Becker & Hickl GmbH

Technology Leader in Photon Counting
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Gated Photon Counter / Multiscaler

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Picosecond Diode Laser

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Modular TCSPC systems

**SPC-630 TCSPC module**
- Multi-dimensional photon distribution mode
- Photon stream (time tag) mode; buffer size 256 k photons
- Multi-detector / multi-wavelength operation
- FCS in combination with fluorescence lifetime
- Burst-integrated fluorescence lifetime detection
- Fast unlimited sequential recording
- Fast multiplexing of excitation sources
- Total recordable count rate 4 MHz, saturated count rate 8 MHz
- Time channel width 813 fs
- Each channel expandable for up to 8 detectors
- 16-channel multi-wavelength detection with PML-SPEC assembly

**SPC-830 TCSPC module**
- Multi-dimensional photon distribution mode
- Photon stream (time tag) mode; buffer size 8 M photons
- Multi-detector / multi-wavelength operation
- Synchronisation of channels for photon correlation
- Fast scanning: single- and multi-wavelength FLIM module for laser scanning microscopes
- FCS in combination with fluorescence lifetime
- Burst-integrated fluorescence lifetime detection
- Fast sequential recording
- Fast multiplexing of excitation sources
- Total recordable count rate 4 MHz, saturated count rate 8 MHz
- Time channel width 813 fs
- Each channel expandable for up to 8 detectors

**SPC-134 TCSPC package**
- Four fully parallel TCSPC channels
- Multi-dimensional photon distribution mode
- Photon stream (time tag) mode; buffer size 8 M photons
- Multi-detector / multi-wavelength operation
- Synchronisation of channels for photon correlation
- FCS in combination with fluorescence lifetime
- Burst-integrated fluorescence lifetime detection
- Unlimited fast sequential recording: TCSPC module for DOT systems
- Fast multiplexing of excitation sources
- Total recordable count rate 20 MHz
- Each channel expandable for up to 8 detectors

**SPC-144 TCSPC package**
- Four fully parallel TCSPC channels
- Multi-dimensional photon distribution mode
- Photon stream (time tag) mode; buffer size 2 M photons
- Multi-detector / multi-wavelength operation
- Synchronisation of channels for photon correlation
- Fast scanning: High-speed FLIM module for laser scanning microscopes
- FCS in combination with fluorescence lifetime
- Burst-integrated fluorescence lifetime detection
- Fast sequential recording
- Fast multiplexing of excitation sources
- Total recordable count rate 20 MHz
- Each channel expandable for up to 8 detectors

**New! SPC-154 TCSPC package**
- Four fully parallel TCSPC channels
- Multi-dimensional photon distribution mode
- Photon stream (time tag) mode; buffer size 2 M photons
- Synchronisation of channels for photon correlation
- Fast scanning: High-speed FLIM module for laser scanning microscopes
- FCS in combination with fluorescence lifetime
- Burst-integrated fluorescence lifetime detection
- Unlimited fast sequential recording: TCSPC module for DOT systems
- Fast multiplexing of excitation sources
- Total recordable count rate 20 MHz
- Each channel expandable for up to 8 detectors

**Simple-Tau 140 and 830 compact TCSPC systems**
- Recording by one SPC-140 or SPC-830 TCSPC module
- Detector control via DCC-100 detector controller card
- Compact FLIM systems for laser scanning microscopy
- General time-resolved fluorescence spectroscopy
- Single-molecule spectroscopy
- Combined FCS and fluorescence lifetime systems
- Burst-integrated fluorescence lifetime experiments

**New! Simple-Tau 152 compact TCSPC systems**
- Two parallel SPC-150 TCSPC channels
- One DCC-100 detector controller
- Portable DOT systems
- High-Speed FLIM systems
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SPC-130, SPC-140, SPC-150 TCSPC Modules for Industrial Applications
- Standard fluorescence lifetime, TCSPC FLIM, Diffuse optical tomography, Single-molecule spectroscopy
- Rugged design
- Overvoltage-protected inputs
- Photon distribution, time-tag, sequential-recording and imaging modes
- Low price at large order volumes

Picosecond Photon Correlators

New! DPC-230 16 Channel Picosecond Photon Correlator
- Recording of absolute photon times
- Fluorescence correlation down to ps times
- FCS combined with fluorescence decay
- Autocorrelation within 17 LV/TTL or 4 CFD channels
- 16-channel multiscaler mode
- 3-channel reversed-start-stop TCSPC mode

Multichannel Scalers

MSA-1000 Multichannel Scaler
- Recording of luminescence decay functions in the ns, and µs range
- Time-of-flight mass spectroscopy
- Lidar
- Time resolution 1 ns per time channel
- Maximum count rate 1 GHz
- Compact Simple-Tau MSA systems available

MSA-300 Multichannel Scaler
- Recording of luminescence decay functions in the ns, and µs range
- Time-of-flight mass spectroscopy
- Lidar
- Time resolution 5 ns per time channel
- Maximum count rate 100 MHz
- Compact Simple-Tau MSA systems available

PMS-400 Gated Photon Counter and Multichannel Scaler
- Dated detection of optical signals
- Luminescence decay in the µs and ms range
- Chemoluminescence
- Two parallel recording channels
- Gating down to 1 ns
- Multiscaler operation down to 300 ns per channel

