

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 cm².

A validation protocol was developed to qualify the Sun Nuclear Corporation's ArcCHECK 4D Diode Array phantom, with the Multiplug accessory, for measuring IMRT and SBRT delivered dose on the Reflexion X1 system.

AIM

In order to verify delivered dose accuracy for end-to-end phantom testing and pre-treatment Patient Plan QA, we evaluated the ArcCHECK 4D Diode Array phantom as a dosimetry tool to accurately measure the dose delivered by the Reflexion X1 BgRT machine.

METHOD

- IMRT and SBRT plans, to be delivered to the ArcCHECK phantom, were created on the Reflexion X1 Treatment planning System.
- These plans were delivered to the ArcCHECK phantom with EBT3 Gafchromic film placed in the film cassette of the Multiplug insert.
- The delivered plans were measured simultaneously using a) ArcCHECK with SNC Patient software and b) EBT3 film placed in the Multi-plug insert.
- The measured absolute ArcCHECK surface dose was compared to the TPS plan dose using the 3%/3mm Gamma criterion
- 2D film dose was compared to the relevant 2D-plane in the TPS plan dose using the 3%/3mm Gamma criterion.



Figure 1. Illustration of SNC's ArcCHECK phantom with the MultiPlug Insert

RESULTS

- Seven phantom plans were evaluated to compare the measured ArcCHECK gamma passing rates (3%/3mm) against an independent measurement of gamma passing rates (3%/3mm) using EBT3 film.
- Results indicate that both ArcCHECK and EBT3 film measurements met our acceptance criteria of 3%/3mm gamma passing rates $\geq 90\%$

2D Film Gamma comparison for the 25mm ball, off-axis delivery

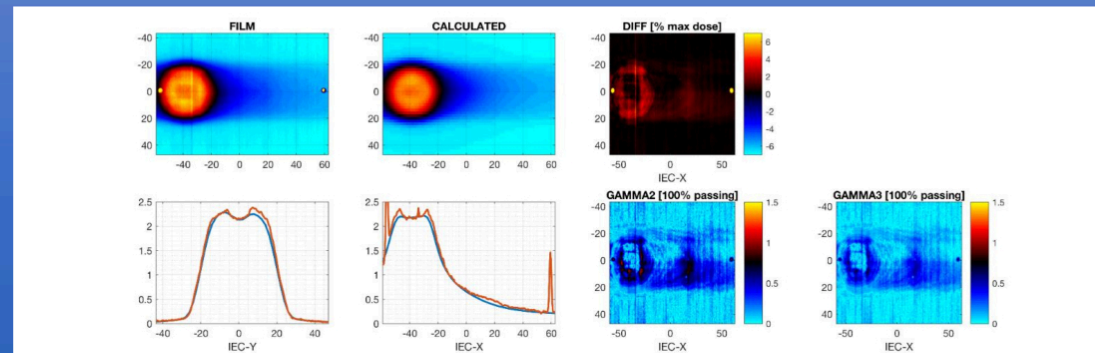


Table 1. Comparison of 3%/3mm gamma passing rates for EBT3 Film and ArcCHECK measurements for seven plan deliveries

Treatment Plan	EBT3 Film 3%/3mm Gamma (Relative) Pass Rates	ArcCHECK 3%/3mm Gamma (Absolute) Pass Rates
8x5 cylinder	99.5%	97.4%
25mm ball	98.8%	100%
40mm ball	99.7%	92.3%
25mm ball off axis	100%	93%
40mm ball off axis	100%	95.6%
2 balls off axis	100%	93.3%
C shape off axis	100%	92.3%

ArcCHECK SNC Patient Gamma comparison results for the 25mm ball, off-axis delivery

Absolute Dose Comparison
 Difference (%) : 3.0
 Distance (mm) : 3.0
 Threshold (%) : 10.0
 Meas Uncertainty : Yes
 Use Global % : Yes
 Cavity Dose : 0.89Gy

