29th RD50 Workshop (CERN)

Report of Contributions

https://indico.cern.ch/e/580875

Contribution ID: **1** Type: **not specified**

Characterisation of HFS detectors

Tuesday 22 November 2016 09:00 (20 minutes)

Results from the study of HFS detectors from RMD will be presented. Some of these sensors have been subjected to neutron irradiation at the Jožef Stefan Institute (Ljubljana, Slovenia). The fluences to which these were exposed are 3E13, 6E13, 3E14 and 1E15 n/cmˆ2. TCT and CV/IV measurements were performed on irradiated and unirradiated samples. The results obtained from these studies will be shown in this presentation.

Author: OTERO UGOBONO, Sofia (CERN/Universidade de Santiago de Compostela (ES))

Co-author: MOLL, Michael (CERN)

Presenter: OTERO UGOBONO, Sofia (CERN/Universidade de Santiago de Compostela (ES))

Session Classification: LGAD, DD-APD, SiPM, UFSD, HFS

Contribution ID: **2** Type: **not specified**

TCAD simulations of p-bulk silicon sensors after a large range of fluences

Tuesday 22 November 2016 16:10 (20 minutes)

In this talk I will present recent results from TCAD simulations using Silvaco tools.
In particular I will focus on p-bulk sensors, both standard diodes and LGADs.
At the beginning I will present a comparison of two radiation damage models for the bulk (Perugia, New Delhi).
Then I will comment on the impact of radiation damage model parameters uncertainties on macroscopic observables.
Eventually I will present some results on simulated thin LGADs under laser red light illumination.

Author: BOMBEN, Marco (Centre National de la Recherche Scientifique (FR))

Presenter: BOMBEN, Marco (Centre National de la Recherche Scientifique (FR))

Session Classification: TCT & Device simulations

Contribution ID: **3** Type: **not specified**

Ion irradiation and semiconductor detector characterization at the Centro Nacional de Aceleradores [MONDAY]

Monday 21 November 2016 11:45 (20 minutes)

The National Accelerator Center (CNA) is a user's facility dedicated to multidisciplinary applications of particle accelerators. In this talk, the infrastructure available at CNA for Ion Irradiation and Characterization of Materials, based on a 3 MV tandem accelerator and a compact cyclotron for 18 MeV protons, will be briefly described. Recent activities carried out at CNA with potential interest for RD50 participants will be presented. The examples include the strain response of proton-irradiated Fiber Bragg Gratings, soft errors produced in SRAM memories and applications of the Ion Beam Induced Current technique to study the transport properties of ion induced damaged Si and SiC diodes and the charge collection efficiency of silicon-3D and Low Gain Avalanche Detectors.

Author: GARCIA LOPEZ, Javier (University of Seville)

Presenter: GARCIA LOPEZ, Javier (University of Seville)

Session Classification: Defect and Material Characterization

Contribution ID: **4** Type: **not specified**

Defect centers in nitrogen-enriched high-resistivity n-type silicon induced by high-energy protons

Monday 21 November 2016 15:50 (20 minutes)

Radiation damage in *n*-type high-resistivity FZ silicon wafers with a nitrogen concentration of ˜1.5E15 cmˆ-3 exposed to 23-MeV protons has been studied by using high-resolution photoinduced transient spectroscopy (HRPITS), infrared absorption (FTIR) and photoluminescence (PL) and measurements. In order to determine the evolution of the radiation defect structure with increasing the proton fluence, the defect centers were produced by the irradiation with four proton fluences: 1E14, 5E14, 1E15, and 5E15 n(eq)/cmˆ2. The irradiation with each fluence resulted in the sharp increase of the material resistivity from ˜2kΩcm to ˜300 kΩcm. The HRPITS results show that 20 defect centers with activation energies ranging from 24 to 565 meV are formed during the irradiation and these centers can be involved in the charge compensation leading to the increase of the resistivity. The detected traps are tentatively assigned to thermal donors, interstitial carbon related complexes, small aggregates of self-interstitials, interstitial oxygen related complexes, and small aggregates of vacancies. According to the FTIR results, the introduction rate of VO complexes significantly decreases with increasing the proton fluence. For the fluences of 1E14 and 5E14 n(eq)/cmˆ2, the effect of the oxygen concentration in the wafer on the VO center introduction rate is also observed. With increasing the fluence from of 1E14 and 5E15 n(eq)/cmˆ2, the introduction rate of divacancies rises from ˜0.15 to 0.3 cm-1. In the low-temperature PL spectra, the lines related to recombination of excitons bound to tri-interstitials, as well as to C(i)C(s), C(i)C(s)H and C(i)O(i) complexes are observed.

Author: KAMINSKI, Pawel (Institute of Electronic Materials Technology (PL))

Presenter: KAMINSKI, Pawel (Institute of Electronic Materials Technology (PL))

Session Classification: Defect and Material Characterization

Contribution ID: **5** Type: **not specified**

Charge collection and Lorentz angle measurement on ATLAS12 sensors

Wednesday 23 November 2016 09:40 (20 minutes)

As a result of the radiation damage expected at HL-LHC, the collected charge and the Lorentz angle on the silicon strip sensors present at the detectors is expected to change. Therefore, the collected charge and the Lorentz angle are measured on non-irradiated and highly irradiated future ATLAS silicon micro-strip sensors at the DESY II test beam. The results of the change in the collected charge and the Lorentz angle will be presented in this talk.

