7th Beam Telescopes and Test Beams Workshop

Report of Contributions

https://indico.cern.ch/e/bttb7

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

Welcome from the organizers

Monday 14 January 2019 13:40 (5 minutes)

Presenter: SPANNAGEL, Simon (CERN)

Session Classification: Welcome

Contribution ID: **2** Type: **not specified**

Welcome & Practical Information by the Local Organizers

Monday 14 January 2019 13:45 (10 minutes)

Presenter: WILKENS, Henric (CERN)

Session Classification: Welcome

Contribution ID: **3** Type: **not specified**

Welcome address by CERN

Monday 14 January 2019 13:30 (10 minutes)

Presenter: ELSEN, Eckhard (CERN)

Session Classification: Welcome

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

Beam generation for test beams

Monday 14 January 2019 14:00 (45 minutes)

The presentation introduces the concepts of the secondary and tertiary beams for the use as test beams. It describes the generation of the test beams by interaction of primary or secondary beam with e.g. a target, converter, radiator or absorber and explains the parameters of particle production. The design of secondary and tertiary beamlines is presented, including the methods for selection of particle type and beam energy, as well as for the manipulation of beam parameters such as beam size, divergence, intensity etc. An overview of the common beam diagnostic tools and their functionality is given. Finally, the specifics of the beam generation and equipment at CERN are briefly discussed.

Author: GERBERSHAGEN, Alexander (CERN)

Co-authors: GATIGNON, Lau (CERN); BERNHARD, Johannes (CERN); CHARITONIDIS, Nikolaos (CERN)

Presenter: GERBERSHAGEN, Alexander (CERN)

Session Classification: Overview Lectures

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

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

Wednesday 16 January 2019 14:40 (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 device should cover the pseudo-rapidity range of 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 pico-seconds per hit (i.e 30 pico-seconds per track) in order to assign the particle to the correct vertex. Each readout cell has a transverse size of 1.3 mm × 1.3 mm 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.

Through a 4 period test-beam campaign at the CEN SPS H6A & B beamlines, proton and neutron irradiated LGAD prototypes for the HGTD upgrade were tested from several different technologies and manufactures. Gallium, boron and carbon implanted 1.3x1.3 mm2 diodes and 2 x 2 arrays are compared for achieved timing performance, post-irradiation efficiency and uniformity at fluences up to 6e15neq/cm2. A time resolution of < 50 psec 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.

Authors: MORANGE, Nicolas (Centre National de la Recherche Scientifique (FR)); CASTILLO GARCIA, Lucia (The Barcelona Institute of Science and Technology (BIST) (ES))

Presenter: CASTILLO GARCIA, Lucia (The Barcelona Institute of Science and Technology (BIST) (ES))

Session Classification: Analysis - Timing Detectors

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

ATLAS NSW Micromegas Test-Beam System

Friday 18 January 2019 11:30 (20 minutes)

The LHC at CERN plans to have a series of upgrades to increase its instantaneous luminosity to 7.5×1034 cm−2s−1. The ATLAS experiment will upgrade its inner end-cap muon chambers to cope with the increased collision rate expected from the High-Luminosity-LHC. This project, called New Small Wheel, includes resistive Micromegas chambers together with small-strip Thin Gap Chambers (sTGC), conforming a system of ˜2.4 million readout channels in total. This is the first time that large Micromegas are built in such a scale. In total, 128 Micromegas modules up to 3 m2 in size, and from different production sites spread in Europe, will be produced, with target installation at the end of Long Shutdown 2 (LS2) of the LHC. A series of test-beam runs have been conducted to test and validate large scale micromegas modules. One of the first series modules in muon/pion beam at the H8 line of SPS.

The experimental setup includes a DAQ system, DCS system based on WinCC-OA for the monitoring and control of HV and monitoring the environmental parameters. A set of Scintillators are used as a trigger system and a series of small size micromegas served as an external reference tracker.

The Micromegas DAQ system (in short: microDAQ) is comprised of one Xilinx VC709 evaluation board that supervises the front-end boards and up to eight VMM/FPGA-bearing front-end boards that can connect to a large Micromegas chamber, or small Micromegas chambers used for tracking. The system is easily scalable and easy to deploy. It is fully compatible with VERSO software process on the back-end, and its main usage is for testbeam and cosmic data-taking applications. Monitoring panels that are integrated with VERSO and on-the-fly analysis tools can be used, in order to verify the quality of the setup. Using the CTF module, one can input an external trigger (i.e. scintillator coincidence) to the DAQ system, which can support rigger rates of up to several hundred kHz without loss of events. For a chamber that has no inclination with respect to the beam, all triggers are accepted. For an inclined setup, where the exact timing of the incident particle must be constrained somehow in order to facilitate track reconstruction, a synchronous-to-BC clock mode is used, which vetoes triggers that are not within ˜1.6ns of the rising-edge of the BC clock. This simulates the behavior of the LHC machine, where the timing of an incident particle is well-defined with respect to the BC clock. Finally, the system supports a stand-alone, self-triggered mode, that does not use an external trigger to initiate the readout. In this mode, the VMM's Address in Real Time (ART) stream is analyzed by the VC709, in which a trigger processor has been implemented and upon the detection of a coincidence, injects a trigger to the front-end boards to read the VMMs out.

Author: Mr BAKALIS, Christos (National Technical Univ. of Athens (GR))

Presenter: Mr BAKALIS, Christos (National Technical Univ. of Athens (GR))

Session Classification: Analysis - Gas Detectors & Tomography

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

Test beam results of prototype modules for the ATLAS ITk Strip detector

Friday 18 January 2019 09:20 (20 minutes)

During the High-Luminosity phase of the LHC conditions for the ATLAS tracking system will be severe in terms of radiation and occupancy, with the goal of accumulating a total of more than 4000 fb^{-1} of data and up to 200 inelastic proton-proton interactions per beam crossing. In order to deal with these conditions, the entire tracking system will be replaced by a new all-silicon detector called the Inner Tracker (ITk). The ITk will consist of a barrel section and end-cap regions, each using a combination of pixel and strip detector layers. New radiation-hard sensors and front-end electronics will be used and are now under development. With module production expected to start in 2020, a full understanding of current prototype modules is crucial. This talk presents the results of tests of prototype strip detector modules, both un-irradiated and irradiated as well as end-cap and barrel types. Measurements were performed at DESY and CERN test beam facilities, using beam telescopes comprised of seven pixel layers for track reconstruction. The main focus of the analysis lies in the study of the spatial resolution, efficiency, noise occupancy, charge collection or cluster size of the modules, both in general and in respect to micro- or macro-features of the modules, like track positions within a strip or the edges of the sensors. The obtained results give confidence that the ITk strip detector will perform well for the full duration of the HL-LHC.

Author: RUEHR, Frederik (Albert Ludwigs Universitaet Freiburg (DE))

Co-authors: KROLL, Jiri (Acad. of Sciences of the Czech Rep. (CZ)); KELLER, John Stakely (Carleton University (CA))

Presenter: RUEHR, Frederik (Albert Ludwigs Universitaet Freiburg (DE))

Session Classification: Analysis - Silicon Pixel & Strips

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

Material Budget Imaging in two and three dimensions

Friday 18 January 2019 12:10 (20 minutes)

The environment of test beam facilities and the utilization of high-resolution beam telescopes enable the application of a novel imaging technique, named Material Budget Imaging. This technique is based on the multiple Coulomb scattering of highly energetic charged particles in matter, leading to an effective deflection of the particles. Measuring the deflection angles and the incidence positions at a sample for a multitude of particles then enables a position-resolved determination of the sample's material budget. Combined with a rotation of the sample, a three-dimensional imaging becomes feasible.

Highly energetic particles in the GeV-range are able to traverse several radiation lengths of a given material. Thus, material budget images can reliably be acquired for high-density objects, showing a reduced number of artefacts than it is the case for many other tomographic imaging techniques, such as e.g. Computed Tomography.

In this contribution, we present the method of material budget imaging in two and three dimensions and demonstrate its potential and limits. We show first results from measurements performed at the DESY II Test Beam Facility and a comparison to images acquired via Computed Tomography.

Authors: SCHÜTZE, Paul (Deutsches Elektronen-Synchrotron (DE)); JANSEN, Hendrik (Deutsches Elektronen-Synchrotron (DE))

Presenters: SCHÜTZE, Paul (Deutsches Elektronen-Synchrotron (DE)); JANSEN, Hendrik (Deutsches Elektronen-Synchrotron (DE))

Session Classification: Analysis - Gas Detectors & Tomography

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

H4DAQ: a modern and versatile data-acquisition package for calorimeter prototype test-beams

Tuesday 15 January 2019 09:40 (20 minutes)

The upgrade of the calorimeters for the High Luminosity LHC (HL-LHC) or for future colliders requires an extensive programme of tests to qualify different detector prototypes with dedicated test beams. A common data-acquisition system (called H4DAQ) was developed for the H4 test beam line of the CERN SPS North Area in 2014, and it has since been adopted by an increasing number of teams involved in the CMS experiment and AIDA groups. Several different calorimeter prototypes and precision timing detectors have used H4DAQ from 2014 to 2017. H4DAQ has proven to be a versatile application, portable to many beam test environments, including the CERN beam lines (EA-T9 at the PS and H2/H4 at the SPS) and the INFN Frascati Beam Test Facility. H4DAQ is fast, simple, modular and can be configured to support different setups. The different functionalities of the DAQ core software are split into three configurable finite state machines: the data readout, run control, and event builder. The distribution of information and data between the various computers is performed using ZEROMQ (0MQ) sockets. Different plugins are available to read different types of hardware, including VME crates with different types of boards, PADE boards, custom front-end boards, and beam instrumentation devices. The raw data are saved as root files, using the CERN C++ root libraries. A graphical user interface (GUI), based on the python gtk libraries, is used to operate the H4DAQ and the integrated data quality monitoring (DQM), written in C++. This GUI allows for fast processing of events for quick feedback to the user. The 0MQ libraries are also available for the National Instruments LabVIEW program. This facilitates communication with existing instrumentation and detector control systems, via commands issued by the H4DAQ GUI. The design, functionality, and operational experience with the H4DAQ system will be described in this talk.

Author: Dr CUCCIATI, Giacomo (CERN)

Presenter: Dr CUCCIATI, Giacomo (CERN)

Session Classification: Software Tools

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

CHROMIE - The CMS High Rate Telescope

Wednesday 16 January 2019 11:30 (20 minutes)

A new pixel telescope was designed, built and commissioned at CERN for beam tests with prototype modules for the CMS Phase-2 Tracker upgrade. It is based on 16 CMS Phase-1 Barrel Pixel modules, which are of the same type as used in the current CMS pixel detector. In this talk the final design is described and the commissioning of the telescope is discussed. In addition, the first results of two small beam tests are shown.

