

Comparison of CT Number to Mass Density Curves for Multiple Scanners with Universal Protocols for Photon Treatment Planning



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PURPOSE

- Universal CT number to mass density (CTN-to-MD) curves in large hospital networks with multiple CT simulators and treatment planning systems reduces the potential for error during photon treatment planning.
- The goal of this study was to evaluate the effects of peak kilovoltage (kVp) and scatter conditions of clinical protocols and to develop universal curves to be used across the hospital network.

METHODS

- We acquired scans of the Advanced Electron Density phantom (Sun Nuclear Corporation, Melbourne, FL) with 12 matched clinical pediatric and adult protocols on five SOMATOM CT simulators (Siemens Healthineers, Erlangen, Germany):
 1. Drive
 2. Edge+
 3. go.Open
 4. Definition AS (two different scanners)
- The protocols include scans at 100kVp, 120kVp, and 140kVp.
- The phantom has a large (40x30cm² elliptic cylinder) and small (20cm diameter cylinder) configuration.
- Three high-density inserts (MD=2.71-8.0g/cc) and four bone inserts (MD=1.21-1.93g/cc) were placed sequentially in the central insert.
- Low-density, soft-tissue, and solid-water inserts (MD=0.29-1.08g/cc) were placed in the remaining spaces.
- Extended dynamic range was configured for all protocols.
- Scans with high-density inserts were also reconstructed with iterative metal artifact reduction (IMAR) algorithms.

RESULTS

- The phantom configurations demonstrated effects on CTN for scan protocols with 140 kVp, especially for cortical bone. This effect was less pronounced with 120kVp.
- The variation in CTN between four of the five scanners was <1% for all inserts and protocols.
- IMAR reconstructions of scans with high-density inserts changed the CTN of soft-tissue inserts by <32HU, regardless of phantom configuration, kVp, and IMAR algorithm.
- The Extremity, Brain, and Head and Neck protocols use the “Small” curves. All other anatomical sites use the “Large” curves.

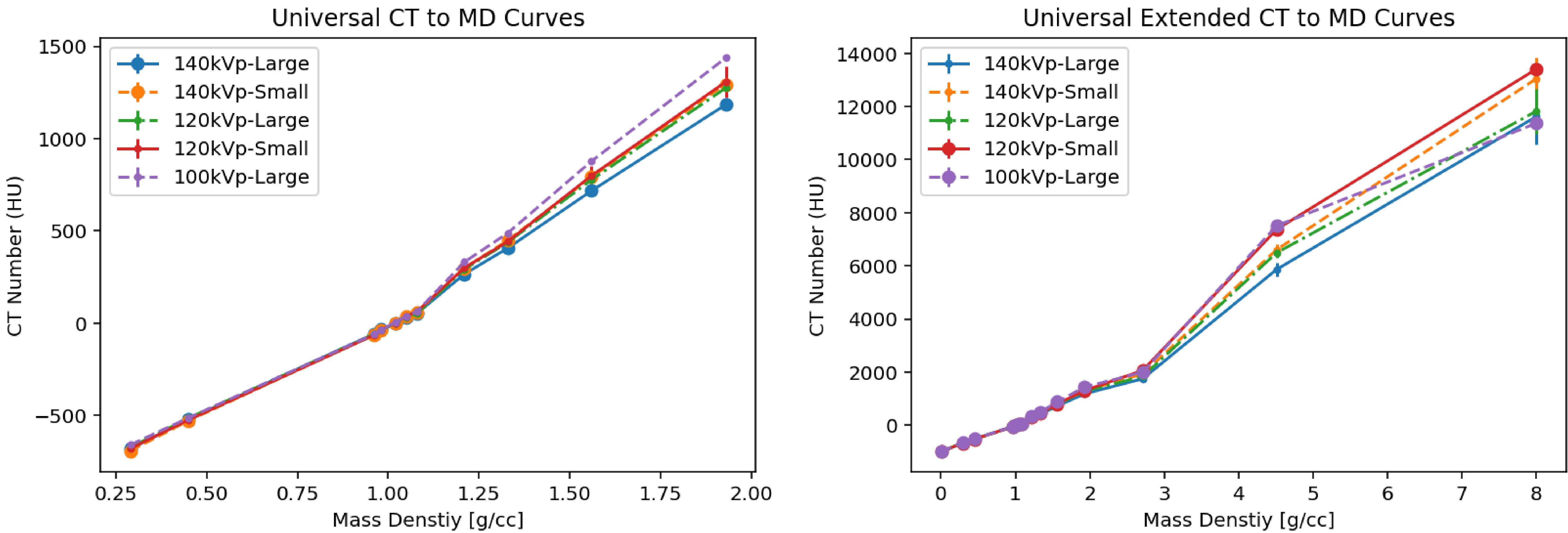


Figure 1. Universal CTN-to-MD curves, separated into five curves based on kVp and phantom size. The phantom configuration demonstrated effects on the CTN for 140kVp, especially for the cortical bone. This effect is less pronounced for the 120 kVp protocols.

