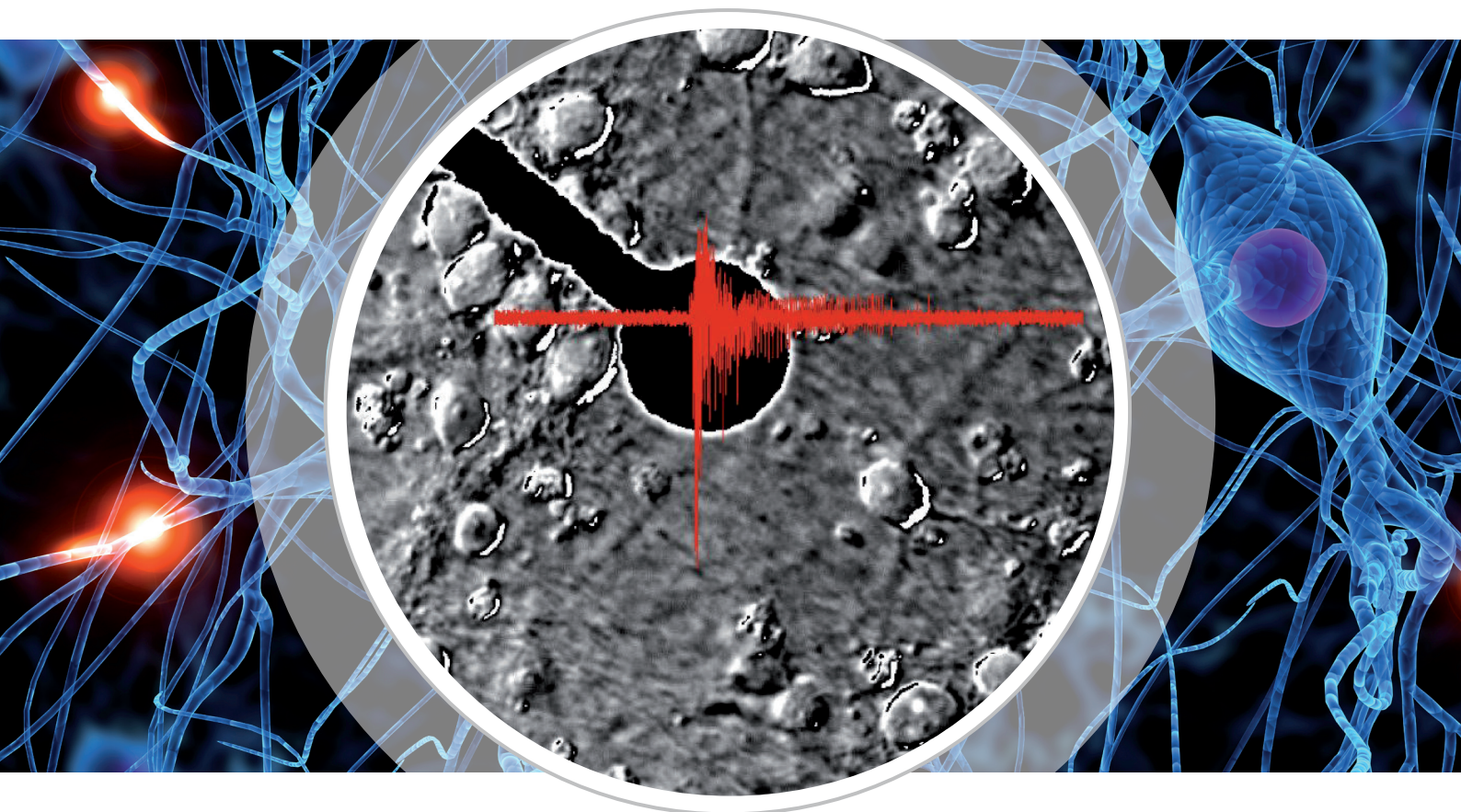


# *In vitro* Solutions for Extracellular Recording



- Recording from up to 4225 channels
- Real-time signal detection and feedback
- Microelectrode arrays with various layouts
- Suitable for a wide range of cell and tissue preparations
- Multiwell-solutions available



a division of Harvard Bioscience, Inc.

# Overview on Systems

## MEA-Systems for all applications

Multi Channel Systems offers various MEA-System configurations, each well adapted for your specific application. Whether you work with neuronal cultures or slices, whether you want high resolution or high throughput - we certainly have the right

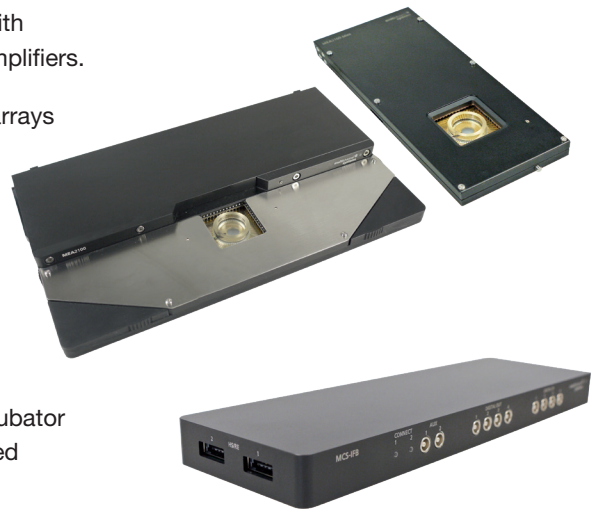
system for you. Please do not hesitate to contact our application specialists and experienced sales people, who will help you to find the system that suits your needs.

## MEA2100-Systems: The flexible solution

The MEA2100-Systems are a set of versatile *in vitro* recording systems with integrated stimulation, following the tradition of high-quality, low-noise amplifiers.

It is the complete setup for extracellular recordings from microelectrode arrays (MEAs), including everything you need for your experiment: Data acquisition computer with software, signal collector unit, interface board, MEA-headstage with integrated amplification and stimulation, MEAs, as well as temperature control and perfusion heating. We offer various versions of the system with the newest being the MEA2100-Mini.

The MEA2100-Mini headstage with its small footprint, low heat emission, and possibility for parallel operation of many headstages is ideal for continuous, undisturbed recordings and stimulation of samples in the incubator or on a microscope stage with environmental control. Due to its minimized design you can position the Mini-headstage on any inverted or upright microscope.

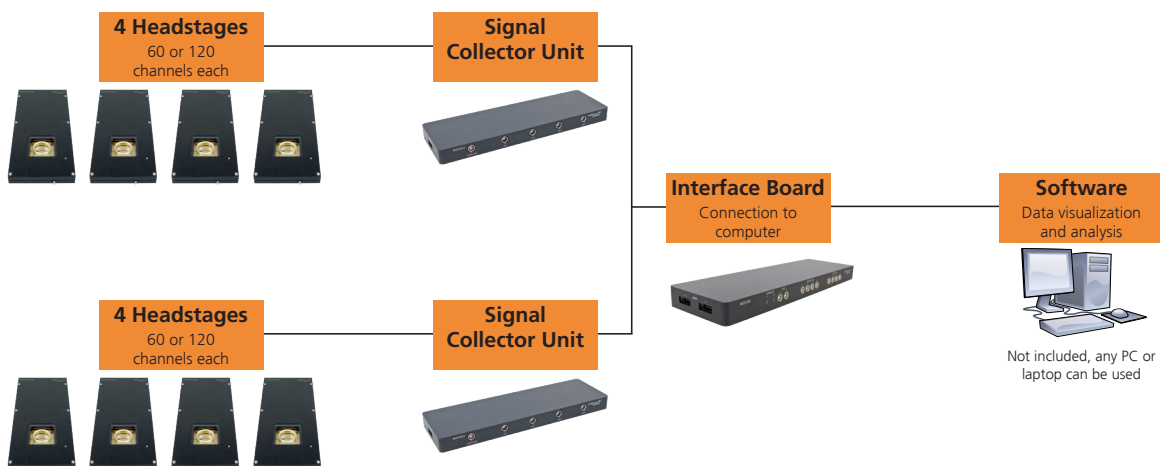


## Flexibility

The main advantage of the MEA2100-Mini-System is its flexibility. Beginning with a single headstage, the system can be upgraded step by step to a maximum of four headstages on a single Signal Collector or eight on two SCUs, connected to one Interface Board. The new Mini headstage features one variant for 60- and one for 120-electrode MEAs. Hence, the system allows for recording from up to 480/960 channels.

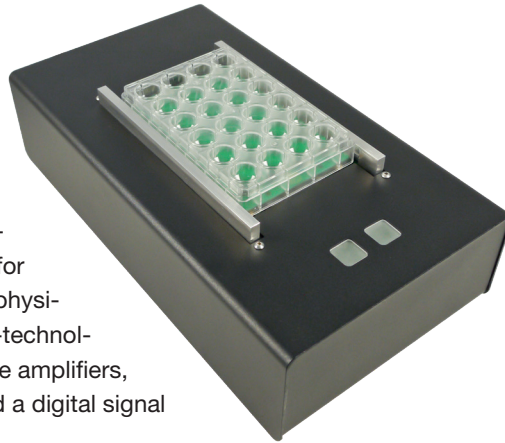
The headstages are controlled completely independently by starting the data acquisition software multiple times.

The MEA2100-legacy-system has variants for one 60-electrode MEA, one 120-electrode MEA, one 256-electrode MEA or two 60-electrode MEAs.



## Multiwell-MEA-System for higher throughput

Featuring 24- and 96-well plates with up to 1152 electrodes, the Multiwell-MEA-System is the perfect tool for medium and high throughput electrophysiology. Being based on the MEA2100-technology, it includes high-quality, low-noise amplifiers, freely-programmable stimulators, and a digital signal processor for individual analyses.



Integrated heating as well as a connection to CO<sub>2</sub> supply enable full climate control of the recording chamber.

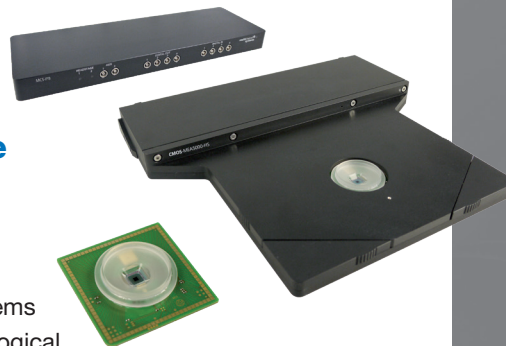
One big advantage of the Multiwell-MEA-System is the high sampling rate. Your data is sampled at up to 50 kHz per channel (simultaneously on all channels). Thus, the accuracy of your data is guaranteed, whether you record from cardiac or neuronal samples.

The shown headstage is connected to the same interface board as the MEA2100-Systems using USB 3.0, so you can establish your experiment on 60 or 120 electrodes, then purchase the Multiwell-headstage and start screening.

The Multiwell-MEA-System comes with the screening software package Multiwell-Screen. The program includes documentation, work flow control and automated analysis, like the calculation of dose-response curves.

## CMOS-Technology: Highest resolution with active arrays

Based on the complementary metal-oxide semiconductor technology, the CMOS-MEA5000-System from Multi Channel Systems opens up new possibilities in electrophysiological research.



With more than 4000 recording sites, each of them sampled at 25 kHz simultaneously, the chip allows extracellular recordings at a very high spatio-temporal resolution. By including amplification on the chip itself, noise is minimized and a high signal quality is guaranteed.

As stimulation sites are included in the chip and a stimulus generator in the headstage, the system is ideal for closed-loop experiments.

The CMOS-MEA5000-System is controlled and its data recorded by the software package CMOS-MEA-Control. The software gives an online, real-time activity overview on the complete chip. You can then define regions of interest and zoom into the areas where you see most activity. You can switch off areas to decrease file size as well.

The software also controls the integrated stimulator. You can freely define 3 independent stimulus patterns, using and adjusting the drag'n'drop modules.



## Interface board multiboot

The MCS-IFB 3.0 multiboot is a new generation of interface boards, which enables you to operate a wide range of MCS *in vitro* and *in vivo* headstages: MEA2100-HS, MEA2100-Mini-HS, MEA2100-Beta-Screen-HS, Multiwell-MEA-HS, CMOS-MEA-HS, W2100-RE, and ME2100-HS. This allows cost-effective combinations with only one interface board and multiple recording systems.



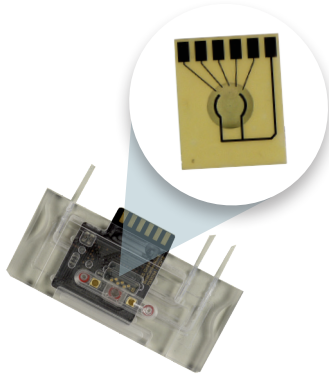
## Beta Cell Screening:

### Recording of glucose induced electrical activity in pancreatic beta cells

#### Acute recordings

##### MEA2100-Beta-Screen-System

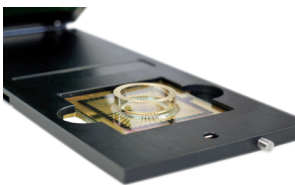
- Easy to use for electrophysiological recordings of up to 40 islets simultaneously
- Non-invasive and fast, medium throughput screening device
- Beta cell specific analysis software included
- Islets secured using suction
- Drug screening also possible with human beta cells



#### Chronic recordings with incubator-ready system

##### MEA2100-Mini-System

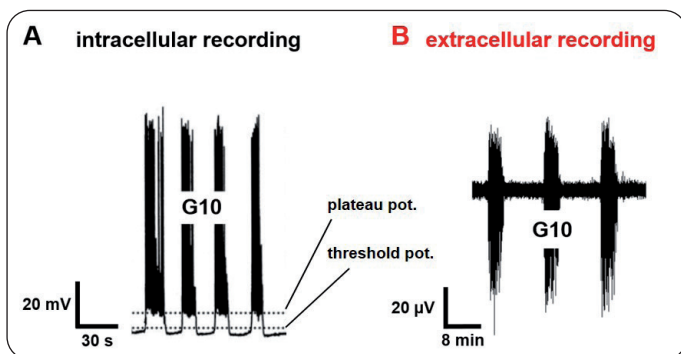
- Small footprint, low heat emission
- Possibility for parallel operation of many headstages
- Ideal solution for continuous, undisturbed recordings and stimulation of samples in the incubator or on a microscope stage with environmental control



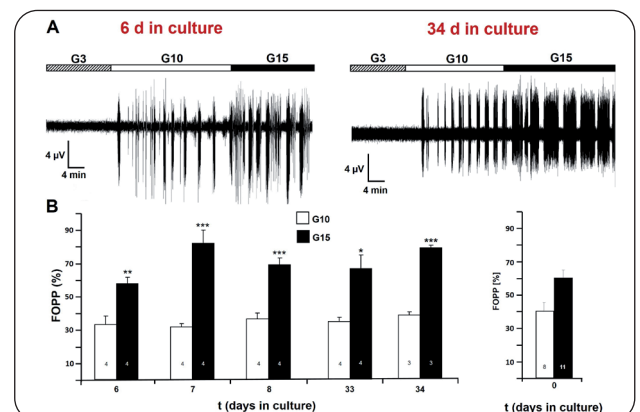
#### Scalability

The MEA2100-Beta-Screen headstage comes with a chamber for perforated miniature MEAs with 5 electrodes for a perfect positioning of the beta cell.

