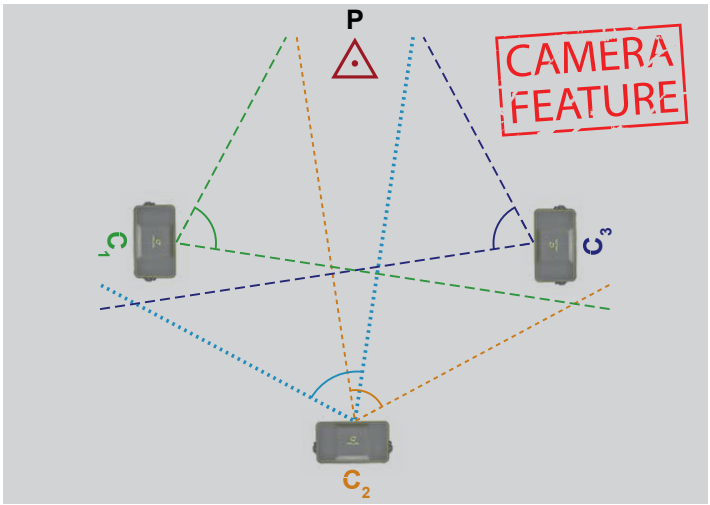
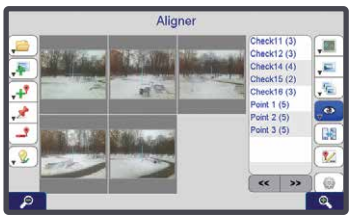
Offset Survey with built in camera

You can survey points with internal TRIUMPH-LS camera with accuracy of about 2 cm. Take pictures from at least three points. Leave a flag on points that you take pictures from, otherwise accuracy will be about 10 cm.



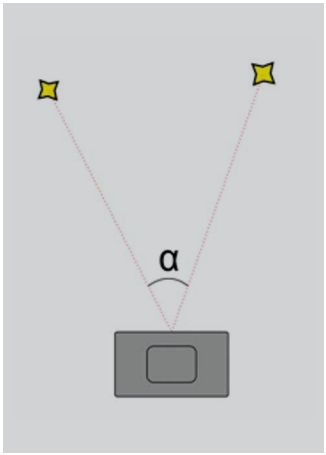


Visual Angle Measurement with Triumph LS

The new Visual Angle Measurement function of the TRIUMPH-LS allows measuring angles between points by using photos taken by the TRIUMPH-LS camera and use in CoGo tasks with the Accuracy of about 10 angular minutes.

To measure an angle:

- just take an image containing both objects of interest and open it in the Measure Angle screen
- select first and second point (using zoom to focus on necessary features)
- The angle between points is immediately displayed on the screen.



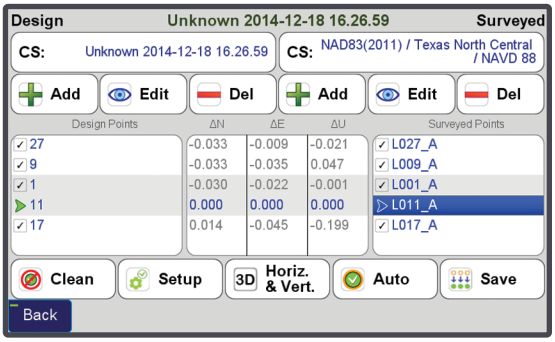
Precision with TRIUMPH-LS

Our friend from Javad GNSS, Michael Glutting, recently related that a surveyor in Minnesota asked how he could use his Triumph-LS and corrections from the MnCORS real time network to accurately work within his projects previously established with HARN. The MnDOT provides mount points for various adjustments of NAD83, however, a surveyor can quickly produce reliable, highly accurate transformation parameters for a local set of known positions as this paper describes.

In 2000, Stanger Surveying of Tyler, Texas, established a GPS control network consisting of 30 monuments for my hometown of Kilgore, Texas, over an area measuring about 7 miles square (50 square miles). Even after 15 years, the network proves to be incredibly accurate and was well constructed with ties to two different HARN PACS (High Accuracy Reference Network Primary Airport Control Stations) and multiple repeat and braced vectors. This network predated the modern proliferation of CORS stations, and so there is no precise relation to the CORS and therefore no precise relationship to NAD83_2011. This means that there is some unknown translation from the Kilgore GPS Control Network of 2000 and NAD83_2011. Because of this, we must resolve these transformation values by observation.

