INTERNATIONAL WOOL TEXTILE ORGANISATION

TECHNOLOGY & STANDARDS COMMITTEE **BUENOS AIRES MEETING**

Sliver Group **May 2003**

Chairman: J. TURK (Australia) **Report No: SG 02**

Progress of the OFDA4000 and Comparison with Almeter

By

Mark Brims

SUMMARY

The OFDA4000 is a new instrument for the measurement of fibre length and diameter of wool tops. The instrument has undergone several modifications and improvements since it was first reported at the Barcelona IWTO meeting. The instrument can measure various fibre types in sliver form and now has the capacity to measure fibre snippets on the 70mm glass slides as used by the OFDA100.

The OFDA4000 measurements were compared to Almeter measurements on 43 commercial tops. The OFDA4000 estimates of hauteur and CvH closely matched those of the Almeter. Because the OFDA4000 directly counts fibres within the drawn sample, another estimate of fibre length distribution can be determined (now called mean fibre length). This estimate of mean fibre length was poorly correlated to the hauteur estimate made by Almeter for the 43 tops. Furthermore, there was a very poor relationship between short fibre content (% Fibres < 25mm) estimated by the length method of the OFDA4000, and the estimates of short fibre content made by the Almeter. A simple experiment involving manual counting of short fibres suggests that the estimates of short fibre content made by the Almeter can be underestimated by a large magnitude (0.2% for Almeter vs. 12.5% for manual count). In this case, some wool tops will tend to have underestimated values of short fibre when measured by the Almeter.

PROGRESS OF OFDA4000

Over the past year many mechanical improvements have been made to the OFDA4000. The improvements have greatly simplified the design, maintenance and operation. An adapter has been designed to allow the measurement of fibre snippets in the same 70mm glass slides as the OFDA100. For applications where medullation measurement is not required, this eliminates the need to have an OFDA100.

The OFDA4000 Fibroliner has been tested on a wide range of fibre types including Optim wool, cotton, silk, cashmere and synthetic fibres and has performed very well due to the ability to vary the draw density using feedback from the video microscope.

Further measurement of commercial wool tops verifies that significant differences can exist between Almeter hauteur and OFDA4000 mean fibre length, due to diameter profile along the beard [1]. Measured short fibre content can be very different, and a small experiment is described to manually verify whether the length or hauteur measurement was more accurate.

1.System converted to modular design for ease of maintenance (Figure 1). The OFDA4000 consists of 5 modules that can be electrically unplugged from the base plate. They are:

a) Fibroliner4000

b) Microscope arm

c) Gripper

d) Gripper drive

e) Control box

2. Lower vacuum noise. Redesign of the gripper to remove sharp bends from the air path greatly reduced the noise of air travelling through the gripper.

3. Fibres are removed through gripper rather than by external inlet. A much simpler and more reliable gripper design allows large beards to be vacuumed way through the gripper mouth. Beards can now be "gobbled" up by the gripper without having to be completely pulled out of the fibroliner4000, improving speed and measurement flexibility.

4. Removal of requirement of Teflon tape on gripper: the new gripper design uses precision ground blades to hold the fibres and does not require Teflon tape.

