POSTER SESSION

from the participants attending the course

Wednesday April 3, 2019: 4 pm - 6 pm

Poster Session instructions:
http://sirad.pd.infn.it/scuola_legnaro/Documenti/Instructions-for-Poster-Session.docx

Abstracts

01) The MYTHEN III strip detector prototypes

Marie Andrä *(Paul Scherrer Institut, Switzerland)*

Abstract

MYTHEN 3 is a new single-photon-counting readout chip being developed by the SLS detector group at Paul Scherrer Institute, Switzerland, in 110 nm UMC technology.
It will equip a 60 k-channel, 50 µm pitch microstrip detector optimized for powder diffraction experiments. Every readout channel features an amplifier and a shaper with variable gain and shaping time. The shaper output is fed to three independent discriminators, each one having a dedicated threshold, trim bit set and enable signal. The outputs of the three discriminators are processed by the counting logic section which, according to the mode of operation selected, generates the hits for the three following 24-bit counters.

Several operation modes are foreseen: dual polarity, energy-windowing, count rate improvement, charge sharing suppression and pump with multiple probe time slots. The first 64-channel prototype has been tested in the lab, with fluorescence X-rays and with a synchrotron beam to characterize its noise and count rate capability. Based on the results obtained from the first chip a second 64-channel prototype has been developed and sent to production. The architecture of the chip and characterization results of the both chips will be presented.

02) 3D Diamond Detectors for Particle Tracking and Dosimetry

Alice Porter *(University of Manchester, UK)*

Abstract

Diamond has many desirable properties as a radiation detector material. Paired with a 3D electrode geometry extremely radiation hard devices can be fabricated. Investigation into optimizing their use in radiation therapy and for beam condition monitoring at HEP experiments. Graphitic electrodes can be fabricated with a femto-second laser focused in the bulk of the diamond material to form a 3D geometry. This allows for a smaller inter-electrode distance, increasing the charge collection efficiency.

The detectors are characterized with X-rays, radiative sources (Sr90, Fe55, Am241) and protons. This is done alongside TCAD simulations to qualitatively understand and optimize the electric field distribution inside the detector. Currently in development is the use of a 3D printed plastic mouse phantom containing a 3D diamond dosimeter. The mouse provides a standardized phantom which can be made universal between hospitals and reduce the large deviations in pre-clinical inter-laboratory dosimetry. The impact of this project will aid advances in precision radiotherapy and the frontiers of particle physics.

03) Radiation-hard voltage reference: from measurements-based VerilogA model of standard diodes and DTMOS to circuit realization

Alicja Michalowska-Forsyth *(Graz University of Technology, Austria)*

Abstract

Reference voltage required by electronic measurement and monitoring systems must be stable with variable environmental conditions, like temperature. In ionizing environments the stability must be ensured also under exposure to radiation.

A systematic approach to radiation tolerant bandgap reference design is presented. Initially reference devices: standard diodes and custom designed DTMOS (dynamic threshold MOS) are characterized at different temperatures. The extracted parameters show that temperature dependence largely varies with device type and DTMOS gate and drain bias conditions. Consequently each device requires different parametric balance to achieve a stable voltage reference. A VerilogA model applicable for circuit simulations, including this temperature dependence, is adapted for both standard diodes and DTMOS. The radiation susceptibility of the traditionally used standard diodes and of the radiation tolerant DTMOS is assessed. Finally the XREFIC testchip with a family of integrated radiation tolerant voltage references is introduced.

04) The CMS outer tracker upgrade for the High-Luminosity LHC

Valentina Mariani *(INFN Perugia, Italy)*

Abstract

The LHC is planning an upgrade program in order to bring the luminosity at about $5\text{-}7 \cdot 10^{34}$ cm^{-2} s^{-1} in 2028, reaching an integrated luminosity of about 3000 fb^{-1} by the end of 2039. This High-Luminosity LHC scenario (HL-LHC), will require a preparation program of experiment detectors, known as Phase-2 upgrade.

Both the current CMS Outer Tracker and the recently installed CMS Phase-1 Pixel detector couldn't survive at such extreme HL-LHC radiation conditions. Thus, CMS will need a completely new tracker detector in order to fully exploit the high-demanding operating conditions and the delivered luminosity. The new Outer Tracker will cover a wider acceptance area and will have trigger capabilities. Intense activities of R&D have been carried out to study the best solutions.

The design choices for the Outer Tracker upgrades will be discussed along with some highlights on the technological choices.

05) Design and test of thin targets for the NUMEN experiment

Vittoria Capirossi *(Politecnico and INFN Torino, Italy)*

Abstract

The NUMEN experiment, based in LNS-INFN, aims to measure the cross section of Double Charge Exchange (DCE) reactions. Since DCE are rare reactions, NUMEN will use intense ion beams (around 50microA) to have large statistics.