Detectors and Detector Assemblies

Detector and shutter assemblies
- PMC-100 detector: IRF width 150 ps
- Hamamatsu R3809U MCP PMTs: IRF width 28 ps
- Hamamatsu H7422 modules: IRF width 300 ps, ultra-high efficiency
- Shutter operation via DCC-100 detector controller
- Overload shutdown of PMT
- Input field lens
- Compatible with NDD ports of multiphoton laser scanning microscopes
- Part of bh modular FLIM systems

Shutter / beamsplitter / detector assemblies
- For PMC-100, R3809U and H7422 detectors
- Shutter operation via DCC-100 detector controller
- Overload shutdown of PMT
- Dichroic beamsplitters, input field lens, input filter, bandpass filters in front of detectors
- Compatible with NDD ports of multiphoton laser scanning microscopes
- Part of bh modular FLIM systems

PMC-100 cooled PMT modules
- Cathode versions for UV to NIR region
- Internal PMT voltage generation
- IRF width 150 ps
- Ultra-stable IRF up to recorded count rates of 5 MHz
- Internal preamplifier
- Overload shutdown
- Power supply and control via DCC-100 detector controller
- Part of the bh modular FLIM and modular DOT systems

Single-photon avalanche photodiode modules (SPADs)
- Ultra-high efficiency in visible region
- IRF width 40 ps
- Active areas of 20µm, 50µm and 100µm
- Stable IRF over count rate
- Detector count rates up to 8 MHz, recorded count rates up to 5 MHz
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**New!** PML-SPEC multi-wavelength detection modules
- Simultaneous fluorescence decay detection in 16 wavelength channels
- Multi-spectral FLIM for confocal laser scanning microscopes
- IRF width 150 ps
- Works with all bh TCSPC modules
- Internal high-voltage power supply
- Internal routing electronics
- Overload shutdown
- Full control via DCC-100 card
- Part of the bh multi-wavelength FLIM systems for laser scanning microscopes

**New!** MW FLIM multi-spectral NDD FLIM detection systems for multiphoton microscopes
- Multi-spectral FLIM
- Non-descanned (direct) detection
- Adapters for Zeiss, Leica, Olympus
- Efficient light collection from deep sample layers
- IRF width 150 ps
- Works with all bh TCSPC modules
- Internal high-voltage power supply
- Internal routing electronics
- Protected by shutter and overload shutdown
- Full control via DCC-100 card
- Part of the bh multi-wavelength FLIM systems for laser scanning microscopes

**Detector Electronics**

**HRT-41 four-channel router**
- Connects up to four PMC-100, H7422 or R3809U detectors to one TCSPC channel
- All detectors are detecting simultaneously

**HRT-81 eight-channel router**
- Connects up to eight PMC-100, 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 and HFAM-26 Preamplifiers**
- For R3809U MCP PMT, H7422 modules, and other PMTs
- Power supply from TCSPC module
- Overload shutdown in conjunction with DCC-100 controller

**Experiment Control**

**DCC-100 detector controller**
- Power supply, gain control and overload shutdown for two detectors
- Control of shutters or other actuators
- Control of bh detector / shutter assemblies
- Power control of bh BHLP and BDL lasers
- Part of the bh modular FLIM, modular DOT, and Simple-Tau systems

**DDG-200 Digital Delay Generator**
- Multiplexing of lasers and routing into TCSPC Modules
- Multiplexing rate up to 100 kHz
- Non-overlapping multiplexing
- On-times programmable individually
- Part of the bh modular DOT systems

**New!** GVD-120 Scanner Control Card
- Generation of scan signals for galvo mirrors and piezo stages
- Dual-axis control
- Fully digital signal generation
- Independent of software response times
- Cycloid flyback
- Extremely high scan rates
- Pixel times down to 0.5 μs
- Fully Integrated into SPCM software of bh TCSPC modules
- Part of bh DCS-120 confocal scanning systems
**Picosecond Diode Lasers**

**New!** BDL-375-SMC, BDL-405-SMC, BDL-440-SMC and BDL-473-SMC picosecond / CW diode lasers

- Single-mode fibre coupler with beam correction optics
- Up to 70% coupling efficiency
- All commonly used fibre couplers with 1" mounting pitch
- 375 nm, 405 nm, 440 nm, 473 nm
- Repetition rate 20, 40, 80 MHz
- High-Power CW mode
- Pulse width typically 40 to 80 ps
- Fast on/off/multiplexing capability
- Fast electronic power control
- All driver electronics integrated
- Simple wall mounted +12V power supply
- 405 nm: 1 mW from single-mode fibre
- 440, 473 nm: 0.4 mW from single-mode fibre
- Part of the bh modular FLIM systems for laser scanning microscopes

**New!** BDL-375-SMCP, BDL-405-SMCP, BDL-440-SMCP and BDL-473-SMCP picosecond diode lasers with fibre pigtails

- Single-mode fibre pigtail
- Single-mode fibre permanently attached to laser
- No fibre alignment required

**BHL-600 picosecond diode lasers**

- Wavelengths from 635 nm to 1300 nm
- Repetition rate 50 MHz
- Pulse width typ. 40 to 50 ps
- Power typ. 0.3 mW
- All driver electronics integrated
- Simple wall mounted +12V power supply

