8th Beam Telescopes and Test Beams Workshop

Report of Contributions

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

Welcome

Session Classification: Welcome

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

Overview over CERN test beam facilities and updates on their modifications during Long Shutdown 2

Tuesday, 28 January 2020 10:30 (20 minutes)

CERN's accelerator complex offers a great variety of multi-purpose test beam facilities. In this presentation, the multiple possibilities of various beams in North and East experimental areas are presented. Different particle beams with momenta from 0.5 GeV/c to 400GeV/c at intensities up to 10ˆ7 particles per extraction are available. We present the numerous services that we provide to test beams and experiments, including the software for controlling, monitoring and logging of the beam that can be accessed directly by our users. This presentation will show as well the changes that currently are taking place in the North Area, such as the extension of user zones and facilities (e.g. GIF++), and the new infrastructure for experimental gases. An overview of the on-going renovation of the complete East Area complex is presented in addition, which is scheduled to be finished by 2021.

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Session Classification: Facilities & Infrastructure

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

Test beam results for the ATLAS ITk Strip upgrade

Friday, 31 January 2020 12:10 (20 minutes)

In order to cope with the occupancy and radiation doses expected at the High-Luminosity LHC accelerator, the ATLAS experiment will replace its Inner Detector with an all-silicon Inner Tracker (ITk), consisting of pixel and strip subsystems. The strip subsystem will be built from modules, consisting of one n+-in-p silicon strip sensor, and one or two PCB hybrids containing the front-end electronics glued directly to the sensor. A powerboard, including an HV switch, a monitoring and control ASIC, and a DC-DC converter, is also glued to the sensor.
In the last year, several prototype ITk strip modules have been tested using beams of high energy electrons produced at the DESY II testbeam facility. Tracking was provided by EUDET telescopes, consisting of six Mimosa26 pixel planes. Tracks are reconstructed using the General Broken Lines algorithm, giving a spatial resolution of several microns. An additional pixel layer, based on either the FEI4 or Alpide technology, was used to improve the timing resolution. The modules tested are built from three sensor types: the rectangular SS and LS sensors, which will be used in the central barrel region of the detector, and the annular R0 sensor, which will be used in the forward End-Cap region. For the first time, the final production version of the readout electronics, known as ABCStar, has been used. Additionally, one LS and one R0 module have been tested after irradiation to 50% beyond the expected end-of-lifetime fluence.
The data obtained allow for thorough tests of the module performance, including charge collection, noise occupancy, detection efficiency and tracking performance. Moreover, the excellent tracking resolution allows for detailed studies of various strip sensor features. Measured data have also been compared with the outputs of Allpix2 simulations. The results give confidence that the ITk strip detector will meet the requirements of the ATLAS experiment.

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Session Classification: Analysis & Simulations

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

A High-Granularity Timing Detector for the Phase-II upgrade of the ATLAS Calorimeter system: beam test results

Thursday, 30 January 2020 11:20 (20 minutes)

The expected increase of the particle flux at the high luminosity phase of the LHC (HL-LHC) with instantaneous luminosities up to L ⊠ 7.5×1034 cm−2 s-1 will have a severe impact on the ATLAS detector performance. The pile-up is expected to increase on average to 200 interactions per bunch crossing. The reconstruction and trigger performance for electrons, photons as well as jets and transverse missing energy will be severely degraded in the end-cap and forward region, where the liquid Argon based electromagnetic calorimeter has coarser granularity and the inner tracker has poorer momentum resolution compared to the central region. A High Granularity Timing Detector (HGTD) is proposed in front of the liquid Argon end-cap calorimeters for pile-up mitigation and for bunch per bunch luminosity measurements.
This detector should cover the pseudo-rapidity range from 2.4 to about 4.0. Two silicon sensors double sided layers are foreseen to provide a precision timing information for minimum ionizing particle with a time resolution better than 50 ps per hit (i.e 30 ps per track) in order to assign the particle to the correct vertex. Each readout cell has a transverse size of 1.3×1.3 mm2 leading to a highly granular detector with about 3 millions of readout electronics channels. Low Gain Avalanche Detectors (LGAD) technology has been chosen as it provides an internal gain good enough to reach large signal over noise ratio needed for excellent time resolution.
A 4 period test-beam campaign in 2019 has been conducted at the DESY T22 beamline. Proton and neutron irradiated LGAD prototypes for the HGTD were tested from different technologies and manufacturers. Gallium, boron and carbon implanted 1×1 mm2 diodes and 2×2 arrays are compared for achieved timing performance, post-irradiation efficiency and uniformity at fluences up to 3e15 neq/cm2. A time resolution of < 50 ps is observed in most cases, while integrating timing information to the EUDET system allows for a surface resolution of less than 50 µm. 2-dimensional timing maps are exploited to establish noise occupancy levels and lateral field expansion at high fluences. The triggering architecture, picosecond synchronization scheme and analysis logic will also be presented as well as application-specific electronics and components.

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Session Classification: Analysis & Simulations

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

SPS H2 Beam Line Simulation: Energy Loss and Material Impact at HGCAL Test Beam

Tuesday, 28 January 2020 11:10 (20 minutes)

The R&D challenges of the future CMS High Granularity Calorimeter (HGCAL) necessitate validation with data of the various components, with fully controlled beam quality (in terms of momentum resolution and contamination). For this reason, test beams in the dedicated test-beam area of the H2 beam line of CERN's North Area took place during the autumn of 2018. Different high-energy hadron and electron beams, were delivered to the HGCAL prototype, with various momenta in the range of 20 –300 GeV/c. Towards the better understanding of the beam parameters and the key factors affecting it, a detailed, complete simulation study of the H2 beam line, including all the material present in the beam trajectory from the target until the HGCAL module has been developed. The model, developed in the specialized Monte-Carlo code G4beamline, allows the study of virtually all beam characteristics, background, momentum resolution and particle rate. Beam line simulation results implemented to detector simulation. In this study, the simulation results for different electron and pion beams are being presented and compared with test-beam data. Results of the study demonstrate the effect of synchrotron radiation in the definition of the beam momenta in the high-energy range, as well as the energy loss due to Bremsstrahlung due to the beam windows and beam detectors present permanently in the beam line. The model can be used by other users or experiments with similar stringent requirements, towards the better understanding of the beam characteristics present in the CERN North Area beam lines.

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Session Classification: Facilities & Infrastructure

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

Resolution studies of the ELAD sensors

Friday, 31 January 2020 10:00 (20 minutes)

Future experiments in particle physics foresee few-micrometer single-point position resolution in their vertex detectors, motivated by e.g. b-tagging capabilities. Instead of scaling down pitch sizes the so-called enhanced lateral drift (ELAD) sensor concept seeks to improve the position resolution by increasing the lateral size of the charge distribution already during the drift in the sensor material. To this end, it is necessary to carefully engineer the electric field in the bulk of the ELAD sensor. This is achieved by introducing volumes with additional doping (buried implants) inside the bulk which influence the charge carriers' drift paths.

To find an optimal sensor design, detailed simulation studies were conducted using SYNOPSYS TCAD. The geometry of the buried implants, their doping concentration and the position inside the sensor were optimised for different sensor thicknesses.

To estimate the position resolution of the ELAD sensor, test beam simulations using the AllPix2 software have been performed applying the realistic electric field profiles from the TCAD simulations. In the AllPix2 simulations, 2D and 3D electric fields have been used. Results of the geometry optimisation are shown realising an optimal charge sharing and hence position resolution.

A position resolution of a few micrometers is expected by using buried implants without relying on a Lorentz drift or tilted incident angle. Results on the resolution studies for different sensor thicknesses are presented.

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Session Classification: Analysis & Simulations

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

Overview of beam tests for the ATLAS ITk planar sensor market survey

Friday, 31 January 2020 11:50 (20 minutes)

After the upgrade of the LHC to the HL-LHC, the experiments will need to cope with new, more challenging conditions. The higher luminosity and particle flux of the HL-LHC will cause a higher occupancy and radiation dose. Therefore, a new tracking system for the ATLAS experiment is required: the Inner Tracker (ITk). It will consist of several types of silicon sensors. For the pixel detector there are different technologies foreseen, like 3D and planar pixel sensors with different thicknesses.
Due to the large volume of the sensor production for ITk, a global market survey was started to identify vendors to invite to tender. As part of the market survey process a group of institutes test the delivered sensors' functionality and quality. These tests include measurements in the lab as well as beam tests.
This talk presents an overview of the testbeam campaigns at DESY for the ATLAS ITk planar sensor market survey. The recorded data is reconstructed with EUTelescope and analysed with TBMon2. To ensure comparable results of different beam tests fixed values for some of the parameters used in the reconstruction and analysis are chosen. The choice of these values for EUTelescope as well as for TBMon2 is explained exemplarily. In addition, first results of different measurements are presented.