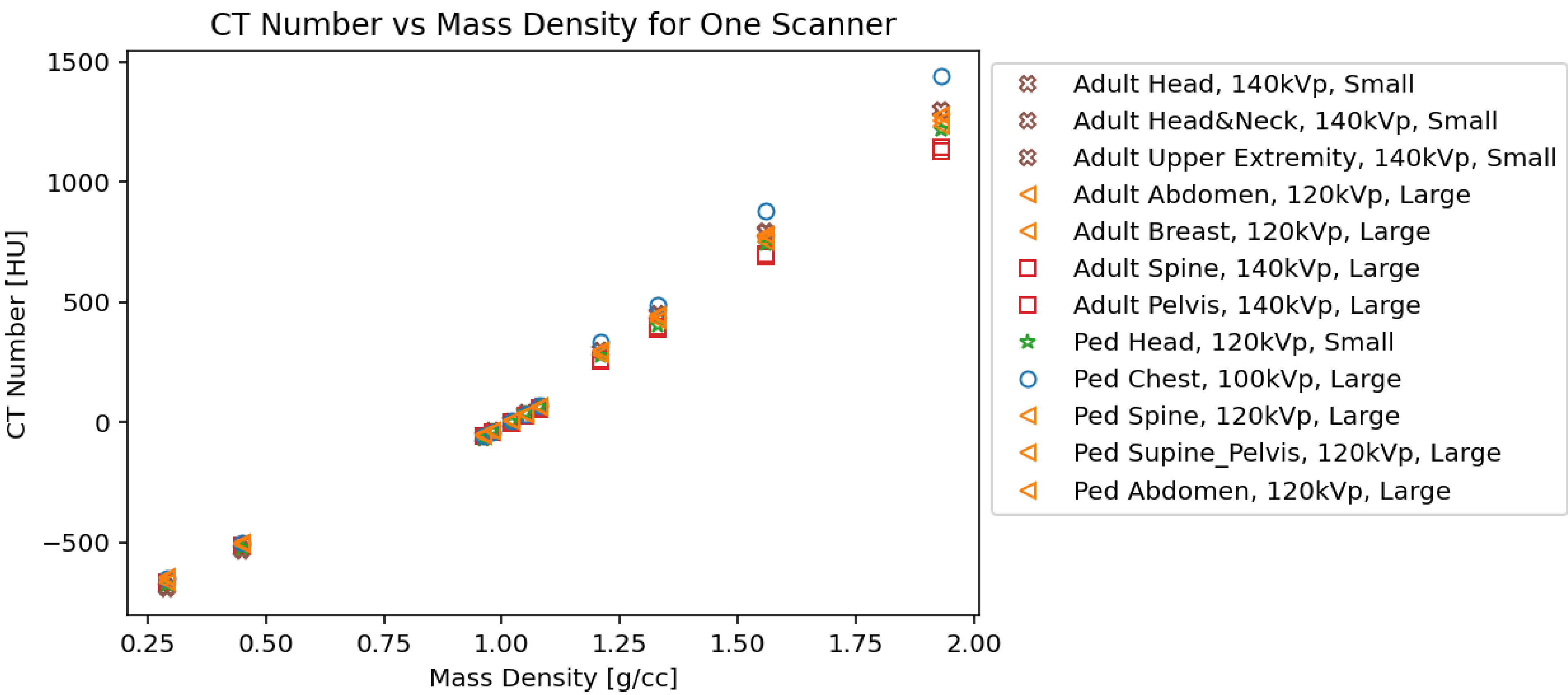


Figure 2. CTN-to-MD of all protocols from one scanner. The plot is separated by peak kilovoltage and phantom size (id. Orange triangle represents 120kVp with large phantom configurations). The separation between the 140kVp-Large (Brown X) and 140kVp-Small (Red Square) is evident in the bone inserts.

