PoWHEG + Pythia matching

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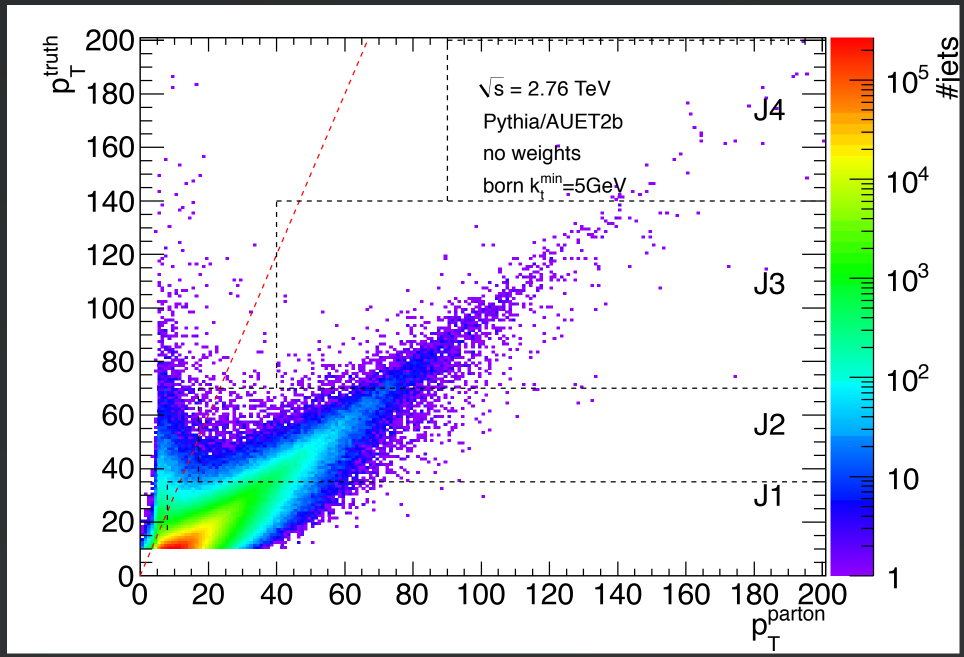
Introduction

- PoWHEG provides a scale (SCALUP) that is an *indication* of where the shower should take over from the perturbative calculation.
- There may be some mis-matching between Pwg and Pythia about what is considered the scale of an emission. e.g. pT isn't very indicative of the hardness of a very forward emission.
- In extreme cases, the shower may be allowed to run wild, e.g. this old version of PoWHEG that has since been patched



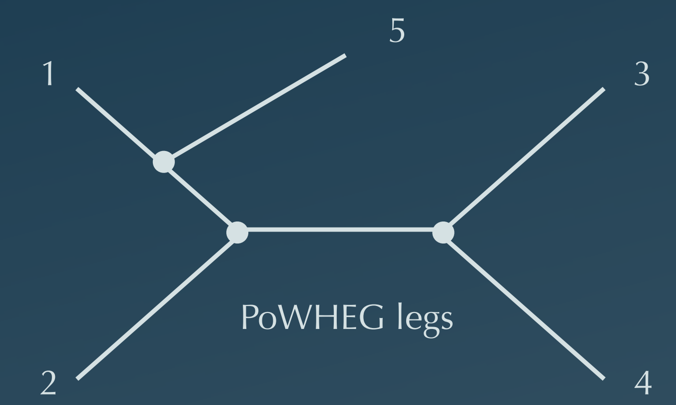
Alternative matching schemes

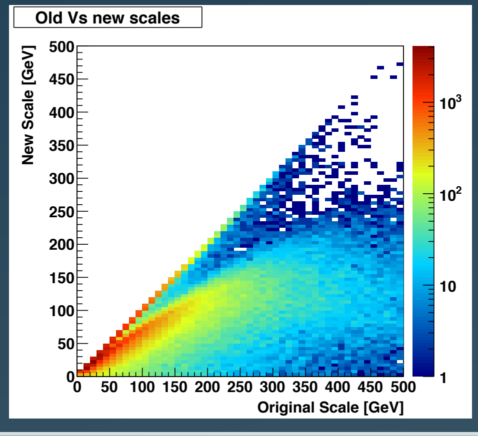
Suggested by PoWHEG authors as a way to explore systematics of (reducing) scale choice

