

## G 2 Operation

### G 2.1 Starting the "ZLM Position" program module

When the "Esox" management program is started, the "ZLM Position" program module is not active yet. To start this program module,

1. activate the "ZLM" application window (as described in detail in Section "C 3 Starting measurement programs") and open it to regular or maximized size.
2. Now, either double-click the "ZLM Position" icon with the mouse or use the keys , , , or , to activate this icon and then press the  key.

### G 2.2 Elements of the "ZLM Position" window

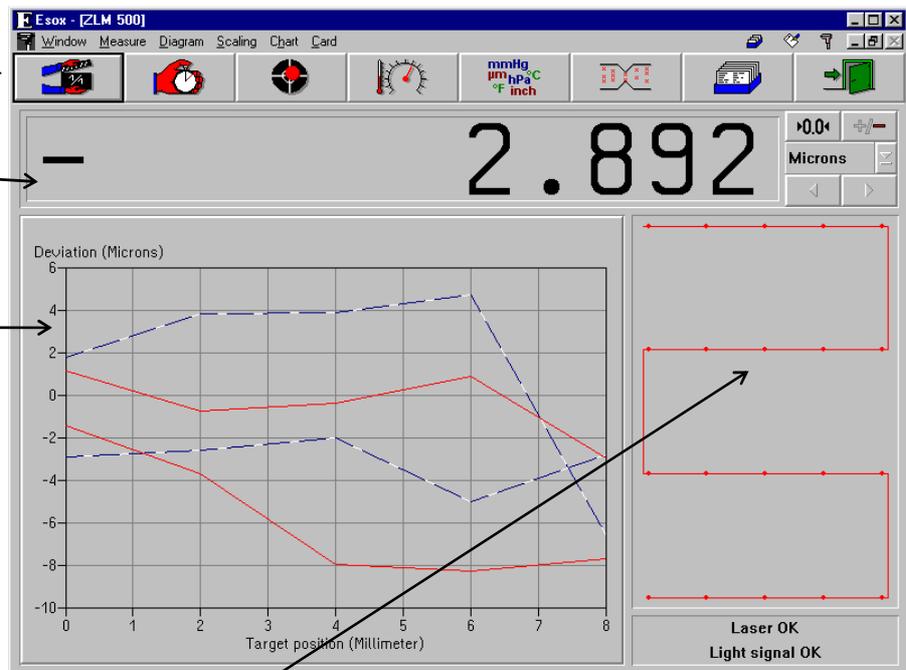
If you want to work with the "ZLM Position" measurement program for a longer time, we recommend to maximize its window after having started it.

Within the window, several fields can be distinguished:

The top margin shows a row of buttons.

Below this there is a large numerical display of the current reading.

The bottom left portion of the window is occupied by a large button showing a diagram generated from the measured data currently in the memory. This field is empty if no data are in the memory.



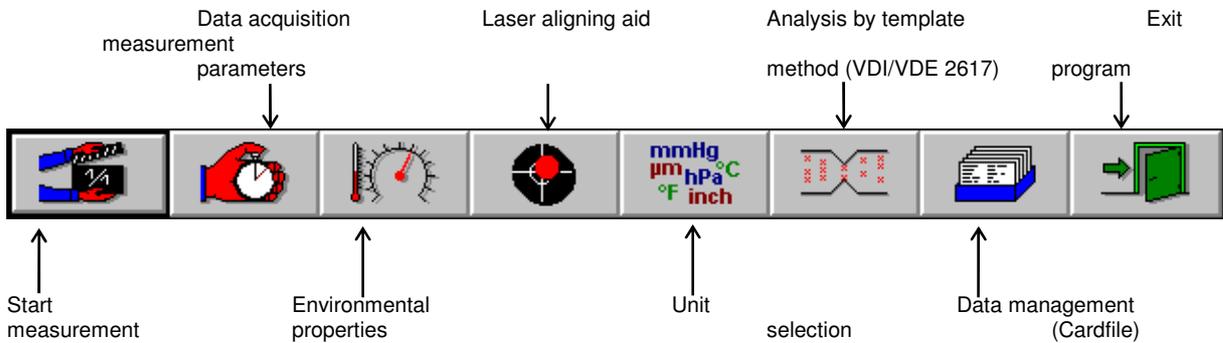
The field to the right of the diagram shows the number of readings currently in the memory and the positioning method by which the readings were obtained. With no data in the memory, this field is empty, too.