Author: YILDIRIM, Eda (Johannes-Gutenberg-Universitaet Mainz (DE))

Presenter: YILDIRIM, Eda (Johannes-Gutenberg-Universitaet Mainz (DE))

Session Classification: Pixel and Strip sensors; LHC experiments

Contribution ID: **6** Type: **not specified**

Measurements on 50um thick LGAD from CNM

Tuesday 22 November 2016 09:40 (20 minutes)

For Ultra-fast Silicon Detectors, we are using thin Low-Gain Avalanche Diodes.
We report results from a series of measurements, including electrical characterization, charge collection and time resolution in beam tests.

Author: SADROZINSKI, Hartmut (University of California,Santa Cruz (US))

Presenter: SADROZINSKI, Hartmut (University of California,Santa Cruz (US))

Session Classification: LGAD, DD-APD, SiPM, UFSD, HFS

Contribution ID: **7** Type: **not specified**

Simulation of Low Gain Avalanche Detector characteristics based on the concept of negative feedback in irradiated silicon detectors with carrier impact ionization (Part II)

Tuesday 22 November 2016 15:00 (20 minutes)

The dependencies of the collected charge versus bias voltage and fluence for LGADs are calculated to fit experimental data. The calculations are based on two models of radiation degradation in Si detectors previously developed at the Ioffe Institute and adapted to the LGAD structure: 1) a model of two effective energy levels of radiation-induced defects responsible for the electric field profile, and 2) a mechanism of internal negative feedback responsible for the gain degradation in irradiated Si detectors with avalanche multiplication. It is shown that the developed models give adequate quantitative description of the experimental results for the LGADs including the detector pulse response. In irradiated LGADs negative feedback leads to the transfer of a significant fraction of the potential drop from the built-in layer toward the p+ contact. It initiates two negative effects, which both cause the gain degradation with irradiation: the lowering of the electric field in the n+-pbi region that reduces the multiplication probability, and the increase of the collection time and trapping-related charge losses.

Author: Dr VERBITSKAYA, Elena (Ioffe Institute)

Presenter: Dr VERBITSKAYA, Elena (Ioffe Institute)

Session Classification: TCT & Device simulations

Contribution ID: **8** Type: **not specified**

New results of measurements with irradiated CMOS detectors in Ljubljana

Monday 21 November 2016 10:15 (20 minutes)

New results of E-TCT and Sr90 measurements with CMOS detectors produced on substrates with different resistivities will be presented. With Edge-TCT method the thickness of depleted layer can be estimated and its dependence on irradiation flunece was studied. Collected charge deposited by MIPs from Sr90 source in passive CMOS detectors was measured with external amplifier. The dependence of collected charge on fluence will be presented and compared to E-TCT measurements.

Author: MANDIC, Igor (Jozef Stefan Institute (SI))

Presenter: MANDIC, Igor (Jozef Stefan Institute (SI))

Session Classification: CMOS sensors

Contribution ID: **9** Type: **not specified**

Run II Radiation Damage Effects and Operation of the LHCb Vertex Locator

Wednesday 23 November 2016 09:20 (20 minutes)

The LHCb Vertex Locator (VELO) is a silicon micro-strip detector operating extremely close to the LHC proton beams. During nominal data-taking the innermost active strips are as close as ˜8 mm to the beams. This proximity makes the LHCb VELO an ideal laboratory to study radiation damage effects in silicon detectors.
There are numerous challenges for VELO, both in proton and ion runs.
The VELO operation is monitored with a dedicated scans: IT, IV and CCE.
The CCE scans provide the best handle on to project the bias voltages needed to operate the VELO efficiently throughout LHC Run 2. Run 2 of the LHC exceeds the radiation damage requirements the LHCb VELO was originally designed for. The latest results from radiation damage studies and their impact on the operation of the LHCb VELO in LHC Run 2 will be presented.

Author: OBLAKOWSKA-MUCHA, Agnieszka (AGH University of Science and Technology (PL))

Presenter: OBLAKOWSKA-MUCHA, Agnieszka (AGH University of Science and Technology (PL))

Session Classification: Pixel and Strip sensors; LHC experiments

Contribution ID: **10** Type: **not specified**

Simulation of Dynamic Characteristics of GaN p-i-n Avalanche Diode Type Particle Detector

Tuesday 22 November 2016 15:20 (20 minutes)

The future upgrading of detectors for the high luminosity colliders requests the detectors that are capable work in the conditions where fluence of neutrons exceeds 1e17 cm-2 (e.g., the forward callorimeter in CMS). We make an attempt to investigate the possibilities of GaN detectors that works at room and higher temperature.
The dynamic characteristics of the GaN p-i-n avalanche diodes have been simulated using a drift-diffusion model according to the software package Synopsys TCAD Sentaurus. Particle detection is emulated through photo-excitation of an excess carrier domain at different locations of the active volume of a diode. Shockley-Read-Hall (SRH), Auger and radiative recombination was taken into account. It has been shown that the pulse shape of a total current strongly depends on the excess carrier photo-injection location due to the considerable difference of the electron and hole saturation velocity and impact ionization coefficient in GaN. The internal gain due to charge multiplication ensures sufficient charge collection on electrodes of the relatively thin (5 micrometers) avalanche diodes. Our calculations show that the necessary charge collection exists even in the case of a very low carrier lifetime (about 10 ps).

