RHIC & AGS
Annual Users' Meeting 2021

This meeting will be held as a virtual event.
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Direct Photon Production in Au+Au Collisions at 200GeV Beam Energy

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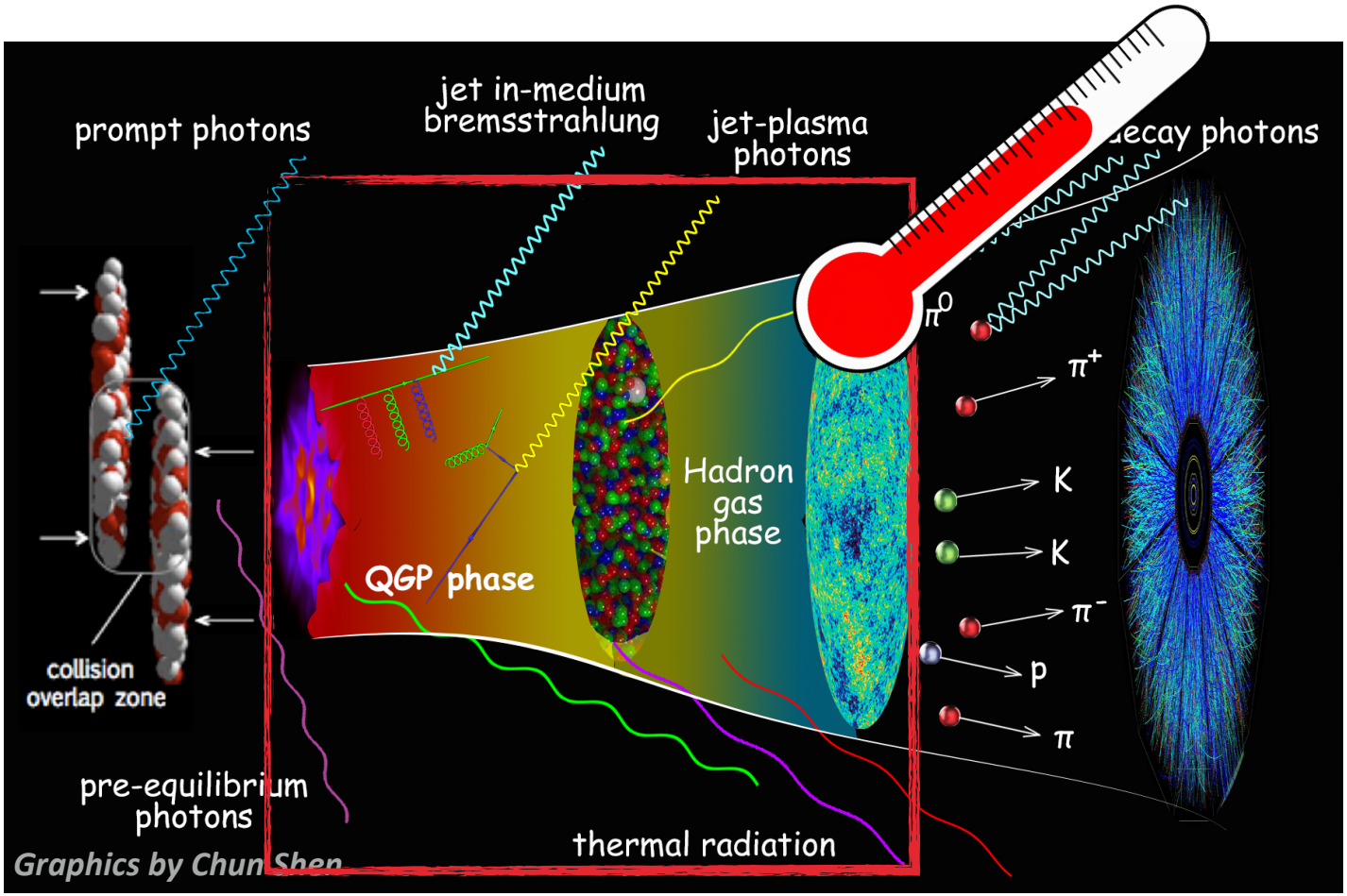
Why photons?

- **Photons are a unique probe for QGP**
  - "Color blind" (do not experience strong interaction), provide a direct fingerprint of its creation point
  - All thermal media emit radiation in the form of photons or low mass lepton pairs



