Novanta PHOTONICS

ASOPS ENGINE LASER DATA SHEET

NEXT GENERATION, TIME-DOMAIN SPECTROSCOPY SYSTEM

Novanta develops photonics solutions specializing in cutting-edge components and sub-systems for laser-based diagnostic, analytical, micromachining and fine material processing applications. Powerful lasers, coupled with advanced beam steering and intelligent sub-systems incorporating software and controls, deliver extreme precision and performance, tailored to our customers' demanding applications.

Turn-key Ti:Sapphire 1 GHz lasers

PRECISE AND FAST

As the leading supplier for ASynchronous OPtical Sampling (ASOPS) technology for almost 15 years, Laser Quantum's third generation ASOPS technique allows for the most precise and fastest time-domain spectroscopy available on the market today. The ASOPS Engine includes all components necessary for high-speed ASOPS time-domain spectroscopy: two femtosecond lasers, master and slave, in addition to the TL-1000 ASOPS electronic unit for stabilizing the repetition rate of the slave laser with an offset to its master laser. Laser Quantum offers a choice of either 1 GHz or 84 MHz femtosecond laser options.

Key features of the ASOPS Engine include extremely fast acquisition speed of up to 20 kHz, an unprecedented time-resolution of significantly below 60 fs* for 1 GHz lasers and below 100 fs for 84 MHz lasers respectively. This unique combination of high scan rates, long measurement windows and excellent time resolution is impossible with conventional time domain spectrometers.

* typical values for the time resolution are <45 fs @ 1 GHz and < 100 fs at 84 MHz.

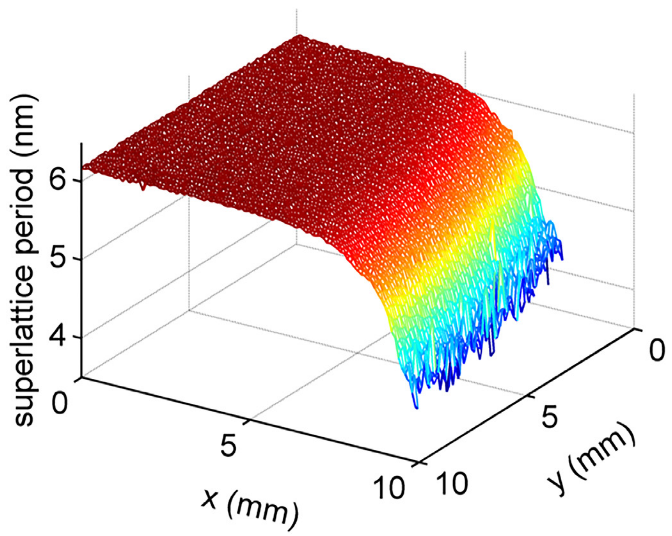


Fig. 1. Two-dimensional thickness measurement of a Si/Mo superlattice structure using ASOPS. At each pixel the time-resolved reflectivity change is measured and the superlattice period can be directly extracted from photoinduced ultrasonics with sub-nm resolution. The fast acquisition time allows quick measurement of a two dimensional 100x100 pixel scan with two adjacent pixels separated by 100 µm.

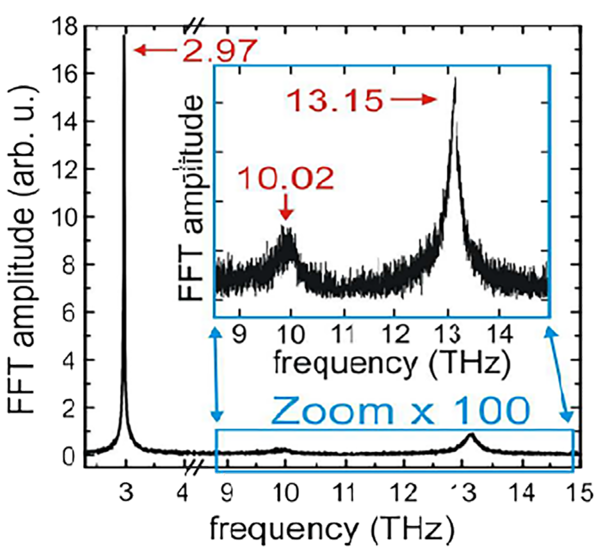


Fig. 2. Fourier transform of reflectivity measurements taken on ZnO samples with an ASOPS system. The excellent time stability provided by the TL-1000 ASOPS control unit allows it to measure even high phonon frequencies such as the observed 13.15 THz phonon mode in ZnO.

