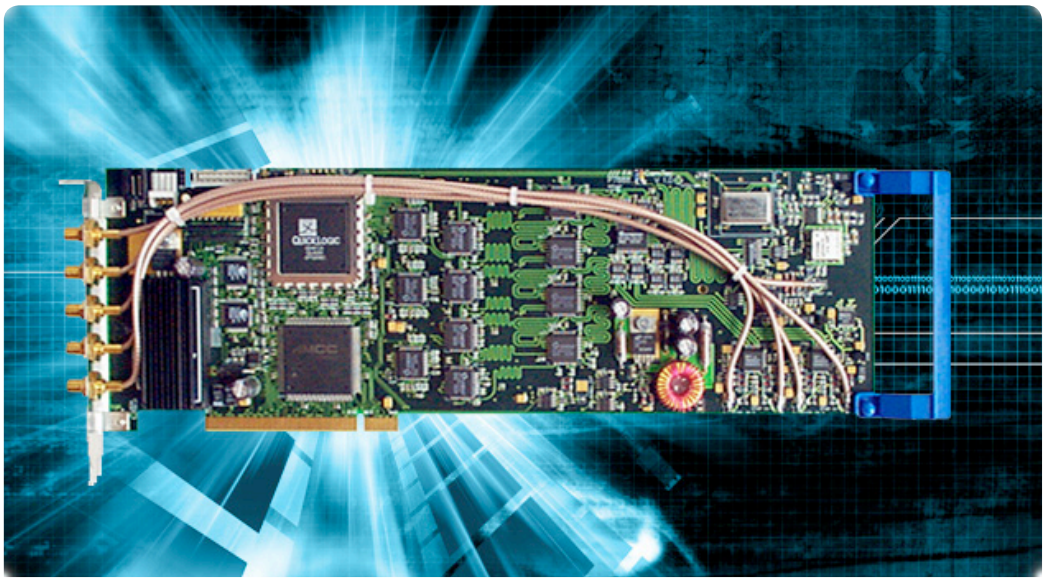
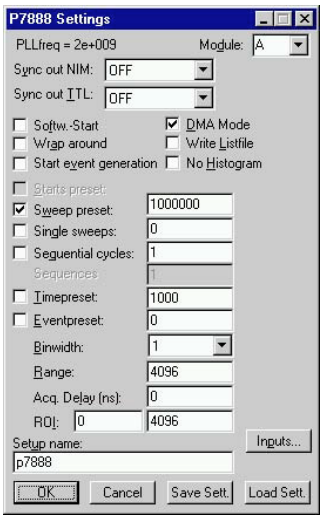
Model P7888 Series, Dual and Quad 0,5/1 GHz Multiscaler, Time-of-Flight



The Model P7888 Series are one of the fastest commercially available multiple-event time digitizers with up-to four inputs. They can be used as an ultra fast Multiscaler/TOF system in Time-of-Flight mass-spectrometry and time-resolved single ion- or photon counting.

Description

In operation the sweep is started by a user supplied start (trigger) pulse. Then events detected at the stop inputs are recorded, each in a specific time bin corresponding to the time of arrival relative to the start pulse. Compared to non-multihit devices the P7888 Series can accept stop event as soon as 1000ps/2000ps after a prior event - limited by the max. count rate only. The P7888 Series are designed with fully digital circuitry capable of accepting peak (burst) count rates of up to 0,5 and 1 GHz.
The P7888 Series have been optimized for the best possible pulse-pair resolving while providing state-of-theart time resolution available in digital designs. The built-in 900 MHz discriminators are a useful addition to this board.
The large time range enables sweeps of 2s up to a max. of 68.7 seconds (programmable in 2s increments) with a time resolution of 1000ps/2000 ps.
A PLL oscillator assures a resolution of typically <700ps FWHM at a full scale time range of 1ms (measured in the last time bin of 1.000.000 time bins, 60 min.). The FIFO memory buffers all stop events at full speed (4 x 500 MHz) for at least 4 microseconds while a second 16k FIFO buffers the PCI transfer. Thus, average TOF-Mass Spectrum of a Leafpigment, MW=739u (GSF-ISS, Neuherberg, Germany) sustained data transfer rates of approx. >28.000.000/s can be achieved .
For experiments requiring repetitive sweeps the spectral data obtained from each sweep can be summed in the PC enabling very high sweep repetition rates up to wrap around speed.
The P7888 is designed with „state-of-the-art" components which offer excellent performance and reliability.
The high-performance hardware is matched by a sophisticated software delivered with each P7888. MCDWIN - the MS-WINDOWS-98/NT/2000 based operating software - provides a powerful graphical user interface for setup, datatransfer and spectral data display.
The performance data shown is for the Model P7888. The other models differ only in the number of inputs and time resolution which is shown in the selection chart.



