5th International Workshop on New Photon-Detectors (PD18)

Report of Contributions

https://indico.ipmu.jp/e/166

Contribution ID: **2** Type: **Oral**

Fast-timing microchannel plate photodetectors: design, fabrication and characterization

Thursday 29 November 2018 10:15 (20 minutes)

We report detailed design, fabrication and characterization of 6 × 6 cm^2 fast timing photodetectors based on next-generation microchannel plates (MCP). The whole assembly is made of low-cost borosilicate glass materials and hermetically sealed with a bialkali photocathode in a vacuum. The flexible photodetector design provides the potential of modifying individual components as well as the entire configuration to fit for different applications. A series of prototype MCP-photodetectors were fabricated following a step-by-step process including functionalization of glass capillary array through atomic layer deposition, MCP baking and scrubbing, photocathode deposition and hermetic thermo-compression sealing. The prototype MCP-photodetectors exhibit electron gains well beyond 107 level with excellent relative uniformity. The photodetectors present fast rise time of ~ 500 ps level and fall time of ~ 1.5 ns. Excellent timing resolution at single photoelectron mode of 20 ps and magnetic field tolerance up to 1.3 Tesla were achieved for photodetector with 10 μm pore size MCPs, comparing to that of 63 ps and 0.7 Tesla for the one with 20 μm pore size MCPs.

Primary author: XIE, Junqi (Argonne National Laboratory (US))

Co-authors: Dr DEMARTEAU, Marcel (Argonne National Laboratory); Dr MAY, Edward (Argonne National Laboratory); Dr WAGNER, Robert (Argonne National Laboratory); Dr XIA, Lei (Argonne National Laboratory)

Presenter: XIE, Junqi (Argonne National Laboratory (US))

Session Classification: Thursday morning

Contribution ID: **3** Type: **Oral**

First precision spectroscopy of cesium-137 from the ground to 150 m above in Fukushima

Wednesday 28 November 2018 16:40 (20 minutes)

After the Fukushima nuclear disaster in 2011, large amounts of radioisotopes (mainly ^{137}Cs and ^{134}Cs) were released into the environment. Various monitoring activities have revealed radiation on the ground both in local and wide areas; however, aerial dose variation in the vertical direction is poorly known.
This paper presents the first results of airborne gamma-ray spectroscopy of a contamination field in Namie, Fukushima, as measured from 0 m to 150 m above the ground by drone.
We found that the gamma-ray dose rate measured at 100 m height is about seven times higher than that expected based on ground measuring, which is caused by two factors: (1) the integrated dose includes contamination of upward scattered 662-keV gamma rays and (2) radiation from ^{137}Cs is vertically collimated because ^{137}Cs is buried in the soil. We also argue novel method to obtain the distribution of radioactive substances in the soil only through aerial mapping.

Primary author: KURIHARA, Takuya (Waseda University)

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Presenter: KURIHARA, Takuya (Waseda University)

Session Classification: Wednesday afternoon

Contribution ID: **4** Type: **Oral**

Evaluation of a novel photon-counting CT system using a 16-channel MPPC array for multicolor 3-D imaging

Wednesday 28 November 2018 17:00 (20 minutes)

X-ray computed tomography (CT) is widely used in diagnostic imaging of the interior of the human body; however, the radiation dose of conventional CT typically amounts to 10 mSv. Under such environments, X-ray photons are severely piled-up; therefore, the CT images are monochromatic and various artifacts are present due to beam hardening effects. In contrast, photon counting CT (PC-CT) offers a low dose and multicolor CT system. At present, PC-CT systems based on CdZnTe devices are widely studied. This system is yet far from being an established clinical technique, owing to the high-cost and complexity of huge number of read out channels; the pixel size of CdZnTe must be as small as ~0.1-0.2 mm to withstand high counting rate due to the slow mobility of electron-hole pairs. In this paper, we propose a cost-effective, novel CT system consisting of 16-ch multipixel photon counter (MPPC) coupled with a high-speed scintillator array. As a proof of concept, we show 3-D color images of a lighter phantom taken in a sufficiently low-dose environment. Material identification is possible by setting multiple energy windows. Next, we applied our PC-CT system for K-edge imaging, which can improve blood-tissue contrast using a specific contrast agent. By setting appropriate energy windows, our PC-CT system accurately reconstructed absolute concentration of iodine and gadolinium. Finally, we discuss the prospects and possible future clinical applications of the developed PC-CT system.

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Presenter: Mr MARUHASHI, Takuya (Waseda University)

Session Classification: Wednesday afternoon

Contribution ID: **5** Type: **Oral**

High-Density Silicon Photomultipliers with Epitaxial Quenching Resistors at NDL

Tuesday 27 November 2018 10:15 (20 minutes)

Silicon photomultipliers (SiPMs), also known as multi-pixel photon counters (MPPCs), represent an alternative solution that to a large extent combines the advantages of PMTs and APDs. They have high gain, low bias voltage, excellent timing properties and are insensitive to magnetic fields. SiPMs are replacing the traditional PMTs gradually in various applications like high energy physics, astrophysics and nuclear medical imaging. Novel Laboratory Device (NDL) SiPM uses the bulk resistors in the epitaxial layer as quenching resistor (EQR SiPM); it avoids the use of polysilicon employed by other SiPM as an absorber of light and can potentially lead to a higher photon detective efficiency (PDE) and large dynamic range. NDL EQR SiPM features small micro cells with high fill factor, fast response to even a single photon, simple fabrication technology and excellent packing fraction. This report detail the latest progress of EQR SiPM at NDL. The device has active area of 3×3 mm2, comprising 90000 individual cells, a dark count rate of 700 kHz/mm2, the peak PDE was typically 34% for 420 nm photons. The PDE was characterized using both photon counting method and Poisson method. The photon counting method is modified by use of making analysis of the noise component through deducting the correlated-noise component. By analyzing the scatter plot to fitting the recovery curve, the recovery time constant for the microcell of EQR SiPM was obtained approximately 4.0 ns. An intrinsic single photon timing resolution was optimized as 81 ps (FWHM) under 9 V overvoltage at room temperature.

Primary authors: Dr LIANG, Kun (Novel Device Laboratory, Beijing Normal University); Dr LI, Baicheng (Novel Device Laboratory, Beijing Normal University); Mr DAI, Lei (Novel Device Laboratory, Beijing Normal University); Ms LIU, Hongmin (Novel Device Laboratory, Beijing Normal University); Dr YANG, Ru (Novel Device Laboratory, Beijing Normal University); Prof. HAN, Dejun (Novel Device Laboratory, Beijing Normal University)

Presenter: Prof. HAN, Dejun (Novel Device Laboratory, Beijing Normal University)

Session Classification: Tuesday morning

Contribution ID: **6** Type: **Poster**

Gain Stability Evaluation of 50 cm Diameter Photomultiplier Tubes for Hyper-Kamiokande with Optimizing the Voltage Ratio

Tuesday 27 November 2018 18:00 (2 minutes)

Hyper-Kamiokande (HK), scheduled to start construction in 2020, will be the next generation water Cerenkov experiment in Japan. 50 cm Diameter Box & Line Photomultiplier Tubes (R12860 made by Hamamatsu) were evaluated. The dynamic range of the output was improved by optimizing the voltage dividing ratio between dynodes. The linearity and rate tolerance of the gain were also evaluated.

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Presenter: MOCHIZUKI, Toshiki (ICRR)

Session Classification: Poster session

Contribution ID: **7** Type: **Poster**

The Calibration and Evaluation of 140 20-inch Box and Line Photomultiplier Tubes Designed for Hyper-Kamiokande

Tuesday 27 November 2018 18:02 (2 minutes)

As the next generation of water Cherenkov detector, Hyper-Kamiokande (Hyper-K) has the potential to advance the study of a variety of physics ranging from proton decay to neutrino oscillations. With the first Hyper-K tank's construction scheduled in 2020, it is vital to validate the feasibility of mass production for the 20" Box and Line (B&L) photomultiplier tubes (PMTs) designed for Hyper-K. By this summer, we have finished the measurement of around 140 new B&L PMTs that arrived at Super-Kamiokande (SK) and replaced the Venetian blind PMTs inside during the SK tank opening. Important parameters including the voltage supply (HV), collection efficiency, transit time spread, magnetic field effect, dark rate, etc. were recorded for each individual PMT and used for simulation of group performance inside SK. Our purpose was to know the quality of these PMTs and to select those qualified for installation in SK. In addition, the results of this calibration are also used as a reference to improve the upcoming Hyper-K PMT production, for which the most important goal is to understand the stabilized dark rate through long term operation in SK. In our sample group, we have observed no systematic issue or unqualified PMTs. Over 90% of the PMTs from our sample group have been installed at different vertices in the SK tank. By comparing these newly installed PMTs to the old ones, the Hyper-K's physical reach can be double checked with the SK detector simulation including the new B&L PMTs.

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Presenter: Mr XIA, Junjie (Institute for Cosmic Ray Research, The Univ. of Tokyo)

Session Classification: Poster session

Contribution ID: **8** Type: **Oral**

Calibration and Development of preamplifier for 8-inch Hybrid Photo Detector

Thursday 29 November 2018 14:40 (20 minutes)

Direct measurement of internal properties of the Earth using neutrino has been discussed for more than 30 years. Discovery of the neutrino oscillations opened a new window for geoscience, as well as for particle physics. By measuring matter effect of neutrinos oscillations of atmospheric neutrinos that penetrate through the Earth, and by comparing them with our knowledge of Earth's density profile, we obtain electron density of Earth's core that constrains its chemical composition (Neutrino Spectrometry).

The most challenging part of the method is to build a mega-ton to giga-ton neutrino detector that has sensitivity in GeV energies. In-fill strings of IceCube-Gen2 can be one of the candidates that fulfill the condition.

We present our calibration studies of Hamamatsu Hybrid Photo Detector (Hamamatsu R12112) as a candidate of optical sensor for future large volume neutrino detectors. Our new preamplifiers for Hamamatsu R12122, newly developed to take maximum advantage of HPD's superior timing resolution and charge resolution will be introduced.

Primary authors: Dr TAKETA, Akimichi (Earthquake Research Institute, the University of Tokyo); Dr HOSHINA, Kotoyo (Earthquake Research Institute)

Presenter: Dr HOSHINA, Kotoyo (Earthquake Research Institute)

Session Classification: Thursday afternoon

Contribution ID: **9** Type: **Oral**

First demonstration of portable Compton camera to visualize 223-Ra concentration for radionuclide therapy

Wednesday 28 November 2018 17:20 (20 minutes)

Radionuclide therapy (RNT) is an internal radiation therapy that can selectively damage cancer cells. Very recently, the use of alpha-emitting radionuclides was initiated in RNT owing to its dose concentration and short range. In particular, 223-Ra is widely used for bone metastasis cancer. Despite its potential for clinical applications, it is difficult to see whether the drug has been properly delivered to the target lesion; thus, large uncertainties remain regarding the optimal dosage for each patient. As such, we propose a new method of monitoring nuclear gamma rays promptly/simultaneously emitted from 223-Ra in alpha-decay by using a high-sensitivity Compton camera. We first observed a small bottle of 223-Ra solution that had a total radio-activity of 0.56 MBq. By selecting gamma lines of 270 and 351 keV, the reconstructed image converged at the correct position with a position resolution of ~20 mm at a plane 10 cm ahead of the camera. Next, we observed a phantom consisting of three spheres, with diameters ranging from 13 to 37 mm, filled with 223-Ra solution (9 kBq/ml) and then surrounded by a ~20-cm layer of water. A 3D image was constructed by rotating the Compton camera around the phantom. Then, images were taken from eight directions at 30-min intervals, respectively. Although the image resolution remains limited at 351 keV, three spheres were resolved at the correct position in the 3D image with their relative intensities. Finally, we discuss current problems and plans for improving the sensitivity and angular resolution for future clinical applications.

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Presenter: Mr FUJIEDA, Kazuya (Waseda University)

Session Classification: Wednesday afternoon

Contribution ID: **10** Type: **Oral**

Development of a UV-transparent Lens Array Enlarging the Effective Area of Multi-channel SiPMs

Wednesday 28 November 2018 11:05 (20 minutes)

Recent progress of the SiPM technologies, such as high photon detection efficiency (PDE) and well-suppressed optical crosstalk have made it possible to replace conventional photomultiplier tubes (PMTs) with SiPMs in many applications. However SiPM prices per unit area is still higher than those of PMTs, and thus production of a large SiPM array is not cost effective yet. We have developed a UV-transparent lens array for multi-channel SiPMs, with which incident photons can be concentrated onto a smaller region of the SiPM surface, resulting in a larger effective area with the same SiPM size. We report a ray-tracing simulation and measurement result of the lens array performance.

Primary author: OKUMURA, Akira (ISEE, Nagoya University)

Presenter: OKUMURA, Akira (ISEE, Nagoya University)

Session Classification: Wednesday morning

Contribution ID: **12** Type: **Oral**

Development of the front-end electronics for the new optical module "D-Egg" for IceCube-Gen2

Wednesday 28 November 2018 16:00 (20 minutes)

IceCube-Gen2 is an extension of IceCube Neutrino Observatory at the South Pole to significantly enhance the detection sensitivity to high-energy as well as low energy neutrinos. It occupies $\sim$8 km^3 of Antarctic ice and an array of $\sim$10,000 optical modules to capture Cherenkov photons efficiently from the secondary charged particles produced in the neutrino interactions.

The novel optical module called "D-Egg" is being developed as a main component of the IceCube-Gen2 detector. A D-Egg contains two 8-inch high-QE PMTs facing up and down inside the ellipsoid vessel made of UV transparent borosilicate glass along with the front-end electronic board. Photo-electron signals from two PMTs are digitized with two 250 MSPS 14 bit ultra-low power ADCs and processed in an FPGA before being sent to the surface DAQ system, located 1.5–2.5 km above the array of optical modules.

This presentation focuses on the evaluation of the first prototype of the front-end board for D-Egg. The location of the detector places constraints on power consumption ($<$4 W). All components must work at low temperature (-40°C). Small dead-time ($<$1%) and wide dynamic range of 1–300 photo-electrons/10 ns are required for the best physics performance. The first prototype shows that the design of the current board satisfies the physics requirements with small modifications. Performances of the prototype board at low temperature are also verified. Results of the first evaluations as well as the future prospects for D-Egg developments are discussed in this contribution.

Primary author: NAGAI, Ryo (Chiba University)

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Presenter: NAGAI, Ryo (Chiba University)

Session Classification: Wednesday afternoon

Contribution ID: **13** Type: **Poster**

Measurements of low-energy X-rays with a detector using a plastic scintillator and an MPPC

Tuesday 27 November 2018 18:06 (2 minutes)

A MPPC (Multi-Pixel Photon Counter) has some advantages in a low-voltage operation and easily making a multi-element type detector, when comparing with a photomultiplier tube. We tried to detect soft X-rays of less than 6 keV with a scintillation detector using an MPPC. The detector consists of a plastic scintillator (Pilot U, 2.5×2.5 mm^2, 1 mm thick) and an MPPC (Hamamatsu Photonics, S13360-6642, 3×3 mm^2, pixel size: 25 μm, without a resin window). We measured pulse-height spectra using a charge-sensitive preamplifier (Canberra 2005, 22.7 mV/pC), cooled down to −10℃. The detector could clearly distinguish 6 keV X-rays from noise signals. We also measured time spectra of X-ray pulse structure of 2-ns intervals in the multibunch operating mode of a Photon Factory ring. A time resolution (Full width of half-maximum) of 0.51±0.06 ns was obtained at a bias voltage of +60 V and at −10℃, using a fast amplifier having a gain of 100.

Primary authors: Prof. KISHIMOTO, Shunji (IMSS, KEK); Prof. AMEMIYA, Kenta (IMSS, KEK); Dr SAKAMAKI, Msako (IMSS, KEK)

Presenter: Prof. KISHIMOTO, Shunji (IMSS, KEK)

Session Classification: Poster session

Contribution ID: **14** Type: **Oral**

Fast Charged Particle Detector with High Dynamic Range at Horizon-10T Cosmic Rays Detector System

Thursday 29 November 2018 11:25 (20 minutes)

Horizon-10T (H10T) detector system is constructed to study the Extensive Air Showers (EAS) with energy of the primary particle above 10^16 eV. Detector system consists of 10 detection points. The aim of the H10T is the study of the spatial and temporal structure of EAS events. For that purpose, each detection point should have high time resolution, so the fast time response of the components. H10T detection points were equipped with the fastest PMT-based particle detectors with 2 ns rise time of the pulse. Single detector consists of the optical glass as the detection medium and fast Hamamatsu R7723 photomultiplier tube (PMT). Detectors allow single minimum ionizing particle (MIP) calibration and have dynamic range up to 3000 MIP for cosmic rays detection. Simulation, construction and calibration of this detector system will be presented.

Primary author: BATYRKHANOV, Ayan (Nazarbayev University)

Presenter: BATYRKHANOV, Ayan (Nazarbayev University)

Session Classification: Thursday morning

Contribution ID: **15** Type: **Oral**

Large Area Photo-Detection System using 3-inch PMTs for the Hyper-Kamiokande Outer Detector

Thursday 29 November 2018 14:20 (20 minutes)

Hyper-Kamiokande, scheduled to begin construction as soon as 2020, is a next generation underground water Cherenkov detector, based on the highly successful Super-Kamiokande experiment. It will serve as a far detector, 295 km away, of a long baseline neutrino experiment for the upgraded J-PARC beam in Japan. It will also be a detector capable of observing — far beyond the sensitivity of the Super-Kamiokande detector — proton decay, atmospheric neutrinos, and neutrinos from astronomical sources.

An Outer Detector (OD) consisting of PMTs mounted behind the inner detector PMTs and facing outwards to view the outer shell of the cylindrical tank, it would provide topological information to identify interactions originating from particles outside the inner detector. Any optimization would lead to a significant improvement for the physics goals of the experiment, which are the measurement of the CP leptonic phase and the determination of the neutrino mass hierarchy.

An original setup using small 3”PMTs is being designed for the Hyper-K OD. They would give better redundancy, spatial, and angular resolution, as they would be twice or three times more photo-sensors that the original 8”design proposal of the experiment, and for a reduce cost. In this presentation, I will show the characterization of several 3”PMTs candidates considered for the Hyper-K OD, tested at Queen Mary University London. Moreover, I will carefully assessed the measurement stand performances, and evaluation of the systematics. I will show how we are minimizing those by working with state-of-the-art software and DAQ.

Primary author: Dr ZSOLDOS, Stephane (Queen Mary University London)

Presenter: Dr ZSOLDOS, Stephane (Queen Mary University London)

Session Classification: Thursday afternoon

Contribution ID: **16** Type: **Oral**

Plastic scintillator detector with the readout based on an array of large-area SiPMs for the ND280/T2K upgrade and SHiP experiments

Tuesday 27 November 2018 16:05 (20 minutes)

Plastic scintillator detectors are extensively used in particle physics experiments for decades. A large-scale detector is typically arranged as an array of staggered long bars which provide a fast trigger signal and/or particle identification via time-of-flight measurement. Scintillation light is collected by photosensors coupled to the both ends of every bar. In this talk we present our study on a direct replacement of commonly used phtomultiplier tubes by arrays of large-area SiPMs. An SiPM array which is directly coupled to the scintillator bulk, has a clear advantage with respect to PMT: compactness, mechanical robustness, high PDE, low operation voltage, insensitivity to magnetic field, low material budget, possibility to omit light-guides. In this study arrays of eight 6 mm x 6 mm area SiPMs from HPK were coupled to the ends of a plastic scintillator bars with 1.5 m, 1.68 m and 2.3 m lengths. An 8 channel SiPM anode readout ASIC (MUSIC R1) was used for the readout, amplification and summation of signals of individual SiPMs. Timing characteristics of a large-scale detector prototype has been studied in test-beams at the CERN PS. This technology is proposed for the ToF system of the ND280/T2K upgrade at JPARC and the timing detector of the SHiP experiment at CERN SPS.

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Presenter: Dr KORZENEV, Alexander (University of Geneva (CH))

Session Classification: Tuesday afternoon

Contribution ID: **17** Type: **Poster**

MaPMT relative efficiency measurements for the LHCb RICH upgrade

Tuesday 27 November 2018 18:08 (2 minutes)

The Large Hadron Collider beauty experiment (LHCb) at CERN is aimed to study flavor-physics. The Ring Imaging Cherenkov detector system (RICH), which provides particle identification, have been operating successfully since 2010. During the second Long Shutdown of the LHC of 2019-2020, the RICH detectors will be upgraded to maintain the excellent PID performance at an order of magnitude higher luminosity level. In addition, the detector will be readout at the full LHC bunch frequency of 40MHz using a flexible software based trigger. To cope with that changes the current hybrid photon detectors (HPD) will be replaced by Hamamatsu R13472 multi-anode photomultipliers (MaPMT) with the external brand new frontend electronics. The new photodetectors and the associated electronics have been subjected to calibration procedures. Working voltage identification, relative efficiency measurements of MaPMT pixels and their calibration procedure for the RICH detector system will be presented.

Primary author: BATYRKHANOV, Ayan (Nazarbayev University)

Presenter: BATYRKHANOV, Ayan (Nazarbayev University)

Session Classification: Poster session

Contribution ID: **18** Type: **Oral**

Experimental SiPMs parameter characterization from avalanche triggering probabilities

Tuesday 27 November 2018 11:45 (20 minutes)

Silicon photo-multipliers (SiPMs) are detectors sensitive to single photons that are widely used for the detection of scintillation and Cherenkov light in subatomic physics and medical imaging. In order to understand the over-voltage dependence in detail, we have built a new model by extracting the electron and hole avalanche triggering probabilities using VUV and Infra-red light sources. Then we show that we can describe the over-voltage dependence of the dark noise, after-pulsing and cross-talk rates using a minimum set of parameters and extract the relative contribution of electrons vs holes for each process. We also show that this model predicts the behaviour of the IV (current-voltage) curve. The data that are used in this analysis are for Hamamatsu VUV4 at temperatures ranging from -40 to -110 C.

Primary authors: GALLINA, Giacomo (TRIUMF); RETIERE, Fabrice (TRIUMF); Mr KROEGER, Jens

Co-authors: Mr WARD, Mark; Dr GIAMPA, Pietro; Dr ZHANG, Guoqing

Presenter: GALLINA, Giacomo (TRIUMF)

Session Classification: Tuesday morning

Contribution ID: **19** Type: **Poster**

Characterization of cryogenic SiPM down to 6.5 K

Tuesday 27 November 2018 18:10 (2 minutes)

SiPM operation at very low temperatures has the potential to improve detector systems for experiments at cryogenic temperatures. We characterised electrical and optical properties of a commercially available cryogenic SiPM over a temperature range from 6.5 K to 286 K, such as breakdown voltage, quenching resistance, gain, waveform shape, photon detection efficiency and dark count rate. We observed a non-linear temperature dependence of the breakdown voltage and the small change of the waveform shape at low temperatures. The SiPM gain and maximum allowed overvoltage decrease at low temperatures, however, stable operation down to 6.5 K has been demonstrated. Furthermore, the feasibility of assembling a detector with a plastic scintillator was studied.

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Presenters: IWAI, Ryoto (ETH Zurich); IWAI, Ryoto (ETH Zurich)

Session Classification: Poster session

Contribution ID: **20** Type: **Poster**

Impact of proton irradiation on SiPM dark current for high-energy space instruments

Tuesday 27 November 2018 18:12 (2 minutes)

As photon detection is a major issue in any high-energy astronomy instrumentation, many space missions combined photomultiplier tubes (PMTs) with scintillators, for converting incoming high-energy photons into visible light, which in turn is converted in an electrical pulse. The silicon photomultipliers (SiPM), instead of photomultiplier tubes (PMTs) which are bulky, fragile, and requiring a high-voltage power supply of up to several thousand volts, seem to be an encouraging alternative in the space field. We started a R&D program to assess the possibility of using SiPMs for space-based applications in the domain of high-energy astronomy. We already presented some results of the detector characterization to study the SiPM performance in a representative space environment, namely at low temperature and low pressure. For this purpose, we developed a dedicated vacuum chamber with a specific mechanical and thermal controlled system. After measuring dark current, dark count rate and PDE (Photon Detection Efficiency), we performed a first campaign of irradiation tests at UCL (Belgium) in order to understand the susceptibility of SiPM to radiation damage on two selected detectors (Ketek and SensL references) with a high level of fluence. Finally we led a new proton irradiation campaign based on several lower levels of fluence and two energies for further study. We then present the results of dark current measurements of irradiated SensL detectors.

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Presenter: LACOMBE, Karine (IRAP CNRS)

Session Classification: Poster session

Contribution ID: **21** Type: **Poster**

A Glass Study to Reduce Backgrounds of the Hyper-Kamiokande Photodetectors

Tuesday 27 November 2018 18:14 (2 minutes)

Hyper-Kamiokande is a large water Cherenkov detector planned in the near future. A fiducial volume of Hyper-Kamiokande is about twenty times larger than Super-Kamiokande.
It is equipped with forty thousands of a 50 cm photomultiplier tube (PMT), R12860 by Hamamatsu Photonics K.K.
The PMT has a high quantum efficiency, faster time response, better charge resolution and a higher detection efficiency with a stable mechanical structure, compared to the PMTs in Super-Kamiokande.
The detection efficiency of the R12860 is double by the Super-Kamiokande PMTs, but the obtained current dark hit rate is relatively high compared to the Super-Kamiokande PMT.
A reduction of the dark hit rate can improve physics sensitivities of Hyper-Kamiokande.
Since a light derived from PMT glass could contribute to the dark hit rate, I investigate the light background of the PMT glass.

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Presenter: OKAMOTO, Kodai (YNU)

Session Classification: Poster session

Contribution ID: **22** Type: **Oral**

Performance of the Hyper-Kamiokande 20"PMT

Thursday 29 November 2018 09:35 (20 minutes)

Hyper-Kamiokande, scheduled to start construction in 2020, will be the next generation water Cerenkov experiment in Japan, and will provide unprecedented sensitivity to study the oscillations of accelerator, solar and atmospheric neutrinos, search for proton decay and study the neutrinos coming from the explosion of a nearby supernova. In the baseline design, this massive new detector will be instrumented with 40k 20"PMT. We will report measurements of the performances of the candidate 20"PMTs in this presentation, as well as on-going studies to improve some of their properties.

The primary candidate ("Box & Line PMT") is the Hamamatsu R12860 PMT, which provides improved photo-detection efficiency, timing and charge resolution compared to the Hamamatsu R3600 PMT used in the current Super-Kamiokande experiment. We will present measurements of the properties of 140 of those PMTs, as well as a study of the uniformity (with respect to photon hit position and magnetic field) of the performances of 9 of them. We will also present studies to characterize and reduce the dark noise of this model.

An alternative candidate ("MCP PMT") is produced by North Night Vision Technology Co. and is based on a micro-channel plate system instead of the dynode system. We will present measurements of the performance of an improved model with better timing resolution, and their uniformity.

Primary authors: Dr BRONNER, Christophe (ICRR, The University of Tokyo); Dr NISHIMURA, Yasuhiro (RCCN, ICRR, The University of Tokyo); Mr XIA, Junjie (ICRR, The University of Tokyo); Mr MOCHIZUKI, Toshiki (ICRR, The University of Tokyo); Mr CHABERA, Mariusz (Warsaw University of Technology, NCBJ)

Co-authors: Mr TAKENAKA, Akira (ICRR, The University of Tokyo); Mrs SUGIMOTO, Rika (University of British Columbia)

Presenter: Dr BRONNER, Christophe (ICRR, The University of Tokyo)

Session Classification: Thursday morning

Contribution ID: **23** Type: **Poster**

The Performance Evaluation and Optimization of the Light Concentrator for the Hyper-Kamiokande Photodetector

Tuesday 27 November 2018 18:16 (2 minutes)

Hyper-Kamiokande is a water Chenrekov detector, that is composed of a cylindrical tank with a diameter of 74 m and a depth of 60 m filled with ultra pure water.
Forty thousands of optical sensors look inside to catch Cherenkov light generated underwater.
We can reconstruct momentum, direction and particle type from Cherenkov ring imaged from cone shaped Cherenkov light.
Detection efficiency is important in Hyper-Kamiokande, therefore we examined a mirror to improve the photoelectron collection efficiency.

The purpose of this study is to evaluate the performance of the light collection (LC) mirror and optimize the design of LC.
Various shapes of the LC such as a height and a curvature is simulated using WCSim, which is a GEANT4 based program for developing and simulating large water Cherenkov detectors.
As a result of the simulation, one of LC shapes brings 1.4 times more photoelectrons collected than that without the LC.
With checking the impact on the events close to the wall and reflections, the best LC shape for Hyper-Kamiokande is studied with a measurement.

Primary authors: TSUKADA, Mai (Nagoya Univercity); NISHIMURA, Yasuhiro (ICRR); YANO, Takatomi (ICRR); Prof. ITOW, Yoshitaka (ISEE, Nagoya Univ.)

Presenter: TSUKADA, Mai (Nagoya Univercity)

Session Classification: Poster session

Contribution ID: **24** Type: **Oral**

Characterization of SiPM Optical Crosstalk and its Resin Thickness Dependence

Tuesday 27 November 2018 12:05 (20 minutes)

Silicon photomultipliers (SiPMs) are widely used in many applications in medical imaging, particle physics, and high-energy astrophysics owing to their high photon detection efficiency, high charge resolution, compactness, and low voltage. It is known, however, that so-called optical crosstalk (OCT), which generate secondary infrared photons in the micro silicon cell that fired first, can worse the SiPM charge resolution. This is because the secondary photons can be accidentally detected by surrounding micro cells. As a result, the trigger threshold in fast photon pulse detectors such as atmospheric Cherenkov telescopes needs to be increased and less bright photon events can be lost. In our previous study (Asano et al. 2017), we found that the OCT rates of single channel SiPMs have resin thickness dependence, which may be explained by photon propagation inside the protection resin coating. In the present study we simulated this photon propagation with a dedicated ray-tracing simulation model, and it is compared with our measurements. We also measured the OCT rate of multi-channel SiPMs, resulting in a discovery of "neighboring-pixel OCT," in which OCT photons are propagated into neighboring pixels. We report our single- and multi-channel SiPM OCT measurements and comparison with ray-tracing simulations.

Primary author: Mr NAKAMURA, Yuki (Nagoya University)

Presenter: Mr NAKAMURA, Yuki (Nagoya University)

Session Classification: Tuesday morning

Contribution ID: **25** Type: **Oral**

Direct Measurement of Optical Cross-Talk in SiPMs Using Light Emission Microscopy

Tuesday 27 November 2018 11:25 (20 minutes)

Silicon Photomultipliers (SiPMs) are attractive light detectors for high energy and astroparticle physics experiments. They are compact in size, have fast (few ns) response time, operate at lower voltage compared to classical photomultiplier tubes, are insensitive to magnetic fields, and the newer samples offer photon detection efficiencies of > 40%. The optical cross-talk effect, whereby light emitted during the initial avalanche breakdown process may be absorbed by neighboring cells causing additional breakdowns, can degrade the performance of SiPMs. We describe ongoing work at the Max Planck Institute for Physics in Munich where we constructed a light emission microscopy setup to directly measure the emission due to optical cross-talk in SiPMs. This method provides the most precise measurement of cross-talk as well as allows one to inspect and directly visualize the existence of hot cells, which could over-proportionally contribute to the noise of a SiPM chip. We will report on the comparison of the cross-talk measurements by using the method of light emission microscopy and the traditional "blind" measurement based on amplitude measurements. Also, by using the light emission microscopy, we are exploring the possible influence of the topology of a SiPM on the cross-talk; this could help developing methods for further reducing the cross-talk. We present an overview of our setup and measurements performed. This work is part of SENSE, a roadmap for the ideal low light level sensor development and funded by the European Commission under Future and Emerging Technologies Open Coordination and Support Action.

Primary authors: STROM, Derek (Max Planck Institute for Physics); MIRZOYAN, Razmik (Max Planck Institute for Physics); BESENRIEDER, Jürgen (Max Planck Institute for Physics)

Presenter: STROM, Derek (Max Planck Institute for Physics)

Session Classification: Tuesday morning

Contribution ID: **26** Type: **Oral**

Photo-detector system with large area SiPM in nEXO

Wednesday 28 November 2018 14:30 (20 minutes)

The Enriched Xenon Observatory (EXO) is aiming to search for $0\nu\beta\beta$ decays of ^{136}Xe by using liquid xenon TPC detector. nEXO is the second phase of EXO with 5 tons of enriched liquid xenon TPC with ultra-low background. In order to meet the requirements of 1% energy resolution (at Q of 136Xe, 2.458 MeV) and low background, ~4 m^2 of SiPM arrays will be used to collect 175 nm scintillation light from xenon. The overall photon detection efficiency in TPC, consisting of photon transport efficiency and photon detection efficiency of SiPMs, is one of main factors that limits the energy resolution. In the past few years, lots of efforts have been made to characterize the performance of SiPMs and develop the photo-detector system. In this talk, we will discuss the following topics: (a) requirements of photo-detector system in nEXO; (b) characterization of SiPMs manufactured by Fondazione Bruno Kessler (FBK) and Hamamatsu Photonics; (c) measurement of SiPM VUV reflectivity in vacuum and liquid xenon; (d) development of silicon interposer used to support and connect SiPM and readout electronics; (e) some of other challenging issues.

Primary author: Dr CAO, Guofu (Institute of High Energy Physics)

Presenter: Dr CAO, Guofu (Institute of High Energy Physics)

Session Classification: Wednesday afternoon

Contribution ID: **28** Type: **Oral**

Development of High-density NIR sensitive Silicon photomultipliers at FBK

Tuesday 27 November 2018 10:35 (20 minutes)

Analog silicon photomultipliers (SiPMs) have obtained growing attention as an alternative to the traditional photomultiplier tubes in detection of scintillation light, e.g., in nuclear medicine and high-energy physics. However, SiPMs are also emerging as very sensitive detectors in many single-photon or few-photons applications, like: LIDAR, optical spectroscopy, Cherenkov radiators and NIR scintillation detection in TPCs. Some of these new applications are based on detection at red and NIR wavelengths. In Fondazione Bruno Kessler, FBK, we developed different technologies in the last years. Recently, we produced a SiPM technology with enhanced sensitivity in NIR wavelength region, called "NIR-HD". The main goal is increasing the PDE at such long wavelengths, where the absorption depth of silicon is typically higher than the epi-layer thickness. There are both technological and design challenges. We used a thick epi-layer of 8µm and we developed different SiPMs and SPADs versions, obtaining good PDE in the NIR. We observed that maximum PDE was limited mainly by the effects of the border region of the SPAD, reducing effective FF. These effects get bigger with thick epi-layer. Therefore, based on TCAD simulations, we further developed the cell structure, improving the edge sensitivity. We present here and compare the performance of standard and improved NIR-HD FBK technologies. For example, with 6V of excess bias, we obtaine a PDE of ~45% at 500nm and ~9% at 900nm for 25µm cell SiPM, and of ~13% at 900nm for 54µm cell SiPM. Noise is around 800kcps/mm2 and direct CT between 15% and 25%.

Primary authors: ACERBI, Fabio (FBK); Dr PATERNOSTER, Giovanni (FBK); Mr CAPASSO, Massimo (FBK); Mr ZORZI, Nicola (FBK); Dr GOLA, Alberto (FBK)

Presenter: ACERBI, Fabio (FBK)

Session Classification: Tuesday morning

Contribution ID: **29** Type: **Oral**

R&D on the extension of the MCP-PMT lifetime

Thursday 29 November 2018 16:10 (20 minutes)

A Micro-Channel-Plate PMT (MCP-PMT) has an excellent time resolution. A disadvantage of the MCP-PMT is a short photocathode lifetime, which means a drop of the quantum efficiency (QE) of the photocathode. It is a major issue for applications to detector s at high intensity experiments, such as the Belle II TOP detector.
In the first part of the presentation, we talk about the improvement we made so far. Improvement of the lifetime was made by suppressing the residual gas. By applying an atomic layer deposition technique on the MCPs, we improved the lifetime by an order of magnitude; The average lifetime of eight samples was measured to be 10.4 C/cm^2. We succeeded in improving the lifetime by applying the further residual gas reduction processes; The lifetime of eight samples was measured to be longer than 13.6 C/cm^2. These results will be shown in detail in this presentation.
In the second part of the presentation, we talk about further lifetime improvement. We first need to understand the mechanism of the photocathode deterioration. We studied the residual gas by analyzing after-pulses caused by feed-backed ions. We can identify the ion species from the timing of the after-pulse. We studied the correlation between the lifetime and appearance of ion species. To investigate the effect of the other ions and neutral gas, which were blocked by an aluminum layer applied on the MCP, we also measure the lifetime of samples without the aluminum layer. These results will also be presented.

Primary author: MUROYAMA, Genta (Graduate School of Science, Nagoya University)

Co-authors: MATSUOKA, Kodai (KMI, Nagoya University); INAMI, Kenji (Graduate School of Science, Nagoya University); IIJIMA, Toru (Graduate School of Science, Nagoya University)

Presenter: MUROYAMA, Genta (Graduate School of Science, Nagoya University)

Session Classification: Thursday afternoon

Contribution ID: **30** Type: **Poster**

Silicon Photo Multiplier Design Using Silicon on Insulator Technology

Tuesday 27 November 2018 18:18 (2 minutes)

A 6 × 6 silicon photomultiplier (SiPM) array aimed at one-to-one coupling to a finely separated scintillator array was fabricated and characterized. All SiPMs were formed in the bulk substrate layer of a silicon on insulator (SOI) wafer for enabling future SiPMs which consists of 3-D integrated electronics without mechanical bump bonding. Each channel had a size of 250 × 250 μm² and was arranged for satisfying the counting-rate requirements of over 2 Mcps/mm² in energy-resolvable X-ray photon counting computed tomography (PCCT). In this study, the basic performance of SOI-SiPM prototype was characterized. Several features, such as a fast recovery time around 16 ns and a gain of 1 × 10⁵ were within requirements to realize Photon counting computed tomography.

Primary authors: Mr KOYAMA, Akihiro (The University of Tokyo); Mr HAMASAKI, Ryutaro (The Graduate University for Advanced Studies); Prof. SHIMAZOE, Kenji (The University of Tokyo); Prof. TAKAHASHI, Hiroyuki (The University of Tokyo); Prof. TAKESHITA, Tohru (Shinshu University); Prof. KURACHI, Ikuo (High Energy Accelerator Research Organization); Prof. MIYOSHI, Toshinobu (High Energy Accelerator Research Organization); Prof. NAKAMURA, Isamu (High Energy Accelerator Research Organization); Prof. KISHIMOTO, Shunji (High Energy Accelerator Research Organization); Prof. ARAI, Yasuo (High Energy Accelerator Research Organization)

Presenter: Mr KOYAMA, Akihiro (The University of Tokyo)

Session Classification: Poster session

Contribution ID: **31** Type: **Oral**

Performance of the MCP-PMTs of the TOP counter in the first beam operation of the Belle II experiment

Thursday 29 November 2018 15:50 (20 minutes)

We developed a square-shaped micro-channel-plate photomultiplier tube (MCP-PMT) in collaboration with Hamamatsu Photonics K.K., successfully produced more than 630 MCP-PMTs so far, and installed 512 MCP-PMTs into the TOP counter of the Belle II experiment in 2016. The TOP counter is the first-ever detector that is equipped with such a large number of MCP-PMTs. All the MCP-PMTs have a time resolution better than 50 ps for single photon detection and a peak quantum efficiency of 29% on average at a wavelength around 360 nm. Those excellent time resolution and efficiency are essential for the TOP counter to reconstruct the Cherenkov image for particle identification.
Using the laser calibration system which can distribute single photons to all the installed MCP-PMTs in situ, the gains of the MCP-PMTs were tuned to be 5times;10⁵ in 1.5 T of the magnetic field. The efficiency of the readout electronics to discriminate the MCP-PMT pulses at that gain was evaluated to be greater than 90%. With this configuration, the MCP-PMTs were operated in success for the first beam data taking of the Belle II experiment in 2018. The number of detected photons per track from the beam collisions was evaluated, and it was confirmed to be roughly consistent with our expectation.
In this presentation, we will show the performance of the MCP-PMTs measured in detail in our test benches ahead of the installation and the one confirmed in the first beam operation.

Primary authors: MATSUOKA, Kodai (KMI, Nagoya University); ON BEHALF OF THE BELLE II PID GROUP

Presenter: MATSUOKA, Kodai (KMI, Nagoya University)

Session Classification: Thursday afternoon

Contribution ID: **32** Type: **Poster**

MCP based detectors, calibration, acceptance tests and first photon radiation measurements.

Tuesday 27 November 2018 18:20 (2 minutes)

Abstract
Detectors based on micro channel plates (MCP) are used to detect the radiation of free electron lasers. Three MCP detectors were developed by JINR for the European
XFEL (SASE1, SASE2, and SASE3 beamlines). These detectors were designed to operate in a wide dynamic range from the level of spontaneous emission to the SASE saturation level (between a few nJ and up to 25 mJ), and in a wide wavelength range from 0.05 nm to 0.4 nm for SASE1 and SASE2, and from 0.4 nm to 4.43 nm for SASE3. The photon pulse energies are measured
by an MCP with anode and with a photodiode. The photon beam image is observed by an
MCP imager with a phosphor screen anode.
Three different tasks can be performed with the EuXFEL MCP-based photon detectors:
1) study of the initial stage of the SASE regime;
2) measurement of the photon pulse energy;
3) measurement of the photon beam image.

Primary authors: Mr BROVKO, Oleg (JINR); Mr SYRESIN, Evgeny (JINR); Mr GREBENTSOV, Alexander (JINR); Mr YURKOV, Mikhail (DESY); Mr FREUND, Wolfgang (European XFEL); Mr GRUENERT, Jan (European XFEL)

Presenter: Mr GREBENTSOV, Alexander (JINR)

Session Classification: Poster session

Contribution ID: **33** Type: **Oral**

STRAW - Strings for Absorption Length in Water

Thursday 29 November 2018 11:45 (20 minutes)

STRAW - Strings for Absorption Length in Water is a project aimed at investigating the optical properties (scattering and absorption length, in particular) of the deep-sea water at Cascadia Basin (British Columbia, Canada). This is the first step of a broader feasibility study for a future large-scale neutrino telescope in the Pacific Ocean. Two strings equipped with 5 modules for light detection (SDOM - Straw Digital Optical Module) and 3 modules for light emission (POCAM-Precision Optical CAlibration Module) have been deployed in June 2018 and connected to the deep-sea infrastructure of Ocean Network Canada (ONC). This work has covered the process of designing, building and calibrating of the SDOMs and the POCAM (already deployed with success in GVD-Baikal in March 2017). During the presentation the system will be accurately described with a special focus on the used technologies and on preliminary results of data-taking.

Primary author: REA, Immacolata Carmen (Technische Universität München)

Presenter: REA, Immacolata Carmen (Technische Universität München)

Session Classification: Thursday morning

Contribution ID: **34** Type: **Oral**

Upgrade of the Cesium Iodide calorimeter for the KOTO experiment

Tuesday 27 November 2018 15:15 (20 minutes)

The KOTO experiment, conducted at J-PARC (Ibaraki Japan), is set to observe the rare decay $K_L \to \pi^0\nu\bar{\nu}$. The branching ratio is heavily suppressed in the Standard model (SM) and the experimental observation may reveal hints from physics beyond the SM.
The observed signature of $K_L \to \pi^0\nu\bar{\nu}$ is two γ's produced from a π^0 and no other signal. Thus the KOTO detector consists of an electromagnetic calorimeter and hermetic veto counters.

The calorimeter, made of 50-cm-long Cesium Iodide (CsI) crystals, plays a crucial role in both the detection of photons, and the rejection of neutron-induced background.
%It is a key to reject accidental hits of neutron produced by beam to maintain the sensitivity.
In addition to already established techniques, we need to reject neutrons by a factor of ten to achieve the standard model sensitivity.
We are instrumenting the front surface of CsI calorimeter with Multi Pixel Photon Counters (MPPC) to measure the timing difference between the arrival of signals at MPPCs and at photo multiplier tubes connected to the rear surface of the calorimeter.
The depth of energy deposition is measured through the timing difference, which in turn aids to discriminate neutron and photon.
In this presentation, we present the status of the upgrade.

Primary author: Mr SHIMIZU, Nobuhiro (Osaka University)

Presenter: Mr SHIMIZU, Nobuhiro (Osaka University)

Session Classification: Tuesday afternoon

Contribution ID: **35** Type: **Poster**

Study of Silicon drift sensor for Gamam-ray Compton Camera

Tuesday 27 November 2018 18:22 (2 minutes)

Compton camera used in the Hitomi SGD is a useful detector for soft gamma-ray in space observation. Si-pixel sensor with 3.4 mm pixels is used as scatterer in the SGD Compton camera. But this pixel size does not allow us to measure a direction of Compton-recoil electrons in the Si sensor, and thus the sensitivity is limited. To improve, it is important to measure the direction of recoil electrons and constrain the incoming direction of photons to a part of Compton ring. It is an advantage to use a silicon drift sensor for this point. The silicon drift sensor(SDD) has strip-like readout channels and a drift time of signal electrons gives information of hit positions in another axis. There are three advantages compared with Si-pixel sensor. One is that high position resolution is expected by measuring drift time and a smaller channel pitch. The second is that high energy resolution is expected by smaller capacitance. The third is that a low power consumption due to smaller numbers of readout channels. Low power consumption is very important for satellite.
We made the prototype silicon drift sensor whose size is $18 \times 46.5 \times 0.5\ \mathrm{mm}^3$ and 64 readout channels and $0.1 \times 0.07\ \mathrm{mm}^2$ channel size with Hamamatsu Photonics. We studied the basic properties of our prototype SDD especially about the depletion layer and the drift field with checking performance.

Primary author: Mr IMAZATO, Fumiya (Hiroshima university)

Co-authors: Mr FUKAZAWA, Yasushi (Hiroshima university); Mr OHSUGI, Takashi (Hiroshima university); Ms OKADA, Chiho (Hiroshima university); Mr TAJIMA, Hiroyasu (Nagoya university)

Presenter: Mr IMAZATO, Fumiya (Hiroshima university)

Session Classification: Poster session

Contribution ID: **36** Type: **Poster**

Scintillator hodoscope with a few millimeter position resolution for cosmic-ray test stand

Tuesday 27 November 2018 18:24 (2 minutes)

An large prototype of the analogue hadron calorimeter for the International Linear Collider (ILC) was constructed and performance studies in beam are underway. The detection layers of the hadron calorimeter are highly segmented into 30~mm square scintillator tiles, each readout individually with a SiPM. A large number of detection tiles of the prototype (∼22,000 tiles in total) had to be tested and calibrated. As an efficient tool to calibrate multiple layers simultaneously, a cosmic-ray test stand was newly developed. The test stand was designed to determine the cosmic-ray track precisely for precise tile calibration. Each top and bottom counter is a plastic scintillator plate ($42 \times 42 \times 6\mathrm{cm}^3$) readout with wavelength shifting fibers embedded on top and bottom surfaces orthogonally at 5 mm intervals. The two dimensional incident position can be reconstructed from the signal distribution at the fibers with a few mm position resolution. Five to six fibers are bundled periodically to reduce the number of readout channels.
The measured performance of the scintillator hodoscope and the results from the calibration of the detection layers in the cosmic-ray test stand will be presented.

Primary author: Mr KOBAYASHI, Satoru (The University of Tokyo)

Co-authors: LIU, Linghui (The University of Tokyo); TSUJI, Naoki (The University of Tokyo); Mr TORIMARU, Tatsuro (The University of Tokyo); OOTANI, Wataru (ICEPP, University of Tokyo)

Presenter: LIU, Linghui (The University of Tokyo)

Session Classification: Poster session

Contribution ID: **37** Type: **Oral**

A multi-PMT photodetector for the Hyper-Kamiokande experiment

Thursday 29 November 2018 14:00 (20 minutes)

Hyper-Kamiokande, a 260 kton water Cherenkov detector to be built in Japan, is the next generation of the Super-Kamiokande experiment. Its broad physics program includes nucleon decay, neutrinos from astronomical and human-made beam, with the main focus to determine the leptonic CP violation. To detect the weak Cherenkov light generated by neutrino interactions or proton decay, the primary photo-detector candidate are 20" "Box & Line" PMTs (Hamamatsu R12860). In order to enlarge Hyper-Kamiokande physics program, the use of multi-PMT modules is considered as a complement of the primary candidates. A multi-PMT Optical Module based on a pressure vessel instrumented with multiple small diameter photosensors, readout electronics and power, offers several advantages as higher sensitive surface, weaker sensitivity to Earth's magnetic field, increased granularity, reduced dark rate, improved timing resolution and directional information with an almost isotropic field of view.

We will present the multi-PMT module developed for Hyper-Kamiokande, as well as the measurement of the performances of its individual 3" PMTs. We will finally show the impact of these modules in Hyper-Kamiokande physics in both the high and low energy sectors.

Primary author: QUILAIN, Benjamin (Kavli IPMU, The University of Tokyo)

Presenter: QUILAIN, Benjamin (Kavli IPMU, The University of Tokyo)

Session Classification: Thursday afternoon

Contribution ID: **38** Type: **Poster**

Fast calorimeter on the pure CsI crystals for the modern e+ e- Super Factories

Tuesday 27 November 2018 18:26 (2 minutes)

Modern high luminosity e+ e- factories, like Belle II at SuperKEKB or planned Super Charm-Tau factory require fast calorimeters to cope with severe background conditions. The prototype of the fast electromagnetic calorimeter based on pure CsI scintillation crystals, wavelength shifters with the novel nanostructured organosilicon luminophores, and avalanche photodiodes Hamamatsu S8664-55 is discussed. The results of the tests of the basic element of the calorimeter will be reported.

Primary author: EPIFANOV , Denis (Budker Institute of Nuclear Physics)

Presenters: EPIFANOV , Denis (Budker Institute of Nuclear Physics); EPIFANOV, Denis (Budker Institute of Nuclear Physics)

Session Classification: Poster session

Contribution ID: **39** Type: **Poster**

A comparitive study on various methods for SiPM gain calibration

Tuesday 27 November 2018 18:28 (2 minutes)

Silicon photomultipliers (SiPM) are the photo detectors of choice for many applications thanks to their excellent performance in counting photons. To use SiPMs as photon counters, the gain must be known beforehand and the stability of the gain must be constantly monitored.
The gain is commonly determined by resolving the single photoelectron peak in the detected charge distribution. Although this method has shown high accuracy and reproducibility, a good signal to noise ratio (S/N) and an appropriate light level are required so as to resolve each peak in the charge distribution. The purpose of our study is to compare the performance of alternative calibration methods.

In our study, two additional methods to calibrate the gain of SiPMs are studied. One method uses the statistical fluctuation of detected charge in measurements with a Poisson distributed light. As shown in a previous study, we confirmed that the linearity between the mean and the variance can be used to obtain the gain. We also found some issues to be addressed.
In the other method, the gain is calculated from the shape of the signal waveform, which was tested for PMTs in a previous study. In this study, we applied this method to SiPMs. It was found that this method works for SiPMs, although there are some issues specific to SiPMs.

Primary authors: OYA, Atsushi (ICEPP, University of Tokyo); Mr KOBAYASHI, Satoru (The University of Tokyo); OOTANI, Wataru (ICEPP, University of Tokyo); MORI, Toshinori (The University of Tokyo); TOYODA, Kazuki (The University of Tokyo); YANAI, Kosuke (The University of Tokyo)

Presenter: OYA, Atsushi (ICEPP, University of Tokyo)

Session Classification: Poster session

Contribution ID: **40** Type: **Oral**

A detection unit designed for the study of the UHECRs from space

Thursday 29 November 2018 11:05 (20 minutes)

A new generation detection unit has been developed in the frame of the JEM-EUSO program to detect Ultra-High Energy Cosmic Rays (UHECR) from space. This 256 pixels compact (55 x 55 x 60 mm), low consumption (< 500mW) and fast detection unit (>150 Mhz) is based on four Hamamatsu multi-anodes photomultipliers (MAPMT), one Cockcroft-Walton high-voltage circuit and four SPACIROC 3 ASICs. This type of unit has been developed for different pathfinders, on ground (since 2013), onboard stratospheric balloons (EUSO-Balloon in 2014, EUSO-SPB in 2017, EUSO-SPB2 in 2021), onboard ISS (in 2020) and will operate in future space missions K-EUSO (ISS 2023) and POEMMA (2028).

Primary author: PREVOT, Guillaume (Laboratoire APC (UMR 7164))

Co-author: Mrs BLIN, Sylvie (OMEGA (IN2P3))

Presenter: PREVOT, Guillaume (Laboratoire APC (UMR 7164))

Session Classification: Thursday morning

Contribution ID: **41** Type: **Oral**

Results of the Parallel Operation of Large-size SiPM Detector Modules and PMTs in IACTs

Wednesday 28 November 2018 11:45 (20 minutes)

At the Max Planck Institute for Physics, we developed three prototype detector modules using silicon photomultipliers (SiPM) instead of PMTs for the imaging cameras of the Major Atmospheric Gamma Imaging Cherenkov (MAGIC) telescopes. The detector modules use Hamamatsu, SensL or Excelitas devices, respectively.

To achieve an active area comparable to a 1-inch PMT, we used a matrix of up to nine 6x6 mm² SiPMs, actively summing the individual signals while maintaining their fast signal response.
The installation of the three prototype modules was finished in 2017. Since then, they are operated alongside the PMT based camera on nightly basis. This data, comprised of Cherenkov light generated in extensive air showers and artificial light pulses, is collected during real telescope operation and used for performance comparisons.

The MAGIC camera structure allows for the installation of up to six prototype detector modules next to the PMTs and to operate them in parallel.
The outer camera rim, where we installed the SiPM based detector modules, is not included in the trigger. For an even better comparison, one prototype module was installed to the camera centre for a single night.

The two MAGIC telescopes, utilized in this study, are located on the Canary Island of La Palma. Each telescope consists of a 17 m diameter mirror dish, and a camera composed of a thousand photomultiplier tubes (PMTs).

We will present our findings on the SiPM performance using both collected data sets during telescope operations.

Primary authors: HAHN, Alexander (Max Planck Institute for Physics, Munich, Germany); Mr DETTLAFF, Antonios (Max Planck Institute for Physics, Munich, Germany); Mr FINK, David (Max Planck Institute for Physics, Munich, Germany); Dr MAZIN, Daniel (Institute for Cosmic Ray Research, Tokyo, Japan); MIRZOYAN, Razmik (Max Planck Institute for Physics, Munich, Germany); Prof. TESHIMA, Masahiro (Institute for Cosmic Ray Research, Tokyo, Japan)

Presenter: HAHN, Alexander (Max Planck Institute for Physics, Munich, Germany)

Session Classification: Wednesday morning

Contribution ID: **42** Type: **Oral**

Radiation hardness of SiPMs

Wednesday 28 November 2018 09:00 (35 minutes)

The current understanding of radiation tolerance of Silicon Photomultipliers (SiPMs) is reviewed. Effects of radiation damage caused by hadrons, electrons and gammas on SiPMs are presented and discussed. Ideas are presented on how to approach the development of radiation hard SiPMs for the future HEP experiments.

Primary authors: Dr MUSIENKO, Yuri (University of Notre Dame (Notre Dame)/INR RAS (Moscow)); Mr HEERING, Adriaan (University of Notre Dame (Notre Dame))

Co-authors: Prof. WAYNE, Mitchell (University of Notre Dame (Notre Dame)); Mr KARNEYEU, Anton (INR RAS (Moscow))

Presenters: Dr MUSIENKO, Yuri (University of Notre Dame (Notre Dame)/INR RAS (Moscow)); Mr HEERING, Adriaan (University of Notre Dame (Notre Dame))

Session Classification: Wednesday morning

Contribution ID: **43** Type: **Oral**

Studies of radiation damage to SiPMs at low temperatures.

Wednesday 28 November 2018 09:35 (20 minutes)

Hamamatsu and KETEK SiPMs were irradiated with neutrons up to 2E12 n/cm^2 (1 MeV equivalent) at the CERN CHARM irradiation facility. The SiPMs'temperature during irradiation was stabilized at -30 C using Peltier thermoelectric cooler. In this article, we report about studies of the SiPM dark currents during and after irradiation.

Primary authors: Mr HEERING, Adriaan (University of Notre Dame (Notre Dame)); Dr MUSIENKO, Yuri (University of Notre Dame (Notre Dame)/INR RAS (Moscow))

Co-authors: Mr KARNEYEU, Anton (INR RAS (Moscow)); Prof. WAYNE, Mitchell (University of Notre Dame (Notre Dame))

Presenters: Mr HEERING, Adriaan (University of Notre Dame (Notre Dame)); Dr MUSIENKO, Yuri (University of Notre Dame (Notre Dame)/INR RAS (Moscow))

Session Classification: Wednesday morning

Contribution ID: **44** Type: **Oral**

Development of TPC Trigger Hodoscope for J-PARC E42/E45 hadron experiment

Tuesday 27 November 2018 16:45 (20 minutes)

We have developed HypTPC consists of TPC and the trigger hodoscope for the J-PARC E42/45 hadron experiments. The TPC Hodoscope has large scintillators of 80 x 7 x 1 cm to cover the TPC. Especially, to detect photons generated in a large area of a scintillator, a multiple MPPC signal readout is developed.
Generally, a method of applying a voltage to a Multi-MPPC is a parallel connection and a serial connection. In the case of parallel connections, a signal has a long tail due to the large sensor capacitance. MEG collaboration used four MPPC segments as a serial connection. However, in the case of a series connection, an extremely high voltage is required, and the gain is low. To avoid this problem, we have developed a method of summing signals after individually applying a voltage to each MPPC.
The multiple MPPC signal readout circuit consists of preamplifiers and a summing amplifier. The preamplifier is a differentiator circuit using an AD8000 ultra-fast opamp with short rising time. In the preamplifier, the MPPC has applied a voltage and the signal is amplified. The amplified signals are summed in a summing amplifier.
We also made a prototype detector and performed a cosmic-ray test. We have confirmed that the signal summing method has better time resolution than others. Currently, the TPC Hodoscope can simultaneously measure up to 32 MPPC signals.
In this presentation, we will discuss the function of the TPC Hodoscope's signal processing circuit and the results of cosmic ray test.

Primary author: Mr JUNG, Wooseung (Korea University)

Co-authors: Prof. AHN, Jung keun (Korea University); Ms KIM, Shinhyung (Korea University); Dr ICHIKAWA, Yudai (JAEA); Dr SAKO, Hiroyuki (JAEA); Dr HASEGAWA, Shoichi (JAEA); Dr TANIDA, Kiyoshi (JAEA); Dr SATO, Susumu (JAEA); Prof. HICKS, Kenneth (Ohio University); Dr HWANG, Sanghoon (KRISS)

Presenter: Mr JUNG, Wooseung (Korea University)

Session Classification: Tuesday afternoon

Contribution ID: **45** Type: **Poster**

Front-end circuits for MPPCs for the KOTO CsI calorimeter upgrade

Tuesday 27 November 2018 18:30 (2 minutes)

The purpose of the J-PARC KOTO experiment is to search for new physics beyond the standard model(SM) with the rare kaon decay $K_L \to \pi^0\nu\bar{\nu}$.
The branching ratio of this decay was predicted to be $\mathrm{BR} = 3.0 \times 10^{-11}$ in the SM.
The KOTO detector consists of an electromagnetic calorimeter made of undoped Cesium Iodide(CsI) crystals, and hermetic veto counters.
To reach the sensitivity predicted in the SM, we need to suppress the halo-neutron backgrounds by a factor of ten.
We are now installing 4096 Multi Pixel Photon Counters (MPPCs) on the upstream side of the crystals to discriminate neutrons and gammas.
In the KOTO detector, the MPPCs will be exposed to 1.5×10^9 $n_{1\mathrm{MeV}}/\mathrm{cm}^2$ doses. We confirmed that radiation damage did not affect MPPC's performance: breakdown voltage and photon detection.
For the updated calorimeter, we developed front-end circuits including MPPC connection, summing amplifier circuit for the signal, and control system.

Primary author: HARA, Nobuhiro (Osaka Univ.)

Presenter: HARA, Nobuhiro (Osaka Univ.)

Session Classification: Poster session

Contribution ID: **46** Type: **Poster**

Performance Test of New-type MPPC

Tuesday 27 November 2018 18:32 (2 minutes)

MPPC (Multi-Pixel Photon Counter) is a SiPM device made by Hamamatsu Photonics. In high energy physics experiments, MPPC with lower crosstalk has been desired to get a good photon counting resolution. Thus, suppression of the crosstalk had been a long-term challenge.
Recently, Hamamatsu has developed a new type of MPPC which has lower crosstalk probability and therefore better photon counting resolution than the present one. This characteristic was achieved by Hamamatsu's new trench isolation technology. So far, the trench isolation with small pixel pitch less than 15 um had never been achieved. However, the new technology enables the trench isolation even with 10 um pitch and this leads to the low crosstalk probability. It is expected that the MPPC shows considerably low crosstalk probability less than one percent. In this presentation, we will show a result of the measurement of this new MPPC's performance including the voltage or temperature dependences of dark noise rate, crosstalk probability, gain, and so on.

Primary author: Mr ODAGAWA, Takahiro (Kyoto University)

Presenter: Mr ODAGAWA, Takahiro (Kyoto University)

Session Classification: Poster session

Contribution ID: **47** Type: **Poster**

Performance test of optical interface for super-FGD in the T2K experiment

Tuesday 27 November 2018 18:34 (2 minutes)

Super-FGD is a part of the near detector (ND280) upgrade of the T2K experiment.
Super-FGD consists of about two million scintillator cubes read out along three orthogonal directions by wavelength shifting fibers, to realize fine granularity.
The light from the fibers is read out by sixty thousand Multi-Pixel Photon Counters (MPPCs).
Optical interface design for super-FGD between MPPCs and the fibers is important for the precise measurement of light yield.
It must be tested whether the design is validated or not in terms of light tightness, fiber coupling and so on. We will present the result of the perfomance test of the interface and optimization of its design.

Primary authors: KURIBAYASHI, Soichiro (Kyoto University); MATSUBARA, Tsunayuki (KEK)

Presenter: KURIBAYASHI, Soichiro (Kyoto University)

Session Classification: Poster session

Contribution ID: **48** Type: **Poster**

Study on Granularity Optimization for ILD Hadron Calorimeter

Tuesday 27 November 2018 18:36 (2 minutes)

The Analogue Hadron CALorimeter (AHCAL) at the International Linear Collider (ILC) is a high granularity hadron calorimeter based on scintillator tiles readout by MPPCs. Toward the construction of ILC, it is necessary to make a more realistic design of ILD detector. The optimization of AHCAL granularity is, therefore, now revisited, and we study the mixed granularity with larger scintillator tile at outer layers. However, the performance of the larger tile than standard $30\times30\mathrm{mm}^2$ tile has not ever been demonstrated. We tested the performance such as light yield and uniformity by using the prototype with a $60\times60\mathrm{mm}^2$ tile. Light yield of $60\times60\mathrm{mm}^2$ tile is found to be about a half of $30\times30\mathrm{mm}^2$ tile, while $60\times60\mathrm{mm}^2$ tile has excellent uniformity in tile response. Since the performance of the single tile was demonstrated, a detection layer composed of 144 tiles of $60\times60\mathrm{mm}^2$ was constructed. MPPCs with a twice larger active area ($2\times2\mathrm{mm}^2$) than that for the standard detection layer are used to recover light yield reduction. It was added to the large technological prototype of AHCAL composed of 38 detection layers with the $30\times30\mathrm{mm}^2$ tiles.
A test beam experiment was carried out at May and June/July 2018. The detection layer with $60\times60\mathrm{mm}^2$ tiles worked properly. The peak of single photoelectron is clearly resolved and $60\times60\mathrm{mm}^2$ tiles on HBUs have good enough light yield. We report in details the performance of the larger scintillator tile and the detection layer with $60\times60\mathrm{mm}^2$ tiles.

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Presenter: TSUJI, Naoki (The University of Tokyo)

Session Classification: Poster session

Contribution ID: **49** Type: **Oral**

Development of sampling calorimeter to use information from segmented lead glass absorber with Cherenkov light

Wednesday 28 November 2018 16:20 (20 minutes)

Sampling calorimeter is indispensable for physics measurement at collider experiment with particle flow algorithm.
Particle flow algorithm optimized calorimeter is important not only energy information but also position information.
Position information can be improved by creating a very finely granulated detection layer.
However, energy resolution is degraded by uncertainty of deposit energy in the absorption layer.
This problem will be solved by using lead glass as absorber, which is clear and high density.
High energy charged particles produce Cherenkov lights whose light yield corresponds to the track length in the lead glass.
Because MPPC is very thin, optical readout of this detector is possible with very small dead volume.
Information on absorption layer which absorber is made of segmented lead grass and read by a MPPC as Cherenkov light.
We are developing prototype of sampling calorimeter with segmented lead Glass absorber because this information from the absorber will improve the energy resolution of the calorimeter.
This prototype is being checked and calibrated by cosmic-ray muon.
Performance of this calorimeter prototype will be tested for positron at ELPH beam at Tohoku University will be presented.
We developed the segmented lead glass calibration method with beam in order to guarantee calorimeter uniformity.
We will discuss this prototype problems and its capabilities.

Primary author: TERADA, Reima (Shinshu University)

Co-authors: Prof. TAKESHITA, Tohru (Shinshu University); Mr ISHIHAMA, Hiroki (Shinshu University)

Presenter: TERADA, Reima (Shinshu University)

Session Classification: Wednesday afternoon

Contribution ID: **50** Type: **Oral**

Operation of multi-MPPC system for cylindrical scintillation fiber tracker

Tuesday 27 November 2018 17:05 (20 minutes)

The J-PARC E40 experiment is a scattering experiment between a Σ hyperon and proton in order to hyperon-nucleon interaction and to confirm the repulsive force due to the Pauli effect in quark level.
In order to measure the cross section of Σp scattering, we will use a new detector system called CATCH which surrounds a liquid hydrogen target. The trajectories and the kinetic energies of related charged particles such as recoil proton and decay particles are measured by CATCH in order to identify Σp scattering.
CATCH consists of a Cylindrical Fiber Tracker (CFT) and a bismuth germanate (BGO) calorimeter. CFT is a tracking detector with a fast time response made of 5,000 scintillation fibers with a diameter of 0.75 mm. Each fiber signal is read by Multi-Pixel Photon Counter MPPC fiber by fiber. All MPPCs are operated by the EASIROC boards which is optimized for the readout of a large number of MPPCs. In order to reconstruct trajectories three dimensionally, CFT has two types of cylindrical layers where fibers are placed with the straight and spiral configurations.
We have just launched a Σ proton scattering experiment at J-PARC in this year. I will report on the operation and energy calibration method of such a large number of scintillation fibers for CFT in the test experiment and actual Σp scattering experiment. I also show the separation of proton and π by using the energy deposit in CFT as a result of the energy calibration.

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Presenter: AKAZAWA, Yuya (KEK)

Session Classification: Tuesday afternoon

Contribution ID: **51** Type: **Oral**

Performance of CATIROC : ASIC for smart readout of large photomultiplier arrays

Wednesday 28 November 2018 14:50 (20 minutes)

CATIROC is an ASIC designed to read large photomultiplier areas for neutrinos experiments. This "System-on-Chip"is a very innovative concept as it sends out only relevant data by network to the central data storage, minimizing the links and the cost. The ASIC integrates 16 independent channels, with a self-triggering capability down to 1/3 photoelectron (50 fC). It then provides time measurement better than 0.5 ns and charge measurement over 13 bits, up to 100 pC with two gains. Data are converted internally over 10 bits and read-out at 80 MHz. The chip has been chosen by the JUNO collaboration to readout the 25,000 small photomultipliers of the experiment.

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Presenter: Mrs BLIN, Sylvie (OMEGA Ecole polytechnique/CNRS)

Session Classification: Wednesday afternoon

Contribution ID: **52** Type: **Oral**

Development of Scintillator Electromagnetic Calorimeter for ILD

Tuesday 27 November 2018 14:55 (20 minutes)

International Linear Collider (ILC) is a project of a future electron–positron collider and one of its goals is precise measurements of the Higgs particle.
We are developing Scintillator Electromagnetic Calorimeter (ScECAL) with SiPM as one of candidates of electromagnetic calorimeter for ILC.
ScECAL consists of 2mm x 5mm x 45mm scintillator strips and SiPMs.
We have fabricated some types of prototypes with different combinations of scintillator strips and SiPMs, in order to optimize the detector which has enough dynamic range, while having good separation of MIPs from noise with embedded read out electronics board for ScECAL.
We tested them with positron beam at Tohoku University this month as well as beta ray source.
In this talk We will report recent status of development.

Primary author: Mr YOSHIMURA, Yuya (Shinshu University)

Presenter: Mr YOSHIMURA, Yuya (Shinshu University)

Session Classification: Tuesday afternoon

Contribution ID: **53** Type: **Poster**

Performance evaluation of HAPDs in the Belle II Aerogel RICH counter

Tuesday 27 November 2018 18:38 (2 minutes)

The Aerogel Ring Imaging Cherenkov (ARICH) counter is a particle identification device located in the endcap region of the Belle II detector. The main components of the ARICH counter are 248 silica aerogel tiles built into the Cherenkov radiator and 420 Hybrid Avalanche Photo Detectors (HAPDs) making up the photon detector. Angular distribution of Cherenkov photons emitted from silica aerogel and detected by HAPDs is used to identify charged particles. Therefore, HAPD performance is essential for the ARICH counter.
The HAPD is a vacuum tube made of ceramic body, quartz window with semitransparent photocathode and 4 segmented Avalanche Photo Diode (APD) chips. APD chips consist of 36 pixels covering $4.9 \times 4.9mm^2$ each. Multiplication in an HAPD is a combination of impact ionization of a photo-electron accelerated by the high voltage applied between photocathode and APD, bombardment gain, and APD avalanche process, avalanche gain.
All the HAPDs were tested before the installation into ARICH detector. One of the issues of HAPDs is a very large signal observed when operated inside the magnetic field therefore each HAPD was also tested in the magnetic field.
Installation of HAPDs to the ARICH detector finished in July 2017, and the ARICH was installed in the Belle II detector at the end of 2017. Belle II beam commissioning is operated from February to July 2018. Evaluation of the HAPD performance during Belle II beam commissioning and the result of Belle II beam commissioning are reported.

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Presenter: YONENAGA, Masanobu (Tokyo Metropolitan University)

Session Classification: Poster session

Contribution ID: **54** Type: **Poster**

Proposal of Silicon on Insulator Reach-through APDs for soft X-ray imaging optimized by TCAD simulation

Tuesday 27 November 2018 18:40 (2 minutes)

To study surface science of material and spintronics application, experiments using soft X-ray (0.1-4keV) is now paid attention to in the next generation synchrotron radiation facility. In order to perform such experiment, a new high-resolution, high-sensitive soft X-ray imager is required. For that purpose, we are developing an imager, Silicon on Insulator-Reach Through-Avalanche Photo Diodes (SOI-RT-APD). This imager integrates an amplifier for each detector in an SOI layer which is just top of the SOI-RT-APD in a handle wafer to enhance detector's fill factor and reduce the pixel size for high spatial resolution. To obtain sufficient gain, APD's Pwell formation conditions are optimized. In order to realize back-side illumination of soft X-ray, a high-resistivity floating zone (FZ) wafer was applied to achieve full depletion. Because of mechanical weakness of FZ wafer, no high temperature furnace annealing but high energy implantations and rapid thermal annealing are newly introduced to form Pwell. TCAD simulation of this proposed SOI-RT-APD confirms sufficient high gain (>10) and low noise factor (ionization ratio k factor < 0.2).

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Presenter: HAMASAKI, Ryutaro (Department of Particle and Nuclear Physics, School of High Energy Accelerator science, SOKENDAI)

Session Classification: Poster session

Contribution ID: **55** Type: **Poster**

SiPM based Neutron monitors for CMS experiment

Tuesday 27 November 2018 18:42 (2 minutes)

Monitoring of neutron radiation field is an important task for the CMS experiment at CERN.

neutron background affects electronics situated in the experimental cavern inducing single event effect (SEU, SEL etc).

In addition, neutron flux is a main source of the background for the muon chambers, so it affects both performance and longevity of the detectors,

especially for high luminosity operation.

The existing shielding of the beam pipe may have some imperfections due to mechanical constrains and necessity of the maintenance of beam pipe

itself and associated equipment.

So we need a distributed system of neutron monitors around the shielding and in proximity of the detector/electronics components.

The neutron monitors detectors should be insensitive to fringe magnetic field (up to 1000Gs) and should effectively discriminate neutrons from ionizing radiation.

SiPM based detector could be considered as good candidate for monitoring of CMS neutron background. Several types of SiPMs coupled to neutron sensitive scintillators were

deveoped, produced, calibrated and tested in CMS cavern at several levels of luminosity. Experimental results are presented and discussed.

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Presenter: Dr POPOVA, Elena (NRNU MEPhI)

Session Classification: Poster session

Contribution ID: **56** Type: **Oral**

Gain Stabilization of SiPMs and Afterpulsing

Wednesday 28 November 2018 09:55 (20 minutes)

The gain of silicon photomultipliers increases with bias voltage and decreases with temperature. To operate SiPMs at stable gain, the bias voltage can be readjusted to compensate for temperature changes. We have tested this concept with 30 SiPMs from three manufacturers in a climate chamber at CERN varying the temperature from 1 degree C to 48 degrees C. We built an adaptive power supply that is based on a linear dependence of bias voltage versus temperature. With one selected dV/dT value, we stabilized four SiPMs simultaneously. We fulfilled our goal of stabilizing most SiPMs with gain changes of less than ±0.5% in the 20-30 degree C temperature range. We studied afterpulsing of SiPMs at different temperatures for different bias voltages.

Primary author: EIGEN, Gerald (University of Bergen)

Presenter: EIGEN, Gerald (University of Bergen)

Session Classification: Wednesday morning

Contribution ID: **57** Type: **Poster**

Design and performance of MPPC-array readout system for the WAGASCI neutrino detector

Tuesday 27 November 2018 18:44 (2 minutes)

In order to reduce the uncertainties in the T2K long baseline neutrino oscillation experiment by improving the understanding of the neutrino-nucleus interaction at around 1 GeV, we have constructed the WAGASCI neutrino detector at J-PARC. The WAGASCI neutrino detector consists of an array of thin plastic scintillator strips, configured into a three-dimensional grid structure with gaps filled by water which serves as the neutrino interaction target. The light from scintillators is read out by MPPCs via wave length shifting fibers. The total number of MPPC channels is 1280 for a WAGASCI module.
In order to read out signals from MPPC arrays, a dedicated readout system has been developed. It is based on Silicon PM Integrated Read-Out Chip (SPIROC). SPIROC has been developed with the requirements of large dynamic range, low noise, low consumption, high precision and large number of readout channels. SPIROC is on the front-end board named Active Sensor Unit (ASU) which is connected to a 32-channel arrayed MPPC. The readout signal from ASU are processed through an interface board (IF) and a detector interface (DIF) which controls SPIROC chips. Giga data concentrator card (GDCC) communicates with DAQ PC and the output data from DIF sent to DAQ PC via GDCC. To synchronize the DAQ system to the J-PARC neutrino beam, pre-beam trigger and beam trigger are sent to Clock Control Card. (CCC)
The design of the readout system and its performance will be presented.

Primary author: Mr MATSUSHITA, Kohei (University of Tokyo)

Presenter: Mr MATSUSHITA, Kohei (University of Tokyo)

Session Classification: Poster session

Contribution ID: **58** Type: **Oral**

Performance study of a large CsI(Tl) scintillator with an MPPC readout for nanosatellites used to localize gamma-ray bursts

Wednesday 28 November 2018 11:25 (20 minutes)

Currently, we are developing a fleet of nano-satellites for detection and position determination of short gamma-ray bursts (SGRBs) for the proposing CAMEROT (Cubesats Applied for MEasureing and LOcalising Transients) mission. We synchronize time information of each satellite by using a global positioning system, and plan to use large-area CsI(Tl) scintillators which provide a high light output and readout by multi-pixel photon counters (MPPC), which have low power consumption that is suitable for nanosatellite platform.
We plan to use one of the latest-model MPPCs provided by Hamamatsu Photonics, namely, S13360-6050CS, which have an active area of 6×6 mm^2. We compared the performance of two scintillators of different sizes ($150 \times 75 \times 5$ mm^3, $100 \times 75 \times 5$ mm^3); the bigger one is the maximum size that can be mounted on a three-unit satellite we are planning to apply, and found the difference of light yield was only $\sim$13%. We also tested two-MPPC readout to improve the energy threshold and uniformity by using signals from ^{241}Am source. We confirmed the same energy threshold as one-MPPC readout of $\sim$10 keV at 25°C and energy resolution got better by 7% thanks to the improved uniformity. Then we investigated the optimum position of two-MPPCs on the scintitllator by using ray-tracing Monte Carlo simulator, and found that symmetrical configurations against to the center of the scintillator gives the best performance of light yield.

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Presenter: TORIGOE, Kento

Session Classification: Wednesday morning

Contribution ID: **59** Type: **Poster**

Fast APD detector with a short tail in the timing response for an experiment using synchrotron radiation X-ray beam

Tuesday 27 November 2018 18:46 (2 minutes)

We developed a fast X-ray detector system for a nuclear resonant scattering (NRS) experiment of thorium-229. The system employs silicon avalanche photo-diode (Si-APD) as a fast X-ray sensor. The system is able to acquire both timing and energy of a single X-ray photon simultaneously in a high rate condition, 106 counts per second for one Si-APD. The performance of the system was investigated in KEK-PF. A quite small tail in the time spectrum by a level of $10^{-8.5}$ at 0.5 ns apart from the peak was achieved. The energy response was measured in the range of 6–33keV. The behaviour was well explained by the simulation. For the future improvement, the position dependences of the responses were also measured. They indicated that the outermost region was poor in comparison to the other region.

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Presenter: MASUDA, Takahiko (Okayama University)

Session Classification: Poster session

Contribution ID: **60** Type: **Oral**

Baby MIND readout electronics architecture for accelerator neutrino particle physics detectors employing silicon photomultipliers

Wednesday 28 November 2018 15:10 (20 minutes)

The Baby MIND neutrino particle detector was installed at J-PARC in Tokai Japan in February 2018 and commissioned with first neutrino beam a few weeks later. It is instrumented with 3'996 Hamamatsu MPPCs type S12571-025C. A full readout electronics chain was developed to extract energy deposition and timing information of tracks left by charged particles from neutrino interactions in the Baby MIND and surrounding structures. Data from particle beam tests at CERN and commissioning at J-PARC are presented, to illustrate how the electronics readout architecture fulfils the physics requirements. A brief description of the adoption of this architecture for planned 60'000 MPPCs of a new 3D fine grained scintillator detector for operation at J-PARC from 2021 is given.

Primary author: NOAH, Etam (University of Geneva)

Co-authors: BLONDEL, Alain (University of Geneva); KHABIBULLIN, Marat (INR RAS); KUDENKO, Yury (INR RAS); MINAMINO, Akihiro (YNU); CADOUX, Franck (University of Geneva); DOUQA, Dana (University of Geneva); FAVRE, Yannick (University of Geneva); HALLSJÖ, Sven-Patrik (University of Glasgow); ICHIKAWA, Atsuko (University of Kyoto); KHOTYANTSEV, Alexey (INR RAS); MEFODIEV, Alexander (INR RAS); MINEEV, Oleg (INR RAS); MITEV, Georgi (INRNE); NESSI, Marzio (CERN); PARSA, Saba (University of Geneva); SANCHEZ, Federico (University of Geneva); SOLER, Paul (University of Glasgow); TSENOV, Roumen (University of Sofia); YASUTOME, Kenji (University of Kyoto)

Presenter: NOAH, Etam (University of Geneva)

Session Classification: Wednesday afternoon

Contribution ID: **61** Type: **Oral**

Performance estimation of the Belle II Aerogel RICH counter in the first beam collision

Thursday 29 November 2018 15:00 (20 minutes)

The Belle II experiment at the SuperKEKB facility started observation of beam collisions in 2018 to search for the New Physics beyond the Standard Model using 50 times higher statistics of electron-positron collisions of the Belle experiment. The Aerogel Ring Imaging Cherenkov (ARICH) counter is a newly developed particle identification device in the forward endcap of the Belle II spectrometer to secure 4σ separation of charged kaons and pions up to momenta of 3.5 GeV. Several techniques were developed to maximize the pion-kaon separation performance in 1.5 T of high magnetic field and 30 cm depth of narrow space in the endcap region. The ARICH counter is a proximity-focusing RICH counter. Photons are emitted in two layers of the Sirica Aerogel radiators with different reflective indices to be detected by the Hybrid Avalanche Photo Detector (HAPD) as 2-dimensional Cherenkov ring images. Types of the articles is identified based on the difference of radiation angles of the emitted photons. Construction and installation of the ARICH counter is finished in 2017. Commissioning of the SuperKEKB accelerator and the Belle II spectrometer using beam collisions has been finished in July of 2018. We have collected ring images by particles from the collisions passing the ARICH and studies for the PID performance estimation is carried out. Results of the PID performance study using the collision data and prospects for full operation of the SuperKEKB/Belle II for the BSM search in 2019 will be discussed in this presentation.

Primary authors: KONNO, Tomoyuki (Kitasato University); ADACHI, Ichiro (High Energy Accelerator Research Organization (KEK),SOKENDAI (The Graduate University of Advanced Science)); BURMISTROV, Leonid (Laboratoire de Laccelerateur Lineaire); DIBERDER, Francois Le (Laboratoire de Laccelerateur Lineaire (LAL)); DOLENEC, Rok (University of Ljubljana); HATAYA, Koki (Tokyo Metropolitan University); IIJIMA, Toru (Nagoya University); KAKIMOTO, Shiori (Tokyo Metropolitan University); KAKUNO, Hidekazu (Tokyo Metropolitan University); KAWAI, Hideyuki (Chiba University); KOHRIKI, Takashi (High Energy Accelerator Research Organization (KEK)); KORPAR , Samo (University of Maribor); KOU, Emi (Laboratoire de Laccelerateur Lineaire (LAL)); KRIZAN, Peter (University of Ljubljana,Jozef Stefan Institute); KUMITA, Tetsuro (Tokyo Metropolitan University); LAI, Yun-Tsung (High Energy Accelerator Research Organization (KEK)); MACHIDA, Masahiro (Tokyo University of Science); MRVAR, Manca (Jozef Stefan Institute); NISHIDA, Shohei (High Energy Accelerator Research Organization (KEK), SOKENDAI (The Graduate University of Advanced Science)); NOGUCHI, Kouta (Tokyo Metropolitan University); OGAWA, Kazuya (Niigata University); OGAWA, Satoru (Toho University); PESTOTNIK, Rok (Jozef Stefan Institute); SANTELJ, Luka (High Energy Accelerator Research Organization (KEK)); SHOJI, Masayoshi (High Energy Accelerator Research Organization (KEK)); SUMIYOSHI, Takayuki (Tokyo Metropolitan University); TABATA, Makoto (Chiba University); TAMECHIKA, Sachi (Tokyo Metropolitan University); YONENAGA, Masanobu (Tokyo Metropolitan University); YOSHIZAWA, Morihito (Niigata University); YUSA, Yosuke (Niigata University)

Presenter: KONNO, Tomoyuki (Kitasato University)

Session Classification: Thursday afternoon

Contribution ID: **62** Type: **Oral**

Application of MPPC for T2K near detector upgrade

Tuesday 27 November 2018 16:25 (20 minutes)

We plan to equip about 60,000 MPPCs to build novel plastic scintillator detector for T2K near detector upgrade. Current goal of the T2K experiment is to measure CP violation phase in the neutrino sector, by measuring neutrino appearance in the long-baseline neutrino experiment. The upgrade of T2K near detector (ND280) aims to suppress systematic error to obtain better sensitivity for the experiment. A novel plastic scintillator detector, called SuperFGD, was then designed for this purpose. It consists of about 2,000,000 of 1 cm^3 plastic scintillator cubes with readout of three orthogonal directions, using WLS fibers, surface-mount MPPC array on PCBs and electronics of those. This fully-active detector can provide about 2 tons of target mass, fine granularity and isotropic acceptance. We will present the application of MPPC for our detector and R&D status.

Primary author: MATSUBARA, Tsunayuki (KEK)

Presenter: MATSUBARA, Tsunayuki (KEK)

Session Classification: Tuesday afternoon

Contribution ID: **63** Type: **Oral**

MPPCs in highly granular calorimetry - from ILC to LHC and beyond

Tuesday 27 November 2018 14:35 (20 minutes)

Following a first successful demonstration of the use of MPPCs in scintillator-based calorimeters, the CALICE collaboration has developed over the last years a concept scalable to large collider detectors with millions of channels, thanks to embedded read-out electronics layers including surface-mounted MPPCs. A prototype with 22000 channels has been constructed and was tested in hadrons beams this summer. Based on a very similar integration concept, the CMS collaboration plans to use this technology for their upgrade of their endcap calorimeter for the high-luminosity phase of the LHC, which brings additional challenges in terms of radiation hardness, speed and thermal coupling. The talk will present the CALICE prototype layout and some first impressions from test beam data, and discuss the extension of application range to irradiated hadron collider environments.

Primary author: Dr SEFKOW, Felix (DESY, Hamburg, Germany)

Presenter: Dr SEFKOW, Felix (DESY, Hamburg, Germany)

Session Classification: Tuesday afternoon

Contribution ID: **64** Type: **Oral**

Characterisation and temperature stabilisation of a system with 22000 MPPCs

Wednesday 28 November 2018 10:15 (20 minutes)

The construction of a highly granular scintillator-tile calorimeter with 22000 MPPCs required new approached to quality control and provided both test bench and in-situ data for the characterisation of a large sample of photo-sensors. Thanks to the excellent uniformity of device parameters, it was possible to stabilise the MPPC responses in the presence of temperature variations by automatic adaptations of the bias voltage on the basis of regular temperature measurements. The talk will present the approach to parameter monitoring during the construction phase, in-situ characterisation results and report the experience with the implementation of automatic temperature compensation at system level.

Primary author: Dr SUDO, Yuji (DESY)

Presenter: Dr SUDO, Yuji (DESY)

Session Classification: Wednesday morning

Contribution ID: **66** Type: **Oral**

Mass Production of MCP-PMT for JUNO and Development of 20-inch MCP-PMT with TTS Improved

Thursday 29 November 2018 09:55 (20 minutes)

In order to meet the requirement of JUNO, 20-inch microchannel plate photomultiplier (MCP-PMT) was researched by the MCP-PMT collaboration, which was established by Institute of High Energy Physics (IHEP) and North Night Vision Technology Co., Ltd (NNVT) in 2012. By the breakthrough of the key technology, such as the electronic optics structure design, the high quantum efficiency photocathode process, and so on, the 20-inch MCP-PMT was developed successfully by the end of 2015. The collection efficiency was about 98% and the detection efficiency (DE) was about 27%. At the same year, NNVT successfully bided for the 15000 PMTs of JUNO. In order to finish the contract of MCP-PMTs, the production line of 20-inch MCP-PMT was built on the 25th Nov of 2016. The production line was the domestic advanced photomultiplier production line with capable of 7500 pieces 20-inch MCP-PMTs a year. By building the batch test system, the charge performance of 32 pieces PMTs could be tested at the same time. Recently, NNVT had delivered JUNO total 7000 pieces 20-inch MCP-PMTs. The average DE was increased to 30% from 27% since June 2018, and the average dark count rate was about 30 kHz. Based on the research finding of 20-inch MCP-PMT for JUNO, the 20-inch MCP-PMT with good time response was researched to meet the requirement of Hyper-K project, and developed successfully. The new 20-inch MCP-PMT had a flower-like focusing electrode. The transit time spread was about 5 ns, namely FWHM, better than the one of the original 20-inch MCP-PMT.

Primary author: Dr REN, LING (North Night Vision Technology Co., Ltd)

Co-authors: Mr CAO, YIQI (North Night Vision Technology Co., Ltd); Mr HUANG, GUORUI (North Night Vision Technology Co., Ltd); Mrs HOU, WEI (North Night Vision Technology Co., Ltd); Dr JIN, MUCHUN (North Night Vision Technology Co., Ltd); Mrs JIN, ZHEN (North Night Vision Technology Co., Ltd); Prof. LIU, SHULIN (Institute of High Energy Physics, Chinese Academy of Sciences); Dr QIAN, SEN (Institute of High Energy Physics, Chinese Academy of Sciences); Mr SUN, JIANNING (North Night Vision Technology Co., Ltd); Mr SI, SHUGUANG (North Night Vision Technology Co., Ltd); Mrs SHI, MENGYAO (North Night Vision Technology Co., Ltd); Mr WANG, XINGCHAO (North Night Vision Technology Co., Ltd); Mr XU, HAIYANG (North Night Vision Technology Co., Ltd)

Presenter: Dr REN, LING (North Night Vision Technology Co., Ltd)

Session Classification: Thursday morning

Contribution ID: **68** Type: **Oral**

Poster highlight

Tuesday 27 November 2018 17:25 (25 minutes)

Primary author: NAKAMURA, Isamu (KEK)

Presenter: NAKAMURA, Isamu (KEK)

Contribution ID: **69** Type: **not specified**

Banquet

Wednesday 28 November 2018 19:30 (2 hours)

Contribution ID: **70** Type: **Oral**

Recent development of MPPC and Si detectors for HEP experiments

Tuesday 27 November 2018 09:40 (35 minutes)

Nearly 10 years have passed since Hamamatsu started developing the MPPC, which is a part of the SiPM family. The most important feature is its photon counting capability due to its high gain and low noise, but the MPPC has many additional features such as compact size, low operation voltage, robustness, high detection efficiency, and immunity to magnetic fields. Over the years, various types of MPPC technology and devices have been developed for specific applications such as academic research, medical, precise measurement, and industrial. Recent developments resulted in covering different wavelength regions such as VUV, VIS, and NIR, to make the MPPC suitable for a wider field of applications. Recently, the demand for NIR-enhanced MPPCs became very popular in distance measurement applications in the automotive industry. In addition to developing the detector, Hamamatsu also developed ASIC, power supplies, and modules using these components to make it easy for customers to design their systems.
Hamamatsu SSD(Silicon Strip Detectors) and PAD(Pixel Array detectors) have been used in many collider experiments (ATLAS, CMS, Belle, etc.). Now we are developing larger PAD with 8inches wafer for HL-LHC.
In this presentation, we will discuss new MPPCs and various techniques to control MPPCs. And we will talk about new silicon detectors developing for HEP experiments.

Primary author: Mr YAMAMOTO, Koei (Hamamatsu Photonics)

Presenter: Mr YAMAMOTO, Koei (Hamamatsu Photonics)

Session Classification: Tuesday morning

Contribution ID: **71** Type: **not specified**

Opening

Tuesday 27 November 2018 09:30 (10 minutes)

Session Classification: Tuesday morning

Contribution ID: **72** Type: **not specified**

SiPM overview: status and trends

Tuesday 27 November 2018 14:00 (35 minutes)

Primary author: ACERBI, fabio (FBK)

Co-author: Dr GOLA, Alberto (FBK)

Presenter: ACERBI, fabio (FBK)

Session Classification: Tuesday afternoon

Contribution ID: **73** Type: **Oral**

SiPM readout for cryogenic applications

Wednesday 28 November 2018 14:00 (30 minutes)

Silicon PhotoMultipliers (SiPM) provide an efficient photon read-out to particle detectors thank to their high photon detection efficiency, their immunity to magnetic fields and their high granularity. Recently SiPMs are being studied for cryogenic application within dark matter or neutrinos detector. This talk will describe the behavior of newest FBK cryogenic SiPMs and the associated read-out electronics for the production of large PMT replacement photo-detectors

Primary author: RAZETO, Alessandro (INFN)

Presenter: RAZETO, Alessandro (INFN)

Session Classification: Wednesday afternoon

Contribution ID: **74** Type: **Oral**

Advanced vacuum photodetectors and their applications

Thursday 29 November 2018 09:00 (35 minutes)

Primary author: KORPAR, Samo (University of Maribor, Jozef Stefan Institute)

Presenter: KORPAR, Samo (University of Maribor, Jozef Stefan Institute)

Session Classification: Thursday morning

Contribution ID: **75** Type: **not specified**

Summary of workshop

Thursday 29 November 2018 16:30 (30 minutes)

Primary author: KUDENKO, Yury (INR RAS)

Presenter: KUDENKO, Yury (INR RAS)

Session Classification: Thursday afternoon

Contribution ID: **76** Type: **not specified**

Next PD workshop

Thursday 29 November 2018 17:00 (5 minutes)

Session Classification: Thursday afternoon