

MANTIS Lab Best Practices for Riegl VZ-400 TLS Field Operation

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Corpus Christi, TX
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This manual was developed by Melanie Gingras to document our best practices for Riegl VZ-400 Terrestrial Laser Scanner field operation and data collection.



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EQUIPMENT LIST

General:

- Field Laptop (with licensed version of RiSCAN Pro installed including camera license for image capture)
- 4-8 target tripods (for targets)
- 1 Fixed-height Leica Tripod (for TLS)

Large Black (Target) Pelican Case:

- 4-8 10 cm reflective cylindrical targets
- 4-8 tribrachs (for targets)

Large Black (TLS) Pelican Case:

- TLS
- TLS battery power cable
- TLS battery charging cable
- Spare computer mouse
- TLS battery

Small Black (Camera) Pelican Case:

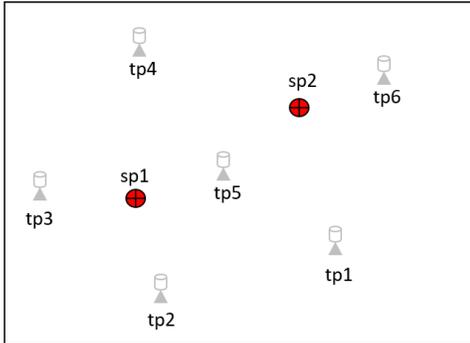
- Camera
- Camera cleaning spray
- Camera cloth
- Camera spare parts bag

For Longer Surveys:

- Laptop charging cable
- Laptop backup battery
- Spare TLS battery

SCANNER FIELD WORKFLOW:

1. Set up the targets throughout the study site such that the scan positions (sp#) are in central locations relative to the targets (tp#) but all the targets are visible from each scan position: make a circle with the targets around the scan positions then add one target to a central location between the scan positions. Scan positions should be in areas of relatively higher relief to minimize occlusion.



2. Each target tripod should have a tribrach. When first placing the tripod, take particular care to deeply seat tripod feet in the ground and level the tripod head as best as you can before leveling the tribrach. The tribrach should be leveled and the 10 cm reflective cylinder should be screwed in place using the brass adapter plug of the tribrach.



3. When first placing the tripod for the scanner, take particular care to deeply seat tripod feet. Any small movements during the scan can cause major differences to the coordinates so if the wind picks up you may want to wait until the wind dissipates to conduct a scan. Once the tripod is firmly in place, complete the following in order: (1) level the tripod/tribrach, (2) screw scanner in place with the brass adapter plug from the tribrach, (3) once scanner is secure on tribrach, attach scanner camera to the top of the scanner, (4) remove lens from camera, (5) connect battery cable to battery (do not let the cable touch the ground, we want to minimize dust and sand in the pelican case!), (6)

connect battery cable to scanner, and turn on scanner if it doesn't power on automatically (if you power the scanner before the camera is connected you will wait a long time for the scanner to recognize the camera but if the camera is connected before the power this takes less than a minute). **Tribrach set up is preferred practice.**

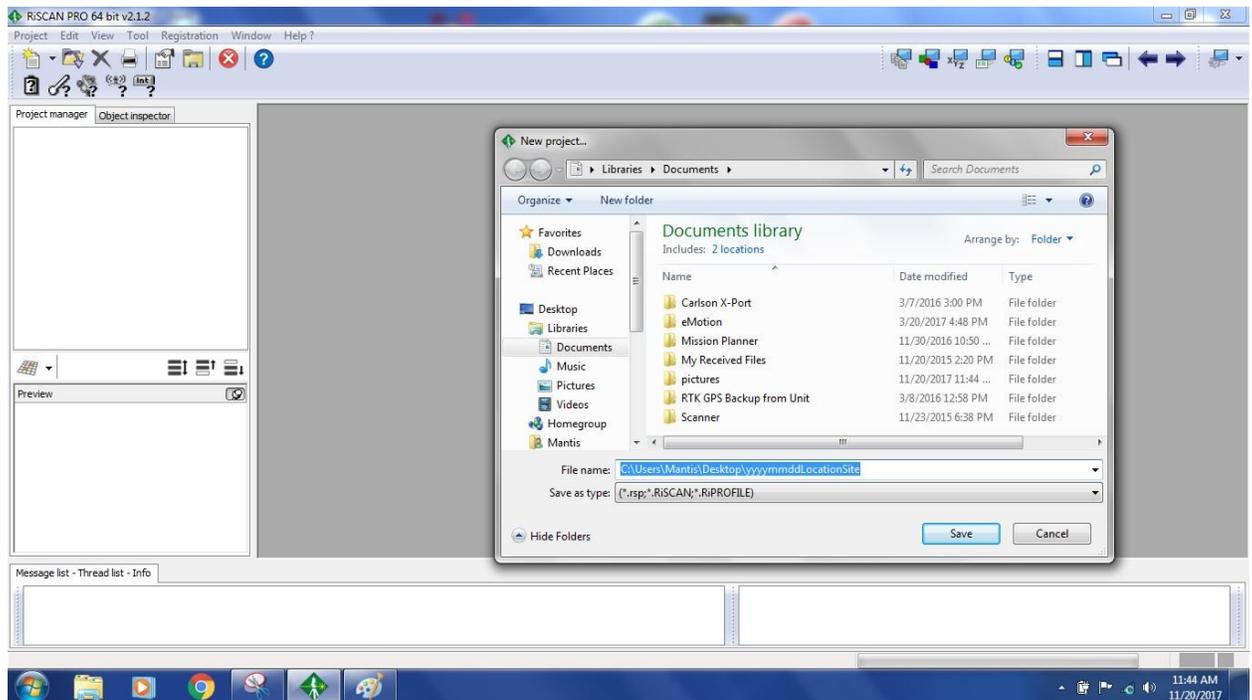


4. Connect to the scanner network S9999826 under computer's wifi settings. If this connection has not been saved, it may ask for a security key upon connection. The security key is: 0123456789.

