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Scattering studies with the DATURA beam telescope

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High-precision particle tracking devices allow for two-dimensional analyses of the material budget distribution of particle detectors and their periphery. These tracking devices, called beam telescopes, enable a precise measurement of the track of charged particles with an angular resolution in the order of a few ten microradian and a position resolution of a few micrometer. The material budget is reconstructed from the variance of the angular distribution of the scattered particles. Similarly, a new tomographic technique exploiting the deflection of electrons with an energy of a few GeV in a sample requires precise reference measurements of the scattering angle distribution of targets of known thicknesses.

At the DESY test-beam facilities, the DATURA beam telescope, a high-precision tracker using pixel sensors, was used to record GeV electrons traversing aluminium targets with precisely known thickness between 13 um and 1e4 um. A track reconstruction was performed enabling the measurement of the scattering angle at the target due to multiple scattering therein. For that purpose, the General Broken Lines method was used incorporating a new unbiased target-material estimator.

In response to the increased interest in material budget measurements, we present the reconstruction of electron tracks and detail the analysis and accuracy of the angular deflection measurements. The width and the shape of the recorded distributions are compared to theoretical estimates and Geant4 simulations. Additionally, calibration techniques required as input for precise tomographic reconstructions are discussed.

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