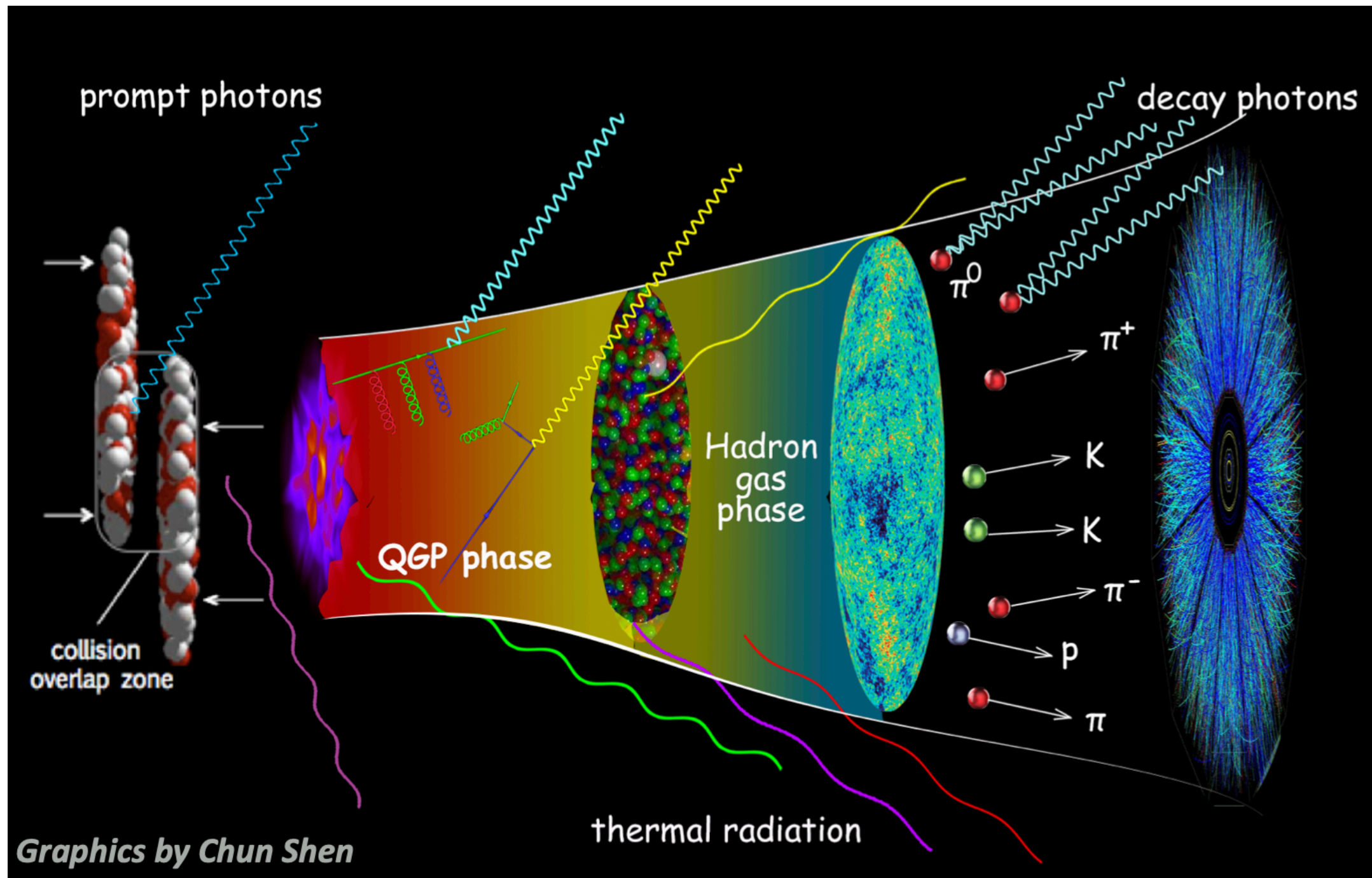


Measurement of low p_T direct photons with PHENIX

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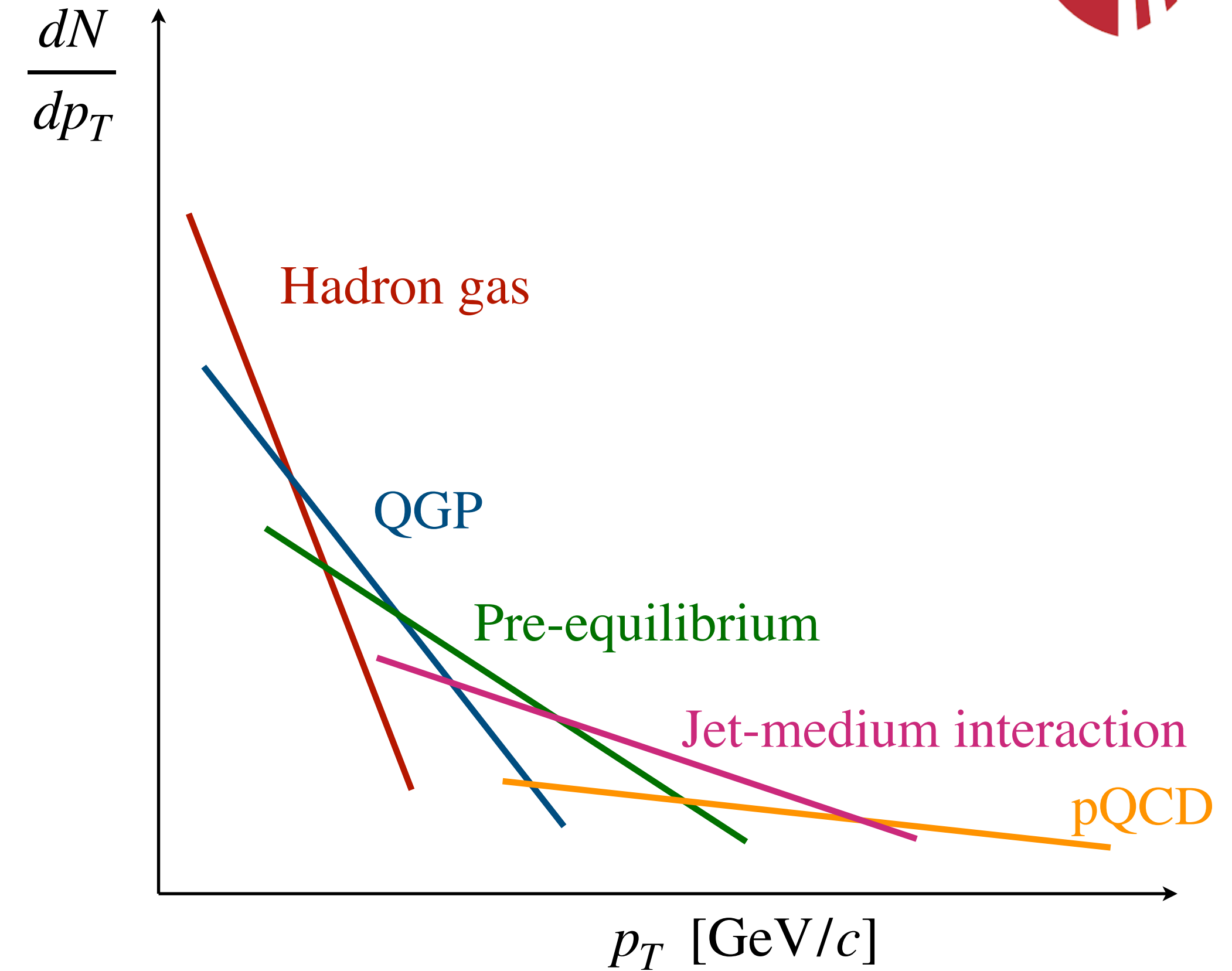
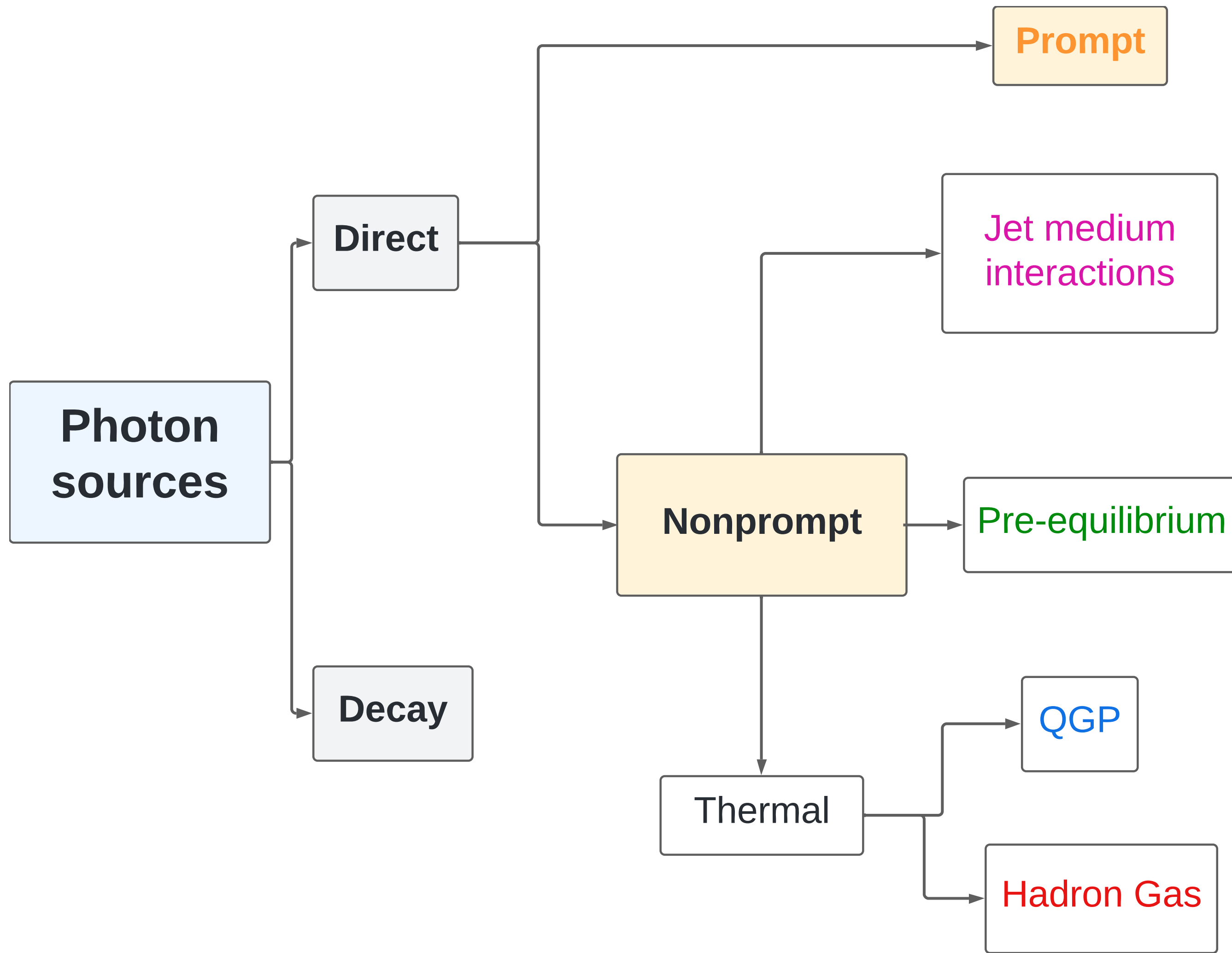


