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Signal simulation under the bias rail in nˆ+-in-p pixel sensors before and after irradiation

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We have developed novel radiation-tolerant nˆ+-in-p pixel sensors with biasing network from the outer bias ring to individual pixels. The network is to provide the reverse bias voltage to individual pixels, made of bias rails passing through columns of pixels and bias resistors branching from the rail to individual pixels. The biasing network enables to verify the high voltage operation of individual pixels for quality control for identifying the sensors having defective pixels, e.g. having the microdischarge at a lower bias voltage. The pixel sensors were gone though beamtests for measuring track finding efficiency in pixel in detail, before and after radiation damage by protons. The device showed little efficiency loss, initially, before irradiation. After irradiation, the same device/geometry showed efficiency loss, especially under the bias rail, noticeably. In order to understand the underlying physics, we have developped a Monte Carlo signal simulation program with the standard procedures of Ramo's potential and drifting carriers. In this signal simulation, we have imported distributions of the electric fields and the weighting potentials in high precision from TCAD calculations. We have evaluated the charges lost to the bias rail with and without radiation damage. The comparison has confirmed the efficiency loss quantitatively and the insight into the underlying physics.

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