FILM DOSIMETRY CHARACTERIZATION OF THE RESEARCH LINAC AT THE UNIVERSITY OF MARYLAND

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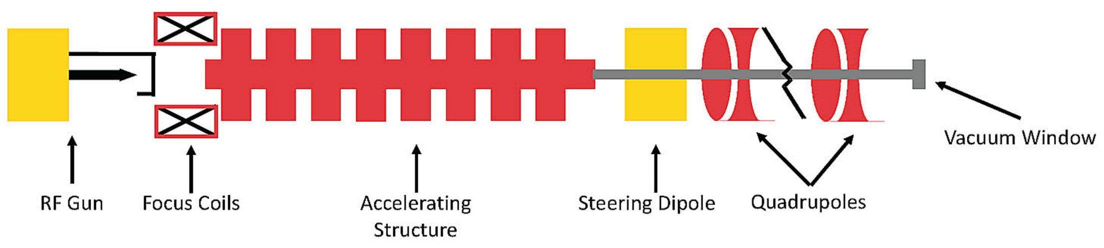
Abstract

A heavily modified Varian linac was installed as part of the University of Maryland Radiation Facilities in the early 1980s. The electron linac was initially used for materials testing and pulse radiolysis. Overtime, diagnostics such as spectrometer magnets and scintillator screens have been removed, limiting the ability to describe the electron beam. The beamline is currently configured with a thin titanium window to allow the electrons to transition from the vacuum region and interact with samples in air. A calibrated film dosimetry system was used to characterize the beam spot size and shape, uniformity, and energy in air. The results of these experimental measurements will be described in this paper.