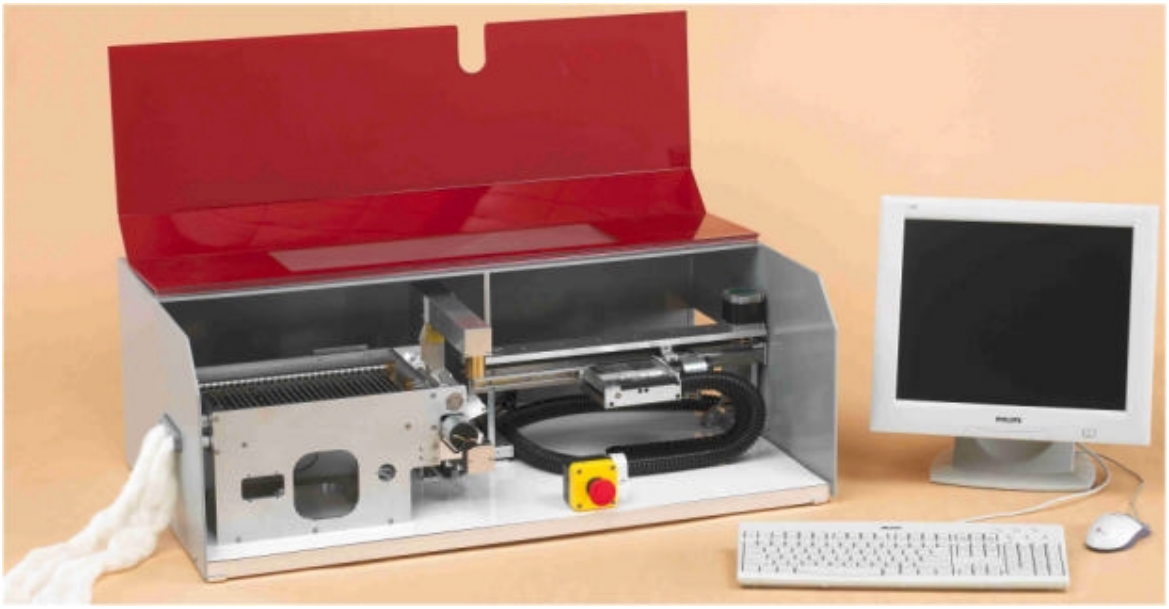

Figure 1. The Commercial Version of the OFDA4000

OFDA4000 IN 100 MODE: 70MM GLASS SLIDE MODE

Several customers expressed a strong desire to be able to measure snippets so that they do not require an additional instrument such as the OFDA100. The new gripper design allowed a simple adapter plate to be inserted into the gripper jaws to hold a 70mm glass slide (Figure 2). The same sample preparation is followed as with the OFDA100 (IWTO TM47) and the OFDA2000 in 100 mode (added to IWTO TM47 at the Barcelona conference in 2002). The diameter and curvature measurement program is also identical to the OFDA100 and the OFDA2000 in 100 mode.

Essentially, the 4000 in 100 mode is exactly the same as the 2000 in 100 mode except for the clamping of the aluminum holder.

To convert from normal mode to 100 mode takes less than 1 minute, it involves placing the 70mm holder in the gripper jaws, selecting the 70mm slide calibration, placing a slide in the holder and selecting measure. Damage cannot occur if the slide holder is accidentally left in the jaws before a normal measurement.