Authors: DEELEN, Nikkie (CERN); MERSI, Stefano (CERN)

Presenter: DEELEN, Nikkie (CERN)

Session Classification: Beam Telescopes

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

LEMMA (Low Emittance Mu+ Mu- Accelerator) 2018 CERN test beam results

Tuesday 15 January 2019 11:30 (20 minutes)

The muon collider idea was born some decades ago, but nowadays it is very attractive since such a machine would provide both a high centre of mass energy, typical of hadron accelerators, and a clean experimental environment, typical of lepton machines.
Thanks to its features, the muon collider can help to consolidate the present knowledge of the Standard Model of particle physics (SM) and search for deviations from its predictions that would be signal of new physics. The muon collider can therefore be used to explore the multi-TeV frontier and serve as Higgs boson factory, helping in the search for the double-Higgs boson production, fundamental point for probing the SM.
The muon collider has to face lots of challenges. One of these is the production of a low-emittance muon-antimuon beam which serves as input for a suitable accelerator complex. Recently a new approach for producing such low-emittance muons has been proposed, and it exploits the process $e^+e^- \to \mu^+\mu^-$, through the collision of a 45 GeV positron beam on a Beryllium fixed target. The energy of the incident beam is chosen in order to use the interested process at the threshold in order to obtain the desired muon-antimuon low emittance flux.
The experimental evidence of the new approach is the goal of the Low Emittance Mu+ Mu− Accelerator (LEMMA) collaboration who realized in August and September 2018 dedicated tests with a 45 GeV positron beam on a Beryllium target in the H2 CERN experimental area. These tests were based on a silicon telescope set-up complemented by a dipole magnetic field (to separate the produced positive and negative particles), a set of calorimeters (to tag electrons and positrons), and a set of drift-tube chambers (to detect the produced muons with high precision).
The ultimate goal of the LEMMA collaboration is the measurement of the emittance of the produced muons and antimuons flux and the measurement of the corresponding cross-section at threshold.
The concept and the experimental set-up of the LEMMA test beams will be presented is this talk, together with the results of the analysis of collected data.

Author: CAPPATI, Alessandra (Universita e INFN Torino (IT))

Presenter: CAPPATI, Alessandra (Universita e INFN Torino (IT))

Session Classification: Facilities & Infrastructure

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

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

Wednesday 16 January 2019 14:20 (20 minutes)

The electromagnetic calorimeter (ECAL) of the Compact Muon Solenoid Experiment (CMS) has been operating at the Large Hadron Collider (LHC) with proton-proton collisions at 13 TeV center-of-mass energy and a bunch spacing of 25 ns since 2015. Challenging running conditions for CMS are expected after the High-Luminosity upgrade of the LHC (HL-LHC). We review the design and R&D studies for the CMS ECAL barrel crystal calorimeter upgrade and present first test beam studies performed in the SPS H4 beam line. Particular challenges at the HL-LHC are the harsh radiation environment, the increasing data rates, and the extreme level of pile-up events, with up to 200 simultaneous proton-proton collisions. We present test beam results of the new readout and trigger electronics, which must be upgraded due to the increased trigger and latency requirements at the HL-LHC. In addition, particle detectors with a timing resolution of order 10 ps can tremendously improve event reconstruction at high luminosity hadron colliders. The CMS ECAL barrel upgrade will achieve a timing resolution of around 30 ps for high energy photons and electrons. The benefits of precision timing for the ECAL event reconstruction at HL-LHC will be discussed in this presentation. Simulation and test beam studies carried out for the timing upgrade of the CMS ECAL barrel will be presented, and the prospects for a full implementation of this option will be discussed.

Author: PIGAZZINI, Simone (ETH Zurich (CH))

Presenter: PIGAZZINI, Simone (ETH Zurich (CH))

Session Classification: Analysis - Timing Detectors

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

Test beam results of irradiated silicon sensors with modified pixel layout

Friday 18 January 2019 09:40 (20 minutes)

Planar n+-in-n silicon pixel sensors used in tracking detectors like the ATLAS Inner Detector need a high efficiency to detect most of the traversing particles. Based on the IBL pixel design with a pitch of 250 µm x 50 µm new designs with modified n+-implants or bias grid modifications were developed in Dortmund to investigate the effects on the efficiency.
Several different modified designs are placed on one sensor which is read out with a FE-I4B. Thus a direct comparison between the designs can be made.
After irradiation to different fluences, different sensors are tested in test beam measurements at CERN. The raw data is reconstructed with EUTelescope and analysed with TBMon2.
The in-pixel efficiency maps of the different designs reveal special regions with higher efficiencies towards the pixel edges. This causes an anomalous distribution of the residuals which are calculated by EUTelescope and used to perform the alignment. In this talk the problem is outlined and a solution for the inaccurate alignment of EUTelescope is presented.

Author: HOHM, Valerie Vanessa (Technische Universitaet Dortmund (DE))

Co-authors: GISEN, Andreas (Technische Universitaet Dortmund (DE)); WEINGARTEN, Jens (Technische Universitaet Dortmund (DE)); KROENINGER, Kevin Alexander (Technische Universitaet Dortmund (DE)); WEERS, Mareike (Technische Universitaet Dortmund (DE)); ALTENHEINER, Silke (Technische Universitaet Dortmund (DE))

Presenter: HOHM, Valerie Vanessa (Technische Universitaet Dortmund (DE))

Session Classification: Analysis - Silicon Pixel & Strips

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

Corryvreckan reconstruction software

Tuesday 15 January 2019 10:20 (20 minutes)

Corryvreckan is a modular reconstruction framework developed for test beam data analysis within the CLICdp collaboration. It has been created in the same spirit as Allpix squared, and thus shares its philosophies of high configurability and flexibility, user-friendliness, and high standard of documentation. Corryvreckan's modular structure allows for 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 user manual. Notable features of Corryvreckan are the 4D tracking capabilities, 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, and details of the module capabilities discussed. Examples of reconstructed data and configuration set-ups will also be shown.

In conjunction with this talk there will be a 2.5 hours 'hands-on'tutorial on Corryvreckan during BTTB7.

Author: WILLIAMS, Morag Jean (University of Glasgow (GB))

Presenter: WILLIAMS, Morag Jean (University of Glasgow (GB))

Session Classification: Software Tools

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

Results from the LHCb SciFI Tracker 2018 Slice Test at the CERN SPS

Thursday 17 January 2019 18:20 (20 minutes)

The Scintillating Fibre (SciFi) Tracker is designed to replace the current downstream tracking detectors in the LHCb Upgrade during 2019-20 (CERN/LHCC 2014-001; LHCb TDR 15). Collecting data at the increased luminosity foreseen for the upgrade will only be possible with front-end electronics read out at 40MHz and a flexible software-based triggering system that will increase the data rate as well as the events-of-interest efficiency . The SciFi Tracker is based on 2.5 metre long multi-layered ribbons from a total of 11000 km of 0.250 mm diameter scintillating fibre as the active medium and signal transport over 12 planes covering 340 mˆ2. Cooled silicon photomultiplier (SiPM) arrays with 128 channels and 0.25 mm channel width are used as readout. The front-end electronics are designed to digitise the signals from the SiPMs with a custom ASIC chip, the PACIFIC, for the approximately 500k channels and reconstruct the track hit position within an on-board FPGA. The PACIFIC is a 64-channel chip with a fast 10˜ns shaping time, dual 25 ns interleaved integrators, and provides binary signal-over-threshold information from three signal comparators per channel.

This presentation will cover the test beam results and experiences from the 2018 Slice Test at the CERN SPS. We will report the performance of the fibre tracker from first measurements using the production front-end electronics readout with the LHCb MiniDaq2 (PCIE40) 40 MHz readout which was run synchronously with the TimePix3 telescope.

Authors: LEVERINGTON, Blake (Ruprecht Karls Universitaet Heidelberg (DE)); WITOLA, Lukas (PI Heidelberg)

Presenter: WITOLA, Lukas (PI Heidelberg)

Session Classification: Analysis - Fibers & Calorimetry

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

Beam Tests of Deep Diffused Avalanche Photodiodes for Charged Particle Timing

Thursday 17 January 2019 09:00 (20 minutes)

The upgrades ATLAS and CMS for the High Luminosity LHC (HL-LHC) highlighted physics objects timing as a tool to resolve primary interactions within a bunch crossing. Since the expected pile-up is around 200, with an rms time spread of 170ps, a time resolution of about 30ps is needed. The timing detectors will experience a 1-MeV neutron equivalent fluence of $\Phi_{eq} = 10^{14}$ and 10^{15}cm^{-2} for the barrel and end-cap regions, respectively.
In this contribution, the results of a beam test characterization of deep diffused Avalanche Photo Diodes (APDs) produced by Radiation Monitoring Devices are presented. To improve the detector's timing performance, the APDs are used to directly detect the traversing particles, without a radiator medium where light is produced.
Non-irradiated devices with an active area of $8 \times 8\text{mm}^2$ were characterized in beam tests. Two readout schemes were investigated: 1) a direct coupling to the APD with off-sensor capacitive coupling and 2) a capacitive coupling on the sensor realized by means of a metallic mesh isolated from the detector by a kapton layer. The timing performance and signal properties were measured as a function of position on the detector using a beam telescope and an MCP-PMT.

Author: CENTIS VIGNALI, Matteo (CERN)

Presenter: CENTIS VIGNALI, Matteo (CERN)

Session Classification: Analysis - Timing Detectors

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

The spatial dependence of MCP-PMTs timing performance and its usability as a t0-reference detector

Wednesday 16 January 2019 14:00 (20 minutes)

A hyper-precise time reference is needed for characterization measurements of precise timing detector prototypes. The reference detector is normally placed together with a device under test (DUT) in a beam telescope. The time resolution of this reference detector should be considerably better than the time resolution of the DUT. Measurements with MCP-PMTs of the type R3809U-50 by Hamamatsu have been performed in order to characterize their spatial distribution of the time resolution and to validate them as a proper t0-reference detector. These measurements were conducted during the tests of precise-timing Picosec Micromegas prototypes at the CERN/SPS-H4 beam line using a beam telescope consisting of three triple-GEM tracker and various trigger detectors. A time resolution of up to 3.75±0.14 ps has been obtained in the inner part of the active area of the MCP-PMT.

