Calculating the angle between jet axes

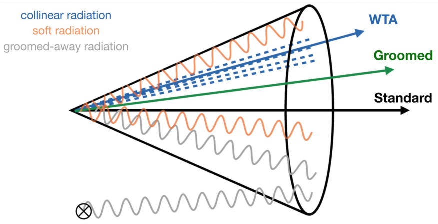
Zuhal Seyma Demiroglu

31 Jan, 2022

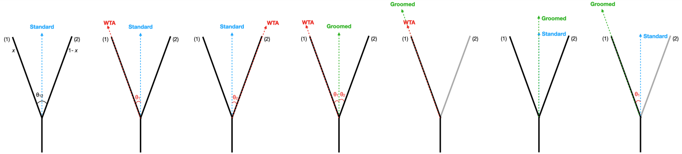
Jet-axis differences

Jet Axes

- **Standard:** anti-k_T jet with E-scheme recombination.
- **Groomed**: Apply Soft drop grooming with different values of z_{cut} and β
- **Winner-Take-All (WTA)**: Jet axis is given by its leading constituent.
- Calculate the angular separation: $\Delta R_{axis} = \sqrt{\Delta y^2 + \Delta\phi^2}$



Pedro Cal, Duff Neill, Felix Ringer Wouter J. Waalewijn[ArXiv: 1911.06840]



Motivation

Angles have different degrees of soft sensitivity:

ST-WTA → Moderate dependence on soft radiation
WTA-GR → Low dependence on soft radiation
ST-GR → High dependence on soft radiation

Grooming Algorithms

- Intended to remove soft and wide-angle radiation from the jet.
- Help to reduce the PU dependence of jet mass and shape observables.

Soft Drop

- Recluster the jet constituents with C/A algorithm
- Evaluate the condition for subjet j_1 and j_2,

$$z_g \equiv \frac{\min(p_{T,1}, p_{T,2})}{p_{T,1} + p_{T,2}} \geq z_{cut} \left(\frac{\Delta R_{12}}{R_0} \right)^{\beta}$$

  - If it fails, remove the softest constituent and reiterate reclustering.

Event Selection

- PYTHIA8 event generator. 10M events. pp collision at $\sqrt{s} = 200$GeV
- Also, used the Detroit Tune [arXiv:2110.09447v2]:

TABLE I. PYTHIA 8 settings and tuning parameters.

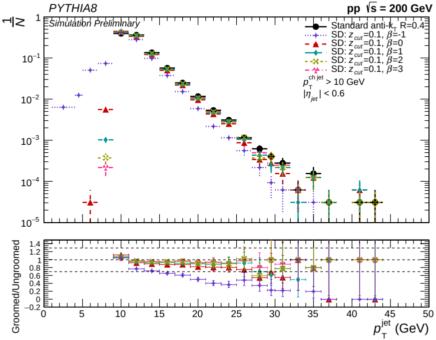
Setting	Default	New
PDF:pSet	13	17
MultipartonInteractions:ecmRef	7 TeV	200 GeV
MultipartonInteractions:bprofile	3	2

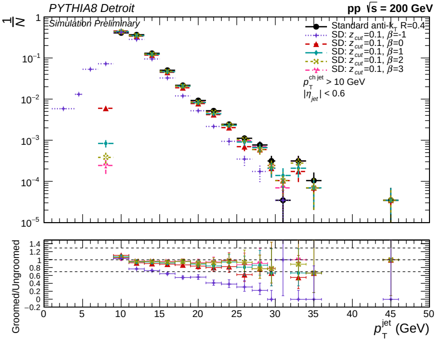
TABLE III. PYTHIA 8 tuned parameters.

