15th RD50 Workshop

Monday, 16 November 2009 - Wednesday, 18 November 2009

CERN

Book of Abstracts

Contents

Strip Sensors / **1**

Charge collection annealing study of p-in-n silicon microstrip detectors

Author: Craig Wiglesworth[1]

[1] *Department of Physics*

The annealling of the charge collection as a function of the RT equivalent time (CCET) is now well established with n-side readout sensors. It is though less known with p-in-n sensors. Results of CCET measurements with this type of detectors irradiated to the dose anticipated for the inner microstrip layer of the present ATLAS SCT are here presented. The results are discussed in view of possible annealing scenarios in the ATLAS experiments. Also, future work for confirming the present studies with sensors of the same type of the ATLAS SCT p-in-n devices is annonunced.

Pad Detector Characterization & Studies on Charge Multiplication / **2**

Investigation of electric field and charge multiplication in irradiated silicon detectors by Edge-TCT

Author: Gregor Kramberger[1]

Co-authors: Igor Mandić [1]; Marko Milovanović [1]; Marko Zavrtanik [1]; Mikuž Marko [1]; Vladimir Cindro [1]

[1] *Jozef Stefan Institute*

Corresponding Author: gregor.kramberger@ijs.si

A Transient Current Technique (TCT) utilizing IR laser with 100 ps pulse width and beam diameter of FWHM=8 um was used to evaluate non-irradiated and irradiated p-type silicon micro-strip detectors. The beam was parallel with the surface and perpendicular to the strips (Edge-TCT) so that the electron hole pairs were created at known depth in the detector. The pulse shapes were analysed in a new way, that does not require the knowledge of effective trapping times, to determine: drift velocity, charge collection
and electric field profiles in heavily irradiated silicon detectors.
The profiles were studied at different laser beam positions (depth of carrier generation), voltages and fluences up to 5e15 neutrons 1/cm2. Strong evidences for charge multiplication at high voltages were found for detector irradiated to the highest fluence.

Strip Sensors / **3**

Annealing of Charge Collection Efficiency in highly irradiated MCz-n strip detectors.

Author: Nicola Pacifico[1]

[1] *CERN & Universita degli Studi di Bari*

Corresponding Author: nicola.pacifico@cern.ch

MCz p-readout strip detectors, irradiated to sLHC foreseen fluences, were characterized through Charge Collection Efficiency (CCE) measurements at different isothermal annealing steps. Though n-readout detectors have shown so far remarkable CCE performances, engineering issues (e.g. strip insulation) make them a less reliable alternative to n-readout sensors. The results of this study

are compared with existing studies on CCE of different materials already published in literature to evaluate the possibility to consider the MCz p-in-n as a feasible alternative to n-readout detectors for the sLHC tracking system upgade.

Strip Sensors / 4

Surface properties of ATLAS n-on-p sensors

Author: Hartmut Sadrozinski[1]

Co-authors: Alex Lancaster [2]; Chris et al UC Santa Cruz Gang [3]; Kazu et al Tsukuba Lab [4]

[1] *SCIPP, UC santa Cruz*

[2] *Uk*

[3] *SCIPP*

[4] *Tsukuba Univ.*

Corresponding Author: hartmut@scipp.ucsc.edu

Date on Rint, Cint, Punc-through pre-rad and post rad from the ATLAS07 test sensors (HPK) will be presented

New structures, Pixel and 3D detectors & Lorentz Angle Measurements / 5

Measurements of 3D/FBK sensors

Author: Alessandro La Rosa[1]

[1] *CERN*

Corresponding Author: alessandro.larosa@cern.ch

3D-Si sensors fabricated at FBK-irst with the Double-side Double Type Column approach and columnar electrodes only partially etched through p-type substrates were tested in laboratory and in a 1.4 Tesla magnetic field with a 180 GeV pion beam at CERN SPS.
We'll present leakage current and noise measurements, results of functional tests with gamma-ray sources, charge collection tests with beta-source, an overview of preliminary result from the CERN beam test and of present irradiation at CERN PS.

