Validation and Optimization of a Scatter Correction Method for Total-Body Positron Emission Tomography

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The uEXPLORER is a 2-m-long total-body PET scanner which provides improved image quality and increased sensitivity compared to conventional scanners. However, due to vastly increased data sizes, image reconstruction and data correction techniques (like scatter correction, SC) become computationally more challenging. We now present a recently developed Monte Carlo-based SC method.

The tool was developed using images reconstructed with 3D-TOF-OSEM with point spread function-modeling, corrections for attenuation, dead-time, and random events, and without image post-processing filters. Simulation-based scatter correction factors were calculated after every OSEM iteration.

The image quality was quantitatively assessed using phantom scans following the NEMA NU 2-2018 protocol. The contrast recovery coefficient in scatter corrected images was up to 18.2 percentage points higher than without SC, and the residual lung error was reduced by about a factor of three.

Furthermore, an 83 y/o patient with lung cancer was scanned for 20 min (120 min p.i., 373.7 MBq [18F]FDG), and reconstructed with the above parameters. The scatter corrected image showed better apparent diagnostic image quality with increased lesion conspicuity, especially in metastases in adrenal glands and lymph nodes.

The average peak-to-valley-ratio (PVR) along a line profile through the center of 13 vertebrae was calculated. The PVR in the scatter corrected image was 3.46 compared to 1.98, without SC.

The scatter removal in the trachea was also quantified: despite residual scatter contamination inside the trachea, the average activity concentration was 31.0% lower than in peripheral lung tissue (6.9% lower without SC).

A SC technique was successfully implemented and quantitatively and qualitatively validated. These results serve as a basis for further optimizing accuracy and performance. We are currently testing different scaling methods and are investigating the minimum number of required SC iterations and number of events and envisage cloud-based computing for performance enhancement.

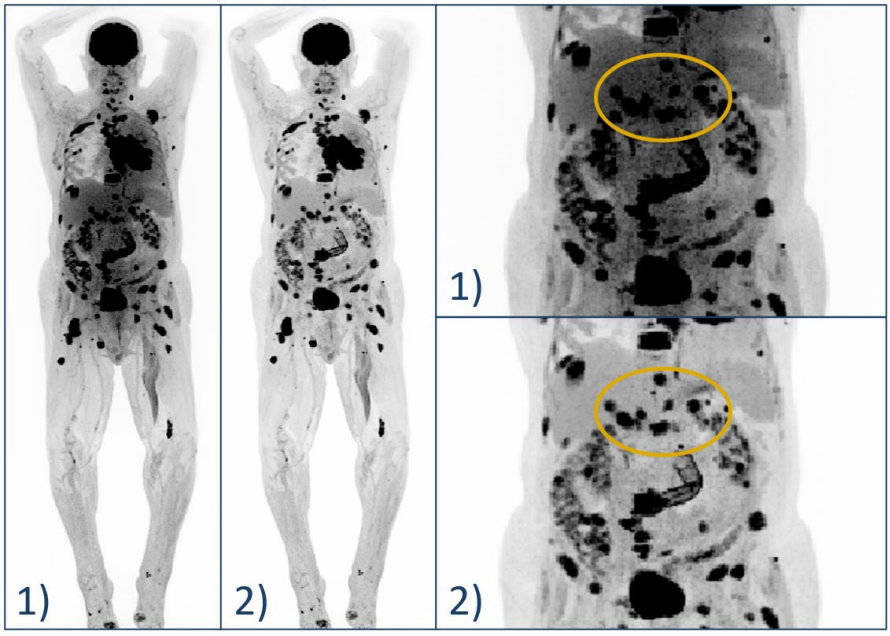

Fig. 1. MIPs of a total-body PET scan of a human subject without SC (#1) and with SC (#2). The orange oval contours the region with the most noticeable changes.