



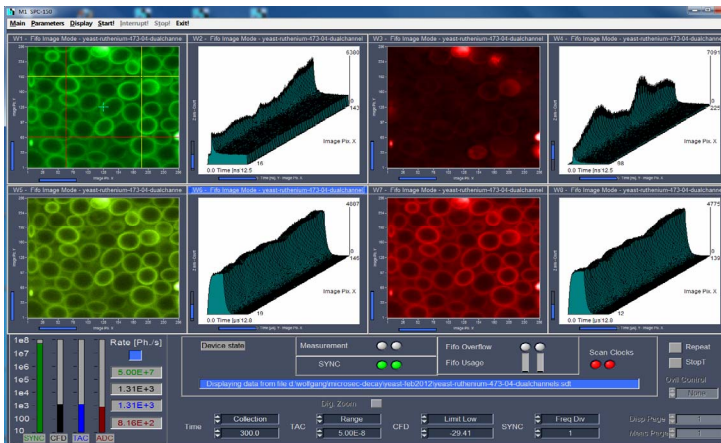
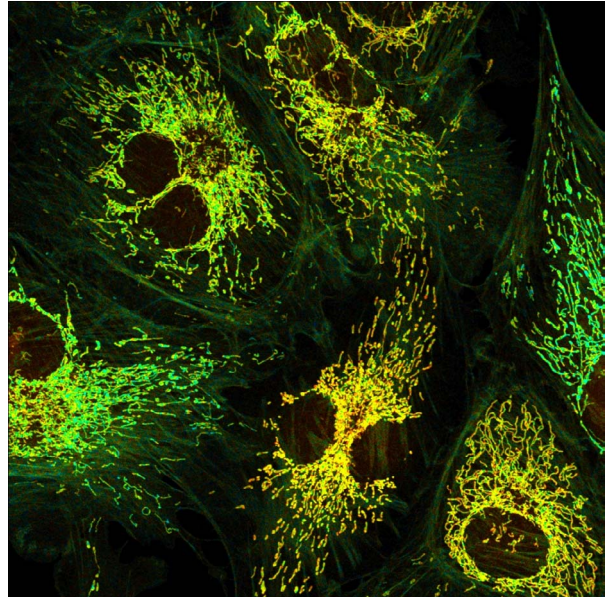
SPC-160

TCSPC/ FLIM Module

Time-Correlated Single Photon Counting Module

- Input discriminator bandwidth 4 GHz
- Sub-ps low-frequency timing wobble
- Multi-detector / multi-wavelength capability
- Photon distribution and parameter-tag modes
- FLIM by bh Megapixel Technology
- Mosaic FLIM mode
- Multiscaler imaging mode
- Parallel counter channel for FLIM intensities
- Parallel operation of 2, 3 or 4 modules
- Time channel width down to 813 fs
- Electrical time resolution (Jitter) 2.5 ps rms
- Laser repetition rates up to 150 MHz
- Saturated count rate 12.5 MHz
- Dead time 80 ns

- Standard fluorescence lifetime experiments
- Multi-wavelength lifetime experiments
- Recording of transient fluorescence lifetime effects
- Single-wavelength FLIM, multi-wavelength FLIM
- Fast-acquisition FLIM, time-series FLIM
- Mosaic FLIM, lateral, longitudinal, temporal mosaics
- FLITS
- Simultaneous PLIM and FLIM
- Single and double-exponential FRET imaging
- Recording of Ca²⁺ transients
- fNIRS and NIRS experiments
- Single-molecule spectroscopy
- FCS, FCCS, Photon Counting Histograms
- Anti-bunching experiments



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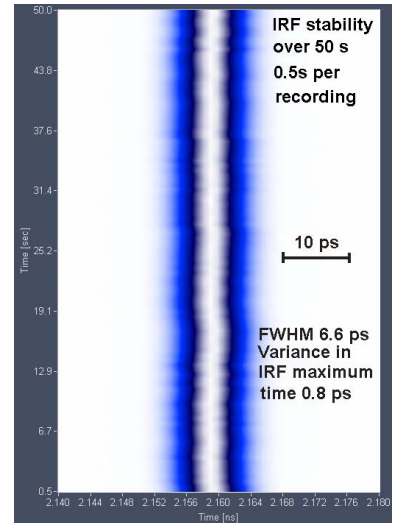
SPC-160

