

MEA\*

System

Extracellular Recording  
with Microelectrode Arrays



\* **Extracellular multisite recording**

- Easy to set up and operate
- Simultaneous recording from 60 electrodes in a single experiment greatly increases throughput
- Long-term studies of cell cultures or slices for several weeks or even months possible

\* **Compact and functional hardware**

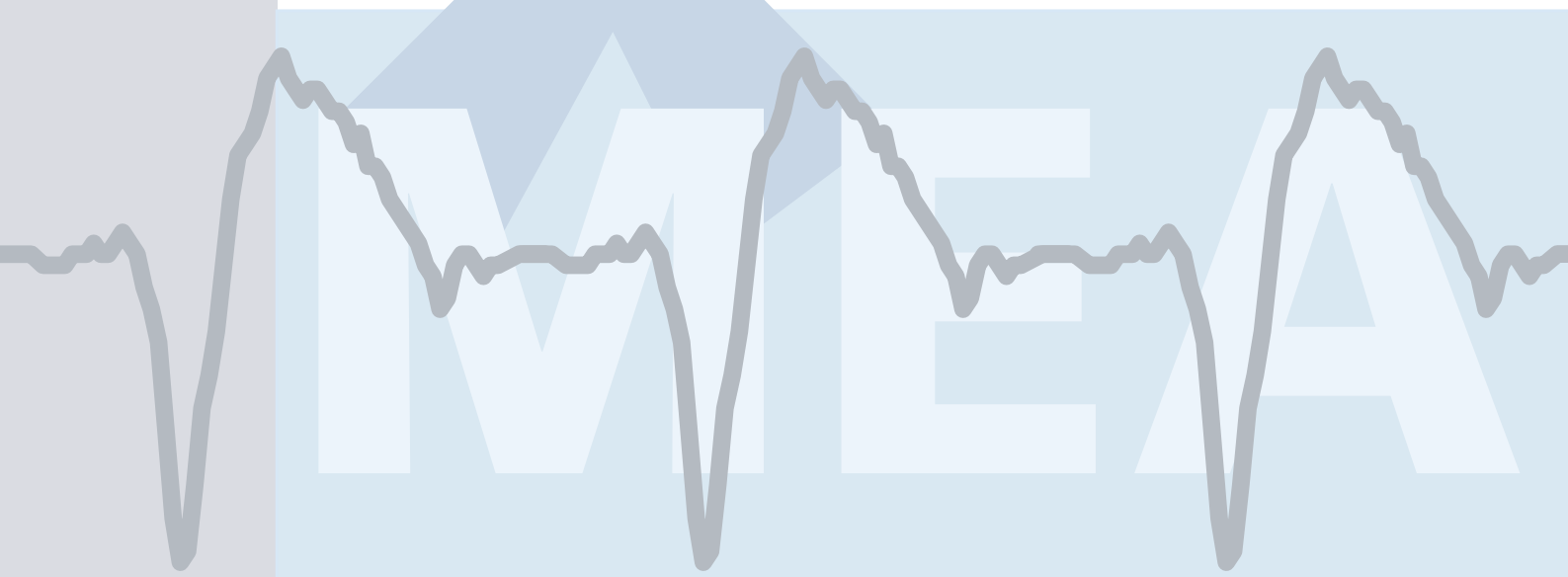
- Complete plug and play system with light-weight, compact, and functional components
- Combined MEA interface and amplifier – minimized noise
- Broad range of MEAs layouts available – optimized for different applications
- Modular system, can be easily upgraded and combined with various custom instruments
- System performance advances with computer performance and new technologies

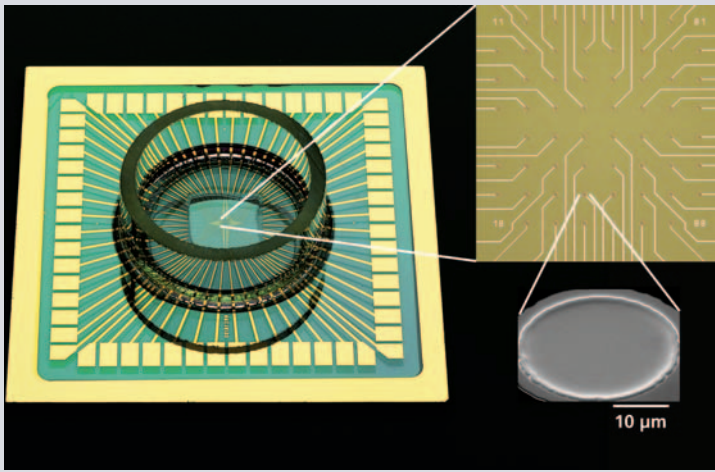
\* **Flexible software – for all applications**

