Roscoff (France), 11-15 juin 2014

Imagerie (photonique) multi-échelle de la structure et de la fonction du cerveau

Optical imaging of brain structure and function on multiple special scales

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Rapport sur la conférence

Conference report

RESUMÉ DU RAPPORT

La Conférence Jacques Monod "Imagerie (photonique) multi-échelle de la structure et de la fonction du cerveau" s'est tenue à Roscoff du 11 au 15 juin 2014, sous la présidence du Prof Angus Silver (UCL, Londres) (vice-président, Christophe Mulle, DR CNRS, Bordeaux).
Cette conférence internationale a rassemblé des experts mondialement reconnus de France, de différents pays d'Europe, des Etats-Unis et du Japon. Ils ont présenté les tous derniers développements technologiques et les découvertes sur l'analyse des synapses et des réseaux de neurones pour une meilleure compréhesion du fonctionnement du cerveau. La force de cette conférence est de mettre en relation étroite des neurobiologistes et des chercheurs actifs dans le développement de nouvelles technologies. L'analyse de la fonction du cerveau dépend étroitement des progrès en imagerie cellulaire sur le plan des sondes et des dispositifs instrumentaux, en techniques microscopiques super-résolutives, et de l'utilisation d'outils optogénétiques. Cette multidisciplinarité, qui fait la force et l'orginalité de cette conférence, a été unanimement appréciée par les participants, dont un nombre important de thésards et post-doctorants (70). Les organisateurs ont donné la possibilité à certains jeunes chercheurs (6) de présenter oralement leur travail.
Les discussions ont été très riches durant les conférences et au cours des sessions de communications affichées et des multiples possibilités d'échanges informels. Jusqu'à la toute fin de la Conférence, l'auditoire était quasiment au maximum de la capacité.
Malgré les difficultés liées aux grèves de train et de taxi, la qualité de l'organisation locale (Nathalie Babic) et du soutien technique a été excellente.

Report on the conference

1. Meeting overview

The conference "***Optical imaging of brain structure and function on multiple spatial scales***" took place in Roscoff from June 11th to June 15th, 2014. This international symposium brought together world experts to present their latest discoveries and technological developments on connectomics, imaging and optogenetic methods for studying synaptic, neuronal and network structure and function. This enabled scientific exchange between neurobiologists specialized in the molecular, cellular and physiological mechanisms of synaptic transmission and integration, in network structure and information processing in networks with those actively developing new optical methods and optogenetic tools. The meeting consisted of 102 participants, of which 30 were invited and 72 were applicants. The applicants were made up of 15 students and 55 postdocs and PI's.

The national composition of the invited speakers and conference participants was as follows:

	Invited contributors
Austria	1
France	11
Germany	3
Hungary	1
Japan	2
Switzerland	1
United Kingdom	5
USA	6
	30

	Participants
Australia	2
France	30
Germany	1
Hungary	2
Italy	1
Japan	2
Slovenia	1
Switzerland	2
United Kingdom	21
USA	10
	72

The meeting consisted of one special lecture (50 minutes plus discussion), six sessions with scientific talks (~25 minutes duration plus 5 minutes discussion), three session with short talks (~12 minutes duration plus 3 minutes discussion) and three poster sessions.

The invited speakers were selected to cover a wide range of spatial scales of brain function ranging from the molecular to the network level as well as the very latest technological developments in microscopy and optogenetics. The main criterion for the selection was scientific excellence.

The meeting was advertised using several different strategies. First, Nathalie Babic sent out several advertisement posters. Second, the organizers sent many emails to neuroscientists all over the world by utilizing contacts and targeted email lists of interested parties. Third the meeting was widely advertized within universities. 72 applications were approved, and based on the quality and the topics of the submitted abstracts, 5 were selected for short oral presentations (short talks).

The local organization of the meeting, performed by Nathalie Babic, was excellent in the run up, during and after the meeting. The lecture theater near the coast provided an excellent environment for scientific discussions. The technical support was also extremely good. This enabled the meeting to run smoothly without a hitch, which was remarkable, given that there were ongoing train and taxi strikes at the time.

The funding for the meeting was provided mainly by the CNRS, which we very gratefully acknowledge. We would also like to acknowledge the very generous support of Gatsby Charitable Foundation, which allowed us to waive (or reduce) the registration and accommodation of 10 young scientists, enabling them to attend the meeting. The Gatsby Charitable Foundation also sponsored the travel and the accommodation of three distinguished speakers from the USA and Japan and other conference expenses. Nature Methods also contributed to some conference expenses.

The traditional excursion to the island of Batz was particularly pleasant, with beautiful weather, allowing unformal and friendly discussions.

