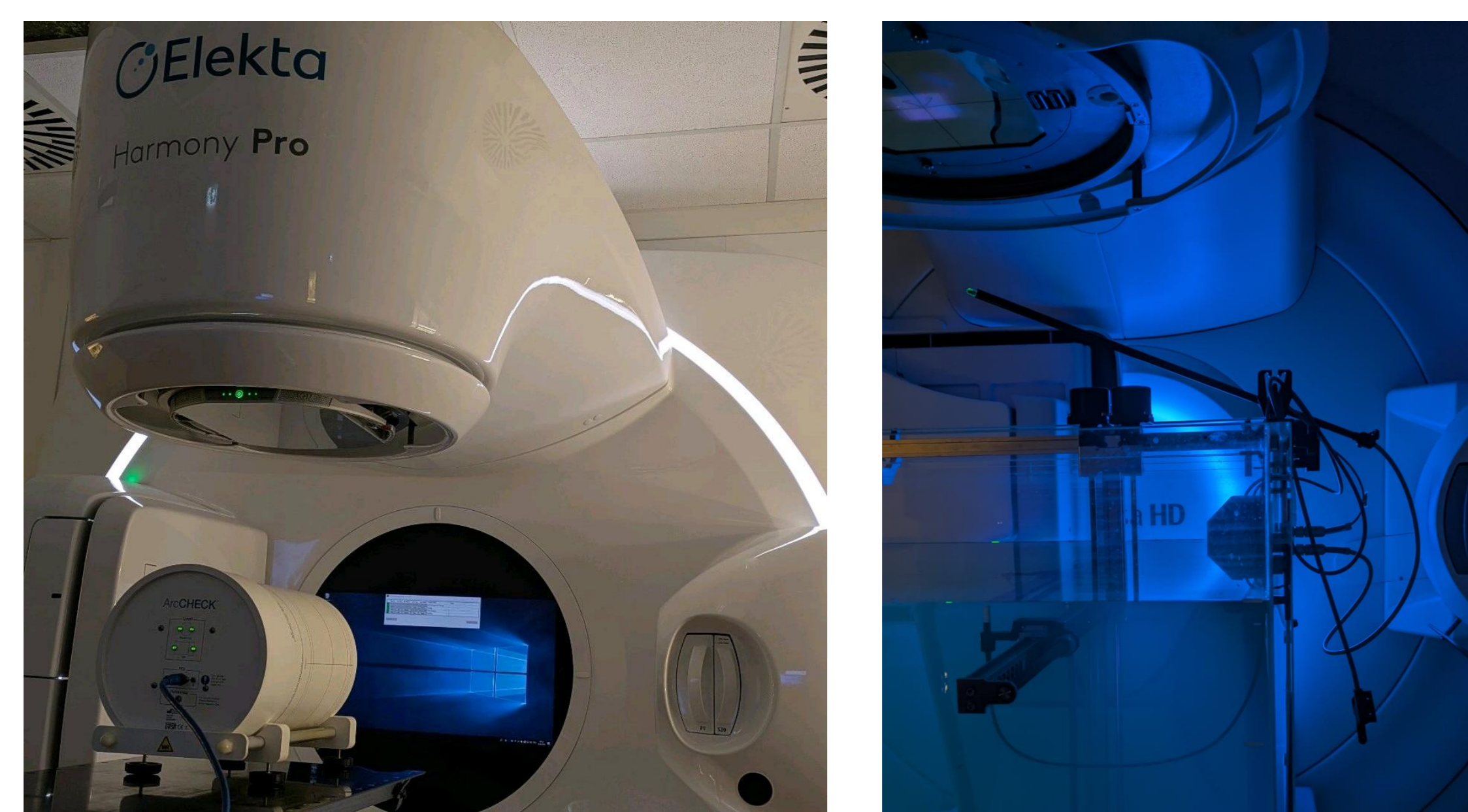


Preparation and introduction of a gantry-mounted in-vivo dosimetry chamber for patient treatment

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Question

Since the introduction and extensive in-house validation of the iQM detector (iRT-Systems) for patient and machine QA, the time required for QA procedures has been significantly reduced without compromising quality. The next step to fully exploit the potential of the iQM system is its use during patient treatment—eliminating the need for a dedicated fraction 0 and enabling real-time monitoring of the delivered dose for each treatment fraction. To ensure consistent treatment quality, the impact of the iQM on the beam was quantified in terms of absorption, shape, and applied dose.



