



US Army Corps of Engineers  
ERDC -CHL



# FIELD OPERATION CENTER

## Coastal Hydraulics Lab

Field Data Collection and Analysis Branch

**Presenter**

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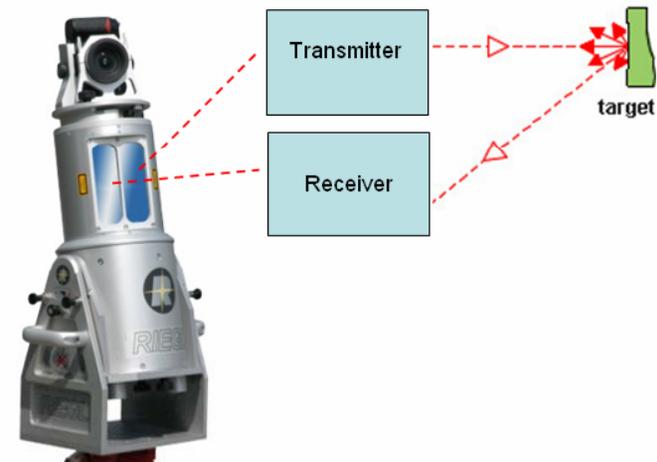


# LIDAR

- The term “laser scanning” is not completely descriptive of the technology – the key technology is commonly referred to as “lidar”.
- Lidar (Ligh detection and ranging) is a type of laser radar technology determining distance to an object by measuring the time between the emission of a light pulse and return from an object surface
- This type of Lidar is called “pulsed” lidar technology and is the technology employed by Riegl Systems.



Pulsed signal  
transmission  
and processing

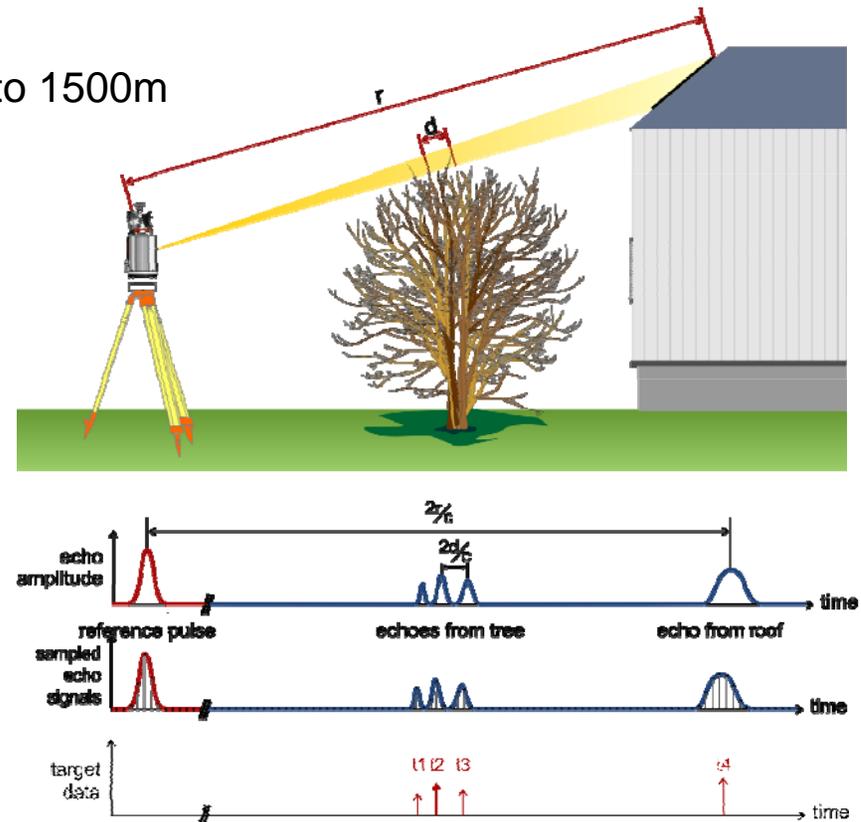




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- **Principle:**
- Time-of-flight method
  - TOF devices capture data at a rate between hundreds and thousands of points per second
  - Useful data can be provided from 1m up to 1500m
- Near-infrared wavelength
- Class 1 eye safe in Riegl instruments
- 24 KHz pps laser source in Z series scanners
- Pulsed diode laser transmitter
- Sensitive narrow-band optical receiver
- **Advantages:**
- High Reliability
- High interference immunity
- Quick Data Acquisition
- Highly collimated measuring beam
- Excellent cost / performance ratio
- Compact Size
- Long range





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## Rangefinder Performance

Laser Product Classification



according to IEC60825-1:1993+A1:1997+A2:2001  
The following clause applies for instruments delivered into the United States:  
Complies with 21 CFR 1040.10 and 1040.11 except for deviations pursuant  
to Laser Notice No. 50, dated July 26, 2001.

	<i>Long Range Mode</i>	<i>High Speed Mode</i>
Laser PRR (Peak) <sup>2)</sup>	100 kHz	300 kHz
Effective Measurement rate <sup>2)</sup>	42 000 meas./s	125 000 meas./s
Max. Measurement range <sup>3)</sup> for natural targets $\rho \geq 80\%$ for natural targets $\rho \geq 10\%$	500 m 160 m	300 m 100 m
Max. Number of targets per pulse	practically unlimited <sup>4)</sup>	practically unlimited <sup>4)</sup>
Accuracy <sup>5) 7)</sup>	5 mm	5 mm
Precision <sup>6) 7)</sup>	5 mm	5 mm

Minimum range 1 m  
Laser wavelength near infrared  
Beam divergence <sup>8)</sup> 0.3 mrad



## Scanner Performance

### Vertical (line) scan

Scan angle range	total 100° (+60° / -40°)
Scanning mechanism	rotating multi-facet mirror
Scan speed	3 lines/s to 120 lines/s
Angular stepwidth $\Delta \vartheta$ <sup>9)</sup> between consecutive laser shots	$0.0024^\circ \leq \Delta \vartheta \leq 0.288^\circ$
Angle measurement resolution	better 0.0005° (1.8 arcsec)

### Horizontal (frame) scan

Scan angle range	max. 360°
Scanning mechanism	rotating head
Scan speed <sup>10)</sup>	0°/s to 60°/s
Angular stepwidth $\Delta \varphi$ <sup>9)</sup> between consecutive scan lines	$0.0024^\circ \leq \Delta \varphi \leq 0.5^\circ$
Angle measurement resolution	better 0.0005° (1.8 arcsec)
Inclination Sensors	integrated, for vertical scanner setup position
Internal Sync Timer	integrated GPS-synchronized time stamping of scan data



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## Terrestrial and Mobile Scanning In and Around Structures





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## Mobile Scanning and Acoustic Under Water Profiling From a Boat



