

23rd RD50 Workshop (CERN)

Report of Contributions

Contribution ID: 0

Type: **not specified**

Workshop Opening

Wednesday, 13 November 2013 10:00 (10 minutes)

Primary author: MOLL, Michael (CERN)

Presenter: MOLL, Michael (CERN)

Session Classification: Workshop Welcome

Contribution ID: 1

Type: **not specified**

Characterization of CNM's 3D pixel sensors for the phase-2 upgrade of the CMS vertex detector

Friday, 15 November 2013 09:40 (20 minutes)

The Large Hadron Collider (LHC) is developing a very successfully work in the last two years, and it will suffer an important accelerator upgrade by 2020, the High Luminosity-LHC (HL-LHC). These improvements will increase by a factor ten the instantaneous luminosity as well as the particle fluxes at the detectors, such as the Compact Muon Solenoid (CMS) experiment. The inner tracker detector will be the most affected part, increasing substantially its occupancy and radiation damage. In order to conserve the sensors performance under this new conditions, the CMS pixel detector will be upgraded. The new requirements demand the use of new silicon technologies instead of actual pixel planar sensors. Planar sensors have not shown enough radiation hardness for the innermost layers where the radiation doses can reach values around 2×10^{16} neq/cm². 3D sensors technologies are one of the candidates to be used in the closest layers to the beam pipe. They show higher radiation hardness at lower operating voltages, and the double sided design provide some additional technical advantages. Several wafers have been produced at the IMB-CNM (Barcelona, Spain), implementing two different pitches between p-electrodes. First characterizations have been carried out at IMB-CNM and PSI (Villigen, Switzerland). Results after electrical characterization and radioactive source test (90 Sr), before and after irradiation will be presented, as well as the first results after a test beam at DESY facilities.

Primary author: Ms MUÑOZ SÁNCHEZ, Francisca J. (IFCA)

Co-authors: Dr QUIRION, David (CNM-IMB); CURRAS RIVERA, Esteban (Universidad de Cantabria (ES)); GOMEZ, Gervasio (Universidad de Cantabria (ES)); PELLEGRINI, Giulio (Universidad de Valencia (ES)); VILA ALVAREZ, Ivan (Universidad de Cantabria (ES)); JARAMILLO, Richard (IFCA); ROHE, Tilman (Paul Scherrer Institut (CH))

Presenter: Ms MUÑOZ SÁNCHEZ, Francisca J. (IFCA)

Session Classification: 3D detectors and slim edges

Contribution ID: 2

Type: **not specified**

Investigation of non gaussian noise in irradiated p-on-n sensors

Thursday, 14 November 2013 10:05 (20 minutes)

In the CMS campaign to find the new baseline material for the next tracker, irradiated p-on-n sensors showed a non-gaussian noise behaviour. The effect has been quantified and studied systematically as a function of the applied bias voltage and sensor annealing, as well as irradiation fluence, particle type and energy and sensor geometry. In some operation area, this effect would lead to a noise occupancy of the sensor of over 10%, which makes this p-on-n sensors unuseful as a tracking device. The dependence on the sensor geometry (strip pitch and w/p ratio) indicates, that a high electric field at the strip side promotes the effect. T-CAD simulations of irradiated strip sensors showed an intrinsically higher electric field at the front side of p-on-n sensors compared to n-on-p sensors, thus making the occurrence of the effect more likely in p-on-n sensors.

Primary author: NURNBERG, Andreas Matthias (KIT - Karlsruhe Institute of Technology (DE))

Co-authors: DIERLAMM, Alexander (KIT - Karlsruhe Institute of Technology (DE)); Prof. MULLER, Thomas (KIT - Karlsruhe Institute of Technology (DE)); HEINE, Volker (KIT); DE BOER, Wim (KIT - Karlsruhe Institute of Technology (DE))

Presenter: NURNBERG, Andreas Matthias (KIT - Karlsruhe Institute of Technology (DE))

Session Classification: Full Detector Systems

Contribution ID: 3

Type: **not specified**

Electrical and alpha TCT measurements on LGAD produced by CNM (not on Wed. morning)

Wednesday, 13 November 2013 16:00 (20 minutes)

WE have performed I-V, C-V and alpha TCT measurements

Primary author: SADROZINSKI, Hartmut (SCIPP, UC santa Cruz)

Co-author: FADEYEV, Vitaliy (U)

Presenter: SADROZINSKI, Hartmut (SCIPP, UC santa Cruz)

Session Classification: Detectors with Charge Multiplication

Contribution ID: 4

Type: **not specified**

Radiation hard silicon sensors for the CMS tracker upgrade (Not Wednesday early morning)

Thursday, 14 November 2013 09:30 (35 minutes)

At an instantaneous luminosity of $5 \times 10^{34} \text{ cm}^{-2} \text{ s}^{-1}$, the high-luminosity phase of the Large Hadron Collider (HL-LHC) is expected to deliver a total of 3000 fb^{-1} of collisions, hereby increasing the discovery potential of the LHC experiments significantly. However, the radiation dose of the tracking systems will be severe, requiring new radiation hard sensors for the CMS tracker. The CMS tracker collaboration has initiated a large material investigation and irradiation campaign to identify the silicon material and design that fulfills all requirements for detectors for the high-luminosity phase of the Large Hadron Collider (HL-LHC). Focusing on the upgrade of the outer tracker region, pad diodes as well as fully functional strip sensors have been implemented on silicon wafers with different material properties and thicknesses. The samples were irradiated with a mixture of neutrons (1 MeV) and protons (23 MeV, 800 MeV and 23 GeV) corresponding to fluences as expected for the positions of detector layers in the future tracker. Three different proton energies were used for irradiations to investigate the energy dependence of the defect generation in oxygen rich material. The measurements performed on the structures include electrical sensor characterization, measurement of the collected charge injected with a beta source or laser light and bulk defect characterization. In this talk, results and conclusions of the campaign are presented, with a focus on the recent decision to use p-bulk silicon strip sensors in the outer tracker of CMS.

