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Comparisons Between OFDA4000 and IWTO Standardised Methods for Measurements Made on Wool Tops: Part 1 Diameter Characteristics

By

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SUMMARY

A comparison of the measurement of OFDA4000 and the IWTO Standardised Laserscan on 601 commercial tops from the TEAM-3 project and 301 research tops derived from the processing of single sale lots has been completed. The three measurements considered were Mean Fibre Diameter (MFD), the Standard Deviation of Diameter (SD) and the Coefficient of Variation of Fibre Diameter (CVD).

Evidence is presented that shows that the SD measured by Laserscan and OFDA100 are not equal and for the purpose of comparison the Laserscan SD was modified mathematically to give an OFDA100 equivalent (SDm). The Laserscan CVD was also modified to give an OFDA100 equivalent (CVDm). The modification reduced the size of the observed differences.

In the case of the TEAM-3 comparisons average differences were found for all three parameters examined (MFD +0.16µm; SDm -0.11 µm; CVDm -0.68%). The respective SD of differences between the measurement systems gives an indication of the spread around the average difference for each parameter (SD of Differences (MFD 0.14µm; SDm 0.10µm; CVDm 0.45%). The Standard Deviation of Differences for MFD was consistent with what could be expected from the Airflow apparatus. This means that 95% of the comparisons were within the following: MFD -0.1µm to +0.4µm; SDm -0.3µm to +0.1µm; CVDm -1.6% to +0.2%. There was no evidence of any level dependency in the observed differences for MFD, SDm or CVDm.

In the case of the Single Sale Lot comparisons average differences were found for all three parameters examined (MFD +0.17µm; SDm -0.04 µm; CVDm -0.37%). These were close to the values found for TEAM-3. The respective SD of differences between the measurement systems gives an indication of the spread around the average difference for each parameter (SD of Differences (MFD 0.16µm; SDm 0.12µm; CVDm 0.60%). These results were slightly higher than those found for the TEAM-3 tops. The Standard Deviation of Differences for MFD was consistent with what could be expected from the Airflow apparatus. This means that 95% of the comparisons were within the following: MFD -0.1µm to +0.5µm; SDm -0.3µm to +0.1µm; CVDm -1.6% to +0.8%. In contrast to the TEAM-3 tops all three parameters (MFD, SDm or CVDm) for the Sale Lot tops exhibited level dependencies in the observed differences.

INTRODUCTION

At the IWTO Conference in Hobart, a report (Baxter (2005)) was presented on a comparison of OFDA4000 measurements against standardised IWTO Methods for diameter and length parameters. The report presented data from a round trial that was designed to demonstrate equivalence of the OFDA4000, or otherwise, with the relevant IWTO Test Methods. The trial involved 3 laboratories testing 40 selected top samples, which were replicated, on both an OFDA4000 and either an OFDA100 (2 laboratories) or a Laserscan (1 laboratory) for diameter measurements, with an OFDA4000 and an Almeter for length measurements.

A request was made at the Conference for the presentation of data comparisons from a larger number of tops. AWTA Ltd has performed a series of measurement comparisons on both the commercial tops gathered during the TEAM-3 project (TEAM (2004)) and the research tops produced during the single sale lot processing trial (Fish et al (2004)).

This report deals with the comparisons relevant to the diameter characteristics:

- Mean Fibre Diameter (MFD);
- Standard Deviation of Fibre Diameter (SD); and
- Coefficient of Variation of Fibre Diameter (CVD).

A separate report (Balasingam et al (2005)) to be presented to this Forum will cover the various length parameter comparisons.

MATERIALS AND METHODS

Source of Tops

The Comparison Trial used two sources of top samples where IWTO Standardised results had already been performed.

The first was the TEAM-3 tops which gave a wide cross section of commercial tops (TEAM-3 Steering Committee (2004)). Only 601 of the tops had enough material remaining to be included in this Trial.

The second was the tops prepared for the Single Sale Lot Processing prediction studies (Fish (2004)) where it was possible to include 301 of the tops in this Trial. These tops differ significantly from the TEAM-3 tops in that they were all prepared in a research processing mill (Smith (1982)). In addition, the sale lots were processed individually with no commercial imperative for Hauteur, CV Hauteur or Romaine. The selection of the sale lots that were processed has been reported in detail in a previously presented report (Fish (2004)). Suffice it to say for this report that they covered the widest possible range from best quality fleece wool to lots representing bellies, pieces etc. Their inclusion in this trial is to provide some insight into whether or not the measurement systems can measure the extreme tops as well as the commercial top benchmark provided by the TEAM-3 tops.

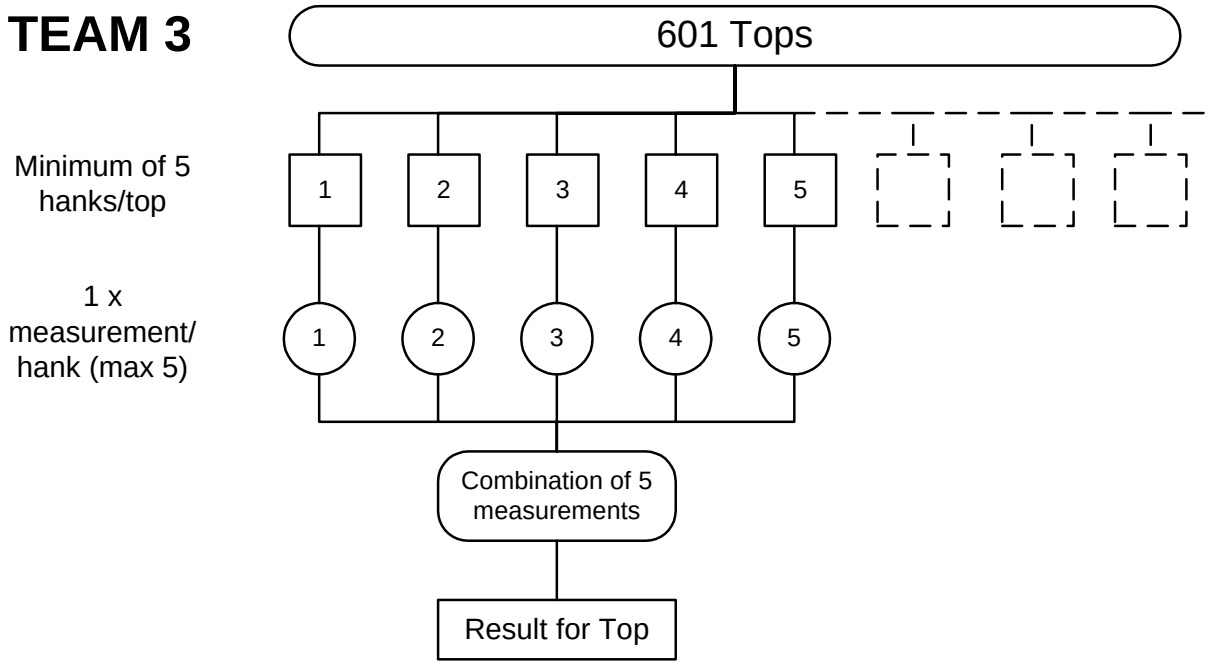
Sampling and Measurement of Top Samples by Laserscan and Almeter.

All Laboratory Samples of top were taken in accordance with IWTO-17-03, such that a 1.2m length of top was converted into a hank with 30 turns/m.

All diameter testing was performed by AWTA Ltd for both the TEAM-3 and Sale Lots tops in accordance with the procedures set out in IWTO-12.

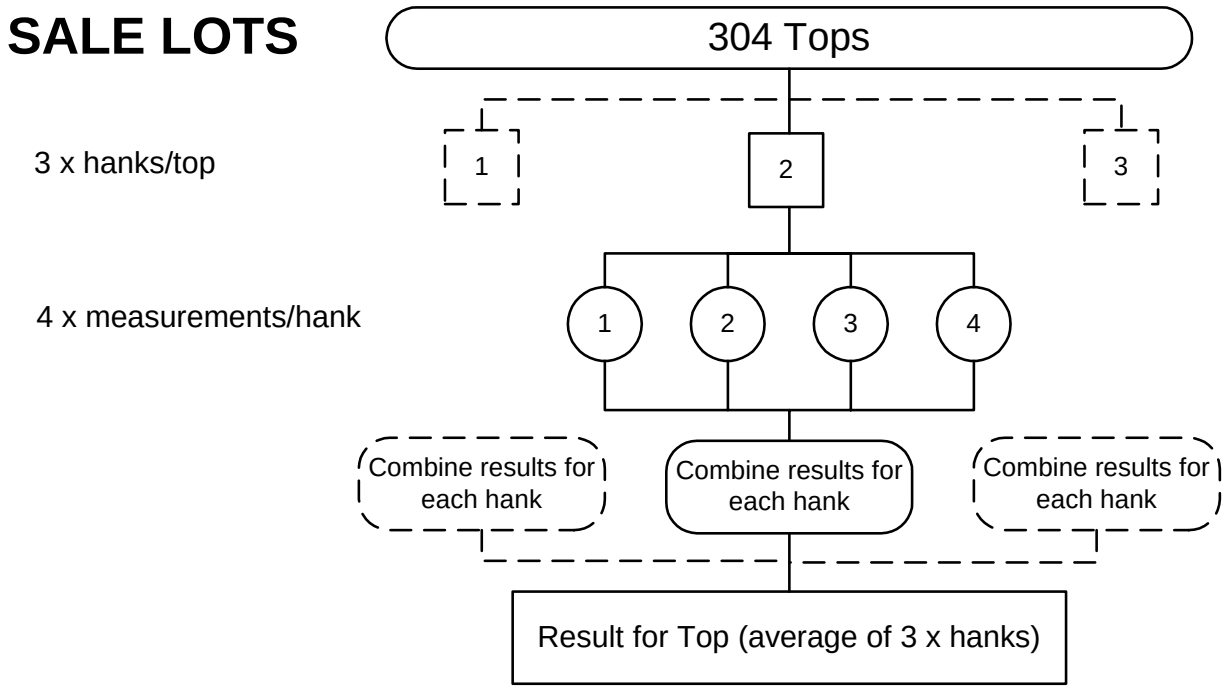
TEAM-3 tops were supplied as hanks (Laboratory Samples) by commercial mills. Five measurements were made for each TEAM-3 consignment as per the IWTO Regulations for Testing Wool Slivers. One measurement (that is two test specimens of 1000 fibre counts) was made from each of five hanks and results of these measurements were combined to provide an overall result (derived from 10,000 individual fibre measurements) for that consignment. In cases where more than 5 hanks were submitted, 5 hanks were randomly selected for measurement.

The sampling and measurement process for the TEAM-3 tops is shown diagrammatically below.



For the Sale Lots tops, each lot produced one ball of top. Three Laboratory Samples (or hanks) were taken from each top at the beginning, middle and end of the ball. Four test specimens of 1,000 counts were measured from each hank. The results from the three (3) hanks were averaged to produce the overall result for each lot.

The sampling and measurement process for the Sale Lots tops is shown diagrammatically below.



The diameter measurements for the TEAM-3 tops were carried out using two Laserscans in one AWTA Ltd laboratory whereas the measurements for the Sale Lots tops were performed on a different

Laserscan in a different AWTA Ltd Laboratory. All Laserscans within AWTA Ltd are subjected to a rigorous Quality Control program.

Sampling and Measurement of Top Samples by OFDA4000.

