

pulseCheck The Modular Autocorrelator

Pulse Measurement Perfection with the Multitalent from APE

- It is good to have plenty of options at hand. Suitable for the characterization of virtually any ultrafast pulsed laser, the pulseCheck autocorrelator from APE covers the broadest possible range of wavelengths and pulse widths. This flexibility is achieved by using exchangeable Optics Sets, typically consisting of a nonlinear crystal and a dedicated detector module.



- Exchangeable Optics Sets for broadest spectrum coverage from 200 nm to 12 μm
- Pulse widths from as low as < 10 fs all the way up to 500 ps
- Ultra-precise delay resolution
- Toggle between interferometric and intensity autocorrelation
- Wide range of sensitivity levels covered with PMT, PD, and TPA
- Automatic phase matching
- Gaussian, Sech^2 , and Lorentzian fitting routines
- Ready to use software and USB interface
- TCP/IP remote control with standardized command set for easy programming
- NIST traceable calibration
- Option: FROG for complete pulse characterization

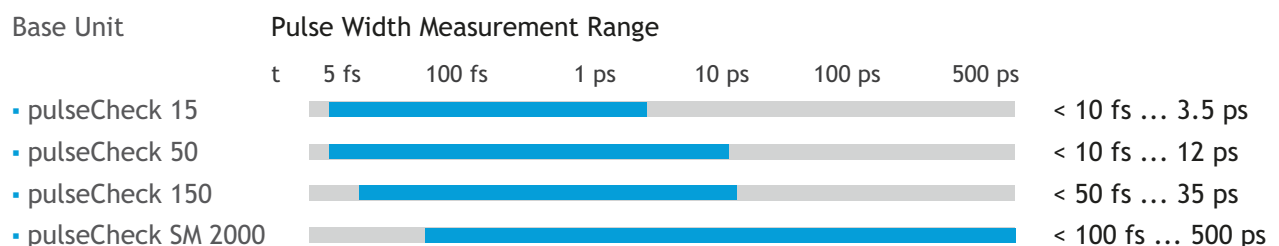
... Flexibility for your Experiments

Maximum Functionality through Modular Design

- APE fulfills a growing need for maximum functionality and flexibility with the modular concept on which its pulseCheck autocorrelator series is based.

1. From Ultrashort to Longer Pulses

- The various pulseCheck configurations can be optimized accordingly to suit your individual pulse width measurement needs. Extra-long pulse durations are accessible with pulseCheck SM, which utilizes fast and highly precise stepping motor technology to measure long pulses across a larger scan range.



2. High Sensitivity and Low Noise with Three Types of Detectors

- The three detector types address the need for low noise and enhanced sensitivity in different applications. For pulse measurement with extreme sensitivity and low pulse energy, we recommend our photomultiplier (PMT) detector. Spectrally enhanced photodiodes (PD, TPA), on the other hand, are the ideal choice for measurements requiring sensitivities of a few mW^2 .

- | | |
|-------------------------------|-------------------------------------------------|
| ▪ 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 |

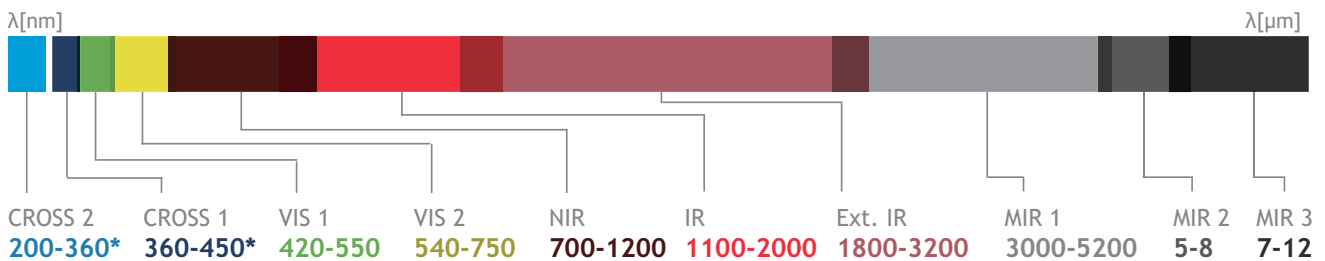
pulseCheck Unprecedented Wavelength Range

3. Ultimate Wavelength Range

- The detectors and Optics Sets available from APE cover a wide range of wavelengths, from UV at 200 nm to Mid-IR at 12 μm .

