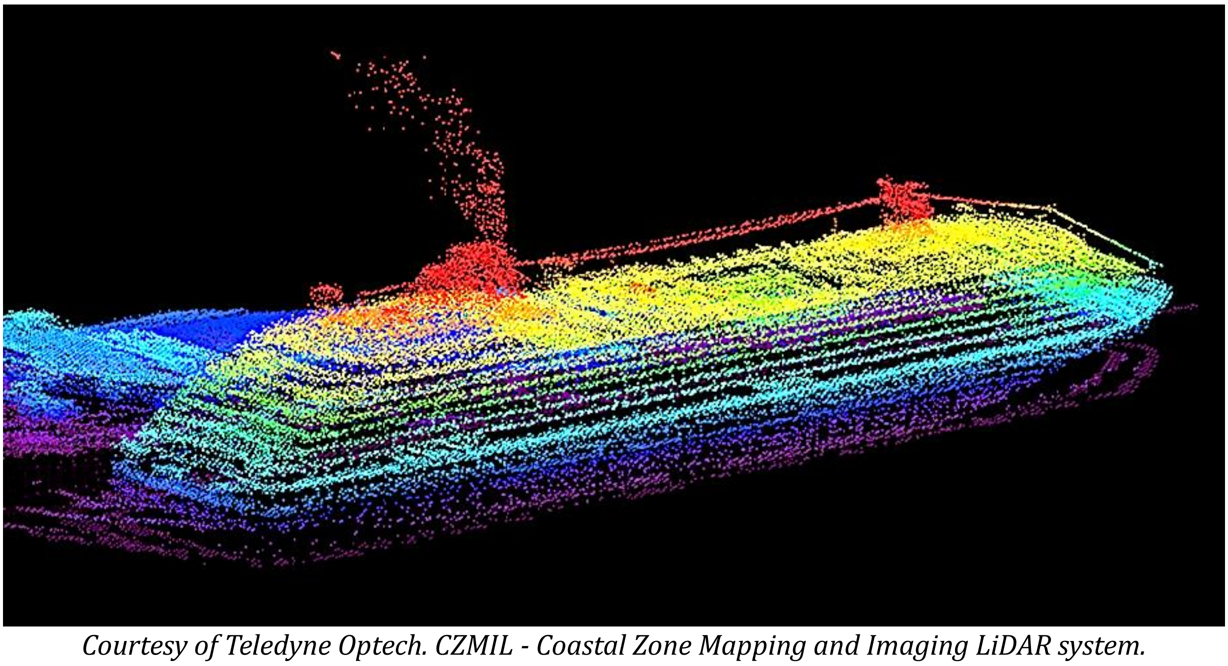
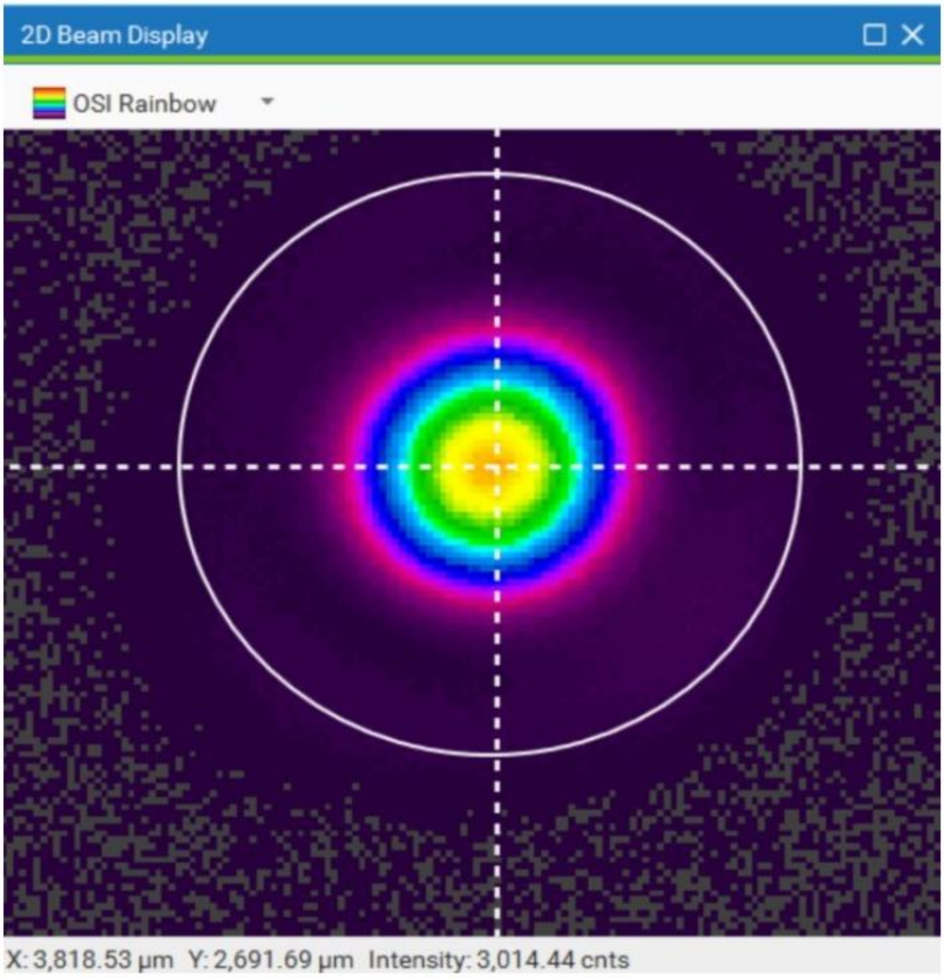
Lasers for Bathymetric and Topographic LiDARs