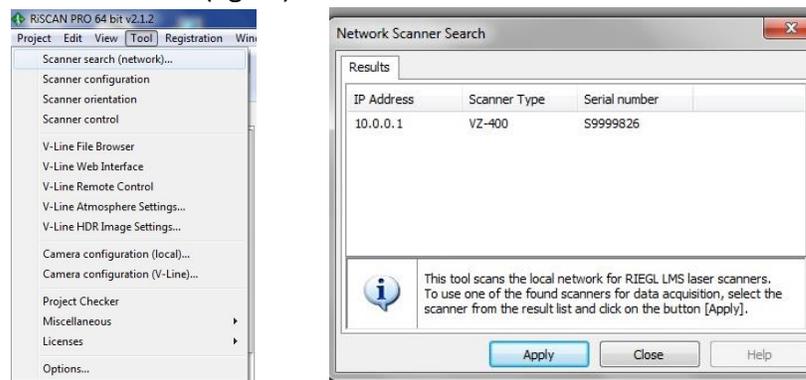


5. Create new project in RiSCAN Pro name should state the location and date of survey for example if you are doing a scan of Aransas Wildlife Refuge on July 8, 2016, you might

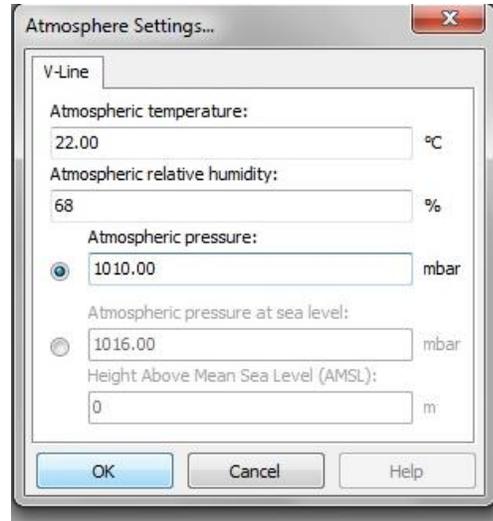
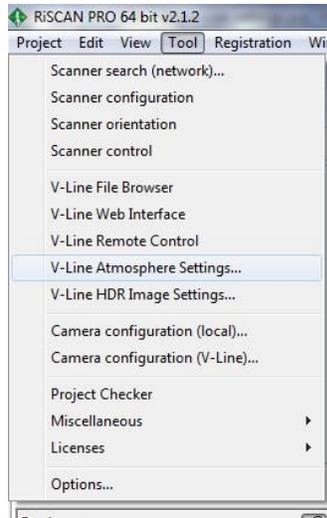
choose to title the scan “20160708 Aransas”.



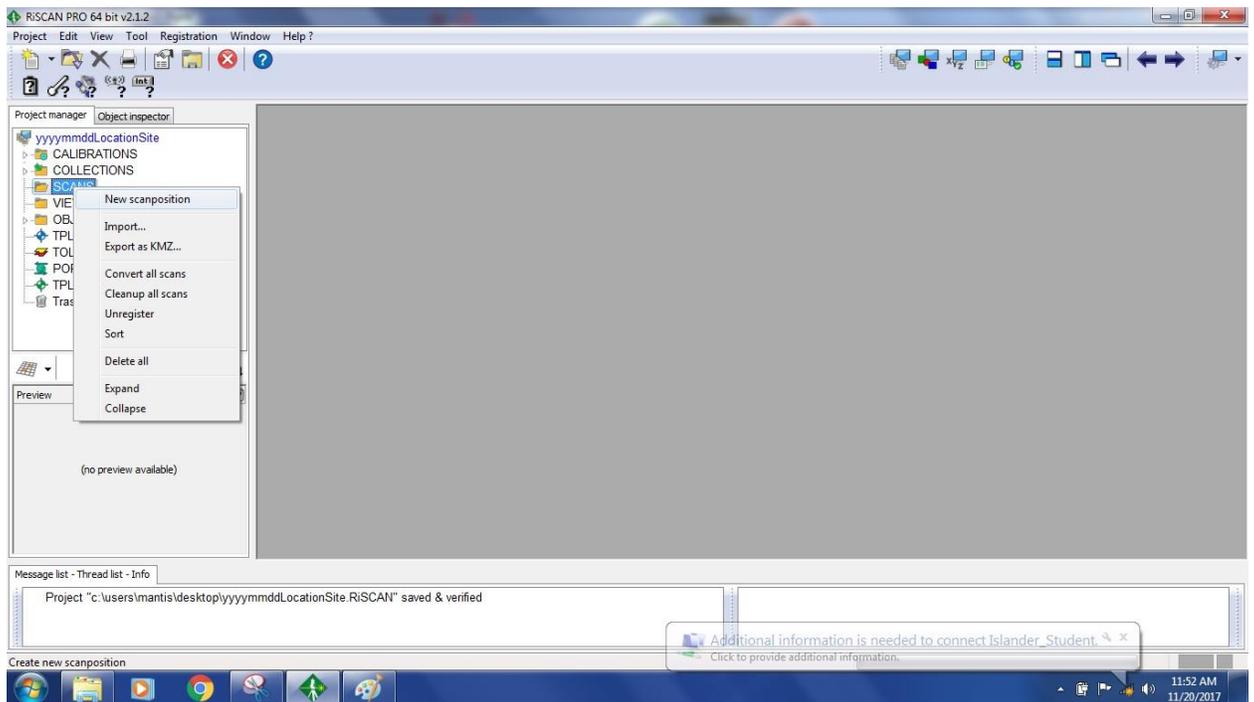
6. Electronically level the scanner:
 - Press second arrow from left on scanner (settings)
 - Select option “instrument position”
 - Manually adjust tribrach until electronic sensor is level (bubble is in the middle)
7. In RiSCAN Pro click “Tool” at the top and select “scanner search” from dropdown menu and connect to the scanner (again).