Since the targets will be very thin (of the order of 500nm) to guarantee the required energy resolution in the detection of the reaction products, it will be necessary to efficiently dissipate the heat produced by the beam to avoid the target melting.

A target system has been designed, using high thermal conductive pyrolytic graphite as support for the target isotopes deposition. In order to study the thickness and the thickness uniformity of target and substrate, tests on some prototypes have been performed in Politecnico of Turin with alpha particles transmission and in LNL-INFN with Rutherford backscattering measurements.

In this poster first preliminary results of these studies will be presented.

06) Study of Radiation Hardness of Silicon Strip Sensors for ATLAS ITk Upgrade Project

Věra Latoňová

(Charles University and Institute of Physics of the Czech Academy of Sciences in Prague, Czech Republic)

Abstract

The upgrade of the Large Hadron Collider in CERN into the High Luminosity Large Hadron Collider (HL-LHC) requires a complete replacement of the ATLAS Inner Detector by a new all-silicon Inner Tracker (ITk). For this reason a new micro-strip sensor type n+-in-p was developed. These sensors are expected to have many advantages, such as higher radiation resistance, the ability to operate even if not fully depleted and faster response.

The main purpose of this poster is to introduce the newly developed semiconductor sensors which will be used in the new ITk, describe the radiation effects on the sensors caused by high particle fluence (e.g. in HL-LHC) and present the results on the radiation hardness of the sensors obtained as a comparison of electrical characteristics performed on non-irradiated and irradiated sensors.

07) Development of a readout system for the HEPD-2 particle tracker

Giuseppe Gebbia *(Department of Physics, University of Trento, Italy)*

Abstract

The High Energy Particle Detector 2 (HEPD-2) is one of the payloads that will be part of the CSES-02 satellite. The detector is designed to study manly particles trapped in the Earth ionosphere performing calorimetry and tracking with a planar geometry. A major technical difference respect to others similar experiments is the use of the ALPIDE CMOS pixel sensors in its three tracking layers.

With a total of 150 chips and the stringent restrictions typical of a space missions in term of power consumption and processing power available, the readout of such tracker imposes challenges that can only be addressed with the development of a heavily parallel solution based on Field Programmable Gate Array (FPGA) devices. As illustrated in this poster, we are implementing a test bench to study, develop and implement the DAQ of the ALPIDE tracker using a single low power
FPGA chip.

08) The GALILEO spectrometer

Irene Zanon *(University of Ferrara and INFN National Laboratories of Legnaro, Italy)*

Abstract

The development of high intensity stable and radioactive ion beams, coupled to the state-of-the-art detector setups, has allowed extending our knowledge of nuclear structure and reactions closer to the drip-line. Thanks to the high efficiency of the new γ-ray array, the investigation of the structure along the proton and neutron numbers but also with the excitation energy has made substantial progress.

In this contribution, the GALILEO γ-ray array will be presented. GALILEO is an array of 25 Compton-suppressed high-purity germanium detectors, arranged in four rings at 152◦, 129◦, 119◦ and 90◦. It has been active since 2014 in the INFN National Laboratories of Legnaro, coupled with different ancillary detectors as EUCLIDES, SPIDER and Neutron Wall. To better understand the capabilities of this apparatus, a comparison between a raw and a Compton-suppressed spectrum will be presented, showing the low-lying states of the 188Hg nucleus.

09) Calorimeter development for the iMPACT pCT scanner

Filippo Baruffaldi

(Department of Physics and Astronomy and INFN Padova, Italy)

Abstract

In recent years, the use of hadrons for cancer radiation treatment is becoming widespread in industrialized nations. To overcome the limitations inherent to the usage of X-rays CT scanners to plan the dose delivery, a proton CT (pCT) scanner can be employed, exploiting the same protons used for the therapy to reconstruct a 3D image of the target. It has been demonstrated that a pCT can generate 3D images with the necessary detail by recording at least 108 proton tracks in a volume of 103 cm3, which means measuring, for each single proton, its entry and exit positions, as well as its energy loss in the patient.

In the framework of the iMPACT project, we are developing a hybrid energy-range calorimeter, based on fast scintillators readout by Silicon Photomultipliers (SiPMs), able to sustain a particle rate higher than 100 kHz/cm2. A fine segmentation of the calorimeter volume improves both the measurement of the proton path length and the maximum allowed particle rate. The modules can be arrayed to instrument a transverse area of about 32 × 32 cm2, and stacked along the z-axis up to about 30 cm to fully stop a 228 MeV proton. About 4000 channels will be present in the final design and, at the target proton rate, an analog readout of each channel is not sustainable. A digital approach, which encodes the signal amplitude in a few bits only, has therefore been chosen. We have developed a prototype DAQ system to validate the digital readout approach; it is able to readout the signal of 16 detectors and implementing, for each channel, one amplifier stage (analog output available on a dedicated connector), plus up to 4 comparators with programmable thresholds and LVDS output. The differential signals are sent to an FPGA, which collects, packets the data and send them to a PC via USB.

