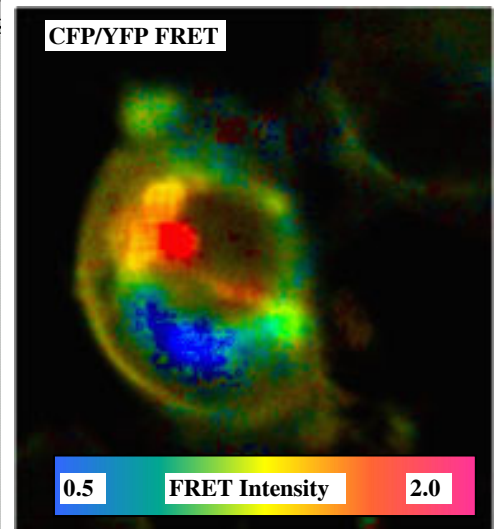
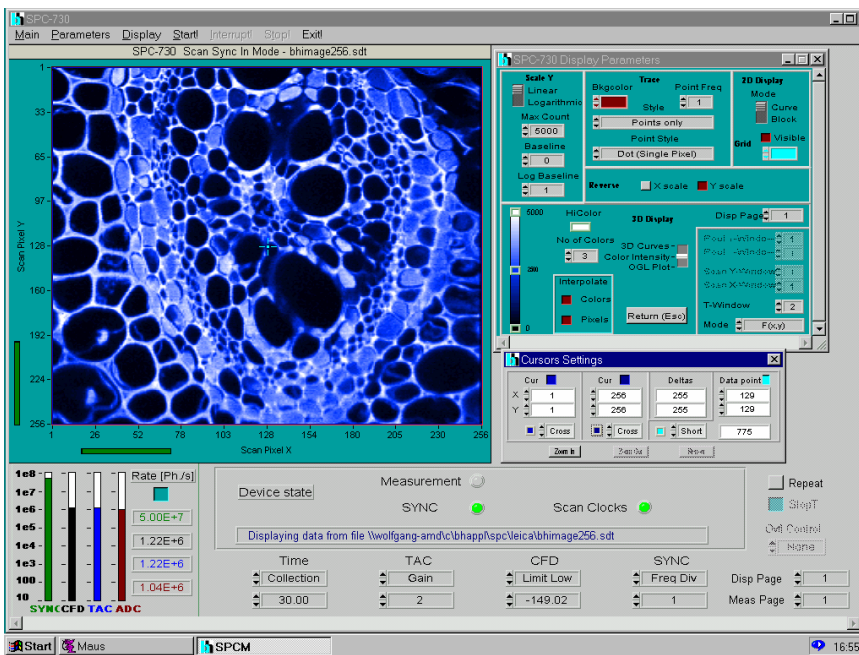
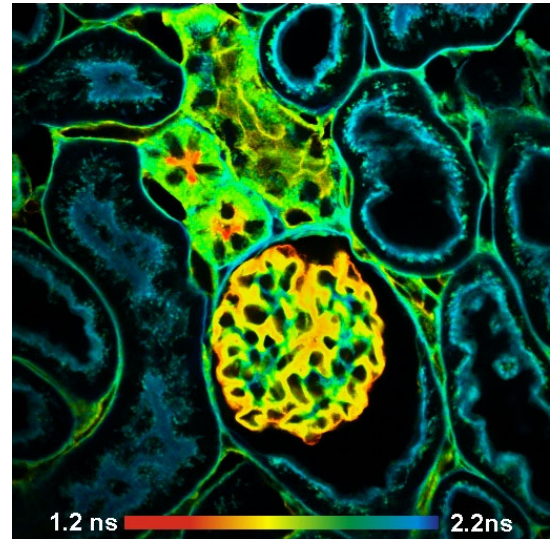




High-Resolution Time-Correlated Single Photon Counting Imaging and FCS Module for Laser Scanning Microscopes

