Company Profile

Who are we?

Time-Bandwidth Products, Inc., a spin-off from the Ultrafast Laser Physics group at the Swiss Federal Institute of Technology (also known as ETH - the Eidgenössische Technische Hochschule), began operations in 1995 to commercialize new developments in ultrafast diode-pumped laser systems. We are the only authorized spin-off of the Ultrafast Laser Physics group. The company has grown to include a wide range of OEM and customized picosecond and femtosecond laser systems, and is headquartered in Zurich, Switzerland.

Product Highlights

Time-Bandwidth specializes in ultrafast diode-pumped solid-state laser systems (DPSSLs). The company's products use passive mode-locking with its patented SESAM® device technology to generate ultrashort laser light pulses. This technology is a very simple and stable method to produce mode-locked pulses in the range of picoseconds to femtoseconds. The advantages of diode-pumping, combined with the SESAM® technology, allows our products to generate pulses with wavelengths from the ultraviolet into the infrared, with very high peak and average powers, very low amplitude noise, and subpicosecond timing jitter using an optional active cavity length control system. The simplicity of these laser systems enables a broad range of new applications in areas such as precision measurements, pump-probe measurement systems, opto-electronic testing, optical communications & clocking, medical & life-science diagnostics, material processing, and frequency conversion. Time-Bandwidth Products has supplied a wide range of customized and OEM solid-state laser systems to leading companies and institutions world-wide.

What does our name mean?

The term "time-bandwidth product" comes from the relation between a pulse's duration in time and the optical frequencies necessary to construct it (its bandwidth). For ideal pulses, the product of the pulse width times its bandwidth has a minimum, constant value. For an ultrafast laser, this principle simply tells us that shorter pulses require more bandwidth. The product of the pulse width times its bandwidth, however, remains constant. Most of our lasers use a significant fraction of the available bandwidth of the laser material, so this "time-bandwidth product" is a daily reminder of nature's limits on our products' performance. In addition, we characterize our lasers both in the time domain (with sampling oscilloscopes and autocorrelators) and in the frequency domain (with microwave spectrum analyzers and optical spectrum analyzers). This two-domain approach allows us to better characterize our lasers performance and to ensure that they operate at the peak of their capabilities.

What is passive modelocking?

When a saturable absorber with the proper parameters is inserted into a laser cavity, it acts like a gating mechanism to induce pulsed operation. All the individual operating longitudinal modes pass through the mode-locker only when the gate is "open" (i.e. when the SESAM® device is saturated and high reflective). This forces all cavity modes to be locked together in phase, hence the name "mode-locked" (or "phase-locked"). The superposition of all the modes running in phase produces an ultrashort laser pulse - in the same way that the sharply-spiked mathematical delta function is composed of many Fourier components that are in phase at one point, but cancel out everywhere else. This results in a continuous train of ultrashort laser pulses, where the spacing between the pulses is set by the round-trip time (twice the effective cavity length divided by the speed of light).

Typical pulse repetition frequencies are in the range of 100 MHz, but repetition rates from <25 MHz to >10 GHz are commercially available. Passive modelocking also means that no active (i.e. complicated & expensive) high frequency electronics are needed. With the SESAM® device, the pulse generation process is self-starting, pulse drop-outs are inhibited, cavity stability alignment is less sensitive, and the environmental conditions are less demanding than typical with other approaches such as active modelocking or Kerr-lens modelocking.

What is a saturable absorber?

A saturable absorber is a material which has decreasing light absorption with increasing light intensity. Most materials show some saturable absorption, but often only at very high optical intensities. We require saturable absorbers which show this effect at intensities typical in solid-state laser cavities. The key parameters for a saturable absorber are its wavelength range (where it absorbs), its dynamic response (how fast it recovers), and its saturation intensity and fluence (e.g. at what intensity or pulse energy it saturates).

What is a SESAM® device?

Our saturable absorbers are semiconductors integrated into a mirror structure, resulting in a device that reflects more light as the intensity of the light impinging on the device increases. The SESAM® technology has several key advantages compared to other mode-locking techniques. Saturable absorbers used in the past were typically fluid organic dyes, which suffer from short lifetimes, toxicity, and complicated handling, limiting their application to the laboratory. Crystalline solid-state saturable absorbers such as Cr:YAG typically operate over only limited ranges of wavelength and saturation values. Semiconductors, however, can operate over a broad range of wavelengths (from the visible to the mid-infrared), and their recovery time, saturation fluence, and modulation depth can be controlled through growth parameters and device design. Since the devices are solid-state, they don't experience the degradation typical for dyes.

Collaborating with the Ultrafast Laser Physics Laboratory at ETH, headed by the inventor of the SESAM® technology, Prof. Ursula Keller, we have significantly improved the device design, fabrication process, and long-term device reliability. We have designs that cover wavelengths from <800 nm to >1600 nm, pulse widths from tens of femtoseconds to hundreds of picoseconds, with power levels up to tens of Watts, pulse energies from nanojoules to millijoules, and repetition rates above 10 GHz (see the reference list for further technical details).

What else does Time-Bandwidth Products offer?

Our technical team can provide a customized solution for your application. We can individual laser systems, or cost competitive OEM solutions via our OEM laser platforms (e.g. the Lynx, Cheetah-X, or Pallas). The acquisition of GigaTera in 2003 and continuing development of this technology provides a versatile but compact platform for telecom pulsed laser products operating at repetition rates of 10 GHz and higher. We also are leaders in pulse synchronization using phase-locked loops and active cavity length control, and have the instrumentation to test and verify sub-picosecond synchronization. Please ask us about your custom requirements - we can propose solutions to requirements involving other wavelengths (frequency conversion), higher powers, amplified systems, and more.

References and to find out more ...

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- Summary paper on timing stabilization: M. J. W. Rodwell, D. M. Bloom, K. J. Weingarten, "Subpicosecond laser timing stabilization," IEEE J. Quantum Electron., vol. 25, pp. 817-827, 1989

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