X. Workshop on Resistive Plate Chambers and Related Detectors

Report of Contributions

https://indico.gsi.de/e/662

Contribution ID: **0** Type: **not specified**

Performance of the ATLAS Resistive Plate Chambers

Tuesday, 9 February 2010 09:40 (20 minutes)

The ATLAS detector is now installed at CERN's LHC and fully operational. RPCs provide the first-level muon trigger and the measurement of the non bending coordinate in the barrel region. To achieve these goals, a system of about 4000 gas gaps operating in avalanche mode was built (resulting in a total of ~ 350000 readout strips).
Such a large-scale system allows the study of the performance of RPCs with unprecedented sensitivity to rare effects. On the other hand, a prerequisite for this kind of studies is the exact knowledge of the working point of the detector, and its uniformity along the whole muon spectrometer. This means fine-tuning thousands of parameters (involving both front end electronics and gap voltages), as well as constantly monitoring performance and environmental quantities such as gap/panel efficiencies, average cluster size, temperature, gas flow, gap currents, counting rates.
We will present here an overview of this effort and some example results, addressing in particular three aspects. First, the full exploitation of the high-precision tracking provided by ATLAS Monitored Drift Tubes when measuring the performance of the RPCs. Second, the use of a dedicated data stream to achieve the required statistics. Last, the central role of GRID facilities in providing the necessary computing resources.

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Presenter: Mr CATTANI, Giordano (Department of Physics, University of Rome "Tor Vergata", INFN Rome "Tor Vergata")

Session Classification: Status and performance of wide-gap RPC systems (I)

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

The CMS RPC project, results from 2009 cosmics data taking

Tuesday, 9 February 2010 10:00 (20 minutes)

The Resistive Plate Chambers are used in the CMS experiment as a dedicated muon trigger both in barrel and endcap system. About 4000 square meter of double gap RPCs have been produced and have been installed in the experiment since 2007. The full barrel system and a fraction of the endcaps have been extensively commisioned with milions of cosmic rays collected by the full CMS experiment. Making use of the redundant muon system composed by Drift Tube in the barrel and CSC in the endcaps that provide independent tracking and trigger informations, the performances of the RPCs have been studied in terms of efficiency, cluster size multiplicity, spatial resolution and trigger response. Moreover during the long period of detector operations the stability of the system has been monitored to study the dark currents and noise behavior as a function of time. First results obtained using the cosmic rays data taken during 2009 will be reported here.

Primary author: Mr CARRILLO, Camilo (Universidad de los Andes, Bogotá Colombia)

Presenter: Mr CARRILLO, Camilo (Universidad de los Andes, Bogotá Colombia)

Session Classification: Status and performance of wide-gap RPC systems (I)

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

Commissioning of the Resistive Plate Chambers for the ALICE muon arm

Tuesday, 9 February 2010 10:20 (20 minutes)

The trigger for the ALICE muon spectrometer will be issued by 72 single-gap, low resistivity bakelite RPCs, arranged in two stations of two planes each. The area covered by one plane is 5.5x6.5 m2. In order to operate RPCs both in streamer and avalanche mode, two dierent gas mixtures have been developed.
After installation in the ALICE experimental hall, the detectors have undergone a two year commissioning phase, both with cosmic rays and during early LHC operation, and they are now ready for physics data taking. The results of the commissioning both in streamer and avalanche mode will be presented, with particular regard to the RPC
performance in terms of eficiency, current and counting rate. The detector behaviour during the first physics run, expected by end 2009, will also be highlighted.

Primary author: Dr GAGLIARDI, Martino (INFN Torino)

Presenter: Dr GAGLIARDI, Martino (INFN Torino)

Session Classification: Status and performance of wide-gap RPC systems (I)

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

RPC based Muon Trigger Upgrade for the PHENIX Experiment at RHIC

Tuesday, 9 February 2010 10:40 (20 minutes)

The PHENIX experiment is located at the Relativistic Heavy Ion Collider at Brookhaven National Laboratory on Long Island, New York. RHIC collides heavy ion beams at energies up to sqrt(sNN) = 200 GeV and proton beams at energies up to sgrt(s) = 500 GeV.
One of the major physics goals at RHIC is the exploration of the origin of proton spin. RHIC provides the unique capability of accelerating polarized protons to high energies and makes it possible to study proton spin structure through polarized proton-proton collisions in the perturbative QCD region. In the future observation of inclusive lepton asymmetries from W-boson decays at sqrt(s) = 500 GeV will make it possible to measure flavor separated quark and anti-quark helicity distributions for the proton.
The current first level trigger of the PHENIX muon spectrometers does not have the capability to filter out high momentum muons from W-decays from the dominant background of low momentum muons resulting from hadron decay. An upgrade of the PHENIX first level muon trigger is underway and has the following two components:
1. The addition of fast trigger front-end electronics to the existing muon tracking system.
2. The introduction of bakelite double gas gap RPCs upstream and downstream of the existing muon detection system.
In combination, these upgrades will make it possible to select high momentum muon tracks from decays of W-bosons in the level-1 trigger. The RPC based new trigger will provide rejection against backgrounds from both beam and collision related by more than a factor 10000.
In this talk, we present the status of the PHENIX muon trigger upgrade including the status of the new muon tracker front-end electronics. We further present results from RPC prototypes operated during RHIC run 2009 and finally we report the progress made recently on the RPC detector assembly and installation.

Primary author: Dr KIM, Young Jin (University of Illinois at Urbana Champaign)

Presenter: Dr KIM, Young Jin (University of Illinois at Urbana Champaign)

Session Classification: Status and performance of wide-gap RPC systems (I)

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

Performance and aging of OPERA bakelite RPCs

Tuesday, 9 February 2010 11:30 (20 minutes)

OPERA is an experiment dedicated to the observation of numu into nutau oscillations through tau appearance on the CNGS beam. The experiment is composed by two identical super-modules, each with a target section (made of emulsion/lead bricks alternated to a scintillator Target Tracker) and a muon spectrometer (instrumented with bakelite RPCs and drift tubes).
The RPCs are operated in streamer mode with the gas mixture Ar/C2H2F4/isoC4H10/SF6=75.4/20/4/0.6.
The performances of the RPC system are presented. The sample of events induced by the CNGS neutrino beams as well as a large sample of cosmic rays have been used to study general properties of streamer-operated RPCs. The aging status of the detector, after four years of operation, is also described.

Primary author: Dr PAOLONI, Alessandro (Laboratori Nazionali di Frascati dell'INFN)

Presenter: Dr PAOLONI, Alessandro (Laboratori Nazionali di Frascati dell'INFN)

Session Classification: Status and performance of wide-gap RPC systems (II)

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

Performance of the RPC L1 Trigger during CRAFT09

Tuesday, 9 February 2010 11:50 (20 minutes)

During the months of july-september 2009 CMS has taken data from cosmic particles keeping the magnetic field on. This data taking was called Cosmics Runs At Four Tesla (CRAFT). CRAFT 2009 was a chance to measure the flexibility and the stability of the Level 1(L1) Trigger of RPCs . The Pattern Comparator (PAC) is the RPC L1 Trigger algorithm : during CRAFT it was modified in order to be better suited for cosmic muons. The efficiency of the RPC L1 Trigger was measured in the Barrel region of the CMS detector, and it was possible to make a local map of the trigger efficiency in this region. The efficiency was studied as a function of the transverse momentum of the particles. Also a study of the efficiency for the L1 Trigger logical sectors (towers) was made. Detailed results of the studies are reported.

Primary author: Dr IORIO, Alberto Orso Maria (Università degli studi di Napoli Federico II)

Presenter: Dr IORIO, Alberto Orso Maria (Università degli studi di Napoli Federico II)

Session Classification: Status and performance of wide-gap RPC systems (II)

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

RPC monitoring and results from the ARGO-YBJ experiment

Tuesday, 9 February 2010 14:50 (20 minutes)

The ARGO-YBJ air-shower array is composed of 1836 Resistive Plate Chambers operated instreamer mode, with a total sensitive area of about 6400 m2. The experiment, with its complete layout, has been running almost uninterruptedly since October 2007. The main working features of the detector, namely the operating current of each gas volume, atmospheric pressure, temperature and relative humidity, monitored by the Detector Control System, provide crucial information about the correct operation and long-term stability of the detector. The correlation between the average RPC absorption current and the monitored environmental parameters was studied in detail. The stable detector operation is allowing to obtain crucial results both in gamma-ray astronomy and cosmic-ray astrophysics.
The features of the detector operation and the main physics results from ARGO-YBJ are presented.

Primary author: Dr CAMARRI, Paolo (University of Roma "Tor Vergata" and INFN Roma Tor Vergata)

Presenter: Dr CAMARRI, Paolo (University of Roma "Tor Vergata" and INFN Roma Tor Vergata)

Session Classification: Status and performance of wide-gap RPC systems (III)

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

Design and Performance of the Detector Control System of the ATLAS RPC Muon Spectrometer

Tuesday, 9 February 2010 12:10 (20 minutes)

Muon detection plays a key role at the Large Hadron Collider. Resistive Plate Chambers (RPC) provide the barrel region of the ATLAS detector with an independent muon trigger as well as a twocoordinate measurement. The chambers, arranged in three concentric layers, are operated in a strong magnetic toroidal field and cover a surface area of about 4000 m2.
The RPC Detector Control System is required to monitor and safely operate tens of thousand of channels, which are distributed on several subsystems, including low and high voltage power supplies, trigger electronics, currents and thresholds monitoring, environmental sensors and gas and electronic infrastructure. The System is also required to provide a level of abstraction for ease of operation as well as specific tools allowing expert actions and detailed analysis of archived data. The hardware architecture and the software solutions adopted are shown in detail along with a few results from the comissioning and first running phases. The material presented here can be a base to future test facilities and projects.

Primary author: Dr POLINI, Alessandro (INFN Bologna)

Presenter: Dr POLINI, Alessandro (INFN Bologna)

Session Classification: Status and performance of wide-gap RPC systems (II)

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

ATLAS RPCs operation and performance tuning through the Detector Control System at the startup of 2009 LHC run

Tuesday, 9 February 2010 12:30 (20 minutes)

Detailed studies on the behavior of ATLAS RPCs have been performed during last year of commissioning by using cosmic rays data and the first proton-proton collisions at 450 GeV.
Detector parameters like the environment variables (temperatures, pressures, gas mixture) or other working parameters (high voltage levels, front-end discriminating thresholds, pull-down currents) have been used to optimize the efficiency and the stability of the system. The correlations of these parameters with gas gap currents and trigger rates are shown.
An overall status of the detector readiness and its performance at the start of 2009 LHC operation is presented. Data are compared with those from the previous year running conditions, focusing on the improvement of trigger tower coverage and on the overall functionality of the detector.

Primary author: Dr BINDI, Marcello (University and INFN of Bologna)

Presenter: Dr BINDI, Marcello (University and INFN of Bologna)

Session Classification: Status and performance of wide-gap RPC systems (II)

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

Offline monitoring and data quality of the ATLAS Resistive Plate Chambers at CERN Tier0 facility

Tuesday, 9 February 2010 12:50 (20 minutes)

Resistive Plate Chambers (RPC) were installed in the barrel region of ATLAS detector to provide the muon trigger (and a coarse measure of the "non-bending" phi coordinate) in the region |eta| < 1.05. The RPC are gaseous detector which measure the muon trajectory with 3 cm strips in the bending plane (r-z) and in the orthogonal direction (r-phi) with few nanoseconds time resolution. The trigger is done in both projections
and has a programmable threshold from about 5 to 20 GeV transverse momentum. A total of 596 RPC chambers were installed, arranged in three cylindrical layers. They cover an area of 3650 square meters and are equipped with 368000 read-out electronic channels. The monitoring and the control of such a large subsystem is crucial to maximize the physics reach of the experiment.
A dedicated tool was developed to perform the offline monitoring, to evaluate the quality of the RPC data and the detector performance. This tool is executed together with the reconstruction process at "Tier-0" CERN computer farm automatically at every run end. It provides detailed informations about the status of whole RPC subsystem and evaluates the relevant parameters for the detector operation like: the efficiency of strips and of single detectors part of a trigger tower, the noise rate, the cluster size and the space resolution, the time resolution and the coincidence timing.
In this work, after a description of the standalone monitoring code and the offline RPC data quality infrastructure, all the results of the monitoring will be reviewed. A detailed performance of ATLAS RPC subsystem will be presented using the large statistics of cosmic ray triggers collected during the commissioning period and first results with beam condition.

