INDEPENDENT VERIFICATION OF A BATCH-CALIBRATION METHOD FOR PLASTIC SCINTILLATOR IN-VIVO DOSIMETRY

Natasha Mulenga[1], Jeremy E. Hallet[2], Megan A. Clark[3], **Roman Vasyltsiv[4],** Daniel A. Alexander[6], Allison Matous[5,6], Lesley Jarvis[5,6], Petr Bruza[1], David Gladstone[1,5,6]

[1]Thayer School of Engineering, Dartmouth College, Hanover, NH

[2]Department of Medical Physics, University of Wisconsin School of Medicine and Public Health, Madison, WI

[3]Stanford Department of Radiation Oncology, Stanford, CA

[4]Department of Radiation Oncology, Perelman Center for Advanced Medicine, University of Pennsylvania, PA

[5]Department of Radiation Oncology and Applied Sciences, Geisel School of Medicine at Dartmouth College, Hanover, NH

[6]Dartmouth Cancer Center, Lebanon, NH

2026 JULY 19–22 VANCOUVER, BC
JOINT AAPM | COMP MEETING

PURPOSE

To verify a batch-calibration method and dose-reading protocol for in-vivo scintillation imaging dosimetry during radiation therapy.

METHODS

Plastic scintillator disc targets (1.5 cm diameter; DoseOptics) were positioned at a series of known coordinates on an IC Profiler (Sun Nuclear Corporation). Placement accuracy was ensured with a laser-cut acrylic template. The setup was irradiated at 100 cm source-to-surface distance (SSD) using a 6 MV, 30×30 cm² photon beam. Light emitted from each scintillator was recorded at 16 fps with a gated, intensified CMOS camera (DoseOptics LLC).

Dose Measurements

Using the same beam parameters, dose measurements were performed in a water tank at depths 1 mm (water-equivalent depth of the scintillator disc) and 9 mm (effective measurement point of the profiler ion chambers). This allowed for the extrapolation of the profiler-reported doses to the exact locations of the scintillator discs.

Image Processing

Raw images were background subtracted and flat-field corrected. In each frame, the scintillation signal from each scintillator disc was fitted to an ellipse, and peak amplitudes were summed across all frames to yield cumulative intensity per scintillator disc. Calibration factors for scintillator discs were expressed in counts/cGy. Additionally, dose-linearity (40-800cGy), dose-rate dependence (100-600 MU/min), and energy dependence (6-18 MV) were evaluated.

RESULTS

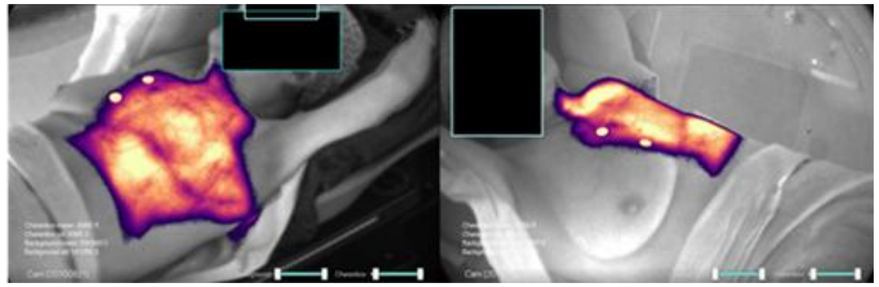


Figure 1: Clinical use case for scintillator discs: measuring contralateral breast dose.

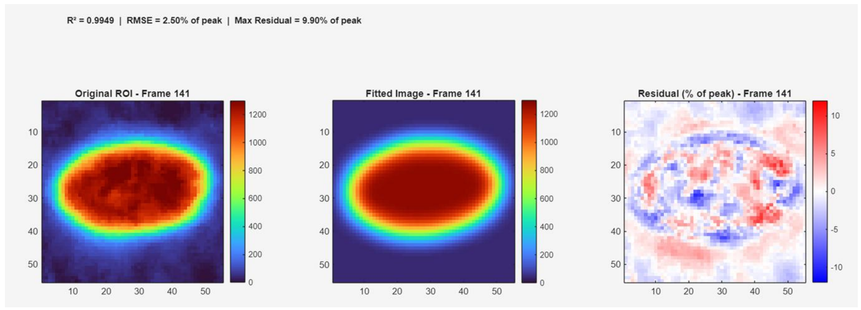


Figure 3: Region of interest (ROI) enclosing a single scintillator disc (left), fitted ellipse (center), and residuals (right).

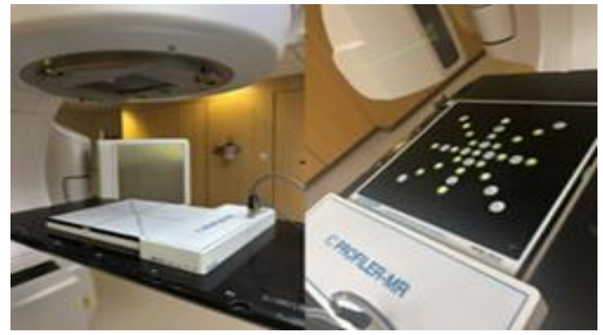


Figure 2: Experimental setup. Scintillator discs placed on IC Profiler using laser-cut acrylic template.

