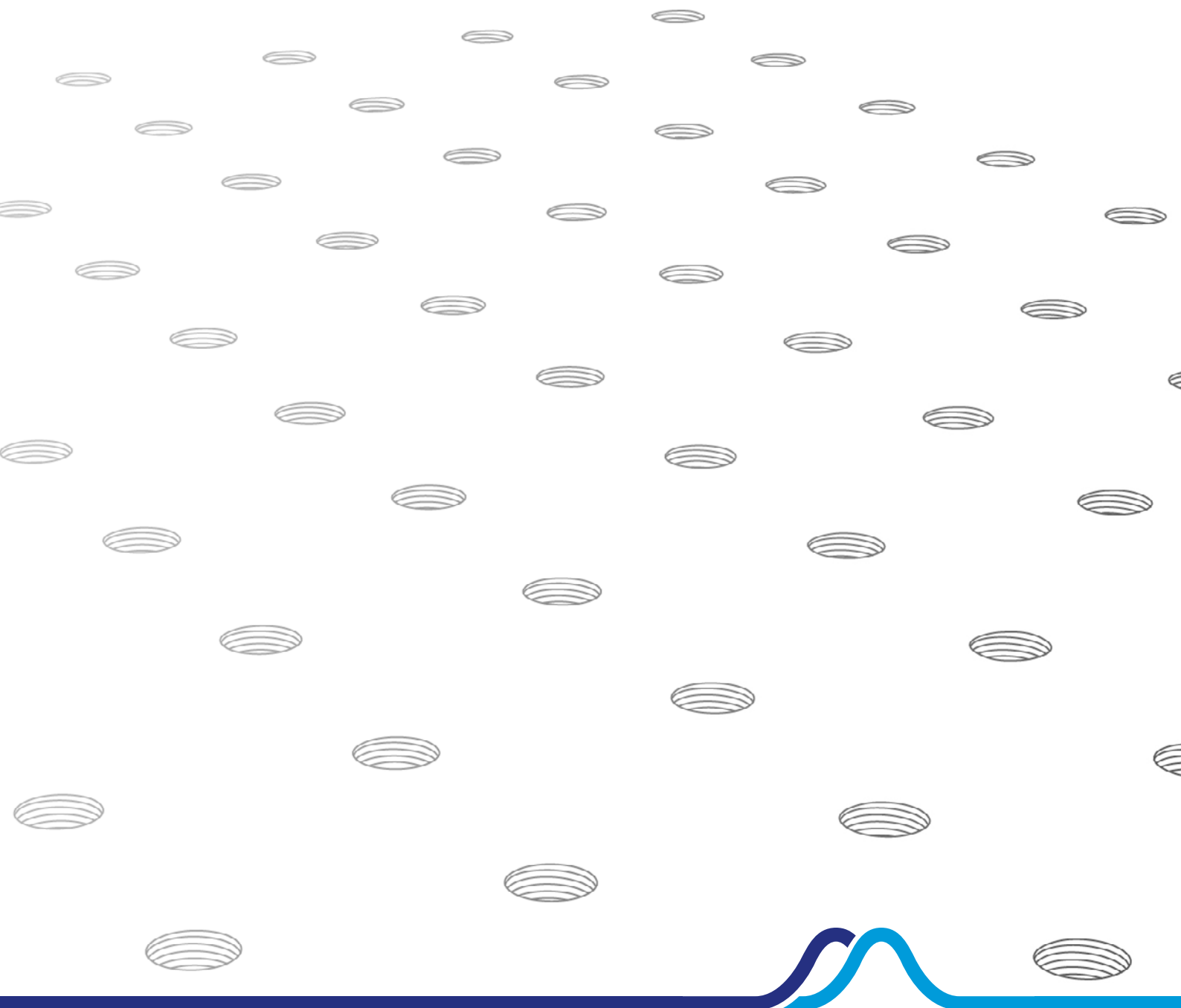


# ULTRAFAST

## LASER DIAGNOSTICS



# USE OUR APP IN YOUR LAB

The faster way to master  
nonlinear phenomena...

- Wavelength conversion calculator
- Bandwidth and pulse duration
- Frequency conversion
- Bandwidth conversion
- Dispersion calculator
- Propagation of light



# Content

■ APE Calculator	02 Use Our App In Your Lab			
■ Autocorrelator	04 Product Family	07 Benefits & Technology		
■ Autocorrelator Models and Details	08 pulseCheck + FROG <i>Most Flexible</i>	14 Mini TPA <i>Tuning-free</i>	17 Mini PD <i>Routine</i>	20 Carpe <i>For Microscopy</i>
■ Spider Pulse Characterization	22 Product Overview	24 Compact LX Spider	26 FC Spider	28 Spider IR
■ Spectrometer	30 waveScan <i>Spectrometer</i>			
■ Peak Power	32 peakDetect <i>Peak Power Monitoring</i>			
■ Appendix	34 FROG Crystals	35 Technical Drawings		

# APE Autocorrelator Product Family

## APE Autocorrelators

- The autocorrelator product family by APE includes a variety of impressive features and properties, designed to cater for a wide range of ultrafast laser applications. Market pioneer for almost 25 years, APE provides both standard and customized solutions for even the most sophisticated requirements.
- The technology behind APE products makes it possible to measure ultrashort pulses from femtoseconds to picoseconds, with either Second Harmonic Generation (SHG) detection or Two Photon Absorption (TPA) detection principle, to suit your individual measurement needs.



## APE Autocorrelators at a Glance

- Wide choice of optics and detector sets (PMT, PD, or TPA)
- Ready to use software and USB interface
- Wide wavelength range from 200 nm to 12  $\mu\text{m}$
- Wide range of pulse widths from < 10 fs to 400 ps
- Compact footprint with the Mini PD and Mini TPA line
- NIST traceable calibration
- TCP/IP remote control with standardized command set for easy programming



# Autocorrelators Model Overview



## pulseCheck

- Multitalent  
for any task  
[page 8](#)



## Mini TPA

- Compact  
and tuning-free  
[page 14](#)



## Mini PD

- Routine tasks with a  
fixed wavelength range  
[page 17](#)



## Carpe

- First choice for  
multiphoton microscopy  
[page 20](#)

## ... Benefits & Technology

### Optics and Detector Technology

- The APE range of three different detector types and Optics Sets enables you to cover a wide diversity of professional applications. For example, photomultiplier (PMT) detectors are highly sensitive and are therefore ideal for pulse measurement at lowest pulse energies. Spectrally enhanced photodiodes, on the other hand, are perfect for measurements of higher power laser beams. In combination with highly efficient optics, these detectors pave the way for measurements across an extensive wavelength spectrum from 200 nm to 12  $\mu\text{m}$ .

### Collinear and Non-Collinear Measurements

- Both the pulseCheck and Mini PD products support fast switching between collinear and non-collinear measurement modes. Collinear, often referred to as interferometric or fringe-resolved mode, provides additional qualitative information about the chirp and central wavelength of the pulse. In contrast, non-collinear mode, also known as intensity autocorrelation, provides a background-free autocorrelation with a high dynamic range. A „hybrid“ of these two modes, collinear intensity autocorrelation, is realized with the Mini TPA and TPA Optics Sets for the pulseCheck.

### Automatic Phase Matching

- Phase-sensitive, nonlinear processes, such as those used by the autocorrelator, require phase matching for highly efficient Second Harmonic Generation. The pulseCheck by APE achieves this fully automatically for any wavelength range, resulting in precise and fast operation with no manual adjustment needed. Because they perform the task of both detector and nonlinear optics, the TPA detectors provides tuning-free operation over a wide wavelength range.

### NIST Traceable Calibration

- Laboratories and manufacturers are often faced with systematically establishing an unbroken chain of calibrations to specified references. All APE autocorrelator models are calibrated to a traceable standard in accordance with NIST (U.S. National Institute of Standards and Technology) measurement traceability specifications. A printed and signed calibration certificate is provided with each instrument.

### Acquisition Software and TCP/IP Standard Software Interface

- All models come with an easy to use data acquisition software, allowing for real-time data display. Furthermore, the TCP/IP-based standard software interface by APE makes it straight forward to set up remote control. This allows you, for example, to design your own automated measurement routines. Simply use our protocol templates for rapid configuration with familiar programming languages, including C++, C#, LabVIEW, Python, Matlab, and Ruby.

