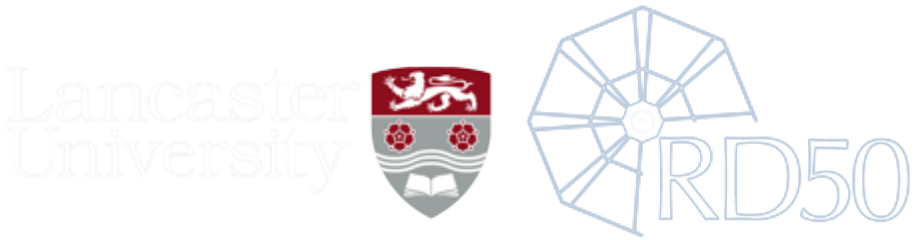
34th RD50 Workshop (Lancaster)



Report of Contributions

https://indico.cern.ch/e/812761

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

The effect of temperature and irradiation on the LGAD gain mechanism

Wednesday, 12 June 2019 11:00 (20 minutes)

In this contribution, I will present the data currently available on the effects of temperature and irradiation on the gain mechanisms of LGAD. The data currently available regard both the multiplication mechanism in the bulk and in the gain layer. From these measurements, a model of the behavior of future LGAD productions vs temperature and fluence can be established.

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

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

Session Classification: Precision Timing Detectors

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

LGAD radiation hardness studies for the High-Granularity Timing Detector (Phase-II upgrade of the ATLAS detector)

Wednesday, 12 June 2019 10:40 (20 minutes)

A High Granularity Timing Detector (HGTD) is proposed for the ATLAS detector upgrade for the high luminosity LHC phase where the pile-up is expected to increase on average to 200 interactions per bunch crossing. The detector will be in front of the liquid Argon end-cap calorimeters for pile-up mitigation and for bunch per bunch luminosity measurements. Two Silicon sensors double sided layers are foreseen to provide a precision timing information for minimum ionizing particle with a time resolution better than 50 pico-seconds per hit (i.e 30 pico-seconds per track) in order to assign the particle to the correct vertex. Each readout cell has a transverse size of 1.3 mm × 1.3 mm leading to a highly granular detector with about 3 million readout electronics channels on each side of the detector. Low Gain Avalanche Detector (LGAD) technology has been chosen as it provides an internal gain good enough to reach a large signal to noise ratio needed for excellent time resolution.

The main challenge faced by the HGTD collaboration is the development of an LGAD with sufficient radiation hardness for the entire lifetime of HL-LHC running, corresponding to a fluence of 5E15 n/cm2 equivalent neutrons and a total ionizing dose of 4 MGy. An interchange of the inner disc of detector with higher irradiation is planned mid-run. The chosen sensor must maintain throughout the entire run time the time resolution of 50 pico-seconds and a sufficient collected charge to allow the read out electronics to operate properly.
During the presentation the latest studies on radiation hardness of LGAD silicon detectors will be shown including the progress on deep gain layer implantation and carbon addition.

Primary author: Dr MAZZA, Simone Michele (University of California,Santa Cruz (US))

Co-authors: SEIDEN, Abraham (University of California,Santa Cruz (US)); SADROZINSKI, Hartmut (SCIPP, UC santa Cruz); SCHUMM, Bruce Andrew (University of California,Santa Cruz (US)); GEE, Carolyn (University of California,Santa Cruz (US)); ZHAO, Yuzhan (University of California Santa Cruz); CARTIGLIA, Nicolo (INFN Torino (IT)); GALLOWAY, Zachary

Presenter: Dr MAZZA, Simone Michele (University of California,Santa Cruz (US))

Session Classification: Precision Timing Detectors

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

Characterization and identification of defects in Si-pixel and CdTe detectors using scanning laser-TCT

Thursday, 13 June 2019 09:40 (20 minutes)

Pixel detectors, made of Si and CdTe, were characterized by raster scanning the detector surfaces with laser-TCT setup. The detectors were manufactured using aluminum oxide (Al_2O_3) thin films grown by atomic layer deposition (ALD) as dielectric and field insulator. From the TCT-maps we measure signal shaping within the bulk, locate defects, and evaluate their impact to the charge collection efficiency. By separating the maps in time domain, we can study the uniformity of the rise time and the signal duration in the pixels. Further, by combining these resulting frames in a stack with intensity matching, a 3d-projection can be made by using the intensity value as Z-coordinate. We present some selected results on the detector scans, where we locate and identify various types of defects using the current transients.

