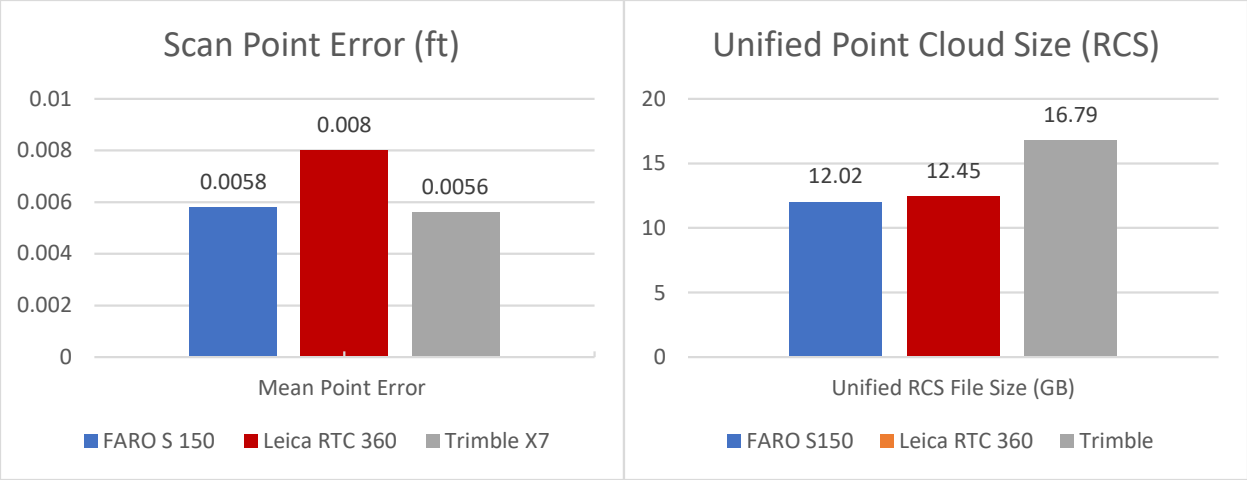
Scanner Comparison: FARO S 150 vs. Leica RTC 360 vs. Trimble X7

Introduction: With laser scanning technology constantly evolving, it is necessary to periodically compare the different platforms available in the market. To do so, we tested a Leica RTC 360 against a FARO S150 and a Trimble X7 performing three simulated scanning scenarios. In each of the scanning situations, we tried to keep the comparisons as similar as possible in terms of comparable settings used, similar scanner positions, and methods. For the Trimble X7, less scans were captured with each scenario due to different settings. At the Medium density setting, it captures 58 million points (much higher than the FARO or Leica). To get an even comparison, the total number of points were calculated for each scenario. Though the X7 has fewer scans, it still achieves the same total number of points.

Scenario 1: The first comparison of the scanners was done in the vacant half of our Western District office. This approx. 27,000 sf area represents a typical core and shell project with minimal interior walls (just a couple of bathrooms, a mechanical room, and custodial closet). The intent was to compare the scanning and registration times of the two scanners for a registration of 100 scans.

Scan setups were approximately 20 ft. apart to create a very simple registration for the software. Our intent was not to create a complex registration that requires troubleshooting, but rather to get a good time comparison of the processes given ideal scanning and registration conditions to understand the overall scan and registration processes for each scanner.

Comparison Metric	FARO Focus S150	Leica RTC 360	Trimble X7
Scanner Settings	1X Quality ¼ Resolution (43.7 M pnts.)	Medium Density (42.4 M pnts.)	Medium Density (58 M pnts.)
Color Settings	Color scans, speed mode	HDR color mode	Quick color (1 min)
Time for each scan	3 minutes 25 seconds	2 minutes 03 seconds	4 minutes 30 seconds
Total Number of scans	100	100	73
Average file size	216 MB	290 MB	335 MB
Total Scan Time	6 hours 31 minutes	4 hours 36 minutes	6 hours 48 minutes
Raw scan import Time	5 minutes 32 seconds	3 hours 40 minutes	N/A tablet registered
Scan Registration Time	3 hours 25 minutes	60 minutes	35 minutes (refining)
Scan Export / Publishing Time	4 minutes (FLS)	43 minutes (E57)	3 minutes (TDX)
Total Time	10 hours 5 minutes	10 hours 30 minutes	7 hours 26 minutes



Figures taken from registration reports created in Cyclone Register 360, FARO SCENE 2019.2, and Trimble FieldLink. The default settings were used for each, no additional steps were taken to further tighten the registration accuracy.

