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#9-282 Ultra-thin scintillator as dose monitor for pulsed proton beams at FLASH rates

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In particle therapy of cancer, patients are typically submitted to a total radiation dose of a few tens of Gy fractionated in several daily sessions of some minutes of treatment time. During recent years evidence has been provided for reduced therapeutic side effects when the same total dose is applied in less than a second. This so-called FLASH effect is the subject of clinical and pre-clinical research. In order to understand the underlying, physical and biological mechanisms and to identify ideal therapy conditions a wide parameter space in terms of total dose, mean dose rate, and peak dose rate is to be explored. This is experimentally challenging; many clinical accelerators are not capable of reaching the necessary, high beam currents. As a consequence, dedicated beamlines for the irradiation of biological samples have been built at accelerator facilities for fundamental or applied research. In addition, standard instruments for dose measurement, such as ionization chambers, suffer from saturation effects at high dose rates.

A beam monitor for the measurement of the proton flux in pencil beams has recently been developed at Institute for Instrumentation in Molecular Imaging (i3M, Valencia). Its active volume consists of an ultra-thin plastic scintillator making it capable for transmission operation with protons of a few MeV which are especially interesting for in-vitro irradiation studies with cell cultures and other, pre-clinical models. Part of the scintillation light is guided to a photomultiplier tube which anode pulses are registered on a fast oscilloscope. Tests at the 3 MV tandem accelerator of Centro Nacional de Aceleradores (CNA, Sevilla) have shown a linear relation between beam current and signal levels for pulsed proton beams of 4 MeV over a wide range of intensities. The total dose, up to about 60 Gy within a spot of 3 mm diameter, is calculated from the known particle fluence considering water as reference medium. Independent, absolute dose measurements have been provided with radiochromic film sheets of type EBT3-Unlaminated placed behind the scintillator. Experiments were carried out with mean dose rates below and above 40 Gy/s, the value currently considered as onset of the FLASH regime. Various configurations in terms of pulse duration and pulse rate have been tested. We present the detector layout and the calibration and test results from CNA.

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