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Session Classification: Analysis & Simulations

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

Corryvreckan reconstruction software

Tuesday, 28 January 2020 09:00 (20 minutes)

Corryvreckan is a modular test beam data reconstruction and analysis framework developed within the CLICdp collaboration. Its modular structure allows for a separation between the framework core and the implementation of the algorithms in each module. This allows users to 'plug-in'the wanted modules and configure their parameters easily from one configuration file. The software is written in modern C++, following the C++11 and C++14 standards and has a continually updated extensive user manual. Notable features of Corryvreckan are the 4D tracking capabilities, the online monitoring module useful for checking data quality during data taking, and the ability to use different combinations of triggered and trigger-less devices.

In this talk, the software framework will be outlined, details of the module capabilities are discussed, and improvements since BTTB7 are summarized. In particular, the highly flexible event building logic is explained and supplemented by example use cases based on recent data-taking campaigns at the DESY test beam facility.

In conjunction with this talk there will be a 2.5 hours 'hands-on'tutorial on Corryvreckan during BTTB8, repeated twice.

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Session Classification: Software & Data Acquisition Tools

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

Test beam for Low EMittance Muon Accelerator

Wednesday, 29 January 2020 09:00 (20 minutes)

A muon collider could provide scattering at the multi-TeV centre of mass energy characteristic of a hadron-hadron machine in the clean experimental environment typical of an electron-positron one, allowing for a consolidation of the present knowledge of the Standard Model and for the search of new physics. The Low EMittance Muon Accelerator (LEMMA) scheme has been recently proposed: low emittance muon and antimuon beams are produced from the collision of an about 45 GeV low emittance positron beam on a fixed target. Design studies are ongoing and it is hence important to investigate the various component starting from the muons production. The experimental characterization of the emitted muon beams from 45 GeV positron beams impinging on a fixed target is the goal of dedicated tests carried out at the CERN experimental areas H4 in 2017 and H2 in 2018. These tests were based on a silicon telescope setup complemented by a dipole magnetic field, muon chambers and a set of calorimeters to tag electrons and positrons. After a brief introduction to the LEMMA scheme, the concepts, the experimental setup and the results of the 2018 test beams are presented. In conclusion we discuss the ideas and perspectives of the next test beam at CERN in 2021.

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Session Classification: Analysis & Simulations

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

Scintillators characterization with KOMAC proton beam

Thursday, 30 January 2020 12:20 (20 minutes)

The operation of the proton linear accelerator for multipurpose application started from 2013 at Korea Multipurpose Accelerator Complex (KOMAC) at Gyeongju, Republic of Korea. They supply two energy of proton beams to users, one for 20 MeV and the other for 100 MeV proton beam for various applications with the energy range from 20 to 100 MeV by degraders.
We tested several scintillators of scintillation properties, particle response and radiation hardness using proton beam. Proton beam test results of newly developed Tl2LaCl5:Ce and Gd3Al2Ga3O12:Ce, and glass scintillators will be presented.

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Presenter: KIM, HongJoo (Kyungpook National University)

Session Classification: Analysis & Simulations

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

Test-beam and irradiation facility for high rates and occupancies with a LHC like beam frequency of 42.5 MHz at the 25 MeV proton cyclotron CYRCé at Strasbourg

Monday, 27 January 2020 18:10 (20 minutes)

The IPHC (Institut Pluridisciplinaire Hubert Curien) has installed a specific beam line for tests and irradiation of detectors with the 25 MeV proton beam of the cyclotron CYRCé. The beam line is composed of standard beam line elements like quadrupoles and steerers and contains several beam diagnostic instruments. The beam leaves the vacuum chamber through a thin Al window, just in front of the experiment. Beam intensities range from 1 fA to maximal 100 nA. The Cyclotron delivers a pulsed beam with a frequency of 85 MHz, which will be divided at the source by an oscillating electrostatic field of 21.25MHz down to 42.5 MHz. The kicker will be commissioned in January 2020 and will allow combined detector and electronics operation at frequencies close to the LHC. An experimental setup has been developed to carry out detector and irradiation tests. It will also be adapted to allow for irradiation of sensors. The setup consists of two thin beam scintillators, a mechanical X-Y positioner for the DUT (Detector Under Test) and two reference planes of four CMS-Pixel-Phase-1 modules. This reference telescope allows to determine individual trajectories of protons with a spatial resolution of about 150 microns, mainly limited by multiple scattering. The telescope will be described in a separate contribution. Because the air could possibly be activated at higher beam intensities, an extraction system will create a small under-pressure of 20 Pascal in the setup.

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Session Classification: Facilities & Infrastructure

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

Test Beam and Lab Results of ATLAS Sensors with Modified Pixel Implantations

Friday, 31 January 2020 10:20 (20 minutes)

During the first Long Shutdown (LS1) of the LHC the Insertable B-Layer (IBL) was installed in the ATLAS experiment to improve the tracking performance. It is placed between the existing inner pixel layer and a new beam pipe. Because of the small distance to the interaction point, the planar and 3D sensors of the IBL are exposed to a high flux of ionizing radiation. The planar n^+-in-n pixel sensors are designed to withstand a fluence of $5 \cdot 10^{15}$ n_{eq}/cm^2. The pixels with a size of $250\,\mu m \times 50\,\mu m$ are arranged in a matrix of 80 columns and 336 rows and they are read out with the FE-I4B read-out chip.
These IBL sensors are the baseline for new pixel implantation shapes designed in Dortmund. The new shapes are designed to increase the electrical field strength maxima and thus increase the charge collection. Higher particle detection efficiencies at lower voltages, especially after irradiation, could be achieved.
In this talk, test beam results of irradiated sensors with modified pixel implantation shapes are presented. Results after various annealing steps are compared to laser-induced charge collection measurements performed in the lab.

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Presenter: WAGNER, Mareike (Technische Universitaet Dortmund (DE))

Session Classification: Analysis & Simulations

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

Test beam results on highly irradiated scCVD diamond timing sensors

Thursday, 30 January 2020 12:00 (20 minutes)

Sensors based on ultrapure single crystal CVD diamonds have been operated in the Precision Proton Spectrometer (PPS) of the CMS experiment during the LHC Run 2 (2016-2018). Such sensors were used for the timing system of PPS and were hosted in the Roman Pots (RPs), movable devices allowing to bring the hosted detector inside the LHC beam pipe, at few millimeters from the beams. The sensors were exposed to an highly non uniform proton irradiation field, with a fluence peaking at about $\sim 5 \cdot 10^{15}$ p/cm^2 ($\sim 2 \cdot 10^{15}$ neq/cm^2). Dismounted at the end of LHC Run 2, they were tested in May in the T24 test beam line of DESY (Hamburg), with electrons with energy in the range 4-6 GeV. Data were acquired with a fast sampler (SAMPIC chip, 6.4 Gsa/s) and an offline procedure was developed to merge them with the information of the EUDET telescope. During that campaign synchronization was made via the Trigger Logic Unit (TLU) of the telescope, providing trigger and event number to the SAMPIC board. The resulting 4D information was crucial to determine the radiation damage, both in terms of its localization and of effect on the sensors performance. A description of the sensor and setup will be presented, along with the results obtained.

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Session Classification: Analysis & Simulations

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

A generic ROOT monitoring tool for eudaq2

Tuesday, 28 January 2020 09:20 (20 minutes)

An example of a successful integration in the eudaq2 environment of a readout board developed and used at the joint CMS-TOTEM Precision Proton Spectrometer (PPS) along LHC Run 2 is presented. It allows to perform an online event matching between the DUT signals, digitised with a sampler chip (SAMPIC), and the EUDET telescope. To assess the activity of the system during the tests of this new device at a campaign of PPS test beams operated at DESY-II in 2019, a new ROOT-based online and offline monitoring tool for eudaq2 was developed. Designed with flexibility to hardware specific requirements in mind, it features a base object that can be specialised according to users' needs, through the definition of a collection of variables monitored along data collection. A particular use case is presented where the readout of complex data streams is performed, as provided by the SAMPIC fast waveform sampling chip.

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Session Classification: Software & Data Acquisition Tools

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

Beam-tests of CMS High Granularity Calorimeter prototypes at CERN

Wednesday, 29 January 2020 13:10 (20 minutes)

As part of the HL-LHC detector upgrade programme, the CMS experiment is developing a High Granularity Calorimeter (HGCAL) to replace the existing endcap calorimeters. The HGCAL will be realised as a sampling calorimeter, including 36 layers of silicon pads and 14 layers combining both silicon and scintillator detectors interspersed with metal absorber plates. Prototype modules based on 6-inch hexagonal silicon pad sensors with pad areas of 1.0 cm2 have been constructed. Beam tests of different sampling configurations made from these modules have been conducted at the CERN SPS using beams of charged hadrons and electrons with momenta ranging from 20 to 300 GeV/c. The setup was complemented with a CALICE AHCAL prototype, a scintillator-based sampling calorimeter, mimicking the proposed design of the HGCAL scintillator part. This talk summarises the test beam measurements at CERN in 2018, including measurements of pedestal and noise, gain characterisation, calibration with single charged particles and energy reconstruction performance of electron and hadron induced showers. We also show measurements of the timing capabilities of this prototype system and the steps being taken towards electron and hadron identification.

