Measurement of double differential groomed jet observables in p+p collisions at STAR

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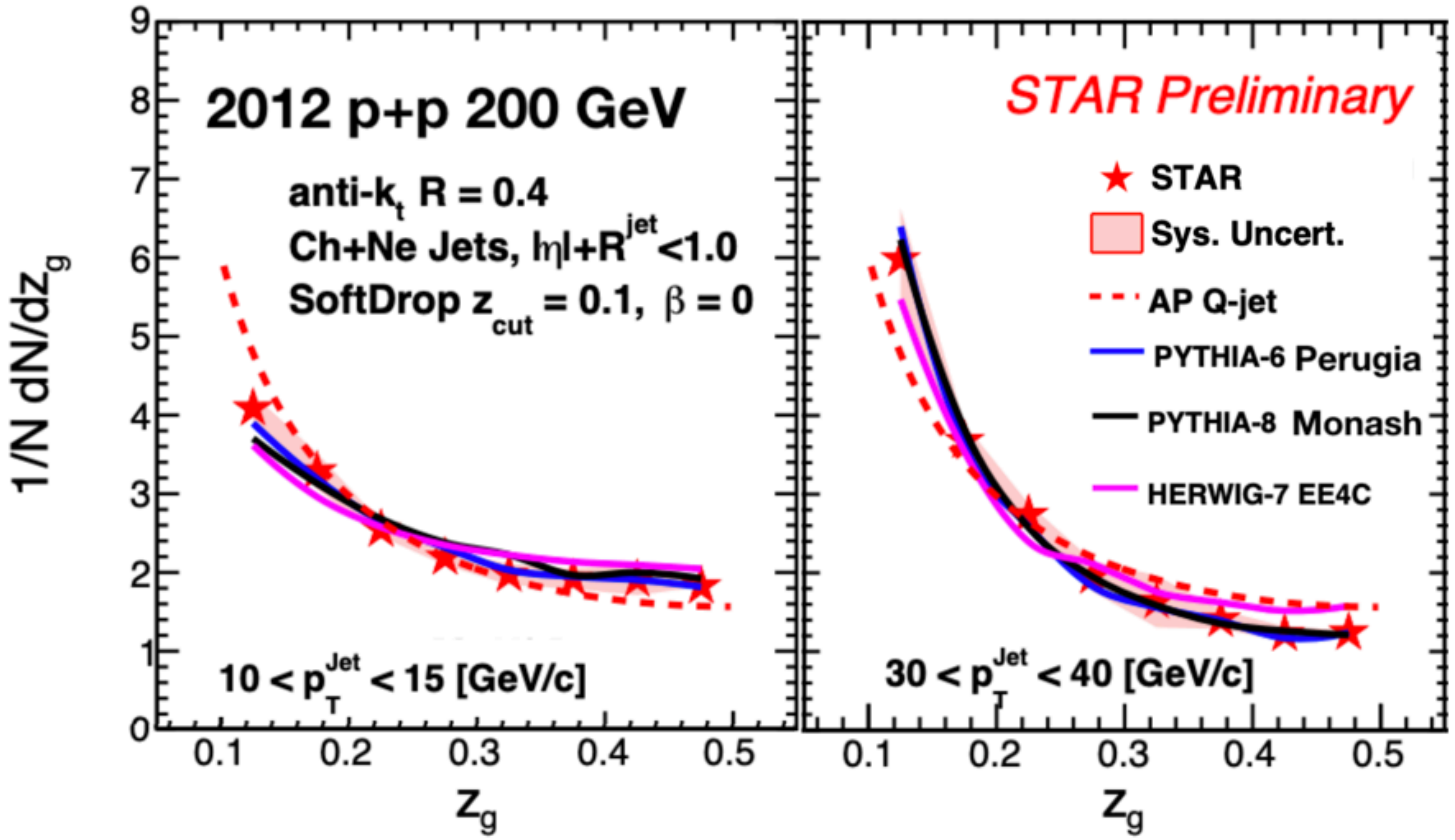
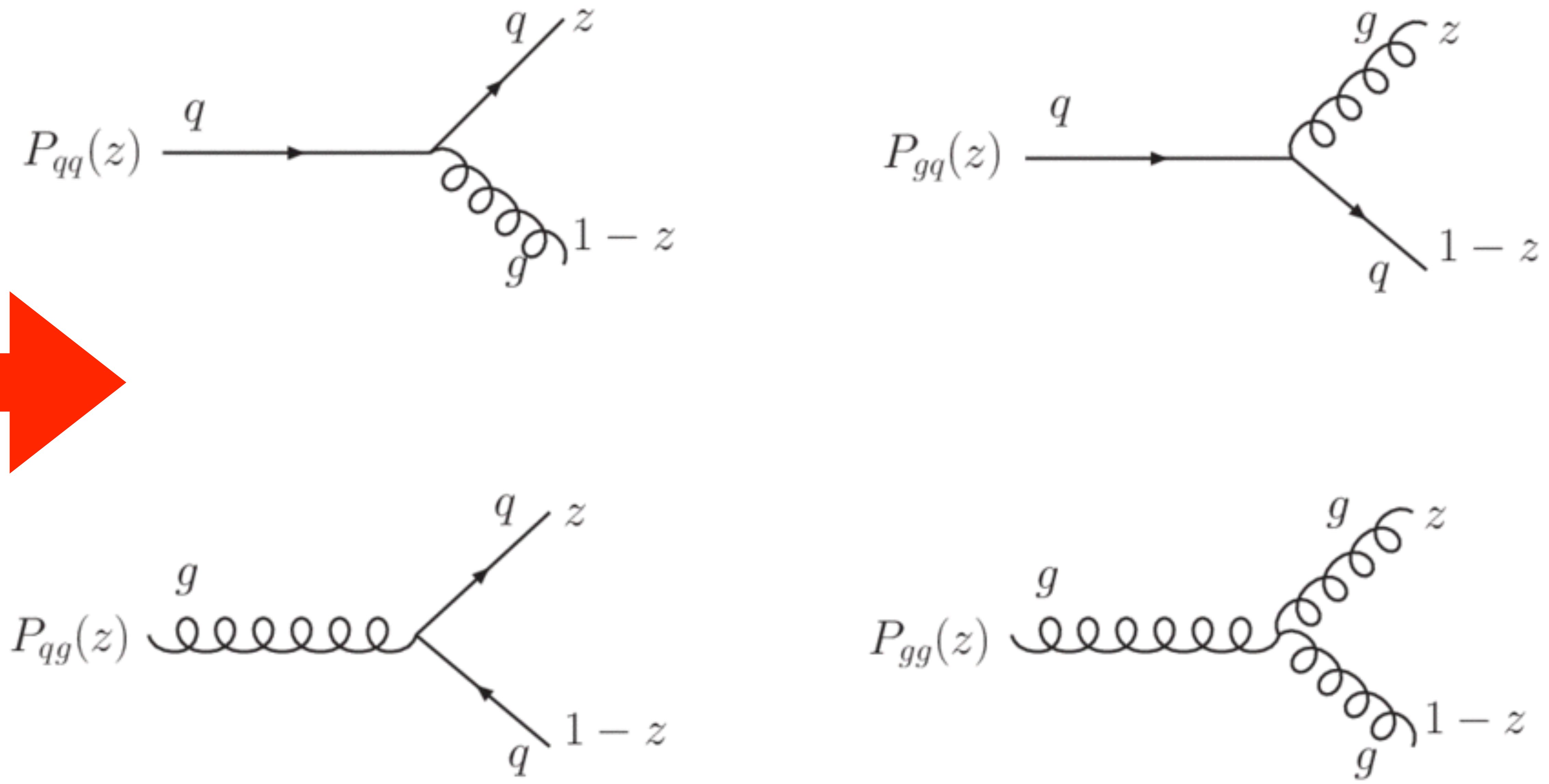
Motivation for measuring $\log(k_T)$, $p_{T,b}$ and z_g

z_g distribution converges towards vacuum AP splitting function for $z > z_{cut}$