Primary author: Dr STEINBRUECK, Georg (Hamburg University (DE))

Presenter: Dr STEINBRUECK, Georg (Hamburg University (DE))

Session Classification: Full Detector Systems

Contribution ID: 6

Type: **not specified**

TCAD for Radiation, a review

Thursday, 14 November 2013 13:35 (20 minutes)

We present a compendium of our latest works about simulation of radiation effects in electronics using Sentaurus TCAD. Adapting the tool, we simulate pulsed laser ionization effects, ion tracks, total ionization dose and displacement damage.

Primary author: Dr PALOMO PINTO, Fco. Rogelio (School of Engineering University of Sevilla)

Co-author: Dr HIDALGO, Salvador (Microelectronics National Center CNM-IMB)

Presenter: Dr PALOMO PINTO, Fco. Rogelio (School of Engineering University of Sevilla)

Session Classification: Device Simulations and some key experimental data

Contribution ID: 7

Type: **not specified**

A Single Event Effects tool for VLSI designers

Thursday, 14 November 2013 13:55 (20 minutes)

We present our SEE circuit simulation tool. It leverages from the Cadence design suite, makes automatic placement of SEE sources and uses heuristics to determine circuit sensitivities.

Primary author: Dr MUÑOZ CHAVERO, Fernando (School of Engineering University of Sevilla)

Co-author: Dr PALOMO PINTO, Fco. Rogelio (School of Engineering University of Sevilla)

Presenter: Dr PALOMO PINTO, Fco. Rogelio (School of Engineering University of Sevilla)

Session Classification: Device Simulations and some key experimental data

Contribution ID: 8

Type: **not specified**

Systematic investigation of p-irradiated Micron pad detectors of different silicon materials

Wednesday, 13 November 2013 11:41 (20 minutes)

A clear understanding of the underlying physics is essential for the evaluation of detectors in high energy physics. For this purpose Micron detectors of different silicon types (FZ, MCz, n-bulk, p-bulk) provided by the RD50 collaboration have been irradiated with 24GeV protons at CERN PS up to fluences of 3×10^{16} neq/cm². In addition to the characteristics of leakage current (IV), capacitance (CV) and effective doping concentration (N_{eff}) dependent on the fluence and the temperature, signals of the transient current technique (TCT) were systematically analysed to investigate the charge collection efficiency (CCE) using red and IR Laser illumination. Results and further plans of these studies will be presented.

Primary author: NEUGEBAUER, Hannes (Hamburg University (DE))

Co-authors: GALLRAPP, Christian (CERN); FERNANDEZ GARCIA, Marcos (Universidad de Cantabria (ES)); MOLL, Michael (CERN)

Presenter: NEUGEBAUER, Hannes (Hamburg University (DE))

Session Classification: Defect and Pad Detector Characterization

Contribution ID: 9

Type: **not specified**

Studies of LGAD diodes in Ljubljana (an update)

Wednesday, 13 November 2013 15:20 (20 minutes)

A large set of diodes was characterized before irradiations and after neutron irradiations with different techniques CV/IV/TCT/CCE. It was found that large spread of device leakage current before irradiation has no impact on gain (constant within 15% for all samples) of the devices, but it does on noise. The excess current seem no to be related to the bulk current and there are indications that it evenly distributed over the surface.

Irradiations decrease the gain significantly for both high and low gain devices. As the decrease of electric field in the multiplication layer may be due to removal of shallow acceptor a set of simple diodes with different resistivities was irradiated and parameters of acceptor removal studied.

Primary author: KRAMBERGER, Gregor (Jozef Stefan Institute (SI))

Co-authors: QUIRION, David (CNM); PELLEGRINI, Giulio (Universidad de Valencia (ES)); MANDIC, Igor (Jozef Stefan Institute (SI)); MIKUZ, Marko (Jozef Stefan Institute (SI)); Dr ZAVRTANIK, Marko (Jozef Stefan Institute (SI)); BASELGA BACARDIT, Marta (Universidad de Valencia (ES)); FERNANDEZ, Pablo (CNM); HIDALGO, Salvador (CNM); CINDRO, Vladimir (Jozef Stefan Institute (SI))

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

Session Classification: Detectors with Charge Multiplication

Contribution ID: 10

Type: **not specified**

Beam test results of 3D pixel devices for forward tracking

Friday, 15 November 2013 10:00 (20 minutes)

Tracking detectors for forward physics experiments impose two critical requirements: first, the active area of the detector has to be as close as possible to the beam, which means that the dead region of the sensor has to be minimized. Second, the device has to be able to cope with an inhomogeneous radiation distribution. In this presentation results of beam tests of slim-edged 3D pixel devices and of in-homogeneously irradiated devices carried out at DESY in June and July 2013 will be presented.

Primary authors: MICELLI, Andrea (IFAE Barcelona); LOPEZ PAZ, Ivan (Universitat Autònoma de Barcelona (ES)); LANGE, Joern (IFAE Barcelona); GRINSTEIN, Sebastian (IFAE/ICREA Barcelona)

Presenter: LANGE, Joern (IFAE Barcelona)

Session Classification: 3D detectors and slim edges

Contribution ID: 11

Type: **not specified**

Update on the temperature dependence of the bulk current in Si (remote)

Thursday, 14 November 2013 16:05 (20 minutes)

New data on the temperature dependence of the current generated in Si bulk are presented. Modification of the test set-up allowed measurements with the sensor irradiated by $1\text{E}+16$ neq per square cm.

Primary author: CHILINGAROV, Alexandre (Lancaster University (GB))

Presenter: CHILINGAROV, Alexandre (Lancaster University (GB))

Session Classification: Device Simulations and some key experimental data

Contribution ID: 12

Type: **not specified**

Discussion on LGAD and other detectors with Avalanche

Wednesday, 13 November 2013 16:20 (30 minutes)

Discussion on measurements and the technology developed for the fabrication of Low Gain Avalanche Detectors (LGAD) for tracking applications.

Primary author: Dr PELLEGRINI, Giulio (CNM-IMB-CSIC (ES))

Presenter: Dr PELLEGRINI, Giulio (CNM-IMB-CSIC (ES))

Session Classification: Detectors with Charge Multiplication

Contribution ID: 13

Type: **not specified**

Future sensor-chip packaging technologies at CiS

Friday, 15 November 2013 11:40 (20 minutes)

In the past, the CiS research institute has made a mark as a vendor of reliable radiation hard planar silicon sensors for various important HEP detectors.