Primary author: Mr GUIDA, Angelo (INFN Lecce & Physics department of Salento University)

Presenter: Mr GUIDA, Angelo (INFN Lecce & Physics department of Salento University)

Session Classification: Status and performance of wide-gap RPC systems (II)

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

Commissioning and first operation experience of the CMS RPC Detector Control System at LHC

Tuesday, 9 February 2010 14:30 (20 minutes)

The CMS Resistive Plate Chambers (RPC) system consists of 912 double-gap chambers. The challenging constrains on the design and operation of this system imposed the development of a complex Detector Control System to assure the operational stability and reliability of a so large and complex detector and trigger system . The final layout and functionality of the CMS RPC DCS as well as the operational experience during the detector's commissioning and first phase of LHC operation are presented here.

Primary author: Dr POLESE, Giovanni (University of Bari)

Presenter: Dr POLESE, Giovanni (University of Bari)

Session Classification: Status and performance of wide-gap RPC systems (III)

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

Monte Carlo evaluation of CMS L1 muon trigger with p-p collisions using data-driven methods

Tuesday, 9 February 2010 15:10 (20 minutes)

The CMS muon system consists of three gaseous detectors with complementary features: the Drift Tubes chambers (DT) in the barrel and the Cathode Strips Chambers in the endcaps provide good spatial resolution and the Resistive Plate Chambers (RPC) have an excellent time resolution. These three detectors provide muon trigger for the hardware Level-1 trigger. The informations transmitted from the three subsystems are collected by the Global Muon Trigger board and merged according to a quite sophisticated algorithm. The GMT candidates are then transmitted to the Global Trigger board which performs the final L1 decision. By exploiting the GMT features a method for evaluating the RPC system trigger efficiency with data from p – p collisions has been developed. The GMT candidates containing RPC information are used for efficiency evaluation in two ways: on one hand using bare GMT candidates and on the other hand using the GMT candidates with DT measurement as seed for the muon system tracks reconstruction. Results and foreseen developments are hereby discussed.

Primary author: Ms SHARMA, Archana (Panjab University, Chandigarh)

Presenter: Ms SHARMA, Archana (Panjab University, Chandigarh)

Session Classification: Status and performance of wide-gap RPC systems (III)

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

Commissioning of the ALICE Muon Spectrometer Trigger at LHC

Tuesday, 9 February 2010 15:30 (20 minutes)

The forward Muon Spectrometer of the ALICE experiment aims at investigating the properties of strongly interacting matter at the extreme energy density reached in heavy ion collisions at LHC. The trigger system of the Muon Spectrometer, called Muon Trigger, consists of four planes of RPC (Resistive Plate Chamber) detectors with a total area of 140 m2, 21k frontend channels and fast-decision electronics. It is designed to reconstruct (muon) tracks, in a large background environment. A fast trigger decision, for both single-muons and dimuons, is delivered each 25 ns (40 MHz) with a total latency of about 800 ns. The Muon Trigger setup and design will be described. The performances, especially the ones related to trigger decision, obtained with dedicated test tools, cosmic rays and first beams will be presented.

Primary author: Mr BLANC, Aurelien (LPC, Clermont-Ferrand)

Presenter: Mr BLANC, Aurelien (LPC, Clermont-Ferrand)

Session Classification: Status and performance of wide-gap RPC systems (III)

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

Quality Control of RPCs for the PHENIX Trigger Upgrade

Tuesday, 9 February 2010 15:50 (20 minutes)

Many significant questions remain to be answered about the origin of the proton spin. A new fast Resistive Plate Chamber (RPC) based trigger system is being developed for the PHENIX muon spectrometer arms that will allow for the first time the measurement of the flavor structure of the quark polarization in the proton through the observations of W-bosons in polarized proton-proton collisions at the Relativistic Heavy Ion Collider (RHIC) at Brookhaven National Laboratory (BNL). The new PHENIX Muon Trigger will improve the efficiency by which the data acquisition system can identify potential W events by approximately two orders of magnitude. W-bosons can be detected through the appearance of a highenergy muon in one of the two existing muon spectrometers. The trigger upgrade is based on new front-end electronics for the muon tracking chambers and RPCs that will be installed in two stations of both muon arms. Components of the RPCs were fabricated at many different locations around the world. After they were shipped to BNL, these components are tested and then the RPC modules are constructed. Once assembled, these modules are extensively tested and jointed in half octant units for installation into the PHENIX spectrometer. Results from a series of quality control tests including tests on a cosmic test stand will be presented.

Primary author: Prof. TOWELL, Rusty (Abilene Christian University)

Presenter: Prof. TOWELL, Rusty (Abilene Christian University)

Session Classification: Status and performance of wide-gap RPC systems (III)

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

Calibration of the RPC charge readout in the ARGO-YBJ experiment

Tuesday, 9 February 2010 16:10 (20 minutes)

In the ARGO-YBJ experiment, the charge readout is performed on two Big Pads equipped in each RPC to measure the charged particle density of the shower front up to 104/m2, enabling the study of primaries with energies in the "Knee" region. It's the first time for RPCs being used this way. To calibrate the number of charged particles injected on one RPC versus its charge readout, a telescope is setup with RPCs to be calibrated and scintillation detectors to measure the number of injected charged particles. Shower secondary particles are taken as the calibration beam. The telescope was tested at sea level and then moved to ARGO-YBJ site for coincident operation with ARGO-YBJ experiment. The charge readout shows good linearity with the particle density in the dynamic range. Using the data of the ARGO-YBJ experiment, all the Big Pads can be calibrated relatively to that of the RPCs in the telescope, thus the absolute calibration is propagated to the whole array.

Primary author: Dr SHENG, Xiangdong (Institute of High Energy Physics, CAS, Beijing)

Presenter: Dr SHENG, Xiangdong (Institute of High Energy Physics, CAS, Beijing)

Session Classification: Status and performance of wide-gap RPC systems (III)

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

Oiled Multigap-Gap Resistive Plate Chambers for High-Rate Particle Triggers

Tuesday, 9 February 2010 17:00 (20 minutes)

We report a development of oiled multi-gap RPCs for high-rate particle triggers in high-energy physics experiments. RPCs with higher rate capability is promising, especially, for effective muon triggers at the RE1/1 region of the CMS in the LHC experiment. In this study, we designed and built two six-gap prototype RPCs made of 1-mm thick melamine-based high pressure laminated (HPL) resistive plate. Relatively low resistive HPL whose bulk resistivity is less than 10e11 Ωcm was chosen to enhance detection rate capability. The thickness of each gap of the prototype RPCs was 0.65 mm. The prototype RPCs were linseed-oil coated to suppress dark currents and spurious detector hits. The prototype RPCs were tested for cosmic rays and gamma rays to study the detector characteristics, i.e., efficiencies, charge distributions, cluster sizes, noise rates, and detection rate capability. Furthermore, the details for development of the HPL and the choice of the bulk resistivity are also discussed in this report.

Primary author: Prof. LEE, Kyong Sei (Korea University, Seoul)

Presenter: Prof. LEE, Kyong Sei (Korea University, Seoul)

Session Classification: R & D in wide-gap RPCs

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

Characterization of CMS end-cap RPCs assembled in India

Tuesday, 9 February 2010 17:20 (20 minutes)

The work presented here describes the characterization of double gap, bakelite RPCs for the end-cap region of the "Compact Muon Solenoid" experiment at LHC, which were built, assembled and tested in India, before their dispatch to CERN in 2008. These detectors consisted of eight of RE*/2 and two of RE*/3 type geometry for the CMS. The RE*/2 detectors had gas-gaps made at KODEL, Korea and the two RE*/3 detectors had gas-gaps, procured much earlier, from GT, Italy. We discuss the efficiency, leakage currents, strip profile and cluster size of these detectors as has been evaluated with the cosmic hodoscope at ISR Lab., at CERN, where all the eight RE*/2 RPCs qualified for the comic tests, thereby ascertaining the QA/QCs procedures followed during assembly at RPC Lab., at Nuclear Physics Division, BARC, Mumbai which is also geared up for the RPC upscope for CMS. Present developments such as an open loop gas recovery-recirculation system would also be discussed during the talk.

Primary author: Dr PANT, Lalit (BARC, Mumbai)

Presenter: Dr PANT, Lalit (BARC, Mumbai)

Session Classification: R & D in wide-gap RPCs

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

Production of Bakelite RPC Gas Gaps for the PHENIX Muon Trigger Upgrade

Tuesday, 9 February 2010 17:40 (20 minutes)

The muon trigger upgrade of PHENIX includes the construction and installation of resistive plate chambers (RPCs) in the forward muon spectrometers and to upgrade the frontend electronics of the existing muon tracking chambers.
About 300 gas gaps were produced, passed strict quality assurance procedures and are presently being assembled into RPC-1 and RPC-3 stations.Recently, the installation of station RPC-3 in the north muon arm has been completed.
Results from the strict quality assurance procedures for the RPC with linseed oil treatment will be presented. Together with the quality assurance data, we also present
a procedure to ensure the quality of the gas gaps.
Finally, the characteristics of the PHENIX RPCs in avalanche operation mode
will be compared with those of the double gap muon trigger RPCs developed for the CMS forward region.

Primary author: Prof. PARK, Sung (Korea University, Seoul)

Presenter: Prof. PARK, Sung (Korea University, Seoul)

Session Classification: R & D in wide-gap RPCs

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

Development of 2m x 2m size Glass RPCs for INO

Tuesday, 9 February 2010 18:00 (20 minutes)

The India-based Neutrino Observatory (INO) colllaboration is planning to build a massive 50kton magnetised iron calorimeter (ICAL) detector to study atmospheric neutrinos. About 30,000 2m x 2m size glass RPCs will be used as active detector elements. Starting with a small 30cm x 30cm size RPCs, we have now started developing full size 2m x 2m RPCs. The production method for this large size RPCs as well as their performance will be discussed in this paper.

Primary author: Mr BHEESETTE, Satyanarayana (TIFR, Mumbai)

Presenter: Mr BHEESETTE, Satyanarayana (TIFR, Mumbai)

Session Classification: R & D in wide-gap RPCs

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

Cosmic Ray test of INO RPC stack

Tuesday, 9 February 2010 18:20 (20 minutes)

The India-based Neutrino Observatory (INO) colllaboration is planning to build a massive 50kton magnetised iron calorimeter (ICAL) detector using glass RPCs as active detector elements. A stack of 12 such glass RPCs of 1m x 1m in area are tracking cosmic ray muons over the last two years. In this paper, we will review the performance of the RPCs using this cosmic ray data collected so far.

