7th International Conference on Position Sensitive Detectors

Report of Contributions

Contribution ID: **0** Type: **Invited Talk**

Solid State Detectors for Charged Particles

Monday 12 September 2005 16:00 (30 minutes)

Author: Dr LUTZ, Gerhard (MPI Semiconductor Laboratory)

Presenter: Dr LUTZ, Gerhard (MPI Semiconductor Laboratory)

Session Classification: S2 : Pixel Detectors for Charged Particles

Track Classification: Pixel Detectors for Charged Particles

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

Position Resolution Considerations for the SmartPET Imaging System

Author: Mr BEVERIDGE, Toby (Monash University)

Co-author: Prof. LEWIS, Robert (Monash University)

Presenter: Prof. LEWIS, Robert (Monash University)

Contribution ID: **2** Type: **Contributed Poster**

Position Resolution Considerations for the SmartPET Imaging System

Thursday 15 September 2005 10:30 (30 minutes)

The SmartPET collaboration is investigating the e_cacy of using two planar High-Purity Germanium (HPGe) double-sided strip detectors as a Compton imaging Positron Emission Tomography (PET) system. Monte Carlo simulations suggest that a large proportion of interactions within the detectors will occur within a small spatial and temporal window, introducing signi_cant ambiguities within the position and energy measurements made by the detectors. The a_ect of this ambiguity on the quality/quantity of information used for image reconstruction is the subject of this study.

Each detector in the system is to act as a single layer Compton camera, thus the interaction sequences of annihilation -rays need to be tracked within a detector volume, and the location and energy deposit of each interaction determined. The resulting information can then be used, depending on the interaction sequence combination, to backproject either a cone of response (as in standard Compton imaging) or a line of response (as in standard PET) into the image space.

Each detector has an active area of 60mm x 60mm x 20mm and a strip pitch of 5mm. Position resolution in the plane of the detector will be achieved by analysis of the signals from strips neighbouring the primary charge collector, and is expected to be around 1mm when a single interaction occurs within the volume between two orthogonal strips (intersection volume). Depth resolution will be obtained by measuring the timing separation between the front and rear signals. When multiple interactions occur within one intersection volume the position resolution will be degraded. The resulting signal is likely to be misinterpreted as a single interaction, or, the presence of multiple interactions may be correctly identifed but the position and energy information of each interaction will be irretrievable or subject to a large uncertainty. Preliminary analysis of simulated signals indicate that the detected position will be (approximately) the average of the true interaction positions, and the detected energy the sum of the true interaction energies.

This study will present the probability of multiple interactions occurring within an intersection volume, the probability that those interactions will be indistinguishable from a single interaction, and the a_ect the incorrect measurements have on the accuracy of backprojected lines/cones.

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Co-author: Prof. LEWIS, Robert (Monash University, Australia)

Presenter: Prof. LEWIS, Robert (Monash University, Australia)

Session Classification: P : Coffee and Poster Session

Track Classification: New Techniques for Positron Emission Tomography

Contribution ID: **4** Type: **Contributed Poster**

A compact PC-based X-ray Imaging System

Thursday 15 September 2005 10:30 (30 minutes)

A portable PC-based X-ray imaging system has been developed based on a 2D silicon microstrip detector and particle physics readout electronics. The sensor is housed in a specially built hybrid, which also hosts the front-end electronics. This hybrid is attached to the PC with a flat cable which makes it a flexible probe. The hybrid, including the sensor was developed earlier in the framework of the EU FP4-Biomed-BRSMS project. The control and the readout electronics used are based on the standard PCI and PMC architectures and were originally developed for High Energy Physics Experiments. The use of PCI based electronics and the development of the control software for the PC-Linux platform led to a compact, portable, low cost imaging system. The system was initially tested and evaluated with beta particles from a 90Sr radioactive source, gamma rays from a 241Am radioactive source and cosmic rays, and it displayed consistent response. It was then operated using a compact X-ray machine with Mo tube and images of various targets were reconstructed offline using the ROOT data analysis package. Typical exposure times, to achieve image quality comparable to film imaging, were long. Shorter exposure times required for medical applications could be accomplished with the use of faster front-end chips.

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Presenter: Mr ASIMIDIS, Asimakis (University of Ioannina)

Session Classification: P : Coffee and Poster Session

Track Classification: X-ray and Gamma-ray Detectors

Contribution ID: **6** Type: **Contributed Talk**

Modification of CMOS APS detectors for use in the UV

With attractive features such as low power consumption, high dynamic range and increased in-pixel functionality, Active Pixel Sensors (APS) have begun to rival charge-coupled devices (CCD) for use as imaging sensors. Recently work has been undertaken in order to produce APS devices with enhanced performance and extended wavelength sensitivity as an alternative to so-called science grade CCD devices used in a variety of applications. Undertaken as part of the MI-3 project, this work will show how modifications were made to a Startracker chip –a 525x525 array of 25um square pixels - for use in the imaging of UV signals. Using photolithographic and wet etching techniques, windows were removed in the passivation layers of each pixel, permitting the sensor to be sensitive to an extended UV range. The selective opening of windows on the sensitive surface maintains the integrity of the interconnect layers of the CMOS process.

Improvements in spectral response measurement will be shown after the introduction of the oxide windows and the performance of the device pre and post processing discussed.

Author: Dr BLUE, Andrew (Dept. Of Physics & Astronomy, University of Glasgow)

Presenter: Dr BLUE, Andrew (Dept. Of Physics & Astronomy, University of Glasgow)

Track Classification: Applications in Astronomy and Astrophysics

Contribution ID: **7** Type: **Contributed Talk**

Intraoperative beta probe for brain tumor surgery

Tuesday 13 September 2005 16:30 (15 minutes)

Surgery is still considered the primary therapeutic procedure for high grade gliomas and several recent clinical studies have shown that gross total tumor resection is directly associated with longer and better survival when compared to subtotal resection. Considering this context and based on a first experience in radio-guided surgery [1,2], we are currently developing an intraoperative positron imaging probe specifically designed to help neurosurgeons to locate residual radiolabeled brain tumor (with 18F-FDG or FET) after the bulk has been excised. Our detector was conceived to be compact and electrically safe in order to be easily used inside the operative wound jointly to other surgical tools.

We chose to build our ⊠⊠ imaging probe around plastic scintillating multiclad fibers which optimize the detection of positrons emitted by tumor while significantly reducing annihilation gamma rays background noise. Scintillating fibers are disposed on two concentric rings and are thermally fused to a 2 m length optical fiber bundle to export the signal outside of the operative wound until a multi-channel PMT. To eliminate the ⊠ background noise, each detection pixel is composed of 2 scintillating fibers: 1 on the internal ring and 1 on the external ring which is beta shielded wich a thin inox layer. The ⊠+ distribution is obtained in real time by subtracting the signal from these 2 fibers for each detection pixel.

Monte Carlo simulations using MCNP were realized on a voxelised anthropomorphic brain phantom with different radiotracer activities to optimize the detector geometry in a realistic clinical environment. A first prototype of the probe composed of 8 detection pixels is currently under development. Its experimental beta and gamma sensitivities were measured using 204Tl and 22Na point sources. Simulations show that optimal performances are obtained with 2 mm diameter and 0.5 mm length scintillating fibers giving a gamma ray rejection efficiency of 99.9%. These results were confirmed by experimental measurements. With a homogeneous tracer distribution in the tumor margins and a detector placed in contact with the tissues, the probe sensitivity is 11 cps/nCi/mm3 for each detection pixel. The theoretical minimum radiotracer detectable concentration is 1.8 nCi/mm3 for 18F-FET and an acquisition time of 5 s. This minimum value has to be compared to the 2.9 nCi/mm3 average concentration of 18F-FET in the bulk of the tumor and is expected to be sufficient to help surgeons to detect residual lesions in the resection margins of the tumor.

In addition to these promising performances, we are performing experimental measures on radioactive phantom to validate the operating parameters of the probe in a clinical context.

Author: Mr BONZOM, Sebastien (IPN Orsay, France)

Presenter: Mr BONZOM, Sebastien (IPN Orsay, France)

Session Classification: S6 : Applications in Nuclear Medicine and Radiology

Track Classification: Applications in Nuclear Medicine And Radiology

Contribution ID: **9** Type: **Contributed Talk**

A gaseous imaging detector based on thick GEM-like (THGEM) multipliers

Thursday 15 September 2005 10:15 (15 minutes)

The thick GEM-like (THGEM) electrode is a rather new gas-avalanche electron multiplier, economically produced by standard printed circuit board (PCB) drilling and etching techniques. Its structure is similar to that of standard GEM, but its dimensions are expanded, with thickness varying from 0.4 to 3.2 mm and the mechanically-drilled hole diameter varying from 0.3 to 1mm. The Cu layer around the drilled hole is further etched by 0.1mm at its rim. The operation principle of the THGEM is similar to that of the standard GEM, though the operation voltages and the charge transport parameters (e.g. diffusion) do not scale with the dimensions. The hole dimensions are large with respect to the electron's mean-free-path and diffusion, which results in very high electron multiplication within the holes and very efficient electron transport into and out of the holes, permitting an efficient cascading of several multipliers. Gains of 105 and 107 were recorded in single- and double-THGEM structures respectively, in various gases including highly scintillating ones such as CF4. Furthermore, the THGEM can operate at very low gas pressures; e.g. gains of 105 and 107 were recorded in 1 and 10 Torr of isobutane, respectively. The avalanche process is fast, with the pulse rise-time in the few-ns range at all pressures investigated, and with a counting rate capability in the range of 1MHz/mm2 at gains above 104. All these properties make the THGEM an attractive solution for efficient radiation detection and imaging, from single electrons to heavily ionizing particles, over very large active area, with resolution in the sub-mm range.

We have investigated the multiplier's performance using THGEM elements of different geometries, at atmospheric and at low gas pressures, down to a fraction of a Torr. In particular we have studied the electron transport, which is very important for single-electron detection applications, e.g. photon counting with gaseous photomultipliers. We present the results of this study, discuss the role of various geometrical and operational parameters and demonstrate conditions for reaching full single-photoelectron detection efficiency.

We present an imaging-detector prototype of 10x10 cm2, comprising a double- THGEM cascaded multiplier coupled through a resistive anode to a 2D readout electrode; the detector performance, studied with various radiation sources, is discussed, and possible applications are illustrated.

Author: Dr CHECHIK, Rachel (The Weizmann Institute of Science, Israel)

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Presenter: Prof. BRESKIN, Amos (The Weizmann Institue of Science)

Session Classification: S10 : New Gas-based Tracking Detectors

Track Classification: Novel Gas-based Detection Techniques

Contribution ID: **10** Type: **Contributed Poster**

Diffraction-Enhanced Imaging of normal and arthritic mice feet

Thursday 15 September 2005 10:30 (30 minutes)

The aim of this experiment was to use the Diffraction-Enhanced Imaging (DEI) system at Daresbury, which has recently upgraded with new Channel-cut crystals to produce images of mice's feet. There were two types of mice's feet used, normal and arthritic. The two types of sample were imaged and compared in order to determine whether it was possible to detect the changes in cartilage that are linked with arthritis. The analysis of the results with regards to the presence of arthritis is still to be carried out, however the refraction images of the samples do show clearly some soft tissue structures and the joints in the ankle.

Author: CRITTELL, Suzanne (University of Liverpool)

Presenter: CRITTELL, Suzanne (University of Liverpool)

Session Classification: P : Coffee and Poster Session

Track Classification: Applications in Nuclear Medicine And Radiology

Contribution ID: **11** Type: **Contributed Talk**

Beam Test and Simulation of Prototypes for the ALICE Silicon Pixel Detector

Monday 12 September 2005 17:00 (15 minutes)

The silicon pixel detector (SPD) of the ALICE experiment in preparation at the Large Hadron Collider (LHC) at CERN is designed to provide the excellent vertex resolution needed for measuring heavy avour production in heavy ion collisions at very high energies and high multiplicity. The detector consists of 1200 read out ASICs, each consisting of 8192 pixels, bump-bonded to 200 _m thick silicon sensors. The SPD forms the innermost part of the Inner Tracking System (ITS), which also includes silicon drift and silicon strip detectors. Single assembly prototypes of the ALICE SPD have been tested at the CERN SPS using high energy proton/pion beams in 2002 and 2003. We report on the experimental determination of spatial precision and detector e_ciency obtained from these tests. We also report on the _rst combined beam test of the pixel prototypes, together with prototypes of the other ITS silicon technologies, at the CERN SPS in November 2004. The issue of SPD simulation using GEANT and FLUKA is briey discussed.

Author: Dr CONRAD, Jan (PH/EP Dept., CERN)

Presenter: Dr CONRAD, Jan (PH/EP Dept., CERN)

Session Classification: S2 : Pixel Detectors for Charged Particles

Track Classification: Pixel Detectors for Charged Particles

Contribution ID: **12** Type: **Contributed Talk**

SmartPET: A Small Animal P.E.T Demonstrator using HyperPure Germanium Planar Detectors

Tuesday 13 September 2005 11:45 (15 minutes)

The SmartPET project aims to exploit advances in the sensitivity, speed, position and energy resolution of HPGe detectors to construct a small animal Positron Emission Tomography (PET) system.

The small animal scanning system will consist of two planar HPGe detectors separated by 109mm and housed in a rotating frame allowing data acquisition over a full 180o range. Each detector will have a 60x60x20mm crystal electrically segmented with 5mm strip pitch. The development of sophisticated digital acquisition techniques and the use of Pulse Shape Analysis (PSA) and Gamma Ray Tracking (GRT) will allow accurate position and energy information to be extracted.

The techniques outlined allow scattered interactions to be identified and used for image reconstruction and therefore hold the potential to increase patient throughput and/or reduce patient dose.

This coupled with investigation into the use of three dimensional statistical image reconstruction aims to provide proof of principle for the use of germanium detectors in medical imaging applications.

This talk will provide an overview of the SmartPET project, its potential as a PET system and the advantages it holds over conventional systems. Preliminary results will also be presented.

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Presenter: Mr COOPER, Reynold (University of Liverpool)

Session Classification: S4 : New Techniques for Positron Emission Tomography

Track Classification: New Techniques for Positron Emission Tomography

Contribution ID: **13** Type: **Contributed Talk**

MAYA, a gaseous active target

Thursday 15 September 2005 10:00 (15 minutes)

With the recent improvement in the field of exotic beam, especially with the SPIRAL facility at GANIL, a new area of the nuclear chart is now available for experimentation. Nevertheless the intensity of such beams is still relatively low (few thousands of particles per second), and for some reactions of interest the cross sections are low. Thus it is essential to be able to perform experiments using detectors which cover the larger possible solid angle with the best achievable resolution on any measured parameters. It is also necessary to use thick targets to increase the reaction counting rates, but this should be done without loss of resolution. We developed the MAYA detector to fulfil all these experimental requirements. MAYA is a gaseous active target detector: the gas is used as detection material and also as target. MAYA allows tracking, identification and kinematics measurement for all the participants of binary direct reactions. This detector is able to work at gas pressure of up to 3 atmospheres, as a way to increase the density and thus the thickness of the target. The tracking capability prevents any loss of resolution, especially on the reaction energy that usually occurs in such cases and also allows a very low threshold in energy of reactions. The design of this detector and the rather new electronics which is used will be showed during this presentation. Some recent preliminary results will also be presented in order to show the possibility and the resolutions of the measured kinematics parameters (reaction energy, energy or range and angle for the recoil and scattered particle) of this detector.

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Session Classification: S10 : New Gas-based Tracking Detectors

Track Classification: Applications in Nuclear Physics

Contribution ID: **14** Type: **Contributed Talk**

OSI: A Prototype Microstrip Dosimeter for Characterisation of Medical Radiotherapy and Radiosurgery Systems

Tuesday 13 September 2005 16:45 (15 minutes)

The treatment of cancer using radiotherapy is rapidly advancing; particularly with the advent of Intensity Modulated Radiotherapy (IMRT) which allows dynamic shaping of the dose delivered to the patient. This makes possible the treatment of tumours close to critical areas of the body eg. the spine. To allow the full potential of this powerful technique to be realised requires matching advances in techniques to characterise the dose distributions of radiotherapy systems for quality assurance so that accurate IMRT models can be implemented in treatment planning systems. This requires detailed knowledge of the dose distribution in high gradient regions with submilimetre spatial resolution, easy deployment in a hospital environment and rapid characterization to minimise the downtime of these valuable and busy facilities. The measurement of precise, film-like, dose distributions on-line is particularly valuable for dynamic IMRT as well as for Stereotactic Radio-Surgery (SRS), which uses small beams of the order of 1cm.
The goal of the OSI project is to develop a prototype multichannel dosimeter based on well established Si micro-strip technology and multi-channel readout electronics, and demonstrate its operation in a hospital radiotherapy system. An IMRT prototype composed of a 0.25 mm pitch, 128 channel pixel array from Micron and read-out by one XDAS board has been tested in a clinical LINAC and shown to measure the penumbra with an accuracy comparable to film (figure 1 above). A 512 channels (4 XDAS boards) version of the previous detector, covering a field of view of 128 mm, is being assembled. A 2d pixel detector intended both for SRS and IMRT has been designed. It has 22x22 channels with 1 mm pitch and 0.9 mm x 0.9 mm pixel size (0.2 mm x 0.2 mm for IMRT), and will use the same 4 XDAS read-out system as the 512 channels pixel array. In this paper we will decribe the prototypes and report on beam tests using a Weston Park Hospital clinical LINAC.

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Co-author: BUTTAR, C (Department of Radiotherapy Physics, Weston Park Hospital)

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Session Classification: S6 : Applications in Nuclear Medicine and Radiology

Track Classification: Applications in Nuclear Medicine And Radiology

Contribution ID: **15** Type: **Contributed Poster**

NEW MICRO PATTERN GAS DETECTOR BASED ON A 2D POSITION READOUT MESH

Thursday 15 September 2005 10:30 (30 minutes)

Micro pattern gas detectors (MPGD) could become suitable devices to carry out time-resolved X-ray diffraction experiments in the sub-millisecond time scale at synchrotron radiation facilities. This is because the small anode-cathode distances in these devices allow short ion drift times, thus reducing one of the most important count rate limitations, i.e. space charge effects. This results in potentially very high local count rates. In addition, the possibility to manufacture electrode structures with high electrode densities offers the prospect for excellent spatial resolution. Nevertheless, these devices are not free of problems. Among other problems: the build-up of ions in the detector components; the susceptibility of the materials in the structure to dielectric breakdown, and; the non-uniformity of response over large areas. Here we present a new MPGD design we have called Micro Reading Mesh Chamber (MRMC). Its layout (see Figure 1) is based on a resistive anode (red), support pillars (green) and a mesh formed by two planes of pick-up strips (yellow and orange).

Figure 1. View of the mesh and the anode from the window (left), view of the mesh and the pillars from the anode (center) and lateral view of the whole structure (right).

In order to improve the cathode signals quality, we use the mesh to read the avalanche. In this manner the size of the induced charge is larger than in more conventional geometries. It allows lower multiplication field intensities, what reduces formation of sparks, keeping the same detection efficiency. Moreover, a resistive anode has been designed to quench the sparks at an early stage. With the aim of preventing charging up, a common problem with GEMs and MPGD in general, a minimum amount of dielectric material has been used in the design. The aim has been to avoid dielectric near the drift paths of the ions.

Finally, the use of one pillar every four cells guarantee good gain uniformity. In this work we report on the development of this detector. We show several detailed simulations of every aspect of the MRMC such as the gas properties, the electron and ion drift characteristics, a complete model for the multiplication including the space charge and the resistive layer effects, the signal formation, the crosstalk between tracks…The optimization process of the different parameters of the detector (geometry, electric fields, anode resistivity…) is also shown. Finally, we report on the building up technique and capabilities.

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Session Classification: P : Coffee and Poster Session

Track Classification: Novel Gas-based Detection Techniques

Contribution ID: **16** Type: **Contributed Talk**

The CMS Silicon Strip Tracker - Overview and Status

Friday 16 September 2005 09:30 (15 minutes)

With more than 15000 silicon strip modules and an active silicon area of 200 squaremetres, the CMS silicon strip tracker will be the largest silicon tracker ever built. While module mass production has started in 2004, the detector construction has recently entered its crucial phase with modules being assembled onto larger substructures, which in turn are being integrated into the tracker barrel and end cap structures.

In this presentation the detector design will be introduced. The challenges and experiences of the silicon module mass production, with focus on the key components such as sensors and hybrids, will be presented. The status of the integration of modules onto the detector substructures, as well as the construction and integration of the large barrel and end cap structures, will be described. Finally an overview will be given on the excellent performance of subsystems of the tracker as observed in system tests and test beam experiments.

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Presenter: Dr FERNANDEZ, Javier (IEKP, Universitaet Karlsruhe, Germany)

Session Classification: S14 : Applications in Particle Physics

Track Classification: Applications in Particle Physics

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

P-spray implant optimization for the fabrication of n-in-p

Thursday 15 September 2005 10:30 (30 minutes)

One of the technological challenges of the fabrication of n-in-p and n-in-n microstrip silicon detectors is to obtain a good insulation of the n-strips while ensuring a satisfactory electrical performance of the devices. A common practice to avoid the formation of the conductive electron layer at the oxide-silicon interface is the definition of p-type zones ("p-stops") that surround the n-strips, but it has the drawback of adding a mask level to the fabrication process that increases its complexity. Furthermore, the high electric fields present at the edge of the p-stops have been shown to induce pre-breakdown micro-discharges. Another solution consists on performing a uniform p-implant ("p-spray") in the silicon surface, but it has to be carefully calibrated in order to ensure the strip isolation and avoid early breakdowns.

In this work we present an optimization study of the p-spray profile on n-in-p microstrip silicon detectors. A thorough simulation process, consisting on technological and electrical simulations, was carried out. The best technological options were chosen for the fabrication of miniature n-in-p microstrip detectors on high resistivity FZ wafers. A detailed analysis of the impact of the p-spray characteristics on the performance of the different fabricated devices will be presented.

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Session Classification: P : Coffee and Poster Session

Track Classification: Pixel Detectors for Charged Particles

Contribution ID: **18** Type: **Contributed Talk**

The CMS Muon system

Friday 16 September 2005 10:15 (15 minutes)

The CMS (Compact Muon Solenoid) is one of the detectors designed to study the future p-p interactions of the LHC (Large Hadron Collider) accelerator at CERN. Muons from p-p collisions are expected to provide clean signatures for many of the interesting processes which will be studied at LHC. CMS has put a big emphasis on developing a highly efficient muon system. It consists of four layers of concentric stations integrated in the return yoke of the 4T superconducting solenoid. This system will allow identification, track reconstruction and trigger of muons with momenta from a few GeV to a few TeV. It uses three different technologies of gaseous detectors:
For the barrel region, where the expected particle rates are low and the magnetic field will not be too high, Drift Tube Chambers (DT) have been chosen. The chambers are made by three independent subunits called SuperLayers (SL) (2Φ, 1θ) consisting on 4 layers of drift tubes staggered by half a cell. In addition to the anode wire and two I-beams with aluminium strips forming the cathodes, the cell design incorporates two aluminium strips facing the wire which shape the electric field and improve the linearity in the space-time relation. Each cell has a resolution <250μm thus ensuring a resolution <100μm per station. The tests performed in presence of magnetic field showed that the degradation in the performance is not significant for the values expected in CMS. Efficiencies per cell bigger than 99% were obtained.
Chamber electronics include a local trigger system. At the SL level, the Bunch and Track Identifier identifies the position, angle and time of passage of the particle by using a meantimer technique. It provides an efficient local standalone bunch crossing identification. The two ΦSLs are combined in a Track Correlator which reduces the noise and improves the angular resolution to 10mrad.
For the endcaps Cathode Strips Chambers (CSC) will be better suited: they must operate with high rates, and, in addition, the magnetic field will not be uniform and can reach 3.5 Teslas. The chambers consist of 6 detecting layers, with strips in the radial direction providing precise position measurement on the bending plane (resolutions better than 75 micron can be achieved), and wires perpendicular to them providing measurement in the radial direction and giving timing information. Chambers are equipped with trigger electronics. Muon segments are first found separately by anode and cathode electronics and then time correlated. A Local Charged Track (LCT) is formed when a coincidence of ≥4 hit strips (CLCT) or wires (ALCT) in different layers, belonging to a predefined road

occurs. Cathode trigger is optimised to measure Φ precisely and anode trigger is optimised for high efficiency bunch crossing identification A third detector, Resistive Plate Chambers (RPC), located both in the barrel and in the endcaps, provides a redundant and complementary trigger. The RPC are gaseous detectors made by two resistive parallel plates (Bakelite) separated by a few millimetres gas gap. It can operate in streamer or in avalanche mode but the streamer mode is not adequate for LHC because the rate capability in this case is limited ˜100Hz/cm2. The RPC design on CMS is made of two gaps, with common pickup strips in the middle to enhance the signal. To improve the rate capability Bakelite with "low" resistivity has been chosen. An excellent time resolution below 3ns, even at very high rates, is achieved. RPC trigger is performed by the Pattern Comparator Trigger. It requires a temporal coincidence of hits in at least 3 muon stations and compares the observed hit patterns with predefined valid patterns with defined pT. The bunch crossing is determined by the time coincidence of hits.

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Session Classification: S14 : Applications in Particle Physics

Track Classification: Applications in Particle Physics

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

The Effect of Position Resolution on LoR Discrimination for a Dual Head Compton-Camera

Thursday 15 September 2005 10:30 (30 minutes)

The SmartPET is a novel Positron Emission Tomography (PET) system that uses High Purity Germanium (HPGe) detectors in a dual-head camera design. Alone, the superior 3D position resolution o_ered by semi-conductor detectors removes the depth-of-interaction problem inherent in many PET camera designs. However, there is another opportunity o_ered by the system. Coincident measurement, in a single detector, of an interaction sequence arising from the path of a single photon allows each of the detectors to act independently as a Compton Scatter Camera (CSC).

