Proceedings

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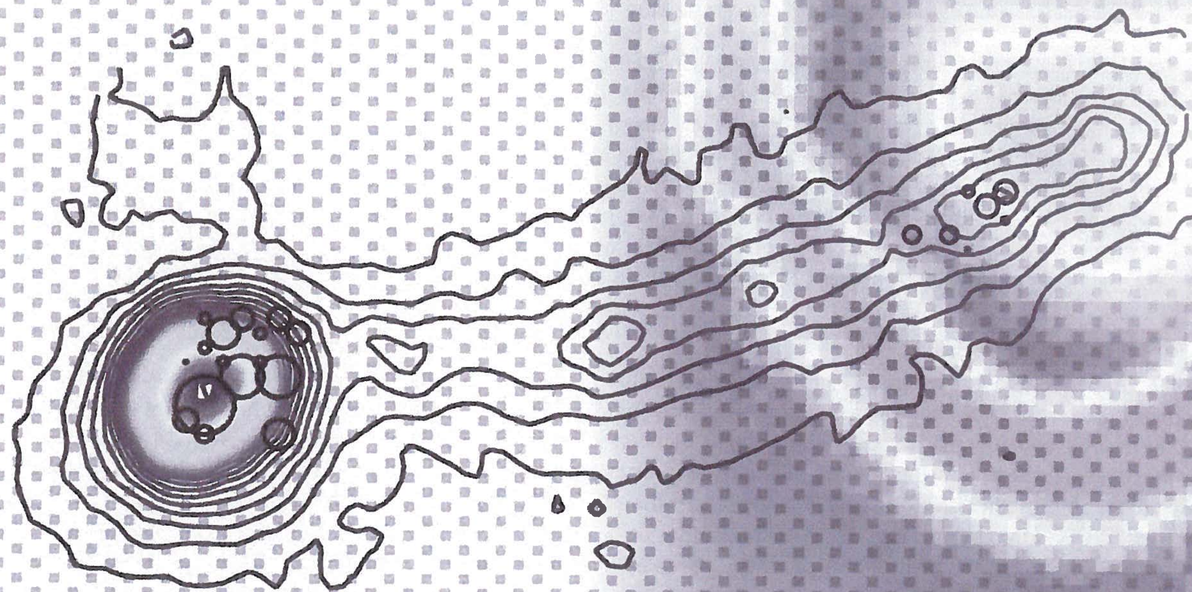

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Band 9

Investigation of Neuronal Activity Recorded with Multi-Electrode Arrays Using Principal Component Analysis

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Abstract

Analyzing neuronal activity recorded with Microelectrode Arrays (MEAs) can be a tricky task especially with a high amount of electrodes coupled with a high sampling rate. There are several methods to identify single neurites in the recorded data, each dependent on the scientific question. To investigate the influence of neurotrophins on the growth and activity of neurites we developed a specific MEA with an upper compartment where the electrical activity of neurites in microchannels is recorded. The unknown number of these neurites in the microchannels provides a huge challenge in data analysis. We developed an analyzing software using principal component analysis to detect the neuronal activity in each microchannel, to quantify the number of neurites per channel and to correlate the identified neurites. The developed software can be easily adapted to different MEA designs and several parameters can be adjusted to fit the requirements of the experiment. Using optical microscopy we further correlated the number of neurites in the channels with the analyzed data.

1 Introduction

In the last years MEAs emerged to a standardized method to record neuronal activity from in-vitro cultures. Nevertheless, many scientific questions require an individual design of the MEA. To investigate the influence of neurotrophins on the growth and activity of neurites individual MEAs were developed at the Institute of Solid State Electronics to separate neurites from their somata using artificial microchannels (Figure 1). Neuronal activity was recorded using microelectrodes below these microchannels. The identification of single neurites out of the recorded data in a single channel is a tricky task. There are several methods to identify neuronal activity in the recorded data e.g. threshold-, matched-filter-, or wavelet detection [1-3].

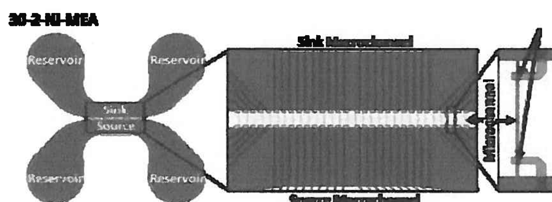

Fig. 1. Neurite Isolation-Multi Electrode Array microchannel/microelectrode setup

In order to identify single neurites we used principal component analysis (PCA) with clustering. Using MATLAB we developed a new analysis software called SpikeControl to detect the neuronal activity in each microchannel, quantify the number of neurites per channel and correlate the identified neurites with each other. We also correlated the analyzed data with optical investigations of the microchannels resulting in similar numbers of neurites.

2 Materials and Methods

Figure 2 shows the data flow of the recorded neuronal activity. Using the individual designed MEA electrical signals were recorded using the MEA1060 Amplifier and MC_Rack v4.5.3 software. The recorded data was then processed using our software SpikeControl (SC) with graphical user interface, developed in MATLAB. Because of the long analyzing time due to a high sampling rate and a high number of electrodes we divided SpikeControl in two parts (Figure 2).

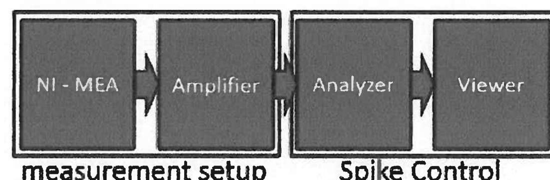

Fig.2. Data flow diagram of the developed SpikeControl software