The time resolution declines up to several ten picoseconds in the outer parts due to decreasing pulse amplitudes. The Cherenkov light cone is not anymore fully projected onto the photocathode in this region. Less and less photoelectrons are extracted from the photocathode by the diminishing light. The measurement shows a coherence to the theoretical expected relation between the time resolution and the initial number of photoelectrons.

This contribution will present the general beam setup of the Picosec Micromegas collaboration as well as the detailed studies of the MCP-PMT as a t0 reference detector.

Author: SOHL, Lukas (Université Paris-Saclay (FR))

Presenter: SOHL, Lukas (Université Paris-Saclay (FR))

Session Classification: Analysis - Timing Detectors

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

Beam Test Measurements on Planar Pixel Sensors for the CMS Phase 2 Upgrade

Friday 18 January 2019 10:00 (20 minutes)

The high luminosity upgrade of the LHC will lead to an increased multiplicity of proton-proton interactions, with up to 200 events per beam bunch crossing, in the CMS experiment.
The irradiation level that the detectors will have to withstand will reach a 1MeV neutron equivalent fluence of 2×10^{16} n_{eq}/cm^2 at the innermost part of the CMS pixel detector, at 2.8 cm distance from the beam axis.
To build a pixel detector with good performance under these conditions, planar pixel sensors are so far considered only for the pixel barrel layers 2-4, where the irradiation level will reach a 1 MeV neutron equivalent fluence of 5×10^{15} n_{eq}/cm^2, as the limit of their radiation hardness is still under investigation.
Several variants of new n+p, planar pixel sensors with pixel sizes of 50×50 μm^2 and 100×25 μm^2 and an active thickness of 150 μm have been designed and bump bonded to ROC4SENS read-out chips. Apart from the pixel size, the design variants differ with respect to the implantation and metalization geometry as well as the pixel isolation and biasing scheme.
To select the most promising design for the future CMS pixel detector, 18 weeks of beam test with a campaign of measurements on more than 50 sensors, non-irradiated and irradiated up to 1 MeV neutron equivalent fluences of 4×10^{15} n_{eq}/cm^2, have been completed at the DESY test beam facility.
The measurements were performed using the DATURA beam telescope for tracking and a CMS Phase 1 reference module for timing.
The edge-on method is used to measure the depletion depth and possibly trapping effects due to irradiation as the track passes the pixel cells at varying depths. In this talk, efficiency and edge-on measurements are shown as a function of the applied bias voltage, for irradiated and non-irradiated sensors.

Authors: FEINDT, Finn (Hamburg University (DE)); Mr EBRAHIMI, Ali (Graduate University of Advanced Technology); GARUTTI, Erika (Hamburg University (DE)); NIEMEYER, Caroline (Hamburg University (DE)); Dr PITZL, Daniel (DESY); SCHWANDT, Joern (Hamburg University (DE)); STEINBRUECK, Georg (Hamburg University (DE)); GUNNELLINI, Paolo (University of Hamburg); ZOI, Irene (University Hamburg)

Presenters: FEINDT, Finn (Hamburg University (DE)); NIEMEYER, Caroline (Hamburg University (DE))

Session Classification: Analysis - Silicon Pixel & Strips

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

The DESY II Testbeam Facility

Wednesday 16 January 2019 09:00 (20 minutes)

The DESY II Test Beam Facility will resume operations beginning February 2019. The current status and possibilities for future improvements and extensions of the facility will be presented.

Additionally, we show recent results on characterization measurements on the time structure and explain its convolution.

Authors: MEYNERS, Norbert (Deutsches Elektronen-Synchrotron (DE)); STANITZKI, Marcel (Deutsches Elektronen-Synchrotron (DE)); DIENER, Ralf (DESY)

Co-author: DREYLING-ESCHWEILER, Jan (Deutsches Elektronen-Synchrotron (DESY))

Presenter: MEYNERS, Norbert (Deutsches Elektronen-Synchrotron (DE))

Session Classification: Facilities & Infrastructure

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

Updates on Allpix Squared

Tuesday 15 January 2019 10:00 (20 minutes)

Allpix Squared is a generic open-source simulation framework for pixel detectors. Its goal is to ease the implementation of detailed simulations for both single detectors and more complex setups such as beam telescopes. It has successfully been used for a range of simulations, including test beam data from thin planar silicon sensors as well as monolithic CMOS detectors with a thin high-resistivity epitaxial layer used in the CLIC detector studies.
The simulation chain is arranged with the help of intuitive configuration files and an extensible system of modules, which implement the separate simulation steps. Detailed electric field maps imported from TCAD simulations can be used to precisely model the drift behavior of the charge carriers, bringing a new level of realism to the simulation of particle detectors.

This contribution provides an overview of the framework and its continuous development over the last 1.5 years, with a special focus on newly added features and further extension plans for the future.

Author: SPANNAGEL, Simon (CERN)

Presenter: SPANNAGEL, Simon (CERN)

Session Classification: Software Tools

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

Hands-On: The Allpix Squared Simulation Framework

Thursday 17 January 2019 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 how electric fields from finite element simulations can help in improving the detector description, 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)

There are four options:

1. Compile and install Allpix Squared locally, with local ROOT and Geant4 versions - please follow the installation instructions in the user manual
2. Use the Docker images - please refer to the user manual
3. Use Allpix Squared on LXPLUS using the centrally provided version on CVMFS. For this, you only need to source the appropriate script and you are ready to go:

   For CERN CentOS7:

   source /cvmfs/clicdp.cern.ch/software/allpix-squared/<VERSION>/x86_64-centos7-gcc7-opt/setup.sh

   For CERN Scientific Linux 6:

   source /cvmfs/clicdp.cern.ch/software/allpix-squared/<VERSION>/x86_64-slc6-gcc7-opt/setup.sh
4. Compile and install Allpix Squared locally or on LXPLUS, while using CVMFS versions of ROOT and Geant4 - this works only for SLC6 and CentOS7 systems - install the CERN CVMFS daemon and source appropriate ROOT and Geant4 versions using their .sh-scripts. Then compile Allpix Squared.

For all options including dependencies from CVMFS: It might take a while until the CVMFS cache is populated with the necessary libraries when starting the program for the first time.

Author: SPANNAGEL, Simon (CERN)

Presenter: SPANNAGEL, Simon (CERN)

Session Classification: Hands-On Tutorials

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

Testing the ALPIDE sensor for applications in a proton CT

Friday 18 January 2019 10:20 (20 minutes)

Radiation therapy is an important tool in the treatment of cancer tumors. During this treatment, the tumor is destroyed by irradiating it with photons or hadrons (protons or heavier nuclei). In hadron therapy, the organs surrounding the tumor receive a smaller dose than in the treatment done with photons; however, to plan such a treatment the energy loss of hadrons in the surrounding tissue has to be known precisely. In the current state of the art, this is calculated based on a conversion of the photon attenuation coefficient measured in a photon CT to the stopping power. This conversion, however, is not based on physical principles and therefore results in large uncertainties effectively limiting the potential of hadron therapy. CT measurements done using protons would allow us to largely reduce these uncertainties, therefore reducing the unnecessary radiation dose received by the patient and making hadron treatment available for more types of cancer. I will show the developments of such a proton CT based on the ALPIDE sensor which was originally developed for the Inner Tracking System of the ALICE detector. I will focus on the test beam measurements of the sensor which are conducted to test its response to very low energy protons and helium ions (< 200 MeV) which is the energy range typically used in hadron therapy.

Author: VARGA-KOFARAGO, Monika (Hungarian Academy of Sciences (HU))

Presenter: VARGA-KOFARAGO, Monika (Hungarian Academy of Sciences (HU))

Session Classification: Analysis - Silicon Pixel & Strips

Contribution ID: **29** Type: **not specified**

A telescope based on MALTA CMOS sensors

Thursday 17 January 2019 11:10 (20 minutes)

MALTA is a novel monolithic active pixel CMOS sensor chip designed in TowwerJazz 180nm imaging technology for the phase II upgrade of the ATLAS Inner Tracker (ITk) detector. A MALTA telescope has been developed with 6 planes. In this contribution we will review the performance of the telescope in terms of spacial resolution and timing and will be compared with simulations. The results show that the new MALTA based telescope is a capable system for characterisation with a preliminary resolution of 4 μm achieved.

Authors: SHARMA, Abhishek (University of Oxford (GB)); SOLANS SANCHEZ, Carlos (CERN); SCHIOPPA, Enrico Junior (CERN); ASENSI TORTAJADA, Ignacio (Univ. of Valencia and CSIC (ES)); FREEMAN, Patrick Moriishi (University of Birmingham (GB)); DAO, Valerio (CERN)

Presenter: ASENSI TORTAJADA, Ignacio (Univ. of Valencia and CSIC (ES))

Session Classification: Beam Telescopes

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

Secondary infrastructure for test beams

Wednesday 16 January 2019 10:20 (20 minutes)

While telescopes are often a core requirement to conduct a test beam experience shows that secondary infrastructure plays also a central role. Secondary infrastructure can be remote control and monitoring of power supplies and stages, positioning tables for telescopes as well as DUTs. Another important part of this secondary infrastructure are means to provide cooling of telescope planes as well DUTs. The ATLAS pixel detector test beam group had several iterations of cold boxes for DUTs since 2009. These employed different active cooling agents (chillers, peltier elements) or passive cooling (dry ice). The latest iteration reaches -40℃ and has been used as a semi-permanent installation with the ACONITE telescope by several different detector groups. Some of the previous attempts will be presented and pros / cons discussed. A brief overview of other systems will be given as well.

Author: Dr RUMMLER, Andre (CERN)

Presenter: Dr RUMMLER, Andre (CERN)

Session Classification: Facilities & Infrastructure

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

Beam-tests of CMS High Granularity Calorimeter Prototypes at CERN and DESY 2018

Thursday 17 January 2019 17:00 (20 minutes)

As part of its HL-LHC upgrade program, CMS is developing a High Granularity Calorimeter (HGCAL) to replace the existing endcap calorimeters. The HGCAL will be realised as a sampling calorimeter, including 28 layers of silicon pad and 24 layers of silicon+scintillator detectors interspersed with metal absorber plates. In 2018, beam tests of different sampling configurations made from these modules have been conducted at CERN's SPS using beams of electrons and charged hadrons with momenta from 10 to 300 GeV/c. The setup was complemented with CALICE's AHCAL prototype, a 39-layer scintillator+SiPM sampling calorimeter, mimicking somewhat the proposed design of the HGCAL's back part. Delay wire chambers for particle tracking, MCPs for time reference measurement and threshold Cherenkov counters for hadron identification have been integrated in the data taking.