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Session Classification: Analysis & Simulations

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

Measurements performed with a test DAQ system developed for the CMS Phase-2 outer tracker upgrade

Thursday, 30 January 2020 10:00 (20 minutes)

The CMS detector at the LHC is foreseen to experience a major upgrade in order to cope with increased radiation flux due to the high-luminosity operation phase of the accelerator. The CMS tracker will be replaced completely, introducing a new module concept in the outer part of the subsystem, which will exploit the strong magnetic field inside the CMS detector to select high transverse momentum particles locally and send the corresponding information to the triggering system thus enhancing the efficiency of the latter.

In order to allow for module prototyping and production testing, an intermediate DAQ system, referred to as μDTC, was developed. The system allows for prototype configuration, control, monitoring and read-out, and provides all the necessary infrastructure for the module qualification. This talk will briefly describe the upgrade project with a focus on the existing module prototypes and the structure of the FPGA firmware developed for the μDTC. A sequence of test beam measurement campaigns was carried out using the aforementioned DAQ system, and the results obtained from two of them will be presented.

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Session Classification: Software & Data Acquisition Tools

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

The CMS ECAL Upgrade for Precision Crystal Calorimetry at the HL-LHC

Wednesday, 29 January 2020 13:30 (20 minutes)

LHC Run-II finished at the end of 2018 after operating since 2015. During this time the electromagnetic calorimeter (ECAL) of the Compact Muon Solenoid (CMS) has been performing tremendously under very challenging conditions at a center-of-mass energy of 13 TeV and a bunch-spacing of 25 ns. The environment will be even more challenging for the ECAL after the the High-Luminosity upgrade of the LHC (HL-LHC) with up to 200 proton-proton collisions per bunch crossing and a considerably higher data rate. In regards to those challenges, the plan for the upgrade of the ECAL will be described in this presentation. One of the measures to mitigate the issues arising from the HL-LHC upgrade is to increase the sampling rate of the read-out electronics from 40 MHz to 160 MHz. Results from test beams of the new read-out and trigger electronics in the SPS H2 and H4 beam lines covering this aspect will be shown. As the conditions in the vicinity of the ECAL during the running of the HL-LHC will feature an unprecedented amount of radiation that can damage the detector, irradiation experiments with its components have been performed. Selected results from those will be reviewed.

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Session Classification: Analysis & Simulations

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

The DESY II Test Beam Facility

Tuesday, 28 January 2020 11:30 (20 minutes)

The DESY II Test Beam Facility was in operation from February to December in 2019 and will resume operation after the End-of-the-Year-Shutdown in February 2020. In this contribution, a review over the test beam period in 2019 and an outlook on the upcoming season 2020 will be given. Furthermore, the current status and plans for the near and far future of the DESY II Test Beam Facility will be presented.

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Session Classification: Facilities & Infrastructure

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

Hands-On: Track reconstruction of testbeam data with EUTelescope

Tuesday, 28 January 2020 16:30 (2h 30m)

Scope of the tutorial

In this tutorial, the participant will learn how to reconstruct particle tracks of the EUDET-type telescopes with the *EUTelescope* framework. *EUTelescope* has many functionalities to reconstruct your taken testbeam data step by step. After converting the raw data (interface to *EUDAQ*), it is possible to cluster event entries and form hits on the telescope planes. For the alignment of the telescope planes as well as for the final step, the fitting of the track, the general broken lines (*GBL*) algorithm will be used.

The working principle of *EUTelescope* will be shown by doing three types of reconstruction analysis. First part is to begin with an empty telescope, so no DUT. After this, a scattering material will be used to show the material budget imaging possibility. Finally, an active DUT will be analyzed.

The goal of the hands-on is to have a possibility to perform a *EUTelescope* reconstruction, based on the presented examples, but being able also to transfer the reconstruction steps to the user's own testbeam data.

Preparation

We will offer different options to follow the hands-on by *EUTelescope*. An installation guide as well as further preparation recommendations will be provided in time before the workshop here: https://github.com/eutelescope/eutelescope/wiki/Installation-and-preparation-for-BTTB8.

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Session Classification: Hands-on tutorials

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

Material Budget Imaging: Calibration and Correction Methods

Friday, 31 January 2020 11:10 (20 minutes)

A key point in the design stage of a HEP tracking detector is to minimize the amount of material and therefore radiation lengths (X_0) associated with the detector. The values for simple and bare materials are available in tables, but more complex material compounds, such as adhesives or composite materials, are often not directly available and only estimations exist.

The method of material budget imaging (MBI) enables to perform a direct measurement of the material budget $\epsilon = X/X_0$ as input for calculations or simulations of detector performance and behavior.
For this, electrons with energies between 1 and 5 GeV from the DESY testbeam traversing the inserted device, the scatterer under test (SUT), will be scattered inside the material. The amount of scattering is dependent on the radiation lengths traversed. By using the provided EUDET-type beam telescopes it is possible to reconstruct the particle tracks with high spatial and angular resolution and to evaluate the angular scattering distribution.

The reconstruction of particle tracks is performed within the *EUTelescope* framework, using the General Broken Lines (*GBL*) track fitting algorithm. Finally, by applying theoretical scattering models, such as the Highland formula, the radiation length of the material can be extracted.

For a routinely use of the MBI method for testbeam users at DESY, a calibration with a large variety of known scattering materials as well as different measurement parameters (e.g. particle energy, telescope setup) is necessary. Moreover, the comparison of theoretical modelling for the extraction of the radiation length with the measured data allows to test corrections to these model predictions.

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

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

Session Classification: Analysis & Simulations

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

Test Beam results of 3D pixel sensors interconnected to RD53A readout chip before and after irradiation

Friday, 31 January 2020 09:20 (20 minutes)

The High Luminosity upgrade of the CERN Large Hadron Collider (HL-LHC) calls for new high-radiation tolerant silicon pixel sensors, capable of withstanding fluences up to 2.3E16 neq/cm2 (1MeV equivalent neutrons). In this presentation results obtained in beam test experiments with 3D pixel sensors interconnected with the RD53A readout chip are reported. RD53A is the first prototype in 65nm technology issued from RD53 collaboration for the future readout chip to be used in the upgraded pixel detectors. The interconnected modules have been tested on an electron beam at DESY, before and after irradiation, which was performed in CERN IRRAD facility, up to an equivalent fluence of 1E16 neq/cm2. The sensors were made in FBK foundry in Trento, Italy, and their development was done in collaboration with INFN (Istituto Nazionale di Fisica Nucleare, Italy). Analysis of collected data shows hit detection efficiencies around 99% measured after irradiation. All results are obtained in the framework of the CMS R&D activities.

Primary authors: CECCARELLI, Rudy (Universita e INFN, Firenze (IT)); MESCHINI, Marco (Universita e INFN, Firenze (IT)); CASSESE, Antonio (INFN, Firenze (IT)); VILIANI, Lorenzo (Universita e INFN, Firenze (IT)); GENNAI, Simone (Universita & INFN, Milano-Bicocca (IT)); Prof. DALLA BETTA, Gian Franco (Universita degli Studi di Trento è INFN (IT)); BOSCARDIN, Maurizio (FBK Trento)

Presenter: CECCARELLI, Rudy (Universita e INFN, Firenze (IT))

Session Classification: Analysis & Simulations

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

The Beamline for Schools competition

Monday, 27 January 2020 17:30 (20 minutes)

Beamline for Schools (BL4S) is a competition in particle physics for high school students from all around the globe. Each participating team proposes a fixed target experiment that can be performed at the available test beam facilities, making use of the available infrastructure and detectors. The first prize in this competition, awarded to two teams, is a trip to a renowned research institute, where these teams perform and analyze their own proposed experiments guided by supporting scientists and get an insight into the work life of an experimental physicist.

While from 2014 until 2018 the teams executed their experiments at the PS Test Beam areas at CERN, in the 6th BL4S edition in 2019, the DESY II Test Beam Facility hosted the two winning experiments due to the maintenance of the CERN accelerator complex. The new infrastructure, additional available detectors and the changed beam conditions opened up further opportunities for the proposed experiments and at the same time introduced new challenges concerning their implementation. In 2020, two winning experiments of the BL4S competition will take place at DESY and a third winning team will be invited to the DAFNE Beam-Test Facility (BTF) at LNF.

In this presentation the concept and the infrastructure of the BL4S competition will be discussed. In addition, some of the winning experiments from the previous years are outlined and an outlook for the upcoming edition is given.

