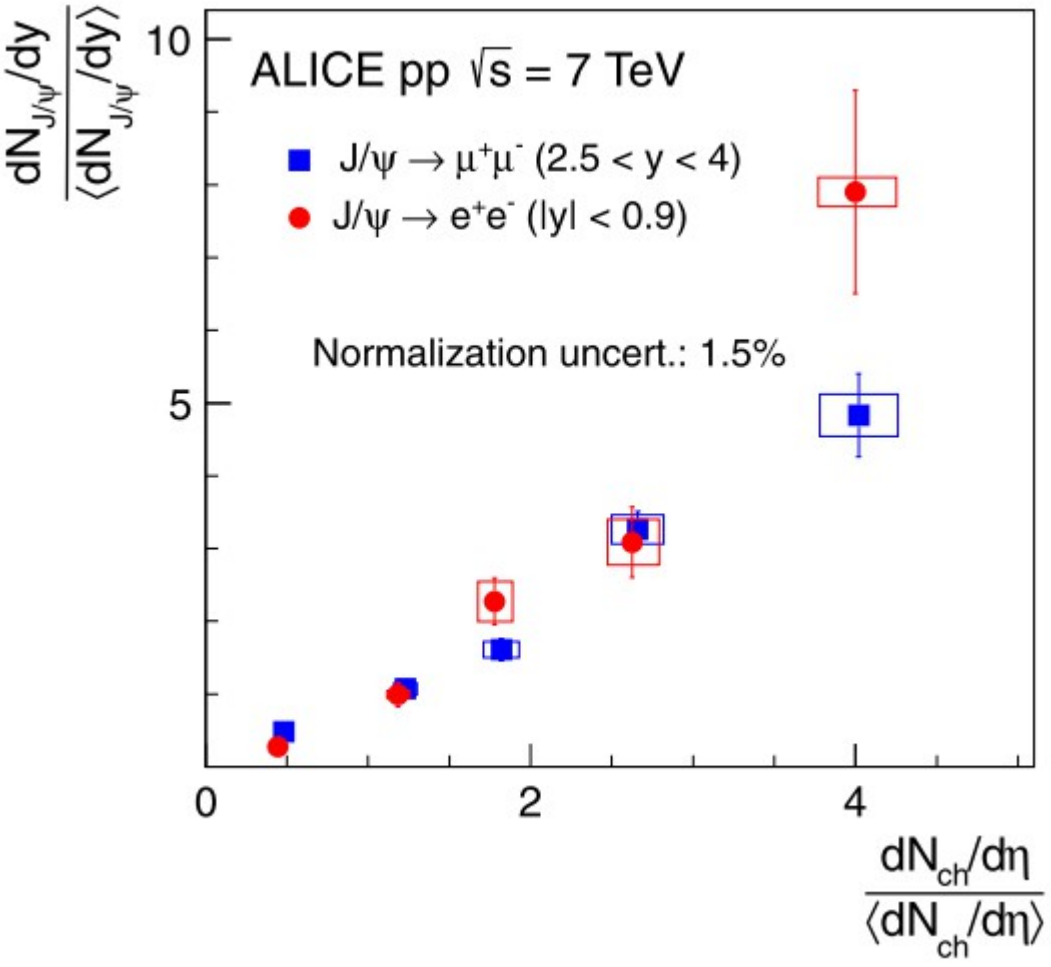




$\langle dN_{ch}/d\eta \rangle = 6.01 \pm 0.01(stat.)^{+0.20}_{-0.12}(syst.)$

Physics Letters B 712 (2012) 165–175

J/ψ yield vs event activity at LHC

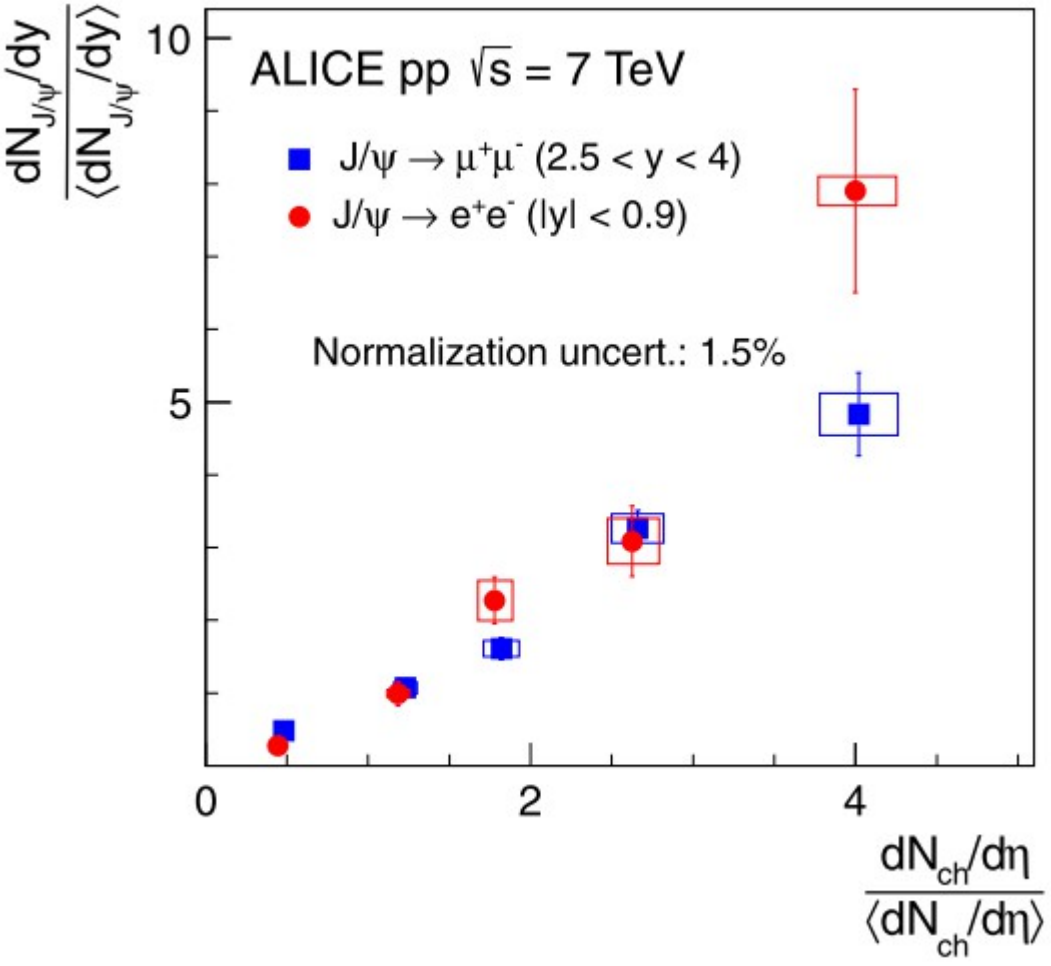


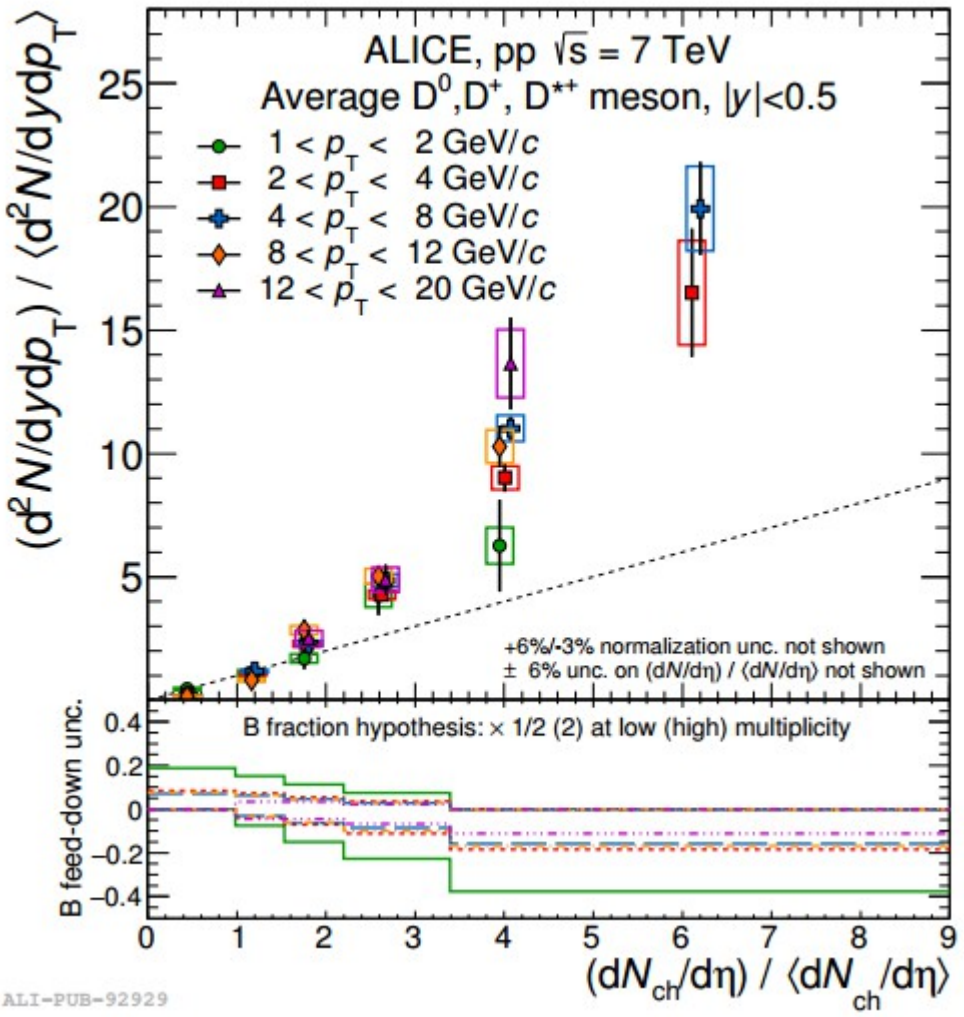
Faster increase at y ~ 0 that at forward rapidity

Indication of production in jets?