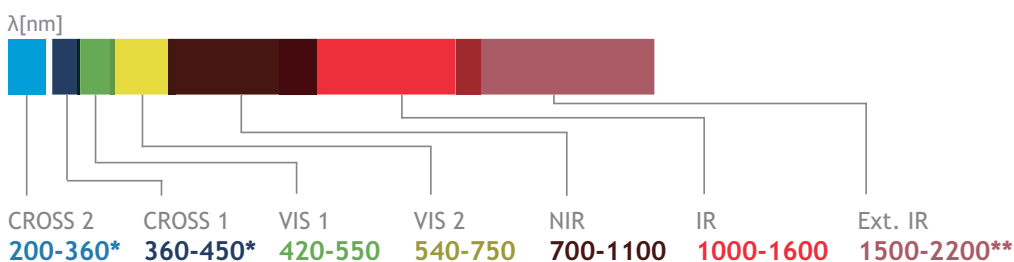
Photodiode (PD)

- Typ. Sensitivity: 1 W^2 • Rep. Rate: $> 10 \text{ Hz}$ • Measurement Mode: Collinear and Non-collinear



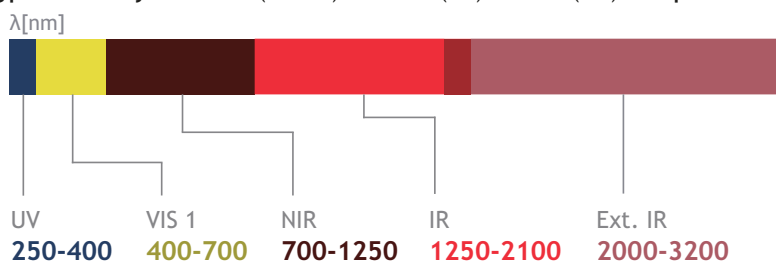
Photomultiplier (PMT)

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



Two Photon Absorption (TPA)

- Typ. Sensitivity: $< 0.1 \text{ W}^2$ (NIR/IR) $< 500 \text{ W}^2$ (UV) $< 50 \text{ W}^2$ (VIS) • Rep. Rate: $> 10 \text{ Hz}$ • Measurement Mode: Collinear Intensity



* 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 Specifications

Specifications

Measurable Pulse Width Range	Depending on Base Unit: < 10 fs ... 3.5 ps < 10 fs ... 12 ps < 50 fs ... 35 ps < 100 fs ... 500 ps
Wavelength Range	200 nm - 12 μm, depends on Optics Set
Optics Sets	Exchangeable
Detector (Optics Sets)	PMT, PD, or TPA
Delay Resolution	< 0.001 % of scan range; pulseCheck SM 1 fs
Delay Linearity	< 1 %
Sensitivity	Typically 1 ... 10 ⁻⁶ W ² depending on Optics Set*
Recommended 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 collinear intensity
Mode Switching	Available for PMT, PD
SHG Tuning for Phase Matching	PMT/PD: automatic; TPA: not applicable
Trigger Mode	TTL, f < 50 kHz; pulseCheck SM < 10 kHz
Input Polarization	Linear horizontal, vertical available as option
Input Beam Coupling	Free-space; Option: fiber coupling FC/PC, FC/APC, SMA
Max Input Power	1 W (e.g. oscillator with a rep. rate of approx. 70 MHz) or 10 μJ (e.g. amplified system with rep. rates in the kHz range), whichever results in lower value
Input Aperture	6 mm (free-space)
Software	Included; Real-time display of pulse width and central wavelength, different fitting routines
Fitting Routine	Gaussian, Sech ² , Lorentz
Connection	USB
Remote Control	Possible via TCP/IP (SCPI command set)
Calibration	NIST traceable calibration certificate included

Options

- Various Optics Sets incl. detector
- Fiber coupling
- Polarization rotator
- FROG**

Dimensions and Power

Dimensions	250 x 190 x 315 mm (pulseCheck 15 / 50) Different dimensions for pulseCheck 150 and SM series (See appendix for details)
Power	95 ... 240 V, 50 ... 60 Hz, 60 W

* Measured sensitivity including Optics Set, defined as average power times peak power of the incident pulses $P_{AV} * P_{peak}$

