AFIS Status Report
With Focus on Fineness
And Maturity

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Research and Development

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It has become fortunately clear to us that AFIS is being recognized as a textile process quality control tool. Frequently, Uster AFISs are located in the QC Laboratories of world-class mills, beside Uster Testers or TensoRabides. (See Figure 1.) This means that in-process fiber properties and yarn properties are increasingly being related by such mills. Many of them already use HVI data and Engineered Fiber Selection: It is a matter of a short period of time until AFIS parameters enter EFS Procedures.

The status of AFIS Information Module Performance, insofar as measurement feasibility is concerned, is summarized in Table 1. The middle column shows the degree of correlation between AFIS and alternative methods of measurement which are reference methods accepted by out industry. Careful laboratory testing of special fibers or other materials was executed to demonstrate feasibility. The third column, payback months, is, of course, blank for presentations like this but everyone knows that such cost/benefit data are as important as scientific data of purchase justifications.

You will hear status reports from others here at EFS 4th about some of the AFIS Information Modules. Mike Watson of Cotton Incorporated will report on a reference method for shiny neps. Devfon Thibodeaux of SRRC will compare NIR and AFIS readings of fineness and maturity. Richard Furter will give the second milestone paper on Neps: the first was given by our Session Chairman, Dr. Sasser, in July 1987. I wish to alert you that several very important advances in knowledge about neps are in these milestone papers. Norma keyes, of Cotton Incorporated will report on Length. There may even be others who speak to the point of AFIS status.

My comments on AFIS status provide a very brief overview of AFIS principles, focus on measurement of maturity, and conclude with recognition of those whose really affect AFIS status.

Figure 2 shows that a fiber sample is fed into the AFIS Fiber Individualizer Microdust, fibers, and trash are separated into individual entities and are pneumatically transported to elector-optical sensors whose signals are processed by an industrialized personal computer. The Fiber Individualizer in Figure 3 consists of two pinned cylinders and other customary elements. The first cylinder is perforated and microdust is pulled into it. Trash is ejected out of two counterflow slots. Fibers and neps are air doffed form the second cylinder and are carried to the fiber sensor.

The Fineness and Maturity Information Module requires simultaneous detection of extinction mode (Ve) and scatter mode (Vs) signals shown in Figure 4. For contrast, normal Neps and L&D require only the Ve signal. The Ve or Vs signals resemble the trapezoidal (single fiber) or triangular waveforms (neps) shown in Figure 5.

My colleague Dr. Y. T. Chu, the AFIS F&M Data Product Champion, has developed an algorithm which uses Ve and Vs to predict the shape or circularity single fiber passing through the sensor. The distribution of circularity is the most basic physical measure of fiber maturity.

Figure 6 shows the precision of this prediction when compared to the image analyzer reperence method and clearly demonstrates feasibility. The image analyzer data are provided by Dr. Thibodeaux and his colleagues form Southern Regional Research Center. SRRC has participated in the evolution of AFIS F&M and their support is gratefully acknowledged. The 36 cotton samples were selected by Mr. John Price of Texas Tech University. Whose cooperation and support are also appreciated.

Please note samples 9 and 27, the least and most mature.

AFIS and Image Analyzer also provide fineness distributions via cross-sectional area A and the precision of AFIS prediction relative to the IA is seen in Figure 7.

Only the Image Analyzer and AFIS methods can provide fiber-by-fiber or distribution data. Figures 8 and 9 compare Image Analyzer (dotted) with AFIS (solid) distributions. The agreement is generally satisfactory. For later use, let us define the immature fiber fraction, IFF as that of fibers for which $\theta \leq 0.25$. This agrees with Dr. E. Lord's definitions. Thus AFIS gives IFF = 9% for samples 27 and 26% for sample 9.

For completeness, Figures 10 and 11 compare IA and AFIS distributions in fineness. FFF is the Fine Fiber Fraction and is that % of fibers having F < 75 millitex.

Now let us quickly move from principles of operation and feasibility demonstration to the real world were dye up-take or dye uniformity problems are of practical interest.

Please recall the Goldthwaite or differential dye test where more immature fibers take up more green dye and more mature fibers take up more red dye.

Figure 12 shows that the AFIS measure of average maturity, $\bar{\theta}$, satisfactorily predicts differential dye results of the Goldthwaite Method. Predicting dye up-take or perhaps dye uniformity can thus be effected well in advance of dying.

Shiny neps, our terminology for undyed specks, or dye-resistant neps, are sometimes a serious problem. We are approaching the QC Lab-based measurement of shiny neps in two very different ways different ways with AFIS: (1) Direct Measurement via extension of AFIS-N information module capabilities and (2) Prediction via the Immature Fiber Fraction IFF from AFIS M. In both cases, AFIS is processing undyed, in-process material - from bale through sliver or roving.

Mike Watson will describe progress with direct measurement: much of the progress in that approach lies in the area of developing a dye-based reference method for shiny neps content, in number per gram.

I will now describe IFF prediction of shiny neps. For emphasis and clarity, please note that the AFIS Maturity distribution, from which IFF is derived, is made on undyed material, on a fiber-by-fiber basis. We thus seek to establish how well IFF predicts a physically different entity - shiny neps.

Figure 13 compares the IFF readings with a 4-group ranking by visual examination of dyed cotton. Group 1 is best and Group 4 is worst. If, for example, a mill decides that it wishes to ship yarns constructed form fibers with the lowest shiny nep ranking #1, then it would wish to process fibers whose IFF is smaller than about 12%.

Figure 14 shows a more quantitative result comparing IFF and absolute shiny nep counts per gram obtained results from the thin, dyed web method. Following the same logic as before, if a mill chose to process fiber with IFF less than 12%, then it could expect that fewer than 200 shiny neps per gram would result in the average.

I will conclude by sharing with you three observations that we have reached so far in our R%D on predicting shiny neps from maturity distributions.

First, we are somewhat surprised that the prediction of shiny neps from single fiber maturity distributions is as good as $r^2 = 0.86$, for visual ranking or $r^2 = 0.77$, for more absolute count per gram. This result supports the hypothesis that increasing shiny neps count is correlated with increasing IFF or decreasing average maturity. But it does not say that shiny neps are generated from the immature part of the maturity distribution. To the contrary, true shiny neps are more flake-like than like an entangled structure of fibers, however immature. Further, this positive result does not mean that IFF prediction is better than direct detection of shiny neps: only extensive mill experience will resolve which is the better QC tool.

Second, what good, you may ask, will it do to detect immature fiber or fiber with excessive shiny nep content in the QC Lab? Is it too late by then to take corrective action? Only extensive mill experience will prove whether machine alterations or material diversions are practical or not. We have to start somewhere in the manufacturing process and testing silver in the QC Lab Makes good sense.

Third, all cotton has some immature fibers and some shiny neps: determination of acceptable levels needs to be thorough investigated, as do alterations in the textile manufacturing process. Whether visual ranking of "1" or whether fewer than 200 shiny neps per gram will keep the customers coming back rather than the goods coming back are the kinds of serious, practical questions demanding investigation.

Chairman Sasser, with your kind permission I with to introduce this group 3 of its partners in the tasks of refining and applying AFIS measurements in the QC labs to the ends of improving textile processing quality:

Mr. Michael E. Galyon, Length and Diameter Data Product Champion

Mr. Joseph C. Baldwin, Neps Data Product Champion

Dr. Youe - T. Chu, Fineness and Maturity Data Product Champion

There are other R&D Data Product Champions in R&D and, of course, many others within Zellweger Uster who are working toward the some ends.

Much more importantly, however, it is those outside our firm who really affect the status of AFIS as a QC tool and who are moving it toward inclusion of EFS.

Ladies and gentlemen, you can expect to hear increasingly about AFIS status from the Data Product Champions. For maturity and shiny neps, my subject this morning, we intend to begin beta-site testing soon with both prediction and direct measurement. We expect to provide up-dated status reports and possibly application notes at the Beltwide in Nashville and at Bremen. Thank you.