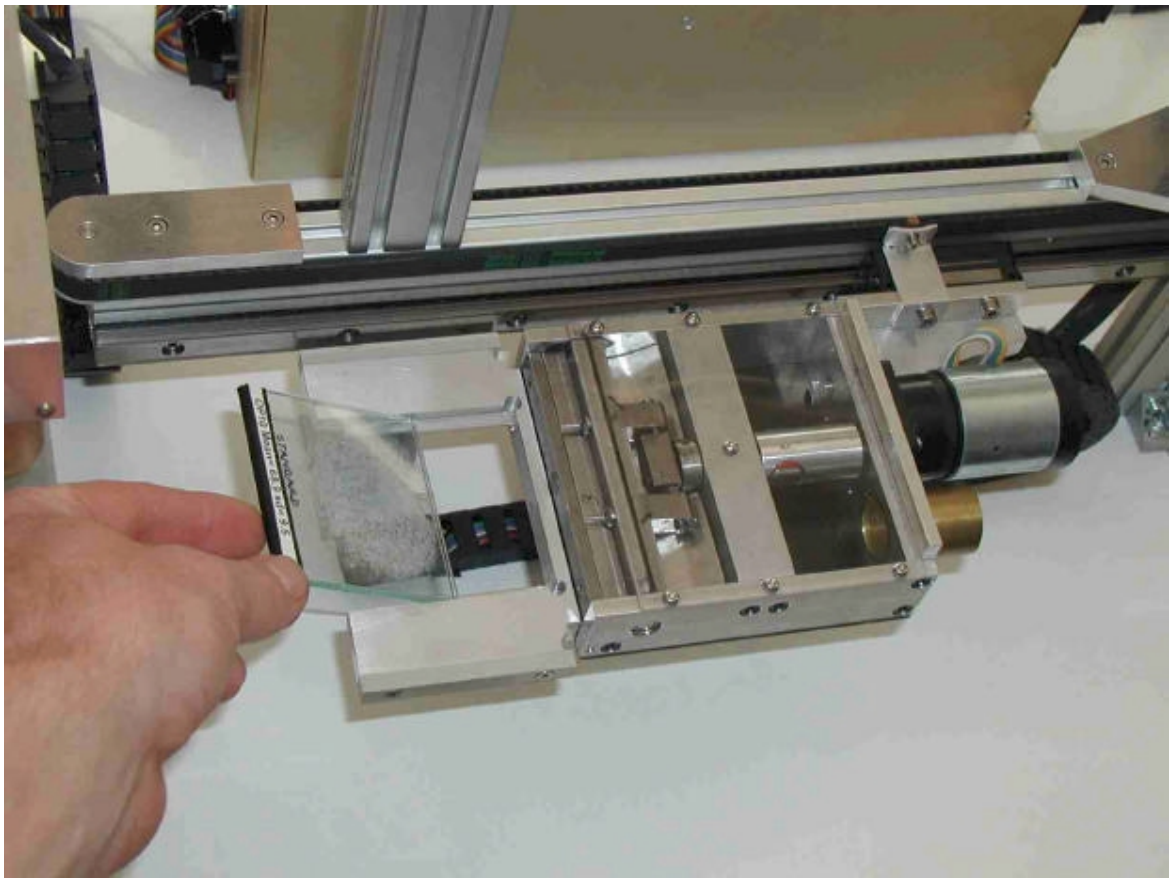

Figure 2. Addition of 70mm glass slide mode for conventional fibre diameter measurement

MANUAL VERIFICATION OF SHORT FIBRE COUNT

As described in the original OFDA4000 paper [1], hauteur is cross section biased length and is strongly affected by the diameter profile along the beard. Several commercial tops have been measured that show a significant lower fibre diameter at the leading edge of the drawn beard. This could be caused by blending short fine fibres or by using some autumn shorn Western Australian wools. These tops have a measured hauteur that is longer than the measured length, and a lower short fibre content by hauteur than by length. One commercial top had a short fibre content by hauteur of 2% and by length it was 8%. Differences of this magnitude should be easy to detect by manual inspection of the beard.

A top prepared by the Western Australian Department of Agriculture from autumn shorn wool was selected as the most extreme case. To count the short fibres in the beard, the OFDA4000 was set to a very low beard density and extracted beards of about 200 fibres per draw from the prealigned top end in the needle bed. The measurement progressed normally until halted manually after the beard had been pulled 25mm through the fibre guide. The fibres longer than 25mm are still held by the guide, and adhesive tape was used to tape the longer fibres onto the needle side of the guide to ensure they were not pulled through the guide.

The gripper was then opened and the gripper moved away from the beard end. A piece of black felt was wiped gently across the protruding beard end and fibres shorter than 25mm were left on the felt. These fibres were then manually counted.

This top was measured by Almeter, and the hauteur indicated a short fibre content of 0.2%. OFDA4000 hauteur measured the short fibre content at 0.6% and by OFDA4000 length the short fibre content was 12.0%.

Five draws were counted, consisting of a total of 898 fibres, of which 113 were manually counted at less than 25mm long. This gave a percentage of fibres less than 25mm as 12.5% (Table 1). This result was closer to the short fibre percentage obtained from OFDA4000 mean fibre length and different to the percentage obtained by hauteur.

Table 1. Estimation of short fibre content (% fibres < 25mm) of a top using 4 techniques

Almeter short fibre %	OFDA4000 hauteur short fibre %	OFDA4000 length short fibre content %	Manual count short fibre %
0.2	0.6	12.0	12.5

PERFORMANCE OF FIBRES IN FIBROLINER4000

A range of fibre types was tested in the Fibroliner4000. Different fibre types have greatly varying fibre to fibre friction, and the original Fibroliner as used for the Almeter had two versions with different needle spacing to cope with wool fibres and with shorter cashmere and cotton fibres.