Direct photon = Inclusive photon - decay photon

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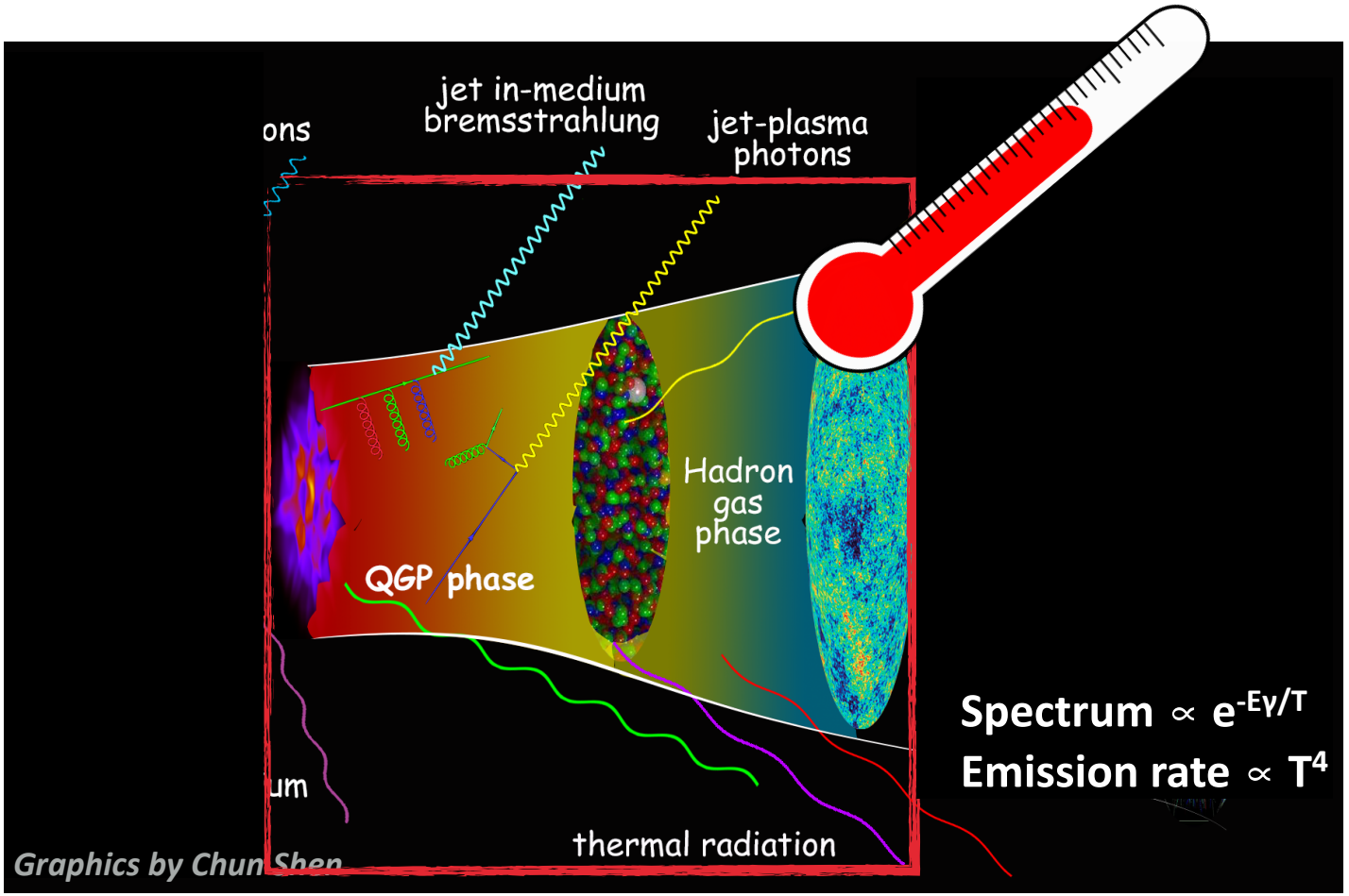


Direct photon = Inclusive photon - decay photon

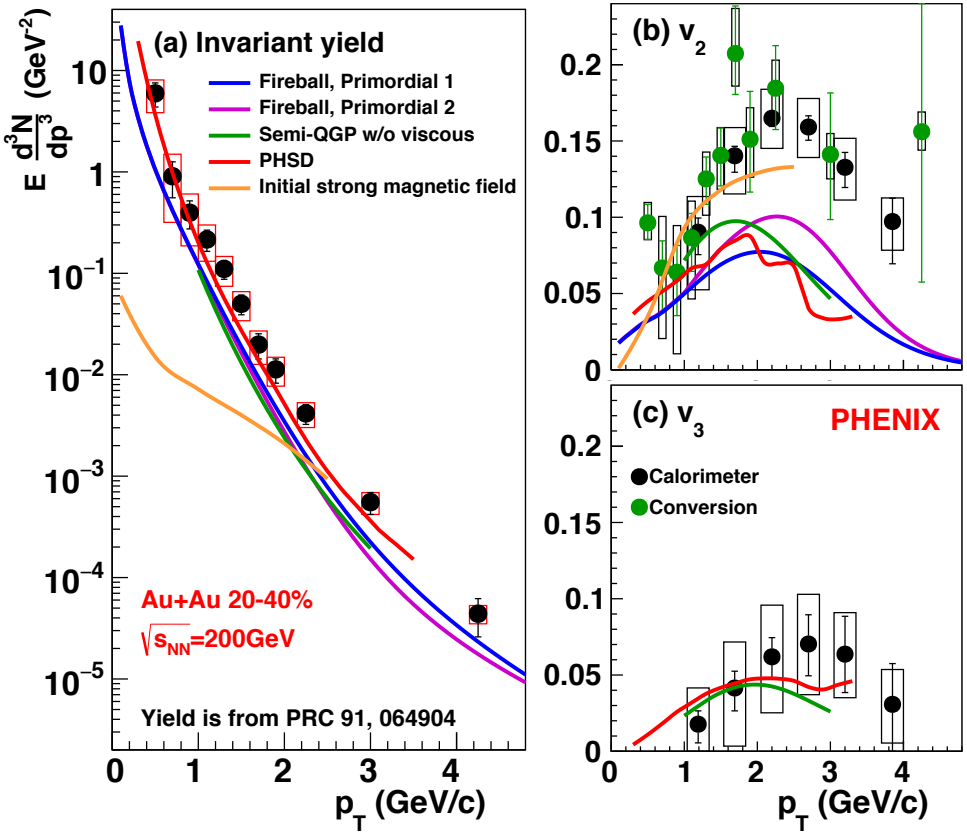
Estimate the prompt photons from p+p baseline