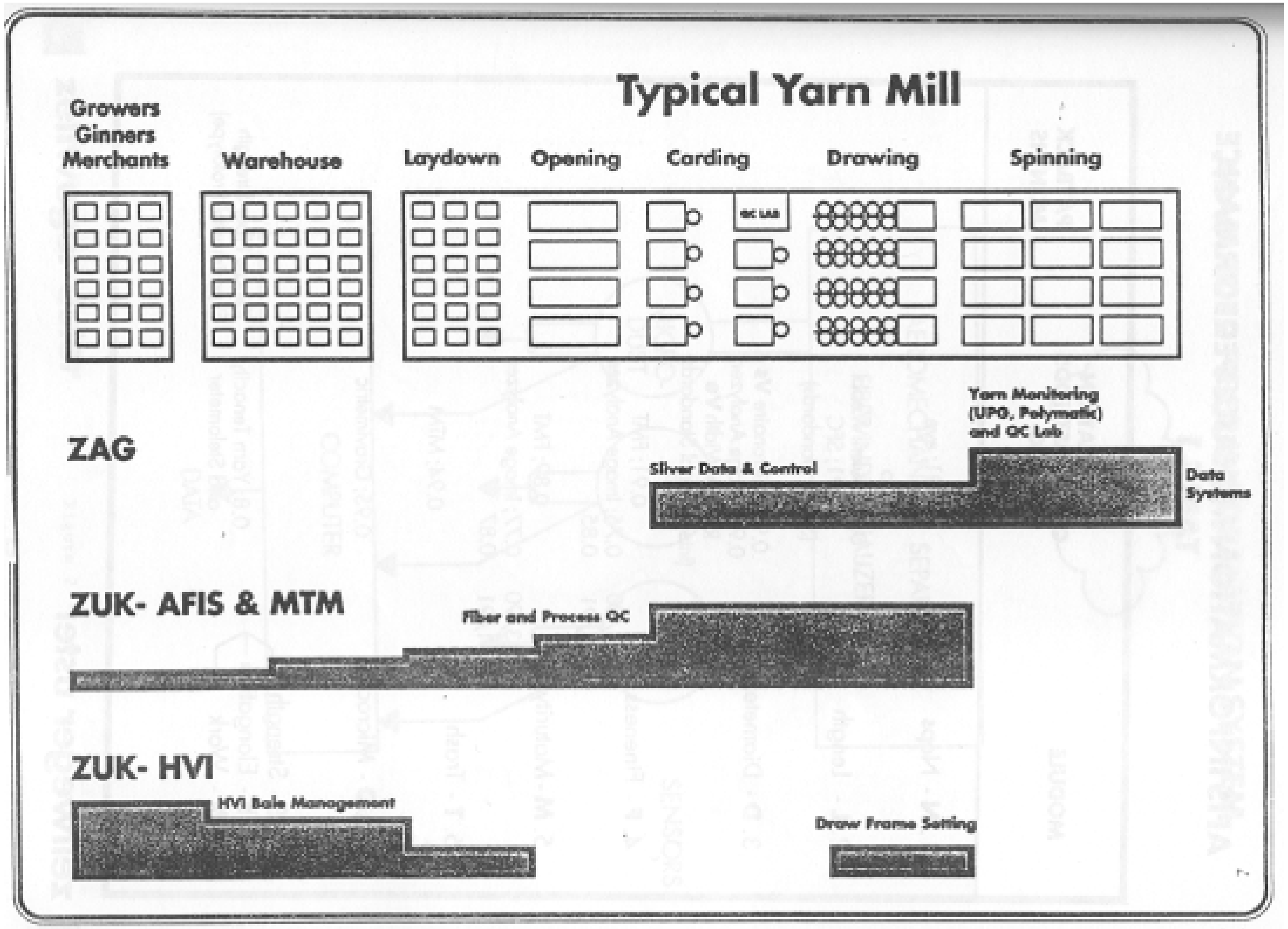

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Figure 1

4/8/91

AFIS INFORMATION MODULE PERFORMANCE
TABLE 1

MODULE		CORRELATION OTHER METHODS r^2; TO	PAYBACK MONTHS
1. **N** - Neps		0.91; eye	
2. **L** - Length		0.98; Suter-Webb 0.91; SFC (Staple Standards)	
3. **D** - Diameter		0.96; Micronaire **Vs** 0.97; Image Analyzer Ribbon Width **Ve** (International Standards)	
4. **F** - Fineness	 3/90 1/91	0.91; FMT 0.75; Image Analyzer 0.85	
5. **M** - Maturity	 3/90 1/91	0.89; FMT 0.77; Image Analyzer 0.87	
6. **T** - Trash		0.94; MTM	
7. µ**D** - Microdust		0.95; Gravimetric	
8. **S** - Strength **E** - Elongation **W** - Work		0.8; Yarn Tenacity and Stelometer	(Single Fiber Strength Experimental Prototype)

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ADVANCED FIBER INFORMATION SYSTEM