TCSPC / FLIM Module

Photon Channel

Principle
 Discriminator Input Bandwidth
 Time Resolution (FWHM / RMS, electr.)
 Variance in time of IRF maximum
 Optimum Input Voltage Range
 Min. Input Pulse Width
 Threshold
 Zero Cross Adjust

Constant Fraction Discriminator (CFD)
 4 GHz
 6.6 ps / 2.5 ps
 <1 ps over 50 seconds
 - 30 mV to - 500 mV
 200 ps
 0 to - 250 mV
 - 100 mV to + 100 mV



Synchronisation Channels

Principle
 Discriminator Input Bandwidth
 Optimal Input Voltage Range
 Min. Input Pulse Width
 Threshold
 Frequency Range
 Frequency Divider
 Zero Cross Adjust

Constant Fraction Discriminator (CFD)
 4 GHz
 - 30 mV to - 500 mV
 200 ps
 0 to -250 mV
 0 to 150 MHz
 1-2-4
 -100 mV to + 100 mV

Time-to-Amplitude Converters / ADCs

Principle
 TAC Range
 Biased Amplifier Gain
 Biased Amplifier Offset
 Time Range incl. Biased Amplifier
 min. Time / Channel
 ADC Principle
 Diff. Nonlinearity, electrical

Ramp Generator / Biased Amplifier
 50 ns to 5 us
 1 to 15
 0 to 50% of TAC Range
 3.3 ns to 5 us
 813 fs
 50 ns Flash ADC with Error Correction
 < 0.5% rms, typ. <1% peak-peak

Data Acquisition (Histogram Mode)

Method
 Dead Time
 Saturated Count Rate
 Useful count rate
 Channels / Pixel
 max. Scanning Area
 max. Counts / Time Channel
 Overflow Control
 Collection Time
 Display Interval Time
 Repeat Time
 Sequential Recording
 Synchronisation with Scanning
 Count Enable Control
 Experiment Trigger

on-board multi-dimensional histogramming process
 80ns, independent of computer speed
 12.5 MHz
 6.25 MHz
 4096 1024 256 64 16 4 1
 16x16 64x64 128 x 128 256x256 512x512 1024x1024 2048x2048
 $2^{16}-1$
 none / stop / repeat and correct
 0.1 us to 100,000 s
 0.1 us to 100,000 s
 0.1 us to 100,000 s
 Programmable Hardware Sequencer, unlimited recording by memory swapping, in curve mode and scan mode
 pixel, line and frame clocks from scanning device
 1 bit TTL
 TTL

Data Acquisition (FIFO / Parameter-Tag Mode)

Method
 Online display
 FCS calculation
 Number of counts of decay / waveform recording
 Dead Time
 Saturated count rate, peak
 Sustained count rate (bus-transfer limited)
 Output Data Format (ADC / Macrotime / Routing)
 FIFO buffer Capacity (photons)
 Macro Timer Resolution, internal clock
 Macro Timer Resolution, clock from SYNC input
 Curve Control (external Routing)
 External event markers
 Count Enable Control
 Experiment trigger

Parameter-tagging of individual photons and continuous writing to disk
 Decay function, FCS, Cross-FCS, PCH, MCS traces
 Multi-tau algorithm, online calculation and online fit
 unlimited
 80 ns
 12.5 MHz
 typ. 4 MHz
 12 / 12 / 4
 2 M
 50ns, 12 bit, overflows marked by MTOF entry in data stream
 10ns to 100ns, 12 bit, overflows marked by MTOF entry in data stream
 4 bit TTL
 4 bit, TTL
 1 bit TTL
 TTL

Data Acquisition, FIFO / Parameter-Tag Imaging Mode

Method
 Online display
 Synchronisation with scanner
 Detector / Wavelength Channels
 Image size in FIFO Imaging Mode (64 bit software)
 time channels / pixel
 No. of pixels, 1 detector channel
 No. of pixels, 16 detector channels (MW FLIM detector)

