First Silicon Carbide characterization for relative dosimetry with flash-radiotherapy

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In this work, a new generation of solid-state detectors for flash-radiotherapy applications based on Silicon Carbide (SiC) technology was investigated [1]. The SiC-based detector has attracted considerable attention in recent years as a potential material for sensors manufacturing in medical physics applications. This is due primarily to its strong chemical bonds that determine many of its properties: high refractive index, broadband transparency in the visible light spectrum, radiation hardness and wide-bandgap. Some potential applications of SiC are related its hardness (high-temperature and radiation hard electronics, high-temperature coating, etc.), others applications are a consequence of its capacity to sustain, due to the low leakage current, high values of electric potential and then use for all those space applications where the low power consumption is required. The goal of this study was to characterize a Silicon Carbide detector in terms of those properties that are of particular importance in relative dose measurements, e.g. reproducibility, dose rate dependence, dose linearity, and energy. The obtained results indicate the SiC detector as a suitable detector for absolute dosimetry with charged particles in twofold conditions: extreme high dose rate (1000Gy/min) and clinical proton beams (20 Gy/min). SiC was characterized at Laboratori Nazionali del Sud of Istituto Nazionale di Fisica Nucleare by using a bunched proton bursts of 62 MeV in energy and up to 50 nA in current. In Figure 1 the adopted experimental set-up is shown. The characterized detector has a 0.3 µm thick p-layer with a doping concentration N_A=$10^{19}$$cm^{-3}$ and a 10 µm thick n-layer with a doping concentration N_D = 0.5 - 1 10^{14} cm^{-3}. The active area corresponds to about 10 x 10 mm^2, was mounted on the PCB board designed to be housed in an aluminum box. The depletion voltage of the device was about 10 V. The investigated SiC detector showed a stable response, with variations within the experimental uncertainties, as evaluated by the reproducibility measurements. Good behavior in terms of linearity as respect to the released dose was found. Its negligible LET and dose rate together with extremely high radiation hardness, represent very advantageous features as compared to the ones of other commercially solid-state detectors for ion beam dosimetry. Moreover, such features represent a promising basis for forthcoming development of SiC dosimeter for laser-driven ion beams. SiC-based detectors show the potential to radically change the panorama of the current research in relative dosimetry with extremely intense dose rate. This new detector technology is, in fact, able to provide online information of dose delivered at a biological sample in a laser-driven accelerated ion beam. The possibility to use the SiC technology for dosimetric application is covered by a national patent (N. Rif. 102018000007139).

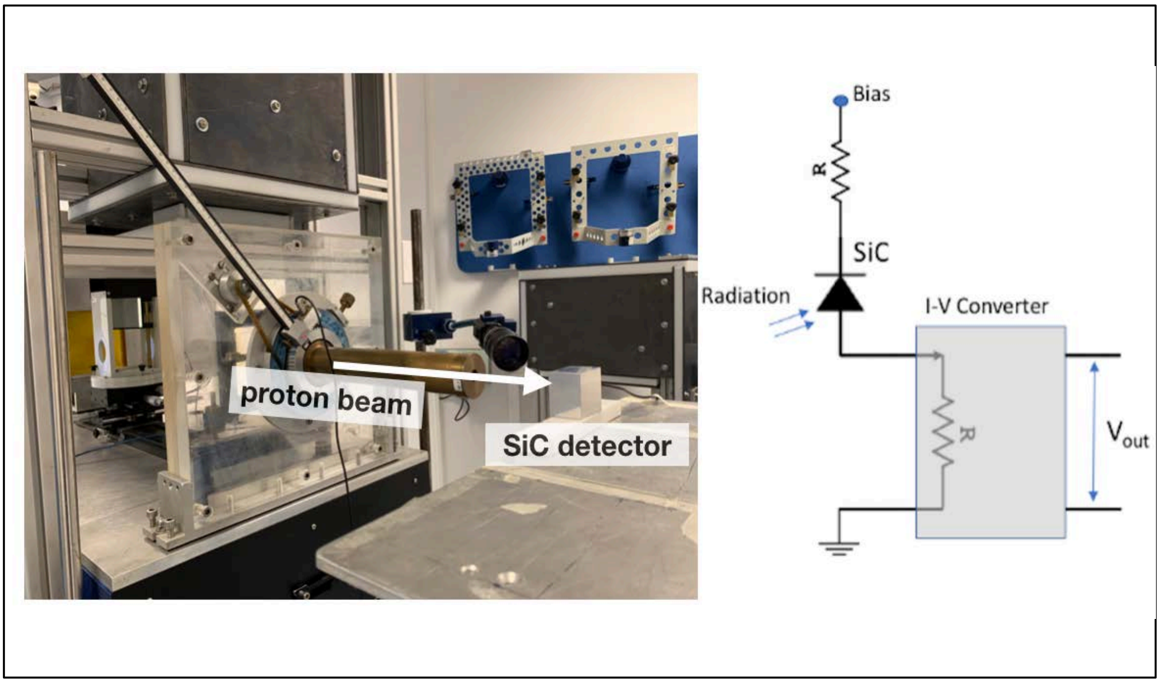

Figure 1: Right: Scheme of the irradiation setup: SiC detector was positioned at the isocenter, 8 cm beyond the beam final collimator at the CATANA facility (Centro di Adroterapia ed Applicazioni Nucleari Avanzate) of LNS-INFN; Left: Schematic representation of the circuit diagram of reading of the detector in the condition of clinical proton beam dosimetry (low dose rate)

[1] S. Tudisco *et al.*, "SiCILIA - Silicon Carbide detectors for intense luminosity investigations and applications", Sensor **18**, (2018)