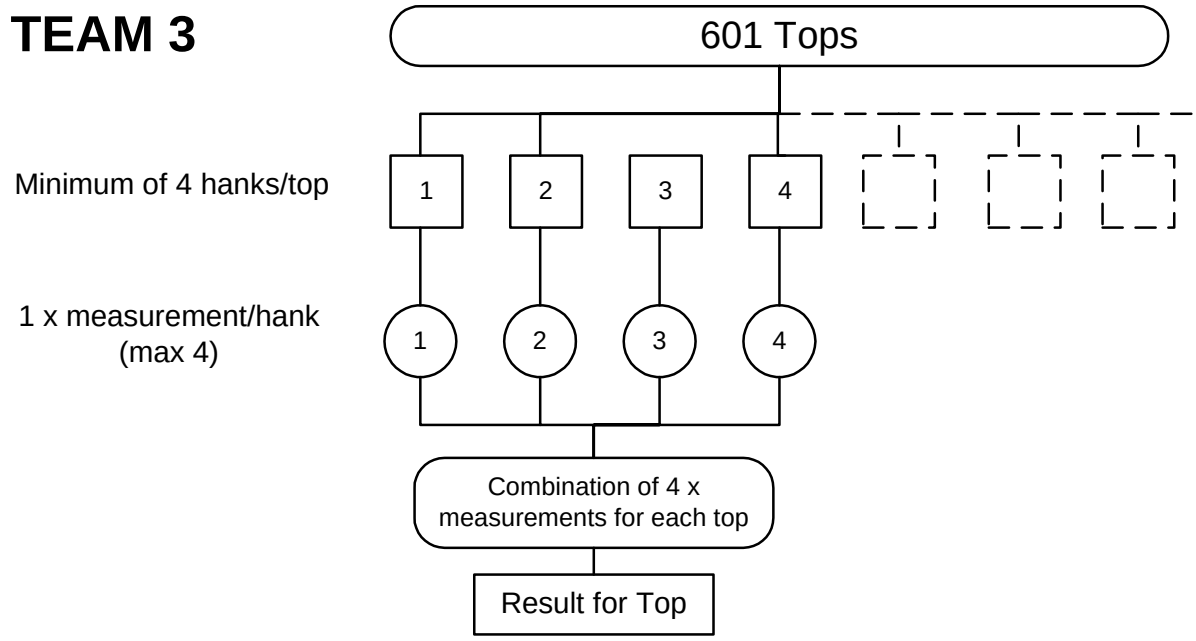
All OFDA4000 measurements were made using the software Version 5.18. One feature of this version that differs from earlier versions is that the size of the step between adjacent scans of the top was 5mm from 0mm (0mm is equivalent to the base end of an Almeter beard) to 60mm and then 10mm from 60mm to the end of fibre draw/beard.

OFDA4000 testing was preformed by CSIRO, Textile and Fibre Technology, for both TEAM-3 and Sale Lots tops on one OFDA4000 Instrument.

The sampling and testing protocol ensured that four (4) measurements were taken from each processing consignment or batch.

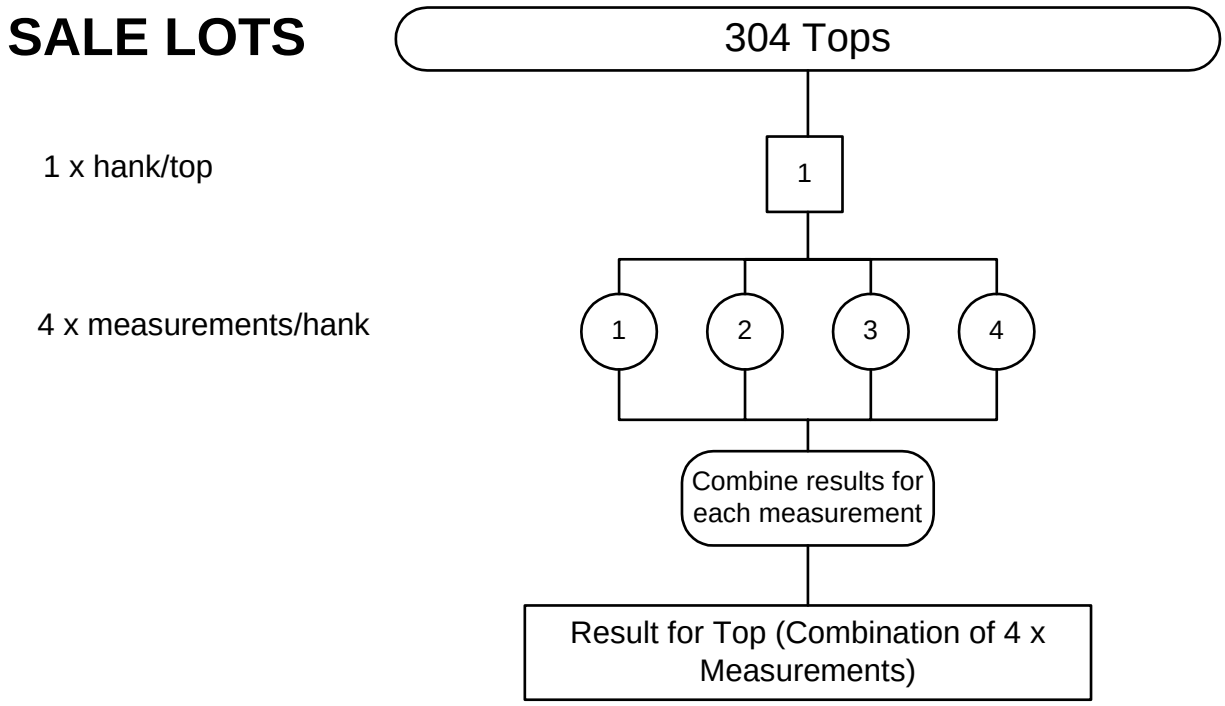
For TEAM-3, this meant taking one test specimen from each Laboratory Sample, or hank, where four hanks were available. In cases where fewer than four (4) hanks were available due to insufficient material remaining after Almeter testing for the TEAM-3 project, multiple measurements were made on the available hanks such that a total of four (4) measurements were made for each consignment top. These four (4) measurements were combined by the OFDA4000 software to provide the result for analysis.

The sampling and measurement process for the TEAM-3 tops is shown diagrammatically below.



For the Sale Lots tops one hank was supplied for each batch, and so four (4) Test Specimens were measured from the hank. The four (4) measurements were combined by the OFDA4000 software to provide the results for analysis.

The sampling and measurement process for the Sale Lots tops is shown diagrammatically below.



Statistical Analyses

The analyses reported relate to 601 TEAM-3 tops and 301 Single Sale Lots tops. Data for three of the Single Sale Lots was not able to be reconciled for both instruments.

All comparisons between measurements were conducted using the procedures defined in IWTO-0.

The full details for all the IWTO-0 analyses, summarised in the body of the report, are included as Appendix A. The convention for reporting statistical significance throughout this report is as follows:

- NS denotes not statistically significant at a probability level of 0.05;
- * denotes statistically significant at a probability level of 0.05;
- ** denotes statistically significant at a probability level of 0.01; and
- *** denotes statistically significant at a probability level of 0.001.

RESULTS AND DISCUSSION

The summaries of the results and discussion will be presented in the order Mean Fibre Diameter, Standard Deviation of Fibre Diameter and Coefficient of Variation of Fibre Diameter. Differences of 0.01 units can occur in the tables due to rounding of the individual average values for the OFDA4000 and the Laserscan whereas the Difference values are calculated prior to any rounding. The analyses are presented in full in Appendix 1.

Mean Fibre Diameter (MFD)

Table 1 summarises the results for comparing the MFD measurements for both the TEAM-3 Tops and the Single Sale Lot tops. The results from the 2004/05 OFDA4000 Round Trial are included for comparison.

Table 1: Summary of Mean Fibre Diameter Results

Data Set	Number of Tops	OFDA4000 Average	Laserscan Average	Average Difference	Statistical Significance	SD of Differences	GM Slope	Statistical Significance
TEAM	601	20.45	20.30	0.16	***	0.14	1.00	NS
Sale Lots	301	19.76	19.59	0.17	***	0.16	1.02	***
SG02[#]	40	23.55	23.64	-0.09	***	0.08	1.00	NS

Note: # Baxter, P. (2005) *"Report on the 2004/05 OFDA4000 and Almeter/OFDA100/Laserscan Round Trial."* IWTO T&S Committee, Hobart, SG02.

The results for the TEAM-3 and Sale Lot Trials indicate a statistically significant bias of +0.16µm and +0.17µm compared to the -0.09µm bias found in the earlier Round Trial.

The Standard Deviation of Differences indicates that 95% of the data for the OFDA4000 fell within -0.1µm and +0.5µm of the Standard IWTO Method. The lower SD of differences for the 2004/05 OFDA4000 Round Trial (SG02[#]) could either relate to:

- the difference in experimental design (the differences were derived from the grand mean of twelve measurements (3 laboratories, 2 hanks, 2 measurements) for the OFDA4000 and reference method); or
- the wider range of top characteristics interacting in some way with the measurement of Mean Fibre Diameter.

The Sale Lot tops data set exhibited a level dependent bias whereas the TEAM-3 data set and the Round Trial data set did not. The magnitude of the level-dependent bias for the Sale lot tops varied from +0.07µm at 15µm to +0.51µm at 35µm. The data are presented graphically in Figures 1 and 2.

In order to put the reported Standard Deviation of Differences into context with current commercial practice the IWTO Regulations for the testing of Wool Slivers For Mean Fibre Diameter and Mean Fibre Length were reviewed. The Maximum Retest Range for Mean Fibre Diameter less than 26 µm was 0.7µm. However, this figure includes a within consignment deviation of 0.21µm which is not a factor in the data for this trial. For the purpose of estimating a comparable Standard Deviation of Differences between two test results the data in IWTO-6-98 from Table A2.2 was used. The Confidence Limit for Tops with a Mean Fibre Diameter less than 26 µm was ±0.23µm, when five hanks were tested. Using this 0.23µm value and dividing it by 1.96, to convert it to a Standard Deviation, and then multiplying by the square root of two gave an estimate of the Standard Deviation of Differences for IWTO-6 of 0.17µm. This value compares favourably with the values reported above for the TEAM data set (0.14µm) and the Sale Lots data set (0.16µm).

Figure 1: Mean Fibre Diameter Differences for the TEAM-3 Tops.

