Flavour anti-kT

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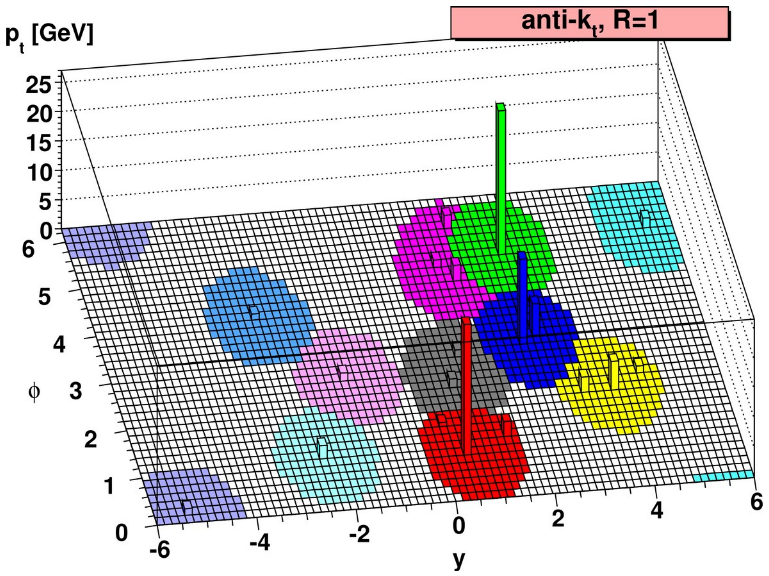
Problem solved, isn't it?

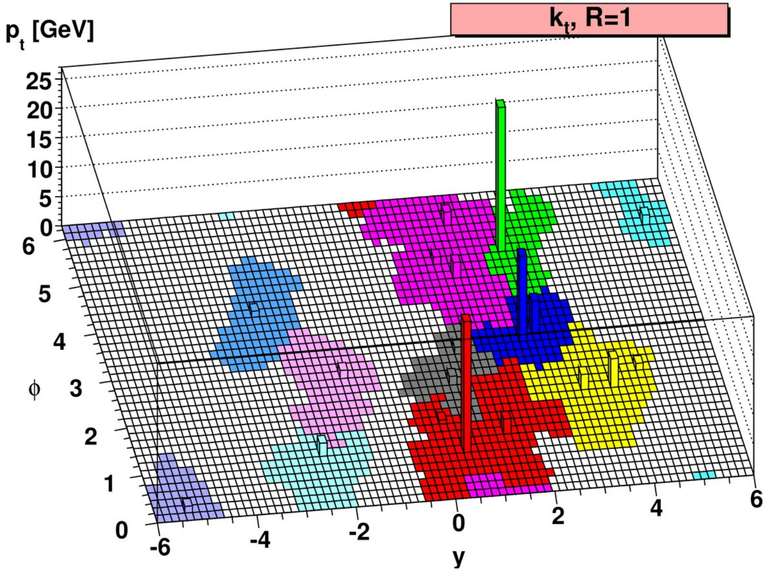
The standard algorithm for the LHC is the anti-kT:

→ nice geometric properties

→ less sensitive to soft physics

Towards Jetography
Salam 0906.1833





Flavour anti-kT

Anti-kT: $d_{ij} = \min(k_{T,i}^{-2}, k_{T,j}^{-2}) R_{ij}^2 \qquad d_i = k_{T,i}^{-2}$

Idea:
Modification to ensure the correct recombination of flavoured pairs in the double soft limit.

