35th RD50 Workshop (CERN)

Report of Contributions

https://indico.cern.ch/e/855994

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

Measurements with Si detectors irradiated to extreme fluences

Wednesday 20 November 2019 10:00 (20 minutes)

In this contribution measurements with detectors irradiated with reactor neutrons up to 1e17 n/cm2 will be presented. Measurements were made with CNM LGAD pad detectors made on 75 um thick epitaxial layer on low resistivity support silicon. LGADs were chosen because this was the available set of thin pad detectors that could withstand high bias voltages. Edge-TCT, charge collection with Sr-90 and detector current were measured under reverse and forward bias. Measurements were repeated after several annealing steps at 60 C.

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

Co-authors: GORISEK, Andrej (Jozef Stefan Institute (SI)); HITI, Bojan (Jozef Stefan Institute (SI)); KRAMBERGER, Gregor (Jozef Stefan Institute (SI)); Prof. MIKUZ, Marko (Jozef Stefan Institute (SI)); ZAVRTANIK, Marko (Jozef Stefan Institute (SI)); SKOMINA, Petja (Jožef Stefan Institute); CINDRO, Vladimir (Jozef Stefan Institute (SI))

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

Session Classification: Sensor Characterization Techniques (TCT, CV); Extreme Fluences

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

ATLAS pixel detector radiation damage monitoring and modeling status report

Tuesday 19 November 2019 15:55 (20 minutes)

This talk presents updated measurements of fluence-sensitive radiation damage quantities with the ATLAS pixel detector. In particular, the first full Run 2 fluence measurement using the leakage current is presented. The mismodeled |z|-dependence is observed across all of Run 2 and with measurements of additional quantities. In addition to leakage current, the depletion voltage is also presented and the fidelity of the Hamburg model is discussed. Finally, the status of radiation damage modeling in the ATLAS simulation will be presented.

Author: NACHMAN, Ben (Lawrence Berkeley National Lab. (US))

Presenter: NACHMAN, Ben (Lawrence Berkeley National Lab. (US))

Session Classification: CMOS

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

Low-temperature photoluminescence spectroscopy for LGAD structures

Monday 18 November 2019 13:50 (20 minutes)

A short introduction to the measurement method low temperature photoluminescence (LTPL) spectroscopy is given. Samples from a low gain avalanche detector processing run are studied by LTPL before and after electron irradiation. In carbon doped samples the characteristic G-line is found after electron irradiation.

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

Co-authors: Dr SCHULZE, Dirk (TU-Ilmenau); Prof. KRISCHOK, Stefan (TU-Ilmenau); RODER, Ralf Mario (CIS Institut fuer Mikrosensorik GmbH (DE)); Prof. ORTLEPP, Thomas (CiS Forschungsinstitut für Mikrosensorik)

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

Session Classification: Defect Characterization

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

Determination of the electric field in highly-irradiated silicon sensors using edge-TCT measurements

Wednesday 20 November 2019 11:10 (20 minutes)

A method is presented which allows to obtain the position-dependent electric field and charge density by fits to velocity profiles from edge-TCT data from silicon strip-detectors. The validity and the limitations of the method are investigated by simulations of non-irradiated n+p pad sensors and by the analysis of edge-TCT data from non-irradiated n+p strip-detectors. The method is then used determine the position dependent electric field and charge density in n+p strip detectors irradiated by reactor neutrons and 200 MeV pions to fluences between 5e14 and 1e16 cmˆ-2 for forward-bias voltages between 25 V and up to 550 V and for reverse-bias voltages between 50 V and 800 V. In all cases the velocity profiles are well described. The electric fields and charge densities determined provide quantitative insights into the effects of radiation damage for silicon sensors.

Authors: KLANNER, Robert (Hamburg University (DE)); KRAMBERGER, Gregor (Jozef Stefan Institute (SI)); MANDIC, Igor (Jozef Stefan Institute (SI)); MIKUZ, Marko (Jozef Stefan Institute (SI)); MILOVANOVIC, Marko (Deutsches Elektronen-Synchrotron (DE)); Dr SCHWANDT, Joern (Hamburg University (DE))

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

Session Classification: Sensor Characterization Techniques (TCT, CV); Extreme Fluences

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

Annealing effects on LGAD performance

Tuesday 19 November 2019 10:00 (20 minutes)

Several sets of LGADs produced by HPK and CNM withing the framework of ATLAS high granularity timing detectors were irradiated with reactor neutrons up to fluences of 6e15 cm-2. After the irradiation they underwent controlled annealing at 60C. At each annealing step the sensors were measured with Sr90 electrons at -30C in timing setup. The evolution of signal and time resolution at different annealing times will be presented.

Authors: KRAMBERGER, Gregor (Jozef Stefan Institute (SI)); HITI, Bojan (Jozef Stefan Institute (SI)); CINDRO, Vladimir (Jozef Stefan Institute (SI)); MANDIC, Igor (Jozef Stefan Institute (SI)); MIKUZ, Marko (Jozef Stefan Institute (SI)); HOWARD, Alissa (Jozef Stefan Institute); KLJUN, Zan (Jozef Stefan Institute)

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

Session Classification: Precision Timing Detectors - LGADs

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

Defect investigations of neutron irradiated high resistivity PiN and LGAD diodes

Monday 18 November 2019 14:30 (20 minutes)

Defect investigation studies, by TSC and TEM techniques, after neutron irradiation of high resistivity PiN and LGAD float-zone silicon diodes have been performed. The diodes were irradiated with fluences of E14 and E15 n/cm2. TSC studies during annealing treatments at 80C have been performed with emphasis on the acceptor-removal process. The results are discussed in correlation with the changes in the macroscopic parameters during annealing treatments as seen in depletion voltage and Neff. Changes in the electrical activity of BiOi defect are observed in both type of diodes, with a direct impact on the depletion voltage value.

