Project - Panel 2

City, State, 05/28/2013

The enclosed report contains the data and analysis summary for the SoniCaliper panel caliper, performed at Project (Panel 2), City, State on Tuesday, May 28, 2013 by the SoniCaliper Engineer. The panel was calipered from a reference depth of 5.0 feet to a depth of 140.0 feet.

The minimum concrete volume is calculated to be 437.5 yd^3, based on the area of the calipered cross-sections and a Top of Concrete depth of 1.0 feet. (Note that this includes theoretical volume based on a nominal barrette cross-sectional area between depths of 140.0 feet and 149.1 feet, which was not calipered.)

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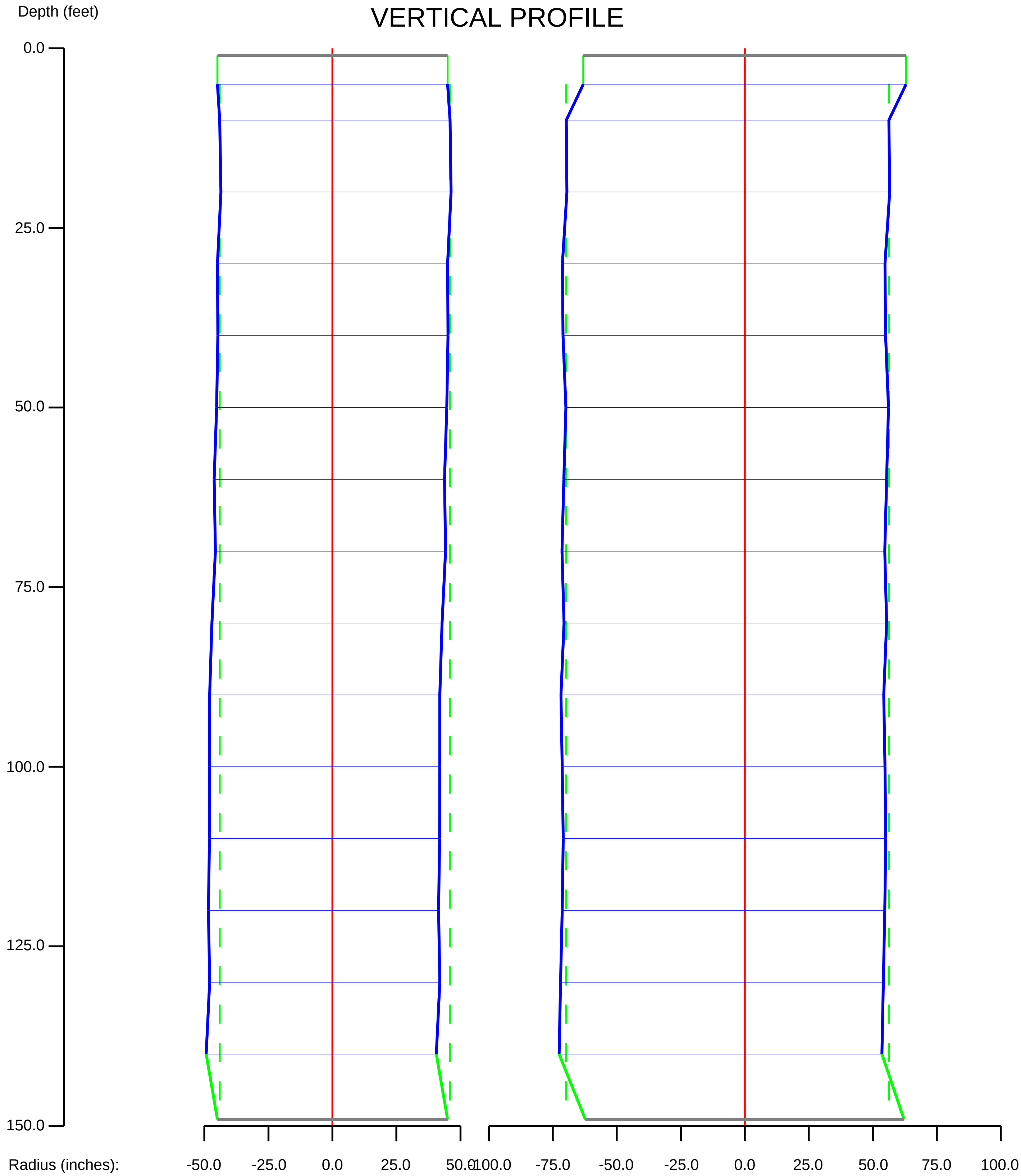
VERTICAL PROFILE



