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I am submitting herewith a thesis written by Heather Darlene Cochran entitled "Analysis of Carbon Fiber Characterization Techniques." I have examined the final electronic copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Aerospace Engineering.

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Analysis of Carbon Fiber Characterization Techniques

A Thesis Presented for
the Master of Science
Degree

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Heather Cochran
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Thank you all for your help.

ABSTRACT

Accurate and efficient fiber characterization is critical to developing a successful process for producing low cost, high quality carbon fibers from pitch. This study analyzes current methods for characterizing diameter, tensile strength, and tensile modulus for carbon fibers using a Dia-stron® automated system consisting of a FDAS 765 laser scan micrometer and a LEX 810 linear extensometer. Fiber diameters measured by the Dia-stron® system are compared with diameters measured by Scanning electron microscope (SEM) and by optical microscope at 20X and 40X magnifications. Tensile measurements were also analyzed. This study found that fiber alignment during tensile testing is critical to determining a fiber's strength accurately. Most of the uncertainty in determining tensile strength, which is reported in terms of stress, comes from error in diameter measurements.

The Dia-stron® had an estimated uncertainty of about 3.7 % for single measurements of a 9.8-micron diameter fiber. The optical method had an estimated uncertainty of about 9.6% for an 8.58-micron diameter. The SEM micrometer had a resolution of ± 1 micron which for a 9.8-micron fiber is an uncertainty of about 10.2%. The range of uncertainty for the SEM method for fibers with diameters between 7 – 12 microns is about 14.3-8.3%. The SEM and Dia-stron® agreed within 7% for a sample group. Individual fiber comparisons between the Dia-stron® system and the optical microscope had agreement between 2% and 15%. The SEM and optical methods both produced images of the fiber, but could only provide one view of the fiber due to its fixed mounting whereas the Dia-stron® system measured 180 degrees around the fiber circumference. The Dia-stron® was found to be the most efficient of these methods for taking a large number of measurements in a relatively short amount of time.

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CHAPTER I: INTRODUCTION

Carbon Fiber Overview

Carbon fiber has many useful applications in today's industry. Its high-strength, low density and other properties are ideal for creating lightweight, fuel-efficient vehicles. The most prevalent carbon fibers in the commercial market today are made from a polymer precursor polyacrylonitrile (PAN). These fibers have been used in high-end applications such as aircraft, but are relatively expensive. Lowering production costs would allow carbon fibers to be available for many industrial applications that are now cost prohibitive.

Research is ongoing at the University of Tennessee Space Institute (UTSI) to manufacture lower cost, high quality carbon fibers by producing them from a patented mesophase pitch precursor. Carbon fibers spun from mesophase pitch have different properties from carbon fibers derived from the PAN precursor. Pitch based fibers can have both high tensile strength and a high tensile modulus. They also can be made to be electrically conductive and are good conductors of heat.

During the research process, fiber characterization is critical to improving fiber properties. Accurate data enables the research process to determine how different spinning methods and heat treatment profiles affect the final properties of the fibers. The main properties of concern here are the tensile strength and tensile modulus of the fiber. Accurate diameter measurements are also important as the diameter is related to the utility of the fiber and is used in determining the break stress and modulus of the fiber. Break force measurements are critical in providing reliable property information for the fibers, so that they can be properly utilized.

This study analyzes and seeks to improve current characterization methods as they pertain to mesophase pitch based carbon fibers. The current method at UTSI uses the Dia-stron ® automated system consisting of a laser scan micrometer (LSM) and a linear extensometer. The Dia-stron® method for

diameter measurements will be examined and analyzed for accuracy and resolution along with two other methods, which will be compared to the current system. These methods include the scanning electron microscope (SEM), and the optical microscope. The Dia-stron® system for determining tensile strength and tensile modulus will also be examined.

Literature Review and Background

A paper, A Survey of Current High-Performance Carbon Fiber Characterization Methods, (Nguyen, Ghiorse, and Mulkern, 2000) was reviewed as it pertains to single fiber characterization. Their primary focus was the characterization of PAN based fiber. Three methods were analyzed for measuring single carbon fiber diameters. The methods were optical microscope, scanning electron microscope, and laser diffraction method. The study found that while the SEM produced high-quality fiber images, it was impractical to use for fibers that also needed to be tested for strength. The paper reported on a previous study that found the optical microscope to have the largest standard deviation of the three methods (Chen and Diefendorf, 1982). It reported on another study that concluded that the laser diffraction method was the most practical method for determining carbon fiber diameters that were also to be tensile tested. (Fukuda, Miyazawa, and Tomatsu, 1993). Carbon fiber diameters can also be measured using an optical microscope and reflected light for carbon fibers, which had been embedded in epoxy resin and polished. Also, if the linear density of the carbon fiber is known, the weight of the carbon fiber can be used to determine the fiber cross-sectional area. Both of these methods have been used to measure the diameters of PAN based carbon fibers. More information about UTSI pitch based carbon fibers is available in a final report for a project for the Federal Transit Administration (FTA) entitled “Low Cost Carbon Fiber Technology Development for Carbon Fiber Composite Applications (Vakili, et al, 2007).” More information pertaining to the processing and properties of pitch-

based carbon fibers is available in the book Carbon Fiber Composites (Chung, 1994).

Characterization Overview

Fiber characterization includes many areas such as physical, electrical, optical, thermal, chemical, and magnetic properties. The interest of this study is physical properties: diameter measurement, tensile strength, and Young's Modulus. Tensile strength can be expressed in terms of stress (σ), particularly break, or ultimate, stress. Reporting strength in terms of stress normalizes a fiber's tensile strength allowing strength comparison between fibers of varying diameters. Stress is defined in equation 1 as the force (F) applied to the sample divided by the cross-sectional area of the fiber (A). Break stress is the stress at which the fiber breaks. The cross-sectional area used was the mean area computed for the fiber before tensile testing. Carbon fibers typically do not elongate very much during the tensile testing process, and so do not experience a significant change in cross-sectional area due to tensile testing.

$$\sigma = \frac{F}{A} \qquad (1)$$

Where A for a circular cross-section is given by:

$$A = \frac{\pi d^{2}}{4} \qquad (2)$$

and d is the fiber diameter. Young's Modulus of Elasticity (E) is a measure of the fiber's stiffness. The modulus is computed by taking the break stress divided by the strain (ε) as shown in equation 3.

$$E = \frac{\sigma}{\varepsilon} \quad (3)$$

During tensile testing, the stress applied is graphed opposite the displacement, or strain, of the fiber. The curve produced is referred to as the stress-strain curve. The end point of the curve indicates the ultimate stress or, the stress at which the sample broke. The modulus is the slope of this curve. Carbon fiber does not yield, and so has a linear stress-strain curve. A typical curve is shown in Figure 1.

Reporting accurate properties is critical to fiber utility. The break stress and tensile modulus data will determine in which applications the fibers can be used. Diameter data is also important as shown by equations 1 and 2. The diameter measurement affects the value of the determined break stress and through it, the value of the elastic modulus. Therefore, it is also essential that the diameter measurements be as accurate as possible.

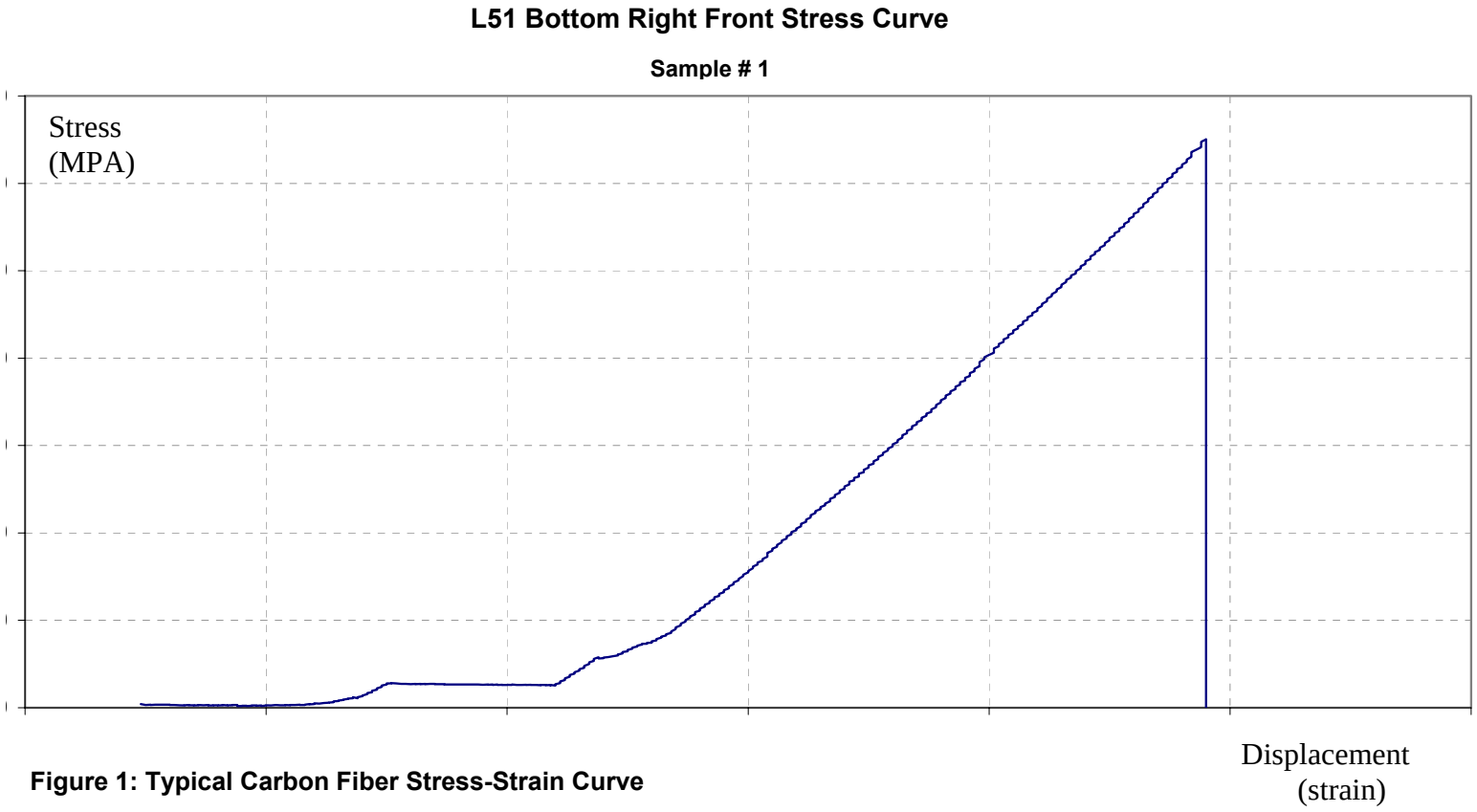


Figure 1: Typical Carbon Fiber Stress-Strain Curve

CHAPTER II: MATERIALS AND METHODS

Selection of Methods

The methods employed were selected based on current characterization processes and readily available equipment. As previously stated, the system currently in use at UTSI is the Dia-stron® system (Dia-stron Limited, UK) shown in Figure 2. This system is employed for its high-resolution measuring capabilities and its automated operating capabilities. Other methods chosen for diameter characterization include an ISI Super III A scanning electron microscope (SEM) and a Nikon Metaphot® optical microscope. These were chosen due to their ability to make high-resolution images of the samples. A second optical microscope was also employed to determine the effect of fiber alignment on tensile strength.

Dia-stron® System

System Overview:

The Dia-stron® system is comprised of a FDAS 765 laser scan micrometer for diameter measurements and a LEX 810 linear extensometer for strength testing. The Dia-stron® is equipped with an automated mechanism that uses suction to lift and carry a mounted fiber to and from the laser scan micrometer

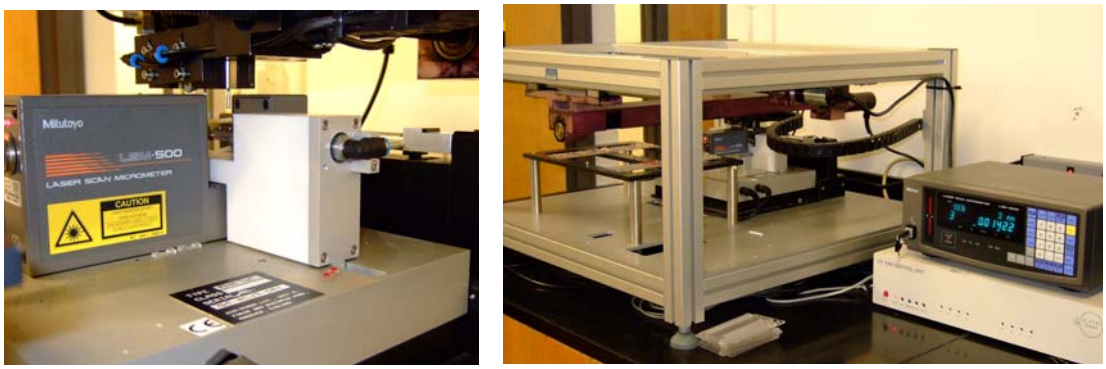


Figure 2: Dia-stron® System and Control Unit

and tensile tester for characterization. It can be programmed to test up to 15 samples consecutively. A large amount of data can be taken relatively quickly. For the current system configurations, a single fiber requires about 10 minutes for both diameter measuring and tensile testing.

Sample Preparation:

Sample fibers are loaded using specially designed plastic mounting tabs, also referred to as feet, as shown in Figure 3. The inner edge of each tab contains a well for securing the fiber with glue or wax. Jeweler's wax is generally used to secure the fiber, but both super glue and a UV setting glue (Dymax Ultra-light weld) have been used. The glue requirement is to attach the fiber locally to the tab and does not spread over the fiber which would result in erroneous results. The tabs are inserted into slotted rows on a plastic tray for loading as shown in Figure 4. The sample fiber is attached in the inner well of one tab and stretched across the tray to the inner well of the second tab. Notches in the center of each well help align the fibers during mounting as they are placed between the two tabs. To ensure fiber alignment, the fibers must be in these notches when secured. If the fibers are misaligned during tensile testing, the

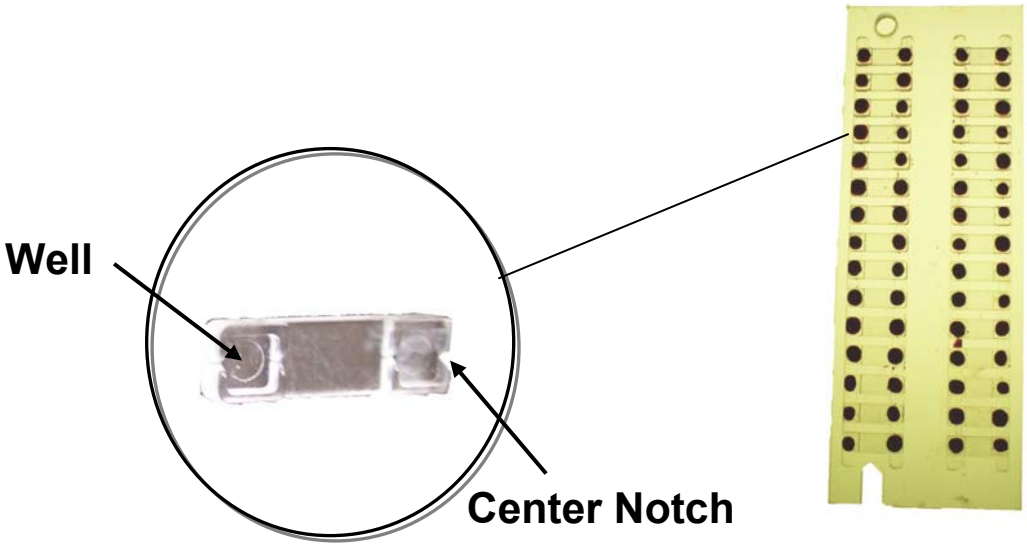


Figure 3: Diagram of a mounting tab

Figure 4: Loaded tray

force will create bending moments on the fiber, which could cause premature breakage due to the fibers' low bending moment strength. After mounting, the fiber ends are trimmed to leave clear the center of the tab where suction cups attach to transport the sample. Any obstruction in the tab's center could keep the suction cup from sealing properly resulting in a dropped tab or failure to pick up the tab.

Sample length is a factor involved in mounting that can affect tensile testing. The tensile strength for a fiber has been shown to vary depending on the sample length tested. This is due to the statistical likelihood that defects in the fiber increase with length. The defects are weak points in the fiber caused by impurities or imperfections in the fiber's molecular structure. The sample length is set by the Dia-stron® system, which can be adjusted to test samples of different lengths. A loading tray with slots spaced the same distance as the sample length must be used. For this study, the fiber samples were tested with a length of 10 mm.

Data is exported to a computer where the software, UV-Win, analyzes and reports it. Exported files include Summary, Dimensional, Tensile, and Modulus reports. Extensive diameter data, and the stress-strain curve, as well as the tensile modulus are the outputs of the system.

FDAS 765 Laser Micrometer:

The Dia-stron® system employs a FDAS 765 laser scan micrometer for diameter measurements. It is equipped with a Mitutoyo LSM 500 Laser Micrometer and UV1000 Control Unit. The laser micrometer has a wavelength of 650 nm and a width of 200 microns when in focus. The micrometer operates by shining a laser beam onto a rotating polygon mirror, which is synchronized by clock pulses. The beam is sent through a collimator lens, which directs it toward the sample. The rotating mirror causes the beam to move from top to bottom in a scanning motion. The beam scans across the fiber perpendicular to its longitudinal axis and into a receptor that contains a photovoltaic cell. As the laser

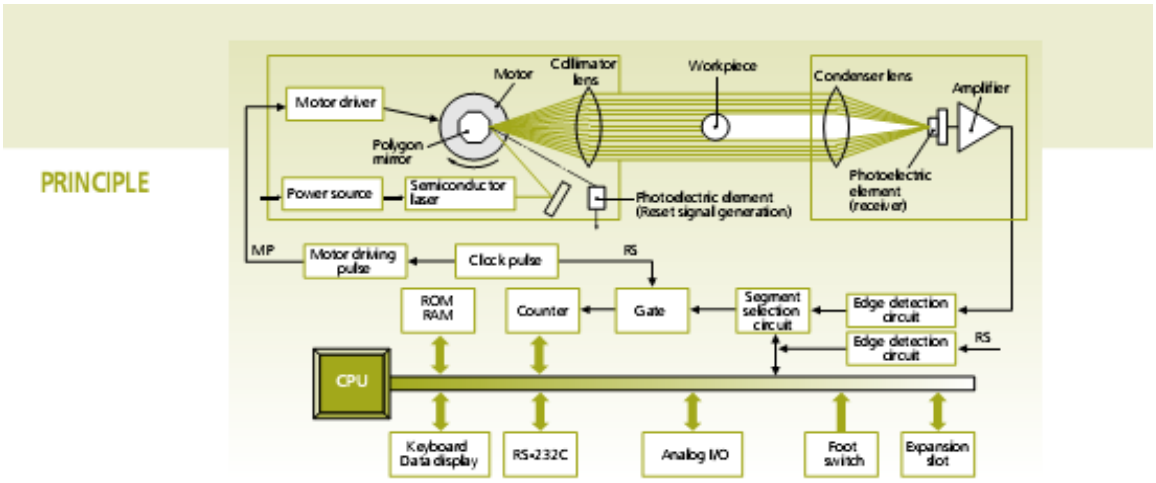


Figure 5: Operating Schematic for the LSM 500 taken from the Mitutoyo Laser

scans, the amount of laser light that reaches the receptor varies as it is blocked by the fiber. The photovoltaic cell detects the variation of laser light as a voltage change. The pulses are used as a counter to determine how long the sample obstructed the beam, and from this information the fiber diameter is determined. A schematic of the Mitutoyo LSM 500 laser micrometer is found in Figure 5. The reported rate for the laser scan micrometer is up to 1600 scans per second. It has a designed operating range of 5 to 2000 microns with a specified resolution of 0.1 microns and a repeatability of 0.06 microns. Detailed specifications for the FDAS 765 laser scan micrometer can be found in Appendix A.

The FDAS 765 laser micrometer secures the fiber in place for diameter measuring using a mechanized holder. The holder rotates and moves horizontally so that measurements can be taken along the length of the fiber as well as at different points around the fiber circumference. Taking multiple data points produces a more accurate cross-sectional area than taking readings at a single point or angle since irregularities in shape such as bulges or asymmetrical cross-sections can be averaged out. Readings are taken along the length of the fiber at points referred to as “slices.” At each slice, diameter measurements are taken around the fiber as it is rotated incrementally to 180°. At each angle,

multiple measurements are made which are averaged to give the mean diameter and cross-sectional area. The mean, as well as the minimum and maximum diameters, and the mean cross-sectional area for each angle are recorded and reported in a dimensional report exported by the UV-Win software. The mean cross-sectional areas for each angle of each slice are then averaged to give the mean cross-sectional area of the fiber. A summary reports gives the mean cross-sectional area, the average min. diameter, and the average max. diameter for each fiber. The average min. and max. diameters are not the min. and max. of the average diameter, but the average of all the min. and max. diameters computed at each angle of each slice. The user sets the number of slices, as well as the rotation angle. In this study, 10 slices and a 20° rotation angle were used.

LEX810 High Resolution Extensometer:

The LEX810 High Resolution Tensile Tester uses a DC micrometer motor to stretch or elongate the sample. A Sensotec semi-conductor strain gage load cell measures the load applied to the sample. The maximum applied force is 250 grams-force (gmf) with a resolution of 0.005 gmf. It has a reported positional repeatability of 0.1 microns and a range of 50 mm. The elongation speed is user-defined with a lower limit of 0.01 mm per minute. The tensile data is exported in a tensile file, which contains the coordinates of the stress-strain curve. UV-Win software allows the force to be viewed in several different units including force units in Newtons or grams-force, and stress in Pascals or MegaPascals. Detailed specifications for the LEX810 can be found in Appendix B.

Young's Modulus of Elasticity Data:

The modulus of elasticity can be determined from the tensile data using several functions in the UV-Win software. The modulus is the slope of the stress-strain curve. The software computes the modulus from the curve using set points in an automatic mode, or user-defined points in the interactive mode. The tangent method determines the modulus by taking the slope of the stress-strain

curve between two points. In automatic mode, the modulus is taken to be the portion of the curve with the highest slope. The least-square method uses a least square error regression to determine the slope. In automatic mode, the user sets an initial position at which the analysis begins. The third function takes the secant between two user defined points in interactive mode to determine the modulus of elasticity. In automatic mode, a start point is specified for all samples as in the least square mode.

Scanning Electron Microscope

Scanning Electron Microscope (SEM) Overview:

The SEM uses an electron beam to create detailed images of its specimen. A scanning beam of electrons is directed at the sample within a vacuum. As the electrons hit the sample, they scatter. This scattering of electrons is used to generate a detailed image of the sample fiber.

Sample Preparation:

A single fiber is placed length-wise onto a metal bar with the ends secured by press-on glue tabs. Since the SEM uses electrons in its imaging process, the specimen must be conductive or it will begin to charge. Charging interferes with the imaging process causing the sample image to blur. The carbon fiber samples tested were not electrically conductive, and had to be sputter-coated with gold to prevent them from charging during the imaging process. Figure 6 shows a tested sample which has been sputter-coated. The fiber is visible at the left end of the speciman where it was attached. The rest of



Figure 6: Sputter-Coated Sample prepared for the SEM

the fiber has been removed to be tested with the Dia-stron® laser scan micrometer.

ISI Super III SEM:

The ISI Super III A SEM (Topcon Corp., Japan) was used to make detailed images of the carbon fibers. Images were taken at different locations along the fiber length. Due to the sample's attached nature, it could not be rotated around its vertical or horizontal axes, so that only the top view for each fiber was imaged. As a result, a circular cross-section is assumed when measuring the diameter from the image. A micrometer function in the SEM software (IXRF Systems 2004 Version 1.3) was used to measure the fiber diameter from the images. Even though the SEM is capable of very resolute images, the built in micrometer only has a resolution of 1 micron.

Optical Microscope

Optical Microscope Overview:

An optical microscope uses lenses to magnify the sample optically. Two optical microscopes were employed in this study, the Nikon Metaphot® and the Leica GZ6. Both microscopes were equipped with cameras that interface with a computer. Matrox Inspector 4.0 software allowed images from the microscopes to be captured and saved digitally.

Nikon Metaphot® Optical Microscope:

The Nikon Metaphot® optical microscope was used to determine the fiber diameter along the length of the fiber. It is equipped with lenses of varying magnifications. A digital camera attached to the eyepiece interfaces with a computer to allow digital viewing and capturing of the sample image. For this study, the 20X and 40X magnification lenses were used.

Optical Measurement Techniques:

The diameter was measured from digital images taken with the Nikon Metaphot® microscope using two techniques: the image measurement technique and the intensity plot technique. The image measurement technique measured the fiber diameter in pixels directly from the image using the "imtool" function in the software program MATLAB (Mathworks). The intensity plot technique measured the fiber diameter from an intensity plot generated using the "improfile" function in MATLAB. This plot shows variation in light intensity of an image along a user-drawn line. The line was drawn across the fiber, so that the x-axis is the distance in pixels across the fiber diameter. In the optical images, the fiber is black, which appears on the plot as zero intensity. The diameter was measured from this plot using the zero intensity as an indicator of the fiber diameter. The intensity plot technique is useful in determining the edges of the fiber, which can appear fuzzy on the microscope images. Details of the diameter determination from the intensity plot can be found in Chapter 4. The MATLAB intensity program is included in Appendix C.

Both methods result in diameter measurements in pixels. A calibration micrometer was imaged to obtain a correlation between distance in microns and pixels. The distance in microns was known from the divisions on the micrometer. After imaging the micrometer with the Nikon microscope, the known distance was measured in pixels. The known distance in microns was then divided by the measured distance in pixels to give a micron to pixel ratio. This ratio allowed the fiber diameter in pixels to be converted to microns. The micrometer must be under the same magnification as the sample to give the correct ratio. The micron to pixel ratio decreases with magnification increasing the resolution of the measurement. For this study, an Olympus 0.01 mm calibration micrometer was used.

Leica GZ6 Microscope:

A second optical microscope, a Leica GZ6, has a wider scope and a zoom range from 6.7X to 40X. The images from this microscope provide a view of the fiber length. The alignment of loaded fibers, as well as their degree of straightness, was viewed with this microscope.

Sample Preparation:

Fiber samples were attached directly to glass slides for diameter measuring. Afterwards, these same fibers were then loaded for the Dia-stron® system. This method allowed the same fibers that were viewed in the optical microscope to be measured also using the laser scan micrometer for direct comparison. The samples used for measuring alignment and its effect on tensile strength were prepared in the same manner as those for the Dia-stron® system, which uses plastic mounting tabs and slotted trays. A loaded tray was placed under the Leica optical microscope to view fiber alignment and geometry before tensile testing.

CHAPTER III: RESULTS AND DISCUSSION

Diameter Measurements

Carbon fiber diameters were measured using a laser scan micrometer, SEM, and optical microscope. The results for each are detailed and discussed.

Dia-stron® Laser Scan Micrometer Method

A large number of fiber samples were tested using the Dia-stron® laser micrometer. Diameter measurements were taken for 10 slices along the length of the fiber with 20° rotational increments at each slice. Multiple readings were taken and averaged at each 20° increment to give a mean diameter and mean cross-sectional area. The average of these cross-sectional area measurements for all 10 slices gave the mean cross-sectional area for the fiber. These values, as well as the maximum and minimum diameters for each 20° increment, were computed by the UV-Win software and exported in summary and dimensional reports. The dimensional report listed the mean, min, and max diameters for each 20° increment for all the slices of all the fibers. The summary report listed the mean cross-sectional area, the mean minimum, and the mean maximum diameters for each fiber. The “Mean Min” and “Mean Max” diameters were the average of the minimum and maximum diameters measured at each 20° angular increment. The diameter range was the span from the minimum to the maximum mean slice diameter for the sample batch where the mean slice diameter was the average of all the diameters taken at a slice. The slice diameter and range were computed using the UV-Win dimensional report.

The Dia-stron® data does not provide a physical image of the fiber as is produced by the other two methods. However, the fiber cross-section can be visualized using the Dia-stron® dimensional data. The diameters measured for each slice can be mapped with their corresponding angles to give an image of the cross-section at that location. MATLAB was used to graph the cross-section.

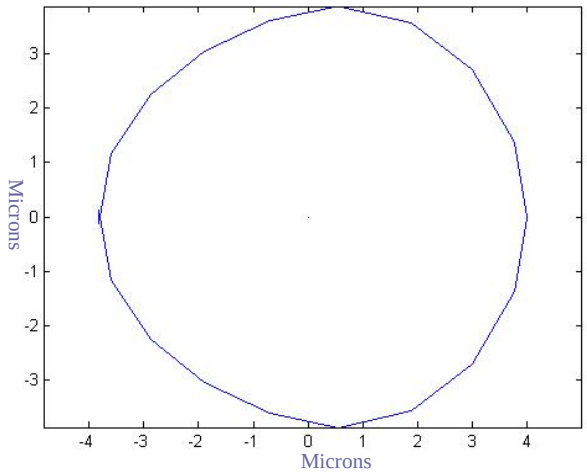


Figure 7: Cross-section of Fiber 2 from L51 BLF Noted 4 Slice 1 recreated with data from the laser scan micrometer

Figure 7 shows a cross-section for a UTSI sample fiber recreated from the data taken using the Dia-stron® laser micrometer.

The diameter was measured for a total of 180°, which gave a view of half the fiber. In Figure 7, the measured diameters were graphed and then reflected across the axis to recreate the entire fiber cross-section. Using the dimensional data generated by the laser micrometer, a 3-D replica of the fiber can also be constructed. Graphical representations of the fiber shape along its horizontal and vertical axes are shown in Figure 8. The 3-D fibers were reconstructed using the mesh function in MATLAB to graph the Cartesian points determined from the dimensional report. The aspect ratio is highly exaggerated so that the variation in the diameter can be seen. Figure 9 compares the front view of the reconstructed fiber with the correct aspect ratio to the photo taken with the Leica microscope. Only half of the fiber length is shown to increase visibility. The variation in fiber diameter cannot be seen at such a scale. Notice that the reconstructed fiber appears straight. The laser-scan micrometer uses laser light to determine only the diameter of the fiber, and can provide no information about fiber alignment or axial geometry as the optical method can. The SEM method does not provide alignment or curvature data either since its area of focus is so minute.

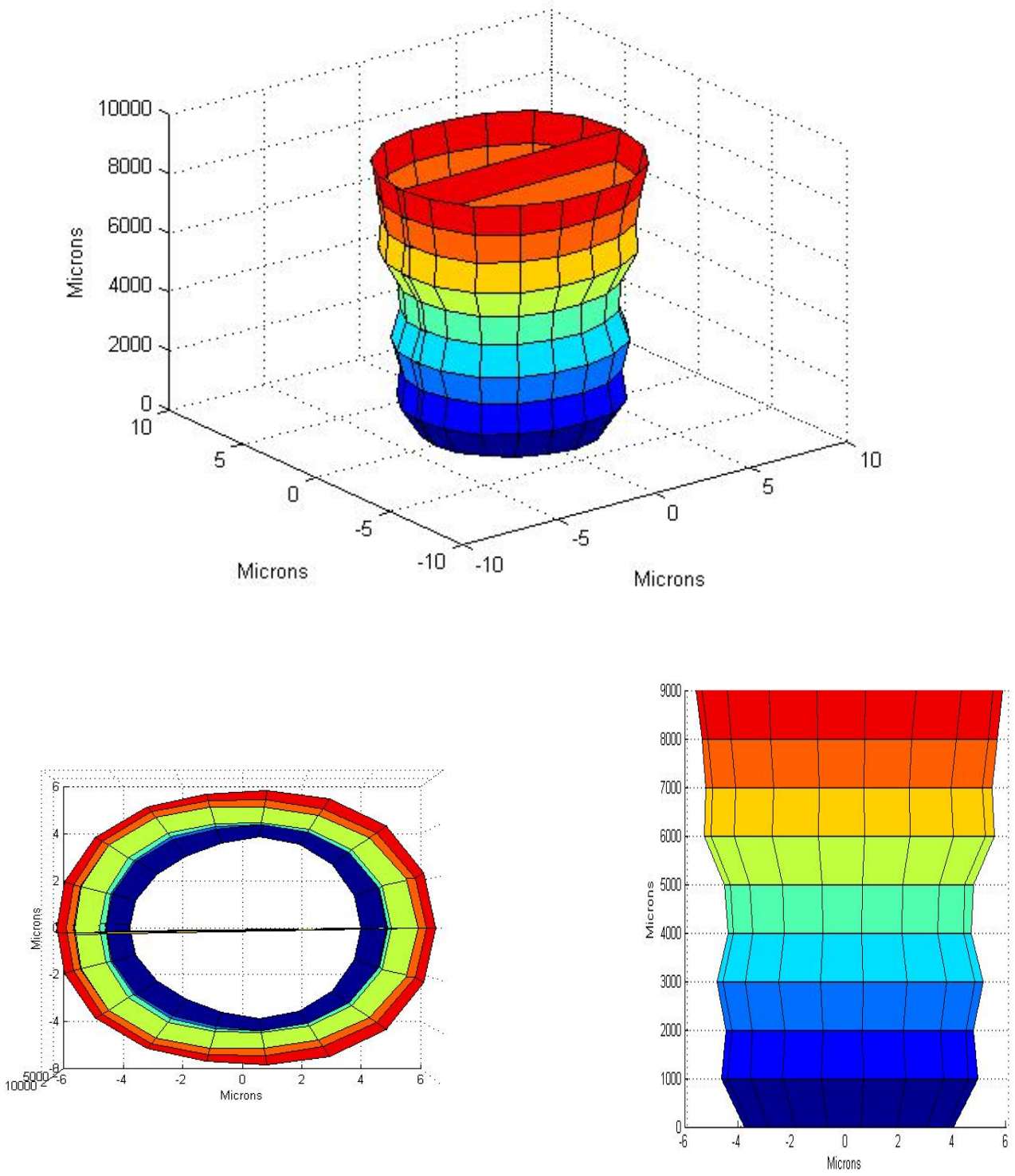


Figure 8: Isotropic, axial, and frontal views of a reconstructed fiber with exaggerated aspect ratio using data from the FDAS 765 laser scan micrometer

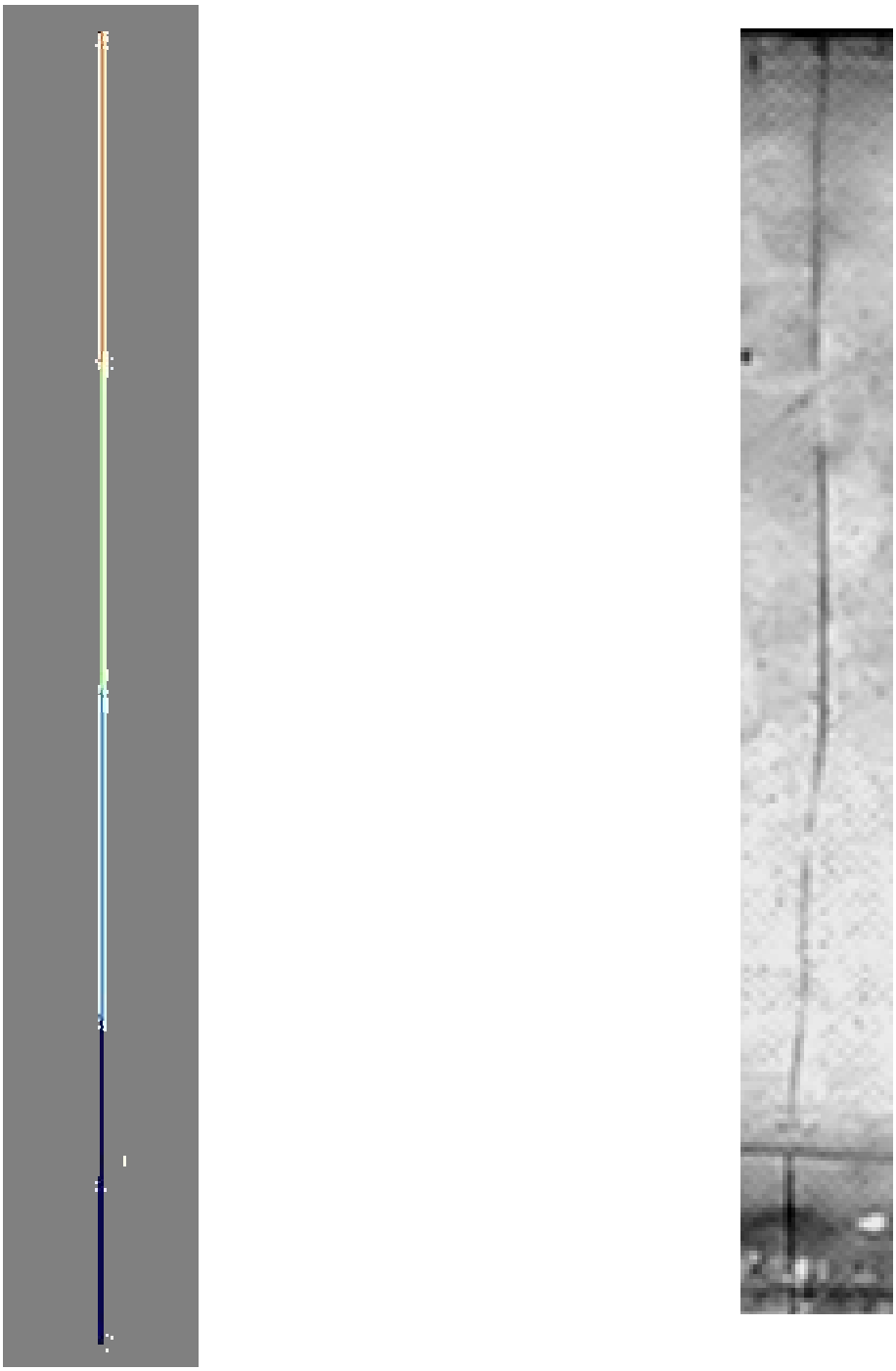


Figure 9: L51 BLF Noted 4 Fiber 2. Reconstructed half of fiber shown using computational means, and approximate first half of fiber shown using optical means

Table 1: Repeatability results

Repeatability Summary Data				
Record	**Mean Min. Diameter**	**Mean Max. Diameter**	**Mean Diameter**	**Mean Cross-Section**
	Microns	Microns	Microns	Sq. Microns
1	51.20	51.30	51.27	2064.90
3	51.30	51.40	51.37	2072.90
4	51.40	51.40	51.40	2075.30
5	51.30	51.40	51.33	2069.20
6	51.20	51.30	51.26	2063.70
7	51.30	51.40	51.33	2069.60
8	51.40	51.40	51.40	2075.20
9	51.30	51.30	51.32	2068.30
10	51.40	51.40	51.42	2076.40
11	51.20	51.30	51.26	2063.80
Std. Deviation	.08	.05	**.06**	4.86

*Note: Mean diameter computed from Mean Cross-section data

Repeatability:

The FDAS 765 Laser Scan Micrometer has a reported repeatability of 0.06 microns. A wire with specified diameter of 50.8 microns was tested in 10 separate runs using the Dia-stron® laser micrometer. Ten slices and a rotation angle of 20° were used. The tolerance of the wire diameter was unknown, so the results were used only to determine repeatability. The results are shown in Table 1. The results for this analysis had a standard deviation of 0.06 for the mean diameter, which agreed with the reported repeatability. This deviation resulted in a range difference of about 13 square microns or about 0.6 % of the average mean cross-sectional area. The dimensional report for the repeatability test can be found in Appendix D.

Slice Importance:

The number of slices taken for a sample is important in the characterization process. More slices provide a higher resolution measurement

of the fiber diameter. Resolution is most important when the fiber cross-section varies significantly. Only taking one slice could result in a biased picture of the fiber diameter, as the slice may be taken at a valley or bulge in the fiber. Averaging many slices gives a truer picture of the fiber cross-section. However, taking many slices of data is a time consuming process, especially when multiplied by a large quantity of samples. The test requires about a minute per slice for diameter measuring. A good medium should be found so that just enough slices are taken to give an adequate average of the fiber's cross-sectional area.

Two cases are represented: one for a commercially available pitch fiber and one for a UTSI produced fiber. Tables 2 and 3 show the results of varying the number of slices taken while measuring a single fiber for these two cases. The case for the commercial pitch had little variation dependent on slice number. The variation between the extrema was only 0.2 microns or about 1.6% of the mean fiber diameter. The maximum and minimum values both occurred for slice numbers under 8. For every test with 8 slices or above, the diameter averaged out to 12.5 microns. The UTSI fibers had more variation based on slice number as shown in Table 3. The extrema for the fiber diameter occurred for the cases of 1 and 3 slices taken with measured diameters of 12.7 and 11.0 microns respectively. For slice number 5 and above, the diameter averaged out a little more consistently. However, the variation was still larger than was seen with the commercial pitch fibers. The diameter never reaches a constant as it did with the commercial fibers. The variation did decrease, however, to give a range of 0.3 microns with diameters from 11.2 to 11.5 microns. The uncertainty in this range was about 2.6 to 2.7%.

UTSI is continually researching to develop the method for the spinning and processing of pitch fibers. As a result, these fibers may have more variation in cross-section than the commercially available fibers. This development research makes determining the fiber diameter even more important since the error in the cross-sectional area increases the uncertainty in the

Table 2: Comparison of slice number on diameter measurements for commercial pitch fibers. Note: Mean Diameter computed from Mean Cross-sectional Area.

Slice Comparison for a Commercial Pitch Fiber					
Summary Data		**Commercial Pitch**			
Number of Slices	**Record**	**Mean Min. Diameter**	**Mean Max. Diameter**	**Mean Diameter**	**Mean Cross-Section**
1	3	12.3	12.4	12.4	120.5
3	6	12.5	12.6	12.6	123.9
5	4	12.5	12.6	12.6	123.8
8	5	12.4	12.5	12.5	122.3
10	2	12.4	12.5	12.5	122.6
13	8	12.4	12.5	12.5	122.6
17	1	12.5	12.5	12.5	122.8
20	7	12.4	12.5	12.5	122.7
Std.Dev.		0.071	0.064	0.053	1.046

Table 3: Comparison of slice number on diameter measurements for UTSI fibers. Note: Mean Diameter computed from Mean Cross-sectional Area.

Slice Comparison for a UTSI L51 BLF Fiber					
Summary Data		**L51 BLF**			
Number of slices	**Record**	**Mean Min. Diameter**	**Mean Max. Diameter**	**Mean Diameter**	**Mean Cross-Section**
1	4	12.7	12.8	12.7	127.2
3	5	10.8	10.9	11.0	95.6
5	3	11.1	11.2	11.3	100.7
8	6	11.3	11.4	11.5	104.2
10	2	11.2	11.3	11.4	101.6
13	8	11.4	11.5	11.6	104.8
17	1	11.2	11.3	11.4	101.6
20	7	11.1	11.2	11.2	98.9
Std.Dev.		0.573	0.573	0.516	9.69

determination of tensile strength. Accurate and consistent data enables the research to continue progressing. For this study, 10 slices is taken as a reasonable compromise between resolution and the practicality of time restraints. The dimensional report for the slice importance test is given in Appendix E.

Error Analysis:

The laser micrometer is designed to operate at a range of 5 to 2000 microns with a specified resolution of 0.1 microns and a repeatability of 0.06 microns. UTSI fibers range from about 8 to 30 microns with occasional minima as small as 5 microns depending on the sample batch. For the fibers used in this study, UTSI samples L0047 and L00051, the average was around 9 to 10 microns with smaller fibers around 7 microns. These fibers were within the operating range of the laser micrometer, but were very close to the threshold, which increases the threshold to the uncertainty of the measurement.

The uncertainty (U) for the method was estimated using equation 4 below:

$$U = \pm (b + ts) \qquad (4)$$

Where b is the bias, s is the standard deviation, and t is a correction factor equal to 2.0. To determine the percent uncertainty for a specific sample, the uncertainty was divided by the sample's mean diameter. The bias for this system was not considered due to a lack of a calibration standard with a given tolerance.

A UTSI L51 sample fiber was measured with three slices and a 20° rotation angle ten separate times. The mean slice diameter for the first slice was used to compute the standard deviation and the average mean slice diameter for the ten runs. Only one slice was used so that variation along the fiber diameter would not be included in the estimated uncertainty. The standard deviation for the first slice for the ten measurements had a value of 0.13, which when multiplied by the correction factor, t, gave an uncertainty of about 0.26 microns. Dividing the uncertainty by the 9.8-micron average mean slice diameter, the

percent uncertainty was found to be about 2.7%. The resolution of the micrometer is another source of uncertainty in the measurement. The resolution is 0.1 microns. For a 7 – 12 micron range of sample diameters, the uncertainty due to the 0.1 micron resolution of the micrometer would have a range of 1.4 - 0.83%. The uncertainty due to the resolution of the micrometer decreases with increasing sample diameter. For the fiber with a diameter of 9.8 microns, the uncertainty due to the micrometer resolution was about 1%. The uncertainties from the standard deviation and resolution of the measurement were added together to give a 0.36 micron uncertainty for the 9.8-micron diameter fiber. The percent uncertainty for this fiber is estimated at 3.7%.

The standard deviation was found for the other two slices taken for the UTSI sample L51. The second slice had an average mean slice diameter of 12.6 microns and a standard deviation of 0.18 microns, a percent uncertainty of about 2.9%. Adding in the 0.1 micron resolution uncertainty, the slice had an estimated uncertainty of about 3.7%. The uncertainty for the fiber slice with average diameter of 12.6 microns agrees with the uncertainty found for the slice with average diameter of 9.8 microns.

The third slice taken had a standard deviation of 0.16 for an average mean slice diameter of 12.8 giving it an uncertainty of about 2.5%. The total uncertainty for the third slice was estimated at 3.3% which was slightly lower then the uncertainty estimated for the other two slices.

The uncertainty decreases with increasing sample diameter. For the calibration wire used in the repeatability analysis, the average slice diameter for the first slice of all 10 runs was also used to compute the standard deviation and average mean slice diameter. The standard deviation had a value of 0.069, which gave a percent uncertainty of about 0.27% for the 51.2 micron calibration wire slice. The total estimated uncertainty when the micrometer resolution was factored in for the calibration wire slice was about 0.46%.

SEM Method

Samples imaged with the SEM were taken at magnifications of 2000X or 5000X. The diameters were measured using a micrometer function in the SEM software. The function uses the magnification and scale to determine distances. Data points were taken at slices along the length of the fiber. An image was produced at each of these points. Several diameter measurements were taken for each image. These values were averaged to determine the mean image diameter. The mean image diameters were then averaged to determine the mean fiber diameter. In this case, the minimum and maximum diameter reported is the extrema of the diameter determined for any slice. Figure 10 shows a UTSI sample L47 Middle Rear Left carbon fiber measured using the SEM method. The SEM data and more measured images can be found in Appendix F.

Resolution:

The SEM uses electrons to create images of its samples. This method creates high-resolution images. However, the diameter data is only as accurate

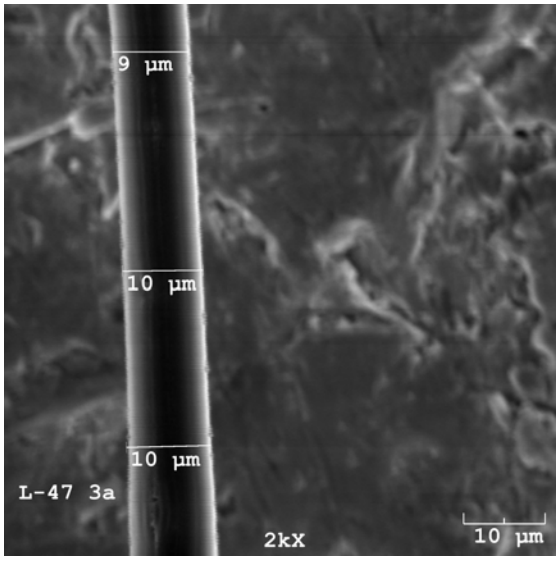


Figure 10: Carbon Fiber Sample image produced by the SEM

as the micrometer function of the software. The micrometer was calibrated by the SEM operator using a calibration sample block with evenly spaced lines. The operator reported that calibration was accurate to the micron. Also, the micrometer function rounds to the nearest micron giving the micrometer a resolution of 1 micron.

Dia-stron® – SEM Comparison:

Five samples from UTSI sample batch L00047, Middle Rear Left (MRL), were imaged with the SEM. For direct comparison, the Dia-stron® method was also used to test these same five samples. The statistical results for the UTSI sample L00047 MRL using the SEM and Dia-stron® methods are found in Tables 4, and 5. These tables show the minimum, maximum, median, and mean, as well as the standard deviation, of the minimum, maximum, and average diameters and average cross-sectional area computed for the five fiber sample batch.

The difference between the averages of the mean diameters measured for L00047 MLR by both methods was about 6%. The SEM data produced an average mean diameter of 9 microns while the Dia-stron® produced an average mean diameter of 9.6 microns. This variation is within the 1 micron resolution of the SEM. The range reported by the two systems is also inline with each other. In the case of the Dia-stron®, the range is the lowest and highest mean slice diameters measured of the fibers in the sample batch. In the case of the SEM, the range is the lowest and highest diameters measured for any image of the fibers of the sample batch. The upper end of the Dia-stron® range was 12 microns, a little lower then SEM measurement of 14 microns. The lower end was 5.1 microns for the Dia-stron® method and 6 microns for the SEM. This is not large when the diameter variation along a fiber's length is considered.

An extreme example of such diameter variation is shown in Figure 11. From the samples imaged, this extreme variation is not typical of these fibers. However, for the sake of analysis, when variation like this does occur, it adds a lot of uncertainty into the measurement. Most carbon fibers, even commercially

Table 4: SEM diameter measurement results for L00047 Middle Rear Left

SEM Diameter Results for UTSI Sample L00047 Middle Rear Left

	Min Diameter	Max Diameter	Mean Diameter	Mean Cross-section
	Micron	Micron	Micron	Sq. Micron
Min	6	7	6	32
Max	9	14	10	79
Median	9	10	9	69
Mean	8	11	**9**	65
Std. Dev	1.6	2.6	1.6	19.3
Diameter Range (Microns)		6 - 14		

Table 5: Dia-stron® diameter measurement results for L00047 Middle Rear Left

Dia-stron® Diameter Results for UTSI Sample L00047 Middle Rear Left

	Min Slice Diameter	Max Slice Diameter	Mean Diameter (fiber)	Mean Cross-Section
	Microns	Microns	Micron	Sq. Microns
Min	5.1	10.0	7.4	43.0
Max	9.0	12.0	10.9	93.3
Median	8.8	11.3	9.9	77.0
Mean	8.0	11.2	**9.6**	72.9
Std Dev	1.6	0.8	1.3	18.4
Diameter Range (Microns)		5.1 – 12.0		

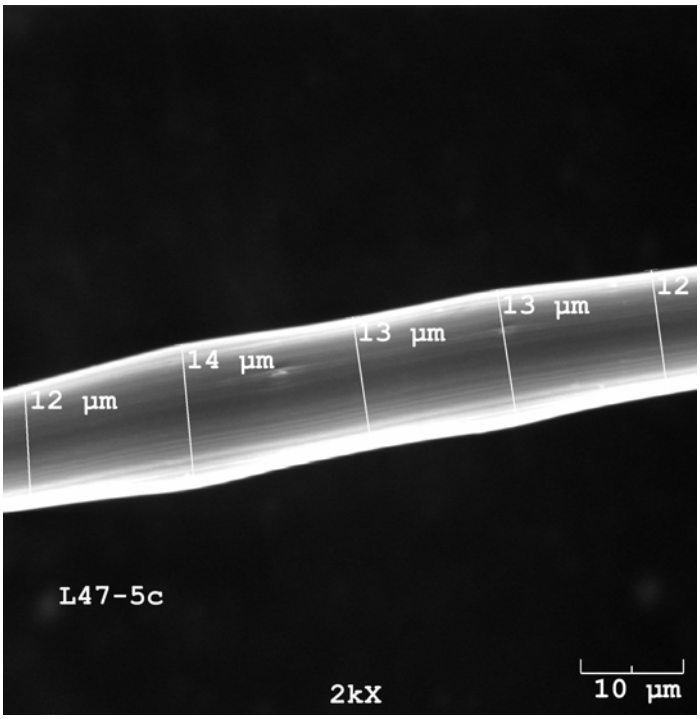


Figure 11: Extreme variation in diameter along the length of a fiber

available ones, do typically show some small variation of fiber diameter along the axis. Specific data on the diameter variation of commercially available pitch based carbon fiber is not currently available. This information may be obtained from the manufacturers.

The comparison of measured diameters for each of the five individual fibers is shown in Table 6. For the SEM data, the mean diameter is the average of the mean image diameters. The minimum and maximum values are the absolute minimum and maximum diameters measured for the fiber. In the case of the Dia-stron® data, the minimum and maximum diameters are the minimum and maximum mean slice diameters measured for a fiber. Only a portion of fiber L47-1 was retrieved and run through the Dia-stron®. 10 slices were taken for all the fibers. However, since L47-1 was a shorter fiber, only 3 of those slices produced data. Detailed Dia-stron® data for the SEM samples can be found in Appendix G. The average diameters for the first and sixth fibers agree closely

Table 6: Comparison of diameter measurements taken using the Dia-stron® and the SEM

Dia-stron® and SEM Diameters Measurements for UTSI Sample Fiber L00047 MRL				
Dia-stron® Summary Data				
Record	**Min. Diameter**	**Max. Diameter**	**Mean Diameter**	**Mean Cross-Section**
	Microns	Microns	Microns	Sq. Microns
1	8.9	11.3	9.9	77.3
2	8.	11.1	9.7	73.8
3	5.1	10	7.4	43.0
5	9	12	10.9	93.3
6	8.8	11.6	9.9	77.0
SEM Summary Data				
Record	**Min. Diameter**	**Max. Diameter**	**Mean Diameter**	**Mean Cross-section**
	Microns	Microns	Microns	Sq. Microns
1	9	12	10	79
2	6	7	6	32
3	9	10	9	69
5	6	14	9	64
6	9	10	10	79

between the two methods. The other fibers have greater variation with the greatest difference for fiber two whose SEM measured cross-sectional area differed by almost 57%. The SEM sample was longer than the Dia-stron® sample. Therefore, only a portion of the fiber tested with the SEM was loaded and tested with the Dia-stron®. Also, more slices were taken using the Dia-stron® system than with the SEM. For fiber two, only two slices were taken with the SEM. The diameter can vary widely along the length of the fiber and could account for the variation between the two systems.

Error Analysis:

Unlike the Dia-stron® method, the SEM method assumes a circular cross-section. A fiber with an oval cross-section will yield results either greater than or less than the actual cross-sectional area depending on how the fiber is laying when imaged. Carbon fibers do not always have perfectly circular cross-sections as is illustrated by the fiber cross-section that was reconstructed using the laser-scan micrometer data in Figure 7.

User error is another factor that contributes to the uncertainty. The micrometer measures the distance using a user-defined vector. The user must draw the vector perpendicular to the fiber axis or the diameter will read slightly larger than the actual value. However, for the large magnification at which these images were produced, a vector off by a few degrees will not contribute greatly to the error. For a fiber with a diameter of 10 microns to be off by 0.5 microns, which would round to the nearest micron, the angle would need to be off by almost 18°. For a fiber with a diameter of 8 microns to have this error, the angle is almost 20°. An angle off by as much as 10° for a 10-micron fiber would increase the diameter by 0.15 microns, which is within the 1-micron resolution of the micrometer. The largest fiber measured for this sample by the SEM had a diameter of 14 microns. For this sample to be off by 0.5 microns, the angle would need to be 15° off perpendicular.

Another consideration is stray fibers or unknown foreign particles that can become attached to the sample. Figure 12 shows a stray fiber (L00047-3 2a) that was found attached to the L00047-3 sample block. A sample fiber must be traced by observation to the glued ends to verify that the fiber being measured is the intended specimen.

The micrometer function built in to the SEM software and used to measure the samples in this study has a resolution of 1 micron giving it an uncertainty of ± 1 micron. For a fiber diameter range of 7 – 12 microns, the uncertainty is about 14.3 - 8.3% uncertainty in the measurement. For a 9.8-micron diameter fiber, the uncertainty is about 10.2%. Multiple measurements of a single sample image were not made during the imaging of these samples, so that equation 4 could not be used to determine uncertainty without including fiber diameter variation in the analysis.

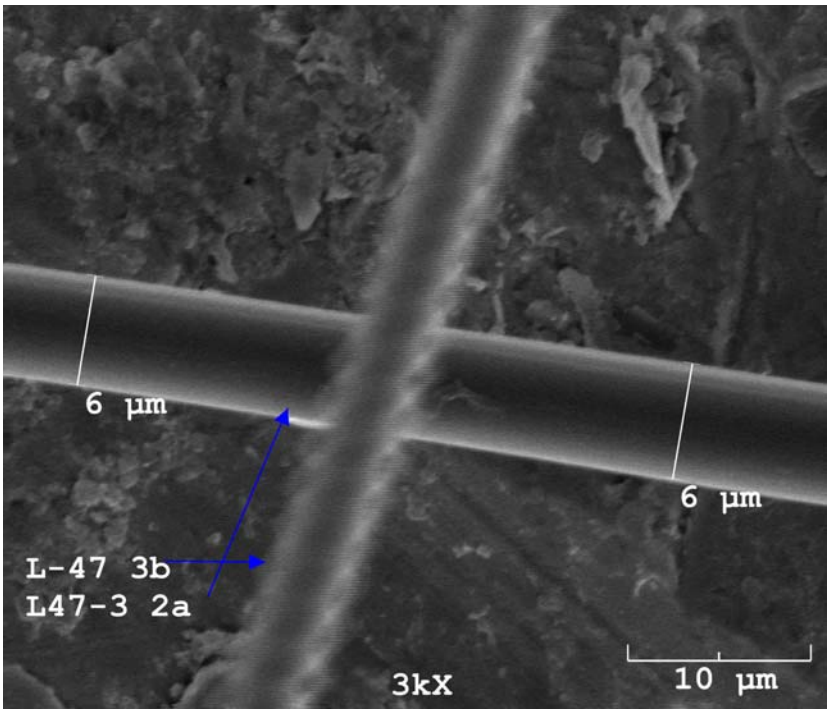
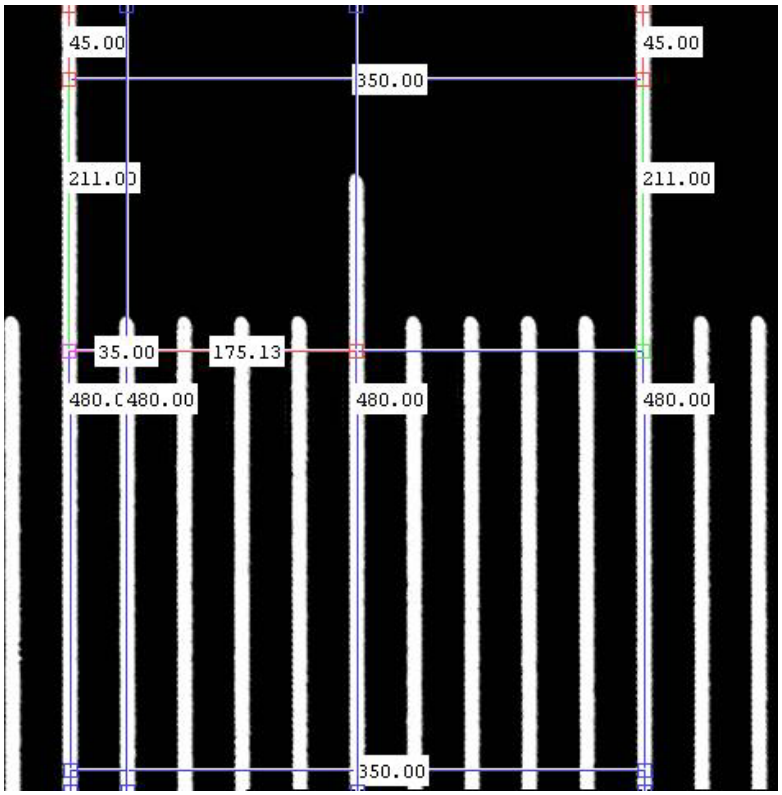


Figure 12: Stray fiber on sample block (L47-3 2a)

Optical Method

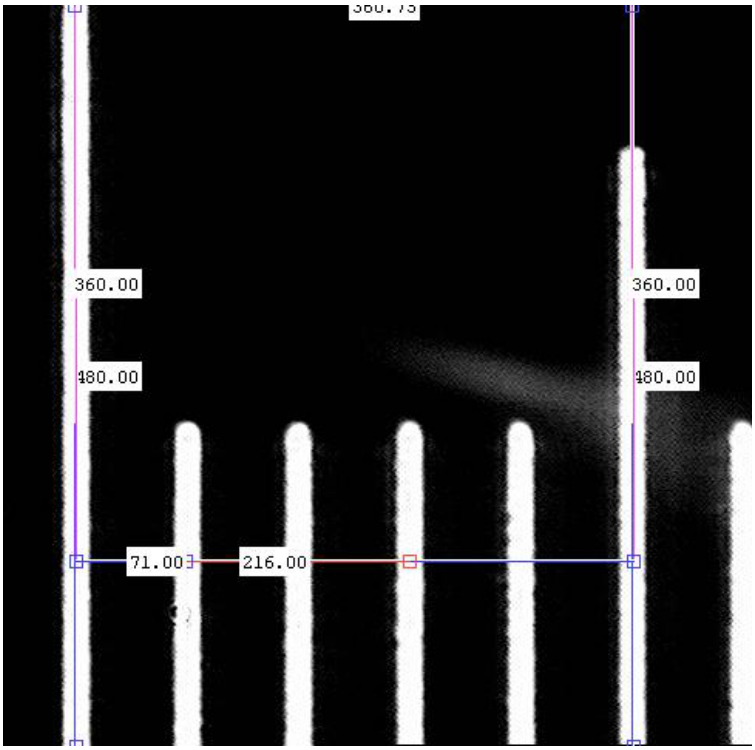
The Nikon Metaphot® optical microscope was used to test fibers from the sample batch L00051 BLF (L51) as well as commercial pitch fibers using 20X and 40X magnification. Measurements were taken along the length of the fiber in 10 slices similar to the laser-scan micrometer. However, these slices were not in equally spaced intervals as in the Dia-stron® method. Also, the fiber length for the optical method was longer than the fiber length used in the Dia-stron® method. Using the image measurement technique, two measurements were made for each slice. These were averaged to give a mean slice diameter. As described previously, in the image measurement technique, the user draws a line across the fiber width, which measures the distance in pixels. To eliminate some user error in drawing the line perpendicular to the fiber edge, the image processing program ImageJ (Open Source, Public Domain) was used to measure the angle between the drawn line and the fiber edge. Using trigonometry and the obtained angle, the measured length in pixels was corrected to the length perpendicular to the fiber edge. In most cases, this angle was only a few degrees off at most which changed the measured diameter very little. The most extreme case was off about 10 degrees or 1.5%.

