J/ψ production in p+p collisions at √s = 500 GeV from STAR

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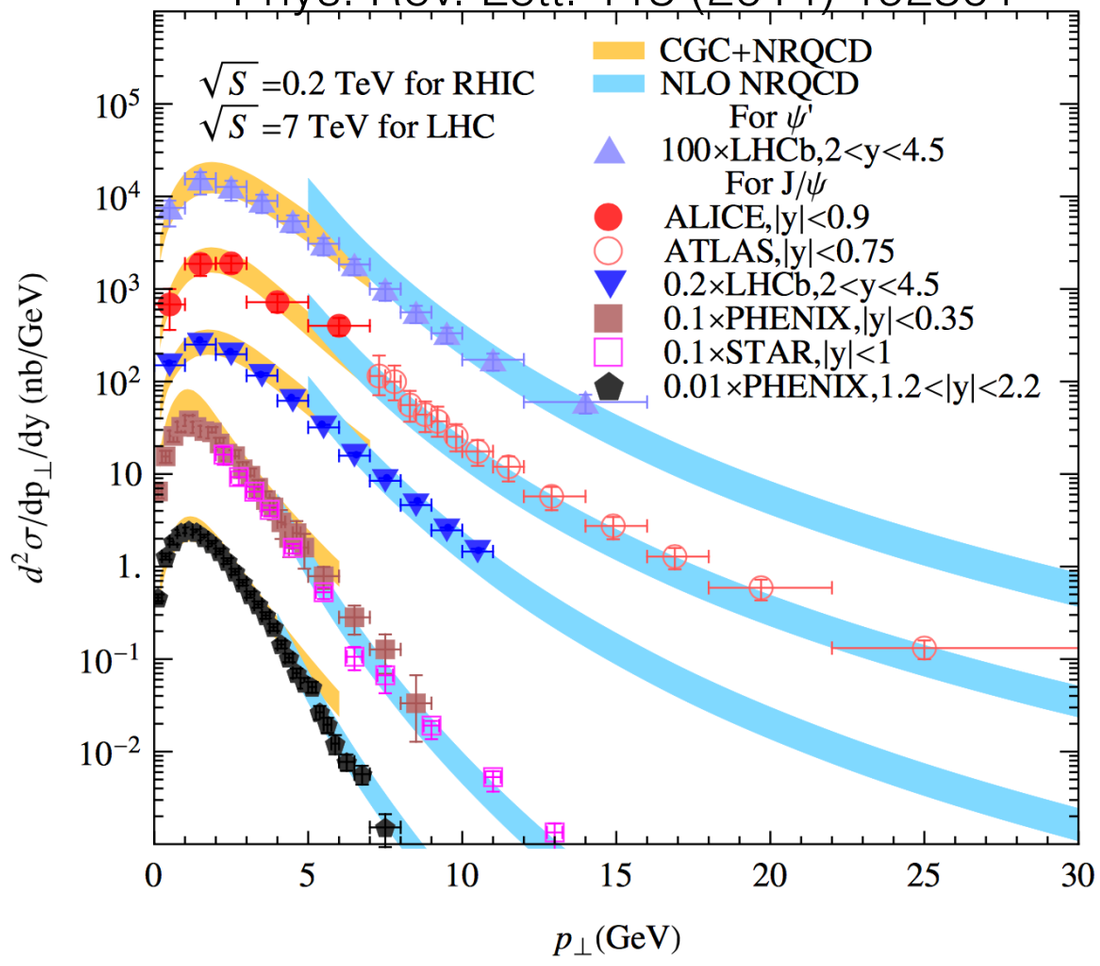
J/ψ in p+p collisions

J/ψ is one of the simplest QCD bound states, but its production mechanism in p+p is not well understood.

Models:

- Color singlet model
- Color evaporation model
- non-relativistic QCD(NRQCD) approach- high p_T
- CGC+NRQCD - applicable at low p_T

Phys. Rev. Lett. 113 (2014) 192301



Inclusive J/ψ production:

- prompt J/ψ
  - direct J/ψ(~60%), feed down from ψ(2s)(~10%) and χ_c(~30%) decays.
- non-prompt J/ψ: B-mesons feed-down(10-25% at 4-12 GeV/c)

STAR: Phys. Lett. B772(2013) 55

Measurement at 500 GeV provides additional constraints on models!!

The Solenoid Tracker At RHIC (STAR)

