Jet substructure and ML

Les Houches 2023

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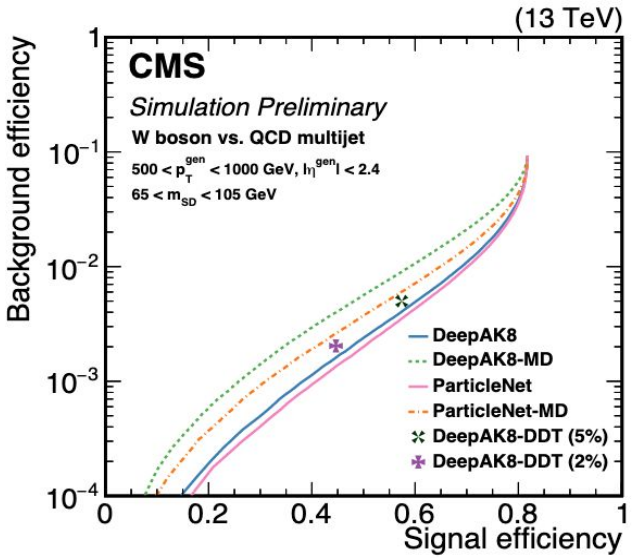
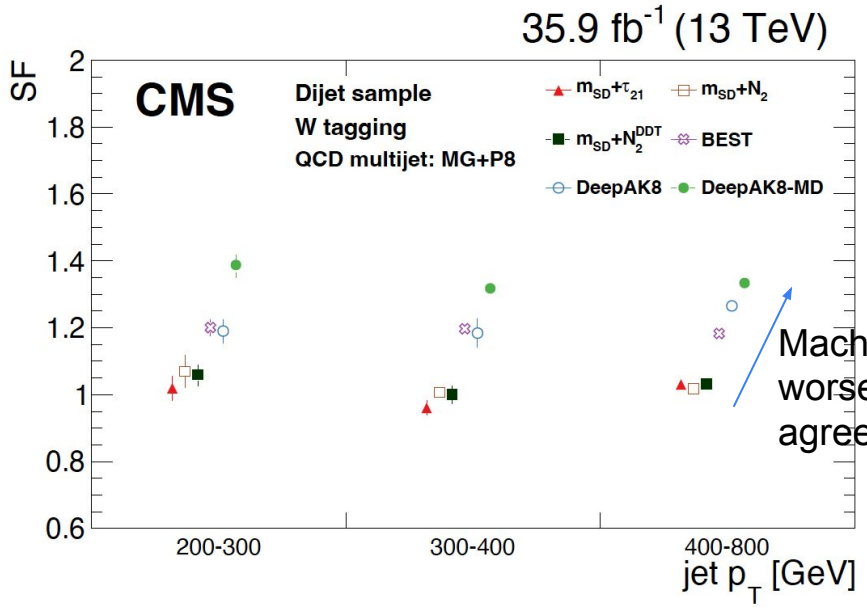
Jet substructure of quark/gluon jets: machine learning

- Experiments use ML-based jet taggers (quark, gluon, bottom, charm, W, Z, H, top), partially correlated with measured jet substructure observables.



