

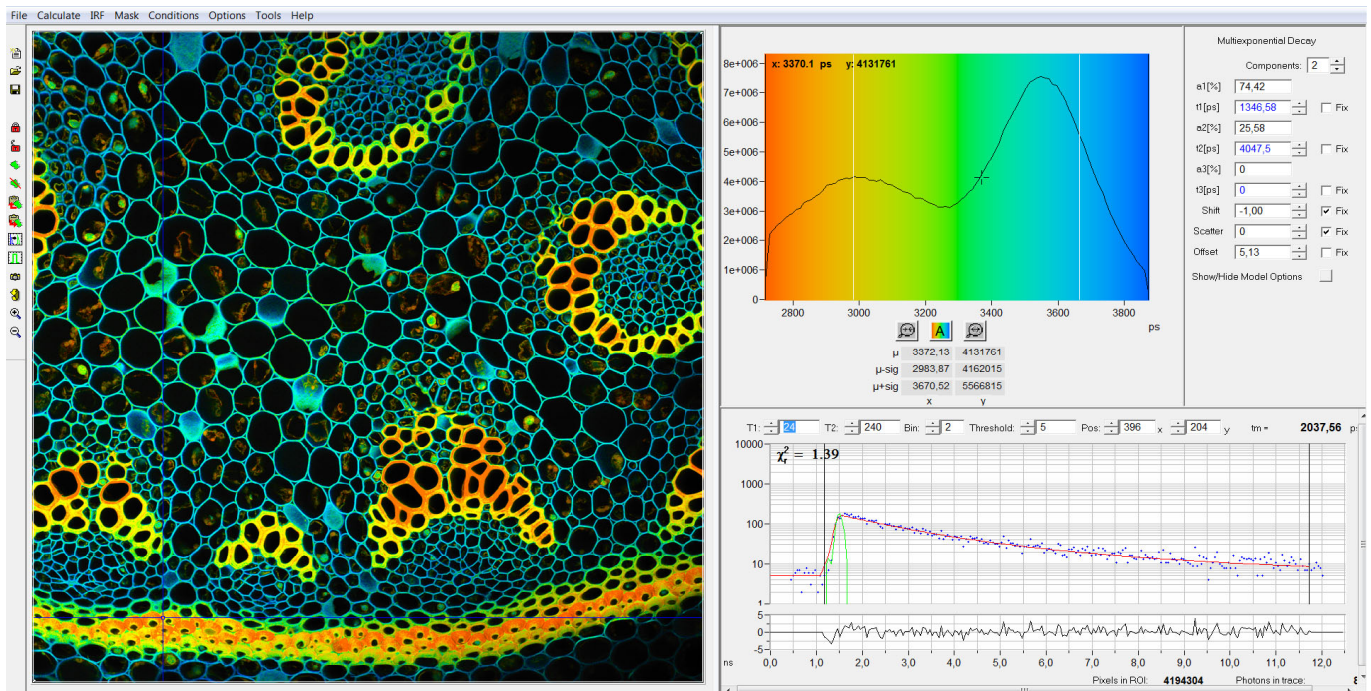
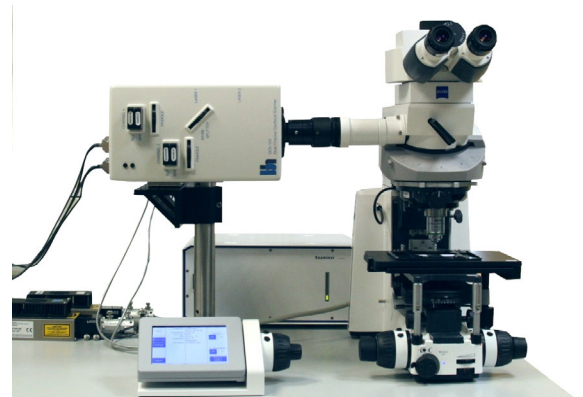
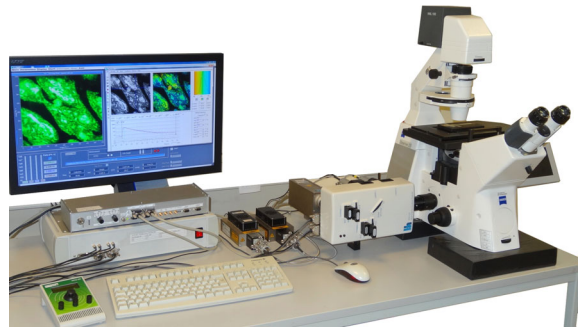
**DCS-120****Confocal Scanning FLIM Systems**

