STRONG-2020

Annual Meeting 2024

NA3-Jet-QGP: Quark-Gluon Plasma characterization with jets – Ankita Budhraja

Plan of presentation

01 NA3 Goals and progress achieved by the WP during the last year

02 Highlights on the survey of jet quenching observables

03 Achievements beyond the initial Work Program and final deliverables

01 NA3 Goals

- Theory-experiment collaboration on probing the QGP with jets
- Identify observables sensitive to specific aspects of parton energy loss
- provide public tools for the above

01 Progress achieved by the WP during the last year

- Report on the survey of observables published in SciPost Physics https://scipost.org/10.21468/SciPostPhys.16.1.015 on 18 January, 2024 after a long review process.
- All analysis pipeline and MC data released publicly https://zenodo.org/records/7808000
- Codes adaptable for further analyses - a preliminary study after UE embedding and subtraction reported by João A. Gonçalves at ECT* in Feb, 2024

01 Progress achieved by the WP during the last year

- Series of meetings organized online in 2021; attended actively by around 20-30 experts.
- Talk on survey of the observables for jet characterization in QGP delivered in ECT* “New jet quenching tools…” conference https://indico.ectstar.eu/event/198/ organized in Feb, 2024.
- A discussion on recommendations for priority observables also held in the same conference.

02 Highlights on the survey of jet quenching observables

- A survey of 31 jet observables that return a single value per jet
  - p_T, n_{const}, azimuthal angle, jet mass
  - angularities [distribution of jet constituents around jet axis]
  - N-Subjettiness
  - jet-charges
  - Dynamical grooming observables [first splitting for given ordering variable]
- all observables computed in SoftDrop groomed jets

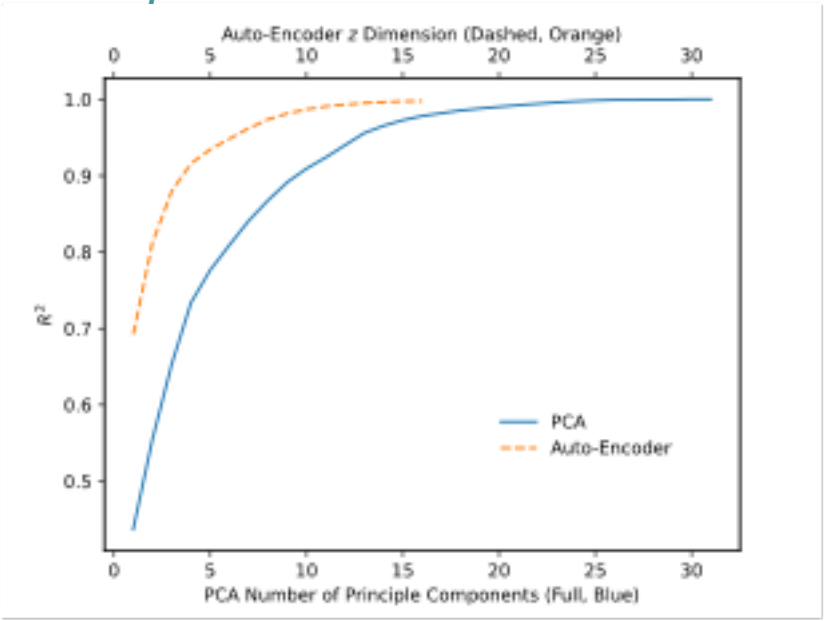
02 Highlights on the survey of jet quenching observables

- Two complementary ML analysis to establish correlations between observables separately on pp and AA samples
  - Principal Component Analysis [PCA] sensitive only to linear correlation
  - Deep Auto-Encoder Analysis [AE] also sensitive to non-linear relations among observables
- Unquenched vs Quenched Discrimination Analysis
  - Boosted Decision Trees [BDT]

