Imaging-based cross-disciplinary research at IIMCB

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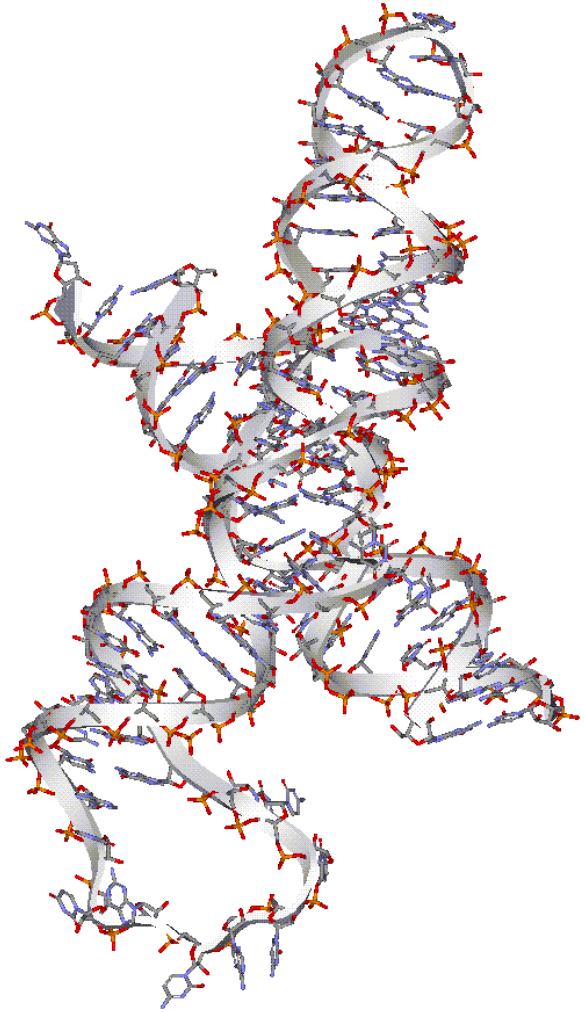
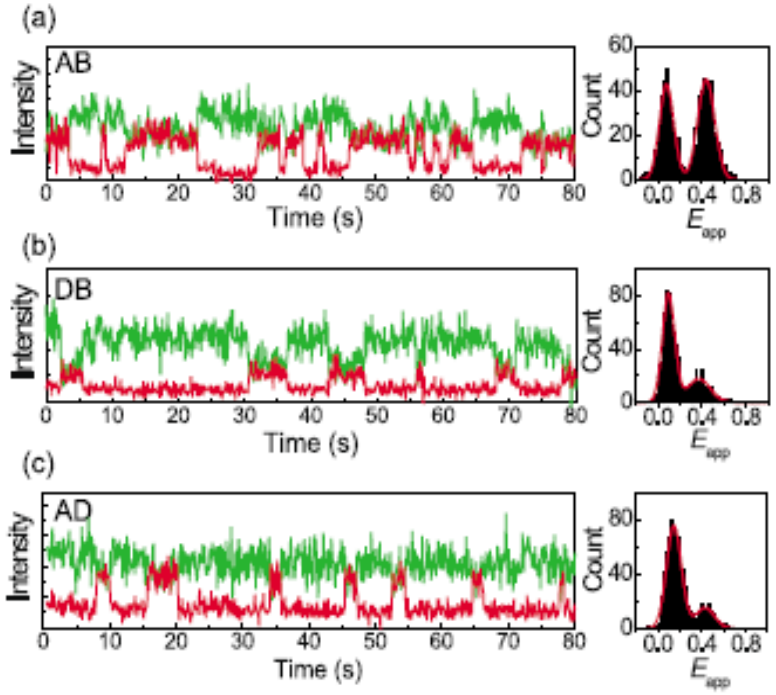
Exemplary problem

RNA 4-way junction of the Hairpin ribozyme



Rupert *et al*, Science, 298, (2002), 1421



smFRET traces show three populations

Hohng *et al*, J.Mol.Biol., 336, (2004), 69

Kalinin, Sołtysinski, et al. 2011

Open questions

Number of species in equilibrium

Solution of structures including less populated states (no X-Ray data)

Interconversion dynamics

Solution: experiments in an open environment

Open optoelectronic setups

Components to collect:

Lasers: continuous waves, pulse: femto seconds

Beam steering: prisms, mirrors, (acoustooptical) filters, splitters, Pockel's cell, confocal scanners, resonant scanners, optical fibers, acoustooptical deflectors, objectives

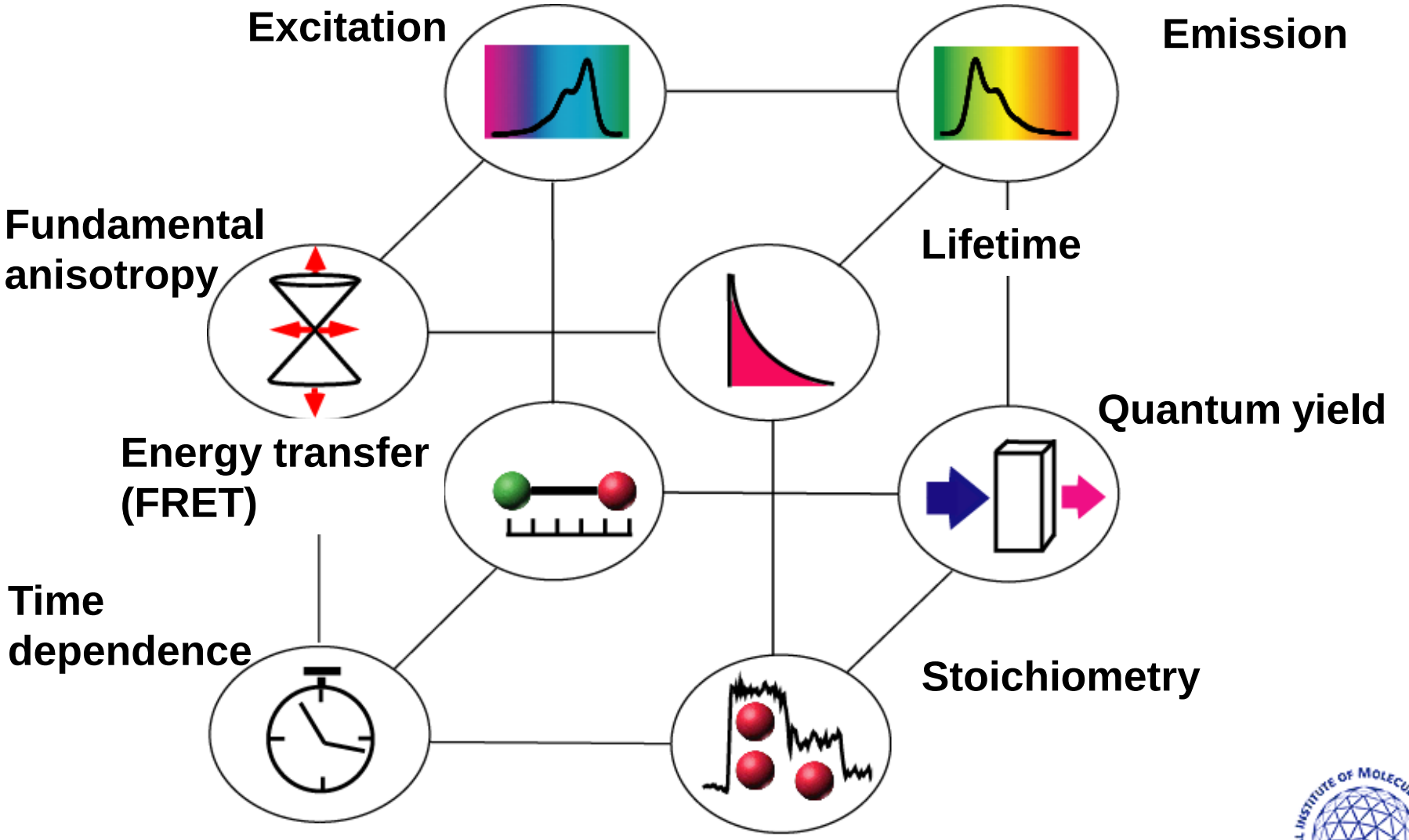
Detectors: Photomultiplier tubes, avalanche photodiodes, fast CCD, wide field CCD, single photons counting cards,