Photons are “color blind” probe of Quark Gluon Plasma

$$\text{Direct photons} = \text{Inclusive photons} - \text{Hadronic decay photons}$$

Measurement of yield constrains initial conditions, sources, emission rates and space-time evolution

- Sensitive to **space-time evolution** and **temperature** of matter produced in relativistic heavy-ion collisions
- Evidence of thermal radiations from QGP and Hadron Gas
- 80-90% photons are decay photons



Measurement of the nonprompt direct photons possible due to large statistics



									
$\sqrt{s_{NN}}$ [GeV]	200	200	200	200	200	200	39	62.4	200
Calorimeter	2003		2003						2004
Virtual $\gamma^* \rightarrow e^+ + e^-$	2005/6		2008		2005				2004
Conversion $\gamma \rightarrow e^+ + e^-$	2015	2015	2016	2014		2012	2010	2010	2007/10 2014

Published

Recently submitted

Ongoing

$$R_\gamma = \frac{\gamma_{inclusive}}{\gamma_{decay}} = \frac{\frac{\gamma_{inclusive}}{\gamma_{\pi^0}}}{\frac{\gamma_{hadron}}{\gamma_{\pi^0}}} = \frac{\langle \epsilon f \rangle \frac{N_\gamma^{inclusive}}{N_\gamma^{\pi^0}}}{\frac{\gamma_{hadron}}{\gamma_{\pi^0}}}$$

$N_{inclusive}$: number of photons that convert to e^+e^- pair within the detector acceptance

N_{π^0} : number of converted photons that can be tagged as a π^0 decay

$\langle \epsilon f \rangle$: detector efficiency and acceptance

Cocktail ratio : ratio of photons coming from all hadrons to those coming only from π^0 decays

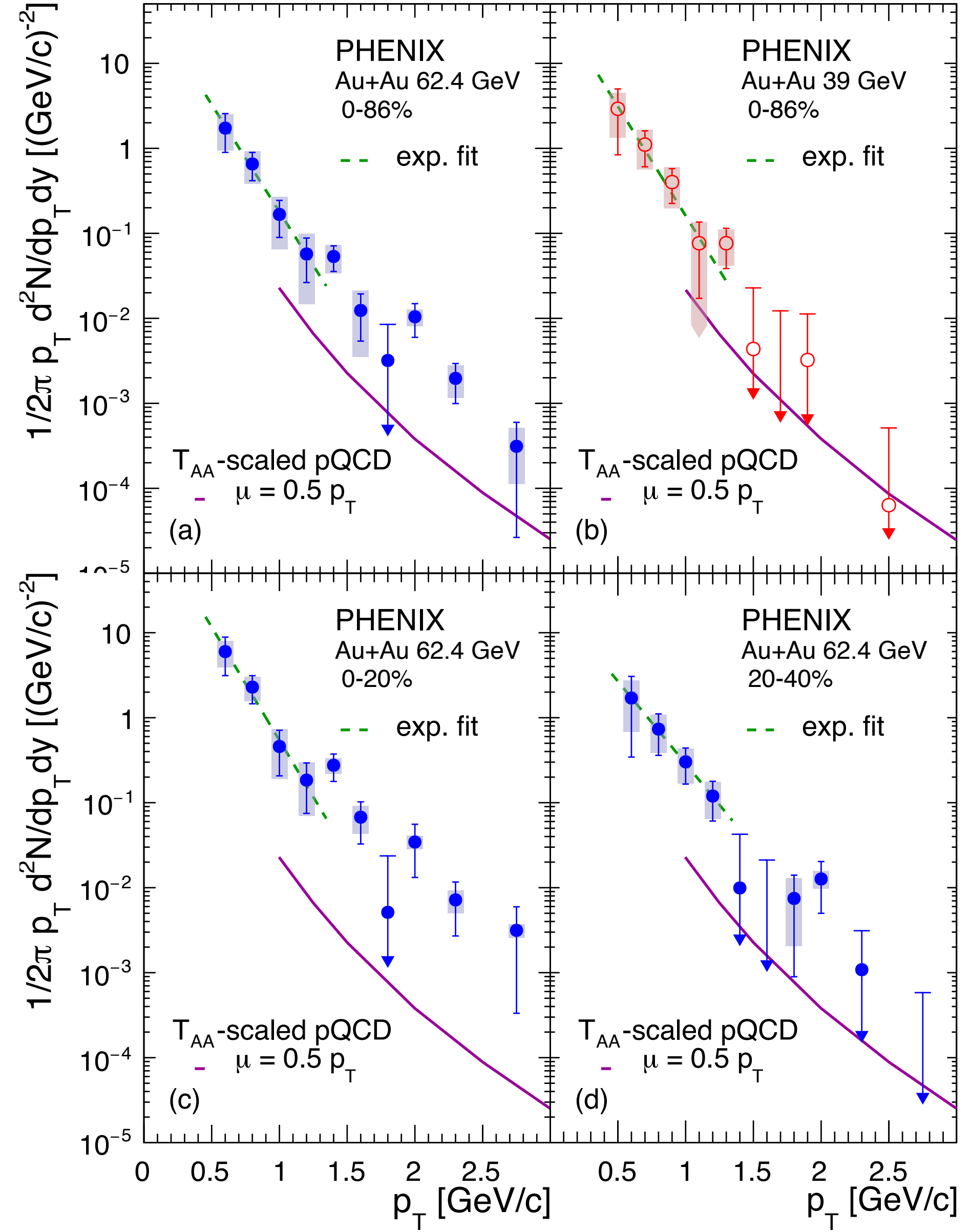
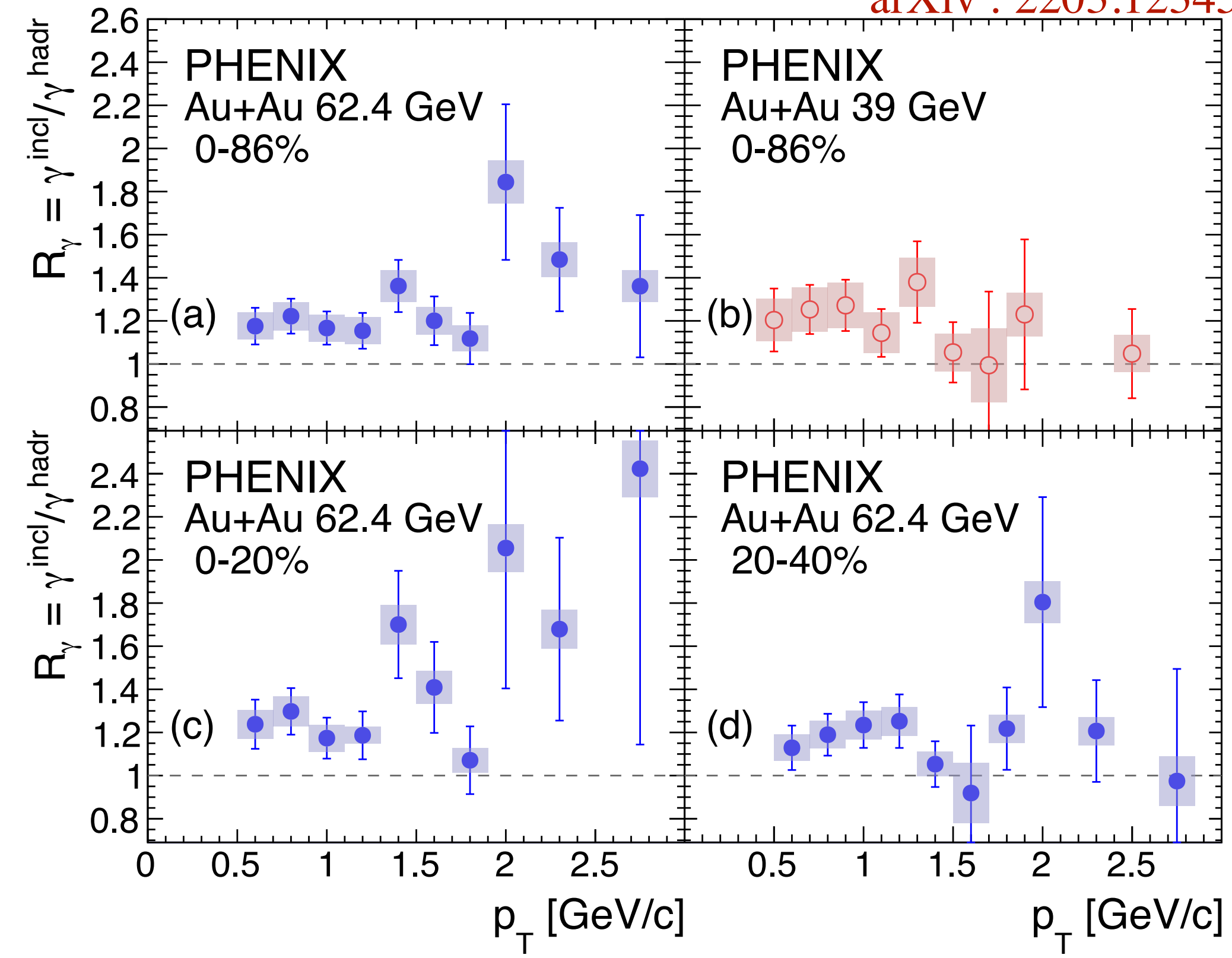
$$\gamma_{direct} = (R_\gamma - 1) \gamma_{hadron}$$

