11th International Workshop on Ring Imaging Cherenkov Detectors (RICH2022)

Report of Contributions

Contribution ID: **2** Type: **presentation**

A SiPM-based optical readout system for the EIC dual-radiator RICH

Thursday, September 15, 2022 2:40 PM (25 minutes)

Silicon photomultipliers (SiPM) are candidates selected as the potential photodetector technology for the dual-radiator Ring-Imaging Cherenkov (dRICH) detector at the future Electron-Ion Collider (EIC). SiPM optical readout offers a large set of advantages being cheap devices, highly efficient and insensitive to the high magnetic field (˜ 1.5 T) at the expected location of the sensors in the experiment. On the other hand, SiPM are not radiation tolerant and despite the integrated radiation level is expected to be moderate (< 10^{11} 1-MeV neq/cm2) it should be tested whether single photon-counting capabilities and the increase in Dark Count Rate (DCR) can be kept under control to maintain the optimal dRICH detector performance across the years.

Several options are available to maintain the DCR to an acceptable rate (below ˜100 kHz/mm2), namely by reducing the SiPM operating temperature, using the timing information with high-precision TDC electronics, selection cuts based on bunch crossing information, and by recovering the radiation damage with high-temperature annealing cycles.

In this presentation we present the current status of the research and the first results on studies performed on a large sample of commercial (Hamamatsu) and prototype (FBK) SiPM sensors. The devices have undergone an irradiation campaign where an increasing NIEL dose up to 1011 1-MeV neq/cm2 has been delivered to different sensor subsets. The sensors have then undergone high-temperature annealing cycles to recover the radiation damage. The results obtained with a complete readout system based on the first 32-channel prototypes of the ALCOR ASIC chip are also reported. Measurements are performed in a controlled-temperature environment where the sensors are mounted in a climatic chamber for characterisation. The setup is also equipped with a movimentation system and a pulsed LED light source to further test the response of multiple sensors and compare the performance of new sensors with the one of irradiated sensors. The time coincidence between the recorded SiPM light signal and the generated LED pulse is used to further discriminate dark-count signals from light signals.

Figure 1: Special care has been used to design a SiPM-carrier board with high-temperature resisting components and an edge connector to cope with temperatures as high as 180 C. (left) One of the custom prototype SiPM boards designed for the irradiation and high-temperature annealing campaign. The shaded area shows the region of the delivered uniform radiation field. (centre) Gafchromic film impressed by the collimated proton beam delivered by the setup shown installed at the TIFPA Trento Protontherapy Centre Irradiation Facility, demonstrating the uniform 3 mm vertical irradiation field. Special care has also been put in the design and realisation of a collimation system with micrometric movimentation to allow us to precisely deliver the proton beam in a 3 mm vertical slit with uniform radiation field. (right) Ratio of the measured current to the current measured on brand new sensor at fixed bias voltage as a function of the level of NIEL delivered radiation, before and after high-temperature annealing.

Figure 2: Measurements of the dark-count rate (DCR) performed with the full readout system coupled to the ALCOR ASIC chip. (left) Single-photon counting is demonstrated by the step-ladder behavior of the DCR as a function of the ALCOR ASIC discriminator threshold for SiPM irradiated up to 10^{11} NIEL after the annealing cycle. The figure shows a sensor that has received 10^{10} 1-MeV neq/cm^2 NIEL, although similar behavior with higher rates is observed for higher delivered NIEL. (right) A comprehensive measurement of the DCR for the large sample of new and irradiated Hamamatsu SiPM sensors shows great uniformity in the response up to the highest

delivered dose. The curves show the DCR as a function of the bias voltage at fixed ALCOR ASIC discriminator threshold (1-pe) for new sensors (blue) and irradiated sensors (red) with increasingly delivered NIEL. The width of the bands represent the dispersion of the rates measured in the large sample of sensors characterised.

Figure 3: Studies with pulsed LED light. (left) The complete prototype readout system inside the climatic chamber mounted on the XY movimentation system in front of the fixed LED light source. The readout system comprises the SiPM matrix carrier board mated with the adapter board, both visible in the picture. The adapter board is coupled with the ALCOR Front-End board which is on the back of the adapter board. The system hosts two SiPM boards, one on the left-hand side with a limited number of sensors which is used as reference for LED light stability checks and one full board for characterisation. (right) Time coincidence between the recorded SiPM light signal and the generated LED pulse.

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Session Classification: Photon detection techniques for Cherenkov counters

Track Classification: Photon detection techniques for Cherenkov imaging counters

Contribution ID: **3** Type: **poster**

Neutrino mass ordering determination through combined analysis with JUNO and KM3NeT/ORCA

The determination of neutrino mass ordering (NMO) is one of the prime goals of several neutrino experiments. KM3NeT/ORCA and JUNO are two next-generation neutrino oscillation experiments both aiming at addressing this question. ORCA can determine the NMO by probing Earth matter effects on the oscillation of atmospheric neutrinos in the GeV energy range. JUNO, on the other hand, is sensitive to the NMO by investigating the interference effects of fast oscillations in the reactor electron antineutrino spectrum at medium baseline. This talk presents the potential of determining the NMO through a combined analysis of JUNO and ORCA data. When measuring the Δm^2_{31} with a wrong ordering assumption, the best-fit values are different between the two experiments. This tension, together with good constraints on the Δm^2_{31} measurement by both experiments, enhances the combined NMO sensitivity beyond the simple sum of their sensitivities. The analysis shows that 5σ significance is reachable in less than 2 years of data taking with both experiments for true normal neutrino mass ordering assuming current global best-fit values of the oscillation parameters, while 6 years will be needed for any other parameter set.

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Session Classification: Poster Session and Welcome Drink

Track Classification: Cherenkov light imaging in neutrino and astroparticle physics experiments

Contribution ID: **4**   Type: **presentation**

Detecting neutrinos in IceCube with Cherenkov light in the South Pole ice

Monday, September 12, 2022 5:40 PM (25 minutes)

The IceCube Neutrino Observatory detects GeV-to-PeV+ neutrinos via the Cherenkov light produced by secondary charged particles from neutrino interactions with the South Pole ice. Relying on over 5000 spherical Digital Optical Modules (DOM), each deployed with a single downward-facing photo- multiplier tube (PMT) and arrayed across 86 strings over a cubic-kilometer, IceCube has measured the astrophysical neutrino flux while searching for their origins, as well as constrained neutrino oscillation parameters and cross sections. These were made possible by an in-depth characterization of the glacial ice, which has been refined over time, and novel approaches in reconstructions that utilize fast approximations of Cherenkov yield expectations.
After over a decade of nearly continuous IceCube operation, the next generation of neutrino telescopes at the South Pole are taking shape. The IceCube Upgrade will add seven additional strings in a dense infill configuration. Multi-PMT OMs will be attached to each string, along with improved calibration devices and new sensor prototypes. Its denser OM and string spacing will extend sensitivity to lower neutrino energies and further constrain neutrino oscillation parameters. The calibration goals of the Upgrade will help guide the design and construction of IceCube Gen2, which will increase the effective volume of IceCube by nearly an order of magnitude to probe astrophysical neutrinos at the energies we've yet to reach.

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Session Classification: Cherenkov detectors in astroparticle physics

Track Classification: Cherenkov light imaging in neutrino and astroparticle physics experiments

Contribution ID: **5**   Type: **presentation**

Performance of the most recent microchannel-plate PMTs for the PANDA DIRC Detectors at FAIR

Thursday, September 15, 2022 4:10 PM (25 minutes)

PANDA is one of the main experiments at the FAIR facility at GSI which will study different aspects in QCD by, e.g., performing hadron spectroscopy, among others in searching for glueballs and exotic states, and by investigating hyperons. The PANDA experiment will use an antiproton beam in the momentum range of 1.5 to 15 $\mathrm{GeV/c}$ colliding with a stationary target. Due to antiproton-proton annihilations the production of exotic particles and states is directly possible. The PANDA detector consists of a target and forward spectrometer. Two DIRC detectors, a cylindrically shaped Barrel DIRC (BaD) around the interaction region and an Endcap Disc DIRC (EDD) covering the forward hemisphere, will be used for particle identification in particular for π/K separation up to $4\ \mathrm{GeV/c}$.
Since the focal planes of both DIRC detectors will reside in an ~ 1 T magnetic field and because of other boundary conditions microchannel-plate photomultipliers (MCP-PMTs) are the only viable sensor candidates. Their advantageous properties in terms of excellent time resolution, moderate dark count rate and especially their favorable gain behavior inside magnetic fields make them most suitable for the PANDA DIRCs. During a planned PANDA operation time of $\sim$10 years at full luminosity the MCP-PMTs have to withstand $>$5 $\mathrm{C/cm^2}$ integrated anode charge without any QE losses. Previous aging problems of MCP-PMTs were recently solved by applying the ALD (atomic layer deposition) coating technique. For this matter an ultrathin layer of alumina or magnesia covers the MCP glass substrate leading to an increased MCP-PMT lifetime of up to a factor $\sim$100. The current status of these measurements will be presented. Furthermore the sensors have to be capable to detect single photons at very high rates [$\sim$0.2 MHz/cm^2 (BaD) and up to 1 MHz/cm^2 (EDD)].
To measure these and other performance parameters by surface scans a semi-automatic setup was built, consisting of a light tight and copper shielded box combined with a 3-axis stepper and a picosecond laser pulser. With the multihit capable, FPGA-based DiRICH/TRB (Trigger and readout Board) DAQ many parameters like time resolution, dark count rate, afterpulsing ratio, charge sharing crosstalk and electron recoil behavior, but also QE and gain homogeneity, can be simultaneously obtained as a function of the xy-position. This paper will present new insights to the performance parameters of several types of the very latest multi-anode MCP-PMTs. In particular properties like gain and internal parameters like charge cloud width and electron recoil distributions were investigated also inside the magnetic field. In addition the performance of new MCP-PMTs from Photonis with an anode layout of 3 $\times$100 pixels will be shown in this talk. Also recently observed side effects with the latest two ALD layer MCP-PMTs will be reviewed.

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Session Classification: Photon detection techniques for Cherenkov counters

Track Classification: Photon detection techniques for Cherenkov imaging counters

Contribution ID: **6** Type: **presentation**

The PANDA Barrel DIRC

Monday, September 12, 2022 4:05 PM (25 minutes)

The PANDA experiment at the international accelerator Facility for Antiproton and Ion Research in Europe (FAIR), Darmstadt, Germany, will address fundamental questions of hadron physics using $\bar{p}p$ annihilations. Excellent Particle Identification (PID) over a large range of solid angles and particle momenta will be essential to meet the objectives of the rich physics program. Charged PID in the target region will be provided by a Barrel DIRC (Detection of Internally Reflected Cherenkov light) counter.
The Barrel DIRC, covering the polar angle range of 22-140 degrees, will provide a π/K separation power of at least 3 standard deviations (s.d.) for charged particle momenta up to 3.5 GeV/c. The design of the Barrel DIRC features narrow radiator bars made from synthetic fused silica, an innovative multi-layer spherical lens focusing system, a prism-shaped synthetic fused silica expansion volume, and an array of lifetime-enhanced Microchannel Plate PMTs (MCP-PMTs) to detect the hit location and arrival time of the Cherenkov photons. Detailed Monte-Carlo simulations were performed, and reconstruction methods were developed to study the performance of the system. All critical aspects of the design and the performance were validated with system prototypes in a mixed hadron beam at CERN. In 2020 the PANDA Barrel DIRC project advanced from the design stage to component fabrication. The series production of the fused silica bars was completed in 2021 and the first MCP-PMTs were delivered in 2022.
We will discuss the validation of the technical design using prototypes and present results from the quality assurance measurements for the bars and MCP-PMTs.

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Session Classification: Cherenkov light imaging in particle and nuclear physics experiments

Track Classification: Cherenkov light imaging in particle and nuclear physics experiments

Contribution ID: **7** Type: **presentation**

The JUNO Water Cherenkov Veto system

Monday, September 12, 2022 6:05 PM (25 minutes)

The Jiangmen Underground Neutrino Observatory (JUNO) is a 20 kton liquid scintillator detector with the primary physics goal of the neutrino mass hierarchy determination. The detector will be built in a laboratory at 700-m underground. . A Water Cherenkov veto system will be built for cosmic muon detection and background reduction. Outside the central detector, the pool is filled with 34 kton ultrapure water. The water Cherenkov light produced by cosmic muons are detected by 2400 MCP-PMT's. The inner surface of the water veto is covered with Tyvek reflector to increase the light collection efficiency. A water system is used for water purification and circulation to keep a high water quality for optimal detector performance. A set of radon removal equipment will be integrated with the water system to reduce the radon-induced background in the central detector. Based on prototype studies, the radon concentration in water in water could be reduced to 10mBq/m^3. The cosmic muon detection efficiency of the water Cherenkov detector is >99%. With this veto system, the cosmic muon-induced fast neutron background can also be reduced to ~0.1/day level.

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Session Classification: Cherenkov detectors in astroparticle physics

Track Classification: Cherenkov light imaging in neutrino and astroparticle physics experiments

Contribution ID: **8** Type: **poster**

FERS-5200: a distributed Front-End Readout System for multidetector arrays

The FERS-5200 is the new CAEN Front-End Readout System, answering the challenging requirement to provide flexibility and cost-effectiveness in the readout of huge detector arrays. FERS-5200 is a distributed and easy-deployable platform integrating the whole readout chain of the experiment, from detector front-end to DAQ. It is based on compact ASIC-based front-end cards integrating A/D conversion and data processing, which can be ideally spread over a large detector volume without drawbacks on the readout performance. Synchronization, event building and DAQ is managed by a single Concentrator board, capable of sustaining thousands of readout channels. Using the appropriate Front-End, the solution perfectly fits a wide range of detectors such as SiPMs, multianode PMTs, GEMs, Silicon Strip detectors, Wire Chambers, Gas Tubes, etc, thus matching the requirements of different applications

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Presenter: Mr VENTURINI, Yuri (CAEN SpA)

Session Classification: Poster Session and Welcome Drink

Track Classification: Technological aspects and applications

Contribution ID: **9** Type: **presentation**

The high voltage system the novel MPGD-based photon detectors of COMPASS RICH-1 and its developement towards a scalable High Voltage Power Supply System with system on chip control for Micro Pattern Gaseous Detectors.

Thursday, September 15, 2022 11:25 AM (25 minutes)

The COMPASS RICH-1 detector has undergone a major upgrade in 2016 with the installation of four novel MPGD-based photon detectors. They consist of large-size hybrid MPGDs with multi-layer architecture composed of two layers of Thick-GEMs and bulk resistive MicroMegas. A dedicated high voltage power supply system has been built and put in operation. It controls more than 100 HV channels. The system is required to protect the detectors against errors by the operator, monitor and log voltages and currents at a 1 Hz rate, and automatically react to detector misbehavior. It includes also a sophisticated HV compensation system against environmental pressure and temperature variation. In fact, voltage compensation is always a requirement for the stability of gaseous detectors and its need is enhanced in multi-layer ones. In particular, the needs posed to high voltage power supply systems by the operation of Micro Pattern Gaseous Detectors in terms of high-resolution diagnostic features and intelligent dynamic voltage control are required both when technology development is performed and when extended detector systems are supplied and monitored. Systems satisfying all the needed features are not commercially available.
A single channel high voltage system matching the Micro Pattern Gaseous Detector needs has been designed and realized, including its hardware and software components.
In this talk the COMPASS HV system and its performance are illustrated, as well as the stability of the novel MPGD-based photon detectors during the physics data taking at COMPASS. As further development, the design, implementation and performance of a HV channel based on DC to DC converter and controlled by a FPGA system is presented. The performance of the single channel power supply when connected to a Micro Pattern Gaseous Detector in realistic working condition during a test beam will be shown

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Session Classification: Technological aspects and applications of Cherenkov detectors

Track Classification: Technological aspects and applications

Contribution ID: **10** Type: **presentation**

The R&D of the MCP based PMTs for High Energy Physics Detectors

Thursday, September 15, 2022 5:15 PM (25 minutes)

Researchers at IHEP have conceived two types of MCP-PMTs for the photon detection in particle physics. One is the 20 inch Large MCP-PMT (LPMT) with small MCP units in the large area PMTs for the neutrino detection. This LPMT has already been mass produced more 15K pieces in the JUNO experiment, and has also been evaluated by the PMT group in LHAASO and HyperK. The other is the 2 inch Fast MCP-PMT (FPMT) with the fast timing resolution for particle identification in the collider detector. The FPMT prototypes have been produced with 50 ps time resolution, and also the 8X8 readout anode for the position resolution. This talk will introduce the two types of MCP-PMT and their performance tested in the lab.