Furthermore, a few HGCAL modules were tested at DESY with electrons up to 6 GeV earlier this year. The DATURA telescope was operated in parallel and allowed, in addition to measurements of efficiency vs position, tomography scans of HGCAL prototypes to be performed for the first time.

This talk summarises the HGCAL test beam efforts in 2018. The different setups including the beam characterising detectors are discussed. Secondly, preliminary results on the studies with minimum ionising particles, as well as on the energy and position resolution of electron and hadron induced showers are shown. The usefulness of independent beam characterising detectors in these tests will be demonstrated. Finally, first impressions on the timing performance of full modules in beam conditions are presented.

Author: QUAST, Thorben (Rheinisch Westfaelische Tech. Hoch. (DE))

Presenter: QUAST, Thorben (Rheinisch Westfaelische Tech. Hoch. (DE))

Session Classification: Analysis - Fibers & Calorimetry

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

Overview of the modular DAQ hardware designed for beam tests of the HGCAL prototype

Thursday 17 January 2019 11:30 (20 minutes)

The CMS collaboration has decided to replace the current endcap calorimeters with a new High Granularity Calorimeter (HGCAL) for operations at the High Luminosity LHC (HL-LHC). To validate the design of the HGCAL, prototype detector modules based on silicon pad sensors have been manufactured and tested extensively both in the laboratory and in beam tests. Each prototype module has 128 channels readout by 4 custom ASICs (SKIROC2CMS). The local readout of these ASICs was controlled by a MAX10 FPGA. Signals from the MAX10 FPGAs were transmitted to a modular off-detector DAQ, which was designed for this detector prototype largely using commercially available components.

The basic unit of this DAQ, called a RDOUT board, controlled the readout from up to 8 detector modules. The RDOUT board employed 5 Kintex7 FPGAs, four of which were for the readout itself. The 5th FPGA controlled the readout sequence and interfaced with the system host via Ethernet using the IPBUS protocol. The RDOUT board was also used to distribute the low and bias voltages to the detector modules connected to it.

Multiple RDOUT boards were operated in synchronization with the help of a SYNCH board, which also uses a Kintex7 FPGA. In addition to synchronization the SYNCH board distributed the clock and the external trigger to the RDOUT boards. It also enabled us to interface our DAQ with those of other detectors for multi-detector operations. Every board in the system was equipped with a Raspberry Pi3 for slow control and testing. The core firmware and software for the DAQ were written in Verilog and C respectively, the latter being based on the EUDAQ framework.

The DAQ was designed to be scalable so that up to 12 groups of RDOUT boards, each under the control of one SYNCH board, could be controlled by a master SYNCH board. In the latest beam test held in October, 2018 the prototype detector comprised 93 detector modules with a total of nearly 24000 electronic channels readout by 14 RDOUT boards. Along with the HGCAL prototype, the CALICE AHCAL prototype was operated jointly with a system host running EUDAQ. We present here the design of this DAQ, our experience operating it, and our plans for future operations with the same.

Author: CHATTERJEE, Rajdeep Mohan (University of Minnesota (US))

Presenter: CHATTERJEE, Rajdeep Mohan (University of Minnesota (US))

Session Classification: Data Acquisition Tools

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

Test beam facility at CYRCé for high particle rate studies with a CMS upgrade module: design and simulation

Tuesday 15 January 2019 11:10 (20 minutes)

The upgrade of the LHC to the High-Luminosity LHC (HL-LHC) is expected to increase the current instantaneous luminosity by a factor of 5 to 7. The resulting large integrated luminosity will provide a great opportunity to search for rare processes. To cope with the increase in particle density CMS will build new silicon tracking devices with higher granularity to reduce occupancy, improved radiation hardness and the capability to contribute to the CMS Level-1 Trigger. During the R&D period, tests performed under beam are a very powerful way to develop and examine the behavior of silicon sensors in real conditions. In order to test the CMS Tracker module under a high particle rate, a new beam line is being constructed at IPHC-Strasbourg. This beam line would be added to the existing cyclotron CYRCÉ, that provides proton beams of 25 MeV with intensities up to 100 nA ($\tilde{6} \cdot 10^{11}$ particles per second) and will make it possible to synchronize the 40 MHz clock of the electronics to the particle arrival. In this presentation, the beam line characteristics and design are described along with a Geant4 simulation that estimates the response of a DUT with a geometrical arrangement similar to a CMS 2S module (with respect to energy loss, cluster multiplicity and spatial resolution) with the help of a simplified version of a new particle telescope made of CMS pixel Phase-1 sensors.

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

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

Session Classification: Facilities & Infrastructure

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

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

Thursday 17 January 2019 17:40 (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 and hadrons at various incident energies and impact angles. The muons data allow to study the dependence of the response on the incident point and angle in the cell. The electron data are used to determine the linearity of the electromagnetic energy measurement. The hadron data allows to tune the modelling of the calorimeter response to pions and kaons with the purpose of improving the reconstruction of the energy of jets. The results of the ongoing data analysis are discussed in the presentation.

Author: ZAKAREISHVILI, Tamar (Tbilisi State University (GE))

Presenters: ZAKAREISHVILI, Tamar (Tbilisi State University (GE)); ATLAS TILECAL SPEAKERS COMMMITTE

Session Classification: Analysis - Fibers & Calorimetry

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

Test Beam Studies for the upgrade of the ATLAS Tile Calorimeter read-out electronics for the HL-LHC

Thursday 17 January 2019 17:20 (20 minutes)

The High Luminosity Large Hadron Collider (HL-LHC) is expected to start in 2026 the delivery of 3-4/ab of proton-proton collisions with up to 200 collisions per proton bunch crossing.
The electronics of the ATLAS Tile Calorimeter has to be upgraded to cope with longer latencies of up to 35 μs needed by the trigger system at such high pileup levels and higher read-out rates. The expected radiation doses will also exceed the qualification range of the current readout system.
In 2016-2018, the beam from the the Super Proton Synchrotron (SPS) was used to test the read-out of the demonstator of the proposed digitizer/shaper and pre-processor cards. Modules of the Tile Calorimeter were irradiated with high energy pions, electrons, muons and kaons in the North Area of CERN and the signals were read-out by the demonstrator electronics.
In additions,a test system based on Multi-anode photo-multipliers (MA-PMs) has been used to read-out the signals of the individual fibers on PMT bundles of the Tile Calorimeter.
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 calibration and tests of the MA-PMs.
The fully assembled and tested demonstrator of the upgrade electronics will be installed already in 2019, during the LHC long shutdown and will read-out a slice of the ATLAS Tile Calorimeter during Run 3. The pulse shape, uniformity, timing precision and read-out capability of the proposed electronics for the HL-LHC upgrade are demonstrated.

Author: CARRIO ARGOS, Fernando (Univ. of Valencia and CSIC (ES))

Presenters: CARRIO ARGOS, Fernando (Univ. of Valencia and CSIC (ES)); ATLAS TILECAL SPEAKERS COMMITTEE

Session Classification: Analysis - Fibers & Calorimetry

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

Testbeam Characterization of the ATLASpix _Simple Pixel Sensor Prototype in View of the Requirements for the CLIC Tracking Detector

Thursday 17 January 2019 10:00 (20 minutes)

The ATLASpix_Simple is a Monolithic Active Pixel Sensor prototype produced in a commercial 180nm HV-CMOS process. It contains a self-triggered 25 x 400 pixel array with a pixel size of 130 um x 40 um.
The chip features tunable in-pixel comparators and a digital periphery allowing for on-chip hit digitization.

In order to characterize the chip and investigate its performance with respect to efficiency, timing and spatial resolution, testbeam campaigns are carried out in which the prototype is placed in a beam telescope consisting of multiple layers of pixel sensors. The beam telescope provides reference tracks to which the hits on the device-under-test can be compared with a high spatial and time resolution.

This talk will introduce the ATLASpix sensor prototype. Furthermore, results from the testbeam performed with the CLICdp Timepix3 Beam Telescope at the H6 beamline of the SPS in November 2018 will be presented in view of the requirements of the CLIC tracking detector.

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

Session Classification: Analysis - Silicon Pixel & Strips

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

The CERN East Area

Monday 14 January 2019 16:50 (20 minutes)

The East Area is among the oldest and longest-operating CERN's facilities, in which beam tests, experiments and irradiations are hosted since the 1960's. The primary beam is extracted from the Proton Synchrotron, from which a 24 GeV/c proton beam is directed either towards the IRRAD and CHARM irradiation facilities or towards a primary target to produce three secondary beams. These beams of up to 12 GeV/c (T9) and 6 GeV/c (T10) serve test beam areas and 3.6 GeV/c T11 beam serves the CLOUD experiment, which studies cloud formation under the influence of cosmic rays.

In order to continue delivering reliable beams in the future, the CERN council has approved the East Area Renovation project in 2016, which is now being implemented during a two-year stop of all beams at CERN. The new East Area will respect modern infrastructure norms and limit better radiation doses to equipment and personnel. A new layout of the beamlines is proposed including new laminated magnets that will allow for cycled powering scheme. Together with a full infrastructure renovation, energy efficiency will be greatly enhanced. The new beamlines will provide higher energies (15 GeV/c T9 and 12 GeV/c T10) and thus provide a useful energy overlap to the North Area beamlines.

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Presenters: BERNHARD, Johannes (CERN); MONTBARBON, Eva (CERN)

Session Classification: Facilities & Infrastructure

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

Use of a novel off beam axis technique in the test of a High Pressure gas Time Projection Chamber in the CERN T10 beamline

Friday 18 January 2019 11:50 (20 minutes)

A High Pressure gas Time Projection Chamber (HPTPC) is a candidate for use as a near detector for future long baseline neutrino experiments such as the Hyper-Kamiokande experiment (Hyper-K) and the Deep Underground Neutrino Experiment (DUNE). Seeking to reduce neutrino-nucleus interaction uncertainties provides the major motivation for researching and developing an HPTPC as a neutrino detector.
An optically read out prototype HPTPC, rated to 5 bar of pressure, was built at Royal Holloway, University of London, to make proton scattering measurements in Argon gas in a test beam, making use of a beam moderator and novel off-axis measurement technique to reduce backgrounds.
A beam test was performed at the CERN East Area T10 beamline from August to September 2018 making measurements of protons in the prototype HPTPC, together with an upstream and downstream time of flight system built by the University of Geneva and University College London respectively. The combination of beam moderator and measurement off the beam-axis allowed for an enhanced ratio of protons to background pions.

