The New Mai Tai Offers the Widest Tuning Range:
710-920 nm of Mode-Locked Output

The latest version of the popular Mai Tai® ultrafast laser builds on three years of experience with tunable one-box lasers to offer both a wider tuning range and more than 1.5 watts of output power. The increased tuning range (710 – 920 nm) is possible thanks to the use of Spectra-Physics’ StabiLok™ active beam stabilization technology, which delivers outstanding beam pointing stability during tuning. The regenerative mode-locking used in the Mai Tai delivers high overall stability and ensures that there are no dropouts from pulsed operation – a symptom commonly associated with pure Kerr lens systems.

Figure 1: The new Mai Tai® delivers over 1.5 W and can be tuned from 710 -920 nm, yet still measures only 23.4” x 13.8” x 5.8” (59.5 cm x 35 cm x 14.7 cm).

The earliest one-box ultrafast lasers were limited to single wavelength operation. This limitation was overcome in 1999 with the introduction of the first Mai Tai by Spectra-Physics. The Mai Tai offers tuning ranges of up to 210 nanometers. The new system reaches a peak output power of more than 1.5 W. Higher overall output power is necessary in order to provide sufficient output energy at the edges of the laser gain curve, with power levels sufficient for multiphoton imaging of biological samples at these wavelengths. In addition, higher output power maximizes penetration depth and also opens up harmonic generation opportunities – further broadening the accessible wavelength range. Just as important, this has been accomplished while maintaining the footprint of this compact ultrafast source.

Built on a Proven Stable Platform

The new laser features high reliability and robust long term performance because it is built on the most proven “one-box” tunable platform in the industry. Spectra-Physics pioneered the whole field of “one-box” tunable ultrafast lasers by introducing the first Mai Tai product back in 1999. Our concept was very simple: to integrate a stable Millennia™ pump laser with a compact Ti:sapphire laser oscillator, in a single, closed laser head that required no special operator expertise. Since then, these lasers have remained the industry standard in most of the important applications because of their simplicity, stability and reliability. As a result there are more Mai Tai lasers in the field than all other one-box tunable lasers combined.
The new Mai Tai laser has been produced as part of Spectra-Physics’ continuing commitment to develop cutting edge products for ultrafast applications. For example, one of our most important previous innovations in tunable, one-box laser design was the recent introduction of StabiLok™ active cavity (Figure 3) stabilization. StabiLok limits far-field beam displacement to less than 70 microradians as the system is tuned from 710 nm to 920 nm. This translates to under 70 microns beam movement at a distance of 1 meter from the output port – less than 1/30th of the beam diameter! This performance has set an industry standard for beam stability from this type of laser. StabiLok also ensures that the laser output power is immune to temperature changes, eliminating the need for a closely controlled operating environment.

Multiphoton Imaging

The most significant potential for a tunable one-box ultrafast laser is in multiphoton imaging. Here the laser is brought to a tight focus within the microscope specimen, creating a high fluence at the beam waist to drive efficient two and three-photon absorption processes. There are now many variations on multiphoton imaging, using a wide variety of fluorescent dyes as well as incipient fluorescence and direct harmonic generation in the sample. Most imaging facilities use the laser as a shared resource and a wide tuning range is essential to allow a full spectrum of dyes to be excited by a single laser (Figure 2). The ability to reach 710 nm is of particular importance in this area. This is because there are several dyes that have peak absorptions in the 700-720 nm spectral region. Examples include compounds used for calcium measurement, such as Indo-1, where the two photon absorption coefficient for calcium-bound Indo-1 is 40% higher at 710 nm than at 720 nm. In the case of some pyrene and styryl derivatives, the difference is a factor of 2:1 between the two photon absorption efficiency at these wavelengths.

Regenerative Mode-Locking

One of the keys to the stability and success of the Mai Tai product line is the use of regenerative mode-locking, first introduced in the Tsunami Ti:sapphire laser in 1991. Regenerative mode-locking is a special case of active mode-locking and uses an acousto-optic element to modulate the cavity losses. Spectra-Physics uses regenerative mode-locking in our Ti:sapphire lasers for several reasons. Most important, the laser is always optimized and will not suffer from dropouts – periods of CW output. In addition, StabiLok mode-locking is not dependent on the laser output power or spectral bandwidth, and works just as well at as the edges of the Ti:sapphire gain curve (e.g. at 710 nm) as it does at the peak output (around 800 nm). In contrast, passively mode-locked Ti:sapphire lasers based on Kerr lensing need a starter mechanism and may suffer from dropouts at the edges of the spectral gain curve, because of the lower available gain at these wavelengths. In addition, a typical passively mode-locked Ti:sapphire laser may lose mode-locking during wavelength tuning and then will have to be re-optimized at the new wavelength.

To find out how Mai Tai Lasers can help enhance your multiphoton applications contact Ian Read, Product Manager, Spectra-Physics. (650) 966-5346 iread@splasers.com.