The microscope lens has a fixed focal length, which the sample is at when in focus. Therefore, all focused samples under the same magnification are the same distance away from the lens. Thus, samples under the same magnification have the same distance scale. This distance can be read off of the generated image in pixels. As previously described in chapter 2, an Olympus 0.01 mm calibration micrometer was measured to obtain a correlation between pixels and microns. For a 0.01 mm micrometer, the smallest division is 10 microns. For 20X magnification, the micrometer was measured in pixels for 10, 50, and 100 micron segments using the image measurement technique. Figures 13 and 14 show the measured calibration micrometer and determined micron to pixel ratio at 20X and 40X magnifications respectively. For 40X magnification, 50, 30 and 10 micron



Calibration Micrometer		
20X Magnification		
Microns	**Pixels**	**Microns per Pixel**
100	350	0.2857
50	175.13	0.2855
10	35.00	0.2857
Microns per Pixel		**0.29**

Figure 13: Calibration Micrometer 20X 32008 under 20X magnification with distance measured in microns for 100, 50, and 10 microns respectively.



Calibration Micrometer		
40X Magnification		
Microns	**Pixels**	**Microns per Pixel**
50	361	0.1385
30	216	0.1389
10	71	0.1408
Microns per Pixel		**0.139**

Figure 14: Calibration Micrometer 32008 under 40X magnification with distance measured in microns for 50, 30, and 10 microns.

segments were measured. The lines used to measure the pixels were made into rectangles to ensure that they were perpendicular to the tick marks. The pixels for each division were compared to the known distance from the micrometer to determine the ratio between distance in microns and pixels.

Single fibers from a commercially available pitch fiber sample and UTSI sample L51 were imaged at 20X magnification and measured using the image measurement technique. The determined micron per pixel ratio was 0.29 or about 3 pixels to a micron. Examples of UTSI and commercial pitch measured fibers at 20X magnification are shown in Figures 15 and 16 respectively. These fibers were then measured using the Dia-stron® laser scan micrometer for comparison. However, the fiber length was longer for the optical method than for the Dia-stron® method. For the Dia-stron®, the samples were reduced to the 10 mm sample length. The results for the commercial pitch and UTSI sample fibers are found in Tables 7 and 8 respectively. The commercial pitch fiber showed good agreement between both methods. The optical method gave a mean diameter of 11.89 microns as compared to the Dia-stron® method, which gave a mean diameter of 11.73 microns, a difference of about 1.4% for the mean diameter and 2.9% for the mean cross-sectional area.

The UTSI sample L51 disagreed more between the optical and Dia-stron® methods than the commercial pitch fiber. The optical method produced a mean diameter of 9.9 microns as compared to 10.7 microns measured with the Dia-stron®. The difference for the UTSI sample is 7.5% for the mean diameter and 15.5% for the mean cross-sectional area. The range for the diameters was fairly close for both fibers. The range of diameters measured optically for the commercial pitch fiber was 11.38 – 12.30 microns. For the Dia-stron®, the range was 11.59 – 11.86 microns. In this case, the minimum and maximum diameters reported for both methods are the minimum and maximum of the mean slice diameters. The range for the UTSI sample L51 measured optically was 8.4 – 12.4 microns as compared to the range of 8.2 – 13.2 microns measured with the Dia-stron®. The range for the UTSI sample was 4 to 5 microns, which is

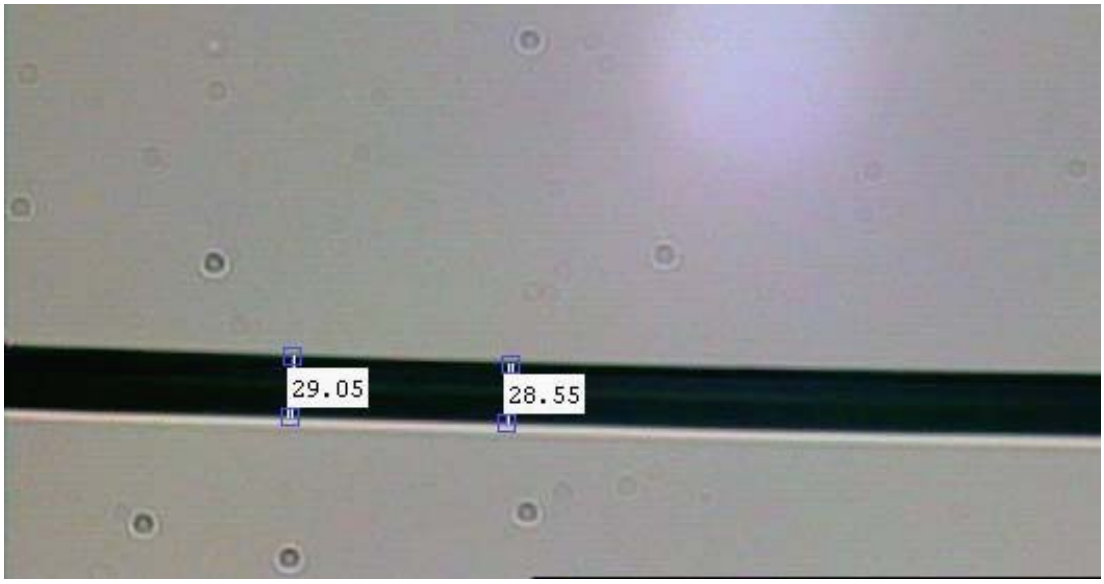


Figure 15: Fiber from L51 BLF imaged with microscope under 20X magnification

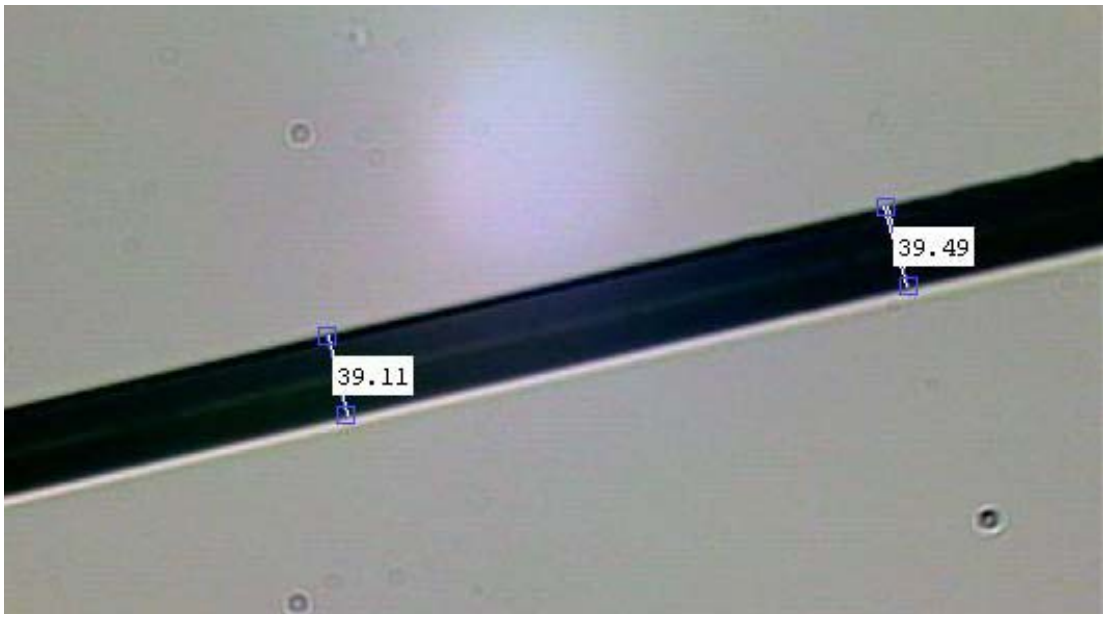


Figure 16: Commercial Pitch fiber imaged with microscope under 20X magnification.

Table 7: Comparison between Dia-stron® measurement method and the optical method for a commercial pitch fiber under 20X magnification. Sample Commercial Pitch 20X Glass

Diameter Measurements for Commercial Pitch Fiber for Dia-stron® and 20X Optical Methods using the Image Measurement Technique

	Min Slice Diameter	Max Slice Diameter	Avg. Diameter	Avg. Cross-sectional Area
	Micron	Micron	Micron	Sq. Microns
Dia-stron®	11.591	11.858	11.73	108
20X Optical	11.38	12.30	11.89	111.10
Different (%)	1.79%	3.74%	1.42%	2.87%

Table 8: Comparison between Dia-stron® measurement method and the optical method for UTSI sample L51 under 20X magnification. Sample L51 20X 40X3

Diameter Measurements for UTSI Sample L51 for Dia-stron® and 20X Optical Methods using the Image Measurement Technique

	Min Slice Diameter	Max Slice Diameter	Average Diameter	Avg. Cross-sectional Area
	Micron	Micron	Micron	Sq. Microns
20X Optical	**8.4**	**12.4**	**9.9**	**77.7**
Dia-stron®	**8.232**	**13.15**	**10.7**	**89.8**
Difference (%)	**2.1%**	**6.1%**	**7.5%**	**15.5%**

much larger than the 1 micron range of the commercial pitch fiber. Greater variation in diameter contributes to the disagreement between the two methods for the UTSI sample. Small variations are generally averaged out, whereas larger variation can affect the diameter considerably as measurements are taken along the length of the fiber. The commercial pitch fiber is in better agreement most likely due to its more consistent diameter.

The above process was repeated for commercial pitch and UTSI sample L51 fibers under 40X magnification. The commercial pitch fiber at 40X was a different sample fiber than the one measured at 20X magnification. The UTSI sample fiber measured at 40X magnification was the same as the one measured for the 20X magnification. The higher magnification should provide more accurate results due to higher resolution. The micron to pixel ratio for 40X magnification is 0.139, or about 7 pixels to the micron, whereas it was 0.29 for the 20X magnification. The smaller micron to pixel ratio reduces uncertainty in diameter measurement. However, as the magnification increased, the sample, which was illuminated from below, became harder to focus. Figure 17 shows how the focus changed with 20X, 40X, and 100X magnification of the sample. The fiber image could not be focused acceptably at 100X to provide valid data, and so was not included in this study. The results at 40X magnification for the commercial pitch and UTSI fibers are found in Tables 9 and 10.

The commercial pitch fiber had a greater percent difference for the 40X magnification than for the 20X magnification. The Dia-stron® measured a mean diameter of 12.86 microns as compared to the optical method, which produced a mean diameter of about 13.48 microns, a difference of .7 microns or 4.85%. The difference was more than doubled for the cross-sectional area to 9.94%. The UTSI sample L51 showed slightly less variation for the 40X magnification than for the 20X. The mean diameters found using the Dia-stron® and optical methods respectively were 10.69 and 10.09 microns, a difference of 6%. The cross-sectional area differed by 12.4%. The same UTSI L51 sample fiber was used to produce the 20X and 40X optical measurements. The difference between the

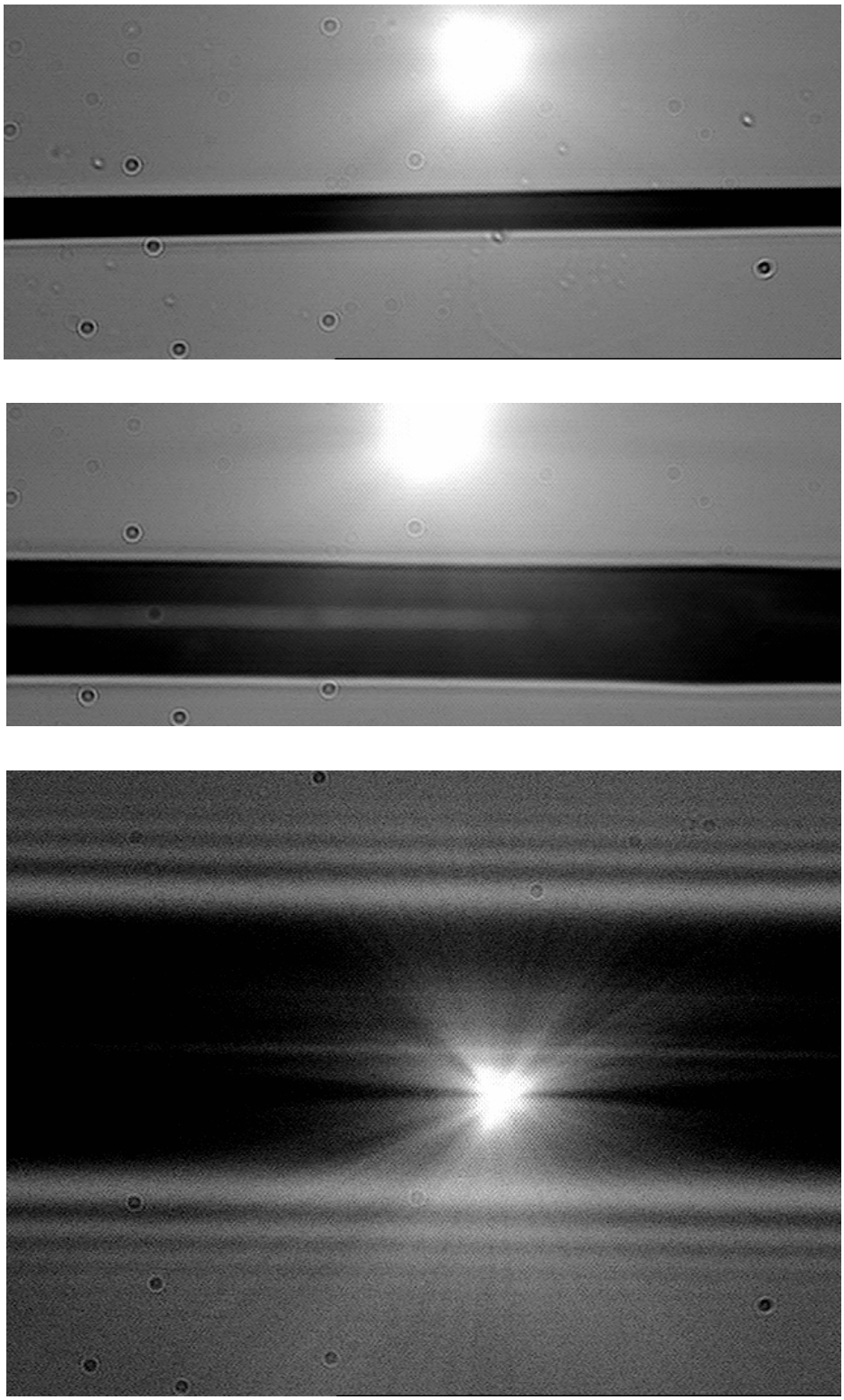


Figure 17: UTSI sample L51 under 20X, 40X, and 100X respectively.

Table 9: Comparison between Dia-stron® measurement method and the optical method for Commercial Pitch under 40X magnification Sample CP 40X OP

Diameter Measurements for Commercial Pitch Fiber for Dia-stron® and 40X Optical Methods using the Image Measurement Technique				
	Min Slice Diameter	Max Slice Diameter	Avg. Diameter	Avg. Cross-sectional Area
	Micron	Micron	Micron	Sq. Microns
Dia-stron®	12.68	13.03	12.86	129.80
40X Optical	13.11	13.82	13.48	142.71
Different (%)	3.38%	6.07%	4.85%	9.94%

Table 10: Comparison between Dia-stron® measurement method and the optical method for UTSI Sample L51 under 40X magnification Sample L51 BLF 40X 3

Diameter Measurements for UTSI Sample L51 for Dia-stron® and 40X Optical Methods using the Image Measurement Technique				
	Min Slice Diameter	Max Slice Diameter	Avg. Diameter	Avg. Cross-sectional Area
	Micron	Micron	Micron	Sq. Microns
Dia-stron®	8.23	13.15	10.69	89.80
40X Optical	7.10	12.14	10.09	79.89
Difference (%)	15.9%	8.4%	6.0%	12.4%

Table 11: Comparison between diameter measurements made of UTSI sample L51 under 20X and 40X magnification. Sample L51 BLF 40X 3

Diameter Measurements for UTSI Sample L51 under 20X and 40X Optical Magnification using the Image Measurement Technique				
	Min Slice Diameter	Max Slice Diameter	Average Diameter	Cross-sectional Area
	Micron	Micron	Micron	Sq. Microns
20X Optical	8.4	12.4	9.9	78
40X Optical	7.1	12.1	10.1	79.9
Difference (%)	15.5%	2.1%	1.4%	2.8%

mean diameters for the various magnifications was only 0.2 microns, or 1.4%, as shown in Table 11. The data for the measured images taken with the Nikon Metaphot® optical microscope for the UTSI and commercial pitch sample fibers under 20X and 40 X magnifications can be found in Appendix H along with some examples of the measured images. The Dia-stron® data for the optically measured fibers is found in Appendix I.

Intensity Plot Method:

The images produced by the optical method do not have sharply defined edges. Determining the fiber edge affects the accuracy of the measurement since the diameter is measured from edge to edge. The light from the optical microscope refracts off of the fiber edge creating a white fringe as shown in Figure 18. Taking the fiber edge to be inside the fringe might underestimate the fiber diameter. However, including the whole fringe in the measurement might overestimate the diameter. To better determine the fiber edge, an intensity plot was made across a sample fiber. An intensity plot graphs the variation of light intensity with respect to distance. In this case, the distance is the length across the fiber diameter in pixels.

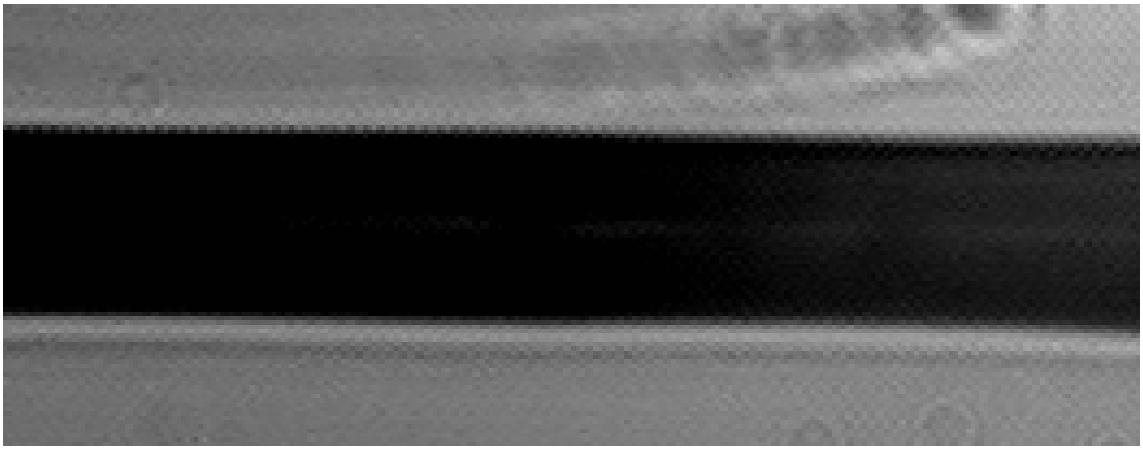


Figure 18: Example of fringe along fiber edge

The intensity is greater for the light background of the image and slopes down to zero intensity for the blackness of the fiber. The slope is repeated for the other edge of the fiber creating a bucket shaped graph. An example of an intensity plot is shown in Figure 19. The sloping portion is of interest as it is the intensity variation in the fringe. The distance between the sloping portions gives the diameter of the fiber. Measuring only the zero intensity portion is equivalent to measuring the diameter on the interior of the fringe. The fiber edge may not be black due to refracted light. This measurement would underestimate the fiber diameter. Taking the measurement at the top where the plot begins to slope may include too much of the fringe and over estimate the fiber diameter. Therefore, the diameter was measured at the bottom, middle, and top sections of the plot to determine the variation between these locations.

Figures 20 and 21 show the measured intensity plot for a UTSI sample fiber from batch L51 for 20X and 40X magnification. The lower, middle, and upper measurements produced diameters of 7.98, 8.64, and 9.51 microns respectively for the 20X magnification. This variation has a range of about 1.5 microns. The 40X magnification resulted in diameters of 8.34, 8.55, and 9.10 microns, a range of about 0.8 microns. For both cases, the difference between the diameters measured at the lower and middle sections were closer than those measured at the upper section due to the lower slope in the upper section.

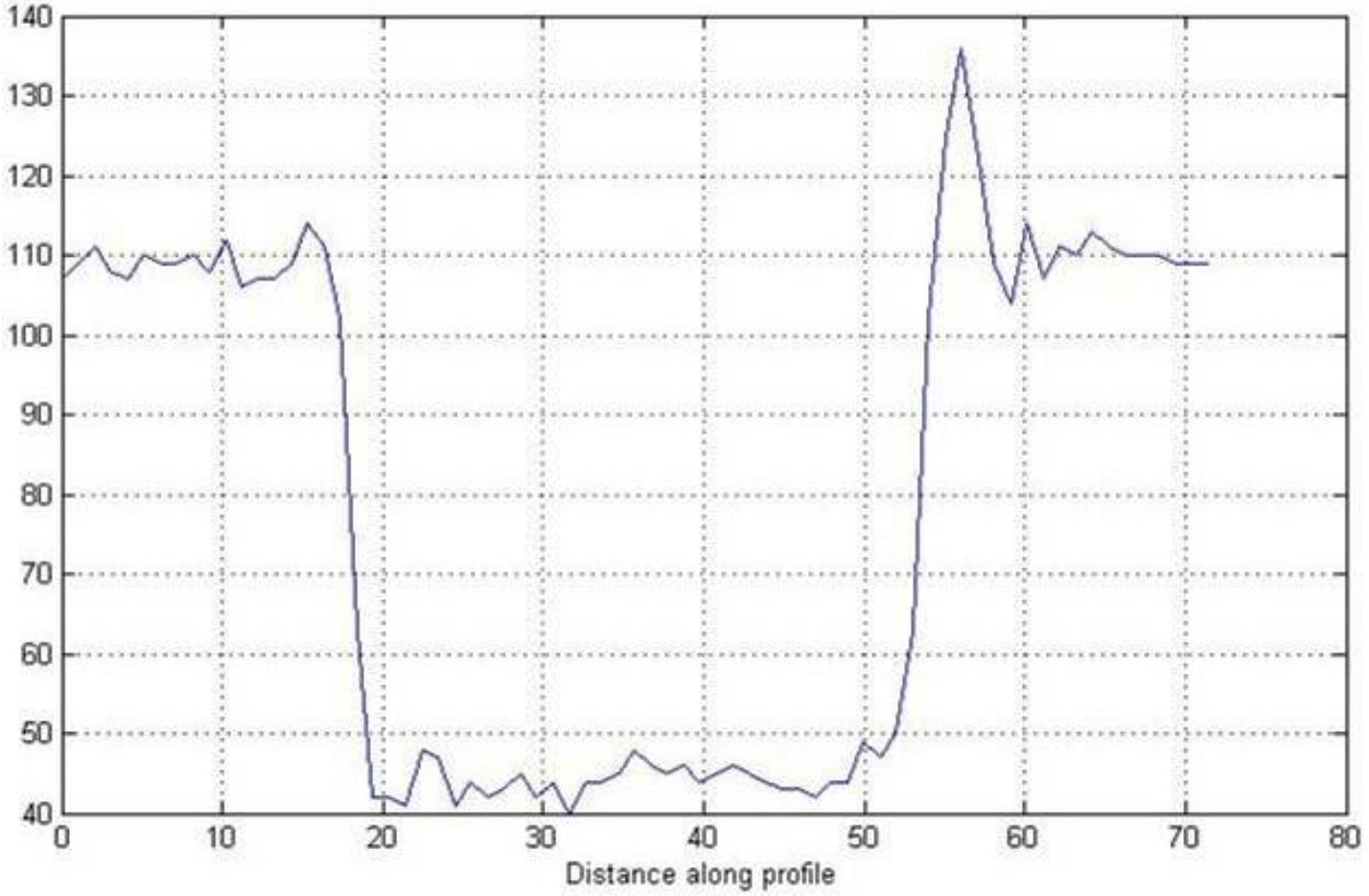
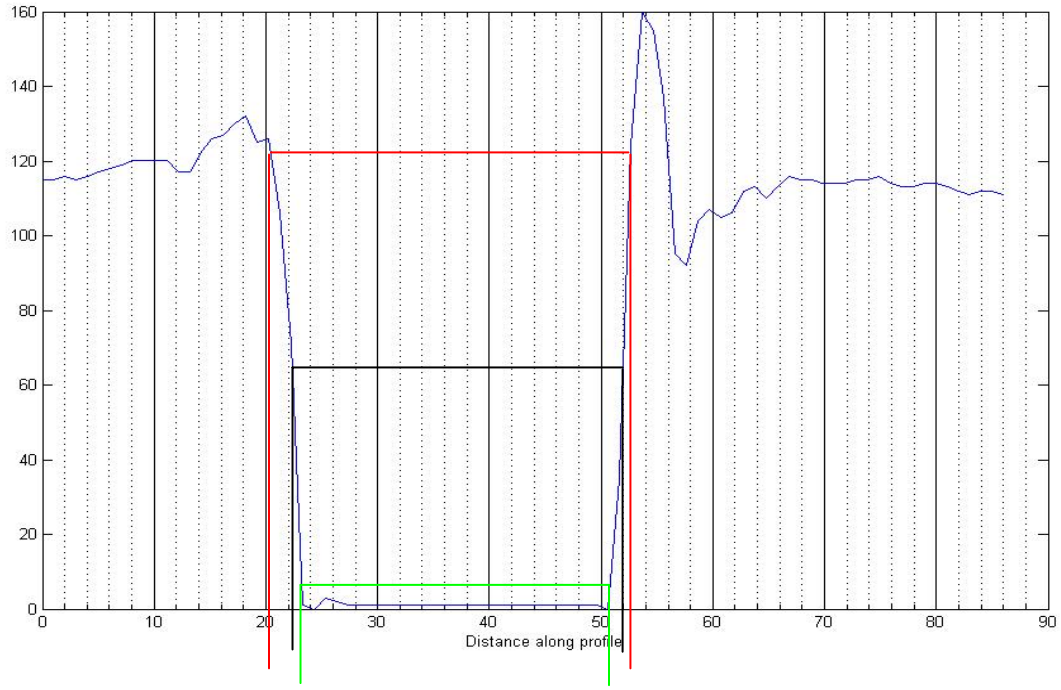


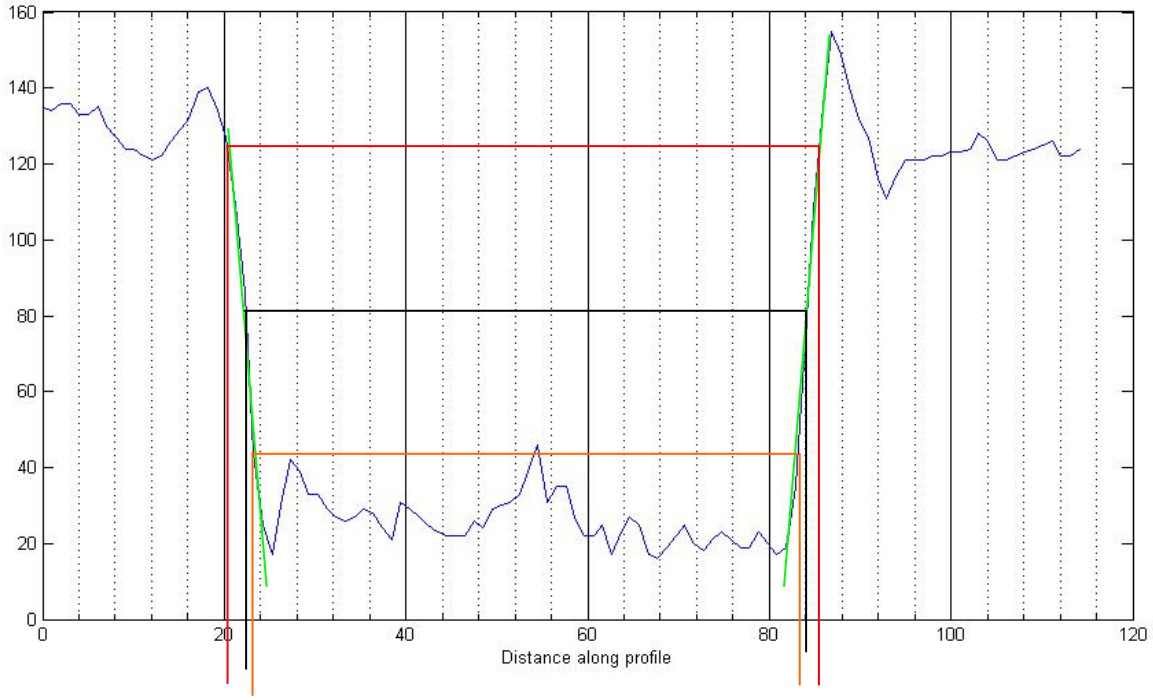
Figure 19: Intensity plot of carbon fiber diameter slice



L51 20X Intensity Diameter Measurement

	Point 1	Point 2	Distance	Diameter
Bottom	23.0	50.5	27.5	7.98
Middle	22.2	52	29.8	8.64
Upper	20.2	53	32.8	9.51

Figure 20: Comparison of diameter measurements using different segments of an intensity plot for UTSI sample L51 20X



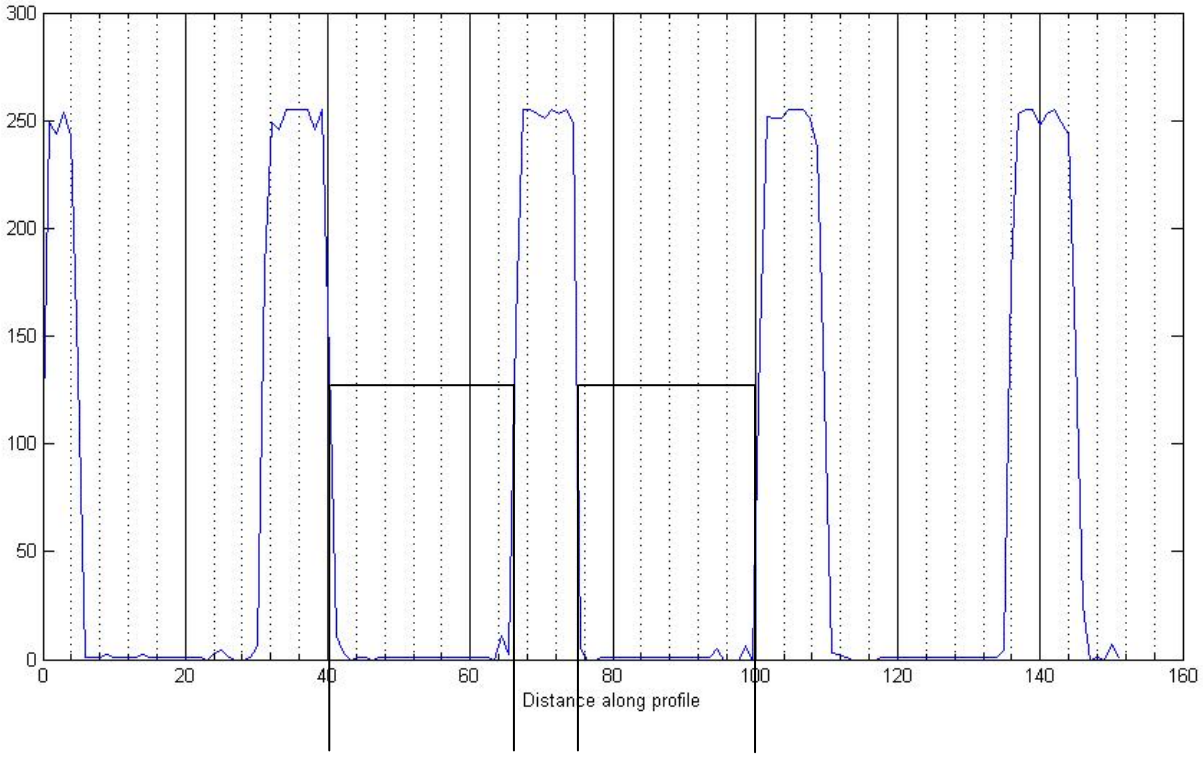
L51 40X Intensity Diameter Measurement				
	Point 1	**Point 2**	**Distance**	**Diameter**
Bottom	23	83	60	8.34
Middle	22.5	84	61.5	8.55
Upper	20	85.5	65.5	9.10

Figure 21: Comparison of diameter measurements using different segments of an intensity plot for UTSI sample L51 40X

The lower slope is evidence of the white and gray fringes along the fiber edge. About midway down the plot, the slope increases as the fringe decreases into the blackness of the fiber. As mentioned previously, the bottom section may eliminate some of the fiber edge. For this reason, the middle section was used when measuring the diameter by the intensity technique.

The calibration micrometer standard was also measured using this technique. Figure 22 shows the measured calibration micrometer for 20X magnification. The distance used is from the midpoint of one marker to the mid point of the next, a distance of 10 microns per division. The micron per pixel ratio found for the 20X micrometer was 0.27 as compared to 0.29 found with the image measurement technique. For the measurements using the intensity plots, the 0.27 micron per pixel ratio was used.

The UTSI sample L51 imaged at 20X and 40X magnification was measured using the intensity plot technique. The images used were from the Nikon Metaphot® optical microscope and were the same ones measured previously using the image measurement technique. The intensity was plotted for a user defined line using the “improfile” function in MATLAB. To help correct for lines drawn at an angle other than perpendicular across the fiber, a screen shot recorded where the line was drawn on the image. The angle between the line and the fiber edge was then determined using ImageJ software. The distance was corrected as in the image measurement technique. The ten slices for each fiber were averaged and compared with the Dia-stron® data of the same fiber. The results for the 20X L51 fiber measured optically with the intensity plot technique and by the Dia-stron® laser micrometer are shown in Table 12. For the two methods, the mean diameter differed by 11.7% as opposed to the 7.5% using the image measurement technique. The difference between the mean diameters found for the fiber using the intensity plot and image measurement techniques differed by 5.1% as shown in Table 13. However, when the 0.29 micron to pixel ratio was used for both techniques, the difference between mean diameters was only 2.0%.



Calibration Micrometer 20X Intensity Measurement					
Plot	**Distance1**	**Distance 2**	**Middle Point**	**Angle**	**Corrected Distance**
1	40	66	53		
2	79	100	89.5		
Distance Mid to Mid			36.5	90.23	36.5
Microns					10
Micron to Pixel Ratio					**0.274**

Figure 22: Determination of the micron per pixel ratio for the calibration micrometer under 20X magnification using the intensity plot technique.

Table 12: Comparison of Diameter measurements for UTSI sample L51 under 20X Optical magnification using the intensity plot and Dia-stron® methods.

Diameter Measurements for UTSI Sample L51 for Dia-stron® and 20X Optical Intensity Methods				
	Min Slice Diameter	Max Slice Diameter	Avg. Diameter	Avg. Cross-sectional Area
	Micron	Micron	Micron	Sq. Microns
20X Optical Intensity	8.1	11.9	9.4	70
Dia-stron®	8.2	13.2	10.7	89.8
Difference (%)	1.6%	9.7%	11.7%	22.0%

Table 13: Comparison of Diameter measurements for UTSI sample L51 at 20X Optical magnification using the intensity plot and image measured techniques

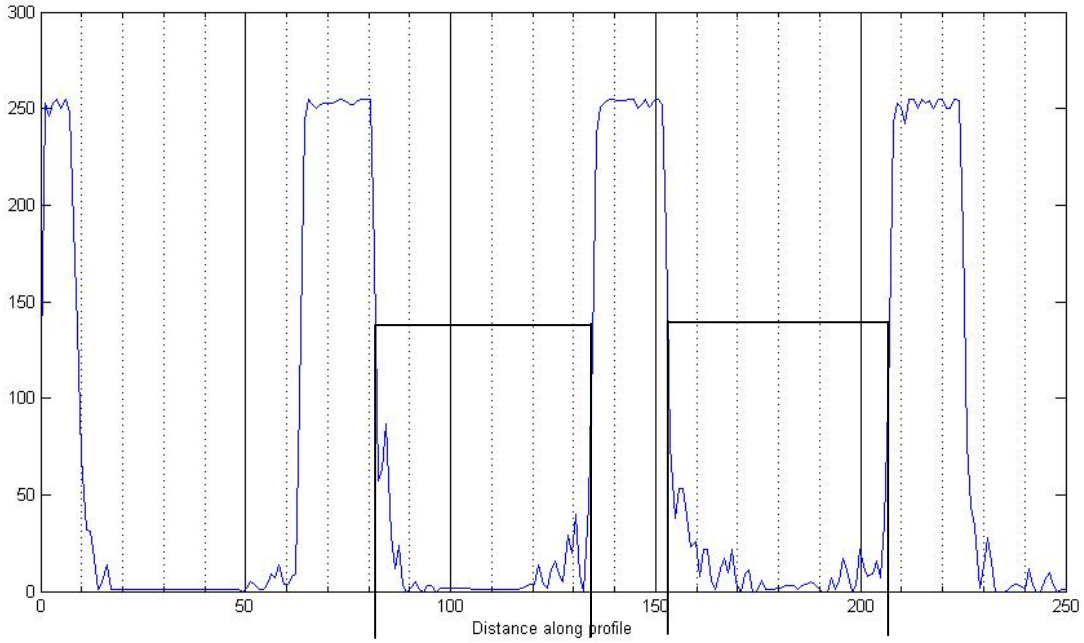
Diameter Measurements for UTSI Sample L51 for 20X Optical Intensity and Image Measured Methods				
	Min Slice Diameter	Max Slice Diameter	Avg. Diameter	Avg. Cross-sectional Area
	Micron	Micron	Micron	Sq. Microns
20X Optical Intensity	8.1	11.9	9.4	70
20X Optical Image Measured	8.41	12.39	10.0	77.73
Difference (%)	3.7%	4.1%	5.1%	9.9%

For the 40X magnification, the calibration micrometer gave a micron to pixel ratio of 0.138 differing by only 0.001 from the image measurement technique. Figure 23 shows the intensity plot for the 40X calibration micrometer. The comparison for UTSI sample L51 at 40X magnification measured by the Dia-stron® and the intensity technique is shown in Table 14. The difference between mean diameters was 7.2% as compared to the image measurement technique, which differed from the Dia-stron® measurement by 6%. The image measurement and intensity plot techniques for the UTSI sample fiber under 40X magnification differed only by a little over 0.1 microns or 1.6%. The comparison is shown in Table 15. The intensity plot data for UTSI sample L51 at 20X and 40X magnifications are included in Appendix J.

Error Analysis:

As with the SEM method, the optical method assumes a circular cross-section for the fibers, which will over or underestimate the cross-sectional area for an oval of irregularly shaped fiber. Since the fiber cannot be rotated, only the top view is available for imaging.

Also, as discussed with the intensity plot measuring technique, focus contributes to the uncertainty of the measurement. Being out of focus makes the image larger and increases the diameter measured. Focus becomes an even greater issue when dealing with the calibration micrometer. An out of focus micrometer increases the size of the divisions, which reduces the micron to pixel ratio. For the 20X magnification, three separate images were taken of the calibration micrometer. Two of the three gave a ratio of 0.29 whereas the third gave a ratio of 0.27. Since the ratio is multiplied by the measured distance, the 0.02 difference can contribute an uncertainty of about 7%. The 40X calibration micrometer varied less. Out of four images taken, three were 0.139 and the fourth was 0.134. The difference here is only 0.005, giving an uncertainty of about 4%. For the image measured data, 0.139 and 0.29 were used for the 40X and 20X samples respectively. For the samples measured using intensity plots,



Calibration Micrometer 40X Intensity Measurement					
Plot	**Distance1**	**Distance 2**	**Middle Point**	**Angle**	**Corrected Distance**
1	81	134	107.5		
2	152	208	180		
Distance Mid to Mid			72.5	90.23	72.5
Microns					10
Micron to Pixel Ratio					**0.138**

Figure 23: Determination of the micron per pixel ratio for the calibration micrometer under 40X magnification using the intensity plot technique.

Table 14: Comparison of Diameter measurements for UTSI sample L51 under 40X Optical magnification using the intensity technique and the Dia-stron® method

Diameter Measurements for UTSI Sample L51 for Dia-stron® and 40X Optical Intensity Methods				
	Min Slice Diameter	Max Slice Diameter	Avg. Diameter	Avg. Cross-sectional Area
	Micron	Micron	Micron	Sq. Microns
40X Optical Intensity	7.0	12.3	9.9	77
Dia-stron®	8.232	13.15	10.7	89.8
Difference (%)	14.8%	6.6%	7.2%	13.8%

Table 15: Comparison of Diameter measurements for UTSI sample L51 under 40X Optical magnification using the intensity plot and image measured techniques

Diameter Measurements for UTSI Sample L51 for 40X Optical Intensity and Image Measured Methods				
	Min Slice Diameter	Max Slice Diameter	Avg. Diameter	Avg. Cross-sectional Area
	Micron	Micron	Micron	Sq. Microns
Optical Measured	7.10	12.14	10.09	79.90
Optical Intensity	7.01	12.28	9.93	77.37
Difference (%)	1.3%	1.2%	1.6%	3.2%

the ratio that was found using the intensity method on the calibration micrometer was used for that measurement. The measurements for the different images of the calibration micrometers can be found in Appendix K.

User error is also a factor in the optical methods. Besides determining the fiber edge, which was discussed in the intensity plot discussion, both of the direct image measure and intensity plot techniques rely on user drawn vectors. The angle between the fiber edge and the drawn vector was recorded using ImageJ software. The diameter was then corrected using trigonometry to give the measure of the distance perpendicular to the fiber's edge. In most cases, the angle was quite small. The extreme cases were about 8.5°, an uncertainty of a little over 1%. However, the angle was also determined by user drawn vectors between the fiber edge and the measuring line. Some uncertainty is inherent in this angle measurement due to the vectors being user-drawn.

The uncertainty of the 20X optical method was estimated using equation 4. An image of the UTSI sample L51 (slice 2) was measured 30 separate times. As discussed with the Dia-stron uncertainty analysis, only one image, or slice, was used so that variation in the fiber diameter would not be included in the analysis. For the 30 measurements of the L51 slice, the standard deviation was 0.124 microns and the average slice diameter was about 8.60 microns resulting in a percent uncertainty of about 2.88%. When the measured diameters were corrected for angle as was done for this study, the standard deviation was 0.122 and the average mean slice diameter was 8.58 microns. The percent uncertainty dropped slightly to about 2.85%. The measurement technique was only accurate to the pixel, which is ± 0.29 microns for 20X magnification. The 0.29 uncertainty is multiplied by a factor of two to become 0.58 microns since the diameter of the fiber is the distance between two pixels. For the range of diameters from 7 – 12 microns, the uncertainty has a range of 8.29 – 4.83%. Adding the 0.58 micron resolution uncertainty, the estimated uncertainty for the 8.58-micron fiber is about 9.6%.

Diameter Measurements Conclusion

Each of these three methods, laser micrometer, SEM, and optical microscope, contains sources of uncertainty. The uncertainty in the laser scan micrometer is due to the size of the fibers since the laser micrometer is designed to operate for a range of samples between 5 and 2000 microns. Also, the laser scan micrometer assumes the fiber is solid. The estimated uncertainty of a measurement made by the laser scan micrometer is around 3.7% for a 9.8-micron fiber.

The SEM method has uncertainty due to the method of mounting the sample. The method assumes a circular cross-section. Also, this method relies on user drawn vectors to measure the fiber diameter. The uncertainty due to the resolution of the micrometer function for a 9.8-micron fiber is around 10.2%. The range of uncertainty for the SEM method for fibers with diameters between 7 – 12 microns is about 8.3-14.3%.

The optical microscope method also assumes a circular cross-section, and relies on user drawn vectors. This method contains even more uncertainty due to the fringe along the fiber edge which can cause the fiber diameter to be over or underestimated. Focus is also an issue when using the optical microscope method. Estimated uncertainty due to the measuring method and resolution of the micrometer is around 9.6% for a fiber with a diameter of 8.58 microns.

The SEM and optical microscope methods are both time consuming and not efficient for measuring a large number of samples. The mounting for the Dia-stron® laser micrometer allows the fiber to be tensile tested using the same mount unlike the SEM and optical microscope methods which require the fiber to be remounted. For measuring diameters of a large number of fibers that are also to be tensile tested, the Dia-stron laser micrometer is the most efficient method. The Dia-stron® laser scan micrometer is the recommended method due to its 0.1 micron resolution and its ability to measure the cross-sectional area of the fiber at different points around the circumference of the fiber.

Tensile Measurements

A large number of samples were tested using the Dia-stron® LEX 810 linear extensometer. The LEX810 applies an increasing tensile load to a fiber until it breaks. The data is exported to the computer where it is displayed using the UV-Win software. A stress-strain curve is the output of the system. The units on the graph are displayed in gram-force and microns. However, the software will display the axes in a variety of user-selected units. For the X-axis, the unit options include: strain (%), millimeters, microns, microseconds, log10 sec, and unit strain. For the Y-axis the unit options include: grams-force, grams-force per square micron, Newtons (N), Newtons per sq. micron, cN per tex, strain(%), millimeters, microns, Pascals (Pa), and megaPascals (MPa). The units displayed on the screen when the file is exported are the units that will appear in the tensile report which gives the coordinates of the stress-strain curve. The current system uses microns for the x-axis and MPa for the y-axis. MPa is a measurement of stress found by the force divided by an area. The area used to determine the stress for the sample is user selected from four options: mean area, mean area minus the standard deviation, maximum area, and minimum area. In this study, the mean unstrained fiber cross-sectional area was used when computing break stress.

Fiber Alignment:

Fiber alignment is very important in determining the tensile strength of a fiber. Misalignment can cause the tension in the fiber to be different from the tension reported by the strain gage. Also, misalignment can cause a moment to be applied at the wax interface. A schematic shows the forces on a misaligned fiber in Figure 24. The axial force, F_A, is the value that is registered by the tensile tester. F_A is generally reported as tensile stress. The actual tension in a fiber, F_T at an angle, θ is:

$$F_T = \frac{F_A}{\cos \theta} \qquad (5)$$

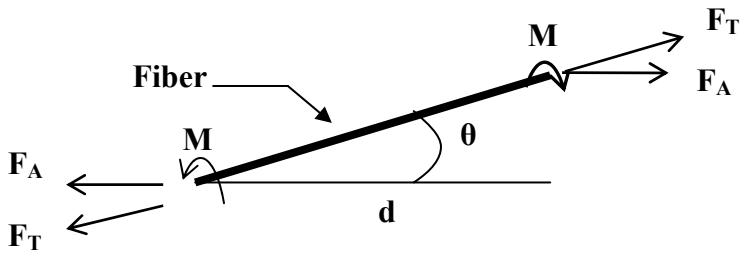


Figure 24: Schematic of the forces on a misaligned fiber

The moment, M, created by the axial force is found by equation 6.

$$M = F_A \cdot d \tan \theta \quad (6)$$

Where d is the horizontal length of the fiber. The stress on the fiber due to the applied moment is:

$$\sigma_M = \frac{Mc}{I} \quad (7)$$

where c is the greatest distance from the neutral axis to the surface, in this case the radius (r), as shown in Figure 25. The cross-section is assumed to be circular. I is the moment of inertia of the cross-section. The moment of inertia for a circular cross-section around any line passing through its center is found in

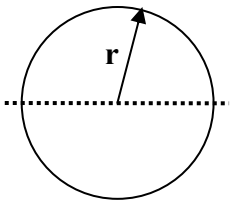


Figure 25: The distance, c, from the neutral axis to the surface for a circle

equation 8.

$$I = \frac{\pi r^4}{4} \qquad (8)$$

In the case of the Dia-stron® system, d is a fixed length of 10 mm. The mounting tabs have notches to ensure fiber alignment. However, some fibers are not perfectly straight or are shifted by the melted wax during loading causing misalignment to occur. The maximum angle that could occur for the Dia-stron® system would be a fiber attached at opposite edges of the loading feet. The width of the foot is approximately 4 mm. The angle would be 21.8 °. The increase of the actual load to the registered load F_A is about 8 %. This case is extreme and is not likely to occur under normal circumstances. A more likely case would be for the fiber to be attached in the middle of one foot and at the edge of the opposite foot. The angle in this case is 11.3°. The increase in load for this case is about 2%. A more significant issue is the bending moment applied at the interface of a misaligned fiber. The moment M is found by the equation below:

$$M = F_A \bullet h \qquad (9)$$

where h is the moment arm found by equation 10:

$$h = l \bullet \tan(\theta) \qquad (10)$$

where *l* is the length of the sample: in this case 10 mm.

For the two cases above, fiber angles of 11.3° and 21.8°, the bending stresses for a fiber with a diameter of 8 microns become 4×10^{13} F_A and 8×10^{13} F_A respectively. The most likely result of these forces is a premature breakage at the attachment interface. This can be easily prevented by careful loading of the sample to ensure alignment in the notches. Fibers which have severe misalignment are generally thrown out before tensile testing.

A fiber, which is twisted when installed, will be subject to torsion forces which could also cause premature breakage at the attachment interface. However, the current system has no way of inspecting a sample fiber to determine if it is subject to torsion forces.

The shape of the fiber is also important to the fiber's break strength. A curved fiber, which is not perpendicular in the notches, can produce a bending moment at the wax interface. Also, the fiber may be perpendicular in the notch but exit it at an angle. Fibers, which are straight and have smooth surfaces, are solely in tension along their horizontal axes. Slack in the fiber sample will cause it to assume a curved or S shape. When tension is applied, the fiber will pull straight and bear the load axially. However, some fibers have more rigid curves. The fibers with rigid kinks, or small radius curvatures, along the axis will exhibit lower break strength. When the fiber is put into tension, the kinks produce stress concentrations causing the fiber to break. An example of a fiber with curves is shown in Figure 26.

Fibers can develop kinks and curves during the spinning process as well as during the heat treatment process. The pitch from which the fibers are spun is mixed with a solvent to lower the melting temperature of the mixture. Once spun into fibers, the solvent must be removed before the fiber can be heated to the high temperatures required for carbonization. Otherwise, the fiber would simply re-melt. Stabilization is the process at which the fiber is heated slowly to remove the solvent. As the fiber is heated, the solvent evaporates and is carried away by gases introduced into the oven. The solvent is removed slowly to prevent cracking or holes in the fiber. Pre-stabilization occurs before stabilization at an even lower temperature to remove enough of the solvent to prevent softening

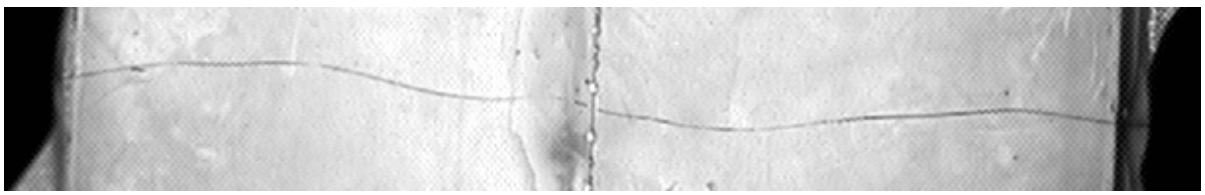


Figure 26: Fiber with curves

during stabilization. If the temperature reaches the melting point of the solvent-pitch mixture before enough of the solvent has been removed in the pre-stabilization or stabilization phases, or if solvent is left in the fiber during carbonization, the fiber will soften. UTSI fiber is currently produced in mats which when heat treated lay horizontally in the oven. Fibers that become softened can bend down around the other fibers in the mat creating kinks and curves. Different processing procedures, such as spooling, are being considered which would eliminate this problem.

A post-break analysis was performed after the samples were broken. Once a fiber breaks in the tensile tester, the vibration of the break usually causes the remaining ends of the fiber to break off as well resulting in no fiber left after the test. These samples generally exhibit higher break stresses. Some fibers break at the wax interface. These samples have the fibers intact, but only attached on one side. These fibers tend to exhibit lower break stresses. Breaking at the interface is most likely due to a bending moment caused either by a fiber that was not perpendicular through the notch, or a fiber attached outside of the notch. Other samples have both pieces of the fiber remaining with the break clearly visible. These fibers also tend to have lower break stresses. One possibility for lower strengths of fibers with visible breaks is a defect or impurity in the fiber causing a weak point. Table 16 shows the percent difference of average break stress as categorized by the post break analysis for 5 sample batches. Each category of fiber was averaged to determine its mean break stress. The table shows the percent difference between the average break stress for a category of fibers and the highest average break stress among those categories. The category which has 0.0% difference is the category that exhibited the highest average break stress. The other two categories for a sample had an average break stress below it. For the first sample batch, UTSI sample L00049 TLR, the category of fibers which had a visible break had an average break stress 67.8% below the average break stress of the fibers which had no fiber left after tensile testing. The category of fibers that broke at the wax had an average break stress

Table 16: Comparison of tensile strength as categorized by post break analysis

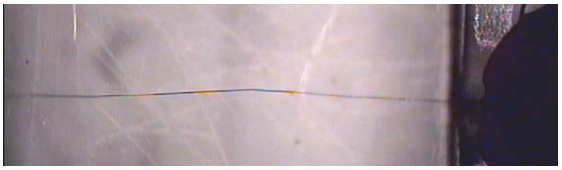
Post Break Analysis Results for UTSI Sample Fibers			
Sample	% Difference of Highest Average		
	No fiber left	Visible break	Broke at wax
L00049 TLR Avg	0.0%	67.8%	48.3%
L00050 MLR Avg	5.8%	0.0%	47.5%
C00043 Avg	0.0%	48.4%	64.9%
L00045 Avg	0.0%	7.0%	45.6%
L51 BLF Avg	0.0%	56.6%	68.0%

48.3% below the fibers which had no fiber left. For all five samples, the fibers that broke at the wax had a reported strength of 45 – 68% lower than the highest average break stress for the sample batch. The samples that had a visible break are less conclusive. For sample L00050 MLR, the highest average is for the fibers with a visible break by about 6%. The range for the other samples is 7 - 67.8% below the max average value.

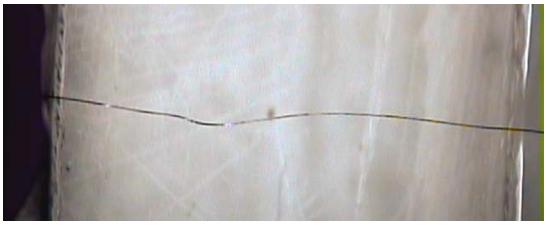
To visualize the effect of alignment on tensile strength, loaded fibers were photographed at the left and right fiber attachments before tensile testing using the Leica GZ6 optical microscope. The photos provide information about the samples' alignment at the wax interface as well as their geometry along the length of the fiber. After the fibers were tensile tested, the break stress was compared with the alignment to determine trends. All of the fibers were from the same sample group. Alignment is not the only determining factor in tensile strength. Fiber impurities and defects can also be the cause of low strength fibers. Also, the alignment is only examined from a two-dimensional viewpoint. Therefore, no information on alignment in the vertical plane is obtained. Four sample fibers are shown in Figure 27. The top fiber (L51 Noted Sample 2), which is mostly straight and aligned, has a break stress that is about 240% greater than the one below it. The second fiber (L51 Noted Sample 3) exhibits several curves,



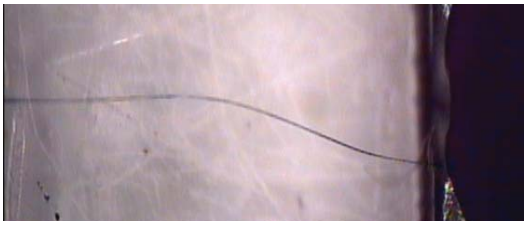
L51 BLF Noted Sample 2 Left Side R
D: 8.9 microns



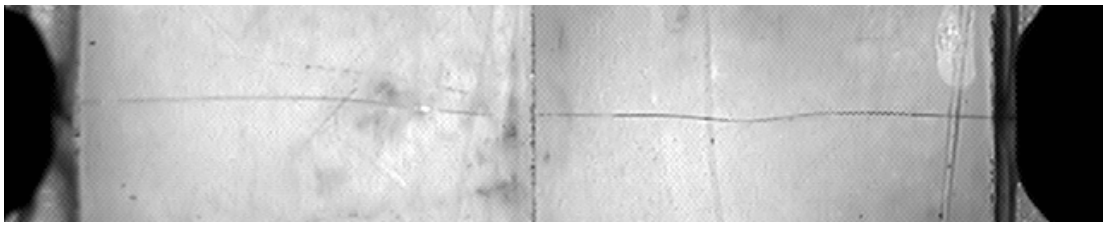
L51 BLF Noted Sample 2 Right Side R



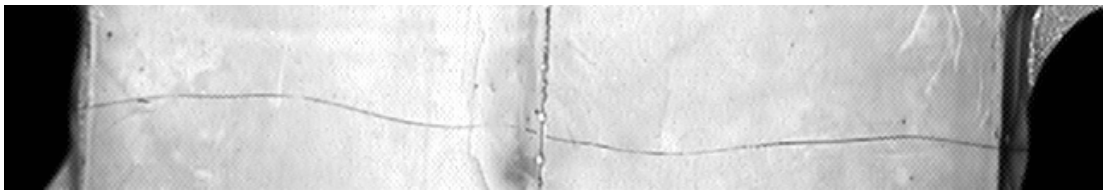
L51 BLF Noted Sample 3 Left Side R
D: 12.6 microns
Broke at wax right side



L51 BLF Noted Sample 3 Right Side R



L51 BLF Noted 4 Sample 13
D: 10.3 microns
Broke at the wax



L51 BLF Noted 4 Sample 7
D: 11.6 microns

Figure 27: Comparison of fiber alignment and break stress

which may contribute to its low break stress. The post break analysis revealed that this fiber broke at the wax interface on the right side where the sample curves sharply. However, the fiber's strength cannot always be determined by visually inspecting alignment. The third fiber (L51 Noted 4 Sample 13) appears aligned and mostly smooth, but this fiber broke at the wax and exhibited a break stress 43% lower than the batch average. This fiber may have been misaligned in the vertical direction or may have contained a defect close to the wax interface. The fourth fiber (L51 Noted 4 Sample 7) appears curved and has small curves along its length. While this fiber was not the strongest of the batch, its break strength was just 1.1% below the batch average.

Another issue involving alignment is that of movement of the sample while in the tensile tester. As carbon fibers do not yield, they produce straight stress-strain curves. However, some tests produced curves with load drops. Through trial and error, it was discovered that applying wax to both ends of the mounting tabs reduced the majority of the load drops in the stress-strain curves. Once the sample is in place, a metal bar slides across the top of the mounting tab to prevent the end from lifting up during testing. With wax only in the well securing the fiber, a gap remained between the tab and the metal bar. When wax is applied to both ends of the tab, the wax is mounded above the extra well. As the tab slides into place, it hits the mounded wax. It is believed that this action forces the tab against the restraint at the front of the tensile tester and locks it into place reducing the shifting during tensile testing which could produce load drops.