**BHL-700 picosecond diode lasers**

- Wavelengths from 635 nm to 875 nm
- Repetition rate 50 MHz
- Pulse width typ. 80 ps at power <1 mW
- Power up to 10 mW at 785 nm
- All driver electronics integrated
- Fast on/off/multiplexing capability
- Power control via DCC-100 detector controller
- All driver electronics integrated
- Simple wall mounted +12V power supply
- Part of the bh modular DOT systems
Fluorescence Lifetime Microscopy

New! Confocal Scanning Systems

FLIM upgrade for conventional microscopes
- Fully confocal scanning by fast galvano mirrors
- One or two input channels for bh BDL-SMC picosecond diode lasers
- Laser wavelengths 405 nm, 440 nm, or 473 nm
- High excitation power by beam-profile-corrected laser couplers
- One or two detection channels
- Channel separation by dichroic or polarising beamsplitters
- Individually selectable pinholes
- Individually selectable filters
- High efficiency by direct-coupled detectors
- PMC-100, H7422 or ultra-fast MCP detector modules
- 16-channel multi-wavelength detector module

Compatible with bh SPC-830, SPC-140, or SPC-150 TCSPC modules

Software for Windows 2000, NT, XP, and Vista

FLIM Systems for Zeiss LSM 510 NLO Multiphoton Microscopes

- Non-descanned detection
- One or two detectors
- Multi-spectral NDD FLIM detection
- Detectors connected to Zeiss NDD switch box
- All options of NDD light path available
- ROI and Zoom functions of LSM 510 available
- Works at any scan rate of LSM 510
- Ultra-high time resolution: 30 ps IRF with MCP detector
- Fast Acquisition

FLIM Systems for Zeiss LSM 510 Confocal Microscopes

- Excitation by bh BDL-405 SMC picosecond diode laser
- Confocal detection
- Single wavelength detection
- ROI and Zoom functions of LSM 510 available
- Works at any scan rate of LSM 510
- Fast Acquisition

FLIM Systems for Leica SP2 and SP5 Microscopes

- bh TCSPC technique fully integrated into Leica systems
- Confocal detection
- Direct (RLD) detection for multiphoton microscopes
- Single wavelength detection
- Multi-spectral detection
- FCS capability
- ROI and Zoom functions of SP2 and SP5 available
- Works at any scan rate of SP2 and SP5
- Full overload protection of detectors

FLIM Systems for Olympus FV1000 and FV300

- Confocal FV1000 systems:
  - Excitation by bh BDL-405 SMC or BDL-473 SMC picosecond diode laser
  - High efficiency by direct coupling of detectors
- Single-wavelength or multi-wavelength detection
- FCS capability
- Multiphoton FV1000 and FV300 systems:
  - High efficiency by non-descanned FLIM detection modules
  - Full overload protection of detectors
  - ROI and Zoom functions of FV1000 or FV300 available
  - Works at any scan rate
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Time-Domain Diffuse Optical Tomography

Modular DOT systems

Several BHLP-700 lasers of different wavelengths multiplexed
Time-of-flight distributions in four wavelength channels and four spatial channels
Four parallel detectors
Four parallel TCSPC channels
DDG-200 digital delay generator
SPC-154 or SPC-134 TCSPC packages
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

1100 Pages of TCSPC Literature from the Technology Leader

Wolfgang Becker
Advanced Time-Correlated Single Photon Counting Techniques
400 pages, 349 figures, 557 references

Wolfgang Becker
The bh TCSPC Handbook
386 pages, 354 figures, 387 references
Available from www.becker-hickl.com

Modular FLIM Systems for Zeiss
LSM 510 Laser Scanning Microscopes
101 pages, 98 figures, 102 references
Available from www.becker-hickl.com

Leica MP-FLIM and D-FLIM
Fluorescence Lifetime Microscopy Systems
63 pages, 58 figures, 101 references
Available from www.becker-hickl.com

Modular FLIM Systems for Olympus Laser Scanning
Microscope Fluoview FV1000
103 pages, 106 figures, 104 references
Available from www.becker-hickl.com

BDL-SMC NUV and Blue Picosecond Diode Lasers
User Handbook
41 pages, 46 figures, 23 references
Available from www.becker-hickl.com

PML-16-C 16 Channel Detector Head for
Time-Correlated Single Photon Counting
User Handbook
39 pages, 40 figures, 28 references
Available from www.becker-hickl.com
Software

SPCM Data Acquisition Software for bh TCSPC modules
- One software for all bh TCSPC modules
- Full access to all functions of the boards
- Parallel operation of up to four SPC or DPC modules
- Online display of images and curves
- Online calculation of FCS, PCH, and MCS traces
- Page stepping
- Accumulation and autosave functions
- Oscilloscope mode
- Single and repeat mode
- Sequential modes
- Imaging modes
- Time tag mode
- Time tag imaging mode
- Integrated scanner control
- 2D and 3D display modes
- Software gating of image display
- Display of multi-wavelength FLIM images
- Saving, loading, and conversion of photon distributions, images, and time-tag data
- Loading of predefined setups
- Main panel configurable by user
- Automatic interaction with SPCImage FLIM data analysis
- Emulation mode for working without SPC hardware
- Runs under Windows 2000, NT, XP, Vista

The SPCM software is free. It can be downloaded from www.becker-hickl.com at any time.

