# Tractography modelling of deep brain stimulation for chronic post-stroke pain

**Background** Deep brain Stimulation (DBS) is neurosurgical intervention widely used in the treatment of movement disorders and less often for other indications such as advanced psychiatric disorders. Since the 1950s, DBS has also been used as a treatment to relive intractable pain, including chronic post-stroke pain[1].

DBS can modulate activity in the lateral and medial pain systems. The lateral one is composed of the spinothalamic tracts connecting the dorsal horn of the spinal cord to the ventral nuclei of the thalamus: the ventral posterior lateral, ventral posterior medial and ventral posterior inferior nuclei. These tracts then project to the somatosensory cortices[1]. The medial pain system also consists of tracts connecting the spine to the thalamus (medial nuclei) but through the brain stem and connecting the limbic system. This second pathway is slower and is thought to modulate the affective component of pain[1]. Therefore, the sensory thalamus is a common DBS target for the treatment of chronic post-stroke pain[1]. Diffusion-weighted magnetic resonance imaging and tractography can be used to identify pathways modulated by DBS and build tractography-based pathway activation models.

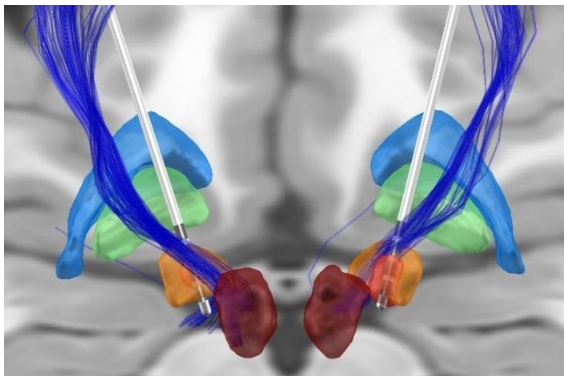

*Figure 1. 3D illustration of DBS leads and subcortical structures. Subthalamic nucleus in orange, volume of tissue activated in red and streamlines in dark blue.*

**Aim** The student will review the thalamic pain pathways targeted by DBS for chronic post-stroke pain. The student will reconstruct the pathways of interest using tractography methods, reconstruct the electrode locations in 5 to 8 patients implanted at Inselspital Bern, and generate the volumes of tissue activated by each of the electrode contacts using clinical stimulation settings. Finally, to generate the pathway activation models, the student will calculate the activation of the pathways by the activation volume and relate it to the clinical outcome.

**Materials and Methods** The student will use MRtrix3 (https://www.mrtrix.org/) for the tractography analysis and the Matlab toolbox Lead-DBS (https://www.lead-dbs.org/) for the leads' reconstruction and generation of activation volumes.

**Nature of the Thesis** Literature review: 20% | Data analysis and programming: 60% | Writing: 20%

**Requirements** Interest in brain connectivity and image analysis

Programming knowledge in Matlab or Python.

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## References

1. Boccard, S. G. J., Pereira, E. A. C. & Aziz, T. Z. Deep brain stimulation for chronic pain. *J. Clin. Neurosci.* **22**, 1537–1543 (2015).