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## Irradiation and Testbeam of KEK/HPK Planar p-type Pixel Modules for HL-LHC

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In the ATLAS detector upgrade for the high luminosity LHC (HL-LHC), a n-in-p planar pixel sensor-module is being developed with HPK. The modules were irradiated at the cyclotron radioisotope center (CYRIC) using 70 MeV protons. For the irradiation, we have designed a novel irradiation box that carries 16 movable slots to irradiate the samples slot-by-slot independently, to reduce the time for replacing the samples by hand, thus reducing the irradiation to human body. The box can be moved horizontally and vertically to scan the samples for an area of 11 cm x 11 cm at the maximum. We have then carried out tests with beam at CERN by using 120 GeV pions, at DESY 4 GeV electrons, and at SLAC 13 GeV electrons. We describe the analyses of the testbeam data of the KEK/HPK sensor-modules, focussing on the comparison of the performance of old and novel designs of pixel structures, together with a reference of the simplest design (no biasing structure). The novel design has shown as good performance as the no-structure design in detecting passing-through charged particles.

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