Autocorrelators Model Overview

pulseCheck NX

- High-Resolution Multitalent
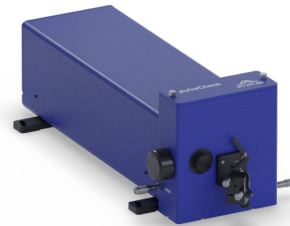
pulseCheck SM 2000

- Long-Range Autocorrelator

... Benefits & Technology

Optics and Detector Technology

A wide variety of professional applications can be covered with various detector types and optics sets. Photomultiplier (PMT) detectors are highly sensitive and are ideal for pulse measurements at low pulse energies. Photodiode detectors, on the other hand, are perfect for measuring lasers with high peak power. In combination with highly efficient optics, our detectors pave the way for measurements over an wide wavelength spectrum from 200 nm to 12 µm.

Collinear and Non-Collinear Measurements

Our autocorrelators support fast switching between collinear and non-collinear measurement modes. The collinear mode - often referred to as interferometric or fringe-resolved mode - provides additional qualitative information about the chirp and the central wavelength of the pulse. In contrast, the non-collinear mode - also referred to as intensity autocorrelation - provides background-free, high dynamic range autocorrelation. Although not background-free, switching between these two modes is even realized with the Mini TPA and TPA optics sets for pulseCheck.

Automatic Phase Matching

Autocorrelators take advantage of phase-sensitive and nonlinear processes and require what is called phase matching. APE's pulseCheck achieves this software aided for each wavelength range, resulting in precise and fast operation without the need for manual adjustment. Measurements are made even easier by using our TPA detectors, which combine detector and nonlinear optics in a single element. Here, phase matching adjustment is no longer necessary at all.

Plug & Play and Easy Integration with Network Interface

The pulseCheck offers easy-to-use plug & play capability via USB. In addition, the pulseCheck can be easily integrated into automated test and measurement environments with an Ethernet connection (SCPI over TCP/IP). And all this is possible without the need for an additional PC. The pulseCheck can also be controlled directly from any location via a network connection.

pulseCheck NX
The Modular Autocorrelator

Pulse Measurement Perfection with the Multitalent from APE

The pulseCheck platform grows with your tasks. Suitable for characterizing virtually all ultrafast pulse lasers, APE's pulseCheck autocorrelator covers a wide range of wavelengths and pulse widths. This flexibility is achieved by using interchangeable optics sets, typically consisting of a nonlinear crystal and a dedicated detector module.

- Exchangeable Optics Sets for wavelength coverage from 200 nm to 12 µm
- Wide range of sensitivity levels covered with PMT, PD, and TPA
- High temporal resolution with a sampling resolution down to 50 attoseconds
- Toggle between interferometric and intensity autocorrelation
- Integrated Controller for data acquisition, data fitting, and fast FPGA data processing
- Software aided wavelength tuning of crystal (phase matching)
- Fully compliant with DIN 58175-2:2021-04 (pulse measurement)
- NX-Software and USB as well as Ethernet connection
- TCP/IP remote control with standardized command set for easy programming
- Option: FROG for complete pulse characterization

pulseCheck NX Overview

Overview

Specifications	pulseCheck NX 50	pulseCheck NX 150	pulseCheck SM 2000
Pulse Width	5 fs – 15 ps	10 fs – 40 ps	20fs – 500 ps
Wavelengths	200 nm – 12 µm, depending on optics set	200 nm – 12 µm, depending on optics set	200 nm – 12 µm, depending on optics set
Delay Resolution	50 attoseconds	200 attoseconds	1 femtosecond
Refresh Rate	10 Hz	7.5 Hz	Depending on scan range, 120 ps/sec
Intensity Resolution	18 bit	18 bit	18 bit
Detector Types	PMT, TPA, PD	PMT, TPA, PD	PMT, TPA, PD
Electronics	Integrated	Integrated	Integrated
Software	NX Software	NX Software	V 2019 Software
Connectivity	USB, Ethernet	USB, Ethernet	USB, Ethernet
			see page 14 pulsecheck SM 2000 for details

