

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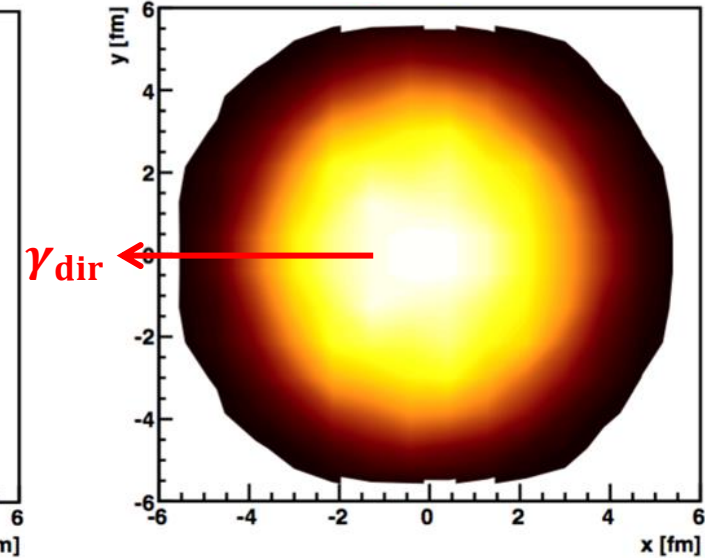
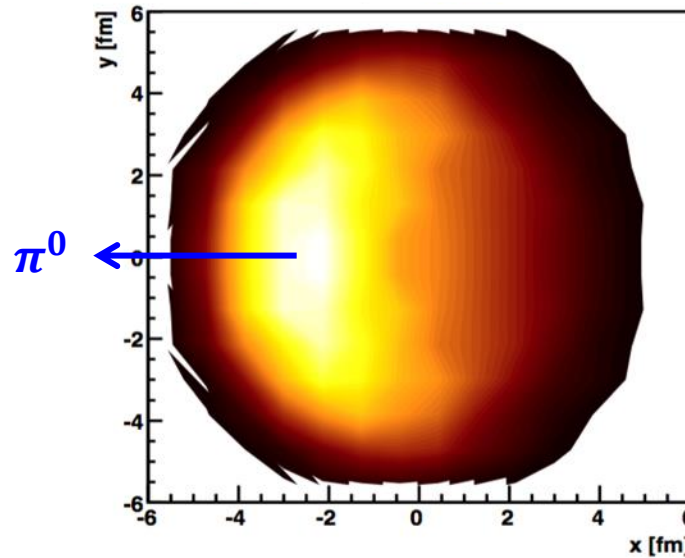
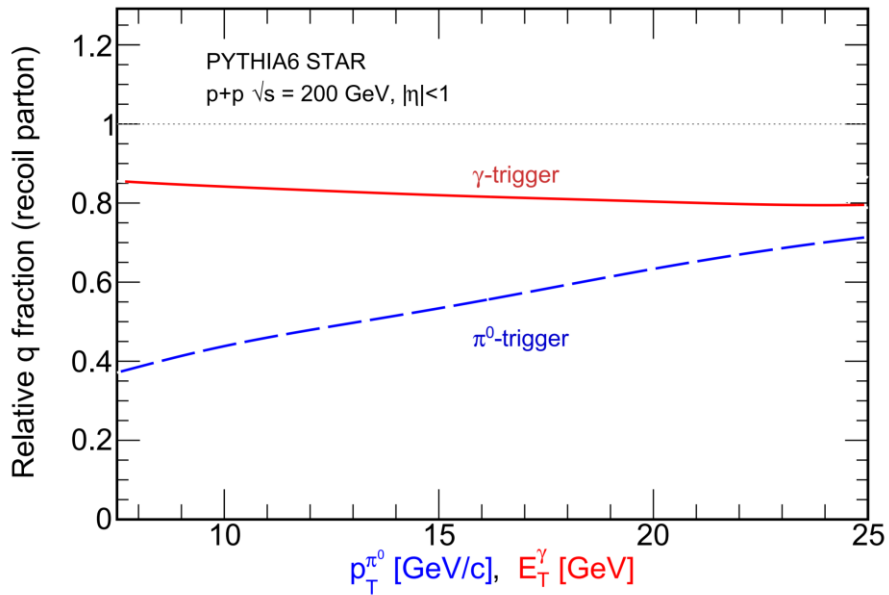
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$\gamma_{\text{dir}}/\pi^0$ + jet as probes of the QGP



