Central exclusive tau pair production with proton tag in CMS data at the LHC

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The Standard Model (SM) has been tested to great lengths, but there remain discrepancies between theoretical predictions and experimental measurements. One of these is the anomalous magnetic moment for the tau lepton a_τ, which relates the magnetic moment of the tau to its spin. The best experimental prediction is currently at $-0.0022 < a_\tau < 0.0041$, which is still orders of magnitude farther from the SM prediction of 0.00117721. I won't be deriving this a_τ value in my MSc thesis, but the goal of my work is to observe the exclusive tau pair production with proton tag, which could later be used to determine this a_τ value with greater precision. I will only be looking at the hadronic decay modes of tau and data from Run 3 2023D at the CMS and TOTEM-PPS at the Large Hadron Collider (LHC).
Exclusive tau pair production corresponds to the process $p+p \to p+\tau\tau+p$, i.e., two protons scatter via two photons, creating a central tau pair in the process. Measuring both protons and removing extra pileup tracks defines the exclusivity and allows one to constrain the kinematics of the central tau pair to the scattering protons. This allows better discrimination of background events.

The two main backgrounds of exclusive tau pair production are QCD jets and Drell-Yan (DY) processes. Tau is a short-lived particle with a lifetime of only $\sim 10^{-13}s$, causing only the decay products of mainly pions and kaons to be observed. Taus are not the only origin for these hadrons, and the most probable origin for them is QCD jets originating from interactions with gluons and quarks, which decay to hadrons as well. These QCD jet hadron-showers look similar to tau decays, and the medium or tight working point of the neural network-based deepTau algorithm, developed by the CMS collaboration, is used to discriminate against these QCD jets.
The second background process is the Drell-Yan (DY), where two of the protons' quarks annihilate to create an intermediate photon or Z-boson that decays into a tau pair, $qq \to Z/\gamma \to \tau\tau$. This process peaks around the Z-boson mass of $90GeV$, so we require both taus to have transverse momentum $p_T > 50GeV$ separately and together $p_T > 110GeV$ to reduce the amount of DY events in our results.
In addition to these, we require the tau pair to be back-to-back with acoplanarity i.e. $A_\phi < 0.015$ and fractional momentum loss ξ_p of the proton to be larger than 0.035.

To estimate the still remaining background after these selections, we do another event selection with only changing the acoplanarity requirement to the range of $0.015 < A_\phi < 0.1$. The results are plotted as a histogram of counts of events in relation to the match of the fractional momentum loss of the proton to the one calculated from the tau pair, $1 - \xi_p/\xi_\tau$. For signal events, we should observe a clear peak around 0 on top of the background shape, which we can estimate from a similar plot from the background event selection.

Currently, there seems to be a small peak visible where it should be, but it might be background quite as well. In addition, for the exclusivity of the process, we need to remove events with extra charged tracks originating from the vertex. This is already implemented, but requiring no extra charged tracks with $p_T > 1GeV$ in $0.5mm$ radius of the interaction vertex leaves only a handful of events. Meaning further tuning is required to reduce the background enough without excluding the actual signal events. The next approach is to look at simulated samples, which would allow us to see how the event selection behaves separately for the signal events and the main background DY.