Authors: WU, Qi; QIAN, Sen

Presenter: QIAN, Sen

Session Classification: Photon detection techniques for Cherenkov counters

Track Classification: Photon detection techniques for Cherenkov imaging counters

Contribution ID: **11** Type: **presentation**

The CTA Large-Sized Telescope project, status and prospects

Tuesday, September 13, 2022 9:00 AM (25 minutes)

The Large-Sized Telescopes (LST) are being deploying four imaging atmospheric Cherenkov telescopes in the Northern site of the future Cherenkov Telescope Array (CTA). The first prototype, LST-1, has been inaugurated at La Palma (Spain) in 2018 and is being commissioned since then while the three others will be built during three coming years. Thanks to their large dish of 23 m diameter, they can collect on the ground the light from the faintest extensive
atmospheric showers and achieve observation of gamma rays
with energies down to 20 GeV.
The status of the project will be presented with emphasis put on the key results from the commissioning phase, mostly focusing on the optics and Cherenkov camera performance. The first science results obtained with LST-1, such as observations of standard sources like the Crab Nebula and Crab pulsar, RS Ophiuchi and BL Lac will be shown demonstrating the high performance level reached in monoscopic operations. Eventually, the status of the production of the LST-2 to 4 will be given.

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Presenter: HELLER, Matthieu (Universite de Geneve (CH))

Session Classification: Cherenkov detectors in astroparticle physics

Track Classification: Cherenkov light imaging in neutrino and astroparticle physics experiments

Contribution ID: **12** Type: **presentation**

THe ASTRI Mini-Array at the Teide Observatory

Tuesday, September 13, 2022 9:25 AM (25 minutes)

The ASTRI Mini-Array is an INAF project to build and operate a facility to study astronomical sources emitting very high energy in the TeV spectral band. It consists of a group of nine innovative aplanatic dual mirror Imaging Atmospheric Cherenkov Telescopes of 4 m diameter. The telescopes will be installed at the Teide Astronomical Observatory of the Instituto de Astrofisica de Canarias in Tenerife (Canary Islands, Spain) based on a host agreement with INAF. Thanks to its expected overall performance, better than those of current IACT arrays, for energies above about 5 TeV and up to 100 TeV and beyond, the ASTRI Mini-Array will represent an important instrument to perform deep observations of the Galactic and extra-Galactic sky at these energies with high angular resolution (a few arcmins). It will be complementary to the wide-field particle shower arrays (based on water Cherenkov and scintillator detectors) like HAWC and LHAASO already operated in the North hemisphere.
The ASTRI Mini-Array is currently under construction. The site infrastructure, including telescope foundations, data and power network, data center, and control room, will be completed by the end of June 2022. The first telescope of the array (ASTRI-1) has been realized and is currently being tested at the premises of the EIE GROUP company in Italy. It will be integrated at the Tenerife site starting in mid-June, with optical commissioning performed during summer 2022. First tests with a reduced version of the onsite information and communication technology are in progress. The second and third telescopes of the array and the first Cherenkov camera will follow by the end of 2022. We plan to complete the array by 2024. In this paper, we will present the status of the ASTRI mini-array, discussing its design and expected performance.

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Presenter: SCUDERI, Salvatore

Session Classification: Cherenkov detectors in astroparticle physics

Track Classification: Cherenkov light imaging in neutrino and astroparticle physics experiments

Contribution ID: **13** Type: **presentation**

ESSnuSB design and performance for CP violating precision measurements

Tuesday, September 13, 2022 9:50 AM (25 minutes)

An EU supported Design Study has been carried out during the years 2018-2021 of how the 5 MW linear accelerator (linac) of the European Spallation Source under construction in Lund, Sweden, can be used to generate a world-uniquely intense neutrino beam for precision measurement of the CP violating phase δCP. As there are definite limits, related to uncertainties in neutrino-nucleus interactions modelling, to by how much the systematic errors in such measurements can be reduced, the way to increase the precision with which δCP can be measured is to make the measurements at the second oscillation maximum, where the CP violation signal is close to 3 times larger than at the first. As the second maximum is located further away from the neutrino source, a higher beam intensity and thus higher proton driver power is required when measuring at the second maximum. The uniquely high power of the ESS linac will allow for the measurements to be made at the second oscillation maximum and thereby for the most precise measurements to be made of δCP. One part of the program, still to be designed, will be to use a Low Energy nuSTORM racetrack ring and a Low Energy Monitored Neutrino Beam to generate beams of both electron and muon neutrinos and measure their cross-sections in the low neutrino energy range with the aim to increase the measurement precision further. In this talk will be described the results of the work made on the design of the main components of the ESSnuSB research infrastructure, which are the ESS linac upgraded to 10 MW, the pulse accumulator ring, the target station, the near neutrino detector and the far neutrino detector, as well as the results of the evaluation of the physics performance for leptonic CP violation discovery and, in particular, the precision with which it will be possible to measure the CP violation phase δCP.

Presenter: EKELOF, Tord (Uppsala University)

Session Classification: Cherenkov detectors in astroparticle physics

Track Classification: Cherenkov light imaging in neutrino and astroparticle physics experiments

Contribution ID: **14** Type: **poster**

The capability of water Cherenkov detectors arrays of the LAGO project to detect Gamma-Ray Burst and High Energy Astrophysics sources

Gamma-Ray Bursts (GRBs) are of the brightest transients detected, with typical energies in their prompt phase ranging from keV to GeV. Theoretical models predict emissions at higher energies in the early times of the afterglow emission, and recently GRB190114C was the first GRB detected at TeV energies by the MAGIC experiment.
The Latin American Giant Observatory (LAGO) operates a network of water Cherenkov detectors (WCD) at different sites in Latin America. Spanning over different altitudes and geomagnetic rigidity cutoffs, the geographic distribution of the LAGO sites, combined with the new electronics for control, atmospheric sensing, and data acquisition, allows the realization of diverse astrophysics studies at a regional scale. LAGO WCDs located at high altitudes possess good sensitivity to electromagnetic secondary radiation that is the expected signature of this kind of high energy event on the ground. It is worth mentioning that due to the characteristics of the WCD and the Wide Field of View (FOV) LAGO possesses a large aperture high duty cycle.
In this work, we present the results of the sensitivity of LAGO small arrays of WCDs for the detection of events like GRB190114C. Also, we extend the study to other galactic sources that are known to emit energies above TeV, such as Pulsar Wind Nebulas, TeV halos and some sources with unidentified categorization. These are interesting sources to study taking advantage of the long term monitoring capabilities of LAGO. We use a dedicated simulation process: ARTI, a toolkit developed by LAGO for high energy air showers, MEIGA, a framework to simulate the response of the detectors and OneDataSim, the new high-performance computing and cloud-based implementation of our simulation framework.

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Session Classification: Poster Session and Welcome Drink

Track Classification: Cherenkov light imaging in neutrino and astroparticle physics experiments

Contribution ID: **15** Type: **presentation**

Current status and operation of the H.E.S.S. array of imaging atmospheric Cherenkov telescopes

Tuesday, September 13, 2022 10:15 AM (25 minutes)

The High Energy Stereoscopic System (HESS) is an array of five imaging atmospheric Cerenkov telescopes (IACTs) to study gamma-ray emission from astrophysical objects in the Southern hemisphere. It is the only hybrid array of IACTs, composed of telescopes with different collection area and footprint, individually optimised for a specific energy range. Collectively, the array is most sensitive to gamma rays in the range of 100 GeV to 100 TeV. The array has been in operation since 2002 and has been upgraded with new telescopes and cameras multiple times. Recent hardware upgrades and changes in the operational procedures increased the amount of observing time, which is of key importance for time-domain science. H.E.S.S. operations saw record data taking in 2020 and 2021 and we describe the current operations with specific emphasis on system performance, operational processes and workflows, quality control and (near) real-time extraction of science results. In light of this, we will briefly discuss the early detection of gamma-ray emission from the recurrent novae RS Oph and alert distribution to the astrophysics community.

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Co-author: FOR THE H.E.S.S. COLLABORATION

Presenter: OHM, Stefan

Session Classification: Cherenkov detectors in astroparticle physics

Track Classification: Cherenkov light imaging in neutrino and astroparticle physics experiments

Contribution ID: **16** Type: **presentation**

A novel fast-timing readout chain for LHCb RICH LS3 enhancements and prototype beam tests

Thursday, September 15, 2022 11:00 AM (25 minutes)

The prompt Cherenkov radiation and focusing optics of the LHCb RICH detectors allow the prediction of the Cherenkov photon detection time from a given track to within ten picoseconds. Fast-timing information on the detected Cherenkov photons can therefore be used to significantly improve the PID performance and the signal-to-noise ratio of the detectors. This concept is a cornerstone for the LHCb RICH detector upgrades and will ultimately allow the system to operate at a luminosity in excess of 10^{34} cm^{-2} s^{-1} during HL-LHC Run 5. The motivation and concepts behind the detector enhancements during Long Shutdown 3 (LS3, 2026-2028) and the proposed new electronic readout chain will be presented. The specifications for the new ASIC called the FastRICH will be discussed in the context of the LS3 enhancements and LHCb Upgrade II. The FastRICH ASIC will perform multi-channel single-photon discrimination, timestamp photons with 25 ps bin size, integrate closely with the LHCb optical link chipset and apply data-compression techniques. It will allow the system to timestamp each photon with an ˜150 ps resolution (dominated by the existing MAPMT transit time spread) within a short gate of ˜2 ns (the time spread from the LHCb collisions). The new electronic readout chain introduces important timing and detector techniques ahead of the Upgrade II RICH system overhaul and the FastRICH has the flexibility to be coupled to sensors with better time resolution for HL-LHC Run 5. Simulation studies have demonstrated improvements in the hadronic PID performance during Run 4 using the FastRICH and the current photon detectors. A first version of the readout chain, based on the FastIC, a predecessor of the FastRICH ASIC, and a TDC-in-FPGA, has been studied using Cherenkov photons at the CERN SPS charged particle beam test facility. The readout chain was coupled to MAPMT and SiPM sensors. The results will be presented and interpreted in the context of the RICH detector future upgrades.

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Presenter: KEIZER, Floris (CERN)

Session Classification: Technological aspects and applications of Cherenkov detectors

Track Classification: Technological aspects and applications

Contribution ID: **17** Type: **presentation**

Particle identification with the NA62 RICH detector

Tuesday, September 13, 2022 3:40 PM (25 minutes)

NA62 is a new generation kaon experiment at the CERN SPS aiming at measuring the branching ratio (BR) of the ultra-rare K+→π+νν decay with 10% accuracy.

One of main challenges of the experiment is the suppression of background decay channels with branching ratios up to 10 orders of magnitude higher than the signal and with similar experimental signatures, e.g. the background from the K+→μ+ν decay, where the muon is misidentified. To provide such suppression, a powerful particle identification (PID) is needed.

A key element of PID in NA62 is the Ring-Imaging Cherenkov (RICH) detector. According to the NA62 requirements, the RICH should identify μ+ and π+ with a muon rejection factor of at least 100. It also measures the arrival time of charged particles with a precision better than 100 ps and is one of the main components of the NA62 trigger system.
The RICH has successfully operated during the 2016-2018 data taking periods, being essential in the measurement of the BR(K+→π+νν). The detector was also used for searches for lepton flavor violation in 3-track kaon decays. The talk is concentrated on the π/μ and π/e separation directly measured with the data for the aforementioned decays.

Presenter: DUK, Viacheslav (INFN Perugia)

Session Classification: Pattern Recognition and data analysis

Track Classification: Pattern recognition and data analysis

Contribution ID: **18** Type: **poster**

From the FastIC ASIC to FastRICH, A Readout Chip for the Upgrade of the LHCb RICH Detector

The arrival of the Cherenkov photons to the photon detectors of the LHCb RICH system from a particular track can be predicted to within 10 picoseconds. This property can be used to improve pattern recognition and particle identification performance when high detector occupancy results from multiple primary vertices, which are slightly displaced in time. Time-stamping the Cherenkov photons with an accuracy of 100 ps or better improves the signal to noise ratio and allows operation with good particle identification for luminosity in excess of $10^{34} cm^{-2} s^{-1}$.

The FastRICH is a readout chip that is being designed in the framework of the upgrade of the LHCb RICH detector to be installed during the LHC Long Shutdown 3 (2026-2028) to read out multi-anode PMTs, while allowing compatibility with a detector R&D programme for operation in Run 5 for which SiPMs are candidates. The Application Specific Integrated Circuit (ASIC) is a derivative of the FastIC ASIC designed in a collaboration between the Microelectronics section at CERN and University of Barcelona.
The FastIC is an 8 channel generic detector readout ASIC developed in 65nm CMOS technology that provides an accurate time stamping of the detected particles and a linear energy measurement with a dynamic range from a few microamperes to ˜20mA. The ASIC contains an analog front-end and discrimination circuitry. The power consumption of the full channel is 12 mW with default settings. The ASIC includes an input stage that can be configured to process the signal from positive or negative polarity detectors with intrinsic amplification, like MCPs, PMTs or SiPMs. Measurements were done using FastIC to read out an R5900 Hamamatsu PMT biased at 800V. The measurement, after time walk correction, showed a time jitter of ˜340 ps FWHM, which corresponds to the intrinsic PMT time uncertainty when detecting tens of photons. The result showed that the ASIC itself introduced a negligible contribution to the measured time uncertainty. The SPTR was also measured (including laser, sensor and electronics contribution) using a blue-light laser source and a 3x3 mm^2 SiPM HPK S13360-3050CS to be 176 ± 3 ps FWHM at 10.6 V of over-voltage. When the FastIC is connected to the new technology HD-NUV Low Field SiPM from FBK (3.2 × 3.12 mm^2, 40 µm cell), the SPTR decreased to 151 ± 3 ps. An extensive campaign of measurements is ongoing to evaluate the chip in the LHCb RICH environment.

The FastRICH chip under development is based on the analog circuitry of FastIC. The 16-channel FastRICH chip is designed to provide a low power, compact and radiation hard readout including the analog front-end, discrimination, Time-To-Digital Conversion and output data zero-suppressed readout compatible with the lpGBT/VTRX+. The chip is designed to deal with 40 MHz hit rates in the single photon regime. In order to optimize the output data bandwidth, a Constant Fraction Discriminator (CFD) is being studied in order to eliminate the need to measure the trailing edge of the signal for time walk correction. The first simulation results including the front-end and CFD circuit show an electronics jitter <40 ps rms for detector signals above 50 μA, and a residual time walk below 200 ps peak to peak within the input range from 50 μA to 2 mA. Also, a hardware shutter programmable in terms of phase with respect to the experiment clock and duration is implemented to reduce the output data bandwidth.

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Presenters: BALLABRIGA SUNE, Rafael (CERN); KEIZER, Floris (CERN)

Session Classification: Poster Session and Welcome Drink

Track Classification: Technological aspects and applications

Contribution ID: **19** Type: **presentation**

Measurement of the photomultiplier efficiency and the mirror reflectivity of the RICH detector of the NA62 experiment at CERN

The number of hits per ring is the convolution of many factors: Cherenkov photon emission, mirror reflectivity, the probability of absorption and diffusion in the radiator, probability of photon transmission in the quartz window, photomultiplier (PM) quantum efficiency, the readout efficiency. Since this number is relatively small even for rings with beta=1 and hits are uniformly distributed along the ring, it is not possible to know whether a single PM covered by the ring was hit by a photon or not. Hence it is not possible to measure the absolute PM efficiency. However, it is possible to measure the relative efficiency on a statistical basis if the position and radius of the Cherenkov rings are precisely inferred by the information coming from other detectors. The measurement of the relative efficiency of the PMs of the NA62 RICH performed with the data collected in 2017 will be presented. A similar method, once the presence of a Cherenkov photon is detected, can be used to measure the relative reflectivity of the mirrors as a function of the photon position on the mirror surface. Preliminary results of this study will also be presented.

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Presenter: PICCINI, Mauro (INFN - Sezione di Perugia (IT))

Session Classification: Technological aspects and applications of Cherenkov detectors

Track Classification: Technological aspects and applications

Contribution ID: **20** Type: **presentation**

KM3NeT: Status and Physics Results

Tuesday, September 13, 2022 11:10 AM (25 minutes)

KM3NeT is a research infrastructure housing two underwater Cherenkov detectors located in the Mediterranean Sea. It consists of two configurations which are currently under construction: ARCA with 230 detection units corresponding to 1 cubic kilometre of instrumented water volume and ORCA with 115 detection units corresponding to a volume of 7 Mton. The ARCA (Astroparticle Research with Cosmics in the Abyss) detector aims at studying neutrinos with energies in the TeV-PeV range coming from distant astrophysical sources, while the ORCA (Oscillation Research with Cosmics in the Abyss) detector is optimised for atmospheric neutrino oscillations studies at energies of a few GeV. Both detectors are using an innovative multi-PMT design of the optical modules which greatly improves their detection capability. In this talk we present the status of ARCA and ORCA focusing on the technological achievements of the experiment. We also discuss the results obtained using data taken with the first detection units, thus demonstrating the potential of each configuration.