The Fibroliner4000 has four major advantages over the original Fibroliner:

1. It can measure the number of fibres in the needle bed by using the video microscope on a drawn beard

2. The needle bed can advance between 0.1mm and 300mm per draw.

3. The gripper can adjust its draw point from 0 to 100mm from the comb point.

4. The air drawn through the gripper tends to straighten any fibre ends that may be protruding after the previous draw. This reduces the chance of these ends folding over and being falsely counted as short fibres.

Experts with many years' experience with different fibres on the original Fibroliner were impressed to see the Fibroliner4000 handle the different fibre types automatically.

It was decided to allow the possibility of doubling a wool top in the same manner as the original Fibroliner to remove the direction effect. The software was altered to cope with much higher fibre density in the needle bed and the Fibroliner4000 was found to cope with wool top up to 25g/m density.

VALIDATION OF OFDA4000 ON COMMERCIAL TOPS

The OFDA4000 was used to estimate the mean fibre length and almeter hauteur of 43 commercial wool tops. These tops were chosen since the fibre diameter profiles of the raw wool were known as well as the full specifications of each top. Details of the source and processing of these tops are described in past papers [2, 3] The tops were stored for up to 3 years in bumps (ie non-twisted) prior to measurement on the OFDA4000.

For each top, a sample 50cm long was removed and split in two lengthwise. One of the halved slivers was reversed in direction before being recombined to the other half of sliver. This sample was then fed into the beard preparer stage of the OFDA4000. A minimum of 10 pre-draws (100mm) was made on the sliver before the final measurement draw was made. About 4 measurement draws were required to measure a total of 2000 fibres. A full fibre length measurement on the sliver was repeated 3 times with a 100mm predraw between each measurement. All measurements were made at 20°C and 65% RH.

Because the OFDA4000 counted fibres along the length of the prepared beard, the fibre length distribution was calculated in a different manner to that of the Almeter. Direct measurement of the number of fibres and mean fibre diameter at 5mm intervals along the prepared beard meant that the OFDA4000 was able to directly measure the frequency of fibre lengths as well as the diameter profile of the beard. This value was referred to as the mean fibre length. Furthermore, by using the mean diameter estimate at each 5mm interval to determine beard density, a value for hauteur was calculated based on the method used by the Almeter.

The mean fibre diameter of the top was calculated based on the arithmetic mean of counted fibres. Because the diameter profile of the beard was also measured, the diameter at the leading edge of fibres could be determined. Using this measurement, a value for fine ends was calculated as the difference between the mean diameter of fibres in the first 5mm of the beard, and the mean fibre diameter of the top (Diameter ends – MFD).

Table 2. The mean and range for 43 tops measured by the OFDA4000

	Mean	Min	Max	Stdev
Mean Fibre Length OFDA4000 (mm)	72.5	65.3	80.2	3.0
Hauteur OFDA4000 (mm)	75.5	67.4	87.4	5.4
Fibre Length CV OFDA4000 (%)	45.8	40.5	49.9	2.1
Hauteur CV OFDA4000 (%)	42.0	25.7	54.2	8.9
Mean Diameter OFDA4000 (µm)	21.0	18.9	21.6	0.6
Fibre Length %<25mm OFDA4000 (%)	13.1	7.0	11.8	1.3
Romaine (%)	5.7	4.8	6.5	0.4
Almeter Hauteur (mm)	75.8	68.0	90.0	5.4
Almeter CVH (%)	42.9	26.9	53.6	7.9
Almeter %<25 (mm)	5.1	0.0	10.7	3.5
Greasy micron (µm)	21.3	19.3	21.8	0.6
Top micron Laserscan (µm)	21.2	19.1	22.1	0.6
Top CV Diameter (%)	21.6	18.8	23.7	1.1
Top Laserscan Curvature (deg/mm)	74.2	66.9	83.3	4.8