High Resolution & Strong Processing Performance

The advanced system-on-chip based architecture enables measurements with low latency, a high time resolution down to 50 attoseconds and an intensity dynamic range of 18 bit. This allows full access to even the tiniest autocorrelation features.
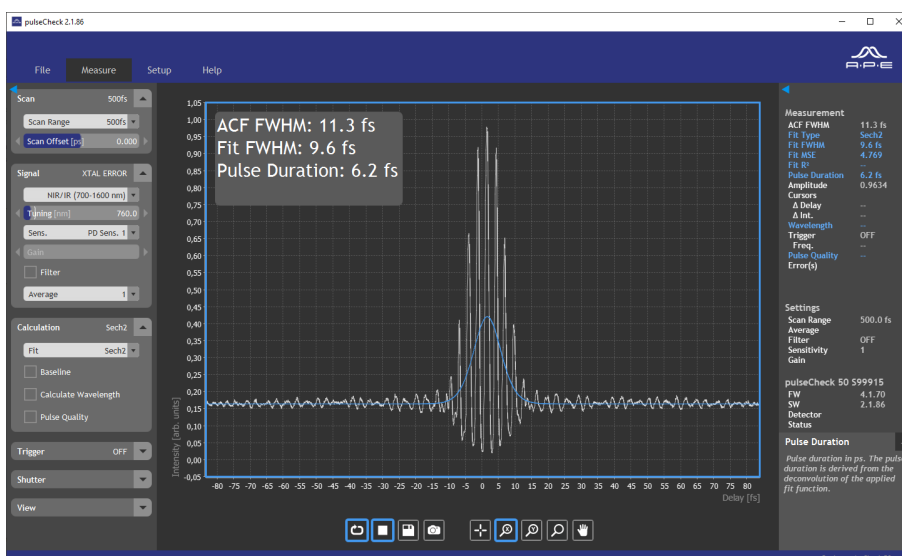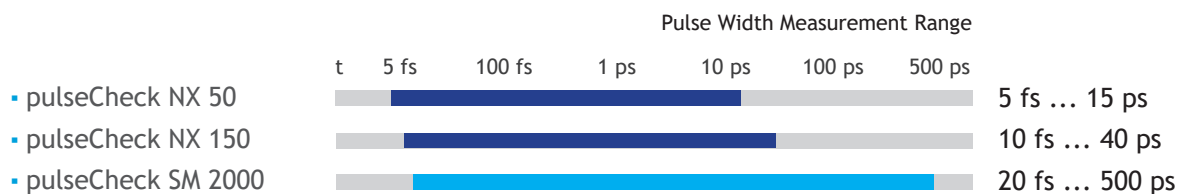

Software GUI for pulseCheck NX

... Flexibility for your Experiments

Maximum Functionality through Modular Design	APE meets the growing need for maximum functionality and flexibility with the modular concept on which the pulseCheck autocorrelator series is based. Thus, Optics sets to upgrade the wavelength range or FROG capability can be added any time.

From Ultrashort to Longer Pulses

Various pulseCheck configurations can be adapted to the individual needs of pulse duration measurement. The measurement of extra long pulse durations up to 500 ps is possible with pulseCheck SM.

Pulse Width Measurement Range

t   5 fs   100 fs   1 ps   10 ps   100 ps   500 ps

- pulseCheck NX 50 — 5 fs ... 15 ps
- pulseCheck NX 150 — 10 fs ... 40 ps
- pulseCheck SM 2000 — 20 fs ... 500 ps

High Sensitivity and Low Noise with Three Types of Detectors

- Photodiode Detector (PD) — Standard sensitivity up to 1 W^2
- Photomultiplier (PMT) — Highest sensitivity up to 10^{-6} W^2
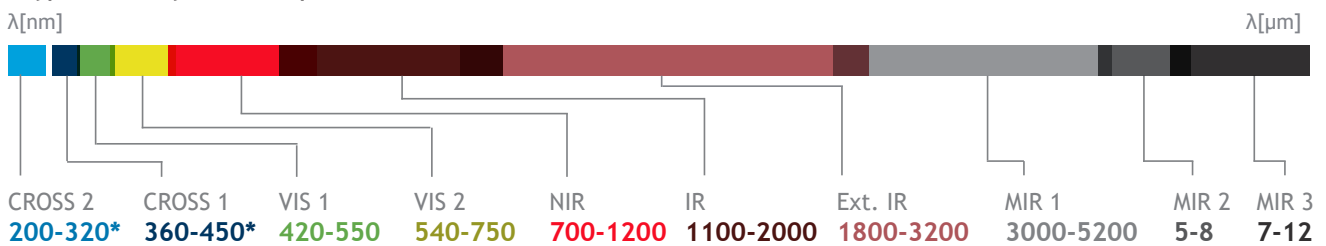- Two-Photon Absorption (TPA) — High sensitivity up to 10^{-2} W^2