**GeoSwath Bathymetric  
Survey System    Riegl Vessel-Mounted LASER**

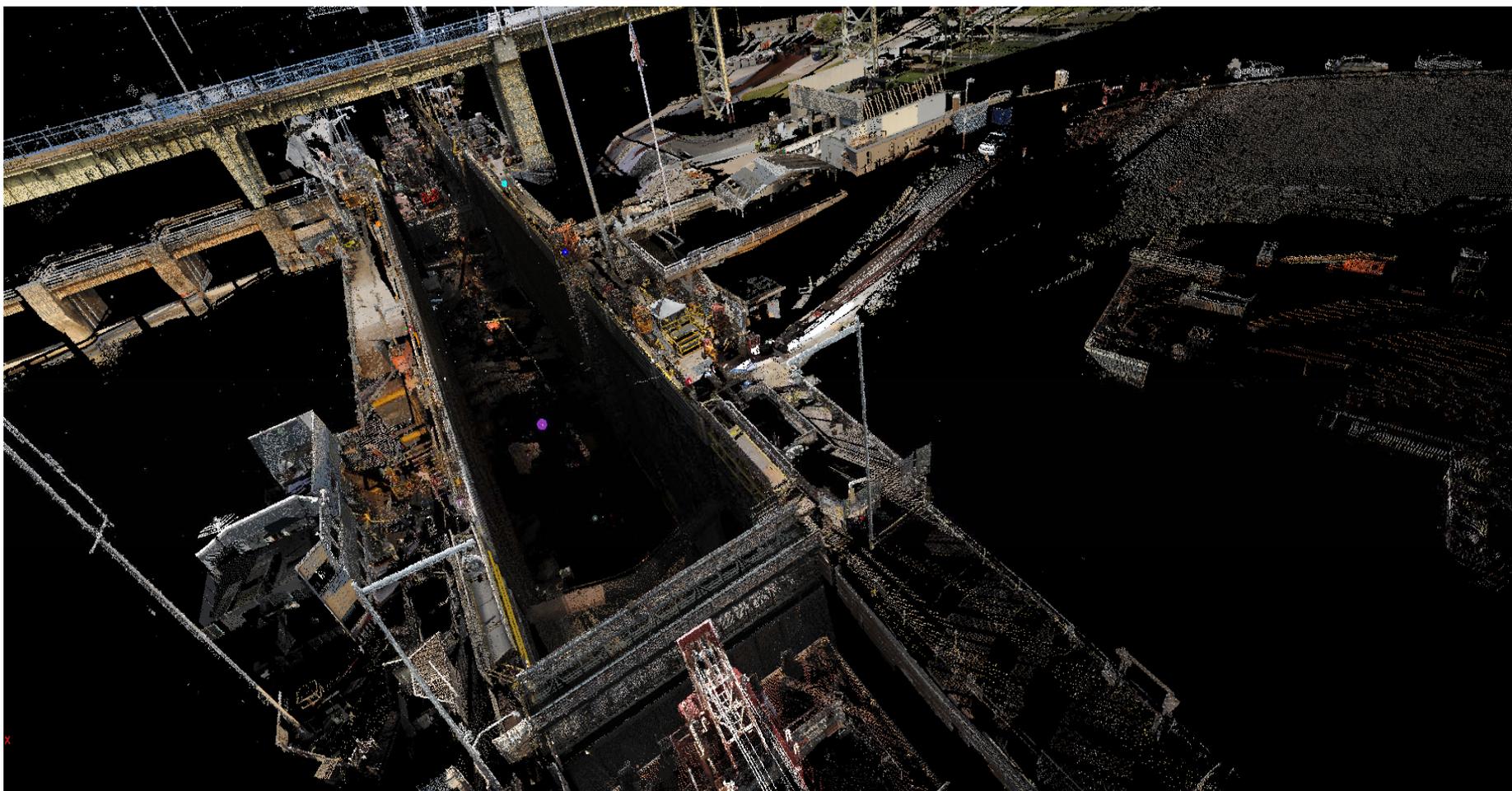


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# Chickamauga Lock and Dam

Point Cloud for As built and Baseline surveys

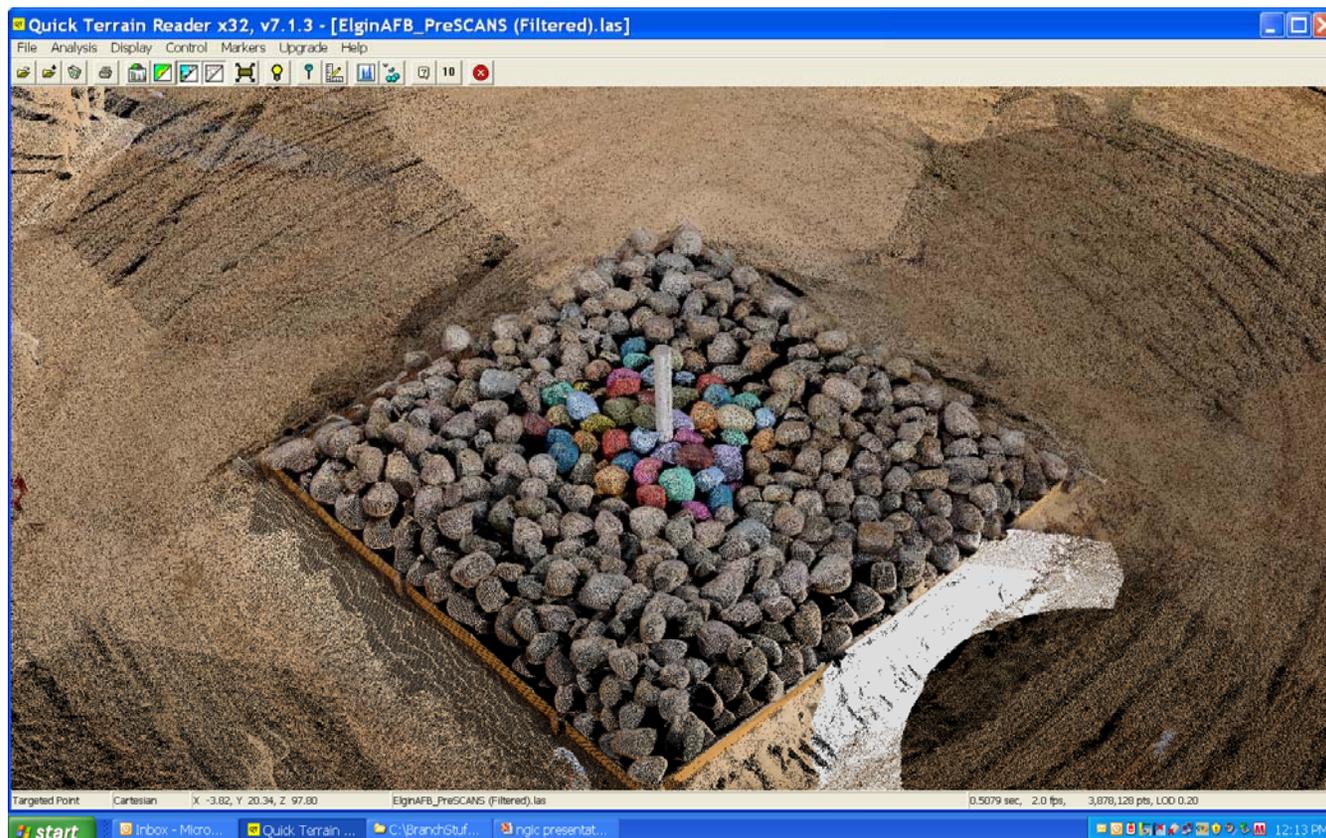




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## Pre Test Scan Plan View





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## Pre Test Scan Side View





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## AVI File of the Post Test



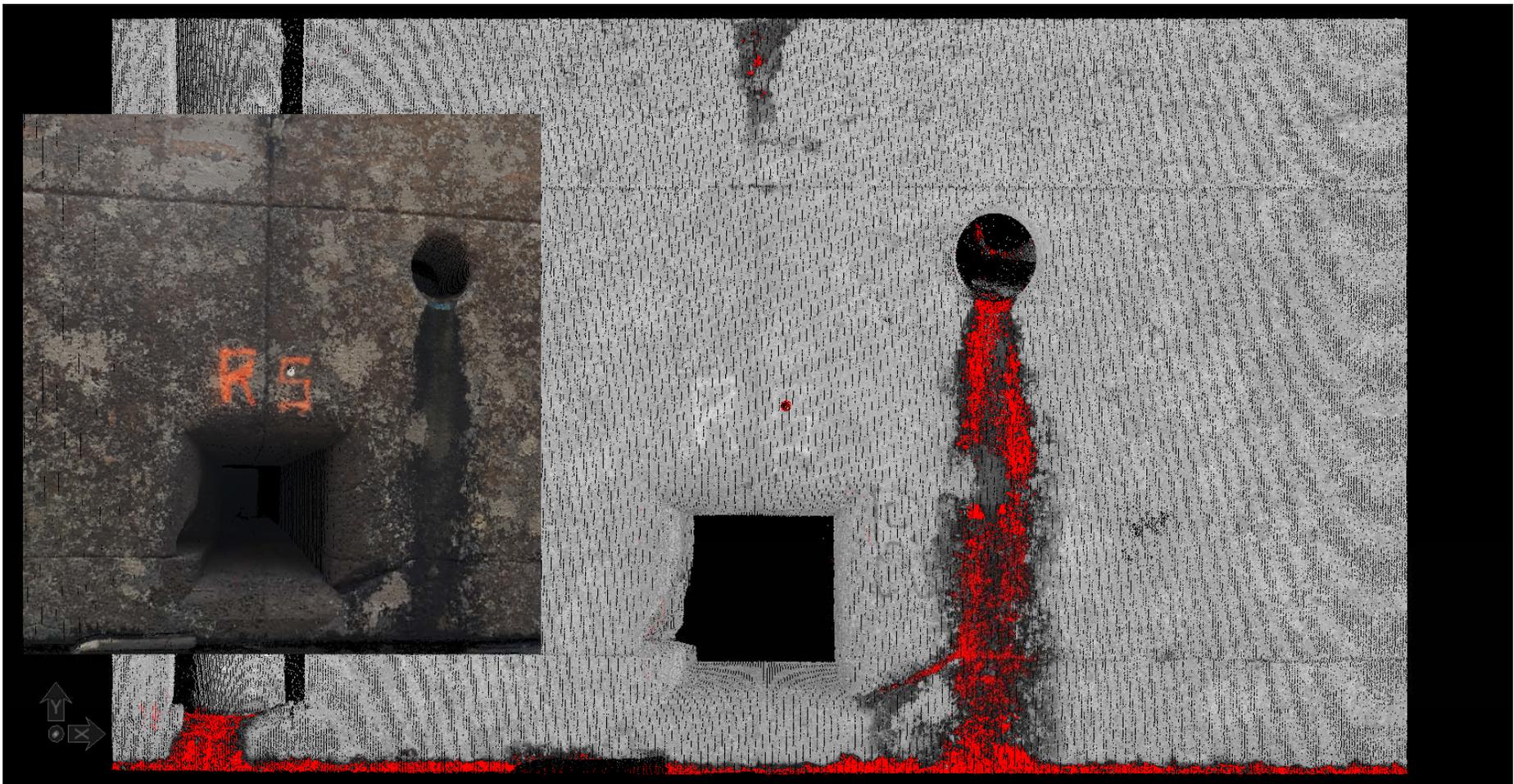
(.avi)