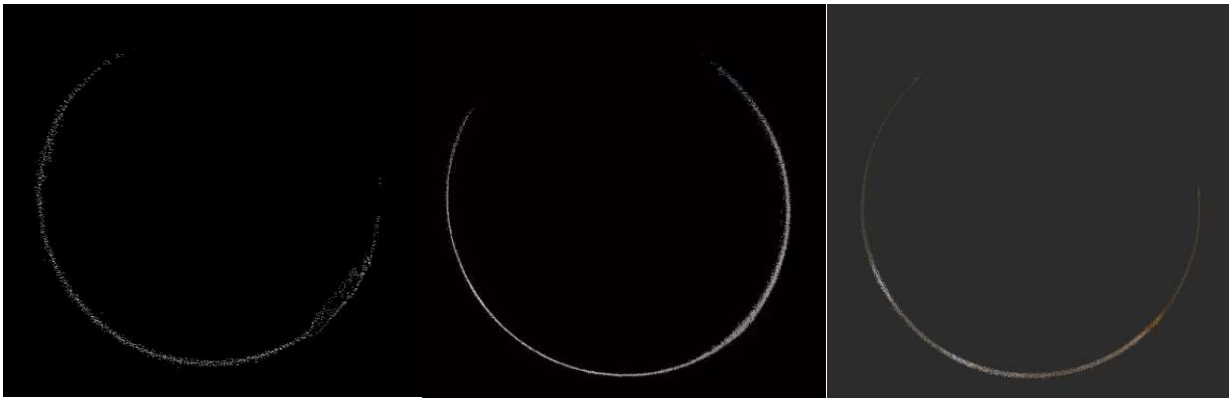


Figure 1: This is a slice through one of the A/C ducts from the FARO S150 (left), Leica RTC 360 (middle), and the Trimble X7 (right). Please note the section missing is due to the content being captured from the ground. Both the RTC 360 and the X7 use time-of-flight capturing technology, which results in less noise in the data. The S150 uses phase-based technology.

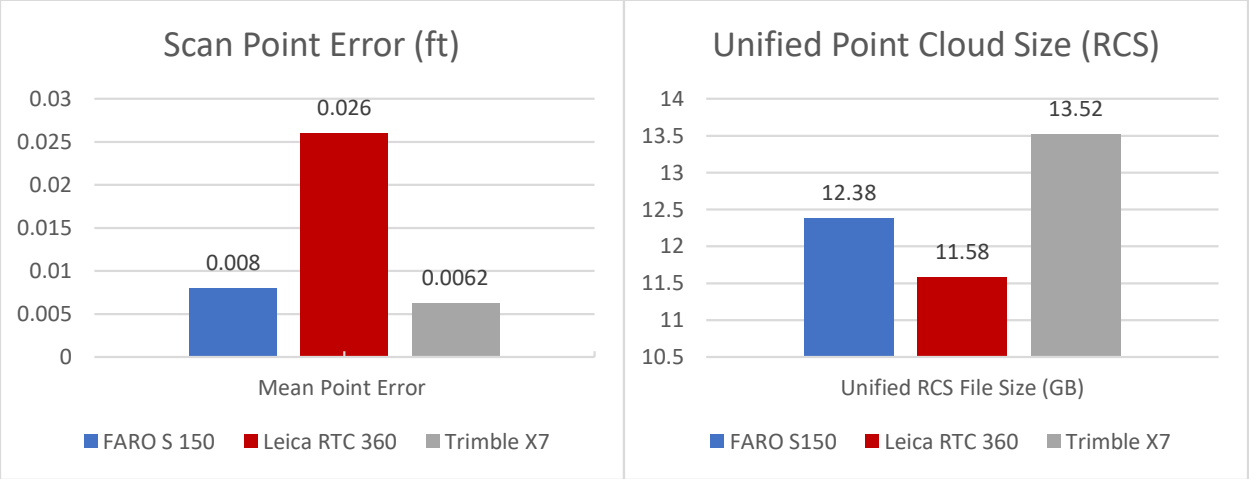
Figure 2: This represents the interior scan quality of the FARO S150.