Author: DRAKOPOULOU, Evangelia

Presenter: DRAKOPOULOU, Evangelia

Session Classification: Cherenkov detectors in astroparticle physics

Track Classification: Cherenkov light imaging in neutrino and astroparticle physics experiments

Contribution ID: **21** Type: **poster**

Measurement of the Muon Lifetime and the Michel Spectrum in the LAGO Water Cherenkov Detectors as a tool to improve energy calibration and to enhance the signal-to-noise ratio

The Latin American Giant Observatory (LAGO) consists of a network of water Cherenkov detectors (WCDs) installed in the Latin American region at various latitudes, from Sierra Negra in México, 18° 59′ N 97° 18'W to the Antarctic Peninsula, 64° 14′ S 56° 38′ W and altitudes from Lima, Peru at 20 m.a.s.l. to Chacaltaya, Bolivia at 5500 m.a.s.l. The detectors of the network are built on the basis of commercial water tanks, so they have several geometries (cylindrical in general) and different water purification methods. All these features generate different profiles in the response to air shower particles measured by our detectors.

LAGO WCDs produce pulse shaped electronic signals. Common sources of noise in a WCD come from light leakage, electronic noise, and noise associated with the operation of photomultiplier tubes (PMTs) such as thermionic emission and after-pulses; they all could produce detectable pulses recorded by the LAGO DAQ system. In LAGO WCDs, these noise signals are expected to present a short pulse width (of a few nanoseconds), while secondary radiation typically produces pulses of several tens of nanoseconds.

We used data from the LAGO DAQ system, which digitizes pulses at 25 ns sampling rate on windows of 300 ns and with a 10-bits resolution (12 temporal acquisition bins). The LAGO DAQ configuration uses a single threshold-based trigger in the 3rd temporal acquisition bin. We proposed a secondary trigger threshold at the 4th bin to improve noise rejection. In this work we show how the optimal values for these triggers are now obtained from the measurement of the muon lifetime within the water volume, and the resulting Michel spectrum. This method is being automated and implemented as part of the new STEMLab 125-14 version of the LAGO DAQ boards.

Our results were also simulated using the LAGO ARTI simulation framework to estimate the expected flux of secondary particles at the detector site; and the Meiga framework, a Geant4-based simulator used to estimate the WCDs response to the air shower particles flux.

Authors: OTINIANO, Luis (Comisión Nacional de Investigación y Desarrollo Aeroespacial, CONIDA); TABOADA, Alvaro (Instituto de Tecnologías en Detección y Astropartículas ITeDA (CNEA/CONICET/UNSAM),); ASOREY, Hernán (Instituto de Tecnologías en Detección y Astropartículas ITeDA (CNEA/CONICET/UNSAM), Departamento Física Médica, Centro Atómico Bariloche (CNEA)); CASTROMONTE FLORES, Cesar M. (Universidad Nacional de Ingeniería); FAUTH, Anderson (Universidade Estadual de Campinas (UNICAMP)); SIDELNIK, Ivan (Departamento de Física de Neutrones, Centro Atómico Bariloche, CNEA and CONICET - Argentina)

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Session Classification: Poster Session and Welcome Drink

Track Classification: Pattern recognition and data analysis

Contribution ID: **22** Type: **poster**

A 32-channel TDC Implemented on an FPGA for Photodetector Timing Studies

Simulation studies have shown that future RICH detectors in high occupancy environments will benefit from time-resolved single-photon readout with sub-nanosecond resolution. We present an FPGA TDC (Time to Digital Converter) implementation developed as part of the LHCb RICH upgrade R&D program. The design requirements for a such TDC core are low logic resource utilization, multi-channel readout, high acquisition rate, closely integrated with the DAQ, and less than 300 ps bin size. The TDC core presented here is based on the previous work of Y. Wang et al., which introduced a multi-channel, multi-phase clock sampling architecture implemented in an FPGA. In our design we have simplified the original TDC logic, in order to implement up to 32-channels, minimize the sampling dead-time and allow measurement of both time of arrival (TOA) and time over threshold (TOT) for the same sample using an FPGA having fewer logic resources than the one used in the previous work. The TDC was implemented in a Xilinx Kintex-7 FPGA using 12 phase-shifted copies of a 320 MHz clock for a 261 ps nominal bin size. Even though its architecture is simple, a challenging step was to manually route and place each TDC logic block. This was required to have the same delays on each path that the input signals take to the sampling blocks of the TDC. The TDC capabilities were simulated first and then validated during lab tests by using a precise pulser with 10 ps step. First measurements with particle beams were performed with this 32-channel TDC at the CERN Super Proton Synchrotron (SPS) in October 2021, where it was used to time-tag Cherenkov photons detected with MaPMTs and SiPMs. An improved version of this TDC with 210 ps nominal bin size is currently under development for the planned July 2022 beam tests.

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Session Classification: Poster Session and Welcome Drink

Track Classification: Technological aspects and applications

Contribution ID: **23** Type: **poster**

Optical Systems For Future RICH Detectors

Optical systems for RICH detectors have historically taken a variety of designs. Nowadays, technological developments allow more flexibility in the design and construction than allowed in the past, such as lightweight secondary mirrors to be placed in acceptance, widespread use of non-spherical optical surfaces, flexible and fast tools for parametric optimization of the optical systems before feeding into a full detector simulation.
Within this context, the design of the LHCb/RICH optical system for the current Run-3 data-taking of the LHC which is starting now, will be presented and compared to the parametric design of the proposed optics for upgrade-II during the HL-LHC phase.

Author: CARDINALE, Roberta (INFN e Universita Genova (IT))

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Presenter: CARDINALE, Roberta (INFN e Universita Genova (IT))

Session Classification: Poster Session and Welcome Drink

Track Classification: Technological aspects and applications

Contribution ID: **24** Type: **presentation**

Ultra-low noise SPADs in 350 nm CMOS technology for Cherenkov radiation detection in particle and astrophysics

Thursday, September 15, 2022 3:05 PM (25 minutes)

An optimized design and process flow in a specialized 350 nm CMOS technology yields Single-Photon Ava-lanche Diodes (SPADs) with extremely low Dark Count Rates (DCR). They show optimal properties for de-tecting visible and near infrared photons in low quantity with high timing resolution. These characteristics are crucial for building up Silicon Photomultipliers (SiPM) to detect Cherenkov radiation in particle detection and astrophysics. SPAD-based SiPM typically excel photomultiplier tubes (PMT) with regard to detection efficiency, integration possibilities and their tolerance of magnetic fields, struggle, however, with a higher noise level, introduced by the DCR [1]. The presented SPADs show extremely low DCR values of 2·10-4 cps/μm² at 260 K down to 4·10-8 cps/μm² (= 0.04 cps/mm2) at 160 K [3] and thus can outperform PMTs in demanding detection applications.
A novel technology for 3D integration using direct bonding of 8"wafers was developed to allow a highly compact and integrated combination of low-noise backside-illuminated SPADs with circuits fabricated in advanced CMOS nodes achieving high readout speed and timing resolution. Customized through-silicon vias (TSV) establish the electrical interconnection of sensor and readout wafers for each individual SPAD. Utilizing this technology, a versatile SPAD-based detector with photon timing as well as counting capabili-ties was developed and successfully applied in LiDAR (Light Detection and Ranging), quantum imaging and quantum number generation [2]. This technology enables integration of high-performance circuits to en-hance the digital SiPM and could make separate front-end-electronic ASICs in detection modules redun-dant. Additionally, multiple techniques in CMOS processing as well as post-processing are shown to en-hance the detection probability and efficiency in specific spectral regions to optimize the performance for various applications.
The combination of these technologies promises great potential for highly integrated, low-noise, efficient and high-resolution digital SiPM. High flexibility in design, improvements by CMOS- as well as post-processing and the availability of a reliable 3D integration technology enable a viable path towards small to medium volume fabrication of enhanced detectors for Cherenkov radiation.

Authors: Dr WEILER, Dirk (Fraunhofer IMS); Mrs HAUSER, Julia (Fraunhofer IMS); Dr LIGGES, Manuel (Fraunhofer IMS); Dr VOM STEIN, Peter (Fraunhofer IMS); Dr DREINER, Stefan (Fraunhofer IMS); Dr WEYERS, Sascha (Fraunhofer IMS)

Presenter: GROSSE, Simon (Fraunhofer IMS)

Session Classification: Photon detection techniques for Cherenkov counters

Track Classification: Photon detection techniques for Cherenkov imaging counters

Contribution ID: **25** Type: **poster**

Particle Classification in the LAGO Water Cherenkov Detectors using Clustering Algorithms

The Latin American Giant Observatory (LAGO) is a ground based observatory studying solar or high energy astrophysics transient events. LAGO takes advantage of its distributed network of Water Cherenkov Detectors (WCDs) in Latin America as a tool to measure the secondary particle flux reaching the ground. These secondary particles are produced during the interaction of the modulated cosmic rays flux with the atmosphere.
The LAGO WCDs are sensitive to secondary charged particles, high-energy photons through pair creation and Compton scattering and even neutrons thanks to the deuteration of protons in the water volume. The pulse shape generated by these particles depends on detector geometry, water purity, reflectivity and diffusivity of the inner coating. Due to the decentralized nature of LAGO, these properties are different for each node. Additionally, the pulse shape depends on the convolution between the response of the detector central photomultiplier (PMT) to individual photons and the time distribution of the Cherenkov photons reaching the PMT. Typically, a WCD gives pulses with a sharp rise time (~10 ns) and a longer decay time (of ~70 ns). The WCD data used in this work was acquired using the first version of the LAGO DAQ that digitizes pulses at a sampling rate of 40 MHz and 10 bits resolution on windows of 300 ns.
In this scenario, we applied unsupervised machine learning techniques to find patterns in the WCDs data and subsequently create groups, through clustering, that can be used to provide particle separation. We used LAGO data acquired with individual WCDs, showing that density-based clustering algorithms are suitable for automatic particle separation producing good candidate groups. Improved separation would help LAGO to reconstruct in situ the properties of the secondary cosmic rays flux. The obtained outcomes were validated with a dedicated Monte Carlo simulation that takes into account the effects expected during the regular operation.
These results open the possibility to deploy machine-learning-based models in our distributed detection network for onboard data analysis in a semi-operative manner, and allow the installation of detectors at very remote sites.

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Session Classification: Poster Session and Welcome Drink

Track Classification: Pattern recognition and data analysis

Contribution ID: **26** Type: **presentation**

Simulation studies related to the particle identification by the forward and backward RICH detectors at Electron Ion Collider

Tuesday, September 13, 2022 5:25 PM (25 minutes)

The Electron Ion collider (EIC) will be the ultimate facility to address the internal dynamics played by the quarks and gluons to global phenomenology of the nucleons and nuclei. The essential physics programs greatly rely on an efficient particle identification (PID) in both the forward and the backward region. The forward and the backward RICHes of the EIC have to be able to cover wide acceptance and momentum ranges. In the forward region a dual radiator RICH (dRICH) is foreseen and in the backward region a proximity focusing RICH is foreseen to be employed.

The geometry and the performance studies of the dRICH have been performed and prescribed in the EIC Yellow Report. This prescription has been adopted in the ATHENA proto-collaboration detector scheme and has been integrated to the ATHENA software. The part of our work reports the effort following the call for EIC detector proposals. In this proposed design, as per prescriptions of the EIC Yellow Report, the forward and the backward RICHes cover wide acceptance and momentum range. In the forward region, dRICH performance showed a pion-kaon separation around 1 GeV/c to 50 GeV/c; whereas in the ATHENA scheme the backward region proximity focusing RICH (pfRICH) is designed with a 40 cm proximity gap is enhanced with filled C4F10 to use this RICH also in the threshold mode. This enables an electron-pion-kaon separation around 1 GeV/c to 10 GeV/c.

This contribution will give an overview of the simulation studies of the particle identification performance of both RICHes designed for the proposal of the ATHENA detector. A detailed description of the simulation chain in DD4Hep framework, the reconstruction of the single photon Cherenkov angle, the models of both RICHes, their performances, and technological synergies and the future plans will be addressed in this contribution.

Author: CHATTERJEE, Chandradoy (INFN Trieste (IT))

Presenter: CHATTERJEE, Chandradoy (INFN Trieste (IT))

Session Classification: R&D for future experiments

Track Classification: R&D for future experiment

Contribution ID: **27** Type: **presentation**

Aerogel RICH detector for the next generation heavy-ion experiment at LHC

Wednesday, September 14, 2022 11:35 AM (25 minutes)

The ALICE collaboration is proposing a new apparatus, ALICE 3, to investigate the Quark Gluon Plasma (QGP) properties, exploiting precise measurements of heavy-flavour probes as well as electromagnetic radiation. Electromagnetic probes can give access to the system temperature before hadronization, requiring a novel detector concept aimed at an unprecedented level of purity of the thermal di-lepton signal. e/p and K/p separation up to about 2 GeV/c and 10 GeV/c, respectively, is required. In this context, conceptual studies for the development of a RICH detector for ALICE 3 are ongoing. The proposed baseline layout is a proximity-focusing RICH, using aerogel (n = 1.03 at lph = 400 nm) as Cherenkov radiator and a layer of Silicon Photomultipliers (SiPM) for the photon detection, with an area of about 40 m^2. The proposed detector represents the largest one using this technology. A multi-layer (focusing) aerogel layout, with increasing refractive index, is also considered. If sufficient time resolution can be achieved in the SiPM photons detectors, they can be able to identify charged hadrons via TOF measurements. The detector specifications and performance, obtained by means of dedicated Monte Carlo simulation, will be presented. The design and R&D challenges will be also discussed.

Presenter: VOLPE, Giacomo (Universita e INFN, Bari (IT))

Session Classification: R&D for future experiments

Track Classification: R&D for future experiment

Contribution ID: **28** Type: **presentation**

Determination of bunch-crossing time at Belle II with TOP counter

Tuesday, September 13, 2022 4:35 PM (25 minutes)

At the Belle II experiment a Time-of-Propagation (TOP) counter is used for particle identification in the barel region. This novel type of particle identification device combines the Cherenkov ring imaging technique with the time-of-flight and therefore it relies on a precise knowledge of the time of collision in each triggered event. We will present a maximum likelihood based method which we have developed at Belle II for the determination of event collision time from the measured data.

Presenter: STARIC, Marko

Session Classification: Pattern Recognition and data analysis

Track Classification: Pattern recognition and data analysis

Contribution ID: **29** Type: **presentation**

Highlights of the very-high-energy gamma-ray sky as seen by MAGIC

Tuesday, September 13, 2022 11:35 AM (25 minutes)

MAGIC is a system of two 17-m diameter Cherenkov telescopes operating at the Observatorio del Roque de Los Muchachos in La Palma (Canary Islands, Spain) since 2009. The telescopes detect very-high-energy (VHE, E > 100 GeV) gamma rays ranging from few tens of GeV to few tens of TeV. In this contribution I will present a selection of the latest scientific results obtained by the MAGIC telescopes, regarding Gamma-Ray Bursts observations, multi-messenger and multi-wavelength astronomy, and the discovery of VHE gamma-ray emission from the first VHE nova, RS Ophiuchi

Author: LOPORCHIO, Serena (Universita e INFN, Bari (IT))

Presenter: LOPORCHIO, Serena (Universita e INFN, Bari (IT))

Session Classification: Cherenkov detectors in astroparticle physics

Track Classification: Cherenkov light imaging in neutrino and astroparticle physics experiments

Contribution ID: **30** Type: **presentation**

Long term stability and perspective of the ALICE-HMPID detector at LHC during Run3

Monday, September 12, 2022 2:25 PM (25 minutes)

The High Momentum Particle IDentification (HMPID) detector successfully participated to the LHC Run 1 (2009-2013) and Run 2 (2015-2018) data taking periods, providing the expected contribution to the ALICE physics program. The detector showed so far very stable PID performance, ensured by the stability of its different condition parameters, i.e., MWPCs gain, photocathode quantum efficiency, and liquid radiator transparency. Approaching the LHC Run 3 period, the HMPID is fully integrated in the new ALICE computing framework (O2) and Trigger environment. The HMPID status and the activities undertaken to get the detector compliant with the new experiment requirements will be presented. The detector performance obtained with the first available data from LHC Run 3 period, will be discussed and the perspective of the physics contribution in the ALICE program will be shortly mentioned.

Author: DE CATALDO, Giacinto (Universita e INFN, Bari (IT))

Presenter: DE CATALDO, Giacinto (Universita e INFN, Bari (IT))

Session Classification: Cherenkov light imaging in particle and nuclear physics experiments

Track Classification: Cherenkov light imaging in particle and nuclear physics experiments

Contribution ID: **31** Type: **presentation**

A 256 channel photon counting module using a square microchannel plate PMT in a tight packing envelop achieving < 100 ps single photon timing.