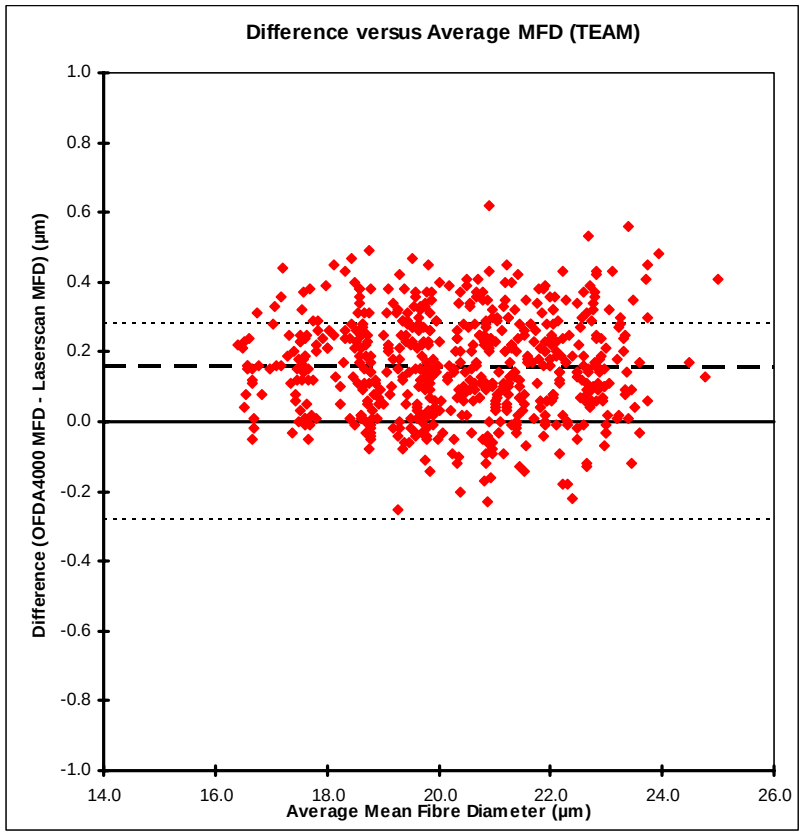
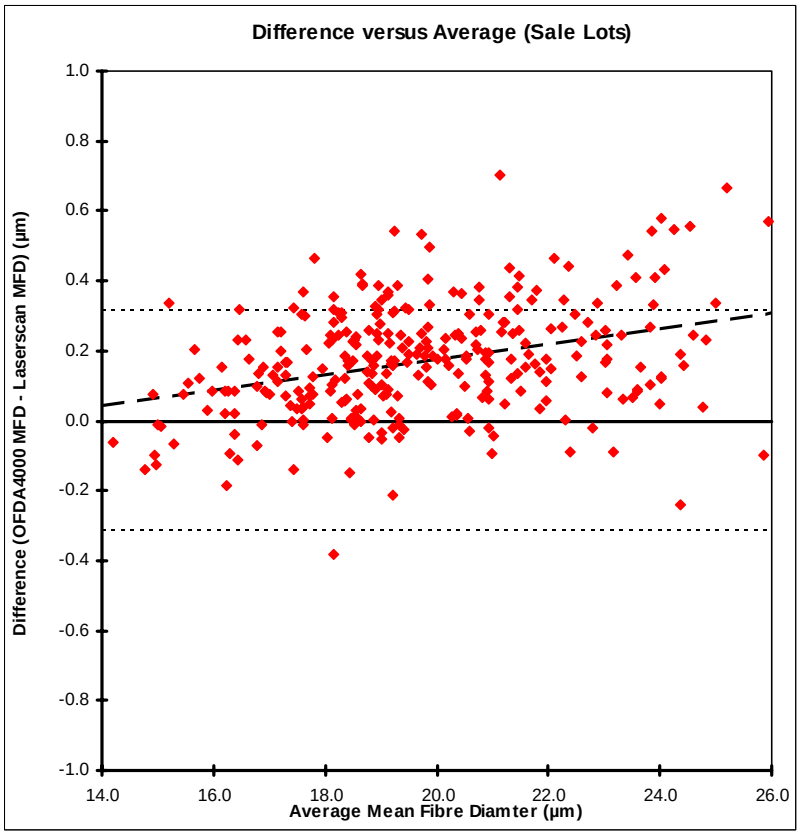


Figure 2: Mean Fibre Diameter Differences for the Sale Lot Tops.



Standard Deviation of Fibre Diameter (SD)

Table 2 summarises the results for comparing the SD measurements for both the Team-3 Tops and the Single Sale Lot tops. The results from the 2004/05 OFDA4000 Round Trial are included for comparison.

Table 2: Summary of Standard Deviation of Fibre Diameter Results

Data Set	Number of Tops	OFDA4000 Average	Laserscan Average	Average Difference	Statistical Significance	SD of Differences	GM Slope	Statistical Significance
TEAM	601	4.16	4.28	-0.12	***	0.14	0.84	***
Sale Lots	301	3.96	3.94	0.03	***	0.14	0.90	***
SG02[#]	40	5.28	5.36	-0.08	***	0.09	0.95	***

Note: # Baxter, P. (2005) *"Report on the 2004/05 OFDA4000 and Almeter/OFDA100/Laserscan Round Trial."* IWTO T&S Committee, Hobart, SG02.

The results for the TEAM-3 and Sale Lot Trials indicate a statistically significant bias of -0.12µm and +0.03µm compared to the -0.08µm bias found in the earlier trial.

As was observed for Mean Fibre Diameter, the Standard Deviation of Differences was higher for both the TEAM-3 and Single Sale Lots Tops (0.14 µm) than was observed in the Round Trial data set (0.09 µm). For the TEAM-3 and Sale Lot data sets 95% of the OFDA4000 results fell within -0.4µm and +0.3µm of the Standard IWTO Test Method.

All three data sets exhibited a level dependent bias. The data are presented graphically in Figures 3 and 4.

Harig (1995) presented data based on a Round Trial conducted that indicated a curvilinear relationship existed between the SD measured by Laserscan and the SD measured by OFDA100. Analysis of the data from the 2004/05 Round Trial (Baxter (2005)), and a further analysis of Interwoollabs Round Trial data would both support the view that there is not a one-to-one relationship between the SD measured by OFDA100 and Laserscan (see Figures 5 and 6). The dotted lines on Figures 5 and 6 represent the one-to-one relationship.

The curvilinear relationship was found to be best defined by a cubic relationship. The relationships presented in Figures 5 and 6 for the two totally independent data sets are extremely close to each other as can be seen from the coefficients.

In order to ascertain if the level dependent bias was due to the difference between Laserscan measurements and OFDA100 measurements, it was decided to modify the Laserscan SD measurements for both the TEAM and Sale Lots data sets to reflect an OFDA100 SD measurement.

As the Interwoollabs data represented a larger number of tops and also represented the average relationship for about 30 laboratories using Laserscan and about 40 Laboratories using OFDA100, it was used to transform the Laserscan SD data.

Figure 3: Standard Deviation of Diameter Differences for the TEAM-3 Tops.

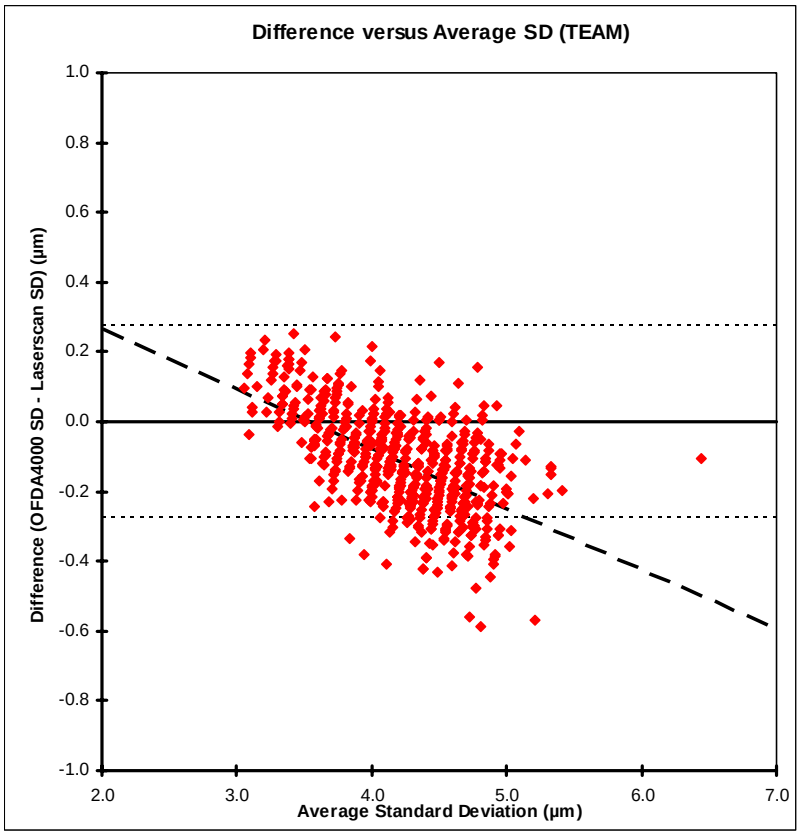


Figure 4: Standard Deviation of Diameter Differences for the Sale Lot Tops.

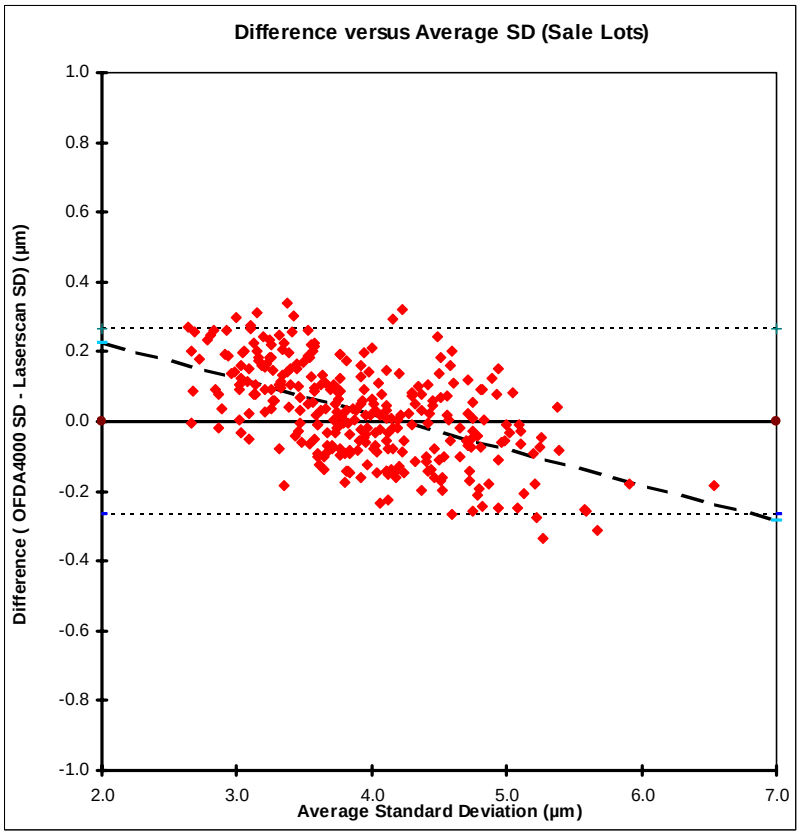


Figure 5: SD Measurement Comparison based on the OFDA4000 2004/05 Round Trial Data

