WHITE PAPER

Dynamic Safety L.L.C.

Laser Scanner Basics for Public Safety - Scene Marking, Scanner Placement, and Scanner Settings

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The Best Practices Approach to Scene Marking, Scanner Placement, and Scanner Settings

Abstract

The use of terrestrial laser scanners has revolutionized the forensics investigator's ability to capture evidence data at crash and crime scenes by significantly reducing the man hours required, while simultaneously improving accuracy of the measurements. Police departments and private investigation firms are choosing FARO® Focus Laser Scanners, the industry leader, for their 3D measurement and imaging solutions. By combining photographs and data points collected from the scanner, software, such as FARO SCENE, is used to turn the information collected into an exact, 3D representation of the scene.

This white paper is the result of an experiment and demonstration performed by Dynamic Safety, LLC to establish and report best practices in scene marking, scanner placement, and scanner settings to yield the most ideal results for crash and crime scene investigators.

Marking the Scene

One of the early tasks in any investigation is correctly marking the evidence at the scene. The use of evidence marks makes it easier to catalog the evidence, helps to define the location of evidence within the scene for later analysis, and enhances the view of evidence items within photographs. Similarly, proper evidence marking done before scanning a scene allows the evidence to be identified and seen more clearly in the point cloud data that is captured with the laser scanner.

FARO

Specialized crime scene and crash investigation classes spend multiple hours discussing the identification, marking and collection of evidence. While utilizing the FARO placement of the laser scanner and ideal settings to capture a scene, there are several items worth considering that enhance the appearance of evidence for collection and identification. In the field, we have tested several marking materials (Figure1). These include the following:

- Chalk
- Paint Stick
- Reflective Chalk
- Spray Chalk
- Marking Paint

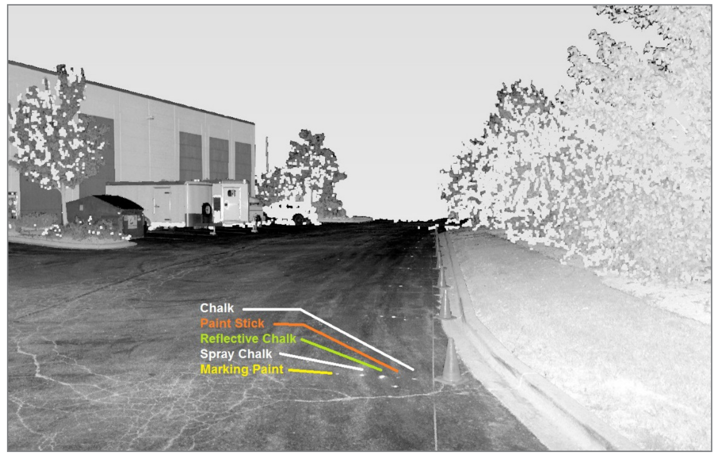

Figure 2. Grayscale scan image of the point cloud showing dots.

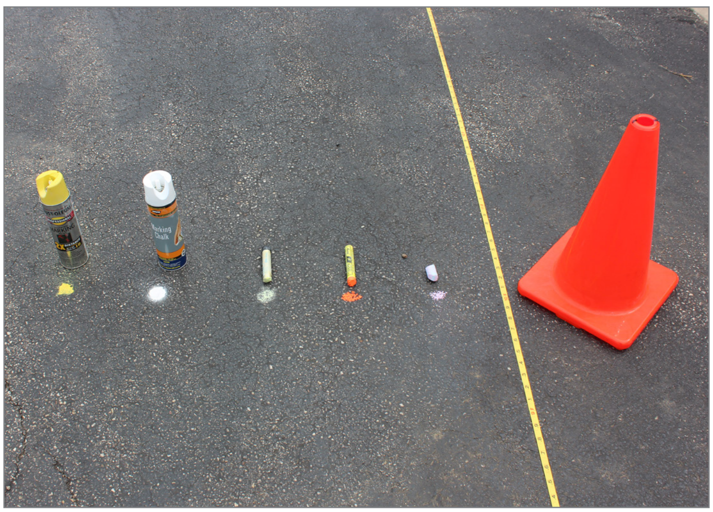

Figure 1. Photograph of the marking materials used in the experiment.

Figure 3. Colorized scan image of the point cloud showing dots.

We set up an experiment utilizing all of these materials on a dry, sunny day, marking every 10 feet (3.05 meters) along a total distance of 100 feet (30.48 meters). In a line, we marked dots of similar size with different colors and marking materials.