Thursday, September 15, 2022 5:40 PM (25 minutes)

Photek have developed a square microchannel plate (MCP) PMT using 6 μm pore MCPs to achieve superior timing, compared to the previous generation which used 15 μm pores. The native anode pattern is 64x64, but for this module the pattern is ganged to a 16x16 design using an epoxy bonded PCB giving an anode size of 3.3×3.3 mm2 in a 53×53 mm2 active area. The electronic front-end is the TOFPET2d ASIC from Petsys Electronics, a combined amplifier / discriminator / TDC with 30 ps time bins and capable of 480 kHz per channel count rate, with sufficient dynamic range to allow for the gain variation inherent in large area MCP-PMTs. Communications is through gigabit ethernet. The outer envelope of the combined PMT and electronic front-end package allows for close packing on 4 sides with outer dimensions of 60×62 mm giving a 76% fill factor. We present results showing the uniformity of detection efficiency, single photon timing accuracy and count rate capability. All data is taken on PMTs with ALD coated MCPs capable of > 5 C/cm2 accumulated lifetime.

Authors: MILNES, James; Mrs DURAN, Ayse (Photek Ltd); CONNEELY, Thomas (Photek LTD); HINK, Paul (Photek USA LLC)

Presenter: MILNES, James

Session Classification: Photon detection techniques for Cherenkov counters

Track Classification: Photon detection techniques for Cherenkov imaging counters

Contribution ID: **32** Type: **poster**

Qualification of DIRICH readout chain

Qualification of DIRICH readout chain
for the CBM RICH- and TRB collaborations.

DIRICH is a multi-channel FPGA based TDC readout chain aiming for excellent timing precision in single photo-electron measurement applications. It was originally developed for the readout of Multianode Photomultipliers (MAPMT) in the HADES- and CBM RICH detectors at GSI/FAIR, but is also foreseen to be used e.g. in the PANDA experiment at FAIR. High collision rate experiments like CBM will produce high photon rates in their RICH detectors; for CBM, single photon rates up to ~ 500 kHz in each pixel of its 8 × 8 pixel Multianode photo multiplier tubes are expected in certain regions of the photon detectors.
A dedicated lab setup producing realistic detector signals, by using a pulsed picosecond laser light source in combination with a LED, was set up in order to validate the high rate capability of the DIRICH readout. It could be shown that individual readout channels can withstand photon rates up to 2.2 MHz/pixel, limited only by maximum data rate capability and buffer size on the frontend board.
In addition, also effects of high photon occupancy on the MAPMTs were investigated, which might cause additional signals due to capacitive cross talk within the MAPMT or readout chain. Occupanc-ies of up to 55 % (simultaneous photon hits on more than half of the MAPMT pixels) were investigated, indicating that in the expected occupancy range of 10–15 % the readout works flawlessly with very low crosstalk.
The talk will focus on the laboratory test setup and qualification measurements of the readout chain obtained herewith.

Author: Mr SUBRAMANI, Pavish (Bergische Universitaet Wuppertal (DE))

Co-authors: Dr FÖRTSCH, Jörg (Bergische Universitaet Wuppertal (DE)); MICHEL, Jan (Goethe University Frankfurt (DE)); Dr PAULY, Christian (Bergische Universitaet Wuppertal (DE)); Mr PFEIFER, Dennis (Bergische Universitaet Wuppertal (DE)); TRAXLER, Michael (GSI Helmholtzzentrum für Schwerionenforschung GmbH); Prof. KAMPERT, Karl-Heinz (Bergische Universitaet Wuppertal (DE))

Presenter: Mr SUBRAMANI, Pavish (Bergische Universitaet Wuppertal (DE))

Session Classification: Poster Session and Welcome Drink

Track Classification: Technological aspects and applications

Contribution ID: **33** Type: **poster**

Characterisation of Cherenkov Optimised Silicon Photomultipliers Following Long Duration Operation

Silicon photomultipliers (SiPMs) specifically designed with a high photon detection efficiency (PDE) at the UV end of the visible spectrum are now competing with traditional photomultiplier tubes (PMTs). Typical applications where UV sensitive photosensors play a key role include Cherenkov and scintillation light detection in particle, astroparticle, nuclear physics, and medical physics.
PMTs have held prime place in UV photosensor applications owing to their photon counting capability, low dark count rate, high radiation-hardness, and large format. However, they are fragile both mechanically and to high illumination, have a finite lifetime and require high operating voltages. SiPMs on the other hand, are robust, operate at much lower voltages and have much longer potential lifetime. SiPM technology has developed considerably over the last decade resulting in lower dark count rate, reduced optical crosstalk, and PDE optimised for Cherenkov imaging, with increased sensitivity in the UV region and suppression at longer wavelengths, and they are now replacing PMTs in applications requiring UV photosensors. Being a solid-state device, they should operate indefinitely however external factors can degrade performance and inevitably lifetime.
In this research we describe results from a 64-pixel tile of Hamamatsu MPPC (SiPM) (peak sensitivity 465 nm) which has been operating continuously since January 2021 while gathering data from air shower events. The SiPM tile was temperature stabilised to 11° C in air, with the relative humidity maintained at <70%. All 64 pixels have been active during this period and we have collected continuous event data for four of these pixels. Accounting for some instrument downtime, we have currently (April 2022) accumulated >10,900 hours of live operation.
We present results characterizing the 64-pixel tile at start and end of the period of operation, including identification of failed and faulty pixels. The SiPM characteristics of the four pixels were monitored across the whole period of study and we assess the results for degradation in performance.

Authors: LAPINGTON, Jon (University of Leicester); LEACH, Steven

Presenter: LEACH, Steven

Session Classification: Poster Session and Welcome Drink

Track Classification: Photon detection techniques for Cherenkov imaging counters

Contribution ID: **34** Type: **presentation**

Performance of the new hadron blind HADES RICH in heavy ion collisions*

Monday, September 12, 2022 2:50 PM (25 minutes)

The ring imaging Cherenkov detector of the High Acceptance Dielectron Spectrometer (HADES) at GSI Darmstadt, Germany, has been upgraded with a new photon detection device based on 428 multianode photo electron multipliers (Hamamatsu H12700) partly coated with \textit{p}-Terphenyl as a wavelength shifter.
It is the key component for efficient identification of electrons and positrons emitted from hot and dense fireballs produced in heavy ion collisions.
Operated with a gaseous C_4H_{10} (isobutane) radiator the RICH is essentially hadron blind for particle momenta up to approximately 2 GeV/c.
In total, 27392 MAPMT channels are read out by the FPGA based DIRICH readout electronic scheme which is also going to be incorporated in the future CBM-RICH and PANDA-DIRC detectors.
The DIRICH readout allows to measure leading and trailing edges for each pixel pulse and hence time over threshold and hit arrival time down to sub-nanosecond precision.

Within the FAIR-0 research program, a Ag\+Ag run at $E = 1.58$A GeV incident energy marked the first beam time use of the upgraded RICH.
The detector could be operated at sustained triggered event rates of 16 to 18\,kHz with high electron purities while keeping large efficiencies for a recorded data sample of $\sim 15 \times 10^9$ events.

We present key features of the upgrade and report performance results of the RICH for this whole measurement campaign.

* Work supported by GSI, GSI Helmholtzzentrum für Schwerionenforschung, Campus Gießen, BMBF contract No. 05P15RGFCA, 05P19RGFCA, 05P21RGFC1, 05P15PXFCA, 05P19PXFCA, 05P21PXFC1 and Hessen für FAIR (HFHF)

Co-authors: WEBER, Adrian Amatus; HOEHNE, Claudia; PAULY, Christian (Bergische Universitaet Wuppertal (DE)); PFEIFER, Dennis (Bergische Universitaet Wuppertal (DE)); Mr SCHWAB, Erwin (Gesellschaft für Schwerionenforschung (GSI)); Dr FRIESE, Jürgen (Technische Universität München); MICHEL, Jan (Goethe University Frankfurt (DE)); OTTO, Jan-Hendrik (JLU Giessen); KAMPERT, Karl-Heinz (Universität Wuppertal); BECKER, Marten; Prof. DÜRR, Michael (Justus-Liebig-Universität Giessen); FAUL, Mike; TRAXLER, Michael (GSI Helmholtzzentrum für Schwerionenforschung GmbH); LEBEDEV, Semen (Justus Liebig University Giessen); Mr PATEL, Vivek (University of Wuppertal)

Presenter: FÖRTSCH, Jörg (Bergische Universitaet Wuppertal (DE))

Session Classification: Cherenkov light imaging in particle and nuclear physics experiments

Track Classification: Cherenkov light imaging in particle and nuclear physics experiments

Contribution ID: **35** Type: **presentation**

The DIRC Detector for the Future Electron Ion Collider Experiment

Wednesday, September 14, 2022 9:00 AM (25 minutes)

The next-generation nuclear physics facility in the United States will be the Electron-Ion Collider (EIC), scheduled to be built at Brookhaven National Laboratory (BNL).
%The EIC will be a powerful new high-luminosity facility with the capability to collide high-energy electron beams with high-energy proton and ion beams, providing access to those regions in the nucleon and nuclei where their structure is dominated by gluons. Excellent particle identification (PID) is one of the key requirement for the EIC central detector. Identification of the hadrons in the final state is critical to study how different quark flavors contribute to nucleon properties. A detector using the Detection of Internally Reflected Cherenkov light (DIRC) principle, with a radial size of only 7-8 cm, is a very attractive solution to meet these requirements. The R&D program performed by the EIC PID collaboration (eRD14 and eRD103) is focused on developing a high-performance DIRC (hpDIRC) detector that would extend the momentum coverage well beyond the state-of-the-art 3 standard deviations or more separation of π/K up to 6~GeV/c, and contribute to low momentum e/π separation. Key components of the hpDIRC detector are a 3-layer compound lens and small pixel-size photo-sensors. Currently, the hpDIRC R&D program is focused on developing and validating the radiation hard 3-layer lens, quality assurance of the BaBar DIRC radiation bars, and the early stage of the hpDIRC prototype program with Cosmic Ray Telescope at Stony Brook University, in preparation for beam tests at Fermilab in 2023 and 2024.

Author: KALICY, Greg (The CUA University)

Presenter: KALICY, Greg (The CUA University)

Session Classification: R&D for future experiments

Track Classification: R&D for future experiment

Contribution ID: **37** Type: **presentation**

Endcap Disc DIRC Developments for Future Detectors

Endcap Disc DIRCs have been designed for the PANDA Experiment at FAIR and for the Super Charm Tau Factory at Novosibirsk. The original PANDA Endcap Disc DIRC was designed to provide particle identification and especially π/K separation of at least 3 standard deviations in the forward region of 5° to 22° polar angle. It features a fused silica radiator with attached cylindrical focusing optics and MCP-PMT based photon detection read out by a free running ASIC based readout system. The design has been extensively verified with beam experiments. The Super Charm Tau Factory requires μ/π separation in the 1 GeV/c range. New Disc DIRC designs have been studied, using lenses and dispersion correction. A modified readout module using cooled SiPM matrices is currently tested inside the Giessen Cosmic Station to evaluate the limits of SiPM detectors for Cherenkov single photon detection. The DIRC group in Giessen presents recent results of prototype tests.

Authors: Dr HAYRAPETYAN, Avetik; Mr TAKATSCH, Chris (II. Physikalisches Institut Justus Liebig Universität Gießen); KÖSEOGLU, Ilknur; Mr HOFMANN, Jan Niclas (II. Physikalisches Institut Justus Liebig Universität Gießen); BODENSCHATZ, Simon Karl Manfred (Justus-Liebig-Universitaet Giessen (DE)); PEREIRA DE LIRA, Jonatan (II. Physikalisches Institut Justus Liebig Universität Gießen); Mr WELDE, Leonard (II. Physikalisches Institut Justus Liebig Universität Gießen); Prof. DÜREN, Michael (II. Physikalisches Institut Justus Liebig Universität Gießen); Dr SCHMIDT, Mustafa; STRICKERT, Marc (II. Physikalisches Institut Justus Liebig Universität Gießen); Mrs KEGEL, Sophie (II. Physikalisches Institut Justus Liebig Universität Gießen); Mr VETTIG, Vincent (II. Physikalisches Institut Justus Liebig Universität Gießen); BRÜCK, Lisa (II. Physikalisches Institut Justus Liebig Universität Gießen)

Presenter: BODENSCHATZ, Simon Karl Manfred (Justus-Liebig-Universitaet Giessen (DE))

Track Classification: R&D for future experiment

Contribution ID: **38** Type: **poster**

Calibration of the Aerogel radiator tiles for the RICH of the HELIX Experiment

HELIX (High Energy Light Isotope eXperiment) is a balloon-borne instrument designed to measure the chemical and isotopic abundances of light cosmic-ray nuclei. In particular, HELIX is optimized to measure ^{10}Be and ^{9}Be in the range 0.2 GeV/n to beyond 3 GeV/n. To measure the energy of nuclei beyond about 1 GeV/n, HELIX utilizes a ring-imaging Cherenkov (RICH) detector. The RICH detector consists of aerogel tile radiators (refractive index ˜1.15-1.16) and a silicon photomultiplier detector plane. To adequately discriminate between ^{10}Be and ^{9}Be isotopes, the refractive index of the aerogel tiles must be known to a precision of 0.1%. In this contribution we describe the measurement of the refractive index, and its lateral position dependence, for the aerogel tiles using a 35 MeV electron beam and an array of inexpensive one-dimensional CCD sensors.

Author: O'BRIEN, Stephan

Presenters: O'BRIEN, Stephan; HANNA, David

Session Classification: Poster Session and Welcome Drink

Track Classification: Technological aspects and applications

Contribution ID: **39** Type: **presentation**

Development of an integrated housing for SIPM for future RICH photon-detectors

Thursday, September 15, 2022 10:15 AM (25 minutes)

The housing of the sensors for future RICH detectors is a complex task, regardless of the sensor choice,
due the many requirements. In order to save on the required resources and simplify the design, different
functions should be possibly integrated all together, including, for SIPM-like sensors, some sort of active
cooling. A local cooling strategy is being investigated first, to cool down a region as small as possible around
the sensor only, exploiting the industrial technologies existing today for cooling of solid state devices by
many applications. The results of test conducted so far will be presented together the current conceptual
design, tests and prototyping.

Author: CARDINALE, Roberta (INFN e Universita Genova (IT))

Co-authors: FONTANELLI, Flavio (INFN e Universita Genova (IT)); SERGI, Antonino (INFN e Universita Genova (IT)); BARTOLINI, Matteo (University of Cambridge (GB)); MINUTOLI, Saverio (INFN e Universita Genova (IT))

Presenter: CARDINALE, Roberta (INFN e Universita Genova (IT))

Session Classification: Technological aspects and applications of Cherenkov detectors

Track Classification: Technological aspects and applications

Contribution ID: **40** Type: **presentation**

Development of a hybrid single-photon imaging detector with encapsulated CMOS pixelated anode

Friday, September 16, 2022 9:25 AM (25 minutes)

The development of a single-photon detector based on a vacuum tube, transmission photocathode, microchannel plate and CMOS pixelated read-out anode is presented. This imager will be capable of detecting up to 1 billion photons per second over an area of 7 cm^2, with simultaneous measurement of position and time with resolutions of about 5 microns and few tens of picosecond, respectively. The detector has embedded pulse processing electronics with data-driven architecture, producing up to 160 Gb/s data that will be handled by a high-throughput FPGA-based external electronics with flexible design. These performances will enable significant advances in particle physics, in particular for the realisation of future Ring Imaging Cherenkov detectors, capable of achieving high efficiency particle identification in environments with very high particle multiplicities, exploiting time-association of the photon hits at the level of tens of picoseconds.

Authors: COTTA RAMUSINO, Angelo (Universita e INFN, Ferrara (IT)); ALOZY, Jerome Alexandre (CERN); FIORINI, Massimiliano (Universita e INFN, Ferrara (IT)); CAMPBELL, Michael (CERN); GUARISE, Marco (Universita e INFN, Ferrara (IT)); BIESUZ, Nicolo Vladi (Universita e INFN, Ferrara (IT)); BOLZONELLA, Riccardo (Universita e INFN, Ferrara (IT)); CAVALLINI, Viola (Universita e INFN, Ferrara (IT)); LLOPART CUDIE, Xavi (CERN)

Presenter: FIORINI, Massimiliano (Universita e INFN, Ferrara (IT))

Session Classification: Photon detection techniques for Cherenkov counters

Track Classification: Photon detection techniques for Cherenkov imaging counters

Contribution ID: **41** Type: **presentation**

Modular RICH Detector Development for the Future Electron Ion Collider Experiment

Thursday, September 15, 2022 9:50 AM (25 minutes)

Excellent particle identification is an essential requirement for the future Electron Ion Collider (EIC) experiment. Particle identification (PID) of the final state hadrons in the semi-inclusive deep inelastic scattering allows the measurement of flavor-dependent gluon and quark distributions inside nucleons and nuclei. The EIC PID Consortium (eRD14 Collaboration) was formed in 2015 for identifying and developing PID detectors using ring imaging Cherenkov(RICH) and the ultra-fast time-of-flight (TOF) techniques for the EIC experiments with broad kinematics coverage.