Authors: Dr KUNCSER, Andrei (National Institute of Materials Physics); Dr BESLEAGA STAN, Cristina (National Institute of Materials Physics); Dr FILIP, Dragos Lucian (National Institute of Materials Physics); PINTILIE, Ioana (NIMP Bucharest-Magurele, Romania); MAKARENKO, Leonid (Belarusian state University); MOLL, Michael (CERN); GURIMSKAYA, Yana (CERN)

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

Session Classification: Defect Characterization

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

Development of LGADs and AC-LGAD at BNL and neutron detection

Tuesday 19 November 2019 10:50 (20 minutes)

Low-Gain Avalanche Diodes (LGADs) exhibit excellent timing performance, in the orders of a few tens of ps, thanks to a combination of high signal-to-noise ratio and short rise time. This technology has attracted interest for applications in a wide variety of fields such as in timing detectors for High-Energy Physics experiments or for the detection of neutrons with precise timing, among others.
We present the response of two different types of LGAD sensors, designed and fabricated at the Brookhaven National Laboratory, to 14.1 MeV fast neutrons generated by Deuterium-Tritium source.
However, LGAD devices aiming for timing performance suffer from poor spatial resolution. To overcome this limitation, the AC-coupled LGAD (AC-LGAD) approach was introduced. We detail the fabrication and the first functional tests of such new device, which solves this drawback while retaining timing performance comparable to that of a regular LGAD.
AC-LGADs have been fabricated at the BNL silicon processing facility, and their response characterized with radioactive sources and transient current technique. Results show large gains and fast signal, while the noise is comparable to that of a standard LGADs.

Authors: D'AMEN, Gabriele (Brookhaven National Laboratory (US)); LAVITOLA, Luigi (Universita' di Napoli); Dr GIACOMINI, Gabriele (Brookhaven National Laboratory (US)); TRICOLI, Alessandro (Brookhaven National Laboratory (US)); RAMSHANKER, Sneha (Oxford)

Presenter: D'AMEN, Gabriele (Brookhaven National Laboratory (US))

Session Classification: Precision Timing Detectors - LGADs

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

Radiation damage investigation of epitaxial P type Silicon using Schottky diodes and pn junctions

Monday 18 November 2019 15:40 (20 minutes)

This project investigates radiation damage of epitaxial P type silicon.

Test structures consisting of Schottky diodes and pn junctions of different size and flavors are going to be fabricated at different facilities, including RAL and Carleton.

The structures are fabricated on a 50 um thick epitaxial layer of various P type doping: 1e13, 1e14, 1e15, 1e16, and 1e17 cm-3.

Up to 25 wafers / doping level of 6 inch size will be available for device fabrication.

Update on the design, simulation and initial fabrication phase will be given. Plans for the testing of the devices will also be discussed.

Authors: VILLANI, Enrico Giulio (Science and Technology Facilities Council STFC (GB)); WILSON, Fergus (Science and Technology Facilities Council STFC (GB)); ZHU, Hongbo (Chinese Academy of Sciences (CN)); MANDIC, Igor (Jozef Stefan Institute (SI)); WORM, Steven (University of Birmingham)

Presenter: VILLANI, Enrico Giulio (Science and Technology Facilities Council STFC (GB))

Session Classification: Defect Characterization

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

Cobalt-60 gamma irradiation of p-type silicon test structures for the HL-LHC

Monday 18 November 2019 09:15 (20 minutes)

During the era of the High-Luminosity (HL) LHC the experimental devices will be subjected to enhanced radiation levels with fluxes of neutrons and charged hadrons in the inner detectors up to $2.3\times10^{16}\ n_{eq}/cm^2$ and total ionization doses up to ˜1.2 Grad. A systematic program of radiation tests with neutrons and charged hadrons is being run by the LHC detector collaborations in view of the upgrade of the experiments, in order to cope with the higher luminosity of HL-LHC and the associated increase in pile-up events and radiation fluxes. In this talk we present results from complementary radiation studies with ^{60}Co-γ in which the doses are equivalent to those that the outer layers of the silicon tracker systems of the large LHC experiments will be subjected. The devices under test are float-zone oxygenated p-type silicon diodes and MOS capacitors. CV and IV measurements on these test structures are presented as a function of the total absorbed radiation dose following specific annealing protocol.

Author: ASENOV, Patrick (Nat. Cent. for Sci. Res. Demokritos (GR))

Co-authors: ASSIOURAS, Panagiotis (Nat. Cent. for Sci. Res. Demokritos (GR)); KAZAS, Ioannis (Nat. Cent. for Sci. Res. Demokritos (GR)); KYRIAKIS, Aristoteles (Nat. Cent. for Sci. Res. Demokritos (GR)); LOUKAS, Dimitrios (Nat. Cent. for Sci. Res. Demokritos (GR))

Presenter: ASENOV, Patrick (Nat. Cent. for Sci. Res. Demokritos (GR))

Session Classification: Full Detector Systems

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

Evidence of charge multiplication in silicon detectors operated at a temperature of 1.9 K

Monday 18 November 2019 11:00 (20 minutes)

The work is dedicated to studying the kinetics of the process of charge collection in silicon detectors at a temperature of 1.9 K in situ irradiated by protons. The main research method is TCT, which allows one to receive current responses of high time resolution. As a result of in situ tests, non-standard current pulse shapes were obtained, which can be described only within the framework of a two-stage charge transfer process model. The model is complicated by the effects of polarization of the electric field in the detector volume, which creates a region of the electric field of such a magnitude that is sufficient for the avalanche multiplication of charge carriers. The experimental results are analyzed in detail. Based on the analysis, a physical model of charge collection is proposed. Moreover, qualitative and quantitative estimates of the transport parameters of charge carriers in the detector are given.

