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Supervisor Expression of Interest
MSCA-IF Marie Sklodowska Curie Action-Individual Fellowship

Supervisor name:	Giuseppe Bertuccio
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Department Name: Research topic: (https://www.polimi.it/en/scientific-research/research-structures/departments/)	Department of Electronics, Information and Bioengineering PE7_5 Micro- and nanoelectronics, optoelectronics and photonics
MSCA-IF Research Area Panels	☐ CHE_Chemistry ☐ ECO_Economic Sciences X **ENG_Information Science and Engineering** ☐ ENV_Environmental and Geosciences ☐ LIF_Life Sciences ☐ MAT_Mathematics ☐ PHY_Physics ☐ SOC_Social Sciences and Humanities
Politecnico di Milano Areas:	☐ Cultural Heritage ☐ Smart Cities ☐ Territorial Fragilities ☐ Health **X Industry 4.0**
Brief description of the Department and Research Group (including URL if applicable):	**The Department** The DEIB was born officially at the Politecnico di Milano in 2013, from the merger of three previous departments: Bioingegneria, Elettronica e Informazione, and Elettrotecnica. Although the Dipartimento di Elettronica e Informazione (DEI) was officially established in 1992, its history dates back to the year 1928, when the Institute of Electrical Engineering was founded at the Politecnico di Milano. The Italian tradition in computer engineering started in 1954 right here, when Prof. Luigi Dadda brought from the U.S. one of the first CRC computers. The pioneering work in numerical computing and in the design of programming languages and hardware originated from these events. Since then the Department has

been recognized as a world-class scientific institution that contributes to key achievements in computer engineering, telecommunications, industrial automation, electronics and microelectronics. Research in the field of bioengineering was started by Prof. Biondi, and led in 1991 to the creation of the Dipartimento di Bioingegneria, now again connected with DEI. The historic Dipartimento di Elettrotecnica, founded in 1886, has common roots with the DEI in the principles and theories of electromagnetism, at the base of electrical engineering, electronics, computer science and telecommunications. In the past few decades the exponential growth of ICT has boosted an impressive expansion of DEIB's researchers and activities. Despite the variety of its interests, however, the Department has been able to preserve a unique scientific identity. Here cross-fertilization is a working reality and our ICT researchers and specialists are eager to tackle extremely complex and diverse problems in many technical, economic, and social fields. Today our Department counts 232 faculty members and about 460 short-term researchers and PhD students. It is organized in six distinct scientific areas: Bioengineering, Computer Science and Engineering, Electrical Engineering, Electronics, Systems and Control, and Telecommunications. DEIB is also a key node of many research networks, and is a widely recognized gateway to a highly qualified know-how and expertise.

The Research Group

The Research Group of the Semiconductor Detectors and Integrated Circuit Laboratory (SDIC Lab.), head by prof. Giuseppe Bertuccio, is part of the Electronics Section of DEIB. Prof. Bertuccio started his activity in 1987 as member of the Research Group of prof. Emilio Gatti, a pioneering leading scientist in the field of nuclear electronics since 1950. Since then, Bertuccio has been active in the research and development of semiconductor radiation detectors and associated front-end electronics. The SDIC Lab. group has lead fundamental and applied research on two connected topics: I) Study and development of Silicon and compound semiconductors (GaAs, CdTe, CdZnTe, SiC) detectors for imaging and spectroscopy of ionizing radiation; II) Design of low-noise and low-power Integrated Circuits in CMOS and BiCMOS technologies for radiation detectors. The SDIC Lab. has collaborated with many Italian Universities and International Research Centers and Industries such: National Institute of Nuclear Physics (INFN), National Institute of Astrophysics (INAF), Italian Space Agency (ASI), European Space Agency (ESA), Elettra Synchrotron, Thales Alenia

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	Space, Canberra Industries, Alenia Marconi Systems, Check Cap Ltd, Ketek GmbH, Altalab srl, Xnext srl. Between the most significant and internationally recognized results obtained at SDIC Lab there are the study and development of 1) high energy resolution Gallium Arsenide X-ray detectors, 2) Silicon Carbide room and high temperature radiation detectors, 3) ultra low-power low-noise large format ASIC for pixel detectors, 4) CMOS charge sensitive preamplifier with sub-electron equivalent noise, 5) Silicon Drift Detector–CMOS front-end system operating at room temperature with the highest energy resolution. In the last 20 years, more than 30 Master's degree students, 7 PhD students and 5 Postdoc Researchers have made their thesis and worked at the SDC Lab.

Brief project description: **(max 1 page)**	**Study and Development of X-Gamma Ray Spectroscopic Imaging Systems for Harsh Environments in Scientific Research and Industrial Contexts** The aim of the project consists in the research and development of innovative X-gamma ray semiconductor detectors and associated electronics able to operate in the harsh environments common to many scientific and industrial contexts such as: a) Synchrotron Light Sources, b) Laser generated plasmas experiments, d) X-ray scanners for inspection and material identification, e) Space telescopes for astrophysics. In both scientific as industrial contexts, the strong request of innovative X-gamma ray detectors and front-end electronics is nowadays motivated by the need of systems able to operate: 1) at room or high temperature (from +20°C to +70°C) with no or minimal thermal control; 2) under very high photon fluxes (up to 10^7 photon/mm^2 per seconds); 3) with very high energy resolution (allowing high resolution spectroscopy in 0.1-100 keV range). Just as an example, most of the above-mentioned features are required for the next generation X-ray inspection systems designed for real-time chemical and physical analysis of materials on production lines of medical and food Industries, improving the production and safety by detecting contaminants or not compliant products. The real-time information provided by the high speed systems of the next generation will allow immediate correction in case of anomalies. Such idea stems

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	from the industrial need to perfect the production chain and optimize all the lacks (Smart Factory -Industry 4.0). The proposed project will be focused on the study of different semiconductor-based X and gamma ray detectors realized with Silicon Carbide (SiC), Cadmium Telluride (CdTe) and Cadmium Zinc Telluride, being these the most promising materials to fulfill the stringent requirements in the above-mentioned contexts. For very high energy resolution at low photon energies (<10 keV) and room temperature operation or for space telescope, silicon drift detectors produced with an innovative technology will be considered, together with SiC devices. For high phonon energies (up to 100 keV) CdTe/CdZnTe will be considered. Hybrid solutions employing stack of different semiconductor (Si on CdTe) will be considered to cover the full energy range with the highest energy resolution and detector efficiency. The study and the implementation of the system prototype will make use of state of the art custom front end electronics designed in our laboratory with microelectronics CMOS technologies. The project will take advantage of an already consolidated national collaboration between Politecnico di Milano, University of Udine, National Institute of Nuclear Physics (INFN Pavia and Trieste), National Institute of Astrophysics (INAF - Rome and Bologna), Fondazione Bruno Kessler (FBK – Trento) and Elettra Synchrotron (Trieste). A collaboration already active with the company XNEXT srl (http://www.x-next.com/) operating in the development of advanced X-ray inspection systems will give perspectives of a realistic and medium-term technology transfer of the results of the present research activity in industrial contexts.