Pic.1: Setups for absorption measurements with 2D array (ArcCheck) and Farmer-type chamber.

Material & Method

To assess the influence of the iQM, several test fields were defined and irradiated both with and without the iQM mounted. Static 20×20 cm² fields (gantry angles 0°, 90°, 180°, 270°; each with collimator angles 0° and 90°) and VMAT fields were evaluated with flattening filter. Measurements were performed using the QuickCheck, ArcCheck, and Octavius 2D-array detectors to determine absorption and to compare beam flatness and symmetry. Absolute dosimetry was conducted in a water phantom using a Farmer-type ionization chamber. Additionally, cross-validation of VMAT and IMRT plans was performed, comparing results with and without the iQM (considering its tray factor) using γ -analysis (3 mm/3%). All measurements were carried out on three Elekta linacs. One Versa HD, which is the reference machine, and two beam-matched Harmony Pro.

Results

	abs. dos.	QC
6MV	100,0	100,7
6MV iQM	93,3	94,3
6FFF	100,0	100,5
6FFF iQM	93,3	94,4

Tab.1: Percentage of the absorption measured in water (abs. dos.) and with the QuickCheck (QC)

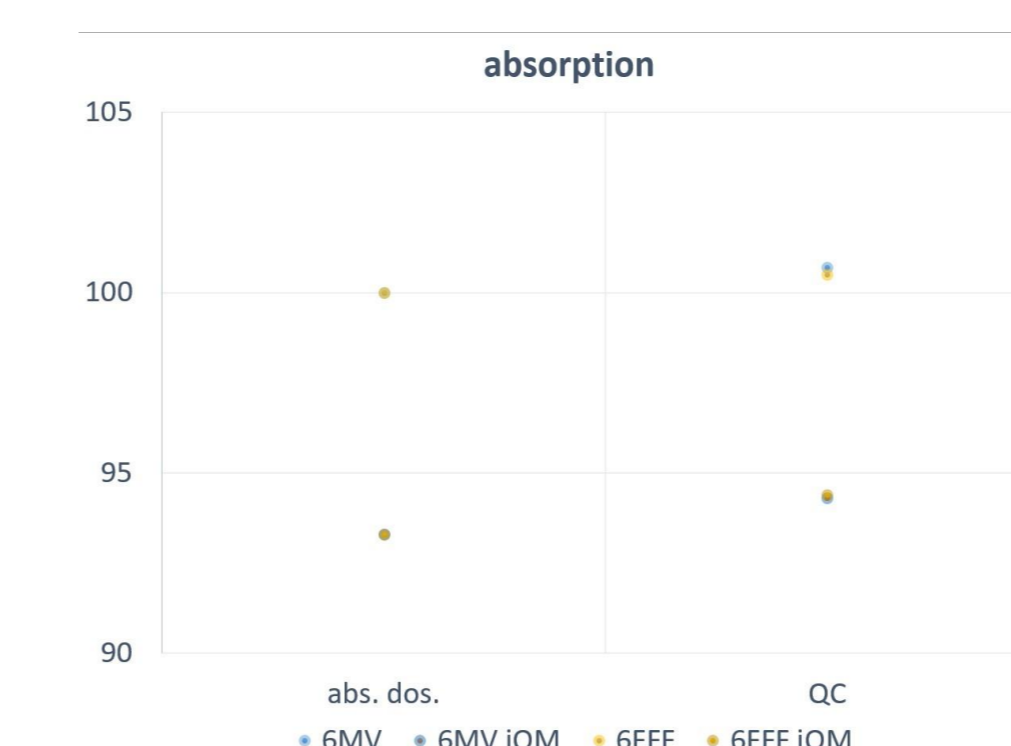


Fig.1: Graphical presentation of the measured absorptions of the Versa HD

The measured absorption varied slightly depending on the detector used but was consistent across linacs and energies: water phantom $6.7 \pm 0.1\%$ (abs. dos.), QuickCheck $5.7 \pm 0.3\%$, and ArcCheck $5.5 \pm 1.1\%$. Differences in normalized flatness ($fn < 0.5\%$) and symmetry ($symn < 0.4\%$) were negligible for all devices. With these the tray factor was set:

$$TF=6.7\%$$

Cross-validation of VMAT plans yielded γ passing rates $>98\%$ when comparing iQM plans with applied TF to the corresponding non-iQM QA plans.