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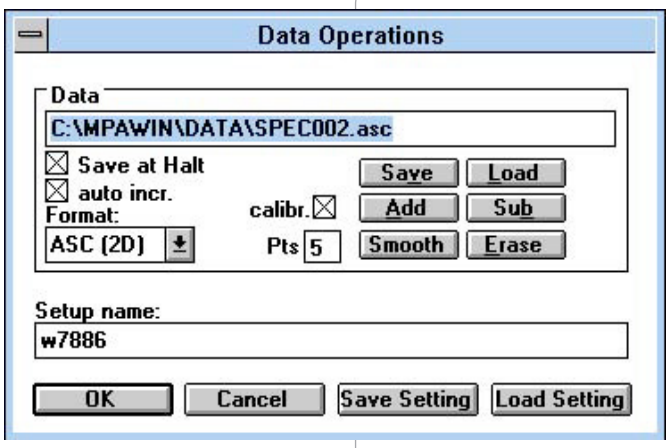
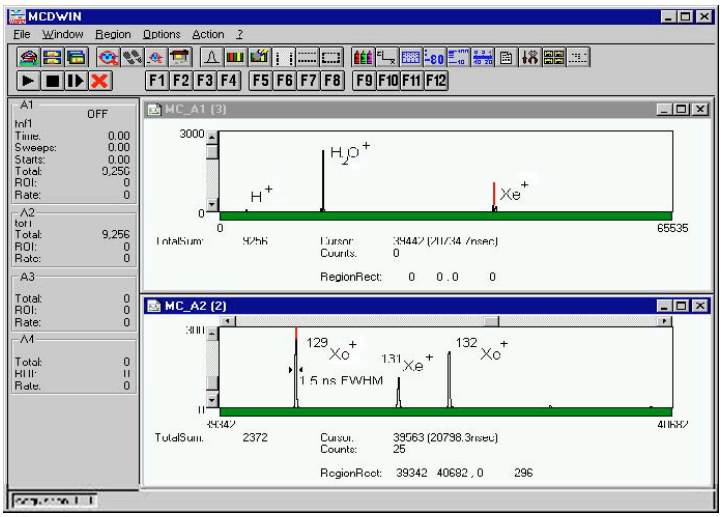
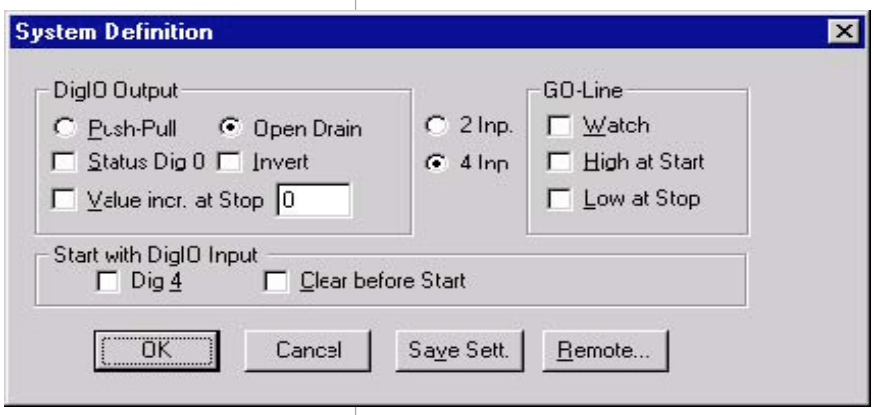




