

MR COMPATIBLE OCTAVIUS AND PHANTOM SYSTEMS ARE SUITABLE FOR PLAN QA IN A 1.5 T MR-LINAC

Viktoriia Gorobets¹, Wilfred de Vries², Nicole Brand², André Wopereis¹, Thomas Foppen¹, Simon Woodings¹

¹ Department of Radiotherapy, University Medical Center Utrecht

² PTW Freiburg GmbH

INTRODUCTION

MR-compatible detector arrays, such as the OCTAVIUS Detector 1500 MR with 1405 air-filled ion chambers and the 1600 MR with 1521 liquid-filled ion chambers, have been evaluated in magnetic fields (0.35 T and 1.5 T) using the older static phantom. These tests have revealed considerable angular sensitivity.^{1,2} Recently, PTW introduced the MR-compatible OCTAVIUS 4D system, which is designed to rotate, ensuring a constant and optimal alignment between detectors and each beam segment direction. The fully MR-compatible systems are now available for testing and implementation in MR-Linacs. This study aims to evaluate the suitability of the MR-compatible systems for patients' plan QA in a 1.5 T MR-linac.

MATERIALS



- OCTAVIUS 4D Phantom MR⁴
- OCTAVIUS Detector 1500 MR
- Farmer Ionization Chamber

- Elekta Unity 1.5 T MR-linac
- OCTAVIUS Detector 1600 MR
- RW3 slabs

METHOD

- Detectors underwent fundamental dosimetry characterization. The results were compared to gold-standard ion chamber measurements
- 25 clinical treatment plans across various anatomical sites were evaluated using OCTAVIUS Detector 1500 MR and OCTAVIUS 4D Phantom MR

RESULTS

Basic dosimetry characteristics:

- Short-term reproducibility $\leq \pm 0.2\%$
- Dose linearity $\leq \pm 1\%$
- Dose rate dependence $\leq \pm 0.8\%$
- Dose per pulse dependence $\leq \pm 0.4\%$
- Field size dependence $\leq \pm 0.5\%$ for big fields (Figure 1)
- Angular dependence $\leq \pm 1.2\%$

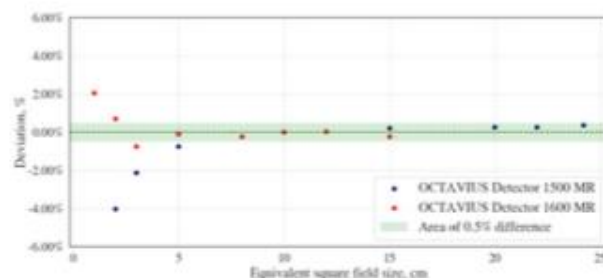


Figure 1. Field size dependence of the OD 1500 MR and OD 1600 MR central chambers in the MRI.

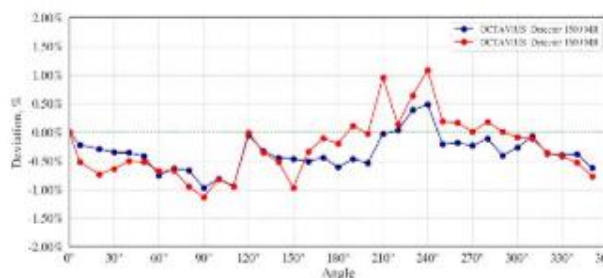
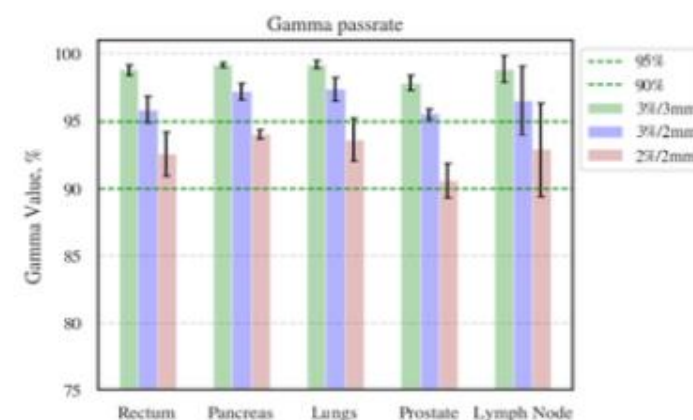


Figure 2. Angular dependence of the OD 1500 MR and OD 1600 MR central chambers in the MRI.

RESULTS

Octavius 1500MR in the OCTAVIUS 4D Phantom MR



DISCUSSION

The Octavius Detector 1500 MR demonstrated compatibility with the standard 95% pass rate when employing a 3%/3mm gamma criterion, and a 90% pass rate using a 2%/2mm gamma criterion for different targets. Both devices exhibit field size dependence in smaller field sizes, due to the volume averaging effect, density perturbation, and ion recombinations.³

CONCLUSION

The new MR-compatible OCTAVIUS detectors and 4D phantom are suitable for QA of patient treatment plans in a 1.5 T MRI-linac.

REFERENCES

1. Mönnich, et al., Physics in Medicine & Biology, 2020.
2. Poppinga et al., ptwdosimetry.com, 2021.
3. Kutcher et al., INTERNATIONAL ATOMIC ENERGY AGENCY, 2017.
4. <https://www.ptwdosimetry.com>