10) Development of small pitch 3D sensors for the High Luminosity LHC

Neha Deot and Md. Arif Abdulla Samy *(University of Trento and INFN TIFPA, Italy)*

Abstract

The Innermost Tracking Layer (ITk) of the forthcoming ATLAS experiment upgrade at the High-Luminosity Large Hadron Collider (HL-LHC) plans to use 3D pixel sensors in the innermost layer. To this purpose, the development of a new generation of these devices has been the object of a joint R&D project involving Fondazione Bruno Kessler (FBK) and several INFN groups since 2014, with TIFPA INFN of Trento being responsible for the device design. The new 3D pixels have to cope with several challenging requirements, such as extreme radiation hardness up to the expected fluence of 1.3×10^{16} n_{eq}/cm^2, increased pixel granularity (50×50 or 25×100 μm^2 cell size), thinner active region (~150 μm), narrower columnar electrodes (~5 μm diameter) with reduced inter-electrode spacing (~30 μm), and very slim edges (~100 μm).

We will report on the most important design and technological aspects, with selected results from the characterization of pixel sensors and test structures.

11) The LHCb Vertex Detector Upgrade. The prototypes study with the Timepix3 Telescope

Bartlomiej Rachwal *(AGH University of Science and Technology, Cracow, Poland)*

Abstract

A dedicated irradiation programme with a particle beam followed by detailed studies are essential for proper evaluation of detector prototypes and predict their performance after accumulating the predicted particle fluence at the end of their lifetime.

In order to perform precise measurements with the LHCb VELO (Vertex Locator) detector prototypes a dedicated high-resolution pixel beam telescope was developed based on 8 Timepix3 detector planes. This telescope has been taking data at CERN in the PS and SPS facilities since 2014. The Timepix3 can operate in a trigger less mode (data driven readout) with very precise timestamps.

The data produced by the telescope can easily incorporate the signals from the Device Under Test (DUT) and in particular for Timepix3 devices the analysis is straight forward. The offline analysis compares the performance after irradiation with several fluences of protons or neutrons from 2 to 8×10^{15} 1-MeV n_{eq}/cm^2; different silicon substrates (n-on-p or n-on-n), distances from last pixel to the edge, guard rings designs and different vendors. Charge collection efficiencies, track resolution, eta correction are of particular interest as function of fluence.

The presentation will describe the detailed LHCb VELO upgrade design choices as well as with some highlights of the Timepix3 Telescope operational performance.

12) Temperature Dependent Electrical Characterisation of Silicon Photomultipliers for the Compact High Energy Camera in the Cherenkov Telescope Array

Angaraj Duara *(University of Leicester Space Research Centre, UK)*

Abstract

Accurate characterisation of silicon photomultiplier (SiPM) detectors is critical to their application in high energy astrophysics. Various SiPM devices have been characterised to determine their optimum performance for use in the Compact High Energy Camera (CHEC-S) prototype developed for the Small Sized Telescope (SST) in the Cherenkov Telescope Array (CTA). Extraction of operational and electrical parameters such as breakdown voltage, charge gain, junction and parasitic capacitance, terminal capacitance, grid capacitance, quenching resistance, slow and fast signal time constant requires accurate measurement in the photon counting regime. Electrical characterisation of SiPMs can be applied to computer simulations to validate experimental results and allows understanding the factors affecting these parameters. Temperature dependence is important for some of these parameters and a facility has been assembled to test SiPMs over a range of temperatures.

This poster presents the research carried out on electrical characterisation of 10 different SiPM devices from Excelitas, Hamamatsu (HPK) and Broadcom, operated at over a range of temperatures from 7oC to 27oC. The results from the characterisation are further validated using an equivalent electrical circuit model simulation in LTSpice. We also present results from series and parallel connected array of SiPMs and discuss benefits and disadvantages.

13) Gate extension area TID enhancement

Varvara Bezhenova and Alicja Michalowska-Forsyth

(Graz University of Technology, Institute of Electronics, Austria)

Abstract

Under influence of total ionizing dose (TID) MOS transistors change their electrical parameters. These effects can be enhanced or mitigated by physical realization of transistor. Reliability and matching in integrated circuits set specific layout requirements to MOS transistors. These requirements can include symmetrical gate contact placement and increased number of these contacts. Such layout may lead to increased area of polysilicon gate, extended over shallow trench isolation (STI). The major origin of TID effects in modern MOS transistors with thin gate oxide is charge trapping in STI and on its interface. The trapping process is highly dependent on weak electric field within this insulating layer. This electric field can be modified by the voltage applied to the gate overlapping STI regions. Within this work transistor gate extension area TID enhancement is discussed. Various custom designed MOS transistors with different gate extension area are studied before and after irradiation with 60keV X-ray source. Experimental results are analysed and verified with the help of TCAD simulation.