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

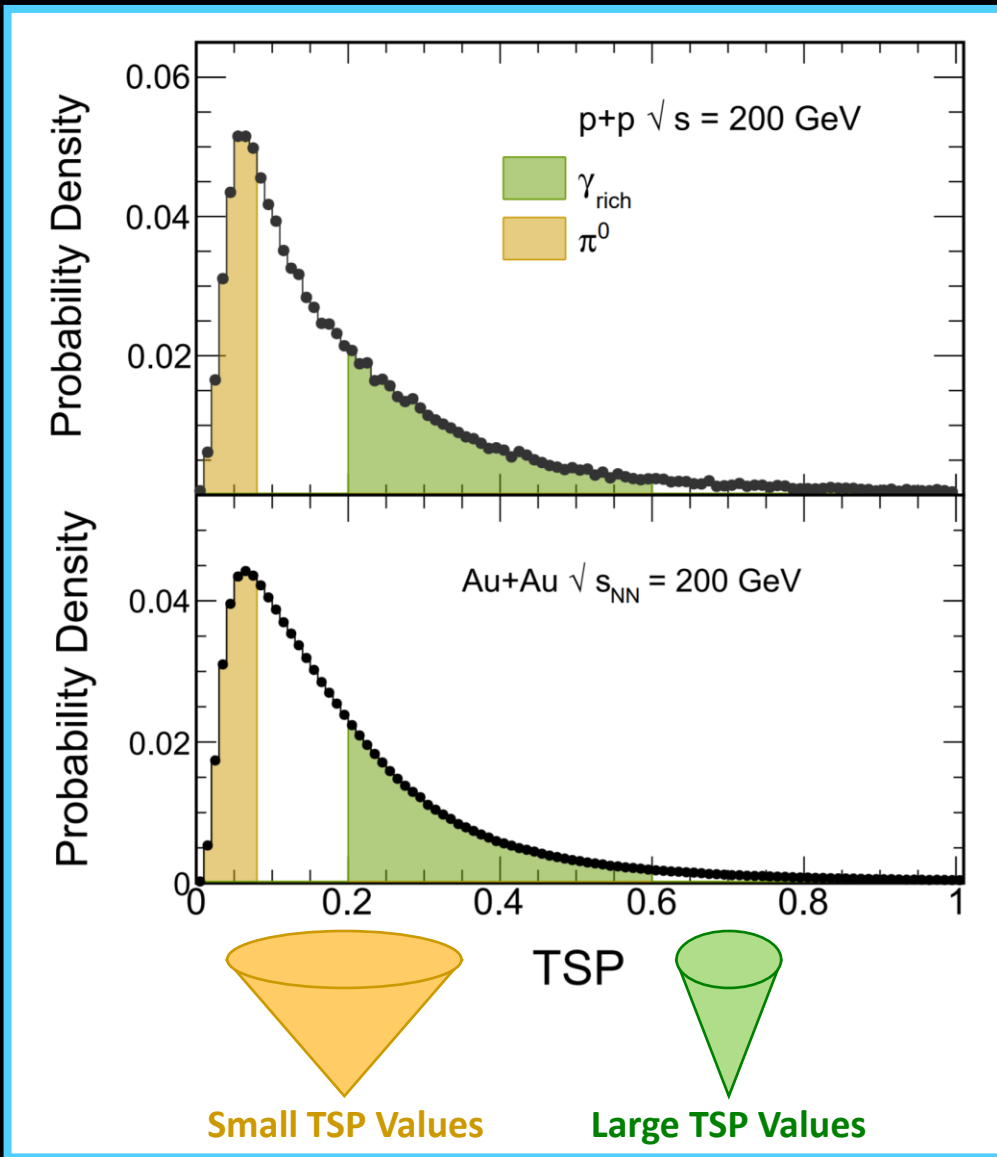
- Jets coincident with direct photons (γ_{dir}) are valuable probe to study in-medium modification (**jet quenching**)

$$\therefore E_T^{\gamma_{\text{dir}}} \approx E_T^{\text{parton}}(t_0)$$

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



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



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

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

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

- ☞ E_{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:

- 95% pure sample of π^0
- Sample with an enhanced fraction of γ_{dir} (γ_{rich})

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

- ☞ γ_{rich} background levels (B)

- 33% ~ 16% (**Au+Au**)
- 57% ~ 47% (**p+p**)

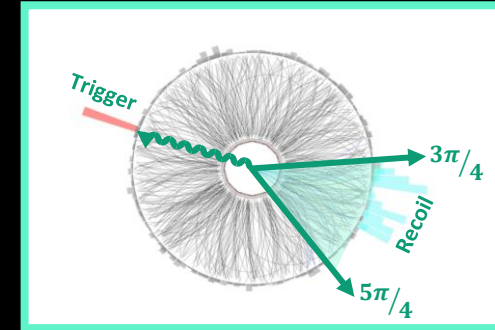
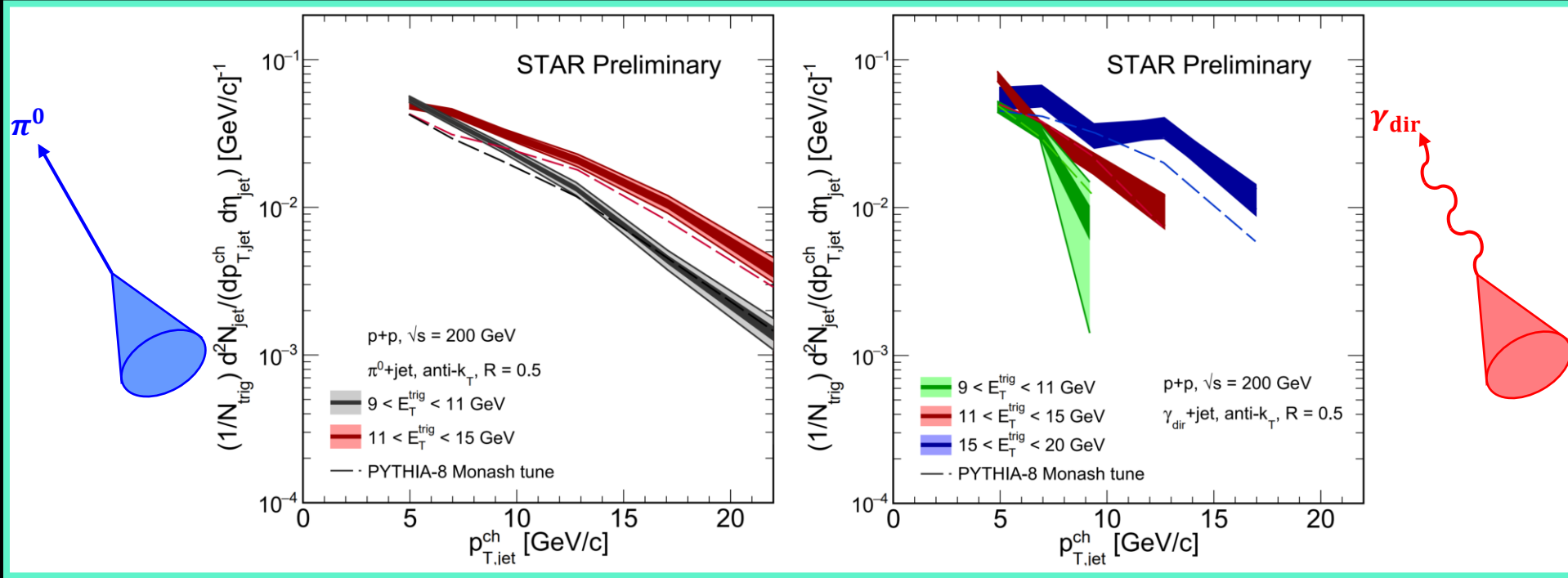
- Decay background in γ_{rich} removed via statistical subtraction