Measuring that will allow us to fully quantify parton shower evolution

In each split we define $p_{T.a}$ **and** $p_{T,b}$, $p_{T,a} > p_{T,b}$, $k_T = p_{T,b}\Delta R_{ab}$ **and** $z = \dfrac{p_{T,b}}{p_{T,a} + p_{T,b}}$

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Motivation for measuring $\log(k_T)$, $p_{T,b}$ and z_g

Jet substructure measurements are important for both p+p and A+A collisions

- Precise measurement of jet substructure allows us to constrain theory models
- A lot of jet substructure observables are calculable within pQCD
- In heavy-ion regime we expect modifications of substructure due to the medium
  - Certain observables are expected to be more sensitive to jet quenching that "plain" jet spectra measurements

Measuring $\log(k_T)$ allows us to map parton shower dynamics more precisely

- M_j, z_g and R_g analyses are in progress at STAR
- This measurement will allow us to map splitting scale in k_T and ΔR simultaneously

Double differential $p_{T,b}$ and z_g measurement on the other hand might serve as a probe of medium induced modification on jet emissions

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Dataset

Run 12 p+p @ 200 GeV dataset is used for current analysis

- Bad runs and bad towers are rejected
- Tracks requirements: $|\eta| < 1$, $p_T \in [0.2, 30]$ GeV/c, $N_{hits} > 20$, $|\text{DCA}| < 1.0$ cm
- Tower requirements: $E_T \in [0.2, 30]$ GeV/c
- Jets are fist clustered with anti-k_t and then reclustered with C/A algorithm
- Jet requirements: $20 < p_T^{jet} < 40$ GeV/c and $|\eta^{jet}| + R < 1$
- All jets are required to pass Soft-Drop condition, i.e. there exists a split for which:

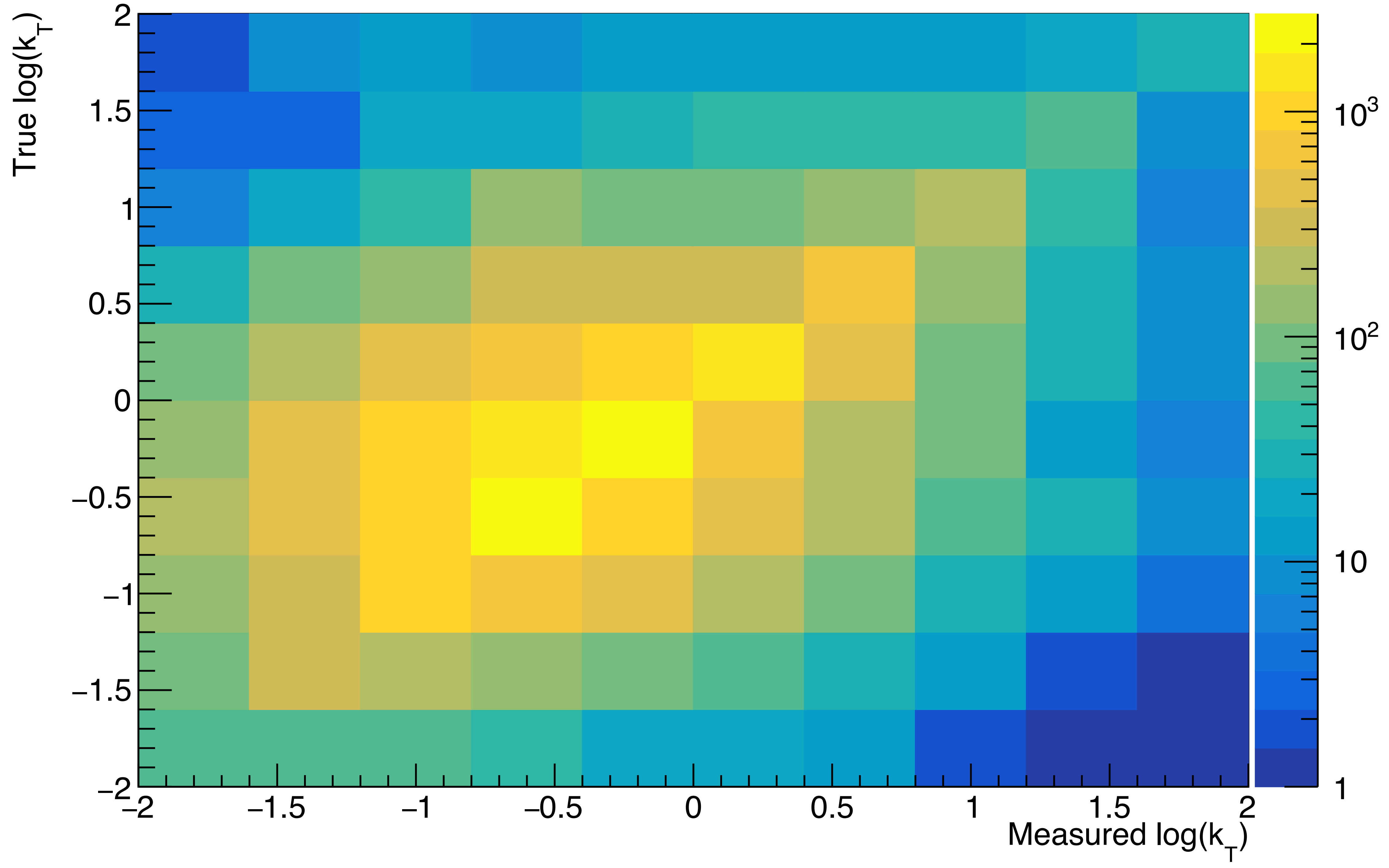
$$z_g = \frac{\min\{p_{T,1}, p_{T,2}\}}{p_{T,1} + p_{T,2}} > 0.1$$

- Soft-Drop is shown to suppress soft radiation as well as hadronization effects in jets

Unfolding

Measured distributions are so-called "detector-level" (using p_T as an example)