- Flexible data stream management saves disk space
- Data file format compatible with many analysis tools such as Matlab, NeuroExplorer, Origin
- Event detector based on threshold or on waveform
- Digital filtering
- Multiple ways to display signals for the best presentation of data
- Free and unlimited software upgrades

\* **Most advanced technology on the market**

- Amplifier with new blanking technology for superior stimulus artifact suppression
- Stimulation and recording from any software selected electrodes
- Signal-triggered TTL pulses for online feedback studies
- MEA120 System for recording from **two** MEAs with a single data acquisition computer
- MEA Switch for recording with software-selected electrodes from up to **four** MEAs in parallel
- Proven technology, many satisfied customers
- World-wide distribution network; free, fast, friendly, and qualified support





### Extracellular recording with microelectrode arrays

A **microelectrode array (MEA)** is an arrangement of multiple (typically 60) electrodes that allows the simultaneous targeting of **several sites** for non-invasive **stimulation** and **extracellular recording *in vitro***.

Cell lines or tissue slices are placed directly on the MEA and can be cultivated for up to several months. Almost all excitable or spontaneously active cells and tissues can be used. For example, you can record signals from central or peripheral neurons, heart, retina, or muscle.

Recorded signals are amplified by a **filter amplifier** and sent to the **data acquisition computer**. You can record, graph, analyze, store, and export the data with the **MC\_Rack program**.

MCS was the first provider of a complete system for a simultaneous recording from 60 microelectrodes and has always set the benchmark in MEA technology.

### Signal amplification and filtering

Raw data from the MEA electrodes is amplified by 60 small filter amplifiers designed in SMD (Surface Mounted Devices) technology.

The compact MEA amplifier combines the **interface** to the MEA probe with the **signal filtering** and **amplification**. When the amplifier is closed, the contact pins in the lid of the amplifier are pressed onto the MEA contact pads. No cable connections between MEA and amplifier are necessary. This compact design greatly reduces the noise level.

Gain and bandwidth can be optimized for your application, or you can use a broadband amplifier and filter the raw data with the digital filter of the MC\_Rack program.

You can connect a stimulus generator to **any** number of electrodes and trigger the recording on the stimulation.

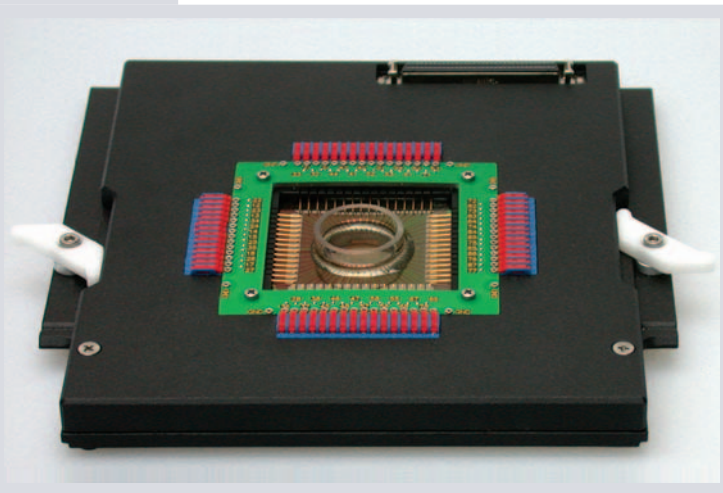
### Temperature control and data acquisition

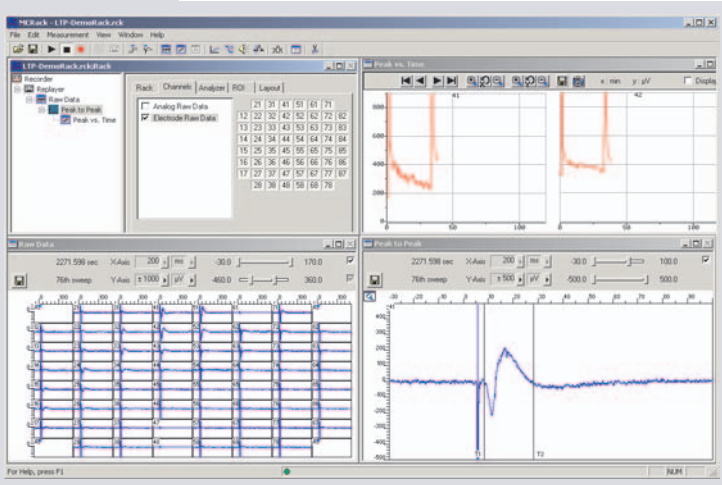
MEA amplifiers have an **integrated heating system** for controlling the MEA's temperature. The buffer temperature is adjusted by the perfusion cannula with heating element and sensor. The desired temperature can be easily set with the temperature controller.

The amplifier is connected by a single MCS High Grade cable to the data acquisition computer. Analog signals are converted into digital data streams at sampling rates of up to 50 kHz **per channel** (12.8 MB/s in total).

Recorded data can be graphed, analyzed, replayed, and exported with the powerful yet easy-to-use MC\_Rack program.

You can examine the specimen with a standard microscope (inverse or upright) during the experiment. The data traces can be aligned to an image of the tissue in the data display using the electrode pattern.





### Flexible and easy to use software

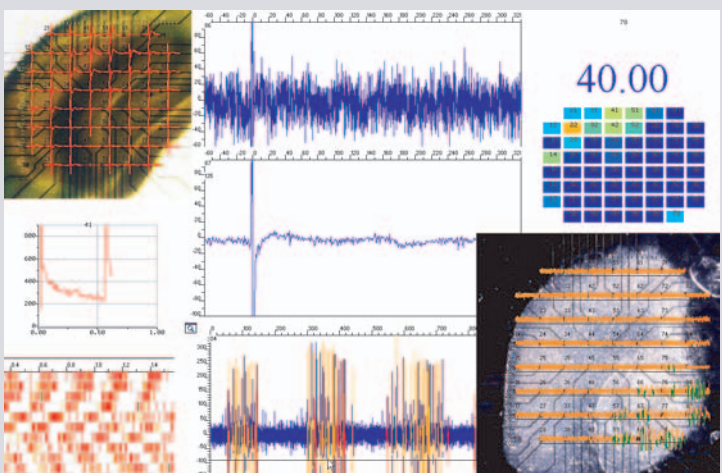
The data acquisition and analysis program MC\_Rack is not limited to standard applications. The software is highly adaptable with essentially **unlimited** possibilities.

The daily work in a lab in mind, the program is set up like an instrument rack on a workbench:

- \* Combine virtual instruments, for example an **oscilloscope**, a **filter**, an **event detector**, a **spike sorter**, a **sound output**, or a **signal-triggered TTL pulse**
- \* Virtual instrument rack: Use task-oriented template racks or design your own according to your application
- \* Select any permutation of data streams for displaying, analyzing, file saving, exporting, and much more
- \* Extract parameters like spike rates and field potential amplitudes in **online** or **offline analyses**
- \* **Average** data over time for signal enhancement

### Graphing data

- \* Select channels of interest and arrange them according to the geometry of the array or customize the layout
- \* Display all data types: analog **raw data**, **spike cutouts**, **event time stamps**, **filtered data**, extracted **parameters**, and **digital TTL pulses**
- \* Choose from several display types to find the best presentation of your data
- \* Display an image of the tissue as a **background picture** and align the traces to the electrode positions
- \* **Overlay** spike cutouts and plot time stamps of spike detection events in a  **raster plot** to visualize patterns
- \* Use a **false color** plot to identify different areas of activity on an MEA
- \* Plot extracted **parameters** such as i/o curves or amplitude vs. time

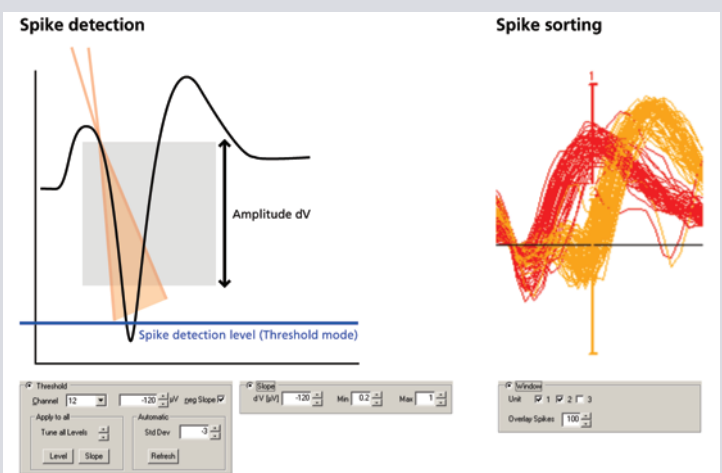


### Spike detection and sorting

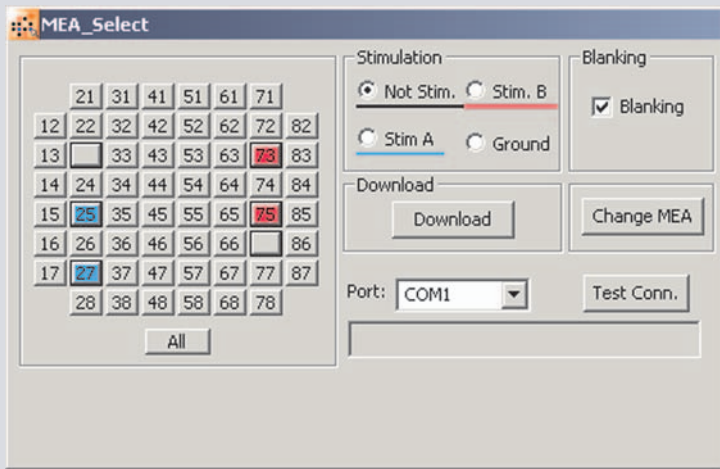
MC\_Rack detects neural spike activity based on a **threshold** or on the **waveform**. Spike detection parameters can be set up separately for each channel.

The picture on the left illustrates both methods:

- You can drag and drop the **threshold** (blue line in the picture) in the data display, or use thresholds that are statistically determined by the program.
- The **waveform method** analyzes the slope (illustrated in orange in the picture) and amplitude (shown in gray) of signals. Spikes are detected reliably in underlying local field potentials even with increased noise.



The picture on the right shows how spikes can be **sorted** into up to **three** groups per electrode. In overlay mode, single unit activities are easily discriminated. Simply drag the unit markers (see red and yellow bars in the image) with your mouse on spike cutouts to tag the corresponding signal streams as single units.



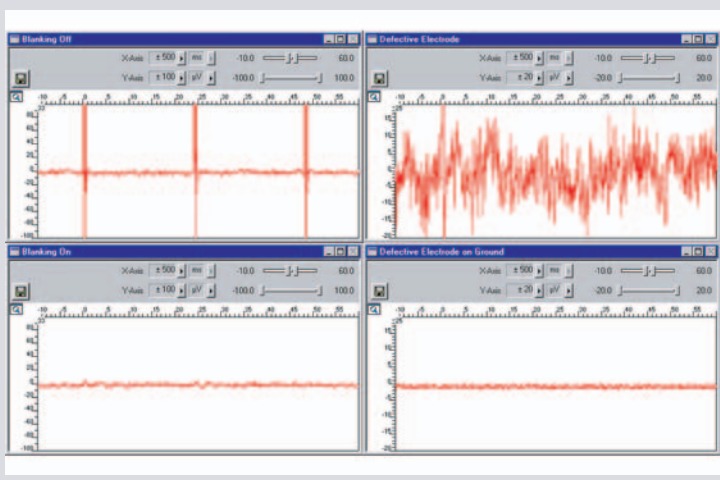
### Software-controlled amplification and stimulation

The amplifier control program MEA\_Select allows you to select any electrode on an MEA for stimulation and recording.

- \* Apply two different stimulus protocols to any subset of electrodes
- \* Easily change the electrode selection during the experiment, for example to use stimulating electrodes for recording and vice versa
- \* Ground unwanted electrodes by mouse-click

In the example, electrodes No. 23, 76 are grounded, the blue electrodes No. 25, 27 are selected for stimulation with protocol A, and the red electrodes No. 73, 75 are assigned to stimulation protocol B.

For advanced applications, it is possible to integrate the program controls (DLL) into your own software.