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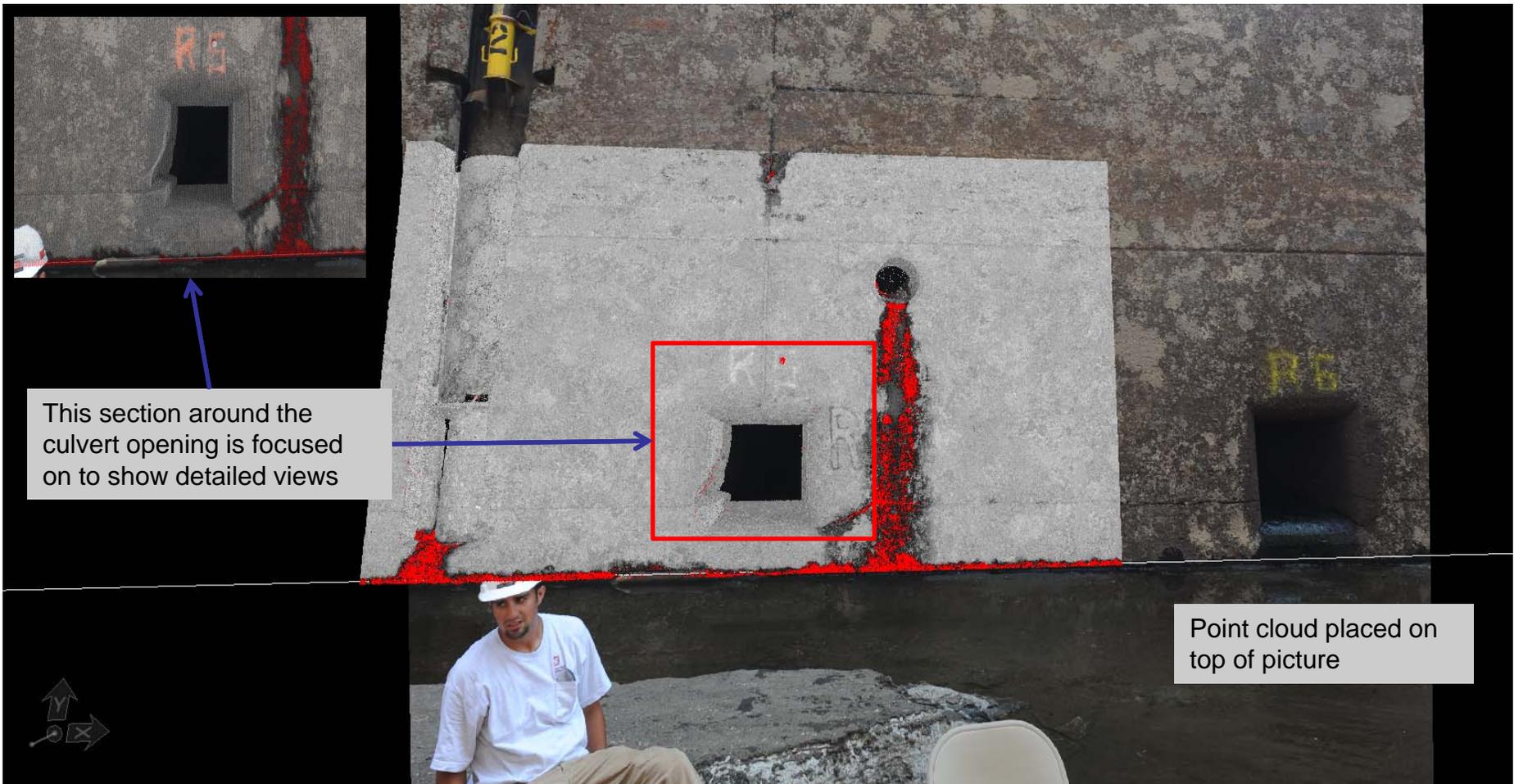


## River Side Culvert Example of Change in Reflectance





## River Side Culvert

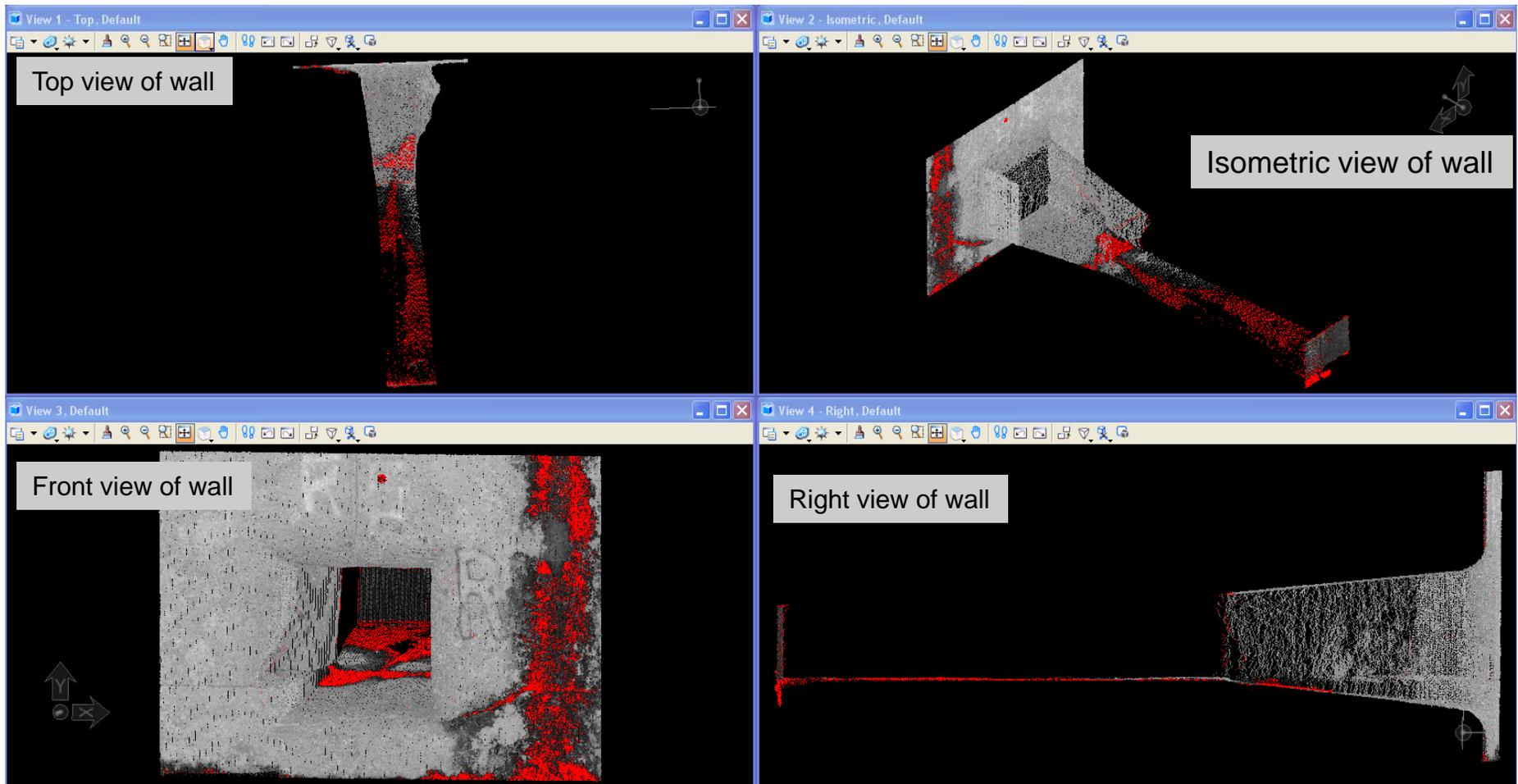


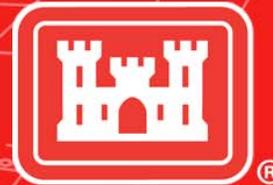
This section around the culvert opening is focused on to show detailed views