Error Analysis:

As previously mentioned, the strength of the fiber is reported in terms of break stress so that two fibers with differing diameters can be easily compared. As a result, the uncertainty of the break stress value is largely dependent on the accuracy of the diameter determination. The percent error in the break stress calculation from the diameter measurement can be found using equation 11.

$$\frac{\frac{F_b}{\frac{1}{4}\pi d_{actual}^{2}} - \frac{F_b}{\frac{1}{4}\pi d_{measured}^{2}}}{\frac{F_b}{\frac{1}{4}\pi d_{actual}^{2}}} \times 100 \quad \% \quad = \quad \% \quad Error \qquad (11)$$

where F_b is the break force, d_{actual} is the actual diameter of the fiber, and $d_{measured}$ is the measured diameter of the fiber. Simplifying the expression, it becomes a function of the two diameters only.

$$1 - \frac{d_{actual}^{2}}{d_{measured}^{2}} \times 100 \quad \% \quad = \quad \% \quad Error \qquad (12)$$

$d_{measured}$ can be written in terms of d_{actual} and an uncertainty term ε.

$$d_{measured} \quad = \quad d_{actual} \quad \pm \quad \varepsilon \qquad (13)$$

where the ε is the difference between the measured and actual diameter.
The expression then becomes:

$$1 - \frac{d_{actual}^{2}}{\left(d_{actual} \pm \varepsilon\right)^{2}} \times 100 \quad \% \quad = \quad \% \quad Error \qquad (14)$$

Graphing this expression for several diameters in Figure 28, it is shown that the percent error increases rapidly for fibers whose measured diameter is smaller than the actual, especially for fibers of small diameters. Currently, the mean diameter is used to compute the break stress for a fiber. Theoretically, the fiber will break at the weakest point, which is generally the smallest cross-section of the fiber.

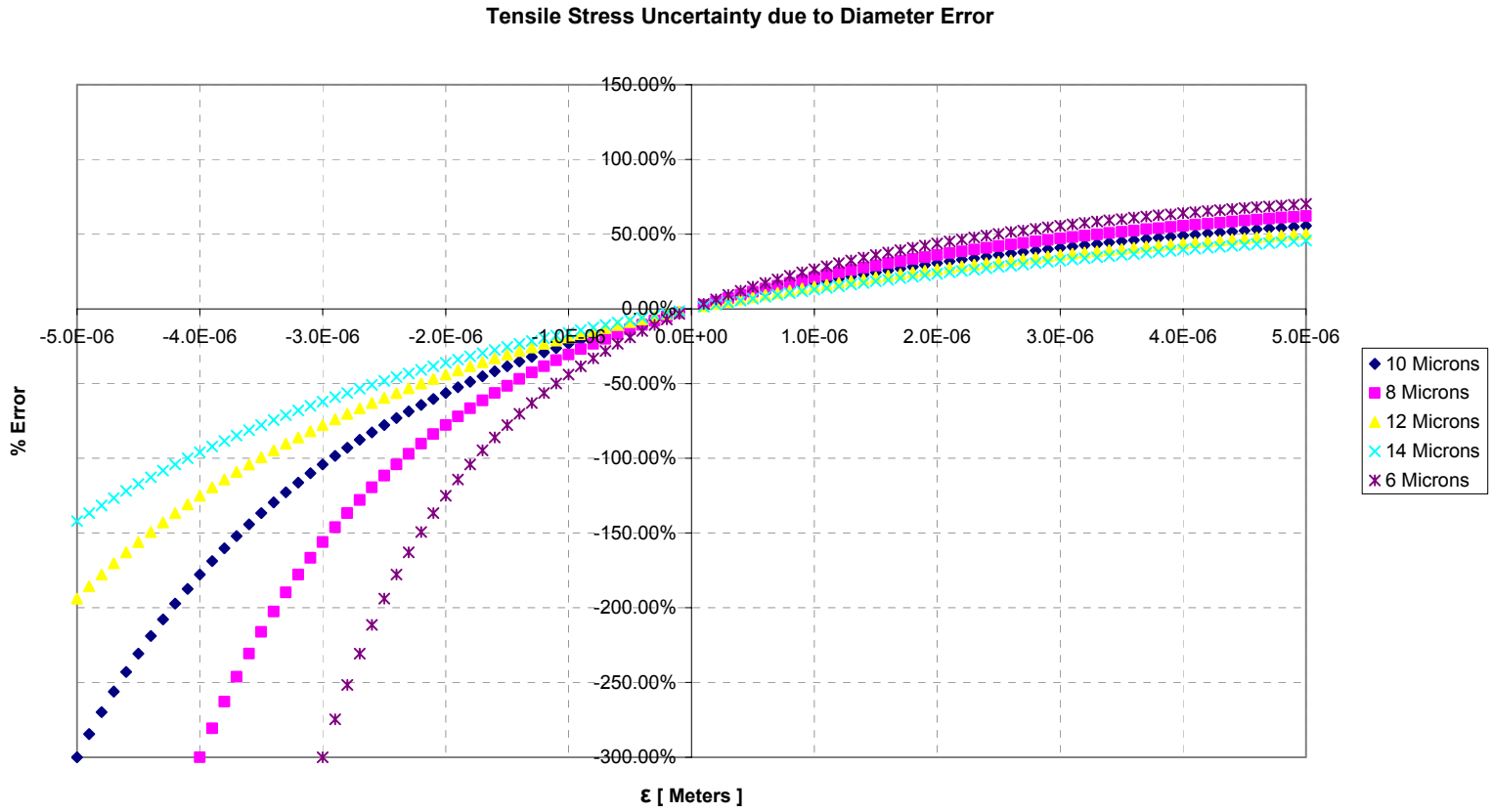


Figure 28: Graphical representation of tensile strength uncertainty due to error (ε) in the fiber diameter measurement

Thus, using the average diameter would tend to over predict the cross-sectional area of the fiber where the break occurs resulting in a lower break stress value. Due to future applications using the carbon fibers, reporting a break stress below the actual is more desirable than over predicting its strength. Also, a diameter measurement that is reported larger has the advantage of less percent error in the tensile stress measurement than one that is reported smaller.

Tensile measuring requires both proper alignment and proper fiber attachment of the samples to produce good data. Much of the uncertainty involved in determining a fiber's break stress and modulus is due to uncertainty in the diameter measurement. Diameter measurements should err on the side of over estimation as relates to break stress calculations to prevent over estimating a fiber's tensile strength.

Elastic Modulus Determination:

The modulus of elasticity, E, is determined from the slope of the stress-strain curve produced during tensile testing. The least squares method was used to determine the modulus. The UV-Win software does a least square regression between two user defined points. The top point is set by the software at the break point of the fiber. However, this point can be moved if the software identifies the wrong break point or if the slope changes suddenly close to the end point. As discussed above, shifting of the sample mounting tab in the tensile tester during testing can result in load drops, or jumps, in the stress-strain curve. These jumps provide discontinuous segments in the curve, which can have varying slopes. Generally, the upper section of the curve, ending at the break point, is the segment used in the modulus determination. Table 17 shows the modulus values determined using different segments for a fiber from UTSI sample L51. The extrema have a difference of between 8 and 9% from the average. Figure 29 shows the stress-strain curves with the top, middle, and lower segments specified. Even when no noticeable load drops occur, the slope of the stress-strain curve can change slightly along its length.

Table 17: Modulus values using different segments of the stress-strain curve

L51Noted 4 Fiber 1 Modulus Determination		
Segment	Elastic Modulus (Pa)	% Difference from Avg.
Top	1.74E+11	8.89%
Middle	1.58E+11	0.65%
Lower	1.46E+11	8.24%
Average	1.59E+11	

Table 18 shows the variation of modulus values for different segments for a curve with no noticeable load drops. An example of this is shown in Figure 30. To determine the elastic modulus for curves with no load drops, the segment taken is from about the center of the curve to the top as shown in Figure 31. The modulus found then is 1.25 E+11 Pa, a difference of about 5.25 % from the average of the three segments and about 2.04% from the top segment.

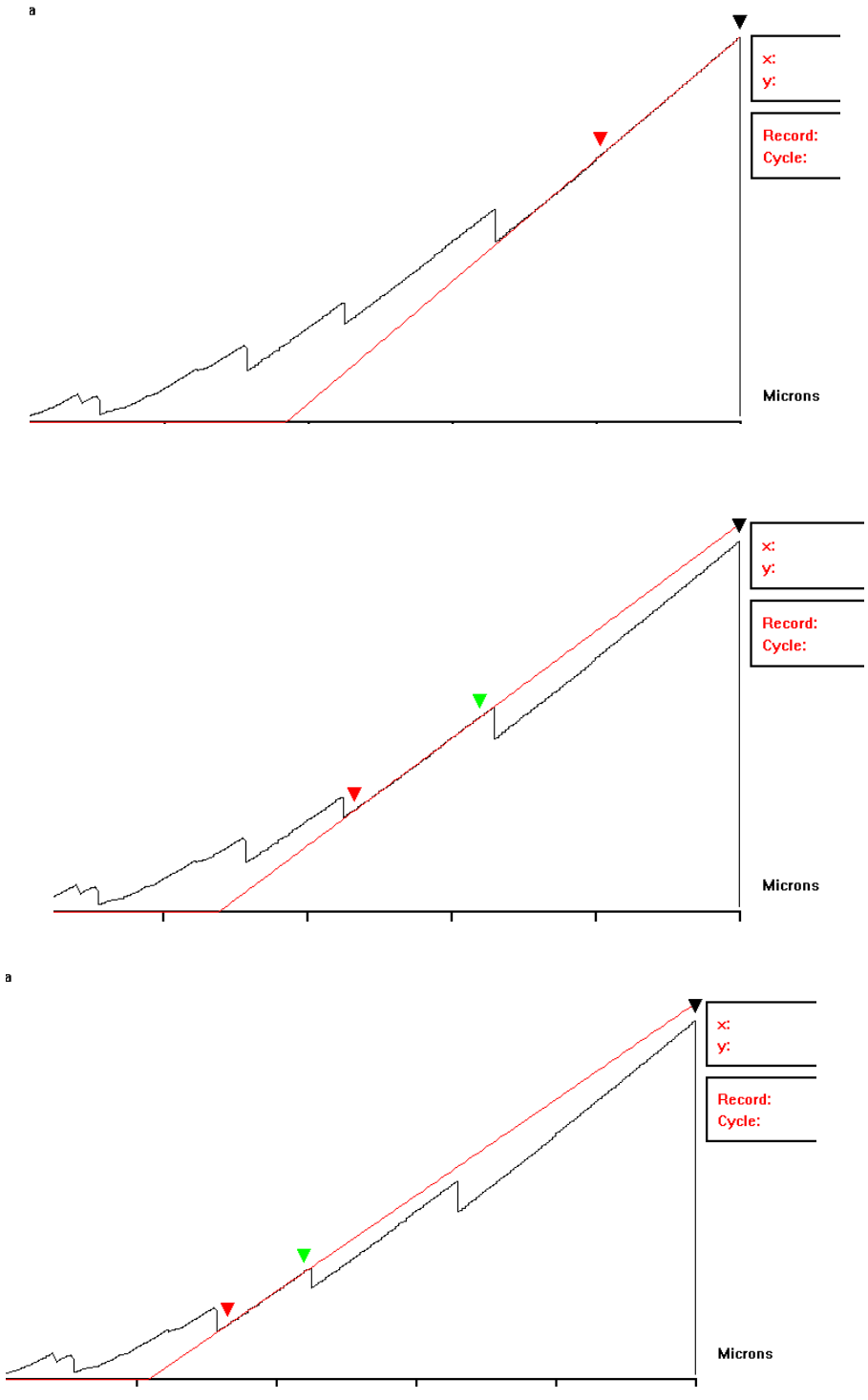


Figure 29: Modulus determination of stress-strain curve with load drops

Table 18: Elastic modulus values for varying slopes of a stress-strain curve

L51 Noted 2 Modulus Determination		
Segment	Elastic Modulus	% Difference from Avg.
Top	1.27E+11	7.43%
Middle	1.21E+11	2.11%
Lower	1.07E+11	9.54%
Average	1.18E+11	

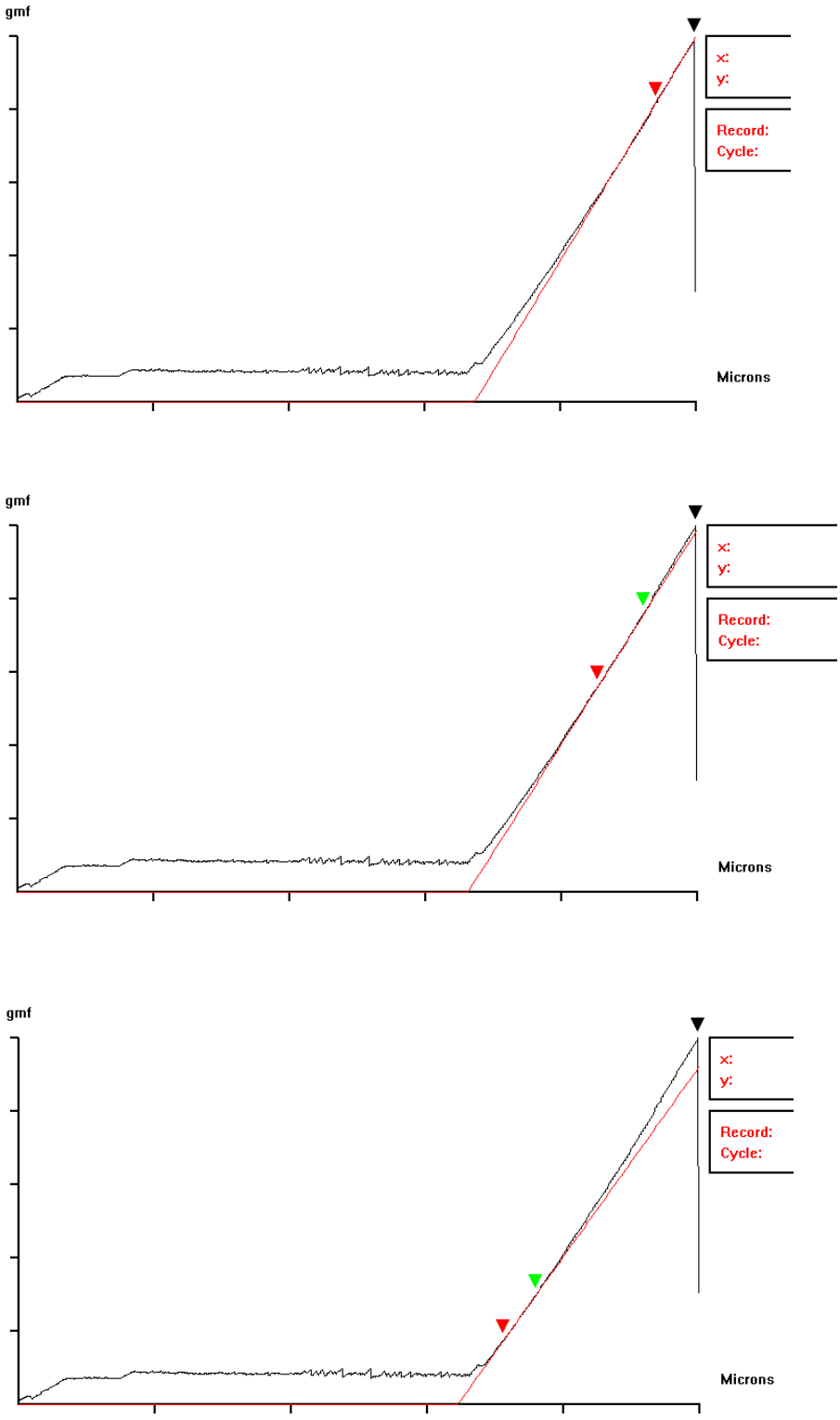


Figure 30: Modulus determination of stress-strain curve for segments of varying slopes

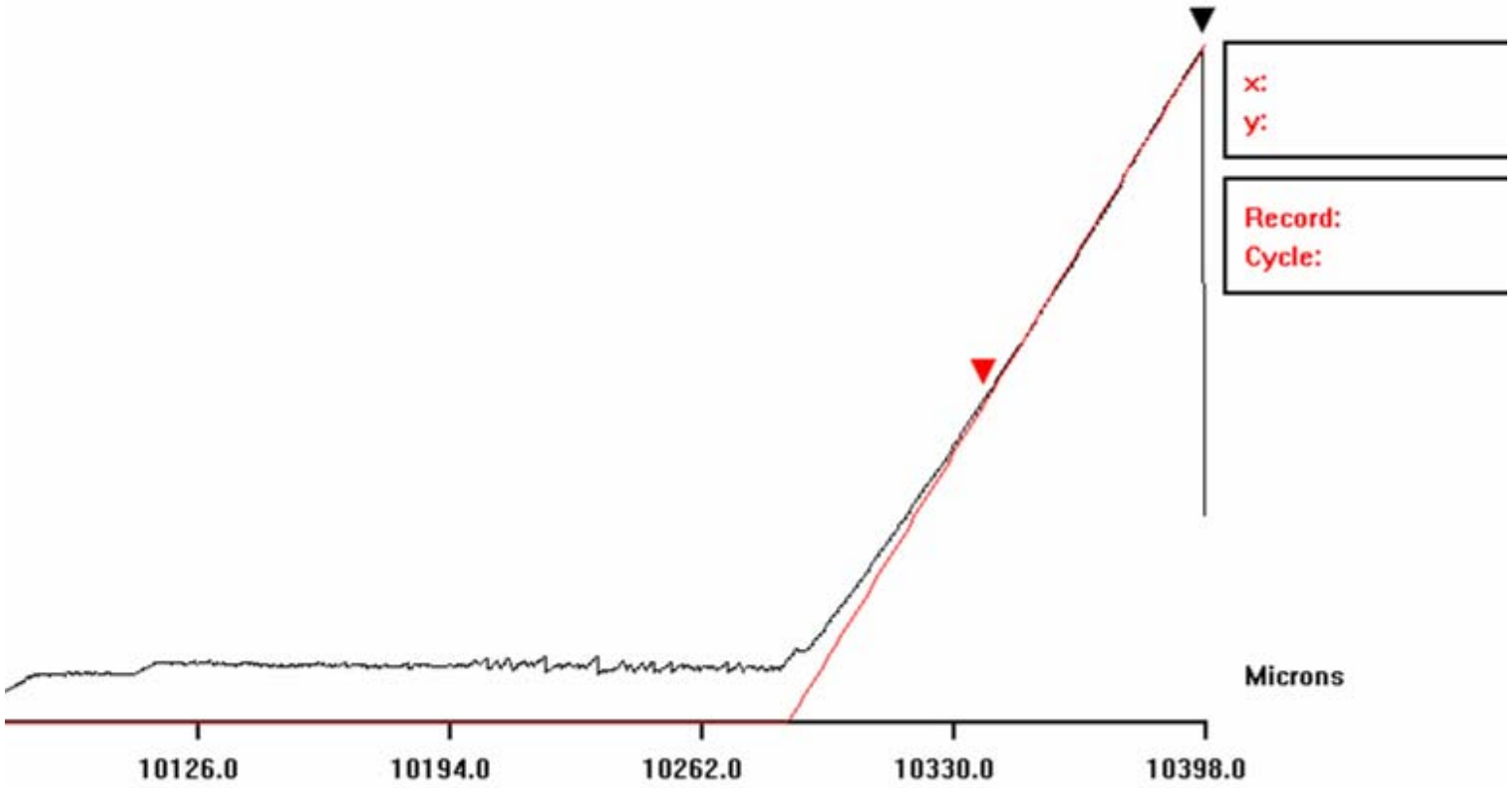


Figure 31: Modulus determination for a straight stress-strain curve.

Chapter IV: Conclusions and Recommendations

A number of fiber characterization techniques suitable for pitch based carbon fibers produced at UTSI were comparatively evaluated. Measurements were performed to determine the repeatability, ease and uncertainty of measuring diameter, tensile strength, and tensile modulus of individual carbon fibers. Diameter measurements were made using a Dia-stron® laser scan micrometer, an ISI Super III A Scanning Electron Microscope (SEM), and a Nikon Metaphot® optical microscope. Strength testing was performed using the Dia-stron® miniature tensile tester, which also generated the stress-strain curve from which the tensile modulus was determined.

Fiber diameter uncertainty was estimated for the three diameter measurement systems: Dia-stron® laser micrometer, SEM, and Nikon optical microscope. The estimated error for the Dia-stron® laser micrometer was about 3.7% for about a 10-micron fiber. The uncertainty estimated for fibers with diameters between 7 and 12 microns by the SEM was in a range of 8.3-14.3%. The estimated uncertainty for the optical microscope method for an 8.6-micron fiber was about 9.6%.

Fiber measurements made with the Dia-stron system were analyzed and compared with measurements made with SEM and optical microscope methods for the same fibers. The three different measurement techniques resulted in fiber diameters that were approximately similar, but did not match. For five sample fibers measured by both the SEM and Dia-stron® laser micrometer, the mean diameters determined by both methods differed by about 7%. Individual fibers measured by the Dia-stron® laser micrometer and the optical microscope at 20X magnification differed by about 2% for a commercial pitch fiber and 15% for a UTSI sample L51 fiber. Individual fibers measured by the Dia-stron laser micrometer and the optical microscope at 40X magnification, differed by 10% for a commercial pitch fiber and 12.5% for a UTSI sample L51 fiber.

Based on the above three methods used to make diameter measurements, the Dia-stron® laser micrometer is the recommended system for its ease of use, resolution, and amount of data points collected. The SEM and optical microscope methods have the advantage of producing visual images of the fiber, so that holes or cracks can be seen. The Dia-stron® laser micrometer assumes a solid cross-section and can provide no data on surface characteristics. However, the Dia-stron® laser micrometer is the only instrument of the three that can provide the data to determine the shape of the fiber cross-section at different points along the fiber. Also, since it is semi-automated, the Dia-stron® laser micrometer can measure a large number of samples in a relatively short period of time.

Error in tensile stress and modulus determination due to uncertainty in diameter measurements is discussed in the error analysis portion of the tensile measurements section.

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LIST OF REFERENCES

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APPENDIX

Data Sheet – FDAS765

FDAS765 High Resolution Dimensional Measurement System.

Measurement system for rapid analysis of cross sectional data from hair and other small fibres.

Quick and easy scanning procedure.

Automated calculation of key parameters such as major/minor axes and cross sectional area.

Accurate measurement with resolution of better than 1µ.

Compatibility with Dia-Stron Miniature Tensile Testing Systems

System Description.

General Information.

The FDAS765 fibre dimensional system is supplied as a fully operational unit, comprising the UV1000 control unit, dimensional test module including Mitutoyo laser micrometer and UvWin applications software. Alternatively the FDAS765 may be incorporated with the MTT675 automated tensile tester or with the ALS1500 sample loading module.

Control Unit.

The common universal control unit (UV1000) supports the dimensional module and other measurement modules including the MTT variants, Cyclic Tester, Bending Module and the automated sample loading modules (ALS). The commonality of the control unit permits compatibility across the product range, allowing the user to integrate testing capability in line with changing needs. The control unit has no user interface and all methods are entered through the PC software.

FDAS765 Dimensional Analysis Module.

The test module incorporates the Mitutoyo scanning laser micrometer (LSM500) for measurement of fibre diameter. The fibres are permanently mounted on small tabs and held in place by the instrument during measurement. The FDAS765 model has a fibre straightening facility to ensure that the fibre is orthogonal to the laser beam. Fibres are not cylindrical in cross section and to obtain an accurate measure they are rotated in the laser and multiple measurements made. Rotation is achieved via a DC motor fitted with a shaft encoder to monitor the angle and multiple measurements are taken so that major and minor axes together with cross sectional area can be determined. The fibre may be measured at a single point, or scanned along up to a 24mm length in discrete 'slices'. In addition, the fibre can be rotated to user selected angles so that the dimensional aspects can be determined. This facility is important when measuring such properties as bending moment of single fibres.

UvWin PC Applications Software.

The FDAS765 is operated through UvWin PC application, a 32Bit software programme written for Windows™ NT, 2000 & XP. The instrument protocols are selected from user interactive dialogues and the software includes method options for specific applications, data display and storage. In addition there are a range of analysis tools designed for particular applications. Data

export to other PC applications is through formatted text files suitable for import into Excel and other similar software. Data report gives full details of all scans along the fibre.

UvWin supports the complete range of Dia-Stron fibre testing instruments, including the automated sample loading modules, and gives a familiar Windows platform over the range of applications.

Specifications.

Sample size:	3.2, 5, 10, 20, 30mm
Linear slices per sample:	1 – 200
Laser type:	Mitutoyo LSM 500
Controller:	Mitutoyo LSM 6000
Measuring range:	5 – 2000 microns
Resolution:	0.1 microns*
Repeatability:	0.06 microns
Scan Rate:	up to 1600 scans/sec*
Laser beam width at focus:	200 microns
Software:	Windows NT, 2000 & XP
Communications:	RS232, USB serial adapter
Power:	Universal supply 85-265vac, 47-63Hz, 100W

* - Software selectable

System Components:

FDAS765 Laser Scan Micrometer
Mitutoyo LSM 6000 Controller
UV1000 Control Unit.
PU1100 Pneumatic Unit.
UvWin PC Applications Software including manuals.
Mains cord and serial cable.

Dia-Stron Limited, 9 Focus Way, Andover, SP10 5NY, UK
Telephone +44(1264) 334700. Fax+44(1264) 334686. Info@diastron.com

Data Sheet – LEX810

LEX810 High Resolution Tensile Tester

High-resolution extensometer for small fibres.
Integrated approach to materials testing, from sample mounting to data analysis.
Compatible with the Automated Sample Loading and Fibre Dimensional Systems.
Uses common Windows platform for Dia-Stron Tensile Testers and automation.

System Description.

General Information.

The LEX810 is a small bench top tensile tester suitable for measurement of fibres and was developed to fulfil the need for a unit to measure material failure at small strain values The LEX810 is a component of the Dia-Stron modularised testing systems for small fibres and can be combined with other units to measure multiple parameters and for integration into the ALS1500 single axis, pick and place robotic system. The LEX810 is supplied as a complete system, comprising the UV1000 control unit, LEX810 mechanical test module and UvWin PC applications software.

Control Unit.

The universal control unit (UV1000) supports all fibre testing measurement modules including the Fibre Dimensional Analysis System, and the Automated Sample Loading modules. Commonality of the control units permits upward compatibility, allowing the user to upgrade testing capability in line with changing needs. . The control unit has no user interface and all method parameters are entered through the PC software.

LEX810 Mechanical Test Module.

A DC micrometer drive unit controls movement of the mechanical test module. This device offers exceptionally smooth travel, combined with high positional repeatability (0.1 microns). The micrometer drive has a full movement range of 50mm and the maximum percentage strain that can be achieved will depend on gauge size (see specifications). Force measurement is provided by a semi-conductor strain gauge load cell (Sensotec, USA) and is calibrated by standard weights according to BS EN 10002-2.

The mechanical test module has 2 options for clamping samples. One option is a user operated manual sample holder, which is suitable for use as a stand-alone unit. The second option has pneumatically operated sample holders and these are required if the instrument is to be used with the automated sample-loading module (ALS1500). Please note that if the automated option is specified, a Pneumatics Unit (PU1100) is also required for operation.

UvWin PC Applications Software.

The LEX810 is operated through UvWin PC application, a 32-bit software programme written for Windows™ NT, 2000 & XP. The instrument protocols are selected from user interactive dialogues and the software includes method options for specific applications, data display and storage, and a range of analysis tools designed for particular applications. Data export to other PC applications is through formatted text files suitable for import into Excel and other similar software.

Appendix B: LEX810 Data Sheet

UvWin supports the complete range of Dia-Stron fibre testing instruments, including the automated sample loading modules, and giving a familiar Windows platform over the range of applications.

Specifications.

Samples size:	3.2-40mm*
Extension Range:	50mm
Speed range:	0.01-60mm/min
Maximum force:	250gmf or 2000gmf
Force resolution:	0.005gmf or 0.05gmf
Load cell linearity:	± 0.08% full scale
Positional repeatability:	0.1 microns
Positional accuracy:	± 10 microns
Software:	Windows NT, 2000 & XP
Communications:	RS232, USB serial adapter
Power:	Universal supply 85-265vac, 47-63Hz, 100W

System Components:

LEX810 Mechanical Testing Module.
UV1000 Control Unit.
UvWin PC Applications Software including manuals.
Mains cord and serial cable.

Dia-Stron Limited, 9 Focus Way, Andover, SP10 5NY, UK
Telephone +44(1264) 334700. Fax+44(1264) 334686. Info@diastron.com

Appendix C: MATLAB Intensity Program

IntensityL51BLF.m

```
function IntensityL51BLF


I=imread('L51 20X 40X3 10 M.jpg');

J=rgb2gray(I);
imshow(J,[]);
improfile
```

Page 1

Appendix D: Dia-stron Dimensional Report for Repeatability Test

Wire Repeatability
Dimensional Data Report

Record	Slice No.	Slice Position	Start Angle	End Angle	Elapsed Time	Cross-Sectional Area	Mean Slice Area	Mean Diameter	Mean Slice	Max. Diameter	Min. Diameter	Std. Deviation
			Degrees	Degrees	Seconds	Sq.Microns	Sq. Microns	Microns	Microns	Microns	Microns	
1	1	0	0	0	0	2063.3		51.25		51.27	51.24	0.014
1	1	0	20	20	0	2054.9		51.15		51.18	51.12	0.018
1	1	0	41	41	0	2066.1		51.29		51.31	51.27	0.012
1	1	0	61	61	0	2070.6		51.34		51.38	51.31	0.016
1	1	0	81	81	0	2059.7		51.19		51.24	51.18	0.018
1	1	0	101	101	0	2053.6		51.15		51.15	51.12	0.012
1	1	0	121	121	0	2065.3		51.27		51.31	51.25	0.0199
1	1	0	141	141	0	2052		51.12		51.13	51.1	0.016
1	1	0	161	161	0	2072.2		51.36		51.39	51.34	0.018
1	1	0	181	181	0	2075	2063.27	51.39	51.251	51.44	51.36	0.016
1	2	10	0	0	0	2086.3		51.53		51.58	51.5	0.0199
1	2	10	21	21	0	2069.7		51.34		51.36	51.31	0.016
1	2	10	41	41	0	2068.9		51.31		51.36	51.29	0.016
1	2	10	61	61	0	2056.9		51.18		51.22	51.13	0.024
1	2	10	81	81	0	2058.9		51.22		51.22	51.18	0.016
1	2	10	101	101	0	2048.8		51.07		51.1	51.05	0.018
1	2	10	121	121	0	2109.9		51.84		51.86	51.8	0.018
1	2	10	141	141	0	2111.5		51.84		51.89	51.81	0.0199
1	2	10	162	162	0	2064.9		51.29		51.31	51.24	0.0199
1	2	10	181	181	0	2094.4		51.63		51.68	51.6	0.024
1	3	20	0	0	0	2064.9		51.29		51.31	51.24	0.0199
1	3	20	20	20	0	2064.9		51.29		51.31	51.24	0.0199
1	3	20	41	41	0	2066.1		51.29		51.34	51.24	0.024
1	3	20	61	61	0	2057.7		51.18		51.22	51.15	0.014
1	3	20	81	81	0	2064.1		51.25		51.29	51.24	0.016
1	3	20	101	101	0	2057.7		51.18		51.22	51.15	0.018
1	3	20	121	121	0	2058.9		51.22		51.22	51.18	0.016
1	3	20	141	141	0	2055.7		51.18		51.19	51.13	0.016
1	3	20	161	161	0	2050.4		51.07		51.12	51.07	0.014
1	3	20	181	181	0	2071		51.36		51.39	51.31	0.0199
1	4	30	0	0	0	2072.2		51.38		51.39	51.34	0.018
1	4	30	20	20	0	2067.3		51.29		51.34	51.27	0.0219
1	4	30	41	41	0	2065.3		51.27		51.31	51.25	0.016
1	4	30	61	61	0	2087.1		51.53		51.58	51.52	0.016
1	4	30	81	81	0	2077.8		51.44		51.46	51.41	0.014
1	4	30	101	101	0	2061.3		51.24		51.27	51.19	0.024
1	4	30	121	121	0	2060.1		51.22		51.24	51.19	0.012
1	4	30	141	141	0	2055.7		51.18		51.19	51.13	0.018
1	4	30	161	161	0	2064.1		51.25		51.29	51.24	0.016
1	4	30	181	181	0	2070.5		51.38		51.47	51.22	0.0619
1	5	40	0	0	0	2070.6		51.34		51.38	51.31	0.018
1	5	40	20	20	0	2070.1		51.31		51.39	51.29	0.0219
1	5	40	41	41	0	2079.4		51.46		51.47	51.44	0.016
1	5	40	61	61	0	2076.2		51.39		51.44	51.39	0.012
1	5	40	81	81	0	2060.5		51.24		51.25	51.19	0.014
1	5	40	101	101	0	2057.7		51.18		51.22	51.15	0.016
1	5	40	121	121	0	2052.8		51.13		51.15	51.1	0.016
1	5	40	141	141	0	2055.7		51.18		51.19	51.13	0.0199
1	5	40	161	161	0	2052.8		51.12		51.15	51.1	0.024
1	5	40	181	181	0	2079.4		51.46		51.5	51.41	0.0199
1	6	50	0	0	0	2067.3		51.34		51.34	51.27	0.018
1	6	50	21	21	0	2065.3		51.29		51.31	51.25	0.018
1	6	50	41	41	0	2068.1		51.31		51.36	51.27	0.0199
1	6	50	61	61	0	2058.5		51.22		51.24	51.15	0.0199
1	6	50	81	81	0	2061.7		51.24		51.25	51.22	0.012
1	6	50	101	101	0	2049.6		51.1		51.12	51.05	0.0219
1	6	50	121	121	0	2045.6		51.05		51.07	51	0.0219
1	6	50	141	141	0	2073.8		51.38		51.41	51.36	0.018
1	6	50	161	161	0	2064.1		51.25		51.29	51.24	0.0199
1	6	50	181	181	0	2077		51.44		51.46	51.39	0.0199
1	7	60	0	0	0	2064.5		51.27		51.29	51.25	0.012
1	7	60	20	20	0	2069.7		51.34		51.36	51.31	0.016
1	7	60	41	41	0	2073		51.36		51.41	51.34	0.018
1	7	60	61	61	0	2063.3		51.25		51.27	51.24	0.0099
1	7	60	81	81	0	2050.8		51.1		51.13	51.07	0.016
1	7	60	101	101	0	2048.4		51.05		51.1	51.04	0.018
1	7	60	121	121	0	2032.4		50.88		50.9	50.84	0.016
1	7	60	141	141	0	2047.6		51.05		51.12	51	0.034
1	7	60	161	161	0	2068.9		51.34		51.36	51.29	0.018
1	7	60	181	181	0	2072.2		51.38		51.39	51.34	0.016
1	8	70	0	0	0	2075.8		51.39		51.44	51.38	0.018
1	8	70	21	21	0	2066.1		51.29		51.31	51.27	0.0099
1	8	70	41	41	0	2068.9		51.34		51.36	51.29	0.0199
1	8	70	61	61	0	2075.8		51.41		51.44	51.38	0.0199
1	8	70	81	81	0	2062.5		51.25		51.27	51.22	0.0199
1	8	70	101	101	0	2040.8		50.98		51.02	50.93	0.0199
1	8	70	121	121	0	2032.4		50.84		50.98	50.76	0.056
1	8	70	141	141	0	2039.2		50.98		51	50.91	0.0219
1	8	70	162	162	0	2057.7		51.19		51.22	51.15	0.0199
1	8	70	181	181	0	2076.6		51.41		51.46	51.38	0.024
1	9	80	0	0	0	2067.3		51.31		51.34	51.27	0.0199
1	9	80	20	20	0	2069.7		51.34		51.38	51.29	0.0199
1	9	80	41	41	0	2071		51.36		51.39	51.31	0.0219
1	9	80	61	61	0	2071		51.36		51.39	51.31	0.0219
1	9	80	81	81	0	2075.8		51.39		51.44	51.38	0.0199
1	9	80	101	101	0	2049.2		51.1		51.12	51.04	0.024
1	9	80	121	121	0	2024		50.76		50.79	50.74	0.014
1	9	80	141	141	0	2057.7		51.18		51.22	51.15	0.016
1	9	80	161	161	0	2078.2		51.46		51.47	51.41	0.018
1	9	80	181	181	0	2079.4		51.46		51.47	51.44	0.016
1	10	90	0	0	0	2083.1		51.5		51.53	51.47	0.018
1	10	90	21	21	0	2083.1		51.52		51.53	51.47	0.018
1	10	90	41	41	0	2071.8		51.34		51.38	51.34	0.016
1	10	90	61	61	0	2073.8		51.38		51.41	51.36	0.014
1	10	90	81	81	0	2047.6		51.07		51.1	51.02	0.018
1	10	90	101	101	0	2045.6		51.02		51.07	51	0.0199
1	10	90	121	121	0	2048.4		51.05		51.1	51.04	0.024
1	10	90	141	141	0	2068.9		51.31		51.36	51.29	0.018
1	10	90	162	162	0	2069.7		51.36		51.38	51.29	0.0199
1	10	90	181	181	0	2082.3		51.5		51.52	51.46	0.0199
3	1	0	0	0	6066	2065.3		51.29		51.31	51.25	0.018
3	1	0	21	21	6066	2064.5		51.27		51.29	51.25	0.014
3	1	0	41	41	6066	2075.8		51.39		51.44	51.38	0.014
3	1	0	61	61	6066	2060.5		51.24		51.25	51.19	0.018
3	1	0	81	81	6066	2064.5		51.25		51.29	51.25	0.014
3	1	0	101	101	6066	2058.9		51.19		51.22	51.18	0.012
3	1	0	121	121	6066	2072.2		51.36		51.39	51.34	0.016
3	1	0	141	141	6066	2054		51.13		51.18	51.1	0.0219
3	1	0	162	162	6066	2067.3		51.29		51.39	51.22	0.052
3	1	0	181	181	6066	2073	2065.6	51.38	51.279	51.41	51.34	0.0219
3	2	10	0	0	6066	2083.1		51.5		51.53	51.47	0.016
3	2	10	21	21	6066	2079.4		51.46		51.5	51.41	0.0199
3	2	10	41	41	6066	2093.2		51.61		51.65	51.6	0.018
3	2	10	61	61	6066	2070.6		51.36		51.38	51.31	0.016
3	2	10	82	82	6066	2057.7		51.18		51.22	51.15	0.018
3	2	10	101	101	6066	2054.4		51.13		51.29	51	0.094
3	2	10	121	121	6066	2091.2		51.58		51.68	51.52	0.048
3	2	10	141	141	6066	2077		51.41		51.46	51.39	0.018
3	2	10	161	161	6066	2054		51.15		51.18	51.1	0.0199
3	2	10	182	182	6066	2082.3		51.5		51.52	51.46	0.018
3	3	20	0	0	6066	2071.8		51.36		51.38	51.34	0.014
3	3	20	21	21	6066	2071.8		51.34		51.38	51.34	0.014
3	3	20	42	42	6066	2063.3		51.25		51.29	51.22	0.0219
3	3	20	61	61	6066	2055.3		51.15		51.19	51.12	0.0199

Appendix D: Dia-stron Dimensional Report for Repeatability Test

3	3	20	81	81	6066	2063.3		51.27	51.27	51.24	0.014
3	3	20	101	101	6066	2059.7		51.22	51.24	51.18	0.016
3	3	20	121	121	6066	2066.9		51.29	51.31	51.29	0.0099
3	3	20	141	141	6066	2059.7		51.19	51.24	51.18	0.018
3	3	20	162	162	6066	2052.8		51.13	51.18	51.07	0.024
3	3	20	182	182	6066	2074.6		51.39	51.41	51.38	0.014
3	4	30	0	0	6066	2079.4		51.44	51.5	51.41	0.0199
3	4	30	21	21	6066	2079.4		51.44	51.5	51.41	0.0219
3	4	30	41	41	6066	2061.7		51.24	51.25	51.22	0.014
3	4	30	61	61	6066	2060.5		51.24	51.25	51.19	0.0199
3	4	30	82	82	6066	2068.9		51.34	51.36	51.29	0.018
3	4	30	101	101	6066	2074.6		51.39	51.41	51.38	0.012
3	4	30	122	122	6066	2066.1		51.27	51.31	51.27	0.012
3	4	30	141	141	6066	2054		51.13	51.18	51.1	0.028
3	4	30	161	161	6066	2063.3		51.24	51.27	51.24	0.014
3	4	30	182	182	6066	2075.8		51.39	51.44	51.38	0.016
3	5	40	0	0	6066	2073.8		51.39	51.41	51.36	0.016
3	5	40	21	21	6066	2071.8		51.38	51.38	51.34	0.014
3	5	40	42	42	6066	2083.1		51.5	51.53	51.47	0.018
3	5	40	62	62	6066	2080.6		51.47	51.5	51.44	0.0199
3	5	40	81	81	6066	2060.9		51.24	51.27	51.18	0.026
3	5	40	101	101	6066	2057.7		51.19	51.22	51.15	0.016
3	5	40	122	122	6066	2073		51.38	51.39	51.36	0.014
3	5	40	142	142	6066	2072.2		51.39	51.39	51.34	0.0199
3	5	40	162	162	6066	2056.5		51.18	51.19	51.15	0.012
3	5	40	182	182	6066	2084.3		51.5	51.65	51.38	0.0799
3	6	50	0	0	6066	2088.3		51.56	51.6	51.53	0.018
3	6	50	21	21	6066	2068.1		51.31	51.34	51.29	0.012
3	6	50	42	42	6066	2064.9		51.27	51.31	51.24	0.018
3	6	50	62	62	6066	2056.5		51.18	51.19	51.15	0.012
3	6	50	81	81	6066	2055.7		51.15	51.22	51.1	0.026
3	6	50	102	102	6066	2110.3		51.84	51.87	51.8	0.024
3	6	50	122	122	6066	2221.2		53.18	53.25	53.11	0.0399
3	6	50	141	141	6066	2293.2		54.02	54.07	54	0.024
3	6	50	161	161	6066	2234.2		53.34	53.38	53.29	0.0219
3	6	50	182	182	6066	2132.3		52.13	52.15	52.06	0.024
3	7	60	0	0	6066	2069.7		51.34	51.38	51.29	0.0219
3	7	60	21	21	6066	2071		51.34	51.39	51.31	0.0199
3	7	60	42	42	6066	2071.8		51.36	51.38	51.34	0.014
3	7	60	62	62	6066	2061.7		51.24	51.25	51.22	0.014
3	7	60	81	81	6066	2048.8		51.07	51.1	51.05	0.014
3	7	60	101	101	6066	2048.4		51.05	51.12	51.02	0.0199
3	7	60	121	121	6066	2040.8		50.98	51	50.95	0.014
3	7	60	141	141	6066	2054.9		51.15	51.18	51.12	0.018
3	7	60	162	162	6066	2069.7		51.34	51.38	51.29	0.0199
3	7	60	182	182	6066	2075.8		51.41	51.44	51.38	0.014
3	8	70	0	0	6066	2080.6		51.47	51.5	51.44	0.018
3	8	70	21	21	6066	2070.6		51.34	51.38	51.31	0.0199
3	8	70	41	41	6066	2066.1		51.29	51.31	51.27	0.012
3	8	70	62	62	6066	2072.2		51.36	51.39	51.34	0.018
3	8	70	82	82	6066	2061.7		51.24	51.25	51.22	0.014
3	8	70	102	102	6066	2041.6		50.98	51.04	50.93	0.024
3	8	70	122	122	6066	2030.4		50.86	50.88	50.81	0.018
3	8	70	141	141	6066	2049.6		51.07	51.12	51.05	0.014
3	8	70	162	162	6066	2064.5		51.27	51.29	51.25	0.012
3	8	70	182	182	6066	2077		51.44	51.46	51.39	0.014
3	9	80	0	0	6066	2075.8		51.41	51.44	51.38	0.018
3	9	80	21	21	6066	2073.8		51.38	51.41	51.36	0.016
3	9	80	42	42	6066	2068.1		51.31	51.36	51.27	0.0219
3	9	80	62	62	6066	2062.5		51.24	51.27	51.22	0.018
3	9	80	82	82	6066	2055.3		51.18	51.19	51.12	0.0219
3	9	80	101	101	6066	2038.8		50.93	51	50.9	0.0299
3	9	80	122	122	6066	2034.4		50.9	50.93	50.86	0.0219
3	9	80	142	142	6066	2064.5		51.29	51.29	51.25	0.014
3	9	80	162	162	6066	2078.2		51.46	51.47	51.41	0.018
3	9	80	182	182	6066	2077		51.44	51.46	51.39	0.018
3	10	90	0	0	6066	2087.1		51.56	51.58	51.52	0.018
3	10	90	21	21	6066	2083.9		51.5	51.63	51.39	0.086
3	10	90	42	42	6066	2068.1		51.31	51.36	51.27	0.0219
3	10	90	62	62	6066	2068.9		51.31	51.36	51.29	0.014
3	10	90	82	82	6066	2044		51.02	51.05	50.98	0.0219
3	10	90	102	102	6066	2042.4		51	51.04	50.95	0.0199
3	10	90	122	122	6066	2052.8		51.12	51.15	51.1	0.0219
3	10	90	141	141	6066	2070.6		51.36	51.38	51.31	0.018
3	10	90	162	162	6066	2072.2		51.38	51.39	51.34	0.018
3	10	90	182	182	6066	2082.7		51.47	51.52	51.47	0.012
4	1	0	0	0	6676	2065.3		51.27	51.31	51.25	0.014
4	1	0	21	21	6676	2060.5		51.24	51.25	51.19	0.018
4	1	0	42	42	6676	2060.1		51.24	51.25	51.18	0.0219
4	1	0	62	62	6676	2060.1		51.22	51.25	51.18	0.018
4	1	0	82	82	6676	2050.8		51.12	51.13	51.07	0.018
4	1	0	102	102	6676	2054		51.13	51.18	51.1	0.024
4	1	0	122	122	6676	2062.5		51.25	51.27	51.22	0.014
4	1	0	141	141	6676	2049.6		51.1	51.13	51.04	0.0299
4	1	0	162	162	6676	2052.8		51.13	51.15	51.1	0.018
4	1	0	182	182	6676	2073	2058.87	51.39	51.41	51.34	0.018
4	2	10	0	0	6676	2067.3		51.31	51.34	51.27	0.0199
4	2	10	21	21	6676	2063.3		51.25	51.27	51.24	0.014
4	2	10	42	42	6676	2061.7		51.24	51.25	51.22	0.012
4	2	10	62	62	6676	2050.8		51.1	51.13	51.07	0.0199
4	2	10	81	81	6676	2064.1		51.25	51.29	51.24	0.018
4	2	10	101	101	6676	2044		51.02	51.05	50.98	0.018
4	2	10	121	121	6676	2064.1		51.27	51.29	51.24	0.0199
4	2	10	141	141	6676	2060.5		51.22	51.25	51.19	0.018
4	2	10	162	162	6676	2054		51.13	51.18	51.1	0.0219
4	2	10	182	182	6676	2064.1		51.25	51.29	51.24	0.0199
4	3	20	0	0	6676	2077.4		51.41	51.47	51.39	0.0219
4	3	20	21	21	6676	2062.5		51.24	51.27	51.22	0.0199
4	3	20	42	42	6676	2078.2		51.46	51.47	51.41	0.016
4	3	20	62	62	6676	2090.8		51.6	51.63	51.56	0.018
4	3	20	82	82	6676	2100.5		51.72	51.73	51.7	0.014
4	3	20	102	102	6676	2060.1		51.24	51.24	51.19	0.016
4	3	20	122	122	6676	2056.9		51.18	51.22	51.13	0.0219
4	3	20	142	142	6676	2038.4		50.95	50.98	50.91	0.016
4	3	20	162	162	6676	2082.3		51.47	51.52	51.46	0.018
4	3	20	182	182	6676	2098.1		51.68	51.72	51.65	0.016
4	4	30	0	0	6676	2076.2		51.39	51.44	51.39	0.012
4	4	30	21	21	6676	2073.8		51.39	51.41	51.36	0.016
4	4	30	42	42	6676	2061.3		51.22	51.24	51.22	0.0099
4	4	30	62	62	6676	2059.7		51.19	51.24	51.18	0.014
4	4	30	82	82	6676	2060.1		51.22	51.24	51.19	0.014
4	4	30	102	102	6676	2058.5		51.19	51.24	51.15	0.0219
4	4	30	122	122	6676	2061.3		51.24	51.27	51.19	0.0219
4	4	30	142	142	6676	2050.4		51.07	51.12	51.07	0.014
4	4	30	162	162	6676	2060.1		51.24	51.25	51.18	0.0219
4	4	30	182	182	6676	2077		51.44	51.46	51.39	0.0199
4	5	40	0	0	6676	2070.6		51.34	51.38	51.31	0.0219
4	5	40	21	21	6676	2070.6		51.34	51.38	51.31	0.0199
4	5	40	42	42	6676	2065.3		51.29	51.31	51.25	0.016
4	5	40	62	62	6676	2059.7		51.22	51.24	51.18	0.014
4	5	40	82	82	6676	2056.5		51.15	51.19	51.15	0.014
4	5	40	102	102	6676	2058.5		51.19	51.24	51.15	0.018
4	5	40	122	122	6676	2077		51.44	51.46	51.39	0.018
4	5	40	142	142	6676	2073		51.38	51.39	51.36	0.014
4	5	40	162	162	6676	2054		51.15	51.18	51.1	0.0219
4	5	40	182	182	6676	2074.6		51.44	51.5	51.29	0.0499
4	6	50	0	0	6676	2083.1		51.52	51.53	51.47	0.018
4	6	50	21	21	6676	2071		51.36	51.39	51.31	0.0199
4	6	50	42	42	6676	2069.7		51.31	51.36	51.31	0.014

Appendix D: Dia-stron Dimensional Report for Repeatability Test

4	6	50	62	62	6676	2059.7		51.19		51.24	51.18	0.016
4	6	50	82	82	6676	2051.6		51.12		51.15	51.07	0.0199
4	6	50	102	102	6676	2185.4		52.76		52.79	52.71	0.0199
4	6	50	122	122	6676	2347.8		54.68		54.72	54.63	0.028
4	6	50	142	142	6676	2415.7		55.45		55.5	55.42	0.0199
4	6	50	162	162	6676	2346.1		54.65		54.69	54.62	0.018
4	6	50	182	182	6676	2155.3		52.4		52.42	52.35	0.0199
4	7	60	0	0	6676	2070.1		51.36		51.39	51.29	0.0199
4	7	60	21	21	6676	2071.8		51.36		51.38	51.34	0.012
4	7	60	42	42	6676	2071		51.36		51.39	51.31	0.026
4	7	60	62	62	6676	2064.1		51.25		51.29	51.24	0.014
4	7	60	82	82	6676	2052		51.12		51.13	51.1	0.014
4	7	60	102	102	6676	2041.6		50.98		51.02	50.95	0.0219
4	7	60	122	122	6676	2028.8		50.84		50.86	50.79	0.0219
4	7	60	142	142	6676	2042.4		51.02		51.04	50.95	0.026
4	7	60	162	162	6676	2068.9		51.31		51.36	51.29	0.014
4	7	60	182	182	6676	2073.8		51.39		51.41	51.36	0.018
4	8	70	0	0	6676	2083.1		51.52		51.53	51.47	0.014
4	8	70	21	21	6676	2067.3		51.29		51.34	51.27	0.016
4	8	70	42	42	6676	2070.6		51.34		51.38	51.31	0.018
4	8	70	62	62	6676	2074.6		51.39		51.41	51.38	0.014
4	8	70	82	82	6676	2055.7		51.18		51.19	51.13	0.0199
4	8	70	101	101	6676	2040		50.95		51	50.93	0.018
4	8	70	122	122	6676	2030.4		50.86		50.88	50.81	0.016
4	8	70	142	142	6676	2038.4		50.95		50.98	50.91	0.016
4	8	70	162	162	6676	2057.7		51.19		51.22	51.15	0.016
4	8	70	182	182	6676	2077		51.44		51.46	51.39	0.016
4	9	80	0	0	6676	2071		51.34		51.39	51.31	0.026
4	9	80	21	21	6676	2073.8		51.39		51.41	51.36	0.014
4	9	80	42	42	6676	2072.2		51.38		51.39	51.34	0.0199
4	9	80	62	62	6676	2088.3		51.56		51.6	51.53	0.018
4	9	80	82	82	6676	2078.2		51.46		51.47	51.41	0.018
4	9	80	102	102	6676	2048		51.07		51.13	51	0.0299
4	9	80	122	122	6676	2024		50.77		50.79	50.74	0.016
4	9	80	142	142	6676	2056.5		51.15		51.19	51.15	0.018
4	9	80	162	162	6676	2073		51.38		51.41	51.34	0.018
4	9	80	182	182	6676	2081.5		51.47		51.52	51.44	0.0219
4	10	90	0	0	6676	2084.3		51.5		51.53	51.5	0.016
4	10	90	21	21	6676	2078.2		51.44		51.5	51.38	0.0379
4	10	90	42	42	6676	2068.9		51.31		51.36	51.29	0.016
4	10	90	62	62	6676	2084.3		51.52		51.56	51.47	0.0199
4	10	90	82	82	6676	2064.1		51.27		51.29	51.24	0.016
4	10	90	102	102	6676	2045.6		51.05		51.12	50.95	0.052
4	10	90	122	122	6676	2040		50.98		51	50.93	0.0199
4	10	90	142	142	6676	2046.4		51.04		51.07	51.02	0.016
4	10	90	162	162	6676	2082.3		51.47		51.52	51.46	0.018
4	10	90	182	182	6676	2083.1		51.5		51.53	51.47	0.0199
5	1	0	0	0	10320	2081.5		51.47		51.52	51.44	0.0199
5	1	0	21	21	10320	2075		51.39		51.44	51.36	0.0219
5	1	0	42	42	10320	2080.6		51.47		51.5	51.44	0.016
5	1	0	62	62	10320	2067.3		51.29		51.34	51.27	0.018
5	1	0	81	81	10320	2044		51		51.05	50.98	0.024
5	1	0	101	101	10320	2048.4		51.07		51.1	51.04	0.016
5	1	0	122	122	10320	2068.1		51.31		51.34	51.29	0.012
5	1	0	142	142	10320	2039.2		50.95		51	50.91	0.0199
5	1	0	162	162	10320	2044.8		51.02		51.07	50.98	0.024
5	1	0	182	182	10320	2096.4	2064.53	51.65	51.262	51.68	51.65	0.008
5	2	10	0	0	10320	2050.8		51.1		51.13	51.07	0.0219
5	2	10	21	21	10320	2056.9		51.18		51.22	51.13	0.0199
5	2	10	42	42	10320	2071		51.34		51.36	51.34	0.0099
5	2	10	62	62	10320	2077		51.44		51.47	51.38	0.0219
5	2	10	82	82	10320	2130.7		52.09		52.11	52.06	0.0199
5	2	10	102	102	10320	2102.5		51.77		51.87	51.61	0.074
5	2	10	122	122	10320	2080.6		51.47		51.5	51.44	0.016
5	2	10	141	141	10320	2078.2		51.46		51.47	51.41	0.016
5	2	10	161	161	10320	2086.3		51.53		51.56	51.52	0.012
5	2	10	182	182	10320	2055.7		51.13		51.19	51.13	0.016
5	3	20	0	0	10320	2070.6		51.34		51.38	51.31	0.0199
5	3	20	21	21	10320	2064.1		51.27		51.29	51.24	0.016
5	3	20	42	42	10320	2063.3		51.25		51.27	51.24	0.012
5	3	20	62	62	10320	2066.5		51.29		51.34	51.25	0.018
5	3	20	82	82	10320	2128.6		52.04		52.11	52.01	0.028
5	3	20	101	101	10320	2095.6		51.68		51.68	51.63	0.016
5	3	20	122	122	10320	2062.5		51.25		51.27	51.22	0.018
5	3	20	142	142	10320	2084.3		51.52		51.56	51.47	0.0219
5	3	20	162	162	10320	2101.3		51.73		51.75	51.7	0.0199
5	3	20	182	182	10320	2071.8		51.36		51.41	51.31	0.0299
5	4	30	0	0	10320	2075.8		51.39		51.44	51.38	0.018
5	4	30	21	21	10320	2069.7		51.34		51.38	51.29	0.0199
5	4	30	42	42	10320	2065.3		51.29		51.31	51.25	0.016
5	4	30	62	62	10320	2059.7		51.19		51.24	51.18	0.016
5	4	30	82	82	10320	2071.8		51.34		51.38	51.34	0.012
5	4	30	102	102	10320	2065.3		51.27		51.31	51.25	0.0199
5	4	30	122	122	10320	2080.6		51.47		51.5	51.44	0.016
5	4	30	141	141	10320	2065.3		51.29		51.31	51.25	0.018
5	4	30	162	162	10320	2065.3		51.29		51.31	51.25	0.018
5	4	30	182	182	10320	2072.6		51.38		51.5	51.24	0.0619
5	5	40	0	0	10320	2068.9		51.34		51.38	51.27	0.026
5	5	40	21	21	10320	2067.3		51.29		51.34	51.27	0.018
5	5	40	42	42	10320	2068.9		51.31		51.36	51.29	0.016
5	5	40	62	62	10320	2059.3		51.22		51.22	51.19	0.0099
5	5	40	82	82	10320	2071.8		51.36		51.38	51.34	0.016
5	5	40	101	101	10320	2065.3		51.27		51.31	51.25	0.014
5	5	40	122	122	10320	2060.5		51.24		51.25	51.19	0.014
5	5	40	142	142	10320	2089.5		51.58		51.63	51.53	0.0219
5	5	40	162	162	10320	2055.7		51.13		51.19	51.13	0.016
5	5	40	182	182	10320	2080.6		51.47		51.5	51.44	0.0219
5	6	50	0	0	10320	2071.8		51.38		51.38	51.34	0.012
5	6	50	21	21	10320	2071.8		51.36		51.38	51.34	0.014
5	6	50	42	42	10320	2069.7		51.34		51.36	51.31	0.012
5	6	50	62	62	10320	2056.9		51.19		51.22	51.13	0.0199
5	6	50	82	82	10320	2054		51.13		51.18	51.1	0.018
5	6	50	102	102	10320	2043.6		51		51.04	50.98	0.016
5	6	50	122	122	10320	2036.8		50.91		50.95	50.9	0.0199
5	6	50	142	142	10320	2056.5		51.19		51.19	51.15	0.012
5	6	50	162	162	10320	2060.5		51.22		51.25	51.19	0.018
5	6	50	182	182	10320	2073.8		51.39		51.41	51.36	0.016
5	7	60	0	0	10320	2067.3		51.34		51.34	51.27	0.0219
5	7	60	21	21	10320	2068.1		51.34		51.34	51.29	0.016
5	7	60	42	42	10320	2068.9		51.31		51.36	51.29	0.018
5	7	60	62	62	10320	2064.5		51.29		51.29	51.25	0.016
5	7	60	82	82	10320	2050.4		51.07		51.12	51.07	0.014
5	7	60	101	101	10320	2040		50.98		51	50.93	0.016
5	7	60	122	122	10320	2036		50.9		50.95	50.88	0.0199
5	7	60	142	142	10320	2055.7		51.18		51.19	51.13	0.014
5	7	60	162	162	10320	2051.6		51.13		51.15	51.07	0.0199
5	7	60	182	182	10320	2072.2		51.38		51.39	51.34	0.016
5	8	70	0	0	10320	2073		51.39		51.41	51.34	0.018
5	8	70	21	21	10320	2072.2		51.38		51.39	51.34	0.016
5	8	70	42	42	10320	2069.7		51.34		51.36	51.31	0.014
5	8	70	62	62	10320	2068.1		51.31		51.34	51.29	0.012
5	8	70	82	82	10320	2052.8		51.12		51.15	51.1	0.018
5	8	70	102	102	10320	2043.6		51.02		51.04	50.98	0.018
5	8	70	122	122	10320	2022		50.74		50.77	50.71	0.018
5	8	70	141	141	10320	2051.6		51.12		51.15	51.07	0.0199
5	8	70	162	162	10320	2066.9		51.31		51.31	51.29	0.008
5	8	70	182	182	10320	2074.2		51.39		51.44	51.34	0.024
5	9	80	0	0	10320	2077		51.44		51.46	51.39	0.016
5	9	80	21	21	10320	2078.2		51.46		51.47	51.41	0.014

