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Experience with the OFDA4000 in two mills - comparisons with other instruments

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SUMMARY

This report summarises comparisons undertaken in two European mills between measurements obtained using OFDA4000, Almeter and OFDA100 / Laserscan instruments. The analyses were carried out on parameters reported by the mills, and are provided for information on typical performance of the OFDA4000 in mill QC environments.

Despite the fact that there were no protocols laid down for this work, both mills reported results from normal QC comparisons that showed encouraging agreement between the instruments. With the exception of the L1 comparisons in mill 2, which require further investigation, the levels of agreement on the parameters reported (H, CvH, short fibre, MFD and CvD in both mills and B in one mill) were either within the tolerances allowed by Interwoollabs for calibration acceptance, or within the normal level of variation experienced within Interwoollabs or other trials. The standard deviations of differences were generally within or similar to expectation based on either IWTO-17 or previous trials reported to the IWTO Sliver group.

INTRODUCTION

The OFDA4000 instrument is based on the principles of the OFDA2000 and is designed to measure fibre length distribution as well as length-diameter profile (Brims 2002) on tops and sliver. It was primarily designed for mill QC use and for fibre length-diameter research. Brims (2003) reported some initial comparisons between the instrument and Almeter at the Buenos Aires meeting.

OFDA4000 instruments have now been installed for a limited period in a small number of mills in order to obtain practical experience with the instrument in a commercial environment, and to allow comparisons between the performance of the instrument and other length and diameter instruments.

This paper describes and analyses comparative performance data obtained in two European mills. In one, the instrument was compared with an AL100 and an OFDA100, and in the other with an AL100 and a Laserscan.

The data reported by the mills are compared using the criteria in IWTO-0, Appendix B.

The comparisons are not intended to specifically provide evidence of equivalence since full details of calibration procedures are not available, no replication was involved, and the mills were not given any detailed protocols to follow. They are solely intended to give some background data for performance assessment in typical mill QA environments.

METHOD

The mills were requested to put the instruments into the QA environment and to accumulate experience comparing the results with the conventional instruments in use. No restrictions were placed on the use of the OFDA4000s.

The mills sent their own Excel files with the comparative data to BSC Electronics for analysis. Since the mills were not given any constraints, they presented the data that they considered most useful, rather than a fixed list of parameters (this requirement will form part of the forthcoming round trial).

The analyses were carried out on the data in the files as presented. In both cases, one line of data had to be removed where it was clear that there was an identification error.

The analyses were carried out in accordance with IWTO-0, Appendix B.

RESULTS

In order to put the results in perspective, it is useful to consider the Interwoollabs criteria for acceptance of Almeter measurements in their round trials. Instruments are considered to be 'calibrated' if the mean results of their measurements on each trial sample fall within the following ranges of the trial grand mean (obtained from approximately 80 participating laboratories). The columns in the table headed "tolerance" show the allowable differences from the grand mean, whereas the columns headed "maximum range between instruments" indicates the maximum systematic differences between instruments that would consequently be acceptable (assuming that each instrument individually complied with the "tolerance"):

(Automatic grip) Mean hauteur (mm)	Tolerance		Maximum range between instruments	
	H	B	H	B
< 40 mm	1.0 mm	1.3 mm	2.0 mm	2.6 mm
40.1 to 50.0 mm	1.1 mm	1.4 mm	2.2 mm	2.8 mm
50.1 to 65.0 mm	1.4 mm	1.8 mm	2.8 mm	3.6 mm
65.1 to 80.0 mm	1.8 mm	2.3 mm	3.6 mm	4.6 mm
> 80.0 mm	2.3 mm	2.9 mm	4.6 mm	5.8 mm

The actual member performance compared to the length and diameter tolerances and can be seen graphically in the Interwoollabs reports to IWTO (Interwoollabs management committee, 2003)

MILL 1

This mill reported 372 valid comparisons on wools ranging from approximately 11 to 21 µm in diameter and 32 to 78 mm H. Most of the samples were in two groups: 35 to 45 mm H, and 65 to 75 mm H.

The sliver samples were taken at the end of the processing line, immediately transferred to the laboratory, twisted in accordance with IWTO-17, conditioned for at least 12 hours in the standard atmosphere and then measured on all instruments.

Each measurement comprised a single beard in the case of the Almeter, and at least 4000 fibres measured for length in the case of the OFDA4000. IWTO-0 analyses of the comparative data are shown in Appendix 1. It should be noted that in most cases even very small differences from 0.0 will be considered significant simply because of the large number of comparisons available for this mill.

Hauteur

The mean difference between Almeter and OFDA4000 was 0.4 mm, which, whilst significantly different to 0.0 at the 0.001 level, is well within the range accepted by Interwoollabs. There was a very small level-dependent effect significant at only the 0.05 level. These results are well within the expectations of

IWTO-17. The standard deviation of the differences was consistent with comparisons of single specimens as reported for the AL100 and AL2000 instruments. (Couchman & Holmes, 2003).

CvH

The mean difference between Almeter and OFDA4000 was 3.1 %, which was significantly different to 0.0 at the 0.001 level. This difference is within the range typically exhibited in Interwoollabs trials. There was a level-dependent effect significant at the 0.001 level. It can be seen from the supplementary plot that the greatest difference in CvH was with the higher H values. The standard deviation of the differences was consistent with the comparison of single specimens.

Barbe

The mean difference between Almeter and OFDA4000 was 2.5 mm, which was significantly different to 0.0 at the 0.001 level. This difference is within the range exhibited in Interwoollabs trials. There was a very small level-dependent effect significant at the 0.01 level. The standard deviation of the differences was consistent with the comparison of single specimens.

Short fibre (%<25mm)

The mean difference between Almeter and OFDA4000 was 0.5 %, which was significantly different to 0.0 at the 0.001 level. This difference is well within the range exhibited in Interwoollabs trials. There was no significant level-dependent effect. The standard deviation of the differences was consistent with the comparison of single specimens.

Mean fibre diameter

The mean difference between OFDA100 and OFDA4000 was 0.09 µm, which was significantly different to 0.0 at the 0.001 level. This difference is well within the range exhibited in Interwoollabs trials. There was a slight level-dependent effect significant at the 0.001 level, but this was probably exacerbated by the leverage of an ultrafine sample. The standard deviation of the differences was consistent with the expectations of IWTO-47.

CvD

The mean difference between OFDA100 and OFDA4000 was 0.06 %, which was significantly different to 0.0 at the 0.01 level. This difference is trivial and well within the range exhibited in Interwoollabs trials. There was a slight level-dependent effect significant at the 0.001 level. The standard deviation of the differences was consistent with the expectations of IWTO-47.

MILL 2

This mill reported 26 valid length comparisons on wools covering from approximately 19 to 27 µm in diameter and 56 to 82 mm H. Diameter measurement data was missing from the file for one sample.

The sliver samples were taken at the last drawing before finishing, immediately transferred to the laboratory, twisted in accordance with IWTO-17, conditioned for approximately 24 hours in the standard atmosphere and then measured on all instruments.

Each measurement comprised a single beard in the case of the Almeter, and at least xxxx fibres in the case of the OFDA4000. IWTO-0 analyses of the comparative data are shown in Appendix 2. For convenience of comparison, plots are scaled similarly to those in Appendix 1, where they are comparable.