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

e:|η|<1, μ:|η|<0.5

MTD-trigger on and identify muons

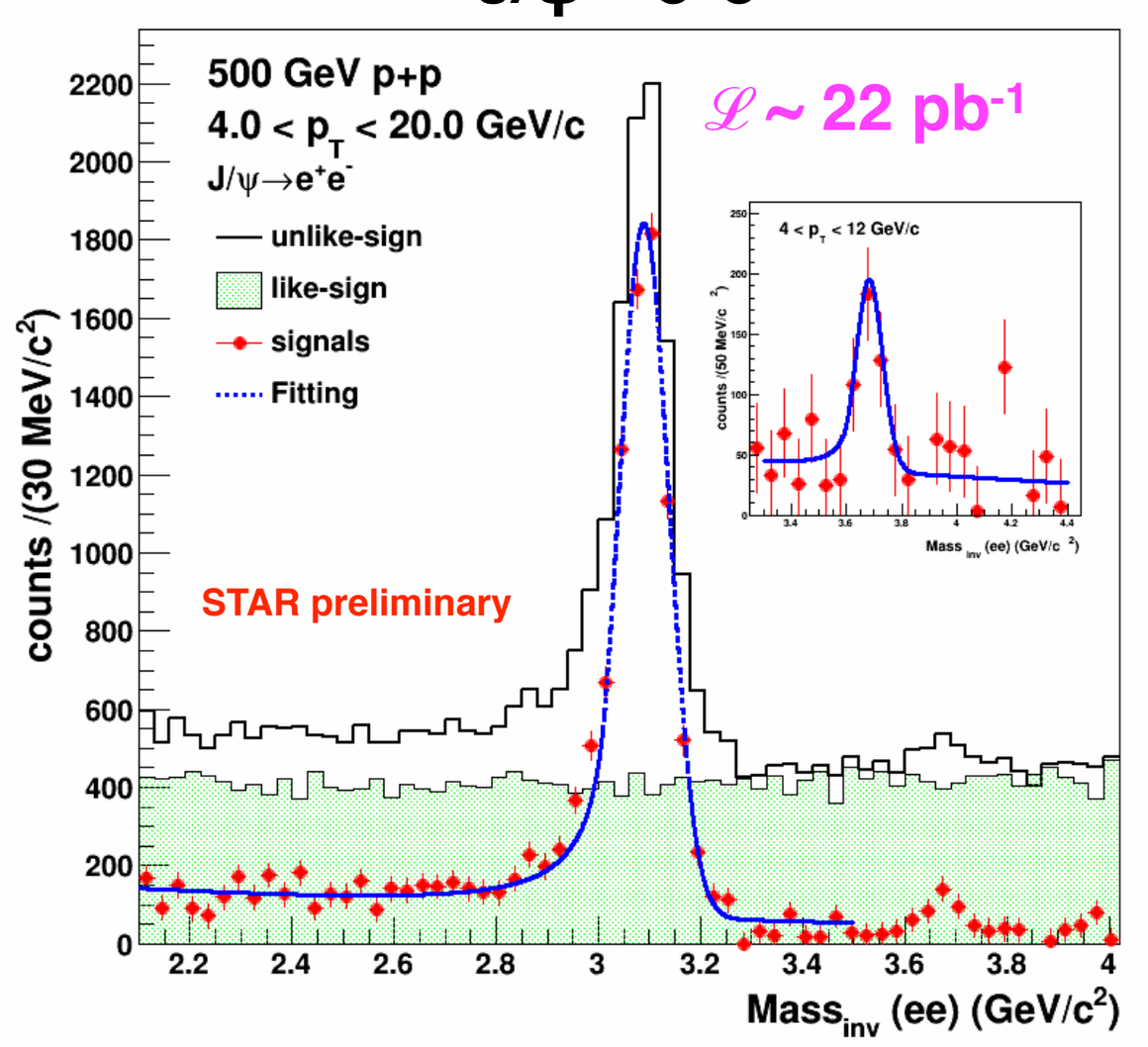
BEMC-trigger on and identify electrons

TPC-momentum and energy loss

TOF-measure charged particle multiplicity

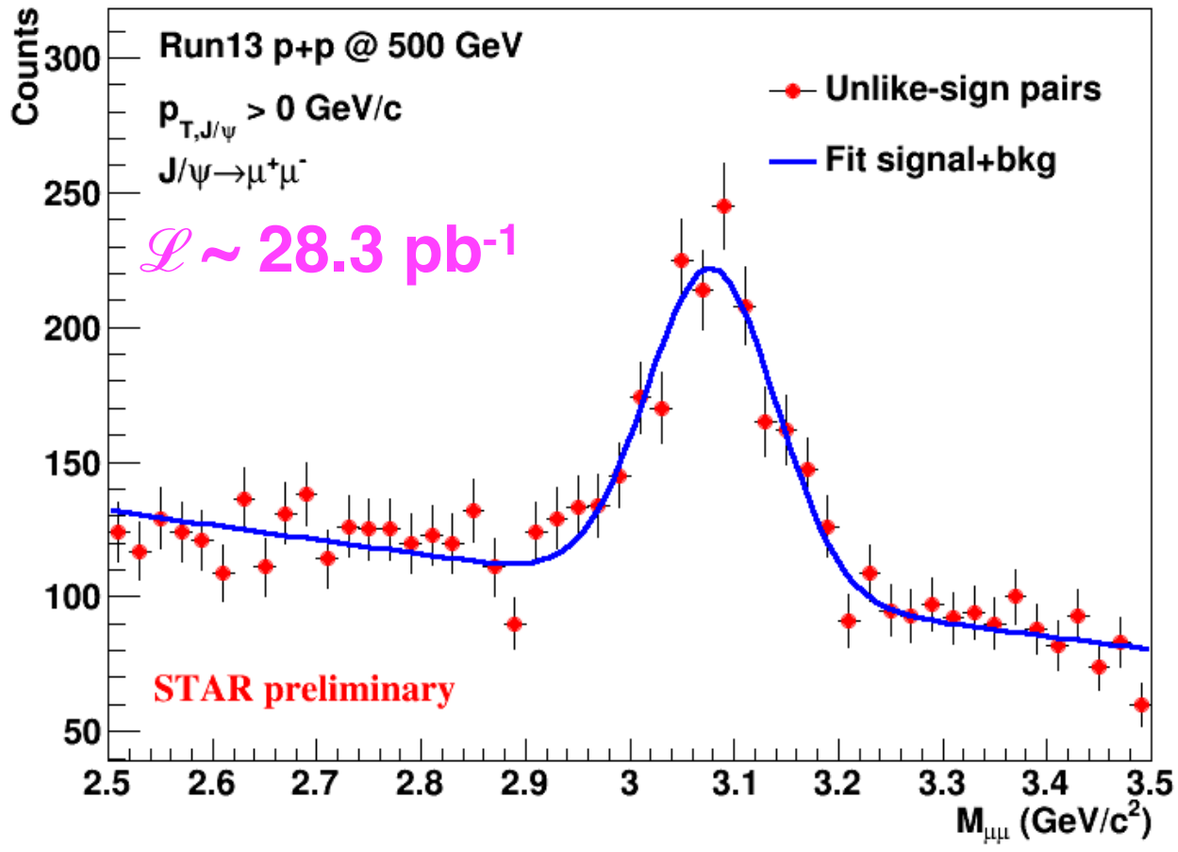
Inclusive J/ψ yield

High-p_T J/ψ
J/ψ→e^+e^-



- Combinatorial background: **like-sign pairs**
- Correlated background: fitting **Crystal ball function**(signal) & **expo**
- Signal extraction: bin counting **[2.7, 3.3]** GeV/c^2