To do this, we conducted two field campaigns. In both sessions, I placed a Javad GNSS receiver on a stable monument, POST, located at our office. The first session, I used a Triumph-1, and for the second, I used a Triumph-2, both broadcasting corrections over the Internet via TCP. The NAD83_2011 position of POST has been accurately determined by hundreds of hours of data from several different GPS recievers processed through OPUS.

In the first session, my father, J.D., and I observed five different monuments from the Kilgore network with the Triumph-LS for 90-120 seconds each. These points were the primary control Stanger established from the HARN PACS. After observing those five points I performed a preliminary localization.

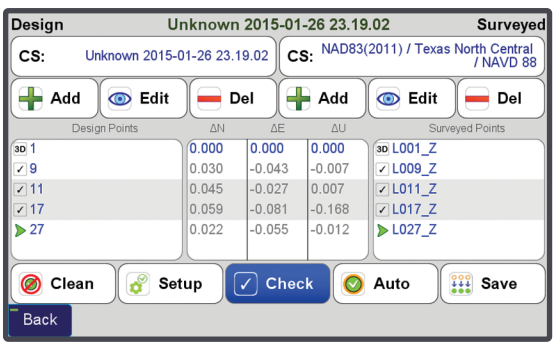


In this preliminary localization, I fixed only one point (point L011_A). Three of the remaining four show very low residuals, however point L017_A, with its noticeably higher vertical residual suggests this point has been displaced since it was established in 2000, or that there is an error in the observation itself - only a repeat occupation will tell.

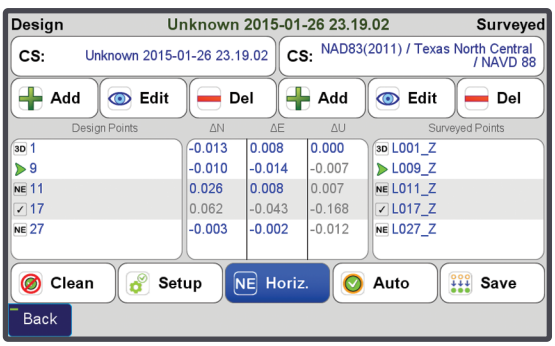
During the second session, we observed the five points again and used the average tool in J-Field to perform a weighted average of the two points. The second observations showed excellent agreement with the first observations. This chart shows the difference in the repeat observations for each of the five stations:

STATIONB	ase-Rover Vector Length (usft)	Δ 2D (usft)	Δ UP (usft)
L001	37342.30	.097	-0.029
L009	23155.70	.048-	0.139
L011	13559.4	0.049-	0.005
L017	24184.6	0.036	0.033
L027	2285.90	.032	-0.005

With the five control points averaged, I began the localization process again. First I performed a minimally constrained localization holding only point L001. Notice that point L017 still appears to be an outlier.



Next, I constrained horizontally to L001, L009, L011 and L027 while still only fixing point L001 vertically. The residuals predictably decrease among the points fixed.



Letter from:
V. Kelly Bellis, PLS
Horizon Surveying Co., Inc.
Ellsworth, Maine 04605
kellybellis@gwi.net

Without question, the Triumph-LS is the most mind-blowing piece of technology that I have ever held in my hands and being able to work with it is the highlight of my 40-year career in land surveying. Intertwined and commensurate with that highlight has also been the incredible honor and privilege in working with Javad Ashjaee, his amazing Moscow-based team of scientists and engineers, as well as some of the brightest surveyors in the United States, all in the shaping of the Triumph-LS and its graphical user interface, J-Field.

There are so many features of the Triumph-LS worth highlighting, it's difficult to know where to start; from the built-in frequency scanners for both UHF interference and GNSS interference, the automated shifting of project coordinates after the base file has been submitted to DPOS (Javad's own version of OPUS for .jps files) and its adjustment received – all being done by J-Field, or to start by mentioning Visual Stakeout using J-Field's unique and way cool Guide feature. The ability to locate objects using photogrammetric methods is another exciting tool included in J-Field's extensive tool-set.