Based on bh's Multidimensional Megapixel FLIM Technology

Complete Laser Scanning FLIM Microscopes

FLIM Upgrades for Existing Conventional Microscopes

FLIM with up to 2048 x 2048 pixels
 Decay curves recorded with up to 4096 time channels
 Time-channel width down to 813 femtoseconds
 One-photon and multiphoton versions
 Scanning by fast galvanometer mirrors
 Two fully parallel detection channels
 One or two BDL-SMN or BDS-MM picosecond diode lasers
 Laser wavelengths 375, 405, 440, 473, 488, 510, 640, 685, 785 nm
 Two confocal detection channels, fully parallel acquisition or
 Two non-descanned detection channels (multiphoton version)
 Channel separation by dichroic or polarising beamsplitters
 Individually selectable pinholes, individually selectable filters
 GaAsP hybrid detectors for visible range
 GaAs hybrid detectors for NIR range
 Ultra-high-speed hybrid detectors
 16-channel multi-wavelength GaAsP detector module
 Fully integrated scan, laser, and detector control
 Z-stack FLIM acquisition with Zeiss Axio Observer Z1
 Spatial Mosaic FLIM via motorised sample stage (optional)
 Online lifetime calculation, online display of lifetime images
 Simultaneous FLIM and PLIM
 Fluorescence lifetime-transient scanning (FLITS)
 Ultrafast time-series recording by temporal mosaic FLIM
 Software for Windows 7 and Windows 10, 64 bit



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Confocal Scanning FLIM Systems

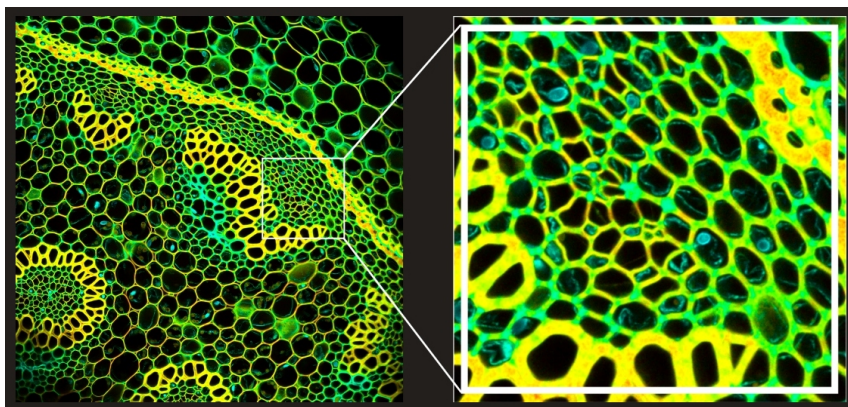
Megapixel FLIM Technology

Extremely large images

Image size up to 2048 x 2048 pixels

Record a large number of cells under identical conditions

Select cells of interest from recorded data



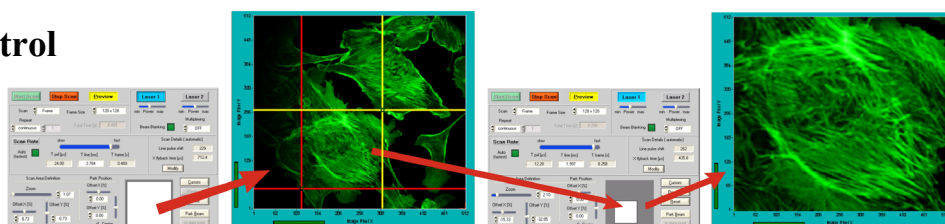
Fast Preview Function

Interactive Scanner Control

Easy focusing and sample positioning

Easy scan area selection

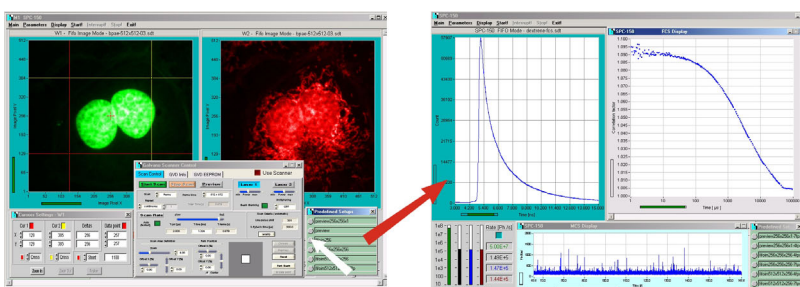
No stop of scanner required



Easy Change of Instrument Configuration

Select system configuration from list of 'Predefined Setups'

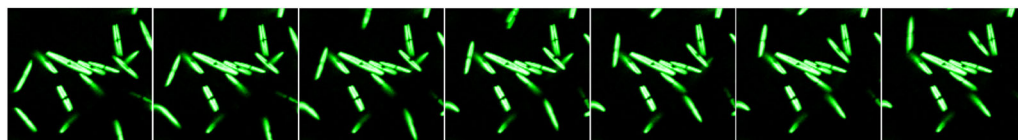
Change instrument configuration on a single mouse click



