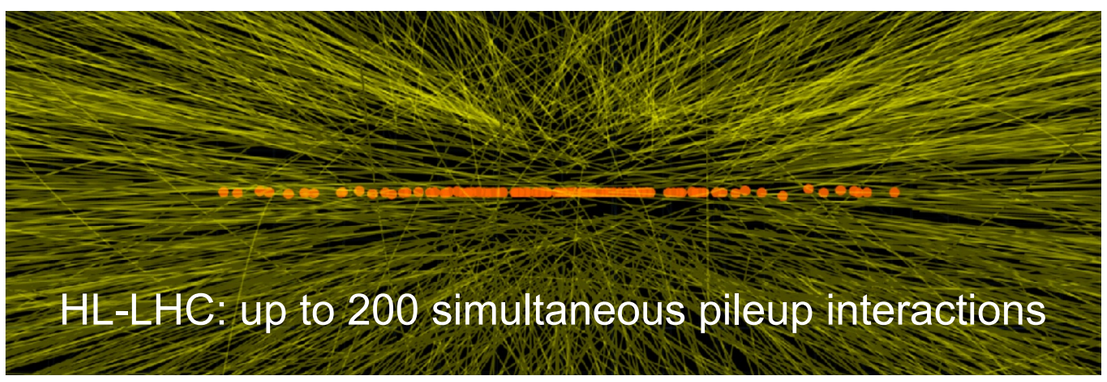
Heavy flavor jet tagging algorithm developments at CMS for HL-LHC

The Tenth Annual Large Hadron Collider Physics conference (LHCP 2022)

Daniel Bloch (IPHC), Ulrich Husemann, Soureek Mitra, Thomas Müller, Max Neukum, **Emanuel Pfeffer**,
On behalf of the CMS collaboration