- ◆ Complete picosecond imaging system on single PC board
- ◆ Picosecond resolution
- ◆ Ultra-high sensitivity
- ◆ Multi detector capability
- ◆ High-speed on-board data acquisition
- ◆ Works at any scanning speed of microscope
- ◆ High resolution picosecond lifetime imaging
- ◆ FRET imaging
- ◆ High-resolution steady state imaging
- ◆ Single-point time-lapse lifetime analysis
- ◆ FCS, FIDA, FILDA, BIFL measurement
- ◆ Time channel width down to 813 fs
- ◆ Image size up to 4096 x 4096 pixels
- ◆ Electrical time (Jitter) 6.6 ps fwhm / 2.5 ps rms
- ◆ Reversed start/stop: Laser repetition rates up to 200 MHz
- ◆ Useful detector count rate up to 8 MHz - dead time 125 ns
- ◆ Active and passive scanning control



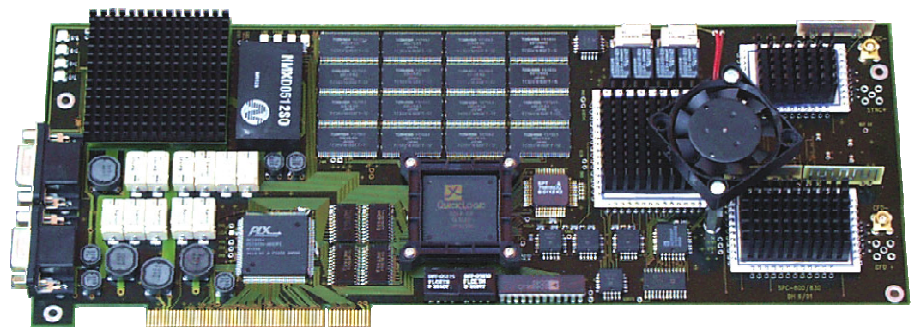
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Covered by patents DE 43 39 784 and DE 43 39 787



Photon Channel

Principle
 Electrical Time Resolution (Jitter, FWHM / RMS)
 Opt. Input Voltage Range
 Min. Input Pulse Width
 Threshold
 Zero Cross Adjust

Constant Fraction Discriminator
 6.5 ps / 2.5 ps
 - 30 mV to - 1 V
 400 ps
 0 to - 500 mV
 - 100 mV to + 100 mV

Synchronisation Channel

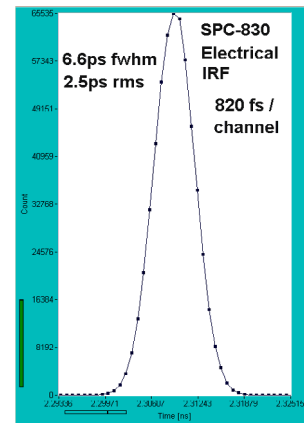
Principle
 Opt. Input Voltage Range
 Min. Input Pulse Width
 Threshold
 Frequency Range
 Frequency Divider
 Zero Cross Adjust

Constant Fraction Discriminator
 - 30 mV to - 1 V
 400 ps
 - 0 to - 500 mV
 0 to 200 MHz
 1-2-4-8-16
 - 100 mV to + 100 mV

Time-to-Amplitude Converter / ADC

Principle
 TAC Range
 Biased Amplifier Gain
 Biased Amplifier Offset
 Time Range incl. Biased Amplifier
 min. Time / Channel
 TAC Window Discriminator
 ADC Principle
 Diff. Nonlinearity (dith width 1/8, 90% of TAC range)

Ramp Generator / Biased Amplifier
 50 ns to 5 us
 1 to 15
 0 to 100% of TAC Range
 3.3 ns to 5 us
 813 fs
 Any window inside TAC range
 50 ns 12 bit Flash ADC with error correction
 < 0.5% rms, typically < 1% peak-peak



Data Acquisition, Histogram Modes

Method
 Dead Time
 Saturated Count Rate / Useful Count Rate
 Number of Time Channels / Pixel
 Image Resolution (pixels), 1 Detector Channel
 Image Resolution (pixels), 4 Detector Channels
 Image Resolution (pixels), 16 Detector Channels
 Counts / Time Channel
 Counts / Time Channel ('Single' mode, repeat and acquire)
 Overflow Control
 Collection Time (per curve or per pixel)
 Display Interval Time
 Repeat Time
 Curve Control (Internal Routing / Scan Sync In Mode)
 Routing Control / Detector Channels
 Count Enable Control
 Control Signal Latch Delay
 Experiment Trigger

on-board 4-dimensional histogramming process over t, x, y, and detector channel number
 125ns, independent of computer speed
 8 MHz / 4 MHz

