33rd RD50 Workshop (CERN)

Report of Contributions

https://indico.cern.ch/e/754063

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

DAQ-ROC4Sens

Wednesday 28 November 2018 09:30 (20 minutes)

Where we will present to the RD50 community our new DAQ card project, now near its completion, capable of managing up to 4 ROC4Sens hybrid pixel detectors, ideal for testbeams, with only one DAQ Card and no external server (the data server is incorporated into the hybrid FPGA, with simple TCP/IP external access). The system is even able to make data processing on site.

Primary authors: Dr PALOMO PINTO, Francisco Rogelio (ETSI-USe); Dr MUÑOZ CHAVERO, Fernando (Dept. Ingeniería Electrónica ETSI Sevilla); Dr MILLÁN VÁZQUEZ DE LA TORRE, Rafael (Dpto. Ingeniería Electrónica ETSI Sevilla); Dr HINOJO, Jose María (Dpto. Ingeniería Electrónica ETSI Sevilla); Mr BLANCO CARMONA, Pedro (Dpto. Ingeniería Electrónica ETSI Sevilla); Mr SÁNCHEZ, Jorge (Dpto. Ingeniería Electrónica ETSI Sevilla); Dr VILA ALVAREZ, Iván (IFCA)

Presenters: Dr PALOMO PINTO, Francisco Rogelio (ETSI-USe); PALOMO PINTO, Francisco Rogelio (Universidad de Sevilla (ES)); PALOMO PINTO, Francisco Rogelio (Universidad de Sevilla (ES))

Session Classification: Pixel and Strip Detectors

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

Charge collection test and TCAD simulation of OVERMOS, a CMOS 180nm MAPS detector

Tuesday 27 November 2018 14:10 (20 minutes)

We will present results of charge collection of OVERMOS, a high resistivity TJ 180nm CMOS MAPS, obtained using 1064 nm calibrated laser source.
Result include charge collection over pixel region, sampled with 5 um resolution, and charge collection time. Test results are compared with 3D TCAD optical simulations, taking into account SiO2 and CoSi2 attenuation.

Primary authors: Dr VILLANI, E. Giulio (STFC Rutherford Appleton Laboratory); Dr DOPKE, Jens (Rutherford Appleton Laboratory); Dr FRENCH, M. Marcus (Rutherford Appleton Laboratory); Prof. MCMAHON, Stephen (Rutherford Appleton Laboratory); Dr SEDGWICK, Iain (Rutherford Appleton Laboratory); Dr SELLER, Paul (Rutherford Appleton Laboratory); Prof. WILSON, Fergus (Rutherford Appleton Laboratory); Dr ZHANG, Zhige (Rutherford Appleton Laboratory); Prof. WORM, Steve (University of Birmingham); Dr LIANG, Zhijun (Institute of High Energy Physics,CAS); Prof. ZHU, Hongbo (Institute of High Energy Physics,CAS); Prof. XIU, Qing lei (Institute of High Energy Physics,CAS)

Presenters: Dr VILLANI, E. Giulio (STFC Rutherford Appleton Laboratory); VILLANI, Enrico Giulio (Science and Technology Facilities Council STFC (GB)); VILLANI, Enrico Giulio (STFC - Science & Technology Facilities Council (GB)); VILLANI, Giullio (Rutherford Appleton Laboratory)

Session Classification: Device Simulation

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

Sequence Dependent Mixed Irradiations

Monday 26 November 2018 12:00 (20 minutes)

This presentation shows CV characteristics and charge collection measurements on strip sensors and diodes after mixed irradiation with 23 MeV protons and 1 MeV neutrons. Samples of different material types were irradiated with neutrons after protons and vice versa with a total fluence of 6e14 n_{eq}/cm^2. The depletion voltage is monitored with CV characteristics after the first and second irradiation step. Annealing studies with seed signal measurements are performed after the full irradiation.

Primary author: GOSEWISCH, Jan-Ole (KIT - Karlsruhe Institute of Technology (DE))

Co-author: DIERLAMM, Alexander (KIT - Karlsruhe Institute of Technology (DE))

Presenter: GOSEWISCH, Jan-Ole (KIT - Karlsruhe Institute of Technology (DE))

Session Classification: Defects and Material Characterization

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

Status on TRAMOS (Trapping MOS) and DotPix (QuantumDot Pixel) ongoing developments

Tuesday 27 November 2018 14:30 (20 minutes)

Abstract: The DotPix project is the result of several attempts to design a new kind of pixel for inner vertex detectors arrays with enhanced point-to-point resolution. As experiments include the DEPleted FET (DEPFET) based detector or monolithic pixels, it is now important to design a pixel based on a single device, which can reach a resolution below the micron with reduced thicknesses allowing track reconstruction and vertex determination with unprecedented accuracy. This is necessary for the future e+e- colliders (FCC,ILC).The proposed pixel structure, based on MOS technology will be described with its different possible implementations. It comprises a buried gate, which acts as a charge-collecting electrode with memory effect and controls the current of a micron-size n-channel MOS transistor. The device may be downscaled. The design of an architecture compatible with a process flow close to standard CMOS has required the massive use of device simulations. We have identified the bottlenecks and we will describe the way we can overcome them in a near future.
Short Bibliography:
Nicolas T. Fourches, IEEE Transactions On Electron Devices, Volume 64, Issue 4, (2017) 1619-1623. http://doi.org/10.1109/TED.2017.2670681
France

Primary author: Dr FOURCHES, Nicolas (IRFU/DEDIP/DePhyS CEA Saclay)

Presenter: Dr FOURCHES, Nicolas (IRFU/DEDIP/DePhyS CEA Saclay)

Session Classification: Device Simulation

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

Measurement of E_eff for Irradiated and Annealed Diodes

Monday 26 November 2018 11:20 (20 minutes)

The leakage current of silicon sensors and diodes depends on temperature. To compare measurements of devices obtained at different temperatures, it is necessary to understand the dependence of the bulk current on the temperature.
Bulk current measurements are used to obtain E_{eff} values for proton irradiated n^+-in-n diodes up to a fluence of $3 \times 10^{15}\ \frac{n_{eq}}{cm^2}$ during different stages of annealing for voltages up to 1000 V. A power limit is used to exclude measurements with significant self-heating. This is a test if the established methods and parameters of scaling are applicable after annealing.