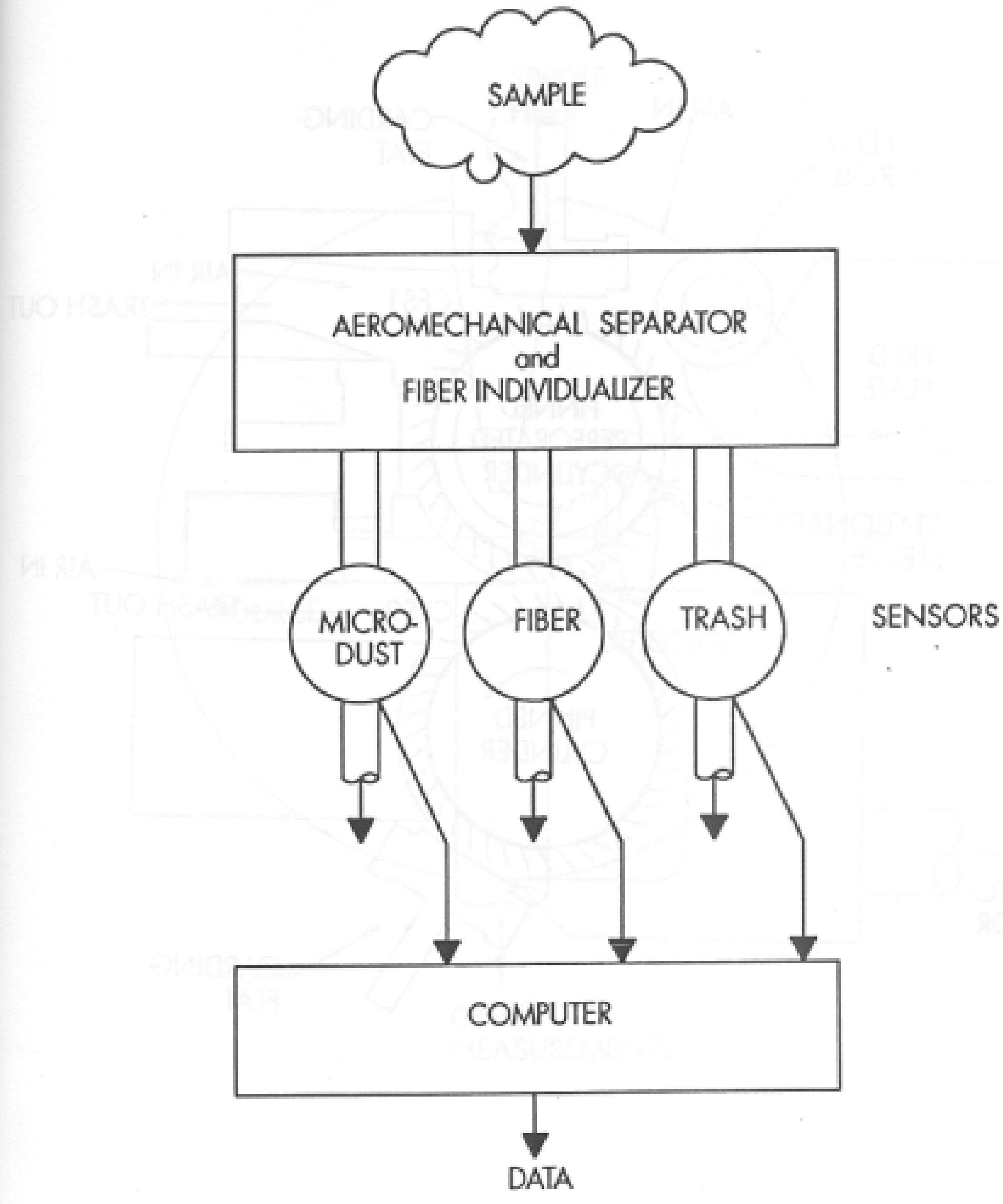

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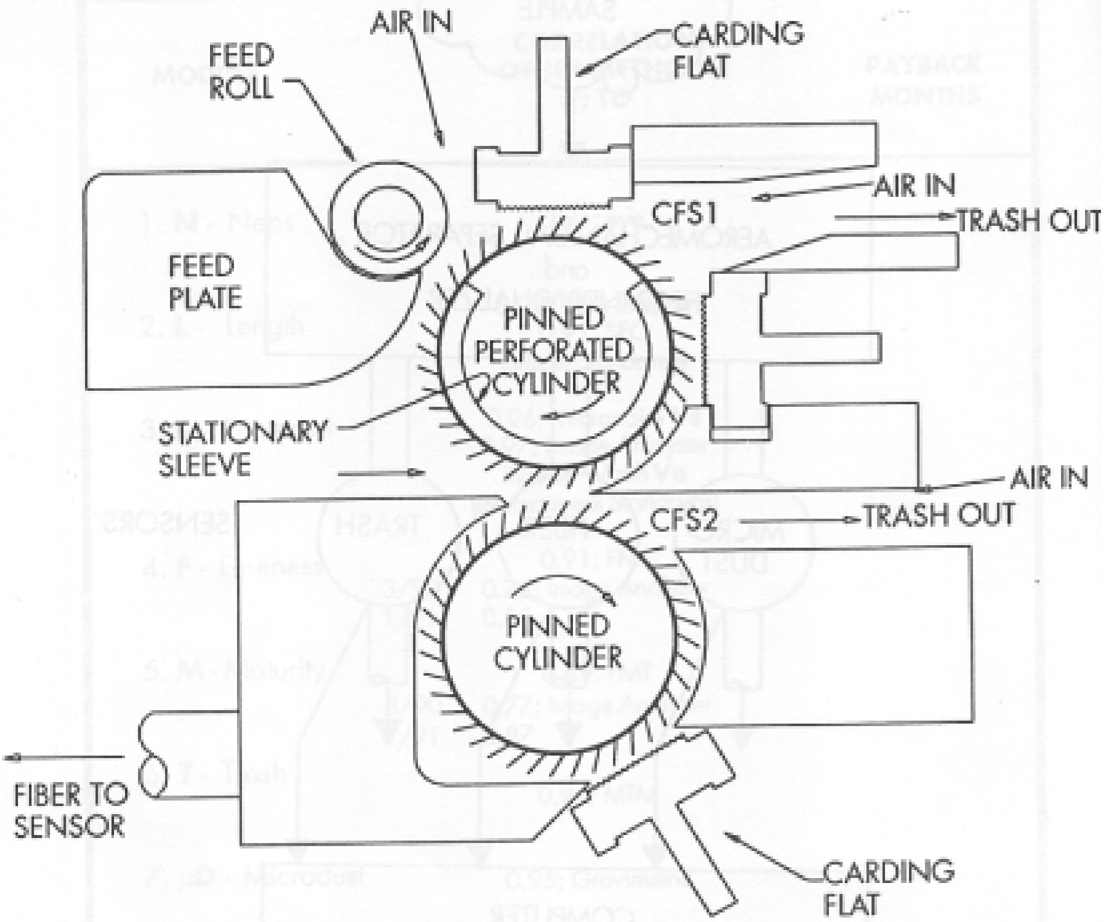
Figure 2

