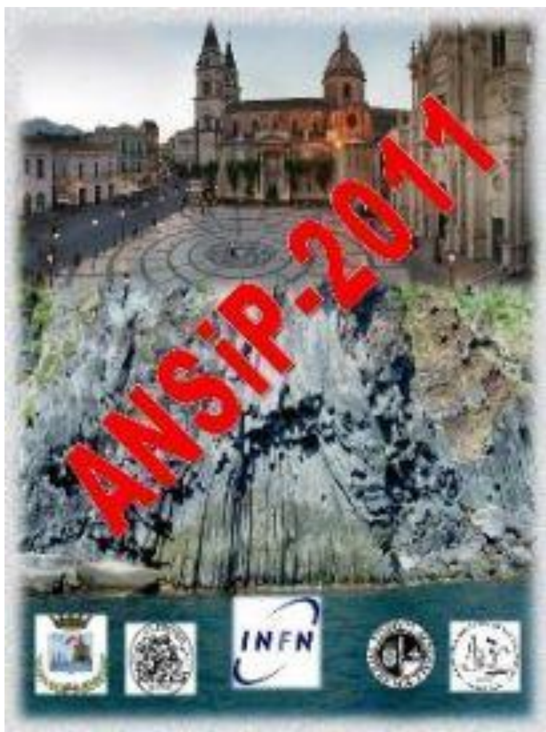
ANSiP 2011

Advanced School and Workshop on Nuclear Physics Signal Processing

Acireale, 21-24 November 2011



BOOK OF ABSTRACTS

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Interconnections – the link between sensors and r/o electronics

The presentation will give an overview of the techniques and technologies to interlink sensors with the r/o electronics. Starting from conventional wire bonding the main emphasis will be put on bump bonding and its implications on the sensor production. The last part of the presentation will give an outlook on fine pitch bump-less flip chip technologies and through silicon vias enabling real 3D integration of smart sensor systems.

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MINOS: a vertex tracker for in-beam γ spectroscopy

MINOS, acronym for 《 MagIc Numbers Off Stability 》, is a new target-detector device dedicated to the γ spectroscopy of the most neutron-rich nuclei. The concept is to use a thick liquid-H2 target to produce the nuclei of interest via (p,2p) or (p,p’n) reactions. The detector surrounding the target is a TPC proton tracker allows to measure the position of the reaction vertex and therefore to accomplish a good Doppler correction for γ energy. A resolution over the vertex position below 3 mm FWHM has to be reached. For this purpose, simulations with Geant4 of the target-detector setup, coupled with the DALI2 γ-detection array, which have to take into account the electronics process, have been performed. The conception of the TPC and its electronics are being developed and will be presented.

POSTER SESSION

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Off-line event building

The time stamping system is now becoming common technology to build physics events in nuclear physics experiments. The concept of the time stamping system is that attach long-continued timing information to each event data taken by individual DAQ systems. It allow us to use different triggers for several DAQ systems. Physics events will be constructed by software, after the data taking. Namely, this is "Off-line event building". Here, I'd like to talk about "What is time-stamp based event building", "A novel way to do the off-line event building".

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Design and construction of an innovative detector system for particle spectroscopy using accelerated radioactive beams

We present the design of an innovative detector system for gamma-particle spectroscopy with bunched radioactive beams. The system is equipped with a diagnostic system specific for the use of secondary beams produced at modern linear accelerators. Its main features are the reduced size of detector array, allowing the combination of particle-gamma spectroscopy, and the use of innovative techniques for beam diagnostics needed to tune and characterize the accelerator beam. The particle detector is based on doubled sided silicon strip detectors (DSSD), allowing for particle identification and measurement of linear momentum of reaction fragments. The system is integrated with various beam diagnostic devices, based on single crystal diamonds (CVD) for timing applications and silicon sensors for beam transmission optimization. The R&D work is of interest for the future generation of particle detectors being build at FAIR and SPIRAL2.

POSTER SESSION

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FAZIA front-end electronics, global synchronization and trigger design

FAZIA stands for the Four Pi A and Z Identification Array. This is a project which aims at building a new 4pi particle detector for charged particles. It will operate in the domain of heavy-ion induced reactions around the Fermi energy. It puts together several international institutions in Nuclear Physics. It is planned to be operating with both stable and radioactive nuclear beams. A large effort on research and development is currently made, especially on digital electronics and pulse shape analysis, in order to improve the detection capabilities. This contribution will describe electronic layout from detector signal conversion to data transport through optical fiber. System synchronization for "time-of-flight" measurement of particles, trigger development and overall tests will be also discussed.

POSTER SESSION
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Overview on the physics perspectives in the future european laboratories

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Signal Formation in Radiation Detectors: Ramo's theorem and its application in practical cases

The analysis of the signals produced at the electrodes of radiation detectors is crucial to optimize the measurement quality of position, energy or time information of the interaction as well as to tailor the appropriate signal processing techniques. The lecture will review the Shockley-Ramo theorem which is at the basis of signal formation in gas and semiconductor detectors as well as its applications to a variety of practical cases.