In addition to the sensor production, it is aiming for an extension of the possibilities of in-house sensor-chip packaging. Initial tests of a combination of electroless nickel UBM and solder ball bumping have been started. This batch-wise process presents a cost-efficient method for large-area silicon applications.

Further approaches include light induced or MoSi-based electroplating. The investigations of radiation hardness and minimization of the bump pad dimensions as requested for future pixel designs are as well an important objective which is pursued.

Primary author: WITTIG, Tobias (Technische Universitaet Dortmund (DE))

Co-authors: KOMPATSCHER, Arno Emanuel (Technische Universitaet Dortmund (DE)); ROEDER, Ralf (CiS FIMP)

Presenter: WITTIG, Tobias (Technische Universitaet Dortmund (DE))

Session Classification: 3D detectors and slim edges

Contribution ID: 14

Type: **not specified**

Preliminary results on measurements of surface recombination velocity on SLIM edges passivated Si (not Friday)

Wednesday, 13 November 2013 10:50 (20 minutes)

The light pulse excited microwave conductivity decay method for surface recombination rate measurement is presented. The preliminary results are performed in the differently passivated silicon samples surface.

Primary author: Dr GAUBAS, Eugenijus (Vilnius university)

Co-authors: Mr TEKORIUS, Audrius (Faculty of Physics, Vilnius University); SADROZINSKI, Hartmut (SCIPP, UC Santa Cruz); Prof. VAITKUS, Juozas (Vilnius University); Dr CEPONIS, Tomas (Institute of Applied Research, Vilnius University); FADEYEV, Vitaliy (U)

Presenter: Prof. VAITKUS, Juozas (Vilnius University)

Session Classification: Defect and Pad Detector Characterization

Contribution ID: 15

Type: **not specified**

PECULIARITIES OF DARK CONDUCTIVITY IN IRRADIATED SILICON (not Friday)

Wednesday, 13 November 2013 10:10 (20 minutes)

The electrical properties of the irradiated by neutrons Si are analyzed by means of the Hall effect and magnetoresistance temperature dependence in a few series of Si samples. It is demonstrated that the electron mobility decrease with temperature as a power law with index less than in the nonirradiated silicon and can become near to one in the highly irradiated silicon. The analyze of contribution of the local levels showed a possibility to approximate the temperature dependence by V2 and V3 contribution in the samples irradiated up to $3 \times 10^{14} \text{ cm}^{-2}$. In a higher irradiated samples the activation energy depended on the fluence and a modified model of the cluster and its environment is proposed.

Primary author: Prof. VAITKUS, Juozas (Vilnius University)

Co-authors: Dr MEKYS, Algirdas (Institute of Applied Research, Vilnius University); Dr STORASTA, Jurgis (Dept. Semiconductor Physics, Vilnius University); Mr RUMBAUSKAS, Vytautas (Institute of Applied Research, Vilnius University)

Presenter: Prof. VAITKUS, Juozas (Vilnius University)

Session Classification: Defect and Pad Detector Characterization

Contribution ID: 16

Type: **not specified**

TCAD simulations and beam tests: measuring the electric field in irradiates sensors

Thursday, 14 November 2013 17:05 (20 minutes)

Beam test data and simulations can make accessible the electric field profile of silicon sensors. Different bulk materials, irradiation and annealing scenarios can be contrasted thanks to the charge profile technique (e.g.: T. Lari and C. Troncon, IEEE TNS, VOL. 53, NO. 5, OCTOBER 2006; V. Chiochia, IEEE TNS, VOL. 52, NO. 4, AUGUST 2005)

High pointing resolution telescopes and detailed TCAD simulations are needed to complete this task.

I will present a project for beam tests and simulations campaigns.

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

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

Session Classification: Device Simulations and some key experimental data

Contribution ID: 17

Type: **not specified**

A parametrization of the performance of Ultra-Fast Silicon detector

Wednesday, 13 November 2013 14:10 (20 minutes)

Using data from existing silicon pixel systems, a model to estimate the performance of UFSD is presented.

Primary author: Mr CARTIGLIA, Nicolo (INFN)

Co-authors: SEIDEN, Abraham (University of California, Santa Cruz (US)); SADROZINSKI, Hartmut (SCIPP, UC Santa Cruz)

Presenter: Mr CARTIGLIA, Nicolo (INFN)

Session Classification: Detectors with Charge Multiplication

Contribution ID: 18

Type: **not specified**

Charge Collection Measurements on Dedicated RD50 Charge Multiplication SSDs

Wednesday, 13 November 2013 13:30 (20 minutes)

The Collection charge of specially designed charge multiplication silicon strip detectors produced by MICRON Semiconductor Co. Ltd. within the CERN RD50 framework is investigated. Charge collection measurements are performed before and after irradiation with a proton fluence of 1×10^{15} and a neutron fluence ranging from $1-5 \times 10^{15}$ 1 MeV neq/cm^2 (neq/cm^2). Structures and modifications on these devices include implants processed with increased diffusion times and energies, different sensor thicknesses, the use of intermediate biased or floating strips between the readout strips, and several different strip width and pitch geometries. The charge collection for these devices is compared to standard FZ $300 \mu\text{m}$ thick silicon strip sensors having a strip width= $25 \mu\text{m}$ and pitch= $80 \mu\text{m}$. Several sensors exhibit enhancement of the collected charge compared to the standard sensor after irradiation. Measurements include position resolve studies using an IR laser in order to investigate low and high field regions near the detector surface.