02 Highlights on the survey of jet quenching observables

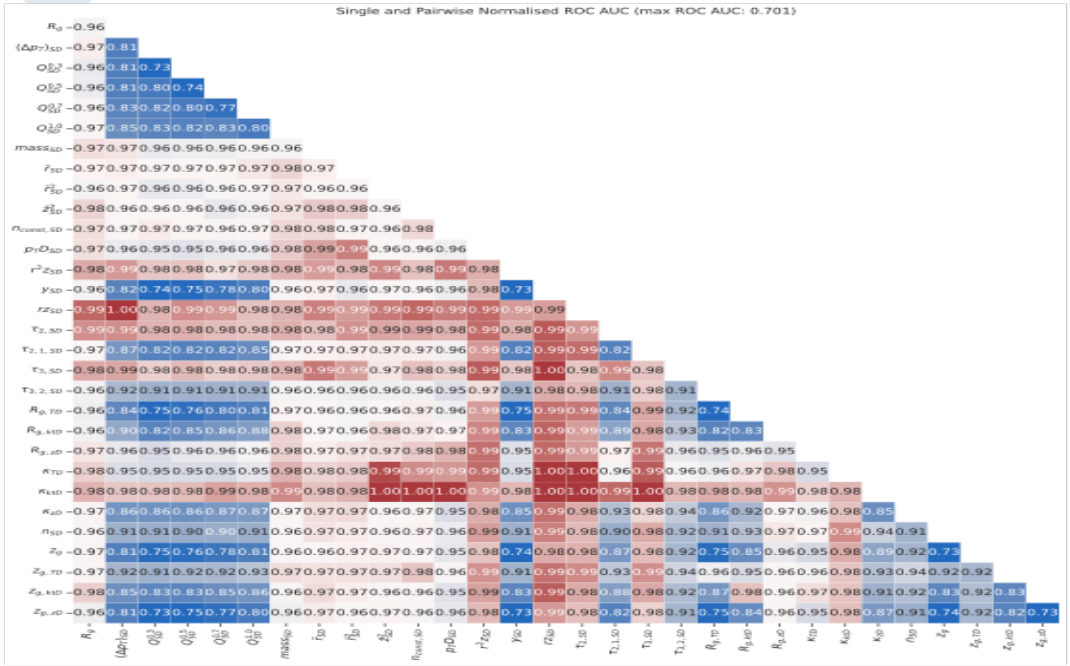
Ability to reconstruct full distributions of all observables given a number of independent dof

- Information content of the entire set can be described by a small number of effective dof
- Number of effective dof decreases once non-linear relations [AE] taken into account
- Effective dof do not correspond to simple observables, but rather combinations of [almost] all observables