Physics Letters B 712 (2012) 165–175

J/ψ yield vs event activity at LHC

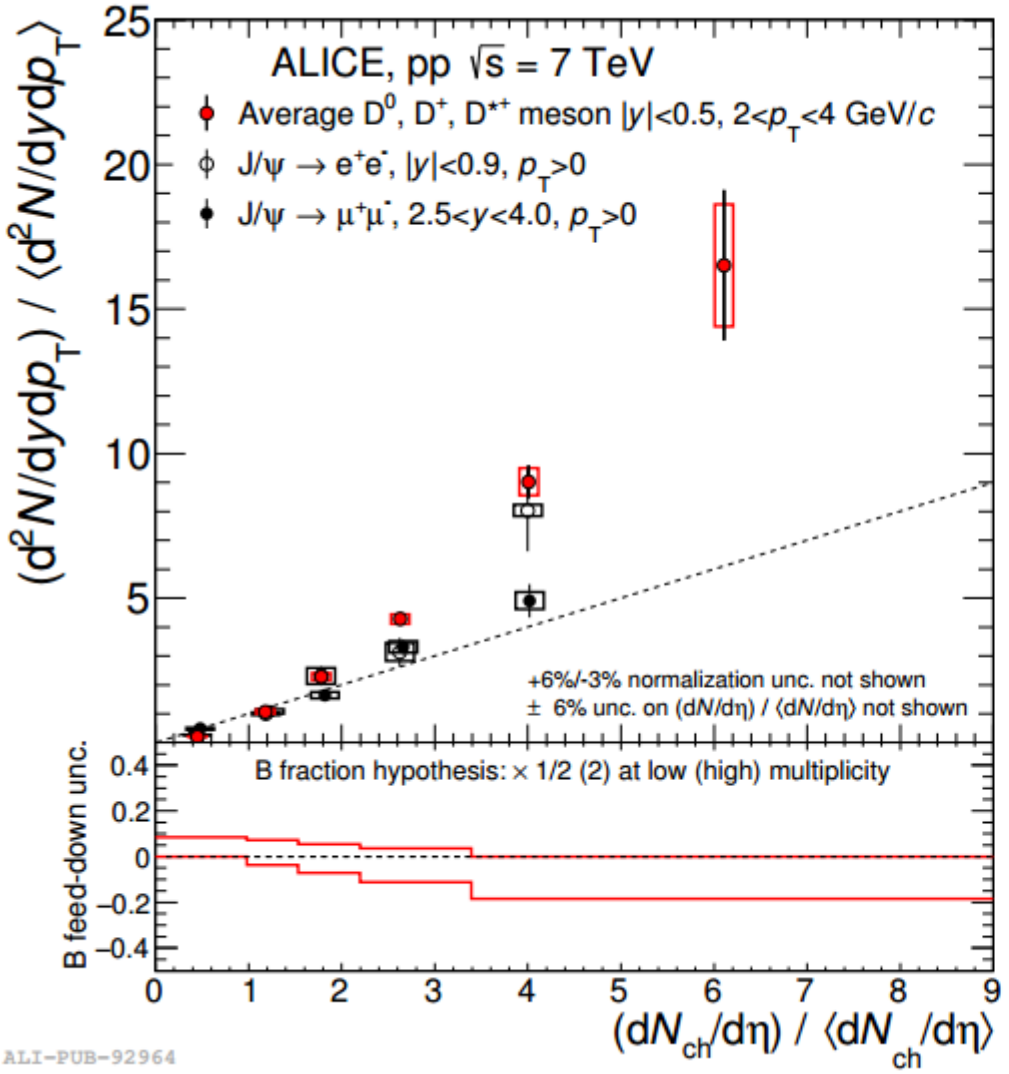


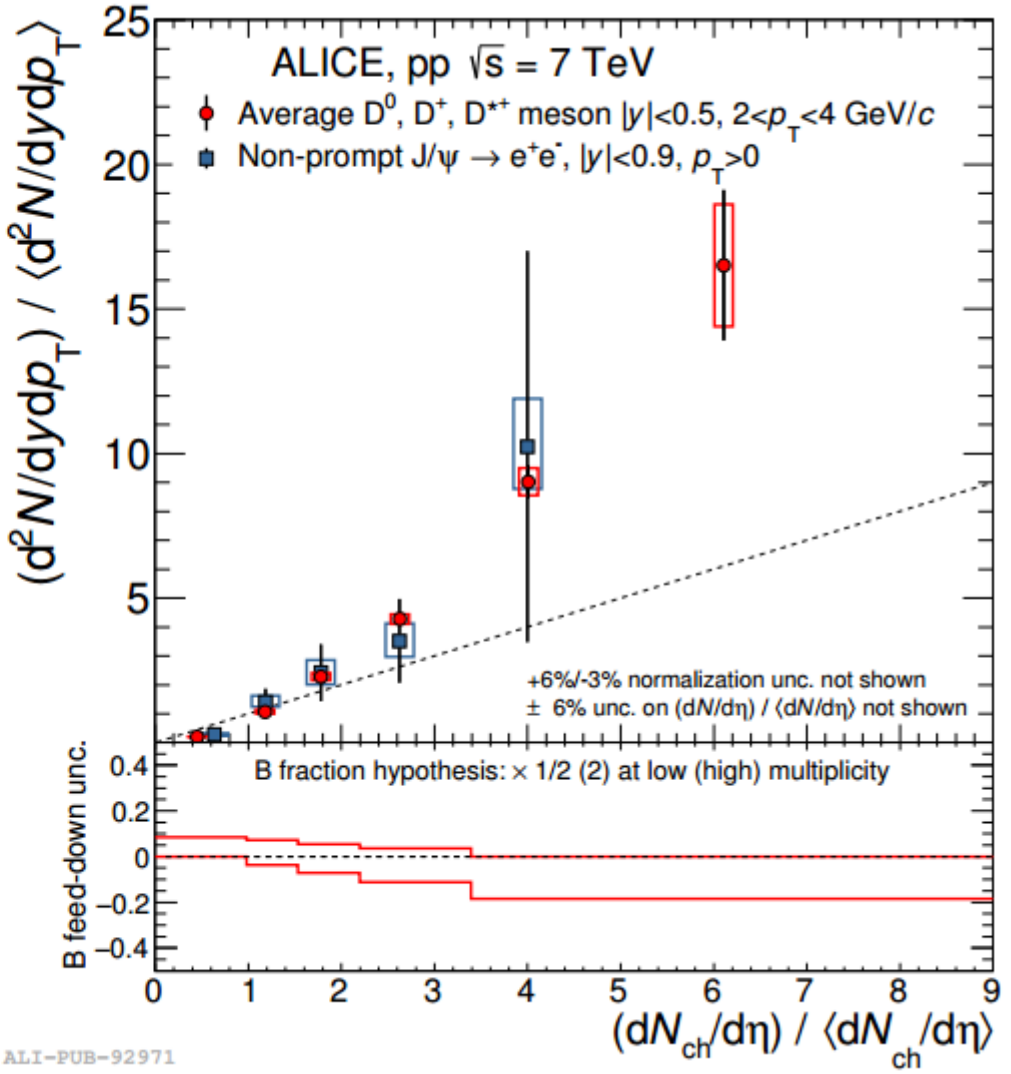


JHEP09(2015)148

Physics Letters B 712 (2012) 165–175

J/ψ yield vs event activity at LHC



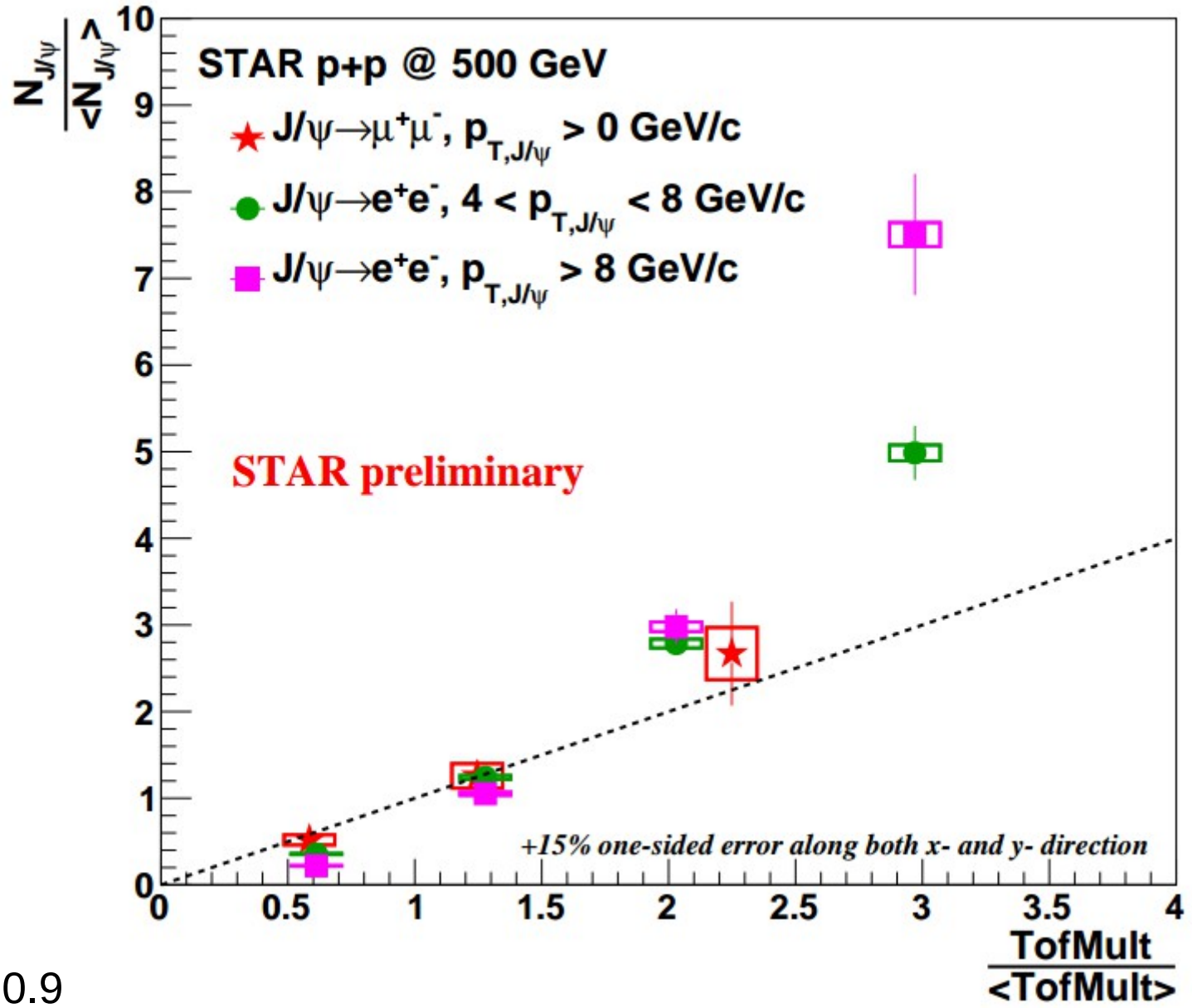


JHEP09(2015)148

J/ψ yield vs event activity at RHIC

High p_T yields increase faster than at low p_T

Indication of production is jets?

