2026 JULY 19–22 VANCOUVER, BC
JOINT AAPM | COMP MEETING

Assessing the Octavius 4D MR Phantom for VMAT Validation on the 1.5 T MR-Linac

P.T.S. Borman[1], C.R. Hoek[1], W.J. de Vries[2], V. Gambetta[2], B.W. Raaymakers[1], M.F. Fast[1]
[1]Department of Radiotherapy, UMC Utrecht, Utrecht, Netherlands
[2]PTW Freiburg, Freiburg, Germany

BACKGROUND

- MR-linacs enable online adaptive radiotherapy
  - Increased dose conformality
  - Improved therapeutic ratios.
- VMAT unavailable on clinical MR-linac systems
- VMAT technically demonstrated on a research 1.5 T Unity MR-linac (Elekta, Sweden)[1]
- Increased delivery efficiency w.r.t. IMRT has been shown[2]
- The OCTAVIUS 4D MR (PTW Freiburg, Germany) phantom is released for IMRT on the MR-linac[3]

GOALS

- Report on the suitability of the OCTAVIUS 4D MR phantom for VMAT-specific MR-linac machine and patient QA.

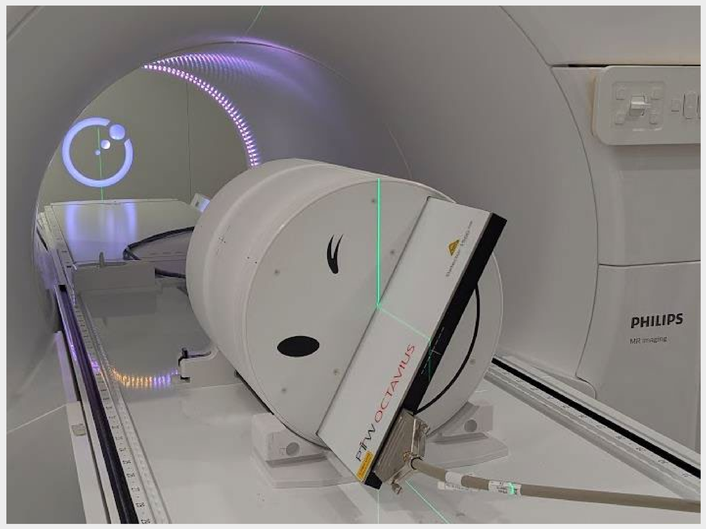

Figure 1. The OCTAVIUS 4D MR phantom with array OCTAVIUS Detector 1500 MR inserted. The phantom rotates around its principal axis, such that the detector array is always orthogonal to the radiation beam.

CONCLUSIONS

- The OCTAVIUS 4D MR with modified software is a suitable phantom for VMAT-specific machine and patient QA on the MR-linac.
- Better gantry synchronization could yield further performance gains.

REFERENCES

1. Hoek et al. 2026, doi: 10.1016/j.radonc.2026.111568
2. Snyder et al. 2025, doi: 10.1016/j.ijrobp.2024.10.028
3. Gorobets et al. 2024 doi: 10.1088/1361-6560/ad67

METHODS AND MATERIALS

- 1.5T Elekta Unity MR-linac with modified control system enabling VMAT deliveries
- OCTAVIUS 4D MR phantom
- OCTAVIUS 1500 Detector MR: 1405 ion chambers, 27x27 cm grid (fig. 1)
- Modified phantom control software to enable continuous rotation.

- Dynamic angular dependency:
  - 200MU 10x10 cm^2, 20x20 cm^2
  - dynamically vs. statically with 30° intervals (averaged)

- Patient QA:
  - 5x7.25 Gy prostate VMAT plan
  - Monaco research v6.29.0.0 (Elekta, Sweden)
  - Two arcs: 180°-5°, 21°-180°

RESULTS

- Dynamic square field measurements agreed with the static ones for the 10x10 cm^2 and 20x20 cm^2 fields (fig. 3):
  - MAE: 0.3%, 0.5%
  - 95th-percentile: 0.6%, 1.1%
- 96% Gamma pass-rate (global, 3%/3mm) for the prostate plan, fig. 4
- The phantom's rotation trailed the linac-reported gantry angle by 1.1° (RMSE), fig. 2

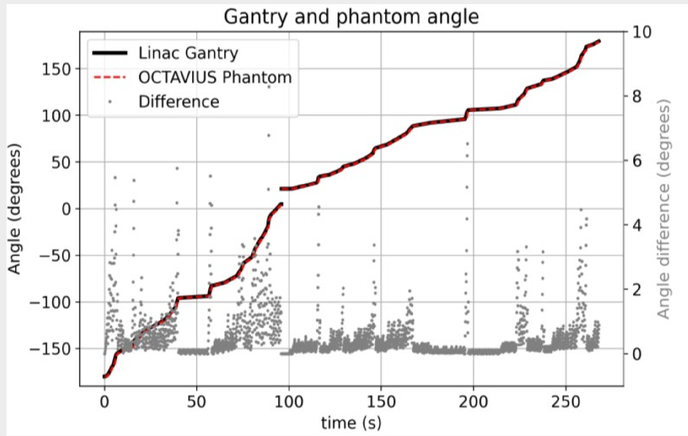

Figure 2. linac-reported gantry angle versus the phantom angle during the prostate plan delivery. Due to the relatively low reporting rate (1.3Hz), the phantom rotation trails the gantry rotation, especially when the gantry rotates fast.

