Abstract ID: 16484 Title: Convolution based dose calculation in Microbeam Radiation Therapy

Purpose: Microbeam Radiation Therapy (MRT) uses synchrotron keV x-ray sources. So far dose calculations in MRT are based on time consuming Monte Carlo (MC) simulations. We have developed convolution based methods to calculate dose in MRT employing theoretically motivated kernels.

Methods: Whereas the Compton effect is the only dominant effect in the MeV x-ray range, the photoelectric effect becomes more important at lower energy (E<150keV) rendering simple electron density scaling impossible. Furthermore photon scattering becomes more important, whereas electrons are absorbed locally. We have split energy absorption into scattering orders according to the number of preceding Compton events. With some reasonable approximations of the scattering cross sections, spatial energy distributions can be derived analytically in different scattering orders. From this we derive rules to scale kernels in different materials. The microbeam profile is produced by electrons created in primary photon interactions that have a range of less than 300µm. We also simplified electron scattering in order to predict beam penumbras.

Results: Comparisons with MC simulations at different energies show good agreement. Differences for broad field irradiation of homogeneous material are less than 1% along the beam axis and less than 20% inside a 100mm radius. Simulations of bone in water show differences of up to 12% close to interfaces. Application of the methods to a real head CT also showed good agreement. Due to the integrating character of the method structures in the scattered dose cannot be resolved. The microbeam profile is well resolved and agreement in the valley region is better than 5%.

Conclusions: The developed methods reduce dose calculation times in MRT down to a few minutes and make parameter optimisation and treatment planning possible. However, the accuracy cannot compete with MC simulations, but this seems not to be a big compromise considering biological uncertainties.