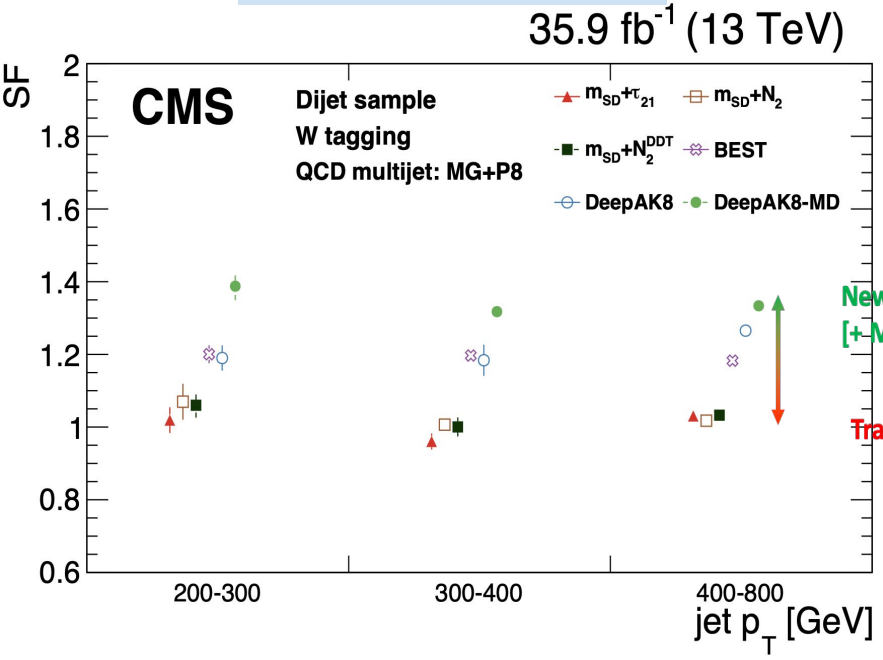


Machine learning worsens data/MC agreement

Dependence on MC generation

- Di-jet events [i.e. gluon-enriched]: MG+Pythia8.212 vs. Herwig++ v2.7.1

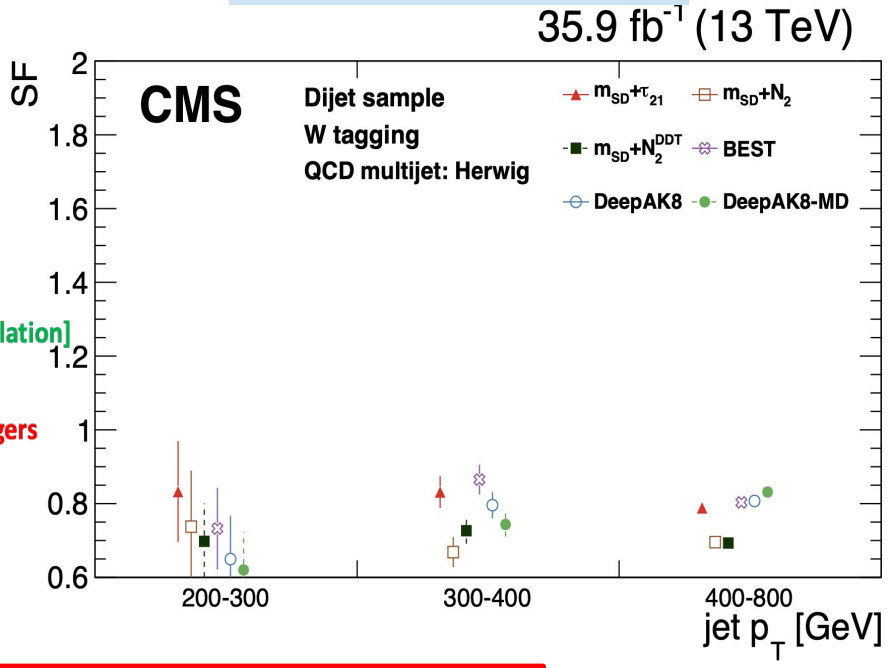
QCD MC: MG+P8



New generation [+ Mass decorrelation]

Traditional taggers

QCD MC: HERWIG

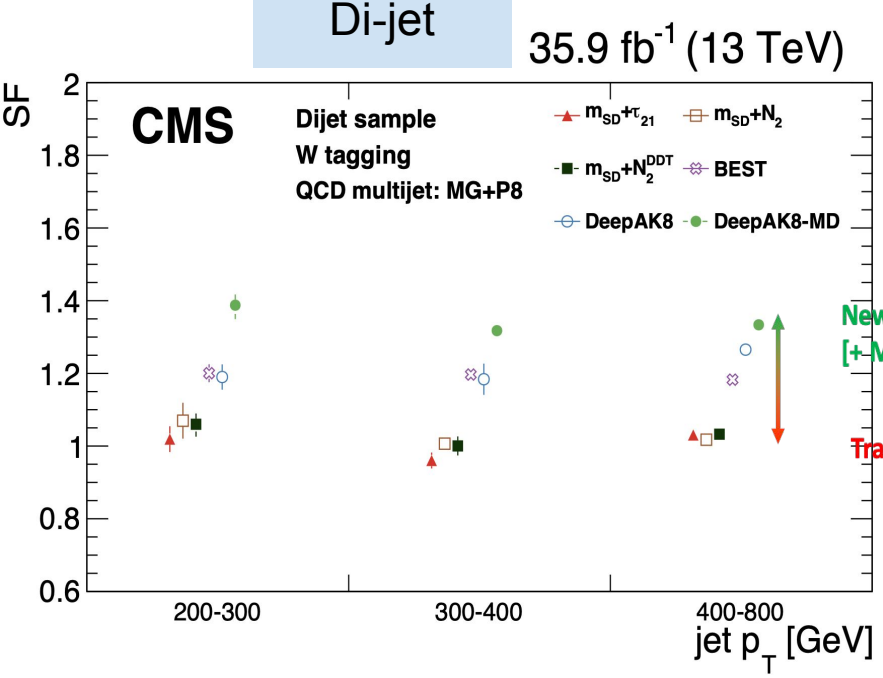


Strong dependence on the MC generator choice

Dependence on sample composition: Q-vs-G

- Same MC generator [MG+Pythia8.212]
  - Di-jet events [i.e. gluon-enriched] vs, γ+jets events [i.e. quark-enriched]

