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# Experimental Determination of Proton Hardness Factors at Various Irradiation Facilities.

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The scheduled upgrade of the LHC to the HL-LHC presents new challenges in radiation damage studies. Around the world, campaigns to measure radiation hardness of detector sensors and components are being undertaken. Upon analysis of the I–V and C–V characteristics of BPW34F photodiodes, the hardness factors for proton beams at three different facilities have been measured. By computing the change in leakage current of the photodiodes pre- and post-irradiation as a function of proton fluence, the hardness factor of the University of Birmingham's MC40 cyclotron was found to be 2.20 ± 0.08 for an energy of 25 MeV. For a beam energy of 23 MeV, and adopting a similar methodology, a value of 2.20 ± 0.28 was determined for the cyclotron at the Karlsruhe Institute of Technology. The hardness factor of the IRRAD proton facility at CERN was measured to be 0.62±0.02 for a beam energy of 24 GeV, which is consistent with an independent measurement of 0.63 with FZ sensors at IRRAD. The value for the MC40 cyclotron is in agreement with the currently quoted value, and the values for the IRRAD facility and the Karlsruhe Institute of technology agree with other independent studies.

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