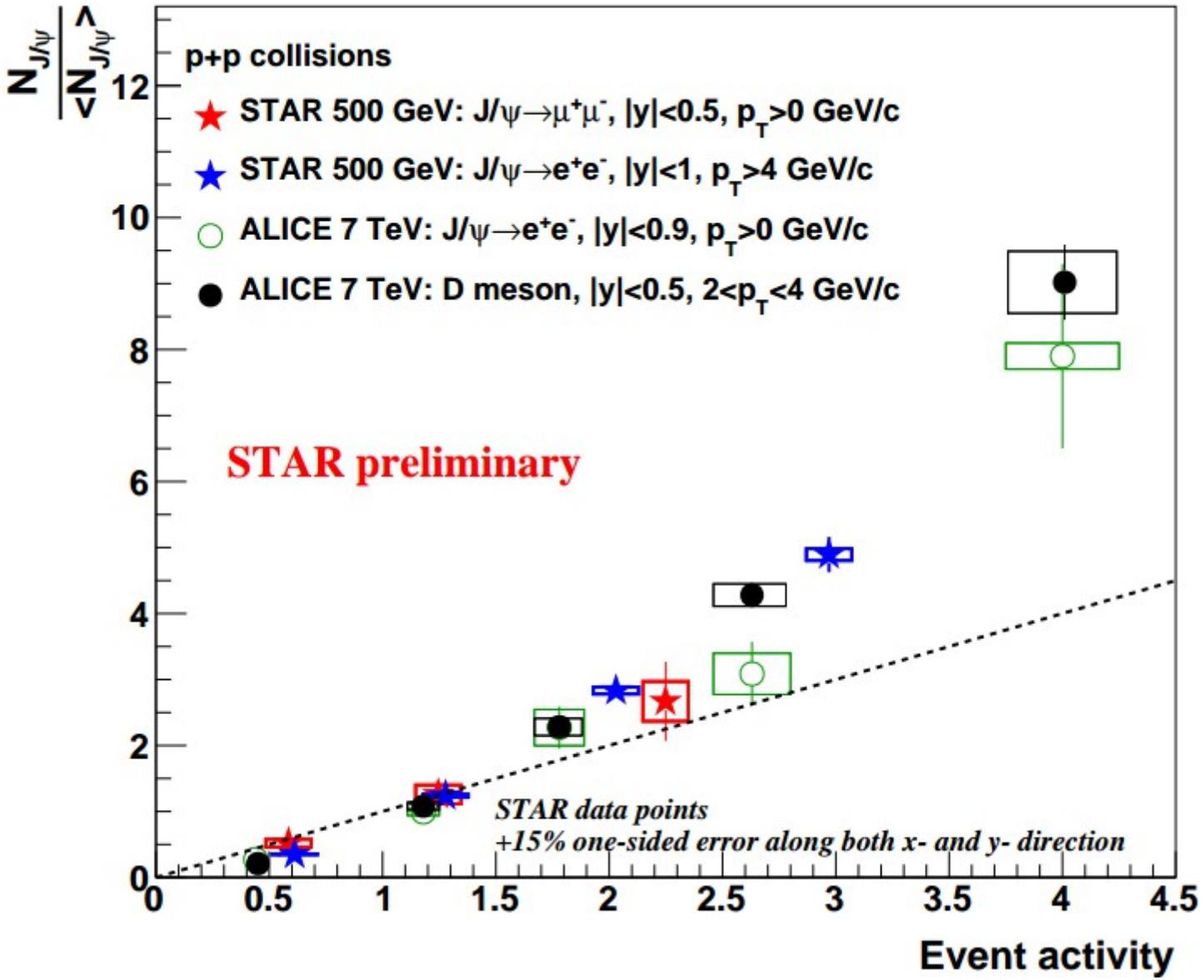


Time of Flight (ToF): |y|< 0.9

STAR, Hard Probes 2015, arXiv:1509.06440 [nucl-ex]

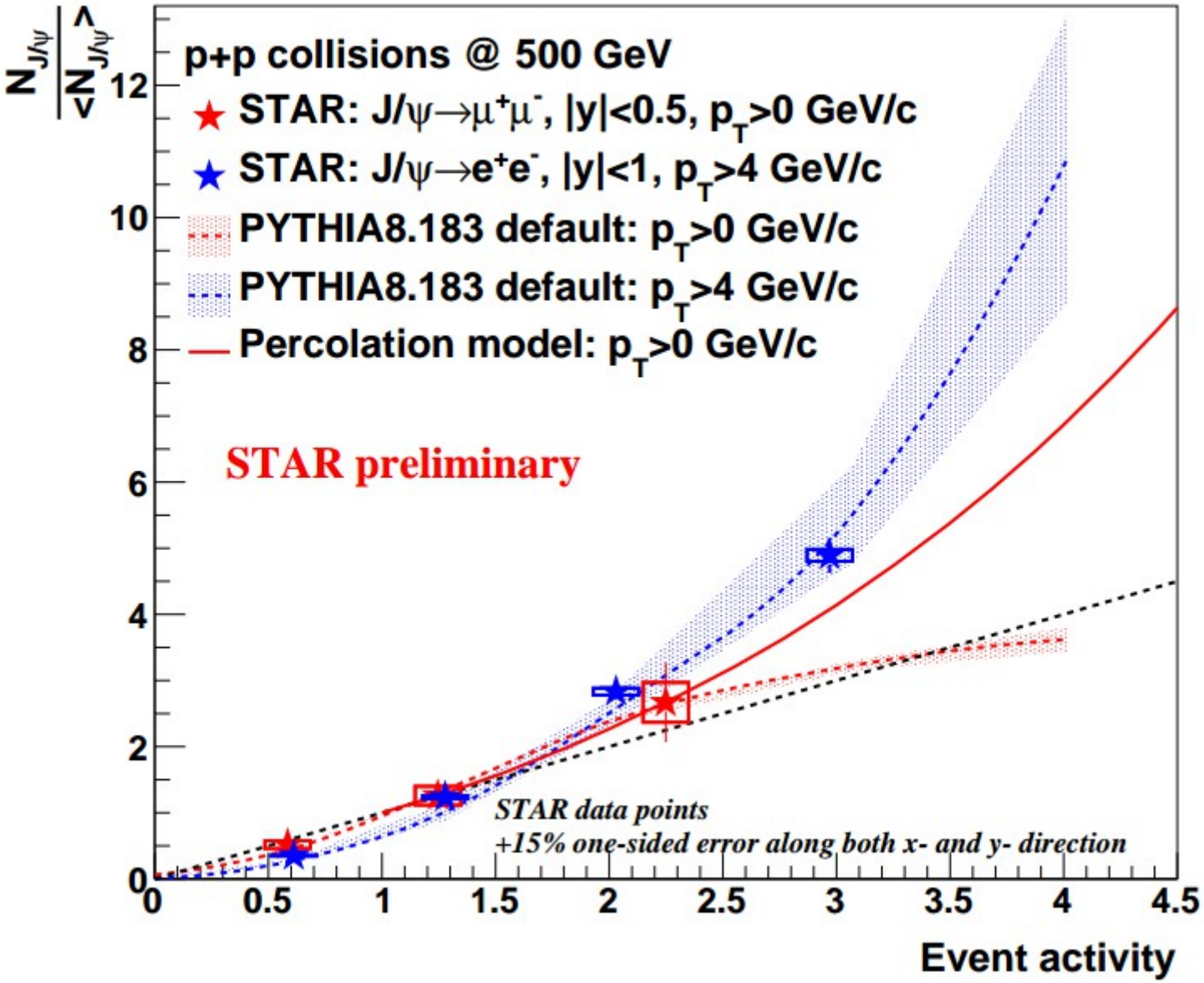
J/ψ yield vs event activity at RHIC

Similar trend at RHIC and LHC



STAR, Hard Probes 2015, arXiv:1509.06440 [nucl-ex]