** Except for pulseCheck SM models

Second Harmonic Generation FROG

Complete Pulse Characterization with pulseCheck and FROG Option

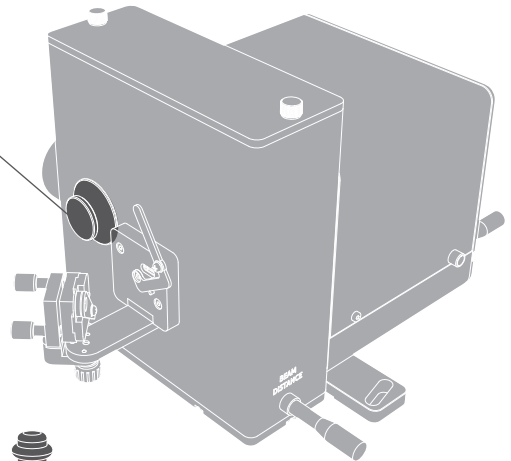
- Second Harmonic Generation FROG is the most popular spectrometer-less Frequency Resolved Optical Gating method. The pulseCheck autocorrelators by APE optionally integrate FROG, giving access to complete pulse characterization. The addition of a special nonlinear crystal module and dedicated software opens the door to complete spectral and temporal pulse characterization.



Crystal Module

FROG Setup:

1. Crystal Module within pulseCheck
2. Replacement Focus Mirror
3. FROG Software Upgrade



VIS I
420-550



VIS II
550-700



NIR
700-900



IR I
900-1200



IR II
1200-1600



Ext. IR I
1800-2200

Different crystal modules for various wavelength ranges.*

- Complete pulse characterization with Second Harmonic Generation FROG
- Different crystal modules available to cover wavelengths from 420 - 2200 nm
- FROG trace data processing and visualization with included software
- Pulse width ranges from as low as 20 fs up to 6 ps
- High spectral resolution up to 0.1 nm
- Available for the pulseCheck autocorrelator series**

* See appendix for configuration details (page 34)

** Except for pulseCheck SM models; Required laser rep. rate >10 kHz

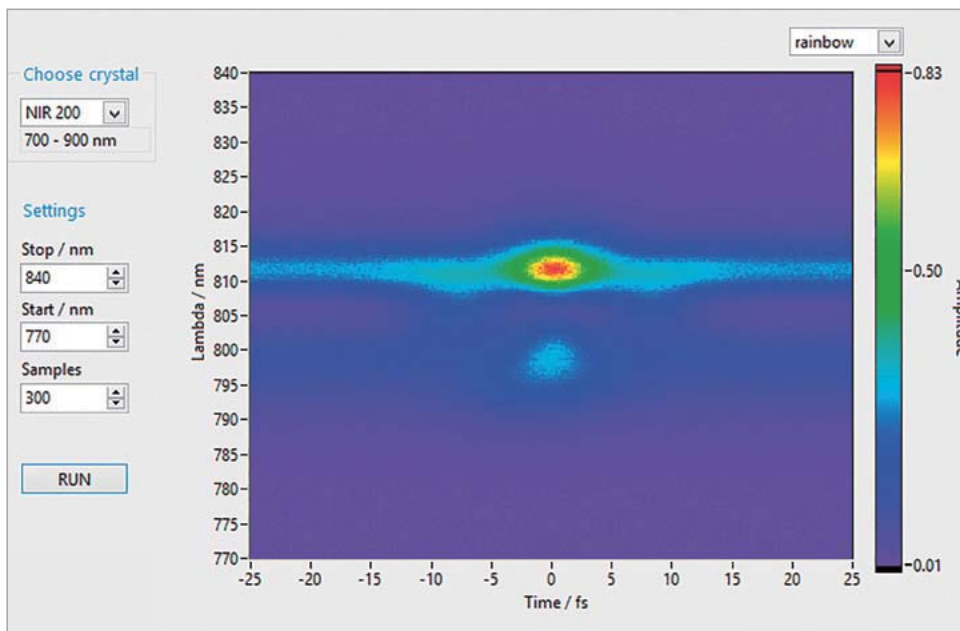
... FROG Pulse Characterization Software

FROG Trace

- The software provides the laser pulse intensity as a function of time and frequency (wavelength). This is visualized in form of the common FROG trace diagram.
- With the implemented phase matching routine from pulseCheck, it only is a matter of seconds to automatically find the required phase matching tuning angle.

Wavelength and Pulse Coverage

- The various crystals available guarantee coverage of wavelengths from 420 nm right up to 1600 nm, of pulse widths from 20 fs to 6 ps, and a spectral resolution starting as high as 0.1 nm.
- The FROG option is designed for laser repetition rates above 10 kHz and is available for the pulseCheck autocorrelator series (except for SM models).



