

TESTING IQM: A SYSTEM FOR REAL-TIME MONITORING OF COMPLEX RADIOTHERAPY TREATMENTS



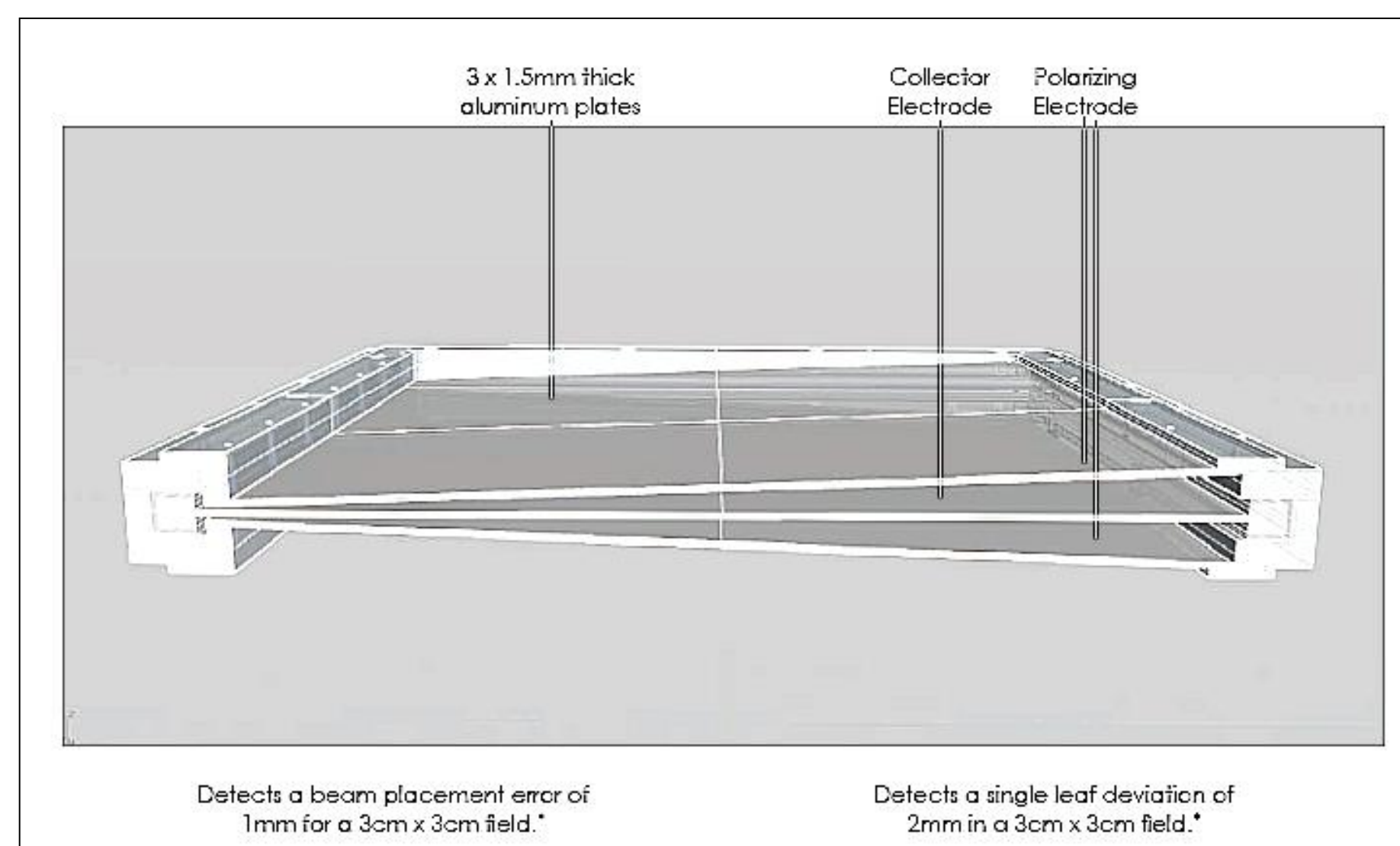
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AIM: To test the **Integral Quality Monitoring (IQM)** device (IRT Systems GmbH, Koblenz, Germany): a system for online monitoring of Intensity Modulated Radiation Therapy (IMRT) treatments.