Double ratio tagging method reduces systematic uncertainties

PHENIX Direct γ for Au+Au at 39 and 62.4 GeV



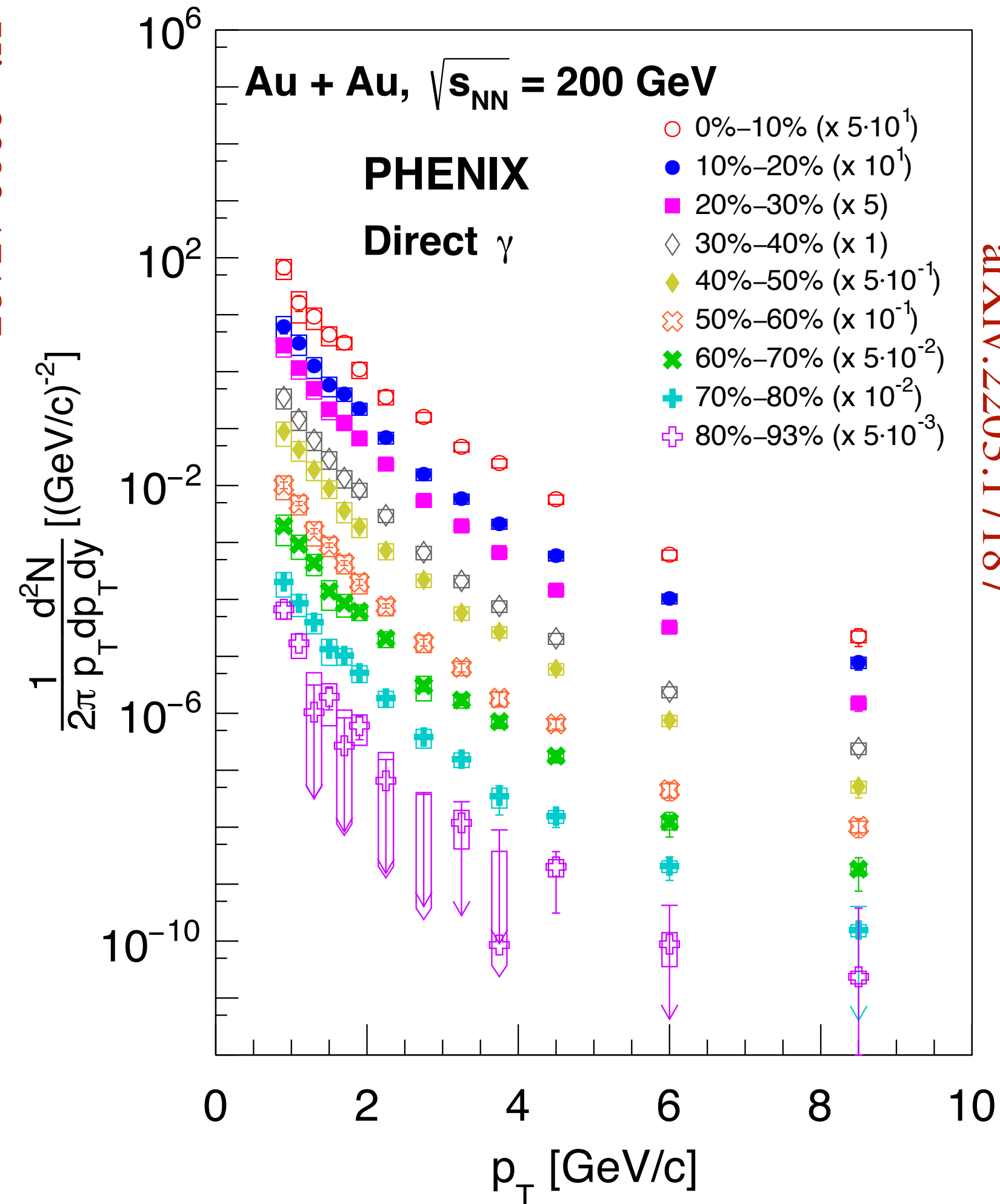
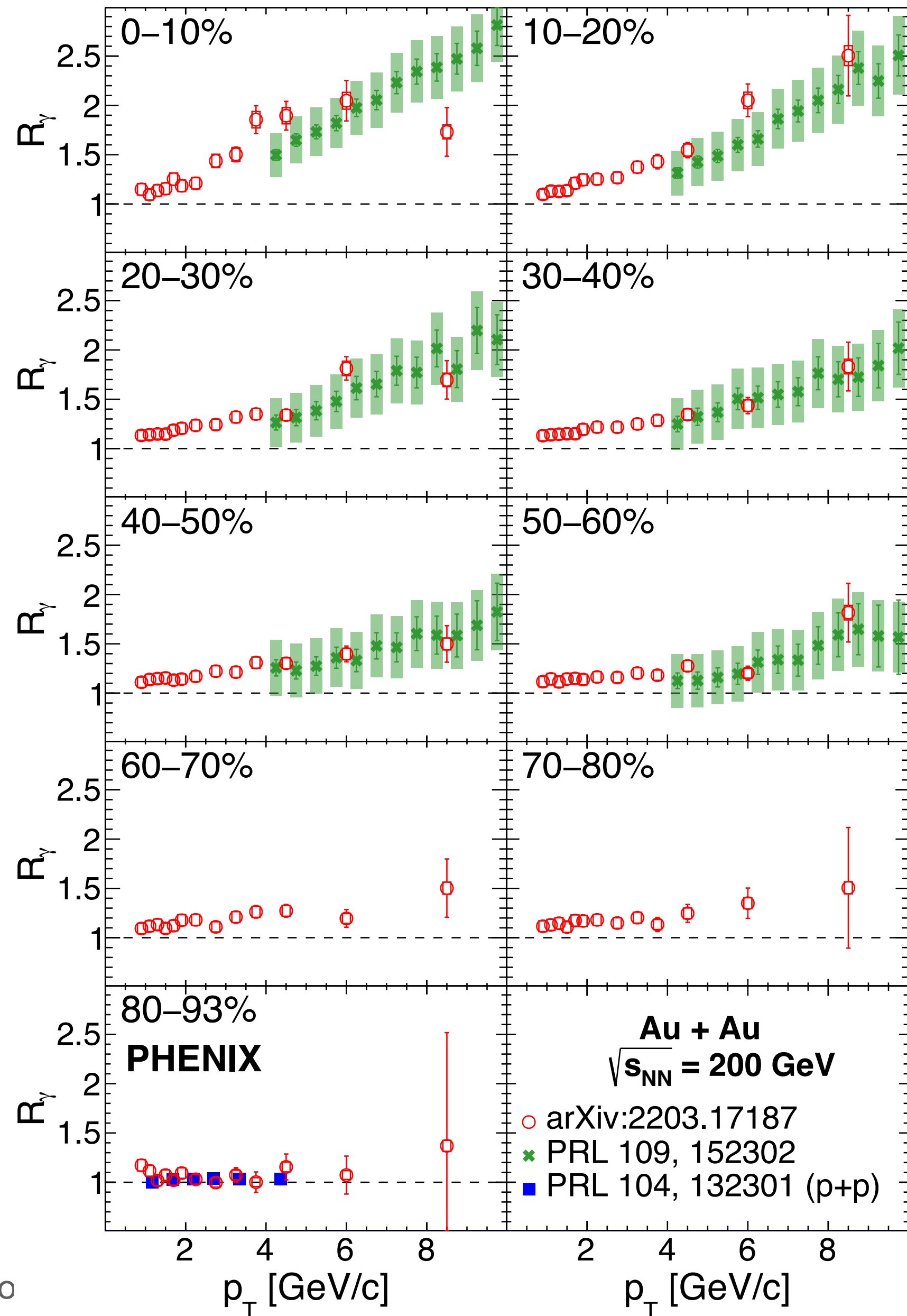
arXiv : 2203.12345