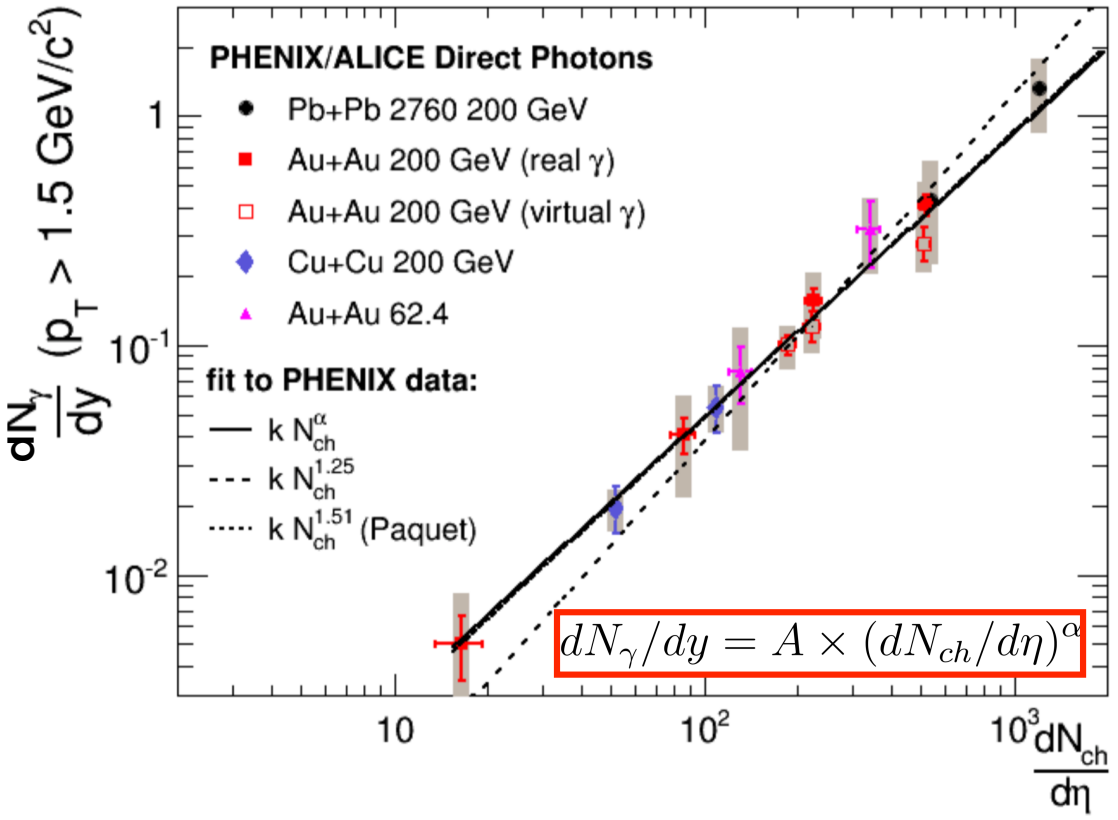
Extract temperature from thermal photon yield

Direct photon puzzle

- Qualitatively: in agreement with thermal source
  - Large yield of low p_T direct photons
  - Large anisotropic emission
  - Universal scaling with α ~5/4
- Quantitatively: in tension with current model predictions

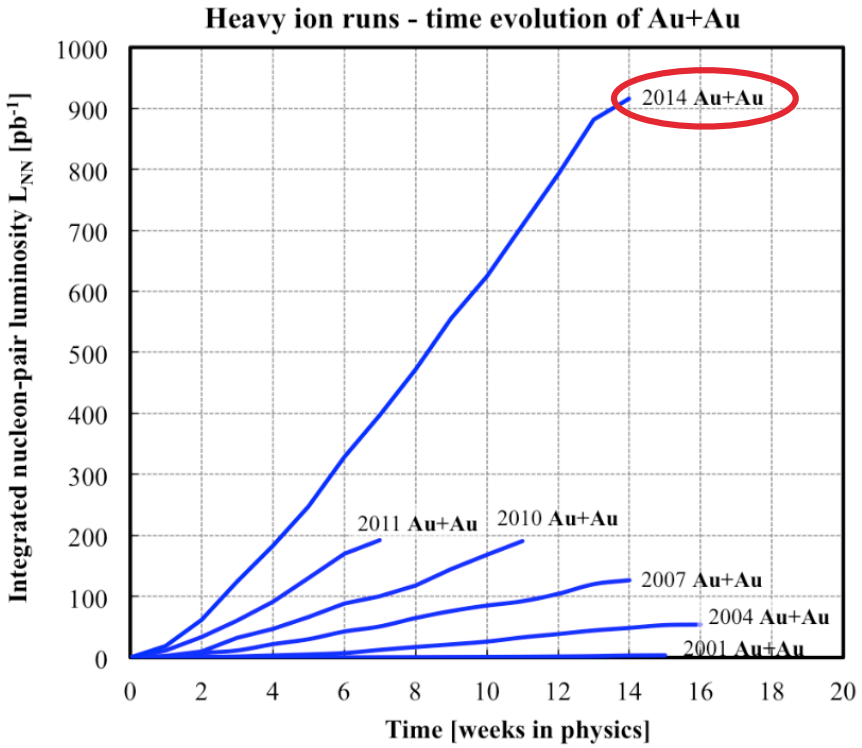
What is the main source for low p_T direct photons?