The field in the bottom right corner indicates whether the laser operates stably and which light intensity hits the detector.

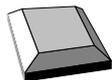
During the measurement and diagram analysis processes the appearance of the window changes, as described in detail in the following subsections.

### G 2.2.1 Button field

With these buttons you can activate specific functions of the program, such as start of data recording, setting options for data recording, and data evaluation by diagrams. All these functions can also be started via menu commands. They are explained in detail in the following subsections.



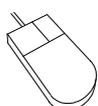
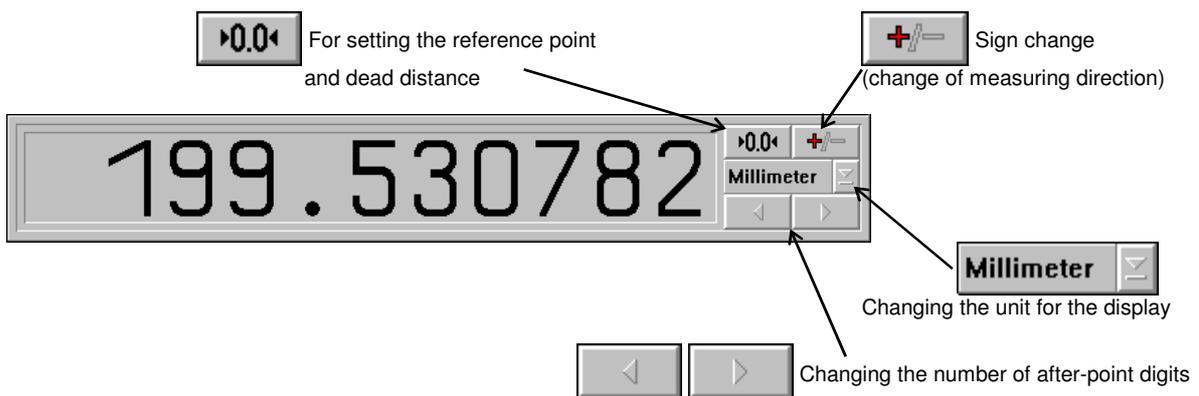
Clicking a button with the mouse activates the function assigned to this button.



On program start, the first (left) button  is made active as is indicated by the thicker black frame around it. By pressing the  key you can make the next button active. The function assigned to the active button is released by pressing the  key.

### G 2.2.2 Numerical display field

The numerical display field shows the current position. The displayed numerical value is updated 10 times per second unless the computer is overloaded by other tasks. Several operating elements are located at the right margin of the numerical display field.



The button functions ( , ,  or  ) are released by clicking the button with the mouse. To change the active option in a drop-down list box, click on the underlined arrow right of the list box. This opens the list box and allows you to click the desired option.



Press the  key until the wanted list box or button is marked and thus active. Active buttons are displayed with a thicker black frame around the button (  ,  ,  or  ). Active list boxes are marked by highlighted entries. To open the pull-down list, press the key combination **Alt** +  . By pressing the  or  keys you can choose the wanted option. To confirm your choice, press the  key.

To release a button function, press the  key.

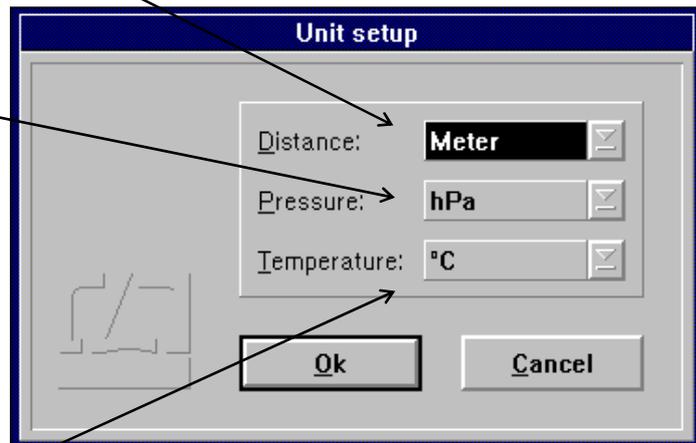
### G 2.3 Unit systems

Units of distance, atmospheric pressure and temperature can be selected in the **"Unit setup"** dialog box.