SPCImage FLIM Data Analysis Software
- Deconvolution of single curves and FLIM data
- Single, double, and triple-exponential decay analysis
- Single and double-exponential FRET
- Display of lifetime images
- Display of FRET images
- Display of lifetimes, amplitudes, intensities or ratios of these parameters
- Histograms of lifetimes, amplitudes, intensities or ratios of these parameters
- Export of lifetime data
- Export of images
- Direct interaction with SPCM software
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Operating Software for bh Multichannel Scalers

- Setting of system parameters
- Configuration of measurement sequences
- Data display
- Data processing
- Load and save of measurement data and setup parameters
- Operation of up to four modules
- Emulation mode to work without hardware
- Runs under windows 2000, NT, XP, Vista

The MSA and PMS software is free. It can be downloaded from www.becker-hickl.com at any time.

Operating Software for DCC-100 Detector controller

- Safe operation of PMTs, PMT Modules, and MCPs
- Control of high voltage of PMT modules or high voltage power supplies
- Control of shutters
- Control of coolers
- DCC panel can be placed anywhere within SPCM or MSA software panels
- Runs under windows 2000, NT, XP, Vista

The DCC software is free. It can be downloaded from www.becker-hickl.com at any time.

DLL and Lab View Libraries for TCSPC and Multiscaler Modules

Integration of bh systems into user-designed instrument software
The TCSPC General Solution  SPC-600/630

Time-Correlated Single Photon Counting Modules with dual Memory and PCI Bus

- Complete TCSPC Systems on single PC Boards
- Dual Memory Architecture: Unlimited Sequential Curve Recording
- Histogram Mode: Recording of Decay Curves
- FIFO Memory Mode: Continuous Recording by BIFL Method
- Reversed Start/Stop: Repetition Rates up to 200 MHz
- Electrical Time Resolution down to 8 ps FWHM / 5 ps rms
- Channel Resolution down to 813 fs
- Up to 4096 Time Channels / Curve
- Ultra High Count Rate: Up to 8 MHz (125 ns Dead Time)
- Measurement Times down to 0.1 ms
- Multi Detector Capability: Up to 128 Detector Channels
- Software Versions for Windows 95 / 98 / 2000 / NT
- Optional Step Motor Controller for Wavelength or Sample Scanning
- Direct Interfacing to most Detector Types
- Single Decay Curve Mode
- Oscilloscope Mode
- Multiple Decay Curve Mode (Wavelength, Time or User Defined)
- Spectrum Scan Mode with 8 Independent Time Windows
- Multichannel X-Y-T-Mode
- Continuous Flow and BIFL Mode for Single Molecule Detection

Covered by patents DE 43 39 784 A1 and DE 43 39 787 A1

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SPC-600

Photon Channel
- Principle: Constant Fraction Discriminator
- Time Resolution (FWHM / RMS, electr.): 13 ps / 7 ps, 8 ps / 5 ps
- Opt. Input Voltage Range: ±10 mV to ±80 mV, 5 mV to 80 mV, 5 mV to 80 mV
- Lower Threshold: ±10 mV to +10 mV
- Upper Threshold: ±10 mV to +10 mV
- Zero Cross Adjust: ±10 mV to +10 mV

Synchronisation Channel
- Principle: Constant Fraction Discriminator
- Opt. Input Voltage Range: ±10 mV to ±50 mV, 5 mV to 80 mV
- Threshold: ±10 mV to +10 mV
- Frequency Range: 0 to 200 MHz
- Frequency Divider: 1-2-4-8-16
- Zero Cross Adjust: ±10 mV to +10 mV

Time-to-Amplitude Converter / ADC
- Principle: Ramp Generator / Biased Amplifier
- TAC Range: 50 ns to 2 μs
- Biased Amplifier Gain: 1 to 15
- Biased Amplifier Offset: ±50 mV to ±1 V
- Time Range incl. Biased Amplifier: 3.3 ns to 2 μs
- TAC Window Discriminator: 813 fs
- ADC Principle: 0 to 200 MHz
- Diff. Nonlinearity: <0.5 % rms, typically 0.6 to 1% peak-peak

Data Acquisition (Histogram Modes)
- Method: on-board 2-dimensional histogramming process
- Dead Time: 125 ns, independent of computer speed
- max. Number of Curves in Memory: 4096
- max. Number of Detector Channels: 1024
- Number of Time Channels / Curve: 256
- max. Counts / Channel: 4096
- Overflow Control: none / stop / repeat and correct
- Collection Time: 0.1 us to 10000 s
- Display Interval Time: 10 ms to 1000 s
- Repeat Time: 0.1 ms to 1000 s
- Curve Control (internal): Programmable Hardware Sequencer
- Curve Control (external Routing): 7 bit TTL
- Add/Sub (Lock-in) Control: 1 bit TTL
- Count Enable Control: 1 bit TTL
- Control Signal Latch Delay: 0 to 255 ns

Data Acquisition (FIFO / BIFL Mode)
- Method: Time-tagging of individual photons and continuous writing to disk
- Dead Time: 150 ns
- Output Data Format (ADC / Macrotime / Routing): 12 / 24 / 8, 8 / 17 / 3
- FIFO buffer Capacity (photons): 128 k, 256 k
- Macro Timer Resolution: 50 ns, 24 bit, 50 ns, 17 bit
- Curve Control (external Routing): 8 bit TTL, 3 bit TTL
- Count Enable Control: 1 bit TTL
- Routing Signal Latch Delay: 0 to 255 ns

