

# Becker & Hickl GmbH

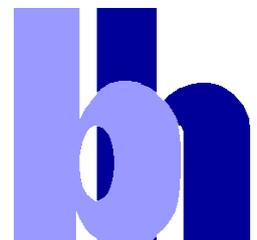
Technology Leader in Photon Counting

## Product Catalog

 **Boston** Electronics

**2023**

[www.boselec.com](http://www.boselec.com)  
[tcspc@boselec.com](mailto:tcspc@boselec.com)  
617.566.3821

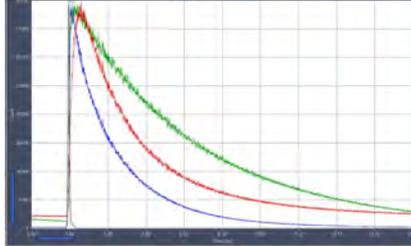


## About bh

Founded in 1993, Becker & Hickl have introduced a proprietary time-correlated single-photon counting principle that made TCSPC more than 100 times faster than the existing devices. Moreover, bh introduced a multi-dimensional TCSPC process that records the photons not only versus the time in the signal period, but also versus other parameters, such as experiment time, wavelength, or spatial coordinates. The bh devices are designed to record multi-dimensional photon distributions, time-resolved images, sequences of photon distributions, or multi-dimensional time-tag data. The bh TCSPC products are complemented by bh picosecond diode lasers, detector modules, multi-spectral detector assemblies, and experiment control modules. Based on these components Becker & Hickl supply their own confocal fluorescence lifetime laser scanning microscope and FLIM upgrade kits for laser scanning microscopes of various manufacturers. Moreover, bh is supplier of TCSPC and lasers for clinical FLIM devices. Bh market activities include currently five workshops around the world yearly and the distribution of more than 1500 pages of TCSPC literature.

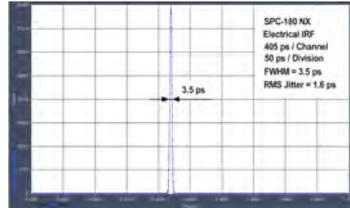
- 1993 Introduction of multidimensional TCSPC. Introduction of fast TAC/ADC conversion. TCSPC becomes 100 times faster than it was before.
- 1994 SPC-330 modules. Improved IRF width. Routers for parallel operation of detectors.
- 1995 SPC-430 modules. Continuous Flow mode for infinite sequential recording. Saturated count rate 8 MHz. First single-molecule applications.
- 1996 SPC-432 modules. Introduction of Time-Tag recording for single molecule spectroscopy. First version of PML-16 sixteen channel PMT module.
- 1996 SPC-535 modules. First implementation of TCSPC FLIM. First FLIM applications in laser scanning ophthalmology.
- 1997 SPC-630 modules. Introduction of PCI bus. Modules contain time-tag mode, standard photon distribution modes, and continuous flow mode.
- 1998 SPC-730 modules. Introduction of TCSPC FLIM. Scan Sync In and Scan Sync out mode. First applications in FLIM microscopy.
- 1999 SPC-130 TCSPC board. SPC-134 four-channel packages for optical tomography. Saturated sustained count rate 32 MHz.
- 2000 FLIM upgrade kits for Zeiss LSM 510 NLO microscopes. SPCImage FLIM data analysis software. BHL-600 red and NIR picosecond diode lasers.
- 2001 SPC-830 modules. For the first time, FLIM and single-molecule techniques were combined in one instrument.  
DCC-100 detector controller solves the problem of detector overload.
- 2002 FLIM systems for Leica, Olympus, and Biorad laser scanning microscopes. First multi-spectral FLIM. First demonstration of double-exponential FRET imaging. BDL-405 UV picosecond diode lasers.
- 2003 BDL-375, 440, and 473 picosecond diode lasers. PML-16 multi-wavelength detector.
- 2004 Simple-Tau 140 and Simple-Tau 830 compact TCSPC systems. First multi-spectral NDD FLIM systems for multiphoton microscopes.  
Macro-time synchronisation of several TCSPC modules. First full correlation down to the picosecond region.
- 2005 New PML-16 sixteen channel detector. Internal high-voltage generator, overload shutdown, control via DCC-100.  
High-efficiency single-mode fiber coupling of BDL picosecond diode lasers. First edition of bh TCSPC Handbook.
- 2006 High-power CW mode for BDL-SMC picosecond diode lasers.
- 2007 DCS-120 confocal laser scanning systems. Complete fluorescence-lifetime laser scanning microscopes. DPC-230 16 channel photon correlator.  
SPC-154 package and SPC-150 modules.
- 2008 FLIM systems for Zeiss LSM 710 microscopes. NDD FLIM systems for Leica SP2 MP and SP5 MP microscopes. Simple-Tau 152 and -154 two and four channel TCSPC systems.
- 2009 HPM-100-40 GaAsP hybrid detectors. 8-channel parallel TCSPC and TCSPC FLIM systems.
- 2010 Eight-channel SPAD detector. GaAsP hybrid detectors in all bh FLIM systems. Z stack FLIM. 4th edition of bh TCSPC Handbook.
- 2011 Phosphorescence Lifetime imaging (PLIM) in DCS-120 and Zeiss LSM 710 FLIM systems. Fluorescence Lifetime-Transient Scanning (FLITS).  
DCS-120 Wideband, DCS-120 Multiphoton, and DCS-120 Macro FLIM systems
- 2012 DCS-120 electronic alignment, NIR FLIM, FLITS integrated in DCS-120 and LSM 710 FLIM systems, 5th edition of bh TCSPC Handbook.
- 2013 MW-FLIM and PML-16 GaAsP multi-wavelength detectors, SPC-150N TCSPC module, BDL-SMN series and BDS series picosecond diode lasers.  
Single-molecule burst analysis software.
- 2014 64-bit SPCM software. Megapixel FLIM, Mosaic FLIM, triggered accumulation of time series by mosaic FLIM, Z stack recording by Mosaic  
FLIM. SPC-160 TCSPC modules. 6th edition of bh TCSPC Handbook.
- 2015 Imaging of Ca<sup>2+</sup> transients in neurons. SPC-150NX module, world record in TCSPC time resolution with superconducting NbN detector. Fiber-  
based TCSPC systems for in vivo applications. W. Becker (ed.), Advanced Time-Correlated Single Photon Counting Applications.
- 2016 Fast Online FLIM, FLIM with Abberior STED microscopes, SPC-160PCIe, DCC-100PCIe, GVD-120PCIe PCI-Express TCSPC, Detector Control,  
and Scan Control modules. Simple Tau II TCSPC systems with Thunderbolt interface. FLIM for Sutter Instrument MOM microscopes.
- 2017 Sub-20 ps (FWHM) IRF width with new HPM-100-06 and -07 hybrid detectors. Spatial Mosaic FLIM with with DCS-120 confocal and  
multiphoton FLIM systems. Phasor analysis integrated in SPCImage. SPCM Software controls Ti:Sa laser, AOM, and motorised sample stage.  
7th edition of bh TCSPC Handbook.
- 2018 FASTAC fast-acquisition FLIM system, 25 ps with fast HPM detectors.
- 2019 Metabolic FLIM with multiplexed diode lasers. Parallel detection of NADH and FAD fluorescence. SPCImage NG next-generation FLIM analysis  
software. MLE fit and GPU Processing. 4.4 ps FWHM with single-nanowire SSPD. New world record in TCSPC time resolution
- 2020 Metabolic FLIM with multiplexed 2p-excitation. SPCImage NG data analysis. Max-Tau 12-Channel TCSPC system. LHB-104 Laser Hub with  
four ps diode lasers, common single-mode fibre output.
- 2021 Ultra-Fast TCSPC/FLIM Modules with fast PCIe Interface: SPC-180NX and SPC-130INX. 9th edition of bh TCSPC Handbook.
- 2022 USB-controlled ps diode lasers: BDU-SM series; three Channel TCSPC/FLIM Module with fast PCIe Interface: SPC-QC-104.

## bh Modular TCSPC Systems - Unsurpassed in Time Resolution



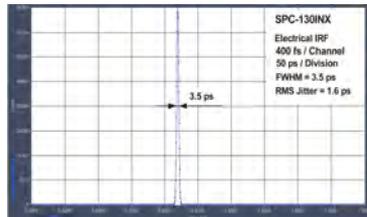
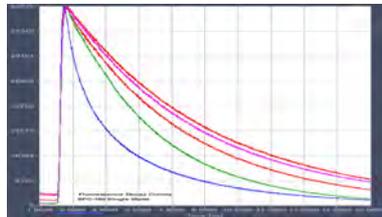
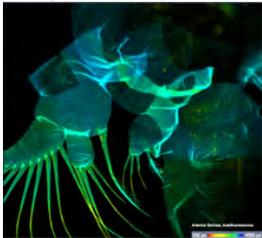
### New: SPC-QC-104: Three Channel TCSPC / FLIM Module - Fast PCIe Interface

SPC-QC-104: Electrical response <40 ps FWHM, timing jitter <20 ps RMS  
 Three Parallel TCSPC/FLIM Channels, one Synchronisation/Reference Channel or Four Parallel Absolute Timing Channels  
 Adjustable SYNC Delay  $\pm 128$  ns  
 Minimum time channel width 4 ps  
 Low dead time  
 High-peak cCount rate, up to 120 MHz  
 Recording of fluorescence decay and other optical waveforms  
 Multi-wavelength detection of fluorescence decay and FLIM data  
 Photon time- and parameter tagging  
 Photon correlation down to the ps range



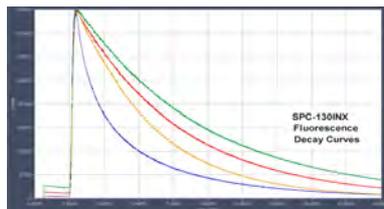
### SPC-180N Series: Ultra-High Resolution TCSPC / FLIM Module - Fast PCIe Interface

SPC-180N: Electrical response 6.5 ps FWHM, timing jitter 2.5 ps RMS  
 SPC-180NX: Electrical response 3.5 ps FWHM, timing jitter 1.5 ps RMS  
 SPC-180NX: Electrical response 2.5 ps FWHM, timing jitter 1 ps RMS  
 Ultra-fast discriminators, 5 GHz input bandwidth  
 Ultra-fast timing for ultra-fast detectors  
 Ideal for fast HPDs, SPADs, SSPDs  
 Minimised low-frequency timing noise  
 Minimum time channel width 813 fs / 407 fs / 203 fs  
 Recording-time interval from 0.8 ns to 5  $\mu$ s, resolved into 4096 time channels  
 Dead time 80 ns, saturated count rate 12 MHz  
 Internal histogramming modes and Photon stream (parameter tag) modes  
 Classic TCSPC, phosphorescence lifetime detection, FCS, Photon Correlation  
 Multi-wavelength recording, Ultra-fast triggered time series,  
 Laser-wavelength multiplexing  
 Part of bh modular FLIM systems  
 Four-Module packages available



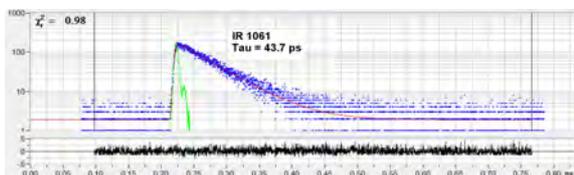
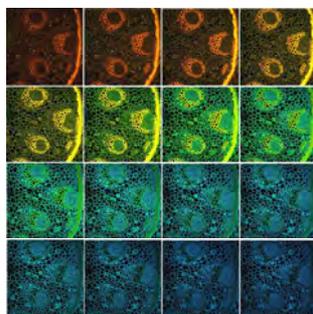
### SPC-130IN Series: Ultra-High Resolution TCSPC Module - Fast PCIe Interface

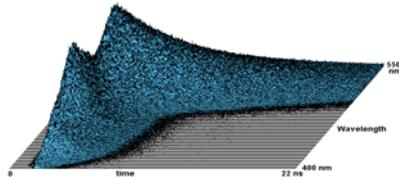
The module for non-FLIM applications  
 SPC-180N technology  
 SPC-130IN: Electrical response 6.5 ps FWHM, timing jitter 2.5 ps RMS  
 SPC-130INX: Electrical response 3.5 ps FWHM, timing jitter 1.5 ps RMS  
 SPC-130INX: Electrical response 2.5 ps FWHM, timing jitter 1 ps RMS  
 Ultra-fast discriminators, 5 GHz input bandwidth  
 Ultra-fast timing for ultra-fast detectors  
 Ideal for fast HPDs, SPADs, SSPDs  
 Minimised low-frequency timing noise  
 Minimum time channel width 813 fs / 407 fs / 203 fs  
 Recording-time interval from 0.8 ns to 5  $\mu$ s, resolved into 4096 time channels  
 Dead time 80 ns, saturated count rate 12 MHz  
 Internal histogramming modes and Photon stream (parameter tag) modes  
 Classic TCSPC, phosphorescence lifetime detection, FCS, Photon Correlation  
 Multi-wavelength recording, Ultra-fast triggered time series,  
 Laser-wavelength multiplexing  
 Four-Module packages available