Primary author: Dr KALLIOKOSKI, Matti (Ruđer Bošković Institute (HR))

Co-authors: Dr KARADZHINOVA-FERRER, Aneliya (Ruđer Bošković Institute); Dr HÄRKÖNEN, Jaakko (Ruđer Bošković Institute); BHARTHUAR, Shudhashil (Helsinki Institute of Physics); GOLOVLEVA, Maria (Helsinki Institute of Physics (FI)); GÄDDA, Akiko (Helsiki Institute of Physics); LUUKKA, Panja (Helsinki Institute of Physics (FI)); OTT, Jennifer (Helsinki Institute of Physics (FI))

Presenter: Dr KALLIOKOSKI, Matti (Ruđer Bošković Institute (HR))

Session Classification: Defects and Material Characterization

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

Status of LGAD R&D for the CMS MIP Timing Detector

Wednesday, 12 June 2019 10:20 (20 minutes)

The MIP Timing Detector (MTD) of the Compact Muon Solenoid (CMS) is designed to provide precision timing information (with resolution of ˜40 ps) for charged particles as part of the Phase II upgrade program to prepare for the HL-LHC. The endcap region of MTD, called the Endcap Timing Layer (ETL), will cover the high radiation pseudo-rapidity region between $|\eta|$=1.6 and 3.0. The ETL will be instrumented with silicon low gain avalanche detectors (LGADs), which will receive fluences up to approximately 10^{15} neq/cm^2 We present an overview on the status of the LGAD R&D for the MTD ETL. In particular, we highlight recent results from the Fermilab Test Beam Facility focusing on characterization of the timing performance and uniformity of irradiated LGAD sensors produced by Hamamatsu (HPK) and Fondazione Bruno Kessler (FBK).

Primary author: HELLER, Ryan (Fermi National Accelerator Lab. (US))

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Presenter: HELLER, Ryan (Fermi National Accelerator Lab. (US))

Session Classification: Precision Timing Detectors

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

Simulation of small pixel LGAD's, PixeLGADs.

Thursday, 13 June 2019 13:30 (20 minutes)

Low Gain Avalanche Detectors (LGAD) are part of family of Avalanche Photodiodes but have only small gain of an order of magnitude. LGAD's have been shown to have a very fast response time, order of picoseconds, which can make them useful in many applications, including concurrent excellent time and position resolution tracking for particle physics and synchrotron applications. In this work we present results of TCAD detector simulations. Synopsis TCAD software was employed to perform fabrication process simulations, electrical properties modelling, detector response to incident radiation and influence of pixel size on the effective fill factor. Effective fill factor is the fraction of pixel which shows gain. Several devices with differing pixel periphery's were studied to look at the effective fill factor as a function of pixel size. The effective fill factor was shown to have a large dependence on pixel periphery and size.
LGAD's have been fabricated at Micron Semiconductor for variety of pixel size, down to 55um. Limited results show this same dependence on pixel size and periphery design.
Maximising the effective fill factor is essential for devices with a pitch of 55um, such as those used with the Timepix3 chip. First results of the electrical performance of such devices are presented.
This work is done in collaboration with the University of Manchester, and AGH in Krakow working towards the new Velopix chip for the LHCb upgrade.

Primary authors: MOFFAT, Neil (University of Glasgow (GB)); Dr BATES, Richard (University of Glasgow (GB))

Presenter: MOFFAT, Neil (University of Glasgow (GB))

Session Classification: Device Simulation

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

Performance studies on thin LGAD sensors after proton irradiation

Wednesday, 12 June 2019 11:20 (20 minutes)

For the high luminosity LHC or Phase-II operation, the ATLAS and CMS experiments are planning to include especial detector in order to perform timing measurements of minimum ionizing particles (MIPs). Both detector will be exposed to a radiation levels up to 3E15 neq/cm2 and will required a timing performance of about 30 ps. Under these circumstances, Low Gain Avalanche Detectors (LGADs) are one of the sensing technologies under study with more promising results. Therefore, a radiation hardness study of LGADs manufactured at CNM and proton irradiated at PS up to fluences of 3E15 neq/cm2 was performed. The effect of a gain layer doped with carbon on 50-micon LGAD sensors was studied. Also, two different active thicknesses were studied: 35-micron and 50-micron. The timing performance was evaluated with MIPs in a test beam and measured in a dedicated set-up with an infrared laser in the lab. These studies were performed within the RD50 collaboration and founded by AIDA2020.

Primary author: CURRAS RIVERA, Esteban (Universidad de Cantabria and CSIC (ES))

Presenter: CURRAS RIVERA, Esteban (Universidad de Cantabria and CSIC (ES))

Session Classification: Precision Timing Detectors

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

First production of Resistive AC-Coupled Silicon Detectors (RSD) at FBK

Wednesday, 12 June 2019 15:00 (20 minutes)

In this contribution we explore the recent results coming from the first RSD (Resistive AC-Coupled Silicon Detectors) production run at Fondazione Bruno Kessler. After reviewing the design, layout and technology related to the resistive AC-coupled readout paradigm, we present some static and dynamic characterizations of our detectors before irradiation, along with extensive comparisons between measurements and numerical simulation.

Primary author: MANDURRINO, Marco (INFN)

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

Session Classification: Precision Timing Detectors

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

TCAD simulation and test results of neutron irradiated OVERMOS, a CMOS 180nm MAPS detector

Friday, 14 June 2019 09:20 (20 minutes)

We will present latest results of dark current (I-V) and charge collection efficiency (CCE, obtained using a calibrated laser source) of OVERMOS, a high resistivity TJ 180nm CMOS MAPS, irradiated with neutrons up to 1e15 cm-2 fluence. Results of charge collection within the 40 x 40 um2 pixel region,with 5um resolution, and charge collection time will be shown.
Test results are compared with 3D TCAD results using a device structure obtained through process simulator SPROCESS and using SDEVICE for electro/optical simulations.Implemented models in TCAD include SiO2 and CoSi2 optical attenuation, Si/SiO2 surface traps model and HPTM (Hamburg Penta Traps Model) for bulk radiation damage.