Fast Scanning

0.5 s snapshots every 1 s

Bacteria caught in flight



Dual-Channel FLIM

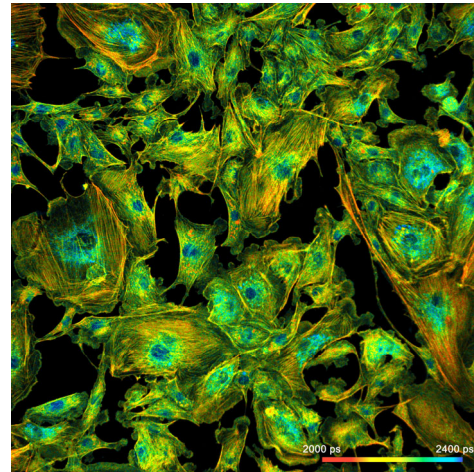
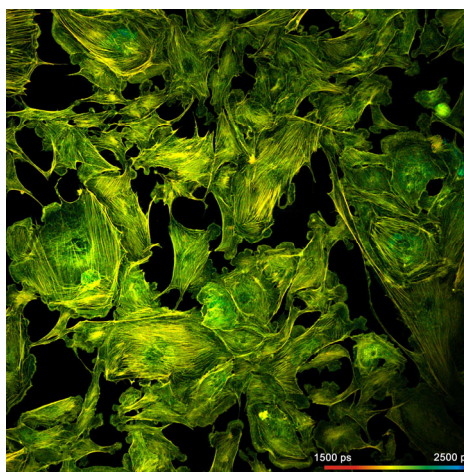
Separate filters and pinholes

Fully parallel TCSPC channels

High data throughput

Short acquisition times

No amplitude or lifetime crosstalk



25 years experience in multi-dimensional TCSPC. More than 1800 TCSPC systems worldwide.



DCS-120

Confocal Scanning FLIM Systems

Multi-Wavelength FLIM

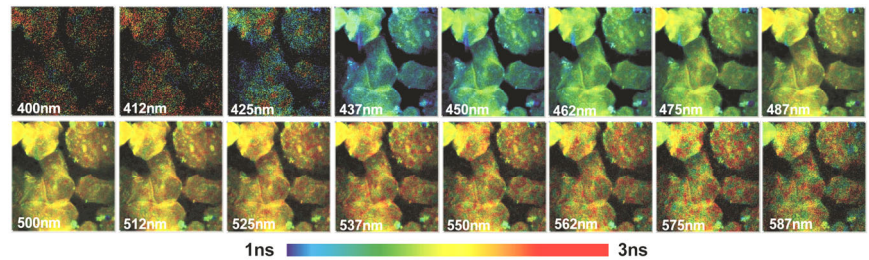
Simultaneous detection in 16 wavelength channels