### SPC-150N Series: Ultra-High Resolution TCSPC / FLIM Module - PCI Interface

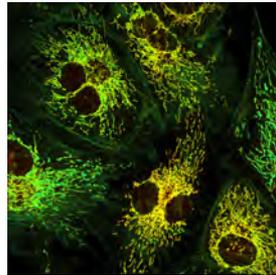
SPC-150N: Electrical response 6.6 ps FWHM, timing jitter 2.5 ps RMS  
 SPC-150NX: Electrical response 3.5 ps FWHM, timing jitter 1.6 ps RMS  
 SPC-150NX: Electrical response <3 ps FWHM, timing jitter 1.1 ps RMS  
 Ultra-fast discriminators, 5 GHz input bandwidth  
 Ideal for fast HPDs, SPADs, SSPDs  
 Extra-low low-frequency timing noise  
 Minimum time channel width 813 fs  
 Minimum time channel width 813 fs / 407 fs / 203fs  
 Recording-time interval from 0.8 ns to 5  $\mu$ s, resolved into 4096 time channels  
 Internal histogramming modes and Photon stream (parameter tag) modes  
 Multi-detector / multi-wavelength / laser multiplexing operation  
 Triggered Multichannel Scaler (phosphorescence) mode  
 High-speed FLIM / PLIM / FLITS for laser scanning microscopes  
 Megapixel Technology: Mosaic, Time Series, Z-stack, Multi-spectral FLIM  
 FCS / FCCS in combination with fluorescence lifetime  
 Single-molecule multi-parameter burst analysis  
 Unlimited fast sequential recording for DOT systems  
 Dead time 100 ns, saturated count rate 10 MHz  
 Part of bh modular FLIM systems  
 Direct plug-in for older SPC-150 modules  
 Four-Module packages available





**SPC-130-EMN Series**

Module for non-FLIM applications  
 Improved SPC-130 with larger memory  
 SPC-150N technology  
 SPC-130-EMN: Electrical response 6.6 ps FWHM, timing jitter 2.5 ps RMS  
 SPC-130-EMNX: Electrical response 3.5 ps FWHM, timing jitter 1.6 ps RMS  
 SPC-130-EMNXX: Electrical response <3 ps FWHM, timing jitter 1.1 ps RMS  
 Photon distribution, parameter-tag, sequential-recording modes  
 Standard fluorescence and phosphorescence lifetime, diffuse optical tomography, single-molecule spectroscopy, FCS, photon correlation  
 Fluorescence decay with ultra-fast detectors  
 Rugged design  
 Direct plug-in for older SPC-130 modules  
 Four-Module packages available



**SPC-160: High Performance in All TCSPC Applications**

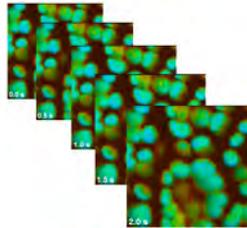
Internal histogramming modes and photon stream (parameter tag) modes  
 Multi-detector / multi-wavelength / laser multiplexing operation  
 Triggered multichannel scaler (phosphorescence) mode  
 High-speed FLIM / PLIM / FLITS for laser scanning microscopes  
 Megapixel Technology: Mosaic, Time Series, Z-stack, Multi-spectral FLIM  
 High-speed parallel imaging channel  
 FCS / FCCS in combination with fluorescence lifetime  
 Single-molecule multi-parameter burst analysis  
 Unlimited fast sequential recording for fNIRS / DOT systems  
 Dead time 80 ns, saturated count rate 12.5 MHz  
 Ultra-fast discriminators, 5 GHz input bandwidth  
 Extra-low low-frequency timing noise  
 Part of bh modular FLIM systems



**SPC-160PCIe TCSPC Module with PCI Express Interface**

Functions and parameters see SPC-160  
 Part of Simple-Tau II system

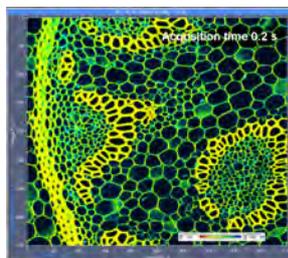
**Four-Module TCSPC / FLIM Packages**



- Four Parallel SPC-180N, NX, or NXX modules**
- Four Parallel SPC-130IN, INX, or INXX modules**
- Four Parallel SPC-150N, NX, or NXX modules**
- Four Parallel SPC-130EMN, EMNX, or EMNXX modules**

High count rate, high data throughput  
 Multi-dimensional photon distribution mode  
 Multi-detector / multi-wavelength operation / laser multiplexing operation  
 Photon stream (parameter tag) mode; buffer size 2 M photons  
 Triggered MCS (phosphorescence) mode  
 Synchronisation of channels for photon correlation  
 High-speed FLIM / PLIM / FLITS for laser scanning microscopes  
 Single-molecule multi-parameter burst analysis  
 Unlimited fast sequential recording for fNIRS / DOT systems  
 Total recordable count rate 24 MHz, saturated count rate 48 MHz  
 Each channel expandable for up to 8 detectors  
 Part of bh FASTAC Fast-Acquisition FLIM System

**FASTAC Fast-Acquisition FLIM System**



Photons distributed into four parallel SPC-150NX or SPC-180NX Modules  
 Count rates up to 40 MHz  
 Acquisition times down to 100 ms  
 Image rate up to 10/s  
 No compromise in time resolution and time channel width  
 IRF width 25 ps FWHM with fast HPM detectors  
 Time-channel width down to 407 fs  
 Images up to 2014 x 2024 pixels, 1024 time channels  
 Acquisition time down to 100 ms for 256 x 256 pixel images  
 Fast acquisition FLIM or Precision FLIM  
 Temporal and Lateral Mosaic FLIM  
 Simultaneous FLIM / PLIM  
 Works with DCS-120, DCS-120 MACRO, and Zeiss LSM 880 / 980

## Simple-Tau Compact TCSPC and TCSPC-FLIM Systems



### Simple-Tau 150N, and -160 Compact TCSPC Systems

- One SPC-150N, or SPC-160 TCSPC channel
- One DCC-100 detector controller
- Portable DOT systems
- High-Speed FLIM systems
- Compatible with bh multispectral FLIM detectors
- Part of bh DCS-120 confocal scanning FLIM systems
- Part of bh FLIM systems for Zeiss LSM 510 and LSM 710 family
- Part of bh NDD FLIM systems for Leica SP2 and SP5 MP
- Can be upgraded with additional SPC-150N or measurement control cards

### Simple-Tau 152N, and -162 Compact TCSPC Systems

- Two parallel SPC-150N, or SPC-160 TCSPC channels
- One DCC-100 detector controller
- Portable DOT systems
- High-Speed FLIM systems
- Part of bh DCS-120 confocal scanning FLIM systems
- Part of bh FLIM systems for Zeiss LSM 510 and LSM 710 family
- Can be upgraded with additional SPC-150N or measurement control cards



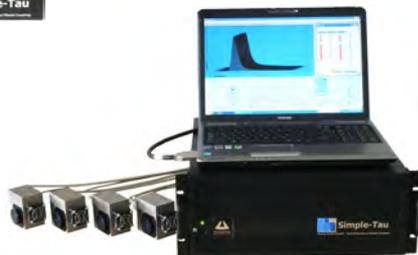
### Simple-Tau 154N, and -164 Compact TCSPC Systems

- Four parallel SPC-150N, or SPC-160 TCSPC channels
- Portable DOT systems
- Ultra-High-Speed parallel multispectral FLIM systems



### Simple-Tau 130-EMN Compact TCSPC Systems

- One SPC-130-EMN TCSPC channel
- One DCC-100 detector controller
- Standard fluorescence lifetime applications
- Anti-bunching measurements
- Can be upgraded with additional SPC-130-EMN or measurement control cards



### Simple-Tau 'Big' Versions

- Up to seven TCSPC and measurement control cards
- User-specific hardware and software configuration
- High speed parallel FLIM systems
- Portable DOT systems



### Simple-Tau 'Large Screen' Versions

- Combines large screen area with small size of TCSPC system
- FLIM and other TCSPC Imaging applications
- High-resolution FLIM in combination with 64 bit SPCM software



### **New:** Simple-Tau III TCSPC/FLIM Systems

- Laptop or standard PC with Thunderbolt-connected extension box
- Three slots for measurement and measurement-control cards
- SPC-180 series or SPC-QC series TCSPC / FLIM modules
- DCC-100pcie detector controller module
- GVD-140 scan controller module
- Single or dual-channel FLIM systems
- Single, dual or triple-channel TCSPC systems
- Operated by SPCM TCSPC/FLIM data acquisition software
- Easy to use
- Highly portable

## PC-Based TCSPC and TCSPC-FLIM Systems



### Multi-Tau 8-Channel TCSPC Systems

Eight SPC-150N or SPC-130-EMN TCSPC modules controlled from a standard Pentium PC  
Portable DOT systems  
Ultra-High-Speed FLIM systems



### Power-Tau TCSPC Systems

Up to six TCSPC or measurement control cards in high performance PC  
Highly modular systems  
User-specific hardware and software configuration  
Large system memory for megapixel FLIM applications and DOT  
High data transfer rate  
High on-line computation power

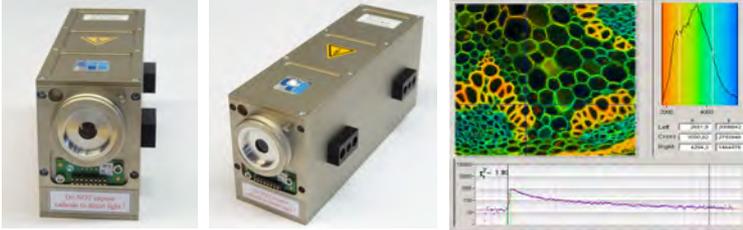


### Max-Tau TCSPC Systems

Up to 12 TCSPC or measurement control cards  
Available with Power-Tau or Laptop based TCSPC system  
Highly modular system  
User-specific hardware and software configuration  
High data transfer rate  
High on-line computation power

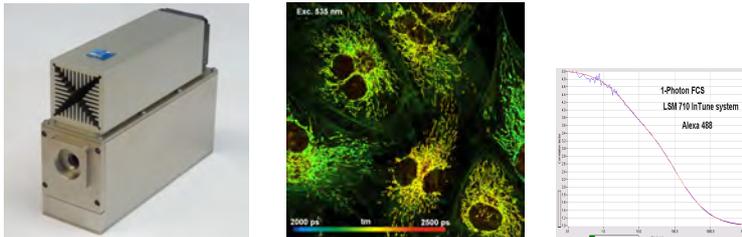
## Detectors and Detector Assemblies

bh guarantee that their TCSPC devices work with any photon counting detector



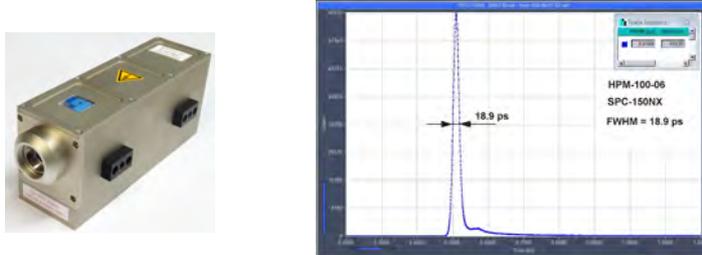
### HPM-100-40 and -50 Hybrid Detector Modules

Based on Hamamatsu R10467 hybrid detector tubes  
 GaAsP versions: 40 % detection efficiency throughout visible spectrum  
 GaAs versions: 15 % detection efficiency up to 850 nm  
 GaAsP versions: typ. 120 ps IRF width  
 No afterpulsing  
 Internal high-voltage generator, power supply and control via DCC-100, DCU-400 or DCU-800  
 Active area 3 mm diameter  
 C-Mount adapter  
 Adapter to bh DCS-120 confocal scanning FLIM system  
 Adapter to NDD and BIG port of Zeiss LSM 710 NLO microscopes  
 Adapter to RLD port of Leica SP2 MP and SP5 MP microscopes  
 SMA and FC multi-mode fiber adapters



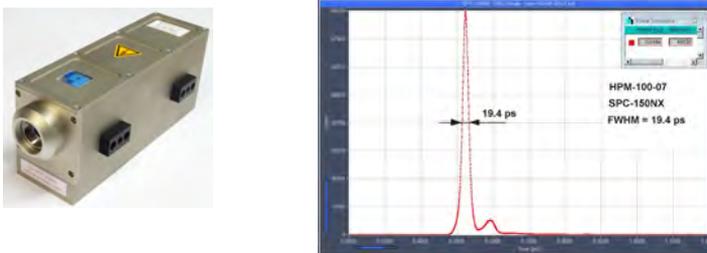
### HPM-100-40C and -50C Cooled Hybrid Detector Modules

Based on Hamamatsu R10467 hybrid detector tubes  
 GaAsP versions: 40 % detection efficiency throughout visible spectrum  
 GaAs versions: 15 % detection efficiency up to 850 nm  
 GaAsP versions: typ. 120 ps IRF width  
 No afterpulsing  
 Reduced dark count rate by cooling  
 Internal high-voltage generator, power supply and control via DCC-100, DCU-400 or DCU-800  
 Active area 3 mm diameter  
 C-Mount adapter  
 Adapter to bh DCS-120 confocal scanning FLIM system  
 Adapter to BIG port of Zeiss LSM 710 NLO microscopes  
 Adapter to RLD port of Leica SP2 MP and SP5 MP microscopes  
 SMA and FC multi-mode fiber adapters



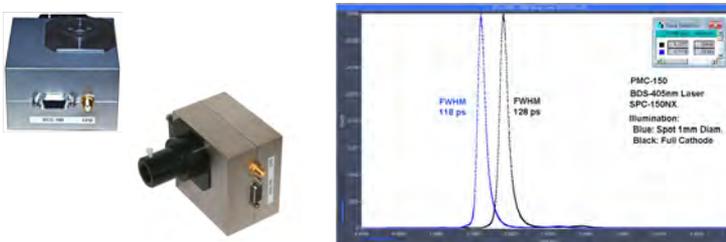
### HPM-100-06 and -06C Ultra-Fast Hybrid Detector Modules

Based on Hamamatsu R10467-06 hybrid detector tubes  
 Bi-alkali cathode, 220 to 650 nm  
 Clean TCSPC response, no tails and bumps  
 < 20 ps IRF width with SPC-150NX, -NXX, SPC-180NX, -NXX  
 No afterpulsing  
 Cooled version: HPM-100-06C



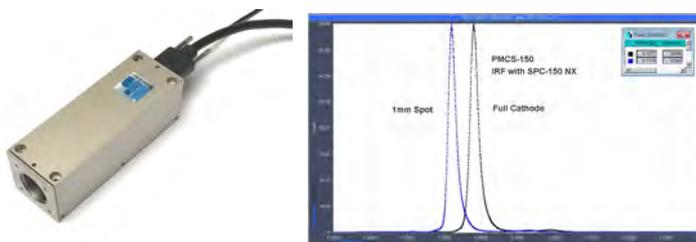
### HPM-100-07 and -07C Ultra-Fast Hybrid Detector Modules

Based on Hamamatsu R10467-07 hybrid detector tubes  
 Multialkali cathode, 220 to 850 nm  
 Clean TCSPC response, no tails and bumps  
 < 20 ps IRF width with SPC-150NX, -NXX, SPC-180NX, -NXX  
 No afterpulsing  
 Cooled version: HPM-100-07C



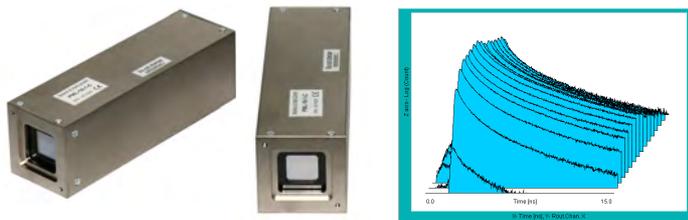
### PMC-150 Cooled PMT Modules

Cathode versions for UV to NIR region  
 Internal PMT voltage generation  
 IRF width typ. 130 ps  
 Ultra-stable IRF up to recorded count rates of 5 MHz  
 Internal preamplifier  
 Overload shutdown  
 Power supply and control via DCC-100, DCU-400 or DCU-800  
 Adapters for Zeiss LSM NDD ports, Zeiss LSM confocal ports, Leica SP2 and SP5 RLD Ports, bh DCS-120 confocal FLIM system  
 Replaces older PMC-100 detector



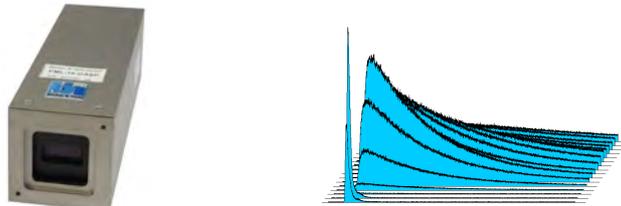
### PMCS-150 Cooled PMT Modules

Pre-set gain  
 Internal preamplifier  
 Internal overload shutdown  
 IRF width 130 ps  
 Ultra-stable IRF up to recorded count rates of 5 MHz  
 +12 V Power supply



**PML-16 C - 16-Channel TCSPC Detectors**

16-channel detector with routing electronics and internal HV power supply  
 Based on Hamamatsu R5900-L16 multi-anode PMT  
 Simultaneous detection in 16 channels  
 Connects directly to all bh SPC modules  
 Power supply and control via DCC-100, DCU-400 or DCU-800  
 IRF width typ. value 180 to 240 ps  
 Part of bh multispectral TCSPC FLIM detectors



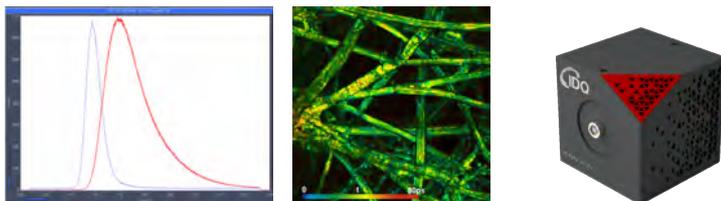
**PML-16 GaAsP - 16-Channel TCSPC Detectors**

16-channel detector with high-sensitivity GaAsP cathode  
 Based on Hamamatsu GaAsP multi-anode PMT  
 Simultaneous detection in 16 channels  
 Internal Routing electronics and HV power supply  
 Connects directly to all bh SPC modules  
 Power supply and control via DCC-100, DCU-400 or DCU-800  
 IRF width typ. value 280 ps  
 Part of bh multispectral TCSPC FLIM detectors



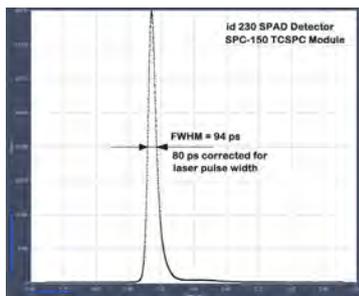
**Single-Photon Avalanche Photodiode Modules (SPADs)**

Manufacturer: ID Quantique  
 Direct-coupled and fiber-coupled versions  
 Active area  $d = 20 \mu\text{m}$  and  $d = 50 \mu\text{m}$   
 Ultra-high efficiency in visible region  
 IRF width typ. 40 ps, max. 60 ps  
 Active areas of  $20 \mu\text{m}$  and  $50 \mu\text{m}$  diameter  
 Stable IRF over count rate  
 Dark count rates  $< 7 \text{ s}^{-1}$  (ID100-20 ULN) and  $< 60 \text{ s}^{-1}$  (ID100-50 ULN)  
 Detector count rates up to 20 MHz  
 Direct-coupled and fiber-coupled versions  
 Focusing and alignment adapters



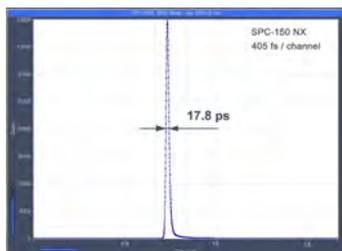
**ID-Qube-NIR-FR InGaAs IR SPAD Detectors**

Manufacturer: ID Quantique  
 Detection from 900 nm to 1700 nm  
 Quantum efficiency up to 20 %  
 Continuous operation - no gating required  
 Compatible with all bh TCSPC devices  
 IRF width 90 ps FWHM  
 Fiber coupling, FC/PC connector  
 Fluorescence and phosphorescence decay recording  
 Photon correlation  
 FLIM, PLIM



**ID-230 InGaAs IR SPAD Detectors**

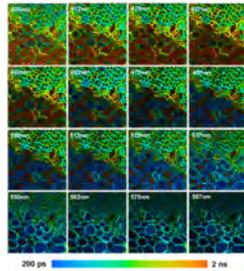
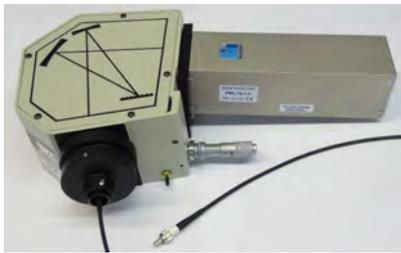
Manufacturer: ID Quantique  
 Detection from 900 nm to 1700 nm  
 Quantum efficiency up to 25 %  
 Extremely low dark count rate - down to 50 – 80 counts / s  
 Continuous operation - no gating required  
 Compatible with all bh TCSPC devices  
 IRF width typ. 90 ps  
 Fiber coupling, SMA connector  
 Fluorescence and phosphorescence decay recording  
 Photon correlation  
 FLIM, PLIM



**SCONTEL Superconducting NbN Detectors**

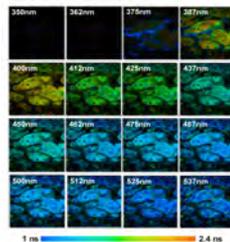
Manufacturer: SCONTEL, Moscow  
 Detection from 400 nm to 1700 nm  
 IRF width down to 17.8 ps FWHM with SPC-150NX  
 Timing Jitter with SPC-150NX 7.8 ps RMS  
 (Cooperation with SCONTEL temporarily suspended)

## Multi-Spectral TCSPC / FLIM Detectors



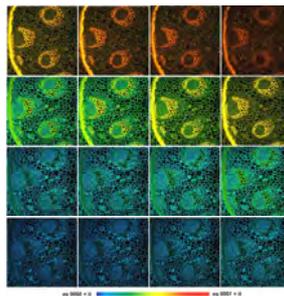
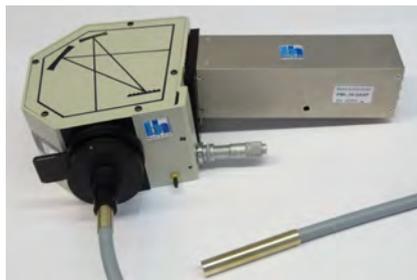
### PML-SPEC and PML-SPEC GaAsP Multi-Wavelength Detection Modules

Simultaneous fluorescence decay detection in 16 wavelength channels  
 SMA 905 or FC fiber adapter  
 Fiber diameter up to 1 mm  
 Multi-spectral FLIM for confocal laser scanning microscopes  
 IRF width 180 ps – 280 ps FWHM  
 Works with all bh TCSPC modules  
 Internal high-voltage power supply  
 Internal routing electronics  
 Overload shutdown  
 Full control via DCC-100, DCU-400 or DCU-800  
 Part of the bh multi-wavelength FLIM systems for laser scanning microscopes  
 Adapter for DCS-120 confocal scanning FLIM system



### MW FLIM Multi-Spectral FLIM Detection Modules for Multiphoton Microscopes

Multi-spectral FLIM in 16 wavelength channels  
 Fiber bundle for large area detection and area transformation  
 Non-descanned (NDD) detection or confocal detection  
 Adapters for Zeiss, Leica, Olympus, Nikon, bh DCS-120  
 IRF width 180 ps – 240 ps FWHM  
 Works with all bh TCSPC modules  
 Internal high-voltage power supply  
 Internal routing electronics  
 Protected by overload shutdown  
 Shutter for input protection available  
 Full control via DCC-100, DCU-400 or DCU-800  
 Part of the bh multi-wavelength FLIM systems for laser scanning microscopes



### MW FLIM GaAsP Multi-Spectral NDD FLIM Detection Systems for Multiphoton Microscopes

Multi-spectral FLIM in 16 wavelength channels  
 High-efficiency GaAsP cathode  
 Fiber bundle for large area detection and area transformation  
 Non-descanned (direct) detection or confocal detection  
 Adapters for Zeiss, Leica, Olympus, bh DCS-120  
 IRF width 280 ps FWHM  
 Works with all bh TCSPC modules  
 Internal high-voltage power supply  
 Internal routing electronics  
 Protected by overload shutdown  
 Shutter for input protection available  
 Full control via DCC-100, DCU-400 or DCU-800  
 Part of the bh multi-wavelength FLIM systems for laser scanning microscopes

## Opto-Mechanical Detector Components



### Detector / Shutter Assemblies for Various PMTs

For NDD ports of multiphoton laser scanning microscopes  
 Shutter operation via DCC-100, DCU-400 or DCU-800  
 Overload shutdown of PMT  
 Input field lens  
 For bh PMC-150 and HPM-100 modules, Hamamatsu R3809U, Hamamatsu H7422  
 Part of bh modular FLIM systems



### Beamsplitter / Detector Assemblies

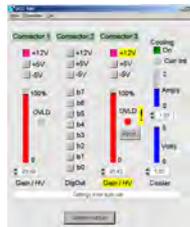
For HPM-100, PMC-150, R3809U and H7422 detectors  
 Dichroic beamsplitters, polarising beamsplitters  
 Input filter, bandpass filters in front of detectors  
 Compatible with NDD ports of multiphoton laser scanning microscopes  
 Part of bh modular FLIM systems



### Detectors and Detector Assemblies with Fiber Adapters

For HPM-100, PMC-150, R3809U and H7422 detectors  
 Input filter, bandpass filters in front of detectors

## Detector Electronics



### DCC-100 Detector Controller DCC-100PCIe Detector Controller with PCI Express Interface

- Power supply for two detectors
- Power supply of thermoelectric coolers of detectors
- Power supply of preamplifiers
- Detector gain control
- Detector overload shutdown
- Control of shutters or actuators
- Control of bh detector / shutter assemblies
- Intensity control of bh BDL and BDS ps diode lasers
- Integrated in SPCM TCSPC software package
- Part of the bh modular FLIM, modular DOT systems
- Part of bh Simple-Tau TCSPC systems



### DCU-400 / DCU-800 Detector Controller Unit with USB Interface

- Power supply for 4 / 8 detectors
- Power supply of thermoelectric coolers of detectors
- Power supply of preamplifiers
- Detector gain control
- Detector overload shutdown
- Control of shutters or actuators
- Control of bh detector / shutter assemblies
- Intensity control of bh BDL and BDS ps diode lasers
- Integrated in SPCM TCSPC software package
- Part of the bh modular FLIM and modular DOT systems
- Part of bh TCSPC systems



### HRT-41 Four-Channel Router

- Connects up to four PMC-150, H7422 or R3809U detectors to one TCSPC channel
- All detectors are detecting simultaneously

### HRT-81 Eight-Channel Router

- Connects up to eight PMC-150, H7422 or R3809U detectors to one TCSPC channel
- All detectors are detecting simultaneously

### HRT-82 Eight-Channel Router

- Connects up to eight SPAD modules to one TCSPC channel
- All detectors are detecting simultaneously



### HFAC-26 Preamplifiers

- For R3809U MCP PMT, H7422 modules, and other PMTs
- Power supply from SPC or DCC module
- Overload shutdown in conjunction with DCC-100 controller
- Overload thresholds 0.1 µA, 0.3 µA, 1 µA, 2 µA, 3 µA, 10 µA, 100 µA

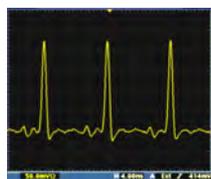
### HFAH-26 Preamplifiers

- Low-noise
- For R3809U MCP PMT, H7422 modules, and other PMTs
- Power supply from SPC or DCC module
- Overload shutdown in conjunction with DCC-100 controller



### HPM-CON-02 Frequency-to-Analog Converter for PMT Pulses

- Converts single-photon-pulse signals of photon-counting detectors into an intensity-proportional analog signal
- Analog output independent of single-photon pulse amplitude
- Inserts directly in detector output pulse line
- Provides photon pulses to TCSPC modules and intensity signal to analog electronics
- Input pulse amplitude -30 mV to -200 mV, input pulse width down to 500 ps
- Input pulse rate up to  $10^7$  pulses per second
- Output voltage range 0 to +4.9 V
- Power supply  $\pm 5$  V from bh SPC or DCC module



### APS-100 TCSPC Synchronisation Module

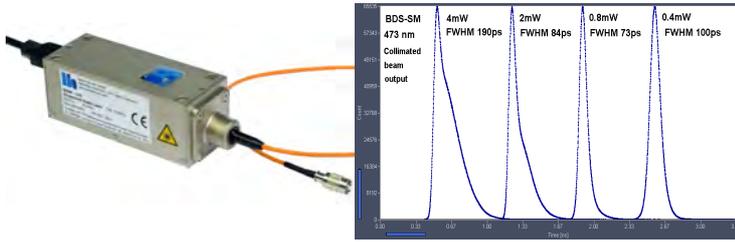
- For synchronisation of TCSPC experiments with Ti:Sapphire lasers
- Output amplitude widely independent of laser intensity and laser wavelength
- Intensity range 1:100
- Power supply from SPC, DCC or DCU module



### PHD-400 PIN Photodiode Modules

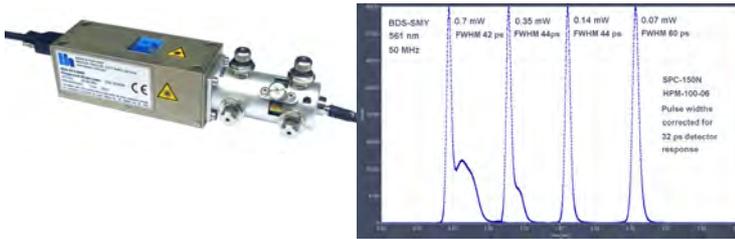
- For synchronisation of TCSPC experiments with lasers
- Power supply from SPC, DCC or DCU module
- Detector area 0.25 mm<sup>2</sup>
- Current indicator for easy alignment

## Picosecond Diode Lasers



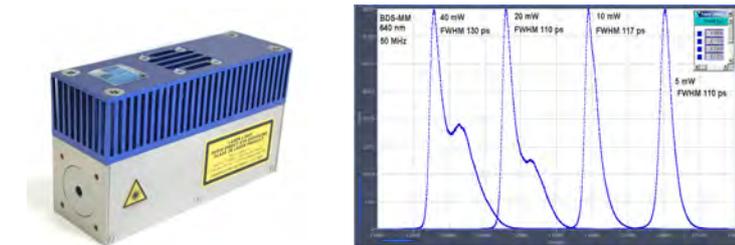
### BDS-SM Series Picosecond Diode Lasers

Small-size Module, single-mode output  
 Dimensions 40 mm x 70 mm x 120 mm (40 mm x 40 mm x 120 mm OEM version)  
 Wavelengths 375, 405, 445, 473, 488, 515, 640, 685, 785, 1064 nm  
 Single-Mode free-beam or single-mode fiber output  
 Fibres permanently attached (pig-tailed) or via fibre coupler  
 Pulse width down to 40 ps  
 Pulse repetition rate 20 MHz / 50 MHz / 80 MHz and CW  
 CW equivalent power up to 1.3 / 3 / 5 mW @ 20 / 50 / 80 MHz  
 CW mode with up to 50 mW power  
 Fast ON / OFF / multiplexing capability  
 Ext. Trigger input (single pulse to 80 MHz), Trigger output  
 Internal power stabilisation  
 All electronics integrated, no external driver unit required  
 Operation from simple +12 V power supply  
 Part of the bh modular FLIM systems for laser scanning microscopes



### BDS-SMY Series Green / Yellow Picosecond Diode Lasers

Small-size Module, single mode output  
 Dimensions 40 mm x 70 mm x 120 mm (40 mm x 40 mm x 120 mm OEM version)  
 Wavelength 532 nm, 561 nm and 594 nm  
 Single-Mode free-beam or single-mode fiber output  
 Fibres permanently attached (pig-tailed) or via fibre coupler  
 Pulse width down to 50 ps  
 Pulse repetition rate 50 MHz (20 MHz on request)  
 CW equivalent power up to 0.5 mW @ 50 MHz  
 Operation from simple +12 V power supply



### BDS-MM Series Picosecond Diode Lasers

Small-size Module, multi-mode output  
 Dimensions 40 mm x 70 mm x 120 mm (40 mm x 40 mm x 120 mm OEM version)  
 Wavelengths 405, 445, 525, 640, 685, 785, 915 nm  
 Multi-Mode free-beam or multi-mode fiber output  
 Pulse width down to 65 ps  
 Pulse repetition rate 20 MHz and 50 MHz  
 CW equivalent power up to 50 mW  
 Fast ON / OFF / multiplexing capability  
 Ext. Trigger input (single pulse to 50 MHz), Trigger output  
 Internal power stabilisation  
 All electronics integrated, no external driver unit required  
 Operation from simple +12 V power supply



### New: BDU-SM Series USB-Controlled Picosecond Diode Lasers

Small-size Module, single-mode output  
 USB interface  
 Dimensions 40 mm x 80 mm x 120 mm  
 Wavelengths 375, 405, 445, 473, 488, 515, 640, 685, 785 nm  
 Single-Mode free-beam or single-mode fiber output  
 Fibres permanently attached (pig-tailed) or via fibre coupler  
 Pulse width down to 40 ps  
 Pulse repetition rate 20 MHz / 50 MHz / 80 MHz and CW  
 CW equivalent power up to 1.3 / 3 / 5 mW @ 20 / 50 / 80 MHz  
 CW mode with up to 20 mW power  
 Fast ON / OFF / multiplexing capability  
 Internal power stabilisation  
 All electronics integrated, no external driver unit required  
 Power supply from USB port  
 Part of the bh modular FLIM systems for laser scanning microscopes



### Laser Power Supply and Control

Power supply from +12V AC/DC adapter  
 Key switch, frequency switch, and power control via LSB laser switch module  
 Laser switch modules for one laser or for two lasers  
 Interface to DCC-100 and DCU-400, -800 laser/detector controllers  
 Manual control or Software control from bh SPCM data acquisition software

### OEM Operation of Lasers

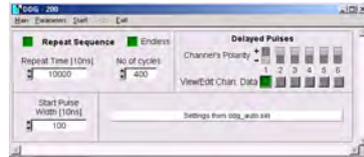
Lasers can be operated directly from a +12V power supply  
 Control signals can be applied directly to the laser

### Laser-Hub

Up to 4 diode lasers from BDS family  
 Flexible wavelength configurations  
 Wavelength range from 405 to 640 (other on request)  
 Outputs combined into single beam  
 Free beam or single-mode fiber output  
 Fast ON / OFF / Multiplexing  
 All electronics integrated  
 No external driver unit  
 Manual control or control from bh SPCM data acquisition software  
 Simple +12 V Power Supply from AC/DC adapter



## Experiment Control and Connecting Electronics



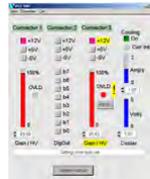
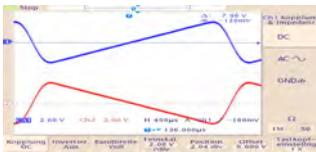
### DDG-210 Digital Delay Generator

Multiplexing of lasers and routing to TCSPC Modules  
 Multiplexing rate up to 1 MHz  
 Laser on/off modulation for PLIM  
 Non-overlapping laser multiplexing  
 On-times programmable individually  
 Part of bh modular DOT systems  
 Part of bh FLIM / PLIM systems for Zeiss LSM 710 / 780 / 880 family  
 Integrated in bh SPCM TCSPC instrument control software



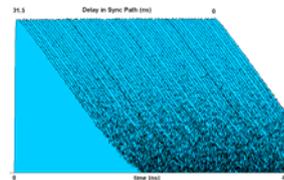
### GVD-120 Scan Controller Card GVD-120PCIe Scan Controller Card GVD-140PCIe Scan Controller Card

Generation of scan signals for galvanometer scanners and piezo stages  
 Dual-axis control  
 Frame scan, line scan, high-stability point operation  
 Laser beam blanking  
 Laser multiplexing, synchronously with scan  
 GVD-120: Two lasers  
 GVD-140: Four laser  
 Laser on/off modulation for simultaneous FLIM/PLIM  
 Linear x scan with cycloid flyback  
 Sinusoidal x scan option  
 Extremely high scan rates  
 Fully digital signal generation  
 Independent of software response times  
 Pixel times down to 0.5  $\mu$ s  
 Pixel numbers up to 4048 x 4048  
 Fully integrated in bh SPCM TCSPC / FLIM software  
 Part of bh DCS-120 confocal scanning systems



### DCC-100 and DCC-100PCIe Detector Controllers

Control of two bh TCSPC detectors or two BDS lasers  
 Intensity control of two picosecond diode lasers  
 For details, please see 'Detector Electronics'



### Delay-Box-32N

32 step passive delay line  
 Delay from 0 to 31.5 ns in 0.5 ns steps  
 Selection of one of two signal sources  
 Transmits any signal waveform  
 Signal bandwidth 1 GHz  
 No noise, no jitter  
 No external power supply needed  
 Settings persist when box is disconnected from USB  
 Easy adjustment of TCSPC SYNC path length  
 Control integrated in bh SPCM TCSPC operating software



### BOB-104 Signal Distribution Box

Distributes scan clock signals to four SPC modules  
 Combines routing signals and other control signals into 15-pin control inputs of four SPC-130-EMN, -150N, and -160 modules  
 Auxiliary +12 V input for power supply of amplifiers, routers, detectors



### BOB-101 Signal Distribution Box

Combines routing signals and other control signals into 15-pin control inputs of one SPC-130-EMN, -150N, and -160 modules  
 Auxiliary +12 V input for power supply of amplifiers, routers, detectors



### DCS Connection Box

Power supply and control of two bh BDS or BDL-SMN ps diode lasers  
 Connects scan clocks and laser multiplexing signals of GVD-120 scan controller into two SPC-150N or SPC-160 modules and two BDS or BDL-SMN diode lasers  
 Connects routing signals of two bh multi-spectral FLIM detectors into SPC modules  
 Configurable by SPCM software

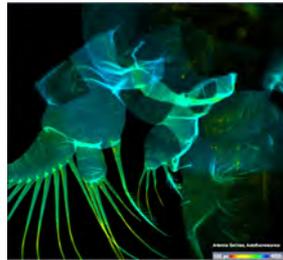
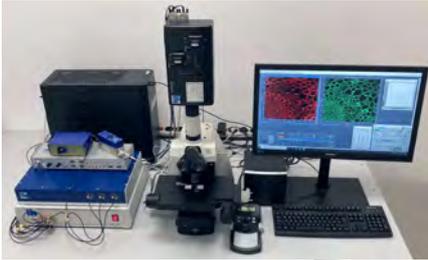


### Cables and Adapters

A-PPI-D passive pulse inverters  
 1:3, 1:4 power splitters and combiners  
 Attenuators  
 SMA cables  
 SMA-to SMA adapters  
 SMA-to BNC adapters  
 Power supply cables for detectors  
 Interface cables for bh FLIM systems for various laser scanning microscopes

A reasonable set of cables and adapters is delivered with each bh SPC module or Simple-Tau system

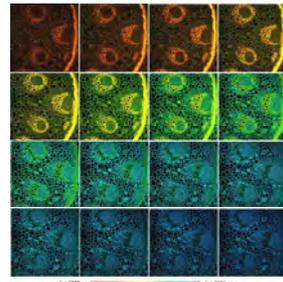
## Fluorescence Lifetime Microscopy



### New! DCS-120 Black FLIM System

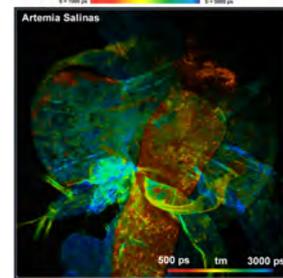
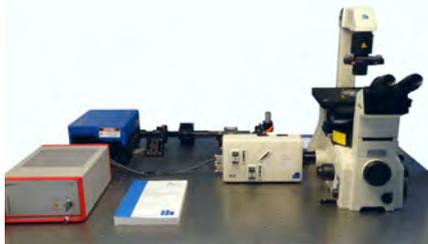
#### DCS-120 Confocal Scanning FLIM Systems Based on bh's 64-bit megapixel FLIM technology

FLIM with up to 2048 x 2048 pixels  
 Complete Confocal Laser Scanning FLIM microscopes  
 FLIM upgrade for existing conventional microscopes  
 Scanning by fast galvanometer mirrors  
 Two fully confocal detection channels  
 One or two BDS or BDL-SMN picosecond diode lasers  
 Laser wavelengths 375, 405, 445, 473, 488, 515, 640, 685, 785 nm  
 Tuneable excitation by super-continuum laser with AOTF  
 One or two confocal detection channels, parallel acquisition  
 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  
 16-channel multi-wavelength GaAsP detector module  
 Z-stack FLIM acquisition with Zeiss Axio Observer Z1  
 Spatial Mosaic FLIM via motorised sample stage (optional)  
 Simultaneous fluorescence and phosphorescence lifetime imaging (PLIM)  
 Fluorescence lifetime-transient scanning (FLITS)  
 Ultrafast time-series recording by temporal mosaic FLIM function  
 Wideband (WB) version, compatible with tuneable lasers  
 Electronic pinhole alignment



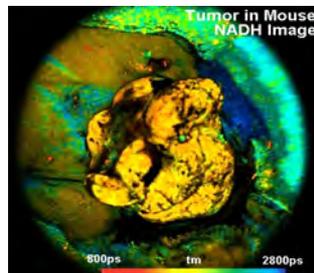
#### DCS-120 MP Multiphoton FLIM Systems

Multiphoton version of DCS-120 scanning system  
 Excitation by Ti:Sa laser of femtosecond fibre laser  
 IRF width <20 ps FWHM with HPM-100-06 detectors  
 Laser control integrated in SPCM data acquisition software  
 Laser intensity control and PLIM laser modulation by AOM  
 One or two non-descanned detection channels  
 Clear Images from deep tissue layers  
 Excellent spatial and temporal resolution  
 Images up to 2048 x 2048 pixels, 256 time channels  
 Full field of view of microscope lens scanned  
 Optional 16-channel multi-wavelength GaAsP detector module  
 Z-stack FLIM acquisition with Zeiss Axio Observer Z1  
 Spatial Mosaic FLIM via motorised sample stage (optional)  
 Simultaneous fluorescence and phosphorescence lifetime imaging (PLIM)  
 Fluorescence lifetime-transient scanning (FLITS)  
 Ultrafast time-series recording by temporal mosaic FLIM function

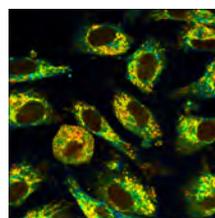


#### DCS-120 Macro System

FLIM of macroscopic objects  
 Scan field up to 15 mm diameter  
 FLIM with up to 2048 x 2048 pixels  
 Scanning by fast galvano mirrors  
 Two fully confocal detection channels  
 One or two BDS or BDL-SMN picosecond diode lasers  
 Laser wavelengths 375, 405, 445, 473, 488, 515, 640, 685, 785 nm  
 Tuneable excitation by super-continuum laser with AOTF  
 One or two confocal detection channels, parallel acquisition  
 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  
 Optional 16-channel multi-wavelength GaAsP detector module  
 Spatial Mosaic FLIM via motorised sample stage (optional)  
 Simultaneous fluorescence and phosphorescence lifetime imaging (PLIM)  
 Fluorescence lifetime-transient scanning (FLITS)  
 Ultrafast time-series recording by temporal mosaic FLIM function  
 Wideband (WB) version, compatible with tuneable lasers  
 Electronic pinhole alignment

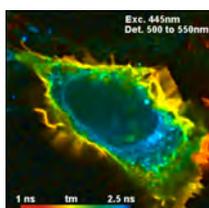
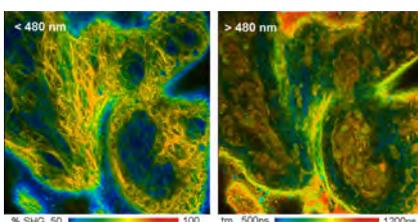


Please see handbook:  
 DCS-120 Confocal Scanning FLIM Systems, 9th Edition, December 2021  
 Overview brochure DCS-120 Confocal Scanning FLIM Systems

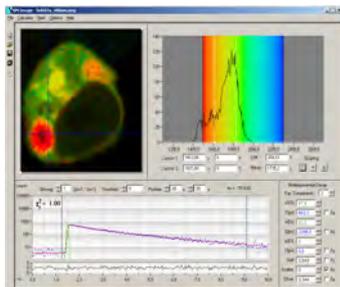


#### FLIM Systems for Zeiss LSM 710, 780, 880, 980 LSM 710 / 780 / 880 / 980 NLO, LSM 7MP Multiphoton Microscopes LSM 710, LSM 780, LSM 880, LSM 980 Confocal Microscopes

Based on bh's 64-bit megapixel FLIM technology  
 FLIM with up to 2048 x 2048 pixels  
 Multiphoton FLIM, PLIM, multispectral FLIM, FCS  
 Confocal FLIM, PLIM, multispectral FLIM, FCS  
 FLIM with bh HPM hybrid detectors or Zeiss BIG-2 detectors  
 Fast preview mode, both for intensity and lifetime  
 Mosaic FLIM, Z Stack FLIM, Fast Time-series FLIM  
 Acquisition by 1, 2, 3 or 4 parallel TCSPC FLIM channels  
 Simultaneous fluorescence and phosphorescence lifetime imaging (PLIM)  
 Fluorescence lifetime-transient scanning (FLITS) fully integrated  
 Ultrafast time-series recording by temporal mosaic FLIM function  
 Confocal NIR FLIM up to 900 nm detection wavelength  
 Two-Photon OPO FLIM up to 900 nm detection wavelength

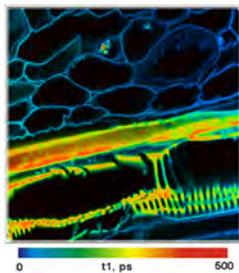
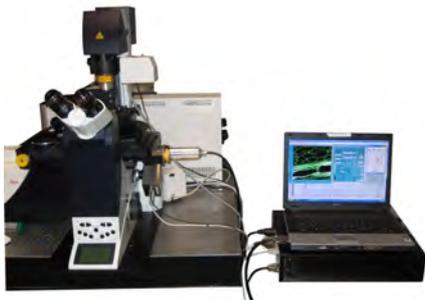


Please see:  
 Handbook Modular FLIM Systems for Zeiss LSM 710 / 780 / 880 Family Laser Scanning Microscopes, 7th ed.  
 FLIM systems for Zeiss LSM 980 Microscopes, Addendum to 7th ed. of handbook



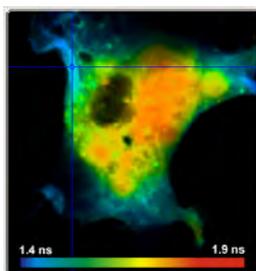
**Still available: FLIM Systems for Zeiss LSM 510 NLO Multiphoton Microscopes**

FLIM with up to 2048 x 2048 pixels  
 Multiphoton excitation with non-descanned detection  
 Detectors connected to Zeiss NDD switch box  
 Single-wavelength NDD FLIM  
 Dual-wavelength NDD FLIM  
 Multi-spectral NDD FLIM  
 Fast preview mode  
 Mosaic FLIM  
 Z Stack FLIM  
 Fast time-series FLIM  
 HPM-100-40 hybrid detectors  
 One or two parallel SPC-150N TCSPC channels  
 PC-based systems or Simple-Tau TCSPC systems



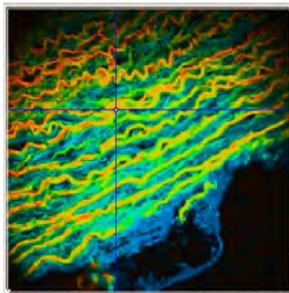
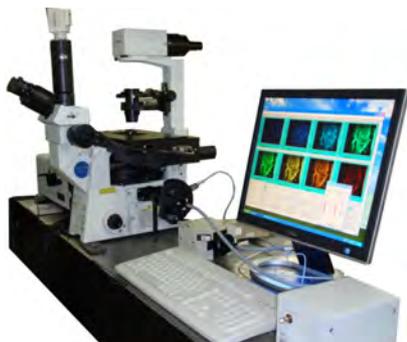
**Non-Descanned FLIM Systems for Leica SP2 MP, SP5 MP, SP8 MP Microscopes**

**64-bit megapixel FLIM technology**  
 Non-descanned detection via Leica RLD port  
 1 detector coupled directly to RLD port  
 2 detectors via external beamsplitter  
 Simple-Tau 150N or -152N TCSPC systems  
 Acquisition in 1 or 2 parallel TCSPC FLIM channels  
 bh HPM-100-40 hybrid detectors or Leica HYD detectors  
 Multi-spectral FLIM with 16-channel GaAsP detector  
 Works at any scan rate of SP2 and SP5  
 Fast acquisition, fast preview mode  
 Megapixel FLIM, 2048 x 2048 pixels  
 Fluorescence lifetime-transient scanning (FLITS)  
 Ultra-fast time series by temporal mosaic FLIM  
 Simultaneous FLIM / PLIM



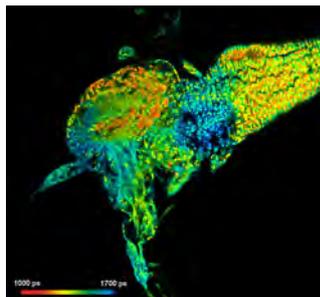
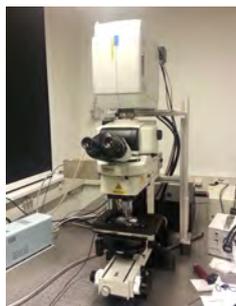
**FLIM Systems for Olympus FV1000 and FV300 Confocals**

**64-bit megapixel FLIM technology**  
 Excitation by bh BDS-405-SM or BDS-473-SM picosecond diode laser  
 High efficiency by direct coupling of detectors  
 Single-wavelength detection: PMT, MCP-PMT, or Hybrid PMT  
 Multi-wavelength detection: bh PML-SPEC detector  
 Full overload protection of detectors  
 ROI and Zoom functions of FV1000 or FV300 available  
 Works at any scan rate  
 FCS capability  
 Megapixel FLIM  
 Fluorescence lifetime-transient scanning (FLITS)



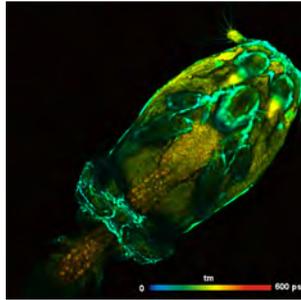
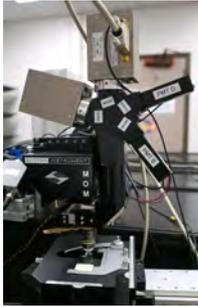
**Non-descanned FLIM Systems for Olympus FV1000 and FV300 Multiphoton Microscopes**

**64-bit megapixel FLIM technology**  
 Multiphoton FV1000 and FV300 systems with inverted microscopes  
 High efficiency by non-descanned FLIM detection  
 Deep-tissue imaging capability  
 Single-wavelength detection: PMT, MCP-PMT, or Hybrid PMT  
 Multi-spectral FLIM with 16-channel GaAsP detector  
 Full overload protection of FLIM detectors  
 ROI and Zoom functions of FV1000 or FV300 available  
 Works at any scan rate  
 Megapixel FLIM  
 Fluorescence lifetime-transient scanning (FLITS)



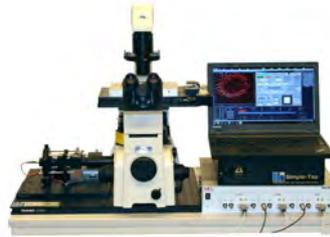
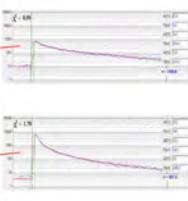
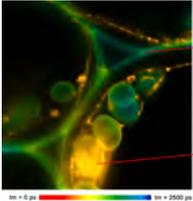
**FLIM Systems for Nikon A1+ Microscopes**

**64-bit megapixel FLIM technology**  
**New!** Nikon-integrated version available  
 One FLIM channel or two parallel FLIM channels  
 High-efficiency HPM-100 hybrid detectors  
 Non-descanned detection for multiphoton microscopes  
 Confocal detection for one-photon microscopes  
 Multi-spectral FLIM with 16-channel GaAsP detector  
 Works at any scan rate  
 Megapixel FLIM  
 Fluorescence lifetime-transient scanning (FLITS)  
 Ultra-fast time series by temporal mosaic FLIM  
 Simultaneous FLIM / PLIM



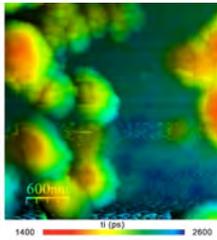
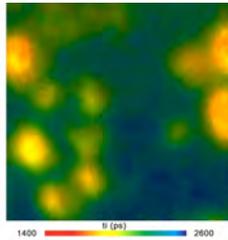
**FLIM Systems for Sutter Instrument MOM Microscopes**

Up to four parallel FLIM channels  
 Multiphoton excitation by Ti:Sa laser  
 Non-descanned detection for deep-tissue imaging  
 Overload protection of FLIM detectors  
 Up to 1024 x 1024 pixels, 1024 time channels  
 High efficiency  
 Fast acquisition  
 SPCM Online FLIM function available  
 Simultaneous FLIM / PLIM



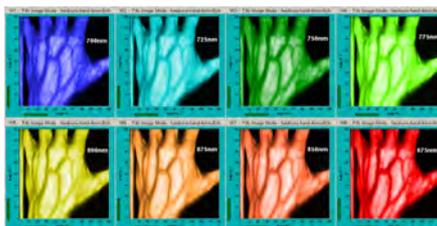
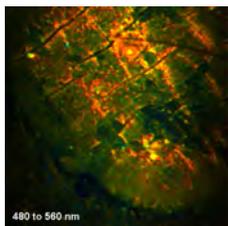
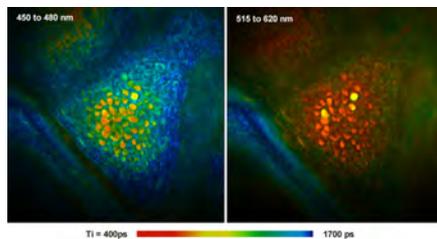
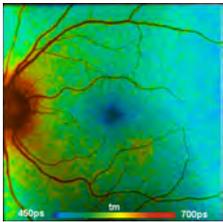
**PZ-FLIM-110 Stage-Scanning FLIM System**

Sample scanning by piezo scan stage  
 Excitation by BDL or BDS series ps diode lasers  
 Confocal detection  
 HPM-100 hybrid detector  
 Optional PML-SPEC GaAsP multi-spectral detector  
 Excellent contrast and resolution  
 Fully controlled by bh SPCM TCSPC/FLIM data acquisition software  
 Compact electronics, integrated in bh Simple-Tau system  
 Megapixel FLIM technology - images up to 2048 x 2048 pixels  
 Lateral (x-y) and vertical (z) scanning  
 Simultaneous FLIM / PLIM



**FLIM for NSOM Systems**

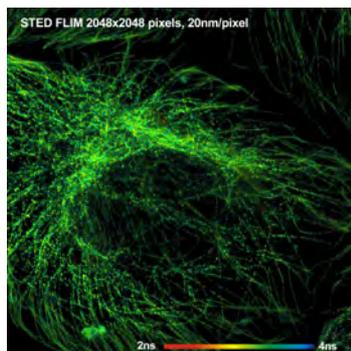
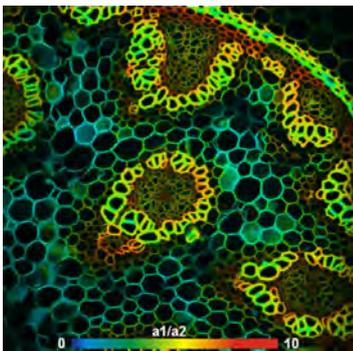
For NSOM systems of Nanonics and NT-MDT  
 Combines atomic-force and fluorescence lifetime information  
 High sensitivity by HPM-100 hybrid detectors  
 Fluorescence and phosphorescence lifetime imaging  
 Single-point transient-lifetime recording  
 Please see bh TCSPC Handbook or contact bh.



**FLIM Systems for Clinical Imaging**

**64-bit megapixel FLIM technology**

FLIM systems for ophthalmology  
 FLIM systems for dermatology  
 FLIM systems for tissue imaging  
 FLIM through endoscopes  
 Time-resolved NIRS and fNIRS Imaging  
 Online FLIM at rates of up to 10 images per second  
 Please see bh TCSPC Handbook or contact bh



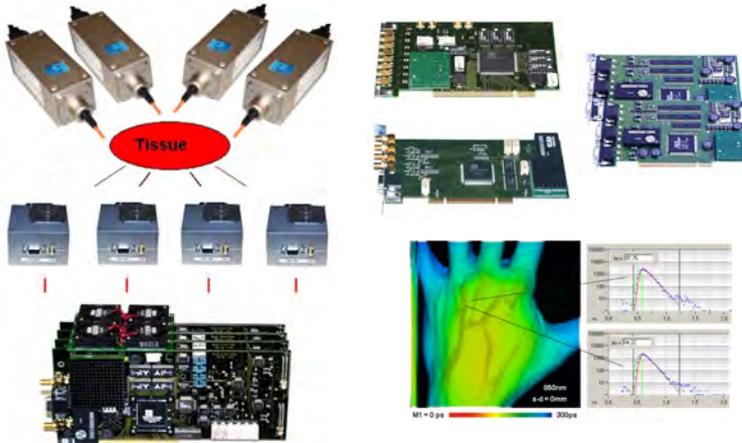
**FLIM for other Scanning Systems**

bh FLIM systems can be configured for almost any conceivable laser scanning system. They work with galvanometer scanners, polygon scanners, resonance scanners, and motor-driven and piezo-driven scan stages.

Left: FLIM recorded with Lucid Vivascope, ultra-fast polygon scanner  
 Right: STED FLIM recorded with STED microscope of Abberior Systems, Gottingen

Please see bh TCSPC Handbook or contact bh.

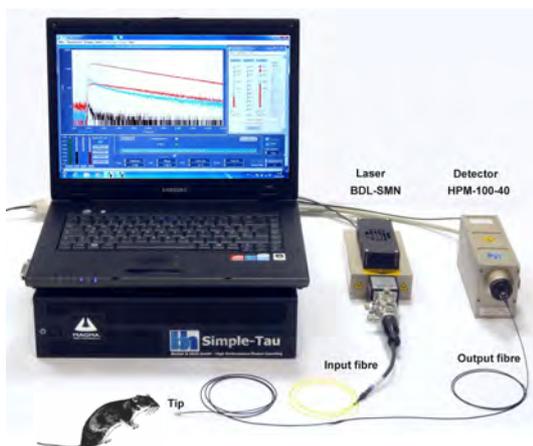
## TCSPC Systems for Time-Domain Diffuse Optical Tomography



### Modular DOT systems

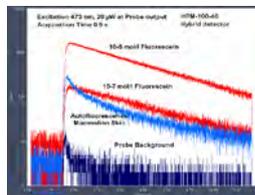
- Up to 8 parallel TCSPC channels
- Up to 32 detector channels
- Up to 8 BDS-MM lasers with wavelength multiplexing
- Up to 8 wavelengths multiplexed with supercontinuum laser
- Recording with multiplexed source position
- Time-of-flight distributions for all combinations of wavelength, source, and detection channels
- Diffuse correlation in 16 channels
- Recording by SPC-134-EMN, SPC-154N, or SPC-164 TCSPC packages
- Laser control by DDG-210 digital delay generator
- Detector control via DCC-100 cards
- Saturated count rates up to 40 MHz
- Multiplexing periods of lasers individually programmable
- Unlimited sequential recording by continuous flow mode
- Acquisition rate up to 20 time-of-flight distributions per second
- Non-contact scanning by galvanometer scanner controlled by GVD-120 card

## Fiber-Based Fluorescence-Lifetime Systems for *in-vivo* Applications

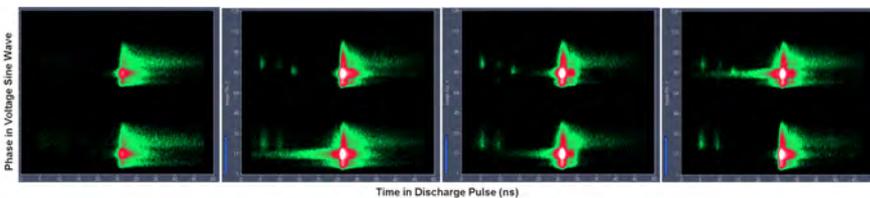


### Fiber-based TCSPC system for *in-vivo* application

- Implantable fiber tip, removable from fiber system
- Single mode excitation, multi-mode detection
- Excitation by BDL or BDS ps diode lasers
- Detection by hybrid detectors or SPAD detectors
- Multi-wavelength detector option
- Excellent sensitivity
- Excellent time resolution
- Low background fluorescence
- Detection of NADH, FAD, or exogenous fluorophores
- Ca<sup>2+</sup> detection in neuronal tissue
- pO<sub>2</sub> measurement in live tissue

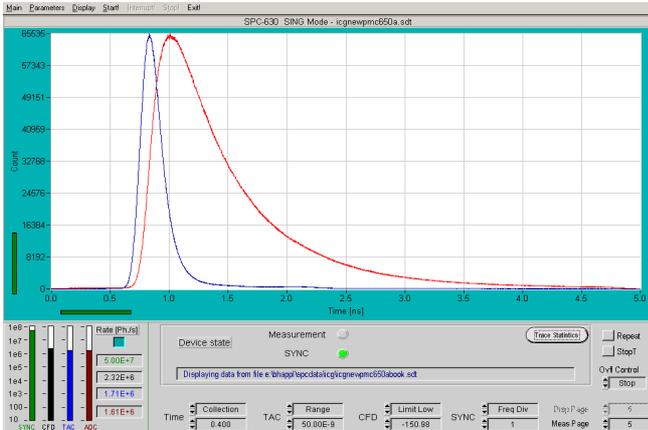


## Systems for Recording Optical Emission from Barrier Discharges



- Recording of full spatio-temporal pulse profiles
- Multi-dimensional TCSPC process
- Sinusoidal discharge voltage, 5 to 15 kHz
- Fast galvanometer scanning along discharge gap
- Control by GVD-120 scan controller
- Fully integrated in SPCM software
- Detection of optical signals by one or two detectors
- Optional 16-wavelength detector
- Recording by one or two parallel SPC-150N TCSPC modules
- Online display of data
- Please see bh TCSPC Handbook, 9th edition

## TCSPC Instrument Software



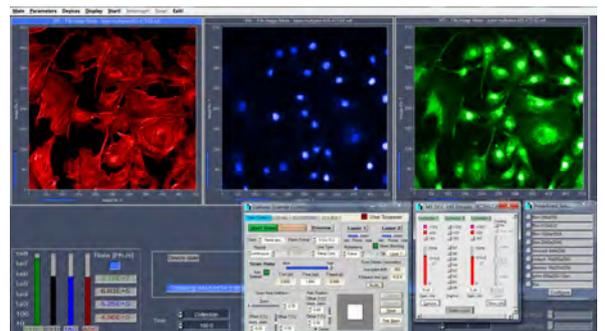
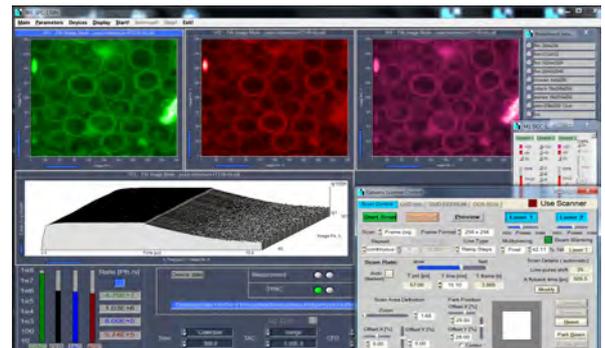
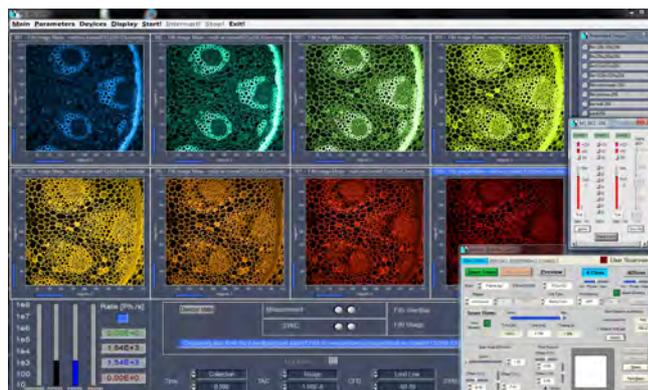
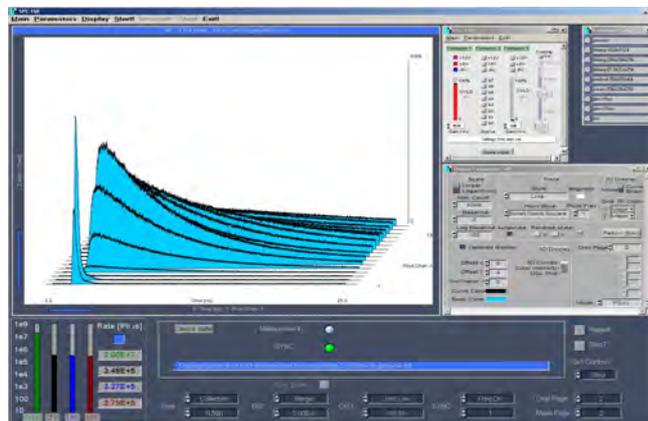
### SPCM Data Acquisition Software for all bh TCSPC Modules and DPC-230 Photon Correlator

#### True 64 bit software for Windows 10 and Windows 11 Megapixel FLIM Technology

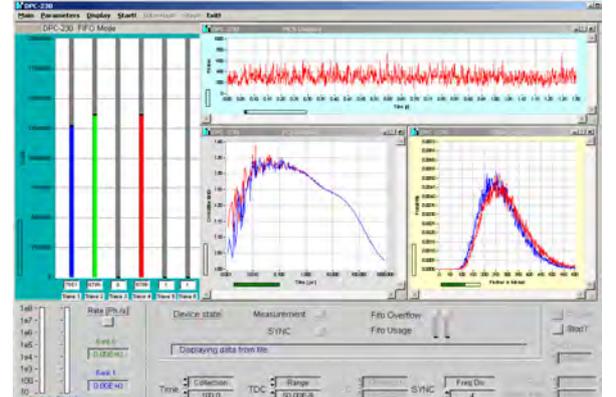
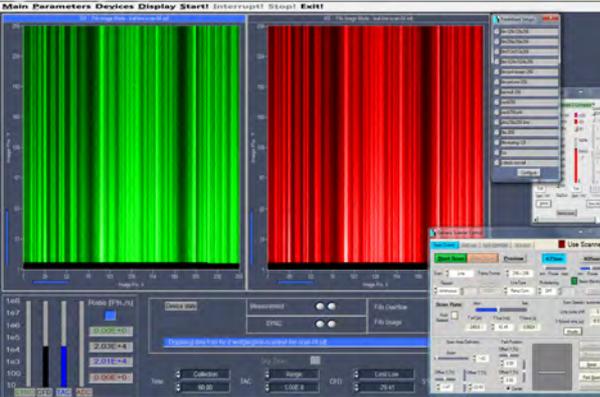
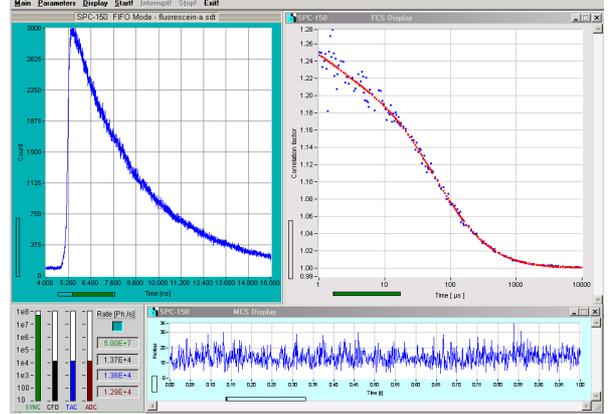
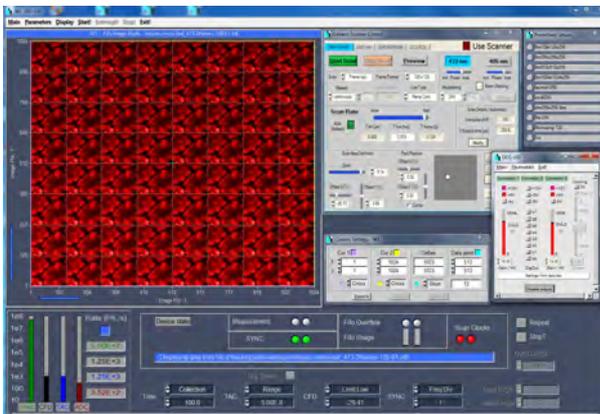
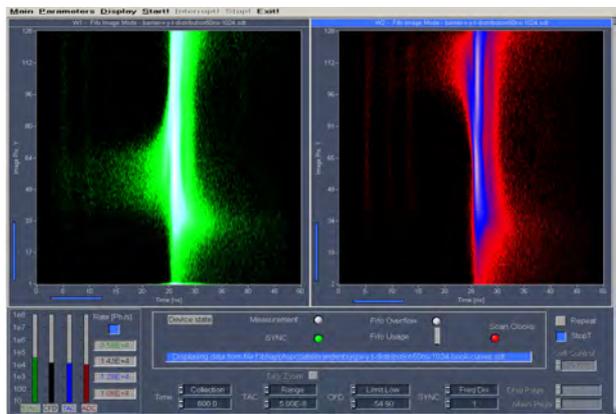
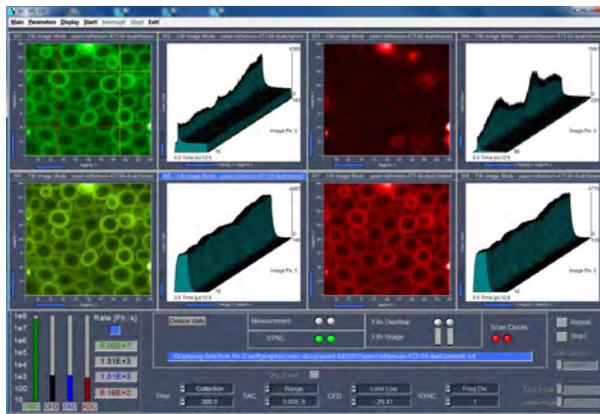
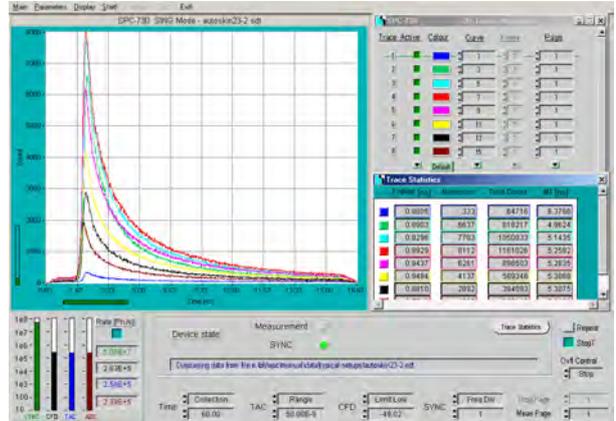
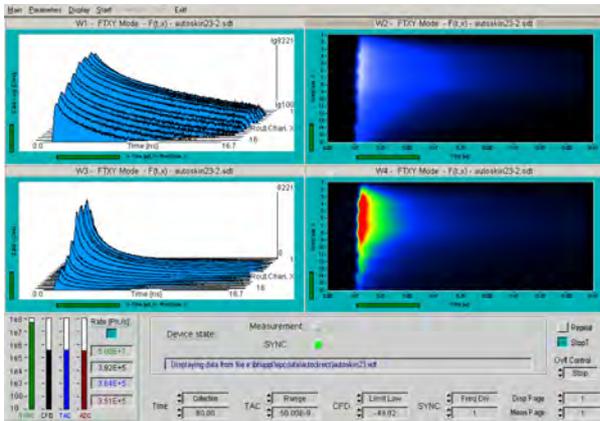
Same software for all bh TCSPC modules and DPC-230 card

- One software for all operation modes
- Full access to all functions of the boards
- Configurable for different instrument configurations
- Parallel operation of up to four SPC or DPC modules
- Online display of images and curves
- Online display of lifetime images
- Online calculation of FCS, PCH, and MCS traces
- Online fit of FCS curves
- Cycle function
- Page stepping
- Autosave functions
- Oscilloscope mode
- Multi-wavelength fluorescence decay recording
- Single and repeat mode
- Sequential modes
- Imaging modes
- Single photon parameter-tag mode
- Hardware-accumulation FLIM mode
- Software-accumulation (parameter tag) FLIM mode
- Multi-wavelength FLIM
- Spatial Mosaic FLIM
- Temporal mosaic FLIM for accumulation of ultrafast time series
- Fluorescence lifetime transient scanning (FLITS)
- Simultaneous recording of FLIM and PLIM
- Integrated scanner control
- Integrated detector control
- Integrated laser control for PLIM
- Integrated control of Ti:Sa laser and AOM
- Integrated control of motorised sample stage
- Integrated control of Zeiss Axio Observer Z1 microscope
- 2D and 3D display modes
- Online display of lifetime images
- Image display with software gating
- Display of multi-wavelength FLIM images
- 3D Curve mode, colour-intensity display of multi-dimensional data
- Saving, loading, and conversion of photon distributions, images, and time-tag data
- Loading of instrument configuration via predefined setups
- 2D and 3D data processing functions
- Automatic interaction with SPCImage FLIM data analysis
- Runs under Windows 8, Windows 10, and Windows 11

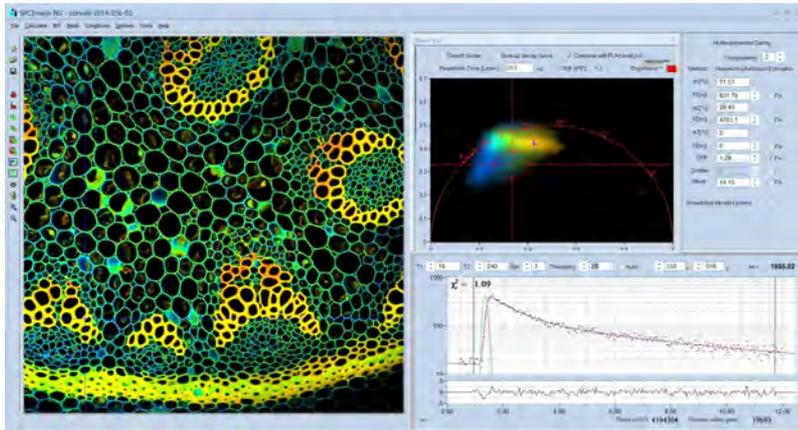
The SPCM software is free. Please downloaded from [www.becker-hickl.com](http://www.becker-hickl.com).



**SPCM Data Acquisition Software for bh TCSPC Modules and DPC-230 Photon Correlator**  
**One Software - Multiple Applications**

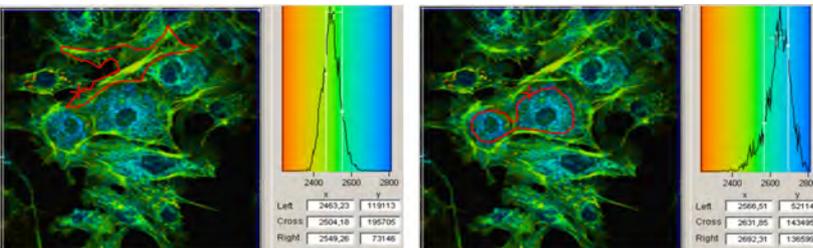
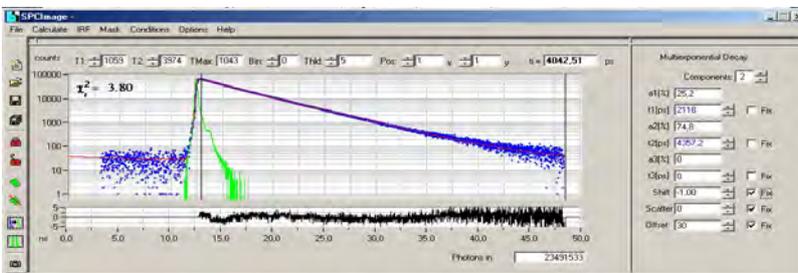


**TCSPC Data FLIM Analysis Software**  
**GPU Processing - FLIM Analysis within Seconds**

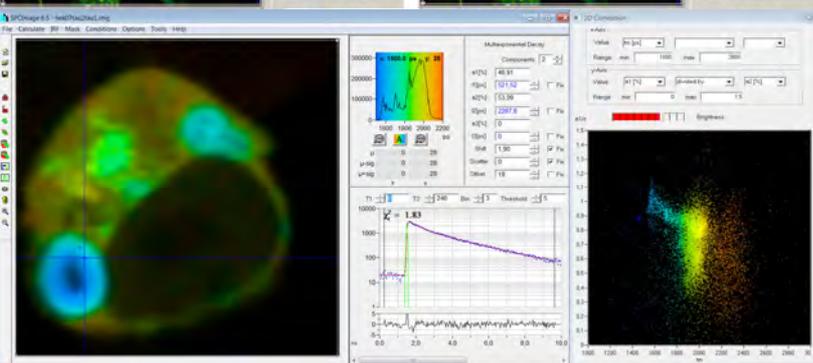


**SPCImage NG FLIM Data Analysis Software**

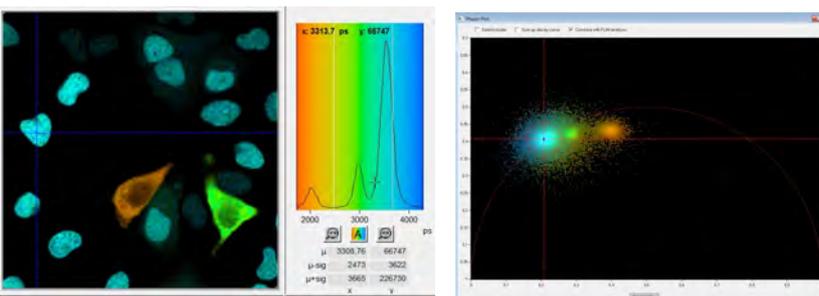
- Combination of time-domain analysis and phasor analysis
- Maximum-likelihood algorithm
- GPU processing
- Analysis of FLIM data
- Analysis of PLIM data
- Analysis of single FLIM or PLIM channels
- Analysis of multiple FLIM or PLIM channels
- Analysis of single-curve fluorescence data
- Analysis of single-curve phosphorescence data
- Analysis by iterative convolution and fit procedure
- Analysis by first moment of photon distribution
- Multi-thread 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
- Automatic IRF modelling
- Extraction of IRF from SHG components in FLIM image
- Region-of-interest selection
- Image segmentation by phasor plot and 2D histogramming
- Single and double-exponential FRET
- Display of lifetime images
- Display of FRET images
- Display of lifetimes, amplitudes, intensities or ratios of parameters
- Calculation of FRET efficiencies
- Histograms of lifetimes, amplitudes, intensities or ratios of these parameters
- 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



Multiple region of interest definition

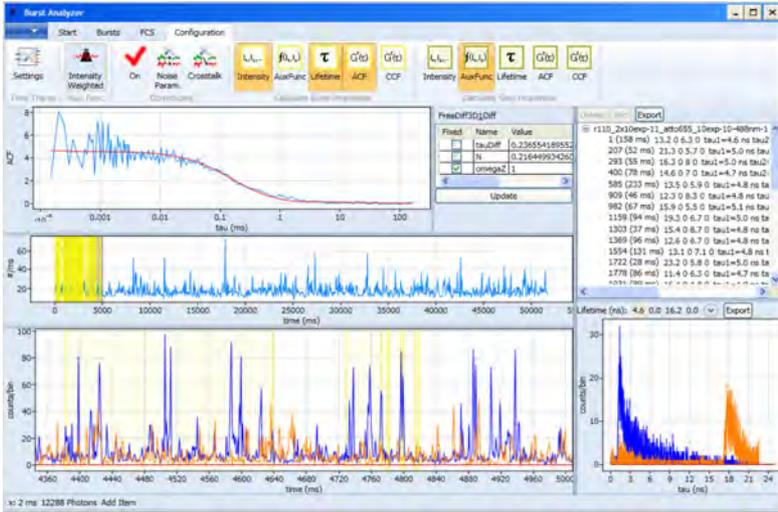


- Two-dimensional histograms of decay parameters
- Histograms of pixel frequency over two selected parameters of the fluorescence decay
- Coloured annotation of pixels in 2D histograms
- Back-annotation of 2D parameter ranges in FLIM images



- Combination of time-domain analysis with phasor plot
- Fourier transform of decay data
- Histograms of amplitude and phase of decay data in frequency space
- Coloured annotation of pixels in phasor plot
- Back-annotation of parameter ranges in FLIM images
- Cluster selection in phasor plot
- Combination of corresponding decay data in single curve

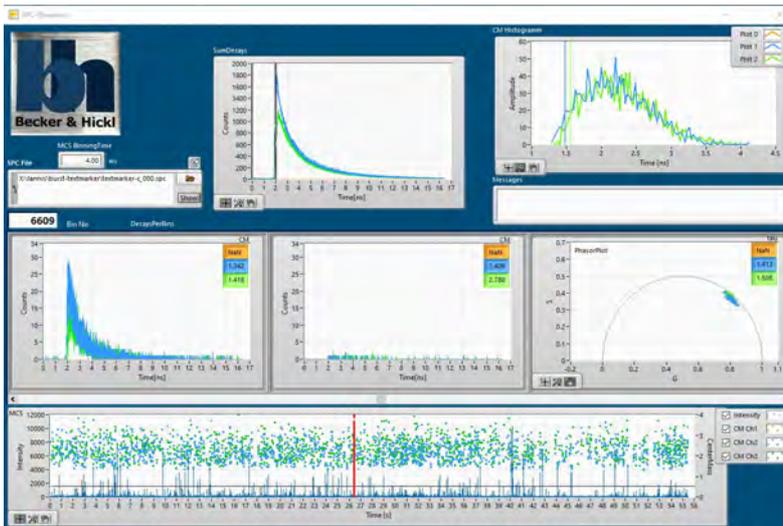
## TCSPC Single-Molecule Burst-Analysis Software



### Single-Molecule Burst-Analysis Software

- Identification of single-molecule photon bursts in parameter-tag data
- Analysis of fluorescence intensity within photon bursts
- Analysis of fluorescence lifetime within photon bursts
- One- and two-dimensional histograms of burst parameters
- Filtered histograms of burst parameters
- Discrimination of different fluorescent species
- Determination of FRET efficiencies
- Discrimination of different FRET states
- Calculation of FCS and cross-FCS
- FCS fit with user-defined model functions
- Exclusion of artefacts in intensity traces
- Time-gating
- Selection of excitation channels in PIE data

## SPCDynamics Data Viewer / Data Analysis Software

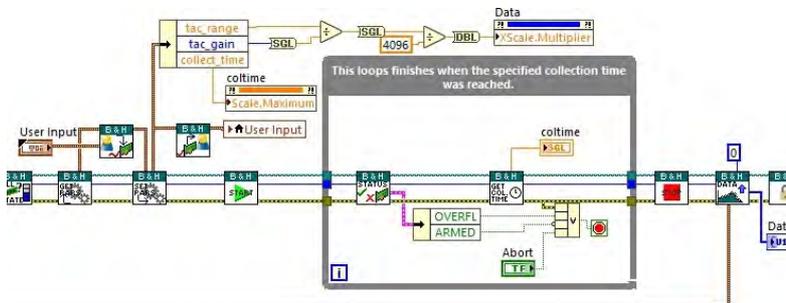


### Visualisation and Analysis of Dynamic Effects in TCSPC / FLIM Data

- Statistical analysis of photon-burst data
- Decay analysis of moving particles
- Decay analysis of single molecules
- Analysis of dynamic effects within TCSPC FLIM recordings
- Analysis of transient physiological effects in live systems

Based on .spc time-tag data of SPCM Software

## Lab-View Library for bh TCSPC / FLIM Modules



### Lab View modules for basic functions of bh TCSPC / FLIM modules

- Measurement and measurement control functions
- Parameter setup functions
- Display functions
- Load and save functions

Example programs

## DLL Libraries for TCSPC / FLIM and Experiment Control Modules

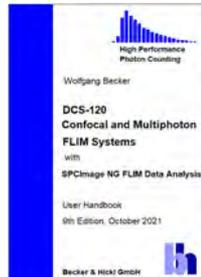
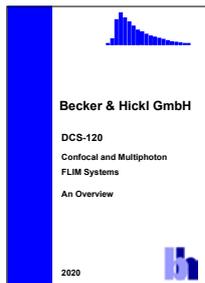


DLL libraries for bh data acquisition and experiment control modules  
For designing user-specific instrument software  
Please contact bh for details.

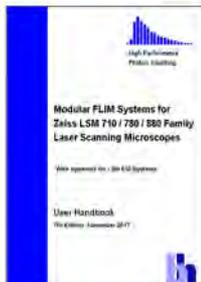
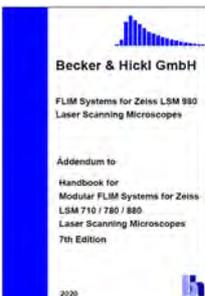
## TCSPC Literature from the Technology Leader



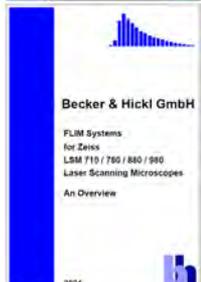
Wolfgang Becker  
**The bh TCSPC Handbook**  
 9th Edition, September 2021,  
 981 pages, 1283 references, 1220 figures  
 Available from [www.becker-hickl.com](http://www.becker-hickl.com)  
 Please contact bh for printed copies



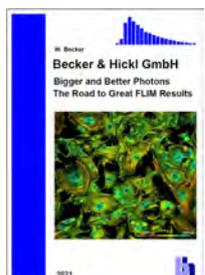
**DCS-120 Confocal and Multiphoton FLIM Systems**  
**User handbook**  
 9th Edition, October 2021  
 453 pages, 601 references, 610 figures  
 Available from [www.becker-hickl.com](http://www.becker-hickl.com)  
 Please contact bh for printed copies



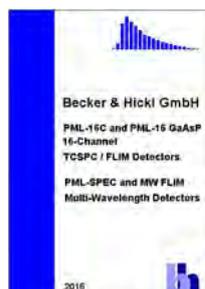
**DCS-120 Confocal Scanning Systems**  
**Overview brochure**  
 Edition 2021  
 44 pages, 85 references, 63 figures  
 Available from [www.becker-hickl.com](http://www.becker-hickl.com)



**Modular FLIM Systems for Zeiss LSM 710 / 780 / 880 Family**  
**Laser Scanning Microscopes**  
 with appendix for LSM 510 systems  
 7th edition, November 2017  
 357 pages, 531 references, 458 figures,  
 Available from [www.becker-hickl.com](http://www.becker-hickl.com)  
 Please contact bh for printed copies



**FLIM Systems for Zeiss LSM 980 Laser Scanning Microscopes.**  
**Addendum to: Handbook for modular FLIM systems for Zeiss LSM 710 / 780 / 880 family laser scanning microscopes.**  
 February 2020, 24 pages  
 Available from [www.becker-hickl.com](http://www.becker-hickl.com)  
 Please contact bh for printed copies



**FLIM for Zeiss LSM 710 / 780 / 880 Family**  
**Laser Scanning Microscopes**  
**Overview brochure**  
 60 pages, 206 references, 67 figures  
 Available from [www.becker-hickl.com](http://www.becker-hickl.com)

**SPCImage Next Generation FLIM Data Analysis Software**  
**Overview Brochure**  
 19 pages  
 Available from [www.becker-hickl.com](http://www.becker-hickl.com)

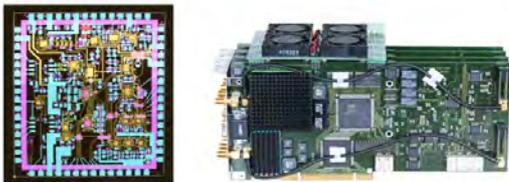
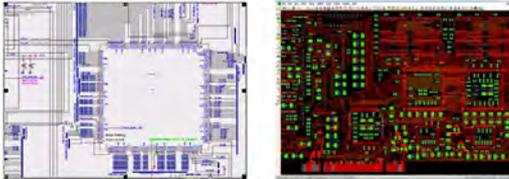
**The bh TCSPC Technique Principles and Applications**  
**Overview Brochure**  
 27 pages, 46 references  
 Available from [www.becker-hickl.com](http://www.becker-hickl.com)

**Bigger and Better Photons**  
 The Road to Great FLIM Results  
 Jan. 2021, 39 pages

**DPC-230 16 Channel Photon Correlator**  
 User Handbook  
 April 2008  
 66 pages, 89 figures, 31 references  
 Available from [www.becker-hickl.com](http://www.becker-hickl.com)

**PML-16-C 16 and PML-16 GaAsP 16 Channel TCSPC / FLIM Detectors**  
**PML-SPEC and MW FLIM Multi-Wavelength Detectors**  
 User Handbook  
 61 pages, 75 figures, 99 references  
 Available from [www.becker-hickl.com](http://www.becker-hickl.com)

## Design, Manufacturing and Quality Management



### A Strong Partnership

bh and Dorazil form an alliance since 1993. Located in the same building, our companies closely cooperate at all stages through schematics design, hybrid circuit design, board layout, and computer-aided manufacturing and testing. Continuous quality management through the complete design and manufacturing flow results in high reliability and short delivery time both for prototypes and large order quantities.

### Continuous flow from design into manufacturing

Hybrid-circuit, FPGA, and PCB design

### Electronics running off the mill

High-density automatic SMD placement  
Automatic soldering  
**ROHS lead-free**

### Thin film and thick film hybrid circuits

In-house manufacturing  
Automatic placement of components  
Automatic chip bonding

### ISO 9001 and ISO 14001 certified

Quality management through entire manufacturing process  
Uncompromised quality at any number of pieces

**bh International Sales Representatives**



USA, Canada  
Boston Electronics Corp  
tcspc@boselec.com  
www.boselec.com



UK:  
Photonic Solutions PLC  
sales@psplc.com  
www.psplc.com



Japan:  
Tokyo Instruments Inc.  
sales@tokyoinst.co.jp  
www.tokyoinst.co.jp



China and Hongkong:  
DynaSense Photonics Co. Ltd.  
info@dyna-sense.com  
www.dyna-sense.com



India:  
Carl Zeiss India  
info.microscopy.in@zeiss.com  
<http://www.zeiss.co.in>



Russian Federation:  
BioVitrum  
<http://www.biovitrum.ru>  
(Cooperation temporarily suspended)



Russian Federation:  
Azimuth Photonics  
info@azimp.ru  
<http://www.azimp.ru>  
(Cooperation temporarily suspended)



Korea:  
UniNanoTech Co.Ltd.  
nano@uninanotech.com  
<https://www.unithink.co.kr>

Other Regions:  
Please feel free to contact bh directly



**Becker & Hickl GmbH**

Nunsdorfer Ring 7-9, 12277 Berlin, Germany

Tel. +49 / 30 / 212 800 20 Fax. +49 / 30 / 212 800 213

email: [info@becker-hickl.com](mailto:info@becker-hickl.com)

[www.becker-hickl.com](http://www.becker-hickl.com)