Primary author: WIZEMANN, Felix (Technische Universitaet Dortmund (DE))

Presenter: WIZEMANN, Felix (Technische Universitaet Dortmund (DE))

Session Classification: Defects and Material Characterization

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

Test beam results of irradiated silicon sensor with modified ATLAS pixel implantations

Wednesday 28 November 2018 11:20 (20 minutes)

Planar n^+-in-n silicon pixel sensors with modified n^+-implantations were designed in Dortmund to cause electrical field strength maxima to increase charge collection after irradiation and thus increase particle detection efficiency. Baseline for the pixel designs was the pixel layout of the IBL planar silicon pixel sensor with a $250\,\mu\text{m} \times 50\,\mu\text{m}$ pitch.
The modified pixel designs and the standard IBL design are placed on one sensor which can be read out by an FE-I4 to test and compare the different pixel designs.
After irradiation with protons and neutrons respectively the performance of several sensors is tested in test beam measurements.
The relative performance of the pixel designs is different for sensors irradiated to the same fluence with neutrons in Sandia compared to sensors irradiated with neutrons in Ljubljana or with protons at CERN PS.
In this talk the current status of our investigation is presented to explain these significant differences which are visible in in-pixel efficiency maps.

Primary author: WEERS, Mareike (Technische Universitaet Dortmund (DE))

Co-authors: ALTENHEINER, Silke (Technische Universitaet Dortmund (DE)); GISEN, Andreas (Technische Universitaet Dortmund (DE)); HOETTING, Marius (Technische Universitaet Dortmund (DE)); HOHM, Valerie Vanessa (Technische Universitaet Dortmund (DE)); KROENINGER, Kevin Alexander (Technische Universitaet Dortmund (DE)); LOENKER, Jonas (Technische Universitaet Dortmund (DE)); MUSCHAK, Mike Richard (Technische Universitaet Dortmund (DE)); RAYTAROWSKI, Anna-Katharina (Technische Universitaet Dortmund (DE)); WEINGARTEN, Jens (Technische Universitaet Dortmund (DE)); WIZEMANN, Felix (Technische Universitaet Dortmund (DE))

Presenter: WEERS, Mareike (Technische Universitaet Dortmund (DE))

Session Classification: Pixel and Strip Detectors

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

Overview of design and evaluation of depleted CMOS sensors within RD50

Wednesday 28 November 2018 13:50 (20 minutes)

This contribution describes the status of the design and evaluation of depleted CMOS sensors within the CERN-RD50 collaboration. In particular, we will present laboratory measurements of RD50-MPW1 and TCAD simulated results of the structures on this chip. The results obtained so far, especially those related to the leakage current generated by the sensors, necessitate the submission of a second test MPW prior to the fabrication of the planned large area submission (RD50-ENGRUN1). The second test MPW (RD50-MPW2) will integrate several passive single pixels with different features and one or two very small matrices of pixels with fast low-noise readout circuitry. The aim of RD50-MPW2 is to understand the origin of the leakage current generated by the sensors and to evaluate different approaches to minimizing this problem. We will report on the microelectronic design and TCAD simulations towards RD50-MPW2. We will also report on the progress of design work towards RD50-ENGRUN1. In particular, that related to the improvement of the time resolution of depleted CMOS sensors with the utilization of sampling circuitry.

Primary author: VILELLA FIGUERAS, Eva (University of Liverpool (GB))

Co-authors: ALONSO CASANOVAS, Oscar (University of Barcelona); CASANOVA MOHR, Raimon (The Barcelona Institute of Science and Technology (BIST) (ES)); CASSE, Gianluigi (University of Liverpool (GB)); DIEGUEZ, Angel (Universitat de Barcelona); FRANKS, Matthew Lewis; GRINSTEIN, Sebastian (IFAE - Barcelona (ES)); MARCO HERNANDEZ, Ricardo (Instituto de Fisica Corpuscular (ES)); MASSARI, Nicola (FBK); MUNOZ CHAVERO, Fernando (Universidad de Sevilla (ES)); PALOMO PINTO, Francisco Rogelio (Universidad de Sevilla (ES)); POWELL, Samuel (University of Liverpool (GB)); VOSSEBELD, Joost (University of Liverpool (GB)); ZHANG, Chenfan (University of Liverpool)

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

Session Classification: CMOS

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

Development in Radiation hardness study on the third FBK production of Ultra fast silicon Detectors

Tuesday 27 November 2018 10:10 (20 minutes)

A new Ultra Fast Silicon Detectors production (UFSD3) has been produced by Fondazione Bruno Kessler (FBK) in Trento, in collaboration with University of Trento and National Institute of Nuclear Physics in Turin (INFN).
This new UFSD batch has been produced on Silicon-on-Silicon Epitaxial and Float Zone wafers, with an active thickness of 50μm.
One of the target of the UFSD3 production is the improvement of the radiation hardness and the investigation of the initial acceptor removal mechanism in the multiplication layer (gain layer).
The previous Ultra Fast Silicon Detector production (UFSD2) demonstrated an improvement of the radiation hardness in UFSD sensors with Carbon co-implantation in gain layer; In UFSD3, 4 splits in Carbon dose have been used to investigate the acceptor removal mechanism.
We will report on electrical characterization of not-irradiated and irradiated devices, measurements of acceptor removal on sensors with four different Carbon doses co-implantation and preliminary comparison on irradiated UFSD3 and UFSD2 sensors.

