focus

Single Molecule Activation and Computing

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Nature	**Dissemination Level**
[X] R = Report	**[X] PU** = Public,
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[ ] O = Other	**[ ] CO** = Confidential, only for members of the consortium (including the Commission Services).

In the first period (months 1-12) RAPP designed a hybrid microscope to investigate 2D planar devices. Further efforts in that first period were characterisation of the planar devices provided by IIT.

In the second period (months 13-24) this microscope has been further developed and two systems were built, one at IIT in Genova and one at RAPP. Both systems were equipped with a galvanometric scanning system to target the laser beam to the individual nanometer holes. The software was further developed for automated exposure to the laser beam of individual nanometer holes on the device. As part of the collaborative project, RAPP representatives visited ITT in Genova in 2012 to set up and test the hybrid microscope with the galvanometric scanning system. Such a hybrid microscope is shown in Fig. 1 and Fig. 2.

Progress in the design and development of fabricating the planar devices will be reported by the colleagues from IIT.

Such a planar device was utilized by the members of Prof. Benfenati's group at IIT during the second period of the project. Cells were grown on the device and selectively illuminated. Details will be reported by the colleagues from IIT.

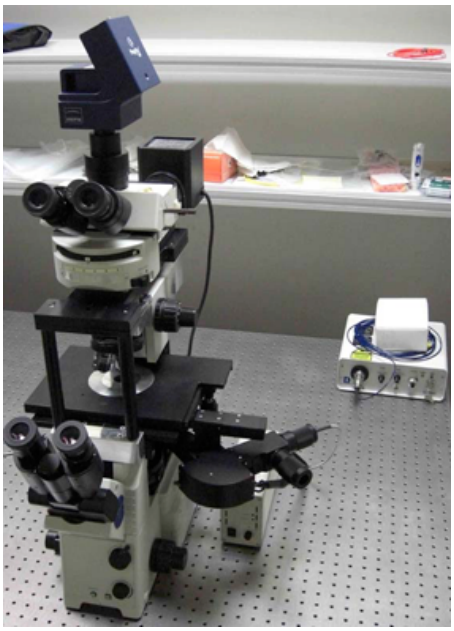

Fig. 1. Hybrid microscope consisting of inverted and up-right microscope components with objectives on both sides of the sample plane. The inverted microscope is equipped with galvanometric scanning system with RAPP designed and built micro-processor control and a fibre optically coupled laser for selective illumination. The upright part of the microscope is equipped with a fluorescence attachment, a binocular tube, a camera port and CCD camera.

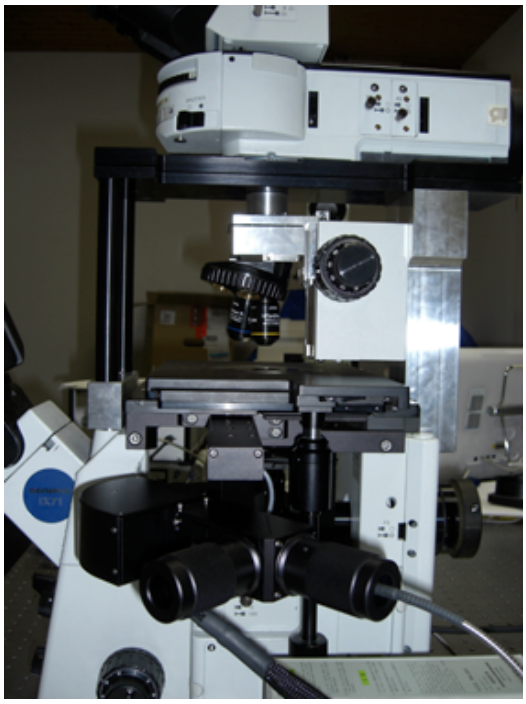

Fig. 2. Hybrid microscope showing in detail the coupling of the galvanometric scanning system.

In 2012, a second project was started in collaboration with SISSA in Trieste. One of the projects at SISSA is to investigate the differences between far-field and near-field optical stimulation. To contribute to this project, we have redesigned a laser system used at SISSA in Trieste such that it can be used in a versatile way to illuminate one optical fibre for full field (= far field) illumination and two tapered optical fibres for near-field optical stimulation.

The original system consisted of a 491nm laser with an acousto-optic modulator (AOM). It has been modified such that the laser beam can be switched under computer-control between 2 tapered optical fibres for near-field optical stimulation and one multi-mode optical fibre for far-field stimulation. The system allows the programming of arbitrary sequences of laser pulses and pulse trains between the various optical fibre ports. In addition, the laser power can be programmed over four orders of magnitude. Such a large dynamic range cannot be achieved by simply using the AOM. Therefore, we have installed an additional fast filter wheel equipped with neutral density filters. The filter wheel modulates the optical power in decade increments (100%, 10%, 1%, 0.1%). Power levels can be adjusted on a microsecond time scale using the AOM and on a 30-50ms time scale using the fast filter wheel. To ensure rapid switching between pre-set power levels, a sequence controller was developed which, for a given sequence of laser pulses of different intensities, optimizes the movement of the filter wheel in combination with the AOM to obtain the desired power for each pulse.