Open this box by clicking the  button or selecting the **"Units"** option of the **"Measure"** menu.

The program can show distances and quantities derived from them in either metric (metre) or imperial (Inch) measure. Switch between them in the **"Distance"** list box.

In the "Pressure" list box you can select between "Hectopascal" and "Millimetre mercury".  
(1000 hPa = 100 kPa = 1000 mbar,  
and  
1 mmHg = 1 torr)



In the "Temperature" list box you can select between "Degree Celsius" and "Degree Fahrenheit".

## G 2.4 Preparation for a measurement

In preparation for a measurement you need to specify

- the positioning method to be used,
- the number of readings to be taken at each position,
- the type of event by which a reading is to be triggered, and
- the required mode of compensation for environmental influences.

For this purpose, use the "Parameters" and "Environment" dialog boxes.

### G 2.4.1 Parameter setting for measurement data acquisition

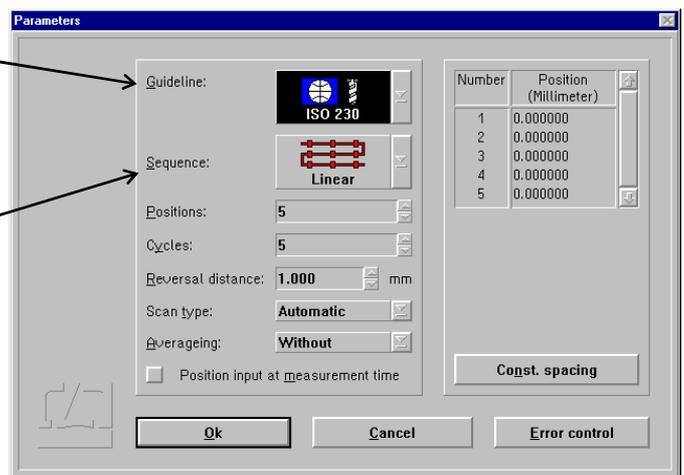
Access the "Parameters" dialog box by opening the "Measure" menu and choosing the "Configuration"

option or by clicking the  button.

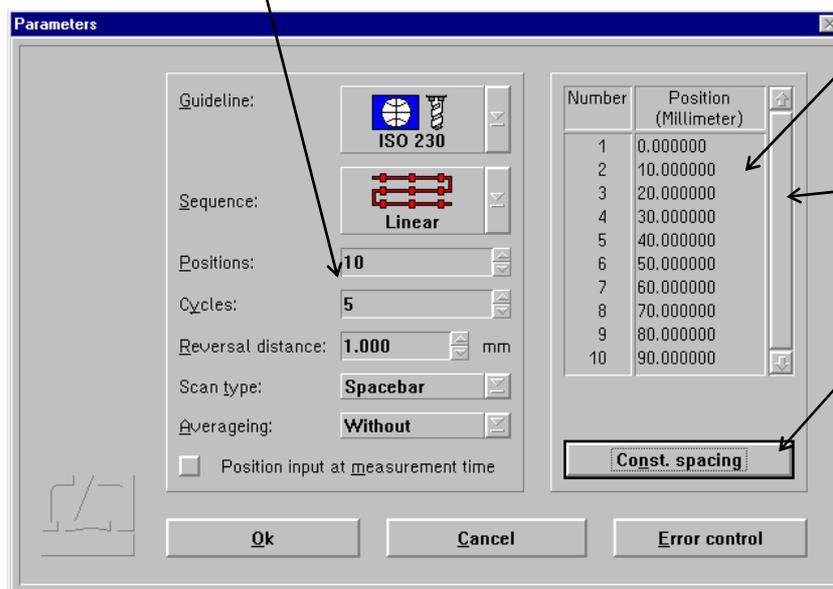
In the drop-down list box "**Guideline**" you can select between VDI/DGQ 3443, VDI/VDE 2617, ISO 230 and NMTBA. You may change to another standard later when you analyse the measurements.

