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A new diagnostic system based on SiC technology for proton beam range detection

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Monitoring the Percentage Depth-Dose (PDD) distribution is a fundamental step in beam quality control programs with clinical proton beams, due to its correlation with the beam range, which is closely involved in the patient's treatment plan definition. The uncertainties related to the estimation of the proton range in the biological tissue lead to the extension of the treatment volume, with a consequent increase in the total absorbed dose. In this context, we will present the work done within the PRAGUE (Proton Range Measurement Using Silicon Carbide) project, funded by the H2020 and Fyzikální ústav AV ČR v.v.i. under the MSCA-IF IV framework, and by the INFN through a young researcher grant. The main goal of PRAGUE was the realisation and characterisation of a SiC (Silicon Carbide) multilayer detector able to measure online the PDD distribution of 30-150 MeV proton beams with both conventional (10^7 pps) and high (10^{14} pps) intensity. The electronic readout, based on the chip TERA08 (commercialised by the DE.TEC.TOR company), can manage up to 64 input channels, converting the incoming charge into counts with a wide range of sensitivity. It was designed to avoid loss of collection efficiency also under high-intensity irradiation conditions. A detector prototype was already realised and tested with 30 MeV and 70 MeV conventional proton beams to study the feasibility of using a multilayer SiC-based system to resolve the PDD distribution of proton beams. A new generation of 80 SiC devices (10 µm active layer, $15x15$ mm^2 sensitive area) was adopted and characterised using X-ray and alpha particle sources as part of the final PRAGUE detector. The results indicate that SiC devices suit relative dosimetry with charged particles. The detectors show a stable and reproducible response, and outstanding behaviour in terms of linearity with absorbed dose was found. The negligible dependence of SiC response against energy and dose rate and the high radiation hardness represent advantageous features compared to commercial solid-state detectors for ion beam dosimetry.

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