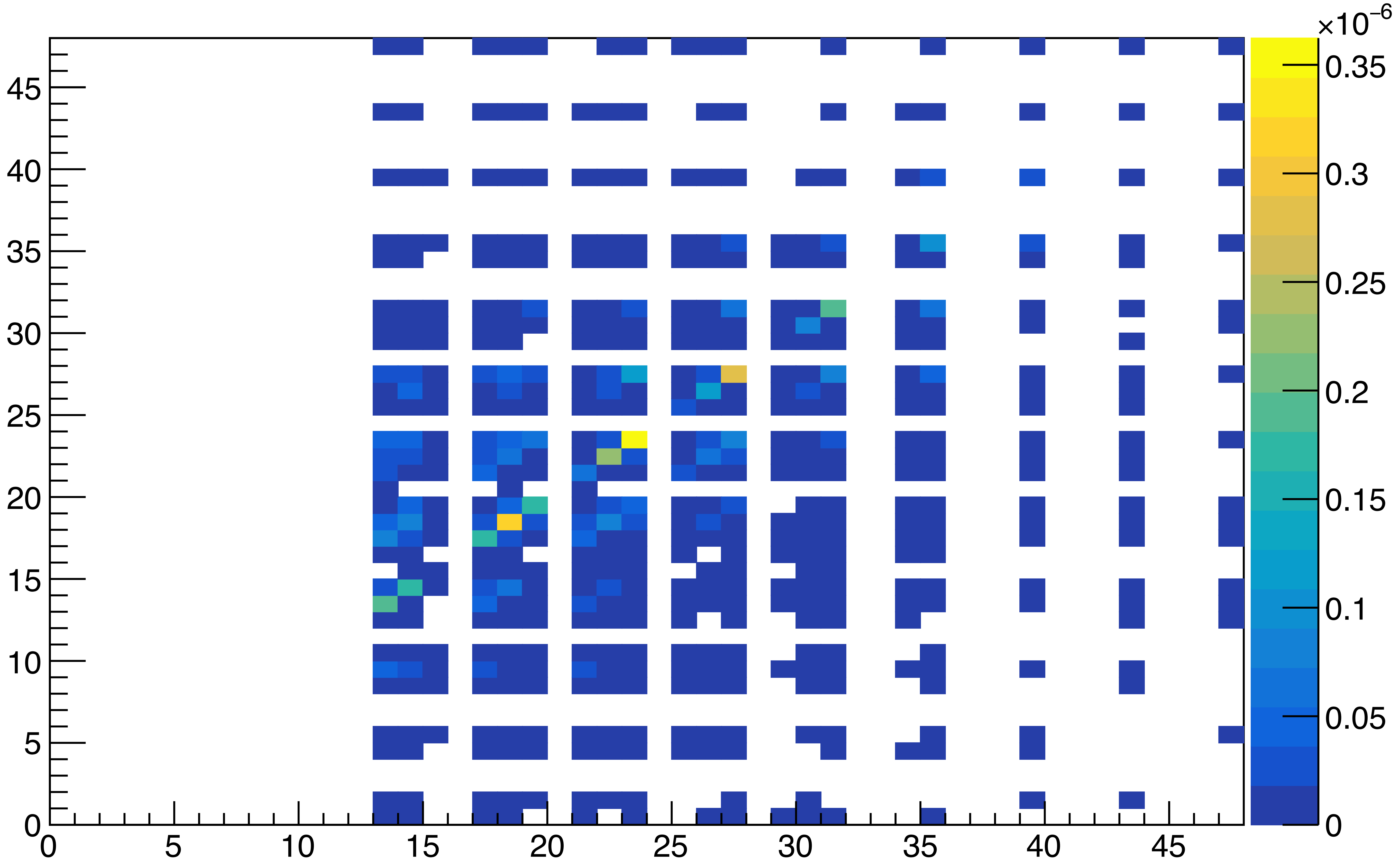
- They are convolved with detector resolution, noise, e.t.c.
- Mathematically this can be described as $p_T^{meas} = D \star p_T^{true} + \varepsilon$
- Our goal is to deconvolve this noise and get **true-level** distribution
- For this we need to estimate response matrix $\mathbf{R}[p_T^{true} \rightarrow p_T^{meas}]$
- Our goal is then to solve for true distribution $\mathbf{p}_T^{meas} = \mathbf{R}[p_T^{true} \rightarrow p_T^{meas}]\mathbf{p}_T^{truth}$

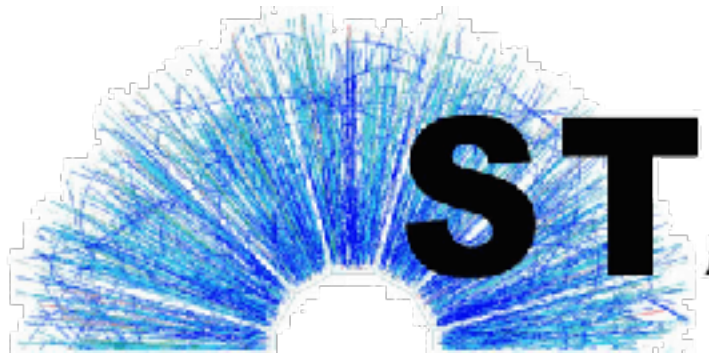


Unfolding

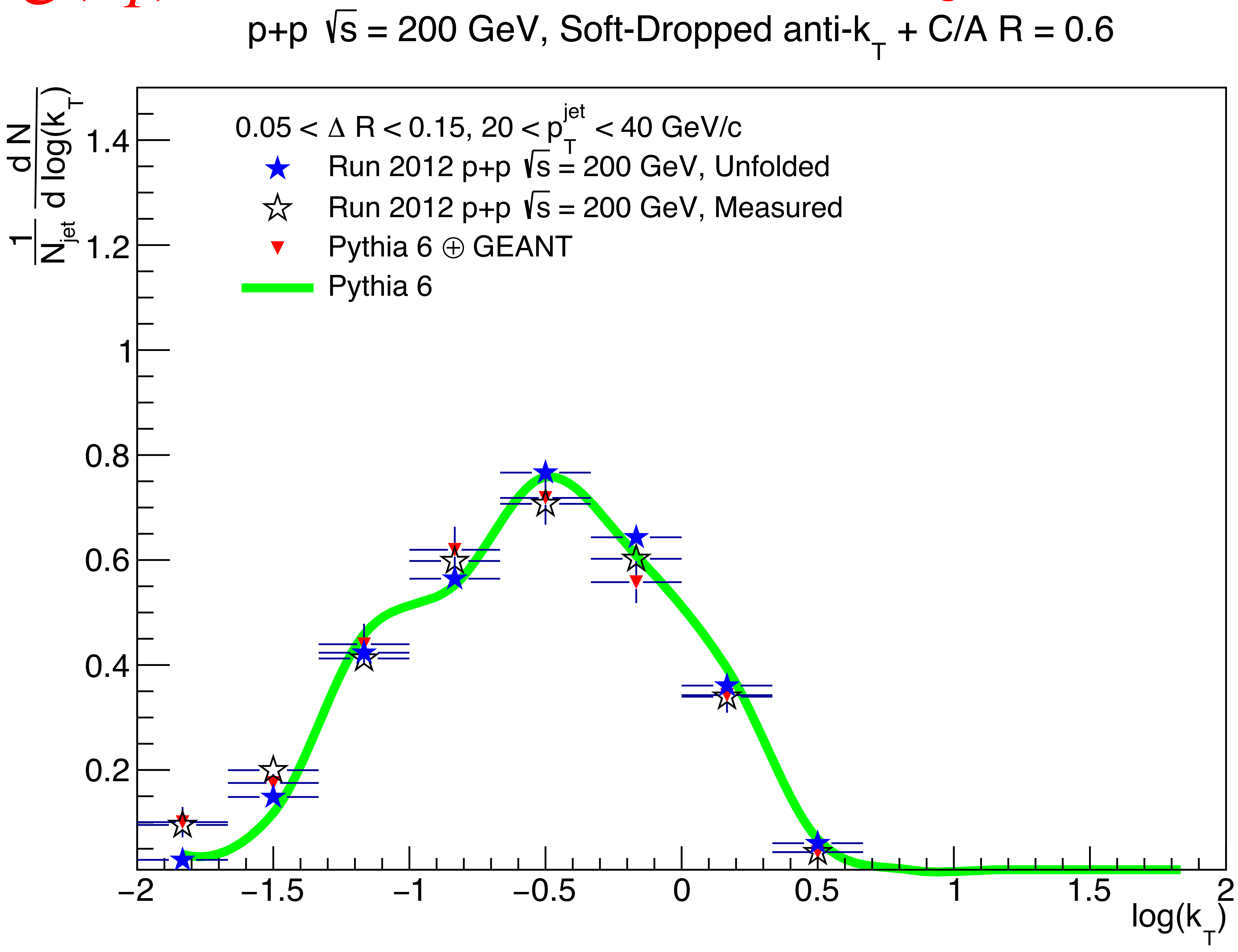
To unfold measured distribution we use Bayesian unfolding

