DEVELOPMENT OF A NEW CONCEPT OF GAMMA IMAGER

THESIS SUPERVISOR: GILBERT DUCHENE
IPHC, 23, RUE DU LOESS, 67037 STRASBOURG CEDEX 2
TEL: 03 88 10 66 12; E-MAIL: GILBERT.DUCHENE@IPHC.CNRS.FR

MIRION CONTACT: MICHAEL GINSZ
MIRION TECHNOLOGIES, 1 CHEMIN DE LA ROSERAIE, 67380 LINGOSLHEIM
TEL: 06 16 90 35 55; E-MAIL: MGINSZ@MIRION.COM

The IPHC team is in close partnership with the MIRION Technologies Company on a high-level nuclear-research project as part of the European AGATA collaboration and is competing with the best North-American gamma-spectroscopy teams. MIRION Technologies, the worldwide expert in gamma sensors based on multi-segmented hyper-pure germanium (HPGe), produces innovative detectors for various scientific projects. The AGATA collaboration comprising 10 countries, including more than 40 laboratories, develops technologies to increase the performance of the AGATA multi-detector gamma array, such as high throughput digital electronics, on-line pulse-shape analysis and gamma-ray tracking.

IPHC has built a 3D investigation tool dedicated to analyse the performance of germanium crystals, unique in its speed, precision and versatility. This 3D scanning table was simulated, tested and validated then further upgraded during two previous PhD thesis works co-financed by the MIRION Technologies Company. The two PhD students are currently on permanent contracts, one of which in MIRION.

The proposed thesis subject is part of a novel concept, applying the techniques developed within the framework of AGATA to a societal application: a new design gamma-ray imager. The main objective of the proposed thesis is to carry out Monte-Carlo simulations (Geant4) to define and optimize the new concept of imager, to validate it at MIRION Technologies on small HPGe detectors then, taking advantage of the IPHC 3D scanning table, to develop the imaging algorithms and optimize them using Artificial Intelligence (AI). These developments open up to various applications such as Compton imaging, decontamination of nuclear or industrial sites as well as applications on transit security in ports and airports.

The objectives of the thesis are to:

- acquire skills in gamma-ray detection and detailed understanding of the response of a HPGe gamma-ray detector with all the associated electronic chain, as well as the skills in simulations (Monte-Carlo methods, software for generating pulse shapes and for data analysis),
- simulate the response of various gamma imager concepts, assess their realistic response and figure of merit,
- characterize different imager prototypes using relatively small HPGe crystals on the IPHC scanning table, analyze their response and compare them to simulations
- with an optimized imager design, develop the artificial intelligence algorithms to improve the performance in terms of image precision and/or data processing time.

Funding is provided via co-funding between Grand-Est region and MIRION Technologies.

The PhD student is expected to split his working hours on a weekly/monthly basis between the IPHC site (Strasbourg) and the MIRION Lingolsheim site (10 km away) accordingly to the IPHC-MIRION contract. He/she will participate in national and international conferences related to the field, in particular those of the AGATA community.