Measurement of slub yarns
Part 1 / Basics
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1 Introduction

Slub yarns are used in the textile industry for various applications. Therefore, slub yarn manufacturing is not a niche market anymore. Up until now, it was not possible to determine the quality characteristics of slub yarns in detail which are needed for a quality management.

An accurate determination of slub yarn characteristics is also required for negotiations and specifications between slub yarn spinners and weavers, knitters, traders and retailers.

As the requirements of the textile industry are increasing, Uster Technologies developed a new software which allows the measurement and evaluation of slub yarns accurately. The result of this effort is the so-called “Fancy Yarn Profile” as a software option to the USTER® TESTER 5. This option was introduced to the market in June 2007. The Fancy Yarn Profile offers a comprehensive analysis of all slub yarn types by means of various statistical values and graphics.

This option fulfills the requirements of slub yarn producers, knitters, weavers, traders and retailers.

2 Purpose of the Fancy Yarn Profile measurement

The goals of the Fancy Yarn Profile measurement follow mainly two directions:

- **Daily quality control** in order to be able to compare the reproducibility of the slub yarn production, to compare machine settings, etc.
- **Detailed analysis** of the slub yarn to provide information for the spinner to create and develop a slub yarn

Based on the results of the measurement, the most important questions can be answered, like e.g.:

- Which slubs are produced?
- How many slubs per unit length are produced?
- What is the slub distribution?
- What is the individual size of the slubs, their distance and the mass increase?
- What is the relationship between the settings of the slub yarn device and the resulting yarn?
- Are there any disturbing mass decreases before or after a slub?
- Is the sequence of the slubs correct and/or is there a repeating pattern?
- What is the variation between machines and batches?
3 Explanation of terms

In this chapter the basic terms of the slub yarn measurement are explained. These are:

- Reference level
- Ideal slubs
- Mass increase
- Slub length
- Slub length bottom / slub length distance
- Ratio T/B
- Populations
- Slub distance
- Mass decrease (left / right)
- Percentage slub length / slub distance
- Count of slub / base yarn
- Configuration
- Outliers

**Reference level**

The reference level is a line, which is on the level of the base yarn. All slub yarn calculations are based on this reference level. This level is set automatically by the software, but can be modified, if required, in the setting mode of the configuration (refer to chapter 5.1). The reference value of this reference level is defined as 0%.

**Ideal slubs**

The ideal slubs are marked in orange in the mass diagram. It shows how the software substitutes the real slub by an ideal slub to avoid calculation errors. Based on this orange area the slub length, slub distance, and mass increase are calculated. The ideal slubs are required to produce reproducible results.

For the slub marking a trapezoidal shape was selected as it covers most of the slub shapes. However, for complex shapes of slubs, this trapezoidal waveform is only an approximation.

**Slub Yarn Configuration**

Overall definition, how a slub yarn should be evaluated regarding the reference level, setting of a boundary to separate slubs from non-slubs or random thick places and the definition of populations (refer to chapter 5.1).
Mass increase
The mass increase is defined as the mass increase from the base to the top of the orange trapezoid (Fig. 1). The base yarn has a reference level of 0%. The mass increase is calculated starting from this base.

Slub length
The slub length is measured at half of the height of the trapezoid (Fig. 1). This definition is selected to level out various kinds of ramps for different slub yarn types.

Slub length bottom
The slub length bottom is defined according to Fig. 1. This length is measured at the bottom (basic line) of the orange trapezoid.

Ratio T/B
The ratio T/B (ratio top to bottom slub length) gives an indication about the steepness of the ramps of a yarn. It correlates the length of the top of the trapezoid to the length of the bottom of the trapezoid. If the two lengths are about the same, the value reaches 1. A value going toward 0 means that the length of the top is much shorter than the length on the bottom of the trapezoid. This results in a rather flat ramp. The appearance of a slub in a fabric can vary considerably depending on the length and kind of the ramp.

Fig. 1
Definition of slub length and mass increase
Slub populations

Slub yarns can be designed to have two or more "populations". This means that there are at least two different slub sizes regarding e.g. different mass increases or slub lengths or combinations of both in one slub yarn (Fig. 2). These different populations can be evaluated separately with the Fancy Yarn Profile. This means that the statistical values of the individual populations in the result table are listed separately. The setting of slub populations is explained in detail in chapter 5.1.

