The feasibility of MatriXX^{Evolution} system for quality assurance of RapidArc^{TM}

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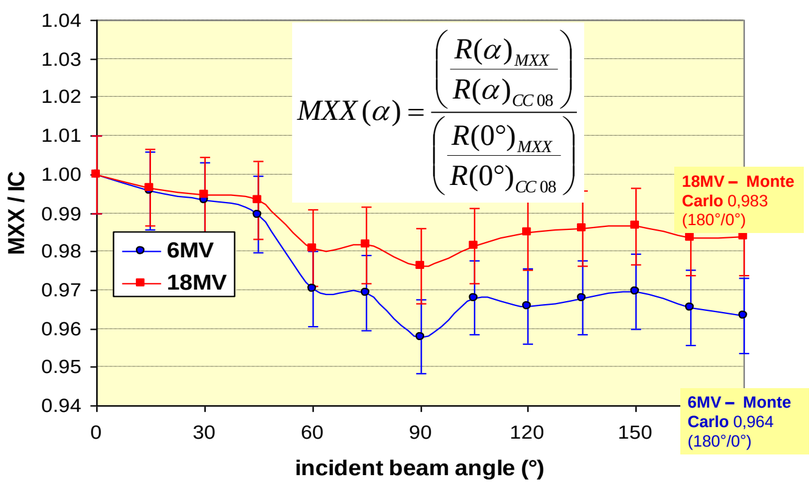
Purpose: *In this work was evaluated suitability of a* **MatriXX**^{Evolution} *system (IBA Dosimetry) consisting of a 2D ionization chamber array (MatriXX), dedicated phantom made from a PlasticWater® (*MULTICube*) and application software (*OmniPro I'm*RT) for dosimetry quality assurance of* ***RapidArc***^{TM} *(Varian) treatment delivery technique.*

Material& Methods:

Measurements presented in this poster were performed on a Varian Clinac 2300C/D with RapidArc^{TM} 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 2D array detector consisting of 1020 air vented plane-parallel ionization chambers placed in a square pattern of 32x32 with center-to-center distance of 7.62 mm covering the area of 24x24cm². Each single chamber (volume 0.07cm³, ϕ=4.5 mm, h=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 v1.5 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 centre 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 was irradiated with a 10x10 cm² field at 45 different gantry angles covering the range from 0°- 180°. The response of the MatriXX chamber (position 16,16 – central area of detector) was compared to the signal of a cylindrical ionization chamber CC08 (IBA Dosimetry) which was inserted into the exactly same position at the effective point a dummy MatriXX sensor. The angular dependence of the system 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 figure.*



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.

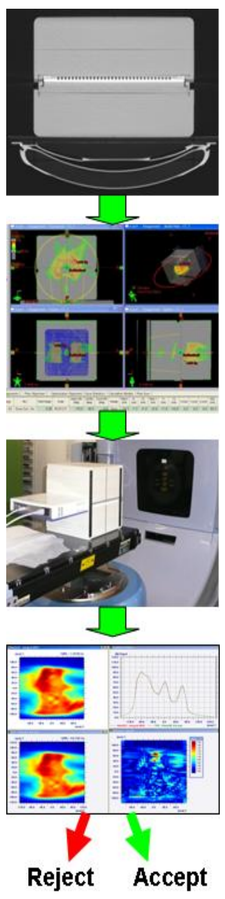
Clinical workflow:

***1.** CT of the MatriXX & MULTICube and export to a TPS (ECLIPSE^{TM})*

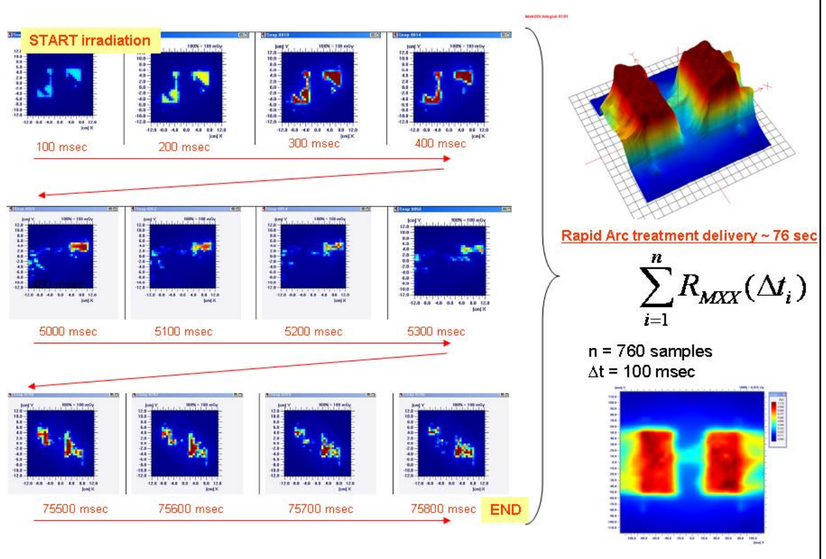
***2.** Recalculation of a treatment plan with the ECLIPSE^{TM} and export of dose maps into the OmniPro I'mRT*

***3.** Setup of the MatriXX & MULTICube on a treatment couch and irradiation under clinical conditions*

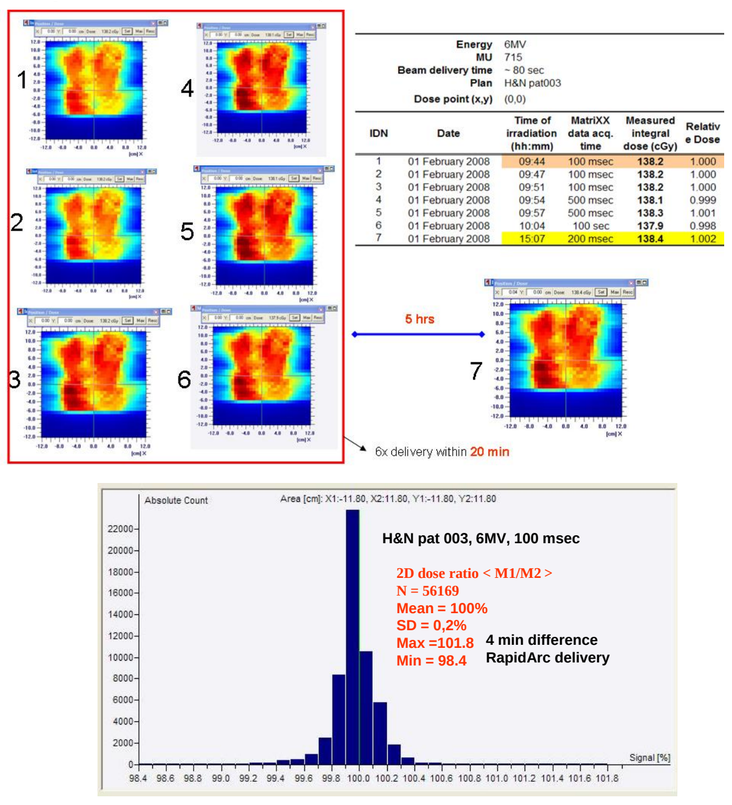
***4.** Comparison of the measured and the calculated dose distribution to accept or reject the irradiation of a patient*