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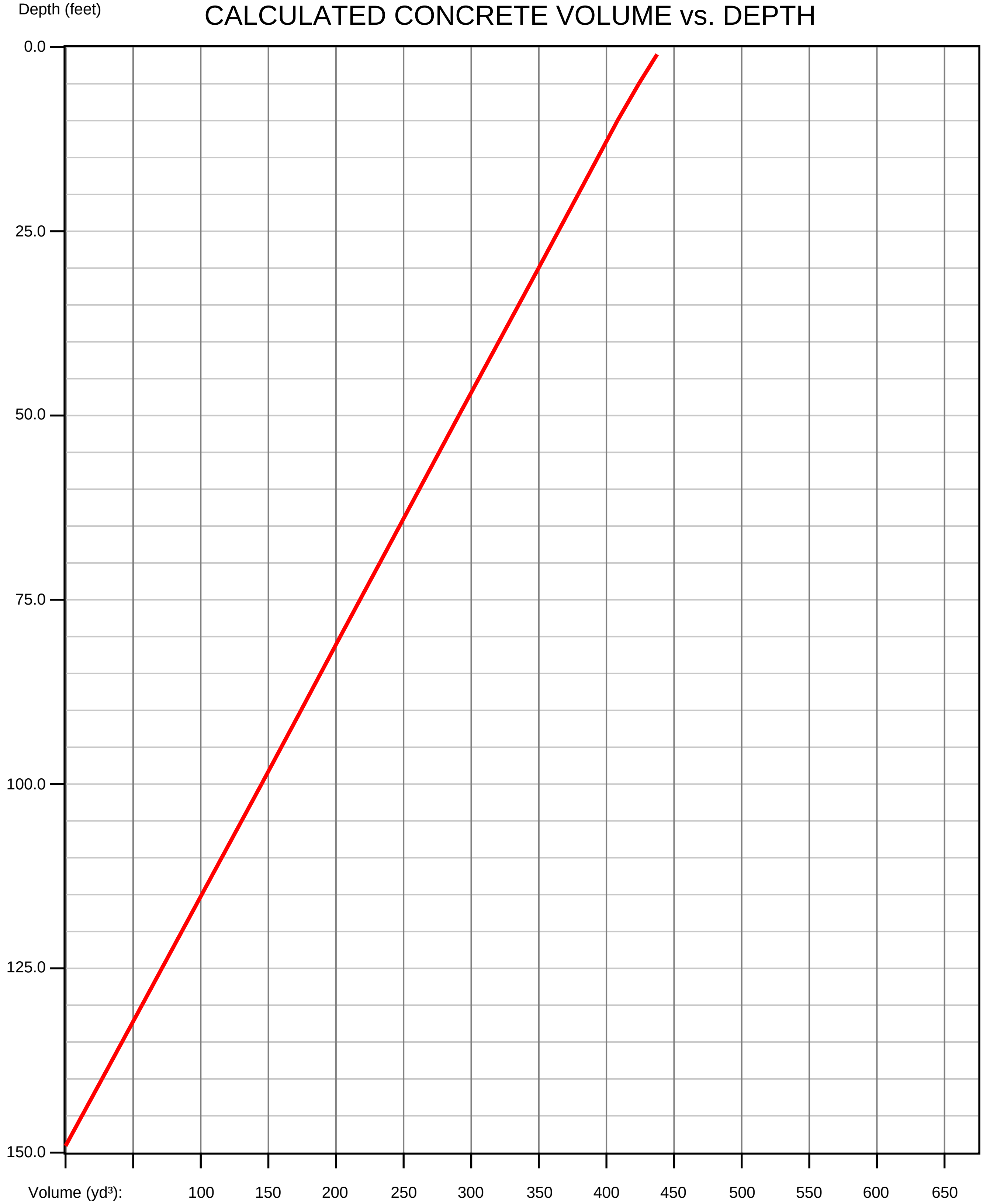
CALCULATED CONCRETE VOLUME vs. DEPTH



