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Iterative image reconstruction algorithm for computed tomography with very high energy electron beam

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We present an iterative image reconstruction for a novel tomographic technique using an electron beam with energies from several hundreds megaelectronvolt to a few gigaelectronvolt. When a high-energy electron beam passes through an object, the electrons are deflected by multiple Coulomb scattering, and the angular distribution depends on the material budget of the traversed material. The trajectory of the electrons traversing a target is reconstructed using a pixel beam telescope with sensor planes situated in front of and behind the target. The material budget distribution of the target is reconstructed from the width of the angular distribution between the incoming and the outgoing electrons. We create the sinograms of position-resolved width-estimators making use of the track reconstruction framework 'Corryvreckan'.

Conventional analytical tomographic image reconstruction based on the radon transform produces artefacts due to statistical noise and systematical effects. We developed a simultaneous algebraic image reconstruction, which suppresses statistical noise using iterative methods, and total variation superiorization, which reduce the strength of artefacts in the reconstructed images. Based on the results of the test beam experiments performed in 2020, the reconstructed images and the performance of the iterative image reconstruction algorithms will be discussed.

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