Primary author: FERRERO, Marco (Universita e INFN Torino (IT))

Co-authors: BOSCARDIN, Maurizio (FBK Trento); PATERNOSTER, Giovanni (Fondazione Bruno KEssler); DALLA BETTA, Gian Franco (Universita degli Studi di Trento è INFN (IT)); PANCHERI, Lucio (University of Trento); FICORELLA, Francesco; BORGHI, Giacomo; CARTIGLIA, Nicolo (INFN Torino (IT)); ARCIDIACONO, Roberta (Universita e INFN Torino (IT)); SOLA, Valentina (Universita e INFN Torino (IT)); MANDURRINO, Marco (INFN); SIVIERO, Federico; MARTA, tornago

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

Session Classification: Precision Timing Detectors

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

Irradiation study of CMOS pixel detector structures on RD50-MPW1 chips from LFoundry

Wednesday 28 November 2018 14:10 (20 minutes)

RD50 submitted a pixel detector prototype ASIC in the 150 nm CMOS technology at LFoundry. It contains two matrices of MAPS pixels and few test structures. The test structures include passive pixel arrays near the edge of the chip suitable for E-TCT measurements. The chips were manufactured on p-type silicon with two different initial resistivities around 500 Ohm-cm and 2000 Ohm-cm. Chips were irradiated with neutrons in Ljubljana up to maximal fluence of 2e15 n/cm2. Edge-TCT measurements were made with passive devices and evolution of effective space charge concentration on neutron fluence was measured for the two different initial resistivities. Results of this study will be presented in this contribution.

Primary author: MANDIC, Igor (Jozef Stefan Institute (SI))

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

Session Classification: CMOS

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

Performances of the third UFSD production at FBK

Tuesday 27 November 2018 09:50 (20 minutes)

In this presentation we describe the third production of Ultra-Fast Silicon Detectors (UFSD3) by Fondazione Bruno Kessler (FBK) in Trento, in collaboration with University of Trento and National Institute of Nuclear Physics (INFN) in Torino.
The new UFSD3 production has been designed in order to study specific features requested for the future Endcap Timing Layer of CMS at the High Luminosity LHC, such as uniformity and narrow interpad distance.
Uniformity studies have been done by FBK on wafer and in Torino on cut structures.
Different strategies for gain termination implants have been pursued and measurements of the resulting inactive space between pads have been performed using the Transient Current Technique (TCT).
Plans towards future UFSD production at FBK will also be discussed.

Primary author: TORNAGO, marta

Co-authors: BOSCARDIN, Maurizio (FBK Trento); PATERNOSTER, Giovanni (Fondazione Bruno KEssler); DALLA BETTA, Gian Franco (Universita degli Studi di Trento è INFN (IT)); PANCHERI, Lucio (University of Trento); CARTIGLIA, Nicolo (INFN Torino (IT)); ARCIDIACONO, Roberta (Universita e INFN Torino (IT)); SOLA, Valentina (Universita e INFN Torino (IT)); MANDURRINO, Marco (INFN); FERRERO, Marco (Universita e INFN Torino (IT)); SIVIERO, Federico; FICORELLA, Francesco; BORGHI, Giacomo

Presenter: TORNAGO, marta

Session Classification: Precision Timing Detectors

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

Timing performance of small cell 3D silicon detectors

Tuesday 27 November 2018 12:20 (20 minutes)

A silicon 3D detector with a single cell of 50x50 um2 was produced and evaluated for timing applications. The measurements of time resolution were performed for 90Sr electrons with dedicated electronics used also for determing timing resolution of Low Gain Avalanche Detectors (LGADs). The measurements were compared to those in LGAD and also simulations. The studies showed that the
dominant contribution to the timing resolution comes from the time walk originating from different induced current shapes for hits over the cell area. This contribution decreases with high bias volates, low temperature and small cell size. The values reached are around 30 ps for (50x50 um2, 150 V, -20C) which is comparable to time walk due to Landau fluctuations in LGADs. It improves for inclined tracks and larger pads composed of multiple cells. A good agreement between measurements and simulations was obtained, thus validating the simulation results.

Primary authors: CINDRO, Vladimir (Jozef Stefan Institute (SI)); HITI, Bojan (Jozef Stefan Institute (SI)); KRAMBERGER, Gregor (Jozef Stefan Institute (SI)); MANDIC, Igor (Jozef Stefan Institute (SI)); Prof. MIKUZ, Marko (Jozef Stefan Institute (SI)); Dr PELLEGRINI, Giulio (Centro Nacional de Microelectrónica (IMB-CNM-CSIC) (ES)); ZAVRTANIK, Marko (Jozef Stefan Institute (SI))

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

Session Classification: Precision Timing Detectors

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

Beam Test of Deep Diffused APDs

Tuesday 27 November 2018 11:00 (20 minutes)

Deep diffused avalanche photodiodes are studied as timing detectors for minimum ionizing particles. This application does not require a radiator to generate light to be detected by the APD. The signal is generated and amplified within the APD bulk.
In this talk, preliminary results of a beam test characterization of deep diffused APDs are presented. The beam test setup comprised an MCP-PMT used as a time reference and a beam telescope. These elements allow to study the behavior of various parameters as a function of the impact position of the particles on the detector.