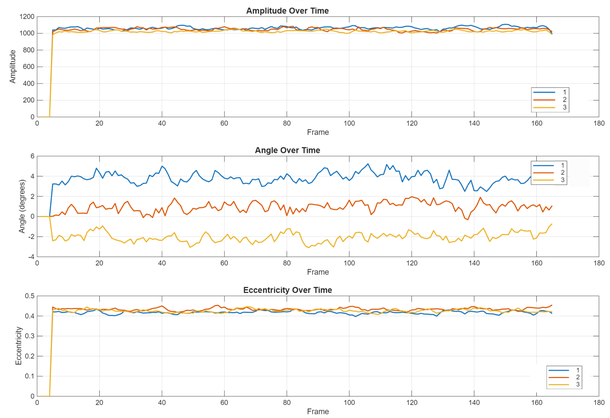
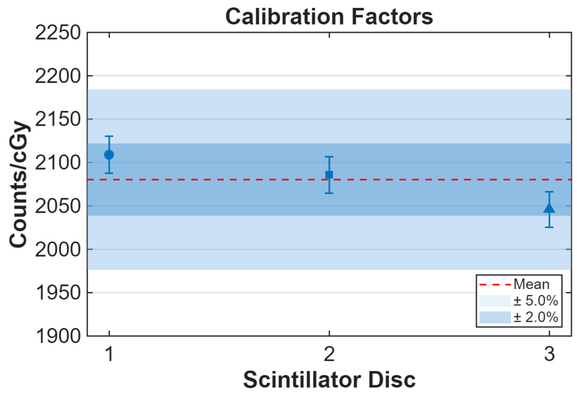
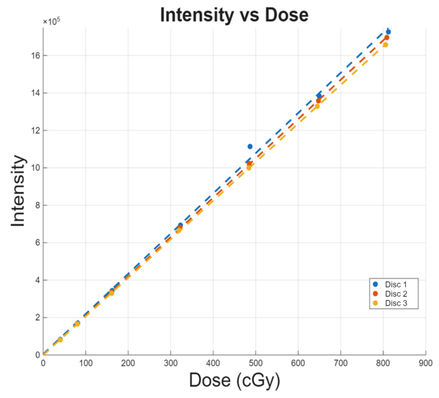
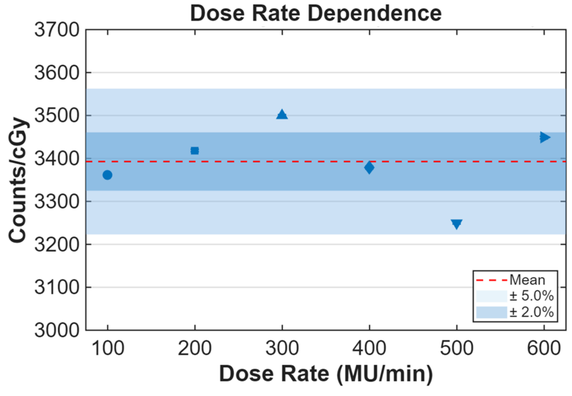
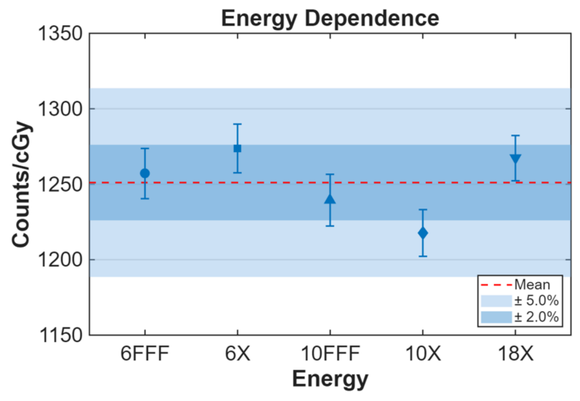


Figure 4: Ellipse fit parameters: peak amplitude, angle and eccentricity for an acquisition for one batch of scintillator discs.









CONCLUSION

- The derived calibration factors demonstrated high intra-batch consistency with a coefficient of variation (CV) of 1.0%.
- Each scintillator disc exhibited a linear dose response (R^2=0.99) over the tested range.
- Dose-rate dependence and energy dependence tests yielded CVs of 2.6% and 1.6%, respectively.

The proposed workflow yields highly reproducible calibration factors, minimal dose-rate and energy dependence, as well as robust linearity, key for reliable, batch-calibration of plastic scintillators for in-vivo patient dosimetry.

Acknowledgements: This work was funded by
1. NIH/NCI SBIR 46175N91024C00083
2. 5P30CA023108-40