GERMAN CANCER RESEARCH CENTER
IN THE HELMHOLTZ ASSOCIATION

Research for a Life without Cancer

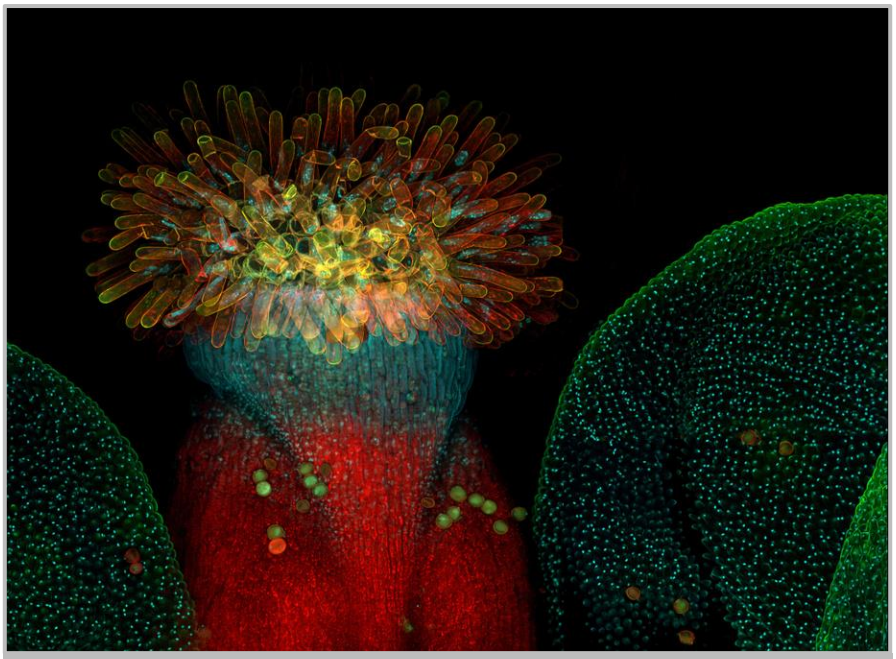
TECHNOLOGY OFFERS

Quadscanner for High Resolution Scanning Microscopes and Array Reader (P-750)

A fast, adaptive optical scanning device with application in high resolution microscopes

EXECUTIVE SUMMARY

The presented beam scanning concept is the first beam scanner based on regular galvanometers for a STED microscope. To decouple the rotation and the position of the beam complete for both scanning axes a novel four mirror approach was presented. This concept allows a completely free positioning of the scanning mirrors regarding the conjugated back focal plane. It was shown that the mirror rotation ratio of each two mirror scan unit is important for the later beam position precision. For the implementation of the QuadScanner a calibration routine was developed, which corrects the rotation ratio of each axis for the complete FOV with beam position precision better than 20 µm in the back focal plane. The STED setup does not work at its optimal performance until this calibration is carried out. This fact was demonstrated at PSF measurements and imaging of Crimson fluorospheres.



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Category	Indication	Development stage	Seeking
Devices	Microscope	Prototype	Licensing, Development partner

BENEFITS

- Fast, adaptive optical scanning device; calibration with 4 galvanometers
- Completely free positioning of the scanning mirrors regarding the conjugated back focal plane
- Reduces significantly adjustment efforts for customers

TECHNOLOGY BACKGROUND

The implantation of this two mirror scanning unit into each of the classical two mirror scanner results into the QuadScanner. This technique decouples mirror rotation and beam shift for both scanning axes. The pupil can also axially be freely positioned and the ratio of each mirror couple is adjusted so that the point of rotation reclines on the pupil plane of the system. To provide an alignment near the theoretical L = D the mirrors must be positioned in a way, that the conjugated back focal plane is located between both scanner units. In contrast to the three mirror concept the galvanometers no longer need to be precisely positioned at a certain location. A calibration of the mirror ratio allows for complete compensation of mounting tolerances. Experimental evaluation of the QuadScanner using STED microscopy showed a high performance and scanning speed with a small ROI at a clearly increased resolution. Analysis of the images revealed comparable resolution to fixed sample measurements with much longer dTs. The smallest reasonable dT was 4 µs. Smaller dTs resulted in a not acceptable SN ratio but could still be performed by the scanner unit. An application of a detection unit consisting out of more than one APD should result in even better performance of the setup.

DEVELOPMENT STAGE

The device is successfully applied in STED microscopes at the DKFZ and the Max-Planck-Institute in Göttingen.

APPLICATIONS

- Application in high resolution microscopes (fluorescence, Raman, STED, localization)
- Application in high resolution array reader

INTELLECTUAL PROPERTY

Patent application submitted. Patented.

- The priority application was filed December 19, 2008 as EP 08 172 450.2.
- WO2010069987A1
- EP2359178B1 and US8520280B2 have been granted.

PUBLICATIONS & REFERENCES

- “Parallelized STED fluorescence nanoscopy” by Pit Bingen et al. in Opt Express. 2011 Nov 21;19(24):23716-26

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ABOUT THE DKFZ Innovation Management

Working at the interface of research and industry, the Innovation Management of the German Cancer Research Center (DKFZ) helps to get new cancer drug candidates, diagnostic tests, and research instruments onto the market as quickly as possible.

The DKFZ with its more than 3,000 employees is the largest biomedical research institution in Germany. At the Center more than 1,300 scientists investigate how cancer develops, identify cancer risk factors and endeavor to find new strategies to prevent people from getting cancer. They develop novel approaches to make tumor diagnosis more precise and treatment of cancer patients more successful. DKFZ is a member of the Helmholtz Association of National Research Centers, with ninety percent of its funding coming from the German Federal Ministry of Education and Research and the remaining ten percent from the State of Baden-Württemberg.