Fast log-polar based reconstruction of parallel-beam tomography data

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We propose a fast log-polar-based method for parallel-beam tomography data reconstruction with reduced computational complexity of O(N^2 logN). The method is based on the fact that the projection and the back-projection operators, i.e. the main computational parts for constructing reconstruction schemes, can both be expressed as convolutions in log-polar coordinates. Hence they can be rapidly evaluated in terms of FFT if data is resampled at log-polar coordinates. Sinograms are typically given on an equally spaced grid in polar coordinates, and reconstructions are represented in Cartesian coordinates.

Therefore, in addition to FFT, several steps of interpolation have to be conducted in order to apply the transforms by means of convolutions. However, in comparison to the interpolation conducted in Fourier-based gridding methods, the interpolation performed in the polar and image domains will typically deal with data that are substantially less oscillatory. Reasonable reconstruction results can thus be expected using interpolation schemes of moderate order. It also provides better control over the artifacts that can appear due to measurement errors since the interpolation errors are kept local. The log-polar based reconstruction method is implemented at the MAX IV Laboratory on GPUs with the processing times faster than analogues therefore we foresee a high impact in the reconstructing of large (time-resolved) tomographic datasets.