Ph.D. in Information Technology: Thesis Defenses

February 9th, 2018

DEIB Alpha Room (building 24) – 10.30 am

Giovanni BELLOTTI – XXX Cycle

"Silicon Drift Detectors and Readout Electronics for High Throughput Spectroscopy Applications"

Advisor: Prof. **Carlo Fiorini**

Abstract:

ARDESIA (ARray of DEtectors for Synchrotron radIation Applications) is an experimental project funded by the INFN National Scientific Committee V, whose goal is the realization of an X-ray spectrometer for synchrotron experiments based on arrays of SDDs. The project has started in 2015 and it is expected to end in 2018. The spectrometer has been designed and manufactured in all its parts, from the detection module to the mechanical structure and the readout electronics.

Matteo CESARINI – XXX Cycle

"Fully Printed Organic Imagers on Flexible Substrates for Large Area Applications and Novel Radiation Detectors"

Advisor: Prof. **Dario Natali**

Abstract:

The focus of this work has been the development of novel, flexible electronics for photodetection and large area imaging. These prototypes, fabricated by scalable printing techniques, compatible with industrial processes, represent new prospective cost-effective solutions in conformal imaging, large object scanning and dosimetry applications.

Giulia Cozzi – XXX Cycle

"Development of Scintillation Detectors Based on Silicon Photomultipliers for High-Energy Gamma-Ray Applications"

Advisor: Prof. **Carlo Fiorini**

Abstract:

The Dissertation represents a new challenge of Silicon PhotoMultiplier (SiPM) application to high-energy gamma-ray detection with scintillators in nuclear physics experiments and Prompt Gamma Imaging (PGI) in proton therapy. Although SiPMs are considered a promising alternative to the PhotoMultiplier Tubes (PMTs) in many medical imaging applications, more efforts are mandatory to introduce SiPM technology also into the field of high-energy gamma-ray detection (from tens of keV to tens of MeV). In this context, it is mandatory an optimization of the detector and the front-end electronics to face the wide energy range and to get high spectroscopic performances and imaging capability comparable to that measured with PMTs. Therefore, the thesis deals with the design, development and experimental validation of a multichannel SiPMs-based gamma-ray detection module of about 100 electronic channels which allows to read large LaBr3:Ce scintillators (1" x 1'' and 2" x 2'') for nuclear physics experiments, achieving both spectroscopic (measured energy resolution of 3.2% at 662 keV) and position sensitivity results in line with PMT standards and the best one within published results. Moreover, the photodetector was modified for PGI, proposing a pixelated structure of LYSO crystals which utilizes the multichannel readout developed earlier. The experimental results demonstrate that the designed photodetection module is suitable for prompt gammas detection in terms of spectroscopic performances, position sensitivity and energy range.

Andrea Grande – XXX Cycle

Design of Ultra-Fast Front-End Electronics for New Pixel Detec-Tors for the European XFEL

Advisor: Prof. Carlo Fiorini

Abstract:

My research project aims to develop an innovative read out electronics for the European XFEL (X-Ray Free Electron Laser) for new pixel detectors. In these new sensors a readout PMOS transistor is integrated in the ASIC and used for the reading of the signal. It is also required to have a compression of the signal for higher number of photons, so a compression stage is integrated in the front-end itself. In this way it is possible to facilitate the design of the detector, especially if compared with DEPFET detectors in which a FET is integrated on the detector itself. At the same time, it will still be important to have good noise performances, so a low noise architecture front-end, based on a Flip Capacitor Filter, has been implemented.

PhD Committee:

Prof. **Carlo Ettore Fiorini**, DEIB – Politecnico di Milano

Dr. **Matteo Porro**, European XFEL GmbH, Hamburg

Dr. **Antonio Valletta**, CNR-IMM

DEIB Conference Room "Emilio Gatti" (building 20) - 11.00 am

Jacopo MOROSI – XXX Cycle

"Phase-Coded Brillouin Optical Correlation Domain Analysis for Fast and Highly-Resolved Distributed Strain and Temperature Monitoring"

Advisor: Prof. **Mario Martinelli**

Abstract:

A Brillouin fiber-optic sensing system capable of providing distributed temperature and strain information along the entire length of a sensing fiber has been developed. Traditional distributed sensors, based on Spontaneous or Stimulated Brillouin Scattering, obtain spatial information through Optical Time Domain Reflectometry techniques (BOTDR/BOTDA) by analyzing the backscattered power from a pulsed signal sent into the sensing fiber. However, these techniques suffer from a few major drawbacks, such as poor spatial resolution, high hardware complexity and high cost. However, the proposed solution - called phase-coded Brillouin Optical Correlation Domain Analysis (phase-coded BOCDA) - exploits correlation control of CW counter-propagating pump and probe signals to efficiently confine the Brillouin gain process on a small section of the sensing fiber (down to cm-range), thus guaranteeing accurate ultra-high-resolution monitoring which outperforms BOTDA systems. Slope-assisted techniques have also been applied to the proposed sensing solution, avoiding the need of reconstructing the whole Brillouin Gain Spectrum to extract strain/temperature information, thereby leading to a significant reduction of the measurement time. The application of a new polarization scrambler, based on nonlinear interaction between a signal and its own counter-propagating replica generated by a time-delayed reflective loop, has also been proposed to cope with polarization dependency of the Brillouin gain process.

Nicola PESERICO – XXX Cycle

"Integrated Optical Platform for Biosensor Applications"

Advisor: Prof. **Andrea Melloni**

Abstract:

Biosensors are essential tools for daily life, used in various environments from clinical exams up to food quality controls. There are several technologies available for implementing biosensors, but research is always looking for new solutions, aiming to higher sensitivity, faster responses, wide dynamics range, and solutions

suitable for low-cost implementations. This thesis has been dedicated to research on integrated optics circuits for biosensing applications. The research has mainly concentrated on the implementation of an innovative, robust, and reliable device for the detection of several analytes, using integrated optics technology. The outputs have led to several projects and publications, including a patent.

PhD Committee:

Prof. **Pierpaolo Boffi**, DEIB – Politecnico di Milano

Prof. **Annamaria Cucinotta**, Università di Parma

Prof. **Francesca Parmigiani**, Università di Southampton

DEIB Conference Room "Emilio Gatti" (building 20) - 1.30 pm

Antonio LEANZA – XXX Cycle

"Decorrelation phenomena in a Geosynchronous Synthetic Aperture Radar: theory, techniques and performance"

Advisor: Prof. **Andrea Monti Guarnieri**

Abstract:

Geosynchronous orbit (GEO) Synthetic Aperture Radar is a novel concept which would provide significant potential advantages over the present Low-Earth Orbit (LEO) systems. In particular the nearly-zero inclined GeoSAR would grant the continuous time coverage of the observed sub continental region with 12 hours revisit time, coarse resolution imaging every 20 minutes and high integration gain to compensate the significant spread loss, limiting in this way the required physical antenna size and trasmitted power. However the long integration time (minutes to hours) introduces signal decorrelation problems. The thesis tackles the study of these decorrelation phenomena, providing analysis, both theoretical and experimental, performance evaluations and when possible, methods to counteract their effects on the focused images.

Francesco SETRAGNO – XXX Cycle

"Feature-based Analysis and Modelling of Violin Timbre"

Advisor: Prof. **Augusto Sarti**

Abstract:

The timbre of musical instruments is one of the most complex and ambiguous case of study in music research. Nevertheless, timbre is a very important aspect of music and it is of great interest for manufacturers, musicologists and researchers to be able to analyse and control the sound properties of musical instruments. Among the others, the sound of the violin received particular interest for decades, due to its complex behaviour and the aura of legend that surrounds the masterpieces of the ancient Cremonese masters - Stradivari, Guarneri, Amati. In this thesis, timbral analysis techniques are studied and applied to the specific case of violins. The choice of this class of instruments depends on different reasons: the complexity of the bowed instruments family; the great interest in the manufacturing, music and research communities; and the availability of the remarkable collection of the Violin Museum in Cremona, that includes historical and top-quality contemporary violins. The musical timbre depends both on the physics of sound (low-level perspective) and human perception (high-level perspective). For this reason, this study is conducted at different levels of abstraction. We start from the measurable characteristics of the audio signal that characterize the sound of violins and we model the way the sound is perceived and described by the listener. The description of timbre is formalized with the implementation of an ontology.

PhD Committee:

Prof. **Matteo Cesana**, DEIB – Politecnico di Milano

Prof. **Nicola Orio**, Università di Padova

Prof. **Stephen Hobbs**, Cranfield University