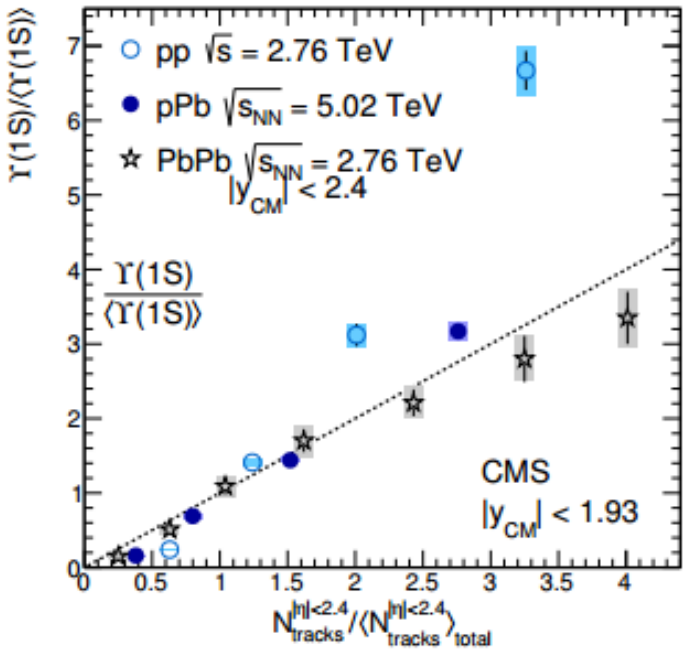
J/ψ yield vs event activity at RHIC

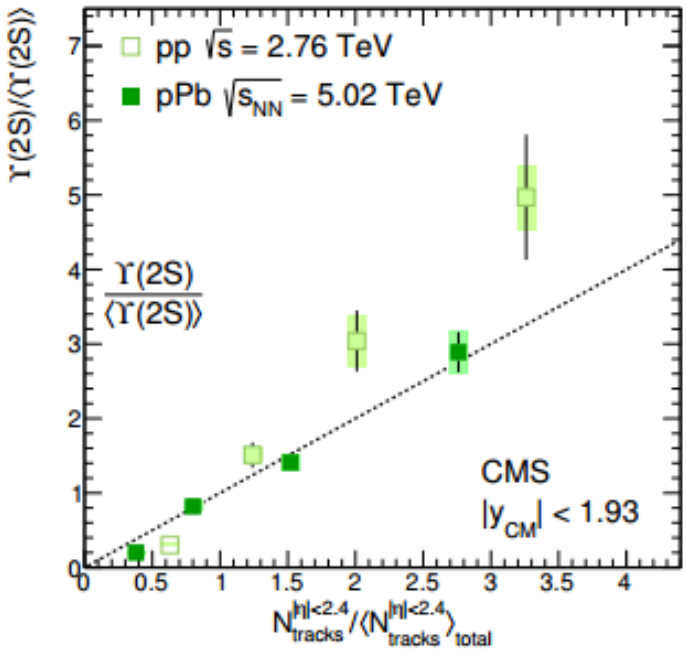


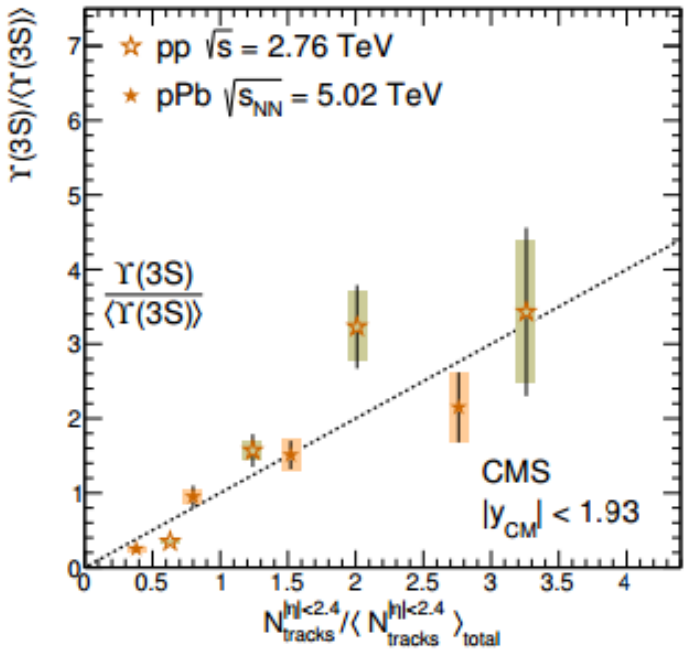
Percolation model: E. G. Ferreiro, C. Pajares, Phys. Rev. C86 (2012) 034903.

STAR, Hard Probes 2015, arXiv:1509.06440 [nucl-ex]