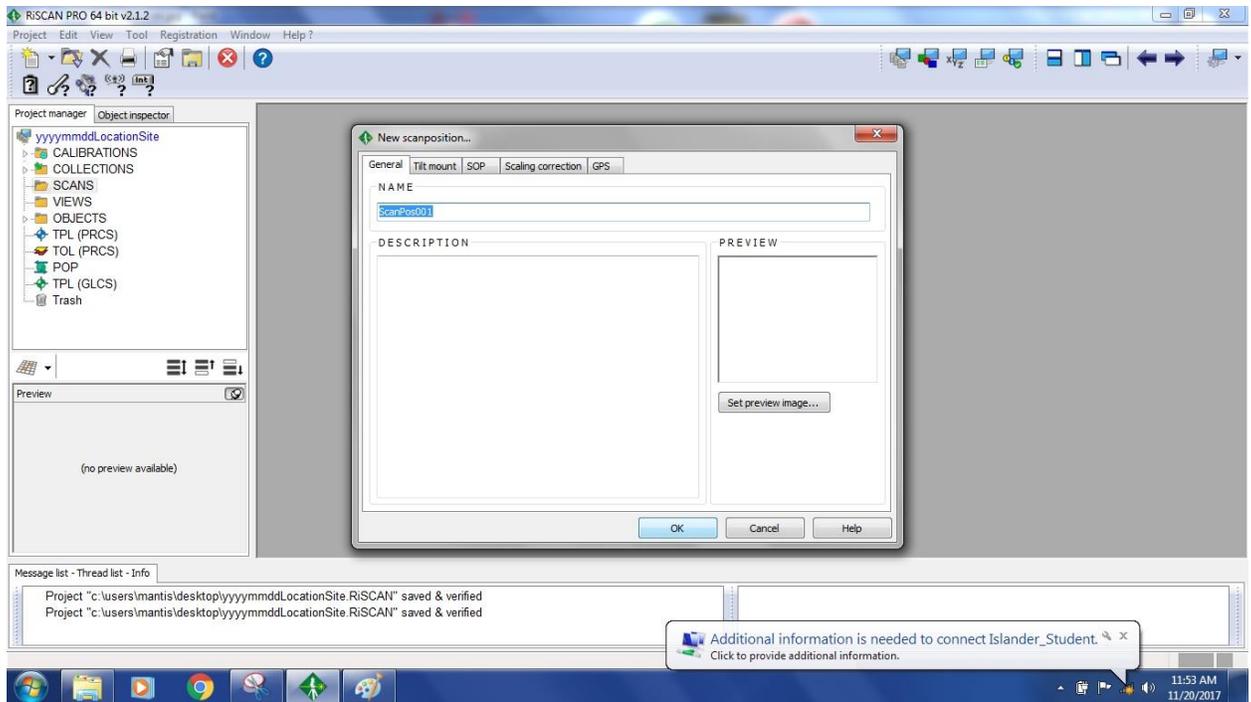


8. Click on “Tool” again and select “V-Line Atmosphere Settings”, to the nearest whole number, enter the temperature in Celsius, the % humidity, and the atmospheric pressure in mb using the Kestral.