# 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  $\mu\text{m}$
- Pulse widths from as low as  $< 10$  fs all the way up to 400 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,  $\text{Sech}^2$ , 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 (page 12)



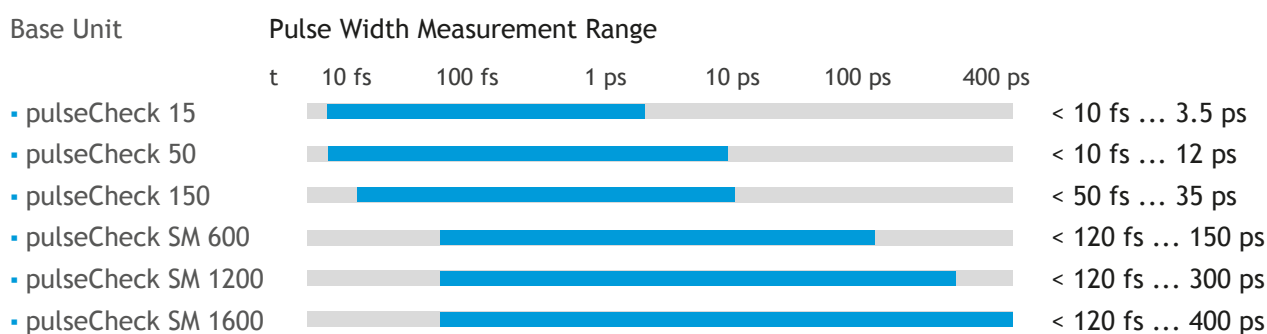
## ... Flexibility for your Experiments

### 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  $\text{mW}^2$ .

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

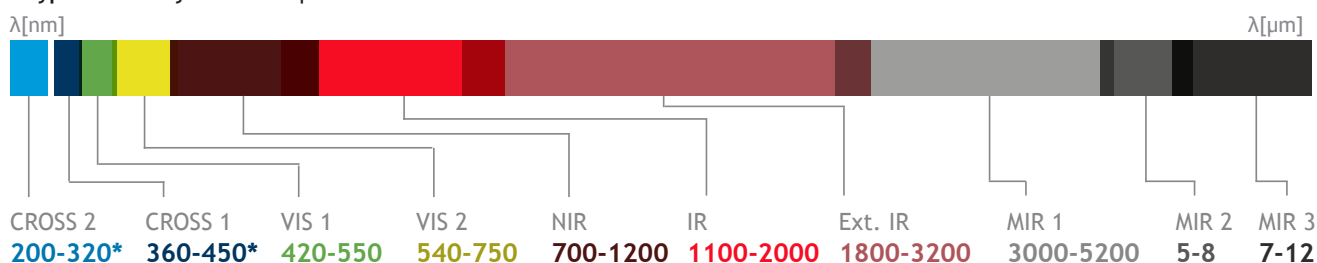
# pulseCheck Unprecedented Wavelength Range

## 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  $\mu\text{m}$ .

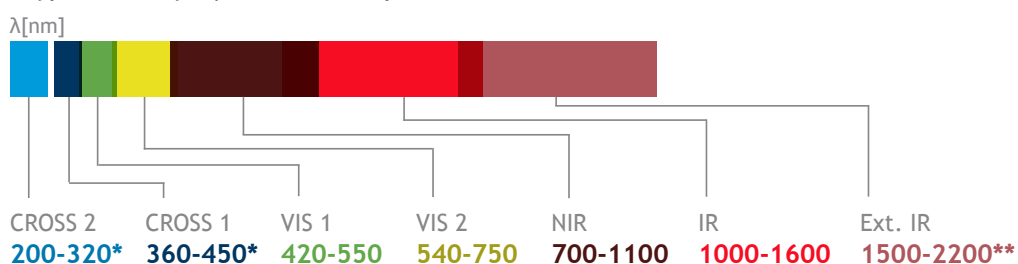
### Photodiode (PD)

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



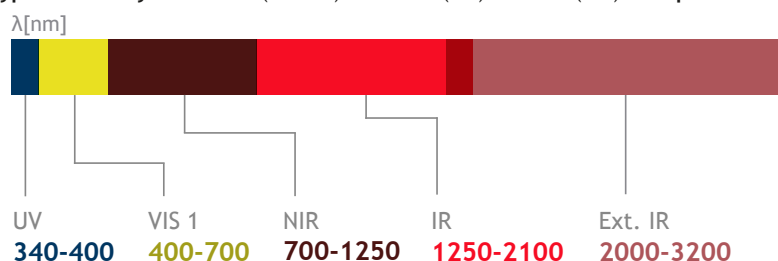
### Photomultiplier (PMT)

- Typ. Sensitivity: up to  $10^{-6} \text{ W}^2$  • 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 < 120 fs ... 150 ps    < 120 fs ... 300 ps    < 120 fs ... 400 ps
Wavelength Range	200 nm - 12 $\mu$ m, depends on Optics Set
Optics Sets	Exchangeable
Detector (Optics Sets)	PMT, PD, or TPA
Delay Resolution	< 0.001 % of scan range
Delay Linearity	< 1 %
Sensitivity	Typically 1 ... $10^{-6}$ W <sup>2</sup> 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 < 1 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 $\mu$ J (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 <sup>2</sup> , 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

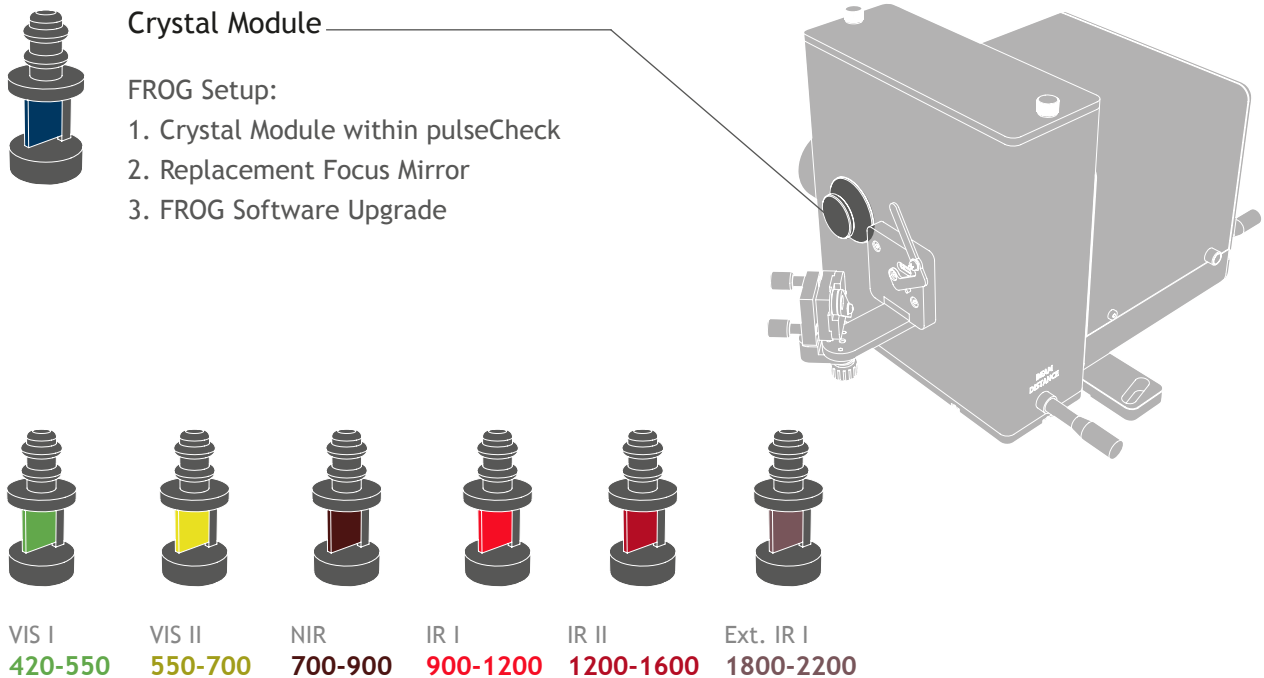
\* Measured sensitivity including Optics Set, defined as average power times peak power of the incident pulses  $P_{AV} \cdot P_{peak}$

\*\* 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.



