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Unusual annealing of charge collection efficiency of silicon strip detectors, ATLAS18, irradiated to high fluences with 24 GeV/c protons

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Extensive studies of effects of annealing at 60℃ on charge collection efficiency were made during development and production of sensors for ATLAS ITk strip detector. After irradiation with neutrons or low energy protons, at bias voltages below ˜ 900 V, "typical"annealing behaviour was observed: beneficial effect of short term annealing was followed by a drop of charge collection efficiency at longer annealing times.
After irradiation with high energy 24 GeV/c protons at CERN IRRAD facility usual annealing was observed at low fluences but not at high fluence. Charge collection was measured with 320 μm thick n-in-p type strip detectors, ATLAS18, using Alibava system. After first few tens of minutes at 60℃, annealing was beneficial at low fluences, but at high fluences charge collection efficiency didn't increase. It stayed unchanged or even dropped. Edge-TCT measurements indicated that the unusual annealing may be related to the double peak electric field profile in the detector. The double peak profile is caused by polarization of space charge within the depleted region. Different annealing of positively and negatively charged defects may result in the observed annealing behaviour of charge collection.
In this contribution results of charge collection and E-TCT measurements with detectors irradiated with 24 GeV/c protons will be presented. Edge-TCT annealing study after irradiation with low energy protons will be shown and compared with high energy proton results.

Primary experiment

ATLAS

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