The CSC relies on the measurement of the position and energy from individual inelastic scattering and photo-absorption interactions of a single incident photon. Measurement of two or more of these interactions (and knowledge of the incident energy) allow the CSC to define a Cone-Surface of Response (CSR), along which lies the incident trajectory of the photon. The resolution of this CSR is defined entirely by the uncertainty in position and energy in the measurements of the individual interactions.

The angular resolution of this CSR is defined by the scattering angle, the spatial and spectral resolutions of the detector, along with the distance between the first two interactions in the sequence [1].

The current study proposes the use of these CSR events in the discrimination of Lines of Response (LoR) in a PET system. Current PET studies show that up to 36 % of detected events may scatter inside the object [2], furthermore, in fully 3D PET up to 50 % of the coincident detections might arise from random coincidence [3]. LoR validation through CSR aquisition o_ers the ability to discriminate Compton scattered and randomly coincident detections, without the need to apply scatter correction algorithims nor implement delay coincidence channels respectivly.

As each of the detectors acts as a standalone CSC, each will acquire a number of different interaction sequence types, depending on the number of interactions that an incident photon undergoes. In a dualhead PET system coincident interaction sequences may be acquired leading to LoRs. Generally, in order to correctly define a CSC a knowledge of the incident energy is required. However, for discrimination purposes, 511keV may be assumed due to the CSC/LoR relationship requiring that an LoR lie along any associated CSC. If the assumption is false then a correct match is highly unlikely. Further, if time resolution is introduced at the interaction sequence level, then the coincidence of two interaction sequences in opposing detectors may not be defined uniquely, particularly in a high activity environment. In this scenario, each interaction sequence in a timing bin may be interrogated for LoR matching purposes.

The above validation was performed on co-linear 511 keV photon events simulated using Geant4. The simulation modeled HPGe detectors separated by 6-10 cm and a dual source at the center of the detector geometry. While energy resolution is still required in the definition of CSRs, the importance of position resolution in this PET detector design was the main focus of this study. Hence, energy resolution was initially assumed to be perfect, and the e_ect of position resolution on the ability of the CSRs to discriminate LoRs was investigated. CSR discrimination proved successful in removing both Compton scattered and random coincidences from the data. Moreover, the importance of positional resolution in CSC detection in the PET process is highlighted by this study.

These techniques may be used to reduce the number of false LoRs in a PET image obtained from such a system. It also indicates that the importance placed on full energy deposit and timing information, the focus of PET measurement over the past few years, may be reduced.

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Session Classification: P : Coffee and Poster Session

Track Classification: New Techniques for Positron Emission Tomography

Contribution ID: **21** Type: **Contributed Talk**

Micro Pixel Chamber Operation with Gas Electron Multiplier

Wednesday 14 September 2005 10:15 (15 minutes)

We are developing a micro-Time Projection Chamber (micro-TPC) based on a micro-pixel chamber (μ-PIC). A Micro-TPC is employed for an electron-tracking Compton camera [1,2].

A μ-PIC is a fine pixel-type two-dimensional imaging detector with a pixel pitch of 400μm and it has a detector area of 10×10cm2. We achieved a maximum gas gain of 15,000 and stable operation over 1,000 hours at a gas gain of 5,000. However, the stable gas gain of 5,000 is not high enough for detecting Compton-recoil electrons, dE/dx of which are the same as that of minimum ionizing particles (MIPs). A required gas gain for MIP detection is 2 –4 times as large as the achieved one.

Therefore, a hybrid detector consisting of a μ-PIC and a gas electron multiplier (GEM) is employed for realizing the required gain. A GEM is installed just above a μ-PIC and operated at a low gas gain (less than 50). We plan to use a GEM temporarily until a gas gain of a μ-PIC reaches the aimed gas gain alone by improvements of the electrode structure and manufacturing process. We used a GEM developed by Center for Nuclear Study, the University of Tokyo. The GEM consist of 50μm a thick kapton foil, and copper clad on each side, 70μm holes arranged with 140μm between centers, with detection area of 10×10cm2.

Operating a μ-PIC at a gas gain of 2.5×103, we achieved a maximum total gas gain of more than 105, and energy resolution of 1.2keV (21%) FWHM at 5.9keV (at a gas gain of 3.3×104). Long-term stability over 170 hours was also confirmed at a total gas gain of 2.0×104 (the μ-PIC was operated at a gas gain of 2.0×103, the GEM at 10). We achieved enough stable gain to detect MIPs and detected cosmic ray muons by micro-TPC. The ion feedback was suppressed to less than 10%, when GEM was operated at a gas gain of 10, which enables us to detect tracks of particles at higher rates.

Now we are developing a larger μ-PIC with a detection area of 30×30cm2 and GEM with that of 28×25cm2. The larger hybrid detector will increase detection efficiency of detecting charged particles, and enable us to measure longer tracks.

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Session Classification: S7 : Novel Photon Detection Systems

Track Classification: New Gas-based Tracking Detectors

Contribution ID: **22** Type: **Contributed Talk**

The Silicon photomultiplier for application to high-resolution gamma cameras for PET applications

Tuesday 13 September 2005 12:00 (15 minutes)

Positron Emission Tomography (PET) for small animal studies requires high-resolution gamma cameras with high sensitivity. Traditionally, inorganic scintillators are used and, in recent times, coupled to position sensitive PMTs. Such PSPMTs are costly, operated at high voltage and have a relatively low packing fraction. However, their advantage, compared to current solid state photodetectors, is their high signal-to-noise ratio.

The Silicon Photomultiplier (SiPM) is a silicon diode detector that shows great promise as a photodetector for scintillators and hence application in nuclear medicine imaging applications. The MRS (Metal-Resistor-Semiconductor) structure of the SiPM leads to a self-quenching, Geiger-mode avalanche photodiode (GAPD), that produces a large gain (106) at low bias voltage (50V). The standard operation of a GAPD is such that each signal produced in the depletion region, regardless of the original number of photoelectrons, produces the same fixed amplitude output signal, the magnitude of which is determined by the quenching resistance. In this way a GAPD performs as a digital counter, giving no information of the number of original photoelectrons produced and thus prohibiting the possibility of having analogue information for spectroscopy. The SiPM structure overcomes this inherent limitation by dividing the silicondiode surface area into a large number of regions called microcells, each of which acts like an independent and identical GAPD. This is achieved by forming the p-n junction in ˜20 x 30 ⍰m2 cells, separated by a gap of a few microns, that defines the detector structure. Thus, the avalanche region is localised to each cell. If the outputs of all these microcells are summed together then the output signal is proportional to the number of microcells activated. In the MRS SiPM, the microcell signals are multiplexed by the common metal electrode contact layer. In this way, the SiPM provides a large, proportional signal for low to moderate photon flux (Nphotons< Ncells), such that even a single optical photon can be easily detected and resolved. The preliminary studies we have made of the MRS SiPM have demonstrated a very promising photodetector that is stable and rugged, has excellent single photoelectron resolution, fast recovery time and a high gain at low bias voltage. Experimental results demonstrating these performance characteristics will be presented. The fabrication is fairly simple and does not require special high-resistivity silicon, therefore having the potential to be a low cost detector solution. There is no requirement for special, low-noise electronics since the gain is sufficient to give a large signal-to-noise ratio. Its dimensions are ideal for forming high-resolution matrices for PET or other scintillator imaging applications.

The disappointment with the original SiPM that was studied was that the quantum efficiency was found to be very low. For this reason the light yields measured with scintillation pixels was found to be small, of the order of 25 photoelectrons for a 511 keV photopeak in LSO. However, in the meantime, SiPM development has focused on the improvement of the quantum efficiency to obtain better light yields. In fact, with a blue sensitive version of this device we have measured an energy resolution at 511 keV with a LSO pixel of 25% which is approaching that measured with position sensitive PMTs. Such a compact silicon detector, with a performance similar to a PMT, is obviously well disposed to being developed into a close-packed array in order to have a position-sensitive detector surface. We propose a miniature, high-resolution detector head for a small-animal PET imaging system that is based on such an array of SiPM. The design is based upon the classic Anger camera principle; one detector module layer consists of a continuous slab of scintillator, viewed by a matrix of SiPM. A detector head of 5×5 cm2 in area is proposed, constructed from three module layers of the continuous detector described above. The stacked layers would give the system intrinsic depth of interaction (DOI) information. Results of a simulation, using the Monte Carlo package GEANT4 are presented. The simulation results are used to determine the performance of a single detector head and to optimize the geometry of the detector, resulting in a high spatial resolution of up to ˜0.6 mm full-width at half maximum (FWHM) and a sensitivity determined by the number of layers used.

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Presenter: Dr HERBERT, Deborah (INFN Pisa)

Session Classification: S4 : New Techniques for Positron Emission Tomography

Track Classification: New Techniques for Positron Emission Tomography

Contribution ID: **23** Type: **Contributed Talk**

The novel multi-collimator using BP-1 glass and an application for X-ray CCDs

Thursday 15 September 2005 17:15 (15 minutes)

Charge-coupled devices (CCDs) are widely used in soft X-ray Astronomy as a focal plane detector which has a capability both of good spatial resolution and good energy resolution up to 10 keV, simultaneously. For the future X-ray space mission, the thick CCDs are developed to improve the quantum e±ciency of high energy X-rays beyond 10 keV.

A mesh experiment has been, so far, the only practical technique to study CCD response with subpixel resolution. The mesh technique has revealed the X-ray response within a pixel for various types of CCDs (see e.g., Hiraga et al. 2001[1]). Hiraga et al. [2] developed this technique to directly measure the final charge cloud shape. However the mesh experiment is valid for X-rays only when they can pass through the mesh at a hole. The mesh of the out-of-hole position must be opaque for X-rays. Employing the gold mesh of about 13 µm thickness that is the thickest one in current production, the e®ective energy range was thought to have an upper limit of 7 keV. This fact has prevented us to measure the charge cloud shape for higher energy X-rays.

We have proposed the new method to produce the novel multi-collimator using Barium Phosphate (BP-1) glass which has originally developed as a solid state track detectors (Wang et al. 1988[3]). The BP-1 collimator enables us to determine the interaction position of each X-ray photon much precisely than the CCD pixel size (10µm in general) up to 20 keV Xrays.

We performed the first experiment of this project in which 80-100MeV/nucleon of Xe beam was irradiated to the 1.3mm-thick-BP-1 glass. After the etching process, we obtained the first prototype of BP-1 collimator. It has lots of tapered pinholes which are randomly distributed, » 104 holes cm−2 with high aspect ratio. In this conference, we will report the novel collimator and the results of an application to the X-ray CCDs.

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Session Classification: S13 : Applications in Space Science

Track Classification: Novel Photon Detection Systems

Contribution ID: **24** Type: **Contributed Poster**

Novel Position-Sensitive Ion-Current Detector Arrays Using a Self-Collection Method for Secondary-Electron Suppression

Thursday 15 September 2005 10:30 (30 minutes)

Recent findings of the importance of radially sheared electric-field formation in plasmas enhance the requirements of spatial-profile measurements of ion-confining potentials and ion-current signals simultaneously. For instance, the frequency analyses of end-loss ion-energy spectrometer arrays (IES) signals show the existence of electron drift waves, giving a peaked structure over a few kHz and turbulence-like fluctuations without any coherent azimuthal phasing relation below a few kHz during a weaker sheared period. On the other hand, some finite levels of turbulent fluctuations and remarkable suppression of turbulence are found during a stronger sheared period with ECH. This encourages the usefulness of potentials and radial electric-field shear for confinement improvements.

For the purpose of observations of these important parameters, we have been developing several types of multigridded electrostatic ion-energy spectrometers and ion-current detectors because of their compact-sized simple structures and convenient handling without the effects on the plasma-confining magnetic fields of the plasma device. These ion-diagnostics are proposed to obtain precise ion-energy spectra and absolute values of ion currents without any perturbations from simultaneously incident energetic electrons into the arrays. For instance, the ion-current detector consists of a set of parallel metal plates with respect to lines of ambient magnetic forces of a plasma device for analyzing incident ion currents along with a grid for shielding the collector against strays due to the metal-plate biasing. One of the most essential characteristic properties of the proposed detector is based on the physics principle of a "self-collection"mechanism for suppressing the effects of secondary-electron emission from a metal collector. Availability of the detector is clearly demonstrated in the GAMMA10 plasma experiments.

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Session Classification: P : Coffee and Poster Session

Track Classification: X-ray and Gamma-ray Detectors

Contribution ID: **25** Type: **Contributed Poster**

Characterization of X-ray Energy Responses of both n-type and p-type Silicon Tomography Detectors Irradiated with Fusion Produced Neutrons

Thursday 15 September 2005 10:30 (30 minutes)

Two- or three-dimensional X-ray tomographically reconstructed data analyses by the use of multichannel silicon semiconductor detectors play an important role in investigating plasma electron behaviour in controlled thermonuclear fusion research. However, recent harsh radiation environments in fusion experiments with deuterium-tritium (D-T) and/or deuterium-deuterium (D-D) reactions pose the serious problem of radiation-induced degradation in X-ray detection characteristics of silicon semiconductor detectors.

In order to clarify the effects of fusion-produced neutrons on silicon semiconductor x-ray detectors, the characterization experiments for both n-type and p-type multichannel silicon x-ray-tomography detectors used in the Joint European Torus (JET) and the GAMMA 10 tandem-mirror are carried out by utilizing D-T fusion neutron production at the Fusion Neutronics Source (FNS) facility of Japan Atomic Energy Research Institute (JAERI). These detectors are characterized before and after the fusion-produced neutron exposure by the use of synchrotron radiation from a 2.5-GeV positron storage ring at the Photon Factory of High Energy Accelerator Research Organization (KEK). Different fluence dependence is found between these two types of detectors; (i) for the n-type detector, the recovery of the degraded response is found after the neutron exposure beyond around 1013 neutrons/cm2 onto the detector. A further finding is followed as a "re-degradation"by a neutron irradiation level over about 1014 neutrons/cm2. On the other hand, (ii) the energy response of the p-type detector shows only a gradual decrease with increasing neutron fluences. Similar characterization experiments for p-type detectors with different effective doping concentrations are also carried out. These properties are interpreted by our proposed theory on semiconductor x-ray responses in terms of the effects of neutrons on the effective doping concentration and the diffusion length of a semiconductor detector.

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Session Classification: P : Coffee and Poster Session

Track Classification: X-ray and Gamma-ray Detectors

Contribution ID: **27** Type: **Contributed Talk**

Photosensitive Gaseous Detectors for Cryogenic Temperatures Applications

Friday 16 September 2005 11:45 (15 minutes)

Noble liquids are excellent detecting medias: they have a rather high stopping power, allow electrons and ions to drift and they have an exceptionally high scintillation yield. All these properties are simultaneously exploited in the noble liquid Time Projecting Chambers (TPCs) which allow to visualize charge tracks, measure the deposited energy and the light to charge ratio [1]. One of the critical elements of noble liquid TPCs are photosensitive detectors. Nowadays, vacuum PMs are usually used for this purpose. The main drawbacks of these detectors are: the high cost and sensitivity to magnetic fields (desirable for some experiments).

We have demonstrated recently that some gaseous detectors combined with CsI photocathodes could operate at cryogenic temperatures [2,3]. Such detectors are much cheaper than PMs and they are insensitive to magnetic fields. In this report we will present our new and yet unpublished results on the development of sealed planar gaseous detectors (wire- type and hole- type) combined with reflective and semitransparent CsI photocathodes and present the studies of their operation inside LAr and LN2. Results of systematic measurements of their quantum efficiencies, the maximum achievable gains and long-term stabilities will be presented. In addition the operation of gaseous detectors combined with other solid photocathodes was also studied.

We will also present the results on the operation of windowless photosensitive detectors (parallel-mesh-type and hole-type) placed either in cooled gases or directly in vapours a few cm above the noble liquid level will. Based on the obtained results a comparison will be done between the sealed and windowless photosensitive gaseous detectors. Note that the windowless detectors could also be used for the detection of the charge tracks. As an example we will describe our first experiments with muon's charge track extraction from the LAr and detected by a specially developed hole-type detector made of G10 [4].

The successful operation of these detectors open realistic possibilities in replacing PMs by photosensitive gaseous detectors in some applications dealing with cryogenic liquids. Examples could be: the ICARUS experiment, WIPMs search LAr/Xe detectors, noble liquid scintillating calorimeters and cryogenic PETs.

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Session Classification: S15 : Novel Gas-based Detection Techniques

Track Classification: Novel Gas-based Detection Techniques

Contribution ID: **28** Type: **Contributed Poster**

A readout ASIC for a counting silicon microstrip detector used in a Compton polarimeter

Thursday 15 September 2005 10:30 (30 minutes)

An ASIC capable of counting individual hits on a silicon microstrip detector used in a Compton polarimeter has been developed. Laser photons backscattered off an incident high-energy electron beam in the 3.5GeV electron stretcher ring ELSA at Bonn university are pair converted in a lead convertor and then detected on a silicon strip sensor. The sensor is read out by a mixed-signal ASIC that consists of 128 channels, each one having a charge sensitive amplifier with continuous reset, configurable pole-zero cancellation, a CR-RC shaper with variable shaping time, a comparator and a DAC to tune the comparator threshold. For each channel an asynchronous ripple counter and additional digital circuitry is available to count the number of hits and to serialize the counter reading. The digital circuitry uses differential current logic to minimize digital to analogue crosstalk and substrate noise coupling. The shaping time, the pole-zero cancellation and the TRIM-DAC is configured via an I2C interface. In this talk the detector system, the ASIC architecture and performance measurements will be presented.

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Presenter: Dr KARAGOUNIS, Michael (Universitaet Bonn)

Session Classification: P : Coffee and Poster Session

Track Classification: Applications in Particle Physics

Contribution ID: **29** Type: **Contributed Poster**

High-position-resolution neutron imaging detector with crossed wave-length shifting fiber read-out using two ZnS:Ag/6LiF scintillator sheets

Thursday 15 September 2005 10:30 (30 minutes)

High-intensity pulsed neutron sources have made a great deal of progress at Japan (J-PARC project), U.S.A. (SNS project), and UK (ISIS-II project). The specifications required for neutron imaging detectors used at these facilities are a high-position resolution, high-detection efficiency, a high counting rate, a high n/⊠ ratio, etc. Especially the detectors which exhibit a high-position resolution and high detection efficiency are required for the crystallography diffractometers. Moreover, it is also essential for these detectors to be compact and to have the least dead-detection area for a large solid-angle coverage.

We have developed a compact high-position-resolution neutron-imaging detector with wavelength shifting (WLS) fibers using two scintillator sheets. The two ZnS:Ag/6LiF scintillator sheets are placed in front and back side of the crossed WLS fibers arrays. The luminescent light generated in either scintillator sheet is detected by few WLS fibers surrounding to the incident point of the neutron. The X and Y positions of the incident neutron are measured by the photon counting method or by the double coincidence method. The WLS fibers are bent at right angle at the edges of the scintillator sheets to reduce the dead-detection area of the detector. The developed detector structure ensures compactness and easy assembly of these types of detectors.

It was confirmed that the neutron imaging detector using WLS fibers with a size of 0.5 x 0.5 mm exhibited a position resolution of less than 0.8 mm. The detection efficiency for thermal neutrons was improved 55% by two scintillator sheets from 29% by the single sheet.

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Session Classification: P : Coffee and Poster Session

Track Classification: Applications in Nuclear Physics

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

High speed position readout for MCP based space plasma instruments

Thursday 15 September 2005 10:30 (30 minutes)

Position sensitive micro-channel plate detectors are attractive for space plasma instruments but have a number of limitations. Most of the techniques have limited global rate handling and require the MCP to run at high gain with MCP lifetime implications. In addition, available mass and power resources limit the number of channels of readout electronics.

A fast position sensing technique has been developed that is well suited for MCP-based space plasma applications. The output charge from the MCP falling on an anode pixel is capacitively split to two separate channels of readout electronics. Introducing a time difference between the channels and choosing an appropriate readout pattern provides unique identification of the position of the incoming event. The time difference can be due to differences in the amplitude of the signal as described in (J.S.Lapington, Nucl. Instr. and Meth., 513 (2003) 132) or due to discreet delays introduced in the system. The channels can be interleaved so that each readout channel can be connected to several pixels, reducing the total number of readout channels and the performance of the system can be optimised depending on the resolution, rate-handling and lifetime requirements of the instrument. Details of the application and preliminary results with an electrostatic plasma analyser are presented.

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Session Classification: P : Coffee and Poster Session

Track Classification: Applications in Space Science

Contribution ID: **31** Type: **Contributed Poster**

Fast Scintillator Strip Position Detector with R7400 Photomultipliers Readout used in ZEUS Experiment at HERA II Collider

Thursday 15 September 2005 10:30 (30 minutes)

A position sensitive scintillator strip detector used for the Luminosity Monitor of the ZEUS experiment is described. The detector readout based on the R7400 photomultipliers is presented. It offers satisfactory spatial resolution of 3 mm and a good signal to noise ratio that allows to run at the rate up to 10 MHz. The data obtained with the position detector are used for luminosity measurement and also for the monitoring and on-line correction of the HERA II beams.

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Session Classification: P : Coffee and Poster Session

Track Classification: Applications in Particle Physics

Contribution ID: **32** Type: **Contributed Talk**

Performance of Micromegas detector in CAST experiment

Tuesday 13 September 2005 09:30 (15 minutes)

A micropattern gaseous detector has been designed for the CERN Axion Search experiment CAST, based on the Micromegas technology. The twodimensional readout, with XY strip structure, allows for sufficient spatial sensitivity and the low natural radioactivity materials used for its construction meet the experiment demands for low background. The detector is operated with an Argon/Isobutane (95% 5%) mixture and is controlled by a VME data acquisition system. It is optimized for soft Xrays (110keV) detection, exhibiting linear response and good energy resolution (19% FWHM at 5.9 keV). The Micromegas detector operated efficiently during the 2003 and 2004 data taking periods of CAST and its upgrade for the 2004 run, supported by the development of sophisticated software analysis tools, improved the background rejection leading to a rate of about 5.105 events/keV/cm2/s with 92% efficiency. Detailed Monte Carlo studies, using the GEANT4 package, indicate that the measured background is induced by muons hitting the surrounding materials as well as neutrons from the experimental site and environmental radioactivity (Radon).

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Presenter: Mr KOUSOURIS, Konstantinos (Nuclear Physics, NCSR Demokritos)

Session Classification: S3 : X-ray and Gamma-ray Detectors

Track Classification: X-ray and Gamma-ray Detectors

Contribution ID: **33** Type: **Contributed Poster**

A Semiconductor Compton Camera Using Position-Sensitive Si/CdTe Detectors

Thursday 15 September 2005 10:30 (30 minutes)

Compton cameras are the most promising approach for gamma-ray detection from several tens keV to several MeV. High energy resolution and position resolution are of particular importance to obtain high angular resolution, and hence clear images. We are developing new Compton cameras using Si and CdTe semiconductor position-sensitive detectors. Si is suitable for a scatterer because
it has high Compton scattering efficiency below 1 MeV, and CdTe is appropriate for an absorber with its high photo-electric absorption efficiency.
Here, we will demonstrate the results obtained with our prototype compton camera. The Compton camera consists of six layers
of Si Strip detectors, and CdTe pixel detectors. Low noise analogue
ASICs, VA32TAs are utilized to read out signals from the detectors.
We obtained Compton-reconstructed images and spectra of line gamma-rays from 81 keV to 662 keV. An angular resolution of several degrees is obtained when we reconstructed Compton scattering events.
The energy resolution is 9.1 keV and 18 keV at 356 keV and 511 keV, respectively. In this presentation, the most recent prototype of Compton cameras combined with scintillators for anti-shields will also be addressed.

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Session Classification: P : Coffee and Poster Session

Track Classification: X-ray and Gamma-ray Detectors

Contribution ID: **34** Type: **Contributed Talk**

A multichannel detector array with 768 pixels developed for electron spectroscopy

Wednesday 14 September 2005 15:00 (15 minutes)

A one dimensional detector array using MCP technology in conjunction with a custom ASIC is presented. The detector chip features 768 pixels, each 3mm in length on a pitch of 25um, giving a length in the dispersive direction of 19.2 mm. Each pixel is furnished with a pre-amplifier and discriminator coupled to a 16-bit counter. The chip and MCP are mounted on a ceramic and stainless steel assembly that replaces the conventional channeltron in a CLAM4 electron energy analyser. Results are presented showing key aspects of the detector, including the yield of the chip at wafer stage, the vacuum compatibility of the system, the speed of readout, uniformity of response and maximum count rate.

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Session Classification: S9 : Detectors for Synchrotron Radiation and Spallation Neutron Sources

Track Classification: Detectors for Synchrotron Radiation and Spillation Neutron Sources

Contribution ID: **35** Type: **Contributed Talk**

A Demountable Readout for Optical Image Intensifiers

Thursday 15 September 2005 16:30 (15 minutes)

The performance and operational advantages of using electronic image readouts in image intensifiers, such as their simplicity, flexible format, low noise, and capability for high spatial and temporal resolution, are offset by the practical issues of housing them within the detector vacuum enclosure. They commonly require oversized, non-standard vacuum enclosures, multiple low noise electronic ultra high vacuum (UHV) feed-throughs, need to be manufactured in UHV suitable materials capable of being baked to high temperatures, and are often difficult to re-use should a failure occur during detector assembly, for example due to a vacuum leak.
We describe an image intensifier utilizing the Image Charge technique which eliminates the requirement for the electronic image readout to be located within the vacuum enclosure. The Image Charge technique utilizes a single resistive anode within the vacuum enclosure to localize the event charge, while the charge signal is capacitively coupled to the readout device through a dielectric substrate which doubles as the rear wall of the vacuum enclosure.
We present results obtained using a generic intensifier design with a variety of readout devices manufactured using standard multi-layer PCB techniques, from a 50 ohm multi-element design optimized for high speed operation to a four electrode multi-layer device developed from the wedge and strip anode with enhanced image resolution. The benefits of this intensifier design are discussed and a readout scheme with integrated multi-channel ASIC based electronics, which combines high spatial resolution at very high count rates, is proposed

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Session Classification: S13 : Applications in Space Science

Track Classification: Applications in Space Science

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

Non-linearity Reduction in Electronic Image Readouts

Thursday 15 September 2005 10:30 (30 minutes)

Simulation of detector operation can be a valuable tool in optimizing design before recourse to cutting metal, and if successful, can significantly reduce the requirement for design iteration. This paper describes this process as applied to the reduction of spatial non-linearities in electronic charge division readout devices.