Figure 3: This represents the interior scan quality of the Leica RTC 360.

Figure 4: This represents the interior scan quality of the Trimble X7.

Scenario 2: The second scenario was scanning the exterior of the District Office. We did not use any survey control and scanned in a giant loop around the exterior of the building, so we were interested to see how tightly the scans would match up in the overlapping area.

Comparison Item	FARO Focus S150	Leica RTC 360	Trimble X7
Scanner Settings	1X Quality ¼ Resolution (43.7 M pnts.)	Medium Density (42.4 M pnts.)	Medium Density (58 M pnts.)
Color Settings	Color scans, speed mode	HDR color mode	Quick color (1 min)
Time for each scan	3 minutes 25 seconds	2 minutes 03 seconds	4 minutes 30 seconds
Total Number of scans	67	62	49
Average file size	192 MB	500 MB	271 MB
Total Scan Time	3 hours 20 minutes	2 hours 43 minutes	4 hours 51 minutes
Raw scan import Time	12 minutes	2 hours 14 minutes	N/A tablet registered
Scan Registration Time	1 hour 20 minutes	10 minutes	13 minutes (refining)
Scan Export / Publishing Time	5 minutes (FLS)	1 hour 3 minutes (E57)	3 minutes (TDX)
Total Time	4 hours 57 minutes	6 hours 10 minutes	5 hours 7 minutes



Figures taken from registration reports created in Cyclone Register 360, FARO SCENE 2019.2, and Trimble FieldLink. The default settings were used for each, no additional steps were taken to further tighten the registration accuracy.

Figure 5: This small section of the exterior scans highlights accurate colorization for the FARO scanner and crisp surfaces. Please see reference image on right to compare with actual conditions.

Figure 6: This is a similar comparison for the Leica RTC 360. Please note the darker shades coming from the HDR photos. It is faster with cleaner overall data, but the pixel coloration did not match the field color conditions as accurately as the FARO.

Figure 7: This is the same area as captured from the Trimble X7. Like the Leica, the data is very crisp. The saturation levels are a bit higher than true field conditions, but the higher contrast also makes it easy to identify content particularly on interior scans.

Figure 8: This is a cross section cut of the wall (on right of image) as well as some asphalt from the parking lot as captured by the FARO S150. The vehicle data looks very clean, but there is some reflection noise near the top of the wall due to a combination of the angle of the scan from the ground and the reflective nature of the paint.

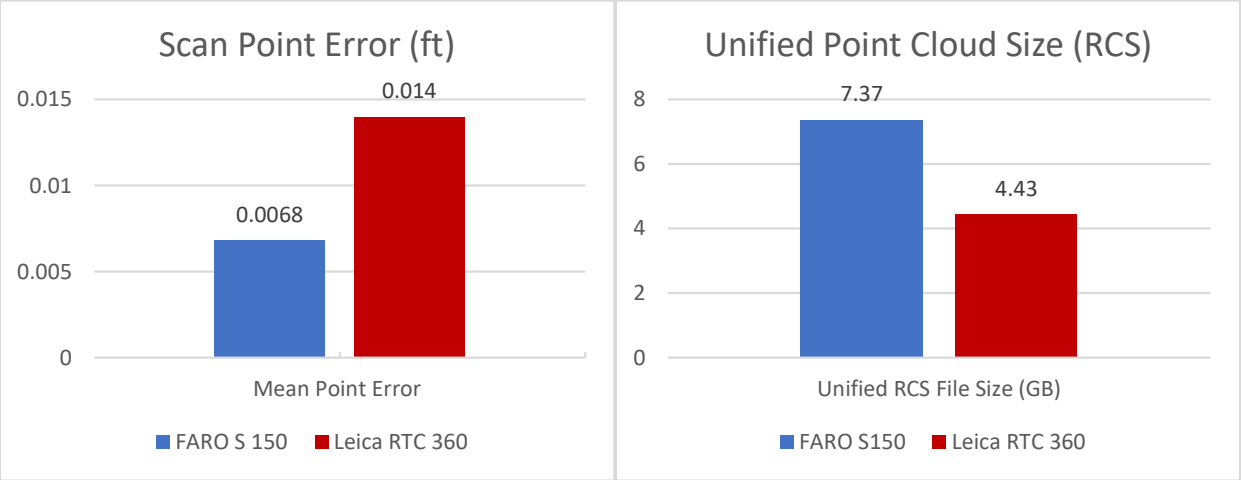
Figure 9: This is a similar slice as captured by the Leica RTC 360. The wall profile is very crisp with no range noise. It is interesting to note that the RTC even captured some content on the rear window of the truck.