*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

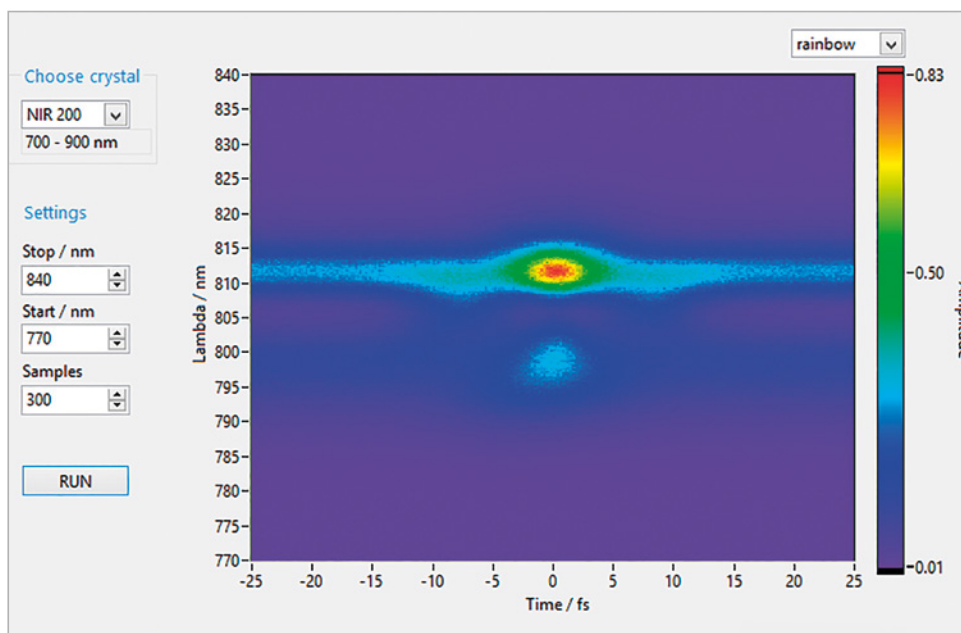
## ... FROG Pulse Characterization Software

### 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).

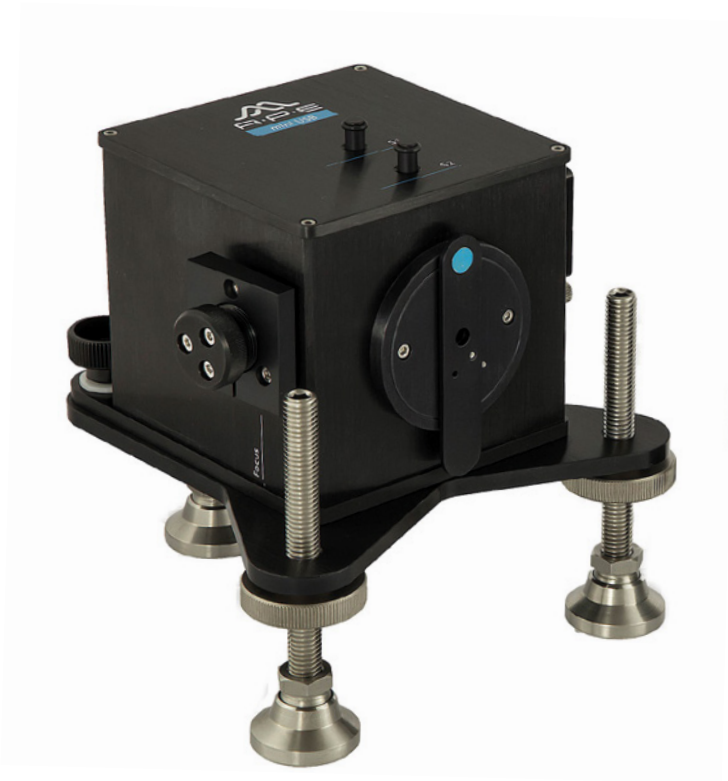


Software interface FROG for pulseCheck

# Mini TPA Compact and Tuning-free Autocorrelator

## Compact and Tuning-free Autocorrelator

- The Mini TPA by APE is the perfect combination of tuning-free autocorrelation measurement, compact size and high sensitivity.



- Exchangeable Optics Sets for spectral coverage from 340 nm to 3200 nm
- Tuning-free TPA detection process
- UV measurement without cross-correlation
- Compact design for minimum space requirements and maximum portability
- Ultra-precise delay resolution
- Hybrid collinear intensity autocorrelation
- Gaussian, Sech<sup>2</sup>, and Lorentzian fitting routines
- Including software and USB interface
- TCP/IP remote control with standardized command set for easy programming
- NIST traceable calibration
- Aluminium carrying case

## ... with Exchangeable Optics Sets

### Tuning-Free Wavelength Matching

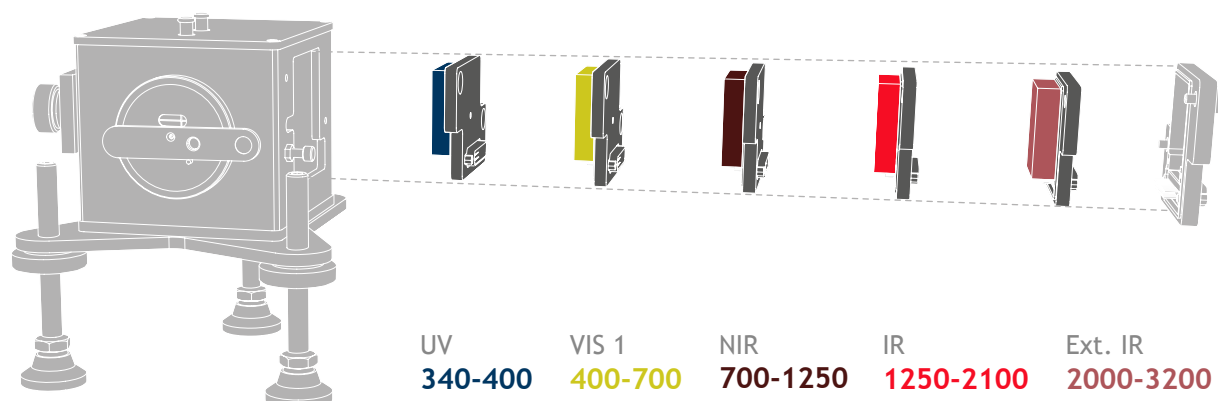
- Conventionally, autocorrelators used to split an optical pulse into two replicas and recombine them for the Second Harmonic Generation (SHG) in a nonlinear crystal. The APE Mini TPA instead benefits from the two photon absorption principle. This eliminates the need of SHG crystal angle tuning and makes the wavelength tuning process unnecessary.

### UV Range without Cross-Correlation

- Together with an UV Optics Set, the Mini TPA provides simple pulse width measurement in the UV range, from 340 nm to 400 nm – without the need for cross-correlation. Elimination of the cross-correlation approach also makes the data evaluation easier, by cutting the conventional two-step process to a single-step solution.

### Ultra-wide Wavelength Coverage in Compact Design

- APE provides a selection of exchangeable Optics Sets, ranging from UV at 340 nm to IR at 3200 nm, for sensitive measurements across an extremely broad wavelength region. Due to its compact footprint, the Mini TPA is also the perfect answer to your space-saving and easy portability requirements.



# Mini TPA Specifications

## Specifications



Measurable Pulse Width Range	50 fs ... 3.5 ps; Optional: down to 35 fs
Wavelength Range	340 nm - 3200 nm, depending on Optics Set
Optics Sets	Exchangeable
Delay Resolution	< 0.001 % of scan range
Delay Linearity	< 1 %
Sensitivity	Typically 0.1 W <sup>2</sup> *, UV range < 500 W <sup>2</sup> * (depending on Optics Set)
Recommended Repetition Rate	> 300 Hz; For UV only: upper limit 2 MHz
Type of Measurement Mode	Collinear intensity
Mode Switching	No
SHG Tuning for Phase Matching	Not required
Trigger Mode	300 Hz ... 50 kHz
Input Polarization	Linear horizontal, vertical available as option
Max. Input Power	300 mW or 5 µJ (whichever results in lower value)
Input Aperture	6 mm (free-space)
Input Beam Coupling	Free-space; Optional: fiber coupling FC/PC, FC/APC, SMA
Beam Input Height	86 ... 150 mm; Optional 50 mm
Software	Included; Real-time display of pulse width and central wavelength, different fitting routines
Fitting Routine	Gaussian, Sech <sup>2</sup> , Lorentz
Connection	USB
Remote Control	Possible via TCP/IP (SCPI command set)
Calibration	NIST traceable calibration certificate included

## Options

- Various Optics Sets incl. detector
- Short pulse option
- Fiber coupling
- Input polarization rotator
- Reduced input beam height

## Dimensions and Power

Dimensions	160 x 220 (or 140**) x 155 mm (W x H x D) (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  $P_{AV} \cdot P_{peak}$

\*\* Optional for 50 mm input beam height



# Mini PD Autocorrelator for Routine Tasks

## Autocorrelator for Routine Tasks

- The Mini PD by APE is the perfect combination of compact size and a single wavelength range.



