State-of-the-art multiphoton tomography and FLIM

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ABSTRACT:

FLIM (fluorescence lifetime imaging) microscopy based on an ultrashort laser scanning microscope and time-correlated single photon counting (TCSPC) was introduced in Jena/Germany in 1988/89. Shortly later, Denk et al. introduced two-photon microscopy using a sub-picosecond dye laser. Multiphoton tomography in humans was introduced in Jena in 2002/2003 after pioneering skin imaging work of Peter So et al. using a two-photon lab microscope.
One major FLIM application in cell biology is the study of protein-protein interactions in live cells by FLIM-FRET microscopy. Clinical FLIM applications are still on a research level and include preliminary clinical studies on one-photon fluorescence lifetime imaging ophthalmology (FLIO) of patients with ocular diseases using picosecond laser diodes, time-gated imaging during brain surgery with a nanosecond nitrogen laser, and two-photon clinical FLIM tomography in patients with skin disorders and brain tumors with near-infrared femtosecond lasers and TCSPC.
Current multiphoton tomographs in Australia, China, Europe, the US, and Russia are mainly used for non-invasive, label-free 4D (x,y,z,tau) *in vivo* histology of murine and human tissue based on two-photon autofluorescence and second harmonic generation (SHG).
Current projects include early diagnosis of black skin cancer, to study skin inflammation, to track intratissue pharmaceutical components, to check the quality of cornea transplants, to visualize pluripotent stem cells in hair follicles, and to detect skin age modifications in astronauts after long-term space flights and in customers after anti-ageing treatments. The add-on CARS module enables intratissue lipid and water imaging.
A novel application of multiphoton tomographs and two-photon TCSC microscopes is 4D imaging of in-bulk recombination dynamics in crystalline grains inside photovoltaic thin films, such as CdTe solar cells.

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Reference
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