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Characterization of the IMRT and SBRT performance of a novel biology-guided radiotherapy (BgRT) machine using ArcCHECK

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INTRODUCTION

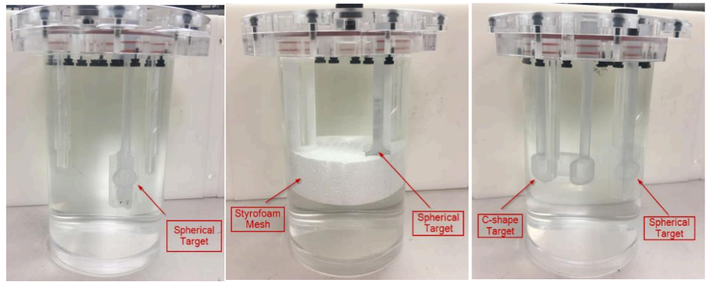
The RefleXion™ X1 biology-guided radiotherapy (BgRT) machine consists of a rotating gantry that includes a 6MV linear accelerator, kilovoltage fan-beam CT, two 90° PET detector arcs and a megavoltage CT detector, continuously spinning at 60 rpm. It can achieve a nominal dose rate of 850 cGy/min and supports two clinical field sizes: 40x1 and 40x2 cm^2.

This work describes performance measurements characterizing the RefleXion X1 dose delivery accuracy of IMRT/SBRT treatments for static targets using the ArcCHECK device.

AIM

To characterize the IMRT and SBRT performance of the RefleXion X1 BgRT machine using the ArcCHECK dosimetry device

METHOD



(a)	(b)	(c)
Homogenous insert spherical target	Heterogenous insert spherical target	Homogenous insert C-shape + spherical targets

Figure 1: Images of the different custom inserts used with the ArcCHECK: a) Homogenous insert with spherical target, b) Heterogenous insert with Styrofoam mesh and spherical target and c) Homogenous insert with two targets (C-shape + spherical)

Custom Inserts for ArcCHECK

- Customized Inserts were designed to fit inside the ArcCHECK cavity
- Inserts simulated homogenous and heterogenous material, surrounding the targets.
- Inserts accommodated different target shapes: sphere and C-shape)
- Inserts that can be configured to hold up to 2 targets were used to test delivery accuracy of IMRT/SBRT plans

Dose Delivery Accuracy

- Dose delivery accuracy was evaluated using 3%/3mm Gamma criterion [1]

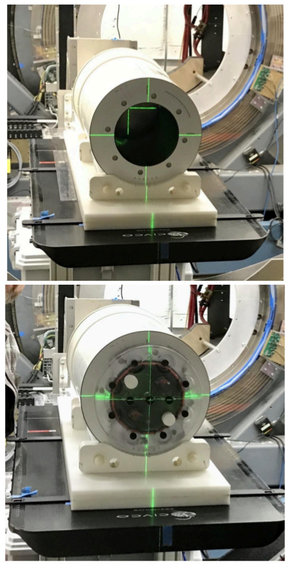


Figure 2: Front-side view of the ArcCHECK without an insert (top) and front-side view of the ArcCHECK with custom insert (bottom)

RESULTS

Table 1: Results of Static IMRT/SBRT tests using the 3%/3mm gamma criterion for dose accuracy

Target Shape	Surrounding Material	Jaw Size	Prescription Dose	Gamma pass rate
22mm sphere	Homogenous	2 cm	1000 cGy	99.4%
22mm sphere	Heterogenous	2 cm	1000 cGy	96.9%
C-shape	Homogenous	1 cm	1000 cGy	91.0%
C-shape	Homogenous	2 cm	1000 cGy	100%
22mm sphere + C-shape (2-target plan)	Homogenous	2 cm	1000 cGy	98.0%
TG119 (Prostate)§	Homogenous	2 cm	1000 cGy	97.7%
TG119 (C-shape) §	Homogenous	1 cm	200 cGy	93.4%
TG-119 (Head-Neck) §	Homogenous	2 cm	200 cGy	97.3%

§Targets and OARs based on TG-119 were simulated rather than physically constructed