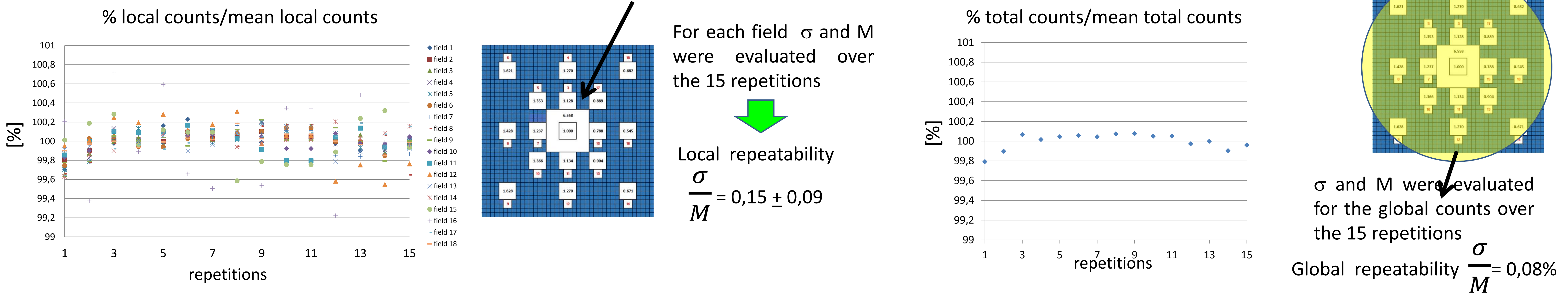


IQM = It is a large area ionization chamber [1], with a gradient in the electrode plate separation, and a calculation algorithm to predict the signal based on the field information received from the treatment planning system. The signal from the ionization chamber provides a spatially dependent (one-dimensional) dose-area-product signal for each beam segment.

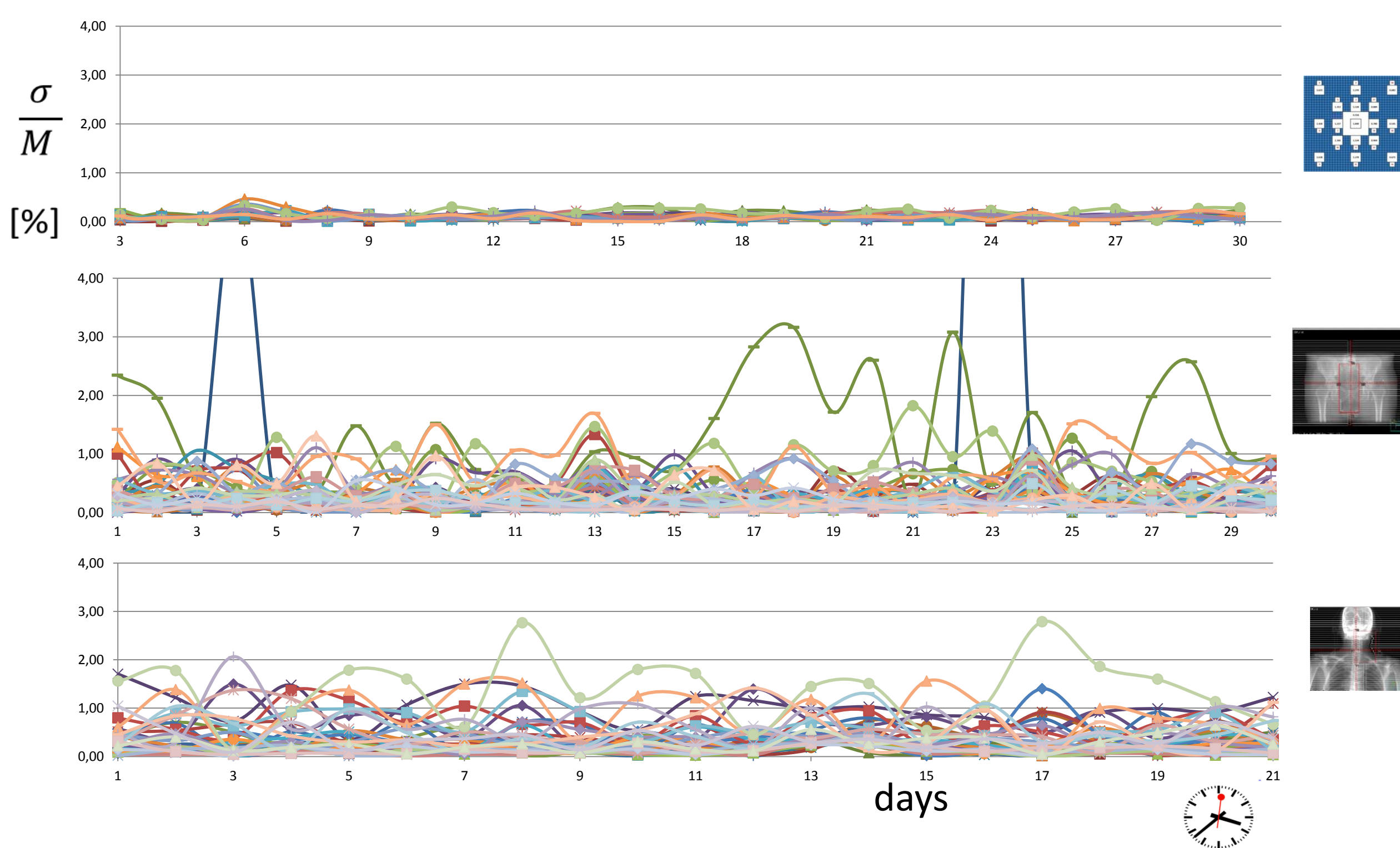


TESTS

INTRA-FRACTION Repeatability was checked by delivering 15 times (about 2 hours) the same plan composed by 17 square fields 4cm x4cm and 1 larger field 10cmx10cm irradiating different regions of the detector.