Author: WASCKO, Morgan (Imperial College (GB))

Presenters: NONNENMACHER, Toby (Imperial College London); NONNENMACHER, Toby Sean (Imperial College (GB))

Session Classification: Analysis - Gas Detectors & Tomography

Contribution ID: **43** Type: **not specified**

The LYCORIS Telescope at the DESY II Test Beam Facility

Wednesday 16 January 2019 11:10 (20 minutes)

The DESY II Test Beam Facility is one of few facilities around the world capable of providing multi GeV particle beams. It is, as such, a key component in current detector development.
As part of the AIDA2020 project, the LYCORIS telescope was designed based on a hybrid-less silicon strip tracker with a strip pitch of $25\,\mu\mathrm{m}$ and an active area of $9.3 \times 9.3\,\mathrm{mm}^2$. LYCORIS is designed to be complementary to the current EUDET-type telescopes, to address user demands of a larger active area, higher time resolution and/or a smaller support structure. \\
The latest state of the system will be presented, including hardware construction highlights, the latest performance results from beam tests, and the DAQ system status.

Authors: STANITZKI, Marcel (Deutsches Elektronen-Synchrotron (DE)); WU, Mengqing (Deutsches Elektronen-Synchrotron (DE)); DIENER, Ralf (DESY); BEHNKE, Ties (Deutsches Elektronen Synchrotron (DESY)); KRAEMER, Uwe (DESY)

Presenter: WU, Mengqing (Deutsches Elektronen-Synchrotron (DE))

Session Classification: Beam Telescopes

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

High rate electron beam tests with MuPix8 sensors at MAMI

Thursday 17 January 2019 10:20 (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 μA it is well suited for diverse test beam applications. One of them is the high rate testing of detector prototypes.
The talk discusses tests that have been conducted with MuPix8 sensor prototypes during a beam time in August 2018. Preliminary results focusing on the dependency of the detection efficiency on the particle rate will be presented. This is especially relevant for the envisaged usage of this sensor type in the P2 parity violating electron scattering experiment at the new Mainz Energy-recovering Superconducting Accelerator (MESA).

Author: GRZESIK, Carsten (Universität Mainz)

Presenter: GRZESIK, Carsten (Universität Mainz)

Session Classification: Analysis - Silicon Pixel & Strips

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

The CERN Proton Irradiation Facility (IRRAD) during and after the CERN Long Shutdown 2

Monday 14 January 2019 17:10 (20 minutes)

During its first run, in the period 2014-2018, the CERN Proton Irradiation Facility (IRRAD) in the PS East Area has been heavily used for performing irradiations of particle detectors, electronic components and materials. More than 2500 elements were tested and irradiated during this run. During the Long Shutdown 2 (LS2) from 2019 to summer 2021, the IRRAD facility will undergo several upgrades in order to cope with the increasing demand for irradiation experiments required to complete the activities related to the High-Luminosity upgrade of the CERN Large Hadron Collider (scheduled during LS3). In this talk, we will present the planned modifications and upgrades in the global IRRAD infrastructure, but also the current work in progress performed within the AIDA-2020 project. Specifically, we will show the new IRRAD Data Manager System that is used to follow up the overall irradiation experiment procedure and operation. The presentation will also include details about the current irradiation tests and results of a new enhanced version of the currently used beam diagnostic in IRRAD, the Beam Profile Monitor (BPM). Moreover, the results of calibration measurements performed with Xe (2017) and Pb (2018) ion beams in IRRAD will be discussed in order to evaluate the possibility of providing to the users community Heavy Ion beams in IRRAD after LS2. These upgrades will allow for a more efficient and comprehensive operation of the IRRAD facility after LS2.

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Co-authors: RAVOTTI, Federico (CERN); GORINE, Georgi (EPFL - Ecole Polytechnique Federale Lausanne (CH)); MATEU, Isidre (CERN); BRONUZZI, Jacopo (EPFL - Ecole Polytechnique Federale Lausanne (CH)); PEZZULLO, Giuseppe (CERN); LAZZARONI, Michael (CERN); BRETHOUX, Damien; JAEKEL, Martin Richard (CERN); MATLI, Emanuele (CERN); GLASER, Maurice

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

Session Classification: Facilities & Infrastructure

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

Test beam measurements of irradiated CVD diamond

Thursday 17 January 2019 09:20 (20 minutes)

Several CVD diamond detectors irradiated up to fluence of $5{\cdot}10^{15}$ protons/cm^2 were tested with a 180 GeV pion beam at the Northern Area at CERN in 2018. The main objective was to observe the effect of irradiation on the signal amplitude spectrum with electronics designed for timing purposes. Many of the detectors were attached to the front-end electronics with a bond- and glue-less method.

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Presenter: NAARANOJA, Tiina Sirea (Helsinki Institute of Physics (FI))

Session Classification: Analysis - Timing Detectors

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

The INSULAb telescope: a modular and versatile tracking system for beam tests

Wednesday 16 January 2019 11:50 (20 minutes)

The main features of the high performance INSULAb telescope are presented. The detector consists of several silicon microstrip layers with different widths and pitches, thus guaranteeing a good compromise between high spatial resolution (down to ~ 5 μm for smaller layers owing to analog readout and floating strip scheme) and wide transverse coverage (up to $\sim 10 \times 10$ cm^2 for bigger layers). The large number of strips per layer makes particle multiplicity measurement possible as well, even for high intensity beams. Since each x-y module comes with independent electronics and mechanics the telescope fits several different beam test configurations; a survey on all the 2018 applications is presented.

Author: SOLDANI, Mattia (Università degli Studi dell'Insubria & INFN Milano Bicocca)

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Presenter: SOLDANI, Mattia (Università degli Studi dell'Insubria & INFN Milano Bicocca)

Session Classification: Beam Telescopes

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

Two New Low Energy Beam Lines at the CERN North Area: from Design to Commissioning

Monday 14 January 2019 17:50 (20 minutes)

The CERN North Area facility at the Super Proton Synchrotron (SPS) provides secondary beams for numerous fixed target experiments and test beams. Recently, the available beam line spectrum has been enriched by two new tertiary branches of the existing beam lines designated as H2-VLE and H4-VLE. They are designed to provide low-momentum charged particles in the range of 0.3 to 12 GeV/c. Their individual properties, e.g. momentum and time-of-flight, can be determined by the instrumentation employed. With extensive beam dynamics studies, the particle transmission throughout the beam lines has been optimized and fully detailed Monte Carlo simulations have been performed to estimate the rates and compositions of the beams. This presentation gives an overview of the beam line design and instrumentation and the very good agreement between the Monte Carlo studies and first results of the commissioning is discussed.

Authors: ROSENTHAL, Marcel (CERN); CHARITONIDIS, Nikolaos (CERN); KARYOTAKIS, Yannis (LAPP CNRS/IN2P3); CHATZIDAKI, Panagiota; ORTEGA RUIZ, Inaki (CERN); SALA, Paola (CERN and INFN Milano); Dr NOWAK, Elzbieta (CERN); BOOTH, Alexander (University of Sussex); GIROD, Sylvain (CERN); CLERC, Vincent; DE JESUS, Victor (CERN); HARROUCH, Erwan (University of Patras (GR)); EBN RAHMOUN, Aboubakr (CERN)

Presenter: ROSENTHAL, Marcel (CERN)

Session Classification: Facilities & Infrastructure

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

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

Thursday 17 January 2019 14:00 (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.

Author: BARNEY, David (CERN)

Presenter: BARNEY, David (CERN)

Session Classification: Hands-On Tutorials

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

Status of the EUDET-type beam telescope infrastructure

Tuesday 15 January 2019 11:50 (20 minutes)

EUDET-type beam telescopes are widely used by test beam users. Based on six Mimosa26 sensors they provide a high-spatial resolution and a simple integration for users. The infrastructure comes with three pillars: the hardware for mechanical mounting of user devices and a trigger communication to the EUDET/AIDA TLU, the EUDAQ software as a top-level DAQ framework and the EUTelescope software for track reconstruction and analysis.

In this talk, we report on the status of the available devices and recent developments within the infrastructure. This includes the status from CERN (ACONITE, AIDA, AZALEA) and the status from DESY (DATURA, DURANTA). A motivation and an overview are given on the necessary changes for updating user integrations for EUDAQ2, as well as the possibilities of new trigger and synchronisation modes which are coming with the AIDA TLU. This will be applied in a hands-on session of the workshop. Finally, a new and common GBL processor within EUTelescope was written as well as an N-tuple dumper. These developments provide a clearer scope of EUTelescope as well as possibilties for new interfaces. In two hands-on session of this workshop different use cases are explained. We conclude with educational applications and a 3-stage future development plan.

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Presenter: DREYLING-ESCHWEILER, Jan (Deutsches Elektronen-Synchrotron (DESY))

Session Classification: Facilities & Infrastructure

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

Photon tagged beam line at the DESY II test beam

Wednesday 16 January 2019 09:20 (20 minutes)

The three beam lines of the DESY II Test Beam Facility provide electrons with a selectable momentum of 1-6 GeV/c and are widely used in the R&D community of HEP. A feasability study for a photon tagged beam line was performed this year. Here, secondary bremsstrahlung photons are generated in the test beam area and electrons are a deflected by the Big Red Magnet of beam line TB21. With such a setup the electron/gamma separation capability of calorimeter can be tested. In addition it provides an indirect energy measurement of the bremsstrahlung photons. Simulations and measurement results are presented.

Authors: DUNNE, Katherine (University of California,Santa Cruz (US)); DREYLING-ESCHWEILER, Jan (Deutsches Elektronen-Synchrotron (DESY))

Co-author: STANITZKI, Marcel (Deutsches Elektronen-Synchrotron (DE))

Presenter: DUNNE, Katherine (University of California,Santa Cruz (US))

Session Classification: Facilities & Infrastructure

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

The Frascati beam-test facility doubling

Wednesday 16 January 2019 09:40 (20 minutes)

The improvements of the Frascati beam-test facility (BTF) are based on the splitting of the existing beam-line: adding a second branch in the BTF it will be possible to run in parallel two different setups. This is realized by splitting the beam with a pulsed 15° dipole (<100 ms ramp) and a two-way vacuum pipe, and with a second set of beam diagnostics for the monitoring of the beam intensity, of the spot size and position.
The project of all new elements, of the improvement of the vacuum, power, cooling and conditioning systems, as well as the modifications to the building has been completed in-house by the Frascati staff, the new elements and vacuum components have been then built. After having completely dismantled the old beam-line, the services and infrastructure of the facility have been revised and upgraded. The beam-line has been finally rebuilt in the new configuration with the new two branches: BTF-1 dedicated to long-term installations, and BTF-2 for shorter duration test-beam activities.