Being a person that has always gravitated to understanding things visually, J-Field's approach and graphical displays has aided my transition from strictly being an L1 guy for more than a dozen years; (6) ProMark2 Ashtech[1] receivers, to finally get with today's surveying using RTK. Of course, the Triumph-LS's very competitive price point also made this transition possible.

Shown here is just one example of the visual presentation of information given the surveyor. It includes being able to see at a glance the image of the rod bubble beneath the instrument's second camera and the textual display of Triumph-LS's internal pitch and roll values.

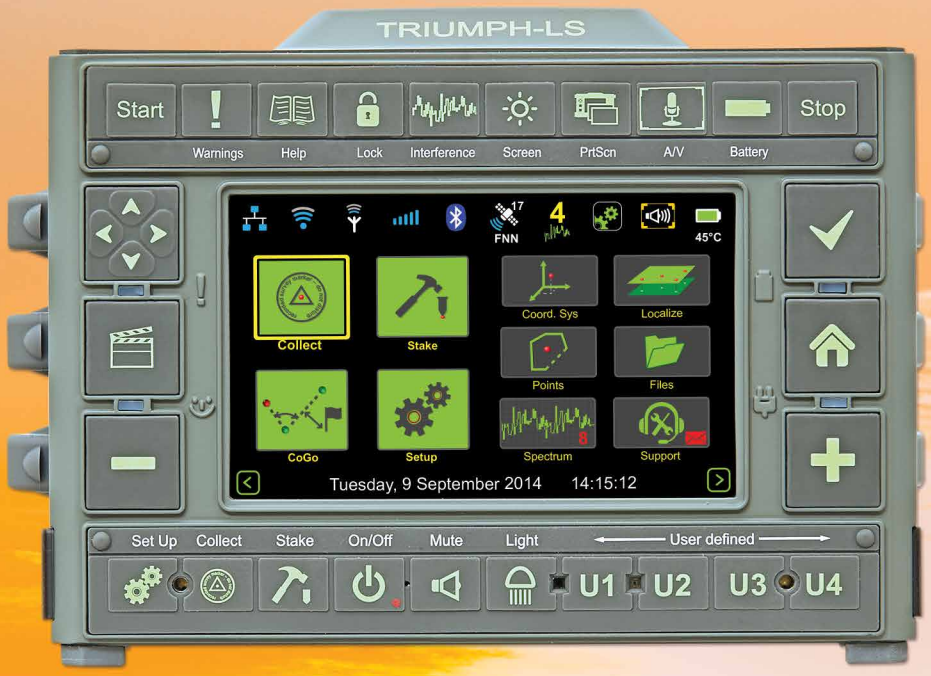
If I was limited to saying only one thing about the Triumph-LS that has impressed me the most, I'd have to say that it doesn't have anything to do with technology whatsoever. It has to do with a GNSS manufacturer that has so openly embraced the surveying profession during the development of a specific product, and most notably, professional land surveyors in the United States. As a matter of policy, Javad GNSS users are encouraged to suggest improvements and new features to all Javad GNSS products. And nowhere is that policy reflected more clearly than in J-Field.

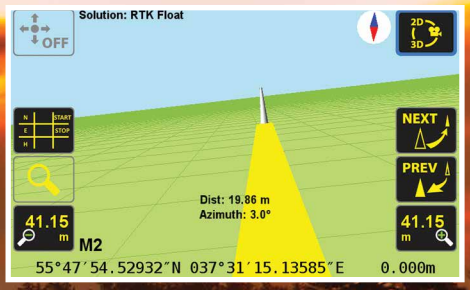
The Javad PLS Support Network is an other reflection of Javad GNSS's commitment to supporting the U.S. Professional Land Surveyor and their use of Javad equipment. Composed of a core group of licensed professional land surveyors scattered across the United States, the so-called 5PLS members stand ready to assist by phone or email. The best method of support is actually using the website's support forum (https://support.javad.com/index.php) which serves not only as a portal to quickly getting answers to questions from all of the licensed land surveyors, Javad GNSS geodesists, scientists, engineers and even Javad Ashjaee himself, but also ever increasingly the support forum serves as a reference source and suggestion box.

