AbstractID: 8558 Title: Analytical derivation of the Noise Power Spectrum for a fan beam system

Purpose: To examine some unique properties of the noise power spectrum (NPS) of a fan beam CT that are quite different from the more well known NPS of a parallel beam CT, and to examine non-stationary behavior.

Method: An analytical expression for the noise in a fan beam CT was derived. To validate it, 100 128 128 noise images were simulated for several settings: uniform and non-uniform noise and fan angles of 29°, 8.5°, and 2.5°. For each image, 200 projections were used, and each projection had 128 elements which were filtered by an unweighted ramp filter. A central 90 by 90 array of each noise image was extracted. By squaring the magnitude of the 2D FFT of extracted images, 2D NPS images were generated. The 1D radial NPS was calculated by circumferencial averaging and by averaging over the 100 realizations. The non-stationary behavior was examined by similar processing of local regions.

Result: The measured 1D NPS from a entire FOV and from local regions shows good agreement with the analytically derived 1D NPS formula. The analysis shows that whereas the NPS in a parallel beam CT is proportional to frequency, a fan beam NPS has a reduced amplitude, “kink”, at high frequency. It is due to the variable magnification across the FOV and thereby is more pronounced as the fan angle increases. The 2D NPS of a entire FOV with non-uniform statistics shows the directional dependence and the 2D NPS of local regions shows a shading effect.

Conclusion: The NPS provides a useful metric to analyze the image quality. Local measurements can be used when the image noise is not stationary. Interesting differences compared to a parallel beam CT are shown, as are instances of non-stationary noise.