To meet the challenge of limited confined space of electron end-cap in the EIC experiments, a compact modular ring imaging Cherenkov (mRICH) detector has been developed that provides K/π separation over a momentum coverage of 2 GeV/c to 8 GeV/c , and an e/π separation up to 2 GeV/c or more. The mRICH detector consists of an aerogel block, a Fresnel lens, photosensor plane and flat mirrors forming the sides of the space between the lens and photosensors. The first prototype of this detector was successfully tested at Fermi National Accelerator Laboratory (FNAL) in April 2016 for verifying the detector work principles.This was followed by a second prototype test in 2018 at FNAL with much improved optical design and photosensor integration, which allowed adaptation of different readout options. In September 2021, the third beam-test was carried at Jefferson Laboratory (JLAB) with the goal of testing mRICH performance with a precision tracking capability.

Author: SHARMA, Deepali (Georgia State University)

Presenter: HE, Xiaochun (Georgia State University)

Session Classification: Technological aspects and applications of Cherenkov detectors

Track Classification: Technological aspects and applications

Contribution ID: **42** Type: **poster**

Study of the accuracy of common modeling of Cherenkov light emitted by MeV electrons

Cherenkov light is used in a wide variety of neutrino detectors for observing the secondary charged particles produced after neutrino interactions. The SNO+ experiment has reported a discrepancy between data and Monte-Carlo in the isotropy of the Cherenkov light emitted by electrons with energies of a few MeV. SNO+ relies on Geant4, a widely used simulation package, to approximate the trajectory of charged particles assuming full coherence of the Cherenkov radiation they emit. These assumptions may not hold for MeV electrons. In this work, we explore the influence of the scattering model used for particle propagation on the resulting Cherenkov light distribution. We also evaluate a possible loss of coherence of the radiation along the particle's path caused by the scattering of the electron in the matter.
As a result, we develop a new Cherenkov radiation model for Monte-Carlo simulations and tune it in the 2.2 - 6.1 MeV energy range using SNO+ calibration data. Tuning the model removes the discrepancy between simulated and measured light distributions in SNO+.
The presented method considers the physical processes that are taking place during electron propagation more accurately and could be relevant to new, more precise experiments that use Cherenkov light imaging.

Authors: MINCHENKO, Dmytro (University of Alberta); YANEZ, Juan-Pablo (University of Alberta)

Presenter: MINCHENKO, Dmytro (University of Alberta)

Session Classification: Poster Session and Welcome Drink

Track Classification: Pattern recognition and data analysis

Contribution ID: **43** Type: **poster**

Muon vs. pion separation at low momenta

Searches for New Physics effects at the intensity frontier are based on very precise measurements of observables involving rare processes within the Standard Model. Semileptonic decays of B meson are particularly interesting due to persistent hints of Lepton Flavour Universality (LFU) violation seen in $b \to c\tau\nu_\tau$ transitions with a massive τ lepton in the final state. Compared to the decays involving light leptons (electrons and muons) in the final state, where charged leptons can be detected directly, in semitauonic decays τ lepton must be reconstructed from its long-lived decay products making these decays experimentally more challenging. One of the crucial steps in the analysis of semitauonic decays is particle identification. In the Belle II experiment the sub-detectors designed for particle identification are: Time-of-Propagation (TOP) detector in the barrel region and the Aerogel Ring-Imaging Cherenkov detector (ARICH) in the forward endcap for hadron identification, while the outermost Klong-and-Muon (KLM) system provides K_L^0 and muon identification. Due to the large mass of the τ lepton its charged decay products (e. g., e or μ) are expected to have low momenta; this affects mainly the muon identification efficiency since muons from these decays often have momentum too low to be within the acceptance of the dedicated sub-detector KLM. One possibility to improve identification for momenta below $0.8\ \mathrm{GeV/c}$ would be the Cherenkov based TOP detector. At such low momenta, however, multiple scattering in the quartz bar blurs the pattern considerably making the identification with the TOP counter very inefficient. To mitigate this problem, we are exploring a possible extension of muon identification coverage ($p_T < 0.6\ \mathrm{GeV/c}$) by using the information from the electromagnetic calorimeter (ECL). Our main goal is to improve the separation of low momentum muons from hadronic background (mainly pions) using the information from the ECL in a form of 11×11 images, where the pixel intensity is set on the energy deposited by the charged particle in the ECL crystals. As a classifier we are using the Convolutional Neural Network (CNN), a powerful machine learning technique designed for working with two dimensional images. Using CNN on ECL images allows us to access the information on the shape of the energy deposition without depending on cluster reconstruction or track-cluster matching, i. e., the currently used high-level features. Comparing the performance of the classifiers based only on the ECL information on the simulated events, the CNN outperforms the existing classifiers based on expert-engineered ECL variables. Furthermore, combining the newly obtained information from the ECL in the global likelihood also improves the muon identification compared to the existing likelihood combination, using the standard likelihood from the ECL.

Authors: NOVOSEL, Anja (Jozef Stefan Institute); NARIMANI CHARAN, Abtin (Deutsches Elektronen-Synchrotron DESY); Prof. FERBER, Torben (Karlsruhe Institute of Technology); Dr SANTELJ, Luka (Jozef Stefan Institute)

Presenter: NOVOSEL, Anja (Jozef Stefan Institute)

Session Classification: Poster Session and Welcome Drink

Track Classification: Pattern recognition and data analysis

Contribution ID: **44** Type: **presentation**

Status of the development of the RICH detector for CBM including a mRICH prototype in mCBM

Wednesday, September 14, 2022 9:25 AM (25 minutes)

The Compressed Baryonic Matter (CBM) experiment is being built at the future Facility for Antiproton and Ion Research (FAIR) next to GSI, Darmstadt, Germany. The fixed-target CBM experiment will explore dense baryonic matter at moderate temperatures produced in A+A collisions at beam energies from 2-11 AGeV. In the matter being created in this collision process, conditions are achieved as they are present in mergers of neutron stars. A key diagnostic probe in order to characterize this matter created in the laboratory is electromagnetic radiation from the fireball, e.g. giving access to its temperature or its lifetime. In CBM, virtual photons will be measured through the reconstruction of di-electrons, the electrons being identified with a gaseous RICH detector and several layers of TRD detectors.

The CBM RICH detector is under development since long, and recently passed the threshold to construction with first mass production of part of the electronics. A full-size prototype of one of the two photodetector planes is under construction in order to test the mechanical stability, handling and the air-cooling concept. Approximately half of the H12700 MAPMTs are temporarily in operation in the upgraded HADES RICH detector. The DiRICH based readout chain now running in HADES has been commonly developed and will also be integrated in CBM. However, in contrast to the triggered HADES readout, CBM will be operated with a free-streaming readout where all detectors send their data with precise time stamps to a central GPU farm for event building and trigger decision. This way, interaction rates of up to 10 MHz will be recorded. In order to test this novel readout concept, a “mini-CBM” (mCBM) experiment has been set up with prototypes of all CBM subdetectors implementing the full functionality of the future free-streaming readout already here. For this purpose a “mini-RICH” (mRICH) detector has been constructed in a proximity focussing geometry using aerogel tiles as radiator. The DiRICH readout has successfully been adopted to the free-streaming CBM readout making use of microtimeslices readout by regular triggers. Recorded data are used to develop AI based noise reduction and ring finding algorithms which will be compared to the so far used Hough Transform.

In this report, a brief update on the development and status of the CBM RICH detector will be given. Main focus of the talk will however lie on the successful construction, operation and characterization of the mRICH detector with free streaming readout. The performance will be evaluated with data recorded in several beamtimes at GSI FAIR phase 0.

- Work supported by GSI and BMBF contract No. 05P15RGFCA, 05P19RGFCA, 05P21RGFC1, 05P15PXFCA, 05P19PXFCA, 05P21PXFC1, and Helmholtz Forschungsakademie Hessen für FAIR (HFHF), GSI Helmholtzzentrum für Schwerionenforschung, Campus Gießen

Author: HOEHNE, Claudia (University Giessen, GSI)

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Presenter: HOEHNE, Claudia (University Giessen, GSI)

Session Classification: R&D for future experiments

Track Classification: Cherenkov light imaging in particle and nuclear physics experiments

Contribution ID: **45** Type: **presentation**

Operation and performance of the Belle II Aerogel RICH detector

Monday, September 12, 2022 3:15 PM (25 minutes)

The Belle II experiment at the SuperKEKB asymmetric-energy e^+e^- collider is a B factory experiment to study rare decays with high precision such as $B \to \rho(\to \pi\pi)\gamma$ and $B \to K^*(\to K\pi)\gamma$. In order to study these processes, particle identification, especially the separation of charged kaons and pions is very important. In the Belle II detector, a proximity focusing Aerogel Ring Imaging CHerenkov counter (ARICH) is implemented to separate kaons from pions with momenta up to 4 GeV/c. The ARICH detector consists of a silica aerogel radiator and Hybrid Avalanche Photo Detector (HAPD) as the photon detector. Using the emission angle of the Cherenkov photon, the separation of the charged kaons from pions is performed.

The performance of the particle identification is studied using the collision data. The good separation between charged kaons and pions is observed, close to our expectations. We report the performance of the particle identification in the ARICH detector using the data.

The Belle II experiment started the physics run with full detectors in 2019 and accumulated more than 300 fb^{-1}of collision data. The ARICH detector has been operated stably and the performance of the HAPDs is consistent with our expectations. The concern is the deterioration of HAPDs due to silicon bulk damage by neutron radiations. The increase of the leakage current is observed due to the radiation, but the fluency of the neutrons is below the tolerable level. Currently, 94% of channels are operational and good performance is provided. The single event upset in the FPGAs due to the radiation is also considered. We implemented the scrubber of correcting radiation-induced errors in the firmware. Thanks to this implementation, the readout firmware has been running stably. In this presentation, we report the operation of ARICH including the fraction of dead channels and stability of HAPDs.

Author: UNO, Kenta

Presenter: UNO, Kenta

Session Classification: Cherenkov light imaging in particle and nuclear physics experiments

Track Classification: Cherenkov light imaging in particle and nuclear physics experiments

Contribution ID: **46** Type: **presentation**

Characterisation and operations of the Multianode Photomultipliers Tubes for the LHCb RICH detectors

Friday, September 16, 2022 11:00 AM (25 minutes)

The upgraded LHCb RICH detectors are equipped with Multianode Photomultiplier Tubes, covering a total area of approximately 4 square metres. In order to achieve the same excellent hadron identification performance as during LHC Run 1 and 2 at five times the instantaneous luminosity, the photon detectors have to be sensitive to single photons with repetition rates of up to 100 MHz/cm^2 and to have a very low noise count rate.
The main properties of the photomultipliers are presented, together with the characterisation of an unexpected source of noise observed in the Hamamatsu R11265 Multianode Photomultiplier Tubes, extending up to several microseconds after the primary signal. The quality control results and the mitigation strategies to operate the photon detectors and to perform optimal single-photon counting at 40 MHz are described.

Author: CAVALLERO, Giovanni (CERN)

Presenter: CAVALLERO, Giovanni (CERN)

Session Classification: Photon detection techniques for Cherenkov counters

Track Classification: Photon detection techniques for Cherenkov imaging counters

Contribution ID: **47** Type: **poster**

Details of the study of the superluminal electrons

Roots of the observations technique.
The contribution of participants in the observations.
Two main roles in experiments conducting.
The limitations of the technique.
Pattern of the performer.
Choice of the research topic.
Name of radiation of superluminal electrons in Russia.
Vavilov in Russian physics and in LPI.

Author: CHERENKOVA, Elena

Presenter: CHERENKOVA, Elena

Session Classification: Poster Session and Welcome Drink

Contribution ID: **48** Type: **presentation**

The Silicon Photomultiplier-based Camera for the Cherenkov Telescope Array Small-Sized Telescopes

Tuesday, September 13, 2022 12:00 PM (25 minutes)

The Cherenkov Telescope Array (CTA) is the next generation ground-based gamma-ray astronomy observatory, planned to comprise two arrays of imaging air Cherenkov telescopes (IACTs) located in the northern and southern hemispheres. Three telescope sizes are required to cover the CTA gamma-ray energy range from 20 GeV to 300 TeV.
An array of several tens of Small-Sized Telescopes (SSTs) at the southern site situated in the Andes at Paranal in Chile, will provide unprecedented sensitivity above 1 TeV and up to 300 TeV, and offer the highest angular resolution of any instrument at these energies. Following a down selection from three prototype telescopes, the design finally selected for SST comprises a dual mirror Schwarzchild-Couder optic with a 4.3 m diameter primary mirror and a 1.8 m secondary mirror imaged by a SiPM-based camera with a ˜9° field of view. The dual mirror optics produces a smaller plate-scale aplanatic focal plane allowing a small, low-cost camera to be employed, compared to that required for the conventional single mirror Davies-Cotton IACT design.
The camera comprises an array of 2048 SiPM pixels, configured as 32 sensor and electronics modules each with an 8 x 8 pixel2 tile populated with 6 x 6 mm2 SiPM pixels. Full waveform capture on every channel is provided by the TARGET ASIC which performs the dual function of event triggering and waveform digitization of the full camera at 1 GSample/s.
We describe the finalized SST camera design including its optimization for the production phase of the project anticipated to begin in 2023.

Author: LAPINGTON, Jon

Presenter: LAPINGTON, Jon

Session Classification: Cherenkov detectors in astroparticle physics

Track Classification: Cherenkov light imaging in neutrino and astroparticle physics experiments

Contribution ID: **49** Type: **poster**

Quality Assurance procedures for the LHCb RICH Upgrade

During the Long Shutdown 2 of the LHC, the LHCb RICH system has undergone an upgrade to implement the LHCb trigger strategy which increased the read-out rate from 1 MHz to 40 MHz. The new challenging operating conditions of the upgraded experiment impose the replacement of the Hybrid Photon Detectors (HPD) with Multi-Anode Photomultiplier tubes (MaPMT) and the introduction of customised front-end electronics. The optics and mechanics of RICH 1, the upstream detector, are improved as well, and the support and cooling system redesigned accordingly. The new RICH detectors have a modular design to facilitate maintenance and assembly. The fundamental core element is the Elementary Cell, which is composed of 1 or 4 MaPMTs, depending on the type of the MaPMT, and the associated front-end electronics. Four ECs and one or two Digital Boards containing the interfacing FPGAs, are grouped together into a Photon Detector Module. The RICH photon detectors are arranged into independent columns, with a single column made of 6 PDMs stacked together. The modularity of the detector allowed the development of procedures devoted to test and characterise each component in order to assure compliance with the specification and uniformity of the detector. An overview of the protocols and testing facilities which have been designed and put in place to perform the quality assurance programme is presented. The quality control process lasted more than six years and included the testing and characterisation of the new front-end electronics, the MaPMTs, the ECs, and the assembly, commissioning, and installation of the columns in the LHCb cavern.
Keywords—RICH, Quality Assurance, MaPMT

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Session Classification: Poster Session and Welcome Drink

Track Classification: Technological aspects and applications

Contribution ID: **50** Type: **presentation**

Technological and physical aspects of the production of aerogel radiators for Cherenkov detectors of various types.

Thursday, September 15, 2022 9:25 AM (25 minutes)

Aerogel radiators for Cherenkov detectors have been produced in Novosibirsk by a collaboration of Budker Institute of Nuclear Physics (BINP) and Boreskov Institute of Catalysis (BIC) for more than three decades. Over this time aerogel radiators were manufectured for different threshold Cherenkov detectors (KEDR, SND experiments at BINP; DIRAC at CERN) and Ring Imaging Cherenkov detectors (AMS-02, LHCb, CLASS12 experiments). Production of raw aerogel tiles is conducted in BIC.
In this work we present our experience in the characterization, selection and mechanical processing of aerogel tiles. The following physical parameters are measured: refractive index, variations of the refractive index, the light scattering length, the light absorption length. The index of refraction of the blocks is controlled through their density. The variations of the index of refraction within tile volume are measured using digital X-ray detector. The light scattering length is measured through the transparency dependence on the light wavelength. To control the light absorption length several specialized stands have been developed.
Aerogel tiles can be machined using different technologies to fit the case of Cherenkov detector. For this work we use polishing machine, diamond wheel and diamond wire cutting machines.
The silicon dioxide aerogel we produce is hygroscopic. It requires special dry storage conditions. If needed, after aerogel characterization and processing the absorbed water could be removed from aerogel tile using annealing. This procedure restores initial optical parameters.

