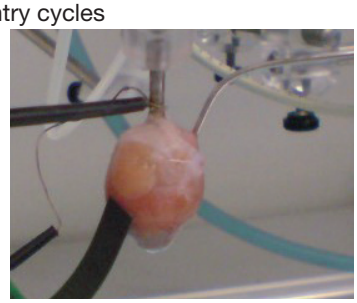
Epicardial Mapping

Cardiac Surface Mapping - Application Card

Introduction

The purpose of research using epicardial mapping is to:

- Understand how arrhythmias are generated
- Develop new drugs to cure arrhythmia
- Map the patterns of excitation spreading
- Indicate delays and conduction velocity
- Detect reentry cycles



Langendorff Heart in IH-SR-Set-up by Hugo Sachs Elektronik, a flexible MEA from MCS records from the ventricle

Species & Preparations

The two dimensional mapping can be performed at cell, tissue and organ preparations:

- Langendorff hearts
  - Rat
  - Mouse
  - Guinea Pig
  - Rabbit
- In vivo (open chest) recordings
  - all on the left plus
  - Pig
  - Sheep
  - Goat

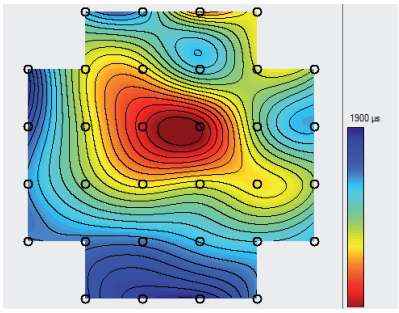
Application & Research Fields

The key research field here is arrhythmia research, including supraventricular and ventricular tachy-arrhythmia and their generation.

However, drug testing, cardiac tissue engineering, and testing of artificial pacemakers also benefit from this experimental concepts. A second approach focuses on predicting how stem cell derived cardiomyocytes do integrate in the environment of primary cardiomyocytes or even native cardiac tissue.

Data Analysis and Software

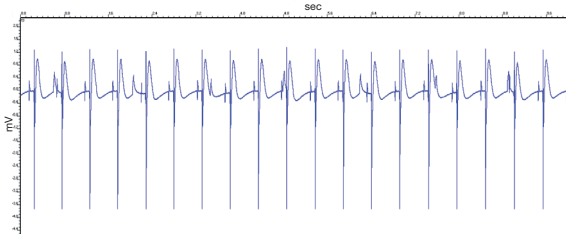
Data analysis is an integral part of the experiment. Cardio2D is the ideal tool for cardiac electrophysiology. With only a few clicks, Cardio2D extracts the most important parameter and makes attractive pictures suitable for publication or videos of signal propagation.



High resolution mapping of electrical signal propagation of the sino-atrial note area of a isolated murine heart.

Parameters Extracted

- Data traces for field potential, monophasic action potential or ECG
- Delay between electrodes
- Conduction velocity
- Color coded maps of local activation time
- Visualization of voltage distribution as false color map
- Movies of latency maps and voltage maps to detect switching between pacemaker
- Excitation patterns and pathways
- Heart rate, Peak-Peak amplitude, Field potential duration
- Slope of depolarization component
- Optional test setups for drug modulated changes in the parameters listed above
- Optional: Stimulation / Pacing



Recording from a isolated electrode of the FlexMEA32 in a open chest in vivo recording of a murine heart.

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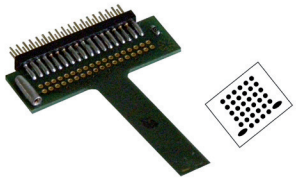
Application Card: Epicardial Mapping - Cardiac Surface Mapping

Suggested Instrumentation

Electrodes / Arrays

The sensing elements (the actual probes) are interfacing directly with the contractile tissue - in an isolated heart or in an open chest in vivo situation. Here, we suggest flexible arrays of microelectrodes which can be attached directly to the surface of the heart. The material, size, and number of the electrodes depend on species and intention of the experiment. Below, a 32 electrode FlexMEA is pictured. From 32 up to 256 electrodes many different configurations are possible. A customized design to meet specific needs is possible as well.



Flexible MEA with 32 recording electrodes (EcoFlexMEA36)

Positioning of the Electrodes

The accurate and stable positioning of the electrode arrray on the Langendorff heart is essential. The Holding and Positioning Unit (HPU) is an easy way to flexibly place the electrode.

Amplification

For an optimal signal extraction, we suggest using a headstage amplifier with integrated amplifier, stimulator, and A/D converter. The 24bit ADC conversion provides highest dynamic amplification range. These headstages minimize noise and allow very stable recordings, while every electrode is selectable for stimulation.

Range of headstages with various channel counts and connectors

Data Acquisition

High-end data acquisition systems collect the data from up to 8 headstages. High channel counts (up to 256) and flexible set-ups make these devices the best DAQs for this application. The interface board (in the back of the picture below) can be used for a variety of applications, e.g. also for in vitro MEA recordings.

Complete ME2100-System with 32-channel headstage, signal collector, and interface board (from front to back)

Summary

The ME2100-System together with flexible MEAs are the optimal components to receive a high resolution epicardial mapping. These systems are designed to work with small rodent isolated hearts and perfectly match the Langendorff products from Hugo Sachs Elektronik. Both companies are integrated under the roof of Harvard Bioscience and the products complement each other perfectly.

References

Zhang, Y., Guzadhur, L., et al. (2014). “Arrhythmic substrate, slowed propagation and increased dispersion in conduction direction in the right ventricular outflow tract of murine Scn5a+/- hearts.” Acta Physiol (Oxf) 211(4): 559-73.

Jungen, C., Scherschel, K., et al. (2018). “Impact of Intracardiac Neurons on Cardiac Electrophysiology and Arrhythmogenesis in an Ex Vivo Langendorff System.” J. Vis. Exp. (135), e57617, https://www.jove.com/video/57617/impact-intracardiac-neurons-on-cardiac-electrophysiology

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