GaAsP multi-wavelength detector

No wavelength scanning, no time gating

Near-ideal recording efficiency

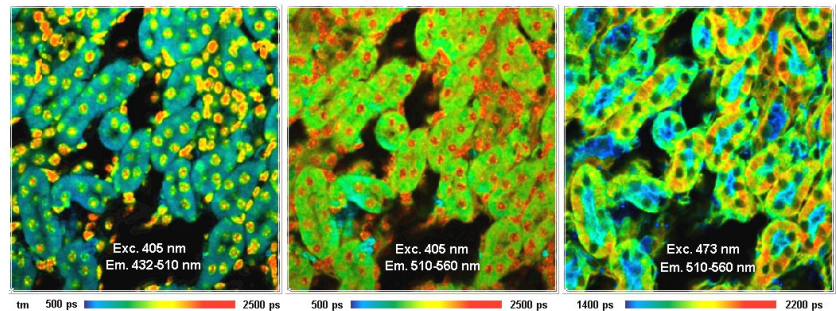
Maximum SNR at minimum sample exposure



Laser Wavelength Multiplexing

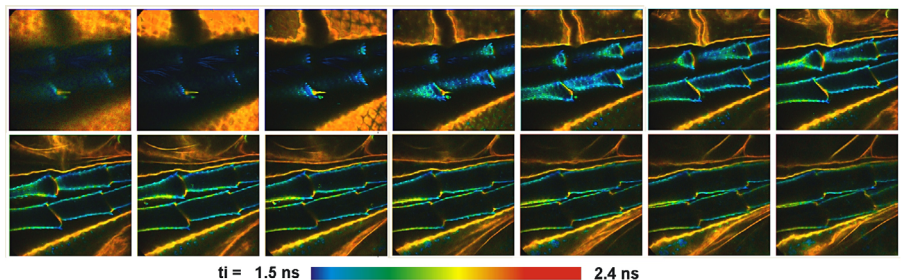
Pixel, line, or frame multiplexing

Separation of fluorophores by excitation and emission wavelength



Z Stack FLIM

Automatic FLIM acquisition in consecutive Z planes



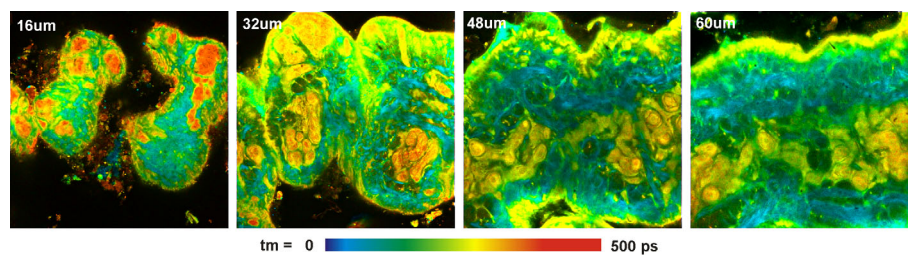
Multiphoton FLIM

Ultra-high sensitivity combined with deep-tissue imaging capability

Simultaneous, fully parallel detection in two wavelength channels

Simultaneous FLIM and SHG imaging

Extraction of SHG component from FLIM data



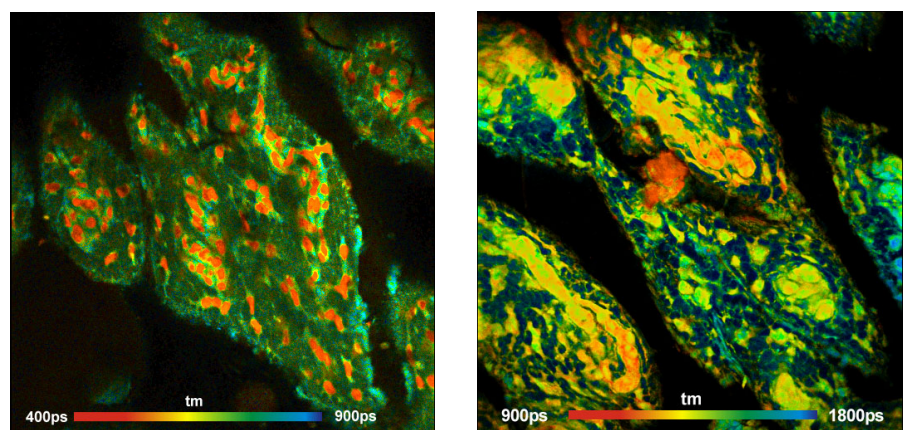
Near-Infrared FLIM

Confocal FLIM with NIR fluorophores

Excitation by ps diode lasers, 640 to 785nm, by supercontinuum laser, or by Ti:Sa laser