Several theoretical analyses of the non-linearities expected such devices in have been previously undertaken, however all suffer from the inability to analyze the perimeter pattern areas where the electrode geometry does not bear simple analytical description. We present a technique whereby an arbitrary radial charge footprint may convolved with any electrode structure which can be defined as a closed polygon, to calculate total charge deposited on the electrode. This technique can be used for electronic charge division image readouts to accurately determine the effect of arbitrary electrode perimeter designs; the major cause of non-linearity in these devices.

We present measurements of readout non-linearity both from pattern simulations and from manufactured readout patterns used in an operational microchannel plate detector, and use comparison to demonstrate the validity of this convolution technique. We describe a computer procedure whereby the linearity measurements from real image data may be obtained automatically by looking for correlation between a predefined kernel obtained from the image, and representing repetitive elements within the image data.

We demonstrate how the design of the electrode perimeter is crucial in the mitigation of readout non-linearity and present results from designs optimized using this simulation technique. We discuss the degree of improvement gained using this method and suggest areas where simulation prior to manufacture may be used to good effect.

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Session Classification: P : Coffee and Poster Session

Track Classification: Applications in Space Science

Contribution ID: **37** Type: **Contributed Talk**

Status and Performance of the CDF Run II Silicon Detector

Friday 16 September 2005 09:45 (15 minutes)

The CDFII silicon detector with its 8 layers of double-sided silicon microstrip sensors and a total 722,432 readout channels is one of the largest silicon detector devices presently in use by a HEP experiment. We report our experience commissioning and operating this complex device during the first four years of Tevatron Run II program. The performance of the system and its impact on physics analysis are reviewed. As the luminosity delivered by the Tevatron increases, measurable effects of radiation damage have been observed. Recently updated studies of charge collection and noise versus applied bias voltage at several different integrated luminosities will be presented. These results and their impact on the expected lifetime of the detector will be discussed.

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Presenter: Dr MITRA, Ankush (Institute of Physics, Academia Sinica Taiwan/Fermilab, USA)

Session Classification: S14 : Applications in Particle Physics

Track Classification: Applications in Particle Physics

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

PSD Infrared Monitor for Remote Diagnostics of Accelerated Beams and Bunches

Thursday 15 September 2005 10:30 (30 minutes)

Results of measuring the equilibrium radius and dimensions of the small cross section of the electron ring bunch are presented. The description of multi-channel sistem for investigation of dynamics of the electron ring compression by synchrotron radiation is given. The system consists of an optical channel, infrared radiation detector, a unit of amplifiers, electronics of monitoring and coupling with a computer. The program of the information read out operates in the real time disc operation system.

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Presenter: Dr MALTSEV, Anatoly (JINR. Dubna)

Session Classification: P : Coffee and Poster Session

Track Classification: Detectors for Synchrotron Radiation and Spillation Neutron Sources

Contribution ID: **39** Type: **Contributed Talk**

Technology transfer of microstrip detectors; from medical applications to synchrotrons

Wednesday 14 September 2005 15:15 (15 minutes)

The microstrip detector is the workhorse of position sensitive detectors for tracking in particle physics experiments. Spatial resolution of a few µm is easily achieved at read-out rates of few MHz. Utilising modern fabrication techniques (photolithography and ion implantation) provides with reliable and versatile devices with designs that can be tailored to meet the demands of different and diverse applications where PSD's are in demand, ranging from medical dosimetry to beam line monitoring in synchrotrons. To that extend we build a silicon microstrip detector around the XCHP ROIC originally developed for SR experiments. This comprises of a series of charge sensitive preamplifiers (128 of) working on integrating mode with on chip multiplexing and correlated double sampling (CDS). Now commercially available by ETL as part of XDAS, it provides with a complete, versatile and low cost PC based DAQ system. The use of multileaf collimators (MLC) in modern radiotherapy techniques like IMRT requires dynamic measurements in the presence of high dose gradients. This requires a dynamic range dosimeter with sub-millimetre spatial resolution as well as high linearity. In addition, real time measurements will be beneficial to the QA procedures of modern LINACs. Preliminary trials of our prototype microstrip detector at the Weston Park Hospital in Sheffield (UK) produced very encouraging results showing a film like penumbra (Figure 1). Further results of the detector's evaluation as PS dosimeter for IMRT and from experiments with other radiotherapy modalities, like the synchrotron based Microbeam Radiation Therapy (MRT) will be presented.

In addition, results will be presented with its use as beam position monitoring device in synchrotron experiments. This is very important with the ever decrease in sample and beam size accordingly, which imposes severe constrain in beam focus and stability especially for measurements that require long acquisition times, as any drift will be detrimental or at worst catastrophic for the data quality.

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Session Classification: S9 : Detectors for Synchrotron Radiation and Spallation Neutron Sources

Track Classification: Detectors for Synchrotron Radiation and Spillation Neutron Sources

Contribution ID: **40** Type: **Contributed Poster**

Accurate timing of gamma photons with high-rate Resistive Plate Chambers

Thursday 15 September 2005 10:30 (30 minutes)

Timing Resistive Plate Chambers (tRPCs) are planar gaseous detectors made with resistive electrodes, accurately spaced, that define very thin gas gaps. Such detectors are known to provide timing accuracies around 50 ps sigma for minimum ionizing particles.

In practice, the counting rate capability of RPCs is strongly conditioned by the availability of suitable resistive materials for the electrodes. For many applications of tRPCs, e.g., time-of-flight measurements in heavy-ion high-energy physics, the extension of the counting rate capabilities achievable with glass electrodes, around 2 kHz/cm2, to much higher values is of fundamental importance.
To address this issue we developed 9 cm2 single-gap tRPCs with electrodes made from metal and from a commercially available ceramic material with a measured resistivity of 109 ⊠•cm and free of charge-depletion effects.

Time resolution tests were performed irradiating with simultaneous 511 keV photons from the annihilation of positrons emitted by 22Na. The time resolution remains essentially unchanged, at around 90 ps ⊠, up to 20 kHz/cm2 without any visible rate-induced efficiency loss. Previous experience with timing RPCs, tested both in particle beams and with annihilation photons, has shown that, while single-gap counters may reach a time resolution close to 50 ps ⊠ in particle beams, similar counters irradiated with 511 keV simultaneous photons reach only about 90 ps ⊠. Such behaviour may be attributed to the different characteristics of the primary charge distributions resulting from each irradiation method.

The present result establishes the practical feasibility of accurate timing measurements with RPCs at rates up to 20 kHz/cm2, while keeping a time resolution below 100 ps ⊠.

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Session Classification: P : Coffee and Poster Session

Track Classification: Pixel Detectors for Charged Particles

Contribution ID: **41** Type: **Contributed Poster**

Automatic method to manufacture 2D Multiwire Proportional Counter frames

Thursday 15 September 2005 10:30 (30 minutes)

One of the most known 2D X-ray detectors is the MWPC (Multiwire Proportional Counter). This is a 2D position sensitive gas detector based in the proportional chamber. It consists of a frame with parallel wires which form a plane (anode) sandwiched between two cathodes planes formed also by parallel wires.

In this job, we describe a complete solution to manufacture anodes and cathodes for a MWPC. The solution consists of a semiautomatic winding machine and a soldering method by radiation. This method allows manufacturing one frame in two hours and with a minimum human intervention. The machine can work with several types of frames and a great accuracy in the position of the wires can be achieved.
The idea of making an automatic system of manufacturing arises of several reasons:

- When we work with a big area (> 200x200 mm2) MWPC and spatial resolution better than 0.3 mm FWHM in the submilisecond scale, the frames (anode and cathode) need a high accuracy grade in the positioning and the stress of the wires. With the traditional method of soldering (by hand), the accuracy achieved in the positioning was not good enough for our purpose. For example, with wires separated 1 mm, an error of 0.1 mm in the positioning inserts uncertainties of 20% in the gain. Then, when we work with big area detectors, we achieve a non-homogeneous behavior.
- When we operate with a MWPC in synchrotron facilities, the aging is one of the main problems due mainly to the fact that high rate X-rays induce deposits in the frames wires which need to be repaired or changed often. The traditional method to manufacture these frames needs a lot of time and ability. It can take a month to make a set of two cathodes and one anode. For this reason is necessary to dispose of an automatic and fast system for the manufacture of these frames.
- Errors in the stress of the wires necessarily imply an error in the positioning getting the same effect commented in the previous section. For this reason it is very important that all the wires had the same stress and this was as bigger as possible (especially for small diameter wires ☒10 ☒m).
- The way of fixing the wires to the frames is to solder with tin. The weldings's shape in the frames must be smooth in order to avoid sparks and broken wires due to discharges, reducing drastically the detector's life. In a set of frames of a big area detector there are more than 1200 weldings, therefore to weld them at the same time all it is a great idea.

In this job we present a system with the following advantages:

1. With this system a fast and accurate method of frame manufacture is achieved. The positioning of the wires improves considerably.
2. The weldings has a smooth shape and avoid the electrostatic discharges.
3. Any technician could work without many problems. It is not necessary he/she was an authentic artisan.

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Session Classification: P : Coffee and Poster Session

Track Classification: X-ray and Gamma-ray Detectors

Contribution ID: **42** Type: **Contributed Poster**

Hybrid pixel detector development for medical radiography

Thursday 15 September 2005 10:30 (30 minutes)

The instrumentation group within Monash Centre for Synchrotron Science (MCSS) and the Co-operative Research Centre for Biomedical Imaging Development (CRC BID) are developing detectors for medical, industrial, synchrotron and other scientific applications. A seven year project has been initiated to develop hybrid pixel detectors for medical radiography. The device will comprise an array of semiconductor diodes bonded to chips containing an array of readout pixels. Chips will be tiled to produce large area detectors, capable of energy dispersive photon counting operation at moderate spatial resolution (to 5 lp/mm), facilitating simultaneous multi-spectral image data acquisition.

The read out chips provide individual data acquisition channels for each pixel. Each channel comprises a pre-amp, shaping amp, analogue-to-digital converter (ADC), histogramming memory, a controller and digital-to-analog converter (DAC) to adjust amplifier gains. The controller places data to the correct memory location and must communicate with adjacent pixels to identify and resolve multi-pixel events. Considerable challenges must be overcome to meet these design goals using current 90 nm fabrication processes. The project will investigate newer the compound semiconductor materials GaAs, CdTe, Cd0.9Zn0.1Te and HgI2, and explore methods for bonding these onto the readout chips.

The rapid acquisition of multi spectral data will enable K-edge -subtraction imaging of contrast agent distribution and quantitative methods of x-ray analysis (QXRA), which delivers information about the density and composition of the sample. The principle obstacles to realising QXRA are the energy resolution and stability of the detector, the detection of scattered radiation and the limited number of photons available per channel. We present preliminary results from studies examining the design features of the hybrid pixel detector, and the feasibility for using the device for QXRA.

Acknowledgements

This study was supported by grants from the Australian government, department for education, science and training CRC for Biomedical Imaging Development.

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Session Classification: P : Coffee and Poster Session

Track Classification: Applications in Nuclear Medicine And Radiology

Contribution ID: **43** Type: **Invited Talk**

The Potential for New Detector Technologies in Medical Imaging

Tuesday 13 September 2005 11:00 (30 minutes)

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Presenter: Prof. LEWIS, Robert (Monash University, Australia)

Session Classification: S4 : New Techniques for Positron Emission Tomography

Track Classification: New Techniques for Positron Emission Tomography

Contribution ID: **45** Type: **Contributed Talk**

Results from the analysis of digitally acquired experimental data collected with the AGATA symmetric prototype detector and its implications to the Advanced GAmma Tracking Array

Thursday 15 September 2005 10:30 (30 minutes)

High-precision g-ray spectroscopy is currently the most powerful tool that can be used to investigate the structure of a nucleus under extreme conditions. High Purity Germanium (HPGe) detectors with their excellent energy resolution and good timing resolution have been the main 'work horse'in this field.

The AGATA symmetrical segmented Canberra Eurisys (CE) prototype germanium crystal has been tested at the University of Liverpool. A highly collimated Cs-137 (662keV) beam was scanned across the detector in both singles and coincidence modes. The output pulse shapes from all 37 channels (one for each of the 36 segments + the centre contact) were digitised and stored for offline analysis. The analysis of the characteristics of the real and transient pulse shapes from the detector (Pulse Shape Analysis) gives us detailed information on its performance in relation to both the possibilities and limits of g-ray tracking with the proposed 180 crystal array. The results of this analysis are presented

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Session Classification: P : Coffee and Poster Session

Track Classification: Applications in Nuclear Physics

Contribution ID: **47** Type: **Contributed Talk**

Development of Large area Gamma-ray Camera with GSO(Ce) Scintillator Arrays and PSPMTs

Tuesday 13 September 2005 14:30 (15 minutes)

We have developed a position-sensitive scintillation camera with an area of 15×15cm2 for absorber of a Compton gamma-ray camera for astronomy. It consists of 3×3 array of position sensitive PMTs (Hamamatsu Flatpanel H8500). Each PMT has 8×8 anodes with a pitch of 6mm and is coupled to 8×8 array of pixelated 6×6×13mm3 GSO scintillators.

We chose the GSO scintillator because it has advantages in astronomical use, such as high radiation hardness and high stopping power. The crystal surface was polished by chemical etching. We adopted 3M ESR(Enhanced Specular Reflector) film with a thickness of 65μm as reflector of the scintillator. Therefore, we can increase the effective area of scintillator array to 97.8% from 93.4 % in case of Teflon with a thickness of 200μm. Total effective area of our scintillation camera with size of 15×15cm2 was improved to 80%. In order to reduce power consumption in a balloon-born experiment, the number of readout channels was reduced by using chained resistors. The signals from 24×24 anodes were readout through 48 channels. The energy resolution was 7.1%(FWHM) at 1275keV, 9.8% at 662keV and 24.3% at 122keV. The position of incident gamma ray was calculated on the principle of charge division method, and each pixel in flood field irradiation image was able to be clearly resolved.

Aiming at higher energy resolution we have been studying Zr/Ce-codoped GSO scintillators, because its light output is larger than that of conventional Ce-doped GSO. Furthermore in order to improve position resolution we have been developing 16×16 array of pixelated 3×3×13mm3 GSO scintillators coupled to the PSPMT. These results will also be presented.

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Session Classification: S5 : Applications in Astronomy and Astrophysics

Track Classification: Applications in Astronomy and Astrophysics

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

Minimizing guard ring dead space in the Si detector with n-guard ring at the edge of the detector

Thursday 15 September 2005 10:30 (30 minutes)

Detectors for n-type silicon with an n+ -type guard ring have been investigated. The Si detectors in high-energy physics experiments require a reliable performance in irradiation conditions. Minimizing dead wafer space is an additional advantage as it enhances the efficiency of a detector [1]. The guard ring technique has evolved to minimize this dead space at the edge of the detector. Also the guard ring structure is used for improving the breakdown performance of the Si detectors.

In the present work, the new p+ / n / n+ detector structure with n+ guard ring is described. The guard ring is placed at the edge of the detector and the distance from p+ anode to the back edge of the guard ring is 300 µm, which is also the wafer thickness. The depth of the junction and the guard ring is 3 µm. Also the width of the guard ring is 3 µm.

The detector depletes also sideways, so the signal can be collected very close to the n-guard ring. In this kind of structure, the dead space of the detector is minimized and we have dead space only below the guard ring. This is proved by simulations done by Silvaco / ATLAS software.

References
[1] –K. Ranjan et al., Solid-State Electronics 48 (2004) 1587-1595
[2] –N. Egorov et al., Nuclear Instruments and Methods in Physics Research A 426 (1999) 197-205

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Session Classification: P : Coffee and Poster Session

Track Classification: Applications in Particle Physics

Contribution ID: **49** Type: **Contributed Poster**

Direct Charge Sharing Observation in Single-Photon Counting Pixel Detector

Thursday 15 September 2005 10:30 (30 minutes)

Charge sharing is an important factor to be considered in pixel detector design for single-photon counting electronics. Its effect on such devices, if proper adjustment of the pixel threshold is not performed, is to give rise to false counts in the pixels neighbouring the hit one. Nevertheless, it is difficult to evaluate or measure, as single-photon counting electronics do not give information about the charge quantity collected in every single pixel. In this work we present the results obtained measuring an X-ray source with a CdTe detector bump-bonded to a Medipix2 chip. Medipix2 is a single-photon counting read-out chip that also features a small matrix of 3×3 pixels with an analog output. The signal generated by an incoming particle can therefore also be read-out through an oscilloscope, making possible a detailed study of charge sharing. The detector features a pixel pitch of 55 µm and a thickness of 1 mm. The measurements presented here were taken in the framework of our medical imaging research; therefore energies of interest are below 100 keV. This study has general impact on the design of pixel detectors; however its impact on the design and the operation of pixel detectors coupled to photon counting electronics is deeper.

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Session Classification: P : Coffee and Poster Session

Track Classification: Applications in Nuclear Medicine And Radiology

Contribution ID: **50** Type: **Contributed Talk**

An X-ray Scanner Prototype Based on a Novel Hybrid Gaseous Detector

Tuesday 13 September 2005 09:45 (15 minutes)

In the last few years several groups and companies tried to develop mammographic scanners based on GaAs, Si solid -state detectors or high -pressure Xe gaseous detectors [1-3]. The main advantages of the scanner system are the simplicity of the design (1D detector) and the readout electronics and hence a low cost.

We have developed and successfully tested an innovative approach in the X-ray scanning systems which combines the advantages of high stopping power and a high position resolution typical for solid-state detectors with high avalanche multiplications offered by gaseous detectors. A novel scanner prototype consists of a gas chamber (filled with Ar-based gas mixture at p=1atm) inside which a 1D hybrid gaseous detector was installed; the last one was an edge-on illuminated capillary plate (the X-ray converter) combined with a parallel-plate gas multiplication structure. The capillary plate (CPs) tested were made of lead glass and had thicknesses of 0,4-1 mm; the holes had diameter of 12, 25 or 50 µm and the wall thickness was 2,5, 5 or 8 µm respectively. A readout plate was placed 0,4 mm below the CP. It was a ceramic plate with Cr strips of a 50 µm pitch. Strips were connected to an ASIC having a digital readout. The X-ray beam (with energy of 19-30 keV) was collimated by a slit of 50 µm in width. The collimated X-ray beam enters the CP in between of its anode and cathode surface and parallel to them (edge-on illuminated geometry). Such a geometrical arrangement allows one to achieve a high stopping power and at the same time does not require very high accuracy in the beam alignment with respect the CP. Photo (and Compton) electrons liberated from the thin walls of the CP entered the capillary holes and created there microtracks of primary electrons. Under the influence of the electric filed applied between the capillary electrodes, the primary electrons drifted through the capillary holes and finally were the extracted to the gap between the CP and the readout plate. A voltage of 1-2 kV could be applied between the CP and the readout plate which made it possible for avalanche multiplication to take place in this region. At a gas gain of ≥104 the readout electronic detected primary photoelectrons with a 100% efficiency

The usual glass CP operate without noticeable charging up effects at counting rates of 50 Hz/mm2 and hydrogen -treated CP -up to 105 Hz/mm2. The efficiency of the hybrid detector was, depending on energy, between 8 and 42 %, position resolutions of 50 µm in digital form. Images of several objects and a mammography phantom obtained with this detector will be demonstrated. Since the detector operated in photon counting mode, high quality images could be obtained at radiation dose of 3- 5 times less than with standard mammographic technique. The developed scanner may open new possibilities for medical imaging, for example mammography, radiology (including security devices) crystallography and many other applications.

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Sensitive Detectors, NIM A513, 2003 2002
[3] See talks at the Proceedings of the Conference "Imaging -2003"
NIM A525, 2004

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Session Classification: S3 : X-ray and Gamma-ray Detectors

Track Classification: X-ray and Gamma-ray Detectors

Contribution ID: **51** Type: **Contributed Talk**

The DEPFET Prototype System for the ILC Vertex detector: Test beam Measurements

Monday 12 September 2005 17:15 (15 minutes)

By incorporating a field effect transistor into a fully depleted sensor substrate the DEPFET sensor combines radiation detection and amplification allowing for low noise measurements and high spatial resolution. This makes DEPFET sensors an auspicious technology for the vertex detector of the planned International Linear Collider (ILC). The demands on the vertex detector are high, including small pixels (20-30 µm) and fast readout of almost a giga pixel in 50µs. Aiming to meet these high demands a prototype system with fast steering chips, a current based readout chip and a 64x128 pixel matrix has been build. Lab measurements of the system with 55Fe show excellent behavior with noise less than 250 e- (ENC).
In order to study the systems behavior under more realistic conditions and with regards to the detection of MIPs a test beam period at the DESY Synchrotron in January and February 2004 has been carried out. Modifications concerning hardware and read out mode were necessary to ensure compatibility of the DEPFET system with the Bonn microstrip telescope (used before for ATLAS) which was employed for particle tracking. The DAQ- and offline software had to be written largely from scratch as this is the first time for the DEPFET system to be operated under test beam conditions. Two different matrices have been characterized with an emphasis on charge collection efficiency. The talk will give a short description of the system and its performance in the lab and then focus on the test beam setup and its results

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Session Classification: S2 : Pixel Detectors for Charged Particles

Track Classification: Pixel Detectors for Charged Particles

Contribution ID: **52** Type: **Contributed Talk**

Development of a High Resolution TPC for the ILC

Thursday 15 September 2005 09:30 (15 minutes)

A high resolution TPC with gas amplification based on micro pattern gas detectors is a promising candidate for the main tracker at the ILC detector. The physics goals and the expected enviroment at the ILC requires the development of a TPC with unprecedented performance.

Extensive R&D work has started to meet these challenges. We studied the process of ion backdrift and significant reduction was reached using special settings of theGEM structures. The influence of the space charge, produced by the remaining ions, on the track reconstruction has been investigated.

To further study the spatial resolution of a GEM-based TPC, a prototype with a low-mass field cage was constructed and operated within a high-resolution hodoscope based on silicon-strip detectors. Measurements of this prototype in high magnetic fields and in test beams are scheduled. Additionally, we spent extensive effort on the development of an accurate numerical simulation of the effects in our TPC, such as drift, diffusion and gas amplification.

The talk will give a status report of our R&D work and will address the questions which still have to be answered in order to meet the challenges of the ILC.

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Session Classification: S10 : New Gas-based Tracking Detectors

Track Classification: New Gas-based Tracking Detectors

Contribution ID: **54** Type: **Contributed Talk**

Development of Gaseous Tracking Devices for WIMPs Search

Thursday 15 September 2005 11:45 (15 minutes)

Time Projection Chamber (TPC) has been recognized as a potentially powerful detector for the WIMPs search by measuring the directions of nuclear recoils, in which the most convincing signature of WIMPs caused by the earth's motion around the Galaxy appears [1]. Since the energy deposits of WIMPs to nuclei are only a few tens of keV and the ranges of nuclei are limited, such TPCs should have very fine special resolutions and should be operated in low pressures. We are developing a "micro-TPC"based on a gaseous 2D imaging detector with micro pixel electrodes, "μ-PIC"[2]. The prototype micro-TPC has a detection volume of 10×10×10 cm3. Normal pressure gas flow operations show that it possess sufficient ability to detect the tracks and the Bragg curves (which sense the direction of tracks) of charged particles with track length of down to 3 mm, and we expect that the dE/dx threshold of better than 10 keV/cm can be achieved [2, 3].

Assuming these thresholds of the prototype micro-TPC, it turned out that 20 torr operation of CF4 and 5 torr operation of Xe are feasible for WIMPs detection. We describe the first results of the performance study of the low pressure operation of the micro-TPC with Ar+C2H6 (90:10). The micro-TPC was put into an aluminum vessel and operated at 0.2 atm for the first step. It was operated with a gas gain of 1500 and its stability was checked over 60 hours. Then, we evaluated its tracking performance with the irradiation of gamma rays and neutrons from 252Cf . Electron recoils and proton recoils were clearly separated by plotting the track length as a function of recoil energy due to the difference of their dE/dx. We could observe proton tracks and their Bragg curves with energies of as low as below 100 keV. We also tested 0.2 atm operation with CF4 gas and Xe gas. These results show that the micro-TPC can provide accurate measurements of the recoil directions and will have the sensitivity to the signature of WIMPs.

A larger detection volume (30×30×30 cm3) micro-TPC is now being developed. We are going to operate it at lower pressures and measure longer tracks of not only protons but also C, F, and Xe recoils.

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Session Classification: S11 : Detectors for Astro-Particle Physics

Track Classification: Detectors for Astro-Particle Physics

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

Modelling Orthogonal Strip HPGe Detector Systems

Thursday 15 September 2005 10:30 (30 minutes)

The Monash Centre for Synchrotron Science (MCSS) Instrumentation Group is working on various detector designs for biomedical imaging and synchrotron use. The development of orthogonal planar strip HPGe detectors offers advantages of good energy and x,y,z-axis position resolution of gamma ray interactions. The efficiency in terms of photoelectron absorption type events is quite low however (~3%), but could be greatly improved by tracking and including Compton interactions through the detector. If successful a system such as a small animal PET detector would have either better image resolution or shorter acquisition time (lower radioisotope dose).

In order to optimise the detector design it is useful to simulate the various stages from interaction, through to detection, and image reconstruction. This will aid decision making on the cost/benefit trade-offs of increasing electronics complexity versus better image resolution. For example, using more strips in the design would improve the (x, y) position resolution but require more high speed data channels. Likewise increasing pre-amplifier bandwidth would improve resolution in depth (z) of near-coincident interactions but increase the noise. Each of these effects on final image quality will be evaluated before starting construction.

