Review of the New Leica Disto

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Laser distance measuring equipment (DME), like most high technology consumer electronics, has gotten smaller, cheaper, and better – with all three of these characteristics occuring simultaneously. This is unlike so many things in life. Silicon integrated circuit fab is continuously driven by the market for electronic systems to reduce size, increase density, and add features.

Leica, the pioneer in consumer and industrial-grade laser rangers, has continued to refine the Disto series of laser DMEs. This report will only discuss the Disto, although Bosch, Hilti, and other companies have produced similar products, some even taking license to put their brand-name on Disto. In the mid 1990s, Distos were large handheld instruments costing nearly a thousand dollars. By Y2K, the models were smaller, power consumption was lower, reliability higher, and the cost was halved. Two years ago, another step forward produced much smaller units, and the prices continued to drop. The present Leica Disto A2, A3 and Stanley TLM100 are both examples of the state of the art. Mark Kliewer at LASERSTREET.COM has an excellent comparison chart on his website, so I refer the reader to this for exact features of each model.

The Stanley TLM series has three models, although I will only discuss the least expensive TLM100 here. The TLM300 has the performance of the Leica Disto A5, both costing $449 at present. The TLM100, at $99 or less, is a good deal for what it does, for 40% of the cost of the A2. But it doesn't beep after measurements, doesn't display prior readings on screen, is not sealed from the elements, has no LCD backlight, and requires removal of the 9 volt battery when hauling it in a pack to prevent turn on. It has a minimum to maximum working range of 2 to 100 feet. The operating temperature range is limited to 41 – 122 deg F, for the stated +/-0.25 inch accuracy. In comparison, the A2 has a backlit display, and a range of 2 inches to 325 feet. It also has a limited specified temperature range of 32 – 104 deg F. The Leica Disto A3, on the other hand, is all that the original Disto's and Disto Classic models were, plus some. It is close to the same size as the A2, at 5.3 inches long, 1.8 inches wide and 1.2 inches thick, weighing 5.1 oz. It has the same range as the A2, adds a bubble level and is spash/dust proof. It also operates accurately over a wider temperature range, from -14 to +122 deg F. This means it can be used in cold alpine caves as well as hot vents in Hawaii. For the money ($299 at present), this is the unit to get for cave surveying. It has an on-screen display of the last three measurements, beeping after each one is taken. With this addition, I can press the button successive times without looking at the unit, concentrating on keeping the laser spot on target. Usually we use a hand or survey book for a target. A glance at the display will give instant knowledge that the three readings are in agreement (I accept it if it is within a few hundredths, but a few tenths is good enough!). It is important to always take multiple measurements when using hand-held laser DME for a cave survey, as you never know for certain that that tiny spot is "on station", especially if you are shivering or had too much java in your blood. One has to remember

to round up to tenths, since Disto displays to 0.01' and has a rated accuracy of +/- 0.125 inches out to 325 feet. All of these can be changed to SI units, or even inches and feet if you were so inclined to keep book this way. Going up the product line to the A6 gives Bluetooth wireless output capability, and the A8 includes an inclinometer. These two models are priced like the original Disto: $649 and $995.

How has Leica managed to reduce the size and cost of Disto rangefinders? An examination of the guts of a Stanley TLM100 gave me some insight into this feat of engineering. It uses a sealed diecast Leica optoelectronic (OE) module to do the complicated function, rangefinding and exporting the data representing the measured distance, and a small embedded CPU to handle display, and user interface. The OE module is approximately 3.8 cm W x 3.2 cm L x 2.2 cm thick. There is a small board with a fine pitch flexible circuit to the main PCB. The LCD display sits on one side of the OE module, and has a separate interconnecting flex circuit. The main board has metalization for the pushbuttons (not sealed from environment), LM317 regulator, several other low pin count housekeeping logic and analog ICs and a Renesas (Hitachi) H8/38024 microcontroller with built-in LCD driver. That's it! The ranging is done inside the Leica OE module. This made the development of the Stanley TLM Fat Max series simplier as Stanley could depend on Leica for the OE and concentrate on the package and CPU.

The Disto Classic and A-series are patented with US 59495331. This was issued Sept. 7, 1999, as a division of US 5815251. That patent, issued a year earlier, was listed on the earlier (larger) Disto classic models. They are virtually the same patents. I discussed details on this patent on the Speleonics email list on 15 April, 1999. I summarized it in a review of the Classic3 in CREG Journal No. 43, March, 2001. I will summarize it again for this updated report. This base patent discusses using a laser diode with a collimator object lens, a method to modulate the laser radiation, a receiving object lens, and a switchable beam deflection device to generate an internal reference optical path between the laser and receiving diode. The receiver contains a downstream optoelectronic transducer, with a moving optical deflecting device (mirror, lightguide or prism) to adjust the relative imaging position for the incoming light to the transducer, for long and short distance ranging. This counters the parallax problem of having the laser and receiver photodiode separate.

Fluctuations in the laser wavelength and the optoelectronics can introduce phase modulations that, if not checked, can cause up to 1.3 nS delays. This would give an apparent distance shift of 200 mm. An internal calibration method compensates for these fluctuations and drifts by measuring a short internal path through the same optoelectronics. One significant difference between the older and newer Distos is how this internal calibration is implemented.

Pulse modulation of the laser with less than 2 nanosecond pulses is used. Due to fluctuations of the modulation phase from speckle structure (seen in any laser beam), an error of up to 20 mm could be introduced. By exciting the laser with these short pulses, the modulation phase differences from the modes of light reflected and falling on

the objective is so that the distance fluctuations are smaller than 2 mm.

World patent WO 9427164 (1994) is similar to the aforementioned patent. WO 9818019 (1998) additionally covers an electronic calibration method, using a mixer, to calibrate for the temperature-dependent phase shifts of the avalanche photodiodes used in the receiver and as the reference detector. This significantly improved the measuring time (~50%), as well as the physical dimensions and cost. The older Disto's had a motor (more like a meter movement) that flopped across the path with a mirror.

WO 0216964 (2002) discusses the overall method of using phase detection of the incoming reflected radiation with respect to the reference signal (detected from the laser diode in the Disto). This patent discusses the fundamental concept used in the new Distos. While it is similar in principle to the old Disto, use of the electronic calibration mechanism and new electronics has warranted a new patent issuance. And rightly so, I should add.

WO 0244754 (2002) discusses the method of frequency synthesis in the Disto. A quartz-driven ring oscillator is described, which has delay elements (flip-flops) to generate the first high frequency used for the modulation. Using a MUX clocked by a lower frequency derived from the actual measurement, a second high frequency is generated for a mixer. The purpose of all this is to develop the clocks in a simple low power way, while minimizing jitter.

Kurt Giger is the common patentee for the original 1994 world patent, as well as the 2002 overall patent. His name is also on all of the other patents, with a few others. It is assumed that Mr. Giger had much input in the development of Distos for Leica AG.

Something should be said about the ruggedness of Distos. In 2005, a Disto Classic3 got dropped in Lechuguilla Cave. I don’t mean dropped from hand to the floor. It came bouncing down a 30 foot pit, as I was below it, hanging on prepared for a falling object to clobber me. Instead of yelling DISTO or even ROCK, the caver just screamed in agony as it slipped from his grip. The worst part of this was that it belonged to the National Park Service and it disappeared into loose breakdown at the bottom. We were unable to find it after an hour of searching in circles. Its one thing to bring back a wrecked instrument belonging to the government (believe me, I have had my share of crushed Suuntos capsules), but to return without even a piece of it was extremely poor form. For a few days we reverted to using a 50 foot tape (what’s that, you ask?). We had no other options - being at the most remote camp in Lechuguilla Cave for the week. When we had time to look again, after more crawling under the breakdown, the Disto was located, just beyond hand reach. We checked it against our tape, and there was no discrepancy. This incident proved that these Disto’s are more than “just a miniature plastic optical bench” inside.

This past summer, Mark Kliewer gave me a $275 trade-in value on my 5 year old Disto Classic3+Stanley TLM100. He added a red Pelican 1030 case, with foam insert, that protects it in my muddy cave pack. The A3 lists for $299, and with his “caver” discount

was ~$285. My old Disto was in immaculate condition as it had always been carried in an Otter box, and was not dragged in mud. I was happy to upgrade to the A3, from the old Classic3. When I am hauling 35+ pounds of gear for a week underground in Lechuguilla Cave, every square inch and ounce of mass makes a different. With the new Disto packed, I can afford to bring something else like my camera, which often gets removed during the last minute frenzy to lighten up my pack. I highly recommend the new Disto's. Surf to www.laserstreet.com and check them out.