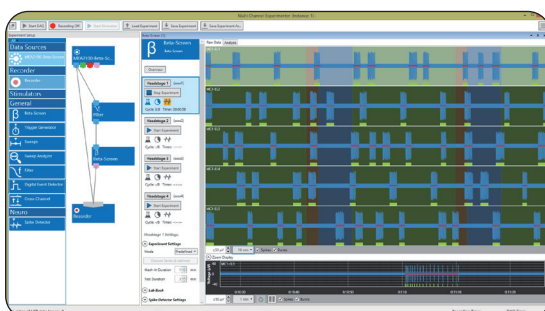
The flexibility of the MEA2100-Beta-Screen-System is similar to the MEA2100-Mini-System in the possibility to connect up to 4 headstages to one signal collector unit and two of the latter to one interface board. This way, it is possible to record from up to 40 islets at the same time.



Extracellular recordings with MEA technology are qualitatively comparable to intracellular measurements (Figure A taken from Drews et al., 2015)

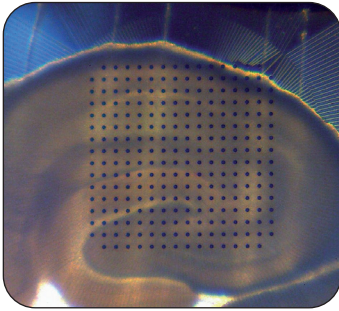


Long term electrophysiological experiments made possible by non-invasive in vitro MEA technology



#### Beta-Screen software

The Beta-Screen software is specifically designed for long-term and acute beta cell recordings. It is a specialized tool set for spike/burst (oscillation) analysis and dose response experiments on pancreatic beta cells in islets of Langerhans.



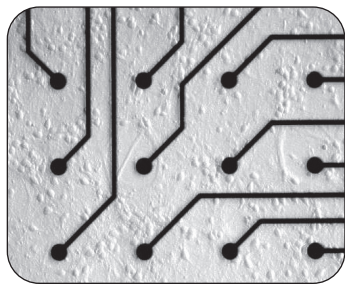
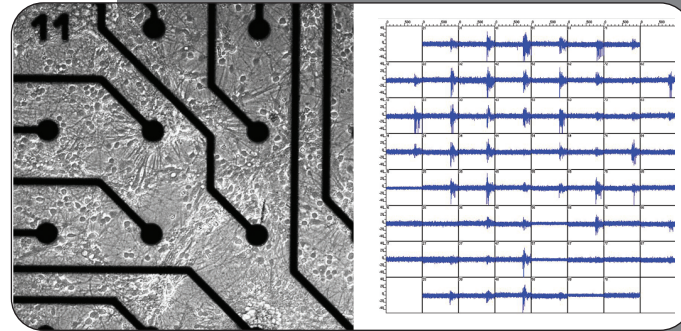
## Acute slices

Acute slice preparations can be placed on the MEA, and all electrodes can be used for simultaneous recording or stimulation. The large number of electrodes makes it possible to acquire information from all areas of your preparation simultaneously.

Our MEA-Systems with integrated blanking circuit technology allow to

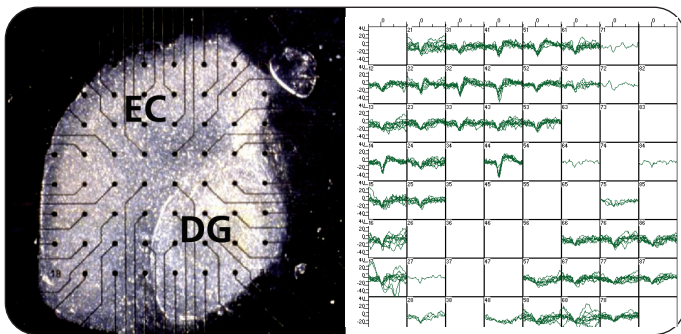
scan easily and quickly for the best stimulation site, as the stimulation electrode can be selected by software.

Perforated MEAs were specifically designed to optimize recording conditions and survival of acute tissue slices on MEAs, thereby allowing stable long-term recordings. pMEAs are also available in layouts adapted to the hippocampal formation.



## Stem cell derived neurons

Stem cells cultivated on MEAs have been successfully differentiated into neurons. MEA recordings provide a simple and quick functional assay to evaluate the electrophysiological and pharmacological properties of stem cell derived neurons, (without the need for specially trained personal.)



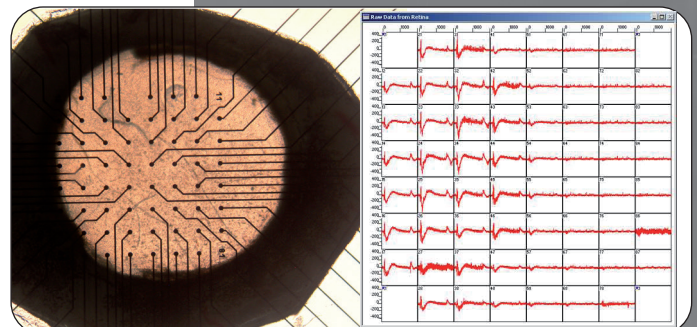
## Organotypic cultures

Organotypic cultures can be grown on filter membranes and then be recorded on MEAs the same way as acute tissue preparations. Alternatively, it is possible to grow the tissue cultures directly on the MEAs. This enables repeated recordings over an extended period of time, and makes it possible to follow long term processes like neuronal development or regeneration in one preparation.

## Retina preparations

Retina whole mount preparations can be recorded on the MEA. Special MEA layouts are available that are adapted to the architecture of the retina. It is possible to stimulate the tissue either with light or with electrical stimuli with the MEA electrodes.

Spikes and  $\mu$ ERGs can be recorded at the same time and the signal components can be separated by adjustable online filters.



## Neuronal cell cultures

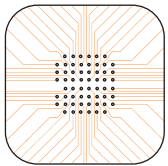
It is possible to grow primary neuronal cells or cell lines directly on the MEA surface, and record continuously or repeatedly over extended periods of time (up to several months). The high number of electrodes and the large recording surface ensures that the activity from a wide part of the network is detected, and not only from a single spot. Neuronal cultures on MEA are a well established system that is used in many labs around the world.

# Microelectrode Arrays

## Introduction

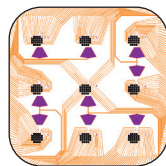
Your experiment starts with the microelectrode array, where your biological sample interfaces with the hardware. So choosing the right MEA for your specific application is crucial to the success of your experiment. Multi Channel Systems provides the widest variety of MEA layouts. Depending on the size of your cells, you might need smaller or larger electrodes and depending on your research question, you might need different electrode numbers or densities.

With our wide portfolio, we will definitely find the right MEA for your application. As we collaborate closely with the Natural and Medical Sciences Institute ([www.nmi.de](http://www.nmi.de)), where our MEAs are produced, it is also possible to create your own custom layout. Please contact us and we will be happy to help you find your MEA.



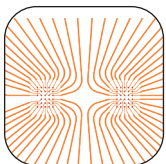
### Standard layouts

- 60 or 120 electrodes
- 8x8 or 6x10 grid (60 electrodes)/ 12 x 12 grid (120) large recording area + high density
- Available with 100, 200 or 500  $\mu\text{m}$  interelectrode distance, 10, 30 or 50  $\mu\text{m}$  electrode diameter



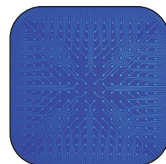
### Multi-well layouts

- 60 electrodes divided into 6 wells
- 256 electrodes divided into 9 wells
- Increased throughput
- Ideal for toxicology, neurobiology, stem cell research, and safety pharmacology



