Rising possibilities of quantitative phase imaging

Zuzana Nováková, Application Specialist at Telight.

Quantitative phase imaging (QPI) technology is on the rise. Several main factors have contributed to its popularity. Live-cell imaging is the key approach to cell analysis in both primary and applied research. QPI enables researchers to perform long-term experiments on live cells without altering their nature thanks to its label-free approach to analysis. Despite the ongoing progress in the fluorescence microscopy (the development of less toxic and more stable fluorophores, low-power lasers and more sensitive detectors), label-free imaging remains crucial when monitoring cells in an undisturbed environment - for example, in drug testing studies or studies of differentiation.

Obtaining quantitative data on cell morphology and dynamics is critical. Compared to routinely used label-free tools for cell visualisation like phase contrast or differential interference contrast, the QPI provides direct information on various cell parameters such as dry mass, motility, area, or cell density. QPI is also a suitable method for cell population analysis because it can capture rare cell events and detect unique cell phenotypes non-invasively and quantitatively, therefore reliably and precisely. Let us look at several fields where QPI has a strong impact already.

The importance of QPI in current research

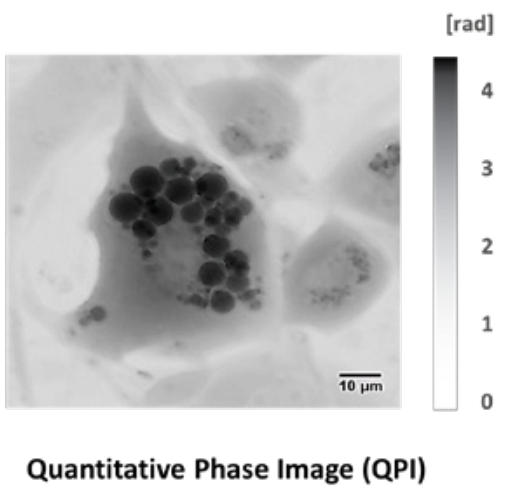
Cancer research

One of the cancer cell hallmarks is its ability to avoid programmed cell death. Understanding this phenomenon is therefore one of the main focuses of cancer research and correct cell death type classification is crucial. Predominant types of cell death can be detected by flow cytometry. Nevertheless, the absence of cellular morphology analysis may lead to the misclassification of cell death type. QPI can overcome this phenomenon, moreover, without the use of fluorescent labels. Researchers from Masaryk University (Brno, Czech Republic) have been using QPI intensively for studies on cell death. Recently, they managed to predict the cell death timing using a long-short term memory neuronal network and classify the cell death type as apoptotic or lytic. Importantly, the model was trained solely on QPI data and achieved 75% accuracy [1].

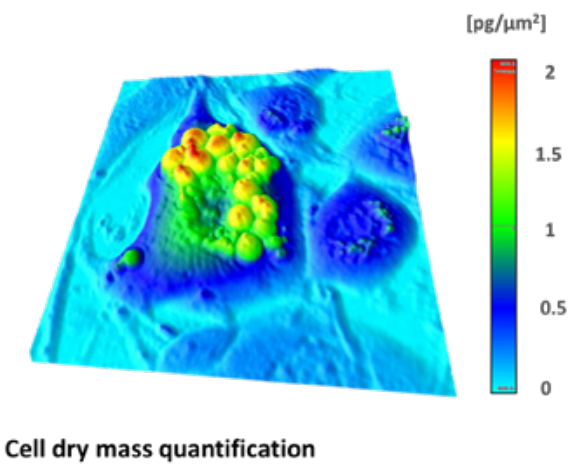
Millions of people are treated with cytostatics every year. The success of the therapy can be easily ruined by cancer cells gaining resistance. To overcome this, scientists are exploring nanomaterials as possible drug carriers. For example, the research team from the Center for Advanced Functional Nanorobots found out that nanomaterial carrying the cytostatic doxorubicin significantly enhanced the drug intake and affected positively the cell behavior. Based on QPI data, they describe how both proliferation and motility of drug-resistant cancer cells decreased [2].