	1	4	16	64	256	1024	4096
Number of Time Channels / Pixel	4096 x 4096	2048 x 2048	1024 x 1024	512 x 512	256 x 256	128 x 128	64 x 64
Image Resolution (pixels), 1 Detector Channel	2048 x 2048	1024 x 1024	512 x 512	256 x 256	128 x 128	64 x 64	32 x 32
Image Resolution (pixels), 4 Detector Channels	1024 x 1024	512 x 512	256 x 256	128 x 128	64 x 64	32 x 32	16 x 16
Image Resolution (pixels), 16 Detector Channels							
Counts / Time Channel			$2^{16}-1$	$2^{32}-1$			
Counts / Time Channel ('Single' mode, repeat and acquire)							
Overflow Control			none / stop / repeat and acquire				
Collection Time (per curve or per pixel)			100 ns to 100,000 s				
Display Interval Time			100 ns to 100,000 s				
Repeat Time			100 ns to 100,000 s				
Curve Control (Internal Routing / Scan Sync In Mode)			up to 262,144 decay curves				
Routing Control / Detector Channels			14 bit TTL / 16384				
Count Enable Control			1 bit TTL				
Control Signal Latch Delay			0 to 255 ns				
Experiment Trigger			TTL				

Data Acquisition, FIFO/Time-Tag Mode

Method
 Online Display
 FCS calculation
 Waveform recording
 No of counts per time channel
 Dead Time
 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)
 Markers
 Count Enable Control

Time- and wavelength-tagging of individual photons, continuous writing to disk
 Decay function, FCS, Cross-FCS, PCH, MCS traces, images
 multi-tau algorithm, online calculation and online fit
 online from time-tag data, up to 16 detector channels
 unlimited
 125 ns
 12 / 12 / 4
 8 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

Data Acquisition, FIFO / Time-Tag Imaging Mode

Method
 Online display
 Synchronisation with scanner
 Detector / Wavelength Channels
 Image resolution, for time channels / pixel
 1 detector channel
 16 detector channels

Online buildup of Images from time-tag data
 up to 8 images in different time and wavelength windows
 via Frame Clock, Line Clock, and Pixel Clock pulses
 1 to 16

	1	4	16	64	256	1024	4096
1 detector channel	8192 x 8192	4096 x 4096	2048 x 2048	1024 x 1024	512 x 512	256 x 256	128 x 128
16 detector channels	2048 x 2084	1024 x 1024	512 x 512	256 x 256	128 x 128	64 x 64	32 x 32

Operation Environment

Computer System
 Bus Connector
 Power Consumption
 Dimensions

PC Pentium, multi-core CPU recommended
 PCI
 approx. 20 W at +5V, 0.7 W at +12V
 312 mm x 122 mm x 28 mm

Related Products

SPC-130EM TCSPC modules
 SPC-134 EM 4-channel TCSPC modules
 SPC-150 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
 DPC-230 16-channel ps photon correlator module

PMC-100 cooled PMT modules
 HPM-100 GaAsP and GaAs hybrid detectors
 PML-SPEC and MW-FLIM multi-wavelength detectors
 R3809U MCP PMTs, with HVM-100 power supply module
 id-100 SPAD detector modules
 DCC-100 detector controller
 HRT-41, HRT-81, HRT-82 routing modules
 Detector / shutter assemblies

BDL-SMC picosecond diode lasers
 BHL-600 picosecond diode lasers
 BHL-700 picosecond diode lasers
 DDG-200 laser multiplexing controller
 SPCLmage decay analysis
 Optispec decay analysis

Related Literature

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 W. Becker, The bh TCSPC Handbook, 3rd edition. 466 pages, 503 references. Available on www.becker-hickl.com
 PML-16-C 16 channel detector head for time-correlated single photon counting. User handbook. Available on www.becker-hickl.com
 Becker & Hickl GmbH, SPCLmage Data Analysis Software for Fluorescence Lifetime Imaging Microscopy, handbook. Available on www.becker-hickl.com
 BDL-375-SMC, BDL-405-SPC, BDL-440-SMC, BDL-473-SMC NUV and blue picosecond diode lasers, handbook. Available on www.becker-hickl.com
 Please see also www.becker-hickl.com 'Literature', 'Application notes'