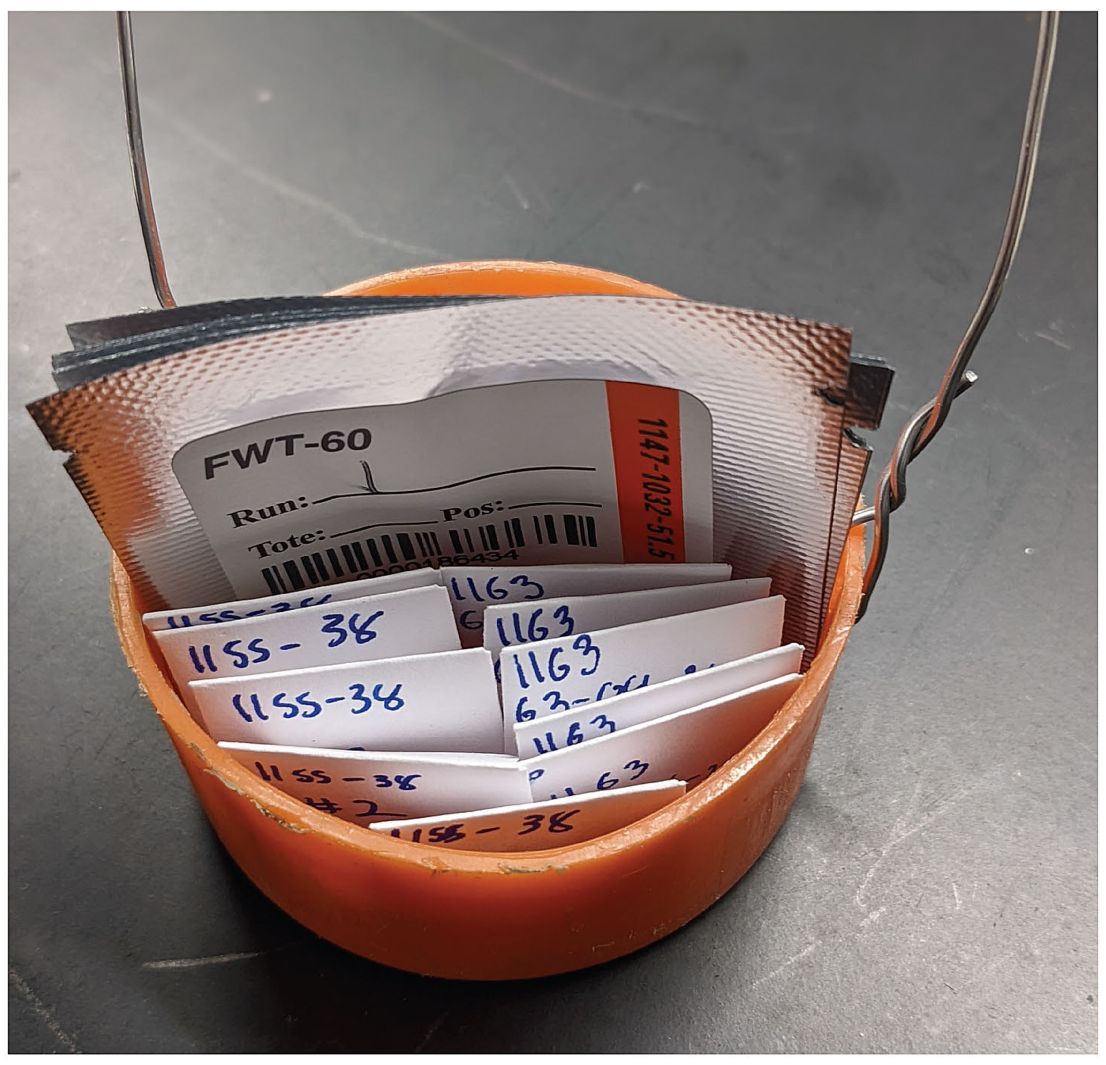


Overview of the UMD Electron Linac.

Experimental Setup and Results

Film Calibration

- 5 film samples are placed in the UMD Co-60 Irradiator and irradiated to various doses as measured with a calibrated ion chamber.



FWT-60 films prepared for irradiation.

- Films cure for 24 hours before their optical density is measured

FWT-92D Film Reader and FWT-60 film pouches.

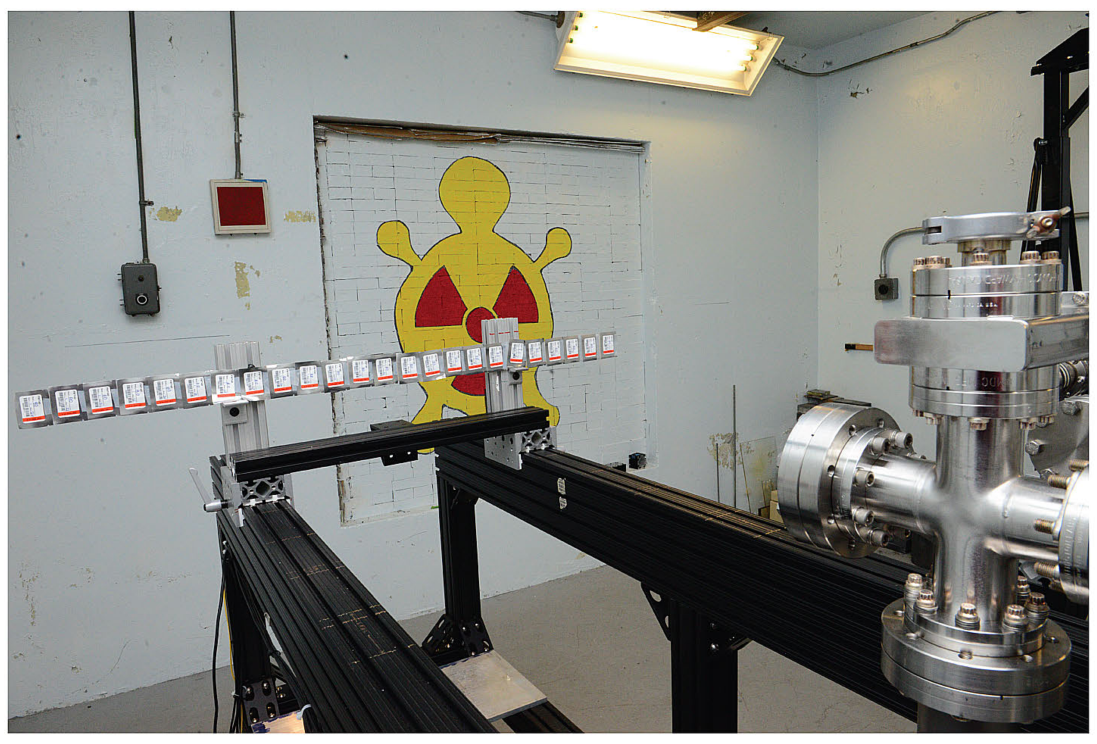
- Color change of films as a function of dose is used to determine calibration constants.

0 kGy	1 kGy	5 kGy	10 kGy	25 kGy	50 kGy	100 kGy	150 kGy	200 kGy

Film colors following irradiation to various doses.

