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Silicon sensor study for the forward strip tracker of the ATLAS experiment for the HL-LHC

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The upgrade to the High Luminosity LHC foreseen in about ten years represents a great challenge for the ATLAS inner tracker and the silicon strip sensors in the forward region which have to sustain a radiation fluence up to 2*10^15 n_eq/cm^2. Several strip sensor designs have been developed by ATLAS and fabricated by Hamamatsu in order to maintain enough performance in terms of charge collection efficiency and its uniformity throughout the active region. Of particular attention, in case of a stereo-strip sensor, is the area near the sensor edge where shorter strips have been ganged to the full ones.
In this work we present the electrical and charge collection test results on miniature sensors with forward geometry irradiated with protons at different sites. The irradiated devices were tested systematically before, after irradiation and after annealing at 60°C for 80 min.
The I(V) and C(V) measurements results demonstrate reasonable full depletion voltages and current levels. Results from charge collection efficiency measurements show that at the maximum expected fluence, the collected charge is roughly halved with respect to the one obtained prior to irradiation. However, it is still high in comparison with the expected noise level. No significant difference between different sensor layouts has been observed.
Laser measurements show a good signal uniformity over the sensor. Uniform charge collection between different strips and along the strip direction has been observed and the ganged strips have a similar efficiency as full strips. Only a small difference has been seen between the different ganging techniques, the DC ganging collecting slightly more as the AC ganging.
Both studies indicate good performance of the forward strip sensors for the ATLAS upgrade.

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