Appendix D: Dia-stron Dimensional Report for Repeatability Test

5	9	80	42	42	10320	2066.1		51.31		51.31	51.27	0.014
5	9	80	62	62	10320	2075.8		51.39		51.44	51.38	0.018
5	9	80	81	81	10320	2059.7		51.19		51.24	51.18	0.018
5	9	80	102	102	10320	2048		51.05		51.15	50.98	0.0439
5	9	80	122	122	10320	2040.8		51		51	50.95	0.012
5	9	80	142	142	10320	2088.3		51.58		51.6	51.53	0.016
5	9	80	162	162	10320	2087.9		51.56		51.6	51.52	0.0199
5	9	80	182	182	10320	2078.2		51.44		51.47	51.41	0.016
5	10	90	0	0	10320	2077.4		51.41		51.47	51.39	0.0219
5	10	90	21	21	10320	2079.4		51.44		51.5	51.41	0.018
5	10	90	42	42	10320	2079.4		51.47		51.5	51.41	0.0199
5	10	90	62	62	10320	2072.2		51.36		51.39	51.34	0.018
5	10	90	82	82	10320	2058.9		51.18		51.25	51.15	0.026
5	10	90	102	102	10320	2039.2		50.93		51.05	50.86	0.054
5	10	90	122	122	10320	2107.8		51.81		51.84	51.77	0.016
5	10	90	141	141	10320	2149.5		52.31		52.35	52.28	0.024
5	10	90	162	162	10320	2098.1		51.7		51.72	51.65	0.016
5	10	90	182	182	10320	2073.8		51.38		51.41	51.36	0.0199
6	1	0	0	0	11683	2065.3		51.27		51.31	51.25	0.014
6	1	0	21	21	11683	2061.3		51.24		51.27	51.19	0.0199
6	1	0	42	42	11683	2060.5		51.22		51.25	51.19	0.0199
6	1	0	62	62	11683	2056.5		51.15		51.19	51.15	0.016
6	1	0	82	82	11683	2047.6		51.04		51.1	51.02	0.0219
6	1	0	102	102	11683	2046.4		51.05		51.07	51.02	0.016
6	1	0	122	122	11683	2059.7		51.19		51.24	51.18	0.018
6	1	0	142	142	11683	2045.6		51.02		51.07	51	0.024
6	1	0	162	162	11683	2049.6		51.1		51.12	51.05	0.018
6	1	0	182	182	11683	2070.6	2056.31	51.36	51.164	51.38	51.31	0.018
6	2	10	0	0	11683	2068.1		51.31		51.34	51.29	0.012
6	2	10	21	21	11683	2065.3		51.29		51.31	51.25	0.018
6	2	10	42	42	11683	2058.5		51.22		51.24	51.15	0.0199
6	2	10	62	62	11683	2050		51.1		51.13	51.05	0.024
6	2	10	82	82	11683	2060.1		51.19		51.25	51.18	0.0199
6	2	10	102	102	11683	2040		50.93		51.07	50.86	0.054
6	2	10	122	122	11683	2064.1		51.24		51.38	51.15	0.052
6	2	10	142	142	11683	2058.9		51.19		51.22	51.18	0.012
6	2	10	162	162	11683	2049.6		51.07		51.12	51.05	0.014
6	2	10	182	182	11683	2069.7		51.34		51.38	51.29	0.0219
6	3	20	0	0	11683	2075		51.41		51.44	51.36	0.0199
6	3	20	21	21	11683	2063.3		51.25		51.27	51.24	0.014
6	3	20	42	42	11683	2080.6		51.46		51.5	51.44	0.024
6	3	20	62	62	11683	2088.7		51.58		51.61	51.53	0.018
6	3	20	82	82	11683	2098.1		51.7		51.72	51.65	0.016
6	3	20	102	102	11683	2057.7		51.19		51.22	51.15	0.016
6	3	20	122	122	11683	2054		51.15		51.18	51.1	0.0219
6	3	20	142	142	11683	2033.6		50.88		50.91	50.86	0.018
6	3	20	162	162	11683	2071		51.34		51.39	51.31	0.024
6	3	20	182	182	11683	2093.2		51.63		51.65	51.6	0.018
6	4	30	0	0	11683	2078.6		51.44		51.5	51.39	0.024
6	4	30	21	21	11683	2075.8		51.39		51.44	51.38	0.018
6	4	30	42	42	11683	2066.5		51.27		51.34	51.25	0.018
6	4	30	62	62	11683	2062.5		51.24		51.27	51.22	0.014
6	4	30	82	82	11683	2060.1		51.24		51.24	51.19	0.016
6	4	30	102	102	11683	2051.6		51.12		51.15	51.07	0.0219
6	4	30	122	122	11683	2060.5		51.24		51.25	51.19	0.018
6	4	30	142	142	11683	2045.6		51.04		51.07	51	0.0219
6	4	30	162	162	11683	2060.1		51.24		51.24	51.19	0.014
6	4	30	182	182	11683	2075.8		51.41		51.44	51.38	0.018
6	5	40	0	0	11683	2077.8		51.44		51.46	51.41	0.012
6	5	40	21	21	11683	2073		51.38		51.41	51.34	0.0199
6	5	40	42	42	11683	2077.4		51.46		51.47	51.39	0.0219
6	5	40	62	62	11683	2065.3		51.27		51.31	51.25	0.016
6	5	40	82	82	11683	2060.1		51.24		51.25	51.18	0.0199
6	5	40	102	102	11683	2056.5		51.18		51.22	51.12	0.0299
6	5	40	122	122	11683	2052.8		51.13		51.15	51.1	0.026
6	5	40	142	142	11683	2054.9		51.15		51.18	51.12	0.0219
6	5	40	162	162	11683	2050		51.1		51.13	51.05	0.0219
6	5	40	182	182	11683	2085.9		51.53		51.63	51.44	0.0419
6	6	50	0	0	11683	2071.8		51.36		51.38	51.34	0.016
6	6	50	21	21	11683	2065.3		51.29		51.31	51.25	0.016
6	6	50	42	42	11683	2067.3		51.31		51.34	51.27	0.014
6	6	50	62	62	11683	2055.7		51.18		51.19	51.13	0.018
6	6	50	82	82	11683	2060.5		51.24		51.25	51.19	0.016
6	6	50	102	102	11683	2043.6		51.04		51.07	50.95	0.028
6	6	50	122	122	11683	2052.8		51.13		51.15	51.1	0.018
6	6	50	142	142	11683	2073		51.38		51.41	51.34	0.0199
6	6	50	162	162	11683	2054.9		51.13		51.18	51.12	0.018
6	6	50	182	182	11683	2081.9		51.5		51.53	51.44	0.026
6	7	60	0	0	11683	2073.8		51.39		51.41	51.36	0.016
6	7	60	21	21	11683	2072.2		51.36		51.39	51.34	0.018
6	7	60	42	42	11683	2073		51.38		51.39	51.36	0.016
6	7	60	62	62	11683	2063.3		51.27		51.27	51.24	0.014
6	7	60	82	82	11683	2049.6		51.07		51.12	51.05	0.016
6	7	60	102	102	11683	2045.6		51.02		51.07	51	0.024
6	7	60	122	122	11683	2035.2		50.91		50.93	50.88	0.016
6	7	60	142	142	11683	2047.2		51.07		51.07	51.04	0.014
6	7	60	162	162	11683	2068.9		51.31		51.36	51.29	0.018
6	7	60	182	182	11683	2075.8		51.41		51.44	51.38	0.014
6	8	70	0	0	11683	2082.3		51.5		51.52	51.46	0.016
6	8	70	21	21	11683	2069.7		51.36		51.36	51.31	0.012
6	8	70	42	42	11683	2070.6		51.34		51.38	51.31	0.018
6	8	70	62	62	11683	2076.6		51.41		51.46	51.38	0.024
6	8	70	82	82	11683	2056.9		51.19		51.22	51.13	0.018
6	8	70	102	102	11683	2038.4		50.95		50.98	50.91	0.018
6	8	70	122	122	11683	2031.6		50.88		50.88	50.84	0.014
6	8	70	142	142	11683	2040		50.95		51	50.93	0.018
6	8	70	162	162	11683	2058.9		51.19		51.22	51.18	0.016
6	8	70	182	182	11683	2073.8		51.41		51.41	51.36	0.018
6	9	80	0	0	11683	2084.3		51.5		51.53	51.5	0.016
6	9	80	21	21	11683	2084.3		51.52		51.56	51.47	0.0219
6	9	80	42	42	11683	2069.7		51.36		51.36	51.31	0.016
6	9	80	62	62	11683	2073		51.38		51.41	51.34	0.018
6	9	80	82	82	11683	2059.7		51.19		51.24	51.18	0.018
6	9	80	102	102	11683	2037.2		50.95		51	50.86	0.034
6	9	80	122	122	11683	2036.8		50.91		50.95	50.9	0.0199
6	9	80	142	142	11683	2057.7		51.18		51.24	51.13	0.026
6	9	80	162	162	11683	2068.1		51.34		51.34	51.29	0.014
6	9	80	182	182	11683	2076.2		51.41		51.44	51.39	0.014
6	10	90	0	0	11683	2091.6		51.6		51.65	51.56	0.0219
6	10	90	21	21	11683	2088.7		51.58		51.61	51.53	0.024
6	10	90	42	42	11683	2072.2		51.36		51.39	51.34	0.014
6	10	90	62	62	11683	2073.8		51.38		51.41	51.36	0.018
6	10	90	82	82	11683	2049.2		51.05		51.12	51.04	0.0219
6	10	90	102	102	11683	2041.6		50.98		51.02	50.95	0.018
6	10	90	122	122	11683	2077.8		51.44		51.46	51.41	0.016
6	10	90	142	142	11683	2094.8		51.63		51.68	51.61	0.018
6	10	90	162	162	11683	2066.1		51.29		51.31	51.27	0.014
6	10	90	182	182	11683	2085.5		51.52		51.56	51.5	0.018
7	1	0	0	0	14429	2081.5		51.47		51.52	51.44	0.0219
7	1	0	21	21	14429	2071		51.34		51.39	51.31	0.0219
7	1	0	42	42	14429	2079.4		51.47		51.52	51.39	0.032
7	1	0	62	62	14429	2066.5		51.27		51.34	51.25	0.024
7	1	0	82	82	14429	2044.8		51.02		51.05	51	0.018
7	1	0	102	102	14429	2048.8		51.07		51.1	51.05	0.016
7	1	0	122	122	14429	2070.6		51.36		51.38	51.31	0.016
7	1	0	142	142	14429	2042.4		50.98		51.04	50.95	0.0219
7	1	0	162	162	14429	2046.4		51.04		51.07	51.02	0.016
7	1	0	182	182	14429	2090	2064.14	51.6	51.262	51.61	51.56	0.016
7	2	10	0	0	14429	2066.1		51.31		51.31	51.27	0.016

Appendix D: Dia-stron Dimensional Report for Repeatability Test

7	2	10	21	21	14429	2078.2		51.44	51.47	51.41	0.018
7	2	10	42	42	14429	2086.3		51.53	51.58	51.5	0.024
7	2	10	62	62	14429	2059.7		51.19	51.24	51.18	0.0199
7	2	10	82	82	14429	2052.8		51.12	51.15	51.1	0.018
7	2	10	102	102	14429	2055.3		51.15	51.18	51.13	0.014
7	2	10	122	122	14429	2064.1		51.25	51.29	51.24	0.018
7	2	10	142	142	14429	2054		51.13	51.18	51.1	0.0219
7	2	10	162	162	14429	2046.4		51.04	51.07	51.02	0.018
7	2	10	182	182	14429	2050		51.1	51.13	51.05	0.024
7	3	20	0	0	14429	2073		51.38	51.39	51.36	0.012
7	3	20	21	21	14429	2065.3		51.29	51.31	51.25	0.0199
7	3	20	42	42	14429	2063.3		51.24	51.27	51.24	0.012
7	3	20	62	62	14429	2070.5		51.31	51.44	51.25	0.0439
7	3	20	82	82	14429	2140.5		52.2	52.23	52.18	0.016
7	3	20	101	101	14429	2110.3		51.84	51.87	51.8	0.0219
7	3	20	122	122	14429	2063.3		51.24	51.27	51.24	0.014
7	3	20	142	142	14429	2077		51.41	51.46	51.39	0.016
7	3	20	162	162	14429	2083.9		51.52	51.56	51.46	0.026
7	3	20	182	182	14429	2073.8		51.39	51.41	51.36	0.016
7	4	30	0	0	14429	2079		51.44	51.52	51.38	0.052
7	4	30	21	21	14429	2070.6		51.34	51.38	51.31	0.016
7	4	30	42	42	14429	2064.5		51.27	51.29	51.25	0.012
7	4	30	62	62	14429	2059.7		51.18	51.24	51.18	0.018
7	4	30	82	82	14429	2095.6		51.68	51.7	51.61	0.0219
7	4	30	102	102	14429	2123.3		52	52.04	51.95	0.024
7	4	30	122	122	14429	2155.7		52.38	52.43	52.35	0.018
7	4	30	142	142	14429	2142.5		52.23	52.26	52.2	0.014
7	4	30	162	162	14429	2087.5		51.53	51.58	51.53	0.016
7	4	30	182	182	14429	2078.2		51.46	51.47	51.41	0.018
7	5	40	0	0	14429	2073		51.38	51.41	51.34	0.018
7	5	40	21	21	14429	2068.1		51.31	51.36	51.27	0.018
7	5	40	42	42	14429	2068.1		51.34	51.34	51.29	0.014
7	5	40	62	62	14429	2058.5		51.22	51.24	51.15	0.024
7	5	40	82	82	14429	2072.2		51.38	51.39	51.34	0.016
7	5	40	102	102	14429	2065.3		51.29	51.31	51.25	0.014
7	5	40	122	122	14429	2063.3		51.25	51.29	51.22	0.0199
7	5	40	142	142	14429	2092.4		51.61	51.63	51.6	0.012
7	5	40	162	162	14429	2055.7		51.18	51.19	51.13	0.016
7	5	40	182	182	14429	2081.5		51.5	51.52	51.44	0.0219
7	6	50	0	0	14429	2073		51.38	51.39	51.36	0.016
7	6	50	21	21	14429	2072.2		51.36	51.39	51.34	0.0199
7	6	50	42	42	14429	2070.6		51.34	51.38	51.31	0.016
7	6	50	62	62	14429	2055.3		51.15	51.19	51.12	0.0219
7	6	50	82	82	14429	2052.8		51.12	51.15	51.1	0.016
7	6	50	102	102	14429	2041.6		51	51.04	50.93	0.0219
7	6	50	122	122	14429	2040.8		50.98	51.02	50.93	0.0219
7	6	50	142	142	14429	2059.3		51.19	51.22	51.19	0.0099
7	6	50	162	162	14429	2064.1		51.27	51.29	51.24	0.016
7	6	50	182	182	14429	2075		51.38	51.44	51.36	0.024
7	7	60	0	0	14429	2073		51.38	51.41	51.34	0.018
7	7	60	21	21	14429	2069.7		51.31	51.36	51.31	0.014
7	7	60	42	42	14429	2070.6		51.36	51.38	51.31	0.016
7	7	60	62	62	14429	2068.1		51.31	51.34	51.29	0.012
7	7	60	82	82	14429	2049.2		51.05	51.12	51.04	0.018
7	7	60	102	102	14429	2041.6		50.98	51.02	50.95	0.016
7	7	60	122	122	14429	2036.8		50.93	50.95	50.9	0.018
7	7	60	142	142	14429	2059.7		51.19	51.24	51.18	0.018
7	7	60	162	162	14429	2052.8		51.13	51.15	51.1	0.016
7	7	60	182	182	14429	2073.8		51.39	51.41	51.36	0.0219
7	8	70	0	0	14429	2076.2		51.41	51.44	51.39	0.014
7	8	70	21	21	14429	2074.6		51.39	51.41	51.38	0.014
7	8	70	42	42	14429	2070.6		51.34	51.38	51.31	0.014
7	8	70	62	62	14429	2071		51.34	51.36	51.34	0.0099
7	8	70	82	82	14429	2055.3		51.15	51.18	51.13	0.016
7	8	70	102	102	14429	2044		51.04	51.05	50.98	0.024
7	8	70	122	122	14429	2026.8		50.79	50.84	50.76	0.0219
7	8	70	142	142	14429	2051.6		51.12	51.15	51.07	0.0219
7	8	70	162	162	14429	2068.9		51.34	51.36	51.29	0.016
7	8	70	182	182	14429	2077.8		51.41	51.46	51.41	0.014
7	9	80	0	0	14429	2080.2		51.46	51.52	51.41	0.024
7	9	80	21	21	14429	2079.4		51.44	51.5	51.41	0.0219
7	9	80	42	42	14429	2068.1		51.31	51.34	51.29	0.012
7	9	80	62	62	14429	2077		51.41	51.47	51.38	0.024
7	9	80	82	82	14429	2062.5		51.24	51.27	51.22	0.016
7	9	80	102	102	14429	2050.4		51.07	51.15	51.04	0.028
7	9	80	122	122	14429	2047.2		51.05	51.07	51.04	0.0099
7	9	80	142	142	14429	2094.4		51.63	51.68	51.6	0.0219
7	9	80	162	162	14429	2088.3		51.58	51.6	51.53	0.016
7	9	80	182	182	14429	2079.4		51.46	51.5	51.41	0.024
7	10	90	0	0	14429	2077		51.44	51.46	51.39	0.0219
7	10	90	21	21	14429	2069.7		51.34	51.36	51.31	0.014
7	10	90	42	42	14429	2060.1		51.22	51.24	51.19	0.014
7	10	90	62	62	14429	2069.7		51.34	51.38	51.29	0.0219
7	10	90	82	82	14429	2056.5		51.18	51.19	51.15	0.016
7	10	90	102	102	14429	2038.4		50.95	50.98	50.91	0.016
7	10	90	122	122	14429	2065.3		51.29	51.31	51.25	0.018
7	10	90	142	142	14429	2098.5		51.72	51.73	51.65	0.024
7	10	90	162	162	14429	2078.2		51.46	51.47	51.41	0.018
7	10	90	182	182	14429	2075		51.39	51.44	51.36	0.0219
8	1	0	0	0	15368	2054		51.12	51.18	51.1	0.0219
8	1	0	21	21	15368	2054.9		51.15	51.18	51.12	0.0199
8	1	0	42	42	15368	2064.5		51.27	51.29	51.25	0.012
8	1	0	62	62	15368	2052.8		51.13	51.15	51.1	0.016
8	1	0	82	82	15368	2050.4		51.07	51.12	51.07	0.014
8	1	0	102	102	15368	2038.4		50.95	50.98	50.91	0.018
8	1	0	122	122	15368	2057.7		51.18	51.22	51.15	0.0199
8	1	0	142	142	15368	2042.4		51	51.04	50.95	0.024
8	1	0	162	162	15368	2052		51.1	51.13	51.1	0.016
8	1	0	182	182	15368	2059.7	2052.68	51.19	51.116	51.24	51.18	0.016
8	2	10	0	0	15368	2071		51.36	51.39	51.31	0.024
8	2	10	21	21	15368	2071.8		51.34	51.38	51.34	0.012
8	2	10	42	42	15368	2062.5		51.24	51.27	51.22	0.016
8	2	10	62	62	15368	2051.6		51.12	51.15	51.07	0.018
8	2	10	82	82	15368	2055.7		51.18	51.19	51.13	0.018
8	2	10	102	102	15368	2044.8		51.02	51.07	50.98	0.0299
8	2	10	122	122	15368	2096.4		51.68	51.72	51.61	0.024
8	2	10	142	142	15368	2085.5		51.53	51.56	51.5	0.018
8	2	10	162	162	15368	2057.7		51.19	51.22	51.15	0.016
8	2	10	182	182	15368	2087.1		51.53	51.58	51.52	0.016
8	3	20	0	0	15368	2072.2		51.38	51.39	51.34	0.0199
8	3	20	21	21	15368	2062.5		51.25	51.27	51.22	0.014
8	3	20	42	42	15368	2079.4		51.46	51.47	51.44	0.0099
8	3	20	62	62	15368	2082.7		51.47	51.52	51.47	0.014
8	3	20	82	82	15368	2087.9		51.53	51.6	51.52	0.018
8	3	20	102	102	15368	2055.7		51.15	51.19	51.13	0.0199
8	3	20	122	122	15368	2051.6		51.13	51.15	51.07	0.0219
8	3	20	142	142	15368	2033.6		50.9	50.91	50.86	0.016
8	3	20	162	162	15368	2061.7		51.24	51.25	51.22	0.014
8	3	20	182	182	15368	2088.3		51.58	51.6	51.53	0.016
8	4	30	0	0	15368	2077		51.44	51.46	51.39	0.018
8	4	30	21	21	15368	2075		51.41	51.41	51.39	0.008
8	4	30	42	42	15368	2065.3		51.27	51.31	51.25	0.016
8	4	30	62	62	15368	2062.5		51.24	51.27	51.22	0.016
8	4	30	82	82	15368	2061.7		51.24	51.25	51.22	0.016
8	4	30	102	102	15368	2054		51.13	51.18	51.1	0.024
8	4	30	122	122	15368	2060.5		51.24	51.25	51.19	0.016
8	4	30	142	142	15368	2047.2		51.05	51.07	51.04	0.014
8	4	30	162	162	15368	2059.7		51.22	51.24	51.18	0.018
8	4	30	182	182	15368	2078.2		51.44	51.47	51.41	0.0199

Appendix D: Dia-stron Dimensional Report for Repeatability Test

8	5	40	0	0	15368	2077		51.41	51.46	51.39	0.016
8	5	40	21	21	15368	2071		51.34	51.39	51.31	0.0199
8	5	40	42	42	15368	2066.1		51.29	51.31	51.27	0.012
8	5	40	62	62	15368	2055.7		51.15	51.19	51.13	0.0199
8	5	40	82	82	15368	2062.5		51.27	51.27	51.22	0.018
8	5	40	102	102	15368	2055.7		51.18	51.19	51.13	0.016
8	5	40	122	122	15368	2058.5		51.19	51.24	51.15	0.024
8	5	40	142	142	15368	2051.6		51.12	51.15	51.07	0.018
8	5	40	162	162	15368	2052.8		51.15	51.15	51.1	0.016
8	5	40	182	182	15368	2079.4		51.47	51.52	51.39	0.0299
8	6	50	0	0	15368	2081.9		51.47	51.53	51.44	0.028
8	6	50	21	21	15368	2072.2		51.38	51.39	51.34	0.016
8	6	50	42	42	15368	2071.8		51.36	51.38	51.34	0.012
8	6	50	62	62	15368	2060.1		51.22	51.24	51.19	0.012
8	6	50	82	82	15368	2056.5		51.18	51.19	51.15	0.014
8	6	50	102	102	15368	2208.3		53.05	53.05	53	0.016
8	6	50	122	122	15368	2367.6		54.91	54.93	54.88	0.0199
8	6	50	142	142	15368	2412.3		55.44	55.45	55.39	0.0219
8	6	50	162	162	15368	2342.3		54.59	54.68	54.54	0.034
8	6	50	182	182	15368	2158.6		52.43	52.47	52.38	0.032
8	7	60	0	0	15368	2076.2		51.39	51.44	51.39	0.012
8	7	60	21	21	15368	2071.8		51.38	51.38	51.34	0.012
8	7	60	42	42	15368	2071		51.36	51.39	51.31	0.0199
8	7	60	62	62	15368	2066.1		51.31	51.31	51.27	0.016
8	7	60	82	82	15368	2054		51.13	51.18	51.1	0.026
8	7	60	102	102	15368	2040.8		51	51	50.95	0.014
8	7	60	122	122	15368	2028.8		50.84	50.86	50.79	0.016
8	7	60	142	142	15368	2040		50.95	51	50.93	0.0199
8	7	60	162	162	15368	2065.3		51.29	51.31	51.25	0.016
8	7	60	182	182	15368	2073.8		51.39	51.41	51.36	0.018
8	8	70	0	0	15368	2081.5		51.5	51.52	51.44	0.0219
8	8	70	21	21	15368	2072.2		51.36	51.39	51.34	0.0199
8	8	70	42	42	15368	2070.6		51.36	51.38	51.31	0.016
8	8	70	62	62	15368	2077		51.39	51.47	51.38	0.026
8	8	70	82	82	15368	2061.7		51.25	51.25	51.22	0.012
8	8	70	102	102	15368	2040.8		50.95	51	50.95	0.016
8	8	70	122	122	15368	2031.6		50.86	50.88	50.84	0.0099
8	8	70	142	142	15368	2040		51	51	50.93	0.016
8	8	70	162	162	15368	2063.3		51.25	51.27	51.24	0.012
8	8	70	182	182	15368	2077		51.44	51.46	51.39	0.0199
8	9	80	0	0	15368	2075.8		51.39	51.44	51.38	0.012
8	9	80	21	21	15368	2076.6		51.39	51.46	51.38	0.0199
8	9	80	42	42	15368	2073		51.39	51.39	51.36	0.016
8	9	80	62	62	15368	2074.6		51.38	51.41	51.38	0.014
8	9	80	82	82	15368	2077.4		51.44	51.47	51.39	0.026
8	9	80	102	102	15368	2047.6		51.05	51.1	51.02	0.0199
8	9	80	122	122	15368	2024.8		50.79	50.79	50.76	0.016
8	9	80	142	142	15368	2060.5		51.22	51.25	51.19	0.016
8	9	80	162	162	15368	2081.5		51.47	51.5	51.46	0.012
8	9	80	182	182	15368	2077.4		51.44	51.47	51.39	0.0219
8	10	90	0	0	15368	2086.3		51.53	51.58	51.5	0.026
8	10	90	21	21	15368	2077		51.41	51.46	51.39	0.016
8	10	90	42	42	15368	2069.7		51.34	51.38	51.29	0.026
8	10	90	62	62	15368	2073.8		51.39	51.41	51.36	0.014
8	10	90	82	82	15368	2050.8		51.1	51.13	51.07	0.0199
8	10	90	102	102	15368	2050.8		51.12	51.13	51.07	0.0199
8	10	90	122	122	15368	2039.2		50.98	51	50.91	0.0219
8	10	90	142	142	15368	2046.8		51.04	51.1	51	0.024
8	10	90	162	162	15368	2084.3		51.52	51.56	51.47	0.0199
8	10	90	182	182	15368	2082.7		51.5	51.53	51.46	0.0199
9	1	0	0	0	15958	2087.1		51.53	51.58	51.52	0.016
9	1	0	21	21	15958	2078.2		51.46	51.47	51.41	0.0199
9	1	0	42	42	15958	2088.3		51.56	51.6	51.53	0.018
9	1	0	62	62	15958	2068.9		51.34	51.36	51.29	0.014
9	1	0	82	82	15958	2038.4		50.93	50.98	50.91	0.0199
9	1	0	102	102	15958	2046.4		51.04	51.07	51.02	0.0219
9	1	0	122	122	15958	2061.7		51.25	51.25	51.22	0.014
9	1	0	142	142	15958	2033.6		50.91	50.91	50.86	0.018
9	1	0	162	162	15958	2045.6		51.04	51.07	51	0.0219
9	1	0	183	183	15958	2082.7	2063.09	51.5	51.256	51.53	51.46	0.0219
9	2	10	0	0	15958	2074.2		51.38		51.44	51.34	0.024
9	2	10	21	21	15958	2084.3		51.5		51.56	51.47	0.0199
9	2	10	42	42	15958	2087.1		51.53		51.6	51.5	0.028
9	2	10	62	62	15958	2058.9		51.19		51.22	51.18	0.014
9	2	10	82	82	15958	2049.2		51.1		51.12	51.04	0.024
9	2	10	102	102	15958	2050.4		51.12		51.15	51.04	0.028
9	2	10	122	122	15958	2055.3		51.18		51.19	51.12	0.0199
9	2	10	142	142	15958	2043.6		51.02		51.04	50.98	0.018
9	2	10	162	162	15958	2039.2		50.95		51	50.91	0.0199
9	2	10	182	182	15958	2046.8		51.04		51.1	51	0.032
9	3	20	0	0	15958	2078.6		51.44		51.5	51.39	0.026
9	3	20	21	21	15958	2073.8		51.38		51.41	51.36	0.016
9	3	20	43	43	15958	2067.3		51.29		51.34	51.27	0.0199
9	3	20	62	62	15958	2073.8		51.39		51.41	51.36	0.014
9	3	20	82	82	15958	2129		52.06		52.09	52.04	0.018
9	3	20	102	102	15958	2100.5		51.72		51.73	51.7	0.016
9	3	20	122	122	15958	2062.5		51.24		51.27	51.22	0.0199
9	3	20	142	142	15958	2044.8		51.02		51.07	50.98	0.026
9	3	20	162	162	15958	2041.6		50.98		51.02	50.95	0.018
9	3	20	183	183	15958	2075		51.38		51.44	51.36	0.0219
9	4	30	0	0	15958	2086.3		51.52		51.58	51.5	0.0199
9	4	30	21	21	15958	2077.8		51.44		51.46	51.41	0.016
9	4	30	42	42	15958	2067.3		51.31		51.34	51.27	0.016
9	4	30	62	62	15958	2055.7		51.18		51.19	51.13	0.016
9	4	30	82	82	15958	2107		51.8		51.84	51.75	0.018
9	4	30	102	102	15958	2158.6		52.43		52.45	52.4	0.014
9	4	30	122	122	15958	2191.6		52.81		52.86	52.79	0.018
9	4	30	142	142	15958	2168.1		52.54		52.56	52.52	0.012
9	4	30	162	162	15958	2085.5		51.52		51.56	51.5	0.018
9	4	30	183	183	15958	2075.8		51.39		51.44	51.38	0.018
9	5	40	0	0	15958	2079.4		51.44		51.47	51.44	0.012
9	5	40	21	21	15958	2075		51.39		51.44	51.36	0.0199
9	5	40	42	42	15958	2071.8		51.34		51.38	51.34	0.014
9	5	40	62	62	15958	2058.9		51.22		51.22	51.18	0.014
9	5	40	82	82	15958	2066.1		51.29		51.31	51.27	0.016
9	5	40	102	102	15958	2063.3		51.24		51.29	51.22	0.0199
9	5	40	122	122	15958	2057.7		51.18		51.22	51.15	0.0199
9	5	40	142	142	15958	2064.9		51.27		51.31	51.24	0.0199
9	5	40	162	162	15958	2055.7		51.18		51.22	51.1	0.0299
9	5	40	183	183	15958	2077		51.41		51.46	51.39	0.016
9	6	50	0	0	15958	2078.2		51.44		51.47	51.41	0.0199
9	6	50	21	21	15958	2075.8		51.39		51.44	51.38	0.018
9	6	50	42	42	15958	2071.8		51.36		51.38	51.34	0.016
9	6	50	62	62	15958	2054.5		51.18		51.19	51.1	0.024
9	6	50	82	82	15958	2052.8		51.12		51.18	51.07	0.024
9	6	50	102	102	15958	2049.2		51.12		51.12	51.04	0.0199
9	6	50	122	122	15958	2041.6		51		51.02	50.95	0.0199
9	6	50	142	142	15958	2051.6		51.12		51.15	51.07	0.0199
9	6	50	162	162	15958	2056.5		51.18		51.19	51.15	0.012
9	6	50	183	183	15958	2066.1		51.29		51.31	51.27	0.016
9	7	60	0	0	15958	2082.3		51.46		51.52	51.46	0.0199
9	7	60	21	21	15958	2073.8		51.38		51.41	51.36	0.018
9	7	60	42	42	15958	2072.2		51.38		51.39	51.34	0.018
9	7	60	62	62	15958	2067.3		51.29		51.34	51.27	0.012
9	7	60	82	82	15958	2052.8		51.13		51.18	51.07	0.024
9	7	60	102	102	15958	2046.8		51.04		51.1	51	0.024
9	7	60	122	122	15958	2038.4		50.95		50.98	50.91	0.016
9	7	60	142	142	15958	2057.7		51.18		51.22	51.15	0.016
9	7	60	163	163	15958	2048.4		51.05		51.1	51.04	0.0199

Appendix D: Dia-stron Dimensional Report for Repeatability Test

9	7	60	182	182	15958	2068.1		51.34	51.34	51.29	0.018
9	8	70	0	0	15958	2083.1		51.47	51.53	51.47	0.0199
9	8	70	21	21	15958	2077		51.44	51.46	51.39	0.014
9	8	70	42	42	15958	2071.8		51.36	51.38	51.34	0.012
9	8	70	62	62	15958	2070.6		51.36	51.38	51.31	0.016
9	8	70	82	82	15958	2054.9		51.15	51.18	51.12	0.018
9	8	70	102	102	15958	2049.6		51.1	51.12	51.05	0.016
9	8	70	122	122	15958	2033.2		50.86	50.9	50.86	0.014
9	8	70	142	142	15958	2050		51.12	51.13	51.05	0.024
9	8	70	162	162	15958	2066.1		51.31	51.31	51.27	0.012
9	8	70	182	182	15958	2070.6		51.34	51.38	51.31	0.014
9	9	80	0	0	15958	2084.3		51.52	51.56	51.47	0.0219
9	9	80	21	21	15958	2082.7		51.5	51.52	51.47	0.014
9	9	80	42	42	15958	2066.1		51.27	51.31	51.27	0.014
9	9	80	62	62	15958	2073.8		51.39	51.41	51.36	0.016
9	9	80	82	82	15958	2062.5		51.25	51.27	51.22	0.014
9	9	80	102	102	15958	2054.9		51.15	51.18	51.12	0.016
9	9	80	122	122	15958	2052.8		51.12	51.15	51.1	0.0199
9	9	80	142	142	15958	2082.3		51.47	51.52	51.46	0.014
9	9	80	162	162	15958	2067.3		51.29	51.34	51.27	0.014
9	9	80	183	183	15958	2073		51.38	51.41	51.34	0.024
9	10	90	0	0	15958	2071.8		51.34	51.38	51.34	0.012
9	10	90	21	21	15958	2075		51.39	51.44	51.36	0.018
9	10	90	42	42	15958	2069.7		51.36	51.36	51.31	0.016
9	10	90	62	62	15958	2062.1		51.24	51.38	51.1	0.0879
9	10	90	82	82	15958	2053.6		51.13	51.15	51.12	0.014
9	10	90	102	102	15958	2043.6		51.02	51.04	50.98	0.018
9	10	90	122	122	15958	2046.4		51.05	51.07	51.02	0.018
9	10	90	142	142	15958	2048.8		51.07	51.1	51.05	0.016
9	10	90	162	162	15958	2056.1		51.18	51.18	51.15	0.0099
9	10	90	182	182	15958	2064.1		51.25	51.29	51.24	0.0199
10	1	0	0	0	16521	2060.5		51.24	51.25	51.19	0.0199
10	1	0	21	21	16521	2054		51.13	51.18	51.1	0.018
10	1	0	42	42	16521	2062.5		51.25	51.27	51.22	0.024
10	1	0	62	62	16521	2062.5		51.25	51.27	51.22	0.018
10	1	0	82	82	16521	2059.7		51.24	51.24	51.18	0.0199
10	1	0	103	103	16521	2060.5		51.24	51.25	51.19	0.016
10	1	0	122	122	16521	2073.8		51.39	51.41	51.36	0.016
10	1	0	142	142	16521	2056.9		51.19	51.22	51.13	0.018
10	1	0	162	162	16521	2076.6		51.44	51.46	51.38	0.0199
10	1	0	182	182	16521	2083.1	2065.01	51.52	51.53	51.47	0.018
10	2	10	0	0	16521	2064.5		51.25	51.29	51.25	0.012
10	2	10	21	21	16521	2068.1		51.31	51.34	51.29	0.016
10	2	10	43	43	16521	2073.8		51.39	51.41	51.36	0.014
10	2	10	62	62	16521	2062.5		51.25	51.27	51.22	0.016
10	2	10	82	82	16521	2058.5		51.19	51.24	51.15	0.0219
10	2	10	102	102	16521	2060.1		51.22	51.24	51.19	0.0099
10	2	10	122	122	16521	2109.9		51.81	51.86	51.8	0.016
10	2	10	142	142	16521	2095.6		51.65	51.68	51.63	0.014
10	2	10	163	163	16521	2058.9		51.22	51.22	51.18	0.014
10	2	10	182	182	16521	2072.2		51.36	51.39	51.34	0.0219
10	3	20	0	0	16521	2063.3		51.25	51.27	51.24	0.014
10	3	20	21	21	16521	2064.5		51.27	51.29	51.25	0.016
10	3	20	42	42	16521	2060.1		51.22	51.24	51.19	0.016
10	3	20	62	62	16521	2056.5		51.18	51.19	51.15	0.014
10	3	20	82	82	16521	2071.8		51.36	51.38	51.34	0.016
10	3	20	103	103	16521	2067.3		51.27	51.34	51.27	0.0199
10	3	20	122	122	16521	2060.1		51.22	51.24	51.19	0.012
10	3	20	142	142	16521	2048.4		51.05	51.1	51.04	0.0199
10	3	20	162	162	16521	2055.3		51.13	51.19	51.12	0.0219
10	3	20	182	182	16521	2075.8		51.41	51.44	51.38	0.016
10	4	30	0	0	16521	2077		51.41	51.46	51.39	0.012
10	4	30	21	21	16521	2075.8		51.39	51.44	51.38	0.018
10	4	30	43	43	16521	2060.1		51.24	51.24	51.19	0.016
10	4	30	62	62	16521	2066.1		51.29	51.31	51.27	0.0099
10	4	30	82	82	16521	2075.8		51.39	51.44	51.38	0.018
10	4	30	102	102	16521	2073		51.38	51.39	51.36	0.016
10	4	30	122	122	16521	2063.3		51.25	51.27	51.24	0.014
10	4	30	142	142	16521	2058.9		51.19	51.22	51.18	0.012
10	4	30	163	163	16521	2068.1		51.31	51.34	51.29	0.014
10	4	30	183	183	16521	2084.3		51.52	51.56	51.47	0.0219
10	5	40	0	0	16521	2075.8		51.39	51.44	51.38	0.018
10	5	40	21	21	16521	2072.2		51.38	51.39	51.34	0.016
10	5	40	43	43	16521	2088.3		51.56	51.6	51.53	0.0199
10	5	40	62	62	16521	2079.4		51.44	51.5	51.41	0.0199
10	5	40	82	82	16521	2064.1		51.27	51.29	51.24	0.014
10	5	40	103	103	16521	2057.7		51.19	51.22	51.15	0.016
10	5	40	122	122	16521	2065.3		51.29	51.31	51.25	0.016
10	5	40	142	142	16521	2069.7		51.34	51.36	51.31	0.016
10	5	40	162	162	16521	2059.7		51.19	51.24	51.18	0.014
10	5	40	182	182	16521	2088.3		51.58	51.6	51.53	0.016
10	6	50	0	0	16521	2077.4		51.44	51.47	51.39	0.0199
10	6	50	21	21	16521	2070.6		51.34	51.38	51.31	0.0199
10	6	50	43	43	16521	2069.7		51.34	51.38	51.29	0.0199
10	6	50	62	62	16521	2057.7		51.19	51.22	51.15	0.0219
10	6	50	82	82	16521	2053.6		51.13	51.15	51.12	0.014
10	6	50	102	102	16521	2178		52.68	52.7	52.62	0.0199
10	6	50	122	122	16521	2315.7		54.31	54.34	54.26	0.024
10	6	50	142	142	16521	2376.3		55.02	55.05	54.96	0.024
10	6	50	162	162	16521	2297.9		54.11	54.11	54.07	0.012
10	6	50	183	183	16521	2139.3		52.18	52.23	52.15	0.0199
10	7	60	0	0	16521	2073.8		51.38	51.41	51.36	0.018
10	7	60	21	21	16521	2073		51.36	51.41	51.34	0.0199
10	7	60	43	43	16521	2073.8		51.39	51.41	51.36	0.016
10	7	60	62	62	16521	2066.1		51.29	51.31	51.27	0.014
10	7	60	82	82	16521	2050.8		51.12	51.13	51.07	0.016
10	7	60	103	103	16521	2049.2		51.1	51.12	51.04	0.0199
10	7	60	122	122	16521	2035.2		50.88	50.95	50.86	0.028
10	7	60	142	142	16521	2052		51.12	51.13	51.1	0.016
10	7	60	162	162	16521	2066.9		51.31	51.31	51.29	0.008
10	7	60	183	183	16521	2078.2		51.47	51.47	51.41	0.0219
10	8	70	0	0	16521	2081.5		51.47	51.52	51.44	0.026
10	8	70	21	21	16521	2071.8		51.36	51.38	51.34	0.018
10	8	70	43	43	16521	2073		51.38	51.41	51.34	0.028
10	8	70	62	62	16521	2080.6		51.46	51.5	51.44	0.0199
10	8	70	82	82	16521	2059.7		51.24	51.24	51.18	0.018
10	8	70	102	102	16521	2041.6		51	51.02	50.95	0.014
10	8	70	122	122	16521	2027.2		50.79	50.84	50.77	0.018
10	8	70	142	142	16521	2040.8		51	51.02	50.93	0.0219
10	8	70	163	163	16521	2060.5		51.22	51.25	51.19	0.0219
10	8	70	183	183	16521	2079.4		51.46	51.5	51.41	0.0199
10	9	80	0	0	16521	2078.2		51.46	51.47	51.41	0.0219
10	9	80	21	21	16521	2077		51.44	51.46	51.39	0.016
10	9	80	43	43	16521	2075		51.38	51.44	51.36	0.0219
10	9	80	62	62	16521	2073		51.38	51.41	51.34	0.024
10	9	80	82	82	16521	2064.1		51.25	51.29	51.24	0.018
10	9	80	102	102	16521	2042.8		51	51.02	50.98	0.016
10	9	80	122	122	16521	2030.4		50.86	50.88	50.81	0.014
10	9	80	142	142	16521	2060.5		51.24	51.25	51.19	0.016
10	9	80	162	162	16521	2073.8		51.39	51.41	51.36	0.018
10	9	80	183	183	16521	2080.6		51.47	51.5	51.44	0.024
10	10	90	0	0	16521	2085.5		51.52	51.56	51.5	0.018
10	10	90	21	21	16521	2079.4		51.46	51.5	51.41	0.0219
10	10	90	43	43	16521	2075.8		51.41	51.44	51.38	0.018
10	10	90	62	62	16521	2082.3		51.5	51.52	51.46	0.0219
10	10	90	82	82	16521	2057.7		51.18	51.22	51.15	0.016
10	10	90	102	102	16521	2056.9		51.18	51.22	51.13	0.0219
10	10	90	122	122	16521	2036.8		50.93	50.95	50.9	0.018
10	10	90	142	142	16521	2044.8		51.02	51.05	51	0.018

Appendix D: Dia-stron Dimensional Report for Repeatability Test

10	10	90	163	163	16521	2083.1		51.5		51.53	51.47	0.018
10	10	90	183	183	16521	2086.3		51.53		51.58	51.5	0.0219
11	1	0	0	0	17126	2050.8		51.1		51.13	51.07	0.016
11	1	0	21	21	17126	2055.7		51.13		51.19	51.13	0.018
11	1	0	43	43	17126	2054.9		51.13		51.18	51.12	0.0219
11	1	0	62	62	17126	2049.6		51.07		51.12	51.05	0.0199
11	1	0	83	83	17126	2050.8		51.12		51.13	51.07	0.016
11	1	0	102	102	17126	2042.4		51		51.04	50.95	0.0199
11	1	0	122	122	17126	2055.7		51.15		51.19	51.13	0.014
11	1	0	142	142	17126	2047.6		51.05		51.1	51.02	0.0219
11	1	0	163	163	17126	2041.6		51		51.02	50.95	0.018
11	1	0	183	183	17126	2060.1	2050.92	51.22	51.097	51.25	51.18	0.0199
11	2	10	0	0	17126	2059.7		51.19		51.24	51.18	0.016
11	2	10	21	21	17126	2063.3		51.24		51.27	51.24	0.012
11	2	10	43	43	17126	2068.1		51.34		51.34	51.29	0.014
11	2	10	62	62	17126	2055.7		51.18		51.19	51.13	0.016
11	2	10	83	83	17126	2051.6		51.12		51.15	51.07	0.0199
11	2	10	103	103	17126	2064.1		51.25		51.29	51.24	0.0199
11	2	10	123	123	17126	2063.3		51.25		51.27	51.24	0.012
11	2	10	142	142	17126	2045.2		51.02		51.04	51.02	0.0099
11	2	10	162	162	17126	2051.6		51.12		51.15	51.07	0.018
11	2	10	183	183	17126	2060.9		51.24		51.27	51.18	0.032
11	3	20	0	0	17126	2073.8		51.39		51.41	51.36	0.014
11	3	20	21	21	17126	2076.6		51.44		51.46	51.38	0.0199
11	3	20	43	43	17126	2064.5		51.25		51.29	51.25	0.012
11	3	20	62	62	17126	2050.4		51.1		51.12	51.07	0.014
11	3	20	82	82	17126	2061.7		51.24		51.25	51.22	0.012
11	3	20	102	102	17126	2050.8		51.12		51.13	51.07	0.018
11	3	20	122	122	17126	2057.7		51.18		51.22	51.15	0.016
11	3	20	142	142	17126	2040.8		50.98		51.02	50.93	0.024
11	3	20	163	163	17126	2049.2		51.1		51.12	51.04	0.0219
11	3	20	183	183	17126	2075		51.39		51.44	51.36	0.0219
11	4	30	0	0	17126	2077.4		51.44		51.47	51.39	0.024
11	4	30	21	21	17126	2075.8		51.41		51.44	51.38	0.018
11	4	30	42	42	17126	2068.1		51.31		51.38	51.25	0.032
11	4	30	63	63	17126	2060.5		51.24		51.25	51.19	0.0199
11	4	30	83	83	17126	2054.9		51.13		51.18	51.12	0.0199
11	4	30	102	102	17126	2056.5		51.19		51.19	51.15	0.014
11	4	30	123	123	17126	2054		51.15		51.18	51.1	0.0219
11	4	30	142	142	17126	2044.4		51		51.04	51	0.014
11	4	30	162	162	17126	2063.3		51.24		51.29	51.22	0.024
11	4	30	183	183	17126	2080.6		51.47		51.5	51.44	0.018
11	5	40	0	0	17126	2073.8		51.38		51.41	51.36	0.014
11	5	40	21	21	17126	2073		51.38		51.41	51.34	0.026
11	5	40	43	43	17126	2068.1		51.31		51.34	51.29	0.014
11	5	40	62	62	17126	2057.7		51.19		51.22	51.15	0.018
11	5	40	82	82	17126	2055.3		51.15		51.19	51.12	0.0199
11	5	40	102	102	17126	2059.7		51.19		51.24	51.18	0.018
11	5	40	122	122	17126	2055.3		51.15		51.24	51.07	0.0399
11	5	40	142	142	17126	2054.9		51.13		51.18	51.12	0.018
11	5	40	163	163	17126	2064.5		51.25		51.29	51.25	0.012
11	5	40	183	183	17126	2072.2		51.36		51.39	51.34	0.016
11	6	50	0	0	17126	2074.6		51.39		51.41	51.38	0.012
11	6	50	21	21	17126	2073.8		51.38		51.41	51.36	0.014
11	6	50	43	43	17126	2073.8		51.38		51.41	51.36	0.016
11	6	50	62	62	17126	2064.5		51.27		51.29	51.25	0.016
11	6	50	83	83	17126	2050.8		51.1		51.15	51.05	0.026
11	6	50	103	103	17126	2047.6		51.04		51.1	51.02	0.024
11	6	50	122	122	17126	2048.8		51.07		51.1	51.05	0.016
11	6	50	142	142	17126	2056.9		51.18		51.22	51.13	0.0199
11	6	50	162	162	17126	2056.5		51.19		51.19	51.15	0.016
11	6	50	183	183	17126	2080.6		51.47		51.5	51.44	0.0199
11	7	60	0	0	17126	2081.5		51.47		51.52	51.44	0.0199
11	7	60	21	21	17126	2080.2		51.46		51.52	51.41	0.028
11	7	60	43	43	17126	2080.6		51.47		51.5	51.44	0.016
11	7	60	63	63	17126	2102.1		51.72		51.75	51.72	0.016
11	7	60	82	82	17126	2096.4		51.65		51.7	51.63	0.014
11	7	60	102	102	17126	2065.3		51.27		51.31	51.25	0.0219
11	7	60	123	123	17126	2061.3		51.24		51.27	51.19	0.026
11	7	60	142	142	17126	2067.3		51.31		51.34	51.27	0.0199
11	7	60	163	163	17126	2063.3		51.25		51.27	51.24	0.0099
11	7	60	183	183	17126	2076.2		51.41		51.44	51.39	0.014
11	8	70	0	0	17126	2086.3		51.53		51.58	51.5	0.028
11	8	70	21	21	17126	2073		51.39		51.41	51.34	0.0219
11	8	70	43	43	17126	2069.7		51.34		51.38	51.29	0.018
11	8	70	63	63	17126	2079.4		51.46		51.5	51.41	0.0199
11	8	70	82	82	17126	2065.3		51.29		51.31	51.25	0.016
11	8	70	103	103	17126	2048.4		51.05		51.1	51.04	0.0219
11	8	70	123	123	17126	2036.8		50.9		50.95	50.9	0.0199
11	8	70	142	142	17126	2050		51.07		51.13	51.05	0.0199
11	8	70	162	162	17126	2067.3		51.31		51.34	51.27	0.016
11	8	70	183	183	17126	2080.6		51.47		51.5	51.44	0.016
11	9	80	0	0	17126	2084.7		51.5		51.6	51.44	0.0439
11	9	80	21	21	17126	2081.5		51.46		51.5	51.46	0.014
11	9	80	43	43	17126	2080.2		51.44		51.52	51.41	0.024
11	9	80	63	63	17126	2070.6		51.34		51.38	51.31	0.014
11	9	80	82	82	17126	2056.5		51.18		51.19	51.15	0.016
11	9	80	102	102	17126	2049.2		51.07		51.12	51.04	0.0219
11	9	80	122	122	17126	2030.4		50.86		50.88	50.81	0.018
11	9	80	142	142	17126	2055.3		51.15		51.18	51.13	0.018
11	9	80	163	163	17126	2071.8		51.34		51.38	51.34	0.012
11	9	80	183	183	17126	2088.3		51.58		51.6	51.53	0.0199
11	10	90	0	0	17126	2080.6		51.47		51.5	51.44	0.0199
11	10	90	21	21	17126	2075.8		51.41		51.44	51.38	0.016
11	10	90	43	43	17126	2072.6		51.36		51.38	51.36	0.0099
11	10	90	62	62	17126	2084.3		51.52		51.56	51.47	0.024
11	10	90	83	83	17126	2062.5		51.24		51.27	51.22	0.016
11	10	90	103	103	17126	2067.3		51.31		51.34	51.27	0.018
11	10	90	123	123	17126	2044		51.04		51.05	50.98	0.018
11	10	90	142	142	17126	2055.3		51.13		51.18	51.13	0.012
11	10	90	162	162	17126	2068.9		51.31		51.38	51.27	0.0219
11	10	90	183	183	17126	2077		51.39		51.47	51.38	0.026

	5.409146164	0.069287
	2060.442	51.2185
	0.005250472	0.27%
	0.525047166	0.270556

Appendix E: Dia-stron Dimensional Report for Slice Importance

Commercial Pitch Slice Importance
Dimensional Data Report

Record	Description	Slice No.	Slice Position	Start Angle	End Angle	Elapsed Time	Cross-Sectional Area	Mean Diameter	Max. Diameter	Min. Diameter	Std. Deviation
				Degrees	Degrees	Seconds	Sq.Microns	Microns	Microns	Microns	
1	FDAS:Average	1	0	0	0	0	123.4	12.5	12.61	12.46	0.0419
1	FDAS:Average	1	0	20	20	0	123.2	12.53	12.57	12.48	0.036
1	FDAS:Average	1	0	42	42	0	122.2	12.48	12.52	12.43	0.026
1	FDAS:Average	1	0	62	62	0	121.2	12.41	12.46	12.38	0.026
1	FDAS:Average	1	0	82	82	0	122.5	12.5	12.55	12.43	0.0299
1	FDAS:Average	1	0	102	102	0	124.1	12.55	12.64	12.5	0.0299
1	FDAS:Average	1	0	122	122	0	124.9	12.6	12.65	12.57	0.024
1	FDAS:Average	1	0	142	142	0	125.4	12.65	12.67	12.6	0.026
1	FDAS:Average	1	0	162	162	0	124.1	12.55	12.61	12.53	0.026
1	FDAS:Average	1	0	183	183	0	123.7	12.57	12.57	12.53	0.014
1	FDAS:Average	2	6	0	0	0	123.2	12.52	12.55	12.5	0.018
1	FDAS:Average	2	6	21	21	0	123.4	12.53	12.57	12.5	0.026
1	FDAS:Average	2	6	42	42	0	121.1	12.41	12.48	12.35	0.0299
1	FDAS:Average	2	6	62	62	0	121.2	12.43	12.46	12.38	0.026
1	FDAS:Average	2	6	82	82	0	121.7	12.46	12.5	12.4	0.028
1	FDAS:Average	2	6	102	102	0	121.3	12.41	12.46	12.4	0.0199
1	FDAS:Average	2	6	122	122	0	123.2	12.52	12.57	12.48	0.026
1	FDAS:Average	2	6	142	142	0	124.4	12.6	12.65	12.52	0.032
1	FDAS:Average	2	6	162	162	0	126.1	12.65	12.73	12.61	0.034
1	FDAS:Average	2	6	182	182	0	125.1	12.61	12.67	12.57	0.026
1	FDAS:Average	3	12	0	0	0	120.9	12.41	12.46	12.35	0.028
1	FDAS:Average	3	12	20	20	0	120.6	12.41	12.43	12.35	0.026
1	FDAS:Average	3	12	42	42	0	121.6	12.43	12.48	12.41	0.0199
1	FDAS:Average	3	12	62	62	0	125.1	12.61	12.69	12.55	0.0379
1	FDAS:Average	3	12	82	82	0	125.2	12.64	12.65	12.6	0.0219
1	FDAS:Average	3	12	102	102	0	124	12.55	12.61	12.52	0.026
1	FDAS:Average	3	12	122	122	0	124.1	12.6	12.61	12.53	0.024
1	FDAS:Average	3	12	142	142	0	126.3	12.67	12.72	12.64	0.018
1	FDAS:Average	3	12	162	162	0	127.4	12.73	12.78	12.69	0.0219
1	FDAS:Average	3	12	183	183	0	124.5	12.61	12.65	12.53	0.0299
1	FDAS:Average	4	18	0	0	0	118.5	12.29	12.31	12.26	0.018
1	FDAS:Average	4	18	21	21	0	118.2	12.28	12.31	12.23	0.026
1	FDAS:Average	4	18	42	42	0	119.5	12.31	12.41	12.26	0.0399
1	FDAS:Average	4	18	62	62	0	119.7	12.35	12.38	12.31	0.018
1	FDAS:Average	4	18	82	82	0	120.9	12.41	12.46	12.35	0.026
1	FDAS:Average	4	18	102	102	0	121.3	12.41	12.48	12.38	0.0219
1	FDAS:Average	4	18	122	122	0	121.4	12.41	12.52	12.35	0.0399
1	FDAS:Average	4	18	142	142	0	123.4	12.53	12.57	12.5	0.024
1	FDAS:Average	4	18	162	162	0	125.7	12.67	12.69	12.61	0.0219
1	FDAS:Average	4	18	183	183	0	122.2	12.48	12.52	12.43	0.024
1	FDAS:Average	5	24	0	0	0	121.7	12.43	12.5	12.4	0.0299
1	FDAS:Average	5	24	20	20	0	120.5	12.38	12.43	12.34	0.028
1	FDAS:Average	5	24	42	42	0	116.9	12.22	12.23	12.17	0.018
1	FDAS:Average	5	24	62	62	0	117.3	12.19	12.28	12.16	0.0299
1	FDAS:Average	5	24	82	82	0	123.4	12.52	12.57	12.5	0.0219
1	FDAS:Average	5	24	102	102	0	126.5	12.69	12.73	12.65	0.0199
1	FDAS:Average	5	24	122	122	0	122.3	12.48	12.53	12.43	0.024
1	FDAS:Average	5	24	142	142	0	124.9	12.61	12.69	12.53	0.0399
1	FDAS:Average	5	24	162	162	0	132.9	13.02	13.1	12.92	0.046
1	FDAS:Average	5	24	183	183	0	131.7	12.93	13	12.9	0.032
1	FDAS:Average	6	30	0	0	0	117.2	12.22	12.26	12.17	0.024
1	FDAS:Average	6	30	21	21	0	117.2	12.19	12.26	12.17	0.024
1	FDAS:Average	6	30	42	42	0	117.5	12.26	12.29	12.17	0.032
1	FDAS:Average	6	30	62	62	0	122.5	12.5	12.55	12.43	0.036
1	FDAS:Average	6	30	82	82	0	126.7	12.67	12.76	12.64	0.0299
1	FDAS:Average	6	30	101	101	0	123.4	12.52	12.57	12.5	0.024
1	FDAS:Average	6	30	122	122	0	122	12.48	12.53	12.4	0.0379
1	FDAS:Average	6	30	142	142	0	120.3	12.4	12.41	12.34	0.024
1	FDAS:Average	6	30	162	162	0	121	12.4	12.48	12.34	0.0399
1	FDAS:Average	6	30	183	183	0	120	12.35	12.41	12.31	0.032
1	FDAS:Average	7	36	0	0	0	116.6	12.19	12.23	12.14	0.026
1	FDAS:Average	7	36	20	20	0	116.9	12.22	12.26	12.14	0.0399
1	FDAS:Average	7	36	42	42	0	119.4	12.34	12.38	12.28	0.026
1	FDAS:Average	7	36	62	62	0	121.7	12.43	12.5	12.4	0.032
1	FDAS:Average	7	36	82	82	0	121.5	12.46	12.48	12.4	0.0299
1	FDAS:Average	7	36	102	102	0	122	12.46	12.5	12.43	0.0219
1	FDAS:Average	7	36	122	122	0	122	12.46	12.5	12.43	0.0219
1	FDAS:Average	7	36	142	142	0	119.9	12.35	12.4	12.31	0.026
1	FDAS:Average	7	36	162	162	0	121.6	12.43	12.48	12.41	0.016
1	FDAS:Average	7	36	183	183	0	120.9	12.41	12.46	12.35	0.0219
1	FDAS:Average	8	42	0	0	0	118.5	12.29	12.31	12.26	0.018
1	FDAS:Average	8	42	21	21	0	118.2	12.28	12.31	12.23	0.028
1	FDAS:Average	8	42	42	42	0	116.2	12.17	12.22	12.11	0.0299
1	FDAS:Average	8	42	62	62	0	117.5	12.26	12.29	12.17	0.036
1	FDAS:Average	8	42	82	82	0	119.4	12.34	12.38	12.28	0.026
1	FDAS:Average	8	42	102	102	0	120.8	12.41	12.46	12.34	0.034