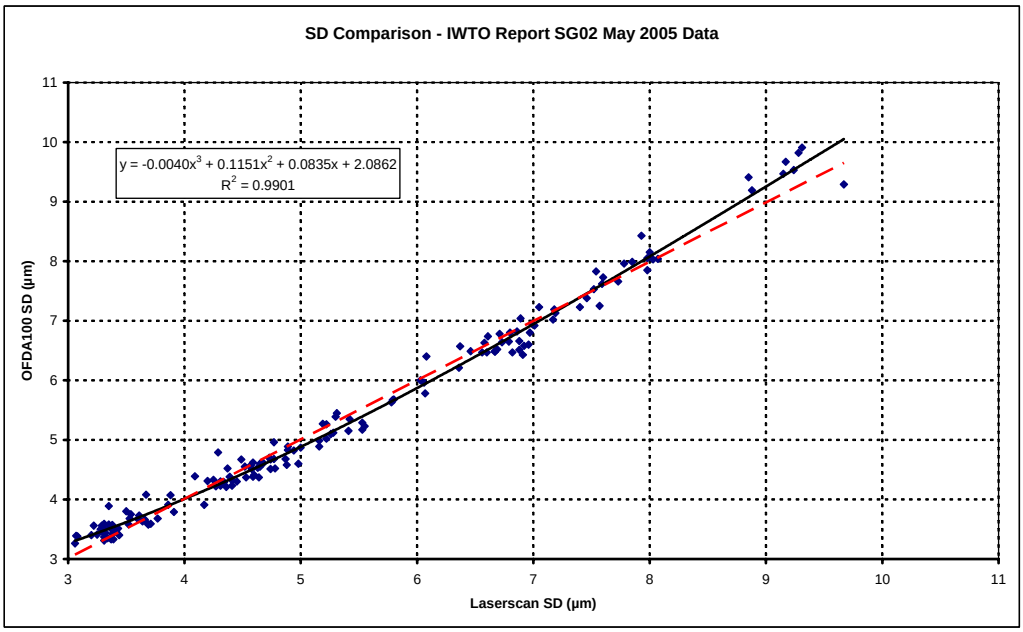


Figure 6: SD Measurement Comparison based on Interwoollabs Round Trial Data

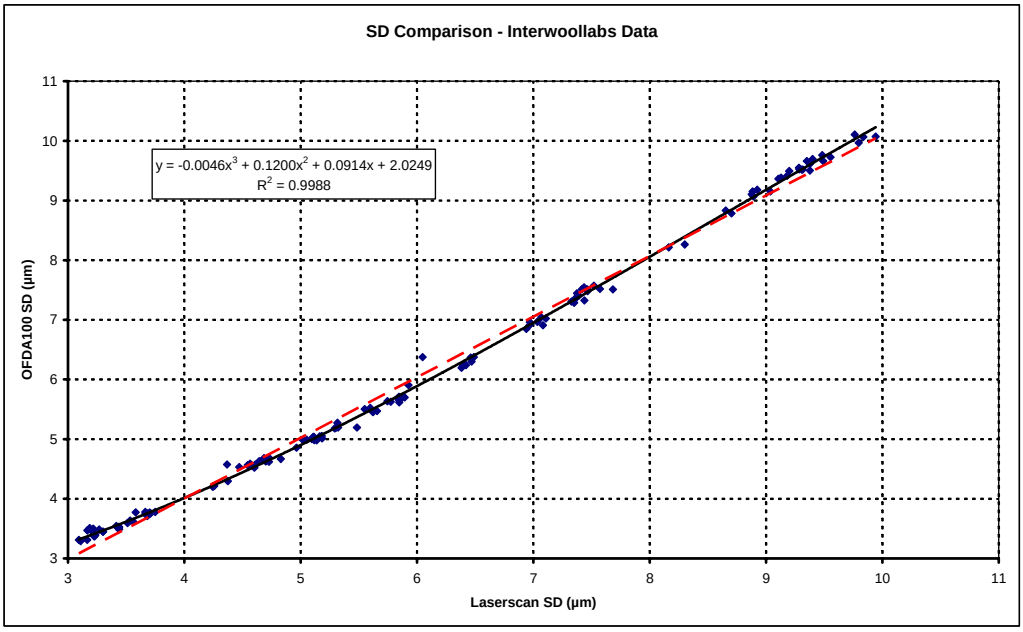


Table 3 summarises the analyses for Standard Deviation of Fibre Diameter after the Laserscan SD values were modified to reflect the values that would be expected for an OFDA100 measurement. The data are also presented graphically in Figures 6 and 7.

Table 3: Summary of Modified Standard Deviation of Fibre Diameter Results

Data Set	Number of Tops	OFDA4000 Average	Laserscan Average	Average Difference	Statistical Significance	SD of Differences	GM Slope	Statistical Significance
TEAM	601	4.16	4.27	-0.11	***	0.10	0.98	NS
Sale Lots	301	3.96	4.00	-0.04	***	0.12	1.07	***

Figure 6: Modified Laserscan SD Measurement Comparison for the TEAM-3 Tops

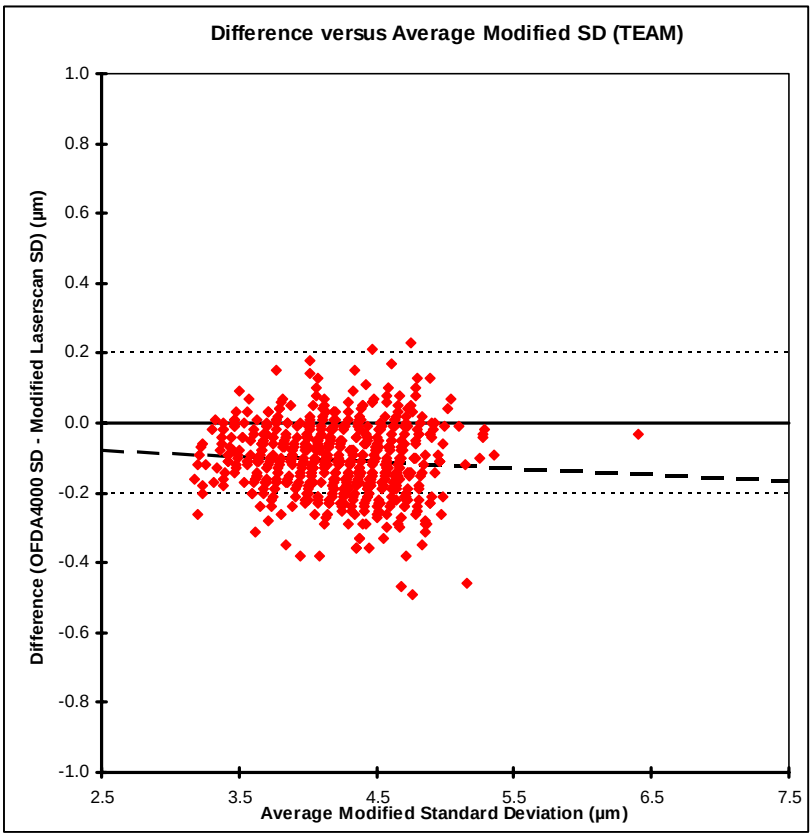
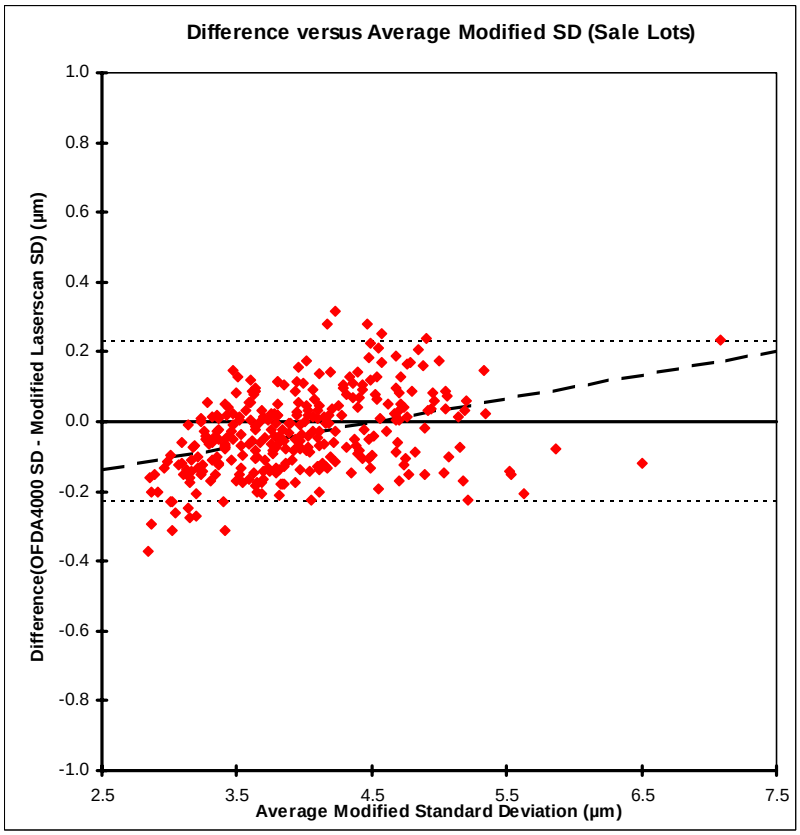


Figure 7: Modified Laserscan SD Measurement Comparison for the Sale Lot Tops



The modification to the Laserscan SD measurements removed the level dependency for the TEAM-3 tops and at the same time reduced the Standard Deviation of Differences from 0.14µm to 0.10µm. In the case of the Sale Lot Tops the improvement was not as good. The slope changed from 0.90 to 1.07 while the Standard Deviation of Differences was reduced from 0.14µm to 0.12µm. Closer examination of Figure 7 indicates that a number of individual tops could possibly be exhibiting high leverage on the statistics. An analysis with eight such data points removed only changed the slope slightly (1.07 to 1.06) and had only a small reduction on the Standard Deviation of Differences (0.12µm to 0.11µm) (see Appendix 1 for the details).

The major difference between the TEAM-3 tops and the Sale Lot tops is that in the specific case of the Sale Lots they were all processed as individual lots without any commercial targets for Hauteur (H), CV of Hauteur (CVH) or Romaine. The shapes of the Hauteur diagrams between the two have been already reported as exhibiting differences (Fish (2005)).

Coefficient of Variation of Fibre Diameter (CVD)

Table 4 summarises the results for comparing the CVD measurements for both the Team Tops and the Single Sale Lot tops.

Table 4: Summary of Coefficient of Variation of Fibre Diameter Results

Data Set	Number of Tops	OFDA4000 Average	Laserscan Average	Average Difference	Statistical Significance	SD of Differences	GM Slope	Statistical Significance
TEAM	601	20.34	21.04	-0.70	***	0.64	0.76	***
Sale Lots	301	20.01	20.00	0.01	NS	0.74	0.91	***

The results for the TEAM-3 data indicate a statistically significant bias of -0.70 % whereas the results from the Single Sale Lots indicated a +0.03 % bias which was not statistically significant.

For the TEAM-3 and Sale Lot data sets 95% of the OFDA4000 results fell within -2.1 % and +1.4 % of the Standard IWTO Test Method.

Both data sets exhibited level dependent biases. The data are presented graphically in Figures 8 and 9.

A modified Laserscan CVD (to emulate an OFDA100 CVD) was calculated for each lot from the modified Laserscan SD and the measured Mean Fibre Diameter. The results for the statistical analysis are summarised in Table 5.

Table 5: Summary of Modified Coefficient of Variation of Fibre Diameter Results

Data Set	Number of Tops	OFDA4000 Average	Laserscan Average	Average Difference	Statistical Significance	SD of Differences	GM Slope	Statistical Significance
TEAM	601	20.34	21.03	-0.68	***	0.45	0.99	NS
Sale Lots	301	20.01	20.38	-0.37	***	0.60	1.16	***

As was the case for SD the level dependency for the TEAM-3 tops was corrected and the Standard Deviation of Differences was reduced from 0.64 % to 0.45 %. Once again it was apparent that when the same modification was applied to the Sale Lot tops the Standard Deviation of Differences was reduced from 0.74 % to 0.60 % but the level dependency remained.

The comparison between the OFDA4000 and the Modified Laserscan Results are presented graphically in Figures 10 and 11.

Figure 8: Coefficient of Variation of Fibre Diameter Differences for the TEAM-3 tops.

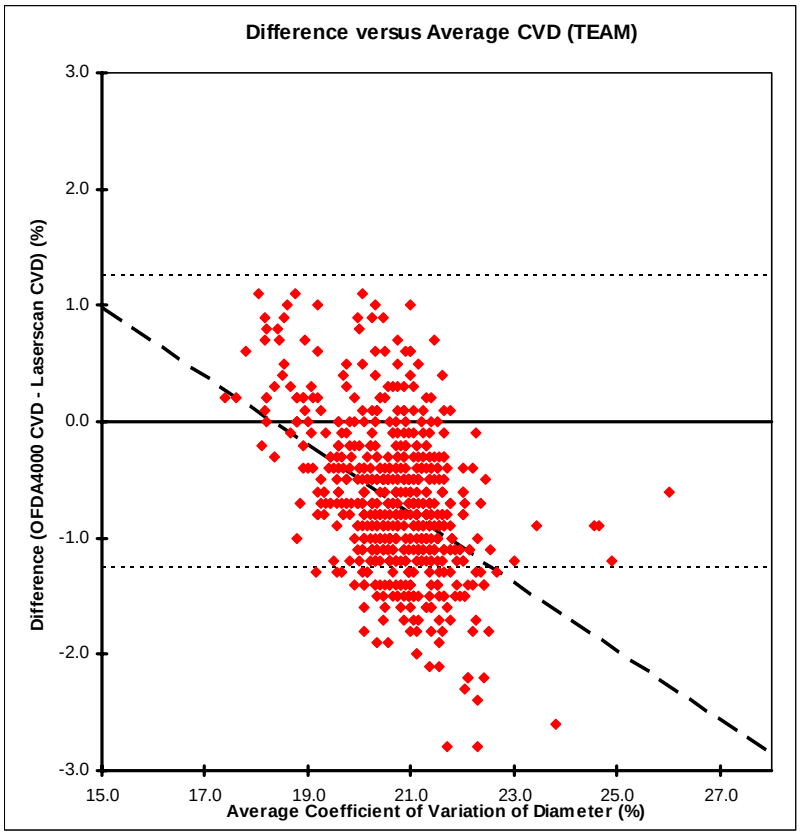


Figure 9: Coefficient of Variation of Fibre Diameter Differences for the Sale Lot Tops.