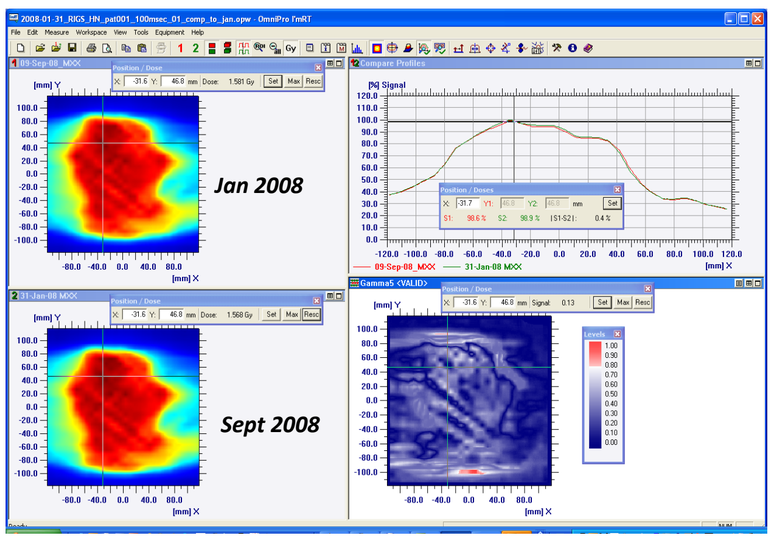
MatriXX dynamic measurements for a typical H&N delivery: from subfields (left) to a composite dose distribution (right).

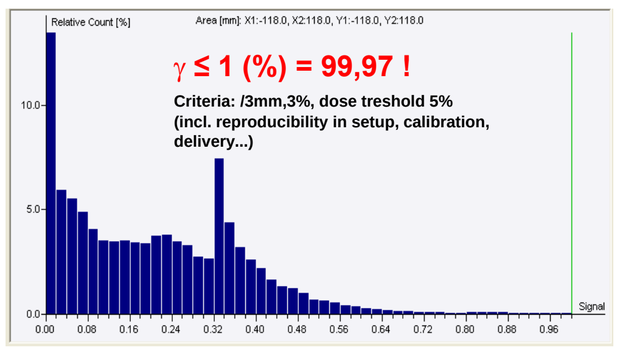


Short term reproducibility (intraday) of RapidArc^{TM} delivery (H&N case) and MatriXX^{Evolution} system

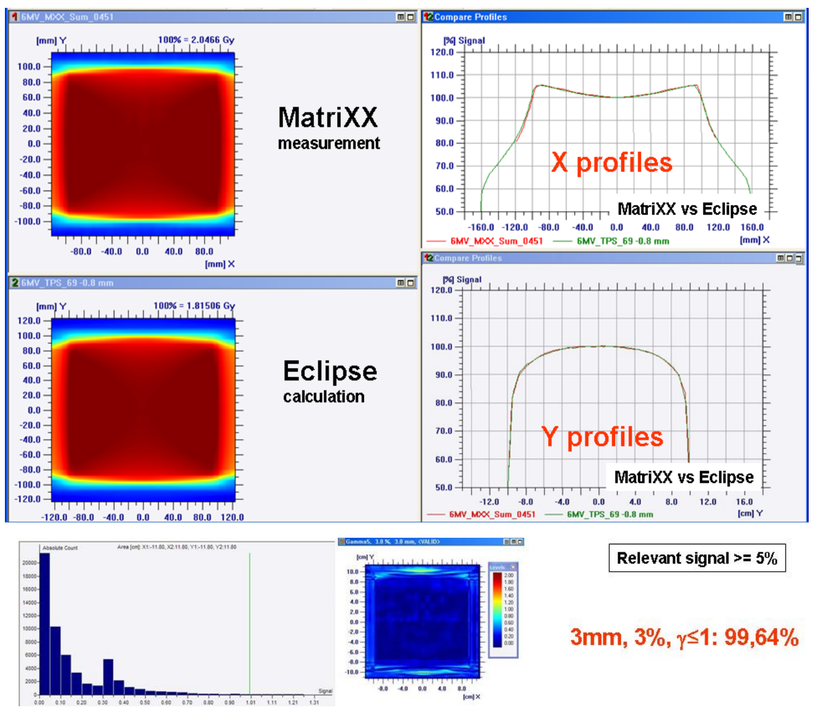


Long term reproducibility (7 months) of RapidArc^{TM} delivery (H&N case) and MatriXX^{Evolution} system