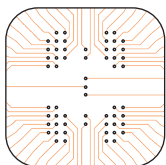
### High Dense layout

- 60 electrodes in two recording areas
- Interelectrode spacing of 30  $\mu\text{m}$ , electrode diameter of 10  $\mu\text{m}$
- High resolution recording of individual neurons in neuronal networks



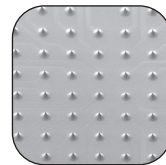
### MEAs with 256 electrodes

- 256 electrodes in a 16 by 16 grid
- Available with 30, 60, 100 or 200  $\mu\text{m}$  interelectrode distance, 8, 10 or 30  $\mu\text{m}$  electrode diameter
- Available with 6 or 9 wells or as ThinMEA



### Special layouts

- Wide range of special electrode layouts developed together with customers
- Custom layouts on request



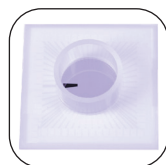
### 3D MEAs

- 60 electrodes
- 40 to 100  $\mu\text{m}$  electrode height for deep tissue penetration
- Ideal for recording from inner cell layers



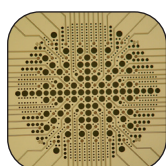
### Transparent MEAs

- 60 and 120 electrodes
- Transparent tracks and electrodes
- Image individual cells and cell populations directly on top of the transparent electrodes/tracks - inside the active amplifier and using high resolution objectives



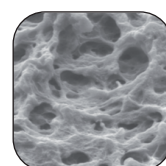
### ThinMEAs

- Recording area is as thin as a coverslip glass (180  $\mu\text{m}$ )
- Facilitates use of low working distance objectives with high magnification
- Available with 60 or 256 electrodes



### Perforated MEAs

- Electrodes on polyimide foil with perforations
- Ideal for acute slice recordings
- Available with 32, 60 or 120 electrodes



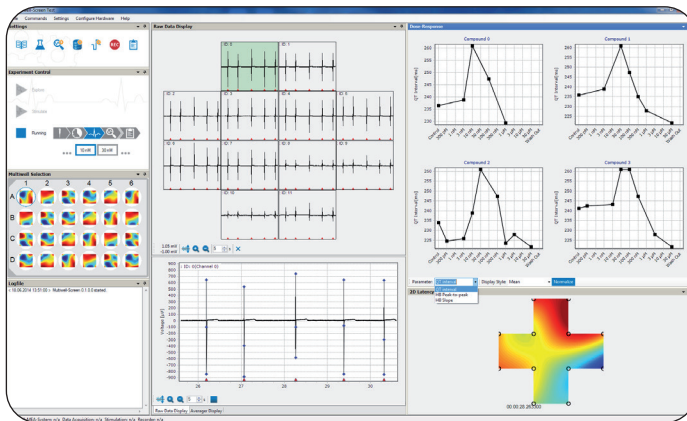
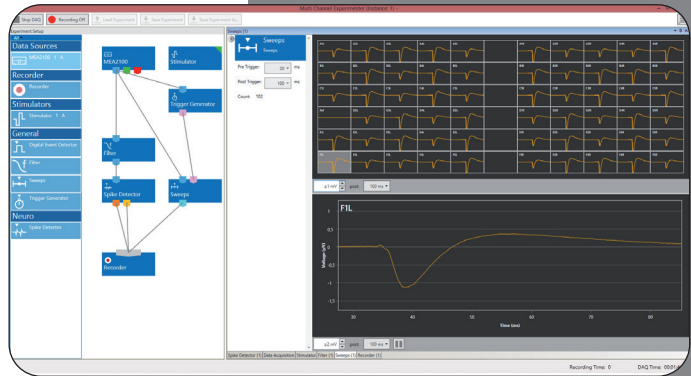
### Pedot-CNT-MEAs

- Electrodes with a composite of carbon nanotubes and PEDOT
- Reproducible low impedance
- High signal-to-noise ratio
- Ideal for stimulation