14) Measurement of the production of light (anti-)(hyper-)nuclei with ALICE at the LHC

Pinto Chiara *(University and INFN Catania, Italy)*

Abstract

In high-energy hadronic collisions light (anti-)(hyper-)nuclei are produced besides other particle species. ALICE has excellent tracking and particle identification capabilities over a broad momentum range. Light (anti-)(hyper-)nuclei are identified in the pseudorapidity region |η|<0.9 using the Inner Tracking System (ITS), which consists of 6 cylindric layers of silicon detectors, the Time Projection Chamber (TPC), which is a cylindric gas detector and the Time of Flight (TOF) detector, which is based on a MRPC technology.

In ALICE (anti-)(hyper-)nuclei up to A=4, such as (anti-)deuterons, (anti-)tritons, ($\overline{^{3}He}$) ^{3}He ($\overline{^{4}He}$) ^{4}He and ($\overline{^{3}_{\Lambda}H}$) $^{3}_{\Lambda}H$ have been measured with a very high precision. The measurement of (anti-)(hyper-)nuclei production is important to understand the hadronization process: currently two phenomenological models are used, the thermal-statistical and the coalescence models.

In this poster the detector performance on light nuclei identification together with some recent results, such as the d/p or ^{3}He/p ratio yields as a function of the event multiplicity, are shown. Such ratios are interesting to study the hadronization process and its dependence on the system size. The poster will also discuss the planned analysis program for the recent data collected in December 2018 with Pb-Pb collisions at 5.02 TeV.

15) Binary Population Synthesis with TRILEGAL and BSE. Towards an information rich simulated LSST catalog

Piero Dal Tio *(Astronomic Observatory, INAF Padova and Department of Physics and Astronomy, University of Padova, Italy);*

Abstract

To predict in detail what we will observe with LSST and other future surveys is important to define the observation strategy and to prepare data analysis routines. For the Galactic sources, predictions can be done with population synthesis codes like TRILEGAL. TRILEGAL is able, by using a stellar spectral library, to simulate the photometry in virtually any broad-band system for any Galaxy field.

Now, we are working in order to include binary systems in TRILEGAL simulations. Our aim is to predict the population effects due to the many kinds of binary systems and their parameters distributions (e.g. mass ratio, orbital separation, eccentricity), with particular care for the fields covered by the LSST survey. In brief, our method for generating binary populations consists in using the TRILEGAL code for setting binaries initial conditions and computing the evolution of the systems with the BSE code, implemented by J. R. Hurley, up to a given age. Finally, apparent magnitudes are computed by TRILEGAL. A further analysis and elaboration of the TRILEGAL output allows us to identify eclipsing binaries candidates and to distinguish between resolved and unresolved binaries on the base of the expected LSST performance. Surveys like GALEX and SDSS might allow us to put constraints on the model input parameters and so to extend our knowledge of binary populations.

16) BepiColombo mission and the SIMBIO-SYS camera

Nicolò Borin

(Center of Studies and Activities for Space (CISAS), University of Padova, Italy)

Abstract

BepiColombo is a ESA/JAXA cornerstone mission launched in October 2018 with the aim to study the planet Mercury. After a long trip of about 7 years, the spacecraft will reach the inner planet of the Solar System and start its operative phase.

The scientific goals of the mission are mostly related with the study of the planet itself: its origin, geology, magnetic field along with performing tests of the Einstein's Theory of General Relativity.

The instrumentation is carried in a dual spacecraft: the Mercury Planetary Orbiter (MPO) that will principally study the surface and the composition and the Mercury Magnetospheric Orbiter (MMO) that will instead head to the measurements of the magnetosphere and the particle environment.

Among the different instruments, SIMBIO-SYS is an integrated suite for imaging and spectroscopic investigations formed by three channels with the objective of characterizing the surface of the planet. It will provide a global mapping of the planet with 3D and spectroscopic reconstructions and different high-resolution images of the most interesting features. From this information it will be possible to evaluate the mineralogical and morphological characteristics.

17) Novel monolithic array of Silicon Drift Detector systems designed for low energy X-ray

Daniela Cirrincione *(University of Udine and INFN Trieste, Italy)*

Abstract

In recent decades, new and better detectors for X-ray spectroscopy have been developed, and, among these, many are based on Silicon Drift Detectors (SDD). We present a further improvement resulting from the dedicated optimization of the whole detection system: new and optimized SDD detector design and production technology, ultra-low noise front-end electronics, dedicated acquisition system and digital filtering. Two new detector systems based on monolithic arrays of SDD have been developed.