Primary authors: VILLANI, Enrico Giulio (Science and Technology Facilities Council STFC (GB)); DOPKE, Jens (Science and Technology Facilities Council STFC (GB)); FRENCH, Marcus Julian (Science and Technology Facilities Council STFC (GB)); Dr MCMAHON, Stephen (Science and Technology Facilities Council STFC (GB)); SEDGWICK, Iain (STFC); SELLER, Paul (RAL); WILSON, Fergus (Science and Technology Facilities Council STFC (GB)); ZHANG, Zhige (Science and Technology Facilities Council STFC (GB)); WORM, Steven (University of Birmingham); LIANG, Zhijun (Chinese Academy of Sciences (CN)); ZHU, Hongbo (Chinese Academy of Sciences (CN)); XIU, Qinglei (Chinese Academy of Sciences (CN))

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

Session Classification: CMOS Sensors

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

The weighting field of irradiated silicon detectors

Thursday, 13 June 2019 14:30 (20 minutes)

The understanding of the weighting field of irradiated silicon sensors is essential for calculating the response of silicon detectors in the radiation environment at accelerators like at the CERN LHC. Using 1-D calculations of non-irradiated pad sensors and 1-D TCAD simulations of pad sensors before and after irradiation, it is shown that the time-dependence of the weighting field is related to the resistivity of low field regions with ohmic behaviour in the sensor. A simple formula is derived, which relates the time constant of the time-dependent weighting field, τ, with the resistivity and the extension of the low-field region for pad detectors. As the resistivity of irradiated silicon increases with fluence and finally reaches the intrinsic resistivity, τ becomes much larger than the charge-collection time and the weighting field becomes essentially independent of time. The TCAD simulations show that the transition from a time-dependent to a time-independent weighting field occurs at a neutron-equivalent fluence of ≈ 5 × 10¹² cm^{−2} for a 200 µm thick pad diode operated at 40 V and −20°C. It is therefore concluded that the use of a time-independent weighting field calculated with the same method as for a fully-depleted non-irradiated sensor is also appropriate for the simulation of highly irradiated silicon sensors.

Primary authors: SCHWANDT, Joern (Hamburg University (DE)); KLANNER, Robert (Hamburg University (DE))

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

Session Classification: Device Simulation

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

Status of LGAD development at BNL (and other silicon R&D activities)

Wednesday, 12 June 2019 13:00 (20 minutes)

Profiting from our internal silicon-dedicated clean-room facility, we developed an LGAD technology in-house. We fabricated single pads and arrays of pads on several 50-um thick p-type epitaxial wafers. The wafers differ for the implantation parameters (i.e., energy and dose) of the gain-layer, resulting in the achievement of gains in a wide range. We attain maximum gains in the order of 25, measured with an 55Fe source, while signals are very fast, due to the thin substrates. We report the performance of our devices, from probe station measurements to functional tests with radioactive sources. At BNL we are also involved, within the ATLAS HGTD collaboration, in the characterization of LGADs fabricated by several vendors, which allows us to compare performance of LGADs in a broader range of technologies. We also update on the performance after neutron irradiation of a High-Voltage silicon vertical JFET, a new device initially conceived as a candidate for the High-Voltage Multiplexing switch in the ATLAS upgrade of the silicon microstrip Inner Tracker (ITk).

Primary authors: Dr GIACOMINI, Gabriele (Brookhaven National Laboratory (US)); TRICOLI, Alessandro (Brookhaven National Laboratory (US)); D'AMEN, Gabriele (Brookhaven National Laboratory (US)); CHEN, Wei (Brookhaven National Laboratory); LYNN, David (Brookhaven National Laboratory (US))

Presenter: Dr GIACOMINI, Gabriele (Brookhaven National Laboratory (US))

Session Classification: Precision Timing Detectors

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

Study of the physics models for fluence simulation in LHC environment

Thursday, 13 June 2019 09:00 (20 minutes)

At the end of LHC Run II fluence in silicon trackers reached the level 10e15 1MeV neq/cm2. Comparison of prediction with measurements showed some discrepancies between experiments which may be driven by differences in tools used for the simulation. In this study, we compared two physics models: Pythia 8.2 and DPMJET3 used for the fluence simulation in Fluka package for geometry of the typical LHC silicon tracker.

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

Co-authors: SZUMLAK, Tomasz (A); WINIARSKA, Barbara (AGH UST Krakow)

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

Session Classification: Defects and Material Characterization

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

Fast calculation of capacitances in planar pixel and strip silicon sensors

Thursday, 13 June 2019 13:50 (20 minutes)

We present a program for fast calculation of capacitances in planar silicon pixel (strip) sensors, based on a 3D (2D) numerical solution of the Laplace equation. A comparison between calculated capacitances and measurements on silicon strip sensors, along with simulation results obtained with the TCAD Sentaurus suite are presented. The validity of 2D calculations is checked with measurements on a Multi-Geometry Silicon Strip Detector (MSSD) developed as a test structure during the CMS HPK campaign toward the specifications of silicon sensors for the CMS Phase-II Tracker. The agreement between calculations and measurements is ˜20%, while CPU time for a typical 2 GHz, 4 Core processor is below 5 min. In addition, our work includes calculations for various configurations of pixel geometry. The program is a useful tool for fast estimation of interstrip, interpixel and backplane capacitances before an embarkation to more sophisticated programs is launched.