Primary author: SCHÜTZE, Paul (Deutsches Elektronen-Synchrotron (DE))

Co-authors: JOOS, Markus (CERN); ARETZ, Sarah (CERN); BEIRAO DA CRUZ E SILVA, Cristovao (CERN); PETERSEN, Jorgen (CERN)

Presenter: SCHÜTZE, Paul (Deutsches Elektronen-Synchrotron (DE))

Session Classification: Facilities & Infrastructure

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

Studies of the response of the ATLAS Tile Calorimeter to beams of particles at the CERN test beams facility

Wednesday, 29 January 2020 13:50 (20 minutes)

The Large Hadron Collider (LHC) Phase II upgrade aims to increase the accelerator instantaneous luminosity by a factor of 10. Due to the expected higher radiation levels, aging of the current electronics and to provide the capability of coping with longer latencies of up to 35 μs needed by the trigger system at such high pileup levels, a new readout system of the ATLAS Tile Calorimeter (TileCal) is needed.
A prototype of the upgrade TileCal electronics has been tested using the beam from the Super Proton Synchrotron (SPS) accelerator at CERN. Data were collected in 2016-2018 with beams of muons, electrons aat various incident energies and impact angles.
This presentation summarizes the setup for particle identification and study of the ATLAS Tile Calorimeter data taking in preparation for the production of main boards and digitizer/shaper boards for the photo-multiplier tubes and the results of the analysis of muons data, used to study the dependence of the response on the incident point and angle in the cell and of electron data, used to determine the linearity of the electromagnetic energy measurement.

Primary author: MLYNARIKOVA, Michaela (Charles University (CZ))

Presenter: MLYNARIKOVA, Michaela (Charles University (CZ))

Session Classification: Analysis & Simulations

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

Study of energy response and resolution of the ATLAS Tile Calorimeter to hadrons of energies from 16 to 30 GeV

Wednesday, 29 January 2020 14:10 (20 minutes)

Three spare modules of the ATLAS tile calorimeter were exposed to test beams of pions, kaons and protons from the Super Proton Synchrotron (SPS) accelerator at CERN in 2017.
The measurements of the energy response and resolution of the detector to pions, kaons and protons with energy in the range 16 to 30 GeV are reported.
The characterization of the response of the ATLAS calorimeter to hadrons is important to probe, validate and improve the modelling of the jets energy characterization of the ATLAS simulation using the Geant-4 toolkit.

Primary authors: FIORINI, Luca (Univ. of Valencia and CSIC (ES)); ZAKAREISHVILI, Tamar (Ivane Javakhishvili Tbilisi State University (GE))

Presenter: ZAKAREISHVILI, Tamar (Ivane Javakhishvili Tbilisi State University (GE))

Session Classification: Analysis & Simulations

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

First results and future plans of the CHROMIE telescope

Wednesday, 29 January 2020 10:30 (20 minutes)

A high rate beam telescope for high-rate beam studies with CMS Phase-2 prototype modules was built and commissioned at CERN in 2018. This telescope was build with CMS standard technology and it was based on 16 Phase-1 Pixel modules. From the measurements performed during the commissioning it was found that the telescope has a 7 μm resolution in the horizontal, and a 10 μm resolution in the vertical direction. This CMS High Rate telescOpe MachInE (CHROMIE) was used for the first time with a CMS prototype in the SPS H6 beam line at the end of LHC Run 2. Now, during the Long Shutdown 2 of the LHC, preparations are ongoing to place the telescope permanently in the H6 beam line of the SPS. This talk will be focused both the design and first test beam re- sults of CHROMIE. In addition, an overview will be given of the ongoing preparations that will make the telescope more user friendly during Run 3 of the LHC.

Primary author: DEELEN, Nikkie (CERN)

Presenter: DEELEN, Nikkie (CERN)

Session Classification: Beam Telescopes

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

Fermilab Test Beam Facility Status and Plans

Monday, 27 January 2020 18:30 (20 minutes)

The Fermilab Test Beam Facility is a world class facility for testing and characterizing particle detectors. With two operational beam lines, the facility can deliver a variety of particle types and momenta ranging from 120 GeV protons in the primary beam line down to 200 MeV particles in the tertiary beam line. In the past year, the facility has added an integrated DAQ that includes our silicon telescope and wire chambers. A new irradiation facility is under construction. Facility capabilities, scheduling, and plans will be discussed in this talk.

Primary author: Dr NINER, Evan (Fermilab)

Presenter: Dr NINER, Evan (Fermilab)

Session Classification: Facilities & Infrastructure

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

Performance of a simple 2-plane telescope (CHROMini) and a CMS 2S module in a 25 MeV proton beam: Comparison between data and Geant4 simulation

Wednesday, 29 January 2020 11:10 (20 minutes)

The CHROMini telescope has been assembled at the 25 MeV proton test beam facility at IPHC-Strasbourg, consisting of two reference planes placed in front and behind the DUT (Detector Under Test), respectively, with each plane consisting of two CMS Pixel Phase-1 silicon modules. In this talk the development of a standalone Geant4 simulation, which was used to verify the design of the telescope and for estimating its expected performance with respect to spatial resolution, cluster width and cluster charge is presented, along with a study for the optimization of relative distances in the setup. In addition, the measured response of the telescope and a mini 2S module of CMS as DUT is compared to simulation.

Primary author: ASENOV, Patrick (Nat. Cent. for Sci. Res. Demokritos (GR))

Presenter: ASENOV, Patrick (Nat. Cent. for Sci. Res. Demokritos (GR))

Session Classification: Beam Telescopes

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

The BL4S Data Acquisition System

Thursday, 30 January 2020 10:40 (20 minutes)

The Beamline for Schools (BL4S) competition is a worldwide competition targeted at teams of high school students. The winning teams are invited to travel to a research institute and perform their proposed experiments in a real test beam setup. The first five years the experiments were performed at CERN, but in 2019, due to the ongoing shutdown at CERN, the experiments were performed at the DESY II Test Beam Facility.

Since the start of the BL4S competition in 2014, the BL4S Data Acquisition System (DAQ) has been based on the Atlas ROD Crate DAQ (here called TDAQ for short). It is a VME based DAQ originally developed for ATLAS, in particular for test beam setups. The choice to use an existing DAQ brings with it some challenges but has some advantages as well. TDAQ is a complex system, needing to support multiple machines in the Atlas DAQ environment. This complexity makes the system difficult to fully comprehend but allows to have a very functional and flexible setup, such as having computers dedicated to monitoring the data taking, thus separating the data acquisition and the data monitoring functionality.

With the competition taking place at DESY, some new detectors became available, specifically the EUDET-type beam telescope. In addition, for one of the BL4S detectors, the micromegas, new readout electronics were used. With these changes, the BL4S DAQ had to be updated. The fundamental change in the BL4S DAQ for 2019 was the integration of the TDAQ and EUDAQ into a hybrid DAQ. This merging allowed for simultaneous data taking with the beam telescope and the pre-existing BL4S detectors in an integrated manner.

This presentation will discuss some of the tradeoffs with using TDAQ in the context of the BL4S competition as well as some of the modifications and adaptations which have been performed for the competition in 2019 taking place at DESY.

Primary author: BEIRAO DA CRUZ E SILVA, Cristovao (CERN)

Co-authors: SCHÜTZE, Paul (Deutsches Elektronen-Synchrotron (DE)); PETERSEN, Jorgen (CERN); ARETZ, Sarah (CERN); JOOS, Markus (CERN)

Presenter: BEIRAO DA CRUZ E SILVA, Cristovao (CERN)

Session Classification: Software & Data Acquisition Tools

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

The Test Beam Facilities Online Database

Tuesday, 28 January 2020 11:50 (20 minutes)

Irradiation and test beam facilities are used for detector R&D and more specifically for performing experiments about radiation hardness characterization and testing of detectors'performance, respectively. The availability of these facilities and the choice of the most suitable one for a given experiment is an important factor that may affect the quality of the experiment itself, its result and cost. In the past, several static lists with information about these facilities existed, however, the information contained there were limited and often outdated. Within the AIDA-2020 EU-project, an online database (DB) with information about more than 200 irradiation facilities has been developed and now being used since two years. Following the success of this project and as a request from the test beam community a new test beams facility online DB was developed and will be soon deployed and made public. In this presentation, the new test beam facilities DB and its features will be presented; along with updates related to the irradiation facilities one. Moreover, in the framework of the new call for Detector Innovation Pilot 2020, a new project concerning a platform that will enhance the knowledge sharing on experiments'results and research work in the test beam and irradiation facilities community will be also presented.