Drivers: PCs: multi CPU/GPU with solid state hard drives, piezoelectronic drivers, FPGA

Mechanical equipment: optical tables, mounting tools, safety covers, piezomotors/positioners

Software: LabView/Matlab/Python

What can we gain? 8 Dimensions of Fluorescence: MFD Multiparametric fluorescence detection



Widengren et al., Anal. Chem. (2006) p.2039

Research problems to address

Coupling of single molecule experiments to theoretical modeling

Proteins/nucleid acids folding and unfolding

Examination of properties of biological molecules

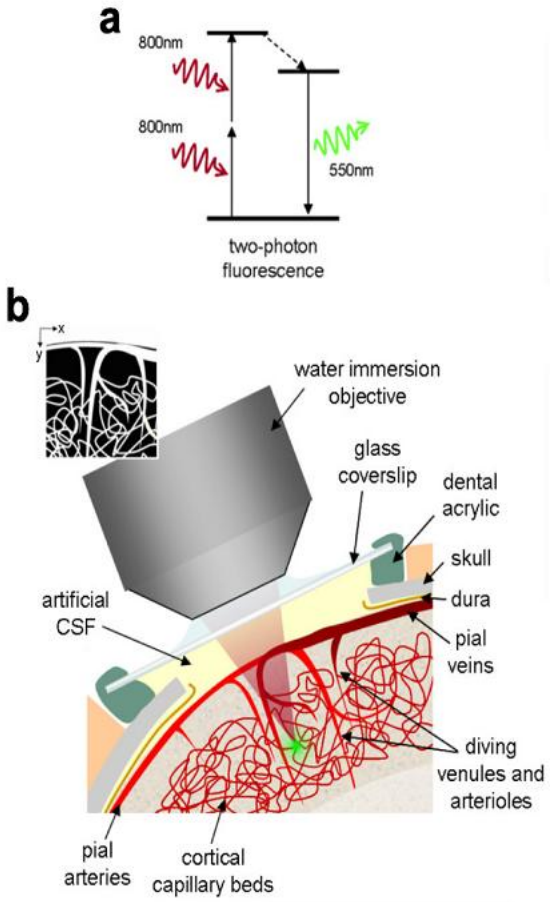
Interaction of biological molecules

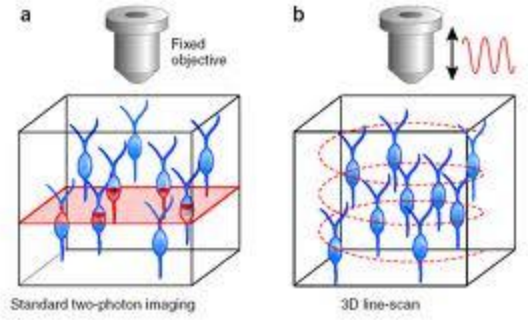
Determination of structure and function of biological molecules

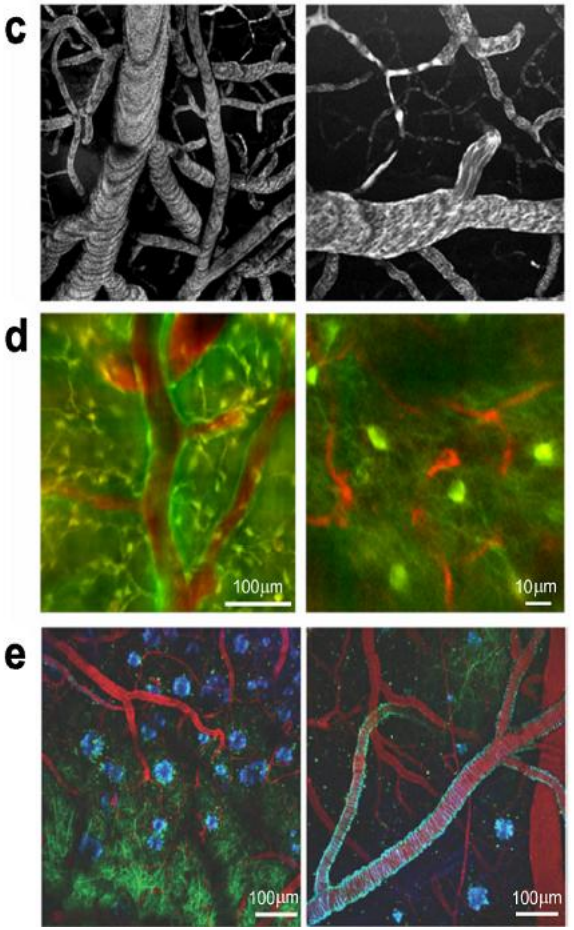
Monitoring target molecules in a cell natural environment