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PSD on Double Sided Si-Strip Detectors

POSTER SESSION

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New setups for direct reactions with exotic nuclei at SPIRAL2

To fully exploit the opportunities offered by the upcoming radioactive-beam facilities, significant improvements in term of efficiency, resolution and simultaneous particle and gamma detection are demanded. The GASPARD (GAmma Spectroscopy and PARticle Detection) array and the ChyMENE (french acronym for thin hydrogen target) windowless solid-H2 target are two projects dedicated to direct reaction studies with the SPIRAL2 beams which are currently under study. The results of a full simulations of gamma and particle detection with GASPARD for a typical SPIRAL2 physics case will be compared with the ones obtained with existing setups (EXOGAM+MUST2). The performance of a prototype of the ChyMENE target obtained in an in-beam test experiment will be presented.

POSTER SESSION

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Data acquisition systems (DAQ) "essentials"

In this lecture will be shown some basic and common concepts of Data Acquisition systems (DAQ) without references to a particular project or specific technologies. Some topics like DAQ and triggers, data readout, codifiers, buses, data networking, DAQ software, etc, will be covered giving a short example for each one and a glossary. The aim of the lecture is to define introductorial concepts or topics, giving a minimum background in order to better understand the specialized conference talks on this argument.

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Front-end design in CMOS for high resolution detectors

This lecture focuses on the design of low-noise charge amplifiers in deep submicron CMOS technologies, for use in high resolution detectors. Techniques for achieving high resolution under constraints on power, voltage, and real estate are discussed. Topics include input MOSFET optimization, low-frequency noise, low-noise voltage and charge amplification, dynamic range.

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Statistical Suppression of Sign-Symmetric Noise in Spectroscopic Measurements

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We have developed a method of evaluation and suppression of sign-symmetric noise in spectroscopic measurements, and have implemented and tested its application in a new type of highly sensitive and stable system for low-level environmental radiation monitoring at Jefferson Lab. The necessity to assess, minimize, and correct for the signal noise is a typical problem in spectroscopy and in the other fields of study related to signal measurement technologies. Our new method is different from the prior art as it is based on the observation that many sources of noise in Nature may be characterized as "sign-symmetric", that is, the sign of the disturbances along the signal line relative to the true average value could be random and accidental, and the shapes of the disturbances are independent of their sign. In particular, many important types of noise are due to the statistical fluctuations in the number of charge carriers in a unit time; with the number of carriers large, the fluctuations around the average are sign-symmetric relative to the average level. Any of the types of the "white noise" are generally sign-symmetric. Radio frequency noises in the environment, or acoustic noises are also sign-symmetric in general (with the exception of the wave fronts from explosions or such). A good example of a signal line, providing zero average signal level, is the AC connection line, which, in its simplest form, just uses a proper capacitor to connect the source of the signal to the line. The useful signals to be detected and measured are often not sign-symmetric, as it is in the case of particle detectors using photomultipliers, semiconductor detectors, ionization chambers, etc. Our method introduces the new concept of the "sign-symmetric trigger", which is used to detect both signal and noise events coming along the zero-average-level signal line. The trigger works as a function of the absolute value of the input signal level, providing identical response both for negative and for positive level variations in the signal line. The trigger level value is selectable, as in any regular signal trigger setup. If the value of the trigger function exceeds threshold, the signal is recorded as is, without taking the absolute value of it, by an Amplitude-to-Digital Converter capable of recording signals of both signs. At the data analysis stage, negative signals collected during the measurement represent the spectrum of the noise in the line (assuming the real signals are all positive). Positive signals consist both of real signals and the noise; therefore, the difference between the two spectra represents the evaluated signal spectrum

with the symmetric noise contribution subtracted. The trigger, and the signal amplitude measurement functions could be realized as the electronics hardware blocks, or they could be implemented as the software routine analyzing the continuous flow of signal level measurements made by a high frequency data acquisition station. Our demonstrated implementation utilized the High Pressure Ionization Chamber with a pulse mode readout electronics front end as a source of measured radiation event signals, recorded continuously by a 192 kHz PCI Audio card, and then analyzed online and offline. The detectors together with the electronics front ends were installed permanently at the CEBAF site boundary, subject to the full range of environmental temperatures, and radio frequency and acoustic noises. The sign-symmetric noise subtraction procedure helps to provide extremely stable long term operation of the devices, eliminating the temperature and external noise dependence of the detectors' outputs.