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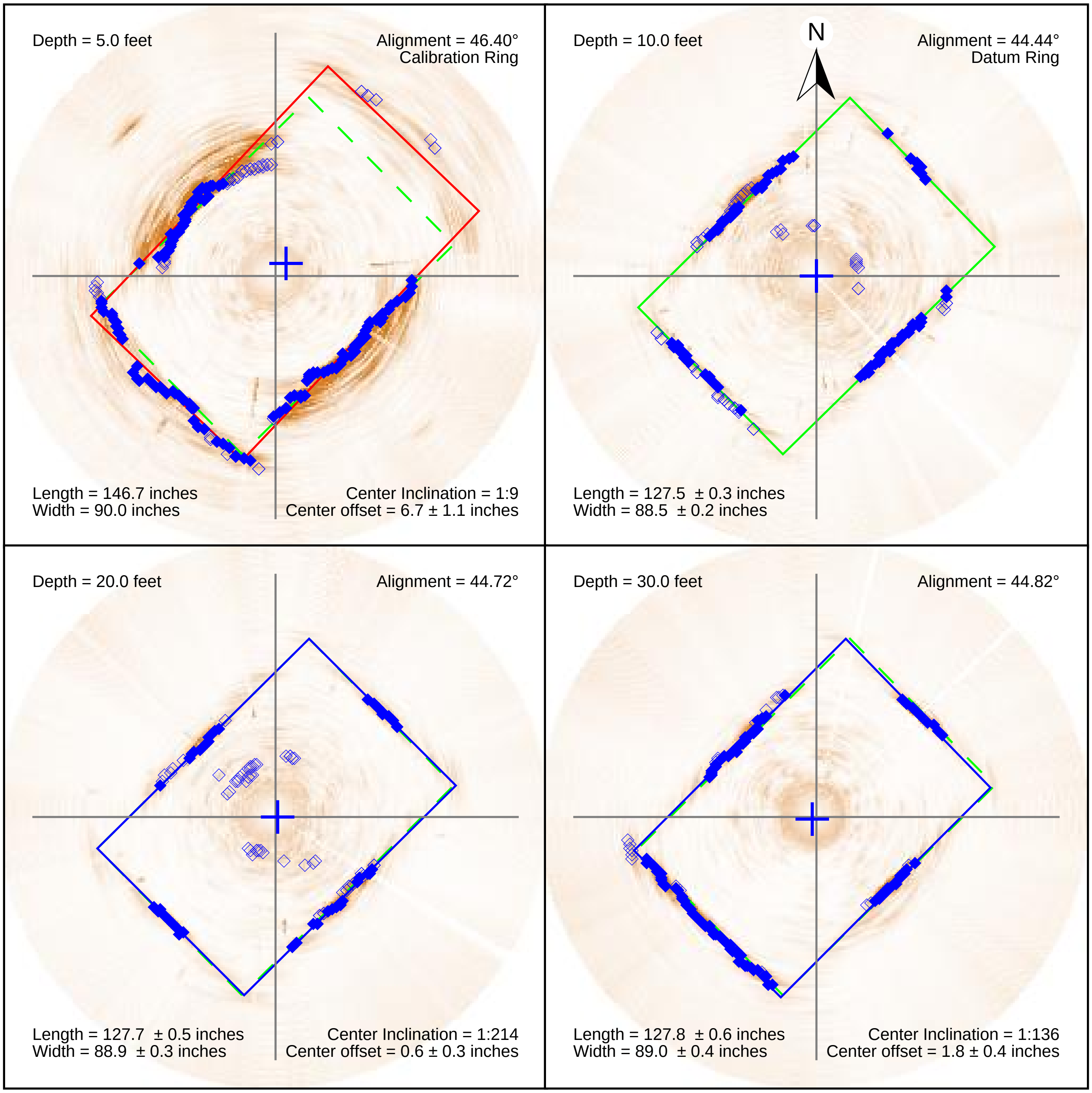

