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In-depth characterisation of diamond sensors for dosimetry in beam-loss monitoring

Thanks to their unique properties, artificially-grown diamond crystals are suitable as solid-state particle detectors and dosimeters in high-radiation environments. We developed and installed a system based on single-crystal artificial-diamond detectors to monitor the beam losses near the interaction region of the SuperKEKB collider for the the Belle II experiment.
We carried out several tests using and radiations to asses the crystal quality and response of the devices. We devised a novel current-to-dose-rate calibration method using radiation, which employs a silicon diode as a reference to greatly reduce uncertainties associated with the source activity and with the setup simulation. The calibration has been validated by measuring the calibration factors with X and γ radiation, spanning a dose rate range from tens of nrad/s to some rad/s.
We report on these results (published in Nucl. Instum. Method A 1004 (2021) 165383) and a new set of tests and calibrations for 10 additional devices to be installed at SuperKEKB in 2022. The new results feature several refinements of the measurement and of their interpretation and will include the first irradiation of the devices with 1-GeV electrons from the linac of the FERMI@Elettra FEL in Trieste (Italy).

Primary experiment

Belle II

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