arXiv : 2203.12345

Conversions on the backplane of Hadron Blind detector

Significant direct photon component relative to those from hadron decays



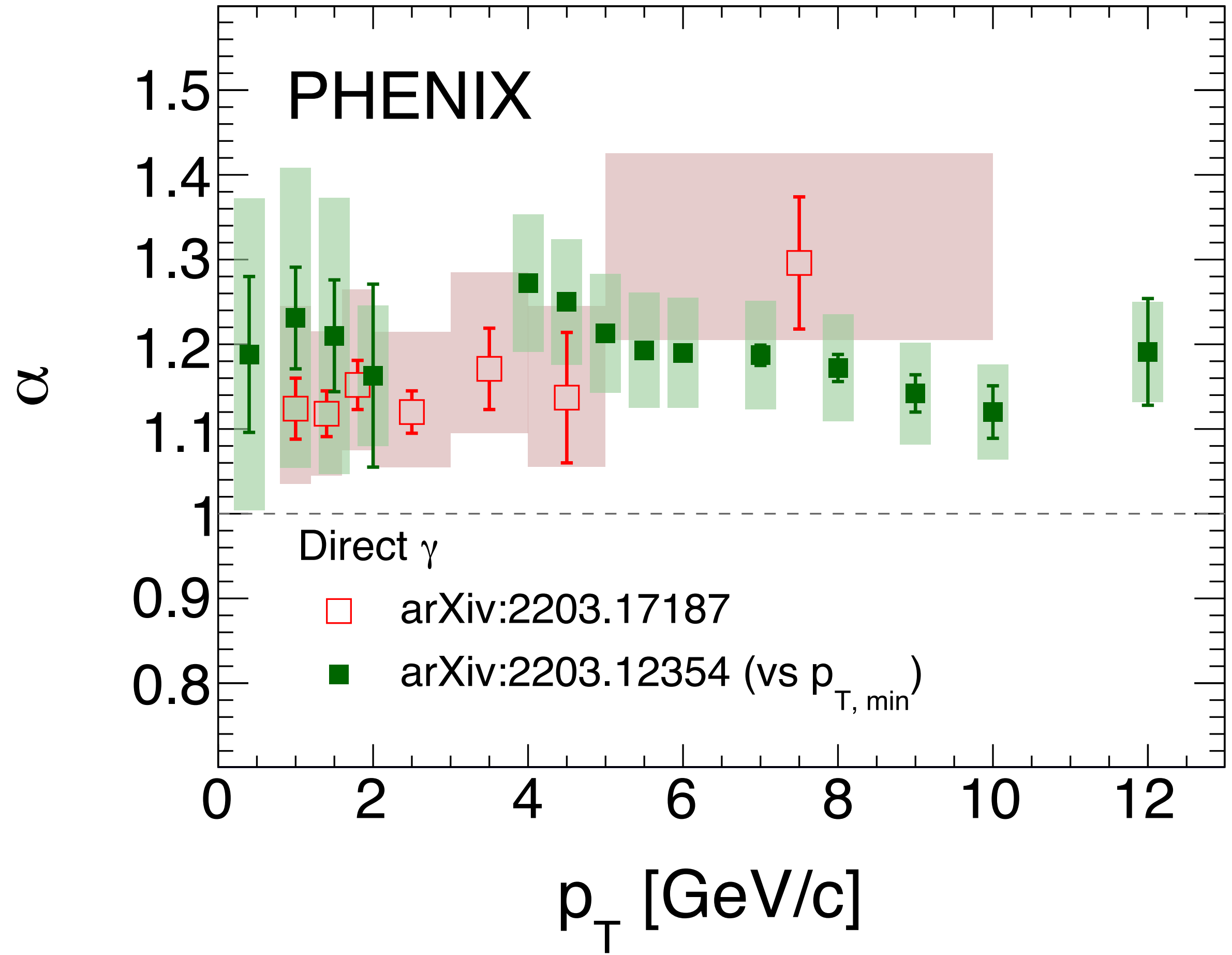
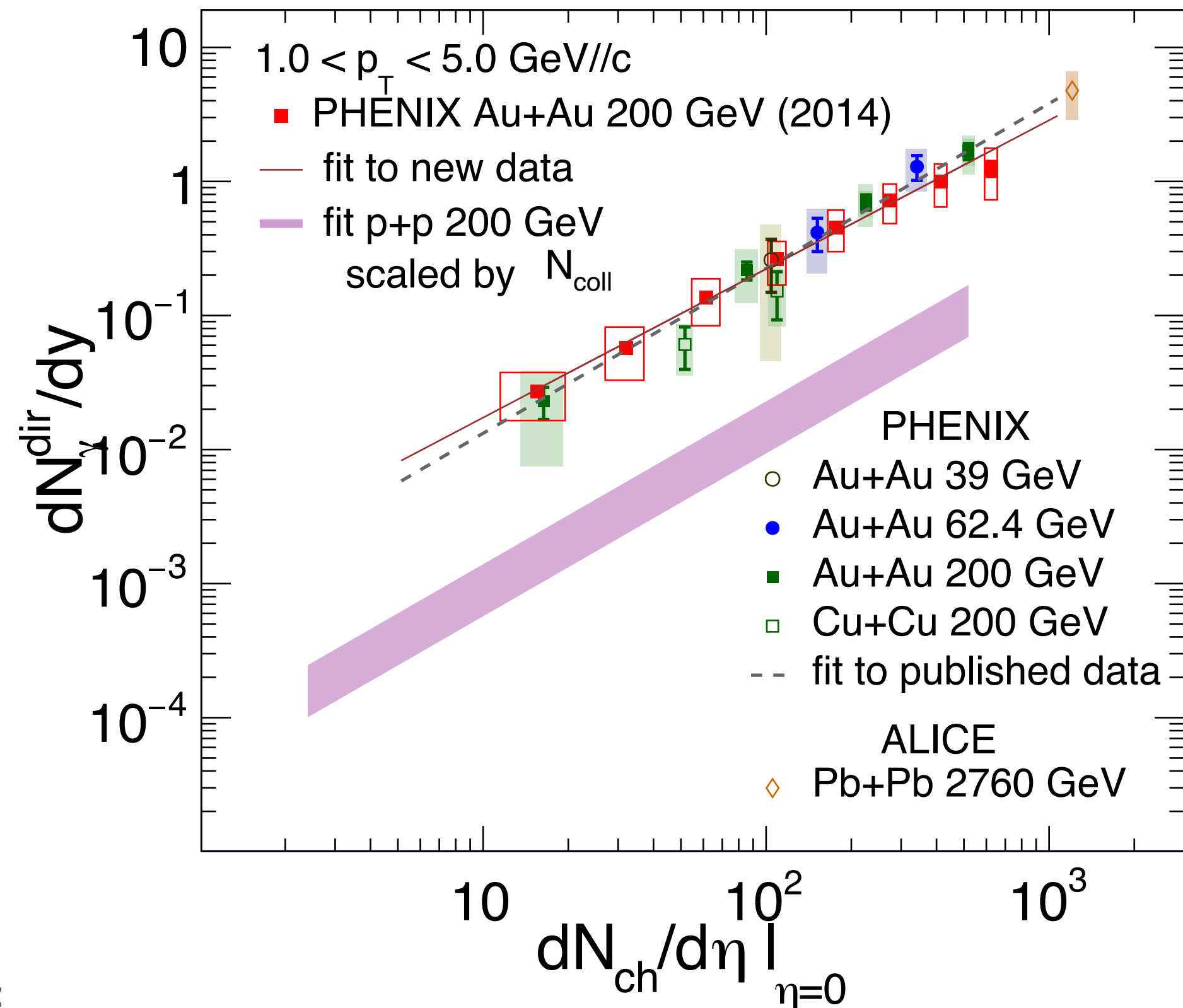
Conversions in the layers of the Silicon Vertex detectors