Authors: VALENTE, Paolo (Sapienza Universita e INFN, Roma I (IT)); DI GIULIO, Claudio; FOGGETTA, Luca Gennaro (INFN-Laboratori Nazionali di Frascati); Dr BUONOMO, Bruno (INFN LNF)

Presenter: VALENTE, Paolo (Sapienza Universita e INFN, Roma I (IT))

Session Classification: Facilities & Infrastructure

Contribution ID: **53** Type: **not specified**

The CERN Gamma Irradiation Facility (GIF++) operation during the CERN Long Shutdown 2 and planned upgrades to the facility

Monday 14 January 2019 17:30 (20 minutes)

The Gamma Irradiation Facility (GIF++) is a mixed photon/muon irradiation facility designed for the needs of the particle detector community working with muon detectors, especially the upgrade programs of the LHC experiments for the HL-LHC. Inside a shielding bunker it hosts a nominal 14 TBq Cs Irradiator, operated throughout the year. In addition, a medium intensity muon beam is provided (from H4 beam line) for approximately 6-9 weeks per year. The facility provides two independent radiation fields, each one equipped with an attenuation system of iron/lead filters, with the purpose of optimizing the gamma field for the required tests.
Since its first year of operation in 2015, the facility is constantly overbooked, the main limitation being the large size of the detectors and the limited space inside the irradiation bunker. During the LS2, the work will even intensify, as several mass-production test of muon chambers are scheduled. This talk will present the plans to significantly enlarge the Irradiation Bunker by 40 m2, to be able to host more detectors and better combine different irradiation requirements. Planned updates to the Cosmic Trigger setup and general improvements to the facility, currently under implementation, will be shown.

Authors: JAEKEL, Martin Richard (CERN); PEZZULLO, Giuseppe (CERN); RAVOTTI, Federico (CERN); CHARITONIDIS, Nikolaos (CERN)

Presenter: JAEKEL, Martin Richard (CERN)

Session Classification: Facilities & Infrastructure

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

A versatile data acquisition system based on programmable hardware

Thursday 17 January 2019 11:50 (20 minutes)

The process of a detector development includes a subtask concerning the readout of data and controlling the detector. It typically consist of designing hardware in form of a readout board containing programmable logic to provide an interface to the chip, power supplies for biasing the detector chip, as well as DACs and ADCs for setting and measuring operation parameters, test pulses, etc. One also needs to write software for control and readout. This process can be repeated again and again for each new chip developed, which requires different voltage levels or different number of data lines. The CaRIBOu system, on the other hand, provides a robust, versatile DAQ system, which can be easily adjusted to the needs of different detector chips. Using such a system saves development cost and reduces the time needed to get first data from the detector. CaRIBOu is a combination of hardware and software modules that forms a stand-alone readout and DAQ system for detector prototypes. It was initially developed for testing newly developed pixel-detector chips for ATLAS and for a future CLIC detector. Adding support for a new chip is a matter of writing a piece of code performing an interface between the chip-specific features and the standard data and control interface of the CaRIBOu system. The system is based on a Xilinx Zynq System-on-Chip (SoC) architecture combining the power of a programmable hardware (FPGA) and a full Linux operating system allowing to run software in a higher programming language. It can run either stand-alone, storing data to a local filesystem, or connected via network interface to a data storage or a superior control system. The data decoding and analysis can be done either directly in the system both in software and in FPGA-based hardware, or it can be stored in a raw format and analysed offline.
The talk presents the structure and capabilities of the DAQ system and shows example applications and future plans.

Author: VANAT, Tomas (CERN)

Presenter: VANAT, Tomas (CERN)

Session Classification: Data Acquisition Tools

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

The AIDA-2020 TLU - A trigger/timing unit for beam tests

Thursday 17 January 2019 12:10 (20 minutes)

The AIDA-2020 Trigger/timing Logic Unit (TLU) was developed as a successor to the EUDET TLU. It can accept signals to from PMT, NIM or TTL sources and generate a trigger for up to four devices under test (DUTs).

The interface with the DUT can either be an asynchronous two way (trigger/busy) handshake used for the EUDET TLU or a synchronous interface with clock , trigger and synchronisation signals.

The AIDA-2020 TLU can be integrated into the EUDAQ DAQ framework or used stand-alone.

We describe the functionality of the AIDA-2020 TLU, some measurements of its performance and experience of its use in beam-tests of detectors.

Authors: BAESSO, Paolo (University of Bristol (GB)); CUSSANS, David (University of Bristol (GB))

Presenter: CUSSANS, David (University of Bristol (GB))

Session Classification: Data Acquisition Tools

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

HGTD testbeam at the SLAC beamline

Thursday 17 January 2019 18:40 (20 minutes)

The ATLAS detector at CERN will undergo several updates for the High Luminosity phase of LHC in 2023. A completely new silicon tracker (ITk) will be installed, furthermore a new timing detector called High Granularity Timing Detector (HGTD) composed of 2 layers of high timing precision silicon detectors (LGADs) will be placed in the end-cap region of the detector.

The SLAC beamline in the end station A facility (ESTB) is equipped with a telescope of the EUDET type (codename: Caladium) that was produced by DESY for the RD50 collaboration. The setup in End Station A was used to produce results for the HGTD LGAD sensors.

LGADs (Low Gain Avalanche Detectors) are a relatively new technology that allows timing measurements with a precision of 20-50 ps of timing resolution. Bare single pad sensors and arrays on analog amplifier boards were tested to probe the efficiency, cross talk and time resolution as a function of position of the hit on the sensor. Since a critical parameter of the LGADs is the resistance to radiation damage the sensor were tested both before and after irradiation at different fluences.

In the presentation the setup for the experiment will be presented as well as the beam parameters and operating conditions at SLAC. Some test beam results will also be shown.

Author: Dr MAZZA, Simone Michele (University of California,Santa Cruz (US))

Presenter: Dr MAZZA, Simone Michele (University of California,Santa Cruz (US))

Session Classification: Analysis - Fibers & Calorimetry

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

Timing performance of the Timepix3 telescope

Wednesday 16 January 2019 12:10 (20 minutes)

A beam telescope based on the Timepix3 ASIC was built in order to perform detailed studies of VELO Upgrade prototypes using charged particle beams. The telescope consists of 8 planes of hybrid pixel detectors with 300 um p-on-n silicon sensors, designed to cope with high particle rates using a DAQ system based on Xilinx Virtex 7 FPGA development boards. Tracks measured with the telescope have excellent spatial resolution, reaching under 2 um due to the small (55x55 um2) pitch, per-pixel measurements of the deposited charge, and the orientation of the detector planes in order to maximally profit from charge sharing.

In addition to precise spatial measurements, the Timepix3 ASIC operates with a 640 MHz oscillator that allows hit time-stamping in steps of 1.56 ns, giving a potential time-measurement resolution of 450 ps per plane. It is of great interest for future pixel trackers to investigate how precise time measurements can be combined to give optimal track time precision. Detailed studies have been performed to investigate the temporal resolution of individual telescope planes and the track timestamp obtained through the combination of the 8 planes.

In order to control systematic effects and provide an independent time measurement, two plastic scintillators mounted on fast PMTs were placed at opposing ends of the telescope. Their signals are treated by constant fraction discriminators to minnimise timing jitter. The combination of this setup and the track timestamps results in a temporal resolution of approximately 200 ps, which has allowed the assessment of new prototypes with more promising technologies for precise timing. The sub-nanosecond precision of the track time allows the study of timing structures within the pixel chip, along with measurements of other potential systematic effects. Complementary studies are being performed in the lab with a laser setup and preliminary results will be presented.

In this presentation the most recent results on the temporal resolution of the Timepix3 telescope will be presented, together with the timing performance of new sensor prototypes.

Author: HEIJHOFF, Kevin (Nikhef National institute for subatomic physics (NL))

Co-authors: CARVALHO AKIBA, Kazuyoshi (Nikhef); VAN BEUZEKOM, Martin (Nikhef National institute for subatomic physics (NL))

Presenter: HEIJHOFF, Kevin (Nikhef National institute for subatomic physics (NL))

Session Classification: Beam Telescopes

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

mini-VeloPix telescope

The upgrade of the LHCb experiment will transform the experiment to a trigger-less system reading out the full detector at the LHC collision rate and up to $2\times10^{33}\text{cm}^{-2}\ \text{s}^{-1}$ instantaneous luminosity. The Vertex Locator (VELO) is the silicon detector surrounding the interaction region. The upgraded VELO is based on a hybrid pixel system equipped with data driven electronics and designed to withstand a radiation dose up to 370 MRad or 8×10^{15} 1 MeV neq cm^{-2}. The detector will be composed of silicon pixel sensors with $55 \times 55\ \mu\text{m}^2$ pitch, read out by the VeloPix ASIC which is being developed based on the TimePix/MediPix family.

In the upgraded VELO, the ASIC with the highest occupancy is expected to be crossed on average by 8.5 charged particles in one pp collision event, corresponding to a peak hit rate of 900 million hits / s. In order to measure the hit finding efficiency as a function of the track (or particle) rate, a small beam telescope comprised of five planes of hybrid pixel detectors (200 µm thick n-on-p silicon sensors with an active area of $1.4\times1.4\ \text{cm}^{-2}$, bump-bonded to VeloPix ASICs) was constructed and installed in the high-rate area of the Fermilab Testbeam Facility. In this talk, first results from this testbeam area presented.

Timewalk is another important requirement to minimise the number of hits assigned to a wrong LHC bunch crossing. The most recent results on the VeloPix timewalk studies will also be shown.

Authors: DALL'OCCO, Elena (Nikhef National institute for subatomic physics (NL)); SCHINDLER, Heinrich (CERN); CARVALHO AKIBA, Kazuyoshi (Nikhef); VAN BEUZEKOM, Martin (Nikhef National institute for subatomic physics (NL)); COLLINS, Paula (CERN)

Presenter: SCHINDLER, Heinrich (CERN)

Session Classification: Beam Telescopes

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

Enhanced Lateral Drift Sensors: resolution studies

Thursday 17 January 2019 09:40 (20 minutes)

Future experiments in particle physics need a few-micrometer position resolution in their tracker and vertex detectors. Silicon is today's material of choice for high-precision detectors and offers a high grade of engineering possibilities. Instead of scaling down pitch sizes, which comes at a high price for an increased number of channels, our new sensor concept seeks to improve the position resolution by increasing the lateral size of the charge distribution already during the drift in the sensor material. To this end, it is necessary to carefully engineer the electric field in the bulk of this so-called enhanced lateral drift (ELAD) sensor. This is achieved by implants deep inside the bulk which influence the charge carriers' drift paths.
In order to find an optimal sensor design, detailed simulation studies were conducted using SYNOPSYS TCAD. The geometry of the implants, their doping concentration and the position inside the sensor were optimised. The electric field simulation shows that the deep p- and n- implants create repulsive and attractive areas inside the bulk of the sensor.
Finally, to estimate the position resolution of an ELAD sensor, test beam simulations using the AllPix2 software have been performed using the realistic electric field profile from the TCAD simulations.
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 deep implants without relying on a Lorentz drift or tilted incident angle. Results on the resolution studies are presented.

Author: VELYKA, Anastasiia (DESY)

Co-author: JANSEN, Hendrik (Deutsches Elektronen-Synchrotron (DE))

Presenter: VELYKA, Anastasiia (DESY)

Session Classification: Analysis - Silicon Pixel & Strips

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

A modular software framework for test-beam data analysis. The TbGaudi package

Tuesday 15 January 2019 09:20 (20 minutes)

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

In order to perform precise measuremens with the LHCb VELO detector prototypes a dedicated high resolution pixel beam telescope was developed based on 8 Timepix3 detector planes. This telescope has been taking data at CERN in the PS and SPS facilities since 2014. The Timepix3 can readout on data driven mode with very precise timestamps which makes triggering unnecessary.

At the centre of the telescope a Device Under Test (DUT) can be installed on a motion stage allowing angular rotations about the y axis, and x and y translations, where the z coordinate is the beam direction. The telescope provides precise measurements of particle trajectories with a pointing resolution of ~2 μm and a time resolution of ~1 ns allowing in-depth analysis of the DUT performance.

The data produced by the telescope can easily incorporate the signals from the DUT and in particular for Timepix3 devices the analysis is straight forward. The LHCb software embeded in the so-called Kepler project performs the decoding of raw data and produces track objects inside the official LHCb's Gaudi framework. In this way it is simple to produce histograms and ntuples with track and cluster data information.

Subsequently, the offline analysis compares the performance after irradiation with several fluences of protons or neutrons from 2 to 8×10^{15} 1 MeV neq/cm^2; different silicon substrates (n-on-p or n-on-n), distances from last pixel to the edge, guard rings designs and different vendors. Charge collection efficiencies (CCE), track resolution (TR), Eta correction are of particular interest as function of fluence.

For purposes described above, a modular software framework has been developed. It allows to handle the test beam data for a set of runs, as well as the set of different DUTs in one-go, and obtain an integrated workflow to present the results.

All code is written in C++, which is a general-purpose objective programming language. A class based design makes it flexible to add any new features of the device under investigation following a plug-in scheme. Currently, the toolkit handles different types of analysis such as CCE, TR and Eta correction, implemented for non-uniform irradiated sensors.

The presentation will describe the implemented analysis framework as a proposal of the prototype of a general design framework for test beam campaigns, that could be followed to obtain a quick ROOT based application for complex test beam data analyses being performed in different facilities and different irradiation sources or profiles. The interface is implemented for a series of algorithms in a user-friendly way. We believe it is a valuable complement to used by different groups performing detector R&D programs.

Authors: RACHWAL, Bartlomiej (AGH University of Science and Technology (PL)); SZUMLAK, Tomasz (AGH University of Science and Technology (PL))

Presenter: RACHWAL, Bartlomiej (AGH University of Science and Technology (PL))

Session Classification: Software Tools

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

Hands-On: Starting with EUTelescope - no or passive DUT

Tuesday 15 January 2019 13:30 (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 two types of reconstruction analysis. First part is to begin with an empty telescope, so no DUT. With this one can perform an alignment of the Mimosa26 sensors of the telescope. After this, a scattering material as DUT will be used to show the material budget imaging possibility.

This tutorial will show the basics of EUTelescope reconstruction, the next step is then to analyze an (active) DUT, for which we offer another, advanced EUTelescope tutorial.

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.

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

Co-authors: ROSSI, Edoardo (Deutsches Elektronen-Synchrotron (DE)); DREYLING-ESCHWEILER, Jan (Deutsches Elektronen-Synchrotron (DESY)); QUEITSCH-MAITLAND, Michaela (Deutsches Elektronen-Synchrotron (DE)); BECOT, Cyril Pascal (Deutsches Elektronen-Synchrotron (DE))

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Session Classification: Hands-On Tutorials

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

Hands-On: EUTelescope reconstruction with an active DUT

Tuesday 15 January 2019 16:30 (2h 30m)

Scope of the tutorial

In this tutorial, the participant will use the EUTelescope framework to reconstruct particle tracks of the EUDET-type telescopes, in order to test the response of an active DUT.
After converting the raw data to the LCIO data format using EUDAQ, the hits from the detector are grouped into clusters and then transformed into hits in the global coordinate system of the telescope. The General Broken Lines (GBL) algorithm is then used for aligning the planes and perform the track fitting.

The goal of the tutorial is to perform tracking in the presence of an active DUT, where a test data sample will be provided. Moreover, it will be explained how to extrapolate some basic but crucial quantities, such as the hit detection efficiency or the detector residuals. The goal is to provide the user with the knowledge to perform the reconstruction for several types of active DUTs.

For this tutorial, it is recommended to be already quite familiar with the EUTelescope reconstruction framework. A beginner's introduction is given in the first EUTelescope tutorial.

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.

Author: ROSSI, Edoardo (Deutsches Elektronen-Synchrotron (DE))

Co-authors: ARLING, Jan-Hendrik (Deutsches Elektronen-Synchrotron (DE)); QUEITSCH-MAITLAND, Michaela (Deutsches Elektronen-Synchrotron (DE)); DREYLING-ESCHWEILER, Jan (Deutsches Elektronen-Synchrotron (DESY)); BECOT, Cyril Pascal (Deutsches Elektronen-Synchrotron (DE))

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Session Classification: Hands-On Tutorials

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

Platform-independent integration of DAQ software in EUDET family telescopes using docker containers

Tuesday 15 January 2019 09:00 (20 minutes)

Containerization software has been proved to be an interesting approach to facilitate the creation, deployment and run applications, reducing time-consumption tasks like, for instance, software installation, error reproducibility or software maintenance.

The DAQ software for telescopes and DUTs is an excellent candidate to be "dockerize", as it will minimize usual bottle necks in the DAQ sotware integration and development, and posterior deployment in the test beam areas.

We present an example of successful "dockerization" of the DAQ softwares for the EUTEL/AIDA telescopes and the RD53A DUT readout chips, tested during this year beam test campaigns for the Phase-II Upgrade of the CMS Inner Tracker.

Author: Dr DUARTE CAMPDERROS, Jordi (Universidad de Cantabria (ES))

Presenter: Dr DUARTE CAMPDERROS, Jordi (Universidad de Cantabria (ES))

Session Classification: Software Tools

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

Pixel modules tests at ESTB for the ATLAS high-lumi upgrade

Friday 18 January 2019 09:00 (20 minutes)

The ATLAS detector at CERN will undergo several updates for the High Luminosity phase of LHC in 2023. A completely new silicon tracker (ITk) will be installed.

Pixel modules built with the RD53A chip and planar sensors were studied using the EUDET telescope for reference tracks. Sensor thicknesses of 100 and 150 microns were investigated. Pixel sizes of 50 microns x 50 microns and 25 microns by 100 microns were compared at various incidence angles. The measurements of interest for this run were: absolute charge measurement calibration from calculated MIP peak, vs. depletion voltage, position resolution (residuals) attained with the different sensors, and absolute timing dispersion of pixels in the RD53A chip. The last measurement is unique to this facility, and relies on the delivery of a large number of particles (few 100) in a single shot which cross the sensor at the same time with ps accuracy.

The SLAC beamline in the end station A facility (ESTB) is equipped with a telescope of the EUDET type (codename: Caladium) that was produced by DESY for the RD50 collaboration. This presentation will discuss the experimental setup as well as the beam parameters and operating conditions at SLAC. Some preliminary results will also be shown.

Author: NACHMAN, Ben (Lawrence Berkeley National Lab. (US))

Presenter: NACHMAN, Ben (Lawrence Berkeley National Lab. (US))

Session Classification: Analysis - Silicon Pixel & Strips

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

The Fermilab Test Beam Facility

Wednesday 16 January 2019 10:00 (20 minutes)

The Fermilab Test Beam Facility is a world class facility for testing and characterizing particle detectors. 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. Facility capabilities, scheduling, and plans will be discussed in this talk.

Authors: UPLEGGER, Lorenzo (Fermilab); ROMINSKY, Mandy

Presenters: UPLEGGER, Lorenzo (Fermilab); UPLEGGER, Lorenzo (Fermi National Accelerator Lab. (US))

Session Classification: Facilities & Infrastructure

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

Hands-On: The Corryvreckan reconstruction software

Tuesday 15 January 2019 13:30 (2h 30m)

Corryvreckan is a data reconstruction software developed for test beam data analysis. This tutorial will guide you through the framework of Corryvreckan and what functionality it possesses. You will learn how to configure your analysis, obtain result plots for your devices under test, and how to monitor your data quality during data taking. Some of the unique features of Corryvreckan will also be utilised, such as 4D tracking, and by the end you will be able to confidently use the modular framework to analyse your data from a variety of different test beam configurations. Only a basic knowledge of C++ and an installation of Corryvreckan are required for the tutorial.

Data for the Tutorial

wget https://cern.ch/corryvreckan/data/tutorial_data.tar.gz

tar -xvf tutorial_data.tar.gz

Preparation:

Please install the latest release version of Corryvreckan 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 Corryvreckan github: (https://gitlab.cern.ch/corryvreckan/corryvreckan)

There are four options:

1. Compile and install Corryvreckan locally, with local ROOT version - please follow the installation instructions in the user manual
2. Use the Docker images - please refer to the user manual
3. Use Corryvreckan on LXPLUS using the centrally provided version on CVMFS. For this, you only need to source the appropriate script and you are ready to go:

   For CERN CentOS7:

   source /cvmfs/clicdp.cern.ch/software/corryvreckan/<VERSION>/x86_64-centos7-gcc7-opt/setup.sh

   For CERN Scientific Linux 6:

   source /cvmfs/clicdp.cern.ch/software/corryvreckan/<VERSION>/x86_64-slc6-gcc7-opt/setup.sh
4. Compile and install Corryvreckan locally or on LXPLUS, while using CVMFS version of ROOT - this works only for SLC6 and CentOS7 systems - install the CERN CVMFS daemon and source appropriate ROOT version using its .sh-script. Then compile Corryvreckan.

For all options including dependencies from CVMFS: It might take a while until the CVMFS cache is populated with the necessary libraries when starting the program for the first time.

