

Low dose rate irradiation of the RD53A chip with Kr-85 beta source

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To test the performance of the future pixel readout chip in the harsh High Luminosity LHC (HL-LHC) environment, an irradiation experiment has been setup with gaseous Kr-85 beta source with dose rate of about 7 rad/s. This setup was designed to emulate as closely as possible operation in the HL-LHC conditions of the ATLAS detector inner layer, including temperature, radiation, and continuous electrical operation. The low dose rate irradiation setup has been running since September 5th 2018 at a temperature of -15 degrees Celsius. The first results will be presented with a 500 Mrad total dose received.

Summary (500 words)

The High Luminosity LHC (HL-LHC) will reach a factor of five larger instantaneous luminosity than the current LHC, enabling the ATLAS and CMS experiments to achieve the full physics potential of the LHC beyond 2025. With the luminosity, the radiation levels are also increasing. The current tracking detectors will be completely replaced with a new generation pixel detector. A new readout chip for the upgraded pixel detector has to meet specifications after 1 Grad total dose received in the HL-LHC conditions. A prototype of the pixel readout integrated circuit has been designed by the RD53 Collaboration in 65nm CMOS technology. To test the performance of the RD53A chip in the harsh HL-LHC environment, an irradiation experiment has been setup with gaseous Kr-85 beta source. The total dose of the Kr-85 source is estimated to about 7 rad/s which roughly corresponds to the expected conditions at the HL-LHC. From a single transistor irradiation experiments it is observed that for the same integrated dose, the radiation damage is worse with low dose rate compared to the high dose rate. Since an accurate scaling from a high dose rate measurements to low dose rate has not been yet developed, the low dose rate irradiation provides an accurate answer about the survivability of these chips in the real conditions of the detector. The SLIPPER (SLOW Irradiation of Phase-II Pixel Readout) setup was designed to emulate as closely as possible operation the HL-LHC inner layer of the ATLAS detector, including temperature, radiation, and continuous electrical operation. The low dose rate irradiation started on September 5th 2018 and it is been running for 2.5 years now. The chip is running all the time at a temperature of -15 degrees Celsius. The first results will be presented with a 500 Mrad total dose received. The effects of irradiation form a high and low dose rate are compared.

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