pulseCheck NX

Optics Sets

A variety of different and exchangeable optics sets cover a wide wavelength range: from UV at 200 nm to mid IR at 12 μm.
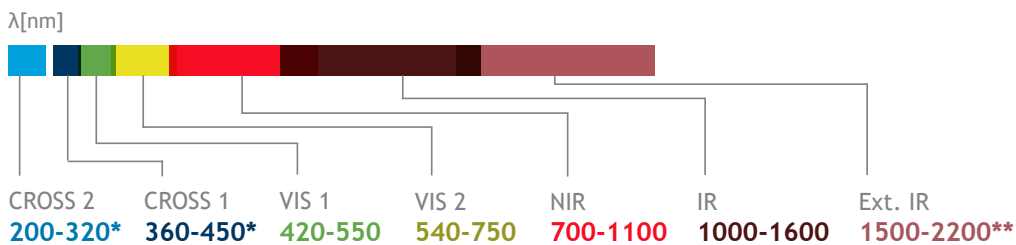
Photodiode (PD)

- **Typ. Sensitivity:** 1 W^2 - **Rep. Rate:** > 10 Hz - **Measurement Mode:** Collinear and Non-collinear

λ[nm]   λ[μm]

| CROSS 2	CROSS 1	VIS 1	VIS 2	NIR	IR	Ext. IR	MIR 1	MIR 2	MIR 3
200-320*	360-450*	420-550	540-750	700-1200	1100-2000	1800-3200	3000-5200	5-8	7-12

Photomultiplier (PMT)

- **Typ. Sensitivity:** up to 10^{-6} W^2 - **Rep. Rate:** > 250 kHz - **Measurement Mode:** Collinear and Non-collinear

λ[nm]

CROSS 2	CROSS 1	VIS 1	VIS 2	NIR	IR	Ext. IR
200-320*	360-450*	420-550	540-750	700-1100	1000-1600	1500-2200**

Two Photon Absorption (TPA)

- **Typ. Sensitivity:** < 0.1 W^2 (NIR/IR) - < 1 W^2 (VIS) - < 100 W^2 (UV) - **Rep. Rate:** > 10 Hz - **Measurement Mode:** Collinear Intensity

λ[nm]

UV	VIS	NIR	IR	Ext. IR
250-400	400-700	700-1250	1250-2100	2000-3200
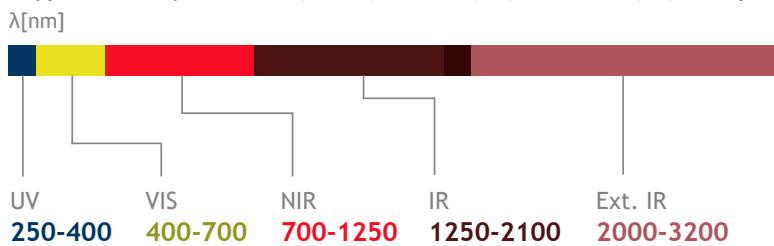
* For cross-correlation: wavelength range depends on pump wavelength
** For the wavelength range 1500 - 2200 nm we recommend to use the highly sensitive IR detector "Extended IR PD SELECTED"

pulseCheck NX Specifications

Specifications

Measurable Pulse Width Range*	5 fs - 15 ps with pulseCheck NX 50; 10 fs - 40 ps with pulseCheck NX 150
Wavelength Range	200 nm - 12 μm, depending on Optics Set
Exchangeable Detector (Optics Sets)	PMT, PD, or TPA
Dealy Sampling Resolution	Down to 50 attoseconds (NX 50), 200 attoseconds (NX 150)
Refresh Rate	10 Hz (NX 50); 7.5 Hz (NX 150)
Sensitivity	Typically 1 … 10^{-6} W^2 depending on Optics Set**
Intensity Resolution	18 Bit
Pulse Repetition Rate	PD, TPA: 10 Hz and above; PMT: 250 kHz and above
Type of Measurement Mode	PMT, PD : non-collinear intensity, collinear interferometric; TPA: hybrid non-collinear intensity, collinear interferometric;
SHG Tuning for Phase Matching	PMT/PD: automatic; TPA: not applicable
Trigger Mode	TTL for f < 50 kHz
Input Polarization	Linear horizontal, vertical available as option
Input Beam Coupling	Free-space (6 mm aperture); Option: fiber coupling FC/PC, FC/APC, SMA
Max Input Power	0.5 W (e.g. oscillator with a rep. rate of approx. 70 MHz) or 5 μJ (e.g. amplified system with rep. rates in the kHz range), whichever results in lower value
Connectivity	USB and Ethernet
Remote Control	Possible via TCP/IP (SCPI command set)
Calibration	NIST traceable calibration certificate included
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NX Software & Electronics

