Tau reconstruction and identification performance with the ATLAS detector for the High Luminosity LHC

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Tau reconstruction and identification

Tau reconstruction

The visible decays of the τ-leptons are reconstructed using the anti-k_t algorithm seeded by jets with p_T > 10 GeV. $\tau_{had\text{-}vis}$ candidates are required to have p_T > 20 GeV, contain one or three associated tracks (prongs) with a total charge of ± 1 and be within the range of |η|<4.0.

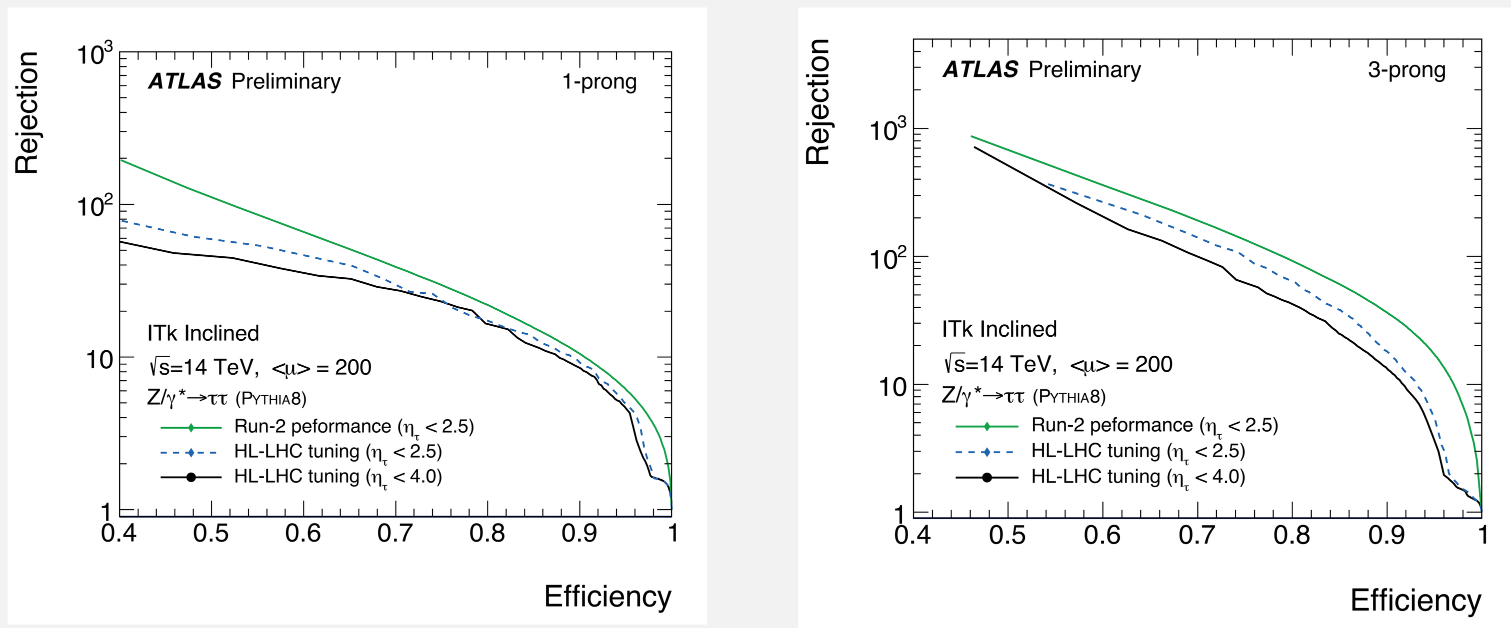
To separate $\tau_{had\text{-}vis}$ from **jet backgrounds**, a **Boosted Decision Tree (BDT) multivariate identification algorithm** is trained separately for one- and three-prong taus using **tracking** and **calorimetric shower** information. The algorithm presented here is optimized for the ATLAS detector and conditions envisaged for the HL-LHC. It is trained on a Drell-Yan signal sample, and is designed to provide τ identification efficiencies independent of both number of interactions per bunch crossing and the $\tau_{had\text{-}vis}$ p_T.

Three efficiency working points are evaluated as benchmark working points. They are evaluated for one-prong (three-prong) τ candidates, with efficiencies of 85% (75%) for the Loose, 75% (60%) for the Medium and 60% (45%) for the Tight working points.

Performance of the tau identification algorithm

A decrease in performance is seen for the **HL-LHC tuning** with respect to the **Run 2 performance**. The Run 2 algorithm is optimized for the current tracker and conditions (<μ> ~ 25), for $\tau_{had\text{-}vis}$ candidates in a range restricted to |η| < 2.5, and is applied to taus and jets simulated with the current detector layout and conditions. The HL-LHC algorithm is optimized for the HL-LHC conditions and detector layout, for tau candidates in a range extending to |η| = 4.0.