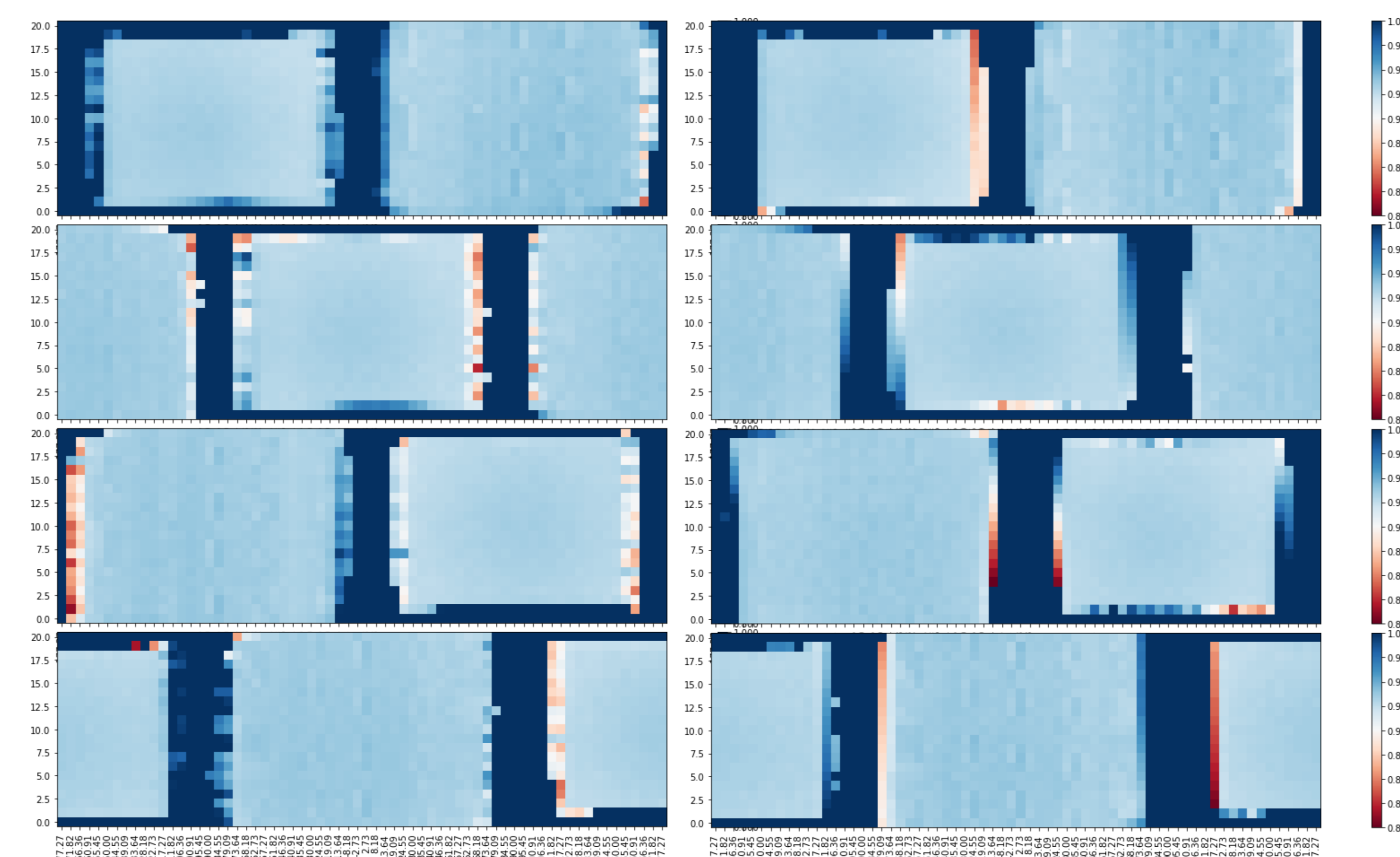


Fig.2: Example set of all static field absorptions measured with the ArcCheck at the Versa HD. Relative comparison in percentage - w/o iQM vs. w/ iQM