Here the modules for each simulation stage are described, the first two of which have been written in IDL. In the first module the detector geometry is defined and the signals appearing on each strip for a set of incident gamma rays are generated using the method-of-images. A graphical interface allows the user to vary the detector's physical and electronics parameters and view the signal results, or batch process an events file into a signal output file.

The second module implements the Pulse Shape Analysis (PSA) algorithms to identify the charge collecting and spectator strip signals. The PSA algorithm is first calibrated by fitting signature waveforms to the current signals of charge collecting strips at a grid of known locations. As well, the ratio of induced signals on the adjacent spectator strips is stored for points across the strip width. This aids the later separation of superimposed interactions along the z-axis and improve the x,y-axis positioning to better than one strip width. The aim is to capture as much detail about partial gamma energy interactions as possible and determine the limits of resolving separate interactions. While initially the PSA algorithms are intended for modelling and off-line analysis, the second aim is for the final algorithms to be robust and fast enough to use in a real-time embedded system.

The resulting interaction positions and energies can then be used for the image reconstruction stage, details of which are presented in companion MCSS papers. Where there are multiple Compton interactions the energy and position of the first, and position of the second interactions are needed. This cycle is repeated for different detector designs and some initial results will be presented.

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Session Classification: P : Coffee and Poster Session

Track Classification: Applications in Nuclear Medicine And Radiology

Contribution ID: **56** Type: **Contributed Talk**

Hybrid Photon Detectors for the LHCb Ring Imaging Cherenkov Detectors

Wednesday 14 September 2005 10:00 (15 minutes)

Hybrid Photon Detectors (HPD) have been chosen for the Ring Imaging Cherenkov (RICH) detectors of the LHCb experiment. Photons impinging on a multi-alkali S20 photo-cathode deposited on a quartz window produce photo-electrons that are accelerated by a 20 kV potential onto a silicon pixel sensor anode. The sensor is segmented into 8192 pixels of size 0.0625 mm x 0.5 mm that are electronically ORed together into 1024 super-pixels of 0.5 mm x 0.5 mm. The cross-focusing electron optics has a demagnification factor of five, resulting in an effective pixel size of 2.5 mm x 2.5 mm at the photo-cathode. The silicon sensor is bump-bonded to a pixel chip fabricated using 0.25 µm deep submicron radiation-tolerant technology, which amplifies and digitizes the anode signals and operates at the LHC speed of 40 MHz. The sensor/chip assembly is mounted inside the HPD vacuum envelope.

Mass production of 484 HPDs for the LHCb experiment has commenced, in close collaboration with industry. Measurements of HPD properties carried out using dedicated laboratory test facilities will be presented. These measurements will include supply currents, threshold scans, maps of the pixel chip, the depletion voltage of the silicon anode, the signal rate versus the applied high voltage, the demagnification of the electron optics and the image distortions due to magnetic fields. Stability studies under accelerated ageing of quantum efficiency, dark count and ion feed-back rates are shown. Finally, results from studies of the HPD performance in particle test beams using Cherenkov light will be reported.

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Session Classification: S7 : Novel Photon Detection Systems

Track Classification: Novel Photon Detection Systems

Contribution ID: **58** Type: **Contributed Poster**

X-ray tomography systems for observations of electron cyclotron heated plasmas using novel position-sensitive X-ray semiconductor-detector arrays

Thursday 15 September 2005 10:30 (30 minutes)

Tomographic reconstructions of X-ray emission from hot electrons having a temperature of several tens of keV have been carried out by the use of the novel position-sensitive X-ray semiconductor detector array. The X-ray detection system in the thermal-barrier region of the GAMMA 10 tandem-mirror plasmas consists of a 48-channel silicon semiconductor detector array.

X-ray energy responses of the new detector array along with response uniformity of detector channels have been characterized by using synchrotron radiation at the Photon Factory of High Energy Accelerator Research Organization (KEK) in Japan. The X-ray reconstructed signals under standard thermal-barrier operational conditions indicate a good axisymmetric radial profile peaked on the magnetic axis. When we make outward shifts of the second-harmonic electron cyclotron layers radially by intensifying the mirror magnetic fields in the thermal-barrier region, tomographically reconstructed signals show hollow X-ray profiles. Several applications including investigations of these hot electrons due to the second-harmonic electron-cyclotron heatings are made with the novel position-sensitive X-ray semiconductor-detector array. For instance, essential investigations in relation to an internal transport barrier and intermittent turbulent vortex-like structures are carried out for the purpose of physics studies of universal effects of radially sheared electric fields on plasma-confinement improvements.

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Session Classification: P : Coffee and Poster Session

Track Classification: X-ray and Gamma-ray Detectors

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

A very large area Micro Pixel Chamber

Thursday 15 September 2005 10:30 (30 minutes)

A Micro Pixel Chamber, called "μ-PIC", is a gaseous 2D imaging detector with a fine pixel electrode based on the Printed Circuit Board technology, and we developed it for the X/gamma-ray imaging and the tracking of the charged particles [1]. The previous μ-PIC has a fine position resolution (RMS ~120μm), a high gas gain (Max ~15000), good gas gain uniformity (4.5% RMS) and the stable operation (more than 1000 hour). But the detection area of the previous μ-PIC (~10×10 cm2) is not large enough for a variety of the application, for example an MeV gamma-ray Compton camera [2] and dark matter search [3].

For these purpose, we developed a new μ-PIC having a ~30×30 cm2 detection area. The structure and the pitch of the electrode are same as those of the previous μ-PIC. There are 768×768 pixels in the whole area, and each pixel works as a proportional counter. The anodes and the cathodes of the pixels are formed on the 768 anode strips and the 768 cathode strips, which connect to the read-out board with the wire bonding, and the anode strips are orthogonal to the cathode strips. Therefore, this large μ-PIC is expected to have a fine 2 dimensional position resolution same as the previous μ-PIC, and the 9 times detection area. The yield of the first production was about 50%, and there is only ~1% dead pixels in the whole area. By these results, it is a prospect to the mass production of the μ-PIC.

We started the test operation of this large μ-PIC at the beginning of 2005, and we succeeded to detect the first signal with γ-ray of 90Sr/Y. This μ-PIC (SN041129-1) worked with a stable gas gain of ~3000 and a maximum gain of ~6000 at the center, and the ratio of the gain was 2.2 between the minimum and the maximum gain area. An X-ray image of 30×30cm2 was also taken by irradiating the X-rays from 109Cd (22keV) to the whole detection area. And, for more applications, we are developing a time projection chamber with a large volume (~30×30×30cm3).

In this presentation, we will report the manufacturing quality and performance of the first large area μ-PIC, and we also present the development of the readout system and a large size time projection chamber for an application of the new μ-PIC.

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[3] T. Tanimori et al., Phys. Lett. B, vol. 578, pp. 241-246, 2004.

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Presenter: Mr TAKADA, Atsushi (Kyoto University)

Session Classification: P : Coffee and Poster Session

Track Classification: New Gas-based Tracking Detectors

Contribution ID: **60** Type: **Contributed Poster**

Development of 40 channel waveform sampling CMOS ASIC board for Positron Emission Tomography

Thursday 15 September 2005 10:30 (30 minutes)

We have designed and fabricated 10 channel/6bit waveform sampling ASICs using ROHM 0.35 um CMOS technology. This chip was designed for GSO-APD gamma-ray detector and provides a function of "waveform recording"at a sampling frequency of 100MHz. This chip has 10channel inputs and each channel has preamp/variable gain amplifier/6-b folding ADC. The folding ADC greatly reduces the number of comparators and the power consumption of the chip. This chip provides a full function of recording a transient behavior of detector charge signals for each pulse. Self trigger function is equipped with the system and this will enable simultaneous record of all input waveforms. Each channel has 64 word FIFO where each waveform data are stored. Stored data are converted to serial data and passed to an FPGA where we can implement a detailed signal processing. This chip is operated at 3.3 V and the power consumption is 1.2W/chip.

We have developed a data acquisition board using 4 bare chips. This board has 40 input channels and we plan to use this board for APD-based DOI-PET detector system which utilizes several different crystals to recognize depth positions by the difference in their decay times.

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Session Classification: P : Coffee and Poster Session

Track Classification: New Techniques for Positron Emission Tomography

Contribution ID: **61** Type: **Contributed Talk**

Ultra-long MicroStrip Gas Counter for Spallation Neutron Source Facilities

Wednesday 14 September 2005 15:30 (15 minutes)

We are developing a new ultra-long multi-grid-type microstrip gas counters (640 mm long) for neutron scattering experiments at spallation neutron source facilities. We employed a multi-grid-type electrode structure for stabilizing the gas amplification process in this MSGC. Also, we implemented a global-local-grading method for fast readout method where we divide a cathode signal into two categories. Positive ions are created around the anode strip and they travel to the neighboring two cathode strips. In this process signal charge are divided into two parts. We utilized this nature to encode the incident position. From one cathode strip a rough position is obtained and the other cathode strip provides a fine position. We also implemented a graded cathode pattern. Each cathode strip is composed of two conductive elements. One element is connected to the ground and the other one is connected to readout electronics. Then, we alter the ratio of two conductive areas according to the incident position. This is implemented by a periodical electrode pattern in practice. We used a stepwise change in the rough position. Zig-zag modulation for the fine position. A test plate was successfully fabricated. X-ray test showed an energy resolution of ~14% FWHM at 5.9keV. The uniform gas gain was obtained through entire active length. Position resolution of 1-4 mm FWHM is obtained and the principle of this method is successfully demonstrated.

Now we are fabricating another series of plates for a large-are 2-D array. Each plate has 8 strips with an anode pitch of 3 mm. We plan to make a tiled 2-D detector with these plates. In this way, we can fabricate very large micropattern gas detectors at a reasonable cost.

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Session Classification: S9 : Detectors for Synchrotron Radiation and Spallation Neutron Sources

Track Classification: Detectors for Synchrotron Radiation and Spillation Neutron Sources

Contribution ID: **63** Type: **Contributed Talk**

Development of a thinned back-illuminated CMOS Active Pixel Sensor for Extreme Ultra Violet Spectroscopy and Imaging in Space Science

Thursday 15 September 2005 16:45 (15 minutes)

We describe our programme to develop a large-format, science-grade, monolithic CMOS active pixel sensor for future space science missions, and in particular an extreme ultra-violet spectrograph for solar physics studies on ESA's Solar Orbiter. Our route to EUV sensitivity relies on adapting the back-thinning and rear-llumination techniques first developed for CCD sensors. Our first large-format sensor consists of 4kx3k 5μm pixels fabricated on a 0.25 μm CMOS imager process. Wafer samples of these sensors have been thinned by e2v technologies with the aim of obtaining good sensitivity at EUV wavelengths. We present results from both front and back-illuminated versions of this sensor.

We also present our plans to develop a new sensor of 2kx2k 10 μm pixels which will be fabricated on a 0.35 μm CMOS process. In progress towards this goal, we have designed a test-structure consisting of six arrays of 512x512 10 μm pixels. Each of the arrays has been given a different pixel design to allow verification of our models, and our progress towards optimizing a design for minimal system readout noise and maximum dynamic range. These sensors will also be back-thinned for characterization at EUV wavelengths.

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Session Classification: S13 : Applications in Space Science

Track Classification: Applications in Space Science

Contribution ID: **64** Type: **Contributed Talk**

High-stability multi-CCD Focal Plane for ESA imaging missions

Thursday 15 September 2005 17:00 (15 minutes)

Results are described from a high-stability multi-CCD focal plane assembly developed by MSSL for ESA, using new large-format CCDs from e2v technologies. Particular subjects of investigation are stability at the 10e-4 to 10e-5 level and crosstalk between CCDs as well as between nodes of each two-port CCD.

Space-based planetary-transit hunting and asteroseismology missions such as ESA's Eddington and NASA's Kepler require large multi-CCD focal planes in order to simultaneously observe a large number of objects to improve the odds of finding habitable planets. A second driving requirement is that the system must be extremely stable so that false detections are not generated. This places significant constraints (both in-orbit and for the ground-based tests described here) on, for example, temperature stability and electronics stability. Other significant requirements are wide dynamic range (16-bit digitisation, using a CCLRC CCD signal processor ASIC) and a moderately high readout rate of ˜1.2Mpix/s per output chain (Eddington has in total ˜3 focal planes each with 12 output chains).

Although Eddington is currently not in ESA's approved mission list, MSSL has received an ESA contract to develop a demonstration FPA with realistic constraints on parameters such as performance (e.g. stability, noise), mass, power, and component selection (radiation hardness etc.). This work provides real world data for future ESA studies. In addition, the demo-FPA electronics has been designed to be compatible with the Gaia-RVS focal plane, another system which requires multiple CCDs, low noise and stability. The demo-FPA is populated with three e2v CCD42-C0s, a member of the CCD42 family specifically developed for Eddington under ESA contract.

The demo-FPA system is described here, including the new high-accuracy temperature-control system and the high-throughput spacewire digital data links. Results are described from the tests performed on the demo-FPA, specifically stability, noise and both inter- and intra-CCD crosstalk. Finally, the application of the system to the Gaia-RVS focal plane (which uses e2v electron-multiplying low-light-level CCDs) is described.

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Session Classification: S13 : Applications in Space Science

Track Classification: Applications in Space Science

Contribution ID: **66** Type: **Contributed Talk**

DEPFET Active Pixel Sensors and pnCCDs for room temperature imaging (Xray) Spectroscopy in space missions and terrestrial astronomy

Tuesday 13 September 2005 14:00 (15 minutes)

Two dimensional back-illuminated (500 µm sensitive thickness) X-ray pixel detectors with pixel sizes from 36 µm, 51µm, 75 µm to 150 µm have been developed for applications in X-ray astronomy (0.1 keV to 20keV) and for wave front sensing in adaptive optics systems up to 1 µm wavelength in the NIR. In both applications the environmental conditions are such that operation at "warm temperatures´´ around -30o to -10o C is highly desired simultaneously to high readout speed and low noise operations. During our tests with device formats of 64×64 to 264×264 frame rates of up to 1.000 per second have been achieved with noise floors of 2.5 electrons (rms). For temperatures around - 20o C single stage Peltier cooler can be used, making the system compact and easy to use. The achieved energy resolutions with a pnCCD in the full imaging mode was 210 eV (FWHM) at the MnKá – line at 5.9 keV at - 100 C and with 75 µm pixels and a format of 256 × 128 being read out at 200 frames per second. The active pixels sensor DEPFET achieved at the same temperature with the same pixel size but with a format of only 64 × 64 and 300 frames per second an energy resolution of 150 eV only. pnCCD for wave front sensing with a format of 264 × 528 were operated at 1.000 frames per second and a noise of less than 3 electrons at - 400 C. The full set of measurements will be shown to taste the comfortable parameter space for applications in heaven and on earth.

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Presenter: Dr TREIS, Johannes (MPI Munich)

Session Classification: S5 : Applications in Astronomy and Astrophysics

Track Classification: Applications in Astronomy and Astrophysics

Contribution ID: **67** Type: **Contributed Talk**

High Energy Resolution 4 cm wide Double-sided Silicon Strip Detectors for Semiconductor Compton Telescope

Tuesday 13 September 2005 10:15 (15 minutes)

Large area imaging spectrometer with good energy resolution based on double-sided Si strip detector (DSSD) is a key technology for a new generation of Gamma-ray astronomy. It is well suited as the scatterer detector of semiconductor Compton telescopes (SCTs) working at sub-MeV to MeV band. High energy resolution is of particular importance because it ensures better angular resolution and higher detection sensitivity, as well as wider energy range down to 100 keV. We are developing DSSDs and read-out ASICs with special care on the energy resolution. Recently, we developed a system of a 2.56 cm wide DSSDs (from HPK) read-out with low-noise analog ASICs, VA32TA (from Ideas), with a good energy resolution of 1.3 keV (FWHM) for 60 keV and 122 keV at 0 C (H. Tajima et al. IEEE 2004). The DSSDs are used in our prototype SCT, combined with CdTe pixel detectors, and a Compton reconstruction is achieved at an energy as low as 81 keV thanks to its high energy resolution (S. Watanabe et al. IEEE 2005).

In this work, we present our results on the new larger 4 cm wide DSSDs. This device is based on the 2.56 cm DSSD and designed to improve the detection area by a factor of 2.25 with minimum degradation of energy resolution. The thickness of the detector is 300 um. The strip pitch is 400 um with a gap of 100 um, and the strip length is 38.4 mm. There are 96 strips each on p and n sides implanted on orthogonal direction. The p-strips of the DSSD are connected directly to three ASICs, VA32TAs. The n-strips are connected via RC filter chip for AC connection (RC-chip) to another three ASICs. A bias voltage of 100 V is applied from the RC-chip. The system works well and a fine image with 241Am source is obtained. When operated at a temperature of -10 C, we obtain an energy resolution of 1.7 keV (FWHM) for the p-strips for 59.5 keV gamma-rays. Detail of this detector, read-out system and their performance will be addressed

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Session Classification: S3 : X-ray and Gamma-ray Detectors

Track Classification: X-ray and Gamma-ray Detectors

Contribution ID: **68** Type: **Contributed Talk**

Current Status of the AGATA Prototype Detector Analysis and Comparison of Experimental and Theoretical Data Sets

Wednesday 14 September 2005 11:30 (15 minutes)

Nuclear structure studies utilizing the technique of gamma ray spectroscopy requires the use of state of the art detector systems. The advent of highly segmented High-Purity Germanium detectors and the method of Pulse Shape Analysis to determine the positions of interactions [1] will allow for greatly improved efficiency as well as excellent angular resolution. The Advanced Gamma Tracking Array (AGATA), when completed, will consist of 180 of these large volume, 36-fold segmented HPGe detectors mounted in a spherical geometry to cover the full solid angle [2]. Advanced digital electronics developed especially for this application will be utilized.

Detailed scans of the AGATA prototype detector have been performed using a precision scanning table and a fully digital data acquisition system at the University of Liverpool in order to characterise the detector's response and its position sensitivity. Comparison of this data to theoretical results from electric field simulation software (MGS) [3] is paramount to the completed array's functionality as it will provide a method of matching the induced pulse shapes, using a least squares fit technique, to a specific position of interaction for the entire array. This position resolution will be of the order of a few millimetres, as image charge shape and asymmetry differ substantially between interaction positions of this order.
Preliminary results show that the detector is capable of producing such position sensitivity and the comparison of experimental and theoretical data sets shows excellent agreement. A summary of the methods used and up-to-date results of this ongoing analysis will be presented.

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[2] Gerl J, W Korten. Technical proposal for an Advanced Gamma Tracking Array for the European gamma spectroscopy community. 2001.
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Presenter: NELSON, Laura (University of Liverpool)

Session Classification: S8 : Applications in Nuclear Physics

Track Classification: Applications in Nuclear Physics

Contribution ID: **69** Type: **Contributed Poster**

Germanium MOS Technology for Infra-Red Detectors

Thursday 15 September 2005 10:30 (30 minutes)

There are a number of position sensitive detector applications where there is a requirement for an imaging device which has enhanced response in the near infra-red spectrum (0.77μm to 1.5μm). Although infra-red detectors are fabricated using III-V and HgCdTe materials, integration with silicon readout circuitry is not easily achievable, often relying on bump-bonding technology. Germanium (Ge) is compatible with silicon device technology, and is once again becoming a mainstream semiconductor material. A Ge detector will exhibit a high quantum efficiency at all wavelengths from ultra-violet up to near infra-red, and is thus highly desirable for multi-spectral imaging and image fusion applications.

Fabrication of an electrically stable dielectric is a key enabling technology in the production of a Ge detector. This work investigates the use of atmospheric pressure CVD (APCVD) silicon dioxide (SiO2) deposited on Ge at 400oC using SiH4, O2 and N2 source gases. After deposition the SiO2 layers were densified at 800oC for 10 minutes in N2. To study the electrical properties of the Ge-SiO2 interface MOS capacitors have been fabricated on p-type 2Ω-cm Ge substrates, using a dielectric thickness of 170nm. Analysis of these characteristics reveals a satisfactory oxide surface-state charge (Qss) of 1.7x1011cm-2, a flat-band voltage (Vfb) of -1.77V, and a threshold voltage (Vth) of -0.60V. The DC leakage current density through the Ge MOS capacitors is less than 2x10-11Acm-2 for applied voltages between −5V and +5V, thus verifying the insulating properties of the dielectric.

At a frequency of 10kHz the capacitance measured in strong inversion approaches that of the dielectric alone. This 'low frequency' mode of operation occurs at a frequency approximately three orders of magnitude higher than would be observed for a Si MOS capacitor, and is due to the increased charge generation rate in the narrower bandgap Ge substrate. SIMS analysis of the APCVD SiO2 after densification at 800oC shows that significant Ge outdiffusion from the substrate into the dielectric layer has occurred. For comparison, results from Ge MOS capacitors incorporating APCVD SiO2 layers densified at 600oC, and dielectrics deposited using plasma enhanced CVD (PECVD) will be presented. The effect of 450oC forming gas (H2/N2) post-metal anneals on the capacitor characteristics will also be discussed.

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Session Classification: P : Coffee and Poster Session

Track Classification: New Solid-State Detector Technology

Contribution ID: **71** Type: **Contributed Talk**

SEARCH FOR TWO-PHOTON EMISSION FROM EXCITED 0+ STATE N 72GE USING PULSE-SHAPE ANALYSIS WITH HIGHLY-SEGMENTED GERMANIUM DETECTORS

Wednesday 14 September 2005 11:45 (15 minutes)

Two photon emission is a second order nuclear decay process which can, in principle, compete with any single photon or electron decay mechanism. In practice, such a process is very difficult to observe in the presence of a competing single-photon decay due to it being indistinguishable from Compton scattering. The two-photon branch can, however, be distinguished where no single photon decay is possible, such as the case of a 0+ -> 0+ transition which can only proceed by electron emission (or pair production for high energy transitions). The few examples of nuclear two-photon emission so far measured are in 16O, 40Ca and 90Zr, where the lowest excited state unusually has spin/parity of 0+. In each case, the two-photon branch was found to be ~10-4 [1].

We have carried out a search for two-photon emission from the first excited 0+ state in 72Ge. This isotope is a major component (28%) of natural germanium. Two highly segmented coaxial hyperpure germanium detectors were used as both the target and the detector. The excited 0+ state at 690 keV in 72Ge was excited within the detector using 2.45 MeV pulsed neutrons from the unique pulsed neutron facility at Chalmers University of Technology. The detectors were triggered with a delay to the prompt neutron pulse which allowed the clean seperation of the transition from the 0+ state of interest, which has a 400ns half-life. For each event, the full pulse shapes in each detector segment were recorded. In the analysis, two photon events will be distinguished from single electron events on the basis of their multiplicity and their range, as deduced from the pulse shape analysis. Reference pulse shapes for the detectors were obtained from a seperate measurement using a collimator source and x-y tracking table at Liverpool.

Simulations of the detector setup with Monte Carlo code, GEANT4, indicate a high efficiency for detection of two-photon decays within the detector of around 20%. The details of these simulations will be reported as well as the outcomes of the ongoing analysis. The effects on the recorded pulse shapes of the fast neutron flux will be discussed.

[1] J.Kramp et al., Nucl. Phys. A474, 412(1987)

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Session Classification: S8 : Applications in Nuclear Physics

Track Classification: Applications in Nuclear Physics

Contribution ID: **72** Type: **Contributed Talk**

Modification of a Medical PET Scanner for engineering PEPT

Tuesday 13 September 2005 12:15 (15 minutes)

Over the last 20 years, positron emission tomography (PET) has developed as the most powerful functional imaging modality in medicine. Over the same period, the University of Birmingham Positron Imaging Centre has developed the use of positron emitting tracers to study flow in engineering systems. Much of this work has used the technique of positron emission particle tracking (PEPT) which was developed at Birmingham. In PEPT, a single radioactively-labelled tracer particle is tracked by detecting simultaneously the pairs of back-to-back photons arising from positron/electron annihilation.

Since 1999 this work has used an ADAC Forte "positron camera" consisting of two planar gamma camera heads, each containing a crystal of sodium iodide 50×40 cm2 and 16mm thick, operated in coincidence. This system can record up to 100k events per second, allowing a tracer particle to be located to within approximately 1mm 1000 times per second. This camera has been used to study a wide range of engineering processes, by means of PEPT, tracking tracer particles down to 100µm diameter.

Medical PET scanners consisting of rings of hundreds of small bismuth germanate detectors have high sensitivity and can operate at high count rate. We have adapted such a scanner for PEPT use. The Ecat931 scanner was previously operated at Hammersmith Hospital until 2002, and comprises 32 detector modules ("buckets"), each consisting of 128 detection elements. The buckets have been remounted on a rectangular frame and the data acquisition system has been modified to record fully-3D data in list mode for subsequent processing by the PEPT algorithm.

This paper presents initial results from this system. Count rates of over 250k events per second have been achieved, but the sensitivity varies significantly within the field of view. Fast moving tracer particles can be accurately located every 0.8ms.

This system has a flexible geometry which can be optimised to suit the object being studied. Another advantage of this system is that it is in principle transportable. In the near future we plan to use it to perform PEPT studies on an industrial site.

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Session Classification: S4 : New Techniques for Positron Emission Tomography

Track Classification: Novel Photon Detection Systems

Contribution ID: **73** Type: **Contributed Talk**

Bulk-Micromegas detector technology

Friday 16 September 2005 12:00 (15 minutes)

A new technique of fabrication of Micromegas (MM) using the PCB technologies has been developed. A standard commercial wire mesh (19 ⊠m) was employed as cathode element and the amplification gap was defined by using spacers (pillars) made out of a 100 ⊠m thick Solder Mask (SM). After a three steps process, lamination, insulation and development, the detector core is obtained as a single-compact piece (Bulk Micromegas): In a first process the anode read-out, the SM and the mesh are laminated at high temperature (100℃). The polymerisation is done under UV insulation through a mask which provides the required shape (edges and pillars). Finally the non insulated part is removed by development in a chemical bath. The result is a self-sustained unit containing the PCB board and the mesh which is kept between two layers of SM : the outer border (2 mm wide) and the pillars (⊠ 0.4 mm every 2 mm) in the inner region are left embracing the mesh. Several 10 cm x10 cm prototypes have been fabricated and successfully tested. High gas gains up to 105 have been reached in Argon mixtures and an energy resolution of 20% (FWHM) was measured, using x-rays from a 55Fe source.
The advantage of this technique that allows large area detector fabrication is the robustness, the reliability and the low cost. The Bulk technology opens new perspectives: large MM mosaic detectors with negligible dead space, double stage MM, curved shape MM (i.e. cylinder of thin Kapton bulk)

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Session Classification: S15 : Novel Gas-based Detection Techniques

Track Classification: Novel Gas-based Detection Techniques

Contribution ID: **74** Type: **Contributed Talk**

R&D on MAPS Detectors for High Energy Physics

Monday 12 September 2005 16:45 (15 minutes)

Results are presented on recent studies of Monolithic Active Pixel Sensors developed for future application in High Energy Physics. The status of the HEPAPS programme at the Rutherford Appleton Laboratory (RAL) is presented and some recent results from the UK MAPS collaboration on charged particle detection are discussed.