Author: VYSNIAUSKAS, Juozas (Vilnius University (LT))

Presenter: VYSNIAUSKAS, Juozas (Vilnius University (LT))

Session Classification: TCT & Device simulations

Contribution ID: **11** Type: **not specified**

Study of prototype sensors for the LHCb Upstream Tracker Upgrade

Wednesday 23 November 2016 09:00 (20 minutes)

The UT working group is developing the Upstream Tracker for the LHCb experiment upgrade. Four testbeams were carried out in 2015 and 2016 to assess the performance of both full size and mini prototype silicon strip detectors. We present results on the performance of these sensors at various levels of sensor irradiation.

Author: ELY, Scott Edward (Syracuse University (US))

Presenter: ELY, Scott Edward (Syracuse University (US))

Session Classification: Pixel and Strip sensors; LHC experiments

Contribution ID: **12** Type: **not specified**

Status of CNM technological developments on LGAD and future plans

Tuesday 22 November 2016 10:20 (20 minutes)

Last developments on LGAD fabrication, as well as future plans, will be presented.

Author: CARULLA ARESTE, Maria del Mar (Instituto de Microelectronica de Barcelona IMB-CNM)

Presenter: CARULLA ARESTE, Maria del Mar (Instituto de Microelectronica de Barcelona IMB-CNM)

Session Classification: LGAD, DD-APD, SiPM, UFSD, HFS

Contribution ID: **13** Type: **not specified**

Radition damage studies in LGAD detectors from recent CNM and FBK runs

Tuesday 22 November 2016 10:00 (20 minutes)

The most important results from the lates LGAD runs at CNM and FBK will be presented.

Author: KRAMBERGER, Gregor (Jozef Stefan Institute (SI))

Presenter: KRAMBERGER, Gregor (Jozef Stefan Institute (SI))

Session Classification: LGAD, DD-APD, SiPM, UFSD, HFS

Contribution ID: **14** Type: **not specified**

Impact of electron irradiation on N- and O-enriched FZ silicon p-in-n pad detectors

Monday 21 November 2016 16:10 (20 minutes)

Nitrogen and oxygen enriched FZ silicon was investigated with respect to the radiation hardness under electron irradiation. P-in-n pad detectors were fabricated on four groups of FZ silicon wafers (FZ, NFZ, DOFZ and DOPFZ). Group NFZ was enriched with nitrogen during crystal growth. The DOFZ and DOPFZ groups were enriched with oxygen by oxygen indiffusion during prolonged annealing. The DOPFZ group received an additional oxygen precipitation treatment. Nitrogen and oxygen concentrations were measured by low temperature FTIR spectroscopy. The p-in-n diodes were characterized by IV measurements prior and after irradiation. Additionally, the excess charge carrier lifetime was determined by measuring the open circuit voltage decay prior and after irradiation. It was found that for all types of enrichment the irradiation induced defect density is reduced in comparison to the reference FZ silicon group. Strongest reduction of the induced defect density was found for the DOPFZ group.

Author: LAUER, Kevin (CIS Institut fuer Mikrosensorik GmbH (DE))

Co-author: KAMINSKI, Pawel (Institute of Electronic Materials Technology)

Presenter: LAUER, Kevin (CIS Institut fuer Mikrosensorik GmbH (DE))

Session Classification: Defect and Material Characterization

Contribution ID: **15** Type: **not specified**

Two Photon edge-TCT measurements of a neutron irradiated HVCMOS

Monday 21 November 2016 10:35 (20 minutes)

First Two Photon edge-TCT measurements of an HVCMOSv3 (ams 180 nm) irradiated with neutrons to a fluence of 7e15 neq/cm2 will be presented. The superior spatial resolution of TPA allows to accurately calculate the depletion width and effective doping concentration of the bulk. We attempt to profile the electric field inside the detector, including its distribution inside the Deep Implant. We compare the results with those obtained from the non-irradiated device, already measured with this technique.

Author: FERNANDEZ GARCIA, Marcos (Universidad de Cantabria (ES))

Co-author: MOLL, Michael (CERN)

Presenter: FERNANDEZ GARCIA, Marcos (Universidad de Cantabria (ES))

Session Classification: CMOS sensors

Contribution ID: **16** Type: **not specified**

Calculation of the effective space charge profile of a detector using TRACS

Tuesday 22 November 2016 14:20 (20 minutes)

We present a new software that aims to calculate the effective space charge distribution of a silicon detector. The software uses TRACS (TRAnsient Current Simulator) to simulate the induced transients currents in a detector under edge-TCT illumination. Inside TRACS a Neff(z) profile is assumed. The parameters of the profile are extracted from a fit of measured transient currents to the simulation. Since this is a CPU demanding process, TRACS was parallelized and is ran in a multicore machine. This new TRACS version with fitting capabilities are available in the CERN-cloud service.