Hauteur

The mean difference between Almeter and OFDA4000 was 1.9 mm, which, whilst significantly different to 0.0 at the 0.001 level, is within the range accepted by Interwoollabs. There was no significant level-dependent effect. The standard deviation of the differences was slightly greater than for mill 1, but probably exaggerated by one large difference of 7mm.

CvH

The mean difference between Almeter and OFDA4000 was 0.7 %, which was not significantly different to 0.0. There was an apparently significant level-dependent effect, but this is probably an artefact of the data which has a very limited range of values compared with mill 1. The standard deviation of the differences was again higher than for mill 1, but possibly exaggerated by one large difference of 7%, associated with the same sample which was noted as an outlier in the hauteur comparison.

Short fibre (%<30mm)

The mean difference between Almeter and OFDA4000 was 1.4 %, which was significantly different to 0.0 at the 0.01 level. This difference is well within the range exhibited in Interwoollabs trials. There was a small level-dependent effect significant only at the 0.05 level. The standard deviation of the differences was slightly higher than for mill 1 (on %>25mm).

Short fibre (%<40mm)

The mean difference between Almeter and OFDA4000 was 0.2 %, which was not significantly different to 0.0. There was no significant level-dependent effect. The standard deviation of the differences was slightly better than for the %<30mm data and reasonably consistent with expectation.

Long fibre (L1%)

The mean difference between Almeter and OFDA4000 was 12.8 %, which was significantly different to 0.0 at the 0.001 level. There was no significant level-dependent effect. This difference may be of commercial importance and will require further investigation. However, to put the figure into perspective, Couchman & Holmes report variations in this parameter of between 15 and 55 mm within individual topmaking batches, and differences between the two models of Almeter of up to 5mm on individual samples. The standard deviation of the differences was slightly better than for the %<30mm data and reasonably consistent with expectation. The bias is inconsistent with other OFDA4000/Almeter comparisons.

Mean fibre diameter

The mean difference between Laserscan and OFDA4000 was 0.04 µm, which was not significantly different to 0.0. There was no significant slight level-dependent effect. The standard deviation of the differences was consistent with the expectations of IWTO-47 and IWTO-12.

CvD

The mean difference between Laserscan and OFDA4000 was 0.4 %, which was significantly different to 0.0 at the 0.001 level. This difference is relatively small and well within the range exhibited in Interwoollabs trials. There was no significant level-dependent effect. The standard deviation of the differences was consistent with the expectations of IWTO-47 and IWTO-12.

COMMENTS AND CONCLUSIONS

Despite the fact that there were no protocols laid down for this work, both mills reported results from normal QC comparisons that showed encouraging agreement between the instruments. With the exception of the L1 comparisons in mill 2, the levels of agreement on the parameters reported (H, CvH, short fibre, MFD and CvD in both mills and B and L1 in one mill) were either within the tolerances allowed by Interwoollabs for calibration acceptance, or within the normal level of variation experienced within Interwoollabs or other trials. The standard deviations of differences were generally within or similar to expectation based on either IWTO-17 or previous trials reported to the IWTO Sliver group.

Further work is required to investigate the L1 bias in mill 2. The magnitude of the difference is inconsistent with other OFDA4000/Almeter comparisons.

REFERENCES

Brims, M.A. (2002) Introducing OFDA4000: A new instrument for simultaneous measurement of fibre length and diameter in tops, Barcelona, Report SG 02

Brims, M.A. (2003) Progress of the OFDA4000 and comparison with Almeter, Buenos Aires, Report SG 02.

Couchman, R.C. and Holmes, P.J. (2003) Report on equivalence round trials for the AL2000, Dubrovnic, report SG03 and supplements.

Interwoollabs management committee (2003) Interwoollabs report on round trials completed in 2002, Buenos Aires, Report SG 01

APPENDIX 1

DETAILED RESULTS FOR MILL 1

Hauteur

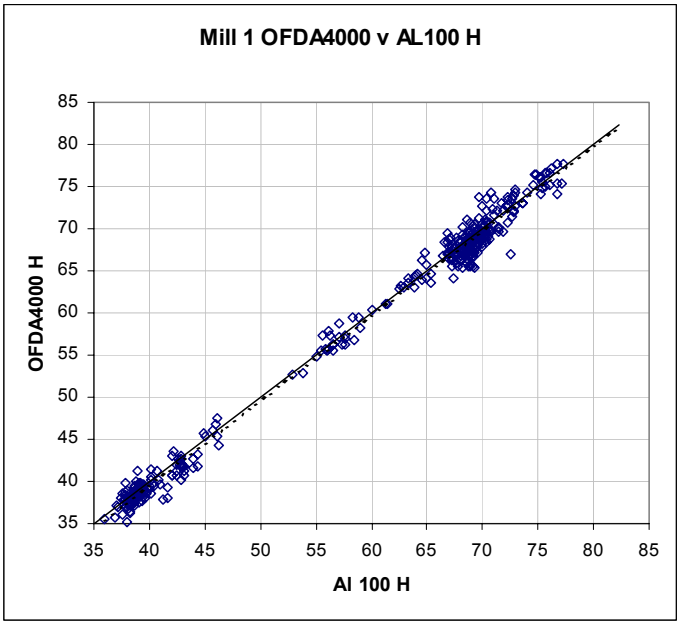
Summary statistics:

	OFDA4000	AL100	Difference	Average
Number of results	372	372	372	372
Mean (mm)	58.9	59.3	-0.40	59.1
Standard deviation (mm)	13.9	13.8	1.28	13.8
Standard error (mm)	0.72	0.71	0.07	0.72
Significance of difference	--	--	***	--

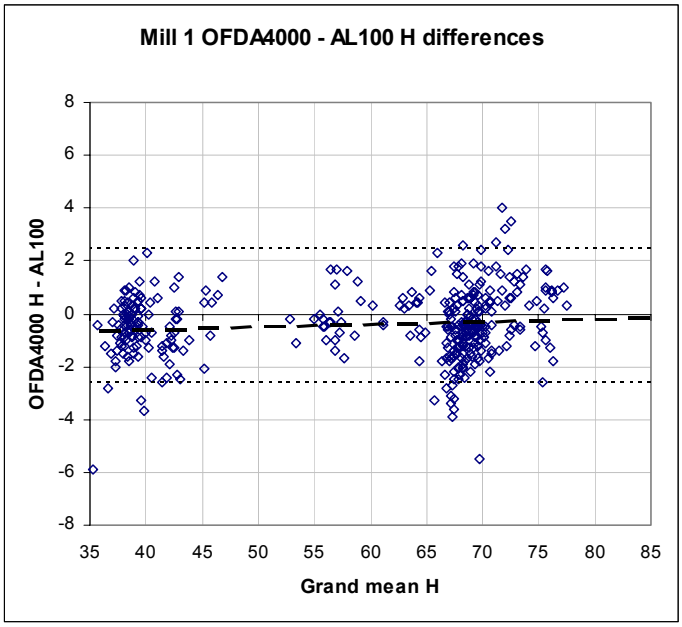
Summary of statistical data from regression analyses:

Statistics		Regression type	
		Geometric mean	Difference v Average
Estimated slope		1.010	0.010
Standard error of slope		0.005	0.005
Significance of slope	t-value	2.079	2.092
	Significance	*	*
Significance of correlation:	R value	0.996	0.108
	t value	208.1	2.081
	Significance	***	*