At the business meeting on the last day of the conference Christophe Mulle, research Director at CNRS Bordeaux, France, was confirmed as the president of the next meeting (in 2016). Furthermore, Prof Fritjof Helmchen, Zurich, Switzerland, was unanimously elected as the new vice-president. This choice of president and vice-president bode well for future meetings, which will develop new themes in neuroscience and microscopy.

In summary, we, the organizers, believe the meeting was a great success. Many participants confirmed that it was one of the best meetings they ever attended, and some said that it was the best conference they had ever been to.

2. Report on scientific aspects

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Day 1

The meeting started on the first evening with a welcome reception and dinner followed by an Introduction from Angus SILVER. This was followed by an impressive plenary lecture from Karel SVOBODA. The high quality of his talk and the fact that he has consistently used the latest developments in optical microscopy, genetically encoded indicators and optogenetic methods in the field of circuits and behaviour, set the tone for the subsequent presentations during the meeting.

Day 2

The meeting was structured from 'bottom up', starting at a fine spatial scale with a session entitled ***Synaptic mechanisms and super resolution imaging***. This brought together experts on synaptic transmission and receptor function and the latest developments in optical superresolution methods including STED and STORM, which break the classical diffraction limit of optical microscopy. Speakers in this session included Ryohei YASUDA who presented work on imaging signal transduction in single dendritic spines, Alain MARTY who talked about Vesicular release at single GABAergic synapses and Daniel CHOQUET who presented his latest work using superresolution methods to study AMPAR receptor diffusion and stargazin and how they affect surface trafficking and synaptic transmission. After coffee Tomoyuki TAKAHASHI presented new work on Imaging vesicle trafficking in calyceal presynaptic terminals. Zoltan NUSSER then described CB1-mediated regulation of GABA release from CCK positive axon terminals of the hippocampus. In the last talk in this session Valentin NAGERL described his latest results using STED microscopy to study the properties of spines. This session highlighted the huge potential of superresolution methods for analyzing synaptic function and the new concepts that are emerging in the field of synaptic function and plasticity. Importantly, speakers presented largely unpublished, cutting edge results.

At lunch round tables ensure that speakers and participants mixed and discussed their work. After lunch there was the first of the 3 different poster sessions. As for all the poster sessions this was very well attended and there was a great deal of interaction.

The afternoon session focused on ***Synaptic mechanisms and synaptic integration*** and this session was a mixture of invited main speakers and short presentations selected from the applicants. Stefan HALLERMANN presented his latest work investigating the properties of presynaptic calcium dynamics at cerebellar

mossy fibre boutons. This was followed by two short talks. The first was from Kirill VOLYNSKI who described the use of superresolution hopping probe ion conductance microscopy for studying presynaptic function and the second was from Balázs RÓZSA who presented work using high speed 3D random access multiphoton imaging (RAMP) using an acousto-optic lens microscopy to image dendritic spikes in parvalbumin-expressing interneurons during hippocampal sharp waves. The last talk in the afternoon session was from David DIGREGORIO who presented new work showing that synaptic inputs conveying different types of sensory information to the cerebellar cortex exhibit distinct proerties.

The early evening session continued on the same theme with Christophe MULLE (the vice president of the meeting) presenting his work on the role of presenilin in presynaptic plasticity using novel optogenetic tools. Peter JONAS presented his latest work using 2-photon imaging to make electrical recordings from fine dendritic and axonal structures of interneurons. Throughout the first day and subsequent days of the conference the level of audience participation was extremely high with many questions and animated discussions after each talk.

Day 3

Moving up the spatial scale, the morning session on day 3 focused on the ***Structure and function of brain circuits***. Rosa COSSART presented evidence that hippocampal network can encode distance using large scale 2-photon imaging of hippocampal network dynamics in the adult awake mouse. Philippe ISOPE presented some of the first evidence in a mammalian system that fine scale functional connectivity is similar across animals. This provided new insight into the extent to which neuronal properties arise from experience dependent plasticity versus their genetic predetermination. Massimo SCANZIANI explored the ratio between excitation and inhibition and showed that it is equalized across pyramidal cells in visual cortex. This work has subsequently been published in Nature.
The morning session continued with Michael HÄUSSER who discussed in vivo dendritic measurements and the role of dendritic computation in sensory processing and hippocampal function. This was followed by a short talk form Lucie BARD who used fluorescence lifetime to assay resting [Ca^{2+}] in different compartments of CA1 pyramidal neurons *in situ*. The morning session ended with an impressive talk from Fritjof HELMCHEN who described a new type of 2-photon microscope for recording from two different brain regions simultaneously.