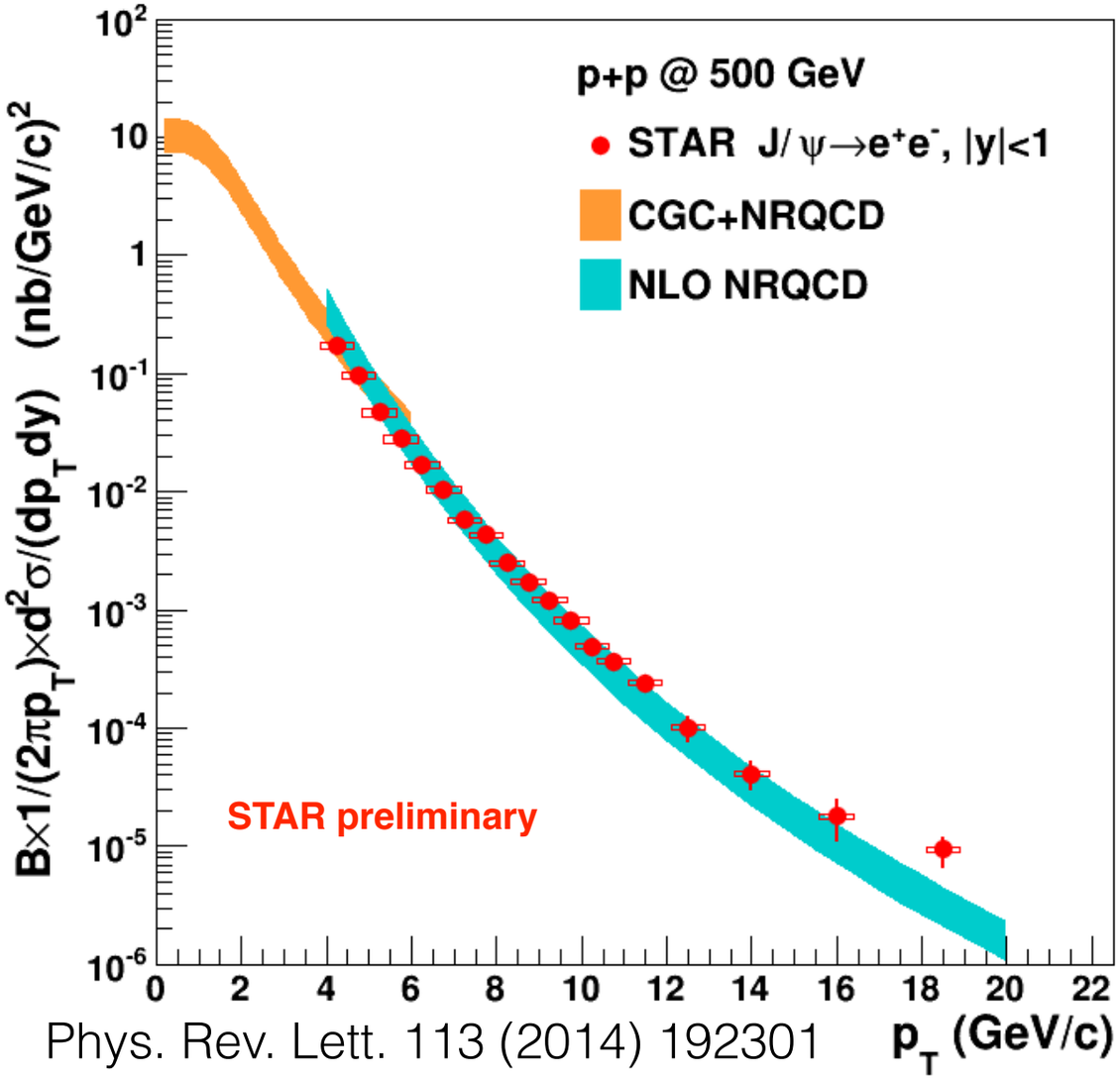
low-p_T J/ψ
J/ψ→$\mu^+\mu^-$



- Background: fitting **Gaussian** (signal)& **expo+pol0**
- Signal extraction: bin counting **[2.8, 3.3]** GeV/c^2