Point cloud placed on top of picture



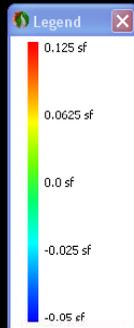
## River Side Culvert





## Structural Scanning for Change Detection Lock Chamber Empty

Color scheme for distance from ACS Plane



Points in the point cloud that are furthest from plane (in the positive direction) are colored red. Points that are in-line with plane are green

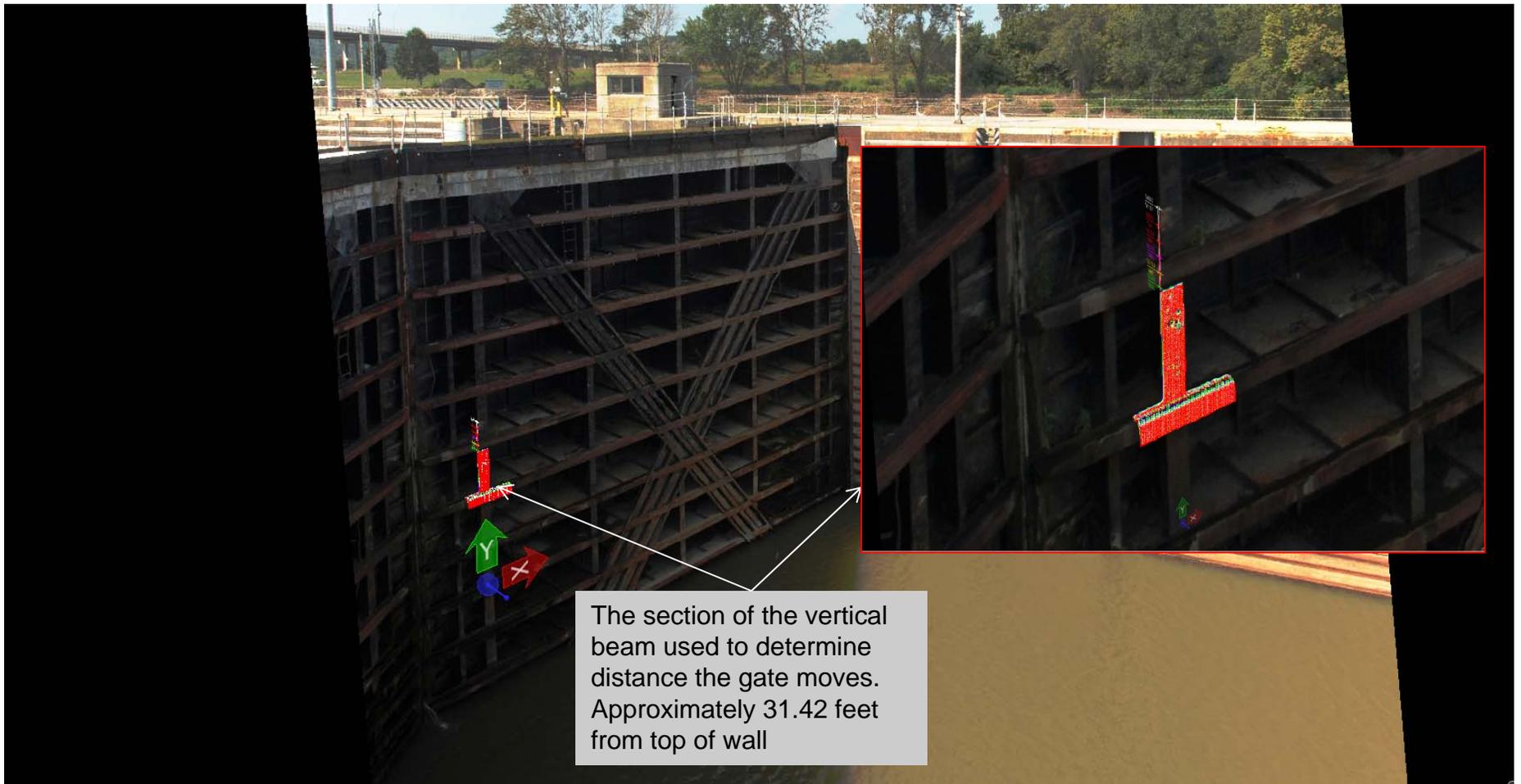
Lock chamber empty for first scan and about to fill.

Disp	Color	Points	File Path
On	6	1889055	...NGLESCANSVDSM_RS_04_EMPTY_fill.rsp
Off	7	1894375	...NGLESCANSVDSM_RS_04_05ft_fill.rsp
Off	8	1897316	...NGLESCANSVDSM_RS_04_10ft_fill.rsp
Off	9	1898043	...NGLESCANSVDSM_RS_04_18ft_fill.rsp
Off	10	1901437	...NGLESCANSVDSM_RS_04_25ft_fill.rsp
Off	12	1905152	...NGLESCANSVDSM_RS_04_FULL_fill.rsp
Off	13	1871910	...NSVDSM_RS_04_FULL_NOBOAT_empty.rsp
Off	14	1874070	...NGLESCANSVDSM_RS_04_05ft_fill.rsp