Large penetration depth

No autofluorescence background



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DCS-120

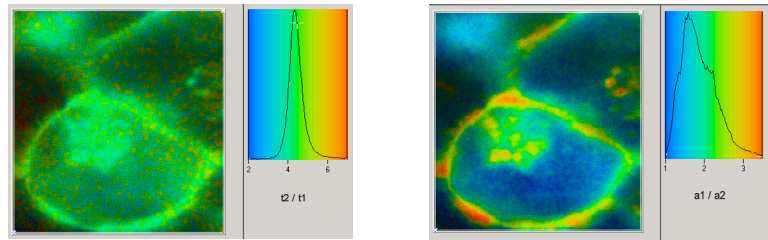
Confocal Scanning FLIM Systems

Multi-Exponential FRET Analysis

FRET, separation of interacting and non-interaction donor

Self-calibrating FRET

Correct conventional FRET efficiencies

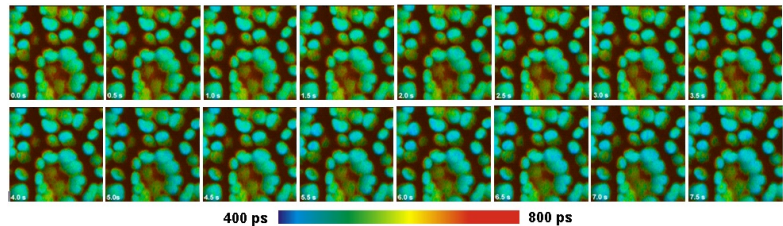


Time-Series FLIM

Time-series as fast as 2 images per second

Physiological effects

Chlorophyll transients

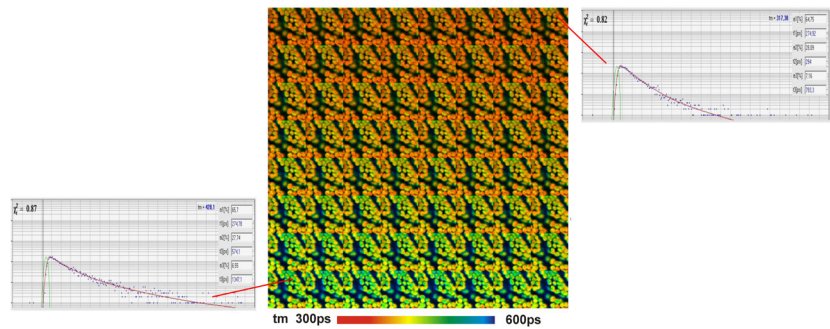


Temporal Mosaic FLIM

Time series at rates down to 40 ms per image

Record Ca^{2+} transients by FLIM

Record chlorophyll transients

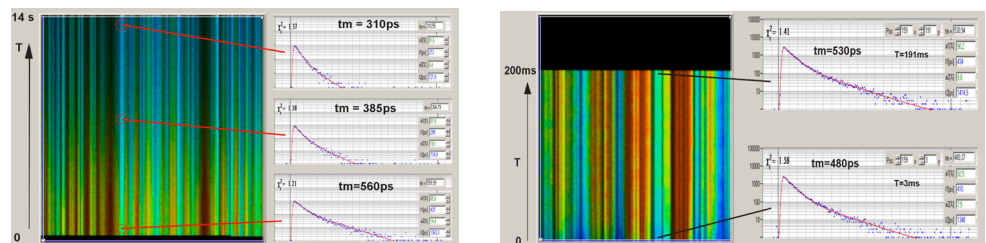


FLITS

Resolve transient lifetime effects down to 1 millisecond by line scanning

Record photochemical chlorophyll transients

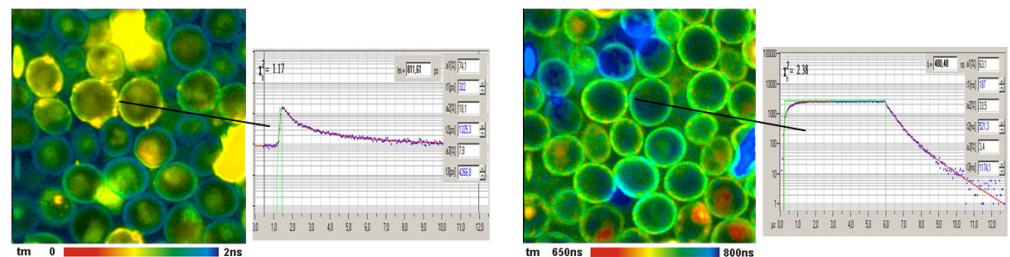
Record Ca^{2+} transients in live neurons



PLIM

Simultaneous recording of phosphorescence and fluorescence lifetime images

Record metabolic effects by FLIM and track O_2 concentration by PLIM



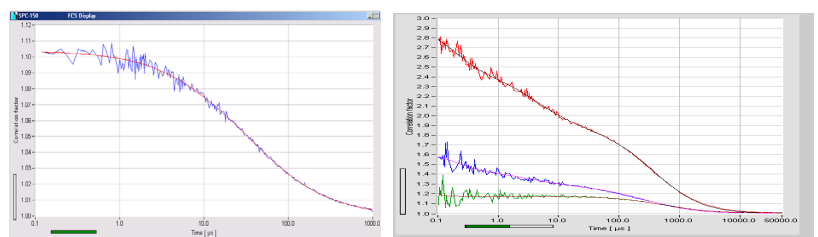
FCS

High-efficiency by GaAsP hybrid detectors

No afterpulsing peak

Online calculation, online fit

Time-gating for suppression of Raman light



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Confocal Scanning FLIM Systems

SPCImage FLIM and PLIM Data Analysis

Single, double, and triple-exponential decay analysis

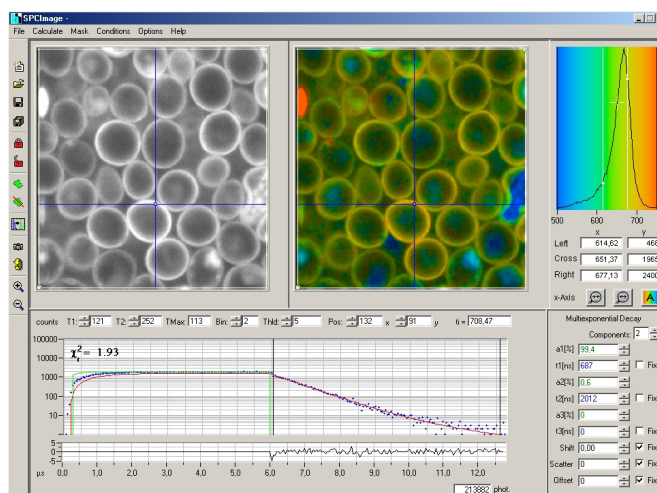
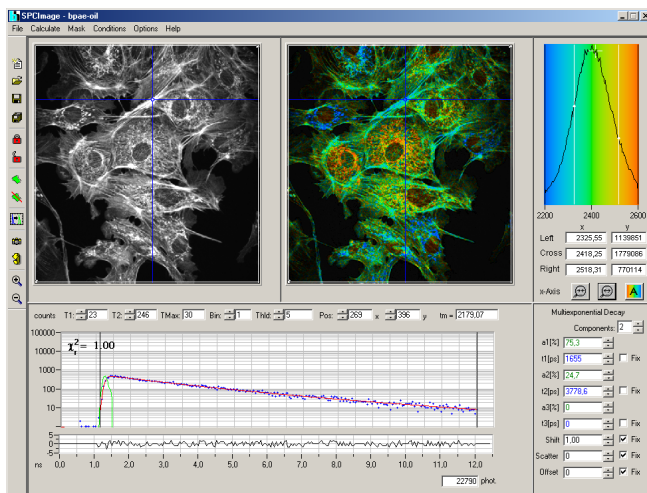
No IFR measurement required