Primary author: BETANCOURT, Christopher (Freiburg University)

Co-authors: FORSHAW, Dean Charles (University of Liverpool (GB)); CASSE, Gianluigi (University of Liverpool (GB)); JAKOBS, Karl (Albert-Ludwigs-Universitaet Freiburg (DE)); Mr HAUSER, Marc (University of Freiburg); DERVAN, Paul (University of Liverpool (GB)); KODYS, Peter (Charles University (CZ)); SOMMER, Philipp (University of Freiburg); MORI, Riccardo (Albert-Ludwigs-Universitaet Freiburg (DE)); KUEHN, Susanne (Albert-Ludwigs-Universitaet Freiburg (DE)); WONSAK, Sven (University of Liverpool (GB)); PARZEFALL, Ulrich (Albert-Ludwigs-Universitaet Freiburg (DE))

Presenter: BETANCOURT, Christopher (Freiburg University)

Session Classification: Detectors with Charge Multiplication

Contribution ID: 19

Type: **not specified**

Status of Scribe-Cleave-Passivate (SCP) Slim Edge Technology

Friday, 15 November 2013 10:50 (20 minutes)

We are pursuing a “slim edge” technology which allows a drastic reduction of inactive region along the perimeter of silicon detectors. Such reduction would benefit construction of large-area tracker and imaging systems. Key components of this method are surface scribing, cleaving, and passivation of the resulting sidewall. We will give a short overview of the project and describe recent progress on the manufacturing technology and device studies. The latter includes charge collection near the edge and irradiation studies.

Primary authors: SADROZINSKI, Hartmut (SCIPP, UC Santa Cruz); FADEYEV, Vitaliy (University of California, Santa Cruz (US))

Co-authors: Dr BLUE, Andrew (University of Glasgow); MACCHIOLO, Anna (Max-Planck-Institut fuer Physik (Werner-Heisenberg-Institut) (D)); PARKER, Colin (SCIPP, UCSC); PELLEGRINI, Dario (Ecole Polytechnique Federale de Lausanne (CH)); Prof. DALLA BETTA, Gian-Franco (INFN and University of Trento); PELLEGRINI, Giulio (Universidad de Valencia (ES)); NGO, Jeffrey (SCIPP, UCSC); RAFI, Joan Marc (CNM); Dr ULLAN COMES, Miguel (Universidad de Valencia (ES)); BATES, Richard (University of Glasgow (GB)); BENITEZ CASMA, Victor Hugo (Universidad de Valencia (ES)); Mr GALLOWAY, Zachary (SCIPP, UCSC)

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

Session Classification: 3D detectors and slim edges

Contribution ID: 20

Type: **not specified**

Silicon Sensors Irradiation Study for ILC Extreme Forward Calorimetry

Thursday, 14 November 2013 11:15 (20 minutes)

We are working on the proposed small angle calorimeter for ILC, “BeamCal”. The detector, which is envisioned as a tungsten sandwich calorimeter, will be subject to high fluences EM radiation that will shower in the tungsten radiator. We are doing studies that explore the effects of radiation damage on candidate sensors at shower-max within the induced shower. In addition to electrons, positrons and photons, these showers will contain a flux of neutrons from the de-excitation of the giant dipole resonance that may significantly contribute to radiation damage. The anticipated fluence of the order of 100 MRad/year instigated studies of exotic sensor materials, such as GaAs. Instead, we are studying conventional silicon sensors as an alternative.

A major part of our efforts was beam test at SLAC electron beam facility in June and July of 2013. Silicon strip sensors of different types have been irradiated up to the dose of 220 MRad. We will describe the first charge collection results and on-going annealing studies.

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

Co-authors: SCHUMM, Bruce Andrew (University of California,Santa Cruz (US)); TIMLIN, Conor (SCIPP, UCSC); MARTINEZ-MC KINNEY, Forest (University of California,Santa Cruz (US)); MISTRY, Khilesh (University of Pennsylvania); WILDER, Max (SCIPP, UCSC); SPENCER, Ned (University of California,Santa Cruz (US)); NIDUMOLU, Ravi (SCIPP, UCSC); BAND, Ryan (SCIPP, UCSC); KIM, Tae Sung (SCIPP, UCSC); MARUYAMA, Takashi (SLAC); MARKIEWICZ, Tom (SLAC)

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

Session Classification: Full Detector Systems

Contribution ID: 21

Type: **not specified**

Trapping related negative feedback as the reason for collected charge restriction in heavily irradiated Si detectors operating with avalanche multiplication

Thursday, 14 November 2013 16:25 (20 minutes)

Enhancement of the collected charge Q_c in Si detectors irradiated beyond 10^{15} neq/cm² is analyzed basing on the PTI model and compared with the internal gain in avalanche photodiodes. The results show that in heavily irradiated Si detectors Q_c enhancement due to avalanche multiplication is strongly restricted and simultaneously stabilized by the negative feedback arisen from carrier trapping, which is an inherent property of the diodes with high concentration of deep level defects in the sensitive bulk. This negative feedback reduces the sensitivity of the internal Q_c gain to the design of the detector high electric field region.

Primary author: Dr VERBITSKAYA, Elena (Ioffe Physical-Technical Institute of Russian Academy of Sciences, St. Petersburg, Russia)

Co-authors: Prof. ZABRODSKII, Andrei (Ioffe Physical-Technical Institute of Russian Academy of Sciences, St. Petersburg, Russia); Dr LUUKKA, Panja (Helsinki Institute of Physics, Helsinki, Finland); Dr EREMIN, Vladimir (Ioffe Physical-Technical Institute of Russian Academy of Sciences, St. Petersburg, Russia); Dr LI, Zheng (Brookhaven National Laboratory, USA)

Presenter: Dr VERBITSKAYA, Elena (Ioffe Physical-Technical Institute of Russian Academy of Sciences, St. Petersburg, Russia)

Session Classification: Device Simulations and some key experimental data

Contribution ID: 22

Type: **not specified**

Contribution from Eg(T) dependence into parameterization of the bulk generation current of irradiated Si detectors

Thursday, 14 November 2013 15:45 (20 minutes)

The influence of the bandgap temperature dependence $E_g(T)$ on the parameters of irradiated Si detectors extracted from $I(T)$ measurements was analyzed via transformation of “statistical” form of the rate equation for the current generation to the “activation” form. The energy of the current generation, $E_t = 0.65$ eV, was defined for the single effective level $I(T)$ parameterization. The two level model based on the contribution from effective DDs and DAs positioned at $E_v + 0.48$ eV and $E_c - 0.52$ eV, respectively, was adapted for simultaneous calculation of the reverse current and the electric field distribution in irradiated detectors. The results of the study show that both models fit well to the experimental data and the contribution of the $E_g(T)$ dependence to E_t does not exceed 5%.

