Contribution ID: **151** Type: **not specified**

Developing a physics inspired neural recording platform

Background
Conventional recording and analysis of electrical brain activity is done with a neuro-biological rather than physical perspective. The way signals are treated, closely reflect the prevalent neuro-biological theories, which see the functional organization of the brain as an electro-chemical digital circuit. Typically, the recorded data are high-pass filtered and thresholded to produce binary sequences carrying information much like a digital computer. This signal processing, once justified by technical limitation in computational resources or users' culture, poses potential limitations to the investigation and discovery of neuronal communication strategies.

The challenge
In order to move beyond current practice, one must rethink data collection. Conventionally, electrodes used to record brain activity are sampled at low frequencies that reflect the time-scale of "binary"neural signals, however neural "spikes"cannot be reduced to delta-function when recorded with any technique but patch clamping, and may contain higher frequency components than suggested by the minimum interval between any two spikes, or prime neighbors‶echoes"to be deconvolved.
Therefore, it could be interesting to sample neural signals at a higher rate to explore whether any potentially relevant information has been ignored so far. Furthermore, EEG pulses are the resultant of several overlapped signals. It could help that the spatial relation between sources and sensors is in principle knowable and fixed once measured, thus opening to the possibility of implementing a deconvolution, in order to identify the individual signal sources, through the charge centroids images generated on the sensors. Higher space-time resolution sampling could offer room for new ways of thinking about neuronal communication. However, one of the essential challenges is to avoid spurious cross talk in the recording process itself; specifically, conventional electrodes are subject to unwanted inter-electrode cross-talk when electrodes are close together. Also, one would like to explore the limits of the field of action of a given sensing technology, to optimize its design according to the feasible positioning.

Methods
The expected S/N should be similar to the typical one for high resolution particle detectors, but the signal density is much higher on the much slower typical pulse time scale of 1 ms. All in all the problem can be faced by taking from high resolution particle detector experience, exasperating the pileup countermeasures and strategies.
The present project proposes to design and prototype an analogue programmable recording platform based on high-density micro-pattern readout system, with optimized resistivity of the contacts to avoid contact noise, and resistivity of the read-out system/cabling to avoid EM disturbances. This platform will allow programming and testing custom sampling modalities to investigate how to optimally treat and encode signals, to support electrophysiology research.

Summary

Primary author: Dr KJELDSEN, Henrik (Truust Imaging)

Co-authors: AIELLI, Giulio (Universita e INFN Roma Tor Vergata (IT)); MANCA, Marco (CERN); BAUER, Roman

Presenters: AIELLI, Giulio (Universita e INFN Roma Tor Vergata (IT)); Dr KJELDSEN, Henrik (Truust Imaging); MANCA, Marco (CERN); BAUER, Roman