

# PhD fellowship

## Exponential Data Consistency Conditions for Patient Motion Detection and Correction in SPECT



<https://www.creatis.insa-lyon.fr/site7/en/node/47190>

### Context

The ANR project SPECT-Motion-eDCC is a collaborative project between CREATIS, TIMC, OHI and LUMEN. Single photon emission computed tomography (SPECT) is a technique for imaging the 3D distribution of a radioactive tracer that has been administered to a patient to track certain biological functions. The long acquisition times (10-40 minutes) of SPECT make them prone to patient motion which decreases image quality. Exponential data consistency conditions (eDCC) are mathematical equations [1] that should be verified by the input data of SPECT reconstruction algorithms. Inconsistencies might be used to correct input data, e.g., to improve correction of the attenuation [2].

### Objective

The goal of this PhD fellowship is to evaluate the ability of eDCC to detect and correct motion in SPECT. The investigations will focus first on realistic Monte Carlo simulations of clinical SPECT scanners with a parallel collimator as those available at the LUMEN. For this geometry, eDCC are known and motion detection can be readily evaluated. The motion can then be estimated and compensated to generate consistent motion-compensated projections and reconstruct SPECT images with improved quality. Successful application of eDCC-based motion detection and correction to simulated data will be applied to real data of the simulated SPECT scanners.

The project also aims at expanding eDCC theory for pinhole SPECT scanners. A secondary objective of the PhD student will be the simulation of pinhole SPECT data for the validation of these new eDCCs or for the application of parallel eDCCs to rebinned pinhole data.

### Tasks

- Model SPECT scanners available at the LUMEN,
- Select patient data from which SPECT acquisitions will be simulated,
- Simulate SPECT projections with patient motion using GATE,
- Implement eDCCs and evaluate their ability to detect motion,
- Develop motion estimation and generate consistent SPECT projections,
- Reconstruct motion-corrected SPECT images with RTK,
- Repeat each step with pinhole SPECT data.

### Required skills

- **Education:** Master in applied mathematics, computer sciences or medical physics.
- **Scientific interests:** applied mathematics, medical image processing, medical physics, Monte Carlo simulations.
- **Programming skills:** Python, C++ (ITK, RTK).
- **Languages:** command of English required, French optional.

### Practical information

- **Supervision:** Simon Rit and Ane Etxebeste
- **Location:** Mainly at the Centre Léon Bérard, Lyon, France.
- **Period:** 3 years, starting in September 2022.
- **Salary (net):** 1700 euros/month.
- Post CV and a brief statement of interest on <https://bit.ly/3u66p0E>.

### References

- [1] V. Aguilar, L. Ehrenpreis, and P. Kuchment. Range conditions for the exponential Radon transform. *Journal d'Analyse Mathématique*, 68(1):1–13, 1996.
- [2] R.G. Wells and R. Clackdoyle. Feasibility of attenuation map alignment in pinhole cardiac SPECT using exponential data consistency conditions. *Med Phys*, 48(9):4955–4965, 2021.