Utrecht University

Jet quenching observables

a quick look at some proposals in this meeting

Marta Verweij

Mar. 5, 2021

STRONG2020

Frequently returning question in this seminar series:

How robust is this observable in the ‘real’ world?

This talk: a first shot at answering that question

Disclaimer: due to lack of time or tools I wasn’t able to address all proposed methods.

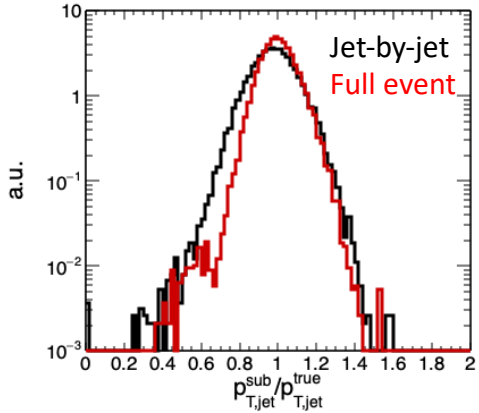
Approach

Embed PYTHIA8 events in thermal background

Same setup as for TH Institute jet workshop in 2017 [arXiv:1808.03689]

Subtract background using Constituent Subtraction

- Jet-by-jet
- Full event



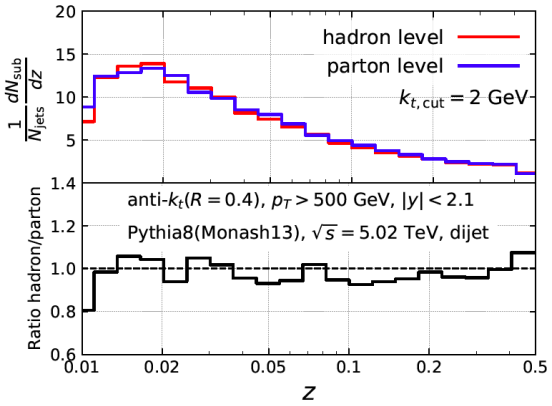
Jet fragmentation into subjets in heavy-ion collisions

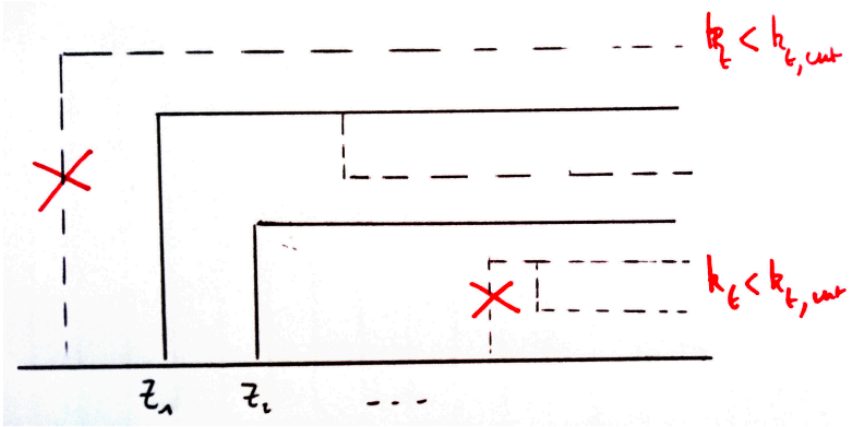
P. Caucal, E. Iancu, A.H. Mueller and G. Soyez

Institut de Physique Théorique

STRONG2020 workshop - November 27th - online
see also **JHEP 10 (2020) 204**

FF from subjets: *pp* study



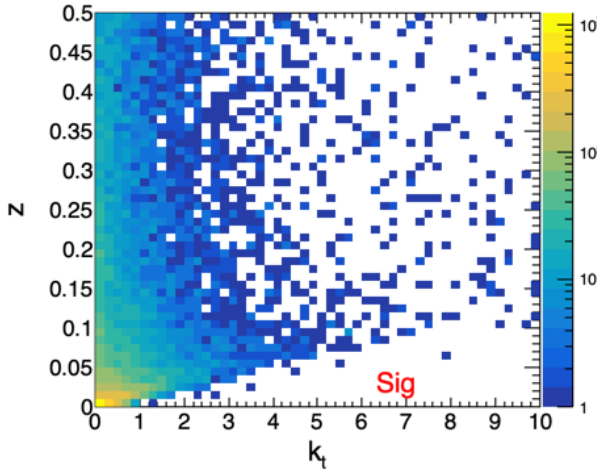


Subjet FF in HI background

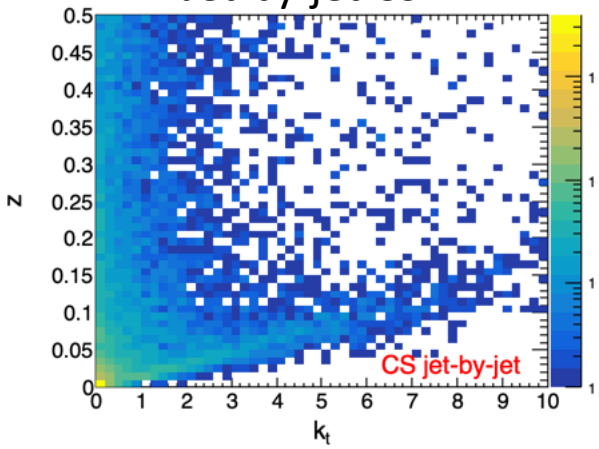
Anti-k_T, R=0.4
$p_{T,jet}$>130 GeV, |eta|<2
Reclustering: C/A