Primary authors: GKOTSE, Blerina (Mines ParisTech (FR)); RAVOTTI, Federico (CERN); WILKENS, Henric (CERN); AZIMOVA, Sabina

Presenter: GKOTSE, Blerina (Mines ParisTech (FR))

Session Classification: Facilities & Infrastructure

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

Reference telescope for detector tests at the 25 MeV proton cyclotron CYRCé at Strasbourg

Wednesday, 29 January 2020 10:50 (20 minutes)

For the experimental setup at the 25MeV proton test beam facility in Strasbourg a reference telescope has been assembled. Four CMS Pixel-Phase-1 modules have been used to build two reference planes in front and behind the detector under test (DUT), each plane consisting of two modules mounted side by side with a small overlap of about one millimetre. The pixel modules are read out by an intermediate board identical to the CMS beam telescope CHROMIE . The purpose of this telescope is to define tracks of individual protons and to determine the impact point with a spatial resolution in the order of the granularity of the DUT, approximately 150 micron, mainly limited by multiple scattering. We will describe the geometrical setup of the pixel modules, the electronic read-out and Data Acquisition Chain (DAQ). First results with beam are presented and the challenge of running the LHC electronics of the telescope synchronized with the beam frequency of 42.5 MHz will be discussed.

Primary author: GRIMAULT, Clement (Centre National de la Recherche Scientifique (FR))

Co-author: GOERLACH, Ulrich (Centre National de la Recherche Scientifique (FR))

Presenter: GRIMAULT, Clement (Centre National de la Recherche Scientifique (FR))

Session Classification: Beam Telescopes

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

Silicon Pixel Detector Test-beam Studies for the CLIC Tracking System

Friday, 31 January 2020 09:40 (20 minutes)

Challenging requirements are imposed on the vertex and tracking system of the detector for the proposed future Compact Linear Collider CLIC. A temporal resolution of a few ns and a spatial resolution of a few μm need to be achieved simultaneously with a material budget of down to less than one percent per detection layer. Various silicon pixel detector technologies are under investigation in a broad technology R&D programme. CLICpix2, a 65 nm CMOS chip with a pixel pitch of 25 μm, has been designed to fulfil the requirements of the CLIC vertex detector. Hybrid assemblies with CLICpix2 chips bump-bonded to thin planar active edge sensors have been produced and characterised in beam tests. The large collection electrode ATLASpix monolithic CMOS chip with a pixel size of 40 μm x 130 μm has been produced in a 180 nm High-Voltage CMOS process and is under study for the CLIC tracker. Moreover, a small collection-electrode monolithic CMOS chip with a pixel size of 30 μm x 300 μm, the CLICTD, has been developed for the CLIC tracker. This novel chip design with sub-pixel segmentation of the analogue frontend is implemented in two variants of a modified 180 nm CMOS imaging process, optimised for fast collection and high spatial resolution. These different detector prototypes are tested using the 6 GeV electron beam at DESY and a EUDET-type reference telescope with the EUDAQ2 DAQ framework. A Timepix3 plane has been integrated in the telescope setup, allowing for a track-time reference of ˜1 ns. The different Devices Under Test are read out by the Caribou DAQ system, a versatile data acquisition system based on a System-On-Chip FPGA architecture. Details of the test-beam data-taking setup as well as analysis results will be presented in this talk.

Primary author: MUNKER, Magdalena (CERN)

Presenter: MUNKER, Magdalena (CERN)

Session Classification: Analysis & Simulations

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

LGAD Performance at Low Energy Proton and Ion Beams for Medical Applications

Thursday, 30 January 2020 11:40 (20 minutes)

Over the past decade, proton and ion-beam therapy has become an established form of cancer treatment. Currently, the achievable precision of this therapy is limited by uncertainties due to treatment planning based on conventional photon imaging. A significant effort is therefore invested into the development of proton or ion imaging modalities. A typical apparatus for such applications consists of a front and rear tracking detector, which surrounds the target, followed by a calorimeter.

Low Gain Avalanche Detectors (LGADs) are a rather new technology that would be particularly well suited as time-of-flight calorimeter for such applications. While for the detection of minimum ionising particles (MIPs) their resolution is typically limited to around 30 ps due to Landau fluctuations, it is expected that for higher energy deposits, such as from a few hundred MeV proton beam, this limitation is reduced. Additionally, they would allow to simplify the full detector concept by eliminating the rear tracking detector as the spatial resolution of existing LGAD designs is most likely already enough to improve the tracking accuracy below the multiple Coulomb scattering (MCS) limit.

At the MedAustron particle therapy centre, proton energies between 62 MeV and 800 MeV as well as carbon ions between 120 MeV/n and 400 MeV/n are available for treatment and research purposes. Beam test results on the timing performance of LGADs at those beam energies will be shown and their possible application to ion imaging will be discussed.

Primary author: PITTERS, Florian Michael (HEPHY)

Presenter: PITTERS, Florian Michael (HEPHY)

Session Classification: Analysis & Simulations

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

UA9 Test Beams for Bent Crystal Studies - Experience and Results

Wednesday, 29 January 2020 09:20 (20 minutes)

In the last 10 years, the UA9 collaboration has used the H8 line in the North Area of the CERN SPS; the aim of the tests was to investigate coherent interaction physics of charged particles with bent crystals and to characterize their properties and performance for application in circular accelerators (SPS and LHC).
A telescope tracker, based on CMS inner tracker silicon strips, was developed and optimised for bent crystal investigation. The telescope has been improved by linking it to an external fast trigger and to other detectors for nuclear interaction studies. It is also a powerful device for monitoring of the beam line where it is installed.
During LHC Run 1 and 2 beam was consistently delivered by SPS to the North Area; about 4-5 weeks per year were grant to UA9 for test beams. The crystals were developed for several applications, namely beam collimation, beam extraction, and beam manipulation (beam focusing/defocusing). The test beams have been carried out with various beam species, both protons and ions (Argon, Xenon and Lead), and different energies (in the range of hundreds of GeV per nucleon).
An overview on the experimental set-up and the results of the different measurements taken during the CERN Run 2 (2014-2018), during which more than 200 crystals were tested, will be presented.

Primary author: ROSSI, Roberto (CERN)

Presenter: ROSSI, Roberto (CERN)

Session Classification: Analysis & Simulations

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

Non-clinical test beams at MedAustron

Monday, 27 January 2020 17:50 (20 minutes)

MedAustron is a synchrotron based particle therapy centre located in Wiener Neustadt, close to the capital of Austria. At MedAustron, proton beams with energies up to 252.7 MeV are used for cancer treatment. The facility also features an unique beam line exclusively for non-clincial research. This research beam line is also commissioned for even higher proton energies of up to 800 MeV. Additionally, all beam lines at MedAustron will be able to provide carbon ions of up to 400 MeV/u by the end of 2019.

This contribution introduces the possibilities for performing non-clinical beam tests at MedAustron in general. Also our development efforts towards an ion beam computed tomography system will be presented.

Since our detectors are not designed for the nominal clinical particle rates (≈ 4 GHz), different proton rate settings ranging from ≈ 300 Hz to ≈ 4 MHz were commissioned and are now available for test beams at MedAustron. For this purpose an online beam monitor system has been developed, which consist of a rate monitor (using EUDAQ2 and the AIDA2020 TLU) and double sided Silicon strip detectors for beam profile monitoring. The currently available beam settings at MedAustron will be discussed.

After reducing the particle flux, different proton imaging modalities were tested, including track-based multiple scattering tomography and proton computed tomography. First imaging results will be shown.

Primary author: ULRICH-PUR, Felix (Institue for High Energy Physics (HEPHY), Vienna)

Presenter: ULRICH-PUR, Felix (Institue for High Energy Physics (HEPHY), Vienna)

Session Classification: Facilities & Infrastructure

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

An HV-MAPS-based Tracking Telescope

Thursday, 30 January 2020 17:00 (20 minutes)

The Mu3e experiment will search for the charged lepton flavor violating decay of an anti-muon into two positrons and an electron. Up to 10^9 anti-muons per second will be stopped on a target, allowing to reach a sensitivity of 10^{-16}. The reconstruction of the trajectories of the low-momentum decay particles requires an ultra-thin pixel detector with excellent momentum, vertex and time resolution.
The baseline for this project is the high-voltage monolithic active pixel sensor (HV-MAPS). The sensors are thinned down to 50 um and connected to high density interconnects via SpTAB bonds, creating an ultra-thin tracking layer with a material budget of 0.115 % radiation lengths. The triggerless readout of sensors, in combination with the on-chip zero suppression, allows operation at high rates.
In the context of pixel sensor R&D, test beam campaigns are used to investigate efficiency, time resolution, and noise. For efficient test beams at various facilities, a thin tracking telescope based on HV-MAPS is developed. It allows the implementation of new prototype generations of MuPix and ATLASPix with minimal effort. The compact configuration of the telescope comprises three reference layers of the latest large scale HV-MAPS prototype, a device under test, and scintillating tiles for additional precise time information.
The talk introduces the MuPix-telescope and sketches its performance. A selection of highlights from test beam campaigns is presented, and an outlook for the telescope's future is discussed.