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

Presenter: LOUKAS, Dimitrios (Nat. Cent. for Sci. Res. Demokritos (GR))

Session Classification: Device Simulation

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

Recent studies and characterization on UFSD sensors

Wednesday, 12 June 2019 11:40 (20 minutes)

This contribution is focusing on two main topics in UFSD characterization: uniformity of gain in a UFSD productions and effect of the irradiation on these sensors.

In the first part of this contribution I will report on the measurements of the gain layer uniformity performed on UFSD sensors manufactured by Hamamatsu Photonics (HPK) and by Fondazione Bruno Kessler (FBK).

The second part of this contribution is on the effect on the irradiation on UFSD and PiN detectors. We measured the acceptor creation and trapping mechanisms up to fluences of 1E16 n/cm2, and for both effects we saw the onset of saturation.

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

Co-authors: CARTIGLIA, Nicolo (INFN Torino (IT)); ARCIDIACONO, Roberta (Universita e INFN Torino (IT)); SOLA, Valentina (Universita e INFN Torino (IT)); OBERTINO, Maria Margherita (Universita e INFN Torino (IT)); MANDURRINO, Marco (INFN); SIVIERO, Federico (INFN - National Institute for Nuclear Physics); TORNAGO, Marta; STAIANO, Amedeo (Universita e INFN Torino (IT)); PATERNOSTER, Giovanni (Fondazione Bruno KEssler); BOSCARDIN, Maurizio (FBK Trento); BORGHI, Giacomo (TERA Foundation (IT)); PANCHERI, Lucio (University of Trento); DALLA BETTA, Gian-Franco (INFN and University of Trento); FICORELLA, Francesco (FBK)

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

Session Classification: Precision Timing Detectors

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

An update on measurements with Si detectors irradiated to extreme fluences

Thursday, 13 June 2019 09:20 (20 minutes)

Silicon detectors were irradiated with with reactor neutrons up to very high fluences of 3e17 n/cm2. First results of measurements at these fluences were shown at the 32nd RD50 workshop. New charge collection measurements with Sr-90 source and new E-TCT measurements will be presented in this contribution.

Primary authors: MANDIC, Igor (Jozef Stefan Institute (SI)); KRAMBERGER, Gregor (Jozef Stefan Institute (SI)); CINDRO, Vladimir (Jozef Stefan Institute (SI)); Prof. MIKUZ, Marko (Jozef Stefan Institute (SI)); ZAVRTANIK, Marko (Jozef Stefan Institute (SI)); HITI, Bojan (Jozef Stefan Institute (SI))

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

Session Classification: Defects and Material Characterization

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

Development of a modular DAQ to characterize the RD50 depleted monolithic active pixel sensors

Friday, 14 June 2019 10:00 (20 minutes)

This contribution will describe the last developments carried out and the ones foreseen for the characterization of the RD50 MPW1 and RD50 MPW2 depleted monolithic pixel sensors implemented in the LFoundry 150 nm technology in the framework of the RD50 collaboration. A modular and scalable DAQ system is being developed for this purpose and for other possible applications in the future (characterization of other radiation detectors, accelerator instrumentation, medical physics, etc.). It is based on function specific FPGA Mezzanine Card (FMC) modules which can be connected to a platform board with a System-on-Chip (SoC), volatile and non-volatile memories, two FMC connectors and Gigabit Ethernet communication capability. Several platform boards will be able to be connected for test beam measurements and to scale up the DAQ. Specific custom boards have been already designed to accommodate the RD50 MPW1 and RD50 MPW2 devices and to connect these devices to the corresponding FMC interface module. Two different FMC modules are being designed, one for triggering and communication purposes, and another to interface the devices under test.

Primary author: RICARDO, Marco-Hernández

Co-authors: THOMAS, Bergauer; CHRISTIAN, Irmler; SALVADOR, Martí-García; SAM, Powell; HELMUT, Steininger; EVA, Vilella

Presenter: Dr MARCO HERNANDEZ, Ricardo (CERN)

Session Classification: CMOS Sensors

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

LF2 Characterization

Friday, 14 June 2019 11:20 (20 minutes)

The LF2 is a depleted MAPS prototype chip produced in 2018 in the LFoundry 150 nm HV-CMOS process by the collaboration of IFAE, University of Liverpool, University of Geneva and KIT with the support of RD50.
The chip includes two monolithic matrices which are completely independent and only share the substrate: a tracking pixel detector and a photon counting device.