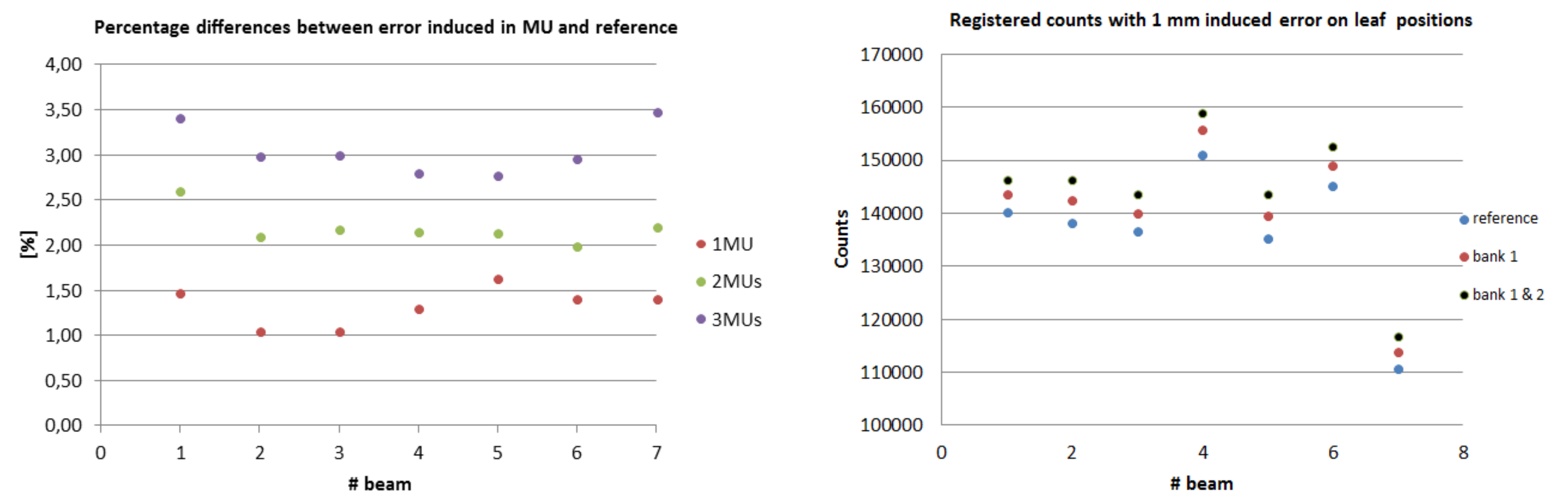
INTER-FRACTION Detector Repeatability Inter-fraction detector repeatability was checked by delivering three IMRT treatments for more than seventy times in a period of thirty days. The chosen treatments were: a Head & Neck (H&N), a Prostate and a test IMRT treatment. For each segment of the IMRT treatment σ and M were evaluated over the number of repetitions (21 for H&N; 30 for prostate and test IMRT). In H&N and prostate tests gantry rotation and small field of different shape and size were considered.



Much larger errors were found for field of small size (approx. 6cm²). Global and local intra and inter-fraction detector repeatability results, shown in the table below, demonstrate the optimal detector performances.

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 $\pm\sigma$)	0.15 \pm 0.09	0.36 \pm 0.36	0.28 \pm 0.54	0.15 \pm 0.17

ERRORS WERE INDUCED to an H&N IMRT treatment composed by seven beams (gantry angles = 0°, 40°, 80°, 140°, 220°, 280°, 320°) generating five new treatments. Errors were induced **modifying the number of delivered MU (between 1 and 3)** and by introducing **small deviations in leaf positions** for each segment of each beam (mimicking an MLC bank error).



Percentage differences between the IQM signal acquired for each beam of the reference treatment and f the correspondent beam with induced errors in MUs.

Counts registered with 1 mm induced errors in leaf positions of bank n°1 and for banks 1&2

Conclusions: IQM provides optimal performance for signal reproducibility of complex IMRT plans. It is also capable of detecting small errors in MU and leaves position sufficient for clinical practice.

[1] Mohammad K. Islam et al. "An integral quality monitoring system for real-time verification of intensity modulated radiation therapy," in *Medical Physics*, 36 (12) pp 5420-5428 December 2009