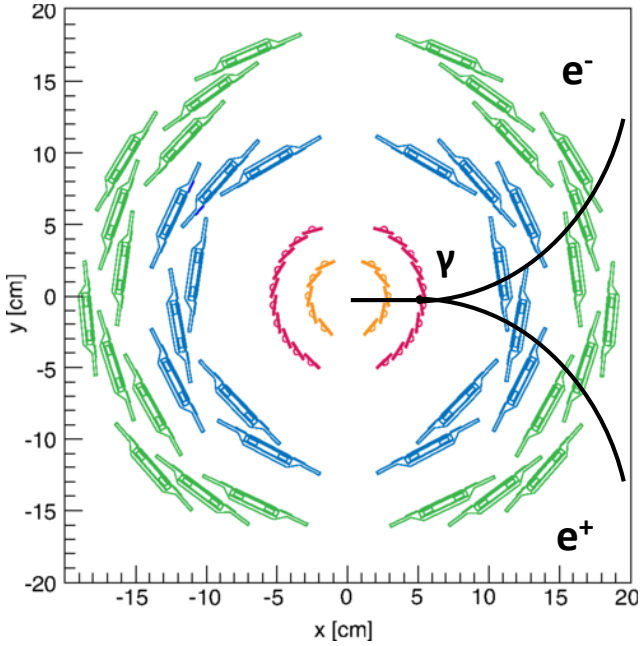




Goal of this thesis work

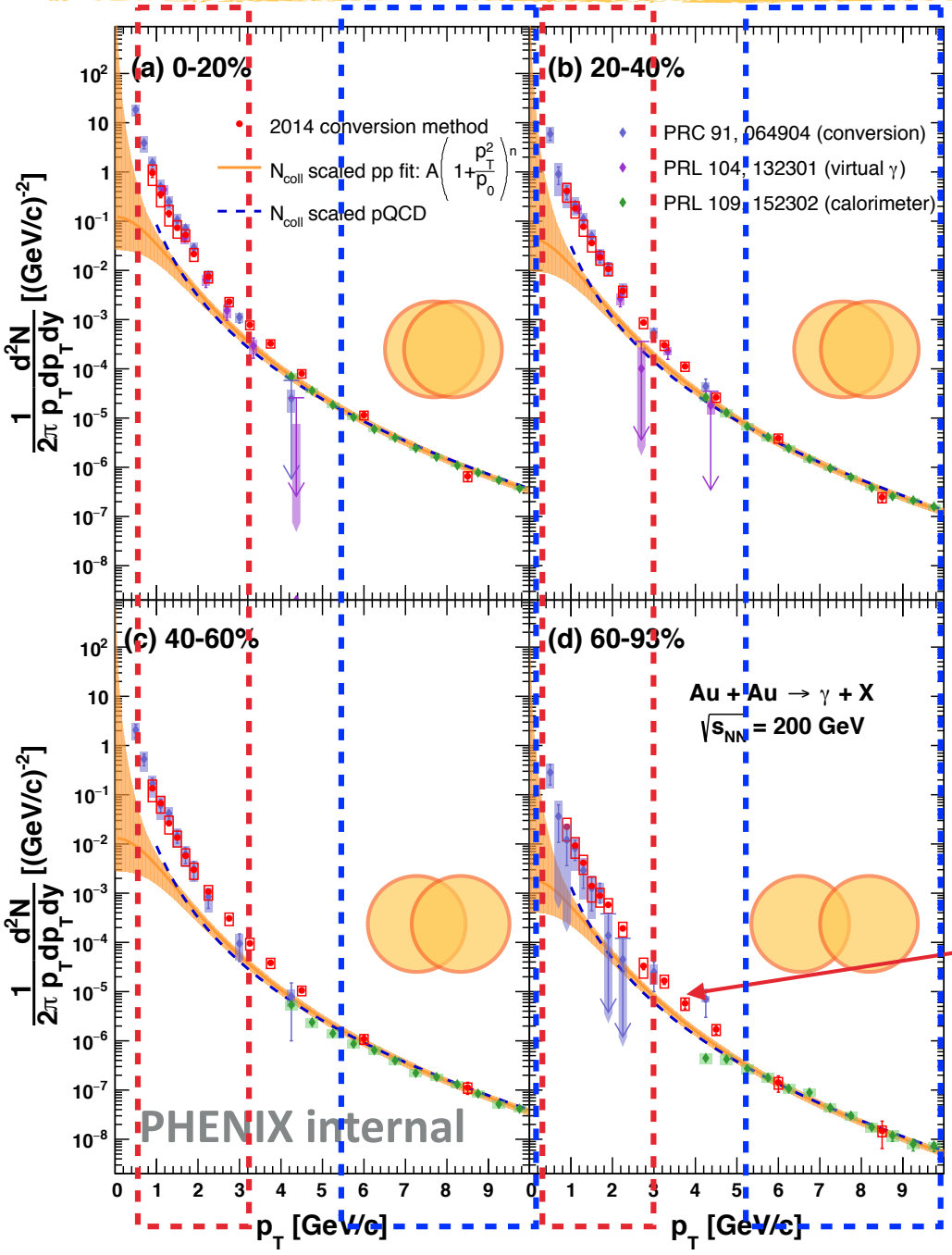
- Using **2014 PHENIX Au+Au** data to study the direct photon with high statistical precision in more detail
  - Higher luminosity
  - More conversions at the PHENIX silicon vertex detector (VTX) ($X/X_0 \sim 14\%$)





