2nd ATTRACT TWD Symposium in Detection and Imaging (Strasbourg)

Friday, November 4, 2016 - Saturday, November 5, 2016

Other Institutes

Book of Abstracts

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Omni-purpose detectors based on stacks of CMOS active pixel sensors

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The trend in subatomic physics experiments is to increase the granularity of measurements, in space and time. Practical difficulties limit the achievable performances, since current experiments mostly rely on the integration of heterogeneous technologies. In contrast, a continuous pixelated sensitive volume could replace a complete complex setup and provide unprecedented performances, if the material can detect various particle types. CMOS monolithic active pixel sensors (CMOSMAPS) benefit nowadays from a high sensitivity and a thickness almost entirely sensitive. A stack of CMOS-MAPS in direct contact would act as the volume dreamed for, providing tracking, calorimetric and timing information. The number of layers in the stack, their thickness and the specifications of their pixel sensors would be adapted to optimise the overall performances depending on the type of particles (charged particles, ions, X-rays, gamma-rays), their energy and flux. The potential applications of this new type of instruments span a vast range of domains, from scientific to industrial measurements. The plasticity of the stack configuration and versatility offered by CMOS-MAPS will grant cross-fertilisation between these fields. The realisation of such stacks of CMOS-MAPS will combine and optimise processes from the semi-conductor industry to solve the main issues, among which are interconnections, mechanical stability, power dissipations and data throughput.

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Fastissimo-Plus: ..or the ultimate design for ultra-high speed radiation sensors.

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We propose to develop silicon sensors with superior time (~10 ps) and position (~10 μm) resolutions with the required robustness to be used in very harsh radiation environments. This can be achieved by taking advantage of the fast response properties of MEMS based 3-Dimensional (3D) sensors with trench-electrodes processed throughout the silicon bulk rather than on the wafer's surface and a modified read-out electronics based on fast current amplifiers.
3D sensors are particularly favoured for timing applications due to their electrodes configuration, which allows strong and homogeneous electric fields, inter distance as close as 50 microns and large signals. The particle arrival time can be measured by using the rise time of the induced current signal with reduced fluctuations due to the fact that in 3D sensors all charges along the ionization track, including those from delta rays, are generated within similar, and at the same time shorter, distance from the collecting electrode. This is to be compared with planar sensors where each charge carrier from an impinging minimum ionising particle is generated at a different distance from the collecting electrode, inducing peak signals at different times.
So far the fast response characteristics of 3D sensors have not been fully exploited, because of both non-optimized sensor design and technology, and limits coming from the read-out electronics. However, a time resolution ranging from~30 ps to ~180 ps, depending on the signal amplitude, was already obtained [1] giving hope to further improvements with a dedicated design of both sensor and electronics.
Preliminary TCAD simulations have shown that electric field values high enough for carrier velocity saturation can be obtained in most of the sensitive volume by adopting an hexagonal 3D cell, with current signal rise times of ~10 ps, regardless of the particle impact position.
Proposed Workflow:
For the feasibility study phase (12 months) we plan to process Trench-Electrodes devices and to test their time response with fast commercial single channel readout electronic chips and multi channel front-ends designed for the CERN-NA62 Giga Tracker experiment. For the following phase we plan to research and develop the entire fast-system chain including exploring state of the art fast data transmission lines, and explore the use of GPUs and parallel algorithms for ultra fast processing of big data and finally explore the best optimization of data storage.
It should also be stressed that the proposed sensors maintain all earlier features of 3D sensors such as extreme radiation hardness and sensitivity to the last few microns of the sensors's volume by the use of active edges. These are essential requirements in high multiplicity collider experiments and make this approach unique with respect of alternative proposals using charge multiplication techniques.