On Off Unload

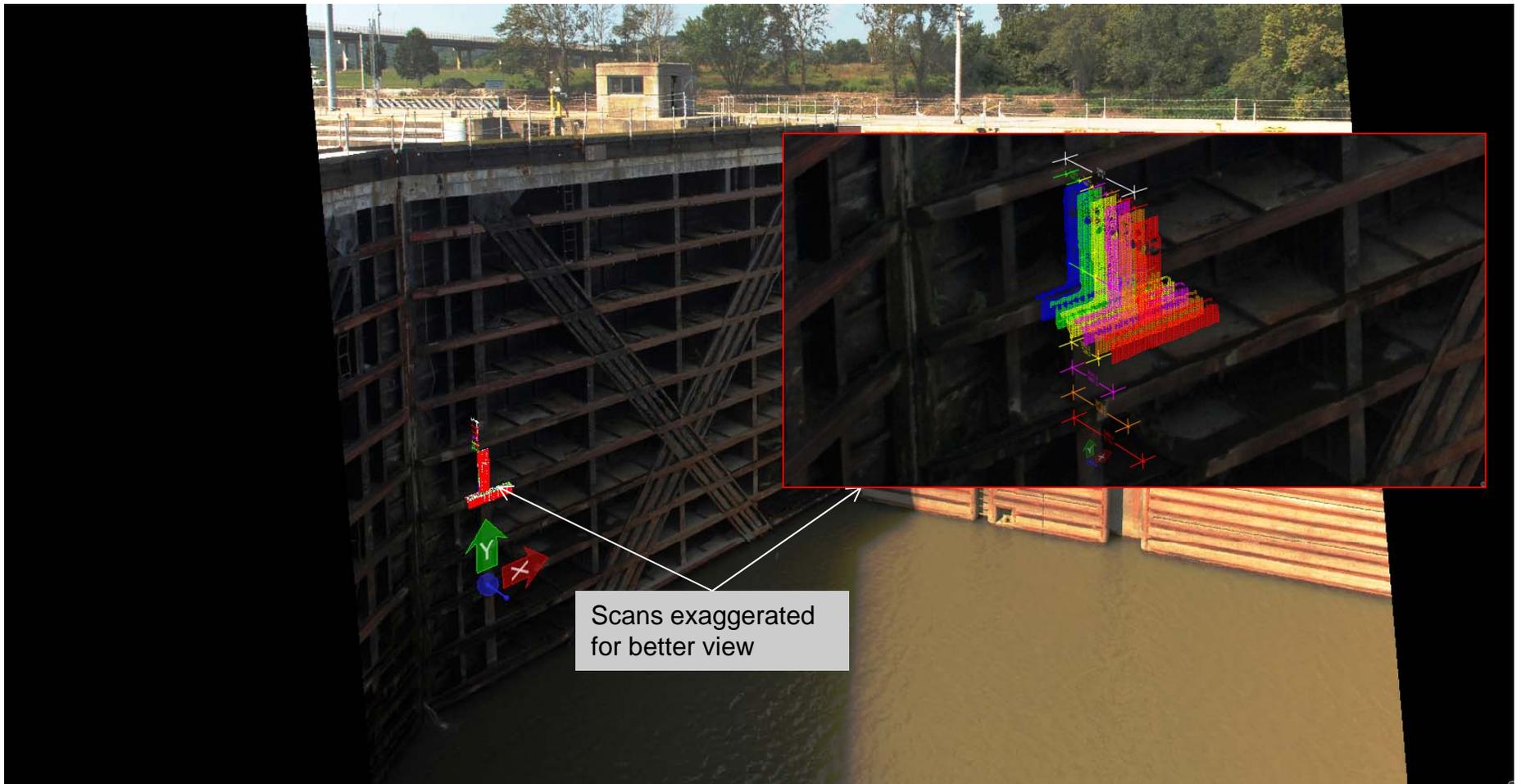


## Distance of a Point on Vertical Beam to ACS Plane



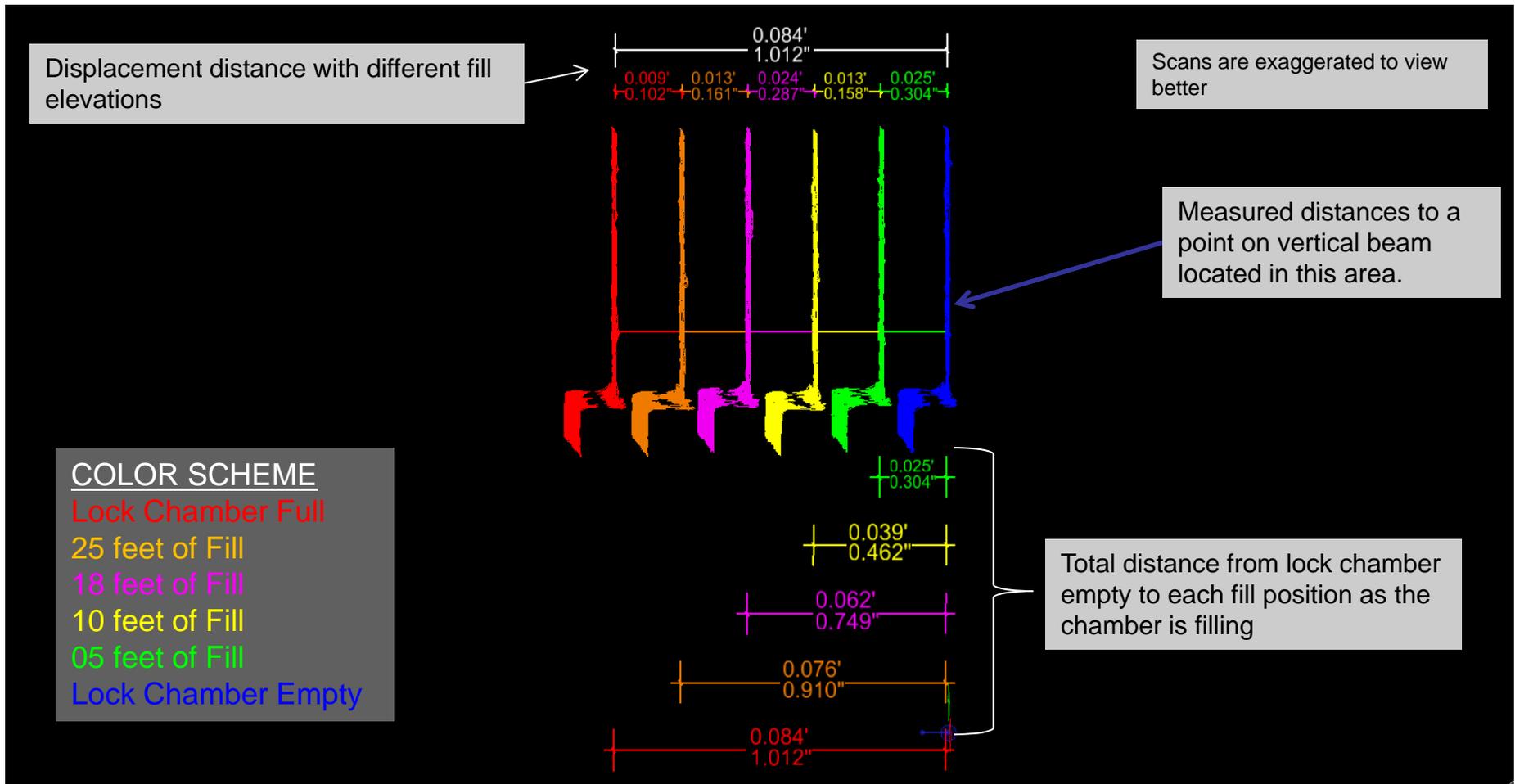


## Distance of a Point on Vertical Beam to ACS Plane (Exaggerated View)





## Distance of a Point on Vertical Beam to ACS Plane (Exaggerated View)

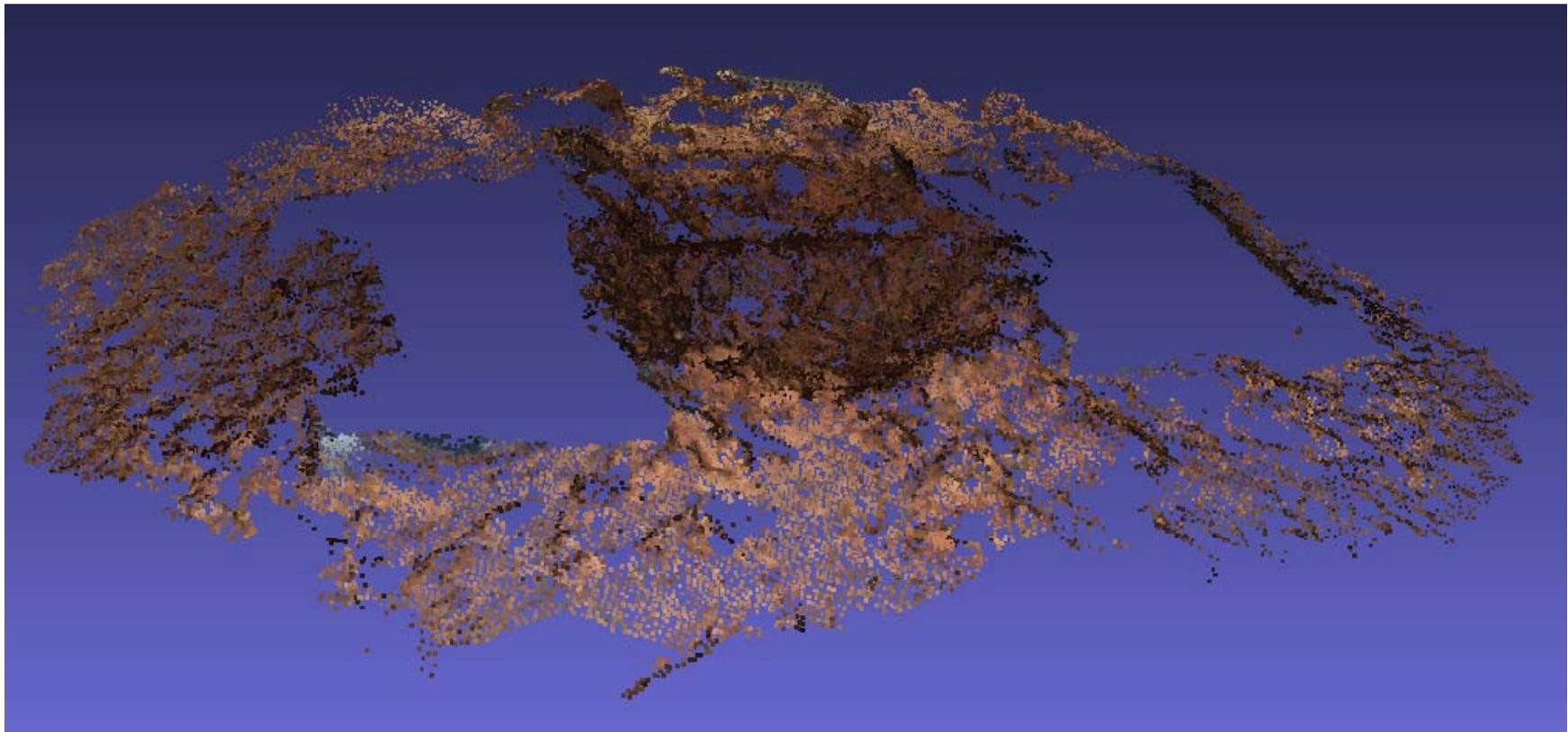




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Shot 1

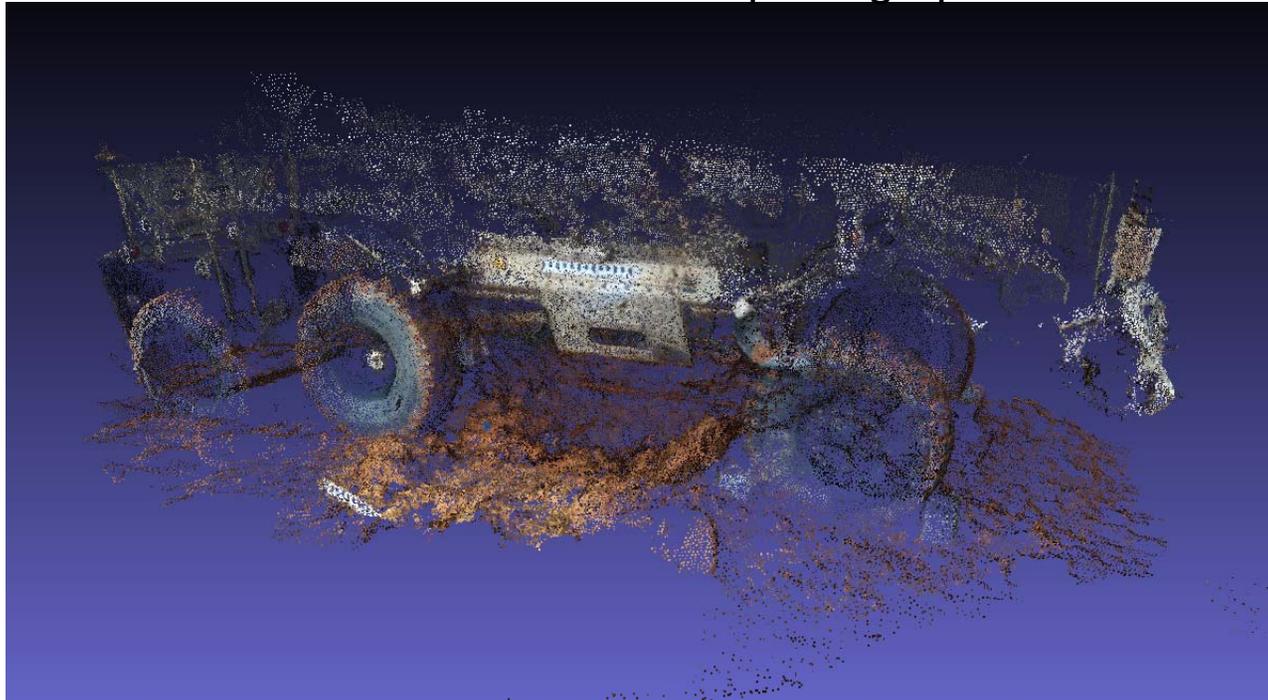




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Point cloud from photograph

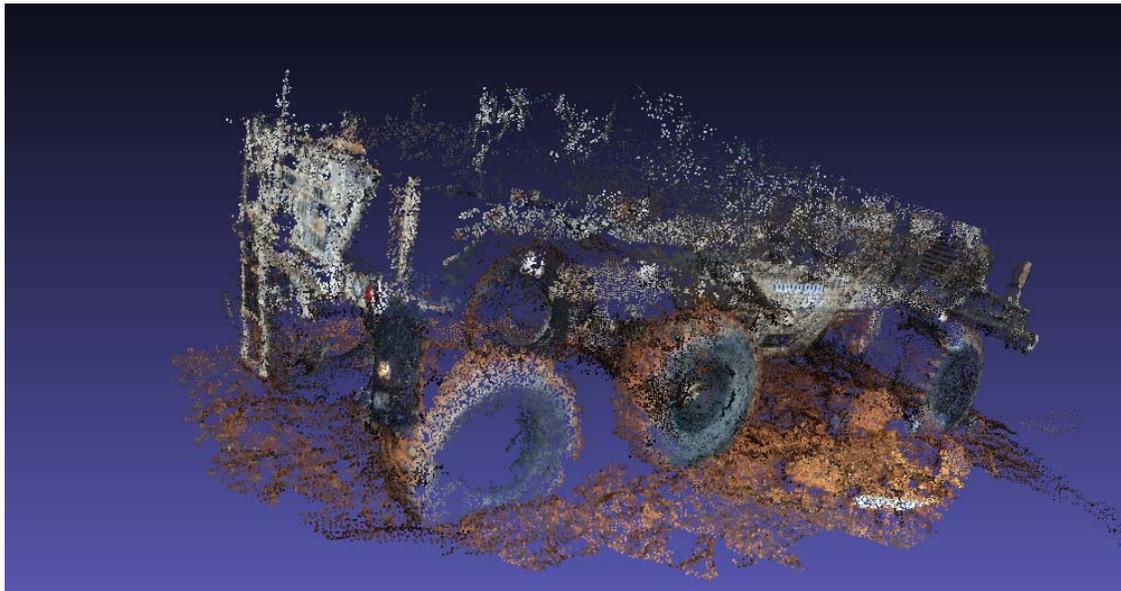




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Point from photograph





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After crop

The screenshot displays a software interface for crater analysis. The main window is titled "ce-04-06\_crater contour plot" and shows a 3D top-down view of a crater with a grid overlay. The X and Y axes are labeled in feet, ranging from 0 to 30. Below the 3D plot is a vertical slider and a "Panel" section with buttons for "Find X Angle", "Find Y Angle", and "Ground to Zero".

To the right of the 3D plot is a cross-section plot titled "ce-04-06\_crater cross-section X". The Y-axis is labeled "Z (feet)" and ranges from 0 to 5. The X-axis is labeled "Y (feet)" and ranges from 0 to 34. Below this is another cross-section plot titled "ce-04-06\_crater cross-section Y". The Y-axis is labeled "Z (feet)" and ranges from 0 to 5. The X-axis is labeled "X (feet)" and ranges from 0 to 34.

At the bottom left, there is a "Crater Profile" diagram showing a cross-section of the crater with various parameters labeled: L (Lip to Lip Diameter), M (Apparent Crater Diameter), SW (Shelf Width), SD (Shelf Depth), D (Apparent Crater Depth), and LH (Lip Height). The diagram also indicates "Ground Zero" and "Crater Profile".

In the center, there is an "Operations" panel with buttons for "Load Picture", "Rotate (X)", "Rotate (Y)", "Rotate (Z)", "Recenter", "Crop", "Cut CS", and "Crater Slope Plot". It also includes input fields for "Angle", "Axis", "Spacing", "x1", "x2", "y1", and "y2".

On the right side, there is a "Metrics (Units - Feet)" panel with a table of measurement options:

Measurement	X	Y	Avg	on/off	Notes
Lip to Lip Diameter	L				
Apparent Crater Diameter	M				
Apparent Crater Depth	D				
Lip Height	LH				
Shelf Depth	SD				
Shelf Width	SW				
Depth of Burial	DOB				
Apparent Crater Volume	ACV				cubic ft
General measurement 1	GM 1				
General Measurement 2	GM 2				
General Measurement 3	GM 3				
General Measurement 4	GM 4				

At the bottom of the metrics panel is a "Clear All" button.



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**ce-04-06\_crater contour plot**

**ce-04-06\_crater cross-section X**

**ce-04-06\_crater cross-section Y**

**Crater Profile**

**Operations**

**Metrics (Units = Feet)**

Measurement	X	Y	Avg	on/off	Notes
Lip to Lip Diameter	L				
Apparent Crater Diameter	M				
Apparent Crater Depth	D				
Lip Height	LH				
Shelf Depth	SD				
Shelf Width	SW				
Depth of Burial	DOB				
Apparent Crater Volume	ACV				cubic ft
General Measurement 1	GM 1				
General Measurement 2	GM 2				
General Measurement 3	GM 3				
General Measurement 4	GM 4				



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Before Crop

The screenshot displays the 'crater\_GUI' software interface. The main window is titled 'ce-04-06\_crater contour plot' and shows a 3D top-down view of a crater with a green circular selection. Below this is a 'Panel' with buttons for 'Find X Angle', 'Find Y Angle', and 'Ground to Zero'. To the right is a 'ce-04-06\_crater cross-section X' plot showing Z (feet) vs Y (feet). A dialog box with a question mark asks 'Press yes to crop' with 'Yes', 'No', and 'Cancel' buttons. Below the dialog is a 'ce-04-06\_crater cross-section Y' plot showing Z (feet) vs X (feet). The bottom left shows a 'Crater Profile' diagram with labels for L, M, SW, SD, D, and LH. The bottom right contains a 'Metrics (Units = Feet)' panel with various input fields and buttons for measurements like Lip to Lip Diameter, Apparent Crater Diameter, Apparent Crater Depth, Lip Height, Shelf Depth, Shelf Width, Depth of Burial, and Apparent Crater Volume. There are also 'General Measurement' fields (GM 1-4) and a 'Clear All' button.





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## Point Cloud from Scan

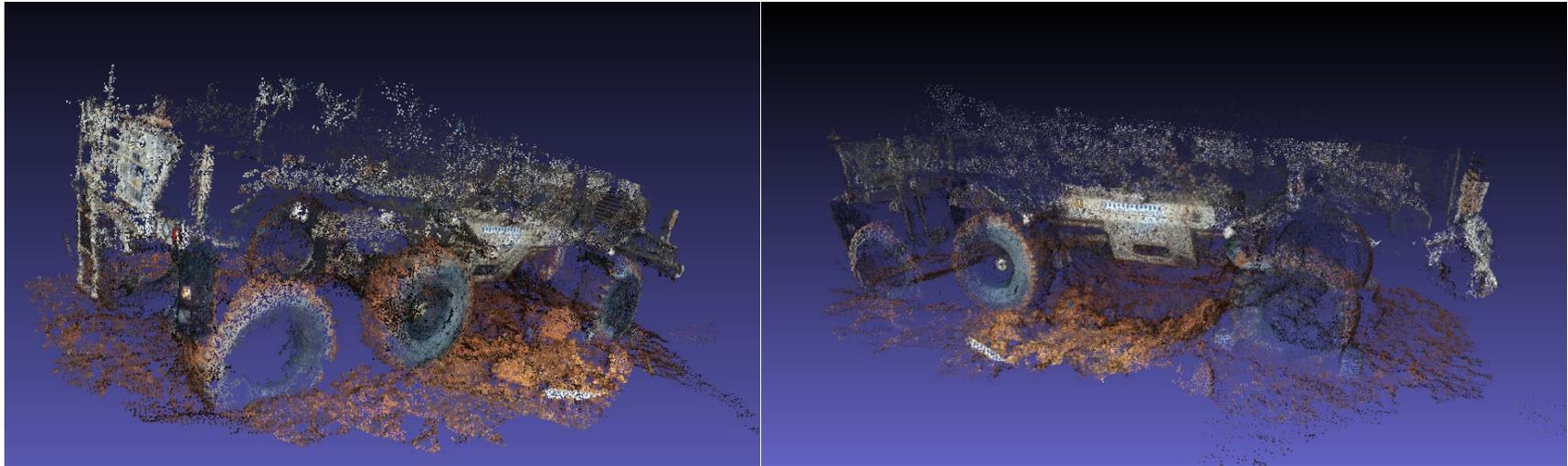




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## Point Cloud from Pictures

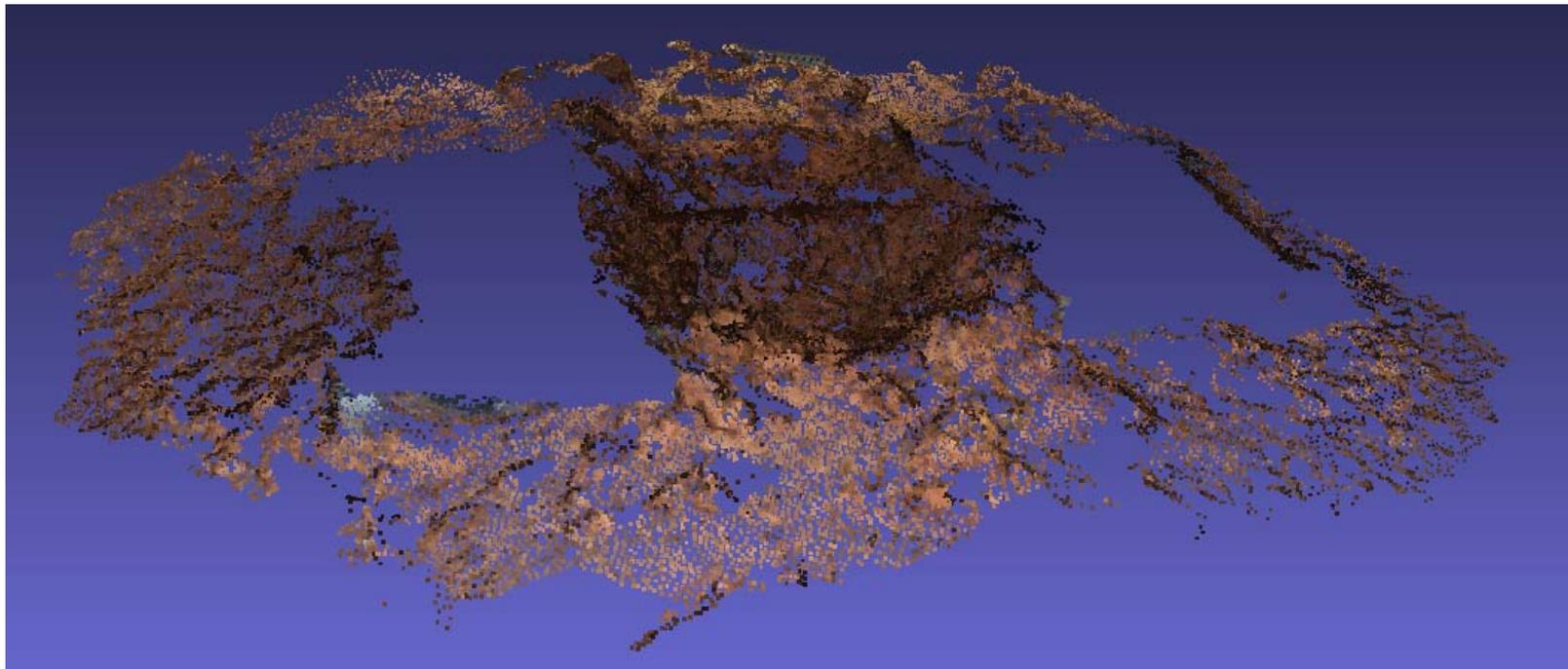




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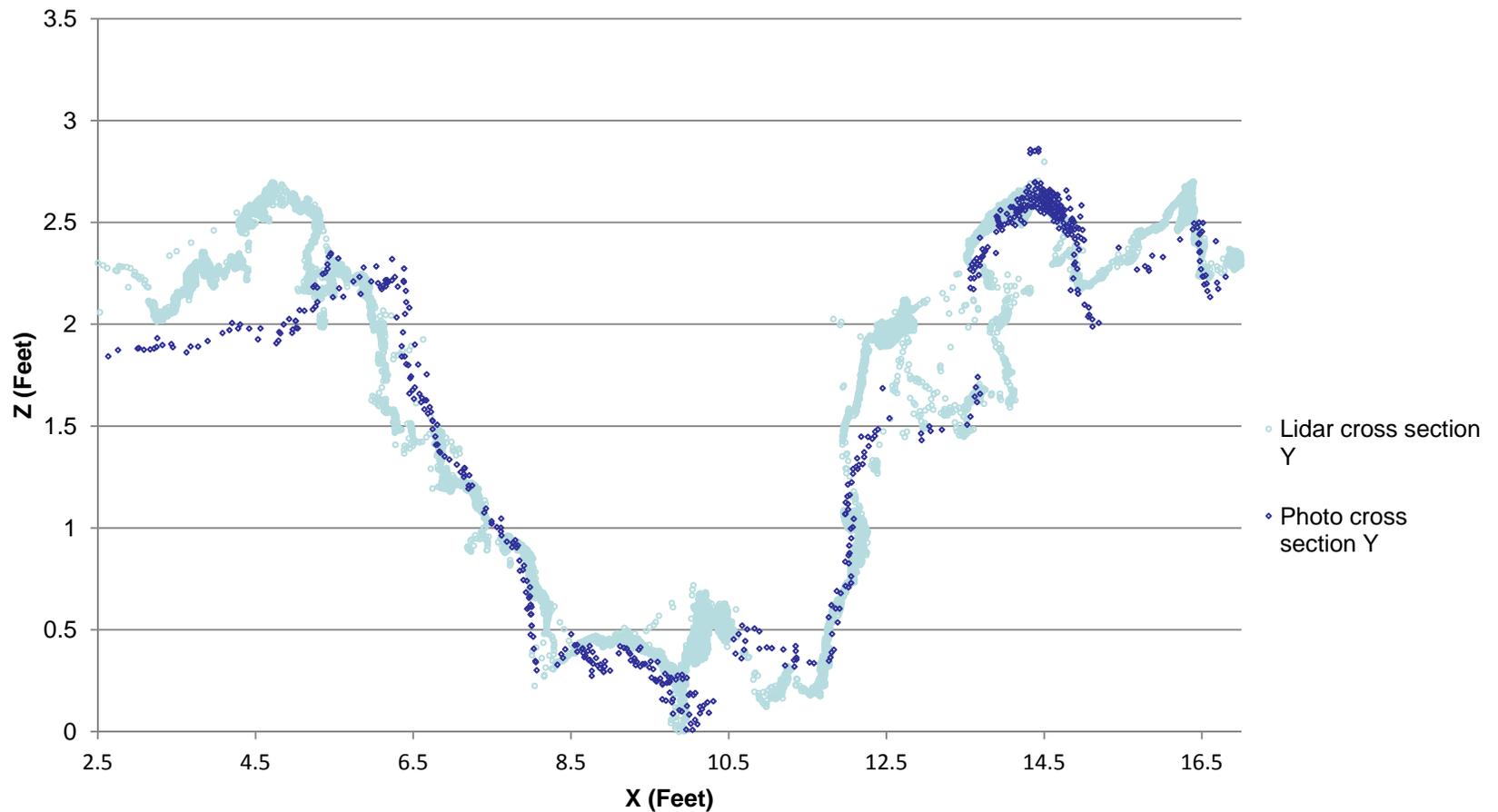


Photo Crater after Vehicle Is Removed



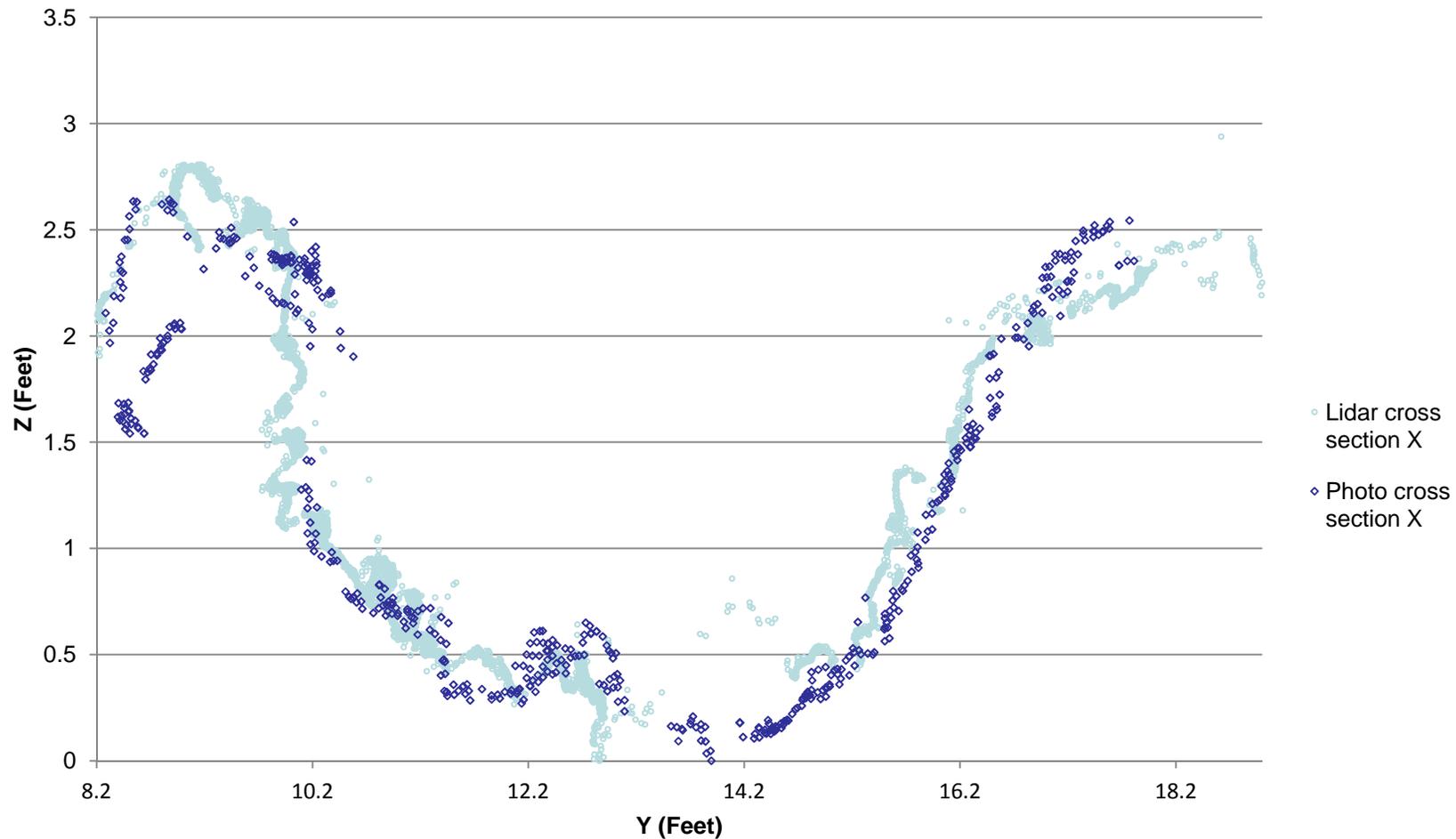


### Crater CE-04-01 cross-section Y





### Crater CE-04-01 cross-section X





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## First Step upon Importing

The screenshot displays the ERDC software interface for crater analysis. It includes several key components:

- ce-04-06\_crater contour plot:** A 2D plot showing the crater's footprint with X and Y axes in feet.
- Operations Panel:** A central control area with buttons for "Find X Angle", "Find Y Angle", "Ground to Zero", "Load Picture", "Rotate (X)", "Rotate (Y)", "Rotate (Z)", "Recenter", "Crop", "Crater Slope Plot", "Angle", "Cut CS", "Axis", "Spacing", "x1", "x2", "y1", "y2", and "Out CS".
- ce-04-06\_crater cross-section X:** A vertical plot of Z (feet) vs Y (feet) showing a cross-section of the crater.
- ce-04-06\_crater cross-section Y:** A vertical plot of Z (feet) vs X (feet) showing another cross-section.
- Crater Profile:** A detailed diagram of the crater's cross-section with labeled parameters: L (Lip to Lip Diameter), M (Apparent Crater Diameter), SW (Shelf Width), SD (Shelf Depth), D (Apparent Crater Depth), and LH (Lip Height). It also indicates "Ground Zero" and "Crater Profile".
- Metrics (Units = Feet):** A panel on the right for data entry and calculation, including fields for Ground Z, Radial CS Ht, Radial CS D, Lip to Lip Diameter (L), Apparent Crater Diameter (M), Apparent Crater Depth (D), Lip Height (LH), Shelf Depth (SD), Shelf Width (SW), Depth of Burial (DOB), Apparent Crater Volume (ACV), and four General Measurement (GM) fields.