Significantly higher statistics for a more differential measurement

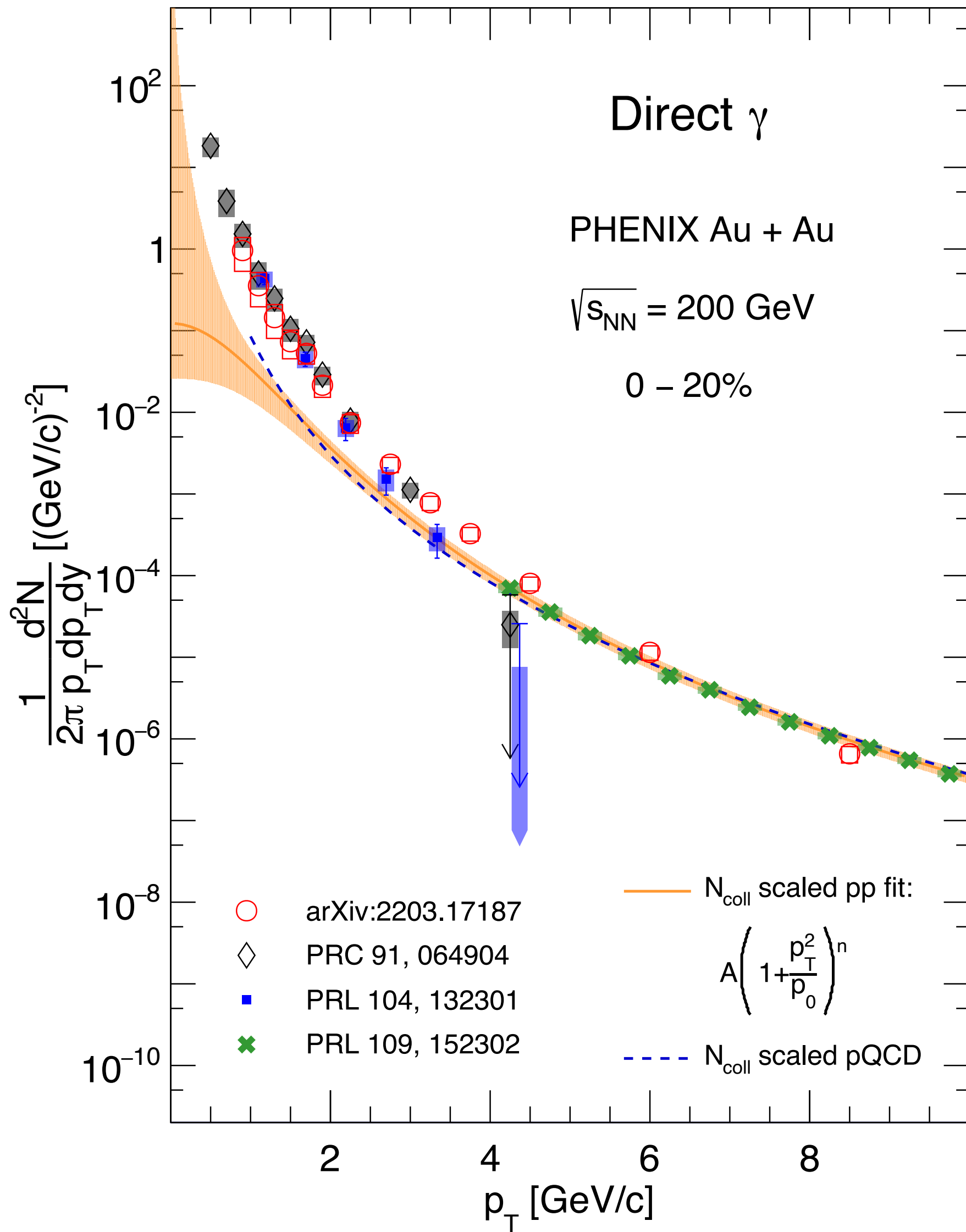
$$dN_\gamma/dy = A \times (dN_{ch}/d\eta)^\alpha$$