Authors: SHEPELEV, Artem (Ioffe Institute (RU)); EREMIN, Vladimir (Ioffe Institute (RU)); VERBITSKAYA, Elena (Ioffe Institute (RU))

Presenter: SHEPELEV, Artem (Ioffe Institute (RU))

Session Classification: Defect Characterization

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

Improving spatial resolution of radiation-tolerant pixel sensors

Tuesday 19 November 2019 16:35 (20 minutes)

We present a general concept to improve the spatial resolution of silicon pixel detectors via introducing position dependent inter-pixel cross-talk. By segmenting the readout implantations and AC-coupling the resulting sub-pixels, a part of the pixel charge is shared with neighboring pixels. Simulations to study the impact of different coupling capacitor values on spatial resolution are depicted and the feasibility of such design using a radiation-tolerant high-voltage CMOS technology is discussed. An improvement of the spatial resolution by about 40% for 50µm x 50 µm pixels is demonstrated.

Authors: ZHANG, Sinuo (University of Bonn (DE)); POHL, David-Leon (University of Bonn (DE)); HEMPEREK, Tomasz (University of Bonn (DE))

Presenter: ZHANG, Sinuo (University of Bonn (DE))

Session Classification: CMOS

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

Modeling of Defects Properties in Bragg Peak

Monday 18 November 2019 14:10 (20 minutes)

The presented report is focused on the problem of analyzing irradiation-induced highly disordered regions in the detector bulk. Such regions could be settled down close to the Bragg Peak maximum - ion stopping range. Noted regions were created in the detectors of low-resistance silicon via low energy irradiation by heavy 40Ar ions at the Ioffe Institute Cyclotron. Electrophysical properties of irradiated structures are investigated and unexpected issues of the capacitance characteristics are revealed. The model of a highly disordered damaged region is proposed and its correspondence to experimental data (DLTS spectrum) is demonstrated.

Authors: Ms MITINA, Daria (Ioffe Institute (RU)); EREMIN, Vladimir (Ioffe Institute (RU)); VERBITSKAYA, Elena (Ioffe Institute (RU))

Presenter: Ms MITINA, Daria (Ioffe Institute (RU))

Session Classification: Defect Characterization

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

On the frequency dependence of the admittance of radiation damaged pad diodes

Monday 18 November 2019 14:50 (20 minutes)

The admittance of n+p pad diodes (200 µm thickness, 5×5 mm^2 area) irradiated by 24 GeV/c protons to 1 MeV neutron equivalent fluences Φ_{eq} = 3, 6, 8 and 13×10^{15} cm^{-2} has been measured for reverse voltages Vrev between 1 and 1000 V and for frequencies f between 100 Hz and 2 MHz at temperatures T = −30 ℃ and −20 ℃. A simple model, which assumes that radiation damage causes a position-dependent resistivity ρ only, provides an excellent description of the data. For the position dependence a phenomenological parametri¬sation with 3 parameters for every Φ_{eq}, V_{rev} and T is used. In part of the pad diode a "low ρ"region is obtained, with a ρ value compatible with the intrinsic resistivity ρ_{intr}(T). In the remainder of the pad diode a value $\rho \gg \rho_{intr}$ is found. The "low ρ"region is interpreted as the non-depleted region, and the "high ρ"region as the depleted region. It is con¬cluded that the f dependence of the admittance of irradiated silicon detectors can be described without assumptions about the response time of radiation-induced traps and that dependence of the admittance on f allows determining the depletion depth in irradiated silicon pad diodes

Authors: FRETWURST, Eckhart (Hamburg University (DE)); GARUTTI, Erika (Hamburg University (DE)); KLANNER, Robert (Hamburg University (DE)); SCHWANDT, Joern (Hamburg University (DE)); STEINBRUECK, Georg (Hamburg University (DE))

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

Session Classification: Defect Characterization

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

Effective trapping probability of electrons in neutron irradiated Si detectors using Transient Current Technique simulations

Wednesday 20 November 2019 09:00 (20 minutes)

The Transient Current Technique (TCT) has been evolved as one of the principal tools for studying solid state particle detectors over the years. Si detectors are being exposed to intense radiation environment in collider experiments which affects their charge collection performance. The strength of the signal produces because of generation of charge carriers by traversing particles, gets reduced due to resulting radiation damage of detectors. In the present work, Silvaco TCAD tool is used to model the neutron irradiation effects in Si detectors. This model is then applied to study the effective trapping probability of electrons due to the traps generated by neutron irradiation in p-on-n Si detectors using TCT simulations. The model is found to be able to reproduce the corresponding measurements carried out on neutron irradiated Si detectors.

Author: Mr JAIN, Chakresh (CDRST, Department of Physics and Astrophysics, University of Delhi, India)

Co-authors: Ms SAUMYA, Saumya (CDRST, Department of Physics and Astrophysics, University of Delhi, India); Dr BHARDWAJ, Namrata (Swami Shraddhanand College, University of Delhi, India); Dr BHARDWAJ, Ashutosh (CDRST, Department of Physics and Astrophysics, University of Delhi, India); Prof. RANJAN, Kirti (CDRST, Department of Physics and Astrophysics, University of Delhi, India)

Presenter: Mr JAIN, Chakresh (CDRST, Department of Physics and Astrophysics, University of Delhi, India)

Session Classification: Sensor Characterization Techniques (TCT, CV); Extreme Fluences

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

Update on IHEP RD50 activities

Tuesday 19 November 2019 09:00 (20 minutes)

The latest development of LGAD sensors by IHEP-NDL in China have been evaluated with laser , beta source and test beam. The result of proton irradiation at CIAE will be introduced. The simulation of LGAD based on TRACS and TCAD study with irradiation modeling will also be shown.

Author: SHI, Xin (Chinese Academy of Sciences (CN))

Presenter: SHI, Xin (Chinese Academy of Sciences (CN))

Session Classification: Precision Timing Detectors - LGADs

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

Enhanced influence of defect clusters on the electric field distribution in Si detectors: irradiation with 40Ar ions

Monday 18 November 2019 11:20 (20 minutes)

The study is concerned with enhanced influence of defect clusters on the profiles of the electric field E and effective space charge concentration Neff in Si detectors irradiated with 1.62 GeV 40Ar ions and operating at temperatures from 292 down to 200 K. The electric field profiles reconstructed from the shapes of the detector current pulse response measured by TCT demonstrated the double-peak electric field distribution and space charge sign inversion on lowering the temperature, all typical of Si detectors irradiated with hadrons and neutrons. To find a correlation with microscopic parameters specific to the damage induced by ions, the profiles were simulated in terms of the model of two effective deep levels of radiation-induced defects. It is shown that the reconstructed and simulated distributions are in a qualitative agreement; however, simulation required an accurate correction of the deep acceptor parameters and the use of the density of thermally generation current much higher than the experimental value. The latter was ascribed to the generation of a significantly higher concentration of primary vacancies that form defect clusters and affect the parameters of deep acceptors and their interaction with equilibrium carriers from the detector generation current.

Authors: Dr EREMIN, Vladimir (Ioffe Institute); Dr VERBITSKAYA, Elena (26 Politekhnicheskaya, St. Petersburg 194021, Russian Federation); Mr SHEPELEV, Artem (Ioffe Institute)

Presenter: Dr EREMIN, Vladimir (Ioffe Institute)

Session Classification: Defect Characterization

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

Effects of trapping on the collected signals from subsequent laser pulses in irradiated silicon sensors

Wednesday 20 November 2019 10:20 (20 minutes)

During studies on the signal formation in silicon strip sensors, irradiated and annealed until the occurring of the phenomena of charge multiplication, it was observed that previously flowing free carriers changed the detector response. In particular, it was inferred that trapping of free carriers produced by a laser pulse changes the electric field distribution.
The impact of subsequent laser pulses distant even several microseconds on the signals was then studied by means of Edge- and Top-Transient Current Technique. A strong reduction of the collected charge and a change in the signal shape have been observed for different laser pulse repetition times and intensities, temperatures and sensor irradiation fluences.
The results confirm that trapping processes change the electric field distribution. This phenomenon known as "polarization effect"has been observed in other materials or in silicon at very low temperatures. In this work the consequences of this effect on the measured signals are shown at operation temperatures (-15℃-30℃).

Authors: DIEHL, Leena (Albert Ludwigs Universitaet Freiburg (DE)); MORI, Riccardo (Albert Ludwigs Universitaet Freiburg (DE))

Co-authors: HAUSER, Marc (Albert Ludwigs Universitaet Freiburg (DE)); PARZEFALL, Ulrich (Albert Ludwigs Universitaet Freiburg (DE)); WIIK-FUCHS, Liv (Albert Ludwigs Universitaet Freiburg (DE)); JAKOBS, Karl (Albert Ludwigs Universitaet Freiburg (DE))

Presenter: DIEHL, Leena (Albert Ludwigs Universitaet Freiburg (DE))

Session Classification: Sensor Characterization Techniques (TCT, CV); Extreme Fluences

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

A status update on the CMOS work package within the CERN-RD50 collaboration

Tuesday 19 November 2019 16:15 (20 minutes)

This contribution will present the status and latest results of the CMOS work package within the CERN-RD50 collaboration. This will consist of describing the RD50 Data AcQuisition System (DAQ) for the test chip RD50-MPW1 and the obtained results, including chip hit maps and pixel address decoding debugging. Measurements of the effects of the clock rate of the on-chip state machine on the on-chip pixel address line crosstalk will also be shown. Post-layout simulations to study possible crosstalk between on-chip pixel address lines and efforts to reduce these effects in a future prototype will be presented as well.

An update on the manufacture of the test chip RD50-MPW2 and its expected delivery date will be presented, along with a description of the resources available and in development for the evaluation of this chip. This will include a brief description of the status of the chip board, FPGA firmware and readout system architecture.

S. Powell, E. Vilella, O. Alonso, M. Barbero, R. Casanova, G. Casse, A. Dieguez, M. Franks, S. Grinstein, J. M. Hinojo, E. Lopez, R. Marco-Hernandez, N. Massari, F. Munoz, R. Palomo, P. Pangaud,. Vossebeld, C. Zhang

Author: Mr POWELL, Samuel (University of Liverpool)

Presenters: Mr POWELL, Samuel (University of Liverpool); POWELL, Samuel (University of Liverpool (GB))

Session Classification: CMOS

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

A Proton Irradiation Site at the Bonn Isochronous Cyclotron at University of Bonn

Monday 18 November 2019 09:35 (20 minutes)

A proton irradiation site for silicon detectors has been developed at Bonn University. The site is located at the Bonn Isochronous Cyclotron of Helmholtz Institut für Strahlen- und Kernphysik (HISKP) which provides protons with 14 MeV (≈ 12 MeV on-device) kinetic energy. Light ions, such as deuterons, alphas up to ^{12}C, can also be produced with kinetic energies from 7 to 14 MeV per nucleon. On-site, beam currents of a few nA up to 1 ⊠A are available with adjustable beam diameters in between a few mm and 2 cm. Dedicated beam diagnostics have been developed for online beam-current and position monitoring at extraction which allow to measure the primary beam current with a relative precision of a few %. This enables the determination of the proton fluence ϕ_p at the device with an accuracy below 10%. Devices are irradiated in a thermally-insulated box to avoid uncontrolled annealing. Evaluation of irradiated silicon PiN-diodes yields a proton hardness factor κ_p which allows to irradiate up to $10^{16}\,\frac{n_{eq}}{cm^2}$ in approximately one hour. Typical irradiation parameters, characterization of the beam diagnostics for different light ions and proton hardness factor measurements are presented in this talk.

Authors: WOLF, Pascal (University of Bonn); EVERSHEIM, Dieter (University Bonn); POHL, David-Leon (University of Bonn (DE)); WERMES, Norbert (University of Bonn (DE)); DINGFELDER, Jochen Christian (University of Bonn (DE))

Presenter: WOLF, Pascal (University of Bonn)

Session Classification: Full Detector Systems

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

Working points of UFSD sensors at HL-LHC

Tuesday 19 November 2019 14:25 (20 minutes)

In this contribution, I will review our current understanding of the working points of UFSDs manufactured by HPK and FBK during the lifetime of the CMS and ATLAS timing layer detectors. Specifically, I will point out the achievable time resolution as a function of fluence, including the effect of the leakage current Shot noise.

Authors: SADROZINSKI, Hartmut (SCIPP, UC santa Cruz); SEIDEN, Abraham (University of California,Santa Cruz (US)); CARTIGLIA, Nicolo (INFN Torino (IT))

Presenter: CARTIGLIA, Nicolo (INFN Torino (IT))

Session Classification: Precision Timing Detectors - LGADs

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

CNM activities on LGADs in the RD50 framework

Tuesday 19 November 2019 09:20 (20 minutes)

In this contribution, we will present our last LGAD developments. We have fabricated two LGAD runs. The first one is devoted to calibrate our 6-inch technology in 50 μm SOI wafers. In this sense, pad diodes are fabricated with different boron implantation doses and energies, covering a wide range of values. Some samples from this run have been distributed to different RD50 laboratories to characterize them.
The second run corresponds to a repetition of the AIDA2020 run presented at previous RD50 meetings. The masks set have been modified in order to avoid the high leakage current observed. The new detectors show a low leakage current with a breakdown voltage in the range of the expected values.

Authors: DOBLAS MORENO, Albert; Dr HIDALGO VILLENA, Salvador (Instituto de Microelectronica de Barcelona (IMB-CNM-CSIC)); MANNA, Maria (Centro National de Microelectronica - CNM-IMB-CSIC); FLORES GUAL, David (Instituto de Fisica Corpuscular (ES)); Dr MERLOS DOMINGO, Angel (Instituto de Microelectronica de Barcelona IMB-CNM(CSIC)); Dr OTERO UGOBONO, Sofia (Consejo Superior de Investigaciones Cientificas (CSIC) (ES)); Dr PELLEGRINI, Giulio (Centro Nacional de Microelectrónica (IMB-CNM-CSIC) (ES)); Dr QUIRION, David (IMB-CNM, CSIC)

Presenter: DOBLAS MORENO, Albert

Session Classification: Precision Timing Detectors - LGADs

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

Plasma Effects in TCT-TPA

Wednesday 20 November 2019 09:40 (20 minutes)

TCT-TPA (Transient Current Technique-Two Photon Absorption) is a new pulsed infrared laser method for mapping the electric field in solid state particle detectors, combining high spatial resolution with the use of Ramo theorem. As it uses focused ultrashort infrared lasers, plasma effects need to be contended with. They are responsible of the increase of detector current pulse duration. From a mathematical model originated in the analysis of plasma effects during ion detection with semiconductor detectors, we determine the charge collection time increase and the verification with a TCT-TPA experiment. The agreement is good enough to predict the maximum admissible femtosecond laser pulse energy to avoid plasma effects.

Authors: PALOMO PINTO, Francisco Rogelio (Universidad de Sevilla (ES)); MOLL, Michael (CERN); MONTERO, Raul (UPV/EHU); FERNANDEZ GARCIA, Marcos (Universidad de Cantabria and CSIC (ES)); Dr VILA ALVAREZ, Ivan (Instituto de Física de Cantabria (CSIC-UC))

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

Session Classification: Sensor Characterization Techniques (TCT, CV); Extreme Fluences

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

Radiation hardness of 6” SoI CNM LGADs

Tuesday 19 November 2019 09:40 (20 minutes)

The new 6” CNM SoI LGADs are studied under neutron irradiation on fluences up to 5e15 neq/cm2. Gain reduction, dark rate, leakage current and breakdown voltage is estimated for two different doping concentrations of the gain layer. Through charged particle measurements, the time resolution and gain is estimated for sleeted fluneces in three different temperatures (-10C, -20C and -30C).

Author: Dr GKOUGKOUSIS, Vagelis (Institut de Fisica d’Altes Energies (IFAE))

Presenter: Dr GKOUGKOUSIS, Vagelis (Institut de Fisica d’Altes Energies (IFAE))

Session Classification: Precision Timing Detectors - LGADs

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

Stability and operational safety on LGADs

Tuesday 19 November 2019 14:05 (20 minutes)

The maximum operating voltage, efficiency and stability of 1x1 mm highly proton and neutron irradiated LGADs is presented for a boron, boron+carbon and gallium gain layer. Through charged particle measurements, electrical characterization and risk analysis using experience on calamities, a discussion is introduced on establishing safe operating limitations on thin LGADs.

Author: GKOUGKOUSIS, Vagelis (Institut de Fisica d'Altes Energies (IFAE))

Presenter: GKOUGKOUSIS, Vagelis (Institut de Fisica d'Altes Energies (IFAE))

Session Classification: Precision Timing Detectors - LGADs

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

Characterisation of 3D pixel sensors irradiated at extreme fluences

Wednesday 20 November 2019 11:30 (20 minutes)

In this talk we present for the first time, the 3D pixel sensors irradiated with neutrons up to a fluence of 3×10^{17} [n_{eq} /cm^2]. TCT measurements and charge collection efficiency showed that the sensors remain operative despite the unprecedented levels of irradiation similar of those estimated in the Future Circular Collider (FCC).

Author: MANNA, Maria (Centro National de Microelectronica - CNM-IMB-CSIC)

Co-authors: GRIECO, Chiara (Istitut de Fisica d'Altes Energies (IFAE) - Barcelona (ES)); QUIRION, David (IMB-CNM, CSIC); PELLEGRINI, Giulio (Centro Nacional de Microelectrónica (IMB-CNM-CSIC) (ES)); HIDALGO VILLENA, Salvador (Instituto de Microelectronica de Barcelona (IMB-CNM-CSIC)); GRINSTEIN, Sebastian (IFAE - Barcelona (ES)); TERZO, Stefano (IFAE Barcelona (ES))

Presenter: MANNA, Maria (Centro National de Microelectronica - CNM-IMB-CSIC)

Session Classification: Sensor Characterization Techniques (TCT, CV); Extreme Fluences

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

Latest Developments on Trench-Isolated LGADs

Tuesday 19 November 2019 11:50 (20 minutes)

Trench-Isolated LGAD (TI-LGAD) is a novel LGAD design where the standard inter-pixel isolating structure has been replaced with a trench, physically etched in the silicon and filled with a dielectric material.
The first TI-LGAD samples with 250 μm pitch have been produced at FBK and characterized with I-Vs and C-Vs analysis. In this contribution, we will discuss the technology design and the main results from the electrical characterization. We will present also the latest updates on the "RD50 TI-LGAD" project, an R&D project funded by RD50 and aimed at producing pixelated detectors, based on the TI-LGAD technology, with pixel and strips dimensions down to 50 μm.

Authors: Dr PATERNOSTER, Giovanni (Fondazione Bruno Kessler); BORGHI, Giacomo (Fondazione Bruno Kessler); CENTIS VIGNALI, Matteo (FBK); FICORELLA, Francesco (FBK); GOLA, Alberto (Fondazione Bruno Kessler); BELLUTTI, Pierluigi (FBK); BOSCARDIN, Maurizio (FBK Trento)

Presenter: Dr PATERNOSTER, Giovanni (Fondazione Bruno Kessler)

Session Classification: Precision Timing Detectors - LGADs

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

Laboratory measurements of FBK Trench-Isolated LGADs in Torino

Tuesday 19 November 2019 12:10 (20 minutes)

Trench-Isolated Low-Gain Avalanche Diodes (TI-LGAD) are a recent development of LGAD, in which the standard isolation structures are replaced by narrow trenches that are etched in the Silicon substrate. Trenches allow reducing the inactive region between pixels from the 30-40 microns of the standard technology down to a few microns, significantly improving the fill factor of TI-LGADs with respect to traditional LGADs.
The first production of TI-LGAD produced by Fondazione Bruno Kessler (FBK, Italy) was completed in summer 2019, featuring a wide range of 2x1 pixel arrays.
In this contribution, I will present several laboratory measurements performed on this production, including TCT characterization, showing gain and inactive area width (interpad) measurements, and time-resolution measurements obtained with a Sr90 beta source.
The comparison of TI-LGAD inactive area width with previous measurements performed on standard LGADs is particularly interesting as it quantifies their improvement on the fill factor.
All measurements were done in the Laboratory of Innovative Silicon Detectors of Torino University / INFN.

Author: SIVIERO, Federico (Universita e INFN Torino (IT))

Presenter: SIVIERO, Federico (Universita e INFN Torino (IT))

Session Classification: Precision Timing Detectors - LGADs

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

Defect characterisation after electron irradiation and overview of acceptor removal in Boron doped Si

Monday 18 November 2019 13:30 (20 minutes)

Radiation induced acceptor removal effect leads to the performance changes (mostly degradation) in LGADs, CMOS sensors and standard p-type Si detectors. Microscopic understanding of this effect is still incomplete.
In the framework of on-going acceptor removal project defect characterisation studies were performed on electron irradiated PiN diodes of 10 and 50 Ω·cm resistivity irradiated with 5E+14 and 2E+14 neq/cm2, respectively. These results will be discussed in correlation with the macroscopic changes in Neff and Ileak.
An overview of existing data for different types of irradiation, devices and material and parametrization of acceptor removal will be reviewed as well.

Authors: GURIMSKAYA, Yana (CERN); FERNANDEZ GARCIA, Marcos (Universidad de Cantabria and CSIC (ES)); MATEU, Isidre (CERN); MOLL, Michael (CERN); FRETWURST, Eckhart (Hamburg University (DE)); MAKARENKO, Leonid (Byelorussian State University (BY)); PINTILIE, Ioana (NIMP Bucharest-Magurele, Romania); SCHWANDT, Joern (Hamburg University (DE))

Presenter: GURIMSKAYA, Yana (CERN)

Session Classification: Defect Characterization

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

Characterization of the first RSD production at FBK

Tuesday 19 November 2019 11:10 (20 minutes)

In this contribution we present recent results on the characterization of Resistive AC-Coupled Silicon Detectors (RSD) produced by FBK in 2019. Both electrical measurements and signal response of un-irradiated sensors will be presented. Being the RSD devices intended for 4D particle tracking, we also show preliminary but very promising results about their spatial and time resolution. All the measurements come from extensive testing campaigns performed at CERN (SSD Lab) and in the Torino Innovative Silicon Detectors Lab.

Authors: TORNAGO, Marta (Universita e INFN Torino (IT)); Dr MANDURRINO, Marco (Universita e INFN Torino (IT))

Co-authors: ARCIDIACONO, Roberta (Universita e INFN Torino (IT)); BORGHI, Giacomo (Fondazione Bruno Kessler); BOSCARDIN, Maurizio (FBK Trento); CARTIGLIA, Nicolo (INFN Torino (IT)); CENTIS VIGNALI, Matteo (FBK); DALLA BETTA, Gian-Franco (INFN and University of Trento); FERNANDEZ GARCIA, Marcos (Universidad de Cantabria and CSIC (ES)); FERRERO, Marco (Universita e INFN Torino (IT)); FICORELLA, Francesco (FBK); MOLL, Michael (CERN); PANCHERI, Lucio (University of Trento); PATERNOSTER, Giovanni (Fondazione Bruno KEssler); SIVIERO, Federico (Universita e INFN Torino (IT)); SOLA, Valentina (Universita e INFN Torino (IT)); MANDURRINO, Marco (INFN)

Presenters: TORNAGO, Marta (Universita e INFN Torino (IT)); Dr MANDURRINO, Marco (Universita e INFN Torino (IT))

Session Classification: Precision Timing Detectors - LGADs

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

Interpad optimisation strategies on LGAD manufactured at FBK

Tuesday 19 November 2019 11:30 (20 minutes)

In this contribution, we will present the latest results from laboratory measurements on UFSD3.1 production form FBK. Focus of the production is to investigate different strategies to design inter-pad on LGAD sensors, to reduce at minimum the size of the no-gain region between pads, while maintaining stable operation of the detectors.

Authors: SOLA, Valentina (Universita e INFN Torino (IT)); ARCIDIACONO, Roberta (Universita e INFN Torino (IT)); BOSCARDIN, Maurizio (FBK Trento); BORGHI, Giacomo (Fondazione Bruno Kessler); CARTIGLIA, Nicolo (INFN Torino (IT)); CENTIS VIGNALI, Matteo (FBK); COSTA, Marco (Universita e INFN Torino (IT)); Prof. DALLA BETTA, Gian Franco (Universita degli Studi di Trento è INFN (IT)); FERRERO, Marco (Universita e INFN Torino (IT)); MANDURRINO, Marco (INFN); PANCHERI, Lucio (University of Trento); PATERNOSTER, Giovanni (Fondazione Bruno KEssler); FICORELLA, Francesco (FBK); STAIANO, Amedeo (Universita e INFN Torino (IT)); SIVIERO, Federico (Universita e INFN Torino (IT)); TORNAGO, Marta

Presenter: SOLA, Valentina (Universita e INFN Torino (IT))

Session Classification: Precision Timing Detectors - LGADs

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

Development of SiC sensors for harsh environment applications

Monday 18 November 2019 10:10 (20 minutes)

Currently CNM-Barcelona is involved in two projects that focus on the development of innovative planar and 3D SiC sensors for harsh environment applications. Both projects are in alignment with the objectives put forward in the RD50 Research Project 2018, specifically targeting two milestones from the New Materials research line: the fabrication of new radiation detectors in different wide bandgap (WBG) high quality materials, and the study of the radiation hardness of detectors based on WBG materials.
The objective of this presentation is to introduce both projects to the RD50 community.

Author: OTERO UGOBONO, Sofia (Consejo Superior de Investigaciones Cientificas (CSIC) (ES))

Presenter: OTERO UGOBONO, Sofia (Consejo Superior de Investigaciones Cientificas (CSIC) (ES))

Session Classification: Full Detector Systems

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

Investigation of the reactor neutron irradiated Si single crystal by a low energy neutron scattering.

Monday 18 November 2019 11:40 (20 minutes)

In this research the low energy neutron diffraction technique, a non-destructive technique, was applied to analyze hadron generated clusters. The Si single crystals were irradiated in TRIGA nuclear reactor to the neutron fluence 1e16 cm-2.
The experiment was performed on IN3 beam at ILL (www.ill.fr). Instrument was used in fully elastic mode, with incident and scattered wave vectors of 2.662Å. In order to improve instrument resolution, analyzer was used in single central blade configuration (flat geometry), and collimations before and after sample were set to 20'. High temperature was achieved thanks to a standard ILL furnace. To reduce as much as possible background, shielding and sample holder were made of vanadium.
The neutron scattering was measured in the FZ Si samples at room temperature: 1.before irradiation, 2.after irradiation and 3. after annealing at high temperature.

Authors: VAITKUS, Juozas (Vilnius University); Dr LEMEE-CILLEAU, Marie-Helene (ILL); Dr BOEHM, Martin (ILL); MOLL, Michael (CERN)

Presenter: VAITKUS, Juozas (Vilnius University)

Session Classification: Defect Characterization

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

Popcorn Noise and Timing Measurements in LGADs

Tuesday 19 November 2019 13:45 (20 minutes)

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Author: BOELL, Julian Alexander (Hamburg University (DE))

Presenter: BOELL, Julian Alexander (Hamburg University (DE))

Session Classification: Precision Timing Detectors - LGADs

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

TPA-TCT – Two Photon Absorption - Transient Current Technique

Wednesday 20 November 2019 09:20 (20 minutes)

The Transient Current Technique (TCT) is a very important technique for characterization of unirradiated and irradiated silicon detectors.
In recent years a novel method, the Two Photon Absorption - Transient Current Technique (TPA-TCT), based on the charge carrier generation by absorption of two photons, was developed. TPA-TCT proved to be very useful in 3D characterization of silicon devices and is offering an unprecedented spatial resolution. Currently the first compact TPA-TCT setup is under development at CERN. The status of the setup and first measurements are presented.

Authors: WIEHE, Moritz Oliver (Albert Ludwigs Universitaet Freiburg (DE)); MOLL, Michael (CERN); FERNANDEZ GARCIA, Marcos (Universidad de Cantabria and CSIC (ES)); MONTERO, Raul (UPV/EHU); PALOMO PINTO, Francisco Rogelio (Universidad de Sevilla (ES)); VILA ALVAREZ, Ivan (Instituto de Física de Cantabria (CSIC-UC)); MATEU, Isidre (CERN)

Presenter: WIEHE, Moritz Oliver (Albert Ludwigs Universitaet Freiburg (DE))

Session Classification: Sensor Characterization Techniques (TCT, CV); Extreme Fluences

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

Discussion Session: LGAD

Tuesday 19 November 2019 14:55 (30 minutes)

Presenters: VILA, Ivan (IFCA (CSIC-UC)); VILA ALVAREZ, Ivan (Instituto de Física de Cantabria (CSIC-UC)); CARTIGLIA, Nicolo (INFN Torino (IT))

Session Classification: Precision Timing Detectors - LGADs

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

Discussion Session: Defects

Monday 18 November 2019 16:00 (30 minutes)

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

Session Classification: Defect Characterization

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

Discussion Session: TCT, Extreme Fluences and Modelling

Wednesday 20 November 2019 11:50 (20 minutes)

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

Session Classification: Sensor Characterization Techniques (TCT, CV); Extreme Fluences

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

Electron transport via defect network

Monday 18 November 2019 12:00 (20 minutes)

The electron transport via defect network becomes important in highy irradiated solid state and in Si clusters of defects induced by hadron irradiation if it acts as a dipole type recombination center. Electron transport via localized defect sites can be roughly described by Fermi Golden Rule type hopping. However, this approach does not include electron delocalization among nearby defect atoms, the spectral content of the crystal is poorly accounted for as well. Instead, we develop a microscopic theory for this problem based on the tight binding model with respect to the defect sites, what allows proper description of partly delocalized defect-related electron wave-functions. The concepts of quantum relaxation theory are applied to include phonon spectral densities involved in system-bath energy exchange processes. Consequently we obtain the temperature and concentration-dependent electron transport via defects.

Authors: Prof. ABRAMAVICIUS, Darius (Institute of Chemical Physics, Vilnius University); Mrs GUIGAITE, Ieva (Faculty of Physics, Vilnius University); VAITKUS, Juozas (Vilnius University)

Presenter: Prof. ABRAMAVICIUS, Darius (Institute of Chemical Physics, Vilnius University)

Session Classification: Defect Characterization

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

CMOS - Discussion

Tuesday 19 November 2019 16:55 (30 minutes)

Presenter: VILELLA FIGUERAS, Eva (University of Liverpool (GB))

Session Classification: CMOS

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

Chulalongkorn (TH): Local capabilities and TH-proposed R&D topics

Monday 18 November 2019 09:55 (15 minutes)

Presenter: KANJANACHUCHAI, Songphol (Chulalongkorn University, Bangkok, Thailand)

Session Classification: Full Detector Systems

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

Parameterization of initial acceptor removal - thoughts

Tuesday 19 November 2019 14:45 (10 minutes)

Presenter: CENTIS VIGNALI, Matteo (FBK)

Session Classification: Precision Timing Detectors - LGADs

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

Welcome and RD50 News

Monday 18 November 2019 09:00 (15 minutes)

Presenter: MOLL, Michael (CERN)

Session Classification: Welcome