ALIBAVA - First experiences within RD50 / 6

Status of the Freiburg ALIBAVA systems on the laser and beta setups

Author: Michael Breindl[1]

[1] *Freiburg University*

There are two setups in Freiburg with the new ALIBAVA system as a replacement for the binary ATLAS SCT DAQ for
testing silicon strip detectors (planar and 3D detectors). The first setup is a beta setup with a radioactive source (Sr90) for charge collection

efficiency measurements and the second one is a laser setup with an infrared pulsed PicoQuanT laser to investigate the space-resolved electric field and the charge collection efficiency. Some laser scans were performed on various parts of a planar reference detector with ALIBAVA. In the future we want to learn more about the electric field distribution and space-resolved charge collection efficiency of the detectors with this measurement.
Measuring highly irradiated detectors requires an efficient cooling system to reduce leakage current and prevent thermal runaway. Standard cooling systems as used (e.g. on ATLAS module tests) circulating a cooled liquid are not sufficient. Therefore in the near future a new cooling system based on liquid nitrogen will be installed in Freiburg to cool down to deep temperatures.

Pad Detector Characterization & Studies on Charge Multiplication / 7

Mixed irradiation studies with magnetic czochralski diodes

Author: Robert Eber[1]

Co-authors: Alexander Dierlamm [1]; Martin Frey [1]; Pia Steck [1]; Thomas Müller [1]; Wim de Boer [1]

[1] *IEKP, KIT*

Corresponding Author: eber@iekp.fzk.de

TCT measurements with magnetic czochralski diodes (n-in-p and p-in-n) after a mixed irradiation with protons und neutrons at five different fluences above 3*10ˆ(14)/cmˆ2 were performed. Annealing studies are ongoing. Trapping times for the lower irradiated diodes could be extracted. The electric field inside the diode at different voltages was simulated and reconstructed from the TCT-Signal.

New structures, Pixel and 3D detectors & Lorentz Angle Measurements / 8

New Detectrors with Novel Electrode Configurations for Applications in sLHC and Photon Sciences

Author: Zheng Li[1]

[1] *BNL*

Corresponding Author: zhengl@bnl.gov

Concept, simulations, and design of the US patent-pending new detectors with novel electrode configurations will be presented. These detectors can be ultral radiation hard for applications in extremely high radiation environment such as sLHC, and for applications in photon sciences.

New structures, Pixel and 3D detectors & Lorentz Angle Measurements / 9

Simulations of guard ring designs for n-on-p sensors and of 3D detectors

Author: Daniela Bortoletto[1]

Co-author: Ozhan Koybasi [1]

[1] *Purdue University*

Corresponding Author: daniela.bortoletto@cern.ch

Electrical simulations have been performed with the Synopsys Sentaurus TCAD to develop a guard ring structure that minimizes the electric field throughout the periphery of an n-on-p silicon particle detector. The behavior of the breakdown voltage has been studied as the function of the radiation fluence, the field plate length, and the oxide thickness.
Preliminary results of the performance of 3D detectors after irradiation will also be presented.

Pad Detector Characterization & Studies on Charge Multiplication / 10

Effects of annealing on charge collection in heavily irradiated silicon micro-strip detectors

Author: Marko MILOVANOVIĆ[1]

Co-authors: Gregor KRAMBERGER [1]; Igor MANDIĆ [1]; Marko MIKUŽ [1]; Marko ZAVRTANIK [1]; Vladimir CINDRO [1]

[1] *Jozef Stefan Institute, Ljubljana*

Corresponding Author: marko.milovanovic@ijs.si

Electric field and charge collection properties of a n+-p strip detector irradiated to 5e15 cm-2 were investigated by Edge-TCT (E-TCT) during long term annealing.
It was found that charge collection improves with time, due to larger avalanche multiplication. On the other hand, when operated under forward bias, charge collection properties of the detector were not affected by the annealing process.

Defect Characterization / 11

INTERSTITIAL DEFECT REACTIONS IN P-TYPE SILICON IRRADIATED AT DIFFERENT TEMPERATURES

Author: Leonid Makarenko[1]

Co-authors: Leonid Murin [2]; Michael Moll [3]; Stanislav Lastovskii [2]