Electronics	• Integrated controller for data acquisition, processing and data fitting • Fast FPGA data post-processing • > 10k datapoints per scan • Connectivity: USB and Ethernet • In-field software and firmware updates
Software	• Intuitive and easy-to-navigate • Plug & play installation • Real-time display of the pulse width (measured ACF and fitted pulse width) • Fitting Routines: Gaussian, $Sech^2$, Lorentz • Measurement of central wavelength
NX Software Enhancements	• The metadata dashboard displays all measurement results and device status • The new help section displays hints and explanation for all software buttons and functions • The new monochromatic Contrast Screen Mode helps to enhance the readability of the screen while wearing laser safety glasses
Remote	• Direct remote control via TCP/IP (no PC software required) • Users can create their own measurement remote routines using the standardized SCPI command set and data aquisition

*   13 fs^2 internal dispersion at 800 nm for short-pulse option to be considered
** Sensitivity is defined as measured sensitivity including Optics Set, defined as average power times peak power of the incident pulses $P_{AV} * P_{peak}$

Options

- Various Optics Sets
- Fiber coupling
- Polarization rotator
- FROG

Compliance

- CE certified
- NIST tracable calibration with HeNe laser
- Fully compliant with DIN 58175-2:2021-04 (Autocorrelation measurement methods)

Dimensions and Power

Dimensions	244 x 201 x 309 mm (pulseCheck NX 50) 244 x 201 x 395 mm (pulseCheck NX 150) See appendix for technical drawings
Power	95 … 240 V, 50 … 60 Hz, 60 W

pulseCheck SM 2000
Long-Range Autocorrelator

**Pulse Width Measurement
up to 500 ps**

With the revised version of the long-range delay technology in pulseCheck SM, the new autocorrelator offers a scanning range up to three times larger and a measuring speed up to five times faster than the previous long-range models. The pulseCheck SM includes a high performance controller that is integrated into the device.

The pulseCheck SM is suitable for particularly long pulse durations of up to 500 ps. At the other end, short pulses down to 20 fs can be measured. A resolution of 1 fs and a sampling rate of 1 MHz is available over the entire measurement range.

- Pulse widths from 20 fs up to 500 ps
- Optics Sets from 200 nm to 12 µm
- Measurement speed of 120 ps/sec
- Automatic phase matching
- Integrated high performance controller
- Toggle between interferometric and intensity autocorrelation
- Wide range of sensitivity levels covered with PMT, PD, and TPA
- USB & Ethernet connectivity and TCP/IP remote control
- Gaussian, Sech^2, and Lorentzian fitting routines
- NIST traceable calibration

pulseCheck SM 2000 Specifications

Specifications

Measurable Pulse Width*	20 fs … 500 ps (20 fs - 150 ps directly measured, 150 ps - 500ps half ACF measured)
Wavelength Range	200 nm - 12 µm, depends on Optics Set
Optics Sets	Exchangeable; Detector-Types: PMT, PD, or TPA
Delay Resolution	1 fs
Delay Linearity	< 1 %
Scan Speed	120 ps/s
Sampling Rate	1 MHz
Sensitivity**	Typically $1 \ldots 10^{-6}$ W^2 depending on Optics Set
Recommended Repetition Rate	PD, TPA: 1 Hz … GHz; PMT: 250 kHz … GHz
Type of Measurement Mode	PMT, PD : non-collinear intensity, collinear interferometric; TPA: hybrid collinear intensity
Trigger Mode	TTL, repetition rate 1 Hz - 10 kHz
Input Polarization	Linear horizontal, vertical available as option
Input Beam Coupling	Free-space (6 mm aperture); Option: fiber coupling FC/PC, FC/APC, SMA
Max Input Power	0.5 W (e.g. oscillator with a rep. rate of approx. 70 MHz) or 5 µJ (e.g. amplified system with rep. rates in the kHz range), whichever results in lower value
Software	Included; Real-time display of data and pulse parameters
Fitting Routines	Gaussian, Sech^2, Lorentz
Connection	USB, Ethernet
Remote Control	Possible via TCP/IP (SCPI command set)
Calibration	NIST traceable calibration certificate included