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Analogue memories for particle physics detectors

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Present situation in GEM and Micromegas detectors/ structure and production upgrades

This talk will mainly give an overview of the CERN PCB workshop production activities in the field of Gas detectors
After a fast description of standard MICROMEGAS and GEM detectors we will present the last improvement on these 2 technologies, mainly introducing resistive protection layers in Micromegas detectors and introducing a new simplified method to assemble GEM detectors . The resistive layers change the behavior of detectors in positive but also negative way, the gain rate dependency will be explained. In the last part of the talk some comments on Large primary ionization dynamic range detectors will be given based on observation on many different Gas detectors.

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Cases for nuclear physics: The S^3 instrumentation and comparisons to the AIDA project

The Super Separator Spectrometer (S^3) is a facility designed for experiments with the coming very high intensity beams of heavy ions provided by the LINAG superconducting accelerator of Spiral2. Its main physics motivation is the delayed studies of rare nuclei produced by fusion-evaporation reactions. These nuclei are selected by the separator-spectrometer from beam-like ions and other contaminants and are transmitted with high efficiency up to the end of the line. The combination of an electric and a magnetic dipole distributes these nuclei according to their mass over charge ratio on the final focal plane. At this point different studies can be performed, notably decay spectroscopy measurements.
For this purpose, the standard detection of S^3 is an implantation-decay station that aims at first, measuring the position of the ions on the focal plane to establish their M/q, and second detecting any proton, alpha, electron or gamma emission from the unstable nucleus. This configuration includes:

- Transmission detectors measure the time of flight and position sensitive based on the emissive foil technique,
- An implantation detector measures the time and energy of the incoming ion, a well as the time and energy of the subsequent p, α, or e^- emitted during the decay.
- A tunnel detector forms a box around the implantation detector, to detect p, α, or e^- that are emitted backward.
- Several gamma detectors surround the box to detect gamma emission.

Using the recoil decay tagging method, we can correlate the implanted ion with its decays.
After the description of this set-up, we will define the performances that such measurements require from the detectors and their associated electronics. We will also describe the different R&D paths that have been explored to solve these problems, both on the front-end electronics (high dynamics fast resetting preamplifier, floating-point ASIC preamplifier, Retroaction preamplifier) or back-end electronics (GET electronics, NUMEXO2 ADC, CAEN ADC+DAC) and the current status of our studies.

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Proton and Deuterium Identification by Means of PSA at Energies Below 1 MeV

Proton and Deuterium identification has been achieved by means of pulse shape analysis (PSA) at energies below 1 MeV. The experiment was carried out using a Si-NTD 500um detector in a low-field injection scenario. The electronic chain was calibrated with mono-energetic proton and deuterium beams. Finally, the data from a Li7+C12 (34 MeV) reaction was acquired with a 100 MHz ADC.

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Two CMOS Solutions for Two Different Signal Processing Problems

The Integrated Circuits (IC) Design Group at Southern Illinois University Edwardsville in collaboration with the Nuclear Reactions Group at Washington University in St. Louis have developed a pair of custom, multi-channel integrated circuits for use in low and intermediate energy nuclear physics experiments. The first chip is an analog shaped and peak sensing IC known as HINP16C (Heavy Ion Nuclear Physics - 16 Channels) and targets Si-strip detector applications. The second chip, christened PSD8C (Pulse Shape Discrimination - 8 Channels), was designed to logically complement (in terms of detector types) the HINP16C chip and is capable of particle identification. This presentation describes the design and performance of the two ICs.

A Case Study: Design of a CMOS ASIC For Pulse Shape Discrimination

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The AGATA Demonstrator Array at LNL

E.Farnea
On behalf of the AGATA and PRISMA Collaborations

The expected experimental conditions at the planned future facilities for radioactive ion beams and for high-intensity stable beams are extremely challenging, requiring unprecedented levels of efficiency and sensitivity, which cannot be reached with the conventional 4π arrays of Compton-suppressed high-purity germanium detectors.
The approach pursued in the past few years implies covering the full 4π solid angle with germanium detectors only. The photopeak efficiency and the peak-to-total ratio are maximised through the identification of the interaction points of the photons within the germanium crystals (pulse shape analysis) and a software reconstruction of the trajectories of the individual photons (γ-ray tracking). Arguably, the major advantage with respect to the present generation arrays is the excellent spectra quality provided up to relativistic beam velocities, where the Doppler broadening correction is dominated by the position resolution within the individual crystals rather than by the finite opening angle of the detectors.
Presently, two projects aim to build an array based on the concepts of pulse shape analysis and γ-ray tracking: AGATA in Europe and GRETA in the United States. Both instruments are expected to play a major role in the future nuclear structure studies at the very limits of nuclear stability.
This contribution will focus on the status of the AGATA project. A subset of the whole array, known as the AGATA Demonstrator Array, is operating since 2009 at the Laboratori Nazionali di Legnaro, where it is installed at the target position of the magnetic spectrometer PRISMA. The Demonstrator is presently composed of five triple clusters, with a photopeak efficiency ranging from 3% to 7% for single 1 MeV photons depending on the target-detector distance.
Following the commissioning runs, the experimental campaign has started at the beginning of 2010 and it will continue until the end of 2011. Most of the performed and of the proposed experiments aim to study neutron-rich nuclei using AGATA in coupled operation with PRISMA, although also experiments studying proton-rich nuclei in standalone operation are also foreseen. Preliminary results from the experiments performed so far will be presented.