Display of lifetimes, amplitudes, intensities or ratios of decay parameters

Histograms of lifetimes, amplitudes, intensities or ratios of parameters in regions of interest

Phasor plot

Direct interaction with SPCM instrument software



Burst Analyzer Single-Molecule Data Analysis

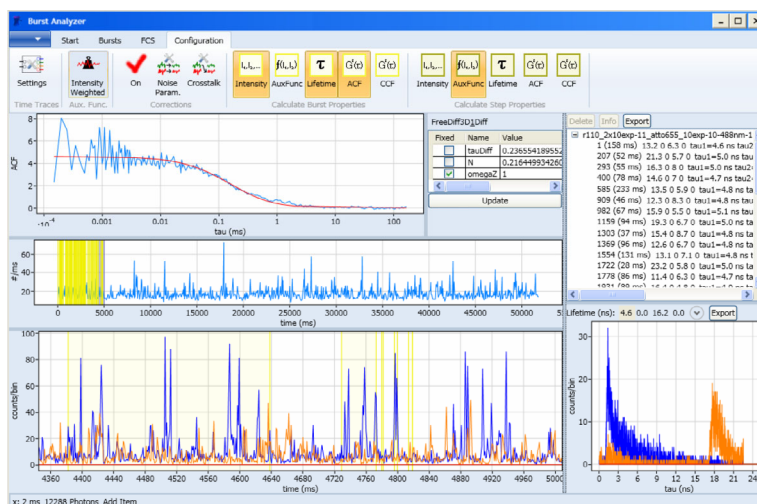
Identification of photon bursts from single molecules in parameter-tag data

Calculation of intensity and lifetime histograms

Calculation of single-molecule FRET intensities

Advanced FCS calculation

Time-gated FCS, selection of time windows in PIE data



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Confocal Scanning FLIM Systems

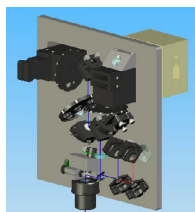
System Components

Lasers



Available Wavelengths	375nm, 405 nm, 445 nm, 473 nm, 488 nm, 515nm, 640nm, 685nm, 785nm
Repetition rates	20 MHz, 50 MHz, 80 MHz, CW
Pulse width	375nm to 445nm: typ. 40 ps 473nm to 785nm: typ. 60 ps
Intensity control, electronic	1:10
Beam correction optics	Beam-profile and astigmatism correction
Fibre coupling	Single-mode, into Qioptiq fibre
Power delivered into fibre:	405 nm: 1 mW, 440 nm: 0.4 mW, 473 nm: 0.4 mW, 488 nm: 0.4 mW
Laser Multiplexing	Within each pixel, line by line, or frame by frame, PIE
Beam blanking	During x and y flyback, via bh GVD-120 scan controller

Scanner



Laser inputs	Point-Source Kineflex push-and click fibre manipulator
Laser power regulation, optical	Attenuators, 1:1 to 1:50
Laser beam combiner	Dichroic mirror
Scanner	Close-coupled galvanometer mirrors
Main beamsplitter	Dichroic 420 nm, 450 nm, 490 nm, 405/473 nm
	80:20 mirror
Secondary beamsplitter	Beamsplitter wheel. Dichroics 510 nm, 560 nm, polarising beamsplitter, 100% channel 1, 100% channel 2. Other dichroics on request
Pinholes	From approx. 0.5 AU to 10 AU ¹⁾
Filters	Filter sliders, standard filters LP 435, LP 485, BP 480/40, BP535/30, BP 620/60

