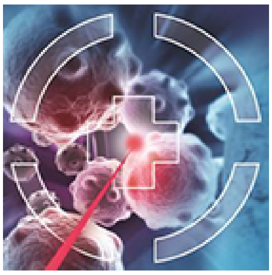

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Preparation of a radiobiology beam-line at the 18 MeV proton cyclotron facility at CNA

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Biophysical investigations using particle accelerators have gained interest in the last decades, coinciding with the spread of particle therapy centres worldwide and with the establishment of proton and ion therapy as recognized treatments for different types of tumours, with excellent clinical outcomes. Radiobiological experiments at proton and heavy-ion accelerators pose stringent conditions both on the physical and on the biological point of view. Firstly, a homogeneous dose distribution throughout the biological sample must be ensured, with a meaningful dose rate comparable to that used in the clinic (of the order of 2 Gy/min). Furthermore, when dealing with low-energy accelerators, the limited particle range makes it difficult to irradiate samples in tissue flasks filled with medium, meaning that cells must be exposed inside open culture vessels, vulnerable to bacterial contaminations. Finally, as biological targets are always made of living material, the environmental parameters such as room temperature, air pressure and humidity must be taken under control, to ensure that there is no additional impact on the cell viability.
At the National Centre of Accelerators (CNA) in Seville, Spain, the experimental beam line installed at the 18 MeV proton cyclotron facility has been adapted for the irradiation of mono-layer cell cultures placed vertically with respect to the beam.
In order to improve the homogeneity and decrease the beam intensity, a completely defocused beam has been used, scattering it 1.7 m upstream the exit window by placing an aluminium foil of 0.5 mm thickness. With these arrangements, a beam of 14.5 MeV is extracted, with a size of 4 mm diameter. Measurements have been done at different distances from the beam exit window to find the best conditions for the irradiation of biological samples, ensuring homogeneous dose profiles with deviations lower than 5% in the central 35 mm of the beam. Furhtermore, dosimetric studies using EBT3 radiochromic films and a transmission ionization chamber have been performed and compared with a Geant4 Monte Carlo simulation, which reproduces accurately the cyclotron beam properties and experimental setup. Finally, a preliminary experiment with cell cultures has been carried out irradiating human bone osteosarcoma epithelial cells with two different proton doses.

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