Geometric mean plot:



Difference versus average plot:



Coefficient of variation of Hauteur:

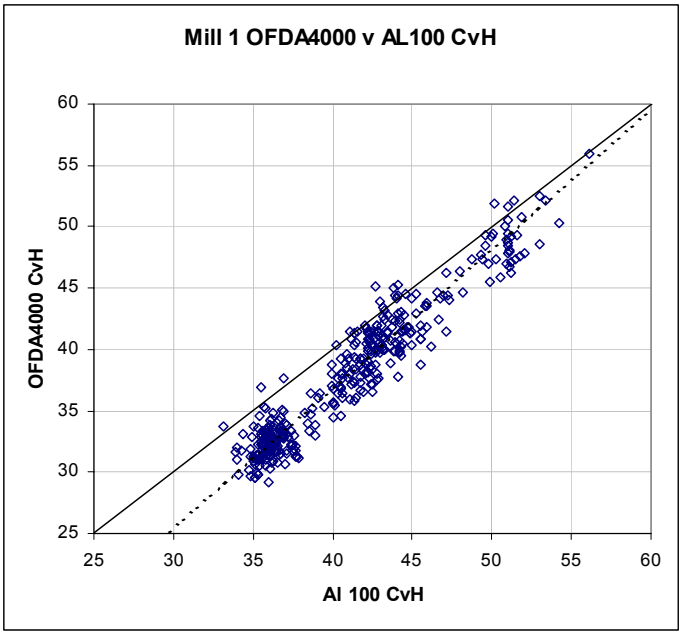
Summary statistics:

	OFDA4000	AL100	Difference	Average
Number of results	372	372	372	372
Mean (%)	37.8	40.9	-3.1	39.4
Standard deviation (%)	5.7	5.0	1.67	5.3
Standard error (%)	0.29	0.26	0.09	0.27
Significance of difference	--	--	***	--

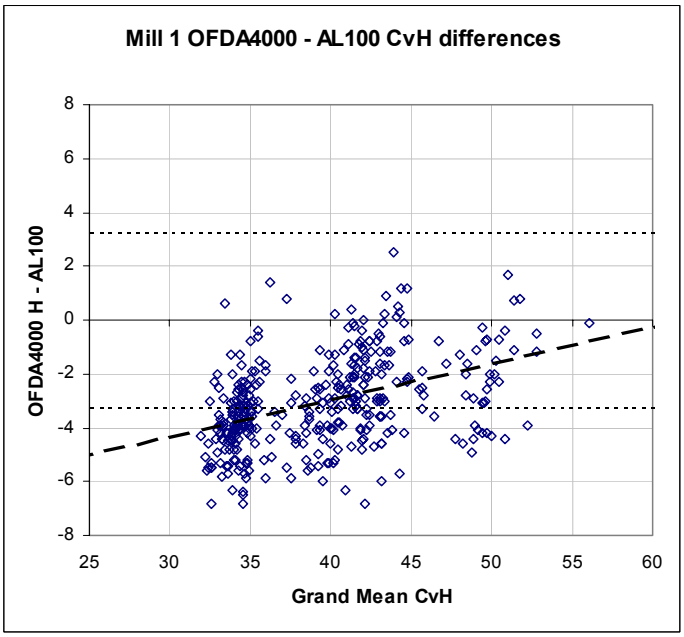
Summary of statistical data from regression analyses:

Statistics		**Regression type**	
		Geometric mean	**Difference v Average**
Estimated slope		1.143	0.136
Standard error of slope		0.017	0.015
Significance of slope	t-value	8.471	9.087
	Significance	***	***
Significance of correlation:	R value	0.919	0.427
	t value	65.1	8.214
	Significance	***	***

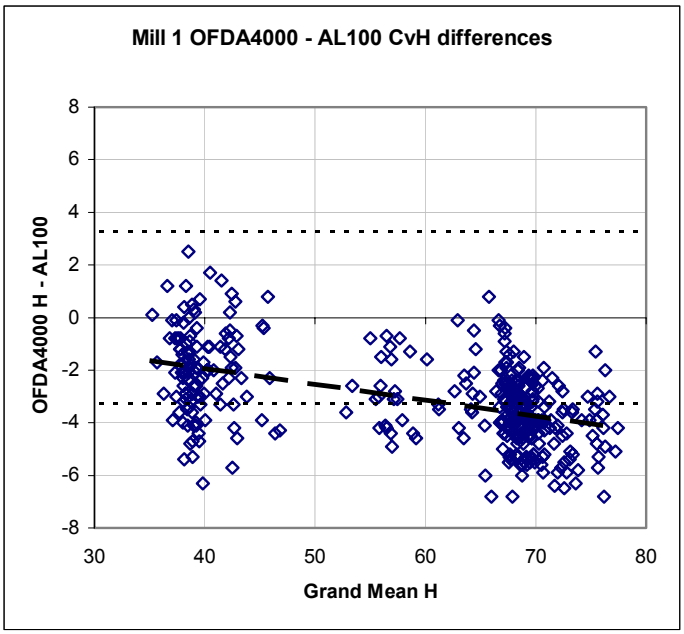
Geometric mean plot:



Difference versus average plot:



For diagnostic purposes the differences are also plotted against the mean Hauteur:



Barbe

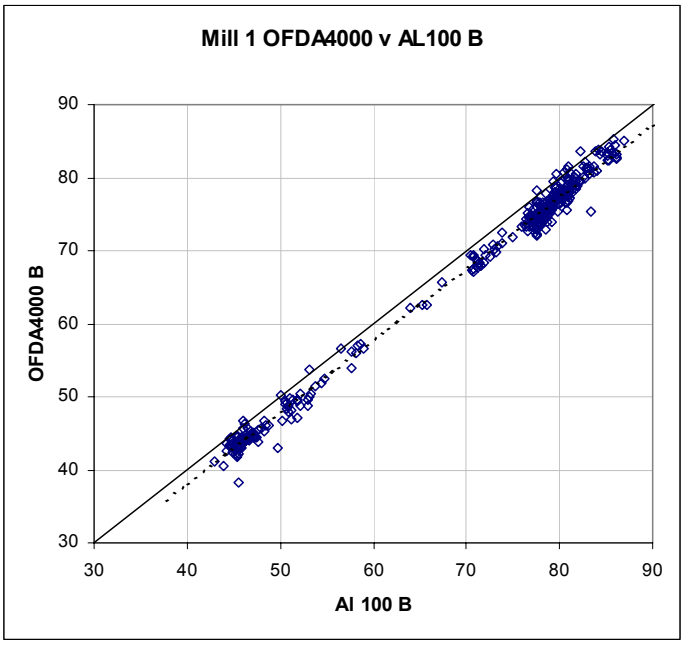
Summary statistics:

	OFDA4000	AL100	Difference	Average
Number of results	372	372	372	372
Mean (mm)	66.6	69.0	-2.46	67.8
Standard deviation (mm)	14.7	14.7	1.19	14.8
Standard error (mm)	0.76	0.77	0.06	0.76
Significance of difference	--	--	***	--

