Purpose:Very little information is available for noise properties using a dual-detector cone-beam CT (CBCT) system. Geometric misalignment, cross-scatter, and inhomogeneous detector response are additional concerns in a dual-detector system. This study characterizes the noise power spectrum of a dual CBCT system for image-guided radiation therapy (IGRT).

Methods:A bench-top dual-detector CBCT system with two orthogonal 40x30cm flat panels has been developed in our laboratory. The noise power spectrum (NPS) was evaluated by scanning two uniform phantoms with diameters of around 26cm and 20cm under different kVs, mAs, and acquisition modes. The three-dimensional NPS was calculated using 3D Fourier transform for a region of interest of 10x10x10cm3 as the metric to evaluate the noise performance. The structural fluctuations were removed by subtraction between two identical scans. The radial averaging is then calculated every degree in the central slice of the 3D Fourier space to reduce the measurement fluctuation. The profile of the radial averaging is used for comparison between dual/single detectors, at different kVs, mAs, and acquisition modes.

Results:The NPS amplitude of the dual CBCT system can be up to 50% lower than that of a single CBCT system in simultaneous acquisition mode. In alternating acquisition mode, the NPS of the dual CBCT system is comparable both in amplitude and shape with a single CBCT system. The cross-scatter is identified as the major contributing factor for the discrepancy. The cross-scatter and the amplitude of the discrepancy are correlated with the sizes of the scanned objects under various current and voltage parameters.

Conclusions:The Cross scatter reduces the amplitude of NPS. The effect is more dominant for large objects. Quantitative results from this noise power analysis provide guidance for dual CBCT reconstruction, cross-scatter reduction and acquisition optimization.

Funding Support, Disclosures, and Conflict of Interest:

This work is supported in part by a research grant from Varian Medical Systems.