Features

- Four-Input Ultra Fast Multiscaler / TOF
- 1 ns time-resolution for each input using two inputs, 2 ns if four inputs are used.
- 1 GHz max. count rate (burst) for each input (in two input mode), 500 MHz using four inputs.
- Start- and Stop-Inputs: built-in 900 MHz, +/- 3 V falling-edge discriminator, sensitivity: 30 mV
- 35/36 bit dynamic range (32 ns to 68.7s programmable range with 2 ns resolution)
- No dead time between time bins
- No double counting
- On-board FIFO for ultra fast data transfer to the PC - approx. >10,000,000 stop events/sec.
- Three operating modes: Continuous (wrap around), stop after sweep and sequential
- TTL Sync-out for triggering of external devices, FAST-NIM output optional
- Ultra high sweep repetition rates up to wrap around speed
- Optional insertion of „Start-of-Sweep“ marker into the list-mode (event by event) datastream
- Presettable 32 bit sweep counter
- PCI-compatible board design
- Up to four P7888 can be operated in one PC
- „GO“-line I/O for experiment synchronization
- 8-bit digital I/O port



Typical Applications

Typical applications are:

- TOF Time-of-Flight Mass Spectrometry (clusters) with exceptional Z-range at full 1 or 2 ns time resolution and burst data rates of up to 500 MHz
- Static TOF SIMS secondary electron Mass-Spec.
- TOF SIMS to analyze traces of heavy metals
- ESI-TOF with simultaneous detection of positiveand
- negative ions
- TOT Mass Spectrometry using a Quadrant-Anode
- PMT for the simultaneous recording of four stop events
- Quantum Cryptography research
- Laser-induced fluorescence spectroscopy in biological samples
- Laser-induced photo-electron spectrometry to analyze the electronic state of gas and solid state samples
- Single molecule counting
- Single photon counting
- LIDAR (15/30 cm spatial resolution)

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P7888 Series Selection Chart					
Model	**Inputs**	**Inp. Discr.**	**Time resolution per input channel**	**maximum Counting rate**	**Order No.**
P7888	4	5	2 x 1 ns / 4 x 2 ns	2 x 1 GHz, 4 x 500 MHz	TOFP88
P7888-2	2	3	2 x 1 ns	P2 x 1 GHz	TOFP882

Performance (for P7888)

Number of Time Bins: 64 to 2^{37} selectable in steps of 32. Transfer of recorded data in List-Mode to RAM or Harddisk.

Time range per shot: 32 ns to 2 sec. Offset selectable in increments of 2 sec. up to 66 sec.

Memory: 256 word high speed multi-event FIFO (2GHz) plus 16k PCI-bus FIFO

Time Resolution: Typical: 700ps FWHM measured at a distance of 1ms after the start (1.000.000 time bins) for models with 1 ns time resolution.

Pulse Pair Resolving Time: 1 or 2 ns

Bin-width: 1 ns/2 ns, independent of selected range.

Deadtime: No deadtime between time bins.

Count Rate: The peak count rate is 1GHz to the FIFO, the average data throughput is an absolutely staggering >28,000,000 stops/sec. to the computer memory (using a computer with an Pentium4, 2.6 GHz processor and DDR400 RAM).

No Double Counting ! No loss of counts ! prevented by the proprietary input logic used.

Linearity: Differential linearity <+/-1%

Data Reduction: by recording stop-events within a selected time window only (no „0" events as for example in transient digitizers) significantly increases the sweep repetition data rate capabilities.

Operating Modes: Continous (wrap-around), end-aftersweep and sequential (software)

Sweep Counter: hardware sweep counter (32 bit) with programmable preset. Optional Start-of-Sweep marker insertion in the list mode data streem

End-of-Sweep Dead Time:

Continuous mode: wrap around time (no dead time at the end of a sweep).

Triggered sweep: approx. 200ns dead time between end of sweep and rearm

Specifications Inputs

Start Input: SMA-connector 900 MHz bandwidth, +/-3V, falling edge sensitive, +/-2V progr. threshold, Z_{in} = 50 Ohm, sensitivity 50 mV.

Stop Inputs: Four SMA-connectors, 900 MHz bandwidth, +/-3V, falling edge sensitive, programmable threshold, Z_{in} = 50 Ohm, sensitivity: 50 mV

Sync output 1: SMA-connector outputs FAST-NIM pulses, Z = 50 Ohm (optional)

Start and Stop inputs are located on the boards mounting bracket.

I/O port connector: 16 pin header cable connected to 15-pin D-SUB (female, bracket mounted), TTL compatible, 8-bit digital I/O port, GO-line, Sync output, +5V power

GO-line connector: 2-pin header on the PCB, open drain, wired-AND, 100k Ohm pull-up

Operating Temperature Range: 0°C to +50°C

Power Requirements (TBD)

+5V, 0.45A, +12V, 1.2A, -12V, 65mA, supplied by the PC (extra power cable for DC power is included)

PC Requirements: 32 bit PCI slot, 32 bit Windows XP / Vista / 7, no DELL PC.