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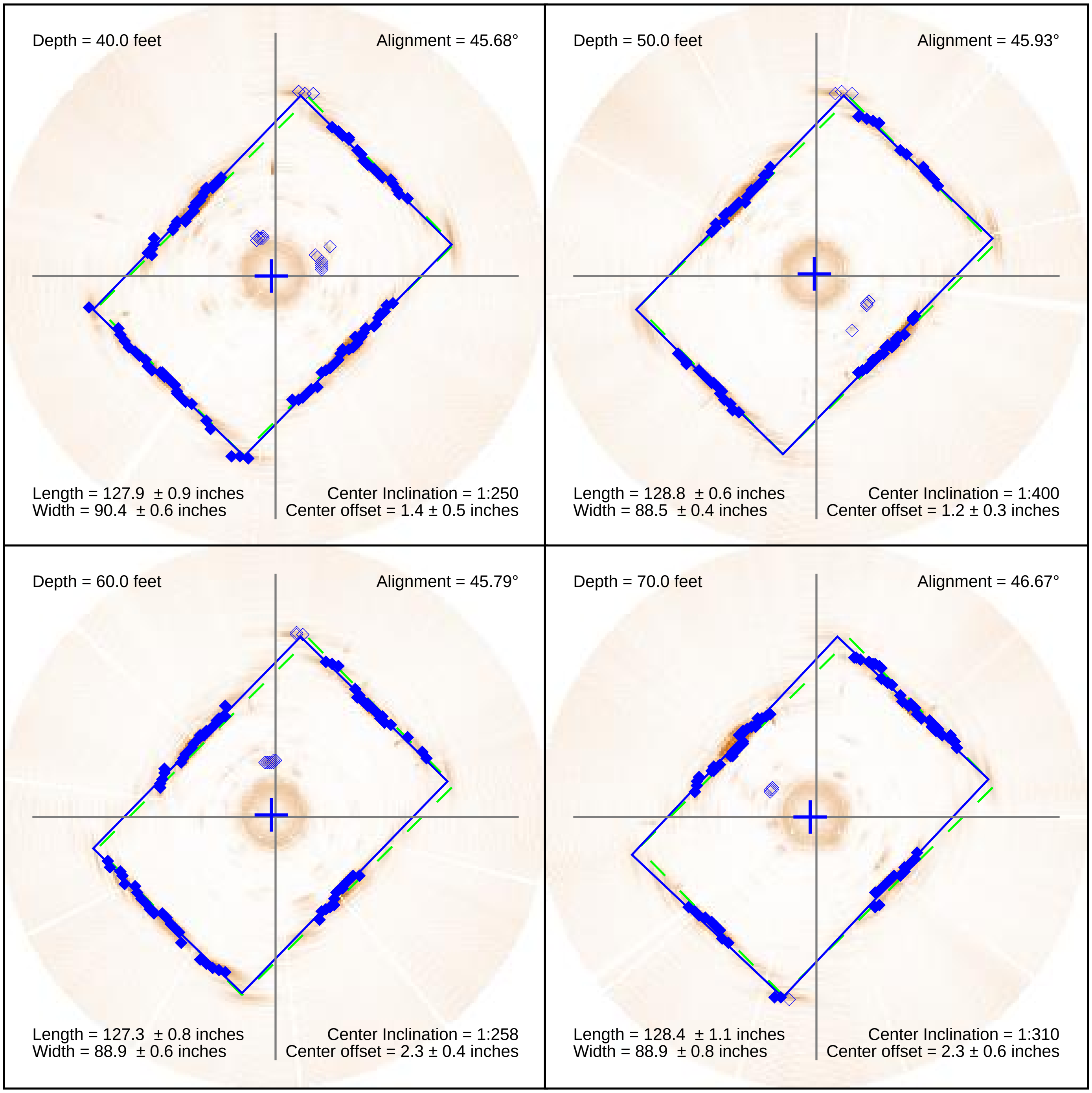

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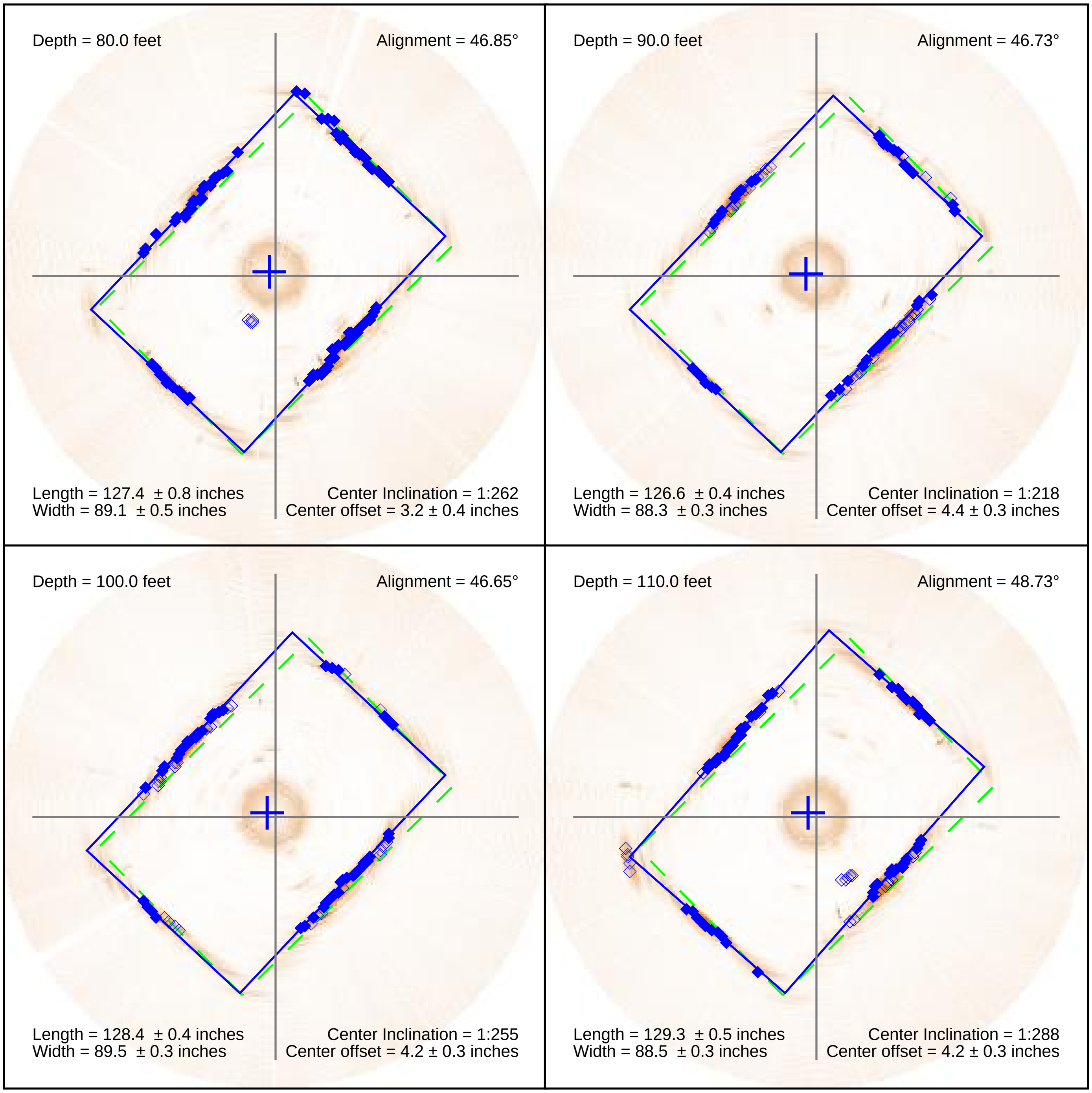