![Fig. 2](image)

**Fig. 2**
**Definition of slub populations**

Slub distance

The slub distance is measured at half of the trapezoid height between the end of a previous slub to the start of the subsequent slub (Fig. 3). All slub distances plus all slub lengths together will add up to the overall test length.

![Fig. 3](image)

**Fig. 3**
**Definition of slub distance**

If two or more populations are defined, the slub distance is defined within the same population. Additionally, the mean slub distance between consecutive slubs can be evaluated, if required.
**Slub distance bottom**

The slub distance bottom is the counterpart to the slub length bottom. It is measured at the base line of the yarn. Slub distance bottom plus length bottom add up to the total test length (Fig. 4).

**Mass decrease (left / right)**

Mass decreases before and after a slub can lead to severe weak places in the yarn. They are often related to the settings of the slub yarn device and / or the spinning machine. Therefore, this parameter is an important quality characteristic of a slub yarn as it can lead to problems in the further processing of the yarn.

Only mass decreases within a distance of three centimeters on the left or right side of a slub (ends of the trapezoids) are evaluated. The starting points of this distance are at the ends of the slubs. A mass decrease is counted, when the mass drops below 30% of the base yarn (Fig. 5).
THE YARN INSPECTION SYSTEM

Percentage slub length & slub distance
This value is equivalent to the percentage of the slub lengths or slub distances compared to the overall test length. It shows the ratio of slub length to slub distance.

Count of slub / base yarn
Usually, the nominal count of a slub yarn consists of a mean value of the overall mass per unit length. With the Fancy Yarn Profile, it is possible to separate the count of the slubs from the count of the base yarn, in order to describe the yarn more accurately. The count is given in the selected system like e.g. Ne, Nm, tex.

Outliers
These are slubs or other events that are located beyond the defined boundary, but do not belong to any population. If no populations are defined, outliers do not exist.

4 Practical measurement

4.1 Measurement of a slub yarn type for the first time
For the measurement of slub yarns, the material type Fancy Yarn must be selected in the Test Job Editor. In the settings of the sensor CS (Test Job Editor ➔ UT5 ➔ Settings of Sensor CS), an empty configuration should be selected. After the first measurement of one sample, the configuration for this specific slub yarn type must be defined in the dialog Fancy Yarn Configuration. For the next measurement of this slub yarn type, the respective configuration can be selected and applied (Fig. 6).
4.2 Repetitive measurements of slub yarns

If a configuration for a specific slub yarn type is already defined, the respective configuration can be selected in the setting of the sensor CS in the Test Job Editor and applied to the slub yarn (Fig. 7). The results will be evaluated based on this configuration.

4.3 Recommended test length

Due to the random distribution of slubs in a slub yarn, we recommend to select a measuring length of a minimum of 1000 m either at a measuring speed of 400 m/min or at a speed of 800 m/min.
5 Fancy Yarn Configuration

5.1 Setting a Fancy Yarn Configuration

In order to get the best results for the different slub yarn types, a configuration for each slub yarn type must be defined. This is done in the dialog System Control ➔ Definitions ➔ Fancy Yarn Configuration. In order to access this dialog, the user level Head of laboratory must be selected.

By default, the Fancy Yarn Configuration shows the first sub-sample of a test. With help of navigation tools it is possible to scroll through the various sub-samples of a test.

Fig. 8 shows the dialog Configuration Fancy Yarn, identifying five areas of operation.

Area 1

In this part, a tested sample can be selected, which should be used to define a configuration. The fields Catalog, Article, Nom. Count and Sample ID can be used as a filter to find a tested sample. The field Configuration is grayed-out. It shows which configuration is currently applied to the selected sample. By clicking on the icon next to this field this configuration is re-loaded.

In this area, there are also arrows which allow the user to click from one subsample to the next.
When a sample is selected, the measured yarn is shown in area 2 (diagram) and area 3 (scatter plot).

**Area 2**

In this part of the dialog, the mass diagram of the yarn including the base yarn and the slubs is shown in the upper window. The automatically defined reference level is indicated as a blue line. In most cases this reference line does not need any correction. Certain slub yarn types, however, might require that this reference line is adjusted to a lower or a higher level. By entering and confirming a number in the range of +500% and -100% in the field above the mass diagram, the reference level will be adjusted. The adjusted reference line will be marked in red in addition to the automatically set reference level (blue).