Operation Environment
- Computer System: PC Pentium or 486
- Bus Connector: PCI
- Power Consumption: approx. 20 W at +5V, 0.7 W at +12V
- Dimensions: 312 mm x 122 mm x 28 mm

Multi Module Systems
- Number of modules operable parallel: 4

Accessories and Associated Products
- Detectors (MCPs, PMTs), Multichannel Detector Heads, Routing Devices for Multichannel Measurements, Step Motor Controllers, Preamplifiers, PIN and Avalanche Photodiode Modules, ps Diode Lasers. Also available: SPC-134, SPC-700 and SPC-730 time-correlated single photon counting modules, gated photon counters and multiscalers. Please call for individual data sheets and descriptions. For TCSPC imaging applications please see SPC-700/730 data sheets, for ultra-high count rate please see SPC-134 data sheet.
**DPC-230 16 Channel Photon Correlator**

**Photon correlation down to the ps range**

- 16 LVTTL inputs for SPADs or 4 CFD inputs for PMTs
- Recording of absolute photon times
- Autocorrelation within 16 LVTTL or 4 CFD channels
- Cross-correlation between any pairs of LVTTL or CFD channels
- 3-channel TCSPC mode with 165 ps time channel width
- Multiscaler operation of 15 LVTTL or 3 CFD channels
- Single-slot PCI module
- Operating software for Windows 2000, NT and XP

**Fluorescence correlation experiments down to the ps range**
**Antibunching experiments**
**Fluorescence correlation and antibunching from one experiment**
**Luminescence lifetime measurements**
### DPC-230  16 Channel Photon Correlator

**LVTTL Inputs**
- No. of channels: 16
- Input Voltage: LVTTL
- Threshold: 1.4 V
- Min. Input Pulse Width: 2 ns
- Min. Pulse Distance: 5.5 ns
- Connectors: MCX, on board

**CFD Inputs**
- No. of channels: 4
- Threshold: -20 mV to -500 mV
- Zero Cross Adjust: -100 mV to +100 mV
- Connectors: SMA, front panel

**Experiment Trigger Input**
- Input Voltage: LVTTL
- Threshold: 1.4 V

**Data Acquisition, Correlation Mode**
- Method: Time-tag recording, absolute photon times
- Correlation of photons: Multi tau or linear tau algorithm, online or offline
- Autocorrelation: all channels
- Cross-correlation: any pairs of channels
- Time increment: 164.61 ps
- Dead Time: < 10 ns
- No of parallel channels: 16 LVTTL or 4 CFD channels
- On-board FIFO Buffer size: 4-10^6 photons
- Readout: continuous readout during measurement
- Sustained readout rate (typ., depends on computer): 7-10^6 photons

**Data Acquisition, TCSPC Mode**
- Method: Time-tag recording, reversed start-stop
- Correlation of photons: Start-stop histogram, online or offline
- Start (photon) channels: 3 CFD inputs
- Dead Time: < 10 ns
- Stop channel: 1 CFD input
- Stop input rate: max 150 MHz
- Stop frequency divider: 1 - 2 - 4
- Time channel width: 164.61 ps
- On-board FIFO Buffer size: 4-10^6 photons
- Readout: continuous readout during measurement
- Sustained readout rate (typ., depends on computer): 7-10^6 photons

**Data Acquisition, Multiscaler Mode**
- Method: Time-tag recording, direct start-multistop
- Correlation of photons: Start-stop histogram, online or offline
- Start (reference) channel: 1 CFD input or 1 LVTTL input
- Stop (photon) channels: 3 CFD inputs or 15 LVTTL inputs
- Dead Time: < 10 ns
- Time channel width: 164.61 ps
- On-board FIFO Buffer size: 4-10^6 photons
- Readout: continuous readout during measurement
- Sustained readout rate (typ., depends on computer): 7-10^6 photons

**Operation Environment**
- Computer System: Pentium PC
- Recommended configuration: >1024 Mb RAM, >100 Gb HD
- Bus Connector: PCI
- Power Consumption: approx. 12 W from +5V
- Dimensions: 312 mm x 124 mm x 20 mm

**Related Products**
- SPC-830, SPC-630, SPC-134, SPC-144, SPC-154 TCSPC modules, MSA-1000 and MSA-300 multiscalers, DCC-100 Detector controller, BDL-375, -405, -440, -473 picosecond / CW diode lasers, id-100 SPAD modules, PMT detector modules, detector / shutter assemblies.