Primary author: CENTIS VIGNALI, Matteo (CERN)

Presenter: CENTIS VIGNALI, Matteo (CERN)

Session Classification: Precision Timing Detectors

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

Innovative TCT studies on the breakdown of UFSD3 sensors by FBK

Tuesday 27 November 2018 11:20 (20 minutes)

The third production of Ultra-Fast Silicon Detectors (UFSD3) was recently completed by Fondazione Bruno Kessler (FBK) in Trento.
This new production features pads and strips arrays with 4 different strategies of the gain implant termination, ranging from an inactive area comparable to UFSD2 production to a configuration with a much narrower width. This choice allows studying the impact of the inactive region width on the sensor properties.
In my contribution, I will present the laboratory measurements performed in the Torino Silicon Lab (INFN –University of Torino), aimed at studying in detail the breakdown voltage of UFSD3 sensors and its dependence on the width of the inactive area.
In particular, I will focus on the results achieved using a state of the art CCD camera and employing the Transient Current Technique (TCT) in an innovative way, which gave us a new tool for mapping the sensors hot spots.
Finally, I will report on the observation of micro-discharges occurring both in irradiated and unirradiated UFSD3 sensors.

Primary author: SIVIERO, Federico

Co-authors: BOSCARDIN, Maurizio (FBK Trento); PATERNOSTER, Giovanni (Fondazione Bruno KEssler); BORGHI, Giacomo; FICORELLA, Francesco; DALLA BETTA, Gian Franco (Universita degli Studi di Trento è INFN (IT)); PANCHERI, Lucio (University of Trento); CARTIGLIA, Nicolo (INFN Torino (IT)); ARCIDIACONO, Roberta (Universita e INFN Torino (IT)); SOLA, Valentina (Universita e INFN Torino (IT)); MANDURRINO, Marco (INFN); FERRERO, Marco (Universita e INFN Torino (IT)); TORNAGO, marta

Presenter: SIVIERO, Federico

Session Classification: Precision Timing Detectors

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

Performance of LPNHE/FBK/INFN thin planar \textit{n-on-p} silicon pixels after HL-LHC radiation fluences

Wednesday 28 November 2018 11:00 (20 minutes)

The tracking detector of ATLAS, one of the experiments at the Large Hadron Collider (LHC), will be upgraded in 2024-2026 to cope with the challenging environment conditions of the High Luminosity LHC (HL-LHC). The LPNHE, in collaboration with FBK and INFN, has produced 130˜µm thick n−on−p silicon pixel sensors which can withstand the expected large particle fluences at HL-LHC, while delivering data at high rate with excellent hit efficiency. Such sensors were tested on beam before and after irradiation both at CERN-SPS and at DESY, and their performances are presented in this paper. Beam test data indicate that these detectors are suited for all the layers where planar sensors are foreseen in the future ATLAS tracker: hit-efficiency is greater than 97% for fluences Φ⊠7e15 neq/cm2 and module power consumption is within the specified limits. Moreover, at a fluence Φ=1.3e16 neq/cm2, hit-efficiency is still as high as 88% and charge collection efficiency is about 30%.

Primary author: BOMBEN, Marco (LPNHE & Université Paris Diderot, Paris (FR))

Presenter: BOMBEN, Marco (LPNHE & Université Paris Diderot, Paris (FR))

Session Classification: Pixel and Strip Detectors

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

Comparative analysis of proton and ion damages in Si detectors supplemented with SRIM simulations

Monday 26 November 2018 15:00 (20 minutes)

In the study impact of ⁴⁰Ar ion irradiation was compared with proton irradiation for scaling the silicon detectors degradation characteristics and evaluating the influence of the vacancy generation rate on the degradation. The ⁴⁰Ar ions with the total energy of 1.62 GeV were chosen since they provide uniform defect generation like 23 GeV protons. The values of the current related damage rate, introduction rates for microscopic defects and the effective space charge concentration were obtained from the experimental data at increasing ion fluence. The results are discussed using the data on vacancy generation obtained from SRIM simulation.

Primary authors: MITINA, Daria (Ioffe Institute); EREMIN, Vladimir (Ioffe Institute (RU)); VERBITSKAYA, Elena (Ioffe Institute (RU))

Presenter: MITINA, Daria (Ioffe Institute)

Session Classification: Defects and Material Characterization

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

Thin LGADs characterization using Ion Beam Induced Charge (IBIC) and Time-resolved IBIC at the Centro Nacional de Aceleradores

Tuesday 27 November 2018 11:40 (20 minutes)

In this talk we will present the first results obtained within our RD50 project concerning the study of thin (50 μm) Low Gain Avalanche Detectors with four sectors.
Using a nuclear microprobe, with a lateral resolution of a few micrometers, we have analyzed the CCE homogeneity of the sensor and the behavior of the peripheral regions under proton irradiation. We will show the gain curve measured with protons at 3, 4 and 18 MeV and with an alpha source, and the experimental data will be compared with TCT results. In addition, crosstalk effects between different sectors have been observed using the scan system of the microbeam line. Finally, the transient signal of the induced carriers has been recorded at several voltages.

Primary authors: Dr JIMENEZ RAMOS, Carmen (National Accelerator Center); GARCIA LOPEZ, Javier (University of Seville); Dr VILA ALVAREZ, Ivan (Instituto de Física de Cantabria (CSIC-UC)); Dr HIDALGO VILLENA, Salvador (Instituto de Microelectronica de Barcelona (IMB-CNM-CSIC)); GOMEZ--CAMACHO, Joaquin (Universidad de Sevilla)

Presenter: Dr JIMENEZ RAMOS, Carmen (National Accelerator Center)

Session Classification: Precision Timing Detectors

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

Novel view on extraction of charge carrier transport parameters from classical TCT

Tuesday 27 November 2018 15:50 (20 minutes)

The main experimental instrument for study of the field distribution in irradiated silicon detectors is a transient current technique (TCT). It is shown in this study that even in the case of significant contribution of carrier trapping to the shape of current response, the raw data of regular TCT (shape of current response in pad detector) allow to derive the electric field distribution with accuracy better than 5%. The new approach was applied for treatment of experimental double peak responses obtained for irradiated detectors and demonstrated specific of E(x) evolution with the bias voltage.