We then scanned the area from the "0" point, using a FARO Focus^{3D} X 330 Laser Scanner, in front of, or to the north of, the markings. The scan collected was at 1/4 resolution with a 3X quality setting. Figures 2, 3 and 4 show scans for this test.

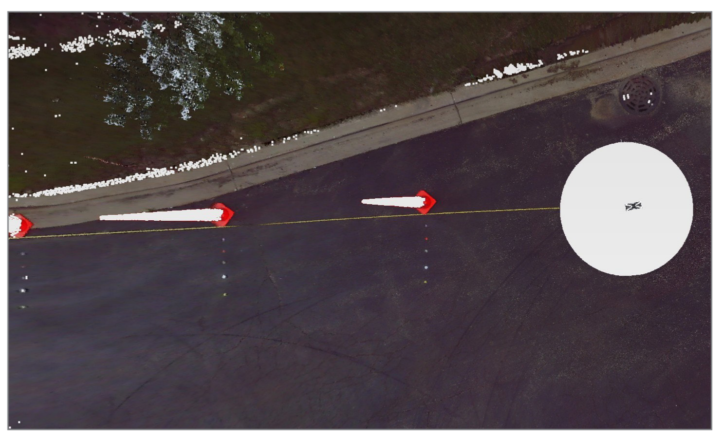

Figure 4. Colorized scan ortho image of the point cloud showing dots.

Figure 5 shows each distance in the point cloud where the marks were well-defined (having clearly distinguishable boundaries) and the maximum distance where the mark could still be visible. It was determined that the reflective chalk works best when captured in a grayscale point cloud, as those marks were well-defined at a distance of 60 feet (18.29 m) from the laser scanner and still visible at a distance of 80 feet (24.38 m). The spray chalk, which is not reflective, is more effective when working with colorized point clouds. It has also been determined that reflective chalk is an excellent marking tool when scanning a scene in wet conditions.

Subsequent real-world scans that have been done confirm the effectiveness of these marking materials; however, the distance where the marks were well-defined and visible varied based on lighting, road conditions, moisture, and other factors.

Grayscale Image Point Cloud					
	Marking Paint	Spray Chalk	Reflective Chalk	Paint Stick	Chalk
Well-Defined Distance	20' (6.10 m)	40' (12.19 m)	**60' (18.29 m)**	60' (18.29 m)	30' (9.14 m)
Visibility Max. Distance	30' (9.14 m)	30' (9.14 m)	**30' (9.14 m)**	30' (9.14 m)	40' (12.19 m)

Colorized Image Point Cloud					
	Marking Paint	Spray Chalk	Reflective Chalk	Paint Stick	Chalk
Well-Defined Distance	30' (9.14 m)	**50' (15.24 m)**	40' (12.19 m)	20' (6.10 m)	30' (9.14 m)
Visibility Max. Distance	70' (21.34 m)	**80' (24.38 m)**	70' (21.34 m)	40' (12.19 m)	60' (18.29 m)

Figure 5. Experiment distance results.

Placement of the Scanner

To effectively capture any scene with a laser scanner, it is important to understand where best to place the scanner and how far to move the scanner to the next position. Since each scan takes time to complete and process, you want to use as few scans as possible, but ensure you effectively capture the entire scene. The use of a field sketch is a great tool to use to help with scanner placement and ensure the data can be processed easily later.

We tested the FARO Focus^{3D} X 330 Laser Scanner to determine the best practice for scanner placement.

In the demonstration, we scanned some tire marks using a FARO Focus^{3D} X 330 Laser Scanner. We used the staggered methodology and kept within the 70-foot (21.34-meters) radius between scanner placements (Figure 6 and 7).

Changing the vertical height from a standard tripod (6 ft+ /1.83 m+) to an extra tall tripod (9 ft+ /2.74 m+) did not gain much distance in the horizontal plane. In fact, the further the scan goes out, the more separation there is between the scan points. Your scanned data at the extremes will certainly have greater separation.

As seen in Figure 8, the white dots represent the laser scanner placements and the red lines trace the tire marks captured.

The most effective and efficient methodology we have found is to stagger our scanner placement from one side to another, maintaining a 70-foot (21.34-meters) radius between placements. If your scanner placement is too far away from other placement locations, or larger than the 70-foot (21.34-meters) radius, you may miss critical evidence.