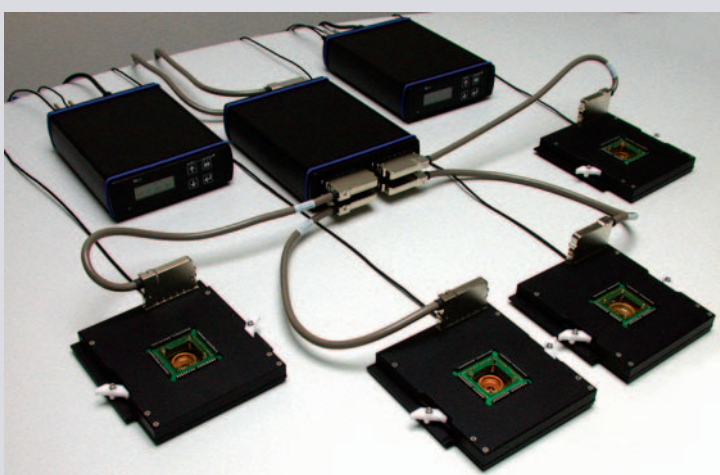
### Stimulus artifact suppression

A blanking signal (TTL pulse) transiently switches off the input stage of the amplifiers during the stimulus, thus avoiding the stimulus artifacts on recording electrodes. After the TTL pulse, the channel output follows the input signal again.

Amplifier saturation is effectively prevented and the recovery time is greatly reduced. It is also possible to record from stimulating electrodes shortly after stimulation.

The screen shots on the left demonstrate the effect of **artifact suppression**. You can clearly see the stimulus artifacts (without blanking) on the top left picture. The bottom left picture shows the same electrode and stimulation pattern **with** blanking.

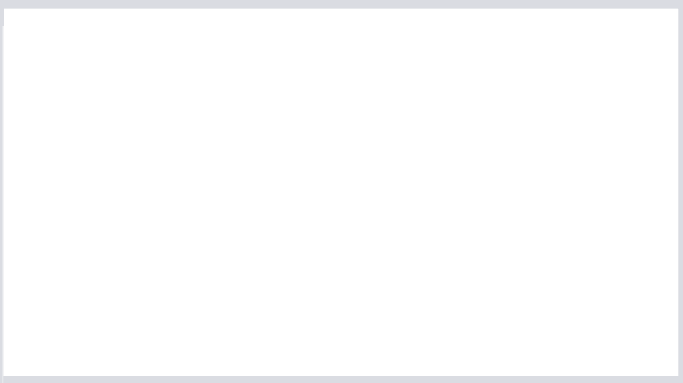
The right-hand pictures show the effective software-controlled **grounding** of a defective electrode.



### Advanced systems and add-ons

Various configurations of the MEA System and a broad range of add-ons for a variety of applications are available. You can easily upgrade the system with more amplifiers or accessories at need:

- \* **MEA120 System** for simultaneous recording from **two** MEAs with **120** electrodes in total
- \* Upgrade the MEA120 System with the **MEA Switch** and record from **four** MEAs simultaneously with a single data acquisition computer. In the picture, you see a set up with four amplifiers connected to a MEA Switch and two temperature controllers. Select up to 120 recording channels in the software from 240 electrodes in total.
- \* 1, 2, 4, or 8-channel **stimulus generators**
- \* **Perfusion** equipment and **temperature controllers**
- \* **Signal splitters** and **collectors**, **channel grounding units**, and various **adapters** for all applications

**Distributed by:**

**Multi Channel Systems  
MCS GmbH  
Aspenhastraße 21  
72770 Reutlingen  
Germany  
Fon +49-7121-90 92 5- 0  
Fax +49-7121-90 92 5-11  
info@multichannelsystems.com  
www.multichannelsystems.com**

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MEA Systems are complete with everything you need to start right away:

- Microelectrode array dimensions and layouts of your choice
- Compact MEA interface and filter amplifier with custom gain (from 100 to 5000) and bandwidth (from 0.1 Hz – to 10 kHz)
- Software-selectable recording and stimulating electrodes (typical switch enable time: 20 ns)
- Preinstalled data acquisition computer with TFT monitor
- 50 kHz sampling rate per channel, 12.8 MB/s total conversion rate
- Software-selected input range from +/- 400 mV to +/- 4 V
- Additional digital in- /output and 3 analog inputs for synchronizing other instruments with the recording, and for recording additional information in parallel to the extracellular recording, for example signals from other amplifiers such as patch clamp amplifiers
- Easy to use MC\_Rack program for displaying and recording data, with online and offline analysis tools
- Temperature controller for heating the MEA and the perfusion cannula
- More equipment available on request, for example for stimulation