Primary author: Prof. MONDAL, Naba (TIFR, Mumbai)

Presenter: Prof. MONDAL, Naba (TIFR, Mumbai)

Session Classification: R & D in wide-gap RPCs

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

Performances of silicone coated high resistive bakelite RPC

Tuesday, 9 February 2010 18:40 (20 minutes)

High resistive bakelite RPCs, made with silicone compound coating, applied to the inner electrode surfaces, are studied in a cosmic ray test bench. The long term tests of the RPCs operated in streamer mode with gas mixture of Ar/isoC4H10/R-134a= 34/7/59 (mass ratio), show stable efficiency > 90% and time resolution ~ 2 ns (FWHM). Comparative studies of performance of the RPCs, made with different types of silicone coatings are done, and attempts are made to analyze the differences based on studies of various detector parameters. The same RPCs, when operated in avalanche mode, show efficiency > 95%. Charge spectra of the RPCs, operated in two different modes are also studied, and the results will be presented.

Primary author: Mr BISWAS, Saikat (VECC, Kolkata)

Presenter: Mr BISWAS, Saikat (VECC, Kolkata)

Session Classification: R & D in wide-gap RPCs

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

Welcome

Tuesday, 9 February 2010 09:00 (20 minutes)

Primary author: Prof. HERRMANN, Norbert (UNI Heidelberg)

Presenter: Prof. HERRMANN, Norbert (UNI Heidelberg)

Session Classification: Status and performance of wide-gap RPC systems (I)

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

Summary & Closing

Friday, 12 February 2010 12:50 (20 minutes)

Session Classification: Gas systems and ageing (II) and digital systems

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

The MRPC-based ALICE Time-Of-Fight detector: commissioning and first performance

Wednesday, 10 February 2010 09:00 (20 minutes)

The ALICE Time-Of-Flight (TOF) detector is a cylindrical array with a total area of around 150 m2 and more than 150000 readout channels, covering the whole barrel region; it will identify pions and kaons up to 2.5 GeV/c and protons up to 4 GeV/c extending the ALICE PID capabilities to higher momenta. This performance requires a total time resolution of about 100 ps which is achieved by means of the Multi-gap Resistive Plate Chambers (MRPC) able of an intrinsic time resolution smaller than 50 ps with an overall efficiency close to 100%.
The TOF detector is fully installed since April 2008 and it has successfully operated during cosmic-ray data taking, demonstrating a very good stability, noise level, time and track matching performance which will be presented.
Despite an optimal timing calibration demanding a channel-to-channel approach to derive single channel correction parameters will be achieved only with pp data, a very encouraging resolution of 130 ps on single-hit channel has been already obtained with cosmic data. The status of calibration and first-physics results with the TOF detector will be presented as well.

Primary author: Dr ALICI, Andrea (INFN Bologna and Physics Department of Bologna University)

Presenter: Dr ALICI, Andrea (INFN Bologna and Physics Department of Bologna University)

Session Classification: Status and performance of narrow-gap RPC systems

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

Multigap RPCs in the STAR Experiment at RHIC

Wednesday, 10 February 2010 09:20 (20 minutes)

A large-area (50 m^2) Time of Flight system has recently beeninstalled in the STAR Experiment at RHIC. The detectors are Multigap Resistive Plate Chambers (MRPCs) and are digitized using custom electronics based on the CERN "NINO" and "HPTDC" chips. Several different prototype systems were built and operated in STAR from
2003 to 2005. The design and performance of the prototypes, as well as the ~70%-installed final system during the 2009 RHIC Run, will be presented. A possible future upgrade to the STAR Experiment is the so-called Muon Telescope Detector (MTD). This system will use very large MRPCs with double-ended strip readout to identify the
muons that pass through steel backlegs of the STAR magnet. The design of this system, and the performance of MTD prototype systems in a test beam and in STAR during several RHIC runs, will also be presented.

Primary author: Prof. LLOPE, William J. (Rice University)

Presenter: Prof. LLOPE, William J. (Rice University)

Session Classification: Status and performance of narrow-gap RPC systems

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

RPC HADES-TOF wall cosmic ray test performance

Wednesday, 10 February 2010 09:40 (20 minutes)

In this work we present results concerning the ground-level cosmic ray test, prior to the final installation and commissioning of the new Resistive Plate Chamber (RPC) Time of Flight (TOF) wall for the High-Acceptance DiElectron Spectrometer (HADES) spectrometer at GSI [1].
The TOF wall is composed of six equal sectors, each one constituted by 187 individual 4-gaps glass-aluminum shielded RPC cells distributed in three columns and two partially overlapping layers, covering an area of 1.26 m2. All sectors were tested with the final FEE and DAQ described in [2], [3].
Results confirm a very uniform time response below 85 ps sigma, crosstalk on the few % level and moderate timing tails along with an average longitudinal position resolution better than 10 mm sigma.
[1] D. Belver, et al., The HADES RPC inner TOF Wall, NIMA Vol 602, Issue 3, 1 May 2009, 687-690.
[2] D. Belver, et al., Performances of the front-end for the HADES RPC TOF wall on a C12 beam, NIMA
Vol 602, Issue 3, 1 May 2009, 691-695.
[3] A. Gil et al., Journal of instrumentation 2007 JINST 2 T11001, (2007)

Primary author: Mr BLANCO CASTRO, Alberto (LIP-Coimbra)

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Session Classification: Status and performance of narrow-gap RPC systems

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

FOPI MMRPC ToF Barrel

Wednesday, 10 February 2010 10:00 (20 minutes)

We report on the performance of the FOPI Time-of-Flight (ToF) Barrel in a Heavy-Ion (HI) collision experiments. The Barrel is made out of Multi-strip Multi-Gap Resistive Plate Counters (MMRPC), where each counter has 16 strips with the pitch of 2.54 mm. Strips are 90 cm long and read out from both sides. With such system we have repeatedly obtain the ToF resolution better than 95 ps. The features of the narrow
multi-strip design are outlined, particularly in respect to the multi-hit detection performance.

Primary author: Dr KIŠ, Mladen (RBI Zagreb, UNI Heidelberg)

Presenter: Dr KIŠ, Mladen (RBI Zagreb, UNI Heidelberg)

Session Classification: Status and performance of narrow-gap RPC systems

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

Study of the cosmic data taken with the ALICE TOF detector at the LHC

Wednesday, 10 February 2010 10:20 (20 minutes)

The commissioning of the Time-of-Flight (TOF) detector of ALICE has been carried out and the apparatus is presently fully operational. With a high-statistics calibration the detector is expected to provide pi/K and K/p identification up to a momentum of 2.5 GeV/c and 4.0 GeV/c respectively for charged particles.
The Multigap Resistive Plate Chambers (MRPC) are the base element of ALICE TOF detector, that is composed of 18 "supermodules", each containing 1638 MRPC strips. Each strip has two rows of 48 pads.
A study of the pad clusters has been carried out: when a ionizing particle crosses the sensitive volume of the chambers, a set of neighbouring pads can catch a fraction of the avalanche charge.
The possibility to profit from this effect, in terms of time and geometric resolution, will be reported. Moreover a study of the cosmic muons distribution in the ALICE pit will be also shown.

Primary author: Dr DE GRUTTOLA, Daniele (University and INFN of Salerno)

Presenter: Dr DE GRUTTOLA, Daniele (University and INFN of Salerno)

Session Classification: Status and performance of narrow-gap RPC systems

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

Cosmic tests of the ALICE TOF system

Wednesday, 10 February 2010 10:40 (20 minutes)

Preliminary tests of the ALICE Time-Of-Flight (TOF) system components, built of numerous MRPC strips, were not possible with beam particles and extensively involved cosmic measurements. For this purpose, a Cosmic Ray Test Facility (CRTF) was specially constructed, built and put into action at CERN. It represents a two-layer telescope of Scintillation Tiles with MRS APD Light Readout, provides 100% detection efficiency for MIP and negligible intrinsic noise.
All ALICE TOF modules were tested and calibrated at CRTF before their installation into the ALICE experimental area, detected faults were repaired. The tests were performed with the final versions of electronics and software (mood, PVSS), currently used in ALICE. Subsequent measurements taken during commissioning of the ALICE TOF proved to be in good agreement with preliminary calibration at CRTF.
CRTF, or similar cosmic setup, can be used in the future for tests of large-scale TOF systems at CBM (FAIR) and MPD (NICA).

Primary author: Mr MALKEVICH, Dmitry (ITEP, Moscow)

Presenter: Mr MALKEVICH, Dmitry (ITEP, Moscow)

Session Classification: Status and performance of narrow-gap RPC systems

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

Progress of R&D and production of timing RPC in Tsinghua University

Wednesday, 10 February 2010 11:30 (20 minutes)

Multi-gap resistive plate chambers (MRPCs) are planar gaseous detector made with resistive electrodes. Such detectors have good time resolution, high efficiency and low cost. These excellent characteristics, as well as the possible coverage of large areas, made MRPCs favorite detectors for high-granularity large-area time of flight (TOF) systems in modern nuclear and particle physics experiments, such as ALICE, FOPI, HADES, HARP and STAR. Department of Engineering Physics of Tsinghua University is the collaboration member of RHIC-STAR and FAIR-CBM. We started to study MRPC technology from 1999. We developed a kind of six-gap (with 0.2mm gap width) MRPC for STAR-TOF. Its time resolution is about 70ps and detection efficiency is larger than 95%. A MRPC workshop was established at the Miyun production facility of Tsinghua University and 3100 MRPC modules were fabricated in last two and half years. In order to meet the rate requirement of CBM-TOF, we developed a kind of silicate glass with resistivity in the order of 10e10Ω.cm. High rate pad- and strip-readout MRPCs were also developed. The beam test results in GSI show that time resolutions below 85ps and efficiencies larger than 90% were obtained at counting rates up to 20 kHz/cm2. Our high rate MRPC is a good candidate used to construct high rate CBM-TOF system.

Primary author: Prof. WANG, Yi (Tsinghua University)

Presenter: Prof. WANG, Yi (Tsinghua University)

Session Classification: R & D in narrow-gap RPCs (I)

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

A prototype of high rate MRPC for CBM-TOF

Wednesday, 10 February 2010 11:50 (20 minutes)

The time-of-flight (TOF) system of CBM experiment is proposed to be assembled of multi-gap resistive plate chambers (MRPCs). This system should have a counting rate capability up to 20 kHz/cm2. Usage of low-resistivity glass is a promising way of improving the MRPC rate capability. To address this issue, we produced special silicate glass with bulk resistivity in the order of 10e10Ωcm and tested its long term stability. The thickness of the glass is 0.7mm and its largest dimension is 30cm×30cm. The 50cm×50cm glass will also be produced in about six months. A 10-gap (with 0.25mm gap width) MRPC prototype with silicate glass electrodes was developed for suitability in TOF applications at high rates. Beam tests at GSI have yielded inspiring results: Time resolutions below 85ps and efficiencies larger than 90% were obtained at counting rates up to 20 kHz/cm2. It can be seen that this detector is a good candidate for constructing the high rate CBM-TOF system.

Primary author: Dr WANG, Jingbo (Tsinghua University, Beijing)

Presenter: Dr WANG, Jingbo (Tsinghua University, Beijing)

Session Classification: R & D in narrow-gap RPCs (I)

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

Ceramics high rate timing RPC

Wednesday, 10 February 2010 12:10 (20 minutes)

For the most forward, high rate environment, region of Compressed Baryonic Matter experiment at the future Facility for Antiproton and Ion Research in Darmstadt the installation of timing Resistive Plate Chambers (RPC) is under consideration. Prototype timing RPCs have been developed at Forschungszentrum Dresden-Rossendorf (FZD).
RPC electrodes with volume resistivity of about 10^9 Ω·cm are preferred for high rate capability purposes. After few years of investigations with different electrode materials (e.g. plastics with nano-fillers, semiconducting glasses) special ceramics composites have been developed and processed.
The prototype with a dimension of the ceramics electrodes of 10x10 cm2 has been exposed at the electron accelerator ELBE at FZD with 32 MeV single-electron beam pulses. The flux of the primary beam is tunable from few electrons/s to 10^7 electrons/s. The exposed region amounts to about 10 cm2.
A careful analysis of the results allows a continuous improvement of the ceramics RPC properties. During an exposition in September 2009 it appeared that the ceramics RPC shows an all-time high rate capability for resistive plate counters.
The efficiency of the four-gap device with 300 μm gas gap width amounts to 95% for fluxes up to 5x10^5 s-1·cm-2. The time resolution is independent for fluxes up to 10^5 s-1·cm-2 and amounts to about 100 ps.