Mechanical cell properties

Retrieving the information about the transmitted light wave phase can be used not only for the quantification of cell dry mass, but the obtained phase values can be used to evaluate the mechanical properties of cells as well. The golden standard in mechanophenotypisation studies is atomic force microscopy. However, it is based on direct contact of the cantilever and cell which can lead to stress and possibly affect the results. QPI, as a non-



Quantitative Phase Image (QPI)



Cell dry mass quantification

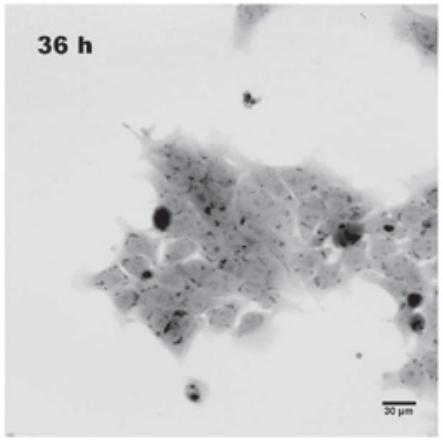
Examples of cell parameters obtained from the QPI method

1. Cell dry mass
2. Area
3. Perimeter
4. Circularity
5. Density
6. Growth speed

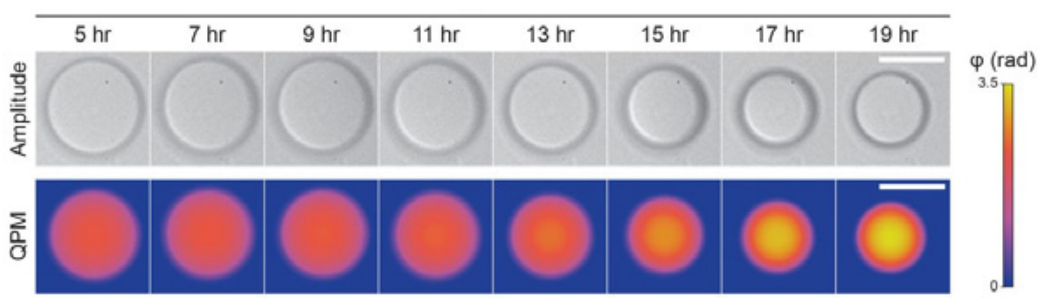
Morphology

7. Speed
8. Euclidean distance
9. Meandering index
10. Directionality
11. Trajectory length

Motility



QPI of human embryonic stem cells.



Timelapse of protein condensate.

invasive method, opens new possibilities for cell-friendly evaluation of viscoelastic properties like cell stiffness [3].

Biomolecular condensates

The research team from MPI in Dresden (Germany) used QPI for the analysis of biomolecular condensates [4]. These membrane-less and protein-rich cell compartments have been shown to play an important role in biochemical cellular processes. However, their composition, that crucially affects the phase separation mechanism, remains less understood. McCall and colleagues found out that using QPI, the protein concentration and condensate temperature-dependent shape can be determined more precisely and more efficiently when compared with traditionally used methods like fluorescence microscopy or optical diffraction tomography.

AI and QPI

QPI output is an image that contains quantitative information about a sample, which makes it well-suited for subsequent automated analysis. Furthermore, the high contrast and uniform quality of QPI data suit well with the ongoing development of segmentation algorithms and machine learning applications [5].

Want to know what QPI can do for your research?

Companies like **Telight** offer professional consultation on QPI and its applicability in specific research. If you have ever struggled with phototoxicity, disturbances during staining or cell segmentation, struggle no more. Assisted sample analysis can be conducted in several places around Europe through the EuroBioimaging platform or via www.telight.eu.

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Society saddened to learn of death of Dr Michael Ormerod Hon FRMS

Honorary Fellow made enormous contribution to Flow Cytometry

The RMS was deeply saddened to learn of the death of Dr Michael (Mike) Ormerod Hon FRMS, in late April.

Mike made a huge contribution - not only to the UK cytometry community, but also to worldwide education in cytometry in a career spanning more than 35 years.

He worked for many years at the Institute of Cancer Research in Sutton, Surrey, where he headed the flow facility until he left to become an independent consultant in flow cytometry.

In 1985 he co-founded the first informal gathering of flow cytometrists - the London Flow Club, and two years later was elected to the first Flow Cytometry Committee of the RMS. The section - which has thrived ever since - only came about due to the efforts of Mike and his fellow enthusiasts.

Mike set up and ran the annual RMS Flow Cytometry Course for many years, and taught on several international courses including in India (where he was born), Uruguay, South Africa, Egypt and Iran. For 15 years, he also ran the world's only distance learning course on Flow Cytometry for the Virtual School of Biomedical Sciences, University of Ulster.

Mike wrote several books, including 'Flow Cytometry: A Practical Approach' - a familiar sight on the shelves of many a flow cytometry laboratory – and 'Flow Cytometry: A basic Introduction' which is still used on the RMS course today.

In 2015 he was awarded the Honorary Fellowship of the RMS in recognition of his contributions to both the UK cytometry community and worldwide education.

Mike's contribution to the world of flow cytometry, his passion, friendliness and support given throughout his career leaves a legacy of thankful flow cytometrists that ensures that he will not be forgotten.

The RMS offers its sincere condolences to Mike's family and friends at this time.

Mike receiving his RMS Honorary Fellowship from former President Pete Nellist, in early 2016.