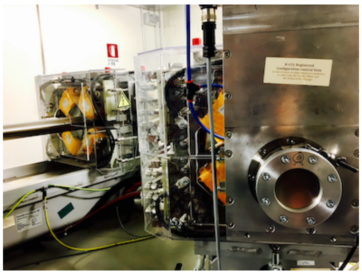

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Direct Detection of MeV Protons by Flexible Organic Thin Film Devices

Monday, 9 November 2020 10:00 (10 minutes)

The development of detectors for protons and heavy particles is a long-lasting research topic not only for fundamental applications, but, more recently, for monitoring energy and flow of particles in ion beam applications. However, the most demanding application of ion beams, for which accurate measurements are increasingly needed, is hadron therapy of cancer. For this application there is an increasing demand of systems apt for the accurate recording and mapping of the dose delivered during a treatment plan.
In proton therapy a detector has to satisfy two major requirements: i) the capability to detect dose rate and position of the beam in real time; ii) the monitoring of the dose on healthy tissues. In all these cases, detectors have to be in contact with the patient in order to record the dose in real time. A few types of detectors are able to reliably provide such information, such as silicon based MOSFET. The main drawbacks are the need of accurate calibration procedures and the fact that the detectors are intrinsically non-water equivalent with an energy-dependent response.
In this work we present the first study on responsivity of organic semiconductor detectors to proton beams. Organic semiconductors have already been demonstrated to be reliable detectors for ionizing radiation, and they offer also appealing properties for the proton beams monitoring. In fact, they can be processed and deposited at low temperature (<150 °C) by solution leading the possibility to realize multiple mm pixels of the order of mm2 onto thin, flexible and large-area substrates. They do not require expensive fabrication processes and they are reusable and disposable, thus targeting a potential low-cost, industrially scalable sensing system. Finally, a crucial point for the dosimetry application is the fact that they are water tissue equivalent in terms of absorption and, consequently, the calibration of the sensor is not needed.
The organic devices here presented act as a solid-state detector in which the energy released by the protons within the active layer of the sensor is converted into an electrical current. These sensors are able to quantitatively and reliably measure the dose of protons impinging on the sensor both in real-time and in integration mode. This study shows how to detect and exploit the energy absorbed both by the organic semiconducting layer and by the plastic substrate, allowing to extrapolate information on the present and the past irradiation of the detector. The measured sensitivity S = (5.15 ± 0.13) pC Gy-1 and limit of detection LOD = (30 ± 6) cGy s-1, of the here proposed detectors assess their efficacy and their potential as proton dosimeters in several fields of application, such as in medical proton-therapy.

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