Semi-inclusive measurements of π^0+jet and γ_{dir}+jet in $\sqrt{s} = 200$ GeV p+p collisions and their impact on measurements of medium-induced modification at the STAR experiment

Derek Anderson
Texas A&M University
For the STAR Collaboration

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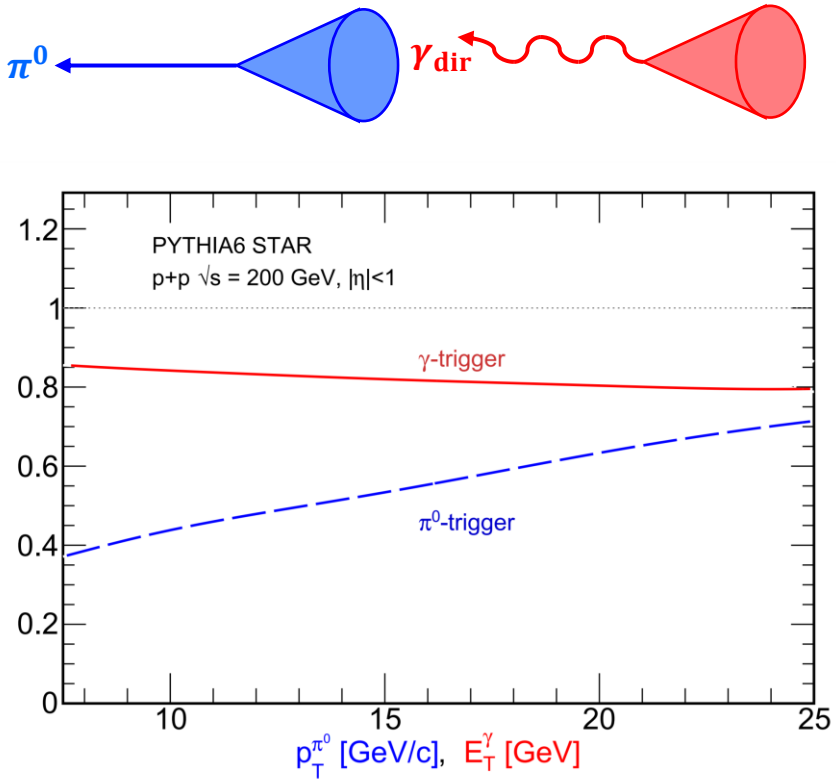
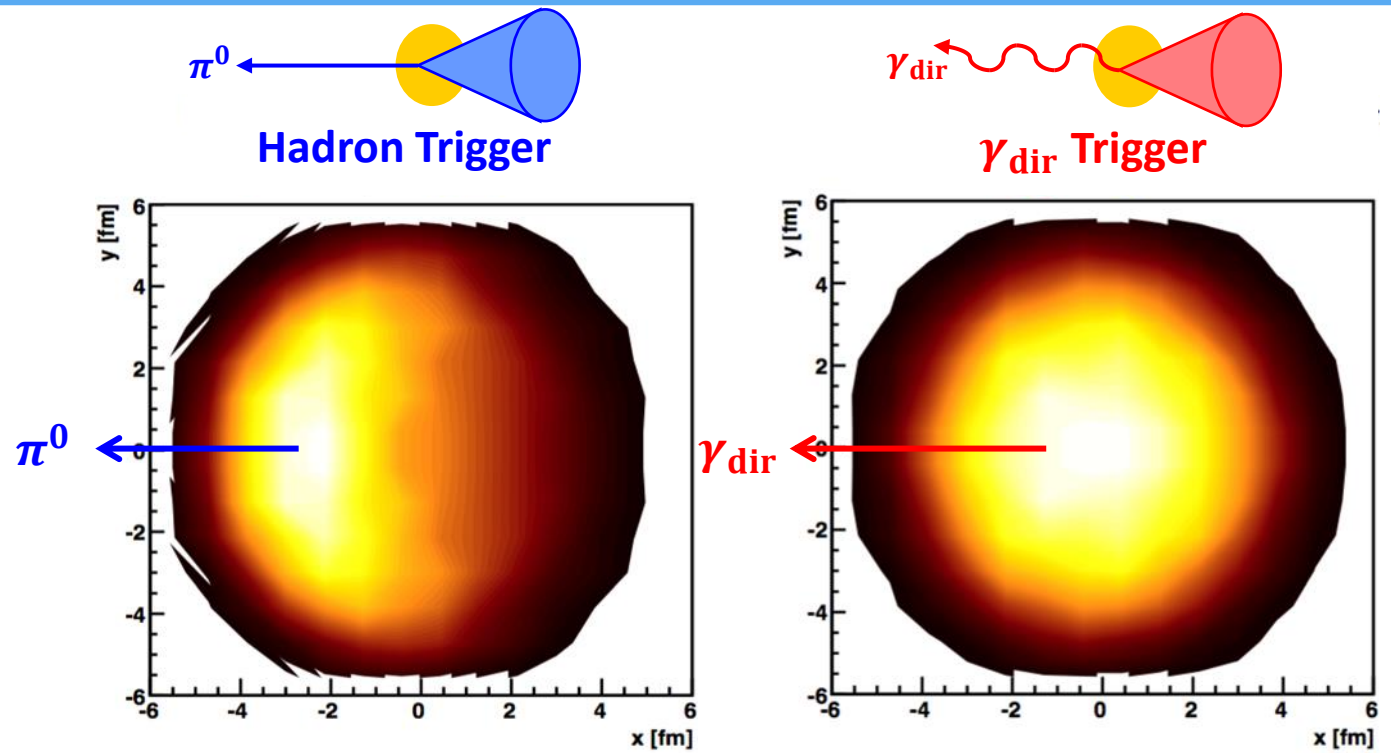
$\gamma_{\rm dir}/\pi^0$+jet as probes of the QGP