After lunch there was a boat trip to Batz island, with time to explore. This provided a wonderful (sunny) opportunity for more extended scientific discussions. The second poster session started in the early evening and, as for the first session, this was very well attended.

Day 4

The first session of the day focused on **Sensory encoding and sleep and developments in high speed 2-photon imaging**. Arthur KONNERTH briefly described two projects on Calcium signaling in spines and dendrites of cortical and hippocampal neurons *in vivo* that had just been published. He then moved onto unpublished work detailing a new behavioural paradigm for studying cerebellar function. Two short talks followed from Isabel LLANO, who described excitatory $GABA_AR$-mediated effects in the adult cerebellar cortex *in vivo* and from Mahesh KARNANI who described his work on VIP interneurons and their role in mediating local control of cortical activity. Attila LOSONCZY presented his latest work on two-photon functional imaging of hippocampal microcircuits.

After coffee, the session continued with Angus SILVER presenting the latest technical developments in high speed 3D 2-photon microscopy and adaptive optics with an acousto-optic lens. Ingrid BUREAU then presented her recent work on mapping the plasticity within neuronal circuits of the somatosensory cortex induced by associative learning. The session closed with a very impressive talk from Gero MIESENBOECK, who described the neural basis of the sleep cycle in flies.

After lunch there was the final poster session. As for all the poster sessions this was very well attended and there was a great deal of interaction.

The afternoon and evening sessions were dedicated to ***Network dynamics and optogenetic stimulation***. Due to a schedule rearrangement with the session on *Structure and function of brain circuits* this session started with a talk from Moritz HELMSTAEDTER, who described new work on dense reconstruction of cortical circuits, with a focus on layer 4. This was complemented with description of the considerable technical challenges involved in such a large scale project. This was followed by a presentation from Logan GROSENICK, who described a new camera-based 3D microscope, based on micro-lenses. Moreover he also described new work on the neural basis of social behaviour that has subsequently appeared in Cell. Valentina EMILIANI presented new technical developments in the field of adaptive optics and described new methods for photoactivating cells.

Continuing on in the early evening Claire WYART presented her work on investigating sensory motor loops recruited during active locomotion. In the last talk of the day Misha AHRENS presented his latest results and analysis methods for whole brain functional imaging in zebrafish at single neuron-resolution. The scientific discussions continued during the conference Banquet and late into the night.

Day 5

The last scientific session focused on Network dynamics and metabolism, with the first talk from Andreas SCHAEFER who described his recent work on Independent control of gamma and theta activity by distinct interneuron networks in the olfactory bulb. This was followed by Serge CHARPAK who showed a new 2-photon method for imaging of oxygen partial pressure at micron resolution in the brain of awake mice. The last presentation was from Haruhiko BITO who presented a new red genetically encoded calcium indicator that has remarkably linear properties and his new data imaging active neuronal ensembles *in vivo*. The exceptional quality of the science and the active discussion was maintained for the entire duration of the conference.

3. Conclusions and recommendations

The meeting combined outstanding scientific presentations of the very latest research in neuroscience with cutting edge technology development in microscopy and photostimulation. Throughout the conference, whether it be at the posters or in the main talks, the audience engagement was impressive and the scientific discussion was animated. Due to the continued interest and the venue of the conference, the attendance remained close to its maximum from the beginning to the very last talk. The venue was excellent and the local CNRS organization, run by Nathalie Babic, ran like clockwork. Our informal feedback from the participants was extremely positive.

The fields of neural communication, neuronal circuits and their relation to behaviour are in their infancy. The rate of discovery of novel brain properties in these fields is extremely high and many more exciting and important results are expected in the coming years. This is largely due to the new optical methods that have recently been developed for studying brain function. A major factor in the success of this conference series is the fact that it is multidisciplinary, bringing together physicists and biologists. Indeed, this Jacques Monod conference, and its predecessors, has been highly influential in bringing together leaders in these important and rapidly expanding fields. This combination of method development and cutting edge neurobiological results is a great strength and should be continued. The format of the Jacques Monod conferences has proven to be an excellent one, with no major change required.

Nevertheless, we would like to suggest some minor adjustments that could further strengthen this highly successful conference in the future.

Distinct poster sessions with different posters (rather than keeping them all up during the entire conference) should be continued because it ensured a very high

attendance in each session. But perhaps a little more time could be allocated for each session.

The number of short talks could be increased from 5 to 8 and these could be restricted to junior researchers rather a mixture of junior researchers and established PI's. This would give more young researchers the opportunity to present their work.

August 5th 2014

R. Angus Siver
President

Christophe Mulle
Vice-President