- We fix jet p_T to lie in $20 < p_T^{jet} < 40$ GeV/c bin





Unfolded $\log(k_T)$ distributions for R = 0.6 jets at $\Delta R \in [0.05, 0.15]$



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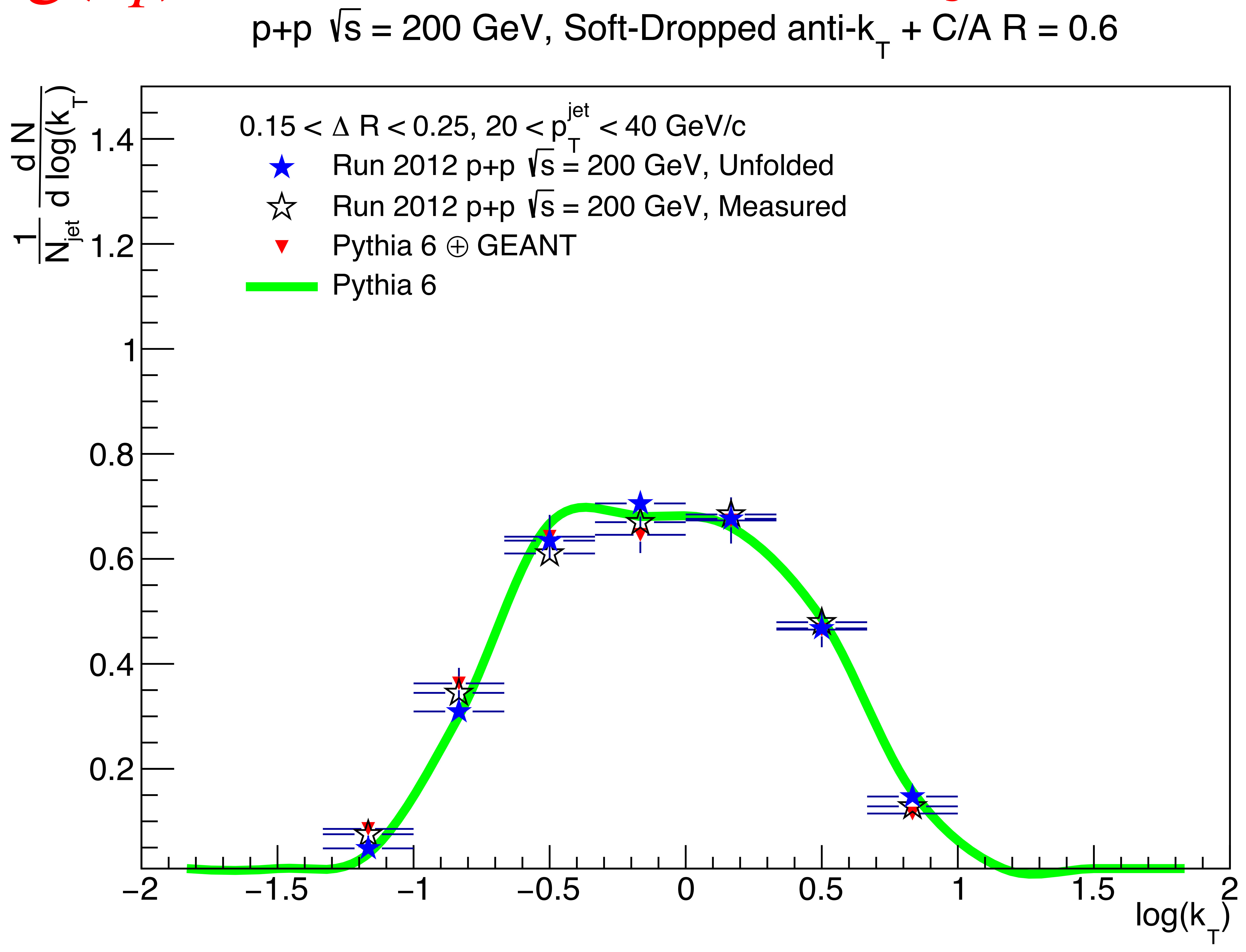

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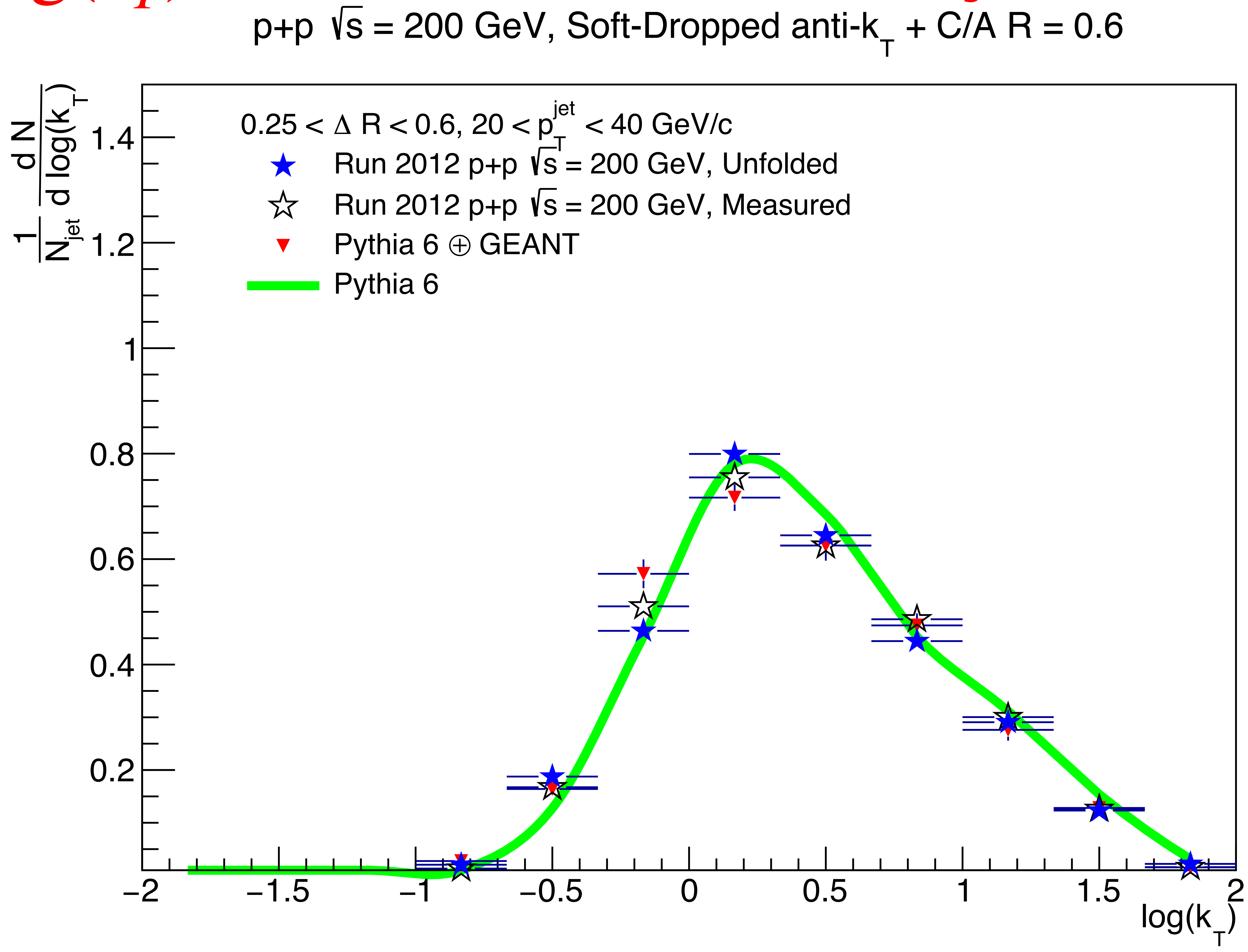