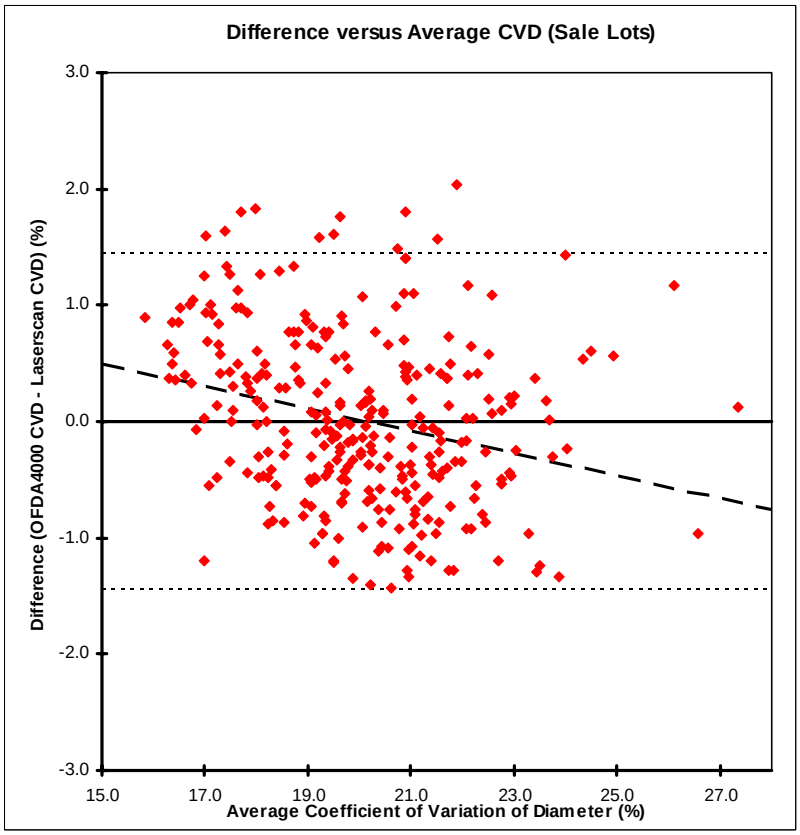


Figure 10: Modified Coefficient of Variation of Fibre Diameter Differences for the TEAM-3 tops.

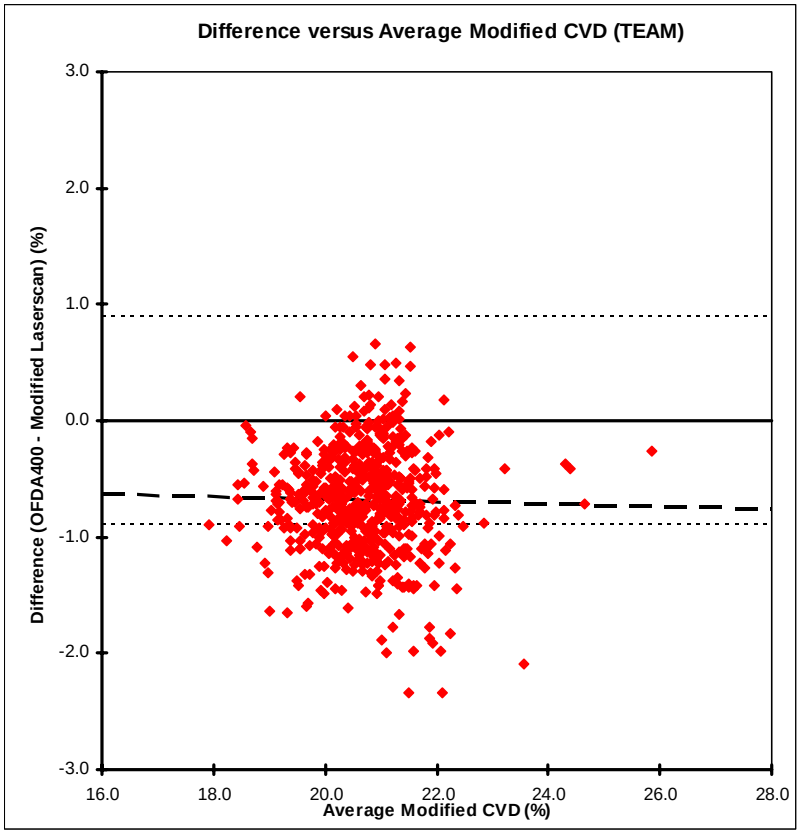
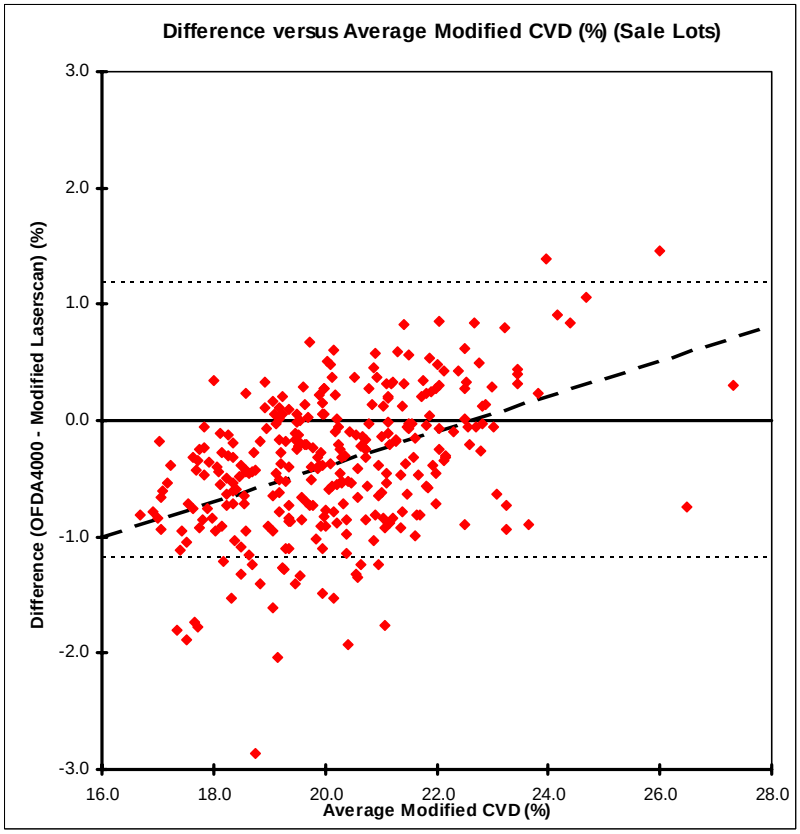


Figure 11: Modified Coefficient of Variation of Fibre Diameter Differences for the Sale Lot tops.



The comments regarding the differences in processing conditions between the TEAM-3 tops and the Sale Lot tops made in the Standard Deviation section are equally applicable here as the calculation of CVD includes the SD.

CONCLUSIONS

A comparison of the measurement of OFDA4000 and the IWTO Standardised Laserscan on 601 commercial tops from the TEAM-3 project and 301 research tops derived from the processing of single sale lots has been completed. The three measurements considered were Mean Fibre Diameter (MFD), the Standard Deviation of Diameter (SD) and the Coefficient of Variation of Fibre Diameter (CVD).

Evidence is presented that shows the SD measured by Laserscan and OFDA100 are not equal and for the purpose of comparison the Laserscan SD was modified mathematically to give an OFDA100 equivalent (SDm). The Laserscan CVD was also modified to give an OFDA100 equivalent (CVDm).

In the case of the TEAM-3 comparisons average differences were found for all three parameters examined (MFD +0.16µm; SDm -0.11 µm; CVDm -0.68%). The respective SD of differences between the measurement systems gives an indication of the spread around the average difference for each parameter (SD of Differences (MFD 0.14µm; SDm 0.10µm; CVDm 0.45%). The Standard Deviation of Differences for MFD was consistent with what could be expected from the Airflow apparatus. This means that 95% of the comparisons were within the following: MFD -0.1µm to +0.4µm; SDm -0.3µm to +0.1µm; CVDm -1.6% to +0.2%. There was no evidence of any level dependency in the observed differences for MFD and SDm or CVDm (once the SD and CVD were modified to reflect an OFDA100).

In the case of the Single Sale Lot comparisons average differences were found for all three parameters examined (MFD +0.17µm; SDm -0.04 µm; CVDm -0.37%). These were close to the values found for TEAM-3. The respective SD of differences between the measurement systems gives an indication of the spread around the average difference for each parameter (SD of Differences (MFD 0.16µm; SDm 0.12µm; CVDm 0.60%). These results were slightly higher than those found for the TEAM-3 tops. The Standard Deviation of Differences for MFD was consistent with what could be expected from the Airflow apparatus. This means that 95% of the comparisons were within the following: MFD -0.1µm to +0.5µm; SDm -0.3µm to +0.1µm; CVDm -1.6% to +0.8%. In contrast to the TEAM-3 tops all three parameters (MFD, SDm or CVDm) for the Sale Lot tops exhibited level dependencies in the observed differences.

ACKNOWLEDGEMENTS

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IWTO-6-98: *Method of Test for the Determination of the Mean Fibre Diameter of Wool Fibres in Combed Sliver using the Airflow Apparatus*.

IWTO-12-03: *Measurement of the Mean & Distribution of Fibre Diameter Using the Sirolan-Laserscan Fibre Diameter Analyser.*

IWTO-17-03: *Determination of Fibre Length Distribution Parameters by Means of the Almeter.*

IWTO-47-00: *Measurement of the Mean & Distribution of Fibre Diameter Using an Optical Fibre Diameter Analyser (OFDA).*

IWTO Regulations for the Testing of Wool Slivers for Mean Fibre Diameter and Mean Fibre Length.

Smith, L.J. & Hoschke, B.N. (1982) *Mini-processing as an Assessment Technique.* J. Text. Inst., 6(264).

TEAM-3 Steering Committee (2004) *TEAM-3 Final Report June 2004*.

APPENDIX 1

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The following pages present the detail of the IWTO-0 analyses conducted.

Mean Fibre Diameter Comparison (TEAM)

(A) Test for Overall Relative Bias & Paired t-test.

	Overall Bias		Paired
	Laserscan	OFDA4000	t-test
Number	601	601	601
Average	20.2968	20.4541	**0.1573**
SD	1.7953	1.7948	0.1431
SE	0.0732	0.0732	0.0058
t value	277.1600	279.3830	26.9377
p value	0.0000	0.0000	0.0000
Significance			***

(B) Test for Correlation.

Number	601
DF	599
R	0.9968
t-value	306.1841
p-value	0.0000
Significance	***

(C) Test for Level Dependent "Bias".

