Purpose: Uncertainties in radiochromic film dosimetry applied to microbeam radiation therapy (MRT) dosimetry at the Canadian Light Source (CLS) are investigated. A dose-dependent change in film response as a function of microbeam width is characterized and its impact on peak-to-valley dose ratios (PVDRs) evaluated. Variation across the MRT collimator and inhomogeneity in film construction are also studied.

Methods: Gafchromic® EBT2 film was used to measure doses from a filtered synchrotron source on the surface of solid water for microbeams ranging from 10 micrometers to 1 mm and doses between 0.4 – 74 Gy. The microbeams were generated using a variable slit or a MRT collimator (50 micrometer slits, 400 micrometer spacing). The film was scanned with an Epson Perfection V700 Photo digital scanner (4800 dpi). Corresponding Monte Carlo (PENELOPE) simulations were performed.

Results: A dose-dependent reduction in film response with decreasing microbeam width was observed. The measured ratio of dose for a 50 micrometer slit beam relative to a 1 mm beam ranged from 0.15 and 0.56, decreasing as the dose is increased. A corresponding simulation predicts a ratio of 0.91. Depending on dose, measured PVDRs ranged from 7 to 64. Variability in measured doses between different slits of the MRT collimator is also problematic, with deviations from the average of up to 26% in the microbeam path, and over 70% between two microbeams. Inherent inhomogeneity in optical density of the unexposed EBT2 film may also result in uncertainties of approximately 0.15 Gy.

Conclusions: Although the high resolution of radiochromic film makes it a potentially attractive two-dimensional dosimeter for MRT, large uncertainties arise from variations in dose-response as a function of microbeam size, and spatial inhomogeneity of the response. These problems must be addressed before film can be considered for accurate measurement of absolute doses, and even relative metrics.