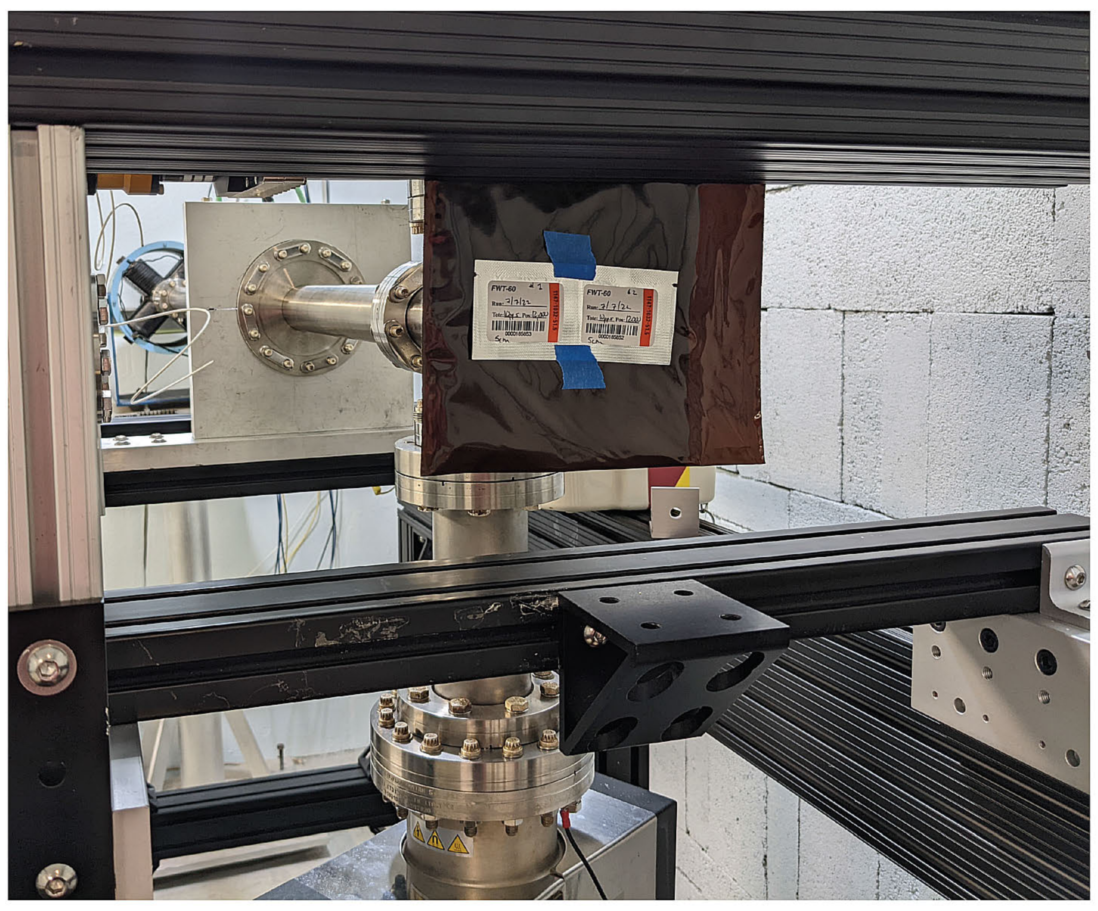
Transverse Beam Measurements

- 24 films were positioned along a 120 cm strip of polypropylene which was placed in the beam to measure spot size at 20, 63, and 100 cm from the vacuum window.