Primary author: Dr NAUMANN, Lothar (FZD, Dresden-Rossendorf)

Presenter: Dr NAUMANN, Lothar (FZD, Dresden-Rossendorf)

Session Classification: R & D in narrow-gap RPCs (I)

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

Understanding the ageing process in RPC materials from an ion conductivity approach

Wednesday, 10 February 2010 12:30 (20 minutes)

Resistive Plate Chambers operating at high particle fluxes require the use of materials with a specific set of properties. At present it is believed that the dominant effect, for the case of sustained and homogeneous irradiation, is caused by the product of the plate thickness (d) times its resistivity (r) times the average charge per gap (q), as expected from the dynamic ohmic drop in a simple (stationary) DC model of the device
as a whole. The first variable is much dominated by mechanics requirements and it is in fact changing little in typical designs, the latter is roughly fixed once the working mode is decided, so in practice one is left with only one parameter free for optimisation, the plate resistivity, that should fullfill the approximate phenomenological relation (F·r)<1-5 for timing RPCs, in order not to deteriorate the detector performances (F is the particle flux given in kHz/cm2 and r the resistivity in TWcm). Coping with particle fluxes as high as 20 kHz/cm2, as intended in the future CBM experiment at FAIR, will therefore require to work with materials having resistivities in the range r=0.05-0.25 TWcm or lower. It is, however, difficult to find 'well-behaved' materials in this range. For such purpose ceramic/metal composites have been essayed. Several electric measurements have been done on this system such as I/V curves, impedance spectroscopy and ageing, and we have found evidences of ion conductivity at high values of the electric field. In this sense, the RPC plates under high irradiation have been compared with the electrical response of a classic solid electrolyte in order to understand the ageing phenomena. Thus, simple estimations can be made for determining the maximum RPC working time before instabilities related to electrochemical breakdown appear. Several solutions will be proposed in order to span the RPC lifetime.

Primary author: Mr MORALES, Miguel (University of Santiago de Compostela)

Presenter: Mr MORALES, Miguel (University of Santiago de Compostela)

Session Classification: R & D in narrow-gap RPCs (I)

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

Quantification and inhibition of the gas polymerization process in timing RPCs

Wednesday, 10 February 2010 12:50 (20 minutes)

Aging of glass RPCs has been extensively studied over the last years, with most authors referring effects such as an increase of dark counting rate, reduction of the counter efficiency and the appearance of deposits over the electrodes surfaces.
Previous studies have shown that the deposit on both glass electrodes (cathode and anode) is essentially formed by olygomers of tetrafluoroethylene and its derivatives [1]. Knowing the nature of the deposit, the next logical step, and the aim of this study, is to find the conditions to minimize or eliminate the formation of the deposit. This requires inevitably the quantification of the deposit in order to properly evaluate the success of the variations to be introduced in the gas mixture composition
The majority of the known processes of polymerization of ethane derivatives have an initiation step for the formation of the reactive species that catalyse the polymerization. The addiction of chemical species that react with the reactive species more efficiently than tetrafluoroethylene - inhibitors of polymerization - could be the most effective way to eliminate the formation of the deposit.
In this work will be presented studies about the methodology for the quantification of the deposit, the relationship with the experimental conditions used in the operation of the detector (drawn current and integrated charge), and the advances in the use of polymerization inhibitors to avoid the formation of the deposits.
[1] S. Gramacho et al., A long-run study of aging in glass timing RPCs with analysis of the deposited material, Nucl. Instrum. and Meth. in Phys. Res. A 602 (2009) 775-779

Primary author: Ms GRAMACHO, Sílvia (LIP-Coimbra)

Presenter: Ms GRAMACHO, Sílvia (LIP-Coimbra)

Session Classification: R & D in narrow-gap RPCs (I)

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

Toward a high granularity, high counting rate, differential read-out RPC

Wednesday, 10 February 2010 14:30 (20 minutes)

Next generation of experiments like CBM at FAIR will be confronted with the selection of rare probes in high multiplicity environment at collision rates up to 107 events/sec. Hadron identification in such a limiting environment is a real challenge and requires intensive R&D activity for developing high resolution and high granularity timing detectors at affordable cost. Recently, significant achievements in developing symmetric, multi-gap, multi-strip RPC architecture for high counting rate experiments using low resistivity glass electrodes, differential read-out and high granularity structures, were obtained. Results based on radioactive sources and in-beam tests will be presented.

Primary author: Dr PETRIS, Mariana (NIPNE, Bucharest)

Presenter: Dr PETRIS, Mariana (NIPNE, Bucharest)

Session Classification: R & D in narrow-gap RPCs (II)

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

The CBM Time-of-Flight wall

Wednesday, 10 February 2010 14:50 (20 minutes)

The Compressed Baryonic Matter spectrometer (CBM) is expected to be operational in year 2015 at the Facility for Anti-proton and Ion Research (FAIR) in Darmstadt, Germany. The spectrometer aims at systematically studying rare and bulk probes stemming from heavy ion reactions in the energy regime 2-90GeV, in order to precisely characterize the phase diagram of nuclear matter and eventual first or second order phase-transitions. The key element providing hadron identification is a Time-of-Flight wall placed at 10m, with a polar angular coverage [2.5-25deg] and full azimuth. The necessary particle Id capabilities require of 80ps system resolution at high efficiency.
For the time being, the most promising technological solution consists on a 150m2 carpet based on Resistive Plate Chambers. The existing conceptual design foresees two well defined regions: while the outer-most part can be probably covered with standard float glass RPCs in multi-strip fashion, the central region will consist of densely packed read-out cells (either strips or pads) made of low resistive electrodes. The CBM-TOF wall will therefore consist of the largest multi-strip RPC system used for timing world-wide and, simultaneously, the one with the highest rate capability so far (20 kHz/cm2).
We will present comprehensively the behavior as a function of the rate for various prototypes, where we have observed an approximate 1/(rho d) scaling of their rate capability, as arises from a simple DC modeling of the
counter. Additionally, a large number of multi-strip designs, with lengths ranging from 0.25-1m have been tested with optimized designs under realistic conditions. We will show how cross-talk can be minimized and multi-hit performance ensured by convenient design choices.

Primary author: Mr DEPPNER, Ingo (Universität Heidelberg)

Presenter: Mr DEPPNER, Ingo (Universität Heidelberg)

Session Classification: R & D in narrow-gap RPCs (II)

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

Progress in the simulation of Resistive Plate Chambers with multi-strip read-out

Wednesday, 10 February 2010 15:10 (20 minutes)

RPCs in Multi-strip fashion are widely regarded as very convenient designs for covering large areas under low track multiplicities. It will be shown, from the perspective of Multi-gap structures and high accuracy timing, how the strip impedance, weighting field profile and cross-talk are very important limiting factors of this kind of designs. Comparison of avalanche simulations with published data will be presented, aiming at emphasizing and illustrating the above-mentioned effects. Recent results from optimized Multi-strip structures will be presented to show how these potentially 'limiting factors' can be minimized or even virtually suppressed by convenient choices.

Primary author: Dr GONZALEZ-DIAZ, Diego (GSI Darmstadt)

Presenter: Dr GONZALEZ-DIAZ, Diego (GSI Darmstadt)

Session Classification: R & D in narrow-gap RPCs (II)

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

NeuLAND: MRPC-based time-of-flight detector for 1 GeV neutrons

Wednesday, 10 February 2010 15:30 (20 minutes)

The NeuLAND detector at the R3B experiment at FAIR aims to detect fast neutrons (0.2-1.0GeV) with high time and spatial resolutions (sigma_t<100 ps, sigma_x,y,z<1 cm). The detector will consist of about 60 subsequent MRPC stacks containing a 4mm thick anode made of iron converter material, with an additional 4mm of converter material between two stacks. The secondary charged particles stemming from hadronic
interactions of the high energetic neutrons in the converter will be detected in the MRPC's.
As part of the ongoing development effort, at FZD and GSI a number of prototypes for this detector have been developed and built. By testing these prototypes in experiments with picosecond electrons at ELBE (Dresden, Germany) and with 175 MeV quasi-monochromatic neutrons at TSL (Uppsala, Sweden) it was shown that the working principle is sound.

Primary author: Dr BEMMERER, Daniel (FZD, Dresden-Rossendorf)

Presenter: Dr BEMMERER, Daniel (FZD, Dresden-Rossendorf)

Session Classification: R & D in narrow-gap RPCs (II)

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

Development of MMRPC prototype for R3B, FAIR

Wednesday, 10 February 2010 15:50 (20 minutes)

R3B, FAIR collaboration aims to measure four momentum vectors of kinematical complete reaction products from relativistic radioactive nuclei. To achieve energy resolution around 50 KeV (dE<50 KeV) for invariant mass of exotic nuclei above neutron threshold, a high energy neutron detector (1Gev<=En=>200MeV) with very good timing resolution (Dt~100 ps) and position resolution (Dx, Dy, Dz ~1 cm) will be necessary. As an active part of the detector, scintillators with PMT is an easy solution but more economic and useful solution is multi-gap resistive plate chamber (MRPC).
At SINP, Kolkata, we have developed multistrip two/four gap glass RPC (MMRPC). We would like to present details of the designing and development of MMRPC (20cmx40cm) and its performance in comparison with scintillators using gamma source and cosmic background. We want to present also preliminary plan for the design of FPGA based embedded system for the readout controller circuit for Neuland MRPC. We want to discuss about our R&D for RPC gas recovery system by open loop method.