Software interface FROG for pulseCheck

Appendix FROG Crystals

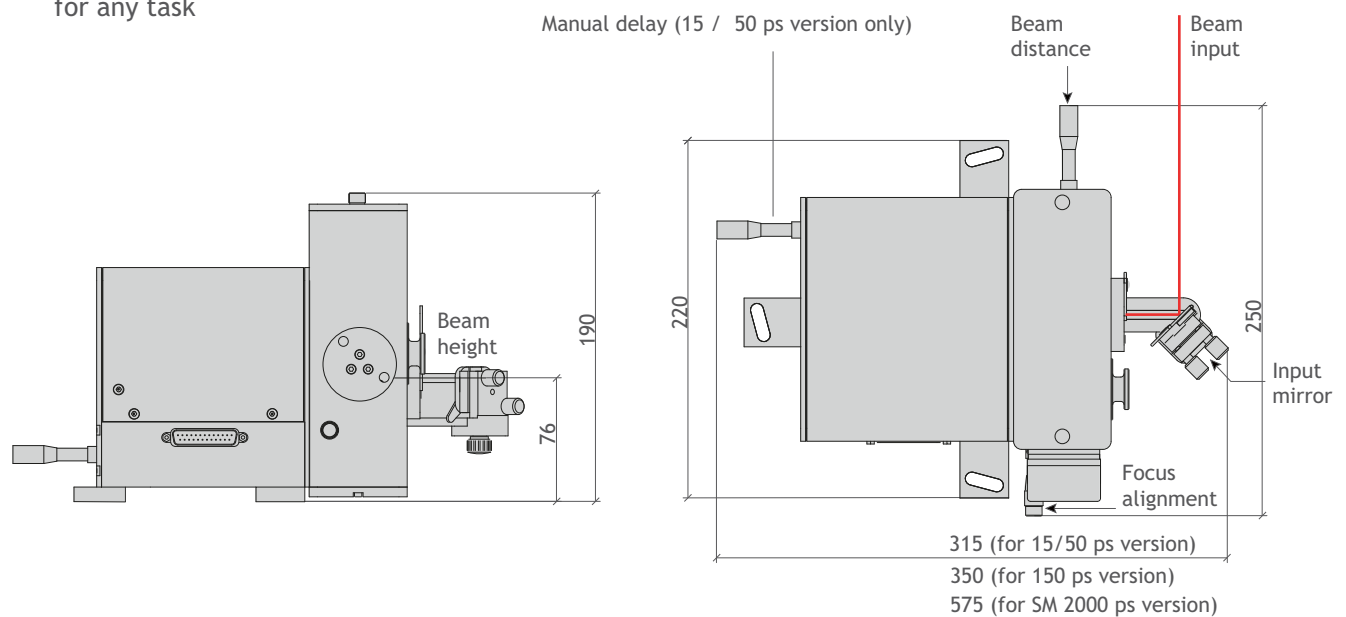
FROG Crystal	Wavelength Range	Pulse Width Range	Spectral Resolution
VIS-I-200	420 ... 550 nm	200 ... 6000 fs	0.1 nm
VIS-I-50	420 ... 550 nm	50 ... 200 fs	0.3 nm
VIS-I-20	420 ... 550 nm	20 ... 70 fs	1 nm
VIS-II-150	550 ... 700 nm	150 ... 2000 fs	0.1 nm
VIS-II-50	550 ... 700 nm	50 ... 200 fs	0.3 nm
VIS-II-20	550 ... 700 nm	20 ... 60 fs	2 nm
NIR-200	700 ... 900 nm	200 ... 5000 fs	0.1 nm
NIR-50	700 ... 900 nm	50 ... 500 fs	0.2 nm
NIR-20	700 ... 900 nm	20 ... 50 fs	3 nm
IR-I-150	900 ... 1200 nm	150 ... 900 fs	0.2 nm
IR-I-60	900 ... 1200 nm	60 ... 200 fs	1 nm
IR-I-30	900 ... 1200 nm	30 ... 60 fs	5 nm
IR-II-100	1200 ... 1600 nm	100 ... 700 fs	0.5 nm
IR-II-50	1200 ... 1600 nm	50 ... 100 fs	2 nm
IR-II-30	1200 ... 1600 nm	30 ... 50 fs	9 nm
Ext. IR-I-50	1800 ... 2200 nm	50 ... 200 fs	19 nm

Appendix Technical Drawings

All Dimensions in mm

pulseCheck

- Multitalent for any task



pulseCheck Type 2 High Contrast

High Dynamic Range Autocorrelator for High Contrast Pulse Characterization

Revealing Pre-/Post-pulses, Pedestals, Satellites

- High contrast measurements with the Autocorrelator *pulseCheck Type 2 High Contrast* provide information about how far in time and intensity the main pulse is accompanied by pre-pulses, post-pulses and pedestals.
- With a high contrast ratio of > 65 dB, *pulseCheck Type 2 High Contrast* is ideally suited for the characterization of high-intensity laser pulses, such as those used in material processing or in ultra-high-intensity laser-matter interaction experiments.