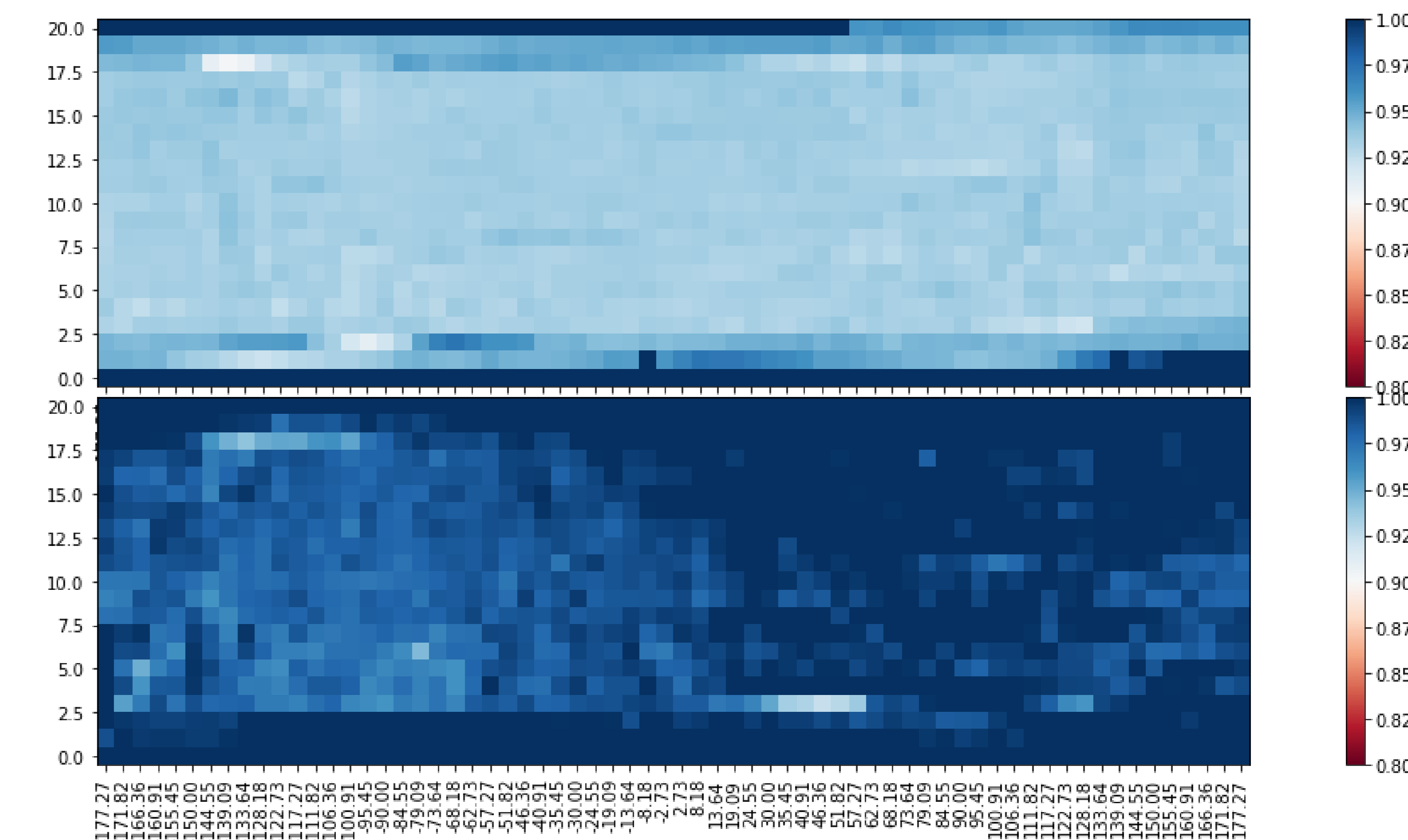


Fig.3: Example set of the VMAT absorption and correction with the tray factor measured with the ArcCheck at the Versa HD. w/o iQM vs. w/ iQM (top) and w/o iQM vs. w/ iQM+TF (bottom)

	VMAT			static		
	Versa	Harmony 1	Harmony 2	Versa	Harmony 1	Harmony 2
pass@3mm3%						
w/o iQM	99,9	99,9	99,8	100,0	98,6	99,0
w/ iQM	88,8	98,5	98,2	67,9	81,4	76,6
w/ iQM+TF	100,0	100,0	99,9	100,0	100,0	100,0

Tab.2: Overview of the passing rates per Linac based on the QA-plan.

Conclusion

Implementation of the iQM detector for in-vivo patient treatment enables real-time dose verification without compromising treatment delivery or prescription accuracy. Furthermore, it eliminates the need for a separate QA fraction, thereby reducing overall QA time and allowing more focus on complex and stereotactic treatment QA.