Universal scaling behavior in all A+A systems

arXiv:2203.17187



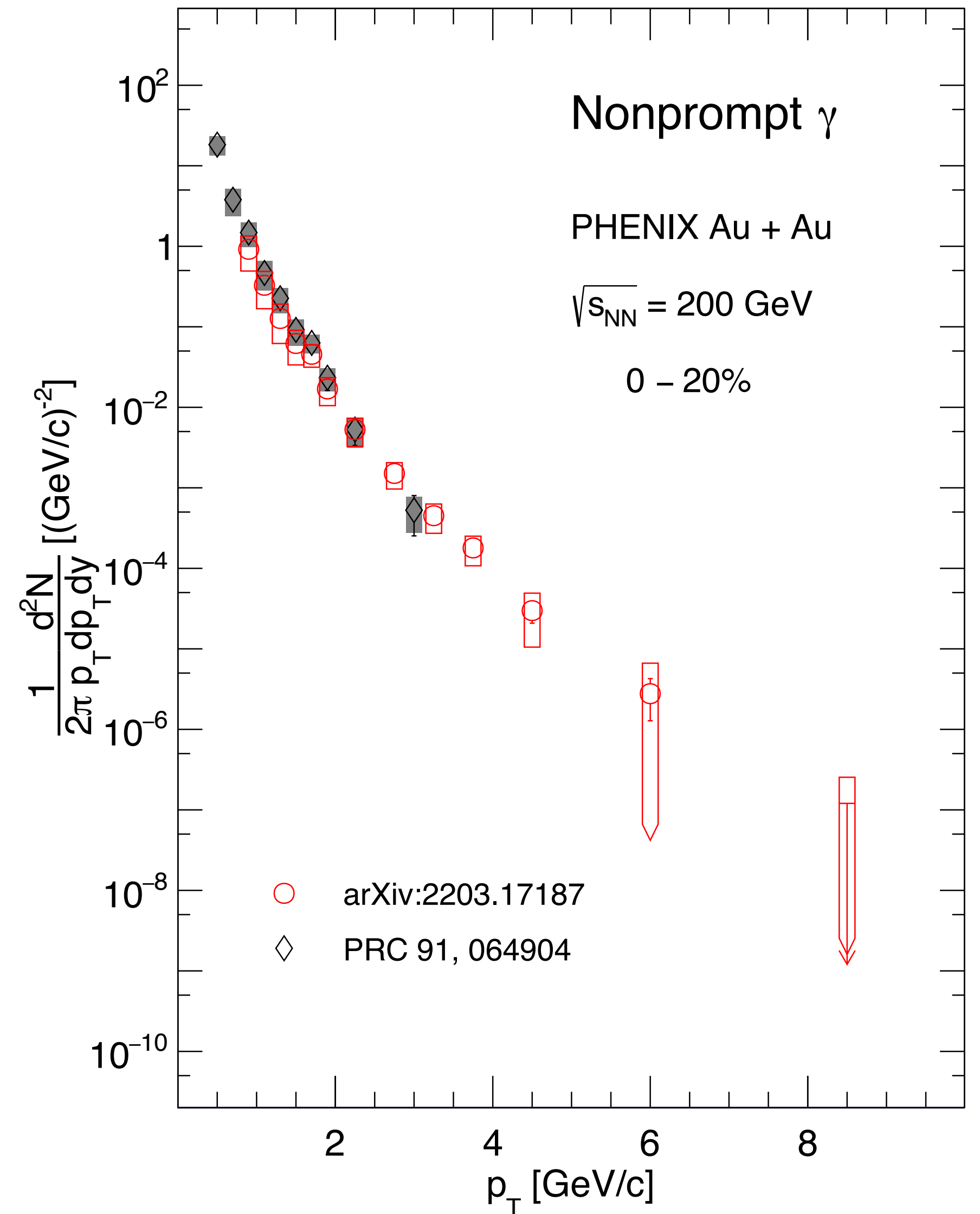
$\alpha > 1$ and independent of p_T

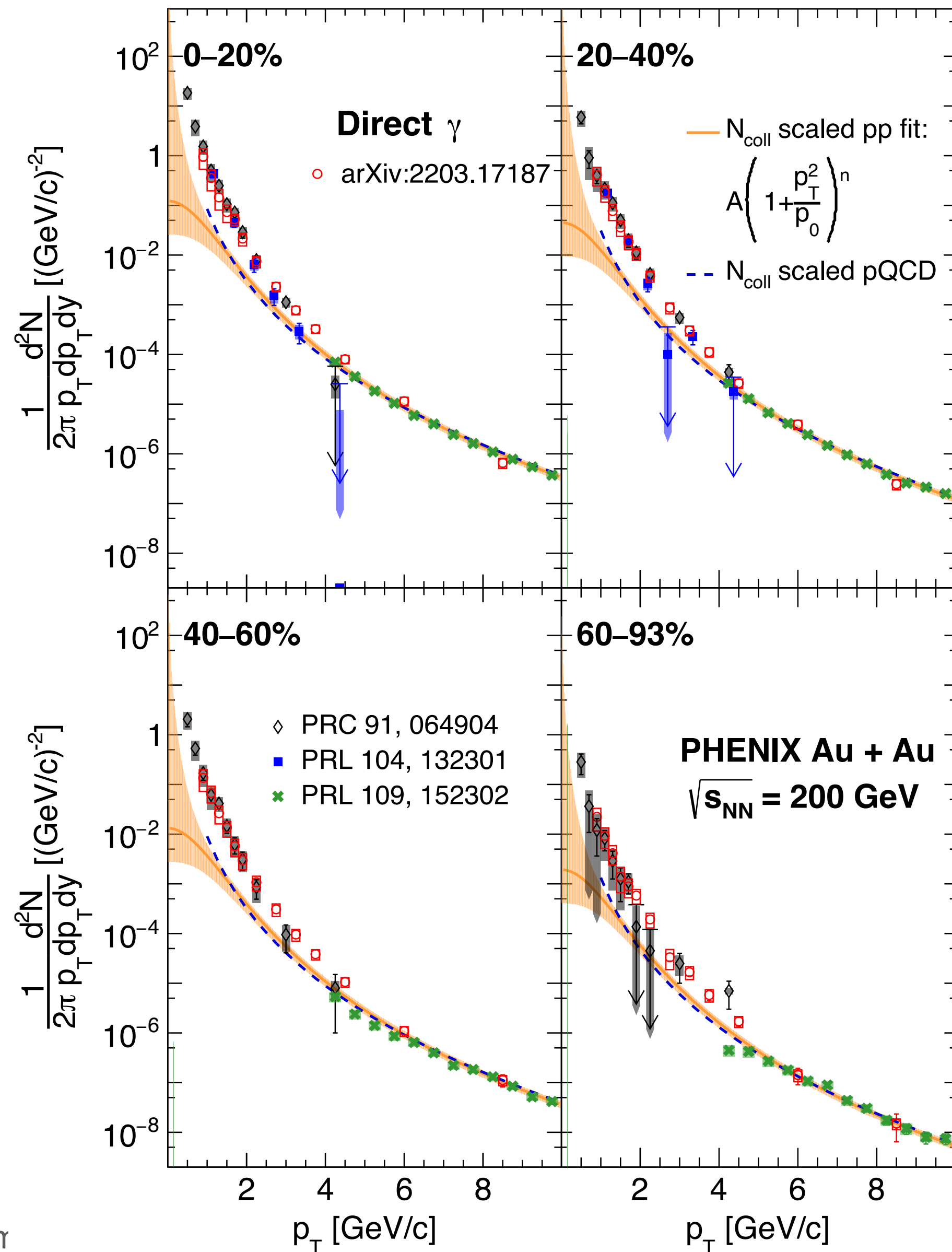


Direct photon

