REPRODUCIBILITY AND SENSITIVITY OF IQM: A REAL-TIME MONITORING DEVICE FOR COMPLEX RADIOTHERAPY TREATMENTS

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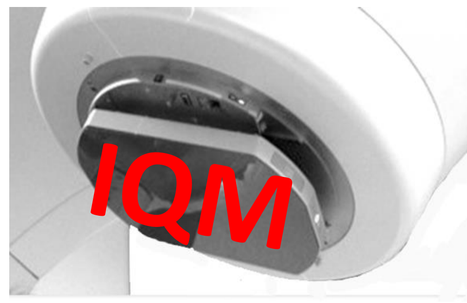
Objectives:

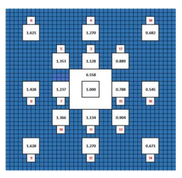
To evaluate the output signal reproducibility and sensitivity in detecting small errors in delivery parameters of IMRT step and shoot treatments of the Integrated Quality Monitoring (IQM) device (iRT Systems GmbH, Koblenz,Germany)



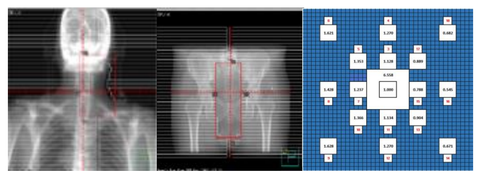
Methods:

IQM is a monitoring on line delivery system composed of a large ionization chamber with a gradient applied on electrode plate providing a spatially dependent (one-dimensional) dose-area-product signal for each beam segment. A calculation algorithm predicts the signal by receiving data from the treatment planning.

INTRA-FRACTION Repeatability was checked by delivering with an Elekta Precise linac (6 MV), for about 2 hours, the same treatment field composed by 17 square fields 4cm x4cm and 1 larger field 10cmx10cm irradiating different regions of the detector.



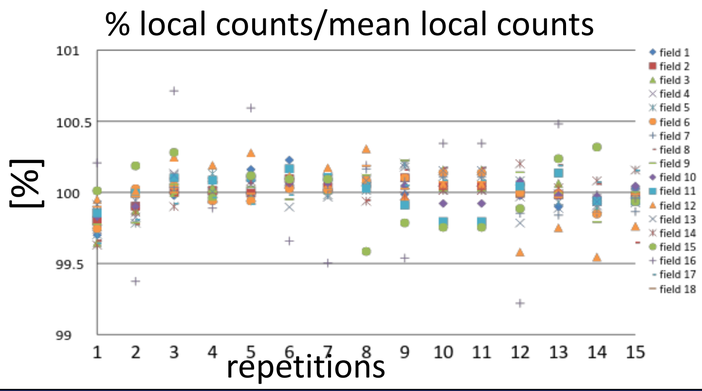
INTER-FRACTION Repeatability was checked by delivering three IMRT plans (Head & Neck, Prostate and an IMRT sample plan) with an Elekta Precise linac (6 MV) for more than 70 times in a period of thirty days.