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Narval : a generic framework to develop Data Acquisition System

Narval is a ten years old framework to develop Data Acquisition System. It first aim was to replace OASIS a client/server generic DAQ system used at IPN Orsay. From the beginning it is designed to support small (test bench, VME acquisition @ ALTO) to huge systems (AGATA). It can also be used to connect other acquisition systems together. It is written in Ada 2005 and used in many laboratories around the world.

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Noise mechanisms in electronic devices: physical origin and circuit model

The Lecture will review the main sources of noise, present in most electronic devices, trying to highlight their physical origin and providing a circuit model able to take into account the device noise contribution at the schematic level. Noise modeling and analysis will be performed both in the time domain and in the frequency domain. The fundamental theorems related to noise analysis will be discussed and the main noise parameters relevant for the model of the noise behavior of detector-frontend electronic systems will be introduced.

Signal processing techniques for the extraction of physical observables in presence of different noise sources

The Lecture will review the main signal processing techniques for the extraction of physical observables like energy, time of arrival, pulse rise-time in presence of the typical noise contributions affecting a detection system and compute the achievable signal-to-noise ratio in the different cases.

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Development of the Time Projection Chamber readout for heavy RI collision experiment

RIKEN Radioactive Isotope Beam Facility (RIBF) is the novel ion cyclotron type accelerator, which accelerates proton to Uranium ion up to 345 AMeV. For the study of nuclear equation of state (EoS) through heavy RI collision experiments, a Time Projection Chamber (TPC) has been developed by international collaboration. By using the TPC, multiple particles, such as protons and light ions, are measured simultaneously. In terms of the study of nuclear EoS, it is important to be able to measure the heavier nucleus. On the other hand, large number of charged particles are produced in heavy RI collisions, and all of particle tracks and no fake tracks should be reconstructed. Here, fake track means the reconstructed tracks but not due to the real particles. One of the sources for such kind of tracks are expected to be crosstalk from heavier particle tracks. The deposited energy in gaseous detector is proportional to the square of Z, and the pads around ion tracks are strongly affected by the crosstalk of the larger signal induced by a higher Z particle. We will report the development of a low crosstalk readout pad design by an electromagnetic simulator and radio frequency instruments. The development requirement is the crosstalk level on an adjacent transmission line should be less than 0.5%, for the measurement of protons of $Z=1$ and light ions of $Z<10$ simultaneously. It is realized by putting a ground plane on the upper, lower side and the surrounding of a signal line. In addition, we started the R&D study of MicroMEGAS readout for heavy RI collision experiments. Better two track separation capability is expected in the case of MicroMEGAS readout. The status of the MicroMEGAS study in Japan will be given.

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Adaptive gamma-ray spectrometer With High event processing rate

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The adaptive to different types of scintillator gamma-ray spectrometer with high event processing rate is introduced. It processes gamma energy spectrum in the time window sequence with resolution <4% in the energy range from 20 keV to 10 MeV by count rate up to 106 counts/sec in real-time mode. The digitization of the detector signal by 14-bit ADC with a sampling rate up to 64 MHz and real-time data stream processing are used for separating overlapping events and for correct generation of spectra.

POSTER SESSION
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SPADIC - Self Triggered Pulse Amplification and Digitization ASIC

For the readout of the TRD sub-detector of the planned fixed-target CBM experiment at FAIR/GSI (Darmstadt, Germany), a new self-triggered amplification and digitization mixed-signal chip with 32 channels is under development. The next iteration, including all planned features for the first time, is currently being worked on and will be submitted in the near future. Each channel will be composed of a low-noise and low-power charge sensitive amplifier, a 9 bit pipelined ADC running at 25 MHz sampling rate, a fully programmable digital signal processing unit for detector specific tasks such as ion tail cancellation and baseline correction, as well as hit detection logic which triggers the readout of signal snapshots. Channel data will be sent out in a message-based format through an arbitrated inter-channel network preserving the temporal order. The latest 180 nm prototype chip with 8 active channels successfully showed the oscilloscope-like operation of the whole analog and digital data path with both injected test signals and signals from a connected TRD chamber prototype.

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Introduction to FPGAs:

Basics of FPGA technology, tools and example application areas (emphasis on detector readout)

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Triggering Philosophies for Large Nuclear Physics Experiments

Large physics experiments require triggers to select the interesting data from the background. This talk will consider modern triggering techniques including triggerless hardware time stamps where data are selected later by software triggers and also more conventional hardware trigger selection schemes.