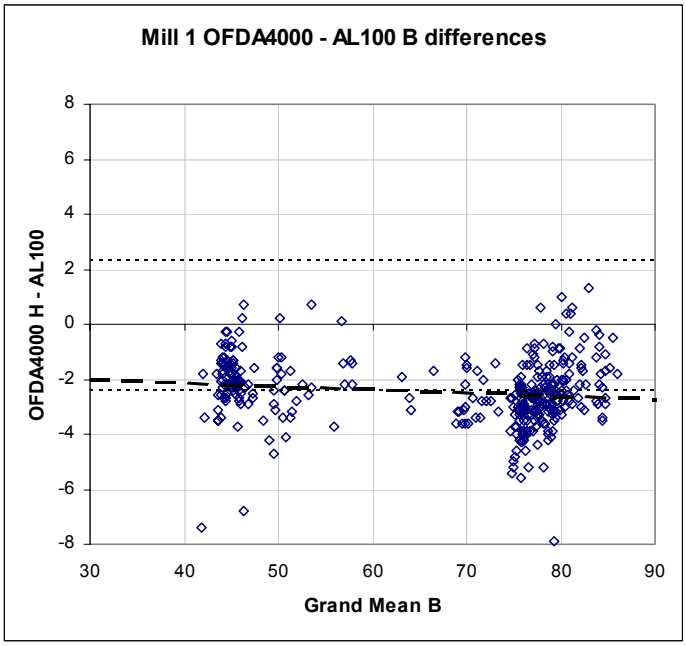
Summary of statistical data from regression analyses:

Statistics		Regression type	
		Geometric mean	Difference v Average
Estimated slope		0.988	-0.012
Standard error of slope		0.004	0.004
Significance of slope	t-value	2.939	2.925
	Significance	**	**
Significance of correlation:	R value	0.997	0.150
	t value	240.1	2.892
	Significance	***	**

Geometric mean plot:



Differences versus average plot:



Short fibre (Percent less than 25 mm)

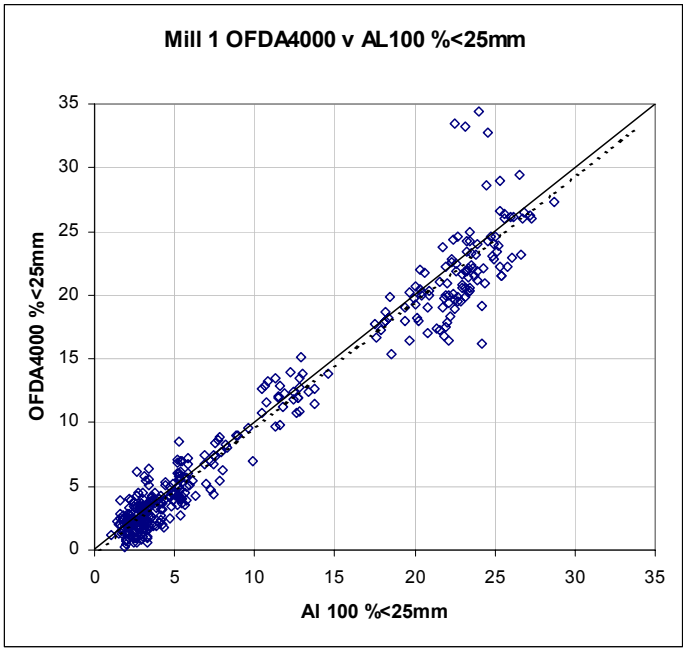
Summary statistics:

	OFDA4000	AL100	Difference	Average
Number of results	372	372	372	372
Mean (%)	9.8	10.2	-0.47	10.0
Standard deviation (%)	8.8	8.8	1.89	8.8
Standard error (%)	0.45	0.46	0.10	0.45
Significance of difference	--	--	***	--

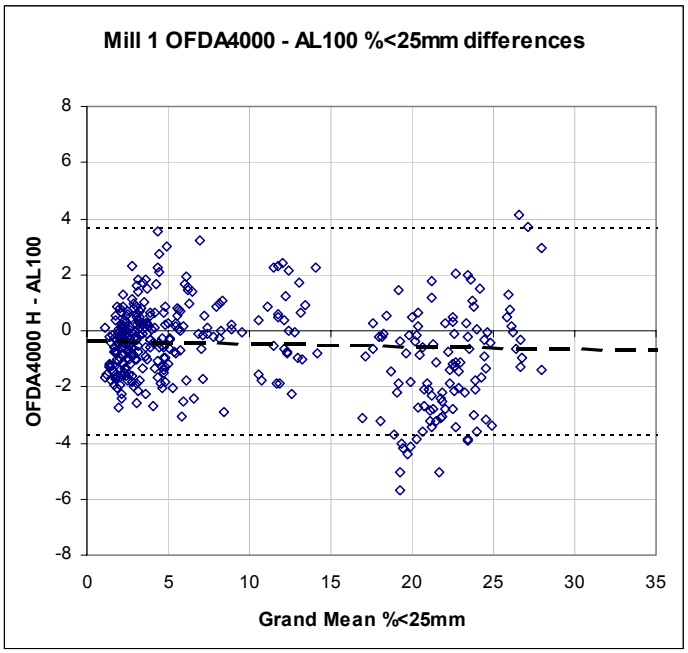
Summary of statistical data from regression analyses:

Statistics		Regression type	
		Geometric mean	Difference v Average
Estimated slope		0.991	-0.010
Standard error of slope		0.011	0.011
Significance of slope	t-value	0.855	0.852
	Significance	NS	NS
Significance of correlation:	R value	0.977	0.044
	t value	87.7	0.851
	Significance	***	NS

Geometric mean plot:



Difference versus average plot:



Mean fibre diameter (compared with OFDA100)

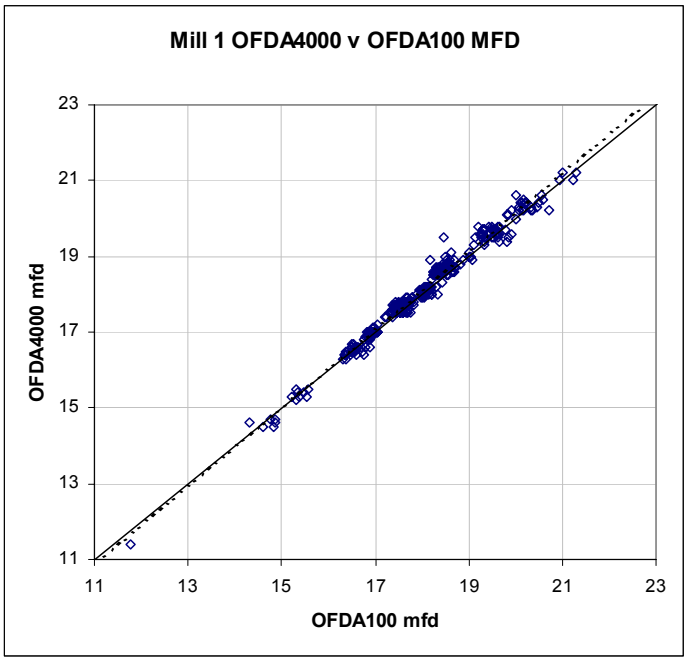
Summary statistics:

	OFDA4000	OFDA100	Difference	Average
Number of results	372	372	372	372
Mean (µm)	18.1	18.0	0.09	18.0
Standard deviation (µm)	1.27	1.23	0.17	1.25
Standard error (µm)	0.06	0.06	0.009	0.06
Significance of difference	--	--	***	--

