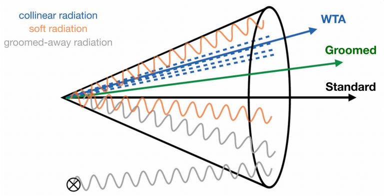
Stony Brook University

Center for Frontiers in Nuclear Science

Calculating the angle between jet axes

11 Jan, 2022

Jet-axis differences



- **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: $\Delta R_{axis} = \sqrt{\Delta y^2 + \Delta\phi^2}$
- IRC-safe observable sensitive to soft radiation, TMDs and PDFs[*]

- 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

[*] Pedro Cal, Duff Neill, Felix Ringer & Wouter J. Waalewijn [ArXiv: 1911.06840]
https://link.springer.com/article/10.1007/JHEP04(2020)211

Event Selection

- PYTHIA8 event generator. 1M events. pp collision at $\sqrt{s} = 200\text{GeV}$
  - Used the Detroit Tune [arXiv:2110.09447v2]:

TABLE I. PYTHIA 8 settings and tuning parameters.

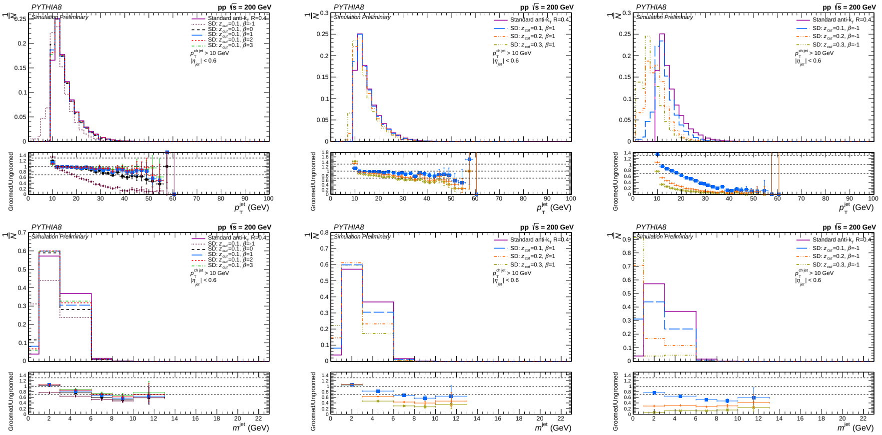
Setting	Default	New
PDF:pSet	13	17
MultipartonInteractions:ecmRef	7 TeV	200 GeV
MultipartonInteractions:bprofile	3	2

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

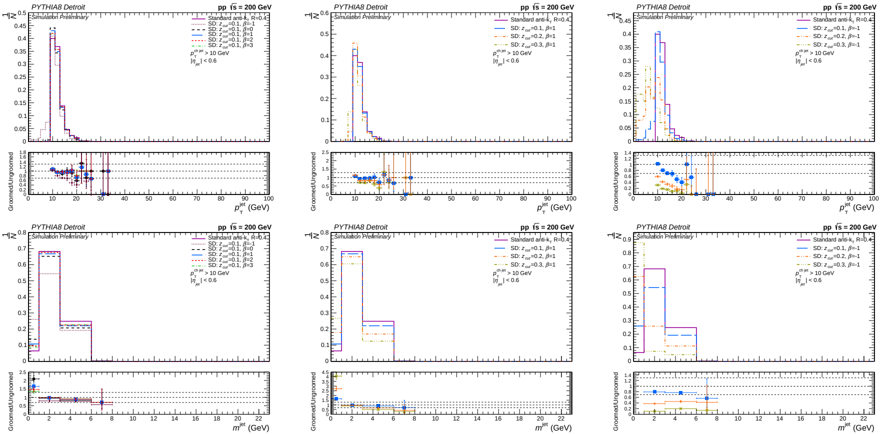
- Charged-particle jets were reconstructed at $|\eta| < 3$ using the anti-k_T algorithm with R = 0.4.
- Selection: $p_T^{ch,jet} > 10$ GeV, $|\eta_{jet}| < 0.6$.
- Scan different Soft-Drop parameters;
  - $z_{cut} = 0.1$, $\beta =$ -1, 0, 1, 2, 3
  - $z_{cut} = 0.1, 0.2, 0.3$, $\beta = 1$
  - $z_{cut}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