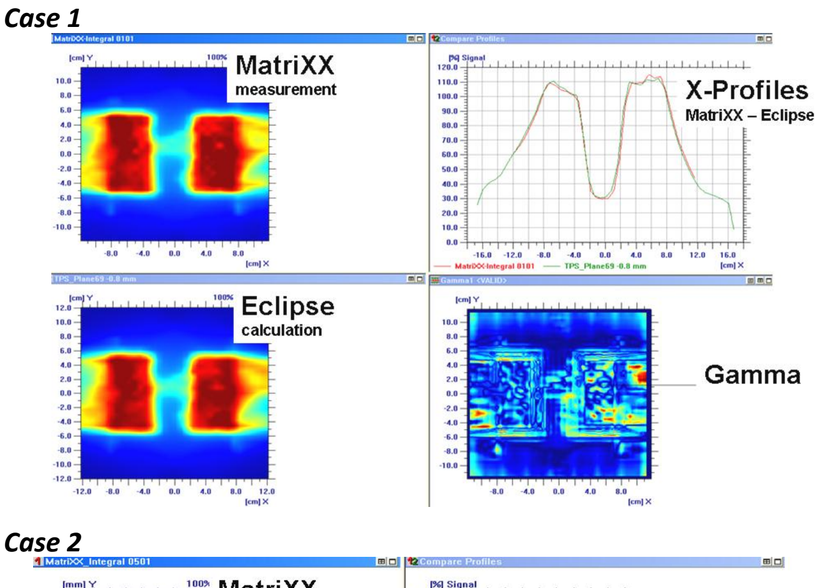


Pretreatment Linac QA, 6MV, 20x20cm, full arc 360°

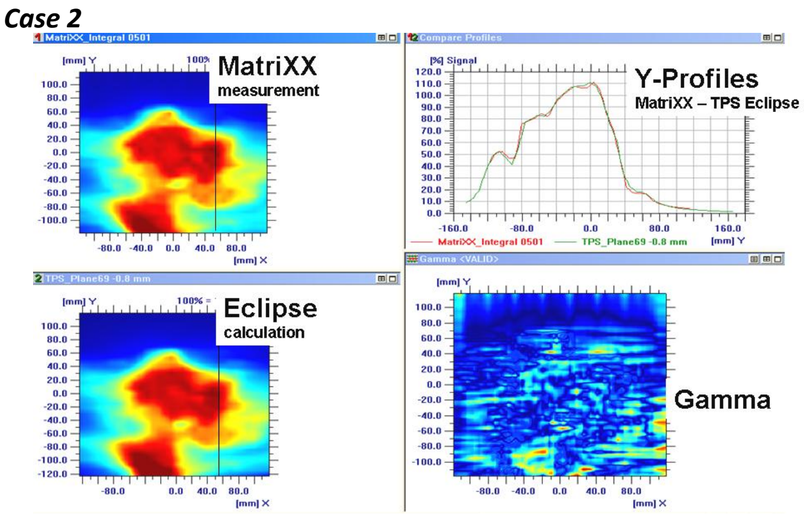


H&N – four clinical cases

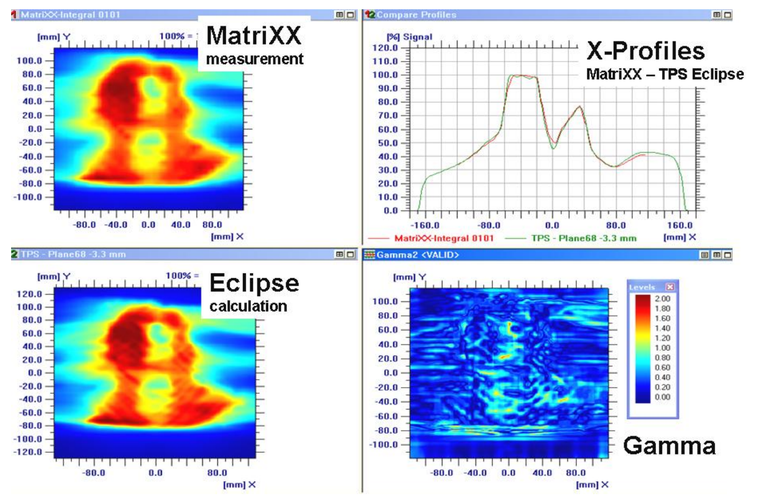
Case 1



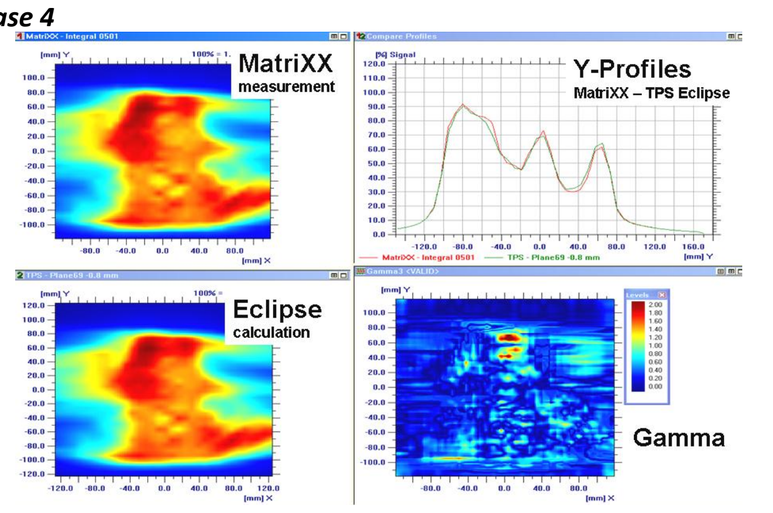
Case 2



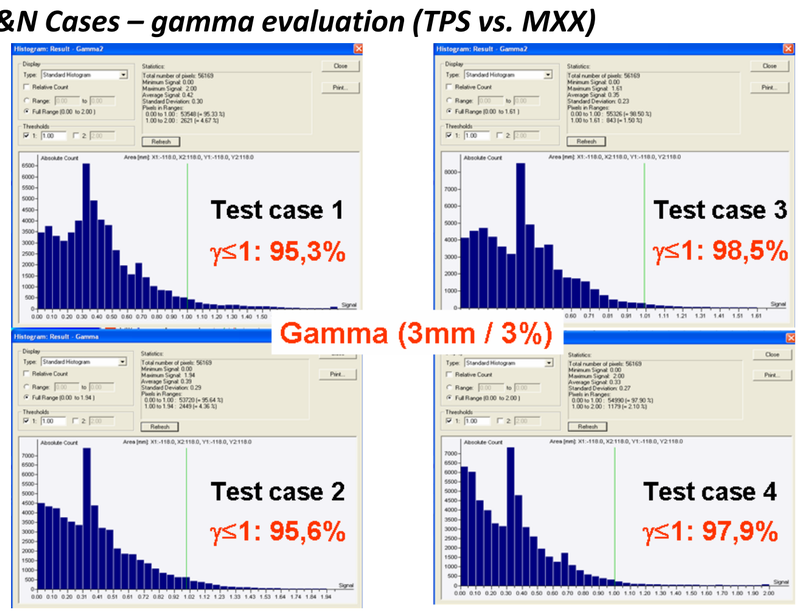
Case 3



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^{TM}. The results have clearly proven the MatriXX^{Evolution} system to be fast, reliable and accurate dosimetry method for QA of RapidArc^{TM} treatment delivery.

References:

-Stine Korreman et al. „RapidArc verification measurements using three different dosimetric systems", ASTRO 2008 Boston
-Joakim Medin et al. "Dosimetric verification of RapidArc™ volumetric modulated arc therapy", ESTRO 27 Göteborg 2008
-Tom Depuydt et al. "The feasibility of a Helical Dosimetry system for hybrid plan quality assurance of IMRT, ESTRO 27 Göteborg 2008
- Igor Gomola et al. „Influence of treatment couch attenuation on dose delivered by Rapid Arc^{TM} volumetric modulated arc therapy measured by a 2D ion chamber array" ESTRO 27 Göteborg 2008
-Wilko Verbakel et al. "A dosimetric validation of RapidArc treatment plans for 5 treatment sites" AAPM 2008 Houston

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