- Available in various models, each covering a different wavelength range
- Compact design for minimum space requirements and maximum portability
- Switching between interferometric and intensity autocorrelation
- Ultra-precise delay resolution
- Software-aided phase matching
- Gaussian, Sech<sup>2</sup>, and Lorentzian fitting routines
- Including software and USB interface
- TCP/IP with standardized command set for easy programming
- NIST traceable calibration
- Aluminium carrying case

## ... Autocorrelator for Routine Tasks

### Different Models for Different Wavelengths

- The Mini PD is available in a selection of models, each of which covers a different wavelength range, and is ideal for routine tasks where a change in Optics Sets is not necessary.

### Compact Design

- With its compact footprint of only 160 x 220 x 155 mm, the Mini PD is perfect for working environments where space is limited. When it is needed elsewhere, simply place this portable unit in the lightweight aluminum case provided, for easy and safe transportation to the next site.

### Switching Between Collinear and Non-Collinear Mode

- The Mini PD supports quick and easy switching between collinear and non-collinear measurement modes. While collinear mode provides pulse width measurement with additional qualitative information about the chirp, non-collinear mode gives background-free autocorrelation with a high dynamic range.



*View of alignment window in collinear and non-collinear mode.*

# Mini PD Specifications

## Specifications

Measurable Pulse Width	50 fs ... 3.5 ps; Optional: down to 10 fs
Wavelength Versions	VIS 1 420 ... 550 nm; VIS 2 540 ... 750 nm; NIR 700 ... 1200 nm; IR 1100 ... 1800 nm
Optics Sets	Not exchangeable
Detector	PD
Delay Resolution	< 0.001 % of scan range
Delay Linearity	< 1 %
Sensitivity	Typically 1 W <sup>2</sup> *
Recommended Repetition Rate	> 300 Hz
Type of Measurement Mode	Non-collinear intensity, collinear interferometric
Mode Switching	Yes
SHG Tuning for Phase Matching	Software aided
Trigger Mode	300 Hz ... 50 kHz
Input Polarization	Linear horizontal, vertical available as option
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)
Input Beam Coupling	Free-space; Optional: fiber coupling FC/PC, FC/APC, SMA
Beam Input Height	86 ... 150 mm; Optional 50 mm
Software	Included; Real-time display of pulse width and central wavelength, different fitting routines
Fitting Routine	Gaussian, Sech <sup>2</sup> , Lorentz
Connection	USB
Remote Control	Possible via TCP/IP (SCPI command set)
Calibration	NIST traceable calibration certificate included

## Options

- Short pulse option
- Input polarization rotator
- Fiber coupling
- Reduced beam input height

## Dimensions and Power

Dimensions	160 x 220 (or 140**) x 155 mm (W x H x D) (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  $P_{AV} \cdot P_{peak}$

\*\* Optional for 50 mm input beam height

# Carpe Microscopy Autocorrelator

## Microscopy Autocorrelator

- APE's Carpe is a handy option for reviewing the management of short laser pulses in an optical microscope system.
- The Carpe autocorrelator measures the pulse duration at both the sample location and the input of the microscope. A comparison of the pulse widths obtained at these two spots enables you to calculate the pulse broadening effect. This effect is caused by dispersion of the microscope optics, but also depends to a large extent on the pulse width of the incoming laser beam.
- Furthermore, power detection at the sample location supports systematic and quantitative studies which explore how laser power affects samples or the fluorescence lifetime of probes.
- By examining the influence of the laser pulse duration, the power, and the dispersion of the microscope optics, you can fine-tune and optimize microscopy imaging at the relevant spot.
- These measurements can be also done using large NA (numerical aperture) or immersion lenses.



- Study the effect of pulse duration, power, and optics dispersion on microscopy imaging
- Measure pulse widths at the sample position and point of microscope input
- Measure average power at sample position
- Estimate the peak power in conjunction with the pulse width
- ☐ Option: Short working distance, e.g. for immersion objective lenses
- ☐ Option: femtoControl for optimizing the duration of femtosecond laser pulses



# Spider Pulse Characterization

## Spectral and Temporal Characterization of Ultrashort Laser Pulses

- The Spider series by APE is an all-purpose and frequently used solution for complete characterization of ultrashort laser pulses. Even complex pulse shapes can be measured rapidly and at fast update rates. Different models are available to cover various pulse durations, bandwidths, and wavelengths.
- Our Compact LX Spider has been designed specifically for use with Ti:Sa lasers and any applications requiring easy portability and handling.
- The FC Spider (Few Cycle Spider) is the best choice for very short pulses down to sub 5 fs and supports pulse spectra that cover up to one octave.
- The Spider IR is ideal for infrared laser pulses with a central wavelength of around 1  $\mu\text{m}$ .



### Compact LX Spider

- Compact version, ideal for the characterization of Ti:Sa Lasers  
[page 24](#)



### FC Spider

- Measurement of very short pulses with only a few cycles  
[page 26](#)



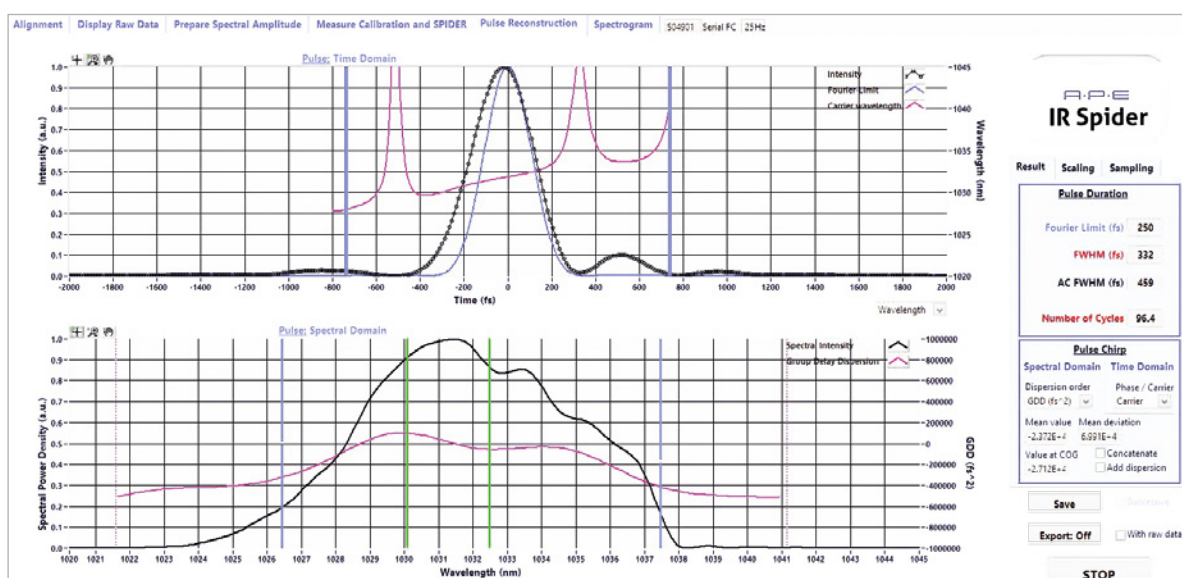
### Spider IR

- Measurement at central wavelengths of around 1  $\mu\text{m}$   
[page 28](#)

## ... Spider Software

### Spider Software Features

- Important software features for advanced pulse characterization are provided with all APE Spiders. If desired, a PC or notebook with pre-installed software will be delivered together with the instrument.