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Session Classification: S2 : Pixel Detectors for Charged Particles

Track Classification: Pixel Detectors for Charged Particles

Contribution ID: **75** Type: **Contributed Talk**

Detection of ultra rare alpha decays of super heavy nuclei

Wednesday 14 September 2005 12:00 (15 minutes)

Three approaches to the measurement of a rare alpha decaying products produced in heavy-ion induced nuclear reactions are described. One is based on a chemical extraction and following deposition of the nuclides under investigation onto the surface of the detector, whereas the second one is associated with long –lived products implanted into silicon detectors by using the electromagnetic separation technique. The third approach relates with an application of real-time mode detection of correlated energy-time-position recoil-alpha sequences from 48Ca induced nuclear reactions with actinide targets, like 242, 244Pu, 245,248Cm, 239Am and 249Cf [1-3]. Namely with this technique it has became possible to provide a radical suppression of backgrounds in the full fusion (3-5n) reactions aimed to the synthesis of super heavy elements with Z=113-116.

[1] Yu.S.Tsyganov and V.I.Tomin, Appl.Radiat. and Isotopes, Vol.49, Nos.1-2, pp.113-115 (1998)

[2] Yu.S.Tsyganov et al. Nucl.Instrum. and Meth. In Phys. Res., A525 (2004)213-216

[3] Yu.Ts.Oganessian et al., Phys. Rev. C69 (2004) 02161.

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Session Classification: S8 : Applications in Nuclear Physics

Track Classification: Applications in Nuclear Physics

Contribution ID: **77** Type: **Contributed Talk**

Design and Performance of Radiation Hard Silicon Sensors for the LHCb Experiment at CERN

Thursday 15 September 2005 14:00 (15 minutes)

The LHCb experiment at CERN depends critically on silicon sensors to provide vertex, tracking and trigger information. The environment the sensors will be operated in is unique amongst the next generation of LHC experiments; the sensors will be run in high vacuum conditions and will receive a high radiation dose. The design of the sensors for LHCb is described, together with the criteria that must be met.

The technological solution for the first generation of vertex detector for LHCb is n+n (n implants in n bulk) silicon with radial and azimuthal geometry. Details of the performance of the sensors are given.

Further enhancements to the design are discussed with particular attention to the fabrication of large scale n+p sensors. These sensors are prototypes sensors which could be used in a potential LHCb upgrade

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Session Classification: S12 : New Solid-State Detector Technologies

Track Classification: New Solid-State Detector Technology

Contribution ID: **78** Type: **Contributed Talk**

Large Area Near Infrared Detectors for Astronomy

Tuesday 13 September 2005 14:15 (15 minutes)

The technology of Infrared detectors has made significant advances over the last decade evolving from their small size and number of pixels to the present large format 2k x 2k pixel devices. These large format near infrared detectors (1 –2.5μm) are now routinely available to the astronomical community and are based on HgCdTe grown by either an LPE or MBE process on silicon or CdZnTe substrates. The performance of these devices, such as quantum efficiency, dark current generation and read noise etc. has also been significantly improved. The advent of these devices in buttable packages has prompted the build of large focal plane mosaics for wide field imaging in which the U.K. is a world leader. Four Hawaii-2 (2k x 2k) detectors mounted in a 2 x 2 sparse mosaic have recently been commissioned in the Wide Field Camera at U.K.I.R.T. on Hawaii. More ambitiously, the VISTA IR camera currently being built in the U.K. for an ESO telescope in Chile, will have a sparse mosaic of 16 (2k x 2k) VIRGO detectors mounted at its focal plane. We present details of the performance and characteristics of the Hawaii-2 and VIRGO detectors based on test results measured at the UKATC. We will also present details on the next generation of detectors.

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Session Classification: S5 : Applications in Astronomy and Astrophysics

Track Classification: Applications in Astronomy and Astrophysics

Contribution ID: **79** Type: **Contributed Poster**

SmartPET Image Reconstruction Techniques and Results

Thursday 15 September 2005 10:30 (30 minutes)

The SmartPET project will examine the possibility of using planer Hyper Pure Germanium Detectors (HPGe) within a Positron Emission Tomography (PET) system. This system is designed to image small animals.

The image reconstruction algorithms take measured or simulated projection data of an underlying radioactive source distribution and attempt to produce an accurate 2D or 3D image of this distribution.

Two main groups of algorithm exist, analytical methods such as Filtered Back Projection (FBP) and statistical methods such as Maximum Likelihood Expectation Maximization (ML-EM). Each algorithm has advantages and disadvantages; often the trade-off is between the quality of the final image and the computational power needed to produce it.

This presentation will provide an overview of the image reconstruction process from collection of the projection data (sinogram) to the use of this data in forming an image using either FBP or ML-EM. Example reconstructed images will be shown for both simulated and preliminary experimental data from the SmartPET system.

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Session Classification: P : Coffee and Poster Session

Track Classification: New Techniques for Positron Emission Tomography

Contribution ID: **80** Type: **Contributed Talk**

Position sensitive detector array for radioactive ion beam experiments

Wednesday 14 September 2005 12:15 (15 minutes)

We present an array of position sensitive detectors designed for the work with the beam of radioactive nuclei delivered by the separator ACCULINNA /1/. It is in use in the studies made on the structures of light nuclei with extreme neutron excess /2/. A pair multi wire proportional chambers (MWPC) installed in the front of a target is used for the measurement of the hit co-ordinates and inclination angles of the trajectories of individual beam nuclei entering the target. An annular type ⊠E⊠⊠E⊠E charged particle telescope, intended for reaction products, makes another part of the detector array.
Each MWPC has two planes of mutually perpendicular wires. Each plane is made by 32 20 μm Ta(Au) wires wound with a 1 mm step. These chambers can deal with a maximum beam intensity approaching 5⊠105 pps. The two chambers working together provide for a 95 % detection efficiency for the beam nuclei of 6He and 8He. The telescope involves three annular silicon detectors and a circular array of CsI (Tl) crystals matching the geometry the Si detectors. The front Si detector involves eight separate 40 μm thick Si modules assembled to make a detector ring with inner and outer diameters of 26 and 70 mm, respectively. A 300 μm thick annular Si detector with an active area having the inner and outer diameters of 32 and 85 mm, respectively, just follows after the front detector in the telescope. This double-side strip detector has 32 unbroken rings, on one side, and 64 sector strips on another side. The third, 1000 μm thick Si detector is similar in its active area with the second one, but it has only one set of 64 strips. The CsI(Tl) array is composed of sixteen 19 mm thick trapeziform modules in a way allowing one to cover with its sensitive area a ring having inner and outer diameters of 33 and 88 mm, respectively. The read out of the light coming from the CsI(Tl) crystals is provided by spectrometric photodiodes. The energy resolution is characterized by 50 and 150 keV full widths at half maximum obtained for 5.5 MeV α peaks, respectively, with the 300 and 1000 μm Si detectors and with the CsI(Tl) crystals. By means of this telescope one can well detect and identify nuclei with atomic numbers from Z=1 to Z=6 having energy in a range from 1.5 to 70 MeV. The whole system works well in experiments where the hitting position of individual ions on the target is defined with a precision of ±0.75 mm and the emission angles of reaction products are fixed within ±1.5 mrad. Beam tests showed an overall energy resolution of 0.7 % obtained for 130 MeV 6He nuclei.

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Session Classification: S8 : Applications in Nuclear Physics

Track Classification: Applications in Nuclear Physics

Contribution ID: **81** Type: **Contributed Talk**

Characterization of micro-strip detectors made with high resistivity n- and p-type Czochralski silicon

Thursday 15 September 2005 14:15 (15 minutes)

We report on the processing and characterization of micro-strip sensors produced on n- and p-type Czochralski silicon. The aim of this work is the development of radiation hard detectors for very high luminosity colliders. The activity is funded by INFN within the SMART project in the framework of the RD50 Collaboration.
The devices have been produced by ITC-IRST on 4"wafers, together with test-structures to monitor the process parameters and to study the modification of the bulk and of the surface properties as a function of the received fluence. Each wafer hosts ten mini-sensors with different strip geometries in order to compare the detector performances while varying the widths of the strip p+ implantation and of the metal layer.
The detectors have undergone two irradiation campaigns using 24 GeV/c protons at CERN and 26 MeV/C protons in Karlsruhe up to fluences of 5.0x1015 cm-2 and 1.6 x1015 cm-2 respectively.
The mini-sensors have been characterized before and after irradiation by measuring the IV and CV characteristics, the inter-strip capacitance and with scans of the strip currents.
Their performances have been compared with those of detectors of the same design processed on standard Fz silicon. Their relative radiation hardness has been established in terms of the depletion and breakdown voltages and by studying the inter-strip capacitance.
The preliminary outcomes of these measurements are discussed.

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Session Classification: S12 : New Solid-State Detector Technologies

Track Classification: New Solid-State Detector Technology

Contribution ID: **82** Type: **Contributed Talk**

An active pixel sensor and microelectrode array for retinal stimulation

Wednesday 14 September 2005 09:30 (15 minutes)

Degenerative photoreceptor diseases, such as age-related macular degeneration and retinitis pigmentosa, are the most common causes of blindness in the western world. A potential cure is to use a microelectronic retinal prosthesis to provide electrical stimulation to the remaining healthy retinal cells. Due to the success of cochlear implants in restoring hearing to the profoundly deaf this is becoming a widespread research area.
Here we describe a system capable of detecting the visual scene and translating the image into a train of electrical pulses that stimulates live retinal tissue. This system requires a position-sensitive detector to act as a smart retinal chip. We have developed a CMOS active pixel sensor with a 10 by 10 array of 100μm pixels. Each pixel contains a photodiode and on-pixel circuitry that translates the intensity of the incoming light into a certain frequency of output voltage pulses.
The outputs of the pixels are connected to a biocompatible microelectrode array, which makes contact with the retinal cells. This electrode array has 74-electrodes spaced at 60μm and is fabricated on a flexible polyimide substrate that is only 20μm thick. Each electrode is a platinum disc of diameter 5μm, which forms the interface to the retinal cells.
We have verified the electrical contact between the electrodes and the retina by recording the response of the output (ganglion) cells to light. A typical signal to noise ratio of 30:1 has been achieved with an overall system noise of 5μV rms. Retinal cells of only 10μm in diameter have been stimulated by a range of voltages from 0.1 to 2V with pulse durations of 0.1-1μs. The effects of charge spreading within the retina have been studied and optimal stimulation parameters determined. This

system permits the
simultaneous stimulation and recording of neural activity on the
retina and allows the
image processing that occurs within the retina to be studied.

Author: Dr MATHIESON, Keith (University of Glasgow)

Presenter: Dr MATHIESON, Keith (University of Glasgow)

Session Classification: S7 : Novel Photon Detection Systems

Track Classification: New Techniques for Positron Emission Tomography

Contribution ID: **83** Type: **Contributed Poster**

Optimization of Direct-Scintillator-Deposited Charge-Coupled

Thursday 15 September 2005 10:30 (30 minutes)

We developed a new photon-counting device for X-ray in the 0.1-100 keV energy range. The new device is an X-ray charge-coupled device (CCD) on which scintillator is directly deposited. It is called a scintillator-deposited CCD (SD-CCD). Low energy X-rays (0.1-10 keV) can be directly detected by the CCD while high energy X-rays (10-100 keV) pass through it into the scintillator where they generate hundreds or thousands of visible light photons. Their number is proportional to the incident X-ray energy. These photons can be detected by the CCD, a fact that enables it to effectively detect X-rays in the 0.1-100 keV energy range.
In order to achieve a high energy resolution, it is important that the number of visible light photons detected by the CCD increase. There are two types of CCD: a front-illuminated (FI) CCD and a backside-illuminated (BI) CCD. The BI CCD has higher sensitivity at low energy as well as visible light photons than the FI CCD, so we employed the BI CCD. As scintillator, we selected CsI(Tl). CsI(Tl) possesses the highest light yield among scintillators, and the light yield is above 60 photons/keV at -60oC. The emission spectrum of CsI(Tl) ranges between 350 and 700nm with a maximum at 550 nm. The detection efficiency of the FI CCD is of 20% while the BI CCD is of 85% at 550 nm. We fabricated two types of SD-CCD. One is coupled CsI(Tl) to the front side of the BI CCD with an optical cement, and the other one is directly deposited CsI(Tl) to the front side of the BI CCD. We suppose that depositing SD-CCD is less photons loss between CsI(Tl) and CCD than coupling SDCCD.
But the coupling SD-CCD is higher energy resolution than the depositing SD-CCD.
The FWHM energy resolution at 59.5 keV of the coupling SD-CCD is (26±1% whereas the depositing SD-CCD is (38±3)%.
In order to optimize the structure of SD-CCD, we employed the Monte-

Carlo simulation
software, DETECT2000. Since the CsI(Tl) crystals of the SD-CCDs were
needlelike structure,
it prevents the lateral spread of visible light photons. We
simulated light transport in
the needlelike CsI(Tl) and the non-needlelike CsI(Tl). In the
needlelike CsI(Tl), the spread
of visible light photons on the CCD is 60 μm at FWHM while it is
270 μm in the nonneedlelike
CsI(Tl). Therefore, the number of photons detected in one pixel (24x24 μm2) of
the SD-CCD employing non-needlelike CsI(Tl) is about half that of
the SD-CCD employing
needlelike CsI(Tl). This simulation is consistent with experimental
result obtained with
SD-CCD.

Author: Mr TAWA, Noriaka (Osaka University)

Presenter: Mr TAWA, Noriaka (Osaka University)

Session Classification: P : Coffee and Poster Session

Track Classification: Applications in Astronomy and Astrophysics

Contribution ID: **85** Type: **Contributed Talk**

Position sensitive CZT detectors for the COBRA neutrinoless double beta decay project

Thursday 15 September 2005 12:00 (15 minutes)

When Pauli first postulated the existence of the neutrino, he suggested that it would have no charge and no mass. This view held for almost 70 years, but a few years ago results from solar and atmospheric neutrino studies, now confirmed by terrestrial accelerator and reactor measurements, revealed the phenomenon of neutrino oscillations. This is the changing of one type of neutrino to another as they propagate through space, so that a beam of pure electron-neutrinos can evolve into a mixture of electron-, muon- and tau-neutrinos, with the ratios changing with distance. One consequence of the oscillation phenomenon is that it implies that neutrinos cannot have zero mass. Unfortunately, while the oscillation measurements can reveal the differences between the three neutrino masses (or more correctly the mass-squared differences) they cannot tell us what the absolute mass scale is. Given the enormous consequences of a finite neutrino mass there is great interest in determining this quantity.

Conventional approaches to measuring the neutrino mass involve measurements of the end point of beta decays. A number of new measurements are in progress and the view is that these will reach a sensitivity of around 0.5 eV. However, theorists favour a mass between 10-50 meV, which will be beyond the reach of this type of measurement. The only approach known which might achieve this sensitivity is neutrinoless double beta decay (0⊠⊠⊠). Neutrino accompanied double beta decay (2⊠⊠⊠⊠) is a rare decay process with a lifetime > 1020 years. There are 36 known isotopes where this decay can occur and it has been observed in about a dozen of these. 0⊠⊠⊠ ⊠ decay, if it occurs, will be even rarer and estimates put the lifetime in the region of 1026 years. Experiments to record this process will require large target masses (tonnes) and will need to be operated in low background underground laboratories.

The COBRA project uses a novel approach in using CZT (Cadmium Zinc Telluride) detectors both as the target and the detector. CZT is a room temperature semiconductor, so offering high resolution for the decay. The neat aspect is that the detector is also the source of the decay particles, because there are 9 isotopes of Cd, Zn and Te which are candidates for 0⊠⊠⊠⊠ decay. The signal of the decay is then two beta particles which are emitted from the same point in the detector and whose energies sum to the energy release in the decay.

At present the test setup employs an array of 1x1x1 cm cubic crystals supplied by eV Products. The main problem with CZT detectors is the poor hole mobility, which leads to excessive hole trapping and a consequent position dependence on the signal depending on the interactions depth in the crystal. The detectors we use employ the “gridded cathode”approach to remove this position dependency. However, as with any experiment of this type, the key is to reduce signals from background processes. One of the ways in which we hope to improve this is by employing pixellated detectors, by using digital pulse shape readout to record signal risetimes and by exploiting induced charge sharing between readout electrodes to determine event positions within the detector volume. These ideas will be explored in the talk.

Author: Prof. FULTON, Brian (University of York)

Presenter: Prof. FULTON, Brian (University of York)

Session Classification: S11 : Detectors for Astro-Particle Physics

Track Classification: Detectors for Astro-Particle Physics

Contribution ID: **86** Type: **Contributed Poster**

Compositional Analysis of Microchannel Plates Using Energy-Dispersive X-ray Fluorescence Spectroscopy

Thursday 15 September 2005 10:30 (30 minutes)

Modern microchannel plate detectors exhibit low quantum efficiency in the extreme ultra violet range (100-1000 Å) compared to those manufactured before 1990. The cause of this reduction in efficiency is unknown. We describe recent investigations into the variation of surface composition along the channels of a number of MCPs exhibiting high and low efficiency. These compositional profiles, generated using energy dispersive X-ray fluorescence spectroscopy, provide insight into the mechanisms underlying the observed reduction in quantum efficiency and may assist in efforts to restore the EUV performance of MCPs through modifications to the manufacturing process.

Author: Mr CARPENTER, James (Space Research Centre, University of Leicester)

Presenter: Mr CARPENTER, James (Space Research Centre, University of Leicester)

Session Classification: P : Coffee and Poster Session

Track Classification: Applications in Space Science

Contribution ID: **87** Type: **Contributed Poster**

Results of Irradiation Quality Assurance of CMS Silicon Microstrip Sensors

Thursday 15 September 2005 10:30 (30 minutes)

The Compact Muon Solenoid is one of the experiments at the Large Hadron Collider under
construction at CERN. Its inner tracking system consist of the world largest Silicon
Strip Tracker. Its sensors are single sided n-doped sensors with p-strip
implants, poly crystalline bias resistors and AC coupling. In total 24244 sensors
covering an area of 206 m^2 will be implemented in the tracker. In order to construct a
large system of this size and ensure its functionality for the full lifetime of 10
years under LHC condition, the CMS collaboration developed an elaborate design and a
detailed quality assurance program.
After arriving at CERN the sensors are delivered to the Quality Test Centers, the
Process Quality Controll Centers and to the Bonding Test Centers to determine the initial
quality of the sensors. A fraction (around 1%) of the sensors is sent to the Irradiation
Qualification Centers in Karlsruhe (Germany) and Louvain-la-Neuve (Belgium), where they
are irradiated with 26MeV-protons (Karlsruhe) or with fast neutrons (Louvain-la-Neuve).
After the irradiation with a fluence corresponding to 10 years operation at LHC the
sensors are tested again to test the radiation hardness. If problems occur special
irradiation campaigns have to be done to find out the origins and the solutions for the
problems.
The talk describes the radiation environment of the CMS tracker and after explaining
the radiation hardness concept of the sensors, the main results of the irradiation
qualification with 26MeV-protons and the special irradiation campaigns will be discussed.

Author: Mr FURGERI, Alexander (University of Karlsruhe)

Presenter: Mr FURGERI, Alexander (University of Karlsruhe)

Session Classification: P : Coffee and Poster Session

Track Classification: Applications in Particle Physics

Contribution ID: **89** Type: **Contributed Poster**

Space Charge Effects on Gas Gain in Non-Uniform Field Argon-Based Detectors

The charge carriers in the detector volume created in the gas amplification process cause a space charge effect. The fluctuation in gas amplification process is one of the main factor in the energy resolution of proportional counters. At low bias voltages only a very small number of charge carriers are generated and so the space charge effect is negligibly low. However, as bias voltage increases so does the gas amplification factor and the number of the secondary charge carriers grows, reducing the electric field strength between space charges and the anode wire.

In the present work, a Monte Carlo simulation code [1] has been used in order to investigate the influence of space charge effect on the gas gain and its fluctuation for different operation voltages and gas mixture ratios. In order to compare simulation and experimental results, the simulation code has been applied for the well-known ALEPH Inner Tracking Detector geometry whick is a non-uniform field argon-based gas detector that is operated in a proportional mode.

The results show that under normal operation conditions such space charge effect can cause significant change in the relative variance of the gain distribution started by a single primary electron generated in the different position.

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Author: Mrs DEMIR, Nilgun (Uludag Universitesi)

Co-author: Dr TAPAN, Ilhan (Uludag Universitesi)

Presenter: Dr TAPAN, Ilhan (Uludag Universitesi)

Track Classification: Applications in Particle Physics

Contribution ID: **90** Type: **Contributed Talk**

Investigation of Optimal Compton-Suppression Schemes for the TIGRESS HPGe Detector Array

Tuesday 13 September 2005 10:00 (15 minutes)

The TRIUMF-ISAC Gamma-Ray Escape-Suppressed Spectrometer (TIGRESS) is a new gamma-ray detector array being developed in order to take advantage of the radioactive ion beams to be delivered by the new ISAC-II facility at TRIUMPH. When complete, TIGRESS will consist of twelve large-volume 32-fold segmented HPGe clover detectors, fitted with 20-fold segmented Compton-suppression shields. The high efficiency of TIGRESS, predicted to be ˜18% in the "high-efficiency" and ˜10% in the "optimized peak-to-total" configurations for 1MeV gamma rays, will make it ideal for experiments with low-intensity radioactive ion beams. However, the photopeak efficiency and the peak-to-total response degrade as the multiplicity of the emitted gamma ray increases, due in part to an increase in the probability of false suppression. In order to counteract this problem, the high segmentation of the Compton suppression shield will be utilized. Suppression schemes, in which the suppression of events is based on analysis of which crystals and suppressor segments are hit have been developed. In order to accomplish this, data taken from a prototype TIGRESS detector were used to validate the results of a GEANT4 simulation of the full TIGRESS array. This simulation was used to examine the changes in peak-to-total and efficiency that result from the use of different suppression schemes. The results of this search, and the methodology behind it, will be presented

Author: Mr SCHUMAKER, Michael (University of Guelph)

Presenter: Mr SCHUMAKER, Michael (University of Guelph)

Session Classification: S3 : X-ray and Gamma-ray Detectors

Track Classification: X-ray and Gamma-ray Detectors

Contribution ID: **91** Type: **Contributed Poster**

Parallel Ionization Multiplier: a gaseous detector for the tracking of minimum ionization particles

Thursday 15 September 2005 10:30 (30 minutes)

We report on gain and discharge rate measurements with micro-pattern gaseous detectors using micro-meshes. Some geometrical configurations of Parallel Ionization Multiplier (PIM) and MICROMEGAS, operated with Ne+10%CO2 gas mixture, are considered. Tests have been performed on the T9 proton-pion beam facility at CERN.

For MICROMEGAS configurations, the discharge rate, greater than 2x10-7, is correlated to the thickness of the amplification gap. On the other side, for lower probabilities, the amplification gap thickness does not seem to be discriminant, suggesting that strong processes take place.

With the PIM structure operated at a gain of 5000, the best configuration allows to achieve a rate lower than 10-9. Some elements are now understood to reduce this discharge rate with only two amplification stages, such as using ions with greater velocities or thinner amplification gap. R&D activities are under progress in order to complete this study and to know the spatial resolution.

Author: Mr BEUCHER, Jerome (Ecole des Mines de Nantes)

Presenter: Mr BEUCHER, Jerome (Ecole des Mines de Nantes)

Session Classification: P : Coffee and Poster Session

Track Classification: Novel Gas-based Detection Techniques

Contribution ID: **92** Type: **Contributed Poster**

Enhancements to the spatial resolution and sensitivity of the MWPC-based PETRRA

Thursday 15 September 2005 10:30 (30 minutes)

The PETRRA positron camera is a novel, large-area positron camera based on coupling barium fluoride crystals to a multiwire proportional chamber filled with a photosensitive vapour, tetrakis-dimethylamino ethylene (TMAE). The present camera consist of two detectors each with 600mm x 400mm sensitive area containing sheets of 1cm thick crystals. This camera has a spatial resolution of ˜6-7mm FWHM, a timing resolution of 3.5ns and a sensitivity of 8kcps/kBq/ml. Whilst the former parameters are entirely acceptable, an increase in sensitivity is needed if the camera is to be competitive in a clinical environment. The sensitivity and spatial resolution are defined by the crystal thickness and increasing the latter to improve sensitivity would reduce the spatial resolution unless some form of crystal segmentation is used.

Experiments have been carried out using a small (100mm x 100mm) prototype detector at the Rutherford Appleton Laboratory. Small barium fluoride crystals 50mm x 4.6mm in length and width and thickness of 10mm, 15mm, 20mm and 25mm have been tested suing a Na-22 point source and a NaI(Tl) detector in coincidence with the camera. Preliminary results show that the sensitivity can be increased by more than a factor of two with the thicker crystals whilst the resolution is ˜4-5mm across the width and ˜9-10mm along the length. Based on these results it is proposed that the barium fluoride crystals in the PETRRA detector can be replaced with 25cm thick crystals segmented to ˜5-6m in one dimension. This would increase the coincidence efficiency for two detectors by ˜5-6 whilst retaining the transaxial spatial resolution to ˜5mm.