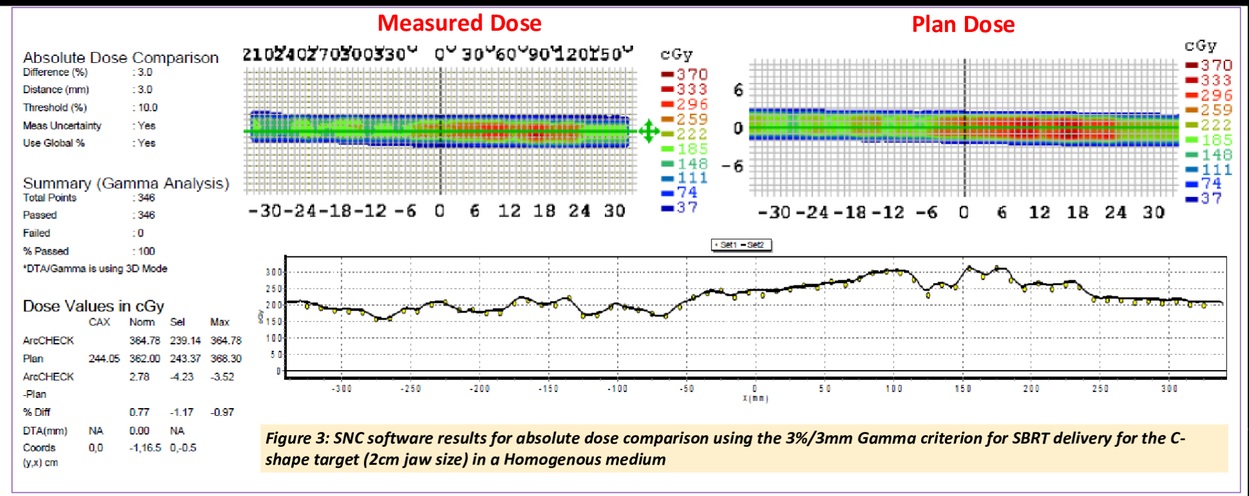


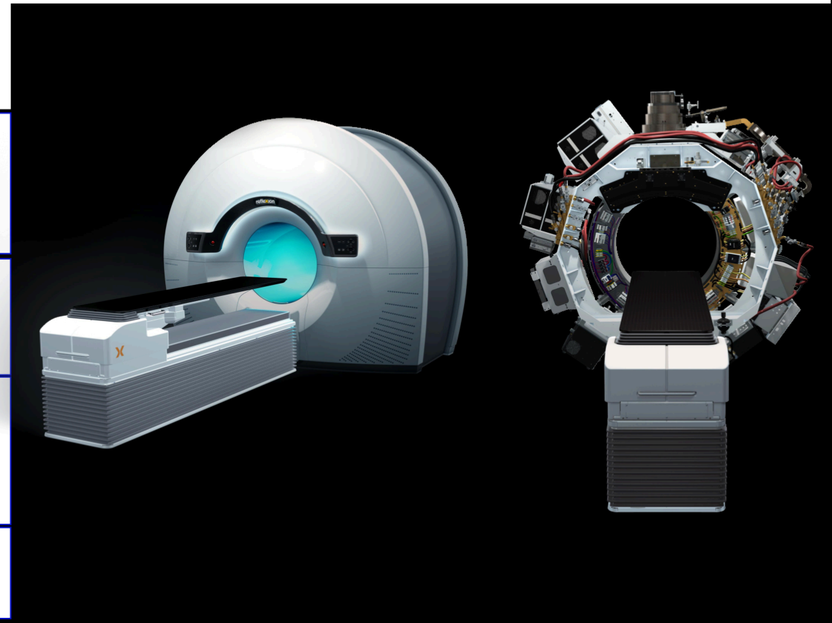
Figure 3: SNC software results for absolute dose comparison using the 3%/3mm Gamma criterion for SBRT delivery for the C-shape target (2cm jaw size) in a Homogenous medium

Static Targets

- All eight delivered IMRT/SBRT plans met the gamma index PASS criteria of at least 90% of the measurement points achieving the 3%/3 mm closeness criteria (see Table 1)

CONCLUSIONS

The performance measurements indicate that the RefleXion X1 System has the required dose delivery accuracy to deliver IMRT/SBRT treatments in a variety of test conditions.



ACKNOWLEDGEMENTS

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REFERENCES

[1] D. A. Low et al, "A technique for the quantitative evaluation of dose distributions", Med Phys 1998; 25: 656-661
[2] G. A. Ezzell et al, "IMRT commissioning: Multiple institution planning and dosimetry comparisons, a report from AAPM Task Group 119", Med Phys 36; 2009: 5359-5373

CONTACT INFORMATION

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