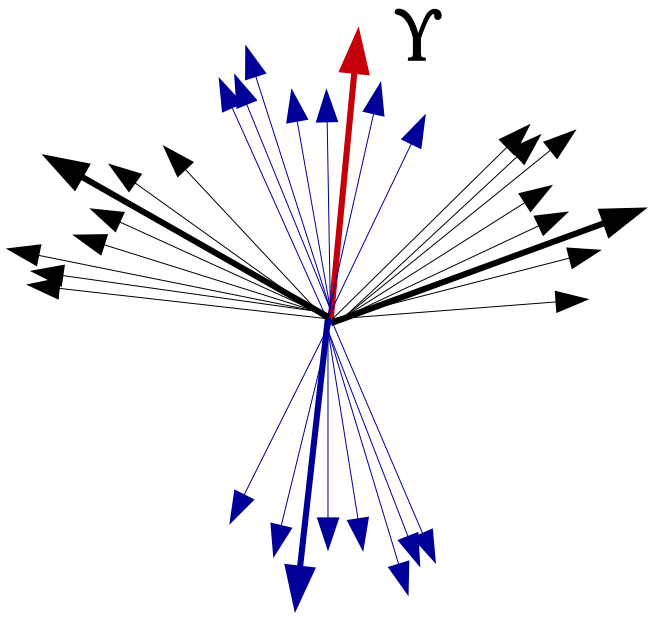
ϒ yield vs event activity at LHC





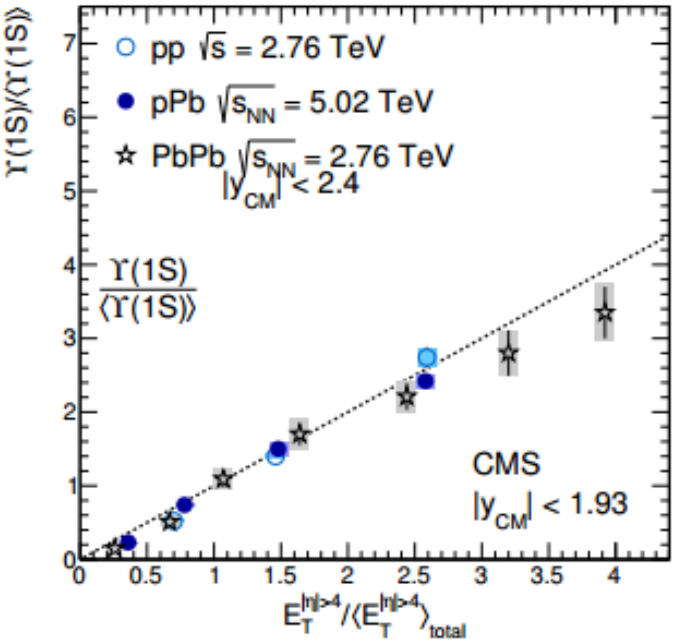


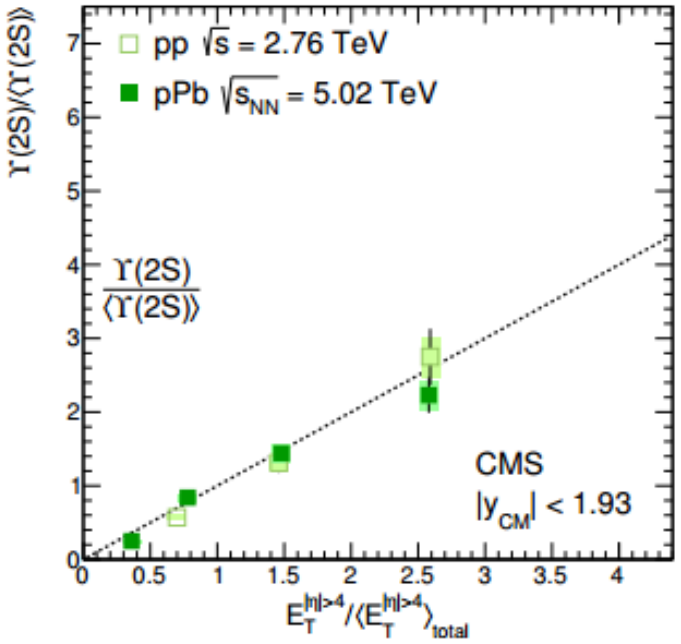
Event activity measured at midrapidity

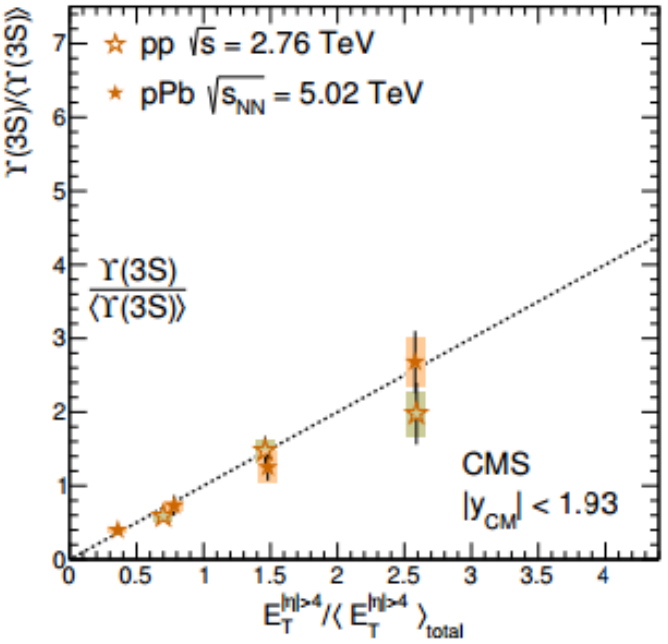


CMS, JHEP04(2014)103

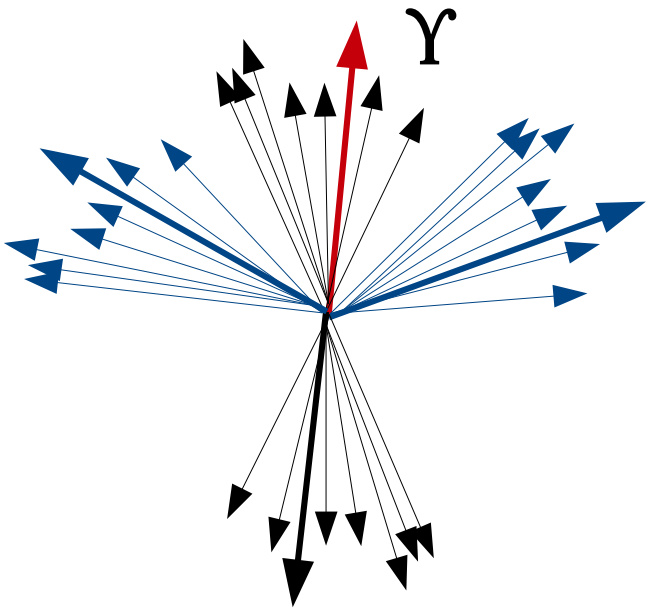
ϒ yield vs event activity at LHC





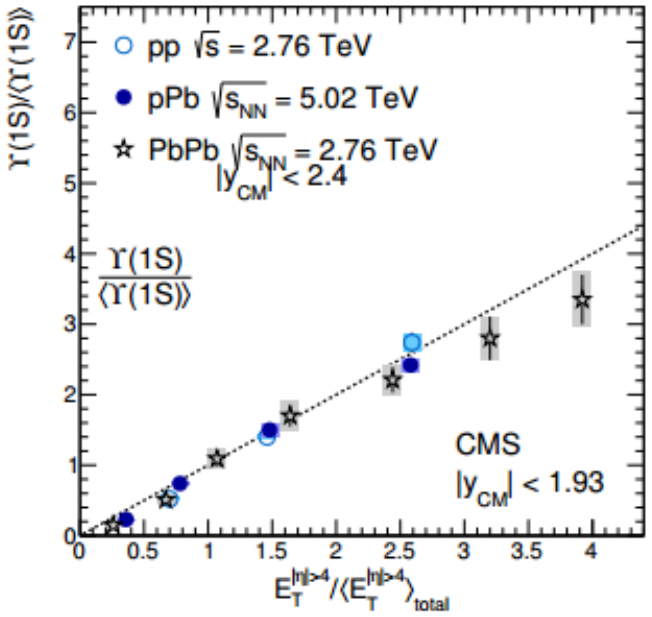


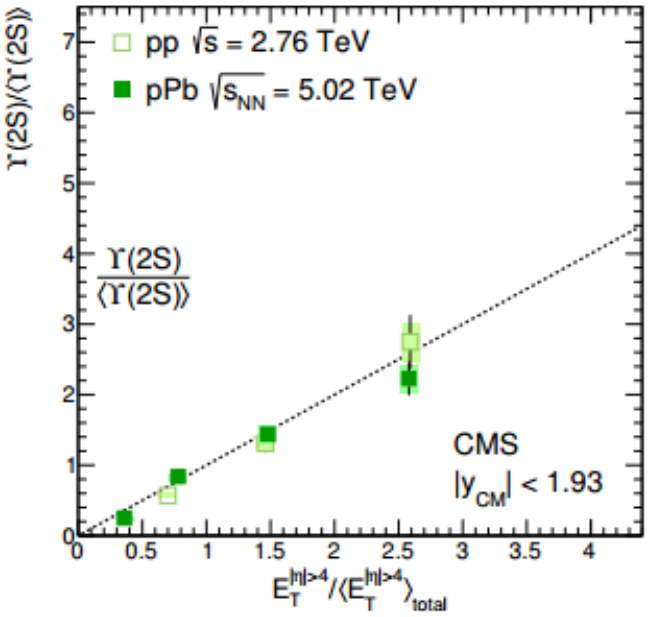
Event activity measured at forward rapidity

