

Committee for Aid and Education in Neurochemistry

CAEN

Scientific Report of the CAEN Workshop on Physics and Biology: Heading Towards Quantitative Neuroscience

II RCN- Second Joint Meeting of the Argentine Society for Neuroscience (SAN) and the Argentine Workshop in Neurociences (TAN) Casa Serrana OSPEC, Huerta Grande, Córdoba, Argentina. October 6-10, 2010

The CAEN-supported Workshop was held as part of the Second Joint Meeting in Neurosciences, or II RCN by its acronym in Spanish. For the second time in our country two long-standing active groups in neuroscience, who historically held separate annual meetings, met in a single event which brought together most local neuroscientists. The II RCN and associated workshop are the most important annual events in the Neuroscience as well as Neurochemistry research fields in Argentina. Attendance to the meeting included 320 scientists, mostly from Argentina but also from Australia, Brasil, Chile, the United States of America, France, Germany, the Netherlands and the United Kingdom. Participants to the workshop and meeting included undergraduate students interested in entering a Ph.D. program, Ph.D. and postdoctoral fellows, as well as young PI and senior scientists.

The CAEN-supported workshop preceding the meeting on the "**Interactions between Physics and Neuroscience**" consisted in a 2-day intensive course of high quality lectures instructed by highly expert international scientist. The workshop was devoted to the presentation and discussion of physic's concepts and tools that have had an enormous influence in the last decades on Neuroscience. In particular, the workshop emphasized neuronal modeling at different scales, as well as the use of different technologies that have revolutionized the Neuroscience field.

These lectures provided the ideal setting to share basic aspects of model systems and a thorough description of the novel techniques, allowing for a very direct interaction between the experts (6) and the students (roughly 120).

Workshop Program included the following activities:

On October 6th

10.00 Introductory lecture: Physics and Biology: heading towards quantitative neuroscience (Prof. Manuel Eguía).

10.30 Pascal Martin, Institut Curie recherche, Paris, France. I:

"The psycho physical properties of hearing. Mechanical vibrations in the ear."

12.00 Pascal Martin II: *"Mechano-electrical transduction by the inner ear's receptor cells, the hair cells"*

13.30 Lunch.

14:30 Pascal Martin III: *"Somatic electromotility by mammalian outer hair cells The "critical" cochlea: active oscillators as amplifying elements in hearing"*.
16:00 Laurent Bourdieu, Institut de Biologie de l'École Normale Supérieure, Paris, France. I: *"Sensory coding in the whisker to barrel pathway"*.
17:30 Coffee break.
18:00 Laurent Bourdieu II: *"Recent optical developments in neuron network imaging"*.
19:30 Laurent Bourdieu III: *"Late maturation of the direction selectivity map in the rat barrel cortex"*.
22:00 Round Table: new perspectives in neuroscience.

On October 7th

8.30 Breakfast with speakers.
10:00 Dario Ringach, Jules Stein Eye Institute, David Geffen School of Medicine, University of California, Los Angeles, USA. I: *"Receptive fields and maps in early visual cortex: basic concepts"*
11:30 Dario Ringach II: *"Receptive fields and maps in early visual cortex: open questions"*
13.00 Lunch.
14:00 Dario Ringach III: *"Receptive fields and maps in early visual cortex: a statistical wiring model of primary visual cortex"*
15:30 Rodrigo Quian Quiroga, Department of Engineering, University of Leicester, United Kingdom. I: *" Processing of extracellular recordings: spike sorting"*
17:00 Coffee break.
17:30 Rodrigo Quian Quiroga II: *" Extracting information from neural populations: Basic principles and clinical applications "*
19:00 Matias Ison, Department of Engineering, University of Leicester, United Kingdom. *"A possible mechanism for generating sparse responses in the human medial temporal lobe"*
22:00 Closing round table: Bridging scales in neuroscience.

The first day kicked off with an introductory lecture by Dr. Manuel Eguía (Professor of the Universidad Nacional de Quilmes, Argentina, CONICET) one of the workshop organizers, who took 30 minutes to give a broad overview of the topic, introduced each of the speakers and acknowledged the support received from CAEN.

Then, three lectures of Dr. Pascal Martin dealt with the active mechano-sensation by hair cells of the auditory system. He explained the psychophysical properties of hearing: threshold, frequency selectivity, dynamical range, distortion products. Mechanical vibrations in the ear: middle ear mechanics, the cochlea as an "acoustic prism", the cochlear amplifier. Mechano-electrical transduction by the inner ear's receptor cells, the hair cells: the hair bundle as a mechanosensory antenna, the "gating-spring model" of mechano-electrical transduction, adaptation to saturating stimuli. Mechano-electrical transduction by the inner ear's receptor cells, the hair cells: nonlinear hair-bundle mechanics (negative stiffness), active hair-bundle motility (spontaneous oscillations), the hair-bundle amplifier, and somatic electromotility. Active oscillators in the cochlea as amplifying elements in hearing.

