Second Workshop on Particle Minibeam Therapy



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Impact of positioning uncertainty of detectors on the dosimetry of Particle Minibeam Therapy.

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An experimental campaign was conducted at Institut Curie, France, to perform dosimetry with the Primary Standard Proton Calorimeter (PSPC) developed by the National Physical Laboratory (NPL), UK, in proton minibeams. The minibeams were produced using a collimator with 400µm wide slits of 5cm length and 4mm separation. Dosimetry was also performed with EBT3 radiochromic film and PTW Roos chambers.

The dose distribution was determined from EBT3 radiochromic film, and the integrated dose calculated over the sensitive area of each detector in the centre of this distribution. The dose in the same sized region was then calculated after applying a lateral offset, representing experimental positioning uncertainty of the detector. This calculation was also performed for PTW Advanced Markus and PTW Bragg Peak chambers for additional comparison.

The dose was found to increase by approximately 8% when applying a 2mm offset to the position of the calorimeter and PTW Roos chambers compared to that when aligned centrally. In comparison, the dose decreased by approximately 8% in the case of the PTW Advanced Markus chamber, and decreased by <1% for the PTW Bragg Peak chamber.

The significant difference in the dose when applying a small lateral offset highlights the difficulties in performing reference dosimetry for minibeams. The results also demonstrate there is an interplay effect between the size of the sensitive region of the detector and the specific configuration of the minibeams. A much larger sensitive region demonstrated a much-reduced effect, highlighting that encapsulating more of the beam when performing dosimetry would reduce the uncertainty on the measurement. A device such as a Dose-Area-Product calorimeter currently under development at NPL could help address this for the purpose of primary standard dosimetry of spatially fractionated radiotherapy.

Fig[1]: https://drive.google.com/file/d/1lZ9GUHlmy2FdkUQ5XYIR-Rzw8xsTUQDN/view?usp=drive_link "Dose over the detectors' sensitive area with lateral offset, relative to that with zero offset."

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