ASOPS TECHNOLOGY

The key feature of the ASOPS technology is the use of two femtosecond lasers with repetition rates fR locked together in a master-slave configuration with a slight offsetfR. This offset, typically between 10 Hz and 10 kHz, causes the delay among pairs of pulses from the lasers to incrementally increase by = fR/ fR with each shot, for example, a 10 fs increase at fR = 10 kHz. If the lasers are then used as pump and probe lasers time-delay happens automatically, and the delay between pump and probe pulse pairs undergoes a linear ramp = tfR/fR as function of real time t, replicating itself at a rate given by fR. Figure 3 illustrates the principle for an optical pump-probe time domain spectrometer (TDS) setup. The lasers are then used as they would be in a classical setup except that no translation stage is required. Timing precision is now determined by the ability to measure and stabilise the repetition rate offset. Uncertainties at the level of a few parts in 105 are reached — typically more than an order of magnitude better than mechanical delay generators.

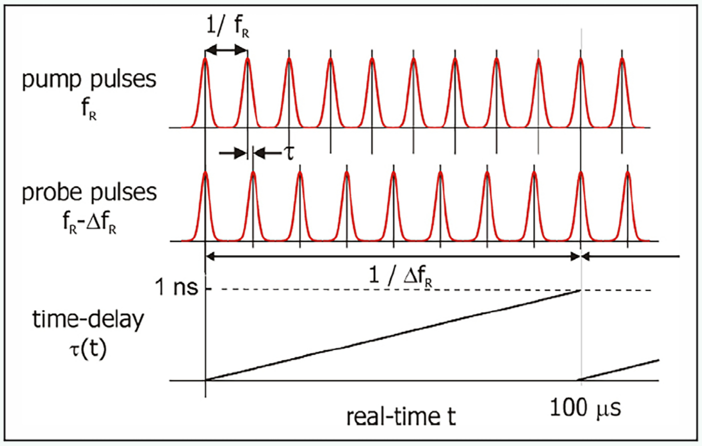


Fig. 3. Realization of the time delay increment of an ASOPS system. The pulse to pulse separation for pump and probe pulse trains differs by the time increment which increases linearly over time as seen in the above graph. Very short scan times of the order 100 µs can be realized with a measurement window of 1 ns using the ASOPS technique based on our 1 GHz taccor laser range. If 84 MHz lasers are employed, much longer scan delays

EXCELLENT TIME-RESOLUTION

Excellent time-resolution of significantly below 60 fs for 1 GHz lasers and significantly below 100 fs for 84 MHz lasers is ensured by stabilizing the master and slave lasers using the third generation TL-1000 ASOPS unit based on the patented DDS technology. The ASOPS Engine is available with the range of 1 GHz taccor lasers as well as the 84 MHz lasers from our venteon and gecco series. Typical time resolution values for both MHz and GHz ASOPS Engine systems can be seen in Figure 4 and 5 respectively.

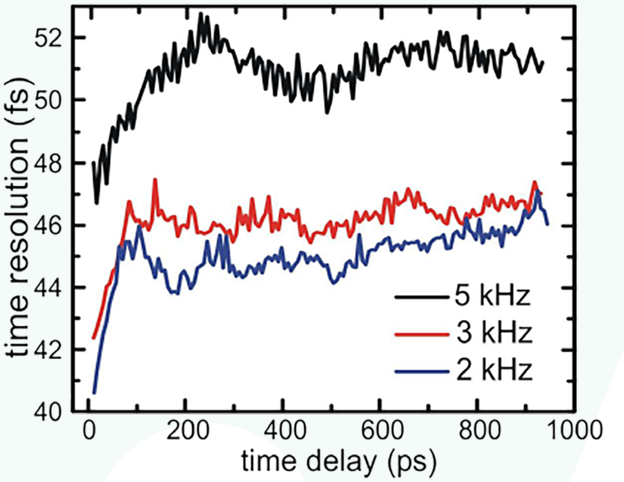


Fig. 4. Measured timing jitter for a 1 GHz based ASOPS system for offset frequencies between 2 and 5 kHz showing 60 fs or better. At larger offset frequencies the time resolution increases due to the limited bandwidth of the data acquisition card.