Please download or call for individual data sheets and manuals.
Simple-Tau 830   Table-Top TCSPC Systems

Ultra-fast time-correlated single photon counting systems in lap-top format

- Complete TCSPC system and detector control
- Cooled fast PMT module
- Picosecond resolution
- Unprecedented count rate
- Unprecedented timing stability
- Time channel width down to 813 fs
- Multi-dimensional on-board data acquisition
- Lifetime imaging capability
- Optional multi detector operation
- Optional multi-spectral operation
- Standard fluorescence lifetime applications
- On-line FCS recording
- Fast triggered sequential recording
- Lifetime imaging with scanning microscopes
- Works at any scan rate of microscope
- High-resolution steady-state imaging
- Diffuse optical tomography
- Single molecule spectroscopy
- Works under windows 2000, NT or XP

Covered by patents DE 43 39 784 and DE 43 39 787

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Simple-Tau 830 Table-Top TCSPC Systems

Photon Channel
- Principle: Constant Fraction Discriminator (CFD)
- Time Resolution (FWHM / RMS, electr.): 7 ps / 4 ps
- Opt. Input Voltage Range: -50 mV to - 1 V
- Min. Input Pulse Width: 400 ps
- Threshold: -20 mV to -500 mV
- Zero Cross Adjust: 1-2-4-8

Synchronisation Channel
- Principle: Constant Fraction Discriminator (CFD)
- Opt. Input Voltage Range: -50 mV to - 1 V
- Min. Input Pulse Width: 400 ps
- Threshold: -20 mV to -500 mV
- Frequency Range: 0 to 200 MHz
- Frequency Divider: 1, 2, 4, 8
- Zero Cross Adjust: -100 mV to + 100 mV

Time-to-Amplitude Converters / ADC
- Principle: Ramp Generator / Biased Amplifier
- TAC Range: 50 ns to 2 μs
- Biased Amplifier Gain: 1 to 15
- Biased Amplifier Offset: 0 to 100% of TAC Range
- Time Range: 3.3 ns to 2 μs
- Biased Amplifier Offset: 0 to 100% of TAC Range
- Time Range: 3.3 ns to 2 μs
- TAC Window Discriminator: Any window inside TAC range
- ADC Principle: 50 ns Flash ADC with Error Correction
- Diff. Nonlinearity: < 0.5% rms, typ. <1% peak-peak

Data Acquisition (Histogram Mode)
- Method: on-board multi-dimensional histogramming process
- Dead Time: 125 ns, independent of computer speed
- Saturated Count Rate, per TCSPC channel / total: 8 MHz
- Useful count rate, per TCSPC channel / total:
- Number of Time Channels / Pixel:
  - 1, 4, 16, 64, 256, 1024, 4096
- TAC Range: 50 ns to 2 μs
- Biased Amplifier Gain: 1 to 15
- Biased Amplifier Offset: 0 to 100% of TAC Range
- Frequency Range: 0 to 200 MHz
- Frequency Divider: 1, 2, 4, 8
- Zero Cross Adjust: -100 mV to + 100 mV
- ADC Principle: 50 ns Flash ADC with Error Correction
- Diff. Nonlinearity: < 0.5% rms, typ. <1% peak-peak

Data Acquisition (FIFO / Time-Tag Mode)
- Method: Time-tagging of individual photons and continuous writing to disk
- Dead Time: 125 ns
- Output Data Format (ADC / Macronite / Routing):
  - 12 / 12 / 3
- FIFO buffer Capacity (photon):
  - 8 M
- Macro Timer Resolution, internal clock:
  - 50ns, 12 bit
- Macro Timer Resolution, clock from SYNC input:
  - 10ns to 100ns, 12 bit
- Curve Control (external Routing):
  - 3 bit TTL
- Experiment Trigger:
  - 1 bit TTL

Detector control
- Number of independently controlled detectors:
  - one or two
- Resolution of gain control:
  - 12 bit
- Voltage Range Pin 12 of connector 1 and 3:
  - 0 to +10 V
- Voltage Range Pin 13 of connector 1 and 3:
  - 0 to +0.9 V
- Output Time Constant:
  - 100 ms
- Detector overload shutdown:
  - via TTL signal from PMC-100 detector module or preamplifier
- Reset of overload shutdown:
  - By Software and at Power-ON
- Shutter control:
  - 8 independent high-current switches
- Max. Switch Current, Single Switch:
  - 2 A
- Max. Switch Current, Sum of all Switches:
  - 5 A
- Max. turn-off Voltage at Switches:
  - 20 V
- Control of thermoelectric coolers:
  - 0 to 5 V
- Total output voltage:
  - 0 to 2 A
- Output Current:
  - 12 bit
- Resolution of Output Voltage and Current:
  - 12 bit

Detectors, see individual data sheets
- Standard detector
- Optional detector
- Optional detector
- Optional detector
- Optional detector

Related Products and Accessories
- SPC-134 through SPC-830 TCSPC boards, Detector Heads (MCPs, PMTs), Multichannel Detector Heads, Routing Devices for Multichannel Measurements, Step Motor Controllers, Preamplifiers, PIN and Avalanche Photodiode Modules, ps Diode Lasers, Adapter Cables for Scanning Microscopes. Please download or call for individual data sheets.

Please visit our web site to download the manuals, the device software and application notes.
1ns Photon Counter / Multiscaler

Ultra-fast accumulation
High repetition rate
No dead time between sweeps
No dead time between channels
Fast on-board discriminators

Input pulse width down to 800 ps
Time / channel 1 ns
Count rate up to 1000 MHz
Up to 128 k points / curve
Software for Windows 95 / 98 / 2000 / NT

The MSA-1000 is an ultra-fast multiscaler for photon counting, Lidar measurements or other fast particle detection applications. By using a 128 bit memory structure a dead-time-free accumulation of subsequent sweeps is achieved. This makes the MSA-1000 exceptionally useful for a wide variety of high-repetition rate signal recording applications.
Specification

