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Combined fit of the hadronic tau energy scale and the identification scale factor

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A new method is presented for calibrating hadronic tau leptons (τ_h) using $Z \to \mu\tau_h$ events, recorded by CMS experiment during 2018 at $\sqrt{s}$ = 13 TeV. The calibration is performed using data samples that reconstruct the decay of a Z boson into $\tau_\mu\tau_h$. By reconstructing the invariant visible mass from the visible decay products, a distribution is obtained for events with a true Z decay into leptons. This mass distribution enables the differentiation between signal and background contributions, which mostly consist of particles misidentified as τ_h. The comparison of this distribution in data and simulation allows adjustments to the identification efficiency and the energy scale. The combined fit of the two correction factors avoids double-counting of the correction factor uncertainties, which is currently entering the energy scale calibration and takes in account the possible correlations between the two correction factors. The fit is performed separately for each decay mode region (DM) and for each decay and in splitting of different transverse energy ($p_T(\tau_h)$). This splitting allows for a better modeling of the physics, taking in account the different kinematics of the regions. The corrective factors were found to have negligible correlation as a function of DMs but not with $p_T(\tau_h)$, revealing the importance of the combined fit. This study is interesting for analysis using calibrate hadronic tau leptons such as the search of CP violation in $H \to \tau\tau$ decay.

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