Detectors



GaAsP hybrid detectors	HPM-100-40 hybrid PMT modules. IRF width 130 ps ²⁾
Standard PMTs	PMC-100-1 or -20 cooled PMT modules. IRF width 180 ps ²⁾
High-speed MCP-PMTs	R3809U-50 MCP PMTs, IRF width 70 ps ²⁾
Multi-wavelength detector	bh MW FLIM GaAsP detector. Please see individual data sheet.
Detector control	Gain, cooling, overload shutdown, via bh DCC-100 detector controller

TCSPC Modules



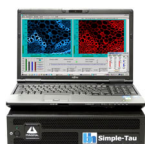
1 SPC-150 TCSPC module	Single-channel FLIM systems with one HPM-100-40, one PMC-100, or one multispectral FLIM detector
2 SPC-150 TCSPC modules	Dual-channel FLIM systems with two HPM-100-40, two PMC-100, or two multispectral FLIM detectors
	High-speed FLIM systems

Scanner Control



Scan controller	bh GVD-120 (single-slot PCI module)
Generation of scan signals	Hardware, digital signal synthesis
Image size	16 x 16 to 2048 x 2048
Max. scan rate, time/frame	128x128: 0.32s, 256x256: 0.6s, 512x512: 1.5s ³⁾
Zoom factor	1:1 to 1:10 ⁴⁾
Beam blanking	During flyback, on / off selectable
Laser multiplexing	Pixel by pixel, line by line, or frame by frame
Beam park function	any location within scan area
Scan control software	Integrated in standard SPCM TCSPC software
Galvo driver amplifier	bh GVP-120

Electronics box and system computer



Lap-top PC with PCI-extension box	Extension box contains: 1 or 2 SPC-150 TCSPC modules 1 GVD-120 scan controller 1 DCC-100 detector controller
Also available:	SPC, GVD, and DCC modules installed in standard PC

1) depends on microscope lens used
2) Includes pulse width of ps diode laser
3) maximum scan rate depends on zoom factor
4) useful zoom range depends on microscope



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Confocal Scanning FLIM Systems

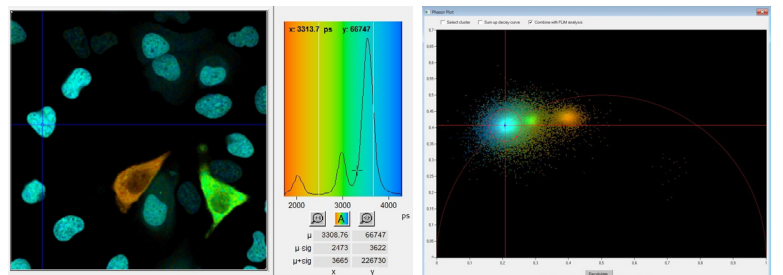
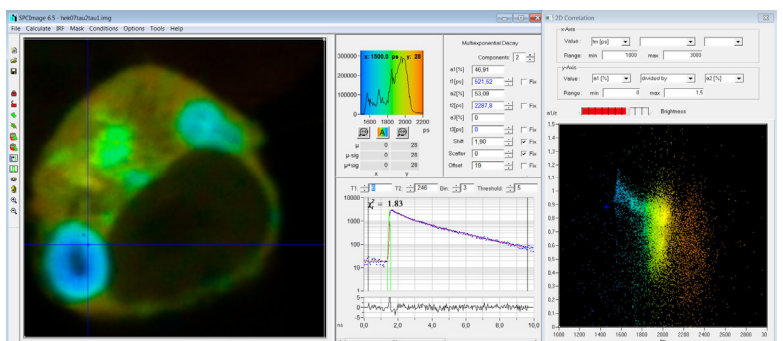
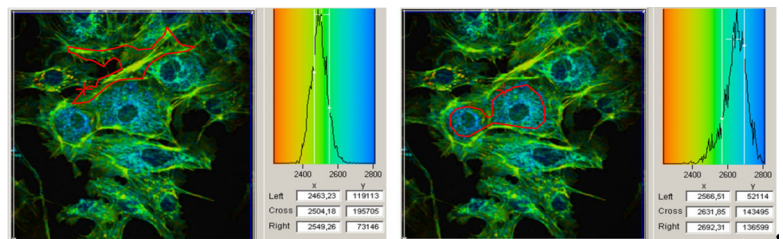
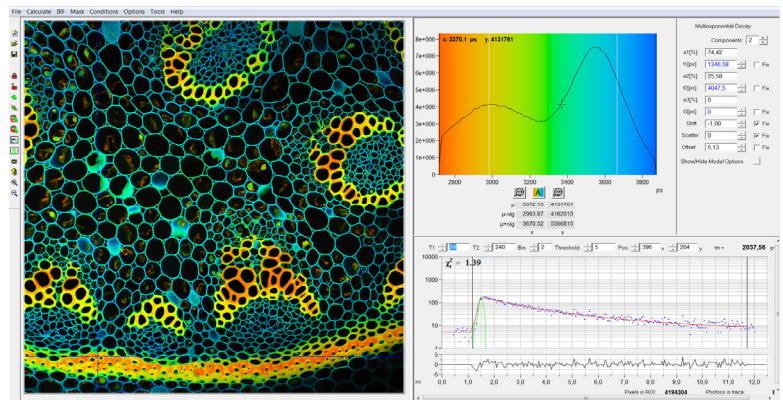
SPCImage FLIM Data analysis

