Project 1: Advanced image processing for the quantitative analysis of the in-vivo thalamic nuclei from magnetic resonance imaging

The thalamus has a key role in brain function as it is the central relay of many cortical areas. Given their functional importance, the ability to non-invasively map and differentiate the thalamic nuclei is of extreme value in a wide range of neuroscience research areas as well as in clinical practice. For instance, having a direct visualization of thalamic nuclei would be crucial in a better understanding of the pathophysiology and psychopathology of Schizophrenia disease or for assisting the planning and guidance of non-invasive radio-surgical interventions.

The major challenge of a precise image analysis of the thalamus is related to its high complex architecture, made of small nuclei of a few millimeters only, connected to many cortical regions and, at the same time, to other grey matter nuclei and brain areas like the cerebellum. However, there is today the ability to in-vivo image the thalamus through advanced magnetic resonance imaging modalities at both 3T and 7T. In this project we will explore how to exploit this imaging techniques, based on multi-modal MRI, and further develop them as well as to set up an advanced image processing framework to quantify the thalamic nuclei. This project is based on previous research developed in our laboratory and it will be done in collaboration with the Neurosurgery department (Prof. M. Levivier & Prof. J. Bloch) and the Psychiatric Department (Dr P. Steullet & Prof. K. Do) from the Lausanne University Hospital.

Related publications: (1) "*Robust thalamic nuclei segmentation method based on local diffusion magnetic resonance properties",* Battistella G., Najdenovska E., et al. Brain structure & function, 222 (5), 2017. (2) "*In-vivo probabilistic atlas of human thalamic nuclei based on diffusion- weighted magnetic resonance imaging"***,** Najdenovska E., Alemán-Gómez Y., et al., Scientific data, 5, 2018. (3) "*Comparison of MRI-based automated segmentation methods and functional neurosurgery targeting with direct visualization of the Ventro-intermediate thalamic nucleus at 7T",* Najdenovska E., Tuleasca C., et al., Scientific reports, 9 (1), 2019.