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Digital Pulse Processing for Physics Applications

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STUDY OF THE PULSE SHAPES IN THE DESIGN OF A RAPID AND PORTABLE ALPHA-PARTICLE SPECTROMETER

Transport of illegal radioactive materials is a major problem today. Rapid methods to identify possible radioactive materials are needed. This is even more important when alpha-particle emitting nuclides are involved because of the low range of this type of emission. Generally, alpha-particle spectrometry involves sophisticated and laborious radiochemical and destructive processes, requiring several days, or even weeks, to quantify the individual contents of a sample. The development of a device allowing rapid and straightforward α-particle spectrometry would be very useful for detecting the radioactive contents of unknown samples. A portable device has been constructed to perform the tests. The device consists of an aluminium canister with a flat face open and directed towards the sample to be measured, with a silicon detector inside. The detector is connected to the necessary electronics.

All the equipment has been designed to be portable to perform measurements in situ. The proposed measurement method is direct: no vacuum application or chemical treatments are needed. The canister is placed onto a surface of the unknown sample and a rough spectrum is quickly obtained. Knowledge and correct identification of the electronic pulses is fundamental. Measurements have been made of different samples containing one or several radionuclides under different conditions. The results show that identification of samples containing not very low activities of alpha-particle emitting nuclides is possible in very short times

POSTER SESSION
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Noise performance analysis of different digital pulse filters

In this work, we compare the noise performance of digital CR-(RC)n, trapezoidal and triangular shaping. The filters are realized using recursive algorithms suitable for real-time measurements. The comparison is carried out using simulation and experimental measurements. In the simulation part, a noise generator which generates pure series, 1/f and parallel noise is used to study the performance of the filters against each source of electronic noise. The experimental part is performed using signals from germanium and room temperature semiconductor detectors. The results of our study reveals that
(i) in regard to parallel noise, opposite to the results of the previous noise index calculations, a CR-(RC)4 filter has a better performance than a trapezoidal filter.
(ii) Under the noise condition that the series noise is the dominant noise, the trapezoidal filter is the best choice.
(iii) The best performance against the 1/f noise is achieved using the trapezoidal filter.

POSTER SESSION

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Signatures of special nuclear materials from fission by PSD analysis of liquid scintillation detector signals

We study methods for the detection of special nuclear material (SNM). For this purpose we carry out experimental investigations at the Pulsed Neutron Interrogation Test Assembly (PUNITA). The pulsed 14-MeV neutron generator allows to induce fission in SNM samples first by a burst of fast neutrons, and after a certain slowing-down time time, by a burst of thermal neutrons. We use the signal of prompt fission neutrons as signature for the presence of SNM in a go/no go detection system. We are currently studying the use of scintillation detectors based on the BC-501A liquid, and pulse shape analysis of the charge pulse collected at the PMT anode output. For this purpose we use 3” x 3” and 5” x 5” detectors from Saint Gobain and the N6720 and N6751 signal digitizers from CAEN. Important requirements to the digitizers are wide bandwidth input of analogue signal, and the capability of handling trigger rates variable over many orders of magnitude due to the pulsing of the neutron generator. However this kind of data processing has particular advantages in relation to the detection of the fission signatures such as: - The PMT anode signal has a rise time of only few nanoseconds. This feature may be exploited for the detection of coincidence prompt emissions in multiple detectors. In addition, this signal is not perturbed by dead-time effects even during the intense 14-MeV neutron burst. - Due to the different scintillation mechanisms of gamma rays and fast neutrons, the anode signal can be used to distinguish these two types of radiation by means of the so-called pulse shape discrimination (PSD). - Neutrons below certain energy do not produce sufficient scintillation in the detector to be detected directly. Thus only fast fission neutrons are observed from a thermal neutron induced fission event. These features allow the interrogation of an object in PUNITA by epi-thermal and thermal neutrons, and subsequent detection of the prompt fission neutrons in the scintillation detector. By combining multiple BC-501A based detectors the coincident prompt neutron and gamma emission from a fission event can be detected in very short coincidence intervals.

POSTER SESSION

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Front-end electronics solutions for large arrays of segmented detectors

Solutions for a modular structure of the front-end electronics (FEE) with discrete components, for a large variety of segmented detectors with single-ended and differential read-out capabilities are presented. Although these FEE solutions were dedicated mainly for highly segmented HP-Ge detector, e.g. AGATA (EU-project), Miniball (CERN), Tigress (Vancouver), Sega (NSCL-Michigan) etc. one can easily reconfigure them for other specific requirements of a much larger family of segmented detectors, e.g. DSSSD, MRPC, MWPC, diamond detectors etc.