Part of the decrease in performance can be attributed to the change in eta ranges, but low training statistics and higher levels of pileup also affect the performance of the algorithm.



Jet rejection as a function of τ efficiency for the algorithm optimized for HL-LHC detector and conditions ("HL-LHC tuning") for τ candidates within |η| < 4.0 as well as for tau candidates restricted to |η| < 2.5, compared to the Run 2 performance optimized for the Run-2 detector and conditions ("Run-2 performance") for τ candidates within |η| < 2.5, shown for one-prong (left) and three-prong (right) taus.

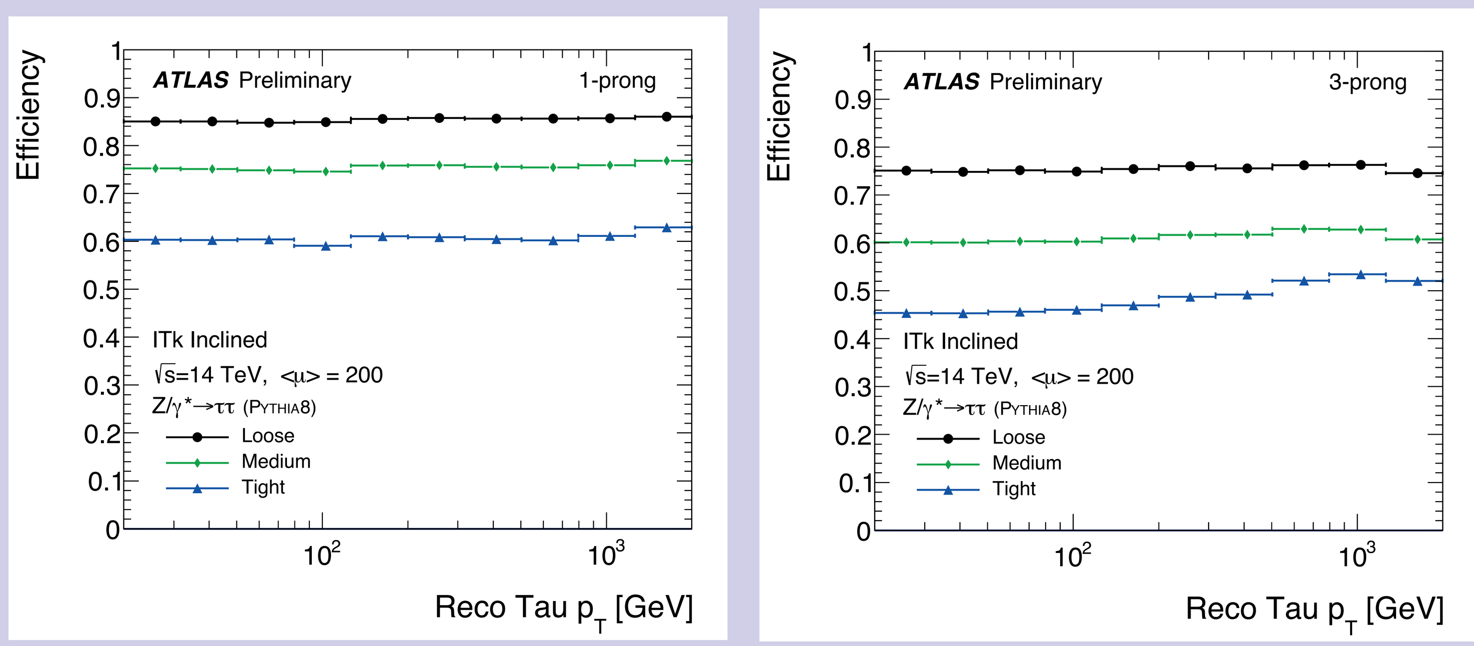
Identification Efficiencies

The efficiencies for the three working points remain mostly flat over the entire $\tau_{had\text{-}vis}$ p_T range considered.

A dependence on η is seen for the working point efficiencies from one-prong and three-prong taus, with an decrease in efficiency in the forward region.

Possible improvements

- Recover efficiency at high eta by training a BDT to allow for better categorization and counting of tracks
- Explicit tau candidate vertex selection to reduce pile-up rates



Tau identification efficiency for the three working points (Loose, Medium and Tight) as a function of p_T for reconstructed τ candidates, shown for one-prong (left) and three-prong (right) taus.