Microbeam Radiation Therapy: the challenges in Dosimetry

E. Bräuer-Krisch, Y. Prezado, A. Bravin
ESRF, ID17, BP220, F-38043 Grenoble

Keywords: Dosimetry, Gafchromic films, Microdosimetry, MRT

Microbeam Radiation Therapy (MRT) uses highly collimated, quasi-parallel X-ray microbeams of 50-600 keV generated by 3rd generation synchrotron sources, like on ID17, the bio-medical beamline at the European Synchrotron Radiation Facility, in France.
Preclinical trials on different animal models, including mice, rats and piglets, use ~25 micron wide beams separated by 100 – 400 microns and peak entrance doses up to 600 Gy, which are extremely well tolerated by the normal tissues.
Quantitative dosimetry for MRT has proven to be very challenging, especially at dose rates of 20000 Gy/sec and if a spatial resolution of about 5 micron is required.
Over the last 10 years several dosimeters were tested and showed either severe limitations with respect to the dose rate or in terms of spatial resolution. For the spatially non-fractionated beam several ionchambers, TLDs, Gafchromic films and Alanine Dosimeters were tested, but do still not meet the usual standard as in conventional radiation therapy, like absolute dose measurements within 3 % accuracy. The Monte Carlo calculated spatially fractionated dose profiles at different depth were compared to dose measurements using MOSFET dosimeters, radiochromic films, TLDs and other dosimeters. An overview of the different approaches to measure absolute dose in the peak and in the valley will be presented.

Some strategies to implement adequate dosimetry protocols are proposed in order to make advances in view of upcoming clinical trials. An adequate TPS (Treatment Planning Systems) for MRT needs to be developed in order to assure the highest level of therapeutic effective irradiation and best possible control for a reliable and safe treatment.