The PSC-2008 Charge Sensitive Preamplifiers firstly designed for Miniball Array of Segmented and Encapsulated HP-Ge Detectors is a very low noise, very fast and designed in a highly compact version with overall dimensions of only 26x40mm. The structure of charge sensitive preamplifiers is both single ended or fully differential with very wide dynamic range and a selectable full range from 40MeV up to 170MeV. The intrinsic noise is less than ~ 600eV with a slope of ~ 9eV/pF (detector capacity) and in the version with differential outputs combined with shielded-twisted pair transmission line assemblies they are preserving the original quality of the signal/noise ratio, which makes the preamplifier assembly suitable for noisy experimental environments.

Secondly, using innovative front-end electronics developed for segmented HP-Ge detectors we were able to significantly extend the range of spectroscopic measurements well beyond the fast pipe-line ADCs dynamic range. Combining standard pulse height analysis to a time variant technique (ToT) we obtained an unprecedented intrinsic signal dynamic range as large as ~92 dB. This front-end electronics was developed for the central electrode of 36-fold segmented, high purity germanium detectors in the frame of AGATA array of detectors. It is a fast and very low noise hybrid front-end electronic device consisting of a complex charge sensitive preamplifier with a built in fast reset circuitry as well as a very accurate programmable spectroscopic pulser. The intrinsic energy resolution in conjunction with a highly segmented detector is less then ~800 eV for central electrode with a detector capacity of ~ 47 pF. The dynamic range of the central charge sensitive stage is as large as ~92 dB, ranging from 0.1 fC to 10 pC, i.e. from ~3 keV to 170 MeV in terms of photon energy. To achieve such an unprecedented wide dynamic range, the standard analog electronics was designed with two conversions gains, namely: ~200mV/MeV and ~50mV/MeV respectively, to match the 1V input dynamic range of the very fast, pipe line ADCs used by the digitizer units. To extend the pulse-height spectroscopy range well beyond the fast ADC analog input range, a new method was implemented and at a certain threshold we are switching from a standard pulse height analysis method to a time over threshold technique (ToT). In order to achieve that, adjacently to the pole-zero cancellation circuit, a fast-reset circuit controlled by a fast comparator and an accurate zero crossing detector have been developed. Using this technique we can achieve an energy resolution of ~0.04% for equivalent gamma energies up to ~170MeV.

An innovative programmable spectroscopic pulser has been designed and implemented in front-end electronics of the central electrode to achieve 'self-calibration standards' in both time and amplitude domain, which was needed to characterize such a complex, highly segmented high HP-Ge detector operating in either conventional pulse height spectroscopic mode or in the time threshold mode.

The second family of front-end electronics was developed in the frame of LYCCA project (LYCCA as an acronym for "Lund-York- Cologne Calorimeter" is a core device for the HISPEC-DESPEC program, which is part of the NuSTAR collaboration and thus a FAIR device). This front-end electronics was dedicated mainly to the single or double-sided multi-strip detector readout. The ΔE detectors are 310μm thick, square-shaped DSSSD with an active area of 58x58mm, and having 32 strips on each side are produced by RADCON Ltd., Zelenograd, Russia and they are bonded on custom made printed circuit at Lund with the PCB design at Cologne. The LYCCA charge sensitive preamplifiers are very low noise, very fast and designed in a highly compact version of 32-channels preamplifiers module with overall dimensions of only 40x80x100mm. The structure of charge sensitive preamplifiers is fully differential with very wide dynamic ranges; their full ranges are factory selectable from 10MeV up to 10GeV. The intrinsic noise is less than ~ 3.5keV with a slope of ~0.05keV/pF (detector capacity) and due to their differential outputs and twisted pair transmission line cable assemblies (68 wires, high density, industry standard) they are preserving the original quality of the signal/noise ratio, which makes the preamplifier assembly suitable for noisy experimental environments.

Based on previous fast charge sensitive amplifiers (CSP) developments at IKP-Cologne with discrete components, significantly up-graded solutions are suggested keeping the very low noise energy features but incorporating an ultra-fast timing channel. Adding a very fast timing channel with fully differential ultra-fast amplifiers (~200ps rise time) and -ultra-fast comparators (~40ps rise time and ~10ps deterministic jitter), we expect timing resolution well below 50 ps. Moreover, if the detector accepts differential readout then solutions to improve S/N ratio for the energy channels are also presented

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Case study in nuclear physics: the FAZIA project

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Instrumentation needs

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**Cutting-edge circuit technology able to boost the dynamic range of CMOS charge-sensitive
preamplifiers far beyond their saturation limit**

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The growing interest on satellite telecommunication systems led Selex Elsag (formerly Selex Communications) to acquire more than 30 years of experience on the design, realization and on-site deployment of a large variety of earth stations for civil, military and radio astronomy applications. Over the past years the Selex Elsag activity has been devoted to exploit all different technological fields that the SatCom industry and the lrge antenna design for Telecoms, radio astronomy and remote sensing involves. Recently the new-std Digital Modems (DVB-RCS, DVB-S2) for voice, data, video and videoconference have been designed and the Software Radio is under development. This presentation will show the main technological achievements that have been carried out in the design of SatCom Terminals (master stations, naval, transportable) focusing the attention on the new SOTM (Satellite On The Move) Terminals having the innovative solution of phase array antennas, on he large telescope like the 64-meter antenna SRT (Sardinia Radio Telescope) and Remote Sensing Ground Terminals (Cosmo SkyMed).

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System design for nuclear structure experiments: online data reduction and distributed systems

Experiments in the upcoming facilities will be more and more complex in view of a multiple use of the available beam time. This leads to an extended necessity to couple a diversity of systems using different data acquisition concepts and trigger schemes. In my lecture I'd like to discuss powerful on-line data processing and reduction techniques which will allow to cut down the amount of spectroscopic information to reasonable values. The use of time distribution systems is in that view necessary to combine the data coming from the different systems, and will be

handled separated by different use cases. Special focus will be put on design issues related to a potentially universal application.

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Reflections on two ASIC development projects for nuclear physics

In a basic science collaboration with colleagues at the NSCL and a technical collaboration with colleagues at Southern Illinois University at Edwardsville (SIUE), we have developed two ASICs for use in our basic nuclear science effort. The product of one of the projects was recently selected for an applied nuclear science (Homeland security) effort. While this talk will review tboth the basic and applied projects (at a non-technical level) and mention some of the physics highlights, its major focus will be on what this researcher believes are the required ingredients to execute such a development effort. I will highlight the sociological and demographic differences between nuclear physics (NP) and high-energy (HE) physics. A few of the issues for NP might not be obvious, at least if the perspective is from high-energy physics. First, the project should have short-term goals so that physics can be extracted in just a couple of years and that each basic science student can have a basic science accomplishment for his/her thesis. Second, the project must be divisible so that small university groups can have identifiable accomplishments. Finally, as NP has real world applications, it is desirable to solve a real world problem with the same technology. Doing so helps solves a major problem - continued financial support.

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Wide Dynamic range readout preamplifier for Silicon Strip Sensor

RIKEN Radioactive Isotope Beam Facility (RIBF) has capability to accelerate proton to Uranium ion up to 345 AMeV, By using these high intensity primary beam, various RI beam are generated. We plan to utilize these RI beam for coulomb break up experiments. Signature of the events is one proton and one heavy ion at final state. In order to identify the proton and heavy ion just after interaction point, silicon strip sensors are placed near by the target. Energy deposit into Si is proportional to the Z**2, when Z is charge of heavy ion. We would like to identify proton and heavy ion which has up to Z=50. So readout electronics must have wide dynamic range as 4*50**2 = 10,000. We have developed preamplifiers with two methods. One is Dual Gain Charge Sensitive amplifier (DGCS) and other is square root form amplifier (ROOT amp). The DGCS has two independent amplifies, low gain and high gain, per channel. These two amplifies are connected to one Si strip. When the large signal comes from sensor, it will saturate high gain amplifies and it propagate to the low gain amplifier input through feedback circuit and then low gain amplifier is saturated. When saturation is happen in the high gain, feedback circuit is shorted in order to propagate the saturation to the low gain. The ROOT amp has output of pseud square root shape response for input charge by using diode turn-on characteristics at feedback circuit. We will report the status of the two schemes of the wide dynamic range preamplifiers. It includes development of hybrids with discrete devices and ASICs.

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Measure of the DSSSD efficiency

DSSSD are Si detectors segmented in strips in both faces, they are widely used in nuclear physics and for applicative purposes. Their efficiency for the full energy reconstruction is influenced by the presence of a insulating layer that separates the strips. Ionizing particles impinging on the detector in such interstrip region can generate signals of reduced amplitudes, or with an inverted polarity, reducing the overall efficiency for the full energy reconstruction. In this communication will be presented a systematic study on the efficiency for full energy reconstruction for different energies using two different ions (Li and O). Moreover the effects of the applied bias will also be discussed.

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FAZIA DATA ACQUISITION: STATUS, DESIGN AND CONCEPT

The FAZIA project groups together several institutions in Nuclear Physics, which are working in the domain of heavy-ion induced reactions around and below the Fermi energy. The aim of the project is to build a 4Pi array for charged particles, with high granularity and good energy resolution, with A and Z identification capability over the widest possible range. It will use the up-to-date techniques concerning detection, signal processing and data flow, with full digital electronics. The FAZIA data acquisition system introduces various issues about high data flow bandwith (~600 MB/s) and design of nested data event format (up to five level). In this talk DAQ design and architecture will be described focusing on event data model, software trigger and NARVAL, a novel event transport framework. Overall benchmarks and first results will be also discussed.

POSTER SESSION

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《Foating Point》 Charge Sensitive Amplifier, a large dynamic range energy measurement chip for the focal plane of the Super Separator Spectrometer of the SPIRAL2 project

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The Super Separator Spectrometer S^3 is dedicated to the studies of heavy and super heavy elements produced using the stable ion beam at very high intensity delivered by the linear accelerator at GANIL designed in the framework of the SPIRAL2 project.
The focal plane detection system of S^3 will consist of an implantation Si detector for decay spectroscopy of heavy and super heavy elements. The 400-channel double sided strip silicon detector permits the localization and the timing measurement of the heavy ions implantation of the heavy ion and their alpha decay.
The heavy ions are depositing in the silicon detector a maximum energy of 500MeV that have to be measured with 5-10 MeV resolutions whereas the alpha particles energy deposition is only in the range of 10MeV that have to be measured with a resolution of 15keV. For the electronics, the real challenge is to measure accurately an alpha decay particle of 10 MeV few (typically 10) microseconds after the huge energy deposition related to the heavy ion implantation in the same strip.

To fulfil this requirement, we have designed a new ASIC charge sensitive amplifier. The principle of this CSA, described in this paper, consists in a switching feedback capacitors as a function of output signal level.
At reset, or in steady state conditions, the CSA starts with a high gain configuration. When the output signal reaches a high level threshold, a low gain capacitor is added in parallel to the other. Consequently, the gain of the CSA changes and the output signal decreases quickly in few nano seconds and settles to its final value in about 30ns. A logical output "low gain" indicates if a low gain event was detected. The 2 gains have the same relatively short time constant of 700ns allowing a return of the CSA output signal to the baseline in less than the specified 10µs, with a drawback of parallel noise. This time constant is supposed to be cancelled after digitization.

A 2-channel prototype chip was designed in the AMS 0.35 µm CMOS technology. It is compatible with both polarities of the input signal and its DC output voltage can be tuned according to the application and provides differential analog output signals for better noise immunity. The two gains are respectively 2.1mV/MeV and

44.4 mV/MeV but both can be optionally doubled.

The simulated Integral Non Linearity performances are:

- ~25.10^{-3} % equivalent to 8.6keV with the high gain for the low energy from 1 to 33MeV
- ~0.3% equivalent to 1.6MeV with low gain for the high energy from 33 to 500MeV
- ~18.10^{-3} % equivalent to 90keV with low gain for the high energy from -250keV to -7.5MeV

For an input capacitance of 50pF (detector and cable), the simulated equivalent noise charge, using an ideal filter (supposed to be performed digitally) made of pole zero and CR-RC2 filters with 0.5µs peaking time are:

- 2700 e- rms equivalent to 23keV FWHM for low gain
- 847 e- rms equivalent to 7.2keV FWHM for high gain

The prototype circuit uses 3.3 mm^2 of silicon area, precisely 500µm * 1100µm by channel, and was packaged in a 44-pin ceramic CQFP.

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General Electronic for TPC(GET), an architecture based on the µTCA standard... with a short introduction to µTCA for physics

This talk gives an overview of the "General Electronic for TPC" (GET project) mainly at the hardware point of view. With the next Time Projection Chambers of more than 10^4 channels, it explains what are the goals and the challenges of this new architecture based on the µTCA standard. A focus is made on the µTCA "MUTANT" trigger with its several features in order to reduce and label data buffers. A short introduction to the new µTCA for physics (MTCA.4) is showed at the end of the presentation.

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A DAQ system using a 100-MHz time stamp for β-γ spectroscopy experiments at RIBF

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A decay experiment for the neutron-rich isotopes produced by ^{238}U beam operated at RIBF, RIKEN Nishina center. We have performed β−γ spectroscopy experiment [1, 2, 3] for neutron-rich Zr isotopes around A=110 at the RIBF facility in the end of Dec. 2009.
Produced RI beams were separated and identified by BigRIPS and ZDS [4]. At the end of the beam line, double-sided silicon strip detectors (DSSDs) were placed as a stopper for RI beams. The DSSDs measured the energy of beam particles and detected subsequent β-rays emitted from the implanted RI. Four Clover-type Ge detectors were placed around the DSSDs to detect g-rays following b and isomeric decays.
In this experiment, a DAQ system with a 100-MHz time stamp was introduced for the first time. In this system, trigger timing of each detector was stored with 100-MHz time stamp. So we can build DAQ setup for each detector independently. As the points of difference between this system and the previous system [5], it is not necessary to make a common trigger for circuits placed belong along the beam line and circuits for b-g spectroscopy measurement placed on the end of the beam line. Therefore, building DAQ setups become more convenient. Using the time stamp information, we can get a time difference between implantation time and detection time of β decay. As a result, 18 new half-lives were obtained [1].
In addition, there were not only VME modules but also a DSP module, APV8008, produced by TechnoAP for Ge detectors. Information of signals output from pre-amplifier of Ge detectors was stored in FIFO of this module after digital signal processing using a 100-MHz clock. We experimentally introduced this module for the purpose of efficiently collecting the data from a Ge detector in this experiment.
I will present the result of experiment using this system combined with APV8008, and report the current status.

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POSTER SESSION