A novel cylindrical 3D water scanner for beam data collection: II. Dosimetric characteristics.

**Innovation/Impact:** We studied the dosimetric characteristics of a novel cylindrical 3D water scanner by comparing the noise levels and scanned profiles/percent-depth ionization against another commercial scanner.

**Purpose:** To study the dosimetric characteristics of a commercial three-dimensional water scanner used for beam data collection (3D SCANNER, Sun Nuclear Corp., Melbourne, FL). The novel cylindrical water tank uses a compact electrometer that is mounted on the side of the tank, eliminating the need for ion chamber extension cables. The electrometer has a wide dynamic range, requiring no gain adjustment for all scanning conditions.

**Methods:** The noise levels and profiles obtained using the 3D SCANNER were benchmarked against another commercial 3D scanner (Blue Phantom, IBA Dosimetry GmbH, Germany) with the same sampling intervals. Noise levels were characterized for both the default scan speed (5 mm/s) and the fast scan speed (8 mm/s). Profile comparisons were done for 6 MV and 18 MV photon beams using the following scanned measurements: 10x10 cm$^2$ and 30x30 cm$^2$ open field percent-depth dose (PDD); in-plane and cross-plane profiles at dmax, 10 cm, and 30 cm depth; 30x30 cm$^2$ wedge field in-plane (wedge direction) profiles at 10 cm depth. For electron beams, percent-depth ionization (PDI) and in-plane and cross-plane profiles at depths of dmax were obtained for 6 MeV, 12 MeV, and 20 MeV using a 20x20 cm$^2$ applicator. All scans were obtained with CC13 (IBA Dosimetry) ion chambers for the field and reference detectors. Radiation was delivered using an Elekta Synergy linear accelerator.

**Results:** The RMS noise in the scanned profiles were 0.09% for the default scan speed and 0.12% for the fast scan speed. This is comparable to those of the Blue Phantom scanned profiles, which has an RMS noise of 0.1% for its default scan speed. Fig. 1 compares the photon beam profiles and PDD from the 3D SCANNER and the Blue Phantom. Between the two scanners, all photon beam profiles agree within the noise levels outside the penumbra area (20%-80%). The measured field sizes agree within 0.6 mm, with the largest field size difference seen for the 30x30 cm$^2$ field size. There is no need for electrometer gain adjustment when switching between open and wedge field scans. The measured D10/D20 ratios for all PDDs differ by less than 0.4%. Fig. 2 compares the electron beam profiles and PDI from the two scanners. The biggest difference is approximately 0.5% in profiles seen in the shoulder of 12 MeV, and approximately 0.8% in PDI seen near the surface of 6 MeV. The measured field widths are within 0.5 mm and the measured $I_{50}$ are within 0.2 mm of each other.

**Conclusion:** The quality of scanned profiles/PDI from the 3D SCANNER is comparable to that of another commercial 3D scanner with similar noise levels. The cylindrical 3D SCANNER has several unique features compared to conventional scanners. The accuracy of its automatic-setup procedure and mechanical reproducibility were presented in a separate study.