Software Interface FC Spider and Spider IR

### FC Spider, Spider IR (Software)

- Spectral and temporal reconstruction
- Alternative interferogram demodulation methods: Fourier / Wavelet
- E-field plot
- Peak power calculation
- Measurement of phase differences
- Spectral phase derivation up to fourth order
- Simulation of additional theoretical dispersion (GDD, TOD, FOD)
- Spectrogram (X-FROG, SHG-FROG) and Wigner trace representation of the pulse

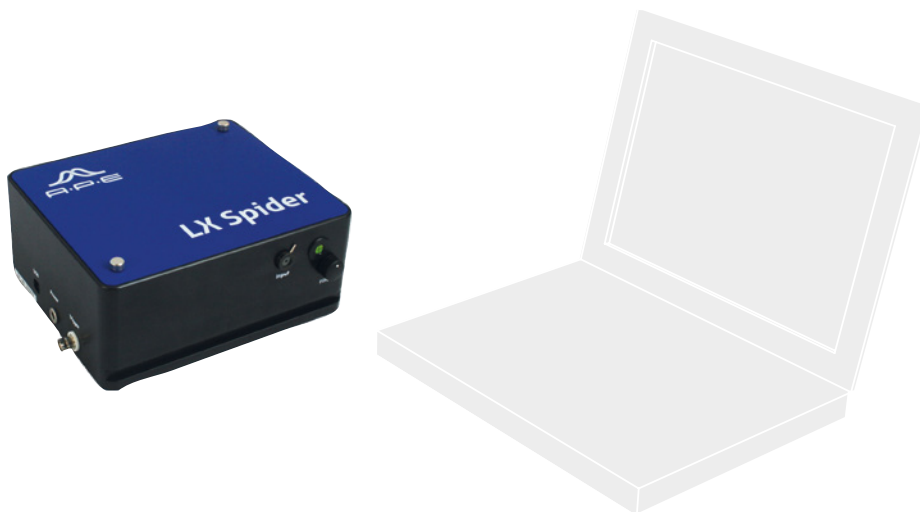
### Compact LX Spider (Software)

- Spectral and temporal reconstruction
- Bar plot of dispersion orders
- Spectral phase fit and analysis up to fourth order

# Compact LX Spider

## The Compact Choice for the Ti:Sa Wavelength Range

- The Compact LX Spider by APE is a portable, compact and robust instrument for spectral and temporal characterization of femtosecond laser pulses. It is the ideal candidate for Ti:Sa laser applications and other ultrashort pulse oscillators or amplifiers in the wavelength range 750 - 900 nm.
- Two interchangeable Optics Sets are available to cover pulse durations between 16 and 300 fs.
- Based on the popular Spider method (Spectral Phase Interferometry for Direct Electric-field Reconstruction), the Compact LX Spider allows you to visualize the spectral and temporal characteristics of the measured pulse.
- The patented optical design\* incorporates a long crystal to up-convert two test pulse replicas. It also introduces spectral shear without the need for an additional chirped pulse. Both the temporal amplitude and the phase are calculated in real-time.
- The Compact LX Spider has been drastically simplified to feature fewer optical components, making it much easier to align and use. It is delivered as a pre-calibrated unit, complete with hardware and software. One click of the mouse and recalibration of this fully automated device is performed within seconds.




- Ideal for the wavelength range of 750 - 900 nm, e.g. Ti:Sa Laser
- Compact and robust design for easy portability
- Real-time measurement of phase/intensity profiles
- Software suite included
- Fully automated

\* International Patent No.: US 7,599,067 B2, WO 2006123148



# Compact LX Spider Specifications

## Specifications



Wavelength Range	750 - 900 nm
Typical Application	Ti:Sa Laser characterization
Optics Sets	Exchangeable
Spectral Bandwidth	Depending on Optics Set Optics Set 1: 13 ... 65 nm Optics Set 2: 5 ... 15 nm
Pulse Width	Depending on Optics Set Optics Set 1: 16 ... < 150 fs Optics Set 2: 70 ... < 300 fs
Laser Repetition Rate	Any; Single Shot
Input Polarization	Linear (any orientation)
Input Power	> 10 mW at e.g. 80 MHz, 80 fs 20 mW at e.g. 5 kHz, 35 fs
Input Trigger	TTL for $f < 10$ Hz
Connection	USB
Software	Included; Features e.g. <ul style="list-style-type: none"> <li>▪ Spectral and temporal reconstruction</li> <li>▪ Bar plot of dispersion orders suitable for alignment purpose</li> <li>▪ Spectral phase fit and analysis up to fourth order</li> </ul>

## Options

- Optics Set 1 or Optics Set 2
- Notebook with pre-installed Software

## Dimensions

228 x 99 x 192 mm (W x H x D) (See appendix for details)

# FC Spider Few Cycles

## Precise Characterization of Very Short Pulses Down to < 5 fs

- The FC Spider (Few Cycle Spider) by APE provides spectral and temporal characterization of ultrashort laser pulses down to below 5 fs. It covers both the red and near infrared range, and visible wavelength region with the FC Spider VIS.
- This high-precision tool is ideal for aligning and monitoring the performance of broadband Ti:Sa oscillators and amplifier chains with bandwidths starting at 30 nm.
- The FC Spider VIS supports the visible spectral region down to 450 nm, suitable for characterization of e.g. nonlinear optical parametric amplifiers (NOPA).
- Based on the proven and patented Spider\* technology, using a non-drifting, etalon interferometer and a material dispersion stretcher, the FC Spider directly measures the spectral phase by analyzing a spectral interferogram. In combination with a simultaneously measured power spectrum, real-time calculation and visualization of the spectral and temporal amplitude and phase is accomplished.



- Short pulse characterization down to < 5 fs
- Spectral coverage in the IR range and VIS range
- Real-time and single-shot measurement of phase and intensity
- High level of automated software support and internal camera-assisted alignment
- Full software suite included
- Ideal for broadband Ti:Sa oscillators, hollow-core fiber compressors, and NOPA

\*Spectral Phase Interferometry for Direct Electric-field Reconstruction;

International Patent No.: EP 1000315, WO 1999/006794

# FC Spider Specifications

Specifications	FC Spider NIR	FC Spider VIS
Wavelength Range	550 ... 1050 nm *	450 ... 900 nm *
Typical Application	Characterization of very short pulses, broad bandwidths; E.g. Ti:Sa Laser, hollow-core fiber compressor	Characterization of very short pulses, broad bandwidths; Visible wavelength range; E.g. NOPA
Spectral Bandwidth	> 30 nm at e.g. 800 nm	10 ... 50 nm at e.g. 550 nm, other options available
Pulse Width	< 5 ... 200 fs	10 ... < 150 fs at e.g. 550 nm, other options available
Laser Repetition Rate	Any; Single Shot	Any; Single Shot
Input Polarization	Linear horizontal	Linear horizontal
Input Power	> 50 mW at e.g. 80 MHz, 10 fs 20 mW at e.g. 1 kHz, 20 fs	On request
Input Trigger	TTL for $f < 10$ Hz	TTL for $f < 10$ Hz
Connection	USB	USB
Software	Included; Features e.g. <ul style="list-style-type: none"> <li>▪ Alternative interferogram demodulation analysis: Fourier / Wavelet</li> <li>▪ Peak power calculation</li> <li>▪ Measurement of phase differences (Dispersion measurement)</li> <li>▪ Spectral phase derivation up to fourth order</li> <li>▪ Simulation of additional theoretical dispersion (GDD, TOD, FOD)</li> <li>▪ Spectrogram (X-FROG, SHG-FROG) and Wigner trace representation of the pulse</li> <li>▪ E-field plot</li> </ul>	

## Options

▪ Wavelength Range	500 ... 1000 nm 660 ... 1160 nm Customized wavelengths on request	Pre-mounted optics optimized for various center wavelengths, e.g.
		Center Wavelength:    Pulse width:    Spectral bandwidth: ▪ 500 nm                    12 ... 180 fs    6 ... 30 nm ▪ 600 nm                    8 ... 120 fs    14 ... 70 nm ▪ 700 nm                    6 ... 100 fs    25 ... 125 nm ▪ 800 nm                    7 ... 80 fs    40 ... 140 nm
▪ External Beam Splitter and Beam Routing Kit	For lasers with low repetition rates (kHz or less)	For lasers with low repetition rates (kHz or less)
▪ Pre-installed Notebook	Available	Available
▪ Fiber Coupling	Available for fundamental input port	Not available

## Dimensions

561 x 244 x 316 mm (W x H x D) See appendix for details	561 x 244 x 316 mm (W x H x D) See appendix for details
------------------------------------------------------------	------------------------------------------------------------

\* Other wavelength ranges on request

# Spider IR 1 $\mu\text{m}$ Central Wavelength

## Towards Short Pulses at 1 $\mu\text{m}$ Central Wavelength

- The Spider IR is a precision tool optimized for the complete spectral and temporal characterization of laser pulses in the infrared. Based on the patented Spider\* technology, it extends the existing range of APE Spider models to cover longer pulses, between 30 and 500 fs, at a central wavelength of around 1  $\mu\text{m}$ .
- It also supports detection of the chirp sign for stretched pulses greater than 2 ps width, making it a smart choice for the alignment of pulse compressors.
- With its two internal spectrometers (for fundamental spectrum and upconverted interferogram) the Spider IR is able to simultaneously measure and analyze both spectra needed for pulse reconstruction, by using the same pulse. This gives it true single-shot capability.
- Furthermore, the Spider IR control software supports real-time calculation of the temporal amplitude and phase. The user-friendly design features highly automated software to guide the operator through calibration and alignment procedures and enable measurements to be executed with a minimum of data input.




