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Enhanced Background Modelling and Signal Extraction for Electroweak Zjj Measurements with ATLAS

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Electroweak production of a Z boson in association with two jets (EW Zjj) provides a clean way of probing vector boson fusion (VBF) and serves as a sensitive test of electroweak couplings within the Standard Model at high energies. Using the ATLAS detector at the Large Hadron Collider, this analysis aims to measure differential cross-sections of key observables in the dilepton channel and to investigate the distinct VBF topology characterized by two forward, high-pT jets with large invariant mass (m_{jj}) and rapidity separation (Δy_{jj}). The study uses the full Run 2 dataset at √s = 13 TeV (139 fb^{-1}) and most of the available Run 3 dataset at √s = 13.6 TeV (164 fb^{-1}), enabling independent measurements with increased sensitivity in the high-m_{jj} and high-Δy_{jj} regions where EW contributions dominate. A central challenge of the EW Zjj measurement is suppressing and precisely modelling the dominant QCD-induced Z+jets background, which mimics the signal topology but lacks colour-singlet exchange. This work develops an improved background-estimation strategy using control-region constraints in an optimized phase space, combined with a custom multi-bin likelihood fit. The analysis benefits from both datasets being reprocessed with the latest ATLAS calibration and reconstruction algorithms, providing improved object performance and enabling a more robust background-subtraction and signal-extraction procedure compared with previous EW Vjj measurements. Preliminary studies show enhanced discrimination power in the VBF-like phase space. While the datasets cannot be statistically combined due to their different centre-of-mass energies, they allow for a direct comparison of sensitivities and highlight the increased statistical and kinematic reach provided by Run 3 data. The resulting measurements are expected to provide a valuable benchmark for future Effective Field Theory (EFT) interpretations.

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