XRV-2000 Falcon Fluence to Film Dose FWHM Comparison

Jesse McKay, M.S., Ronald Berg, Ph.D. - Erlanger Medical Center, Chattanooga, TN
Brett Nelson, M.S. - Logos Systems, Scotts Valley, CA

Introduction

The CyberKnife Iris collimator shapes the radiation beam into a dodecagon that approximates a circle and is capable of 12 different beam diameters: 5, 7.5, 10, 12.5, 15, 20, 25, 30, 35, 40, 50, and 60 mm. Measurement of these beams is typically performed at 800 mm SAD using film, scanner, and third-party software. The goal of this study was to determine if X-ray beam fluence measured at the same 800 mm SAD compares with the Full Width Half Maximum (FWHM) film dose diameters.

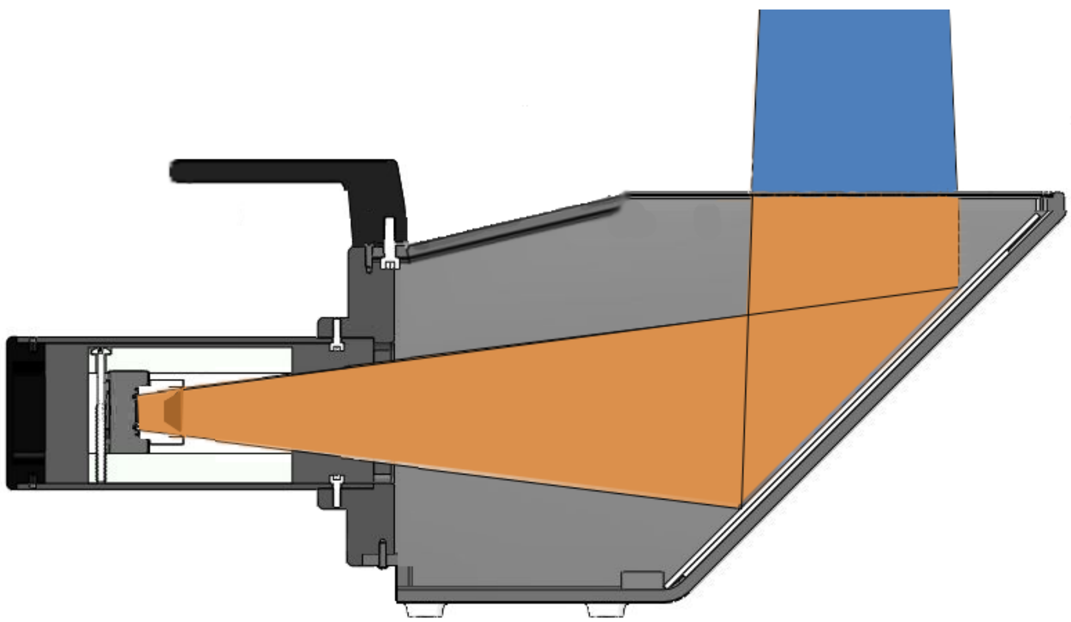

Figure 1 – The Falcon converts X-ray beam fluence (blue) to visible light (yellow) using a 20 x 20 cm scintillator. The scintillator is replaced with a calibration plate to enable the software to accurately convert pixels distances into millimeters.

Materials and Methods

A camera/scintillator system (XRV-2000 Falcon – Logos Systems) was placed beneath the CyberKnife at a distance of 800 mm such that the radiation beam enters the scintillator orthogonally. The blue measuring pointer supplied with the CyberKnife was used to verify the distance as shown in Figure 2. The end of the pointer is shown pointing to the scintillator surface which is 5 mm below the top of the target. This 5 mm distance consists of a 3.4 mm thick target and a 1.6 mm scintillator support backing both made of PMMA/acrylic plastic.

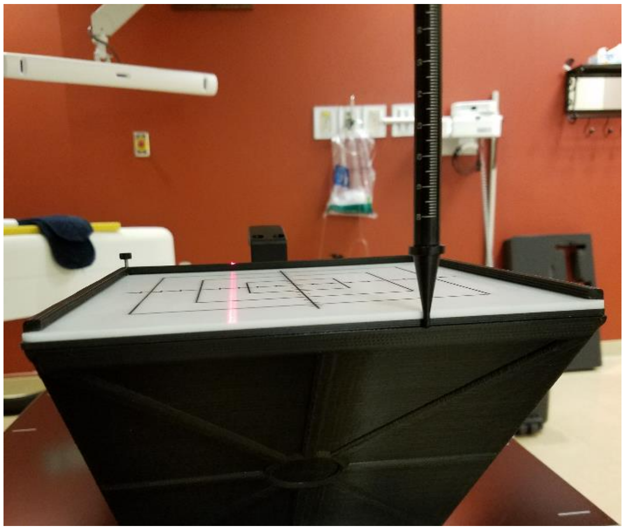

Figure 2 – The couch vertical position is used adjust the height of the Falcon so that the scintillator surface is 800 mm from the virtual source of the CyberKnife Linac.

