

## High Precision Absolute Dose Measurement Using Radiochromic Film and a Validated Optical Densitometry System

We present an evaluation of Gafchromic MD-55-2 radiochromic film (RCF) dosimetry performed with a high-resolution (100  $\mu\text{m}$  pixel size) helium-neon scanning-laser film digitizer which has been modified to eliminate optical densitometry artifacts as large as 30%. An exposure and readout protocol was developed to prevent systematic errors inherent to RCF: temperature-dependent time evolution of RCF response, sensitivity inhomogeneity, and optical-polarization artifacts. RCF precision was evaluated with films given uniform 6MV x-ray doses between 1 and 200 Gy. RCF absolute dose accuracy was evaluated by comparing RCF measurements to ion chamber measurements for conformal external beam and Monte Carlo calculation for  $^{125}\text{I}$  and  $^{192}\text{Ir}$  brachytherapy sources. Single pixel-to-pixel standard deviations of uniformly irradiated films were less than 1% for doses between 10-150 Gy; between 1-5% for lower doses and 1-1.5 % for high doses. Pixel averaging to form 200-800  $\mu\text{m}$  pixels reduces these values by 50-80%. Comparison of absolute doses show agreement within 1.5-4% of dose benchmarks, consistent with a highly accurate dosimeter limited by its observed precision and the precision of the dose standards. These results provide a comprehensive benchmarking of RCF and show a considerable improvement over previously reported precision and accuracy attained by optical densitometry imaging systems.

This work was supported in part by NIH GRANT R01 CA 46640 AND a grant from Proxima Therapeutics Inc.