Monitoring of cell functions

MFD *in vivo*? Multiphoton imaging

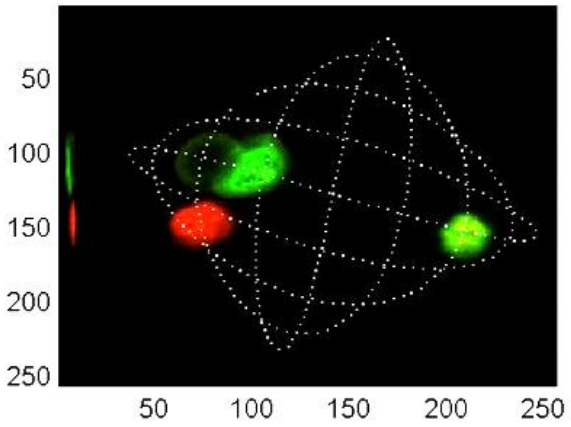


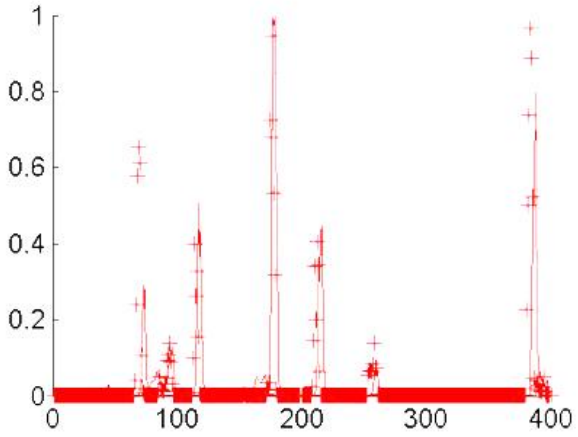




Kherlopian *et al. BMC Systems Biology* 2008 2:74

Unique trajectories

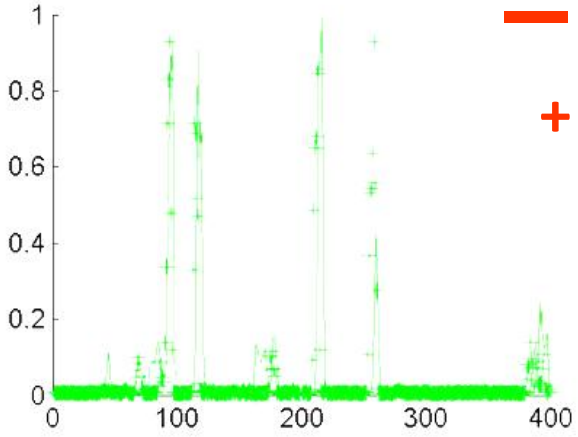




Red channel