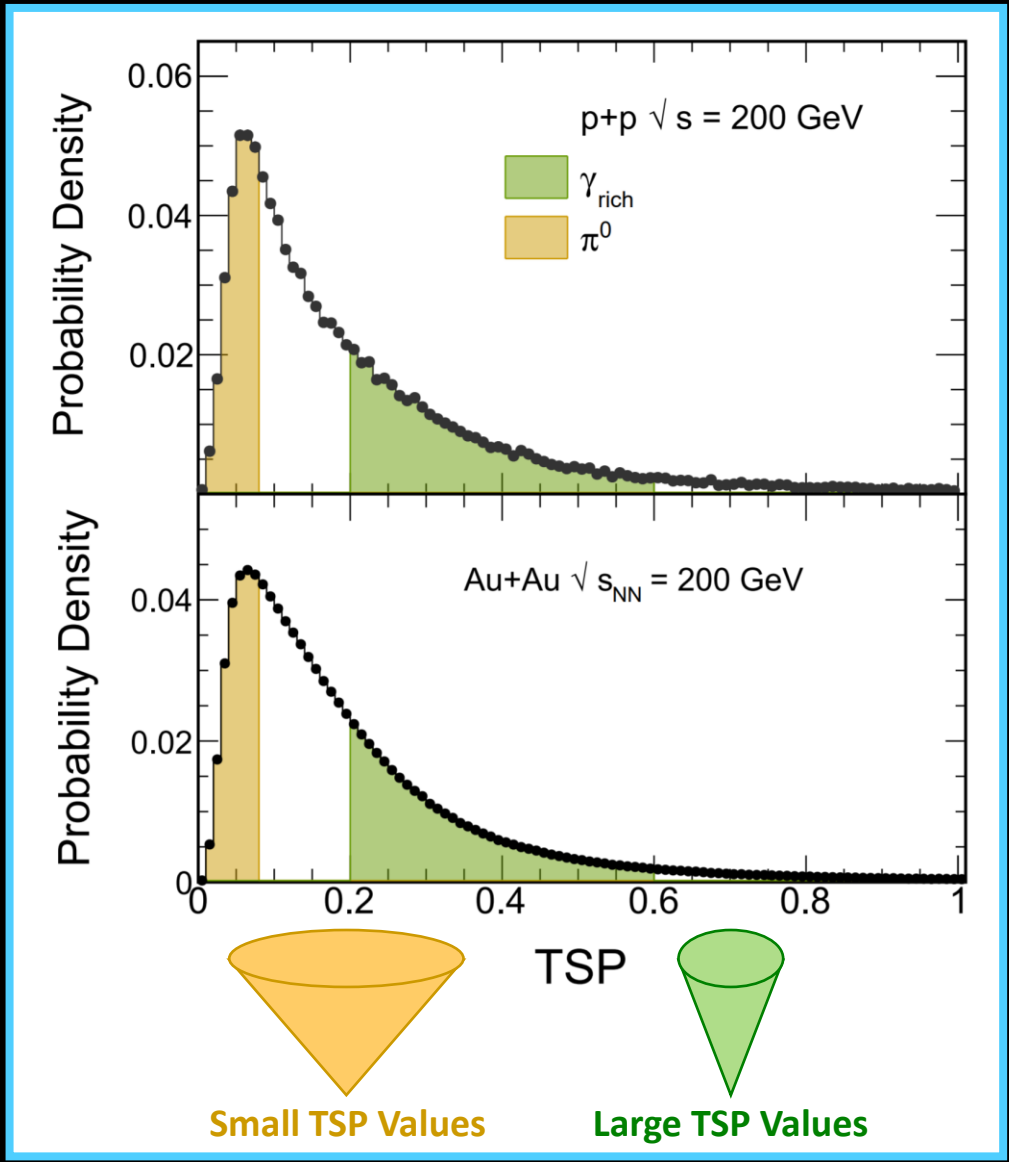


Adapted from
Renk, PRC **88**, 054902 (2013)

- Jets coincident with direct photons **($\gamma_{\rm dir}$)** are valuable probe to study in-medium modification **(jet quenching)**
  - $\because E_{\rm T}^{\gamma_{\rm dir}} \approx E_{\rm T}^{\rm parton}(t_0)$

- Comparing $\gamma_{\rm dir}/\pi^0$ triggers:
  - ☞ **Different q/g fractions**
  - ☞ **Different recoil path length distributions**

$\gamma_{\rm dir}/\pi^0$ identification



- Candidate $\pi^0/\gamma_{\rm dir}$ triggers are clusters made of:
  - **1 or 2 BEMC towers**, and
  - **15 η and 15 ϕ BSMD strips**

- $\pi^0/\gamma_{\rm dir}$ identified via **Transverse Shower Profile (TSP):**

$$\mathrm{TSP} \equiv \frac{E_{\rm cluster}}{\sum_i e_i r_i^{1.5}}$$

  - ☞ $E_{\rm cluster}$: total cluster energy
  - ☞ e_i: energy of BSMD strip
  - ☞ r_i: distance of BSMD strip to cluster centroid

- TSP used to split data into two samples:
  i. 95% pure sample of π^0
  ii. Sample with an enhanced fraction of $\gamma_{\rm dir}$ **($\gamma_{\rm rich}$)**

☞ $\gamma_{\rm rich}$ background levels **(B)**
  - $33\% \sim 16\%$ **(Au+Au)**
  - $57\% \sim 47\%$ **(p+p)**