[1] *Belarusian State University*

[2] *Scientific-Practical Materials Research Centre of NAS of Belarus*

[3] *CERN*

Corresponding Author: makleo@mail.ru

In this work we present some new findings on the formation and annealing behavior of radiation-induced defects of interstitial type in p-silicon irradiated with 6 MeV electrons and alpha-particles of Pu-239 at temperatures of 78 K (LNT) and 273-295 K (RT). The samples studied were n+-p structures with a hole concentration in the base region from about 3×10ˆ12 cmˆ-3 to 6×10ˆ14 cmˆ-3. The low hole concentration allowed to minimize the injection annealing of primary defects upon electron irradiation by using the beam of low intensity.
The defect transformation kinetics have been studied using DLTS measurements. To monitor the mobile interstitial Si atoms we use a DLTS peak related to interstitial carbon Ci (Ea=0.29 eV).
We have found that after electron irradiation at LNT this peak begins to appear only after thermal annealing at temperatures higher than 300 K. The irradiation with alpha-particles at RT also keep self-interstitials immobile. However direct current injection resulted in complete transformation of

self-interstitials to Ci already at 78 K. These facts indicate that silicon self-interstitials have very low mobility even at room temperature in p-Si, but become extremely mobile under electron injection. It is shown that upon annealing of interstitial carbon in p-Si a metastable state for interstitial carbon-interstitial oxygen complex is formed. This state has an energy level of about Ev+0.36 eV. The formation of the stable and metastable states takes place concurrently. The observed features of the carbon-related complexes formation are likely related to the existence of different crystallographic orientation of the equiprobable pathways through which the interstitial carbon and oxygen atoms can approach each othe

Pad Detector Characterization & Studies on Charge Multiplication / **12**

Detailed investigation of charge multiplication properties in highly irradiated thin epitaxial silicon diodes

Author: Jörn Lange[1]

Co-authors: Eckhart Fretwurst [1]; Gunnar Lindström [1]; Julian Becker [1]; Robert Klanner [1]

[1] *University of Hamburg*

Corresponding Author: joern.lange@desy.de

Recently, charge multiplication has been observed in charge collection measurements of highly irradiated (i.e. several 1e15 to 1e16 n/cm²) 75, 100 and 150 µm thin epitaxial silicon diodes. CCE results for different sources (670, 830, 1060 nm laser light and 5.8 MeV alpha particles with different absorber layers between source and diode) will be presented and compared to theoretical considerations. The pulse height and charge spectra for single TCT pulses were investigated and compared for different charge multiplication levels. Moreover, the spatial homogeneity and long-term stability of collected charge in the multiplication regime were studied.

New structures, Pixel and 3D detectors & Lorentz Angle Measurements / **13**

Results of Beam Test Measurements with 3D-DDTC Silicon Strip Detectors

Author: Michael Koehler[1]

[1] *Freiburg University*

Corresponding Author: michael.koehler@cern.ch

Detectors in the 3D-DDTC (double-sided double type column) layout combine the intrinsically radiation hard design of 3D detectors with a simplified processing technology. This talk presents results of 3D-DDTC detectors obtained in beam test measurements with high-energy particles at the CERN SPS. The Silicon Beam Telescope (SiBT), provided by the University of Helsinki, was utilised to measure the reference tracks. Special emphasis of the analysis is placed on space-resolved evaluation of charge collection and efficiency. Results of detectors produced by CNM-IMB (Barcelona) and FBK-IRST (Trento) are presented.

Welcome / **14**

Welcome to the 15th RD50 Workshop

Corresponding Author: michael.moll@cern.ch

ATLAS and CMS - Phase I upgrades / **15**

The ATLAS Insertable B-Layer (IBL)

Author: Heinz Pernegger[1]

[1] *CERN*

Corresponding Author: heinz.pernegger@cern.ch

ATLAS and CMS - Phase I upgrades / **16**

A low mass 4 layer pixel system for CMS

Author: Hans-Christian Kaestli[1]

[1] *PSI*

Corresponding Author: hans-christian.kaestli@psi.ch

Pad Detector Characterization & Studies on Charge Multiplication / **17**

Results on diodes

Author: Katharina Kaska[1]

[1] *Technische Universitaet Wien*

Corresponding Author: katharina.kaska@cern.ch

Results on diodes

ALIBAVA - First experiences within RD50 / **18**

Status of the CERN ALIBAVA system

Authors: Eduardo Del Castillo Sanchez[1]; Michael Moll[1]

[1] *CERN*

Corresponding Author: michael.moll@cern.ch

First experiences with the hard and software will be presented.

ALIBAVA - First experiences within RD50 / **19**

Alibava System Hardware

Author: Ricardo Marco Hernandez[1]

[1] *Instituto de Fisica Corpuscular (IFIC)-Universitat de Valencia-U*

Corresponding Author: ricardo.marco.hernandez@cern.ch

A short description of all the Alibava system hardware including both the MB and the DB.