Buildup of images from time- and wavelength tagged data
 up to 8 images in different time and wavelength windows
 via Frame Clock, Line Clock, and Pixel Clock pulses
 1 to 16
 64 256 1024 4096 4096 4096
 4096 x 4096 2048 x 2048 1024 x 1024 512 x 512 256 x 256 128 x 128
 1024 x 1024 512 x 512 256 x 256 128 x 128 128 x 128 128 x 128

Operation Environment

Computer System
 Bus Connectors
 Used PCI Slots
 Total power Consumption
 Dimensions

PC Pentium, multi-core, >8GB RAM and 64 bit operating system recommended
 PCI
 1
 approx. 12 W from +5V, 0.7 W from +12V
 312 mm x 130 mm x 15 mm

Related Products

SPC-150 and SPC-150N TCSPC modules
 SPC-154 4-channel TCSPC modules
 Simple-Tau compact TCSPC systems
 FLIM systems for laser scanning microscopes
 DCS-120 confocal scanning FLIM system

HPM-100 GaAsP and GaAs hybrid detectors
 PML-SPEC and MW-FLIM multi-wavelength detectors
 PMC-100 cooled PMT modules
 id-100 SPAD detector modules
 BDL-SMN and BDS ps diode lasers

DCC-100 detector controller
 GVD-120 scan controller
 DB-32 USB-controlled delay module

Related Literature

W. Becker, Advanced time-correlated single photon counting techniques. Springer 2005. Please contact bh for availability.
 W. Becker, The bh TCSPC Handbook, 5th edition. 690 pages, 823 references. Available on www.becker-hickl.com. Contact bh for printed copies.
 PML-16-C 16 channel detector head for time-correlated single photon counting. User handbook. Available on www.becker-hickl.com
 DCS-120 Confocal Scanning FLIM Systems, handbook. Available on www.becker-hickl.com
 Modular FLIM systems for Zeiss LSM 510 and LSM 710 laser scanning microscopes, handbook. Available on www.becker-hickl.com.
 BDL-SMN picosecond diode lasers, handbook. Available on www.becker-hickl.com
 Please see also www.becker-hickl.com, 'Literature', 'Application notes'



More than 20 years experience in multi-dimensional TCSPC. More than 1500 TCSPC systems worldwide.