Figure 10: This is a similar slice as captured by the Trimble X7. The wall profile is very crisp with no range noise. The car appears to have two different colors, that is due to being captured from multiple scans on a cloudy day. The brighter coloring is from a scan in full sun, whereas the darker color is due to cloud cover during that scan.

Scenario 3 (FARO & Leica only): In this scenario, we had access to a 2.5-acre lot where a home is being built. With a pour just being completed, we had access to scan a slab on grade. With the deck being completely clear of clutter, this was an ideal test case for the floor flatness capabilities of each scanner. This reflects a typical scanning application on a construction site, though smaller in size.

With the cost of the RTC being roughly twice that of the FARO, we wanted to test relative efficiency running two FARO scanners vs. a single RTC 360. With the Trimble demo occurring weeks later, it was not tested in this scenario.

Comparison Item	FARO Focus S150	Leica RTC 360
Scanner Settings	1X Quality ¼ Resolution (43.7 M pnts.)	Medium Density (42.4 M pnts.)
Color Settings	Color scans, speed mode	HDR color mode
Time for each scan	3 minutes 25 seconds	2 minutes 03 seconds
Total Number of scans	86	55
Average file size	261 MB	500 MB
Total Scan Time	2 hours 28 minutes (2 scanners)	2 hours 21 minutes
Raw scan import Time	35 minutes	1 hour 52 minutes
Scan Registration Time	4 hours 11 minutes	2 hours 10 minutes
Scan Export / Publishing Time	5 minutes (FLS)	17 minutes (E57)
Total Time	7 hours 19 minutes	7 hours 31 minutes



Figures taken from registration reports created in Cyclone Register 360, FARO SCENE 2019.2, and Trimble FieldLink. The default settings were used for each, no additional steps were taken to further tighten the registration accuracy.

Figure 11: This is a portion of the FARO S150 data for the slab on grade. The pristine condition of the slab was great for capturing clean content, but also made it difficult to register due to a lack of reference objects.

