Report on the experiment MD-393. Y. Prezado et al. Dosimetric characterization of Minibeam Radiation Therapy.

At the ID17 beamline of the ESRF an innovative radiotherapy technique is under development: the so-called Minibeam Radiation Therapy (MBRT). This technique is based on the same principle of spatial fractionation of the beam like in Microbeam Radiation Therapy (MRT), which has already proved in preclinical studies its efficiency in sparing the healthy tissues and in the ablation of gliomas. In the MBRT, the beam thickness is around 600 micrometers with a separation between two adjacent minibeams of the same value, whilst in the MRT the thickness is of the order of 25 to 50 μm with a distance between adjacent microbeams in the order of 200 μm. While such thin microbeams can only be produced by synchrotron sources and have other practical limitations to clinical implementation, MBRT could conceivably be implemented with high power orthovoltage X-ray tubes. Recent studies showed that beams as thick as 0.68 mm retain part of their sparing effect in the rats Central Nervous System (CNS).

Therefore it is of high interest to focus the research on this new technique and to implement it at the ESRF; in addition, all the findings and the skills achieved in the technique would be made available to the users community. For this purpose, an exhaustive theoretical and experimental dosimetry characterization was needed. According to different international recommendations, the percentage depth doses (PPD) and the dose profiles inside the water phantoms need to be assessed.

Monte-Carlo simulations of the dose deposition of minibeams of 0.6 mm width and 1.2 mm center to center distance in a water and in a human head phantom have been compared with the experimental data taken in this experiment MD 393.

The experiment was performed at the MRT station at ID17. The dosimetric characterization was performed in a water phantom and in a solid water phantom following international recommendations. The dose distributions were measured by using a PTW ionization chamber and Gafchromic films. The measurements performed, based on international standards, were the following: absolute dose in a reference point, percentage depth doses and dose profiles at different depths. These measurements are needed in order to perform the dosimetry characterization of the technique to be able to implement it to perform preclinical experiments in a systematic way. These measurements were compared with the simulations in order to validate the Monte-Carlo calculations and a good agreement is obtained. See figures 1 and 2. This means that our dosimetric knowkledge is good enough to open the door to the biological studies.

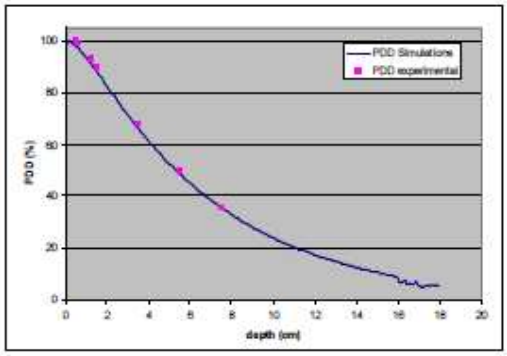

Figure 1. Comparison of the simulated PDD (blue line) and the experimental data (pink points).

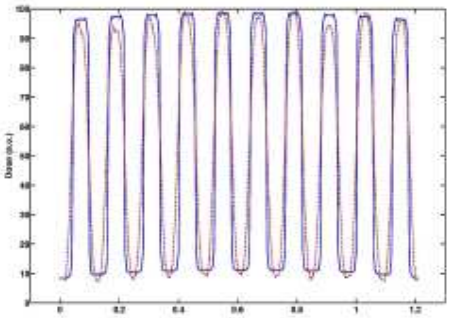

Figure 2. Comparison of the simulated dose profiles at 8 cm depth in a solid water phantom (blue line) and the experimental data (dashed red line).