The main components of the analog readout electronics, very similar in both matrices, are a sensor bias circuit based on a high ohmic resistor, a charge sensitive amplifier, a source follower, filter and a CMOS comparator with a local 4-bit DAC to compensate for offset variations. Each pixel also includes an injection circuit to test the readout electronics. With respect to the digital readout electronics, the photon counting array contains a 16-bit counter while in the tracking matrix the circuits follow an FE-I3 readout approach. The analog and digital readout electronics are embedded inside the pixel sensitive area in both matrices.

The LF2 ASICs were received in 2018 and a readout system, based on the Xilinx ZC706 FPGA board, was developed. The initial results of the table-top characterization of the devices will be presented.

Primary author: FORSTER, Fabian Alexander (IFAE Barcelona (ES))

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Presenter: FORSTER, Fabian Alexander (IFAE Barcelona (ES))

Session Classification: CMOS Sensors

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

Timing resolution of the LGADs pads from a common AIDA2020 run produced at CNM

Wednesday, 12 June 2019 13:40 (20 minutes)

In this contribution we will show the latest results from laboratory measurements of Low-Gain Avalanche Diodes (LGADs) from a common AIDA-2020 run fabricated by CNM. These sensors come in two different thickness (50 and 35 μm) and different gain layer doping concentrations. The test setup used for this studies consist of a Sr-90 source and couples of identical sensors aligned to form a coincidence telescope. Each sensor is wire bonded to US-SC readout board which carry the first stage amplifier, while the second stage is a home made three stage amplifiers. Finally the signals are read out on a fast oscilloscope and the analysis is performed offline. In this presentation we will focus on the timing performance of the sensors, describing the test setup, the signals characteristics, the analysis procedure and the timing resolution for the different sensors.Additionally the electrical characterisation of the sensors will be discussed.

Primary authors: DEL BURGO, Riccardo (Universitaet Zuerich (CH)); MACCHIOLO, Anna (Universitaet Zuerich (CH)); CANELLI, Florencia (Universitaet Zuerich (CH)); KILMINSTER, Ben (Universitaet Zuerich (CH)); Dr PELLEGRINI, Giulio (Centro Nacional de Microelectrónica (IMB-CNM-CSIC) (ES)); Dr VILA ALVAREZ, Ivan (Instituto de Física de Cantabria (CSIC-UC)); Dr HIDALGO VILLENA, Salvador (Instituto de Microelectronica de Barcelona (IMB-CNM-CSIC))

Presenter: DEL BURGO, Riccardo (Universitaet Zuerich (CH))

Session Classification: Precision Timing Detectors

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

TCAD Simulation of the HVCMOS sensor for the MIDAS personal active dosimeter

Friday, 14 June 2019 09:40 (20 minutes)

The MIDAS device is an active dosimeter for application in the mixed field of space environment under development. It will use active pixel sensors for the measurement of energy depositions by charged particle tracks in Si pixel layers covering five out of six faces of a plastic scintillator cube. The Si active pixel sensors are based on commercial High Voltage CMOS technology which has proven its radiation hardness in the context of the upgrade of the HEP experiments for the high-luminosity LHC. The dynamic range of the charge signal induced by Galactic Cosmic Rays makes necessary the study of the electrical behavior and especially of the signal formation process in the pixel sensor. It is performed with the aid of the Sentaurus TCAD tools suite. We will present results for all the parameters affecting the electrical behavior of the pixel: Depletion region, leakage current, capacitances, transient signals induced by the passage of charged particles.

Primary authors: ASSIOURAS, Panagiotis (Nat. Cent. for Sci. Res. Demokritos (GR)); LOUKAS, Dimitrios (Nat. Cent. for Sci. Res. Demokritos (GR)); Prof. LAMBROPOULOS, Charalambos (Technological Education Institute of Sterea Ellada,); Dr THEODORATOS, Gerasimos (ADVEOS MIcroelectronics Systems PC)

Presenter: LOUKAS, Dimitrios (Nat. Cent. for Sci. Res. Demokritos (GR))

Session Classification: CMOS Sensors

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

Defect-engineering of new detector solutions

Thursday, 13 June 2019 11:40 (20 minutes)

CiS has started various projects to develop detectors for the detection of UV / DUV, X-ray, neutrons, low energy electrons, alpha and beta particles, prompt-gamma detection and Delta-E detectors.
This requires amongst others extremely flat pn junctions with sufficient sheet resistance even for larger areas and thinnest dead layers.
Technological methods, such as Plasma Immersion Ion Implantation PIII with BF3 and B2H6, solid phase epitaxial regrowth SPER, co-implantation will be used and investigated.
These structures (for example low gain avalanche detectors (LGAD)) and technological process chains should be designed in such a way that the radiation hardness can be maintained or increased.
In particular the disappearance of the gain layer in LGAD structures due to irradiation must be circumvented by defectengineering approaches.
Various new or advanced approaches of defect engineering of silicon detectors will be investigated and the suitability of different analysis methods (eg low temperature photoluminescence (LTPL) and / or TEM, eddy current measurement and others) have to be evaluated.
Concept and ongoing work for LGAD and silicon diodes adjusted for detection of low energy electrons will be presented.