Statistical Significance

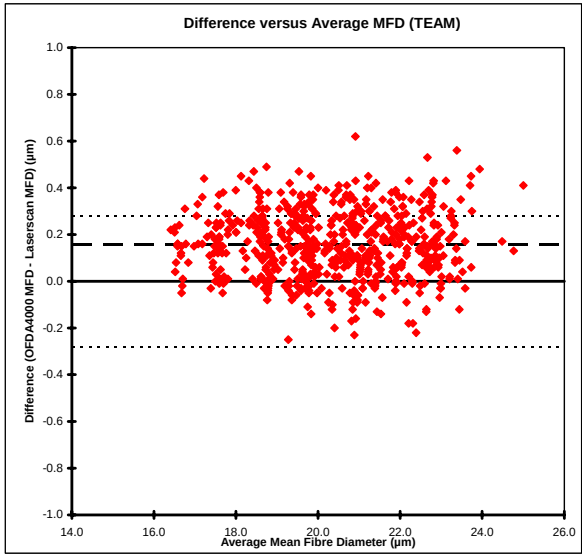
Regression	Slope	Significance	SE of Slope	t-Value	p-value	Rsq
GM	**0.9997**	**NS**	0.0033	0.0826	0.9342	0.9937
DVA	**-0.0003**	**NS**	0.0033	0.0826	0.9342	
Intercept(GM)	0.1627					STEYX
Intercept(DVA)	0.1628					0.1432

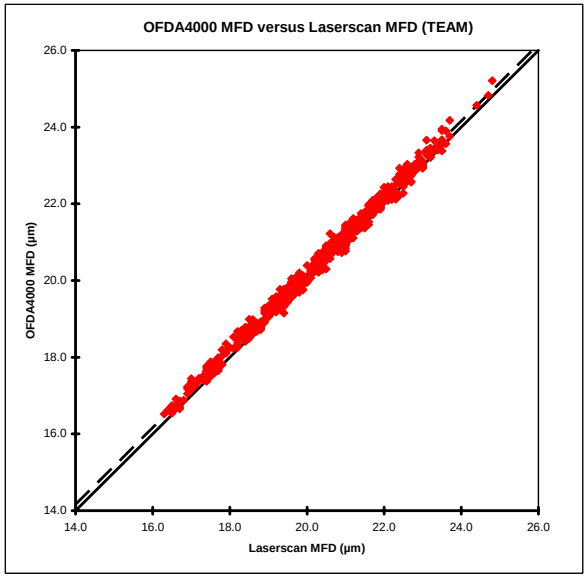
Magnitude of the Level Dependent "Bias".

Nominal	Calculated	Avg. "Bias"
15	15.16	0.16
18	18.16	0.16
20	20.16	0.16
25	25.16	0.16
30	30.15	0.15
35	35.15	0.15

Max/Mins.

Control	max	24.80
	min	16.30
Treatment	max	25.21
	min	16.52
average	max	25.01
	min	16.41
difference	max	0.62
	min	-0.25





Mean Fibre Diameter Comparison (Sale Lots)

(A) Test for Overall Relative Bias & Paired t-test.

	Overall Bias		Paired
	Laserscan	OFDA4000	t-test
Number	301	301	301
Average	19.5891	19.7582	**0.1691**
SD	2.3713	2.4239	0.1594
SE	0.1367	0.1397	0.0092
t value	143.3225	141.4188	18.4016
p value	0.0000	0.0000	0.0000
Significance			***

(B) Test for Correlation.

Number	301
DF	299
R	0.9980
t-value	275.1550
p-value	0.0000
Significance	***

(C) Test for Level Dependent "Bias".

Statistical Significance

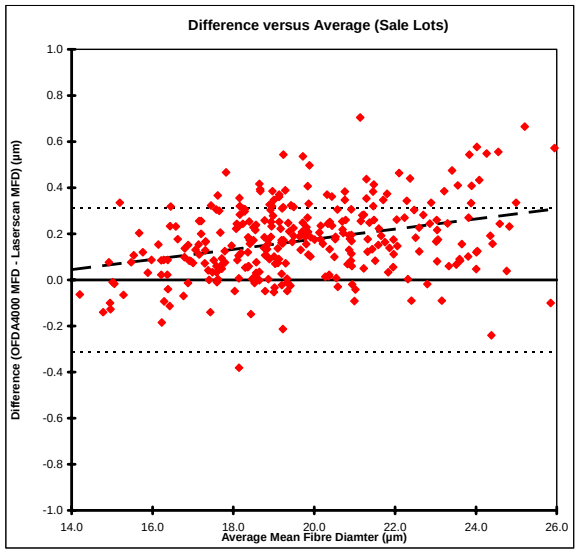
Regression	Slope	Significance	SE of Slope	t-Value	p-value	Rsq
GM	**1.0222**	***	0.0037	5.9897	0.0000	0.9961
DVA	**0.0220**	***	0.0036	6.0562	0.0000	
Intercept(GM)	-0.2660					STEYX
Intercept(DVA)	-0.2635					0.1490

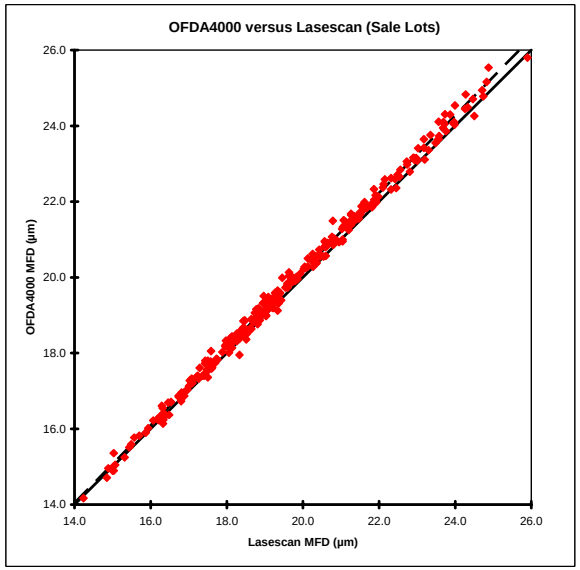
Magnitude of the Level Dependent "Bias".

Nominal	Calculated	Avg. "Bias"
15	15.07	0.07
18	18.13	0.13
20	20.18	0.18
25	25.29	0.29
30	30.40	0.40
35	35.51	0.51

Max/Mins.

Control	max	25.90
	min	14.23
Treatment	max	26.23
	min	14.17
average	max	25.94
	min	14.20
difference	max	0.70
	min	-0.38





Standard Deviation of Diameter Comparison (TEAM)

(A) Test for Overall Relative Bias & Paired t-test.

	Overall Bias		Paired
	Laserscan	OFDA4000	t-test
Number	601	601	601
Average	4.2804	4.1645	**-0.1159**
SD	0.5243	0.4420	0.1401
SE	0.0214	0.0180	0.0057
t value	200.1532	231.0086	-20.2709
p value	0.0000	0.0000	0.0000
Significance			***

(B) Test for Correlation.

Number	601
DF	599
R	0.9723
t-value	101.7319
p-value	0.0000
Significance	***

(C) Test for Level Dependent "Bias".

Statistical Significance

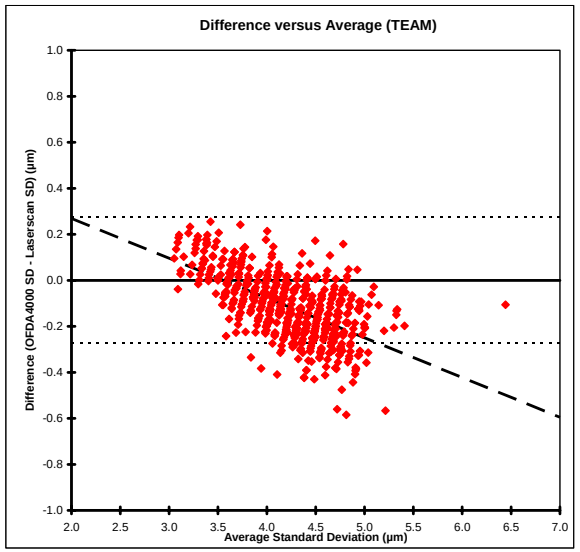
Regression	Slope	Significance	SE of Slope	t-Value	p-value	Rsq
GM	**0.8430**	***	0.0081	19.4899	0.0000	0.9453
DVA	**-0.1728**	***	0.0096	17.9598	0.0000	
Intercept(GM)	0.5562					STEYX
Intercept(DVA)	0.6137					0.1227

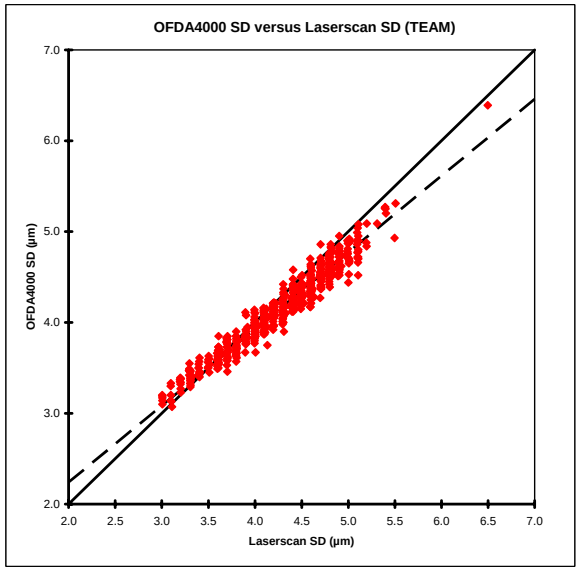
Magnitude of the Level Dependent "Bias".

Nominal	Calculated	Avg. "Bias"
2	2.24	0.24
3	3.09	0.09
4	3.93	-0.07
5	4.77	-0.23
6	5.61	-0.39
7	6.46	-0.54

Max/Mins.

Control	max	6.50
	min	3.00
Treatment	max	6.39
	min	3.07
average	max	6.44
	min	3.05
difference	max	0.25
	min	-0.59





Standard Deviation of Diameter Comparison (Sale Lots)

(A) Test for Overall Relative Bias & Paired t-test.

	Overall Bias		Paired
	Laserscan	OFDA4000	t-test
Number	301	301	301
Average	3.9351	3.9616	**0.0265**
SD	0.7421	0.6707	0.1361
SE	0.0428	0.0387	0.0078
t value	91.9931	102.4824	3.3779
p value	0.0000	0.0000	0.0008
Significance			***

(B) Test for Correlation.

Number	301
DF	299
R	0.9865
t-value	104.2639
p-value	0.0000
Significance	***

(C) Test for Level Dependent "Bias".

Statistical Significance

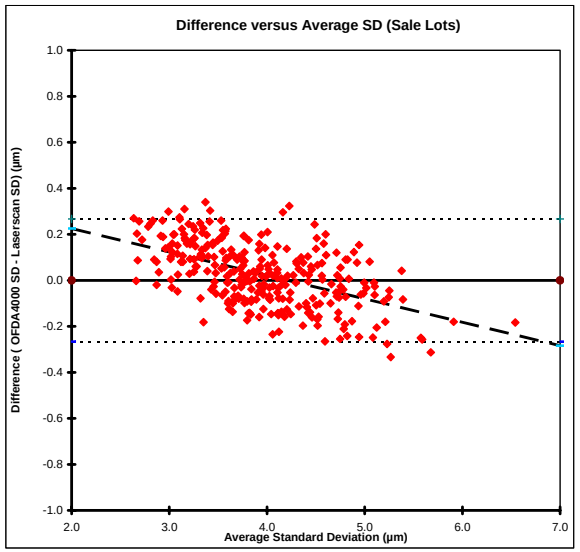
Regression	Slope	Significance	SE of Slope	t-Value	p-value	Rsq
GM	**0.9037**	***	0.0086	11.2634	0.0000	0.9732
DVA	**-0.1019**	***	0.0095	10.7210	0.0000	
Intercept(GM)	0.4055					STEYX
Intercept(DVA)	0.4287					0.1216

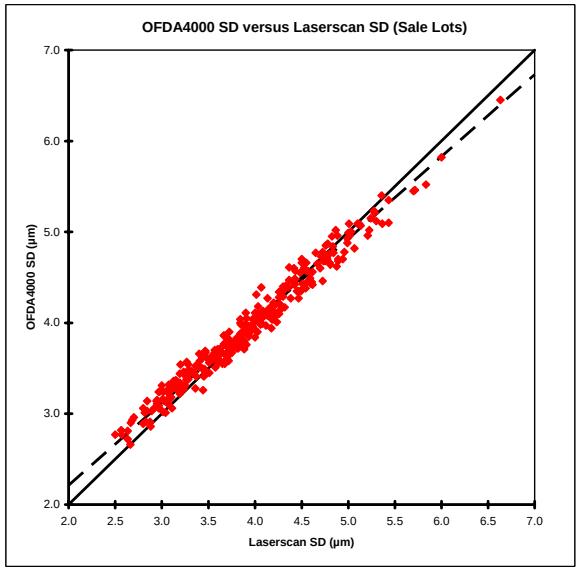
Magnitude of the Level Dependent "Bias".