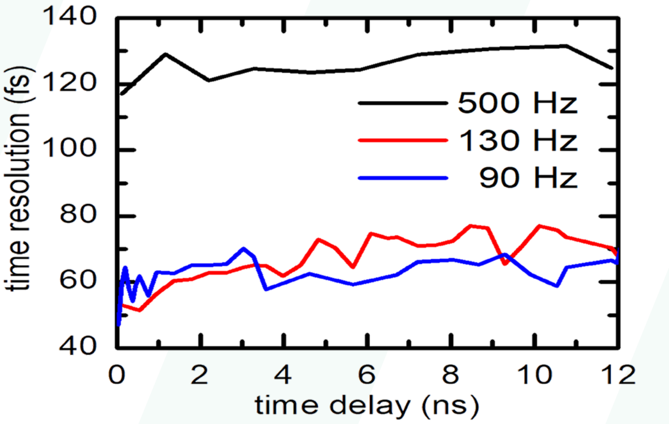


Fig. 5. Measured timing jitter for a 84 MHz based ASOPS system and offset frequencies between 90 Hz and 500 Hz. Note that at larger offset frequencies the time resolution is worse as the required real time bandwidth becomes comparable to the repe

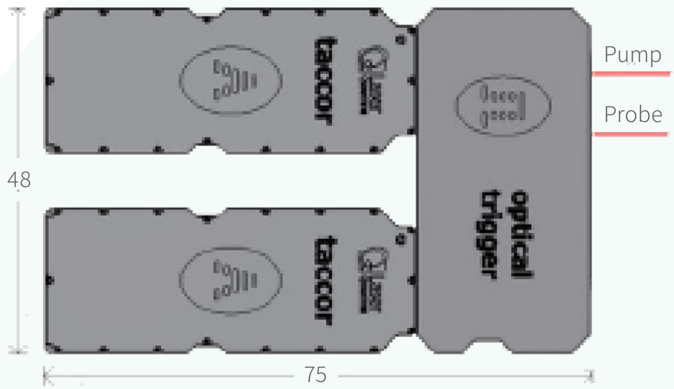
ASOPS ENGINE LASER SPECIFICATIONS

Specification*	ASOPS Engine GHz	ASOPS Engine MHz
Repetition Rate	1 GHz	84 MHz**
Typical Repetition Rate Offset	2 kHz to 20 kHz	10 kHz to 1 kHz
Time Resolution	< 60 fs* Over Full 1 ns Window	< 100 fs* Over 5 ns Window
Time Delay Window	1 ns	11.9 ns

**Time resolution inherently increases at larger offset frequencies.*

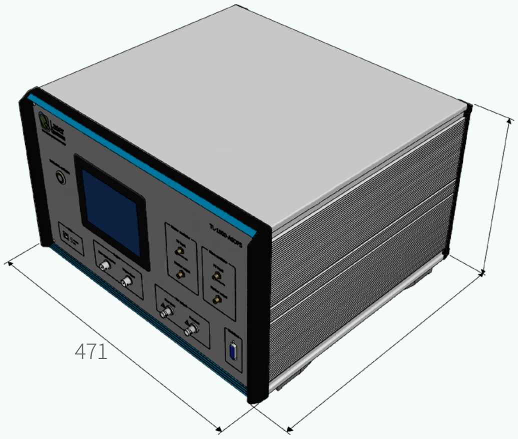
*** The standard repetition rate is chosen to be 84 MHz. Customer specific repetition rates between 80 MHz and 90 MHz are available upon request.*

DIMENSIONS (mm)



Drawings are for illustrative purposes only, please contact us for complete engineer's drawings

POWER SUPPLY UNIT



SYSTEM CONFIGURATION

The ASOPS Engine consists of two femtosecond lasers, a TL-1000 ASOPS for offset frequency stabilization, an optical trigger unit, a high-speed balanced optical photoreceiver, a personal computer housing the data acquisition card and the HASSP-Scope software for measurement and analysis of time-domain data. The femtosecond lasers used can be chosen from either the 1 GHz or the 84 MHz range of lasers.

ADDITIONAL INFORMATION

- Enables two-color pump-probe experiments
- Available at repetition rates of 84 MHz and 1 GHz
- Enables high-speed data acquisition up to 20 kHz
- Turn-key locking electronics
- Offset frequencies between 4 μHz and 20 kHz

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