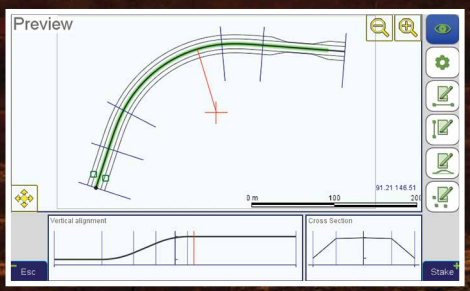
1 Ashtech was the first GNSS company that was founded by Javad Ashjaee.

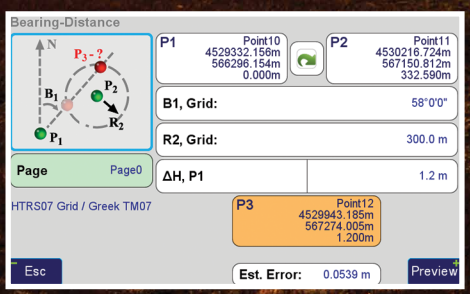
TRIUMPH-LS

Receiver+Antenna+Radio Modem+Controller+Pole









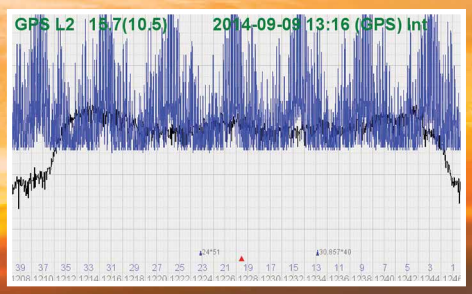
- **864 Channels for all GNSS signals**
- **24 Hours Battery Life**
- **Interference monitoring of all GNSS and UHF channels**
- **Visual Stake out**
- **Lift & Tilt**
- **6 parallel RTK engines**

TRIUMPH-NT

Receiver+Radio Modem+Controller+Pole

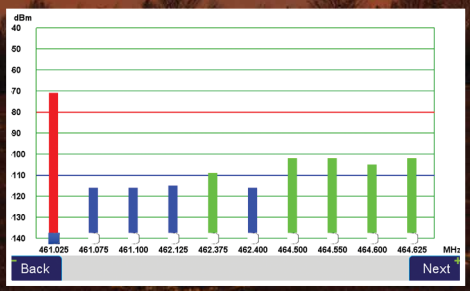
Similar to TRIUMPH-LS but without integrated GNSS antenna.

TRIUMPH-NT and GrAnt antenna makes a complete RTK system.



Built-in GNSS Spectrum Analyzer
to detect interference in all GNSS bands.

TRIUMPH-NT + GrAnt



Built-in UHF Scanner
In certain areas, the UHF airwaves may be congested and if you're corrections are being broadcast at the same frequency as another surveyor is using, there may be irratic communications.
Built-in UHF Scanner shows condition of each UHF band.

We have been testing the Javad equipment lately. The receiver we used is the Triumph-LS which has the receiver and data collector incorporated into one unit with a battery life of 30 hours. It utilizes all the current satellite systems, is designed to incorporate additional systems when they become available. It comes with a lifetime offer of software upgrades. The main reason we offered to test it was to see if it would produce better results under canopy than our present equipment and IT DID. It utilizes over 800 channels and 6 engines and an auto-verification system that will guarantee the results if you follow the guidelines. If fact, if you can prove you got a bad fix, they will pay you $10,000. Cameras are incorporated in the unit. The software programs have lots of useful tools and their customer service was very good. They are very open to suggestions for improvements or changes to the software and very efficient at incorporating beneficial recommendations. We are considering ordering units for all our surveyors if affordable.

One important thing we learned while testing the equipment: If you are using a VRS signal when you are working in areas with lots of tree cover and getting lots of multipath signals when trying to get fixed RTK results, you will get better results if you set up your base nearby and use the base instead of VRS (that applies to all brands). And with the Javad equipment you may get additional satellites.