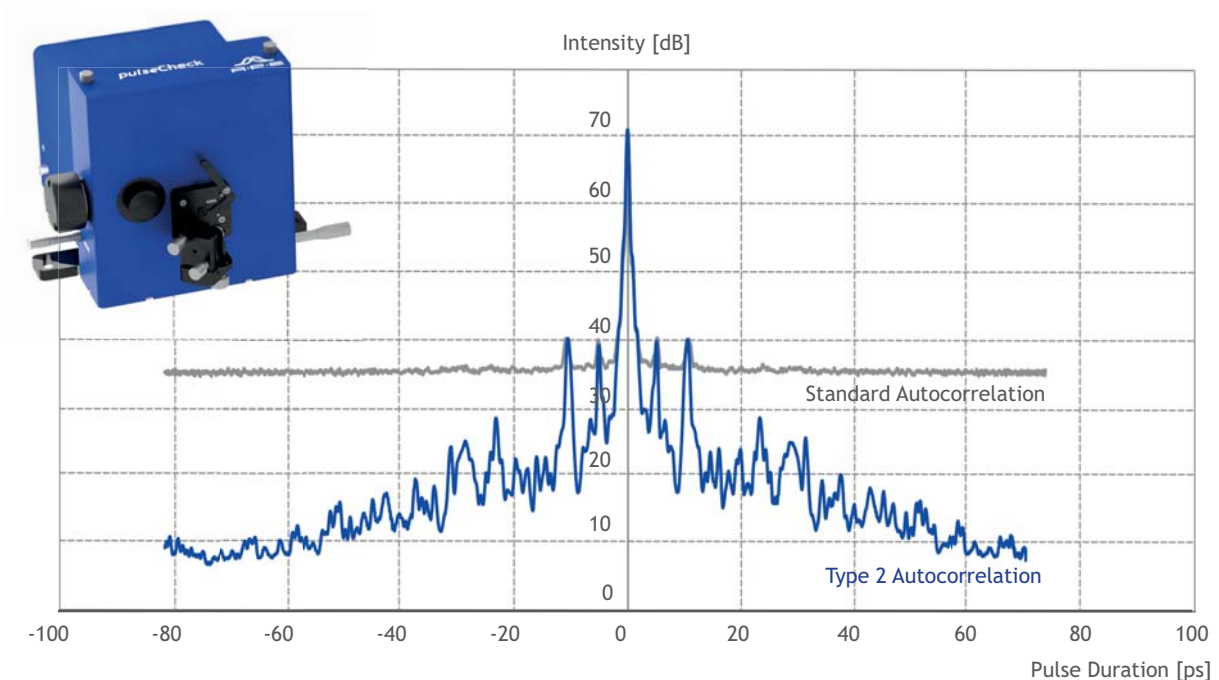


Figure: Type 2 high contrast autocorrelation measurement of an industrial femtosecond fiber laser with a nominal pulse duration of ~ 250 fs (please note the ps scale of the measurement).
Measurement conditions: ~ 1030 nm, 35 mW, 1 MHz.

- Measuring intense pulses and their pre-pulses, post-pulses, pedestals
- High dynamic range measurements
- Ultra-precise delay resolution
- Automatic phase matching
- NIST traceable calibration
- Ready to use software and USB interface
- TCP/IP remote control with standardized command set for easy programming

pulseCheck Type 2 High Contrast Specifications

Specifications

Measurable Pulse Width Range	Depending on Base Unit: < 100 fs ... 3.5 ps < 100 fs ... 12 ps < 100 fs ... 35 ps < 120 fs ... 150 ps < 120 fs ... 300 ps < 120 fs ... 400 ps
Wavelength Range	NIR 700 - 1200 nm (Others on request)
Detector	PD
Dynamic Range	> 65 dB
Delay Linearity	< 1 %
Delay Resolution	< 0.001 % of scan range
Recommended Repetition Rate	> 100 kHz for high contrast measurements
Type of Measurement Mode	Collinear
SHG Tuning for Phase Matching	Automatic
Input Polarization	Linear
Input Beam Coupling	Free-space
Input Aperture	6 mm (free-space)
Software	Included; Real-time display of pulse width and central wavelength
Connection	USB
Remote Control	Possible via TCP/IP (SCPI command set)
Calibration	NIST traceable calibration certificate included

Dimensions and Power

Dimensions	250 x 190 x 315*/350*/440* mm (*depending on base unit)
Power	95 ... 240 V, 50 ... 60 Hz, 60 W

Contact

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