- Results on following slides are from my thesis, publication in preparation

Direct photons in Au+Au collisions



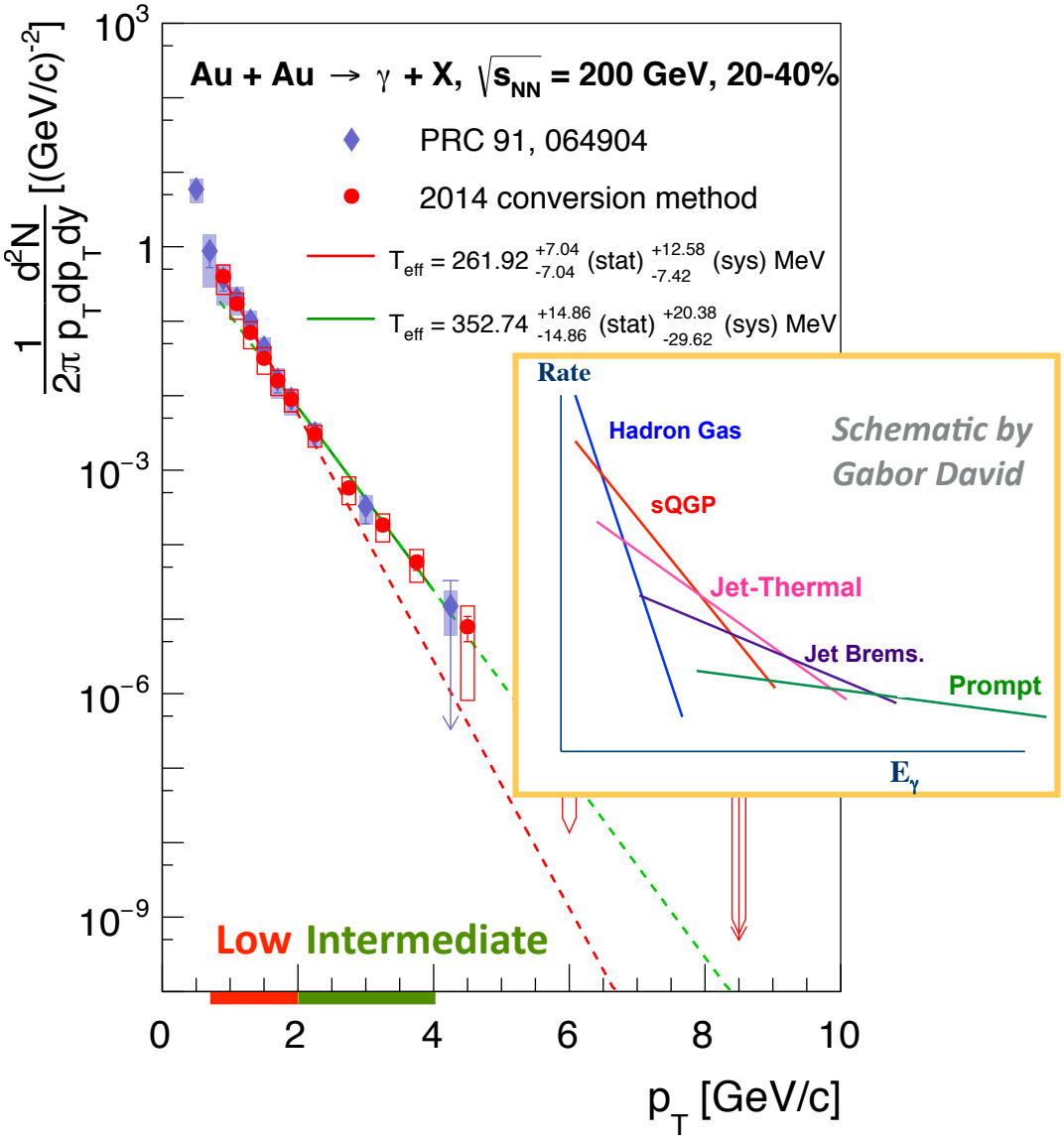
At high p_T, Au+Au data consistent with N_{coll} scaled p+p ➜ the dominant photon source is hard scattering

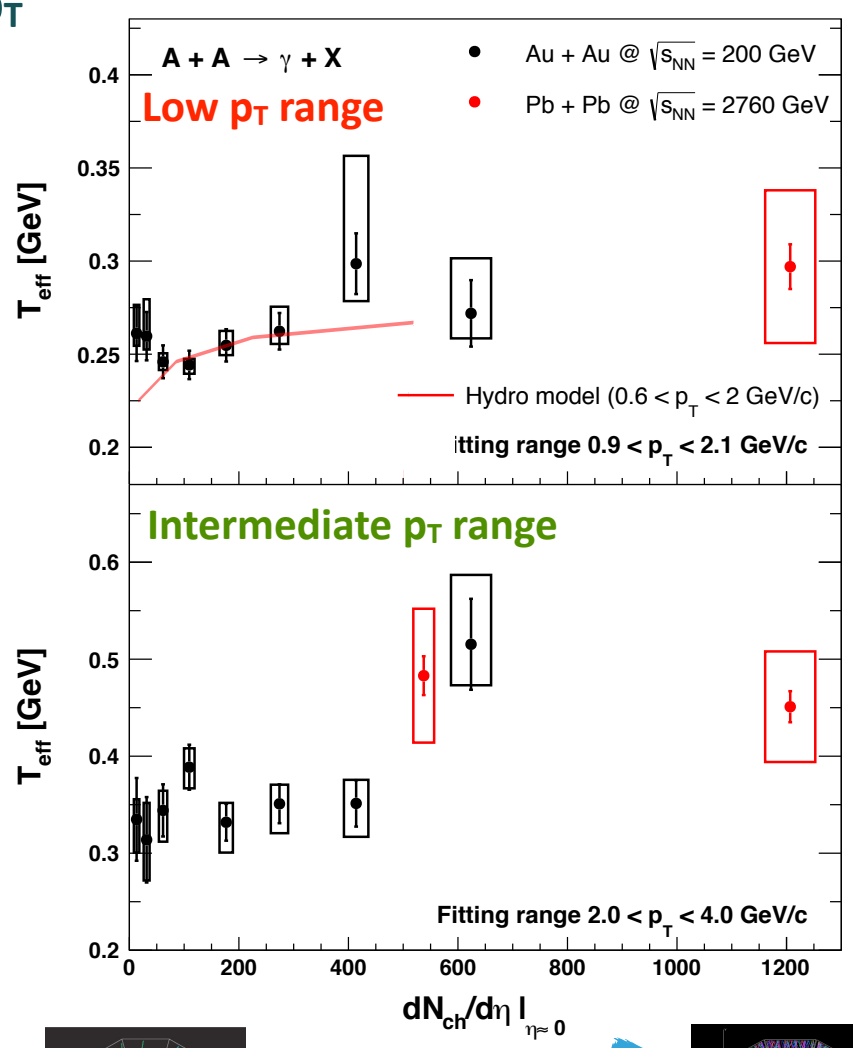
At low p_T, Au+Au data shows a clear enhancement wrt the prompt contribution below 3GeV