FIBER INDIVIDUALIZER



FIBER SENSOR

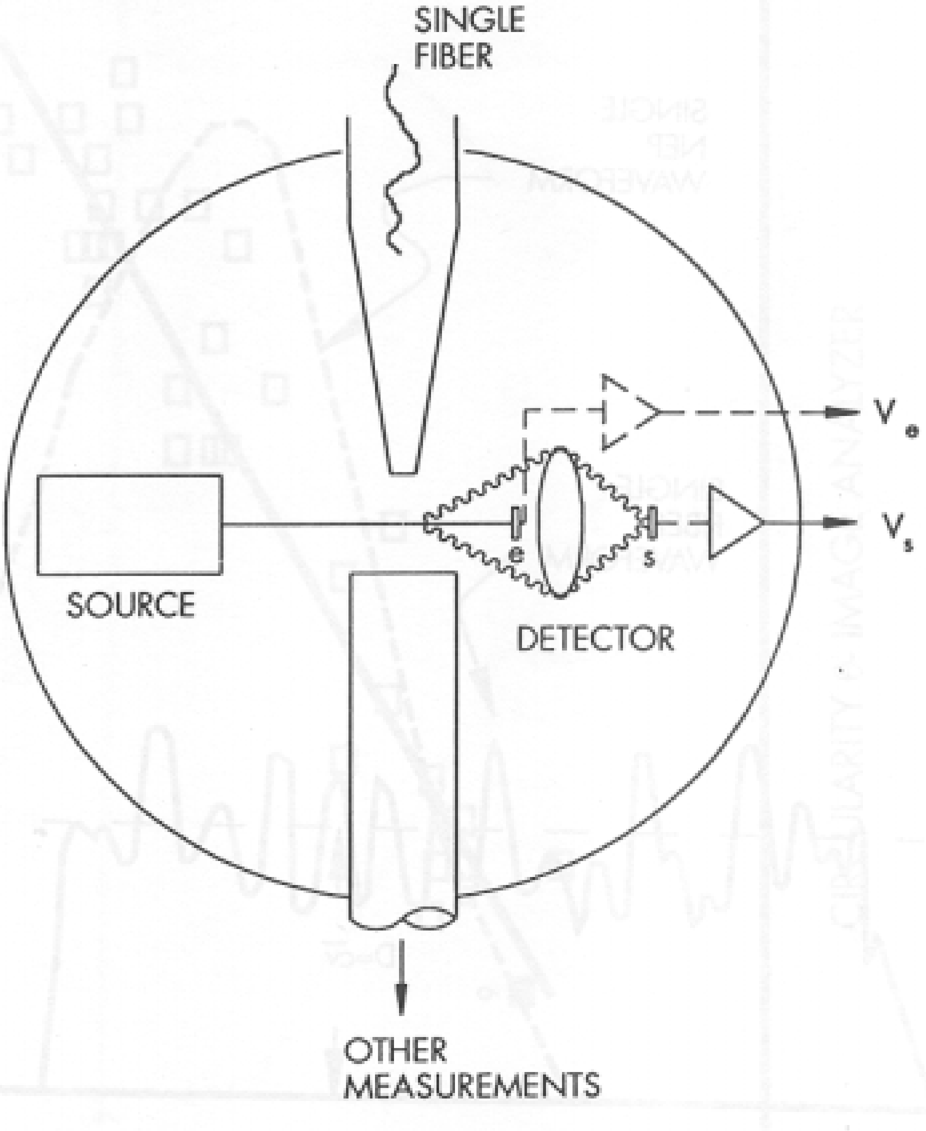


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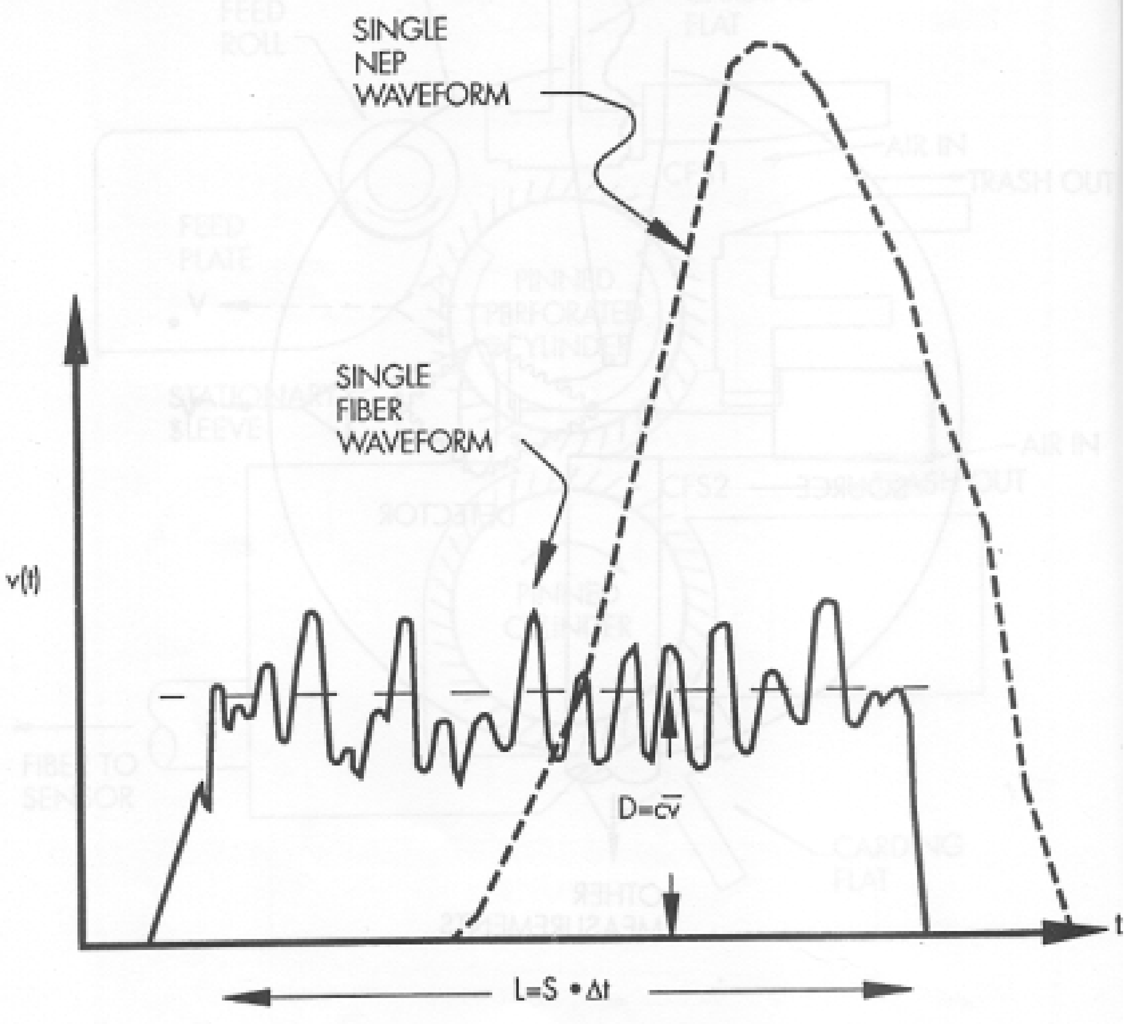
Figure 4