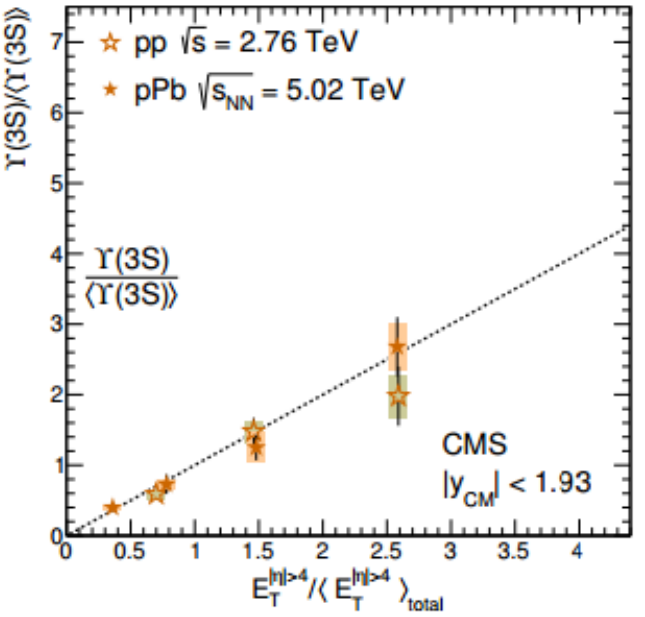


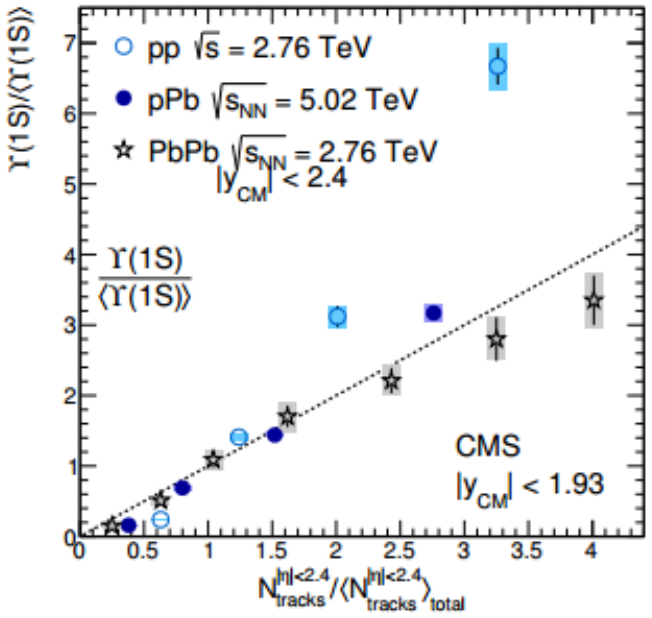
CMS, JHEP04(2014)103

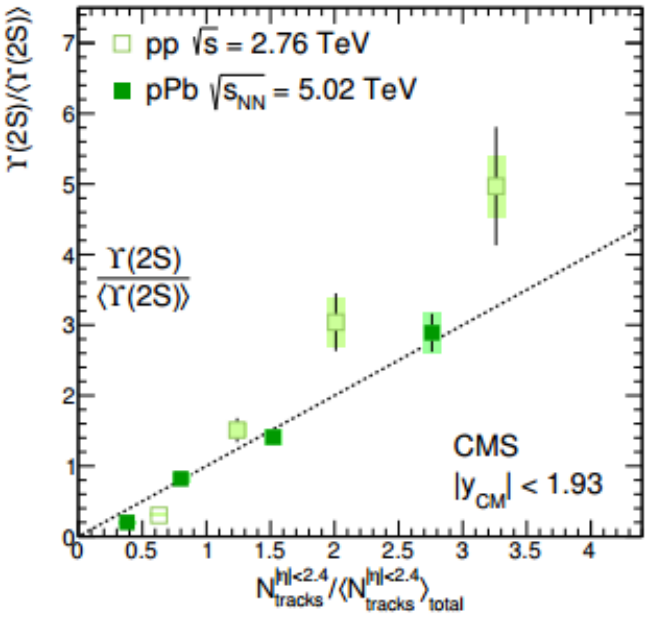
ϒ yield vs event activity at LHC

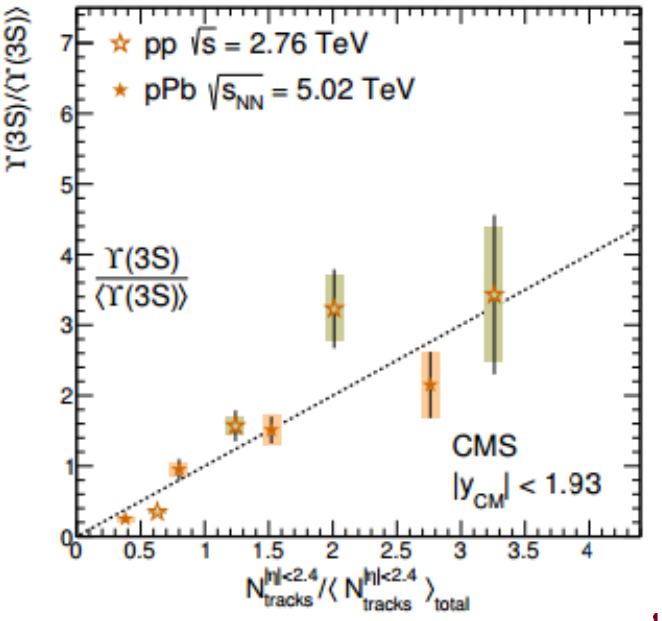






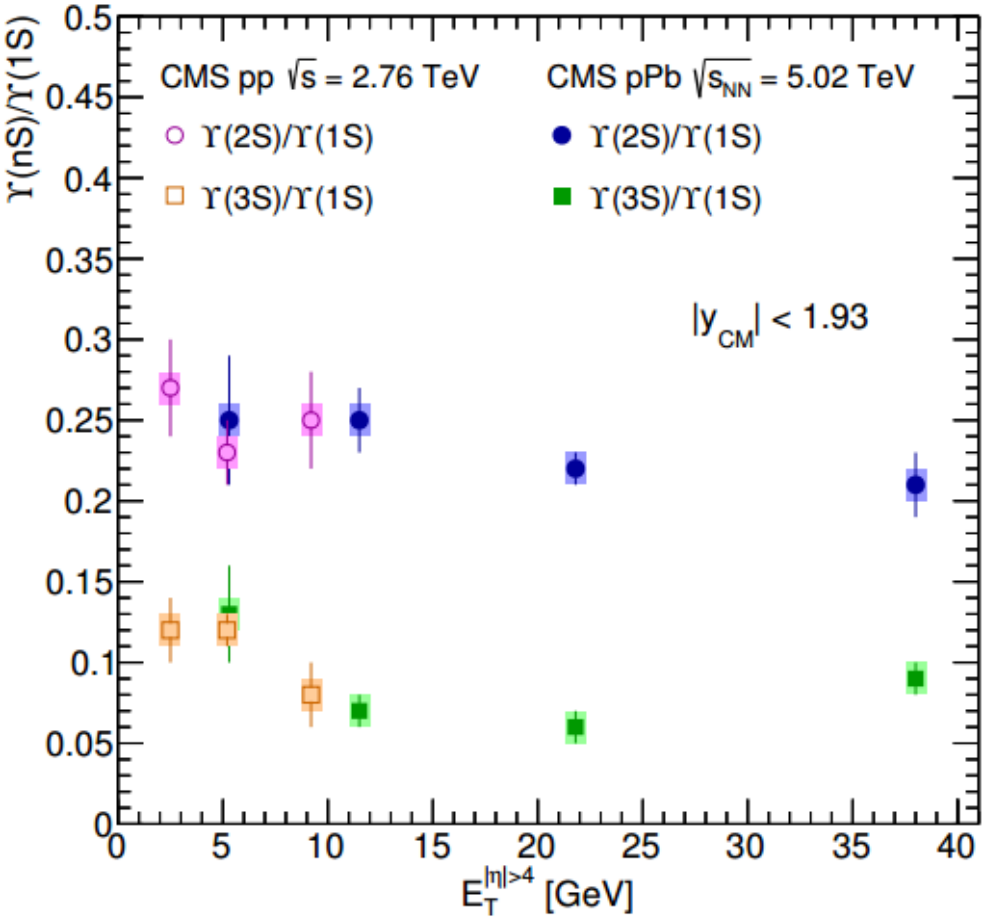


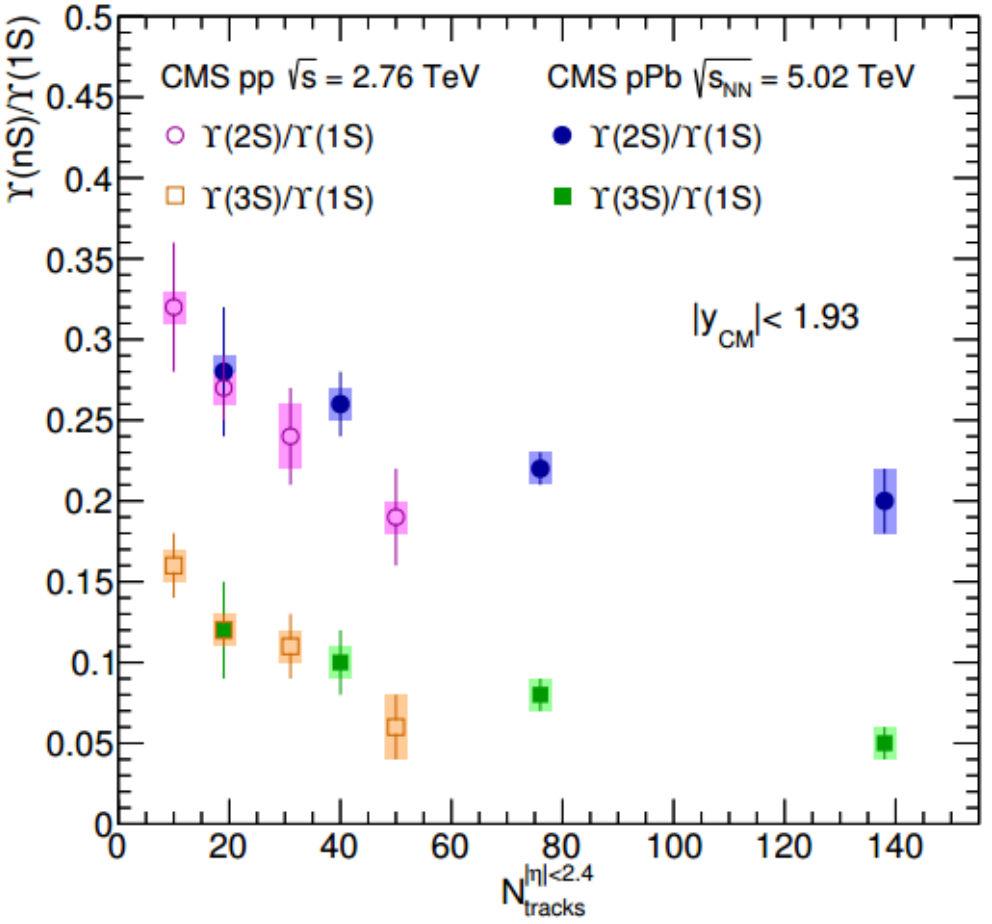




CMS, JHEP04(2014)103

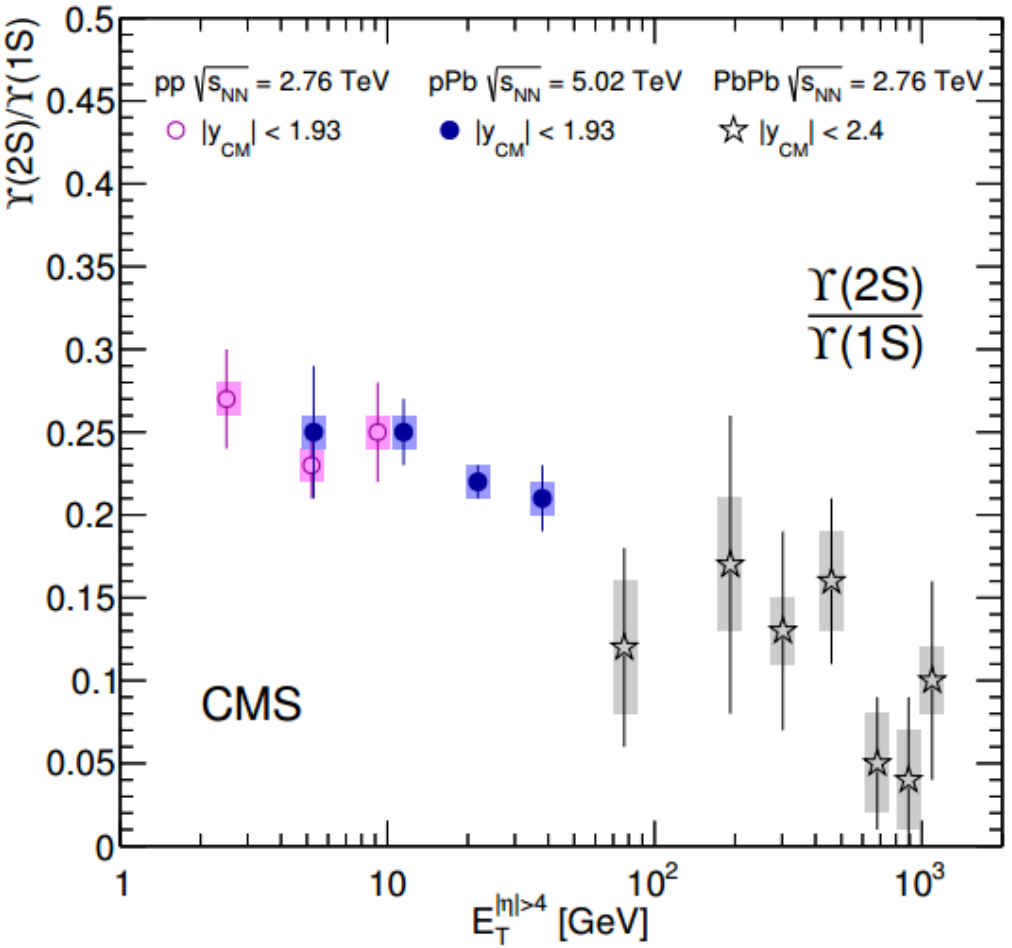
ϒ yield vs event activity at LHC

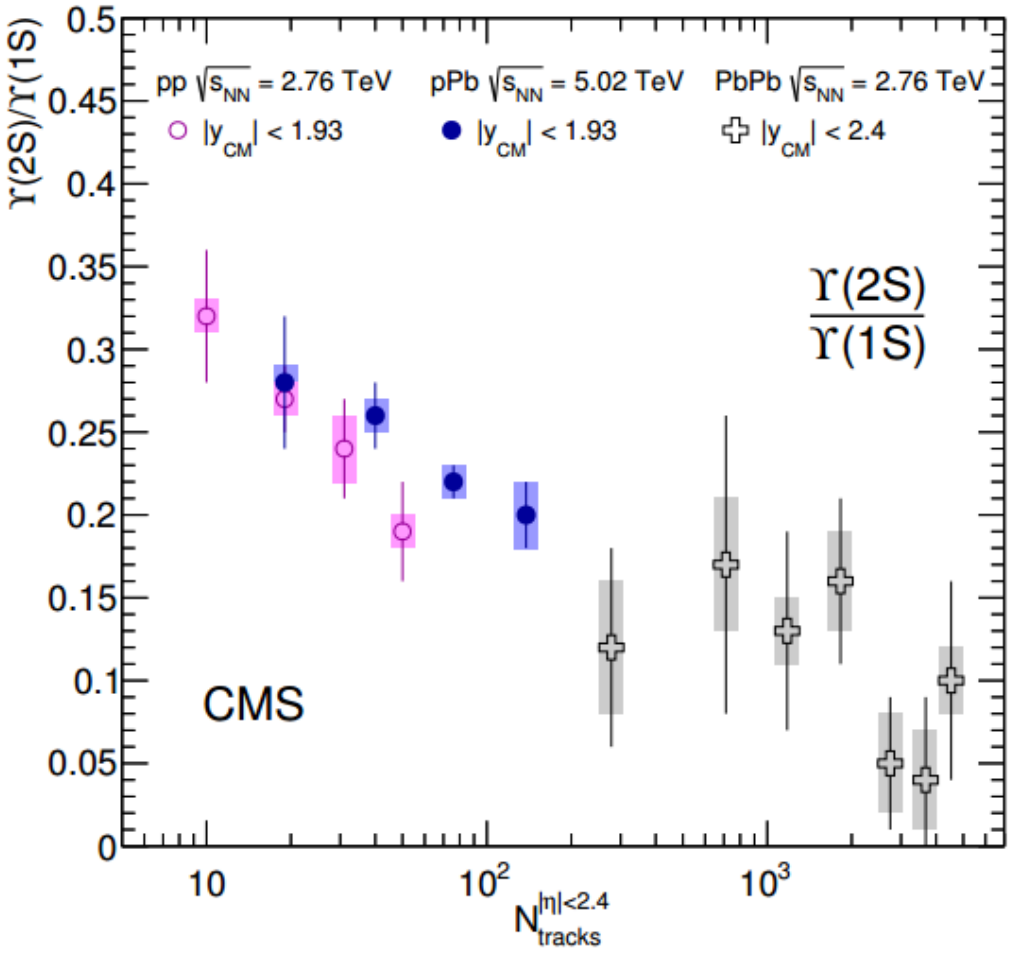




CMS, JHEP04(2014)103

ϒ yield vs event activity at LHC





CMS, JHEP04(2014)103

Summary