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Session Classification: Technological aspects and applications of Cherenkov detectors

Track Classification: Technological aspects and applications

Contribution ID: **51** Type: **poster**

The artificial neural network based method for mass composition analysis of the primary cosmic rays for the TAIGA experiment

Imaging air Cherenkov telescopes (IACT), non-imaging optical detectors (HiSCORE), and scintillation detector array are the three detector systems of the TAIGA experiment at Tunka Valley. The scintillation detectors register the secondary charged particles produced by the extended air showers (EASs). In both IACT and HiSCORE systems, Cherenkov photons from the EASs are registered. Studying the mass composition of the cosmic rays and searching for high-energy cosmic gamma-quanta are two most interesting goals of the experiment. EASs induced by protons or nuclei produce different numbers of secondary charged particles and Cherenkov photons. The Cherenkov detectors give the information about secondary particles in the EASs at high altitudes, while scintillation detectors measure particles at the ground level. The aim of this study is to use both features for studying of the mass composition of primary cosmic rays.
Using the computer model of the HiSCORE optical detectors and the Tunka-Grande scintillation detectors array, we have developed nuclei identification method based on the specially developed artificial neural network. This research consists of the following steps: EAS simulation with CORSIKA, secondary particle selection with COAST library, Cherenkov photon data evaluation with 'eventio' library, simulation of scintillation detector array with GEANT4 program, ANN optimization and nuclei identification study. This research is focused on EASs with energies 1 to 3 PeV and zenith angle ranging from 0 to 45 degree. The data on the nuclei identification efficiencies and fake rates are presented.

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Presenters: KRAVCHENKO, Evgeniy (Novosibirsk State University); VAIDYANATHAN, Arun (Novosibirsk State University)

Session Classification: Poster Session and Welcome Drink

Track Classification: Pattern recognition and data analysis

Contribution ID: **52** Type: **presentation**

MCP-PMT quantum efficiency monitoring and operation status of the TOP counter at the Belle II experiment

Friday, September 16, 2022 9:00 AM (25 minutes)

The BelleII experiment is a high luminosity electron and positron collider experiment at SuperKEKB in Japan. In this experiment, we aim to measure B-decay precisely and search for effects from New Physics. We started physics data taking with the whole detector system in March 2019. The Time-of-propagation (TOP) counter is a detector for particle identification in the barrel region of the BelleII detector. It consists of a quartz radiator and high timing resolution photodetector, and it can identify $K^{\pm}$ and $\pi^{\pm}$ from the arrival time and hit position of Cherenkov light.
Micro-Channel-Plate Photomultiplier(MCP-PMT) is the photodetector for the TOP counter; it measures photon timing with a resolution of 30 ps; it gives excellent particle identification performance. One of the issues for the TOP counter is the lifetime of the photocathode of MCP-PMTs. The quantum efficiency (QE) will decrease by the accumulated output charge of MCP-PMTs due to the outgassing from MCPs. We have worked to improve the lifetime of the photocathode and installed three types, Conventional type, Atomic Layer Deposition (ALD) type, and Life-extended ALD type, in the TOP counter. The lifetime of the conventional MCP-PMT is 1.1 $\mathrm{C/cm^2}$ on average, and we are planning to replace it with the Life-extended ALD type that has the longest lifetime during the long shutdown that starts in 2022 summer.
We have developed monitoring tools for MCP-PMTs and measured the gain, output charge, and QE of MCP-PMTs during physics data taking. First, we measured the gain, and it changed about 10% during physics data taking due to the characteristics of ALD that applied to MCP for a longer lifetime. To make the output charge of MCP-PMTs smaller, we are operating with relatively low gain. Due to this, threshold efficiency will decrease during physics data taking. We increased the high voltage for MCP-PMTs during physics data taking, considering gain decrease and output charge to keep efficiency. Second, we measured the output charge of MCP-PMTs. (Figure1) These are small enough compared to their lifetime, and we expect that there is almost no QE degradation in all MCP-PMTs. Finally, we measured the QE degradation considering the threshold efficiency drop during the physics data taking. (Figure2) As a result, we found a more considerable QE degradation than expected in 5% of MCP-PMTs. We think this degradation is a problem of the MCP-PMT production, noise from the read-out system, etc.
We will present the MCP-PMT status and the operation status of the TOP counter at the BelleII experiment.

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Session Classification: Photon detection techniques for Cherenkov counters

Track Classification: Cherenkov light imaging in particle and nuclear physics experiments

Contribution ID: **53** Type: **presentation**

Performance studies of the TORCH detector

Wednesday, September 14, 2022 9:50 AM (25 minutes)

The Time Of internally Reflected CHerenkov detector (TORCH) is a proposed large-area time-of-flight detector, which aims to enhance the particle identification performance of the LHCb experiment in the 2–10 GeV/c momentum range. A TORCH module consists of a 10 mm thick quartz plate in which the positions and arrival times of Cherenkov photons from a charged track are detected by highly segmented MCP-PMTs. A general overview of TORCH and its operating principles will be presented, which will then be highlighted by the excellent performance of a 1.25 m length TORCH prototype module (Proto-TORCH). This was equipped with two MCP-PMTs and exposed to an 8 GeV/c test-beam at CERN. Single-photon timing resolutions of between 70-110 ps have been measured, dependent on the beam position in the plate, and photon yields agree with expectations. Another test-beam period has been scheduled for autumn 2022 when the existing TORCH optics will be equipped with a full complement of MCP-PMT detectors and readout, allowing a full system test to be made. Finally, the projected PID performance of TORCH at the LHCb experiment will be shown.

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Session Classification: R&D for future experiments

Track Classification: R&D for future experiment

Contribution ID: **54** Type: **poster**

STOPGAP - a Time-of-Flight Extension for the Belle II TOP Barrel PID System

The Belle II barrel region is instrumented with the Time of Propagation (TOP) particle identification system comprising sixteen quartz radiator bars arranged around the interaction point. These quartz bars do not overlap, leaving a gap of around 2cm in the azimuthal direction between them and causing a 6% drop in acceptance. An additional 3% of tracks suffer from degraded identification information as they cross the bars close to the edges, leading to an overall inefficiency of around 9%. This affects both the Particle identification capabilitoes and the overall event reconstruction, as TOP provides the best event time resolution within Belle II, which is an important input for the track reconstruction algorithms.
We propose a possible solution to remedy these gaps in the form of a Supplemental TOP GAP instrumentation (STOPGAP) that covers the dead area between adjacent quartz bars with fast, low-granularity silicon detectors, providing a measurement of the time-of-flight of traversing particles. Modern silicon sensors and readouts can offer sufficient time resolution for the task at hand, so that STOPGAP modules could be built compact enough to fit into the limited space available in the area of interest between the Belle II central drift chamber (CDC) and the TOP system.

This talk will present a simulation study demonstrating the feasibility of a silicon time-of-flight system, based on its reconstruction performance in simulated Y(4S) -> BBbar events. It will discuss the performance requirements for possible sensor technologies and demonstrate that such a project could be realised with novel, fast monolithic CMOS sensors that are expected to reach MIP timing resolutions of down to 50ps.

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Session Classification: Poster Session and Welcome Drink

Track Classification: R&D for future experiment

Contribution ID: **55** Type: **presentation**

Torch pattern recognition and particle identification performance

Tuesday, September 13, 2022 5:00 PM (25 minutes)

The Time Of internally Reflected CHerenkov (TORCH) detector is a proposed large-area time-of-flight detector, which aims to enhance the particle identification performance of the LHCb detector in the 2–10 GeV/c momentum range. The Cherenkov light pattern in TORCH is a three-dimensional image (in space and time), which is folded by reflections from the sides of the detector modules. This talk will describe the development of pattern recognition algorithms for TORCH and discuss the challenge of reconstructing detector images in the high occupancy environment expected in the phase II upgrade of the LHCb detector. The reconstruction separates different species of hadron using likelihood ratio tests. The probability density function of the TORCH image is computed semi-analytically from the known Cherenkov emission spectrum, and knowledge of the detector optics. This approach has been shown to be robust and provide good separation between hadron species in the momentum range of interest. The image reconstruction and likelihood calculation are well suited to parallelisation and R\&D into implementation on hardware accelerators is ongoing. The expected particle identification performance of TORCH, and potential applications in the LHCb physics programme will also be discussed.

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Presenter: GARCIA MARTIN, Luis Miguel (University of Warwick (GB))

Session Classification: Pattern Recognition and data analysis

Track Classification: Pattern recognition and data analysis

Contribution ID: **56** Type: **presentation**

FARICH with dual aerogel radiator

Wednesday, September 14, 2022 10:15 AM (25 minutes)

The Super c-Tau Factory is the project of future electron-positron colliding beam experiment with unprecedented high luminosity $10^{35} cm^{-2} s^{-1}$ in the interaction energy range from 3 to 7 GeV, where the most part of charmonium states are produced and the tau-lepton production threshold is located as well. To provide a such high luminosity the Crab-Waist (CW) scheme of beam interaction was suggested. The main goals of the project are to make precise tests of the standard model (SM) and search for the phenomena beyond the SM with statistic exceeded in few orders of magnitude all data accumulated in previous experiments in this energy range. To perform a broad Physics program of the project the high performance universal detector is needed. The current status of R&D on particle identification system for the SCTF project based on Focusing Aerogel RICH (FARICH) is presented as well as a brief description of the SCTF project status. The FARICH is a very powerful particle identification technique. The FARICH detector based on 4-layer focusing aerogel monolithic radiator with total thickness 36 mm and maximal refractive index n=1.05 is able to provide excellent π/K-separation up to momentum P=6 GeV/c and mu/pi-separation up to P=1.5 GeV/c. The main disadvantage of the FARICH technique is the relatively high threshold momentum for mu/pi-separation (about P=0.4 GeV/c). For μ/π separation below 0.2 GeV/c it is necessary to use energy loss deposition technique in the track system because particles with such momentum will not reach the dedicated PID system due to magnetic field of detector (about 1.5 T). To provide μ/π-separation in the gap between 0.2 and 0.4 GeV/c the FARICH detector with dual aerogel radiator was suggested. The capability of particle separation for dual radiator RICH based on 4-layer focusing aerogel with maximal n=1.05 tile combined with aerogel tile with n=1.1 was studied with help of GEANT4 simulation. New production technology of high transparent aerogels with high optical densities based on small dope of zirconium dioxide to SiO_2 aerogels was suggested. Parameters of first ZrO_2-SiO_2 aerogels were measured and presented. It is shown that such approach allow us to produce aerogel with n=1.12 and light scattering length at 400 nm above than 30 mm. First beam tests results of FARICH based on dual radiator combined of 4-layer focusing tile and tile with n=1.1 are presented.

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Co-authors: KONONOV, Sergey A. (Budker Inst. Novosibirsk); KRAVCHENKO, Evgeniy (Budker INP SB RAS/ Novosibirsk State University)

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

Session Classification: R&D for future experiments

Track Classification: R&D for future experiment

Contribution ID: **57** Type: **poster**

The dual Ring Imaging Cherenkov detector for the Electron-Ion Collider

The Electron-Ion Collider (EIC) is the new large-scale particle accelerator planned in the US and designed to collide polarized electrons with polarized protons and nuclei and investigate the dynamics of quarks and gluons, unlocking the secrets of QCD. The capability to distinguish charged particles over the full momentum range, while working in a strong (about 1T) magnetic field, is required for a general purpose detector at EIC
A prototype of dual Ring Imaging Cherenkov (dRICH), a detector which exploits the Cherenkov light produced in two different mediums, is being developed to discriminate between pions, kaons and protons in the extended momentum range from few GeV/c up to 50 Gev/c, and support electron identification in the EIC hadronic endcap. Particles crossing a layer of aerogel (n ⊠ 1.02) and a volume of C2F6 gas (n ⊠ 1.00085) with a velocity greater than the light in medium, produce Cherenkov photons which are focalized by two different spherical mirrors onto the same photon detector array. The photon detection area was instrumented either with multi-anode photomultipliers, used as reference, or custom matrices of magnetic-insensitive silicon photomultipliers (SiPMs), cooled at -30 ℃ to mitigate the dark rate. The combined information of two imaged Cherenkov rings and the particle momentum allow to infer the mass and therefore the type of the crossing particle.
Two test beams were performed at CERN in fall 2021, when a full tracking and imaging system has been commissioned. In this presentation, the prototype and the preliminary results obtained, together with a preview of the future test beams which will occur in fall 2022.
The development of the dRICH prototype is an EIC_NET initiative.

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Presenter: VALLARINO, Simone (Universita e INFN, Ferrara (IT))

Session Classification: Poster Session and Welcome Drink

Track Classification: R&D for future experiment

Contribution ID: **58** Type: **poster**

Simulating the Effect of External Magnetic Fields on Microchannel Plates

Microchannel Plates (MCPs) are used in many applications, including in Cherenkov and scintillation detectors. There are several characteristics that need to be considered when designing MCPs for such applications. The time resolution and gain are two important characteristics that affect the ability to measure a pulse and the time between interactions that can be measured.
MCPs have many geometric and electric parameters that affect the time resolution and gain, including the length to diameter ratio (L/D), bias angle and potential applied across the MCP. Many of these parameters have been extensively investigated experimentally, however manufacturing new designs of MCPs to test these further is an extremely complex process.
We have developed a simulation of an MCP and have previously demonstrated how this can be used to analyse the gain and timing resolution of an MCP with varying parameters. These results have all been for a single MCP and with no external fields present. These simulation results have been extremely valuable in demonstrating the relationship between different parameters.
Experimentally however, there is often an external magnetic field that needs to be considered. Magnetic fields affect the trajectories of the electrons travelling through the MCPs and will therefore affect the total electron output. We present our model of the MCP with external magnetic fields of varying direction and field strength applied to see how this effects the gain, time resolution and electron trajectories.
It's also common to see MCPs arranged in chevron or Z arrangements to obtain high gains with minimal aging and saturation effects of the individual components. There will be additional variation in electron trajectories, and therefore reduced time resolution, with each stage of the electron multiplication device. We present the results of multi-stage MCP simulations using different simulation methods.

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Co-authors: LAPINGTON, Jon; LEACH, Steven

Presenter: BALDWIN, Emily

Session Classification: Poster Session and Welcome Drink

Track Classification: Photon detection techniques for Cherenkov imaging counters

Contribution ID: **59** Type: **presentation**

The LHCb RICH Upgrade II

Wednesday, September 14, 2022 11:10 AM (25 minutes)

The hadron particle identification provided by the RICH system in LHCb over a momentum range of 2.6 –100 GeV/c has been a key element of the success of the experiment and will remain equally important for Upgrade II. With luminosities expected to up 7.5 times those expected for Upgrade I and 75 times those released in the past, maintaining in Run 5 and beyond the same excellent PID performance expected in Runs 3 and 4 and demonstrated in Runs 1 and 2, asks for a substantial improvement in the precision of the measurements of the space and time coordinates of the photons detected in the RICH. It will require a readout strategy with high-resolution timing information and making significant improvements in the resolution of the reconstructed Cherenkov angle, new optical schemes and very light-weight components and a DAQ network and reconstruction farm capable of handling and reducing the enormous data flow. The reconstruction software will also need a major upgrade to benefit from these improvements to the measurements. The key elements towards the realisation of these improvements will be discussed, with a view to the needed R&D, simulation results and basic principles.

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Presenters: WOTTON, Stephen (University of Cambridge (GB)); PAPANESTIS, Antonis (Science and Technology Facilities Council STFC (GB))

Session Classification: R&D for future experiments

Track Classification: R&D for future experiment

Contribution ID: **60** Type: **presentation**

The LHCb RICH Upgrade

Monday, September 12, 2022 2:00 PM (25 minutes)

During the second LHC long shutdown, the LHCb experiment underwent a major upgrade in order to be able to operate at the instantaneous luminosity of 2 × 10−33 cm−2 s−1, reading data at a rate of 40 MHz, with a fully software-based trigger.
The RICH system of LHCb has been completely refurbished installing new photon detectors (Multi-anode Photomultiplier Tubes) equipped with a custom developed read-out chain. In order to reduce the unprecedented peak occupancy, the full optics and mechanics of the RICH1 detector has been re-designed to distribute the Cherenkov photons over a larger surface of the photon detectors planes.
The overview of the RICH upgrade programme is described including the design, installation and commissioning phase. The validation of the newly installed detectors, together with early performance studies is presented.