Primary author: Dr EREMIN, Vladimir (Ioffe Physical-Technical Institute of Russian Academy of Sciences, St. Petersburg, Russia)

Co-authors: Dr VERBITSKAYA, Elena (Ioffe Physical-Technical Institute of Russian Academy of Sciences, St. Petersburg, Russia); Dr LI, Zheng (Brookhaven National Laboratory, Upton, NY 11973, USA)

Presenter: Dr EREMIN, Vladimir (Ioffe Physical-Technical Institute of Russian Academy of Sciences, St. Petersburg, Russia)

Session Classification: Device Simulations and some key experimental data

Contribution ID: 23

Type: **not specified**

Initial acceptor removal in p-type silicon detectors

Wednesday, 13 November 2013 10:30 (20 minutes)

Initial acceptor removal in p-type silicon detectors was studied for different samples after reactor neutron and 24 GeV proton irradiations. Although at HL-LHC fluences the initial acceptor removal is not important for standard detectors, it may play an important role in changing the properties of the multiplication layer of LGAD devices and consequent reduction of gain. A set of simple pad detectors with different resistivities was irradiated and parameters of acceptor removal studied.

Primary author: KRAMBERGER, Gregor (Jozef Stefan Institute (SI))

Co-authors: MANDIC, Igor (Jozef Stefan Institute (SI)); MIKUZ, Marko (Jozef Stefan Institute (SI)); Dr ZAVRTANIK, Marko (Jozef Stefan Institute (SI)); CINDRO, Vladimir (Jozef Stefan Institute (SI))

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

Session Classification: Defect and Pad Detector Characterization

Contribution ID: 24

Type: **not specified**

Irradiated n-in-p planar pixel sensors of different thicknesses and active edge designs

Friday, 15 November 2013 11:10 (20 minutes)

We present results of the characterization of n-in-p planar pixel modules employing 100 and 200 μm thin sensors with active edges produced at VTT, Finland, and 150 μm thin sensors produced at MPP/HLL.

These are interconnected with bump bonding to either FE-I3 or FE-I4 ATLAS read-out chips and irradiated up to a fluence of $1e16$.

A comparison of the performance of the different sensor thicknesses and studies of the edge properties for the VTT sensors have been performed with radioactive sources in the laboratory and using precise beam test measurements with 120 GeV pions at CERN SpS and 4 GeV electrons at DESY, Hamburg.

Primary author: TERZO, Stefano (Max-Planck-Institut fuer Physik (Werner-Heisenberg-Institut) (D))

Co-author: MACCHIOLO, Anna (Max-Planck-Institut fuer Physik (Werner-Heisenberg-Institut) (D))

Presenter: TERZO, Stefano (Max-Planck-Institut fuer Physik (Werner-Heisenberg-Institut) (D))

Session Classification: 3D detectors and slim edges

Contribution ID: 25

Type: **not specified**

Charge collection and laser measurements on double-sided 3D strip sensors irradiated up to $2 \cdot 10^{16} \text{ n}_{\text{eq}}/\text{cm}^2$

Friday, 15 November 2013 09:20 (20 minutes)

Although 3D silicon sensors are characterized by higher capacitance (thus higher noise), lower spatial uniformity and more fabrication process complexity than standard sensors, the higher radiation hardness motivates the investigation of this layout in view of the LHC upgrade. In between the different 3D layouts, the double-sided represent the most attractive but also the most mechanically challenging.

We performed charge collection (with a beta source) and laser studies on irradiated (up to $2 \cdot 10^{16} \text{ n}_{\text{eq}}/\text{cm}^2$), *p*-type, 3D double-sided strip sensors from the ATLAS Insertable B-Layer (IBL) production wafers, fabricated at FBK (Trento). We compared the results with the one obtained before irradiation and with simulations performed with TCAD.

While the charge collection reflect the expectation from simulation and show the relatively high radiation hardness, being significant also at relatively low bias voltages (e.g. at 25 V for $5 \cdot 10^{15} \text{ n}_{\text{eq}}/\text{cm}^2$), laser measurements shows that the most effective regions are located and grows with the bias voltage dependently on the irradiation fluence (showing unexpected high collection close to the *p*+ columns).

Primary author: Prof. DALLA BETTA, Gian-Franco (INFN and University of Trento)

Co-authors: Mr LECINI, Besnik (Trento University); BETANCOURT, Christopher (Freiburg University); GIACOMINI, Gabriele (Fondazione Bruno Kessler); JAKOBS, Karl (Albert-Ludwigs-Universitaet Freiburg (DE)); Ms THOMAS, Maira (Albert-Ludwigs Universitaet Freiburg); POVOLI, Marco (University of Trento (Italy)); BOSCARDIN, Maurizio (FBK Trento); ZORZI, Nicola (Fondazione Bruno Kessler - FBK); MORI, Riccardo (Albert-Ludwigs-Universitaet Freiburg (DE)); MENDICINO, Roberto (Universita della Calabria (IT)); KUEHN, Susanne (Albert-Ludwigs-Universitaet Freiburg (DE)); PARZEFALL, Ulrich (Albert-Ludwigs-Universitaet Freiburg (DE))

Presenter: MORI, Riccardo (Albert-Ludwigs-Universitaet Freiburg (DE))

Session Classification: 3D detectors and slim edges

Contribution ID: 26

Type: **not specified**

Status of the Low Resistance Strip Sensors Project

Thursday, 14 November 2013 11:35 (20 minutes)

An update will be presented on the status of the LowR project. General performance results from the first Low-R sensors fabricated at the clean room of CNM-Barcelona will be shown (technological parameters, IV, CV). Results on the tests on other important sensor parameters like strip resistance, inter-strip isolation, and pulse shape will also be presented. First tests on the PTP structures behaviour indicate that some technological issues should still be solved in order to have a full PTP performance. Yet, initial laser tests that emulate beam loss and enable dynamic measurements show promising reduction of the strip peak voltage. New sensors with corrected design are being processed that will allow a full demonstration of this technology. The optimization and solutions proposed for the second batch, will be detailed, together with new technological proposals to be implemented.

