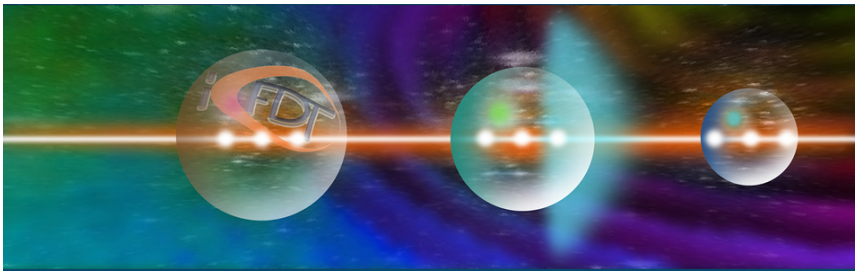

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Irradiation and dosimetry arrangement for a radiobiological experiment employing laser-accelerated protons

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Due to the phenomenon of the Bragg Peak, the use of charged particle beams in cancer treatment allows for precise energy deposition in a tumour, whilst largely reducing the dose deposited to the surrounding healthy tissue in comparison with treatment from traditional photon radiotherapy. However, the residual dose that is deposited to the surrounding area is non-negligible and may result in cell death or sub-lethal cell damage, although the full extent of this biological impact is uncertain. Additionally, the role of the particle dose rate on these effects is unknown, and motivates radiobiology experiments with particle beams accelerated through innovative, laser-driven processes enabling the delivery of ultrashort bursts protons at extremely high dose rates,in excess of 10^9 Gy/s. These studies are also of relevance in view of the proposed use of laser-driven ions as an alternative to RF accelerators for future radiotherapy.
In light of the peculiar properties of laser-driven ion beams (high-flux, divergence, short pulse duration, broad-band spectrum), carrying out radiobiology experiments with laser-accelerated ions, as well as characterizing the dose delivered to the samples, requires bespoke solutions which differ significantly from the arrangements typically employed on conventional accelerators or microbeams.
We report on the dosimetric and irradiation arrangement employed in an experiment carried out in the LULI2000 facility (pico2000 beamline), where a laser-driven proton was used to irradiate human cell line samples (HUVEC cells and AGO1522 fibroblasts). A series of biological assays were carried out in the LULI2000 laser facility using the pico2000 beamline; clonogenic, senescence and FOCI assays. The laser beamline delivered 80J in ~ 1 ps pulses at 1 w at a repetition rate of approximately 1 shot every 90 minutes. The proton beam accelerated from a foil was dispersed by a magnetic system and used to irradiate the cells through a transmission window located on an insertion tube. Dosimetry was carried out through the use of high sensitivity EBT-3 Gafchromic films (customized so the protective top layer was removed), and CR-39. These dosimeters were placed immediately after the film substrate where upon the cells were deposited in order to monitor the dose deposition of the sample on a shot to shot basis.

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