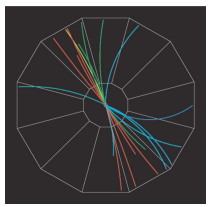
At intermediate p_T (3-5 GeV), Au+Au data also shows an enhancement wrt the prompt contribution

Closer look at "thermal" excess in Au+Au collisions

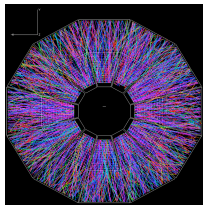
- Inverse slope (T_{eff}) changes towards higher p_T







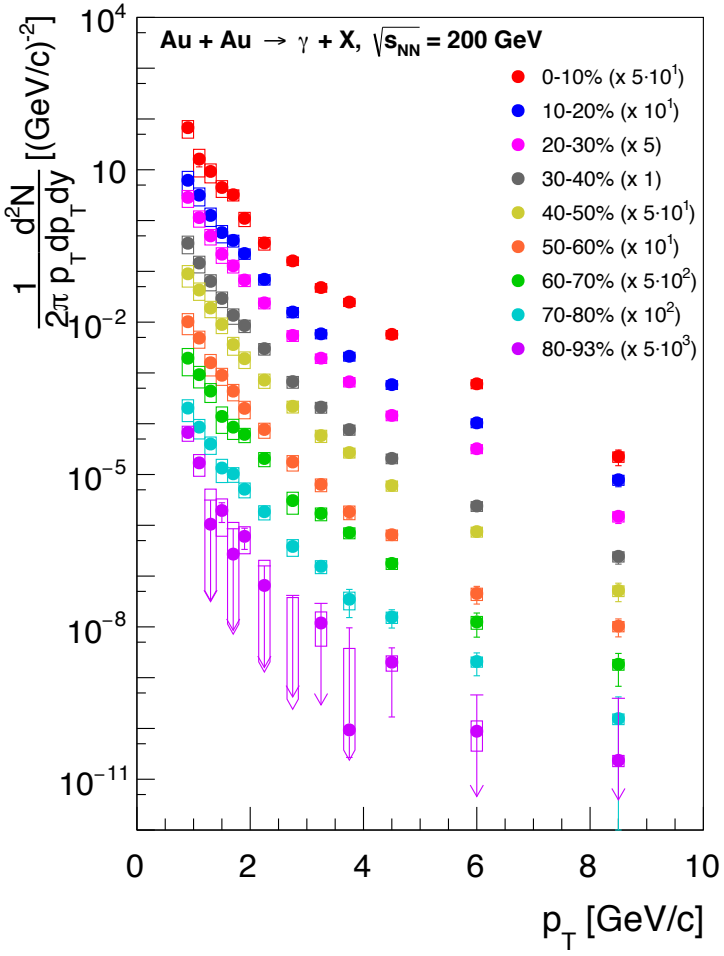
more central collision
higher beam energy
heavier nuclei A