FIBER AND NEP WAVEFORMS



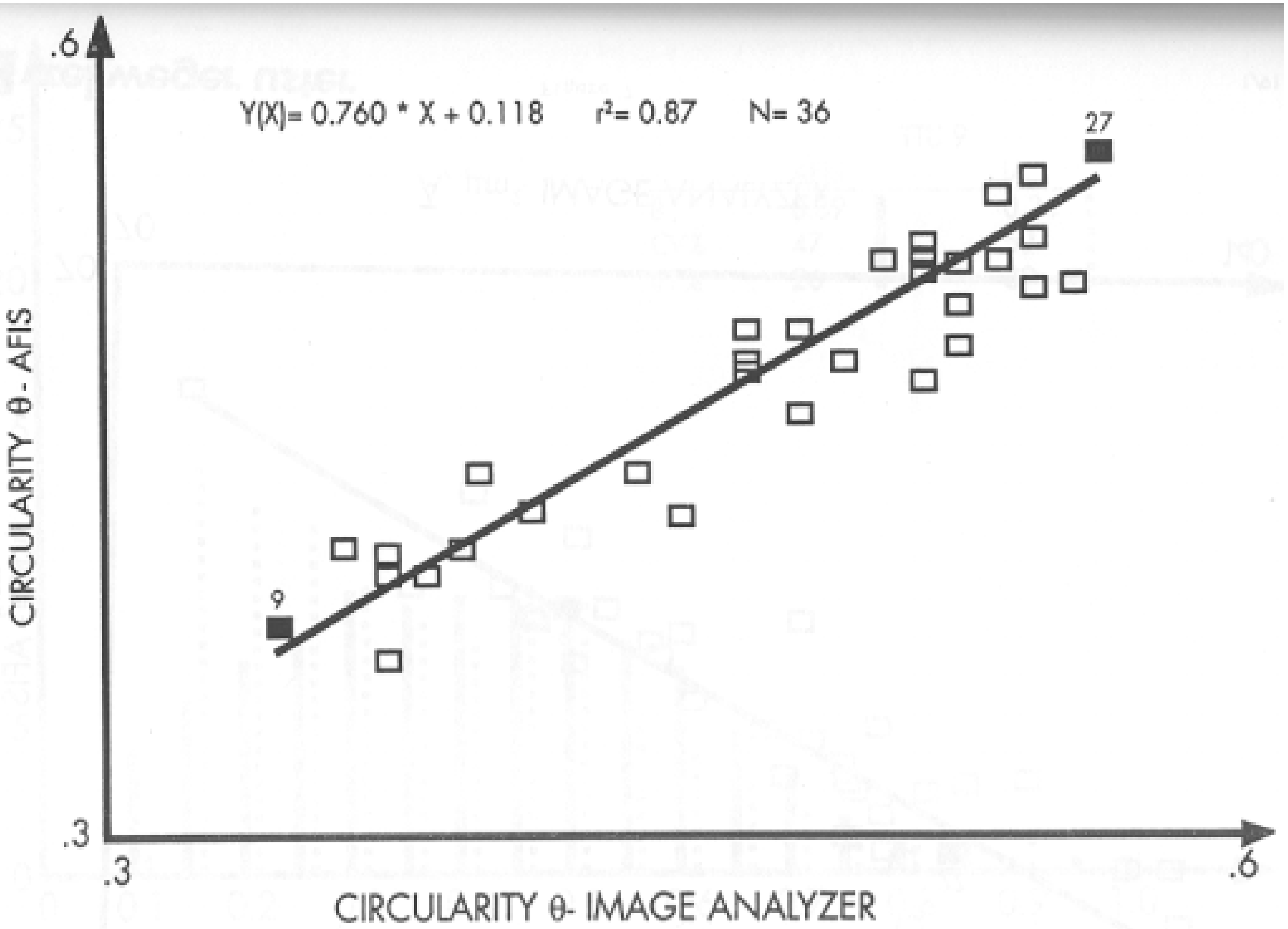


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Figure 6

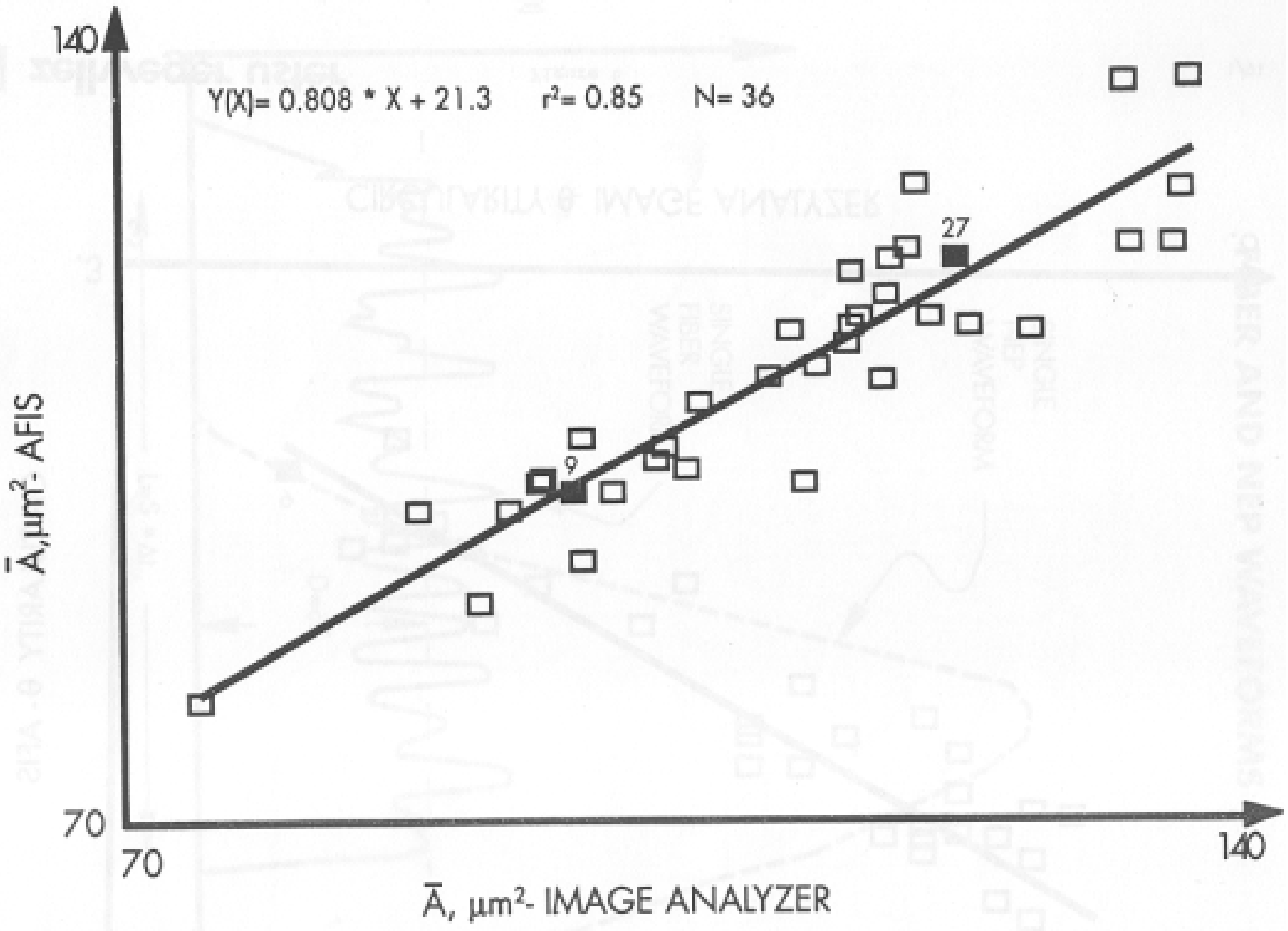
140
Y(X)= 0.808 * X + 21.3
r²= 0.85
N= 36
27
9
Ā,µm²- AFIS
70
70
140
Ā, µm²- IMAGE ANALYZER