Proposed modification:

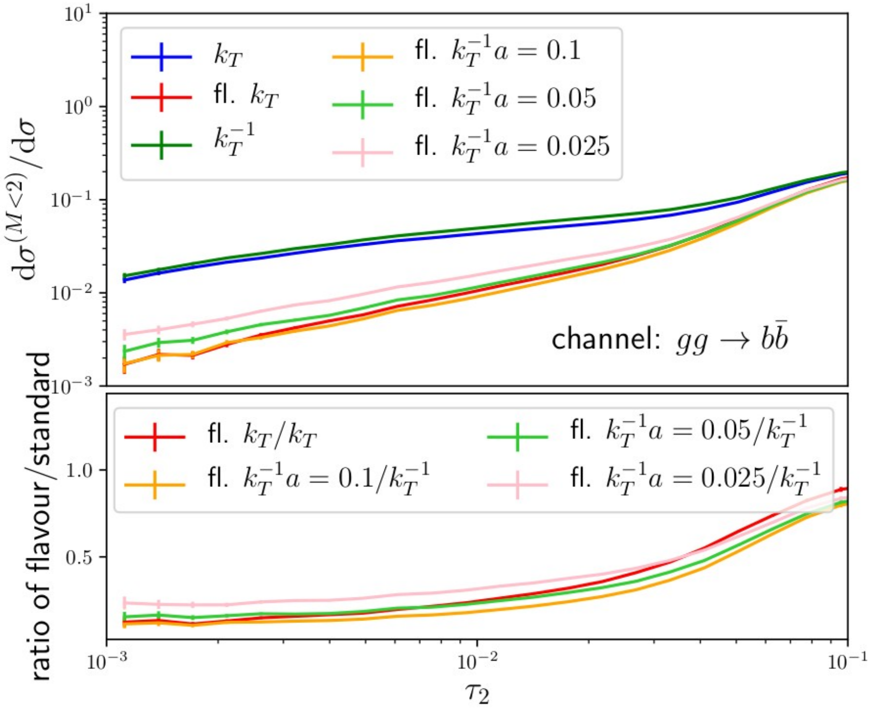
A soft term designed to modify the distance of flavoured pairs.

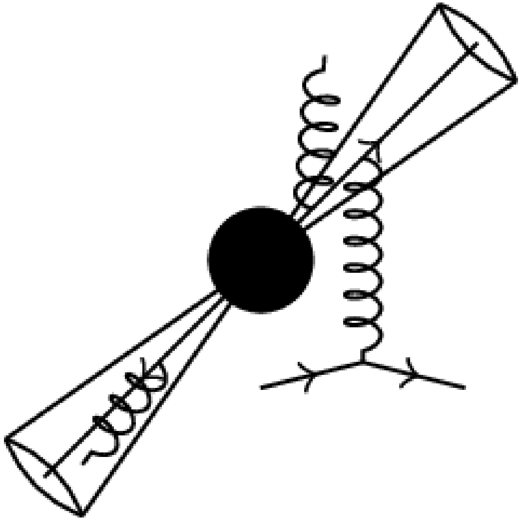
$$d_{ij}^{(F)} = d_{ij} \begin{cases} \mathcal{S}_{ij} & \text{i,j is flavoured pair} \\ 1 & \text{else} \end{cases}$$

$$\boxed{\mathcal{S}_{ij} \equiv 1 - \theta\left(1 - \kappa_{ij}\right) \cos\left(\frac{\pi}{2}\kappa_{ij}\right) \quad \text{with} \quad \kappa_{ij} \equiv \frac{1}{a} \frac{k_{T,i}^2 + k_{T,j}^2}{2k_{T,\max}^2} \,.}$$

Tests of IR safety with parton showers

In the di-jet limit the flavour needs to correspond to tree level flavours
→ misidentification rate needs to vanish in di-jet back-to-back limit
→ IR sensitive observable 2-jettiness