Primary author: Dr ULLAN COMES, Miguel (Universidad de Valencia (ES))

Co-authors: GRILLO, Alex (University of California,Santa Cruz (US)); LACASTA LLACER, Carlos (IFIC-Valencia); Prof. GARCIA, Carmen (IFIC Valencia (ES)); PELLEGRINI, Giulio (Universidad de Valencia (ES)); SADROZINSKI, Hartmut (SCIPP, UC santa Cruz); LOZANO FANTOBA, Manuel (Universidad de Valencia (ES)); SOLDEVILA SERRANO, Urmila (IFIC (CSIC-UVEG)); BENITEZ CASMA, Victor Hugo (Universidad de Valencia (ES)); FADEYEV, Vitaliy (University of California,Santa Cruz (US))

Presenter: Dr ULLAN COMES, Miguel (Universidad de Valencia (ES))

Session Classification: Full Detector Systems

Contribution ID: 27

Type: **not specified**

Update on irradiation experiments with electrons of different kinetic energies (between 1.5 MeV and 27 MeV) performed on n-type silicon [Not on Wednesday]

Friday, 15 November 2013 09:00 (20 minutes)

Studies regarding the radiation damage induced by electrons of different kinetic energies, from 1.5 MeV to 27 MeV, are presented. The aim is to identify the chemical structure of those defects that have a direct impact on the device performance at the operating temperature. The results obtained via electrical characterization (DLTS&TSC) can be connected with structural and chemical investigations (HRTEM & EPR) only by following the annealing behaviour of the defects. DLTS&TSC results regarding annealing at high temperatures will be presented and discussed. Preliminary HRTEM and EPR results obtained on samples (some enriched with O and C isotopes) irradiated with electrons of energies 15MeV and 27 MeV will be also presented.

Primary author: Dr PINTILIE, Ioana (NIMP Bucharest-Magurele, Romania)

Co-authors: FRETWURST, Eckhart (II. Institut fuer Experimentalphysik); Dr LINDSTROEM, Gunnar (Hamburg University); Prof. KLANNER, Robert (Hamburg University (DE)); RADU, Roxana (University of Hamburg)

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

Session Classification: 3D detectors and slim edges

Contribution ID: 28

Type: **not specified**

Simulations of Hadron Irradiated n+p- Si Strip Sensors Incorporating Bulk and Surface Damage

Thursday, 14 November 2013 14:35 (20 minutes)

The future upgrade of LHC to the SLHC, with the goal for over an order of magnitude higher luminosity ($> 10^{35} \text{ cm}^{-2} \text{ s}^{-1}$) and over 4 times more integrated luminosity (3000 fb^{-1}) have posed challenges to develop the extreme radiation hard Si sensors. To address the problem, extensive measurements and simulation studies aimed for ATLAS and CMS tracker requirements have been initiated which are investigating different designs, materials and polarity for Si microstrip sensors. Si sensors installed in the tracker region are exposed to both charged and neutral radiation, undergo both surface damage and bulk damage. Most of the efforts to simulate the radiation effects on Si sensors in the past concentrated either studying surface damage or the bulk damage model only. However, in Si sensors degrading effects due to both take place simultaneously. In the present work, extensive simulations have been carried out for the p-type of Si microstrip sensors incorporating both surface and bulk damage together. The surface damage is incorporated using different amount of surface oxide charge density between interface of Si and SiO_2 while bulk damage is included by a new trap model. Simulations of various properties of Si strip sensors, like Interstrip Resistance (R_{int}) and Interstrip Capacitance (C_{int}) have been carried out and compared against the measurements on sensors. The results are in agreement and help to understand the underlying physics of radiation damage to some extent. Further, the simulations for different p-stop designs are presented and regions of critical field are investigated to propose possible design for future detectors.

Primary author: RANJEET, Ranjeet (University of Delhi (IN))

Co-authors: ELLIOTT-PEISERT, Anna (CERN); BHARDWAJ, Ashutosh (University of Delhi (IN)); RANJAN, Kirti (University of Delhi (IN)); MOLL, Michael (CERN); SHIVPURI, Ram Krishen (University of Delhi (IN))

Presenter: RANJEET, Ranjeet (University of Delhi (IN))

Session Classification: Device Simulations and some key experimental data

Contribution ID: 29

Type: **not specified**

Comparison of Radiation Hardness Properties of p+n- & n+p- Si Strip Sensors Using Simulation Approach

Thursday, 14 November 2013 16:45 (20 minutes)

To address the problems caused by intense radiation environment in planned SLHC tracker, extensive measurements and simulations studies aimed for CMS tracker requirements have been initiated which are investigating different designs, materials and polarity for Si microstrip sensors. One of the most important task is to compare the sustainability of p+n- and n+p- type of Si strip sensors after different level of radiation damages. In the present work, extensive simulations have been carried out for the n-type and p-type of Si microstrip sensors incorporating surface damage and bulk damage together. The simulations have been performed using Silvaco TCAD tools. The surface damage is incorporated using different amount of surface oxide charge density between interface of Si and SiO₂ while bulk damage is included by a new trap model. Various properties of n-type and p-type sensors have been compared for different levels of radiation damage. Further, observed higher microdischarge rate in measured irradiated n-type Si strip sensors is explained using a qualitative model and electric field simulations.

Primary author: RANJEET, Ranjeet (University of Delhi (IN))

Presenter: RANJEET, Ranjeet (University of Delhi (IN))

Session Classification: Device Simulations and some key experimental data

Contribution ID: 30

Type: **not specified**

Non-uniform 3-level defect model and status of edge-TCT simulations

Thursday, 14 November 2013 14:55 (20 minutes)

Proton model (effective 2-defect model based on the EVL model) used in Synopsys Sentaurus package, has proven to produce matching simulation results with measurements. However, at high fluence ($> 1e15 \text{ cm}^{-2}$) and thus high oxide charge, the model does not produce radiation enhanced isolation to the strips, observed in a real p-type detector. Also simulated Cint and CCE loss in the center of the pitch reflect this shortcoming. Novel non-uniform 3-level defect model solves these problems without affecting the experimentally matching simulation results of proton model. Edge-TCT provides a method for the measurement of the drift velocity of the charge carriers as a function of depth. This could make it possible to extract electric field distribution in the detector bulk. Comparison of non-irradiated/irradiated device edge-TCT simulations with measurements will be presented.