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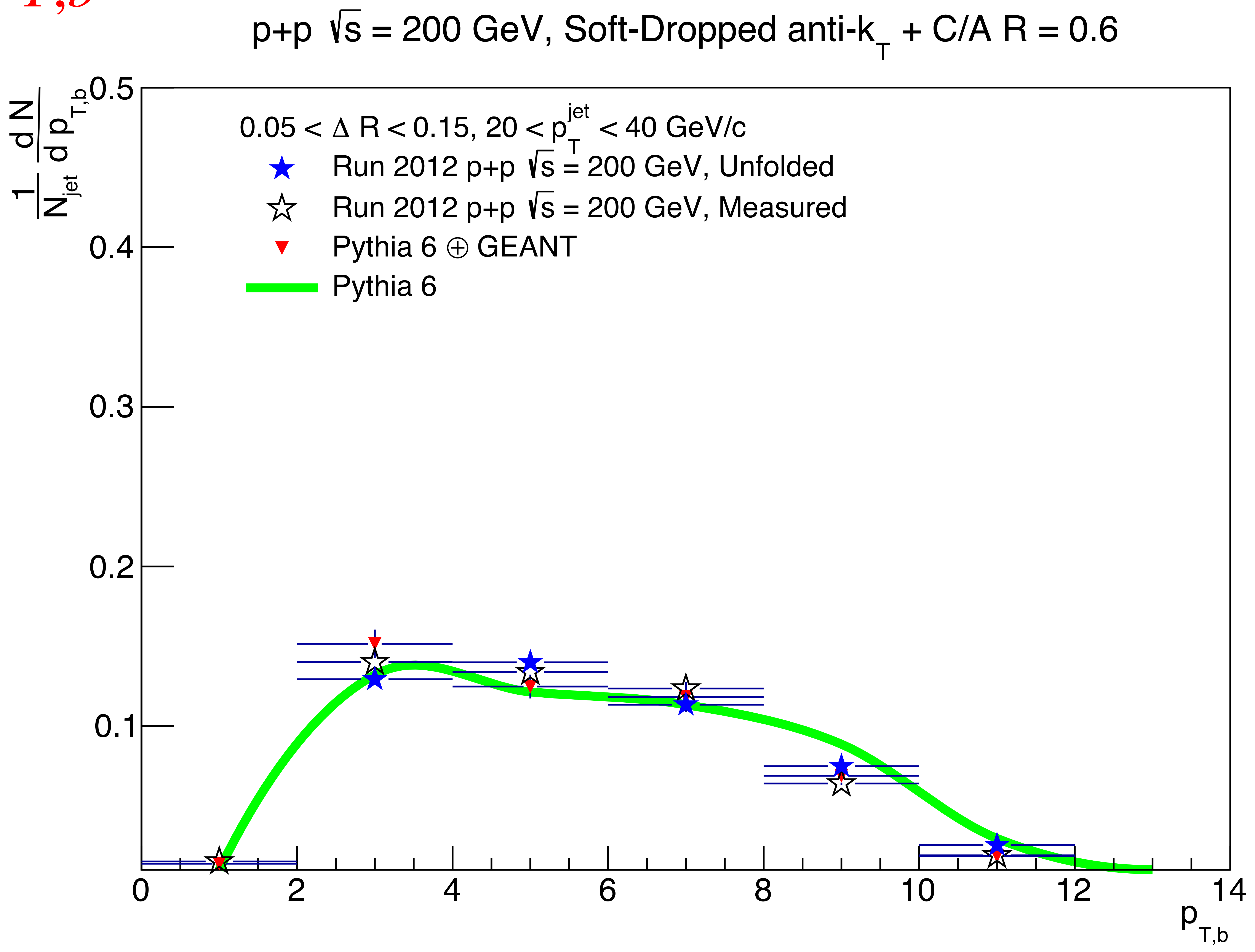
Unfolded $p_{T,b}$ distributions for R = 0.6 jets at $\Delta R \in [0.05,0.15]$



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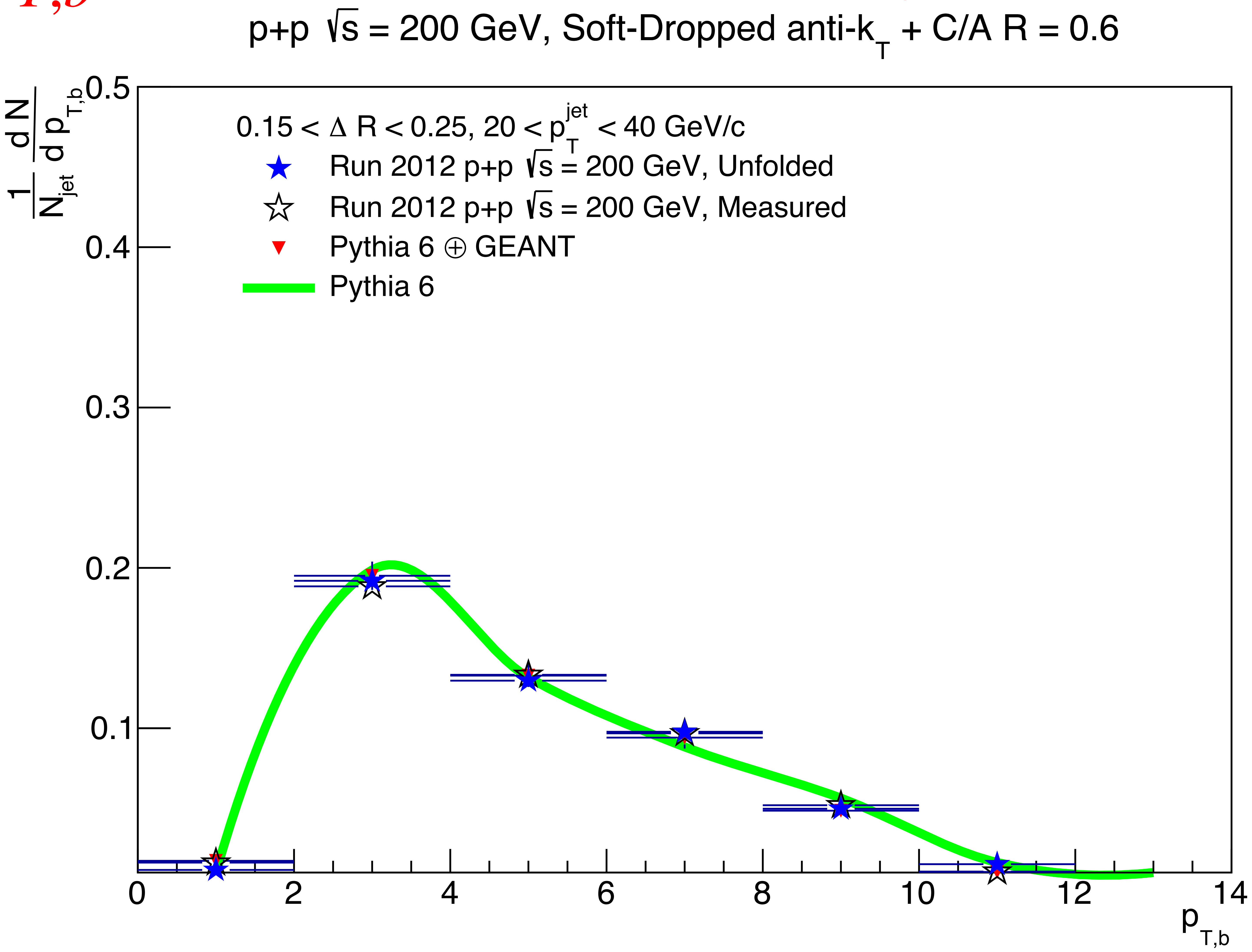