PoWHEG Scale Recalculation Scheme

Recalculate the veto scale, μ, based on the configuration of the PoWHEG legs

$$\mu = \min_{i,j} \frac{|p_i \times p_j|}{|p_j|}$$



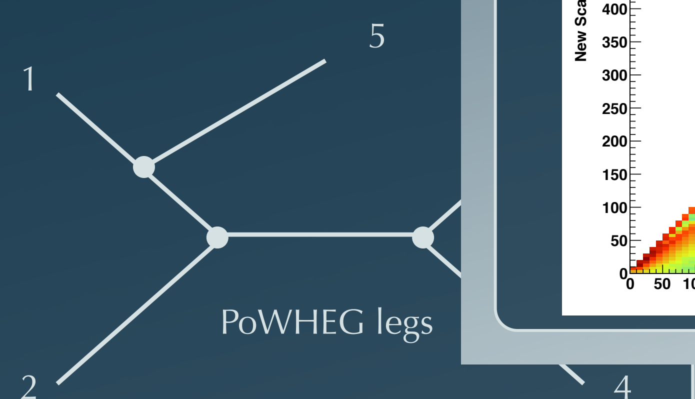


Start the shower at the kinematic limit (“power shower”), but veto any emission above this calculated μ

Leg-emission veto

For each proposed shower emission, p_s, calculate a scale μ_s

$$\mu_s = \max_i \frac{|p_s \times p_j|}{|p_j|}$$



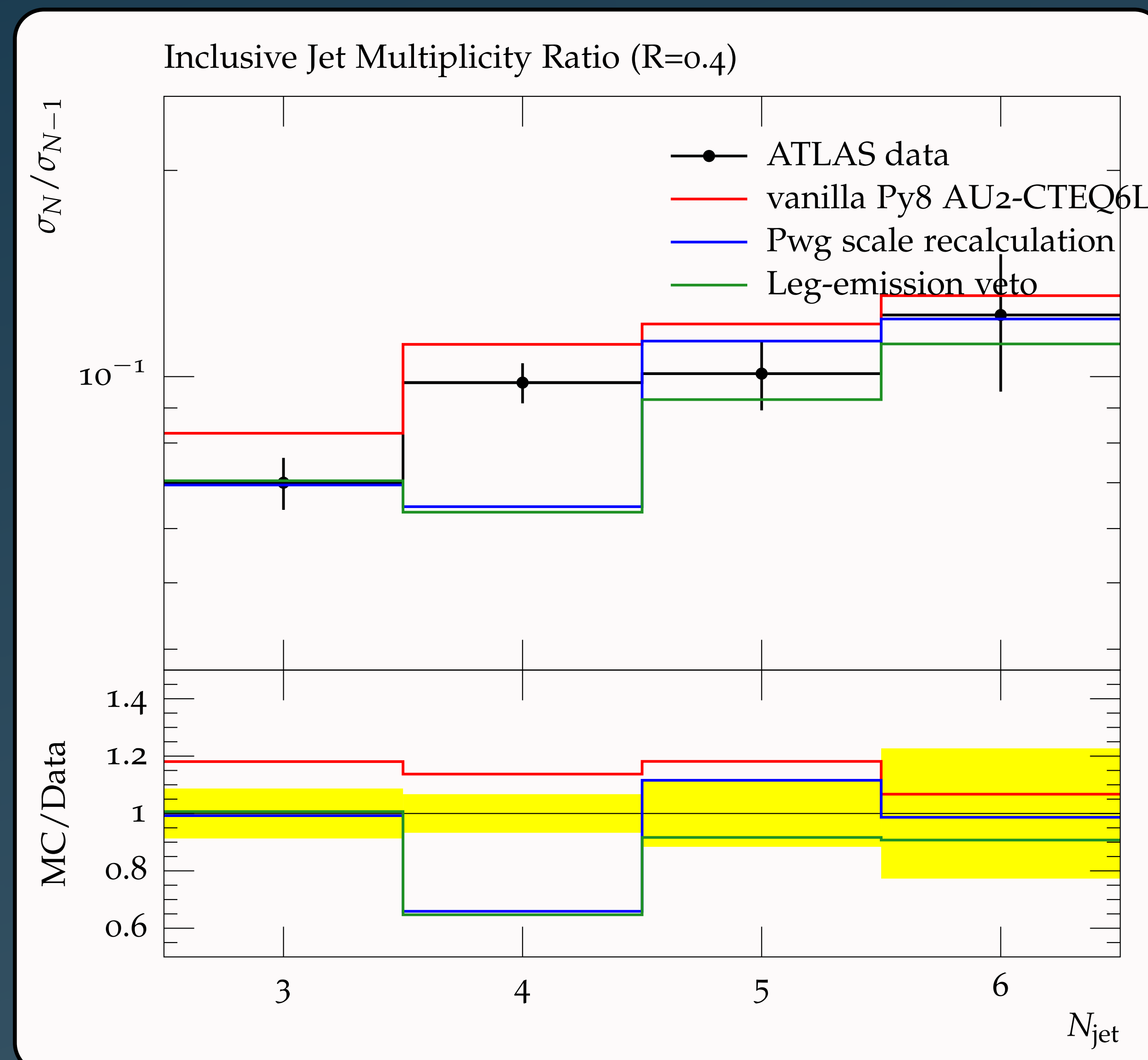
Start the shower at the kinematic limit (“power shower”), but veto any emission for which μ_s is above the (unchanged) PoWHEG veto scale

