

AbstractID: 10811 Title: The investigation and correction of a bowtie-related cone-beam CT circular band artifact

**Purpose:** In the course of developing projection-space preprocessing algorithms for improving on-board CBCT CT number accuracy and uniformity, a persistent, prominent circular band artifact (CBA) with asymmetric illumination shadows was discovered. The CBA remain unchanged even after applying beam-hardening, scatter subtraction, and veiling glare corrections to Varian OBI full-fan projection data but only when a bow-tie filter is used. This study investigates the causes and correction strategies of the CBA.

**Method and Materials:** CBCT images were acquired, preprocessed, and reconstructed with an in-house FDK engine for phantoms of different diameters and locations relative to isocenter, on several OBI systems, to characterize CBA behavior and to form hypotheses as to its origin. Numerical simulations were used to evaluate all hypothesized contributing factors, as assessed by the necessary experimental measurements. A custom calibration was performed to identify the dependence of kV source location and flat-panel detector pose as a function of gantry angle. Different correction approaches were tried on both synthetic and measured datasets, including gantry-angle-dependent normalization, full- and partial kV beam geometry calibrations, and empirical cancellation. The interplay between the CBA corrections and scatter and beam hardening corrections was also studied.

**Results:** The CBA had a diameter of about 15 cm, was centered at the isocenter, and had similar asymmetric illumination, for all phantom dimensions, locations, and machines, and was reproducible over time. It appeared only when the bowtie filter was used. Simulations and experimental studies identified that a combination of geometric wobble and the bowtie filter slope caused the artifact. Gantry-angle dependent calibrations of normalization were sufficient for about 80% CBA mitigation, but that complete elimination required gantry-angle dependent beam-hardening corrections.

**Conclusion:** CBCT geometric wobble with the presence of bowtie filter could cause a circular band artifact.

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