8th International Workshop on Semiconductor Pixel Detectors for Particles and Imaging.

Contribution ID: **65** Type: **contributed paper**

Status of HVCMOS Sensor Developments for ATLAS

The HVCMOS sensors are a type of CMOS active sensors where signal generation occurs in depleted silicon. HVCMOS sensors are fast and radiation tolerant, mostly due to use of large pixel electrodes and high depletion voltage that leads to uniform and strong electric field and fast charge collection. The development of these sensors started in 2006 and they are now seen as an option to the standard sensor technologies such as hybrid- or strip-detectors for several particle physics experiments, among others ATLAS and CLIC. For Mu3e experiment HVCMOS is the main technology.

In the last year there were several important achievements in HVCMOS development - for instance the design and production of the first reticle-size HVCMOS sensor in AMS H35 technology –H35DEMO that was performed in collaboration between Universities of Bern, Geneva, Liverpool, KIT and CERN. H35DEMO can be readout either as a monolithic detector, with the readout electronics implemented on the sensor chip, or attached to an external readout chip. In the latter case, capacitive signal transmission between the sensor- and the readout-chip can be used. The sensor has been implemented on four different substrates from the standard low-resistivity substrate to the >k Ohm cm substrate. The main purpose of H35DEMO project is to demonstrate that a large HVCMOS sensor fulfils the ATLAS specifications and to show that HVCMOS is a reliable and mature technology. H35DEMO is currently being tested in our group and the first results are encouraging. For instance, we measure significantly better signal to noise ratio than with the previous smaller prototypes, the time resolution is also better.

In 2016 the first HVCMOS reticle-size prototype for the ATLAS strip layers has been also designed and submitted. The goal of this project, performed in collaboration of ATLAS strip groups and us, is to design a segmented strip detector - a pixel detector with long pixels - that can replace the strip sensors.

In parallel to the characterization of H35DEMO, we are already working on several more advanced large-area monolithic sensors that contain all the features necessary for the use in the ATLAS experiment. The submission of these designs is planned for Summer 2016. The designs are optimized according to several application scenarios of HVCMOS sensors that are currently discussed between ATLAS groups: 1) The use of monolithic HVCMOS sensors in the outer pixel layers. 2) The use of capacitively- or DC-coupled pixel detectors based on a HVCMOS sensor and a new readout chip in the inner pixel layer. Here, the goal is a pixel size of 25 x 25 micrometers or less. 3) The use of HVCMOS segmented-strip monolithic sensors in the outer tracker regions. 4) The design of triplet layers.

For these application cases, novel electronic blocks have been developed: very small content addressable memory cells that can be used to keep the particle-hit information for relatively long time > 25 microseconds and to detect the coincidence of the hit information with a trigger signal, small HVCMOS pixels, high-rate and low-latency readout blocks and different circuits for enhancement of time resolution.

This contribution will present the status of the project; the architecture and the design details of the new sensors will be described as well. In the second part of the contribution the results of latest measurements performed at KIT will be presented. The measurement results of other collaboration partners will be presented in the talk of Dr. Vilella Figueras.

Summary

The HVCMOS sensors are a type of CMOS active sensors where signal generation occurs in depleted silicon. HVCMOS sensors are fast and radiation tolerant, mostly due to use of large pixel electrodes and high depletion voltage that leads to uniform and strong electric field and fast charge collection. The development of

these sensors started in 2006 and they are now seen as an option to the standard sensor technologies such as hybrid- or strip-detectors for several particle physics experiments, among others ATLAS and CLIC. For Mu3e experiment HVCMOS is the main technology.

In last year there were several important achievements in HVCMOS development: For instance the design and production of the first reticle-size HVCMOS sensor in AMS H35 technology –H35DEMO that was performed in collaboration between Universities of Bern, Geneva, Liverpool, KIT and CERN. H35DEMO can be readout either as a monolithic detector, with the readout electronics implemented on the sensor chip, or attached to an external readout chip. In the latter case, capacitive signal transmission between the sensor- and the readout-chip can be used. The sensor has been implemented on four different substrates from the standard low-resistivity substrate to the >k Ohm cm substrate. The main purpose of H35DEMO project is to demonstrate that a large HVCMOS sensor fulfils the ATLAS specifications and to show that HVCMOS is a reliable and mature technology. H35DEMO is currently being tested at KIT and the first results are encouraging. In parallel to the characterization of H35DEMO, we are already working on several more advanced large-area monolithic sensors that contain all features necessary for the use in the ATLAS experiment. The submission of these designs is planned for Summer 2016.

This contribution will present the status of the project; the architecture and the design details of the new sensors will be described as well. In the second part of the contribution the results of latest measurements performed at KIT will be presented.

Primary author: Prof. PERIC, Ivan (KIT Karlsruhe Germany)

Co-authors: Ms WEBER, Alena (KIT); EHRLER, Felix (KIT); Ms ZHANG, Hui (KIT); Ms PRATHAPAN, Mridula (KIT); LEYS, Richard (KIT); Mr BLANCO, Roberto (KIT IPE); Mr SCHIMASSEK, Rudolf (KIT)

Presenter: Prof. PERIC, Ivan (KIT Karlsruhe Germany)