In the "**Method**" list box you can select between the four positioning methods:

- Linear
- Unidirectional linear
- Pendulum-step (Oscillation) and
- Quasi-pilger step (Quasi-pilgrim)



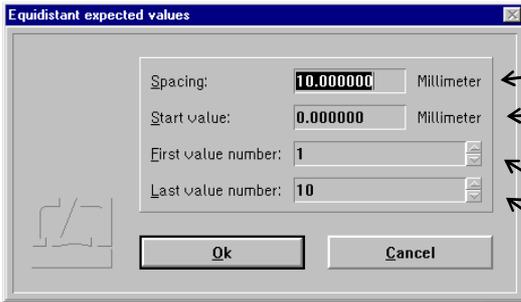
In the "**Number of positions**" text box you can enter the number of nominal positions to be measured.



In the right column of this dialog box you can enter the individual nominal positions.

Use the vertical scroll bar on the right margin to access positions not visible in the list.

If you want to have the nominal positions equally spaced, use the "**Constant spacing**" button for fast setting.



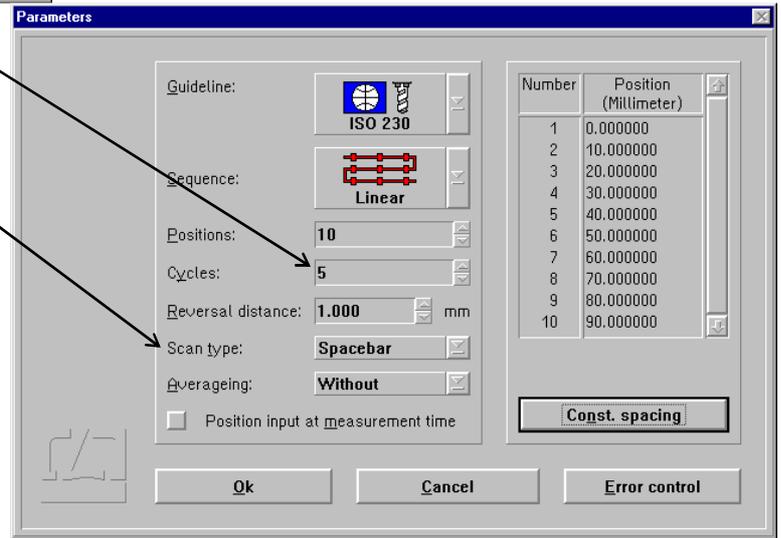
Clicking the "Constant spacing" button opens a dialog box headed "**Equidistant expected values**", in which you can enter the constant interval and the start position.

If you want a certain range of positions rather than all positions to be constantly spaced, you can specify this range in the boxes headed "**First value number**" and "**Last value number**".

In the "**Cycles**" text box you can enter the number of times each position is to be travelled to from one direction.

In the "**Scan type**" list box you can select the event which is to trigger data acquisition.

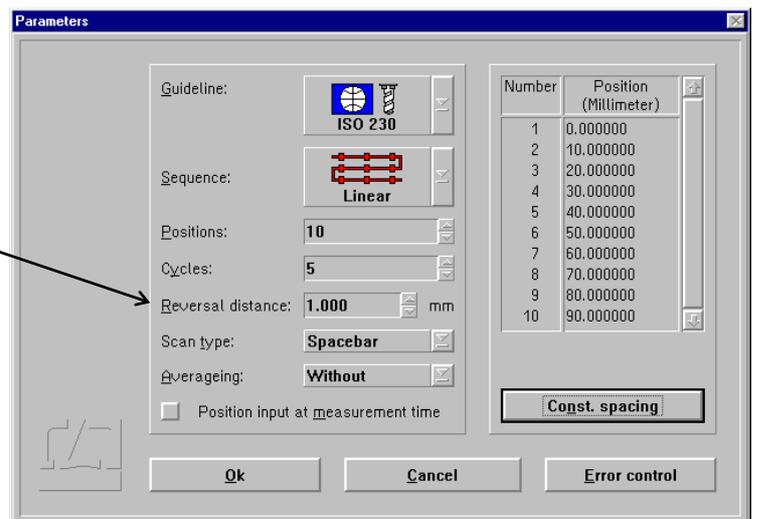
If you select the "**Space bar**" entry, a reading will be taken when you press the **Space bar** of your computer keyboard after starting the measurement.



If you select the "**External**" entry, you can trigger data acquisition with a hand-held pushbutton or by a TTL signal. See Annex I for a description of where to connect the respective signal line.

