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Understanding the frequency dependence of CV measurements of irradiated silicon detectors

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Capacitance-voltage (CV) measurements are a widely used technique in
silicon detector physics. However, this only works if the sensor is not too heavily irradiated. After irradiation, the measured CV curves show strong frequency dependencies which is not the case before irradiation and thus, the derived parameters vary over a wide range, indicating that the method is not applicable for such devices. In this work, an existing, but not sufficient model for fitting CV measurements of irradiated sensors is extended. With this, the whole frequency range can be described. Unirradiated sensors produced by a CMOS foundry as well as irradiated CMOS, ATLAS R0 and ATLAS R5 sensors have been CV measured over the full, technically available, frequency range and were fitted with the derived model. Furthermore, it is investigated where the different frequency behaviour of the current CV analysis technique originates and it is shown how sensor parameters like the depletion voltage, the effective doping concentration and the bulk resistivity can be determined.

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