

Performance validation of a Novel Biology-Guided Radiotherapy (BgRT) TPS following the IAEA-TECDOC-1540 Methodology

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INTRODUCTION

The first Biology-guided Radiation Therapy (BgRT) TPS is validated for performance using static field plans under the IAEA-TECDOC-1540 specification for acceptance testing. Static beam doses were calculated for different field sizes in homogeneous and heterogeneous solid slab materials to simulate water, bone, and lung. Depth doses, X and Y profiles at different depths were compared using standard techniques and metrics.

AIM

To validate the Reflexion BgRT TPS and validate static plan and delivery for performance using testing methodology outlined in IAEA-TECDOC-1540: Specification and Acceptance Testing of Radiotherapy Treatment Planning Systems.

METHOD

Static field plans were developed on the prototype system TPS and the resulting RTDOSE DICOM files were exported for comparison to measurements. Dose measurements were made with the iBA Blue Phantom Helix water phantom and solid slab materials simulating water, bone and lung. In addition, IMRT & SBRT plans were delivered to the Sun Nuclear ArcCHECK phantom with a custom insert in the ArcCHECK cavity. IMRT & SBRT plan delivery was checked against dose calculation accuracy using 2D gamma. All ion chambers were calibrated by an ADCL laboratory.

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CONTACT INFORMATION

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field size (cm ²)	2%/2mm, X	2%/1mm, X	2%/2mm, Y	2%/1mm, Y
5x1	100.0	88.4	100.0	100.0
5x2	100.0	93.6	100.0	100.0
10x1	100.0	94.4	100.0	100.0
10x2	100.0	100.0	100.0	100.0
40x1	98.6	97.0	100.0	100.0
40x2	98.7	97.0	100.0	100.0

field size (cm ²)	% difference
5x1	0.7
5x2	-0.7
10x1	0.9
10x2	0.0
40x1	0.8
40x2	0.2

field size (cm ²)	X offset (cm)	% dose difference
10x1	0	0.7
10x1	2.5	-1.3
10x1	4	-0.7
10x2	0	0.3
10x2	2.5	-0.5
10x2	4	-0.8

field size (cm ²)	X (mm)	Y (mm)
5x1	-0.50	0.15
5x2	0.50	-0.10
10x1	0.00	0.15
10x2	-0.10	-0.10