The most convenient way of data acquisition is to have the program recognize when the object under test is at standstill and automatically take a reading at just this moment. This way the measurement can be completely automated, provided that the object tested has a control system that allows the execution of a control program for the selected positioning sequence. If you want to use this automatic mode, select the "**Automatic**" entry.

A problem involved in automatic data acquisition is the recognition of standstill at such positions in the programmed sequence that are travelled to immediately before the tested object reverses the direction of its movement. Therefore, you can tell the program in the "**Reversal distance**" text box what is the minimum travel of the tested object between the last nominal position and the reversing point.



When using automatic data acquisition, you are confronted with one of two cases:

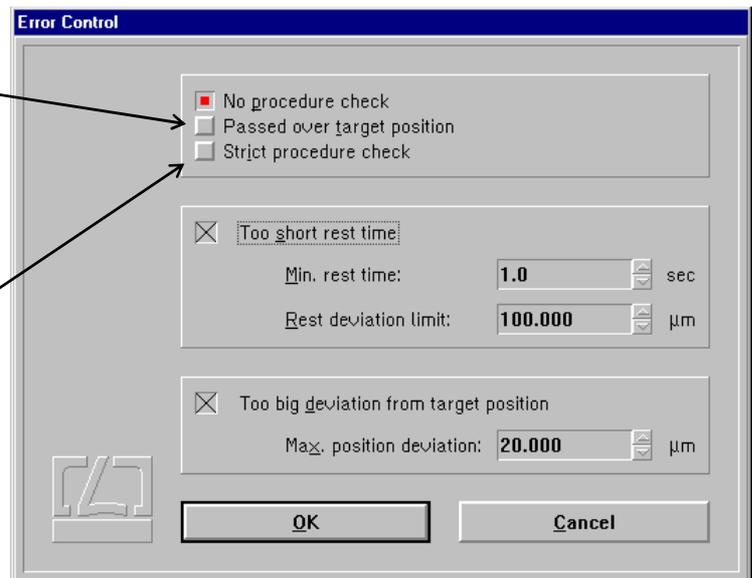
1. You want to make a successful measurement with the least possible number of positions.
2. You want to be informed about any problem cropping up during the measurement as early as possible by means of an error message.

Therefore you can select which errors the program is to recognize and display.

Clicking the **"Error control"** button in the bottom right corner of the "Parameters" dialog box opens the "Error control" dialog box. When you start the program for the first time, all error messages are switched off, and during a measurement the program will try to find the measuring positions under any circumstances.

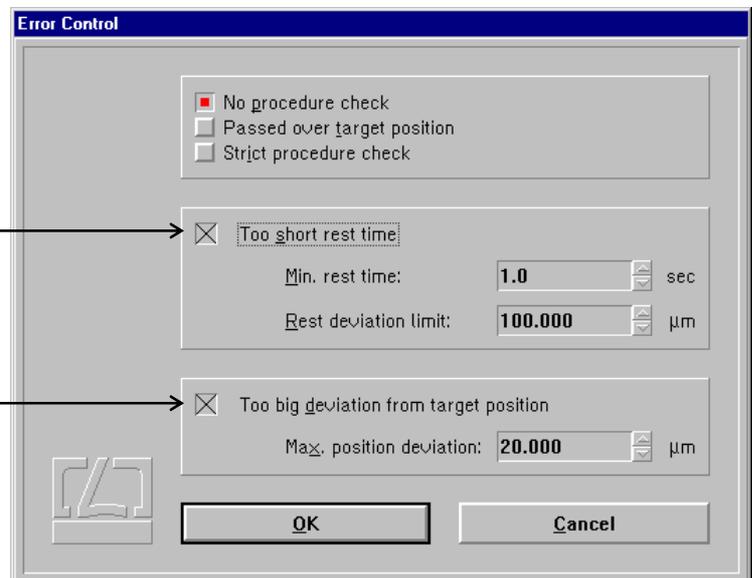
If you select **"Passed over target position"**, an error message will appear if a position has been reached prematurely, i.e. before its scheduled place in the positioning method selected. This error is an indication that probably the correct target position has not been recognized.

If you select **"Strict procedure check"**, the program additionally checks whether the tested object travels in the correct direction according to the positioning method chosen, and whether it performs the correct return loops.



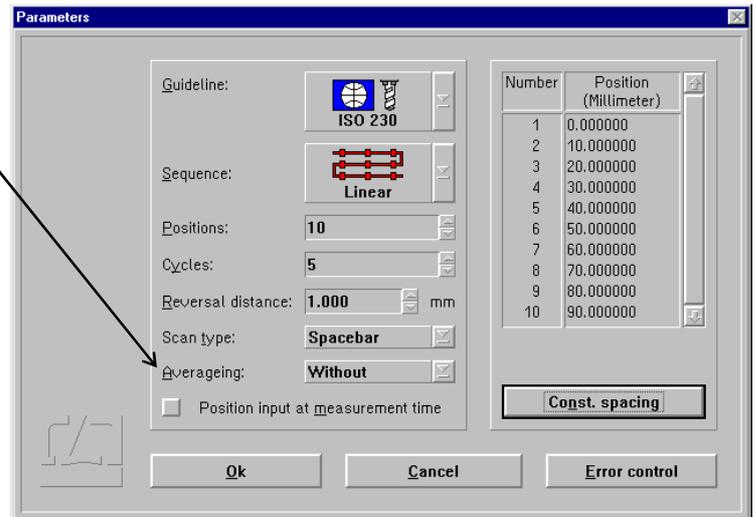
If you want to make sure that readings are only taken if the tested object moves not farther than a certain distance over a given time, you can activate the **"Rest time too short"** switch and enter the maximum permissible standstill error and the minimum permissible dwell time.

If you expect the tested object to satisfy a certain accuracy, you can enter a maximum deviation of the readings from the nominal positions and have an error message displayed if the maximum is exceeded.



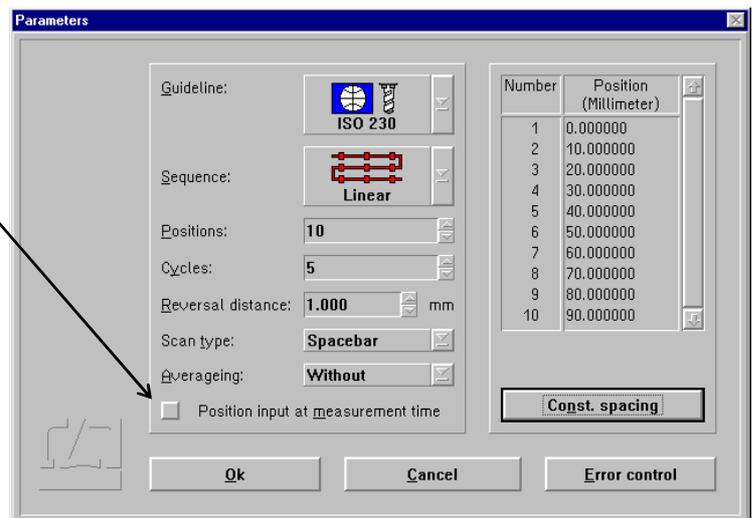
The program can filter out vibrations during a measurement by time averaging. The time over which an average is to be obtained can be set in the **"Short term averaging"** list box.

In a measurement with automatic data acquisition, the optimum entry is 0.1s, because during standstill the program takes a reading every 0.1s and then forms the average of these readings. Longer times for averaging might create problems in standstill recognition.



With the "Space bar" and "External" data acquisition triggering modes, select a time that is somewhat shorter than the standstill period to be expected of the tested object.

With some objects it is not possible without unreasonable effort to travel to a nominal position so that the object itself indicates this position (e.g., certain one-coordinate length measuring machines). If you activate the button **"Position input at measurement time"**, a text box will appear during the measurement immediately after each reading, in which you can enter the value indicated by the object as the nominal position.



## G 2.4.2 Compensation of environmental influences

The accuracy of a distance measurement made with a laser interferometer depends on whether the refractive index of the ambient air is known and allowed for. The ZLM Distance program can compute the refractive index from properties of the atmospheric environment and correct the measurements accordingly.

The ZLM Distance software can further allow for the thermal expansion of the test object as a function of its temperature, and correct the measured data so that they represent the readings that would have been obtained with the test object having a temperature of 20 °C.