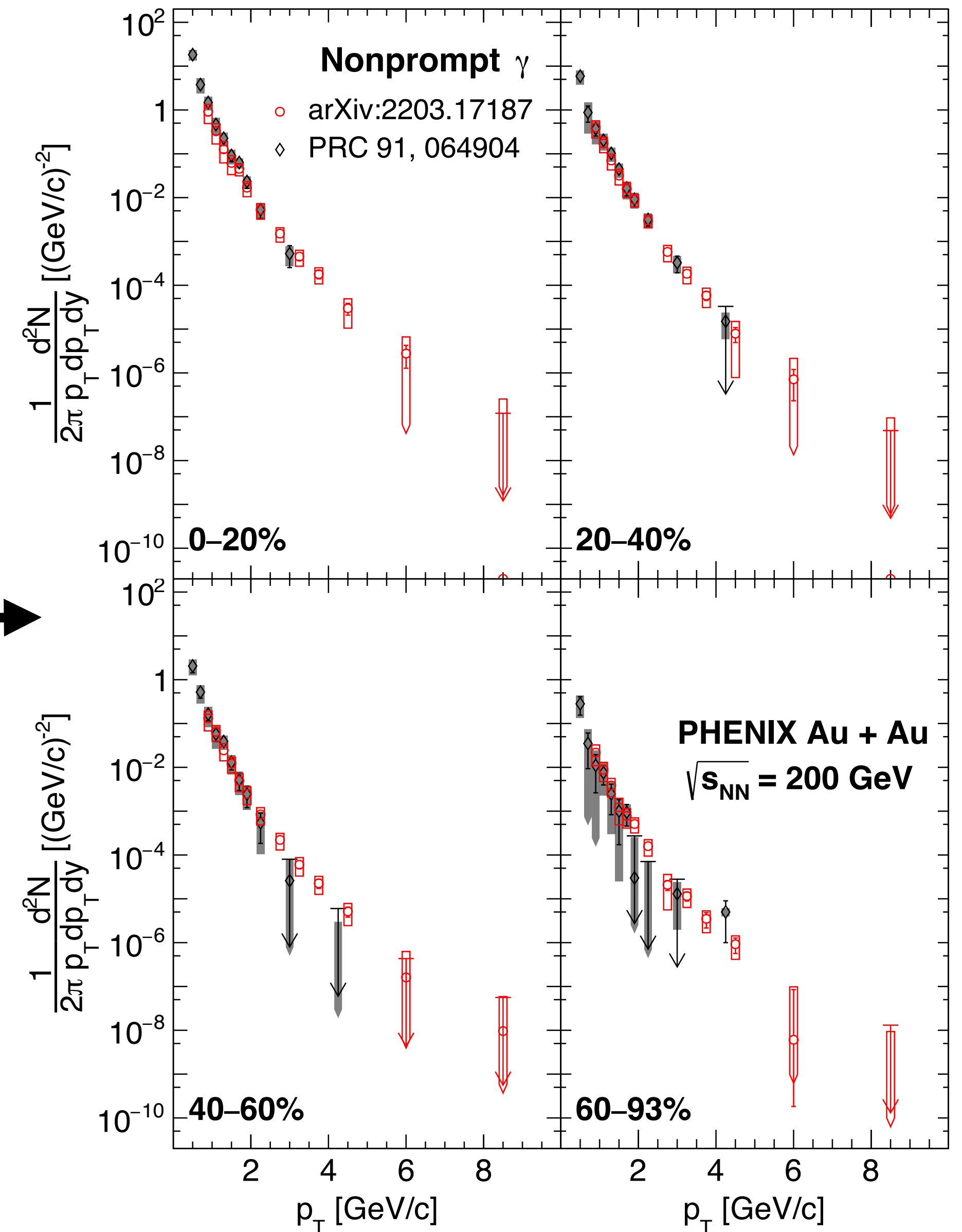
— N_{coll} scaled
p+p fit

**Non-prompt
direct photon**





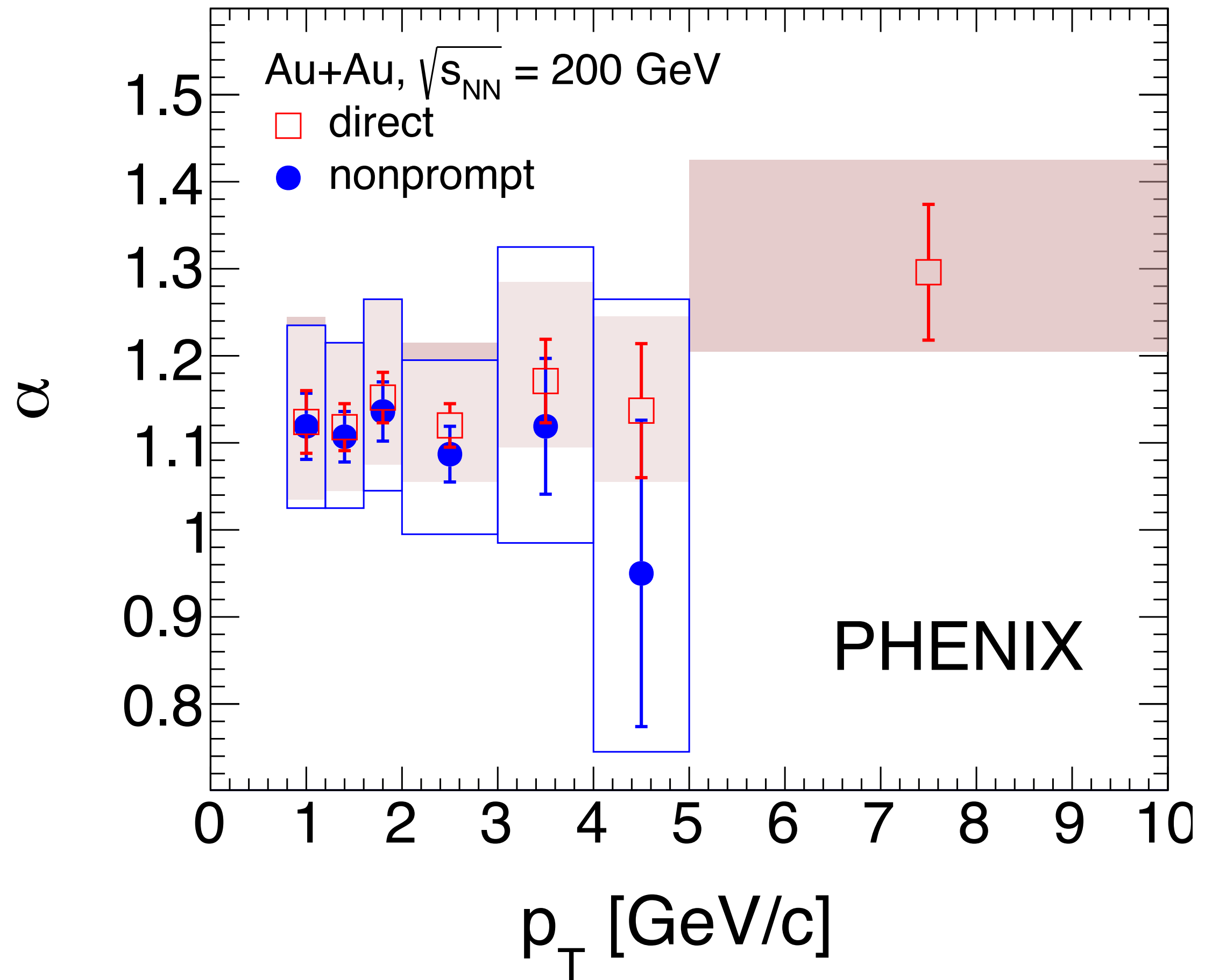
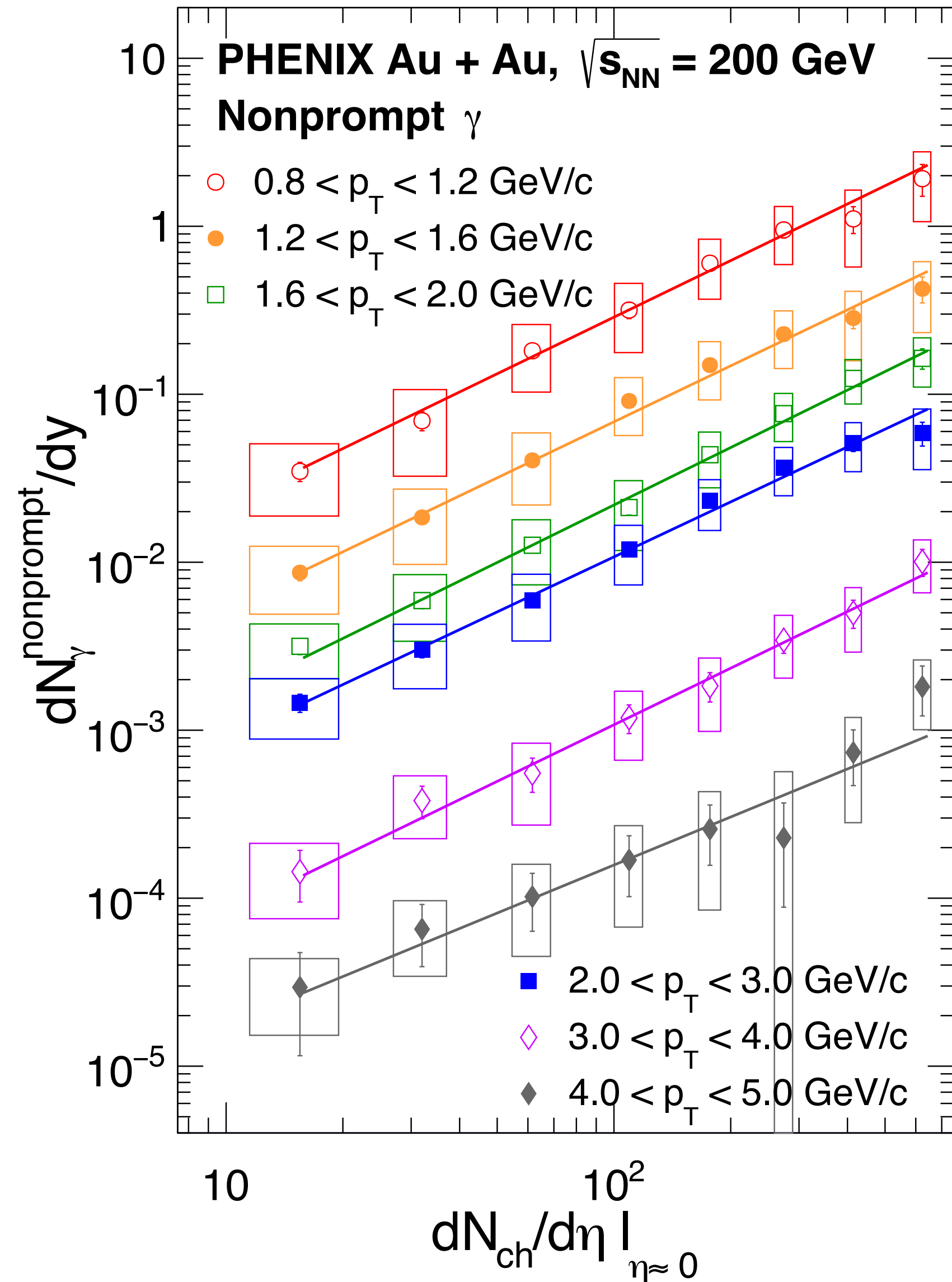
— N_{coll} scaled
p+p fit