Primary author: Prof. DATTA PRAMANIK, Ushasi (Saha Institute Of Nuclear Physics, Calcutta)

Presenter: Prof. DATTA PRAMANIK, Ushasi (Saha Institute Of Nuclear Physics, Calcutta)

Session Classification: R & D in narrow-gap RPCs (II)

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

Some results of the R&D of a ToF-Wall to identify relativistic ions

Wednesday, 10 February 2010 16:10 (20 minutes)

The detection setup of the R3B experiment in the FAIR facility includes time of flight (ToF) walls, dedicated to the isotopic identification of ions of any charge and mass at energies of some hundreds AMeVs. The experiments related to heavy ions require large active surfaces and a very demanding time resolution (<50 ps) for the ToF detectors in order to accomplish with their duties with reasonable flight-paths (up to 20m).
It was proposed rather early that timing-RPCs could provide an adequate solution for this detector [1]. Although the time-resolution provided by deployed tRPCs (HARP, ALICE, FOPI, HADES) can reach values well below 80 ps, they were developed and used only for MIPs. In that sense, it was clear that an important effort of R&D is needed for both, adapting the materials and geometry to heavy ions, and also to study the large dynamic-range that is expected that ions will impose to the detectors.
Only very recently it has been demonstrated [2] that typical RPC cells can perform rather well with ions up to Z=6 keeping their extreme timing properties, up to moderate rates.
In this work we show our progress in the construction of RPCs suitable to the detection of heavy ions in conditions as those of the R3B environment. We used beams at GSI of C, but also of Ni and a fragments of U. Here we show results of successful measurements in a wide range of charges, or equivalently in wide range of energy depositions, which confirm the suitable use of RPCs in what concerns efficiency, and detector and electronics stability. We also show the electronics solutions we propose after our own R&D, and perspectives to achieve an optimum time resolution adapted to R3B needs.
[1] Nuc. Phys. B 158 (2006) 186
[2] JINST 4 P11007 (2009)

Primary author: Dr CASAREJOS, Enrique (Universidad de Vigo)

Presenter: Dr CASAREJOS, Enrique (Universidad de Vigo)

Session Classification: R & D in narrow-gap RPCs (II)

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

Advanced diamond materials for timing applications

Thursday, 11 February 2010 10:40 (20 minutes)

Recent progress in the production of high-quality 'electronic grade' diamond materials by Chemical Vapour Deposition (CVD) processes enables the development of timing detectors for charged particles of unprecedented time resolution and rate capability. We present the characteristic properties of the three most relevant undoped diamond types for detector applications, which are single crystal CVD diamond plates (scCVDD) grown homoepitaxially on high-quality diamond substrates (produced by High-Pressure-High-Temperature (HPHT) processes), polycrystalline CVD diamond samples grown on silicon (pcCVDD), and 'quasi singlecrystal' Diamond films grown by heteroepitaxy on Iridium wafers (DoI). The thickness of the samples is adjustable between ~ 10 and several hundreds of micrometers.
The dark conductivity of the different diamond materials is correlated to the structural bulk defects as well as to the morphology and roughness of the diamond surfaces, which influence in addition significantly the internal electric field profile of the sensors. The potential of the diamond crystals for timing or/and spectroscopy applications is evaluated by the analysis of the transient current signal shapes generated by short range 241Am particles readout with the Diamond Broadband Amplifiers (DBA) developed at GSI for heavy-ion detection with diamond detectors.
The Charge-Collection Efficiency (CCE) and the corresponding Collection Distance (CD) is measured with high-resolution (silicon) spectroscopy amplifiers developed at the Technical University of Darmstadt (CSTA2 preamplifiers) followed by commercial standard nuclear electronics.
Time resolution data are presented, which have been obtained with scCVDD and pcCVDD sensors readout with different new FEE designs developed from the HADES, the FOPI, and the CBM Collaborations at GSI. A variety of heavy and light ion probes as well as relativistic protons have been used at the SIS of GSI. All data presented are limited by the electronic noise. The best relativistic heavy-ion
result (si = 25ps) has been achieved with 'as grown = unpolished' pcCVDD
detectors of 100 mm thickness readout with a broadband amplifier and discriminator card FEE1 (FOPI), whereas the highest resolution for relativistic protons has been obtained from scCVDD sensors of 400mm thickness readout with a low capacitance
setup (HADES). Preliminary results of a beam test with 6Li ions of 2 AGeV using the latest setup with 100 mm thick diamonds have shown an intrinsic diamond time resolution of 20ps.

Primary author: Mrs BERDERMANN, Elèni (GSI Darmstadt)

Presenter: Mrs BERDERMANN, Elèni (GSI Darmstadt)

Session Classification: New applications

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

A study on the spatial resolution of human RPC-PET

Thursday, 11 February 2010 09:00 (20 minutes)

The Resistive Plate Chamber (RPC) concept for time of flight positron emission tomography (RPC-PET) is based on the converter-plate gamma detection principle and takes advantage of the naturally layered structure of RPCs, of its simple and economic construction, excellent time resolution and very good intrinsic position accuracy. These characteristics may be of interest for the detailed imaging of small animals and for high-sensitivity whole-body human TOF PET.
In this work we address the spatial resolution characteristics of a hypothetical full-body RPC-PET system by simulations performed in GEANT4. Several parameters affecting the spatial resolution are accessed: positron range, photon pair non-collinearity, scatter in the detector, parallax errors introduced by the electrons in the gas gap, depth of interaction and detector readout granularity.

Primary author: Mr COUCEIRO, Miguel (LIP Coimbra)

Presenter: Mr COUCEIRO, Miguel (LIP Coimbra)

Session Classification: New applications

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

Study on the Performance of Large Area MRPC with High Position Resolution

Thursday, 11 February 2010 09:20 (20 minutes)

Multi-gap Resistive Plate Chamber(MRPC), which is first developed in high energy physics experiments with excellent time discrimination, is also highlighted in imaging applications. In our lab a set of 50cm×50cm MRPCs were successfully developed and several experiments have been done to test the performance. Cosmic ray muons were used and proper high voltage and operating gas were chosen. Data analysis indicates good detection efficiency and good position resolution, which encourages further study of its application in RPC-PET and muon tomography.

Primary author: Prof. YUE, Qian (Tsinghua University, Beijing)

Presenter: Prof. YUE, Qian (Tsinghua University, Beijing)

Session Classification: New applications

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

Resistive Electrode Approach in Micropattern Gaseous Detectors

Thursday, 11 February 2010 09:40 (20 minutes)

Recently developed micropattern gaseous detectors offer high position resolution, excellent rate characteristics and good time resolutions. However the fine structure of their metallic electrodes makes them very fragile and easily destroyable by occasional sparks.
Our presentation will consist from two parts. In the first one we will review the latest efforts made from various groups to implement the resistive electrode approach to micropattern detectors technology with the aim to make these detectors similar to RPCs. The first of such successive attempts was made a few years ago by our team to GEM detector and several groups nowadays are experimenting in manufacturing and testing resistive GEMs made of different materials. Recently, a great success was also achieved in the case of MICROMEGAS detectors especially with its Ingrid and Gossip versions in which the anode plates together with the readout micropixels were coated with a SiO2 protective resistive layer. Currently in the framework of the RD51 collaboration several groups are developing conventional type MICROMEGAS with resistive anodes made of different materials and performing their beam test.
In the second part our talk we will present a novel detector developed in the stream of these studies. It is a hybrid of RPC made by a parallel-plate avalanche chamber: a microgap gaseous detector with a resistive drift mesh and a resistive anode plate with outer metallic readout strips. The version with a fine pitch (50μm) strips located inside the anode gap was also successfully tested. The analysis shows that the latest design has a potential for an extremely good position resolution especially in the case of narrow drift gap. The new detector enables to considerably extend the RPC application since it features not only a high position resolution, but also a rather good energy resolution (18-20%FWHM for 6 keV) and if necessary can operate in cascaded mode. We will also report on our efforts to develop a much thinner resistive mesh which can be used in MICROMEGAS as well as in other micropttern detectors.
The main conclusion from these works is that a resistive electrode approach applied to micropattern detectors makes them fully spark protected and thus we consider this direction as very promising.

Primary author: Prof. PESKOV, Vladimir (CERN, Geneva)

Presenter: Prof. PESKOV, Vladimir (CERN, Geneva)

Session Classification: New applications

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

Construction of a Digital Hadron Calorimeter with Resistive Plate Chambers

Thursday, 11 February 2010 10:00 (20 minutes)

We report on the development of a Digital Hadron Calorimeter (DHCAL), built with
Resistive Plate Chambers (RPCs) and 1 x 1 cm^2 readout pads as the active medium, for use in a detector optimized for the application of Particle Flow Algorithms to the measurement of jet energies.
We present the concept and design of a DHCAL and report on the progress in constructing a prototype DHCAL which is about one cubic meter in size. This prototype will contain ~ 40 layers and the total number of channels will be close to 400,000. The RPC and readout system construction and tests are on going now, and we plan to finish construction in Spring 2010. The prototype DHCAL will be tested extensively at Fermilab MTBF.
In order to prepare the operation of a large system that consists of ~120 RPCs, we also tested the RPC performance (efficiency, MIP multiplicity and noise rate) as a function of environmental parameters (temperature, pressure and humidity) and gas flow rate. This result will be presented, and has been submitted to JINST for publication.

Primary author: Dr XIA, Lei (ANL, Chicago)

Presenter: Dr XIA, Lei (ANL, Chicago)

Session Classification: New applications

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

Tests of a Digital Hadron Calorimeter with Resistive Plate Chambers

Thursday, 11 February 2010 10:20 (20 minutes)

In the context of developing a hadron calorimeter with extremely fine granularity (for the application of Particle Flow Algorithms to the measurement of jet energies at a future lepton collider), we report on extensive tests of a small scale prototype calorimeter. The calorimeter contained up to 10 layers of Resistive Plate Chambers with 2560 1 x 1 cm^2 readout pads, interleaved with absorber plates. The tests included the response to broadband muons and to positrons and pions in the energy range of 1 to 16 GeV. Detailed measurements of the chambers efficiency as function of beam intensity have also been performed. The data are compared to simulations based on GEANT4 and to analytical calculations of the rate limitations.
The results of these tests have been published as four separate papers in JINST (see B.Bilki et al.).

Primary author: Dr REPOND, Jose (ANL, Chicago)

Presenter: Dr REPOND, Jose (ANL, Chicago)

Session Classification: New applications

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

Time structure measurement of the ATLAS RPC gap current

Thursday, 11 February 2010 12:30 (20 minutes)

The current absorbed by an RPC represents the sum of the charge delivered in the gas by the ionizing events interesting the gap, integrated by the electrodes time constant.
This is typically of the order of tens of ms thus dominating the gas discharge time scale and characterizing the granular structure observed in the current signal.
In most cases this structure is considered as noise to be further integrated to observe the average gap current, used often as a detector monitoring parameter or to precisely measure the uncorrelated background rate effects. A remarkable case is given if a large number of particles is passing trough the detector within an integration time constant producing a current peak clearly detectable above the average noise. The ATLAS RPC system is equipped with a dedicated current monitoring based on an ADC capable of reading out the average value as well as the transient peaks of the currents above a given threshold. A study on such data was used to spot the gap HV noise, to monitor the cosmic rays shower multiplicity and to detect the LHC splash events and provide additional analogical information when the event multiplicity exceeded the number of available strips in the digital readout.
The first results of this technique are here presented along with the strategy to improve the performance in terms of readout speed and signal to noise ratio.

Primary author: Dr AIELLI, Giulio (University and INFN of Roma "Tor Vergata")

Presenter: Dr AIELLI, Giulio (University and INFN of Roma "Tor Vergata")

Session Classification: Simulations and fundamentals

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

RPC Performances versus Front-End Electronics

Thursday, 11 February 2010 11:50 (20 minutes)

The performances of RPCs are strictly correlated with the FE Electronics parameters.
The prompt charge signal, picked-up on read-out electrodes, has shape and amplitude which depend on the gas mixture, on the applied electric field and on the gas gap width.
The best working point of the detector, which minimize the aging and optimize the time resolution, efficiency and rate capability, is strongly dependent on the characteristic of the FE Electronics project.
In this work we will present an overview of the correlations between the detector and FE performances. In particular a new FE design is presented with first results of it's application.

Primary author: Dr CARDARELLI, Roberto (INFN "Tor Vergata")

Presenter: Dr CARDARELLI, Roberto (INFN "Tor Vergata")

Session Classification: Simulations and fundamentals

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

A Monte Carlo simulation to study the surface roughness effect on RPC performance

Thursday, 11 February 2010 12:10 (20 minutes)

The roughness of the inner surface of resistive plates plays an important role on the performance of RPC. A Monte Carlo simulation method has been developed for the trigger RPC operating in avalanche mode.
Propagation of charged particles through the RPC gas, generation of electrons and their multiplication as well as the saturation and induction [1] are implemented. Experimental data will be compared with the Monte Carlo results.
We have developed a model to simulate the surface roughness with varying degree and their effect on the electric field inside the RPC volume. The influence of surface roughness on the efficiency and time resolution will be presented.
1.Werner Riegler et al., NIM A 500 (2003) 144.