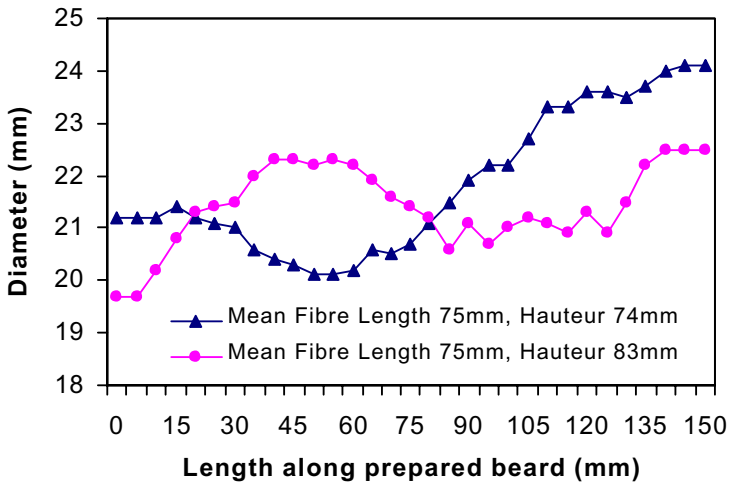

Figure 3. An example of two fibre diameter profiles of drawn top from the OFDA4000

The variance between replicate measurements on the same top was 2.1mm for mean fibre length and 2.0mm for hauteur. This equates to 95% confidence limits of ±2.84mm and ±2.76mm respectively. There was a good correlation (r^2 = 0.91) between the OFDA4000 hauteur and Almeter hauteur with no inherent bias as hauteur increased (Figure 4). Similarly, estimates of CvH between the OFDA4000 and Almeter were strongly correlated (r^2 = 0.97) although there was a bias towards increasing OFDA4000 CvH values relative to Almeter CvH as CvH increased (Figure 5).

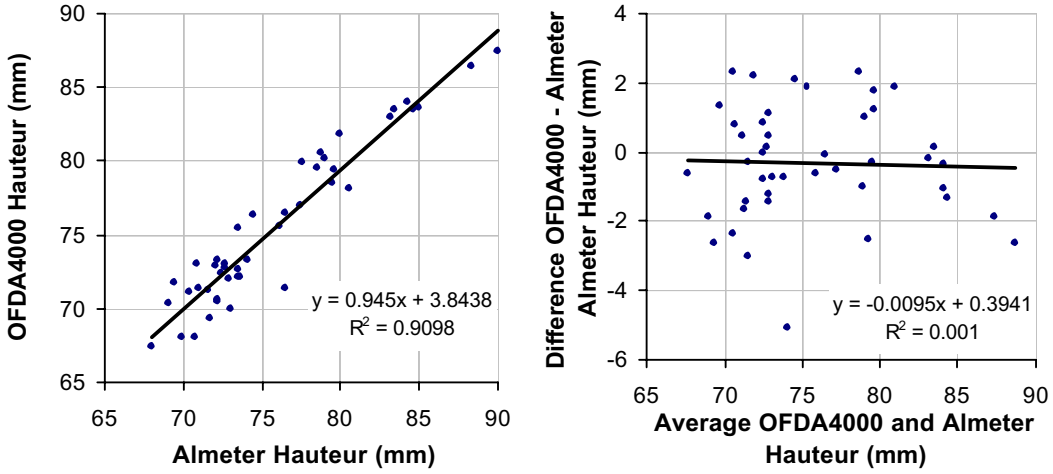

Figure 4. The relationships between Almeter and OFDA4000 derived estimates of hauteur