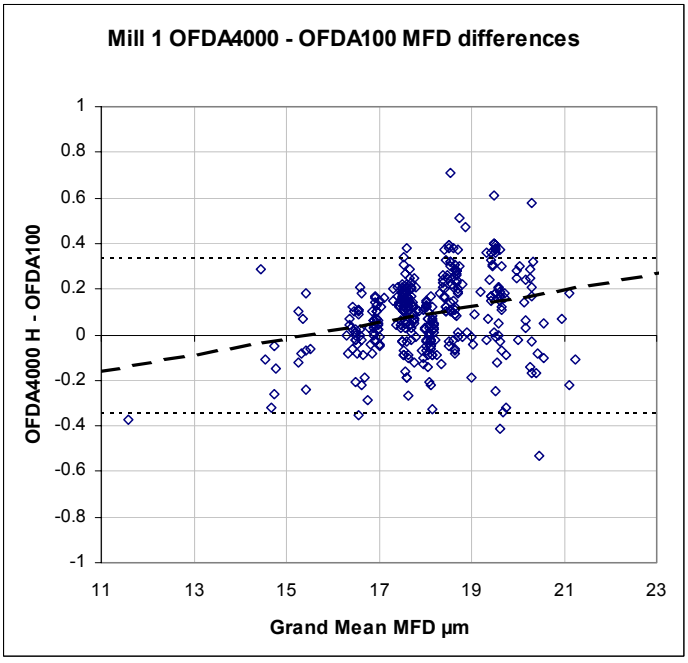
Summary of statistical data from regression analyses:

Statistics		Regression type	
		Geometric mean	Difference v Average
Estimated slope		1.036	0.036
Standard error of slope		0.007	0.007
Significance of slope	t-value	5.022	5.120
	Significance	***	***
Significance of correlation:	R value	0.991	0.257
	t value	142.6	4.947
	Significance	***	***

Geometric mean plot:



Difference versus average plot:



Coefficient of variation of diameter (CvD)

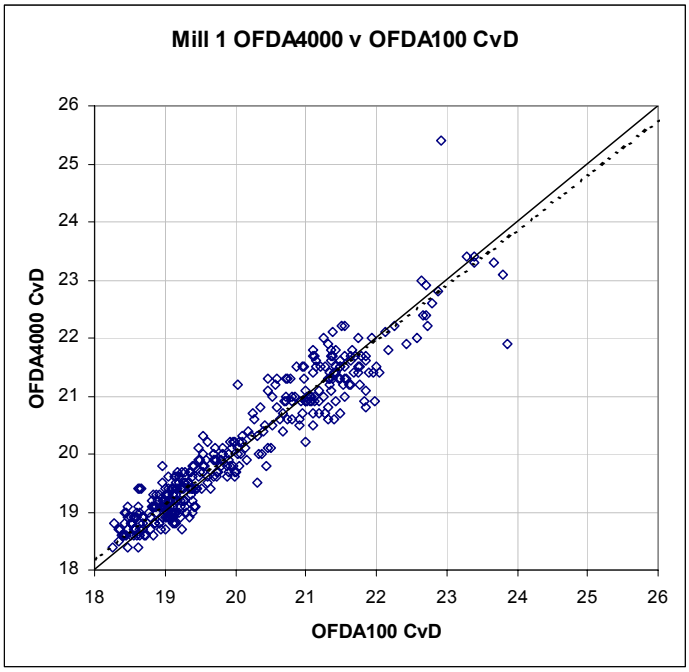
Summary statistics:

	OFDA4000	OFDA100	Difference	Average
Number of results	372	372	372	372
Mean (%)	20.1	20.0	0.06	20.1
Standard deviation (%)	1.17	1.24	0.38	1.19
Standard error (%)	0.06	0.06	0.003	0.06
Significance of difference	--	--	**	--

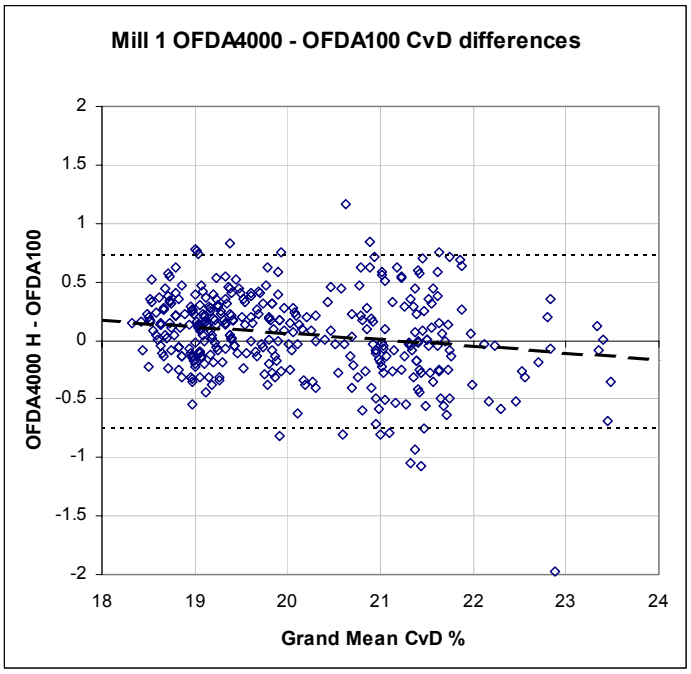
Summary of statistical data from regression analyses:

Statistics		**Regression type**	
		Geometric mean	**Difference v Average**
Estimated slope		0.947	-0.056
Standard error of slope		0.015	0.016
Significance of slope	t-value	3.539	3.450
	Significance	***	***
Significance of correlation:	R value	0.953	0.176
	t value	60.2	3.396
	Significance	***	***

Geometric mean plot:



Difference versus average plot:



APPENDIX 2

DETAILED RESULTS FOR MILL 2

Hauteur

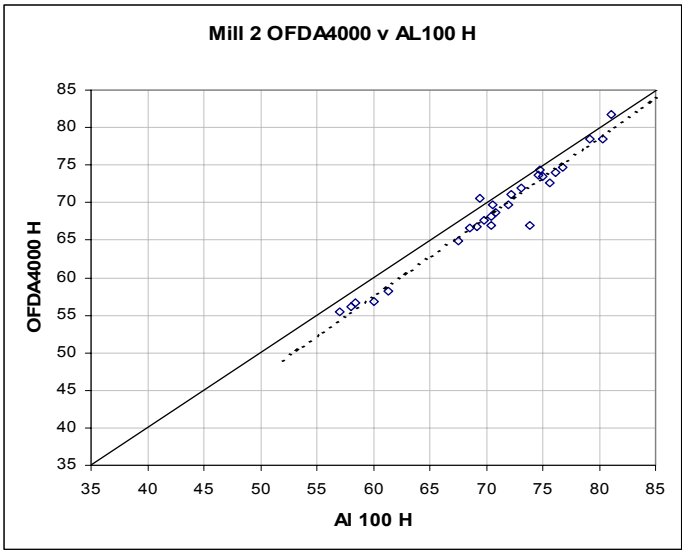
Summary statistics:

	OFDA4000	AL100	Difference	Average
Number of results	26	26	26	26
Mean (mm)	68.5	70.4	-1.9	69.4
Standard deviation (mm)	7.13	6.69	1.49	6.87
Standard error (mm)	1.40	1.31	0.29	1.35
Significance of difference	--	--	***	--