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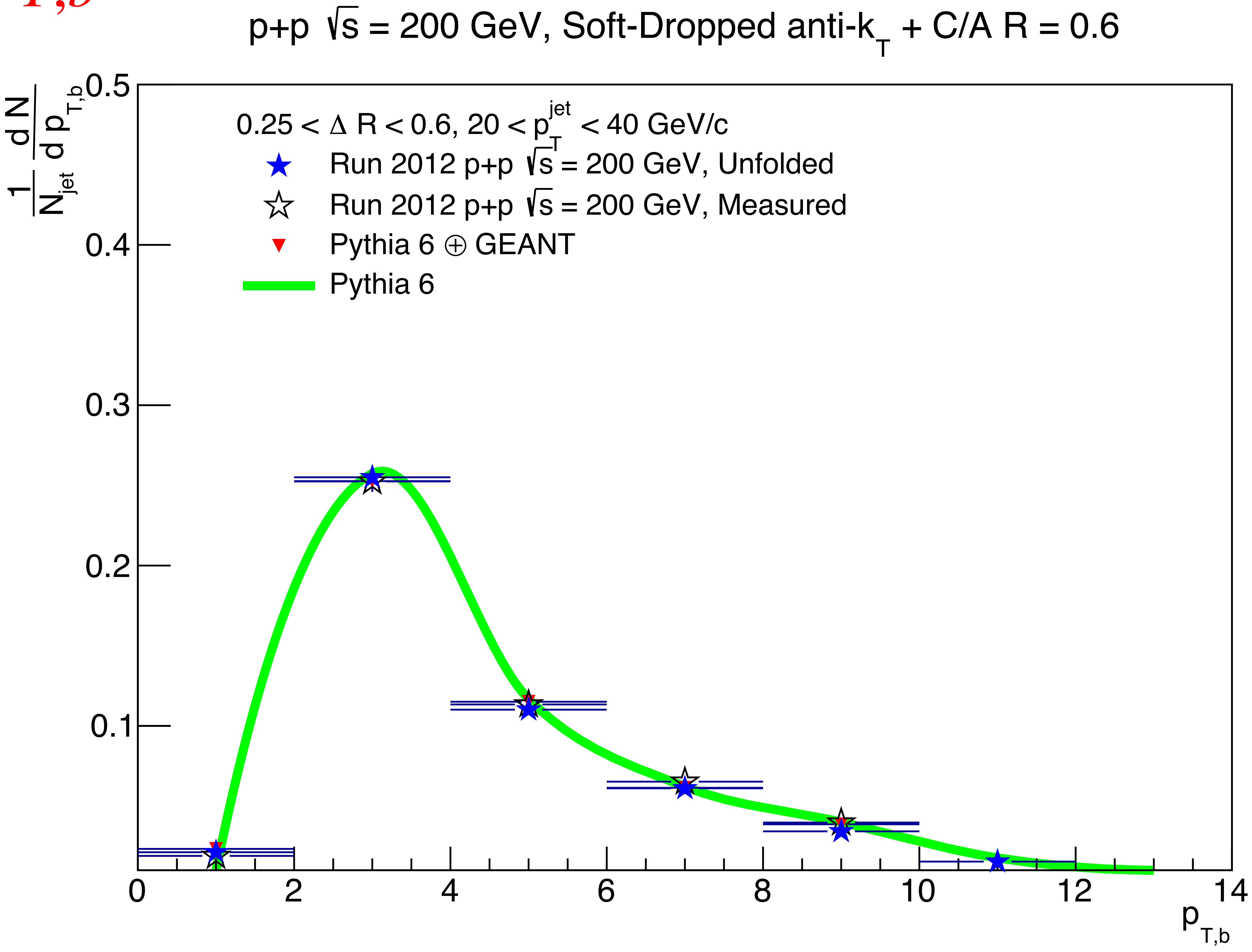