ALIBAVA - First experiences within RD50 / **20**

Alibava - a discussion on Software and FAQ

Author: Henry Brown[1]

[1] *University of Liverpool*

Corresponding Author: browha@gmail.com

A brief discussion on known issues with the Alibava system, the most commonly asked questions/complaints about the system, and the macros developed in Liverpool out of our own requirements that are available on the internet.

Defect Characterization / **21**

Microscopic Study of Proton Irradiated Epitaxial Detectors

Author: Volodymyr Khomenkov[1]

Co-authors: Alexandra Junkes [1]; Cristina Pirvutoiu [1]; Eckhart Fretwurst [1]; Ioana Pintilie [2]

[1] *Hamburg University*

[2] *NIMP Bucharest*

Corresponding Author: volodymyr.khomenkov@desy.de

Thick epitaxial material (e.g. 150 um) may be an option for application in S-LHC, therefore we are interested in the microscopic defect generation and the macroscopic parameters of this material. DLTS and TSC study of n-type pad diodes with thicknesses up to 150 um have been performed after irradiation with 23 GeV protons and following isochronal annealing. A correlation between macroscopic electrical parameters and concentrations of corresponding defects has been observed.

Pad Detector Characterization & Studies on Charge Multiplication / **22**

Charge Collection and Trapping in Epitaxial Silicon Detectors after Neutron Irradiation

Author: Thomas Poehlsen[1]

Co-authors: Eckhart Fretwurst [1]; Joern Lange [1]; Julian Becker [1]; Robert Klanner [1]

[1] *University of Hamburg*

Corresponding Author: thomas.poehlsen@desy.de

The charge collection and the trapping behaviour of 150 µm n-type epitaxial silicon detectors irradiated with neutron fluences between 1E15 and 4E15 cm-2 were investigated. Observed double peaks in the TCT signal could be simulated assuming parabolic electric fields. Contrary to previous assumptions of field independent trapping time constants the field dependence was studied. The experimental results and simulations will be presented and discussed

Strip Sensors / 23

First Results of SiBT test beam 2009

Author: Jaakko Haerkoenen[1]

Co-author: Collaboration SiBT [2]

[1] *Helsinki Institute of Physics HIP*

[2] *http://www.hip.fi/research/cms/tracker/SiBT/php/members.php*

Corresponding Author: jaakko.haerkoenen@cern.ch

This talk gives preliminary results obtained from test beam experiment performed in 29. June-12.July 2009 at CERN H2 area with Silicon Beam Telescope (SiBT). The SiBT is based on CMS Tracker readout electronics and data acquisition sysmten, and the telescope consists of up to eight reference silicon microstrip modules and slots for two test modules.
The sensors used in this study have been processed at Micro and nanoelectronics center of Helsinki University of Technology. The size of detectors is 4cm x 4cm and they have 768 strips with 50um pitch. The detectors under investigation have been irradiated at University of Karlsruhe by 26 MeV protons. This presentation focuses on two modules. First, p-type MCz-Si detector irradiated to 2x10ˆ15 neq/cmˆ2 and second, n-type Fz-Si detector irradiated to 1x10ˆ14 neq/cmˆ2.

Strip Sensors / 24

Interstrip resistance in silicon position-sensitive detectors

Author: Elena Verbitskaya[1]

Co-authors: Nadezda Safonova [1]; Nikolai Egorov [2]; Sergey Golubkov [2]; Vladimir Eremin [1]

[1] *Ioffe Physical-Technical Inst. RAS*

[2] *Research Institite of Material Science and Technology*

Corresponding Author: elena.verbitskaia@cern.ch

Results on interstrip isolation resistance in Si position-sensitive detectors are presented. It is demonstrated that experimental I-V characteristics of the interstrip gap show a step in the current. This feature is caused by the current redistribution between neighboring strips and its influence on the interstrip resistance is more pronounced than ohmic conductance between the strips.