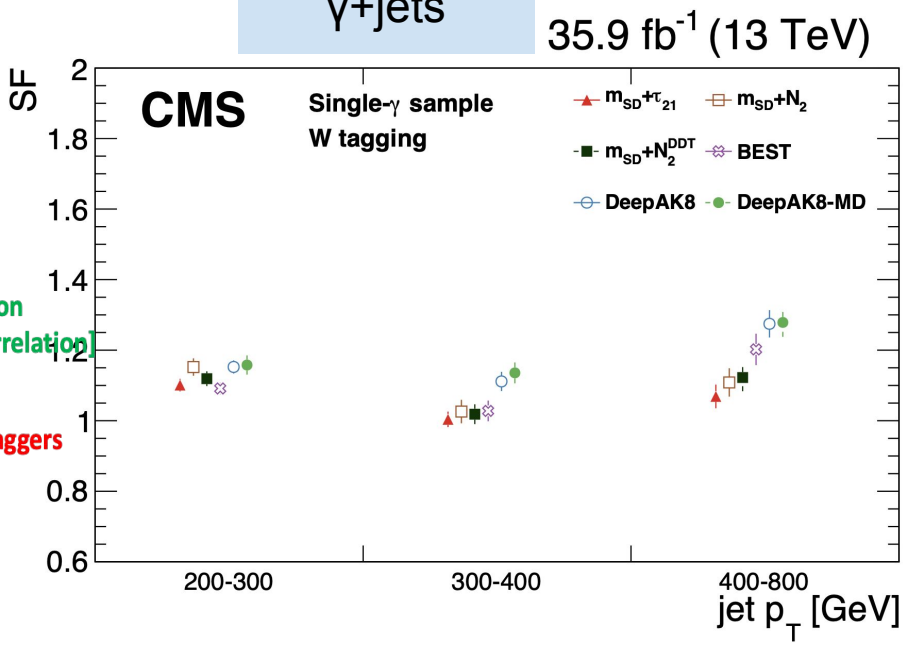
Di-jet



New generation [+ Mass decorrelation]

Traditional taggers

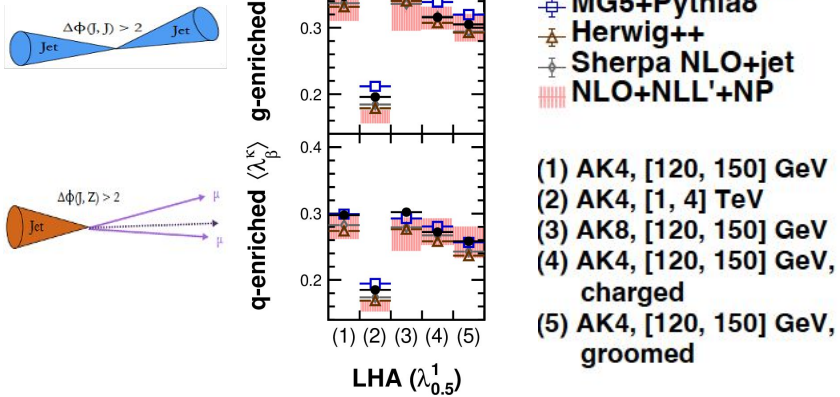
γ+jets



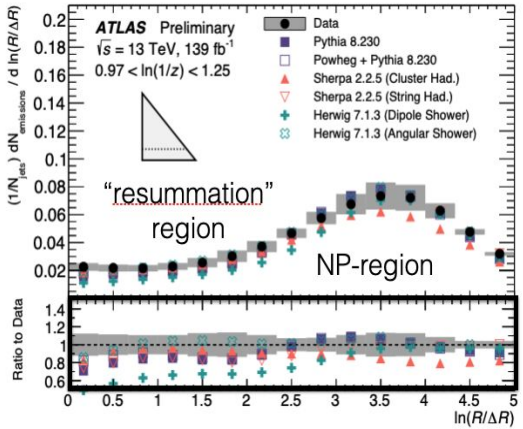
Different behaviour between samples

Jet substructure measurements

- From measurements we know how much simulation is away from the truth for specific observables in q/g jets
- Can we feed this information into the training?
- How much state-of-the-art ML-taggers are correlated to the observables/phasespace in the measurements of substructure we already have?
- How to deal with the uncertainty on the part not-obviously correlated with well understood observables?



[2109.03340]



▲ vs. ▽ hadronization

✚ vs. ⛒ parton shower

[2004.03540]

Some related ideas

Jet tagging in the Lund plane with graph networks

Frédéric A. Dreyer,[a] Huilin Qu[b]

Is infrared-collinear safe information all you need for jet classification?

Dimitrios Athanasakos,[1,2] Andrew J. Larkoski,[3] James Mulligan,[4,5] Mateusz Płoskoń,[4] Felix Ringer[1,2,6,7]

Improving Robustness of Jet Tagging Algorithms with Adversarial Training

Annika Stein[1] · Xavier Coubez[1,2] · Spandan Mondal[1] · Andrzej Novak[1] · Alexander Schmidt[1]

Estimate NN tagger performance

- From state-of-the-art generators compared to measurements
- From state-of-the-art generators reweighted to different measured observables, or Lund-plane