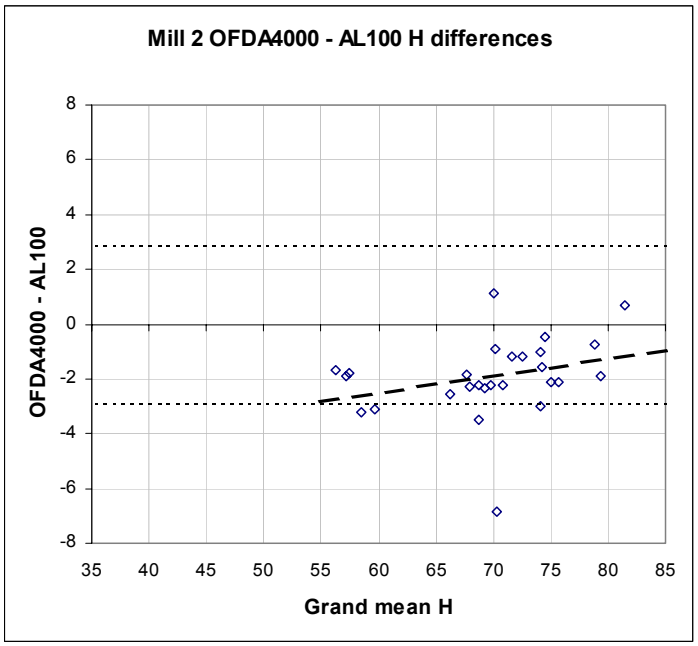
Summary of statistical data from regression analyses:

Statistics		Regression type	
		Geometric mean	Difference v Average
Estimated slope		1.066	0.062
Standard error of slope		0.044	0.041
Significance of slope	t-value	1.494	1.515
	Significance	NS	NS
Significance of correlation:	R value	0.979	0.290
	t value	23.7	0.419
	Significance	***	NS

Geometric mean plot:



Difference versus average plot:



Coefficient of Variation of Hauteur

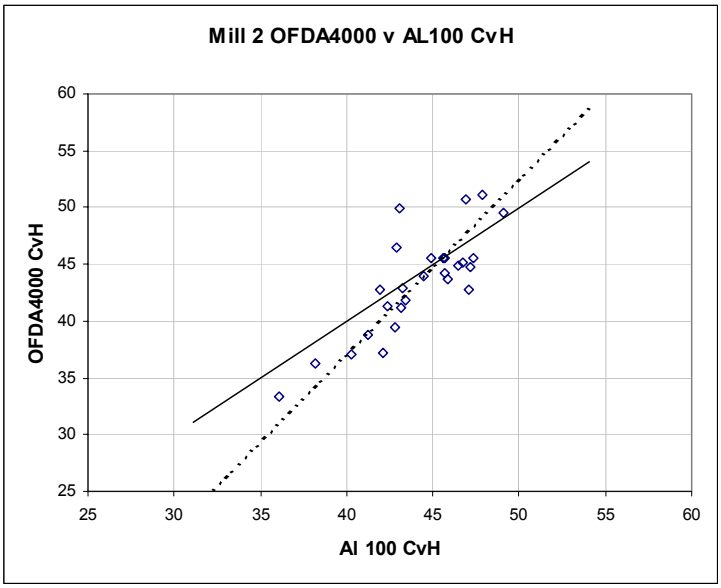
Summary statistics:

	OFDA4000	AL100	Difference	Average
Number of results	26	26	26	26
Mean (%)	43.8	44.4	-0.7	44.1
Standard deviation (%)	4.03	2.63	2.66	3.13
Standard error (%)	0.79	0.52	0.52	0.61
Significance of difference	--	--	NS	--

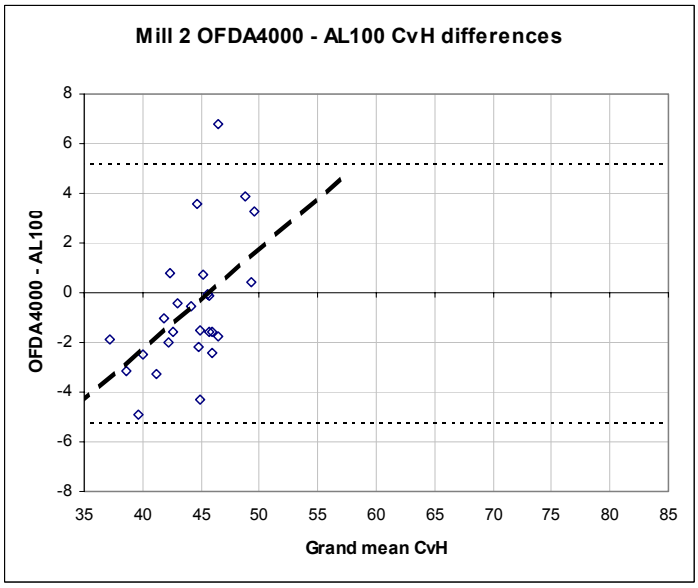
Summary of statistical data from regression analyses:

Statistics		**Regression type**	
		Geometric mean	**Difference v Average**
Estimated slope		1.529	0.410
Standard error of slope		0.181	0.123
Significance of slope	t-value	2.916	3.318
	Significance	*	**
Significance of correlation:	R value	0.813	0.553
	t value	6.78	2.747
	Significance	***	**

Geometric mean plot:



Difference versus average plot:



Short fibre (percentage less than 30 mm)

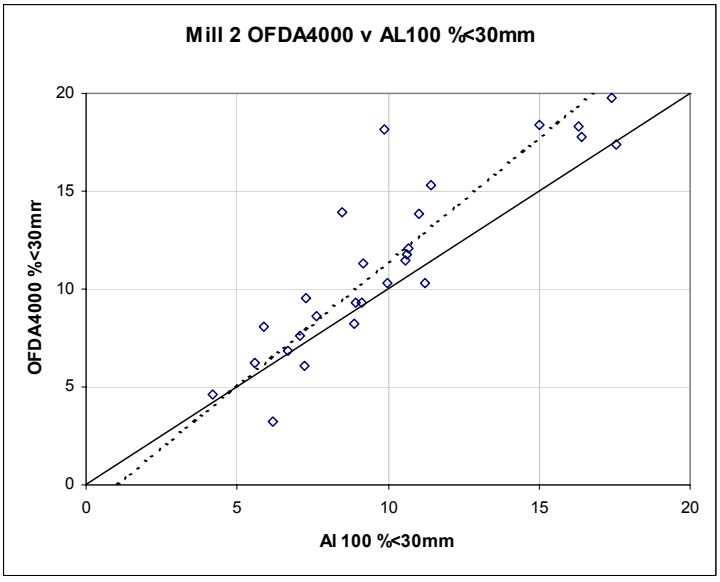
Summary statistics:

	OFDA4000	AL100	Difference	Average
Number of results	26	26	26	26
Mean (%)	11.7	10.2	1.4	11.0
Standard deviation (%)	4.54	3.57	2.22	3.93
Standard error (%)	0.89	0.70	0.44	0.77
Significance of difference	--	--	**	--

