THERMAL IMAGING BY USING GOLD NANOPARTICULES AND WAVEFRONT SENSING FOR THE STUDY OF THERMAL BIOLOGY AT THE SINGLE CELL LEVEL

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Nowadays, thermal studies in cell biology remain complicated to implement. Usually, scientists heat the entire sample, or even the whole microscope, to study the temperature dependence of the metabolism of living cells. The approach has limitation: all the cells are heated at once at the same temperature, and the heating exhibits a large thermal inertia.
We developed an approach to locally heat using gold nanoparticules at the micrometric scale, and control the temperature using an optical wavefront sensor [1]. Furthermore, our setup is able to simultaneously acquire quantitative phase and confocal fluorescence images which allows us to combine morphological and functional informations.
I will illustrate the capabilities of this technique by presenting two recent works.
RPE1 (Retinal pigment epithelial) cells were transfected by a HSF1 (heat stress factor 1) plasmid labeled with a GFP fluorophore. The HSF1 proteins have the property to agglomerate in the nucleus if we heat them at 43°C for a few minutes. We managed to heat single cells and observe the agglomerate formation (see Fig 1).
Microtubules are long hollow filaments that are part of the cytoskeleton. They have many functions like maintaining the cell shape or proteins transport. It has been shown that microtubules can depolymerize at 4°C and polymerize again at 37°C. I will show in my presentation that we can locally modify the polymerization of microtubules within single cells.

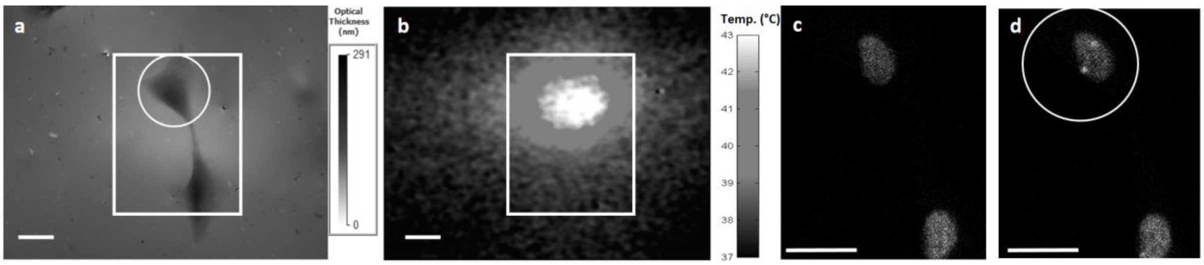

Fig 1: a) Quantitative phase image of RPE1 HSF1-GFP cells b) Temperature map of the field c) Fluorescence image of cells before heating and d) after 5 min of heating at 43°C
Scale bar=20µm, white rectangle=field of fluorescence microscope, white circle= heated area

[1] G. Baffou et al., "Thermal Imaging of Nanostructures by Quantitative Optical Phase Analysis" ACS Nano 6, 2452 (2012)