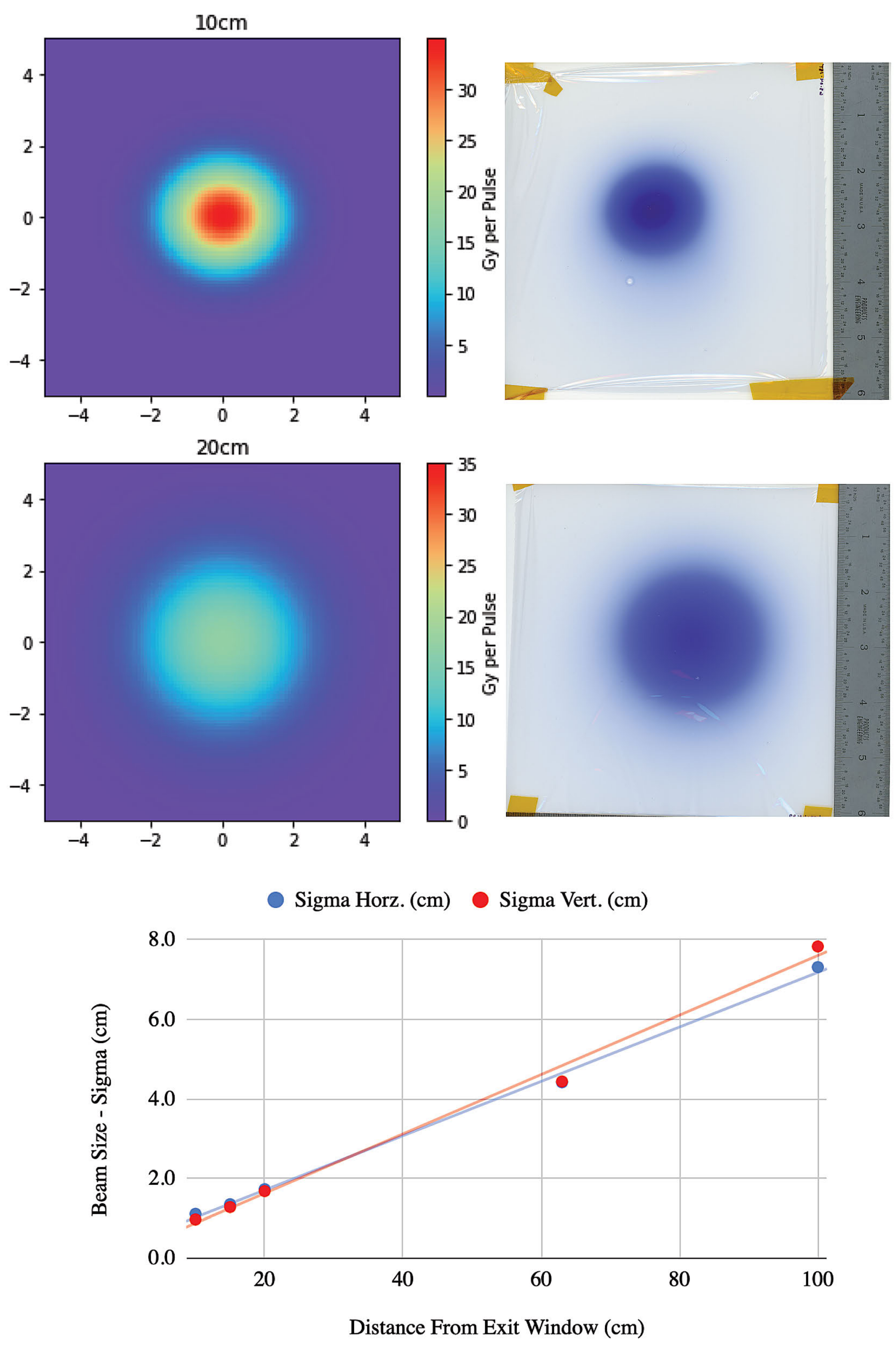


Film positioned for a horizontal beam size measurement.

- 15 x 15 cm sheets of film were placed at 10, 15, and 20 cm from vacuum window



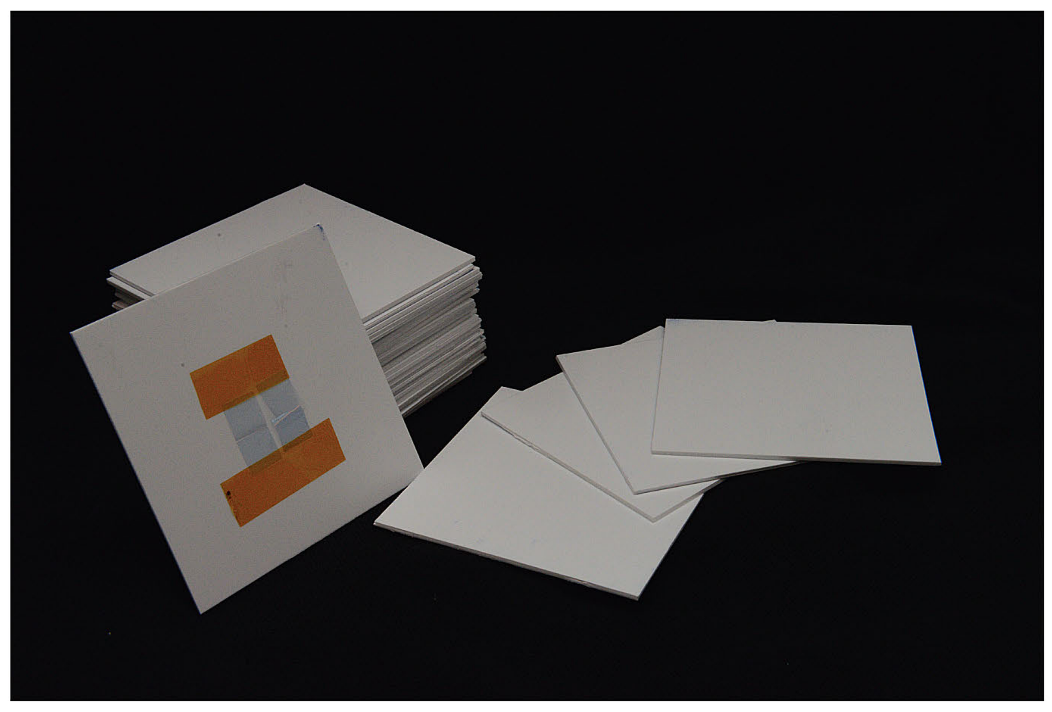
Film sheet in UV protective bag positioned for beam imaging.