## Flexible and easy-to-use software

The data acquisition and analysis program Multi Channel Suite is highly adaptable with unlimited possibilities. With daily lab work in mind, the program is set up like an instrument rack on a workbench, allowing you to combine virtual instruments (e.g. recorder, filter, event detector, spike detector, stimulus generator or signal-triggered TTL pulse) in any way you want. The experimental set-up is very flexible and intuitive. All you have to do is choose the instruments by drag'n'drop and connect them, the way you want. Changes to the setup are always possible. Data is easily exported into HDF5 format, which is compatible with analysis tools like Matlab or Python. Or you can analyze the recorded data in the Multi Channel Analyzer. This tool also offers the import of video data, which can be connected to the recorded data by time stamps. The Multi Channel Suite is an easy-to-use, flexible, yet powerful tool for online and offline data analysis.



## Multiwell-Screen

For screening experiments with the Multiwell-MEA-System, we offer a separate software: Multiwell-Screen.

- Design of experimental setup, including compound applications
- Design of stimulation patterns
- Overview on the activity on the complete wellplate, but also on every single electrode
- Automated calculation of dose-response curves

## Real-time signal detection and feedback

All MEA2100-Systems for 60-, 120- or 256-electrode MEAs are equipped with this advantageous feature. The real-time signal detection/feedback is useful if you need fast and predictable reactions related to recorded analog signals without time delay.

Before, the signal had to be analyzed by the computer, which led to an unpredictable time delay of the stimulus of at least 100 ms. By moving the analysis from the PC to the DSP (Digital Signal Processor) integrated in the interface board of the MEA2100-System, the detour is obsolete and the time delay is now only around 1 ms. All you need to do is to define the condition for the feedback and download it to the MCS interface board (1). During recording (2), the DSP filters the data and detects spikes (3), checking whether your condition is fulfilled. When a designated event is detected, the stimulus generator (integrated in the MEA2100 headstage) generates the stimulus pulse (4).

Personal Computer/  
Laptop

Download settings  
before experiment



# Accessories

## Peristaltic perfusion system

We want to make sure that you get everything you need for your experiment, including peripheral devices like the peristaltic perfusion system, the perfect addition to all microelectrode array recording systems.

The peristaltic pump PPS2 has one inlet and one outlet pump. The main advantage of the PPS2 is its low pulsation. Its construction - including a brushless motor with constant rotation speed and low electromagnetic emission, and droplet isolation chambers - contributes to an overall low pulsation level. The flow rate of both pumps can be adjusted in the following ways:

- Software (included, connection via USB 2.0)
- Touch screen on the pump itself
- Additional analog input

The peristaltic perfusion pump is included with all MEA-Systems with perfusion cannula. In combination with the also included magnetic perfusion holders, you have all that is needed to start perfusion right away.



## Video Microscope Table

The video microscope table is the perfect addition to all microelectrode array recording systems.

The MEA-VMTC is a solid table with a video microscope underneath. It is intended to image the electrode field of a microelectrode array in a MEA2100-Mini-headstage placed on top of the table. Screw holes around the table allow the fixation of additional equipment. LED lights ensure perfect sample illumination.

The MEA-VMTC is equipped with a USB 3.0 camera featuring a 5 megapixel CMOS sensor with 2560x1920 resolution, ensuring precise images. The camera can be controlled via the included software MEA-Monitor.



## Precise control of suction

The CVP with pressure control is a constant vacuum pump with a precision pressure sensor and a waste bottle. It is the perfect addition to your MEA-System if you want to work with acute slices or retina using perforated MEAs.

The differential sensor measures the pressure in the compartment attached to the waste bottle, and compares it to the ambient pressure. The suction pump is then regulated to maintain the selected negative pressure in this compartment. Hence, with this unit, it is possible to precisely control the suction and to keep negative pressure stable.

You can establish and most importantly control the suction, so you get a better electrode-to-tissue contact without the need of a weight and your slice is kept in place. Moreover, your experiments are more reproducible as you can produce the exact same suction again.



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