- Best choice for pulses between 30 and 500 fs at 1  $\mu\text{m}$  central wavelength
- Spectral intensity and phase plus temporal intensity and phase measurement
- Real-time and true single-shot measurement of intensity and phase
- High level of automated software support and internal camera-assisted alignment
- Full software suite included

\*Spectral Phase Interferometry for Direct Electric-field Reconstruction; International Patent No.: EP 1000315, WO 1999/006794

# Spider IR Specifications

## Specifications



Wavelength Range	970 ... 1070 nm *
Typical Application	Characterization of lasers with small bandwidths, larger pulse widths, e.g. 1 $\mu$ m laser
Spectral Bandwidth	> 6 ... 50 nm
Pulse Width	30 ... 500 fs; 5 ps for chirp direction measurement only
Laser Repetition Rate	Any; Single Shot
Input Polarization	Linear horizontal
Input Power	~ 100 mW at e.g. 80 MHz; ~ 20 mW at e.g. 1 kHz
Input Trigger	TTL for $f < 10$ Hz
Connection	USB
Software	Included; Features e.g. <ul style="list-style-type: none"> <li>▪ Alternative interferogram demodulation analysis: Fourier / Wavelet</li> <li>▪ E-field plot</li> <li>▪ Peak power calculation</li> <li>▪ Measurement of phase differences (Dispersion measurement)</li> <li>▪ Spectral phase derivation up to fourth order</li> <li>▪ Simulation of additional theoretical dispersion (GDD, TOD, FOD)</li> <li>▪ Spectrogram (X-FROG, SHG-FROG) and Wigner trace representation of the pulse</li> </ul>

## Options

- |                                               |                                                    |
|-----------------------------------------------|----------------------------------------------------|
| ▪ External Beam Splitter and Beam Routing Kit | For lasers with low repetition rates (kHz or less) |
| ▪ Pre-installed Notebook                      | Available                                          |
| ▪ Wavelength Ranges                           | Customized wavelength ranges on request            |

## Dimensions

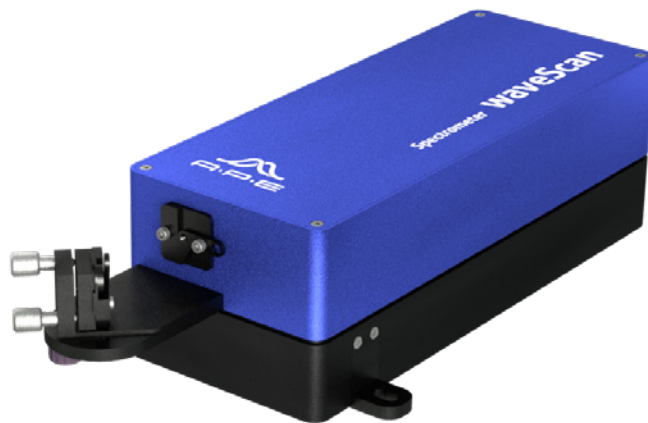
561 x 289 x 320 mm (W x H x D) (See appendix for details)

\* Other wavelength ranges on request

# waveScan High Resolution Spectrometer

## High Resolution Optical Spectrum Analyzer

- waveScan by APE is a compact and cost-efficient optical spectrum analyzer for ultrafast laser systems, delivering rapid measurements at high resolutions.
- The rotating grating technology achieves high scan rates, making it an ideal real-time alignment tool for mode-locked laser systems.
- Different configurations, from 200 nm UV to 6.3  $\mu\text{m}$  in the mid-infrared range, make waveScan the choice for analyzing the spectrum of different laser types.
- As an option, waveScan is available with an interchangeable fiber input in addition to a free-space input.
- Whether you need fast scan rates for adjustment or high resolution, combined with convenient measurement control and data processing - waveScan is the ideal solution.



- High spectral resolution up to 0.05 nm depending on the configuration
- Wavelength ranges available from 200 nm - 6300 nm (UV/VIS/NIR/MIR)
- Compact and robust design
- Free-space or fiber input options
- Easy to use - plug and play via USB connection; Software included

# waveScan Specifications

## Specifications

Configuration	Wavelength Range	Resolution (FWHM)
	200 ... 1100 nm	0.2 nm
	220 ... 540 nm	0.05 nm
	500 ... 1600 nm	0.2 nm
	800 ... 2600 nm	0.5 nm
	1500 ... 6300 nm	up to 0.7 wavenumbers
Scan Rate	~ 6 Hz	
Laser Repetition Rate	> 4 MHz (real-time measurements) > 1 kHz (accumulation mode)	
Wavelength Accuracy	± 0.1 nm (configuration dependent)	
Beam Input	Free-space; Optional fiber coupling*	
Input Polarization	Horizontal	
Connection	USB	
Remote Control	Possible via TCP/IP (SCPI command set)	
Software	Included, Windows compatible	

## Options

- Fiber coupling\*

## Dimensions

381 x 92 x 146 mm (See appendix for details)

\* Single mode fiber input recommended to achieve specified resolution

# peakDetect

## Pulse Quality Online Monitoring & Data Logging

- peakDetect by APE is an innovative measurement device for precise monitoring of variations in peak power to help you maintain reliable laser and process stability.
- The data collected with peakDetect allow you to identify laser pulse issues which affect peak power and which would otherwise not be measurable.
- The compact and robust design makes peakDetect ideal for incorporation into larger laser systems or production lines and as a portable service tool.

## Your Path to peakDetect

- peakDetect is your key to the world of measuring variations in peak power.
- Since no two laser models are the same, APE helps you to customize your individual peakDetect device. Starting with your specific laser parameters and objectives, we support you each step of the way, towards implementing a peakDetect solution at your company. Demo units are available on request.




- peakDetect quantifies peak powers for femto and picosecond lasers
- The software makes it easy to identify and monitor peak power changes over time
- The small form factor allows for easy integration into laser setups



# peakDetect Specifications

## Specifications



Wavelength Range	700 ... 1100 nm
Pulse Width Range	50 fs ... 10 ps
Repetition Rate	1 kHz ... 1 MHz (with internal measurement) > 1 MHz (with manual entry)
Input Polarization	Linear / any orientation
Computer Interface	USB / Java based software
Power Supply	via USB connector

## Options

- Other wavelength ranges on request

## Applications

- Optimization of laser performance e.g. for laser production, microscopy or nonlinear micro-machining
- Medical diagnostics and calibration e.g. for ophthalmology
- OEM laser quality measurement

## Dimensions

44 x 80 x 41 mm (See appendix for details)