Physical: full size PCI compatible board

Shipping weight: 1.8 kg (net 0.75 kg)

Options:

- Ovenized crystal oscillator
- Rubidium disciplined oscillator
- LW800, 800 MHz discriminator with fiber optical isolation

Software:

DLL and VI's for LabVIEW, C and Visual Basic

A DLL (Dynamic Link Library) is available for operation in laboratory automation environment with example programs for LabVIEW, Visual Basic and „C" - see separate datasheets

Autocorrelation Software

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Typical Applications

Time-of-Flight Spectrometry

This application is specifically suitable to the capabilities of the P7888. Because the P7888 has been optimized for the best possible pulse-pair resolving time while providing state-of-the-art time resolution one can easily record peaks that are very closely spaced - for example the mass 14 peaks such as CH2+ and N+, or the mass 16 peaks CH4+ and O+. Because of the multistop capability of the P7888 stop events in all peak locations can be recorded during a single shot - something nearly impossible with analogtype instrumentation.

There is the problem that very often gaseous samples contain impurities of CO and N2. It is no problem for the P7888 to separate the two mass 28 peaks CO+ and N2+.

We know of no viable method of slowing the flight time in a Mass Spectrometer so far down that two peaks as close as CO+ and N2+ can be resolved by analog instruments such as TACs (Time-to-Amplitude Converters) or similar devices etc..

In one session the P7888 can record all peaks that are spaced >2 ns apart. Depending on the detector used the P7888 can simultaneously record up to four stop events (one in each input) In practical terms, a leading edge discriminator can be used to give a yes/no-answer if an ion has arrived, therefore the results are very close to what is happening physically as can be seen in the following spectra.

What you see is the arrival probability of ions on the detector.

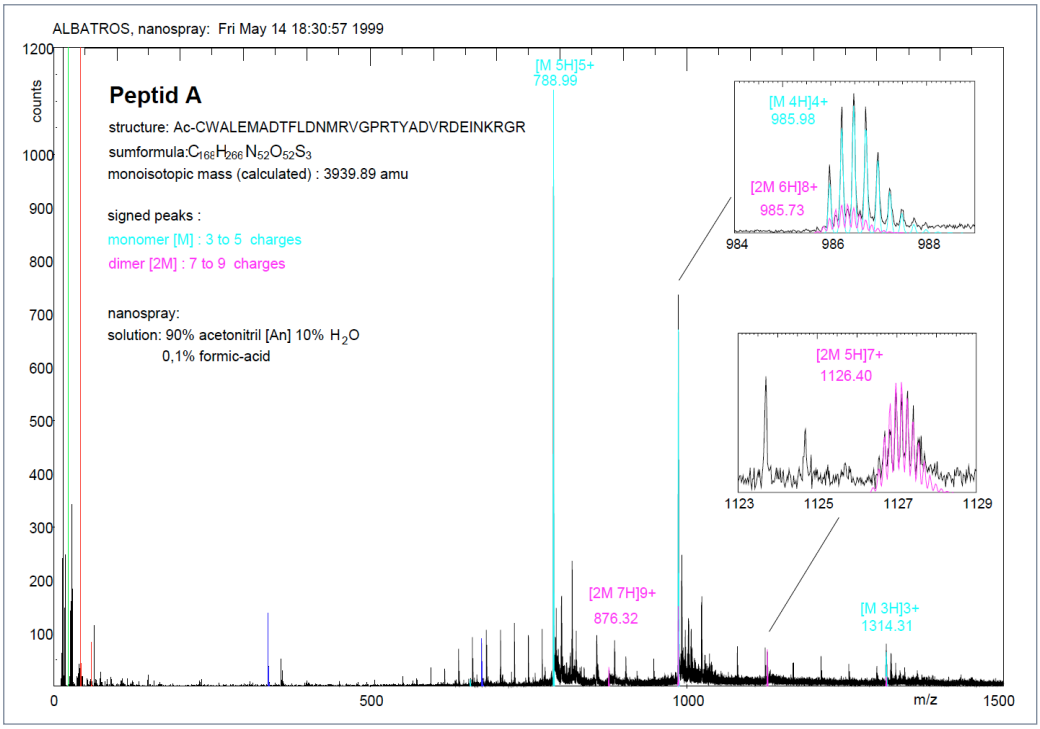
As only the leading edge is being used to determine the time information pulse shapes, amplitude width etc. is not of concern.