Primary author: PELTOLA, Timo Hannu Tapani (Helsinki Institute of Physics (FI))

Co-author: HAERKOENEN, Jasu (Helsinki Institute of Physics (FI))

Presenter: PELTOLA, Timo Hannu Tapani (Helsinki Institute of Physics (FI))

Session Classification: Device Simulations and some key experimental data

Contribution ID: 31

Type: **not specified**

First results of new p-type strip and pad detectors with LGAD in epitaxial wafers (remote, afternoon)

Wednesday, 13 November 2013 15:40 (20 minutes)

In the framework of the RD50 collaboration new p-type devices with LGAD in epitaxial wafers and float zone wafers were fabricated in CNM. Here we present first results of strips and pad detectors.

Primary author: Mrs BASELGA, Marta (CNM (Barcelona))

Presenter: Mrs BASELGA, Marta (CNM (Barcelona))

Session Classification: Detectors with Charge Multiplication

Contribution ID: 32

Type: **not specified**

ATLAS12A Endcap Mini Sensors Electrical Testing

Thursday, 14 November 2013 10:55 (20 minutes)

Electrical tests of ATLAS12A EndCap mini sensors manufactured by HPK were performed in Freiburg, Prague and Valencia. Results of leakage current and full depletion voltage as well as coupling capacitance, bias resistance, inter-strip capacitance and resistance and punch-trough measurements on non-irradiated sensors will be presented.

Primary authors: MIKESTIKOVA, Marcela (Acad. of Sciences of the Czech Rep. (CZ)); KUEHN, Susanne (Albert-Ludwigs-Universitaet Freiburg (DE)); SOLDEVILA SERRANO, Urmila (Universidad de Valencia (ES)); BENITEZ CASMA, Victor Hugo (Universidad de Valencia (ES))

Presenter: MIKESTIKOVA, Marcela (Acad. of Sciences of the Czech Rep. (CZ))

Session Classification: Full Detector Systems

Contribution ID: 33

Type: **not specified**

Status of Silicon Strip Sensor Measurements at Liverpool

Wednesday, 13 November 2013 13:50 (20 minutes)

First charge collection results with room temperature annealed dedicated RD50 charge multiplication sensors will be presented, at $1e15$ neq/cm² and $5e15$ neq/cm². The multiplication sensors feature many different structures specially designed to take advantage of multiplication after heavy irradiation. These devices were produced by Micron Semiconductor Ltd (UK).

To investigate the current dependence of irradiated silicon strip detectors, ATLAS07 sensors were irradiated at Birmingham with doses up to $1e15$ neq/cm². CV and IV measurements were performed at different temperatures which allow verification of the temperature scaling formula. Additionally, the correlation of leakage current and the irradiated fluence will be presented.

Primary author: WONSAK, Sven (University of Liverpool (GB))

Co-authors: BETANCOURT, Christopher (Albert-Ludwigs-Universitaet Freiburg (DE)); FORSHAW, Dean Charles (University of Liverpool (GB)); CASSE, Gianluigi (University of Liverpool (GB)); TSURIN, Ilya (University of Liverpool (GB)); JAKOBS, Karl (Albert-Ludwigs-Universitaet Freiburg (DE)); HAUSER, Marc Manuel (Albert-Ludwigs-Universitaet Freiburg (DE)); WORMALD, Michael (University of Liverpool (GB)); DERVAN, Paul (University of Liverpool (GB)); KODYS, Peter (Charles University (CZ)); MORI, Riccardo (Albert-Ludwigs-Universitaet Freiburg (DE)); KUEHN, Susanne (Albert-Ludwigs-Universitaet Freiburg (DE)); Dr AFFOLDER, Tony (University of Liverpool (GB)); PARZEFALL, Ulrich (Albert-Ludwigs-Universitaet Freiburg (DE))

Presenter: WONSAK, Sven (University of Liverpool (GB))

Session Classification: Detectors with Charge Multiplication

Contribution ID: 34

Type: **not specified**

Thermal characterization of Low Gain Avalanche Detectors (before 4pm)

Wednesday, 13 November 2013 15:00 (20 minutes)

We have studied the thermal characteristics of few tens of Low Gain Avalanche Diodes (LGAD) produced by CNM-Barcelona. Changes of gain and noise as a function of temperature are reported. 2D-mappings of gain over the surface of the detectors have also been measured.

Primary author: FERNANDEZ GARCIA, Marcos (Universidad de Cantabria (ES))

Co-authors: QUIRION, David (Centro Nacional de Microelectronica de Barcelona); PELLEGRINI, Giulio (Universidad de Valencia (ES)); VILA ALVAREZ, Ivan (Universidad de Cantabria (ES)); FERNÁNDEZ MARTÍNEZ, Pablo (Centro Nacional de Microelectronica de Barcelona); JARAMILLO, Richard (IFCA); HIDALGO, Salvador (Centro Nacional de Microelectronica de Barcelona); GRECO, Virginia (Universita degli studi di Siena (IT))

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

Session Classification: Detectors with Charge Multiplication

Contribution ID: 35

Type: **not specified**

Discussion on Simulations

Thursday, 14 November 2013 17:45 (1 hour)

Presenter: EREMIN, Vladimir (Ioffe Physical Technical Institute of Russian Academy of Science)

Session Classification: Device Simulations and some key experimental data

Contribution ID: 36

Type: **not specified**

Planar Pixel Detectors for the ATLAS Pixel Detector upgrade

Thursday, 14 November 2013 09:00 (30 minutes)

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

Session Classification: Full Detector Systems

Contribution ID: 37

Type: **not specified**

Discussion Session on New structures (3D, slim and active edges, ...)