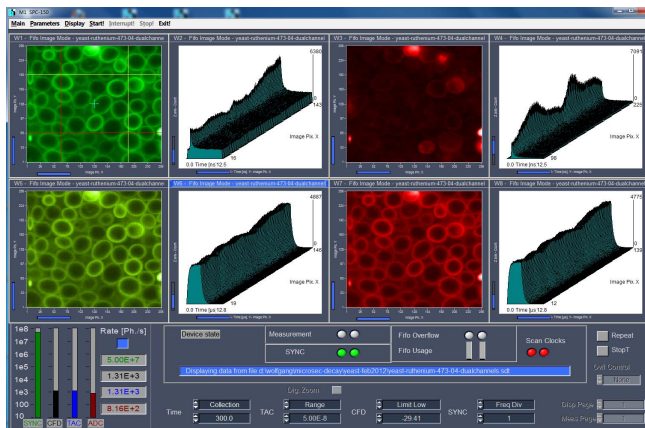
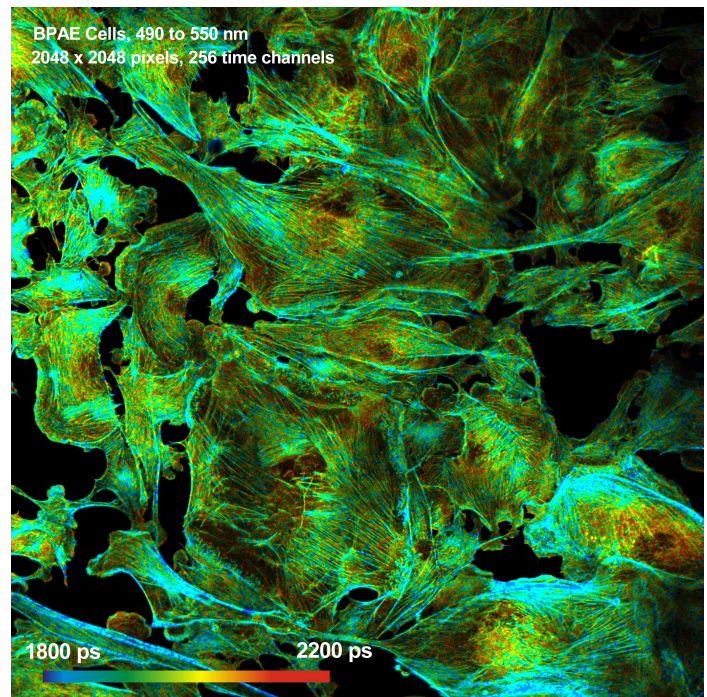
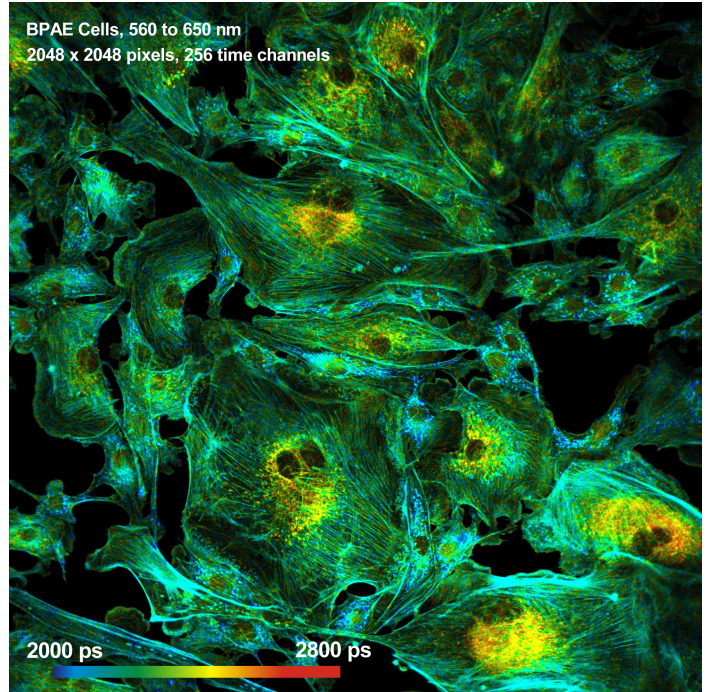
SPC-160 PCIE

TCSPC/ FLIM Module

TCSPC / FLIM Module with PCI Express Interface

- Input discriminator bandwidth 4 GHz
- Sub-ps low-frequency timing wobble
- Multi-detector / multi-wavelength capability
- Photon distribution and parameter-tag modes
- FLIM by bh Megapixel Technology
- Mosaic FLIM mode
- Multiscaler imaging mode
- Parallel counter channel for FLIM intensities
- Parallel operation of 2, 3 or 4 modules
- Time channel width down to 813 fs
- Electrical time resolution (Jitter) 2.5 ps rms
- Laser repetition rates up to 150 MHz
- Saturated count rate 12.5 MHz
- TCSPC dead time 80 ns
- Intensity-channel dead time <10 ns

- Standard fluorescence lifetime experiments
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- Single-wavelength FLIM, multi-wavelength FLIM
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SPC-160 PCIE TCSPC / FLIM Module

Photon Channel

Principle
 Discriminator Input Bandwidth
 Time Resolution (FWHM / RMS, electr.)
 Variance in time of IRF maximum
 Optimum Input Voltage Range
 Min. Input Pulse Width
 Threshold
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Constant Fraction Discriminator (CFD)
 4 GHz
 6.6 ps / 2.5 ps
 <1 ps over 50 seconds
 - 30 mV to - 500 mV
 200 ps
 0 to - 250 mV
 - 100 mV to + 100 mV

Synchronisation Channels

Principle
 Discriminator Input Bandwidth
 Optimal Input Voltage Range
 Min. Input Pulse Width
 Threshold
 Frequency Range
 Frequency Divider
 Zero Cross Adjust

Constant Fraction Discriminator (CFD)
 4 GHz
 - 30 mV to - 500 mV
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 0 to 150 MHz
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Time-to-Amplitude Converters / ADCs

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 TAC Range
 Biased Amplifier Gain
 Biased Amplifier Offset
 Time Range incl. Biased Amplifier
 min. Time / Channel
 ADC Principle
 Diff. Nonlinearity, electrical

