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**Introduction**

One of the smallest motors found in nature are in the membrane of bacteria. These flagellar nanomotors turn at a very high rate and propel their host through a liquid medium. The structure and operation of this motor based on many interlocking proteins has not been elucidated. We propose to mass produce and purify the constitutive proteins of this motor by using molecular recombinant techniques and print these proteins on prepared biomimetic surfaces to observe and study their self assembly and mechanisms of interaction. The goal is to understand how the proteins interact and how they are instrumental to the building and functioning of the *E. coli* nanomotor.

The "artificial" building of this biological motor, block after block, on a solid surface using soft lithography is a technological challenge that couples state of the art techniques of protein production, surface chemistry, nanolithography, self-assembly and dynamic imaging. The technology and conceptual understanding derived from this research will enhance greatly the ultimate goal of building a functional nanomotor in vitro.

The project assembles three different disciplines:  
Biology, Nanotechnologies and Biophysics.

**<sup>2</sup>LBB**

**TASK**

- .Participation in production of recombinant protein in *E.coli* with partner 2
- .Spotting purified recombinant protein on activated surfaces
- slides and investigation of interaction using technology similar to DNA
- . Specific chemistry on silicon and glass surfaces aiming at creating supported phospholipidic bilayers
- . BIAcore experiments to quantify protein-protein interaction

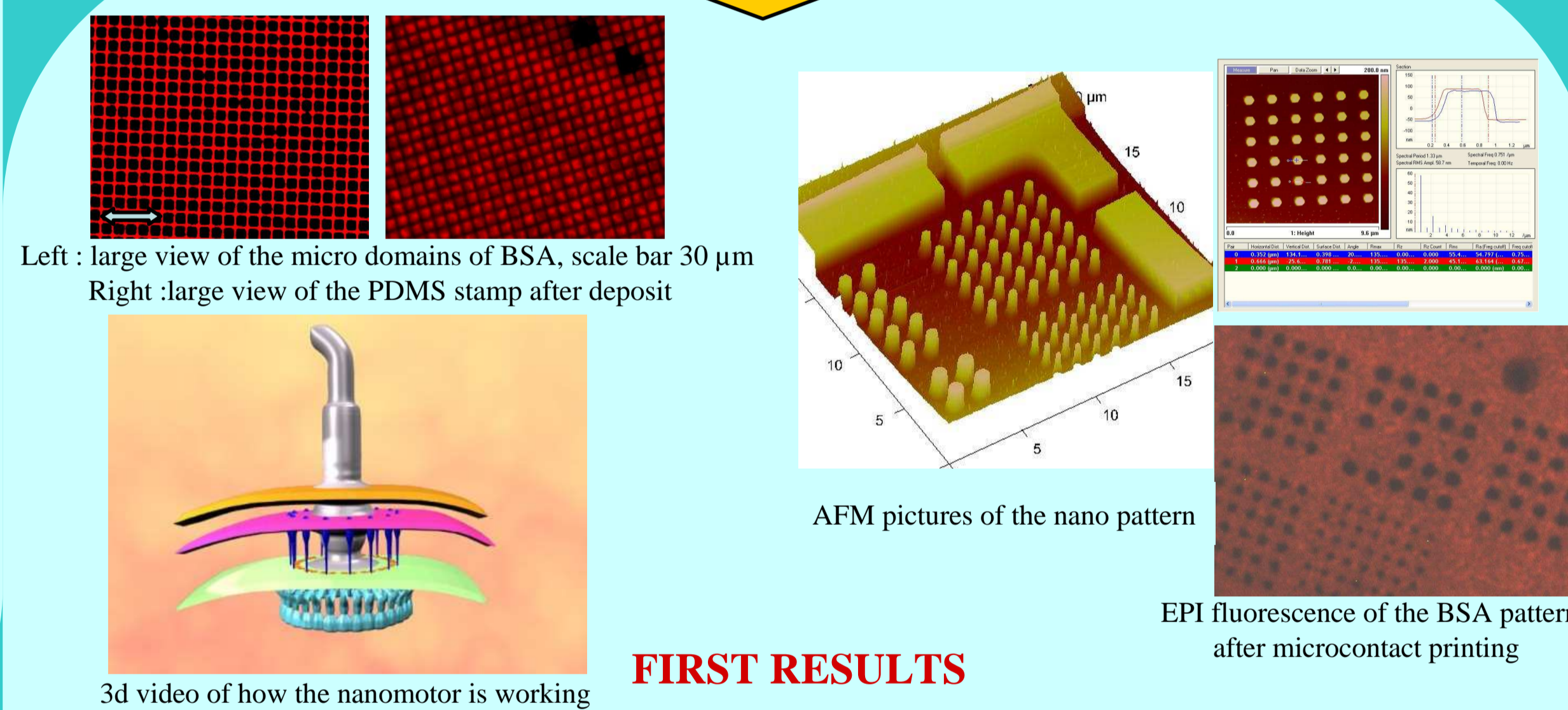
**FIRST RESULTS**

- .Production and purification of FLIM, FLIN proteins of the "switch" part of the motor With their antibodies
- .Beginning of production of FliG, FliF Proteins of the rotor of the nanomotor With their antibodies
- .Studying of interaction FliM/FliN