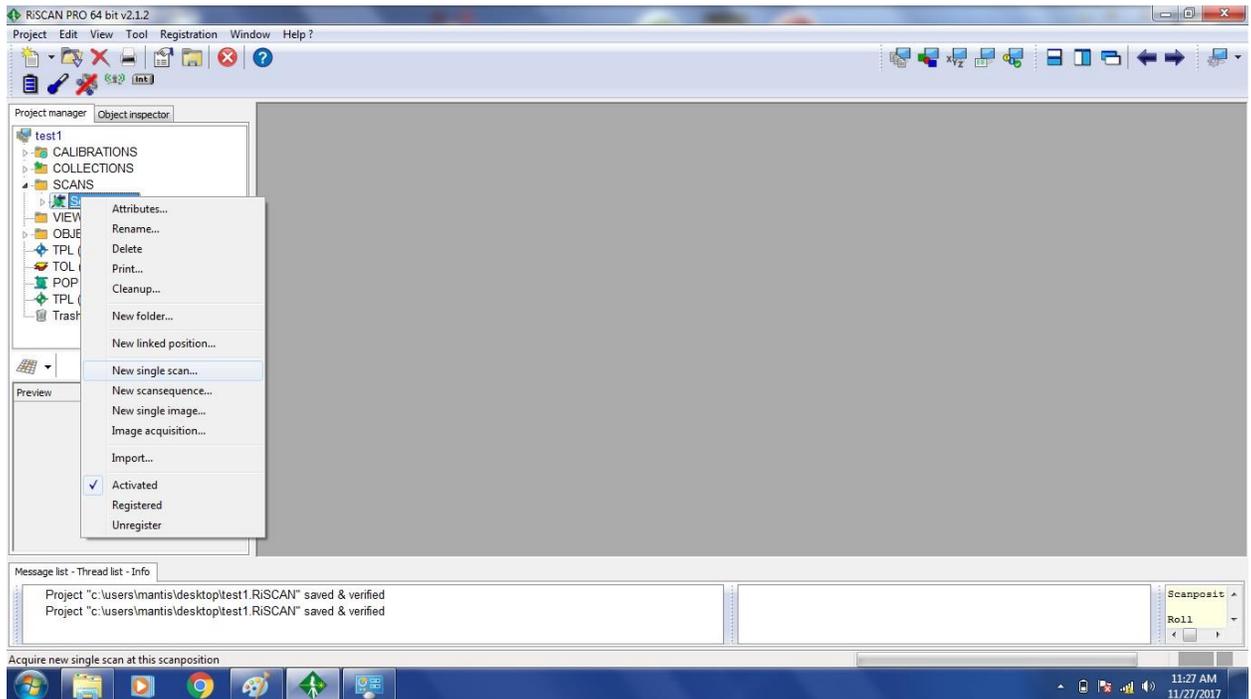


- On the left side, right click "SCANS" and select "New scanposition" from dropdown menu, the default name "ScanPos001" is probably fine but you can change it if you would like



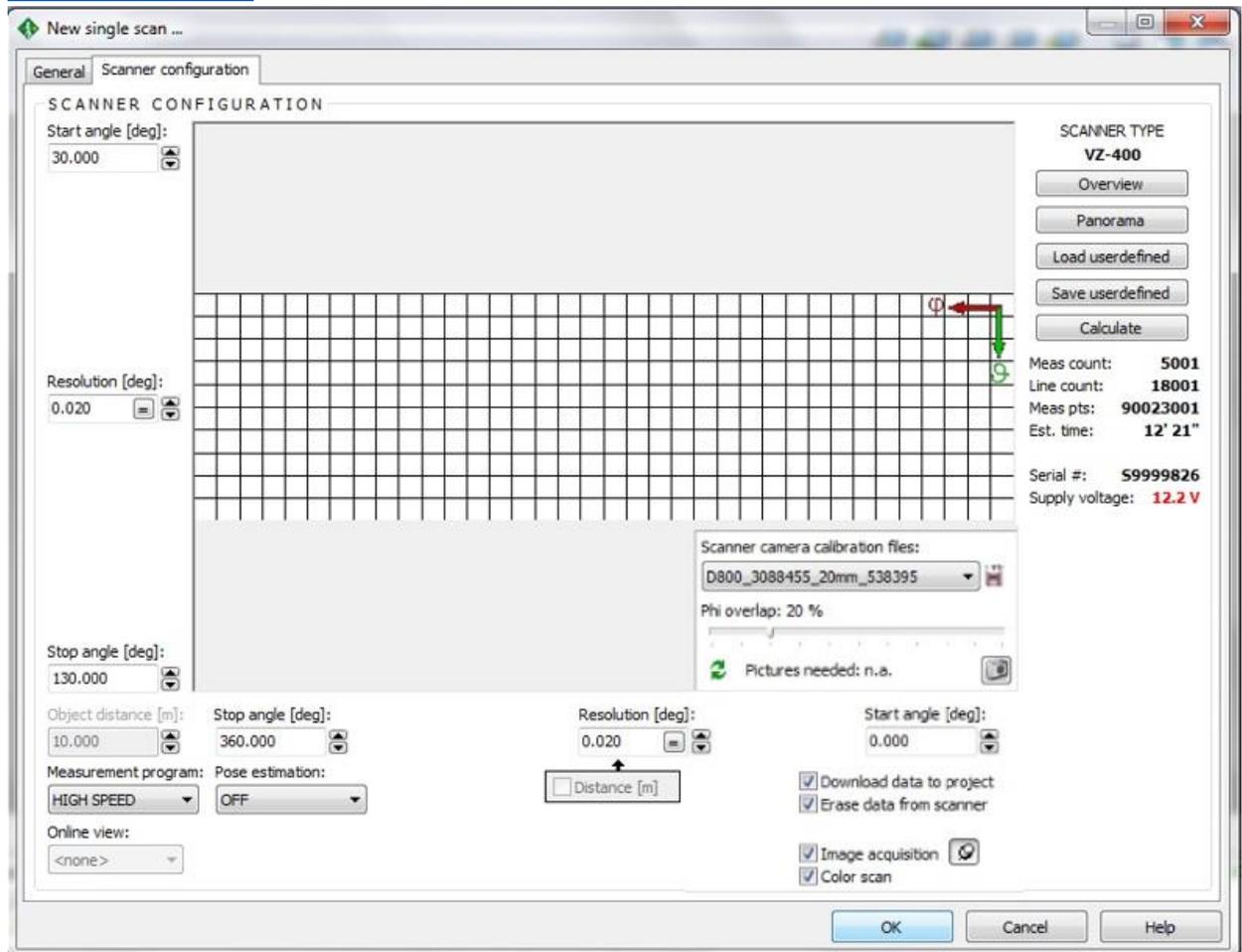


10. Right Click on the new scan position you just created and select “new single scan” from dropdown menu

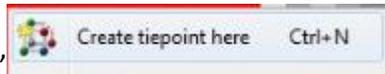


11. Set the desired resolution, mode, and angles for the scan (it is a good practice to click panorama if you’re not sure because it will capture a vertical of 100 degrees (-40 below the horizontal and 60 degrees above) and the full horizontal 360 degrees. Typically, we take scans in “high speed mode” with a resolution of 0.02 or 20 millidegrees). Once the desired settings are entered, begin the scan, taking care to avoid the laser at all times

during the scan. Note, you do not need to color the scan but *it is preferred to acquire images and color the scan*. [Click here to read more about angles and the spherical coordinate system.](#)