arXiv:2203.17187

arXiv:2203.17187



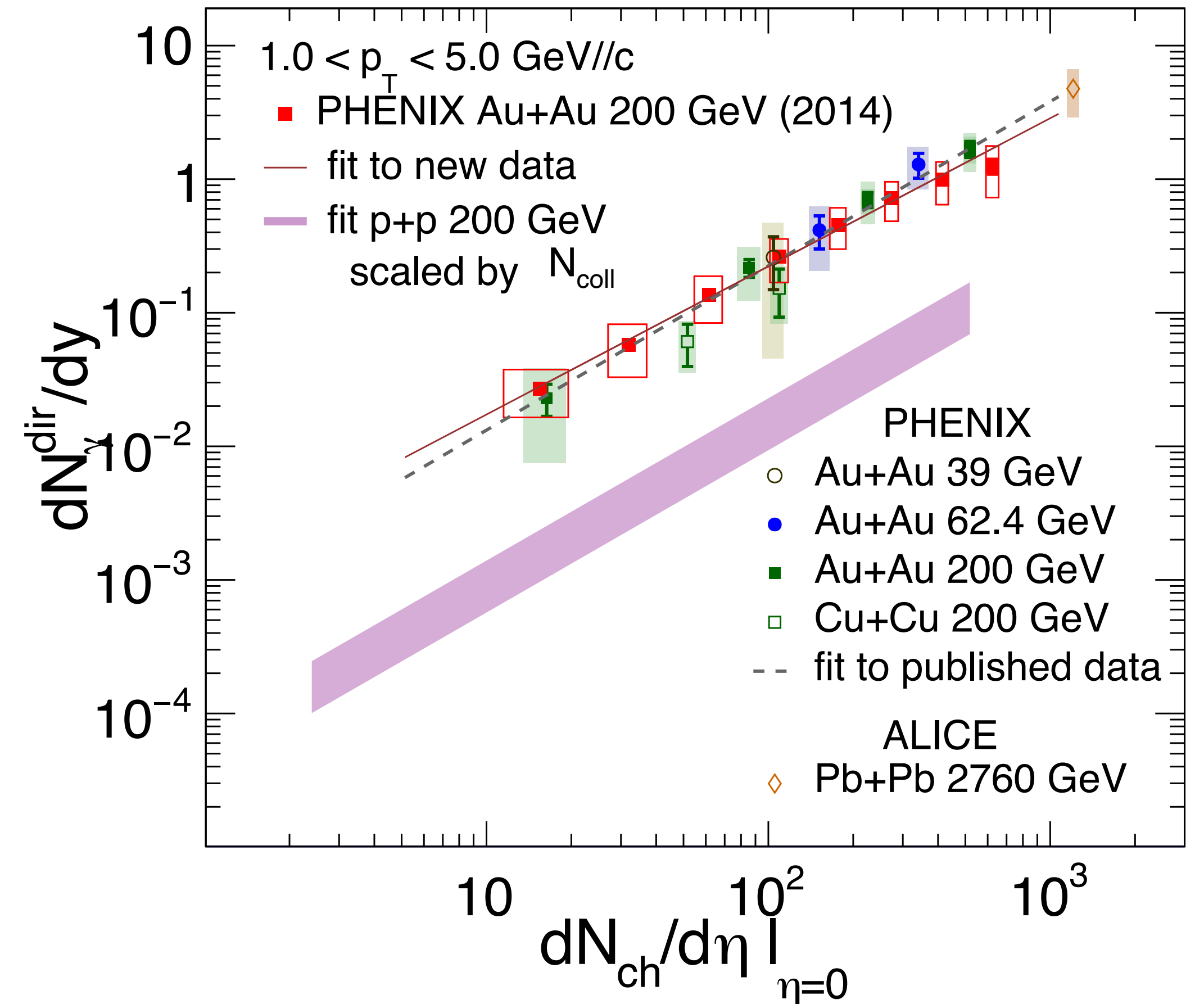
α independent of p_T for direct and nonprompt photons

arXiv : 2203.17187

Recently published Au+Au measurements for $\sqrt{s_{NN}} = 39, 62.4$ and 200 GeV

Universal scaling, $N_{\gamma}^{dir} \propto (dN_{ch}/d\eta)^{\alpha}$ — α independent of p_T for direct and non-prompt photons

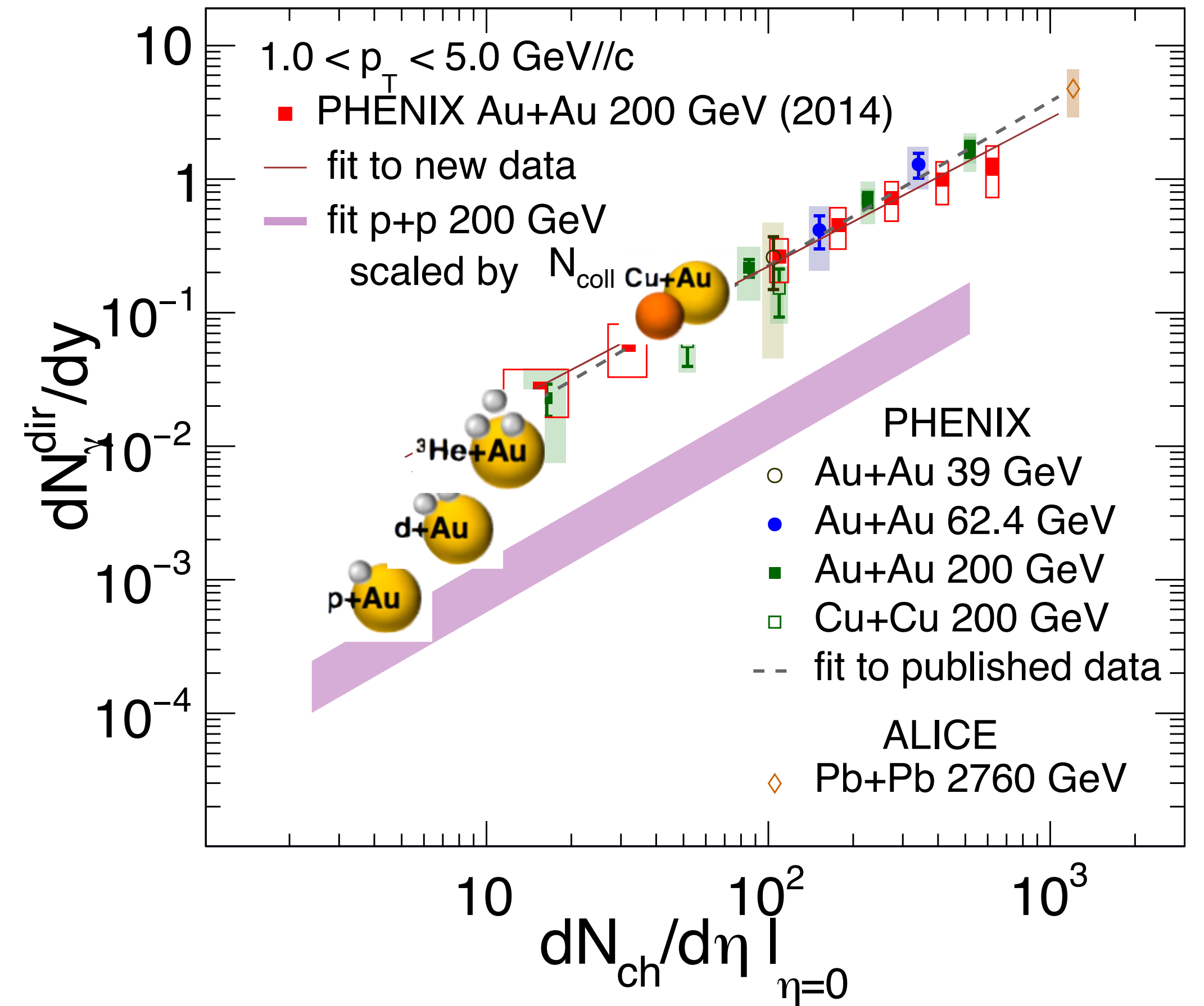
More results coming soon from small system collisions and Cu+Au at $\sqrt{s_{NN}} = 200$ GeV



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Thank you for your attention!

Back-up

Functional form inspired by pQCD

Fit below 1 GeV/c motivated by Drell Yan measurements [Ito, et al, PRD23, 604 (1981)]

Systematic errors include the fit errors, different functional forms

$$\frac{dN}{dy} = a \left(1 + \frac{p_T^2}{b^2} \right)^c$$

$$a = 6.4 \times 10^3$$

$$b = 1.45$$

$$c = -3.30$$

