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Double injection studies on the RD53B-ATLAS chip

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Operation at the High Luminosity LHC (HL-LHC) requires the pixel detectors of ATLAS and CMS to separate collisions occurring with an extremely high pile-up. Fast detectors with a small pixel size are therefore needed such that thousands of charged particles per event can be reconstructed with high fidelity and excellent vertexing resolution.

The RD53 collaboration has been working on the design of a dedicated readout chip to meet these goals, the RD53 chip. This chip will be part of a hybrid device composed of one or more readout chips bump-bonded to a silicon sensor. In this study, we have tested one of the pre-production versions, the RD53B-ATLAS chip.

This talk present charge injection tests performed on the RD53B-ATLAS chip, specifically looking at its response when a pixel is exposed to injections happening close in time. This was achieved by using a novel feature introduced in the RD53 chip. Here, one can perform two injections in rapid succession by utilizing the specialized charge injection circuit attached to each pixel input. In this way, we were able to inject two consecutive charge injections with varying magnitude with a time gap as small as 5 bunch crossings (125 ns).

The purpose is to study the behaviour of the analog front-end, focusing on events where charge deposition of a particle can happen so rapidly that a preceding hit affects the readout of a subsequent hit. These events are more likely to occur in a high-pile up environment.

Results show that the measured charge of an injection is changed by a preceding injection and that this effect scales with the injected magnitude. This is seen by the threshold and the precision Time over threshold values (pToT) measured on the subsequent injection. The results can be explained by the discharge rate of the primary injection.

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