

Macroscopic Entrainment of Neuronal Ensembles with Application to Deep Brain Stimulation

*Institute of Neuroscience and Medicine - Neuromodulation (INM-7) and
Virtual Institute of Neuromodulation, Research Center Jülich, Jülich,
Germany
E-mail: o.popovych@fz-juelich.de*

We show that if a neuronal population receives an external rhythmic input, which may stem from another neuronal population or an external, e.g., sensory or electrical, source, the population local field potential may be entrained by the rhythmic input, whereas the individual neurons are phase desynchronized both mutually and with their field potential. The individual neurons can get entrained by a periodic driving only for much larger strength of the forcing [1]. This property is used for the functional target localization during deep brain stimulation (DBS), which is a standard therapy for medically refractory movement disorders. For the therapeutic effect of DBS a proper electrode placement is of crucial importance. High-frequency test stimulation for tremor suppression is a standard procedure for functional target localization during DBS. However, this method does not work in cases where tremor vanishes intraoperatively, for instance, due to general anaesthesia or due to an insertional effect. To overcome this difficulty, we developed a stimulation technique that effectively evoke the tremor in a well-defined and quantifiable manner, which is phase locked to the stimulus [2]. We show that a weak patterned low-frequency stimulation may cause low-amplitude, but strongly phase-locked tremor, which is also in accordance with our computational results.

- [1] O.V. Popovych and P.A. Tass, Submitted for publication (2010).
- [2] U.B. Barnikol, O.V. Popovych, C. Hauptmann, V. Sturm, H.-J. Freund, and P.A. Tass, *Phil. Trans. R. Soc. A* **366**, 3545 (2008).