The Javad equipment is also much much less expensive that other brands, has tilt compensation, has a collapsible rover rod, has a touch screen with an alternate touch pen in case you don't want to use your fingers and the entire unit is much more compact so it takes up much less space in your vehicle.

I have always dreamed of the "black box" that would give you accurate location coordinates no matter where you are. The Javad equipment is the next step.

Gary Kratz
Regional Land Surveyor
US Fish and Wildlife Service

I was able to maintain a radio link 3 miles away in rolling hills here in northeastern Ohio. That is pretty impressive compared to some of the other systems that I have used. One suggestion is that I would love to see backlit buttons. The downward facing flashlight is great and if the buttons were illuminated, I might never come home at night!

For a while I have been eagerly awaiting my equipment trial and it has finally come. I realize that a lot of feedback has already been received and lots of changes and modifications have already been made before I have received my trial equipment, which is great to see.

Here are some random thoughts, suggestions, and notes after I have had a chance to use the equipment.

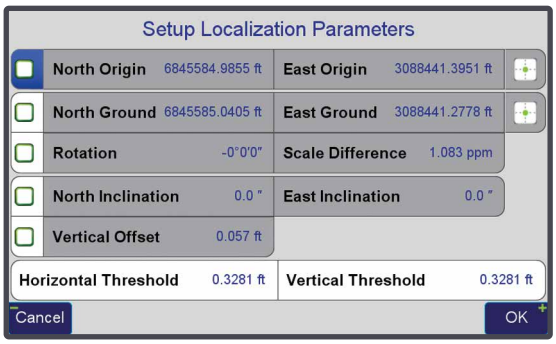
I am no stranger to GNSS equipment and this stuff performs! It is very evident that this setup was designed from the ground up. There is no imitation in the design and there is no equal out there on the market that I know of in terms of features, performance and price. Your team has definitely thought "outside of the box" and that has made all the difference! The small footprint of the equipment is amazing. I would suggest to include/offer a custom pelican case that can hold base, rover, radio, cables, etc. Being compact is very attractive to me.

Hardware: I love the bluetooth radio! Not having a cable from the base to the radio is great. I had my concerns about the range of the 1W radio... until I tested it. With the antenna mounted approximately 20 feet above the ground, I was able to maintain a radio link 3 miles away in rolling hills here in northeastern Ohio. That is pretty impressive compared to some of the other systems that I have used. One suggestion is that I would love to see backlit buttons. The downward facing flashlight is great and if the buttons were illuminated, I might never come home at night!

Software: I really like the flexiblity of changing units and coordinate systems on the fly. The page concept is great. Having DPOS built into J-Field is amazing but I think it needs a little refinement. I processed a base point through DPOS and then through OPUS and the difference in values was about 0.5' horizontally and vertically. Matt Johnson looked into this for me and some changes were made, but it leaves me wondering. The effort made to be able to do all of this right from the receiver is fantanstic and when I presented this issue to him, he and the team checked into the problem promptly and responded very quickly. I have been very pleased with the turnaround time and the idea that I can talk to real surveyors with my questions and concerns is great. Well done here!

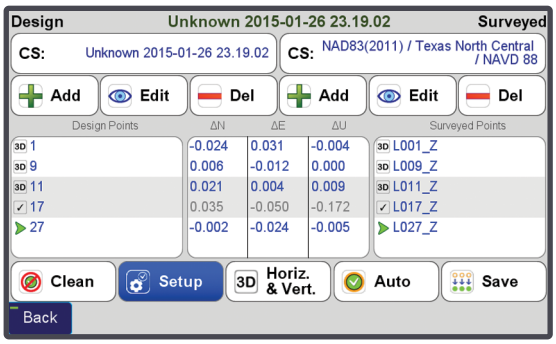
Joseph Paulin, P.S.

With the residuals indicating a good fit, I turn my attention to the parameters of the localization.