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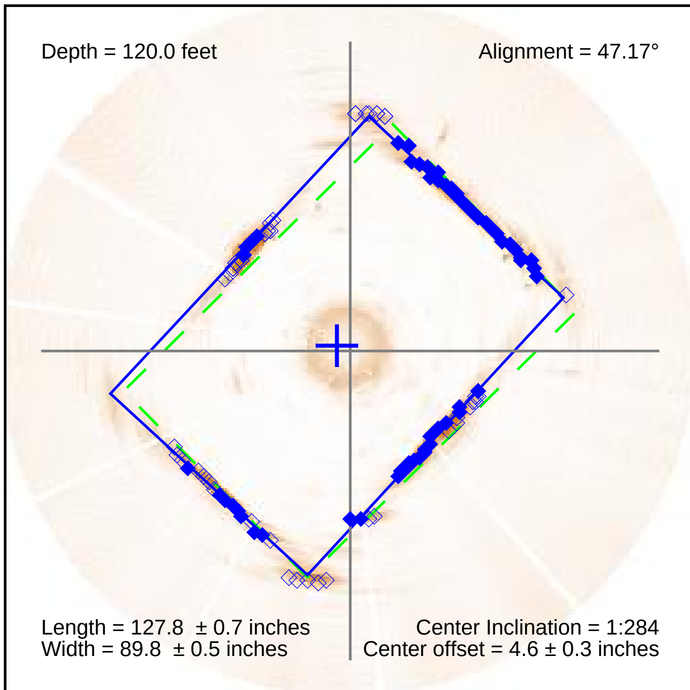