J/ψ cross section and x_T scaling

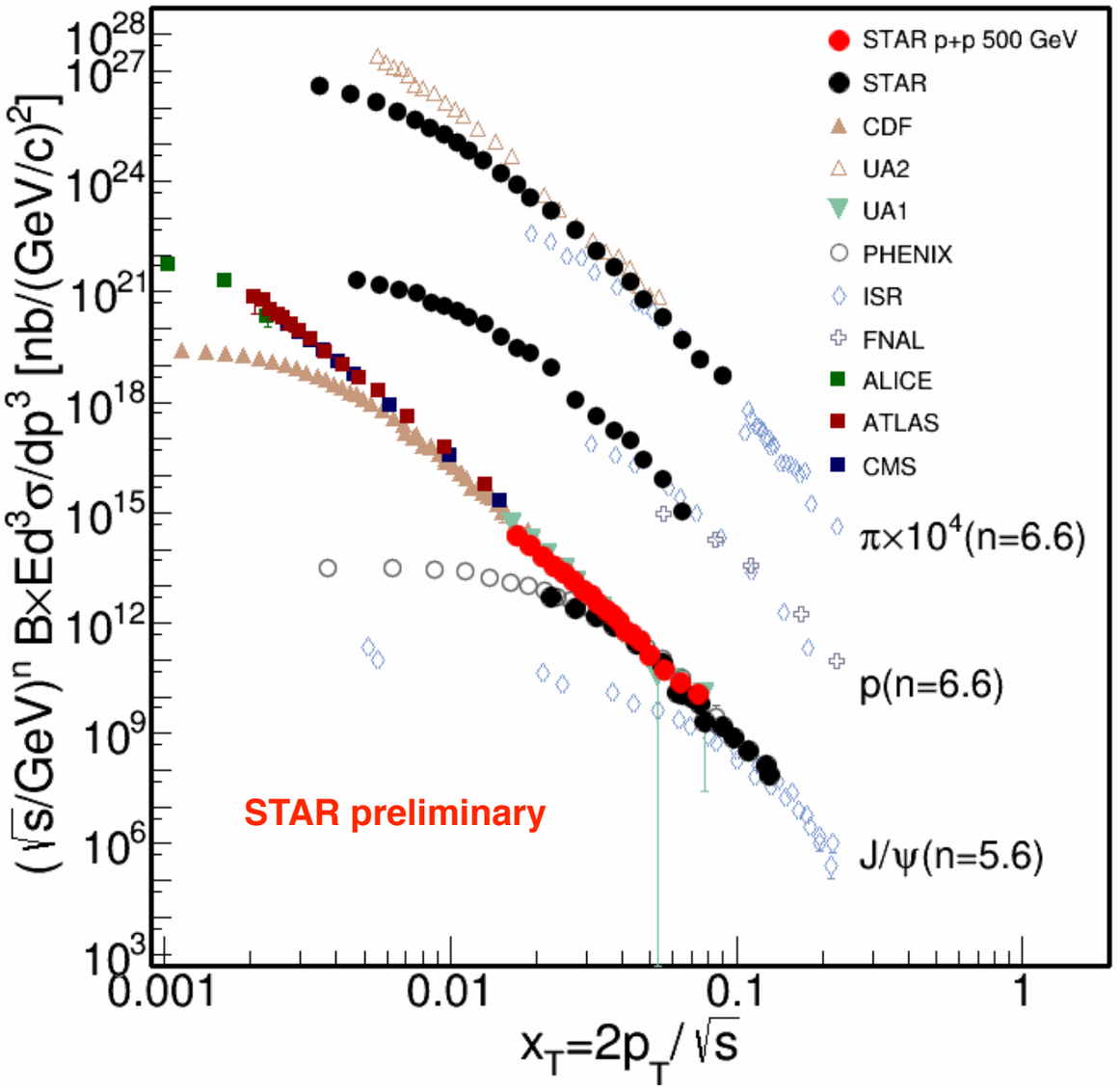
high-p_T J/ψ cross section



Phys. Rev. Lett. 113 (2014) 192301
H. S. Shao et al. JHEP05 (2015) 103

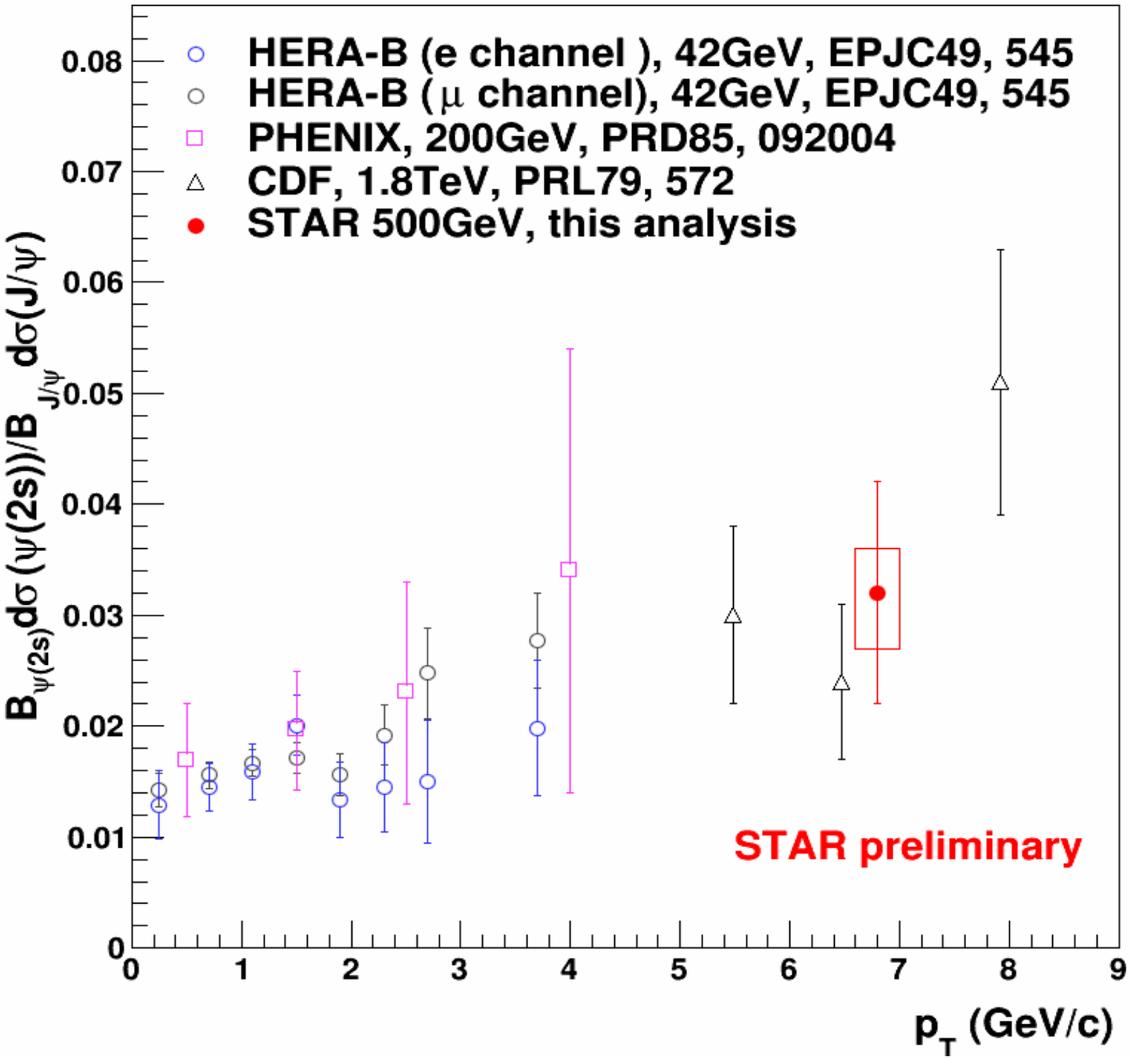
x_T scaling

Phys. Rev. C 80, 041902(2009)