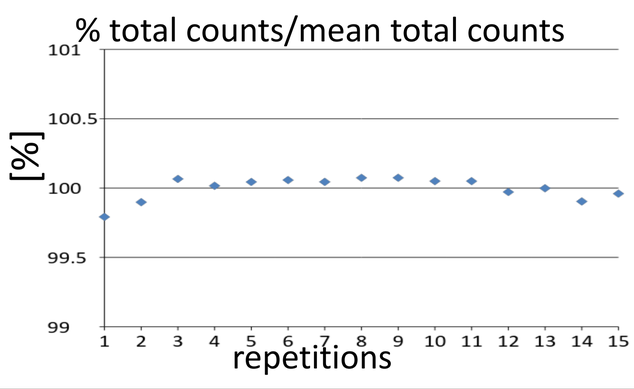


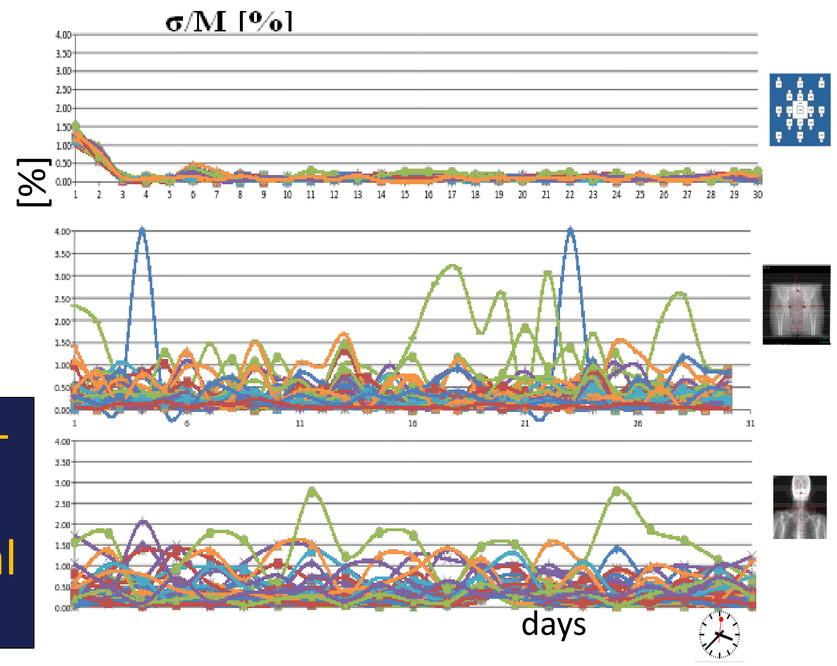
SENSITIVITY IN DETECTING SMALL DELIVERY ERRORS was checked by inducing **7 types of ERRORS** in the IMRT clinical plans for Head & Neck, prostate and the index quadrant by modifying the number of delivered MU (between 1 and 3 per beam) and by introducing deviations in linac leaf positions mimicking an MLC bank error as closing and opening one or both banks.

Results:

Mean local counts (for each segment of IMRT treatment) and mean total counts (for entire treatment) and σ of IQM signal response are evaluated over 15 acquisitions of the IMRT sample plan (delivered on the same session) and over 21 acquisitions for H&N, 30 for prostate and IMRT sample plan (delivered on different days).



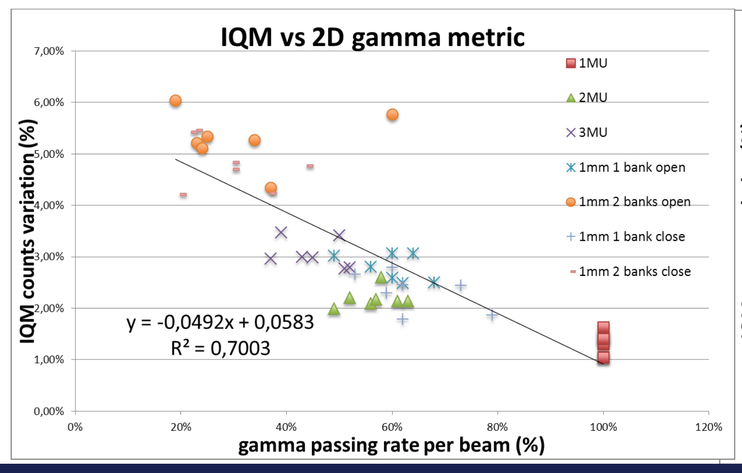


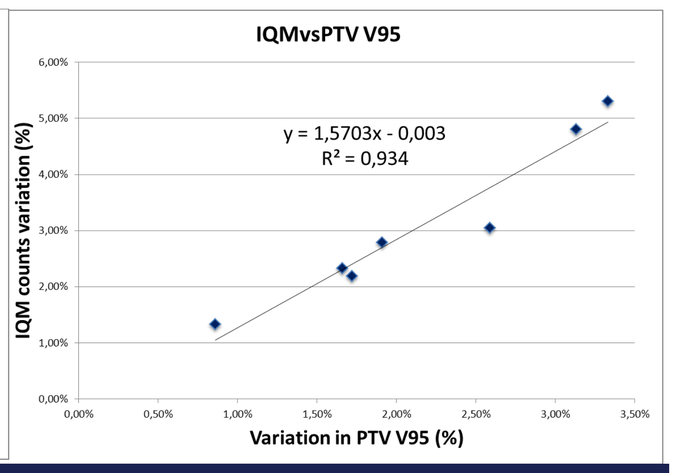


Repeatability	Intra-fraction σ/M [%]	Inter-fraction σ/M [%]		
	Test IMRT	*Head & Neck*	*Prostate*	*Test IMRT*
Global	0.08	0.72	0.67	0.96
Local (mean±σ)	0.15±0.09	0.36±0.36	0.28±0.54	0.15±0.17

Global and local intra and inter-fraction detector repeatability results demonstrate the optimal detector performances

In Figure IQM signal variation is plotted vs 2D γ per beam (1%/1mm, th10, local approach) and the PTV V95% for the H&N example. The correlation function R shows a good correlation with DVH parameters especially.





Conclusions:

IQM provides optimal performance for signal reproducibility of complex IMRT plans. The sensitivity of IQM is suitable to detect small errors in MU and leaves position sufficient for clinical practice and a good correlation between IQM signal variations and 3Dγ, 2Dγ and DVH parameters has been observed.

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