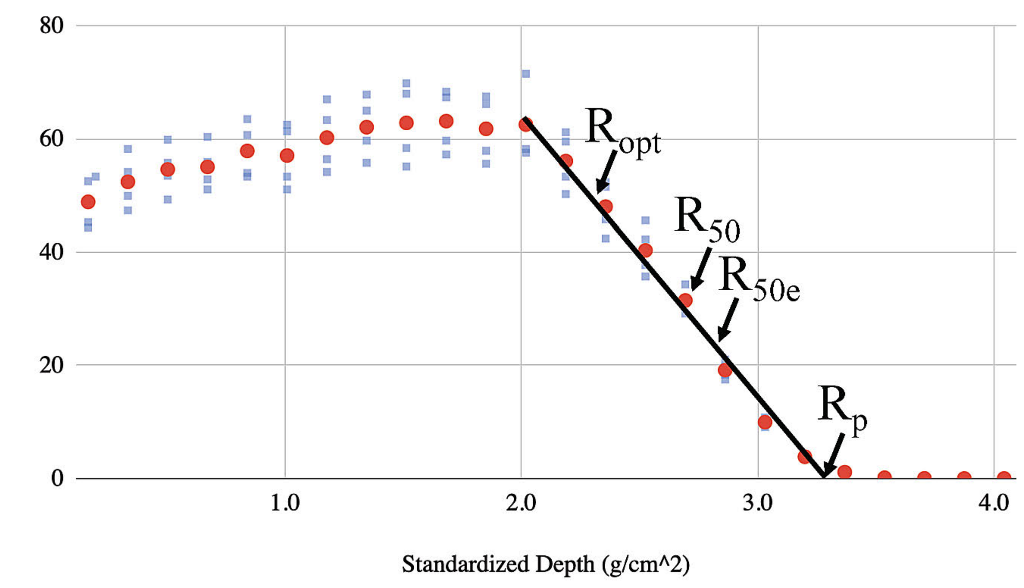
Transverse spot size film scans and measurement results.

Beam Energy Measurements

- Films were interleaved with polypropylene sheets to measure a dose vs. depth curve.



Arrangement of films and polypropylene sheets.



The dose vs. depth curve obtained in polypropylene

- R_{opt} - optimum thickness: depth in homogeneous material at which the absorbed dose equals its value at the entrance surface of the material
- R_{50} - half value depth: depth in homogeneous material at which the absorbed dose has decreased to 50 % of its maximum value
- R_{50e} - half-entrance depth: depth in homogeneous material at which the absorbed dose has decreased to 50 % of its value at the entrance surface of the material
- R_p - practical electron range: depth in homogeneous material to the point where the tangent at the steepest point (the inflection point) on the almost straight descending portion of the depth-dose distribution curve meets the extrapolated X-ray background
- These parameters are then used to calculate the effective beam energy

Conclusion

Measurements with radiochromic films have successfully been used to measure characteristics of the UMD linac beam in air. The results showed that the beam is uniformly distributed with no major hotspots, and the beam energy has been determined with greater accuracy than was previously possible. A table of the beam parameters of the UMD linac is shown below including the measurements made in this study

Peak Energy	6.2 MeV
Pulse Width	3 µs
Peak Beam Current	100 mA
Rep Rate	10-200 PPS
Average Beam Current	60 µA (max)
Beam Power	370 W
Spot Size	10.4 cm (FWHM @ 63 cm)
Dose per Pulse	2 Gy
Frequency	2.99 MHz

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