Primary author: Mr IMMIG, David Maximilian (Physikalisches Institut Heidelberg)

Presenter: Mr IMMIG, David Maximilian (Physikalisches Institut Heidelberg)

Session Classification: Beam Telescopes

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

Beam Tests of the CALICE AHCAL

Wednesday, 29 January 2020 09:40 (20 minutes)

The Analogue Hadron Calorimeter (AHCAL) developed by the CALICE collaboration is a scalable engineering prototype for a Linear Collider detector. It is a sampling calorimeter of steel absorber plates and $3*3$ cm^2 plastic scintillator tiles read out by silicon photomultipliers (SiPMs) as active material (SiPM-on-tile). The front-end chips are integrated into the active layers of the calorimeter. They are designed for minimal power consumption by rapidly cycling the power according to the beam structure of a linear accelerator. In 2017 and 2018, a new large prototype with 38 active layers of $72*72$ cm^2 size has been built. Each active layer contains 576 single channels, arranged on four readout boards and grouped according to the 36-channel SPIROC2E readout chips. The prototype has been assembled using techniques suitable for mass production, such as injection-moulding and semi-automatic wrapping of scintillator tiles, assembly of scintillators on electronics using pick-and-place machines and mass testing of detector elements. The calorimeter was commissioned at DESY and took muon, electron and pion data at the CERN SPS.

The contribution gives an overview of the construction, commissioning, calibration and first test beam results of the large CALICE AHCAL engineering prototype.

Primary author: KRUGER, Katja (Deutsches Elektronen-Synchrotron (DE))

Co-author: ROBLES MANZANO, Maria (Johannes Gutenberg Universitaet Mainz (DE))

Presenter: ROBLES MANZANO, Maria (Johannes Gutenberg Universitaet Mainz (DE))

Session Classification: Analysis & Simulations

Contribution ID: **40** Type: **not specified**

The CERN Proton and Gamma Irradiation Facilities during and beyond the Long Shutdown 2

Tuesday, 28 January 2020 10:50 (20 minutes)

During the first run (2015-2018), the Proton Irradiation Facility (IRRAD) in the PS East Area, and the Gamma Irradiation Facility (GIF++) in the SPS North Area at CERN provided an essential service for performing irradiation experiments on detector & accelerator elements, electronic components and materials.
In IRRAD, the primary 24 GeV/c proton beam of the PS is extracted to the T8 beamline in spills of ˜5×10ˆ11 p and it has been optimized for testing inner particle detector components. During the CERN Long Shutdown 2 (LS2), the IRRAD facility will undergo several upgrades in order to cope with the increasing demand for irradiation experiments required for the HL-LHC. In this presentation we describe: (1) the key modifications to the IRRAD beamline and infrastructure that will be implemented during 2020, (2) the last features implemented to the IRRAD Data Manager System (IDM) used to follow up the irradiation experiments, as well as (3) the results of new ultra-thin Beam Profile Monitor (BPM) devices, the main beam instrumentation of IRRAD. Finally, the results of calibration measurements performed with Xe and Pb Heavy Ion beams in 2017 and 2018 will be also presented.
GIF++ is a mixed photon/muon irradiation facility originally designed for the needs of the community working with muon gas detectors, now hosting a big variety of different test setups. GIF++ provides a 14 TBq Cs-137 source throughout the year, combined with a muon beam (from EHN1-H4 beamline) for several weeks per year. As IRRAD, GIF++ was constantly overbooked since its first run, with the main limitations being the large size of the detectors and the space available inside the irradiation bunker. During LS2, the workload of the facility has even increased because of several mass-production tests. In this presentation, we describe the various upgrades to the facility –including a >50mˆ2 extension of the irradiation area carried out in summer 2019 - plans to enhance the muon beam intensity and availability, as well as the ongoing upgrades of the detector infrastructure available to the users from LS2 onward.

Primary authors: GKOTSE, Blerina (Mines ParisTech (FR)); JAEKEL, Martin Richard (CERN); MATEU, Isidre (CERN); MESKOVA, Viktoria (Democritus University of Thrace (GR)); PEZZULLO, Giuseppe (CERN); RAVOTTI, Federico (CERN)

Presenters: JAEKEL, Martin Richard (CERN); RAVOTTI, Federico (CERN)

Session Classification: Facilities & Infrastructure

Contribution ID: **41** Type: **not specified**

Hands-On: Silicon Detector Monte-Carlo Simulations with Allpix Squared

Tuesday, 28 January 2020 13:30 (2h 30m)

Scope of the Tutorial

This tutorial will provide an insight into different functionalities of the Allpix Squared simulation framework. We will not start from zero, and some prior knowledge is required, i.e. the participants should be familiar with the very basic concepts of the framework (how to configure a simulation, how to set up the detector geometry...).
We will look into using electric fields from finite element simulations, how to use weighting potentials to get time-resolved simulations, and explore some other not-so-obvious features.

Preparation

Please install the latest release version of Allpix Squared on your computer or make sure you have access to a working version online before attending the tutorial.

Detailed instructions can be found in the manual or on the website (https://cern.ch/allpix-squared) The recommended option for this tutorial is to install the Docker image prior to arriving at the workshop venue.

Primary authors: SPANNAGEL, Simon (University of Glasgow (GB)); HYNDS, Daniel (Nikhef National institute for subatomic physics (NL))

Presenters: SPANNAGEL, Simon (University of Glasgow (GB)); HYNDS, Daniel (Nikhef National institute for subatomic physics (NL))

Session Classification: Hands-on tutorials

Contribution ID: **42** Type: **not specified**

The Caribou DAQ System and its EUDAQ2 Integration

Tuesday, 28 January 2020 09:40 (20 minutes)

Developing a new silicon detector requires significant effort for preparing the readout hardware and software for the prototype to be operated in the laboratory and test beams. The aim of the Caribou DAQ system is to significantly reduce the manpower and cost of developing such a system from scratch for every new chip. By utilizing modern system-on-chip (SoC) platforms, it combines programmable logic and a processing system and thereby brings unprecedented flexibility to the DAQ design. A universal interface card connects the SoC with the detector prototype, housing power supplies for biasing as well as DACs and ADCs for setting and measuring operational parameters, test pulses, etc. Through this versatile hardware and the modular design, the turnaround time for supporting new detectors can be minimized. The system is completed by a set of configurable firmware blocks for commonly used functionality as well as the DAQ software Peary. The latter is fully integrated into the EUDAQ2 framework and no further work is required to operate new prototypes in complex test beam environments.
This contribution provides an overview of the Caribou system with an emphasis on showcasing its ease-of-use and the integration into the EUDAQ2 framework for test beam measurements.

Primary author: SPANNAGEL, Simon (University of Glasgow (GB))

Co-author: VANAT, Tomas (CERN)

Presenter: SPANNAGEL, Simon (University of Glasgow (GB))

Session Classification: Software & Data Acquisition Tools

Contribution ID: **44** Type: **not specified**

The EUDET-telescopes: Status, performance and future prospects

Wednesday, 29 January 2020 11:30 (20 minutes)

The EUDET-telescopes are an extremely successful set of tracking telescopes based on the mimosa26 sensors providing unprecedented tracking resolution for test beams. With more than ten years of stable running, the telescopes are about to reach their lifetime and need to be replaced/upgraded.
Midterm solutions are already implemented allowing us to look into novel sensor technologies to build the next generation.
The presentations will discuss the status of the telescopes and list the current mid-term upgrades. Finally, the R&D program based on the beam telescopes will be presented.

Primary author: HUTH, Lennart (Deutsches Elektronen-Synchrotron (DE))

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

Session Classification: Beam Telescopes

Contribution ID: **45** Type: **not specified**

MALTA CMOS sensor telescope: experience from the operation and recent measurements

Thursday, 30 January 2020 17:20 (20 minutes)

MALTA is a novel monolithic active pixel CMOS sensor chip designed in TowerJazz 180nm technology. The chip contains 512x512 square pixels with a pitch size of 36.4 µm, and has a thickness down to 100 µm. A MALTA telescope has been developed that contains 3-6 planes. In this contribution we will review the performance of the telescope evaluated during recent testbeam campaigns at DESY and ELSA. The results show that the MALTA-based telescope is capable to characterise new devices with good spatial resolution at high event rates. The measurements of new sensor types with improved radiation-hardness will be also outlined.

Primary authors: DYNDAL, Mateusz (CERN); SOLANS SANCHEZ, Carlos (CERN); DAO, Valerio (CERN); PERNEGGER, Heinz (CERN); SHARMA, Abhishek (University of Oxford (GB)); ASENSI TORTAJADA, Ignacio (Univ. of Valencia and CSIC (ES)); FREEMAN, Patrick Moriishi (University of Birmingham (GB)); FLORES SANZ DE ACEDO, Leyre (University of Glasgow (GB)); CARDELLA, Roberto (University of Oslo (NO))

Presenter: DYNDAL, Mateusz (CERN)

Session Classification: Beam Telescopes

Contribution ID: **46** Type: **not specified**

High rate electron beam tests with HV-MAPS prototypes at MAMI

Friday, 31 January 2020 11:30 (20 minutes)

The Mainz Microtron (MAMI) is an electron accelerator at the Institute for Nuclear Physics in Mainz, that provides beam energies of up to 1.6 GeV.
With its narrow beam profile, quasi continuous stream of particles and beam currents of up to 100 mA it is well suited for diverse test beam applications.
One of them is the high rate testing of detector prototypes.