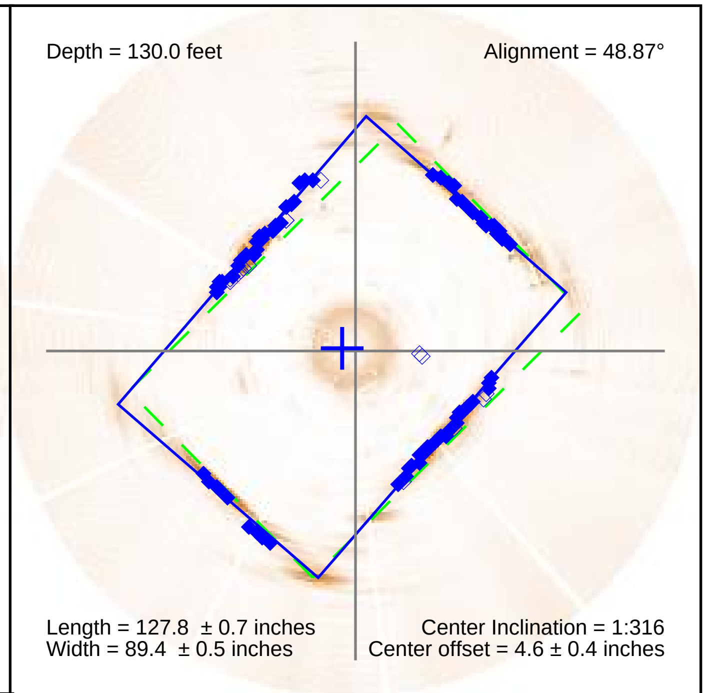

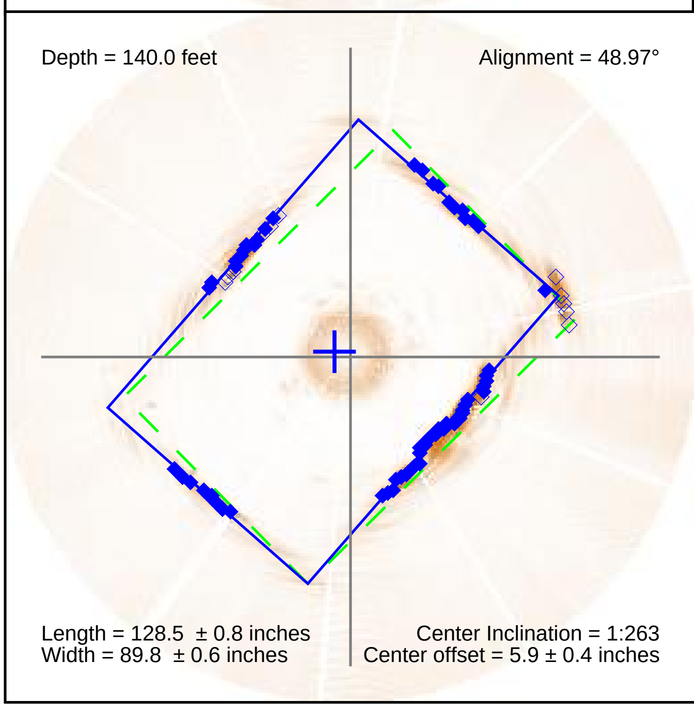

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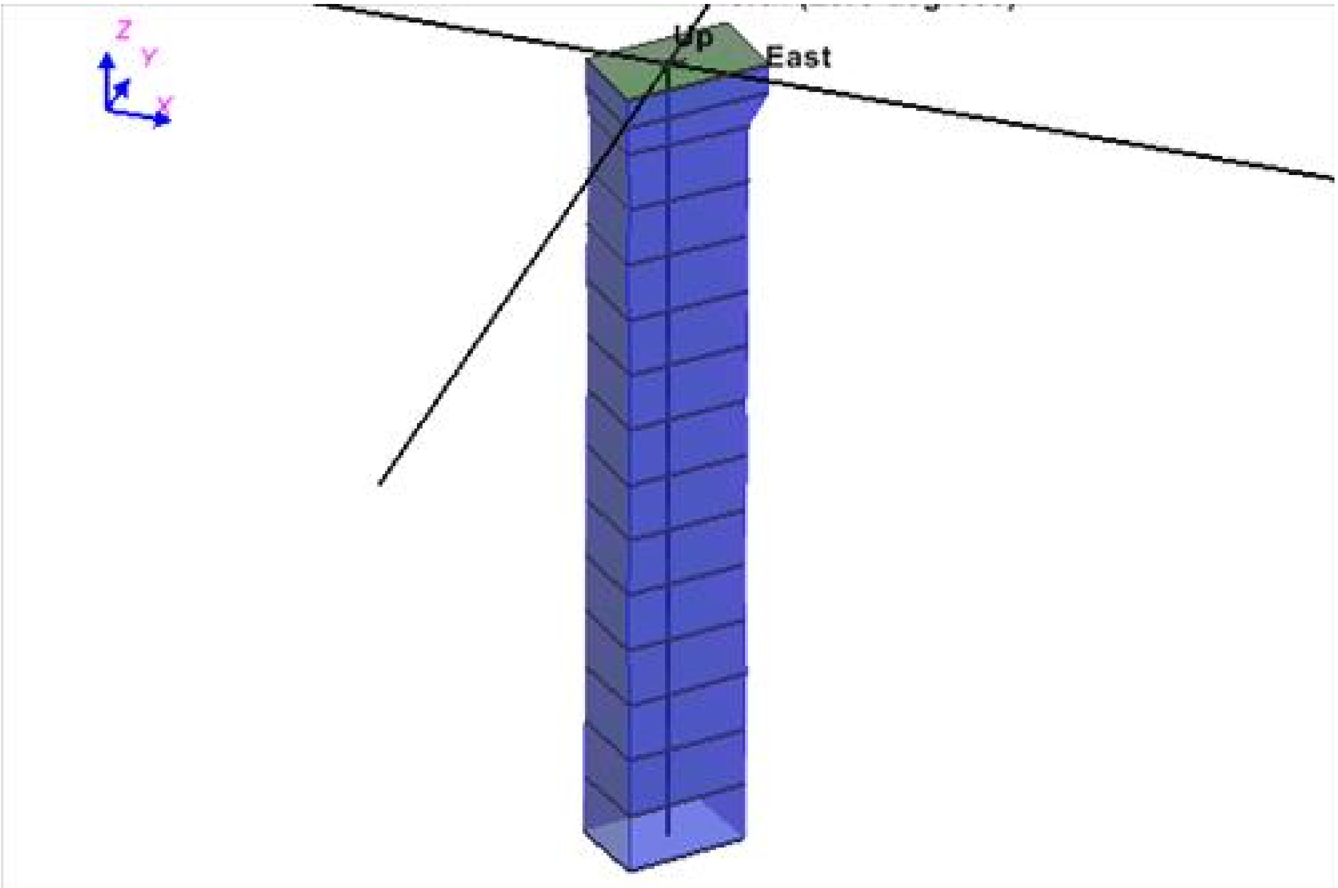
City, State, 05/28/2013