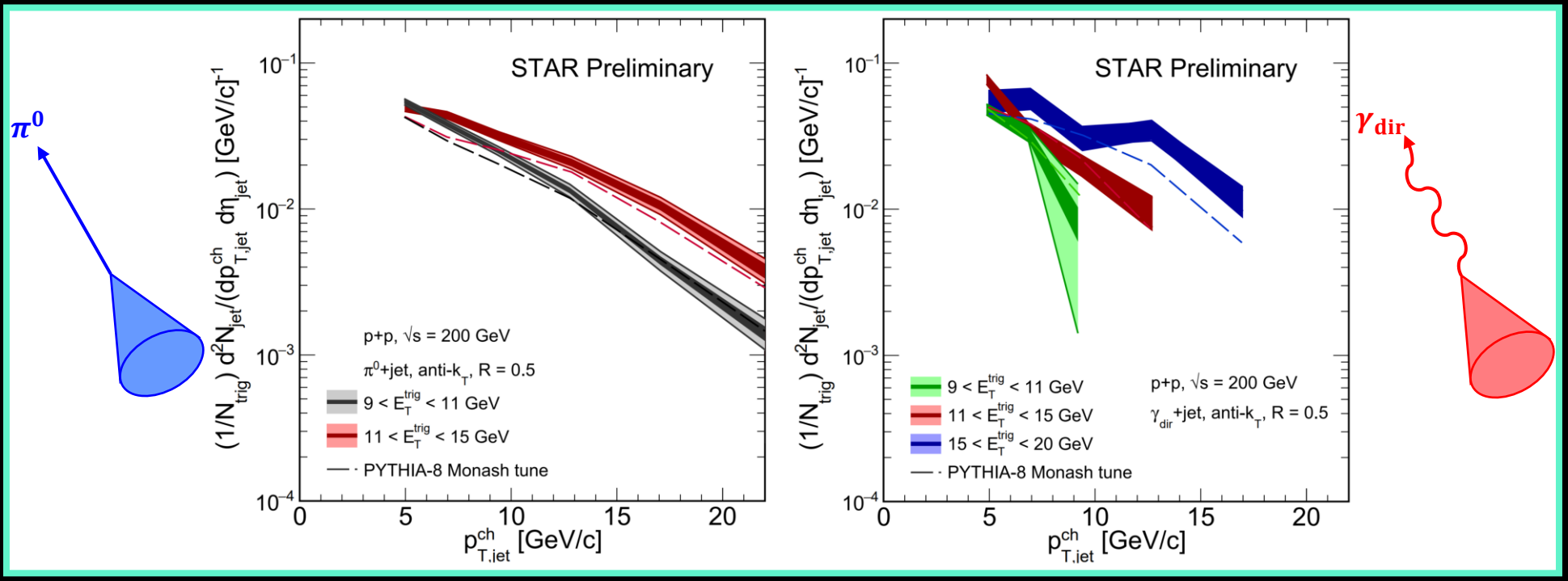
  - ☞ Measured via near-side $h^{\pm}$ yields
  - ☞ Includes some fragmentation photons
  - › STAR, PRC **82**, 034909 (2010)

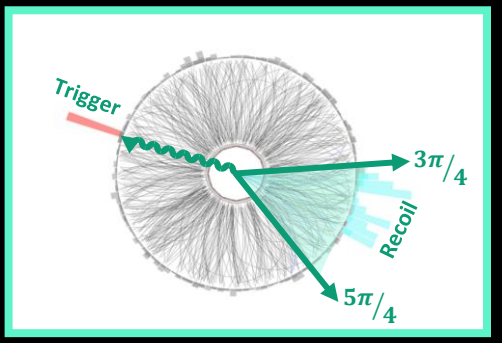
- Decay background in $\gamma_{\rm rich}$ removed via statistical subtraction

$$Y_{\rm pp}^{\gamma_{\rm dir}} = \frac{Y_{\rm pp}^{\gamma_{\rm rich}} - B \cdot Y_{\rm pp}^{\pi^0}}{1 - B}$$

  - ☞ $Y_{\rm pp}^{\star}$: semi-inclusive yield for a trigger

Corrected recoil jet distributions





- Recoil jets reconstructed by clustering TPC tracks
  - Clustered using anti-k_T algorithm with $\boldsymbol{R = 0.2, 0.5}$ **(shown)**
- Negligible effect of UE in p+p
  - ∴ No ME subtraction applied