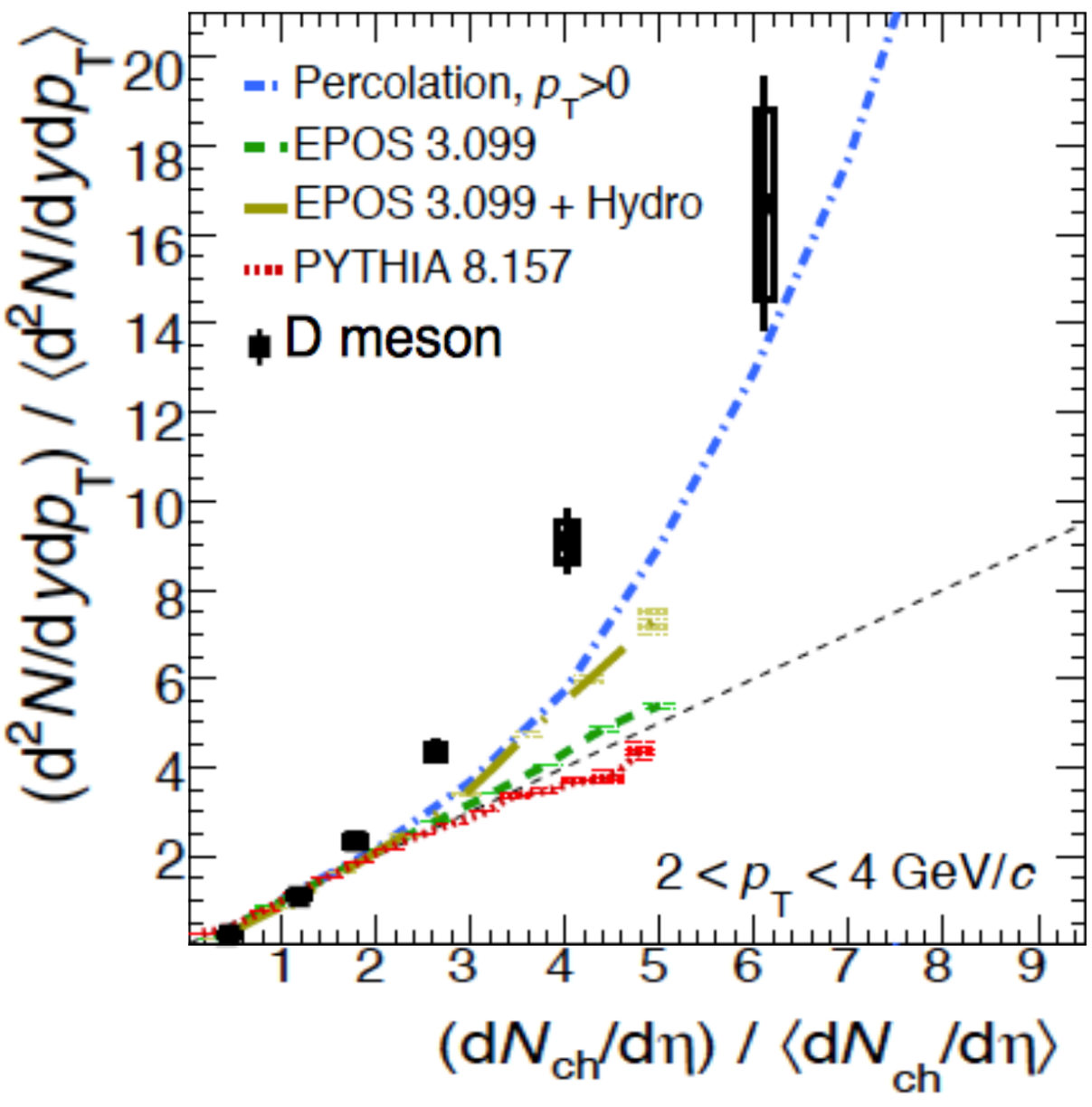
- **Inclusive J/ψ cross section** measured within **4<p_T<20 GeV/c**.
  - **NRQCD** and **CGC+NRQCD** prediction **both agree** with data.
- **x_T scaling of high-p_T J/ψ** observed in STAR at **200** and **500** GeV.
  - **x_T scaling breaking** - transition from **hard to soft process.**

Yield ratio of ψ(2s) to J/ψ



- STAR results **consistent with** world data **trend** versus p_T.
- **No collision energy dependence** is seen with current precision.
- Help to **pin down** the feed-down contribution from ψ(2s) to J/ψ.

Charm production vs. event multiplicity



- Stronger-than-linear rise of open charm production vs event activity.
- Similar behavior seen for inclusive J/ψ at both mid- and forward- rapidity in p+p @7 TeV.