Primary author: Mr RÖDER, Ralf (CiS Erfurt)

Co-author: Dr LAUER, Kevin (CiS Erfurt)

Presenter: Mr RÖDER, Ralf (CiS Erfurt)

Session Classification: Defects and Material Characterization

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

DLTS studies of point and cluster defects in □- and neutron-irradiated p-type Si pad diodes

Thursday, 13 June 2019 10:20 (20 minutes)

P-type silicon pad diodes with variation of material type - EPI, FZ and CZ - and resistivity (boron concentration) have been irradiated with reactor neutrons with different fluences in JSI, Ljubljana, Slovenia and with gamma rays (Co-60) in BGS, Wiehl, Germany. Comparative investigation of the radiation induced defects by Thermally Stimulated Current (TSC) and Deep Level Transient Spectroscopy (DLTS) techniques have been performed. The obtained results will be presented and discussed.

Primary authors: GURIMSKAYA, Yana (CERN); MATEU, Isidre (CERN); UDESEN, Soren (Aarhus University (DK)); DIAS DE ALMEIDA, Pedro (Universidad de Cantabria and CSIC (ES)); FERNANDEZ GARCIA, Marcos (Universidad de Cantabria and CSIC (ES)); MOLL, Michael (CERN)

Presenter: GURIMSKAYA, Yana (CERN)

Session Classification: Defects and Material Characterization

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

Update on IHEP RD50 activities

Wednesday, 12 June 2019 13:20 (20 minutes)

The first LGAD sensors designed and fabricated in China have been evaluated including the basic electrical properties as well as timing properties. The status of the planned proton irradiation in China will also be presented. In addition, the joint project to produce Schottky diodes on epitaxial silicon for radiation damage study will be introduced.

Primary author: SHI, Xin (Chinese Academy of Sciences (CN))

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

Session Classification: Precision Timing Detectors

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

TCT measurements of the H35DEMO HV-CMOS detector by ams

Friday, 14 June 2019 11:00 (20 minutes)

TCT measurements have been performed on the H35DEMO chip, a HV-CMOS sensor produced by ams in H35 350 nm technology, before and after proton and neutron irradiation. The proton irradiation has been performed at the Bern Inselspital cyclotron (18 MeV) and at the Proton Syncrotron at CERN (24 GeV) up to more than 10^{15} 1 MeV $n_{\mathrm{eq}}/\mathrm{cm}^2$. The neutron irradiation has been performed at the Jožef Stefan Institute reactor in Ljubljana up to $2 \cdot 10^{15}$ 1 MeV $n_{\mathrm{eq}}/\mathrm{cm}^2$.
The depletion depth of sensors built on substrates of various resistivities has been measured, along with timing characteristics of the current pulses. Measurement technique, data analysis and results will be presented.

Primary author: ZAFFARONI, Ettore (Universite de Geneve (CH))

Co-author: GONZALEZ SEVILLA, Sergio (Universite de Geneve (CH))

Presenter: ZAFFARONI, Ettore (Universite de Geneve (CH))

Session Classification: CMOS Sensors

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

Time dependent weighting fields for signals in silicon sensors

Thursday, 13 June 2019 14:10 (20 minutes)

The classic Ramo-Shockley theorem applies to detectors with perfectly conducting electrodes and perfectly insulating materials surrounding these electrodes.
In silicon sensors this condition is not necessarily fulfilled. Junctions between different doping layers result in regions of finite conductivity. Radiation damage can lead to large regions of finite conductivity in a sensor that have an effect on the signals.
An extension of the Ramo-Shockley theorem therefore has to be used, which allows the calculation of weighting fields for a detector medium that has a finite conductivity (volume resistivity). The talk will discuss these extended theorems in a form that is well adapted for use with TCAD device simulation programs. As an example, a partially depleted silicon sensor is discussed.

Primary author: RIEGLER, Werner (CERN)

Presenter: RIEGLER, Werner (CERN)

Session Classification: Device Simulation

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

Developments for a proton irradiation site at the HISKP of Bonn University

Thursday, 13 June 2019 11:20 (20 minutes)

A new proton irradiation site for NIEL damage studies is currently being developed at the Bonn isochronous cyclotron of the HISKP. Irradiations with a proton energy of 12.7 MeV at device location and currents up to 1 uA are possible. A unique feature of the site is the newly installed beam-diagnostics system. It allows the determination of the proton fluence at percent level and can be used as an online feedback system for beam current and position steering. The irradiation setup is nearly complete and proof-of-concept irradiations of BPW34F diodes were performed to determine the proton hardness factor. The setup, calibration results, and challenges will be presented.

Primary authors: WOLF, Pascal (University of Bonn); DIETSCHE, Wolfgang (uni bonn); EVERSHEIM, Dieter (University Bonn); POHL, David-Leon; URBAN, Steffen Andreas (University of Bonn (DE)); WERMES, Norbert (University of Bonn (DE))

Presenters: POHL, David-Leon; POHL, David-Leon (University of Bonn (DE))

Session Classification: Defects and Material Characterization

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

Design work of depleted CMOS sensors within the CERN-RD50 collaboration

Friday, 14 June 2019 09:00 (20 minutes)

This contribution describes design work within the CERN-RD50 collaboration to develop depleted CMOS sensors in the 150 nm HV-CMOS (High Voltage-CMOS) process from LFoundry. In particular, we will present the design details of a test chip, named RD50-MPW2, which was submitted for fabrication in January 2019. We will also present the design towards a new pixel flavour, known as a sampling pixel, to improve the time resolution of depleted CMOS pixels and which will be included in the large area submission RD50-ENGRUN1 planned by the collaboration.