3-D View

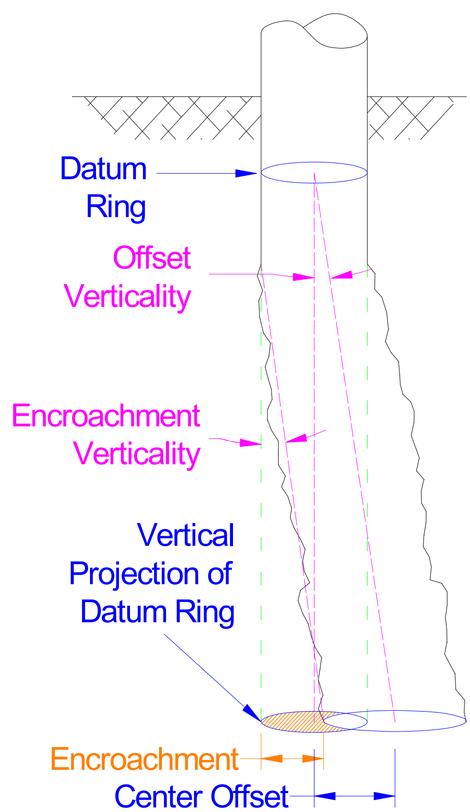
INTERPRETATION OF SONICALIPER FIELD DATA REPORT

General: The SoniCaliper is a profiling sonar device, specially adapted to function in drilling fluids. Each 360° pass generated with the SoniCaliper device produces up to one hundred twenty individual echo returns (profile data points). In the preceding figures (profile ring plots), the diamond points represent individual profile data points. A geometric shape is fitted to the data points using the non-linear least-squares technique (see Gander et al) to approximate the cross-sectional profile of the shaft for verticality, perimeter area and volume calculations. Hollow diamonds designate rejected points which are not used in the data fitting.

Deployment: The device is lowered into the shaft excavation in incremental depths. At each depth, a 360° sweep of the shaft wall is performed. The device is assumed to hang vertically in the shaft (any deviation from verticality can be noted using onboard pitch and roll sensors). Any twist in the device relative to its initial orientation is compensated by onboard compass and/or gyroscope sensors.