field size (cm ²)	X (mm)	Y (mm)
10x1	0.55	0.53
10x2	0.5	0.45

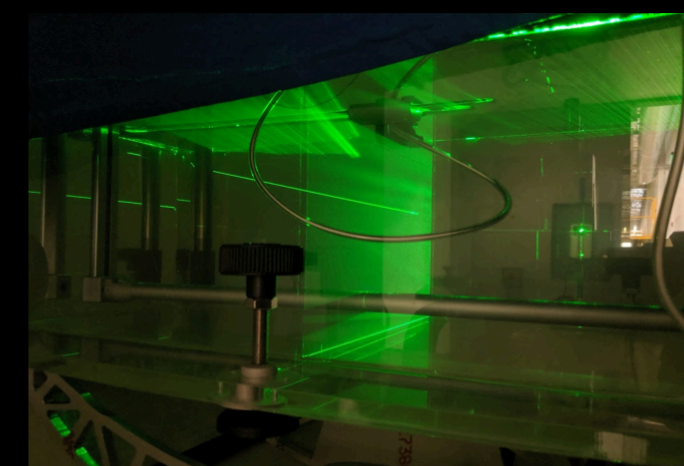
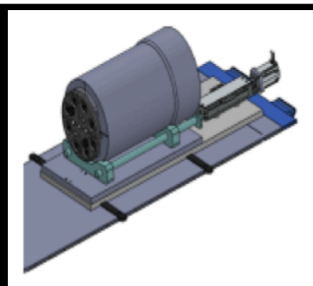
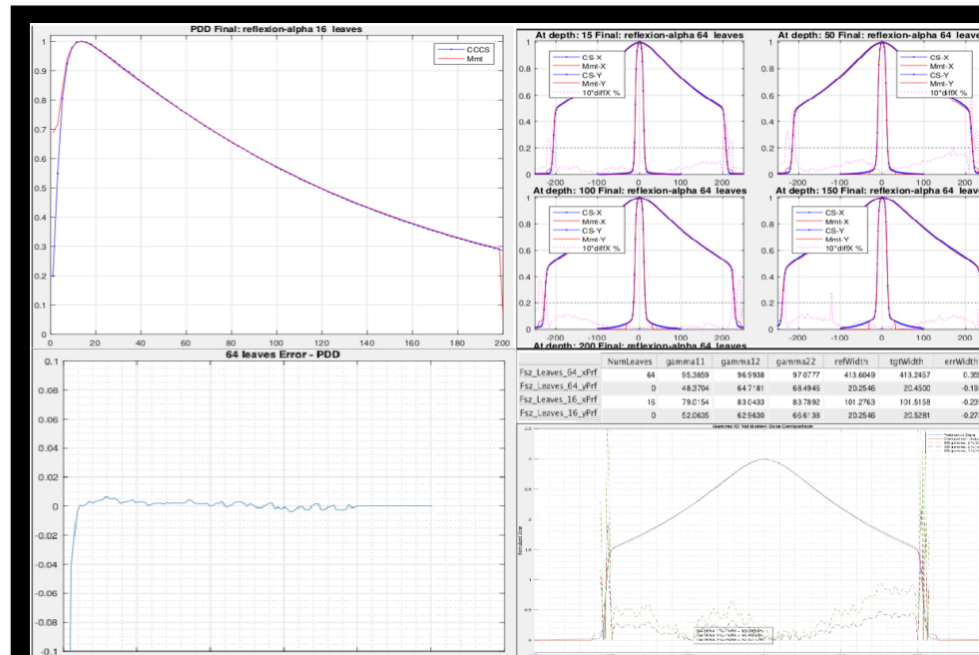


Table 1-5 Measurements performed with iBA Blue Phantom Helix water phantom



Plan	PTV D95 (Gy)	jaw width (cm)	Phantom	Passing rate
Off-axis sphere	10	2	Homo-RTM	99.4%
Off-axis sphere	10	2	Hetero-RTM	96.9%
Off-axis sphere + C-shape	10	2	Homo-RTM	98.0%
Off-axis C-shape	10	2	Homo-RTM	100.0%
Off-axis C-shape	10	1	Homo-RTM	91.0%
TG 119 prostate	10	2	Homo-RTM	97.7%
TG 119 C-shape	2	1	Homo-RTM	93.4%
TG 119 H&N	2	2	Homo-RTM	97.30%

Table 6 Measurements performed using ArcCHECK w/ custom insert



Sample of Commissioning PDF report plots and tables generated by X1 TPS

RESULTS

Depth Doses for field sizes of 10x1, 10x2, 40x1 and 40x2 (cm²) and depths of 10 and 20cm all passed within a 2% tolerance. X/Y profiles for field sizes of 10x1, 10x2, 40x1 and 40x2 (cm²) at 85 cm SSD, 1.5 cm depth all passed within a tolerance of 2%/2mm DD/DTA gamma criteria. Profile widths for 5x1, 5x2 10x1 and 10x2 (cm²) field sizes passed within a 2% (IEC-Y) and 1mm (IEC-X) criteria. Water phantom measurements were also conducted to test the correspondence between calculations and measurements of the following parameters: profile penumbras, build up region, centrally closed MLC leaves, beam symmetry, absolute dose output, field output factor and beam quality.

CONCLUSIONS

Reflexion TPS / System commissioning shows good agreement with measurements in water for PDD and X/Y profiles for different depths and good match in field widths.

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