The lower diagram shows the base yarn of the tested slub yarn by subtracting the ideal slubs from the reference level. Thus, depending on the selected reference level, this diagram will be adjusted as well when the reference level is changed. The settings are good, when it does not show any slubs or mass increases anymore exceeding the expected mass variation.

It is possible to zoom into these diagrams and to check the whole test length by means of a scroll bar on the bottom of this area. The reference level must be checked and if necessary it must be adjusted before any other settings are defined (area 3).
Area 3

This part of the dialog has two objectives:

- Separation of real slubs from mass increases that are not considered as slubs, but are considered as part of the regular yarn body
- Definition of slub yarn populations, if applicable

The separation of real slubs from mass increases of the regular yarn body is done by means of several tools to define the boundary. Depending on the characteristics of the yarn and the slubs that should be evaluated different kinds of boundary lines can be selected. The icons 1 – 3 from left to right define a minimum area of the slub, i.e. minimum slub length and mass increase. Icon 4 only defines a minimum slub length, whereas icon 5 defines only a minimum mass increase. With the editing tool, the boundary can be moved. Also, the boundary can be deleted again with the rubber icon, if it does not meet the requirements.

In order to define populations, two tools are available that can be selected depending on the requirements. With one tool a rectangular boundary can be drawn around a population, whereas the other tool is capable to draw polygons around populations. There is also an editing tool and an icon which deletes the marked population again. A maximum of 5 populations can be defined. Events outside populations are marked as outliers (brown) and will be counted in the subsample table as such.

If a boundary line and populations overlap, then the boundary line has a higher priority, i.e. the part of the population which is beyond the boundary line will not be considered in the population. It is not possible that populations overlap.
Area 4

<table>
<thead>
<tr>
<th>Icon</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="New" /></td>
<td>New&lt;br&gt;Create a new Fancy Yarn configuration.</td>
</tr>
<tr>
<td><img src="image" alt="Load" /></td>
<td>Load&lt;br&gt;Load an existing Fancy Yarn configuration.</td>
</tr>
<tr>
<td><img src="image" alt="Save" /></td>
<td>Save&lt;br&gt;Save a Fancy Yarn configuration (name and version).</td>
</tr>
<tr>
<td><img src="image" alt="Delete" /></td>
<td>Delete&lt;br&gt;Delete the current Fancy Yarn configuration.</td>
</tr>
<tr>
<td><img src="image" alt="Reassign" /></td>
<td>Reassign&lt;br&gt;Reassign the current configuration to the active sample and recalculate all Fancy Yarn results.</td>
</tr>
</tbody>
</table>

Area 5

In this area, the active configuration is shown. For clear identification there is also a version number and a date.

<table>
<thead>
<tr>
<th>Configuration ID:</th>
<th>53</th>
</tr>
</thead>
<tbody>
<tr>
<td>Version No. and Date:</td>
<td>V1.0; 02.05.2007, 08:31</td>
</tr>
</tbody>
</table>

5.2 Consequences of a Fancy Yarn Configuration

When a configuration for a selected sample ID is changed, saved and applied to the data base, all results (numeric as well as graphical) for this sample will be re-calculated. Events below the boundary will neither be considered for any statistical result (slub length, slub distance, mass increase, etc.), nor for the graphs (histograms, classification matrices, etc.).

Fig. 14 shows the diagram of a slub yarn, which was measured without any configuration. The areas indicated in red were automatically recognized as slubs like the “real” slubs marked in green. After the configuration for this yarn type was defined and applied, the diagram was re-calculated as shown in Fig. 16.
Only the “real” slubs are considered for the calculations of the numeric data and various graphical evaluations, which are described in detail in chapter 7.2.

Fig. 15 and Fig. 17 show the effect of the applied configuration on the scatter plot. Without the configuration (Fig. 15) all events are marked in color and used for the calculation of the statistical data, whereas in Fig. 17 the boundary line separates the slubs from other types of random thick places (red circles in Fig. 14). Events which are not considered for the evaluation of the slub yarn are marked in grey color.