Appendix E: Dia-stron Dimensional Report for Slice Importance

1 FDAS:Average	8	42	122	122	0	123.2	12.53	12.57	12.48	0.0219
1 FDAS:Average	8	42	142	142	0	121.7	12.43	12.5	12.4	0.0299
1 FDAS:Average	8	42	162	162	0	121.5	12.41	12.48	12.4	0.0219
1 FDAS:Average	8	42	183	183	0	123.2	12.53	12.55	12.5	0.024
1 FDAS:Average	9	48	0	0	0	116.2	12.17	12.19	12.14	0.0199
1 FDAS:Average	9	48	20	20	0	115.9	12.17	12.19	12.11	0.024
1 FDAS:Average	9	48	42	42	0	115.9	12.16	12.19	12.11	0.0219
1 FDAS:Average	9	48	62	62	0	117.6	12.23	12.28	12.19	0.0219
1 FDAS:Average	9	48	82	82	0	119.4	12.34	12.38	12.28	0.028
1 FDAS:Average	9	48	102	102	0	120.9	12.41	12.46	12.35	0.028
1 FDAS:Average	9	48	122	122	0	122.2	12.48	12.52	12.43	0.024
1 FDAS:Average	9	48	142	142	0	120.4	12.38	12.41	12.35	0.024
1 FDAS:Average	9	48	162	162	0	121.7	12.46	12.5	12.4	0.036
1 FDAS:Average	9	48	183	183	0	121.6	12.43	12.48	12.41	0.0219
1 FDAS:Average	10	54	0	0	0	114.9	12.07	12.16	12.03	0.034
1 FDAS:Average	10	54	21	21	0	114.6	12.1	12.16	12	0.0439
1 FDAS:Average	10	54	42	42	0	116.9	12.19	12.26	12.14	0.0299
1 FDAS:Average	10	54	62	62	0	118.9	12.29	12.35	12.26	0.026
1 FDAS:Average	10	54	82	82	0	122.2	12.48	12.52	12.43	0.026
1 FDAS:Average	10	54	102	102	0	124.1	12.55	12.64	12.5	0.0439
1 FDAS:Average	10	54	122	122	0	123.6	12.53	12.57	12.52	0.024
1 FDAS:Average	10	54	142	142	0	122.5	12.46	12.55	12.43	0.032
1 FDAS:Average	10	54	162	162	0	120.6	12.4	12.43	12.35	0.026
1 FDAS:Average	10	54	183	183	0	118.7	12.31	12.31	12.28	0.016
1 FDAS:Average	11	60	0	0	0	115.3	12.11	12.16	12.07	0.028
1 FDAS:Average	11	60	20	20	0	114.9	12.11	12.16	12.03	0.036
1 FDAS:Average	11	60	42	42	0	114.9	12.1	12.14	12.05	0.024
1 FDAS:Average	11	60	62	62	0	118.1	12.28	12.31	12.22	0.0299
1 FDAS:Average	11	60	82	82	0	124.6	12.57	12.64	12.55	0.0219
1 FDAS:Average	11	60	102	102	0	129.2	12.84	12.86	12.79	0.018
1 FDAS:Average	11	60	122	122	0	132.8	13.02	13.03	12.98	0.018
1 FDAS:Average	11	60	142	142	0	130.6	12.9	12.93	12.86	0.0219
1 FDAS:Average	11	60	162	162	0	124.7	12.57	12.65	12.55	0.028
1 FDAS:Average	11	60	183	183	0	119.7	12.38	12.4	12.29	0.032
1 FDAS:Average	12	66	0	0	0	114.7	12.1	12.14	12.03	0.0299
1 FDAS:Average	12	66	21	21	0	115.1	12.1	12.16	12.05	0.026
1 FDAS:Average	12	66	42	42	0	116.6	12.19	12.23	12.14	0.0299
1 FDAS:Average	12	66	62	62	0	122.1	12.48	12.53	12.41	0.0299
1 FDAS:Average	12	66	82	82	0	122.1	12.46	12.53	12.41	0.036
1 FDAS:Average	12	66	102	102	0	118.5	12.26	12.35	12.22	0.036
1 FDAS:Average	12	66	122	122	0	117.4	12.23	12.28	12.17	0.028
1 FDAS:Average	12	66	142	142	0	116.2	12.16	12.23	12.1	0.0379
1 FDAS:Average	12	66	162	162	0	115.4	12.11	12.19	12.05	0.034
1 FDAS:Average	12	66	183	183	0	117.4	12.23	12.29	12.16	0.034
1 FDAS:Average	13	72	0	0	0	115.3	12.11	12.16	12.07	0.026
1 FDAS:Average	13	72	20	20	0	116.1	12.16	12.22	12.1	0.0299
1 FDAS:Average	13	72	43	43	0	118.6	12.29	12.35	12.23	0.0399
1 FDAS:Average	13	72	62	62	0	125.5	12.64	12.67	12.61	0.018
1 FDAS:Average	13	72	82	82	0	141.6	13.43	13.46	13.39	0.0219
1 FDAS:Average	13	72	102	102	0	144.8	13.55	13.61	13.55	0.0199
1 FDAS:Average	13	72	122	122	0	136.9	13.19	13.26	13.15	0.028
1 FDAS:Average	13	72	142	142	0	124.6	12.6	12.67	12.52	0.046
1 FDAS:Average	13	72	162	162	0	118.1	12.28	12.34	12.19	0.036
1 FDAS:Average	13	72	183	183	0	116.2	12.17	12.19	12.14	0.018
1 FDAS:Average	14	78	0	0	0	114.6	12.1	12.11	12.05	0.0219
1 FDAS:Average	14	78	21	21	0	115.9	12.17	12.19	12.11	0.026
1 FDAS:Average	14	78	42	42	0	131.3	12.92	13.02	12.84	0.0419
1 FDAS:Average	14	78	62	62	0	139.9	13.36	13.39	13.3	0.026
1 FDAS:Average	14	78	82	82	0	140.9	13.39	13.43	13.36	0.026
1 FDAS:Average	14	78	102	102	0	139.2	13.34	13.36	13.27	0.026
1 FDAS:Average	14	78	122	122	0	129.3	12.84	12.88	12.78	0.024
1 FDAS:Average	14	78	142	142	0	118.9	12.29	12.35	12.26	0.024
1 FDAS:Average	14	78	162	162	0	117.2	12.19	12.26	12.17	0.028
1 FDAS:Average	14	78	183	183	0	117.1	12.22	12.26	12.16	0.028
1 FDAS:Average	15	84	0	0	0	126.8	12.69	12.76	12.65	0.026
1 FDAS:Average	15	84	20	20	0	125.9	12.67	12.72	12.6	0.032
1 FDAS:Average	15	84	42	42	0	123	12.5	12.57	12.46	0.034
1 FDAS:Average	15	84	62	62	0	128.3	12.78	12.84	12.72	0.032
1 FDAS:Average	15	84	82	82	0	126.3	12.67	12.72	12.64	0.026
1 FDAS:Average	15	84	102	102	0	122.8	12.52	12.6	12.41	0.0419
1 FDAS:Average	15	84	122	122	0	122.3	12.5	12.53	12.43	0.028
1 FDAS:Average	15	84	142	142	0	120.5	12.41	12.43	12.34	0.026
1 FDAS:Average	15	84	162	162	0	120.8	12.41	12.46	12.34	0.0299
1 FDAS:Average	15	84	183	183	0	125.2	12.64	12.65	12.6	0.0219
1 FDAS:Average	16	90	0	0	0	119.8	12.35	12.41	12.29	0.032
1 FDAS:Average	16	90	21	21	0	119.5	12.35	12.38	12.29	0.0219
1 FDAS:Average	16	90	42	42	0	120.5	12.4	12.43	12.34	0.0299
1 FDAS:Average	16	90	62	62	0	130.9	12.9	12.96	12.86	0.0219
1 FDAS:Average	16	90	82	82	0	138.6	13.3	13.34	13.23	0.026
1 FDAS:Average	16	90	102	102	0	131.1	12.93	12.98	12.86	0.036
1 FDAS:Average	16	90	122	122	0	127.1	12.72	12.79	12.65	0.0299

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1 FDAS:Average	16	90	142	142	0	127	12.69	12.76	12.67	0.0219
1 FDAS:Average	16	90	162	162	0	123.3	12.52	12.6	12.46	0.036
1 FDAS:Average	16	90	183	183	0	121.1	12.4	12.5	12.34	0.0439
1 FDAS:Average	17	96	0	0	0	124.1	12.57	12.61	12.53	0.024
1 FDAS:Average	17	96	20	20	0	124.9	12.64	12.65	12.57	0.0299
1 FDAS:Average	17	96	42	42	0	130.9	12.92	12.96	12.86	0.026
1 FDAS:Average	17	96	62	62	0	135.8	13.15	13.19	13.11	0.0199
1 FDAS:Average	17	96	82	82	0	137.6	13.23	13.3	13.17	0.0299
1 FDAS:Average	17	96	102	102	0	133.9	13.07	13.11	13	0.034
1 FDAS:Average	17	96	122	122	0	131.3	12.96	12.96	12.9	0.0219
1 FDAS:Average	17	96	142	142	0	127.5	12.78	12.79	12.69	0.034
1 FDAS:Average	17	96	162	162	0	124.1	12.6	12.61	12.53	0.028
1 FDAS:Average	17	96	182	182	0	124	12.57	12.61	12.52	0.032
2 FDAS:Average	1	0	0	0	892	120	12.38	12.41	12.31	0.024
2 FDAS:Average	1	0	20	20	892	120	12.35	12.41	12.31	0.026
2 FDAS:Average	1	0	42	42	892	119.5	12.35	12.38	12.29	0.028
2 FDAS:Average	1	0	62	62	892	120	12.35	12.41	12.31	0.0299
2 FDAS:Average	1	0	82	82	892	123.2	12.52	12.57	12.48	0.032
2 FDAS:Average	1	0	102	102	892	124.7	12.61	12.65	12.55	0.028
2 FDAS:Average	1	0	122	122	892	125.2	12.61	12.65	12.6	0.0199
2 FDAS:Average	1	0	142	142	892	124.3	12.6	12.64	12.52	0.032
2 FDAS:Average	1	0	163	163	892	124.3	12.57	12.61	12.55	0.0199
2 FDAS:Average	1	0	183	183	892	123.2	12.53	12.57	12.48	0.0219
2 FDAS:Average	2	10	0	0	892	122.5	12.5	12.55	12.43	0.036
2 FDAS:Average	2	10	21	21	892	121.7	12.46	12.5	12.4	0.0299
2 FDAS:Average	2	10	43	43	892	121.3	12.43	12.48	12.38	0.026
2 FDAS:Average	2	10	62	62	892	122.5	12.5	12.52	12.46	0.014
2 FDAS:Average	2	10	82	82	892	124	12.57	12.61	12.52	0.032
2 FDAS:Average	2	10	102	102	892	124.4	12.57	12.64	12.53	0.028
2 FDAS:Average	2	10	122	122	892	123.7	12.55	12.57	12.53	0.016
2 FDAS:Average	2	10	142	142	892	126.3	12.65	12.72	12.64	0.018
2 FDAS:Average	2	10	162	162	892	130.1	12.88	12.9	12.84	0.024
2 FDAS:Average	2	10	182	182	892	127.2	12.73	12.78	12.67	0.028
2 FDAS:Average	3	20	0	0	892	118	12.26	12.29	12.22	0.024
2 FDAS:Average	3	20	20	20	892	118.1	12.26	12.31	12.22	0.026
2 FDAS:Average	3	20	42	42	892	118.8	12.31	12.34	12.26	0.0199
2 FDAS:Average	3	20	62	62	892	120.5	12.38	12.43	12.34	0.0299
2 FDAS:Average	3	20	82	82	892	121.6	12.46	12.48	12.41	0.016
2 FDAS:Average	3	20	102	102	892	121.3	12.41	12.46	12.4	0.018
2 FDAS:Average	3	20	122	122	892	121.5	12.43	12.48	12.4	0.026
2 FDAS:Average	3	20	142	142	892	125.8	12.65	12.86	12.46	0.1199
2 FDAS:Average	3	20	162	162	892	127.9	12.76	12.79	12.73	0.018
2 FDAS:Average	3	20	182	182	892	123	12.53	12.55	12.48	0.0219
2 FDAS:Average	4	30	0	0	892	116.2	12.17	12.22	12.11	0.024
2 FDAS:Average	4	30	21	21	892	116.2	12.17	12.22	12.11	0.036
2 FDAS:Average	4	30	43	43	892	115.8	12.16	12.19	12.1	0.028
2 FDAS:Average	4	30	62	62	892	117.2	12.19	12.26	12.17	0.026
2 FDAS:Average	4	30	82	82	892	122.3	12.48	12.53	12.43	0.0299
2 FDAS:Average	4	30	102	102	892	128.5	12.81	12.86	12.72	0.0399
2 FDAS:Average	4	30	122	122	892	129.3	12.84	12.88	12.78	0.0299
2 FDAS:Average	4	30	142	142	892	124	12.53	12.61	12.52	0.024
2 FDAS:Average	4	30	162	162	892	122.3	12.48	12.53	12.43	0.0299
2 FDAS:Average	4	30	183	183	892	121.2	12.43	12.46	12.38	0.0199
2 FDAS:Average	5	40	0	0	892	121.7	12.43	12.5	12.4	0.0299
2 FDAS:Average	5	40	20	20	892	121.5	12.43	12.48	12.4	0.0219
2 FDAS:Average	5	40	43	43	892	120.6	12.4	12.43	12.35	0.0199
2 FDAS:Average	5	40	62	62	892	120.6	12.38	12.43	12.35	0.024
2 FDAS:Average	5	40	82	82	892	121	12.4	12.48	12.34	0.0399
2 FDAS:Average	5	40	102	102	892	122.2	12.48	12.52	12.43	0.028
2 FDAS:Average	5	40	122	122	892	122.6	12.48	12.53	12.46	0.024
2 FDAS:Average	5	40	142	142	892	121.7	12.43	12.5	12.4	0.0299
2 FDAS:Average	5	40	162	162	892	123.2	12.53	12.55	12.5	0.0199
2 FDAS:Average	5	40	182	182	892	125.4	12.64	12.67	12.6	0.024
2 FDAS:Average	6	50	0	0	892	117.7	12.23	12.29	12.19	0.028
2 FDAS:Average	6	50	21	21	892	117.7	12.23	12.31	12.17	0.0419
2 FDAS:Average	6	50	42	42	892	117.5	12.23	12.29	12.17	0.028
2 FDAS:Average	6	50	62	62	892	118.2	12.29	12.38	12.16	0.0619
2 FDAS:Average	6	50	82	82	892	119.7	12.35	12.4	12.29	0.032
2 FDAS:Average	6	50	102	102	892	122	12.48	12.52	12.41	0.034
2 FDAS:Average	6	50	122	122	892	122.3	12.48	12.53	12.43	0.036
2 FDAS:Average	6	50	142	142	892	125.6	12.64	12.72	12.57	0.0379
2 FDAS:Average	6	50	162	162	892	125.9	12.67	12.72	12.6	0.032
2 FDAS:Average	6	50	183	183	892	123.7	12.53	12.6	12.5	0.028
2 FDAS:Average	7	60	0	0	892	115.7	12.14	12.17	12.1	0.024
2 FDAS:Average	7	60	20	20	892	116.6	12.17	12.26	12.11	0.032
2 FDAS:Average	7	60	43	43	892	120.2	12.38	12.43	12.31	0.034
2 FDAS:Average	7	60	62	62	892	121.5	12.43	12.5	12.38	0.032
2 FDAS:Average	7	60	82	82	892	128.4	12.79	12.81	12.76	0.024
2 FDAS:Average	7	60	102	102	892	129.5	12.86	12.9	12.78	0.032
2 FDAS:Average	7	60	122	122	892	124.7	12.61	12.67	12.53	0.0419
2 FDAS:Average	7	60	142	142	892	123.4	12.53	12.57	12.5	0.026

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2 FDAS:Average	7	60	162	162	892	120.5	12.41	12.46	12.31	0.036
2 FDAS:Average	7	60	183	183	892	119.1	12.34	12.35	12.28	0.024
2 FDAS:Average	8	70	0	0	892	115.2	12.11	12.17	12.05	0.034
2 FDAS:Average	8	70	21	21	892	115.6	12.14	12.19	12.07	0.0299
2 FDAS:Average	8	70	42	42	892	119.1	12.29	12.35	12.28	0.024
2 FDAS:Average	8	70	62	62	892	126.8	12.72	12.76	12.65	0.036
2 FDAS:Average	8	70	82	82	892	124.6	12.57	12.64	12.55	0.028
2 FDAS:Average	8	70	102	102	892	118.9	12.31	12.35	12.26	0.028
2 FDAS:Average	8	70	122	122	892	118.2	12.28	12.31	12.23	0.0199
2 FDAS:Average	8	70	142	142	892	115.9	12.17	12.19	12.11	0.028
2 FDAS:Average	8	70	162	162	892	115.6	12.14	12.19	12.07	0.034
2 FDAS:Average	8	70	183	183	892	117.7	12.23	12.29	12.19	0.028
2 FDAS:Average	9	80	0	0	892	114.9	12.07	12.16	12.03	0.034
2 FDAS:Average	9	80	20	20	892	115.4	12.1	12.17	12.07	0.032
2 FDAS:Average	9	80	42	42	892	127.8	12.78	12.79	12.72	0.0219
2 FDAS:Average	9	80	62	62	892	136.6	13.22	13.23	13.15	0.024
2 FDAS:Average	9	80	82	82	892	140.9	13.39	13.43	13.36	0.0219
2 FDAS:Average	9	80	102	102	892	143.7	13.51	13.57	13.48	0.028
2 FDAS:Average	9	80	122	122	892	132.5	12.98	13.02	12.96	0.018
2 FDAS:Average	9	80	142	142	892	118.6	12.31	12.35	12.23	0.034
2 FDAS:Average	9	80	162	162	892	118	12.23	12.29	12.22	0.026
2 FDAS:Average	9	80	183	183	892	116.8	12.22	12.23	12.16	0.0219
2 FDAS:Average	10	90	0	0	892	118.1	12.26	12.31	12.22	0.024
2 FDAS:Average	10	90	21	21	892	118.2	12.26	12.31	12.23	0.026
2 FDAS:Average	10	90	43	43	892	122.8	12.52	12.53	12.48	0.016
2 FDAS:Average	10	90	62	62	892	137.3	13.23	13.27	13.17	0.024
2 FDAS:Average	10	90	82	82	892	141.1	13.39	13.43	13.38	0.016
2 FDAS:Average	10	90	102	102	892	128.9	12.81	12.9	12.72	0.046
2 FDAS:Average	10	90	122	122	892	125.2	12.61	12.72	12.53	0.0499
2 FDAS:Average	10	90	142	142	892	124.4	12.6	12.64	12.53	0.026
2 FDAS:Average	10	90	162	162	892	120.8	12.4	12.46	12.34	0.0299
2 FDAS:Average	10	90	183	183	892	118.8	12.29	12.34	12.26	0.024
3 FDAS:Average	1	49	0	0	1487	119.2	12.31	12.38	12.26	0.034
3 FDAS:Average	1	49	20	20	1487	119.1	12.29	12.35	12.28	0.024
3 FDAS:Average	1	49	42	42	1487	118.9	12.29	12.35	12.26	0.026
3 FDAS:Average	1	49	62	62	1487	119	12.29	12.4	12.22	0.0399
3 FDAS:Average	1	49	82	82	1487	121	12.41	12.48	12.34	0.034
3 FDAS:Average	1	49	101	101	1487	121.7	12.43	12.5	12.4	0.028
3 FDAS:Average	1	49	122	122	1487	121.1	12.41	12.48	12.35	0.034
3 FDAS:Average	1	49	142	142	1487	120.3	12.4	12.41	12.34	0.024
3 FDAS:Average	1	49	162	162	1487	122	12.46	12.55	12.38	0.0399
3 FDAS:Average	1	49	183	183	1487	122.6	12.5	12.53	12.46	0.0219
4 FDAS:Average	1	0	0	0	1671	122.1	12.5	12.53	12.41	0.0299
4 FDAS:Average	1	0	20	20	1671	123.2	12.52	12.57	12.48	0.032
4 FDAS:Average	1	0	42	42	1671	122	12.48	12.5	12.43	0.018
4 FDAS:Average	1	0	62	62	1671	120.2	12.35	12.43	12.31	0.028
4 FDAS:Average	1	0	82	82	1671	122.8	12.52	12.55	12.46	0.024
4 FDAS:Average	1	0	102	102	1671	124	12.57	12.61	12.52	0.034
4 FDAS:Average	1	0	122	122	1671	124.9	12.61	12.65	12.57	0.024
4 FDAS:Average	1	0	142	142	1671	124.7	12.6	12.67	12.53	0.036
4 FDAS:Average	1	0	162	162	1671	124	12.55	12.61	12.52	0.026
4 FDAS:Average	1	0	183	183	1671	124.1	12.57	12.61	12.53	0.0219
4 FDAS:Average	2	24	0	0	1671	118.5	12.29	12.31	12.26	0.026
4 FDAS:Average	2	24	20	20	1671	117.9	12.26	12.28	12.22	0.026
4 FDAS:Average	2	24	42	42	1671	116.7	12.19	12.22	12.16	0.018
4 FDAS:Average	2	24	62	62	1671	117.6	12.23	12.28	12.19	0.0219
4 FDAS:Average	2	24	82	82	1671	127.5	12.76	12.79	12.69	0.0219
4 FDAS:Average	2	24	102	102	1671	132.1	12.96	13.02	12.92	0.028
4 FDAS:Average	2	24	122	122	1671	125.3	12.64	12.69	12.57	0.034
4 FDAS:Average	2	24	142	142	1671	122.1	12.48	12.53	12.41	0.0379
4 FDAS:Average	2	24	162	162	1671	127.4	12.76	12.78	12.69	0.026
4 FDAS:Average	2	24	182	182	1671	125.6	12.65	12.69	12.6	0.028
4 FDAS:Average	3	48	0	0	1671	118.2	12.29	12.31	12.23	0.0219
4 FDAS:Average	3	48	21	21	1671	118.5	12.29	12.34	12.23	0.026
4 FDAS:Average	3	48	42	42	1671	117.7	12.26	12.29	12.19	0.028
4 FDAS:Average	3	48	62	62	1671	118.2	12.26	12.31	12.23	0.0219
4 FDAS:Average	3	48	83	83	1671	120.5	12.4	12.43	12.34	0.0299
4 FDAS:Average	3	48	102	102	1671	122	12.48	12.52	12.41	0.036
4 FDAS:Average	3	48	122	122	1671	121.5	12.43	12.48	12.4	0.0219
4 FDAS:Average	3	48	142	142	1671	120.8	12.4	12.46	12.34	0.032
4 FDAS:Average	3	48	162	162	1671	121.7	12.46	12.5	12.4	0.026
4 FDAS:Average	3	48	183	183	1671	122	12.46	12.52	12.41	0.028
4 FDAS:Average	4	72	0	0	1671	116.8	12.19	12.23	12.16	0.026
4 FDAS:Average	4	72	20	20	1671	118.4	12.28	12.34	12.22	0.028
4 FDAS:Average	4	72	43	43	1671	122.7	12.52	12.57	12.43	0.034
4 FDAS:Average	4	72	62	62	1671	121.7	12.43	12.5	12.4	0.032
4 FDAS:Average	4	72	82	82	1671	129.8	12.86	12.9	12.81	0.0199
4 FDAS:Average	4	72	102	102	1671	137.8	13.23	13.3	13.19	0.028
4 FDAS:Average	4	72	122	122	1671	132.2	12.98	13.02	12.93	0.026
4 FDAS:Average	4	72	142	142	1671	121.5	12.43	12.48	12.4	0.0299
4 FDAS:Average	4	72	162	162	1671	117.4	12.23	12.28	12.17	0.034

4 FDAS:Average	4	72	183	183	1671	117.2	12.22	12.26	12.17	0.0219
4 FDAS:Average	5	96	0	0	1671	122.8	12.52	12.55	12.46	0.0299
4 FDAS:Average	5	96	21	21	1671	124.4	12.57	12.64	12.53	0.0299
4 FDAS:Average	5	96	42	42	1671	131.7	12.98	13.02	12.88	0.0399
4 FDAS:Average	5	96	62	62	1671	142	13.43	13.5	13.39	0.032
4 FDAS:Average	5	96	82	82	1671	141.7	13.43	13.48	13.38	0.028
4 FDAS:Average	5	96	102	102	1671	130.9	12.92	12.98	12.84	0.0299
4 FDAS:Average	5	96	122	122	1671	127.3	12.73	12.79	12.67	0.028
4 FDAS:Average	5	96	142	142	1671	124.9	12.64	12.65	12.57	0.026
4 FDAS:Average	5	96	162	162	1671	123.2	12.52	12.57	12.48	0.032
4 FDAS:Average	5	96	183	183	1671	123.2	12.52	12.57	12.48	0.026
5 FDAS:Average	1	0	0	0	2167	123.7	12.53	12.6	12.5	0.0299
5 FDAS:Average	1	0	21	21	2167	124	12.53	12.61	12.52	0.024
5 FDAS:Average	1	0	42	42	2167	123	12.5	12.55	12.48	0.0199
5 FDAS:Average	1	0	62	62	2167	120.9	12.41	12.46	12.35	0.0299
5 FDAS:Average	1	0	82	82	2167	123	12.53	12.55	12.48	0.024
5 FDAS:Average	1	0	102	102	2167	124.5	12.57	12.65	12.53	0.034
5 FDAS:Average	1	0	122	122	2167	124.5	12.6	12.65	12.53	0.036
5 FDAS:Average	1	0	142	142	2167	124.9	12.6	12.65	12.57	0.026
5 FDAS:Average	1	0	162	162	2167	124	12.57	12.61	12.52	0.026
5 FDAS:Average	1	0	183	183	2167	123.9	12.55	12.6	12.52	0.0199
5 FDAS:Average	2	13	0	0	2167	118.5	12.29	12.31	12.26	0.018
5 FDAS:Average	2	13	20	20	2167	119.1	12.31	12.35	12.28	0.018
5 FDAS:Average	2	13	43	43	2167	119.6	12.34	12.4	12.28	0.0299
5 FDAS:Average	2	13	62	62	2167	120.3	12.4	12.46	12.29	0.0439
5 FDAS:Average	2	13	82	82	2167	123.2	12.52	12.55	12.5	0.018
5 FDAS:Average	2	13	102	102	2167	123.6	12.55	12.57	12.52	0.0199
5 FDAS:Average	2	13	122	122	2167	123.4	12.53	12.57	12.5	0.0299
5 FDAS:Average	2	13	142	142	2167	123.7	12.55	12.6	12.5	0.024
5 FDAS:Average	2	13	162	162	2167	124	12.57	12.61	12.52	0.0299
5 FDAS:Average	2	13	182	182	2167	121.1	12.41	12.48	12.35	0.032
5 FDAS:Average	3	26	0	0	2167	117.7	12.23	12.29	12.19	0.0299
5 FDAS:Average	3	26	21	21	2167	118.2	12.23	12.35	12.19	0.0379
5 FDAS:Average	3	26	42	42	2167	116.8	12.22	12.23	12.16	0.026
5 FDAS:Average	3	26	62	62	2167	117.4	12.26	12.28	12.17	0.026
5 FDAS:Average	3	26	82	82	2167	124.1	12.57	12.61	12.53	0.024
5 FDAS:Average	3	26	102	102	2167	130.8	12.92	12.93	12.88	0.018
5 FDAS:Average	3	26	122	122	2167	131.1	12.93	12.96	12.88	0.024
5 FDAS:Average	3	26	142	142	2167	124.1	12.57	12.61	12.53	0.0219
5 FDAS:Average	3	26	162	162	2167	121.5	12.43	12.48	12.4	0.024
5 FDAS:Average	3	26	182	182	2167	120.8	12.41	12.46	12.34	0.0399
5 FDAS:Average	4	39	0	0	2167	123.9	12.57	12.6	12.52	0.026
5 FDAS:Average	4	39	20	20	2167	124.1	12.55	12.64	12.5	0.0379
5 FDAS:Average	4	39	43	43	2167	120	12.38	12.43	12.29	0.032
5 FDAS:Average	4	39	62	62	2167	118.1	12.26	12.31	12.22	0.024
5 FDAS:Average	4	39	82	82	2167	120.3	12.4	12.41	12.34	0.024
5 FDAS:Average	4	39	102	102	2167	122.2	12.5	12.52	12.43	0.0219
5 FDAS:Average	4	39	122	122	2167	124.1	12.55	12.61	12.53	0.0199
5 FDAS:Average	4	39	142	142	2167	122	12.48	12.5	12.43	0.0219
5 FDAS:Average	4	39	162	162	2167	123.8	12.55	12.61	12.5	0.0299
5 FDAS:Average	4	39	183	183	2167	127.4	12.73	12.78	12.69	0.026
5 FDAS:Average	5	52	0	0	2167	115.4	12.11	12.17	12.07	0.024
5 FDAS:Average	5	52	21	21	2167	115.4	12.14	12.17	12.07	0.026
5 FDAS:Average	5	52	42	42	2167	116.8	12.19	12.22	12.17	0.016
5 FDAS:Average	5	52	62	62	2167	119.2	12.31	12.38	12.26	0.032
5 FDAS:Average	5	52	82	82	2167	122.6	12.52	12.53	12.46	0.026
5 FDAS:Average	5	52	102	102	2167	125.7	12.65	12.69	12.61	0.024
5 FDAS:Average	5	52	122	122	2167	126.4	12.67	12.73	12.64	0.026
5 FDAS:Average	5	52	142	142	2167	122	12.46	12.52	12.41	0.026
5 FDAS:Average	5	52	162	162	2167	119.1	12.29	12.35	12.28	0.0299
5 FDAS:Average	5	52	182	182	2167	118.9	12.29	12.38	12.23	0.034
5 FDAS:Average	6	65	0	0	2167	114.9	12.1	12.14	12.05	0.026
5 FDAS:Average	6	65	20	20	2167	114.9	12.11	12.14	12.05	0.024
5 FDAS:Average	6	65	42	42	2167	116.9	12.19	12.26	12.14	0.032
5 FDAS:Average	6	65	62	62	2167	121.5	12.43	12.48	12.4	0.0199
5 FDAS:Average	6	65	82	82	2167	121.3	12.43	12.48	12.38	0.024
5 FDAS:Average	6	65	102	102	2167	118	12.26	12.29	12.22	0.0219
5 FDAS:Average	6	65	122	122	2167	117.6	12.23	12.31	12.16	0.0379
5 FDAS:Average	6	65	142	142	2167	115.8	12.16	12.19	12.1	0.036
5 FDAS:Average	6	65	162	162	2167	115.2	12.11	12.17	12.05	0.034
5 FDAS:Average	6	65	183	183	2167	117.4	12.26	12.28	12.17	0.032
5 FDAS:Average	7	78	0	0	2167	114.4	12.1	12.11	12.03	0.0199
5 FDAS:Average	7	78	21	21	2167	116.2	12.16	12.22	12.11	0.032
5 FDAS:Average	7	78	43	43	2167	133.2	13.02	13.07	12.98	0.034
5 FDAS:Average	7	78	62	62	2167	141.9	13.43	13.46	13.42	0.016
5 FDAS:Average	7	78	82	82	2167	138.6	13.27	13.31	13.26	0.0219
5 FDAS:Average	7	78	102	102	2167	131.5	12.93	13	12.88	0.034
5 FDAS:Average	7	78	122	122	2167	125.6	12.64	12.69	12.6	0.0299
5 FDAS:Average	7	78	142	142	2167	117.7	12.23	12.29	12.19	0.032
5 FDAS:Average	7	78	162	162	2167	116.6	12.17	12.23	12.14	0.026
5 FDAS:Average	7	78	183	183	2167	116.9	12.22	12.23	12.17	0.018

5 FDAS:Average	8	91	0	0	2167	119.4	12.31	12.38	12.28	0.026
5 FDAS:Average	8	91	20	20	2167	119.4	12.34	12.38	12.28	0.028
5 FDAS:Average	8	91	42	42	2167	120.2	12.38	12.4	12.34	0.018
5 FDAS:Average	8	91	62	62	2167	130.6	12.9	12.98	12.81	0.0439
5 FDAS:Average	8	91	82	82	2167	138.1	13.26	13.3	13.22	0.026
5 FDAS:Average	8	91	102	102	2167	130.7	12.88	12.96	12.84	0.028
5 FDAS:Average	8	91	122	122	2167	127	12.69	12.78	12.65	0.032
5 FDAS:Average	8	91	142	142	2167	126.4	12.69	12.76	12.61	0.0399
5 FDAS:Average	8	91	162	162	2167	123.4	12.52	12.57	12.5	0.0219
5 FDAS:Average	8	91	183	183	2167	121.1	12.41	12.48	12.35	0.032
6 FDAS:Average	1	0	0	0	2666	121.4	12.46	12.46	12.41	0.018
6 FDAS:Average	1	0	20	20	2666	121.8	12.46	12.5	12.41	0.0219
6 FDAS:Average	1	0	42	42	2666	121.2	12.4	12.46	12.38	0.0199
6 FDAS:Average	1	0	62	62	2666	120.7	12.4	12.48	12.31	0.046
6 FDAS:Average	1	0	82	82	2666	124.1	12.6	12.61	12.53	0.026
6 FDAS:Average	1	0	102	102	2666	125.4	12.61	12.72	12.55	0.0419
6 FDAS:Average	1	0	122	122	2666	123.2	12.52	12.57	12.48	0.026
6 FDAS:Average	1	0	142	142	2666	123.5	12.55	12.6	12.48	0.028
6 FDAS:Average	1	0	162	162	2666	123.4	12.55	12.57	12.5	0.026
6 FDAS:Average	1	0	183	183	2666	123	12.5	12.55	12.48	0.0199
6 FDAS:Average	2	48	0	0	2666	116.6	12.19	12.23	12.14	0.032
6 FDAS:Average	2	48	21	21	2666	116.6	12.17	12.23	12.14	0.026
6 FDAS:Average	2	48	43	43	2666	116.2	12.14	12.23	12.1	0.046
6 FDAS:Average	2	48	62	62	2666	118.4	12.26	12.34	12.22	0.032
6 FDAS:Average	2	48	82	82	2666	121.2	12.41	12.46	12.38	0.028
6 FDAS:Average	2	48	102	102	2666	125.2	12.64	12.65	12.6	0.018
6 FDAS:Average	2	48	122	122	2666	125.7	12.65	12.69	12.61	0.0199
6 FDAS:Average	2	48	142	142	2666	121.7	12.43	12.5	12.4	0.032
6 FDAS:Average	2	48	162	162	2666	120.3	12.38	12.41	12.34	0.026
6 FDAS:Average	2	48	183	183	2666	120.6	12.41	12.43	12.35	0.0219
6 FDAS:Average	3	96	0	0	2666	120.9	12.43	12.46	12.35	0.032
6 FDAS:Average	3	96	20	20	2666	121.3	12.43	12.48	12.38	0.024
6 FDAS:Average	3	96	42	42	2666	126	12.67	12.69	12.64	0.024
6 FDAS:Average	3	96	62	62	2666	138.5	13.27	13.34	13.22	0.034
6 FDAS:Average	3	96	82	82	2666	144	13.55	13.6	13.48	0.032
6 FDAS:Average	3	96	102	102	2666	136.1	13.17	13.23	13.1	0.0379
6 FDAS:Average	3	96	122	122	2666	131.5	12.93	12.98	12.9	0.028
6 FDAS:Average	3	96	142	142	2666	127.2	12.73	12.78	12.67	0.026
6 FDAS:Average	3	96	162	162	2666	121.3	12.41	12.48	12.38	0.028
6 FDAS:Average	3	96	183	183	2666	121.2	12.43	12.46	12.38	0.026
7 FDAS:Average	1	0	0	0	2969	122	12.48	12.52	12.41	0.026
7 FDAS:Average	1	0	20	20	2969	122.5	12.5	12.52	12.46	0.016
7 FDAS:Average	1	0	42	42	2969	121.8	12.48	12.5	12.41	0.026
7 FDAS:Average	1	0	62	62	2969	120.4	12.4	12.41	12.35	0.014
7 FDAS:Average	1	0	82	82	2969	123	12.53	12.55	12.48	0.0199
7 FDAS:Average	1	0	102	102	2969	124.7	12.61	12.65	12.55	0.028
7 FDAS:Average	1	0	122	122	2969	124.9	12.64	12.65	12.57	0.026
7 FDAS:Average	1	0	142	142	2969	125.6	12.65	12.69	12.6	0.028
7 FDAS:Average	1	0	162	162	2969	124.1	12.57	12.64	12.5	0.032
7 FDAS:Average	1	0	183	183	2969	123.9	12.57	12.6	12.52	0.0219
7 FDAS:Average	2	5	0	0	2969	123.5	12.53	12.6	12.48	0.034
7 FDAS:Average	2	5	21	21	2969	123.2	12.53	12.55	12.5	0.024
7 FDAS:Average	2	5	42	42	2969	120.6	12.41	12.43	12.35	0.024
7 FDAS:Average	2	5	62	62	2969	121.1	12.41	12.43	12.4	0.014
7 FDAS:Average	2	5	82	82	2969	122.2	12.48	12.52	12.43	0.024
7 FDAS:Average	2	5	102	102	2969	121.9	12.46	12.52	12.4	0.032
7 FDAS:Average	2	5	122	122	2969	123	12.53	12.6	12.43	0.034
7 FDAS:Average	2	5	142	142	2969	124.5	12.6	12.65	12.53	0.028
7 FDAS:Average	2	5	162	162	2969	126.4	12.67	12.73	12.64	0.0299
7 FDAS:Average	2	5	183	183	2969	127.2	12.72	12.78	12.67	0.0299
7 FDAS:Average	3	10	0	0	2969	124.9	12.61	12.65	12.57	0.024
7 FDAS:Average	3	10	20	20	2969	125.1	12.61	12.67	12.57	0.0219
7 FDAS:Average	3	10	42	42	2969	124.6	12.6	12.64	12.55	0.018
7 FDAS:Average	3	10	62	62	2969	123.2	12.52	12.57	12.48	0.026
7 FDAS:Average	3	10	82	82	2969	122.3	12.48	12.53	12.43	0.024
7 FDAS:Average	3	10	102	102	2969	123.2	12.53	12.57	12.48	0.028
7 FDAS:Average	3	10	122	122	2969	124.4	12.6	12.64	12.53	0.026
7 FDAS:Average	3	10	142	142	2969	124.9	12.61	12.65	12.57	0.024
7 FDAS:Average	3	10	162	162	2969	128.3	12.79	12.84	12.72	0.032
7 FDAS:Average	3	10	183	183	2969	128.7	12.79	12.84	12.76	0.024
7 FDAS:Average	4	15	0	0	2969	118.2	12.28	12.31	12.23	0.018
7 FDAS:Average	4	15	21	21	2969	118.5	12.28	12.34	12.23	0.0299
7 FDAS:Average	4	15	42	42	2969	117.6	12.26	12.28	12.19	0.0199
7 FDAS:Average	4	15	62	62	2969	119.8	12.34	12.41	12.29	0.034
7 FDAS:Average	4	15	82	82	2969	123.1	12.53	12.69	12.35	0.136
7 FDAS:Average	4	15	102	102	2969	123.4	12.55	12.57	12.5	0.0219
7 FDAS:Average	4	15	122	122	2969	124.5	12.6	12.65	12.53	0.034
7 FDAS:Average	4	15	142	142	2969	125.4	12.64	12.67	12.6	0.0219
7 FDAS:Average	4	15	162	162	2969	125.6	12.64	12.69	12.6	0.0299
7 FDAS:Average	4	15	183	183	2969	122.5	12.5	12.55	12.43	0.0379
7 FDAS:Average	5	20	0	0	2969	117.9	12.26	12.28	12.22	0.018

7 FDAS:Average	5	20	20	20	2969	117.9	12.26	12.28	12.22	0.0199
7 FDAS:Average	5	20	42	42	2969	119.1	12.34	12.35	12.28	0.024
7 FDAS:Average	5	20	62	62	2969	122.8	12.5	12.55	12.46	0.026
7 FDAS:Average	5	20	82	82	2969	138.2	13.26	13.31	13.22	0.028
7 FDAS:Average	5	20	102	102	2969	142.8	13.48	13.51	13.46	0.0199
7 FDAS:Average	5	20	122	122	2969	131.7	13.03	13.11	12.79	0.094
7 FDAS:Average	5	20	142	142	2969	121.3	12.41	12.46	12.4	0.016
7 FDAS:Average	5	20	162	162	2969	123.6	12.55	12.57	12.52	0.0199
7 FDAS:Average	5	20	182	182	2969	121.2	12.43	12.46	12.38	0.024
7 FDAS:Average	6	25	0	0	2969	116.7	12.17	12.22	12.16	0.018
7 FDAS:Average	6	25	21	21	2969	116.8	12.22	12.23	12.16	0.0219
7 FDAS:Average	6	25	42	42	2969	117.4	12.19	12.28	12.17	0.024
7 FDAS:Average	6	25	62	62	2969	118.8	12.29	12.34	12.26	0.0219
7 FDAS:Average	6	25	82	82	2969	123.4	12.55	12.57	12.5	0.0219
7 FDAS:Average	6	25	102	102	2969	128.4	12.78	12.84	12.73	0.026
7 FDAS:Average	6	25	122	122	2969	127.5	12.72	12.79	12.69	0.028
7 FDAS:Average	6	25	142	142	2969	122.2	12.48	12.52	12.43	0.024
7 FDAS:Average	6	25	162	162	2969	120.6	12.41	12.43	12.35	0.0219
7 FDAS:Average	6	25	183	183	2969	120.3	12.38	12.41	12.34	0.0219
7 FDAS:Average	7	30	0	0	2969	116.7	12.17	12.22	12.16	0.018
7 FDAS:Average	7	30	20	20	2969	117.3	12.19	12.28	12.16	0.0379
7 FDAS:Average	7	30	43	43	2969	117.5	12.23	12.29	12.17	0.0379
7 FDAS:Average	7	30	62	62	2969	121.8	12.46	12.5	12.41	0.018
7 FDAS:Average	7	30	82	82	2969	126.7	12.69	12.76	12.64	0.0299
7 FDAS:Average	7	30	102	102	2969	124.1	12.53	12.64	12.5	0.0399
7 FDAS:Average	7	30	122	122	2969	122.2	12.46	12.52	12.43	0.024
7 FDAS:Average	7	30	142	142	2969	120.9	12.41	12.43	12.38	0.016
7 FDAS:Average	7	30	162	162	2969	120.6	12.4	12.43	12.35	0.028
7 FDAS:Average	7	30	183	183	2969	120.2	12.38	12.4	12.34	0.018
7 FDAS:Average	8	35	0	0	2969	115.9	12.16	12.19	12.11	0.028
7 FDAS:Average	8	35	21	21	2969	116.6	12.17	12.26	12.11	0.034
7 FDAS:Average	8	35	42	42	2969	118.6	12.29	12.35	12.23	0.026
7 FDAS:Average	8	35	62	62	2969	121.5	12.41	12.48	12.4	0.0219
7 FDAS:Average	8	35	82	82	2969	121.7	12.46	12.5	12.4	0.028
7 FDAS:Average	8	35	102	102	2969	122.8	12.52	12.55	12.46	0.026
7 FDAS:Average	8	35	122	122	2969	122.6	12.48	12.53	12.46	0.0219
7 FDAS:Average	8	35	142	142	2969	120.5	12.4	12.43	12.34	0.026
7 FDAS:Average	8	35	162	162	2969	121.7	12.46	12.5	12.4	0.028
7 FDAS:Average	8	35	182	182	2969	120.9	12.41	12.43	12.38	0.018
7 FDAS:Average	9	40	0	0	2969	122.1	12.46	12.53	12.41	0.032
7 FDAS:Average	9	40	20	20	2969	121.8	12.46	12.5	12.41	0.0219
7 FDAS:Average	9	40	43	43	2969	118.8	12.31	12.34	12.26	0.0199
7 FDAS:Average	9	40	62	62	2969	119.1	12.31	12.4	12.23	0.036
7 FDAS:Average	9	40	82	82	2969	120.2	12.35	12.4	12.34	0.0219
7 FDAS:Average	9	40	102	102	2969	122.2	12.48	12.52	12.43	0.018
7 FDAS:Average	9	40	122	122	2969	123.9	12.55	12.6	12.52	0.0219
7 FDAS:Average	9	40	142	142	2969	122.2	12.46	12.52	12.43	0.0199
7 FDAS:Average	9	40	162	162	2969	123	12.52	12.55	12.48	0.0199
7 FDAS:Average	9	40	182	182	2969	125.4	12.65	12.67	12.6	0.024
7 FDAS:Average	10	45	0	0	2969	118.8	12.29	12.34	12.26	0.0199
7 FDAS:Average	10	45	21	21	2969	118.1	12.28	12.31	12.22	0.0299
7 FDAS:Average	10	45	42	42	2969	116.2	12.17	12.22	12.11	0.0299
7 FDAS:Average	10	45	62	62	2969	119.1	12.31	12.35	12.28	0.026
7 FDAS:Average	10	45	82	82	2969	127	12.72	12.78	12.65	0.034
7 FDAS:Average	10	45	102	102	2969	133.4	13.03	13.11	12.96	0.036
7 FDAS:Average	10	45	122	122	2969	130.4	12.92	12.96	12.81	0.034
7 FDAS:Average	10	45	142	142	2969	124.3	12.57	12.64	12.52	0.0299
7 FDAS:Average	10	45	162	162	2969	123.2	12.52	12.57	12.48	0.0219
7 FDAS:Average	10	45	183	183	2969	123.2	12.53	12.57	12.48	0.028
7 FDAS:Average	11	50	0	0	2969	116.5	12.17	12.22	12.14	0.0219
7 FDAS:Average	11	50	20	20	2969	116.2	12.17	12.19	12.14	0.0219
7 FDAS:Average	11	50	42	42	2969	115.9	12.16	12.19	12.11	0.0219
7 FDAS:Average	11	50	62	62	2969	118	12.23	12.29	12.22	0.028
7 FDAS:Average	11	50	82	82	2969	120	12.38	12.43	12.29	0.0399
7 FDAS:Average	11	50	102	102	2969	122.5	12.52	12.55	12.43	0.0299
7 FDAS:Average	11	50	122	122	2969	122.5	12.48	12.55	12.43	0.036
7 FDAS:Average	11	50	142	142	2969	122	12.46	12.52	12.41	0.026
7 FDAS:Average	11	50	162	162	2969	121.5	12.43	12.48	12.4	0.026
7 FDAS:Average	11	50	182	182	2969	121.5	12.41	12.48	12.4	0.0219
7 FDAS:Average	12	55	0	0	2969	113.8	12.05	12.1	11.97	0.0379
7 FDAS:Average	12	55	21	21	2969	115.6	12.11	12.19	12.07	0.0299
7 FDAS:Average	12	55	43	43	2969	118.2	12.28	12.31	12.23	0.0219
7 FDAS:Average	12	55	62	62	2969	120.6	12.4	12.43	12.35	0.0199
7 FDAS:Average	12	55	82	82	2969	127.2	12.73	12.76	12.69	0.0219
7 FDAS:Average	12	55	102	102	2969	128	12.78	12.84	12.69	0.0399
7 FDAS:Average	12	55	122	122	2969	123.7	12.57	12.57	12.53	0.012
7 FDAS:Average	12	55	142	142	2969	122.6	12.52	12.53	12.46	0.024
7 FDAS:Average	12	55	162	162	2969	120.3	12.35	12.41	12.34	0.024
7 FDAS:Average	12	55	183	183	2969	118.4	12.29	12.34	12.22	0.0299
7 FDAS:Average	13	60	0	0	2969	115.1	12.1	12.16	12.05	0.0219
7 FDAS:Average	13	60	20	20	2969	114.2	12.05	12.1	12.02	0.018

7 FDAS:Average	13	60	43	43	2969	113.8	12.03	12.07	12	0.024
7 FDAS:Average	13	60	62	62	2969	117.6	12.22	12.31	12.16	0.0439
7 FDAS:Average	13	60	82	82	2969	126	12.67	12.81	12.52	0.086
7 FDAS:Average	13	60	102	102	2969	130.2	12.9	12.96	12.79	0.0399
7 FDAS:Average	13	60	122	122	2969	126.4	12.69	12.73	12.64	0.028
7 FDAS:Average	13	60	142	142	2969	120.6	12.41	12.43	12.35	0.0199
7 FDAS:Average	13	60	162	162	2969	119.9	12.34	12.43	12.28	0.0379
7 FDAS:Average	13	60	183	183	2969	119.1	12.29	12.35	12.28	0.0219
7 FDAS:Average	14	65	0	0	2969	114.8	12.1	12.16	12.02	0.0299
7 FDAS:Average	14	65	21	21	2969	115.3	12.1	12.16	12.07	0.0199
7 FDAS:Average	14	65	42	42	2969	115.9	12.17	12.19	12.11	0.024
7 FDAS:Average	14	65	62	62	2969	118.4	12.28	12.34	12.22	0.034
7 FDAS:Average	14	65	82	82	2969	120	12.38	12.41	12.31	0.028
7 FDAS:Average	14	65	102	102	2969	122	12.48	12.52	12.41	0.024
7 FDAS:Average	14	65	122	122	2969	121.8	12.46	12.5	12.41	0.0199
7 FDAS:Average	14	65	142	142	2969	119.5	12.34	12.38	12.29	0.0199
7 FDAS:Average	14	65	162	162	2969	116.6	12.19	12.26	12.11	0.034
7 FDAS:Average	14	65	183	183	2969	117.5	12.26	12.29	12.17	0.036
7 FDAS:Average	15	70	0	0	2969	118.5	12.29	12.34	12.23	0.028
7 FDAS:Average	15	70	20	20	2969	118.9	12.29	12.38	12.23	0.028
7 FDAS:Average	15	70	43	43	2969	118.1	12.28	12.29	12.23	0.0199
7 FDAS:Average	15	70	62	62	2969	126.4	12.72	12.73	12.64	0.0299
7 FDAS:Average	15	70	82	82	2969	137.8	13.23	13.3	13.19	0.034
7 FDAS:Average	15	70	102	102	2969	132.2	12.96	13.02	12.93	0.026
7 FDAS:Average	15	70	122	122	2969	126.7	12.69	12.79	12.61	0.0419
7 FDAS:Average	15	70	142	142	2969	128.3	12.78	12.84	12.72	0.028
7 FDAS:Average	15	70	162	162	2969	125.6	12.67	12.69	12.6	0.0299
7 FDAS:Average	15	70	183	183	2969	122	12.48	12.52	12.41	0.032
7 FDAS:Average	16	75	0	0	2969	115.6	12.14	12.16	12.1	0.0219
7 FDAS:Average	16	75	21	21	2969	115.3	12.11	12.16	12.07	0.0199
7 FDAS:Average	16	75	43	43	2969	118.5	12.28	12.34	12.23	0.026
7 FDAS:Average	16	75	62	62	2969	121.5	12.43	12.48	12.4	0.024
7 FDAS:Average	16	75	82	82	2969	132	12.93	13.05	12.88	0.0419
7 FDAS:Average	16	75	102	102	2969	142.5	13.48	13.51	13.43	0.0219
7 FDAS:Average	16	75	122	122	2969	132	12.96	13.03	12.9	0.0299
7 FDAS:Average	16	75	142	142	2969	118.6	12.29	12.35	12.23	0.032
7 FDAS:Average	16	75	162	162	2969	118.2	12.28	12.31	12.23	0.024
7 FDAS:Average	16	75	183	183	2969	118.2	12.26	12.31	12.23	0.024
7 FDAS:Average	17	80	0	0	2969	113.9	12.05	12.07	12.02	0.024
7 FDAS:Average	17	80	20	20	2969	113.8	12.03	12.07	12	0.032
7 FDAS:Average	17	80	42	42	2969	119.8	12.38	12.41	12.29	0.028
7 FDAS:Average	17	80	62	62	2969	123.9	12.55	12.6	12.52	0.026
7 FDAS:Average	17	80	82	82	2969	124.1	12.55	12.61	12.53	0.0219
7 FDAS:Average	17	80	102	102	2969	121.9	12.48	12.52	12.4	0.032
7 FDAS:Average	17	80	122	122	2969	121.2	12.43	12.46	12.38	0.024
7 FDAS:Average	17	80	142	142	2969	117.6	12.23	12.28	12.19	0.028
7 FDAS:Average	17	80	162	162	2969	115.6	12.16	12.19	12.07	0.032
7 FDAS:Average	17	80	183	183	2969	117.5	12.23	12.29	12.17	0.0399
7 FDAS:Average	18	85	0	0	2969	119.7	12.35	12.4	12.29	0.032
7 FDAS:Average	18	85	21	21	2969	119.4	12.34	12.4	12.26	0.0299
7 FDAS:Average	18	85	43	43	2969	123.4	12.55	12.57	12.5	0.0199
7 FDAS:Average	18	85	62	62	2969	133.6	13.05	13.11	12.98	0.036
7 FDAS:Average	18	85	82	82	2969	131.3	12.93	12.96	12.9	0.018
7 FDAS:Average	18	85	102	102	2969	124.7	12.61	12.65	12.55	0.024
7 FDAS:Average	18	85	122	122	2969	123.9	12.55	12.6	12.52	0.024
7 FDAS:Average	18	85	142	142	2969	121.2	12.41	12.46	12.38	0.024
7 FDAS:Average	18	85	162	162	2969	118.5	12.29	12.31	12.26	0.0199
7 FDAS:Average	18	85	182	182	2969	121.2	12.41	12.46	12.38	0.0219
7 FDAS:Average	19	90	0	0	2969	118.9	12.31	12.35	12.26	0.032
7 FDAS:Average	19	90	20	20	2969	119.1	12.31	12.35	12.28	0.018
7 FDAS:Average	19	90	42	42	2969	121.1	12.4	12.5	12.34	0.0379
7 FDAS:Average	19	90	62	62	2969	132.2	12.98	13.05	12.9	0.0379
7 FDAS:Average	19	90	82	82	2969	139.6	13.36	13.36	13.3	0.0199
7 FDAS:Average	19	90	102	102	2969	131.7	12.96	13	12.9	0.024
7 FDAS:Average	19	90	122	122	2969	127	12.69	12.78	12.65	0.0299
7 FDAS:Average	19	90	142	142	2969	127	12.72	12.78	12.65	0.034
7 FDAS:Average	19	90	162	162	2969	122.7	12.5	12.57	12.43	0.036
7 FDAS:Average	19	90	182	182	2969	120.9	12.4	12.43	12.38	0.018
7 FDAS:Average	20	95	0	0	2969	121.5	12.43	12.48	12.4	0.024
7 FDAS:Average	20	95	21	21	2969	122.1	12.48	12.53	12.41	0.032
7 FDAS:Average	20	95	43	43	2969	130.8	12.9	12.93	12.88	0.024
7 FDAS:Average	20	95	62	62	2969	142.4	13.43	13.51	13.42	0.028
7 FDAS:Average	20	95	83	83	2969	142.8	13.48	13.55	13.42	0.0379
7 FDAS:Average	20	95	102	102	2969	135.2	13.1	13.19	13.05	0.032
7 FDAS:Average	20	95	122	122	2969	132.8	13	13.05	12.96	0.026
7 FDAS:Average	20	95	142	142	2969	127.8	12.78	12.84	12.67	0.0399
7 FDAS:Average	20	95	162	162	2969	123	12.53	12.55	12.48	0.026
7 FDAS:Average	20	95	183	183	2969	122.3	12.52	12.53	12.43	0.026
8 FDAS:Average	1	0	0	0	4263	121.5	12.43	12.5	12.38	0.034
8 FDAS:Average	1	0	21	21	4263	121.9	12.48	12.52	12.4	0.028
8 FDAS:Average	1	0	42	42	4263	121.3	12.43	12.46	12.4	0.0199

Appendix E: Dia-stron Dimensional Report for Slice Importance

8 FDAS:Average	1	0	62	62	4263	120.9	12.41	12.43	12.38	0.024
8 FDAS:Average	1	0	82	82	4263	123.6	12.53	12.57	12.52	0.014
8 FDAS:Average	1	0	102	102	4263	125.3	12.64	12.69	12.57	0.0299
8 FDAS:Average	1	0	122	122	4263	126.7	12.72	12.76	12.64	0.036
8 FDAS:Average	1	0	142	142	4263	125.6	12.67	12.69	12.6	0.028
8 FDAS:Average	1	0	162	162	4263	124.4	12.61	12.65	12.52	0.034
8 FDAS:Average	1	0	183	183	4263	124.4	12.57	12.64	12.53	0.024
8 FDAS:Average	2	8	0	0	4263	124.7	12.61	12.65	12.55	0.026
8 FDAS:Average	2	8	20	20	4263	124.6	12.6	12.64	12.55	0.024
8 FDAS:Average	2	8	42	42	4263	121.3	12.43	12.46	12.4	0.018
8 FDAS:Average	2	8	62	62	4263	121.8	12.48	12.5	12.41	0.026
8 FDAS:Average	2	8	82	82	4263	122.6	12.52	12.53	12.46	0.018
8 FDAS:Average	2	8	101	101	4263	123.9	12.53	12.64	12.48	0.036
8 FDAS:Average	2	8	122	122	4263	124.7	12.6	12.67	12.53	0.036
8 FDAS:Average	2	8	142	142	4263	124.4	12.6	12.64	12.53	0.024
8 FDAS:Average	2	8	162	162	4263	128.7	12.79	12.84	12.76	0.026
8 FDAS:Average	2	8	183	183	4263	129.8	12.86	12.92	12.79	0.028
8 FDAS:Average	3	16	0	0	4263	117.9	12.23	12.34	12.17	0.0379
8 FDAS:Average	3	16	21	21	4263	117.1	12.22	12.26	12.16	0.028
8 FDAS:Average	3	16	42	42	4263	117.9	12.26	12.28	12.22	0.016
8 FDAS:Average	3	16	62	62	4263	120.3	12.4	12.41	12.34	0.0199
8 FDAS:Average	3	16	82	82	4263	126.3	12.65	12.76	12.6	0.0399
8 FDAS:Average	3	16	102	102	4263	125.1	12.64	12.69	12.55	0.034
8 FDAS:Average	3	16	122	122	4263	125.4	12.61	12.67	12.6	0.026
8 FDAS:Average	3	16	142	142	4263	127.5	12.73	12.79	12.69	0.024
8 FDAS:Average	3	16	162	162	4263	127.7	12.76	12.78	12.72	0.018
8 FDAS:Average	3	16	183	183	4263	122.3	12.5	12.53	12.43	0.0299
8 FDAS:Average	4	24	0	0	4263	121.9	12.46	12.52	12.4	0.034
8 FDAS:Average	4	24	20	20	4263	120.2	12.38	12.43	12.31	0.028
8 FDAS:Average	4	24	42	42	4263	116.5	12.17	12.22	12.14	0.018
8 FDAS:Average	4	24	62	62	4263	116.6	12.22	12.23	12.14	0.028
8 FDAS:Average	4	24	82	82	4263	120.9	12.4	12.46	12.35	0.026
8 FDAS:Average	4	24	102	102	4263	123.2	12.53	12.57	12.48	0.028
8 FDAS:Average	4	24	122	122	4263	123.7	12.55	12.6	12.5	0.028
8 FDAS:Average	4	24	142	142	4263	133.2	13.02	13.07	12.98	0.028
8 FDAS:Average	4	24	162	162	4263	139.4	13.34	13.38	13.27	0.024
8 FDAS:Average	4	24	183	183	4263	131.1	12.93	12.96	12.88	0.0299
8 FDAS:Average	5	32	0	0	4263	116.4	12.17	12.28	12.07	0.046
8 FDAS:Average	5	32	21	21	4263	116.2	12.17	12.22	12.11	0.026
8 FDAS:Average	5	32	42	42	4263	118.8	12.28	12.38	12.22	0.0379
8 FDAS:Average	5	32	62	62	4263	121.7	12.46	12.5	12.4	0.0299
8 FDAS:Average	5	32	82	82	4263	124.5	12.6	12.65	12.53	0.028
8 FDAS:Average	5	32	102	102	4263	123.4	12.53	12.57	12.5	0.0199
8 FDAS:Average	5	32	122	122	4263	122.3	12.5	12.53	12.43	0.026
8 FDAS:Average	5	32	142	142	4263	120.5	12.35	12.43	12.34	0.024
8 FDAS:Average	5	32	162	162	4263	120.6	12.4	12.43	12.35	0.0219
8 FDAS:Average	5	32	183	183	4263	120.6	12.4	12.43	12.35	0.024
8 FDAS:Average	6	40	0	0	4263	119.2	12.31	12.35	12.29	0.0199
8 FDAS:Average	6	40	20	20	4263	118.8	12.29	12.34	12.26	0.024
8 FDAS:Average	6	40	43	43	4263	117.5	12.22	12.29	12.17	0.032
8 FDAS:Average	6	40	62	62	4263	118.1	12.26	12.34	12.19	0.0379
8 FDAS:Average	6	40	82	82	4263	121.5	12.41	12.5	12.38	0.0299
8 FDAS:Average	6	40	102	102	4263	123	12.53	12.55	12.48	0.024
8 FDAS:Average	6	40	122	122	4263	124.4	12.57	12.65	12.52	0.034
8 FDAS:Average	6	40	142	142	4263	123.4	12.53	12.57	12.5	0.024
8 FDAS:Average	6	40	162	162	4263	124.3	12.6	12.61	12.55	0.018
8 FDAS:Average	6	40	183	183	4263	123.9	12.55	12.6	12.52	0.0199
8 FDAS:Average	7	48	0	0	4263	115.8	12.16	12.22	12.07	0.036
8 FDAS:Average	7	48	21	21	4263	115.2	12.11	12.17	12.05	0.0439
8 FDAS:Average	7	48	42	42	4263	116.1	12.17	12.22	12.1	0.036
8 FDAS:Average	7	48	62	62	4263	117.7	12.26	12.29	12.19	0.024
8 FDAS:Average	7	48	82	82	4263	121	12.38	12.52	12.31	0.0499
8 FDAS:Average	7	48	102	102	4263	122.3	12.48	12.53	12.43	0.028
8 FDAS:Average	7	48	122	122	4263	123.2	12.53	12.55	12.5	0.0219
8 FDAS:Average	7	48	142	142	4263	125.4	12.64	12.67	12.6	0.024
8 FDAS:Average	7	48	162	162	4263	127.3	12.72	12.79	12.67	0.032
8 FDAS:Average	7	48	183	183	4263	123.2	12.53	12.57	12.48	0.028
8 FDAS:Average	8	56	0	0	4263	116.5	12.19	12.22	12.14	0.024
8 FDAS:Average	8	56	20	20	4263	117.9	12.23	12.34	12.17	0.0379
8 FDAS:Average	8	56	42	42	4263	123.2	12.53	12.57	12.48	0.0299
8 FDAS:Average	8	56	62	62	4263	119.7	12.35	12.38	12.31	0.0199
8 FDAS:Average	8	56	82	82	4263	123.9	12.57	12.6	12.52	0.0219
8 FDAS:Average	8	56	102	102	4263	127.7	12.78	12.81	12.69	0.028
8 FDAS:Average	8	56	122	122	4263	124.9	12.64	12.67	12.55	0.034
8 FDAS:Average	8	56	142	142	4263	123.7	12.55	12.6	12.5	0.032
8 FDAS:Average	8	56	162	162	4263	121	12.4	12.48	12.34	0.0379
8 FDAS:Average	8	56	182	182	4263	118.1	12.29	12.34	12.19	0.036
8 FDAS:Average	9	64	0	0	4263	113.9	12.05	12.07	12.02	0.018
8 FDAS:Average	9	64	21	21	4263	114.3	12.05	12.11	12.02	0.026
8 FDAS:Average	9	64	42	42	4263	114.4	12.07	12.11	12.03	0.028
8 FDAS:Average	9	64	63	63	4263	117.7	12.26	12.29	12.19	0.032

Appendix E: Dia-stron Dimensional Report for Slice Importance

8 FDAS:Average	9	64	82	82	4263	120.8	12.38	12.46	12.34	0.036
8 FDAS:Average	9	64	102	102	4263	121	12.4	12.48	12.34	0.036
8 FDAS:Average	9	64	122	122	4263	120.6	12.4	12.5	12.28	0.0759
8 FDAS:Average	9	64	142	142	4263	118.2	12.26	12.31	12.23	0.024
8 FDAS:Average	9	64	162	162	4263	118.6	12.31	12.35	12.23	0.028
8 FDAS:Average	9	64	183	183	4263	119.5	12.35	12.38	12.29	0.024
8 FDAS:Average	10	72	0	0	4263	115.2	12.1	12.19	12.03	0.0399
8 FDAS:Average	10	72	20	20	4263	115.8	12.16	12.17	12.11	0.016
8 FDAS:Average	10	72	42	42	4263	120.8	12.4	12.46	12.34	0.032
8 FDAS:Average	10	72	62	62	4263	121.7	12.43	12.5	12.4	0.026
8 FDAS:Average	10	72	82	82	4263	131.1	12.92	12.98	12.86	0.0299
8 FDAS:Average	10	72	102	102	4263	139	13.31	13.39	13.22	0.0419
8 FDAS:Average	10	72	122	122	4263	133.2	13.02	13.05	13	0.018
8 FDAS:Average	10	72	142	142	4263	122.2	12.48	12.55	12.4	0.0399
8 FDAS:Average	10	72	162	162	4263	118	12.23	12.29	12.22	0.0219
8 FDAS:Average	10	72	182	182	4263	117.5	12.23	12.29	12.17	0.028
8 FDAS:Average	11	80	0	0	4263	113.3	12.02	12.05	11.97	0.0199
8 FDAS:Average	11	80	21	21	4263	113.3	12.02	12.05	11.97	0.024
8 FDAS:Average	11	80	42	42	4263	119.1	12.29	12.4	12.23	0.0439
8 FDAS:Average	11	80	62	62	4263	123.4	12.53	12.57	12.5	0.0219
8 FDAS:Average	11	80	82	82	4263	123.2	12.52	12.55	12.5	0.016
8 FDAS:Average	11	80	102	102	4263	122.2	12.5	12.52	12.43	0.0199
8 FDAS:Average	11	80	122	122	4263	122.1	12.46	12.53	12.41	0.032
8 FDAS:Average	11	80	142	142	4263	118.6	12.29	12.35	12.23	0.0299
8 FDAS:Average	11	80	162	162	4263	116.6	12.19	12.26	12.11	0.0379
8 FDAS:Average	11	80	183	183	4263	118.2	12.28	12.31	12.23	0.024
8 FDAS:Average	12	88	0	0	4263	116.2	12.17	12.19	12.14	0.0199
8 FDAS:Average	12	88	20	20	4263	116.4	12.17	12.19	12.16	0.014
8 FDAS:Average	12	88	43	43	4263	121.1	12.41	12.43	12.4	0.016
8 FDAS:Average	12	88	62	62	4263	136.4	13.19	13.22	13.14	0.026
8 FDAS:Average	12	88	82	82	4263	141.7	13.43	13.48	13.38	0.0219
8 FDAS:Average	12	88	102	102	4263	130.8	12.88	13.02	12.79	0.052
8 FDAS:Average	12	88	122	122	4263	125.9	12.64	12.72	12.6	0.036
8 FDAS:Average	12	88	142	142	4263	125.6	12.64	12.69	12.6	0.0299
8 FDAS:Average	12	88	162	162	4263	121.5	12.41	12.48	12.4	0.0299
8 FDAS:Average	12	88	182	182	4263	119.1	12.34	12.35	12.28	0.026
8 FDAS:Average	13	96	0	0	4263	121.7	12.46	12.5	12.4	0.0299
8 FDAS:Average	13	96	21	21	4263	123	12.5	12.6	12.43	0.046
8 FDAS:Average	13	96	43	43	4263	129.1	12.81	12.86	12.78	0.0219
8 FDAS:Average	13	96	62	62	4263	137.6	13.26	13.3	13.17	0.034
8 FDAS:Average	13	96	82	82	4263	138.2	13.26	13.31	13.22	0.026
8 FDAS:Average	13	96	102	102	4263	130.1	12.88	12.9	12.84	0.016
8 FDAS:Average	13	96	122	122	4263	127.8	12.76	12.79	12.72	0.0199
8 FDAS:Average	13	96	142	142	4263	126.9	12.69	12.78	12.64	0.036
8 FDAS:Average	13	96	162	162	4263	124.4	12.57	12.64	12.53	0.032
8 FDAS:Average	13	96	182	182	4263	124.4	12.57	12.65	12.52	0.034

Appendix E: Dia-stron Dimensional Report for Slice Importance

L51 BLF Slice Importance
Dimensional Data Report

Record	Description	Slice No.	Slice Position	Start Angle	End Angle	Elapsed Time	Cross-Sectional Area	Mean Diameter	Max. Diameter	Min. Diameter	Std. Deviation
				Degrees	Degrees	Seconds	Sq.Microns	Microns	Microns	Microns	
1	FDAS:Averag	1	0	0	0	0	60.5	8.8	8.81	8.74	0.024
1	FDAS:Averag	1	0	20	20	0	60.8	8.8	8.84	8.75	0.018
1	FDAS:Averag	1	0	42	42	0	61.1	8.81	8.87	8.77	0.028
1	FDAS:Averag	1	0	62	62	0	59	8.65	8.72	8.62	0.026
1	FDAS:Averag	1	0	82	82	0	54.5	8.34	8.36	8.3	0.018
1	FDAS:Averag	1	0	102	102	0	50.3	8.01	8.05	7.96	0.024
1	FDAS:Averag	1	0	122	122	0	52.1	8.18	8.19	8.1	0.0299
1	FDAS:Averag	1	0	142	142	0	55.6	8.42	8.46	8.37	0.0219
1	FDAS:Averag	1	0	162	162	0	57.7	8.6	8.62	8.53	0.0199
1	FDAS:Averag	1	0	183	183	0	58.4	8.6	8.72	8.53	0.0419
1	FDAS:Averag	2	6	0	0	0	66.8	9.23	9.3	9.15	0.036
1	FDAS:Averag	2	6	20	20	0	67.9	9.3	9.35	9.25	0.026
1	FDAS:Averag	2	6	43	43	0	69.2	9.39	9.44	9.34	0.026
1	FDAS:Averag	2	6	62	62	0	69.5	9.42	9.47	9.35	0.032
1	FDAS:Averag	2	6	82	82	0	66.8	9.23	9.27	9.18	0.0299
1	FDAS:Averag	2	6	102	102	0	61.7	8.86	8.92	8.8	0.032
1	FDAS:Averag	2	6	122	122	0	58.7	8.65	8.69	8.6	0.024
1	FDAS:Averag	2	6	142	142	0	61.4	8.84	8.89	8.8	0.0299
1	FDAS:Averag	2	6	162	162	0	65.5	9.13	9.19	9.07	0.0299
1	FDAS:Averag	2	6	183	183	0	66.9	9.23	9.27	9.19	0.024
1	FDAS:Averag	3	12	0	0	0	66.9	9.25	9.27	9.19	0.018
1	FDAS:Averag	3	12	21	21	0	67.3	9.25	9.3	9.22	0.0219
1	FDAS:Averag	3	12	42	42	0	67.5	9.27	9.32	9.22	0.024
1	FDAS:Averag	3	12	62	62	0	69.5	9.38	9.46	9.35	0.026
1	FDAS:Averag	3	12	82	82	0	69.8	9.44	9.47	9.39	0.0219
1	FDAS:Averag	3	12	102	102	0	66.9	9.25	9.27	9.19	0.0219
1	FDAS:Averag	3	12	122	122	0	62.6	8.94	8.98	8.87	0.0299
1	FDAS:Averag	3	12	142	142	0	58.2	8.62	8.65	8.57	0.024
1	FDAS:Averag	3	12	162	162	0	59.8	8.72	8.77	8.68	0.024
1	FDAS:Averag	3	12	183	183	0	62.4	8.92	8.96	8.87	0.0199
1	FDAS:Averag	4	18	0	0	0	70.3	9.44	9.5	9.42	0.0199
1	FDAS:Averag	4	18	20	20	0	70.4	9.47	9.51	9.42	0.0299
1	FDAS:Averag	4	18	43	43	0	74.5	9.76	9.8	9.68	0.032
1	FDAS:Averag	4	18	62	62	0	75.8	9.84	9.88	9.77	0.0299
1	FDAS:Averag	4	18	82	82	0	77.1	9.89	9.94	9.88	0.0199
1	FDAS:Averag	4	18	102	102	0	78.7	10	10.06	9.96	0.028
1	FDAS:Averag	4	18	122	122	0	78.6	9.97	10.07	9.94	0.032
1	FDAS:Averag	4	18	142	142	0	71.9	9.57	9.61	9.53	0.024
1	FDAS:Averag	4	18	162	162	0	66.3	9.18	9.23	9.15	0.0219
1	FDAS:Averag	4	18	183	183	0	67.3	9.25	9.3	9.22	0.024
1	FDAS:Averag	5	24	0	0	0	75.1	9.77	9.84	9.72	0.036
1	FDAS:Averag	5	24	21	21	0	75.2	9.77	9.84	9.73	0.032
1	FDAS:Averag	5	24	43	43	0	81.5	10.2	10.26	10.11	0.034
1	FDAS:Averag	5	24	62	62	0	86.2	10.47	10.53	10.42	0.034
1	FDAS:Averag	5	24	82	82	0	86.4	10.47	10.53	10.45	0.024
1	FDAS:Averag	5	24	102	102	0	88.1	10.57	10.65	10.53	0.036
1	FDAS:Averag	5	24	122	122	0	90	10.71	10.76	10.65	0.026
1	FDAS:Averag	5	24	142	142	0	86.8	10.52	10.57	10.45	0.0299
1	FDAS:Averag	5	24	162	162	0	78.1	9.97	10.03	9.92	0.0299
1	FDAS:Averag	5	24	183	183	0	72.1	9.6	9.63	9.53	0.032
1	FDAS:Averag	6	30	0	0	0	78	9.97	10.01	9.92	0.032
1	FDAS:Averag	6	30	20	20	0	77.6	9.94	10	9.88	0.0299
1	FDAS:Averag	6	30	42	42	0	79.1	10.06	10.07	10	0.028
1	FDAS:Averag	6	30	62	62	0	84.8	10.39	10.45	10.33	0.0379
1	FDAS:Averag	6	30	82	82	0	88.6	10.61	10.68	10.56	0.0379
1	FDAS:Averag	6	30	102	102	0	89.4	10.7	10.73	10.61	0.032
1	FDAS:Averag	6	30	122	122	0	92.8	10.85	10.92	10.82	0.032
1	FDAS:Averag	6	30	142	142	0	92.8	10.88	10.92	10.82	0.0219
1	FDAS:Averag	6	30	162	162	0	87.5	10.57	10.59	10.52	0.0219
1	FDAS:Averag	6	30	183	183	0	78.7	10.01	10.06	9.96	0.028
1	FDAS:Averag	7	36	0	0	0	78.8	10.01	10.06	9.97	0.026
1	FDAS:Averag	7	36	21	21	0	77.1	9.89	9.96	9.85	0.0299
1	FDAS:Averag	7	36	43	43	0	73.1	9.63	9.68	9.61	0.0199
1	FDAS:Averag	7	36	62	62	0	77.4	9.96	9.97	9.89	0.0199
1	FDAS:Averag	7	36	82	82	0	83.2	10.3	10.44	10.15	0.0879
1	FDAS:Averag	7	36	102	102	0	84.8	10.42	10.45	10.33	0.034
1	FDAS:Averag	7	36	122	122	0	86.7	10.52	10.56	10.45	0.0219
1	FDAS:Averag	7	36	142	142	0	88	10.61	10.64	10.53	0.0299
1	FDAS:Averag	7	36	162	162	0	86.3	10.5	10.53	10.44	0.028
1	FDAS:Averag	7	36	183	183	0	78.3	10	10.03	9.94	0.0299
1	FDAS:Averag	8	42	0	0	0	127.5	12.73	12.79	12.69	0.032
1	FDAS:Averag	8	42	20	20	0	125.1	12.65	12.69	12.55	0.0399
1	FDAS:Averag	8	42	43	43	0	111.4	11.92	11.97	11.85	0.026

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1 FDAS:Averag	8	42	62	62	0	113.3	12	12.05	11.97	0.0219
1 FDAS:Averag	8	42	82	82	0	123.9	12.53	12.6	12.52	0.0219
1 FDAS:Averag	8	42	102	102	0	130.4	12.88	12.93	12.84	0.028
1 FDAS:Averag	8	42	122	122	0	131.7	12.98	13	12.9	0.028
1 FDAS:Averag	8	42	142	142	0	132.8	13.02	13.05	12.96	0.0299
1 FDAS:Averag	8	42	162	162	0	134	13.03	13.14	12.98	0.0379
1 FDAS:Averag	8	42	183	183	0	125.6	12.64	12.69	12.6	0.026
1 FDAS:Averag	9	48	0	0	0	129.4	12.84	12.88	12.79	0.0199
1 FDAS:Averag	9	48	21	21	0	127.5	12.72	12.79	12.69	0.026
1 FDAS:Averag	9	48	42	42	0	113.8	12.03	12.07	12	0.024
1 FDAS:Averag	9	48	62	62	0	106.9	11.68	11.72	11.61	0.028
1 FDAS:Averag	9	48	82	82	0	113.5	12.02	12.16	11.88	0.07
1 FDAS:Averag	9	48	102	102	0	121.3	12.43	12.48	12.38	0.028
1 FDAS:Averag	9	48	122	122	0	126	12.67	12.73	12.6	0.036
1 FDAS:Averag	9	48	142	142	0	127.2	12.73	12.78	12.67	0.026
1 FDAS:Averag	9	48	162	162	0	128.9	12.81	12.86	12.76	0.026
1 FDAS:Averag	9	48	183	183	0	126.1	12.67	12.73	12.61	0.0299
1 FDAS:Averag	10	54	0	0	0	134.5	13.1	13.14	13.03	0.026
1 FDAS:Averag	10	54	20	20	0	133.9	13.03	13.11	13	0.034
1 FDAS:Averag	10	54	43	43	0	120.2	12.38	12.43	12.31	0.0299
1 FDAS:Averag	10	54	62	62	0	111.4	11.92	11.97	11.85	0.028
1 FDAS:Averag	10	54	82	82	0	114.1	12.05	12.23	11.88	0.108
1 FDAS:Averag	10	54	102	102	0	123.4	12.55	12.57	12.5	0.0199
1 FDAS:Averag	10	54	122	122	0	130.3	12.88	12.92	12.84	0.0219
1 FDAS:Averag	10	54	142	142	0	130.6	12.92	12.93	12.86	0.026
1 FDAS:Averag	10	54	162	162	0	132.5	12.98	13.02	12.96	0.018
1 FDAS:Averag	10	54	183	183	0	130.1	12.88	12.9	12.84	0.024
1 FDAS:Averag	11	60	0	0	0	122.6	12.48	12.53	12.46	0.0299
1 FDAS:Averag	11	60	21	21	0	121.8	12.46	12.5	12.41	0.024
1 FDAS:Averag	11	60	43	43	0	112.3	11.96	12	11.92	0.0199
1 FDAS:Averag	11	60	62	62	0	101.8	11.38	11.43	11.34	0.026
1 FDAS:Averag	11	60	82	82	0	100.4	11.31	11.35	11.26	0.0299
1 FDAS:Averag	11	60	102	102	0	107	11.68	11.69	11.65	0.014
1 FDAS:Averag	11	60	122	122	0	114.9	12.1	12.14	12.05	0.0219
1 FDAS:Averag	11	60	142	142	0	118.1	12.28	12.34	12.19	0.0399
1 FDAS:Averag	11	60	162	162	0	118.5	12.26	12.34	12.23	0.034
1 FDAS:Averag	11	60	183	183	0	118.5	12.29	12.34	12.23	0.028
1 FDAS:Averag	12	66	0	0	0	151	13.86	13.92	13.81	0.024
1 FDAS:Averag	12	66	20	20	0	151	13.86	13.92	13.81	0.034
1 FDAS:Averag	12	66	42	42	0	141.9	13.43	13.5	13.38	0.028
1 FDAS:Averag	12	66	62	62	0	129.6	12.86	12.9	12.79	0.024
1 FDAS:Averag	12	66	82	82	0	124	12.57	12.61	12.52	0.034
1 FDAS:Averag	12	66	102	102	0	131.1	12.92	12.96	12.88	0.028
1 FDAS:Averag	12	66	122	122	0	141.4	13.42	13.48	13.36	0.028
1 FDAS:Averag	12	66	142	142	0	146.3	13.68	13.69	13.61	0.0199
1 FDAS:Averag	12	66	162	162	0	147.7	13.72	13.75	13.68	0.026
1 FDAS:Averag	12	66	183	183	0	150.4	13.84	13.88	13.8	0.0219
1 FDAS:Averag	13	72	0	0	0	142.7	13.5	13.53	13.43	0.0299
1 FDAS:Averag	13	72	21	21	0	142.4	13.48	13.5	13.43	0.0199
1 FDAS:Averag	13	72	43	43	0	135.2	13.15	13.17	13.07	0.032
1 FDAS:Averag	13	72	62	62	0	124.5	12.57	12.65	12.53	0.0399
1 FDAS:Averag	13	72	82	82	0	116.6	12.19	12.23	12.14	0.032
1 FDAS:Averag	13	72	102	102	0	122	12.48	12.5	12.43	0.018
1 FDAS:Averag	13	72	122	122	0	132.4	12.98	13.05	12.92	0.0379
1 FDAS:Averag	13	72	142	142	0	137.3	13.22	13.27	13.17	0.026
1 FDAS:Averag	13	72	162	162	0	137.8	13.23	13.27	13.22	0.018
1 FDAS:Averag	13	72	183	183	0	140.9	13.36	13.48	13.31	0.0399
1 FDAS:Averag	14	78	0	0	0	130	12.9	12.92	12.81	0.0299
1 FDAS:Averag	14	78	20	20	0	130.4	12.9	12.93	12.84	0.032
1 FDAS:Averag	14	78	42	42	0	124	12.57	12.61	12.52	0.026
1 FDAS:Averag	14	78	62	62	0	113.3	12.02	12.05	11.97	0.0219
1 FDAS:Averag	14	78	82	82	0	106.1	11.64	11.68	11.57	0.0219
1 FDAS:Averag	14	78	102	102	0	110.6	11.85	11.92	11.81	0.0299
1 FDAS:Averag	14	78	122	122	0	119.7	12.34	12.4	12.29	0.0299
1 FDAS:Averag	14	78	142	142	0	124.7	12.6	12.65	12.55	0.026
1 FDAS:Averag	14	78	162	162	0	124.4	12.55	12.64	12.53	0.0299
1 FDAS:Averag	14	78	182	182	0	124	12.55	12.61	12.52	0.028
1 FDAS:Averag	15	84	0	0	0	118	12.28	12.29	12.22	0.024
1 FDAS:Averag	15	84	21	21	0	118.2	12.28	12.31	12.23	0.026
1 FDAS:Averag	15	84	42	42	0	112.6	11.97	12.02	11.93	0.024
1 FDAS:Averag	15	84	62	62	0	101.3	11.38	11.4	11.31	0.024
1 FDAS:Averag	15	84	82	82	0	95.3	11.03	11.06	10.97	0.0199
1 FDAS:Averag	15	84	102	102	0	100.3	11.3	11.34	11.26	0.024
1 FDAS:Averag	15	84	122	122	0	108	11.73	11.76	11.69	0.024
1 FDAS:Averag	15	84	142	142	0	112.2	11.93	12	11.9	0.032
1 FDAS:Averag	15	84	162	162	0	112.3	11.97	12	11.92	0.024
1 FDAS:Averag	15	84	183	183	0	114.3	12.05	12.11	12.02	0.028
1 FDAS:Averag	16	90	0	0	0	120.9	12.4	12.46	12.35	0.0219

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1 FDAS:Averag	16	90	20	20	0	120.8	12.4	12.46	12.34	0.032
1 FDAS:Averag	16	90	42	42	0	114.9	12.11	12.14	12.05	0.0219
1 FDAS:Averag	16	90	62	62	0	103.5	11.47	11.53	11.43	0.026
1 FDAS:Averag	16	90	82	82	0	97.6	11.15	11.21	11.09	0.026
1 FDAS:Averag	16	90	102	102	0	103.1	11.43	11.52	11.4	0.034
1 FDAS:Averag	16	90	122	122	0	110.6	11.85	11.92	11.81	0.0299
1 FDAS:Averag	16	90	142	142	0	114.6	12.05	12.16	12	0.0419
1 FDAS:Averag	16	90	162	162	0	114.6	12.07	12.11	12.05	0.0199
1 FDAS:Averag	16	90	182	182	0	115.8	12.16	12.19	12.1	0.026
1 FDAS:Averag	17	96	0	0	0	125.3	12.61	12.65	12.61	0.016
1 FDAS:Averag	17	96	21	21	0	125.9	12.64	12.72	12.6	0.036
1 FDAS:Averag	17	96	42	42	0	119	12.29	12.34	12.28	0.0199
1 FDAS:Averag	17	96	62	62	0	106.3	11.61	11.68	11.59	0.0219
1 FDAS:Averag	17	96	82	82	0	101.4	11.38	11.42	11.31	0.026
1 FDAS:Averag	17	96	102	102	0	106.6	11.64	11.69	11.61	0.028
1 FDAS:Averag	17	96	122	122	0	114	12.05	12.1	12	0.028
1 FDAS:Averag	17	96	142	142	0	117.4	12.22	12.28	12.17	0.0299
1 FDAS:Averag	17	96	162	162	0	117.6	12.26	12.28	12.19	0.018
1 FDAS:Averag	17	96	183	183	0	118.9	12.31	12.35	12.26	0.026
2 FDAS:Averag	1	0	0	0	894	60.9	8.81	8.86	8.75	0.0299
2 FDAS:Averag	1	0	21	21	894	61	8.84	8.86	8.77	0.0219
2 FDAS:Averag	1	0	42	42	894	61	8.81	8.86	8.77	0.026
2 FDAS:Averag	1	0	62	62	894	59.1	8.65	8.75	8.6	0.0399
2 FDAS:Averag	1	0	82	82	894	54.2	8.27	8.36	8.25	0.026
2 FDAS:Averag	1	0	102	102	894	49.6	7.94	8	7.89	0.028
2 FDAS:Averag	1	0	122	122	894	51.7	8.13	8.15	8.07	0.024
2 FDAS:Averag	1	0	142	142	894	55.6	8.42	8.46	8.37	0.018
2 FDAS:Averag	1	0	162	162	894	58.1	8.62	8.63	8.57	0.016
2 FDAS:Averag	1	0	183	183	894	58.4	8.62	8.68	8.57	0.0219
2 FDAS:Averag	2	10	0	0	894	66.9	9.23	9.27	9.19	0.0199
2 FDAS:Averag	2	10	20	20	894	67.1	9.23	9.3	9.19	0.028
2 FDAS:Averag	2	10	43	43	894	66.7	9.25	9.32	9.11	0.0599
2 FDAS:Averag	2	10	62	62	894	68.7	9.34	9.39	9.32	0.028
2 FDAS:Averag	2	10	82	82	894	68.5	9.34	9.38	9.3	0.0219
2 FDAS:Averag	2	10	102	102	894	64.8	9.1	9.11	9.06	0.016
2 FDAS:Averag	2	10	122	122	894	60.5	8.77	8.81	8.74	0.0219
2 FDAS:Averag	2	10	142	142	894	58	8.6	8.62	8.56	0.016
2 FDAS:Averag	2	10	162	162	894	60.9	8.81	8.86	8.75	0.026
2 FDAS:Averag	2	10	182	182	894	63.9	9.01	9.06	8.98	0.0199
2 FDAS:Averag	3	20	0	0	894	77.1	9.92	9.97	9.84	0.0379
2 FDAS:Averag	3	20	21	21	894	78.5	10	10.06	9.94	0.028
2 FDAS:Averag	3	20	42	42	894	82.8	10.26	10.32	10.21	0.0299
2 FDAS:Averag	3	20	62	62	894	83.4	10.32	10.35	10.26	0.028
2 FDAS:Averag	3	20	82	82	894	84.9	10.42	10.47	10.33	0.0379
2 FDAS:Averag	3	20	102	102	894	86.7	10.52	10.56	10.45	0.024
2 FDAS:Averag	3	20	122	122	894	87.7	10.57	10.61	10.52	0.026
2 FDAS:Averag	3	20	142	142	894	82.2	10.21	10.26	10.2	0.018
2 FDAS:Averag	3	20	162	162	894	73.9	9.7	9.77	9.63	0.0299
2 FDAS:Averag	3	20	183	183	894	72.7	9.6	9.68	9.56	0.028
2 FDAS:Averag	4	30	0	0	894	87.7	10.57	10.61	10.53	0.024
2 FDAS:Averag	4	30	20	20	894	86.7	10.53	10.57	10.44	0.0399
2 FDAS:Averag	4	30	43	43	894	89.1	10.65	10.71	10.59	0.034
2 FDAS:Averag	4	30	62	62	894	95.3	11.02	11.07	10.96	0.028
2 FDAS:Averag	4	30	82	82	894	98.3	11.18	11.23	11.14	0.028
2 FDAS:Averag	4	30	102	102	894	99.8	11.28	11.31	11.23	0.0199
2 FDAS:Averag	4	30	122	122	894	104.2	11.52	11.57	11.47	0.026
2 FDAS:Averag	4	30	142	142	894	105.1	11.55	11.61	11.53	0.0219
2 FDAS:Averag	4	30	162	162	894	99.7	11.23	11.34	11.19	0.034
2 FDAS:Averag	4	30	182	182	894	89	10.64	10.7	10.59	0.026
2 FDAS:Averag	5	40	0	0	894	129.8	12.86	12.9	12.81	0.018
2 FDAS:Averag	5	40	21	21	894	126.5	12.69	12.73	12.65	0.0219
2 FDAS:Averag	5	40	42	42	894	113.1	12	12.03	11.97	0.024
2 FDAS:Averag	5	40	62	62	894	115.3	12.14	12.16	12.07	0.0219
2 FDAS:Averag	5	40	82	82	894	126	12.67	12.69	12.64	0.0199
2 FDAS:Averag	5	40	102	102	894	132.6	12.98	13.03	12.96	0.0219
2 FDAS:Averag	5	40	122	122	894	134.2	13.05	13.14	13	0.0379
2 FDAS:Averag	5	40	142	142	894	136	13.15	13.22	13.1	0.032
2 FDAS:Averag	5	40	162	162	894	136.5	13.22	13.23	13.14	0.0219
2 FDAS:Averag	5	40	182	182	894	128.7	12.81	12.84	12.76	0.028
2 FDAS:Averag	6	50	0	0	894	130	12.88	12.92	12.81	0.026
2 FDAS:Averag	6	50	20	20	894	129.3	12.84	12.9	12.76	0.036
2 FDAS:Averag	6	50	43	43	894	114.6	12.07	12.14	12.02	0.036
2 FDAS:Averag	6	50	62	62	894	106.6	11.68	11.69	11.61	0.028
2 FDAS:Averag	6	50	82	82	894	111.3	11.92	11.96	11.85	0.028
2 FDAS:Averag	6	50	102	102	894	120.5	12.4	12.43	12.34	0.026
2 FDAS:Averag	6	50	122	122	894	126.5	12.69	12.73	12.65	0.0199
2 FDAS:Averag	6	50	142	142	894	128.7	12.79	12.84	12.76	0.026
2 FDAS:Averag	6	50	162	162	894	132.7	13.02	13.07	12.93	0.032

Appendix E: Dia-stron Dimensional Report for Slice Importance

2 FDAS:Averag	6	50	183	183	894	131.5	12.93	12.98	12.9	0.024
2 FDAS:Averag	7	60	0	0	894	123.7	12.53	12.6	12.5	0.026
2 FDAS:Averag	7	60	21	21	894	122.3	12.5	12.55	12.41	0.036
2 FDAS:Averag	7	60	43	43	894	112.3	11.96	12.02	11.9	0.032
2 FDAS:Averag	7	60	62	62	894	101.7	11.38	11.42	11.34	0.026
2 FDAS:Averag	7	60	82	82	894	100.6	11.31	11.35	11.28	0.026
2 FDAS:Averag	7	60	102	102	894	107.1	11.68	11.72	11.64	0.0199
2 FDAS:Averag	7	60	122	122	894	114.4	12.07	12.14	12	0.036
2 FDAS:Averag	7	60	142	142	894	117.5	12.26	12.29	12.17	0.0419
2 FDAS:Averag	7	60	162	162	894	118.2	12.26	12.31	12.23	0.0219
2 FDAS:Averag	7	60	183	183	894	119.4	12.31	12.4	12.26	0.032
2 FDAS:Averag	8	70	0	0	894	138.3	13.26	13.31	13.23	0.0199
2 FDAS:Averag	8	70	20	20	894	138.7	13.27	13.36	13.22	0.036
2 FDAS:Averag	8	70	43	43	894	130	12.9	12.92	12.81	0.028
2 FDAS:Averag	8	70	62	62	894	118.5	12.28	12.35	12.22	0.032
2 FDAS:Averag	8	70	82	82	894	112	11.93	12	11.88	0.028
2 FDAS:Averag	8	70	102	102	894	117.5	12.23	12.29	12.17	0.034
2 FDAS:Averag	8	70	122	122	894	127	12.73	12.76	12.67	0.026
2 FDAS:Averag	8	70	142	142	894	133	13	13.07	12.96	0.034
2 FDAS:Averag	8	70	162	162	894	132.8	13	13.03	12.98	0.016
2 FDAS:Averag	8	70	183	183	894	134.1	13.05	13.11	13.02	0.0299
2 FDAS:Averag	9	80	0	0	894	123.7	12.53	12.6	12.5	0.032
2 FDAS:Averag	9	80	21	21	894	122.6	12.48	12.53	12.46	0.0199
2 FDAS:Averag	9	80	43	43	894	115.2	12.11	12.17	12.05	0.036
2 FDAS:Averag	9	80	62	62	894	104	11.5	11.55	11.47	0.0219
2 FDAS:Averag	9	80	82	82	894	97.6	11.14	11.19	11.11	0.0199
2 FDAS:Averag	9	80	102	102	894	103.4	11.46	11.52	11.43	0.024
2 FDAS:Averag	9	80	122	122	894	112.2	11.96	12	11.9	0.028
2 FDAS:Averag	9	80	142	142	894	116.5	12.19	12.22	12.14	0.024
2 FDAS:Averag	9	80	162	162	894	117.2	12.22	12.26	12.17	0.024
2 FDAS:Averag	9	80	183	183	894	119.1	12.34	12.35	12.28	0.024
2 FDAS:Averag	10	90	0	0	894	121.8	12.48	12.53	12.38	0.0419
2 FDAS:Averag	10	90	20	20	894	121.2	12.43	12.5	12.35	0.034
2 FDAS:Averag	10	90	43	43	894	114	12.05	12.1	12	0.026
2 FDAS:Averag	10	90	62	62	894	103.2	11.47	11.5	11.43	0.0199
2 FDAS:Averag	10	90	82	82	894	97.3	11.14	11.19	11.07	0.032
2 FDAS:Averag	10	90	102	102	894	103.2	11.47	11.5	11.43	0.018
2 FDAS:Averag	10	90	122	122	894	110.8	11.88	11.92	11.84	0.026
2 FDAS:Averag	10	90	142	142	894	115.7	12.14	12.22	12.05	0.0419
2 FDAS:Averag	10	90	162	162	894	116.3	12.17	12.23	12.11	0.028
2 FDAS:Averag	10	90	182	182	894	117.7	12.23	12.29	12.19	0.028
3 FDAS:Averag	1	0	0	0	1466	61.5	8.86	8.89	8.81	0.0219
3 FDAS:Averag	1	0	20	20	1466	61.4	8.84	8.87	8.81	0.018
3 FDAS:Averag	1	0	42	42	1466	61.7	8.87	8.89	8.84	0.018
3 FDAS:Averag	1	0	62	62	1466	60.1	8.74	8.77	8.72	0.0199
3 FDAS:Averag	1	0	82	82	1466	55.2	8.37	8.43	8.34	0.0219
3 FDAS:Averag	1	0	102	102	1466	50.2	7.98	8.03	7.96	0.0219
3 FDAS:Averag	1	0	122	122	1466	51.9	8.12	8.19	8.07	0.028
3 FDAS:Averag	1	0	142	142	1466	55.9	8.43	8.48	8.39	0.026
3 FDAS:Averag	1	0	162	162	1466	59.2	8.68	8.74	8.62	0.032
3 FDAS:Averag	1	0	183	183	1466	59.4	8.72	8.74	8.65	0.024
3 FDAS:Averag	2	24	0	0	1466	70.5	9.46	9.51	9.44	0.0219
3 FDAS:Averag	2	24	21	21	1466	70.9	9.51	9.53	9.47	0.018
3 FDAS:Averag	2	24	43	43	1466	75.8	9.84	9.88	9.77	0.028
3 FDAS:Averag	2	24	62	62	1466	79.6	10.07	10.11	10.03	0.0199
3 FDAS:Averag	2	24	82	82	1466	81.3	10.18	10.26	10.09	0.036
3 FDAS:Averag	2	24	102	102	1466	81.1	10.18	10.21	10.11	0.036
3 FDAS:Averag	2	24	122	122	1466	83	10.3	10.33	10.23	0.028
3 FDAS:Averag	2	24	142	142	1466	80.7	10.14	10.18	10.09	0.024
3 FDAS:Averag	2	24	162	162	1466	73.4	9.65	9.73	9.61	0.032
3 FDAS:Averag	2	24	183	183	1466	66.8	9.23	9.27	9.18	0.026
3 FDAS:Averag	3	48	0	0	1466	125.6	12.64	12.72	12.57	0.0439
3 FDAS:Averag	3	48	20	20	1466	124.3	12.6	12.61	12.55	0.0219
3 FDAS:Averag	3	48	42	42	1466	111.3	11.92	11.93	11.88	0.018
3 FDAS:Averag	3	48	62	62	1466	104.1	11.5	11.57	11.46	0.0379
3 FDAS:Averag	3	48	82	82	1466	108.1	11.72	11.78	11.68	0.0299
3 FDAS:Averag	3	48	102	102	1466	116.7	12.17	12.31	12.07	0.07
3 FDAS:Averag	3	48	122	122	1466	121.2	12.43	12.5	12.35	0.034
3 FDAS:Averag	3	48	142	142	1466	124.3	12.57	12.64	12.52	0.032
3 FDAS:Averag	3	48	162	162	1466	128.5	12.78	12.86	12.72	0.0379
3 FDAS:Averag	3	48	183	183	1466	127.2	12.72	12.76	12.69	0.0199
3 FDAS:Averag	4	72	0	0	1466	153.1	13.96	14	13.92	0.028
3 FDAS:Averag	4	72	21	21	1466	152.7	13.96	14	13.89	0.0299
3 FDAS:Averag	4	72	42	42	1466	144.3	13.55	13.63	13.48	0.034
3 FDAS:Averag	4	72	62	62	1466	132.6	13	13.03	12.96	0.0219
3 FDAS:Averag	4	72	83	83	1466	124.9	12.6	12.65	12.57	0.024
3 FDAS:Averag	4	72	101	101	1466	128.4	12.78	12.84	12.73	0.032
3 FDAS:Averag	4	72	122	122	1466	139.9	13.36	13.39	13.3	0.028

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3 FDAS:Averag	4	72	142	142	1466	146.1	13.63	13.68	13.6	0.024
3 FDAS:Averag	4	72	162	162	1466	146.9	13.65	13.72	13.63	0.0219
3 FDAS:Averag	4	72	183	183	1466	147.6	13.69	13.74	13.68	0.026
3 FDAS:Averag	5	96	0	0	1466	118.9	12.29	12.35	12.26	0.0299
3 FDAS:Averag	5	96	20	20	1466	118.5	12.29	12.35	12.22	0.0299
3 FDAS:Averag	5	96	43	43	1466	111.3	11.92	11.93	11.88	0.018
3 FDAS:Averag	5	96	62	62	1466	100.8	11.31	11.38	11.28	0.032
3 FDAS:Averag	5	96	82	82	1466	95.5	11.03	11.15	10.9	0.086
3 FDAS:Averag	5	96	102	102	1466	99.5	11.28	11.3	11.21	0.024
3 FDAS:Averag	5	96	122	122	1466	107	11.68	11.73	11.61	0.0299
3 FDAS:Averag	5	96	142	142	1466	111.6	11.92	11.96	11.88	0.028
3 FDAS:Averag	5	96	162	162	1466	112.1	11.96	11.97	11.92	0.0199
3 FDAS:Averag	5	96	183	183	1466	113.8	12.05	12.05	12.02	0.016
4 FDAS:Averag	1	49	0	0	1858	133.9	13.05	13.11	13	0.034
4 FDAS:Averag	1	49	20	20	1858	132.2	13	13.03	12.92	0.0299
4 FDAS:Averag	1	49	42	42	1858	118.1	12.28	12.31	12.22	0.026
4 FDAS:Averag	1	49	62	62	1858	111.9	11.93	11.97	11.9	0.024
4 FDAS:Averag	1	49	82	82	1858	118.9	12.31	12.35	12.26	0.034
4 FDAS:Averag	1	49	102	102	1858	127.2	12.72	12.78	12.67	0.0299
4 FDAS:Averag	1	49	122	122	1858	132.1	12.96	13.02	12.92	0.026
4 FDAS:Averag	1	49	142	142	1858	132.1	12.96	13.02	12.92	0.028
4 FDAS:Averag	1	49	162	162	1858	134.2	13.07	13.11	13.03	0.0219
4 FDAS:Averag	1	49	182	182	1858	131.7	12.93	13	12.9	0.028
5 FDAS:Averag	1	0	0	0	2045	60.1	8.75	8.77	8.72	0.0219
5 FDAS:Averag	1	0	20	20	2045	60.1	8.74	8.81	8.69	0.0299
5 FDAS:Averag	1	0	42	42	2045	61.1	8.84	8.89	8.75	0.0379
5 FDAS:Averag	1	0	62	62	2045	59.7	8.72	8.75	8.68	0.0219
5 FDAS:Averag	1	0	82	82	2045	55.2	8.39	8.43	8.34	0.026
5 FDAS:Averag	1	0	102	102	2045	50.8	8.03	8.07	8.01	0.018
5 FDAS:Averag	1	0	122	122	2045	51.8	8.13	8.18	8.07	0.024
5 FDAS:Averag	1	0	142	142	2045	55	8.37	8.39	8.34	0.026
5 FDAS:Averag	1	0	162	162	2045	57.5	8.57	8.6	8.51	0.0219
5 FDAS:Averag	1	0	183	183	2045	58	8.6	8.62	8.56	0.0199
5 FDAS:Averag	2	48	0	0	2045	129.4	12.84	12.88	12.79	0.0219
5 FDAS:Averag	2	48	21	21	2045	127.2	12.73	12.76	12.69	0.0199
5 FDAS:Averag	2	48	42	42	2045	114.8	12.07	12.16	12.02	0.0379
5 FDAS:Averag	2	48	62	62	2045	107.6	11.69	11.76	11.65	0.0299
5 FDAS:Averag	2	48	82	82	2045	112.7	11.97	12.03	11.93	0.0299
5 FDAS:Averag	2	48	102	102	2045	121.5	12.41	12.5	12.38	0.034
5 FDAS:Averag	2	48	122	122	2045	126.5	12.72	12.73	12.65	0.026
5 FDAS:Averag	2	48	142	142	2045	126.4	12.69	12.73	12.64	0.028
5 FDAS:Averag	2	48	162	162	2045	128.6	12.81	12.86	12.73	0.034
5 FDAS:Averag	2	48	183	183	2045	127.2	12.72	12.78	12.67	0.026
5 FDAS:Averag	3	96	0	0	2045	117.1	12.22	12.23	12.19	0.014
5 FDAS:Averag	3	96	20	20	2045	117.1	12.22	12.26	12.16	0.026
5 FDAS:Averag	3	96	43	43	2045	111.3	11.9	11.96	11.85	0.034
5 FDAS:Averag	3	96	62	62	2045	100	11.28	11.34	11.23	0.0219
5 FDAS:Averag	3	96	82	82	2045	94.9	11	11.03	10.96	0.0219
5 FDAS:Averag	3	96	102	102	2045	99.3	11.23	11.3	11.19	0.032
5 FDAS:Averag	3	96	122	122	2045	106.3	11.61	11.68	11.59	0.028
5 FDAS:Averag	3	96	142	142	2045	109.4	11.78	11.85	11.76	0.0219
5 FDAS:Averag	3	96	162	162	2045	109.6	11.81	11.85	11.78	0.024
5 FDAS:Averag	3	96	182	182	2045	111.2	11.9	11.96	11.84	0.032
6 FDAS:Averag	1	0	0	0	2344	60.9	8.81	8.84	8.77	0.0219
6 FDAS:Averag	1	0	20	20	2344	61.3	8.84	8.87	8.8	0.026
6 FDAS:Averag	1	0	42	42	2344	61.1	8.84	8.87	8.77	0.024
6 FDAS:Averag	1	0	62	62	2344	58.8	8.68	8.69	8.62	0.024
6 FDAS:Averag	1	0	82	82	2344	54.5	8.34	8.36	8.3	0.0199
6 FDAS:Averag	1	0	102	102	2344	49.6	7.96	8	7.89	0.024
6 FDAS:Averag	1	0	122	122	2344	51.7	8.13	8.15	8.07	0.0219
6 FDAS:Averag	1	0	142	142	2344	55.7	8.42	8.48	8.37	0.028
6 FDAS:Averag	1	0	162	162	2344	58.6	8.63	8.68	8.6	0.0199
6 FDAS:Averag	1	0	182	182	2344	58.2	8.62	8.65	8.57	0.0299
6 FDAS:Averag	2	13	0	0	2344	60.5	8.75	8.81	8.74	0.026
6 FDAS:Averag	2	13	21	21	2344	61	8.81	8.87	8.75	0.036
6 FDAS:Averag	2	13	42	42	2344	61.7	8.86	8.89	8.84	0.0199
6 FDAS:Averag	2	13	62	62	2344	62.7	8.94	9	8.87	0.034
6 FDAS:Averag	2	13	82	82	2344	64.2	9.03	9.07	9.01	0.016
6 FDAS:Averag	2	13	102	102	2344	62.8	8.94	9	8.89	0.026
6 FDAS:Averag	2	13	122	122	2344	60.5	8.8	8.81	8.74	0.024
6 FDAS:Averag	2	13	142	142	2344	55.5	8.39	8.46	8.36	0.026
6 FDAS:Averag	2	13	162	162	2344	54.3	8.34	8.36	8.27	0.024
6 FDAS:Averag	2	13	182	182	2344	57.3	8.53	8.57	8.51	0.016
6 FDAS:Averag	3	26	0	0	2344	65.1	9.11	9.15	9.06	0.028
6 FDAS:Averag	3	26	20	20	2344	64.9	9.1	9.11	9.07	0.014
6 FDAS:Averag	3	26	43	43	2344	67.7	9.3	9.34	9.23	0.0219
6 FDAS:Averag	3	26	62	62	2344	71.9	9.56	9.63	9.51	0.032
6 FDAS:Averag	3	26	82	82	2344	73.7	9.7	9.73	9.65	0.026

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6 FDAS:Averag	3	26	102	102	2344	74.3	9.72	9.77	9.68	0.036
6 FDAS:Averag	3	26	122	122	2344	76.9	9.92	9.94	9.85	0.0219
6 FDAS:Averag	3	26	142	142	2344	76.1	9.85	9.89	9.8	0.0299
6 FDAS:Averag	3	26	162	162	2344	70.5	9.5	9.51	9.44	0.0199
6 FDAS:Averag	3	26	183	183	2344	64	9.01	9.06	9	0.016
6 FDAS:Averag	4	39	0	0	2344	135.7	13.14	13.19	13.1	0.032
6 FDAS:Averag	4	39	21	21	2344	131.9	12.98	13	12.92	0.0219
6 FDAS:Averag	4	39	43	43	2344	120.5	12.4	12.43	12.34	0.036
6 FDAS:Averag	4	39	62	62	2344	125.6	12.64	12.72	12.57	0.0299
6 FDAS:Averag	4	39	82	82	2344	136.6	13.19	13.23	13.15	0.0219
6 FDAS:Averag	4	39	102	102	2344	141.7	13.42	13.48	13.38	0.024
6 FDAS:Averag	4	39	122	122	2344	141.9	13.43	13.5	13.38	0.028
6 FDAS:Averag	4	39	142	142	2344	145.1	13.6	13.65	13.53	0.036
6 FDAS:Averag	4	39	162	162	2344	146.2	13.65	13.69	13.6	0.026
6 FDAS:Averag	4	39	183	183	2344	136.5	13.19	13.23	13.14	0.028
6 FDAS:Averag	5	52	0	0	2344	134.5	13.07	13.15	13.02	0.0379
6 FDAS:Averag	5	52	20	20	2344	133.3	13.03	13.1	12.96	0.0439
6 FDAS:Averag	5	52	42	42	2344	119.8	12.38	12.41	12.29	0.032
6 FDAS:Averag	5	52	62	62	2344	110.9	11.9	11.93	11.84	0.032
6 FDAS:Averag	5	52	82	82	2344	114.6	12.07	12.11	12.05	0.018
6 FDAS:Averag	5	52	102	102	2344	122.5	12.5	12.55	12.43	0.032
6 FDAS:Averag	5	52	122	122	2344	129.4	12.84	12.88	12.79	0.0219
6 FDAS:Averag	5	52	142	142	2344	131.1	12.92	12.96	12.88	0.0219
6 FDAS:Averag	5	52	162	162	2344	132.8	13.02	13.03	12.98	0.0199
6 FDAS:Averag	5	52	183	183	2344	130.3	12.88	12.92	12.84	0.026
6 FDAS:Averag	6	65	0	0	2344	162.6	14.37	14.44	14.34	0.0299
6 FDAS:Averag	6	65	21	21	2344	161.7	14.37	14.39	14.31	0.026
6 FDAS:Averag	6	65	43	43	2344	151.7	13.89	14	13.8	0.064
6 FDAS:Averag	6	65	62	62	2344	139.6	13.34	13.39	13.27	0.0299
6 FDAS:Averag	6	65	82	82	2344	134.8	13.11	13.15	13.05	0.028
6 FDAS:Averag	6	65	102	102	2344	139.2	13.3	13.36	13.27	0.026
6 FDAS:Averag	6	65	122	122	2344	150.4	13.84	13.88	13.8	0.028
6 FDAS:Averag	6	65	142	142	2344	155.9	14.12	14.15	14.03	0.0299
6 FDAS:Averag	6	65	162	162	2344	157	14.13	14.18	14.1	0.028
6 FDAS:Averag	6	65	183	183	2344	157.3	14.13	14.18	14.12	0.016
6 FDAS:Averag	7	78	0	0	2344	127	12.72	12.76	12.67	0.0219
6 FDAS:Averag	7	78	20	20	2344	127	12.72	12.79	12.64	0.046
6 FDAS:Averag	7	78	43	43	2344	120.2	12.38	12.43	12.31	0.036
6 FDAS:Averag	7	78	62	62	2344	108.8	11.76	11.81	11.73	0.026
6 FDAS:Averag	7	78	82	82	2344	102.1	11.4	11.46	11.34	0.032
6 FDAS:Averag	7	78	102	102	2344	106	11.65	11.68	11.55	0.0299
6 FDAS:Averag	7	78	122	122	2344	114.9	12.1	12.14	12.05	0.024
6 FDAS:Averag	7	78	142	142	2344	119.5	12.34	12.41	12.26	0.0419
6 FDAS:Averag	7	78	162	162	2344	119.1	12.34	12.35	12.28	0.0299
6 FDAS:Averag	7	78	183	183	2344	119.7	12.34	12.41	12.28	0.034
6 FDAS:Averag	8	91	0	0	2344	126	12.65	12.72	12.61	0.026
6 FDAS:Averag	8	91	20	20	2344	126	12.67	12.72	12.61	0.034
6 FDAS:Averag	8	91	43	43	2344	118.5	12.29	12.31	12.26	0.018
6 FDAS:Averag	8	91	62	62	2344	107.1	11.68	11.72	11.64	0.024
6 FDAS:Averag	8	91	83	83	2344	101.2	11.31	11.42	11.28	0.0399
6 FDAS:Averag	8	91	102	102	2344	106.5	11.65	11.68	11.61	0.0219
6 FDAS:Averag	8	91	122	122	2344	114.9	12.11	12.16	12.03	0.034
6 FDAS:Averag	8	91	142	142	2344	119.6	12.31	12.4	12.28	0.0299
6 FDAS:Averag	8	91	162	162	2344	120.2	12.35	12.4	12.34	0.018
6 FDAS:Averag	8	91	183	183	2344	122.3	12.52	12.53	12.43	0.028
7 FDAS:Averag	1	0	0	0	2842	67.5	9.25	9.32	9.22	0.0299
7 FDAS:Averag	1	0	21	21	2842	67.7	9.27	9.34	9.23	0.028
7 FDAS:Averag	1	0	42	42	2842	66.1	9.18	9.22	9.13	0.0199
7 FDAS:Averag	1	0	62	62	2842	61.7	8.89	8.92	8.81	0.028
7 FDAS:Averag	1	0	82	82	2842	56.7	8.5	8.56	8.43	0.028
7 FDAS:Averag	1	0	102	102	2842	55.5	8.39	8.46	8.36	0.026
7 FDAS:Averag	1	0	122	122	2842	58.8	8.65	8.68	8.63	0.014
7 FDAS:Averag	1	0	142	142	2842	62.6	8.92	8.98	8.87	0.024
7 FDAS:Averag	1	0	162	162	2842	63.9	9.01	9.06	8.98	0.026
7 FDAS:Averag	1	0	183	183	2842	64	9.03	9.07	8.98	0.024
7 FDAS:Averag	2	5	0	0	2842	65.3	9.11	9.13	9.1	0.014
7 FDAS:Averag	2	5	20	20	2842	65.4	9.13	9.18	9.07	0.026
7 FDAS:Averag	2	5	42	42	2842	66.1	9.19	9.22	9.13	0.026
7 FDAS:Averag	2	5	62	62	2842	65	9.1	9.13	9.06	0.026
7 FDAS:Averag	2	5	82	82	2842	60.1	8.75	8.81	8.69	0.028
7 FDAS:Averag	2	5	102	102	2842	55.4	8.37	8.43	8.36	0.018
7 FDAS:Averag	2	5	122	122	2842	55	8.37	8.39	8.34	0.0199
7 FDAS:Averag	2	5	142	142	2842	59.2	8.68	8.74	8.63	0.026
7 FDAS:Averag	2	5	162	162	2842	63.1	8.96	9	8.92	0.0219
7 FDAS:Averag	2	5	183	183	2842	63.5	9	9.03	8.96	0.0199
7 FDAS:Averag	3	10	0	0	2842	70.1	9.46	9.51	9.39	0.0299
7 FDAS:Averag	3	10	21	21	2842	71	9.5	9.57	9.44	0.034
7 FDAS:Averag	3	10	42	42	2842	71.3	9.53	9.56	9.5	0.0219

Appendix E: Dia-stron Dimensional Report for Slice Importance

7 FDAS:Averag	3	10	62	62	2842	72.5	9.61	9.65	9.56	0.032
7 FDAS:Averag	3	10	83	83	2842	70.4	9.46	9.5	9.44	0.016
7 FDAS:Averag	3	10	101	101	2842	64.7	9.1	9.15	9.01	0.034
7 FDAS:Averag	3	10	122	122	2842	59.8	8.74	8.8	8.65	0.032
7 FDAS:Averag	3	10	142	142	2842	61.1	8.86	8.89	8.75	0.0299
7 FDAS:Averag	3	10	162	162	2842	65	9.11	9.13	9.07	0.016
7 FDAS:Averag	3	10	183	183	2842	67.6	9.25	9.32	9.23	0.0219
7 FDAS:Averag	4	15	0	0	2842	62.6	8.94	8.96	8.89	0.0199
7 FDAS:Averag	4	15	20	20	2842	63.3	8.98	9.03	8.92	0.034
7 FDAS:Averag	4	15	43	43	2842	63.9	9.01	9.06	8.98	0.0219
7 FDAS:Averag	4	15	62	62	2842	65	9.1	9.13	9.07	0.0199
7 FDAS:Averag	4	15	82	82	2842	66	9.15	9.22	9.11	0.028
7 FDAS:Averag	4	15	102	102	2842	63.2	8.96	9	8.94	0.016
7 FDAS:Averag	4	15	122	122	2842	57.8	8.6	8.63	8.53	0.026
7 FDAS:Averag	4	15	142	142	2842	54.4	8.31	8.37	8.27	0.024
7 FDAS:Averag	4	15	162	162	2842	55.4	8.42	8.43	8.36	0.0219
7 FDAS:Averag	4	15	183	183	2842	58.8	8.65	8.68	8.62	0.024
7 FDAS:Averag	5	20	0	0	2842	69.8	9.44	9.47	9.39	0.028
7 FDAS:Averag	5	20	21	21	2842	71.1	9.51	9.56	9.47	0.0299
7 FDAS:Averag	5	20	42	42	2842	74.2	9.72	9.76	9.68	0.018
7 FDAS:Averag	5	20	62	62	2842	75.1	9.8	9.84	9.72	0.0299
7 FDAS:Averag	5	20	82	82	2842	77.3	9.92	9.96	9.88	0.024
7 FDAS:Averag	5	20	102	102	2842	77.8	9.96	10.01	9.89	0.0299
7 FDAS:Averag	5	20	122	122	2842	75.6	9.84	9.85	9.77	0.028
7 FDAS:Averag	5	20	142	142	2842	70.1	9.44	9.51	9.39	0.0299
7 FDAS:Averag	5	20	162	162	2842	64.5	9.06	9.1	9.03	0.018
7 FDAS:Averag	5	20	183	183	2842	66.5	9.19	9.25	9.15	0.0299
7 FDAS:Averag	6	25	0	0	2842	77.1	9.92	9.96	9.85	0.028
7 FDAS:Averag	6	25	20	20	2842	77.6	9.94	10	9.88	0.036
7 FDAS:Averag	6	25	42	42	2842	84.2	10.35	10.39	10.32	0.028
7 FDAS:Averag	6	25	62	62	2842	88.2	10.59	10.64	10.56	0.0199
7 FDAS:Averag	6	25	82	82	2842	88.2	10.59	10.64	10.56	0.028
7 FDAS:Averag	6	25	102	102	2842	89.2	10.7	10.71	10.61	0.034
7 FDAS:Averag	6	25	122	122	2842	90.5	10.73	10.77	10.7	0.026
7 FDAS:Averag	6	25	142	142	2842	86.7	10.52	10.56	10.45	0.026
7 FDAS:Averag	6	25	162	162	2842	78.1	9.97	10.03	9.92	0.032
7 FDAS:Averag	6	25	183	183	2842	73.4	9.63	9.72	9.61	0.0299
7 FDAS:Averag	7	30	0	0	2842	66.1	9.19	9.22	9.13	0.0219
7 FDAS:Averag	7	30	21	21	2842	66	9.18	9.22	9.11	0.0299
7 FDAS:Averag	7	30	42	42	2842	69.3	9.39	9.47	9.32	0.0399
7 FDAS:Averag	7	30	62	62	2842	72.8	9.63	9.65	9.61	0.014
7 FDAS:Averag	7	30	82	82	2842	75.3	9.77	9.85	9.73	0.032
7 FDAS:Averag	7	30	102	102	2842	76.2	9.84	9.88	9.82	0.018
7 FDAS:Averag	7	30	122	122	2842	77.7	9.94	9.97	9.92	0.0219
7 FDAS:Averag	7	30	142	142	2842	77.8	9.97	9.97	9.94	0.016
7 FDAS:Averag	7	30	162	162	2842	73.2	9.65	9.7	9.61	0.028
7 FDAS:Averag	7	30	183	183	2842	66.8	9.22	9.27	9.18	0.0299
7 FDAS:Averag	8	35	0	0	2842	88.4	10.59	10.65	10.57	0.0199
7 FDAS:Averag	8	35	20	20	2842	88.2	10.59	10.64	10.56	0.0199
7 FDAS:Averag	8	35	42	42	2842	89	10.64	10.7	10.59	0.024
7 FDAS:Averag	8	35	62	62	2842	96.2	11.07	11.11	11.02	0.026
7 FDAS:Averag	8	35	82	82	2842	100	11.28	11.34	11.23	0.028
7 FDAS:Averag	8	35	102	102	2842	100.8	11.34	11.38	11.28	0.0299
7 FDAS:Averag	8	35	122	122	2842	103.6	11.47	11.55	11.42	0.036
7 FDAS:Averag	8	35	142	142	2842	104.2	11.53	11.57	11.47	0.024
7 FDAS:Averag	8	35	162	162	2842	98.6	11.21	11.26	11.15	0.0299
7 FDAS:Averag	8	35	182	182	2842	89.9	10.7	10.76	10.64	0.032
7 FDAS:Averag	9	40	0	0	2842	78.1	10	10.03	9.92	0.028
7 FDAS:Averag	9	40	21	21	2842	76.7	9.89	9.92	9.84	0.028
7 FDAS:Averag	9	40	42	42	2842	74	9.72	9.77	9.65	0.026
7 FDAS:Averag	9	40	63	63	2842	78.4	9.97	10.01	9.97	0.0199
7 FDAS:Averag	9	40	82	82	2842	83.4	10.3	10.38	10.23	0.034
7 FDAS:Averag	9	40	102	102	2842	84.8	10.39	10.45	10.33	0.032
7 FDAS:Averag	9	40	122	122	2842	86.1	10.47	10.5	10.44	0.0219
7 FDAS:Averag	9	40	142	142	2842	88.2	10.61	10.64	10.56	0.0219
7 FDAS:Averag	9	40	162	162	2842	87.1	10.53	10.59	10.47	0.0399
7 FDAS:Averag	9	40	183	183	2842	79.5	10.03	10.11	10.01	0.026
7 FDAS:Averag	10	45	0	0	2842	115.8	12.14	12.19	12.1	0.026
7 FDAS:Averag	10	45	20	20	2842	113.4	12.05	12.07	11.96	0.034
7 FDAS:Averag	10	45	42	42	2842	101.9	11.42	11.43	11.35	0.026
7 FDAS:Averag	10	45	62	62	2842	103.2	11.42	11.59	11.34	0.064
7 FDAS:Averag	10	45	82	82	2842	108.7	11.78	11.81	11.72	0.026
7 FDAS:Averag	10	45	102	102	2842	115.6	12.16	12.19	12.07	0.034
7 FDAS:Averag	10	45	122	122	2842	117.4	12.23	12.28	12.17	0.024
7 FDAS:Averag	10	45	142	142	2842	119.6	12.34	12.4	12.28	0.032
7 FDAS:Averag	10	45	162	162	2842	122.1	12.46	12.53	12.41	0.034
7 FDAS:Averag	10	45	183	183	2842	117.7	12.23	12.29	12.19	0.032
7 FDAS:Averag	11	50	0	0	2842	131.7	12.96	13	12.9	0.0299

7	FDAS:Averag	11	50	21	21	2842	130.4	12.9	12.93	12.84	0.026
7	FDAS:Averag	11	50	43	43	2842	116.2	12.17	12.22	12.11	0.034
7	FDAS:Averag	11	50	62	62	2842	110.6	11.88	11.93	11.8	0.0299
7	FDAS:Averag	11	50	82	82	2842	117.4	12.23	12.29	12.16	0.0399
7	FDAS:Averag	11	50	102	102	2842	125.9	12.67	12.72	12.6	0.0299
7	FDAS:Averag	11	50	122	122	2842	129.6	12.86	12.9	12.79	0.028
7	FDAS:Averag	11	50	142	142	2842	130.9	12.9	12.96	12.86	0.0299
7	FDAS:Averag	11	50	162	162	2842	134.1	13.07	13.11	13.02	0.032
7	FDAS:Averag	11	50	183	183	2842	131.3	12.92	12.98	12.88	0.0299
7	FDAS:Averag	12	55	0	0	2842	124.1	12.55	12.64	12.5	0.034
7	FDAS:Averag	12	55	20	20	2842	122.6	12.52	12.53	12.46	0.024
7	FDAS:Averag	12	55	43	43	2842	110.9	11.9	11.93	11.84	0.032
7	FDAS:Averag	12	55	62	62	2842	103	11.43	11.52	11.38	0.034
7	FDAS:Averag	12	55	82	82	2842	105.1	11.59	11.61	11.53	0.024
7	FDAS:Averag	12	55	102	102	2842	113.5	12.03	12.07	11.97	0.032
7	FDAS:Averag	12	55	122	122	2842	117.9	12.28	12.34	12.17	0.0439
7	FDAS:Averag	12	55	142	142	2842	120.3	12.38	12.41	12.34	0.024
7	FDAS:Averag	12	55	162	162	2842	122.3	12.48	12.53	12.43	0.0299
7	FDAS:Averag	12	55	183	183	2842	122	12.46	12.53	12.4	0.036
7	FDAS:Averag	13	60	0	0	2842	127.5	12.76	12.79	12.69	0.024
7	FDAS:Averag	13	60	21	21	2842	127	12.73	12.76	12.67	0.0219
7	FDAS:Averag	13	60	42	42	2842	116.3	12.19	12.23	12.11	0.034
7	FDAS:Averag	13	60	62	62	2842	106	11.59	11.68	11.55	0.024
7	FDAS:Averag	13	60	82	82	2842	106	11.61	11.65	11.59	0.018
7	FDAS:Averag	13	60	102	102	2842	113.3	12.02	12.05	11.97	0.0219
7	FDAS:Averag	13	60	122	122	2842	118.9	12.31	12.35	12.26	0.028
7	FDAS:Averag	13	60	142	142	2842	122	12.48	12.52	12.41	0.024
7	FDAS:Averag	13	60	162	162	2842	123.5	12.53	12.6	12.48	0.034
7	FDAS:Averag	13	60	183	183	2842	123.8	12.55	12.61	12.5	0.036
7	FDAS:Averag	14	65	0	0	2842	122	12.46	12.52	12.41	0.024
7	FDAS:Averag	14	65	20	20	2842	121.7	12.43	12.5	12.4	0.032
7	FDAS:Averag	14	65	43	43	2842	113	12.02	12.03	11.96	0.0219
7	FDAS:Averag	14	65	62	62	2842	102.2	11.42	11.46	11.35	0.026
7	FDAS:Averag	14	65	82	82	2842	99.7	11.26	11.3	11.23	0.016
7	FDAS:Averag	14	65	102	102	2842	105	11.57	11.61	11.52	0.028
7	FDAS:Averag	14	65	122	122	2842	113.5	12.02	12.07	11.97	0.0299
7	FDAS:Averag	14	65	142	142	2842	116.5	12.19	12.22	12.14	0.024
7	FDAS:Averag	14	65	162	162	2842	117.7	12.23	12.29	12.19	0.028
7	FDAS:Averag	14	65	182	182	2842	120.4	12.4	12.41	12.35	0.016
7	FDAS:Averag	15	70	0	0	2842	131.7	12.93	12.98	12.92	0.018
7	FDAS:Averag	15	70	20	20	2842	131.7	12.93	13	12.9	0.026
7	FDAS:Averag	15	70	43	43	2842	123.7	12.55	12.6	12.5	0.0299
7	FDAS:Averag	15	70	62	62	2842	111.8	11.93	11.96	11.9	0.0199
7	FDAS:Averag	15	70	82	82	2842	107.6	11.72	11.76	11.65	0.0299
7	FDAS:Averag	15	70	102	102	2842	112.3	11.96	12	11.92	0.0219
7	FDAS:Averag	15	70	122	122	2842	120.7	12.4	12.48	12.31	0.036
7	FDAS:Averag	15	70	142	142	2842	124.9	12.61	12.67	12.55	0.036
7	FDAS:Averag	15	70	162	162	2842	125.7	12.65	12.73	12.57	0.0419
7	FDAS:Averag	15	70	183	183	2842	127	12.72	12.78	12.65	0.024
7	FDAS:Averag	16	75	0	0	2842	148.4	13.72	13.8	13.69	0.0299
7	FDAS:Averag	16	75	20	20	2842	147.9	13.74	13.8	13.65	0.034
7	FDAS:Averag	16	75	43	43	2842	140.6	13.42	13.53	13.23	0.092
7	FDAS:Averag	16	75	62	62	2842	129.1	12.81	12.86	12.78	0.0299
7	FDAS:Averag	16	75	82	82	2842	121.7	12.46	12.5	12.4	0.0299
7	FDAS:Averag	16	75	102	102	2842	125.3	12.64	12.69	12.57	0.034
7	FDAS:Averag	16	75	122	122	2842	134.8	13.14	13.15	13.05	0.028
7	FDAS:Averag	16	75	142	142	2842	141.2	13.42	13.46	13.36	0.0219
7	FDAS:Averag	16	75	162	162	2842	141.2	13.39	13.46	13.36	0.028
7	FDAS:Averag	16	75	182	182	2842	142.5	13.5	13.51	13.43	0.0219
7	FDAS:Averag	17	80	0	0	2842	128.3	12.78	12.84	12.72	0.0299
7	FDAS:Averag	17	80	20	20	2842	128	12.78	12.81	12.72	0.026
7	FDAS:Averag	17	80	43	43	2842	121.9	12.43	12.52	12.4	0.0299
7	FDAS:Averag	17	80	62	62	2842	109.8	11.81	11.85	11.8	0.0199
7	FDAS:Averag	17	80	82	82	2842	104.1	11.5	11.57	11.46	0.036
7	FDAS:Averag	17	80	102	102	2842	106.7	11.68	11.72	11.59	0.034
7	FDAS:Averag	17	80	122	122	2842	116.6	12.17	12.23	12.14	0.028
7	FDAS:Averag	17	80	142	142	2842	121.7	12.46	12.5	12.4	0.028
7	FDAS:Averag	17	80	162	162	2842	122.5	12.52	12.55	12.43	0.036
7	FDAS:Averag	17	80	183	183	2842	124.6	12.61	12.64	12.55	0.0199
7	FDAS:Averag	18	85	0	0	2842	129.2	12.79	12.96	12.69	0.0759
7	FDAS:Averag	18	85	20	20	2842	128	12.78	12.81	12.72	0.028
7	FDAS:Averag	18	85	43	43	2842	122.2	12.48	12.52	12.43	0.018
7	FDAS:Averag	18	85	62	62	2842	110.7	11.85	11.93	11.81	0.034
7	FDAS:Averag	18	85	82	82	2842	103.4	11.47	11.53	11.42	0.028
7	FDAS:Averag	18	85	102	102	2842	108.3	11.73	11.8	11.69	0.028
7	FDAS:Averag	18	85	122	122	2842	116.7	12.19	12.22	12.16	0.0219
7	FDAS:Averag	18	85	142	142	2842	121.7	12.43	12.5	12.4	0.028
7	FDAS:Averag	18	85	162	162	2842	122.6	12.5	12.53	12.46	0.028

Appendix E: Dia-stron Dimensional Report for Slice Importance

7 FDAS:Averag	18	85	182	182	2842	124.5	12.6	12.65	12.53	0.032
7 FDAS:Averag	19	90	0	0	2842	124.8	12.6	12.64	12.57	0.0219
7 FDAS:Averag	19	90	21	21	2842	124.4	12.55	12.64	12.53	0.0299
7 FDAS:Averag	19	90	43	43	2842	117.5	12.23	12.29	12.17	0.032
7 FDAS:Averag	19	90	62	62	2842	106	11.61	11.65	11.59	0.016
7 FDAS:Averag	19	90	82	82	2842	101.3	11.35	11.43	11.28	0.0399
7 FDAS:Averag	19	90	102	102	2842	104.7	11.57	11.59	11.5	0.026
7 FDAS:Averag	19	90	122	122	2842	112.2	11.96	12	11.9	0.0379
7 FDAS:Averag	19	90	142	142	2842	116.9	12.19	12.23	12.17	0.018
7 FDAS:Averag	19	90	162	162	2842	118.2	12.29	12.31	12.23	0.024
7 FDAS:Averag	19	90	182	182	2842	121.2	12.4	12.46	12.38	0.0219
7 FDAS:Averag	20	95	0	0	2842	131.3	12.92	12.96	12.9	0.018
7 FDAS:Averag	20	95	20	20	2842	131.3	12.92	12.98	12.88	0.026
7 FDAS:Averag	20	95	43	43	2842	123.7	12.55	12.6	12.5	0.028
7 FDAS:Averag	20	95	62	62	2842	112.6	12	12.03	11.92	0.036
7 FDAS:Averag	20	95	82	82	2842	105.9	11.64	11.69	11.53	0.048
7 FDAS:Averag	20	95	102	102	2842	110.9	11.88	11.96	11.81	0.0379
7 FDAS:Averag	20	95	122	122	2842	119.4	12.31	12.38	12.28	0.0299
7 FDAS:Averag	20	95	143	143	2842	124.7	12.61	12.65	12.55	0.028
7 FDAS:Averag	20	95	162	162	2842	125.5	12.65	12.67	12.61	0.018
7 FDAS:Averag	20	95	183	183	2842	127.8	12.76	12.79	12.72	0.0199
8 FDAS:Averag	1	0	0	0	5041	59.7	8.72	8.75	8.68	0.024
8 FDAS:Averag	1	0	21	21	5041	60.1	8.75	8.81	8.69	0.032
8 FDAS:Averag	1	0	42	42	5041	60.5	8.8	8.81	8.75	0.0219
8 FDAS:Averag	1	0	62	62	5041	59.4	8.69	8.74	8.65	0.0199
8 FDAS:Averag	1	0	82	82	5041	54.6	8.36	8.37	8.3	0.024
8 FDAS:Averag	1	0	102	102	5041	50.2	8.01	8.03	7.96	0.018
8 FDAS:Averag	1	0	122	122	5041	51.3	8.07	8.12	8.05	0.0199
8 FDAS:Averag	1	0	142	142	5041	54.6	8.34	8.37	8.3	0.0199
8 FDAS:Averag	1	0	162	162	5041	57.4	8.53	8.62	8.48	0.036
8 FDAS:Averag	1	0	182	182	5041	57.5	8.56	8.6	8.51	0.0219
8 FDAS:Averag	2	8	0	0	5041	69.1	9.38	9.44	9.32	0.0299
8 FDAS:Averag	2	8	21	21	5041	69.3	9.39	9.44	9.35	0.018
8 FDAS:Averag	2	8	42	42	5041	70.1	9.47	9.51	9.39	0.028
8 FDAS:Averag	2	8	62	62	5041	71.4	9.56	9.57	9.5	0.026
8 FDAS:Averag	2	8	82	82	5041	70.3	9.44	9.5	9.42	0.026
8 FDAS:Averag	2	8	101	101	5041	66.2	9.18	9.25	9.11	0.0379
8 FDAS:Averag	2	8	122	122	5041	61	8.84	8.86	8.77	0.024
8 FDAS:Averag	2	8	142	142	5041	60.1	8.77	8.81	8.69	0.032
8 FDAS:Averag	2	8	162	162	5041	63.7	9.01	9.03	8.98	0.0219
8 FDAS:Averag	2	8	182	182	5041	65.8	9.15	9.19	9.11	0.026
8 FDAS:Averag	3	16	0	0	5041	70.5	9.47	9.53	9.42	0.0299
8 FDAS:Averag	3	16	20	20	5041	71.4	9.51	9.57	9.5	0.0199
8 FDAS:Averag	3	16	42	42	5041	75.3	9.82	9.85	9.73	0.034
8 FDAS:Averag	3	16	62	62	5041	75.7	9.85	9.88	9.76	0.032
8 FDAS:Averag	3	16	82	82	5041	77.4	9.92	9.97	9.88	0.0299
8 FDAS:Averag	3	16	102	102	5041	79.9	10.09	10.11	10.06	0.018
8 FDAS:Averag	3	16	122	122	5041	78	9.97	10.01	9.92	0.026
8 FDAS:Averag	3	16	142	142	5041	70.7	9.5	9.51	9.46	0.016
8 FDAS:Averag	3	16	162	162	5041	65.6	9.13	9.18	9.1	0.0199
8 FDAS:Averag	3	16	182	182	5041	67.3	9.25	9.32	9.19	0.0299
8 FDAS:Averag	4	24	0	0	5041	74.9	9.72	9.96	9.57	0.116
8 FDAS:Averag	4	24	21	21	5041	75.7	9.82	9.88	9.76	0.0299
8 FDAS:Averag	4	24	42	42	5041	81.5	10.2	10.23	10.14	0.026
8 FDAS:Averag	4	24	62	62	5041	86.7	10.52	10.57	10.44	0.036
8 FDAS:Averag	4	24	82	82	5041	88.1	10.59	10.65	10.53	0.032
8 FDAS:Averag	4	24	102	102	5041	89	10.64	10.68	10.61	0.018
8 FDAS:Averag	4	24	122	122	5041	90.6	10.73	10.8	10.68	0.0399
8 FDAS:Averag	4	24	142	142	5041	87.3	10.53	10.57	10.52	0.0219
8 FDAS:Averag	4	24	162	162	5041	79	10.01	10.06	10	0.0219
8 FDAS:Averag	4	24	183	183	5041	70.5	9.5	9.53	9.42	0.034
8 FDAS:Averag	5	32	0	0	5041	90.3	10.7	10.76	10.68	0.0219
8 FDAS:Averag	5	32	20	20	5041	89.7	10.7	10.77	10.61	0.0399
8 FDAS:Averag	5	32	42	42	5041	88.3	10.61	10.65	10.56	0.0299
8 FDAS:Averag	5	32	62	62	5041	94.8	11	11.03	10.94	0.026
8 FDAS:Averag	5	32	82	82	5041	100.8	11.31	11.38	11.28	0.024
8 FDAS:Averag	5	32	101	101	5041	101.2	11.35	11.4	11.3	0.032
8 FDAS:Averag	5	32	122	122	5041	103	11.43	11.5	11.4	0.0299
8 FDAS:Averag	5	32	142	142	5041	104.2	11.53	11.57	11.47	0.0299
8 FDAS:Averag	5	32	162	162	5041	100.5	11.31	11.4	11.23	0.0399
8 FDAS:Averag	5	32	183	183	5041	89.9	10.7	10.76	10.64	0.036
8 FDAS:Averag	6	40	0	0	5041	133	13.02	13.05	12.98	0.024
8 FDAS:Averag	6	40	21	21	5041	129.7	12.86	13.05	12.65	0.14
8 FDAS:Averag	6	40	42	42	5041	118.6	12.28	12.35	12.23	0.032
8 FDAS:Averag	6	40	62	62	5041	122.5	12.5	12.55	12.43	0.0299
8 FDAS:Averag	6	40	82	82	5041	134.1	13.07	13.26	12.88	0.148
8 FDAS:Averag	6	40	102	102	5041	139.6	13.31	13.39	13.27	0.032
8 FDAS:Averag	6	40	122	122	5041	139.8	13.34	13.38	13.3	0.0199

Appendix E: Dia-stron Dimensional Report for Slice Importance

8	FDAS:Averag	6	40	142	142	5041	140.7	13.38	13.43	13.34	0.024
8	FDAS:Averag	6	40	162	162	5041	142.5	13.48	13.51	13.43	0.0299
8	FDAS:Averag	6	40	183	183	5041	134.4	13.07	13.11	13.05	0.018
8	FDAS:Averag	7	48	0	0	5041	123.2	12.52	12.55	12.5	0.016
8	FDAS:Averag	7	48	20	20	5041	122.2	12.46	12.52	12.43	0.0219
8	FDAS:Averag	7	48	42	42	5041	110.4	11.85	11.9	11.81	0.026
8	FDAS:Averag	7	48	62	62	5041	102.8	11.42	11.5	11.38	0.0299
8	FDAS:Averag	7	48	82	82	5041	106.9	11.68	11.76	11.57	0.046
8	FDAS:Averag	7	48	102	102	5041	114.4	12.07	12.14	12	0.036
8	FDAS:Averag	7	48	122	122	5041	119.5	12.35	12.38	12.29	0.0219
8	FDAS:Averag	7	48	142	142	5041	121.2	12.41	12.46	12.38	0.0219
8	FDAS:Averag	7	48	162	162	5041	123.2	12.52	12.55	12.5	0.018
8	FDAS:Averag	7	48	182	182	5041	122.2	12.48	12.52	12.43	0.0199
8	FDAS:Averag	8	56	0	0	5041	124.4	12.6	12.64	12.53	0.0299
8	FDAS:Averag	8	56	21	21	5041	123.4	12.52	12.61	12.46	0.036
8	FDAS:Averag	8	56	42	42	5041	113	12.02	12.03	11.96	0.0219
8	FDAS:Averag	8	56	62	62	5041	102.7	11.43	11.47	11.4	0.024
8	FDAS:Averag	8	56	82	82	5041	103.5	11.47	11.53	11.43	0.032
8	FDAS:Averag	8	56	101	101	5041	110.5	11.85	11.92	11.8	0.0299
8	FDAS:Averag	8	56	122	122	5041	118.1	12.26	12.31	12.22	0.026
8	FDAS:Averag	8	56	142	142	5041	120.2	12.38	12.43	12.31	0.034
8	FDAS:Averag	8	56	162	162	5041	120.6	12.4	12.43	12.35	0.024
8	FDAS:Averag	8	56	183	183	5041	121.3	12.43	12.46	12.4	0.0199
8	FDAS:Averag	9	64	0	0	5041	160.2	14.27	14.31	14.25	0.0199
8	FDAS:Averag	9	64	20	20	5041	159.7	14.25	14.34	14.18	0.0419
8	FDAS:Averag	9	64	42	42	5041	151	13.86	13.92	13.81	0.0299
8	FDAS:Averag	9	64	62	62	5041	139.1	13.31	13.36	13.26	0.026
8	FDAS:Averag	9	64	82	82	5041	133.2	13	13.07	12.98	0.026
8	FDAS:Averag	9	64	102	102	5041	136.5	13.22	13.23	13.14	0.032
8	FDAS:Averag	9	64	122	122	5041	147.6	13.69	13.77	13.65	0.0299
8	FDAS:Averag	9	64	142	142	5041	153.3	13.96	14.01	13.93	0.028
8	FDAS:Averag	9	64	162	162	5041	154.2	14	14.06	13.96	0.0299
8	FDAS:Averag	9	64	183	183	5041	155.1	14.06	14.1	14.01	0.026
8	FDAS:Averag	10	72	0	0	5041	140.7	13.39	13.46	13.31	0.0439
8	FDAS:Averag	10	72	21	21	5041	143	13.51	13.53	13.46	0.026
8	FDAS:Averag	10	72	42	42	5041	138.6	13.3	13.31	13.26	0.0219
8	FDAS:Averag	10	72	62	62	5041	128.1	12.78	12.81	12.73	0.028
8	FDAS:Averag	10	72	82	82	5041	119.4	12.34	12.38	12.28	0.028
8	FDAS:Averag	10	72	102	102	5041	122.5	12.48	12.52	12.46	0.0199
8	FDAS:Averag	10	72	122	122	5041	131.9	12.96	13	12.92	0.028
8	FDAS:Averag	10	72	142	142	5041	136.7	13.19	13.22	13.17	0.014
8	FDAS:Averag	10	72	162	162	5041	136.5	13.17	13.22	13.15	0.018
8	FDAS:Averag	10	72	183	183	5041	136.9	13.23	13.26	13.15	0.0299
8	FDAS:Averag	11	80	0	0	5041	125.6	12.61	12.69	12.6	0.034
8	FDAS:Averag	11	80	20	20	5041	126	12.65	12.69	12.64	0.024
8	FDAS:Averag	11	80	42	42	5041	121.1	12.4	12.48	12.35	0.036
8	FDAS:Averag	11	80	62	62	5041	109.5	11.8	11.84	11.78	0.016
8	FDAS:Averag	11	80	82	82	5041	102.2	11.42	11.46	11.35	0.024
8	FDAS:Averag	11	80	102	102	5041	106.5	11.65	11.68	11.61	0.016
8	FDAS:Averag	11	80	122	122	5041	114.4	12.07	12.11	12.03	0.024
8	FDAS:Averag	11	80	142	142	5041	118.9	12.29	12.38	12.23	0.032
8	FDAS:Averag	11	80	162	162	5041	119.5	12.34	12.38	12.29	0.018
8	FDAS:Averag	11	80	182	182	5041	121.3	12.41	12.48	12.38	0.026
8	FDAS:Averag	12	88	0	0	5041	120.5	12.38	12.43	12.34	0.028
8	FDAS:Averag	12	88	21	21	5041	120	12.38	12.41	12.31	0.0299
8	FDAS:Averag	12	88	42	42	5041	115.6	12.11	12.19	12.07	0.032
8	FDAS:Averag	12	88	62	62	5041	103.6	11.52	11.57	11.4	0.058
8	FDAS:Averag	12	88	82	82	5041	97.3	11.14	11.19	11.07	0.032
8	FDAS:Averag	12	88	102	102	5041	101.9	11.38	11.47	11.31	0.0419
8	FDAS:Averag	12	88	122	122	5041	109.4	11.8	11.85	11.76	0.026
8	FDAS:Averag	12	88	142	142	5041	113.4	12.02	12.07	11.96	0.032
8	FDAS:Averag	12	88	162	162	5041	114.1	12.07	12.11	12	0.034
8	FDAS:Averag	12	88	183	183	5041	115.9	12.16	12.19	12.11	0.0219
8	FDAS:Averag	13	96	0	0	5041	121.7	12.46	12.5	12.4	0.026
8	FDAS:Averag	13	96	20	20	5041	121.2	12.43	12.5	12.35	0.0399
8	FDAS:Averag	13	96	42	42	5041	115.9	12.16	12.19	12.11	0.0219
8	FDAS:Averag	13	96	62	62	5041	104.1	11.55	11.57	11.46	0.032
8	FDAS:Averag	13	96	82	82	5041	98.1	11.18	11.21	11.14	0.0199
8	FDAS:Averag	13	96	102	102	5041	102.2	11.42	11.47	11.35	0.0399
8	FDAS:Averag	13	96	122	122	5041	110.1	11.84	11.9	11.78	0.036
8	FDAS:Averag	13	96	142	142	5041	113.5	12.02	12.07	11.97	0.028
8	FDAS:Averag	13	96	162	162	5041	114.4	12.05	12.14	12	0.036
8	FDAS:Averag	13	96	182	182	5041	115.7	12.11	12.17	12.1	0.026

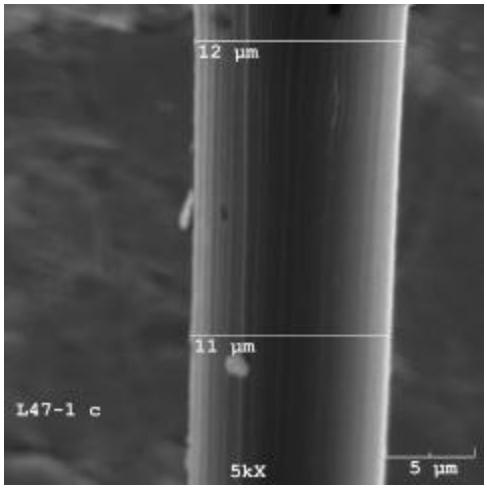
Appendix F: SEM Data and Select Images

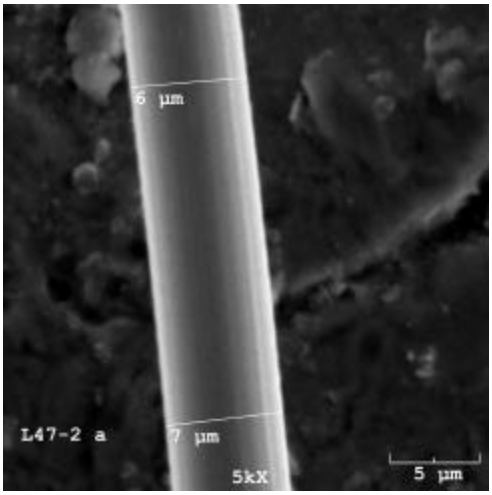
L47-Middle Left Rear
SEM Data

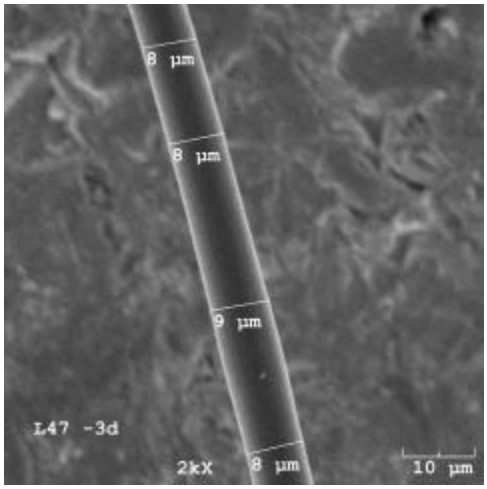
Sample	Slice	Diameter	Mean Image Diar	Mean Fiber Diameter
1	1	9		
		9	9	
	2	11		
		12	11.5	
	3	10		
		9	9.5	
				10
2	1	7		
		6	6.5	
	2	6		
		6		
		7	6.33	
				6
3	1	9		
		10		
		10	9.67	
	2	10		
		10		
		9	9.67	
	3	8		
		9		
		8		
		8	8.25	
				9
4	1	8		
		7		
		7		
		6		
		6	6.8	
	2	7		
		7		
		7	7	
				7
5	1	8		
		8		
		7	7.67	
	2	6		
		6		
		6	6	
	3	12		
		14		
		13		
		13		
		12	12.8	
	4	11		
		10		
		10		
		10	10.25	9
6	1	10		
		10		
		10	10	
	2	9		
		9		
		9	9	
	3	9		
		10		
		10	9.67	
				10

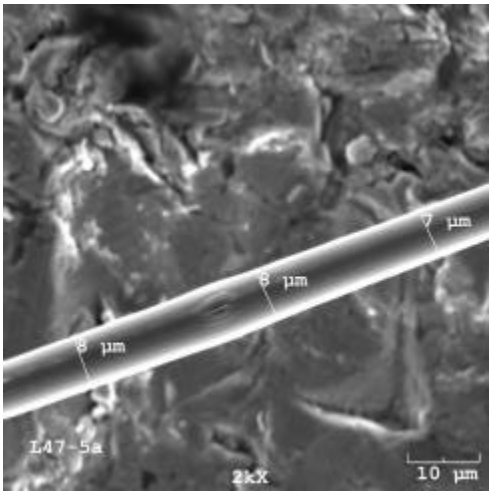
*Mean fiber diameter data rounded to the nearest micron. Data only accurate to the micron

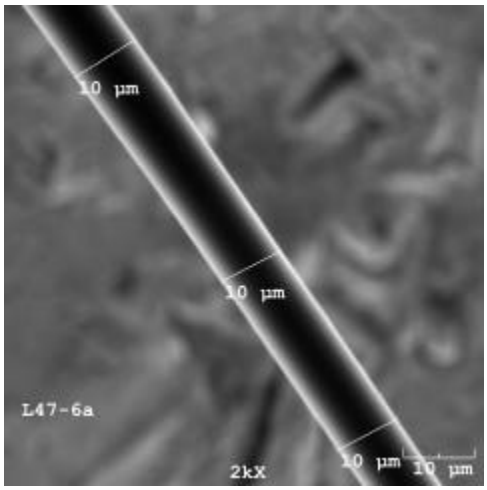
Select Carbon Fiber SEM Measured Images











Appendix G: Dia-stron Dimensional Data for SEM Samples

L47-1 SEM Dia-stron Dimensional
Dimensional Data Report

Record	Slice No.	Slice Position	Start Angle Degrees	End Angle Degrees	Elapsed Time Seconds	Cross-Sectional Sq.Microns	Mean Diameter Microns	Mean Slice Diameter Microns	Max. Diameter Microns	Min. Diameter Microns	Std. Deviation
1	1	0	0	0	0	94.1	10.92		11.07	10.82	0.074
1	1	0	21	21	0	88.8	10.64		10.8	10.47	0.082
1	1	0	42	42	0	67.8	9.3		9.35	9.23	0.032
1	1	0	62	62	0	69	9.34		9.42	9.32	0.034
1	1	0	82	82	0	59.4	8.72		8.74	8.65	0.028
1	1	0	102	102	0	60.1	8.75		8.81	8.69	0.0439
1	1	0	122	122	0	63.3	9		9.07	8.89	0.046
1	1	0	142	142	0	66.3	9.22		9.27	9.11	0.048
1	1	0	162	162	0	74	9.72		9.77	9.65	0.0379
1	1	0	182	182	0	76.3	9.88	9.549	9.94	9.77	0.0499
1	2	10	0	0	0	134.1	13.02		13.3	12.84	0.14
1	2	10	21	21	0	118.1	12.34		12.53	12	0.142
1	2	10	42	42	0	95.5	11		11.11	10.94	0.056
1	2	10	62	62	0	84.4	10.35		10.5	10.23	0.074
1	2	10	82	82	0	75	9.76		9.89	9.65	0.064
1	2	10	102	102	0	76.7	9.88		9.96	9.8	0.0399
1	2	10	122	122	0	99	11.21		11.31	11.14	0.0599
1	2	10	142	142	0	108.3	11.73		11.92	11.57	0.0839
1	2	10	162	162	0	111.9	11.96		12.11	11.76	0.09
1	2	10	182	182	0	107.3	11.68	11.293	11.88	11.5	0.1019
1	3	20	0	0	0	78.6	10.01		10.09	9.92	0.048
1	3	20	21	21	0	70.7	9.51		9.6	9.38	0.0619
1	3	20	42	42	0	65.2	9.11		9.15	9.07	0.0219
1	3	20	62	62	0	62.1	8.89		8.92	8.86	0.018
1	3	20	82	82	0	55.8	8.42		8.56	8.3	0.054
1	3	20	102	102	0	51.3	8.1		8.13	8.03	0.032
1	3	20	122	122	0	56.1	8.43		8.6	8.3	0.0659
1	3	20	142	142	0	58.6	8.62		8.74	8.53	0.0599
1	3	20	162	162	0	67.4	9.27		9.35	9.18	0.054
1	3	20	183	183	0	60.3	8.75	8.911	8.84	8.68	0.046

Min	8.911	Cross-secti	77.25185
Max	11.293		
Median	9.549		
Mean	9.917666667		
Std. Dev	1.23305204		

Appendix G: Dia-stron Dimensional Data for SEM Samples

L47-2 SEM Dia-stron Dimensional
Dimensional Data Report

Record	Slice No.	Slice Position	Start Angle Degrees	End Angle Degrees	Elapsed Time Seconds	Cross-Sectional Sq.Microns	Mean Diameter Microns	Mean Slice Diameter Microns	Max. Diameter Microns	Min. Diameter Microns	Std. Deviation
1	1	0	0	0	0	90.8	10.76		10.8	10.7	0.028
1	1	0	21	21	0	93.2	10.9		10.94	10.85	0.024
1	1	0	42	42	0	102.3	11.42		11.43	11.4	0.016
1	1	0	62	62	0	101.9	11.4		11.43	11.35	0.0219
1	1	0	82	82	0	97.2	11.14		11.18	11.07	0.0299
1	1	0	102	102	0	95.6	11.02		11.07	11	0.024
1	1	0	122	122	0	91	10.76		10.8	10.73	0.0199
1	1	0	142	142	0	84.5	10.35		10.42	10.32	0.028
1	1	0	163	163	0	80.8	10.14		10.2	10.09	0.026
1	1	0	182	182	0	83.2	10.3	10.819	10.35	10.23	0.0379
1	2	10	0	0	0	88.6	10.64		10.71	10.53	0.0379
1	2	10	21	21	0	88.3	10.59		10.65	10.56	0.0299
1	2	10	43	43	0	93.2	10.9		10.94	10.85	0.0219
1	2	10	62	62	0	98.3	11.19		11.23	11.15	0.0219
1	2	10	83	83	0	100.6	11.31		11.38	11.26	0.034
1	2	10	102	102	0	104	11.5		11.55	11.46	0.0299
1	2	10	122	122	0	108.6	11.76		11.8	11.72	0.028
1	2	10	142	142	0	106.9	11.65		11.69	11.64	0.014
1	2	10	162	162	0	98.6	11.19		11.26	11.15	0.028
1	2	10	182	182	0	87.5	10.57	11.13	10.61	10.5	0.032
1	3	20	0	0	0	81.1	10.15		10.21	10.11	0.028
1	3	20	21	21	0	78.9	10.03		10.07	9.97	0.026
1	3	20	43	43	0	73.7	9.72		9.73	9.65	0.026
1	3	20	62	62	0	74.4	9.73		9.76	9.7	0.0199
1	3	20	82	82	0	80.7	10.11		10.2	10.07	0.034
1	3	20	102	102	0	86.3	10.47		10.53	10.44	0.026
1	3	20	122	122	0	90.3	10.7		10.77	10.68	0.0299
1	3	20	142	142	0	91.8	10.83		10.85	10.77	0.0219
1	3	20	162	162	0	91	10.77		10.8	10.73	0.0219
1	3	20	183	183	0	82.4	10.26	10.277	10.3	10.18	0.036
1	4	30	0	0	0	71.4	9.53		9.6	9.47	0.0299
1	4	30	21	21	0	70.6	9.46		9.5	9.46	0.014
1	4	30	42	42	0	63.3	8.98		9.01	8.94	0.0199
1	4	30	62	62	0	57.1	8.53		8.56	8.5	0.0199
1	4	30	83	83	0	55.7	8.46		8.48	8.37	0.028
1	4	30	103	103	0	61.1	8.86		8.87	8.77	0.0299
1	4	30	122	122	0	67.6	9.27		9.32	9.23	0.0299
1	4	30	142	142	0	72.1	9.57		9.63	9.53	0.028
1	4	30	162	162	0	72.6	9.6		9.7	9.53	0.034
1	4	30	182	182	0	70.5	9.46	9.172	9.53	9.42	0.028
1	5	40	0	0	0	66.7	9.22		9.25	9.18	0.0219
1	5	40	21	21	0	67.1	9.23		9.27	9.22	0.0199
1	5	40	43	43	0	63.5	9		9.03	8.96	0.024
1	5	40	62	62	0	58.7	8.65		8.69	8.6	0.026
1	5	40	82	82	0	52.9	8.22		8.27	8.15	0.034
1	5	40	102	102	0	51.2	8.05		8.12	8.03	0.0219
1	5	40	122	122	0	55.2	8.39		8.42	8.34	0.0219
1	5	40	142	142	0	61.7	8.87		8.89	8.84	0.0199
1	5	40	162	162	0	65.9	9.15		9.22	9.1	0.032
1	5	40	183	183	0	66	9.13	8.791	9.27	9.07	0.052
1	6	50	0	0	0	89.4	10.64		10.73	10.61	0.0299
1	6	50	21	21	0	90.4	10.71		10.76	10.7	0.018
1	6	50	43	43	0	87.5	10.57		10.59	10.52	0.026
1	6	50	62	62	0	83	10.3		10.35	10.21	0.0379
1	6	50	83	83	0	79.9	10.09		10.11	10.06	0.0199
1	6	50	102	102	0	75.8	9.84		9.88	9.77	0.028
1	6	50	122	122	0	72.8	9.61		9.68	9.57	0.032
1	6	50	142	142	0	72.8	9.61		9.68	9.57	0.028
1	6	50	162	162	0	79.1	10		10.23	9.84	0.108
1	6	50	182	182	0	83.2	10.3	10.167	10.38	10.2	0.0419
1	7	60	0	0	0	70.7	9.5		9.51	9.47	0.016
1	7	60	21	21	0	70.9	9.51		9.53	9.47	0.018
1	7	60	43	43	0	75.8	9.84		9.85	9.8	0.0199
1	7	60	62	62	0	80.5	10.11		10.18	10.07	0.032
1	7	60	82	82	0	83.2	10.3		10.32	10.26	0.0199
1	7	60	102	102	0	84.3	10.38		10.42	10.3	0.034
1	7	60	122	122	0	85.8	10.45		10.52	10.39	0.0299
1	7	60	142	142	0	82.3	10.21		10.32	10.15	0.046
1	7	60	162	162	0	74.2	9.7		9.76	9.68	0.0219
1	7	60	183	183	0	66.8	9.22	9.922	9.25	9.19	0.0199
1	8	70	0	0	0	76.5	9.85		9.92	9.82	0.036
1	8	70	21	21	0	73.5	9.7		9.72	9.63	0.024
1	8	70	43	43	0	66	9.18		9.22	9.11	0.026
1	8	70	62	62	0	60.8	8.8		8.84	8.75	0.028
1	8	70	83	83	0	61.4	8.84		8.89	8.8	0.026
1	8	70	103	103	0	66.5	9.19		9.3	9.11	0.048
1	8	70	122	122	0	73.4	9.68		9.72	9.61	0.028
1	8	70	142	142	0	79.5	10.06		10.11	10.01	0.028
1	8	70	162	162	0	77.3	9.92		9.96	9.88	0.0219
1	8	70	183	183	0	70.8	9.5	9.472	9.53	9.46	0.028
1	9	80	0	0	0	71.9	9.53		9.6	9.53	0.016
1	9	80	21	21	0	71	9.5		9.56	9.46	0.026
1	9	80	43	43	0	67.7	9.32		9.34	9.23	0.0299
1	9	80	62	62	0	65.7	9.15		9.19	9.1	0.024
1	9	80	82	82	0	64.2	9.06		9.07	9.01	0.018
1	9	80	102	102	0	62.2	8.87		8.94	8.86	0.018
1	9	80	122	122	0	60	8.74		8.8	8.68	0.032
1	9	80	142	142	0	61.2	8.81		8.89	8.77	0.032
1	9	80	162	162	0	63	8.96		9.03	8.89	0.048
1	9	80	183	183	0	63.2	9	9.094	9.07	8.87	0.0659
1	10	90	0	0	0	48	7.82		7.86	7.78	0.0199
1	10	90	21	21	0	47.8	7.82		7.88	7.73	0.036
1	10	90	42	42	0	51.1	8.07		8.13	8.01	0.026
1	10	90	62	62	0	53.4	8.24		8.3	8.19	0.0299
1	10	90	83	83	0	54.3	8.34		8.36	8.27	0.024
1	10	90	102	102	0	54.3	8.31		8.36	8.27	0.018
1	10	90	122	122	0	54.4	8.36		8.39	8.25	0.034
1	10	90	142	142	0	53.4	8.25		8.3	8.19	0.024
1	10	90	162	162	0	48.3	7.86		7.89	7.79	0.026
1	10	90	183	183	0	44.4	7.53	8.06	7.57	7.46	0.032

min	8.06
max	11.13
median	9.697
mean	9.6904
std. dev	0.949287827

Appendix G: Dia-stron Dimensional Data for SEM Samples

L47-3 SEM Dia-stron Dimensional

Dimensional Data Report

Record	Slice No.	Slice Position	Start Angle Degrees	End Angle Degrees	Elapsed Time Seconds	Cross-Sectional Sq.Microns	Mean Diameter Microns	Mean Slice Diameter Microns	Max. Diameter Microns	Min. Diameter Microns	Std. Deviation
1	1	0	0	0	0	28.1	5.98		6.05	5.92	0.0379
1	1	0	21	21	0	27.7	5.94		6	5.88	0.034
1	1	0	42	42	0	30.1	6.2		6.24	6.14	0.028
1	1	0	62	62	0	31.8	6.36		6.42	6.3	0.034
1	1	0	82	82	0	32.2	6.44		6.51	6.3	0.054
1	1	0	103	103	0	33.4	6.53		6.55	6.5	0.018
1	1	0	122	122	0	34.3	6.59		6.68	6.53	0.0399
1	1	0	142	142	0	34	6.55		6.65	6.51	0.0399
1	1	0	162	162	0	31.7	6.36		6.39	6.32	0.0299
1	1	0	183	183	0	29.8	6.15	6.31	6.21	6.11	0.034
1	2	10	0	0	0	30.9	6.3		6.33	6.21	0.0299
1	2	10	21	21	0	31	6.27		6.32	6.24	0.024
1	2	10	43	43	0	34	6.59		6.65	6.51	0.0399
1	2	10	62	62	0	35.7	6.74		6.8	6.69	0.028
1	2	10	82	82	0	36.3	6.81		6.86	6.74	0.032
1	2	10	102	102	0	37.1	6.9		6.94	6.81	0.0299
1	2	10	122	122	0	38.2	6.96		7.03	6.92	0.036
1	2	10	142	142	0	37.5	6.94		6.98	6.84	0.036
1	2	10	163	163	0	34.9	6.65		6.71	6.63	0.0219
1	2	10	183	183	0	33.3	6.51	6.667	6.55	6.48	0.0219
1	3	20	0	0	0	39.1	7.06		7.12	7	0.0379
1	3	20	21	21	0	38.3	7		7.01	6.96	0.018
1	3	20	42	42	0	38.5	7.01		7.07	6.94	0.034
1	3	20	62	62	0	39.1	7.07		7.09	7.03	0.024
1	3	20	82	82	0	40.2	7.15		7.19	7.12	0.024
1	3	20	103	103	0	42.8	7.37		7.46	7.31	0.036
1	3	20	122	122	0	43.8	7.5		7.53	7.4	0.036
1	3	20	142	142	0	45.4	7.59		7.66	7.55	0.028
1	3	20	162	162	0	43.4	7.44		7.5	7.37	0.0299
1	3	20	183	183	0	42.3	7.36	7.255	7.37	7.3	0.0219
1	4	30	0	0	0	81.8	10.21		10.26	10.15	0.024
1	4	30	21	21	0	81.3	10.18		10.21	10.14	0.024
1	4	30	42	42	0	76.9	9.92		9.94	9.85	0.024
1	4	30	62	62	0	68.7	9.35		9.38	9.32	0.0199
1	4	30	82	82	0	68.4	9.34		9.39	9.27	0.026
1	4	30	102	102	0	73.7	9.7		9.77	9.6	0.048
1	4	30	122	122	0	79.7	10.09		10.15	10	0.0399
1	4	30	142	142	0	84.7	10.39		10.44	10.33	0.026
1	4	30	163	163	0	84.3	10.35		10.45	10.27	0.0439
1	4	30	183	183	0	86.1	10.47	10	10.52	10.42	0.034
1	5	40	0	0	0	43.9	7.48		7.5	7.46	0.012
1	5	40	21	21	0	45.4	7.59		7.67	7.53	0.0419
1	5	40	42	42	0	45.2	7.61		7.61	7.57	0.014
1	5	40	62	62	0	40	7.12		7.18	7.09	0.0199
1	5	40	83	83	0	36	6.77		6.81	6.74	0.0199
1	5	40	103	103	0	35.3	6.71		6.77	6.63	0.0379
1	5	40	123	123	0	38.1	6.98		7.01	6.92	0.032
1	5	40	142	142	0	41.5	7.25		7.31	7.22	0.028
1	5	40	162	162	0	42.5	7.34		7.42	7.3	0.0399
1	5	40	183	183	0	45.7	7.61	7.246	7.69	7.57	0.034
1	6	50	0	0	0	19.1	4.94		4.98	4.88	0.0299
1	6	50	21	21	0	19.2	5		5.05	4.84	0.0499
1	6	50	43	43	0	20.7	5.16		5.23	5.05	0.0439
1	6	50	62	62	0	20.8	5.16		5.19	5.11	0.024
1	6	50	82	82	0	21.7	5.26		5.32	5.19	0.028
1	6	50	102	102	0	21.9	5.28		5.32	5.23	0.0219
1	6	50	122	122	0	21.9	5.28		5.32	5.23	0.026
1	6	50	142	142	0	21.3	5.22		5.26	5.16	0.026
1	6	50	163	163	0	19.6	5		5.03	4.96	0.024
1	6	50	183	183	0	19.6	5.05	5.135	5.11	4.88	0.054
1	7	60	0	0	0	27.6	5.94		5.98	5.88	0.028
1	7	60	21	21	0	28.6	6.08		6.15	5.92	0.054
1	7	60	42	42	0	30.5	6.24		6.27	6.2	0.0219
1	7	60	62	62	0	27.3	5.9		5.94	5.86	0.026
1	7	60	83	83	0	25.7	5.71		5.76	5.67	0.0199
1	7	60	102	102	0	23.4	5.46		5.51	5.41	0.0379
1	7	60	122	122	0	23.2	5.44		5.5	5.38	0.0299
1	7	60	142	142	0	23.6	5.51		5.51	5.46	0.018
1	7	60	162	162	0	25.7	5.71		5.76	5.67	0.0219
1	7	60	183	183	0	29.8	6.17	5.816	6.24	6.08	0.0419
1	8	70	0	0	0	36.2	6.77		6.86	6.71	0.034
1	8	70	21	21	0	36.7	6.86		6.87	6.81	0.024
1	8	70	43	43	0	39	7.06		7.09	7	0.0299
1	8	70	62	62	0	38.9	7.03		7.07	7	0.024
1	8	70	82	82	0	40	7.13		7.22	7.06	0.0419
1	8	70	102	102	0	39.2	7.06		7.12	7.01	0.032
1	8	70	122	122	0	39	7.06		7.09	7.01	0.028
1	8	70	143	143	0	38.3	6.98		7.01	6.96	0.0199
1	8	70	162	162	0	37.6	6.9		6.98	6.86	0.034
1	8	70	183	183	0	38.3	7	6.985	7.03	6.94	0.0219
1	9	80	0	0	0	57.1	8.53		8.62	8.43	0.0499
1	9	80	21	21	0	57.4	8.53		8.57	8.53	0.016
1	9	80	42	42	0	55.4	8.39		8.42	8.37	0.008
1	9	80	62	62	0	55.7	8.42		8.48	8.37	0.032
1	9	80	83	83	0	57.8	8.57		8.63	8.53	0.0299
1	9	80	103	103	0	59.2	8.68		8.74	8.63	0.0299
1	9	80	122	122	0	61.3	8.84		8.87	8.8	0.026
1	9	80	143	143	0	61.9	8.89		8.92	8.84	0.024
1	9	80	162	162	0	62.4	8.92		8.96	8.87	0.0219
1	9	80	183	183	0	59.4	8.72	8.649	8.77	8.63	0.0379
1	10	90	0	0	0	54	8.3		8.34	8.25	0.0199
1	10	90	21	21	0	53.1	8.24		8.3	8.15	0.036
1	10	90	42	42	0	50.7	8.03		8.07	8	0.0219
1	10	90	62	62	0	49.6	7.96		8	7.89	0.028
1	10	90	83	83	0	51.8	8.1		8.22	8.03	0.0439
1	10	90	102	102	0	53.5	8.27		8.31	8.19	0.0299
1	10	90	122	122	0	56.3	8.48		8.51	8.42	0.028
1	10	90	142	142	0	57.3	8.53		8.57	8.51	0.018
1	10	90	163	163	0	58.1	8.62		8.63	8.57	0.018
1	10	90	183	183	0	55.6	8.39	8.292	8.53	8.3	0.054

Min	5.135
Max	10
Median	7.1155
Mean	7.2355
Std. Dev	1.43087768

Appendix G: Dia-stron Dimensional Data for SEM Samples

L47 -5 SEM Dia-stron Dimensional
Dimensional Data Report

Record	Slice No.	Slice Position	Start Angle Degrees	End Angle Degrees	Elapsed Time Seconds	Cross-Sectional Sq.Microns	Mean Diameter Microns	Mean Slice Microns	Max. Diameter Microns	Min. Diameter Microns	Std. Deviation
1	1	0	0	0	0	107.9	11.69		11.76	11.68	0.0219
1	1	0	21	21	0	108.2	11.73		11.8	11.68	0.032
1	1	0	42	42	0	105.9	11.59		11.65	11.57	0.026
1	1	0	62	62	0	94.1	10.94		10.97	10.92	0.0219
1	1	0	82	82	0	84.3	10.38		10.39	10.33	0.018
1	1	0	102	102	0	82.5	10.23		10.3	10.2	0.0219
1	1	0	122	122	0	90.6	10.73		10.8	10.68	0.036
1	1	0	142	142	0	101.2	11.35		11.4	11.3	0.026
1	1	0	162	162	0	108.7	11.76		11.84	11.69	0.0299
1	1	0	182	182	0	107.9	11.72	11.212	11.76	11.68	0.026
1	2	10	0	0	0	104	11.47		11.55	11.46	0.026
1	2	10	21	21	0	104.4	11.53		11.59	11.47	0.0299
1	2	10	42	42	0	105.1	11.59		11.61	11.53	0.028
1	2	10	62	62	0	99.4	11.28		11.31	11.19	0.034
1	2	10	82	82	0	92.2	10.83		10.9	10.77	0.0399
1	2	10	102	102	0	84	10.35		10.38	10.3	0.0219
1	2	10	122	122	0	82.5	10.23		10.3	10.2	0.024
1	2	10	142	142	0	88.8	10.64		10.68	10.59	0.024
1	2	10	163	163	0	98.5	11.19		11.34	11.06	0.072
1	2	10	182	182	0	101.8	11.4	11.051	11.43	11.34	0.032
1	3	20	0	0	0	104.7	11.55		11.59	11.5	0.0299
1	3	20	21	21	0	108.1	11.73		11.78	11.68	0.0219
1	3	20	42	42	0	112	11.96		12	11.88	0.034
1	3	20	62	62	0	112	11.92		12	11.88	0.032
1	3	20	82	82	0	110.1	11.84		11.9	11.78	0.028
1	3	20	102	102	0	101.9	11.4		11.43	11.35	0.028
1	3	20	122	122	0	92	10.82		10.85	10.8	0.024
1	3	20	142	142	0	87.1	10.53		10.56	10.5	0.0219
1	3	20	162	162	0	90.8	10.73		10.82	10.68	0.036
1	3	20	182	182	0	98.8	11.19	11.367	11.28	11.15	0.034
1	4	30	0	0	0	115.7	12.11		12.17	12.1	0.0219
1	4	30	21	21	0	119.4	12.34		12.4	12.26	0.0419
1	4	30	42	42	0	121.3	12.46		12.48	12.38	0.028
1	4	30	62	62	0	123.2	12.52		12.57	12.48	0.028
1	4	30	82	82	0	124.3	12.55		12.64	12.52	0.026
1	4	30	102	102	0	117.6	12.22		12.28	12.19	0.026
1	4	30	122	122	0	107.2	11.69		11.76	11.61	0.032
1	4	30	142	142	0	100.6	11.34		11.35	11.28	0.024
1	4	30	163	163	0	102.4	11.4		11.46	11.38	0.0219
1	4	30	182	182	0	108.3	11.76	12.039	11.81	11.68	0.036
1	5	40	0	0	0	116.6	12.17		12.23	12.14	0.0299
1	5	40	21	21	0	118.6	12.29		12.35	12.23	0.032
1	5	40	42	42	0	120.3	12.38		12.41	12.34	0.024
1	5	40	62	62	0	120.9	12.4		12.46	12.35	0.028
1	5	40	82	82	0	119.6	12.35		12.4	12.28	0.032
1	5	40	102	102	0	113.3	12.02		12.05	11.97	0.024
1	5	40	122	122	0	102.4	11.42		11.46	11.38	0.0299
1	5	40	142	142	0	95.8	11.03		11.21	10.88	0.072
1	5	40	162	162	0	98.6	11.19		11.26	11.15	0.026
1	5	40	182	182	0	106.6	11.65	11.89	11.69	11.61	0.032
1	6	50	0	0	0	107.3	11.69		11.73	11.65	0.0219
1	6	50	21	21	0	107	11.65		11.73	11.61	0.032
1	6	50	42	42	0	108.8	11.8		11.81	11.73	0.026
1	6	50	62	62	0	111.3	11.92		11.93	11.88	0.018
1	6	50	82	82	0	109.7	11.81		11.88	11.76	0.0299
1	6	50	102	102	0	102.4	11.42		11.46	11.38	0.0219
1	6	50	122	122	0	94.3	10.96		11	10.92	0.0219
1	6	50	142	142	0	89.9	10.71		10.76	10.64	0.034
1	6	50	162	162	0	93.9	10.92		10.97	10.9	0.026
1	6	50	183	183	0	100.8	11.31	11.419	11.35	11.31	0.016
1	7	60	0	0	0	100.6	11.31		11.38	11.26	0.036
1	7	60	21	21	0	101.3	11.38		11.4	11.31	0.026
1	7	60	42	42	0	104.7	11.55		11.59	11.5	0.026
1	7	60	62	62	0	107.9	11.73		11.76	11.68	0.024
1	7	60	82	82	0	105	11.55		11.59	11.53	0.0219
1	7	60	103	103	0	95.7	11.03		11.11	10.97	0.0379
1	7	60	122	122	0	90.3	10.73		10.77	10.68	0.026
1	7	60	142	142	0	86.3	10.45		10.57	10.39	0.046
1	7	60	162	162	0	88	10.59		10.65	10.52	0.0419
1	7	60	182	182	0	94.3	10.96	11.128	11.02	10.9	0.0439
1	8	70	0	0	0	65.9	9.15		9.22	9.1	0.0379
1	8	70	21	21	0	66.3	9.18		9.22	9.15	0.0199
1	8	70	42	42	0	67.4	9.27		9.3	9.23	0.014
1	8	70	62	62	0	68.1	9.32		9.38	9.25	0.032
1	8	70	82	82	0	65.8	9.15		9.19	9.11	0.0219
1	8	70	102	102	0	62.1	8.89		8.94	8.84	0.026
1	8	70	122	122	0	58.9	8.68		8.72	8.6	0.032
1	8	70	142	142	0	59.3	8.68		8.75	8.63	0.034
1	8	70	162	162	0	61.6	8.84		8.96	8.75	0.0499
1	8	70	183	183	0	65.5	9.13	9.029	9.19	9.07	0.026
1	9	80	0	0	0	65	9.11		9.13	9.06	0.0219
1	9	80	21	21	0	64.6	9.07		9.11	9.03	0.024
1	9	80	42	42	0	65.4	9.13		9.18	9.07	0.026
1	9	80	62	62	0	64	9.01		9.07	8.98	0.026
1	9	80	82	82	0	60.9	8.8		8.86	8.75	0.024
1	9	80	102	102	0	60.3	8.75		8.81	8.72	0.026
1	9	80	122	122	0	61.5	8.84		8.89	8.81	0.0219
1	9	80	142	142	0	63.7	9		9.03	8.98	0.0199
1	9	80	162	162	0	65.9	9.18		9.25	9.07	0.0499
1	9	80	182	182	0	67.3	9.25	9.014	9.32	9.19	0.0399
1	10	90	0	0	0	97.8	11.15		11.23	11.09	0.0379
1	10	90	21	21	0	96.9	11.11		11.15	11.06	0.028
1	10	90	42	42	0	94.5	10.97		11.02	10.92	0.026
1	10	90	62	62	0	89.8	10.71		10.73	10.65	0.0219
1	10	90	82	82	0	88.3	10.59		10.68	10.53	0.034
1	10	90	102	102	0	92.1	10.83		10.9	10.76	0.0379
1	10	90	122	122	0	98	11.18		11.23	11.11	0.032
1	10	90	142	142	0	99.7	11.28		11.34	11.19	0.034
1	10	90	163	163	0	99.4	11.26		11.31	11.19	0.0299
1	10	90	182	182	0	99.6	11.28	11.036	11.31	11.21	0.032

min	9.014
max	12.039
median	11.17
mean	10.9185
STd. Dev	1.054604

Appendix G: Dia-stron Dimensional Data for SEM Samples

L47-6 SEM Dia-stron Dimensional
Dimensional Data Report

Record	Slice No.	Slice Position	Start Angle Degrees	End Angle Degrees	Elapsed Time Seconds	Cross-Sectional Sq.Microns	Mean Diameter Microns	Mean Slice Microns	Max. Diameter Microns	Min. Diameter Microns	Std. Deviation
1	1	0	0	0	0	54	8.27		8.37	8.22	0.0399
1	1	0	21	21	0	54.4	8.31		8.39	8.25	0.0399
1	1	0	42	42	0	61.7	8.87		8.92	8.8	0.0379
1	1	0	62	62	0	63.5	9		9.06	8.92	0.0419
1	1	0	82	82	0	65.5	9.15		9.23	9.03	0.064
1	1	0	102	102	0	65.4	9.13		9.19	9.06	0.0379
1	1	0	122	122	0	65	9.07		9.22	8.98	0.0659
1	1	0	142	142	0	64.5	9.06		9.11	9.01	0.032
1	1	0	162	162	0	52.6	8.18		8.27	8.1	0.0399
1	1	0	183	183	0	57.7	8.53	8.757	8.68	8.46	0.046
1	2	10	0	0	0	79.5	10.09		10.15	9.97	0.0499
1	2	10	21	21	0	82.5	10.23		10.32	10.18	0.0419
1	2	10	42	42	0	95.3	11		11.09	10.94	0.0399
1	2	10	62	62	0	95.9	11.03		11.18	10.92	0.074
1	2	10	82	82	0	95.3	11.02		11.11	10.92	0.0599
1	2	10	102	102	0	92	10.85		10.92	10.73	0.046
1	2	10	122	122	0	85.8	10.45		10.53	10.38	0.0439
1	2	10	142	142	0	86.8	10.52		10.57	10.45	0.034
1	2	10	162	162	0	71.4	9.57		9.68	9.39	0.0759
1	2	10	182	182	0	81.5	10.21	10.497	10.32	10.06	0.0799
1	3	20	0	0	0	81.2	10.18		10.27	10.07	0.0499
1	3	20	21	21	0	82.7	10.27		10.39	10.14	0.068
1	3	20	42	42	0	88.1	10.57		10.71	10.47	0.0599
1	3	20	62	62	0	87.4	10.59		10.71	10.39	0.0839
1	3	20	82	82	0	88.8	10.64		10.8	10.47	0.0759
1	3	20	102	102	0	80.8	10.14		10.23	10.06	0.052
1	3	20	122	122	0	69.5	9.39		9.46	9.35	0.026
1	3	20	142	142	0	72.8	9.63		9.68	9.57	0.032
1	3	20	163	163	0	70	9.39		9.65	9.23	0.0999
1	3	20	183	183	0	80.3	10.14	10.094	10.26	9.97	0.0799
1	4	30	0	0	0	65	9.13		9.23	8.96	0.0839
1	4	30	21	21	0	65.8	9.15		9.23	9.07	0.0439
1	4	30	42	42	0	67.9	9.32		9.38	9.22	0.048
1	4	30	62	62	0	66.5	9.22		9.3	9.11	0.054
1	4	30	82	82	0	64	9.03		9.11	8.94	0.0439
1	4	30	102	102	0	57.5	8.57		8.62	8.5	0.0439
1	4	30	122	122	0	53.8	8.3		8.31	8.24	0.0219
1	4	30	142	142	0	63.4	8.96		9.03	8.94	0.0299
1	4	30	162	162	0	64.9	9.1		9.15	9.03	0.036
1	4	30	183	183	0	67.6	9.27	9.005	9.38	9.18	0.064
1	5	40	0	0	0	82.3	10.2		10.39	10.09	0.09
1	5	40	21	21	0	83.9	10.35		10.44	10.23	0.056
1	5	40	42	42	0	85.9	10.52		10.59	10.33	0.0659
1	5	40	62	62	0	92.8	10.85		11.09	10.65	0.142
1	5	40	82	82	0	95.1	11.02		11.19	10.82	0.0979
1	5	40	102	102	0	91.3	10.77		10.96	10.61	0.0779
1	5	40	122	122	0	84.5	10.33		10.47	10.27	0.052
1	5	40	142	142	0	84	10.35		10.42	10.27	0.046
1	5	40	163	163	0	78.8	10.01		10.11	9.92	0.0499
1	5	40	183	183	0	80.4	10.15	10.455	10.27	9.97	0.108
1	6	50	0	0	0	84.9	10.39		10.45	10.35	0.0219
1	6	50	21	21	0	87.9	10.56		10.64	10.52	0.0379
1	6	50	42	42	0	92.8	10.9		10.97	10.77	0.0599
1	6	50	62	62	0	98.8	11.21		11.34	11.09	0.072
1	6	50	83	83	0	103.3	11.46		11.68	11.26	0.114
1	6	50	102	102	0	98.3	11.15		11.35	11.03	0.082
1	6	50	122	122	0	87.3	10.53		10.64	10.45	0.054
1	6	50	142	142	0	85.7	10.45		10.57	10.32	0.0659
1	6	50	162	162	0	80.6	10.14		10.23	10.03	0.058
1	6	50	183	183	0	84.4	10.38	10.717	10.5	10.23	0.0599
1	7	60	0	0	0	115.4	12.11		12.28	11.97	0.082
1	7	60	21	21	0	111.5	11.93		12.07	11.76	0.0879
1	7	60	42	42	0	105.9	11.61		11.69	11.53	0.0499
1	7	60	62	62	0	102.6	11.42		11.52	11.34	0.0659
1	7	60	82	82	0	98.5	11.23		11.31	11.09	0.07
1	7	60	102	102	0	89.3	10.65		10.76	10.57	0.0439
1	7	60	122	122	0	88.7	10.65		10.73	10.52	0.0659
1	7	60	142	142	0	109.9	11.8		11.88	11.78	0.032
1	7	60	162	162	0	117.1	12.19		12.31	12.11	0.058
1	7	60	183	183	0	114.6	12.07	11.566	12.16	12	0.0439
1	8	70	0	0	0	74	9.72		9.76	9.65	0.028
1	8	70	21	21	0	72.8	9.65		9.7	9.56	0.0379
1	8	70	42	42	0	68	9.3		9.39	9.22	0.048
1	8	70	62	62	0	62.6	8.94		9	8.86	0.0499
1	8	70	82	82	0	61.4	8.86		8.89	8.8	0.0299
1	8	70	103	103	0	62.7	8.94		9.03	8.84	0.0499
1	8	70	122	122	0	67.8	9.27		9.35	9.23	0.034
1	8	70	142	142	0	77.8	9.97		10.03	9.88	0.0419
1	8	70	162	162	0	76	9.88		9.92	9.76	0.0439
1	8	70	183	183	0	74.5	9.73	9.426	9.85	9.63	0.0619
1	9	80	0	0	0	66.7	9.22		9.25	9.18	0.0219
1	9	80	21	21	0	65.5	9.13		9.19	9.07	0.036
1	9	80	42	42	0	59.8	8.68		8.84	8.62	0.056
1	9	80	62	62	0	56.4	8.48		8.53	8.42	0.034
1	9	80	82	82	0	60.5	8.8		8.81	8.74	0.024
1	9	80	102	102	0	62.9	8.96		9.03	8.87	0.0439
1	9	80	122	122	0	67.1	9.25		9.34	9.15	0.048
1	9	80	142	142	0	74	9.7		9.77	9.65	0.034
1	9	80	163	163	0	70.8	9.47		9.57	9.42	0.0379
1	9	80	183	183	0	69	9.38	9.107	9.53	9.22	0.0799
1	10	90	0	0	0	63	8.98		9.03	8.89	0.0439
1	10	90	21	21	0	61.4	8.89		8.94	8.75	0.048
1	10	90	42	42	0	64	9.01		9.1	8.96	0.0419
1	10	90	62	62	0	69.4	9.46		9.5	9.3	0.0499
1	10	90	82	82	0	77.6	9.92		10	9.88	0.0379
1	10	90	103	103	0	77.1	9.89		9.97	9.84	0.0399
1	10	90	122	122	0	77.7	9.96		10.01	9.88	0.048
1	10	90	142	142	0	84.2	10.33		10.39	10.32	0.0219
1	10	90	162	162	0	72.5	9.61		9.65	9.57	0.0219
1	10	90	182	182	0	64.7	9.1	9.515	9.15	9	0.0439

min	8.757
max	**11.566**
median	9.8045
mean	9.9139
Std. Dev	0.897676

Appendix H: Optical Sample Data and Select Images

Optical Measurements

Commercial Pitch 20X

Fiber Slice	Diameter 1 Pixels	Angle Degrees	Diameter 1 Corrected Pixels	Diameter 2 Pixels	Angle Degrees	Diameter 2 Corrected Pixels	Average Diameter Pixels	Average Diameter Microns
1	39.11	91.76	39.09	39.49	93.49	39.42	39.25	11.38
2	39.92	89.81	39.92	40.16	92.59	40.12	40.02	11.61
3	41.30	88.17	41.28	41.10	91.83	41.08	41.18	11.94
4	40.58	94.33	40.46	39.83	85.24	39.69	40.08	11.62
5	40.44	95.46	40.26	41.47	98.51	41.01	40.63	11.78
6	42.39	97.50	42.03	43.27	98.38	42.81	42.42	12.30
7	41.27	89.73	41.27	42.33	91.59	42.31	41.79	12.12
8	41.55	90.16	41.55	41.82	92.93	41.77	41.66	12.08
9	41.55	88.80	41.54	40.98	85.24	40.84	41.19	11.95
10	41.43	88.93	41.42	42.39	91.82	42.37	41.90	12.15