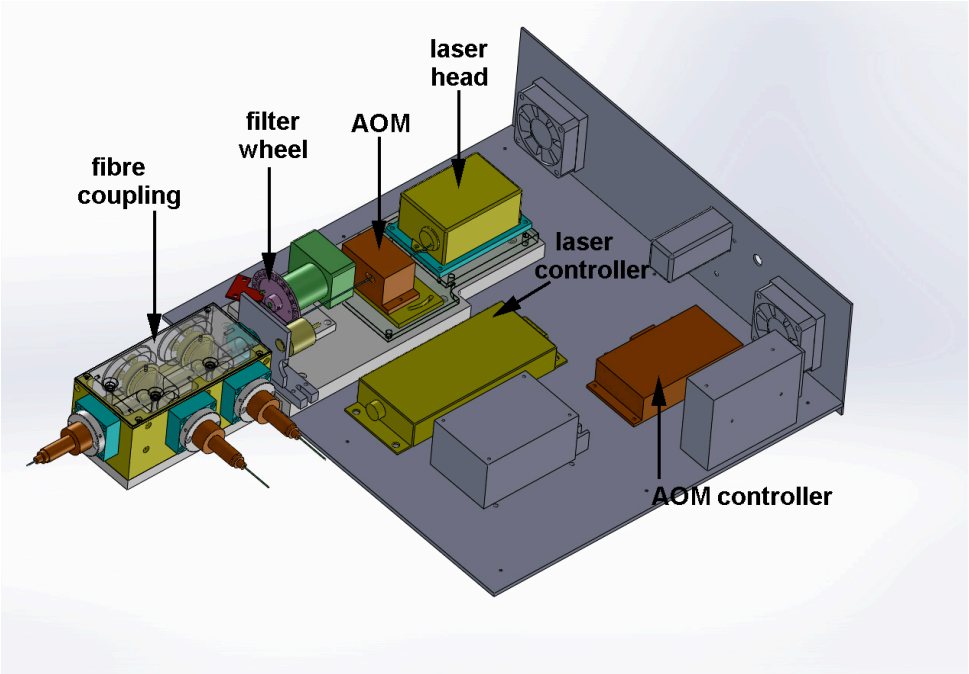

Fig. 3. 3D-CAD representation of the laser together with the acousto-optic modulator (AOM), filter wheel and fibre coupling module. In the fibre coupling module, the laser is split into 3 equally intense beams using two beam splitters. Each fibre launch is equipped with a miniaturized fast mechanical shutter.

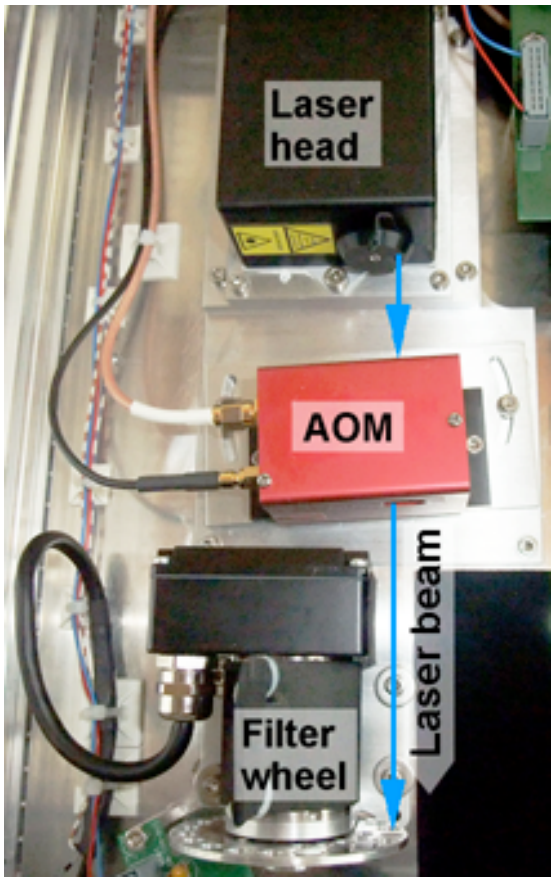

Fig. 4. Interior of the laser system showing the laser head, the acousto-optic modulator (AOM) and the rapid filter wheel equipped with neutral density filters of OD1, OD2 and OD3.

A major task of RAPP is exploiting the commercial potential of the equipment developed.

The first step in this direction was the promotion of the hybrid microscope with the planar devices and the galvanometric scanning system on the following exhibitions, where we had a stand and presented systems of our portfolio.

Exhibition	Place	Date
Biophysical Society Meeting, USA	San Diego, USA	26. – 28. February 2012
ELMI, European Light Microscopy Initiative	Leuven, Belgium	5. – 8. June 2012
FENS, European Neuroscience Meeting	Barcelona, Spain	12. – 17. July 2012
DGfB, German Biophysical Society Meeting	Göttingen, Germany	23. – 25. September 2012
SFN, Society for Neuroscience, USA	New Orleans, USA	13. – 17. October 2012

From our experience, purchase decisions by customers are made on the following grounds:

1.) Seeing the equipment or receiving information about it at exhibitions. This serves to establish a first contact between the new potential customer and RAPP and to inform the customer about the features of the product.
2.) Advertisements in scientific journals and other publications. We did not experience much success using this path of promoting our equipment.
3.) The citation of a system in a scientific publication.
4.) The successful demonstration of a system in a customer's laboratory.

Based on this, while continuing the advertisement, we expect also that, once the system is finished and the first joint publications with our scientific partners within the FOCUS consortium will appear, we will experience rising demands for the equipment. Demonstration to customers can be done once the prototype level has been passed. We expect that will happen in 2013 or 2014.