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

- ☞ Y_{pp}^* : semi-inclusive yield for a trigger



Corrected recoil jet distributions



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

- Recoil jets reconstructed by clustering TPC tracks
 - Clustered using anti- k_T algorithm with $R = 0.2, 0.5$ (shown)
- Negligible effect of UE in $p+p$
 - ∴ No ME subtraction applied
- $p_{T,jet}^{ch}$ smearing and shifting corrected in 2 steps
 - 1) Event-wise adjustment:

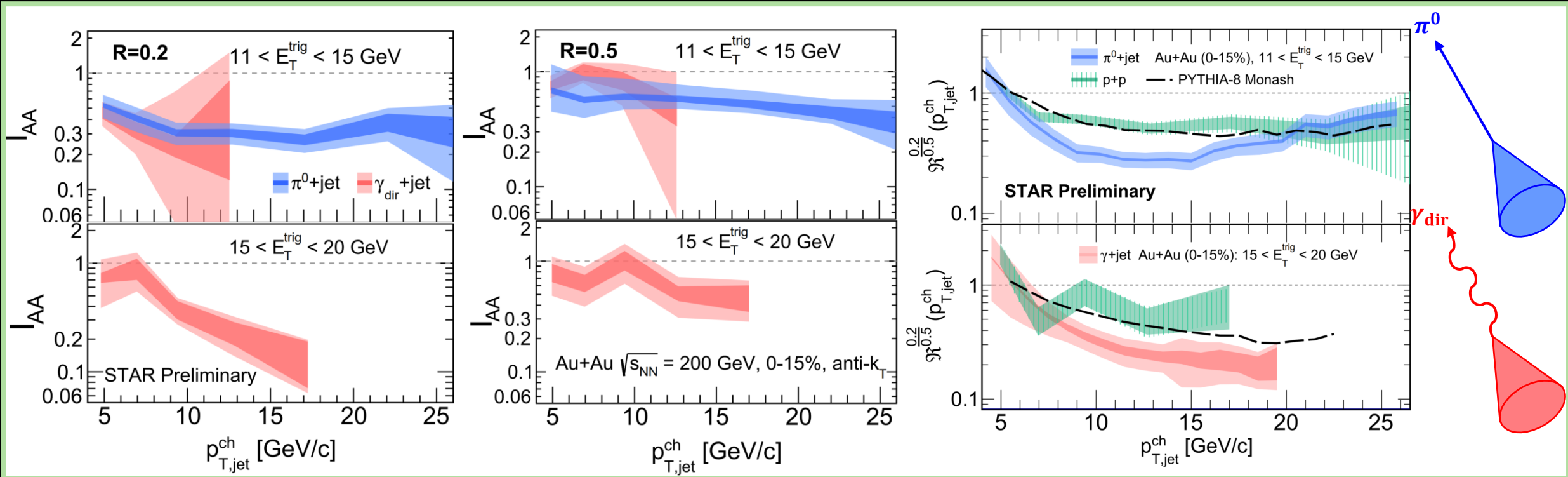
$$p_{T,jet}^{reco,ch} = p_{T,jet}^{raw,ch} - \rho \cdot A_{jet}$$
 - 2) Residual fluctuations corrected with regularized unfolding
 - › STAR, PRC **96**, 024905 (2017)



Impact of $p+p$ data

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

$$\mathfrak{R}^{0.2/0.5} \equiv Y_{0.2}/Y_{0.5}$$



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

- $\mathfrak{R}^{0.2/0.5} < 1$ in $p+p$ due to vacuum parton shower
– PYTHIA-8 agrees with $p+p$ data
- $\mathfrak{R}^{0.2/0.5}$ 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 $\mathfrak{N}^{0.2/0.5}$ demonstrate intra-jet broadening

Next Steps:

- Very sensitive measurement!** Will utilize higher statistics datasets (Runs 23 – 25)
- Extension of π^0/γ_{dir} +jet spectrum analysis to **full jets** (tracks + calorimeter)