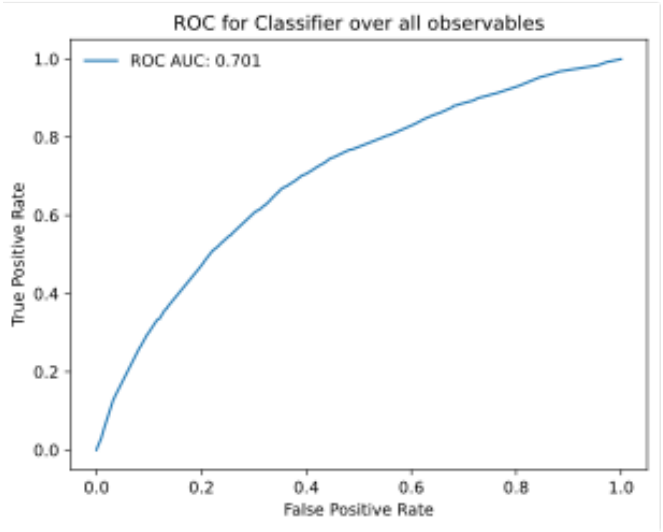


number of independent dof

02 Highlights on the survey of jet quenching observables



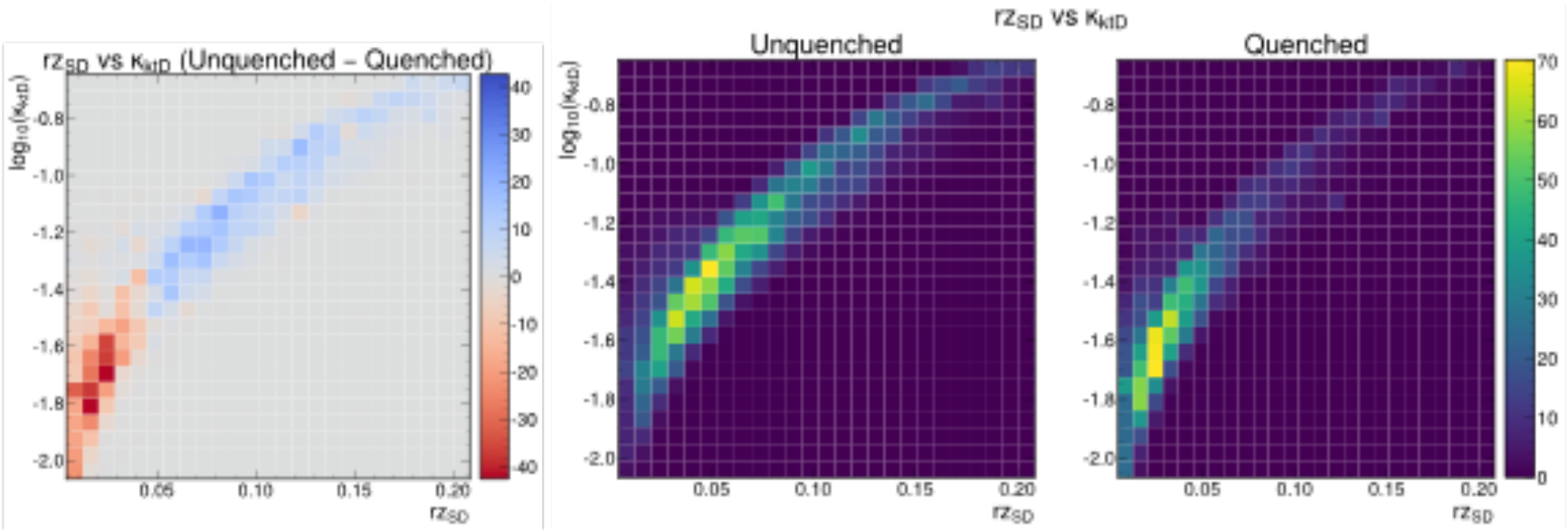
Discrimination power for BDTs trained only on pair of observables



Discrimination power for BDT with all observables

- Some observables and pairs of observables [those in dark red] have same discrimination power as full set :: discrimination can be made using carefully selected pairs

02 Highlights on the survey of jet quenching observables



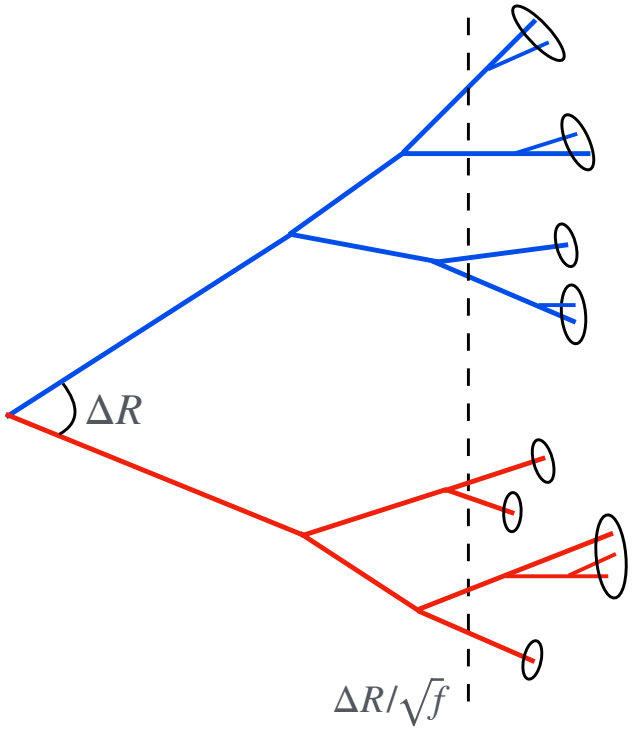
- Quenching effects manifest themselves through strong population migration NOT modification of correlation