Suggested by Pythia authors as a way to better measure how hard an emission is

Multi-jets

Note in particular the 3:2 ratio, which you'd hope to get right with the PoWHEG emission

(something odd in the 4:3 ratio though)



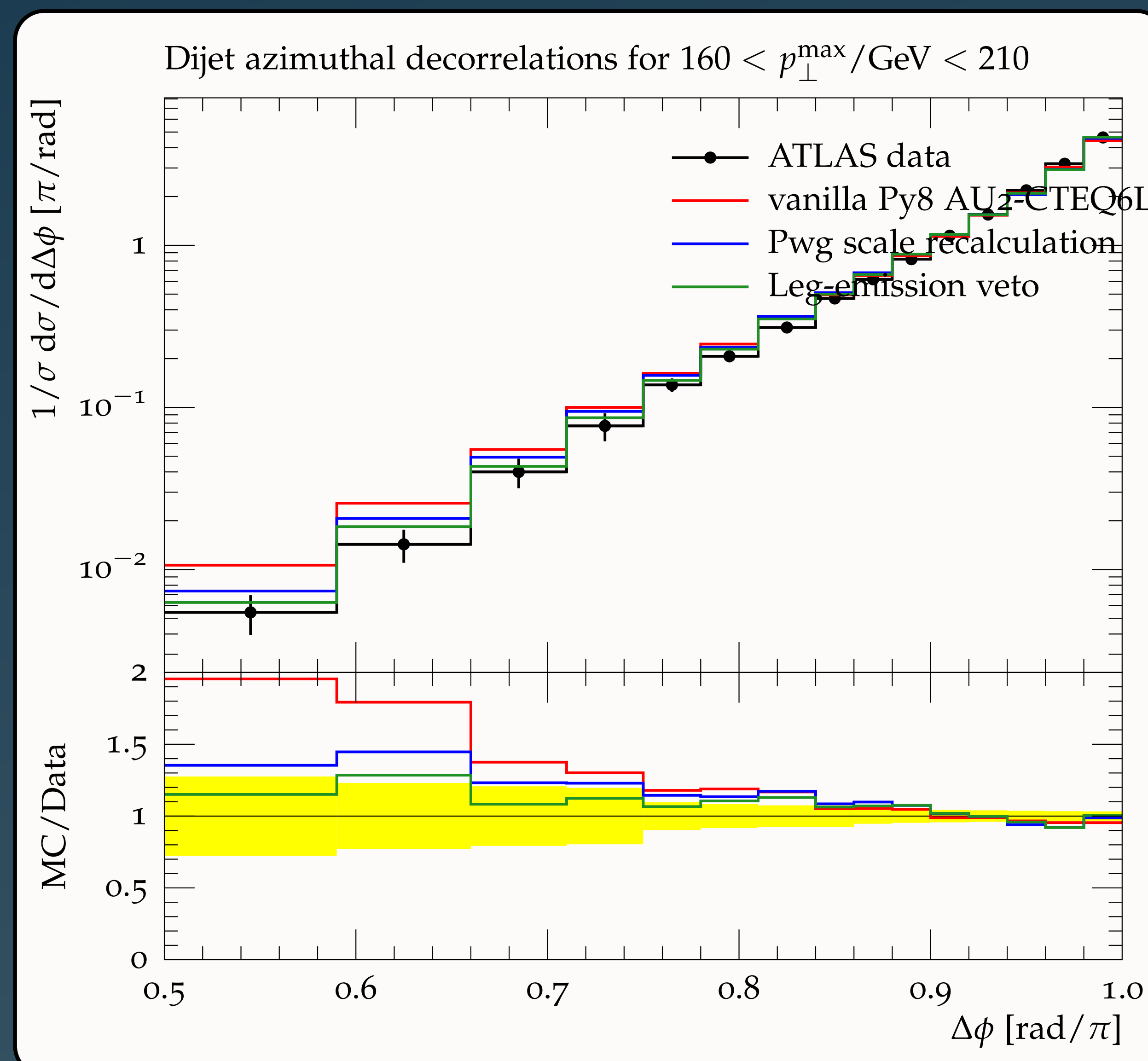
Improved ISR description!..

