Irradiation of cell cultures with laser-driven x-ray and proton sources

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The role of the dose, the dose rate, and the delivery time in radiation therapy are key parameters to understand both the efficacy of the treatment and the level of radiation toxicity in normal tissue that surrounds a tumour. Due to their brightness and their ultrashort duration, laser-driven sources offer the possibility to study the biological effects of pulsed radiation beams operating at peak dose rates that are orders of magnitude larger than those achieved in conventional accelerators. Given that they can reach a certain minimum dose per pulse, these sources can potentially trigger the FLASH effect, a biological phenomenon described as a significant sparing of the healthy tissue when the dose is delivered in short time intervals, while preserving a comparable antitumoral effectiveness as in conventional treatments. In this work we will present two experiments on radiobiology with laser-driven x-ray and proton beams. At the Laser Laboratory for Acceleration and Applications (University of Santiago de Compostela), several sets of lung adenocarcinoma cell cultures have been irradiated with low energy x-rays induced by means of a Ti:Sa laser system. Doses ranging from 3 to 8 Gy have been delivered to study the influence of ionising radiation in proliferation of cancerous cells and colony formation capability. The same biological studies were also performed with low energy laser-driven protons at the Spanish Pulsed Laser Center, particularly utilising the VEGA-3 laser beamline. A dedicated magnetic energy selector was developed to obtain a quasi-monoenergetic proton beam. The preparation, handling and analysis of the cell cultures were performed by the personnel from both the Fundación Pública Galega de Medicina Xenómica and the Instituto de Biología Funcional y Genómica. In addition to the first biological results, we will describe the experimental setup, the detection system, and the technological challenges of both experimental campaigns, which, on a national level, have been the first ones combining laser-driven particle sources with biological research.