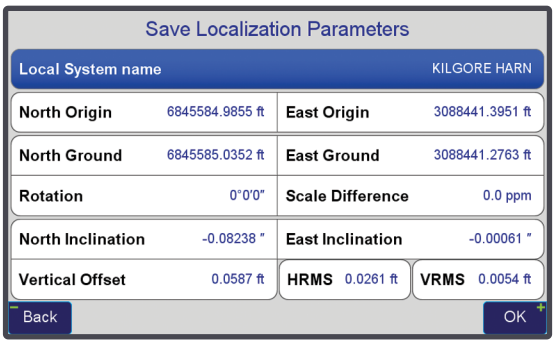


From these parameters, several observations can be made immediately. Because both surveys relied upon the same definition of North, it is expected that there would be little, or no rotation. Furthermore, because both surveys relied upon the same definition of the foot, US Survey foot measured along the same grid surface, Texas Coordinate System of 1983, North Central Zone, there should be little difference in the scale factor. The rotation determined is less than half of one arc second and the scale factor being applied to best fit my survey to Stanger's original work is only 1 part-per-million, revealing very good relative agreement between the surveys.

Finally, I am ready to perform a fully constrained localization, holding all four points (still disregarding the displaced monument L017) both horizontal and vertical.



I set both the rotation and scale to zero as I do not want to redefine North nor the US Survey Foot. Now that more than one point is involved vertically, a tilted plane is calculated. Because the Stanger survey was based on Geoid96 and today's survey is based on Geoid12A, I left the tilt values intact. In this case the inclination values are so small as to be practically insignificant.



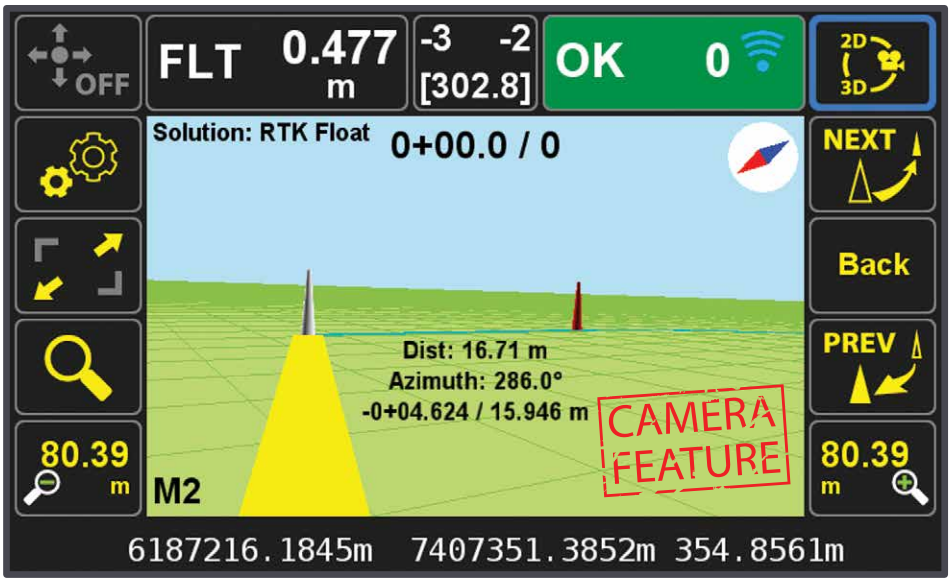
The final results indicate that the translation between the Kilgore GPS Control Network of 2000 and NAD83_2011, epoch 2010, (usft) is N: -0.0497 E: +0.1188 U: -0.0587. From this point forward, I can use this new localization system to survey in coordinates related to the Kilgore GPS Control Network of 2000 with a reference station broadcasting NAD83_2011 corrections, or I can transform coordinates from surveys related to the Kilgore GPS Control Network of 2000 to NAD83_2011.

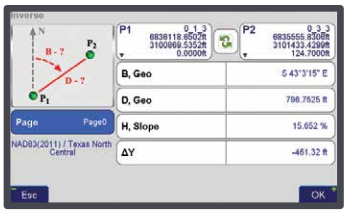
The final step in this exercise is to use this transformation to test on known points. In order to do this, we observed five additional points from the Kilgore network that were not used in the localization. Each point was observed for 120 seconds with the Triumph-LS with corrections from the Triumph-2 onPOST. The chart below depicts the difference in coordinates determined from the LS using the localization and the original Kilgore GPS Control Network of 2000 coordinates.