Author: Prof. OTT, Bob (University of Surrey, Rutherford Appleton Laboratories and the Institute of Cancer Research)

Presenter: Prof. OTT, Bob (University of Surrey, Rutherford Appleton Laboratories and the Institute of Cancer Research)

Session Classification: P : Coffee and Poster Session

Track Classification: Applications in Nuclear Medicine And Radiology

Contribution ID: **93** Type: **Contributed Talk**

Construction of the ATLAS SCT Endcap Modules

Friday 16 September 2005 10:00 (15 minutes)

The ATLAS Semi-Conductor Tracker (SCT) uses silicon strip detectors to measure trajectories of charged particles coming from 14 TeV proton-proton collisions at the Large Hadron Collider at CERN. The SCT provides at least four precise space points, in the radial range of 27 to 50 cm from the beam, for tracks within the angular acceptance |⊠|<2.5. The SCT is built up of 4088 modules, each consisting of two or four silicon detectors, a hybrid carrying several readout ASICS, and components to support, cool and align the detectors.
We report on construction of the endcap part of the SCT, which is built up from 1976 modules of four different flavours. A group of 16 institutes from 7 countries is nearing completion of an intensive 18 months of building all these modules. At the outset we assumed a module assembly yield of 85% and we procured components accordingly. In fact we have comfortably exceeded 85% yield and this paper aims to explain how it was done. First the module specifications are summarised, then we describe our module assembly techniques. We detail the tests that we used for quality control of module components and of completed modules. A key aspect of the project was to fully standardise the final module tests and to insist that test data from all institutes was stored in a single central database, while leaving institutes a lot of freedom to vary their module assembly methods to suit local circumstances. Finally we report our experience in terms of component quality, assembly rates and testing rates, yield of good modules and causes of lost modules

Author: Dr SNOW, Steve (University of Manchester)

Presenter: Dr SNOW, Steve (University of Manchester)

Session Classification: S14 : Applications in Particle Physics

Track Classification: Applications in Particle Physics

Contribution ID: **94** Type: **Contributed Poster**

Relationship between Real Charges and Image Charges from the Planar smartPET Detector and the Advantages of Wavelet Analysis

Thursday 15 September 2005 10:30 (30 minutes)

The smartPET project is an attempt to use high purity germanium detectors for use in positron emission tomography (PET). The current spatial resolution of PET using BGO and LSO detectors is ˜5mm, and the smartPET project aims to improve spatial resolution to 1mm. Two planar Germanium detectors with dimensions of will be used in coincidence; these detectors are pixelated by means of strip contacts.

By utilising a strip spacing and Pulse Shape Analysis (PSA) it's theoretically possible to achieve a spatial resolution. Pulses arising from direct gamma absorption in particular strips are accompanied by image charges in adjacent strips. The shape of these image charges is dictated by the position of photon interaction in relation to these adjacent strips; the closer to the adjacent strip the larger the image charge. The amplitude relationship between image charge and real charge is empirically known to be ˜40% (at maximum), presenting the problem of detecting low amplitude image charges in noise.

Current work will quantify the ratio of image charge to real charge and wavelet analysis will be implemented to de-noise signals. Early results of wavelet analysis appear to be very promising, with significant (almost total) noise reduction and identification of ˜6keV pulses in signals with ˜6keV noise. The results from previous work and current work will be discussed.

Author: Mr SCRAGGS, David (University of Liverpool)

Presenter: Mr SCRAGGS, David (University of Liverpool)

Session Classification: P : Coffee and Poster Session

Track Classification: New Techniques for Positron Emission Tomography

Contribution ID: **95** Type: **Contributed Talk**

Characterising a planar germanium strip detector for imaging applications

Wednesday 14 September 2005 09:45 (15 minutes)

An orthogonal strip
HPGe detector has been manufactured by Ortec. The dimensions of the crystal are 60 × 60 × 20 mm. The crystal is electrically divided into 12 strips of a 5 mm width on both sides of the detector. Combined with digital electronics and pulse shape analysis (PSA), the detector has the potential to reduce the position resolution to 1 mm3. The improvement of position resolution in depth is the major challenge in the characterization of the planar germanium detector.

Digital electronics provides the opportunity to utilize PSA on an event by event basis. The analysis involves two types of signal; real charge and image charge. Information about the depth of interaction can be gained from both signals. The analysis of the real charge correlates the risetime and the depth of interaction. The shape and amplitude of the image charges provides information about the depth and the transverse position in the strip. A depth measure using image charges has been developed and results will be presented.

Author: Mr TURK, Gerard (University of Liverpool)

Presenter: Mr TURK, Gerard (University of Liverpool)

Session Classification: S7 : Novel Photon Detection Systems

Track Classification: New Techniques for Positron Emission Tomography

Contribution ID: **96** Type: **Contributed Talk**

Performance characteristics of a small animal PET camera for molecular imaging

Tuesday 13 September 2005 11:30 (15 minutes)

Background. Molecular imaging using an animal PET camera is a powerful technique for studying the bio-distribution of radiolabelled tracers and ligands, offering a means for in-vivo assessment of new drugs and disease related biochemical processes. The design of such imaging experiments must be guided by knowledge of the performance characteristics of the PET camera. For example, the scientist will need to determine the amount of a compound that must be administered in order for the radiolabelled molecule to produce a PET signal with sufficient strength and resolution to allow detection, visualisation and quantitation. We recently installed a novel type of animal PET camera, the quad-HIDAC, of which only three others are installed world-wide (London, Switzerland, Germany).
The PET Camera. The HIDAC animal PET system, developed by Oxford Positron Systems, is based on high-density avalanche chamber detector modules consisting of argon-flooded multiwire proportional chambers (MWPC) with integrated converter plates made up of laminated layers of lead and insulating sheets, drilled with a dense matrix of small holes, as shown on the left. In each module, the incoming 511 keV photons interact in a converter plate by photoelectric and Compton processes to eject electrons into holes where they are amplified and extracted under a high electric field gradient into the MWPC. The x-y coordinates of the event are recorded by the orthogonal cathode tracks. The holes of the converter planes are 0.4 mm in diameter and 0.5 mm from centre to centre. Four detector banks, each comprising four HIDAC modules, surround the imaging port. The axial field of view is 28 cm long and the transaxial FOV is 17 cm in diameter. Due to the detector design, the HIDAC system inherently yields information on the depth of interaction of the photon in the detector banks. Energy information cannot be obtained with this detector design, but some discrimination of low-energy photons is inherently performed because of the reduced sensitivity of the detectors to low-energy gammas.
Results. The following performance parameters were determined. The values of mean spatial resolution in the three spatial planes were 1.02mm in the horizontal direction, 1.00 mm in the vertical direction, and 0.97mm in the axial direction. Furthermore, measurements across the field of view showed these resolution results to be invariant within a standard deviation of 0.05mm. Therefore, the volumetric resolution is 1.0 cubic mm, or 1 microlitre, which is better than for any other PET system. Absolute sensitivity (scatter-corrected) measured with a point source was

found to be 0.75%. Count-rate capability measurements showed a near-linear response at low activities, rising to a 20% loss rate at an activity of 11.5MBq. These results will be essential in designing animal imaging studies for in vivo assessments of new compounds and biochemical processes. A preliminary study using [18-F]-Fluorodeoxyglucose (FDG), shown on the right, clearly demonstrates superb detail of the in vivo tissue biodistribution of glucose metabolism, with muscles, heart, and individual vertebrae musculature being well defined.
Conclusion. This PET camera was found to have better spatial resolution and better uniformity of response over a larger field of view than has previously been reported, and should allow excellent imaging assessment of small regions of radiotracer uptake in the mouse.

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Presenter: Dr HASTINGS, David (Christie Hospital)

Session Classification: S4 : New Techniques for Positron Emission Tomography

Track Classification: New Techniques for Positron Emission Tomography

Contribution ID: **97** Type: **Contributed Poster**

Time dependence of the behaviour of silicon detectors

Thursday 15 September 2005 10:30 (30 minutes)

Semiconductor detectors are widely used in modern high energy physics experiments. They are elements of the high resolution vertex and tracking system, as well as of calorimeters
The bulk displacement damage in the detector, consequence of irradiation, produces effects at the device level: increases the leakage current, decreasing the satisfactory Signal/Noise ratio, produces carrier trapping, modifying the build-up space charge, changing the required operating voltage. These effects limit the utilisation of the detector as a position sensitive device. In silicon p-n junction detectors, after large irradiation fluences, the negative space charge dominates and the required operating voltage increases. The safe operating value of the depletion voltage limits the detector lifetime and thus the lifetime of detector systems. So, the prediction of time behaviour of detectors in hostile radiation environments, as those expected in the next generation of colliders, represents a very useful tool.
In some recent papers [1,2,3], the authors argued that the main source of discrepancies between data and previous models for degradation of device characteristics (leakage current and effective carrier concentration), especially after hadron irradiation, could be explained considering the contributions to these effects of the "usual"vacancy and the existence of a pseudo vacancy –the SiFFCD defect (fourfold coordinated vacancy defect).
In this contribution we predict the time degradation of silicon detectors –leakage current and concentration of effective carriers, in the radiation environments expected in the LHC machine upgrade in luminosity and energy as SLHC and VLHC respectively, for detectors fabricated using different silicon growth technologies. If these hypotheses are correct, thus, in conditions of continuous long time irradiation, as e.g. LHC and its upgrades, the contribution of primary defects will represent a major problem and must be considered. Also, this study permits to predict which materials are more adequate to obtain harder radiation devices, but experimental confirmations are needed.

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Session Classification: P : Coffee and Poster Session

Track Classification: New Solid-State Detector Technology

Contribution ID: **98** Type: **Contributed Poster**

Position Reconstruction in a Liquid Xenon Scintillation Chamber for Measuring Detection of Low Energy Nuclear Recoils and Gamma-Rays

Thursday 15 September 2005 10:30 (30 minutes)

Liquid xenon has been recognised as a promising medium for direct detection of hypothetical
Weakly Interactive Massive Particles. Therefore, investigation of the response of liquid xenon to
nuclear recoils and g-rays is of primary importance.
In particular, we have recently measured the relative scintillation efficiencies of liquid xenon for
these two particles by irradiating a liquid xenon chamber with monoenergetic neutrons and detecting
the scintillation due to xenon recoils from elastic scattering of the neutrons. The liquid xenon chamber
used in these measurements was equipped with 7 two-inch photomultipliers (PMTs) in the top of a
cylindrical volume ø17×5.5 cm3 surrounded by PTFE reflectors, which define the active volume of
the liquid. The scintillation efficiency of liquid xenon for nuclear recoils with the energy from
140 keV down to 5 keV has been measured. The experimental uncertainties, among other factors,
include the variation of the signal amplitude with the event position and some contribution from
multiple scattering in the liquid.
Thus, measurement of the interaction position and rejection of the events involving two or more
scintillation points would allow the uncertainties to be reduced. For that, we adopted the maximum
likelihood (ML) method previously employed with success for scintillation detectors of similar
configuration [1], [2]. Two main difficulties are normally associated with this method: (i) exact
knowledge of the light collection function throughout the detector volume is essential, but this
function is difficult to measure or model; (ii) search for the maximum of the likelihood function is a
heavy computational task.
In the case of our detector, the rather simple configuration of the device allows to simulate the
light collection using a model with just three free parameters (reflection coefficient of PTFE,
absorption and scattering lengths in liquid xenon) easily adjustable

to experimental data obtained with
gamma-ray source of 122 keV at various positions. The light collection template with 2 mm step in
3D has been obtained in this way. The search for the ML was performed using conventional
techniques such as simplex method, which has been proved to be efficient for this purpose.
In the case when the scintillation signals are of very low amplitude, resulting in emission of just a
few photoelectrons from the PMT photocathodes, the single photoelectron response of the PMTs has
to be taken into account. Therefore, instead of using the Poisson distribution, as it is normally done,
we implemented ML with Polya distribution.
The developed algorithm was tested with 122 keV g-rays from a 57Co source placed under the
chamber bottom. An (x,y)-position resolution of s=6.7 mm was obtained in the xenon layer of a few
mm next to the chamber bottom. In order to assess the resolution in the whole volume, a number of
fake data sets were produced by Monte Carlo simulation and reconstruction algorithm has been
applied to them. The results indicate that at 122 keV the resolution is better than 4-5 mm for the
central region of the chamber (ø80 mm and 40 mm high) and better than 7 mm in approximately 80%
of the total volume of the chamber. For lower energies, the results indicate a slow worsening of the
resolution. For example, for 10 keV energy depositions by g-rays, the position resolution is expected
to become worse by a factor of about 2.
Applying of the developed reconstruction algorithm to the data obtained with nuclear recoils will
allow the necessary corrections to be introduced and thus to improve the precision in determining the
scintillation efficiency of liquid xenon to this particles. This method can potentially be useful for other
liquid xenon purely scintillation detectors that are being developed for other applications.

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Session Classification: P : Coffee and Poster Session

Track Classification: X-ray and Gamma-ray Detectors

Contribution ID: **99** Type: **Contributed Talk**

Test beam measurements of the performances of the production modules of ATLAS Pixel Detector

Monday 12 September 2005 16:30 (15 minutes)

The ATLAS Pixel Detector is the innermost tracking system of the ATLAS experiment at the Large Hadron Collider.

The performances of the production modules of the ATLAS Pixel Detector have been studied using data collected with a 180 GeV/c pion beam at the CERN SPS accelerator.

Several of the modules have been irradiated after assembly and before the test beam using 24 GeV/c proton up to the full LHC fluence of 1015 1 MeV neq cm-2 and a total ionizing dose of 500 kGy.

In this contribution, a selection of the results from the analysis of test-beam data is presented. The post-irradiation depletion voltage and charge collection efficiency have been studied in detail. The spatial resolution, before and after irradiation, will be presented.

Particular emphasis will be given to the measurements of detection efficiency. The efficiency was studied as a function of the phase between the edge of the clock operating the detectors and the particle arrival time provided by the beam trigger detectors. This allowed the study of the optimal clock timing for the operation of the detectors at the LHC. The results for not irradiated and irradiated modules are discussed.

The timing uniformity between the different types of pixel cells and between the 16 front-end readout chips of a detector module is also presented. The interplay between the optimization of detection efficiency and spatial resolution was also studied.

Data were also taken with a high intensity beam in order to reach and exceed the pixel occupancy of the innermost ATLAS tracking layer during operation at the nominal LHC luminosity and test the limits of the data acquisition architecture. The detection efficiency as a function of the beam intensity is discussed for different configuration settings of the read-out electronics.

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Session Classification: S2 : Pixel Detectors for Charged Particles

Track Classification: Pixel Detectors for Charged Particles

Contribution ID: **100** Type: **Contributed Poster**

Simulation of LHCb silcon strip detector response using a

The charge collection properties of the LHCb n on n silicon
Strip detector was modelled using the DIOS and DESSIS
Packages from the ISE/synopsys program suite.
The detector response to MIPS was modelled in detail as a function
Of applied bias voltage,radiation damage and incident track angle.
a centroid shift in the collected charge between positive and
Negative incident track angles has been predicted and operational
Bias voltages deduced.

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Track Classification: Pixel Detectors for Charged Particles

Contribution ID: **101** Type: **Contributed Talk**

Effects of metallization of TlBr single crystals for detector applications

Thursday 15 September 2005 14:30 (15 minutes)

The single crystal TlBr is a promising candidate as a gamma-ray detector due to its high stopping power, density (7.56 g/cm3) and bandgap (2.68 eV). These properties allow to perform a compact device working at room temperature. However, the transport properties of TlBr were still plagued by material problems [1]. These problems are manly arisen from purity and quality of the crystal, both these properties being actively affected by the total process of detector manufacturing.

The study of initial stages of the process, namely the synthesis, crystal growth and purification, has shown the considerable variation in the material properties in respect of methods used [2]. The annealing was shown to improve the crystal quality of TlBr [3] and its purity [2], and as result the electrical, optical and X-ray properties became better. However, the electrical characteristics of the samples were time depended and not fully understood.

In this work, the making of electric contact with different methods was studied. Al, Ti, Cr, In, Sn, as well Ag- and graphite-paste were used for annealed TlBr single crystals. I-V and C-V curves were recorded. The samples were additionally characterised by x-ray rocking curve method, photocurrent measurements and under polarised light. They were also studied under Cu-radiation of x-ray powder diffractometer.

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Session Classification: S12 : New Solid-State Detector Technologies

Track Classification: New Solid-State Detector Technology

Contribution ID: **102** Type: **Contributed Poster**

Radiation hardness of high resistivity n- and p-type magnetic Czochralski silicon

Thursday 15 September 2005 10:30 (30 minutes)

An LHC upgrade with a luminosity increase of one order of magnitude has been recently envisaged. In this scenario, silicon detectors produced according to the present technologies would not withstand the increased radiation fluences.
Magnetic Czochralski silicon (MCz) can be a promising solution for future experiments due to its high intrinsic oxygen concentration, which improves the radiation tolerance. The INFN SMART Collaboration, a research project within the framework of the CERN RD50 Collaboration, recently started an R&D activity to study the properties and the radiation hardness of this material and a possible employment in high energy physics tracking systems.
A large set of MCz 4"wafers of 1 kΩcm resistivity of both n- and p-type has been recently produced by Okmetic (Finland). Wafers were then processed at ITC-IRST in Trento (Italy), with a process tuned for low temperature steps. A few Float Zone (FZ) wafers were also processed with the same masks and process to allow a comparison with the present material.
The wafer layout contains a large number of multiguard diodes, specific test structures and microstrip sensors. Pre-irradiation properties were investigated to assess the manufacturing quality and the bulk properties. Diodes, together with other test structures, underwent an irradiation campaign with 24 GeV/c protons at CERN, 26 MeV/c protons in Karlshrue and nuclear reactor neutrons in Ljubliana, up to fluences of 8x1015 cm-2.
For all diodes, the effective dopant concentration and the leakage current were studied as a function of the annealing time at different temperatures and, according to the fluence and the bulk type, the type inversion could be observed. The increase in leakage current and the effective dopant concentration were also studied as a function of the fluence and both damage constant and beta parameter were measured. Bulk materials and irradiation types were also compared.
A thorough study on defects has been also performed on these diodes via Thermally Stimulated Currents. The occurrence of a shallow donor defect is observed in both types of material at 30 K after irradiation at of 4x1014 cm-2. Type inversion has been also investigated for fluences up to 1015 cm-2 by current transient spectroscopy: results are reviewed and discussed.

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Session Classification: P : Coffee and Poster Session

Track Classification: Applications in Particle Physics

Contribution ID: **103** Type: **Contributed Talk**

ZEPLIN III: Position Sensitivity

Thursday 15 September 2005 12:15 (15 minutes)

ZEPLIN III is a xenon detector for direct dark matter searches soon to be deployed underground at the Boulby mine (North Yorkshire, UK). This two-phase (liquid/gas) system will look for the rare nuclear recoils that should be produced by elastic scattering of Weakly Interacting Massive Particles (WIMPs) off xenon atoms.
Neutron interactions can also cause nuclear recoils and therefore constitute an irreducible background in this type of detector. This is mitigated by the use of radio-pure construction materials, by surrounding the detector with extensive hydrocarbon shielding and by deploying the system deep underground, where a large rock overburden protects it from the effects of cosmic rays. Another key challenge is to identify the very rare nuclear recoil events due to WIMPs or neutrons in a background of beta and gamma-rays from residual internal and external radioactivity. These electron-recoil events are some ˜106 times more abundant and must be effectively discriminated from nuclear recoils.
ZEPLIN III measures both the scintillation and ionisation signals produced in liquid xenon by the interacting particle. The prompt scintillation is measured by an array of 31 photomultipliers immersed in the liquid xenon. A strong electric field also extracts the ionisation from the interaction site, which drifts up to the liquid surface and is extracted into the gas phase. A large number of electroluminescence photons is produced in the gas and detected by same photomultiplier array. A sensitivity down to one electron extracted from the liquid is thus easily achieved. The ratio of the two response channels is different for electron and nuclear recoils, allowing effective discrimination between the two types of interaction down to ˜keV deposited energies (electron-equivalent).
In order to achieve the excellent discrimination ability required to fully separate the electron and nuclear-recoil populations, a very uniform response is necessary for both channels across the active volume. In most detectors, this fiducialisation is achieved by physically delimiting the active region. In ZEPLIN III, this is accomplished by reconstructing the 3-dimensional interaction point and rejecting events occurring in out-lying regions, where the light collection and the electric field may not be uniform. We will describe the position reconstruction methods to be used in ZEPLIN III and how we hope to achieve a positional accuracy of a few millimetres in the horizontal plane and sub-millimetre in the vertical coordinate.

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Session Classification: S11 : Detectors for Astro-Particle Physics

Track Classification: Detectors for Astro-Particle Physics

Contribution ID: **104** Type: **Contributed Talk**

Status of TACTIC: a detector for nuclear astrophysics

Friday 16 September 2005 12:15 (15 minutes)

A new detector for nuclear astrophysics studies is being designed and built by TRIUMF and the University of York. TACTIC, the TRIUMF Annular Chamber for Tracking and Identification of Charged particles, is designed to detect low energy charged particles from reaction studies performed at the relevant astrophysical energies, in inverse kinematics. TACTIC is a cylindrical ionisation chamber with segmented anode strips which allow the dE/dx of the particle to be determined along with the total energy. Information from drift times allows the particle trajectory to be reconstructed. This in turn identifies the interaction point along the beam axis and hence the centre of mass energy of the reaction. To amplify the expected weak signals, a Gas Electron Multiplier (GEM) will be used in place of the usual Frisch grid. Full electronic readout of the charge and timing of each anode strip will be achieved with flash ADC cards allowing pulse shape analysis of the signals. Results from a test chamber and GEANT4 simulations will be presented.

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Session Classification: S15 : Novel Gas-based Detection Techniques

Track Classification: Novel Gas-based Detection Techniques

Contribution ID: **105** Type: **Contributed Talk**

Monte Carlo simulation of a Coded Aperture Imaging with Dedicated Gamma Camera System for scintimammography

Tuesday 13 September 2005 17:00 (15 minutes)

The incident of breast cancer is increasing and thus requires a powerful diagnostic technique for early detection. X-ray mammography (as screening and diagnostic tool) is claimed to be the golden standard in breast tumour imaging. However, mammographic findings are, non-specific in many cases, and adjunctive methods such as nuclear medicine techniques are needed. Planar scintimammography (SM) as an adjunct to mammography has been gaining significant attention. However, when undertaken with a conventional parallel-hole collimator has difficulty detecting tumours that are less than 1cm in diameter. In addition, such camera utilises a very small fraction of the total number of the emitted photons: this limit both the quality and the diagnostic value of the observed images, whereby spatial resolution and sensitivity trade off against each other. Moreover, imaging with standard gamma camera might cause problems gaining close proximity to the breast. As an alternative approach, we focus our attention on the applications of Modified Uniformly Redundant Arrays (MURAs) [1] Coded Aperture (CA) methods with dedicated high resolution gamma camera instrumentation without collimator for use in SM. Such CA pattern has an open area of up to 50%, thus making good use of the emitted photons, as well as exhibiting potentially significant sensitivity improvements. Thus, with enough photon statistics CA imaging might match the imaging objectives in SM: early detection of malignant disease.

The purpose of this study is to investigate and evaluate dedicated gamma camera breast tumour imaging with MURAs CA systems using a well established Monte Carlo simulation method. MCNPX code is used that has many capabilities and provide detailed physics simulation within the photon range encountered in nuclear medicine imaging. In addition, it does however model Compton scatter, X-ray fluorescence as well as photon penetration of the gamma camera collimator. We considered only 99mTc isotropic sources emitting 140 keV photons to perform a complete simulation. The simulation consists of tracing the path of gamma photons through tissue equivalent scattering material, through the CA and until detected in the scintillation crystal. We also simulate the statistical uncertainty in position read out and the statistical charge variation caused by photoelectron variation in the photomultiplier tube array. Thus, all the major physics aspects of the imaging system are considered. A full camera validation is currently under investigation.

The Monte Carlo Simulation model is based on a simple 3D block phantom containing breast and variable legion sizes (5, 10, 20 mm diameter). The breast is schematized as a parallelepiped (of 6 x 6 x 6 cm3) a breast thickness of 6cm was chosen based on the assumption of light breast compression to emulate SM and to increases the lesion detectability. The lesions were always positioned at 3cm depth from the surface of the breast, as point-like sources (lesions represented as spheres) with or without background activity assigned to the surrounding media. The effectiveness and performance of CA SM will be evaluated by quantitative comparison of three fundamental parameters: breast tumour sensitivity, lesion detection (the contrast) and FWHM under a variety of clinical imaging situations. Although this work is primarily aimed at breast tumour imaging, other applications with similar levels of photon statistics may also benefit from such an approach e.g., small animal imaging and clinical paediatric imaging.

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Session Classification: S6 : Applications in Nuclear Medicine and Radiology

Track Classification: Applications in Nuclear Medicine And Radiology

Contribution ID: **106** Type: **Contributed Poster**

Short induction gap Gas Electron Multiplier (GEM) for X-ray Spectroscopy

Thursday 15 September 2005 10:30 (30 minutes)

Abstract: Experimental work was carried out to evaluate the performance of a Gas Electron Multiplier (GEM) operated with a Micromesh readout plane that enabled the induction gap to be set at 50 microns. We measured the essential operational parameters of this system using Ar(75%)-isobutane (25%) as the counter gas mixture. The measurements included the effective gain (signal-to-noise ratio), effective gain stability, X-ray energy resolution and the risetime of the detector output pulses using a 5.89 keV X-ray source. These studies demonstrated several advantages of the current system such as lower operational voltages, higher effective gains, improved effective gain stability and faster detector output pulses.
1) Introduction: The conventional Gas Electron Multipliers (GEMs) operation usually employs the induction gap (Distance between the bottom GEM electrode and the readout plane) set at 1 mm or more. This may lead to effective gain shifts of the detector if the GEM foils sags due to counter gas absorption and moisture. One obvious way to circumvent this is to introduce dielectric pillars between the GEM foil and the readout plane. In the present study, we have used a standard GEM (hole diameter 55 microns, hole pitch 140 microns) coupled with a micromesh with 50 microns tall, 150 microns diameter kapton pillars. The short induction gap had several distinct operational advantages. For example, better effective gain stability owing to a good induction gap definition, the absolute voltages needed to sustain a particular induction field were lowered and faster output pulses were observed.