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Presentation 22 - Ultra-Fast Hybrid Pixel Detector for Synchrotron Time-Resolved Pump-Probe Diffraction Experiments

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Ultra-Fast Hybrid Pixel Detector for Synchrotron Time-Resolved Pump-Probe Diffraction Experiments

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A time-resolved diffraction experiments at Synchrotron SOLEIL are based on a general pump-probe scheme developed and implemented on hard X-ray beamline. In such experiment, samples are excited with an ultra-short laser pulse (the pump) and their atomic structures changes are studied by measuring the diffraction pattern from a single pulse of synchrotron radiation (the probe) with a 2-D pixel detector with a precisely controlled delay. Recently, an improvement to the classical pump-probe scheme has been proposed at Synchrotron SOLEIL to study sample's response at two different delays after each laser excitation. For this purpose, a new pump-probe-probe scheme is proposed, based on a new detection which requires ultra-fast X-Ray hybrid pixel detector for photon counting. This new detector is under development. With this detector, the pump-probe-probe experiments can be carried out with a laser repetition rate up to 5 kHz and with time between two delays below 100 µs. Furthermore, the spatial resolution needed requires square pixels not larger than 75 µm, and a temporal resolution down to few tens of nanoseconds. Moreover, pile-up and cosmic events have to be rejected from the measurement thanks to two detection discriminators thresholds architecture. Despite nice performances principle already existing on small prototypes, large area detector for time resolved studies have still to be demonstrated and should overcome present limitations. Therefore, a new detector generation, dedicated for time resolved studies, is proposed in this project. Such device would be based on a hybrid pixel detector with a dedicated readout circuit working in photon counting mode. The detector would allow acquisition with at least four different delays after laser excitation and would be characterised by an excellent time resolution and temporal dispersion on the nanosecond scale. Together with capability to count for periods of maximum few tens of nanoseconds it would offer a unique possibility to carry out the experiments also on the filling modes of the synchrotron storage ring that today are not adapted for time resolved studies (i.e. uniform). Additionally, the detector would work in the energy windowing mode, to perform energy dispersive time resolved experiments.

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Presentation 23 - Positron emission tomography without image reconstruction

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Positron emission tomography without image reconstruction

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Presentation 2 - Developments and opportunities of Large Infrared Detectors for Astronomy at Sofradir

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Developments and opportunities of Large Infrared Detectors for Astronomy at Sofradir

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Sofradir is world leader in manufacturing and providing infrared detectors for tactical and space applications using different technologies (HgCdTe, InGaAsn InSb,…). From linear detectors in the 90's and then staring arrays at the end of the nineties, the format of the IR detectors still increases for tactical and space missions. Today, standard size of Sofradir IR detectors is in the range 1K² pixels with 15µm pitch. Astronomy new instrument for space mission and especially for ground extremely large telescopes will need huge numbers of very large detectors (2K² or 4k²) with upmost performances to detect very low flux (in the SWIR range of 2µm) with low noise and dark current. This presentation deals with the new challenges that appears today for IR manufacturers. While most of the solutions offered for astronomy applications are coming from US, Extremely Large Telescope program is an opportunity to introduce a European IR detectors for Astronomy applications. This paper will explain Sofradir strategy to answer astronomy needs, developments currently running or starting soon and finally remaining developments and work still to be performed.

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Presentation 12 - SCARLET: A new High-Rate and High-Resolution X-ray Spectroscopy Detector for Synchrotron XRF and XAFS Applications

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SCARLET: A new High-Rate and High-Resolution X-ray Spectroscopy Detector for Synchrotron XRF and XAFS Applications

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Despite the effort in developing suitable detectors for X-ray fluorescence measurements at synchrotron light sources, e.g. for XRF and XAFS experiments, in many applications the capability of fluorescence spectroscopy detectors is rather limited. The high-rate performances of current detectors may be further challenged due to the ongoing machine upgrades or for the use in future sources where a factor between 10 and 100 of beam-on-sample fluxes may be increased with respect to the present conditions. Despite different commercial options for SDDs-based systems presently available, these are actually limited to single- or few-channel systems (4-7 units maximum). This motivates a new, sharp transition of this technology toward compact, multi-channels, high-density systems (hundreds of channels) to build high-resolution, high-rate and also versatile systems for synchrotron radiation applications. We propose the detector SCARLET (Sdd-asiC ARray for Large Events Throughput) aimed to cope with this challenge in the following years. The detector is based on monolithic arrays of SDDs (e.g. 8x8 units of 1mm2 area each) bump bonded to a readout ASIC containing the full CMOS readout chain, from the charge preamplifier to the ADC. Although the detector-ASIC bump bonding architecture is rather popular in X-ray imaging detectors domain, it has not been significantly explored for X-ray spectroscopy-grade detectors and surely not for SDDs. The challenge here is to obtain a hybrid, monolithic detector based on SDDs with a high channel density but still keeping the adequate spectroscopy performances required by the target synchrotron applications. The readout chip will be composed by a CUBE preamplifier, a state-of-the-art CMOS preamplifier for SDDs for the first time integrated on the same chip with the remaining electronics

analog chain, an analog shaping amplifier and an ADC for the on-chip data digitalization, a feature which allows to transmit data out of the detector with high robustness with respect to external pick-ups. At the shortest possible processing time, e.g. 100ns, an energy resolution better than 150eV at 5.9keV can be obtained, with an output counting rate larger than 1Mcps/channel, that, multiplied by the number of channels could allow to achieve several tens of Mcps/detector. The monolithic detector unit will be designed to allow a compact assembly of several units which could increase the count rate capability of the overall detection system up to few hundreds Mcps. This development could lead to a new generation of X-ray spectroscopy detectors for the next generation of high-brightness synchrotron experiments as well as for X-ray industrial applications.

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Flexible, Ultra-Low Voltage, Large-Area Direct Radiation Detectors Based On Organic Semiconductors

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A new generation of ionizing radiation sensors based on organic materials is attracting a large attention exploiting appealing features of such as ease of processing, low power supply and mechanical flexibility. Moreover, the equivalence of the typical density of organic molecules to that of human tissue makes them very suitable for medical X-ray direct dosimetry.
In the field of ionizing radiation detection, organic materials have been mostly employed so far in indirect radiation detection systems, either as scintillating material or as (organic) photodetectors.

Our approach is based on the use of organic semiconductors as the active material for the direct detection of ionizing radiation, implementing real-time and room temperature operating sensors. In the last years, a few works reported the proof-of-principle for direct X-ray detection based either on organic semiconducting single crystals [1] or on polymer thin-films blended either with π-conjugated small molecules, inorganic high-Z nanocomponents [2] to enhance the sensitivity to X-rays improving the charge carriers mobility and the stopping power of the material.

We fabricated direct, thin detectors based on micro-crystalline thin films of TIPS-pentacene deposited by inkjet printing onto flexible substrates and we assessed their high X-ray sensitivity (up to several hundreds of nC/Gy at ultra-low bias of 0.2 V). We investigated the direct X-ray photoconversion process in order to interpret the detection mechanism and we developed a kinetic model that gives an important insight into the physical process that leads to highly sensitive response to ionizing radiation by such low-Z organic materials.

Finally, we assessed the possibility to use the detector under mechanical strain and gave the first demonstration of a 2×2 pixelated matrix organic detector [3].

These results open the way for novel flexible, large area and low voltage ionizing radiation detection systems, capable of providing quantitative and real time information on the dose rate and on the spatial distribution of impinging radiation.

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Presentation 14 - Flexible, Ultra-Low Voltage, Large-Area Direct Radiation Detectors Based On Organic Semiconductors

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Presentation 24 - Neuroscience beyond neurons

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Neuroscience beyond neurons

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Presentation 15 - The method of soil moisture sensing by detection of cosmic ray neutrons

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The method of soil moisture sensing by detection of cosmic ray neutrons

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Large scale quantification of environmental water reservoirs has turned out to be feasible by detecting cosmic albedo neutrons. Such are generated in particle air showers in the upper atmosphere and reflected from the ground in dry conditions or efficiently slowed down in the presence of soil water. As the mean free path of high energetic and fast neutrons can be in the order of 100 meters, the environmental neutron density therefore strongly depends on the water content present in large radius of influence. This method bridges the gap between local and satellite based measurements. Up to now a rapidly growing community relies on stationary cosmic neutron detectors based on helium-3 filled proportional counter tubes. The most promising alternative solution is using boron as a solid converter for neutrons. Therefore we aim to develop a neutron detector based on boron layers in a MWPC geometry optimized for cosmic neutron sensing, which by scaling up the technology will reduce the exposition time to open up the field for mobile applications. This therefore is an interdisciplinary project, which brings together particle, nuclear and environmental physics.

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Presentation 20 - Advanced X-ray imaging with table-top synchrotron in the lab

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Advanced X-ray imaging with table-top synchrotron in the lab

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X-ray analysis is arguably the most powerful, non-destructive tool for investigating materials and doing medical diagnostics. Current lab X-ray sources are commonly based on X-ray tubes, which are limited in brilliance and provide a fixed, broadband X-ray spectrum. For this reason advanced X-ray imaging methods such as K-edge subtraction imaging, phase contrast imaging, coherent diffractive imaging and holography are almost exclusively the terrain of large synchrotron facilities. The availability of the few synchrotrons around is unfortunately very limited in terms of beam time and general accessibility. We are developing a compact and affordable alternative to synchrotron light sources based on Inverse Compton Scattering (ICS) of intense laser light. The principle of an ICS-based X-ray source is not new but the enabling laser technology and X-band accelerator technology have only recently reached the stage that such a source can provide X-ray brilliances presently only available at synchrotrons. Combined with a development programme to advance the X-ray detection technologies even further this will enable the use of advanced X-ray imaging techniques in university labs, museums, industry and hospitals.

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Presentation 8 - Imaging in TPC detectors equipped with high granularity charge readout: transferring technology from rare event searches

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Imaging in TPC detectors equipped with high granularity charge readout: transferring technology from rare event searches

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Imaging techniques are essential for medical diagnosis. The traditional scintillation detectors have limited efficiency and resolution, while new semiconductor detectors are expensive. Gas chamber detectors equipped with high granularity charge readout working with high pressure could be an attractive alternative that offers good energy resolution and excellent spatial resolution, a competitive efficiency, uniform response without dead zones, low cost and the ability to scan large areas, as it would include the entire body. These novel detectors are in the frontier of technology development and more and more used in particle physics due to their high performance and their use could mean a qualitative leap in terms of imagen quality and cost thereof.
In the group of the University of Zaragoza, as part of the T-REX project, a number of R&D and prototyping activities have been carried out during the last years to explore the applicability of gaseous Time Projection Chambers (TPCs) with Micromesh Gas Structures (Micromegas) in rare event searches like double beta decay, axion research and low-mass WIMP searches where the pattern recognition of the signal is crucial. Microbulk Micromegas are able to image events with high quality measuring its energy deposition with an excellent resolution. The group has also developed as open source software, RESTSoft, suitable for simulations, analysis and event reconstructions. This technology and the software are ready to be transferred to medical diagnosis.

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On the possibility utilizing nano materials and spectral imaging for holistic in-vivo cell tracking with x-rays.

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In the field of regenerative medicine therapeutic approaches based on the implantation of stem cell grafts into living hosts are under development. Such therapies hold great promise for the treatment of human diseases; however results from several recent clinical studies have not shown a level of efficacy required for their use as a first-line therapy [1]. This is due to the fact that in most of these studies the fate of the transplanted cells is unknown. Thus monitoring the real-time fate of in-vivo transplanted cells is essential to validate the full potential of stem cells based therapies. Once available such real time in- vivo imaging technique would also allow localization, tracking and the characterization of the distribution of tumor cells and could be used to elucidate the knowledge of in-vivo tumor growth dynamics, which has remained difficult to obtain. At present, there are no cost effective and efficient labeling techniques for tracking cells under in-vivo conditions.
Spectral X-ray CT in combination with nanoparticulate intracellular imaging probes could be used to investigate in animal models of human diseases the location, distribution, long- term viability and preservation of functionality of implanted cells and thus help to resolve controversial issues in stem cell therapy. Moreover such technique could validate models of tumor growth in-vivo and has the potential to elucidate the role of tumor associated macrophages during decease development.
Recent studies carried out with synchrotron radiation and on μ-focus laboratory sources utilizing intracellular label methods based on phagocytosis [2,3] confirmed the feasibility of x-ray based cell tracking with single cell resolution [4] at any anatomical position in rodents. Since high resolution but low efficient x-ray imaging detectors have been employed during these trials the associated radiation dose was substantial. Utilizing solid-state pixel detectors with interpolating readout such as MOENCH [5] the associated radiation dose could be reduced by two orders of magnitudes, which would allow longitudinal investigations on an individual animal. Moreover, the inherent energy resolution of this detector would help to discriminate cell markers based on different elements.
The combination of intracellular labeling, pixel detector and μ focus source will yield a high-resolution analytical imaging tool for biomedical research and novel cell therapies. The associated project will prove and test the principle of high resolution long term cell cluster tracking in different application areas, verify its therapeutic potential, investigate possible limitations and safety risks, and determine

the best conditions for its application. In this manner it will in particular advance non-invasive prediction, diagnosis, monitoring and prognosis of diseases on a holistic basis. This novel instrument will provide the necessary knowledge and know-how that helps to evaluate therapies, develop new therapies (such as new medicines and cell therapies), and plan, support, and guide therapeutic interventions.
Both, preclinical studies of tumor model progression and experimental cell therapies commonly rely on stochastic methods that involve sacrificing large numbers of animals at several key points of disease development over a period of time. The availability of the holistic real time imaging technique described here enables longitudinal, micrometric investigations of the distribution of labeled cells and subsequently the quantification of cell numbers generated from an original implant in an individual host. It could significantly improve the understanding of complex processes of disease progression and the effects of therapies. Eventually it would help to reduce the number of animals required for preclinical trials.

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Presentation 21 - On the possibility utilizing nano materials and spectral imaging for holistic in-vivo cell tracking with x-rays

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4D real-time tracking for high luminosity LHC experiments

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The full exploitation of the physics potential of the high luminosity LHC is a big challenge. Experiments will have to cope with very high data rates, huge amount of data to process and store, and severe radiation damage for the innermost detectors. This requires new instrumentation and innovative solutions.

State of the art tracking pixel detectors with precise time-tagging show a time resolution of about 200ps. We aim to reduce this by one order of magnitude. Crucial aspects to achieve the ultimate time resolution are the optimisation of pixel sensor geometries (in both 3D and planar technologies) to achieve the most uniform electric field, and the design of fast and low noise dedicated front-end ASIC.

This front-end will incorporate a fast current amplifier followed by a discriminator and a time-to-digital converter, and will be developed in 65nm CMOS technology with fault tolerant architecture which matches the radiation hardness requirements.

In this R&D project, we propose to build an innovative tracking detector with superior time (~10ps) and position (~10µm) hit resolutions, to be used in very harsh radiation environments (up to a total fluence exceeding 10^{16} 1 MeV neutrons equivalent per cm^2), capable of performing 4D and real-time tracking for fast trigger decisions. The precise measurement of the time of the hit is the key feature to operate an effective pattern recognition that guarantees a high tracking efficiency while enhancing the ghost track rejection, and to perform selective track triggering [1].

A conceptual design for a detector solution has been recently proposed and simulated [2]. The system consists of fast timing pixel sensors and a fast track finding system based on a massively parallel algorithm implemented in commercial FPGAs [3]. According to simulations the system allows a precise real-time determination of the track parameters (including time) while maintaining a low fraction of reconstructed fake tracks. New results at 40MHz event rate and with thousand tracks per event are promising and will be presented.

We ultimately aim to exploit this detector in flavour physics experiments, in conditions of a high event pile-up, where sensors and front-end electronics are required to continuously operate in a harsh radiation environment (up to a total flux of 10^{17} 1-MeV neutrons equivalent per cm^2). The proposed detector will allow to perform flavour physics at instantaneous luminosities more than one order of magnitude larger than current ones.

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Presentation - Summary conclusions of Day 1

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Sensing the Universe in colour; Kinetic Inductance Detectors for optical and near-IR astronomy

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I will describe the ongoing work in the development of energy-resolving Microwave Kinetic Inductance Detectors (MKIDs) for optical and infra-red astronomy. These super-conducting devices represent an important step towards the development of the 'ultimate detector'; one that can measure the position, energy and arrival time of a photon. Current arrays have 10,000 MKIDs, where each pixel is capable of determining the arrival time of a photon to 1 microsecond and the energy of the photon to around 5%. I will describe the operating principles of the devices, their current status and the future promise of this disruptive technology. I will outline the areas of astronomical instrumentation where we have identified their potentially transformational impact.

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Thermal neutron measurements with high efficiency and high granularity, using large area Micromegas detectors

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Micromegas are Micro-Pattern Gaseous Detectors (MPGD), which have been used in many particle and nuclear physics experiments since their invention in 1996. MPGDs provide high gain, fast signals, high rate capabilities, better aging properties, lower cost and simplified manufacturing processes compared to other gaseous detectors. Appropriately designed Micromegas detectors can be used for neutron measurements. Using special fabrication techniques (Microbulk and XY-Microbulk technology), very low mass-budget, neutron transparent detectors can be built, if required.
Due to the 3He shortage crisis, there is a lot of ongoing research on thermal neutron detection techniques based on alternative converters. Thin films of 10B or 10B4C are used convert neutrons into ionizing particles which are subsequently detected in gas proportional counters, but only for small or medium sensitive areas so far. We propose here a large high-efficiency (up to 50% with 0.025 eV neutrons) Micromegas-based neutron detector with several 10B4C thin layers mounted inside the gas volume in different configurations (substrate material, geometry, and sensor). The principle has been tested with a small size prototype (overall 15x15 cm2). The design is scalable to large area detectors.

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High-precision timing for high-rate environments with Micro-Pattern Gaseous Detectors

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The use of fast timing detectors (~10 ps) is crucial for the exploitation of the full potential of the future LHC operation at the highest luminosity. Ongoing R&D on Avalanche PhotoDiodes (APD) and Low Gain Avalanche Diodes (LGAD) has shown that a timing precision of ~30 ps is possible with small size prototypes. However there are issues with the radiation hardness of such devices that needs to be addressed. Concerning the state-of-the art gaseous detectors, RPCs show excellent timing properties (<30 ps) but suffer from rate limitations (maximum few kHz); on the other hand, the MPGDs that are ideal for high rate environments, have a limited time resolution in the order of few ns due to the nature of the interaction of the particles with the detector gas and the electron diffusion mechanism.

We present here a Micromegas based solution that bypasses these limitations and offers an improvement of the established timing performance of MPGDs by ~2 orders of magnitude. The Micromegas acts as a photomultiplier coupled to a Cerenkov-radiator, aiming to provide a timing resolution of about ~20 ps per incident particle. A prototype has been built in order to demonstrate this performance. The first laboratory tests with a femto-second UV laser have shown a time resolution of 27 ps

for ~40 photoelectrons, or ~180 ps per photoelectron. First results with 150 GeV muons are showing time resolution better than 50 ps (data taking & analysis in progress).

In order to improve the aging properties of the solid photocathodes, diamond based secondary emitters are examined as an alternative to the radiator-photocathode setup, while the option of using photocathodes with a graphene protection layer is also being considered.

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Presentation 26 - Thermal neutron measurements with high efficiency and high granularity, using large area Micromegas detectors

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Presentation 27 - High-precision timing for high-rate environments with Micro-Pattern Gaseous Detectors

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Presentation 5 - ORANGE: advances in optically readout GEM structure

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ORANGE: advances in optically readout GEM structure

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GEM-based detectors have had a noticeable development in last years and have successfully been employed in different fields from High Energy Physics to imaging applications. Light production associated to the electron multiplication allows to perform an optical readout of these devices. The big progress achieved in CMOS-based photosensors make possible to develop a high sensitivity, high granularity and low noise readout.
First results obtained with a triple-GEM structure filled with a CF_4 rich gas mixture (He/CF_4 60/40) and readout by means of a 4 mega-pixel CMOS sensor with noise level lesser than 2 photons per pixel were shown in the Barcelona ATTRACT event:

- about 1000 photons per minimum ionising particle track;

- 80 photons per primary electron;
- a space resolution of about 70 μm;

Since then a lot of new measurements were performed. The light yield was measured as a function of the GEM gain, the particle distance in the drift gap and the particle energy. It resulted that the performance are very stable as a function of the particle position in the drift gap and that a resolution of about 15% in the energy released is obtained. A first attempt of combining light and charge readout, in order to get time resolved measurement gave very promising results.

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Presentation 19 - CMOS based VIS-IR Tunable Multiband Imaging Sensors using Quantum Dots

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CMOS based VIS-IR Tunable Multiband Imaging Sensors using Quantum Dots

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Infrared imaging is used extensively in many fields of science, in defence and security applications, medical diagnostics and gas sensing. At present efforts in infrared (IR) research are directed towards making IR detectors cheaper and more convenient to use by integrating the sensing element on a silicon based read out integrated circuit (ROIC) and by increasing the temperature of operation so that Peltier coolers can be used instead of liquid nitrogen. Integration of IR cameras with complementary metal oxide semiconductor (CMOS) based ROIC would open the way to high resolution IR imaging and to multispectral devices where visible and IR radiation are simultaneously detected. Systems that collect data in multiple spectral bands are capable of discriminating both absolute temperature as well as unique signatures of objects in the scene. By providing this new dimension of contrast, multiband detection also offers advanced spectral processing algorithms to further improve sensitivity above that of single spectral devices.
IR are also a critical component in all astronomical research equipment for both space-based astronomy and earth observation. Yet the technology, based on hybridized HgCdTe/silicon, remains difficult and highly specialized and mostly based in the US. The possibility to extend to NIR and MIR spectra ranges large area CMOS sensor technology would allow to overcome such limitation and to develop a competitive EU based technology.
Quantum dot infrared photodetectors (QDIP) are III-V nanostructured semiconductor based sensors where intersubband transitions between electronic states confined within quantum dots (QD) are used for IR sensing. Being based on quantum confinement effects, the absorption wavelength can be tuned to the desired value by engineering the shape and dimension of the QD. QDIPs are expected to give superior performances at moderate cooling power due to their low noise. [1] Moreover QDIPs have high tolerance to crystal defects.
We are defining detailed procedures for the epitaxial deposition and monolithic integration of QDIP on silicon CMOS VIS sensors and related ROIC. This would allow for the use of state of the art CMOS imaging technology to be extended in the NIR and MIR regions. A Ge photodiode is used to integrate the GaAs/AlGaAs QDIP on CMOS, thus permitting to the detector to cover the NIR region,

up to 1.7 um. Ge is already integrated with Silicon in CMOS foundries, as evidenced by its application in mainstream microelectronics and in Si-based photonics . Moreover due to its negligible lattice mismatch with GaAs (and AlGaAs), Ge is an excellent substrate for the deposition of QDIPs. The quantum efficiency of the device will be boosted both via the strain-free self-assembly of high density QDs, permitted by the droplet epitaxy growth technique [2]. The fabrication of vertically illuminated QDIP, monolithically integrated on Si by Ge on Si epilayers deposited by low-energy plasma enhanced CVD (LEPECVD) has been demonstrated. The realized QDIP pixel consists of an absorbing part made by a 30 nm thick AlGaAs barrier and GaAs QDs with an areal density around 1×1011 cm-2. The fabricated devices exhibit extremely low dark current densities at room temperature and a spectral response measured at 80K in the MIR range demonstrating the feasibility of QDIP integration on Si.
By extending the detecting spectrum of conventional CMOS image sensor, while retaining the simplicity of integration and use, the proposed sensor would enable new applications, for example in automotive, domotic, earth observation as well as scientific.

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Presentation 6 - Automated Multimodal Correlative Microscopy for high resolution in vivo imaging

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Presentation 25 - New concept for beam loss monitoring based on fast neutron detection with Micromegas

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New concept for beam loss monitoring based on fast neutron detection with Micromegas

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The new hadron accelerators under construction will have much higher intensity and power than the actual ones. For example, the European Spallation Source (ESS), a neutron source, located in Lund (Sweden), will produce 5MW proton beam (up to 2 GeV). For the safe and efficient operation of such an accelerator, it is critical to continuously monitor the beam losses and even shut down the beam in a short time after a dangerous beam loss is detected. For the standard Beam Loss Monitors (BLM) the emitted X-rays and photons produced in the superconductive accelerators due to high electric fields may present a real problem since no discrimination can be made from cavity and beam loss contributions.

We propose a new concept for BLM to detect fast neutrons using Micromegas technology (nBLM). They are designed to be highly sensitive only to fast neutrons while being insensitive to X-rays and photons. Different types of moderators and neutrons-to-charge convertors are used to tune the sensitivity, the detection efficiency and the response time of the system, to meet the desired requirements. This new concept will be presented in this work.

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Presentation 6 - A Novel Radio-guided surgery for complete tumor resection

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Presentation 18 - Multi-Gigabit Wireless Data Transfer Using 60 GHz Band

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Wireless Allowing Data and Power Transmission (WADAPT)

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Wireless techniques have developed extremely fast over the last decade and using them for data and power transmission in particle physics detectors is not science fiction any more. During the last years several research groups have independently thought of making it a reality. Wireless techniques became a mature field for research and new developments might have impact on future particle physics experiments.

The Instrumentation Frontier was set up as a part of the SnowMass 2013 Community Summer Study 1 to examine the instrumentation R&D for the particle physics research over the coming decades: « To succeed we need to make technical and scientific innovation a priority in the field ».
Wireless data transmission was identified as one of the innovations that could revolutionize the transmission of data out of the detector. Power delivery was another challenge mentioned in the same report.

We propose a collaboration to identify the specific needs of different projects that might benefit from wireless techniques. The objective is to provide a common platform for research and development in order to optimize effectiveness and cost, with the aim of designing and testing wireless demonstrators for large instrumentation systems.

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Development of Advanced High Performance Silicon Drift Detectors and Electronics for Synchrotron Radiation and X-ray Astrophysics

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We present the results of a continuous effort, carried ahead in the frames of the REDSOX collaboration, which has unlocked significant potentials of SDD detectors performances for future applications.

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Presentation 1 - Development of Advanced High Performance Silicon Drift Detectors and Electronics for Synchrotron Radiation and X-ray

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Development of Advanced High Performance Silicon Drift Detectors and Electronics for Synchrotron Radiation and X-ray Astrophysics

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easyPET – A new concept for democratize the use of axial preclinical PET

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easyPET is a new concept of PET scanner using an innovative acquisition method based on two rotation axes for the movement of detector modules. The concept allows high position resolution and spatial uniformity over the whole field of view (FOV) due to its capability to eliminate (when operating in 2D acquisition mode) the parallax error due to depth of interaction (DOI), characteristic

of ring based PET systems.
The immunity of easyPET to DOI effects does not impose limitations on the proximity of the detector elements to the FOV and thus favors the system sensitivity. Furthermore, full axial imaging is possible with only a small number of detector elements, e.g. 256 scintillator crystal pairs or less.
A small demonstrator with a 16 pairs of crystals, allowing for a FOV of 50 mm diameter x 35 mm axial,was build and the first tests will be presented.
A scaled up version of the easyPET concept for high resolution and good sensitivity for preclinical purposes will be presented and discussed.
Patent pending by the Aveiro University, PCT/IB2016/051487

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Presentation 11 - EasyPET – A new concept for democratize the use of axial preclinical PET

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Presentation 9 - High resolution radiographic detector based on multi-channel-plate

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The effect of rotation speed in tomography acquisition on the reconstruction artifacts

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Thanks to the ultra-fast endstation of the TOMCAT beamline, it is possible to do a tomographic scan with a sub-second temporal resolution which allows following dynamic processes in 4D (3D space + time). This ultra- high-rate tomography acquisition, exploiting the distinctive peculiarities of synchrotron radiation, provides nondestructive investigation of many dynamic processes which were not possible in the past. For example a continuous tensile test has been conducted recently in-situ for the first time with a frequency of 20 tomograms per second (20 Hz acquisition frequency). In the ultra-fast endstation a scintillator is used to convert X-ray to visible photons that can be detected by the camera. However, this conversion is not ideal and the scintillator decays exponentially with afterglow. Afterglow can cause resolution degradation and artifacts (such as ring and band) especially with high rotation speed. On the other hand, to achieve a higher scan speed, thicker scintillators are more common because they result in higher emission intensities that can compensate the short exposure time in fast scans. However, the resolution deteriorates as the scintillator's thickness increases and thicker scintillators show higher afterglow. Performing many ultra-fast scans at the TOMCAT beamline with different acquisition rate, we demonstrate how the rotation speed effects on the projection data and reconstructed images. Using two different thicknesses of LAG scintillator

we also investigate the afterglow artifacts for different acquisition rate and exposure time. Developing a realistic model for afterglow we propose a correction method to remove afterglow from the projections which result in a reconstruction free of afterglow artifacts.

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Presentation 16 - The effect of rotation speed in tomography acquisition on the reconstruction artifacts

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