03 Achievements beyond the initial Work Program and final deliverables

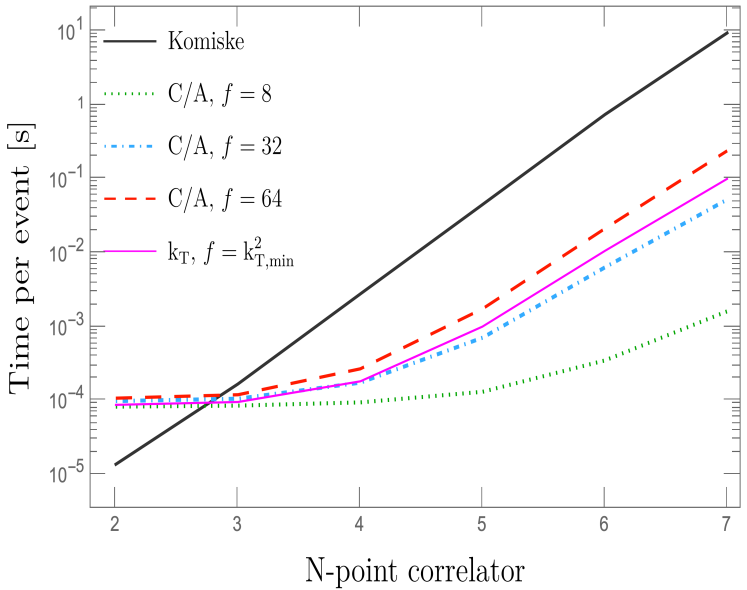
- A new method recently proposed for a fast evaluation of N-point energy correlators.
- Project finished and submitted to arXiv in June, 2024 https://arxiv.org/abs/2406.08577. Will be submitted for publication in Physics Letters B very soon.
- Public release of the code available at https://github.com/abudhraj/FastEEC/releases/tag/0.1.
- The method allows for a substantial gain in computing time for higher point correlators. Eg. For N=7, we obtain a speed up as high as 4 orders of magnitude, depending on the desired accuracy.

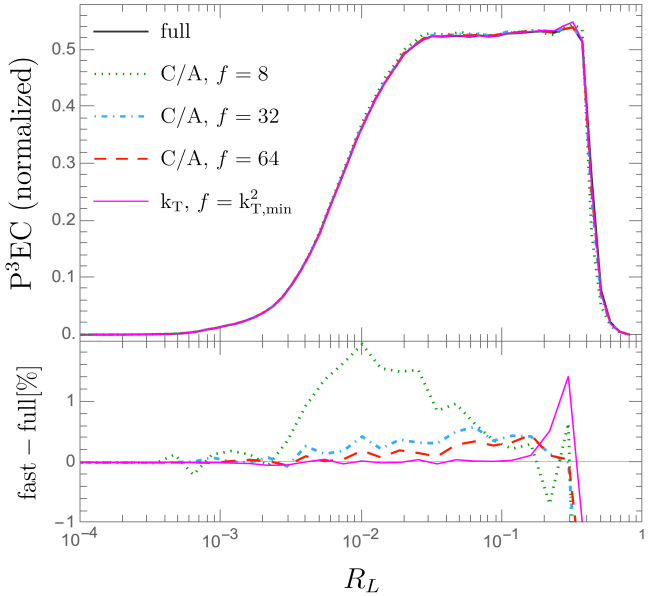
03 Achievements beyond the initial Work Program and final deliverables

- Recluster the final state particles with C/A or kt so that all particles are in one jet.
- Take first split and construct subjets with $r = \Delta R/\sqrt{f}$
- Obtain contribution to correlator involving subjets taking from both sides of split.
- Recurse on the parents to obtain correlations at smaller angular scales.