---

**Fig. 14**
Slub yarn diagram without configuration

**Fig. 15**
Slub yarn scatter plot without configuration

**Fig. 16**
Slub yarn diagram with configuration
6 Definition of the classification matrix

In order to customize the classification matrix for the different slub yarn types, the classification matrix can be set individually. This is done in the dialog System Control ➔ Definitions ➔ Definition Classification Matrix for Fancy Yarn. In order to access this dialog, at least the user level Head of laboratory must be selected.

In order to define a classification matrix, only a name must be given (Fig. 18, section 1), the limits of the slub length classes must be entered (section 2) and the limits of the mass increase must be set (section 3). In the preview window on the right side (section 4) the defined matrix appears. At last, a defined matrix can be saved or deleted again (section 5).
It is possible to select a specific, customized matrix in the report editor as the standard matrix of a report.

7 Evaluation of a slub yarn

7.1 Numeric data

The Fancy Yarn Profile offers a wide range of numeric data for the analysis of a slub yarn. Possible numeric values are listed in Table 1. It is also indicated, if the value is for the general evaluation of the yarn or if it is also available for populations.

<table>
<thead>
<tr>
<th>Quality characteristic</th>
<th>General evaluation</th>
<th>Available also for populations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of slubs per m / per km / absolute</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Slub distance [cm] mean</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Slub distance [cm] min</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Slub distance [cm] max</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Slub distance bottom [cm]</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Slub length [cm] mean</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Slub length [cm] min</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Slub length [cm] max</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Slub length bottom [cm]</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Mass increase [%] mean</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Mass increase [%] min</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Mass increase [%] max</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Mass decrease left [number]</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Mass decrease right [number]</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Percentage slub distance [%]</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Percentage slub length [%]</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Count slub [equivalent to the selected count system]</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Count base [equivalent to the selected count system]</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Outliers [number]</td>
<td>X</td>
<td></td>
</tr>
</tbody>
</table>

Table 1 Parameters of the sub-sample table
Fig. 19 shows a subsample table with all Fancy Yarn parameters.

<table>
<thead>
<tr>
<th>Nr</th>
<th>Mass incr. %</th>
<th>Club length</th>
<th>Club distance</th>
<th>No. of Outliers</th>
<th>Mass decr. %</th>
<th>Mass decr.</th>
<th>Count Shear</th>
<th>Count Stubs</th>
<th>Rate T/B</th>
<th>Sub length</th>
<th>Sub distance</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>120.0</td>
<td>71.2</td>
<td>28.8</td>
<td>0.0</td>
<td>37.6</td>
<td>11.6</td>
<td>62.0</td>
<td>28.7</td>
<td>0.59</td>
<td>0.00</td>
<td>2.2</td>
</tr>
<tr>
<td>2</td>
<td>131.6</td>
<td>71.1</td>
<td>28.9</td>
<td>0.0</td>
<td>37.6</td>
<td>11.6</td>
<td>62.0</td>
<td>28.7</td>
<td>0.59</td>
<td>0.00</td>
<td>2.2</td>
</tr>
<tr>
<td>3</td>
<td>188.8</td>
<td>71.7</td>
<td>28.3</td>
<td>0.0</td>
<td>22.5</td>
<td>11.6</td>
<td>62.0</td>
<td>28.7</td>
<td>0.59</td>
<td>0.00</td>
<td>2.2</td>
</tr>
<tr>
<td>4</td>
<td>194.8</td>
<td>70.9</td>
<td>29.1</td>
<td>0.0</td>
<td>22.5</td>
<td>11.6</td>
<td>62.0</td>
<td>28.7</td>
<td>0.59</td>
<td>0.00</td>
<td>2.2</td>
</tr>
<tr>
<td>5</td>
<td>147.0</td>
<td>71.0</td>
<td>29.6</td>
<td>0.0</td>
<td>22.5</td>
<td>11.6</td>
<td>62.0</td>
<td>28.7</td>
<td>0.59</td>
<td>0.00</td>
<td>2.2</td>
</tr>
<tr>
<td>Mean</td>
<td>172.3</td>
<td>71.3</td>
<td>29.7</td>
<td>0.0</td>
<td>22.5</td>
<td>11.6</td>
<td>62.0</td>
<td>28.7</td>
<td>0.59</td>
<td>0.00</td>
<td>2.2</td>
</tr>
<tr>
<td>CV</td>
<td>7.0</td>
<td>7.8</td>
<td>11.2</td>
<td>0.5</td>
<td>22.5</td>
<td>11.6</td>
<td>62.0</td>
<td>28.7</td>
<td>0.59</td>
<td>0.00</td>
<td>2.2</td>
</tr>
<tr>
<td>1.0</td>
<td>12.0</td>
<td>71.3</td>
<td>29.7</td>
<td>0.0</td>
<td>22.5</td>
<td>11.6</td>
<td>62.0</td>
<td>28.7</td>
<td>0.59</td>
<td>0.00</td>
<td>2.2</td>
</tr>
<tr>
<td>G85</td>
<td>15.5</td>
<td>71.3</td>
<td>29.7</td>
<td>0.0</td>
<td>22.5</td>
<td>11.6</td>
<td>62.0</td>
<td>28.7</td>
<td>0.59</td>
<td>0.00</td>
<td>2.2</td>
</tr>
</tbody>
</table>