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Presenter: SERGI, Antonino (INFN e Universita Genova (IT))

Session Classification: Cherenkov light imaging in particle and nuclear physics experiments

Track Classification: Cherenkov light imaging in particle and nuclear physics experiments

Contribution ID: **61** Type: **presentation**

The LHCb RICH detectors during the runs 1 and 2 of the LHC

Tuesday, September 13, 2022 2:50 PM (25 minutes)

The LHCb RICH system has undergone a major upgrade during the Long Shutdown 2 of the LHC and it is now ready for operation. The previous incarnation provided excellent hadron identification during runs 1 and 2 of the LHC. The LHCb strategy of having offline quality reconstruction at the High-Level Trigger 2 stage for run 2 posed many calibration challenges that were met successfully. The performance and stability has recently been analysed covering the period 2015-18. The alignment and calibration processes and the particle identification performance will be presented together with the physics impact on the LHCb analyses and some of the lessons learned during the eight years of operation.

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Session Classification: Pattern Recognition and data analysis

Track Classification: Cherenkov light imaging in particle and nuclear physics experiments

Contribution ID: **62** Type: **presentation**

C4F10 in COMPASS RICH-1

Thursday, September 15, 2022 9:00 AM (25 minutes)

C4F10 in COMPASS RICH-1
A Liberec-Prague-Trieste collaboration

Abstract:

COMPASS RICH-1 is using high-purity C4F10 as radiator gas since 2001. The operation and control of the radiator gas has evolved over years with continuous improvements.
We report on the experience gained in the 20 year-long operation of C4F10 as COMPASS RICH radiator.

C4F10 procurement is becoming challenging, and the minimization of material waste is now a priority for the protection of the environment. Commercially available C4F10 needs dedicated filtering before usage and typical material losses in the filtering procedure are around 30%. Recent efforts allowed to reduce them to about 5%.
Very accurate values for the radiator gas refractive index are needed for high-performance particle identification. The procedure has evolved over years and the one presently in use, which provides refractive index estimate at the 1 ppm level, is discussed.
A new system, based on a modified folded Jamin interferometer, has been recently built. It will provide very precise online monitoring of the COMPASS RICH-1 gas radiator refractive index.

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Session Classification: Technological aspects and applications of Cherenkov detectors

Track Classification: Technological aspects and applications

Contribution ID: **63** Type: **poster**

Performance of MCP-PMT and LAPPD in Magnetic Field for RICH Detectors

Various ring imaging Cherenkov sub-systems are being proposed in EIC detector for hadron identification with momenta up to 50 GeV/c. It is critical to have a reliable highly pixelated readout sensor working in the high magnetic field environment. Optimization of the photosensor design for high magnetic field tolerance, precision timing resolution, and pixelated readout was performed at Argonne National Laboratory with 6×6 cm^2 microchannel plate photomultipliers (MCP-PMT). Large area picosecond photodetector (LAPPD) with 20×20 cm^2 size was commercialized and the geometry was redesigned to reach the requirement of EIC Cherenkov detectors.
An Argonne MCP-PMT and two LAPPDs were recently tested using the Argonne g-2 magnet. Measurements of these devices'performance in the magnetic field will be discussed. The ANL MCP-PMT shows a performance of over 1.5 Tesla with 10 μm microchannels and optimized design. The LAPPD with 20 μm microchannels also show good performance up to 0.9 Tesla. Although gain was reduced when the magnetic field strength was increased to ~1 T or more, or tipped away from normal to the window, the gain could be recovered simply by increasing the MCP voltage. Data of LAPPD with 10 μm microchannels are still under analysis. Performance comparison of LAPPDs with 10 and 20 μm microchannels will be discussed in the talk.

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Session Classification: Poster Session and Welcome Drink

Track Classification: Photon detection techniques for Cherenkov imaging counters

Contribution ID: **64** Type: **poster**

MUCH: a compact Imaging Atmospheric Cherenkov Telescope for volcano muography

Significant progress has been made in the last years in the field of volcanic muography. This technique takes advantage of the large penetrating power of atmospheric muons and allows us to infer information about the internal structure of volcanoes observing the differential absorption of muons passing through the target.

This, in conjunction with other monitoring techniques, can help to determine the state of activity of a volcano and to reduce the risk related to paroxysmal events. The main challenge in the application of this technique is given by the background noise, due to protons, electrons and scattered low-energy muons, that affects detectors. In order to improve the signal-to-noise ratio it is necessary to use several detection layers and shielding plates that make the detector expensive and difficult to transport. In order to overcome these issues, the use of Imaging Atmospheric Cherenkov Telescopes (IACTs) devoted to muography has been recently proposed and its feasibility demonstrated by our team using Geant4 simulations.

IACTs are telescopes dedicated to the gamma-ray astronomy consisting of an optical system that focuses the Cherenkov light into a high-sensitive and fast read-out camera. When a muon with energy above 5 GeV passes near the telescope aperture, Cherenkov photons induced along the trajectory form on the telescope camera an easily recognizable arc-shaped signal from which it is possible to determine the muon arrival direction. Although Cherenkov telescopes are not able to operate in the daytime, they are not disturbed by the previously mentioned sources of background and a Cherenkov telescope devoted exclusively to muography can be designed with a lightweight support structure that could be easily transported.

Here we present MUCH, a compact IACT specifically designed for volcano muography. The telescope design is characterized by a Schmidt-like optical system and a Silicon Photo-Multipliers (SiPMs) camera working at wavelengths between 280 nm and 900 nm, equipped with a fast read-out electronics capable to operate SiPMs contemporarily in charge integration and photon counting mode. The optical system has an entrance pupil of 2.5 m diameter and is composed of an aspherical mirror and a PMMA Fresnel lens corrector. This results in a field of view (FoV) of about 12° and an angular resolution better than 0.2° throughout the entire FoV which allows us to determine the direction of muons, passing through the whole telescope aperture, with a reconstruction precision better than a few tenths of degree.

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Presenter: MOLLICA, Davide (INAF)

Session Classification: Poster Session and Welcome Drink

Track Classification: Technological aspects and applications

Contribution ID: **65** Type: **presentation**

Recent developments in data reconstruction for aerogel RICH at Belle II

Tuesday, September 13, 2022 3:15 PM (25 minutes)

In the forward end-cap of the Belle II spectrometer particle identification is provided by a proximity focusing RICH detector with an aerogel radiator (ARICH). Its main purpose is to provide good separation between pions and kaons in the momentum range from 0.5 GeV/c up to 4 GeV/c, and in addition to contribute to the identification of low momentum leptons. Since the start of its operation, Belle II has collected more than 200 fb^{-1} of data. Based on this large data sample studies of several effects impacting the performance of the ARICH detector were carried out. Findings helped us to improve the detector performance, either by implementing new calibration algorithms or improving the method of data reconstruction and to improve the agreement between the measured data and data from detector simulation. We will report on the detector alignment methods, including alignment of its global position, alignment of planar mirrors on the outer edges of the detector, and a novel algorithm for the alignment of aerogel tiles based on the computer vision methods. We have studied very detailed features of the observed Cherenkov ring image and identified their origin, these include photons produced in the photo-detector quartz window and their possible reflections within the photo-detector, photons produced by delta electrons, and a few other effects. We were able to reproduce these effects in the simulation, resulting in a very good agreement between the data and the simulation. In addition, the observed features were included in the calculation of the expected ring image on which the evaluation of the PID likelihood is based. Finally, we will discuss the impact of particles that decay in flight or scatter in the material before entering the ARICH detector on the PID performance. We demonstrate that these particles have a significant contribution to the observed particle misidentification rates and present our efforts to mitigate this adverse effect by trying to identify the cases when the track is extrapolated to the ARICH but no particle actually entered it, based on combining the response of several Belle II sub-detectors.

Author: SANTELJ, Luka

Presenter: SANTELJ, Luka

Session Classification: Pattern Recognition and data analysis

Track Classification: Pattern recognition and data analysis

Contribution ID: **66** Type: **presentation**

The Large-area Hybrid-optics CLAS12 RICH: First Years of Data-Taking

Monday, September 12, 2022 12:20 PM (25 minutes)

The CLAS12 deep-inelastic scattering experiment at the upgraded 12 GeV continuous electron beam accelerator facility of Jefferson Lab conjugates luminosity and wide acceptance to study the 3D nucleon structure in the yet poorly explored valence region, and to perform precision measurements in hadron spectroscopy.

A large area ring-imaging Cherenkov detector has been designed to achieve the required hadron identification in the momentum range from 3 GeV/c to 8 GeV/c, with the kaon rate about one order of magnitude lower than the rate of pions and protons. The adopted solution comprises aerogel radiator and composite mirrors in a novel hybrid optics design, where either direct or reflected light could be
imaged in a high-packed and high-segmented photon detector.

Among the innovative components are: aerogel of n=1.05 and cutting-edge transparency; modular spherical mirror in a light composite material; planar glass-skin mirrors, unprecedented in nuclear physics experiments; and large-area multi-anode photomultipliers readout by a modular electronics.

The first RICH module was assembled during the second half of 2017 and successfully installed at the beginning of January 2018, in time for the start of the experiment. A second RICH module is in the final stage of assembling with the goal to be ready, despite the delays caused by the pandemic crisis, for the operation with polarized targets in summer 2022.

In the presentation, the detector performance will be discussed with emphasis on the operation and stability during the data-taking, calibration and alignment procedures, reconstruction and pattern recognition algorithms, and particle identification.

Author: CONTALBRIGO, Marco (Universita e INFN, Ferrara (IT))

Presenter: CONTALBRIGO, Marco (Universita e INFN, Ferrara (IT))

Session Classification: Cherenkov light imaging in particle and nuclear physics experiments

Track Classification: Cherenkov light imaging in particle and nuclear physics experiments

Contribution ID: **67** Type: **poster**

Study of new aerogel radiators for the LHCb RICH upgrade

Hadron identification in LHCb after the high luminosity LHC upgrade (Run 5) will be extremely challenging. A number of different technologies are under study, including the use of aerogel as a Cherenkov radiator. Novel pinhole drying hydrophobic aerogel radiators have improved transparency compared to the tiles used in the Belle II ARICH. In the framework of the LHCb RICH Upgrade we are investigating potential use of novel aerogel radiators for particle identification. In a high energy pion test beam we studied Cherenkov photons from aerogel focused on an array of multianode photomultipliers. Our findings show that the number of detected Cherenkov photons is consistent with the expectations and that the background due to large angle scattering in aerogel is almost negligible. In this contribution, we will show the results of the measurements recorded during summer 2021 beam test.

Author: LOZAR, Andrej (Jozef Stefan Institute (SI))

Co-authors: PESTOTNIK, Rok (Jozef Stefan Institute (SI)); D'AMBROSIO, Carmelo (CERN); CARDINALE, Roberta (INFN e Universita Genova (IT)); DOLENEC, Rok (Jozef Stefan Institute (SI)); Mr FREI, Christoph; KEIZER, Floris (CERN)

Presenter: LOZAR, Andrej (Jozef Stefan Institute (SI))

Session Classification: Poster Session and Welcome Drink

Track Classification: Technological aspects and applications

Contribution ID: **68** Type: **poster**

ARICH performance study in the Belle II experiment

The Belle II experiment at the SuperKEKB asymmetric e+e- collider in High Energy Accelerator Research Organization (KEK, Tsukuba, Japan) is searching for CP asymmetries in different rare decays, as well as a new physics beyond the standard model, and aims to collect a high statistics data set corresponding to an integrated luminosity of 50 ab^{-1} in order to search. The Belle II Aerogel Ring Imaging Cherenkov (ARICH) detector's response in terms of loglikelihood functions are studied using decay samples of $D^{*+} \to D^0 + \pi^+$ and $D^{*-} \to \bar{D}^0 + \pi^-$ resonances. The detection efficiency of the detector as well as the mis-identification rates as a function of a particle momentum and the polar angle will be presented. The experimental data will be shown in comparison of the relevant Monte Carlo simulations.

Author: GHEVONDYAN, Gayane (A.I.Alikhanyan National Laboratory)

Co-authors: Prof. AKOPOV, Norayr (A.Alikhanyan National Science Laboratory); Mr KARYAN, Gevorg (A.Alikhanyan National Science Laboratory)

Presenter: GHEVONDYAN, Gayane (A.I.Alikhanyan National Laboratory)

Session Classification: Poster Session and Welcome Drink

Track Classification: Pattern recognition and data analysis

Contribution ID: **69** Type: **presentation**

Progress on coupling MPGD-based photon detectors with nanodiamond photocathodes

Friday, September 16, 2022 11:25 AM (25 minutes)

Progress on coupling MPGD-based photon detectors with nanodiamond photocathodes
A Bari-Trieste Collaboration

Abstract:
Hydrogenated nonodiamond grains represent an alternative to CsI for detection of single VUV photons in gaseous detectors. A dedicated R&D study on the performance of nanodiamond photocathodes coupled to THGEM-based photon detectors is ongoing.
The first phase of these studies includes the comparison of QE in vacuum and in gaseous atmospheres and measurement of aging effects under irradiation and exposure to moisture: promising values for the VUV sensitivity and high robustness have been observed.
The second phase consists in the characterization of the performance as electron multipliers of THGEMs coated with a variety of nanodiamond photoconverting layers: preliminary encouraging results from the ongoing systematic studies have been obtained.
For the third phase, a photon detector prototype with hybrid Micromegas and THGEMs architecture has been built and equipped with hydrogenated nanodiamond photocathode on the first THGEM layer.

We report on the status and perspective of this R&D programme.

Presenter: TESSAROTTO, Fulvio (Universita e INFN Trieste (IT))

Session Classification: Photon detection techniques for Cherenkov counters

Track Classification: Photon detection techniques for Cherenkov imaging counters

Contribution ID: **70** Type: **poster**

Slow control of the Belle II Aerogel Ring Imaging detecto

Since 2018 an aerogel proximity focusing Ring Imaging Detector (ARICH) efficiently separates hadrons in the forward endcap of the Belle II spectrometer. Cherenkov photons emitted in the double layer aerogel radiator are expanded in the 16 cm space and detected on the photon detector comprising 420 Hybrid avalanche photodiodes and backside readout electronics working in a threshold mode. Each of the sensors requires six different high voltages and a supply of four low voltages for the electronics. Due to power dissipation, the system also incorporates a cooling system implemented by circulating cold water through the Al pipes thermally coupled to the readout electronics. The reliable control of the supply voltages and monitoring of the environmental observables and the status of the sensors ensure the stable operation of the ARICH detector and early response to sudden current changes, single events upsets, the overheating, and other faults. In the contribution we will present the slow control system of the ARICH and the data quality monitor used for performance tracking.

Author: PESTOTNIK, Rok (Jozef Stefan Institute (SI))

Presenter: PESTOTNIK, Rok (Jozef Stefan Institute (SI))

Session Classification: Poster Session and Welcome Drink

Track Classification: Technological aspects and applications

Contribution ID: **71**		Type: **presentation**

Pixelated Capacitively Coupled LAPPDs as photosensors for Ring Imaging Cherenkov Detectors with a High-Resolution Timing Capability

Large Area Picosecond Photon Detectors (LAPPDs) are micro-channel plate (MCP) based photosensors featuring hundreds of square centimeters of sensitive area in a single package and capable of providing timing resolution on the order of 30-50 ps for single photon detection. One of the recent LAPPD models (Gen II) gives the opportunity of building finely pixelated 2D readout configurations which, in addition to high-resolution timing, also provide sub-mm spatial resolution required for Ring Imaging CHerenkov (RICH) detectors. The Gen II readout plane is external to the sealed sensor and is a simple printed circuit board that can be laid out in a custom application-specific way for sensitive area pixellation. This provides unprecedented flexibility in choosing an appropriate segmentation that can be optimized for any detector need in terms of pad size, orientation, and shape. In this talk we first report on the design principles and several practical implementations of the finely pixelated Gen II LAPPD readout boards. We present spatial resolution on the level of ˜ 500-700 μm for single photon detection for a variety of such readout planes with 3-6 mm square and segmented pads in a laser-based setup in the lab. Secondly, we present the world's first demonstration of the Cherenkov ring imaging capability of these finely pixelated photosensors in a 120 GeV proton beam setup at the Fermilab Test Beam Facility (FTBF) using an aspheric quartz lens as a source of Cherenkov photons. In this case we achieved ˜ 600 μm single photon Cherenkov ring radius resolution with a readout plane segmented into 4 mm square pixels. And finally, we will present the first results of the June 2022 beam test, where we are planning to demonstrate a simultaneous LAPPD ring imaging and time-of-flight (TOF) particle identification performance in a proximity focusing RICH configuration with aerogel radiator and a mixed π/K beam in the momentum range ˜5-8 GeV/c.