The main objective of the RD50-MPW2 submission is to implement new methodologies and test their efficiency in minimizing the large leakage currents measured in the previous test chip developed by the collaboration. Two different design methodologies have been implemented. The first one blocks the generation of certain filling layers added by the foundry during the post-processing stage, while the second one includes a series of guard rings around the design to prevent the sensor depletion region from coming into contact with the edge of the chip. Both have been extensively simulated with TCAD.

RD50-MPW2 also includes a small matrix of depleted CMOS pixels with analog readout electronics embedded in the sensing area of the pixels, a bandgap reference circuit, an SEU (Single Event Upset) tolerant memory array and several test structures with depleted CMOS pixels for e-TCT (edge-Transient Current Technique) measurements and with avalanche photodiodes. A small leakage current is expected from these circuits as a result of the new design methodologies implemented in the chip. In addition, the matrix of depleted CMOS pixels includes two different flavours of readout electronics focused on improving the readout speed of the sensor. RD50-MPW2, which is being manufactured on 10, 100, 1.9k and 3k Ω·cm resistivity substrates, is expected to be back from the foundry during the summer of 2019.

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

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

Session Classification: CMOS Sensors

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

Development and First Parametric Characterization of High Fill-Factor Segmented LGADs with Trench Isolation.

Wednesday, 12 June 2019 14:20 (20 minutes)

Low gain avalanche detectors (LGADs) are currently the state-of-the-art silicon detectors for timing application in HEP experiments. One limitation of the current technology is the relatively wide dead region present between pixels (40-60 μm), which reduces the effective fill-factor and the efficiency of the sensors and might limit some applications in which finely segmented detectors are required.
In this work, we will present the new trench-isolated LGAD sensors developed by FBK, in which the standard JTE and isolation structures are replaced by narrow trenches. This new technology has first been investigated by means of TCAD simulations, which enabled us to identify some promising solutions for the pixel border structures and showed that trench isolation could potentially reduce the width of the inter-pixel dead area to less than 10 μm.
Following the indications obtained by TCAD simulations, an R&D batch has recently been produced, in which a wide variety of structures and process splits were implemented. During the workshop, we will present a preliminary parametric characterization of the batch, which shows that the pixels are functional and have the expected gain behaviour.

Primary authors: FICORELLA, Francesco (FBK); BORGHI, Giacomo (FBK); PATERNOSTER, Giovanni (Fondazione Bruno KEssler); BOSCARDIN, Maurizio (FBK Trento)

Presenters: BORGHI, Giacomo (TERA Foundation (IT)); BORGHI, Giacomo (FBK); BOSCARDIN, Maurizio (Universita degli Studi di Trento è INFN (IT))

Session Classification: Precision Timing Detectors

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

Study of Interpad-gap and inactive region of FBK (UFSD3) and HPK sensors with Transient Current Technique

Wednesday, 12 June 2019 14:00 (20 minutes)

The third production of Ultra Fast Silicon Detectors (UFSD3) from Fondazione Bruno Kessler (FBK) and Low Gain Avalanche Detectors (LGADs) from Hamamatsu Photonics K.K. (HPK), produced for CMS, include 2x2 sensors with different structural strategies, specifically with different values of narrower inactive region widths between the pads. These sensors have been designed to study specific features required for the future Endcap Timing Layer (ETL) of CMS at High-Luminosity LHC. We carry out a comparative study on the dependence of breakdown voltage with the interpad gap width for both sensor types.

We will present results from Transient Current Technique measurements performed at Helsinki Institute of Physics (HIP). The presentation will include results of measured interpad gap widths and spatial mappings within their non-active regions, as well as their dependence on temperature variation (from 25°C to -25°C). Further, we will give an insight on their effect at both high and low laser intensities.

Primary author: Mr BHARTHUAR , Shudhashil (Helsinki Institute of Physics)

Co-authors: OTT, Jennifer (Helsinki Institute of Physics (FI)); LITICHEVSKYI, Vladyslav (Helsinki Institute of Physics (FI)); BRUCKEN, Jens Erik (Helsinki Institute of Physics (FI)); MARTIKAINEN, Laura (Helsinki Institute of Physics (FI)); NAARANOJA, Tiina Sirea (Helsinki Institute of Physics (FI)); LUUKKA, Panja (Helsinki Institute of Physics (FI))

Presenter: Mr BHARTHUAR , Shudhashil (Helsinki Institute of Physics)

Session Classification: Precision Timing Detectors

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

Preliminary results of bulk damage study in gamma irradiated n-in-p silicon strip sensors

Thursday, 13 June 2019 10:00 (20 minutes)

We present preliminary results of the TID bulk damage study in gamma-irradiated n-in-p silicon strip sensors.
The sensors were irradiated by a high-flux 60Co gamma rays up to a total dose of 300 Mrad in approximate charged particle equilibrium.
The study was performed on high-rho silicon sensors with initial resistivities of 4 and 17 kOhmcm.
The properties of sensors were characterized before and after irradiation using I-V and C-V measurements and the effective dopant concentration was extracted from these measurements. It was observed that the full depletion voltage and effective doping concentration decreases with increasing TID.