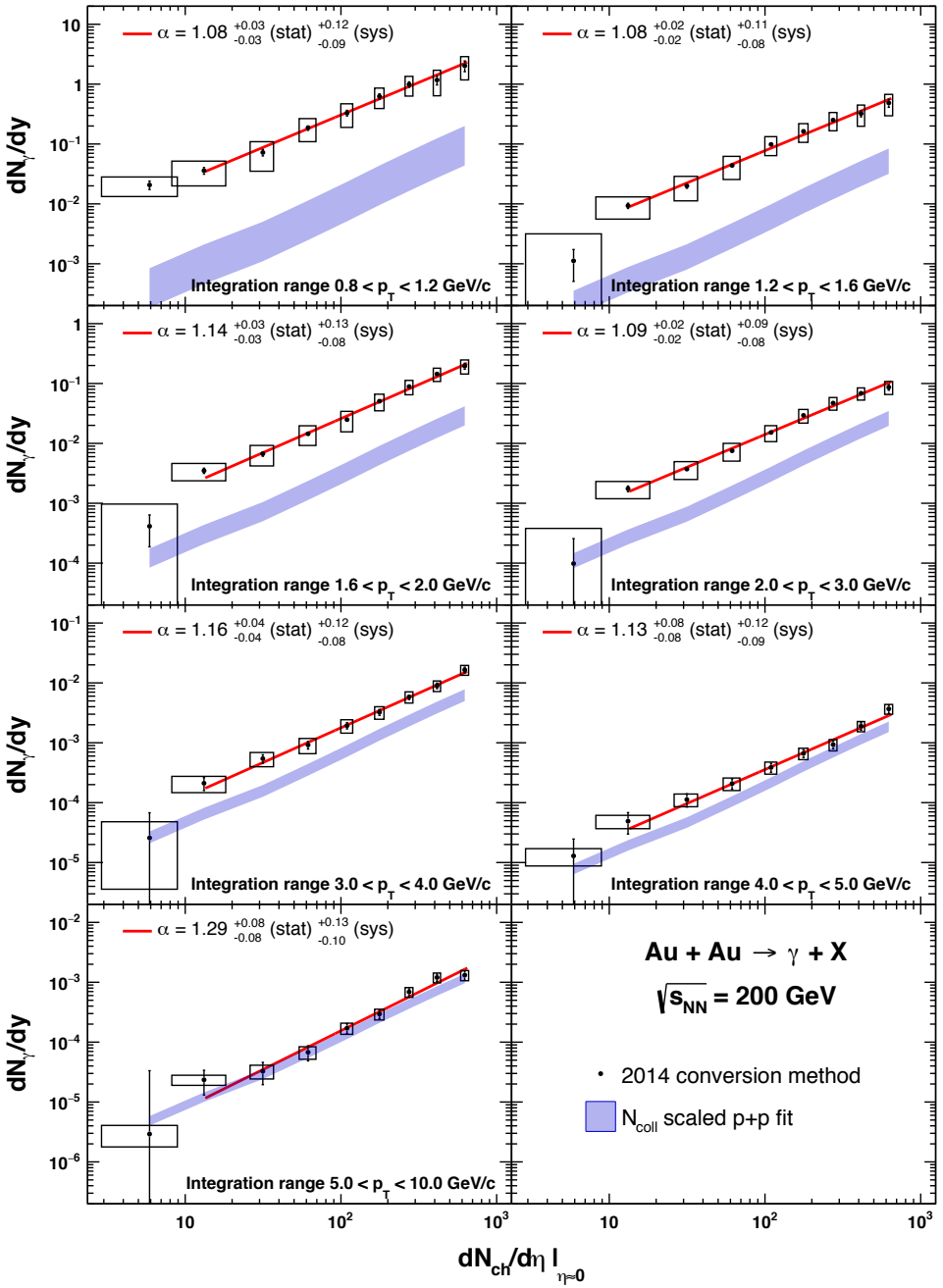


Direct photon vs centrality

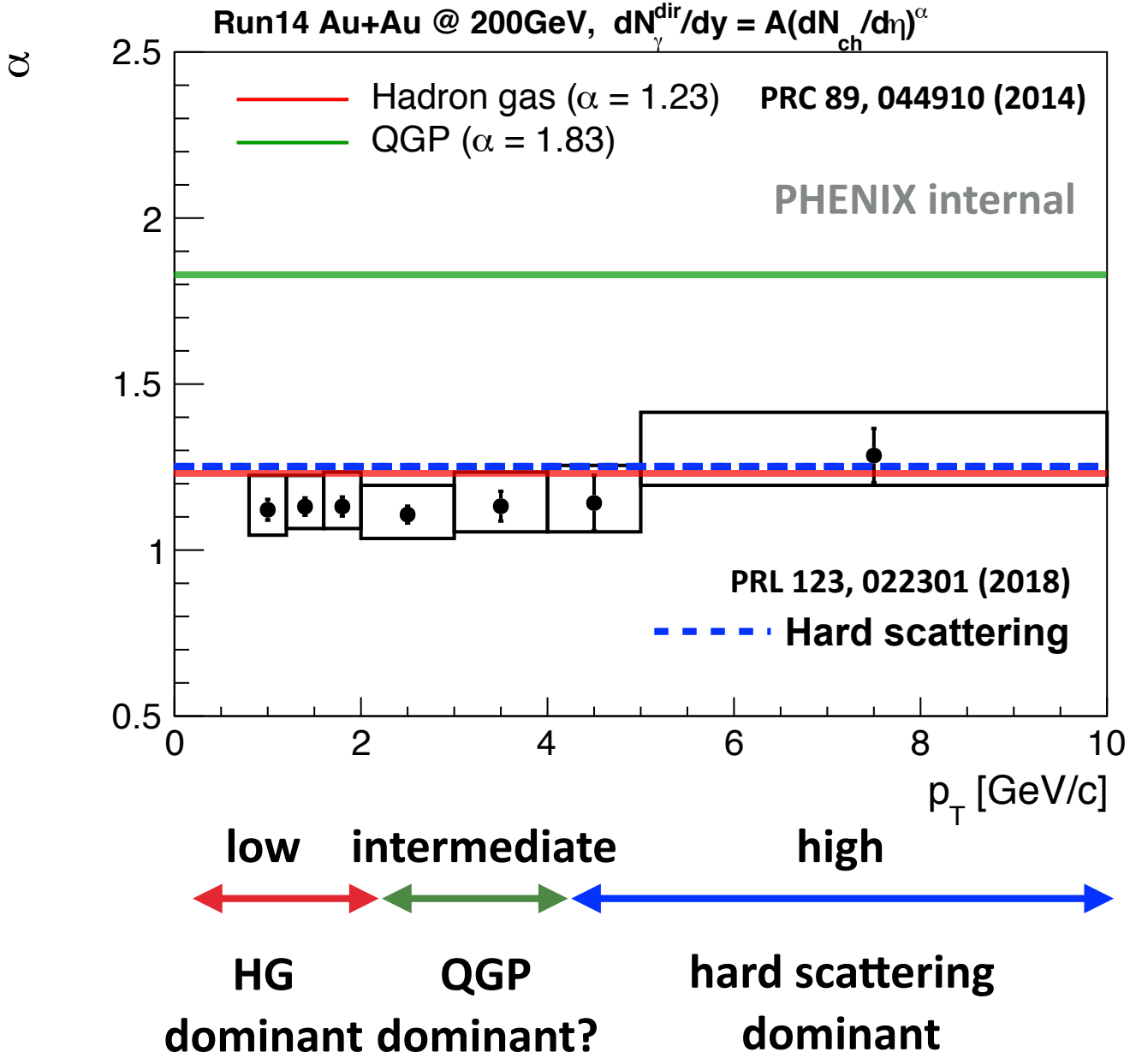
- **Consistent scaling behavior with previous A+A results**