Azimuthal decorrelations

A clear win for the new matchings over the vanilla!

leg-emission matching may be slightly better, but scale reduction is close

All distributions show similar



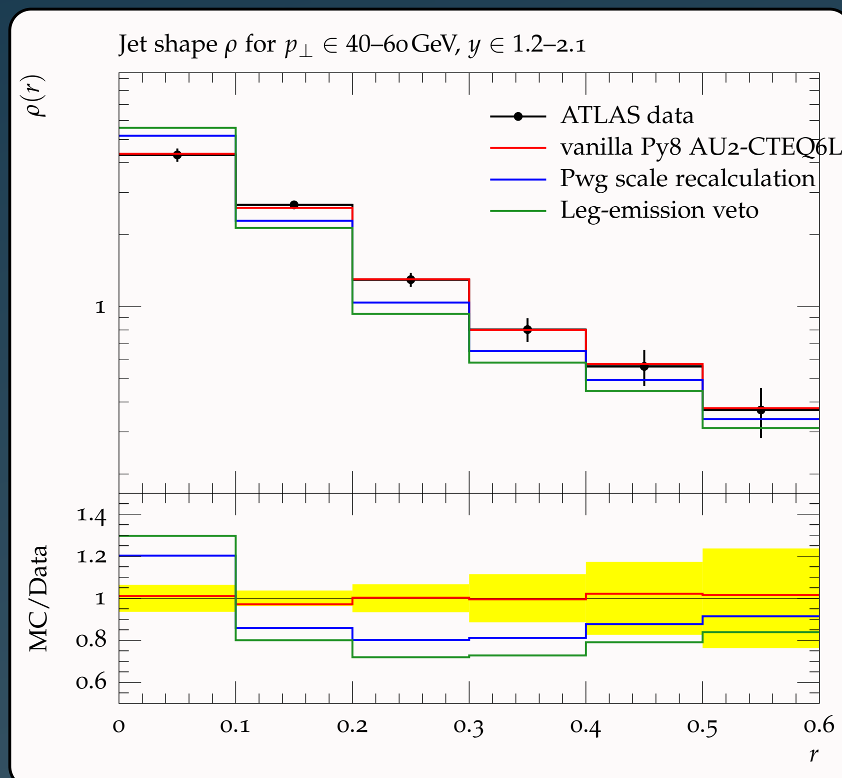
…but (fatally) worsened FSR description

Jet shapes

The new matchings have broken the jet shapes though!