In the afternoon, Dr. Laurent Bordieu discussed with students three lectures on sensory coding in the rodent whisker system for studying the neurobiology of tactile sensation at scales ranging from molecules to neuron networks and behaviour. Dr. Bordieu described experiments which addressed

the detection of surface textures and showed experiments using recently designed multi-whisker stimulators. Dr. Laurent Bordieu second class dealt with optical developments in neuron network imaging by using two-photon fluorescence microscopy (TPFM), which is a powerful tool for imaging deep inside living tissues with sub-cellular resolution. He reviewed the principle of TPFM and some of its major applications in neuroscience. His third lecture explained late maturation of the direction selectivity map in the rat barrel cortex. He explained how to use *in vivo* two photon imaging of anaesthetized rats during single multi-directional stimulations.

On the second day, students have breakfast with the workshop speakers in an informal environment.

During the morning and early afternoon, Dr. Dario Ringach lectured on receptive fields and maps in early visual cortex. He reviewed basic concepts of receptive fields in early visual cortex, including spatio temporal linearity, thresholding and gain control. He discussed spatio-temporal inseparability and its role in direction selectivity and basic organization of neuronal properties in cortical maps and methods for their measurement. During his second lecture, Dr. Ringach discussed with the students open questions about receptive fields and maps in visual cortex such as: What is the role of cortical maps in visual processing? How is the visual cortex wired during development? How do V1 population code visual information? In his third section, he explained a statistical wiring model of primary visual cortex. He discussed an ongoing debate of some of the issues with regards to functional maps in early visual cortex and offered a statistical view of cortical wiring that appears to account for a wide range of experimental data.

At the late afternoon, Dr. Rodrigo Quian Quiroga lectured the students about Processing of extracellular recordings: spike sorting. He explained "Wave_clus", a spike sorting method developed in his lab. The method consisted in detecting spikes at an automatic amplitude threshold, extracting relevant features of the spike shapes using the wavelet transform, features are clustered using superparamagnetic clustering from statistical mechanics. He showed its importance for the analysis of real single cell recordings from the human medial temporal lobe.

During his second lecture Dr. Quian Quiroga explained how to extract information from neural populations: Basic principles and clinical applications. He discussed how two related approaches – decoding and information theory – can be used to extract single-trial information from the activity of neural populations. He also described potential clinical applications.

Finally, Dr. Matias Ison, explained a possible mechanism for generating sparse responses in the human medial temporal lobe. He showed that pyramidal cells recorded *in vivo* from the human medial temporal lobe are more selective than interneurons and presented evidence showing that

hippocampal pyramidal cells exhibit the highest degree of selectivity within the MTL, reflecting the hierarchical processing of visual information.

The workshop ended late at night with a round table about bridging scales in neurosciences.

In summary, the CAEN-supported workshop spanned the work of 5 highly active, top researchers in the field that explore and develop interactions between Physics and Neuroscience using different perspectives and methodologies to understand how the nervous system works. The workshop built knowledge from molecules to neural networks and the whole brain functional level. The speakers provided background and the newest information relevant to their fields as well as advanced methodological and analysis tools issued from the physics. Furthermore, they explained how we can use quantitative approaches to study unresolved questions in neurobiology.

According to the workshop style talks were informal, interrupted frequently by students' questions, which were actively encouraged to participate.

Each talk was followed by ample time for questions. After the end of each section, speakers were lead to lunch with groups of graduate students and postdoctoral fellows interested in discussing the topic further. Since almost all the speakers and students stayed also throughout the meeting the chances for interaction were granted.

On behalf of the Organizing Committee of the Second Joint Neuroscience Meeting as well as the Organizing Committee of the Workshop, I would like to express our gratitude for the extended support provided by CAEN, which allowed us to invite such excellent speakers.

Financial Report Funds provided by CAEN were spent as follows:

STUDENTS that assisted to the CAEN-Workshop on Physics and Biology: Heading Towards Quantitative Neuroscience (II RCN)	ACCOMMODATION in Casa Serrana Hotel 3 DAILY MEALS COFFE BREAKS
TOTAL	(USD) 6000 approximately 23,500 Argentinean pesos (see attached document)

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