

# AUTOFOCUS-CONTROL OF A MICROSCOPE INCLUDING AN ELECTRICALLY TUNABLE LENS

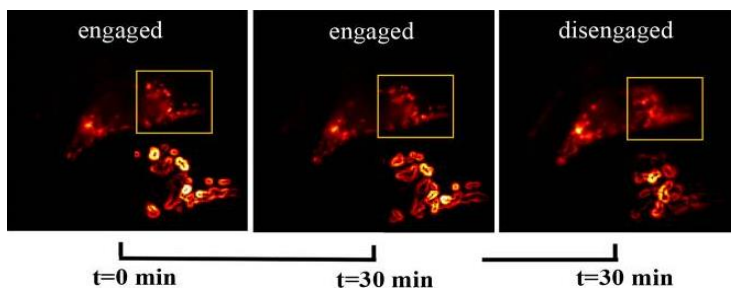
**Keywords:** Closed loop autofocus system, electrical tunable lens, microscope, quadrant photodetector

## INVENTION NOVELTY

The following technology provides for the first time a true closed loop autofocus system using an electrical tunable lens (ETL) where an ETL coupled to the microscope objective readjusts the focal position presenting a fast and cost effective all-optical autofocus solution.

## VALUE PROPOSITION

In optical microscopy maintaining a sample in focus remains a critical challenge: mechanical and thermal fluctuations as well as thermal instability of the microscope body all contribute to focus drifts. These can disrupt routine time lapse imaging, single molecule imaging and super resolution microscopy, even over short periods. To oppose these inevitable fluctuations, it is important to use automatic focal plane detection and stabilization systems within a closed loop system.



*Hek293AD cells displaying labeled mitochondria, imaged over 30 minutes with enabled autofocus (left and middle), and then for another 30 minutes with disabled autofocus (right). Insets show edge detection in a sub-region of the cell, emphasizing the effect of defocus in the right image (Bathe-Peters et al.)*

## TECHNOLOGY DESCRIPTION

The implementation of a closed loop feedback circuit for the auto focus system is based on displacement detection with an integrated laser beam combined with a quadrant photodetector (QPD). The autofocus system adjusts the focal plane by a set-point prediction which allows taking into account also the changes in QPD voltage which arise whenever a new current is applied to the lens. To convert the difference between the measured QPD voltage and the set-point into a focal change of the ETL, the system is calibrated beforehand.

## COMMERCIAL OPPORTUNITY

The technology is available for licensing.

## DEVELOPMENT STATUS

The sample can be kept in focus without any mechanical movement, at rates up to hundreds of Hertz. The device requires only reflective optics and can be implemented at a fraction of the cost required for a comparable piezo-based actuator. Proof of concept has been demonstrated.

## PATENT SITUATION

Patents are granted in US, Europe and China (US11294163, EP3701310, CN111247471), priority of October 2017.

## FURTHER READING

Bathe-Peters, M., Annibale, P., Lohse, M. All-optical microscope autofocus based on an electrically tunable lens and a totally internally reflected IR laser. Optics Express 26, (3) 2359-2368 (2018).