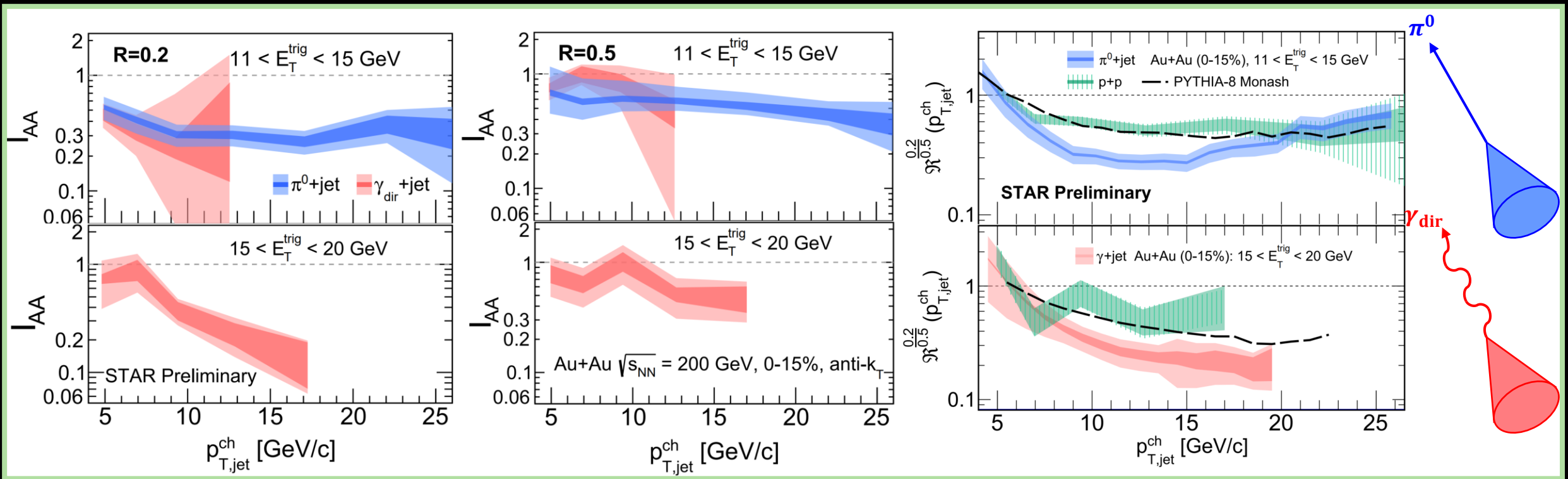
- $p^{ch}_{T,jet}$ smearing and shifting corrected in 2 steps
  1) Event-wise adjustment:
     $$p^{reco,ch}_{T,jet} = p^{raw,ch}_{T,jet} - \rho \cdot A_{jet}$$
  2) Residual fluctuations corrected with regularized unfolding
     - › STAR, PRC **96**, 024905 (2017)

- ☞ $p^{raw,ch}_{T,jet}$: raw p_T of reconstructed recoil jet
- ☞ $p^{reco,ch}_{T,jet}$: p_T of recoil jet after event-wise adjustment
- ☞ $p^{ch}_{T,jet}$: p_T of recoil jet after unfolding

Impact of p+p data

$I_{AA} \equiv Y_{AuAu}/Y_{pp}$

$\Re^{0.2/0.5} \equiv Y_{0.2}/Y_{0.5}$



- $R = 0.2$ more suppressed than 0.5
  - ⇒ Indication of wide angle energy redistribution
- π^0 and γ_{dir} I_{AA} consistent

- $\Re^{0.2/0.5} < 1$ in p+p due to vacuum parton shower
  - PYTHIA−8 agrees with p+p data
- $\Re^{0.2/0.5}$ in Au+Au less than in p+p
  - ⇒ Observation of medium-induced intra-jet broadening in heavy-ion collisions

Summary & Next Steps

- **Summary:**
  - I_{AA} consistent between π^0+jet and γ_{dir}+jet
  - I_{AA} and $\mathfrak{R}^{0.2/0.5}$ demonstrate intra-jet broadening
- **Next Steps:**
  - **Very sensitive measurement!** Will utilize higher statistics datasets (Runs 23 – 25)
  - Extension of $\pi^0/\gamma_{\mathrm{dir}}$+jet spectrum analysis to **full jets** (tracks + calorimeter)