AbstractID: 10886 Title: A CBCT Projection Matrix method for radiation and imaging isocenter QA

Purpose: To test the use of a cone beam computed tomography (CBCT) projection matrix method for determining the imaging isocenter diameter as a replacement for the traditional gantry star shot for radiation isocenter testing.

Method and Materials: The Siemens MVision megavoltage CBCT is calibrated by imaging a geometric reconstruction phantom that contains BBs of various sizes at well characterized positions. This generates several projection matrices, P_θ, that define where a point in the reconstruction volume is projected onto the flat panel detector at gantry angle θ. The standard reconstruction angles are -90° to 110°. A new protocol, with angles from -30° to 170°, provides information about radiation isocenter from posterior angles. Flat panel positions projected to a plane containing the isocenter are $[U_\theta,V_\theta] = [0.276(P_\theta(1,4) – P_0(1,4)), 0.276(P_\theta(2,4) – P_0(2,4))]$. The room coordinates $[x_\theta, y_\theta, z_\theta] = [U_\theta\cos(-\theta), U_\theta\sin(-\theta), V_\theta]$. The radiation isocenter ellipsoid diameters are $(x_\theta^{max} - x_\theta^{min}, y_\theta^{max} - y_\theta^{min}, z_\theta^{max} - z_\theta^{min})$, where superscripts max and min refer to maximum and minimum values of the room coordinate, respectively. The maximum diameter is compared to that of a traditional star shot and a Winston-Lutz type test.

Results: Traditional star shots are limited in accuracy due to the subjectivity in the analysis and set-up error. The maximum radiation isocenter diameters were about 0.8 mm, 0.9 mm and 1.4 mm for the star shot, Winston-Lutz test and the projection matrix analysis, respectively. The result for the projection matrix includes deviations resulting from flat panel motion and is larger than that of the Winston-Lutz test, which is unaffected by flat panel motion.

Conclusion: The projection matrix method simultaneously checks the stability of the imaging and radiation isocenter, while providing an annual geometric calibration for the CBCT system.