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Session Classification: P : Coffee and Poster Session

Track Classification: Novel Gas-based Detection Techniques

Contribution ID: **107** Type: **Contributed Talk**

Use of a novel Controlled Drift Detector for Diffraction Enhanced Breast Imaging

Tuesday 13 September 2005 17:15 (15 minutes)

Although conventional mammography is currently believed to be the most effective breast screening tool, alternative techniques are being sought for those cases in which a second-stage examination is required.
Diffraction Enhanced Breast Imaging (DEBI) is a promising alternative, as the difference in the diffraction profiles of healthy breast tissue and of carcinoma is much more significant than the difference between the X-ray attenuation coefficients of the two, determining the contrast in conventional mammography [1].
In particular, the maximum differences in signal from the two tissue types are detected when the momentum transfer (⊠=1/⊠ sin (⊠/2), where ⊠ is the beam wavelength and ⊠ is the scattering angle) is ⊠ =1.1 nm-1 or ⊠ =1.7 nm-1; in the first case the signal from normal tissue is about twice the signal from carcinoma, while in the second case the diffracted intensity from carcinoma is about 1.5 times higher than that from healthy tissue. The signal intensities are comparable at ⊠ =1.4 nm-1.
Due to the low scattered photons yield, a detector with a very low noise is needed. A good candidate is a Controlled Drift Detector (CDD) developed at Politecnico di Milano, featuring a very low noise level and spectroscopic capabilities [2,3].
This paper presents the preliminary results obtained using a CDD for the acquisition of diffraction images using monochromatic X-rays.

Materials and Methods
A prototype of CDD with a sensitive area of about 6 mm x 4 mm and a pixel size of 180 μm was used.
Monochromatic synchrotron radiation beams from the ELETTRA synchrotron radiation souce were used with an energy of 18 and 26 keV. Both transmission and diffraction images were acquired. For the latter, a multihole collimator was used and the detector was tilted at 9°, hence detecting diffracted X-rays with a momentum transfer of 1.1 nm-1 or 1.7 nm-1 when using 18 keV or 26 keV beams, respectively.
Images of test objects and of meat samples were acquired.
Images were reconstructed by integrating either the whole spectrum detected from each pixel, or only the main peak.

Results and discussion
All diffraction images showed an increase in contrast with respect to the transmission images acquired at the same energies, thus proving the suitability of the CDD for DEBI applications.
No significant difference was found in the peak images with respect to the full-spectrum images; however, the spectroscopic capability appears a promising characteristic for using the CDD with conventional X-ray sources.

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Session Classification: S6 : Applications in Nuclear Medicine and Radiology

Track Classification: Applications in Nuclear Medicine And Radiology

Contribution ID: **108** Type: **Contributed Talk**

Fabrication of 3D detectors with columnar electrodes of the same doping type

Thursday 15 September 2005 14:45 (15 minutes)

Recently, increased attention has been given to 3D detectors owing to their capability to control the depletion mechanism by acting on the layout of the vertical electrodes only. Depletion voltages two orders of magnitude lower and collection times one order of magnitude lower than those of standard planar detectors [ ] can be obtained, by properly designing the electrodes width and pitch. This feature is of particular interest for detectors to be employed in extremely hard radiation environments, as the one foreseen for the Super-LHC.
In the 3D architecture proposed by S.I. Parker et al. [1], columnar electrodes of both doping types are arranged in adjacent cells. The path of the electric field lines begins at one electrode type and ends at the closest electrode of the opposite type in parallel with the detector surface. Acting on the bias voltage the strength of the electric field can be tuned. The fabrication process of 3D detectors is rather long and requires several steps that are not commonly used in standard detector technology. This makes future mass production of 3D devices very critical as far as the fabrication yield and the costs are concerned.
In a previous work [ ] we presented a new 3D detector architecture (3D-stc) aimed at simplifying the manufacturing process making it more suitable for high volume production. In particular, the proposed device features electrodes of one doping type only, e.g., n+ columns in a p-type substrate. The main advantage is that the column etching and doping are performed only once, a fact that provides a considerable process simplification. A drawback of the proposed structure is that it prevents from controlling the electric field strength with the applied voltage when full depletion is reached. The only way to control the electric field is by selecting the appropriate substrate doping concentration. As a result, the low-field regions may have a larger extension with respect to the original 3D detector design. Several tests have been performed to verify the feasibility of single process steps.
In this work we present the layout and the fabrication process used to realize the first prototypes of 3D-stc.
The device process is going to be completed in June 2005, therefore preliminary results of the electrical characterization will be presented at the conference.

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Session Classification: S12 : New Solid-State Detector Technologies

Track Classification: New Solid-State Detector Technology

Contribution ID: **109** Type: **Contributed Talk**

A position-sensitive detector for the Advanced LIGO suspensions

A simple optical displacement sensor consisting of an infrared LED source, a photodiode detector, and an occluding 'flag', has been investigated, for potential use in the Advanced LIGO gravitational wave detectors. A number of different commercially available LEDs and photodiodes were tried in the displacement sensor, and an optimal pair was found. A surprising geometrical effect was noted which allowed the residual noise level to be reduced at low frequencies, permitting a displacement sensitivity of ˜10-10 m/√Hz to be attained at a frequencies in the region of 2 Hz. A novel optical x2 linear displacement amplifier has also been constructed, suggesting that the displacement sensitivity might be further improved by this factor.

The work reported here was carried out in collaboration with the Institute for Gravitational Research at the University of Glasgow, the Department of Physics and Astronomy at the University of Birmingham, and the Rutherford Appleton Laboratory.

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Track Classification: Detectors for Astro-Particle Physics

Contribution ID: **110** Type: **Contributed Poster**

RAPID2 Readout for Gas Micro Strip Detector

Thursday 15 September 2005 10:30 (30 minutes)

Gas filled multi-channel detectors are ideally suited for x-ray applications that require photon counting and position sensitivity. This type of proportional counters is superior in time resolving experiments where low dark noise and microseconds resolution are essential, eg. SAXS/WAXS for investigating polymer formation and XRD for studying mineral crystal growth. Gas Micro Strip Detector (GMSD) has excellent geometric characteristics. It has fine pitch micro-patterns formed by lithography and uniform flatness provided by the glass substrate. The performance of the GMSD can be enhanced by the use of the RAPID2 readout system. This advanced system consists of novel digital signal processing (DSP) and parallel readout electronics technology successfully developed at Daresbury Laboratory. It is capable of a stunning overall rate of over 40 million events per second when operated in 1D and 15 million events/s in 2D. RAPID2 employs ultra fast sampling and interpolation processes that can enhance the inherent spatial resolution defined by the geometric anode pitch on the GMSD. The readout algorithm collects comprehensive information on each photon interaction and thus makes an excellent diagnostic tool on detector response to x-rays. We will demonstrate these by testing and optimising the current RAPID2 readout electronics on a 1D sector (finger/keystone) GMSD.

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Session Classification: P : Coffee and Poster Session

Track Classification: Detectors for Synchrotron Radiation and Spillation Neutron Sources

Contribution ID: **111** Type: **Contributed Poster**

Infrared Synchrotron Diagnostics as a New Perspective Direction in the Physics and Technology of Accelerator Experiments

Thursday 15 September 2005 10:30 (30 minutes)

The methods and detectors for nondestructive diagnostics and study of charged particles of bunches or beams (electron, electron-ion, proton) are submitted in this paper. The methods of based on the use of relativistic particles synchrotron radiation in a wide spectral range, from the ultraviolet to the far long-wave infrared region [1, 2].

Methods for measuring and estimating the energy, number of charged particles (current) and geometrical parameters (cross-section) of beams in ring accelerators using synchrotron radiation are reviewed, together with the information-measuring systems designed to detect synchrotron radiation and realize these methods.

The practical possibilities of infrared synchrotron methods and systems of diagnostics are demonstrated for the example of the low-energy (electron energy E = 2.5 - 20 MeV, electron orbit R = 40 - 4 cm) electron-ion ring accelerator. The synchrotron radiation spectrum that is used mainly in the infrared region (wave length range > 1 mkm). The detection systems incorporate specially designed infrared-optical elements: a high-vacuum window of optical ceramics (analog IRTRAN) and broad-band, long-focus optical channels. The radiation is detected in the spectral region 0.3 - 45 mkm by infrared detectors operating at low temperature or room temperature. Results are presented on the measurement of the number of electrons in the bunch, the equilibrium radius and dimensions of the small cross section of ring bunch, and the angular divergence of the synchrotron radiation relative to the median plane of the ring bunch.

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Session Classification: P : Coffee and Poster Session

Track Classification: Detectors for Synchrotron Radiation and Spillation Neutron Sources

Contribution ID: **112** Type: **Contributed Poster**

Measurement of a Infrared Synchrotron Radiation of Beam Density Profile and it's Fluctuations

Thursday 15 September 2005 10:30 (30 minutes)

Results are presented of measurements of the equilibrium
radius and the minor cross-section sizes of the ring-shaped electron
bunch.
A multichannel diagnostic system based on measurement of the
synchrotron
radiation and disigned for investigation of the dynamics of the
electron
ring compression is described.
The system includes an optical channel; an infrared radiation
detector; an
amplifier unit; circuits for control; and connection to a computer,
which
processes the collected information in the real time environment.

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Session Classification: P : Coffee and Poster Session

Track Classification: Detectors for Synchrotron Radiation and Spillation Neutron Sources

Contribution ID: **113** Type: **Contributed Poster**

Optics of Position-Sensitive Detectors for Infra-Red Synchrotron Accelerator Diagnostics

Thursday 15 September 2005 10:30 (30 minutes)

The special high-vacuum windows and optical systems for the conclusion from the accelerator of synchrotron radiation and focusing it on the detector are submitted in this review [1,2]. The results of account and research of optical system are described punctually. There are examples of practical use of a broad-band long-focus optics with precision by integrated and position-sensitive detectors in accelerator experiments for detection of infra-red synchrotron radiation from low-intensity source and for absolute measurements of the basic parameters of bunches of the charged elementary particles in this article.

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Session Classification: P : Coffee and Poster Session

Track Classification: Detectors for Synchrotron Radiation and Spillation Neutron Sources

Contribution ID: **114** Type: **Contributed Poster**

Laser Tests Of Silicon Strip Detectors

Thursday 15 September 2005 10:30 (30 minutes)

This presentation collects experiences from tests of ATLAS end cap SCT modules using infrared semiconductor laser on 1060 nm wavelenght. Sophisticated method of focusing was developed. Timing and interstrip properties of modules were measured.

Tests of silicon sensors simulate real experimental conditions and check important detector properties. Laser tests have good time and space description, but photons generate electron-hole pairs in silicon bulk via different mechanism. Detailed discusion about usability of laser test for particle detectors is presented.

Laser tests are extremely useful for tuning individual sensor and readout settings to find optimal working parameters. Furthermore they are good for comparison between the same type of detectors with exactly the same top surface properties.

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Session Classification: P : Coffee and Poster Session

Track Classification: Pixel Detectors for Charged Particles

Contribution ID: **115** Type: **Contributed Poster**

The operation of ultra-small pore Microchannel Plates as imaging X-ray detectors

Thursday 15 September 2005 10:30 (30 minutes)

We describe the operation of ultra-small pore Microchannel Plates (MCPs) as detectors for soft X-ray radiation. These new plates represent a marked improvement in MCP technology. Typical plates at present have pore diameters of ˜8-12μm, whereas the new generation have diameters ranging from 3-6μm. This reduction in pore diameter will clearly have a positive impact on the spatial resolution of a detector with MCP limited imaging capabilities. In addition, the reduced pore diameter will also improve the timing characteristics of the detector (reduced rise time and pulse width) as described theoretically by Fraser et al 1990 and references therein. Burle Electro-Optics have recently reported a 2μm MCP but have not investigated it for X-ray photon counting, only as a time of flight ion detector. They find pulse widths of <400ps and rise time of <200ps.
Our work represents the first investigation of ultra small pore detectors in saturated mode for X-ray imaging. We report, pulse counting and timing capabilities of 6, 4.5 and 3.2μm Photonis MCPs operated in saturated (photon counting) mode using a standard electron bombardment X-ray source to produce the required X-ray lines (C-K - 0.28keV, Cu-L - 0.93keV and Si-K - 1.74keV).

Author: Mr MARTINDALE, Adrian (University of Leicester)

Presenter: Mr MARTINDALE, Adrian (University of Leicester)

Session Classification: P : Coffee and Poster Session

Track Classification: Applications in Astronomy and Astrophysics

Contribution ID: **116** Type: **Contributed Talk**

Tracking cosmics: Recent results from a Micromegas-covered MediPix2 pixel CMOS readout circuit in a mini-TPC

Thursday 15 September 2005 09:45 (15 minutes)

Conventional readout systems for Time Projection Chambers (TPCs) based on wire chambers have certain limitations concerning counting rate and spatial resolution. We have built a new type of TPC which will not suffer from these limitations.

Our mini-TPC consists of a MediPix chip, a Micromegas and an cathode plane. With the proper gas mixture and voltages it is possible to detect single (primary) electrons left in tracks of minimum ionizing particles. The information we obtain from the measurement has two key components.
First it is possible to measure the position of the track to much higher resolution than with conventional TPCs. Secondly, by analyzing the track-density of primary electrons, the energy loss function (dE/dx) can be measured.

A coincidence setup composed of three scintillator-photomultiplier detectors defines a trigger signal for, in this case, cosmic muons. This signal is used to read out the MediPix chip at the correct time so the muon track can be measured. The data obtained from the cosmic muons has been analyzed for track resolution and energy loss. These results will be presented along with various further developments.

In the near future it will be possible to create a medipix-micromegas combination in a monolithic form using wafer scale post processing. Trials on dummy wafers and their gas amplification tests will be presented.

The combination of a CMOS pixel device, a Micromegas and a thin layer of gas can be used as vertex detector. This Gas On Slimmed SIlicon Pixel (GOSSIP) device potentially outperforms Si MAP/strip/pixel detectors in parameters like counting rate, radiation hardness and power dissipation.

Author: Dr VAN DER GRAAF, Harry (National Institute for Nuclear Physics and High-Energy Physics, The Netherlands)

Presenter: Dr VAN DER GRAAF, Harry (National Institute for Nuclear Physics and High-Energy Physics, The Netherlands)

Session Classification: S10 : New Gas-based Tracking Detectors

Track Classification: New Gas-based Tracking Detectors

Contribution ID: **118** Type: **Contributed Poster**

I-IMAS: a 1.5D sensor for high resolution scanning

Thursday 15 September 2005 10:30 (30 minutes)

The I-ImaS (Intelligent Imaging Sensors) is an EU project whose objective is to design and develop intelligent imaging sensors and evaluate their use within an adaptive medical imaging system, specifically tailored to Mammography and Dental Radiology. The system will employ an in-line scanning technology approach and proposes the use of CMOS active pixels sensors. The I-Imas system will have the capability of processing the data on every pixel and be able to dynamically respond in real time to changing conditions during imaging recording.The result will be to minimise the radiation exposure to areas of low diagnostic information content while extracting the highest diagnostic information from regions of high interest.
We have developed a 1.5D CMOS active pixel sensor to be used in conjunction with a scintillator for X-ray detection. Multiple sensors will be aligned to form a line-scanning system. Each sensor contains a 512 by 32 array of pixels and the electronics to convert the collected amount of charge to a digital output value. These include programmable gain amplifiers (PGA) and analogue to digital converters (ADC). The gain of the PGA can be switched between one or two, to increase the sensitivity for smaller collected charge; the ADC is a 14-bit successive approximation that runs at 20MHz, with a sampling rate of 1.25MHz.
The ASIC also includes a programmable column fixed pattern noise mitigation circuit and a digitally controllable pixel reset mode block.
Here we will describe the sensor design and the simulated performance.

Author: Mr FANT, Andrea (Rutherford Appleton Laboratory)

Presenter: Mr FANT, Andrea (Rutherford Appleton Laboratory)

Session Classification: P : Coffee and Poster Session

Track Classification: X-ray and Gamma-ray Detectors

Contribution ID: **119** Type: **Contributed Poster**

Macroassembly and Performance of the ATLAS SCT Barrels

Thursday 15 September 2005 10:30 (30 minutes)

The ATLAS SCT (semiconductor tracker) is a major component of the inner detector being built for the ATLAS experiment at LHC. It comprises 2112 barrel modules mounted on four concentric barrels of length 1.6m and up to 1m diameter, and 1976 endcap modules supported by a series of 9 wheels at each end of the barrel region, giving a total silicon area of 60m2.

At The University of Oxford, a pair of custom robots has been used to mount modules onto each of the barrel structures. After a few rows have been completed, the modules are electrically tested using a subset of the data acquisition and power supply hardware that will be used in the final experiment. The evaporative cooling and detector control systems used throughout are also similar to those that will be used in ATLAS.

This presentation highlights the electrical performance of the SCT barrels, the largest of which has an instrumented silicon area of approximately 10m2.

Author: Dr PHILLIPS, Peter (Rutherford Appleton Laboratory)

Co-author: Dr SEDLAK, Kamil (University of Oxford)

Presenter: Dr SEDLAK, Kamil (University of Oxford)

Session Classification: P : Coffee and Poster Session

Track Classification: Applications in Particle Physics

Contribution ID: **120** Type: **Contributed Poster**

The design of an active pixel sensor test structure optimised for the readout of scintillator screens

Thursday 15 September 2005 10:30 (30 minutes)

The design of pixel test structures for CMOS active pixel sensors (APS) being developed by Brunel University and e2v technologies ltd are described in this paper. The APS pixel is a development of a standard readout and sensing arrangement employing three transistors per pixel but has been optimised for indirect x-ray detection applications. The pixel is tuned to have a narrow band response to visible light generated by a scintillator screen and also has a high well capacity. This application demonstrates some of the challenges that need to be overcome when using the standard CMOS foundry processes to develop APS for scientific imaging applications and we present the possibility of using a custom CMOS process to create a low noise high fill factor/QE pinned photodiode pixel

Author: Mr GREIG, Thomas (Brunel University)

Presenter: Mr GREIG, Thomas (Brunel University)

Session Classification: P : Coffee and Poster Session

Track Classification: X-ray and Gamma-ray Detectors

Contribution ID: **122** Type: **Contributed Poster**

Characterisation of CdMnTe for use as a room temperature gamma ray detector

Thursday 15 September 2005 10:30 (30 minutes)

Cadmium Manganese Telluride is a semiconductor material that has previously been used as IR detectors, visible and near-IR lasers and solar cells. However, despite its promising properties for radiation detection, it has so far seen little investigation in this area.
Samples have been grown that show high resistivity (> 1010 Ωcm) and high μτ (>10-6 cm2/V) [1]. It has also been shown that it is possible to grow material with better crystal quality than CdTe with a grown crystal 30 to 40mm in diameter and 50 to 60 mm in length [2]. Some of the properties of single crystal CdMnTe samples are investigated, including mapping of precipitates and defects, band-gap measurements to determine composition, I-V measurements, and alpha spectroscopy.

The distribution of precipitates and defects was mapped using sub band-gap IR microscopy. This technique can give micrometer resolution and provides a good insight into the quality of the crystal, indicating the spread of Te precipitates as well as any twins or grain boundaries that may exist within the crystal from precipitates that lie on the boundaries. Few large precipitates were found in the sample, but there were some lines of precipitates suggesting grain boundaries.

Band gap measurements were carried out using two different methods; room temperature photoluminescence at 632,8nm excitation, and room temperature transmission spectroscopy. The band gap energy calculated from the PL and transmission methods was found to be 1.70 and 1.71 eV respectively. These results were then used to find the composition of the sample using the equation detailed in [3]. The composition of the Cd1-xMnxTe was found to be x = 0.13 from PL and x = 0.14 from transmission data.

I-V curves were measured at room temperature in the range of -100V to +100V bias and at low temperature (150K) in the range of -300V to +350V. The shape of the curves gives information about the properties of the sample and its contacts. The leakage current at room temperature also provides information on how the material is likely to perform as a detector.

The alpha spectra were taken at 150K and over a range of bias voltages from 0 to 200V. The spectra obtained from the CdMnTe sample show the predicted response to varying bias voltage, with CCE increasing with bias voltage. The CCE values obtained are relatively low, and degraded by a relatively high level of leakage current.

[1] Arnold Burger et al., Journal of Crystal Growth 198/199 (1999) 872-876

[2] Kotani et al. Sumitomo, Electrotechnical Review V27 (1998) 166-173

[3] Y.R. Lee and A.K. Ramdas, Solid State Commun. Vol. 51, No. 11 (1984) 861-863

Author: Mr PARKIN, James (University of Surrey)

Presenter: Mr PARKIN, James (University of Surrey)

Session Classification: P : Coffee and Poster Session

Track Classification: New Solid-State Detector Technology

Contribution ID: **124** Type: **Invited Talk**

Position Sensitive Ge Detectors: From Basic Science to Gamma-ray Imaging in Medicine and Industry

Tuesday 13 September 2005 09:00 (30 minutes)

High-resolution gamma-ray detectors based on high-purity germanium (HPGe) are one of the key workhorses of experimental nuclear science.The technical developments of such detectors have been dramatic in recent years, from the emergence of large-volume high-granularity electrically segmented HPGe detectors to position sensitivity using pulse-shape analysis and the novel technique of gamma-ray tracking.

Gamma-ray tracking takes advantage of the recent technological advances in the electrical segmentation of Ge crystals and high-speed digital electronics. It is now feasible to construct a 4π Ge detector array, consisting of 100 –200 highly segmented large Ge crystals, that combines high efficiency with high selectivity even for high-multiplicity events. In a tracking array, pulse-shape analysis of the signals from each segment will be used to reconstruct the energies and three-dimensional positions of all gamma-ray interactions in the detector system. This allows the scattering paths of multiple gamma rays from an event to be disentangled. Gamma-ray tracking arrays, which are now being constructed in Europe (AGATA) and in the United States (Gretina), promise an up to three orders of magnitude gain in performance for nuclear spectroscopy and the possibility of a significant advancement of the frontier of nuclear science.

The development of position sensitive semiconductor detectors, not only using Ge but also, e.g., CdZnTe have been primarily driven by basic science but are now finding applications in other fields such as in gamma-ray imaging for medicine, industry, environment, public security, nuclear safeguards and non-proliferation, etc. The combination of excellent energy resolution and position resolution make such detectors highly interesting for, e.g., positron emission tomography (PET). Furthermore, gamma-ray tracking enables to build collimator-free Compton imaging instruments that can be used for single-photon emission computed tomography (SPECT) and environmental surveying of gamma-emitting radioactive nuclides. The new features of these detector systems, in particular their excellent energy and position resolution and their resistance to large magnetic fields, will enable new modalities and combinations of (multi-) modalities in medical imaging. Such include the possibility of multi-line spect, and combinations of PET, SPECT and (nuclear) magnetic resonance imaging.

Author: Prof. CEDERWALL, Bo (Department of Physics, Royal Institute of Technology, Stockholm, Sweden)

Presenter: Prof. CEDERWALL, Bo (Department of Physics, Royal Institute of Technology, Stockholm, Sweden)

Session Classification: S3 : X-ray and Gamma-ray Detectors

Track Classification: X-ray and Gamma-ray Detectors

Contribution ID: **125** Type: **Invited Talk**

Technology Roadmap for Detectors for Astronomy

Tuesday 13 September 2005 13:30 (30 minutes)

The future requirements for Astronomy and Astrophysics sensor development covering the sub-mm to X-ray range will be discussed.

Author: Prof. CUNNINGHAM, Colin (Director, Technological Development, Royal Obervatory)

Presenter: Prof. CUNNINGHAM, Colin (Director, Technological Development, Royal Obervatory)

Session Classification: S5 : Applications in Astronomy and Astrophysics

Track Classification: Applications in Astronomy and Astrophysics

Contribution ID: **126** Type: **Invited Talk**

Applications in Radiology and Nuclear Medicine

Tuesday 13 September 2005 16:00 (30 minutes)

The presentation will cover the applications of radiation detectors to digital X-ray imaging, fast X-ray CT scanning, single photon emission computed tomography (SPECT) for small animals, whole-body SPECT/CT scanning, positron emission tomography (PET) for small animals and the latest crystals developed for PET and SPECT. There will be a brief introduction to the use of Active Pixel Sensors to medical imaging.

Author: Prof. OTT, Bob (Institute of Cancer, Royal Marsden Hospital, London)

Presenter: Prof. OTT, Bob (Institute of Cancer, Royal Marsden Hospital, London)

Session Classification: S6 : Applications in Nuclear Medicine and Radiology

Track Classification: Applications in Nuclear Medicine And Radiology

Contribution ID: **127** Type: **Invited Talk**

Novel Pixel Detectors for Structural Biology

Wednesday 14 September 2005 09:00 (30 minutes)

Examples of applications of pixel detectors in several areas of the life sciences will be presented with emphasis on x-ray and electron scattering and some comparisons between the two techniques.

Author: Dr FARUQI, Wasi (MRC Lab.Molec.Biology, Cambridge,UK)

Presenter: Dr FARUQI, Wasi (MRC Lab.Molec.Biology, Cambridge,UK)

Session Classification: S7 : Novel Photon Detection Systems

Track Classification: Novel Photon Detection Systems

Contribution ID: **128** Type: **Invited Talk**

Nuclear Structure Studies with Radioactive Beams at 10-50 MeV/nucleon

Wednesday 14 September 2005 11:00 (30 minutes)

Secondary beams of radioactive nuclei open up new opportunities in nuclear structure studies and also bring extra requirements for position sensitive detectors. Individual incident beam particles often need to be tracked, and then the angles and energies of reaction products need to be recorded with extraordinarily high efficiency to compensate for low beam currents of less than 100,000 per second. The UK-led TIARA and CHARISSA collaborations have built and exploited detection systems for charged particles, and TIARA extends also to include position dependent gamma ray detection with segmented Ge in the EXOGAM array. The charged particle detection mainly exploits double-sided and resistive Si strip detectors, but supplemented by CsI scintillators and gas filled drift chambers. The implementation and use in experiments of CHARISSA and TIARA at the GANIL laboratory in France will be described, with examples and an indication of future developments.