The first detector system is dedicated for Low Energy X-Ray Fluorescence (LEXRF), for the TwinMic beamline at Elettra Sincrotrone Trieste. It is composed of 4 trapezoidal monolithic arrays of SDDs, each having 8 square cells, the system has a total non-collimated area of 1230 mm^2 and it is optimized to work in vacuum in an energy range of 200-4000 eV.

The second detector system is optimized for X-Ray Fluorescence (XRF) and X-ray Absorption Fine Structure (XAFS). It is composed of 8 rectangular monolithic arrays of SDDs, each having 8 square cells. This system has a total non-collimated area of 576 mm^2 and it is optimized to work in an energy range of 3-30 keV.

The two detector systems were tested at the Elettra beam-line, the latest characterization results will be presented.

18) LaBr3-SiPM X-rays detector characterization for the FAMU experiment

Marco Baruzzo *(University of Udine and INFN Trieste, Italy)*

Abstract

An array of detectors, formed by 8 scintillation detectors equipped with a LaBr3 crystals and a Silicon PhotoMultipliers (SiPM), was implemented to collect X-ray emissions coming from the target of the FAMU (Fisica Atomi MUonici) experiment. The aim of FAMU is to estimate the Zemach proton radius measuring the 1S hyperfine splitting of the muonic atom. The signs of the occurred transitions will be detected as delayed emissions of X-rays from the muonic atoms formed after the muons injection, produced at the ISIS facility at RAL (UK).

This work refers to the LaBr3-SiPM detectors characterization through the analysis of the data collected during the latest FAMU experiment data acquisition at RAL in December 2018.

19) Preliminary study on a Compton Camera based on a 3D position-sensitive CZT solid state detector for BNCT applications

Chunhui Gong *(INFN Pavia, Italy)*

Abstract

Boron Neutron Capture Therapy (BNCT) is a binary radiotherapy based on $^{10}B(n,\alpha)^{7}Li$ reaction, whose clinical outcome depends on the microscopic selective accumulation of ^{10}B inside cancer cells. The ^{10}B therapeutic dose can be monitored in vivo through the measurement of the 0.478 MeV prompt gamma rays emitted by the de-excitation of 7Li*.

The INFN 3CaTS project aims to realize this real-time dosimetry using an innovative 3D CZT drift strip detector. Considering the higher efficiency of Compton Camera (CC) than collimator based SPECT techniques, this work focuses on the preliminary Monte Carlo feasibility simulations of a single-stage CC based on 3D CZT detectors. The results show that the relative efficiency of the “true event” (defined as one Compton scattering followed by the photoelectric absorption of the scattered photon) of a 20×20×20 mm^3 CZT detector reaches 17.6% at 0.478 MeV, a value comparable with other publications. The positions of Compton scatterings and photoelectric absorptions for true events are always located at the proximal part of the detector, and distributed uniformly in lateral directions.

This work shows a promising application of a single-stage CC based on 3D CZT detectors to measure the 0.478 MeV gamma rays in BNCT. Further studies are required to reconstruct the 10B dose distribution.

20) Simulation of the processes of gamma radiation by high energy electrons passing through a crystal

Alexei Sytov

(Department of Physics and Earth Science, University of Ferrara and INFN Ferrara, Italy)

Abstract

Ordered structure of crystal lattice has a strong influence on radiation effects of high energy electrons and positrons, if they move at relatively small angles w.r.t. crystal planes or axes. Such effects are known as coherent bremsstrahlung (CB) and channeling radiation (CR) and arise due to motion of particles in strong transverse electric field (1010-1012 V/cm), propagated by crystal lattice. Therefore, crystals are very promising for generation of X-ray and gamma radiation, by means of CB and CR in a straight and a bent crystal, and crystalline undulator, being very interesting for nuclear research as well as for medical applications.

We present the CRYSTALRAD simulation code providing Monte Carlo simulations of both charged particle dynamics and radiation emission in straight, bent crystals and crystalline undulator. We also present simulation examples of electron radiation in a crystal as well as compare them with experimental data.

21) Cryogenic CMOS amplifier for dark matter detection

Giampaolo Raffaele Aaron *(Politecnico di Torino, Italy)*

Abstract

The use of “cold” CMOS front-end electronics has been proposed in several neutrino and dark matter experiments using noble liquids in large (Time Projection Chambers) TPCs. This improves the signal integrity of the readout chain, since the front-end is assembled near the light sensor. Moreover, the decrease of the thermal noise, associated to the resistance of the conductive channel in MOS devices, has a positive impact on the signal-to-noise ratio of the amplifier. This work reports on the design of an integrated front-end amplifier for the readout of Silicon Photomultipliers (SiPMs) in Liquid Argon. The design is based on a low power two-stage class-AB cascoded core amplifier, using four transimpedance stages and a voltage summing amplifier, and is optimized for the readout of a 24 cm^2 SiPM channel at a temperature of ~83 *K*, with a total power budget below 85 *mW*. The circuit was designed using a standard CMOS 110 *nm* technology node, on silicon area of ~ 2 mm^2. This work depicts the transistor-level design and considerations, and reports on the characterization results in LN (Liquid Nitrogen) using SiPM tiles developed in the framework of the DarkSide Collaboration.