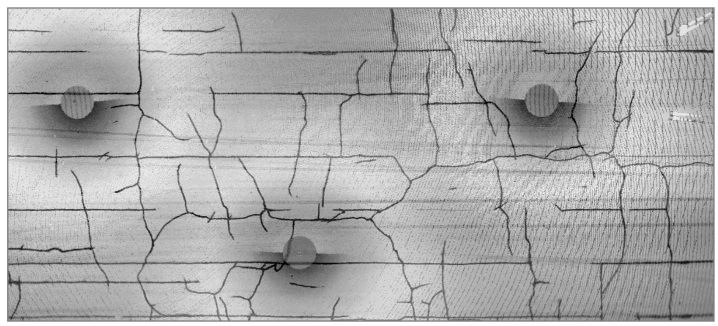

Figure 6. Grayscale scanner placement ortho.

Figure 7. Colorized scanner placement ortho.

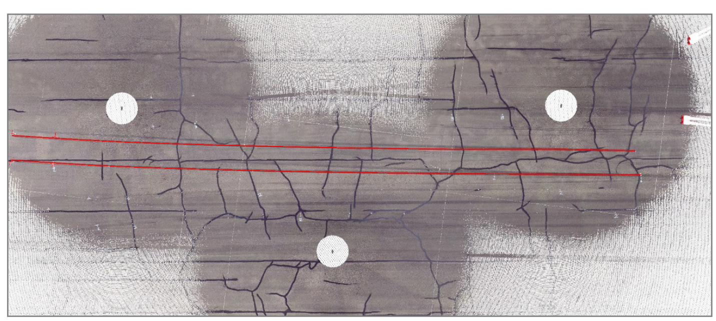

Figure 8. Ortho with tire mark line drawing.

FARO

Resolution and Quality Settings

The FARO Laser Scanners provide the ability to adjust several settings which greatly affect the time required to complete a scan and the quality of the data captured. Resolution is a setting that determines the density of the scan points. Choosing a small value for resolution means there will be a larger distance between points scanned and a lower density of points in the resulting point cloud. Choosing a larger value for resolution means the distance between scanned points is smaller, so the captured points in the cloud will be dense. Figure 10 compares the results of a tabletop scanned at a low resolution (left) and then scanned at a high resolution setting (right).

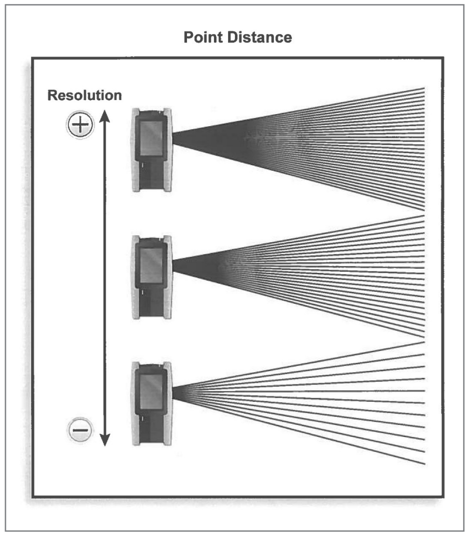

Figure 9. FARO training illustration of resolution and point distance graphic.

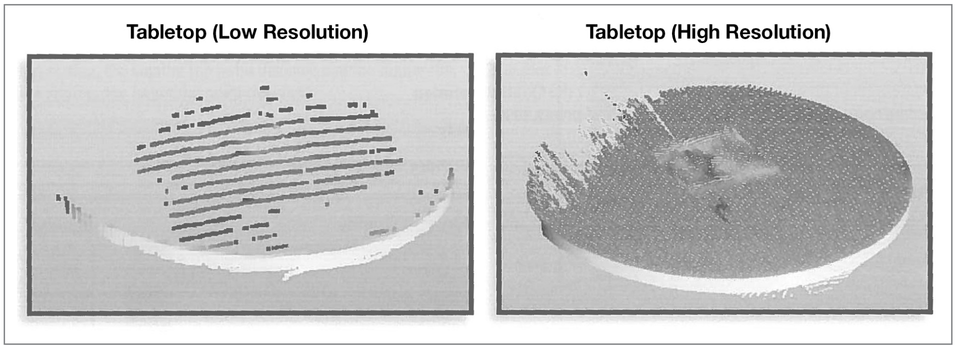

Figure 10. FARO training illustration of resolution.

A dense point cloud provides a more realistic look, but choosing the highest possible resolution each time is not a recommended approach. Choosing a higher resolution setting means each scan takes more time to complete. For most scenes, a resolution value of 1/4 or 1/5 gives good results in a reasonable amount of time. You should experiment with scanning at various resolutions to become comfortable with the difference before called to scan a real scene. In our experiment and demonstration for this article, we used a 1/4 Resolution setting.

Quality is a control that allows more data sampling. By adjusting the quality of the scan, the user is able to reduce the amount of noise (extraneous unwanted points) in the scan data. The higher the quality setting, the less noise in the scan data. You can choose from 1X to 8X depending on the resolution setting. In our experiment and demonstration for this article, we used a 3X Quality setting.