## 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

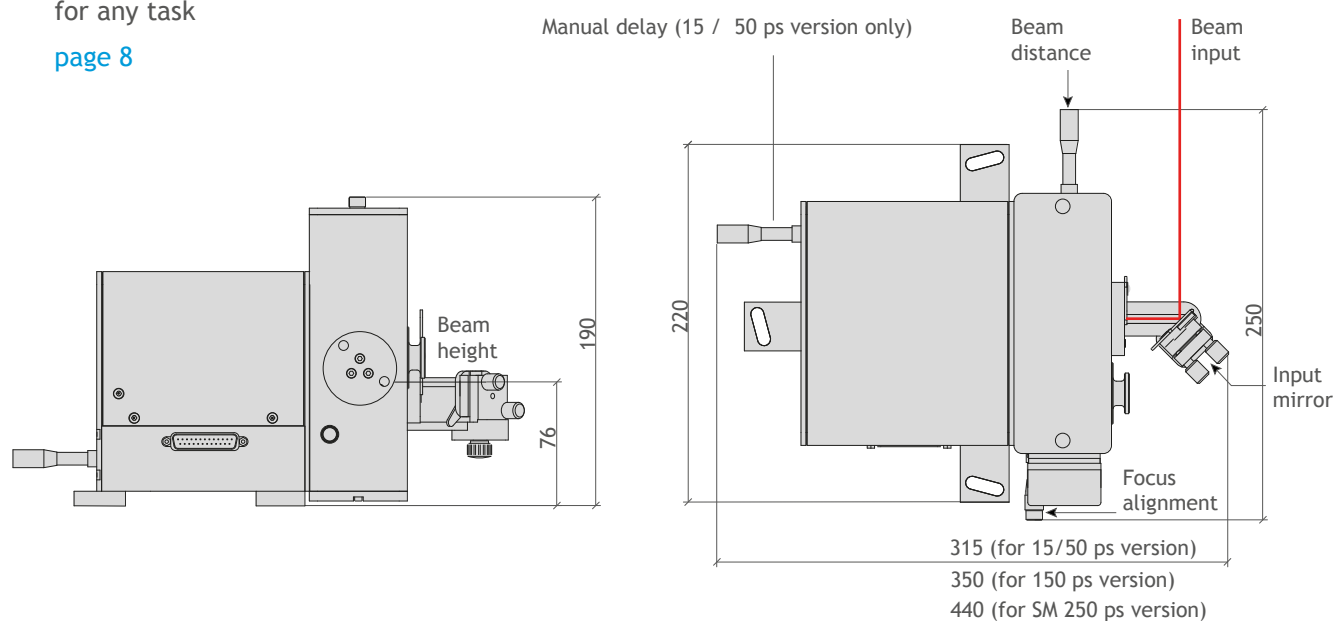
# Appendix Technical Drawings

All Dimensions in mm

## pulseCheck

- Multitalent for any task

[page 8](#)



## Mini TPA

- Compact and tuning-free

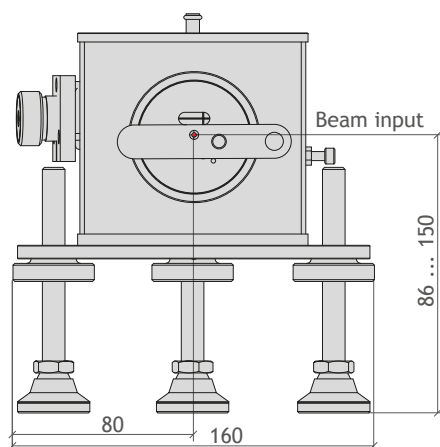
[page 14](#)

## Mini PD

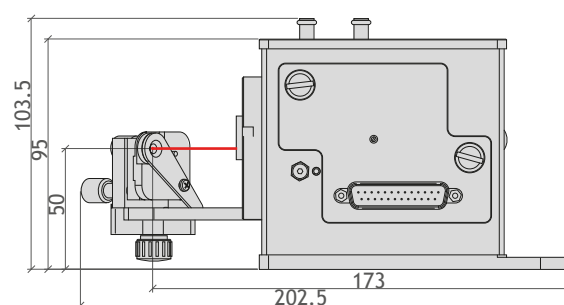
- Routine tasks with a fixed wavelength range

[page 17](#)

Standard Version



Optional Reduced Beam Input Height Version



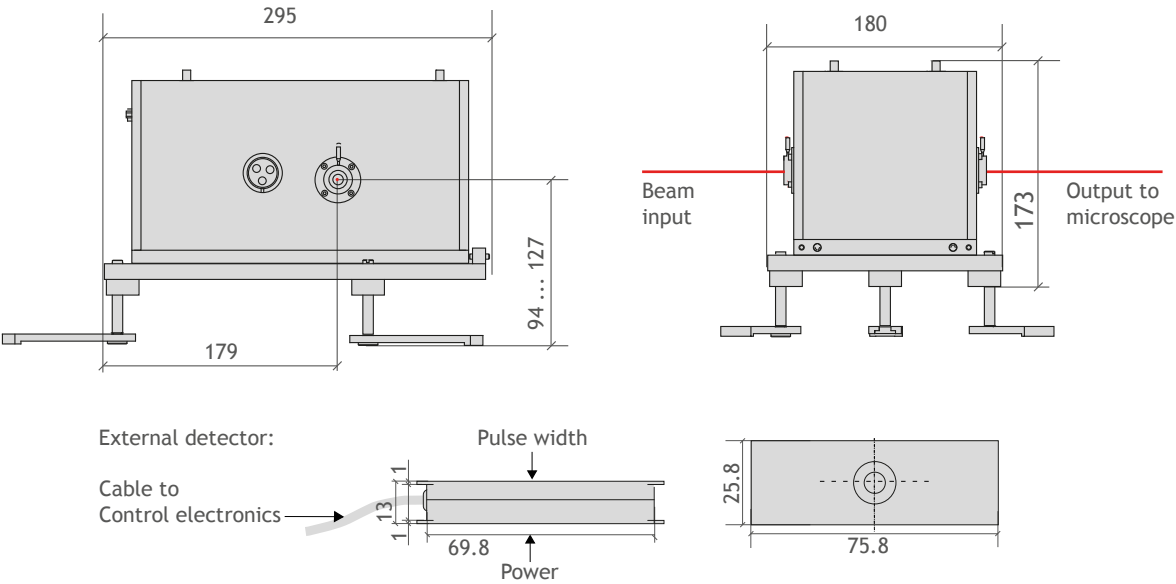
Mini TPA and Mini PD have the same case

# Appendix Technical Drawings

All Dimensions in mm

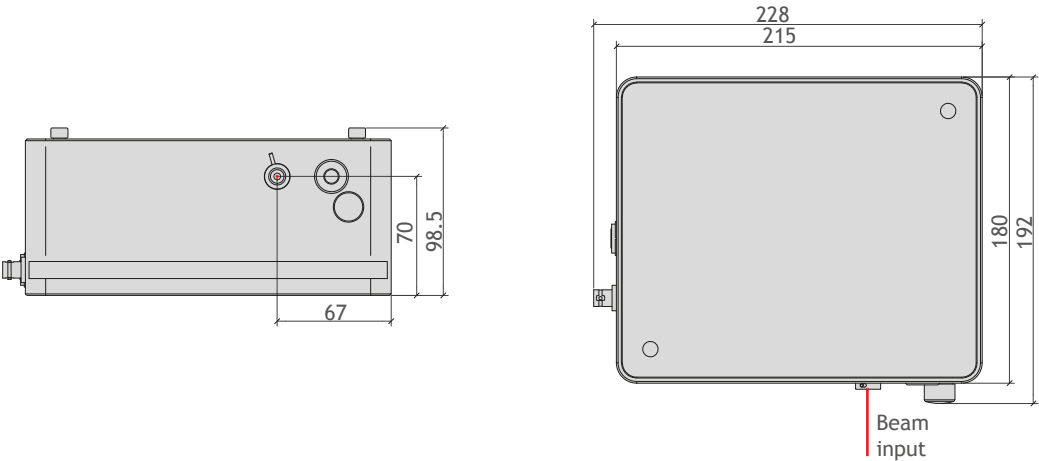
## Carpe

- First choice for multiphoton microscopy  
[page 20](#)