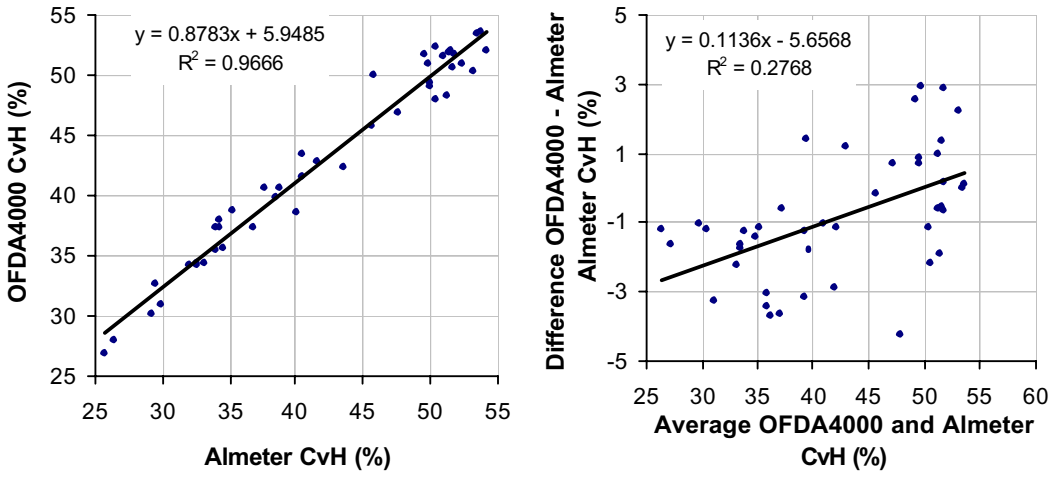

Figure 5. The relationships between Almeter and OFDA4000 derived estimates of CvH

There was a poor relationship (r^2 = 0.39) between mean fibre length and hauteur estimates for each top (Figure 6). There was a larger range (20mm) and standard deviation (5.4mm) in hauteur estimates between the 43 tops than the range (14.9mm) and standard deviation (3.0mm) for fibre length estimates measured by OFDA4000. Similarly, there was a poor relationship (r^2 = 0.48) between the two techniques for estimating CvH using the OFDA4000. There was a very poor negative relationship (r^2 = 0.18) between OFDA4000 and Almeter for estimates of short fibre content (% fibres < 25mm).

The shape of the fibre diameter profile appeared to have the greatest influence on the disparity between estimates of mean fibre length and hauteur on the same top. This was shown by the strong relationship (r^2 = 0.97) between fine ends and the difference between mean fibre length and hauteur (Figure 7). As

the fine ends of the top decreased, the difference between mean fibre length and hauteur increased. The fine ends was strongly correlated to the fibre diameter profile of the raw wool staple. For staples with finer fibre diameters at the ends, the drawn Fibroliner beard also tends to be finer at the leading edge. The diameter at the leading edge of the beard, and the mean diameter of the top determine the fine ends estimate.

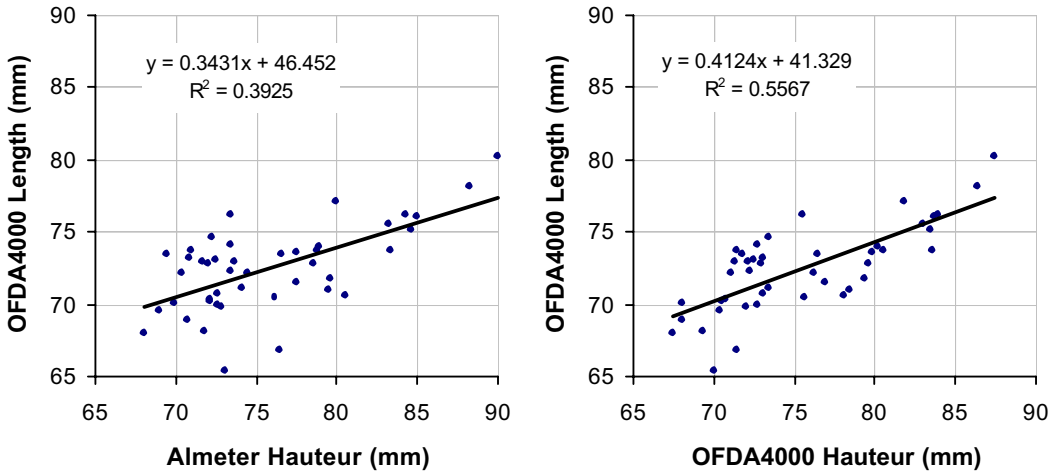

Figure 6. The relationships between mean fibre length and hauteur measurements made with the Almeter and OFDA4000

