

## Bernstein Conference Satellite Workshop 8

# *In Vitro* Neuronal Networks from 2D to 3D

September 14, 2015, 9:00 – 18:30

### Organized by

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### Venue

Ruprecht-Karls-Universität Heidelberg, Neue Universität  
Universitätsplatz, Grabengasse 3-5, 69117 Heidelberg, Germany

### More Information and Registration

<http://www.bernstein-conference.de/>

### Workshop Abstract

Our view is that the biological and computational components and the concepts of realized BIO-ICT interactions have lacked so far the complexity of the actual high level biological neural systems. There are three key features that are needed for biological computational neuronal networks: 1. 3D structures of neuronal cells and networks, 2. interactions between various types of neuronal cells, and finally, structured and patterned 2D and 3D structures of neuronal networks.

The goal of the workshop is to provide insight into novel technologies and recent research results regarding *in vitro* neuronal networks. We aim to present the very latest of the developments in the 3D electrophysiological microelectrode array measurement technology, 3D cell culture technology, and astrocytic neuronal networks, along with the associated electrophysiological signal analysis and network modeling methods.

The content of the workshop is built heavily on the final outcomes of the EU FP7 FET project 3DNeuroN – Biomimicking the brain – towards 3D neuronal network dynamics (<http://www.3dneuron.eu/>). In this project, we have constructed *in silico* and *in vitro* models of 2D and 3D neuronal networks with biomaterials and multi-cell-type neuronal structures derived, e.g., from human stem cells. Also novel 2D and 3D electrode arrays were developed to study neuronal networks and their responses in different network topologies and dynamics. Thus the work is based on cellular, biointerface, bioelectronics, and ICT technology. Novel stem cell and biomimetic technologies provide us a way to grow different human neuronal cell types for 3D neuronal networks. Novel biomaterials, microelectronics, and *in silico* modeling has provided insight into functional dynamics of the constructs.

The beginning of the era of brain-like 3D *in vitro* cultures is now here. In the near future, we expect to see a transition from traditional 2D cultures to 3D cultures, and understand the roles of astrocytes in neuronal networks, which will enable us to study our brains in a more natural setting and provide enhanced possibilities for creating neuronal system spare parts for humans, as well as for drug development and toxicology models. For this we now need to create and perfect the 3D measurement technologies and cell culturing methods. Our *in vitro* and *in silico* technologies provide a starting point to study the organization and functioning of the 3D neuronal networks, and a basis to develop clinical applications.

The 3DNeuroN project has received funding from the European Union's Seventh Framework Programme, Future and Emerging Technologies, grant agreement n°296590.

## P R O G R A M

### Welcome and Introduction

9:00 – 9:30 *Welcome & Introduction to 3D in Vitro Technologies – Case: 3DNeuron*  
Jari Hyttinen, Tampere University of Technology

### Session 1: 3D and Controlled Culturing of Neuronal Networks

9:30 – 10:00 *3D Neural Networks in Engineered Hydrogel Matrices*  
Nicolas Broguiere, Swiss Federal Institute of Technology Zurich

10:00 – 10:45 *Forming Neuron Networks with Controlled Topology in 2D and 3D*  
Janos Vörös, Swiss Federal Institute of Technology Zurich

10:45 – 11:00 **Coffee Break**

### Session 2: Neuronal-astrocytic Networks and their Modeling

11:00 – 11:45 *Role of Astrocytes in Formation of Functional Neuronal Networks in Vitro*  
Susanna Narkilahti, University of Tampere

11:45 – 12:15 *Computational Modeling of Neuronal-astrocytic Networks*  
Kerstin Lenk, Tampere University of Technology

12:15 – 14:00 **Lunch Break**

### Session 3: Technology

14:00 – 14:35 *Signal Acquisition and Measurement System for Neural Networks in Vitro*  
Peter Husar, Ilmenau University of Technology

14:35 – 15:10 *Technology and Material Developments for 3D Multielectrode Arrays*  
Heike Bartsch, Ilmenau University of Technology

15:10 – 15:45 *Microbioreactor Designs with Integrated 3D MEA Devices for Cultivation of Neuronal Cells*  
Andreas Schober, Ilmenau University of Technology

15:45 – 16:15 **Coffee Break**

### Session 4: Stimulation, Analysis, and 3D Network Modeling

16:15 – 16:50 *Investigation of Cultured Neuronal Networks and their Dynamics Induced by Novel Stimulation Paradigms*  
Peter Husar, Fraunhofer IDMT

16:50 – 17:25 *Signal Analysis Methods for Neuronal Microelectrode Array Data*  
Jarno Tanskanen, Tampere University of Technology

17:25 – 18:00 *Computational Modeling from 2D to 3D Networks*  
Kerstin Lenk, Tampere University of Technology

18:00 – 18:30 **Panel Discussion: From 2D to 3D**

18:30 *Closing of the Workshop*  
Jari Hyttinen, Tampere University of Technology