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Feasibility study of track-based multiple scattering tomography

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Tomographic methods for the imaging and visualization of complex structures are widely used not only in medical applications but also for scientific use in numerous fields.
The CT-Imaging technique, which is commonly used for imaging in industry and the medical sector, exploits the difference of attenuation length for photons in different materials. Complete absorption of the photon beam for materials of higher atomic numbers poses a limit on the technique.
We propose a new imaging method based on the tracking of electrons in the GeV range traversing a sample under investigation. By measuring the distribution of the deflection angle at the sample, an estimate on the material budget is extracted for a given 2D-cell in the sample. This allows for the 3D-reconstruction of the material budget making use of an inverse Radon transform.

For the validation of this method, the AllPix Detector Simulation Framework including the Geant4 Framework was used to simulate a realistic setup. This simulation includes the DATURA Beam Telescope for high-precision particle tracking and an electron beam in the range of several GeV as can be found at the DESY Test Beam Facility, for which first tests are planned. A structured aluminum phantom was used as sample under study.

The proposed imaging method represents a candidate for an alternative high-resolution tomographic technique. We will present a feasibility study on the track-based multiple scattering tomography including the simulation setup and reconstruction algorithms.
It is shown that this method is able to resolve structures in the range of a few hundreds of micrometers for aluminum targets. The limits of this tomographic technique are discussed in terms of spatial resolution, cell-to-cell variance and discrimination power on material budget.

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