Dimensions and Power

Dimensions	253 x 190 x 572 mm (W/H/L) See appendix for technical drawings
Power	95 … 240 V, 50 … 60 Hz, Power 60 W

*   13 fs^2 internal dispersion at 800 nm for short-pulse option to be considered
**   Measured sensitivity including Optics Set, defined as average power times peak power of the incident pulses $P_{AV} * P_{peak}$
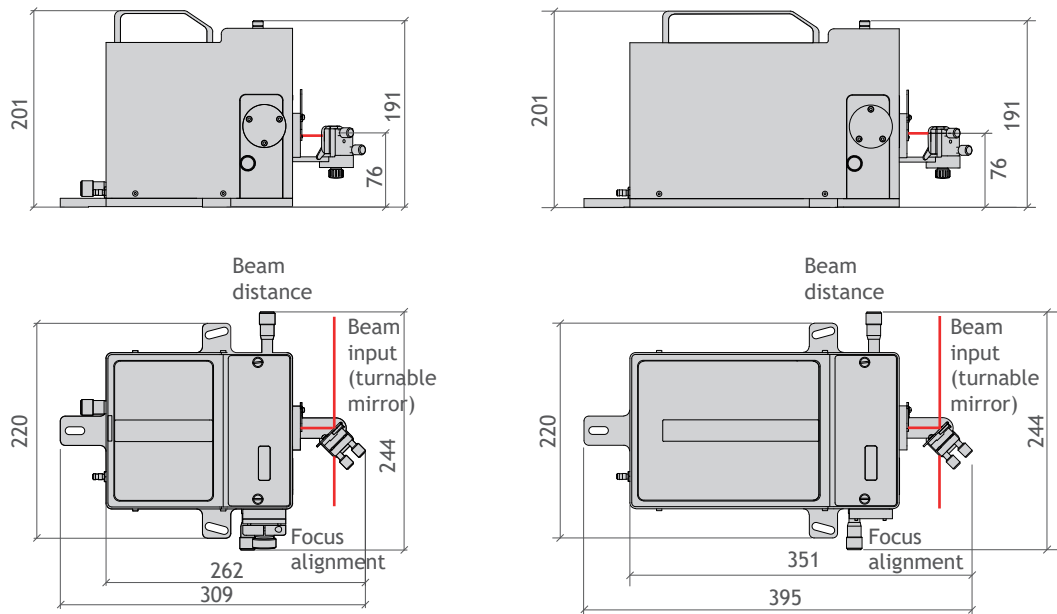
Appendix Technical Drawings

All Dimensions in mm
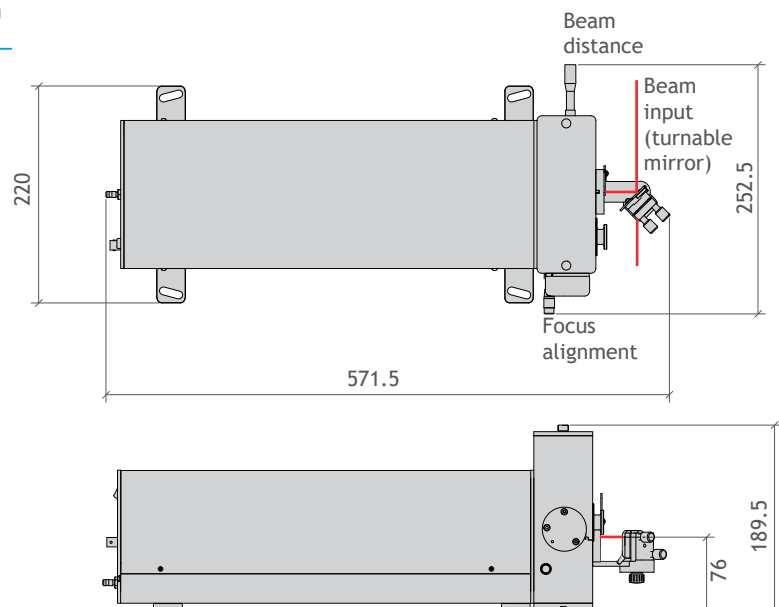
pulseCheck NX

■ Multitalent
for any task

page 3

Beam distance

Beam input (turnable mirror)

Focus alignment

201 191 76 220 244 262 309

Beam distance

Beam input (turnable mirror)

Focus alignment

201 191 76 220 244 351 395

pulseCheck SM 2000

■ Long-range autocorrelator

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Beam distance

Beam input (turnable mirror)

Focus alignment

220 252.5 571.5 189.5 76