Author: CALVO PINTO, Julio (CERN)

Co-authors: VILA ALVAREZ, Ivan (Universidad de Cantabria (ES)); FERNANDEZ GARCIA, Marcos (Universidad de Cantabria (ES)); MOLL, Michael (CERN)

Presenter: CALVO PINTO, Julio (CERN)

Session Classification: TCT & Device simulations

Contribution ID: **17** Type: **not specified**

RD50 collaboration board meeting (https://indico.cern.ch/event/588462/)

The detailed agenda is given on
https://indico.cern.ch/event/588462/
(protected)

Session Classification: Collaboration Board

Contribution ID: **18** Type: **not specified**

RD50 CMOS project

Monday 21 November 2016 08:30 (1 hour)

Presenter: CASSE, Gianluigi (University of Liverpool (GB))

Session Classification: RD50 CMOS project & working group meeting

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

Proton-energy dependent damage to thin Silicon pad diodes

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Author: DONEGANI, Elena (University of Hamburg)

Presenter: DONEGANI, Elena (University of Hamburg)

Session Classification: delete me

Contribution ID: **20** Type: **not specified**

Long Term Annealing of ATLAS12 Sensors

Wednesday 23 November 2016 10:00 (20 minutes)

We will present a summary of long term annealing studies at Room Temperature and 60℃, using irradiated p-type sensors up to a fluence of 2e15 n_eq/cmˆ2. Measurements include the charge collection and leakage current behavior, and based on this estimate the scaling factor between the two temperatures and the behavior of the effective doping concentration.

Author: Ms DIEHL, Leena (University of Freiburg)

Presenter: Ms DIEHL, Leena (University of Freiburg)

Session Classification: Pixel and Strip sensors; LHC experiments

Contribution ID: **21** Type: **not specified**

Laboratory measurement and progress in Low Gain Avalanche Diodes

Tuesday 22 November 2016 11:10 (20 minutes)

We report on the status of the Ultra fast silicon Detector (USFD). UFSD are silicon detectors based on the Low Gain Avalanche Diodes (LGAD); they LGAD have internal moderate gain (˜10 order of magnitude), they exhibit fast and large signal and the signal is about 10 larger than the standard silicon detector. Thanks to their properties they are good candidates for time applications.
We will concentrate the discussion discuss the results on UFSD and LGAD developed by the two international center manufacturers: the Institute of Microelectronics of Barcelona (CNM) and the Fondazione Bruno Kessler of Trento (FBK).

CNM has produced the first 50µm thin LGAD sensor with thickness = 50µm; in this contribution we focused the attention on sensors products for the two CERN experiments TOTEM and CT-PPS.
In this presentation we will show the preliminary IV curves of these detectors as measured in Turin.

FBK has produced many different LGAD structures with thickness = 300µm; we will show the internal gain measurements performed in Turin and the its comparison of these measurements with the gain simulated with the simulations carried over by the University of Trento.
We will also present results on the FBK production of LGAD MultiPad structures with readout segmentation either on n-side or on p-side segmentation; the difference between n-side and p-side LGAD segmentation is the segmented internal gain layer for the first one and the single internal layer for the second one.
In this contribution we will show the preliminary results about the read-out signal for these two different LGAD structure.

Author: Mr FERRERO, Marco (Universita e INFN Torino (IT))

Presenter: Mr FERRERO, Marco (Universita e INFN Torino (IT))

Session Classification: LGAD, DD-APD, SiPM, UFSD, HFS

Contribution ID: **22** Type: **not specified**

Physical limits on the inter-strip resistance for planar strip sensors

Tuesday 22 November 2016 14:00 (20 minutes)

For conventional planar strip sensors the interstrip resistance was observed to have a significant variation with ionizing dose and operational temperature. In principle, it could become low enough to result in lateral charge spread across several strips leading to signal loss and deterioration of the positional resolution. There are two aspects of such evaluation that can be improved: 1) The resistance tests are typically done as static IV scans, whereas the realistic signal charge flow is a dymanic process. 2) The criteria used for sensor quality control sometimes use the bias resistor value as a metric for the inter-strip resistance. The bias resistor comparison has a large built-in safety margin since a more relevant metric is the readout amplifiers' input impedance. We sought to establish a more physical criteria for the interstrip resistance evaluation by using SPICE simulation of the sensor model with dynamic signal and a model of readout amplifier. A wide range of the inter-strip resistance values was simulated and its effect on the lateral signal spread was estimated.

Author: FADEYEV, Vitaliy (University of California,Santa Cruz (US))

Presenter: FADEYEV, Vitaliy (University of California,Santa Cruz (US))

Session Classification: TCT & Device simulations

Contribution ID: **23** Type: **not specified**

Magnetoresistance in the irradiated Si microstrip type samples

Monday 21 November 2016 15:00 (20 minutes)

The standard Si microstrip detector samples were irradiated to high fluence in TRIGA reactor. The magnetoresistance was investigated at different temperature, and the preliminary results of mobility dependence was obtained. It was found a decrease of magnetoresistance mobility up to 640 cm2/sV @ room T in samples irradiated to 1e17 neutron/cm2 fluence. The mobility was near to the same in both FZ and MCZ Si samples but at the lower fluence the differences between the Si type was bigger. The details of the measurement technique and results needs to discuss.

