Contribution ID: **19** Type: **not specified**

Recent Achievements of the ATLAS Upgrade Planar Pixel Sensors R&D Project

Monday, 18 February 2013 15:00 (20 minutes)

To extend the physics reach of the LHC, upgrades to the accelerator are planned which will increase the peak luminosity by a factor 5 to 10. To cope with the increased occupancy and radiation damage of the inner trackers, the ATLAS experiment plans to introduce an all-silicon inner tracker with the HL-LHC upgrade.

To investigate the suitability of pixel sensors using the proven planar technology for the upgraded tracker, the ATLAS Planar Pixel Sensors R&D Project was established comprising 17 institutes and more than 80 scientists.

The presentation will give an overview of the recent accomplishments of the R&D project. Among these are beam test results obtained with pixel sensors irradiated to HL-LHC fluences at realistic b-layer inclination angles and with unirradiated read-out electronics bumped to irradiated sensors, thus eliminating the uncertainty of FE-chip related effects. In addition, first results obtained with heavily irradiated modules using the new ATLAS FE-I4 readout will be shown.

On the topic of edge efficiencies, significant progress has been made with respect to the application of the SCP (scribe-cleave-passivate) post-processing technology which enables the creation of almost active edges even for originally non-slim-edge sensors. New results will be shown for both n-in-n and n-in-p sensors and will be compared to initial TCAD simulations. In addition, first results of planar active edge projects using DRIE trench etching will be presented.

Summary

The high-luminosity upgrades of the LHC will lead to increased occupancy and radiation damage of the inner trackers, approaching fluences of a few 10**16 neq/cm2 at the innermost layer and still some 10**15 neq/cm2 at the outer pixel layers.

The ATLAS experiment plans to introduce an all-silicon inner tracker with the HL-LHC upgrade to cope with the elevated occupancy. With silicon, the occupancy can be adjusted by using the unit size (pixel, strip or short strip sensors) appropriate for the radiation environment. For radiation damage reasons, only electron-collecting sensors designs are considered (n-in-p and n-in-n): Beyond a fluence of about 1015 neq/cm2, trapping becomes the dominant radiation effect and electrons are trapped significantly less than holes.

To investigate the suitability of pixel sensors using the proven planar technology for the upgraded tracker, the ATLAS Planar Pixel Sensor R&D Project was established comprising 17 institutes and more than 80 scientists.
Main areas of research are
* performance assessment and improvement of planar pixel sensors at HL-LHC fluences
* the achievement of slim or active edges to provide low geometric inefficiencies without the need for shingling of modules
* establishment of reliable device simulations for severely radiation-damaged pixel detectors
* the exploration of possibilities for cost reduction to enable the instrumentation of large areas with pixel detectors

Recently, it has been demonstrated with sensors from different vendors that planar pixel sensors can be operated and still yield more than 5000 electrons of signal charge even above 10**16 neq/cm2; hit efficiencies of well above 97% were obtained.
Special slim-edge designs have been implemented and tested and show a reduction of the inactive edges from 1100 µm in the current ATLAS Pixel Detector to only about ˜200 µm. Further improvements towards fully active edges by SCP (scribe-cleave-passivate) and DRIE etching techniques are being investigated.

The presentation will give an overview of the recent achievements of the R&D project, among them
* beam test results with planar sensors irradiated up to *21016 neq/cm2 at different eta angles providing new insight into efficiencies and cluster sizes under realistic b-layer conditions*
** results obtained with n-in-n pixel assemblies with sensors irradiated up to 1.4*10**16 neq/cm2 while readout chips (FE-I3) remained unirradiated to disentangle sensor and FE-related effects**
* **first results from pixel assemblies based on the new ATLAS pixel readout chip FE-I4 irradiated to**

beyond 1*1016 neq/cm2
* systematic studies of the SCP technique to obtain almost active edges by post-processing already existing sensors based on scribing, cleaving and edge passivation
* comparisons of these experimental findings with initial TCAD device simulations
* first results towards fully active edges by means of anisotropic trench etching with planar technology
* experience with recent large-scale planar sensor productions in terms of yield and QA and status of future plans for sensor productions on 6”substrates

Primary author: WEINGARTEN, Jens (Georg-August-Universitaet Goettingen (DE))

Co-authors: GOESSLING, Claus (Technische Universitaet Dortmund (DE)); MUENSTERMANN, Daniel (CERN)

Presenter: WEINGARTEN, Jens (Georg-August-Universitaet Goettingen (DE))

Session Classification: Planar Sensors 1