

PHASICS
the phase control company

PROPOSAL FOR A MASTER THESIS

Dates: April 1st, 2018 – September 30th, 2018

Laboratory: Institut Fresnel
City, Country: Marseille, France

Title of the Master Thesis:
Quantitative phase imaging of cells with high speed and high definition wavefront sensors

Name of the tutor of the Internship: Julien Savatier

Email address: julien.savatier@fresnel.fr

Phone number: 0033 4 91 28 84 95

Mail address: Institut Fresnel, Faculté des Sciences Saint Jérôme. Avenue Escadrille
Normandie-Niémen. 13013 Marseille, France

Summary of the subject:

Quadriwave lateral shearing interferometry (QWLSI) is a well-established quantitative phase imaging (QPI) technique based on the analysis of interference patterns (interferogram) of four diffraction orders by an optical grating set in front of an array detector. As a QPI modality, this is a non-invasive imaging technique which allows to measure the optical path difference (OPD), as well as dry mass, of cells.

In this Master thesis the goal will be to use and improve QWLSI and apply it to perform high-speed, high definition and low noise, as well as multimodal (fluorescence), imaging. We will use a modified QWLSI system containing a versatile optomechanical device that allows to interchange cameras as part of the wavefront analyser, so as to optimize recording parameters (velocity, resolution and sensitivity).

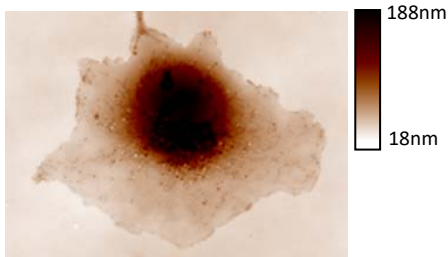
We will first use an ultra-fast CMOS camera to study cell dynamics and blebbing, up to 700 Hz frame rate. This will require some development in image analysis.

We will also use a new and functional prototype that enables to get high definition quantitative phase images (5.5 Mpix), that Phasics just developed. The principle is a bit

different, with the acquisitions of 9 different interferograms that will be combined. This will be used to resolve small objects, and follow vesicular dynamics in living cells.

The structural and density information extracted from the OPD signal is complementary to the specific and localized fluorescence signal, which can be simultaneously acquired. We will be able to label specific organelles and correlate the signals of the two modalities. Image analysis will also take an important part here.

If desired, the student will also learn the basics of cell culture and labelling.



Quantitative phase image of a COS-7 cell

Keywords:

Quantitative phase imaging, prototype, image analysis, cell dynamics

Additional information:

* Required skills: Labview; Matlab, Image J or Icy

* Salary: 570 €/month

* Miscellaneous: This Master thesis will ideally be followed by a CIFRE PhD thesis, in close collaboration between Phisics SA (Saint Aubin, south of Paris), one of the leaders of QPI, and Institut Fresnel. It would be on the development of new applications in quantitative phase imaging for biology, with this fast and high definition wavefront sensor prototype. This would be the fourth CIFRE PhD thesis in a row between us, with more than ten papers already published together.