

**Internship location:** LTSI Inserm U1099, Université de Rennes 1, Rennes, France.

**Centre d'investigation Clinique et d'Innovations Technologiques (CIC-IT), Rennes, France.**

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Keywords : Multimodal image processing, MRI, Visualization, Cardiac resynchronization Therapy

## 1. The CAMI context

Medical Interventions (surgery, interventional radiology, radiotherapy) can provide a significant boost for progress in terms of patient-specific optimal planning and performance. To fulfill patient's demand for Quality, Senior Operators demand to see beyond the immediately visible, to be assisted in their real-time vital decisions and to accede to enhanced dexterity, while junior operators request to "learn to fly" before being left alone, and Public Health Authorities and companies require demonstration of the Medical Benefit of innovations.

The Computer Assisted Medical Interventions LABEX (CAMI LABEX) strategic vision is that an integrated approach of medical interventions will result in a breakthrough in terms of quality of medical interventions, demonstrated in terms of medical benefits and degree of penetration of CAMI technology in routine clinical practice.

Among the different actions undertaken in the scope of the CAMI LABEX, about 10 internships are to be financed yearly. The following internship proposal deals with themes within LABEX's scientific field.

## 2. Subject

Cardiac Resynchronization Therapy (CRT) is a recognized therapy for patients with refractory heart failure (HF). Large clinical trials evaluating CRT have demonstrated significant improvements in cardiovascular function for those patients. But this procedure needs to be optimized to overcome the high rate of 30% of implanted patients that do not respond to the therapy [1]. Because of the cost and invasive nature of CRT, optimal patient selection and optimal interventional CRT gesture for this therapy have become a priority for HF specialists and electrophysiologists. Multimodal cardiac Imaging for Planning and Assistance of CRT is a challenge to provide new efficient solutions [Heydari, 2012][Tavard, 2014].

In this context, cardiovascular magnetic resonance (CMR) using pre- and post- contrast T1 mapping and new MOLLI sequences can be used to measure disturbances in the myocardial extracellular volume fraction (ECV), such as diffuse or focal myocardial fibrosis [4]. Diffuse fibrosis is in particular difficult to access with conventional Late Gadolinium Enhancement sequences (LGE- CMR) and is of high importance to optimize the localization of stimulation leads in CRT.

The internships' work will concern: 1) the segmentation of the myocardium in pre- and post-contrast T1-mapping CMR sequences that are acquired in pre-operative situation; 2) the quantification of the ECV by a post-processing of segmented T1-mapping images to provide new ECV maps associated to the left ventricular myocardium; 3) the

visualization of diffuse fibrosis in per-operative X-Ray images, combined with pre-operative anatomical and mechanical data.

The first part of the work will represent the most important part in which an adapted segmentation method will be implemented and evaluated, from an analysis of reference works in CMR image segmentation [5][6][7]. The second part of the work will be guided by a method of the literature [4] and by using motion correction and registration tools that have been previously developed in the lab in cardiac imaging [3][8]. The final part of the subject will be realized by using registration and visualization tools that are in development in the lab in the context of a CAMI PhD (S. Bruge)[7].

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[6] C.M.S. Nambakhsh, J. Yuan, K. Punithakumar, A. Goela, M. Rajchl, T. M. Peters, I. Ben Ayed, Left ventricle segmentation in MRI via convex relaxed distribution matching *Medical Image Analysis* 17 (2013) 1010–1024.

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### 3. Profile of the applicant

3th year of engineering school ("école d'ingénieurs") or M.Sc. ("master recherche").

Specialized in image processing,

Machine learning, computer vision, image processing, OpenCV.

Medical image processing skill would be a plus.

Programming skills (C++ , ITK / VTK may also be needed).

Strong interest in research and medical imaging.

Ease of adaptation, good communication skills and good teamwork spirit.