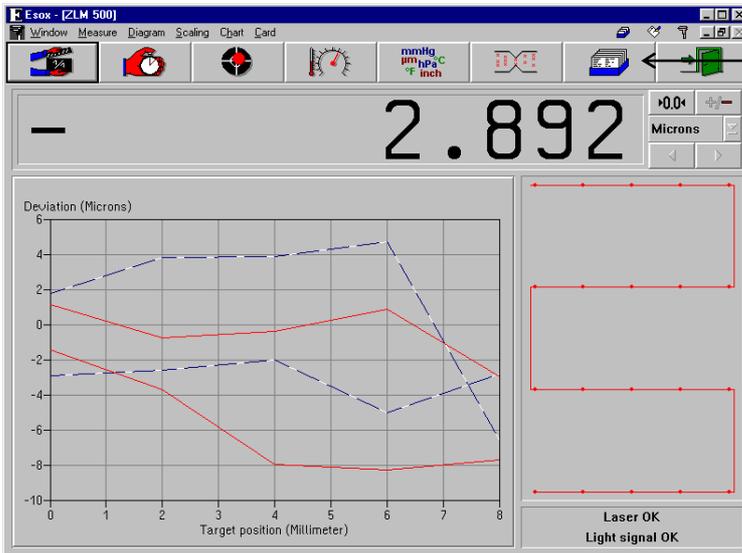


G 2.7 Analysis of previous measurements

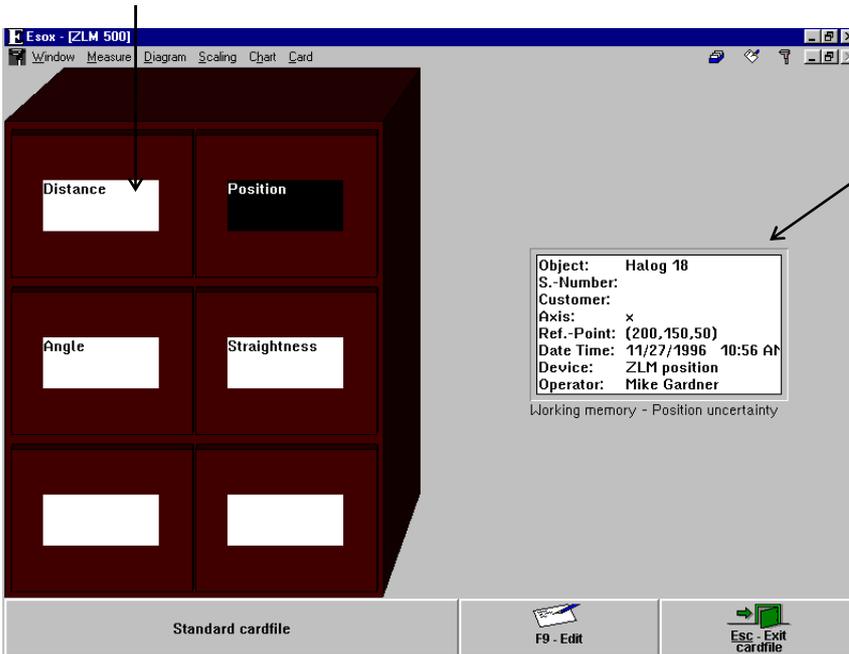
After the measurement a file card is created and the measurement results written on it. These cards are managed by the program module "Cardfile". It lets you load the card with the results of an earlier measurement so that you can analyse them in the ways described in the previous subsection.



To load a card, first click the  button or select the "Card" option of the "Cardfile" menu.

This will change the screen display.

The left half of the window shows a file cabinet with 6 file boxes (drawers).



The right half of the window contains a field with one file card - the one whose data can presently be processed by the program.

If you want to process the data obtained in one of the previous measurements, you need to open the cabinet drawer containing the desired card, select the card from the drawer and move it into the field on the right.

The following subsections briefly describe how card boxes are opened and closed, and how cards are shifted, loaded into the main memory and placed back into the cabinet.

For further details of handling file cards, see section "K - Cardfile / Archiving of measurement Results".

G 2.7.1 Changing the selected (highlighted) card field

One card field or one card box label field is shown highlighted, i.e. white lettering on black background.



With the cursor keys , ,  and  you can move from one card field or card box label to another.

With the  key you can move from the previously highlighted card field on one side of the screen to the card field on the other side of the screen that was highlighted there last.



Click on the card field or card box label you want to highlight. Please note: Clicking on an already highlighted box label will open the respective box.

G 2.7.2 Opening and closing a card box

	Opening	Closing
	If the label of the card box is not highlighted, use  ,  ,  and  to move to this label. Then press  .	If necessary, press  ,  or  to move to the respective side of the screen. Then press  .
	If the label of the card box is not highlighted, click on the label once to highlight it; click on the label again to open the box. If the label of the card box is already highlighted, click on it once to open the box.	Click the  button at the bottom right or left of the window to close the right or left card box.

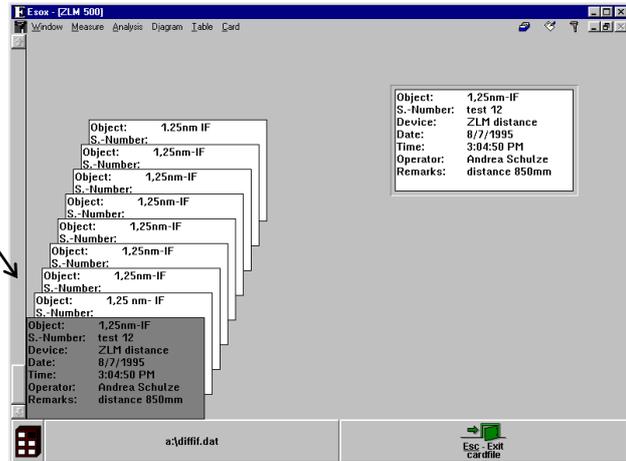
G 2.7.3 Shifting of file cards

The cards in an open card box can be shifted to activate (and highlight) another card. Cards arranged in front of the current card are not displayed.

