Dyna Sti Scientific Abstract:

The project aims to enhance the outcome of Deep Brain Stimulation (DBS) in Parkinson's disease (PD) through the individualization and optimization of stimulation settings. Our vision is to replace the current practice of selecting stimulation pulse width, amplitude, and frequency by trial and error with a model-based patient-specific calculation. This will be achieved by incorporating insights from novel clinical studies into individualized mathematical models underpinning clinically relevant DBS programming tools. To reflect the cross-disciplinary nature of the DBS optimization problem, the consortium is composed of neurologists, electrical and control engineers, computer scientists, movement scientists, and neurosurgeons from four European countries. The partners have complementing research competences and contribute to the project in-house software tools for the automatization of DBS programming. Overall, DynaSti will acquire novel experimental data, extract new knowledge from it regarding the biologic mechanisms of DBS, and design open-source model-based algorithms to improve its effectiveness. These algorithms will then be tested in the participating clinics for improved convergence to clinically optimal DBS parameters in terms of patient benefit, i.e. improved motor control, minimized side effects, and battery consumption.

Approach: The research program of DynaSti departs from the hypothesis that clinical improvement of high-frequency DBS may be predicted through accurate biophysical modelling of the effect of stimulation on electrophysiological and neuroimaging biomarkers of PD. We will place emphasis on the effect of subthalamic nucleus stimulation on cortical networks as identified through DBS-evoked potentials to uncover novel non-invasive markers of effective stimulation. Research data for modeling and validation will be acquired from three hospitals in different countries. To extract new knowledge, we will use a combination of time series and spectral analysis, source localization, system identification, machine and deep learning, as well as data processing and analysis methods of systems and network theory.

Outcomes: Expected outcomes of the research program include higher therapeutic effects in individual treatments, reduced side effects, and improved treatment economy resulting from shorter DBS programming times. Higher degrees of automation in clinical processes will also advance consistency in care quality notwithstanding where it is provided. Further, DynaSti will result in improved understanding of the effects elicited by DBS through the development and validation of patient-specific dynamical models.