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





Direct photon scaling vs p_T



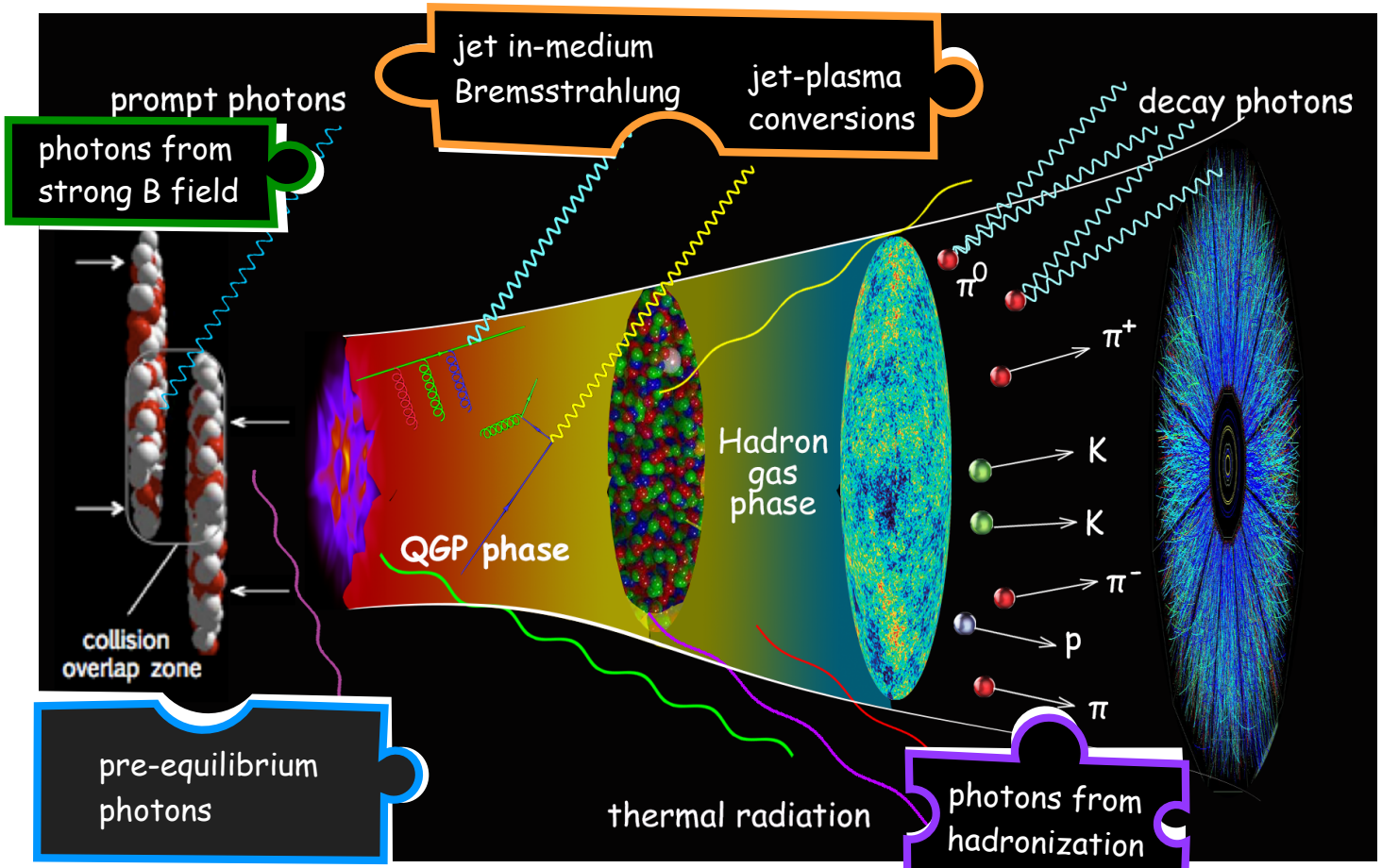
No clear p_T dependence

Centrality dependence (α) in tension with hydro model (including QGP+HG+prompt contribution)

Direct/Thermal photon puzzle — other photon sources?

- Significant intermediate p_T
- Large v_2
- Centrality dependence: $\alpha < 1$?

- Significant intermediate p_T (RHIC)
- Small-negative v_2
- Centrality dependence: $\propto N_{coll}$ ($N_{ch}^{1.25}$) or stronger?



- Significant intermediate p_T
- Small v_2
- Centrality dependence: ?

- Large low p_T yield
- Large v_2
- Centrality dependence similar to HG?