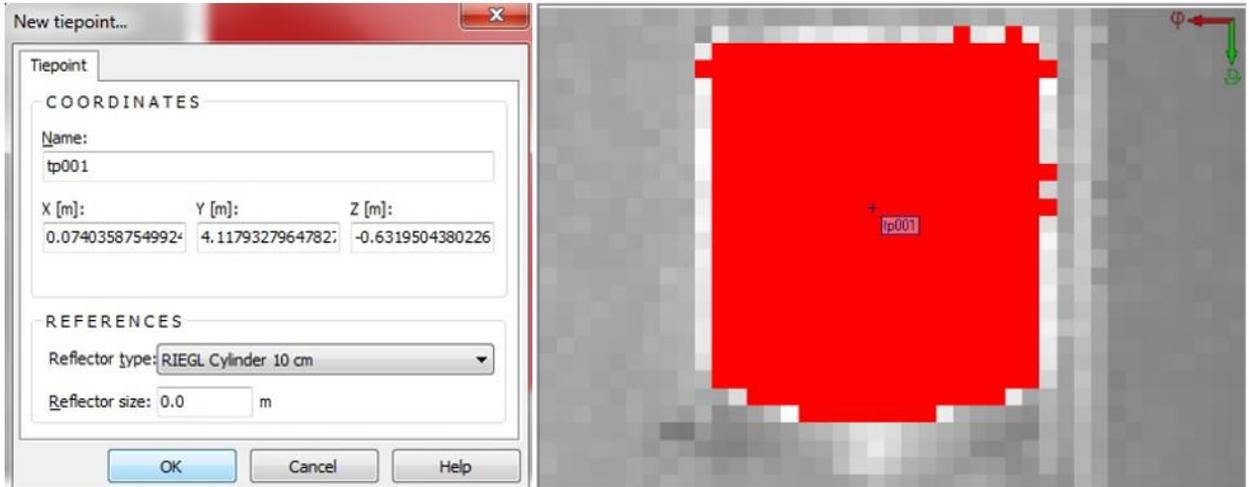


- Once the scan is finished, find the targets in the panorama view of the scene (when you drag the scan into the gray window set “mode” to display the data as 2D→reflectance). Zoom and pan around the scene to find the targets. When you find a tie point, zoom in so the red* of the target occupies most of the screen, right click in the center of the red,

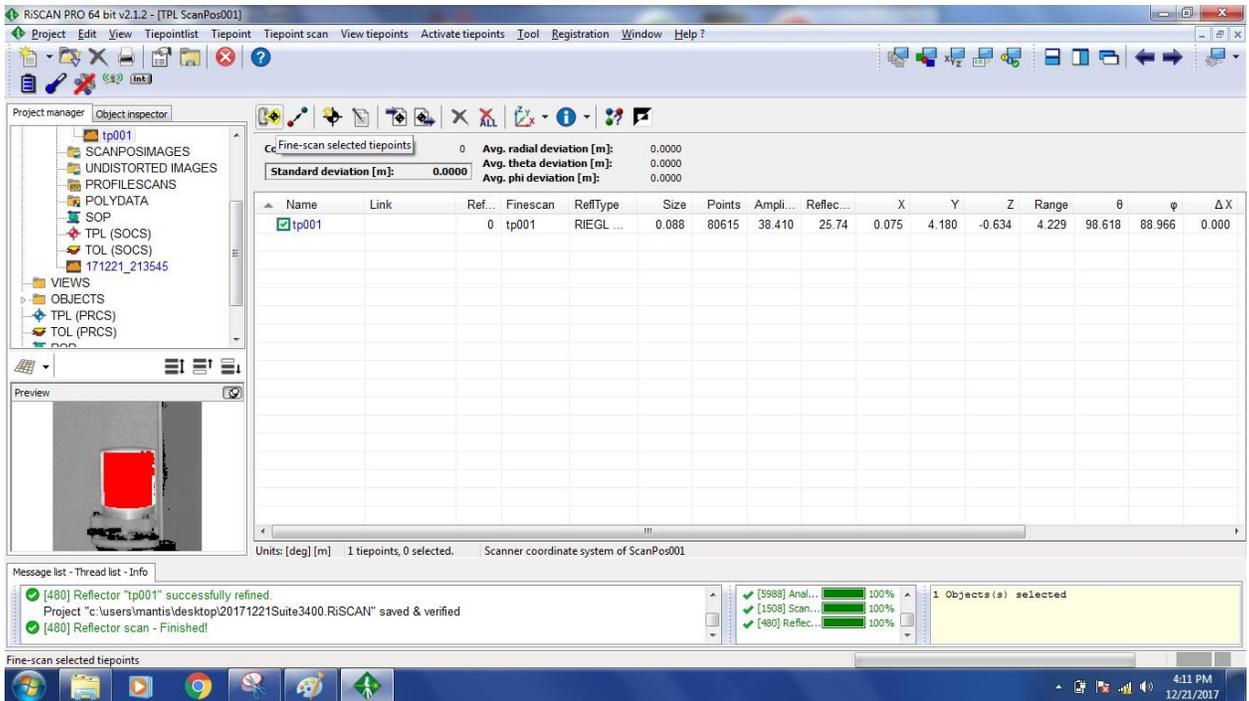


and select “create tiepoint here”. Be sure to set the reflector type to “10cm cylinder” and give it a name that corresponds to its name on your field map (you will want to keep these tie points the same for each scan position because should there be problem with “finding corresponding points” when registering and merging the scans later, the tie points can be merged and registered by name).

***Red indicates maximal reflectance within the scan so white objects may also appear red—take care only to select your targets.**



13. To fine scan the tie points (targets): double click “TPL (SOCS)”, select all your tiepoints, and click the “fine-scan selected tie points” icon  from top menu (if you forgot to select your tiepoints a dialog box will open asking if you want to fine scan all the tiepoints you created—you do).



