Investigating the Spread of Excitation in Cochlear Implant Subjects after Stimulation with Triphasic Pulses: A Test-Setup Design

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Facial nerve stimulation (FNS) can be an undesirable side effect of the electrical stimulation in cochlear implants (CI). Some patients experience symptoms ranging from simple awareness to severe facial spasm *(Berrettini et al. 2011)*. A common approach is reducing stimulation amplitude while simultaneously extend the pulse phase duration. If these measures do not succeed, the affected implant electrodes may be deactivated. However, all these interventions possibly will limit the hearing performance of the patient *(Crew et al. 2012, Dorman & Loizou 1997, Shannon et al. 1995)*. Most modern audio processors use by default charge balanced biphasic pulses (BP) to stimulate the auditory nerve. In two recent studies, stimulation with BP and triphasic pulses (TP) was compared in CI subjects. The results showed a strong FNS-reducing effect of TP stimulation at most comfortable stimulation level (MCL) *(Bahmer & Bauman 2016, Bahmer et al. 2017)*. It has been hypothesized that this amelioration is a result of short-term temporal effects of TP that may focus the current spread in the cochlear. In a future project, spatial spread of neural excitation (SOE) will be investigated within the cochlear after CI stimulation with TP. So far, a tool offering the feature of such measurements is not available. Hence, our first step was to design a research tool capable of applying TP in a SOE task.

A method to estimate the longitudinal SOE in the cochlear evoked by electrical pulses already exists *(Cohen et al. 2003)*. Comparing the SOE after stimulation with BP and TP shall give more insights of the spatial and temporal effects of TP stimulation. Therefore, we extended the aforementioned method by the possibility of using TP stimuli.

Via our testing environment for SOE measurements a research interface box (RIB2, MED-EL, Innsbruck) can be properly controlled (tested with Detectorbox, and in a patient with a SYNCHRONY implant, MED-EL, Innsbruck). The recorded neural response curves could be clearly identified as electrically evoked compound actions potentials (ECAP). A graphical user interface (GUI) programmed with the software MATLAB (MathWorks, Natick, Massachusetts) enables the user to control several parameters of stimulation as well as data acquisition and consequently to perform a large variety of experiments.