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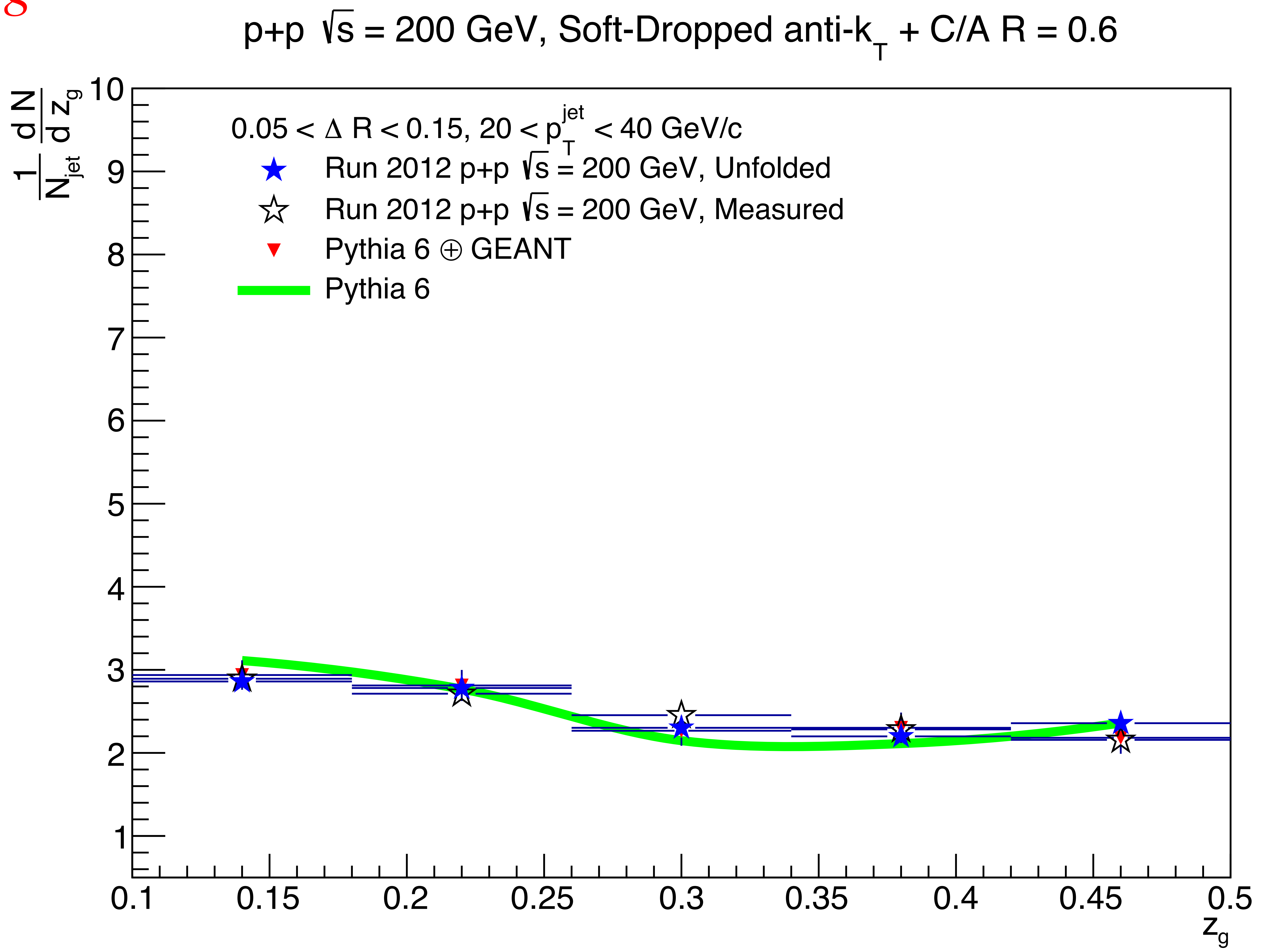
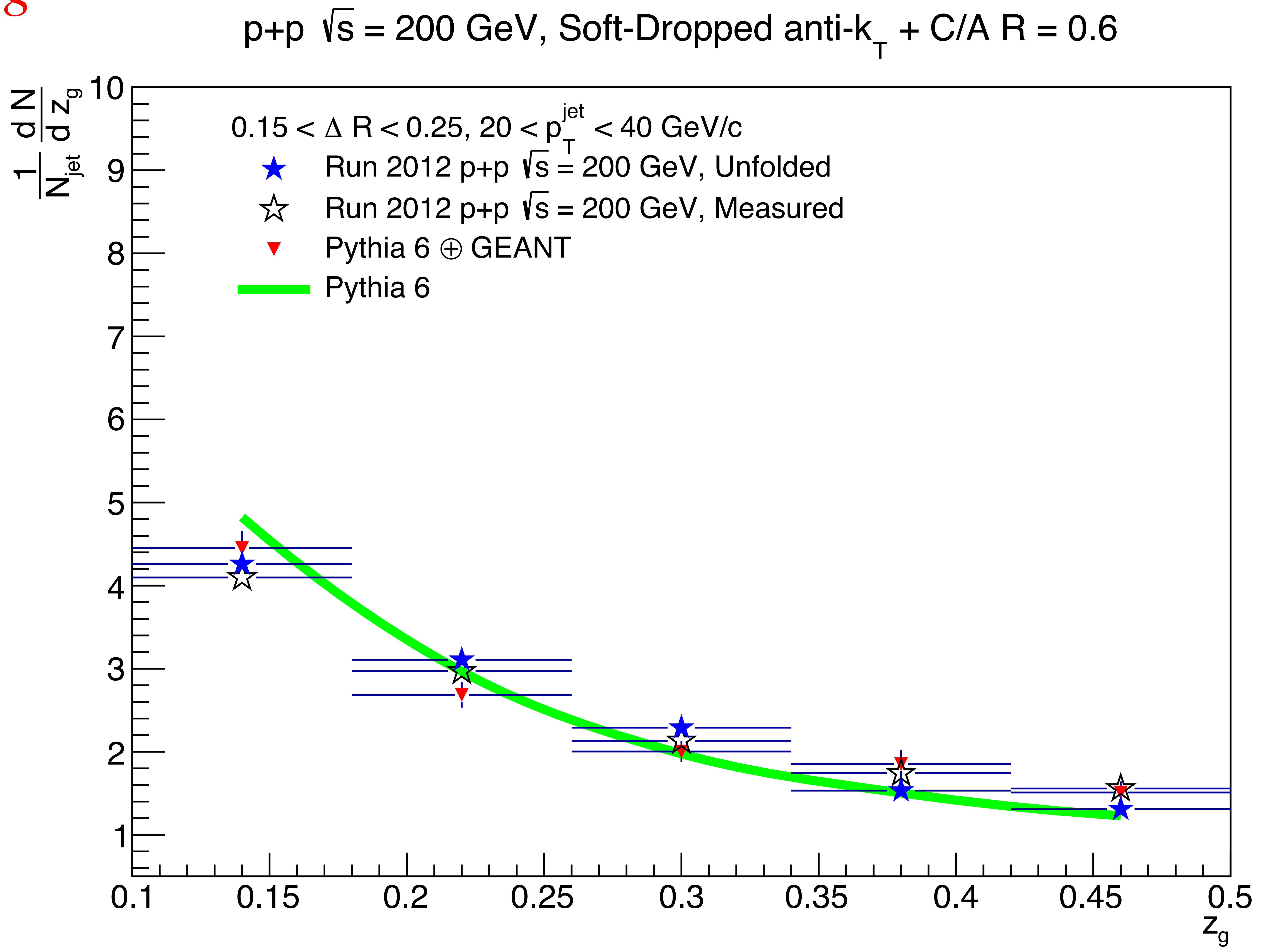
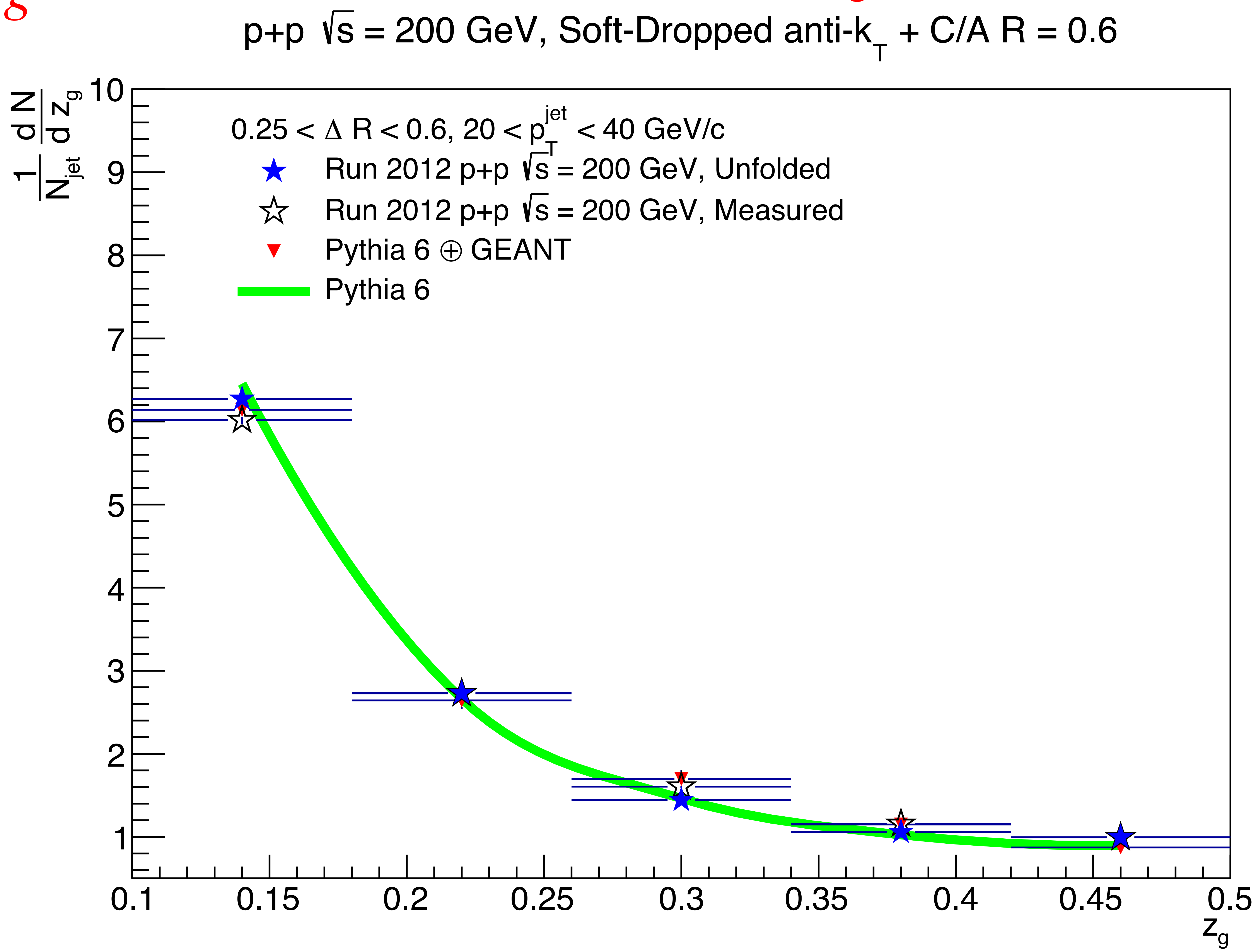
Unfolded z_g distributions for R = 0.6 jets at $\Delta R \in [0.05, 0.15]$



Unfolded z_g distributions for R = 0.6 jets at $\Delta R \in [0.15, 0.25]$



Unfolded z_g distributions for R = 0.6 jets at $\Delta R \in [0.25,0.6]$



Unfolded $\log(k_T)$ distributions comparison wrt ΔR

We observe increase in $\log(k_T)$ with increasing ΔR

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Unfolded $p_{T,b}$ distributions comparison wrt ΔR

We observe increase in flatness with decreasing ΔR

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Unfolded z_g distributions comparison wrt ΔR

We observe increase in flatness with decreasing ΔR

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Conclusion

Analysis of double differential jet substructure at STAR is in progress

- We need to finish correction on jet population due to the detector p_T smearing
  - Currently 3D unfolding of $\log(k_T)/p_{T,b}/z_g$ vs ΔR and p_T is explored
  - Another idea is to use jet energy scale (JES) to correct jet population

Future steps

- Once unfolding is finished we can immediately evaluate systematic errors
- We expect preliminary results by May 2020 and paper proposal by December 2020
- Targets for talks/posters are **BOOST 2020 @ Hamburg** and ICHEP 2020 @ Prague

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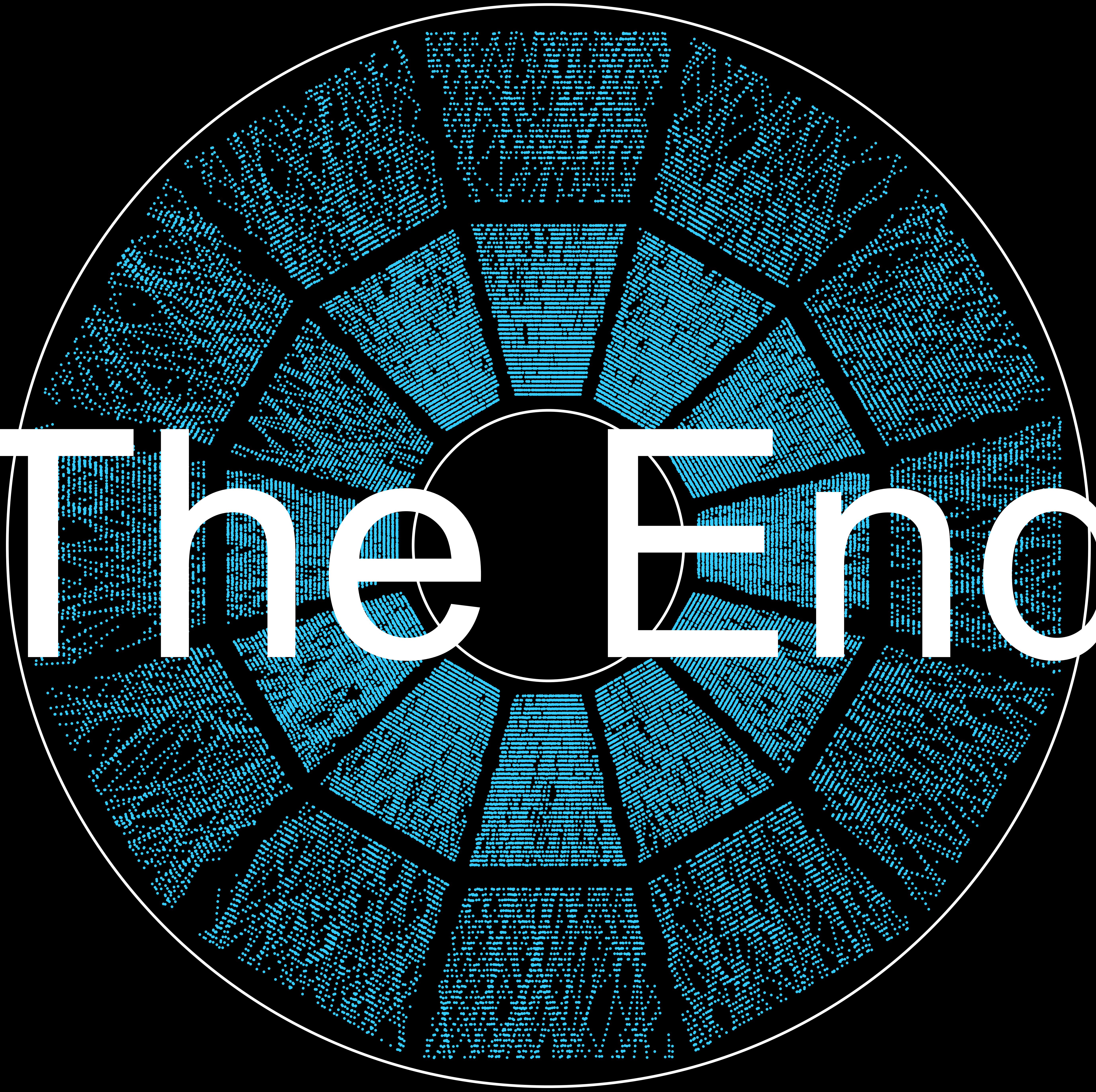
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