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Field Size Evaluation Using a High Resolution 2D Diode Array for Variable-Aperture Collimators in Robotic Radiosurgery

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Abstract
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Abstract

Objectives:

Robotic radiosurgery is increasingly adapted in clinic, and quality assurance (QA) of variable-aperture collimators requires sub-millimeter precision for patient safety (AAPM MPPG 9a). The collimators consist of 12 discrete cone sizes, ranging from 5, 7.5, 10 ... to 60 mm. Conventional film based QA is both experience dependent and time consuming (~30 minutes for 3 cones). To improve productivity, a high resolution 2D diode detector array, sampling every 2.5 mm, is evaluated for spatial frequency, dose profile reconstruction, and sensitivity to field size variances.

Methods:

Dose profiles of 12 cones scanned with a diode in water tank are utilized as golden standards. These profiles were analyzed using spatial Fourier transform to extract applicable sampling frequency. Sampled with the 2D diode array, dose profiles were interpolated using a Python based Cubic B-spline function. For each cone, field size sensitivity of the diode system was studied at various source to detector distances (SSD).

Results:

QA time utilizing the diodes array system is than 10 minutes for 12 cones. Output factor decreases from 100% to 64% as cone sizes decrease, and the maximum gradient is 12%/mm for the 5 mm cone. Except for the 5 mm cone, spatial frequency of the dose profile shows little contribution beyond 0.2 /mm, so a Nyquist sampling of 0.4 /mm is appropriate for dose verification, which corresponds to the 2D diode system with 2.5 mm gap. Dose profiles were reconstructed with Cubic B-spline. For all the cones larger than 5 mm, beam sizes measured with the diode array increase proportionally as the SSDs increase from 78 cm to 85 cm, achieving the sensitivity required for clinic application.

Conclusion(s):

The 2D Diode array with a spatial resolution of 0.4 mm-1 is appropriate for dose verification for all the cones except the 5 mm, and its potential application would effectively improve QA efficiency in SRS.