COLLECTING RTK GPS POINTS:

Once the tie point scans are finished, gather the coordinates of the targets using an RTK GPS rover:

To set up the rover for collection create a new job that has the same name as your scan 20160708 Aransas. Connect to an appropriate network (typically the name of the network will end in DOT—for Florida: FDOT, for Texas: TXDOT), set appropriate state plane coordinate system for the locale and establish VRS network or run static GPS at the site and receive corrections from that. Title the tie point “tp” and the appropriate number from the scan (tp#), make sure that the base height is set to zero and the options are set to record a measurement every second for 60 seconds. Removing the target cylinder and replace it with the RTK GPS rover (you may want to remove the brass adapter plug and screw it into the rover rather than trying to screw the whole rover in place).

Once the tie points are collected, or in between collecting tie points, you should gather ground truth points throughout the study site (usually 50 points is a good rule of thumb). For the ground points on bare earth label them, g# (for example: the first bare earth point would be “g1”), and for the points in vegetation, v#. There should be approximately 30 ground points and 20 vegetated points. Base height should be set to the height of your rover pole (probably 2.000m) and options should be set to take one measurement per second for five seconds. Keep the rover pole as steady and level as you can during the five seconds that the measurement is being taken for each ground truth point.

Back in the office upload the original csv file as yyyyymmdd Site, in this example “20160708 Aransas”. This file should contain all ground points (vegetated and bare earth) and target points. Save this file in the in the correct RTK GPS site folder on Mantis (Mantis:\Data\Terrestrial Lidar\Riegl VZ 400 Projects\Site\yyyyymmdd Site\RTK GPS)

	A	B	C	D
1	Point	Northing	Easting	Z
2	RTCM0307	90411.91	523625.6	7.76
3	tp5	66798.27	547105.2	2.268
4	tp4	66791.48	547098.4	2.205
5	tp3	66784.46	547090.6	3.744
6	tp2	66791.59	547076.8	3.307
7	tp1	66801.37	547069.5	1.988
8	g1	66795.37	547092.2	0.812
9	g2	66799.99	547096.4	0.274
10	g3	66799.39	547100.3	0.28
11	v1	66798.04	547106.2	0.322
12	v2	66796.22	547110.3	0.269
13	g4	66794.8	547112.4	0.541
14	g5	66792.14	547114.9	0.607
15	g6	66794.24	547117.2	0.204
16	v3	66794.52	547119.7	0.176

This PC > Mantis (\\ad.tamucc.edu) (Z:) > Data > Terrestrial Lidar > Riegl VZ 400 Projects > NGS > RTK GPS

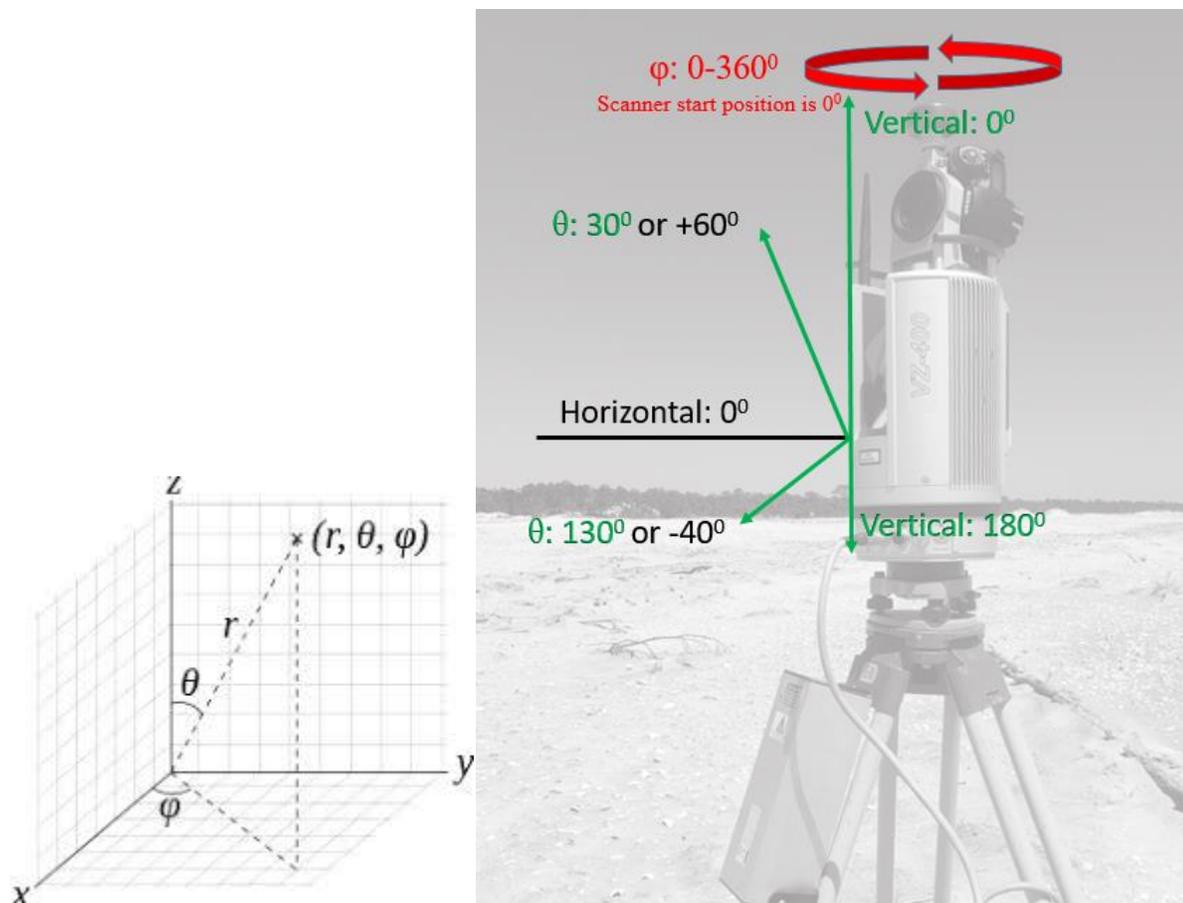
Name	Date modified	Type	Size
Apalachicola	6/1/2018 3:06 PM	File folder	
Aransas	6/1/2018 3:03 PM	File folder	
Big Tree	6/1/2018 3:04 PM	File folder	
Goose Island	6/14/2018 11:00 AM	File folder	
Harbor Island	6/1/2018 3:04 PM	File folder	
Mud Island	6/1/2018 3:04 PM	File folder	
MUI Observatory	6/1/2018 3:04 PM	File folder	
Newport Pass	6/1/2018 3:04 PM	File folder	
Port Aransas South Jetty	6/1/2018 3:04 PM	File folder	