The fact that the jet shapes is so good in the vanilla is a bit surprising - not a combined PoWHEG + Pythia tune

New matching gives too much of a hard core to the jet

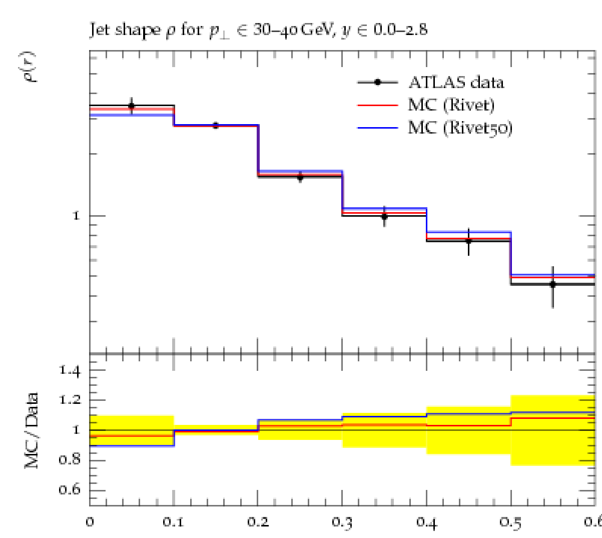


Varying e.g. alpha_s in shower suggested it would not be possible to re-obtain the good jet shape behaviour

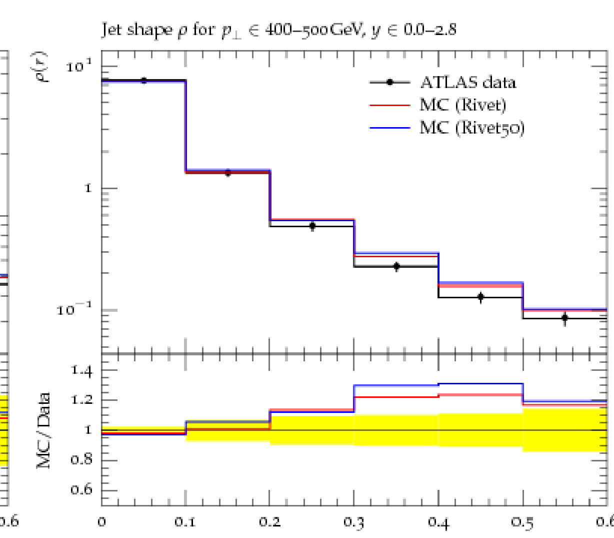
Bolder variation

Turn renormMultFac down to 0.5:

Low pT:

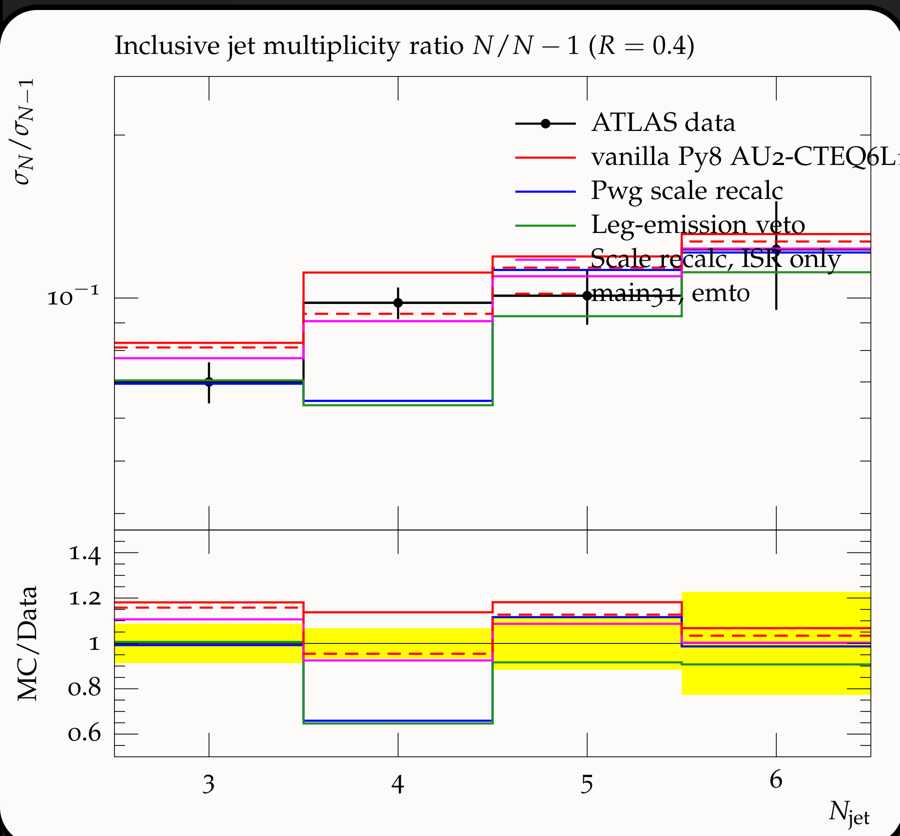


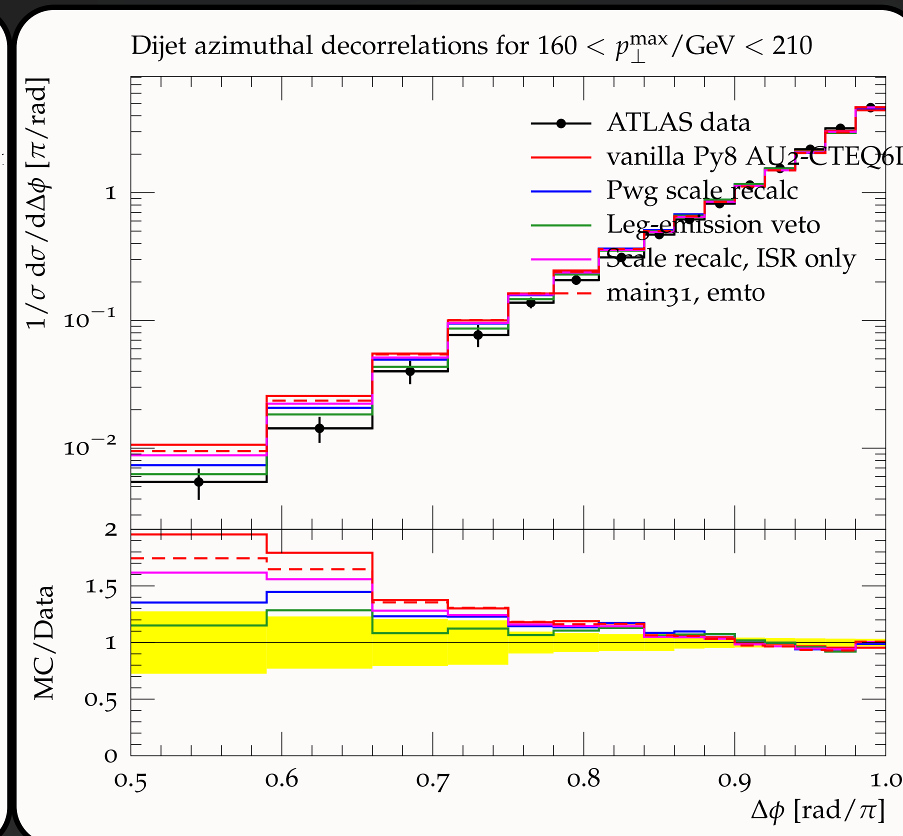
High pT:

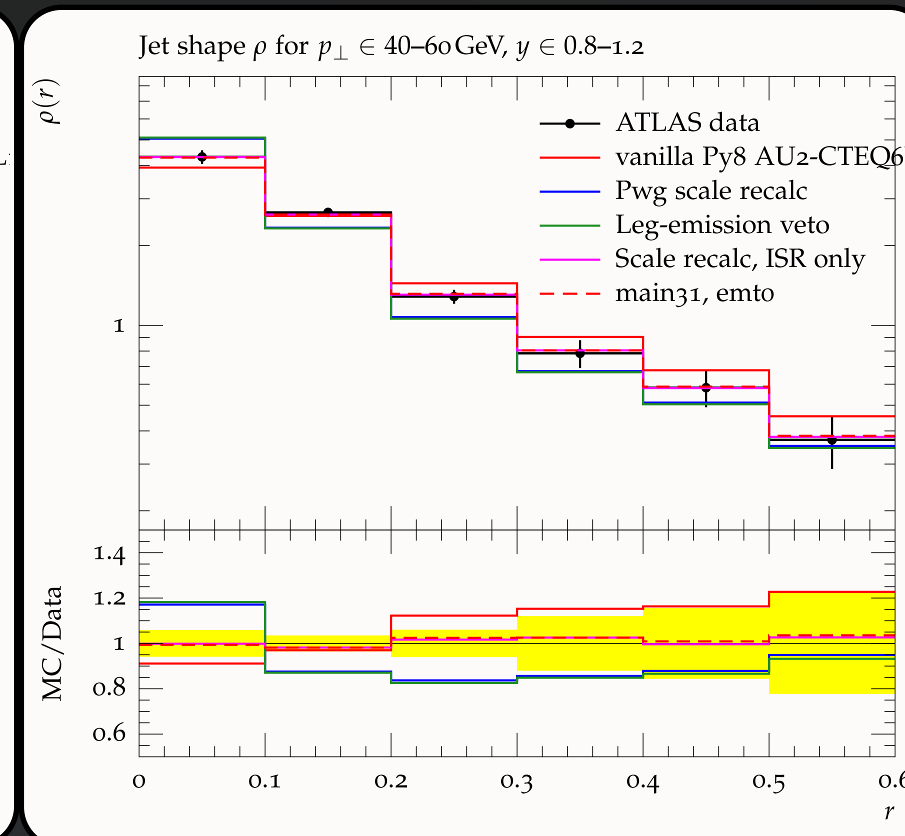


$\rightarrow \rho$ is pretty insensitive even to large variation.
Look at other $|y|$ bins...

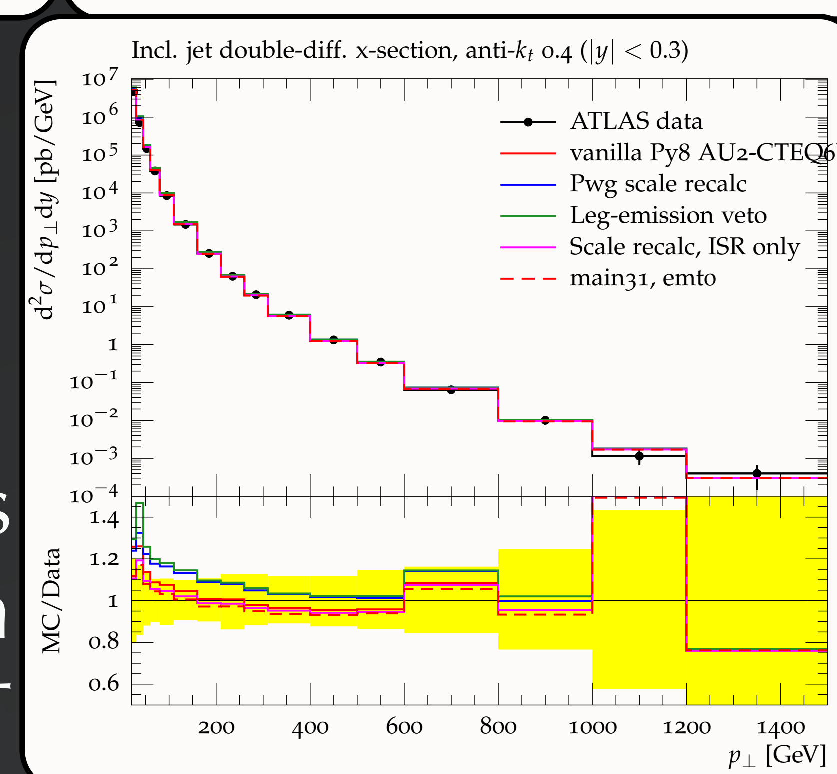
Ad Hoc Solution: only apply the modified matching to ISR







Improves many distributions while keeping the jet shapes unchanged.