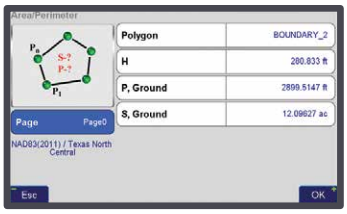
These residuals can be attributed to several different sources: orginal survey error, current survey error, displacement over 15 years, as well as errors in the localization/transformation being used. However these results, together with the residuals from the localization, indicate that the localization, as determined, will allow me to reproduce the Kilgore GPS Control Network of 2000 coordinates within a centimeter, anywhere within the network. The total time required to perform this exercise was 4.5 hours in the field (including redundant observations) and 30 minutes of calculations, which were all made within the Triumph-LS.

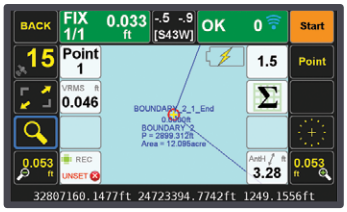
Shawn Billings, PLS

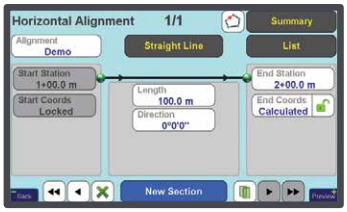
StationB	ase-Rover Vector Length (usft)	2D Residual (usft)	Up Residual (usft)
L007	15363.30	.036	-0.006
L0121	4416.1	0.030	0.101
L0191	2900.90	.025	0.001
L021	7553.00	.048	0.121
L025	11238.80	.011	0.048











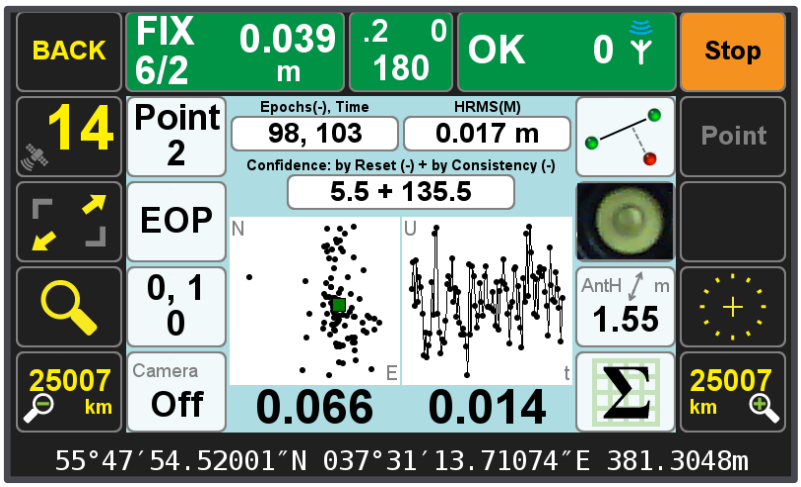
Store and Stake

Introducing GUIDE data collection in the TRIUMPH-LS. Visual Stake-out, navigation, six parallel RTK engines, over 3,000 coordinate conversions, advanced CoGo features, rich attribute tagging on a high resolution, large, bright 800x480 pixel display.
Versatile attribute tagging, feature coding and automatic photo and voice documentation.
The TRIUMPH-LS automatically updates all firmware when connected to a Wi-Fi internet connection.

View and Document your level

The downward camera of TRIUMPH-LS scans and finds the liquid bubble level mounted on the pole. Then focuses on the circular bubble automatically and shows its image on one of the eight white buttons of the Action Screen. You can:

- View the liquid bubble level on the screen.
- Document survey details including the leveling by taking automatic screen shots of the Action Screen, as shown here.
- Calibrate the electronic level of TRIUMPH-LS with the liquid bubble level for use in Lift and Tilt and automatic tilt corrections.



All these camera features are possible only in TRIUMPH-LS where camera, and GNSS antenna are co-located and all other modules integrated.