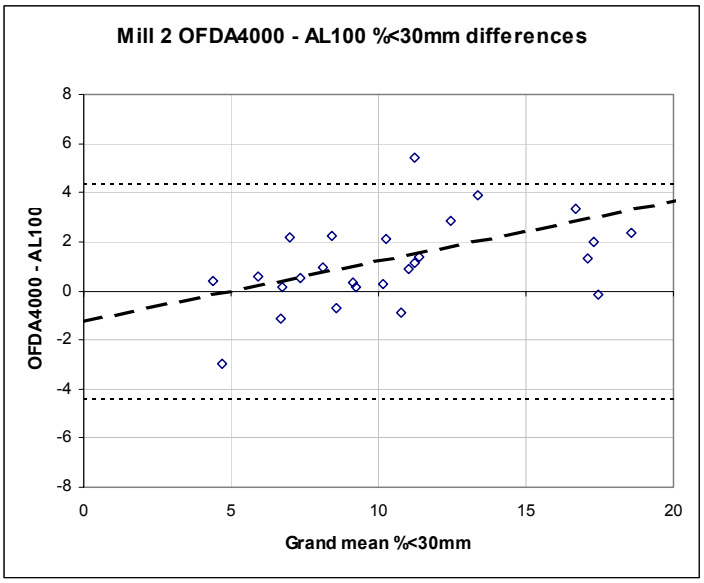
Summary of statistical data from regression analyses:

Statistics		Regression type	
		Geometric mean	Difference v Average
Estimated slope		1.271	0.245
Standard error of slope		0.119	0.096
Significance of slope	t-value	2.273	2.545
	Significance	*	*
Significance of correlation:	R value	0.888	0.454
	t value	9.403	2.258
	Significance	***	*

Geometric mean plot:



Difference versus average plot:



Short fibre (percentage less than 40 mm)

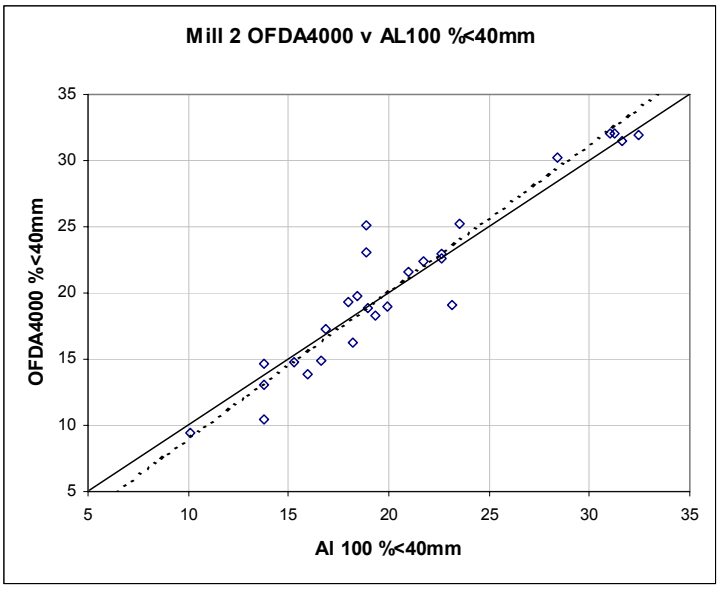
Summary statistics:

	OFDA4000	AL100	Difference	Average
Number of results	26	26	26	26
Mean (%)	21.2	21.0	0.17	21.1
Standard deviation (%)	6.35	5.70	2.11	5.94
Standard error (%)	1.24	1.12	0.41	1.17
Significance of difference	--	--	NS	--

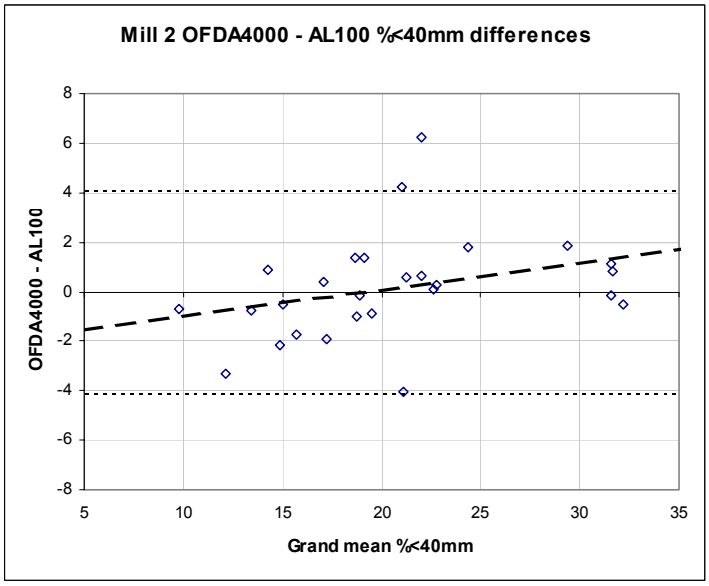
Summary of statistical data from regression analyses:

Statistics		Regression type	
		Geometric mean	Difference v Average
Estimated slope		1.115	0.108
Standard error of slope		0.070	0.063
Significance of slope	t-value	1.638	1.705
	Significance	NS	NS
Significance of correlation:	R value	0.951	0.323
	t value	15.1	1.610
	Significance	***	NS

Geometric mean plot:



Difference versus average plot:



Long fibre (Longest 1%)

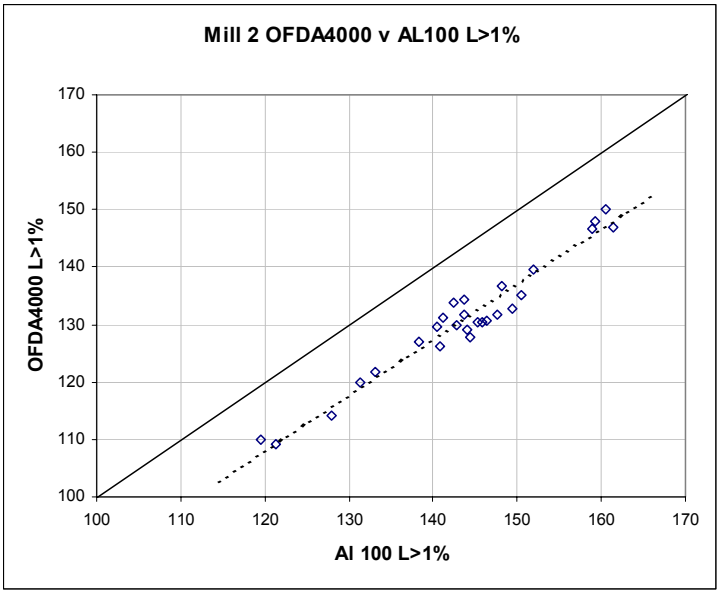
Summary statistics:

	OFDA4000	AL100	Difference	Average
Number of results	26	26	26	26
Mean (mm)	131.0	143.7	-12.8	137.3
Standard deviation (mm)	10.5	10.8	2.35	10.6
Standard error (mm)	2.06	2.12	0.46	2.08
Significance of difference	--	--	***	--