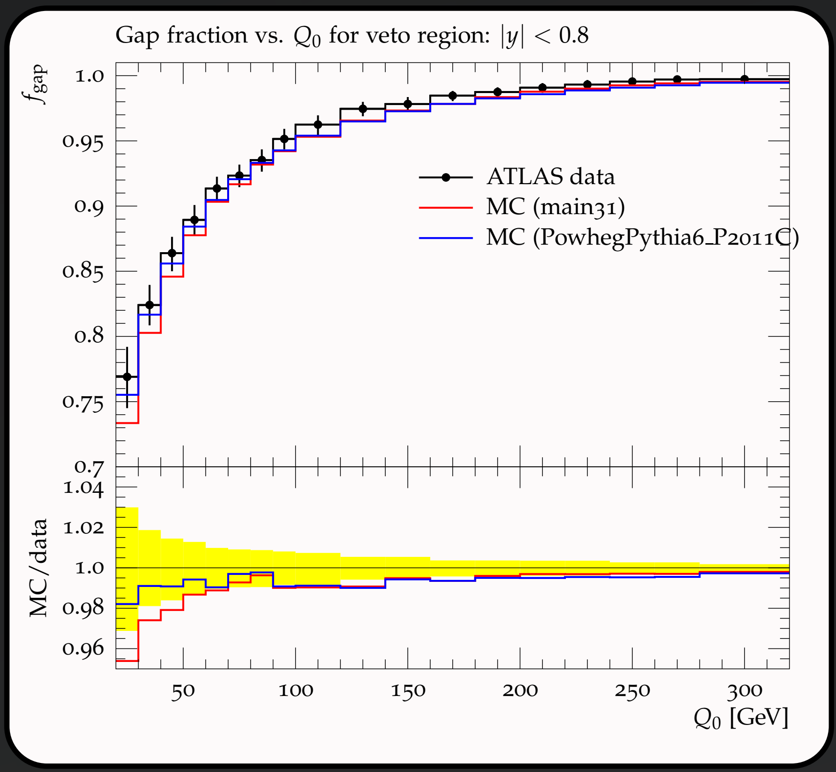


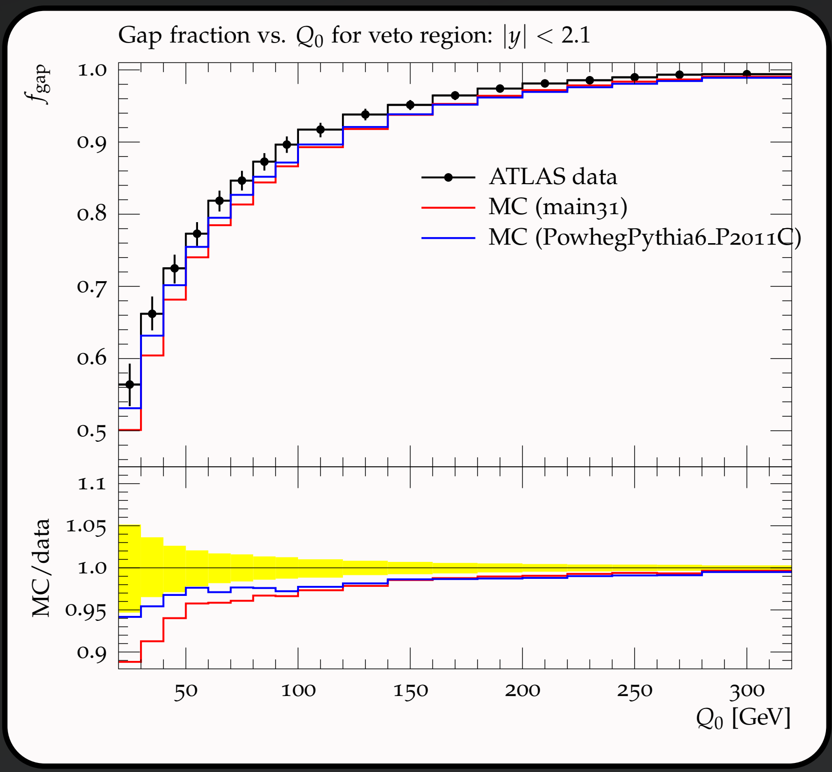
Even slightly improves differential cross section at low pT

“Main31”

- Example matching provided with Pythia. Initially showed very poor description, but recently fixed after interactions with authors.
- Author recommended setup. Applies to both ISR and FSR (although agree that there is more theoretical freedom to vary FSR scale choice)
- Performs almost as well as ISR-only scale reduction (and much better than vanilla setups). Since it’s less ad-hoc, our likely recommendation for future QCD production
- ISR-only setup can provide a nice systematic variation - they both perform well on these distributions.
- Full set of plots here: http://www.nbi.dk/~jmonk/powhegmatching/

Top, Z





Very preliminary studies of top veto by Kiran Joshi suggest there may be issues, but the picture isn't clear yet

Did not affect the Z pT distribution much, but maybe W/Z + jets (c.f. jet Δϕ) will show a difference. No FSR ambiguity in this case