Author: WILLIAMS, Morag Jean (University of Glasgow (GB))

Presenter: WILLIAMS, Morag Jean (University of Glasgow (GB))

Session Classification: Hands-On Tutorials

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

Hands-on: EUDAQ2 and AIDA TLU tutorial

Thursday 17 January 2019 14:00 (2h 30m)

** Please bring your Laptop to the tutorial (optionally with a ROOT6 (or 5) installation/binary for the Online Monitor) **

The EUDAQ framework and the TLU are two main components for EUDET-type telescopes. Both are coming with defined interfaces for user integration.

Slight changes for the users come with the second version of EUDAQ2 and the AIDA TLU. In this tutorial we will go through the installation, a minimum example to understand the EUDAQ framework, how-to to write an producer or move an producer from EUDAQ1 and the control of the AIDA TLU.

In addition, it will presented the new possibilities of data taking: multiple data collectors and different synchronization modes (by event ID, trigger ID or common clock).

As a preparation, participants can install EUDAQ2 on their Laptop/PC before the tutorial: Take the master-branch of the github repository, see the README here for example: https://github.com/eudaq/eudaq#quick-installation-for-unix

Further information are the EUDAQ quick start and manual as pdf: http://eudaq.github.io/ and the AIDA TLU manual: https://github.com/PaoloGB/firmware_AIDA/blob/master/Documentation/Latex/Main_TLU.pdf

Possible contents due to need:
- Installation and usage
- Moving from EUDAQ 1 to 2 (Producer and Converter)
- Using the AIDA TLU and new DataCollectors
- Using the Python interface

** As a possible preparation you can install EUDAQ2**(and CACTUS for the AIDA TLU if you want to control the TLU via EUDAQ):**
-EUDAQ2: https://github.com/eudaq/eudaq#quick-installation-for-unix**
- CACTUS (IPBUS): https://ipbus.web.cern.ch/ipbus/doc/user/html/software/install/compile.html#instructions
- AIDA TLU Producer: https://github.com/eudaq/eudaq/blob/master/user/tlu/README.md

Authors: LIU, Yi (Deutsches Elektronen-Synchrotron (DE)); DREYLING-ESCHWEILER, Jan (Deutsches Elektronen-Synchrotron (DESY))

Co-authors: WU, Mengqing (Deutsches Elektronen-Synchrotron (DE)); CUSSANS, David (University of Bristol (GB)); BAESSO, Paolo (University of Bristol (GB))

Presenters: LIU, Yi (Deutsches Elektronen-Synchrotron (DE)); DREYLING-ESCHWEILER, Jan (Deutsches Elektronen-Synchrotron (DESY)); WU, Mengqing (Deutsches Elektronen-Synchrotron (DE)); CUSSANS, David (University of Bristol (GB))

Session Classification: Hands-On Tutorials

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

Prototype tests for a highly granular SiPM-on-tile hadron calorimeter

Thursday 17 January 2019 18:00 (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 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 and are designed for minimizing 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 has been built. Each active layer contains 576 single channels, arranged on readout boards and grouped according to the 36 channel 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.

Author: KRUGER, Katja (Deutsches Elektronen-Synchrotron (DE))

Presenter: KRUGER, Katja (Deutsches Elektronen-Synchrotron (DE))

Session Classification: Analysis - Fibers & Calorimetry

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

Calorimetry for Upgrades and Future Colliders

Monday 14 January 2019 14:45 (45 minutes)

Calorimeters play a crucial role in modern collider experiments, evolving from energy measurement to a complex role involving background rejection, pattern recognition and event reconstruction. Test beams play an important role in the development of calorimeters, for the validation of technology and performance as well as for the validation and development of detector simulations and simulation tools. This presentation will discuss selected examples of calorimeters in development for LHC upgrades, future colliders and other experiments, and touch on corresponding requirements for the test beam program that accompanies these projects.

Author: SIMON, Frank (Max-Planck-Institut fuer Physik)

Presenter: SIMON, Frank (Max-Planck-Institut fuer Physik)

Session Classification: Overview Lectures

Contribution ID: **70** Type: **not specified**

AIDA WP15 Satellite Meeting

Monday 14 January 2019 10:00 (2h 30m)

https://indico.cern.ch/event/780067/

Presenter: RAVOTTI, Federico (CERN)

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

North Area Consolidation Study

Monday 14 January 2019 18:10 (20 minutes)

The North Area facilities, hosting the secondary beam lines and experimental areas of the SPS complex are invaluable assets for the present and future of CERN's research program. Following the 2016 Chamonix Workshop and Consolidation day, which highlighted the need for urgent renovation and upgrade measures, the CERN EN-EA group received the mandate to lead a study for the North Experimental Area Consolidation. The objective was to provide a comprehensive proposal that shall include safety, all beam related items, infrastructure and civil engineering. Moreover, the study includes an analysis of the consolidation of the area in its present configuration, as well as alternative scenarios linked to future physics requirements. It also addresses cost and energy optimizations, examines implementation strategies and highlights urgent actions.
The results of the study was presented to the Management Board of the Accelerator and Technology Sector on 19th of November. We propose to give a summary of that presentation, showing the contained recommendations together with the timeframe of such a project.

Author: GAUTHERON, Fabrice (Univ. Illinois at Urbana Champaign (US))

Presenter: GAUTHERON, Fabrice (Univ. Illinois at Urbana Champaign (US))

Session Classification: Facilities & Infrastructure

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

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

Tuesday 15 January 2019 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.

Author: BARNEY, David (CERN)

Presenter: BARNEY, David (CERN)

Session Classification: Hands-On Tutorials

Contribution ID: **73** Type: **not specified**

Hands-On: The Allpix Squared Simulation Framework

Tuesday 15 January 2019 16:30 (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 how electric fields from finite element simulations can help in improving the detector description, 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)

There are four options:

1. Compile and install Allpix Squared locally, with local ROOT and Geant4 versions - please follow the installation instructions in the user manual
2. Use the Docker images - please refer to the user manual
3. Use Allpix Squared on LXPLUS using the centrally provided version on CVMFS. For this, you only need to source the appropriate script and you are ready to go:

   For CERN CentOS7:

   source /cvmfs/clicdp.cern.ch/software/allpix-squared/<VERSION>/x86_64-centos7-gcc7-opt/setup.sh

   For CERN Scientific Linux 6:

   source /cvmfs/clicdp.cern.ch/software/allpix-squared/<VERSION>/x86_64-slc6-gcc7-opt/setup.sh
4. Compile and install Allpix Squared locally or on LXPLUS, while using CVMFS versions of ROOT and Geant4 - this works only for SLC6 and CentOS7 systems - install the CERN CVMFS daemon and source appropriate ROOT and Geant4 versions using their .sh-scripts. Then compile Allpix Squared.

For all options including dependencies from CVMFS: It might take a while until the CVMFS cache is populated with the necessary libraries when starting the program for the first time.

Author: SPANNAGEL, Simon (CERN)

Presenter: SPANNAGEL, Simon (CERN)

Session Classification: Hands-On Tutorials

Contribution ID: **74** Type: **not specified**

Future of Silicon Trackers at CERN's HL-LHC and beyond

Monday 14 January 2019 15:30 (45 minutes)

This contribution gives an overview of the silicon detectors at CERN's HL-LHC and future colliders emphasising technological challenges and test beam efforts.

Presenter: PERNEGGER, Heinz (CERN)

Session Classification: Overview Lectures

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

Test beam results of irradiated and non- irradiated silicon strip sensors with embedded pitch adapters

Friday 18 January 2019 11:10 (20 minutes)

Embedded pitch adapters (EPA) are used to adjust the bonding pattern of segmented sensors to the bonding pattern of read-out chips. In this way the sensor geometry can be made independent of the bonding pattern of the read-out chips. This can be very useful for challenging sensor geometries like radial strip sensors which are used in the end-caps of the trackers of several experiments and for prototyping. EPAs are realized by depositing a SiO layer on top of the processed sensor and a second metal layer on the SiO which connects the sensor channels to the bonding pads matching the bonding pattern of the read-out chip. However, the additional SiO and the second metal layer may lead to efficiency loss due to coupling between the bulk and the second metal layer and between the first and the second metal layers increasing e.g. the inter-strip capacitance.

For the high-luminosity upgrade of the ATLAS inner tracker, silicon strip sensors with EPA structures have been investigated as an approach to mitigate the challenging wire-bonding in the end-cap region due to different bonding pattern of the sensors and the readout chips. Prototype end-cap silicon strip sensors with various EPA structures have been produced by Centro Nacional de Microelectronica (IMB-CNM, CSIC), Barcelona, Spain. A non-irradiated sensor and a sensor irradiated to $\Phi_{eq} = 10^{15}\,\mathrm{cm}^{-2}$ with MeV protons were subjected to test beam at DESY using a 4.4 GeV electron beam with a EUDET-type pixel telescope. First results of the tracking efficiency in the region of the EPA compared to the standard region with only one metal layer as well as a study of the coupling between the second metal layer and the bulk will be presented.

Author: SCHARF, Christian (Humboldt University of Berlin (DE))

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Presenter: SCHARF, Christian (Humboldt University of Berlin (DE))

Session Classification: Analysis - Gas Detectors & Tomography

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

The MuPix8 Telescope

Wednesday 16 January 2019 12:30 (20 minutes)

Mu3e is going to hunt for the charge lepton flavour violating decay of a antimuon into two positrons and an electron. A high rate of 10^8 muons/s is stopped on a target and the decay vertex as well as the decay particles momenta are reconstructed in a thin four layer pixel tracker in a magnetic field.
High-Voltage monolithic active pixel sensors are chosen as baseline for the tracker as they offer a high integration level at low material budget. The first large scale prototype, MuPix8, has been integrated in a tracking telescope with up to eight tracking layers framed by scintillating tiles for additional precise time information.
The telescope has been used to study the efficiency, time resolution and noise of the MuPix8 and three other monolithic sensors with a similar readout architecture.
The talk covers the concept of the DAQ system, its rate capability and the monitoring features. The online efficiency calculation and track reconstruction are discussed subsequently and finally a selection of highlights from testbeam campaigns in 2018 is presented.

Author: HUTH, Lennart (Ruprecht Karls Universitaet Heidelberg (DE))

Presenter: HUTH, Lennart (Ruprecht Karls Universitaet Heidelberg (DE))

Session Classification: Beam Telescopes

Contribution ID: **77** Type: **not specified**

Overview of Hands-On Sessions

Monday 14 January 2019 13:55 (5 minutes)

Presenter: DREYLING-ESCHWEILER, Jan (Deutsches Elektronen-Synchrotron (DESY))

Session Classification: Welcome