B-hadron identification in b-jets using novel deep learning technique in pp collisions in CMS

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On behalf of CMS Collaboration

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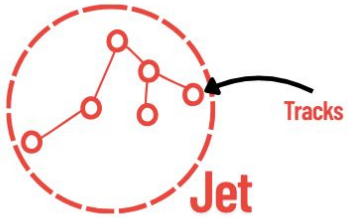
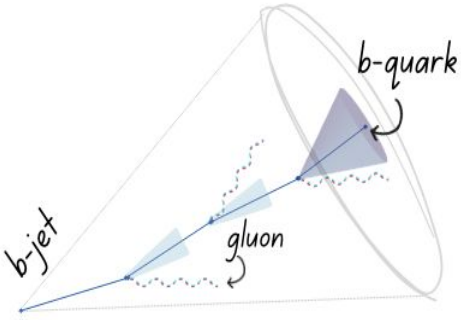
EuCAIF

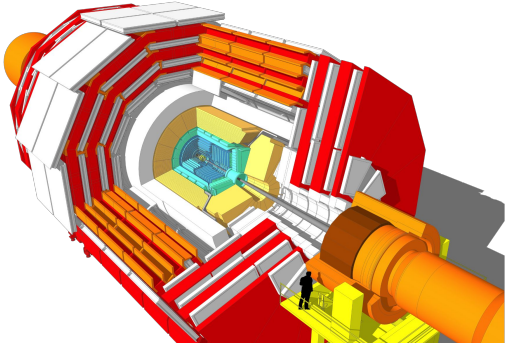
Poster ID: **106**

Input





Jets are modeled as graphs with individual tracks as nodes, enabling the network to capture complex dependencies inherent in particle interactions.



CMS Detector (Compact Muon Solenoid)

- **Silicon Tracker:** Reconstructs charged particle paths.
- **ECAL:** Measures energy of electrons and photons.
- **HCAL:** Measures energy of hadrons.
- **Superconducting Magnet (3.8 T):** Bends charged particle tracks.
- **Muon Detectors:** Identify and track muons outside the calorimeters.

Dataset

- **p-p 5.02 TeV** : Number of jets: ~13M (Testing data: ~40K jets);
  Pb-Pb 5.02 TeV : Number of jets: ~5M (Testing data: ~140K jets)
- Loss Function, L = $CategoricalEntropywithLogits(y_{jet}, y_{truth}) + CategoricalEntropywithLogits(y_{track}, y^{trk}_{truth})$
- 16 features assigned to all tracks (nodes) used for training:
  - **Jet level features:** number of tracks, p_T^{jet}, η^{jet}, ϕ^{jet} . Jet level features are assigned identically to all the tracks (nodes) inside a jet (graph).
  - **Track level features:** p_T^{track}, η^{track}, ϕ^{track} , track impact parameter significance in 3D and 2D, distance of track from jet axis.
  - **Secondary Vertex features**: boolean value for secondary vertex track, Decay length significance in 3D and 2D, secondary vertex mass, Secondary vertex corrected mass* [9], normalized χ^2 of the SV fit.

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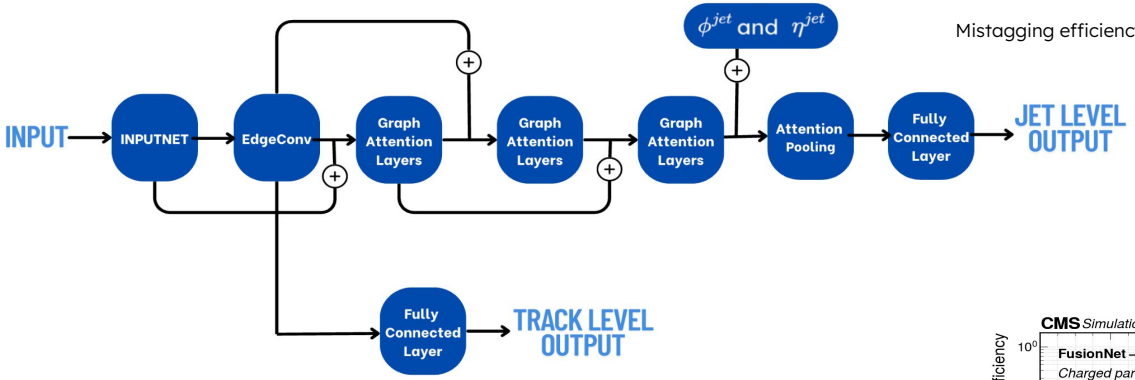
Architecture

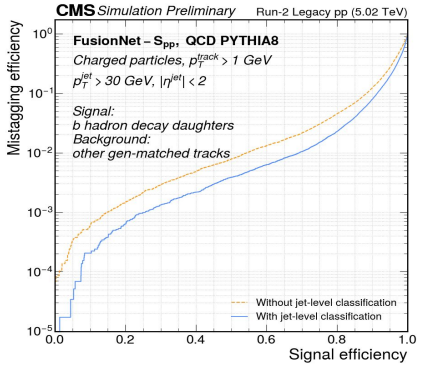
$$\text{Signal efficiency} = \frac{\text{tracks coming from b hadrons decays tagged as b-tracks using model score}}{\text{all tracks from b hadron decays}}$$

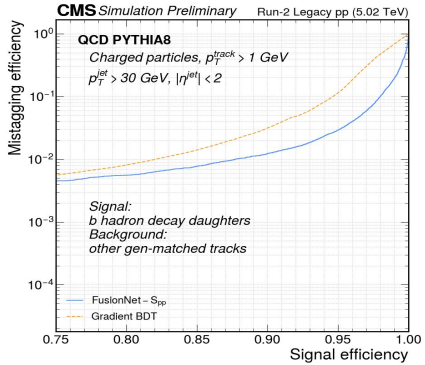
$$\text{Mistagging efficiency} = \frac{\text{non-b tracks tagged as b tracks}}{\text{tracks from all jets that are not matched to b hadrons}}$$



We also do performance analysis in bins of some key jet variables, presented in the poster in pp and PbPb.

Some Results in pp





Session B: 19 June

Thursday 12:00 - 15:00

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