22) ISAE-SUPAERO IEEE Student Branch

Serena Rizzolo *(ISAE-SUPAERO, France)*

Abstract

The aim of the ISAE-SUPAERO IEEE Student Branch is to promote contact and exchange between scientists, engineers, and students in the field of electronics. It also aims to promote the various academic courses related to sciences and electronics.

ISAE-SUPAERO IEEE Student Branch is part of the world's largest professional association IEEE (Institute of Electrical and Electronics Engineers) as a Student Branch. The Branch comprises 21 active members devoted to proposing conferences and networking events. Associated to the IEEE chapter Nuclear and Plasma Sciences Society (NPSS), the association aims to organize conferences by involving distinguished lecturers all around the world coming from the most influential companies and universities.

23) Radiation Induced Defects in CMOS Image Sensors

Alexandre Le Roch *(ISAE-SUPAERO, France)*

Abstract

We propose to identify the displacement damage defects induced by proton and carbon irradiations in a commercial off-the-shelf pinned photodiode (PPD) 8T-CMOS image sensors (CISs) dedicated to space application operating in global shutter mode. This paper aims to provide a better understanding of defects creation in a specific space image sensor. Therefore, it leads to comparable results to those we could find during the mission.

The study focuses on bulk defects located in the PPD depleted region which represents the main dark current contribution in PPD CIS. Four sensors have been irradiated with carbon ions and protons at different energies and fluencies. Using both the dark current spectroscopy and the random telegraph signal (RTS) analysis, we investigate defects behaviour for different isochronal annealing temperatures. By combining these results, we make the connection between two complementary phenomena and bring out the prevalence of divacancies-based defects in term of dark current contribution.

24) Investigating Microchannel Plate PMTs with TOFPET2 multichannel picosecond timing electronics

Thawatchai Sudjai *(Space Research Centre, University of Leicester, UK)*

Abstract

TOFPET2 is the second-generation design of a high-performance multichannel picosecond timing readout electronics ASIC produced by PETsys Electronics SA, Portugal. Originally developed for time-of-flight positron emission tomography (TOFPET) using silicon photomultipliers, in this work we describe an experimental programme to evaluate the performance of TOFPET2 with pixelated microchannel plate (MCP) photomultiplier tube (PMT) detectors. Previous work investigating the first generation TOFPET ASIC demonstrated MCP PMTs operation and multi-anode MCP imaging in single photon counting mode with time resolution of 43 ps. This current work now focuses on the TOFPET2 generation ASIC incorporating significant design advances.

25) Digital self-calibration algorithm for a 12-bit SAR ADC

Andrea Di Salvo *(Politecnico di Torino, Italy)*

Abstract

This work describes the modelling, implementation and simulation results of a self-calibration algorithm for a 12-bit Successive Approximation Register (SAR) Analog-to- Digital Converter (ADC).

The method is named Offset Double Conversion (ODC) and it is a perturbation-based background digital calibration. The algorithm uses an analog offset injection to compute the intrinsic error of the ADC conversion due to mismatching among the capacitances. Thus, adjusting a set of weights, it is achievable a correction taking into account the nonlinearity issues of the sampling process. This technique was preliminary studied in a high level C++ simulation, thereafter physically implemented both in 110 nm and 65 nm CMOS technology. The results were analysed to point out fundamental figures of merit as the Effective Number of Bits (ENOB) and the Spurious Free Dynamic Range (SFDR). This study shows the investigation of the method successfully tested at sampling rate of 40 MHz. According to the results, the average ENOB after the correction is approximately incremented in an range of 2-4 bits by using a 5% random capacitor mismatch. The SFDR is hold below -90 dB. The power consumption is upper limited to 3 mW in the worst case.

26) The LHCb RICH Detector Upgrade

Igor Skiba *(University and INFN Ferrara, Italy)*

Abstract

The LHCb experiment at CERN focuses on heavy flavour physics and is trying to provide evidences of new physics in CP violation and rare decays of beauty and charm quarks. The planned upgrade has started at the beginning of 2019 and will take approximately 2 years.

The upgrade will allow a significant increase of a performance in luminosity and in data acquisition frequency. The luminosity will increase from 4×10^{32} $cm^{-2}\times s^{-1}$ to 2×10^{33} $cm^{-2}\times s^{-1}$, whereas the data acquisition rate will increase from 1 MHz to 4 0Mhz. In order to achieve that the current photon detectors of the Ring Imaging Cherenkov (RICH) detector - Hybrid Photon Detectors (HPDs) will be replaced by Multianode Photomultipliers (MaPMTs) and FE (Front-End) readout electronics will be changed by implementation of the CLARO, a custom amplifier and discriminator ASIC.