- Time per Channel: min. 1 ns
- Count Rate: up to 1000 MHz
- No of Points / Curve: up to 128 k
- Overall Recording Length: up to 131 µs
- Accumulation (up to 256 events/point): Hardware, no dead time between recording cycles
- Accumulation (> 256 events/point): Software
- Count Input Impedance: 50 Ω
- Count Input Amplitude: ±20 mV to ±1 V
- Count Input Threshold: 0 to ±200 mV, ± 8 bit resolution
- Min.Count Input Pulse Width: 800 ps
- Trigger Input Impedance: 50 Ω
- Trigger Input Amplitude: ±20 mV to ±1 V
- Trigger Input Threshold: 0 to ±1 V, ± 8 bit resolution
- Min. Trigger Pulse Width: 800 ps
- Data Readout: subsequent data points are read by subsequent input instructions

Typical readout rate (Pentium 166 MHz): 1µs/point (C++, read 1 point and store into a data array)

Luminescence Decay Measurements

The sample is excited by laser pulses and the luminescence signal is detected by a PMT in the photon counting mode. Due to the deep memory a time scale from ns to ms can be covered in one measurement.

Lidar Measurements

Laser pulses are sent through a telescope and backscattered light from distant objects is detected. Due to the high accumulation speed of the MSA-1000 very high repetition rates and short overall measurement times are achieved.

Accessories: PMTs, PMT detector heads with internal HV supply, preamplifiers, diode lasers, pulse generators for experiment control, step motor controllers. Please see individual data sheets.
Multi-wavelength detection of fluorescence decay functions

16 simultaneously recording wavelength channels
Spectral range 300-850 nm
High time resolution: 180 ps fwhm IRF width
Useful count rate > 2 MHz
Ultra-high sensitivity
Short acquisition times
Greatly reduced pile-up
Works with all bh TCSPC modules

Biomedical fluorescence
Auto-fluorescence of tissue
Time-resolved laser scanning microscopy
Multi-spectral lifetime imaging
Recording of chlorophyll transients
Stopped flow fluorescence experiments

The PML-SPEC uses bh’s proprietary multi-dimensional TCSPC technique. The light is split into its spectrum by a polychromator. The spectrum is detected by a 16-channel multi-anode PMT. The single photons detected in the PMT channels are recorded in a bh TCSPC module. The TCSPC module builds up a photon distribution over the time in the fluorescence decay and the wavelength. The technique does not use any time gating, detector channel multiplexing, or wavelength scanning and therefore reaches a near-ideal counting efficiency.

Covered by patent DE 43 39 787
PML-Spec
Multi-Spectral Lifetime Detection

Specification

Optical System
Type of grating, lines/mm 400 600 1200
Recorded interval\(^1\), nm 320 208 106
Wavelength channel width, nm 20 13 6.65
Spectral range of grating\(^2\), nm 300-850 300-850 300-850
F number F / 3.7
Input slit width, mm 0.6
Input slit height, mm 3

1 any interval within spectral range of grating
2 limited by spectral response of detector

Detector\(^3\)
Cathode spectral response bi-alkali, 300 to 600 nm multi-alkali, 300 to 850 nm
Typical dark count rate, s\(^{-1}\) 200 800
Number of spectral channels 16
Timing output polarity of detector negative
Average timing pulse amplitude 40 mV
Time resolution (FWHM) 150 to 200 ps
Time skew between channels < 40 ps
Timing output connector SMA, 50Ω
Routing signal 4 bit + Count Disable Signal, TTL/CMOS
Routing signal connector 15 pin Sub-D / HD
Power supply -800...-900V / 0.35 mA from external HV power supply

3 please see data sheet and manual of PML-16 multichannel PMT head

Application
Wavelength-Resolved Fluorescence Decay Measurement

Related Products and Accessories
SPC-134 through SPC-830 TCSPC boards, ps diode lasers, FLIM upgrade kits for scanning microscopes, fibre couplers, computer-controlled HV power supplies. Please see www.becker-hickl.com or call for individual data sheets.

Tel. 042) 867-2227
info@skphotonics.com
**Ultraviolet Picosecond Diode Laser**

Pulse width down to 60 ps  
Repetition rate 20-50-80 MHz  
Wavelength 375 nm  
Low skew trigger output  
Extremely low RF noise  
Cooled laser diode  
Simple + 9 V to +12V power supply  
Compact design - no external controller unit

Luminescence lifetime experiments  
Picosecond lifetime microscopy  
Fluorescence correlation  
Time-correlated single photon counting experiments
BDL-375