The vertical scroll bar shows the location of, and the amount of space occupied by, the current card with respect to all cards of the box.



The vertical scroll bar can be used to shift the cards.



Shifting the card with the keyboard requires that the first card on the left is highlighted.

-  The file cards are shifted backward by one position. The card in the order before the card that was current last becomes the new current card.
-  The file cards are shifted forward by one position. The card in the order behind the card that was current last becomes the new current card.
-  The file cards are shifted backward by one screen page. The first card of the previous page becomes the new current card.
-  The file cards are shifted forward by one screen page. The first card of the next page becomes the new current card.

G 2.7.4 Loading and unloading of file cards



The easiest way of loading a card is by using the mouse. Move the mouse pointer on the source card, click and hold the left mouse button down. Now drag the mouse pointer with the file card to the target position, then release the mouse button.

If the main memory already contains a card, the program will automatically put it back to its previous position in the card box.

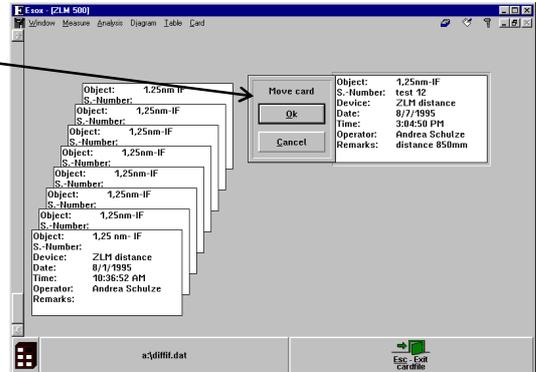
Proceed analogously when putting a loaded card back into its box. Click on the card and drag it to its target position. By dragging the mouse pointer with the card up to the upper or lower margin of the window you can shift the card stack in the box on the left.



Loading a card with the keyboard requires that the card must first be highlighted on the left half of the screen.
Now select the **"Load"** option from the **"Cardfile"** menu.

The screen shows a field with the card to be loaded.

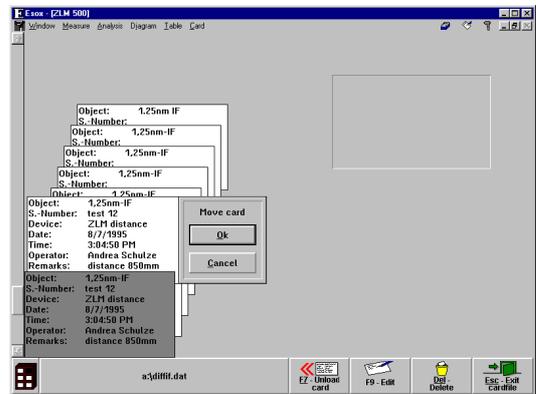
Press the  key.



Putting a card back requires that it must first be highlighted in the main memory field represented on the left half of the screen.
Then select the **"Move"** option from the **"Cardfile"** menu.

The target position can be selected with the direction keys.

Conclude by pressing the  key.



Instead of the menu options "Load" and "Move" of the "Cardfile" menu you can also use the



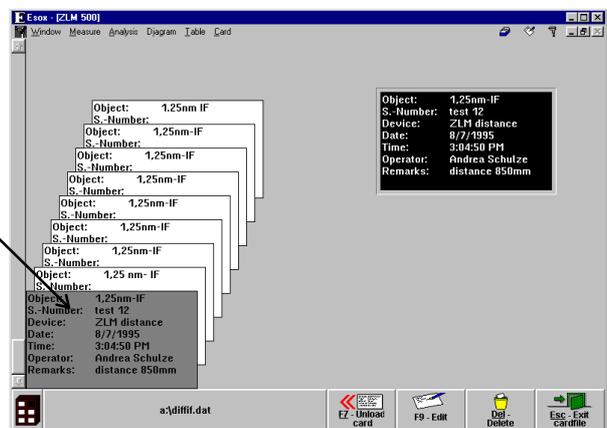
button at the bottom of the screen.

The target position can alternatively be selected with the scroll bar on the left margin.

The keys ,  and  can be used to page up and down for finding remote target positions.
It is thus possible to move a card from a left-side source position to a left-side target position, for the purpose of rearranging the cards.

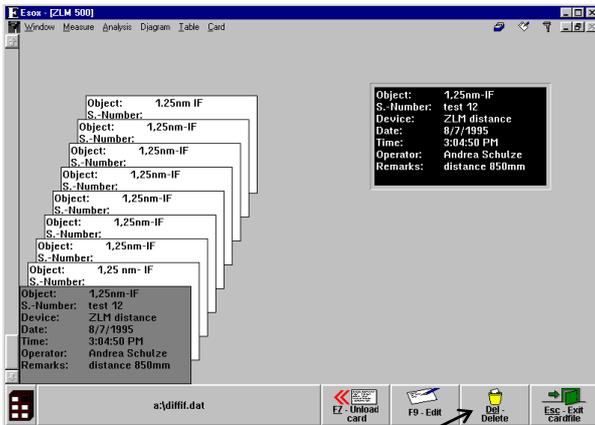
If a card has been loaded into the main memory, it still remains also visible at its source position on the left side, but it is shown here with black lettering on a grey background.