If populations are defined, the number of columns is automatically selected according to the number of defined populations.

For comparison reasons, the results of the Fancy Yarn Profile are only given in the metric system. The measurement however, can be carried out in yards.

### 7.2 Graphical evaluation

Besides the numeric evaluation of the slub yarn, the Fancy Yarn Profile offers a much wider range of graphics than the basic version of the fancy yarn measurement. In addition to that it offers a separation of the base yarn and the slubs in a graphical way, which gives more possibilities to evaluate the yarn. The set boundaries and populations become visible in the graphs.

#### 7.2.1 Mass diagram

The mass diagram is the basis for all calculations. In this diagram, the measurement of the yarn can be followed over the x-axis. The y-axis gives the mass increase of the yarn. The reference level is set to 0%.
With the zoom function (see Fig. 21), the slubs can be analyzed in detail. When zooming in, the trapezoids of the ideal slubs get visible.

On the x-axis, the detected mass decreases before and after the slubs which exceed -30% are indicated as orange rhombi.

In order to analyze the base yarn without the slubs, it is possible to remove the slubs from the diagram by a double click on the word *Original* on top of the diagram. Afterwards, the diagram of the base yarn only appears (Fig. 22). This gives the opportunity to the user to evaluate the yarn without slubs. This can be of special interest, when additional disturbances are applied to the ring-spinning frame besides the regular slab yarn device. Irregularities, slow changes of the mean value or jumps in the diagram become visible.
7.2.2 3D Histogram

In the 3D Histogram, the user can analyze the distribution and the frequency of the slubs, i.e. in which area most of the slubs occur (Fig. 23). Thus, it combines the information from the scatter plot frequency with the information from the histogram. The main purpose however, is to give the user a graphical impression of the yarn. Often, in two-dimensional graphs, it is not so easy to identify the populations clearly. In order to focus on the main area of the slub events, outliers are not shown in this plot. The third axis describes the frequency of the events.

![3D Histogram](image)

Fig. 23 3D Histogram

7.2.3 Slub scatter plot sequence

Each point in the plot represents a slub defined by the slub length (x-axis) and the mass increase (y-axis). The points beyond the boundary are grayed-out, i.e. they are not taken into consideration for any slub calculation. The colors indicate the sequence, when the slubs occurred: the blue dots were the first 20% of all slubs, turquoise dots were following, then green, then pink and then the last 20% of all dots are indicated in red. By clicking on the different colors in the legend on the right side, the order of the subsamples can be changed.

With this kind of scatter plot, it is possible to see, if all slubs are distributed evenly or if any slub occurred earlier or later in the measurement. This can be of special interest, when a whole bobbin or cone is tested. A slub yarn without a fault in the slub yarn program should have the different colored dots on top of each other as shown in Fig. 24 below.
7.2.4 Slub scatter plot frequency

At the first glance the scatter plot frequency looks similar to the scatter plot sequence. But the purpose of this plot is different. The colors indicate the subsamples. Furthermore, it becomes visible that in the center of populations, the color is lighter than on the outside (Fig. 25). This indicates that the frequency of events in the light areas is higher than in the darker areas. Like for the slub scatter plot sequence, it is possible to change the order of the subsamples by clicking on the colors in the legend on the right side.
7.2.5 Sequence diagram

The purpose of the sequence diagram is to make patterns in the sequence of the slub easily visible.