Tuning Parameter	Default	Detroit
MultipartonInteractions:pT0Ref	2.28 GeV	1.40 GeV
MultipartonInteractions:ecmPow	0.215	0.135
MultipartonInteractions:coreRadius	0.4	0.56
MultipartonInteractions:coreFraction	0.5	0.78
ColourReconnection:range	1.8	5.4

- Charged-particle jets were reconstructed at $|\eta| < 3$ using the anti-k_T algorithm with R $=$ 0.4.
- Jet selection: $p_T^{ch,jet} > 10$ GeV, $|\eta_{jet}| < 0.6$.
- Scan different Soft-Drop parameters;
  - $z_{cut} = 0.1$, $\beta =$ -1, 0, 1, 2, 3
  - $z_{cut} = 0.1, 0.2, 0.3$, $\beta = 1$
  - $z_{cut} = 0.1, 0.2, 0.3$, $\beta =$ -1

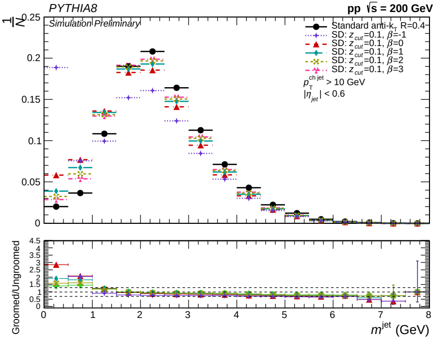
Jet observables: Jet p_T

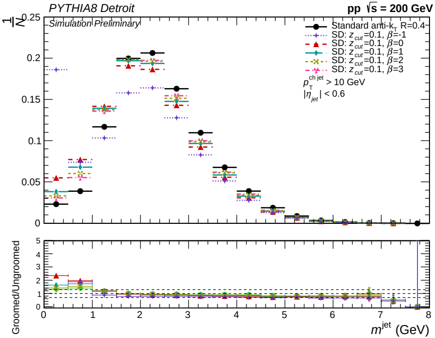




Left: The distributions of the jet transverse momentum for different β values with $z_{cut} = 0.1$ with default Pythia8.
Right: The distributions of the jet transverse momentum for different β values with $z_{cut} = 0.1$ with Pythia8+DETROIT tune.

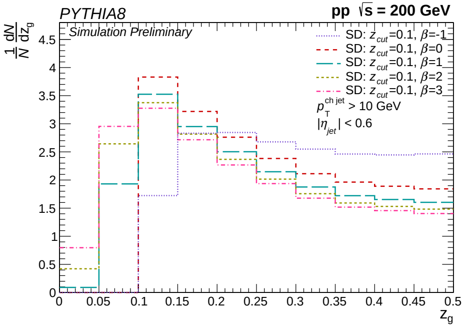
Jet observables: Jet mass

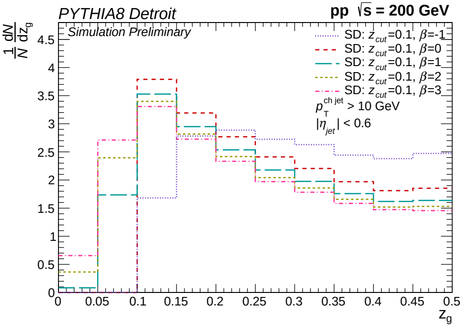




Left: The distributions of the jet mass for different β values with $z_{cut} = 0.1$ with default Pythia8.
Right: The distributions of the jet mass for different β values with $z_{cut} = 0.1$ with Pythia8+DETROIT tune.

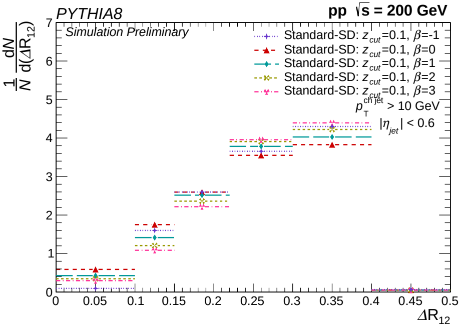
SD observables: z_g

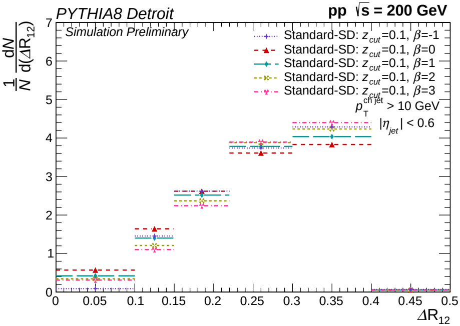




Left: The z_g distributions for charged-particle jets different β values with $z_{cut} = 0.1$ with default Pythia8.
Right: The z_g distributions for charged-particle jets for different β values with $z_{cut} = 0.1$ with Pythia8+DETROIT tune.