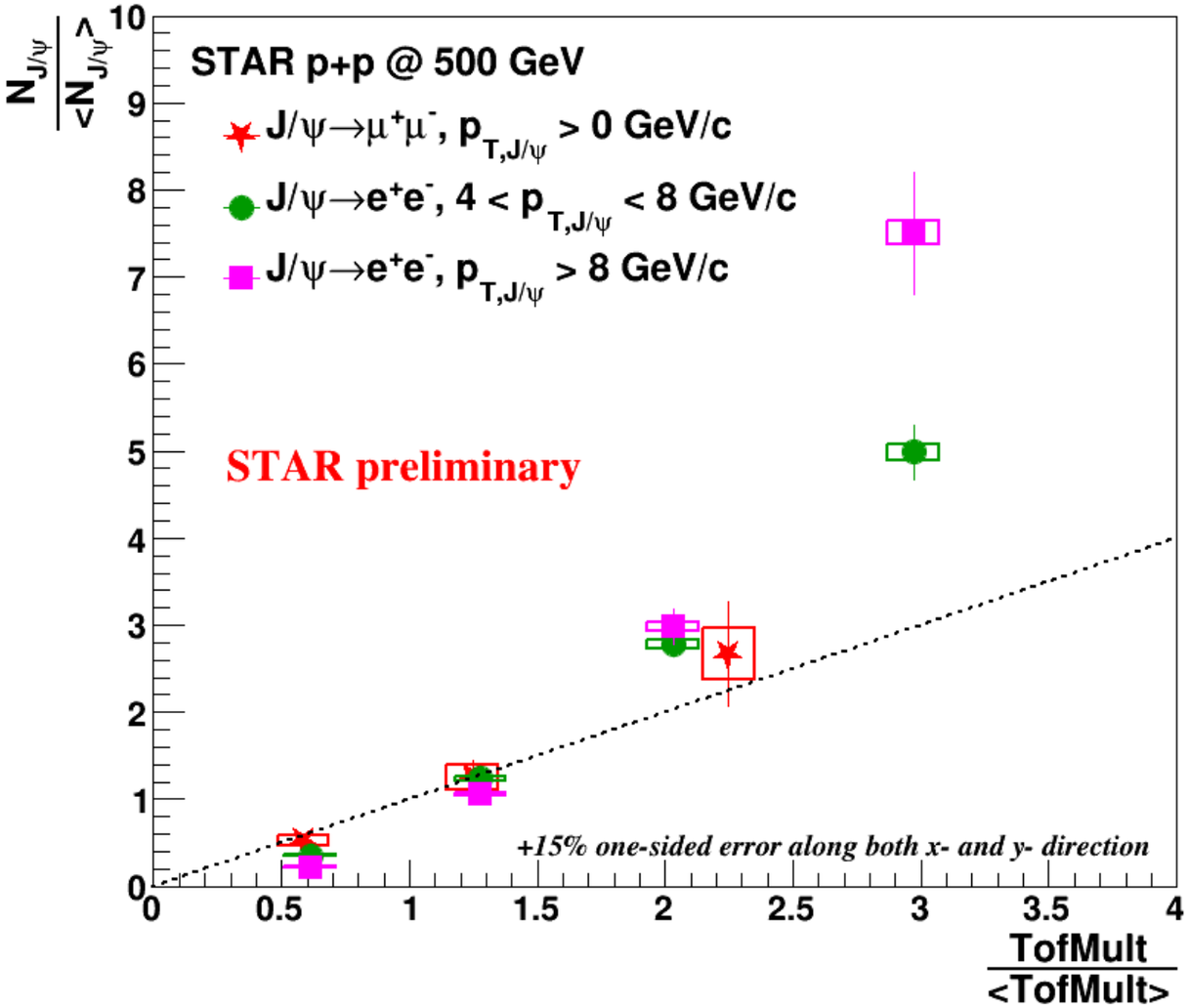
Several models:

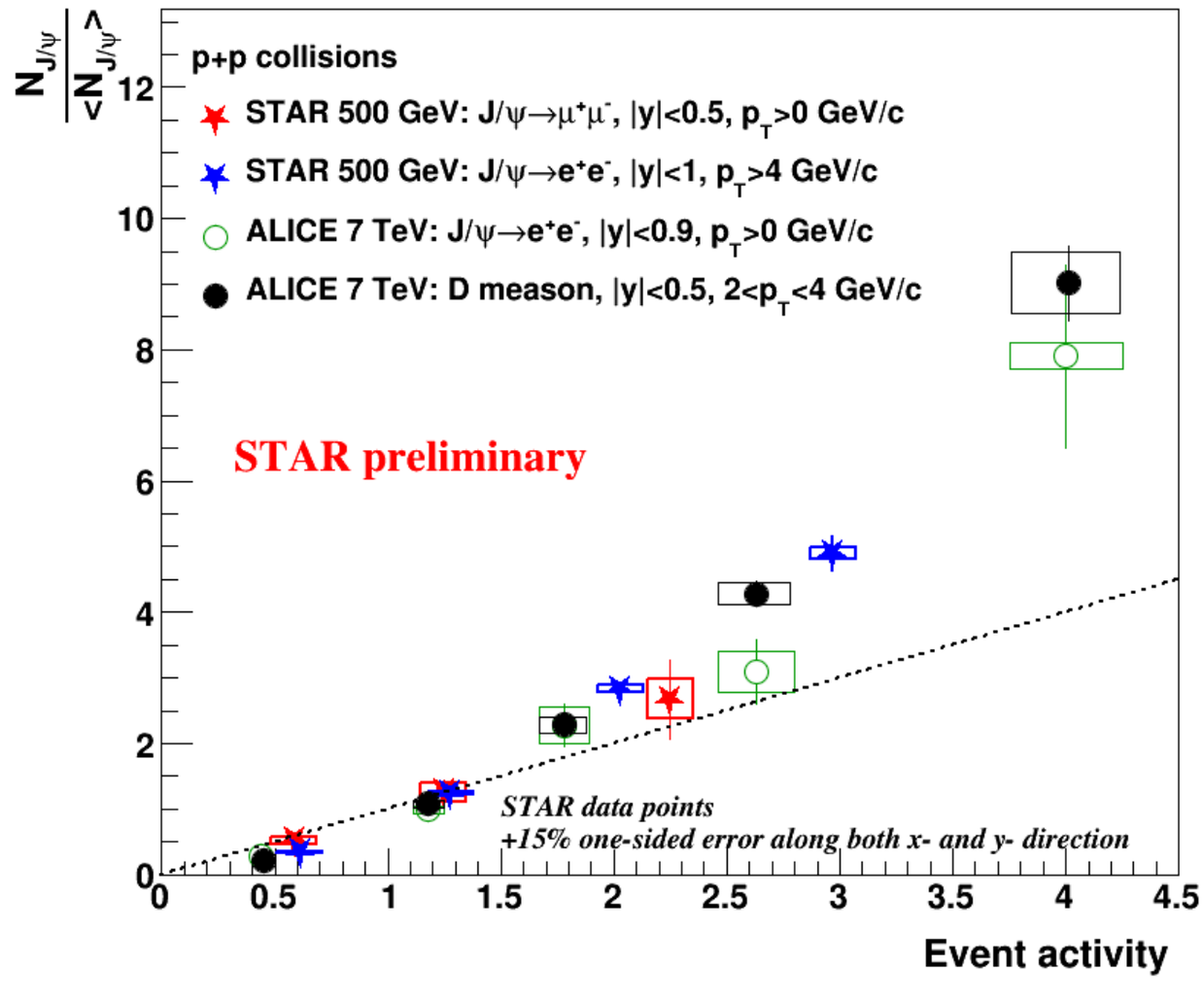
- PYTHIA8 including Multi-Parton-Interaction contributions to c production underestimates yield at large multiplicity
- Percolation model with string screening rises quadratically at high multiplicity.
- EPOS 3 event generator: initial conditions followed by a hydrodynamical evolution

Similar at RHIC energies??