Micron/Pixel Ratio: 0.29

Appendix H: Optical Sample Data and Select Images

Optical Measurements
L51 20X 40X3

Fiber Slice	Diameter 1 Pixels	Angle Degrees	Diameter 1 Corrected Pixels	Diameter 2 Pixels	Angle Degrees	Diameter 2 Corrected Pixels	Average Diameter Pixels	Average Diameter Microns
1	29.51	91.04	29.51	29.05	87.70	29.03	29.27	8.49
2	29.00	91.04	29.00	29.00	88.11	28.98	28.99	8.41
3	30.00	91.16	29.99	29.51	87.32	29.48	29.74	8.62
4	43.00	89.30	43.00	42.52	92.60	42.48	42.74	12.39
5	36.06	89.76	36.06	35.07	90.40	35.07	35.56	10.31
6	30.00	86.83	29.95	29.51	88.42	29.50	29.73	8.62
7	34.03	89.46	34.03	33.58	86.42	33.51	33.77	9.79
8	38.57	90.90	38.57	37.07	86.91	37.02	37.79	10.96
9	42.50	91.36	42.49	41.02	87.67	40.99	41.74	12.10
10	34.50	90.00	34.50	33.00	87.16	32.96	33.73	9.78

Micron to Pixel ratio: 0.29

Appendix H: Optical Sample Data and Select Images

Optical Diameter Measurements
Commercial Pitch 40X Optical

Sample 1 Slice	Diameter 1 Pixels	Angle Degrees	Diameter 1 Corrected Pixels	Diameter 2 Pixels	Angle Degrees	Diameter 2 Pixels	Average Diameter Pixels	Average Diameter Microns
1	94.58	90.79	94.57	95.38	90.16	95.38	94.98	13.20
2	98.13	91.94	98.07	97.68	94.25	97.41	97.74	13.59
3	97.55	90.74	97.54	97.09	90.30	97.09	97.32	13.53
4	95.07	90.96	95.06	93.58	91.52	93.55	94.30	13.11
5	98.05	90.04	98.05	97.01	89.76	97.01	97.53	13.56
6	96.11	91.00	96.10	97.17	89.61	97.17	96.63	13.43
7	95.51	90.04	95.51	97.00	90.58	97.00	96.25	13.38
8	98.02	89.83	98.02	97.05	92.12	96.98	97.50	13.55
9	98.08	90.84	98.07	98.08	90.49	98.08	98.07	13.63
10	100.02	93.27	99.86	99.01	90.88	99.00	99.43	13.82

Micron/Pixel Ratio: 0.139

Appendix H: Optical Sample Data and Select Images

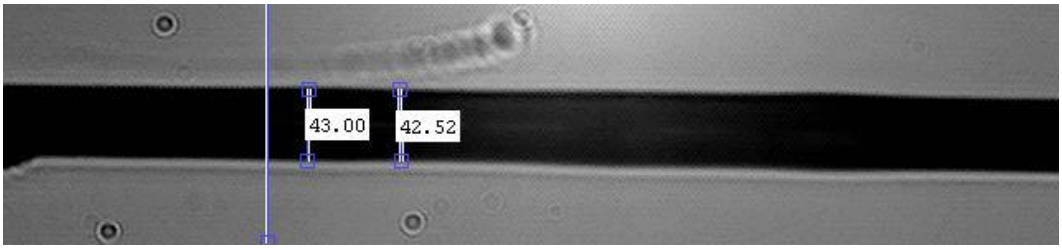
Optical Measurements

L51 BLF **40X** **Fiber 3**

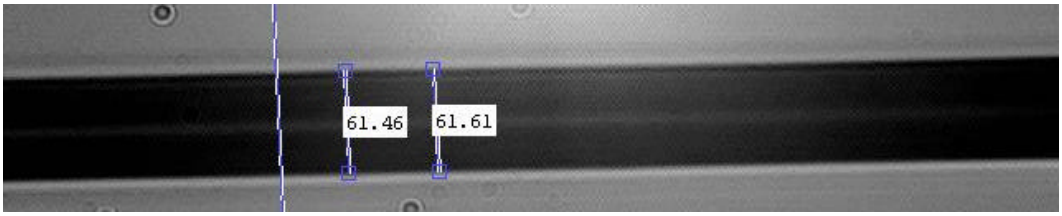
Fiber Slice	Diameter 1 Pixels	Angle Degrees	Diameter 1 Corrected Pixels	Diameter 2 Pixels	Angle Degrees	Diameter 2 Pixels	Average Diameter Pixels	Average Diameter Microns
1	61.46	90.29	61.46	61.61	91.56	61.59	61.52	8.55
2	86.05	88.72	86.03	85.05	93.56	84.89	85.46	11.88
3	66.07	91.53	66.05	66.19	93.67	66.05	66.05	9.18
4	74.11	89.01	74.10	75.24	91.89	75.20	74.65	10.38
5	70.18	91.16	70.17	70.26	92.93	70.17	70.17	9.75
6	51.09	91.95	51.06	51.16	91.16	51.15	51.10	7.10
7	77.16	92.46	77.09	77.32	93.41	77.18	77.14	10.72
8	87.28	91.23	87.26	87.37	91.15	87.35	87.31	12.14
9	83.22	87.50	83.14	82.10	90.63	82.10	82.62	11.48
10	70.11	92.14	70.06	69.12	90.13	69.12	69.59	9.67

Micron / Pixel ratio 0.139

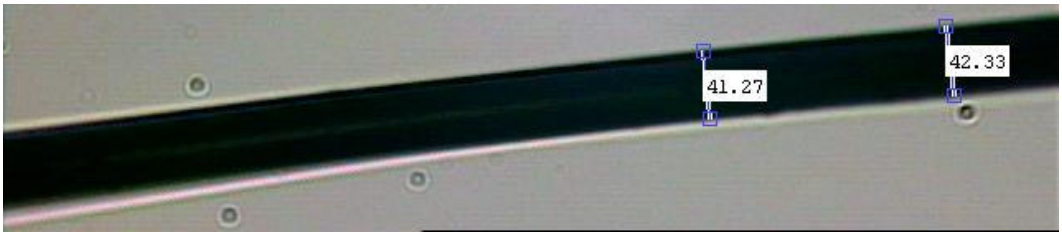
Optical Carbon Fiber Images Measured with the Image Measurement Technique



UTSI Sample 20X: L51 20X 40X3 4



UTSI Sample 40X: L51 BLF 40X 3-1



Commercial Pitch 20X: Commercial Pitch Glass Slide 7 L 20X M



Commercial Pitch 40X :CP 40X 1-7

Appendix I: Dia-stron Dimensional Report for Optical Samples

Dia-stron Data
Commercial Pitch 20X Glass
Dimensional Data Report

Record	Slice No.	Slice Position	Start Angle	End Angle	Elapsed Time	Cross-Sectional Area	Mean Diameter	Mean Slice Diameter	Min Slice D	Max Slice D	Max. Diameter	Min. Diameter	Std. Deviation
			Degrees	Degrees	Seconds	Sq.Microns	Microns				Microns	Microns	
2	1	0	0	0	521	106.1	11.64				11.68	11.57	0.028
2	1	0	21	21	521	107.6	11.68				11.76	11.65	0.028
2	1	0	42	42	521	105.9	11.64				11.69	11.53	0.0399
2	1	0	62	62	521	105.9	11.64				11.65	11.57	0.0219
2	1	0	82	82	521	105.9	11.59				11.65	11.57	0.026
2	1	0	102	102	521	105.8	11.59				11.64	11.57	0.016
2	1	0	122	122	521	105.3	11.59				11.64	11.52	0.034
2	1	0	142	142	521	105.3	11.57				11.64	11.52	0.036
2	1	0	162	162	521	103.4	11.5				11.52	11.43	0.0199
2	1	0	182	182	521	103.4	11.47	11.591			11.53	11.42	0.034
2	2	10	0	0	521	107.1	11.69				11.72	11.64	0.0219
2	2	10	21	21	521	107.7	11.72				11.73	11.69	0.018
2	2	10	42	42	521	109.1	11.78				11.84	11.73	0.0299
2	2	10	62	62	521	108.3	11.72				11.8	11.69	0.0299
2	2	10	82	82	521	107.5	11.69				11.76	11.64	0.0379
2	2	10	102	102	521	107.2	11.69				11.76	11.61	0.0439
2	2	10	122	122	521	108.8	11.78				11.81	11.73	0.026
2	2	10	142	142	521	107.3	11.69				11.73	11.65	0.024
2	2	10	162	162	521	105.1	11.57				11.61	11.53	0.024
2	2	10	182	182	521	103.8	11.47	11.68			11.53	11.46	0.026
2	3	20	0	0	521	107.8	11.69				11.78	11.65	0.034
2	3	20	21	21	521	109	11.78				11.84	11.72	0.028
2	3	20	42	42	521	109.6	11.81				11.85	11.78	0.0219
2	3	20	62	62	521	108.8	11.76				11.81	11.73	0.0219
2	3	20	82	82	521	108.1	11.73				11.78	11.68	0.0299
2	3	20	102	102	521	107.8	11.73				11.78	11.65	0.032
2	3	20	122	122	521	109.1	11.78				11.84	11.73	0.0299
2	3	20	142	142	521	106.9	11.64				11.72	11.61	0.024
2	3	20	162	162	521	105	11.57				11.59	11.53	0.018
2	3	20	183	183	521	103.9	11.5	11.699			11.53	11.47	0.0199
2	4	30	0	0	521	110.4	11.85				11.9	11.81	0.0219
2	4	30	21	21	521	110.9	11.88				11.93	11.84	0.028
2	4	30	42	42	521	112.2	11.97				12	11.9	0.026
2	4	30	62	62	521	111.7	11.93				11.97	11.88	0.0299
2	4	30	82	82	521	112.5	11.97				12.02	11.92	0.028
2	4	30	102	102	521	110.7	11.92				11.96	11.78	0.0419
2	4	30	122	122	521	111.3	11.9				11.96	11.85	0.026
2	4	30	142	142	521	108.8	11.78				11.81	11.73	0.028
2	4	30	162	162	521	107.7	11.73				11.78	11.64	0.0379
2	4	30	183	183	521	106.4	11.65	11.858			11.69	11.59	0.032
2	5	40	0	0	521	108.7	11.76				11.81	11.72	0.028
2	5	40	21	21	521	109.9	11.8				11.97	11.69	0.068
2	5	40	42	42	521	108.8	11.78				11.81	11.73	0.024
2	5	40	62	62	521	109.4	11.78				11.84	11.76	0.0219
2	5	40	82	82	521	109.1	11.81				11.85	11.72	0.036
2	5	40	102	102	521	110.7	11.84				11.93	11.81	0.0299
2	5	40	122	122	521	110.6	11.88				11.92	11.81	0.028
2	5	40	142	142	521	109.1	11.78				11.84	11.73	0.028
2	5	40	162	162	521	108.2	11.72				11.8	11.68	0.034
2	5	40	182	182	521	107	11.65	11.78			11.73	11.61	0.034
2	6	50	0	0	521	105.9	11.65				11.73	11.5	0.0599
2	6	50	21	21	521	107.8	11.69				11.78	11.65	0.034
2	6	50	43	43	521	108.2	11.72				11.78	11.69	0.026
2	6	50	62	62	521	109.1	11.78				11.84	11.73	0.028
2	6	50	82	82	521	108.4	11.76				11.81	11.69	0.0299
2	6	50	101	101	521	109.1	11.78				11.81	11.76	0.0199
2	6	50	122	122	521	108.3	11.73				11.8	11.69	0.028
2	6	50	142	142	521	105.9	11.64				11.69	11.53	0.0419
2	6	50	162	162	521	105.8	11.61				11.68	11.53	0.034
2	6	50	182	182	521	105	11.57	11.693			11.59	11.53	0.0219
2	7	60	0	0	521	108	11.73				11.81	11.64	0.0439
2	7	60	21	21	521	107.8	11.76				11.84	11.59	0.058
2	7	60	42	42	521	108.2	11.78				11.84	11.64	0.054
2	7	60	62	62	521	109.4	11.8				11.88	11.72	0.0399
2	7	60	82	82	521	109.4	11.78				11.84	11.76	0.024
2	7	60	102	102	521	108.4	11.78				11.81	11.69	0.0379
2	7	60	122	122	521	108.2	11.73				11.8	11.68	0.032
2	7	60	142	142	521	107.6	11.72				11.76	11.65	0.028
2	7	60	162	162	521	106.4	11.65				11.69	11.59	0.028
2	7	60	182	182	521	106.5	11.65	11.738			11.72	11.57	0.036
2	8	70	0	0	521	108.8	11.78				11.81	11.73	0.028
2	8	70	21	21	521	109.4	11.8				11.85	11.76	0.028
2	8	70	42	42	521	109	11.8				11.88	11.68	0.048
2	8	70	62	62	521	109.9	11.84				11.88	11.78	0.0299

Appendix I: Dia-stron Dimensional Report for Optical Samples

2	8	70	82	82	521	110.1	11.84				11.88	11.8	0.0219
2	8	70	102	102	521	110.1	11.85				12.03	11.65	0.1059
2	8	70	122	122	521	108.7	11.78				11.8	11.73	0.0219
2	8	70	142	142	521	107	11.68				11.73	11.61	0.036
2	8	70	163	163	521	107.2	11.68				11.72	11.65	0.018
2	8	70	182	182	521	107.2	11.69	11.774			11.73	11.64	0.0299
2	9	80	0	0	521	108.4	11.76				11.81	11.69	0.0299
2	9	80	21	21	521	109.2	11.81				11.85	11.73	0.034
2	9	80	43	43	521	108.6	11.78				11.84	11.68	0.0399
2	9	80	62	62	521	108.8	11.78				11.81	11.73	0.026
2	9	80	82	82	521	109.1	11.8				11.81	11.76	0.018
2	9	80	101	101	521	108.7	11.78				11.84	11.69	0.034
2	9	80	122	122	521	107.2	11.72				11.78	11.59	0.0439
2	9	80	142	142	521	107.1	11.68				11.72	11.64	0.0299
2	9	80	162	162	521	105	11.59				11.61	11.52	0.028
2	9	80	183	183	521	105	11.57	11.727			11.61	11.52	0.0219
2	10	90	0	0	521	109.1	11.78				11.84	11.73	0.028
2	10	90	21	21	521	109.1	11.81				11.85	11.72	0.0379
2	10	90	43	43	521	109.2	11.78				11.85	11.73	0.036
2	10	90	62	62	521	108.4	11.78				11.81	11.69	0.032
2	10	90	82	82	521	108.4	11.76				11.81	11.69	0.0299
2	10	90	102	102	521	109.4	11.8				11.84	11.76	0.024
2	10	90	122	122	521	109.1	11.78				11.84	11.73	0.032
2	10	90	142	142	521	108.3	11.76				11.81	11.68	0.048
2	10	90	162	162	521	108.6	11.76				11.8	11.72	0.0219
2	10	90	183	183	521	108.4	11.73	11.774	11.591	11.858	11.78	11.72	0.0199

Appendix I: Dia-stron Dimensional Report for Optical Samples

Commercial Pitch 40X Optical Dia-stron Data
Dimensional Data Report

Record	Slice No.	Slice Position	Start Angle Degrees	End Angle Degrees	Elapsed Time Seconds	Cross-Sectional Area Sq.Microns	Mean Diameter Microns	Mean Slice D	Min Mean	Max Mean	Max. Diameter Microns	Min. Diameter Microns	Std. Deviation
1	1	0	0	0	0	130.9	12.9				12.96	12.86	0.034
1	1	0	21	21	0	131.3	12.93				12.98	12.88	0.028
1	1	0	42	42	0	129.5	12.84				12.9	12.78	0.0299
1	1	0	61	61	0	128.3	12.78				12.84	12.72	0.036
1	1	0	81	81	0	128.9	12.81				12.86	12.76	0.026
1	1	0	101	101	0	130.9	12.92				12.96	12.86	0.024
1	1	0	121	121	0	133.3	13.03				13.1	12.96	0.036
1	1	0	141	141	0	131.1	12.92				12.96	12.88	0.0219
1	1	0	162	162	0	127	12.72				12.76	12.67	0.0219
1	1	0	181	181	0	122	12.43	12.828			12.53	12.4	0.034
1	2	10	0	0	0	132.3	12.98				13.03	12.93	0.024
1	2	10	21	21	0	131.9	12.96				13	12.92	0.0199
1	2	10	42	42	0	128.7	12.79				12.84	12.76	0.0219
1	2	10	62	62	0	127.5	12.76				12.79	12.69	0.026
1	2	10	81	81	0	129.5	12.84				12.9	12.78	0.028
1	2	10	101	101	0	132.2	12.98				13.02	12.93	0.024
1	2	10	122	122	0	134.2	13.07				13.11	13.03	0.0219
1	2	10	141	141	0	132.1	12.96				13.02	12.92	0.028
1	2	10	161	161	0	127.2	12.73				12.78	12.67	0.026
1	2	10	182	182	0	122	12.48	12.855			12.52	12.41	0.032
1	3	20	0	0	0	128.1	12.76				12.81	12.73	0.024
1	3	20	21	21	0	127.4	12.73				12.78	12.69	0.0219
1	3	20	42	42	0	125.7	12.65				12.69	12.61	0.0219
1	3	20	62	62	0	125.9	12.65				12.72	12.6	0.034
1	3	20	81	81	0	127.5	12.73				12.79	12.69	0.0219
1	3	20	101	101	0	132.2	12.98				13.03	12.92	0.028
1	3	20	121	121	0	136	13.15				13.22	13.1	0.032
1	3	20	142	142	0	132.2	12.96				13.02	12.93	0.024
1	3	20	162	162	0	123.7	12.53				12.6	12.5	0.028
1	3	20	182	182	0	118.8	12.29	12.743			12.34	12.26	0.0219
1	4	30	0	0	0	130.1	12.88				12.9	12.84	0.018
1	4	30	21	21	0	129.3	12.81				12.88	12.78	0.024
1	4	30	42	42	0	126.8	12.72				12.76	12.65	0.024
1	4	30	62	62	0	128	12.76				12.81	12.72	0.0299
1	4	30	82	82	0	132.3	12.96				13.03	12.93	0.032
1	4	30	101	101	0	135.3	13.14				13.15	13.1	0.016
1	4	30	121	121	0	137.2	13.19				13.26	13.17	0.0219
1	4	30	141	141	0	132.6	13				13.03	12.96	0.024
1	4	30	162	162	0	126.5	12.69				12.73	12.65	0.024
1	4	30	182	182	0	120.9	12.41	12.856			12.46	12.35	0.034
1	5	40	0	0	0	131.7	12.96				12.98	12.92	0.0199
1	5	40	21	21	0	131.1	12.92				12.98	12.86	0.028
1	5	40	42	42	0	128.7	12.79				12.84	12.76	0.0219
1	5	40	62	62	0	130.4	12.88				12.96	12.81	0.034
1	5	40	81	81	0	133.2	13.03				13.05	13	0.018
1	5	40	102	102	0	135.4	13.15				13.19	13.07	0.0299
1	5	40	122	122	0	136.1	13.17				13.22	13.11	0.0299
1	5	40	142	142	0	132.8	13.02				13.05	12.96	0.026
1	5	40	162	162	0	128.1	12.79				12.81	12.73	0.0199
1	5	40	182	182	0	122.6	12.5	12.921			12.53	12.46	0.0299
1	6	50	0	0	0	131.5	12.93				13	12.88	0.034
1	6	50	21	21	0	129.5	12.84				12.92	12.76	0.0379
1	6	50	42	42	0	125.6	12.65				12.69	12.6	0.028
1	6	50	62	62	0	127.2	12.72				12.76	12.69	0.018
1	6	50	82	82	0	130	12.86				12.92	12.81	0.028
1	6	50	102	102	0	130.9	12.93				12.98	12.84	0.0399
1	6	50	121	121	0	133	13.02				13.05	12.98	0.0199
1	6	50	142	142	0	130	12.86				12.92	12.81	0.0219
1	6	50	162	162	0	127.8	12.76				12.79	12.72	0.028
1	6	50	182	182	0	125.1	12.64	12.821			12.67	12.57	0.0299
1	7	60	0	0	0	124.7	12.57				12.65	12.55	0.032
1	7	60	20	20	0	124.1	12.55				12.61	12.53	0.028
1	7	60	42	42	0	124.1	12.57				12.61	12.53	0.026
1	7	60	62	62	0	131.5	12.96				12.98	12.9	0.026
1	7	60	82	82	0	135.2	13.14				13.14	13.1	0.012
1	7	60	101	101	0	134.1	13.07				13.11	13.02	0.028
1	7	60	122	122	0	137.8	13.23				13.27	13.22	0.0219
1	7	60	142	142	0	134.2	13.05				13.11	13.03	0.0219
1	7	60	162	162	0	124.5	12.6				12.65	12.53	0.036
1	7	60	182	182	0	118.8	12.28	12.802			12.34	12.26	0.018
1	8	70	0	0	0	127.7	12.76				12.81	12.69	0.034
1	8	70	21	21	0	127	12.69				12.76	12.67	0.0219
1	8	70	43	43	0	124	12.57				12.61	12.52	0.0299
1	8	70	62	62	0	123.7	12.55				12.6	12.5	0.026

Appendix I: Dia-stron Dimensional Report for Optical Samples

1	8	70	82	82	0	125.8	12.64				12.76	12.55	0.0499
1	8	70	102	102	0	127.4	12.72				12.78	12.69	0.024
1	8	70	122	122	0	130.4	12.88				12.93	12.84	0.026
1	8	70	142	142	0	130	12.86				12.92	12.81	0.028
1	8	70	162	162	0	127.2	12.72				12.78	12.67	0.0299
1	8	70	182	182	0	122.8	12.5	12.689			12.55	12.46	0.028
1	9	80	0	0	0	128.1	12.78				12.81	12.73	0.0219
1	9	80	20	20	0	128	12.76				12.84	12.69	0.0379
1	9	80	42	42	0	129.1	12.81				12.88	12.76	0.034
1	9	80	62	62	0	136.2	13.17				13.23	13.11	0.0299
1	9	80	82	82	0	144.2	13.53				13.6	13.5	0.026
1	9	80	102	102	0	144.1	13.57				13.61	13.48	0.0399
1	9	80	122	122	0	140.3	13.36				13.39	13.34	0.0219
1	9	80	142	142	0	132.6	13				13.03	12.96	0.0219
1	9	80	162	162	0	127.8	12.73				12.79	12.72	0.026
1	9	80	182	182	0	124	12.55	13.026			12.61	12.52	0.0299
1	10	90	0	0	0	133.8	13.03				13.1	13	0.0299
1	10	90	21	21	0	133.7	13.05				13.07	13.02	0.018
1	10	90	42	42	0	132.1	12.96				13.02	12.92	0.024
1	10	90	62	62	0	131.1	12.92				12.96	12.88	0.024
1	10	90	83	83	0	132.2	12.98				13.02	12.93	0.0219
1	10	90	101	101	0	133	13.03				13.05	12.98	0.024
1	10	90	122	122	0	132.5	13				13.05	12.93	0.036
1	10	90	142	142	0	132.6	13.02				13.03	12.96	0.024
1	10	90	162	162	0	130.6	12.9				12.93	12.86	0.028
1	10	90	183	183	0	129.1	12.81	12.97	12.689	13.026	12.88	12.76	0.036

Appendix I: Dia-stron Dimensional Report for Optical Samples

Dia-stron Data
for UTSI L51 Sample at 20X and 40X
L51 40X 32008 and 20X 40X3
Dimensional Data Report

Record	Description	Slice No.	Slice Position	Start Angle	End Angle	Elapsed Time	Cross-Sectional Area	Mean Diameter	Mean Slice D	Min Slice	Max Slice D	Max. Diameter	Min. Diameter	Std. Deviation
				Degrees	Degrees	Seconds	Sq.Microns	Microns				Microns	Microns	
3	FDAS:Aver	1	0	0	0	-1158	94.3	10.96				11.02	10.9	0.032
3	FDAS:Aver	1	0	21	21	-1158	94.2	10.96				11.02	10.88	0.0299
3	FDAS:Aver	1	0	42	42	-1158	94.9	10.97				11.03	10.96	0.018
3	FDAS:Aver	1	0	61	61	-1158	93.9	10.96				10.97	10.9	0.024
3	FDAS:Aver	1	0	82	82	-1158	88.3	10.61				10.68	10.53	0.036
3	FDAS:Aver	1	0	101	101	-1158	80.4	10.14				10.18	10.06	0.028
3	FDAS:Aver	1	0	121	121	-1158	79.1	10.06				10.07	10	0.026
3	FDAS:Aver	1	0	141	141	-1158	82.8	10.3				10.33	10.21	0.036
3	FDAS:Aver	1	0	161	161	-1158	87.7	10.57				10.61	10.53	0.0219
3	FDAS:Aver	1	0	182	182	-1158	88	10.59	10.612			10.64	10.53	0.0299
3	FDAS:Aver	2	10	0	0	-1158	70.9	9.51				9.53	9.47	0.024
3	FDAS:Aver	2	10	20	20	-1158	70.8	9.5				9.53	9.46	0.0219
3	FDAS:Aver	2	10	42	42	-1158	71.1	9.53				9.56	9.47	0.0219
3	FDAS:Aver	2	10	61	61	-1158	70.6	9.47				9.5	9.46	0.016
3	FDAS:Aver	2	10	82	82	-1158	66.5	9.19				9.27	9.13	0.0419
3	FDAS:Aver	2	10	101	101	-1158	61.4	8.86				8.89	8.8	0.026
3	FDAS:Aver	2	10	121	121	-1158	61.2	8.84				8.86	8.8	0.0199
3	FDAS:Aver	2	10	142	142	-1158	64.6	9.07				9.13	9.01	0.026
3	FDAS:Aver	2	10	162	162	-1158	67.8	9.32				9.35	9.23	0.028
3	FDAS:Aver	2	10	182	182	-1158	68.6	9.34	9.263			9.42	9.27	0.034
3	FDAS:Aver	3	20	0	0	-1158	67.6	9.27				9.32	9.23	0.0219
3	FDAS:Aver	3	20	21	21	-1158	68.1	9.32				9.35	9.27	0.0199
3	FDAS:Aver	3	20	42	42	-1158	69.1	9.38				9.44	9.32	0.032
3	FDAS:Aver	3	20	62	62	-1158	66.9	9.25				9.27	9.19	0.0219
3	FDAS:Aver	3	20	82	82	-1158	62.9	8.96				9.01	8.89	0.032
3	FDAS:Aver	3	20	101	101	-1158	58.6	8.63				8.65	8.62	0.014
3	FDAS:Aver	3	20	122	122	-1158	58.7	8.65				8.69	8.6	0.032
3	FDAS:Aver	3	20	141	141	-1158	61.4	8.86				8.89	8.8	0.026
3	FDAS:Aver	3	20	162	162	-1158	64.7	9.06				9.15	9	0.0379
3	FDAS:Aver	3	20	182	182	-1158	64.2	9.01	9.039			9.1	8.98	0.028
3	FDAS:Aver	4	30	0	0	-1158	56.8	8.51				8.53	8.48	0.018
3	FDAS:Aver	4	30	21	21	-1158	56.9	8.53				8.56	8.46	0.0299
3	FDAS:Aver	4	30	42	42	-1158	56.3	8.5				8.51	8.43	0.026
3	FDAS:Aver	4	30	62	62	-1158	55.1	8.37				8.39	8.36	0.014
3	FDAS:Aver	4	30	82	82	-1158	51.1	8.07				8.13	8.01	0.0299
3	FDAS:Aver	4	30	102	102	-1158	48.4	7.84				7.91	7.79	0.034
3	FDAS:Aver	4	30	122	122	-1158	48.9	7.86				7.94	7.84	0.026
3	FDAS:Aver	4	30	142	142	-1158	51.3	8.12				8.13	8.03	0.026
3	FDAS:Aver	4	30	162	162	-1158	54.2	8.27				8.37	8.24	0.0399
3	FDAS:Aver	4	30	182	182	-1158	53.4	8.25	8.232			8.3	8.19	0.028
3	FDAS:Aver	5	40	0	0	-1158	85.7	10.45				10.5	10.39	0.0299
3	FDAS:Aver	5	40	21	21	-1158	85.9	10.45				10.5	10.42	0.0199
3	FDAS:Aver	5	40	42	42	-1158	86.4	10.5				10.56	10.42	0.036
3	FDAS:Aver	5	40	62	62	-1158	87.5	10.53				10.61	10.5	0.034
3	FDAS:Aver	5	40	82	82	-1158	83.5	10.33				10.39	10.23	0.0399
3	FDAS:Aver	5	40	101	101	-1158	77.8	9.96				10.01	9.89	0.034
3	FDAS:Aver	5	40	122	122	-1158	75.1	9.77				9.8	9.76	0.014
3	FDAS:Aver	5	40	141	141	-1158	76.8	9.89				9.94	9.84	0.034
3	FDAS:Aver	5	40	162	162	-1158	80	10.09				10.18	10.01	0.036
3	FDAS:Aver	5	40	182	182	-1158	79.6	10.07	10.204			10.14	10	0.036
3	FDAS:Aver	6	50	0	0	-1158	72.2	9.61				9.65	9.53	0.0299
3	FDAS:Aver	6	50	21	21	-1158	72.5	9.61				9.65	9.56	0.0299
3	FDAS:Aver	6	50	43	43	-1158	72.8	9.63				9.65	9.6	0.0219
3	FDAS:Aver	6	50	62	62	-1158	73.4	9.65				9.72	9.61	0.034
3	FDAS:Aver	6	50	82	82	-1158	70.4	9.47				9.51	9.42	0.034
3	FDAS:Aver	6	50	102	102	-1158	66.1	9.18				9.22	9.13	0.0219
3	FDAS:Aver	6	50	122	122	-1158	64.3	9.06				9.1	9	0.026
3	FDAS:Aver	6	50	142	142	-1158	66.5	9.22				9.25	9.15	0.028
3	FDAS:Aver	6	50	162	162	-1158	69.3	9.39				9.44	9.35	0.026
3	FDAS:Aver	6	50	183	183	-1158	69.5	9.42	9.424			9.46	9.35	0.0299
3	FDAS:Aver	7	60	0	0	-1158	122.3	12.5				12.53	12.43	0.028
3	FDAS:Aver	7	60	21	21	-1158	122.3	12.5				12.55	12.41	0.0299
3	FDAS:Aver	7	60	42	42	-1158	124.9	12.64				12.67	12.55	0.0379
3	FDAS:Aver	7	60	62	62	-1158	124.6	12.6				12.64	12.55	0.024
3	FDAS:Aver	7	60	82	82	-1158	115.6	12.16				12.19	12.07	0.036
3	FDAS:Aver	7	60	102	102	-1158	105.4	11.59				11.64	11.53	0.026
3	FDAS:Aver	7	60	122	122	-1158	105.6	11.61				11.64	11.55	0.0199
3	FDAS:Aver	7	60	142	142	-1158	113.1	12				12.03	11.97	0.0219
3	FDAS:Aver	7	60	162	162	-1158	118.8	12.31				12.34	12.26	0.026
3	FDAS:Aver	7	60	182	182	-1158	118.6	12.28	12.219			12.35	12.23	0.032
3	FDAS:Aver	8	70	0	0	-1158	142.8	13.48				13.51	13.46	0.0199
3	FDAS:Aver	8	70	20	20	-1158	143.5	13.51				13.55	13.48	0.026
3	FDAS:Aver	8	70	42	42	-1158	147.7	13.72				13.75	13.68	0.026
3	FDAS:Aver	8	70	62	62	-1158	142.8	13.48				13.55	13.42	0.036
3	FDAS:Aver	8	70	82	82	-1158	131.5	12.92				12.98	12.9	0.028
3	FDAS:Aver	8	70	101	101	-1158	123	12.52				12.55	12.48	0.026
3	FDAS:Aver	8	70	122	122	-1158	123.9	12.53				12.6	12.52	0.024
3	FDAS:Aver	8	70	142	142	-1158	132.2	12.98				13.03	12.92	0.028
3	FDAS:Aver	8	70	162	162	-1158	137.6	13.23				13.3	13.17	0.032
3	FDAS:Aver	8	70	183	183	-1158	136	13.15	13.152			13.22	13.1	0.034
3	FDAS:Aver	9	80	0	0	-1158	128.3	12.78				12.84	12.72	0.0299
3	FDAS:Aver	9	80	21	21	-1158	130	12.9				12.92	12.81	0.028
3	FDAS:Aver	9	80	42	42	-1158	131.3	12.93				13	12.86	0.0379
3	FDAS:Aver	9	80	62	62	-1158	124.5	12.57				12.65	12.53	0.028
3	FDAS:Aver	9	80	82	82	-1158	113	12.02				12.02	11.97	0.014

Appendix I: Dia-stron Dimensional Report for Optical Samples

3	FDAS:Aver	9	80	102	102	-1158	108.7	11.8				11.81	11.72	0.028
3	FDAS:Aver	9	80	122	122	-1158	111.9	11.92				11.97	11.9	0.024
3	FDAS:Aver	9	80	141	141	-1158	119.2	12.31				12.38	12.26	0.032
3	FDAS:Aver	9	80	162	162	-1158	124	12.6				12.65	12.48	0.0419
3	FDAS:Aver	9	80	182	182	-1158	127.5	12.73	12.456			12.79	12.69	0.034
3	FDAS:Aver	10	90	0	0	-1158	105.9	11.64				11.65	11.57	0.026
3	FDAS:Aver	10	90	20	20	-1158	106.7	11.64				11.72	11.59	0.034
3	FDAS:Aver	10	90	42	42	-1158	106.6	11.65				11.69	11.61	0.0199
3	FDAS:Aver	10	90	62	62	-1158	99.1	11.23				11.28	11.19	0.028
3	FDAS:Aver	10	90	82	82	-1158	91	10.76				10.82	10.71	0.032
3	FDAS:Aver	10	90	101	101	-1158	87.7	10.57				10.61	10.52	0.0299
3	FDAS:Aver	10	90	122	122	-1158	91.7	10.82				10.85	10.76	0.028
3	FDAS:Aver	10	90	142	142	-1158	97.2	11.11				11.18	11.07	0.024
3	FDAS:Aver	10	90	162	162	-1158	98.6	11.21				11.26	11.15	0.028
3	FDAS:Aver	10	90	182	182	-1158	99.8	11.28	11.191	8.232	13.152	11.31	11.23	0.0219

Appendix J: Intensity Plot Data

Optical Measurements using Intensity Method
UTSI Sample L51 at 20X Magnification
L51 BLF 20X Intensity Data
Sample L51 20X 40X3

First D Pixels	Second D Pixels	Distance Pixels	Angle Degrees	D Correcte Pixels	Diameter Microns
22	52	30	90.95	30.0	8.1
13	44	31	90.91	31.0	8.4
23	54	31	87.9	31.0	8.4
19	63	44	90.6	44.0	11.9
21	57	36	87.09	36.0	9.7
21	51	30	91.73	30.0	8.1
17	51	34	88.21	34.0	9.2
11	49	38	93.01	37.9	10.2
8	49	41	88.99	41.0	11.1
13	48	35	91.75	35.0	9.4

Micron/Pixel Ratio: 0.27

Appendix J: Intensity Plot Data

Optical Measurements using Intensity Method
UTSI Sample L51 BLF at 40X magnification

First Point Pixels	Second Point Pixels	Diameter Pixels	Angle Degrees	Diameter Corrected Pixels	Diameter Pixels
22.5	84.0	61.5	91.75	61.5	8.5
15.5	104.5	89	90.72	89.0	12.3
26.5	84.5	58	91.42	58.0	8.0
27.0	102.0	75	87.49	74.9	10.3
26.0	100.0	74	85.88	73.8	10.2
30.5	81.5	51	95.08	50.8	7.0
35.5	115.0	79.5	92.33	79.4	11.0
22.5	110.0	87.5	93.56	87.3	12.1
27.0	109.5	82.5	89.32	82.5	11.4
24.0	86.0	62	89.84	62.0	8.6

Pixel to micron ratio
0.138

Appendix K: Calibration Micrometer Data and Images

Calibration Micrometer Measurements

Calibration Micrometers 20X

Calibration Micrometer 20X 32008				
Microns	**Pixels**	**Angle**	**Pixels Corrected**	**Micron to Pixel Ratio**
10	35.00	90.27	35.00	0.2857
50	175.13	90.27	175.13	0.2855
100	350.00	90.27	350.00	0.2857
Average				0.2856

Calibration Micrometer 20X 2				
Microns	**Pixels**	**Angle**	**Pixels Corrected**	**Micron to Pixel Ratio**
10	34.38	89.06	34.38	0.2909
50	171.25	89.06	171.23	0.2920
100	342.25	89.06	342.20	0.2922
Average				0.2917

Calibration Micrometer 20X 121007				
Microns	**Pixels**	**Angle**	**Pixels Corrected**	**Micron to Pixel Ratio**
10	37.01	90.34	37.01	0.2702
50	185.00	90.00	185.00	0.2703
100	373.00	90.00	373.00	0.2681
Average				0.2695

Appendix K: Calibration Micrometer Data and Images

Calibration Micrometers 40X

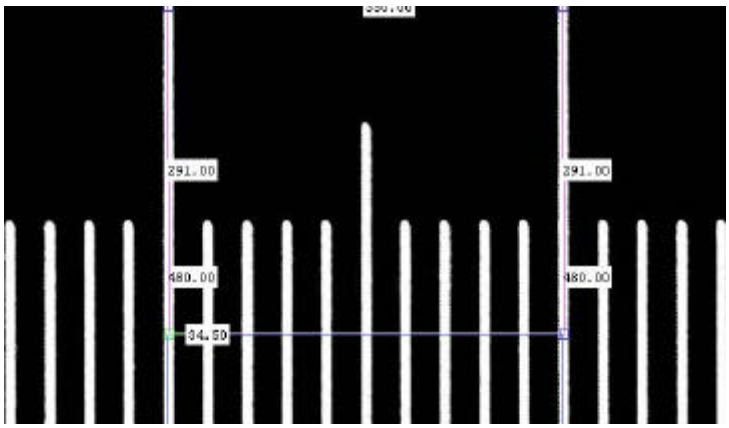
Calibration Micrometer 40X				
Microns	**Pixels**	**Angle**	**Pixel Corrected**	**Micron to Pixel Ratio**
50	373.25	91.09	373.18	0.1340
30	224.00	91.25	223.95	0.1340
10	74.00	91.24	73.98	0.1352
Average				0.1344

Calibration Micrometer 40X 31808				
Microns	**Pixels**	**Angle**	**Pixel Corrected**	**Micron to Pixel Ratio**
50	360.00	90.00	360.00	0.1389
30	216.50	90.00	216.50	0.1386
10	72.00	90.00	72.00	0.1389
Average				0.1388

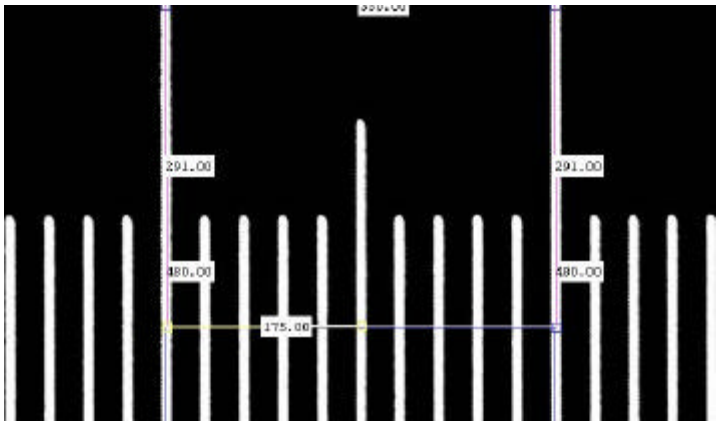
Calibration Micrometer 40X 32008 2				
Microns	**Pixels**	**Angle**	**Pixel Corrected**	**Micron to Pixel Ratio**
40	288.00	90.19	288.00	0.1389
30	216.00	90.19	216.00	0.1389
20	144.00	90.19	144.00	0.1389
10	73.00	90.19	73.00	0.1370
Average				0.1384

Calibration Micrometer 40X 32008				
Microns	**Pixels**	**Angle**	**Pixel Corrected**	**Micron to Pixel Ratio**
50	361.00	90.00	361.00	0.1385
30	216.00	90.00	216.00	0.1389
10	71.00	90.00	71.00	0.1408
Average				0.1394

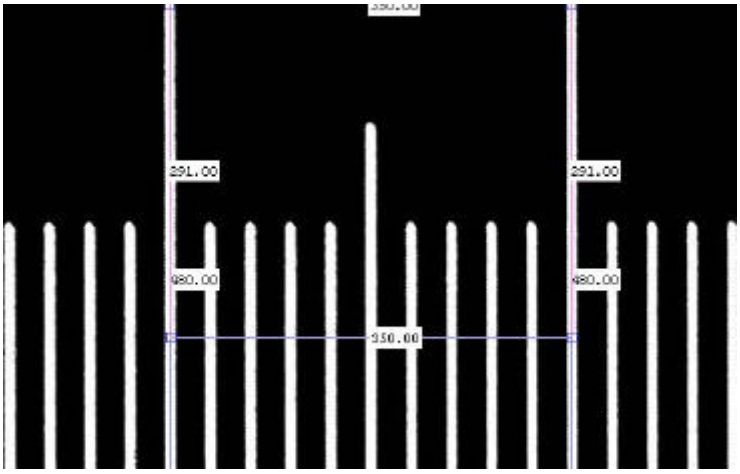
20X Measured Calibration Micrometers
Calibration Micrometer 20X 32008



10 microns



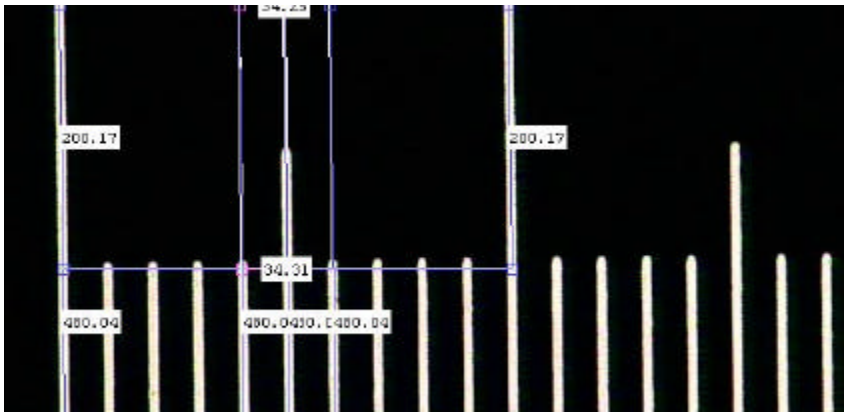
50 microns



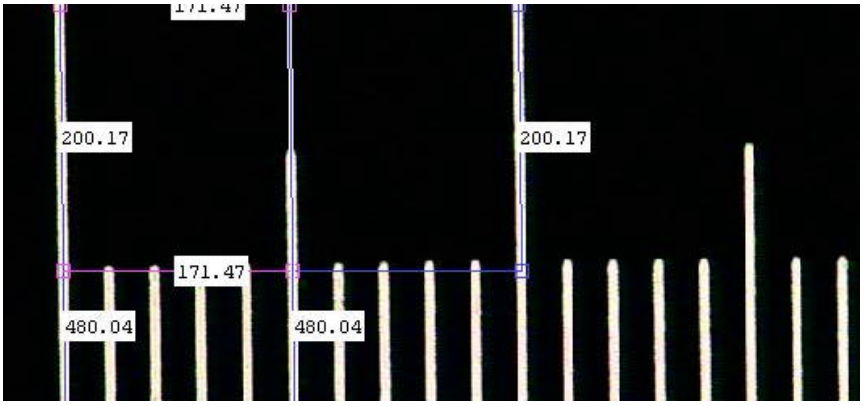
100 microns

Appendix K: Calibration Micrometer Data and Images

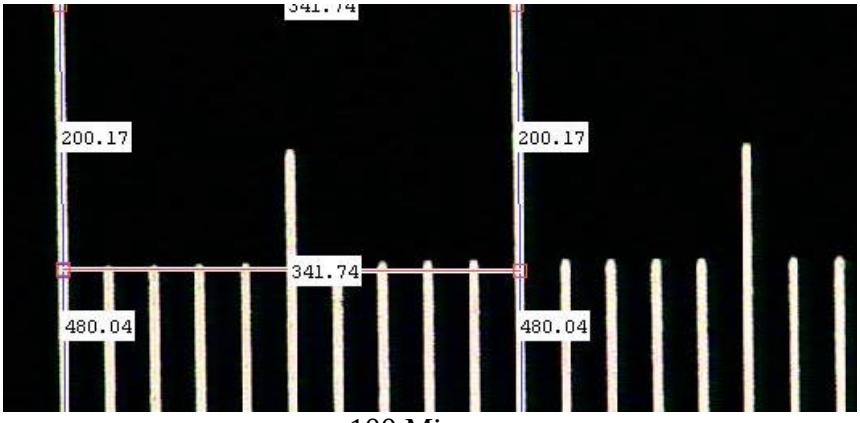
Calibration Micrometer 20X 2



10 microns



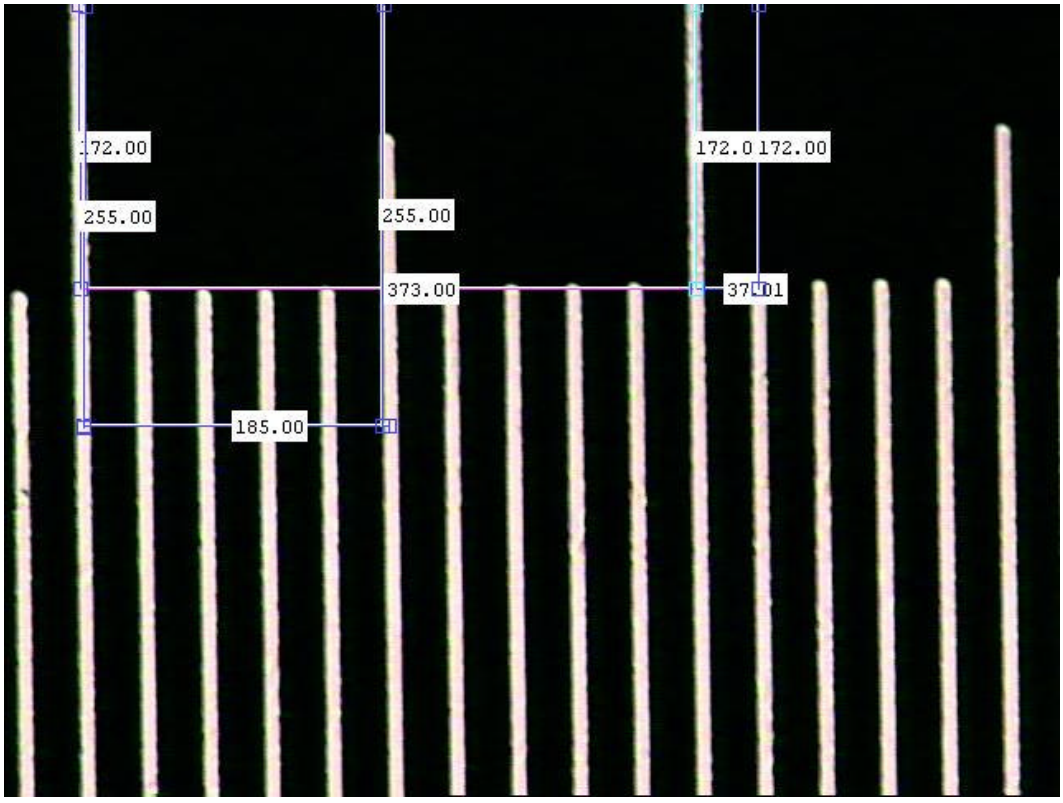
50 Microns



100 Microns

Appendix K: Calibration Micrometer Data and Images

Calibration Micrometer 20X 121007

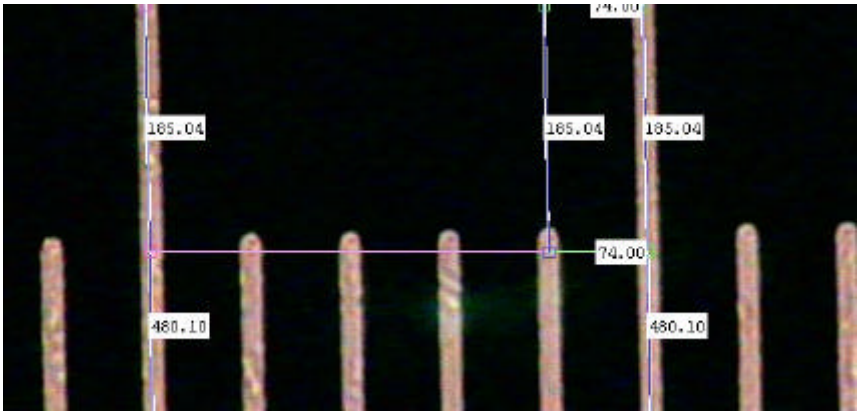


10, 50, and 100 Microns

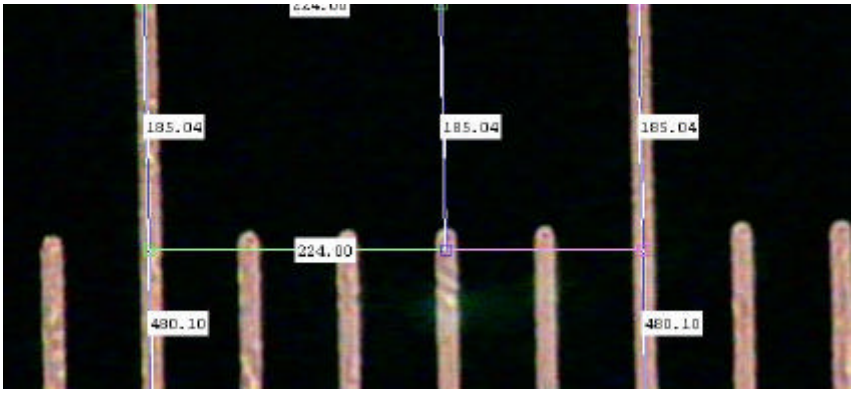
Appendix K: Calibration Micrometer Data and Images

40X Measured Calibration Micrometers

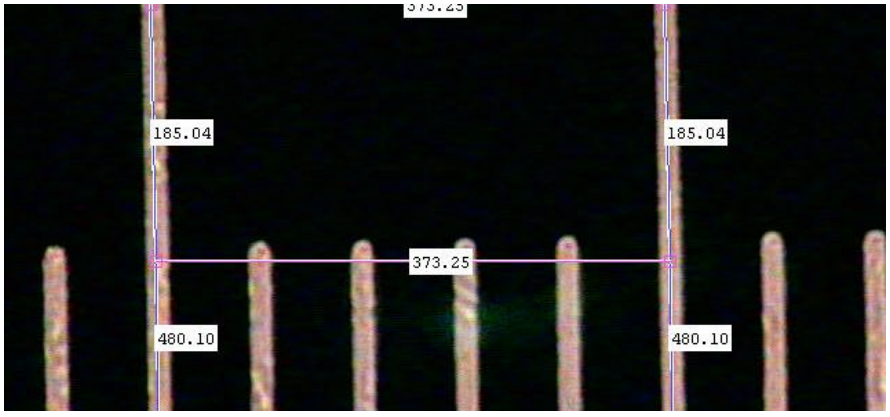
Calibration Micrometer 40X



10 Microns



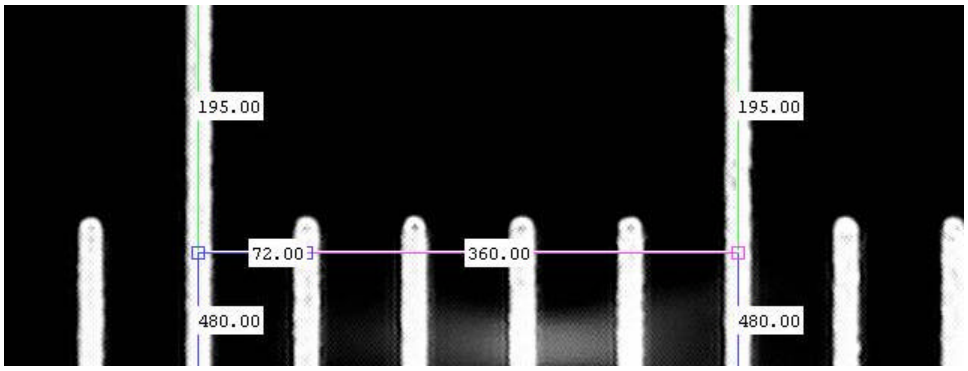
30 Microns



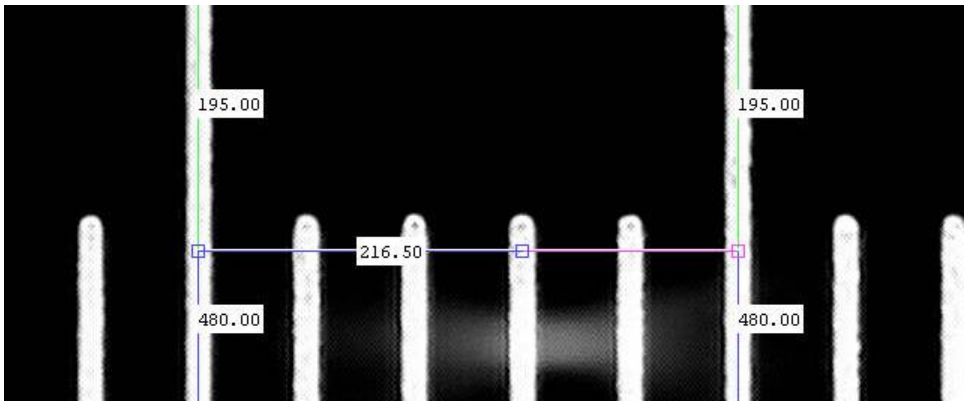
50 Microns

Appendix K: Calibration Micrometer Data and Images

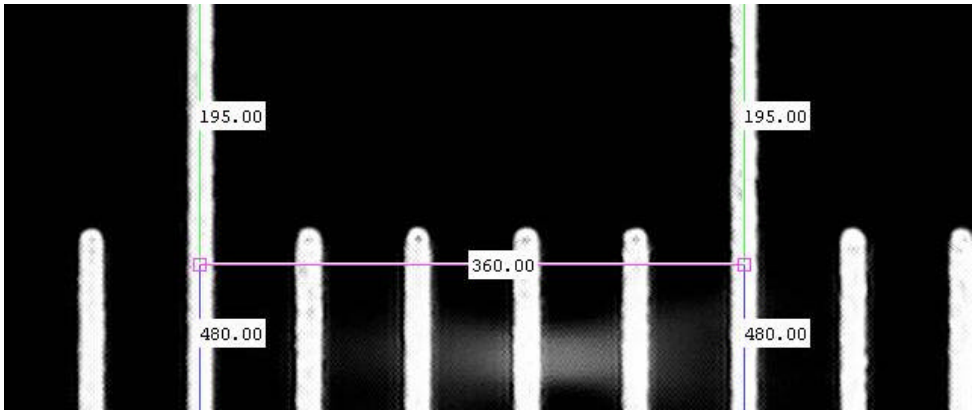
Calibration Micrometer 40X 31808



10 Microns

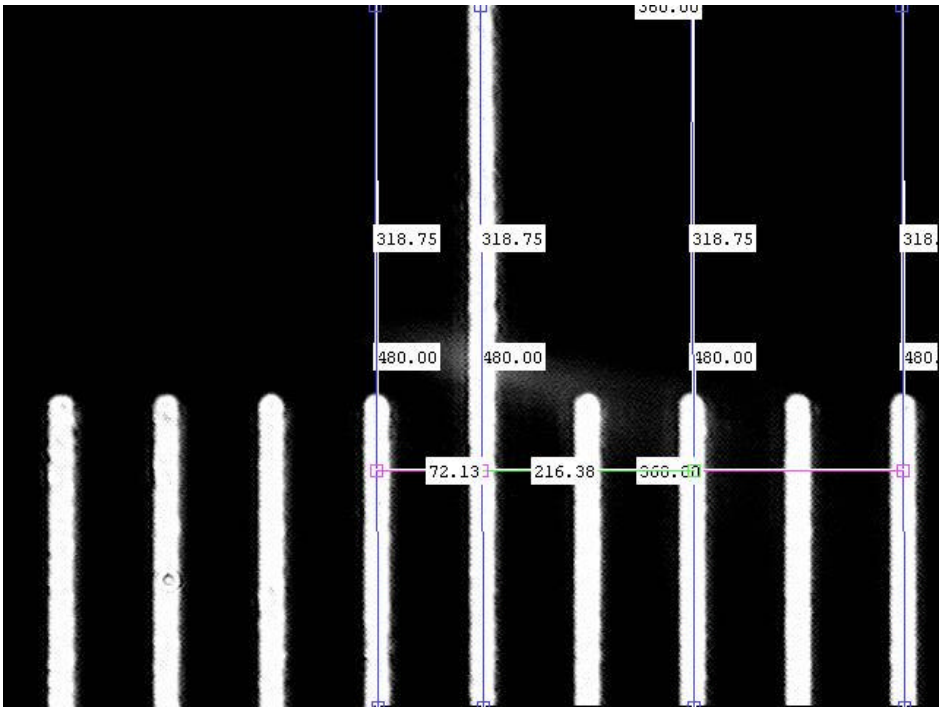


30 Microns



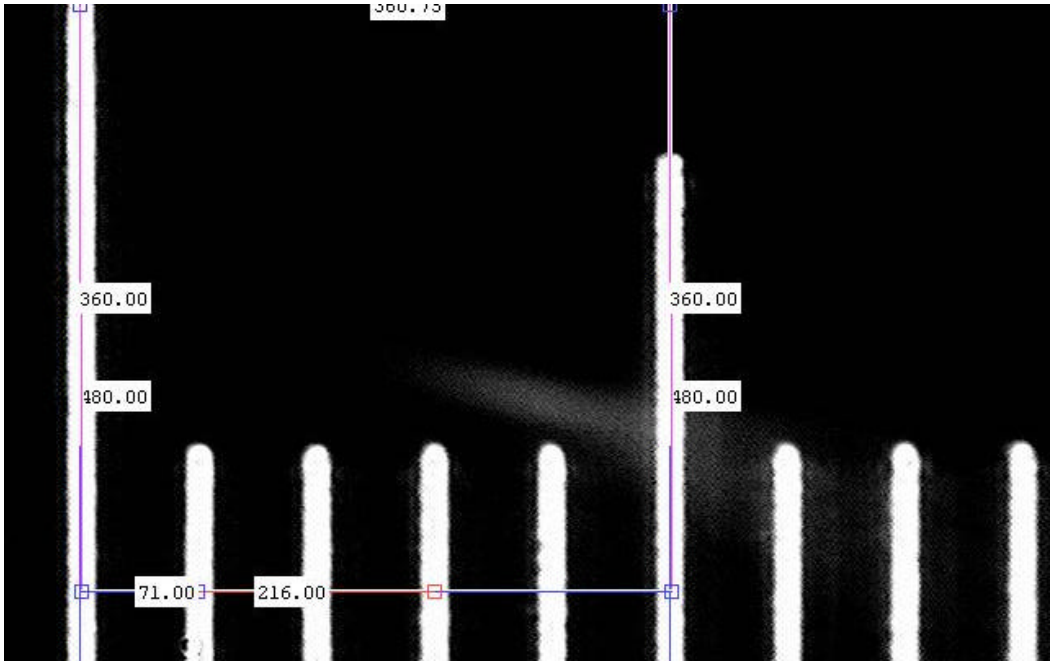
50 Microns

Calibration Micrometer 40X 32008 2



10, 30, and 50 Microns

Calibration Micrometer 32008



10, 30, and 50 Microns

VITA

Heather Cochran graduated from Lipscomb University in May 2006 with a bachelor's degree in Engineering Mechanics. She will receive her master's degree in Aerospace Engineering from the University of Tennessee Space Institute in August of 2008.