Masterproef industriële ingenieurswetenschappen

Feasibility of a 3D printed bolus integrated with polymer gel dosimetry

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Fabrication PAGAT polymer gel

Aam, Bis

Figure 1: monomer solution

gelatine

Figure 2: gelatine solution

Inserted in vials and 3D print

Figure 3: vial with polymer gel

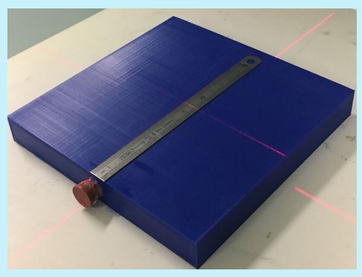
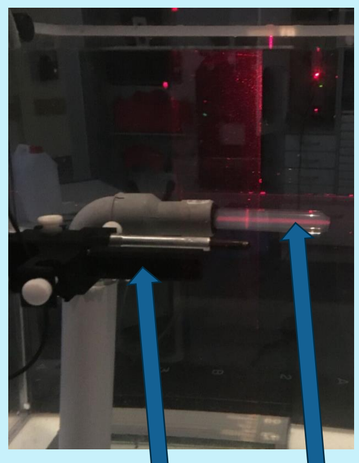


Figure 4: 3D print filled with polymer gel

Irradiation set-up:

Calibration vials in watertank:

Figure 5: irradiaiton set-up



Introduction:
Nowadays high conformal radiation treatments (IMRT, VMAT, PT and IMPT) require 3D dosimetry in-vivo to verify the dose distribution in a proper way. In an attempt to meet these demands, 3D printed boluses with polymer gel as 3D dosimetric component are assessed. A bolus is used as a rangeshifter which results in higher doses near superficial tumours.

MRI read-out:

Head coil:

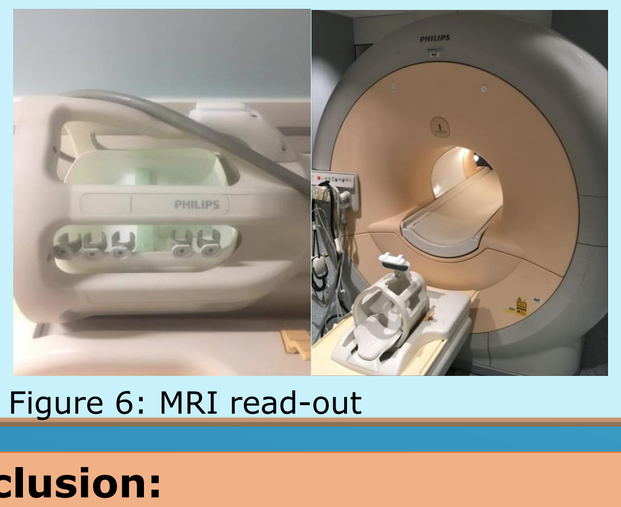


Figure 6: MRI read-out

Results: gamma map analysis (3%/3 mm):

Gel | Film | Gamma (g) | Dose difference:

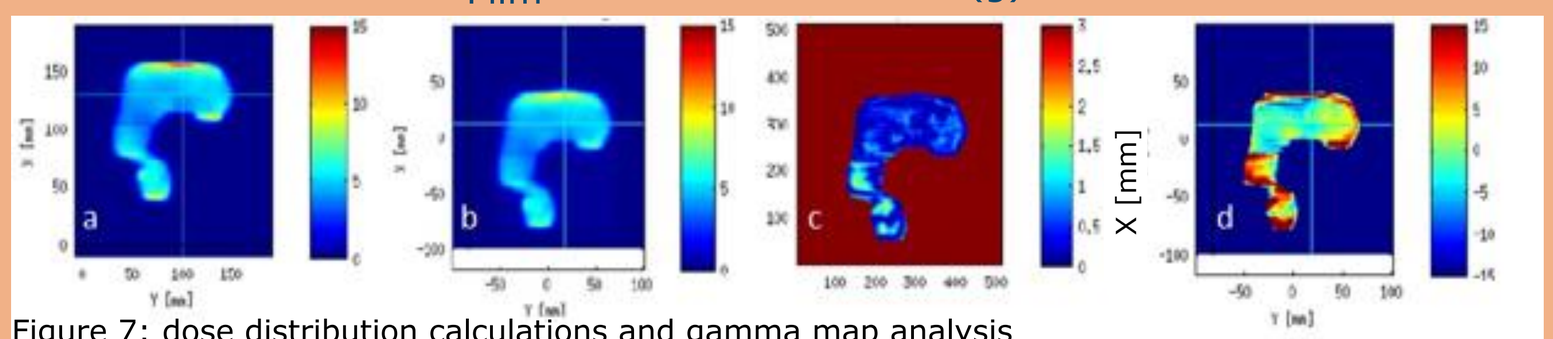
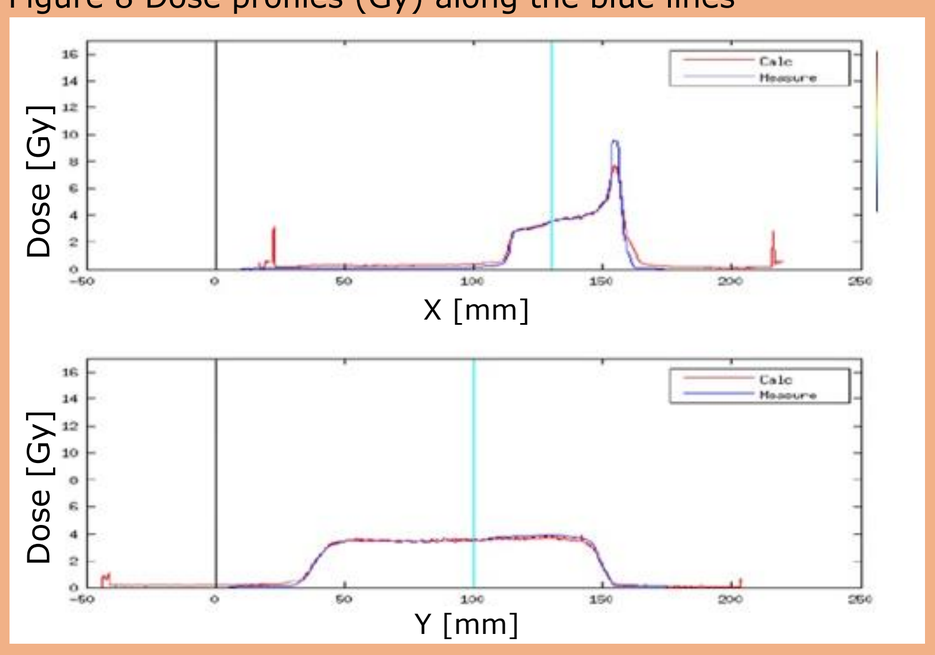


Figure 7: dose distribution calculations and gamma map analysis

Figure 8 Dose profiles (Gy) along the blue lines



Gamma criteria analysis:
The agreement between a measured and predicted radiation dose is expressed by the gamma score for each measurement point hereby allowing a dose difference of 3% or 3 mm distance or any quadratic combination of dose difference and distance.
If g<1 ⟶ criteria passes.

$$g = \sqrt{(\frac{\Delta D}{3\%})^2 + (\frac{\Delta r}{3\ mm})^2}$$

Conclusion:

Gel dosimetry for filled 3D printed boluses is feasible and results in good dose agreement with film dose measurements and TPS dose prediction when strict protocols for gel fabrication and MRI read-out are used. Further improvements in dosimetry accuracy of the in-filled gels is expected with an adequate vial calibration and temperature controlled MRI read-out is obtained.

References:
J. Vandecasteele, Optimisation and validation of three-dimensional polymer gel dosimetry and radiochromic gel dosimetry for clinical applications. PhD thesis, Ghent University, 2013.
D. A. Low, W. B. Harms, S. Mutic, and J. A. Purdy, \A technique for the quantitative evaluation of dose distributions," Medical physics, vol. 25, no. 5, pp. 656{661, 1998

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