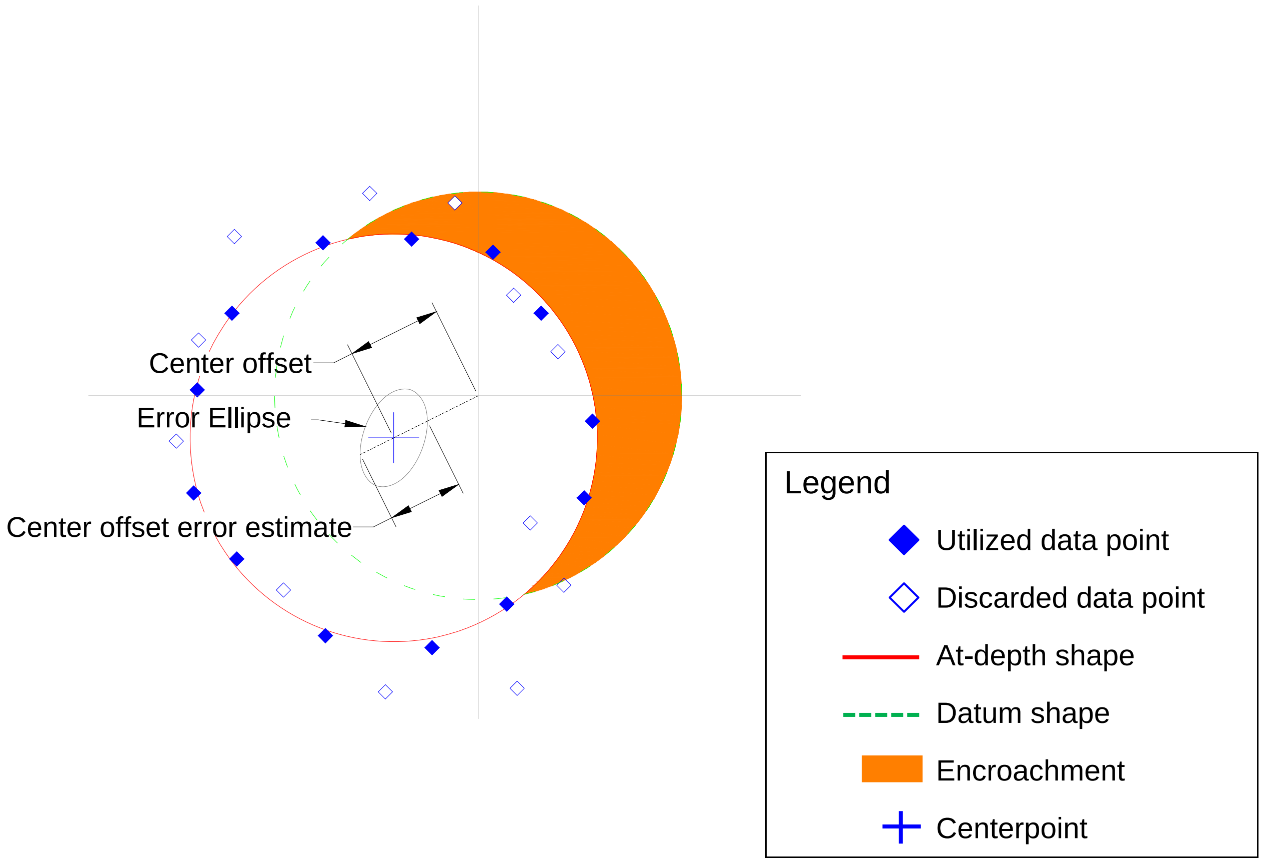
Calibration: Because the properties of drilling fluids vary widely, a calibration must be performed for each shaft to determine fluid wavespeed. This is done by selecting a profile ring of known diameter (drilled shaft) or length & width (panel / barrette) as the "calibration ring". The data analysis then back-calculates the fluid wavespeed based on the known dimensions of this ring. The fluid wavespeed is assumed to be constant over the entire column of fluid depth.

Shaft Verticality: To determine shaft verticality, a profile ring (usually, but not always the calibration ring) is selected as the "datum ring". The geometric centers of the datum ring and all other profile rings are compared. The "center offset" listed on the figures indicates the divergence of each profile ring center point from the datum ring center point. "Encroachment" is presented graphically as the shaded area representing the portion of the shaft wall which would encroach into the perfectly vertical projection of the datum ring to the depth in question. For circular shafts, the maximum encroachment value for each profile ring is also given numerically. The user may also choose to display computed values for the vertical inclination of the shaft between each ring and the datum ring, for both encroachment and center offset. Verticality is computed as the maximum encroachment or center offset (the "deviation") divided by change in depth, and may be expressed as an angle, a percentage or as a deviation:depth ratio.



Calipered Volume: The cross sectional area of each profile ring is determined and a cumulative volume for the calipered portion of the shaft is calculated. Note that this volume is a minimum.

Error Estimation: The accuracy of ranging of the individual data points is specified by the manufacturer under laboratory conditions. Scatter in the data points relative to the assumed geometric cross-section may be due to multiple factors including errors in ranging, suspended solids and/or air entrainment in the fluid column (wet shaft excavations), and roughness of the shaft wall. Random ranging errors are isotropic (not dependent on direction), and since the profile sweep is 360°, are assumed to cancel out. Systematic range errors are compensated for using the calibration ring. The least-squares fitting algorithm includes data filtering which rejects outlier profile data points (designated by hollow diamonds in the profile ring plots). However, the remaining data points will still exhibit a degree of scattering, which introduces an uncertainty to the computed verticality and dimensions of the shaft. Using standard spatial data error estimation techniques (see Ghilani and Wolf 2010), a Gaussian distribution error ellipse can be computed to a specified confidence level around the centerpoint of the geometric fit. The intersection of this ellipse and the chord from the datum to the centerpoint (the "center offset" length, which is used in verticality calculations, see sample profile ring plot below) is then reported as a ± tolerance for each profile ring. A similar approach, using the same confidence level, is used to compute the tolerance band of the principal shaft dimension. Derived dimensions (perimeter, volume, verticality, etc.) do not include further error estimation.



References:

Gander, W., Golub, G. H. & Strebel, R. (1994) "Least-squares Fitting of Circles and Ellipses", *BIT Numerical Mathematics*, Vol. 34, No. 4, pp. 558-578.

Ghilani, Charles D. & Wolf, Paul R. (2010) *Adjustment Computations: Spatial Data Analysis*, J. Wiley & Sons, Hoboken, N.J. ISBN 0470464917.