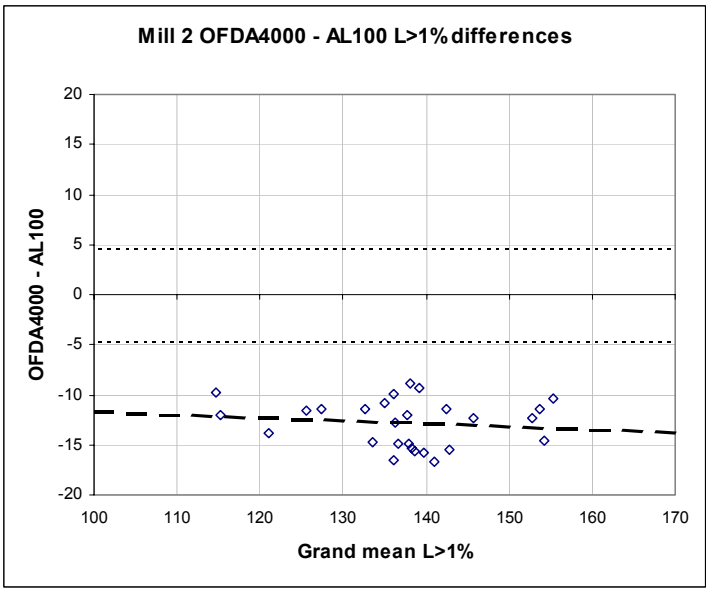
Summary of statistical data from regression analyses:

Statistics		Regression type	
		Geometric mean	Difference v Average
Estimated slope		0.972	-0.281
Standard error of slope		0.044	0.045
Significance of slope	t-value	0.637	0.629
	Significance	NS	NS
Significance of correlation:	R value	0.975	0.125
	t value	21.6	0.623
	Significance	***	NS

Geometric mean plot:



Difference versus average plot:



Mean fibre diameter (versus Laserscan)

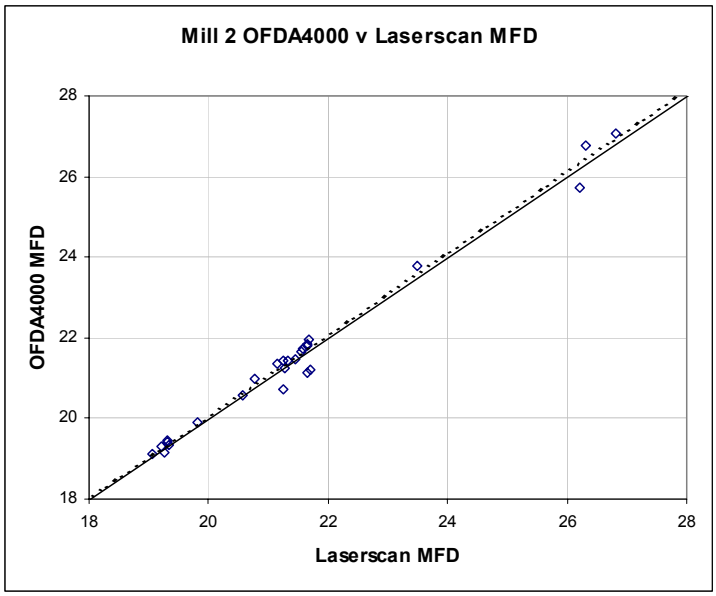
Summary statistics:

	OFDA4000	Laserscan	Difference	Average
Number of results	25	25	25	25
Mean (µm)	21.5	21.5	0.04	21.5
Standard deviation (µm)	2.16	2.13	0.26	2.14
Standard error (µm)	0.42	0.42	0.05	0.42
Significance of difference	--	--	NS	--

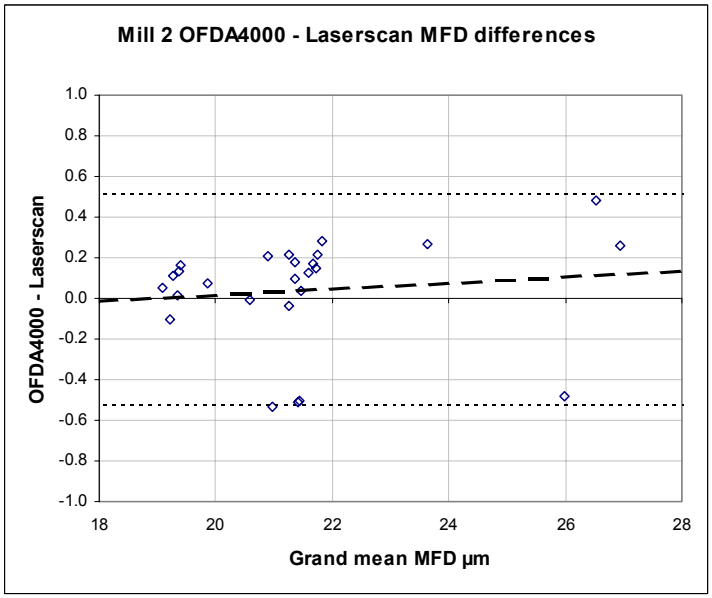
Summary of statistical data from regression analyses:

Statistics		Regression type	
		Geometric mean	Difference v Average
Estimated slope		1.015	0.015
Standard error of slope		0.026	0.025
Significance of slope	t-value	0.573	0.588
	Significance	NS	NS
Significance of correlation:	R value	0.992	0.119
	t value	38.8	0.584
	Significance	***	NS

Geometric mean plot:



Difference versus average plot:



Coefficient of Variation of Diameter

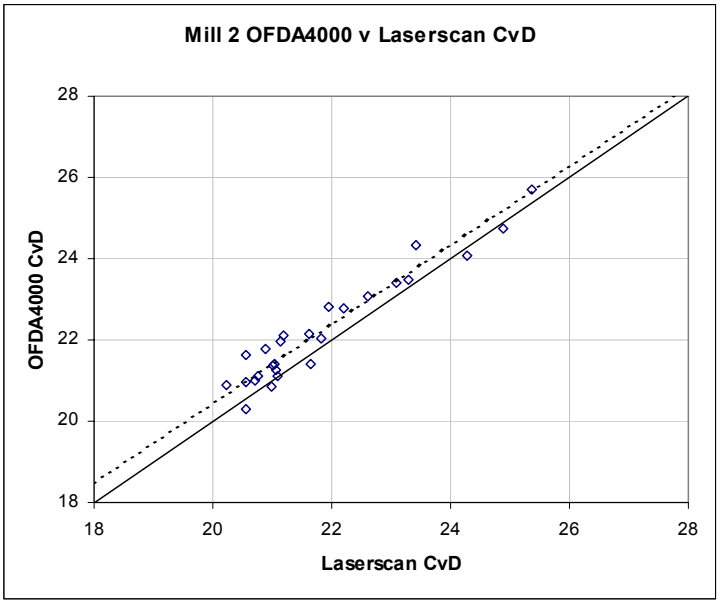
Summary statistics:

	OFDA4000	Laserscan	Difference	Average
Number of results	25	25	25	25
Mean (%)	22.2	21.8	0.37	22.0
Standard deviation (%)	1.37	1.41	0.39	1.38
Standard error (%)	0.27	0.28	0.08	0.27
Significance of difference	--	--	***	--

Summary of statistical data from regression analyses:

Statistics		Regression type	
		Geometric mean	Difference v Average
Estimated slope		0.977	-0.024
Standard error of slope		0.056	0.058
Significance of slope	t-value	0.409	0.412
	Significance	NS	NS
Significance of correlation:	R value	0.961	0.084
	t value	16.7	0.411
	Significance	***	NS

Geometric mean plot:



Difference versus average plot: