The feasibility of MatriXX Evolution system for quality assurance of RapidArc™


1Varian Medical System International AG, Zug, Switzerland, 2IBA Dosimetry, Schwarzenbruck, Germany, 3University Hospital Leuven, Gasthuisberg Campus, Belgium

Purpose: In this work we evaluated suitability of a MatriXX phantom system (IBA Dosimetry) consisting of a 20 ionization chamber array (MatriXX), dedicated phantom made from a PlasticWater® Phantom (MULTICube) and application software (OmniPro® I'mRT) for dosimetry quality assurance of RapidArc™ (Varian) treatment delivery technique.

Material & Methods: Measurements presented in this poster were performed on a Varian Clinac 2300/D with RapidArc™ capability installed in: - Varian Medical Systems laboratory in Baden (Switzerland) - Rigshospitalet, Copenhagen (Denmark)

The angular study was performed in UH Leuven, Gasthuisberg (Belgium).

Detector/phantom combination: The MatriXX is a 20 array detector consisting of 1020 air vented plane-parallel ionization chambers placed in a square pattern of 32 x 32 with center-to-center distance of 7.62 mm covering the area of 24 x 24 cm². Each single chamber (volume 0.07 cm³, φ=4.5 mm, δ=5 mm) is independently read out with a custom electronic without dead time and automatically compensated for temperature and pressure variation. The MatriXX readout and evaluation was performed with the OmniPro® I'mRT v.5.5 software installed on a standard PC. The MatriXX was inserted into the MultiCube Lite phantom having height of 22 cm and width of 34 cm. When inserted, the effective point of the ion chambers in the 2D array goes through the center of the phantom which is marked on its surface for easy alignment with a Clinac laser positioning system. The phantom is made from the PlasticWater® to assure water-equivalence readout in megavoltage photon range.

Angular dependence: The angular dependence of the MatriXX response in the MULTICube phantom was studied in 6 and 18 MV x-ray beams produced by a Clinac 2100 C/D (Varian). The MatriXX was inserted into the MULTICube phantom, which was set up vertically to avoid irradiation through the treatment couch. The detector/phantom combination was irradiated with a 10 x 10 cm² field at 45 different gantry angles covering the range from 0° to 180°.

The response of the MatriXX phantom (position 16, 16 – central area of detector) was compared to the signal of a cylindrical ionization chamber CC (IBA Dosimetry) which was inserted into the exactly same position at the effective point a dummy MatriXX sensor. The angular dependence of the signal was calculated as the ratio of the MatriXX response to the IC response, both normalized to the zero beam incidence. In addition, a Monte Carlo simulation was performed to verify the experimentally determined results of the MatriXX angular dependence as shown in the following figures.

Clinical workflow:

1. CT of the MatriXX & MULTICube and export to a TPS (Eclipse™)
2. Recalculation of a treatment plan with the Eclipse™ and export of dose maps into the OmniPro® I'mRT
3. Setup of the MatriXX & MULTICube on a treatment couch and irradiation under clinical conditions
4. Comparison of the measured and the calculated dose distribution to accept or reject the irradiation of a patient

The angular dependency has proven to be more pronounced for low energy but the signal decrease has been found acceptable without any further correction for rotational type of beam delivery.

H&N – four clinical cases

Case 1

Case 2

Case 3

Case 4

H&N Cases – gamma evaluation (TPS vs. MXX)

Conclusion: The set of measurements performed over the longer time period have shown excellent stability of the Clinac accelerator for the delivery of the RapidArc™. The results have clearly proven the MatriXX™ system to be fast, reliable and accurate dosimetry method for QA of RapidArc™ treatment delivery.

References:

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