Optical
Repetition Rate
20-50-80 MHz, selectable
Wavelength
370 nm to 380 nm, typ. 375 nm
Pulse Width (FWHM, Power 0.5 mW, 50 MHz)
60 to 90 ps
Peak Power
125 mW
Optical Power
20 MHz: 0.1 mW to 0.3 mW
50 MHz: 0.2 mW to 0.8 mW
80 MHz: 0.3 mW to 0.8 mW
(Average or CW-equivalent power, adjustable)
Stability of Repetition Rate
± 100 ppm
Pulse-to-Pulse Jitter
< 10 ps
Power and pulse shape stabilisation after ‘Laser on’ signal
Power and pulse shape stabilisation after switch-on
3 min
Trigger Output
Pulse Amplitude
+100 mV (peak) into 50 Ω
Pulse Width
1 ns
Output Impedance
50 Ω
Connector
SMA
Delay from Trigger to Optical Pulse
< 500 ps
Jitter between Trigger and Optical Pulse
< 10 ps
Control Inputs
Frequency 20 MHz
TTL / CMOS high
Frequency 50 MHz
TTL / CMOS high
Frequency 80 MHz
TTL / CMOS high
/Laser Off
TTL / CMOS low
External Bias Input
analog input, -10 V to +10 V
Power Supply
Power Supply Voltage
+ 9 V to +12 V
Power Supply Current
300 mA to 1 A
Power Adapter
AC-DC power adapter, with key switch and control box in cable
Mechanical Data
Dimensions
160 mm x 90 mm x 60 mm
Mounting Thread
two M6 holes
Maximum Values
Power Supply Voltage
0 V to +15 V
Voltage at Digital Control Inputs
-2 V to +7 V
Voltage at Ext. Bias Input
-12 V to + 12 V
Ambient Temperature
0 °C to 30 °C

1) Typical values, sample tested. Depends on pulse width and selected power.
2) Recommended power adjust range. Lower power gives broader pulses, higher power gives ringing in pulse shape. Power levels above the given range can be selected, but may impair the lifetime of the laser diode.
3) All inputs have 10 kΩ pull-up resistors. Open input is equivalent to logic ‘high’.
4) Dependent on ambient temperature. Cooling current changes due to temperature regulation of laser diode
5) Operation below 13 °C may result in unstable power or extended warm-up time.

Caution: Class 3B laser product. Avoid exposure to beam. Light emitted by the device may be harmful to the human eye and skin. Please obey laser safety rules when operating the devices. Complies with US federal laser product performance standards.

Application: TCSPC lifetime imaging with laser scanning microscopes

The BDL-375 laser excites the sample with 50 MHz, 75 ps pulses. The microscope scans the sample in y-x direction, and the SPC-830 TCSPC imaging module records the photon distribution versus time and the coordinates of the scanning area. The setup detects single and double exponential lifetimes down to a few 10ps. Typical applications are ion concentration, ph, or oxygen saturation measurements by fluorescence quenching, FRET experiments and distinguishing of autofluorescence components. Please see www.becker-hickl.com for detailed information.
DCS-120 Confocal Scanning System

Confocal Scanner for Fluorescence Lifetime Imaging

FLIM upgrade for conventional microscopes
Fully confocal
Scanning by fast galvano mirrors
One or two input channels for bh BDL picosecond diode lasers
Laser wavelengths 405 nm, 440 nm, or 473 nm
High excitation power by beam-profile-corrected laser couplers
One or two detection channels
Channel separation by dichroic or polarising beamsplitters
Individually selectable pinholes
Individually selectable filters
High efficiency by direct-coupled detectors
PMC-100, H7422 or ultra-fast MCP detector modules
16-channel multi-wavelength detector module
Compatible with bh SPC-830, SPC-140, or SPC-150 TCSPC modules
Scan control software for Windows 2000, NT and XP

High speed: Chloroplasts, acquisition in 1 second
Multi-wavelength detection

High accuracy: Triple-exponential decay
DCS-120 Confocal Scanning System

System Configuration and Options

Lasers
- Available Wavelengths: 405 nm, 440 nm, 473 nm
- Repetition rates: 20 MHz, 50 MHz, 80 MHz, CW
- Pulse width: typ. 80 ps
- Intensity control, electronical: 1:10
- Beam correction optics: Beam-profile and astigmatism correction
- Power delivered into fibre: 405 nm: 1 mW, 440 nm: 0.4 mW, 473 nm: 0.4 mW
- Multiplexing: Pixel by pixel, line by line, or frame by frame
- Beam blanking: During x and y flyback, via bh GVD-120 scan controller

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

Detectors
- Standard PMTs: PMC-100-1 or -20 cooled PMT modules. IRF width 180 ps
- High-efficiency PMTs: H7422P-40 GaAsP PMT modules, IRF width 200 to 350 ps
- High-speed MCP-PMTs: R3809U-50 MCP PMTs, IRF width 70 ps
- Single-photon APDs: id-100-50, IRF width 70 ps
- Multi-wavelength detector: bh MW FLIM detector. Please see individual data sheet.
- Detector control: Gain, cooling, overload shutdown. Via bh DCC-100 detector controller, see individual data sheet

TCSPC Options
- 1 SPC-830 TCSPC module: High-speed, large image size with 1 detector.
- 1 SPC-830 + HRT-41 router: Multi-wavelength detector
- 2 SPC-830 TCSPC modules: Medium speed acquisition with two detectors
- 1 SPC-150 TCSPC module: High-speed medium image size systems with 2 detectors
- 2 SPC-150 TCSPC modules: Medium speed ultra-large image size systems with 2 detectors
- Please see individual data sheets or bh TCSPC Handbook

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
- Zoom factor: 1:1 to 1:10
- 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

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

Related Products
- SPC-830, SPC-630, SPC-134, SPC-140/144, SPC-150/154 TCSPC modules, DCC-100 Detector controller, BDL-375, -405, -440, -473 picosecond / CW diode lasers, id-100 SPAD modules, PMT detector modules, PML-SPEC and MW FLIM multi-wavelength detection systems.

Please download individual data sheets and manuals, or see 'The bh TCSPC Handbook', available on www.becker-hickl.com.