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3D microbeam characterization of large-area silicon carbide detectors

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Silicon carbide (SiC) detectors are a state-of-the-art technology for particle detection. The great interest relies in the high radiation hardness of SiC and good energy resolution. Large-area SiC detectors were chosen as the ΔE stage of new telescopes used in the particle identification system of the MAGNEX magnetic spectrometer in the context of the NUMEN project. The adopted SiC detectors are $\approx 2.2 \text{ cm}^2$, with total thickness of $110 \mu\text{m}$ ($100 \mu\text{m}$ epitaxy and $10 \mu\text{m}$ inert substrate) and edge structure $\approx 400 \mu\text{m}$ wide. IV and CV characteristics were measured to define the full depletion voltage and the doping profile. A characterization test of SiC was also performed by using a proton microbeam at the Ruđer Bošković Institute to study the charge collection efficiency. The beam spot was $\approx 2 \mu\text{m}$ and the scan steps were $\approx 10 \mu\text{m}$. Three measurements were performed: i) the inner region and the edges were explored at different voltages and proton energies to obtain 3D characterization of the CCE profile; ii) the inert substrate thickness was estimated by irradiating the sensor on the back side at different incident angles. Indeed, the correlation between the residual energy and the proton incident angle allows to evaluate the thickness of dead layers; iii) a 6 MeV proton beam irradiation crossing the SiC detector was also performed, measuring the residual energy in a silicon detector placed downstream the SiC, to validate the SiC energy loss tables, by knowing the total thickness.

Primary experiment

NUMEN

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