Authors: KISELEV, Alexander; DESHPANDE, Abhay; LYASHENKO, Alexey (Incom Inc.); AZMOUN, Bob (Brookhaven National Laboratory); WOODY, Craig (Brookhaven National Laboratory (US)); XIE, Junqi (Argonne National Laboratory (US)); FOLEY, Michael (Incom, Inc.); MINOT, Michael (Incom Inc.); POPECKI, Mark (Incom, Inc.); PURSCHKE, Martin Lothar (Brookhaven National Laboratory (US)); Dr PARK, Sanghwa (MSU); HEMMICK, Thomas

Presenter: KISELEV, Alexander

Session Classification: Photon detection techniques for Cherenkov counters

Track Classification: Photon detection techniques for Cherenkov imaging counters

Contribution ID: **72** Type: **presentation**

The Ring Imaging Cherenkov detector of the NA62 experiment at CERN: technical aspects, operational characteristic and basic performance.

Monday, September 12, 2022 11:55 AM (25 minutes)

The NA62 experiment is designed to measure the very rare kaon decay K+ -> pi+ nu nubar at the CERN SPS with 10% statistical precision. One of the challenging aspects of the experiment is the suppression of the K+ -> mu+ nu_mu decay whose branching ratio is 10 orders of magnitude higher than the one of the K+ -> pi+ nu nubar decay. Kinematics cuts and the use of the very different stopping power of muons and charged pions in calorimeters are used to reject the K+ -> mu+ nu_mu background. However, a Ring Imaging Cherenkov (RICH) detector with a very long focal length (17 m) is needed in NA62 to further suppress muon contamination by a factor 100 in a sample of charged pions with momentum between 15 and 45 GeV/c while keeping a reasonably high efficiency for the pion selection. With a total time resolution of 70 ps this RICH detector is also used to measure the arrival time of the pion and provide the experiment trigger. The talk will describe the technical aspects and the operation characteristics of the RICH detector with an eye to possible future upgrades and will present, for the first time, the basic performance (time resolution, ring radius resolution, ring centre resolution, single hit resolution and mean number of hits) measured on data collected in 2021/2022 using electron tracks.

Author: BUCCI, Francesca (Universita e INFN, Firenze (IT))

Presenter: BUCCI, Francesca (Universita e INFN, Firenze (IT))

Session Classification: Cherenkov light imaging in particle and nuclear physics experiments

Track Classification: Cherenkov light imaging in particle and nuclear physics experiments

Contribution ID: **73** Type: **poster**

TRICK: a Tracking Ring Imaging Cherenkov Detector

TRICK is a INFN CSNV Young Grant project that will investigate an innovative 5D technique for providing 3D information about the position, time, and ID of incoming particles. The core idea is based on the well-known technology of conventional Aerogel proximity focussing RICH combined with a GEM -based Time Projection Chamber (TPC) in a single box. Both parts, TPC and RICH, are read out simultaneously and instrumented with the same TIGER ASIC developed for the BESIII CGEM-IT detector. By combining the information from both systems, the TRICK technique will improve the performance of each instrument: The tracking will aid rings identification by measuring the expected center even in a magnetic field and reduce the error in the angle measurement caused by extrapolation of the external tracking; in addition, the precise timing information will allow better resolution of the time-projected third space coordinates.
The TRICK -Box prototype, equipped with triple- GEM and Hamamatsu H12700 MA-PMT, aims to achieve a spatial resolution of 100 microns, a time resolution better than 1 ns, and a 3-sigma separation for pi/K up to 4 GeV.
This contribution presents the project, focusing on the initial studies with the prototype, the preparation of the first cosmic stand, and the next steps.

Author: MEZZADRI, Giulio (Universita e INFN, Ferrara (IT))

Presenter: MEZZADRI, Giulio (Universita e INFN, Ferrara (IT))

Session Classification: Poster Session and Welcome Drink

Track Classification: R&D for future experiment

Contribution ID: **74** Type: **presentation**

Status and Initial Performance of the GlueX DIRC

Monday, September 12, 2022 3:40 PM (25 minutes)

The GlueX experiment is located in experimental Hall D at Jefferson Lab (JLab) and provides a unique capability to search for hybrid mesons in high-energy photoproduction, utilizing a ˜9 GeV linearly polarized photon beam. Phase II of the GlueX experiment began in 2020 with the installation of a Detector of Internally Reflected Cherenkov light (DIRC), utilizing components from the decommissioned BaBar DIRC. This upgrade will enhance the particle identification capability of GlueX by providing clean π/K separation up to 3.7 GeV/c momentum in the forward region (θ<11 deg), which will allow the study of kaon final states with significantly higher efficiency and purity. In this contribution we will discuss the status and performance of the GlueX DIRC from this initial dataset.

Author: STEVENS, Justin

Presenter: STEVENS, Justin

Session Classification: Cherenkov light imaging in particle and nuclear physics experiments

Track Classification: Cherenkov light imaging in particle and nuclear physics experiments

Contribution ID: **75** Type: **poster**

Large Area Picosecond Photodetector for the Upgrade II of the LHCb RICH

Tuesday, September 13, 2022 5:50 PM (25 minutes)

The Large Area Picosecond Photodetector (LAPPD) is a commercially available microchannel plate (MCP) based photon detector that is currently driving the attention of the entire scientific community thanks to its large size, excellent timing resolution of 60 ps or better, high gain and low dark rate. The LAPPD has a large sensitive area of 200×200 mm^2, making it an attractive device for RICH detectors at particle colliders, in neutrino experiments, but also in medical imaging and nuclear non-proliferation.
We report on the performance of a new generation-II LAPPD, which is readout by capacitively coupling the signal onto an 8×8 array of square pixels. Measurements of the time resolution, gain and dark count in the laboratory will be presented.
With its excellent time resolution, the LAPPD is a promising candidate photon detector for the Ring Imaging Cherenkov (RICH) detectors of the LHCb experiment where a future LHCb Upgrade II is foreseen at the beginning of the next decade in order to operate the experiment at the full instantaneous luminosity available in the high luminosity phase of the Large Hadron collider. We will also discuss applications for LAPPDs for neutrino detection in water Cherenkov detectors and in medical imaging.

Author: OLIVA, Federica (The University of Edinburgh (GB))

Presenter: OLIVA, Federica (The University of Edinburgh (GB))

Session Classification: R&D for future experiments

Track Classification: Photon detection techniques for Cherenkov imaging counters

Contribution ID: **76** Type: **poster**

THe ASTRI Mini-Array at the Teide Observatory

The ASTRI Mini-Array is an INAF project to build and operate a facility to study astronomical sources emitting very high energy in the TeV spectral band. It consists of a group of nine innovative aplanatic dual mirror Imaging Atmospheric Cherenkov Telescopes of 4 m diameter. The telescopes will be installed at the Teide Astronomical Observatory of the Instituto de Astrofisica de Canarias in Tenerife (Canary Islands, Spain) based on a host agreement with INAF. Thanks to its expected overall performance, better than those of current IACT arrays, for energies above about 5 TeV and up to 100 TeV and beyond, the ASTRI Mini-Array will represent an important instrument to perform deep observations of the Galactic and extra-Galactic sky at these energies with high angular resolution (a few arcmins). It will be complementary to the wide-field particle shower arrays (based on water Cherenkov and scintillator detectors) like HAWC and LHAASO already operated in the North hemisphere.
The ASTRI Mini-Array is currently under construction. The site infrastructure, including telescope foundations, data and power network, data center, and control room, will be completed by the end of June 2022. The first telescope of the array (ASTRI-1) has been realized and is currently being tested at the premises of the EIE GROUP company in Italy. It will be integrated at the Tenerife site starting in mid-June, with optical commissioning performed during summer 2022. First tests with a reduced version of the onsite information and communication technology are in progress. The second and third telescopes of the array and the first Cherenkov camera will follow by the end of 2022. We plan to complete the array by 2024. In this paper, we will present the status of the ASTRI mini-array, discussing its design and expected performance.

Author: SCUDERI, Salvatore

Presenter: SCUDERI, Salvatore

Session Classification: Poster Session and Welcome Drink

Track Classification: R&D for future experiment

Contribution ID: **77** Type: **presentation**

The prototype Schwarzschild Couder Telescope: a Medium-Sized Telescope for the Cherenkov Telescope Array

Tuesday, September 13, 2022 12:25 PM (25 minutes)

The Schwarzschild Couder Telescope (SCT) is a dual mirror medium-sized telescope proposed for the Cherenkov Telescope Array (CTA), the next-generation very-high energy (from about 20 GeV to 300 TeV) gamma-ray observatory. The SCT design consists of a dual-mirror optics and a high resolution camera with a field of view (FoV) of 8 degrees squared, which will allow exceptional performance in terms of angular resolution and background rejection. A prototype telescope (pSCT) has been installed at the Fred Lawrence Whipple Observatory in Arizona, USA. Its camera is partially equipped and covers a FoV of 2.7°. The pSCT has recently successfully detected the Crab Nebula with a statistical significance of 8.6 standard deviations. The upgrade of the pSCT focal plane is now ongoing, aimed to equip the full camera with upgraded sensors and electronics, enhancing the telescope field of view from the current 2.7° to the final 8°. In this presentation, an overview of the pSCT project and obtained results will be given, together with the camera upgrade status and expected performance.

Author: DI VENERE, Leonardo (Universita e INFN, Bari (IT))

Presenter: DI VENERE, Leonardo (Universita e INFN, Bari (IT))

Session Classification: Cherenkov detectors in astroparticle physics

Track Classification: Cherenkov light imaging in neutrino and astroparticle physics experiments

Contribution ID: **78** Type: **presentation**

The RICH detector of the AMS-02 experiment aboard the International Space Station

Tuesday, September 13, 2022 2:00 PM (25 minutes)

The Alpha Magnetic Spectrometer (AMS) is a high-energy particle physics magnetic spectrometer installed on the International Space Station (ISS) in May 2011, successfully operating and taking data since then. The goal of the experiment is to carry out precise measurements of cosmic rays in the energy range from GeV/n to TeV/n. AMS includes a Ring Imaging Cherenkov (RICH), which provides a precise measurement of the particle velocity and its charge. The AMS RICH layout follows a proximity focusing design with two radiators: at the center sodium fluoride tiles surrounded by silica aerogel tiles (n = 1.05). The challenges and the experience gained operating the detector in space for more than 11 years will be presented. The impact of the RICH detector in the AMS physics program will be highlighted and the most recent results on light isotopes in cosmic rays (H, He ,Li and Be) will be shown.

Author: GIOVACCHINI, Francesca (Centro de Investigaciones Energéticas Medioambientales y Tec. (ES))

Presenter: GIOVACCHINI, Francesca (Centro de Investigaciones Energéticas Medioambientales y Tec. (ES))

Session Classification: Cherenkov detectors in astroparticle physics

Track Classification: Cherenkov light imaging in neutrino and astroparticle physics experiments

Contribution ID: **79** Type: **presentation**

Photodetection and electronic system for the Hyper-Kamiokande Water Cherenkov detectors

Tuesday, September 13, 2022 2:25 PM (25 minutes)

Hyper-Kamiokande is a next-generation neutrino experiment that is under construction in Japan. Its multi-decade physics program addresses appealing, unsolved questions in physics, like the discovery of CP-violation in the leptonic sector and searches for proton decay. It will be used to make a long-baseline neutrino oscillation measurement using the upgraded J-PARC accelerator, upgraded T2K near detector, a new Intermediate Water Cherenkov detector and the new far detector. The Hyper-Kamiokande far detector will be the world's largest underground water Cherenkov detector, with a fiducial volume 8 times the size of the currently running Super-Kamiokande detector. It will be hosted in the Tochibora mine, 295 km away from the J-PARC.
Hyper-Kamiokande's far detector will have two optically separated volumes. The inner volume will be instrumented with 20,000 new 50 cm photomultiplier tubes (PMTs) that offer significant performance improvements. In addition, approx. 1000 multi-PMT modules will be installed, which will improve the calibration capabilities of the detector. The outer volume will be instrumented with about 8,000 3-inch PMT's. The readout electronics of the far detector will be placed underwater, and extensive R&D is on-going to ensure high reliability of the developed systems. The talk will present an overview of the photodetection and readout systems of the Hyper-Kamiokande detector. We will also briefly mention additional calibration possibilities thanks to the use of multi-PMT modules.

Author: KISIEL, Jan Emil (University of Silesia (PL))

Presenter: KISIEL, Jan Emil (University of Silesia (PL))

Session Classification: Cherenkov detectors in astroparticle physics

Track Classification: Cherenkov light imaging in neutrino and astroparticle physics experiments

Contribution ID: **80** Type: **not specified**

Welcome address

Contribution ID: **81** Type: **not specified**

Welcome address

Monday, September 12, 2022 9:00 AM (5 minutes)

Session Classification: Opening

Contribution ID: **82** Type: **not specified**

Homage to Jacques Seguinot

Monday, September 12, 2022 9:05 AM (30 minutes)

Presenter: EKELOF, Tord Johan Carl (Uppsala University (SE))

Session Classification: Opening

Contribution ID: **83** Type: **not specified**

Homage to Sheldon Stone

Monday, September 12, 2022 9:35 AM (30 minutes)

Presenter: MUHEIM, Franz (The University of Edinburgh (GB))

Session Classification: Opening

Contribution ID: **84** Type: **not specified**

The ECFA Roadmap process for PID and photon-detector R&Ds

Monday, September 12, 2022 10:05 AM (40 minutes)

35'+5'

Presenter: HARNEW, Neville (University of Oxford (GB))

Session Classification: Opening

Contribution ID: **85** Type: **presentation**

The Ring Imaging Cherenkov detector of the NA62 experiment at CERN: technical aspects, operational characteristic and basic performance.

Presenter: BUCCI, Francesca (Universita e INFN, Firenze (IT))

Session Classification: Cherenkov light imaging in particle and nuclear physics experiments

Contribution ID: **87** Type: **not specified**

Cherenkov detectors in astroparticle physics

Monday, September 12, 2022 5:00 PM (40 minutes)

Presenter: SPIERING, Christian (DESY)

Session Classification: Cherenkov detectors in astroparticle physics

Contribution ID: **88** Type: **not specified**

RICH detectors in particle and nuclear physics experiments

Monday, September 12, 2022 11:15 AM (40 minutes)

Presenter: GAMBETTA, Silvia (The University of Edinburgh (GB))

Session Classification: Cherenkov light imaging in particle and nuclear physics experiments

Contribution ID: **89** Type: **not specified**

The control of refractive index and chromaticity in gas radiators of large Cherenkov detectors:a challenge in the era of diminishing fluorocarbon gas availability.

Wednesday, September 14, 2022 12:00 PM (40 minutes)

Presenter: HALLEWELL, Gregory (Centre National de la Recherche Scientifique (FR))

Session Classification: Technological aspects and applications of Cherenkov detectors

Contribution ID: **90**		Type: **not specified**

Status and perspectives of gaseous micro-pattern photon detectors

Friday, September 16, 2022 9:50 AM (40 minutes)

Presenter: BRUNBAUER, Florian Maximilian (CERN)

Session Classification: Photon detection techniques for Cherenkov counters

Contribution ID: **91** Type: **not specified**

CAEN Early career poster prize award

Friday, September 16, 2022 11:50 AM (10 minutes)

Session Classification: Close-out

Contribution ID: **92** Type: **not specified**

Acknowledgements

Friday, September 16, 2022 12:00 PM (15 minutes)

Presenter: MUHEIM, Franz (The University of Edinburgh (GB))

Session Classification: Close-out

Contribution ID: **93**   Type: **not specified**

Announcements (Proceedings, Next WS venue..) and closing address

Friday, September 16, 2022 12:15 PM (15 minutes)

Presenter: NAPPI, Eugenio (INFN Sezione di Bari)

Session Classification: Close-out

Contribution ID: **95** Type: **not specified**

Status and perspectives of vacuum-based photon detectors

Thursday, September 15, 2022 3:30 PM (40 minutes)

Presenter: LEHMANN, Albert Alwin (Friedrich Alexander Univ. Erlangen (DE))

Session Classification: Photon detection techniques for Cherenkov counters

Contribution ID: **96** Type: **not specified**

Posters

Session Classification: Close-out

Contribution ID: **97**		Type: **not specified**

Status and perspectives of SiPM

Thursday, September 15, 2022 2:00 PM (40 minutes)

Presenter: GOLA, Alberto

Session Classification: Photon detection techniques for Cherenkov counters

Contribution ID: **101** Type: **not specified**

Poster Session

Session Classification: Poster Session and Welcome Drink

Contribution ID: **102** Type: **not specified**

Poster Session and Welcome Drink

Session Classification: Poster Session and Welcome Drink

Contribution ID: **103** Type: **not specified**

Homage to Francois Piuz

Thursday, September 15, 2022 5:00 PM (15 minutes)

Presenter: DI MAURO, Antonello (CERN)