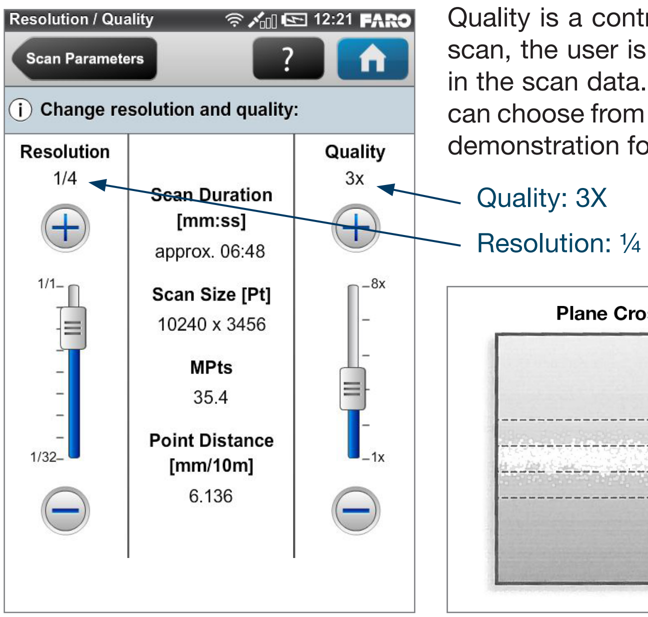

Figure 11. FARO scanner Resolution / Quality setting screen.

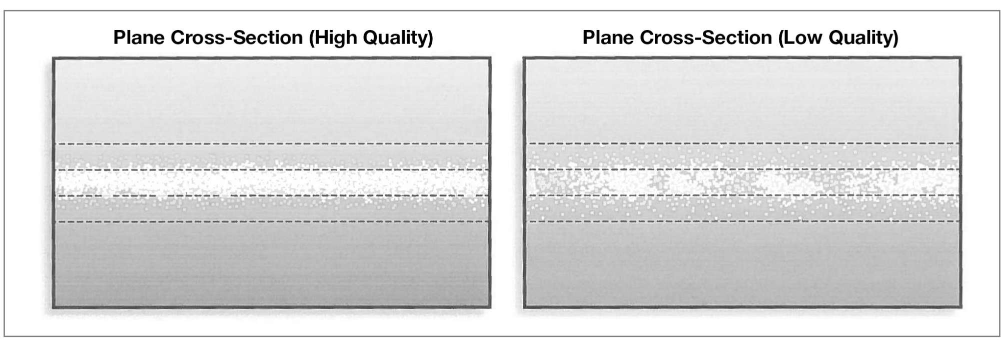

Figure 12. Difference in noise between a high and low quality setting.

As you change the resolution setting, the available quality settings also changes (Figure 13). You should be aware of how your resolution and quality setting affects the time required to complete a scan. In general, as you increase resolution or quality, the scanning time increases. Figure 14 shows how the time required per scan would increase if either resolution or quality changed.

Resolution	Quality (Maximum)	Quality (Minimum)
1	4X	1X
1/2	6X	1X
1/4	8X	1X
1/5	6X	2X
1/8	8X	2X
1/10	8X	3X
1/16	8X	3X
1/20	8X	4X
1/32	8X	4X

Figure 13. Range of available quality settings based on resolution.

Resolution	Quality	Time (Min:Sec)
1/5	4X	7:48
1/5	3X	5:31
1/5	2X	4:22
1/4	4X	10:23
***1/4**	**3X**	**6:48**
1/4	2X	5:01
1/2	4X	31:51
1/2	3X	17:51
1/2	2X	10:23
1	4X	1:57:00
**Setting for the experiment and demonstration of this article using the FARO Focus^{3D} X 330*		

Figure 14. Illustration of time based on settings for the FARO Focus^{3D} X330.

Summary

The goal for all forensic investigators is to collect evidence in an accurate, effective and efficient manner. The portfolio of FARO Focus Laser Scanners allows forensic investigators to accurately and efficiently collect important crime and crash scene data. Before scanning a crash or crime scene, the investigator should mark important evidence with spray chalk or reflective chalk to ensure it is highly visible in the point cloud. For typical scenes, it is recommended to use a staggered scanner position with each scanner placement no more than 70-feet (21.34-meters) apart. It is also recommended that using a resolution setting of 1/4 and a quality setting of 3X results in effective scan data for typical forensic scenes. This article has been prepared as a best-practice approach, based on daylight scanning and good weather conditions.

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