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Electrical characterization of AMS aH18 HV-CMOS after neutrons and protons irradiations

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In view of applications in the tracking detectors of the ATLAS High Luminosity LHC (HL-LHC) upgrade, we have developed a new generation of High Voltage CMOS (HV-CMOS) monolithic pixel-sensor prototypes featuring the AMS aH18 (180 nm) commercial CMOS technology. By fully integrating both analog and digital readout-circuitry on the same particle-detecting substrate, current challenges of hybrid sensor technologies: larger readout input-capacitance, lower production-yield, and higher production and integration cost can be downscaled. The large fill factor design using high resistivity substrates strongly helps to mitigate the charge-trapping effects, making these chips radiation hard. The surface and bulk damage induced at the highly irradiative environment change the effective doping concentration of the device that modulates the high electric fields as the substrate-bias voltage is increased can cause an increased leakage current and premature electrical breakdown due to impact ionization. In order to assess the characteristics of heavily irradiated samples, using ATLASPix1 HV-CMOS chip as test vehicles, we have carried out a dedicated campaign that included irradiations of neutrons and protons, made at different facilities. Here, we report on the electrical characterization of the irradiated samples at different ambient conditions, also in comparison to their pre-irradiation properties. Results demonstrate that hadron irradiated devices can be safely operated at a voltage high enough to allow for high efficiency, up to the fluence of 2×10¹⁵ neq/cm2, beyond the radiation levels (TID and NIEL) expected in the outer barrel region of Inner Tracker (ITk).

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