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Linearity, Resolution, and Simulation Comparison Studies for the CALICE SiW-ECAL Prototype at the 2026 CERN Test Beam

The CALICE Silicon-Tungsten Electromagnetic Calorimeter (SiW-ECAL) is a highly-granular imaging calorimeter prototype developed to validate particle-flow calorimetry techniques for future lepton and hadron collider experiments, using fine transverse and longitudinal segmentation to resolve individual showers within dense jets. We present linearity and energy-resolution studies of the SiW-ECAL prototype using positron beam data recorded during the 2026 CERN test beam campaign across six beam energies (7.5–74-GeV). Energy response is reconstructed using three complementary estimators – hit multiplicity, summed calibrated energy, and tungsten-thickness-weighted energy – with Gaussian fits performed on purified event samples. Event selection is refined using shower-shape variables, including MIP-likeness and the Molière radius, to suppress electronic noise, particle contamination, and shower leakage, and the resulting improvement in resolution is quantified explicitly against the unpurified baseline. The effect of channel-level intercalibration is assessed by comparing reconstructed energies before and after calibration. As part of this work, we identify and correct a methodological limitation in the prior estimate of the transverse beam-spot profile: hits in the first detector layer have already undergone more than one radiation length of tungsten and therefore trace early shower development rather than the incident beam itself. We introduce an alternative estimate based on the reconstructed shower barycentre, compare it against the layer-0-based method, and use the result to inform a matching Geant4-based simulation campaign at the same beam position and energies. Preliminary data-versus-simulation comparisons of linearity and resolution, including a data/MC ratio, are presented, together with an outlook on forthcoming track-reconstruction efficiency studies using newly available tracking software.

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