Primary authors: MIKESTIKOVA, Marcela (Acad. of Sciences of the Czech Rep. (CZ)); MARCISOVSKY, Michal (Acad. of Sciences of the Czech Rep. (CZ)); LATONOVA, Vera (Acad. of Sciences of the Czech Rep. (CZ)); DUDAS, Denis (UJP, Praha a.s.); KROLL, Jiri (Acad. of Sciences of the Czech Rep. (CZ)); ZATOCILOVA, Iveta (Charles University (CZ)); VRBA, Vaclav (Czech Technical University (CZ)); MARCISOVSKA, Maria (Acad. of Sciences of the Czech Rep. (CZ)); KAFKA, Vladimir (Czech Technical University, Prague)

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

Session Classification: Defects and Material Characterization

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

Timing with iLGADs

Wednesday, 12 June 2019 14:40 (20 minutes)

Low Gain Avalanche Diodes provide excellent timing capabilities with moderate radiation resistance for HL-LHC applications. Segmented LGADs (microstrips or pixels) implement the amplification layer below the electrodes, leading to non-uniform gain across the surface of the detector. This is the so-called "filling factor" problem. A possible way to achieve uniform amplification is by moving the multiplication layer away from the segmented electrodes. The device becomes a pad-like LGAD in the backside with segmented front side. Such device is called iLGAD. The signal development is characterized by a first drift of electrons towards the backside LGAD, amplification and final drift of holes towards the segmented electrodes.

We have investigated, using TCT, the timing performance of unirradiated iLGADs, by means of a Constant Fraction Discrimination Method triggered on either the electron or hole part of the signal. We have also compared these figures to PiN diodes of the same run.

Primary authors: FERNANDEZ GARCIA, Marcos (Universidad de Cantabria and CSIC (ES)); VILA ALVAREZ, Ivan (Instituto de Física de Cantabria (CSIC-UC)); JARAMILLO, Richard (IFCA); MOLL, Michael (CERN); CENTIS VIGNALI, Matteo (CERN); CURRAS RIVERA, Esteban (Universidad de Cantabria and CSIC (ES)); GONZALEZ SANCHEZ, Javier (Universidad de Cantabria and CSIC (ES)); DUARTE CAMPDERROS, Jordi (IFCA); HIDALGO VILLENA, Salvador (Instituto de Microelectronica de Barcelona (IMB-CNM-CSIC)); PELLEGRINI, Giulio (Centro Nacional de Microelectrónica (IMB-CNM-CSIC) (ES))

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

Session Classification: Precision Timing Detectors

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

Signal simulation using Garfield++

Thursday, 13 June 2019 14:50 (20 minutes)

Garfield++ is a toolkit for the detailed simulation of particle detectors based on ionization measurement in gases or semiconductors. After a brief introduction to the program, ongoing work on the implementation of the simulation of induced currents using time-dependent weighting fields is presented.

Primary author: SCHINDLER, Heinrich (CERN)

Presenter: SCHINDLER, Heinrich (CERN)

Session Classification: Device Simulation

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

Registration and Coffee

Wednesday, 12 June 2019 09:00 (1 hour)

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

Welcome to the 34th RD50 Workshop and latest RD50 News

Wednesday, 12 June 2019 10:00 (10 minutes)

Presenters: MUENSTERMANN, Daniel (Lancaster University (GB)); MOLL, Michael (CERN)

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

Discussion

Thursday, 13 June 2019 12:10 (20 minutes)

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

Session Classification: Defects and Material Characterization

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

Discussion

Wednesday, 12 June 2019 15:20 (30 minutes)

Presenter: HIDALGO VILLENA, Salvador (Instituto de Microelectronica de Barcelona (IMB-CNM-CSIC))

Session Classification: Precision Timing Detectors

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

Discussion

Thursday, 13 June 2019 15:10 (30 minutes)

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

Session Classification: Device Simulation

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

Discussion

Friday, 14 June 2019 11:40 (30 minutes)

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

Session Classification: CMOS Sensors

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

EoI for AIDA2020 Announcement

Wednesday, 12 June 2019 10:10 (10 minutes)

Presenters: VILA, Ivan (IFCA (CSIC-UC)); VILA ALVAREZ, Ivan (Instituto de Física de Cantabria (CSIC-UC))

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

Welcome reception organisation - and ale overview

Wednesday, 12 June 2019 15:50 (10 minutes)

Presenters: HAYWARD, Connor (Max Plank Institute for Physics); MUENSTERMANN, Daniel (Lancaster University (GB))

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

An extract from photoconductivity spectra in silicon

Thursday, 13 June 2019 12:00 (10 minutes)

Presenter: VAITKUS, Juozas (Vilnius University)

Session Classification: Defects and Material Characterization