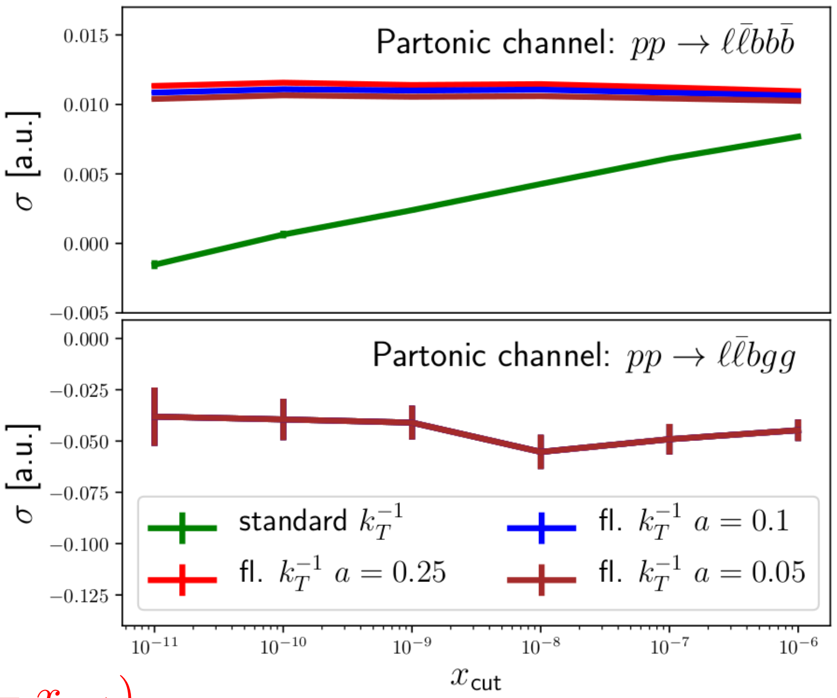


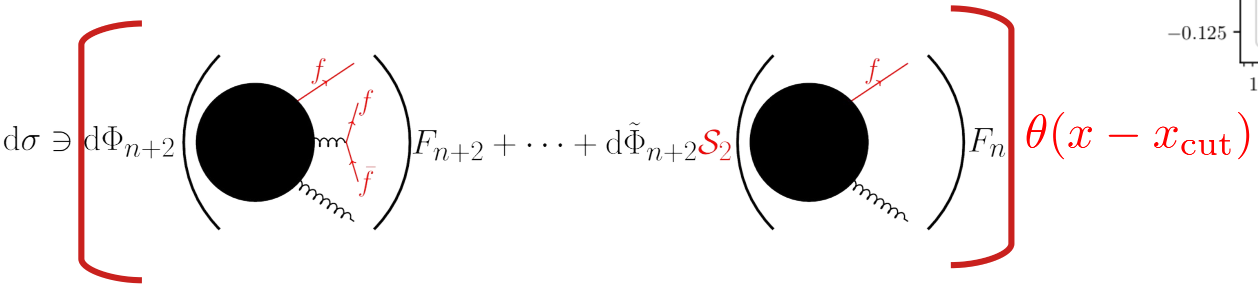
Tests of IR safety with NNLO FO computations

IR sensitivity of jet cross sections on (technical) IR regulating parameter x

In the limit x_cut → 0:

- IR safe jet flavour → no dependence on x_cut
- IR non-safe jet flavour → logarithmic divergent





Remarks to the flavour anti-kT

$$d_{ij}^{(F)} = d_{ij} \begin{cases} \mathcal{S}_{ij} & \text{i,j is flavoured pair} \\ 1 & \text{else} \end{cases}$$

$$\boxed{\mathcal{S}_{ij} \equiv 1 - \theta\left(1-\kappa_{ij}\right)\cos\left(\frac{\pi}{2}\kappa_{ij}\right) \quad \text{with} \quad \kappa_{ij} \equiv \frac{1}{a}\,\frac{k_{T,i}^2 + k_{T,j}^2}{2k_{T,\max}^2}\,.}$$

- What is that kT_max parameter?

  Some scale to define what soft means. Examples:
  1. pT of hardest pseudo jet or lepton at a clustering step
  2. Some fixed dynamical scale, e.g. pT(Z), pT(lep), …
  3. Some fixed hard scale: m_top, m_Z etc.

  → The choice impacts the clustering.

