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Radiation tolerant small-pixel passive CMOS sensors with RD53A readout

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With the HL-LHC upgrade of the ATLAS detector, the surface of the ATLAS pixel detector will increase from 2 m² to approximately 13 m² . Therefore, commercial CMOS processing lines offering high production throughput at comparatively low costs, represent an attractive option for such large-area detectors. Further benefits originate from multiple metal layers, metal–insulator–metal capacitors, and polysilicon layers which offer enhanced sensor designs through additional routing options.

Thinned, small-pixel passive CMOS sensors in 150 nm technology offered by LFoundry were manufactured and assembled into hybrid pixel modules using the RD53A readout chip.

The sensors were characterized, before and after irradiation to fluences of 5×10^{15} n_{eq}/cm² and 1×10^{16} n_{eq}/cm², in the laboratory and also using a minimum ionising electron beam. Their performance in terms of noise and hit-detection efficiency equals that of conventional planar pixel sensors. Special emphasis will be put on the results after a fluence of 1×10^{16} n_{eq}/cm² yielding a hit-detection efficiency of approximately 99 %.

Primary author: DIETER, Yannick Manuel (University of Bonn (DE))

Co-authors: DAAS, Michael (University of Bonn (DE)); DINGFELDER, Jochen Christian (University of Bonn (DE)); HEMPEREK, Tomasz (University of Bonn (DE)); HUEGGING, Fabian (University of Bonn (DE)); JANSSEN, Jens (University of Bonn (DE)); KRUEGER, Hans (University of Bonn); POHL, David-Leon (University of Bonn (DE)); WANG, Tianyang (University of Bonn (DE)); WOLF, Pascal (University of Bonn); WERMES, Norbert (University of Bonn (DE))

Presenter: DIETER, Yannick Manuel (University of Bonn (DE))

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