03 Achievements beyond the initial Work Program and final deliverables





- Provides a natural way to study higher weights of energy correlators without limiting the scales.
- This method will be further exploited to study energy energy correlators based on formation time for jet characterization in QGP.

03 Achievements beyond the initial Work Program and final deliverables

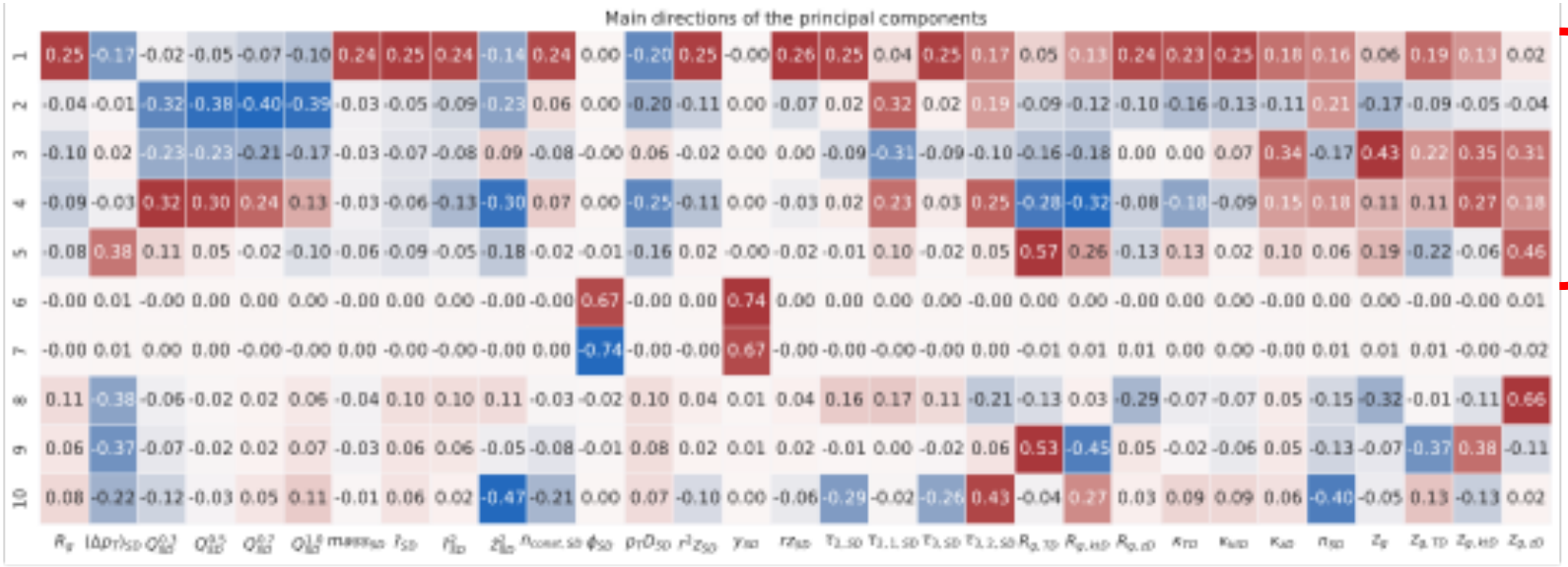
Final deliverable:

- Write-up of white paper is in progress and will be announced soon.

Thank you all for attention !!

Backup Slides

02 Highlights on the survey of jet quenching observables



These 5 dof account predict full distributions of all observables with ~80% accuracy

- Effective dof do not correspond to simple observables, but rather combinations of [almost] all observables