

Purpose: The line-of-response OSEM (LOR-OSEM) algorithm allows a PET image reconstruction from sinograms without any data compression (span=1, mashing=1). The main objective of this work is to accelerate the computation of this algorithm for modern PET scanners such as the Philips Gemini GXL by its implementation on modern GPU devices.

Methods: We implemented the LOR-OSEM algorithm on the NVIDIA Tesla 2050 GPU. The implementation incorporates the attenuation and normalization correction in the sensitivity matrix as weight factors (ANW-LOR-OSEM algorithm). The system matrices are built on-the-fly by using the multi-ray Siddon algorithm. We used 3 rays per detector pair in the tangential direction and 2 rays in the axial direction. To reduce this computation time, the symmetries of the scanner were exploited. This implementation was validated using Monte Carlo simulated data with the GATE package.

Results: The reconstruction was computed for a 188x188x57 array (FOV=376 mm, 2x2x3.15 mm³ voxel size) and for a 144x144x57 array (FOV=576 mm, 4x4x3.15 mm³ voxel size). If the sinograms are pre-corrected for attenuation and detector efficiency, and if the projection data matrix which depends only of the scanner geometry is pre-calculated, the time to compute the LOR-OSEM algorithm for 10 subsets, 1 iteration and 112 million coincidences is 30.5 seconds for the 188x188x57 array and 29.4 seconds for the 144x144x57 array. This time is 73.4 seconds for the 188x188x57 array and 72.7 seconds for the 144x144x57 array for the ANW-LOR-OSEM algorithm.

Conclusions: The LOR-OSEM algorithm was successfully implemented on a Tesla C2050 GPU, including the calculation of the sensitivity matrix, for a PET system that has 85 million LORs. The reported reconstruction times are compatible with a clinical use. The NVIDIA Tesla GPU appears to be a low-cost, high-performance solution for advanced PET reconstruction such as real time 4D gated reconstruction.