Abstract Book

MED-EL

7th Munich LMU Hearing Implant Symposium

Facing 27 Years of Bilateral Cochlear Implantation: Binaural Hearing With Hearing Implants

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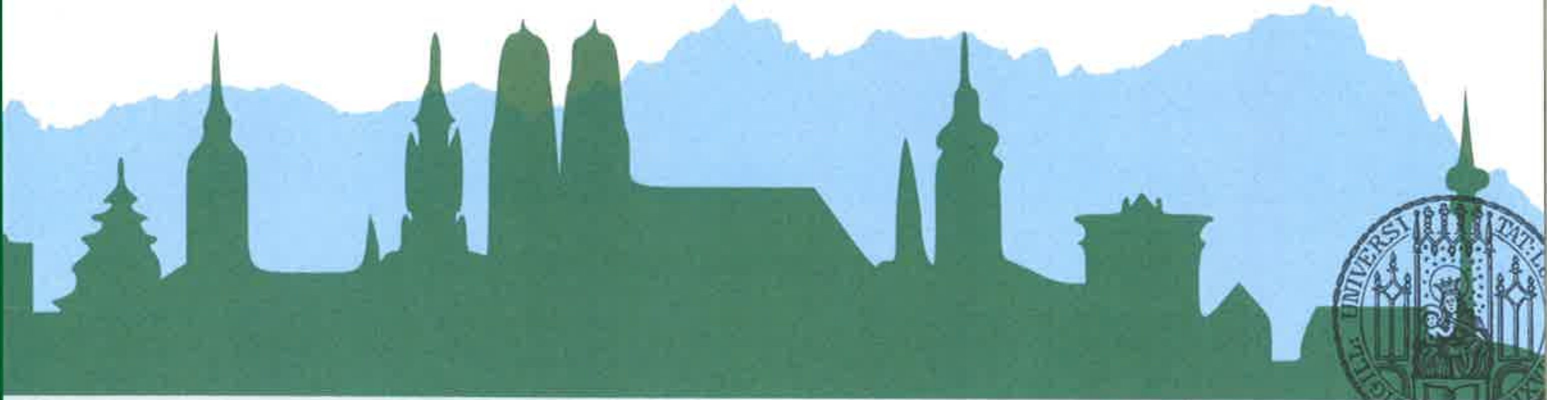
Munich, Germany



Venue: LMU Clinic, Campus Großhadern

Host: Prof. Dr. med. Joachim Müller
Section Otology and Cochlear Implants

Department of Otorhinolaryngology, Head & Neck Surgery (Chairman: Prof. Dr. med. Martin Canis)

LMU KLINIKUM DER UNIVERSITÄT MÜNCHEN

Localisation Under Reverberant Conditions

Bernhard U. Seeber – Germany

Abstract: The ability to locate sound sources with bilateral cochlear implants can be very good in selected users in quiet situations (Seeber et al., 2004), but noise and reverberation severely impair it (Kerber and Seeber, 2012, 2013). The high susceptibility to noise and reverberation in CI listening has several roots: a) CI users dominantly rely on interaural level difference cues for sound localization, while interaural time difference (ITD) cues contribute little additional information (Seeber and Fastl, 2008); b) the neural sensitivity to ITDs carried in the timing of the electric pulses is usually low compared to normal hearing; c) most sound coding strategies in CIs do not code temporal information in the timing of the electric pulses delivered by CIs. Increasing the spectral and temporal coding precision is difficult due to interaction between stimulation pulses at the electrode-nerve interface and due to using high pulse rates. For example, refractoriness and current-spread across channels make it hard to anticipate which electric pulses will evoke a neural response, thus preventing a dedicated coding of temporal fine structure information.

In recent years, models have been presented which predict the auditory nerve response to sequential electrical pulsatile stimulation, such as the S-BLIF model (Takanen and Seeber, 2022; DOI:10.5281/zenodo.4674564). It considers the non-linear interactions at the electrode-nerve interface due to adaptation, facilitation and refractoriness. I present a novel approach for finding the stimulation pattern to be delivered by the CI: First, the processing order is inverse, as the strategy does not start from the sound. Instead, the nerve's spiking response is the target for which a suitable stimulation sequence needs to be found. A nerve response model is placed in the loop of an optimization strategy which computes the pulse timings, amplitudes and durations needed to evoke a given nerve spike pattern. Different constraints can be implemented by penalizing the distance measure inherent to the optimization strategy, for example to prevent two pulses being placed at the same time on different electrodes. I will show examples of the optimization. By basing the cochlear implant strategy on an auditory nerve model and by taking the nerve response as the target to be achieved, temporal information can be coded in a targeted way over the non-linear electrode-nerve interface with the aim to improve the ability to locate sound sources and to listen in noisy situations with cochlear implants.

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Biography: Bernhard U. Seeber received the Dipl.-Ing. degree in electrical engineering and information technology and the Dr.-Ing. degree with distinction from the Technical University of Munich (TUM), Germany, in 1999 and 2003, respectively. Next, he was post-doc at the Department of Psychology at UC Berkeley, USA. In 2007 he joined the MRC Institute of Hearing Research, Nottingham, UK, to lead the Spatial Hearing lab. Since 2012, he is the head of the Audio Information Processing lab and Professor in the Department Computer Engineering at TUM. His research foci are on signal processing for hearing aids and cochlear implants, on virtual acoustics, spatial hearing, auditory modelling and acoustic non-destructive testing. Prof. Seeber is a member of the German Acoustical Society (DEGA), the Association for Electrical, Electronic & Information Technologies (VDE), the Acoustical Society of America (ASA), the Association for Research in Audiology (ARO) and the Bernstein Network for Computational Neuroscience. He heads the technical committee on hearing acoustics in the Society for Information Technology (ITG/VDE) and was member of the executive board of the DEGA from 2016 to 2022. He received the Lothar-Cremer award of the DEGA, the doctoral thesis award of the ITG and the ITG publication award.

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