This diagram shows the exact sequence of the slubs separated in slub distance (blue) and slub length (orange). The x-axis shows the index of each slub, whereas the y-axis shows the length of the slub and the distances between the slubs. Depending on the requirements of the analysis the order of the slub length and slub distance can be altered. In Fig. 26 the yarn is arranged so that the slub length is on the bottom of the graph, whereas the order is altered in Fig. 27 and the slub distance is at the bottom of the graph.

Also, it is possible to zoom into the diagram. By placing the cursor above a line, the slub index, the slub length / slub distance and the position of this slub within the measurement in meter/yard is shown as a tool tip. This makes it easy for the user to find the respective slub in the mass diagram.
7.2.6 Histogram

With the help of the histograms, it is easy to evaluate a single parameter of a slub yarn separately. The distribution and the range of the parameter can be analyzed. Three kinds of histograms are available:

- Histogram for slub length
- Histogram for slub distance
- Histogram for mass increase

This histogram shows that there are two kinds of slubs within this slub yarn. Population 1 shows a slub length in the range of 4 – 8 cm. The second population has a wider range of slub length, which is between 11 and 23 cm. The y-axis represents the frequency of the slubs.
The slub distances in the histogram of Fig. 29 are evenly spread from 7 to 37 cm. The lengths of the bars represent the frequency.

The mass increase of the slubs is between 90% and 250% based on a 0% reference level (Fig. 30). The lengths of the bars represent the frequency.

### 7.2.7 Classification Matrix

The classification of the slubs in a matrix is a tool to quickly check the distribution of the slubs. Uster Technologies provides a standard classification matrix with eight fixed classes for the slub length and 5 classes for the mass increase of the slubs (see Fig. 31). This matrix is particularly useful for quality management.
For a better overview, the classes with higher number of events are marked grey. The higher the number of slubs, the darker the color of the respective fields. In each class, the number of events is given as well as the percentage of events in this class in relation to the total events for the selected test length.

As there are numerous kinds of slub yarns, it is also possible to create own classification matrices based on the individual requirements of the different slub yarns. The maximum number of classes for the slub length as well as for the mass increase is 15, which results in a maximum of 225 classes altogether. Fig. 32 shows an example of a customized classification matrix with 9 length classes and 9 classes for the mass increase.

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**Fig. 31**
Standard classification

**Fig. 32**
Example for a customized classification matrix
7.2.8 Spectrogram

The spectrogram is an ideal tool to check various aspects of a slub yarn:

- Is there a repeat pattern of the slubs?
- Are there any periodic faults in the yarn?
- Are there any nearly-periodic (drafting) faults in the yarn?

With the possibility to separate the base yarn from the slubs, the base yarn can be evaluated separately. Deliberate disturbances or unwanted faults can be detected separately from the slubs.

The Fancy Yarn Profile software offers three kinds of spectrograms to the user:

- Slubs only: only slubs are assigned to the respective frequencies (Fig. 33)
- Slubs removed: only the spectrogram of the base yarn is shown (Fig. 34)
- Spectrogram mass: regular spectrogram of the measured yarn including the base yarn and the slubs (Fig. 35)

The spectrogram for the slubs only (Fig. 33) shows that the slubs of this yarn are distributed evenly. There is a certain repeat length between 15 cm and 1.50 m. Note, that in this kind of spectrogram no limits are applied, like the one used for regular mass spectrograms.
The spectrogram of Fig. 34 shows the spectrogram of the according base yarn without any slubs. It becomes visible that there is a peak at about 8 cm which does not derive from the slubs, but from the spinning process itself.

![Spectrogram Mass](image)

The mass spectrogram of Fig. 35 combines both spectrograms shown before: spectrogram slubs only + spectrogram slubs removed = mass spectrogram. The repeat pattern of the slub length and the slub distances can be found in the range of 15 cm to 1.50 m. The most frequent wavelength is at 40 cm, i.e. the most frequent distance from center to center of the slubs is 40 cm. The repeat pattern at 8 cm becomes also visible in this spectrogram.

### 7.2.9 Long-term report & limits

As for the parameters of regular yarn measurements, it is also possible to create long-term reports for slub yarns. The reports can include all numeric values that can also be found in the regular Fancy Yarn reports. The long-term reports can consist of tables as well as of long-term plots of the parameters. An example is shown in Fig. 36. With this evaluation possibility, a certain article can be observed over a longer period in order to find deviations from the regular production.