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

Presenter: SHEPELEV, Artem (Ioffe Institute)

Session Classification: Characterization Techniques

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

3D silicon sensors for ATLAS ITk pixel detector

Wednesday 28 November 2018 12:00 (20 minutes)

The HL-LHC upgrade will set strong requirements on the radiation hardness of the innermost layer of the new ITk pixel detector of ATLAS due to the large particle fluence.
At the same time the high particle multiplicity will require to reduce the hit occupancy, especially in the large pseudo-rapidity regions of the detector.
The sensor technology that has proven its compliance with the requisites for the innermost layer of ITk is 3D silicon sensors, which has been selected as baseline given its superior radiation hardness.
New 3D silicon sensors have been produced at CNM (Barcelona) with a Silicon On Insulator (SOI) single sided technology. They feature geometries with small pixel cells of 50x50µm2 or 25x100µm2 and active substrates of 150µm and 100µm of thickness.The sensors have been flip-chipped and assembled at iFAE to the novel RD53A ASIC prototypes designed for HL-LHC. The full modules have been irradiated with protons to fluences foreseen for the innermost layer of ITk.
A characterisation before and after irradiation has then been performed in beam tests at CERN SPS with 120 GeV pions. Results will be reported in this contribution.

Primary authors: GIANNINI, Giulia (IFAE Barcelona); GRINSTEIN, Sebastian (IFAE - Barcelona (ES)); TERZO, Stefano (IFAE Barcelona (ES)); MANNA, Maria (Centro National de Microelectronica - CNM-IMB-CSIC); PELLEGRINI, Giulio (Centro Nacional de Microelectrónica (IMB-CNM-CSIC) (ES)); Dr QUIRION, David (IMB-CNM, CSIC)

Presenter: GIANNINI, Giulia (IFAE Barcelona)

Session Classification: Pixel and Strip Detectors

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

Experimental Determination of Proton Hardness Factors at Various Irradiation Facilities.

Monday 26 November 2018 15:20 (20 minutes)

The scheduled upgrade of the LHC to the HL-LHC presents new challenges in radiation damage studies. Around the world, campaigns to measure radiation hardness of detector sensors and components are being undertaken. Upon analysis of the I–V and C–V characteristics of BPW34F photodiodes, the hardness factors for proton beams at three different facilities have been measured. By computing the change in leakage current of the photodiodes pre- and post-irradiation as a function of proton fluence, the hardness factor of the University of Birmingham's MC40 cyclotron was found to be 2.20 ± 0.08 for an energy of 25 MeV. For a beam energy of 23 MeV, and adopting a similar methodology, a value of 2.20 ± 0.28 was determined for the cyclotron at the Karlsruhe Institute of Technology. The hardness factor of the IRRAD proton facility at CERN was measured to be 0.62±0.02 for a beam energy of 24 GeV, which is consistent with an independent measurement of 0.63 with FZ sensors at IRRAD. The value for the MC40 cyclotron is in agreement with the currently quoted value, and the values for the IRRAD facility and the Karlsruhe Institute of technology agree with other independent studies.

Primary authors: DIERLAMM, Alexander (KIT - Karlsruhe Institute of Technology (DE)); FELIX, Bogelspacher (Karlsruhe Institute of Technology); SIMPSON-ALLSOP, Cameron James (University of Birmingham (GB)); RAVOTTI, Federico (CERN); MATEU, Isidre (CERN); NIKOLOPOULOS, Konstantinos (University of Birmingham (GB)); GONELLA, Laura (University of Birmingham (UK)); RAM, Lydia (University of Birmingham); MOLL, Michael (CERN); KNIGHTS, Patrick (University of Birmingham); ALLPORT, Philip Patrick (University of Birmingham (UK)); CANVAN, Rhiann (University of Surrey); PRICE, Tony (University of Birmingham (GB))

Presenter: SIMPSON-ALLSOP, Cameron James (University of Birmingham (GB))

Session Classification: Defects and Material Characterization

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

Characterization before and after irradiation of RD53A planar pixel modules

Wednesday 28 November 2018 09:50 (20 minutes)

Pixel modules built with thin n-in-p planar sensors, produced at MPG-HLL, interconnected to RD53A read-out chips, have been characterized
before and after irradiation. Different sensor design have been implemented, to optimize the performance in view of the application
of these type of devices in the trackers at HL-LHC.
The results in term of hit efficiency obtained in beam tests at CERN SPS will be presented, with modules irradiated up to a fluence of 5e15 neq/cm2.

Primary authors: MACCHIOLO, Anna (Max-Planck-Institut fur Physik (DE)); NISIUS, Richard (Max-Planck-Institut fur Physik (DE)); BEYER, Julien-Christopher (Max-Planck-Institut fur Physik (DE)); CHATTERJEE, Meghranjana (Max-Planck-Institut fur Physik (DE))

Presenter: MACCHIOLO, Anna (Max-Planck-Institut fur Physik (DE))

Session Classification: Pixel and Strip Detectors

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

Development status of a novel proton irradiation site at the HISKP isochronous cyclotron Bonn

Monday 26 November 2018 11:00 (20 minutes)

The development status of a novel proton irradiation site for silicon detectors is presented. The site is located at the isochronous cyclotron of the HISKP (Helmholtz Institut für Strahlen- und Kernphysik) of the University of Bonn. The cyclotron provides protons with up to 14 MeV kinetic energy with beam currents between a few nA and 1 μA. Light ions, such as deuterons, ^{3,4}He or ^{12}C, can also be produced with kinetic energies from 7 to 14 MeV per nucleon. The beam spot at extraction can be adjusted from a few mm to approximately 2 cm in diameter. An electron-cyclotron-resonance (ECR) source with low source-noise enables a stable beam over time. Dedicated secondary-electron monitors with custom readout electronics have been developed for on-line beam-current and position monitoring. The intrinsic resolution of the readout electronics allows to measure the secondary-electron current with a precision of 1\%. The goal is to measure the primary beam current with comparable precision in order to reduce the uncertainty on the proton fluence at the device. Preliminary beam-current calibrations are shown. GEANT4 simulations of energy distributions along the beam line up to the setup conclude a proton hardness factor of $\kappa \approx 3$, allowing to irradiate up to $10^{16} \frac{\text{n.e.q}}{\text{cm}^2}$ in 60 minutes. The intended irradiation parameters such as temperature, scanning and shielding are presented as well as plans for measurements of proton and deuteron hardness factors.