Pad Detector Characterization & Studies on Charge Multiplication / 25

CCE in irradiated silicon detectors with a consideration of avalanche effect

Author: Vladimir Eremin[1]

Co-authors: Andrei Zabrodskii [1]; Elena Verbitskaya [1]; Jaakko Härkönen [2]; Zheng Li [3]

[1] *Ioffe Physical-Technical Institute RAS*

[2] *3Helsinki Institute of Physics, CERN/PH,*

[3] *Brookhaven National Laboratory*

Corresponding Author: vladimir.eremin@cern.ch

The results of modeling of CCE vs. fluence and CCE vs. voltage dependences in a wide range of fluences and bias voltage are presented. The shape of the curves is discussed in the frame of PTI model for avalanche multiplication in p-n junctions on deep level rich semiconductors.

Defect Characterization / **26**

The comparison of the defect generation during the proton irradiation in situ and afterwards in silicon

Author: Juozas Vaitkus[1]

Co-authors: Aurimas Uleckas [1]; Ernestas Zasinas [1]; Eugenijus Gaubas [1]; Jyrki Raisanen [2]

[1] *Vilnius University*

[2] *University of Helsinki*

Corresponding Author: juozas.vaitkus@ff.vu.lt

It was performed the measurement of the photoconductivity decay in MCZ silicon during the irradiation by protons in Helsinki Acellerator Laboratory. It was found the difference of defect generation in the “fresh” samples in comparison with the preirradiated samples. The main difference was observed in the low irradiation region and becomes similar at high fluences, except of the cases of the irradiation at low temperature (50 K).
The cluster model was analyzed by the density functional method and the deformation of the bandgap in the environment of the cluster was found.

Summary:

It was shown the main defects contributing in the free carrier lifetime are related to the clusters. The trapping effects were observed in the shallow levels.

Defect Characterization / **27**

The deep levels in the irradiated Si (WODEAN samples)

Author: Juozas Vaitkus[1]

Co-authors: Neimantas Vainorius [1]; Vaidotas Kazukauskas [1]; Vidmantas Kalendra [1]

[1] *Vilnius University*

Corresponding Author: juozas.vaitkus@ff.vu.lt

A few WODEAN series samples were investigated by extrisic photoconductivity spectrum analyze using the upgraded equipment. More precise data are presented. Measurements were performed at different temperatures.

The slow photoconductivity decay components were measured at different excitation conditions.

Defect Characterization / **28**

Generation of a shallow donor after 6, 15 and 900 MeV electron irradiation

Author: alexandra junkes[1]

Co-authors: Eckhart Fretwurst [1]; Gunnar Lindström [1]; Ioana Pintilie [2]

[1] *Hamburg University*

[2] *NIMP, Bucharest-Margurele*

Corresponding Author: alexandra.junkes@desy.de

This work focuses on the generation of the shallow donor level E30K after 6, 15 and 900 MeV electron irradiation in n-type FZ diodes. The E30K is known to be a cluster related defect which plays a key role in the understanding of non-type inversion of epitaxial diodes after high proton fluences. We found that the generation of E30K is suppressed for increasing electron energies. This suggests a more point like character of the defect.
Defect concentrations were obtained by means of thermally stimulated current technique for several electron fluences.

Defect Characterization / **29**

Discussion: Wodean & Defect Characterization

Authors: Eckhart Fretwurst[1]; Mara Bruzzi[2]

[1] *Hamburg University*

[2] *Dipartimento di Fisica*

Pad Detector Characterization & Studies on Charge Multiplication / **30**

Discussion: Pad Detectors and Charge Multiplication

Strip Sensors / **31**

Discussion on Strip Sensors (FDS)

Author: Gianluigi Casse[1]

[1] *Department of Physics*

New structures, Pixel and 3D detectors & Lorentz Angle Measurements / **32**

Discussion on Pixel, 3D and new structures

Defect Characterization / **33**

TSC studies on n- and p-type MCZ Si pad detectors irradiated with neutrons up to 10ˆ16 n/cmˆ2

Authors: David Menichelli[1]; Mara Bruzzi[1]; Monica Scaringella[1]; Riccardo Mori[1]

[1] *University of Florence*

Corresponding Author: scaringella@fi.infn.it

We report on the investigation of the radiation damage induced by neutron irradiation on both n- and p-type Magnetic Czochralski silicon pad detectors by the Thermally Stimulated Currents technique. Detectors have been irradiated with fast neutrons in the range 10ˆ14-10ˆ16 n/cm2. Temperatures spanned from 10K to 250K to investigate the presence of both shallow and deep traps in the irradiated devices. Priming conditions have been studied in detail in order to investigate the residual electric field due to frozen charged traps after the priming step. Zero bias TSC measurements have also been performed as an additional tool to study the defects distribution and the residual electric field. The electric field distribution inside the sample and its effect on the TSC emission are qualitatively explained by a band diagrams description.