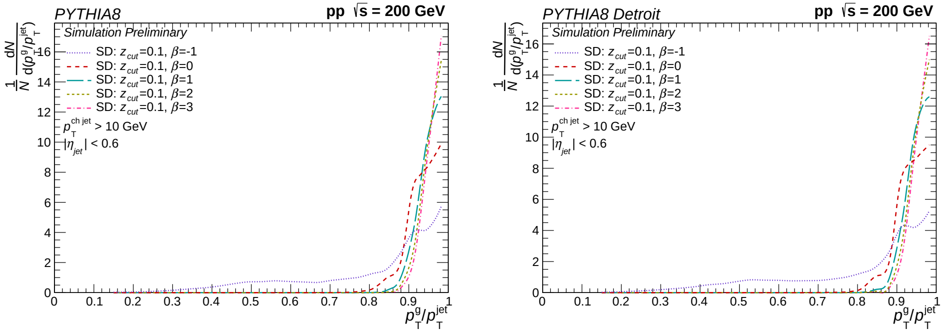
SD observables: R_g





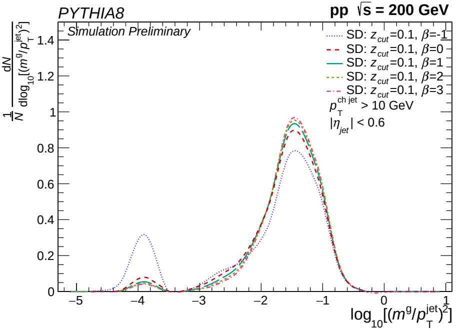
Left: The R_g distributions for charged-particle jets different β values with $z_{cut} = 0.1$ with default Pythia8.
Right: The R_g distributions for charged-particle jets for different β values with $z_{cut} = 0.1$ with Pythia8+DETROIT tune.

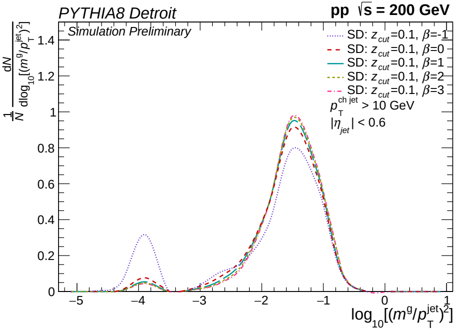
SD observables: p_T^g/p_T^{jet}



Left: The groomed jet energy fraction for different β values with $z_{cut} = 0.1$ with default Pythia8.
Right: The groomed jet energy fraction for different β values with $z_{cut} = 0.1$ with Pythia8+DETROIT tune.

SD observables: $\rho \equiv log(m^2/p_T^2)$

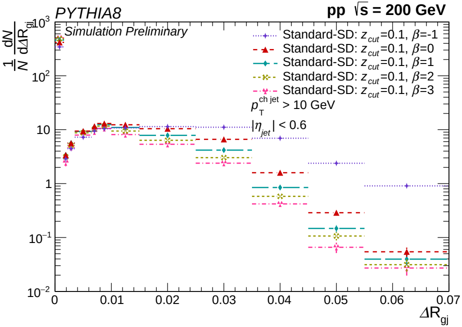


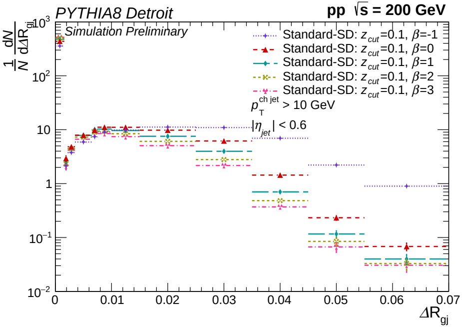


Left: The distribution of $\rho \equiv log(m^2/p_T^2)$, where m is groomed jet mass and p_T is ungroomed jet p_T, for different β values with $z_{cut} = 0.1$ with default Pythia8.

Right: The distribution of $\rho \equiv log(m^2/p_T^2)$, where m is groomed jet mass and p_T is ungroomed jet p_T, for different β values with $z_{cut} = 0.1$ with Pythia8+DETROIT tune.

- Calculate the angular separation: $\Delta R_{axis} = \sqrt{(y_g - y_j)^2 + (\phi_g - \phi_j)^2}$

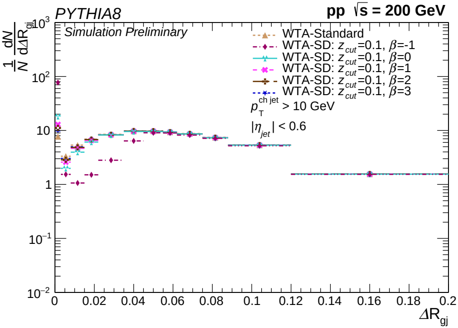


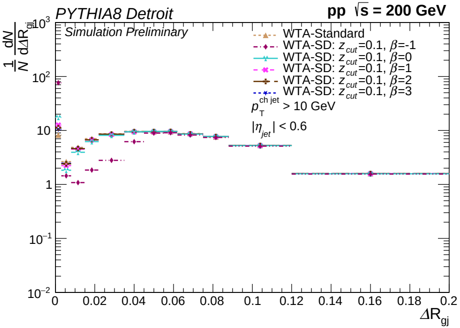


Left: The angular separation between the standard and groomed jet axis for different β values with $z_{cut} = 0.1$ with default Pythia8.
Right: The angular separation between the standard and groomed jet axis for different β values with $z_{cut} = 0.1$ with Pythia8+DETROIT tune.

ΔR_{axis}: WTA-ST, WTA-GR

- Calculate the angular separation: $\Delta R_{axis} = \sqrt{(y_g - y_j)^2 + (\phi_g - \phi_j)^2}$

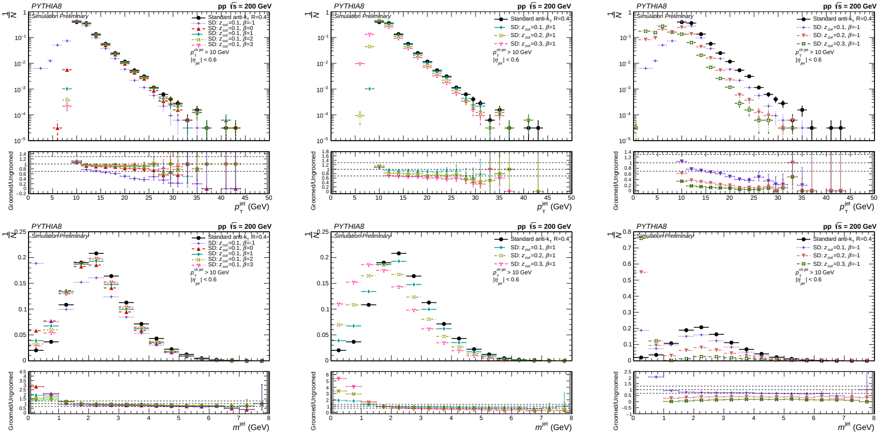




Left: The angular separation between the WTA and standard/groomed jet axes for different β values with $z_{cut} = 0.1$ with default Pythia8.
Right: The angular separation between the WTA and standard/groomed jet axes for different β values with $z_{cut} = 0.1$ with Pythia8+DETROIT tune.

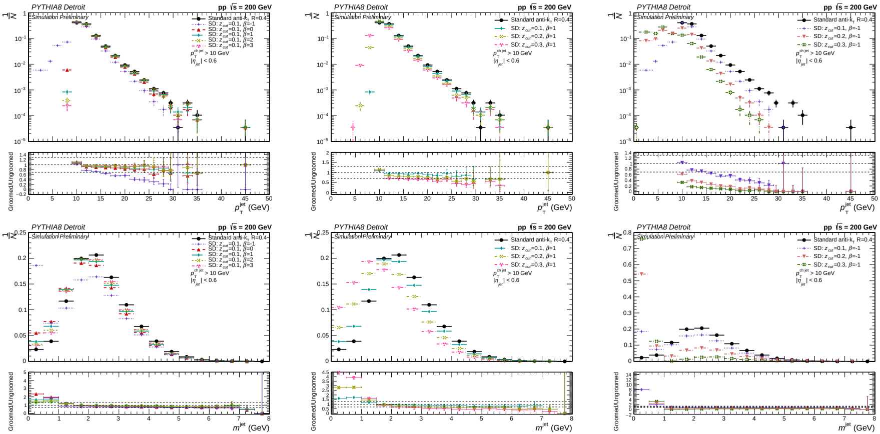
Backup

Jet observables



Top: The distributions of the jet transverse momentum for different β values with z_{cut} = 0.1 (left), different z_{cut} values with β = 1.0 (middle) and β = -1.0 (right).
Bottom: The distributions of the jet mass for different β values with z_{cut} = 0.1 (left), different z_{cut} values with β = 1.0 (middle) and β = -1.0 (right).

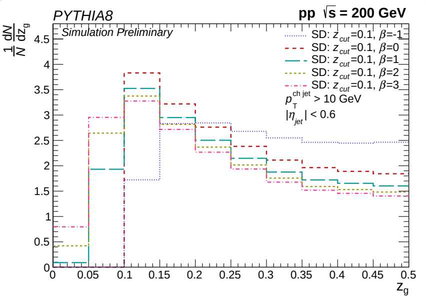
Jet observables

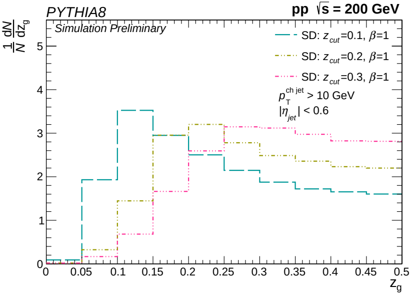


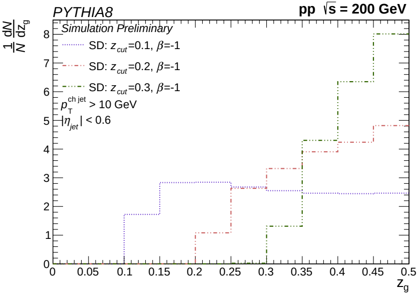
Top: The distributions of the jet transverse momentum for different β values with $z_{cut} = 0.1$ (left), different z_{cut} values with $\beta = 1.0$ (middle) and $\beta =$ -1.0 (right).

Bottom: The distributions of the jet mass for different β values with $z_{cut} = 0.1$ (left), different z_{cut} values with $\beta = 1.0$ (middle) and $\beta =$ -1.0 (right).

SD observables

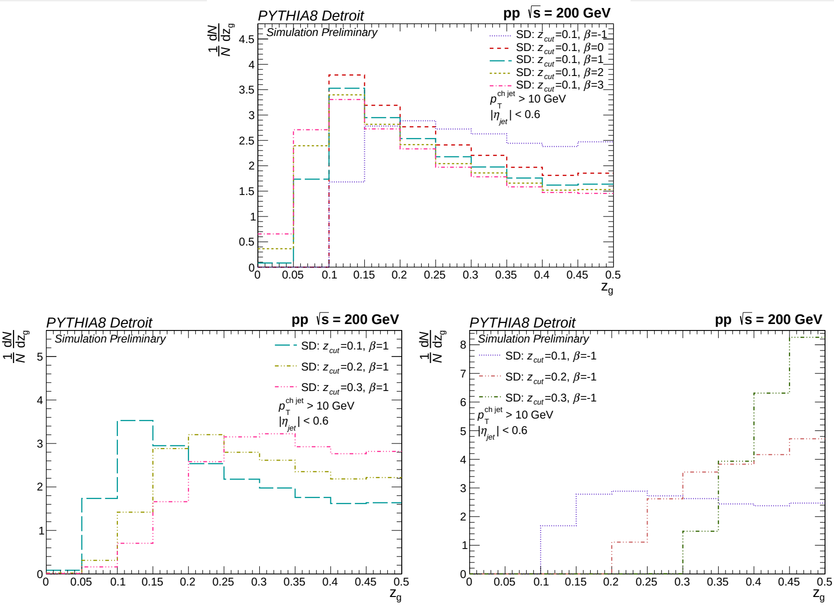






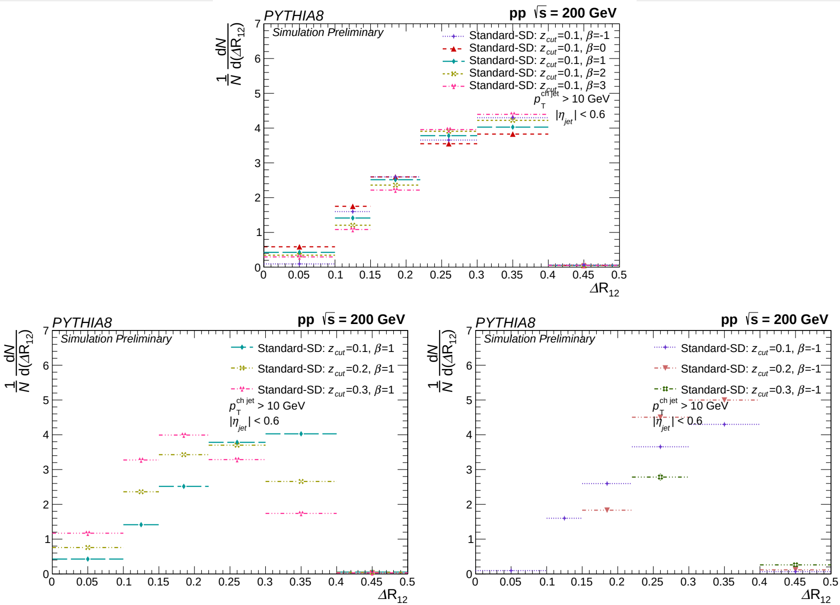
The z_g distributions for charged-particle jets with different β (top) and z_{cut} (bottom) values.

SD observables



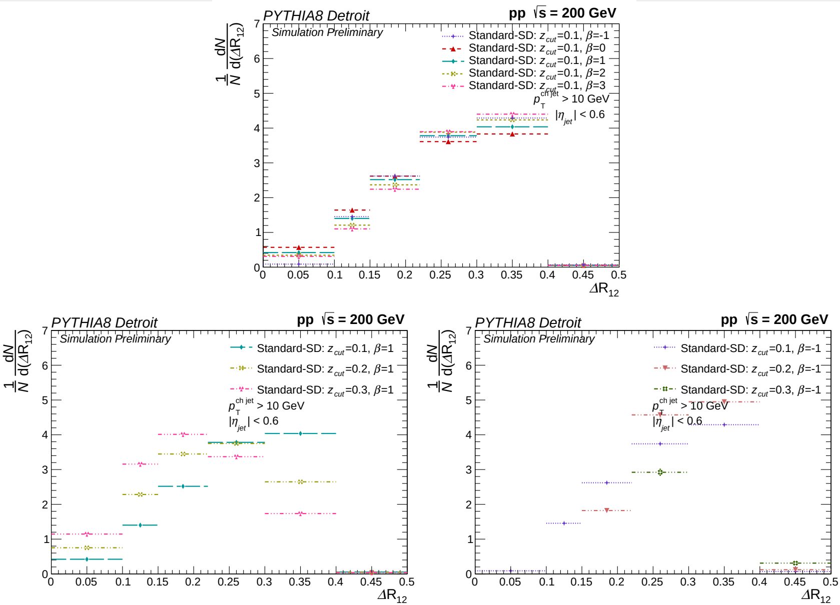
The z_g distributions for charged-particle jets with different β (top) and z_{cut} (bottom) values.

SD observables



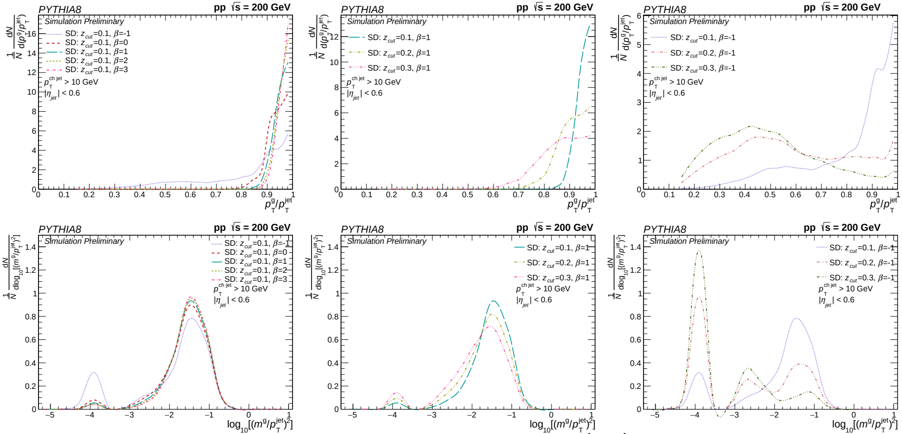
The R_g distributions for charged-particle jets with different β (top) and z_{cut} (bottom) values.

SD observables



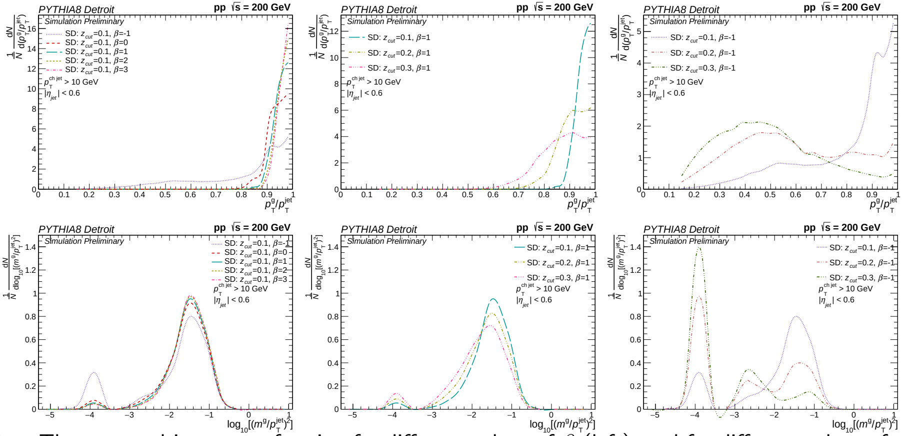
The R_g distributions for charged-particle jets with different β (top) and z_{cut} (bottom) values.

SD observables



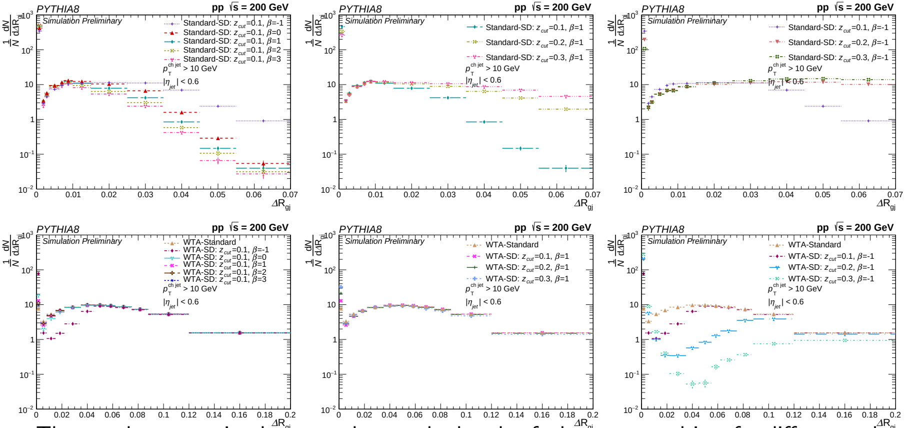
Top: The groomed jet energy fraction for different values of β (left), and for different values of z_{cut} (middle/right). **Bottom:** The distribution of $\rho \equiv log(m^2/p_T^2)$, where m is groomed jet mass and p_T is ungroomed jet p_T.

SD observables



Top: The groomed jet energy fraction for different values of β (left), and for different values of z_{cut} (middle/right). **Bottom:** The distribution of $\rho \equiv log(m^2/p_T^2)$, where m is groomed jet mass and p_T is ungroomed jet p_T.

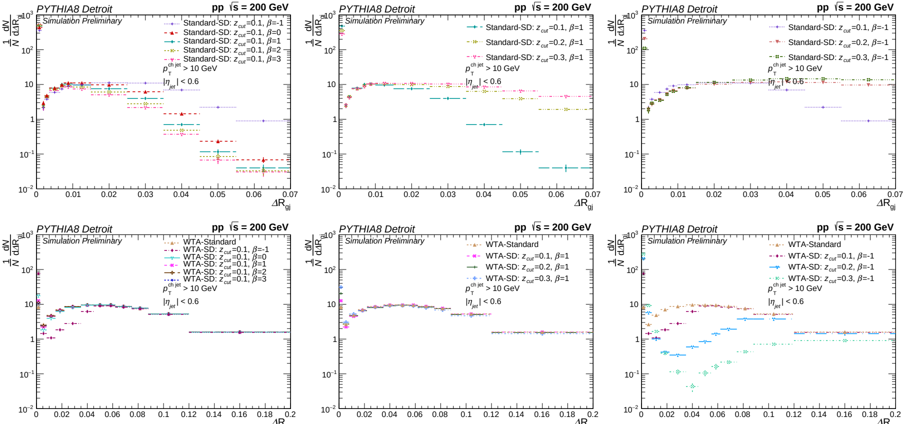
- Calculate the angular separation: $\Delta R_{axis} = \sqrt{(y_g - y_j)^2 + (\phi_g - \phi_j)^2}$



Top: The angular separation between the standard and soft drop groomed jets for different values of β (left), and for different values of z_{cut} (middle/right).

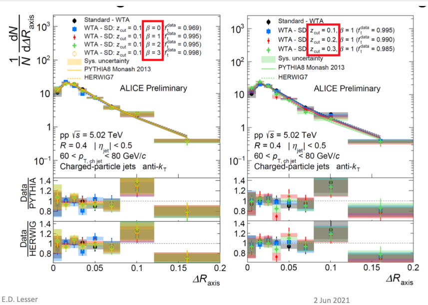
Bottom: The angular separation between the WTA and standard/groomed jet axes for different values of β (left), and for different values of z_{cut} (middle/right)

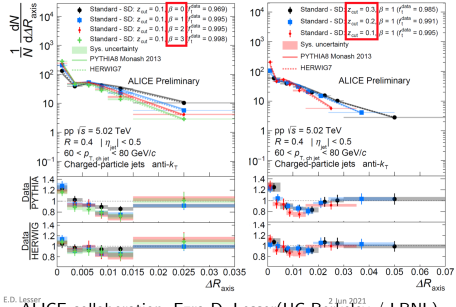
- Calculate the angular separation: $\Delta R_{axis} = \sqrt{(y_g - y_j)^2 + (\phi_g - \phi_j)^2}$



Top: The angular separation between the standard and soft drop groomed jets for different values of β (left), and for different values of z_{cut} (middle/right).
Bottom: The angular separation between the WTA and standard/groomed jet axes for different values of β (left), and for different values of z_{cut} (middle/right)

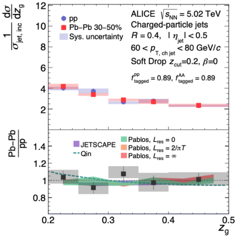
ΔR_{axis}



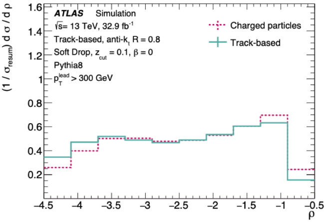


ALICE collaboration, Ezra D. Lesser(UC Berkeley / LBNL)

arXiv:2107.12984v1



arXiv:1912.09837v2



arXiv:1805.05145v2