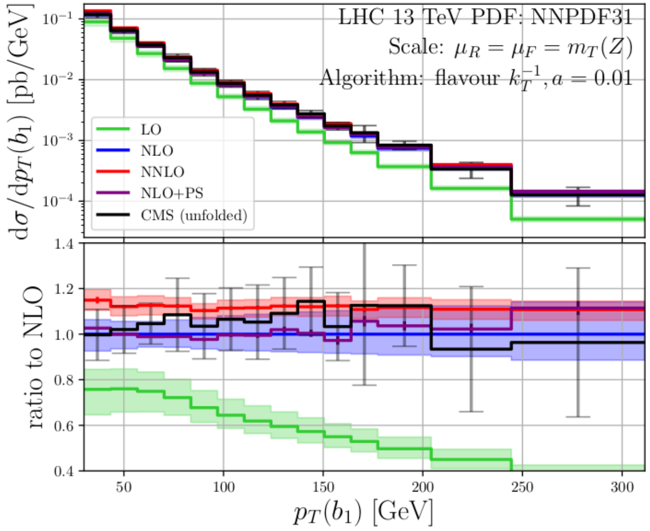
Z+b-jet Phenomenology: Tunable parameter

Benchmark process: pp → Z(ll) + b-jet

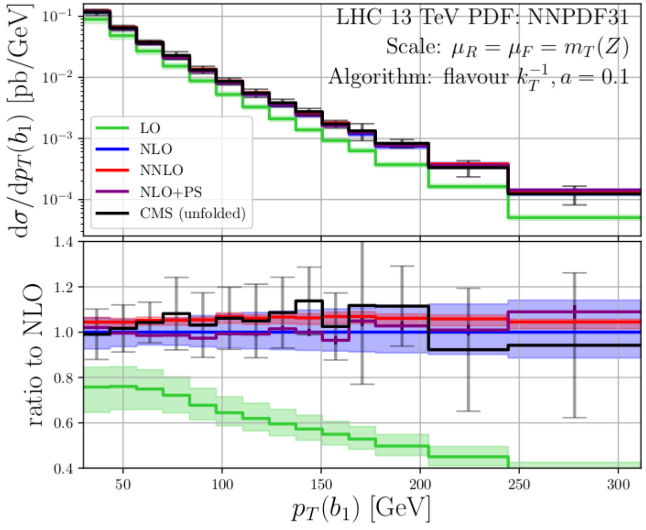
Tunable parameter a:

- Limit a → 0 <=> original anti-kT (IR unsafe)
- Large a <=> large modification of cluster sequence

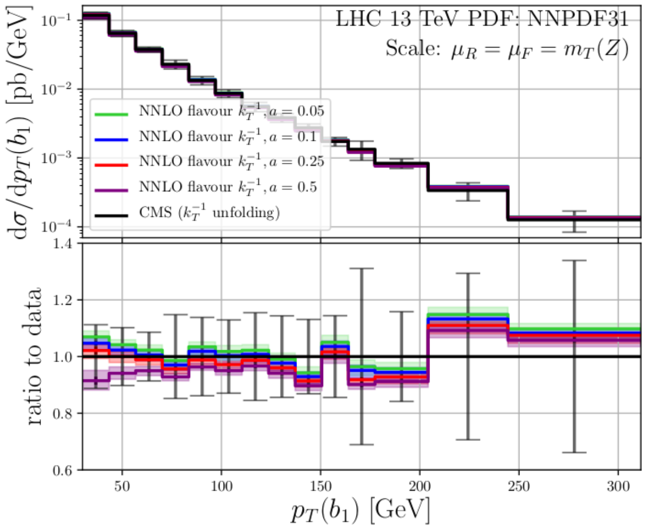
Flavour anti-kT (a=0.01):



Flavour anti-kT (a=0.1):