Nominal	Calculated	Avg. "Bias"
2	2.21	0.21
3	3.12	0.12
4	4.02	0.02
5	4.92	-0.08
6	5.83	-0.17
7	6.73	-0.27

Max/Mins.

Control	max	7.00
	min	2.50
Treatment	max	7.20
	min	2.66
average	max	7.10
	min	2.64
difference	max	0.34
	min	-0.33





Modified Standard Deviation of Diameter Comparison (TEAM)

(A) Test for Overall Relative Bias & Paired t-test.

	Overall Bias		Paired
	Laserscan (m)	OFDA4000	t-test
Number	601	601	601
Average	4.2711	4.1645	**-0.1066**
SD	0.4496	0.4420	0.1031
SE	0.0183	0.0180	0.0042
t value	232.8775	231.0086	-25.3570
p value	0.0000	0.0000	0.0000
Significance			***

(B) Test for Correlation.

Number	601
DF	599
R	0.9734
t-value	104.0209
p-value	0.0000
Significance	***

(C) Test for Level Dependent "Bias".

Statistical Significance

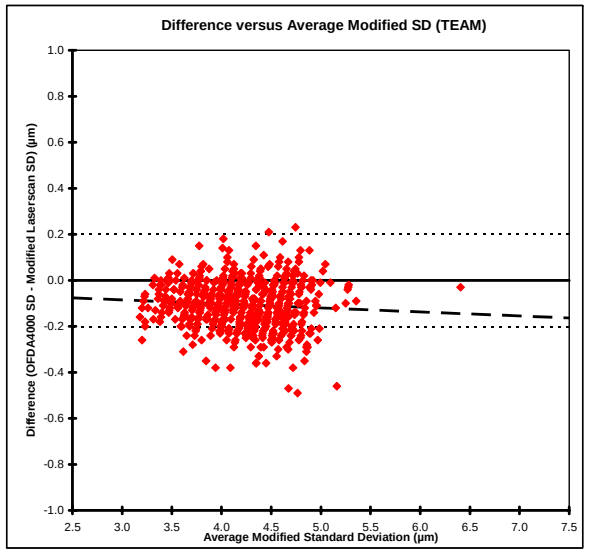
Regression	Slope	Significance	SE of Slope	t-Value	p-value	Rsq
GM	**0.9829**	**NS**	0.0092	1.8560	0.0639	0.9475
DVA	**-0.0175**	**NS**	0.0095	1.8401	0.0662	
Intercept(GM)	-0.0337					STEYX
Intercept(DVA)	-0.0330					0.1031

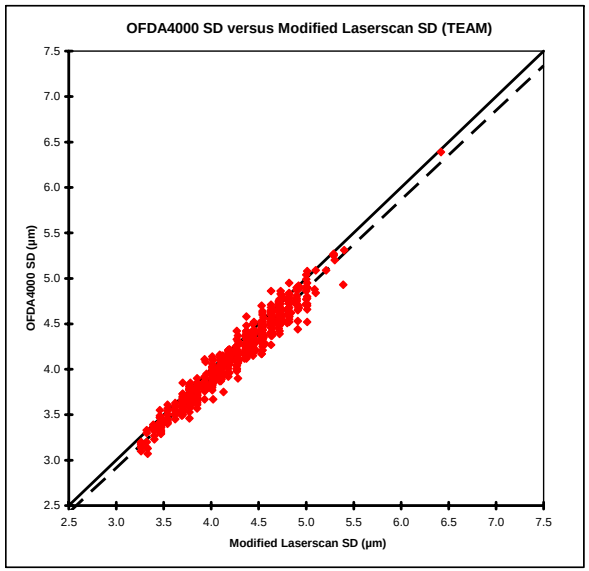
Magnitude of the Level Dependent "Bias".

Nominal	Calculated	Avg. "Bias"
2	1.93	-0.07
3	2.92	-0.08
4	3.90	-0.10
5	4.88	-0.12
6	5.86	-0.14
7	6.85	-0.15

Max/Mins.

Control	max	6.42
	min	3.26
Treatment	max	6.39
	min	3.07
average	max	6.41
	min	3.18
difference	max	0.23
	min	-0.49





Modified Standard Deviation of Diameter Comparison (Sale Lots)

(A) Test for Overall Relative Bias & Paired t-test.

	Overall Bias		Paired
	Laserscan (m)	OFDA4000	t-test
Number	301	301	301
Average	3.9974	3.9616	**-0.0358**
SD	0.6269	0.6707	0.1162
SE	0.0361	0.0387	0.0067
t value	110.6289	102.4824	-5.3474
p value	0.0000	0.0000	0.0000
Significance			***

(B) Test for Correlation.

Number	301
DF	299
R	0.9862
t-value	103.0777
p-value	0.0000
Significance	***

(C) Test for Level Dependent "Bias".

Statistical Significance

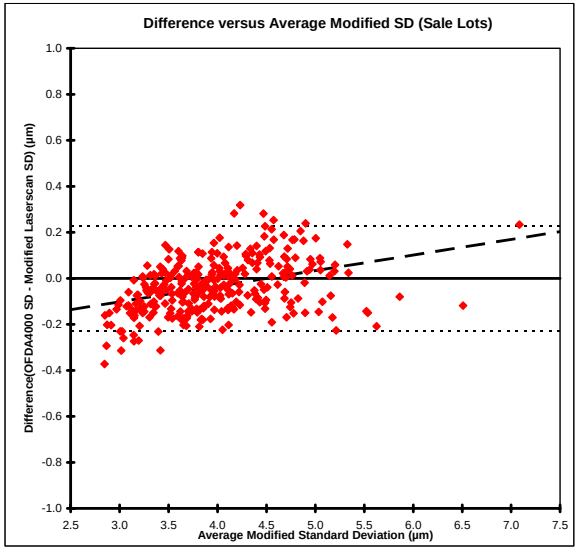
Regression	Slope	Significance	SE of Slope	t-Value	p-value	Rsq
GM	**1.0698**	***	0.0102	6.8211	0.0000	0.9726
DVA	**0.0679**	***	0.0096	7.0592	0.0000	
Intercept(GM)	-0.3149					STEYX
Intercept(DVA)	-0.3061					0.1039

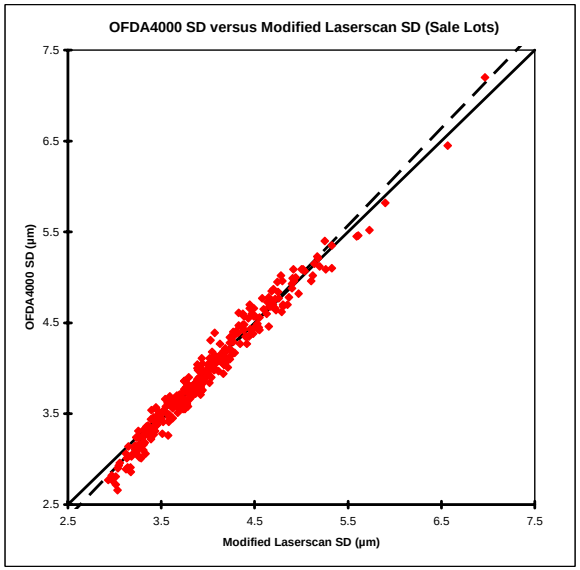
Magnitude of the Level Dependent "Bias".

Nominal	Calculated	Avg. "Bias"
2	1.82	-0.18
3	2.89	-0.11
4	3.96	-0.04
5	5.03	0.03
6	6.10	0.10
7	7.17	0.17

Max/Mins.

Control	max	6.97
	min	2.93
Treatment	max	7.20
	min	2.66
average	max	7.08
	min	2.85
difference	max	0.32
	min	-0.37





Modified Standard Deviation of Diameter Comparison (Sale Lots) Edited

(A) Test for Overall Relative Bias & Paired t-test.

	Overall Bias		Paired
	Control	Treatment	t-test
Number	293	293	293
Average	4.0057	3.9753	**-0.0304**
SD	0.5987	0.6320	0.1091
SE	0.0350	0.0369	0.0064
t value	114.5271	107.6693	-4.7755
p value	0.0000	0.0000	0.0000
Significance			***

(B) Test for Correlation.

Number	293
DF	291
R	0.9857
t-value	99.9319
p-value	0.0000
Significance	***

(C) Test for Level Dependent "Bias".

Statistical Significance

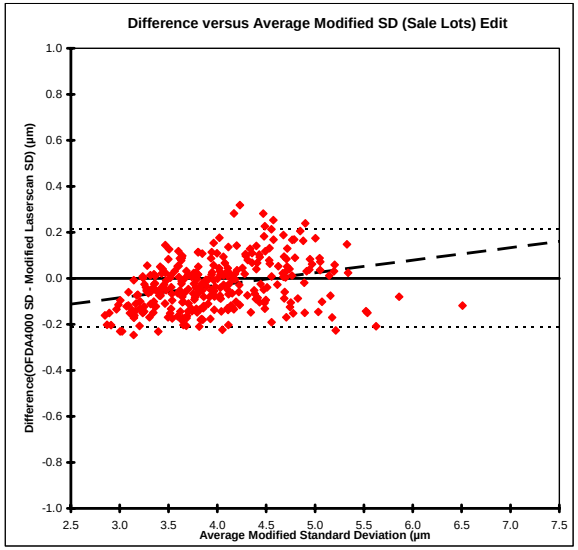
Regression	Slope	Significance	SE of Slope	t-Value	p-value	Rsq
GM	1.0556	***	0.0104	5.3408	0.0000	0.9717
DVA	0.0545	***	0.0099	5.4893	0.0000	
Intercept(GM)	-0.2532					STEYX
Intercept(DVA)	-0.2479					0.1009

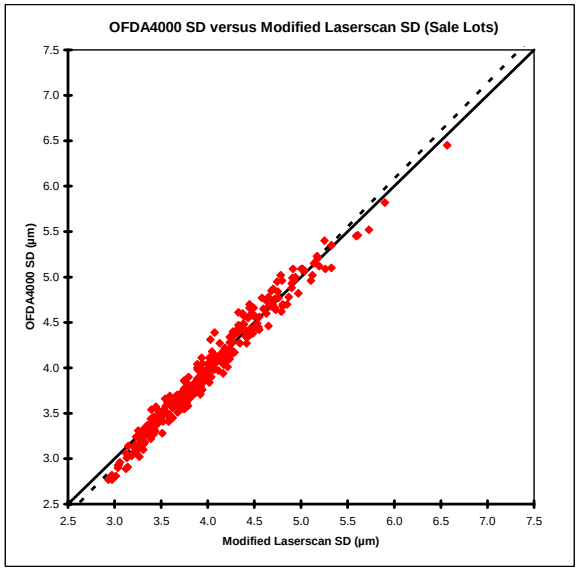
Magnitude of the Level Dependent "Bias".

Nominal	Calculated	Avg. "Bias"
2	1.86	-0.14
3	2.91	-0.09
4	3.97	-0.03
5	5.02	0.02
6	6.08	0.08
7	7.14	0.14

Max/Mins.

Control	max	6.57
	min	2.93
Treatment	max	6.45
	min	2.77
average	max	6.51
	min	2.85
difference	max	0.32
	min	-0.25





Coefficient of Variation of Diameter Comparison (TEAM)

(A) Test for Overall Relative Bias & Paired t-test.

