AbstractID: 7396 Title: Automated linear accelerator quality assurance using a commercial cylindrical calibration phantom

Purpose: Precise mechanical operation of a linear accelerator is critical for accurate dose delivery. Available quantitative procedures for the linac mechanical quality assurance (QA) are time consuming and therefore conducted on a relatively infrequent basis. We present a method for evaluating the mechanical performance of a linac based on a series of projection portal images of a prototype cylindrical calibration phantom with embedded markers.

Method and Materials: We used non-linear multiobjective optimization of information extracted from the images to determine a number of geometric parameters of interest. The markers detection included modeling the imager response to radiation beams where significantly non-uniform background was expected.

Results: The average results for the parameters of our geometric linac model were: gantry angle deviation $0.066 \pm 0.085^{\circ}$ (1 SD), gantry sag $0.026 \pm 0.02^{\circ}$, imager in-plane rotation $0.026 \pm 0.055^{\circ}$, roll $-0.082 \pm 0.16^{\circ}$ and pitch $-0.9 \pm 0.604^{\circ}$, SDD 1489.7 ± 5 mm, SAD 998.3 ± 1.7 mm, and the imager shift $[-0.66, 3.9] \pm [0.30, 1.6]$ mm. The results were corrected for the phantom center shift relative to the linac rotational center. The average rotational center was $\langle R_{rot} \rangle = [0.0 \pm 0.0012,\ 0.11 \pm 1.38,\ 0.08 \pm 0.98]$ mm. The average couch height and angle variations were 0.15±0.9 mm and 0.154±0.1º, respectively. The image analysis quality was examined by comparing the detected set of marker coordinates to its simulated counterpart for three regions of the phantom image: central, near the edge and the intermediate region (relative to the central line of the cylinder). The upper limit of the mean difference was less than 0.25 mm with the cumulative mean of 0.146 mm and SD of 0.07 mm. The results of the primary optimization of directly detected marker coordinates virtually coincided with their counterparts based on the simulated coordinates for all the geometric parameters of the model.

Conclusion: This procedure is accurate and automated, which allows precise mechanic QA to be performed more frequently.

Conflict of Interest: partially supported by Varian Medical Systems.