J/ψ yield vs. event activity

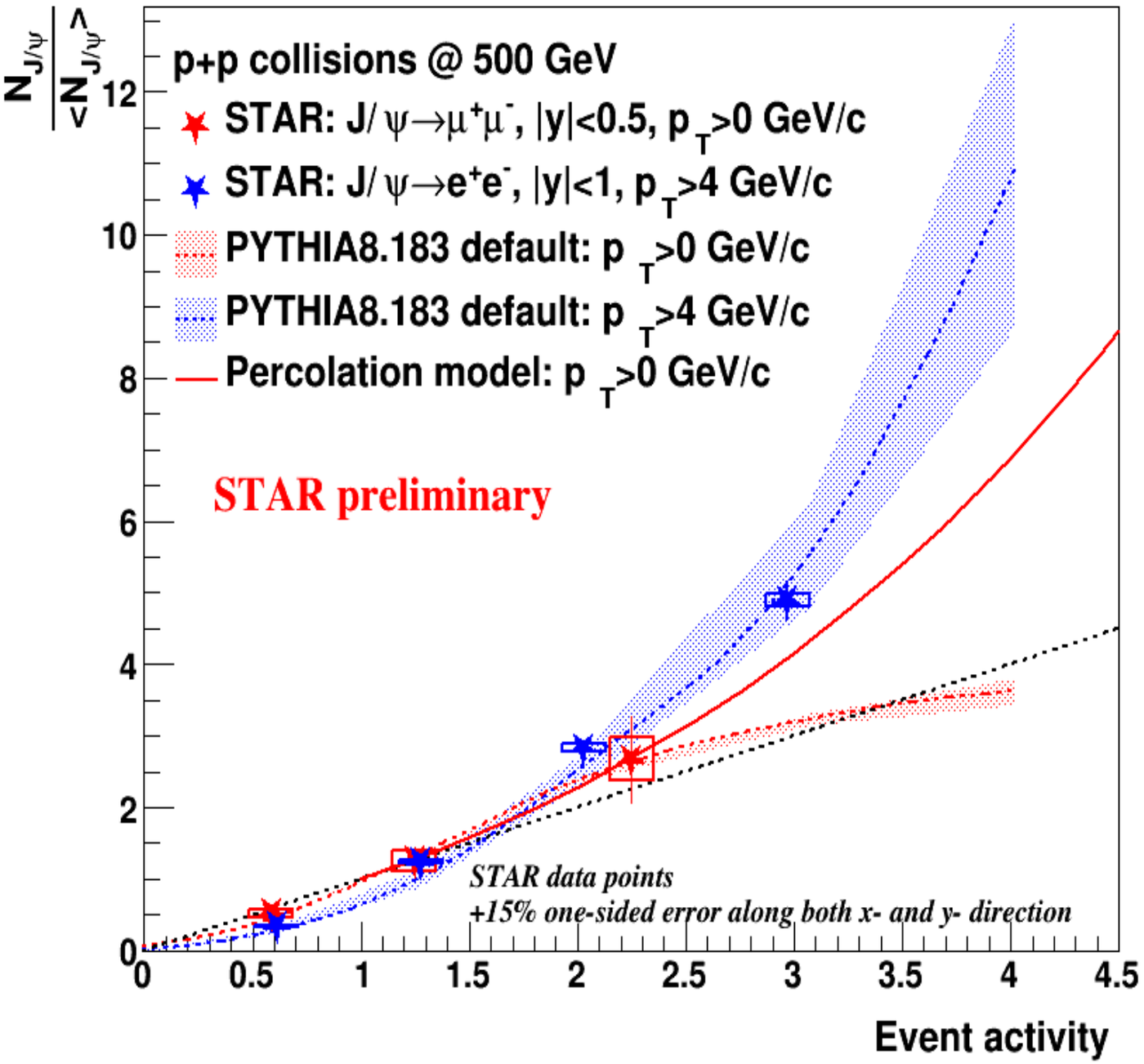
TofMult - Multiplicity of TOF matched tracks, |η|<0.9





- **Stronger-than-linear growth for relative J/ψ yield**.
  - **Soft and hard** processes are **correlated**.
- **Different trends** for low and high p_T J/ψ.
- **Similar trend at LHC and RHIC.**

Compare with models



- **PYTHIA8 describes** the rising **trend** and **p_T dependence** in data.
- **Percolation model** - also qualitatively **reproduces trend in data**.
- Measurement for **higher multiplicity** bins is in progress ➜ important to distinguish between models.

Summary

- First time measured J/ψ in di-muon channel at STAR.

- Inclusive J/ψ p_T spectra are measured above 4 GeV/c in p+p collisions at 500 GeV via di-electron channel. The spectra can be well described by NRQCD predictions.

- The relative J/ψ yield grows rapidly as the charged particle multiplicity increases, and high-p_T J/ψ grows faster than the low p_T J/ψ
  - Similar trend as observed at LHC
  - PYTHIA8 and Percolation model can describe the observed trend in data.
  - Measurement in higher multiplicity bins is in progress
    ➜important to distinguish between models.