Primary author: Ms GHOSH, Tapasi (VECC, Kolkata)

Presenter: Ms GHOSH, Tapasi (VECC, Kolkata)

Session Classification: Simulations and fundamentals

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

RPC Simulation in Avalanche and Streamer Modes Using Transport Equations for Electrons and Ions

Thursday, 11 February 2010 11:30 (20 minutes)

Simulation of development of a signal in an RPC is presented using simultaneous solution of transport equations for electrons, negative and positive ions. The model also includes space charge effect of all charged particles by Poisson equation. The equations are numerically solved using the Lax finite difference scheme. The simulation can well produce three modes of operation of RPC, i.e. avalanche mode, saturated avalanche, and streamer mode. Especially, the reality of Raether limit as the indication of transition from avalanche to streamer mode operation is also investigated by the simulation. In the streamer mode operation, it is shown that the space charge field can be high enough to completely distort the external electric field of the electrodes. In this case, the simulation shows that the streamer signal is basically originated from the growth of electrons and positive ions inside the gap and the development of negative ions is not so important. Accordingly, in the development of the streamer signal, the number densities of electrons and positive ions inside the gap are very similar to each other.

Primary author: Dr MOSHAII, Ahmad (Tarbiat Modares University)

Presenter: Dr MOSHAII, Ahmad (Tarbiat Modares University)

Session Classification: Simulations and fundamentals

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

TimTrack A new algorithm for the tracking of particles with timing detectors

Thursday, 11 February 2010 12:50 (20 minutes)

TimTrack is a tracking algorithm to be used with timing detectors, being specially suitable to work with timing RPCs or fast scintillators. It is being developed in the framework of the Trasgo (TRAck reconStructinG mOdule) project aiming the development of a detector able to work stand-alone with full tracking and timing capabilities.
TimTrack works directly with the primary information provided by the detectors, either coordinates or time, without any time to coordinate reduction. All the detectors must be synchronized and refered to the same zero time.
The algorithm estimates sets of six parameters of the particles: 2 coordinates, 2 slopes, the velocity and the time at a given reference plane. This set of parameters, called SAETA (SmAllest sEt of daTA), is the basic unit of the method. It provides also the complete variance-covariance matrix with 21 independent coefficients allowing a very accurate statistical analysis of the results both for track quality test and for the efficient rejection of outliers.
For most of the more common timing detector layouts TimTrack leads to linear equations allowing to use a very simple matrix formalism providing a very fast solution. In this cases, a saeta s may be obtained directly from the measured through an equation of the type:
s = K^-1 a
where K is a 6x6 matrix (called configuration matrix) that depends only on the detector layout) and a is a 6 dimension vector that can be obtained as a linear combination of the measured data.
The matrix formalism is very easy to be implemented in some kind of electronic components or embedded processor placed in an acquisition board offering online timing and tracking abilities.
The analytical solutions for several layouts of detectors together with their numerical results will be given.

Primary author: Prof. GARZON, Juan A. (University of Santiago de Compostela)

Presenter: Prof. GARZON, Juan A. (University of Santiago de Compostela)

Session Classification: Simulations and fundamentals

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

A new approach in modeling the response of RPC detectors

Friday, 12 February 2010 09:00 (20 minutes)

The response of RPC detectors is highly sensitive to environmental parameters. A novel approach is presented to model the response of RPC detectors in a variety of experimental conditions.
The algorithm, based on neural networks, has been developed and tested on the CMS RPC gas gain monitoring system during operation at the scaled-down
prototype recirculation gas system.

Primary author: Mr COLAFRANCESCHI, Stefano (INFN-LNF, Frascati)

Presenter: Mr COLAFRANCESCHI, Stefano (INFN-LNF, Frascati)

Session Classification: Gas systems and ageing (I)

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

Results from the PHENIX RPC R&D and Long-Term Performance Monitoring

Friday, 12 February 2010 09:20 (20 minutes)

A new Resistive Plate Chamber (RPC) based fast muon trigger system has been developed and partially installed in the PHENIX experiment. This new trigger will allow the PHENIX data acquisition system to efficiently sample high pT (> 20 GeV/c) muons from W decays in polarized proton+proton collisions at ps = 500 GeV at the Relativistic
Heavy Ion Collider at Brookhaven National Laboratory. This measurement will significantly improve our knowledge of flavor separated quark and anti-quark polarization in the proton.
Over the past four years, a multi institutional effort within the PHENIX Forward Trigger
group was devoted to study the properties and performance of bakelite RPCs. In the
presentation, the results of the PHENIX RPC R&D will be reported.

Primary author: Prof. HE, Xiaochun (Georgia State University)

Presenter: Prof. HE, Xiaochun (Georgia State University)

Session Classification: Gas systems and ageing (I)

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

Aging Study for BESIII-type RPC and New development of Bakelite electrode

Friday, 12 February 2010 09:40 (20 minutes)

Following the invention of the Resistive Plate Chamber (RPC) more than 29 years ago1, RPC systems with two major types of Bakelite electrodes have been used in L3 and BaBar, and are presently being used by CMS, ATLAS, STAR, ALICE ToF, and a variety of cosmic ray and neutrino experiments, such as ARGO-YBJ, OPERA and Daya Bay.
In recent years the BESIII Muon group of IHEP (Beijing), together with Gaonengkedi, Inc. (Beijing), have developed a new type of Bakelite, used in the BES III2 and Daya Bay Muon Systems, that does not require linseed-oil treatment for the RPCs to achieve acceptably low dark-noise rates. These RPCs are operated in streamer mode in their present applications. The ILC Hadron Calorimeter and Muon Detector System have expressed strong interest in adopting this technology for their active detector candidate. However, aging of the BESIII-type RPCs has not been thoroughly studied, and there is no published report available on this topic.
Here, we summarize some preliminary aging studies of BESIII-type RPCs to be used in the Daya Bay Muon System. The test results indicate a significant aging effect that must be understood and mitigated prior to use of this technology in accelerator experiments, where the background particle rate is not negligible.
Detailed microscopic study on the surface morphology of the Bakelite electrodes before
and after the aging clearly reveal the direct evidence of HF corrosive action on the white surface of BESIII-type Bakelite electrodes. Although such corrosive action has been suspected for several years, the linseed-oil coating on the dark-colored and/or marble-patterned Italian Bakelite surfaces has made optical microscopic study of the surface morphology difficult.
Our study confirms the role of linseed-oil coating in protecting Bakelite from HF etching. To suppress the aging of future BESSIII-type RPCs, a new procedure to integrate a linseed oil coating into the Bakelite production is being developed3, and the aging performance of samples of this new form of Bakelite is under intensive test. In this report a brief summary of these tests, and further R&D plans, will be presented.
1 R. Santonico and R. Cardarelli, Developemnt of Resistive Plate Counter, NIM 187 (1981) 377
2 J. Zhang et al., Nucl. Instr. and Meth. A 540 (2005) 102
3 This new material is produced by Xianhu Construction Material, Inc. Beijing.

Primary author: Mr LU, Changguo (Princeton University)

Presenter: Mr LU, Changguo (Princeton University)

Session Classification: Gas systems and ageing (I)

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

Decomposition and Removal of Effluent Freon-SF6 Mixture by RF Plasma

Friday, 12 February 2010 10:00 (20 minutes)

The efficiency of recovery achieved by open or closed loop extraction of RPC exhaust gases is in the range of 90% to 95% under optimum conditions. For a large detector setup operating on one volume change per day basis, a 5% loss amounts to discharging 50 kg of R134a and 0.5 kg of SF6 into atmosphere every day. The emissions are equivalent to creating nearly 50,000 m3 of Carbon dioxide daily. Gas emissions need to be completely converted to safer compounds. Gases such as R134a and SF6 are stable compounds. In order to decompose them, the mixture is first activated by adding of 50% oxygen and 2% Argon and under typical RF plasma conditions of 13.56 MHz., 1 torr pressure and 0.2 Watt/cm2 power density. The chemical reaction takes place on the surface of a Silicon electrode. Product of the reaction is mainly SiF4 (gas), which is further hydrolyzed to form HF solution and Silicon Hydroxide sludge. More than 90% of effluent gas mixture can be effectively removed by this method.

Primary author: Mr JOSHI, Avinash (Alpha Pneumatics)

Presenter: Mr JOSHI, Avinash (Alpha Pneumatics)

Session Classification: Gas systems and ageing (I)

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

New gas mixtures for Resistive Plate Chambers operated in avalanche mode

Friday, 12 February 2010 10:20 (20 minutes)

RPCs are widely used in the present LHC experiments, with gas mixtures usually made out of C2H2F4/i-C4H10/SF6 (the "standard mixture"). RPCs assure a nice overall performance, with efficiencies greater than 95%, time resolution of the ns order, and rate capability reaching 1kHz/cm2. However, the standard mixture presents some drawbacks. As a first point, RPCs reach maximum efficiency at voltages greater than 9 kV, implying complex and expensive hardware. Moreover, HF is produced during operation and this may damage them. Finally, the standard mixture is close to the flammability, so all necessary cautions must be taken.
To overcome these problems, it was pointed out that a change in gas pressure would have an immediate effect on the RPCs operating voltage. In principle, operating RPCs at a pressure half of the atmospheric one, for instance, would result in reducing by a factor approximately two the operating voltage. This would overcome these three drawbacks, at least partially.
Since this is not a practical option, the idea is that adding He to the standard mixture would mimick a reduction in the total pressure, since this gas takes part only partially to the avalanche process. In this talk we will report on a series of tests made out using RPCs filled with the standard mixture to which increasing fractions of He were added. Plots about efficiency, time resolution, charge and all other relevant quantities are reported. The results are quite promising and demonstrate the validity of this approach, opening an original path for testing and optimizing a new set of gas mixtures.

Primary author: Prof. ABBRESCIA, Marcello (Physics Dept. and INFN - Bari)

Presenter: Prof. ABBRESCIA, Marcello (Physics Dept. and INFN - Bari)

Session Classification: Gas systems and ageing (I)

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

Optimization of the closed loop gas system for the Resistive Plate Chamber operation at the Large Hadron Collider experiment

Friday, 12 February 2010 10:40 (20 minutes)

Resistive Plate Chambers (RPCs) thanks to their high time resolution (~1 ns), a suitable space resolution (~1 cm) and the low production cost (~25 €/m2) are widely employed for the muon trigger system at the Large Hadron Collider (LHC) experiments where they are covering a surface of about 4000 m2 (16 m3 of gas volume) both in ATLAS and in CMS. The large detector volume and the use of a relatively expensive gas mixture make a closed loop circulation unavoidable. However, at the LHC experiments, RPCs are expected to operate in a high background environment, a condition in which a large amount of impurities (potentially dangerous for long term operation) have been observed in the return gas. Several cleaning agents are currently in use in order to avoid accumulation of impurities in the closed loop circuit. We present the results of a systematic study for the characterization of each cleaning agent. During the test, several RPCs were operated at the CERN Gamma Irradiation Facility (GIF) in a high radiation environment in order to observe the production of the RPC typical impurities: mainly fluoride ions, other molecules of the Freon group and hydrocarbons. The polluted return gas was sent to several cartridges each containing a different cleaning agent. The effectiveness of each material was studied using gas chromatography and mass-spectrometry techniques. Results of this test have revealed a possible optimized configuration that is now under validation. In the presence of radiation, RPCs work well with a relatively high flow rate, equivalent to 0.5-1 volume changes per hour. A finite element simulation study has, therefore, been commend in order to understand and eventually optimize the gas flow distribution inside the RPCs.