**<sup>1</sup>LAAS**

**TASK**

- .Global coordination
- .Pattern Fabrication by photo or electron lithography for high nanoscopic resolution
- .Assembly of motors protein using soft-lithography on the supported bilayer Membrane at the micro scale and after at the nanoscale
- .Elaboration of a video describing our hypothesis for the motor function



**FIRST RESULTS**

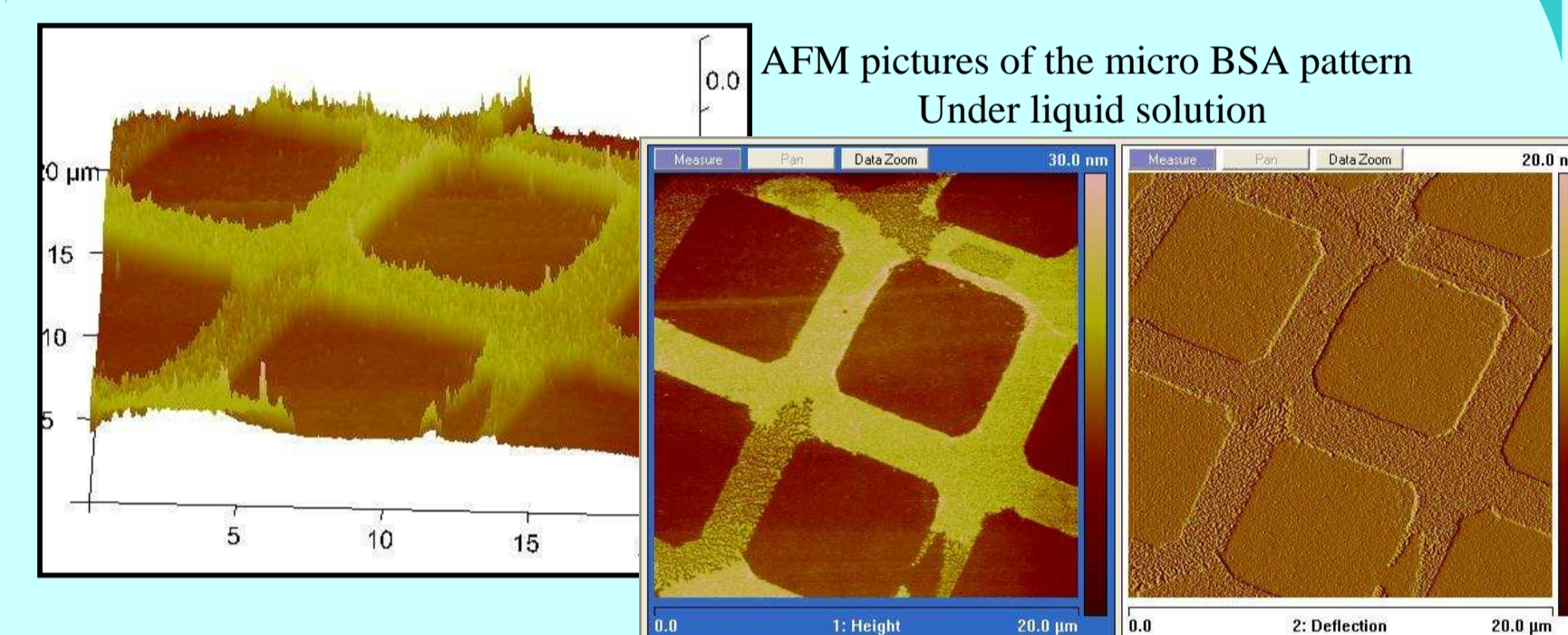
- .Elaboration of a micro and nanopattern using electron lithography
- .Following by elaboration at micro and nanoscale of biological pattern
- . Video of our vision of the motor function available at <http://www2.laas.fr/laas/1-5603-Nanomoteur.php>

**<sup>4</sup>CBS**

**TASK**

- .Development of AFM techniques for high resolution imaging of the samples at high scan rates.
- .Determination of conditions for high resolution imaging of samples.