	Overall Bias		Paired
	Laserscan	OFDA4000	t-test
Number	601	601	601
Average	21.0416	20.3433	**-0.6983**
SD	1.1706	0.8899	0.6396
SE	0.0477	0.0363	0.0261
t value	440.6699	560.4345	-26.7685
p value	0.0000	0.0000	0.0000
Significance			***

(B) Test for Correlation.

Number	601
DF	599
R	0.8415
t-value	38.1194
p-value	0.0000
Significance	***

(C) Test for Level Dependent "Bias".

Statistical Significance

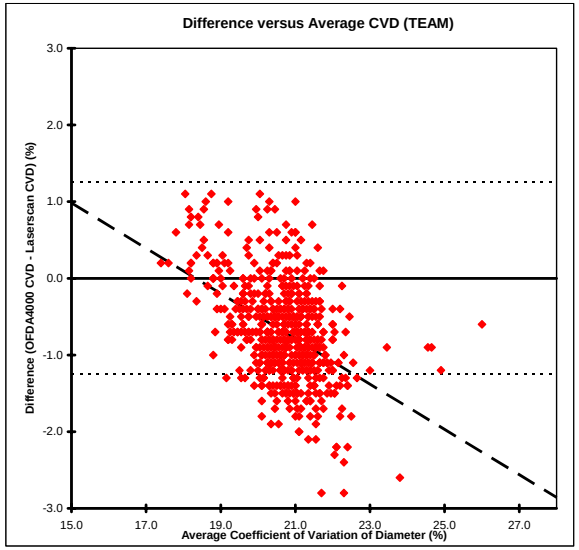
Regression	Slope	Significance	SE of Slope	t-Value	p-value	Rsq
GM	**0.7602**	***	0.0168	14.2892	0.0000	0.7081
DVA	**-0.2954**	***	0.0235	12.5760	0.0000	
Intercept(GM)	4.3473					STEYX
Intercept(DVA)	5.4151					0.6330

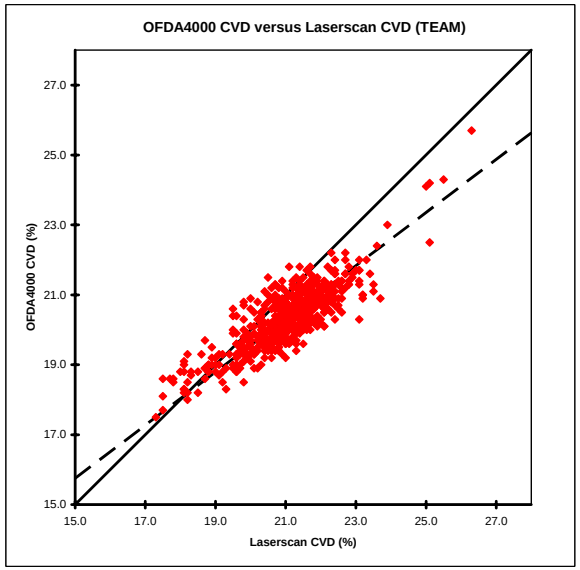
Magnitude of the Level Dependent "Bias".

Nominal	Calculated	Avg. "Bias"
16	16.51	0.51
18	18.03	0.03
20	19.55	-0.45
22	21.07	-0.93
24	22.59	-1.41
26	24.11	-1.89

Max/Mins.

Control	max	26.30
	min	17.30
Treatment	max	25.70
	min	17.50
average	max	26.00
	min	17.40
difference	max	1.10
	min	-2.80





Coefficient of Variation of Diameter Comparison (Sale Lots)

(A) Test for Overall Relative Bias & Paired t-test.

	Overall Bias		Paired
	Laserscan	OFDA4000	t-test
Number	301	301	301
Average	20.0020	20.0120	**0.0100**
SD	2.0904	1.9053	0.7382
SE	0.1205	0.1098	0.0425
t value	166.0105	182.2234	0.2352
p value	0.0000	0.0000	0.8142
Significance			**NS**

(B) Test for Correlation.

Number	301
DF	299
R	0.9359
t-value	45.9344
p-value	0.0000
Significance	***

(C) Test for Level Dependent "Bias".

Statistical Significance

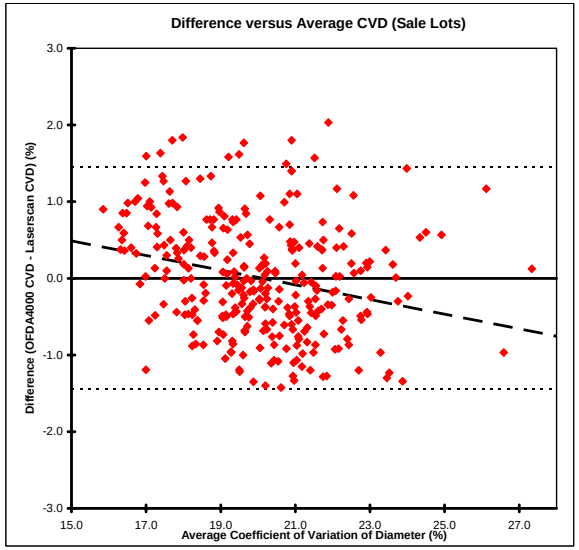
Regression	Slope	Significance	SE of Slope	t-Value	p-value	Rsq
GM	**0.9115**	***	0.0186	4.7664	0.0000	0.8759
DVA	**-0.0957**	***	0.0210	4.5555	0.0000	
Intercept(GM)	1.7805					STEYX
Intercept(DVA)	1.9242					0.7377

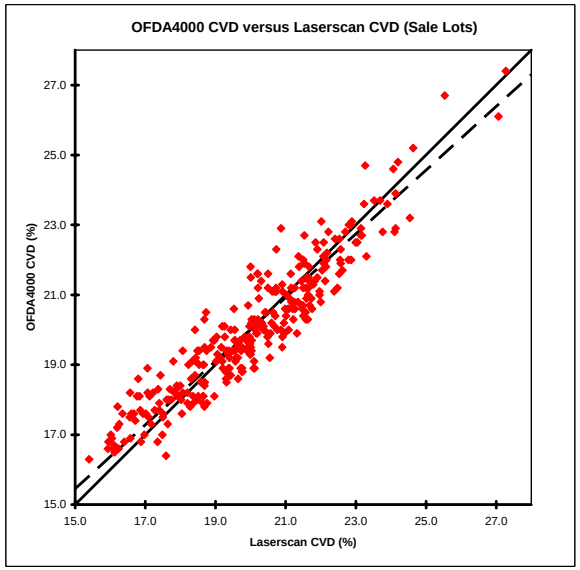
Magnitude of the Level Dependent "Bias".

Nominal	Calculated	Avg. "Bias"
16	16.36	0.36
18	18.19	0.19
20	20.01	0.01
22	21.83	-0.17
24	23.66	-0.34
26	25.48	-0.52

Max/Mins.

Control	max	27.28
	min	15.40
Treatment	max	27.40
	min	16.30
average	max	27.34
	min	15.85
difference	max	2.03
	min	-1.43





Modified CVD Comparison (TEAM)

(A) Test for Overall Relative Bias & Paired t-test.

	Overall Bias		Paired
	Lasersvcan (m)	OFDA4000	t-test
Number	601	601	601
Average	21.0275	20.3431	**-0.6845**
SD	0.8980	0.8890	0.4529
SE	0.0366	0.0363	0.0185
t value	574.0275	560.9972	-37.0501
p value	0.0000	0.0000	0.0000
Significance			***

(B) Test for Correlation.

Number	601
DF	599
R	0.8716
t-value	43.5130
p-value	0.0000
Significance	***

(C) Test for Level Dependent "Bias".

Statistical Significance

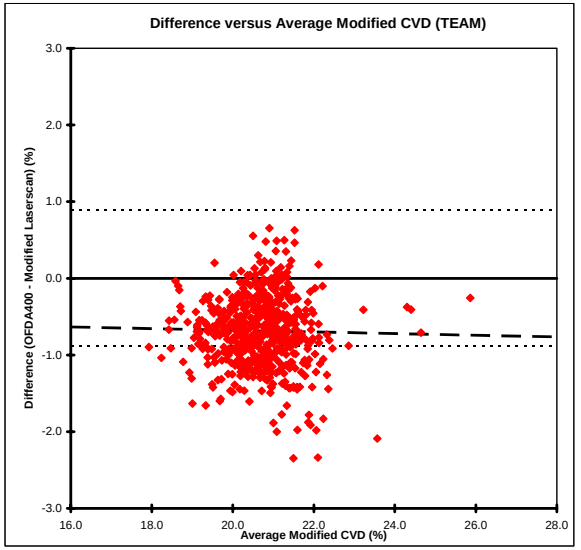
Regression	Slope	Significance	SE of Slope	t-Value	p-value	Rsq
GM	0.9899	**NS**	0.0198	0.5083	0.6114	0.7597
DVA	-0.0108	**NS**	0.0214	0.5058	0.6132	
Intercept(GM)	-0.4725					STEYX
Intercept(DVA)	-0.4605					0.4406

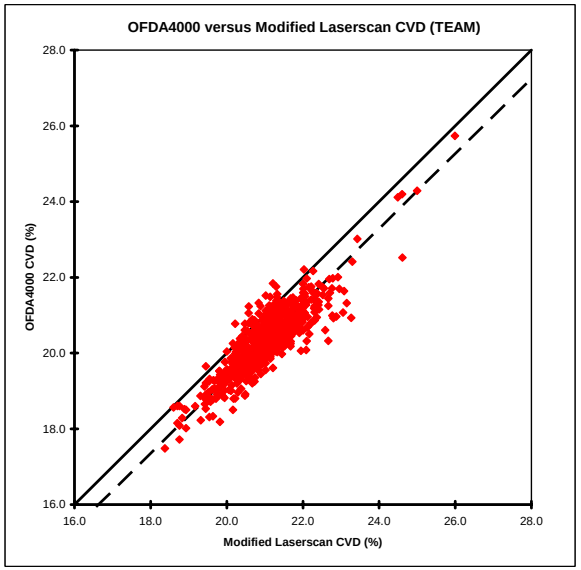
Magnitude of the Level Dependent "Bias".

Nominal	Calculated	Avg. "Bias"
16	15.37	-0.63
18	17.35	-0.65
20	19.33	-0.67
22	21.31	-0.69
24	23.29	-0.71
26	25.27	-0.73

Max/Mins.

Laserscan (m)	max	25.99
	min	18.38
OFDA4000	max	25.73
	min	17.48
average	max	25.86
	min	17.93
difference	max	0.65
	min	-2.35





Modified CVD Comparison (Sale Lots)

(A) Test for Overall Relative Bias & Paired t-test.

	Overall Bias		Paired
	Laserscan (m)	OFDA4000	t-test
Number	301	301	301
Average	20.3830	20.0132	**-0.3699**
SD	1.6451	1.9069	0.6008
SE	0.0948	0.1099	0.0346
t value	214.9610	182.0857	-10.6811
p value	0.0000	0.0000	0.0000
Significance			***

(B) Test for Correlation.

Number	301
DF	299
R	0.9534
t-value	54.6384
p-value	0.0000
Significance	***

(C) Test for Level Dependent "Bias".

Statistical Significance

Regression	Slope	Significance	SE of Slope	t-Value	p-value	Rsq
GM	1.1591	***	0.0202	7.8675	0.0000	0.9090
DVA	0.1509	***	0.0178	8.4934	0.0000	
Intercept(GM)	-3.6133					STEYX
Intercept(DVA)	-3.4177					0.4972

Magnitude of the Level Dependent "Bias".

Nominal	Calculated	Avg. "Bias"
16	14.93	-1.07
18	17.25	-0.75
20	19.57	-0.43
22	21.89	-0.11
24	24.21	0.21
26	26.52	0.52

Max/Mins.

Control	max	27.15
	min	17.10
Treatment	max	27.45
	min	16.28
average	max	27.30
	min	16.69
difference	max	1.45
	min	-2.86