Primary author: Mr GUIDA, Roberto (CERN)

Presenter: Mr GUIDA, Roberto (CERN)

Session Classification: Gas systems and ageing (I)

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

Performance of the Prototype Gas Recirculation System with built-in RGA for INO RPC system

Friday, 12 February 2010 11:30 (20 minutes)

An open loop gas recovery and recirculation system has been developed for the INO RPC system. The gas gas mixture coming from RPC exhaust is first desiccated by passing through molecular sieve (3Å + 4Å). Subsequent srubbing over basic active alumina removes toxic and acidic contaminants. The Isobutane and Freon are then separated by diffusion and liquefied by fractional condensation by cooling upto -26 ℃. A residual Gas Analyser (RGA) is being used in the loop to study the performance of the recirculation system. The results of the RGA analysis will be discussed.

Primary author: Mr KALMANI, Suresh (TIFR, Mumbai)

Presenter: Mr KALMANI, Suresh (TIFR, Mumbai)

Session Classification: Gas systems and ageing (II) and digital systems

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

A multipurpose Trigger Readout Board

Friday, 12 February 2010 11:50 (20 minutes)

The concept of a general purpose Trigger Readout Board (TRB) had its source in the future needs of the HADES (High Acceptance Di-Electron Spectrometer). The HADES is a running experiment, installed at the SIS-18 synchrotron (GSI, Germany). Next years HADES will be moved to the upcoming FAIR accelerator complex. Here, HADES-at-FAIR will continue its experimental program. Due to mentioned plans, the detector and Data Acquisition System (DAQ) undergoes an upgrade. The main purpose of the HADES DAQ upgrade project is to achieve a primary data acquisition rate of 20 kHz (100 kHz) with high (low) occupancy. We preferred a modular design to increment the possible set of applications, which also simplified the debugging phase, and made easier the integration of additional detector systems.
To fulfill all requirements and to provide fast preprocessing for the different trigger levels, the Trigger Readout Board was built. TRB is a major part of the new DAQ system, it serves as a platform for all other subsystems. It is featuring a fast optical link (2.5 Gb/s), Tiger-Shark DSP (600 MHz), 2 Gb SDRAM and ETRAX-FS multiprocessor. The board has also 128 Time to Digital Converter (TDC) electronic channels based on the HPTDC from CERN. The architecture of the chip allows to set measurement parameters. In high (very high) resolution mode it has intrinsic resolution of 34 ps (17ps). In this talk the performance, under realistic conditions, of the TRB will be presented. Good example of working system is newly installed RPC detector. Average time resolution reached for the whole detector is 70 ps. To broaden the spectrum of possible applications in the future DAQ-systems, we added a very high data-rate digital interface connector to this board (15 Gbit/s). It gives the possibility to mount an add-on board to the TRB. The add-on boards then provide the detector-specific interfaces (special connectors) or FEE (like ADCs) and additional computing resources (FPGAs). To show all possible applications of this board also add-on boards will be described.

Primary author: Mr PALKA, Marek (Universität Frankfurt)

Presenter: Mr PALKA, Marek (Universität Frankfurt)

Session Classification: Gas systems and ageing (II) and digital systems

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

High Resolution TDC ASIC for CBM-ToF

Friday, 12 February 2010 12:10 (20 minutes)

In 2005 the GSI ASIC design group started with an evaluation of different TDC core architectures for a high resolution TDC for the CBM Time of Flight detector. Based on this evaluation a high resolution TDC fitting to the ambitious requirements of the CBM experiment was developed.
Now with the GSI Eventdriven TDC with 4 channels (GET4) ASIC a prototype is available with a time resolution of better than 25 ps, a double hit resolution <= 3.2 ns and which can cope with an event rate of several 100 kHz/ch. In this talk the architecture of this TDC and the measurement results of the ASIC specification will be presented. The talk will focus on the TDC core which is based on a delay locked loop and the event driven readout system which is mandatory for the triggerless DAQ schema of CBM.
After this we will demonstrate the FEET TDC pc board which was designed to make the GET4 ASIC availbale for detector tests. Two GET4 TDCs together with some glue electronics are mounted on this board. It is part of a set of pc boards which builds up a demonstrator readout electronics for RPC detectors.

Primary author: Dr FLEMMING, Holger (GSI Darmstadt)

Presenter: Dr FLEMMING, Holger (GSI Darmstadt)

Session Classification: Gas systems and ageing (II) and digital systems

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

Development of High Resolution Readout Electronics for MRPC

Friday, 12 February 2010 12:30 (20 minutes)

High resolution readout electronics is under development for MRPC detectors. It consists of a fast front-end ASIC and an ultra high resolution TDC based on FPGA. The front-end ASIC, CAD (Current Amplifier and Discriminator), works in fully current mode. Signal pulses are amplified by a current mirror with local negative feedback to reduce the input impedance and then are sent to a current comparator. Current mode design can achieve higher bandwidth with less power consumption compared to voltage mode approaches. The chip is designed in a 0.35μm CMOS technology but this architecture is well suited for deep submicron technologies with lower supply voltage.
In order to obtain time resolution of ~10ps in a FPGA TDC, a delay chain is used to interpolate time phases inside a clock. But it usually suffers from bad control of the delay time for each delay unit. The so-called wave union method is used to improve the linearity and the resolution.
The detailed the design and test results will be present in this paper.

Primary author: Dr DENG, Zhi (Tsinghua University, Beijing)

Presenter: Dr DENG, Zhi (Tsinghua University, Beijing)

Session Classification: Gas systems and ageing (II) and digital systems

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

Introduction

Tuesday, 9 February 2010 09:20 (20 minutes)

Primary author: Prof. SANTONICO, Rinaldo

Presenter: Prof. SANTONICO, Rinaldo

Session Classification: Status and performance of wide-gap RPC systems (I)

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

L1 Trigger effciency estimation of RPC detector in CMS experiment

Wednesday, 10 February 2010 17:00 (2 hours)

Here we present the methods for the estimation of L1 trigger effciency of RPC detector placed in the muon chamber of CMS experiment. Two independent methods, Tag&Probe and DTvsRPC, have been tested for RPC trigger eficiency measurement using cosmic muon data and Monte-Carlo cosmic muon sample. The cosmic muon data is collected during Cosmic Run At Full Tesla (CRAFT08) during the year 2008 using CMS experiment. Two methods maninly dier in geometrical acceptence regions (cracks/gaps). RPC trigger eficiency estimated using Tag&Probe and DTvsRPC methods is in good agreement (differ by 2-3%) in the central regions of the RPC detector. RPC trigger eficiency comes out to be almost 90% in the central region of the detector using both the methods.

Primary author: Ms JINDAL, Monika (Panjab University Chandigarh)

Presenter: Ms JINDAL, Monika (Panjab University Chandigarh)

Session Classification: Poster session

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

Systematic study of gas mixtures for timing RPCs

Wednesday, 10 February 2010 17:00 (2 hours)

The RPC timing properties are determined by the maximum ionization rate that can be sustained while keeping the streamer fraction at modest values. This last characteristic, resilience to streamers, cannot today be fully calculated, calling for an experimental approach.
In this work we systematically study the influence of a range of gas mixtures on the performance (background counting rate, efficiency, time resolution and charge spectrum) of timing RPCs, using cosmic rays as ionizing particles. In particular, the effect of gas polymerization inhibitors will be evaluated.

Primary author: Dr LOPEZ, Luís (LIP Coimbra)

Presenter: Dr LOPEZ, Luís (LIP Coimbra)

Session Classification: Poster session

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

Performance of Multigap Resistive Plate Chamber in Streamer and Avalanche Mode

Wednesday, 10 February 2010 17:00 (2 hours)

We have observed the performance of the multigap RPC in streamer and avalanche mode. The multigap RPC was designed to have improved time resolution compared to the single gap RPC. For this reason, we built five type of multigap RPC with a rectangular shape of glass electrode, size of 10 x 10 cm2 and thickness of 1 and 2 mm. Multigap RPCs were operated with gas mixture of Ar, C4H10, C2H2F4 and SF6 for streamer and avalanche mode. We have obtained a preliminary result of the multigap RPC time resolution at high voltage plateau curve in streamer and avalanche mode. From results, the time resolution is considered to be inversely proportional to thickness of glass electrode.
In this conference we will be present more details of the multigap RPC performances.

Primary author: Mr SHOJI, Masayoshi

Presenter: Mr SHOJI, Masayoshi

Session Classification: Poster session

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

Determination of the electron scattering cross section set in tetrafluoroethane (C2H2F4) based on measurements of electron transport coefficients

Wednesday, 10 February 2010 17:00 (2 hours)

One of the most significant goals of swarm physics is determination of the charged particle scattering cross sections based on the available, transport data, such as drift velocity (W) and effective transverse characteristic energy (DT /μ). The first coefficient is the most sensitive to the elastic momentum transfer cross section, and the latter to the energy balance. This fact enables us to renormalize the existing cross sections on the basis of newly measured transport data [1], and also to predict the effective inelastic energy losses that are missing from the cross section sets available in the literature.
In this study we have used drift velocities and effective ionization coefficients ((α-η)/N) measured by the Pulsed Townsend technique in pure C2H2F4 and in mixtures of five different abundances (from 2% to 50% of C2H2F4 in Ar). The initial photoelectrons are released from the aluminum cathode by a UV pulse of a Nd:YAG (355 nm) laser. The displacement current produced by the electrons and ions is measured with a transimpedance amplifier (40 MHz, 105 V/A). The electron drift velocity is calculated as the time elapsed between the half-height of the leading and trailing edges of the measured electron current, which is
I_e(t)=(n_0 q_0/T_e) exp[(alpha-eta)v_e t] (1)
The calculations of the corresponding transport coefficients were performed by using two computer codes and the initial cross section set was that of S. Biagi, from the NIST database, which was mainly based on extrapolations from the C2F6 set. The first code solves the Boltzmann equation in a two-term approximation, and it was used only for numerous runs in the process of adjusting the cross sections. The second code was based on a Monte Carlo simulation technique, and because of its ability to obtain data without implicit limitations it was used for the final calculations.
The results of our investigations are shown in Figure 1. The final set required modifications of the momentum transfer cross section and the attachment cross section to become consistent with the experimental results for the pure gas. However, energy balance is not determined accurately due to the limited availability of data. Fitting C2H2F4 – Ar mixtures with small abundances of C2H2F4 could provide a better check on the energy balance while momentum balance for the mixture would mostly be controlled by Ar. Nevertheless, the present set can be used for modeling plasmas and gas discharges including particle detectors containing sufficiently small amounts of C2H2F4.
[1] De Urquijo J, Juárez A M, Basurto E and Hernández-Ávila J L 2009 Eur. Phys. J. D 51 2 241

Primary author: DE URQUIJO, Jaime (Instituto de Ciencias Físicas)

Presenter: DE URQUIJO, Jaime (Instituto de Ciencias Físicas)

Session Classification: Poster session

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

A closed-circuit gas system for RPC detectors

Wednesday, 10 February 2010 17:00 (2 hours)

The NeuLAND detector for R3B at FAIR will detect high-energy neutrons and will be based on timing resistive plate chambers. Current RPC detectors for timing purposes often use a common gas mixture, composed of 85% Reclin-134a, 10% sulfur hexafluoride, and 5% isobutane, which allows the operation of the detector under optimal conditions. Each gas has a series of advantages and disadvantages, which will be briefly listed. Reclin-134a and sulfur hexafluoride are potent greenhouse gases with high to very high global warming potentials, respectively. The long-term release of these gases to the atmosphere must therefore be avoided. Due to the considerable gas volume involved in the NeuLAND detector, a closed-circuit gas recirculation system is proposed for this purpose, consisting of a main circuit with a gas scrubber for the removal of eventual impurities in the gas, a condensation circuit for the recovery of the gas mixture, an injection circuit for the supply of fresh gas, and an on-line gas-analysis system based on a quadrupole mass spectrometer. This closed-circuit system will be presented, and its various subsystems will be described in detail.