Figure 7

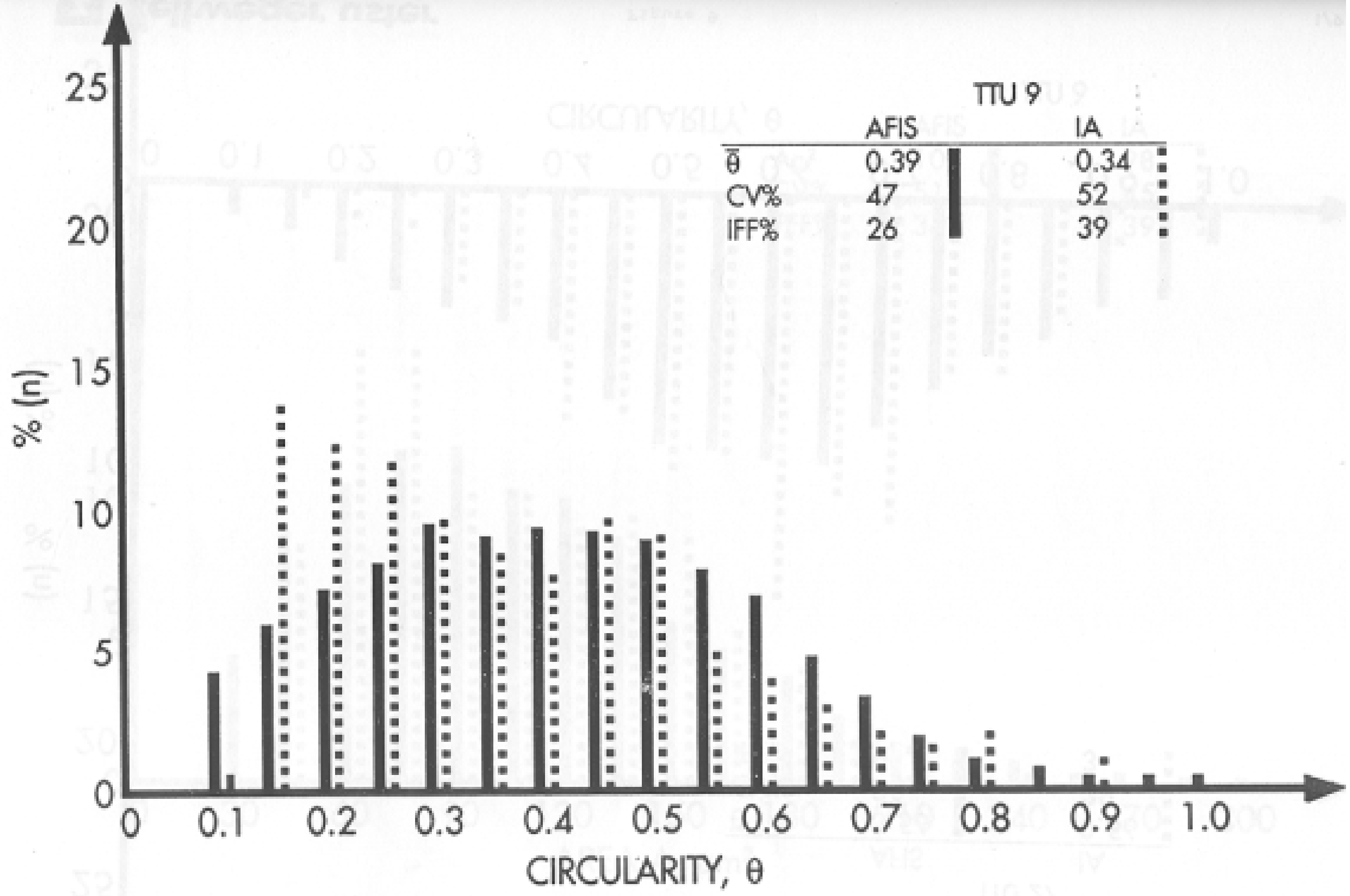

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Figure 8

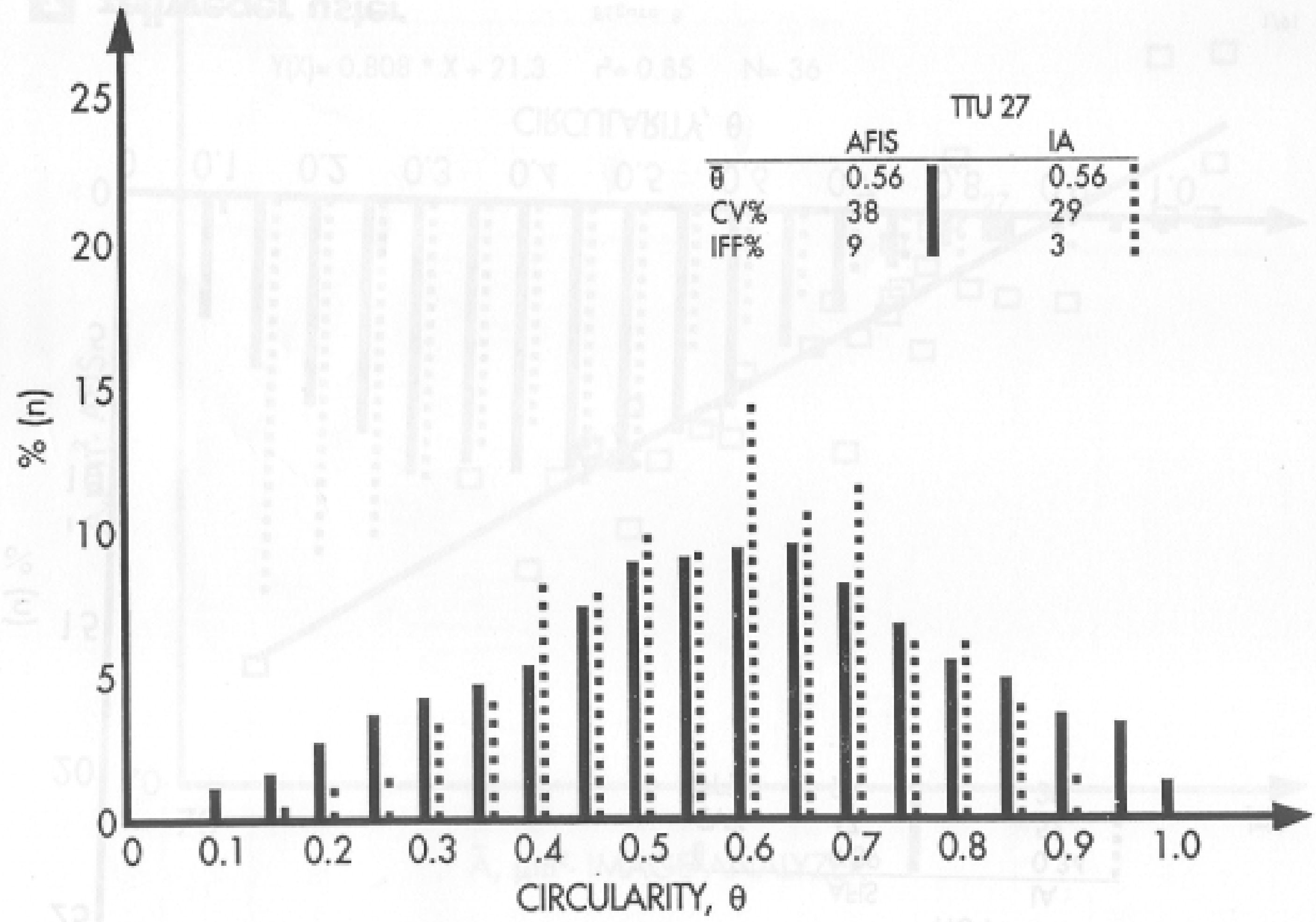

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Figure 9

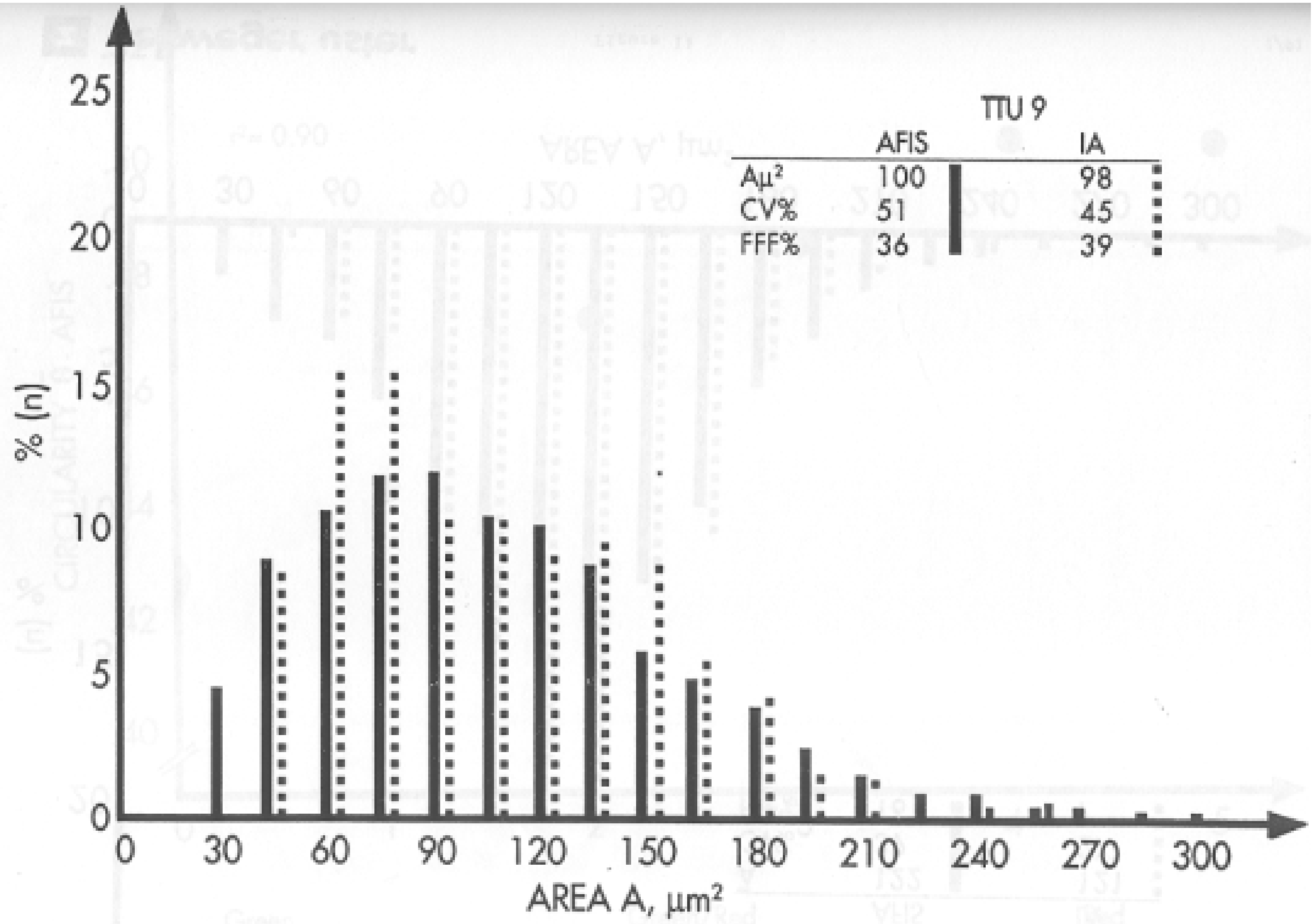

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Figure 10