Friday, 15 November 2013 12:40 (30 minutes)

Presenters: PELLEGRINI, Giulio (Universidad de Valencia (ES)); PELLEGRINI, Giulio (Universidad de Valencia (ES))

Session Classification: 3D detectors and slim edges

Contribution ID: 38

Type: **not specified**

Discussion on Defect and Sensor Characterization

Wednesday, 13 November 2013 12:01 (20 minutes)

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

Session Classification: Defect and Pad Detector Characterization

Contribution ID: 39

Type: **not specified**

Discussion Session - Full Detector Systems

Thursday, 14 November 2013 11:55 (30 minutes)

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

Session Classification: Full Detector Systems

Contribution ID: 40

Type: **Standard (20 min including discussion)**

Experimental study of the Si-SO₂ interface region in p+n-silicon strip sensors before and after X-ray irradiation

Thursday, 14 November 2013 14:15 (20 minutes)

The Si-SO₂ interface region in a DC-coupled p+n-silicon strip sensors has been studied by TCT measurements for eh-pairs produced by focused, sub-nanosecond laser light with wavelengths of 660 nm and 830 nm. Charge losses of either electrons or holes have been observed. The charge losses depend on the biasing history; after changing the sensor voltage, they change, with time constants between tens of minutes and several days, depending on humidity. The observations are qualitatively explained by detailed TCAD simulations: the charge losses depend on the charge distribution on the surface of the sensor, which is in a non-equilibrium state after changing the sensor voltage. The big difference in time constants in reaching the equilibrium is due to the strong dependence of the surface resistivity on humidity. Results before and after irradiation to 1 MGy (~10 keV X-rays) will be presented. The results are relevant for defining the surface boundary conditions when simulating segmented silicon sensors for different surface damages.

The measured dependence of the charge losses on wavelength is compatible with simulations of the electric field close to the Si-SiO₂ interface: a region of zero electric field (saddle point of the potential) in the center between p+ strips, about 5 μm from the Si-SiO₂ interface.

Using simulated weighting potentials for the strips and the backplane, the extension and properties of the electron accumulation layer at the Si-SiO₂ interface for the different experimental conditions is extracted before and after X-ray irradiation. The extension of the accumulation layer strongly influences the breakdown conditions at the edges of the p+implants, and thus the breakdown voltage of the sensor.

Primary author: POEHLSEN, Thomas (University of Hamburg)

Co-authors: FRETWURST, Eckhart (II. Institut fuer Experimentalphysik); ZHANG, Jiaguo (Institute of Experimental Physics, University of Hamburg); SCHWANDT, Joern (Uni Hamburg); Prof. KLAN-
NER, Robert (Hamburg University (DE))

Presenter: POEHLSEN, Thomas (University of Hamburg)

Session Classification: Device Simulations and some key experimental data

Contribution ID: 41

Type: **Standard (20 min including discussion)**

T-CAD simulation of Lorentz angle

Thursday, 14 November 2013 17:25 (20 minutes)

T-CAD simulations are a powerful tool for understanding the properties of silicon sensors. Silvaco T-CAD allows the implementation of magnetic fields of several Tesla in the simulation. Using this simulation package, Lorentz angle measurements on strip sensors have been reproduced. Results on non-irradiated devices and the ongoing work of implementing radiation damage using an effective trap model will be presented.

Primary author: NURNBERG, Andreas Matthias (KIT - Karlsruhe Institute of Technology (DE))

Co-authors: DIERLAMM, Alexander (KIT - Karlsruhe Institute of Technology (DE)); Prof. MULLER, Thomas (KIT - Karlsruhe Institute of Technology (DE)); DE BOER, Wim (KIT - Karlsruhe Institute of Technology (DE))

Presenter: NURNBERG, Andreas Matthias (KIT - Karlsruhe Institute of Technology (DE))

Session Classification: Device Simulations and some key experimental data

Contribution ID: 42

Type: **Standard (20 min including discussion)**

Active pixel sensors in 180 nm HV CMOS technology for HL-LHC detector upgrades

Friday, 15 November 2013 12:00 (20 minutes)

Recently, certain CMOS processes featuring the option to apply significant bias voltages have shown the potential for producing drift-based radiation-hard tracking detectors.

We explore the concept of using a deep-submicron HV CMOS process to produce a drop-in replacement for traditional radiation-hard silicon sensors. Such active sensors contain simple circuits, e.g. amplifiers and discriminators, but still require a traditional (pixel or strip) readout chip. This approach yields most advantages of MAPS (improved resolution, reduced cost and material budget, etc.), without the complication of full integration on a single chip.

After outlining the basic design of the HV2FEI4 test ASIC, results after irradiation with protons, x-rays and neutrons up to $1e16$ neq/cm² or 100MRad will be presented. Design changes towards the optimised HV2FEI4_v2 are discussed and results after irradiation up to 862 MRad are shown before elaborating on future plans and general prospects of active sensors. Finally, an overview is given on similar approaches aiming for fully monolithic rad-hard pixel and strip detectors.

Primary author: MUENSTERMANN, Daniel (Universite de Geneve (CH))

Presenter: MUENSTERMANN, Daniel (Universite de Geneve (CH))

Session Classification: 3D detectors and slim edges

Contribution ID: 43

Type: **not specified**

Proposal for a production of thin active edge diodes and pixels

Friday, 15 November 2013 11:30 (10 minutes)

Presenter: MACCHIOLO, Anna (Max-Planck-Institut fuer Physik (Werner-Heisenberg-Institut) (D))

Session Classification: 3D detectors and slim edges

Contribution ID: 44

Type: **Standard (20 min including discussion)**

Preliminary irradiation studies of ultra thin 3D detectors

Friday, 15 November 2013 12:20 (20 minutes)

We will show the first results of 3D ultra thin silicon detectors irradiated with neutrons at 10^{16}cm^{-2} 1MeV eq. The detectors were tested at room and low temperature with alpha particles.

Primary author: Dr GRECO, Virginia (CNM-IMB-CSIC)

Co-authors: Dr FLETA CORRAL, Celeste (Instituto de Microelectrónica de Barcelona, Centro Nacional de Microelectrónica (ES)); GARCIA FUENTES, Francisco Ignacio (Helsinki Institute of Physics (FI)); PELLEGRINI, Giulio (CNM-IMB-CSIC); Mr ESTEBAN, Sergi (CNM-IMB-CSIC)

Presenters: PELLEGRINI, Giulio (Universidad de Valencia (ES)); Dr GRECO, Virginia (CNM-IMB-CSIC)

Session Classification: 3D detectors and slim edges

Contribution ID: 45

Type: **not specified**

Particulas Demonstration of a Commercial TCT system

Wednesday, 13 November 2013 11:30 (10 minutes)

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

Session Classification: Defect and Pad Detector Characterization