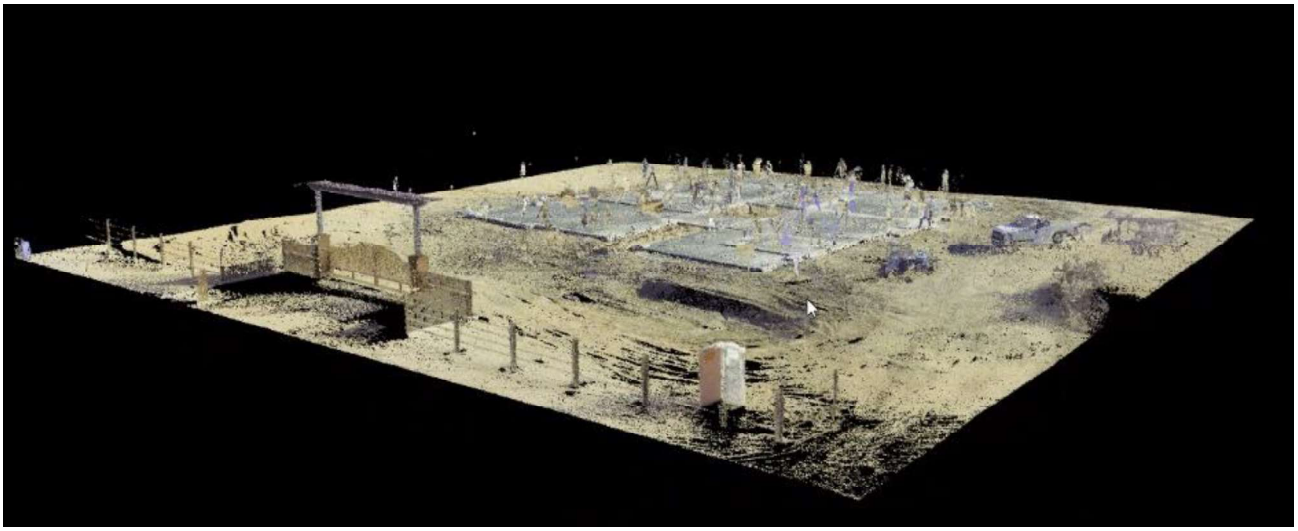


Figure 12: This is the same data as captured from the Leica RTC scanner. Given that fewer scans were able to be captured in the allotted time, you will notice slightly less content was captured overall. This is particularly noticeable on the railing in the front fence.

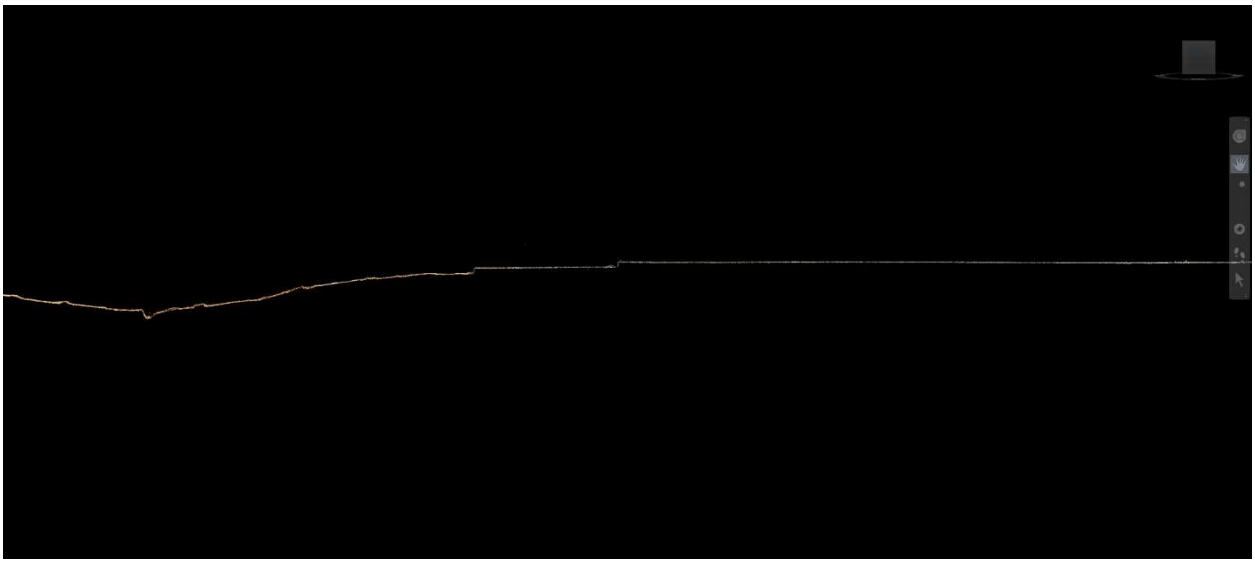


Figure 13: This is a cross section of the slab on grade. Given that the content was not reflective at all (soil and concrete) the data is very clean and the lines are crisp.

Figure 14: This is a similar cross section from the Leica RTC 360 data. Like the FARO, this non-reflective content produces a sharp edge that is great for floor flatness reports.