In a separate file, copy only the target points (tp#) and add 5cm to each of the z coordinates for these targets. Save this new file as “yyyyymmdd Site +5cm”. This file will be used for merging

and georeferencing the point clouds in RiSCAN Pro later. FYI: the CSV for state plane and NAVD88—the systems we typically use—are in the order from left to right: northing (y), easting (x), vertical (z).

Understanding Spherical Coordinates and the Scanner

The theta angle  is the vertical angle and the phi angle  is the horizontal angle. Therefore, when you set a resolution for these angles, this is telling the scanner how many degrees (in our case 20 millidegrees) to move vertically and horizontally between laser pulses. The scanner can rotate through a full horizontal 360 degrees field of view (FOV) in the horizontal; this is the phi (ϕ) angle. The mirror within the scanner can oscillate between 60 degrees above the horizontal (0°) and -40 degrees (or 40 degrees below the horizontal, 0°); this is the theta (θ) angle. In the image below, the horizontal (0°) can be visualized as the xy-plane and theta angles above this plane are positive while angles below the plane are negative. Phi angles vary between 0 and 360 degrees within the xy-plane. In RiSCAN Pro, the start angle is the smaller angle: for phi this is 0° and for theta this is 30° .



USING THE CUSTOM FULL WAVEFORM FEATURE

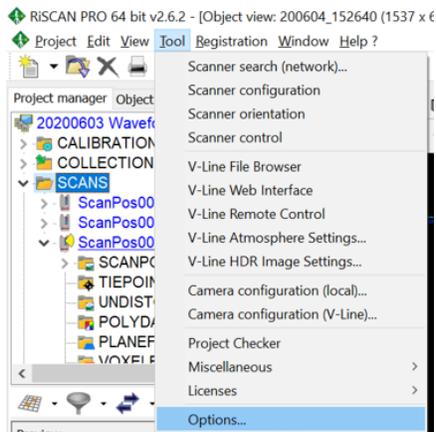
Waveform Data Collection (Scanner Settings)

1. On the scanner, navigate to Project Setup → Full Waveform Feature Settings (on page 3) → Select RANGE+WAVEFORM (make sure the deviation is set to zero)

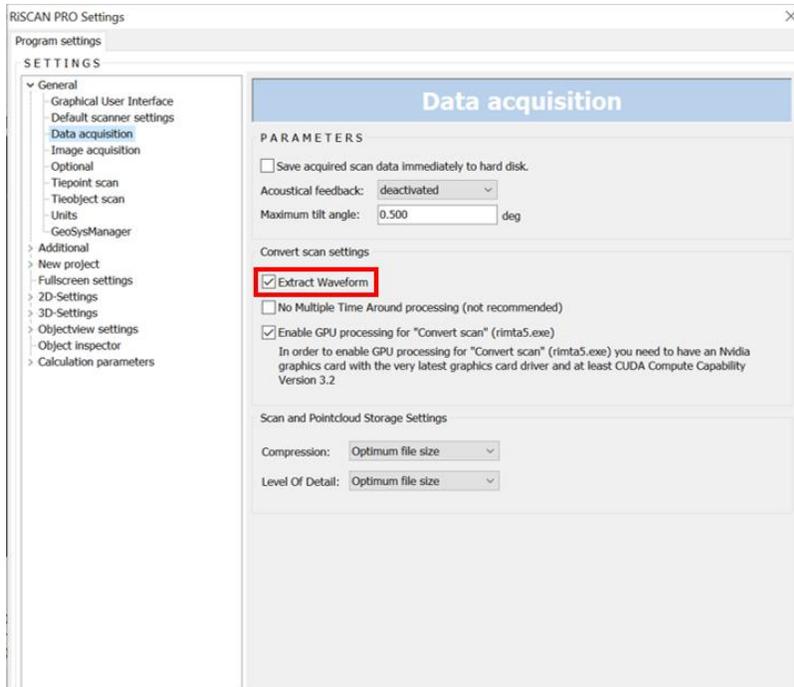


Waveform Data Collection/Conversion (RiSCAN Pro)

