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A High-Precision Proton Irradiation Site for Silicon Detectors Providing Online Fluence Monitoring, Spatial Damage Resolution and Flexible Irradiation Procedures

A modern irradiation site is in operation at the Bonn Isochronous Cyclotron since 2021. The accelerator typically provides 14 MeV/nucleon protons (up to alphas) with 1 μA beam current to the site. Devices-under-test (DUTs) are situated inside an insulated box, actively-cooled by nitrogen gas, to prevent annealing, featuring feed-throughs for powering or reading out the DUT. To achieve uniform fluence distribution on the DUT, the box is mounted on a 2D-linear stage which is moved through the beam on a meander-like pattern. In front of the box, a custom-made, calibrated beam monitor with dedicated readoud electronics, provides online diagnostic of the beam parameters at the DUT with typically 2% relative uncertainty. This enables a beam-based, online dosimetry approach with comparable uncertainty, facilitating spatial resolution of the fluence distribution and the application of corrections during and after the irradiation. This allows for maximizing fluence uniformity, specifically relevant for low-fluence irradiations.

In this contribution, the setup and capabilities of the irradiation site are showcased with emphasis on its flexibility regarding user-specific campaigns.
The concept of dosimetry via online beam parameter monitoring is explained, compared with the conventional offline dosimetry approach via foil activation
for multiple irradiations and its advantages are demonstrated. Furthermore, the proton hardness factor measurement, using 150 μm thin silicon sensors, is shown,
resulting in irradiations of typical DUTs to levels of 10^{16} $\mathrm{n_{eq}/cm^2}$ within one day.

Submission declaration

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