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Mass aware jet clustering with Variable-R and a soft drop veto

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Motivation



Fixed R clustering



Variable R jet clustering



Grooming during jet clustering

QCD distribution is shifted to lower masses; **TOP** peak sharper



Grooming during jet clustering



At low p_T (~200 GeV) $\beta = 0$ performs best, but all are very similar At high p_T (~600 GeV) $\beta > 0$ performs better \rightarrow choose $\beta = 1$ for the following

Where is the radius used?

Effective radius is used in

1. Clustering step

$$R_{\rm eff}(p_{\rm T,i}) = \begin{cases} R_{\rm min} & \text{for } \rho/p_{\rm T} < R_{\rm min} \\ R_{\rm max} & \text{for } \rho/p_{\rm T} > R_{\rm max} \\ \rho/p_{\rm T} & \text{else}, \end{cases}$$

cut

$$d_{i\mathrm{B}} = R_{\mathrm{eff}}^2(p_{\mathrm{T},i})$$
$$d_{ij} = \Delta R_{ij}^2,$$

 $\frac{p_{T_j}}{p_{T_j}} > \frac{\Delta R_{ij}}{C_{cut}} \beta$ $\frac{z_{cut}}{P_{T_j}} 2. \quad \text{Grooming step}$

$$z = \frac{\min(p_{\mathrm{T},i}, p_{\mathrm{T},j})}{p_{\mathrm{T},i} + p_{\mathrm{T},j}} > z_{\mathrm{cut}} \left(\frac{\Delta R_{ij}}{R_{\mathrm{eff}}}\right)^{\beta},$$



2 and 3-body decays

Idea:

- Combine 2 and 3 body decay
- One function $R_{\rm eff}(m, p_{\rm T})$
- Simultaneous tagging of top, W, Z and Higgs possible





Effective radius



For a top mass, the mass-dependent radius is similar at high p_T but smaller at low p_T

Results for Top Quark



At low p_T the mass-dependent radius is slightly better at high p_T they are almost the same Technical details: $f_{p_T} < 0.8$, $N_{sub} \ge 3$, 140 $< m_{jet} < 220$ GeV, $m_{min} > 50$ GeV, scanned over τ_{32}

Results for Higgs Boson



- Mass distribution has a higher tail
- Performance based on τ_{21} and m_{SD} seems similar

Technical details: 110 < $m_{\rm jet}$ < 140 GeV, scanned over τ_{21}

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€s

Results for W Boson



- Mass distribution has a higher tail
- Performance based on τ_{21} and m_{SD} seems similar

Technical details: 65 < $m_{\rm jet}$ < 95 GeV, scanned over τ_{21}



Summary

- Fixed radius clustering has a p_T threshold & a too big radius at high p_T
- Variable R algorithm allows to adapt and overcome these issues
- The inclusion of 2-body decays seems reasonable
- Next: test on FullSim and test ParticleNet on top of HOTVR jets





Results for Top Quark