Scenario 4 (Trimble X7 only): In this scenario, we wanted to test the inspection process for the X7. We started with an IFC model file of our District Office interior. Using the Field Link interface, we then created survey control points using the georeferenced model. With the first setup, we set up the X7 like a total station utilizing its survey-grade leveling and shot in three of the created control points. We then captured five scans, each geolocated to match the model, and ran the inspection tool on the tablet after refining the registration. The result is a color-coded point cloud based on the accuracy of the as-built content vs. the design model.

Process Item	Trimble X7
Scanner Settings	Medium Density (58 M pnts.)
Color Settings	Quick color (1 min)
Time for each scan	4 minutes 30 seconds
Total Number of scans	5
Average Point Error	0.0023 ft.
Importing IFC model to tablet	2 minutes
Creating Control Points from model	5 minutes
Initial Scan Setup to Control	5 minutes (3 points used within 1/4” in XY direction and 1/8” in Z
Total Scanning Time	25 minutes
Registration Refinement Time	3 minutes
Inspection Report Creation Time	3 minutes
Complete Field Inspection Time	43 minutes

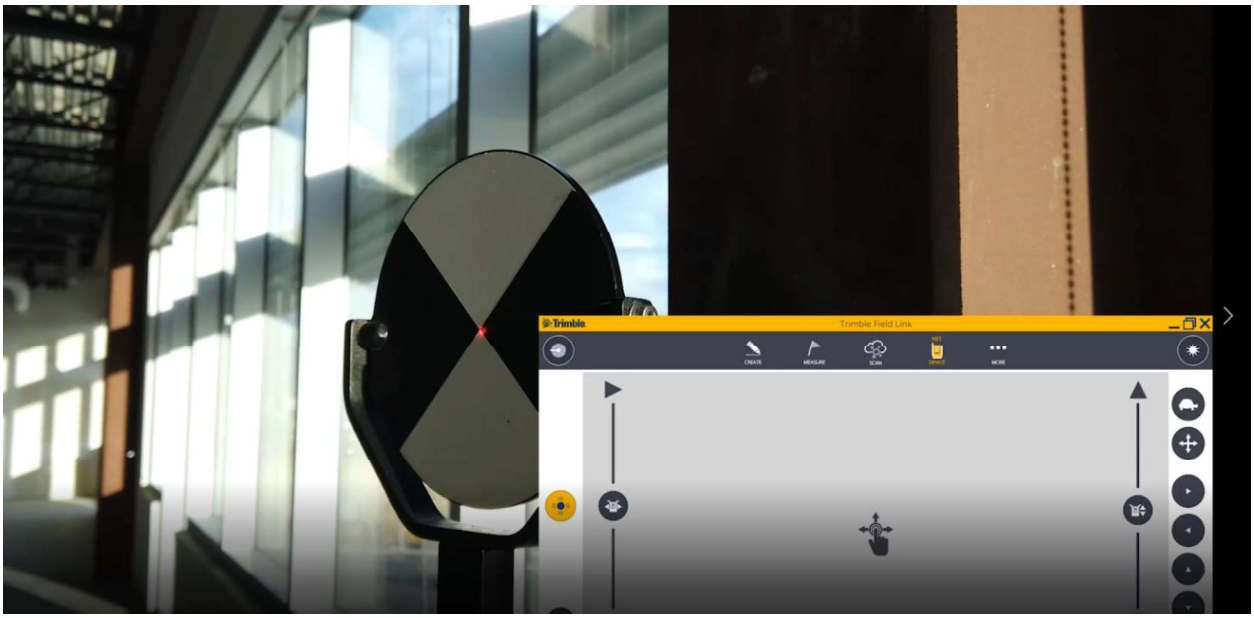


Figure 15: The laser on the Trimble X7 can either measure points directly on the surface, or by utilizing a rotating target for points on the ground. This allows for great flexibility in using points on surfaces such as walls or columns or using structural grid lines on the floor.

Figure 16: This represents the visual results of the inspection process. The end user can identify the specific tolerances to check the model, the point cloud is then colorized to show the accuracy of the installation. This is particularly useful for checking sleeves, anchor bolts, or other components of a deck prior to concreate placement. Measurements can also be performed to enable quick adjustments in the field.