VCI2022 - The 16th Vienna Conference on Instrumentation

Report of Contributions

Contribution ID: **4** Type: **Recorded Presentation**

Design of A 20 Gbps PAM4 VCSEL Driving ASIC for NICA Experiments

The Vertical cavity surface emitting laser (VCSEL) optical link has been prevailingly researched and used for the front-end data acquisition in high-energy physics experiments. As the increasing amount of data produced by the high-energy physics experiments, the bandwidth constraints imposed by the channel and ESD become more severe, which severely limits the development of the non-return-zero (NRZ) signaling. The 4-level pulse amplitude modulation (PAM4) is drawing widely attentions due to its two-fold bandwidth efficiency than NRZ signaling. In this paper, we present the design and the test results of a 20 Gbps PAM4 VCSEL driving ASIC fabricated in 55 nm CMOS technology. This ASIC is part of the optical link in the Nuclotron-based Ion Collider fAcility (NICA) front-end readout electronics. The PAM4 VCSEL driving ASIC consists of two pre-driver stages, a 4PAM-core output driver stage and a SPI module. The two pre-driver stages receive two 10 Gbps NRZ bit streams MSB and LSB. The 4PAM-core output driver stage converts the high-speed voltage signal from the pre-drive stage into a 4-level current signal to the VCSEL. The optical test results show that the ratio level mismatch (RLM) of 20 Gbps eye diagram is 0.96 and the transmitter dispersion eye closure quaternary (TDECQ) is 0.63 dB, the optical modulation amplitude (OMA) is 761 uW. When working at 25 Gbps, the RLM is 0.94 with the TDECQ of 0.91 dB.

Primary experiment

Primary authors: ZHAO, Cong (Central China Normal University); GUO, Di (Central China Normal University)

Co-authors: CHEN, Qiangjun (Central China Normal University); Mr LIWEN, Yi (Central China Normal University); Ms ZENGTAO, Guo (Central China Normal University); Ms YUJING, Gan (Central China Normal University)

Presenters: ZHAO, Cong (Central China Normal University); GUO, Di (Central China Normal University)

Track Classification: Electronics

Contribution ID: **5** Type: **Recorded Presentation**

A new Readout Scheme of Gaseous Detectors

A new readout scheme allowing the exploitation of Resistive Plate Chamber (RPC) spatial precision and using a limited number of electronic channels was designed. The new scheme which exploits the spread of the RPC induced charge on several adjacent inter-connected pads, allows the simultaneous detection of several particles without ambiguity.
In this scheme, pads are connected in rows through buried vias in rear layers in a genuine way so the charged induced by the passage of one particle is shared among pads belonging to different directions. The pads of one row are connected to one electronic channel.
The position of the particle is determined by the intersection of the rows associated to the fired pads and the ambiguity is eliminated by the fact that more than two crossing rows with two different directions are concerned.
The new scheme allows to instrument large detectors with a reduced number of electronics channels without reducing the spatial resolution obtained with pads read out individually.
We will present the results obtained on a cosmic ray bench built with 60 cm x 70 cm RPC read out with the new readout scheme and we will discuss our plan to use the new scheme to instrument large detectors. We will also how show the first results obtained by connecting up to 10such PCB together.

Primary experiment

Primary author: LAKTINEH, Imad (Centre National de la Recherche Scientifique (FR))

Presenter: LAKTINEH, Imad (Centre National de la Recherche Scientifique (FR))

Track Classification: Gaseous Detectors

Contribution ID: **7** Type: **Live Presentation**

Picosecond timing of charged particles using the TORCH detector

Friday, February 25, 2022 2:00 PM (20 minutes)

TORCH is a large-area, high-precision time-of-flight (ToF) detector designed to provide charged-particle identification in the 2-20 GeV/c momentum range. Prompt Cherenkov photons emitted by charged hadrons as they traverse a 1cm quartz radiator are propagated to the periphery of the detector, where they are focused onto an array of microchannel plate photomultiplier tubes (MCP-PMTs). The position and arrival times of the photons are used to infer the particles' time of entry in the radiator, to identify hadrons based on their ToF. The MCP-PMTs were developed with an industrial partner to satisfy the stringent requirements of the TORCH detector. The requirements include a finely segmented anode, excellent time resolution, and a long lifetime. Over a ~10m flight distance, the difference in ToF between a kaon and a pion with 10GeV/c momentum is 35ps, leading to a 10-15ps per track timing resolution requirement. The required single-photon time resolution is 70ps, for an average of 30 detected photons per hadron.
The TORCH R&D program aims to demonstrate the validity of the detector concept through laboratory and beam tests, results from which will be shown. A timing resolution of 70-100ps was reached in beam tests, approaching the TORCH design goal. Laboratory timing tests consist of operating the MCP-PMTs coupled to the readout electronics. A time resolution of the MCP-PMT coupled to the readout electronics of ~50ps was measured. This meets the TORCH target timing resolution.

Primary experiment

TORCH

Primary author: Ms CICALA, Maria Flavia (University of Warwick (GB))

Presenter: Ms CICALA, Maria Flavia (University of Warwick (GB))

Session Classification: Gas and Cherenkov Timing

Track Classification: Cherenkov Detectors

Contribution ID: **9** Type: **Recorded Presentation**

Performance demonstration of multi-modal imaging using hybrid Compton cameras

X-ray and gamma-ray imaging techniques are crucial in various fields. In the field of nuclear medicine, single-photon emission tomography (SPECT) and positron emission tomography (PET) scans are the two most commonly used techniques; however, both techniques only image a specific energy range of either X-rays or gamma rays. SPECT can only image gamma rays with energies less than 300 keV using a collimator, whereas PET can image only 511 keV gamma rays from positron emitters. Compton cameras have attracted attention because of their capability of imaging above 1 MeV.

We propose a hybrid Compton camera (HCC) that realizes simultaneous Compton and pinhole imaging within a single detector system. Similar to conventional Compton cameras, the HCC consists of two layers of scintillator arrays. The front detector acts as a scatterer for high-energy photons (>200 keV) and an active pinhole for low-energy photons (<200 keV). Furthermore, we developed a system consisting of multiple HCCs to simultaneously realize three modalities: Compton, pinhole, and PET imaging. We successfully performed the simultaneous imaging of Cs-137 (Compton mode; 662 keV), Na-22 (PET mode; 511 keV), and Am-241 (pinhole mode; 60 keV) within the same field of view. Further, the 3D distribution of an At-211 tracer inside a mouse was imaged. We also investigated the effectiveness of implementing BGO active shields to enhance the imaging performance. Our study introduces a new imaging modality in nuclear medicine.

Primary experiment

Primary authors: Mr OMATA, Akihisa (Waseda University); Ms MASUBUCHI, Miho (Waseda University); Ms KOSHIKAWA, Nanase (Waseda University); Prof. KATAOKA, Jun (Waseda University); Prof. KATO, Hiroki (Osaka University); Prof. TOYOSHIMA, Atsushi (Osaka University); Prof. TERAMOTO, Takahiro (Osaka University); Prof. OOE, Kazuhiro (Osaka University); Ms LIU, Yuwei (Osaka University); Prof. MATSUNAGA, Keiko (Osaka University); Prof. KAMIYA, Takashi (Osaka University); Prof. WATABE, Tadashi (Osaka University); Prof. SHIMOSEGAWA, Eku (Osaka University); Prof. HATAZAWA, Jun (Osaka University)

Presenter: Mr OMATA, Akihisa (Waseda University)

Track Classification: Medical Applications

Contribution ID: **10** Type: **Recorded Presentation**

First performance results of COMMAND: a COmpact and Multi-purpose Muon And Neutron Detector

Applications of both cosmic-ray (CR) muons and neutrons have grown in numbers in the last decades. Measurements of flux attenuation (radiography) and scattering angles (tomography) of CR muons have been successfully applied to the inspection or monitoring of large natural and civil structures, to the search for heavy metals in container and trucks, to the control of nuclear wastes, and much more. Measurements with CR neutrons have instead been used for the determination of the snow-water equivalent, the soil moisture estimation and climate studies (sometimes together with CR muon measurements). In this talk we present COMMAND, a new compact detector for both muons and neutrons. It consists of 5 independent and removable modules: 3 for the detection of muons, based on scintillating fibers coupled to SiPMs, and 2 for the detection of neutrons, based on lithium enriched phosphor detectors, read by a matrix of SiPM. Several innovative solutions have been implemented in the making of COMMAND, from the use of additive manufacturing, to the design of the electronics, which is based on COTS devices and features realtime time-stamping and triggering, programmable bias for SiPMs, and low-noise/high-speed analogue front-end. An overview of the detector, its current state of development (completion due by the end of the year) and its possible applications are presented.

Primary experiment

Primary author: Prof. PAGANO, Davide (Universita di Brescia (IT))

Co-authors: Dr BODINI, Ileana (Università degli Studi di Brescia); BONOMI, Germano (Universita di Brescia (IT)); DONZELLA, Antonietta (Università di Brescia); Dr PADERNO, Diego (Università degli Studi di Brescia); Prof. VILLA, Valerio (Università degli Studi di Brescia); ZENONI, Aldo (University of Brescia)

Presenter: Prof. PAGANO, Davide (Universita di Brescia (IT))

Track Classification: Astroparticle Detectors

Contribution ID: **14** Type: **Live Presentation**

Commissioning and preliminary performance of the MEG II drift chamber

Tuesday, February 22, 2022 2:25 PM (20 minutes)

In the quest for the Lepton Flavour Violation (LFV) the MEG experiment at the Paul Scherrer Institut (PSI) represents the state of the art in the search for the charged LFV $\mu^+ \to e^+\gamma$ decay. MEG set the most stringent upper limit on the BR($\mu^+ \to e^+\gamma$) $\leq 4.2 \times 10^{-13}$ (90% confidence level), imposing one of the tightest constraints on models predicting LFV-enhancements through new physics beyond the Standard Model. An upgrade of MEG, MEG II, was designed and it is presently in the final commissioning phase, aiming at reaching a sensitivity level of 6×10^{-14}. The Cylindrical Drift CHamber (CDCH) is a key detector in order to improve the e^+ angular and momentum resolutions at 6.5~mrad and 100~keV/c level. CDCH is a low-mass single volume detector with high granularity: 9 layers of 192 drift cells, few mm wide, defined by 12000 wires in a stereo configuration for longitudinal hit localization. After the assembly phase, CDCH was transported to PSI and it has been integrated into the MEG II experimental apparatus since 2018. The commissioning phase lasted for the past three years with continuous improvements both on the hardware and software side. After a conditioning period, the operational stability was reached in 2020 and the complete read out electronics is tested for the first time in 2021. The 2020-2021 data and results will be presented in view of the physics data taking in the upcoming three years.

Primary experiment

MEG II

Primary author: CHIAPPINI, Marco (PSI - Paul Scherrer Institut)

Co-authors: CORVAGLIA, Alessandro (INFN Lecce); BALDINI, Alessandro Massimo (Universita & INFN Pisa (IT)); MICCOLI, Alessandro (INFN Lecce e Universita del Salento (IT)); PAPA, Angela; VOENA, Cecilia (Sapienza Universita e INFN, Roma I (IT)); NICOLÒ, Donato (Pisa University); CEI, Fabrizio (University of Pisa); RAFFAELLI, Fabrizio (Universita & INFN Pisa (IT)); CUNA, Federica (INFN - National Institute for Nuclear Physics); GRANCAGNOLO, Francesco (INFN - Lecce); RENGA, Francesco (INFN Roma); CAVOTO, Gianluca (Sapienza Universita e INFN, Roma I (IT)); CHIARELLO, Gianluigi (INFN Pisa); TASSIELLI, Giovanni F. (INFN Lecce / Università del Salento); SIGNORELLI, Giovanni (INFN); GALLI, Luca (INFN); HILDEBRANDT, Malte (Paul Scherrer Insitut); MEUCCI, Manuel (INFN - National Institute for Nuclear Physics); FRANCESCONI, Marco; GRASSI, Marco (INFN - Italy); PANAREO, Marco (INFN Lecce e Universita del Salento (IT)); SCHWENDIMANN, Patrick (PSI)

Presenter: CHIAPPINI, Marco (PSI - Paul Scherrer Institut)

Session Classification: Large Detector Systems

Track Classification: Gaseous Detectors

Contribution ID: **16** Type: **Recorded Presentation**

The WaveDAQ integrated Trigger and Data Acquisition System for the MEG II experiment

The MEG II experiment at Paul Scherrer Institut aims at a sensitivity improvement on $\mu \longrightarrow e\gamma$ decay by an order of magnitude with respect to the former MEG experiment while keeping the same detection strategy. This is possible thanks to a higher segmentation of all detectors, which improves the resolutions and helps to cope with twice muon stopping rate, mandatory to collect the required amount of statistics in three years.
The new WaveDAQ integrated Trigger and DAQ system has been developed to fit within the experiment upgrade, pushing further the performances of the DRS4 Switched Capacitor Digitizer allowing of GigaSample digitisation of all the 9000 channels in a custom made crate system. The system design is highly scalable and can cover the TDAQ needs ranging from laboratory tests to medium-scale experiments, like MEG II. Each WaveDAQ input channel can provide biasing for SiPMs applications and a programmable high bandwidth frontend, removing the need for additional hardware; the trigger generation is fully programmable on a multiple-FPGA architecture interconnected by low latency links and capable of computing charge and time-based selections in less than 500 ns.
The system has been installed in 2021 and is currently being used in the MEG engineering run. We will report about the overall trigger and DAQ commissioning and describe all the methodologies developed for being able to collect 8Gb/s of data from the WaveDAQ to the online machine.

Primary experiment

MEG II

Primary authors: Mr SCHMID, Elmar (Paul Scherrer Institut); MORSANI, Fabio (Universita & INFN Pisa (IT)); GALLI, Luca (INFN); FRANCESCONI, Marco; RITT, Stefan (Paul Scherrer Institut (Switzerland)); Mr HARTMANN, Ueli (Paul Scherrer Institut); NICOLO, donato (pisa university)

Presenter: FRANCESCONI, Marco

Track Classification: Electronics

Contribution ID: **17** Type: **Recorded Presentation**

Performance demonstration of a novel Photon-counting CT for preclinical application

Photon counting computed tomography (PC-CT) is a novel technology with the potential to dramatically change clinical CT. PC-CT provides energy-resolved CT images with a high contrast-to-noise ratio (CNR) because it can discriminate individual incoming X-ray photons. However, the PC-CT image quality limitation due to image reconstruction in a narrow energy band is a problem that needs to be solved. At present, semiconductor-based PC-CT systems have been widely developed; however, the numerous readout channels with complex rear circuits make these semiconductor-based PC-CT systems complicated. Thus, we developed a novel PC-CT system comprising high-speed scintillators coupled with multipixel photon counters (MPPCs). An MPPC-based PC-CT is a simple system owing to its high internal gain and rapid temporal response. In this study, machine-learning models were applied to PC-CT images to improve image quality. As a result, the CNR of PC-CT images was improved, which led to material decomposition for ultra-low-concentration contrast agents and gold nanoparticles. Moreover, to further demonstrate the performance of MPPC-based PC-CT, we challenged the acquisition of high-resolution PC-CT images, which play important roles in the diagnosis. Finally, using the energy information of contrast agents, we demonstrated that noninvasive internal plant imaging can be performed. These results are promising for the advancement of MPPC-based PC-CT.

Primary experiment

Primary author: Mr TOYODA, Takaya (Waseda University)

Co-authors: Prof. KATAOKA, Jun (Waseda University); Ms SAGISAKA, Mayu (Waseda University); Prof. ARIMOTO, Makoto (Kanazawa University); Dr SATO, Daichi (Kanazawa University); Mr YOSHIURA, Kotaro (Kanazawa University); Prof. KAWASHIMA, Hiroki (Kanazawa University); Prof. KOBAYASHI, Satoshi (Kanazawa University); Prof. KOTOKU, Junichi (Teikyo University); Mr TERAZAWA, Shinsuke (Hitachi Metal Ltd); Mr SHIOTA, Satoshi (Hitachi Metal Ltd); Prof. UEDA, Masashi (Okayama University)

Presenter: Mr TOYODA, Takaya (Waseda University)

Track Classification: Medical Applications

Contribution ID: **19** Type: **Recorded Presentation**

Studies on Fast Neutron Imaging with a Pixelated Stilbene Scintillator Detector

The Neutron Detectors group at the Physics Institute III B, RWTH Aachen University, develops pixelated detectors for fast neutron imaging applications with compact neutron sources, e.g. Americium-Beryllium (AmBe) or neutron generators. The detectors use specialized scintillators such as stilbene that enable to distinguish neutron and gamma induced signals via Pulse Shape Discrimination, coupled to SiPMs. Therefore, these detectors allow for simultaneous investigation of objects with fast neutrons and gammas.
After the successful development and test of a single-pixel prototype, we have currently a 16-pixel detector prototype available. The prototype consists of 16 stilbene cuboids of size 5x5x25 mm^3 arranged in a 4x4 grid, coupled to a 4x4 SiPM array. In the future, it is planned to construct larger detector arrays with custom-made readout electronics developed together with the ZEA-2, FZ Jülich.
In this presentation, detector characterization measurements as well as radiographic and tomographic test measurements, using an AmBe neutron source, a D-D neutron generator and a Cs-137 gamma source, will be shown. Also, results from a detailed Geant4 simulation that helps us better understand the interactions in detector, object of interest and surroundings and study different setups, will be presented.

Primary experiment

Primary authors: HÖFLICH, Nina (RWTH Aachen University); POOTH, Oliver (RWTH Aachen University)

Presenter: HÖFLICH, Nina (RWTH Aachen University)

Track Classification: SiPM

Contribution ID: **20** Type: **Live Presentation**

First experimental results of the spatial resolution of RSD pad arrays read out with the FAST2 full custom 16-ch ASIC

Friday, February 25, 2022 12:20 PM (20 minutes)

Resistive Silicon Detectors (RSD, also known as AC-LGAD) are innovative silicon sensors based on the LGAD technology, characterized by a continuous gain layer and by an internal signal-sharing mechanism.

RSDs are very promising tracking detectors that combine large pitch and extremely accurate position reconstruction: the most recent results show a spatial resolution of 2 μm for a sensor with 100 μm pixels. Such accuracy is achieved by combining the internal sharing mechanism of RSD with a reconstruction method based on a neural network.

This talk will present the first experimental results obtained from RSD arrays read out with a dedicated ASIC (FAST2), tailored to fast signals. The ASIC output is connected to a 16-ch digitizer, allowing simultaneously recording all the detector channels. All tested sensors are 3x3 or 4x4 arrays with different pitch sizes, coming from the RSD1, RSD2 productions manufactured at Fondazione Bruno Kessler (FBK, Italy).

Primary experiment

Primary author: SIVIERO, Federico (Universita e INFN Torino (IT))

Co-authors: STAIANO, Amedeo (Universita e INFN Torino (IT)); ARCIDIACONO, Roberta (Universita e INFN Torino (IT)); CARTIGLIA, Nicolo (INFN Torino (IT)); FERRERO, Marco (Universita e INFN Torino (IT)); MANDURRINO, Marco (INFN); MENZIO, Luca (Universita e INFN Torino (IT)); SOLA, Valentina (Universita e INFN Torino (IT)); TORNAGO, Marta; COSTA, marco (University of Torino)

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

Session Classification: Semiconductor Detectors

Track Classification: Semiconductor Detectors

Contribution ID: **21** Type: **Recorded Presentation**

Development of the micro-RWELL discs for the CMD-3 detector.

The CMD-3 is general purpose detector at the VEPP-2000 electron-positron collider at Budker Institute of Nuclear Physics. CMD-3 is intended to measure parameters of light vector mesons and their excited states with accuracy better than 1% and study dynamics of multihadron production. In order to increase acceptance for the trigger for charged particles and improve precision of track polar angle measurements the end-cap discs based on micro-resistive-WELL (muRWELL) structures are proposed for the upgrade of the CMD-3 tracking system. Two muRWELL discs 50 cm in diameter were assembled and tested. The discs have two-layer readout structure with the top layer of quarter-rings with 2mm pitch in radius and the bottom layer of sectors with average angular pitch of about 0.3 degrees. The first preliminary tests of both discs demonstrated the possibility to reach gas amplification of 20000 locally in some sectors. However the gain is very non-uniform and is below 10000 on average. These measurements have been performed in current mode. The readout structure of the discs is connected to front-end electronics based on VMM3a ASICS. The results of more systematic study of the main parameters of the detectors with front-end electronics will be reported.

Primary experiment

Primary authors: FEDOTOVICH, Gennady (BINP); SHEKHTMAN, Lev (Budker Institute of Nuclear Physics (RU)); KUDRYAVTSEV, Vasily (Budker Institute of Nuclear Physics (RU))

Presenter: SHEKHTMAN, Lev (Budker Institute of Nuclear Physics (RU))

Track Classification: Gaseous Detectors

Contribution ID: **26** Type: **Recorded Presentation**

Borehole cylindrical detector: a compact muon tracker for Muon Radiography applications

Muon Radiography (or muography) is a recent imaging methodology that uses cosmic muons to investigate the interior of large objects, such as volcanoes, mines or buildings as the pyramids. Some applications are intended to use muography to search for hidden cavities in the subsoil. In many cases the muon telescope needs to be installed underground, inside tunnels, excavated chambers or drilled holes. Usually the available locations are difficult to be accessed by people and by big instrumentations; this issue suggested the idea to construct a very compact cylindrical muon tracker, which maximizes the acceptance respect to its small dimensions thanks to arc-shaped plastic scintillator that minimize the dead spaces. It is 1 m high and has a 24 cm diameter; these dimensions are ideal to fit a realizable drilled well.

The new borehole cylindrical detector is made of plastic scintillator elements, read out by SiPMs. Laboratory tests have been completed, and an open sky muon flux measurement is in good agreement with expectations. A first application on field is currently on going: the detector has been installed in the subsoil of Mt. Echia, a little hill in the center of the city of Naples, Italy, where a complex of cavities and tunnels, of very ancient origins, is present. The purpose of this application is to test the potentialities of the cylindrical muon tracker to detect hidden cavities in reasonable time. The detector design and some preliminary results will be presented.

Primary experiment

Primary author: Ms D'ERRICO, Mariaelena (INFN & Università degli Studi di Napoli Federico II)

Co-authors: Prof. AMBROSINO, Fabio (Università degli Studi di Napoli Federico II & INFN); Prof. SARACINO, Giulio (Università degli Studi di Napoli Federico II & INFN); ROSCILLI, Lorenzo (INFN); Dr CIMMINO, Luigi (Università degli Studi di Napoli Federico II & INFN); MASONE, Vincenzo (INFN)

Presenter: Ms D'ERRICO, Mariaelena (INFN & Università degli Studi di Napoli Federico II)

Track Classification: Astroparticle Detectors

Contribution ID: **28** Type: **Live Presentation**

Deep Underground Neutrino Experiment: DUNE

Monday, February 21, 2022 3:15 PM (20 minutes)

DUNE is the most ambitious long-baseline experiment under construction in the US for the study of neutrino oscillation and astroparticle physics. The DUNE far detector consists of four modules (17 kton each) based on the Liquid Argon TPC technology and enhanced by a powerful Photon Detection System (PDS) that records the 128 nm scintillation light emitted by argon.
The talk will cover the main characteristics of the Near Detector and of the two first far detector modules, Horizontal and Vertical Drift respectively, together with the description of the dedicated R&D carried out. A particular emphasis will be given to the characterization of the PDS.

Primary experiment

DUNE

Primary author: FALCONE, Andrea (Universita e INFN, Milano Bicocca(IT))

Presenter: FALCONE, Andrea (Universita e INFN, Milano Bicocca(IT))

Session Classification: Astroparticle Detectors

Track Classification: Astroparticle Detectors

Contribution ID: **30** Type: **Recorded Presentation**

Indirect Detection of WIMPs with NEMESIS

Considerable experimental and theoretical work has been devoted to solving the Dark Matter (DM) puzzle. However, apart from gravitational evidence, no other measurements confirm DM existence. Weakly Interacting Massive Particles (WIMPs) are perhaps the most broadly accepted hypothesis postulated for DM. If true, the galaxies are immersed in a vast halo of WIMP particles moving at a different speed than the visible matter causing a detectable WIMP flux. Several large-scale experiments are searching for recoil signals from WIMP scattering. The new NEMESIS experiment, collecting data since November 2019, has a different approach. We are attempting Indirect WIMP detection following their assumed self-annihilation in a bulky Pb target. With the anticipated WIMP mass ~10 GeV/c2, such an event would also obliterate the target nucleus. The detectable signature would be a massive emission of particles and gamma-rays. Most of the time, only neutrons and high-energy leptons would emerge from the Pb target. Interestingly, our analysis of NEMESIS, NMDS, and ZEPLIN-II data revealed three distinct anomalies in muon-suppressed neutron multiplicity spectra. The statistics are still marginal, but the exact match of the extracted multiplicities and intensities for all three experiments rules out an accidental fluke. The proposed NEMESIS update should cross the needed 5-sigma discovery threshold during the first year of running.

Primary experiment

Primary author: TRZASKA, Wladyslaw Henryk (University of Jyvaskyla (FI))

Presenter: TRZASKA, Wladyslaw Henryk (University of Jyvaskyla (FI))

Track Classification: Dark matter and other low-background experiments

Contribution ID: **31** Type: **Recorded Presentation**

Position sensitive Ultra cold neutron detector using 10B-coated CCD

Ultra-cold neutron are used in many particle physics experiments such as measurment of the neutron EDM, the neutron lifetime or of graviationnal quantum states. These neutrons with energies below 250neV tends to bounce on most material and poses several dectecion challanges.
We present a position-sensitive UCN detector using boron 10 coated CCD sensors reaching an efficiency of 85% in a large velocity range and a spacial resolution close to 2um.

Primary experiment

GRANIT

Primary authors: Dr CLEMENT, Benoit (Université Grenoble Alpes); PIGNOL, Guillaume (LPSC)

Presenter: Dr CLEMENT, Benoit (Université Grenoble Alpes)

Track Classification: Semiconductor Detectors

Contribution ID: **32** Type: **Live Presentation**

Performance Evaluation of Stitched Passive CMOS Strip Sensors

Thursday, February 24, 2022 3:15 PM (20 minutes)

Silicon sensors will continue to be the central tracking elements for upcoming particle physics detectors. They will have to cover large areas and thus be a main cost driver. The currently used silicon sensors are available only from very few manufacturers, thus detector technologies and designs that can be realized through established commercial industrial production processes and are cost-effective are becoming increasingly relevant. The CMOS technology is one of the important candidates. Since typically CMOS foundries are equipped for producing much smaller sizes than the currently used wafer-scale strip sensors, several neighboring reticles have to be connected via a stitching process to obtain large sensors.
In this contribution strip sensors were designed and developed with the passive p-CMOS 150nm process including stitching of up to five reticles. The sensors are processed on a 150 µm thick wafer and are up to 4 cm long. There were two batches of sensors produced and investigated, of which the second batch had an improved backside processing to enhance the HV stability.
After initial electrical characterizations the sensors were tested in the laboratory with a ^90Sr source and infrared lasers. The key investigation was to evaluate the impact of stitching on the sensor performance. The presented results will demonstrate that the stitching does not show any negative effect on the sensor performance and the stitching process is successful.

Primary experiment

Primary authors: RODRIGUEZ RODRIGUEZ, Arturo (Albert Ludwigs Universitaet Freiburg (DE)); DIEHL, Leena (Albert Ludwigs Universitaet Freiburg (DE)); SPERLICH, Dennis (Albert Ludwigs Universitaet Freiburg (DE)); GREGOR, Ingrid-Maria (DESY & Bonn University); HONIG, Jan Cedric (Albert Ludwigs Universitaet Freiburg (DE)); JAKOBS, Karl (Albert Ludwigs Universitaet Freiburg (DE)); WIIK-FUCHS, Liv (Albert Ludwigs Universitaet Freiburg (DE)); SHARMA, Surabhi (Deutsches Elektronen-Synchrotron (DE)); MÄGDEFESSEL, Sven (University Freiburg); WANG, Tianyang (University of Bonn (DE)); HEMPEREK, Tomasz (University of Bonn (DE)); PARZEFALL, Ulrich (Albert Ludwigs Universitaet Freiburg (DE))

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

Session Classification: Semiconductor Detectors

Track Classification: Semiconductor Detectors

Contribution ID: **33** Type: **Live Presentation**

The CMS MIP Endcap Timing Layer: From concept towards production

Wednesday, February 23, 2022 9:00 AM (20 minutes)

The HL-LHC opens up new windows for exciting discoveries but also brings about new challenges due to the high pileup environment of approximately 200 interactions per collision. Precise measurements of track and vertex timing can efficiently mitigate these pileup effects. The CMS detector will be upgraded with a MIP timing detector (MTD) capable of providing ultra-fast timing information of trajectories of charged particles. With a time resolution of below 50ps per hit, the MTD will be a key ingredient to discover new physics.
The endcap region of the MTD has to endure high fluences, motivating the use of thin, radiation tolerant silicon sensors with fast charge collection. Tests and developments of these low gain avalanche detectors (LGAD) by CMS, together with manufacturers, have resulted in a robust design of 16x16 pixel sensors. A custom readout chip for ETL sensors (ETROC) containing clock trees, preamplifier, discriminator, and TDC is being developed in parallel. 4x4 pixel array prototypes of the ETROC have been bump bonded to LGAD sensor prototypes and were tested at the Fermilab test beam facility, showing a time resolution of approximately 45ps per layer. FPGA based boards that emulate the final digital design of the ETROC are used for the development of full system tests including the front-end electronics. In this talk we will present the extensive developments and progress made for the entire ETL detector, from sensors to readout electronics and mechanical design.

Primary experiment

CMS

Primary author: SPITZBART, Daniel (Boston University (US))

Presenter: SPITZBART, Daniel (Boston University (US))

Session Classification: Large Detector Systems

Track Classification: Semiconductor Detectors

Contribution ID: **35** Type: **Recorded Presentation**

A Highly Programmable SiPM Readout ASIC for Neutron Imaging Applications

Silicon Photomultiplers (SiPMs) are now widely accepted photodetection replacements for photomultipler tubes (PMTs) depending on end use application. Various scintillators are also currently being developed and improved for fast neutron/gamma discrimination applications. In parallel, there is a need for compact electronics to operate as front-end systems for high density SiPM array readout and to provide particle classification. The latter is a much needed capability for neutron camera systems operating in a high gamma background environment. PSD_CHIP has been designed to demonstrate these two key components. It integrates a scalable multi-channel SiPM readout front-end system and a novel fast analog pulse shape discrimination (PSD) method. The chip's front-end system is explicitly designed for readout of SensL SiPMs, which have two outputs: a capacitively coupled fast output (FOUT) and a resistively coupled standard output (SOUT). The ASIC features a high level of programmability on-chip to allow for adaptability of the chip for use with various scintillators for a final end use application. Current targeted end use applications include neutron cameras and active neutron-tagging systems for nuclear recoil calibration work of dark matter and neutrino experiments.

Primary experiment

Primary author: JOHNSON, Jyothisraj (UC Davis)

Co-authors: Dr BOXER, Billy (UC Davis); Dr GRACE, Carl (LBNL); Prof. TRIPATHI, Mani (UC Davis); Dr HILLBRAND, Seth (UC Davis)

Presenter: JOHNSON, Jyothisraj (UC Davis)

Track Classification: Electronics

Contribution ID: **40** Type: **Recorded Presentation**

Characterisation of the charge collection in LGAD sensors with a newly developed table-top TPA-TCT system

The Two Photon Absorption – Transient Current Technique (TPA-TCT) uses fs-pulsed infrared lasers, with photon energies below the silicon band gap. Excess charge carriers are generated mainly in a small volume (approximately 1μm × 1μm × 20μm) around the focal point of the laser beam, enabling a resolution in all three spatial directions. Compared to conventional Single Photon Absorption – TCT, the resolution perpendicular to the incident laser beam is typically increased by a factor of ten. Following the initial success of the method, a compact TPA-TCT setup was developed at CERN. The TPA-TCT setup and various measurements with the focus on the charge collection and the gain suppression in LGAD sensors will be presented.

Primary experiment

Primary author: PAPE, Sebastian (Technische Universitaet Dortmund (DE))

Co-authors: HIMMERLICH, Anja (CERN); CURRAS RIVERA, Esteban (CERN); PALOMO PINTO, Francisco Rogelio (Universidad de Sevilla (ES)); VILA ALVAREZ, Ivan (Instituto de Física de Cantabria (CSIC-UC)); FERNANDEZ GARCIA, Marcos (Universidad de Cantabria and CSIC (ES)); MOLL, Michael (CERN); WIEHE, Moritz Oliver (Albert Ludwigs Universitaet Freiburg (DE)); MONTERO SANTOS, Raul (Universidad del Pais Vasco)

Presenter: PAPE, Sebastian (Technische Universitaet Dortmund (DE))

Track Classification: Semiconductor Detectors

Contribution ID: **41** Type: **Recorded Presentation**

Development of compact TPC for future Super Charm-Tau Factory detector

Currently, the Budker INP together with Novosibirsk State University are developing the detector for the future Super Charm-Tau Factory (SCTF) to be built in Russia. SCTF is an electron-positron collider with 3.5 GeV per beam and a luminosity of 10^{35} $cm^{-2} \cdot s^{-1}$. SCTF will be instrumented with a general-purpose detector (SCTD). The innermost part of the SCTD will contain the inner tracker (IT). The main task of the IT is an extension of the lever arm of the central drift chamber, efficient detection of soft hadrons and reconstruction of secondary vertices of particles that decay in the IT volume (like K_s, Λ_0, etc). The most attractive candidate for the IT is the compact time-projection chamber (CTPC). It can be made with a very thin inner wall allowing to reduce significantly the threshold for soft hadrons. In addition, CTPC can provide the dE/dx information for the discrimination of electrons from hadrons. We present recent results on the simulation of spatial resolution and drift time of CTPC as well as space charge effects induced by positive ions. The construction of the prototype of the CTPC is ongoing. The first results from the IT prototype will be reported at the Conference.

Primary experiment

Primary author: Dr SOKOLOV, Andrey (Budker Institute of Nuclear Physics)

Co-authors: Dr SHEKHTMAN, Lev (Budker Institute of Nuclear Physics (RU)); MALTSEV, Timofei (Budker Institute of Nuclear Physics (RU)); VADAKEPPATTU, Vijayanand (Novosibirsk State University)

Presenter: Dr SOKOLOV, Andrey (Budker Institute of Nuclear Physics)

Track Classification: Gaseous Detectors

Contribution ID: **43** Type: **Live Presentation**

Operation and readout of the CGEM Inner Tracker

Wednesday, February 23, 2022 2:50 PM (20 minutes)

A recently approved ten-year extension of the BESIII experiment (IHEP, Beijing) motivated an upgrade program for both the accelerator and the detector. In particular, the current inner drift chamber is suffering from aging and the proposal is to replace it with a detector based on the cylindrical GEM technology.
The CGEM inner tracker consists of three coaxial layers of triple GEM. The tracker is expected to restore efficiency, improve z-determination and secondary vertex position reconstruction with a resolution of 130 μm in the xy-plane and better than 300 μm along the beam direction.
A dedicated readout system was developed. Signals from the detector strips are processed by TIGER, a custom 64-channel ASIC that provides an analog charge readout via a fully digital output up to about 50 fC, less than 3 ns jitter. TIGER continuously streams over-threshold data in trigger-less mode to an FPGA-based readout module, called GEM Read Out Card, that organizes the incoming data by building the event packets when the trigger arrives.
Two of the three layers are in operation in Beijing since January 2020 remotely controlled. Due to the pandemic situation the integration activity has been continued on a small-scale prototype. Recently, a test beam has been performed at CERN with the final electronics configuration.
In this presentation, the general status of the CGEM-IT project will be presented with a particular focus on the results from the test beam data acquisition.

Primary experiment

BESIII Italian Collaboration

Primary authors: CIBINETTO, Gianluigi (INFN Ferrara); GRECO, Michela (Universita e INFN Torino (IT)); WORKING GROUP , on behalf of the CGEM-IT; BALOSSINO, Ilaria (INFN Ferrara)

Presenter: BALOSSINO, Ilaria (INFN Ferrara)

Session Classification: Gaseous Detectors

Track Classification: Gaseous Detectors

Contribution ID: **44** Type: **Recorded Presentation**

TPC Development by the LCTPC Collaboration for the ILD Detector at ILC

A large, worldwide community of physicists is working to realise an exceptional physics program of energy-frontier, electron-positron collisions with the International Linear Collider (ILC). The International Large Detector (ILD) is one of the proposed detector concepts at the ILC. The ILD tracking system consists of a Si vertex detector, forward tracking disks and a large volume Time Projection Chamber (TPC) embedded in a 3.5 T solenoidal field. The TPC is designed to provide 220 three dimensional points for continuous tracking with a single-hit resolution better than 100 μm in rφ, and about 1 mm in z. An extensive research and development program for a TPC has been carried out within the framework of the LCTPC collaboration. Three MPGD concepts are being developed for the TPC: Gas Electron Multiplier, Micromegas and GridPix. Successful test beam campaigns with different technologies have been carried out. Fundamental parameters such as transverse and longitudinal spatial resolution and drift velocity have been measured. In parallel, a new gating device based on large-aperture GEMs have been produced and studied in the laboratory. In this talk, we will review the track reconstruction performance results and summarize the next steps towards the TPC construction for the ILD detector.

Primary experiment

Primary authors: TITOV, Maksym (Université Paris-Saclay (FR)); KAMINSKI, Jochen (University of Bonn (DE))

Presenter: KAMINSKI, Jochen (University of Bonn (DE))

Track Classification: Gaseous Detectors

Contribution ID: **45** Type: **Recorded Presentation**

A SiPM-based 3” LaBr3 Readout Module for PMTs Replacement in Gamma Spectroscopy

GAMMA is a compact detection module for γ-spectroscopy based on a 3” $LaBr_3$(Ce+Sr) co-doped scintillation crystal readout by SiPMs aimed at superseding PMT-based readout of large scintillation crystals in Nuclear Physics experiments maintaining high resolution (<3% at 662keV) and high energy dynamic range (100keV – 30MeV), with the benefits of solid-state detectors.
The system is capable of reaching a state-of-the-art energy resolution of 2.6% at 662keV and a dynamic range spanning from few hundreds of keV up to tens of MeV in a single measurement thanks to the custom front-end ASIC, which exploits an automatic and predictive gain switching (AGC, Adaptive Gain Control) to avoid output saturation and thus extend the full-scale range.
The 3” scintillation crystal is coupled to a square matrix of 144 NUV-HD SiPMs from FBK grouped in nine 1”×1” tiles; the SiPM tile design is customized specifically for this application and hosts 16 SiPMs with 6mm side (30um cell, 77% fill factor, 45% PDE).
The detector communicates via USB 2.0 with the host PC to receive the ASIC configuration and to transmit the raw acquisition data up to 70kcps. However, it also has an analog output proportional to the γ-ray energy to mimick the signal of a PMT: this output can be sampled with data acquisition platforms used in PMT-based experiments (like MCAs) to easily integrate the detector in pre-existing setups.

Primary experiment

Primary authors: Mr DI VITA, Davide (Politecnico di Milano - DEIB); Mr BUONANNO, Luca (Politecnico di Milano - DEIB); Mr CANCLINI, Fabio (Politecnico di Milano - DEIB); Mr TICCHI, Giacomo (Politecnico di Milano - DEIB); Prof. CARMINATI, Marco (Politecnico di Milano - DEIB); Prof. CAMERA, Franco (INFN); Prof. FIORINI, Carlo (Politecnico di Milano - INFN Milano)

Presenter: Mr DI VITA, Davide (Politecnico di Milano - DEIB)

Track Classification: SiPM

Contribution ID: **46** Type: **Live Presentation**

The CMS High Granularity Calorimeter for the High Luminosity LHC

Wednesday, February 23, 2022 9:50 AM (20 minutes)

The CMS Collaboration is preparing to build replacement endcap calorimeters for the HL-LHC era. The new high-granularity calorimeter (HGCAL) is, as the name implies, a highly-granular sampling calorimeter with approximately six million silicon sensor channels (~1.1cm^2 or 0.5cm^2 cells) and about four hundred thousand scintillator tiles readout with on-tile silicon photomultipliers. The calorimeter is designed to operate in the harsh radiation environment at the HL-LHC, where the average number of interactions per bunch crossing is expected to exceed 140. Besides measuring energy and position of the energy deposits the electronics is also designed to measure the time of their arrival with a precision on the order of 50 ps. In addition to the hardware of the HGCAL, developing a reconstruction sequence that fully exploits the granularity to achieve optimal electromagnetic and hadron identification, as well as a good energy resolution in the presence of pileup, is a challenging task.

In this talk, the reasoning and ideas behind the HGCAL, the current status of the project, the many lessons learnt so far, and the challenges ahead will be presented, including recent results from silicon sensors and modules. We will also overview some of the novel reconstruction methods being explored, including iterative and machine-learning techniques to exploit the full imaging power of HGCAL.

Primary experiment

CMS

Primary author: WIEHE, Moritz Oliver (CMS / HEPHY (AT))

Presenter: WIEHE, Moritz Oliver (CMS / HEPHY (AT))

Session Classification: Large Detector Systems

Track Classification: Calorimeters

Contribution ID: **49** Type: **Recorded Presentation**

TCAD Modeling of Bulk Radiation Damage Effects in Silicon Devices with the Perugia Radiation Damage Model

The "Perugia 2019 Surface" radiation damage model is a Synopsys Sentaurus Technology CAD (TCAD) numerical model which accounts for surface damage effects induced by radiation on silicon particle detectors. In order to get a complete picture of the phenomena taking place in the volume of the irradiated silicon detectors, the non-ionizing effects, referred to as bulk damage, also need to be taken into account in the description of a more inclusive "New University of Perugia" model. These non-ionizing effects are responsible for the increase of the leakage current in silicon sensors, the changes in the effective space charge concentration and the charge collection efficiency. In this work, the significance of the input parameters of the model, such as electron/hole cross sections and acceptor/donor introduction rates is investigated, with respect to the changes in the leakage current, the full depletion voltage, the charge collection efficiency and the damage constant α (a figure of merit of an irradiated device) of a PIN diode. A comparison is made between the simulation's output and experimental data from irradiated PIN diodes produced at Fondazione Bruno Kessler (FBK). Finally, the possibility of the validation of the analytical model with the examination of the case of a Low-Gain Avalanche Detector (LGAD), and its general application for future silicon sensors is discussed.

Primary experiment

Primary authors: FONDACCI, Alessandro (Università di Perugia, Perugia, Italy); MOROZZI, Arianna (INFN, Perugia (IT)); PASSERI, Daniele (University & INFN, Perugia (IT)); MOSCATELLI, Francesco (IOM-CNR and INFN, Perugia (IT)); FERRERO, Marco (Universita e INFN Torino (IT)); CARTIGLIA, Nicolo (INFN, Sezione di Torino); ASENOV, Patrick (Universita e INFN, Perugia (IT)); ARCIDIACONO, Roberta (Universita e INFN Torino (IT)); CROCI, Tommaso (INFN - National Institute for Nuclear Physics); SOLA, Valentina (Universita e INFN Torino (IT))

Presenter: ASENOV, Patrick (Universita e INFN, Perugia (IT))

Track Classification: Semiconductor Detectors

Contribution ID: **50** Type: **Live Presentation**

Time and space characterization of novel TI-LGAD structures

Friday, February 25, 2022 11:55 AM (20 minutes)

A spacial and temporal characterization of the novel Trench Isolated LGAD (TI-LGAD) production at FBK from the RD50 collaboration is presented. This technology is promising for the implementation of the so called 4D-pixels aiming to combine in one device position tracking functionality together with a precise timing determination. In the TI-LGAD technology, each pixel is an individual LGAD and they are separated by physical trenches etched in the silicon, thus eliminating the need of the standard gain termination. This technology has the potential to reduce the interpixel dead area, mitigating the fill factor problem. This FBK-RD50 production is the first production of pixelated TI-LGADs. A comprehensive study of the spacial characteristics of the different design patterns (number of trenches, depth of trenches, etc.), as well as the timing performance, is presented in this talk. For a subsample of the structures the measurements will be repeated after irradiation with neutrons and protons. The characterization is performed using a scanning Transient Current Technique (TCT) setup with an infrared laser.

Primary experiment

RD50

Primary authors: MACCHIOLO, Anna (Universitaet Zuerich (CH)); KILMINSTER, Ben (Universitaet Zuerich (CH)); BORGHI, Giacomo (Fondazione Bruno Kessler); PATERNOSTER, Giovanni (Fondazione Bruno Kessler (FBK)); SENGER, Matias (Universitaet Zuerich (CH)); BOSCARDIN, Maurizio (FBK Trento)

Presenter: SENGER, Matias (Universitaet Zuerich (CH))

Session Classification: Semiconductor Detectors

Track Classification: Semiconductor Detectors

Contribution ID: **55** Type: **Recorded Presentation**

The Central Tracker for SCT and CMD3 detector

The CMD3 is a general-purpose detector at VEPP-2000 collider which purpose is to study the exclusive modes of $e^+e^- \longrightarrow hadrons$ in the center of mass energy range below 2 GeV. The CMD3 results will provide an important input for the calculation of the hadronic contribution to the muon anomalous magnetic moment: it will help reducing the uncertainty of its SM prediction. An upgrade of the CMD3 tracker is in progress. The new detector is considered as prototype for the tracking system of the Super Charm-Tau Factory Detector (SCTD). The Central Tracker proposed is an ultra-light drift chamber equipped with cluster counting/timing readout techniques. The main features of this design are the high transparency in terms of multiple scattering contribution to the momentum measurement of charged particles and the very precise particle identification capabilities. The central tracker is a down sized drift chamber derived from the larger one designed for the IDEA detector at both FCC-ee and CEPC future circular e^+e^- colliders. It is inspired by the original design of the KLOE drift Chamber and the construction of the MEG II drift chamber. We present the new structure of the drift chamber, with a focus on the mechanical design of the end plates and their novel tension recovery scheme, which has two main purposes: the minimization of the amount of material in front of the end-plate crystal calorimeter and the maximization of the mechanical stability.

Primary experiment

Primary authors: CUNA, Federica (INFN - National Institute for Nuclear Physics); CHIARELLO, gianluigi (INFN); MICCOLI, Alessandro (INFN Lecce e Universita del Salento (IT))

Co-authors: DE FILIPPIS, Nicola (Politecnico/INFN Bari (IT)); GORINI, Edoardo (Dipartimento di Fisica); GRANCAGNOLO, Francesco (INFN - Lecce); PANAREO, Marco; PRIMAVERA, Margherita (INFN Lecce e Universita del Salento (IT)); TASSIELLI, Giovanni F. (INFN Lecce / Università del Salento); VENTURA, Andrea

Presenter: CUNA, Federica (INFN - National Institute for Nuclear Physics)

Track Classification: Gaseous Detectors

Contribution ID: **57** Type: **Recorded Presentation**

The upgraded low-background germanium counting facility Gator for high-sensitivity γ-ray spectrometry

The Astroparticle Physics Group at the University of Zurich operates a high-purity germanium (HPGe) spectrometer (Gator) in a low-background environment underground at the Laboratori Nazionali del Gran Sasso (LNGS) in Italy. The 2.2 kg γ-ray spectrometer is one of the world's most sensitive HPGe detectors with an integrated count rate of (86.2 ± 0.7) events/(day·kg) in the energy region 100 - 2700 keV. It is used to screen and select materials for rare-event search experiments such as XENON, DARWIN, GERDA and LEGEND. We describe the general facility, the recent upgrades and their impact on the background level. We also demonstrate its sensitivity by presenting the results for several material samples.

Primary experiment

Primary author: Mr BISMARK, Alexander (Universtiy of Zurich)

Co-authors: Ms RODRIGUES ARAUJO, Gabriela (University of Zurich); Prof. BAUDIS, Laura (University of Zurich); Ms BIONDI, Yanina (Universtiy of Zurich); Dr GALLOWAY, Michelle (University of Zurich)

Presenter: Mr BISMARK, Alexander (Universtiy of Zurich)

Track Classification: Dark matter and other low-background experiments

Contribution ID: **58** Type: **Recorded Presentation**

Performance of the silicon micro-strip detector prototype for ultra-fast imaging with new front-end ASIC

Techniques of imaging and SAXS experiments at ultra-fast processes with synchrotron radiation beams are being developed at Siberian Synchrotron and Teraherz Radiation Center (SSTRC) at Budker Institute of Nuclear Physics since the beginning of 2000th. The detector for imaging of explosions, DIMEX, was designed for these purposes. DIMEX is one-dimensional detector that can image the distribution of X-ray flux emitted by single electron bunch and store a series of such images from 100 consecutive bunches. Gaseous version of the detector DIMEX-G has been operating at the VEPP-3 storage ring since 2005 and at the VEPP-4M storage ring since 2015. The main parameters of the detector such as maximum registered X-ray flux and signal measurement precision, frame rate and time resolution can be significantly improved with silicon micro-strip sensor. A dedicated front-end ASIC DMXS6A was developed for such detector. The first ASIC demonstrated high noise that did not allow to get good enough signal to noise ratio. The ASIC was redesigned and the first tests with the prototype with new version of the ASIC DMXS6B have been performed at the SR beam at VEPP-4M. The noise in the new prototype is reduced by a factor of 5 down to 10 equivalent photons. At the same time the detector prototype demonstrates maximum detected photon flux of more than 10000 equivalent photons per bunch per channel (channel pitch 50 um) and maximum frame rate of 40 MFrames/s.

Primary experiment

Primary authors: Ms GLUSHAK, Anastasia (Budker Institute of Nuclear Physics); SHEKHTMAN, Lev (Budker Institute of Nuclear Physics (RU)); Dr TITOV, Vitaly (Budker Institute of Nuclear Physics); Prof. AULCHENKO, Vladimir (Budker Institute of Nuclear Physics); ZHULANOV, Vladimir (Budker Institute of Nuclear Physics (RU))

Presenter: Ms GLUSHAK, Anastasia (Budker Institute of Nuclear Physics)

Track Classification: Semiconductor Detectors

Contribution ID: **59** Type: **Recorded Presentation**

CMS ECAL upgrade for precision timing and energy measurements at the High-Luminosity LHC

The High Luminosity upgrade of the LHC (HL-LHC) at CERN will provide unprecedented instantaneous luminosity of $\sim 5 \times 10^{34}$ $/cm^2$ /s, leading to an average of 150-200 simultaneous collisions. This high instantaneous luminosity scenario presents a significant challenge for the detectors. The barrel region of the CMS electromagnetic calorimeter (ECAL) will be preserved but will be operated at a lower temperature and with a completely new readout and trigger electronics. A dual gain trans-impedance amplifier and an ASIC providing two 160 MHz ADC channels, gain selection, and data compression will be used in the new readout electronics. The trigger decision will be moved off-detector and performed by powerful and flexible FPGA processors, allowing for more sophisticated trigger algorithms to be applied. The upgraded ECAL will be capable of high-precision energy measurements throughout HL-LHC and will greatly improve the time resolution for photons and electrons above 10 GeV. The performance obtained with the new electronics has been tested at CERN under an electron beam with a matrix of ECAL crystals equipped with APDs.

Primary experiment

CMS

Primary author: MAZZA, Gianni (Universita e INFN Torino (IT))

Co-authors: BORCA, Cecilia (Università degli Studi di Torino); SOLDI, Dario (Universita e INFN Torino (IT)); ARGIRO, Stefano (Universita di Torino and INFN (IT)); PIGAZZINI, Simone (ETH Zurich (CH))

Presenter: MAZZA, Gianni (Universita e INFN Torino (IT))

Track Classification: Calorimeters

Contribution ID: **60** Type: **Recorded Presentation**

Fast technique based on transient optical absorption exploited to qualify LYSO:Ce crystals for CMS Barrel Timing Layer

The current upgrade of CMS Barrel Timing Layer puts forward a demand for a fast screening of materials to test the prospective scintillators, select the best crystal providers, and monitor the quality of the provided crystals in view of their timing properties. We report on a novel contactless method based on the transient optical absorption monitored in sub-picosecond domain in pump and probe configuration. The method is tested by comparing with the coincidence time resolution measurements, which are currently conventional but require sample mounting on silicon photodetectors and advanced readout electronics making the measurements time-consuming and difficult to compare. The method is based on the excitation of a scintillating material by a femtosecond laser pulse and probing the population of the emitting centers, Ce3+ ions in LYSO in our study, by a probe beam. The figure of merit to estimate the timing properties of LYSO:Ce is specified. The Pierson's coefficient of 0.95 for the correlation of the figure of merit with the CTR values in a set of high quality LYSO:Ce samples with the CTR values ranging from 80 to 100ps indicates the reliability of the method. The method has a great potential to become a routine procedure for scintillator characterization, as the time required to characterize a sample is less than 0.5 hour and repeatability is high.

Primary experiment

Compact Muon Solenoid (CMS)

Primary author: Dr NARGELAS, Saulius (Vilnius University (LT))

Co-authors: AUFFRAY HILLEMANNS, Etiennette (CERN); DAFINEI, Ioan (Sapienza Universita e INFN, Roma I (IT)); GUNDACKER, Stefan (Universita & INFN, Milano-Bicocca (IT)); KORJIK, Mikhail (Byelorussian State University (BY)); KRATOCHWIL, Nicolaus (CERN); LUCCHINI, Marco Toliman (Università & INFN, Milano-Bicocca (IT)); TAMULAITIS, Gintautas (Vilnius University (LT)); TALOCHKA, Yauheni (Byelorussian State University (BY)); PARAMATTI, Riccardo (Univ. Sapienza and INFN Roma); MECHINSKY, Vitaly (Byelorussian State University (BY)); VAITKEVIČIUS, Augustas (Vilnius University)

Presenter: Dr NARGELAS, Saulius (Vilnius University (LT))

Track Classification: Photon Detectors

Contribution ID: **61** Type: **Recorded Presentation**

Developing a new instrument for muon tomography in constrained environments

Muon tomography consists in using cosmic muons to probe structures in a neither invasive nor destructive way. Following the first muography of a water tower using a muon telescope based on Micro-Pattern Gaseous Detectors and developed at CEA Saclay in 2015, the gaseous detectors and electronics have been developed to be more robust to high variations of temperature, allowing to operate in Egypt for the ScanPyramids mission since 2016. More recently, simulations showed that muon telescopes based on multiplexed Micromegas detectors could also be used to detect cavities for geology studies or dismantling of nuclear facility leading to several partnerships with industrials.
However, telescopes are directional and have a limited compacity. To expand the spectrum of applications, CEA is developing a highly pixelated and 2D-multiplexed compact Time Projection Chamber that would allow a full track reconstruction with a quasi-isotropical angular acceptance.
In this talk the design of this new detector will be presented as well as the first prototypes and results obtained.

Primary experiment

Primary author: LEHURAUX, Marion (Université Paris-Saclay (FR))

Co-authors: GOMEZ MALUENDA, Hector (Université Paris-Saclay (FR)); PROCUREUR, Sebastien (Université Paris-Saclay (FR)); MANDJAVIDZE, Irakli (Université Paris-Saclay (FR)); VANDENBROUCKE, Maxence (Université Paris-Saclay (FR)); ATTIE, David (CEA/DSM/DAPNIA/SPP); ROSSI, Fabrizio (Université Paris-Saclay (FR))

Presenter: LEHURAUX, Marion (Université Paris-Saclay (FR))

Track Classification: Gaseous Detectors

Contribution ID: **62** Type: **Recorded Presentation**

Present outcome from the NUMEN R&D phase

The NUMEN experiment based on the pre-existing large acceptance MAGNEX spectrometer and integrated with new challenging components aims at measuring double charge exchange cross sections using ion beams of unprecedented intensity (10^{13} pps) on specific isotopes at INFN-LNS. These interactions prove to be a way of getting information on the nuclear matrix elements of the neutrinoless double beta decay, the most promising probe to establish the Majorana or Dirac nature of the neutrino, and then to evaluate the effective neutrino mass value.
The expected rate on the sensitive area of about 0.15 m^2 reaches up to about 5 Mpps, demanding for adequate detectors in measuring position, direction, energy, mass end charge of the ions produced by interactions. A gas tracker and a Particle Identifier (PID) wall compose the Focal Plane Detector (FPD). The tracker is based on Micro-Pattern Gas Detectors in the Multiple thick GEM set up, and a segmented multistrip readout. The PID wall is equipped with a large number of telescopes of 100 μm thin SiC sensors and 5 mm thick CsI crystals, with an active area of 2.25 cm^2 each. To discriminate nearby energy states a coincidence between FPD signals and gamma detectors based on $LaBr_3$(Ce), surrounding the scattering chamber with the target inside, is planned. Continuous data transmission is foreseen with an expected output data rate up to 60 Mb/s. Results from the R&D phase and the integration study will be presented.

Primary experiment

NUMEN

Primary author: Dr CALVO, Daniela (INFN Torino (IT))

Co-authors: Dr AGODI, Clementina (Laboratori Nazionali del Sud - Istituto Nazionale di Fisica Nucleare); Prof. CAPPUZZELLO, Francesco (INFN - National Institute for Nuclear Physics); CAVALLARO, Manuela (INFN - National Institute for Nuclear Physics); Dr CARBONE, Diana (INFN - LNS); Dr FINOCCHIARO, Paolo (INFN); Prof. OLIVEIRA, Jose' R. B. (Instituto de Fisica da Universidade de Sao Paulo); Dr PANDOLA, Luciano (INFN-LNS); Dr PINNA, Federico (INFN - National Institute for Nuclear Physics); Dr TORRESI, Domenico (INFN - LNS, Catania (IT)); Prof. MORALLES, Mauricio (Insituto de Pesquisas Energeticas e Nucleares, IPEN/CNEN,Sao Paulo, Brazil); Dr SARTIRANA, Diego (INFN-Torino); Dr TUDISCO, Salvatore (INFN); Dr CIRALDO, Irene (Dipartimento di Fisica e Astronomia 'Ettore Majorana', Universita' di Catania, 95123 Catania, Italy and INFN – LNS , 95123 Catania, Italy); Dr NERI, Lorenzo (INFN – LNS , 95123 Catania, Italy); Dr FISCHELLA, Maria (INFN – LNS , 95123 Catania, Italy); Dr DELAUNAY, Franck (LPC Caen, Normandie Universit e, ENSICAEN, UNICAEN, CNRS/IN2P3, Caen, France and INFN – LNS , 95123 Catania, Italy); Dr BRISCHETTO, Giuseppe (Dipartimento di Fisica e Astronomia 'Ettore Majorana', Universita' di Catania, 95123 Catania, Italy and INFN – LNS , 95123 Catania, Italy)

Presenter: Dr CALVO, Daniela (INFN Torino (IT))

Track Classification: Miscellaneous

Contribution ID: **63** Type: **Live Presentation**

The AMS-100 experiment: The next generation magnetic spectrometer in space

Monday, February 21, 2022 12:20 PM (20 minutes)

The next generation magnetic spectrometer in space, AMS-100, is designed with a geometrical acceptance of 100~m²sr for a ten year operation at Sun-Earth Lagrange Point 2.
The purpose of AMS-100 is to improve the sensitivity for the observation of new phenomena in cosmic rays by at least a factor of 1000.

The AMS-100 detector consists of a high temperature superconducting solenoid, an electromagnetic calorimeter, a tracking system made out of silicon and scintillating fiber modules, a time of flight system based on
plastic scintillators readout by siliconphotomultipliers.

We will present the AMS-100 detector design and its astrophysics potential.
A test coil with a length of 15 cm and a diameter of 12 cm made out of
8 layers HTS tape will be shown. Measurements of the magnetic field, the
critical current and the structural behaviour will be discussed.
Time resolution measurements with a ToF-prototype in the temperature range of +30℃ to -40℃ will be presented.
The first produced 12-layer fiber mat made out of 125μm thick scintillating fibers and the quality control measurements will be shown.

Primary experiment

AMS-100

Primary authors: KIRN, Thomas (Rheinisch Westfaelische Tech. Hoch. (DE)); SIEDENBURG, Thorsten (Rheinisch Westfaelische Tech. Hoch. (DE))

Presenters: KIRN, Thomas (Rheinisch Westfaelische Tech. Hoch. (DE)); SIEDENBURG, Thorsten (Rheinisch Westfaelische Tech. Hoch. (DE))

Session Classification: Astroparticle Detectors

Track Classification: Astroparticle Detectors

Contribution ID: **64** Type: **Recorded Presentation**

pLGAD - A Novel Detector Concept for Low Penetrating Particles

In Low Energy Physics, where particles only penetrate a few hundreds of nanometers within the active sensor depth, obtaining a position resolved signal with high efficiency at a reasonable cost is extremely difficult. While low-noise silicon sensors with internal amplification are available on the market, these sensors are often produced for High Energy Physics applications. Consequently, these sensors lack a thin entrance window (in the order of tens of nm) and full amplification of signals created near the sensor's surface (< 1 μm) to provide a good signal to ratio for the efficient detection of low-penetrating particles.
In this poster, we propose a new pixelated silicon sensor based on the iLGAD (inverted Low Gain Avalanche Detector) principle. The pLGAD (low-penetrating Particles Low Gain Avalanche Detector) sensor concept is specifically designed to detect low-penetrating particles and will have a higher detection efficiency than non-silicon technologies while being a lot cheaper and easier to operate than other competing silicon technologies. Potential applications of such a sensor include usage in neutron beta decay experiments, low energy X-ray detection, medical physics and space experiments.

Primary experiment

Primary author: KHALID, Waleed (OEAW)

Co-authors: Prof. MARTON, Johann (SMI, OeAW); PELLEGRINI, Giulio (Centro Nacional de Microelectrónica (IMB-CNM-CSIC) (ES)); Mr DOBLAS, Albert (CNM-CSIC); Dr FLORES, David (CNM-CSIC); Dr VALENTAN, Manfred; Dr HIDALGO, Salvador (CNM-CSIC); Dr KONRAD, Gertrud

Presenter: KHALID, Waleed (OEAW)

Track Classification: Semiconductor Detectors

Contribution ID: **65** Type: **Live Presentation**

Xenoscope – a full-scale vertical demonstrator for the DARWIN observatory

Monday, February 21, 2022 2:25 PM (20 minutes)

The DARWIN observatory is a proposed multi-purpose experiment for dark matter and neutrino physics. At its heart, DARWIN will feature a 50 tonne (40 tonnes active) dual-phase xenon Time Projection Chamber (TPC) allowing to probe the experimentally accessible parameter space for Weakly Interacting Massive Particles (WIMPs) in a wide mass-range until neutrino interactions with the target become an irreducible background. To test key technological concepts required for the realization of DARWIN, we built Xenoscope at the University of Zürich, a full-scale vertical demonstrator using 350 kg of liquid xenon (LXe). Xenoscope will be used to demonstrate, for the first time, the drift of electrons in LXe over 2.6 m. The facility will also be used to study electron cloud diffusion and to measure optical properties of liquid xenon. In the future, Xenoscope will be available as a platform to test multiple subsystems of DARWIN. This talk will present an overview of the DARWIN experiment and of the Xenoscope facility and its commissioning, as well as current measurements of the purity of liquid xenon and future measurements campaigns.

Primary experiment

Primary author: GIRARD, Frédéric (University of Zürich)

Co-authors: MANFREDINI, Alessandro (University of Zurich); THIEME, Kevin (University of Zurich); BAUDIS, Laura (University of Zurich); GALLOWAY, Michelle (University of Zürich); MC-FADDEN, Neil; SANCHEZ-LUCAS, Patricia (University of Zurich); PERES, Ricardo (University of Zurich); BIONDI, Yanina (University of Zurich)

Presenter: GIRARD, Frédéric (University of Zürich)

Session Classification: Astroparticle Detectors

Track Classification: Astroparticle Detectors

Contribution ID: **66** Type: **Recorded Presentation**

Development of radiation-hard depleted CMOS timing sensors

Developing a tens of picosecond sensor which will survive the radiation environment of the future high physics experiments is a challenge. For position detection, sensors in the HV-CMOS 150 nm process technology have proven to be inherently rad-hard thanks to the full depletion of several hundred microns of the substrate. A first iteration of a timing sensor in this technology, named CACTUS, has been tested with encouraging results but with a time resolution far from the 60 ps expected from the simulations due to unforeseen capacitance. A new prototype called MiniCACTUS has been designed and submitted to fabrication in order to address this issue. It includes integrated front-end electronics with discrimination for each pixel, a programmable slow-control, internal DACs and bias circuits. The baseline pixel pitches are 1 mm^2 and 0.5 mm^2 with additional test structures sizing 50 µm x 50 µm and 50 µm x 150 µm. The prototypes received from the foundry have been thinned to 100 µm and 200 µm and were post processed for backside polarization. The 200 µm samples have shown a breakdown voltage higher than 300 V, a S/N better than 50 with cosmic rays, and a timing resolution around 80 ps, limited by the resolution of our timing reference system. A test-beam campaign is foreseen at CERN this year in order to assess precisely the timing resolution of the sensor. All these results will be presented at the conference.

Primary experiment

Primary authors: GUILLOUX, Fabrice (CEA/IRFU,Centre d'etude de Saclay Gif-sur-Yvette (FR)); DEGERLI, Yavuz (CEA - Centre d'Etudes de Saclay (FR)); MEYER, Jean-Pierre (IRFU-CEA - Centre d'Etudes de Saclay (CEA)); SCHWEMLING, Philippe (CEA/IRFU,Centre d'etude de Saclay Gif-sur-Yvette (FR)); HEMPEREK, Tomasz (University of Bonn (DE))

Presenters: DEGERLI, Yavuz (Université Paris-Saclay (FR)); DEGERLI, Yavuz (CEA Saclay)

Track Classification: Semiconductor Detectors

Contribution ID: **68** Type: **Live Presentation**

A cryogenic superconducting inertial sensor for terrestrial and lunar gravitational wave detection

Monday, February 21, 2022 2:00 PM (20 minutes)

The future of Gravitational Waves (GWs) is bright. LIGO and Virgo have detected more than 70 signals from black hole and/or neutron star mergers. All measured signals came in the LIGO/Virgo sensitive band at around 30 Hz. Suspension control noise, fueled by many cross couplings between angular and translational degrees of freedom, sets this limit by being the dominant noise source below 30 Hz.

Einstein Telescope (ET) will be an underground and cryogenic detector sensitive to GWs down to 2 Hz. We believe the cryogenic environment can be used in combination with superconducting materials to open up pathways to low-loss actuators and sensor mechanics. The Cryogenic Superconducting Inertial Sensor (CSIS) revolutionizes the (cryogenic) inertial sensor field by obtaining a displacement sensitivity at 0.5 Hz of several fm/$\sqrt{\text{Hz}}$. This is 3 orders of magnitude better than the state-of-the-art.

Such highly sensitive device can monitor the effects of low-vibration cryocoolers applied to the penultimate stage of ET as well as aid in control. Not only will it help ET detect GWs from 2 Hz onwards, CSIS will also be deployed on the Moon. The recently published Lunar GW Antenna (LGWA) concept uses an inertial sensor array to probe the surface motion as a result of GW excitation of the lunar body. In summary, CSIS will be the world's most sensitive cryogenic low-frequency inertial sensor and, when deployed in ET and on the Moon, will enable GW science from 1 mHz to 5 Hz.

Primary experiment

Einstein Telescope gravitational wave detector

Primary authors: Mr GATTI, Alberto (KULeuven); Dr CAMILO, Elvis (UCLouvain); Dr BADARACCO, Francesca (UCLouvain); VAN HEIJNINGEN, Joris (UCLouvain); Prof. PERALI, Andrea (University of Camerino); Prof. TAVERNIER, Filip (KULeuven)

Presenter: VAN HEIJNINGEN, Joris (UCLouvain)

Session Classification: Astroparticle Detectors

Track Classification: Astroparticle Detectors

Contribution ID: **71** Type: **Live Presentation**

The Tangerine project: Development of high-resolution 65 nm silicon MAPS

Thursday, February 24, 2022 9:50 AM (20 minutes)

The Tangerine project aims to develop state-of-the-art high-precision silicon detectors. This contribution is focused on Work Package 1, which has the goal of developing a monolithic active pixel sensor using a novel 65 nm CMOS imaging process, with a small collection electrode. This process is so far unused in particle physics applications, but is of great interest as it allows an increased logic density and decreased power consumption and material budget compared to other processes. It is envisioned to be used in for example the next ALICE inner tracker upgrade, and in experiments at the electron-ion collider.

The initial goal of the three-year Tangerine project is to develop and test a sensor in the 65 nm process that can be used in testbeam telescopes at DESY, providing excellent time resolution and spatial resolution, and thus demonstrating the capabilities of the process.
The project covers all aspects of sensor R&D, from electronics and sensor design using simulations, to prototype test chip characterisation in labs and at testbeams. The sensor design simulations are performed by using a powerful combination of detailed electric field simulations and high-statistics Monte Carlo simulations.
This contribution will present first measurement results of two initial test chips, the current sensor architecture, and sensor design simulation results of the ongoing developments and upcoming sensors.

Primary experiment

Primary authors: CHAUHAN, Ankur (DESY); ECKSTEIN, Doris (DESY); GREGOR, Ingrid-Maria (DESY & Bonn University); HANSEN, Karsten (DESY); HUTH, Lennart (Deutsches Elektronen-Synchrotron (DE)); MULYANTO, Budi (Deutsches Elektronen-Synchrotron DESY); RECKLEBEN, Christian (DESY); SIMANCAS, Adriana (Deutsches Elektronen-Synchrotron (DE)); SPANNAGEL, Simon (Deutsches Elektronen-Synchrotron (DE)); STANITZKI, Marcel (Deutsches Elektronen-Synchrotron (DE)); VELYKA, Anastasiia (DESY); WENNLÖF, Håkan (DESY)

Presenter: WENNLÖF, Håkan (DESY)

Session Classification: Semiconductor Detectors

Track Classification: Semiconductor Detectors

Contribution ID: **72** Type: **Recorded Presentation**

The recent status of the FASER detector

FASER, the ForwArd Search ExpeRiment, is a an experiment dedicated to searching for light, extremely weakly-interacting particles at the LHC. Such particles may be produced in the LHC's high-energy collisions and then decay to visible particles in FASER, which is placed 480 m downstream of the ATLAS interaction point. FASER, also includes a sub-detector, FASERν, designed to detect neutrino's produced in the LHC collisions and to study their properties. In this talk, we introduce each component of the FASER detector that has been installed into the LHC complex during Long Shutdown 2.

Primary experiment

FASER experiment

Primary author: INADA, Tomohiro (Tsinghua University (CN))

Presenter: INADA, Tomohiro (Tsinghua University (CN))

Track Classification: Semiconductor Detectors

Contribution ID: **74** Type: **Recorded Presentation**

The μ-RWELL-based preshower and muon detectors of the IDEA detector concept

The IDEA detector concept has been designed to operate at a future large circular e+e- collider, like FCC-ee or CEPC. IDEA has an innovative design with a central tracker enclosed in a superconducting solenoidal magnet. After the magnet there is a preshower system, followed by a dual readout calorimeter. In the iron yoke that closes the magnetic field are then located three stations of muon detectors. The preshower and muon detectors employ the μ-RWELL technology. The μ-RWELL detector inherits the best characteristics of the GEM and Micromegas detectors, being spark robust and simple to assembly. Both the preshower and the muon detector have a modular design, with the basic μ-RWELL tile of an active dimension of 50x50 cm2, with the anode segmented in parallel strips. The preshower main requirement is a spatial resolution of the order of 100 um, while the muon detector must have a reasonable total number of channels.
In order to define the best values of the resistivity and the strip pitch, we have built 2 sets of μ-RWELL detectors. Each set is made of 5 and 3, 16x50 cm2 detectors, with 50 cm long strips. In the preshower set the strip pitch is 400 μm and with a varying DLC resistivity, ranging from 10 to 200 MOhm/square. In the muon detector set, the strip pitch is 800, 1200 and 1600 μm, respectively. All these detectors have been exposed in October 2021 to a muon beam at the CERN SPS. The results obtained will be presented.

Primary experiment

Primary authors: Dr DOMENICI, Danilo (INFN-LNF); Dr DE LUCIA, Erika (INFN-LNF); Dr EVANGELISTI, Federico (INFN-Fe); Dr MEZZADRI, Giulio (INFN-Fe); Dr BALOSSINO, Ilaria (INFN-Fe); Dr MORELLO, Gianfranco (INFN-LNF); Dr BENCIVENNI, Giovanni (INFN-LNF); Dr FELICI, Giulietto (INFN-LNF); Dr GARZIA, Isabella (INFN-Fe); Dr LAVEZZI, Lia (INFN-To); Dr POLI LENER, Marco (INFN-LNF); Dr SCODEGGIO, Marco (INFN-Fe); Dr GIOVANNETTI, Matteo (INFN-LNF); Dr GATTA, Maurizio (INFN-LNF); Dr BERTANI, Monica (INFN-LNF); Dr FARINELLI, Riccardo (INFN-Fe); Mr CAFARO, Vittorio (INFN-Bo); GIACOMELLI, Paolo (Universita e INFN, Bologna (IT))

Presenter: GIACOMELLI, Paolo (Universita e INFN, Bologna (IT))

Track Classification: Gaseous Detectors

Contribution ID: **75** Type: **Recorded Presentation**

A light tracker based on scintillating fibers with SiPM readout

We have developed a novel light tracker based on plastic scintillating fiber arrays readout with Silicon Photomultipliers (SiPMs). The tracker consists of multiple planes, with the fibers in each plane oriented perpendicularly to those in the adjacent plane, in order to allow 3D track reconstruction. The fibers in each plane have round cross sections, with a diameter of 500 um, and are arranged in two staggered layers in a close-packed configuration. The fibers are readout by means of SiPM arrays with a 250 um strip pitch placed at one of their ends.

Scintillating fibers allow a reduced material budget while providing a good spatial resolution and a fast response. This design is therefore suitable to track low-energy particles, such as the lowest energy cosmic rays or the electrons produced in Compton scatterings of gamma rays with energies down to 100 keV.

We have built a detector prototype, equipped with Hamamatsu 128-channel SiPM arrays, readout with 32-channel PETIROC2A front-end ASICs. These ASICs are controlled by a custom data acquisition system board equipped with Xilinx Kintex-7 FPGA with self-triggering capabilities. The prototype has been tested with particle beams, cosmic rays and radioactive sources. The tracker design will be presented and performance of the prototype will be discussed.

Primary experiment

Primary author: MAZZIOTTA, Mario Nicola (Universita e INFN, Bari (IT))

Co-authors: ALTOMARE, Corrado (INFN - National Institute for Nuclear Physics); Dr DE GAETANO, Salvatore (INFN Bari); DE ROBERTIS, Giuseppe (Universita e INFN, Bari (IT)); DI VENERE, Leonardo (INFN - National Institute for Nuclear Physics); GARGANO, Fabio (Univ. + INFN); GIORDANO, Francesco (INFN); LICCIULLI, Francesco (Universita e INFN, Bari (IT)); LOPARCO, Francesco (Universita e INFN, Bari (IT)); LOPORCHIO, Serena (Universita e INFN, Bari (IT)); PANTALEO, Francesca Romana (INFN - National Institute for Nuclear Physics); PASTORE, Cosimo (Universita e INFN, Bari (IT)); Dr PILLERA, Roberta (INFN Bari); SERINI, Davide (Universita e INFN, Bari (IT))

Presenter: MAZZIOTTA, Mario Nicola (Universita e INFN, Bari (IT))

Track Classification: SiPM

Contribution ID: **79** Type: **Recorded Presentation**

Moving charges in particle physics and cosmic ray physics: a general signal theorem for all of electrodynamics

The Ramo-Shockley theorem defines an efficient and physically very intuitive method for the computation of the electrical signal induced by moving charged particles on the readout electrodes of a particle detector.
This theorem, along with its various generalisations and extensions, applies only to situations that are quasi-electrostatic, i.e. where radiation and wave propagation effects do not play an appreciable role.

In this contribution, I will present a fully general signal theorem that encapsulates all electrodynamic effects without any approximations.
It is similar in spirit to the original theorem by Ramo and Shockley, encoding the geometry of the detector in the form of a (time-dependent) weighting field distribution.

I will show the origin of this result as a direct consequence of Maxwell's equations and discuss how the original quasi-static theorem emerges as a special case. Due to its significant generality, this new theorem applies to all devices that detect fields or radiation from charged particles. I will highlight applications ranging from particle physics to cosmic ray physics, where it enables the computation of the radio signature of cosmic ray induced showers.

Primary experiment

Primary author: WINDISCHHOFER, Philipp (University of Oxford (GB))

Presenter: WINDISCHHOFER, Philipp (University of Oxford (GB))

Track Classification: Miscellaneous

Contribution ID: **80** Type: **Live Presentation**

50 litres TPC with sCMOS-based Optical Read Out for the CYGNO project

Tuesday, February 22, 2022 9:50 AM (20 minutes)

The CYGNO project aims at realising a 1 cubic meter gaseous Time Projection Chamber (TPC) equipped with a Scientific CMOS (sCMOS) commercial cameras to optically readout Gas Electron Multiplier (GEM) to be operated at the underground Laboratories of Gran Sasso (LNGS).
The purpose of the project is to study the technology needed for a larger size gaseous TPC (30-100m^3) operated at atmospheric pressure for the directional search of low mass O(GeV) dark matter and low energy (eg solar) neutrinos astronomy. The roadmap of the project foresees the installation of a 50 litres TPC prototype, called LIME, the largest TPC realised with this technology, fully equipped with copper and water shielding. LIME is equivalent to about a 1/20 of the CYGNO demonstrator and aims to validate: the construction materials, the Monte Carlo simulations, the data reconstruction and particle identification performances at low energy threshold. LIME is under installation at the LNGS and it is supposed to start data taking at the beginning of 2022. The detector description and installation will be presented, as well as the overground performance and limitations that require underground characterisation, and, hopefully, the first results at LNGS.

Primary experiment

CYGNO

Primary authors: MAZZITELLI, Giovanni (INFN); ABRITTA, Igor; DOMINGUES AMARO, Fernando (Department of Physics, University of Coimbra); BARACCHINI, Elisabetta (Gran Sasso Science Institute); BENUSSI, Luigi (INFN e Laboratori Nazionali di Frascati (IT)); BIANCO, Stefano (INFN e Laboratori Nazionali di Frascati (IT)); CAPOCCIA, Cesidio (INFN e Laboratori Nazionali di Frascati (IT)); CAPONERO, Michele (INFN e Laboratori Nazionali di Frascati (IT)); CAVOTO, Gianluca (Sapienza Universita e INFN, Roma I (IT)); DANE, Emiliano (LNF-INFN); DHO, Giorgio (INFN - National Institute for Nuclear Physics); DI MARCO, Emanuele (INFN, Roma 1 (IT)); D'IMPERIO, Giulia (Universita di Roma I 'La Sapienza'-Universita e INFN, Roma I); DI GIAMBATTISTA, Flaminia (Gran Sasso Science Institute); MARCELO GREGORIO, Robert Renz (University of Sheffield); IACOANGELI, Francesco (Sapienza Universita e INFN, Roma I (IT)); PESSOA LIMA JUNIOR, Herman (Instituto de Fisica); SILVA LOPES JÚNIOR, Amaro (Faculdade de Engenharia, Universidade Federal de Juiz de Fora); MACCARRONE, Giovanni (INFN e Laboratori Nazionali di Frascati (IT)); PASSOS MANO, Rui Daniel (LIBPhys, Department of Physics, University of Coimbra); MARAFINI, Michela (INFN Roma1 - Centro Fermi); MCLEAN, Alasdair (Department of Physics and Astronomy, University of Sheffield); RODANO, Aleksej (LNF-INFN); RUSSO, Alessandro (INFN e Laboratori Nazionali di Frascati (IT)); MESSINA, Andrea (Sapienza Universita e INFN, Roma I (IT)); PRAJAPATI, Atul (Gran Sasso Science Institute); RIGGIO, Chiara (La Sapienza Univerista' di Roma - LNF-INFN); PIERLUIGI, Daniele (INFN e Laboratori Nazionali di Frascati (IT)); MARQUES, David (Gran Sasso Science Institute); PICCOLO, Davide (INFN e Laboratori Nazionali di Frascati (IT)); PINCI, Davide (Sapienza Universita e INFN, Roma I (IT)); TOZZI, Donatella (La Sapienza Universita' di Roma - LNF-INFN); ROSATELLI, Filippo (INFN e Laboratori Nazionali di Frascati (IT)); RENGA, Francesco (INFN Roma); SAVIANO, Giovanna (INFN e Laboratori Nazionali di Frascati (IT)); LOPES, Guilherme Sebastião Pinheiro (Universidade Federal de Juiz de Fora); MARQUES FERREIRA DOS SANTOS, Joaquim (Universidade de Coimbra (PT)); SPOONER, Neil (University of Sheffield); ANTONIETTI, Rita (LNF-INFN e Roma3); DA CRUZ ROQUE, Rita Joana (Department of Physics, University of Coimbra); TESAURO, Roberto (LNF-INFN); TORELLI, Samuele (Gran Sasso Science Institute); TOMASSINI, Sandro (INFN - National Institute for Nuclear Physics); PIACENTINI, Stefano (Università La Sapienza); BERNARDES MONTEIRO, Cristina (University of Coimbra); ANTUNES NOBREGA, Rafael (Juiz de Fora Federal University (BR)); FONSECA PANIS, Igor (Faculdade de Engenharia, Universidade Federal de Juiz de Fora); PAOLETTI, Emiliano (INFN-LNF); PASSAMONTI, Luciano (Istituto Nazionale Fisica Nucleare (IT)); PELOSI, Alessandro (Sapienza Universita e INFN, Roma I (IT)); PETRUCCI, Fabrizio (Universita e INFN Roma Tre (IT)); PIACENTINI, Francesco (INFN - National Institute for Nuclear Physics)

Presenter: MAZZITELLI, Giovanni (INFN)

Session Classification: Dark matter and other low-background experiments

Track Classification: Dark matter and other low-background experiments

Contribution ID: **84** Type: **Recorded Presentation**

The TES detector of the ALPS II experiment

The Any Light Particle Search II (ALPS II) is a Light-Shining-through-a-Wall experiment under construction at DESY, Hamburg. Its goal is to probe the existence of Axion Like Particles, a possible candidate for dark matter. The proposed region of exploration in parameter space is motivated by hints given by astrophysical anomalies such as stellar evolution. ALPS II might produce axions and reconvert them into photons inside two 125 m optical cavities under the influence of a 5.3 T magnetic field. The expected conversion-reconversion rate in the region of study is on the order of 10^{-5} Hz. This requires a sensor capable of measuring low-energy photons (1.165 eV) with high efficiency and a low dark count rate. A first science run in 2022 will be based on a heterodyne detection scheme. As a second option, we investigate a Transition Edge Sensor (TES) system as a photon-counting detector. The TES reacts to the change in temperature produced by a single photon by operating in the transition between the superconducting and normal conducting phases. In this work, the setup of the TES is presented, along with the proposed design to measure its efficiency and linearity. Due to its high sensitivity, the TES is susceptible to the influence of electronic noise and background events. We perform analyses in time and frequency domain and compare these results with simulations to understand the detector's energy resolution. An overview of background simulations using Geant4 is provided.

Primary experiment

ALPS II

Primary author: RUBIERA GIMENO, José Alejandro (DESY)

Co-authors: SHAH, Rikhav (Universität Mainz); LINDNER, Axel (DESY); MEYER, Manuel (University of Hamburg); JANUSCHEK, Friederike; SOHL, Lukas (DESY); SCHOTT, Matthias (CERN / University of Mainz); ISLEIF, Katharina-Sophie (DESY)

Presenter: RUBIERA GIMENO, José Alejandro (DESY)

Track Classification: Dark matter and other low-background experiments

Contribution ID: **95** Type: **Live Presentation**

A 4D diamond detector for HL-LHC and beyond

Friday, February 25, 2022 10:35 AM (20 minutes)

The unprecedented density of charged particles foreseen at the next generation of experiments at future hadronic machines poses a significant challenge to the tracking detectors, that are expected to stand extreme levels of radiation as well as to be able to efficiently reconstruct a huge number of tracks and primary vertices. To meet this challenge new extremely radiation hard materials and sensor designs will be needed, to build high granularity and excellent time resolution tracking detectors. In particular, the availability of the time coordinate ("4D-tracking") significantly simplifies the track and vertex reconstruction problem. Diamond 3D pixel sensors, with thin columnar resistive electrodes orthogonal to the surface,specifically optimised for timing applications may provide an optimal solution to the above problems.The 3D geometry enhances the well known radiation hardness of diamond and allows to exploit its excellent timing properties, possibly improving the performances of the extensively studied planar diamond sensors.
We report on the timing characterization, based on beta-source and particle beam tests, of innovative 3D diamond detectors optimised for timing applications, fabricated by laser graphitisation of conductive electrodes in the bulk of 500 μm thick single-crystal diamonds. Preliminary results on the simulation of the full chain of signal formation in the sensor will also be presented and plans for further optimisation briefly discussed.

Primary experiment

TIMESPOT

Primary authors: CORSI, Chiara (LENS, Firenze (IT)); LUCARELLI, Chiara (Universita e INFN, Firenze (IT)); PASSALEVA, Giovanni (INFN Florence (IT)); ANDERLINI, Lucio (Universita e INFN, Firenze (IT)); BELLINI, Marco (INO and CNR, Firenze (IT)); VELTRI, Michele (Universita e INFN, Firenze (IT)); SCIORTINO, Silvio (Universita e INFN, Firenze (IT)); LAGOMARSINO, Stefano (INFN, Firenze (IT))

Presenter: VELTRI, Michele (Universita e INFN, Firenze (IT))

Session Classification: Semiconductor Detectors

Track Classification: Semiconductor Detectors

Contribution ID: **98** Type: **Live Presentation**

Phase 2 Upgrade of the ATLAS Inner Tracker

Tuesday, February 22, 2022 4:00 PM (20 minutes)

The ATLAS experiment is currently preparing for an upgrade of the Inner Tracking for High-Luminosity LHC operation, scheduled to start in 2027. The radiation damage at the maximum integrated luminosity of 4000/fb implies integrated hadron fluencies over 2x10^{16} n_{eq}/cm^2 and tracking in very dense environment call for a replacement of the existing Inner Detector. An all-silicon Inner Tracker (ITk) is proposed with a pixel detector surrounded by a strip detector. After an extensive prototyping phase, all the institutes involved in the ITk are currently in pre-production phase, moving toward production mode. In this contribution we present the design of the ITk Detector and its expected performance. An overview of the current status of the various detector components, both pixel, strip and the other common items, focusing on the preparation for production, with its more challenging aspects, will be summarized.

Primary experiment

ATLAS

Primary author: TERZO, Stefano (IFAE Barcelona (ES))

Presenter: TERZO, Stefano (IFAE Barcelona (ES))

Session Classification: Large Detector Systems

Track Classification: Semiconductor Detectors

Contribution ID: **99** Type: **Live Presentation**

The New Small Wheel Project for the ATLAS muon Spectrometer

Tuesday, February 22, 2022 12:15 PM (20 minutes)

After ten years of intense work, the two New Small Wheels (NSW) for the upgrade of the Atlas Muon Spectrometer are now ready for final commissioning and to collect data in LHC Run3, starting February 2022.
The NSW is the largest phase-1 upgrade project of ATLAS. Its challenging completion and readiness for data taking is a remarkable achievement of the Collaboration.
The two wheels (10 meters in diameter) replace the first muon stations in the high-rapidity regions of ATLAS and are equipped with multiple layers of two completely new detector technologies: the small strips Thin Gap Chambers (sTGC) and the Micromegas (MM). the latter for the first time used in such a large scale in HEP experiments. They will cover more than 1200 m2 of active area.
The new system is required to maintain the same level of efficiency and momentum resolution of the present detector, in the expected higher background level in view of the ongoing series of LHC luminosity upgrades. As well as keeping an acceptable muon trigger rate with the same muon momentum threshold.
In this presentation the motivation of the NSW upgrade and the status of the project will be reviewed, with particular focus on the main challenges, the adopted solutions and measured performance of the system, as well as first results from data during commissioning.

Primary experiment

ATLAS

Primary author: COIMBRA, Artur

Presenter: COIMBRA, Artur

Session Classification: Large Detector Systems

Track Classification: Gaseous Detectors

Contribution ID: **100** Type: **Recorded Presentation**

Operational Experience and Performance with the ATLAS Pixel detector at the Large Hadron Collider at CERN

The tracking performance of the ATLAS detector relies critically on its 4-layer Pixel Detector. As the closest detector component to the interaction point, this detector is subjected to a significant amount of radiation over its lifetime. By the end of the LHC proton-proton collision RUN2 in 2018, the innermost layer IBL, consisting of planar and 3D pixel sensors, had received an integrated fluence of approximately $\Phi = 9 \times 10^{14}$ 1 MeV n_{eq}/cm^2.
The ATLAS collaboration is continually evaluating the impact of radiation on the Pixel Detector. During the LHC long shutdown 2 dedicated data taking of cosmic rays have been taken at this purpose.
In this talk the key status and performance metrics of the ATLAS Pixel Detector are summarised, and the operational experience and requirements to ensure optimum data quality and data taking efficiency will be described, with special emphasis to radiation damage experience. A quantitative analysis of charge collection, dE/dX, occupancy reduction with integrated luminosity, under-depletion effects with IBL, effects of annealing will be presented and discussed, as well as the operational issues and mitigation techniques adopted during the LHC Run2 and the ones foreseen for Run3.

Primary experiment

ATLAS

Primary author: USHIODA, Risa (Tokyo Institute of Technology (JP))

Presenter: USHIODA, Risa (Tokyo Institute of Technology (JP))

Track Classification: Semiconductor Detectors

Contribution ID: **101** Type: **Live Presentation**

A High-Granularity Timing Detector for the ATLAS Phase-II upgrade

Wednesday, February 23, 2022 9:25 AM (20 minutes)

The increase of the particle flux at the HL-LHC with instantaneous luminosities up to $L \simeq 7.5 \times 10^{34}\ \mathrm{cm}^{-2}\mathrm{s}^{-1}$ will have a severe impact on the ATLAS detector performance. The forward region where the liquid Argon calorimeter has coarser granularity and the inner tracker has poorer momentum resolution will be particularly affected. A High Granularity Timing Detector (HGTD) will be installed in front of the LAr end-cap calorimeters for pile-up mitigation and luminosity measurement. The HGTD is a novel detector introduced to augment the new all-silicon Inner Tracker in the pseudo-rapidity range from 2.4 to 4.0, adding the capability to measure charged-particle trajectories in time and space. Two silicon-sensor double-sided layers will provide precision timing information for MIP particles with a resolution of 30 ps per track in order to assign each particle to the correct vertex. Readout cells have a size of $1.3 \times 1.3\ \mathrm{mm}^2$ leading to a highly granular detector with 3.7 million channels. Low Gain Avalanche Detectors technology has been chosen as it provides enough gain to reach the large signal over noise ratio needed. Requirements and overall specifications of the HGTD will be presented as well as the technical design and the project status. The on-going R&D effort carried out to study the sensors, the readout ASIC, and the other components, supported by laboratory and test beam results, will also be presented.

Primary experiment

ATLAS

Primary author: FILTHAUT, Frank (Radboud University and Nikhef, Nijmegen (NL))

Presenter: FILTHAUT, Frank (Radboud University and Nikhef, Nijmegen (NL))

Session Classification: Large Detector Systems

Track Classification: Semiconductor Detectors

Contribution ID: **107** Type: **Recorded Presentation**

The LiNA experiment: Development of multi-layered time projection chamber

The neutron lifetime is an important parameter for particle physics and cosmology. There are two types of measurement methods carried out so far, but their results are disagreement with 4.1σ. In the beam method carried out at J-PARC, a neutron bunch passes through a gaseous detector Time Projection Chamber (TPC). The TPC counts a beta decay electron and a neutron flux by ^{3}He(n,p)^{3}H reaction. However, the result of this experiment still has large uncertainty. The largest two contributions of the uncertainty are background contamination and signal cut inefficiency. A new experiment, the LiNA experiment, is proposed to overcome the problems. This system suppresses background events that come from the detector wall and improves signal cut efficiency by applying a uniform magnetic field in parallel to the beam axis. The detector system which has three drift layers was developed at Kyushu University. The detector and magnet integration test was carried out at KEK. The β-ray source was installed in the center of the detector to imitate the neutron beta decay electron. The γ-ray source was installed on the side of the detector to evaluate background suppression with the field. It was confirmed that β-ray is confined while γ-ray background is suppressed to 1/30 in the signal region. This system can measure the neutron lifetime with an accuracy of 0.2% by 30 days measurement at J-PARC.

Primary experiment

LiNA

Primary authors: SUMI, Naoyuki (KEK); ICHIKAWA, Go (KEK); MISHIMA, Kenji (KEK); KITAGUCHI, Masaaki (Nagoya Univ. KMI); MAKISE, So (Kyushu Univ); MATSUZAKI, Shun (Kyushu Univ.); MAKIDA, Yasuhiro (KEK); NAGANO, Tomoya (Kyushu Univ.); OTONO, Hidetoshi (Kyushu Univ. RCAPP); TANIDA, Masaki (Kyushu Univ.); UEHARA, Hideaki (Kyushu Univ.); YANO, Kodai (Kyushu Univ.); YOSHIOKA, Tamaki (Kyushu Univ. RCAPP)

Presenter: SUMI, Naoyuki (KEK)

Track Classification: Gaseous Detectors

Contribution ID: **109** Type: **Recorded Presentation**

ATLAS LAr Calorimeter Commissioning for LHC Run-3

Liquid argon (LAr) sampling calorimeters are employed by ATLAS for all electromagnetic calorimetry in the pseudo-rapidity region $|\eta| < 3.2$, and for hadronic and forward calorimetry in the region from $|\eta| = 1.5$ to $|\eta| = 4.9$. After detector consolidation during a long shutdown, Run-2 started in 2015 and about $150fb^{-1}$ of data at a center-of-mass energy of 13 TeV was recorded. Phase-I detector upgrades began after the end of Run-2. New trigger readout electronics of the ATLAS Liquid-Argon Calorimeter have been developed. Installation began at the start of the LHC shut down in 2019 and is expected to be completed in 2021. A commissioning campaign is underway in order to realise the capabilities of the new, higher granularity and higher precision level-1 trigger hardware in Run-3 data taking. This contribution will give an overview of the new trigger readout commissioning, as well as the preparations for Run-3 detector operation.

Primary experiment

ATLAS

Primary author: BUSCH, Elena (Columbia University (US))

Presenter: BUSCH, Elena (Columbia University (US))

Track Classification: Calorimeters

Contribution ID: **111** Type: **Recorded Presentation**

Upgrade of ATLAS Hadronic Tile Calorimeter for the High Luminosity LHC

The Tile Calorimeter (TileCal) is a sampling hadronic calorimeter covering the central region of the ATLAS experiment, with steel as absorber and plastic scintillators as active medium. The High-Luminosity phase of LHC, delivering five times the LHC nominal instantaneous luminosity, is expected to begin in 2028. TileCal will require new electronics to meet the requirements of a 1 MHz trigger, higher ambient radiation, and to ensure better performance under high pile-up conditions. Both the on- and off-detector TileCal electronics will be replaced during the shutdown of 2025-2027. The TileCal upgrade program has included extensive R&D and test beam studies. A Demonstrator module with reverse compatibility with the existing system was inserted in ATLAS in August 2019 for testing in actual detector conditions. The ongoing developments for on- and off-detector systems, together with expected performance characteristics and recent results of test-beam campaigns with the electronics prototypes will be discussed.

Primary experiment

ATLAS

Primary author: SOTTO-MAIOR PERALVA, Bernardo (Federal University of Juiz de Fora (BR))

Presenter: SOTTO-MAIOR PERALVA, Bernardo (Federal University of Juiz de Fora (BR))

Track Classification: Calorimeters

Contribution ID: **113** Type: **Recorded Presentation**

Development of the space-time self-triggering Silicon Tracking System for the CBM Experiment at FAIR

The Silicone Tracking System (STS) of the future CBM experiment is a unique detector aiming to cope with charged particle tracks and momentum measurement at unprecedented heavy-ion beam-target interaction rates up to 10 MHz. The detector design combines features low material budget down to 2% of radiation length, radiation hardness up to 10^14 n_eq/cm^2, and single-point resolution of ~30 μm which results in the momentum resolution of about 1.5%. The essential property of STS is a free-streaming triggerless read-out which allows to independently obtain data from about 1.8 million silicon microstrip channels with timing better than 5 ns along with charge measurement. The online reconstruction algorithms provide the real-time event building and selection. Such challenging requirements to the detector are dictated by the physics program of CBM: to study strongly interacting matter at high net-baryon densities with multi-strange particle yields and other rare observables.

The CBM-STS team has produced the mSTS detector, consisting of 11 prototype STS detector modules. It was operated in high-intensity heavy-ion beam from the GSI-SIS18 accelerator as a part of the mCBM demonstrator experiment.
From early 2022 the STS assembly centers start the pre-series production of the final-shape detector components. The detector construction is expected to be finished until the end of 2024.

In the presentation, the current prototypes and the detector under preparation will be overviewed.

Primary experiment

CBM

Primary author: TEKLISHYN, Maksym (GSI Helmholtz Centre for Heavy Ion Research)

Presenter: TEKLISHYN, Maksym (GSI Helmholtz Centre for Heavy Ion Research)

Track Classification: Semiconductor Detectors

Contribution ID: **114** Type: **Live Presentation**

The upgraded ALICE Inner Tracking System (ITS): installation, commissioning and performance results

Tuesday, February 22, 2022 11:00 AM (20 minutes)

During the second long shutdown of the LHC, the ALICE Inner Tracking System (ITS) has been replaced with a full-pixel detector constructed entirely with CMOS monolithic active pixel sensors (ITS2).
The ITS2 consists of three inner layers with 50um thick sensors and four outer layers with 100um thick sensors. The entire tracker covers 10 m^2 and comprises approximately 12.5 billion pixels with a single pixel size of 27umx29um.
Its increased granularity, the very low material budget (0.35%X0 for each of the three inner layers) as well as the small radius of the innermost layer combined with a thin beam pipe, will result in a significant improvement of impact-parameter resolution and tracking efficiency at low pT with respect to the previous tracker.
The assembly of the full detector and services, completed in December 2019, was followed by a comprehensive on-surface commissioning campaign. The detector has been installed in the experiment in the first half of 2021. After further in-situ commissioning, both standalone and integrated with the entire ALICE experiment, the detector is expected to see first collisions during LHC pilot beam tests in the second half of October 2021.
In this talk, first results from the ITS2 commissioning with and without beam will be presented. This includes results from calibration measurements, like threshold and noise performance, and from cosmic tracks and collisions, which will give a first measurement of the efficiency and spatial resolution.

Primary experiment

ALICE

Primary author: KEIL, Markus (CERN)

Presenter: KEIL, Markus (CERN)

Session Classification: Large Detector Systems

Track Classification: Semiconductor Detectors

Contribution ID: **116** Type: **Recorded Presentation**

Beam test results of a MAPS designed in a new 130nm High-Resistivity CMOS process

The Topmetal-M is a newly designed Monolithic Active Pixel Sensor (MAPS). It has a matrix of 512 × 100 pixels with the pitch of 40 μm × 40 μm. The Topmetal-M is implemented with a new 130 nm High-Resistivity (> 1 kΩ·cm) CMOS process. This process has four wells: the n-well, the p-well, the deep n-well, and the deep p-well. There are four different shapes of charge collection diode in this MAPS. A heavy-ion campaign and a laser test have been performed to study the performance of this sensor. The test results demonstrate it has a uniform response to particle energy deposition. After being exposed to 14.3krad, this sensor is still functional with a rather low rate of broken pixels. No single event was observed in both the two tests. The average spatial resolution is ~9μm. Therefore, this 130nm HR process is a good candidate for MAPS development. This paper will discuss the heavy-ion and laser beam test results of this MAPS.

Primary experiment

Primary author: YANG, Haibo

Co-author: Prof. ZHAO, Chengxin (IMP, CAS)

Presenter: YANG, Haibo

Track Classification: Semiconductor Detectors

Contribution ID: **120** Type: **Recorded Presentation**

Induced signals in particle detectors with resistive elements: modelling novel structures

Novel particle detector structures are proposed regularly, mixing old and new ideas, with resistive detectors widening the landscape of possible configurations. In this talk an accurate and universal way of calculating the signals induced in structures with restive elements using an extended form of the Ramo-Shockley theorem is applied to several detector configurations.

For detector geometries containing resistive materials, the time dependence of the signals is not sully given by the movement of the charges in the drift medium but also by the time-dependent reaction of the resistive materials. With COMSOL Multiphysics, the needed dynamic weighing potentials can be obtained numerically. This, coupled with Garfield++ and a general-purpose circuit simulation program (e.g., SPICE) to describe the front-end electronics, allows for the targeting of a universal simulation toolkit for the microscopic modelling of the signal induction in particle detectors. In this talk, we present the application of these tools to study not only the signals induced in a variety of Micro Pattern Gaseous Detectors (MPGDs) but also for Multigap Resistive Plate Chambers (MRPCs) and solid-state detectors. In addition to deepening the understanding of existing structures, these studies are important for the design and optimization of the next generation of particle detectors and their application to specific needs driven by HEP experiments and other applications.

Primary experiment

Primary author: JANSSENS, Djunes (Vrije Universiteit Brussel (BE))

Co-authors: RIEGLER, Werner (CERN); VEENHOF, Rob (Uludag University (TR)); VAN STENIS, Miranda (CERN); SCHINDLER, Heinrich (CERN); ROPELEWSKI, Leszek (CERN); OLIVERI, Eraldo (CERN); MULLER, Hans (University of Bonn (DE)); LISOWSKA, Marta (Ecole Normale Supérieure Paris-Saclay (FR)); FLÖTHNER, Karl (HISKP-Uni-Bonn); D'HONDT, Jorgen (Vrije Universiteit Brussel (BE)); BRUNBAUER, Florian Maximilian (CERN); BLEKMAN, Freya (IIHE, Vrije Universiteit Brussel (BE)); UTROBICIC, Antonija (CERN); SCHARENBERG, Lucian (CERN, University of Bonn (DE))

Presenter: JANSSENS, Djunes (Vrije Universiteit Brussel (BE))

Track Classification: Gaseous Detectors

Contribution ID: **121** Type: **Recorded Presentation**

FPGA-based 100G network readout solution for SHINE pixel detector

Abstract
With the progress of semiconductor technology, the spatial resolution of pixel detector in high-energy physics experiments is improving continuously, at the same time, the amount of data generated is also increasing rapidly. In Shanghai HIgh repetition rate XFEL aNd Extreme light facility (SHINE), the data rate of its high frame rate pixel detector is expected to exceed 1.6 Tbps in the future. Traditional gigabit and ten-gigabit networks can no longer meet readout demand and the transmission rate of readout system has become a bottleneck. Obviously, it is necessary and significant to develop a network with higher bandwidth. Combined with the current situation and the needs of upgrading, we developed two 100G readout solutions on FPGA. The first solution, NET-CONV, can extract the raw data from the network packet and converge data stream from multiple 10G links into single 100G link. It supports parallel transmission of up to 12 channels and achieves a total peak rate of 94 Gbps in the test. To further improve the transmission speed of single Ethernet port on readout board, the second solution, NET-TOE, is developed. It implements a complete network protocol stack at 100 Gbps line rate, supporting maximum transmission unit (MTU) adjustment, TCP window scale and UDP. The actual measure shows that the stable transmission rate of the firmware can reach 97 Gbps.

Primary experiment

Primary author: HE, Cong (Institute of high energy physics)

Co-authors: ZHANG, Jie (institute of high energy physics); JIANG, Xiaoshan (institute of high energy physics)

Presenter: HE, Cong (Institute of high energy physics)

Track Classification: Electronics

Contribution ID: **124** Type: **Recorded Presentation**

Improving resolution with enhanced lateral drift (ELAD) sensors

Silicon tracker sensors R&D is aiming at the improvement of the position and timing resolution. Instead of scaling down pitch sizes, which comes at a high price for an increased number of channels, our new sensor concept seeks to improve the position resolution by increasing the lateral size of the charge distribution already during the drift in the sensor material. To this end, it is necessary to carefully engineer the electric field in the bulk of this so-called enhanced lateral drift (ELAD) sensor. We intend to achieve this by implants deep inside the bulk which influence the charge carriers' drift paths. Adding a multiplication layer on top of these additional doping regions would allow a charge gain in the sensor and correspondently improves the timing resolution.

In order to find an optimal sensor design, detailed simulation studies were conducted using SYNOPSYS TCAD. The geometry of the implants and multiplication layer, their doping concentration and the position inside the sensor were optimised. To estimate the position resolution of an ELAD sensor, test beam simulations using the AllPix2 software have been performed. In result, a position resolution of a few micrometers is expected by using deep implants.

Along with the simulation results, a description of the multi-layer production process is presented. In addition, details of the first submission of the ELAD sensors without a multiplication layer will be discussed.

Primary experiment

Primary author: VELYKA, Anastasiia (Deutsches Elektronen-Synchrotron (DE))

Presenter: VELYKA, Anastasiia (Deutsches Elektronen-Synchrotron (DE))

Track Classification: Semiconductor Detectors

Contribution ID: **127** Type: **Live Presentation**

Plastic scintillator production involving Additive Manufacturing

Wednesday, February 23, 2022 4:00 PM (20 minutes)

Plastic scintillator detectors are widely used in high-energy physics, often as an active neutrino target, both in long and short baseline neutrino oscillation experiments. They can provide 3D tracking with 4π coverage and calorimetry of the neutrino interaction final state combined with very good particle identification capabilities and sub-nanosecond time resolution. Moreover, the large hydrogen content makes plastic scintillator detectors ideal for detecting neutrons. However, new experimental challenges and the need for enhanced performance require the construction of detector geometries that are challenging using current production techniques. The solution can be found in additive manufacturing, able to quickly make plastic-based objects of any shape. In this talk, the applicability of 3D-printing techniques to the manufacture of polystyrene-based scintillator will be discussed. We will report the feasibility of 3D printing polystyrene-based scintillator with light output performances comparable with that of detectors manufactured using standard production techniques. The latest advances in R&D aim at combining the 3D printing of plastic scintillator with other materials, such as optical reflectors or absorbers. The status of the R&D and the latest performance results will be presented.

Primary experiment

3DET R&D collaboration

Primary authors: SGALABERNA, Davide (ETH Zurich (CH)); KOSE, Umut (CERN EP-NU)

Presenters: SGALABERNA, Davide (ETH Zurich (CH)); KOSE, Umut (CERN EP-NU)

Session Classification: Photon Detectors

Track Classification: Photon Detectors

Contribution ID: **129** Type: **Recorded Presentation**

The ALICE Run 3 Online / Offline Processing

The ALICE experiment has undergone a major upgrade for LHC Run 3 and will record 50 times more data than before.
The new computing scheme for Run 3 replaces the traditionally separate online and offline frameworks by a unified one, which is called O^2.
Processing will happen in two phases.
During data taking, a synchronous processing phase performs data compression, calibration, and quality control on the online computing farm.
The output is stored on an on-site disk buffer.
When there is no beam in the LHC, the same computing farm is used for the asynchronous reprocessing of the data which yields the final reconstruction output.
O^2 is organized in three projects.
The Event Processing Nodes (EPN) equipped with GPUs deliver the bulk of the compute capacity and perform the majority of the reconstruction and the calibration.
The First Level Processors (FLP) receive the data via optical links from the detectors and perform local processing where it is needed, which can optionally happen in the user logic of the FPGA based readout card.
Between the FLP and the EPN farms the data is distributed in the network such that the EPNs receive complete collision data for the processing.
The Physics and Data Processing (PDP) group develops the software framework and the reconstruction and calibration algorithms.
The current O^2 setup is capable of handling the foreseen peak data rate during 50 kHz of Pb-Pb collisions in real time.

Primary experiment

Primary author: ROHR, David (CERN)

Presenter: ROHR, David (CERN)

Track Classification: Miscellaneous

Contribution ID: **131** Type: **Recorded Presentation**

ALDO2, a multi-function rad-hard linear regulator for SiPM-based detectors

In this contribution, we present ALDO2, a multi-function, adjustable, low dropout linear regulator designed in onsemi I3T80 0.35 μm HV CMOS technology for use in HEP detectors that adopt SiPMs/MPPCs.
The chip features four independent regulators, two low voltage channels (max 3.3 V) used to filter and stabilize the power supply of front-end chips, one with 0.6 A output and one with 20 mA output, and two HV channels (max 70 V), specifically designed to provide the bias voltage to arrays of SiPMs up to a current of 45 mA per channel.
Each regulator can be independently shut down and is protected for over-currents and over-temperature.
The HV regulators also implement a circuit to monitor the bias current of the SiPM arrays, allowing to perform I-V curves and thus to fine-tune the working point of the SiPM arrays during the detector lifetime.
The chip adopts radiation hardening techniques and has been fully qualified up to a TID of 20 Mrad, a 1-MeV-equivalent neutron fluence of 10^{15} cm^{-2}, and with heavy ions up to 40 MeV cm^{2} mg^{-1} LET and 10^{10} cm^{-2} cumulative fluence. The chip will be installed in two CMS detectors in the HL-LHC phase, the Barrel Timing Detector (BTL) and the High Granularity Calorimeter (HGCAL).

Primary experiment

Primary authors: GOTTI, Claudio (Universita & INFN, Milano-Bicocca (IT)); CARNITI, Paolo (Universita & INFN, Milano-Bicocca (IT)); PESSINA, Gianluigi (Universita & INFN, Milano-Bicocca (IT))

Presenter: CARNITI, Paolo (Universita & INFN, Milano-Bicocca (IT))

Track Classification: SiPM

Contribution ID: **132** Type: **Live Presentation**

Development of LGAD Sensors at FBK

Friday, February 25, 2022 11:30 AM (20 minutes)

The High Luminosity upgrade of the Large Hadron Collider highlighted the need for a time-tagging of tracks with a precision of tens of picoseconds. This requirement motivated the development of radiation hard silicon sensors dedicated to the time-of-interaction measurement of minimum ionizing particles. Low Gain Avalanche Detectors (LGADs) are silicon sensors with internal charge multiplication and are the baseline for the timing systems of the ATLAS and CMS experiments. These sensors use the gain to improve the signal to noise ratio (SNR) of detector systems and have been engineered to withstand the harsh radiation environment of the experiments. Fondazione Bruno Kessler (FBK) developed the LGAD technology through several production runs. The improved SNR and excellent time resolution made LGADs suitable also for medical, x-ray, and space applications. A feature of LGADs is the presence of a termination structure between regions with gain that results in areas without gain between the readout channels, reducing the fill factor of the devices. Different strategies to improve the fill factor of LGADs are being developed, such as double-sided LGADs, resistive AC-coupled LGADs, and trench isolated LGADs. This talk summarizes the experience acquired at FBK with the realization of more than ten sensor batches. Selected results in radiation hardness, time resolution, fill factor, and different LGAD applications will be discussed.

Primary experiment

Primary authors: BISHT, Ashish (Fondazione Bruno Kessler); FICORELLA, Francesco (Fondazione Bruno Kessler (FBK)); BORGHI, Giacomo (Fondazione Bruno Kessler); PATERNOSTER, Giovanni (Fondazione Bruno KEssler); CENTIS VIGNALI, Matteo (FBK); BOSCARDIN, Maurizio (FBK Trento); HAMMAD ALI, Omar (Fondazione Bruno Kessler (FBK))

Presenter: CENTIS VIGNALI, Matteo (FBK)

Session Classification: Semiconductor Detectors

Track Classification: Semiconductor Detectors

Contribution ID: **133** Type: **Recorded Presentation**

Fast Interaction Trigger for ALICE Upgrade

ALICE has entered Global Commissioning – the final phase of a three-year upgrade period before the April 2022 start of the LHC Run 3. One of the challenges is two orders of magnitude higher data rate than in the LHC Run 2. To cope with it, all ALICE sub-detectors and systems, especially the readout, have been upgraded. While many upgraded ALICE detectors operate in a continuous readout mode (ITS, MFT, ZDC, TOF, MCH, MID, TPC), some of them (TRD, CPV, HMPID, EMCAL, DCAL, PHOS) require a fast trigger provided by the new Fast Interaction Trigger (FIT) system. FIT triggers are delivered to the Central Trigger Processor less than 425 ns after the collision. Since half of that time comes from cable delay, the trigger hardware and firmware complete signal digitisation and evaluation in just over 200 ns. FIT incorporates three different detector technologies: FT0 (two Cherenkov arrays), FV0 (large, segmented scintillator ring with a novel light collection system), and FDD (two double-layered scintillator plates with fast wavelength shifting bars). All the FIT detectors are at high rapidity to sample unbiased collision multiplicity. In addition to the required triggers, FIT will deliver instantaneous luminosity feedback to the LHC, provide a start for Time-Of-Flight particle identification, reconstruct forward particle multiplicity, centrality, reaction plane, and provide essential data for diffractive physics measurements.

Primary experiment

ALICE

Primary author: SLUPECKI, Maciej (Helsinki Institute of Physics (FI))

Presenter: SLUPECKI, Maciej (Helsinki Institute of Physics (FI))

Track Classification: Photon Detectors

Contribution ID: **134** Type: **Recorded Presentation**

Embedded Artificial Intelligence for Position Sensitivity in Thick Scintillators

This research work consists in the design, development, and experimental characterization of a γ-ray spectrometer based on large lanthanum bromide scintillator crystals (3" × 3") coupled with SiPMs. In nuclear physics experiments where photon's energy ranges from 100 keV to 30 MeV, GAMMA provides state-of-the-art energy resolution (<3% at 662 keV) with a compact, modular and robust structure.

The interaction position reconstruction in the crystal volume is a fundamental information to compensate the Relativistic Doppler effect which leads to an undesired energy shift of the measured photon's energy. To accomplish this task, imaging capabilities have been implemented on GAMMA: different Artificial Intelligence algorithms such as Decision Trees and Neural Networks have been tested. Results about 1-D and 2-D position sensitivity will be shown explaining how an RMS-Error lower than 1.5 cm_{rms} has been met on the 2-D reconstruction; furthermore, an estimate of the DOI in such a thick scintillator will be presented.

Finally, Artificial Intelligence algorithms have been synthesized in an FPGA to allow Real Time position sensitivity. Important results about latency and percentage of hardware resources used (DSP, LUT) will be discussed comparing Decision Tree and Neural Network solutions.

Primary experiment

Primary authors: Mr TICCHI, Giacomo (Politecnico di Milano); Dr BUONANNO, Luca (Politecnico di Milano); Dr DI VITA, Davide (Politecnico di Milano); Dr CANCLINI, Fabio (Politecnico di Milano); Prof. MARCO, Carminati (Politecnico di Milano); Prof. CAMERA, Franco (Università degli Studi di Milano); Prof. FIORINI, Carlo (Politecnico di Milano)

Presenter: Mr TICCHI, Giacomo (Politecnico di Milano)

Track Classification: SiPM

Contribution ID: **137** Type: **Live Presentation**

ALICE 3

Wednesday, February 23, 2022 11:00 AM (20 minutes)

The future ALICE programme for Run 5 and beyond relies on a novel detector concept, ALICE 3, to address the determination of QGP properties that will remain inaccessible with existing and planned detectors in Run 3 and 4. Amongst others, this requires next-level measurements of dileptons down to very low invariant mass as well as the clean reconstruction of heavy-flavour hadrons. They call for a substantial increase in luminosity in combination with unprecedented detector performance. A compact, light, and fast tracker, based on thin silicon sensors, operated in a magnetic field, shall provide good pT resolution over ~8 units of pseudorapidity. To achieve a pointing resolution of ~10 um at 200 MeV/c, an ultralight vertex detector at minimal distance from the interaction point and, thus, within the beampipe is planned. Particle identification can be provided by a time-of-flight detector with 20 ps time resolution, for which R&D on monolithic silicon sensors is ongoing. An aerogel-based RICH detector is being studied to extend the momentum coverage. Further detectors are foreseen for more specialised measurements.

In this presentation, we will present the detector requirements resulting from the physics programme of ALICE 3. We will then discuss a detector concept and technologies suitable to meet these requirements. Additionally, we will highlight R&D activities, in progress and planned, to achieve the required performance.

Primary experiment

ALICE

Primary author: KLEIN, Jochen (CERN)

Presenter: KLEIN, Jochen (CERN)

Session Classification: Large Detector Systems

Track Classification: Miscellaneous

Contribution ID: **138** Type: **Recorded Presentation**

Discharge quenching in Thick-GEM based WELL detectors

The occurrence of discharges, the consequent dead-time, and potential damage to the detector and electronics limit the dynamic range of gaseous detectors. Various resistive anode configurations are used to mitigate these effects. We have been characterizing discharges and the resulting performance of three different resistive Thick-GEM-based WELL configurations. In a bare WELL, the very energetic discharges induce rapid current spikes of a few hundreds of nA on the electrodes, preventing the operation of the detector. In RWELL configuration, placing a resistive layer on an insulator (e.g. DLC on Kapton) in front of the anode shields the readout electronics. This reduces the intensity of the discharge at the cost of current flowing sideways on the resistive layer. A more effective way of discharge quenching is implemented in RPWELL where the charges are evacuated via a highly-resistive plate. Using bulk resistivity at the range of 10^9-10^{12} Ω-cm results in significant quenching of the discharge intensity such that the current induced is at a level of a few nA. We will present a newly-developed method to detect low-intensity discharges in RPWELL detectors. The results will show the role of applied voltage, detector gain, and the rate of incident radiation on discharge production. We will also present the effect of discharges on RPWELL performance as a function of distance from the discharge origin and as a function of time.

Primary experiment

Primary author: Dr JASH, Abhik (Weizmann Institute of Science (IL))

Co-authors: Dr MOLERI, Luca (Weizmann Institute of Science (IL)); Dr BRESSLER, Shikma (Weizmann Institute of Science (IL))

Presenter: Dr JASH, Abhik (Weizmann Institute of Science (IL))

Track Classification: Gaseous Detectors

Contribution ID: **140** Type: **Recorded Presentation**

Cryogenic characterisation of Silicon Photomultipliers for future Dark Matter experiments

The recent R&D for underground low energy particle physics experiments involve SiPMs extensively as the prime photo-detectors due to their ability to enhance the sensitivity of the rare particle events. For cryogenic applications, the SiPMs by LFoundry are being characterised at LNGS, Italy have Dark Count rate of 0.1 cps/□□2-0.3 cps/□□2 over the range of 5-8V over-voltage with after-pulse probability upto 10%. The internal CrossTalk (iCT) on the other hand, increases significantly with over-voltage introducing an excess of noise that can spoil the resolution of the measurement. Specific electronics was designed to test 1cm^2 SiPMs to calculate the iCT. A dedicated Poissonian laser model was constructed to satisfy the observed data. The PDE is another vital parameter that was modelled for cryogenic temperatures down to 87-77K through the direct measurements of triggering probability. For this purpose, a separate setup with two 1 mm^2 SiPMs were mounted and cooled down to 77K and then equally illuminated by different wavelengths' lasers. With the careful modelling of depletion region and absorption length in the SiPM lattice structure, SiPMs can be customised for cryogenic applications with PDE close to 60%. Additionally, external CrossTalk (eCT) phenomena was also explored through a dedicated setup. With maximum likelihood analysis, the parameters for eCT probability were extracted. In this talk, large area SiPM performance at cryogenic temperatures will be highlighted.

Primary experiment

Primary authors: Dr RAZETO, Alessandro (Laboratori Nazionali del Gran Sasso); KACHRU, Priyanka (Gran Sasso Science Institute (IT))

Presenter: KACHRU, Priyanka (Gran Sasso Science Institute (IT))

Track Classification: SiPM

Contribution ID: **141** Type: **Recorded Presentation**

Evaluation of the DECAL Fully Depleted monolithic sensor for outer tracking and digital calorimetry

The DECAL sensor, a depleted monolithic active pixel sensor (DMAPS), is being developed as a possible technology for future digital calorimeters. For this application, the pixel size is required to be sufficiently small to avoid hit saturation and the number of pixels above threshold are counted to estimate the shower energy. The DECAL and DECAL Fully Depleted sensors have been designed and fabricated in the TowerJazz 180 nm CMOS standard and "modified" imaging process, respectively. The latter contains modifications to the implants configuration that have demonstrated improved charge collection and radiation hardness, even to the levels required for barrel ECAL regions of FCC-hh (few 10^{15} n_{eq}/cm^2). Both DECAL variants feature a matrix of 64x64 pixels with a pitch of 55 µm read out every 25 ns. For DECAL FD, the logic has been modified to have the in-pixel comparator threshold trim range extended from five to six bits, where the sixth bit is used to de-activate the comparator. The sensors can be reconfigured to function as either a binary short strip sensor, for particle tracking including as a pre-shower, or as a pad sensor, counting the number of pixels above threshold for digital calorimetry. The presentation contains characterisation results for both prototypes, including digital summing logic, analogue pixel performance, threshold scans under laser illumination and testing with radioactive
sources.

Primary experiment

Primary authors: KOPSALIS, Ioannis (University of Birmingham (GB)); ALLPORT, Philip Patrick (University of Birmingham (UK)); BENHAMMADI, Seddik (STFC); BOSLEY, Robert Ross (University of Birmingham (GB)); DOPKE, Jens (Science and Technology Facilities Council STFC (GB)); FLYNN, Sam (National Physical Laboratory); FREEMAN, Patrick Moriishi (University of Birmingham (GB)); GONELLA, Laura (University of Birmingham (UK)); GUERRINI, Nicola Carlo; NIKOLOPOULOS, Konstantinos (University of Birmingham (GB)); PHILLIPS, Peter (Science and Technology Facilities Council STFC (GB)); PRICE, Tony (University of Birmingham (GB)); SEDGWICK, Iain (STFC); VILLANI, Enrico Giulio (Science and Technology Facilities Council STFC (GB)); WARREN, Matt (University College London); WATSON, Nigel (University of Birmingham (GB)); WILSON, Fergus (Science and Technology Facilities Council STFC (GB)); WINTER, Alasdair (University of Birmingham (GB)); WORM, Steven (Deutsches Elektronen-Synchrotron (DE)); ZHANG, Zhige (Science and Technology Facilities Council STFC (GB))

Presenter: KOPSALIS, Ioannis (University of Birmingham (GB))

Track Classification: Semiconductor Detectors

Contribution ID: **142** Type: **Recorded Presentation**

Latest advancements of the HERD space mission

The High Energy cosmic Radiation Detector (HERD) is one of the prominent space-borne instruments to be installed on - board the upcoming Chinese Space Station (CSS) around 2027 and represents a collaborative effort among Chinese and European institutions. Its primary scientific goals include: precise measurements of Cosmic Ray (CR) energy spectra and mass composition up to the highest achievable energies in space (~ few PeV), gamma ray astronomy and transient studies, along with indirect searches for Dark Matter particles. HERD is uniquely configured to accept particles from both its top and four lateral sides. Owing to its pioneering design, an order of magnitude increase in geometric acceptance is foreseen, compared to current generation experiments. HERD is conceived around a deep (~55 X0, 3 λI) 3D cubic calorimeter (CALO), forming an octagonal prism. Fiber Trackers (FiTs) are instrumented on all active sides, with a Plastic Scintil- lator Detector (PSD) covering the calorimeter and tracker. Ultimately, a Silicon Charge Detector (SCD) envelops the above-stated sub-detectors, while a Transition Radiation Detector (TRD) is instrumented on one of its lateral faces, for energy calibration in the TeV scale. A detailed overview of HERD will be provided in this work, with great emphasis on recent detector advancements and space readiness aspects, along with novelties concerning its particle identification subsystem and double-readout calorimeter.

Primary experiment

HERD

Primary authors: DONG, Yongwei (Chinese Academy of Sciences (CN)); KYRATZIS, Dimitrios (Gran Sasso Science Institute (GSSI) & INFN-LNGS)

Presenter: KYRATZIS, Dimitrios (Gran Sasso Science Institute (GSSI) & INFN-LNGS)

Track Classification: Astroparticle Detectors

Contribution ID: **143** Type: **Recorded Presentation**

AWAGS: a single ASIC to detect from protons up to uranium ions

The Super-FRS is a second-generation in-flight magnetic separator currently under construction at GSI FAIR in Darmstadt (Germany) that will make isotopic separation event by event up to the uranium element and that will be in operation at the end of 2025. New tracking detectors, as beam diagnostic, are currently under development to cope with the physics requirements of this forefront machine: high radiation level, long term stability, homogeneity and high tracking efficiency. The contribution focuses on the Gas Electron Multiplier (GEM)-based Time Projection Chamber (TPC), specifically on the latest promising Front End Electronics solution currently designed and developed at the GSI. The low noise Amplifier With Adaptive Gain Settings (AWAGS) ASIC is characterised by the large dynamic range (from sub fC up to 80 pC of measured charge), low noise level and stable operation due to his architecture based on the folded cascode coupled with five separated capacitors. The presented results are the ASIC characterisation studies and test results of the Front End Electronics coupled with the GEM TPC detector operating in argon-methane (90/10) gas mixture and using the Front End Board with optical Extension (FEBEX) for the signal digitalisation. Comparison with the previous test beam results performed with the antecedent AWAGS version and outlook of a new full read out chain architecture available in trigger and self-trigger mode with data reduction on chip are also shown.

Primary experiment

Primary author: Dr ROCCO, Elena (GSI Helmholtzzentrum für Schwerionenforschung GmbH)

Co-authors: VOSS, Bernd (Helmholtzzentrum für Schwerionenforschung GmbH (GSI)); Dr NOCIFORO, Chiara (GSI Helmholtzzentrum fuer Schwerionenforschung GmbH); Dr SCHMIDT, Christian J. (GSI Helmholtzzentrum fu¨r Schwerionenforschung GmbH, Darmstadt, Germany); Dr CHOKHELI, David (Joint Insitute for Nuclear Research); GARCIA FUENTES, Francisco Ignacio (Helsinki Institute of Physics (FI)); SIMON, Haik (Gesellschaft für Schwerionenforschung mbH (GSI)); Dr FLEMMING, Holger (GSI Helmholtzzentrum fuer Schwerionenforschung GmbH); CHRISTOS, Karagiannis (GSI Helmholtzzentrum fu¨r Schwerionenforschung GmbH, Darmstadt, Germany); Dr GÖTZEN, Klaus (GSI Helmholtzzentrum fuer Schwerionenforschung GmbH); WINKLER, Martin (GSI); LUOMA, Minna (University of Helsinki); Dr KURZ, Nikolaus (GSI Helmholtzzentrum fuer Schwerionenforschung GmbH); Dr WIECZOREK, Peter (GSI Helmholtzzentrum fu¨r Schwerionenforschung GmbH); Dr LÖCHNER, Sven (GSI Helmholtzzentrum fuer Schwerionenforschung GmbH); BLATZ, Tobias (GSI Helmholtzzentrum für Schwerionenforschung GmbH); GRAHN, Tuomas (University of Jyvaskyla (FI))

Presenter: Dr ROCCO, Elena (GSI Helmholtzzentrum für Schwerionenforschung GmbH)

Track Classification: Electronics

Contribution ID: **145** Type: **Live Presentation**

Recent results with radiation-tolerant TowerJazz 180 nm MALTA Sensors

Thursday, February 24, 2022 11:50 AM (20 minutes)

To achieve the physics goals of future colliders, it is necessary to develop novel, radiation-hard silicon sensors for their tracking detectors. We target the replacement of hybrid pixel detectors with Depleted Monolithic Active Pixel Sensors (DMAPS) that are radiation-hard, monolithic CMOS sensors. We have designed, manufactured and tested the MALTA series of sensors, which are DMAPS in the 180 nm TowerJazz CMOS imaging technology. MALTA have a pixel pitch well below current hybrid pixel detectors, high time resolution (<2 ns) and excellent charge collection efficiency across pixel geometries. These sensors have a total silicon thickness of only 100 μm, implying reduced material budgets and multiple scattering rates for future detectors which utilize such technology. Furthermore, their monolithic design bypasses the costly stage of bump-bonding in hybrid sensors and can substantially reduce detector costs. This contribution will present the latest results from characterization studies of the MALTA2 sensors, including new test-beam results demonstrating the radiation tolerance of these sensors.

Primary experiment

ATLAS

Primary authors: SOLANS SANCHEZ, Carlos (CERN); LEBLANC, Matt (CERN); DAO, Valerio (CERN)

Presenter: LEBLANC, Matt (CERN)

Session Classification: Semiconductor Detectors

Track Classification: Semiconductor Detectors

Contribution ID: **146** Type: **Recorded Presentation**

Optimization of Detector Modules for Measuring Gamma-ray Polarization in Positron Emission Tomography

Detection of gamma-ray polarization in Positron Emission Tomography (PET) is yet an unexploited feature that could be used as an additional handle to improve signal-to-background ratio in this imaging modality. The gamma polarization is related to the azimuthal angle in the Compton scattering process, so the initial correlation of polarizations translates to the correlation of azimuthal angles in true coincidence events, while it lacks in the background. We will present a comprehensive experimental study of the polarimetric performance of 5 detector configurations based on scintillator matrices and silicon photomultipliers. The modules consist of either GaGG:Ce or LYSO:Ce pixels with sizes varying from 1.9x1.9x20 mm^3 to 3x3x20 mm^3. The distinctive feature of the modules is that they can reconstruct the Compton scattering by detecting the recoil electron and the scattered gamma in a single detector layer, which simplifies extension to larger systems. We will discuss the factors driving the optimal polarimetric performance of the modules and the perspective of their application in PET.

Primary experiment

Primary authors: Dr PARASHARI, Siddharth (Department of Physics, Faculty of Science, University of Zagreb); Prof. MAKEK, Mihael (Department of Physics, Faculty of Science, University of Zagreb); Dr BOKULIĆ, Tomislav (Department of Physics, Faculty of Science, University of Zagreb); Prof. BOSNAR, Damir (Department of Physics, Faculty of Science, University of Zagreb); KOŽULJEVIĆ, Ana Marija (Department of Physics, Faculty of Science, University of Zagreb); Prof. KUNCIC, Zdenka (School of Physics, University of Sydney); Dr ŽUGEC, Petar (Department of Physics, Faculty of Science, University of Zagreb)

Presenter: Dr PARASHARI, Siddharth (Department of Physics, Faculty of Science, University of Zagreb)

Track Classification: Medical Applications

Contribution ID: **147** Type: **Recorded Presentation**

Encapsulated resistive anode bulk Micromegas detectors for the T2K experiment TPC upgrade

In order to establish accurate leptonic CP violation at 3 σ level for a significant fraction of the possible δ_{CP} values, the T2K collaboration plan to upgrade the beam intensity and to upgrade the near detector ND280.

An innovative concept for this neutrino detection system made with a totally active Super-Fine-Grained-Detector (SuperFGD), two High Angle Time Projection Chamber (HA-TPC) and six time of flight planes.
The HA-TPC will be used for 3D track reconstruction, momentum measurement and particle identification. These TPCs, with overall dimensions of $2\times2\times0.8$ m^3, will be equipped with 32 encapsulated resistive anode bulk Micromegas (ERAM) detectors. The thin field cage (3 cm thickness, 4\% radiation length) will consist of composite material with a Kapton foil with copper strips as inner layer. The 42×34 cm^2 ERAM detector will use a 400 kΩ/
$square$ diamond like carbon (DLC) foil to spread the charge over the pad plane, each pad being approximatively 1 cm^2. New front-end cards electronics, based on the AFTER chip, directly mounted on the back of the detector and parallel to its plane have been developed and used for the signal readout.

The first production ERAM detector modules have been tested in a lab using a X-ray bench and a cosmic bench. In July 2021, data have also been taken in a test beam at DESY in 0.2 T magnetic field. Performance characterization and results from these measurement campaign will be shown.

Primary experiment

T2K

Primary author: Dr ATTIE, David (CEA IRFU Centre d'etude de Saclay Gif-sur-Yvette (FR))

Presenter: Dr ATTIE, David (CEA IRFU Centre d'etude de Saclay Gif-sur-Yvette (FR))

Track Classification: Gaseous Detectors

Contribution ID: **149** Type: **Live Presentation**

The Jiangmen Underground Neutrino observatory (JUNO)

Monday, February 21, 2022 2:50 PM (20 minutes)

The Jiangmen Underground Neutrino observatory (JUNO) experiment uses a large liquid scintillator detector to measure electron antineutrinos issued from nuclear reactors at a distance of 53 km. The main goal is to determine the neutrino mass hierarchy and precisely measure oscillation parameters. The detector will be located at 700 m underground and will consist of 20 ktons of liquid scintillator contained in a 35 m diameter acrylic sphere, instrumented by 17612 20-inch photomultiplier tubes (PMT) and 25600 3-inch PMTs. It will achieve unprecedented 3% energy resolution (at 1 MeV). The objective is to detect 100 000 events after 6 years of data taking. Two vetoes are foreseen to reduce the different backgrounds. A 40 ktons ultrapure water Cherenkov pool instrumented by 2400 20-inch PMTs surrounds the central detector. It will tag events coming from outside the neutrino target. It will also act as a passive shielding for neutrons and gammas. In addition, a muon tracker will be installed on top of the detector (top muon veto) in order to tag cosmic muons and validate the muon track reconstruction. JUNO will be an exceptional multipurpose detector with a rich physics program in neutrino oscillation, geo-neutrinos, astrophysical neutrinos and the search for physics beyond the Standard Model (sterile neutrinos, dark matter, proton decay and others). A general introduction of the JUNO system as well as the main progress since 2019 will be reported.

Primary experiment

The Jiangmen Underground Neutrino observatory(JUNO)

Primary author: Dr YANG, Yifan (Universite Libre de Bruxelles (BE))

Presenter: Dr YANG, Yifan (Universite Libre de Bruxelles (BE))

Session Classification: Astroparticle Detectors

Track Classification: Astroparticle Detectors

Contribution ID: **151** Type: **Live Presentation**

Present and future development of thin silicon sensors for extreme fluences

Thursday, February 24, 2022 4:00 PM (20 minutes)

In this contribution, we present a new development of radiation-resistant silicon sensors. This innovative sensor design exploits the recently observed saturation of radiation damage effects on silicon, together with the usage of thin substrates, intrinsically less affected by radiation. The internal multiplication of the charge carriers will be used to overcome the small signals coming from thin substrates.
At the end of 2020, the Fondazione Bruno Kessler (Italy) delivered Low-Gain Avalanche Diodes (LGADs) produced on 25 and 35 μm thick p-type epitaxial substrates, namely the EXFLU0 production: I-V and C-V characterisation of the sensors has been performed before and after irradiation up to 1E17 1MeV neutron equivalent/cm^2, together with signal analysis from an infrared laser and beta stimulus.
The outcome of the laboratory tests will be implemented in the EXFLU1 production, in which optimisation of the sensor peripheries and the gain layer responsible for internal multiplication will be pursued. The goal is to pave the way for a new design of silicon sensors that can efficiently operate above fluences of 1E17 1MeV neutron equivalent/cm^2.

Primary experiment

Primary authors: SOLA, Valentina (Universita e INFN Torino (IT)); ARCIDIACONO, Roberta (Università del Piemonte Orientale); ASENOV, Patrick (Universita e INFN, Perugia (IT)); BORGHI, Giacomo (Fondazione Bruno Kessler (FBK)); BOSCARDIN, Maurizio (Fondazione Bruno Kessler (FBK)); CARTIGLIA, Nicolo (INFN, Sezione di Torino); CENTIS VIGNALI, Matteo (Fondazione Bruno Kessler (FBK)); CROCI, Tommaso (INFN - National Institute for Nuclear Physics); FERRERO, Marco (Università del Piemonte Orientale); GIOACHIN, Giulia (University of Turin); GIORDANENGO, Simona (Istituto Nazionale di Fisica Nucleare); MANDURRINO, Marco (INFN); MOROZZI, Arianna (INFN, Perugia (IT)); MOSCATELLI, Francesco (IOM-CNR and INFN, Perugia (IT)); PASSERI, Daniele (University & INFN, Perugia (IT)); PATERNOSTER, Giovanni (Fondazione Bruno Kessler (FBK)); SIVIERO, Federico (Università di Torino); TORNAGO, Marta (Università di Torino)

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

Session Classification: Semiconductor Detectors

Track Classification: Semiconductor Detectors

Contribution ID: **153** Type: **Recorded Presentation**

Design of Nupix-A1, a MAPS with timing and energy measurement for heavy-ion physics

The vertex and tracking detectors of the heavy-ion physics experiments at the Heavy Ion Research Facility in Lanzhou (HIRFL) and the High Intensity heavy-ion Accelerator Facility (HIAF) require the development of Monolithic Active Pixel Sensor (MAPS). Hence, the Nupix-A1 has been designed in a 130nm process. It is a MAPS that can measure the particle hit's position, energy, and arrival time. It mainly consists of 128 x 64 pixels with the pitch of 30μm, thirty-two 11-bit column-parallel ADCs, the DAC array with I2C interface, and the data transmission link.

In each pixel, the charge deposited by the particle hit is collected by the charge collection diode and converted into a voltage signal, which goes into the energy and timing paths. The pixels can be tuned and characterized with a configurable DAC array consisting of four 10bit voltage DACs and seven 8bit current DACs. The analog signal from the pixels in four adjacent columns is converted into a digital signal by an 11-bit column-parallel ADC implemented in a novel cyclic structure. Finally, the digitized data is encoded and transmitted by the 5Gbps data transmission link, constituted of a 16b/20b encoder, a 20:1 serializer, and a Feed Forward Equalization (FFE) driver.

The Nupix-A1 is expected to provide a spatial resolution of ~5um, timing accuracy of ~180ps, and equivalent noise charge (ENC) of ~8e-. This paper will discuss the design and performance of this Nupix-A1.

Primary experiment

Heavy Ion Research Facility (HIRFL)

Primary author: YANG, Ping (Central China Normal University)

Co-authors: Dr WANG, Yao; Dr ZHOU, Wei; Dr NIU, Xiaoyang; Prof. WANG, Yongsheng; Ms TIAN, Yuan; Mr WANG, qilin; Prof. ZHAO, Chengxin

Presenter: YANG, Ping (Central China Normal University)

Track Classification: Electronics

Contribution ID: **157** Type: **Live Presentation**

Operating the Resistive Plate Chambers with new eco-friendly gases

Wednesday, February 23, 2022 2:25 PM (20 minutes)

In this presentation we report the performance of the Resistive Plate Chambers (RPC) working with new eco-friendly gases which are intended to replace the traditional standard mixture($C_2H_2F_4/i-C_4H_{10}/SF_6$). The new gaseous components have Global Warming Potential (GWP) and Ozone Depletion Potential (ODP) both at very low or null level. Indeed the $C_2H_2F_4$ (GWP~1430) is replaced by a proper mixture of CO_2 and Tetrafluoropropene ($C_3H_2F_4$, GWP ~ 6) and the SF_6 (GWP ~ 23900) is replaced by a new molecule, the Chloro-Trifluoropropene ($C_3H_2ClF_3$, GWP ~ 5).
We present here, for several tested mixtures: detection efficiency, streamer probability, prompt and ionic charge as a function of the high voltage. Prompt and ionic charges are generated by electrons fast drift and ions slow drift motion respectively.
We also focus the attention on a new category of signals having intermediate properties between avalanche and streamer. This category is negligible for the standard gas mixture but relevant for HFO based gas mixtures.
The timing properties are studied and the detector time resolution is measured.
A direct comparison between SF_6 and $C_3H_2ClF_3$ is performed to study in depth the possibility to replace an industrially very important molecule like SF_6 .

Primary experiment

Primary authors: PROTO, Giorgia (INFN e Universita Roma Tor Vergata (IT)); SANTONICO, Rinaldo (INFN e Universita Roma Tor Vergata (IT)); LIBERTI, Barbara (INFN e Universita Roma Tor Vergata (IT))

Presenter: PROTO, Giorgia (INFN e Universita Roma Tor Vergata (IT))

Session Classification: Gaseous Detectors

Track Classification: Gaseous Detectors

Contribution ID: **159** Type: **Live Presentation**

Characterization of planar and 3D Silicon pixel sensors for the high luminosity phase of the CMS experiment at LHC

Thursday, February 24, 2022 4:50 PM (20 minutes)

The High Luminosity upgrade of the CERN Large Hadron Collider (HL-LHC) calls for an upgrade of the CMS tracking detector to cope with the increased radiation levels while maintaining the excellent performance of the existing detector.
Specifically, new high-radiation tolerant solid-state pixel sensors, capable of surviving irradiation fluencies up to a 2.0×10^{16} n_{eq}/cm^2 at $\approx$ 3 cm from the interaction point, need to be developed. To this extent an R&D program involving different vendors have been launched, aiming at the development of thin n-in-p type pixel sensors.
The R&D covers both planar (Fondazione Bruno Kessler, FBK - Hamamatsu Photonics, HPK - LFoundry) and single-sided 3D columnar (FBK and Centro Nacional de Microeletronica, CNM) pixel devices.
The target active thickness is 150 μm while two different pixel cell dimensions are currently investigated (25 $\times$ 100 and 50 $\times$ 50 μm^2).
Prototypes of hybrid modules have been bump-bonded to the RD53A readout chip (ROC), the first prototype of the ROC that will be employed during HL-LHC operation.
Test beam studies, both of thin planar and 3D devices, have been performed by the CMS collaboration at the CERN, DESY and Fermilab test beam facilities. Results of modules performance before and after irradiation (up to 2.0×10^{16} n_{eq}/cm^2) will be reported.

Primary experiment

CMS

Primary author: ZUOLO, Davide (Universita & INFN, Milano-Bicocca (IT))

Presenter: ZUOLO, Davide (Universita & INFN, Milano-Bicocca (IT))

Session Classification: Semiconductor Detectors

Track Classification: Semiconductor Detectors

Contribution ID: **161** Type: **Live Presentation**

The CMS Outer Tracker sensor production, status and first results

Thursday, February 24, 2022 4:25 PM (20 minutes)

The new demanding environment of High Luminosity LHC, which is expected to reach an integrated luminosity up to 3000-4000 fb^{-1} by the end of its lifetime, sets new challenges for the CMS Tracking System. The full sub-detector needs to be replaced to cope with the increased radiation levels while maintaining the excellent tracking performance of the existing detector. The Phase-2 Upgrade of the CMS Outer Tracker requires the production and installation of 200 m^2 of new and more advanced silicon sensors. After 10 years of R&D studies, the production period of the silicon strip and macro-pixel sensors has begun in 2020. This report aims to provide an overview of the sensor design, the expected performance as defined in the prototyping phase, first results and conclusions regarding the sensor quality and the production stability

Primary experiment

CMS

Primary author: DAMANAKIS, Konstantinos (Austrian Academy of Sciences (AT))

Presenter: DAMANAKIS, Konstantinos (Austrian Academy of Sciences (AT))

Session Classification: Semiconductor Detectors

Track Classification: Semiconductor Detectors

Contribution ID: **162** Type: **Live Presentation**

Vacuum-Compatible Ultra-Thin-Wall Straw Tracker; Detector construction, Thinner straw R&D, and the brand-new graphite-straw development

Wednesday, February 23, 2022 3:15 PM (20 minutes)

The COMET experiment at J-PARC aims to search for a lepton-flavour violating process of muon to electron conversion, with a branching-ratio sensitivity of 10^{-17}, to explore the region predicted by most of theoretical models beyond the Standard Model. The expected signal of this process is mono-energetic 105 MeV single electron. To distinguish such a low energy signal, a material budget of detector is essential since the detection accuracy is primarily limited by multiple scattering.

To realize the required low material detector, a vacuum-compatible ultra-thin-wall straw tracker has been designed, then 20μ-thick Mylar straw with 70nm Al cathode has been developed employing ultrasonic-welding technique. This was reported in VCI2016, and the detector performances such as detection efficiency and intrinsic spacial resolutions were reported in VCI2019. After the previous VCI, a detector construction using this straw was performed. In parallel to this, thinner straw, *i.e.* 12μm-thick straw, has been developed with joint collaboration among KEK, JINR and CERN. During this R&D, it was noticed that the current technology cannot achieve much thinner/smaller tubes than the present one. Then, we launched a brand-new project to realize the **graphite-textile straw** which realizes an extremely low material tracker.

In VCI2022, a brief report on detector construction with 20μm-thick straw, R&D on 12μm-thick straw and a brand-new graphite straw will be provided.

Primary experiment

COMET

Primary author: NISHIGUCHI, Hajime (KEK)

Co-authors: VOLKOV, Alexander (Russian Academy of Sciences (RU)); HAMADA, Eitaro; DANIELSSON, Hans (CERN); Mr SUZUKI, Junichi (KEK); UENO, Kazuki (KEK); Dr WATANABE, Kei (Shinshu university); Mr KAMEI, Naoya (KEK); TSVERAVA, Nikolozi (Georgian Technical University (GE)); Mr OHSAWA, Osamu (Shishu university); MIHARA, Satoshi (KEK); Dr HASHIMOTO, Yoshinori (KEK); TSAMALAIDZE, Zviadi (Georgian Technical University (GE))

Presenter: NISHIGUCHI, Hajime (KEK)

Session Classification: Gaseous Detectors

Track Classification: Gaseous Detectors

Contribution ID: **163** Type: **Live Presentation**

The Belle II Upgrade Program

Wednesday, February 23, 2022 10:35 AM (20 minutes)

The Belle II experiment at the SuperKEKB e+e- collider has started data taking in 2019 with the perspective of collecting 50ab-1 in the course of the next several years. The detector is working well with very good performance, but the first years of running are showing novel challenges and opportunities for reliable and efficient detector operations with machine backgrounds extrapolated to full luminosity. For this reason, and also considering that an accelerator consolidation and upgrade shutdown is being studied for the timeframe of 2026-2027 to reach the target luminosity of 6E35 cm-2s-1, Belle II has started to define a detector upgrade program to make the various sub-detectors more robust and performant even in the presence of high backgrounds, facilitating the SuperKEKB running at high luminosity.
This upgrade program will possibly include the replacement of some readout electronics, the upgrade of some detector elements, and may also involve the substitution of entire detector subsystems such as the vertex detector. The process has started with the submission of Expressions Of Interest that are being reviewed internally and will proceed towards the preparation of a Conceptual Design Report currently planned for 2022. This paper will cover the full range of proposed upgrade ideas and their development plans.

Primary experiment

Belle II

Primary author: FORTI, Francesco (INFN Sezione di Pisa and Universita' di Pisa)

Presenter: FORTI, Francesco (INFN Sezione di Pisa and Universita' di Pisa)

Session Classification: Large Detector Systems

Track Classification: Miscellaneous

Contribution ID: **164** Type: **Recorded Presentation**

Commissioning of the Electron Identification System for Dilepton Measurement in pA Collisions at J-PARC

We will report the performance of the electron identification system in commissioning runs of the J-PARC E16 experiment, which were performed in 2020 and 2021.
The spectrum of vector mesons in nuclear matter is a hot topic in hadron physics. Many theoretical approaches predict the spectral change in hot/dense medium which possibly originate from the chiral symmetry restoration. We will start the physics run of the J-PARC E16 experiment in 2023 to measure the spectral modification of vector mesons using various nuclei for targets. We detect electron-positron pairs from ϕ meson decays, produced in 30 GeV pA reactions. It is a key to separate electrons from huge hadronic backgrounds.
For the electron identification, we developed two-stage detectors comprising hadron blind detectors (HBDs) and lead-glass electromagnetic calorimeters (LGs). The HBD is a gas-type Cherenkov detector with a CF_4 radiator. Emitted Cherenkov photons are converted into electrons at a CsI photocathode, and these electrons are amplified by gas-electron multipliers (GEMs). The LG is able to separate electrons from hadrons based on the quantity of Cherenkov photons induced by electromagnetic showers.
We constructed and installed these detectors at the J-PARC high-momentum beamline and performed the commissioning runs for the spectrometer in 2020 and 2021. The HBDs and the LGs were successfully operated under huge backgrounds, generated in 10-MHz pA interaction at targets.

Primary experiment

J-PARC E16

Primary author: NAKASUGA, Satomi (Kyoto University/JAEA/RIKEN)

Presenter: NAKASUGA, Satomi (Kyoto University/JAEA/RIKEN)

Track Classification: Gaseous Detectors

Contribution ID: **166** Type: **Live Presentation**

The MIMOSIS pixel sensor for the CBM Micro-Vertex Detector and beyond.

Thursday, February 24, 2022 10:15 AM (20 minutes)

The Micro-Vertex Detector of the CBM experiment at FAIR will be equipped with the full custom CMOS Pixel Sensor called MIMOSIS designed at IPHC, which is also developed for the EU project CREMLINplus and serves as a forerunner for future high precision tracking devices.
Several prototypes and building blocks are developed and tested by IPHC-IKF-GSI collaboration in order to fulfill the requirements such as spatial resolution of ~5 μm, radiation tolerance to $7\times10^{13} n_{eq}/cm^2$ (1MeV) and 5 Mrad, continuous read-out with 5 μs time stamp and 70 MHz/cm^2 peak counting rate.
In the first full scale prototype (MIMOSIS-1) the digital logic reduces the data flow from up to 20 Gbits/s to 2.56 Gbits/s at the sensor output by aggregating the data.
Front-end circuit was inspired by ALPIDE (CERN) chip, major difference is an introduction of AC coupled diode variant, allowing for increasing bias voltage and improving the radiation tolerance. However, input capacitance also increases, the trade-off between AC and DC coupling will be discussed.
The results of laboratory tests and beam measurements of MIMOSIS-1, showing the resolution, the charge collection efficiency and the detection efficiency will be presented for different variants of pixels.
The performances before and after irradiation will be assessed in order to validate the final sensor prototype (MIMOSIS-2) which is planned to be submitted in 2021/2022.

Primary experiment

CBM experiment at FAIR

Primary authors: HIMMI, Abdelkader (Centre National de la Recherche Scientifique (FR)); DOROKHOV, Andrei (Centre National de la Recherche Scientifique (FR)); BESSON, Auguste Guillaume (Centre National de la Recherche Scientifique (FR)); ARNOLDI-MEADOWS, Benedict (IKF); MUNTZ, Christian Peter (Goethe University Frankfurt (DE)); GUO HU, Christine (Centre National de la Recherche Scientifique (FR)); COLLEDANI, Claude Pierre (Centre National de la Recherche Scientifique (FR)); MOREL, Frederic (Centre National de la Recherche Scientifique (FR)); CLAUS, Gilles Lucien (Centre National de la Recherche Scientifique (FR)); BERTOLONE, Grégory (IPHC/IN2P3/CNRS/UDS); DOZIERE, Guy (IPHC); DARWISH, Hasan (IKF); VALIN, Isabelle (IPHC); MICHEL, Jan (Goethe University Frankfurt (DE)); BAUDOT, Jerome (IPHC - Strasbourg); STROTH, Joachim (Goethe University Frankfurt (DE)); JAASKELAINEN, Kimmo (Centre National de la Recherche Scientifique); WINTER, Marc (Centre National de la Recherche Scientifique (FR)); GOFFE, Mathieu (Centre National de la Recherche Scientifique (FR)); SPECHT, Matthieu (IPHC); DEVEAUX, Michael (GSI - Helmholtzzentrum fur Schwerionenforschung GmbH (DE)); KOZIEL, Michal (Goethe University Frankfurt (DE)); KLAUS, Philipp (Johann-Wolfgang-Goethe Univ. (DE)); BUGIEL, Roma (IPHC); PHAM, Thanh Hung (Centre National de la Recherche Scientifique (FR)); ZHAO, Yue (IPHC); EL BITAR, Ziad (Centre National de la Recherche Scientifique (FR))

Presenter: DOROKHOV, Andrei (Centre National de la Recherche Scientifique (FR))

Session Classification: Semiconductor Detectors

Track Classification: Semiconductor Detectors

Contribution ID: **168** Type: **Recorded Presentation**

MALTA3: concepts for a new radiation tolerant sensor in the TowerJazz 180nm technology

The upgrade of the MALTA DMAPS designed in TowerJazz 180 nm Imaging process will implement the numerous modifications, as well as front-end changes in order to boost the charge collection efficiency after the targeted fluence of 1x10^{15} MeV n_{eq}/cm^2. The effectiveness of these changes have been demonstrated in recent measurements with a small-scale mini-MALTA demonstrator chip. Proposed changes in the periphery of the future MALTA3 sensor are listed and discussed including research of the overall sensor architecture.

Primary experiment

ATLAS

Primary author: Mr DOBRIJEVIC, Dominik (University of Zagreb (HR))

Co-author: SOLANS SANCHEZ, Carlos (CERN)

Presenter: Mr DOBRIJEVIC, Dominik (University of Zagreb (HR))

Track Classification: Electronics

Contribution ID: **171** Type: **Live Presentation**

Development and characterization of a DMAPS chip in TowerJazz 180 nm technology for high radiation environments and its use case for the Belle II vertex detector upgrade

Thursday, February 24, 2022 12:15 PM (20 minutes)

The increasing availability of commercial CMOS processes with high-resistivity wafers has fueled the R&D of depleted monolithic active pixel sensors (DMAPS) for usage in high energy physics experiments. One of these developments is a series of monolithic pixel detectors with column-drain readout architecture and small collection electrode allowing for low-power designs (TJ-Monopix). It is designed in a 180 nm TowerJazz CMOS process and features a pixel size of 33 µm x 33 µm. The efforts and improvements on the front-end electronics and sensor design of the current iteration TJ-Monopix2 increase the radiation hardness and efficiency while lowering the threshold and noise.
Results from laboratory measurements and test beam campaigns will be highlighted and discussed to evaluate its usage in high-radiation environments.

With its specifications and expected performance, TJ-Monopix2 will serve as a prototype chip for a future DMAPS chip (OBELIX) that will be investigated within the framework of the VTX collaboration for the upgrade of the Belle II detector at SuperKEKB.

Primary experiment

Primary author: BESPIN, Christian (University of Bonn (DE))

Co-authors: BERDALOVIC, Ivan; CAICEDO SIERRA, Ivan Dario (University of Bonn (DE)); DINGFELDER, Jochen Christian (University of Bonn (DE)); HEMPEREK, Tomasz (University of Bonn (DE)); HIRONO, Toko (University of Bonn); HUEGGING, Fabian (University of Bonn); KRÜGER, Hans (University of Bonn); KUGATHASAN, Thanushan (CERN); MARIN TOBON, Cesar Augusto (University of the Witwatersrand (ZA)); MOUSTAKAS, Konstantinos (PSI - Paul Scherrer Institut); PERNEGGER, Heinz (CERN); SNOEYS, Walter (CERN); WANG, Tianyang (University of Bonn (DE)); WERMES, Norbert (University of Bonn (DE))

Presenter: BESPIN, Christian (University of Bonn (DE))

Session Classification: Semiconductor Detectors

Track Classification: Semiconductor Detectors

Contribution ID: **175** Type: **Live Presentation**

The Upgraded ALICE TPC

Tuesday, February 22, 2022 3:15 PM (20 minutes)

During the long shutdown 2 of the LHC, the ALICE Time Projection Chamber (TPC) was upgraded in order to cope with the increased Pb-Pb interaction rate of 50 kHz planned for Run 3. The MWPC-based amplification system was replaced by Gas Electron Multipliers (GEM). These avoid the long dead time caused by the ion gating grid of the MWPC, and hence allow for a continuous readout. At the same time, also the front-end and readout electronics was replaced.

In August 2020, the TPC was moved back to its position at LHC interaction point 2 and an extensive commissioning program was started. It includes measurements of laser tracks, cosmic particles, the irradiation of the TPC with an X-ray source and the flushing of the chamber with radioactive Kr to carry out a pad-by-pad gain calibration. During this measurement campaign, the TPC operated at nominal conditions and the continuous readout capability was tested successfully.

The talk will summarise the performance and challenges during the commissioning phase. Furthermore, the first results of the operation with p-p collisions and plans for the future will be discussed.

Primary experiment

ALICE

Primary author: Mr HAUER, Philip (University of Bonn)

Presenter: HAUER, Philip (University of Bonn (DE))

Session Classification: Large Detector Systems

Track Classification: Gaseous Detectors

Contribution ID: **176** Type: **Live Presentation**

Scintillating sampling ECAL technology for the Upgrade II of LHCb

Wednesday, February 23, 2022 11:25 AM (20 minutes)

The aim of the LHCb Upgrade II is to operate at a luminosity in the range of 1 to 2 x 10^{34} cm^{-2} s^{-1} to collect a data set of 300 fb^{-1}. This will require a substantial modification of the current LHCb ECAL due to high radiation doses in the central region and increased particle densities. The ECAL has to provide good energy and position resolutions in these conditions. Timing capabilities with tens of picoseconds precision for neutral electromagnetic particles and increased granularity with denser absorber in the central region are needed for pile-up mitigation.
Several scintillating sampling ECAL technologies are currently being investigated for this purpose: Spaghetti Calorimeter (SpaCal) with garnet scintillating crystals and tungsten absorber, SpaCal with scintillating plastic fibres and tungsten or lead absorber, and Shashlik with polystyrene tiles, lead absorber and fast WLS fibres. Results from an ongoing R&D campaign to optimise the Upgrade II ECAL are shown. This includes studies of radiation-hard scintillation materials, performance optimisation using detailed simulations and test beam measurements. The presentation also includes an overview of the overall plans for the Upgrade II of the LHCb ECAL.

Primary experiment

LHCb

Primary authors: PIZZICHEMI, Marco (Universita Milano-Bicocca (IT) and CERN); ROLOFF, Philipp (CERN)

Presenter: PIZZICHEMI, Marco (Universita Milano-Bicocca (IT) and CERN)

Session Classification: Large Detector Systems

Track Classification: Calorimeters

Contribution ID: **177** Type: **Live Presentation**

The Mu2e Experiment - Searching for Charged Lepton Flavor Violation

Tuesday, February 22, 2022 2:00 PM (20 minutes)

The Mu2e experiment will search for a Standard Model violating rate of neutrinoless conversion of a muon into an electron in the presence of an aluminum nucleus. Observation of this charged-lepton flavor-violating process would be an unambiguous sign of new physics. Mu2e aims to improve upon previous searches by four orders of magnitude. This requires the world's highest-intensity muon beam, a detector system capable of efficiently reconstructing the 105 MeV/c conversion electrons, and minimizing sensitivity to background events. A pulsed 8 GeV proton beam strikes a target, producing pions that decay into muons. Beam outside the pulse must be suppressed to $< 10^{-10}$ to reduce beam-related backgrounds. The muon beam is guided from the production target along the transport system and onto the aluminum stopping target. Conversion electrons leave the stopping target and propagate to the tracker and electromagnetic calorimeter. The tracker is a system of straw tube panels filled with Ar/CO2 at 1 atm that tracks particles inside of a solenoidal B-field and measures their momenta with ~100 keV/c resolution to resolve signal events from decay-in-orbit backgrounds. The CsI calorimeter provides E/p and is used to seed the track reconstruction algorithm with $\sigma_E/E \sim 10\%$ and $\sigma_t < 500$ ps. Additionally, a novel cosmic ray veto with greater than 99.99% efficiency brings the expected number of background events to fewer than one over three years of running.

Primary experiment

Mu2e

Primary author: HEDGES, Michael

Presenter: HEDGES, Michael

Session Classification: Large Detector Systems

Track Classification: Miscellaneous

Contribution ID: **179** Type: **Live Presentation**

Development and testing of a radiation-hard large electrode DMAPS design in a 150 nm CMOS process.

Thursday, February 24, 2022 11:25 AM (20 minutes)

Monolithic CMOS active pixel sensors in depleted substrates (DMAPS) are an attractive development for pixel tracker systems in high-rate collider experiments. The radiation tolerance of these devices is enhanced through technology add-ons and careful design, which allow them to be biased with large voltages and collect charge through drift in highly resistive silicon bulks. In addition, the use of commercial CMOS technology would reduce the current production complexity and costs of large module areas.

The LF-Monopix chips are two fully functional large-scale DMAPS prototypes with a column drain readout architecture. They were designed in a 150 nm CMOS process that made it possible to place and isolate each pixel's front-end circuitry within a charge collection electrode of a size comparable to the pixel area.

This contribution will give an overview of the chips' design, sensor and front-end performance with a focus on radiation hardness. Measurements on neutron irradiated samples showed an in-time detection efficiency of $\sim$ 97% after a NIEL dose of $1 \times 10^{15} n_{eq}/cm^2$. Moreover, the gain did not degrade and noise only increased by 25% after a X-ray Total Ionizing Dose of 100 Mrad. The characterization of the latest prototype has also shown a positive outcome from the effort to implement a matrix with a column length of 2 centimeters and a reduced pixel pitch of 150×50 um^2.

Primary experiment

Primary author: CAICEDO SIERRA, Ivan Dario (University of Bonn (DE))

Co-authors: BARBERO, Marlon B. (CPPM, Aix-Marseille Université, CNRS/IN2P3 (FR)); BARRILLON, Pierre (Aix Marseille Univ, CNRS/IN2P3, CPPM, Marseille, France); BESPIN, Christian (University of Bonn (DE)); BREUGNON, Patrick (Centre National de la Recherche Scientifique (FR)); CHABRILLAT, Paul Mickael (Centre National de la Recherche Scientifique (FR)); DEGERLI, Yavuz (CEA - Centre d'Etudes de Saclay (FR)); DESTAING, Nicolas (Centre National de la Recherche Scientifique (FR)); DINGFELDER, Jochen Christian (University of Bonn (DE)); GUILLOUX, Fabrice (CEA/IRFU,Centre d'etude de Saclay Gif-sur-Yvette (FR)); Mr HABIB, Amr (Aix Marseille University, CNRS/IN2P3, CPPM.); HEMPEREK, Tomasz (University of Bonn (DE)); HIRONO, Toko (University of Bonn (DE)); HUEGGING, Fabian (University of Bonn (DE)); KRUEGER, Hans (University of Bonn); PANGAUD, Patrick (Aix Marseille Univ, CNRS/IN2P3, CPPM, Marseille, France); ROZANOV, Alexandre (CPPM, Aix-Marseille Université, CNRS/IN2P3 (FR)); RYMASZEWSKI, Piotr (University of Bonn (DE)); SCHWEMLING, Philippe (CEA/IRFU,Centre d'etude de Saclay Gif-sur-Yvette (FR)); WANG, Tianyang (University of Bonn (DE)); WERMES, Norbert (University of Bonn (DE))

Presenter: CAICEDO SIERRA, Ivan Dario (University of Bonn (DE))

Session Classification: Semiconductor Detectors

Track Classification: Semiconductor Detectors

Contribution ID: **181** Type: **Recorded Presentation**

In-depth characterisation of diamond sensors for dosimetry in beam-loss monitoring

Thanks to their unique properties, artificially-grown diamond crystals are suitable as solid-state particle detectors and dosimeters in high-radiation environments. We developed and installed a system based on single-crystal artificial-diamond detectors to monitor the beam losses near the interaction region of the SuperKEKB collider for the the Belle II experiment.
We carried out several tests using and radiations to asses the crystal quality and response of the devices. We devised a novel current-to-dose-rate calibration method using radiation, which employs a silicon diode as a reference to greatly reduce uncertainties associated with the source activity and with the setup simulation. The calibration has been validated by measuring the calibration factors with X and γ radiation, spanning a dose rate range from tens of nrad/s to some rad/s.
We report on these results (published in Nucl. Instum. Method A 1004 (2021) 165383) and a new set of tests and calibrations for 10 additional devices to be installed at SuperKEKB in 2022. The new results feature several refinements of the measurement and of their interpretation and will include the first irradiation of the devices with 1-GeV electrons from the linac of the FERMI@Elettra FEL in Trieste (Italy).

Primary experiment

Belle II

Primary author: GABRIELLI, Alice (INFN - National Institute for Nuclear Physics)

Co-authors: DORIGO, Mirco (INFN Trieste); BOSISIO, Luciano (Universita e INFN, Trieste (IT)); VITALE, Lorenzo (Universita e INFN Trieste (IT)); LANCERI, Livio (University of Trieste and INFN)

Presenter: GABRIELLI, Alice (INFN - National Institute for Nuclear Physics)

Track Classification: Semiconductor Detectors

Contribution ID: **182** Type: **Recorded Presentation**

Moderation of the avalanche gas discharge through a quasi-uniform electric field device: the Resistive Cylindrical Chamber

The saturated avalanche discharge regime led to an increase in term of detection rate capability, allowing RPC to be used in experiments on particle accelerators. Future experiments require even more extreme performance from particle detectors, in term of rate capability and time resolution, so that the saturated avalanche discharge is a limiting factor for the RPCs application.

In this presentation we introduce a new device, which allows the moderation of the avalanche discharge growth thanks to a quasi-uniform geometry of the electric field. This device, which we refer to as the Resistive Cylindrical Chamber(RCC), consists of two concentric cylinderical electrodes, of which at least one is made of resistive material. It is possible to design the device passing from radial to quasi-uniform electric field by modifying the radii of the cylinders, reproducing in the extreme case the same features as an RPC. We show the characterization of the first RCC detector performed with 165 GeV/c muons. The device has been designed to have a non-negligible variation of the electric field within the gas-gap in order to emphasize and study the asymmetrical response of the detector when polarized with positive or negative bias voltage. We analyze the device time response and charge distributions, highlighting how the moderation of the avalanche discharge and the cylindrical geometry may lead to innovative applications, allowing the detector pressurization with eco-friendly gas mixtures.

Primary experiment

Primary authors: ROCCHI, Alessandro (INFN e Universita Roma Tor Vergata (IT)); CARDARELLI, Roberto (INFN e Universita Roma Tor Vergata (IT))

Co-authors: AIELLI, Giulio (INFN e Universita Roma Tor Vergata (IT)); CAMARRI, Paolo (University of Roma "Tor Vergata"); DI CIACCIO, Anna (INFN e Universita Roma Tor Vergata (IT)); DI STANTE, Luigi (INFN e Universita Roma Tor Vergata (IT)); LIBERTI, Barbara (INFN e Universita Roma Tor Vergata (IT)); PASTORI, Enrico (INFN Univ. di Roma II); PIZZIMENTO, Luca (INFN e Universita Roma Tor Vergata (IT)); PROTO, Giorgia (INFN e Universita Roma Tor Vergata (IT))

Presenter: ROCCHI, Alessandro (INFN e Universita Roma Tor Vergata (IT))

Track Classification: Gaseous Detectors

Contribution ID: **183** Type: **Live Presentation**

ALICE ITS3 - a bent, wafer-scale CMOS detector

Tuesday, February 22, 2022 5:15 PM (20 minutes)

ALICE is developing the ITS3 (inner tracker system) as upgrade of the inner layers of the presently installed ITS with the aim to improve the pointing resolution by factor of two and to lower the material budget to an unprecedented value of 0.05% X0 per layer.

Its three layers are based on Monolithic Active Pixel Sensors (MAPS) thinned down to 20-40 µm. The configuration employs half-cylinders, which are bent around the beam pipe with bending radii of 18, 24 and 30 mm, respectively. The sensors are produced using stitching techniques allowing to reach a length of 28 cm. As consequence, the detector consists of six MAPS sensors only. The material budget is kept to a minimum using carbon foam elements to hold the stitched sensors in place, as well as by employing airflow cooling.

The ITS3 R&D has already passed important milestones of proving that bent MAPS are a viable technology option, and that thin wafer-scale silicon can be reliably integrated into true half-cylinders of target radii. A full scale mechanical integration prototype has already been produced. First prototype ASICs in 65 nm target technology are under test and are showing excellent in-beam performances.

This contribution summarises the achieved R&D results on bending and thinning, the mechanical prototype, beam tests and the 65 nm prototype ASIC test, as well as the path towards the last remaining milestone: the implementation of a wafer-scale, stitched sensor design.

Primary experiment

ALICE

Primary authors: MAGER, Magnus (CERN); KLUGE, Alex (CERN)

Presenter: KLUGE, Alex (CERN)

Session Classification: Large Detector Systems

Track Classification: Semiconductor Detectors

Contribution ID: **184** Type: **Live Presentation**

Refurbishment of the CMS Pixel Detector during LS2 and projected lifetime in Run 3

Tuesday, February 22, 2022 2:50 PM (20 minutes)

An upgraded silicon pixel detector, called the phase-1 pixel detector, was constructed for the higher instantaneous luminosity and total radiation fluence experienced during the Run 2 period of the Large Hardon Collider (LHC) and was installed in the Compact Muon Solenoid (CMS) in 2017. The upgraded detector is comprised of four barrel layers and three end-cap disks, with modules in the innermost layer positioned at a smaller radius compared to its predecessor. In order to cope with the higher particle rate and to extend the overall lifetime of the the detector until the end of Run 3, a replacement of the innermost layer was scheduled to be performed during the second long shutdown period (LS2) of the LHC, between 2019 and 2021. This planned operation enabled to make improvements in the readout chips and front-end ASICs of the innermost layer, to update the powering system in order to stabilize its operation, to solidify the cooling distribution system and to review the high-voltage power distribution scheme, all based on operational experience gathered during Run 2. The presentation will describe the outcome of the successful refurbishment process during LS2, give details on the commissioning and future operation of the detector, and show projections for the expected performance in Run 3.

Primary experiment

CMS Experiment at CERN

Primary author: MODAK, Atanu (Kansas State University (US))

Presenter: MODAK, Atanu (Kansas State University (US))

Session Classification: Large Detector Systems

Track Classification: Semiconductor Detectors

Contribution ID: **185** Type: **Live Presentation**

Precise timing measurements with a 10x10 cm2 tileable PICOSEC Micromegas detector module

Friday, February 25, 2022 2:25 PM (20 minutes)

The PICOSEC Micromegas (MM) precise timing detectors offer precise timing on the order of tens of ps by coupling a Cherenkov radiator with a photocathode and a MM amplification structure. Time resolution below 25 ps for MIPs was demonstrated with single-channel prototypes. Recent developments towards instrumenting larger detection areas with precise timing PICOSEC detectors include multi-channel tileable detector modules, resistive MM, alternative photocathode materials, and custom readout electronics.
Timing performance for signals shared across multiple pads was confirmed to be comparable to single-channel results in a previous multi-pad prototype with corrections for non-uniformity of the preamplification gap. A fully tileable 100-ch, 100 cm^2 detector prototype based on the rigid ceramics/FR4 substrate was commissioned. Test beam campaigns showed improvement of the timing response uniformity reaching 26 ps pad level time resolution.
Different readout options including custom preamplifiers and fast charge-sensitive preamplifiers together with digitisation with SAMPIC were investigated to enable readout of 100-ch modules.
The scalability to large detection areas, excellent timing resolution, and flexibility in readout granularity which can enable spatial resolution make PICOSEC Micromegas detectors an attractive technology for precise timing detector systems as well as fast photon detectors.

Primary experiment

RD51 PICOSEC MicroMegas Collaboration

Primary author: UTROBICIC, Antonija (CERN)

Co-authors: AUNE, Stephan (Université Paris-Saclay (FR)); GIOMATARIS, Ioanis (Université Paris-Saclay (FR)); BORTFELDT, Jona (Ludwig Maximilians Universitat (DE)); BRUNBAUER, Florian Maximilian (CERN); FANOURAKIS, Georgios (Nat. Cent. for Sci. Res. Demokritos (GR)); GALLINARO, Michele (LIP Lisbon); GARCIA FUENTES, Francisco Ignacio (Helsinki Institute of Physics (FI)); IGUAZ GUTIERREZ, Francisco Jose (IRFU/CEA-Saclay); KORDAS, Kostas (Aristotle University of Thessaloniki (GR)); LAMPOUDIS, Christos (Aristotle University of Thessaloniki (GR)); LEGOU, Philippe (CEA Saclay DRF/IRFU); LISOWSKA, Marta (Ecole Normale Supérieure Paris-Saclay (FR)); LIU, Jianbei (University of Science and Technology of China (CN)); LUPBERGER, Michael (University of Bonn); MANIATIS, Ioannis Michail (Aristotle University of Thessaloniki (GR)); MULLER, Hans (University of Bonn (DE)); OLIVERI, Eraldo (CERN); PAPAEVANGELOU, Thomas (Irfu, CEA, Université Paris-Saclay); PARASCHOU, Konstantinos (Aristotle University of Thessaloniki (GR)); QI, Binbin (University of science and technology of China); RESNATI, Filippo (CERN); ROPELEWSKI, Leszek (CERN); JANSSENS, Djunes (Vrije Universiteit Brussel (BE)); SAMPSONIDIS, Dimos (Aristotle University of Thessaloniki (GR)); SCHARENBERG, Lucian (CERN, University of Bonn (DE)); SCHNEIDER, Thomas (CERN); SOHL, Lukas (DESY); VAN STENIS, Miranda (CERN); TSIAMIS, Angelos (Aristotle University of Thessaloniki (GR)); TSIPOLITIS, Yorgos (National Technical Univ. of Athens (GR)); TZAMARIAS, Spyros (Aristotle University of Thessaloniki (GR)); VEENHOF, Rob (Uludag University (TR)); WANG, Xu (University of Science and Technology of China (CN)); WHITE, Sebastian (University of Virginia (US)); ZHANG, Zhiyong (University of Science and Technology of China (CN)); ZHOU, Yi (University of Science and Technology of China (CN)); GUSTAVSSON, Thomas (CEA/Saclay); KEBBIRI, Mariam (CEA Saclay); POMORSKI, Michal (CEA-Saclay); DESFORGE, Daniel (CEA Saclay); OLIVIER, Maillard (CEA-Saclay)

Presenter: UTROBICIC, Antonija (CERN)

Session Classification: Gas and Cherenkov Timing

Track Classification: Gaseous Detectors

Contribution ID: **187** Type: **Live Presentation**

The LHCb VELO Upgrade I

Tuesday, February 22, 2022 4:25 PM (20 minutes)

LHCb physics achievements to date include the world's most precise measurements of the CKM phase γ and the rare decay $B_s^0 \to \mu^+\mu^-$, the discovery of CP violation in charm, and intriguing hints of lepton-university violation. These accomplishments have been possible thanks to the enormous data samples collected and the high performance of the sub detectors, in particular the silicon vertex detector (VELO). The experiment is being upgraded to run at higher luminosity, which requires 40 MHz readout for the entire detector and newer technologies for most of the sub detectors.

The VELO upgrade modules are composed of hybrid pixel detectors and electronics circuits mounted onto a cooling substrate, which is composed of thin silicon plates with embedded micro-channels that allow the circulation of liquid CO_2. This cooling substrate gives excellent thermal efficiency, no mismatch to the front-end electronics, and optimises physics performance due to the low and very uniform material distribution. The detectors are located in vacuum, separated from the beam by a thin Al foil. The foil was manufactured through a novel milling process and thinned further by chemical etching. The VELO modules are currently beeing assembled into the two halves before final installation into LHCb. The design, production, installation and commissioning of the VELO upgrade system will be presented together with test results.

Primary experiment

LHCb

Primary author: COLLINS, Paula (CERN)

Presenter: COLLINS, Paula (CERN)

Session Classification: Large Detector Systems

Track Classification: Semiconductor Detectors

Contribution ID: **190** Type: **Recorded Presentation**

High-precision luminosity instrumentation for the CMS detector at the HL-LHC

The HL-LHC will reach an instantaneous luminosity a factor of five to seven times the nominal LHC design value. The resulting, unprecedented requirements create the need for new high-precision instrumentation at CMS for bunch-by-bunch luminosity and beam-induced background measurements based on various radiation-hard detector technologies.
The CMS Tracker Endcap Pixel Detector (TEPX) will be adapted for precision luminometry by implementing dedicated triggering and readout systems, including a real-time clustering algorithm on an FPGA. The innermost ring of the TEPX last layer (D4R1) will be operated independently from the rest of TEPX enabling beam monitoring during the LHC ramp and during unqualified beam conditions with a dedicated timing and trigger infrastructure.
A key component of the Phase-2 luminosity instrumentation is a stand-alone luminometer, the Fast Beam Condition Monitor (FBCM), which is fully independent from the central trigger and data acquisition services and able to operate during all times with an asynchronous readout. FBCM is foreseen to utilize silicon-pad sensors with a few ns timing resolution enabling also the measurement of beam induced background.
The potential of the exploitation of other CMS subsystems, the outer tracker, the hadron forward calorimeter, the barrel muon detectors and the 40 MHz L1 trigger scouting system using a common histogramming firmware module integrated in the corresponding back-end systems is also discussed.

Primary experiment

CMS

Primary authors: PASZTOR, Gabriella (Eötvös University, Budapest); AUZINGER, Georg (CERN)

Presenters: PASZTOR, Gabriella (Eötvös University, Budapest); AUZINGER, Georg (CERN)

Track Classification: Semiconductor Detectors

Contribution ID: **192** Type: **Recorded Presentation**

Garfield++: status and plans

In-depth simulations of the signal formation process are key tools for understanding and optimising the performance of modern particle detectors. This talk discusses recent developments in Garfield++, which is an open-source toolkit for the detailed simulation of detectors that are based on ionisation measurement in gases or semiconductors.
Emphasizing recent work, we briefly review the methods for simulating primary ionisation (focusing on the accurate modeling of primary and delta electrons), for computing electric and weighting fields, for simulating charge transport, and for calculating induced signals (including the modeling of electronic noise and techniques for systems with resistive
elements), and outline plans for further improvements.
In addition to applications in the field of (micropattern) gas detectors, in which Garfield(++) simulations have a strong tradition, we also discuss examples of silicon sensors, without and with internal multiplication (both at finite gain and in breakdown mode).

Primary experiment

Primary author: SCHINDLER, Heinrich (CERN)

Presenter: SCHINDLER, Heinrich (CERN)

Track Classification: Miscellaneous

Contribution ID: **193** Type: **Recorded Presentation**

Investigation of signal characteristics and charge sharing in AC-LGADs with laser and test beam measurements

AC-LGADs, also referred to as resistive silicon detectors, are a recent development of low-gain avalanche detectors (LGADs), based on a sensor design where the multiplication layer and n+ contact are continuous, and only the metal layer is patterned. This simplifies sensor fabrication and reduces the dead area on the detector, improving the hit efficiency while retaining the excellent fast timing capabilities of LGAD technology. In AC-LGADs, the signal is capacitively coupled from the continuous, resistive n+ layer over a dielectric to the metal electrodes. Therefore, the spatial resolution is not only influenced by the electrode pitch, but also the relative size of the metal electrodes. Signal propagation between the metallized areas and charge sharing between electrodes plays a larger role in these detectors than in conventional silicon sensors read out in DC mode.
AC-LGADs from various manufacturers were studied with capacitance-voltage measurements, infrared laser scans and in beam tests. Methods to distinguish between (desired) signal charge sharing, cross-talk and pick-up from other channels, as well as electronic and signal-related noise, are presented. Furthermore, the impact of metal electrode size and pitch, n+ layer resistivity, and applied bias voltage on the detector response and signal characteristics is shown.

Primary experiment

Primary authors: SEIDEN, Abraham (University of California,Santa Cruz (US)); Dr OTT, Jennifer (University of California,Santa Cruz (US)); SCHUMM, Bruce Andrew (University of California,Santa Cruz (US)); RYAN, Eric (University of California, Santa Cruz); SADROZINSKI, Hartmut (University of California,Santa Cruz (US)); WONG, Marcus Clark (University of California,Santa Cruz (US)); MAZZA, Simone Michele (University of California,Santa Cruz (US))

Presenter: Dr OTT, Jennifer (University of California,Santa Cruz (US))

Track Classification: Semiconductor Detectors

Contribution ID: **194** Type: **Recorded Presentation**

DC-coupled resistive silicon detectors for 4-D tracking

In this work, we introduce a new design concept: the DC-Coupled Resistive Silicon Detectors, based on the LGAD technology. This new approach intends to address a few known features of the first generation of AC-Coupled Resistive Silicon Detectors (RSD). Our simulation exploits a fast hybrid approach based on a combination of two packages, Weightfield2 and LTSpice. It demonstrates that the key features of the RSD design are maintained, yielding excellent timing and spatial resolutions: a few tens of ps and a few microns. In the presentation, we will outline the optimization methodology and the results of the simulation. We will present detailed studies on the effect of changing the ratio between the n+ resistivity and the low-resistivity ring, on the effect of noise, and on the achievable temporal and spatial resolution.

Primary experiment

Primary authors: MARTINEZ ROJAS, Alejandro David (INFN, Sezione di Torino); MENZIO, Luca (Universita e INFN Torino (IT)); SIVIERO, Federico (Universita e INFN Torino (IT)); FICORELLA, Francesco (Fondazione Bruno Kessler (FBK)); DALLA BETTA, Gian-Franco (Università di Trento); PATERNOSTER, Giovanni (Fondazione Bruno Kessler (FBK)); PANCHERI, Lucio (Università di Trento); FERRERO, Marco (Università del Piemonte Orientale); MANDURRINO, Marco (Universita e INFN Torino (IT)); TORNAGO, Marta (Universita e INFN Torino (IT)); BOSCARDIN, Maurizio (Fondazione Bruno Kessler (FBK)); CARTIGLIA, Nicolo (INFN, Sezione di Torino); ARCIDIACONO, Roberta (Universita e INFN Torino (IT)); SOLA, Valentina (Universita e INFN Torino (IT))

Presenter: MENZIO, Luca (Universita e INFN Torino (IT))

Track Classification: Semiconductor Detectors

Contribution ID: **196** Type: **Recorded Presentation**

Industrialization of Resistive Plate Chamber Production

Resistive plate chambers (RPCs) with electrodes of high-pressure phenolic laminate (HPL) and small gas gap widths down to 1 mm provide large area tracking at relatively low cost in combination with high rate capability and fast response with excellent time resolution of better than 500 ps. These chambers are perfectly suited for experiments requiring sub-nanosecond time resolution and spatial resolution on the order of a few millimeters over large areas. Thin-gap RPCs will therefore be used for the upgrade of the barrel muon system of the ATLAS experiment at HL-LHC and are candidates for the instrumentation of future collider detectors and for experiments searching for long-lived particles in experiments. RPCs are also frequently used in large area cosmic ray detectors. The large demand for RPCs exceeds the presently available production capacities. At the same time, the requirements on mechanical precision, reliability and reproducibility for collider detectors have increased. Additional suppliers with industry-style quality assurance are urgently needed. We have established RPC production procedures compliant with industrial requirements and are in the process of certifying several companies for RPC production for the ATLAS upgrade for HL-LHC and beyond. We will report about the technology transfer, the RPC prototype production at the selected companies and the results of the certification procedure.

Primary experiment

Primary authors: SOYK, Daniel (Max Planck Society (DE)); KROHA, Hubert (Max Planck Society (DE)); KORTNER, Oliver (Max Planck Society (DE))

Presenter: KORTNER, Oliver (Max Planck Society (DE))

Track Classification: Gaseous Detectors

Contribution ID: **199** Type: **Recorded Presentation**

ASTRA, a novel range telescope concept for proton CT

Proton beam therapy has great potential to improve the treatment of cancers whilst reducing toxicity for oncology patients. However, this technique cannot exploit yet all of its potential due uncertainties in the dose deposition caused by indirect measurements of the stopping power of the materials within a patient. The aim of this work is to present a proof of concept that new technologies developed for High Energy Physics (HEP) experiments can improve the currently explored techniques to achieve proton Computed Tomography (pCT) which measures the Relative Stopping Power (RSP) directly. Existing devices are unable to perform a high quality measurement of the RSP under realistic clinical conditions. The work presented here is based on simulations with the Geant4 toolkit and the technologies used for this project are: A set of four silicon detectors based on the Depleted Monolithic Active Pixel Sensors (DMAPS) developed for the inner tracker upgrades at the High Luminosity Large Hadron Collider (HL-LHC), and a plastic scintillator Range Telescope (RT) based on the technology designed for the Super Fine-Grained Detector (SFGD) at the Tokay to Kamioka (T2K) experiment in Japan. Simulations show that the system is able to provide multi proton tracking at, at least , a 40MHz sampling rate (limited by the current DMAPS specifications) achieving a sub 1% energy resolution and RSP of six different materials.

Primary experiment

Primary author: GRANADO, Marc (University of Birmingham)

Co-authors: Dr GONELLA, Laura (University of Birmingham (UK)); LUX, Thorsten (Universidad Autonoma de Barcelona); PRICE, Tony (University of Birmingham (GB)); PERNEGGER, Heinz (CERN); HEMPEREK, Tomasz (University of Bonn (DE)); JESUS VALLS, Cesar (IFAE-BIST)

Presenter: GRANADO, Marc (University of Birmingham)

Track Classification: Medical Applications

Contribution ID: **200** Type: **Recorded Presentation**

High-Precision Large-Area Tracking and Triggering with Drift-Tube Chambers at Future Colliders

Experiments like the ATLAS detector at the HL-LHC or detectors at future hadron colliders need muon detectors with excellent momentum resolution at the percent level up to the TeV scale both at the trigger and the offline reconstruction level. This requires muon tracking chambers with high spatial resolution even at the highest background fluxes. Drift-tube chambers are the most cost effective technology for the instrumentation of large-area muon systems providing the required high rate capability and three-dimensional spatial resolution. Thanks to the advances in analog and digital electronics, modern drift-tube chambers can be used in stand-alone mode up to the highest background rates providing event times and second coordinates without the necessity of additonal trigger chambers. New key developments in the integrated front-end electronics are active baseline restoration of the shaped signal and picosecond time-to-digital converters for second coordinate measurement with double-sided readout of the tubes. Self-triggered operation has become possible using modern high-performance FPGAs allowing for real-time pattern recognition and track reconstruction.

Primary experiment

Primary authors: KROHA, Hubert (Max Planck Society (DE)); KORTNER, Oliver (Max Planck Society (DE)); RICHTER, Robert (Max Planck Society (DE)); KORTNER, Sandra (Max Planck Society (DE))

Presenter: KORTNER, Oliver (Max Planck Society (DE))

Track Classification: Gaseous Detectors

Contribution ID: **201** Type: **Recorded Presentation**

Towards Redesigning Track Segment Identification at the Belle II Trigger System

One of the cornerstones of the successful physics operation at Belle II is its trigger system that is managing outgoing data rates with the help of its central drift chamber (CDC). While it is performing well in estimating event tracks with vertices that can be traced back to the interaction point, it is not designed to handle events with displaced vertices which are important for future dark matter studies. Already at the initial stage, located directly after the detector readout, the Track Segment Finder (TSF) is suppressing typical background by only allowing tracks that enter and exit the CDC with a limited opening angle. In this paper, we present the first studies to break up these limitations to extend the range of events recorded by the experiment. At first, we will show a straightforward extension of the current TSF by allowing supporting larger acceptance angles. Afterward, an alternative approach is presented with a novel neural network-based TSF (neuroTSF), which allows new opportunities by providing higher flexibility, accuracy, and more functionality at an early stage in the trigger pipeline. Both approaches were prototyped on FPGAs with first resource and latency estimation being presented and discussed. We additionally show the potential of the neural network approach by presenting the efficiency using generated test data. While having high resource demand, it is shown that the neuroTSF approach has a high potential to be used in future operation.

Primary experiment

Belle II

Primary author: UNGER, Kai Lukas (Karlsruhe Institute of Technology (KIT))

Co-authors: Dr BAEHR, Steffen; SKAMBRAKS, Sebastian; MEGGENDORFER, Felix; KIESLING, Christian; BECKER, Juergen

Presenter: UNGER, Kai Lukas (Karlsruhe Institute of Technology (KIT))

Track Classification: Gaseous Detectors

Contribution ID: **202** Type: **Recorded Presentation**

Pixelated Resistive Micromegas for High-Rate Environment

Driven by future upgrades of existing experiments at high-luminosity LHC and for applications at future accelerators, we are developing the Micromegas (MM) technology to increase its rate capability and reach a stable and efficient operation up to particle fluxes of 10 MHz/cm2, three order of magnitudes higher than current applications.
The miniaturization of the readout elements and the optimization of the spark protection system, as well as the stability and robustness under operation, are the primary challenges of the project. Several MM detectors have been built with pixelised, high-granularity readout plane, with 1x3 mm2 pads, implementing different resistive protection schemes, consisting on a pad-patterned structure or uniform DLC layers. Different production techniques have been pursued, and different values of resistivity used and compared.
Thorough characterization studies have been carried out on all the detectors, aiming at optimizing the layout for improved rate capability, performance, and stability. Results will be reported, with their dependence on the gas mixture and operating conditions. Preliminary results will be shown also from recent tests carried out with high energy muon beams at the Gamma Irradiation Facility (GIF++) at CERN, for studies of precision tracking under different conditions of background irradiation.

Primary experiment

rd51

Primary authors: DI DONATO, Camilla (Universita e sezione INFN di Napoli (IT)); SEKHNIAIDZE, Givi (Universita e sezione INFN di Napoli (IT)); SESSA, Marco (Universita e INFN Roma Tre (IT)); ALVIGGI, Mariagrazia (Naples University and INFN); CAMERLINGO, Maria Teresa (Universita e INFN Roma Tre (IT)); D'AMICO, Valerio (Università e INFN Roma Tre (IT)); DELLA PIETRA, Massimo (Universita e sezione INFN di Napoli (IT)); DI NARDO, Roberto (Università e INFN Roma Tre (IT)); IENGO, Paolo (CERN); IODICE, Mauro (INFN - Sezione di Roma Tre); PETRUCCI, Fabrizio (Universita e INFN Roma Tre (IT))

Presenter: ALVIGGI, Mariagrazia (Universita e sezione INFN di Napoli (IT))

Track Classification: Gaseous Detectors

Contribution ID: **203** Type: **Live Presentation**

LGAD technology for HADES, accelerator and medical applications

Monday, February 21, 2022 5:15 PM (20 minutes)

Low Gain Avalanche Diode (LGAD) technology has been used to design and construct prototype and full size detector systems for applications requiring simultaneous time and spatial precision. For these purposes a dedicated LGAD strip sensor production has been conducted at FBK with different strip geometries and sizes.
This contribution will review a wide variety of LGAD applications ranging from the reaction time detector for experiments utilizing proton and pion beams with the High Acceptance Di-Electron Spectrometer (HADES), at GSI Darmstadt, Germany, to beam structure monitoring at the S-DALINAC at TU Darmstadt, operated in energy recovery mode, and medical applications at MedAustron. In addition, a prospect of further upgrade projects at GSI and FAIR will be given.

Primary experiment

HADES

Primary authors: KRÜGER, Wilhelm (TU Darmstadt/GSI); BERGAUER, Thomas (Austrian Academy of Sciences (AT)); GALATYUK, Tetyana (TU Darmstadt / GSI); HIRTL, Albert (TU Wien); KEDYCH, Vadym (TU Darmstadt / GSI); KIS, Mladen (GSI - Helmholtzzentrum fur Schwerionenforschung GmbH (DE)); LINEV, Sergey (GSI Helmholtzzentrum für Schwerionenforschung GmbH); MICHEL, Jan (Institut für Kernphysik, Goethe-Universität); PIETRASZKO, Jerzy (GSI Helmholtzzentrum für Schwerionenforschung GmbH); PITTERS, Florian Michael (HEPHY); ROST, Adrian (FAIR GmbH); SCHMIDT, Christian Joachim (GSI - Helmholtzzentrum fur Schwerionenforschung GmbH (DE)); SVINTOZELSKYI, Volodymyr (Taras Shevchenko National University of Kyiv, Kiev, Ukraine); TRÄGER, Michael (GSI Helmholtzzentrum für Schwerionenforschung GmbH); TRAXLER, Michael (GSI Helmholtzzentrum für Schwerionenforschung GmbH); ULRICH-PUR, Felix (Institue for High Energy Physics (HEPHY), Vienna); WENDISCH, Christian (GSI Helmholtzzentrum für Schwerionenforschung GmbH)

Presenter: KRÜGER, Wilhelm (TU Darmstadt/GSI)

Session Classification: Medical Applications

Track Classification: Semiconductor Detectors

Contribution ID: **204** Type: **Recorded Presentation**

The SHADOWS Experiment

SHADOWS *(Search for Hidden and Dark Objects With the SPS)* is a proposed new beam-dump experiment, whose purpose is to search for a large variety of feebly-interacting particles possibly produced in the interactions of a 400 GeV proton beam with a dense target. SHADOWS has the potential to discover FIPs if they have a mass between the Kaon and the Beauty mass.
FIPs can emerge from the decays of charm and beauty hadrons with a non-negligible transverse momentum and can be detected by an experiment placed off-axis where it is less affected by the beam background. Therefore SHADOWS can be placed at a beam of the CERN SPS and operated concurrently to the NA62 experiment, when NA62 is operated in beam-dump mode.
This contribution describes the state of the art of the detectors of the SHADOWS experiment.
The detector is a spectrometer placed after a long decay volume where FIPs can decay to two (or more) charged tracks or photons. The spectrometer will consist of a tracking system with high accuracy on the mass and decay vertex reconstruction, electromagnetic and hadronic calorimeters, and muon detector and timing detector with excellent time resolution (~ 100 − 200 ps) in order to reduce any combinatorial background (in particular the muon one) by requiring the tracks to be coincident in time.

Primary experiment

SHADOWS

Primary author: CICERO, Valentina (INFN - National Institute for Nuclear Physics)

Presenter: CICERO, Valentina (INFN - National Institute for Nuclear Physics)

Track Classification: Dark matter and other low-background experiments

Contribution ID: **207** Type: **Live Presentation**

ARCADIA Fully Depleted MAPS in a 110-nm CMOS Process

Thursday, February 24, 2022 2:25 PM (20 minutes)

The ARCADIA Collaboration is developing a technology platform for the design, fabrication and characterisation of innovative monolithic sensors compatible with standard CMOS processes. The sensor technology allows to fully deplete the substrate for a fast charge collection only by drift, while the use of a small collection electrode maximises the signal-to-noise ratio. Backside lithography is used for patterning of termination structures, enabling the use of substrate thicknesses up to 500 μm.
The proposed technology will allow to extend the use and benefit of CMOS sensors to many applications in high energy physics, space applications, X-ray detection and medical physics.
To demonstrate the technology, the Collaboration developed system-grade DMAPS, pixel and strip test structures and strip arrays with fully functional embedded readout electronics, fabricated on two full engineering runs using LFoundry's LF11is 110nm CMOS node and a high-resistivity bulk.
The ARCADIA-MD1 chip features 25 μm pitch pixels on a 512x512 clock-less matrix integrated on a power-oriented flow. The triggerless binary readout is designed to cope with event rates up to 100 MHz cm^2, while the architecture implementation enables the scalability of the active area to matrices up to 8192 pixels high.
We shall report on the status of the project, current developments and future perspectives, providing an insight on the first characterisation results of the full-scale DMAPS detectors.

Primary experiment

Primary author: DA ROCHA ROLO, Manuel Dionisio (Universita e INFN Torino (IT))

Presenter: DA ROCHA ROLO, Manuel Dionisio (Universita e INFN Torino (IT))

Session Classification: Semiconductor Detectors

Track Classification: Medical Applications

Contribution ID: **210** Type: **Recorded Presentation**

Studies of LGAD performance limitations, Single Event Burnout and gain suppression, with fs-laser and ion beams

Over the last few years, the intense R&D has resulted in the emergence of mature LGAD technology for timing detectors. However, LGAD has limitations. A highly irradiated LGAD is vulnerable to a loss of gain due to the acceptor removal mechanism; this limitation has been mitigated by an increase in high bias voltage. Unfortunately, this approach is not without limitations; fatalities due to the Single Event Burnout (SEB) event impose upper limits on the LGAD's safe bias voltage. Gain in LGAD also depends on multiple parameters including the impinging particle's energy and radiation type or laser intensity. So it is important to understand these limitations, in particular in experiments with heavily ionizing particles where space charge screening effects affect gain suppression in LGAD. Ions of different masses and energies could be a valuable probe to study the anomalous behavior of gain in LGAD. Investigating the role of screening in determining the charge collection dynamics is best performed by altering the density of the electron-hole pairs along the ion track in a quantifiable manner. This can be best achieved by choosing different ions and their respective energies in such a way that either their Bragg peaks correspond to the same depth in the active region of LGAD, or by mapping the LGAD active volume by conducting experiments with the same species of ion but probing different depths of LGAD. In this presentation we will highlight the results of the studies of LGAD performance limitations, Single Event Burnouts, and gain suppression, with fs-laser at ELI Beamlines and ion beams at the RBI.

Primary experiment

Primary author: LASTOVICKA MEDIN, Gordana (University of Montenegro (ME))

Co-authors: REBARZ, Mateusz (Extreme Light Infrastructure); KRAMBERGER, Gregor (Jozef Stefan Institute (SI)); LASTOVICKA, Tomas (Czech Academy of Sciences (CZ)); ANDREASSON, Jakob (Extreme Light Infrastructure); KROLL, Jiri (Czech Academy of Sciences (CZ)); KROPIELNICKI, Kamil (Extreme Light Infrastructure); JAKSIC, Milko (R. Boskovic Institute, Zagreb, Croatia); RODRIGUEZ RAMOS, Mauricio (AAI@EduHr Single Sign-On Service); CRNJAC, Andreo; MANOJLOVIC, Milos (University of Montenegro (ME))

Presenter: LASTOVICKA MEDIN, Gordana (University of Montenegro (ME))

Track Classification: Semiconductor Detectors

Contribution ID: **213** Type: **Recorded Presentation**

Design and Development of Ultrafast Scintillator with Monolithically Integrated Photodetector for Radiation Detection

Scintillators with excellent timing and light-yield performance are on high demand by high energy physics experiments as well as medical imaging and nuclear security application. Epitaxially grown InAs quantum dots (QDs) embedded in GaAs matrix have been demonstrated to be a viable material for ultrafast radiation detection due to its higher light yield projected to 240 ph./keV, due to narrow GaAs bandgap, high (~60%) QDs luminescence efficiency at room temperature and low self-absorption, thus surpassing the physical limits of inorganic scintillators.
The fabricated InAs/GaAs QD heterostructures with monolithically integrated p-i-n photodiodes (PD) were analyzed using ²⁴¹Am 5.5 MeV alpha-particle source. Distributions of charge collected by the PD appear bi-modal corresponding to geometry of the PD and the scintillating waveguide. With Monte Carlo (MC) simulations, waveguiding features such as absorption and surface scattering are assessed and its impact on detector performance is investigated. MC analysis was used to evaluate charge collection statistics, optical travel length, and time (optical jitter), which aided in the design of a scintillator pixel and integrated photodetector (PD). The waveguiding integrated scintillation detector demonstrated mean charge collection of 30 el./keV or 13% of the theoretically achievable light yield, a decay time of 300 ps and 38 ps time resolution.

Primary experiment

Primary authors: MAHAJAN, Tushar Deepak (SUNY Polytechnic Institute); MINNS, Allan (SUNY Polytechnic Institute); Dr TOKRANOV, Vadim (SUNY Polytechnic Institute); Dr YAKIMOV , Michael (SUNY Polytechnic Institute); Dr HEDGES, Michael (Purdue University); Dr MURAT, Pavel (Fermi National Accelerator Lab. (US)); Prof. OKTYABRSKY , Serge (SUNY Polytechnic Institute)

Presenter: MAHAJAN, Tushar Deepak (SUNY Polytechnic Institute)

Track Classification: Photon Detectors

Contribution ID: **214** Type: **Recorded Presentation**

Progress and perspectives of FARICH R&D for the Super Charm-Tau Factory project.

Particle identification system based on Focusing Aerogel RICH (FARICH) detector is considered as an option for the future experiments at the Super Charm-Tau Factory (Russia). The progress of FARICH R&D at the the Budker Institute of Nuclear Physics is presented. New samples of focusing 4-layer aerogels with maximal refractive index 1.065 were produced in 2020-2021. First beam test results with relativistic electrons demonstrate single photon resolution SPR=8.5~mrad. According to simulation results, the aerogels with such SPR are able to provide μ/π-separation at the level of more than 3 standard deviations for tracks with momentum 1.5 GeV/c. The first version of electronics to readout SiPM arrays based on TDC realized on FPGA (FPGA-TDC) was developed and manufactured. The first test results are presented.

Primary experiment

Primary authors: BARNIAKOV, Alexander (Novosibirsk State University (RU)); KONONOV, Sergey A. (Budker Inst. Novosibirsk); BOBROVNIKOV, Viktor (Budker Institute of Nuclear Physics (RU))

Presenter: BARNIAKOV, Alexander (Novosibirsk State University (RU))

Track Classification: Cherenkov Detectors

Contribution ID: **215** Type: **Recorded Presentation**

Performance assessment of the compact calorimeters for future electron-positron collider

The FCAL collaboration is preparing large-scale prototypes of special calorimeters to be used in the very forward region at future electron-positron colliders. The very forward region sets challenging requirements on several detector parameters, such as detector compactness, radiation hardness, or readout ASICs parameters. In our concept, two compact calorimeters are foreseen, LumiCal and BeamCal. Both are designed as sandwich calorimeters with very thin sensor planes to keep the Molière radius small, facilitating the measurement of electron showers in the presence of the background. Silicon sensor prototypes and dedicated FE ASICs have been developed and produced. The ASICs have been designed to cope with the timing and dynamic range requirements. In the recent beam tests, a multi-plane compact prototype was equipped with thin sensor planes fully assembled with the new readout electronics and installed in 1 mm gaps between tungsten plates of one radiation length thickness. The status of the calorimeter prototype development will be presented, including selected performance results, obtained in a 5 GeV electron beam at DESY, as well as the expected performance obtained from simulation.

Primary experiment

FCAL Collaboration

Primary author: Dr GHENESCU, Veta (Institute of Space Science (RO))

Presenter: Dr GHENESCU, Veta (Institute of Space Science (RO))

Track Classification: Calorimeters

Contribution ID: **217** Type: **Recorded Presentation**

Noble Liquid calorimetry for a future FCC-ee experiment

Noble liquid calorimetry is a well proven technology that successfully operated in numerous particle physics detectors (D0, H1, NA48, NA62, ATLAS, …). Its excellent energy resolution, linearity, stability, uniformity and radiation hardness as well as good timing properties make it a very good candidate for future hadron and lepton colliders. Recently, a highly granular noble liquid sampling calorimeter was proposed for a possible FCC-hh experiment. It has been shown that, on top of its intrinsic excellent electromagnetic energy resolution, noble liquid calorimetry can be optimized in terms of granularity to allow for 4D imaging, machine learning and - in combination with the tracker measurements - particle-flow reconstruction. This talk will discuss the ongoing R&D to adapt noble liquid sampling calorimetry for an electromagnetic calorimeter of an FCC-ee experiment with a focus on signal extraction, noise mitigation and cryostat material budget. In addition to that, performance studies realized with the FCCSW full simulation framework will be presented.

Primary experiment

Primary authors: FRANCOIS, Brieuc (CERN); ALEKSA, Martin (CERN)

Presenter: FRANCOIS, Brieuc (CERN)

Track Classification: Calorimeters

Contribution ID: **218** Type: **Recorded Presentation**

Status of GE2/1, the 2nd CMS muon Triple-GEM system

We present the status of the new Triple-GEM muon sub-system of the CMS forward muon spectrometer, GE2/1. The first station, GE1/1 is under commissioning in CMS while GE2/1 detector construction will start beginning of 2022. A GE2/1 chamber is 4 times larger than a GE1/1 chamber, made of 1 m-long GEM foils. Because of the limitations in the current PCB manufacturing, a GE2/1 chamber is actually divided into 4 individual Triple-GEM detector modules. GE2/1 detector and electronics design benefits of several improvements with respect to GE1/1, namely: (i) new GEM foil segmentation scheme to lower the probability of propagating discharges and to prevent large cross-talk across the foil sectors, and (ii) improved front-end amplifier protection circuit. In Fall 2021 a GE2/1 detector module will be tested in a muon test beam and a full GE2/1 chamber will be installed in CMS as demonstrator. In this contribution we will focus on the GE2/1 detector performance measured with the final prototypes, the preliminary results from the Fall 2021 test beam and from the CMS demonstrator focusing on the improvements compared to GE1/1 and finally presenting the challenge of the GE2/1 chamber construction.

Primary experiment

CMS: Muon Detector

Primary author: PÉTRÉ, Laurent (Universite Libre de Bruxelles (BE))

Presenter: PÉTRÉ, Laurent (Universite Libre de Bruxelles (BE))

Track Classification: Gaseous Detectors

Contribution ID: **219** Type: **Recorded Presentation**

Response of the MIMOSA-28 pixel sensor to a wide range of ion species and energies

CMOS pixel sensors, originally developed for High Energy Physics experiments, are also used for space radiation research and medical applications, providing high resolution particle trajectories, for e.g., cross section measurements. In the present work, the response of the CMOS pixel sensor MIMOSA-28 was investigated for a variety of ion beams and energies. Several experiments were performed at different particle accelerators to study the number of pixels triggered by an incoming particle as a function of the energy loss in the range 10-14000 keV. Measurements were performed for ion beams relevant for clinical applications such as protons and carbon ions, but also for heavier particles like iron ions relevant for space radiation research in the energy range 10 MeV/u - 1 GeV/u. In addition, the spatial energy loss distributions of several ion beams were computed with Monte Carlo simulations and a semi-empirical model, based on thermal diffusion and Coulomb expansion, was developed to reproduce the sensor response as a function of the energy loss. Furthermore, sensors were exposed to mixed radiation fields showed their capability as a suitable, additional tool to improve particle identification in conjunction with other detector systems. To enhance their particle identification capability further, new designs embed the digitization of the energy loss directly in pixels. Small prototypes have been designed by the TIIMM joint research activity and sent to fabrication recently.

Primary experiment

Primary author: Dr REIDEL, Claire-Anne (GSI Helmholtzzentrum für Schwerionenforschung GmbH)

Co-authors: Dr SCHUY, Christoph (GSI Helmholtzzentrum für Schwerionenforschung GmbH); Dr FINCK, Christian (Université de Strasbourg, CNRS); Dr HORST, Felix (GSI Helmholtzzentrum für Schwerionenforschung GmbH); Dr BOSCOLO, Daria (GSI Helmholtzzentrum für Schwerionenforschung GmbH); Prof. BAUDOT, Jérôme (Université de Strasbourg, CNRS); Dr FRIEDRICH, Thomas (GSI Helmholtzzentrum für Schwerionenforschung GmbH); Dr VANSTALLE, Marie (Université de Strasbourg, CNRS); Prof. DURANTE, Marco (GSI Helmholtzzentrum für Schwerionenforschung GmbH); Dr SPIRITI, Eleuterio (INFN, Laboratori Nazionali di Frascati); FEDERICI, Luca (INFN, Laboratori Nazionali di Frascati); REN, Weiping (Université de Strasbourg, CNRS); KACHEL, Maciej (Université de Strasbourg, CNRS); HU-GUO, Christine (Université de Strasbourg, CNRS); SEFRI, Rachid (Université de Strasbourg, CNRS); ZHAO , Yue (Université de Strasbourg, CNRS); Dr WEBER, Uli (GSI Helmholtzzentrum für Schwerionenforschung GmbH)

Presenter: Dr REIDEL, Claire-Anne (GSI Helmholtzzentrum für Schwerionenforschung GmbH)

Track Classification: Electronics

Contribution ID: **220** Type: **Recorded Presentation**

Performance study of dual-phase CO_2 cooling on the example of the ATLAS ITk strip end-cap detector

The technique of evaporative CO_2 cooling is a promising solution for the application in high-energy particle detectors, such as the new ATLAS Inner Tracker (ITk) for the planned high-luminosity upgrade of the LHC by 2026.
The advantages of CO_2 are a high latent heat transfer at reasonable flow parameters, the possibility to use small diameter cooling pipes resulting only in small pressure drops, a well-suited temperature range for detector cooling between +25 and -40°C and being an environment friendly alternative to many other currently used coolants. At the same time when comparing with a monophase coolant, the operation in the dual-phase regime comes with several parameters influencing the cooling performance, which need to be understood in detail.
In this contribution, the results of an experimental study on some of these influencing factors will be presented. For this, prototype structures from the ITk strip detector end-cap were used, like bare local support structures ('cores') or fully loaded structures ('petals'). Here, the design is optimized to guarantee a good heat transfer between the silicon strip modules glued on the surface and the embedded titanium cooling pipe with the CO_2 coolant.
Systematic investigations on the thermal performance using infrared thermography are used to study the influence of dual-phase CO_2 cooling parameters (heat load, mass flow rate, flow orientation) and are finally compared to dedicated simulation results.

Primary experiment

ATLAS ITk

Primary authors: ARLING, Jan-Hendrik (Deutsches Elektronen-Synchrotron (DE)); RENARDI, Alessia (DESY); POBLOTZKI, Frauke (Deutsches Elektronen-Synchrotron (DE))

Co-authors: GREGOR, Ingrid-Maria (DESY & Bonn University); DIEZ CORNELL, Sergio (Deutsches Elektronen-Synchrotron (DESY))

Presenter: ARLING, Jan-Hendrik (Deutsches Elektronen-Synchrotron (DE))

Track Classification: Miscellaneous

Contribution ID: **221** Type: **Recorded Presentation**

Performance evaluation of SiPMs with the PETsys TOFPET2 ASIC

Silicon photomultiplier coupled with scintillating crystals are more and more used radiation detectors in many applications.
In order to evaluate the best photodetector and performance tradeoff between cell sizes, different SiPMs from various companies (FBK, Hamamatsu, Ketek, ON Semiconductor and Broadcom) are coupled with two L(Y)SO crystals and their coincidence time resolutions (CTR) and energy resolutions are measured by the PETsys TOFPET2 readout system. As example, the CTR values range from 414±14 ps (10 µm SPAD size) up to 148±4 ps (50 µm), while the measured energy resolution at 511 keV ranges from 14.7% to 8% for devices from Hamamatsu. For all the SiPMs measured, larger SPAD sizes lead to better performances either in CTR or energy resolution. The best obtained CTR of 118±3 ps FWHM was measured using 40 µm cell sized FBK NUV-HD SiPMs.

Primary experiment

Primary authors: MALENTACCA, Lorenzo (Politecnico of Milano, Cern); Dr POLESEL, Andrea (Cern); Mr KRATOCHWIL, Nicolaus (Cern, University of Vienna); Dr AUFFRAY, Etiennette (Cern)

Presenter: MALENTACCA, Lorenzo (Politecnico of Milano, Cern)

Track Classification: SiPM

Contribution ID: **225** Type: **Live Presentation**

The Belle II Pixel Detector – Operation and Performance

Tuesday, February 22, 2022 11:25 AM (20 minutes)

After multiple dedicated commissioning phases, the SuperKEKB accelerator in Tsukuba, Japan, started providing e+e- -collisions to the Belle II experiment equipped with a new 6 layer silicon VerteX Detector (VXD) in 2019. The two innermost layers of the VXD are comprised of two layers of PiXel Detector (PXD). It is made from all-silicon modules integrating support structure and sensor. The sensors are pixel matrices of DEpleted P-channel Field Effect Transistors (DEPFET) which are steered and read out by 14 ASICs bump-bonded to each module. Due to unforeseen difficulties during construction a de-scoped detector has been installed.
The PXD has been reliably operating as part of the Belle II detector over the last three years. The efficiency and vertex resolution are within the expectations. Expected module degradation due to radiation damage is mostly compensated by continuous recalibration. The global module performance is only partially affected by unexpected effects like local radiation induced bulk current changes in the sensors and faults in individual channels of the fast voltage-switching ASICs (Switchers) due to radiation bursts. These effects could be reproduced in x-ray and electron beam irradiation measurements.
The talk will present a summary of the operation experience and performance and give an outlook on the ongoing preparation for a full-sized replacement of the PXD expected within the next year.

Primary experiment

Belle II

Primary author: SPRUCK, Björn

Presenter: SPRUCK, Björn

Session Classification: Large Detector Systems

Track Classification: Semiconductor Detectors

Contribution ID: **226** Type: **Invited Talk**

4d-tracking, LGADs, and fast timing detectors

Friday, February 25, 2022 9:00 AM (40 minutes)

In the past 10 years, there has been growing interest in developing particle trackers that combine excellent spatial and temporal accuracy. This evolution has been made possible by introducing in the design of silicon sensors several innovations that have substantially increased their capabilities of measuring time accurately. In this presentation, I will review this recent evolution and outline the most promising approaches in silicon technologies and associated electronics to build a particle tracker that matches the requirements of future experiments.

Primary experiment

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

Session Classification: Semiconductor Detectors

Track Classification: Semiconductor Detectors

Contribution ID: **227** Type: **Invited Talk**

Requirements and R&D for Detectors at the Future Electron-Ion-Collider (EIC)

Monday, February 21, 2022 10:20 AM (40 minutes)

The EIC's ability to collide high-energy electron beams with high-energy ion beams will provide access to those regions in the nucleon and nuclei where their structure is dominated by gluons. Moreover, polarized beams in the EIC will give unprecedented access to the spatial and spin structure of gluons and sea-quarks in the proton and light nuclei.

The EIC will be an unprecedented collider with luminosities 2-3 orders of magnitude higher than that at HERA over a very wide range of center-of-mass energies from 20 up to 100-140 GeV, while accommodating highly polarized (~70%) electron and nucleon beams. Equally demanding are the requirements for physics detector(s) that will be needed to carry out the compelling EIC physics program: hermetic coverage in tracking, calorimetry and particle ID within a wide pseudorapidity range, substantial angular and momentum acceptance in the hadron-going direction, as well as high quality hadronic calorimetry among others.

In my talk I will give an overview of the detector requirements and current general-purpose detector concepts, providing a connection between physics requirements, simulations and the ongoing EIC Detector R&D Program.

Primary experiment

Primary author: ULLRICH, Thomas (Yale University (US))

Presenter: ULLRICH, Thomas (Yale University (US))

Session Classification: Large Detector Systems

Track Classification: Miscellaneous

Contribution ID: **229** Type: **Recorded Presentation**

Radiation damage investigation of epitaxial p-type silicon using Schottky and pn-junction diodes

This project focuses on the investigation of trap energy levels introduced by radiation damage in epitaxial p-type silicon. Using 6-inch wafers of various boron doping concentrations (1e13, 1e14, 1e15, 1e16, and 1e17 cm-3) with a 50 µm epitaxial layer, multiple iterations of test structures consisting of Schottky and pn-junction diodes of different sizes and flavours are being fabricated at RAL and Carleton University.

In this talk, details on the diode fabrication and electrical measurements of the structures will be given. IV and CV scans of fabricated test structures have been performed and cross-checked between institutes, the results of which will be presented. Emphasis will be placed on approaches to reduce the surface component of the leakage current that could potentially be applicable to the foreseen irradiated sample measurements.
Furthermore, trap parameters obtained from Deep-Level Transient Spectroscopy (DLTS) and Thermal Admittance Spectroscopy (TAS) as well as process and electrical simulations of the diodes fabricated from the high resistivity wafer will be shown.

Finally, the on-going activities for the next round of wafer processing and proposed plans for irradiation in the coming months, will be reviewed.

Primary experiment

RD50

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

Co-authors: KLEIN, Christoph Thomas (Carleton University (CA)); KOFFAS, Thomas (Carleton University (CA)); TARR, Garry (Carleton University (CA)); VANDUSEN, Robert (Carleton University (CA)); ALLPORT, Philip Patrick (University of Birmingham (UK)); GONELLA, Laura (University of Birmingham (UK)); KOPSALIS, Ioannis (University of Birmingham (GB)); MANDIC, Igor (Jozef Stefan Institute (SI)); WILSON, Fergus (Science and Technology Facilities Council STFC (GB)); CHEN, Yebo (IHEP (CN)); LIU, Peilian (IHEP (CN))

Presenter: KLEIN, Christoph Thomas (Carleton University (CA))

Track Classification: Semiconductor Detectors

Contribution ID: **231** Type: **Recorded Presentation**

Using scientific-grade CCDs for the direct detection of dark matter with the DAMIC-M experiment

The DAMIC-M experiment, successor of the DAMIC at SNOLAB, is devoted to the exploration of the hidden sector and the search for light WIMPs interacting with the electrons or the nucleus of the bulk silicon of fully depleted Charge-Coupled Devices (CCDs). A kilogram-sized target mass will be installed at the Modane underground laboratory which offers an excellent low background environment for rare-event search.
The implementation of the Skipper readout allows for multiple non-destructive pixel charge measurements, reaching a readout noise of a fraction of an electron. This perfect performance in terms of charge resolution can be limited by the radioactive background and the noise introduced by the external electronics. Much effort is put into the protection of the silicon from contamination by cosmic ray spallation, careful choice of the materials to support and shield the CCDs, and development of a new acquisition system with fast and sensitive electronics for the control and readout of a CCD. All these advancements will push the detection threshold down to a few eVs, improving the sensitivity of DAMIC-M by at least one order of magnitude better than previous experiments.
I will present the current status of DAMIC-M describing our technological challenges and the solutions we have adopted, and introduce the ongoing assembly of a prototype detector, the Low Background Chamber, aiming at validating our final design options and produce the first scientific results.

Primary experiment

DAMIC-M

Primary author: PAPADOPOULOS, Georgios

Presenter: PAPADOPOULOS, Georgios

Track Classification: Dark matter and other low-background experiments

Contribution ID: **232** Type: **Recorded Presentation**

Radiation hardness study using SiPMs with single-cell readout

Radiation hardness is one of the key properties of silicon photomultipliers (SiPMs) for their application in experiments with harsh radiation environments. After a certain level of irradiation it becomes impossible to resolve signals generated by a single photon from the noise and the main SiPM parameters cannot be determined from a single photo-electron distribution.

The possibility to readout a single cell enables the study of highly irradiated SiPMs, retaining the single-photon counting capability, which was not presented so far. A dedicated single-cell SiPM structure was designed and produced by Hamamatsu.

Measurements of such a structure were carried out to investigate the radiation damage effects on the parameters of SiPMs exposed to a reactor neutron fluence up to $\Phi = 5e13cm^{-2}$. A method for the data analysis is developed, which includes initial waveform processing, SiPM pulse recognition, validation and pulse parameters calculation. From the acquired data, the main SiPM parameters are extracted.
From the analysis of the data we observed a reduction of the gain by 17% and an increase of V_{off} by about $0.5\ V$ after $\Phi = 5e13cm^{-2}$.

The talk will present the novel studies on a single SiPM cell and the results on radiation damage effect on gain, breakdown voltage, dark count rate and photon detection efficiency.

Primary experiment

Primary authors: KAMINSKIY, Alexander (M.V. Lomonosov Moscow State University (RU)); BYCHKOVA, Oksana (National Research Nuclear University MEPhI (RU)); STIFUTKIN, Alexey (National Research Nuclear University MEPhI (RU)); POPOVA, Elena (National Research Nuclear University MEPhI (RU)); GARUTTI, Erika (University of Hamburg); SCHWANDT, Joern (Hamburg University (DE)); PARYGIN, Pasha (National Research Nuclear University MEPhI (RU)); MARTENS, Stephan (University of Hamburg)

Presenter: BYCHKOVA, Oksana (National Research Nuclear University MEPhI (RU))

Track Classification: SiPM

Contribution ID: **233** Type: **Recorded Presentation**

Upgrading the Beam Telescopes at the DESY II Test Beam Facility

Test beam campaigns are an essential part of modern detector R&D to study performance parameters in an environment closest to the final experiment. The DESY II test beam provides EUDET-style pixel telescopes based on MIMOSA-26 sensors for more than 10 years, which provide an unprecedented pointing resolution but no timing information. As the time resolution becomes more and more important, several upgrades are planned to adapt the telescope to the increasing requirements of the next decade. The novel trigger logic unit is used to synchronize several detector systems has opened the path to more flexible setups: First prototype timing planes based on LGADs as well as a fast region-of-interest trigger and timing plane based on an HV-CMOS process are proposed short term upgrades of the facility. A new telescope, based on a thin CMOS sensor is foreseen as a mid-term replacement of the current telescope, which reaches its end of life soon. A long-term upgrade of the telescope is envisioned to be based on a 65nm imaging sensor
The presentation will briefly introduce the facility and sketch the requirements on the telescopes, as well as the current status. The integration of additional timing layers will be discussed in detail and results from test beam campaigns will be shown to highlight the improvements.

Primary experiment

Primary authors: HERKERT, Adrian (Deutsches Elektronen-Synchrotron (DE)); HUTH, Lennart (Deutsches Elektronen-Synchrotron (DE)); STANITZKI, Marcel (Deutsches Elektronen-Synchrotron (DE)); MEYNERS, Norbert (Deutsches Elektronen-Synchrotron (DE)); Mr SCHÄFER, Oliver (DESY); DIENER, Ralf (DESY); KRAEMER, Uwe (DESY)

Presenter: HUTH, Lennart (Deutsches Elektronen-Synchrotron (DE))

Track Classification: Miscellaneous

Contribution ID: **234** Type: **Live Presentation**

Design and characterization of depleted monolithic active pixel sensors within the RD50 collaboration

Thursday, February 24, 2022 11:00 AM (20 minutes)

The CERN RD50 CMOS working group is designing and characterizing DMAPS for use in high radiation environments fabricated in the LFoundry 150nm HV-CMOS process. The first iteration of this chip, RD50-MPW1, suffered from high leakage current, low breakdown voltage and crosstalk. In order to mitigate these shortcomings, an improved version with improved pixel geometry was designed. The RD50-MPW2 integrates a matrix of 8x8 pixels with analog front-end, but no digital readout. It was delivered in early 2020 and extensively characterized within lab-measurements, an irradiation campaign and beam tests. To read out the chips the Caribou DAQ system is used with a custom chipboard as well as specific firmware and software modules. A third iteration of the chip, the RD50-MPW3, will be submitted to LFoundry end of October 2021 and is expected to be delivered in March 2022. It will keep the well working analog part of its predecessor, completed by an in-pixel digital logic and an optimized peripheral readout for effective pixel configuration and fast serial data transmission. The chip will comprise a matrix of 64x64 pixels arranged in 32 double-columns. In parallel to chip design and production, a digital model of RD50-MPW3 is being implemented in an FPGA and used to develop and verify the readout system of the future chip. We will present an overview of the RD50 HV-CMOS activities focusing on the measurement results of RD50-MPW2 chip, as well as the design and readout of the RD50-MPW3.

Primary experiment

Primary authors: IRMLER, Christian (Austrian Academy of Sciences (AT)); SIEBERER, Patrick (Austrian Academy of Sciences (AT)); BERGAUER, Thomas (Austrian Academy of Sciences (AT))

Presenter: SIEBERER, Patrick (Austrian Academy of Sciences (AT))

Session Classification: Semiconductor Detectors

Track Classification: Semiconductor Detectors

Contribution ID: **238** Type: **Recorded Presentation**

The ATLAS RPC upgrade project for the High Luminosity LHC program

The present ATLAS RPC system is a 3D+time tracking detector providing the first level trigger in the ATLAS barrel. It is constituted by 6 concentric cylindrical layers providing independent space-time measurements along the track, with 1ns x 1cm resolution. This system will undergo a major upgrade for the HL-LHC program, consisting in three additional full coverage layers of new generation RPCs, to be installed in the inner barrel region.
The new system will extend from about 70% to about 96% the trigger acceptance; add redundancy to the legacy RPC; increase the trigger selectivity and bring the resolution on the particle velocity to up 0.5%, thanks to the increased time resolution and lever arm.
The new RPCs are an evolution of the BIS78 RPCs, an ATLAS pilot project installed for the LHC RUN3, designed for working at a rate, compatible with Eco-friendly gas mixtures, with space-time performance one order of magnitude better than the present RPCs.
One sensible feature is the front-end electronics rad-hard chip, based on IHP SiGe BiCMOS technology, and integrating a 100 ps sharp discriminator, 70 ps TDC and 4 GBPS serial encoder, all working at 150 ns of fixed latency compatibly with the fastest ATLAS muon trigger.
The project is in advanced design phase aiming to build final prototypes, to start the construction in 2022. In the present contribution the detailed project design, features and plans, along with the first results of official prototypes will be illustrated.

Primary experiment

ATLAS

Primary author: SIMSEK, Sinem (Istinye University (TR))

Presenter: SIMSEK, Sinem (Istinye University (TR))

Track Classification: Gaseous Detectors

Contribution ID: **239** Type: **Live Presentation**

Silicon pixel-detector R&D for future lepton colliders

Thursday, February 24, 2022 9:00 AM (20 minutes)

The physics aims at future lepton colliders such as CLIC or FCC-ee pose challenging demands on the performance of the vertex and tracking-detector systems. A single-plane spatial resolution of a few microns is needed, combined with a low mass of ~0.2%-1% X0 per layer. Moreover, hit-time tagging with a few ns resolution is required for beam-background rejection at CLIC. An even better timing precision below 100 ps on pixel level opens up the possibility of particle-identification by time of flight measurements within the tracking layers. To address these detector requirements, a broad R&D program on new silicon detector technologies is being pursued within various collaborative frameworks, such as the CERN EP R&D program, AIDAinnova and the CLICdp collaboration. Different hybrid technologies with innovative sensor concepts are explored as candidates for the vertex-detectors. Furthermore, alternative interconnects such as bonding using anisotropic conductive films (ACF) are under development. Advanced monolithic depleted CMOS sensors are under study both for the vertex and the tracking detectors. To predict and optimise the performance of the various prototypes, a fast and versatile Monte Carlo Simulation Tool (Allpix-Squared) has been developed. This contribution introduces the requirements and gives an overview of the R&D program for silicon-based vertex and tracking detectors, highlighting new results from measurements and simulations of recent prototypes.

Primary experiment

CLICdp

Primary author: DANNHEIM, Dominik (CERN)

Presenter: DANNHEIM, Dominik (CERN)

Session Classification: Semiconductor Detectors

Track Classification: Semiconductor Detectors

Contribution ID: **241** Type: **Invited Talk**

Quantum detectors for particle physics

Friday, February 25, 2022 2:50 PM (40 minutes)

An overview of different families of detectors relying on quantum effects and relevant to the field of particle physics will be given, covering existing detectors and applications, ongoing developments, and possible ideas for applications in the context of high energy particle physics.

Primary experiment

Presenter: DOSER, Michael (CERN)

Track Classification: Miscellaneous

Contribution ID: **242** Type: **Organisation**

Opening

Primary experiment

Presenter: KRAMMER, Manfred (CERN)

Contribution ID: **243** Type: **Organisation**

Welcome

Primary experiment

Contribution ID: **244** Type: **Organisation**

Welcome

Primary experiment

Contribution ID: **245** Type: **Organisation**

Welcome

Primary experiment

Contribution ID: **246** Type: **Organisation**

Closing

Primary experiment

Presenter: KRAMMER, Manfred (CERN)

Contribution ID: **247** Type: **Organisation**

Information from the Organizers

Primary experiment

Contribution ID: **248** Type: **Organisation**

Award Ceremony

Primary experiment

Contribution ID: **250** Type: **Invited Talk**

The ALMA Observatory – amazing science discoveries and the Roadmap for the next decade

Monday, February 21, 2022 11:30 AM (40 minutes)

The Atacama Large Millimeter Array (ALMA) at 5000m altitude in northern Chile is an outstanding achievement. The array consists of 66 high-precision antennas, each with a complement of up to 10 state-of-the-art receiver systems that enable observations between 35 GHz up to almost 1 THz. The total collecting area and sensitive receiver systems in this world-leading facility, combined with the long baselines and the high-altitude site, confer unprecedented performance characteristics for scientific exploration of the Universe at sub-millimeter wavelengths. This talk will highlight a number of the ground-breaking science discoveries – the first detailed images of proto-planetary systems, detection of molecules in the first galaxies, and the first direct image of a black hole shadow - and will describe the current operational status of ALMA. Looking to the future, the ALMA2030 Development Roadmap will be presented, the scientific drivers, and the technology development that will confer new observational capabilities that will keep ALMA at the forefront of astronomical research.

Primary experiment

Primary author: DOUGHERTY, Sean (ALMA)

Presenter: DOUGHERTY, Sean (ALMA)

Session Classification: Astroparticle Detectors

Track Classification: Astroparticle Detectors

Contribution ID: **252** Type: **Live Presentation**

Wide-bandgap material SiC as high rate particle detector

Thursday, February 24, 2022 5:15 PM (20 minutes)

The material properties of Silicon-Carbide (SiC) make it a promising candidate for application as particle detector at high beam rates. In comparison to Silicon (Si), the increase in charge carrier saturation velocity and breakdown voltage allow for high time resolution while mitigating pile ups. The larger bandgap improves radiation hardness and suppresses dark current. The presented project aims to accomplish the development of such a detector, together with associated readout electronics.
Current simulation tools are challenged regarding SiC due to its low carrier density, anisotropic effects and insufficient knowledge of material parameters. We present various computational approaches based on the tools TCAD and Weightfield and compare them with experimental results carried out with a 50µm thick SiC pad sensor.
UV-TCT measurements on neutron irradiated samples deliver insight into intrinsic detector properties, while high-rate detector characteristics have been determined with protons and Carbon ion beams for rates up to several hundred MHz, which have been conducted at the ion beam cancer treatment facility MedAustron.
To take full advantage of the fast charge collection of SiC, we are developing advanced single channel readout electronics to be used in beam tests to study the material properties further. Moreover, the developments towards a multi-channel ASIC for using SiC as high-rate beam intensity and position monitor will be shown.

Primary experiment

Primary authors: GAGGL, Philipp (Austrian Academy of Sciences (AT)); WAID, Simon Emanuel (Austrian Academy of Sciences (AT)); BERGAUER, Thomas (Austrian Academy of Sciences (AT)); THALMEIER, Richard

Presenter: GAGGL, Philipp (Austrian Academy of Sciences (AT))

Session Classification: Semiconductor Detectors

Track Classification: Semiconductor Detectors

Contribution ID: **254** Type: **Recorded Presentation**

Study of the heating of SiPMs

For SiPMs, the main effect of radiation damage is a dramatic increase of the dark current. The power dissipated, if not properly cooled, heats the SiPM, whose performance parameters depend on temperature. Therefore, the knowledge of the SiPM temperature is necessary to understand the changes of its parameters with irradiation.
The heating studies were performed with a KETEK SiPM, 15×15 μm^2 pixel size, mounted on an Al_2O_3 substrate, which was either directly connected to the temperature controlled chuck of a probe station, or through layers of material with well-known thermal resistance. The SiPM was illuminated by a 470 nm LED operated in DC-mode. The SiPM current was measured at different voltages, LED currents, chuck temperatures, and thermal resistivities for a number of measurement cycles. The data are used to determine the steady-state temperature as a function of dissipated power and thermal resistance, as well as the time dependencies for heating and cooling. This information can be used to correct the parameters determined for radiation-damaged SiPM for the effects of self-heating. The method can also be employed for packaged SiPMs with unknown thermal contact to a heat sink.
The presentation describes the experimental layout, the data taking, the analysis methods, the results obtained and a comparison to thermal simulations. Finally, the application of the method for the study of radiation-damaged SiPMs and its use in actual experiments is discussed.

Primary experiment

Primary authors: VILLALBA PETRO, Carmen Victoria (Hamburg University (DE)); GARUTTI, Erika (University of Hamburg); SCHWANDT, Joern (Hamburg University (DE)); KLANNER, Robert (Hamburg University (DE)); MARTENS, Stephan (University of Hamburg)

Presenter: VILLALBA PETRO, Carmen Victoria (Hamburg University (DE))

Track Classification: SiPM

Contribution ID: **257** Type: **Recorded Presentation**

Status of the SABRE South Experiment at the Stawell Underground Physics Laboratory

The SABRE (Sodium iodide with Active Background REjection) experiments aim to detect an annual rate modulation from dark matter interactions in ultra-high purity NaI(Tl) crystals. The SABRE South experiment is located at the Stawell Underground Physics Laboratory (SUPL), Australia, and is the first deep underground laboratory in the Southern Hemisphere. SABRE South is designed to disentangle seasonal or site-related effects from the dark matter-like modulated signal first observed by DAMA/LIBRA in the Northern Hemisphere using an active veto and muon detection system. It is a partner to the SABRE North effort at the Laboratori Nazionali del Gran Sasso (LNGS).

SABRE South is instrumented with ultra-high purity NaI(Tl) crystals immersed in a linear alkyl benzene (LAB) based liquid scintillator veto, further surrounded by passive steel and polyethylene shielding and a plastic scintillator muon veto. Significant work has been undertaken to understand the experimental backgrounds and performance of the crystals. The SABRE South experiment is under construction, and will be commissioned from late 2021 to early 2022. We will present the final design of SABRE South, the status of its construction, its expected background, and its sensitivity to a DAMA/LIBRA like modulation. We will also present recent quenching factor measurements of sodium nuclear recoils in NaI(Tl) crystals measured at the Heavy Ion Accelerator Facility, and a report on the status of SUPL.

Primary experiment

SABRE South collaboration.

Primary author: ZUROWSKI, Madeleine (The University of Melbourne)

Presenter: ZUROWSKI, Madeleine (The University of Melbourne)

Track Classification: Dark matter and other low-background experiments

Contribution ID: **258** Type: **Recorded Presentation**

Multispectral Photon-Counting for Medical Imaging and Beam Characterization - A Project Review

Central focus of the MPMIB project - funded via the Academy of Finland's RADDESS 2018-2021 programme - has been research towards a next-generation radiation detection system operating in a photon-counting (PC) multispectral mode: The extraction of energy spectrum per detector pixel can be an important asset for diagnostic imaging and radiotherapy, enabling better diagnostic outcome with lower radiation dose and more versatile characterization of the radiation beam leading e.g. to more accurate patient dosimetry.

We will give a critical review of our achievements, challenges and lessons learned. We present our approach of fabricating direct-conversion detectors based on Cadmium Telluride (CdTe) semiconductor material, hybridized with PC mode capable ASICs. However, although CdTe has excellent photon radiation absorption properties, it is a brittle material that can include large concentrations of defects. A material assessment prior to detector processing is therefore essential. The CdTe crystals were processed at Micronova Nanofabrication Centre in Espoo, Finland, employing techniques such as surface passivation via atomic layer deposition, and flip-chip bonding of processed sensors to read-out chips.

We will further discuss our quality assessment of CdTe crystals and processed detectors, and present experimental data obtained with prototype detectors in x-ray and Co-60 beams at a standards laboratory. We will conclude with possible next steps for a follow-up project.

Primary experiment

Primary author: KIRSCHENMANN, Stefanie (Helsinki Institute of Physics (FI))

Co-authors: GÄDDA, Akiko (Helsiki Institute of Physics); WINKLER, Alex; KARADZHINOVA--FERRER, Aneliya (Helsinki Institute of Physics (FI)); PETROW, Henri Markus (Lappeenranta University of Technology (FI)); OTT, Jennifer (University of California,Santa Cruz (US)); BRUCKEN, Jens Erik (Helsinki Institute of Physics (FI)); TIKKANEN, Joonas (STUK); GOLOVLEVA, Maria; BEZAK, Mihaela (Helsinki Institute of Physics (HIP)); EMZIR, Muhammad (muhammad.emzir@aalto.fi); LUUKKA, Panja (Lappeenranta University of Technology (FI)); BHARTHUAR, Shudhashil (Helsinki Institute of Physics (FI)); SÄRKKÄ, Simo; SIISKONEN, Teemu (STUK); TUUVA, Tuure (Lappeenranta University of Technology (FI))

Presenter: KIRSCHENMANN, Stefanie (Helsinki Institute of Physics (FI))

Track Classification: Medical Applications

Contribution ID: **260** Type: **Recorded Presentation**

Design and construction of the NUCLEUS experiment for the detection of the Coherent Elastic Neutrino Nucleus Scattering

The coherent elastic neutrino nucleus scattering (CEvNS) is a process largely unexplored until today that could provide a new way to study the neutrino fundamental properties and open a window to search for new physics beyond the Standard Model. NUCLEUS is an above-ground CEvNS experiment conceived for the detection of neutrinos from nuclear reactors with unprecedented precision at low energies thanks to cryogenic detectors based on $CaWO_4$ and Al_2O_3 crystals. A prototype detector already demonstrated an ultra-low threshold of 20 eV in nuclear recoil and a rise time of a few 100 us. NUCLEUS will be installed between the two 4.25 GW reactor cores of the Chooz-B nuclear power plant in the French Ardennes and providing an anti-neutrino flux of $1.7\text{x}10^{12}$v/(s cm2). At present, the experiment is under construction and the commissioning of the full apparatus is scheduled in 2022. This talk will show the detectors, shielding and veto systems developed during the last two years and optimized to maximize the sensitivity to the CEvNS signal.

Primary experiment

NUCLEUS

Primary author: DEL CASTELLO, Giorgio

Presenter: DEL CASTELLO, Giorgio

Track Classification: Dark matter and other low-background experiments

Contribution ID: **263** Type: **Recorded Presentation**

Development of CMOS Pixel Sensor prototypes for the CEPC vertex detector

The proposed Circular Electron Positron Collider (CEPC) imposes new challenges for the vertex detector in terms of material budget, spatial resolution, readout speed, and power consumption. The TaichuPix chip is a CMOS Pixel Sensor being developed to meet the highest hit rate (~10^7/cm^2/s) requirement of CEPC vertex detector. Two small scale prototypes capable of achieving a hit rate up to 36 MHz/cm^2, were developed in a 180 nm CMOS process. This talk presents the improvements on the design of in-pixel readout to achieve a pixel pitch of 25 μm and a fast readout capability of 40 MHz. Two new in-pixel digital readout designs, benefiting from the FE-I3 and ALPIDE approaches, have been implemented to achieve a fast readout. The readout of the pixel array is based on a new proposed "column-drain" architecture. Pixels are arranged in double columns, with priority encoder within column and timestamp recorded at the end of double column. All the double columns are read out in parallel, in order to minimize the dead time. When a hit is detected in one of the pixels, the end of column circuitry stores the time stamp with a resolution of 25 ns. The data whose timestamp matches with the trigger are buffered for transmission in the trigger mode. Two TaichuPix prototypes were characterized with electrical and radioactive sources in laboratory. The test results on the chip functionality and the noise and threshold performance before and after ionizing radiation are reported.

Primary experiment

CEPC

Primary author: ZHANG, Ying (Chinese Academy of Sciences (CN))

Co-authors: WEI, Wei (IHEP, CAS, China); WU, Tianya (Institut de Fisica d'Altes Energies (IFAE)(ES)); WEI, Xiaomin; LI, Xiaoting (IHEP, CAS, China); ZHANG, Liang (Shandong University); WANG, Jia (NWPU, China); DONG, Jianing (SDU, China); CASANOVAD, Raimon (IFAE); LIANG, Zhijun (Chinese Academy of Sciences (CN)); GRINSTEIN, Sebastian (IFAE - Barcelona (ES)); BARREIRO GUIMARAES DA COSTA, Joao (Chinese Academy of Sciences (CN))

Presenter: ZHANG, Ying (Chinese Academy of Sciences (CN))

Track Classification: Semiconductor Detectors

Contribution ID: **264** Type: **Recorded Presentation**

Performance Monitoring of the Barrel Time-of-Flight Supermodule for the PANDA Experiment at FAIR

Performance Monitoring of the Barrel Time-of-Flight Super-Module for the PANDA Experiment at FAIR
S. Chesnevskaya, S. Zimmermann, J. Zmeskal
The PANDA experiment at FAIR in Darmstadt will use proton-antiproton collisions, with momenta ranging from 1.5 GeV/c to 15 GeV/c, on a fixed target to study open questions in hadron physics. The Barrel Time-of-Flight detector for this experiment is a scintillating tile hodoscope based on 16 identical and independent subdetectors called Super-Modules arranged in a cylindrical configuration. Extensive studies of the performance of one such Super-Module have been carried out to prove the feasibility of of the Barrel Time-of-Flight detector design. Time resolution, signal delay and amplitude drop along the length of the detector were measured and analyzed as a function of the position on the individual scintillator tiles. An excellent time resolution of about 50 ps has been achieved, which is very important for event timing and particle identification.

Primary experiment

PANDA

Primary author: CHESNEVSKAYA, Svetlana (Austrian Academy of Sciences)

Presenter: CHESNEVSKAYA, Svetlana (Austrian Academy of Sciences)

Track Classification: SiPM

Contribution ID: **265** Type: **Recorded Presentation**

Design and evaluation of UKRI-MPW0: An HV-CMOS prototype for high radiation tolerance and fast charge collection

High-Voltage CMOS (HV-CMOS) sensors are emerging as a prime candidate for future tracking applications that have extreme requirements on material budget, pixel granularity, time resolution and radiation tolerance. HV-CMOS sensors integrate both the sensor and readout circuits into the same substrate, thus eliminating the need for bump-bonding. The high bias voltages widen depletion regions, fasten charge collection and improve radiation tolerance.

The main goal of the R&D programme at Liverpool is to push the boundaries of HV-CMOS sensors to meet the needs of future experiments, especially in terms of single point resolution, fast timing capability and radiation tolerance. This contribution will present our latest HV-CMOS prototype chip, named UKRI-MPW0.

The chip, in the 150 nm HV-CMOS process from LFoundry S.r.l., implements a novel sensor cross-section optimised for backside biasing at unprecedented high voltages. Preliminary measurements have shown the chip is able to sustain high bias voltages much beyond the state of the art, thus promising a large improvement in radiation tolerance. In this 5 mm × 3.5 mm chip, there are two 20 × 29 active pixel matrices (pixel size of 60 μm × 60 μm) for testing three flavours of fast readout electronics with and without Enclosed-Layout Transistors. Several test structures are added for I-V and edge-TCT measurements. The design details and initial performance evaluation, including I-V, gain, noise, and hit map scans, will be presented.

Primary experiment

Primary authors: ZHANG, Chenfan (University of Liverpool (GB)); FRANKS, Matthew Lewis; HAMMERICH, Jan Patrick (University of Liverpool (GB)); KARIM, Nissar Mohammad (University of Liverpool (GB)); POWELL, Samuel (University of Liverpool (GB)); VILELLA FIGUERAS, Eva (University of Liverpool (GB))

Presenter: ZHANG, Chenfan (University of Liverpool (GB))

Track Classification: Semiconductor Detectors

Contribution ID: **266** Type: **Live Presentation**

Designing a Muon Collider Detector

Wednesday, February 23, 2022 11:50 AM (20 minutes)

The particle physics community is currently studying collider projects for the post-LHC era. Among those, muon colliders are particularly interesting due to their ability to reach multi-TeV energies in the environment typical for lepton colliders where backgrounds due to other physics processes are significantly lower than at a hadron collider experiment. However, as muons are unstable particles such a machine will be accompanied with technological challenges for a collider experiment: an unprecedented amount of secondary and tertiary decay products will enter the detector volume. The detector design, choice of technology, and reconstruction algorithms are therefore heavily influenced by the 'beam-induced background' (BIB). In this talk we describe the initial detector concept, present full simulation studies of data reconstruction performance and physics projections at 1.5 and 3 TeV, and outline next steps in the development of a multi-purpose detector for a muon collider with center-of-mass energies up to 10 TeV.

Primary experiment

Muon Collider

Primary authors: LUCCHESI, Donatella (Universita e INFN, Padova (IT)); JINDARIANI, Sergo (Fermi National Accelerator Lab. (US)); MELONI, Federico (Deutsches Elektronen-Synchrotron (DE)); PASTRONE, Nadia (Universita e INFN Torino (IT)); PAGAN GRISO, Simone (Lawrence Berkeley National Lab. (US))

Presenter: JINDARIANI, Sergo (Fermi National Accelerator Lab. (US))

Session Classification: Large Detector Systems

Track Classification: Miscellaneous

Contribution ID: **268** Type: **Live Presentation**

Ion microbeam studies of charge transport in semiconductor radiation detectors with three-dimensional structure

Friday, February 25, 2022 10:10 AM (20 minutes)

Developments of semiconductor detectors with increased tolerance to the high radiation levels are resulting often in devices that deviate significantly from the classical planar electrode designs. Shorter collection distances that are utilised in 3D detectors (silicon and diamond) in which electrodes are penetrating into the crystal bulk, and the introduction of charge multiplication regions such as in silicon LGADs, are two strategies that have been used to increase radiation hardness. One of the possible techniques to explore charge transport properties in such three-dimensional structures is certainly IBIC – ion beam induced charge, a microprobe technique that utilizes single ions of MeV energy range which create charge pairs along the ion trajectory. By the use of different ion species and respective energies, measurable charge signals give insight into carrier transport properties in wide range of detector depths (from 1 to hundreds of micrometers), while 2D raster scanning of ions focussed to micrometre spot size provide planar distribution of charge transport efficiency. Recent improvements of the IBIC setup at the RBI microprobe facility, will be presented along with examples of interpad distance and gain suppression studies in LGAD detectors. In the context of diamond detectors, capabilities of the setup to work at elevated temperatures (up to 450 C) gave us possibilities to characterise charge transport properties and trapping levels in diamond.

Primary experiment

Primary author: Dr JAKSIC, Milko (Ruđer Bošković Institute)

Co-authors: Mr COSIC, Domagoj Donny (Ruđer Bošković Institute); Mr CRNJAC, Andreo (Ruđer Bošković Institute); Dr RODRIGUEZ RAMOS, Mauricio (Ruđer Bošković Institute); Dr PROVATAS, Georgioos (Ruđer Bošković Institute); Mr VIĆENTIJEVIĆ, Milan (Ruđer Bošković Institute)

Presenter: Dr JAKSIC, Milko (Ruđer Bošković Institute)

Session Classification: Semiconductor Detectors

Track Classification: Semiconductor Detectors

Contribution ID: **269** Type: **Recorded Presentation**

Phase 1 Upgrade of the CMS Hadron Barrel Calorimeter

The Phase 1 upgrade of the CMS Hadron Calorimeter detector (HCAL) involved installing silicon photomultipliers (SiPM) to measure the scintillator light output with better signal/noise and upgrading the read-out electronics, allowing for increased longitudinal segmentation and better performance. This talk will summarize the design, testing, installation, and commissioning of the HCAL Barrel Phase 1 upgrade. Performance results for the HCAL endcap and forward detectors using Run 2 data will be presented, together with prospects for Run 3.

Primary experiment

Primary author: ISIK, Candan (Cukurova University (TR))

Presenter: ISIK, Candan (Cukurova University (TR))

Track Classification: Calorimeters

Contribution ID: **272** Type: **Live Presentation**

TOPS: a new class of fast plastic scintillators

Wednesday, February 23, 2022 4:50 PM (20 minutes)

Organic plastic scintillators are largely exploited for fast time detectors thanks to their short scintillation time wrt inorganic crystals. Plastic scintillators are cheap to produce, light and easy to manipulate (standard mechanical workshop can handle the cutting, polishing, etc..). The nowadays best (faster) plastic scintillators are EJ-232 (Eljen Technology) and BC-422 (Saint Gobain) with a rise time of 350 ps, a decay time of 1.6 ns and a pulse width of 1.3 ns. To improve the performances of time detectors the development of faster scintillators can give a crucial contribution, in this framework a collaboration between the physics, engineering, and chemistry groups of University "Sapienza" of Rome and CREF started the TOPS project, focused on the development of a new class of organic scintillators. Comparing the light output and the time properties of the samples with minimum ionizing particles, a selection of the most promising TOPS scintillators has been investigated and characterized (redout with commercial PMTs - Hamamatsu H10721-20). The performance achieved with TOPS samples are extremely promising: a time resolution improvement from 10 up to 35% with respect to the EJ-232 commercial scintillator has been demonstrated. In addition, an increase of light output has been obtained for all samples with a consequent potential improvement in energy resolution measurements of a factor up to 35%.

Primary experiment

Primary author: MARAFINI, Michela

Co-authors: CARLOTTI, Daniele (INFN - Sapienza); DE GREGORIO, Angelica (INFN - National Institute for Nuclear Physics); SARTI, Alessio (Sapienza Universita e INFN, Roma I (IT)); SCIUBBA, Adalberto (INFN e Laboratori Nazionali di Frascati (IT)); TOPPI, Marco (INFN e Laboratori Nazionali di Frascati (IT)); Dr DE MARIA, Patrizia (Sapienza University of Rome, Post-graduate School in Medical Physics, Department of Medico-Surgical Sciences and Biotechnologies, Rome, Italy); DE SIMONI, Micol (Università di Roma "La Sapienza", Fisica, Rome, Italy); FISCHETTI, Marta (INFN - National Institute for Nuclear Physics); Prof. MATTIELLO, Leonardo (Sapienza University of Rome, Department of Basic and Applied Sciences for Engineering, Rome, Italy); FRANCIOSINI, Gaia (INFN - National Institute for Nuclear Physics); Prof. PATERA, Vincenzo (Sapienza University of Rome, Department of Basic and Applied Sciences for Engineering, Rome, Italy); SCHIAVI, Angelo (Università di Roma "La Sapienza"); Mr TRIGILIO, Antonio (Sapienza University of Rome, Department of Physics, Rome, Italy); TRAINI, Giacomo; Dr ROCCO, Daniele (Sapienza University of Rome, Department of Basic and Applied Sciences for Engineering, Rome, Italy)

Presenters: MARAFINI, Michela; TOPPI, Marco (INFN e Laboratori Nazionali di Frascati (IT))

Session Classification: Photon Detectors

Track Classification: Photon Detectors

Contribution ID: **273** Type: **Recorded Presentation**

The Surface Resistive Plate Counter

The principle of operation of standard Resistive Plate Counters (RPC), is based on the use of bulk resistivity electrodes (generally made of bakelite or float-glass): the avalanche (or streamer) current pulses, discharging a limited area around its location, are quenched by the local voltage drop on the resistive electrode. The detector recovery time is proportional to the volume resistivity and the electrode thickness: low volume resistivity and thin electrodes, together with the reduction of the gas gain is the standard recipe to increase the detector rate capability.
The novel approach proposed in this contribution is to realize an RPC based on surface resistivity electrodes manufactured with industrial coating techniques (Diamond-Like-Carbon, DLC) on flexible supports, a completely different concept from the one used in traditional RPCs characterized by volume resistivity. The main advantage of such a solution is that the technology allows to realize electrodes with surface resistivity in a very wide resistive range. Results obtained with hybrid prototypes with one electrode with DLC surface resistivity in the range 1�20 GOhm/square and the second one made of standard float-glass will be presented. Detectors with both electrodes made with DLC film, which seems to require the understanding of photon-feedback as well as field emission effects on DLC surface, will be matter of study in the near future.

Primary experiment

Primary authors: MORELLO, Gianfranco (INFN e Laboratori Nazionali di Frascati (IT)); Dr BENCIVENNI, Giovanni (INFN e Laboratori Nazionali di Frascati (IT)); FELICI, Giulietto (INFN e Laboratori Nazionali di Frascati (IT)); Mr PAPALINO, Giuseppe (Laboratori Nazionali di Frascati - INFN); POLI LENER, Marco (INFN e Laboratori Nazionali di Frascati (IT)); GIOVANNETTI, Matteo (INFN e Laboratori Nazionali di Frascati (IT)); Dr DE OLIVEIRA, Rui (CERN - CH)

Presenter: Dr BENCIVENNI, Giovanni (INFN e Laboratori Nazionali di Frascati (IT))

Track Classification: Gaseous Detectors

Contribution ID: **274** Type: **Recorded Presentation**

3D SuperFGD detector for T2K experiment

The T2K experiment has obtained a first indication of CP violation in neutrino oscillations. To improve its sensitivity to CP violation, the near neutrino detector ND280 will be upgraded to provide a 4\pi solid angle, a low threshold for proton detection and measurement of neutrons using time-of-flight.
A novel 3D highly granular scintillator detector (SuperFGD,) of amass of 2 tons was adopted as a new active neutrino target. It will consist of two millions of small optically-isolated scintillator cubes of 1 cm^3. Each cube is read out in three orthogonal directions with WLS fibers coupled to compact photosensors, MPPC. Parameters of individual cubes (light yield, its nonuniformity, timing) were studied using a beta source and beam particles. Several SuperFGD prototypes were tested in beams with charged particles at CERN and neutrons at Los Alamos. These prototypes showed good performance; high light yield, good timing parameters, low energy threshold for detection of protons, high efficiency for neutron detection, low cross-talk. The production of all scintillator cubes was finished in January 2021, detector is assembled using fishing lines. SFGD will be placed in a special light-protected box which is under construction. Detector electronics and mechanics for SFGD assembly are also under construction. In this talk, the results of the beam tests, obtained parameters, the SFGD current status, plans for installation and commissioning at J-PARC will presented.

Primary experiment

Long baseline neutrino experiment T2K

Primary author: DERGACHEVA, Anna (INR, Moscow)

Co-authors: KUDENKO, Yury (Russian Academy of Sciences (RU)); KHOTJANTSEV, Alexei (Institute for Nuclear Research)

Presenter: DERGACHEVA, Anna (INR, Moscow)

Track Classification: SiPM

Contribution ID: **275** Type: **Live Presentation**

The Silicon Vertex Detector of the Belle II Experiment

Tuesday, February 22, 2022 11:50 AM (20 minutes)

Since the start of data taking in spring 2019 at the Super-KEKB collider (KEK, Japan) the Silicon Vertex Detector (SVD) has been operating reliably and with high efficiency, while providing high quality data: high signal-to-noise ratio, greater than 99% hit efficiency, and precise spatial resolution. These attributes, combined with stability over time, results in good tracking efficiency.
Currently the occupancy, dominated by background hits, is quite low (about 0.5 % in the innermost layer), causing no problems to the SVD data reconstruction. In view of the operation at higher luminosity foreseen in the next years, specific strategies aiming to preserve the tracking performance have been developed and tested on data. The observed trigger jitter allows reduced sampling of the strip amplifier waveform. The good hit-time resolution can be exploited to further improve the robustness against the higher levels of background.
First effects of radiation damage on strip noise, sensor currents and depletion voltage have been measured: they do not have any detrimental effect on the performance of the detector. Furthermore, no damage to the SVD is observed after sudden and intense bursts of radiation due to beam losses.

Primary experiment

Belle II

Primary author: ZANI, Laura (CPPM - Centre de Physique des Particules de Marseille)

Co-author: BETTARINI, Stefano (Univ. + INFN)

Presenter: ZANI, Laura (CPPM - Centre de Physique des Particules de Marseille)

Session Classification: Large Detector Systems

Track Classification: Semiconductor Detectors

Contribution ID: **276** Type: **Recorded Presentation**

Development and tests of WLS plates for Outer Detector of Hyper-Kamiokande

A next generation underground water Cherenkov detector Hyper-Kamiokande will have a total mass of 237 kt of pure water. The inner detector has a cylindrical shape of 67 m in diameter and 69 m in height. This volume is viewed by inward-facing 50 cm PMTs. The outer segment is monitored by outward-facing 10000 PMTs, each embedded in a square Wavelength Shifting (WLS) plate of 30 cm side and 0.6 cm thickness to increase the collection of Cherenkov light. The Outer Detector (OD) acts mainly as a veto for entering particles.
In this talk, we present the results of the measurements of WLS plates manufactured by the V.A.Kargin Polymer Institute, Russia. WLS plates were doped with different WLS fluors. The test bench has a different configuration measurements in air and water, the optical readout was implemented with a Hamamatsu PMT R14374. UV LED light sources were used as an excitation source for each plate. LEDs with wavelengths of 265, 315, 380, and 405 nm covered the full Cherenkov light range of interest. The light yield and attenuation of signals for different WLS plates were measured in air and water. The effect of various WLS dopants and their concentrations was studied. Several reflectors were tested to increase the light yield of WLS plates. It was obtained that the usage of WLS plates in OD gives about a factor of 2 increase in the light signal from Cherenkov radiation compared with the OD configuration with bare PMTs without WLS plates.

Primary experiment

Hyper-Kamiokande

Primary authors: Dr KHOTJANTSEV, Alexei (Institute for Nuclear Research); KUDENKO, Yury (Russian Academy of Sciences (RU)); Dr YERSHOV, Nikolai (Insitute for Nuclear Research); Dr MINEEV, Oleg (Institute for Nuclear Research)

Presenter: KUDENKO, Yury (Russian Academy of Sciences (RU))

Track Classification: Cherenkov Detectors

Contribution ID: **289** Type: **Recorded Presentation**

High resolution photon and neutron imaging options with MCP/Timepix event counting detectors

Event counting detectors with Microchannels Plates coupled to Timepix readouts are considered here for specific UV, soft X-ray and neutron imaging applications where the detection of individual particles enables imaging with high spatial resolution as well as imaging of dynamic processes. The possibility to detect position and time of arrival for each incoming particle enables time-resolved imaging as well as the improvement of spatial resolution well below the size of readout pixel (through the event cetroiding). Our results demonstrate that the spatial resolution of these detectors is currently limited by the size of Microchannel pore spacing (~6 um for photon detection, ~12 um for neutrons) over the active area of 28x28 mm^2. The possibility to perform time-resolved studies of periodic processes, where various phases are imaged simultaneously in one experiment is also demonstrated with imaging frames at a microsecond level, while time tagging of individual events is possible to ns scale, and is expected to be improved to sub-ns with Timepix4 readouts. Time-resolved results from synchrotron-based experiments as well as cluster analysis with scintillator-based detectors will also be demonstrated in this talk.

Primary experiment

Primary author: Dr TREMSIN, Anton (University of California at Berkeley)

Co-authors: Dr LOSKO, Adrian (Forschungs-Neutronenquelle Heinz Maier-Leibnitz); Dr BILHEUX, Hassina (Oak Ridge National Laboratory); Dr CURTIS, Travis (University of California at Berkeley); Dr VALLERGA, John (University of California at Berkeley)

Presenter: Dr TREMSIN, Anton (University of California at Berkeley)

Track Classification: Photon Detectors

Contribution ID: **291** Type: **Recorded Presentation**

The 100μPET project: a small-animal PET scanner for ultra-high-resolution molecular imaging with monolithic silicon pixel sensors

Recent developments in semiconductor pixel detectors allow for a new generation of positron-emission tomography (PET) scanners that, in combination with advanced image reconstruction algorithms, will allow for a few hundred microns spatial resolutions. Such novel scanners will pioneer ultra-high-resolution molecular imaging, a field that is expected to have an enormous impact in several medical domains, neurology among others.

The University of Geneva, the Hôpitaux Universitaires de Genève, and the École Polytechnique Fédérale de Lausanne have launched the 100μPET project that aims to produce a small-animal PET scanner with ultra-high resolution. This prototype, which will use a stack of 60 monolithic silicon pixel sensors as a detection medium, will provide volumetric spatial resolution one order of magnitude better than today's best operating PET scanners.

The R&D on the optimisation of the monolithic pixel ASIC, the readout system and the mechanics, as well as the simulation of the scanner performance, will be presented.

Primary experiment

Primary author: VICENTE BARRETO PINTO, Mateus (Universite de Geneve (CH))

Co-authors: PANDINI, Carlo Enrico (University of Geneva); CADOUX, Frank Raphael (Universite de Geneve (CH)); FERRERE, Didier (Universite de Geneve (CH)); PAOLOZZI, Lorenzo (CERN); SAIDI, Jihad (Universite de Geneve (CH)); VALERIO, Pierpaolo (CERN); IACOBUCCI, Giuseppe (Universite de Geneve (CH))

Presenter: VICENTE BARRETO PINTO, Mateus (Universite de Geneve (CH))

Track Classification: Medical Applications

Contribution ID: **292** Type: **Recorded Presentation**

FlashDC project: development of a beam monitor for Flash radiotherapy

FLASH radiotherapy brings severe challenges to dosimetry, beam control, and treatment verification.
FLASH beam monitors able to measure the rate of impinging particles per pulse are crucial to validate and understand the FLASH effect. The simultaneous request of spatial modulation in dose delivery, high-dose average and instantaneous rates typical of FLASH ask for an accurate beam control that is non-trivial: dose-rate independence, wide dynamic range and specific spatial and temporal resolution are the needed requirements. Until now no technologies fully meet the requirements. The FlashDC project aims to develop an innovative beam monitor for FLASH, based on the physical phenomenon of air fluorescence. Using air as active medium in which fluorescence is developed allows to minimize the impact of the detector on the beam line and to have a device simple and cheap to produce. Fluorescence in air provides a signal unsaturated by the high number of particles per pulse with a very wide dynamic range (typical 1012electron/pulse). Several prototypes of the beam monitors have been developed. Here we present a set of preliminary measurements together with the promising obtained results.

Primary experiment

Primary author: MARAFINI, Michela

Co-authors: DE GREGORIO, Angelica (INFN - National Institute for Nuclear Physics); SARTI, Alessio (Sapienza Universita e INFN, Roma I (IT)); SCHIAVI, Angelo (Università di Roma ”La Sapienza”); SCIUBBA, Adalberto (INFN e Laboratori Nazionali di Frascati (IT)); TOPPI, Marco (INFN e Laboratori Nazionali di Frascati (IT)); TRAINI, Giacomo; TRIGILIO, Antonio (Sapienza University of Rome, Department of Physics, Rome, Italy); CARLOTTI, Daniele (INFN - Sapienza); DE MARIA, Patrizia (Sapienza University of Rome, Post-graduate School in Medical Physics, Department of Medico-Surgical Sciences and Biotechnologies, Rome, Italy); DE SIMONI, Micol (Università di Roma ”La Sapienza”, Fisica, Rome, Italy); FISCHETTI, Marta (INFN - National Institute for Nuclear Physics); FRANCIOSINI, Gaia (INFN - National Institute for Nuclear Physics); GARBINI, Marco; PATERA, Vincenzo (Sapienza University of Rome, Department of Basic and Applied Sciences for Engineering, Rome, Italy)

Presenter: MARAFINI, Michela

Track Classification: Medical Applications

Contribution ID: **298** Type: **Live Presentation**

Recent developments in the field of scintillators for fast radiation detectors

Wednesday, February 23, 2022 4:25 PM (20 minutes)

Since many decades scintillating crystals have been used for radiation detectors such as high resolution electromagnetic calorimeters and positron emission tomographs. Significant progress has been made in the field of inorganic scintillators in the understanding of their scintillation properties, radiation hardness and production methods over the last 30 years. In addition many applications also have more and more need for an improved timing resolution. To this purpose many studies have been carried out in the framework of the Crystal Clear Collaboration on the investigation, improvement and exploitation of different processes for new fast light emission such as wideband semiconductor nanomaterials, hot intraband luminescence, cross luminescence and Cerenkov light, as well as on the production and the assembly of such material: crystal fibers, 3D printing, hybrid structure combining materials with different properties.
In this contribution we will present selected results of recent research efforts and developments on fast timing scintilllators for future detectors.

Primary experiment

Crystal clear Collaboration

Primary author: AUFFRAY HILLEMANNS, Etiennette (CERN)

Presenter: AUFFRAY HILLEMANNS, Etiennette (CERN)

Session Classification: Photon Detectors

Track Classification: Photon Detectors

Contribution ID: **299** Type: **Live Presentation**

MONOLITH - picosecond time stamping capabilities in fully monolithic highly granular silicon pixel detectors

Thursday, February 24, 2022 2:00 PM (20 minutes)

Monolithic silicon pixel detectors are attractive candidates for future large-area trackers in particle physics due to their advantages, for instance to reduce the production effort and material budget. State of the art monolithic silicon pixel detectors can reach high spatial precision. Integrating picosecond time resolution in such devices would significantly improve their performance and further widen their range of applications.
The MONOLITH ERC advanced project aims at achieving this by using SiGe BiCMOS electronics and a novel sensor concept, the Picosecond Avalanche Detector (PicoAD). Standard SiGe BiCMOS processes give access to ultra fast, high gain, low noise, low power frontend, implemented in a large collection electrode monolithic design. Using high-resistivity epitaxial layer material in combination with a continuous deep and thin gain layer, the novel PicoAD sensor concept permits to achieve a picosecond precise detector response over the full pixel cell. Placing the gain layer away from the pixel junctions additionally allows for a small pixel pitch and high spatial precision.
Several prototypes of this technology have been produced and investigated in simulations, laboratory and test-beam measurements. This presentation gives an overview of the novel sensor concept and the designed front end, and discusses the first preliminary results of the project.

Primary experiment

Primary authors: PICARDI, Antonio (Universite de Geneve (CH)); MAGLIOCCA, Chiara (Universite de Geneve (CH)); FERRERE, Didier (Universite de Geneve (CH)); MARTINELLI, Fulvio (EPFL - Ecole Polytechnique Federale Lausanne (CH)); IACOBUCCI, Giuseppe (Universite de Geneve (CH)); RUECKER, Holger (ihp-microelectronics); SAIDI, Jihad (Universite de Geneve (CH)); PAOLOZZI, Lorenzo (CERN); MUNKER, Magdalena (CERN); NESSI, Marzio (CERN); VICENTE BARRETO PINTO, Mateus (Universite de Geneve (CH)); MILANESIO, Matteo (Universite de Geneve (CH)); VALERIO, Pierpaolo (CERN); KOTITSA, Rafaella Eleni (Universite de Geneve (CH)); CARDARELLI, Roberto (INFN e Universita Roma Tor Vergata (IT)); CARDELLA, Roberto (Universite de Geneve (CH)); GONZALEZ SEVILLA, Sergio (Universite de Geneve (CH)); MORETTI, Theo (Universite de Geneve (CH)); GURIMSKAYA, Yana (Universite de Geneve (CH))

Presenter: CARDELLA, Roberto (Universite de Geneve (CH))

Session Classification: Semiconductor Detectors

Track Classification: Semiconductor Detectors

Contribution ID: **301** Type: **Recorded Presentation**

Silicon Detectors for Kaonic Atom X-Ray Measurements at DAFNE

The SIDDHARTA-2 experiment at DAΦNE, aiming to precisely measure the $2p \to 1s$ transition in kaonic deuterium atoms to study the low-energy regime of QCD, utilises two different kinds of novel silicon detectors. For the detection of the $\mathrm{K^-d}$ X-rays, newly developed arrays of Silicon Drift Detectors are used. The CUBE, a MOSFET based preamplifier, allows for a more stable operation and a lower temperature of the SDDs as compared to the JFET technology used for the $\mathrm{K^-p}$ measurement done by SIDDHARTA, leading to faster drift times ($< 1\ \mu$s) and a lower energy resolution of ~ 150 eV at 6 keV.
In addition, the experiment uses Silicon Photomultipliers as part of the active veto system. A barrel of plastic scintillators closely behind the SDDs is read out by the SiPMs to suppress hadronic background. Additionally, this veto system is equipped with a system consisting of pulsed LEDs for the in-situ calibration of the SiPMs. Both detector systems and their characteristics are discussed in detail.

Primary experiment

SIDDHARTA-2

Primary authors: ZMESKAL, Johann (Stefan Meyer Institute); TUECHLER, Marlene

Presenter: TUECHLER, Marlene

Track Classification: Semiconductor Detectors

Contribution ID: **304** Type: **Recorded Presentation**

High level performance of the NA62 RICH detector

NA62 is the last generation kaon experiment at the CERN SPS aiming to measure the branching ratio of the ultra-rare K+⟶π+νν decay with 10% accuracy. The challenging aspect of NA62 is the suppression of background decay channels with branching ratios up to 10 orders of magnitude higher than the signal and with similar experimental signature: one of the main backgrounds comes from the K+⟶μ+ν decay, therefore a highly powerful pion/muon separation is needed. To this purpose good identification (PID) is required. A key element of PID in NA62 is the Ring-Imaging Cherenkov (RICH) detector. According to the NA62 requirements, the RICH identifies μ+ and π+ in the momentum range between 15 and 35 GeV/c with a muon rejection factor of 10−2. It also measures the arrival time of charged particles with a precision better than 100 ps and is one of the main components of the NA62 trigger system. The RICH detector has been successfully operated during the 2016, 2017 and 2018 data taking periods of NA62, being essential in the analysis leading to the first evidence for the observation of the K+⟶π+νν decay. NA62 data taking was resumed in 2021. The main design aspects and operational characteristics of the detector will be described and a detailed report of its performance concerning the π/μ separation, directly measured with the data collected in 2021, will be presented for the first time, together with other preliminary results.

Primary experiment

NA62

Primary author: PANICHI, Ilaria (Universita e INFN, Firenze (IT))

Co-author: Dr BUCCI, Francesca (INFN Florence)

Presenter: PANICHI, Ilaria (Universita e INFN, Firenze (IT))

Track Classification: Cherenkov Detectors

Contribution ID: **305** Type: **Recorded Presentation**

Implementation of large imaging calorimeters

The next generation of collider detectors will make full use of Particle Flow algorithms, requiring high precision tracking and full imaging calorimeters. The latter, thanks to granularity improvements by 2 to 3 orders of magnitude compared to existing devices, have been developed during the past 15 years by the CALICE collaboration and are now reaching maturity. The state-of-the-art status and the remaining challenges will be presented for all investigated readout types: silicon diode and scintillator for a electromagnetic calorimeter, gaseous with semi-digital readout as well as scintillator with SiPM readout for a hadronic one. We will describe the commissioning, including beam test results, of large scale technological prototypes and the raw performances such as energy resolution, linearity and studies exploiting the distinct features of granular calorimeters regarding pattern recognition. Note that, at the time of conference new results obtained in a beam test in Autumn 2021 with a technological prototype of a highly granular silicon tungsten electromagnetic calorimeter will be available. Beyond the mentioned prototypes, the design of experiments addressing the requirements and potential of imaging calorimetry will be discussed. In addition, less established but promising techniques for dedicated devices inverse APD or segmented crystal calorimeters will also be highlighted. In the last year also first results with high resolution timing devices have been obtained. The integration of these devices in the CALICE prototypes is one of the major goals in the coming years.

Primary experiment

CALICE

Primary author: POESCHL, Roman (Université Paris-Saclay (FR))

Presenter: POESCHL, Roman (Université Paris-Saclay (FR))

Track Classification: Calorimeters

Contribution ID: **313** Type: **Recorded Presentation**

High-temperature performance of solid-state sensors

The applicability of SiC diodes as well as single-crystal chemical vapour deposition (sCVD) diamond sensors for particle spectroscopy in high-temperature environments was investigated. An unsealed 241Am alpha-source was used in a vacuum setup for the laboratory measurements. The spectroscopic performance and the leakage current of the detectors were measured as function of temperature, from room temperature up to 300℃. Previously published measurements showed a stable spectroscopic response of sCVD diamond sensors up to 200℃. In this follow-up experiment the temperature was raised to 300℃ and SiC sensors were included in the investigation.

Primary experiment

Primary authors: WEISS, Christina (Vienna University of Technology (AT)); DRESSLER, Rugard (Paul Scherrer Institut); GRIESMAYER, Erich (Vienna University of Technology (AT)); STEINEGGER, Patrick (Paul Scherrer Institut (CH)); TIEBEL, Georg (Paul Scherrer Institut, Villigen PSI, Switzerland); WILSON, Jennifer (Paul Scherrer Institut, Villigen PSI, Switzerland); DEL MAR CARULLA ARESTE, Maria (Paul Scherrer Institut, Villigen PSI, Switzerland); CAMARDA, Massimo (SenSiC GmbH, Park innovAARE, Villigen, Switzerland)

Presenter: WEISS, Christina (Vienna University of Technology (AT))

Track Classification: Semiconductor Detectors

Contribution ID: **318** Type: **Live Presentation**

Charge sensing properties of monolithic CMOS pixel sensors fabricated in a 65 nm technology

Thursday, February 24, 2022 9:25 AM (20 minutes)

Decreasing the process feature size of monolithic CMOS pixel sensors is expected to enhance their overall performance, in terms of time and spatial resolutions, power dissipation and hit handling capabilities. CERN has organized the access to the Tower 65 nm CMOS sensor process, which is currently investigated by a large consortium as a potential technological candidate for the design of sensors to be used in a wide range of future detectors, the closest in time being the ALICE-ITS3 project.

Among other exploratory chips, small pixel matrices, dubbed CE-65, with analogue outputs have been fabricated in 2021. They feature pitches of 15 and 25 µm, various amplification schemes as well as sensing layer modifications allowing for depletion under proper biasing. These prototype sensors are being tested both in labs and in beam to study their charge collection properties, which drive the main performance as detection efficiency and spatial resolution. This contribution will report on the test results contributing to the first evaluation of the detection performance of the Tower 65 nm process.

Primary experiment

ALICE

Primary authors: KLUGE, Alex (CERN); DOROKHOV, Andrei (IPHC, Strasbourg); BESSON, Auguste Guillaume (Centre National de la Recherche Scientifique (FR)); BAUDOT, Jerome (IPHC - Strasbourg); DI MAURO, Antonello (CERN); HU-GUO, Christine (Université de Strasbourg, CNRS); COLLEDANI, Claude Pierre (Centre National de la Recherche Scientifique (FR)); MARRAS, Davide (Universita e INFN, Cagliari (IT)); AGLIERI RINELLA, Gianluca (CERN); USAI, Gianluca (Universita e INFN, Cagliari (IT)); VALIN, Isabelle; JAASKELAINEN, Kimmo Kalevi; WINTER, Marc (Centre National de la Recherche Scientifique (FR)); SULJIC, Miljenko (CERN); SENYUKOV, Serhiy (Centre National de la Recherche Scientifique (FR)); BUGIEL, Szymon (AGH University of Science and Technology (PL)); PHAM, Thanh Hung (Centre National de la Recherche Scientifique (FR)); SARRITZU, Valerio (INFN - National Institute for Nuclear Physics); SNOEYS, Walter (CERN); WU, Yitao (University of Science and Technology of China (CN)); EL BITAR, Ziad (Centre National de la Recherche Scientifique (FR))

Presenter: BUGIEL, Szymon (AGH University of Science and Technology (PL))

Session Classification: Semiconductor Detectors

Track Classification: Semiconductor Detectors

Contribution ID: **320** Type: **Live Presentation**

Studies on alternative eco-friendly gas mixtures and development of gas recuperation plant for RPC detectors

Wednesday, February 23, 2022 2:00 PM (20 minutes)

Resistive Plate Chambers (RPCs) are widely used in particle physics applications, including the CERN LHC experiments. RPCs are often operated with a gas mixture containing C2H2F4 and SF6, both greenhouse gases (GHGs) with a high global warming potential (GWP). The reduction of GHG emissions and the search for eco-friendly alternatives are crucial for use of RPCs in future since F-gases are being phased out in Europe.
The best way to immediately reduce GHG emissions is to use gas recirculation systems. In parallel, CERN gas team is developing a new recuperation system specifically conceived for C2H2F4 and SF6, where good performance has been achieved.
For long-term operation, low GWP gases are studied. Hydrofluoroolefins (HFO), chlorofluorocarbons and 3M Novec are identified as possible replacements for C2H2F4 and SF6. Several eco-friendly gas mixtures were investigated on 2 mm gap RPCs, by measuring detector performance, i.e. efficiency, streamer probability, induced charge, cluster size and time resolution. Studies were done in laboratory and at the CERN Gamma Irradiation Facility (GIF++), which provides a muon beam combined with a gamma source. Comparative analyses were performed between RPC operated with standard mixture and mixtures containing HFO with the addition of He or CO2 or mixtures with alternatives to SF6.
Long-term studies have started at GIF++ where RPCs are operated under recirculation with eco-friendly mixtures to evaluate possible long-term aging effects.

Primary experiment

Primary authors: MANDELLI, Beatrice (CERN); RIGOLETTI, Gianluca (Universite Claude Bernard Lyon I (FR)); GUIDA, Roberto (CERN)

Presenter: MANDELLI, Beatrice (CERN)

Session Classification: Gaseous Detectors

Track Classification: Gaseous Detectors

Contribution ID: **321** Type: **Live Presentation**

A High-granularity Digital Tracking Calorimeter developed for proton CT

Monday, February 21, 2022 4:50 PM (20 minutes)

Hadron therapy is a treatment method that utilizes the energy deposition of protons or heavier ions to concentrate the dose delivered to a patient during the treatment of a malignant tumor. Proton Computed Tomography (pCT) is a novel imaging modality used to reconstruct the relative stopping power (RSP) of an object of interest by tracking single proton trajectories and measuring their residual energy. The Bergen pCT collaboration is constructing a clinical prototype detector capable of both tracking and measuring the energy deposition of ions to minimize uncertainty in proton treatment planning. The pCT detector designed by the Bergen pCT collaboration is a high granularity Digital Tracking Calorimeter (DTC), where the first two layers will be used to obtain positional information of the incoming particle and act as tracking layers. The remainder of the detector will act as a calorimeter. The tracking layers will utilize a carrier made of ~300 µm thick carbon fleece, this is to minimize scattering effects. The DTC will be a 41 layered sandwich structure composed of ALPIDE CMOS sensor chips, which will act as the active part, mounted on 3.5 mm thick aluminum carrier plates, acting as the absorber material. This work will present the implementation of the design, as well as the mechanical and electrical layout of the Bergen pCT. In addition, data from multiple beam experiments will be presented. This includes data taken with electron and hadron beams at various energies.

Primary experiment

Bergen pCT Collaboration

Primary author: EIKELAND, Viljar Nilsen (University of Bergen (NO))

Presenter: EIKELAND, Viljar Nilsen (University of Bergen (NO))

Session Classification: Medical Applications

Track Classification: Medical Applications

Contribution ID: **322** Type: **Live Presentation**

Time resolution of silicon sensors

Friday, February 25, 2022 9:45 AM (20 minutes)

Precision timing with solid state detectors is being employed in many areas of particle physics instrumentation. Applications for pileup rejection and time of flight measurements at the LHC are just two of many notable examples.
During the past years we studied the contributions to the time resolution for various types of silicon sensors. The principal contributors to the time resolution are Landau fluctuations, electronics noise, signal shape fluctuations due to a varying pad response function as well as gain fluctuations. We discuss silicon pad and silicon pixel sensors, LGAD sensors as well as SPADs and SiPMs. The analytic statistical analysis of the contributions to the time resolution has been performed, resulting in elementary expressions for the timing performance of these sensors. These expressions show the basic directions for optimization of these sensors as well as the fundamental limits to the time resolution.

Primary experiment

Primary author: RIEGLER, Werner (CERN)

Presenter: RIEGLER, Werner (CERN)

Session Classification: Semiconductor Detectors

Track Classification: Semiconductor Detectors

Contribution ID: **324** Type: **Recorded Presentation**

Power Efficient High-Frequency Readout Concepts of SiPMs for TOF-PET and HEP

Recent SiPM developments, together with improved readout electronics, opened new doors in TOF-PET and HEP research with a focus on prompt photon detection with inorganic scintillators. For instance, the relatively high Cherenkov yield of Bismuth-Germanate (BGO) upon 511 keV gamma interaction has triggered a lot of interest, especially for its use in total-body PET scanners due to the relatively low production costs of BGO. However, especially in TOF-PET, the electronic readout for BGO still poses unsolved problems. Lab experiments have shown the benefit of Cherenkov detection, with coincidence time resolutions (CTRs) < 200 ps FWHM achieved, but lack system integration due to an unacceptable high power consumption of the used amplifiers. In this contribution we will discuss different readout concepts of modern analog SiPMs for which we tested several high-bandwidth amplifiers, commercially available, small in dimension, cheap and with a power consumption ranging from 288 mW to 17 mW. We found that all tested amplifiers showed similar CTR performance of ~100 ps FWHM coupling a 3x3x3 mm^3 LYSO:Ce cube from Epic-crystals to an S14160-3050HS Hamamatsu SiPM with 3x3 mm^2 active area. The CTR performance with BGO is comparable for all tested amplifiers and the noise contribution to the SPTR is found negligible. A detailed overview and discussion of the front-end readout and key parameters for achieving highest time resolution with prompt photon emitting scintillators will be given.

Primary experiment

Primary author: GUNDACKER, Stefan (RWTH Aachen University)

Co-authors: KRAKE, Mario (RWTH Aachen University); NADIG, Vanessa (RWTH Aachen University); SCHULZ, Volkmar (RWTH Aachen University)

Presenter: GUNDACKER, Stefan (RWTH Aachen University)

Track Classification: SiPM

Contribution ID: **330** Type: **Recorded Presentation**

Development and performance of a fast timing micro-pattern gaseous detector (FTM) for future collider experiments and medical diagnostics

The fast timing MPGD is a micro-pattern gaseous detector conceived for achieving sub-nanosecond time resolution while maintaining the ability to instrument large areas in high-rate environments; applications of such technology are perspected in high-energy physics experiments at future colliders and medical diagnostics with time-of-flight methods. This work is a systematic study carried on a small-size FTM prototype on the performance of GEM foils coated with resistive DLC films, whose performance has been tested with several gas mixtures and compared with the results obtained on conductive foils. The results confirm the development of ever refined coating and etching technologies of resistive laminates is essential for the FTM operation. The ongoing progress towards the improvement of the fast timing principle is also shown, along with the development of a fast time-tagger setup for beam tests.

Primary experiment

Primary authors: PELLECCHIA, Antonello (Universita e INFN, Bari (IT)); VERWILLIGEN, Piet (Universita e INFN, Bari (IT))

Presenter: PELLECCHIA, Antonello (Universita e INFN, Bari (IT))

Track Classification: Gaseous Detectors

Contribution ID: **334** Type: **Recorded Presentation**

The Neutron - Anti-Neutron Oscillation (NNBAR) Experiment at the ESS

The European Spallation Source (ESS) in Lund, currently under construction, is designed to be the most powerful neutron source in the world. Taking advantage of the unique potential of the ESS, the NNBAR collaboration has proposed an experimental program to search for baryon number violation (BNV) due to neutron (n) – anti-neutron ($\bar{n}$) conversions. The sensitivity increase over the previously attained limit obtained at the Institut Laue-Langevin (ILL) is expected to be of three orders of magnitude. The BNV process may occur as free neutrons propagate via ballistic motion to a detector, where the anti-neutrons will annihilate and be detected via their multi-pion decay signature.
To reach the goal of a performance increase of three orders of magnitude, the design and optimization of the NNBAR experiment are underway. This includes the design of the neutron source, the neutron transport and the detector. For the neutron transport a system of optical components consisting of elliptical nested mirrors will be used.
The detector system, comprising calorimetry and tracking is being designed to observe the multi-pion final state arising from the annihilation, to provide the highest possible sensitivity for detecting an anti-neutron event.
In the talk I will give an overview on the present state of the work on the NNBAR experiment with special focus on the optics and detector system.

Primary experiment

NNBAR

Primary author: WAGNER, Richard (Institut Laue-Langevin)

Presenter: WAGNER, Richard (Institut Laue-Langevin)

Track Classification: Miscellaneous

Contribution ID: **336** Type: **Recorded Presentation**

The Photon Detection System of SBND experiment

The SBND (Short Baseline Neutrino Detector) is the near detector of the short baseline neutrino program (SBN) at Fermilab. The SBN consists of three detectors (SBND, MIcroBooNE and Icarus) using liquid argon time projection chambers (LAr-TPC) technology. SBND, is located at 110m from neutrino beam and will record millions of neutrinos charged-current and neutral-current interactions in argon. Beyond searches for sterile neutrinos, the experiment will be able to provide precision studies of neutrino-nucleus interactions in the GeV energy range. One of the goals of the experiment is to develop new technologies which can be used in large scale LAr-TPC. In particular, the scintillation light detection is an area in which SBND is studying a variety of different solutions. The Photon Detection System is a hybrid system, the scintillation light will be readout by an array of standard 8" photomultipliers and also by an array of X-ARAPUCA modules. The X-ARAPUCA is a new generation of light collection device for large LAr-TPC. The PDS will collect not only the direct VUV LAr light, but also the visible one, shifted by the layer of Tetra-Phenyl Butadiene (TPB – emission wavelength around 430nm) deposited on reflective foils installed on the cathode of the TPC. This will allow to test a new version of X-ARAPUCA which is sensitive to visible light, and SBND is the only experiment which will operate this version of X-ARAPUCA.

Primary experiment

Short Baseline Neutrino Detector

Primary author: MACHADO, Ana Amelia (UNICAMP)

Presenter: MACHADO, Ana Amelia (UNICAMP)

Track Classification: Photon Detectors

Contribution ID: **337** Type: **Recorded Presentation**

Upgrade of ASACUSA's Antihydrogen Detector

The goal of the ASACUSA experiment at CERN's Antiproton Decelerator is to measure the difference of the ground state hyperfine splitting of antihydrogen and hydrogen in order to test whether CPT invariance is broken.
The ASACUSA hodoscope is a detector consisting of two layers of 32 plastic scintillator bars and two layers of scintillating fibres, individually read out by silicon photo multipliers (SiPMs). If the antiproton of antihydrogen annihilates in the center of the hodoscope, particles (mostly pions) are produced and travel through the various layers of the detector and produce signals.
The hodoscope was successfully used during the last data taking period at CERN. The necessary time resolution to discriminate between particles travelling through the detector from outside and particles produced in the center of the detector was achieved due to the use of waveform digitizers.
The disadvantage of this readout scheme with digitizers is the slow readout speed, which should be improved by at least one order of magnitude.
To improve the readout speed as well as time resolution, the wave form digitizers were replaced by TDCs reading out the digital time-over-threshold signal produced by the SiPM amplifier boards.
The setup is currently under test and should be installed spring 2022.

Primary experiment

ASACUSA

Primary author: KRAXBERGER, Viktoria

Co-author: CHESNEVSKAYA, Svetlana (Austrian Academy of Sciences)

Presenter: KRAXBERGER, Viktoria

Track Classification: SiPM

Contribution ID: **338** Type: **Recorded Presentation**

Performances of the Large Area Picosecond Photo Detector for the LHCb Upgrade-2

The increase in instantaneous luminosity during the high-lumi phase of the LHC will require detectors capable of mitigating the pileup of proton-proton collisions. A promising strategy is to add the measurement of the time of the hits, exploiting the time separation of the various primary interactions. Time resolutions of the order of 10-20 picoseconds, at least an order of magnitude shorter than the average time span between primary proton-proton collisions, are necessary. A campaign of feasibility studies to exploit the technology of large area picosecond photodetectors (LAPPD) is under investigation for various sub detectors of the LHCb Upgrade-2. The LAPPD is the largest microchannel-plate photomultiplier ever built, all made with inexpensive materials. Laser and electron beam tests at DESY and SPS are used to characterise three LAPPD versions currently available: Gen-I with internal stripline readout and either 10 or 20 um pore sizes, and Gen-II with external pixelated readout and 20 um pore size. Time resolutions as good as 20 ps with single photoelectrons and a few ps with multiple photoelectrons have been demonstrated by the studies. The capabilities of the LAPPD to cope with high rates of incident particles have also been studied. Details of the various experimental setups that have been used and of the relevant results will be shown and discussed.

Primary experiment

LHCb

Primary authors: PERAZZINI, Stefano (Universita e INFN, Bologna (IT)); VAGNONI, Vincenzo (INFN Bologna (IT))

Presenter: PERAZZINI, Stefano (Universita e INFN, Bologna (IT))

Track Classification: Photon Detectors

Contribution ID: **347** Type: **Recorded Presentation**

Microlens-enhanced silicon photomultiplier arrays for LHCb SciFi Tracker Upgrade Ib

A new scintillating fibre (SciFi) tracker is being installed and commissioned as part of the current LHCb Upgrade. The high radiation dominated by fast neutrons reduces the over-all light yield of the detector in the course of LHC Run 3, challenging high hit detection efficiency. The foreseen replacement of the inner fibre mat modules during the next long shutdown (2025 - 2027) requires to exchange the photodetectors. The current R&D is directed to develop microlens-enhanced silicon photomultipliers (SiPMs) to improve photon detection efficiency. The first prototypes have been produced based on the outcome of dedicated simulation studies, and the results for the light yield measurements are presented.

Primary experiment

LHCb

Primary author: TRIPPL, Carina (EPFL - Ecole Polytechnique Federale Lausanne (CH))

Presenters: TRIPPL, Carina (EPFL - Ecole Polytechnique Federale Lausanne (CH)); TRIPPL, Carina (EPFL)

Track Classification: SiPM

Contribution ID: **348** Type: **Recorded Presentation**

Hybrid single-photon imaging detector with embedded CMOS pixelated anode

The development of a single-photon detector based on a vacuum tube, transmission photocathode, microchannel plate and CMOS pixelated read-out anode is presented. This imager will be capable of detecting up to 1 billion photons per second over an area of 7 cm^2, with simultaneous measurement of position and time with resolutions of about 5 microns and few tens of picosecond, respectively. The detector has embedded pulse processing electronics with data-driven architecture, producing up to 160 Gb/s data that will be handled by a high-throughput FPGA-based external electronics with flexible design. These performances will enable significant advances in particle physics, life sciences, quantum optics or other emerging fields where the detection of single photons with excellent timing and position resolutions are simultaneously required.

Primary experiment

Primary authors: COTTA RAMUSINO, Angelo (Universita e INFN, Ferrara (IT)); ALOZY, Jerome Alexandre (CERN); FIORINI, Massimiliano (Universita e INFN, Ferrara (IT)); GUARISE, Marco (Universita e INFN, Ferrara (IT)); CAMPBELL, Michael (CERN); BIESUZ, Nicolo Vladi (Universita e INFN, Ferrara (IT)); CAVALLINI, Viola (Universita e INFN, Ferrara (IT)); LLOPART CUDIE, Xavi (CERN); Mr BOLZONELLA, Riccardo (Universita e INFN, Ferrara (IT))

Presenter: Mr BOLZONELLA, Riccardo (Universita e INFN, Ferrara (IT))

Track Classification: Photon Detectors

Contribution ID: **349** Type: **Recorded Presentation**

Performance of the TOP detector at Belle-II: the first three years

The Belle II Time-Of-Propagation detector is a novel particle identification detector based on the measurement of the propagation time of Cherenkov photons inside a fused silica bar, rather than their impact point on a surface like in RICH and DIRC counters. Similar designs have been proposed for other experiments such LHCb and PANDA, but at the moment TOP is the only operational detector of this kind. The Cherenkov radiation is emitted in thin fused silica bars that also act a light guides, allowing the radiation to reach an array of micro-channel-plate photomultipliers located at one end of the bars. The photomultiplier signal is digitized by zero-deadtime waveform sampling ASIC with time resolution of 20 ps. The waveform features like timing, amplitude and intergral are exctracted online using a Xilinx Zynq FPGA-ARM device.

First collisions were recorded in spring 2018, and now Belle II is entering it high-luminosity phase. We will describe the status of the detector after three years of operation, its performance and the outlook for possible upgrades.

Primary experiment

Belle-II

Primary authors: PINNA ANGIONI, Gianluca (Torino University); TAMPONI, UMBERTO (INFN - National Institute for Nuclear Physics)

Presenters: PINNA ANGIONI, Gianluca (Torino University); TAMPONI, UMBERTO (INFN - National Institute for Nuclear Physics)

Track Classification: Cherenkov Detectors

Contribution ID: **351** Type: **Recorded Presentation**

Time based energy discrimination and pileup recovery for analog SiPM readout

The development of solid state photodetectors likesilicon photomulipliers (SiPMs) has paved the way for a newgeneration of radiation detectors. By utilizing high frequency readout electronics it is possible to access information carried by the first few detected photons. This opens the door for a fully time based detector design without classical charge integration or time over threshold measurement of the full scintillation pulse. Analog SiPMs can be treated in a digital like approach by using two or more time thresholds. In order to validate the feasibility of time based energy discrimination several types of time based estimators were experimentally evaluated with commercially available SiPMs and LYSO:Ce crystals upon 511 keV γ-excitation. By measuring the SiPM signal rise time within the first 150 ps, an error rate below 10 % for photopeak discrimination was achieved.
Moreover, pile-up on the leading edge of the signal pulse induces a sudden change in the leading edge shape. Monitoring this shape fluctuation could prove crucial to identify pile-up at future high-luminosity colliders.

Primary experiment

Primary author: Mr KRATOCHWIL, Nicolaus (CERN)

Co-authors: MARTINAZZOLI, Loris (Universita & INFN, Milano-Bicocca (IT)); GUNDACKER, Stefan (Institute for Experimental Molecular Imaging, RWTH Aachen University, Germany); FRANK, Isabel (Ludwig Maximilians Universitat (DE)); PIZZICHEMI, Marco (Universita Milano-Bicocca (IT) and CERN); AUFFRAY, Etiennette (Cern)

Presenter: Mr KRATOCHWIL, Nicolaus (CERN)

Track Classification: SiPM

Contribution ID: **352** Type: **Live Presentation**

CMOS SPAD Sensor Chip for the Readout of Scintillating Fibers

Thursday, February 24, 2022 2:50 PM (20 minutes)

The detection of light from optical fibers is required in a variety of detector concepts like fiber trackers or sampling calorimeters. Instead of using photo detectors like PMTs or SiPMs and associated readout electronics, we propose to combine Single Photon Sensitive Avalanche Diodes (SPADs) and CMOS readout electronics on the same silicon die. We have developed, fabricated and initially characterized such a 'Digital SiPM' solution. In order to provide a high flexibility in fiber diameters and positions, our architecture allows for assigning the individual SPADs to 'groups' which are routed to chip pins. The purely digital output signals provide the timing by the rising edge and an amplitude information by the pulse width. The first available chip has been successfully used to detect light of individual fibers from a fiber bundle. The proposed concept could significantly reduce the mechanical and electronic complexity as well as the cost of fiber readouts and possibly improve their performance.

Primary experiment

Primary author: FISCHER, Peter

Co-authors: Mr MAISANO, Benedict (Heidelberg University); Mr ZIMMERMANN, Robert (Heidelberg University)

Presenter: FISCHER, Peter

Session Classification: Semiconductor Detectors

Track Classification: SiPM

Contribution ID: **355** Type: **Live Presentation**

The Scintillating Fibre Tracker for the LHCb Upgrade

Tuesday, February 22, 2022 4:50 PM (20 minutes)

LHCb is undergoing a major upgrade during LHC LS2 to be completed in February 2022 to cope with increased instantaneous luminosities and a trigger-less 40 MHz read-out to improve on many world-best physics measurements. A light and homogeneous detector based on plastic scintillating fibres will be installed downstream of the LHCb dipole magnet.
The Scintillating Fibre (SciFi) tracker covers an area of 340 m2 by using more than 10,000 km of blue emitting scintillating fibre with 250 µm diameter, enabling a spatial resolution of
better than 80 µm for charged particles and a hit efficency better than 99%. Six-layer fibre mats of 2.4 m length are assembled to form individual detector modules (0.5 m x 4.8 m) consisting of eight fibre mats each. Linear arrays of Silicon Photomultipliers cooled to -40 ℃ are placed at the fibre ends. The readout of 524k channels occurs through custom-designed front-end electronics with fast 10 ns shaping, dual integrators, and a 3-comparator flash ADC to digitise the signals. An FPGA clusters the signals over threshold and outputs a barycentre to the 40 MHz DAQ farm with a total bandwidth of over 20 Tbits/sec.
At the time of the conference, the tracker assembly will have been completed and installed underground at LHCb. The talk will give a brief overview of the SciFi detector design, production, performance, the experience from the assembly and an early commissioning status.

Primary experiment

LHCb

Primary author: SOARES LAVRA, Lais (Université Clermont Auvergne (FR))

Co-author: LEVERINGTON, Blake (Ruprecht Karls Universitaet Heidelberg (DE))

Presenter: SOARES LAVRA, Lais (Université Clermont Auvergne (FR))

Session Classification: Large Detector Systems

Track Classification: Photon Detectors

Contribution ID: **357** Type: **Recorded Presentation**

Cold electronics for the readout of the DUNE liquid Argon TPC

The DUNE experiment's goals of precision studies of neutrino oscillations, searches for proton decays, and observation of neutrinos from supernova explosions require low noise electronics for the readout of the time project chamber anodes immersed in liquid Argon.
This presentation discusses the design of the readout system for the first DUNE far detector module that uses wire based anode plane assemblies as the sensing element of the TPC, and in particular the chain of custom designed application specific integrated circuits that are used to amplify, digitize, and serialize the signals from the TPC wires. These ASICs are mounted on front-end motherboards that are installed on the APAs inside the cryostat, which is crucial in order to meet the noise specifications of DUNE. This presentation reviews the development of the ASICs and the FEMBs, measurements obtained from standalone prototypes, as well as performance measurements from small scale tests where the FEMBs are installed on APAs operated at cryogenic temperatures.

Primary experiment

Primary author: LIN, Cheng-Ju Stephen (Lawrence Berkeley National Lab. (US))

Presenters: LIN, Cheng-Ju Stephen (Lawrence Berkeley National Lab. (US)); UCHIDA, Melissa (University of Cambridge (GB))

Track Classification: Electronics

Contribution ID: **362** Type: **Invited Talk**

Cryogenic detectors for rare event searches

Tuesday, February 22, 2022 9:00 AM (40 minutes)

Low-temperature single-quantum detectors have long been used in the search for new physics beyond the Standard Model.
Since they were first proposed for neutrino physics experiments in 1984 by E. Fiorini and T. Niinikoski, there have been impressive technical advances: today these techniques offer the high energy resolution and scalability required for competitive experiments that address many outstanding questions.
For decades low-temperature detectors of different sizes have been adapted to provide optimal performance in the energy range of a few eV to a few MeV and thus to be exploited for dark matter searches, neutrinoless double beta decay, coherent neutrino scattering, and for direct neutrino mass measurements.
In this talk I will review the most widely used and advanced sensing techniques based on doped semiconductor sensors, transition-edge sensors, metallic magnetic sensors, and microwave microresonator sensors. In addition, I will introduce new quantum devices, such as those based on superconducting qubits, which have recently made it possible to design new experiments that extend the range of new physics research, particularly with respect to dark matter.
Finally, I will also highlight the most competitive experiments using these technologies and their most exciting prospects in the challenges for the search for new physics beyond the Standard Model.

Primary experiment

Primary author: NUCCIOTTI, Angelo Enrico Lodovico (INFN - National Institute for Nuclear Physics)

Presenters: NUCCIOTTI, Angelo Enrico Lodovico (INFN - National Institute for Nuclear Physics); NUCCIOTTI, Angelo (Universita' di Milano-Bicocca and Sezione di Milano-Bicocca dell'INFN); ENRICO LODOVICO NUCCIOTTI, angelo

Session Classification: Dark matter and other low-background experiments

Track Classification: Dark matter and other low-background experiments

Contribution ID: **363** Type: **Recorded Presentation**

TAIGA - a hybrid detector for the high energy gamma-ray astro-physics and the cosmic ray physics in the Tunka valley

The TAIGA (Tunka Advanced Instrument for cosmic ray physics and Gamma Astronomy) facility aims to study the very high energy gamma-rays at energies from a few TeV to several PeV, as well as cosmic rays from 100 TeV to several EeV. Combination of the wide-angle Cherenkov timing detector TAIGA-HiSCORE with the 4-m class Imaging Atmospheric Cherenkov Telescopes (TAIGA-IACT) of FoV of 9,6 degrees offers a cost-effective way to construct a large array for very high energy gamma astrophysics. At present the one square km installation TAIGA-1 is in operating in Tunka valley, ~50 km West from the southernmost tip of the lake Baikal. It consists of 120 TAIGA-HiSCORE wide-angle (0.6 ster) stations distributed over an area of.1,1 km^2, three 4-m class Imaging Atmospheric Cherenkov Telescopes (IACT) with FoV of 9.6 degrees and 250 m2 of particle detectors. The effective area of the system of 3 IACTs completely covers the area of TAIGA-HISCORE wide-angle installation of the TAIGA-1 complex for gamma-ray energy above 80 TeV. The next plans for the development of the TAIGA-1 installation include the deployment of 2 more IACTs. We expect a sensitivity of the TAIGA-IACT installation with 5 IACTs in the novel, hybrid stereo mode for detecting gamma-rays with energies greater than 10 TeV for 100 hours of observation of 10^{-12} TeV cm^{-2} s^{-1} and an angular resolution of 0.2 degrees. The future development plan of the TAIGA array up to 10 km² is presented.

Primary experiment

TAIGA

Primary author: BUDNEV, Nikolay

Presenter: BUDNEV, Nikolay

Track Classification: Astroparticle Detectors

Contribution ID: **364** Type: **Invited Talk**

ECFA Detector R&D Roadmap

Monday, February 21, 2022 9:30 AM (40 minutes)

The European Strategy for Particle Physics Update recommended that "Organised by ECFA, a roadmap should be developed by the community to balance the detector R&D efforts in Europe, taking into account progress with emerging technologies in adjacent fields". This Roadmap which is based on the input of the community and was developed within the Detector R&D Panel, was approved by ECFA and published at the end of 2021. In this talk the findings of the Task forces and the corresponding detector technology areas or cross-cutting activities will be presented. The important drivers and general strategic recommendations for future Detector R&D will be highlighted.

Primary experiment

Primary author: KUEHN, Susanne (CERN)

Presenter: KUEHN, Susanne (CERN)

Session Classification: Large Detector Systems

Track Classification: Miscellaneous

Contribution ID: **365** Type: **Invited Talk**

Particle detectors for medical applications

Monday, February 21, 2022 4:00 PM (40 minutes)

Primary experiment

Primary author: SCHAART, Dennis (Delft University of Technology)

Presenter: SCHAART, Dennis (Delft University of Technology)

Session Classification: Medical Applications

Track Classification: Medical Applications

Contribution ID: **366** Type: **not specified**

Introduction

Monday, February 21, 2022 9:10 AM (10 minutes)

Presenter: KRAMMER, Manfred (CERN)

Session Classification: Opening

Contribution ID: **367** Type: **not specified**

Welcome

Monday, February 21, 2022 9:20 AM (5 minutes)

Presenter: SCHIECK, Jochen (Austrian Academy of Sciences (AT))

Session Classification: Opening

Contribution ID: **368** Type: **not specified**

Information from the organisers

Monday, February 21, 2022 9:25 AM (5 minutes)

Presenter: KRAMMER, Manfred (CERN)

Session Classification: Opening

Contribution ID: **369** Type: **not specified**

NIM A Young Scientists Awards

Friday, February 25, 2022 3:50 PM (20 minutes)

Primary experiment

Presenter: JORAM, Christian (CERN)

Session Classification: Awards and Closing

Contribution ID: **370** Type: **not specified**

Closing

Friday, February 25, 2022 4:10 PM (10 minutes)

Presenter: KRAMMER, Manfred (CERN)

Session Classification: Awards and Closing

Contribution ID: **371** Type: **Organisation**

Group Photo

Friday, February 25, 2022 3:40 PM (10 minutes)