Author: VAITKUS, Juozas (Vilnius University)

Co-authors: KRAMBERGER, Gregor (Jozef Stefan Institute (SI)); MANDIC, Igor (Jozef Stefan Institute (SI))

Presenter: VAITKUS, Juozas (Vilnius University)

Session Classification: Defect and Material Characterization

Contribution ID: **24** Type: **not specified**

Insight into the behaviour of futuristic low bulk resistivity Si sensors using device simulation.

Tuesday 22 November 2016 16:50 (20 minutes)

There has been a growing interest for the relatively higher bulk doping density (10ˆ13 cmˆ(-3) to 2x10ˆ14 cmˆ(-3)) Si sensors due to their better ability for internal charge multiplication and hence higher charge collection efficiency. The CMOS, APD and LGAD are some of the examples having high bulk doping density (or low resistivity) sensors. However, there has not been a detailed investigation of possible radiation damage effects, which these low resistivity devices may experience in the future collider experiments.
In the present work, we are reporting a systematic TCAD simulation study for the effect of proton fluence (up to 1x10ˆ16 neqcm-2) on charge collection efficiency of low resistivity, p- and n-type Si diodes of thicknesses 100 micron, 200 micron and 300 micron. A two trap proton damage model (Delhi model) is used to implement the radiation damage within TCAD framework. As expected, the results show better radiation hardness behaviour for such devices.

Author: DALAL, Ranjeet (University of Delhi)

Session Classification: TCT & Device simulations

Contribution ID: **25** Type: **not specified**

LGAD design for harsh radiation environments using TCAD simulations.

Tuesday 22 November 2016 14:40 (20 minutes)

The extremely harsh radiation environment of the future trackers necessitates the upgrade of the existing silicon detector technologies. The LGAD detectors, based on their internal charge multiplication mechanism, have attracted a lot of interest in the silicon detector community. However, it has been reported that a rapid decrease in the LGAD gain with irradiation is limiting these devices as the possible detector candidates for future experiments. In this work, it is demonstrated, through the TCAD simulation results, that by tuning certain design parameters, LGAD can be made to sustain the high radiation environment.

Author: JAIN, Geetika (University of Delhi (IN))

Co-author: DALAL, Ranjeet (University of Delhi)

Presenter: BHARDWAJ, Ashutosh (University of Delhi (IN))

Session Classification: TCT & Device simulations

Contribution ID: **26** Type: **not specified**

Near-unity quantum efficiency of broadband black silicon photodiodes with an induced junction

Wednesday 23 November 2016 10:20 (20 minutes)

Ideal photodiodes can detect all incoming photons independently of the wavelength, angle or intensity of the incident light. Present-day photodiodes notably suffer from optical losses and generated charge carriers are often lost via recombination. Here, we demonstrate a device with an **external quantum efficiency above 96% over the wavelength range 250–950 nm**. Instead of a conventional p–n junction, we use negatively charged alumina to form an inversion layer that generates a collecting junction extending to a depth of 30 μm in n-type silicon with bulk resistivity larger than 10 kΩ cm. We enhance the collection efficiency further by nanostructuring the photodiode surface, which results in higher effective charge density and increased charge-carrier concentration in the inversion layer. Additionally, nanostructuring and efficient surface passivation allow for a reliable device response with incident angles up to 70°. We expect the considered device to improve data quality, reduce the area of photodiodes as well as decrease the cost per pixel.

Author: Dr JUNTUNEN, Mikko (Helsinki Institute of Physics)

Presenter: Dr JUNTUNEN, Mikko (Helsinki Institute of Physics)

Session Classification: Pixel and Strip sensors; LHC experiments

Contribution ID: **27** Type: **not specified**

Temperature dependence of the response of Ultra Fast Silicon Detectors

Tuesday 22 November 2016 11:30 (20 minutes)

The Ultra Fast Silicon Detectors (UFSD) are a novel concept of silicon detectors based on the Low Gain Avalanche Diode (LGAD) technology, which are able to obtain time resolution of the order of few tens of picoseconds. First prototypes with different geometries (pads/pixels/strips), thickness (300 and $50\mu m$) and gain (between 5 and 20) have been recently designed and manufactured by CNM (Centro Nacional de Microelectrónica, Barcelona) and FBK (Fondazione Bruno Kessler, Trento).

Several measurements on these devices have been performed in laboratory and in beam test and a dependence of the gain on the temperature has been observed. Some of the first measurements will be shown (leakage current, breakdown voltage, gain and time resolution on the $300\mu m$ from FBK and gain on the $50\mu m$-thick sensor from CNM) and a comparison with the theoretically predicted trend will be discussed.