Such a "greyed-out" card cannot be moved from its place.



G 2.7.5 Deleting a file card

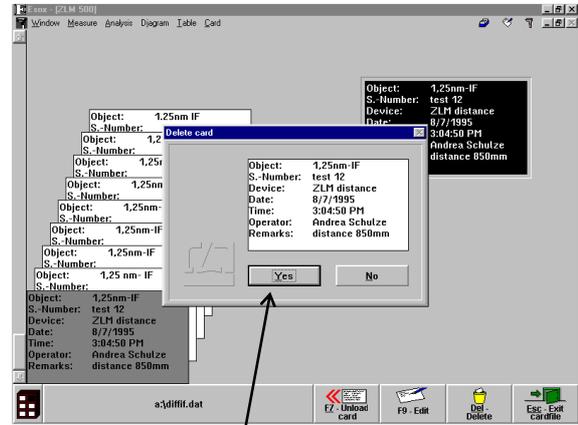
A card you want to delete must first be highlighted.



Select the **"Delete"** option from the **"Cardfile"**



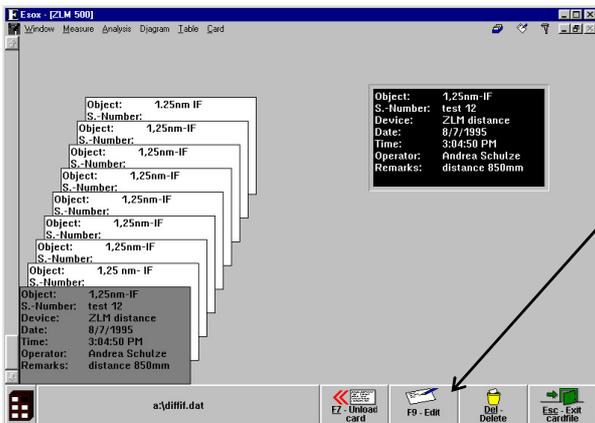
menu or click the **Delete** button. This opens a dialog box.



Click the **Yes** button to delete the highlighted card.

G 2.7.6 Editing of cards and card box labels

First highlight the card or the card box whose inscription you want to edit.



Start the text input mode by selecting the **"Edit"** option from the **"Cardfile"** menu or by clicking the



F9 - Edit button. Annex III contains a list of keys and key combinations that have special functions in the editing of text boxes. In addition you can use the following keys for moving within a card:



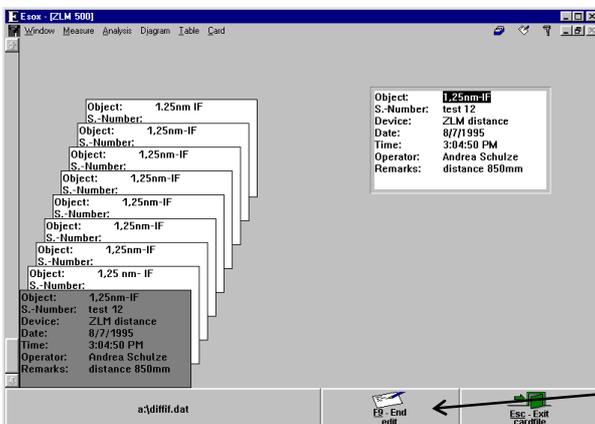
- moves the text cursor to the next card entry in the same line.



- moves the text cursor to the next lower card entry.



- moves the text cursor to the next upper card entry.



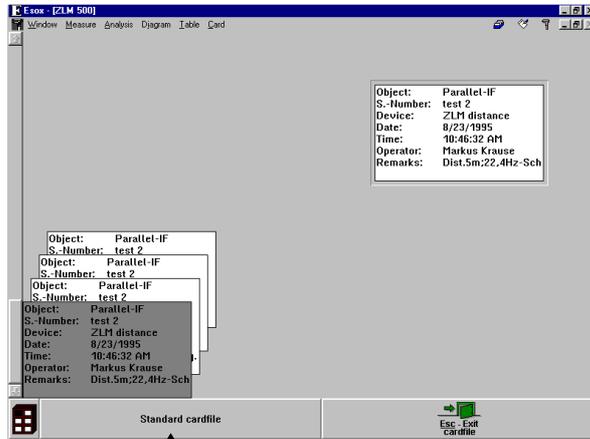
With editing finished, you need to quit the text input mode by selecting **"End edit"** in the **"Cardfile"** menu or clicking the



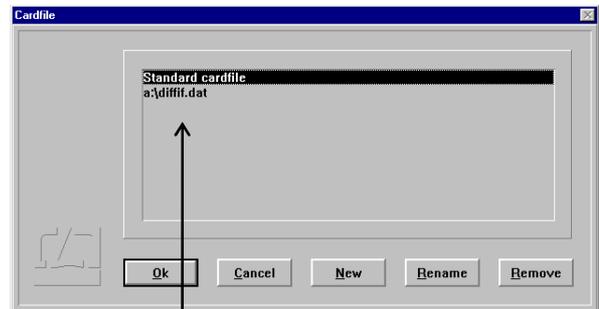
End edit button.

G 2.7.7 Creating, renaming and deleting a card file

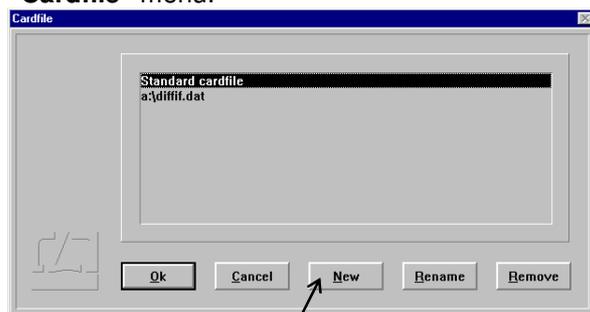
When the program is started first, it creates a card file named "Standard Cardfile" in the system data file "esoxm.dat" located in the installation path. It is possible to create further data files. Each data file comprises a card file cabinet with six card boxes.



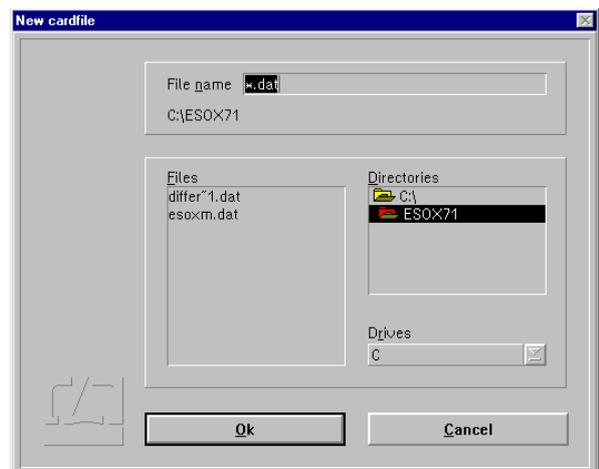
To create a new card file, click on the file name button at the bottom left window margin, or select the menu option "Open cardfile" from the "Cardfile" menu.



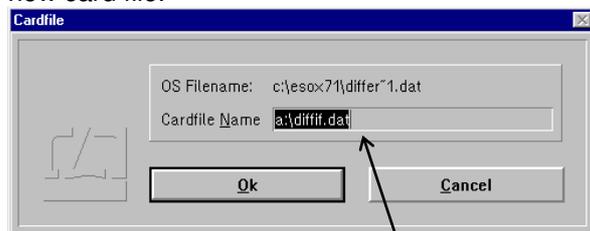
This opens a list showing the names of all existing card files in a dialog box.



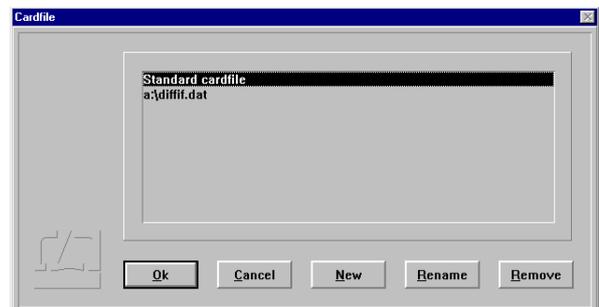
Click the **New** button if you want to create a new card file.



This opens another box in which you must enter the name of the data file.



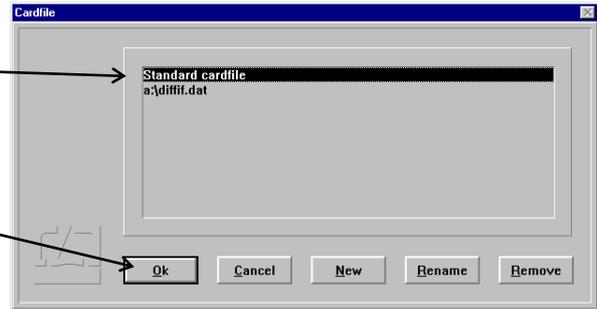
Click the **OK** button to open another dialog box, in which you must enter a card file name, which then appears in the card file list.



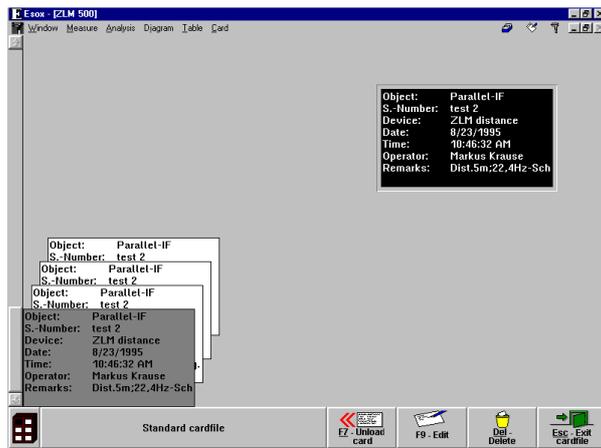
The same dialog box is opened if you use the **Rename** button to rename a card file.

Click the **Remove** button if you want to delete a card file from the card file list. This will not, however, delete the data file from the memory. For deleting the data file, use the file manager.

To select a card file from those created, highlight the file name in the list box and then click the **OK** button.



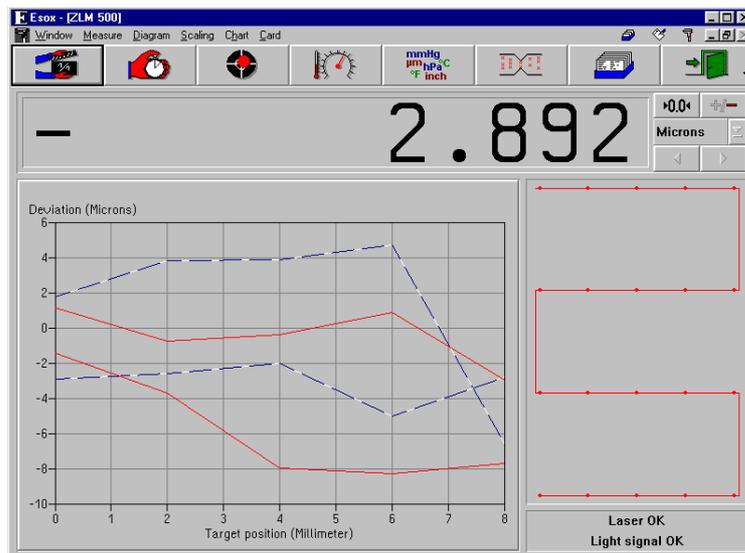
G 2.7.8 Quitting the Cardfile menu



To quit the Cardfile menu, click the button or select the "Exit" option from the "Cardfile" menu.



G 2.8 Exiting the measurement program



To exit the "ZLM-Position" program module, activate the button or choose the "Exit measurement program" option of the "Measure" menu.



G 3 Analysis of position measurements by the template method

Users testing coordinate measuring machines not only require the information gained with the statistical methods described in section G1, but also need to know the machine's length-dependent measuring error. This aspect is allowed for in the "VDI/VDE 2617" standard, which describes a "template method" of analysing a position measurement.

G 3.1 Procedure

With the template method, the program checks, for all measured pairs of position deviations x_i, x_j whether the condition

$$A_p + K_p \cdot |x_i - x_j| \leq B_p$$

applies. A_p , K_p and B_p are positive constants specified by the machine to characterize the accuracy of the measuring machine.

A_p is a basic measuring error to be expected irrespective of the size of the testpiece.

K_p is the length-dependent measuring error, and

B_p is the maximum measuring error occurring with the measuring machine model concerned.

Manufacturers of coordinate measuring machines frequently specify an error in this form:

$$F = \left(1 + \frac{l}{1000}\right) \mu\text{m}, \text{ with } l \text{ in mm.}$$

For converting the manufacturer's specification $F = \left(U + \frac{l}{V}\right) \mu\text{m}$ (with l in mm) into parameters conforming to VDI/VDE 2617, you can use the equations

$$A_p = U \mu\text{m},$$

$$K_p = \frac{1000}{V} \mu\text{m/m} \text{ and}$$

$$B_p = U + \frac{1000}{V} \cdot L \mu\text{m}, \text{ or } B_p = A_p + K_p \cdot L, \text{ with } L \text{ being the maximum length measured.}$$

Examples: (1) $F = \left(1 + \frac{l}{1000}\right) \mu\text{m}$ with l in mm and a maximum measured length $L = 1000$ mm,

yields

$$A_p = 1 \mu\text{m},$$

$$K_p = 1 \mu\text{m/m} \text{ and}$$

$$B_p = 2 \mu\text{m}.$$

(2) $F = \left(5 + \frac{l}{100}\right) \mu\text{m}$ with l in mm and a maximum measured length $L = 600$ mm,

yields

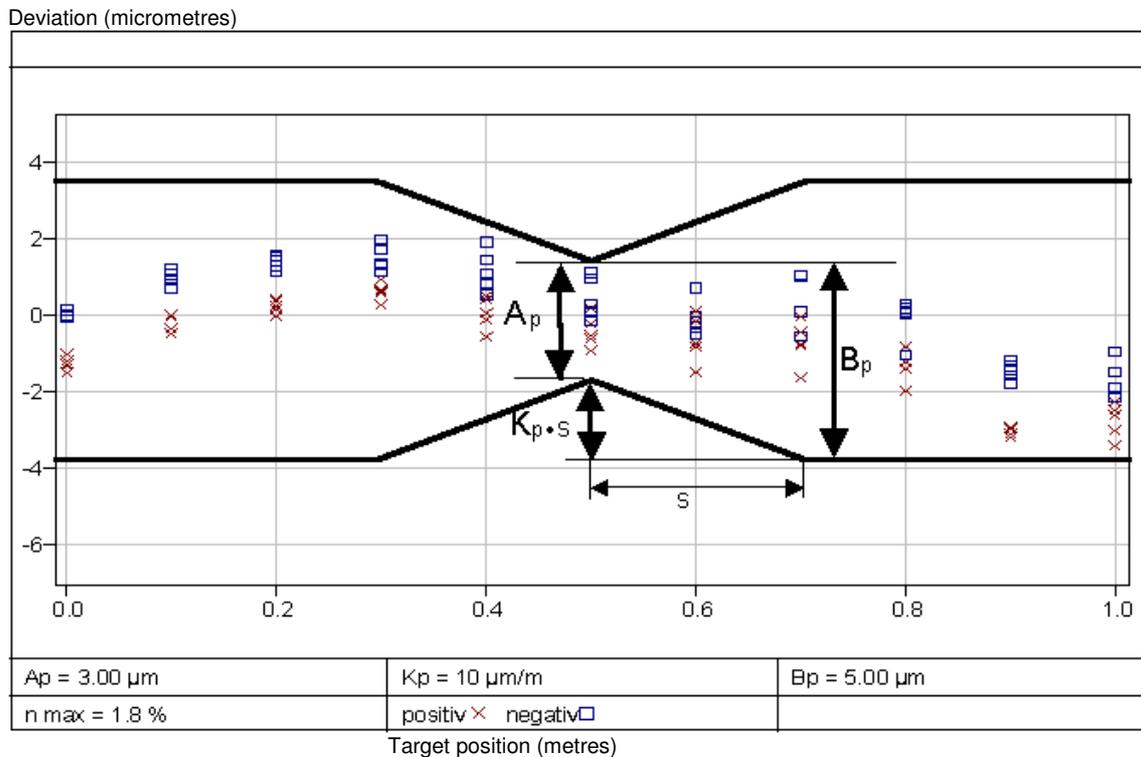
$$A_p = 5 \mu\text{m},$$

$$K_p = 10 \mu\text{m/m} \text{ and}$$

$$B_p = 11 \mu\text{m}.$$

For illustrating the condition $A_p + K_p \cdot |x_i - x_j| \leq B_p$, a template can be made that represents the parameters A_p , K_p and B_p .

Position uncertainty - Template method acc. to VDI/VDE 2617



Shift the neck of the template to the position of reading x_j ; then try to shift the template vertically to find a position in which the readings x_i and x_j lie within the template. If this is possible, the two readings x_i and x_j satisfy the condition $A_p + K_p \cdot |x_i - x_j| \leq B_p$.

1. The manufacturer's specification is satisfied if the inequality $A_p + K_p \cdot |x_i - x_j| \leq B_p$ is true for all position deviations x_i, x_j .
2. If this is not the case, determine all reading numbers "i" for which there is at least one reading number "j" at which $A_p + K_p \cdot |x_i - x_j| \leq B_p$ is not satisfied. If the percentage " n_{max} " of the quantity of the reading numbers "i" thus determined in the total number of readings is not greater than 5%, a repeat measurement can be made.
3. If " n_{max} " is greater than 5 %, the machine does not conform to the manufacturer's specification.

The condition $n_{\text{max}} \leq 5\%$ can also be illustrated with the template. First shift the neck of the template to the first measuring position. Then shift the template vertically until the number of readings lying outside the template is minimum. Mark the readings lying outside the template. Proceed in the same way when shifting the template neck to the other measuring positions. Finally, count the number of marked readings and determine the percentage n_{max} of the counted readings in the total number of readings.

For measurement you can use the Linear, Oscillation ("Pendulum-step") or Quasi-pilgrim step method (see section G 1). Specify at least 11 measuring positions distributed over the whole measuring length. Travel to each position at least five times from both directions.

If a repeat measurement is necessary, measure another 20 cycles. Instead of travelling to all positions it is sufficient now to measure at those positions whose readings were outside the template. At these positions you have then at least 25 readings for either direction.

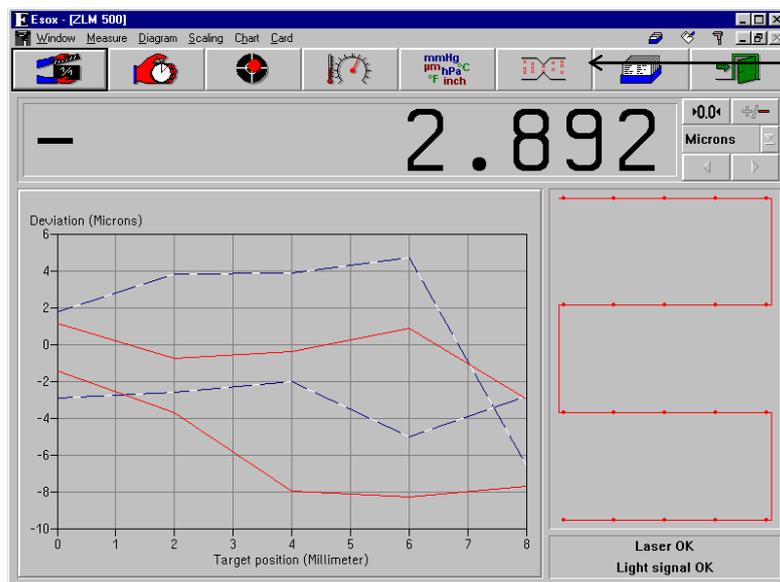
In the period between the first and the repeat measurement, neither the readout of the measuring machine under test nor that of the laser interferometer may be reset, and no interruption of the laser beam may have occurred.

The analysis of the repeat measurement may reveal one of three cases:

1. When determining n_{\max} you find that one reading of a position at which no repeat measurement was made is outside the template area. In this case the machine does not satisfy the manufacturer's specification.
2. If n_{\max} is greater than 5%, the machine does not satisfy the manufacturer's specification.
3. For determining n_{\max} the readings taken at the neck position are scrutinized. The program determines the percentage "ü" of the number of neck readings lying outside the template, in the total number of neck readings. If the maximum \ddot{u}_{\max} of the "ü" readings for all neck positions is greater than 5%, the machine does not satisfy the manufacturer's specification.

VDI/VDE 2617 provides for a table for manual analysis, but the "ZLM Position" software already supplies the n_{\max} and \ddot{u}_{\max} values, as well as the information "Values of first measurement outside" as a measurement result.

G 3.2 Start of analysis

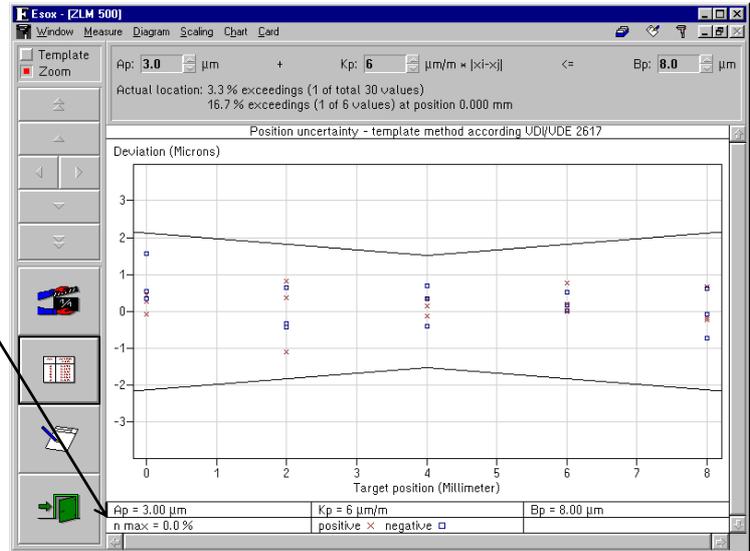


Click the  button or select the "Template" option in the "Diagram" menu to activate the template method of analysis.

G 3.3 Operation of the template method

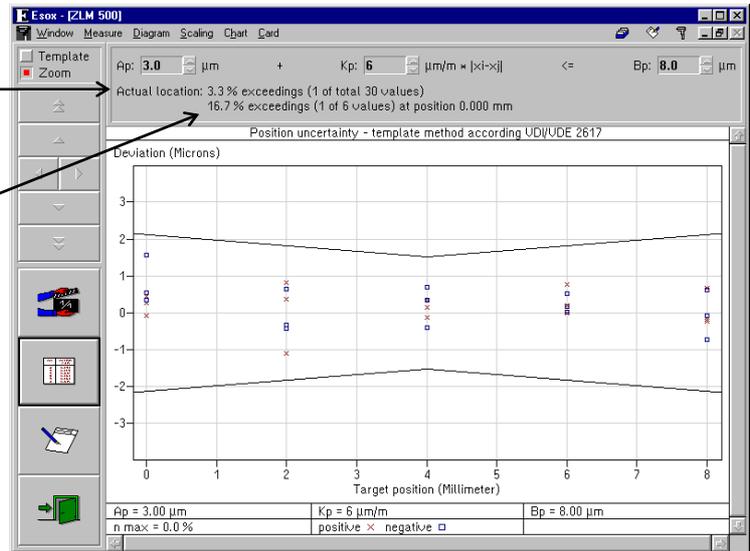
In the text boxes at the top you can enter the parameters A_p , K_p and B_p .

This box at the bottom shows the maximum number n_{max} of outlying readings per neck position. This is the result of the measurement. It is determined by the program from the specified parameters A_p , K_p and B_p , all readings and all neck positions; it is independent of the target currently displayed.



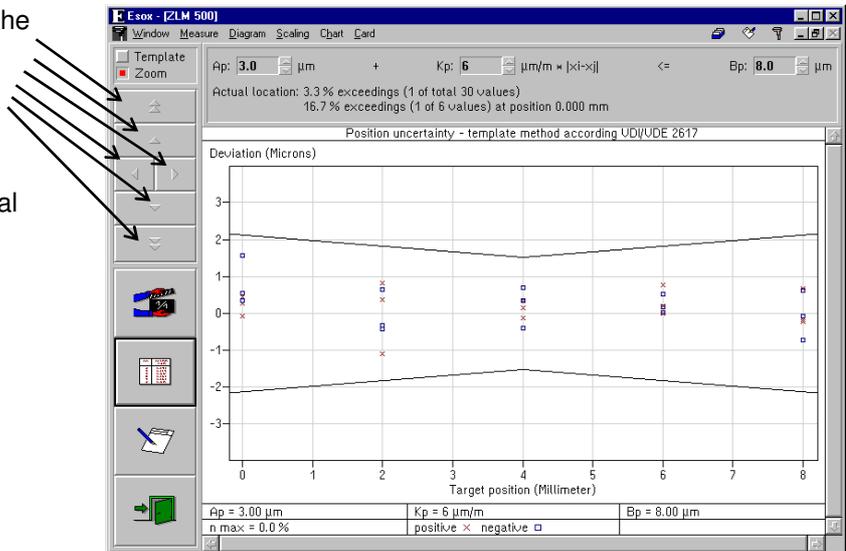
The first line below the parameters indicates how many readings are lying outside the area of the template currently displayed.

The second line is only significant in a repeat measurement. It indicates the position at which the greatest number of readings lie outside the template area, and the percentage of outlying readings at this position relative to all readings taken at this position.



Use the arrow buttons to shift the template.

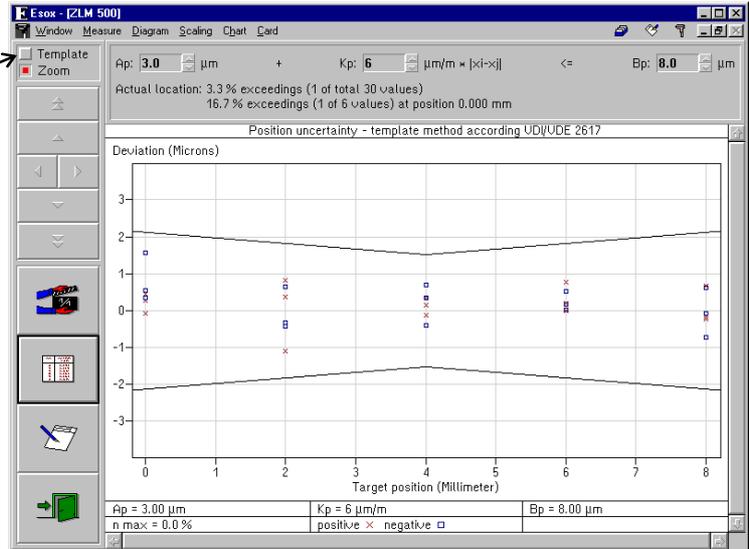
When you shift the template horizontally, the program determines the optimum vertical position for the neck position selected.



You can also shift the template with the mouse.

To enable this option, press the **"Template"** button.

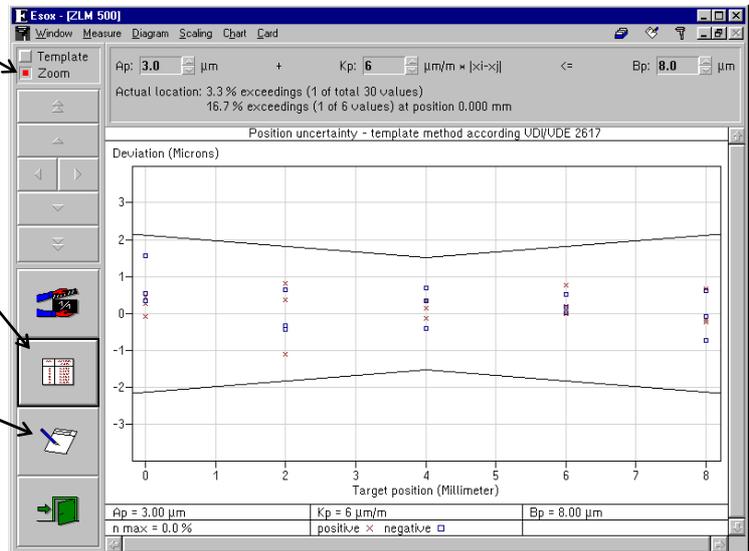
Click on the diagram. Keep the left mouse key depressed and drag the template as required, then release mouse key.



If you click the **"Zoom"** button you can zoom diagram segments same as described in section G 2.6.5.

A click on the  button displays the table of measured data.

Click on the  button if you want to have a record compiled.



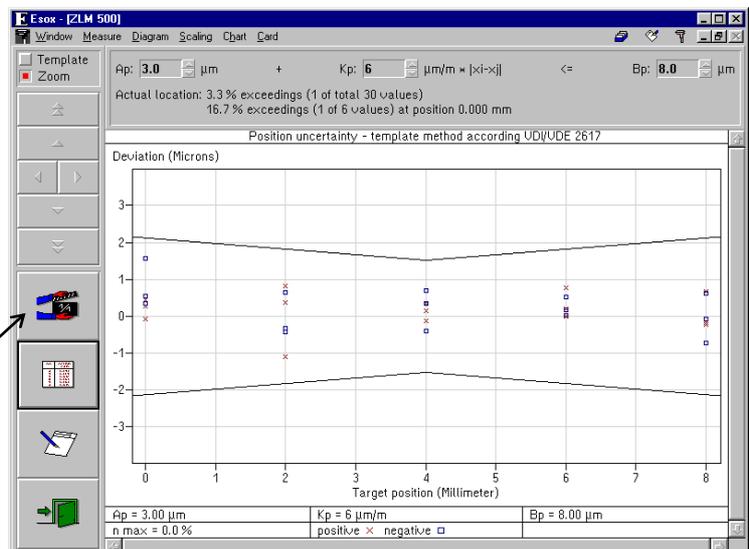
G 3.4 Repeat measurement

If the maximum percentage of outlying readings per neck position (see "n max" at bottom of screen) is zero, the machine satisfies the manufacturer's specification. If it is greater than 5%, the machine does not satisfy the manufacturer's specification. In the third case (n_{max} greater than 0 % and smaller than or equal to 5%), you can make a repeat measurement.

To do this, click the

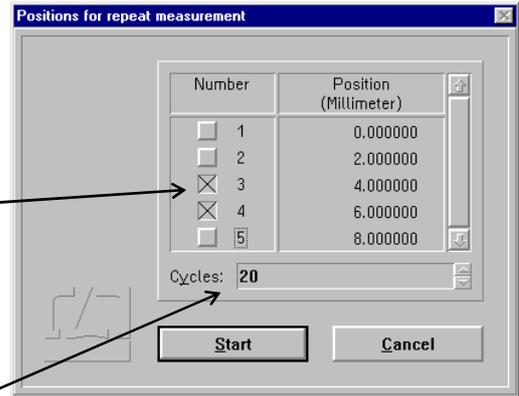


button, or select the **"Repeat measure(ment)"** item in the **"Measure"** menu.



First select the positions at which you want to make a repeat measurement.

In the dialog box **"Positions for repeat measurement"**, the program selects those positions where repeat measurements are absolutely necessary. You may select additional positions or remove positions selected by the program. Mind, however, that after repeat measurement all readings first measured must be within the template area. Therefore, program-selected positions should only be removed if you intend to change the parameters A_p , K_p and B_p after the repeat measurement.



VDI/VDE 2617 recommends 20 runs for the repeat measurement. The total number of cycles for the first and repeat measurements should be 25.

For the repeat measurement, the program uses the same positioning method as for the first measurement, but travels to the selected positions only.

On completion of the repeat measurement, the program saves the data on the same file card as the readings taken in the first measurement.

The repeat measurement data are only available for analysis by the template method. They are not available for the normal position uncertainty analysis, as this assumes the same number of readings for each position measured.

To return to the template analysis method, click the



button or select "Template" in the "Diagram" menu.

In the drop-down list box in the top left corner you can select between presentation and analysis of the first measurement or of the repeat measurement.

In the repeat measurement presentation, the bottom line not only shows "n max" but also the maximum number "ü max" of outlying readings at the measurement positions.

To exit the template display window,

click the

