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Test beam studies of barrel and endcap modules for the ATLAS ITk strip detector before and after irradiation

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In order to cope with the occupancy and radiation doses expected at the High-Luminosity LHC, the ATLAS experiment will replace its Inner Detector with an all-silicon Inner Tracker (ITk), consisting of pixel and strip subsystems. The strip subsystem will be built from modules, consisting of one n^+-in-p silicon strip sensor, manufactured by Hamamatsu Photonics, and one or two PCB hybrids containing the front-end electronics glued directly to the sensor. A powerboard, containing an HV switch, a monitoring and control ASIC, and a DC-DC converter, is also glued to the sensor.

In the last two years, several prototype ITk strip modules have been tested using beams of high energy electrons and charged pions produced at the DESY-II and CERN SPS testbeam facilities. Tracking was provided by EUDET telescopes, consisting of six Mimosa26 pixel planes, giving a resolution around 2 μm. The modules tested are built from two sensor types: the rectangular ATLAS17LS, which will be used in the central barrel region of the detector, and the annular ATLAS12EC, which will be used in the innermost ring (R0) of the forward endcap region. Each sensor geometry has been tested using both the final prototype version of the front-end electronics, known as "star" chipset, as well as a previous prototype chipset developed for lower trigger rate specification. Additionally, a structure with two R0 modules positioned back-to-back has been measured, demonstrating space point reconstruction using the stereo angle of the strips. Finally, two R0 modules, one with each chipset, have been measured after irradiation to 50% beyond the expected end-of-lifetime fluence.

The data obtained allow for thorough tests of the module performance, including charge collection, noise occupancy, detection efficiency, and tracking performance. Additionally, the excellent tracking resolution allows for detailed studies of various sensor features. The results give confidence that the ITk strip detector will meet the requirements of the ATLAS experiment.

Submission declaration

Original and unpublished

Author: RUEHR, Frederik (Albert Ludwigs Universitaet Freiburg (DE))

Co-authors: RODRIGUEZ RODRIGUEZ, Arturo (Albert Ludwigs Universitaet Freiburg (DE)); GREENALL, Ashley (University of Liverpool (GB)); BRUERS, Ben (Deutsches Elektronen-Synchrotron (DE)); CIUNGU, Bianca Monica (University of Toronto (CA)); GALLOP, Bruce (STFC - Rutherford Appleton Lab. (GB)); ESCOBAR IBAÑEZ, Carlos (Instituto de Fisica Corpuscular (IFIC) - CSIC/UV); GARCIA ARGOS, Carlos (Albert-Ludwigs-Universitaet Freiburg (DE)); GUBBELS, Chris (University of British Columbia (CA)); KLEIN, Christoph Thomas (University of Cambridge (GB)); DAVID, Claire (York University (CA)); SAWYER, Craig Anthony (STFC - Rutherford Appleton Lab. (GB)); WIGLESWORTH, Craig (University of Copenhagen (DK)); BECOT, Cyril Pascal (Deutsches Elektronen-Synchrotron (DE)); SPERLICH, Dennis (Humboldt University of Berlin (DE)); KISLIUK, Dylan Perry (University of Toronto (CA)); ROSSI, Edoardo (Deutsches Elektronen-Synchrotron (DE)); BUCHANAN, Emma (Chinese Academy of Sciences (CN)); DREYER, Etienne (Simon Fraser University (CA)); GUESCINI, Francesco (Max-Planck--Institut fur Physik (DE)); MOOS, Franziska Sophia (Albert Ludwigs Universitaet Freiburg (DE)); ZHU, Hongbo (Chinese Academy of Sciences (CN)); MENG, Huan Yu (University of Toronto (CA)); Dr CARLI, Ina (Chinese Academy of Sciences (CN)); GREGOR, Ingrid-Maria (DESY & Bonn University); ARLING, Jan-Hendrik (Deutsches Elektronen-Synchrotron (DE)); LIU, Jianbei (University of Science and Technology of China (CN)); KROLL, Jiri (Acad. of Sciences of the Czech Rep. (CZ)); KELLER, John Stakely (Carleton University (CA)); LOENKER, Jonas (Technische Universitaet Dortmund (DE)); THOMAS, Juergen (University of Birmingham (GB)); REHNISCH, Laura

(Humboldt University of Berlin (DE)); WIIK-FUCHS, Liv (Albert Ludwigs Universitaet Freiburg (DE)); HAUSER, Marc (Albert Ludwigs Universitaet Freiburg (DE)); LIBERATORE, Marianna (Deutsches Elektronen-Synchrotron (DE)); MILOVANOVIC, Marko (Deutsches Elektronen-Synchrotron (DE)); SYKORA, Martin (Charles University (CZ)); BASSO, Matthew (University of Toronto (CA)); MINANO MOYA, Mercedes (Univ. of Valencia and CSIC (ES)); QUEITSCH-MAITLAND, Michaela (CERN); ATLAY, Naim Bora (Humboldt University of Berlin (DE)); Dr RABHI, Nesrine (Acad. of Sciences of the Czech Rep. (CZ)); KOVANDA, Ondrej (Charles University (CZ)); PHILLIPS, Peter (STFC - Rutherford Appleton Lab. (GB)); PRIVARA, Radek (Palacky University (CZ)); NG, Sam Yanwing (Humboldt University of Berlin (DE)); DIEZ CORNELL, Sergio (Deutsches Elektronen-Synchrotron (DESY)); WONSAK, Sven (University of Liverpool (GB)); KOFFAS, Thomas (Carleton University (CA)); AFFOLDER, Tony (University of California,Santa Cruz (US)); ZAHRADNIK, Vit (Acad. of Sciences of the Czech Rep. (CZ)); SONG, Weimin (Science and Technology Facilities Council STFC (GB)); AI, Xiaocong (UC Berkeley); LIU, Yi (Deutsches Elektronen-Synchrotron (DE))

Presenter: RUEHR, Frederik (Albert Ludwigs Universitaet Freiburg (DE))

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