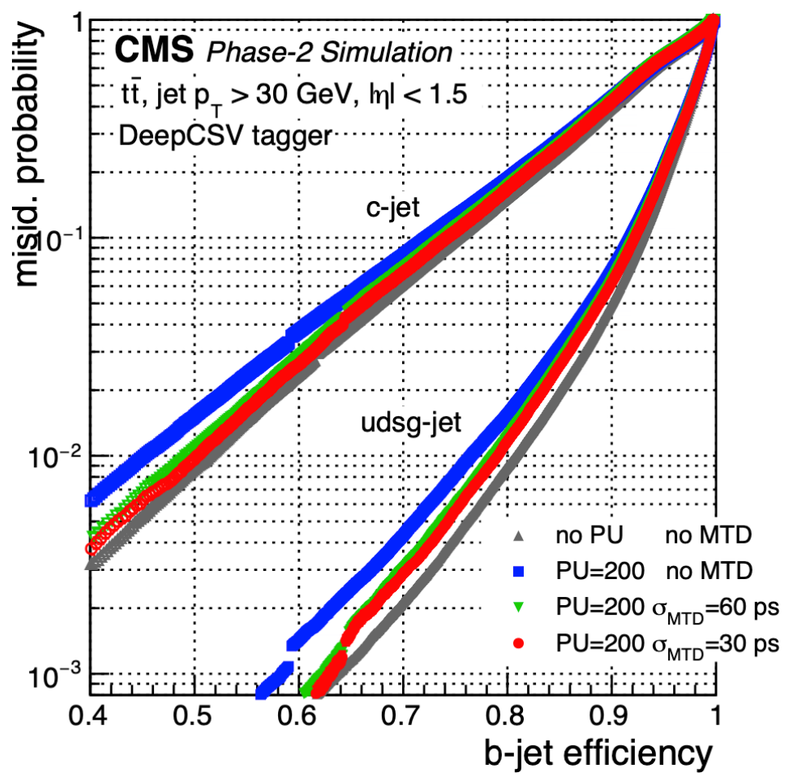
CMS upgrade for HL-LHC

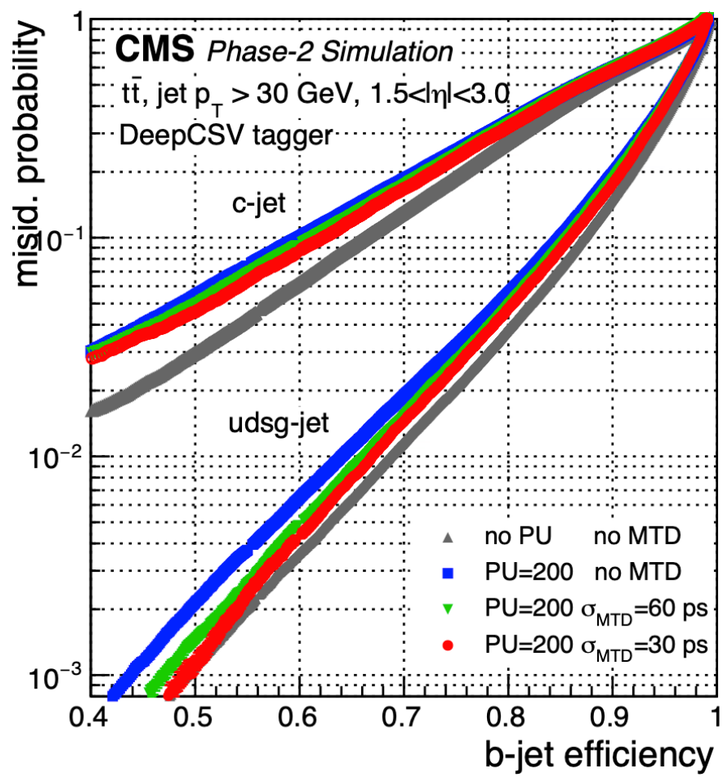


Three major improvements in the detector

- Tracker coverage up to $|\eta| \sim 4$
- Silicon based calorimeter with high granularity and better resolution
- MIP Timing Detector (MTD) with timing information [1] to mitigate spurious secondary vertices arising from pileup (PU)

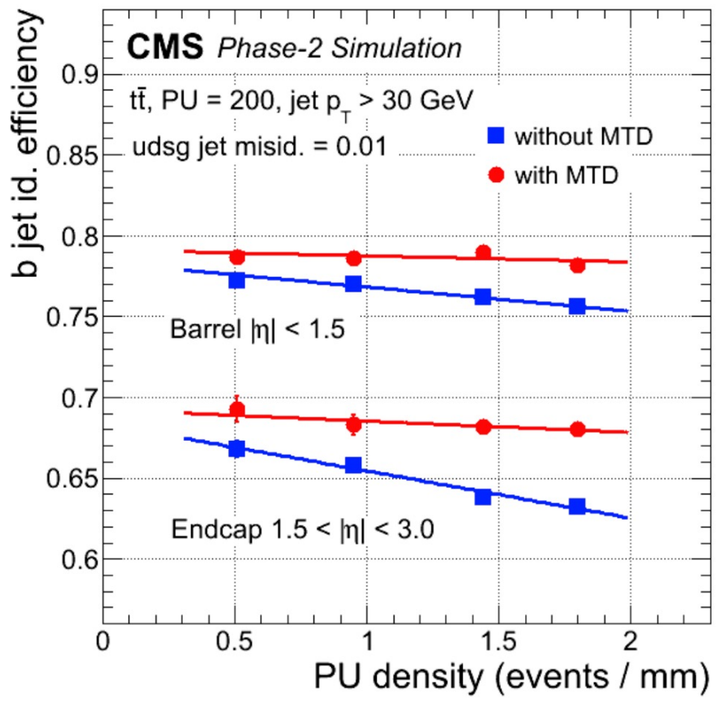
Tagging performance





b-jet tagging efficiency decreases by about 10% at high pileup (≈200) compared to the no-pileup case at 0.1% light (udsg) misdentification rate. ROC curves for light and charm jets for $|\eta| < 1.5$ (left) and for $1.5 < |\eta| < 3.0$ (right) show that the tagging performance is improved with timing for 30 (red) and 60 ps (green) resolution hypotheses compared to the without (blue) timing case. A comparison with the zero pileup hypothesis (grey) indicates that PU effects are reasonably mitigated by the information from MTD.

Performance vs PU



The b-tagging efficiency shows almost no dependence on the PU density at 1% light misidentification rate. Further gain is expected from retraining the b-tagging discriminants for 200 PU conditions.

Outlook

- Overall impact of timing information from MTD on HF jet tagging performance looks promising. More effort planned to extract maximum performance.
- Comparison with DeepJet [3] and ParticleNet [4]

Reference

[1] MTD TDR: https://cds.cern.ch/record/2667167
[2] DeepCSV: DOI: 10.1088/1748-0221/13/05/P05011
[3] DeepJet: DOI: 10.1088/1748-0221/15/12/P12012
[4] ParticleNet: https://arxiv.org/abs/1902.08570

Contact: emanuel.pfeffer@cern.ch