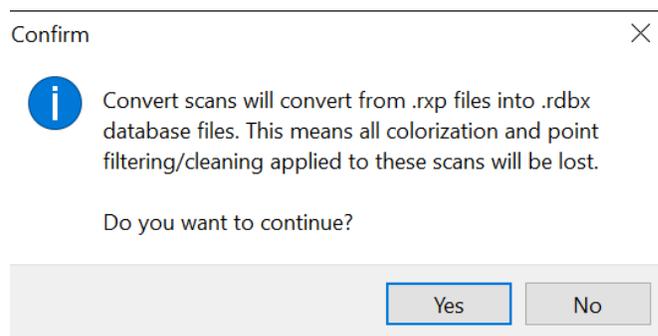
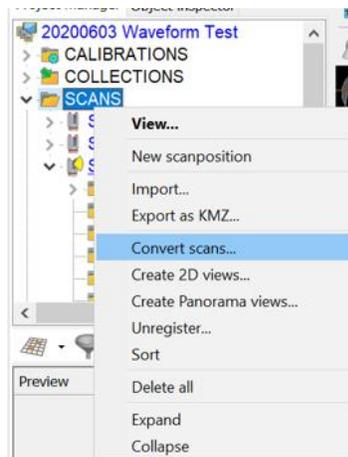
2. Click on the “Tool” tab and selection “options” from the drop-down menu



3. Select “General” → Data Acquisition → Check the box that says “Extract Waveform” → **Hit enter** (the ok/submit button will not be visible in the window but if you do not hit enter your settings to extract the waveform will not be saved)



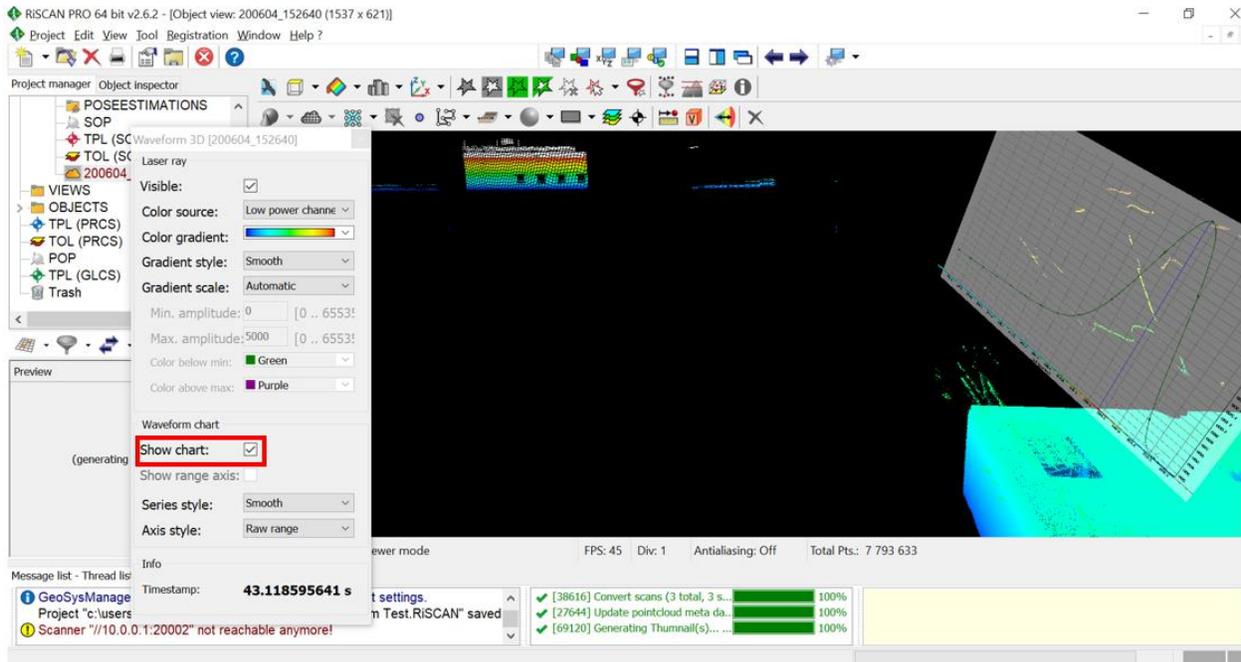
- When you are finished collecting the waveform data, convert the scans by right clicking the “SCANS” folder from .rpx to .rdbx database files and selecting “Convert scans”. When prompted, confirm this by clicking “yes”



Visualizing the Waveform in RISCAN Pro

- When viewing the **3D pointcloud** (2D views will not allow you to use the waveform feature), simultaneously hold the SHIFT, CTRL, W, and left click your point of interest to display the Waveform 3D window. To show the chart, check the box that says “show chart”.

Note: If you encounter licenses issues, troubleshoot the remote license connection (the computer must be connected to the university network to connect to the remote license which will allow you to use the waveform features in RiSCAN Pro).

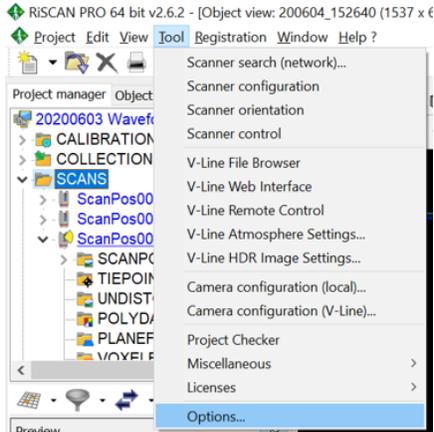


Return the Scanner to NGS Settings (turn off full waveform feature)

1. When finished collecting full waveform data, return the scanner to NGS settings so that that the scanner is not bogged down collecting full waveform data for NGS scan where is not needed (full waveform data takes longer to gather and uses 3x as much memory so only use this feature when required).
2. On the scanner, navigate to Project Setup → Full Waveform Feature Settings (on page 3) → Select RANGE ONLY (make sure the deviation is set to zero)



3. In RISCAN Pro, click on the "Tool" tab and selection "options" from the drop-down menu



4. Select “General” → Data Acquisition → **UNCHECK** the box that says “Extract Waveform” → **Hit enter** (the ok/submit button will not be visible in the window but if you do not hit enter your settings will not be saved)