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



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



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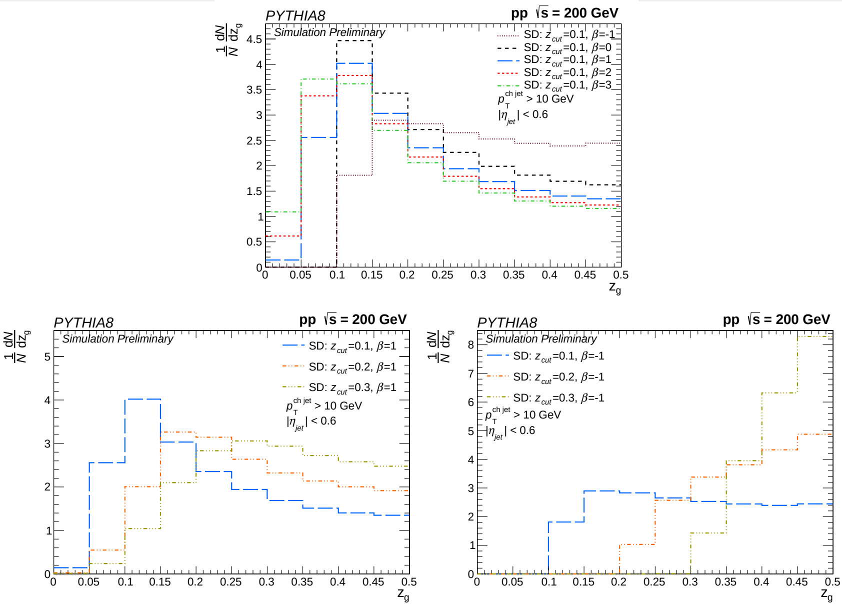
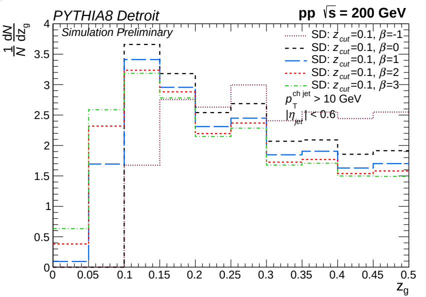
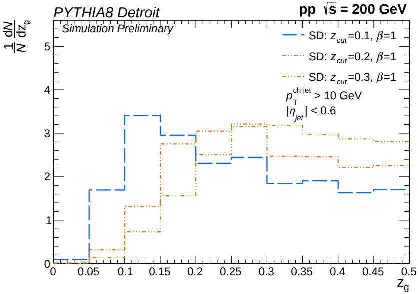
SD observables

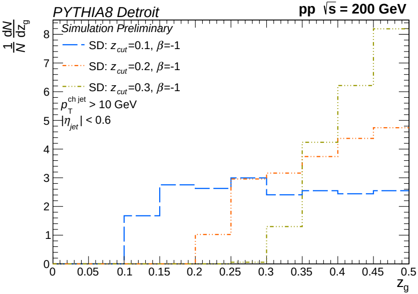


The z_g distributions for charged-particle jets with different β (top) and z_{cut} (bottom) values.

SD observables







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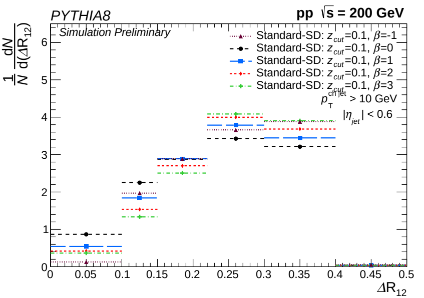
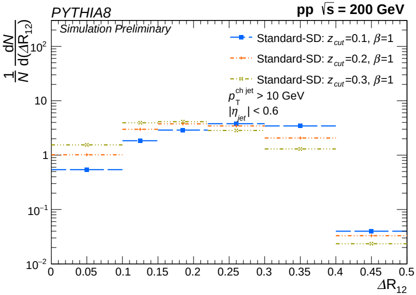
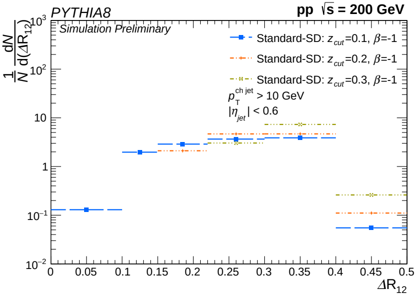
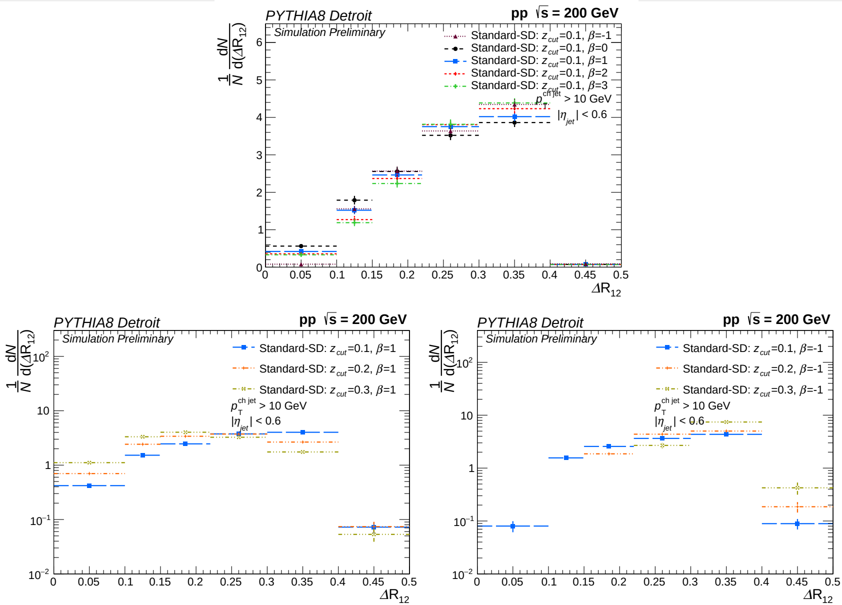






The R_g distributions for charged-particle jets with different β (top) and z_{cut} (bottom) values.

SD observables



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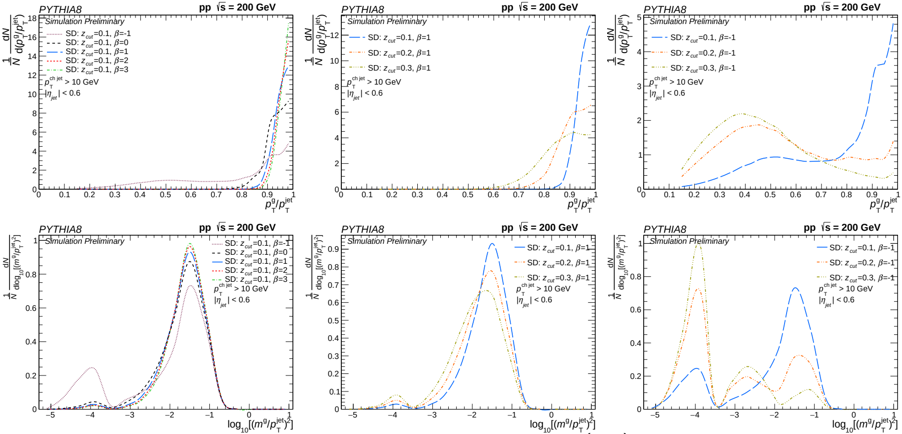
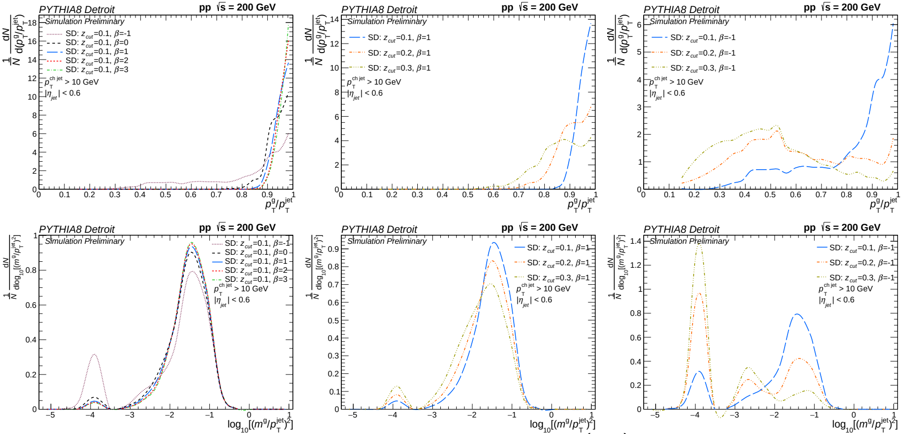


Top: The groomed jet energy fraction for different values of β (left), and for different values of z_{cut} (middle/right). **Bottom:** The distribution of $\rho \equiv log(m^2/p_T^2)$, where m is groomed jet mass and p_T is ungroomed jet p_T.

SD observables



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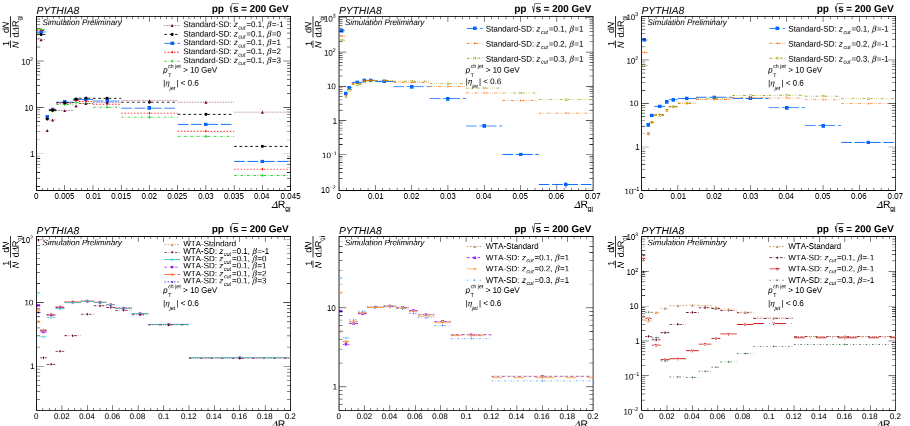
ΔR_{axis}

- 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)

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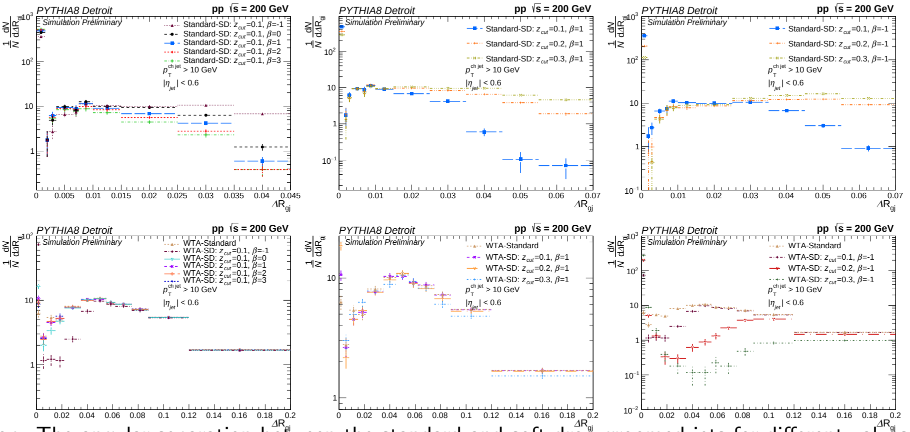

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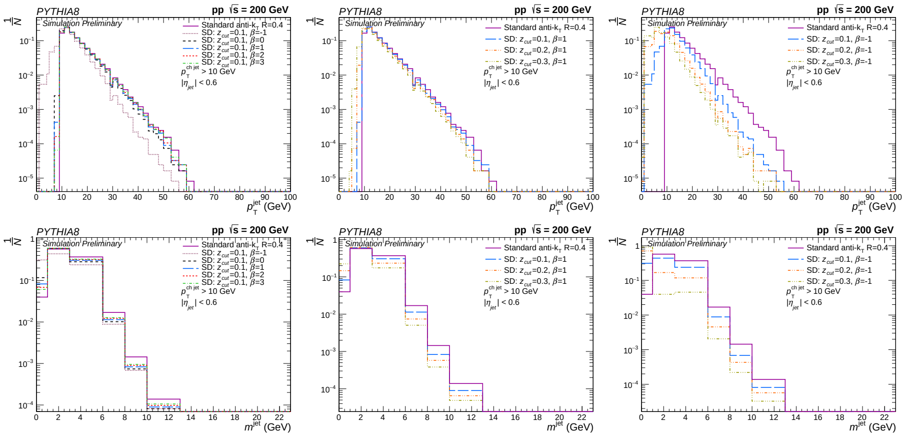
Backup

Jet observables



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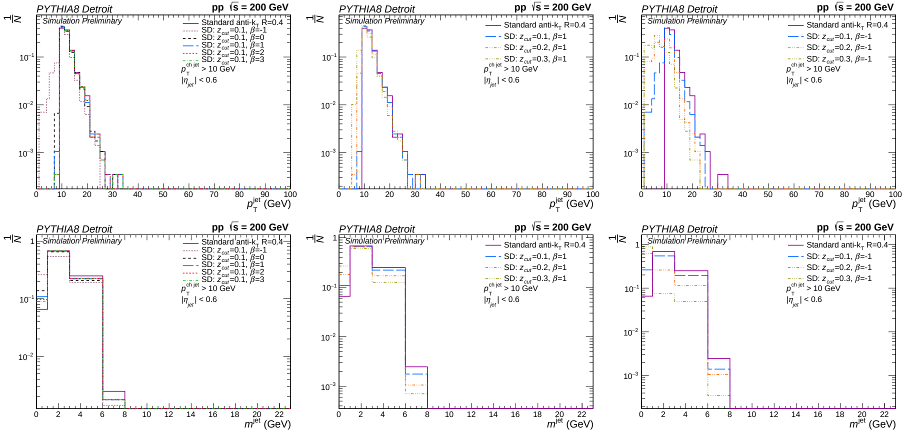

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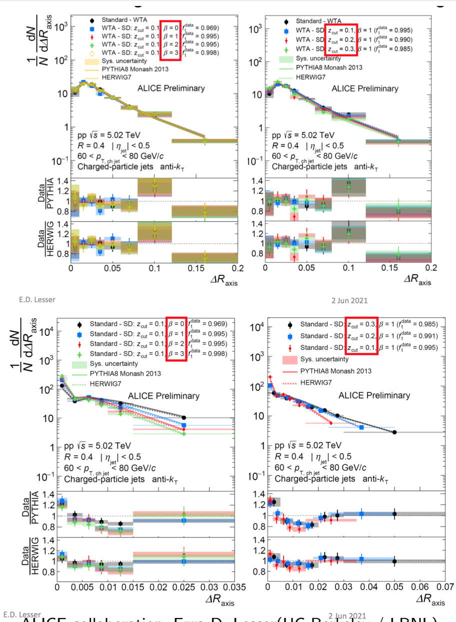
ΔR_{axis}


Standard - WTA
WTA - SD: z_{cut} = 0.1, β = 0 (f_t^{data} = 0.969)
WTA - SD: z_{cut} = 0.1, β = 1 (f_t^{data} = 0.995)
WTA - SD: z_{cut} = 0.1, β = 2 (f_t^{data} = 0.995)
WTA - SD: z_{cut} = 0.1, β = 3 (f_t^{data} = 0.998)
Sys. uncertainty
PYTHIA8 Monash 2013
HERWIG7
ALICE Preliminary
pp $\sqrt{s}$ = 5.02 TeV
R = 0.4 $|\eta_{jet}|$ < 0.5
60 < $p_{T,\,ch\,jet}$ < 80 GeV/c
Charged-particle jets anti-k_T
Standard - WTA
WTA - SD: z_{cut} = 0.1, β = 1 (f_t^{data} = 0.995)
WTA - SD: z_{cut} = 0.2, β = 1 (f_t^{data} = 0.990)
WTA - SD: z_{cut} = 0.3, β = 1 (f_t^{data} = 0.985)
$\frac{1}{N}\frac{dN}{d\Delta R_{axis}}$
Data / PYTHIA
Data / HERWIG
ΔR_{axis}
E.D. Lesser
2 Jun 2021
Standard - SD: z_{cut} = 0.1, β = 0 (f_t^{data} = 0.969)
Standard - SD: z_{cut} = 0.1, β = 1 (f_t^{data} = 0.995)
Standard - SD: z_{cut} = 0.1, β = 2 (f_t^{data} = 0.995)
Standard - SD: z_{cut} = 0.1, β = 3 (f_t^{data} = 0.998)
Standard - SD: z_{cut} = 0.3, β = 1 (f_t^{data} = 0.985)
Standard - SD: z_{cut} = 0.2, β = 1 (f_t^{data} = 0.991)
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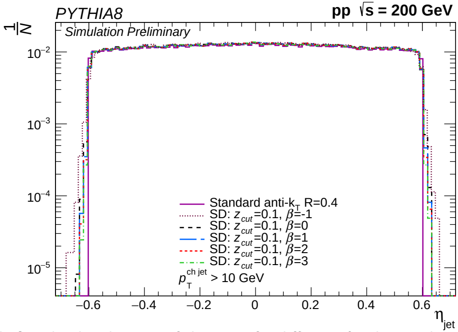
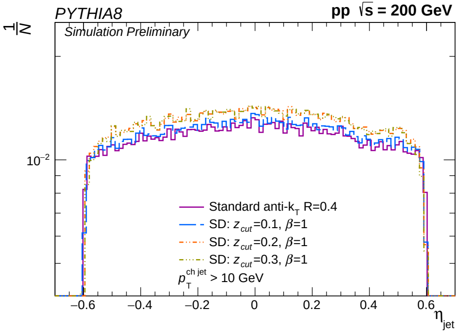
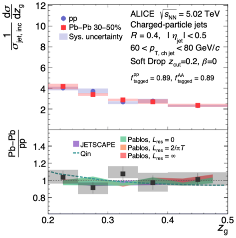
E.D. Lesser
2 Jun 2021



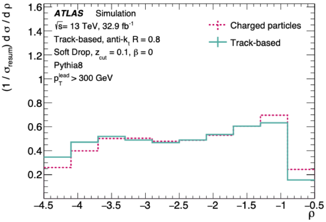


Left: The distributions of the jet η for different β values with $z_{cut} = 0.1$.
Right: The distributions of the jet η for different z_{cut} values with $\beta = 1.0$.

arXiv:2107.12984v1



arXiv:1912.09837v2



arXiv:1805.05145v2