Primary authors: WOLF, Pascal (University of Bonn); EVERSHEIM, Dieter (University Bonn); POHL, David-Leon; Dr URBAN, Martin; WERMES, Norbert (University of Bonn (DE))

Presenter: WOLF, Pascal (University of Bonn)

Session Classification: Defects and Material Characterization

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

Measurements of NitroStrip detectors irradiated with protons and neutrons

Monday 26 November 2018 11:40 (20 minutes)

Nitrogen enrich material showed an improvement of some defects after irradiation. NitroStrip is a RD50 project that aims to compare nitrogen enriched silicon wafers with FZ, DOFZ and MCz material. This presentation will show laser measurements and electrical characterization of NitroStrip samples irradiated at different fluences with protons and neutrons.

Primary author: HONIG, Jan Cedric (Albert Ludwigs Universitaet Freiburg (DE))

Co-authors: DIERLAMM, Alexander (KIT - Karlsruhe Institute of Technology (DE)); FRETWURST, Eckhart (Hamburg University (DE)); PELLEGRINI, Giulio (Centro Nacional de Microelectrónica (IMB-CNM-CSIC) (ES)); Dr RAFÍ, Joan Marc (Consejo Superior de Investigaciones Científicas (CSIC)); SCHWANDT, Joern (Hamburg University (DE)); DIEHL, Leena (Albert Ludwigs Universitaet Freiburg (DE)); WIIK-FUCHS, Liv (Albert Ludwigs Universitaet Freiburg (DE)); BASELGA, Marta (KIT - Karlsruhe Institute of Technology (DE)); CENTIS VIGNALI, Matteo (CERN); MOLL, Michael (CERN); KAMINSKI, Pawel (Institute of Electronic Materials Technology); PARZEFALL, Ulrich (Albert Ludwigs Universitaet Freiburg (DE))

Presenter: HONIG, Jan Cedric (Albert Ludwigs Universitaet Freiburg (DE))

Session Classification: Defects and Material Characterization

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

Processing of pixel detectors on p-type MCz silicon using atomic layer deposition (ALD) grown aluminium oxide

Wednesday 28 November 2018 10:10 (20 minutes)

We report on the fabrication of DC- and AC-coupled n+-in-p pixel detectors on magnetic Czochralski silicon substrates, using aluminium oxide (Al2O3) thin films grown by atomic layer deposition (ALD) as dielectric and field insulator. Al2O3 thin films exhibit high negative oxide charge, and thus do not require p-stop/p-spray insulation implants between pixels. In addition, they provide higher capacitance densities than SiO2, permitting more efficient capacitive coupling of pixels.
For bias resistors, sputtered titanium nitride (TiN) is used.
The mask layout includes AC-coupled detectors compatible with the CMS PSI46dig readout chip, DC-coupled detectors with 50x50 um pixels in a geometry to match the new RD53A readout chip, as well reference structures, such as diodes and MOS capacitors.
Results of characterization of diodes and MOS capacitors with CV, IV, and TCT measurements are presented, and the effect of gamma irradiation on these devices is discussed. Results show the expected high negative charge of the Al2O3 dielectric and acceptable leakage currents. In both new and older devices, we observe the compensation of acceptors in the p-type Si bulk upon gamma irradiation, to the point of apparent type-inversion in some cases. Pixel detectors await flip-chip bonding and characterization with the appropriate readout chips.

Primary author: OTT, Jennifer (Helsinki Institute of Physics (FI))

Co-authors: GÄDDA, Akiko (Helsiki Institute of Physics); NAARANOJA, Tiina Sirea (Helsinki Institute of Physics (FI)); GOLOVLEVA, Maria (Helsinki Institute of Physics (FI)); Ms MARTIKAINEN, Laura (Helsinki Institute of Physics (FI)); BRUCKEN, Jens Erik (Helsinki Institute of Physics (FI)); LITICHEVSKYI, Vladyslav; Dr KARADZHINOVA-FERRER, Aneliya (Rudjer Boskovic Institute (HR)); KALLIOKOSKI, Matti (CERN (CH)); HÄRKÖNEN, Jaakko (Rudjer Boskovic Institute); LUUKKA, Panja (Helsinki Institute of Physics (FI))

Presenter: OTT, Jennifer (Helsinki Institute of Physics (FI))

Session Classification: Pixel and Strip Detectors

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

Characterization of semiconductor detectors using IBIC imaging method

Tuesday 27 November 2018 16:10 (20 minutes)

The Ion Beam Induced Current (IBIC) technique available at the Accelerator laboratory of the Ruder Boskovic Institute is using scanning microbeam to study the properties of various semiconductor devices. The characteristics of the IBIC provide us with information of the response of the material and the coordinate of the beam impact point. The focused IBIC technique allows us to map 2D spatially resolved Charge Collection Efficiency (CCE) of different pad and pixelated detector structures with few micrometer resolution.
Semiconductor devices, made of Si and CdTe, were characterized with 2 MeV proton microprobe with different bias settings to create a detailed charge collection studies. In this work we present results of IBIC scans, study the impact of anode material selection, and analyse the performance of the detectors.