In this talk recent beam time results of 2019 will be discussed.
It includes high rate tests of MuPix8 prototypes as well as their behavior after an exposition to significant electron doses.
This will be especially relevant for the envisaged usage of this sensor type in the P2 parity violating experiment at the new Mainz Energy-recovering Superconducting Accelerator (MESA).

Primary author: GRZESIK, Carsten (Universität Mainz)

Presenter: GRZESIK, Carsten (Universität Mainz)

Session Classification: Analysis & Simulations

Contribution ID: **47** Type: **not specified**

Testbeam Experience with Belle II PXD Modules

The Belle II experiment started taking data at the SuperKEKB electron-positron collider in spring 2019. The central part of the Belle II detector is a silicon vertex detector comprised of 4 double-sided strip and 2 PiXel Detector (PXD) layers.
The layout of the PXD consists of large (~8x1.5cm) ultra-low material budget all-silicon modules with DEPFET (DEpleted P-channel Field Effect Transistor) sensor matrices of 75 um thickness. This sensor technology is employed for the first time in a high energy experiment.
Several final version modules were characterized at the DESY test beam facility in 2018 and 2019. Measurements were conducted with the AIDA beam telescope and the EUDAQ 1 framework and the data were analyzed with the TBSW software. An overview of the experimental setup and analysis techniques will be given and the results of efficiency and resolution measurements presented.

Primary author: PASCHEN, Botho (University of Bonn)

Presenter: PASCHEN, Botho (University of Bonn)

Session Classification: Analysis & Simulations

Contribution ID: **48** Type: **not specified**

Hands-On: Analyzing a gamma-ray spectrum

Tuesday, 28 January 2020 13:30 (2h 30m)

In this tutorial, the participant can learn how to understand and analyze a set of gamma-ray spectra, obtain resolutions and perform automatic calibrations with simple software tools. Only a basic knowledge of C++/ROOT is required. It can be used any computer/laptop, with any OS, and with a working ROOT (https://root.cern.ch/) version installed. Real data acquired in beam tests will be used as examples for writing analysis scripts.

Primary author: CABANELAS EIRAS, Pablo

Presenter: CABANELAS EIRAS, Pablo

Session Classification: Hands-on tutorials

Contribution ID: **49** Type: **not specified**

Gamma-ray calorimetry in Nuclear Physics experiments

Monday, 27 January 2020 15:30 (45 minutes)

Sometimes we forget about the importance of knowing well some basic principles in Physics, like the gamma-ray interaction and detection. And gamma-ray detection is a key factor in Nuclear Physics experiments, since most of the nuclear excited states produced in a nuclear reaction decay fast with gamma emission, and emitted photons can have energies from a few keV up to tens to MeV. Thus, it is needed an analysis that goes from a simple or single gamma-ray energy release measurement to a complex calibration, add-back and pattern recognition and event reconstruction. This presentation gives an overview of gamma-ray detection principles, detectors requirements and analysis methods. The R3B experiment at FAIR illustrates how a test beam plays a crucial role for the development and validation of gamma-ray calorimetry in a big setup.

Primary authors: CABANELAS EIRAS, Pablo; CABANELAS EIRAS, Pablo

Presenters: CABANELAS EIRAS, Pablo; CABANELAS EIRAS, Pablo

Session Classification: Overview Lectures

Contribution ID: **50** Type: **not specified**

Detector requirements for future high-energy collider experiments

Monday, 27 January 2020 14:00 (45 minutes)

Particle detectors for operation at future high-energy collider experiments are designed in view of both their facilities' physics objectives and their experimental conditions, which differ substantially between lepton and hadron colliders as well as between linear and circular colliders. Example differences are background conditions and duty cycles at these colliders, which for instance translate into very different requirements in terms of shielding, radiation hardness requirements and cooling concepts. Furthermore the detector designs take into account cost and engineering constraints as well as anticipate future technology developments. An overview of the physics cases and experimental environments of the currently proposed future high-energy colliders (CEPC, CLIC, FCC, ILC and muon colliders) is given. The corresponding detector design choices are discussed and it is outlined how further detector-design optimisation is pursued. Synergies between future detector projects and already approved HEP experiments and their upgrades are outlined as well as activities in dedicated detector R&D collaborations.

Primary author: SICKING, Eva (CERN)

Presenter: SICKING, Eva (CERN)

Session Classification: Overview Lectures

Contribution ID: **51** Type: **not specified**

The DAQling Framework

Thursday, 30 January 2020 10:20 (20 minutes)

The data acquisition (DAQ) software for most applications in high energy physics is composed of common building blocks, such as a networking layer, plug-in loading, configuration, and process management. These are often re-invented and developed from scratch for each project or experiment around specific needs. In some cases, time and available resources can be limited and make development requirements difficult or impossible to meet.
Moved by these premises, our team developed an open-source lightweight C++ software framework called DAQling, to be used as the core for the DAQ systems of small and medium-sized experiments and collaborations.
The framework offers a complete DAQ ecosystem, including communication layer based on the widespread ZeroMQ messaging library, configuration management based on the JSON format, control of distributed applications, extendable operational monitoring with web-based visualization, and a set of generic utilities. The framework comes with minimal dependencies, and provides automated host and build environment setup based on the Ansible automation tool. Finally, the end-user code is wrapped in so-called "Modules", that can be loaded at configuration time, and implement specific roles.
Few collaborations already chose or are considering DAQling as the core for their DAQ systems, such as FASER, RD51, and NA61. We will present the framework and project-specific implementations and experiences.

Primary author: GAMBERINI, Enrico (CERN)

Presenter: GAMBERINI, Enrico (CERN)

Session Classification: Software & Data Acquisition Tools

Contribution ID: **52** Type: **not specified**

Hands-On: The Corryvreckan reconstruction software

Tuesday, 28 January 2020 16:30 (2h 30m)

Corryvreckan is a modular test beam data reconstruction and analysis framework developed within the CLICdp collaboration. Its modular structure allows for a separation between the framework core and the implementation of the algorithms in each module. This allows users to 'plug-in'the wanted modules and configure their parameters easily from one configuration file.

This 2.5h tutorial will guide you through the Corryvreckan framework and its functionality. You will learn how to configure your analysis, obtain result plots for your devices under test, and how to monitor you data quality online during data taking. In particular, the flexible event building mechanism will be explained and examples including the AIDA TLU and the EUDAQ2 event loader will be covered.

<h2>Preparation:</h2>

Please clone the git repository with the example configuration file prior to the tutorial:

<pre><code> $gitclonehttps : //gitlab.cern.ch/jekroege/bttb8_tutorial_corryvreckan < /code >< /pre >$

and download the example data sets:

<pre><code> $cdbttb8_tutorial_corryvreckan/data$ ./download$_{e}xample_{d}ata_{0}1.sh(onlythisiftheconnectionisss$ ./download$_{e}xample_{d}ata_{0}2.sh$ ./download$_{e}xample_{d}ata_{0}3.sh < /code >< /pre >$

If you like, install the Corryvreckan (v1.0.2 or latest) on your computer. In any case, the different installation options will be discussed in the tutorial and can be followed along. More information can be found on the Corryvreckan website or on the Corryvreckan GitLab repository:

https://cern.ch/corryvreckan
https://gitlab.cern.ch/corryvreckan/corryvreckan

Primary author: KROEGER, Jens (Ruprecht Karls Universitaet Heidelberg (DE))

Presenter: KROEGER, Jens (Ruprecht Karls Universitaet Heidelberg (DE))

Session Classification: Hands-on tutorials

Contribution ID: **54** Type: **not specified**

A Practical Introduction to Particle Tracking

Monday, 27 January 2020 14:45 (45 minutes)

KF, CKF, GBL, MillePede, and it goes on ... . Do you feel a bit lost in all the acronyms? Not sure what it all means? Fear not, this handy introduction will safely guide you through the world of particle tracking.

Tracking detectors are at the core of most particle physics experiments. Consequently, efficient and precise particle tracking becomes an important step during reconstruction. Excellent tracking capabilities are often crucial both for physics analysis, e.g. at the LHC, and for testbeam measurements. This talk will review some of the basic algorithms for particle tracking and related issues.

Primary author: KIEHN, Moritz (Universite de Geneve (CH))

Presenter: KIEHN, Moritz (Universite de Geneve (CH))

Session Classification: Overview Lectures

Contribution ID: **55** Type: **not specified**

Timing and synchronisation in HEP

Monday, 27 January 2020 16:45 (45 minutes)

This presentation will give an introduction to the concepts of timing and synchronisation in particle physics experiments. The next generation of (HL-)LHC experiments will require precise timing information to augment the 3D spatial particle measurements in order to resolve interesting collisions from background events. A brief overview will be presented of current HEP experiment timing systems, and of current developments for the near-term future.