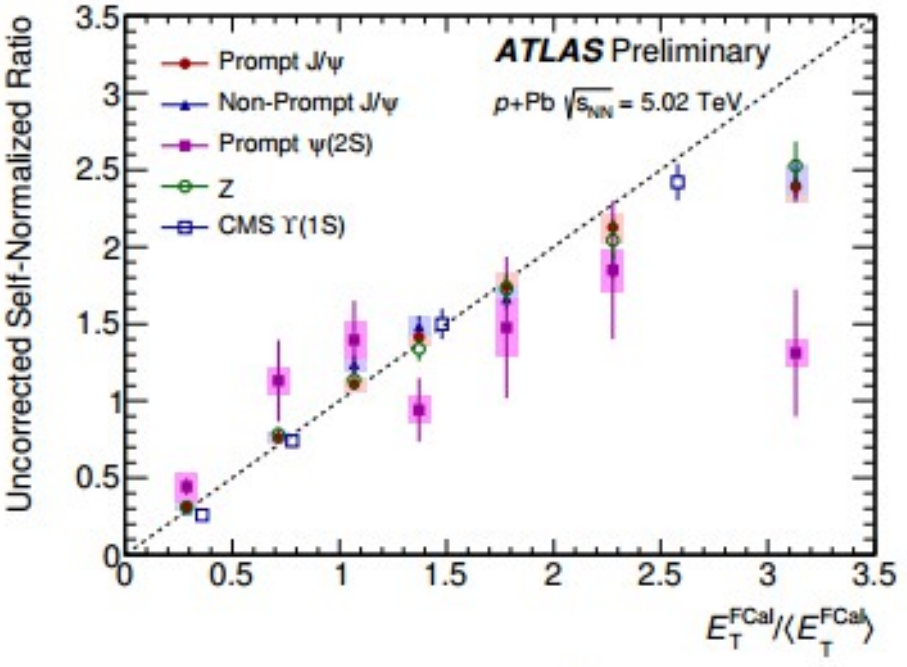
- Heavy flavor production correlated with event activity in p+p collisions at RHIC and LHC

- High p_T J/ψ yields increase faster with event activity than production at low p_T at **RHIC**

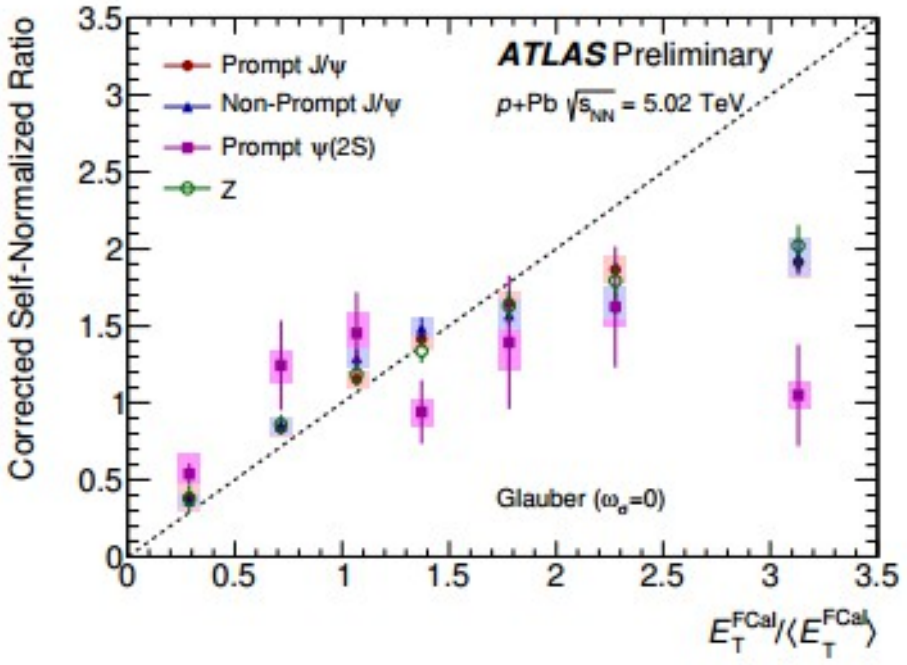
- The trend vs p_T not observed yet at LHC

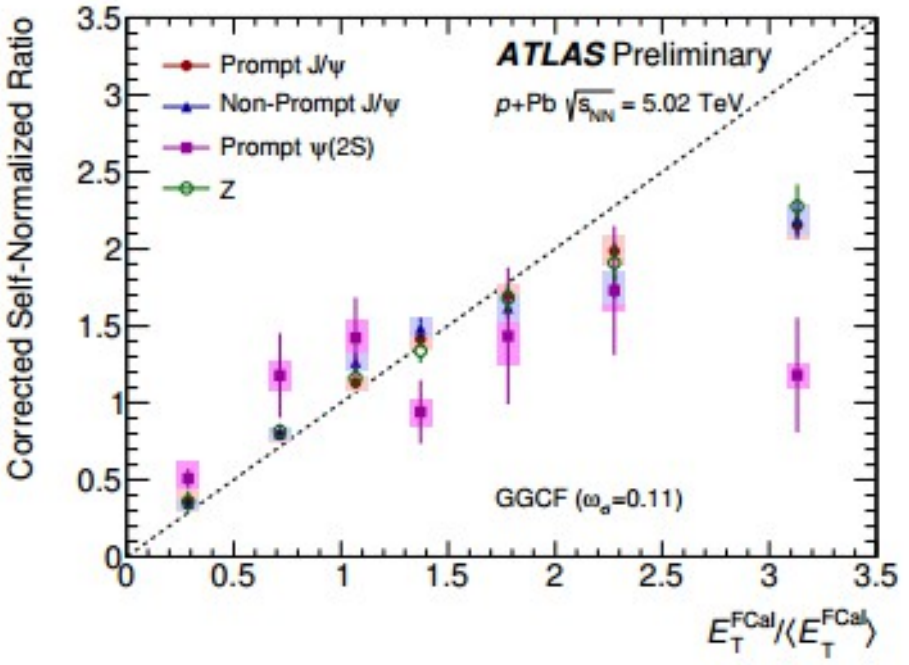
Backup

Yield vs event activity in p+Pb 5 TeV



Journal of Physics: Conference Series 668 (2016) 012011





Event activity in p+p 7 TeV

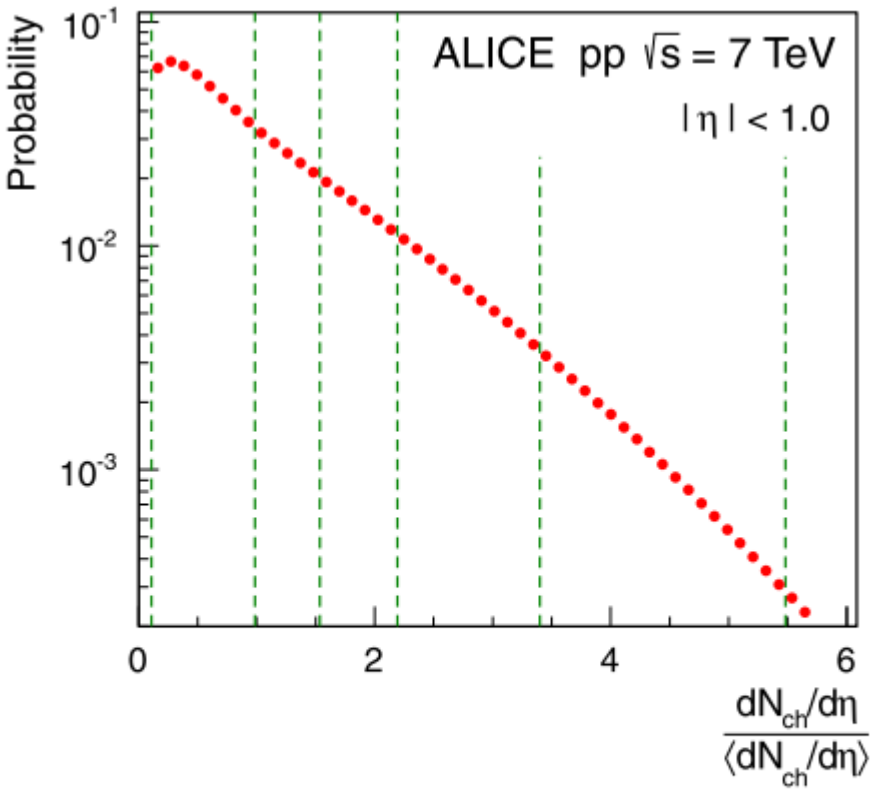
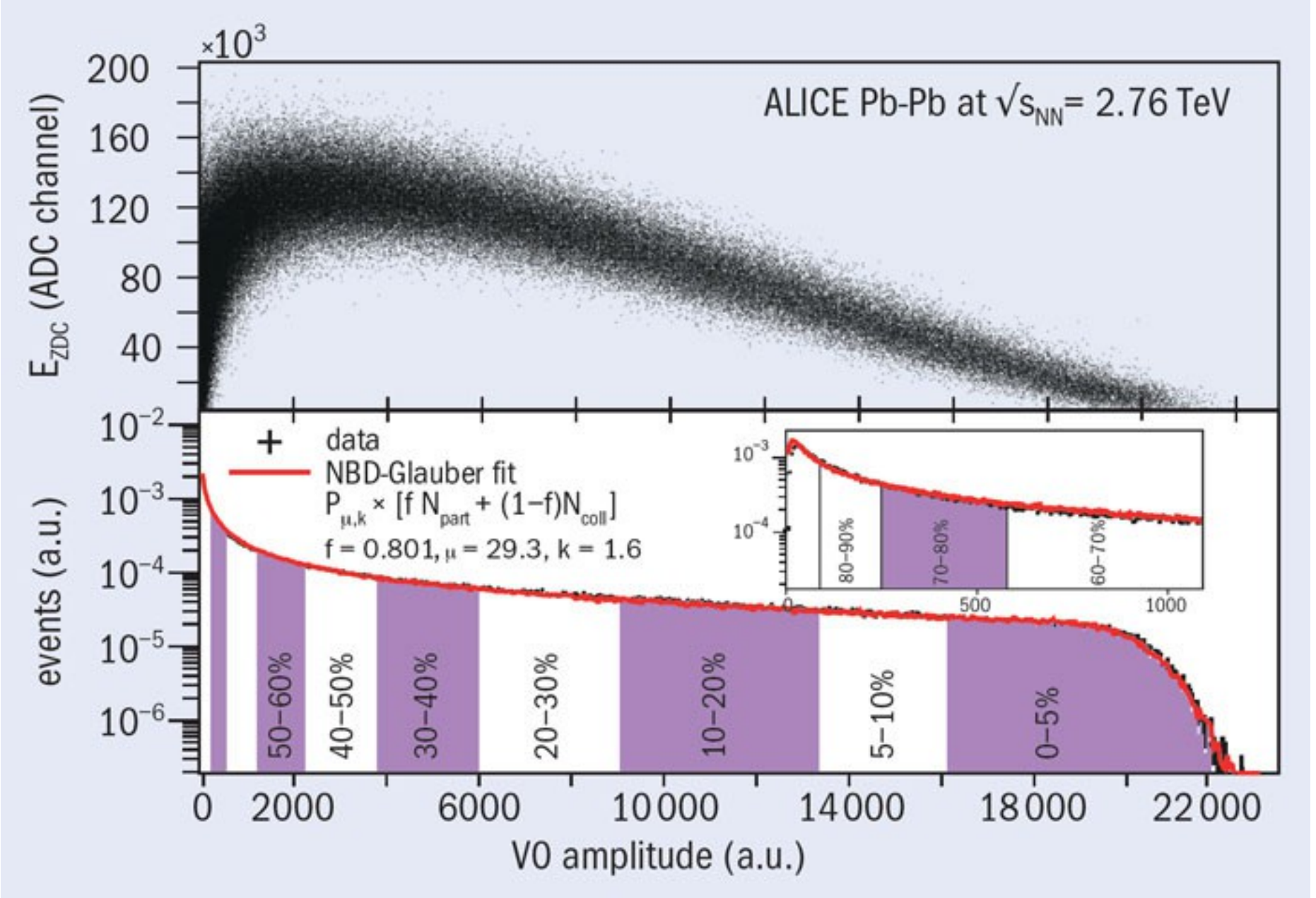