New structures, Pixel and 3D detectors & Lorentz Angle Measurements / **34**

New Measurement of Lorentz angles for electrons and holes in silicon detectors

Author: Mike Schmanau[1]

Co-authors: Alexander Dierlamm [1]; Andreas Sabellek [1]; Michael Schneider [1]; Wim de Boer [1]

[1] *IEKP-KIT-Germany*

Corresponding Author: mike.schmanau@cern.ch

Silicon sensors are commonly used in particle trackers because of their stability and high spatial resolution in the um range. Inside a strong magnetic field the ionization is not entering on the electrode hit by the particle, but shifted to neighboring electrodes because of the Lorentz force in crossed E and B fields, which lets the ionization drift under a certain angle. This Lorentz angle is typically a few degrees for holes and a few tens of degrees for electrons in a 4T magnetic field, so it clearly has to be taken into account in typical experiments. The Lorentz angle depends on bias voltage, depletion voltage, temperature, magnetic field and radiation damage.
The Lorentz angle has been measured and parametrized for a large range of voltages (0-1000V), magnetic fields (0-8T), temperatures (126-293K) and fluences (0-10ˆ16 n/cm2). The measurements were performed by inducing ionization with lasers and observing the position of the collected charge as function of the magnetic field. Preliminary data are presented.

New structures, Pixel and 3D detectors & Lorentz Angle Measurements / **35**

Charge collection studies of irradiated 3D detectors (Late submission)

Corresponding Author: r.bates@physics.gla.ac.uk

Short strip CNM double-sided 3D sensors have been fabricated and irradiated in a 26MeV proton beam. The devices have received a fluence up to 2x10^16 1 MeV neutron equivalent cm-2. The devices have been tested using the Alibava system with a Sr-90 source. Results of the excellent charge collection of the devices after such high fluences are shown.

New structures, Pixel and 3D detectors & Lorentz Angle Measurements / **36**

Beam tests of Medipix2/Timepix double-sided 3D detectors (Late submission)

Corresponding Author: marco.gersabeck@cern.ch

CNM double-sided 3D pixel detectors have been fabricated and assembled to the Medipix2 and Timepix ASICs. Medipix2 assemblies have been tested with a micron-sized beam at the Diamond light source to understand the response of the detector as a function of hit position. The same devices and Timepix assemblies have also been tested in a telescope at a pion beam at the SRS. Complimentary information on the response of the detector as a function of ht position has been obtained and is presented. In addition pulse height spectra is presented from the Timepix assembly.

ALIBAVA - First experiences within RD50 / **37**

Status of the Glasgow Alibava system

Strip Sensors / **38**

Full-size ATLAS Sensor Testing (Late submission)

Corresponding Author: bohm@fzu.cz

Summary:

The ATLAS collaboration R&D group "Development of n-in-p Silicon Sensors for very high radiation environment"has developed single-sided p-type 9.75 cm x 9.75 cm sensors with n-type readout strips having radiation tolerance against the 1015 1-MeV neutron equivalent (neq)/cm2 fluence expected in the Super Large Hadron Collider. The compiled results of an evaluation of the bulk and strip parameter characteristics of 19 new sensors manufactured by Hamamatsu Photonics are presented in this paper. It was verified in detail that the sensors comply with the Technical Specifications required before irradiation. The reverse bias voltage dependence of various parameters, frequency dependence of tested capacitances, and strip scans of more than 23000 strips as a test of parameter uniformity and strip quality over the whole sensor area have been carried out at Stony Brook University, Cambridge University, Geneva University, and Academy of Sciences of CR and Charles University in Prague. No openings, shorts, or pinholes were observed on all tested strips, confirming the high quality of sensors made by Hamamatsu Photonics.

Pad Detector Characterization & Studies on Charge Multiplication / 39

Recent results of annealing measurements in p-type microstrip detector with SCT128 chip (Late submission)

Discussion on future RD50 sensor production runs / 40

Production of RD50 sensors at MICRON

Discussion on future RD50 sensor production runs / 41

Production of RD50 sensors at VTT