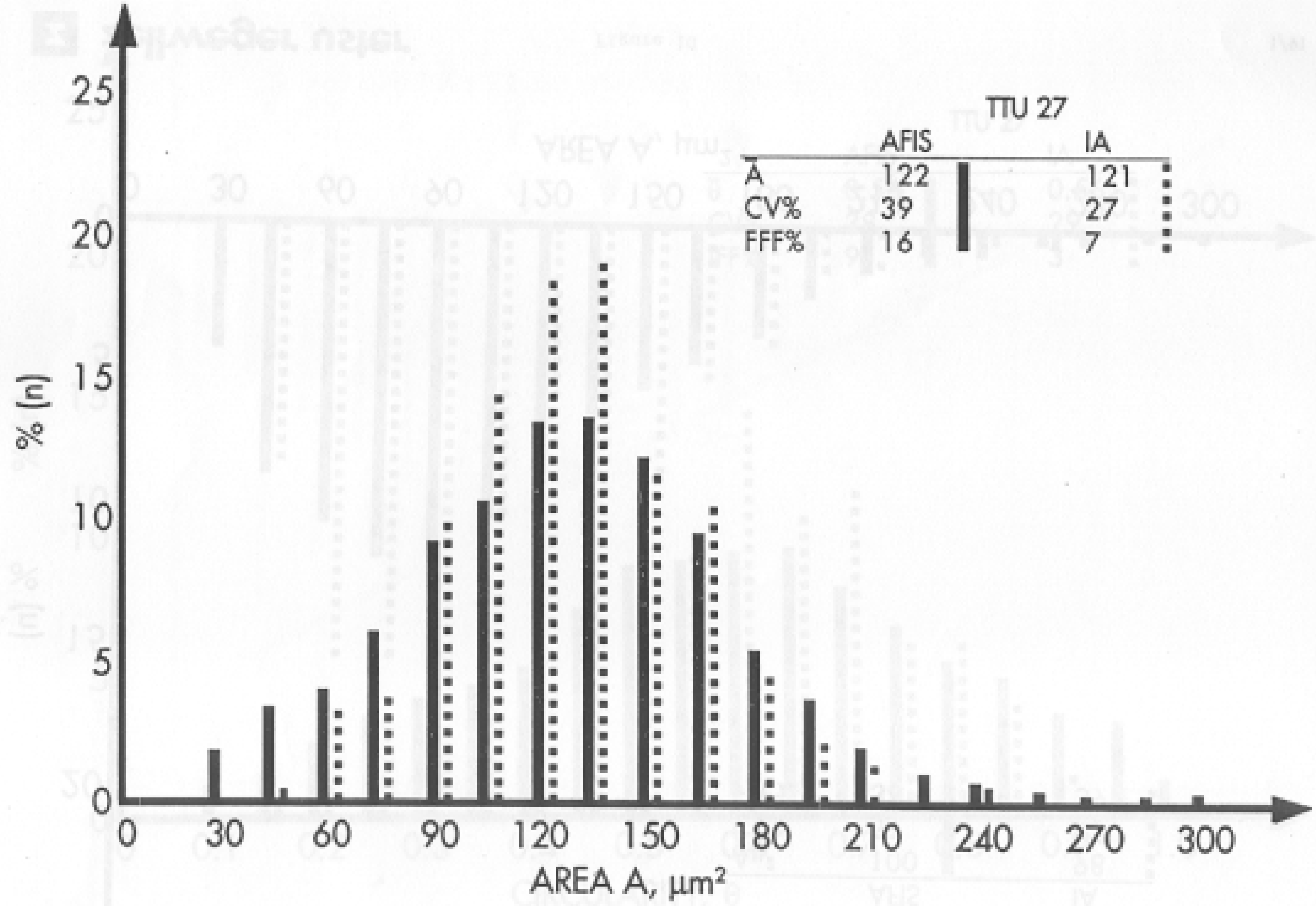

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Figure 11

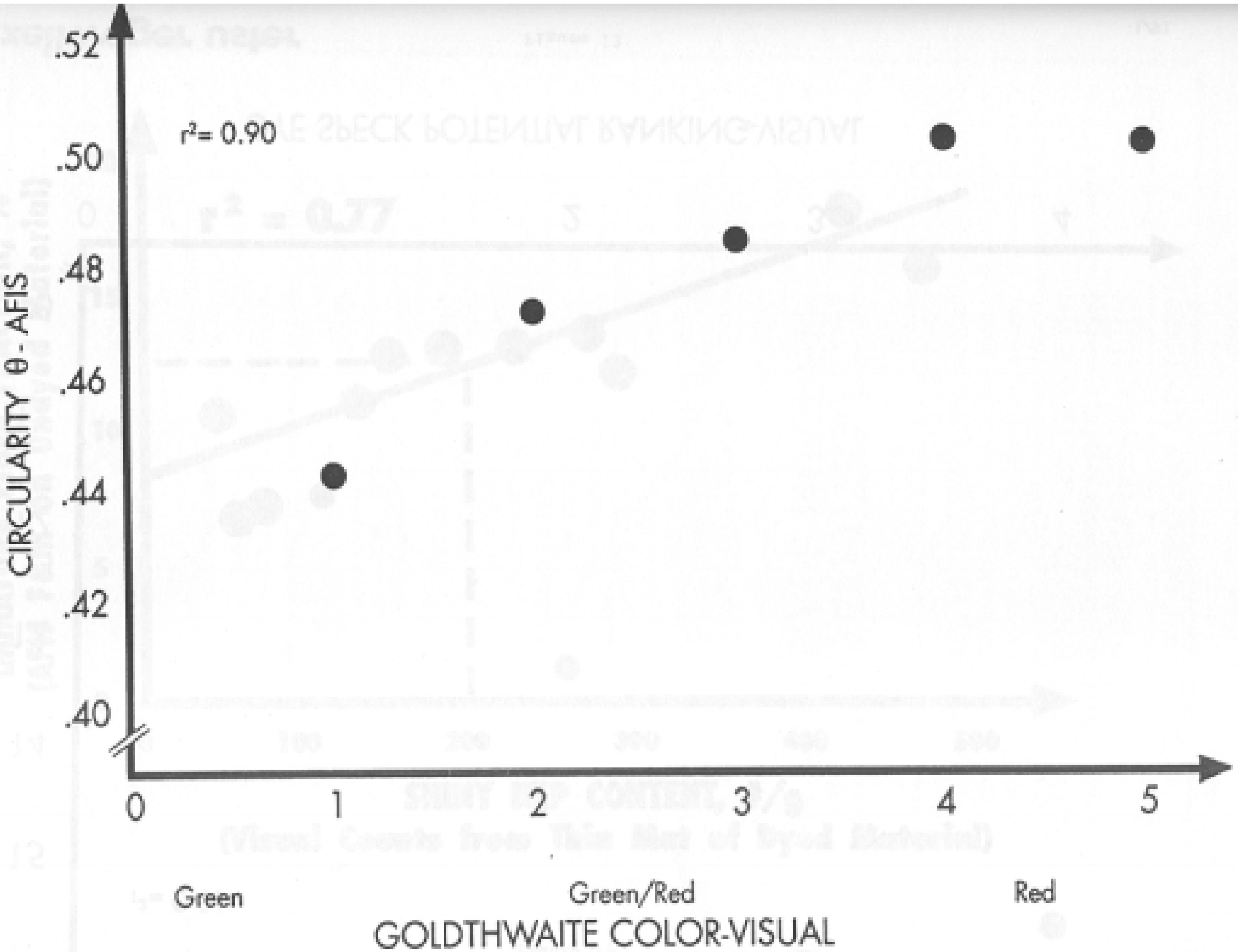

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Figure 12

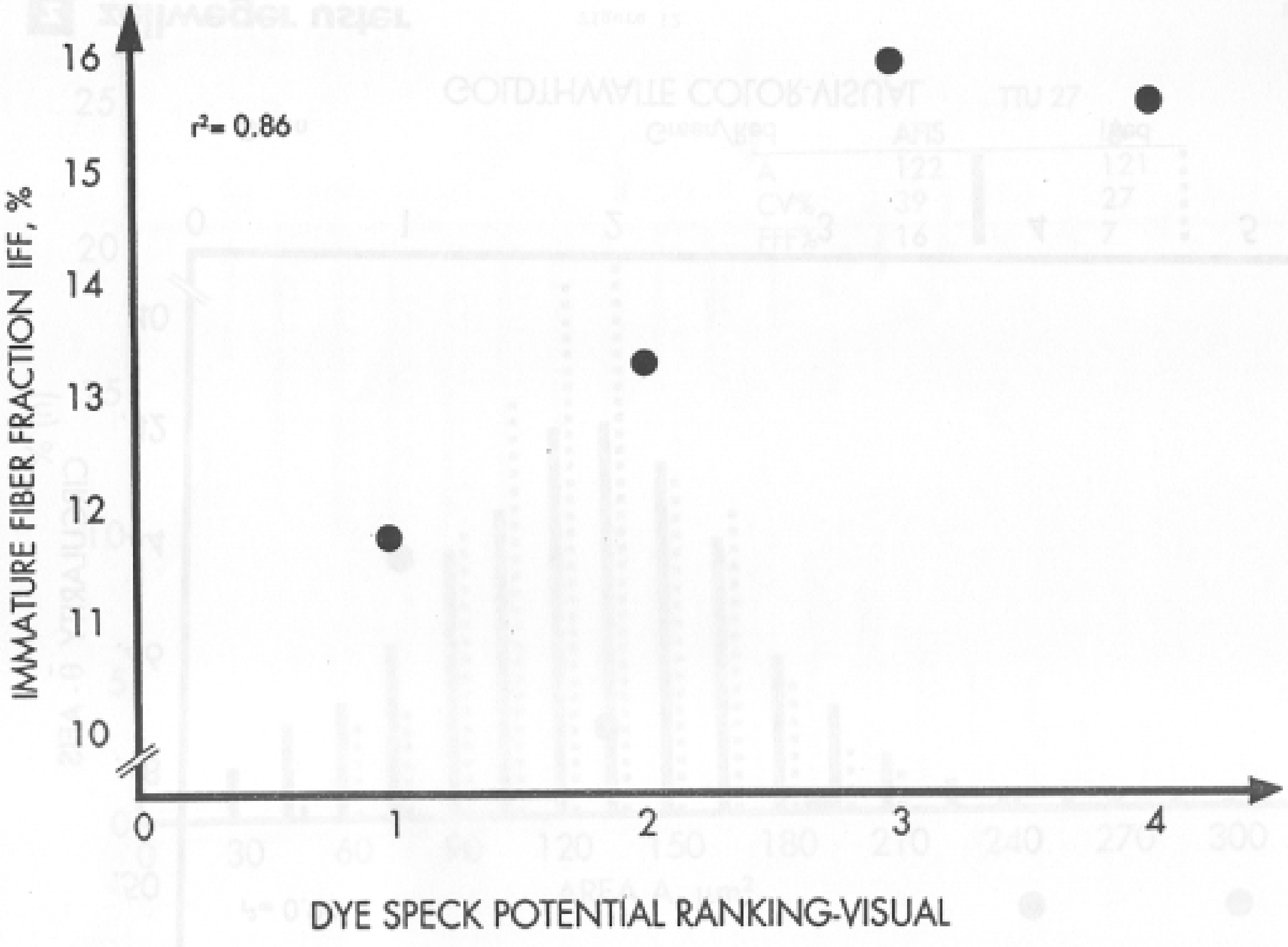
IMMATURE FIBER FRACTION IFF, %
16
15