The gold standard in FLIM analysis

- Analysis of FLIM and PLIM data
- Analysis by iterative convolution and fit procedure
- Analysis by first moment of photon distribution
- Combination of time-domain analysis and phasor plot
- Automatic IRF determination
- Multi-tread calculation procedure
- Single, double, and triple-exponential decay models
- Incomplete decay models
- Baseline correction
- Free or fixed lifetimes of decay components
- Pseudo-global analysis
- Synthetic, measured or manually defined IRF
- Extraction of IRF from SHG components in FLIM image
- Region-of-interest selection
- Single and double-exponential FRET
- Display of lifetime images
- Display of FRET images
- Display of lifetimes, amplitudes, intensities
- Display of ratios of parameters
- Calculation of FRET efficiencies
- Histograms of lifetimes, amplitudes, or parameter ratios
- Multiple region of interest definition
- Two-dimensional histograms of decay parameters
- Phasor plot
- Export of lifetime data
- Export of images
- Direct interaction with SPCM software
- Automatic transfer of SPCM data to SPCImage
- Transfer of data of selected channels or of all channels
- Processing of Megapixel FLIM data
- Processing of Mosaic FLIM data
- Batch processing of multiple FLIM files
- Batch processing of multi-wavelength FLIM data
- Batch export of FLIM images and decay data

For detailed description please see:

FLIM Systems for Zeiss LSM 710 / 780 / 880 family
laser scanning microscopes, user handbook, 7th edition
(2017), www.becker-hickl.com



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**DCS-120****Confocal Scanning FLIM Systems****TCSPC Technique**

	Single-Detector Systems	Dual-Detector Systems	Multi-Spectral Systems
TCSPC system	Simple-Tau 150	Simple-Tau 152	Simple-Tau 150
Components	Lap-top computer PCI extension box SPC-150 TCSPC module DCC-100 detector controller	Lap-top computer PCI extension box Two SPC-150 TCSPC modules DCC-100 detector controller	Lap-top computer PCI extension box SPC-150 TCSPC module DCC-100 detector controller
Saturated count rate	10 MHz	20 MHz	10 MHz
Sustained count rate			
Scan Sync In mode	10 MHz	20 MHz	10 MHz
FIFO Imaging Mode	4 MHz	4 MHz	4 MHz
Scan rate	any	any	any
Scan synchronisation	via pixel clock, line clock and frame clock in all imaging modes		
Zoom	automatic zoom with zoom in microscope		
Online display	in programmable intervals, 1 second or larger		
Max. image size, 64 bit SPCM software			
$px_l \times px_y \times \Delta t$	2048x2048x256	2x 2048x2048x256	16x 512x512x64
(examples)	1024x1024x1024	2x 1024x1024x1024	16x 512x512x256
	512x512x4096	2x 512x512x4096	16x 256x256x1024
	256x256x4096	256x256x4096	

Requirements to Microscope

Confocal FLIM

MP FLIM with NDD

Side port of microscope available

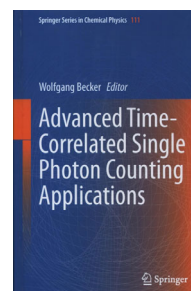
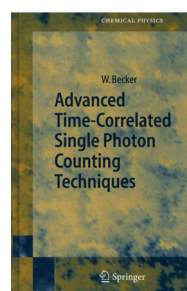
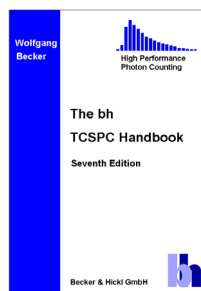
Side port and Lamp port or NDD port available

More specifications: Please see [1] or [2]

Other FLIM configurations: Please note that the bh FLIM systems are highly modular. Therefore a large number of different FLIM system configurations are possible. Please see [1] for details or contact bh.

Literature:

- [1] DCS-120 confocal scanning FLIM systems, user handbook, 7th ed., www.becker-hickl.com
- [2] DCS-120 confocal scanning FLIM systems. Overview brochure. www.becker-hickl.com
- [3] The bh TCSPC Handbook, 7th ed., www.becker-hickl.com
- [4] W. Becker, Advanced Time-correlated single photon counting techniques. Springer 2005
- [5] W. Becker, ed., Advanced time-correlated single photon counting applications. Springer 2015



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