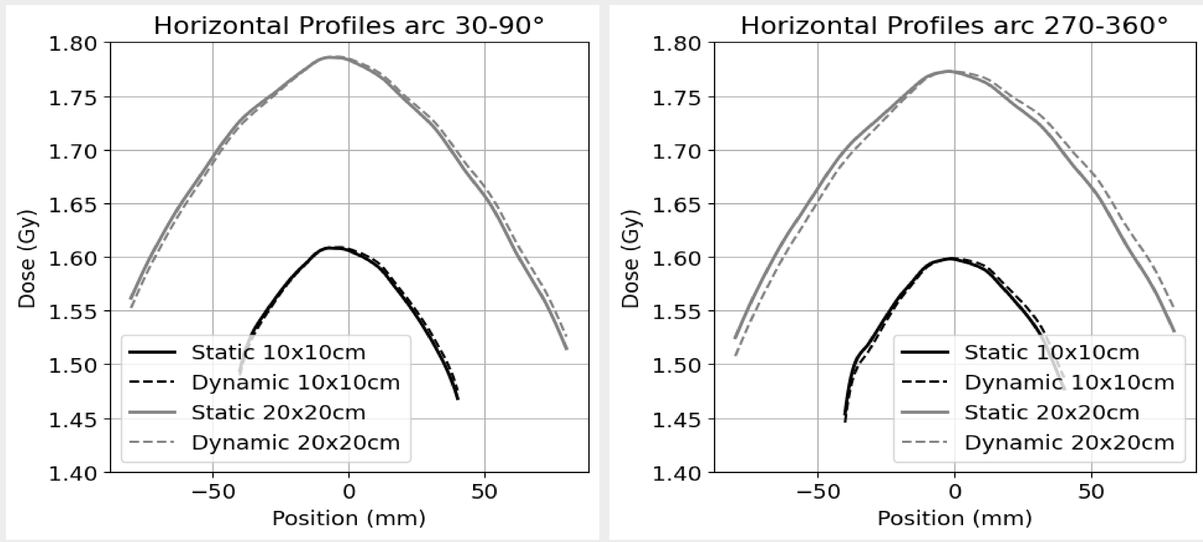

Figure 3. Dose profiles tangential to the gantry rotation direction. The cryostat pipe (0-30 deg) and couch structures (90-270 deg) are avoided. The dynamic fields are slightly offset with respect to the static fields, likely caused by the phantom's rotational latency.

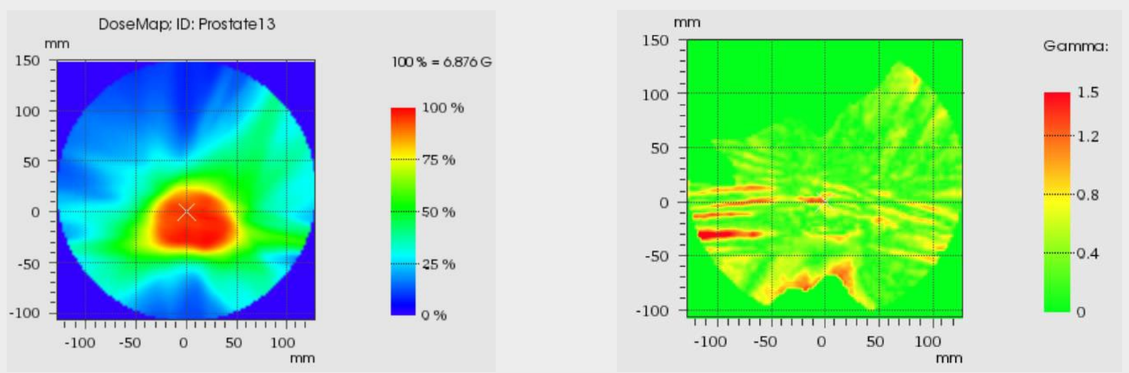

Figure 4. Measured dose of the patient prostate plan (left) and the resulting gamma map (right).

CONTACT

Pim Borman, PhD
University Medical Center Utrecht
Heidelberglaan 100, 3584 CX, Utrecht, NL
pborman@umcutrecht.nl