Fig. 1. The distribution of the relative charged particle density $(dN_{ch}/d\eta)/\langle dN_{ch}/d\eta\rangle$ reconstructed around mid-rapidity ($|\eta| < 1.0$) after correction for SPD inefficiencies. The vertical lines indicate the boundaries of the multiplicity intervals used in this analysis.

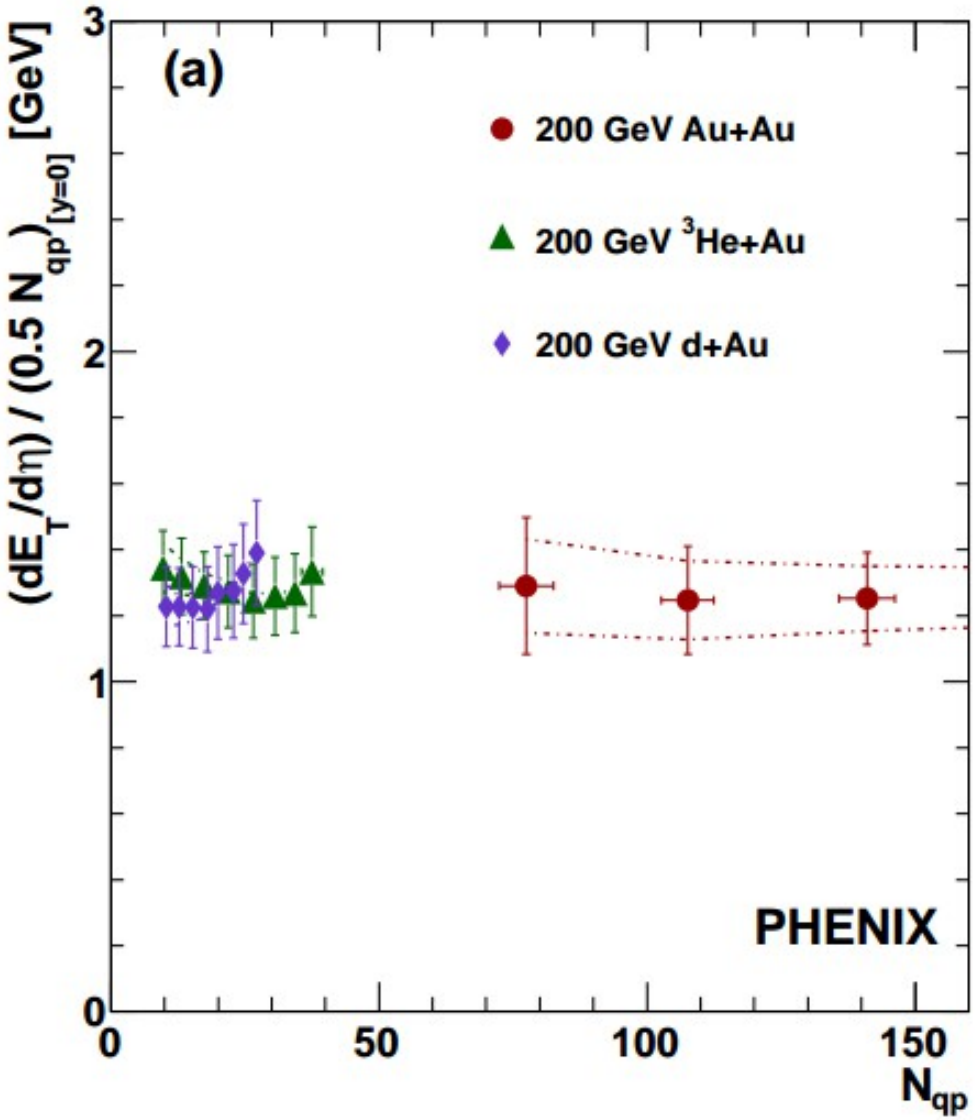
$$\langle dN_{ch}/d\eta \rangle = 6.01 \pm 0.01(\text{stat.}) {}^{+0.20}_{-0.12}(\text{syst.})$$

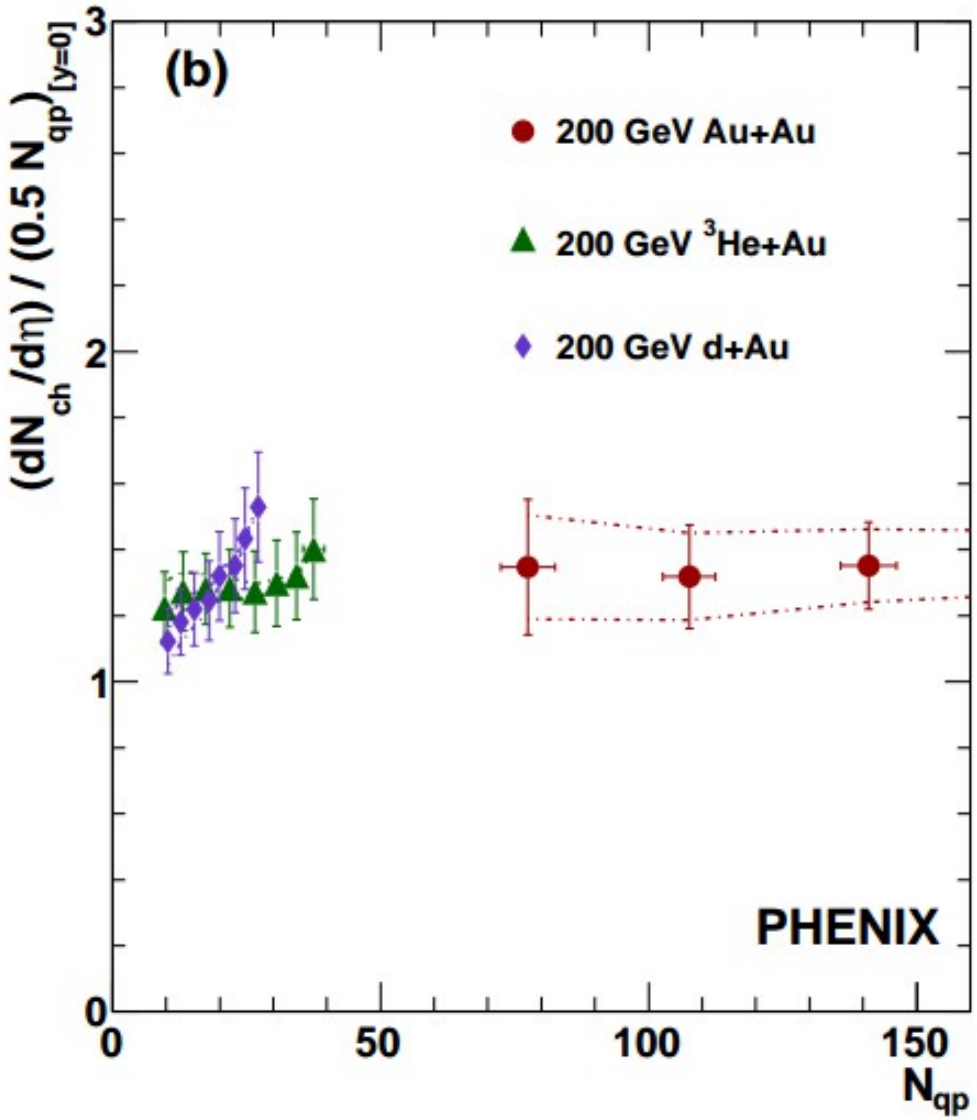
Centrality determination



Phys. Rev. C 88 (2013) 044909

Multiplicity scaling with quark participants





Phys. Rev. C 93, 024901 (2016)

STAR, p+p 200 GeV