X-ray fluence images were captured for the 12 Iris apertures using the Falcon's BeamWorks Strata software. The software measured 72 FWHM diameters at 5 degree intervals on each beam spot in order to develop the average.

Figure 3 – The Falcon is shown sitting on the patient couch with the CyberKnife laser pointed at the target center.

EDR2 film was used to capture beam images of the 12 aperture sizes at 800 mm SAD. Each exposure used 200 MU and was made with 15 mm of tissue equivalent build-up and 82 mm of back scatter material.

A Vidar scanner was used to scan the film and the images were brought into RIT software to measure FWHM dose diameters for each beam. In addition, the film images were input into the Falcon software and agreement was verified between the Falcon and RIT image processing algorithms with a maximum delta of 0.06 mm and an average delta of 0.03 mm (standard deviation 0.01 mm).

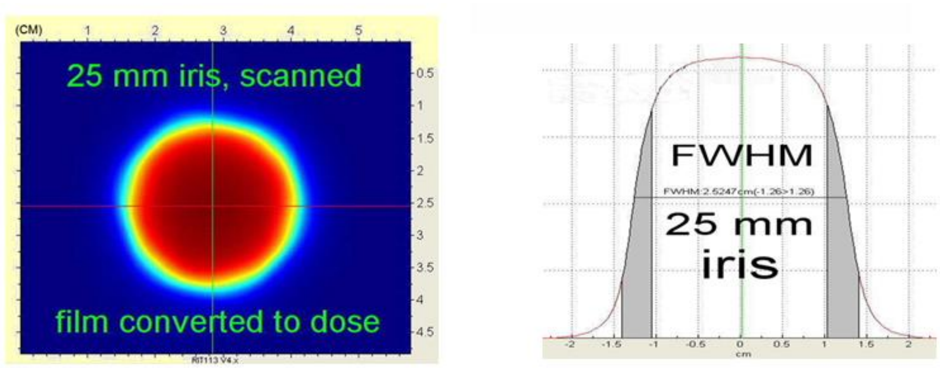

Figure 4 – RIT user interface output for the Iris 25 mm measurement

Test Results and Analysis

Both the Falcon and the film FWHM measurements were made at the same SAD of 800 mm and so can be compared directly to each other.

Iris Aperture (mm)	Falcon FWHM (mm)	Film - RIT FWHM (mm)	Delta Falcon vs Film (mm)	Absolute Value Delta Falcon vs Film (mm)
5	5.45	5.62	0.17	0.17
7.5	7.90	8.34	0.44	0.44
10	10.33	10.64	0.31	0.31
12.5	12.72	12.97	0.25	0.25
15	15.30	15.42	0.12	0.12
20	20.18	20.25	0.07	0.07
25	25.09	25.22	0.13	0.13
30	30.10	30.23	0.13	0.13
35	34.79	34.93	0.14	0.14
40	39.71	39.78	0.07	0.07
50	49.54	49.57	0.03	0.03
60	59.45	59.42	-0.03	0.03
			Average	0.16
			Std. Dev.	0.12

Figure 5 – FWHM Comparison Results

The Falcon fluence diameters measured at 800 mm SAD were equivalent to the film dose measurements with an average delta of 0.16 mm (standard deviation 0.12 mm). The eight largest apertures have an average delta of 0.09 mm (standard deviation 0.05 mm).

Conclusion

This work indicates that the XRV-2000 Falcon system can be used to produce fluence FWHM measurements that closely correlate with the result of conventional film based systems. Since no film is used and the total amount of time saved is more than 1.5 hours, measuring the fluence with a scintillator/camera system can be seen as an effective Iris QA alternative, having a lower incremental cost per measurement.

Contact Information

Jesse McKay, M.S.
Senior Medical Physicist
Ronald Berg, Ph.D.
Medical Physicist

Radiation Oncology Dept.
Erlanger Medical Center
975 East 3rd St
Chattanooga, TN 37403
Ph: 423-778-7485

Brett Nelson, M.S.
Director of Engineering

Logos Systems Int'l
175 El Pueblo Road
Scotts Valley, CA 95066
www.logosvisionsystem.com
Phone: 831-600-6101

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