**FIRST RESULTS**

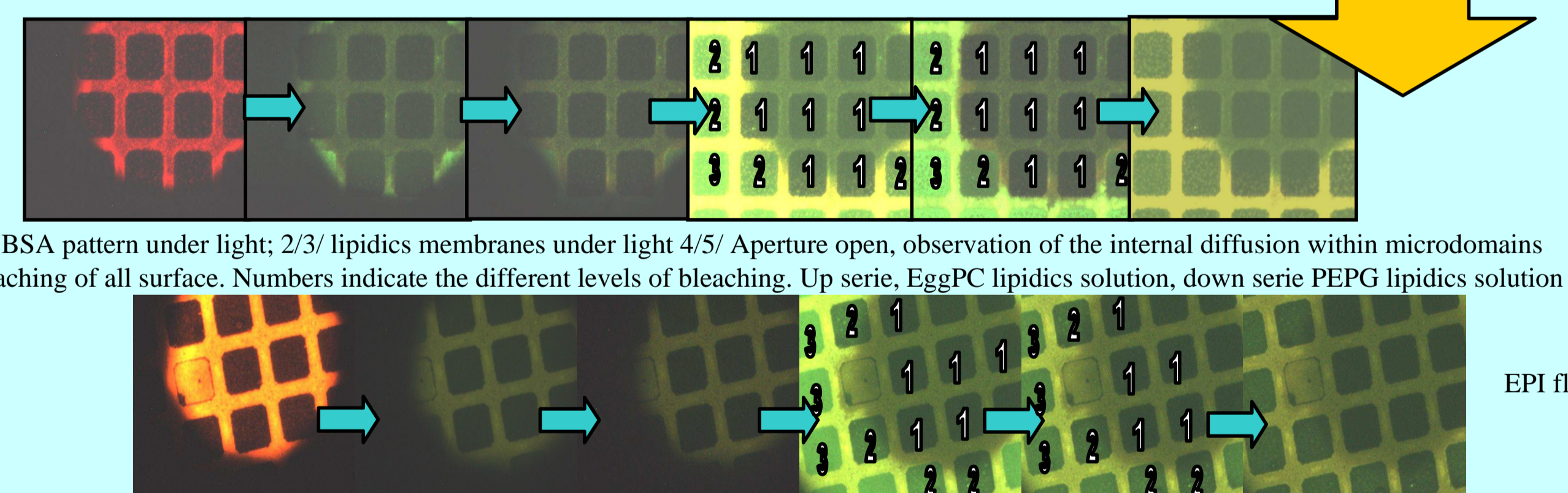


- .First picture of the micro-domains elaborated by Micro contact printing.
- .Determination of conditions for supported Membranes visualisation

**<sup>5</sup>IPBS**

**TASK**

- .Elaboration of supported lipid bilayer membranes at the microscale and nanoscale
- .FRAP experiments and Single Particule Tracking of Motors proteins
- .Proteins insertion on the membranes



**FIRST RESULTS**

- .Elaboration of microdomains of supported bilayer membranes with different composition
- .FRAP experiments for studying diffusion and fluidics properties

**<sup>3</sup>Mansfield University**

Proteins production, purification

- .Production and purification of FLIM, FLIN Proteins of the "switch" part of the motor With their antibodies
- .Beginning of the production of MotA, MotB Proteins part of the stator of the motor with their antibodies

Results were presented several times through the first year:  
Summer school Nanobio at Cargese, 07/2006  
MNE06 at Barcelone 09/2006  
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**Conclusion after year 1**

After one year of working, we have achieved the first primary task for the assembly of the nanomotors proteins, elaboration of microdomains of supported bilayer membrane, and all the different partner has obtained first results. Obtention of a massive quantity of proteins will now open the second part of the project, the assembly of protein on the lipidic membrane. The project primary objective is to learn about the structure and operation mode of this spectacular molecular nano-machine. This quite fundamental work will remain disconnected from any potential applications. However, we have the feeling that due to the very specific investigation approach we have privileged, the project, in some way, prepares a new technology for longer term horizons. Indeed we attack the issue of the assembly of nanobiomachines on solid surfaces and by the way we address the interface between biomolecular operating machines and artificial devices. This problematic is at the center of the so-called Nano-Bio-Info convergence and may play a role in the domain of nanorobotics. Along this prospective direction, the project can be seen as a pioneering study for assessing the feasibility and reliability of technological building blocks like Nano-contact printing, supported nanomembrane technology etc...In the following we would like to list the expected results of the project in term of both technological achievements and knowledge advances. These results will all be the subject of public dissemination (papers, conferences, website...). We will not privileged patenting except if something really unexpected is discovered (as for example means for powering the nanomotor or for exploiting its mechanical energy).