The poster will cover the architecture of an Elementary Cell (EC), which is the basic building block of the RICH detection system, including photodetectors, front-end electronics and digital boards. An overview of the Elementary Cell Quality Assurance (EC QA) test and the radiation hardness qualification will be discussed.

27) Beam and target fragmentation in hadrontherapy: the FOOT (FragmentatiOn Of Target) experiment

Gianluigi Silvestre *(INFN Perugia, Italy)*

Abstract

Hadrontherapy is a form of radiation therapy which uses beams of protons or heavier ions for the treatment of tumors exploiting their higher LET and RBE. Unlike radiotherapy treatment, only a small dose is released to healthy tissues in the entrance region, while the maximum of the dose is released to the tumor at the end of the beam range, in the Bragg peak region.

Nuclear interactions between the beam and patient tissues cause fragmentation of both the projectile and the target also in healthy tissues on the path to the tumor region. The Treatment Planning Systems do not have precise information on the physics of these interactions, hence their prediction of deposited dose in various body regions is not precise as it should. Hence the main objective of the FOOT (FragmentatiOn Of Target) experiment is the measurement of the double differential cross-sections with respect to kinetic energy and emission angle of fragments produced in these interactions. The full detector will include a drift chamber to measure beam direction, a magnetic spectrometer based on silicon pixels and silicon microstrip detectors to measure fragments' momentum, a plastic scintillator for ΔE/dx and TOF measurements and a scintillating crystal calorimeter to measure kinetic energy. These measurements will be combined to accurately identify fragments charge and mass.

28) Study of the cosmic rays with the DAMPE experiment

Enrico Catanzani *(INFN Perugia, Italy)*

Abstract

The DArk Matter Particle Explorer (DAMPE) is a spaceborne experiment, installed on board of an instrumented satellite, launched on 17th December 2015, the detector is smoothly taking data since then and has collected more than 5 10^9 cosmic rays events in 3 years. DAMPE is the result of an active cooperation between Italy, China and Switzerland in order to pursuit the following scientific goals: indirect research of dark matter particles, study of cosmic rays spectrum and high energy gamma-ray astronomy.

DAMPE is characterized by 4 sub-detectors (from top to bottom): Plastic Scintillator Detector (PSD), Silicon-Tungsten-Tracker (STK), 3D imaging BGO calorimeter and the Neutron Detector. The experiment is capable to detect electrons and photons from GeV to 10 TeV, while for the nuclei the energy ranges from 10 GeV to 100 TeV. The detector is also capable of particularly accurate energy measurements and an e/p rejection power of 10^5, a key aspect in order to survey electrons and positrons present into the cosmic rays. In 2017 the DAMPE published the CRE spectrum up to 2 TeV, confirming a break in the teraelectronvolt cosmic-ray spectrum of electrons and positrons (doi:10.1038/nature24475).

The detector performances are still excellent after three years of continuous operation in space, extending the mission lifetime: we present the current status of the detector, its performance in the detection of cosmic rays and a preliminary study on the cosmic ray electron anisotropy.

29) Enhancement of direct X-Ray detection performance in flexible Organic Thin Films by Small Molecules Tailoring

Ilaria Fratelli *(Department of Physics and Astronomy, University of Bologna, Italy)*

Abstract

Ionizing radiation detection over large area is a fundamental task in several fields of human society. In order to fulfil the increasing quest for flexible, portable, low cost and low power consumption sensors, the research interest on novel materials able to overcome the limits of the standard sensing technologies is continuously growing. Electronic devices based on organic materials have already demonstrated to be a promising alternative. In particular, the excellent direct X-ray detection performance exhibited by solution-processed flexible organic thin film transistors based on 100 nm thick microcrystalline (e.g. 6,13-bis-(triisopropylsilylethynyl)-pentacene (TIPS-pentacene)) active layer has been recently reported.

However, in organic detectors high-energy photon absorption is still challenging because of the small cross section of interaction between radiation and low-Z elements. Here, we propose a new approach to enhance the sensitivity of the organic detectors, by increasing the radiation capture cross section by means of the addition of high-Z atoms into the basic molecular structure of the material. In detail, we measured the detection performance shown by a new solution-processable organic molecules derived from TIPS-pentacene, with Ge-substitution in place of the Si atoms, reaching higher sensitivity values and better charge transport, with respect to TIPS-pentacene-based detectors.

30) The key behind HERMES design: broad energy band detection with SDD-scintillator coupled detector

Giuseppe Dilillo *(University of Udine, Italy)*

Abstract

The nature of the radiative mechanism of Gamma Ray Bursts (GRBs) is still uncertain. Recent studies suggest the presence of spectral features at few keV, where only a handful of bursts have been observed.