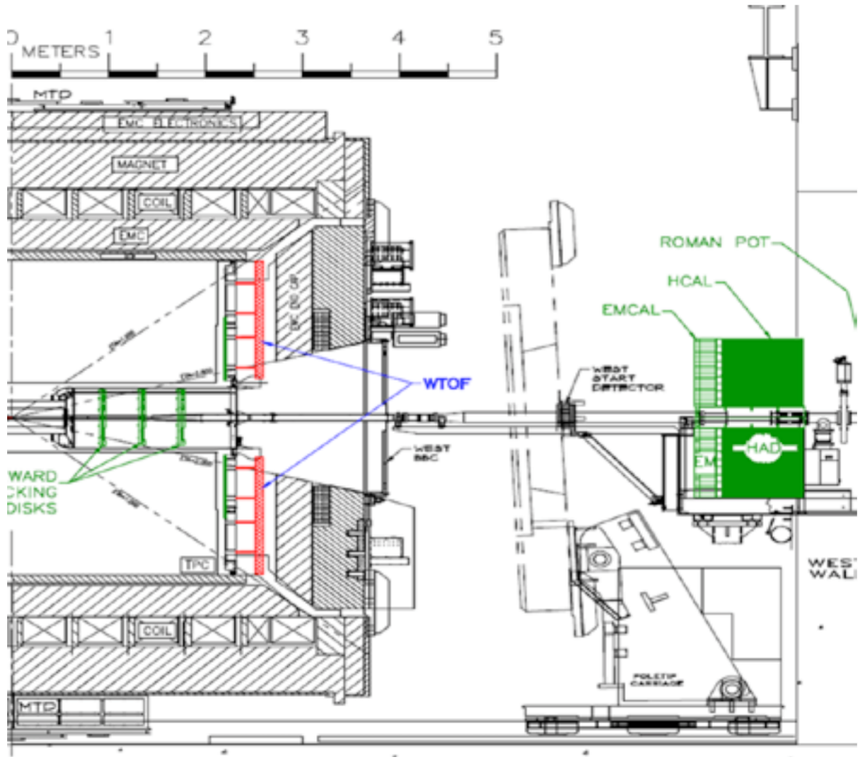
Thank you

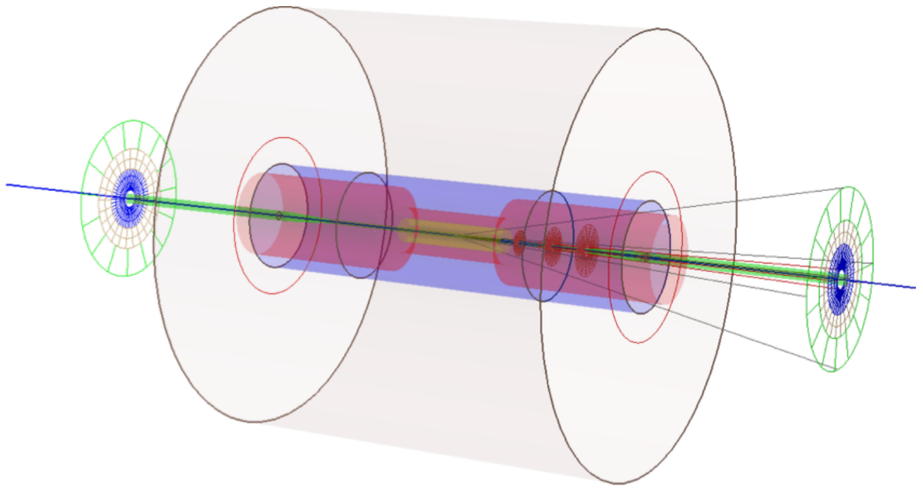
backup

J/ψ at forward rapidity

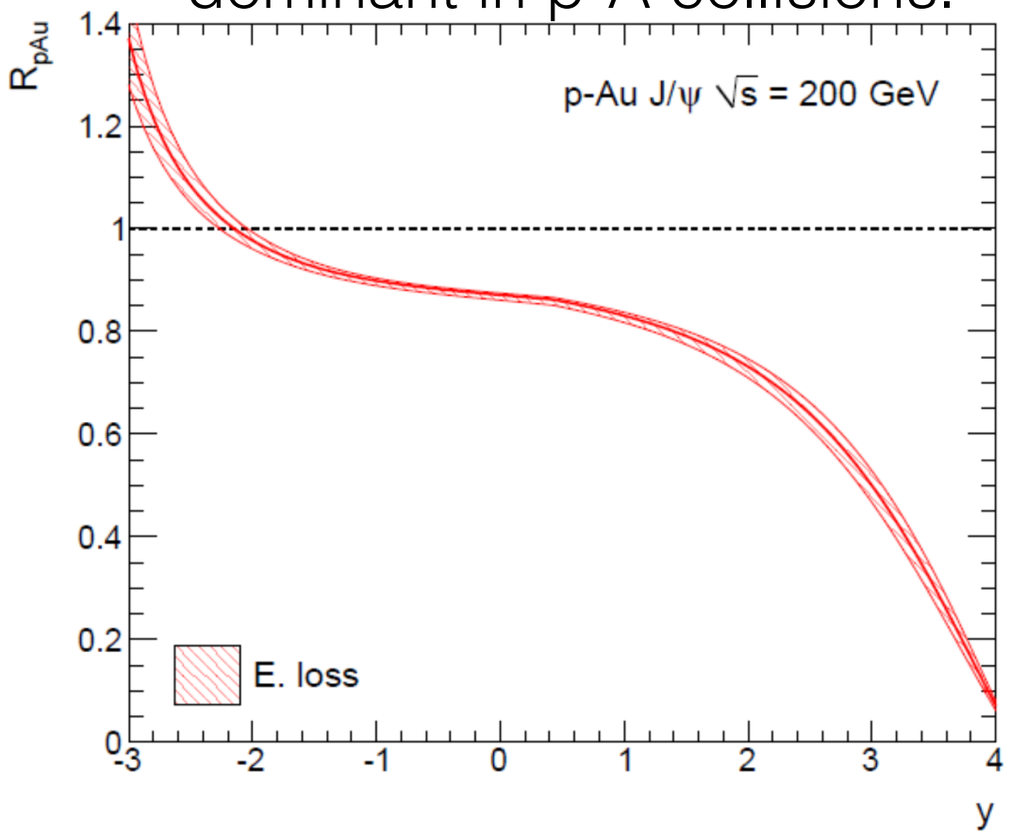
Forward upgrades in STAR:

- **F**orward **C**alorimeter **S**ystem (2.5<η<4)
- **F**orward **T**racking **S**ystem (2.5<η<4)





At very forward rapidity, patron energy loss in cold nuclear matter becomes dominant in p-A collisions.



F. Arleo and S. Peigné, JHEP **03** (2013) 122

p+p 200 GeV $\mathscr{L}$ ~ 1 pb^{-1}

with100% tracking efficiency

~ 22k J/ψ in 2.5<η<4.8