Primary author: HEGEMAN, Jeroen (CERN)

Presenter: HEGEMAN, Jeroen (CERN)

Session Classification: Overview Lectures

Contribution ID: **56** Type: **not specified**

Hands-On: Making the mostof your test-beam time - Understanding the triggering modes of the new AIDA-TLU to optimally match your DAQ system

Tuesday, 28 January 2020 16:30 (2h 30m)

Test-beam time is always limited. The tutorial will introduce the key features to optimally use your test-beam time with the DESY telescopes and the AIDA-TLU., which offers different modes of operation to match to your DAQ requirements. The tutorial consists of three parts:

In the beginning, the required software packages are introduced and installed.

In the second step we will discuss and demonstrate the different modes of operation.

Finally, we will connect two scintillators/PMTs to trigger on cosmics and demonstrate the impact of the modes on the trigger rates.

No expert knowledge is required to participate. Nevertheless, additional information can be found via the following links:

- EUDAQ
- DESY Telescopes
- AIDA-TLU

Primary author: HUTH, Lennart (Deutsches Elektronen-Synchrotron (DE))

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

Session Classification: Hands-on tutorials

Contribution ID: **57** Type: **not specified**

Hands-On: Making the most of your 10 minutes of fame

Tuesday, 28 January 2020 13:30 (2h 30m)

Presentations in working meetings and conferences are the culmination of weeks or months of work and are one of our most important communication methods to our peers. Yet the 10-15 minutes they take are often seen as tedious and boring, both by the audience and even the presenter! We will identify, as a group, some simple but effective methods of improving presentations and posters with hands-on activities to reinforce concepts.

Instructions to participants: bring your own laptops and be prepared to share your work with fellow participants! You should have Powerpoint installed, or something that can open and edit Powerpoint files.

Primary author: BARNEY, David (CERN)

Presenter: BARNEY, David (CERN)

Session Classification: Hands-on tutorials

Contribution ID: **58** Type: **not specified**

First performance results of the Lycoris large area strip telescope

Thursday, 30 January 2020 17:40 (20 minutes)

The Lycoris high precision large area silicon telescope was designed and commissioned for the DESY
II Test Beam Facility as part of the AIDA2020 project.
The telescope was designed to be complementary to the existing EUDET-type telescopes, providing a
large active area with only a minimal support structure while still providing a single point resolution
better than 10 µm. As such, the telescope consists of six 9.35 × 9.35 cm2 hybrid-less silicon microstrip
sensors with a strip pitch of 25 µm. The choice of sensor allows a full arm of the Lycoris telescope to
fit within a space with width of 3.5 cm allowing the testing of, for example, large DUTs together with
a telescope within the PCMAG superconducting solenoid. The full system was completed in 2019
and tested in multiple test beam campaigns. First results of the telescope performance, including the
achievable signal over noise ratio, plane hit efficiency, as well as the achievable single point resolution
of the system will be presented.

Primary author: KRAEMER, Uwe (DESY)

Presenter: KRAEMER, Uwe (DESY)

Session Classification: Beam Telescopes

Contribution ID: **59** Type: **not specified**

Comparing electromagnetic particle showers for electrons and positrons - a BL4S experiment

Thursday, 30 January 2020 11:00 (20 minutes)

By winning the international contest Beamline for Schools, we, a team of six high school students, got the opportunity to conduct our own experiment at the DESY II Test Beam Facility in October 2019. In the experiment we searched for a difference between the electron and positron, concerning the development of electromagnetic particle showers. To measure the spatial evolution of particle showers, slabs of tungsten and copper of different thicknesses were placed in between six silicon sensor planes of a beam telescope.

In this presentation we will give a further explanation of our experiment and share our preliminary results.

Primary authors: Ms DE BRUINE, Frederiek (Praedinius Gymnasium); Ms DE GOEDE, Ilja (Praedinius Gymnasium); Ms KOSTER, Isabelle (Praedinius Gymnasium); Ms WEENING, Janiek (Praedinius Gymnasium)

Presenters: Ms DE GOEDE, Ilja (Praedinius Gymnasium); Ms KOSTER, Isabelle (Praedinius Gymnasium)

Session Classification: Analysis & Simulations

Contribution ID: **60** Type: **not specified**

Welcome address

Monday, 27 January 2020 13:30 (10 minutes)

Session Classification: Welcome

Contribution ID: **61** Type: **not specified**

Welcome from the organizers

Monday, 27 January 2020 13:40 (5 minutes)

Presenter: SCHÜTZE, Paul (Deutsches Elektronen-Synchrotron (DE))

Session Classification: Welcome

Contribution ID: **62** Type: **not specified**

Welcome & Information from the local organizers

Monday, 27 January 2020 13:45 (10 minutes)

Presenter: ZAKAREISHVILI, Tamar (Ivane Javakhishvili Tbilisi State University (GE))

Session Classification: Welcome

Contribution ID: **63** Type: **not specified**

Introduction to the Hands-On Sessions

Monday, 27 January 2020 13:55 (5 minutes)

Presenter: MUNKER, Magdalena (CERN)

Session Classification: Welcome

Contribution ID: **64** Type: **not specified**

Hands-On: The Corryvreckan reconstruction software

Thursday, 30 January 2020 14:00 (2h 30m)

Corryvreckan is a modular test beam data reconstruction and analysis framework developed within the CLICdp collaboration. Its modular structure allows for a separation between the framework core and the implementation of the algorithms in each module. This allows users to 'plug-in'the wanted modules and configure their parameters easily from one configuration file.

This 2.5h tutorial will guide you through the Corryvreckan framework and its functionality. You will learn how to configure your analysis, obtain result plots for your devices under test, and how to monitor you data quality online during data taking. In particular, the flexible event building mechanism will be explained and examples including the AIDA TLU and the EUDAQ2 event loader will be covered.

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https://cern.ch/corryvreckan
https://gitlab.cern.ch/corryvreckan/corryvreckan

Primary author: KROEGER, Jens (Ruprecht Karls Universitaet Heidelberg (DE))

Presenter: KROEGER, Jens (Ruprecht Karls Universitaet Heidelberg (DE))

Session Classification: Hands-on tutorials

Contribution ID: **65** Type: **not specified**

Hands-On: Making the most of your 10 minutes of fame

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Presentations in working meetings and conferences are the culmination of weeks or months of work and are one of our most important communication methods to our peers. Yet the 10-15 minutes they take are often seen as tedious and boring, both by the audience and even the presenter! We will identify, as a group, some simple but effective methods of improving presentations and posters with hands-on activities to reinforce concepts.

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Primary author: BARNEY, David (CERN)

Presenter: BARNEY, David (CERN)

Session Classification: Hands-on tutorials

Contribution ID: **66** Type: **not specified**

Hands-On: Silicon Detector Monte-Carlo Simulations with Allpix Squared

Thursday, 30 January 2020 14:00 (2h 30m)

Scope of the Tutorial

This tutorial will provide an insight into different functionalities of the Allpix Squared simulation framework. We will not start from zero, and some prior knowledge is required, i.e. the participants should be familiar with the very basic concepts of the framework (how to configure a simulation, how to set up the detector geometry...).
We will look into using electric fields from finite element simulations, how to use weighting potentials to get time-resolved simulations, and explore some other not-so-obvious features.

Preparation

Please install the latest release version of Allpix Squared on your computer or make sure you have access to a working version online before attending the tutorial.

Detailed instructions can be found in the manual or on the website (https://cern.ch/allpix-squared) The recommended option for this tutorial is to install the Docker image prior to arriving at the workshop venue.

Primary authors: SPANNAGEL, Simon (University of Glasgow (GB)); HYNDS, Daniel (Nikhef National institute for subatomic physics (NL))

Presenters: SPANNAGEL, Simon (University of Glasgow (GB)); HYNDS, Daniel (Nikhef National institute for subatomic physics (NL))

Session Classification: Hands-on tutorials

Contribution ID: **67** Type: **not specified**

Hands-On: Making the mostof your test-beam time - Understanding the triggering modes of the new AIDA-TLU to optimally match your DAQ system

Thursday, 30 January 2020 14:00 (2h 30m)

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- EUDAQ
- DESY Telescopes
- AIDA-TLU

Primary author: HUTH, Lennart (Deutsches Elektronen-Synchrotron (DE))

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

Session Classification: Hands-on tutorials

Contribution ID: **68** Type: **not specified**

BTTB Forum

Thursday, 30 January 2020 18:10 (1 hour)

Primary authors: JANSEN, Hendrik (Deutsches Elektronen-Synchrotron (DE)); MUNKER, Magdalena (CERN)

Presenters: JANSEN, Hendrik (Deutsches Elektronen-Synchrotron (DE)); MUNKER, Magdalena (CERN)

Session Classification: BTTB Forum