## Compact LX Spider

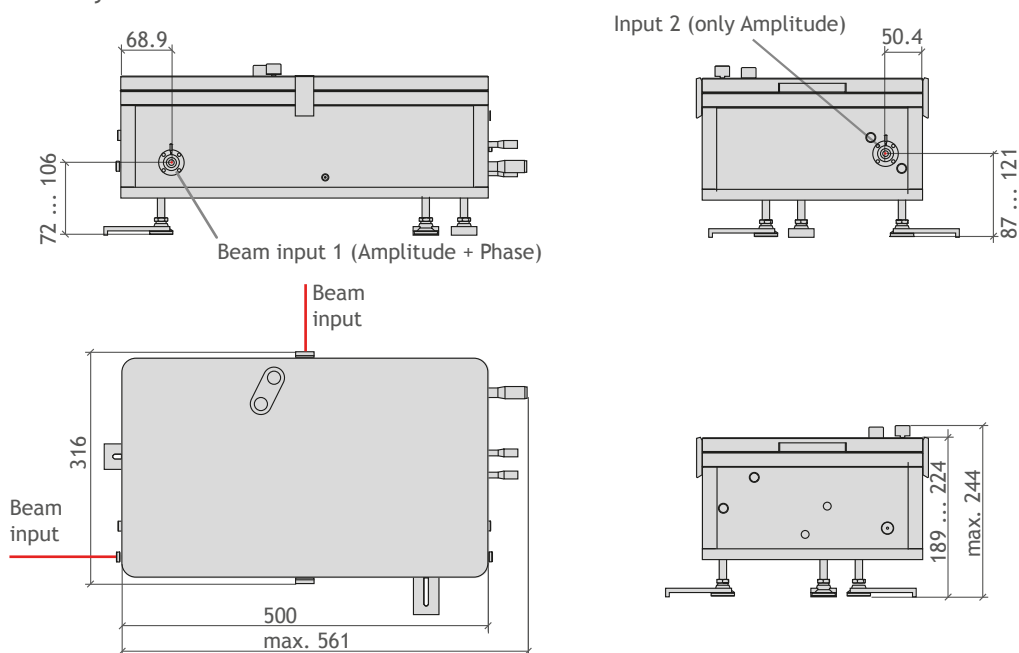
- Compact version, ideal for the characterization of Ti:Sa lasers  
[page 24](#)



## FC Spider

- Measurement of very short pulses with only a few cycles

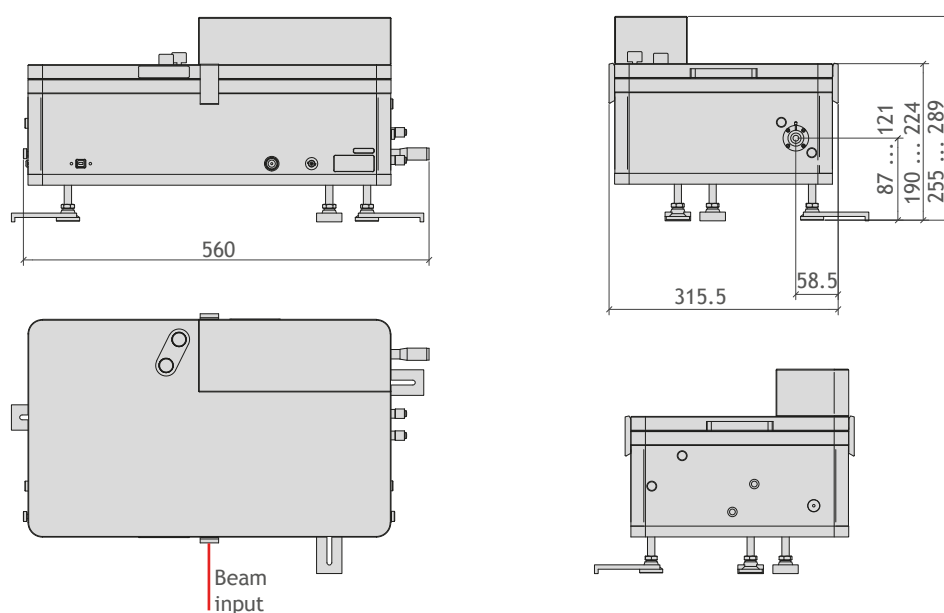
page 26



## Spider IR

- Measurement at central wavelengths of around 1  $\mu\text{m}$

page 28

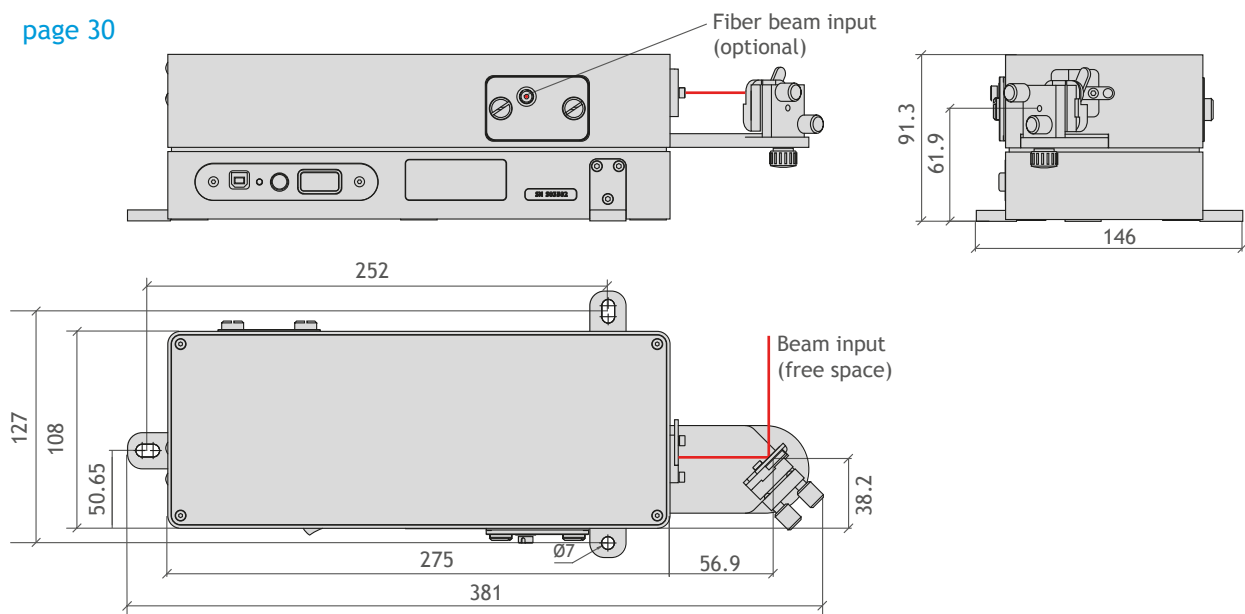


# Appendix Technical Drawings

All Dimensions in mm

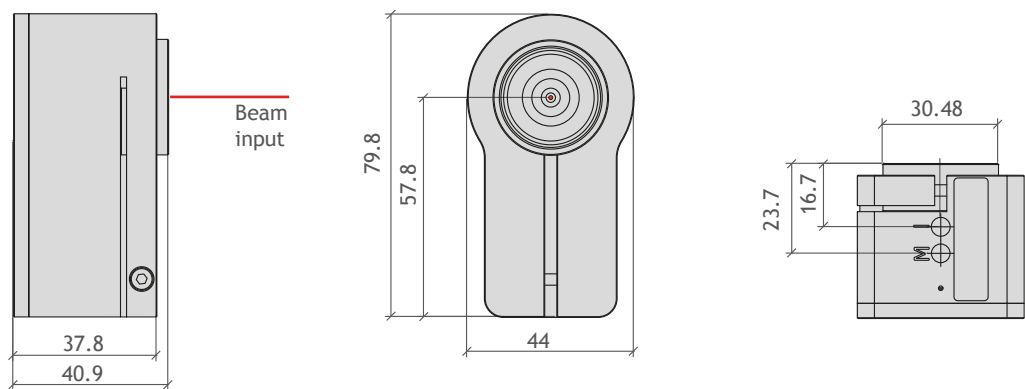
## waveScan

- High resolution spectrometer
- page 30



## peakDetect

- Peak power monitoring
- page 32



# PRODUCT PORTFOLIO

## Optical Parametric Oscillators

fs / ps MHz OPO | fixed frequency pumped  
fs / ps MHz OPO | Ti:Sa laser pumped  
ns kHz | fixed frequency pumped  
OPO pump sources

## Optical Parametric Amplifier

fs high power OPA | fixed frequency pumped

## Diagnostics

Autocorrelators  
Spiders  
Spectrometers  
Peak Power Monitoring

## Wavelength Converters

Harmonic Generators SHG / THG / FHG  
Difference Frequency Generation (DFG)

## Pulse Management

Pulse Pickers  
Cavity Dumpers  
Optical Delay Lines  
Pulse Compressors  
Pulse Shapers

## Acousto-Optics

Electro-optical Modulators  
Intensity Modulators  
Frequency Shifters

## Contact

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## Your local contact:

APE follows a policy of continued product improvement.  
Therefore, specifications are subject to change without notice.

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