Title:	**Deep learning-based spectral reconstruction for Compton camera devices**
Position:	One year post-doc
Topics:	Medical imaging; inverse problems; deep-learning
Institutes:	CREATIS, CNRS UMR 5220 – INSERM UMR 1294, INSA, Lyon, France IP2I, CNRS/IN2P3 UMR 5822, UCBL, Lyon, France
Supervisors:	Voichita Maxim — voichita.maxim@creatis.insa-lyon.fr Étienne Testa — e.testa@ip2i.in2p3.fr

Scientific Context

Interest in the Compton camera has grown lately with the construction of small portable detectors, initially developed for nuclear security applications. The first tests have been carried out in nuclear medicine. Thanks to its superior sensitivity, this device opens the way to reducing the radioactive dose administered to patients in SPECT examinations. New applications such as proton-therapy or targeted radionuclide therapy are explored as well as multi-modal imaging (for instance Compton camera / PET imaging [1]).

Spectral reconstruction, consisting to compute simultaneously images at several emission energies, is a topic largely investigated for X-ray imaging. In γ-ray imaging collimated cameras are not well adapted as the collimators are specific to a narrow range of low energies. Compton cameras do not have this limitation.

Several Compton camera technologies have been proposed with performances depending on the specificities of each application. However, the physics of photon-matter interactions imposes limits on current detectors that could be overpassed by optimized data processing and by tomographic reconstruction algorithms including adapted prior information. This can be done by regularization techniques or by deep-learning. The application of such techniques have been investigated for other tomographic modalities but not yet for compton camera imaging.

Working hypothesis and aims

The objective of this study is to develop and compare regularized reconstruction and deep learning methods for Compton camera spectral imaging. The first method consists in modeling the simultaneous reconstruction of images at different energies as an optimization problem, the solution of which is then calculated using an iterative algorithm. For the deep learning methods a large set of realistic data will be simulated using the Compton camera module from GATE ([2]). The images will be reconstructed with our CORESI code.

Post-doc supervision

The post-doc will be recruited at CREATIS and INSA Lyon and will be co-supervised by Voichita Maxim (CREATIS) and Etienne Testa (IP2I). He/she will work in the Tomoradio team in a stimulating environment composed of researchers in inverse problems, tomography, imaging for radio-therapy and Monte Carlo simulation. This work will be done in a strong collaboration with physicists from IP2I Lyon and LPSC Grenoble. The position is financially supported by the Labex PRIMES.

Profile Required

We are looking for an enthusiastic and autonomous candidate with strong motivation and interest in multidisciplinary research.

- **Education**: PhD in Applied or Pure Mathematics, Computer Science, Signal and Image processing, Biomedical Physics;
- **Scientific interests**: computer sciences, deep-learning, medical applications, applied mathematics;
- **Programming skills**: Python, Tensorflow, C++;
- **Languages**: English required, French optional.

To apply, please send a CV and a cover letter. Review process will begin immediately and will continue until the position is filled. The initial appointment is for one year and can be renewed by 6 months based on performance.

References

[1] H. Tashima, E. Yoshida, H. Wakizaka, M. Takahashi, K. Nagatsu, A. B. Tsuji, K. Kamada, K. Parodi, and T. Yamaya, "3D Compton image reconstruction method for whole gamma imaging," *Physics in Medicine & Biology*, vol. 65, no. 22, p. 225 038, 2020.

[2] A. Etxebeste, D. Dauvergne, M. Fontana, J. Létang, G. Llosá, E. Munoz, J. Oliver, É. Testa, and D. Sarrut, "CCmod: A GATE module for Compton camera imaging simulation," *Physics in Medicine & Biology*, vol. 65, no. 5, p. 055 004, 2020.