Solid line: data from frame image

\+ data from trajectory

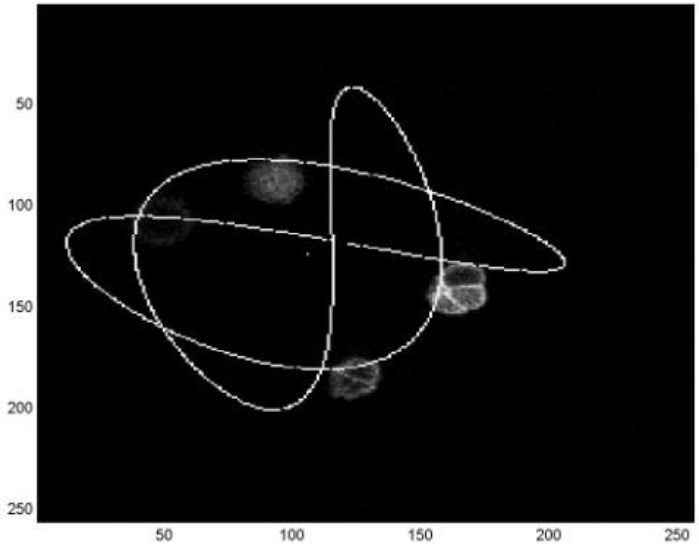


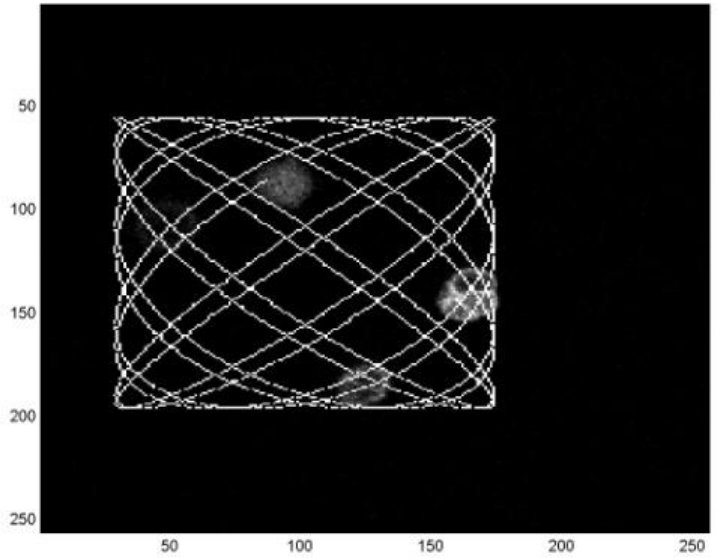
Green channel

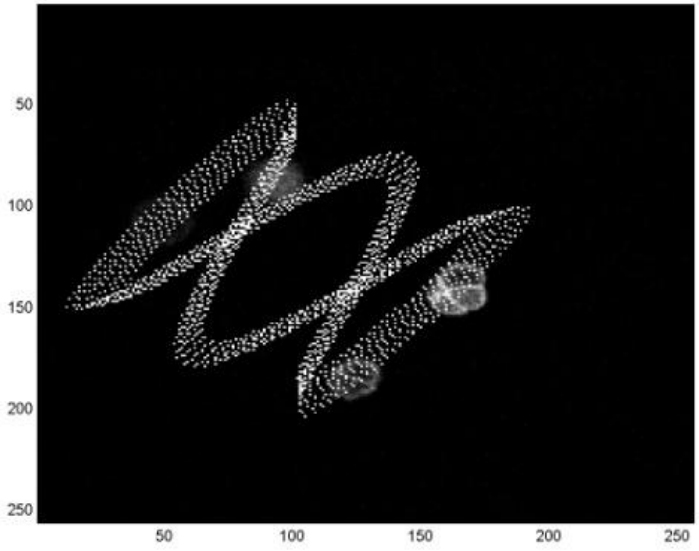
Scanning frequency 1 kHz

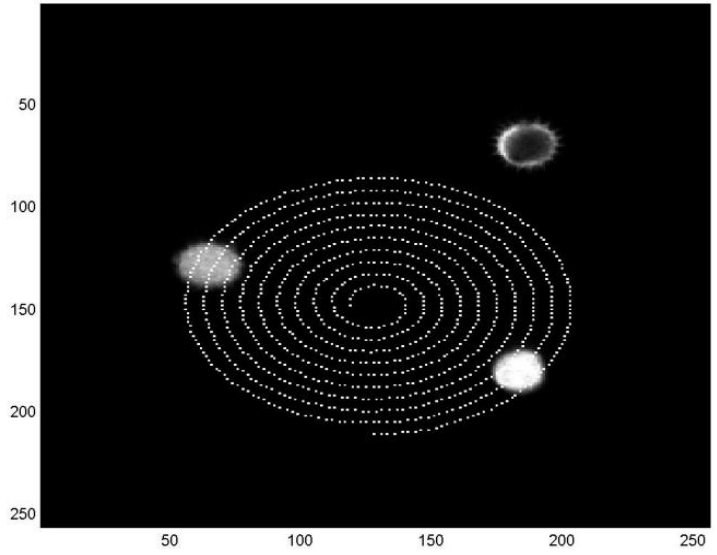
Sołtysiński, in prep.