The quality management of slub yarns can also be improved by setting limits for the slub parameters. If the set limits are exceeded the respective results in the tables will be marked blue (warning limit) and red (control limit) and the limit line will be drawn in the respective long-term plots (Fig. 36).
8 Definition of slub yarns

8.1 Slub yarn types

In the textile industry there are various definitions for the different slub yarn types. In order to avoid any misunderstandings and mix-ups, the definitions of the different slub yarn types according to Uster Technologies AG are given in the table:

<table>
<thead>
<tr>
<th>Term</th>
<th>T/m</th>
<th>(\alpha_e)</th>
<th>Mass</th>
<th>Slub length</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slub yarn</td>
<td>constant</td>
<td>variable</td>
<td>variable</td>
<td>Any length up to 2 meters</td>
</tr>
<tr>
<td>Slub yarn with twist correction</td>
<td>variable</td>
<td>constant</td>
<td>variable</td>
<td>Any length up to 2 meters</td>
</tr>
<tr>
<td>Multicount</td>
<td>variable</td>
<td>constant</td>
<td>variable</td>
<td>Any length over 2 meters</td>
</tr>
<tr>
<td>Multitwist</td>
<td>variable</td>
<td>variable</td>
<td>constant</td>
<td>any</td>
</tr>
</tbody>
</table>

T/m = twist per meter \(\alpha_e\) = English twist multiplier

Table 2
Definition of different slub yarn types
8.2 Distinctive slubs vs. structured slub yarn

Apart from the definitions given in chapter 8.1 one can also distinguish between slub yarns with distinctive slubs and structured slub yarns. For distinctive slub yarns, the slubs can easily be separated from the base yarn (Fig. 37). Setting boundaries and defining populations is clear and simple.

Structured slub yarns on the other hand have small slubs and require a more complex approach. The setting of boundaries and populations is not as clear as the yarn is very uneven and has no or almost no distinctive slubs. The histogram of the slub length, slub distance and mass increase is rather flat. The user has to decide according to his requirements, if a configuration should be applied and where the limits should be set. The classification matrix might be a good way to evaluate such kind of yarns as clear slubs can often not be recognized.
9 Comparison between Fancy Yarn Profile and basic Fancy Yarn measurement

The Fancy Yarn Profile described in this application report refers to the specific software option. The basic Fancy Yarn measurement which is included in the basic USTER® TESTER 5 software differs in many points from the option. Table 3 below shows the differences.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Basic Fancy Yarn</th>
<th>Fancy Yarn Profile</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic values (slub length, slub distance, mass increase)</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Additional values (slubs/m/km, percentage, count slub/base, slub length bottom, slub distance bottom, mass decrease right/left, ratio T/B, outliers)</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Separation of base yarn and slubs in diagram and spectrogram</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Mass diagram</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>3D Histogram</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Scatter plot</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Classification</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Histogram</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Sequence diagram</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Configuration</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Populations</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Outlier analysis</td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>

Table 3 Comparison between the Fancy Yarn Profile and the Basic Fancy Yarn
10 Application examples

10.1 Comparison with machine settings

It must be pointed out that the measured slubs do not necessarily coincide with the settings at the slub yarn mechanism of the spinning machine. The resulting slub yarn does not only depend on the settings at the spinning machine, but is also influenced by the raw material, the staple length, the twist, the yarn guiding elements, etc.

This indicates that an absolute comparison between the settings at the fancy yarn control box and the real results is not recommended. It is more a trial and error method when the fancy yarn is produced for the first time.

10.2 Detection of missing slubs

In Fig. 39 an example of a slub yarn with missing slubs is shown. For a length of 40 meters no slubs were produced. This can clearly be seen in the mass diagram as well as in the slub sequence diagram.

10.3 Repeat patterns

Another serious fault of slub yarn production is shown in Fig. 40. It is a long slub, which repeats periodically. It becomes visible in the diagram, in the scatter plot as well as in the sequence diagram. The repeating long slub is about 90 cm to 1m long and has a mass increase of 50 – 70% compared to relatively short slubs with a lower mass increase. This fault will cause serious problems in the appearance of a fabric. As these long repeating slubs are only a few, they will not influence the numeric values.
Fig. 40
Repeating slubs in mass diagram, scatter plot and sequence diagram