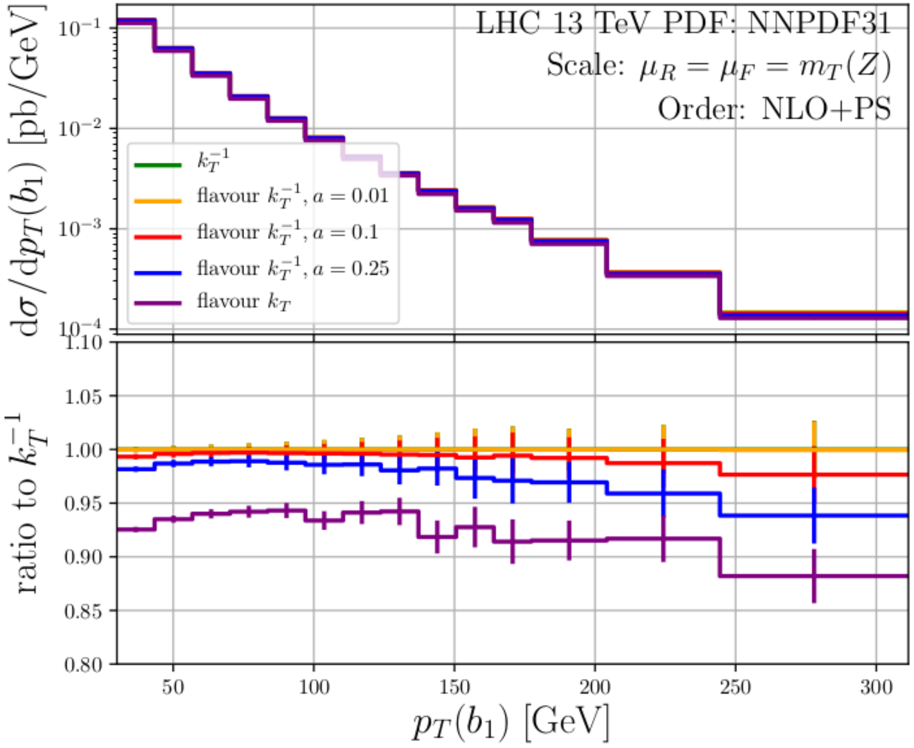


Comparison of different parameter a to data:



Z+b-jet Phenomenology: Tunable parameter II

What happens in the presence of many flavoured partons? → NLO PS



Tunable parameter a:

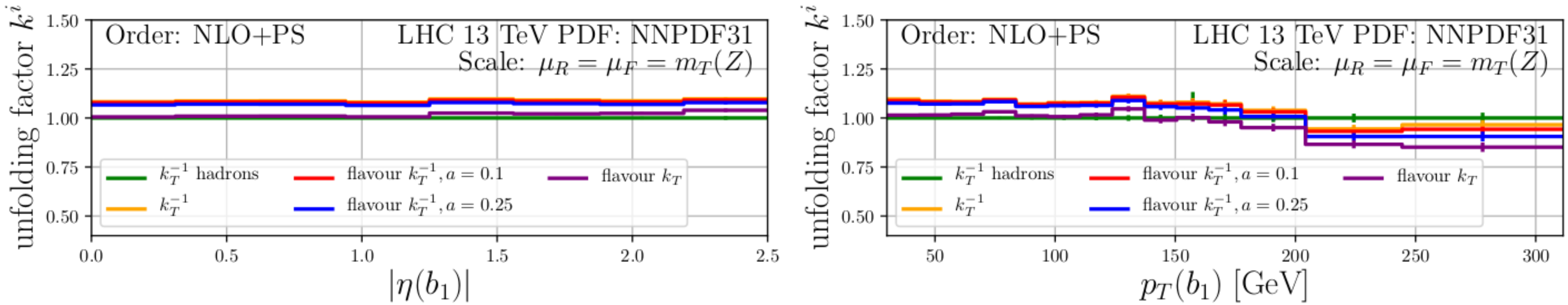
- Small a: Flavour anti-kT results are more similar to standard anti-kT
- Larger a: Larger modification of clustering

Good FO perturbative convergence +
Small difference to standard anti-kT
→ a~0.1 is a good candidate

Bin-by-bin unfolding

Estimation of hadronisation and experimental tagging corrections
→ NLO + PS (Madraph+Pythia8)