Since the very first years after laser invention, a relevant application enabled by the availability of coherent light has been the time-of-flight measurement of target distances. By collecting the back-reflected or back-scattered radiation of a short pulse initially directed to a remote target, it is possible to determine the exact position of the target itself, provided that the time interval between the outgoing pulse and the corresponding echo is precisely measured. The principle is similar to the older radar or sonar techniques, with the major advantage of the higher resolution and accuracy allowed by visible or infrared coherent light sources. Basically, all LiDAR systems nowadays are based on this simple idea, either their purpose is to monitor particle concentration in the atmosphere for pollution detection or to map seafloors, such as in bathymetric applications.



Courtesy of Teledyne Optech. CZMIL - Coastal Zone Mapping and Imaging LiDAR system.

As all airborne topographic LiDARs, bathymetric systems share the same demand for compact, efficient, rugged, industrial-grade laser sources, with an additional degree of complexity, strictly related to the particular features of the transmitting medium, the not-necessarily-clean water of the shallow nearshore zones. First of all, bathymetric systems can efficiently use only a limited range of possible wavelengths due to poor water penetration. While the majority of topographic LiDARs employs infrared detectors and laser sources operating at 1064 nm or at the "retina-safe" wavelength of 1550 nm, those wavelengths would be able to penetrate water only for a few centimeters. Therefore, light absorption sets the ideal wavelength to about 440 nm for clean water and to some longer wavelength around 500 nm for impure scenarios, such as ocean water in the coastal zones, where blue light is essentially absorbed by chlorophyll. Radiation at 532 nm can be easily and efficiently generated from high-peak-power nanosecond-long pulse lasers operating at 1064 nm by a nonlinear optical process, known as second harmonic generation (SHG). Furthermore, generation of green light by SHG of an infrared laser source has the advantage of leaving well-synchronized residual unconverted light at the fundamental wavelength that could be used for the external surface identification. But for a given required pulse energy at 532 nm, the commonly achieved SHG efficiency of 50% implies that a twice-as-high pulse energy is required for the laser source operating at the native wavelength of 1064 nm. Moreover, even assuming low water absorption at 532 nm, transmission is still much lower than in air, thus further increasing the demand for pulse energy.



Typical beam profile of the Vento 15W 532nm.

If ~ 50 µJ pulse energy might be enough for common land topography, few millijoules pulse energy is required for laser bathymetry. An usual way to increase pulse energy in DPSS lasers is to decrease repetition rate, but that comes at the price of a smaller amount of collected data and slower acquisitions. Peak power is not usually an issue since pulse energy is the relevant parameter as far as the total number of emitted photons per single pulse is concerned in the determination of the maximum measurable water depth. It is anyway true that a shorter pulse duration (related to higher peak power for a given pulse energy) is a desirable parameter for optimization of the longitudinal resolution (as described into our previous newsletter **"Low Jitter feature in Actively Q-Switched DPSS lasers"**), provided that the optical spectral linewidth becomes not too large to worsen the signal-to-noise ratio at the detection point. Since ~ 0.1 nm is a reasonable linewidth, sub-nanosecond-long actively Q-switched DPSS lasers providing multi-mJ energies in a close-to-diffraction limited beam profile and at a repetition rate of few kHz, such as the **Vento** series, represent an ideal option for bathymetric LiDARs.

In addition, Vento's form factor and unique rugged design make it the ideal laser platform to be installed into commercial LiDAR systems on aircraft and drones.

Besides standard models at 532nm and 1064nm, Bright Solutions can offer tailored configurations to meet specific customers' needs both in terms of optical performances and mechanical design.

For more technical information on the **Vento** lasers and for exploring other solutions suitable for bathymetric and topographic applications, please visit our website **www.brightsolutions.it** and write to **sales@brightsolutions.it**.