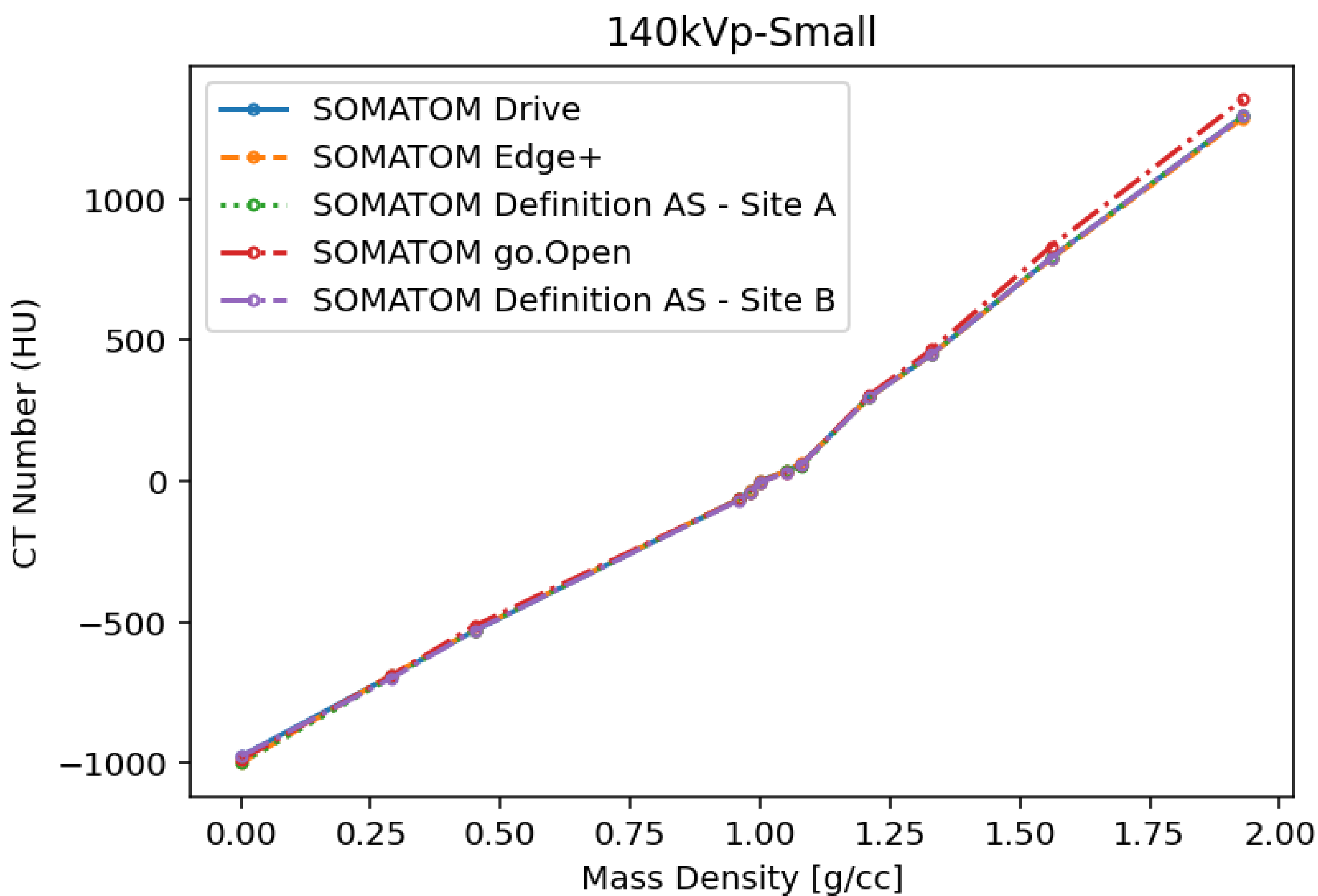


Figure 3. Scanner-specific CTN-to-MD curves for the 140kVp protocols with the small phantom. The Variation in CTN between four scanners was <1% for all inserts and protocols. The go.Open CTN varied by up to 5%, which is attributed to the different collimator size.

CONCLUSION

Five universal CTN-to-MD curves for 12 matched scan protocols were created for clinical use of four scanners across the hospital network based on phantom size and kVp. A separate curve was created for the go.Open scanner due to CTN differences from the collimator size.

CONTACT INFORMATION

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