Author: MULARGIA, Roberto (Universita e INFN Torino (IT))

Co-authors: SADROZINSKI, Hartmut (University of California,Santa Cruz (US)); FERRERO, Marco (Universita e INFN Torino (IT))

Presenter: MULARGIA, Roberto (Universita e INFN Torino (IT))

Session Classification: LGAD, DD-APD, SiPM, UFSD, HFS

Contribution ID: **28** Type: **not specified**

Note on C-DLTS application for study of radiation damage produced by short range particles. V. Eremin, D. Mitina, E. Verbitskaya

Monday 21 November 2016 14:00 (20 minutes)

Short range particles like alphas, low energy protons, ions, etc. are cost effective approaches for the damage production in silicon. The physics of capacitance DLTS application for study of such structures is discussed. The approach is illustrated by the results on silicon detectors irradiated by heavy ions.

Author: Dr EREMIN, Vladimir (Ioffe Institute)

Co-author: Dr VERBITSKAYA, Elena (Ioffe Institute)

Presenter: Dr EREMIN, Vladimir (Ioffe Institute)

Session Classification: Defect and Material Characterization

Contribution ID: **29** Type: **not specified**

Validation strategy for the simulation of highly irradiated silicon pixel sensors

Tuesday 22 November 2016 17:10 (20 minutes)

For the high-luminosity phase of the Large Hadron Collider (HL-LHC), at the expected position of the innermost pixel detector layer of the CMS and ATLAS experiment, the estimated equivalent neutron fluence after 3000 fb^{-1} is $2{\cdot}10^{16}$ n_{eq}/cm^{-2}, and the IEL (Ionizing Energy Loss) dose in the SiO_2 is 5 MGy. The optimization of the pixel sensors and the understanding of their performance as a function of fluence and dose makes a radiation damage model for TCAD simulations, which describes the available experimental data, highly desirable. The currently available models are not able to describe simultaneously the measurements of dark current (I-V), capacitance-voltage (C-V) and charge collection efficiency (CCE) of pad diodes for fluences > $1{\cdot}10^{15}$ n_{eq}/cm^{-2}. For the development and validation of an accurate radiation damage model of the silicon bulk we use I-V, C-V and CCE measurements on pad diodes available within the CMS-HPK campaign and data from samples irradiated recently with 24 GeV/c protons. To determine the parameter of a radiation damage model (energy levels, concentrations and cross sections) we use the "optimizer" of Synopsys TCAD to minimize the difference between the measured and simulated I-V, C-V and CCE. By this method we study in a systematic way the number and type of the defects, which are required for a consistent description of the bulk damage.

Author: SCHWANDT, Joern (Hamburg University (DE))

Presenter: SCHWANDT, Joern (Hamburg University (DE))

Session Classification: TCT & Device simulations

Contribution ID: **30** Type: **not specified**

Workshop opening

Monday 21 November 2016 10:00 (15 minutes)

Presenter: MOLL, Michael (CERN)

Session Classification: Registration and Workshop opening

Contribution ID: **31** Type: **not specified**

Discussion on Defects and Materials

Monday 21 November 2016 16:30 (30 minutes)

Presenter: PINTILIE, Ioana (NIMP Bucharest-Magurele, Romania)

Session Classification: Defect and Material Characterization

Contribution ID: **32** Type: **not specified**

Proton energy dependent damage to thin Silicon pad diodes

Monday 21 November 2016 14:20 (20 minutes)

This work deals with the bulk damage due to 23 MeV, 188 MeV and 23 GeV protons to 200μm silicon pad sensors (bulk materials: FTH, MC or dd-FZ). I-V, C-V-f and TSC measurements were performed at subsequent annealing steps.
Two challenges in performing TSC measurements will be pointed out: the first one concerns the application of a forward current in the order of 1mA at the filling temperature T=10K; the second one is related to the impact of higher filling temperature on the measured TSC spectra.
The TSC spectra are analyzed with a revisited SRH statistics, modified to account for the cluster-related defect contributions.
A proton-energy dependent introduction of defects is found, except for cluster-related defects. Moreover, shallow defects are present in different concentration according to the material type. A correlation between the leakage current and the concentrations of three defects (the V2, E5 and H(220K) defects) is notable. It is not excluded that the changes in the space charge in p-type sensors are mainly due to the E(30K) and the BiOi defects, and three deep acceptors (namely the H(116K), H(140K) and the H(152K)) .

Author: DONEGANI, Elena (University of Hamburg)

Co-author: FRETWURST, Eckhart (II. Institut fuer Experimentalphysik)

Presenter: DONEGANI, Elena (University of Hamburg)

Session Classification: Defect and Material Characterization

Contribution ID: **33** Type: **not specified**

Studies of small-pitch CNM 3D detectors

Monday 21 November 2016 12:05 (20 minutes)

For the HL-LHC pixel detector upgrades, pixel sensors with small pixel size of 50x50 and 25x100 μm² are envisaged.
At CNM, a first run of small-pitch 3D sensors was produced, which are designed to be matched to existing front-end chips like the ATLAS FE-I4. Pixel detectors were bump-bonded and assembled at IFAE Barcelona and tested in the laboratory and beam tests at CERN before and after irradiation. Also strip and pad diodes were studied with IV characteristics and TCT. This talk will present an update of recently achieved results and give an overview on the plans for future developments.

Author: LANGE, Joern (IFAE Barcelona)

Presenter: LANGE, Joern (IFAE Barcelona)

Session Classification: Defect and Material Characterization

Contribution ID: **34** Type: **not specified**

Studies of gain and time resolution of 50 µm LGADs before and after irradiation

Tuesday 22 November 2016 12:10 (20 minutes)

50 um LGADs from the recent CNM production were studied before and after irradiation with neutrons in Ljubljana to 3e14 and 1e15 neq/cm2. The gain was measured with TCT and Sr90 beta particles. The time resolution was measured with 120 GeV pions in two beam tests at CERN SPS in June/July and September 2016.

Author: LANGE, Joern (IFAE Barcelona)

Presenter: LANGE, Joern (IFAE Barcelona)

Session Classification: LGAD, DD-APD, SiPM, UFSD, HFS

Contribution ID: **35** Type: **not specified**

Edge-TCT studies of irradiated HV-CMOS sensors and first test beam results with monolithic H35demo chips

Monday 21 November 2016 10:55 (20 minutes)

The H35Demo is a large area High-Voltage CMOS demonstrator chip for tracking at LHC experiments. It is produced at the AMS foundry in 0.35 µm technology on wafers with resistivity ranging from 20 to 1000 Ohm cm.
Each chip includes two monolithic matrices using nMOS or CMOS transistors and 3x3 pixel test structures without electronics for sensor characterisations. H35demo samples of different resistivities have been irradiated with neutrons at the TRIGA reactor in Ljubljana up to a fluence of 2e15 neq/cm2. The depletion depth of the test structures was measured with the edge-TCT technique after each irradiation step. Results of the TCT measurements together with the very first test beam results of the monolithic CMOS matrices before irradiation will be presented.

Author: TERZO, Stefano (IFAE Barcelona (ES))

Co-author: LANGE, Joern (IFAE Barcelona)

Presenter: TERZO, Stefano (IFAE Barcelona (ES))

Session Classification: CMOS sensors

Contribution ID: **36** Type: **not specified**

Characterization of irradiated thin n-in-planar pixel and active edge sensors

Wednesday 23 November 2016 11:10 (20 minutes)

Latest productions of thin n-in-p pixel sensors designed at MPP will be presented. Sensors of thicknesses of 50, 100 and 150 um have been produced at ADVACAM and CiS (100 and 150 um) and interconnected to FE-I4 chips. At ADVACAM SOI wafers were employed, while at CiS anisotropic KOH etching was carried out to create backside cavities in the wafer leaving thicker frames around each single structure.
To maximize the active area of the thin sensors, slim and active edges were implemented in the sensors of the ADVACAM production. The evaluation assemblies in the entire thickness range have been measured at beam tests and the results on charge collection and edge efficiency will be discussed for unirradiated and irradiated modules up to 3e15.
The performance of modules with a standard edge and with 150um thick sensors after irradiation to 1e16 will be discussed in terms of charge collection and hit efficiency. In addition, the charge collection properties and efficiencies at different depths inside the silicon bulk have been studied before and after irradiation in a thickness range of 50 to 200 um with the grazing angle technique.

Author: SAVIC, Natascha (Max-Planck-Institut fur Physik (DE))

Presenter: SAVIC, Natascha (Max-Planck-Institut fur Physik (DE))

Session Classification: Pixel and Strip sensors; LHC experiments

Contribution ID: **37** Type: **not specified**

Test beam and TCT characterization results of i-LGAD and Strip LGAD sensors

Tuesday 22 November 2016 11:50 (20 minutes)

Results from the the test beam (at CERN's SPS) and TCT characterization of the first i-LGAD and Strip LGAD sensors will be presented.

Author: VILA ALVAREZ, Ivan (Universidad de Cantabria (ES))

Presenter: VILA ALVAREZ, Ivan (Universidad de Cantabria (ES))

Session Classification: LGAD, DD-APD, SiPM, UFSD, HFS

Contribution ID: **38** Type: **not specified**

Discussion session: CMOS & RD50 CMOS project

Monday 21 November 2016 11:15 (30 minutes)

Discussion of RD50 CMOS activity planing

Presenter: CASSE, Gianluigi (University of Liverpool (GB))

Session Classification: CMOS sensors

Contribution ID: **39** Type: **not specified**

TSC Spectra –Point- versus Cluster-Defects

Monday 21 November 2016 14:40 (20 minutes)

TSC Spectra –Point- versus Cluster-Defects
E. Fretwurst, E. Donegani, E. Garutti, R. Klanner
Institute for Experimental Physics, University of Hamburg

Abstract:
The analysis of TSC spectra of silicon diodes after irradiation with GeV protons or neutrons rely on the knowledge of the induced defects which can be either point-like or cluster-related defects. It was found that TSC signals which are attributed to extended defects cannot be reproduced by defect parameter derived for point-like states. It is observed that the TSC signals of extended-defects exhibit much broader peak shapes compared to isolated point defects. A very strong broadening effect has been observed in DLTS spectra for dislocation loops (DLs) in CMOS devices and explained by A. Scheinemann and A Schenk1). The model is based on the change of the local potential due to the Coulomb energy of the charged defect states at the boundary of the DLs. This model has been applied to TSC spectra containing vacancy related cluster-defects. The results obtained for epitaxial diodes after irradiation with 23 GeV protons and neutrons will be presented and discussed.
1) A. Scheinemann and A Schenk, Phys. Status Solidi A 211, No. 1, 136-142 (2014)

Presenter: FRETWURST, Eckhart (II. Institut fuer Experimentalphysik)

Session Classification: Defect and Material Characterization

Contribution ID: **40** Type: **not specified**

Proposal for the organization of an RD50 project aimed at the realization of an Edge-less Device

Wednesday 23 November 2016 11:30 (20 minutes)

The aim of the talk is to show at the RD50 community a proposal for the definition of a RD50 project with the goal of the realization of a edgless detector at FBK.
Respect to the technological approach that used up now so passivate the trench with doping and filling the trench , we suggest to use the idea proposed by Resarch Naval Insitute (Fadeyev) to use the allumina as passivation layer.
We propose to extend this approach by inserting it directly into the process flow and not as a post process. The use of alumina will give a process simplification and also a great freedom in design achievable geometries.

Presenters: BOSCARDIN, Maurizio (Unknown); BOSCARDIN, Maurizio (FBK Trento)

Session Classification: Pixel and Strip sensors; LHC experiments

Contribution ID: **41** Type: **not specified**

Neutron Induced Radiation Damage of KETEK SiPMs

Tuesday 22 November 2016 09:20 (20 minutes)

Silicon photomultipliers (SiPMs), thanks to their excellent performance, are becoming the photodetectors of choice for many applications.
One major limitation, in particular for their use at high-luminosity colliders, is the radiation damage by hadrons.
In this work, SiPMs with 4384 pixels of 15×15 μm^2 size produced by KETEK have been irradiated by reactor neutrons to six fluences up to $\Phi_{eq} = 10^{12}$ cm^{-2} (1 MeV equivalent neutrons).
Pulse-height, IV, and CV measurements with and without illumination by a LED for temperatures between -30 and 30°C have been performed.
In this paper results from the IV, and CV measurements are shown.
The fluence and the temperature dependence of the current and of the SiPM electrical parameters like pixel capacitance, quenching resistance and breakdown voltage allows to better understand the origin of the dark current and find ways to reduce the radiation-induced dark-count-rate.

Author: CENTIS VIGNALI, Matteo (Hamburg University (DE))

Presenter: CENTIS VIGNALI, Matteo (Hamburg University (DE))

Session Classification: LGAD, DD-APD, SiPM, UFSD, HFS

Contribution ID: **42** Type: **not specified**

Discussion: Detectors with Gain - Detectors for timing

Tuesday 22 November 2016 12:30 (30 minutes)

Presenter: HIDALGO VILLENA, Salvador (Instituto de Microelectronica de Barcelona (ES))

Session Classification: LGAD, DD-APD, SiPM, UFSD, HFS

Contribution ID: **43** Type: **not specified**

Discussion: Device Simulation & RD50 Simulation Working Group

Tuesday 22 November 2016 17:30 (30 minutes)

Session Classification: TCT & Device simulations

Contribution ID: **44** Type: **not specified**

Discussion: LHC Experiments; New Technologies; Edgeless

Wednesday 23 November 2016 12:30 (30 minutes)

Session Classification: Pixel and Strip sensors; LHC experiments

Contribution ID: **45** Type: **not specified**

Fitting the LGAD simulation

Tuesday 22 November 2016 16:30 (20 minutes)

Presenter: PALOMO PINTO, Francisco Rogelio (Universidad de Sevilla (ES))

Session Classification: TCT & Device simulations

Contribution ID: **46** Type: **not specified**

Common project proposal: Thin-film based silicon sensors

Wednesday 23 November 2016 11:50 (20 minutes)

Recently, Fraunhofer ISE developed a technology with the potential to epitaxially produce very cost-efficient thin-films of 50-200 um thickness for the solar cell industry, aiming to lower the price for a 156mm by 156mm substrate to below the ˜EUR level. Such thicknesses are precisely what is required for HL-LHC applications and the exitaxial growth might yield some additional benefits.

I would like to propose an RD50 common project to evaluate the suitability of such silicon for the production of sensors and - if successful - their radiation hardness. The presentation will provide details about the process and its limitations and a propose a roadmap for the procurement and processing of an initial batch of substrates.

Presenter: MUENSTERMANN, Daniel (Lancaster University (GB))

Session Classification: Pixel and Strip sensors; LHC experiments

Contribution ID: **47** Type: **not specified**

The new RD50 Logo

Tuesday 22 November 2016 10:40 (5 minutes)

Presenter: MOLL, Michael (CERN)

Session Classification: LGAD, DD-APD, SiPM, UFSD, HFS

Contribution ID: **48** Type: **not specified**

The RD50 database on measured data

Wednesday 23 November 2016 12:10 (20 minutes)

Presenters: CREANZA, Donato (Dipartimento Interateneo di Fisica & INFN - Bari); CREANZA, Donato (Universita e INFN, Bari (IT))

Session Classification: Pixel and Strip sensors; LHC experiments