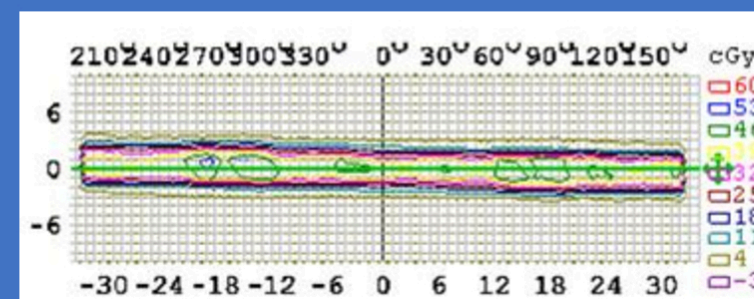
Summary (DTA Analysis)

Total Points : 328
 Passed : 306
 Failed : 22
 % Passed : 93.3
 *DTA/Gamma is using 2D Mode

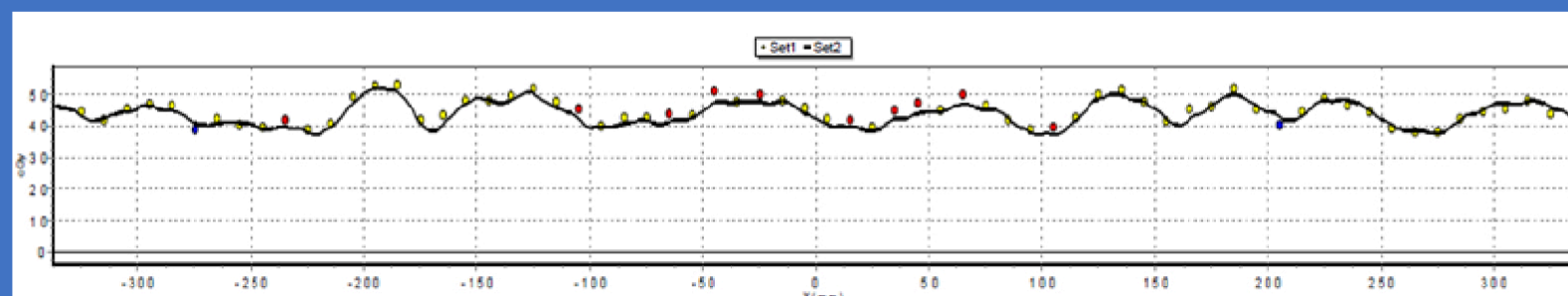
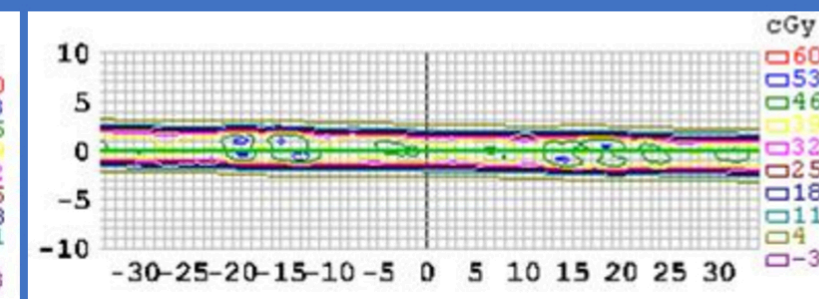
Dose Values in cGy

	CAX	Norm	Sei	Max
ArcCHECK	52.60	45.80	57.45	
Plan	42.39	51.24	43.93	56.45
ArcCHECK -Plan	1.35	1.87	1.00	
% Diff		2.64	3.64	1.95
DTA(mm)	NA	0.00	NA	
Coords (y,x) cm	0,0	-1,-12.5	0,-0.5	

Measured Dose



Plan Dose



CONCLUSIONS

For all 7 delivered plans, both the ArcCHECK and EBT3 film measurements met our acceptance criteria of 3%/3mm gamma passing rates $\geq 90\%$. This indicates equivalent performance between these two independent types of measurements, validating the use of ArcCHECK as a dosimetry tool for use with the novel ring-based architecture of the X1 biology-guided radiotherapy machine.

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