NAD(P)H FLIM for Metabolic Imaging: Fast Acquisition, Faster Analysis, Fastest Decay Detection

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For clinical applications an abnormal metabolism is used as hallmark of carcinogenesis. Essential insight into the cellular energy metabolism is gained by imaging of the fast decay of autofluorescence of NADH.

The fast detection and evaluation of the cellular metabolism based on the fluorescence decay parameters is ideally addressed by TCSPC FLIM. TCSPC FLIM data provides excellent time-resolution and photon efficiency which is essential to maximize the acquisition speed typically limited by the photo damage threshold of life cell samples. For clinical application online displaying of the metabolic state is of high interest. Here, we discuss how the first moment parameter can be applied for qualitative real-time indication of the cell metabolism and how accelerated software analysis in SPCimage obtains quantitative results within seconds of post-processing. The combination of time-domain and frequency-domain analysis allows image segmentation via the phasor plot and pixels with similar signature are combined for high-accuracy time-domain analysis. The fit accuracy is massively improved by the maximum-likelihood algorithm. In addition, the fitting is accelerated by GPU processing that runs the de-convolution and fit procedure for a large number of pixels in parallel.

We show the optimized performance of the TCSPC based metabolic imaging system on cancer cells of a human bladder. The system was tested in collaboration with the Medical Center at the University of Freiburg.

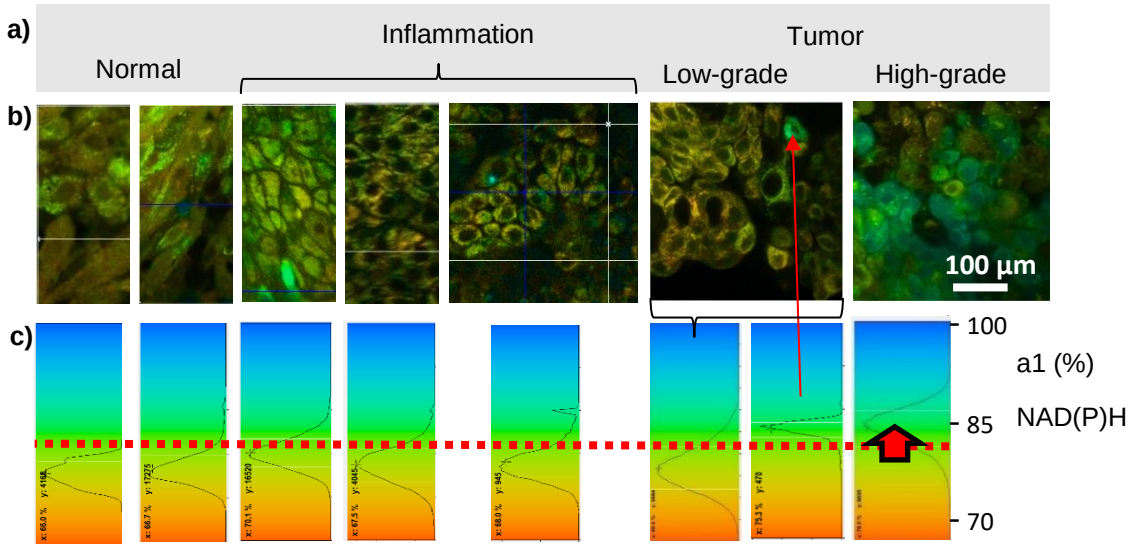

Fig.: NAD(P)H a1 FLIM images of human bladder. Images indicate the metabolism in normal tissue, cells in a region of inflammation and different tumor grades. a) histological findings, b) FLIM a1 images from freshly excised bladder tissue, c) histograms of a1 values integrated over all pixels shown in b). The increase of the a1 values indicates the change of metabolism in tumor cells.