Author: Dr CATFORD, Wilton (University of Surrey)

Presenter: Dr CATFORD, Wilton (University of Surrey)

Session Classification: S8 : Applications in Nuclear Physics

Track Classification: Applications in Nuclear Physics

Contribution ID: **129** Type: **Invited Talk**

Detectors at synchrotron sources; now and in the future

Wednesday 14 September 2005 14:30 (30 minutes)

Detectors at synchrotron sources have always been a weak link, and continue to be so today. Although there has been considerable improvement in the detectors and the detector technologies used at storage rings, the development of the source brilliance has been even more significant, thereby widening the gap between the source and the detector performances. And short overview of the current situation will be given. Followed by a more detailed presentation of ongoing and upcoming detector developments. At the end an attempt will be made to give an analysis of what investments are needed to develop and construct significantly improved detectors.

Author: Prof. GRAAFSMA, Heinz (ESRF, France)

Presenter: Prof. GRAAFSMA, Heinz (ESRF, France)

Session Classification: S9 : Detectors for Synchrotron Radiation and Spallation Neutron Sources

Track Classification: Detectors for Synchrotron Radiation and Spillation Neutron Sources

Contribution ID: **130** Type: **Invited Talk**

Developments and Applications of Gas Based Neutron Detectors

Thursday 15 September 2005 09:00 (30 minutes)

Author: Dr RHODES, Nigel

Presenter: Dr RHODES, Nigel

Session Classification: S10 : New Gas-based Tracking Detectors

Track Classification: New Gas-based Tracking Detectors

Contribution ID: **131** Type: **Invited Talk**

Invited Talk for Detectors for Astro-Particle Physics

Thursday 15 September 2005 11:15 (30 minutes)

Author: Prof. SUMNER, Timothy (Imperial College London)

Presenter: Prof. SUMNER, Timothy (Imperial College London)

Session Classification: S11 : Detectors for Astro-Particle Physics

Track Classification: Detectors for Astro-Particle Physics

Contribution ID: **132** Type: **Invited Talk**

New Materials for Semiconductor Radiation Detectors

Thursday 15 September 2005 13:30 (30 minutes)

The demand for new detector materials continues to develop, across a wide range of applications including X-ray and synchrotron imaging, neutron detection, and radiation hard tracking detectors. In this paper the current status of new materials for semiconductor detectors will be reviewed, with a particular emphasis on the requirements for imaging and pixellated devices. In the field of hard X-ray and gamma ray imaging there has been continued improvement in the quality of detector grade high-Z compound semiconductor materials such as CdTe and CdZnTe. The availability of these materials, whilst still limited, continues to develop. There has also been significant progress in the development of thick film polycrystalline materials such as CdTe, PbO and HgI2 for applications as large area detector layers, suitable for direct-deposition onto pixellated substrates. Single-crystal synthetic diamond is another material that has developed rapidly, with high purity diamond detectors now being developed for various applications in imaging, dosimetry and radiation hard tracking detectors. In this talk I will review these various candidate materials and discuss their application for the next generation of position sensitive detectors.

Author: Dr SELLIN, Paul (University of Surrey)

Presenter: Dr SELLIN, Paul (University of Surrey)

Session Classification: S12 : New Solid-State Detector Technologies

Track Classification: New Solid-State Detector Technology

Contribution ID: **133** Type: **Invited Talk**

Invited talk for Applications in Space Science

Thursday 15 September 2005 16:00 (30 minutes)

Author: Dr HOLLAND, Andrew (Brunel University)

Presenter: Dr HOLLAND, Andrew (Brunel University)

Session Classification: S13 : Applications in Space Science

Track Classification: Applications in Space Science

Contribution ID: **134** Type: **Invited Talk**

New Detectors, New Physics, New Life

Friday 16 September 2005 09:00 (30 minutes)

A long succession of inventions of particle detectors has given life to generations of scientists and has enabled step by step the understanding of chemistry, the physics of light, matter and cosmos. Over the last hundred years the imaging of the interactions of ionizing particles has allowed to penetrate mysteries of elementary objects and forces, far beyond what we can see and feel with our senses. The detectors often provide the confirmation of a postulated phenomenon, such as the positron, but they may also unveil unexpected surprises such as the X-rays. Once something is well understood, however, it needs not be a prime object of study anymore, and more specific and selective techniques are required to reach a deeper level of observation. This may be achieved by evolution, perfectioning existing methods. Fundamentally innovative approaches in instrumentation that tackle the objectives in a different way often achieve a breakthrough in the physics understanding. In particle physics both the accelerators as the probe and the detectors as the analyzer need a continuous process of upgrading. New detection schemes have been based on brilliant but random ideas, such as the Wilson Cloud chamber, or on systematic evaluation of available alternatives. In recent years it has become obvious that the use of the silicon chip technology allows quite innovative and powerful detector designs. It is now possible to envisage unprecedented rates of interactions, nearly a thousand million per second, while keeping the possibility to retrieve all detailed information concerning a few hundred selected interactions only. Some trends in processing and packaging technology may eventually lead to even more advanced detectors. Extrapolating the historical experience one may assume this to be a basis for new observations and new theories, because it seems likely that realms of space structures, forces and quantum phenomena remain undiscovered. Life in science in general, and physics in particular will remain worthwile and full of purpose. The side-effect that new detectors also lead to new industrial potential is not a usual concern for the scientists at the forefront. However, this must be stressed with more emphasis in order to ensure the continuation of support for scientific activity. In hospitals, new detectors can literally give life to sick people, and in the short term that weighs more than the identification of a new meson.

Author: Dr HEIJNE, Erik (CERN-PH)

Presenter: Dr HEIJNE, Erik (CERN-PH)

Session Classification: S14 : Applications in Particle Physics

Track Classification: Applications in Particle Physics

Contribution ID: **135** Type: **Invited Talk**

Some Novel Gas-Based Techniques

Friday 16 September 2005 11:00 (30 minutes)

A description of some basic properties of gas-based detectors that make them attractive for advanced applications will be made. Of those operating with gas gain, emphasis will be given to the gas electron multiplier, the pin detector, and the traditional wire chamber. The benefits of operating in ionization mode will be explored. Examples of these techniques in experiments employing X-ray, neutron and particle position sensing will be described.

Author: Dr SMITH, Graham (Brookhaven National Laboratory, USA)

Presenter: Dr SMITH, Graham (Brookhaven National Laboratory, USA)

Session Classification: S15 : Novel Gas-based Detection Techniques

Track Classification: Novel Gas-based Detection Techniques

Contribution ID: **136** Type: **Contributed Poster**

Digital Signal Filtering For Low Noise CCD Readout

Thursday 15 September 2005 10:30 (30 minutes)

The need for reducing CCD readout noise is highly relevant in X-Ray astronomical detectors such as those proposed for the ESA XEUS mission.
Digital sampling and filtering of a CCD's output using an ADC and DSP or FPGA is presented to reduce the effects of readout noise and lower system complexity. Correlated double sampling is used to resolve individual pixel charge values, with the serial clock control signals determining accurate timing for the sampling of the output signal. This avoids sampling undesirable feed through voltages present on the analogue output caused by reset and serial clocks, leaving the remaining noise components to be digitally filtered out. Experimental results for the readout of a CCD collecting X-Ray photons from an Fe55 source using the ADC-DSP method are presented and evaluated against those obtained from a laboratory based scientific camera system. The usefulness of the technique for practical applications is discussed.

Author: Mr MURRAY, Neil (Brunel University)

Presenter: Mr MURRAY, Neil (Brunel University)

Session Classification: P : Coffee and Poster Session

Track Classification: Applications in Astronomy and Astrophysics

Contribution ID: **137** Type: **Contributed Poster**

A miniature X-Ray Diffraction/X-Ray Fluorescence instrument concept

Thursday 15 September 2005 10:30 (30 minutes)

We describe an instrument concept using Charge Coupled Devices (CCDs) capable of simultaneously recording the X-ray diffraction (XRD) and X-ray fluorescence (XRF) information from a sample. The instrument concept uses deep depletion CCDs in photon counting mode which can efficiently detect X-rays from 0.5-10 keV. One such instrument under study, named Mars-XRD, is a miniature XRD \ XRF instrument to be used on the ESA Mars Rover planned for launch in 2011. The proposal explores the possibility of using 4 CCDs tiled in a 130mm Rowland Circle covering the 3-60o angular range. The main operation of this device is to perform XRD on mineral samples for the purpose of phase identification, with the added capability of XRF for chemical composition analysis. The application of FPGAs (Field programmable Gate Arrays) for real time data analysis of CCD images is also discussed. Using FPGAs, diffraction data from CCDs can be analyzed in real time, greatly reducing the processing requirements of higher level software. Initial data from an early prototype is presented.

Author: Mr INTISAR, Amir (School of Engineering and Design, Brunel University)

Co-authors: HOLLAND, Andrew (Brunel University); HUTCHINSON, I (Brunel University); NELMS, N (Brunel University)

Presenter: Mr INTISAR, Amir (School of Engineering and Design, Brunel University)

Session Classification: P : Coffee and Poster Session

Track Classification: Applications in Astronomy and Astrophysics

Contribution ID: **138** Type: **Invited Talk**

Opening Remarks

Monday 12 September 2005 14:00 (10 minutes)

Author: Prof. NOLAN, Paul (University of Liverpool)

Presenter: Prof. NOLAN, Paul (University of Liverpool)

Session Classification: Keynote Talks

Contribution ID: **139** Type: **Invited Talk**

Welcome to the University of Liverpool

Monday 12 September 2005 14:10 (20 minutes)

Author: Prof. SAUNDERS, Jon (University of Liverpool Pro Vice Chancellor for Research)

Presenter: Prof. SAUNDERS, Jon (University of Liverpool Pro Vice Chancellor for Research)

Session Classification: Keynote Talks

Contribution ID: **140** Type: **Invited Talk**

Keynote Address

Monday 12 September 2005 14:30 (30 minutes)

Author: Mr O'BRIEN, Martin (UKAEA Fusion Programme Manager)

Presenter: Mr O'BRIEN, Martin (UKAEA Fusion Programme Manager)

Session Classification: Keynote Talks

Contribution ID: **141** Type: **Invited Talk**

Keynote Address

Monday 12 September 2005 15:00 (30 minutes)

Author: Prof. WADE, Richard (PPARC Deputy Chief Executive and Director Programmes)

Presenter: Prof. WADE, Richard (PPARC Deputy Chief Executive and Director Programmes)

Session Classification: Keynote Talks

Contribution ID: **142** Type: **Contributed Poster**

SmartPET: A Small Animal P.E.T Demonstrator using HyperPure Germanium Planar Detectors

Thursday 15 September 2005 10:30 (30 minutes)

The SmartPET project aims to exploit advances in the sensitivity, speed, position and energy resolution of HPGe detectors to construct a small animal Positron Emission Tomography (PET) system.

The small animal scanning system will consist of two planar HPGe detectors separated by 109mm and housed in a rotating frame allowing data acquisition over a full 180o range. Each detector will have a 60x60x20mm crystal electrically segmented with 5mm strip pitch. The development of sophisticated digital acquisition techniques and the use of Pulse Shape Analysis (PSA) and Gamma Ray Tracking (GRT) will allow accurate position and energy information to be extracted.

The techniques outlined allow scattered interactions to be identified and used for image reconstruction and therefore hold the potential to increase patient throughput and/or reduce patient dose.

This coupled with investigation into the use of three dimensional statistical image reconstruction aims to provide proof of principle for the use of germanium detectors in medical imaging applications.

This poster will provide an overview of the SmartPET project, its potential as a PET system and the advantages it holds over conventional systems. Preliminary results will also be presented.

Author: Mr COOPER, Reynold (University of Liverpool)

Presenter: Mr COOPER, Reynold (University of Liverpool)

Session Classification: P : Coffee and Poster Session

Track Classification: New Techniques for Positron Emission Tomography

Contribution ID: **143** Type: **Invited Talk**

Welcome to the Daresbury Laboratory

Wednesday 14 September 2005 15:45 (15 minutes)

Author: Prof. WHITEHOUSE, Colin (CCLRC Daresbury Laboratory)

Presenter: Prof. WHITEHOUSE, Colin (CCLRC Daresbury Laboratory)

Session Classification: Welcome

Contribution ID: **144** Type: **Contributed Poster**

MHSP with position detection capability

Thursday 15 September 2005 10:30 (30 minutes)

MicroHole and Strip Plate detector (MHSP) has an intrinsic capability for position detection. This new gaseous multiplier conceived as a combination of an MSGC and GEM in a single, double sided element, integrates two successive independent stages of charge amplification, a GEM-like hole-avalanche and an MSGC-like anode-strip avalanche. Like the GEM, the MHSP is fabricated with printed circuit board (PCB) technology from a 50-μm Kapton film, metallized with 5-μm-thick copper-layers on both sides. On the top-side, a GEM-like pattern of holes is etched through, where on the bottom side a standard microstrip pattern is etched, with the holes centred on the cathode strips and the anodes running between them.
The MHSP achieve gains higher than 10ˆ4, and a ratio between top and anode signal of about 0.3, allowing measuring the charge signal produced on both sides with good efficiency. The first implementation of a position sensitive readout for this new detector is described and tested. The readout consists of a resistive layer crossing the anodes and connected to a preamplifier, on each side. By weighing the charge pulses on both preamplifiers it is possible to determine the interaction point. The second coordinate is attained by structuring the top side of the MHSP with individual strips and using a resistive layer orthogonal to the strips. A 100-ohm resistance layer between consecutive strips was found to be the best compromise between position linearity and energy resolution.
Preliminary results using 22-keV x-rays presents a good linear trend between the measured and the actual position, with a deviation of about 0.8 mm. The performance of the MHSP position detector will be presented and discussed for 1D and 2D readout.

References, e.g.

[1]-A proposed new microstructure for gas radiation detectors: the Micro-Hole-and-Strip Plate, J.F.C.A. Veloso, J.M.F. dos Santos e C.A.N. Conde, Review of Scientific Instruments, Vol. 71, 6(2000)2371-2376.
[2]- Progress in MHSP gaseous electron multiplier operation, J.M. Maia, D. Mörmann, A. Breskin, R. Chechik, JFCA Veloso, JMF Dos Santos, IEEE Transactions on Nuclear Science Ns-51 (2004)1503-1508.

Author: Mr NATAL DA LUZ, Hugo (University of Coimbra)

Presenter: Mr NATAL DA LUZ, Hugo (University of Coimbra)

Session Classification: P : Coffee and Poster Session

Track Classification: New Gas-based Tracking Detectors

Contribution ID: **145** Type: **Contributed Poster**

A neutron imaging gas detector with individual read-outs

Thursday 15 September 2005 10:30 (30 minutes)

We have been developing a neutron imaging gas detector with a high spatial resolution and with a high temporal response for the neutron scattering instruments at the pulsed neutron source in the Japan proton accelerator research complex.

To meet the requirements for the instruments for neutron reflectometery or for small angle neutron scattering, where a spatial resolution of less than 1 mm and a pulse–pair resolution of less than 1 us are required, the gas detector with individual read-outs was developed. The detector comprises the gas vessel which withstands up to 10 atm with the feed-throughs of 541 channels, multi-channel fast amplifier-shaper-discriminator boards, data encoding and taking system.

The performances of the prototype detector using a multi-wire (MW) detector head, which has an active area of 40 x 40 mmˆ2 with a wire pitch of 1 mm for each dimension, were evaluated using a collimated neutron beam. It was confirmed that the detector exhibited a spatial resolution of 1.5 mm and a pulse-pair resolution of about 100 ns with a gas pressure of 6 atm helium with a mixture of 30% CF4. The position-linearity with a deviation less than 1 % was also confirmed.

Moreover, the micro-strip (MS) detector head, which has an active area of 50x50 mmˆ2 with a strip pitch of 0.4 mm for each dimension, was installed on the detector system and the performances were also evaluated up to the total gas pressure of 8 atm.

In the presentation the results obtained by the detector with the MW / MS heads are presented as well as the description of the developed detector system.

Author: Dr NAKAMURA, Tatsuya (Japan Atomic Energy Research Institute)

Co-author: Dr KATAIGIRI, Masaki (Japan Atomic Energy Research Institute)

Presenter: Dr KATAIGIRI, Masaki (Japan Atomic Energy Research Institute)

Session Classification: P : Coffee and Poster Session

Track Classification: Novel Gas-based Detection Techniques

Contribution ID: **146** Type: **Contributed Talk**

MHSP with position detection capability

Friday 16 September 2005 11:30 (15 minutes)

MicroHole and Strip Plate detector (MHSP) has an intrinsic capability for position detection. This new gaseous multiplier conceived as a combination of an MSGC and GEM in a single, double sided element, integrates two successive independent stages of charge amplification, a GEM-like hole-avalanche and an MSGC-like anode-strip avalanche. Like the GEM, the MHSP is fabricated with printed circuit board (PCB) technology from a 50-μm Kapton film, metallized with 5-μm-thick copper-layers on both sides. On the top-side, a GEM-like pattern of holes is etched through, where on the bottom side a standard microstrip pattern is etched, with the holes centred on the cathode strips and the anodes running between them.
The MHSP achieve gains higher than 10ˆ4, and a ratio between top and anode signal of about 0.3, allowing measuring the charge signal produced on both sides with good efficiency. The first implementation of a position sensitive readout for this new detector is described and tested. The readout consists of a resistive layer crossing the anodes and connected to a preamplifier, on each side. By weighing the charge pulses on both preamplifiers it is possible to determine the interaction point. The second coordinate is attained by structuring the top side of the MHSP with individual strips and using a resistive layer orthogonal to the strips. A 100-ohm resistance layer between consecutive strips was found to be the best compromise between position linearity and energy resolution.
Preliminary results using 22-keV x-rays presents a good linear trend between the measured and the actual position, with a deviation of about 0.8 mm. The performance of the MHSP position detector will be presented and discussed for 1D and 2D readout.

References, e.g.
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[2]- Progress in MHSP gaseous electron multiplier operation, J.M. Maia, D. Mörmann, A. Breskin, R. Chechik, JFCA Veloso, JMF Dos Santos, IEEE Transactions on Nuclear Science Ns-51 (2004)1503-1508.

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Session Classification: S15 : Novel Gas-based Detection Techniques

Track Classification: Novel Gas-based Detection Techniques

Contribution ID: **147** Type: **Contributed Poster**

Innovative CCD based PSD system

Thursday 15 September 2005 10:30 (30 minutes)

At the INFN Legnaro Laboratories (Padova, Italy) a new instrument dedicated to the study of induced radiation damage in microelectronics devices has been recently installed in the SIRAD beam line, a facility devoted to heavy ion characterization of microelectronics devices and materials. This new instrument consists of an electronic microscope capable of recognizing with micrometric resolution the impact point of every single ion onto the target. The development of the readout system for this apparatus led to the construction of two novels position detection systems: the first is based on a classic PSD sensor; the second, more innovative, is developed around a new design that employs linear CCDs to provide superior performances.

After detection and amplification, the resulting signal coming from the microscope is a sequence of light spots rapidly blinking on a 4cm diameter phosphor screen. The development of a device capable of detecting the light spots with sufficient time resolution (at least 10,000 events per second) and enough spatial resolution (more than 400 linear point on the phosphor screen diameter) to not degrade the intrinsic resolving power of the microscope was a challenging task. The main issue when extracting the light signal from within the vacuum chamber via an optical system is the relative low intensity of the signal, as the efficiency of the optical system is not better than 1%. This is the main difficulty when using commercial PSD. Also, the need for a fine time correlation did not allow us to use a classical square CCD to image the phosphor screen due to its low frame rate and to the computational overhead in recognizing the multiple signal spots present on every frame.

The first solution involved the development of a sensing system starting from a commercial PSD, developing a dedicated, low noise electronics. This system, based on a 2*2 cm2 two dimensional PSD is currently operating, offering sufficient speed and resolution. A novel solution was also investigated. Instead of using traditional, charge splitting based PSD sensors, we developed a system based on CCD devices. Commercial CCDs offer resolution and sensitivity sufficient to fulfill our needs in terms of image quality but, as said above, they are too slow: even the fastest 1 Megapixel CCD cannot handle more than a few tens of frames per second. Moreover, the stream of data from a 1MPixels CCD running at 10 kiloframes per second would be not manageable by any reasonable data analysis system.

We found a solution by coupling two linear CCDs (1000 pixels each) in an orthogonal arrangement through a dedicated optical system. The optical system made allowed each CCD to read just one dimension, dramatically reducing the amount of data to acquire: to get the same resolution (i.e. 1 Megapixel) we have to read just 1000 pixels instead of the 1 million in a traditional square sensor. Moreover, this solution greatly simplifies data analysis, as two separated vectors have to be analyzed, instead of a single huge matrix. This allows us to implement the entire analysis procedures at hardware level, limiting the data bandwidth towards the DAQ computer to a mere 200 kbyte/s when running at full speed.

We want to remark that this novel standalone system may be useful in any situation where a fast high-resolution determination of the position of a light spot is required. Also, a further development, adopting state of the art sensors and electronics, could bring the speed of such kind of device near 100k frames per second with an equivalent resolution better than 10 Megapixel.

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Session Classification: P : Coffee and Poster Session

Track Classification: Applications in Nuclear Physics

Contribution ID: **148** Type: **Contributed Poster**

GREAT –a Position Sensitive Spectrometer for Studying Exotic Nuclei

Thursday 15 September 2005 10:30 (30 minutes)

GREAT is a Position Sensitive Spectrometer for Studying Exotic Nuclei. It is a detector designed for use in the focal plane of Gas Filled Recoil Separators. The detector system measures alpha, beta, gamma, protons and electron decays of separated fusion products. The GREAT detector consists of a multi-wire proportional counter, 28 Si PIN diodes, two 60x40mm double sided silicon strip detectors, a double sided germanium strip detector and one large germanium Clover detector. The poster will describe the GREAT spectrometer.

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Session Classification: P : Coffee and Poster Session

Track Classification: Applications in Nuclear Physics

Contribution ID: **149** Type: **Contributed Poster**

Mobility-lifetime products of epitaxial GaAs materials

Thursday 15 September 2005 10:30 (30 minutes)

Self-supported thick (larger than 200 microns), non intentionally doped, epitaxial GaAs layers are good candidates for X-ray imaging for the following reasons. Their electronic properties are homogeneous over large areas (4 inches diameter), they can be grown at low cost, the technology to realize pixel detectors of any size is standard, the defect concentration is very low and the fluorescence yield is low. The low defect concentration permits a large minority carrier lifetime, which is at least 100 times larger than in bulk grown materials. Here we demonstrate that the mobility-lifetime product is high. Using Deep Level Transient Spectroscopy combined with photon counting, we evaluate the electron and hole lifetimes to be at least 10-6 s, leading to electrons and holes mobility-lifetime products of 8×10-3 cm2V-1 and 4×10-4 cm2V-1, which are 100 times higher than the standard values (taken from bulk materials) attributed to GaAs, i.e. 8×10-5 cm2V-1 for electrons and 4×10-6 cm2V-1 for holes; about 2 times larger than for the best CdTe materials, i.e. 3×10-3 cm2V-1 for electrons and 2×10-4 cm2V-1 for holes.

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Session Classification: P : Coffee and Poster Session

Track Classification: New Solid-State Detector Technology

Contribution ID: **150** Type: **Contributed Poster**

The DEPFET Active Pixel Sensor for the ILC Environment

Thursday 15 September 2005 10:30 (30 minutes)

A new generation of MOS-type DEPFET active pixel sensors in double metal/double polysilicon technology with ˜25µm pixel size has been developed to meet the requirements of the vertex detector at the ILC (International Linear Collider). The paper presents the design and technology of the new linear DEPFET pixel cells including a module concept and results of a feasibility study on how to build ultra-thin fully depleted sensors. One of the major challenges at the ILC is the dominant e+e- pair background from beam-beam interactions. The resulting high occupancy in the first layer of the vertex detector can be reduced by an extremely fast read out of the pixel arrays but the pair-produced electrons will also damage the sensor by ionization. Like all MOS devices, the DEPFET is inherently susceptible to ionizing radiation. The predominant effect of this kind of irradiation is the shift of the threshold voltage to more negative values due to the build up of positive oxide charges. The paper presents the first results of the irradiation of such devices with hard X-Rays and Gamma rays from a 60Co source up to 1Mrad under various biasing conditions.

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Session Classification: P : Coffee and Poster Session

Track Classification: Pixel Detectors for Charged Particles

Contribution ID: **151** Type: **Contributed Poster**

A Directional Dark Matter Detector

Thursday 15 September 2005 10:30 (30 minutes)

DRIFT (Directional Recoil Identification From Tracks) is a Time Projection Chamber (TPC) that can provide directional signature. As the Earth rotates and revolves around the Sun a diurnal and annual signal modulation could be detected as a result of relative motion between the Earth and a non-rotating WIMP halo - providing very strong background discrimination.
Currently operational and taking WIMP data, the DRIFT-II detector is an array of CS2 gas filled TPCs where ionization from a recoiling target nucleus is drifted to a Multi Wire Proportional Counter (MWPC) readout plane. Low pressure CS2 gas has proven to reduce diffusion of the track by drifting negative ions as opposed to electrons, and discrimination between electron and nuclear recoils is excellent [3]. Track reconstruction then gives energy loss and recoil direction. Thus, DRIFT-II not only has the potential for providing information on WIMP number density and distribution within the halo, but it can also discriminate between different WIMP halo and stream models.

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Session Classification: P : Coffee and Poster Session

Track Classification: Applications in Space Science