Primary author: KARADZHINOVA-FERRER, Aneliya (Rudjer Boskovic Institute (HR))

Co-authors: KALLIOKOSKI, Matti (Rudjer Boskovic Institute (HR)); OTT, Jennifer (Helsinki Institute of Physics (FI)); GOLOVLEVA, Maria (Helsinki Institute of Physics (FI)); LITICHEVSKYI, Vladyslav (Helsinki Institute of Physics (FI)); GÄDDA, Akiko (Helsiki Institute of Physics); LUUKKA, Panja (Helsinki Institute of Physics (FI)); HÄRKÖNEN, Jaakko (Rudjer Boskovic Institute)

Presenter: KARADZHINOVA-FERRER, Aneliya (Rudjer Boskovic Institute (HR))

Session Classification: Characterization Techniques

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

Radiation Damage Monitoring and Modeling with Full Detector Systems at the LHC

Monday 26 November 2018 09:40 (30 minutes)

This talk will be an overview of the inter-experiment (ATLAS, CMS, LHCb, ALICE) activities on monitoring and modeling radiation damage to our silicon detectors.

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

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

Session Classification: LHC Full Detector Systems

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

Characterization of silicon n+-p-p+ detectors with Al2O3 passivating layers grown by Atomic Layer Deposition method

Monday 26 November 2018 12:20 (20 minutes)

The study focuses on evaluating the characteristics of n+-p-p+ silicon detectors with Al2O3 isolation films processed by Atomic Layer Deposition (ALD) method with a goal of determining the value of the charge density in the alumina layer providing detector stable operation at high voltage. For this, distribution of potentials over the multiple n+ rings implemented in the detector as Voltage Termination Structure (VTS) was studied experimentally. Simulation of the potentials and electric field was applied as a tool to extract the charge density Qf in Al2O3 providing appropriate detector performance.
The results showed: a) applicability of the punch-through model to VTS operation in n-on-p Si detectors; b) impact of the Al2O3 charge on the maximum electric field initiating carrier avalanche multiplication. Simulations allowed to define Qf of -(4-7)×1011 cm-2 as a value critical for VTS operation in the detector under study.

Primary authors: Dr VERBITSKAYA, Elena (Ioffe Institute); Dr EREMIN, Vladimir (Ioffe Institute); Dr FADEEVA, Nadezda (Ioffe Institute); MITINA, Daria (Ioffe Institute); Dr HÄRKÖNEN, Jaakko (Ruđer Bošković Institute); Dr LUUKKA, Panja (Helsinki Institute of Physics); OTT, Jennifer (Helsinki Institute of Physics)

Presenter: Dr VERBITSKAYA, Elena (Ioffe Institute)

Session Classification: Defects and Material Characterization

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

Evolution of the working conditions and time resolution of UFSD sensors during the sensor lifetime at HL-LHC

Tuesday 27 November 2018 09:30 (20 minutes)

In this presentation, we will review the evolution of the properties of UFSD sensors produced by different vendors as a function of fluence. We will show the expected working points and time resolution during the HL-LHC lifetime, and we will point out the differences among vendors.

Primary 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

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

Annealing and Characterization of Irradiated Low Gain Avalanche Detectors

Tuesday 27 November 2018 12:00 (20 minutes)

Irradiated Low Gain Avalanche Detectors (LGADs) are investigated using the Transient Current Technique (TCT). The sensors are irradiated to a fluence of 10^{14} $\mathrm{n_{eq}/cm^2}$. For different annealing times (at 60℃), the collected charge, the gain and the electric field profile is measured.

Primary author: WIEHE, Moritz Oliver (CERN / Albert Ludwigs Universitaet Freiburg (DE))

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

Session Classification: Precision Timing Detectors

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

Status of TSC measurements at Hamburg - I. Nitrogen enriched versus standard FZ material, II. Acceptor removal after irradiation with 5.5 MeV electrons

Monday 26 November 2018 14:40 (20 minutes)

Microscopic studies using the Thermally Stimulated Current (TSC) method have been performed on nitrogen enriched and standard n-type FZ samples. The devices were irradiated with 23 GeV protons at the CERN PS and with reactor neutrons at Ljubljana. For the trap filling during the TSC measurement cycles either a forward current of 1 mA was applied or light of 520 nm wave length was injected into the optical window at the p+-electrode. Further first annealing studies were undertaken at 60 ℃ up to 80 min. In addition I-V and C-V measurements have been compared with the microscopic results. The so far preliminary results indicate that an improvement of the radiation hardness by nitrogen enrichment as reported by P. Kaminski [1] could not be reproduced. More details about the comparison with standard FZ material will be presented.
In the second part first studies and results on TSC measurements on highly Boron doped EPI samples with a thickness of 50 µm and irradiated with 5.5 MeV electrons will be presented. One problem connected in TSC measurements with such highly doped material is the fact that the samples could not always be biased up to total depletion in order to extract exact concentration values. This will be discussed in the talk.
[1] P. Kaminski et al., 30-th RD50 Workshop, June 2017, AGH Krakow, Poland

Primary authors: FRETWURST, Eckhart (Hamburg University (DE)); GARUTTI, Erika (Hamburg University (DE)); MAKARENKO, Leonid (Byelorussian State University (BY)); MOLL, Michael (CERN); SCHWANDT, Joern (Hamburg University (DE)); PINTILIE, Ioana (NIMP Bucharest-Magurele, Romania)

Presenter: FRETWURST, Eckhart (Hamburg University (DE))

Session Classification: Defects and Material Characterization

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

Acceptor removal project in the framework of RD50 collaboration and last TSC results on p-type Si pad diodes

Monday 26 November 2018 14:20 (20 minutes)

In present work a new common acceptor removal project in the framework of RD50 collaboration, role of each participant, type of measurement and samples distribution will be outlined.
The proton- and neutron-fluence dependent radiation damage effects, including change in leakage current, effective doping concentration, Neff, space charge sign inversion, but also introduction and annealing evolution of point- and cluster-defects have been studied in Si pad diodes fabricated from p-type EPI material of different resistivities (10-1000Ω·cm). Standard electrical characterisation and TSC (Thermally Stimulated Current) techniques were used.