While serving the supportive role of an all-sky monitor with arcsec localization capability for the new generation of gravitational detections, HERMES will research GRBs on an unprecedented broad band of energies, spanning from keV to MeV.

At the heart of every HERMES units lies a SDD-scintillator coupled detector, which could rightfully be regarded as the mission's enabling technology. In this poster we will 1. briefly discuss HERMES detector design and 2. present our most recent results about the feasibility for space applications of GAGG:Ce, a promising but still largely uncharted new inorganic scintillator.

31) Investigation of post processing resistivity modification for HV-CMOS pixel detectors

William Holmkvist *(Lancaster University, UK and CERN, Switzerland)*

Abstract

Advances in high energy physics and acceleration technology are putting increased demands on future tracking technology in detectors, such as the ATLAS ITk, requiring higher radiation tolerance and larger areas to cover, while still being affordable. Consequently industry standard HV-CMOS technology is being investigated for possible use in pixel detectors. CMOS sensors implement discriminators and amplifiers directly on top of a deep n-implant, potentially saving volume and money. In addition, CMOS sensors have been shown to have adequate radiation tolerance.

While high resistivity is commonly preferred in silicon based pixel detectors, some foundries and most multi project wafer runs only offer low resistivity silicon in the range of 10 - 20 Ωcm, resulting in a small active region. To circumvent the initial low signal generation, pre-irradiation and thermal donor introduction has been investigated. 10 Ωcm HV-CMOS chips made with the 180 nm technology by AMS has been irradiated at LANSCE up to 2×10^{16} N_{eq}/cm^2 and investigated with edge-TCT. In addition, thermal donor introduction was tried to increase the initial resistivity through annealing unirradiated chips at 450 °C.

32) Radiation-Hard Silicon Photonics High-Speed Mach-Zehnder Modulator for High Energy Physics Applications

Simone Cammarata *(Department of Information Engineering, University of Pisa, Italy)*

Abstract

Silicon photonics may well provide the opportunity for new levels of integration between detectors and their readout electronics. This technology can enable high-speed optical data communication taking advantage of CMOS fabrication processes. It is thus being evaluated in order to assess its suitability for use in particle physics experiments.

The target of our work is the realization with the isipp50g technology, available through Europractice, of a radiation-hard Mach-Zehnder modulator in compliance with the radiation levels of the HL-LHC upgrade.

TCAD simulations have been carried out to investigate the dependence of optical modulation performances on doping profiles and radiation-induced degradation effects. Aiming to improve the matching between the photonic device and the electronic driver, RF full-wave simulations have been performed to design a traveling-wave modulator.

33) Integration of the electronics readout for the CGEM - Inner Tracker

Alberto Bortone *(University and INFN Torino, Italy)*

Abstract

An innovative CGEM (Cylindrical Gas Electron Multiplier) detector will upgrade the current inner tracker of the BESIII experiment.

A custom 64ch ASIC has been designed to operate in a constrained power envelope to address the specific requests of the experiment in terms of performance, providing analog charge and time measurements, featuring a fully-digital output.

Off detector, the system integrates 21 FPGA-based modules (GEMROCs) to manage the transmission to/from the front-end chips, for both slow control and data acquisition. The data are then collected via optical links by two FPGA-based Data Collector modules, which build the events and send them to the BESIII DAQ system.

The detector layers are now operating in Beijing and the whole readout system has carried out random noise and cosmic rays testing. The design of the electronics chain will be shown together with the first results of the integration tests.

34) Design and Experimental Verification of 5 Gbps, 800 Mrad TID and SEU-Tolerant Optical Modulators Drivers

Gabriele Ciarpi

(Department of Information Engineering, University of Pisa and INFN Pisa, Italy)

Abstract

This work presents the design and experimental verification of two drivers designed to be compatible with the high dose levels present in the inner layer of the CERN Large Hadron Collider experimental chambers.

The drivers, designed to face up to 800 Mrad Total Ionizing Dose (TID), are able to sustain up to 5 Gbps bit-rate links. They are designed to drive two Silicon Photonics optical modulators: Mach Zehnder Modulator and Ring Resonator, which have shown high rad-tolerant levels. Thanks to the development of a high radiation level MOSFET model, some techniques, such as avoiding the use of P-MOSFETs, increment of the minimum MOSFET lengths for the switching MOSFETS and the use of Enclosed Layout Transistors shape plus some layout precautions, have ensured the high dose levels hardness.

In order to increase the drivers speed, techniques like buffer chain and inductive peaking are used in the drivers design. The experimental results have verified the matching of the high-speed high-voltage required by the application. The TID tests have shown a 30% and 25% amplitude reduction of the output signal eye diagrams of the two drivers. Therefore, the experimental measurements have verified the design of the 800 Mrad optical modulators drivers.