14
13
12
11
10
r^2= 0.86
0
1
2
3
4
DYE SPECK POTENTIAL RANKING-VISUAL

Figure 13

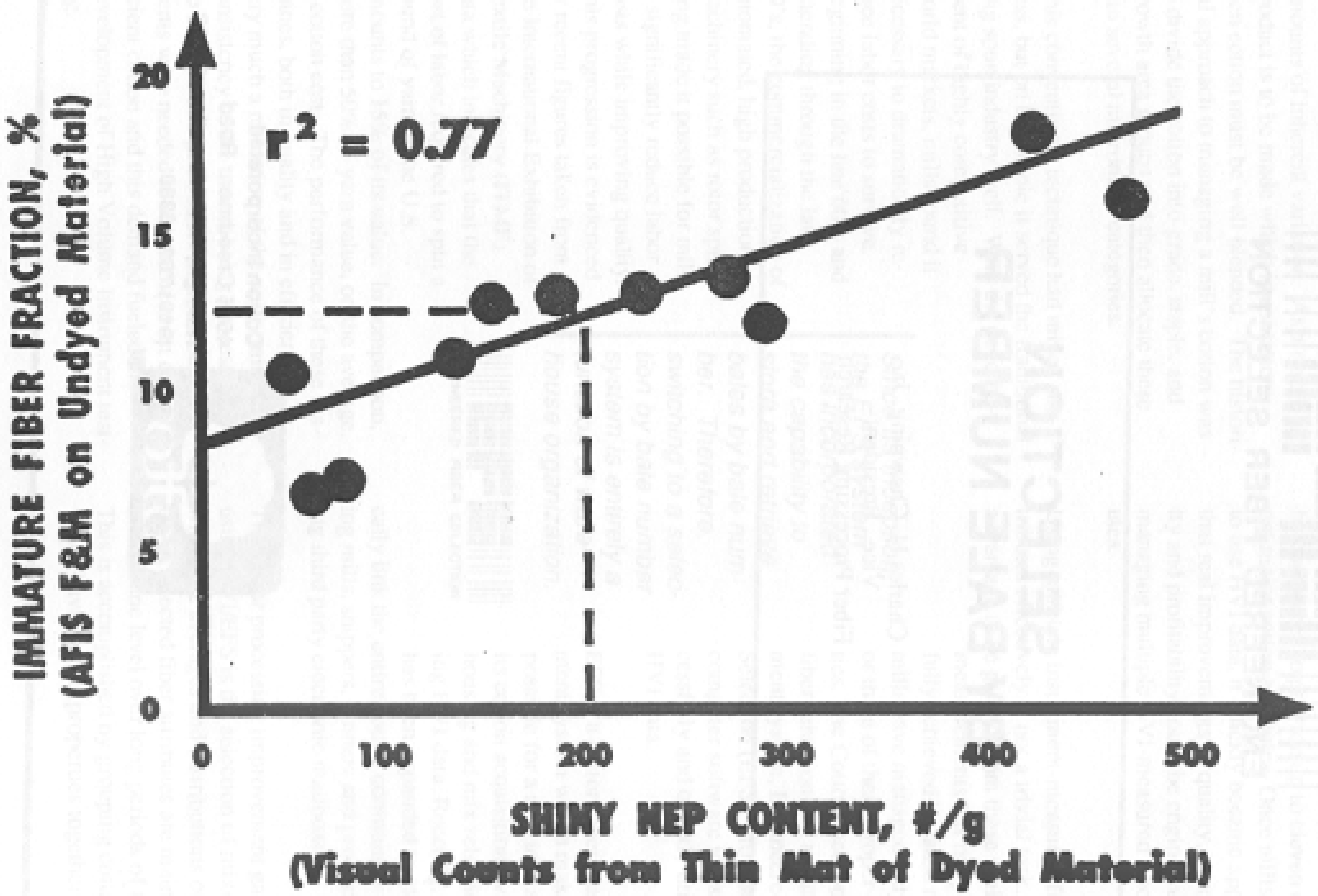
IMMATURE FIBER FRACTION, %
(AFIS F&M on Undyed Material)
20
15
10
5
0
$r^2 = 0.77$
0
100
200
300
400
500
SHINY NEP CONTENT, #/g
(Visual Counts from Thin Mat of Dyed Material)

Figure 14