Results of performed I-V, C-V and TSC measurements are discussed. A promising correlation between effective doping concentration Neff obtained from C-V measurements and defect concentration Nc extracted from TSC measurements for both neutron and proton irradiation is observed.

In TSC measurements a detailed analysis of the dominant peaks - E(30K), BiOi and three main deep acceptor levels H(116K), H(140K) and H(152K) - tentatively responsible for the change in the effective space charge is performed. The origin, field-enhanced and annealing behaviour of E(30) and H(40) and cluster-related defects are discussed as well.

Primary authors: GURIMSKAYA, Yana (CERN); MATEU, Isidre (CERN); DIAS DE ALMEIDA, Pedro (Universidad de Cantabria (ES)); VELISCEK, Iza; FERNANDEZ GARCIA, Marcos (Universidad de Cantabria (ES)); MOLL, Michael (CERN)

Presenter: GURIMSKAYA, Yana (CERN)

Session Classification: Defects and Material Characterization

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

NIEL study of high energy heavy ions in silicon

Monday 26 November 2018 16:10 (20 minutes)

Following the end of the 2017 and 2018 proton irradiation campaigns, high energy Xenon (2017) and Lead (2018) ions were delivered to the IRRAD facility at CERN. While the purpose of the heavy ion beams was mainly to test electronic components for Space in the CHARM facility downstream of IRRAD, dedicated experiments were also performed in which pad diodes were irradiated at different fluences in order to experimentally determine the hardness factor of the two new beams.

Primary authors: MATEU, Isidre (CERN); RAVOTTI, Federico (CERN); PEZZULLO, Giuseppe (CERN); MOLL, Michael (CERN)

Presenter: MATEU, Isidre (CERN)

Session Classification: Defects and Material Characterization

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

Discussion

Tuesday 27 November 2018 13:40 (30 minutes)

Presenters: PELLEGRINI, Giulio (Universidad de Valencia (ES)); KRAMBERGER, Gregor (Jozef Stefan Institute (SI))

Session Classification: Precision Timing Detectors

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

Discussion

Tuesday 27 November 2018 14:50 (30 minutes)

Presenters: SCHWANDT, Joern (Hamburg University (DE)); BOMBEN, Marco (LPNHE & Université Paris Diderot, Paris (FR)); BOMBEN, Marco (U. di Trieste)

Session Classification: Device Simulation

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

Discussion

Monday 26 November 2018 16:30 (30 minutes)

Presenter: MOLL, Michael (CERN)

Session Classification: Defects and Material Characterization

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

Discussion

Wednesday 28 November 2018 13:20 (30 minutes)

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

Session Classification: Pixel and Strip Detectors

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

Discussion

Wednesday 28 November 2018 14:50 (30 minutes)

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

Session Classification: CMOS

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

Discussion

Monday 26 November 2018 10:10 (20 minutes)

Presenters: NACHMAN, Ben (Lawrence Berkeley National Lab. (US)); KRAMBERGER, Gregor (Jozef Stefan Institute (SI)); MOLL, Michael (CERN)

Session Classification: LHC Full Detector Systems

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

Discussion

Tuesday 27 November 2018 16:30 (30 minutes)

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

Session Classification: Characterization Techniques

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

Electrically defects in unirradiated p-type silicon detectors fabricated by different vendors

Monday 26 November 2018 13:40 (20 minutes)

TBA

Primary author: BESLEAGA STAN, Cristina (National Institute of Materials Physics)

Presenter: BESLEAGA STAN, Cristina (National Institute of Materials Physics)

Session Classification: Defects and Material Characterization

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

Defect investigations in 1 MeV neutron irradiated PiN pads and LGADs

Monday 26 November 2018 14:00 (20 minutes)

TBA

Primary author: BESLEAGA STAN, Cristina (National Institute of Materials Physics)

Presenter: BESLEAGA STAN, Cristina (National Institute of Materials Physics)

Session Classification: Defects and Material Characterization

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

Test beam characterization of irradiated (1E16n_eq/cm2) 3D pixel sensors readout with the RD53A ROC

Wednesday 28 November 2018 11:40 (20 minutes)

Pixelated 3D sensors with two different cell form factors(50 um x 50 um, and 25 um x 100 um with one and two junctions)
were characterized at the SPS test beam. The samples were fabricated at FBK using a single side technology.
Sensors were readout with the RD53A ROC. Results on hit efficiency, cluster size and hit position residuals for fresh and
irradiated (1E16 n_eq/cm2) samples are presented. The response against bias voltage and temperature is also considered.

Primary author: GARCIA ALONSO, Andrea (Universidad de Cantabria (ES))

Presenter: GARCIA ALONSO, Andrea (Universidad de Cantabria (ES))

Session Classification: Pixel and Strip Detectors

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

Options and constraints for passive sensor fabrication at CMOS foundries

Wednesday 28 November 2018 14:30 (20 minutes)

With larger and larger areas to be covered for all-silicon trackers and even silicon-based calorimeters, production cost per sensor area and also production turnaround and throughput are becoming important aspects. CMOS foundries have a very large throughput on 8" wafers and may offer very competitive prices, but in turn impose several constraints. The presentation will summarise the pros and cons of CMOS foundries for planar sensor production.

Primary author: MUENSTERMANN, Daniel (Lancaster University (GB))

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

Session Classification: CMOS

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

Welcome to the 33rd RD50 Workshop and latest RD50 news

Monday 26 November 2018 09:30 (10 minutes)

Presenter: MOLL, Michael (CERN)

Session Classification: LHC Full Detector Systems