Primary author: Mr ROSSI, Dominic (GSI Darmstadt)

Presenter: Mr ROSSI, Dominic (GSI Darmstadt)

Session Classification: Poster session

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

Study of gas purifiers in the CMS RPC detector

Wednesday, 10 February 2010 17:00 (2 hours)

The CMS RPC muon detector utilizes a gas recirculation system (Closed Loop) to cope with high gas mixture volumes and costs. A systematic study of Closed Loop gas purifiers has been carried out in 2008 and 2009 at the ISR experimental area of CERN, with the use of RPC chambers with currents monitoring, and gas analysis sampling points. Results on contaminants release and purifier characterization.

Primary author: Dr SAVIANO, Giovanna (INFN-LNF Frascati)

Presenter: Dr SAVIANO, Giovanna (INFN-LNF Frascati)

Session Classification: Poster session

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

The Slow Control System of the HADES RPC wall

Wednesday, 10 February 2010 17:00 (2 hours)

The Control and Monitoring System designed for the Front-End Electronics of the HADES RPC detector, installed at GSI Helmholtzzentrum für Schwerionenforschung GmbH (Darmstadt, Germany), is described. The slow control system controls/monitors about 6500 variables and is being implemented using the Experimental Physics and Industrial Control System (EPICS) Software tool kit. A MEDM graphical interface is being developed for the client system. The Control and Monitoring System attends four different systems: Front-End Electronics, Low Voltage System, Detector and Gas System. Each system communicates the control/monitoring system via an independent hardware interface, and a common software platform.

Primary author: Mr GIL ORTIZ, Alejandro (IFIC-Valencia)

Presenter: Mr GIL ORTIZ, Alejandro (IFIC-Valencia)

Session Classification: Poster session

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

Study on two-dimension induced signal readout of MRPC

Wednesday, 10 February 2010 17:00 (2 hours)

A kind of two-dimension readout mode for the induced signal readout of MRPC has been studied in both simulation and experiments. Several MRPC prototypes are produced and a series of test experiments have been done to compare with the result of simulation, in order to verify the simulation model. The experiment results are in line with those of simulation. This method will be used to design the two-dimension signal readout mode of MRPC in the future work.

Primary author: Dr WU, Yu-Cheng (Tsinghua University, Beijing)

Presenter: Dr WU, Yu-Cheng (Tsinghua University, Beijing)

Session Classification: Poster session

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

VME based DAQ system for INO RPC stack

Wednesday, 10 February 2010 17:00 (2 hours)

A 12 layer 1m x1m glass RPC stack is operational and collecting cosmic ray data for the last two years at TIFR. A VME based DAQ systeem with various graphical interfaces for data acquisition and monitoring has been developed. Both hardware and software aspects of this system will be discussed in this paper.

Primary author: Mr DEEPAK, Samuel (Tata Institute of Fundamental Research, Mumbai)

Presenter: Mr DEEPAK, Samuel (Tata Institute of Fundamental Research, Mumbai)

Session Classification: Poster session

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

Velocity measurement of cosmic muons using INO RPC detector stack

Wednesday, 10 February 2010 17:00 (2 hours)

The India-based Neutrino Observatory (INO) collaboration is planning to build a glass RPC based magnetised iron calorimeter (ICAL). A prototype detector stack comprising of 12 RPCs of 1m x 1m in area is setup to track cosmic ray muons. In order to demonstrate its capability to distinguish between up-going and down-going particles, we measured the velocity of the cosmic muons recorded in this stack. We describe in this paper the detector setup, measurement procedure, calibration and results obtained.

Primary author: Mr PAL, Sumanta (Tata Institute of Fundamental Research, Mumbai)

Presenter: Mr PAL, Sumanta (Tata Institute of Fundamental Research, Mumbai)

Session Classification: Poster session

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

TRASGO An innovative stand-alone detector with full timing and tracking capabilities

Wednesday, 10 February 2010 17:00 (2 hours)

Timing RPCs are very interesting detectors that provide outstanding timing resolution and fast response at an affordable price to cover big surfaces. These features put together with the TimTrack reconstruction algorithm and an electronic chain composed by a FEE amplifying and digitizing electronics and an intelligent data acquisition board (opens the possibility of developing an innovative detector, or TRASGO (TRAck reconStructinG mOdule), able to work stand-alone providing full high performance timing and tracking capabilities.
The main components of a TRASGO are:
1. A High resolution timing detector: In order to provide its best performances, TRASGOs need outstanding timing detectors, like tMRPCs or fast scintillators. Sealed RPCs are being developed facing the possibility of using RPCs based TRASGOs in Astroparticle experiments without the need of cumbersome gas systems.
2. A fast and reliable reconstruction algorithm: The TimTrack algorithm (see the contribution to this Workshop) offers the best performances for the fast and smooth reconstruction of tracks. It provides a set of six parameters, or a saeta (SmAllest sEt of daTA), composed by 2 coordinates, 2 slopes, the velocity and the time of the particle at a reference plane.
3. A stand-alone FEE-DAQ chain: The DAQ structure of a TRASGO is based on the HADES DB-MB-TRB philosophy. Namely:
- A compact high bandwidth pre-amplifying and digitizing electronics codifying time and charge in a single LVDS digital signal.
- A HPTDCs and FPGAs based intelligent acquisition board driven by an ETRAX processor able to house the hit fitting and tracking algorithms.
This work presents some of the developments already done and those that are on the way facing the development of the first TRASGO prototype in order to test their performances with cosmic rays.
The TRASGO concept may be of interest in several research fields, like:
- Astroparticle Physics: where its high granularity, performances and capability to work stand-alone may facilitate the measurement of extended air showers properties.
- Particles and Nuclear Physics: either working stand-alone or as component of a spectrometer, where TRASGOs may be very useful for trigger and tracking purposes.

Primary author: Mr KORNAKOV, Georgy (University of Santiago de Compostela)

Presenter: Mr KORNAKOV, Georgy (University of Santiago de Compostela)

Session Classification: Poster session

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

NeuLAND MRPC-based detector prototypes tested with fast neutrons

Wednesday, 10 February 2010 17:00 (2 hours)

A detector for momentum measurement of high-energy neutrons in the energy range 0.2 - 1 GeV is being developed for the R3B (Reactions with Relativistic Radioactive Beams) experiment at FAIR. Based on the running LAND detector at GSI, NeuLAND will consist of a layered structure made of iron converters, to convert neutrons mainly to protons, and multigap resistive plate chamber (MRPC) detectors in order to detect the secondary charged particles. The excellent time resolution of the MRPC units will allow for a very good time-of-flight resolution of NeuLAND, meeting the design goal of sigma_t <100ps . The full NeuLAND detector will consist of about 60 iterations of the basic structure (converter + MRPC), leading to close to 100% detection efficiency for neutrons with energy higher than 200 MeV.
Prototypes built at GSI and FZD were tested using MIPs at the ELBE electron beam facility at FZD. Here we present recent results from a first irradiation of the prototypes with fast neutrons. The TSL Uppsala* monoenergetic neutron beam of En = 175 MeV is well-suited for such a study. This data will serve both for the validation of the basic detection scheme and as important input to refine GEANT4 and FLUKA simulations of the final detector.

Primary author: CAESAR, Christoph (GSI Darmstadt)

Presenter: CAESAR, Christoph (GSI Darmstadt)

Session Classification: Poster session

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

Testing timing RPC's at ELBE/Dresden using 32MeV single-electron bunches with picosecond time resolution

Wednesday, 10 February 2010 17:00 (2 hours)

In the framework of detector development efforts worldwide, there is an increasing demand for a rapid and reliable way of testing timing RPC's regarding their efficiency and time resolution. One possible avenue to reach this goal is to employ pulsed electron beams of several tens of MeV energy, which are close to the minimum of ionization. The timing response can then be measured with the accelerator RF signal as reference, obviating the need for fast scintillators.
This technique has been used successfully at the 40MeV superconducting electron accelerator ELBE in Dresden, Germany, since several years in the framework of the CBM and NeuLAND collaborations [1, e.g.]. Recently, the MRPC testing capabilities at ELBE have been greatly boosted by the introduction of a new, single-electron per bunch, mode of operation of the accelerator. This new mode of operation allows for the first time to use the primary electron beam, as opposed to scattered beam, for MRPC testing. This leads to much lower background, while electron rates can now vary from 101–107 s–1 on an exposed region of a few cm2. The intrinsic time resolution is sigma ~= 25 ps. Based on this upgrade, a new RPC testing station has been constructed at ELBE. This station will be presented in the poster, together with some
recent results obtained there.
The MRPC testing station and the ELBE accelerator are open to the worldwide scientific community as a user facility, with proposals collected every six months and evaluated based on their scientific merits.
[1] R. Kotte et al., Nucl. Inst. Meth. A 564, 155 (2006)

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NeuLAND MRPC prototypes tested at ELBE/Dresden

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Prototypes for the NeuLAND detector have been built at FZD and GSI and then studied using the 32MeV pulsed electron beam at the superconducting electron accelerator ELBE in Dresden, Germany. Owing to the new, single-electron per bunch mode of operation, a rapid validation of the design criteria (>=90% efficiency for minimum ionizing particles, s_t <= 100 ps time resolution) was possible.
Tested properties of the prototypes include glass thickness, spacing of the central anode, and a comparison of single-ended and differential readout. Tested frontend electronics schemes include FOPI (single-ended), PADI-based (both single-ended and differential mode tested), and ALICE (differential).
The NeuLAND detector at the R3B experiment at the future FAIR facility in Darmstadt aims to detect fast neutrons (0.2-1.0GeV) with high time and spatial resolutions s_t<100 ps, s_x,y,z<1 cm). The detector will consist of about 60 subsequent MRPC stacks containing a 4mm thick anode made of iron converter material, with an additional 4mm of converter material between two stacks. The secondary charged particles stemming from hadronic interactions of the high energetic neutrons in the converter will be detected in the MRPC's.

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Some results of the R&D of a ToF-Wall to identify relativistic ions

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The detection setup of the R3B experiment in the FAIR facility includes time of flight (ToF) walls, dedicated to the isotopic identification of ions of any charge and mass at energies of some hundreds AMeVs. The experiments related to heavy ions require large active surfaces and a very demanding time resolution (<50 ps) for the ToF detectors in order to accomplish with their duties with reasonable flight-paths (up to 20m).
It was proposed rather early that timing-RPCs could provide an adequate solution for this detector [1]. Although the time-resolution provided by deployed tRPCs (HARP, ALICE, FOPI, HADES) can reach values well below 80 ps, they were developed and used only for MIPs. In that sense, it was clear that an important effort of R&D is needed for both, adapting the materials and geometry to heavy ions, and also to study the large dynamic-range that is expected that ions will impose to the detectors.
Only very recently it has been demonstrated [2] that typical RPC cells can perform rather well with ions up to Z=6 keeping their extreme timing properties, up to moderate rates.
In this work we show our progress in the construction of RPCs suitable to the detection of heavy ions in conditions as those of the R3B environment. We used beams at GSI of C, but also of Ni and a fragments of U. Here we show results of successful measurements in a wide range of charges, or equivalently in wide range of energy depositions, which confirm the suitable use of RPCs in what concerns efficiency, and detector and electronics stability. We also show the electronics solutions we propose after our own R&D, and perspectives to achieve an optimum time-resolution adapted to R3B needs.
[1] Nuc. Phys. B 158 (2006) 186
[2] JINST 4 P11007 (2009)

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