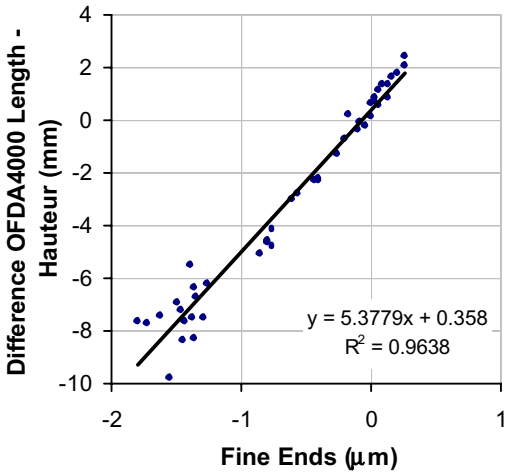

Figure 7. The relationship between the differences in mean fibre length and hauteur estimates from the OFDA4000, and the fine ends diameter of the drawn top

There was good agreement between the OFDA4000 and Laserscan for measurement of the mean fibre diameter of top (Table 1). The correlation (r^2 = 0.92) between OFDA4000 and Laserscan estimates of MFD for each top was strong (Figure 8).

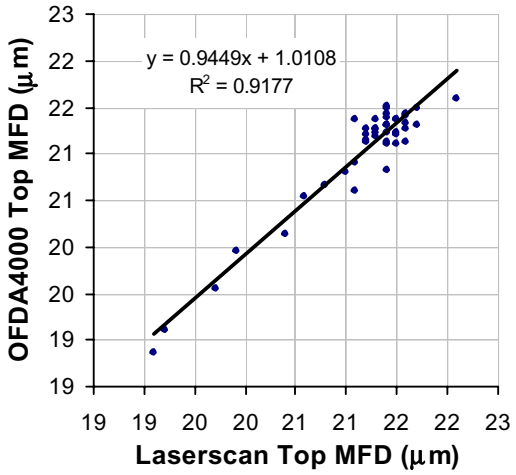

Figure 8. The relationship between OFDA4000 measured MFD and the MFD measured by Laserscan of 43 commercial tops.

The OFDA4000 was shown to agree well with the current IWTO accredited instrument used to measure the hauteur and CvH of wool top. These results suggest that verification of the OFDA4000 should now proceed to IWTO accreditation for the measurement of hauteur and CvH. As was seen in an earlier paper [1] there was a poor relationships between Almeter measurements of hauteur and CvH, and the measurements of mean fibre length and CvL based on the measurement technique of the OFDA4000. This poor agreement is probably due to the fibre diameter profile of the prepared beard. Because the fibre diameter varies along the length of these prepared beards, the number of fibres at any given point were either over or under-estimated since the cross-sectional area of the beard did not accurately reflect the number of fibres at any one point. This phenomenon has the largest effect on the estimation of short fibre within the top.

CONCLUSION

The addition of the ability to measure snippets in the standard 70mm glass slide as in the OFDA100 allows OFDA4000 to measure the fibre diameter of non-parallel fibres.

Measurements show that the OFDA4000 length and hauteur measurements behave as predicted from the diameter profile, and that fibre length and hauteur can be poorly correlated for some wool types.

Many processing prediction equations utilise the hauteur measurement with success. However, it is possible that processing effects are more likely due to the fibre diameter profile of fibres within the top rather than the fibre length distribution. Given the difference between length and hauteur, it is probable that more accurate processing prediction could be achieved with the extra OFDA4000 measurements.

REFERENCES

1) Brims, M. (2002) *Progress of the OFDA4000 and Comparison with Almeter.* IWTO Sliver Group, Barcelona, Report SG02

2) Peterson, A.D., and Oldham, C.M. (2000). *The influence of date of shearing on the processing performance to top of mini-commercial consignments of merino fleece wools grown in either southwestern or eastern Australia – 2. Improved prediction from the FD profiles of staples from component sale lots.* 10th Int. Wool Textile Research Conference, Aachen.

3) Peterson, A.D., and Oldham, C.M. (2002). Predicting hauteur from the fibre diameter profiles of the OFDA2000. *Wool Tech. Sheep Breed.* **50(4)**, 847-52.