All splits in the primary branch are used
(no grooming)

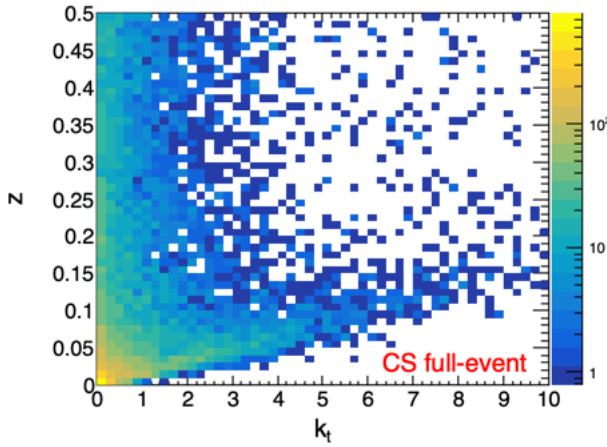
PYTHIA8, no bkg



PYTHIA8 + bkg
Jet-by-jet CS



PYTHIA8 + bkg
Full event CS

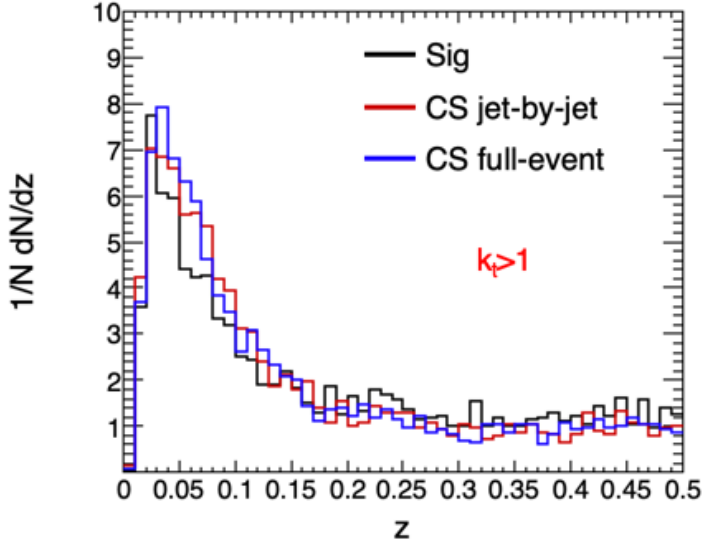


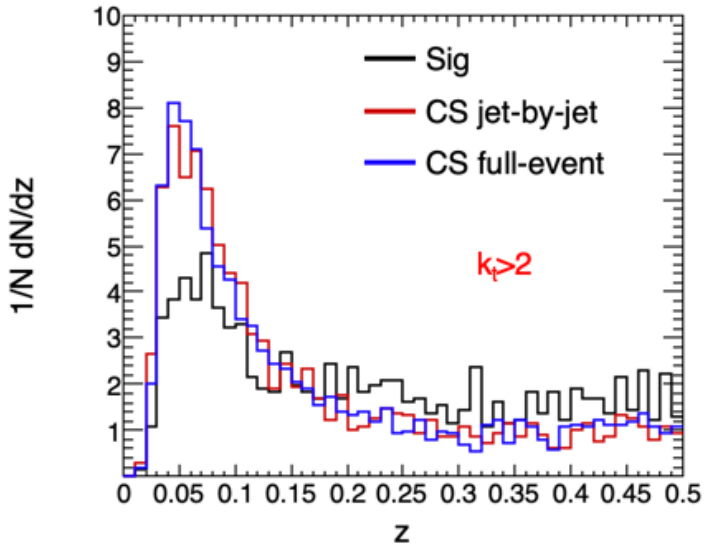
With background+subtraction a linearly correlated structure appears at large k_t

Subjet FF in HI background

Anti-k_T, R=0.4
$p_{T,jet}$>130 GeV, |eta|<2
Reclustering: C/A

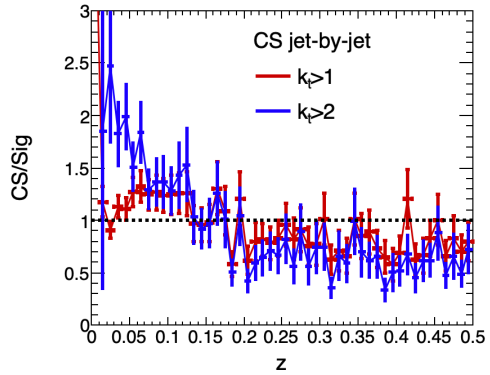
All splits in the primary branch are used (no grooming)

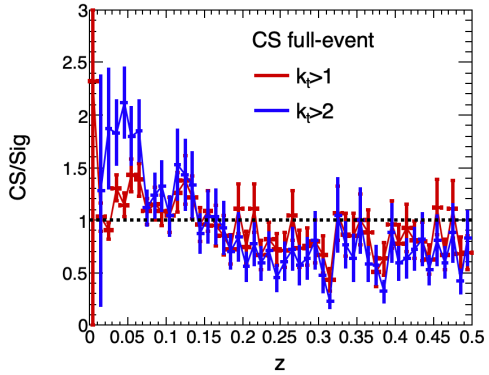




The linear structure in the correlation plot (z,k_t) enhances low z subjets
Effect larger for larger k_t cut

Subjet FF in HI background

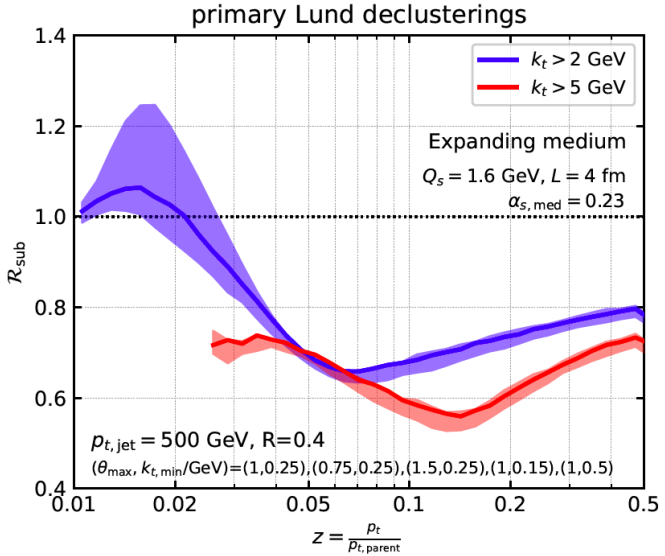




Physics and background features very similar

To be studied:

- How often do ‘fake’ leading branches contribute?
- Or are we dominated by ‘fake’ soft splittings?



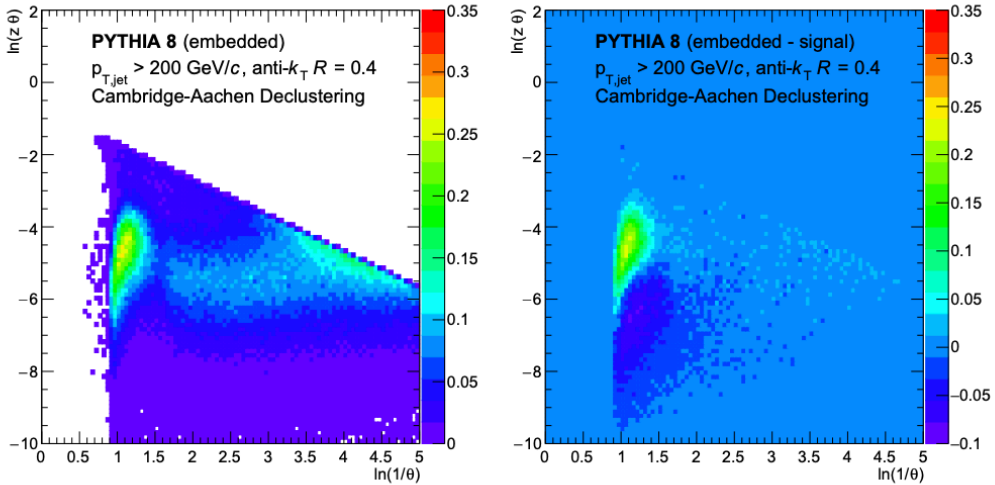
JHEP 10 (2020) 204

P. Caucal, Nov. 27

https://github.com/mverwe/JetToyHI/blob/strong2020/runSubjetFF.cc

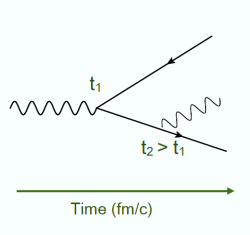
Noisy Lund Plane

The observed problem is the same as reported after the 2017 jet TH institute



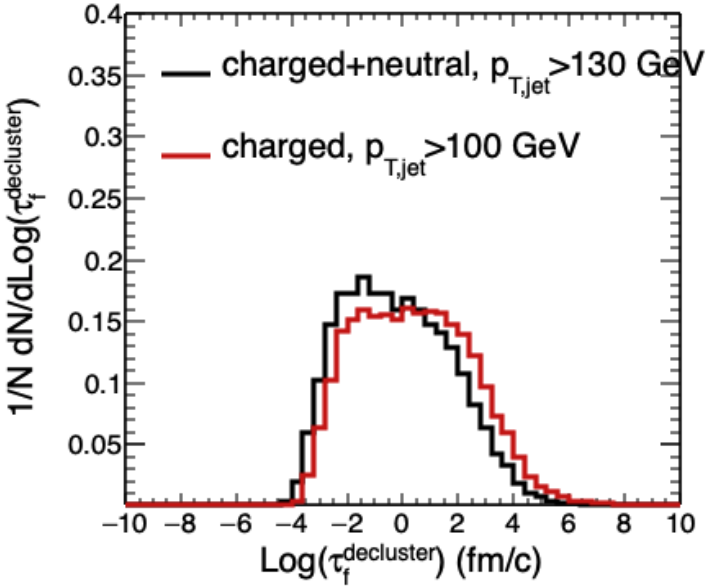
arXiv:1808.03689

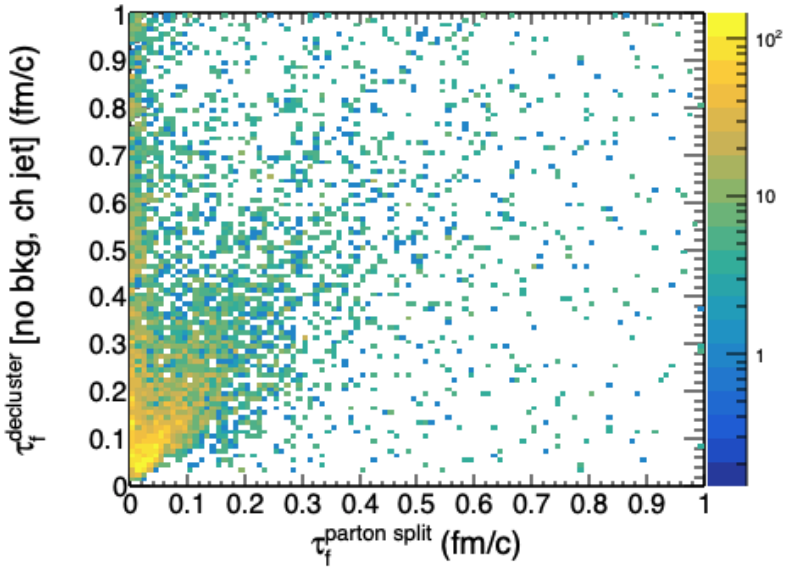
Time clustering



Based on ideas presented by Liliana on Jan. 8. See also: arXiv: 2012.02199

Expect to need the best angular resolution detectors can offer → charged particles
Does the signal survive if we only use charged particles? YES

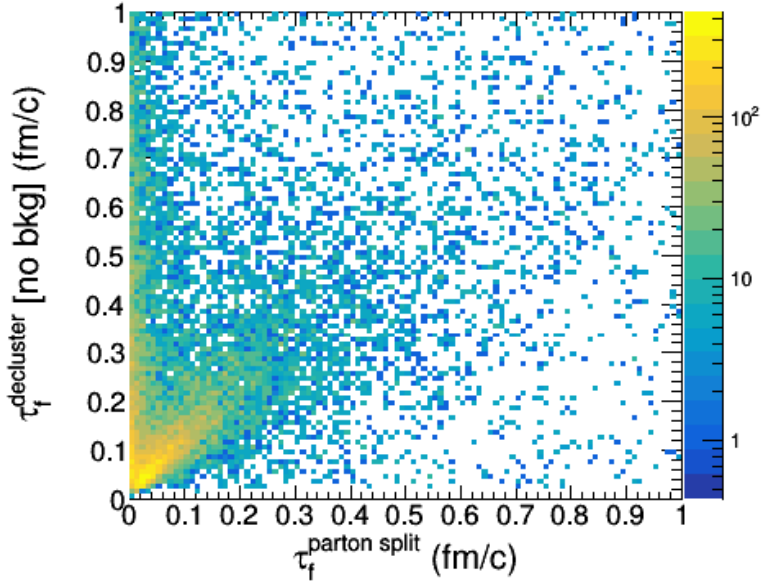


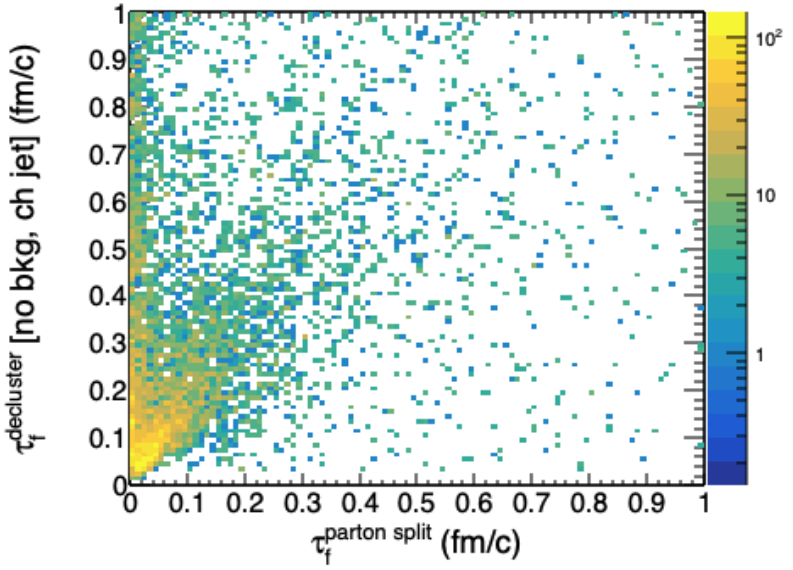


$$\tau_{form} \approx \frac{1}{2Ez(1-z)(1-\cos\theta_{12})}$$

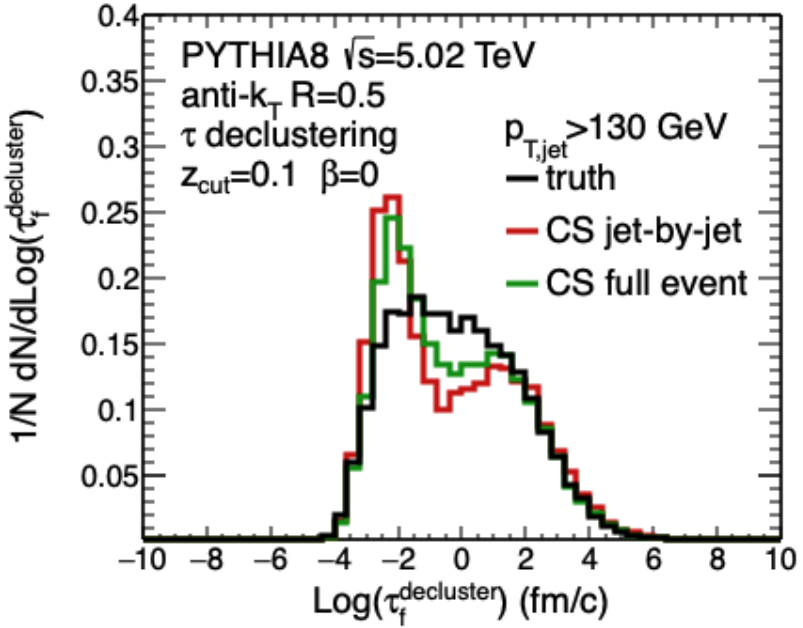
Time clustering

Expect to need the best angular resolution detectors can offer.
Does the signal survive if we only use charged particles? YES, but weaker





Time clustering



For all 3 distributions same jet sample.
Selected on kinematics of signal.

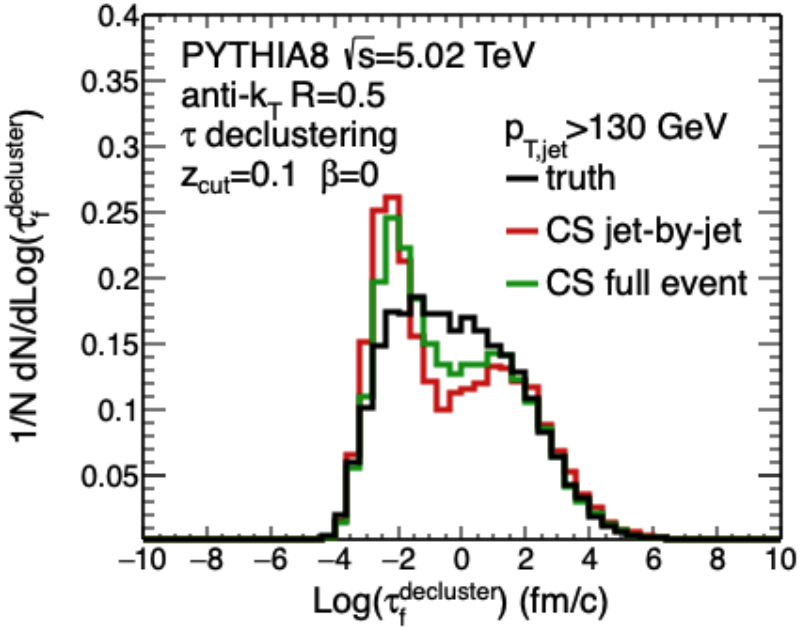
Adding heavy-ion background to the exercise

Background: thermal model. Rho~220 GeV

Subtraction with constituent subtraction:
- jet-by-jet, a=0
- Full-event, a=0, Rparam=0.25

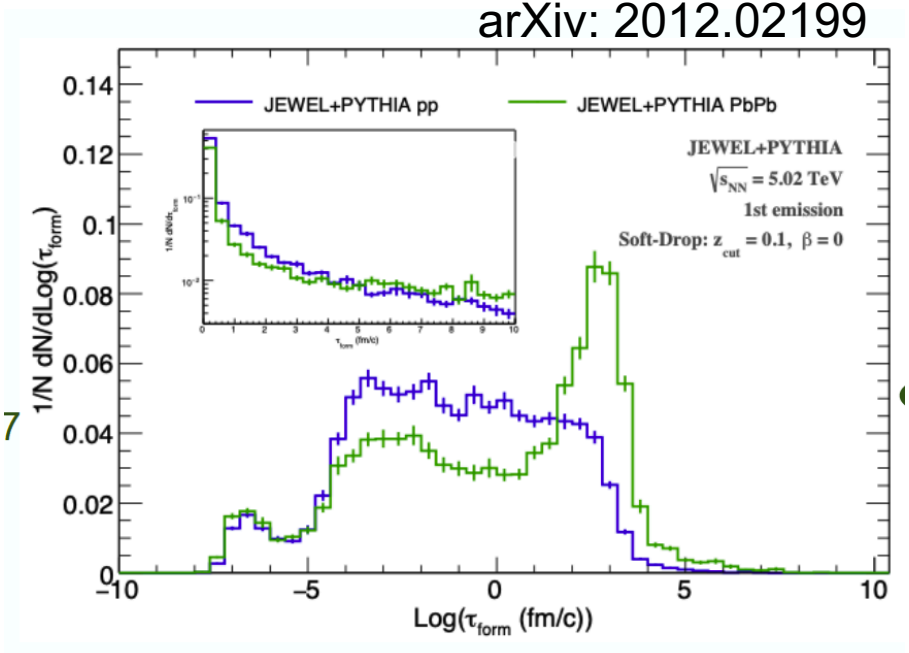
Background causes a peak for small tf

Time clustering



For all 3 distributions same jet sample.
Selected on kinematics of signal.

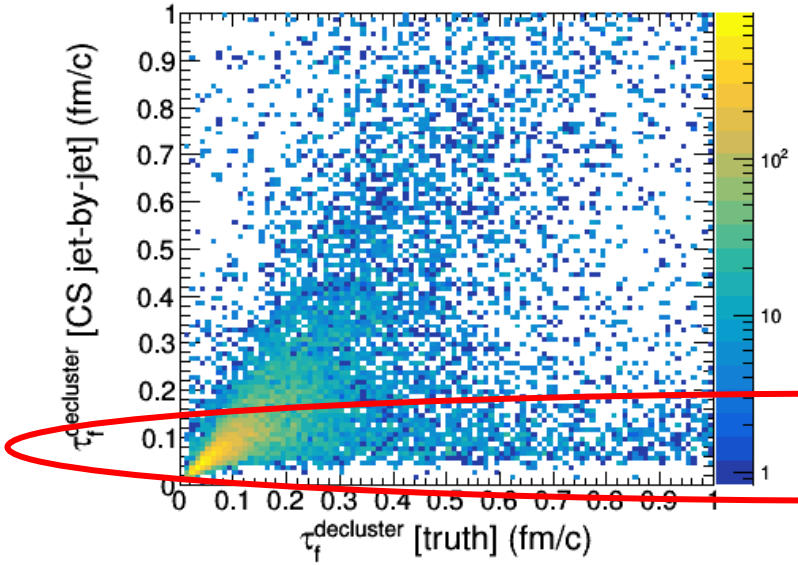
arXiv: 2012.02199



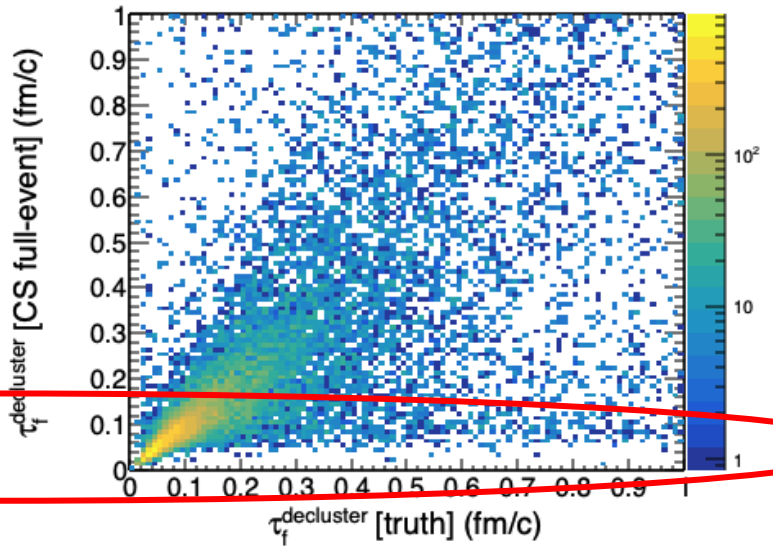
Good news: background and quenching signal peaking in different part of distribution

Time clustering

CS jet-by-jet



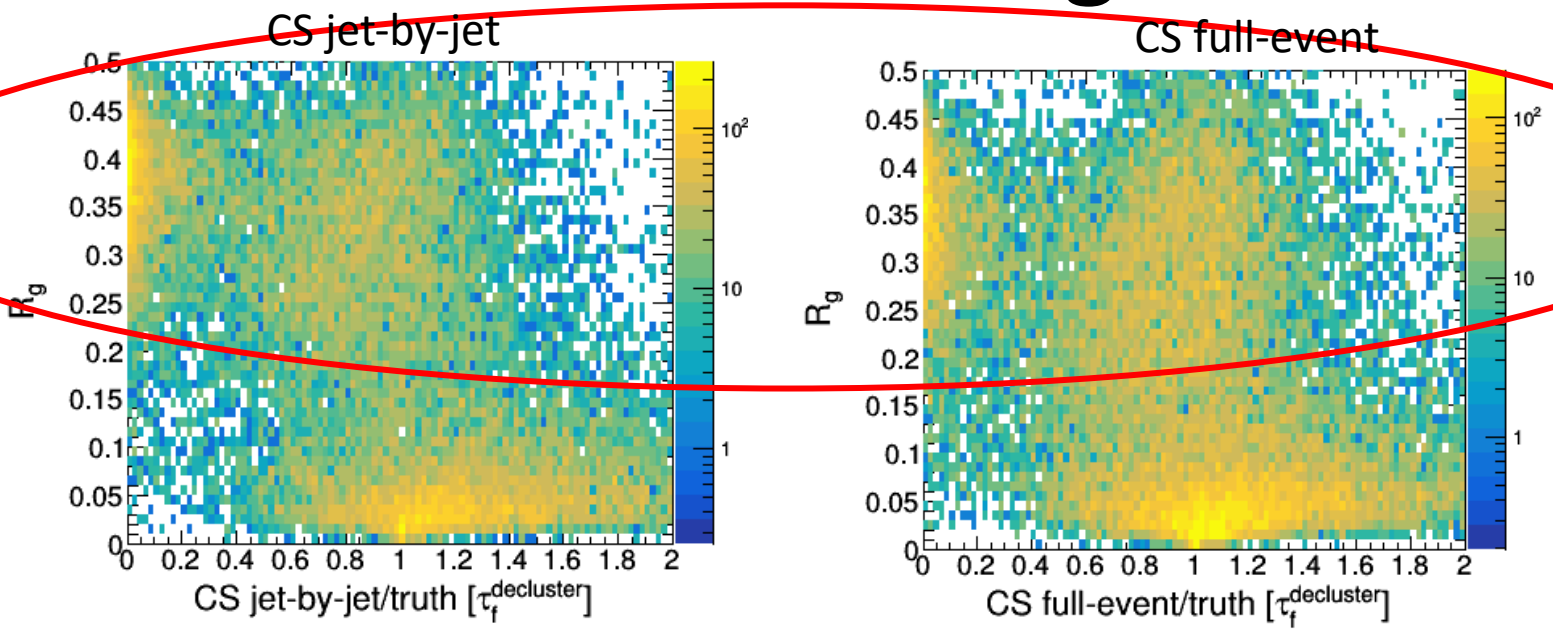
CS full-event



Peak comes from subjets that have bad correlation with the PYTHIA-only jet

We've seen this before

Time clustering

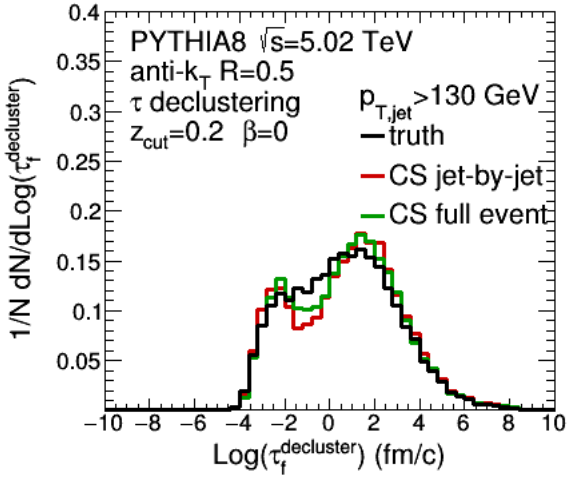


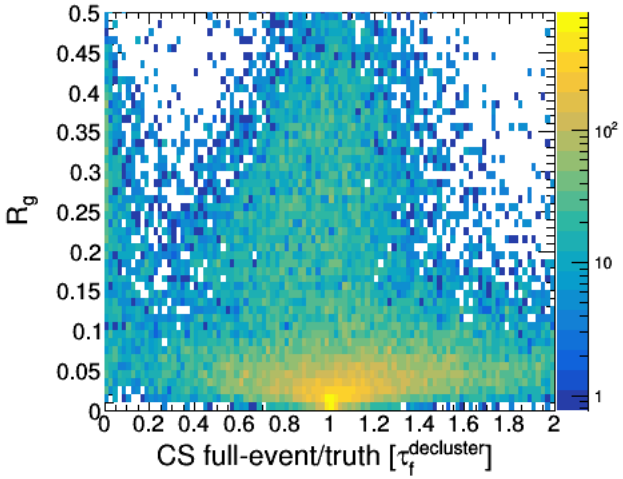
True subjet is not selected due to background contribution to softer jet

Performing these type of measurements using grooming techniques, forces you into a region of phase-space where quenching effects are small

Time clustering – z_{cut}=0.2

As for R_g in the ALICE analysis, with z_{cut}=0.2 your biggest problems are removed





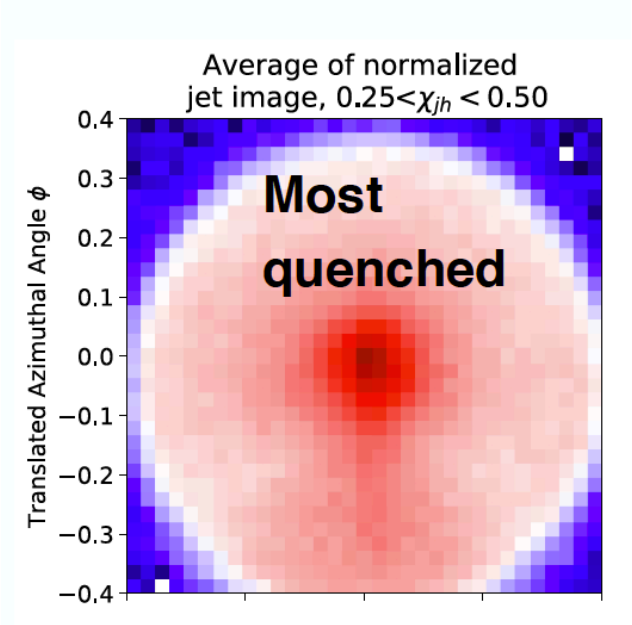
Alternatives:

- move to much higher p_T
- improve your background subtraction
- don’t groom

https://github.com/mverwe/JetToyHI/blob/strong2020/runTimeClusBkg.cc

Predicting energy loss

Dani's CNN, presented on Dec. 4



Images are rotated such that subjets are oriented in the same way

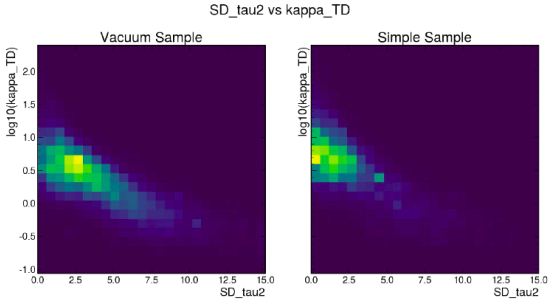
Will need aggressive background removal to avoid that background defines jet rotation. Example: grooming with large z_{cut}

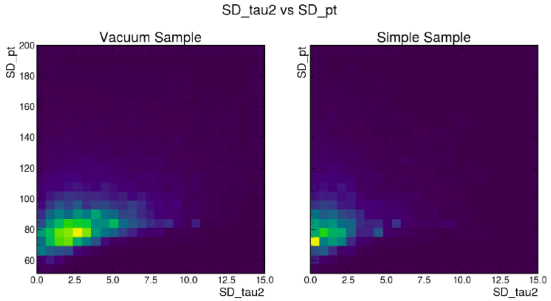
How much will that affect the energy loss prediction? Dani showed it will be less predictive with particle p_T cut. Need compromise: taking in account model with the soft HI background

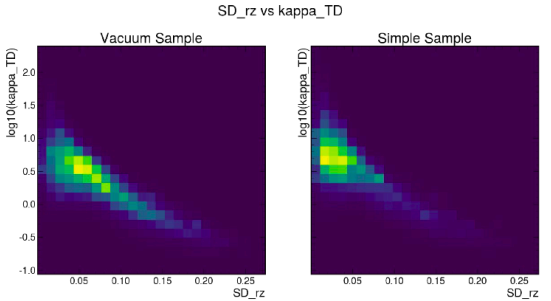
arXiv:2012.07797

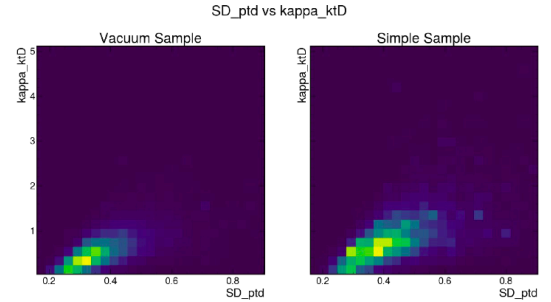
Correlations

Most discriminative correlations from Miguel. Nov. 20









Bingo for:

- (tau2, kappaTD)
- (tau2, pt)
- (rz, kappaTD)
- (ptD, kappaktD)

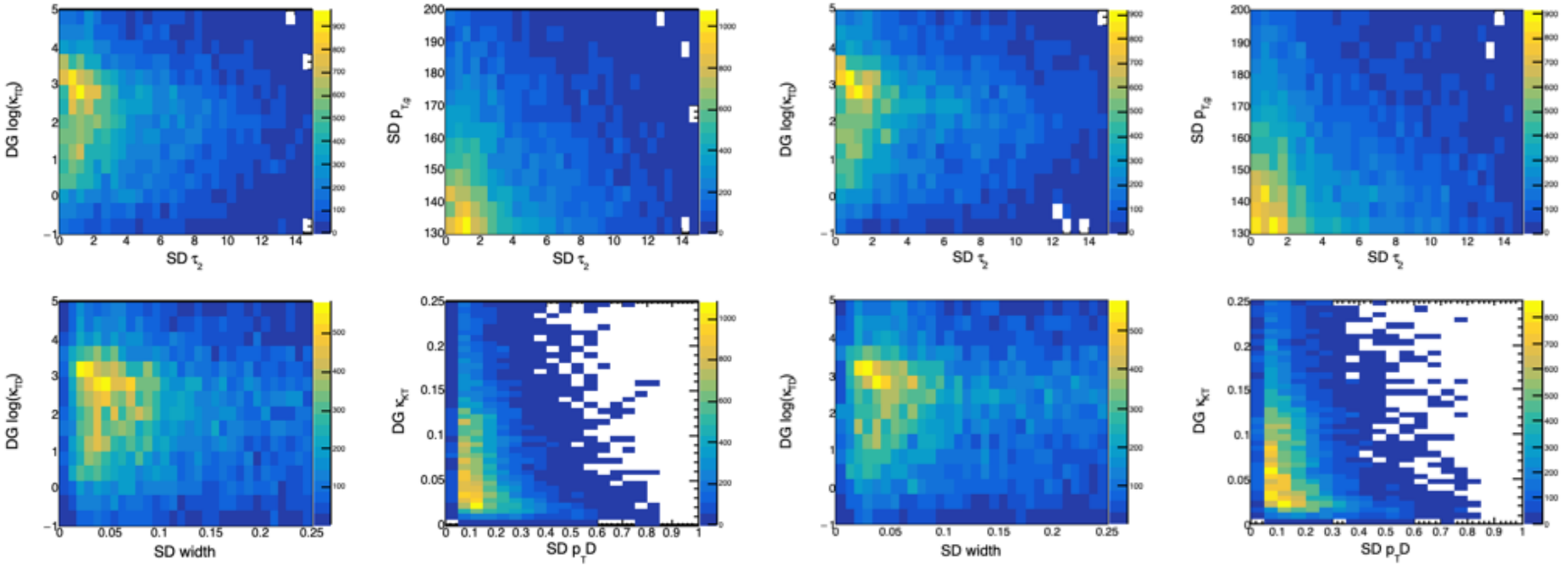
Do these correlations survive the noisy environment?

Correlations in background

Anti-k_T, R=0.4
$p_{T,jet}$>130 GeV
|eta|<2

PYTHIA only

CS full-event



Work in progress. But for now, the correlations seem to survive the noise

https://github.com/mverwe/JetToyHI/blob/strong2020/runMiguelsVariablesBkg.cc

Summary

All observables suffer from a noisy environment

Not performed here: one could setup a procedure to assign noise-sensitivity / robustness against noise

Thank you for all the creative ideas. We've work to do!