Novel algorithms for rapid scanning

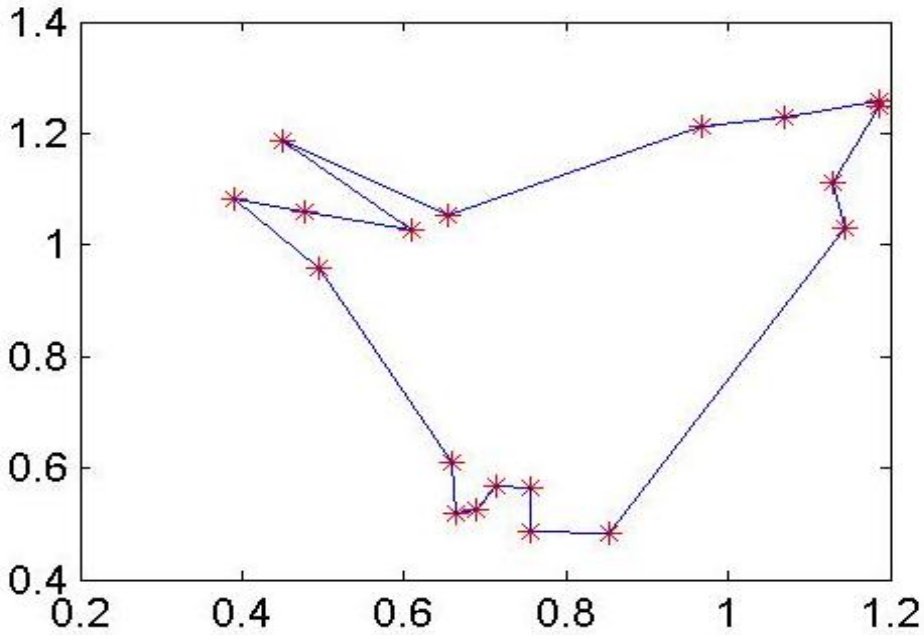


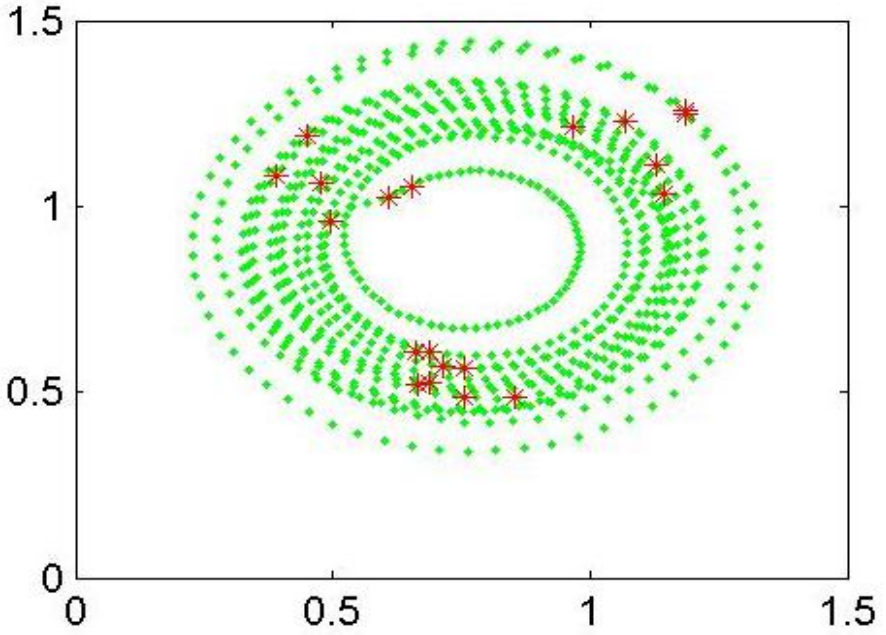






Low inertial scan modes for rapid scanning





Sołtysiński, Proceedings of WMIC 2010

Research problems to adress (*in vivo*)

Tracing the hemodynamic response to a stimulus

Calcium-based imaging in neocortex

Blood flow monitoring at capillary level

Glial and neuronal networks coupling

Disfunction of capillaries in Alzheimer's disease

Dendrites and synapses growth

Gene expression in neuronal cells and optogenetics

Trafficking of tumor cells

Thank you for

your attention!

Early microscopes