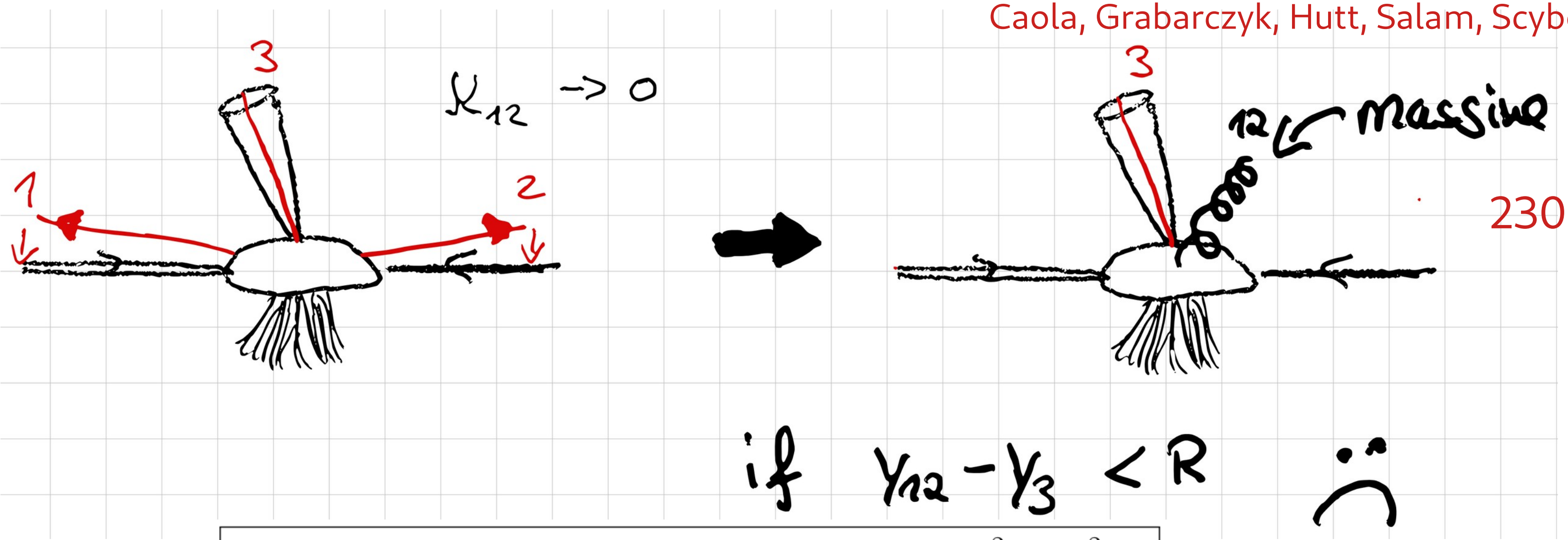
Unfolding factor = NLO+PS (had = Off) / NLO+PS (had = On)



New developments...

Issue for double collinear limits wrt. to initial states

Many thanks to
Caola, Grabarczyk, Hutt, Salam, Scyboz,Thaler



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$$\boxed{\mathcal{S}_{ij} \equiv 1 - \theta\left(1-\kappa_{ij}\right)\cos\left(\frac{\pi}{2}\kappa_{ij}\right) \quad \text{with} \quad \kappa_{ij} \equiv \frac{1}{a}\,\frac{k_{T,i}^2 + k_{T,j}^2}{2k_{T,\max}^2}\,.}$$

Their proposal: $$\mathcal{S}_{ij} \to \overline{\mathcal{S}}_{ij} = \mathcal{S}_{ij}\frac{\Omega_{ij}^2}{\Delta R_{ij}^2}$$ $$\Omega_{ik}^2 \equiv 2\left[\frac{1}{\omega^2}\left(\cosh(\omega\Delta y_{ik})-1\right)-\left(\cos\Delta\phi_{ik}-1\right)\right]$$

Solves also an issue at α_s^3

Plans/Suggestions for this week

- Comparison of the different algorithms in a benchmark process @ NNLO QCD
  pp → Zb/Wc, pp → W H (→ bb~), pp → tt~ + decays
- (More for me) See what the impact of that flavour anti-kT fix
  is on the already computed processes
  It appears to be small at PS level
- FastJet implementations → Tests & validations