Averaging sweeps at low ion rates is very efficient because just the actual stop pulses need to be summed while empty time bins are ignored. It is therefore possible to achieve very high sweep repetition rates that are not achievable with other devices.

A further advantage is the virtually unlimited number of time bins that can be selected. This will by far exceed the mass-range that are used in mass-spectrometry. The P7888 can cover 2^{37} time bins with 500 ps time resolution.

An option is the oven stabilized PLL oscillator that has a temperature stability which provides the ultimate in time stability - the ideal match for spectrometers offering high mass resolution and an exceptionally large mass-range. Summing of data from repeated shots will result in a precise recording of all lines in a mass spectrum.

Reference: http://www.fastcomtec.com



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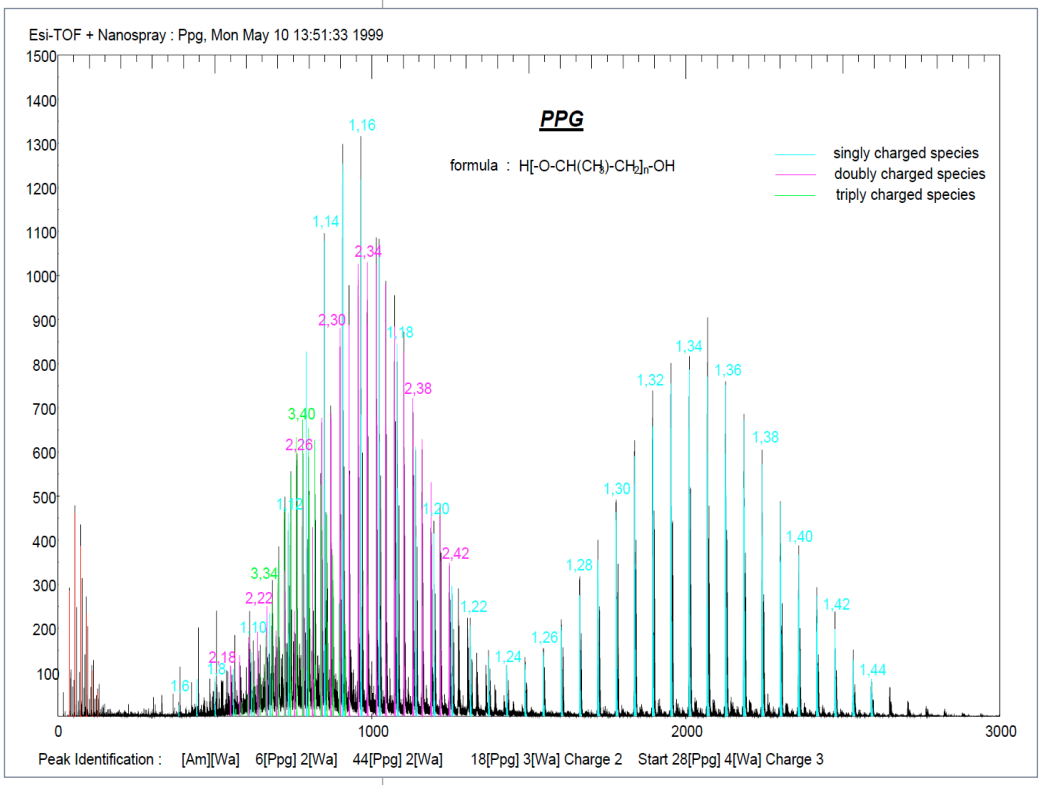
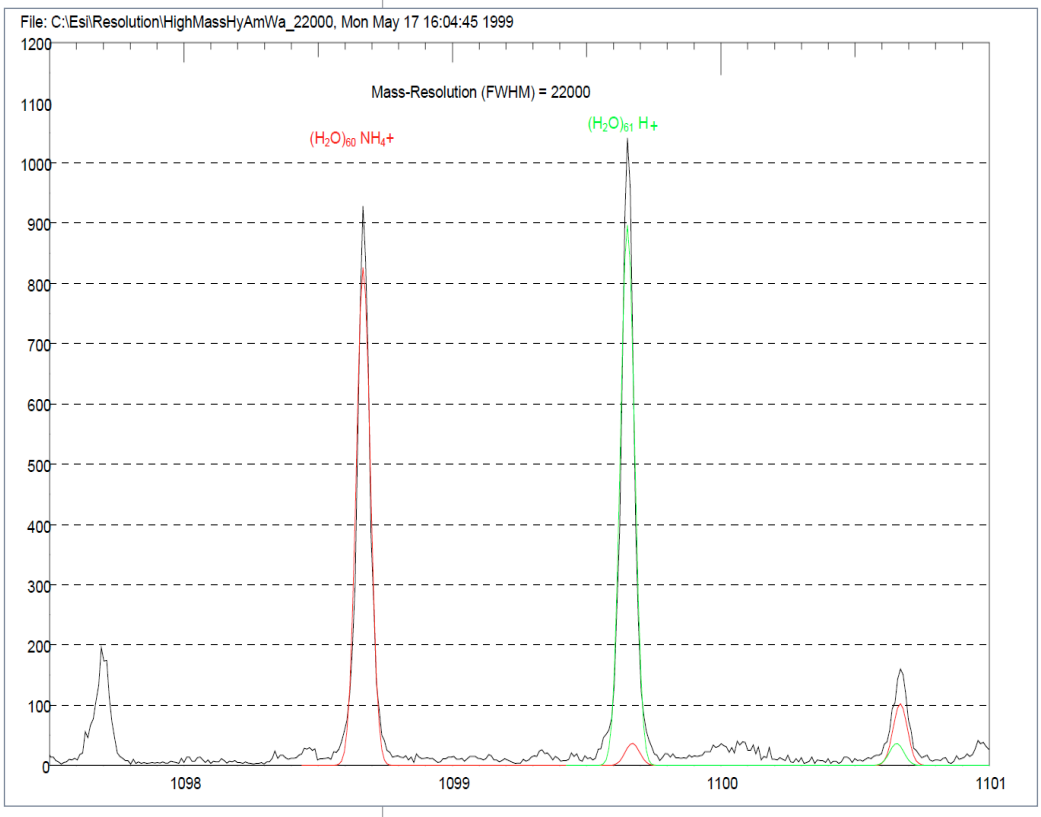
Application Notes Mass Spectrometry





Break-through in mass-resolution

Recently BME-Bergmann has made a first batch of measurements with a new high resolution mass-spectrometer.
They have reached for the first time a mass resolution of 1 : 29.000. The best available TOF mass-spectrometer currently on the market offers a mass resolution of 1 : 8.000. The graphs show results obtained with a 1 ns time-bin settings that still achieve a mass resolution of 1 : 22.000
BME is using a FAST ComTec 7886 because this is the only device which offers the large range and a high shot rate capability to get these superb results.
Single ion counting is very simple with a P7888 - it requires no corrections, mathematical unfolding of multiple peaks that are separated by just a few nanoseconds etc.
And in lowrate ion counting the user transfers just a few stop pulses during each sweep to the PC for averaging which enables sweep averaging rates at wrap around speed.
TAC/ADC methods or other analog 5 counting techniques are not useable in such an application because they lack the required dynamic range. Transient digitizers can be used if there are sufficient ions available but summing the sweeps requires a long time and further requires intricate mathematical calculations to unfold peaks.
The requirements for using large memories will make this a more expensive approach.

Look at the application notes on our web-page
http://www.fastcomtec.com

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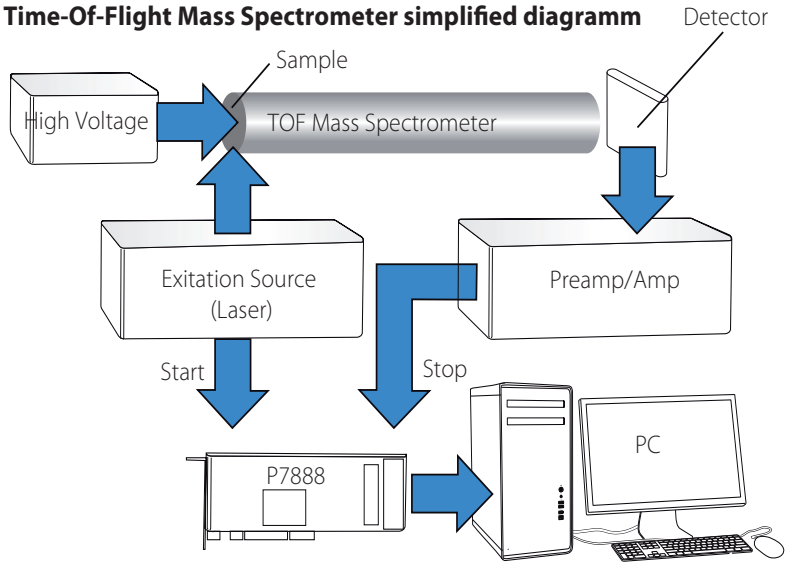
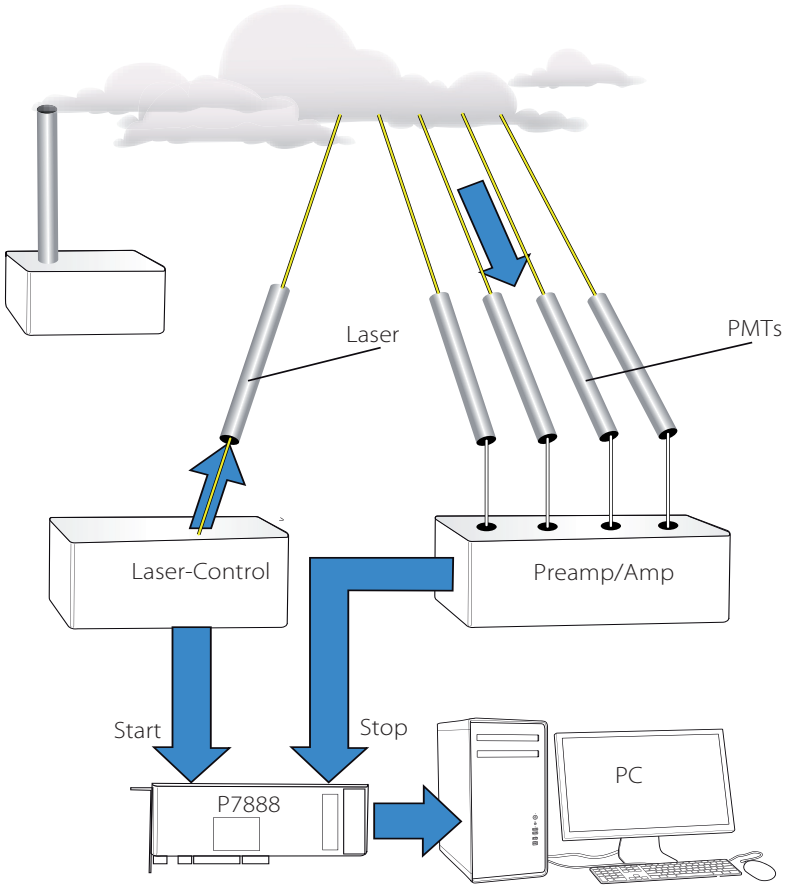
Typical Applications

Time-Of-Flight Mass Spectrometer simplified diagramm



A Simplified Diagram of a LIDAR Setup



LIDAR

The beam of a pulsed LASER is aimed at an object from as close as a plume of a smoke stack to as far as a cloud or the exhaust vapor of a Jet engine flying at high altitudes. The reflected beam is detected, for example with a PMT and the photons are counted as stop pulses by the P7888.
Responses from repeated shots from the LASER are summed to improve the statistical precision. The incredible time range of the P7888 from 1 ns to 68 s can be used to measure objects from close range up to distances far exceeding the useful range of a LIDAR System. The spatial resolution is 15/30 cm - uniformly over the entire selected range. Four inputs can be used to acquire the response from different wavelengths.
Very important in LIDAR applications is the multistop capability of the P7888 which will produce a full spectrum with relatively few shots. Therefore the P7888 is ideally suited to analyze such transient phenomena such as exhaust plumes of fast moving objects at very high altitudes.

Other Applications

Time-resolved fluorescenceand luminescence analysis

Lifetime measurements
Time resolved Single-Molecule detection: the P7888 can record decay schemes with multiple decay time constants. Due to the zero deadtime between recording of events at up to 1/ 0.5 GHz count rates the fast components will not be distorted - i.e. no correction of the accumulated (raw) data is required.

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