Ramp Generator / Biased Amplifier
 50 ns to 5 us
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 0 to 50% of TAC Range
 3.3 ns to 5 us
 813 fs
 50 ns Flash ADC with Error Correction
 < 0.5% rms, typ. <1% peak-peak

Data Acquisition (Histogram Mode)

Method
 Dead Time
 Saturated Count Rate
 Useful count rate
 Channels / Pixel
 max. Scanning Area
 max. Counts / Time Channel
 Overflow Control
 Collection Time
 Display Interval Time
 Repeat Time
 Sequential Recording
 Synchronisation with Scanning
 Count Enable Control
 Experiment Trigger

on-board multi-dimensional histogramming process
 80ns, independent of computer speed
 12.5 MHz
 6.25 MHz

| | | | | | | |
|-------|-------|-----------|---------|---------|-----------|-----------|
| 4096 | 1024 | 256 | 64 | 16 | 4 | 1 |
| 16x16 | 64x64 | 128 x 128 | 256x256 | 512x512 | 1024x1024 | 2048x2048 |

 $2^{16}-1$
 none / stop / repeat and correct
 0.1 us to 100,000 s
 0.1 us to 100,000 s
 0.1 us to 100,000 s
 Programmable Hardware Sequencer, unlimited recording by memory swapping, in curve mode and scan mode
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 50ns, 12 bit, overflows marked by MTOF entry in data stream
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Method
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 Dead Time
 Detector / Wavelength Channels
 Image size in FIFO Imaging Mode (64 bit software)

Buildup of images from time- and wavelength tagged data
 up to 8 gated intensity images or up to 8 lifetime images
 via Frame Clock, Line Clock, and Pixel Clock pulses
 TCSPC: 80 ns, Intensity Channel: <10 ns
 1 to 16

| | | | | | | |
|--|-------------|-------------|-------------|-----------|-----------|-----------|
| time channels / pixel | 64 | 256 | 1024 | 4096 | 4096 | 4096 |
| No. of pixels, 1 detector channel | 4096 x 4096 | 2048 x 2048 | 1024 x 1024 | 512 x 512 | 256 x 256 | 128 x 128 |
| No. of pixels, 16 detector channels (MW FLIM detector) | 1024 x 1024 | 512 x 512 | 256 x 256 | 128 x 128 | 128 x 128 | 128 x 128 |

Operation Environment

Computer System PC Pentium, multi-core, >8GB RAM and 64 bit operating system recommended
 Bus Connectors PCI
 Used PCI Slots 1
 Total power Consumption approx. 12 W from +5V, 0.7 W from +12V
 Dimensions 312 mm x 130 mm x 15 mm

Related Products

| | | |
|---|--|-----------------------------------|
| SPC-160 TCSPC / FLIM modules | DCS-120 confocal scanning FLIM system | BDL-SMN and BDS ps diode lasers |
| SPC-150 and SPC-150N TCSPC modules | HPM-100 GaAsP and GaAs hybrid detectors | DCC-100 detector controller |
| Simple-Tau compact TCSPC systems | PML-SPEC and MW-FLIM multi-wavelength detectors | GVD-120 scan controller |
| FLIM systems for laser scanning microscopes | id-100, id-220 Si and InGaAs SPAD detector modules | DB-32 USB-controlled delay module |

Related Literature

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 W. Becker (ed.), Advanced time-correlated single photon counting applications. Springer 2015. Please contact bh for availability.
 W. Becker, The bh TCSPC Handbook, 6th edition, 2015. 768 pages, 1007 references. Available on www.becker-hickl.com. Contact bh for printed copies.
 DCS-120 Confocal Scanning FLIM Systems, handbook. Available on www.becker-hickl.com
 Modular FLIM systems for Zeiss LSM 510 and LSM 710 laser scanning microscopes, handbook. Available on www.becker-hickl.com.
 PML-16-C and PML-16 GaAsP 16-channel TCSPC / FLIM detectors, PML-SPEC and MW-FLIM multi-wavelength detectors. User handbook, 20016. Available on www.becker-hickl.com
 BDL-SMN picosecond diode lasers, handbook. Available on www.becker-hickl.com
 Please see also www.becker-hickl.com, 'Literature', 'Application notes'



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