

MEGAFRAME Project

(Million Frame per second, time-correlated single photon camera)

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Analysis of complex molecular phenomena in molecular process physics, such as in biological and medical research, requires advanced scientific equipment in order to “capture” high speed images. However, even the best high speed digital cameras dedicated to research applications are not able to observe molecular reactions, which typically occur in just a few billionths of a second.

The goal of the MEGAFRAME research project is to develop a system capable of capturing 1 million images per second with a time resolution over ten times below one billionth of a second (50ps).

To reach this ambitious goal a research team, coordinated by the Ecole Polytechnique Fédérale de Lausanne, will work together on a collaborative project over the next three years. The consortium is composed of European experts in the field of vision systems (FBK-irst and the University of Edinburgh), optical systems (University of Pavia) and STMicroelectronics (a world leader in semiconductor CMOS image sensors).

The main innovation of the sensor developed within the MEGAFRAME project revolves around the use of special photo-detectors called SPADs (Single Photon Avalanche Diodes), which are able to detect the presence of a single photon. Together with read-out circuitry, an array of these SPAD devices will be integrated into a single chip to produce a compact, reliable and low-cost microelectronic system able to detect and count the arrival of photons.

To further improve the sensor performance in terms of sensitivity to the incident light, an array of micro-optical concentrators, to be placed on the top of the SPAD array, will be designed and fabricated.

The system developed within this research project will help scientists to improve their understanding of many biological phenomena, particularly in the field of proteomics and intra-cellular analysis. The possibility of detecting ultra-fast events in the nanosecond timescale will facilitate precision micro-analysis, opening up new frontiers in the areas of physics, chemistry and biological research.

The developed system could be applied to modern and sophisticated techniques used in biomedical analysis, such as Fluorescence Lifetime Imaging Microscopy (FLIM) and Fluorescence Correlation Spectroscopy (FCS).

One of the main long-term goals of the MEGAFRAME project is to demonstrate the possibility of integration of this new single-photon detection paradigm, using modern deep-submicron technologies, into cost-effective high-tech analysis equipment, thus opening new perspectives in the realisation of imager-networks with embedded digital processing.

This project is part-funded by the European Commission's 6th Framework Program (Information Society Technologies). The project began in June 2006 and will last for 36 months.