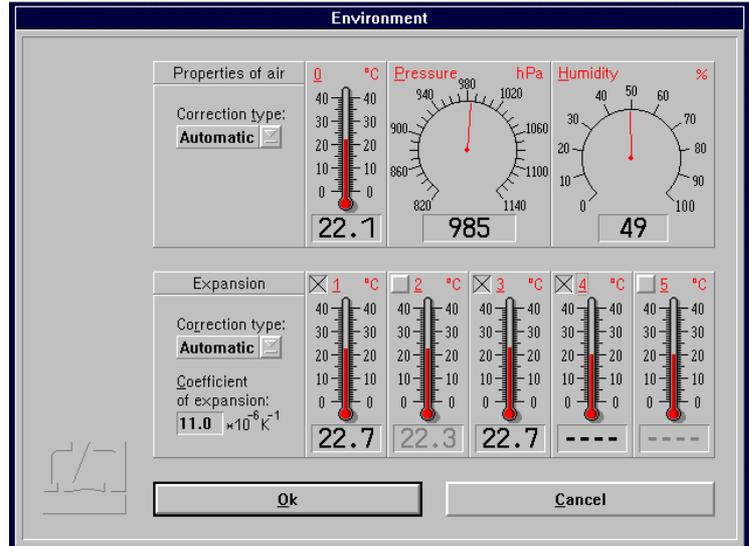
The necessary settings can be made in the "**Environment**" dialog box.

This is accessible by opening the "**Measure**" menu and choosing the "**Environment**" option, or by clicking the



button.

All the settings made in this box have an effect both on the taking of readings as well as on the numerical display and the real-time diagram.



### G 2.4.2.1 Atmospheric properties

In the top part of the "Environment" dialog box you can choose how to compensate for the effects of atmospheric properties on the refractive index and thus on the measured result.

#### Manual Correction

Choose the "**Manual**" option of the pull-down list box "**Correction type**". You will have to enter the atmospheric properties in the respective text boxes.



Keys that facilitate inputs:

Coarse setting - and

Fine setting - and



1. Move the mouse pointer to the field where you want to make an entry.
2. Press the left mouse button and keep it depressed.
3. Drag the mouse until the thermometer column or the pointer indicates the desired value.
4. Release the mouse button.

Consult Annex III for information about the accuracy required for the measurement and entry of atmospheric properties.

#### Automatic Correction

When you use the AUK 500 Automatic Environment Detector to measure the atmospheric properties, choose the option "**Automatic**" of the pull-down list box "**Correction type**".

### G 2.4.2.2 Material temperature

In the bottom part of the "Environment" dialog box you can choose whether and how the measured values are to be corrected for thermal expansion (material temperature). With correction activated, the readings are converted into readings that would be obtained at a material temperature of 20 °C.

**Without correction** If you want to work without this correction, choose the option "**None**" of the pull-down list box "**Correction type**".

**Manual correction** If you want to enter the material temperature manually, choose the option "**Manual**" of the pull-down list box "**Correction type**".

In the text box "**Coefficient of expansion**" type in the linear expansion coefficient of the test object.

The material temperature can be entered in the same way as the manual entry of atmospheric temperature (see Section "G 2.4.2.1 Atmospheric properties").

**Automatic correction** If you want to use the AUK 500 Automatic Environment Detector for compensating the errors due to material expansion, choose the option "**Automatic**" of the pull-down list box "**Correction type**".

In the temperature display boxes, temperature sensors that are not connected are indicated by "---". In the figure, material temperature sensors 4 and 5 are not connected.

You have the possibility to select from the available sensors those you want to use for the correction. For this purpose, every temperature display field has a button at the top left.

Button is not checked:

The respective material temperature sensor is excluded from correction and - on colour screens - the temperature value is displayed in grey instead of in black colour. In the figure, material temperature sensors 2 and 5 are not included in the correction of material expansion.

Button is checked:

The sensor reading enters the correction if the sensor is connected.

With automatic correction activated, the program reads the data of the material temperature sensors once per second. The program computes the mean value of all the measured values of the sensors that are connected and activated via the respective button of the display field. This value is used by the program to correct the data for material expansion.

If none of the sensors is connected and activated, the measured values are not corrected. In the example shown in the figure, the mean value of the temperatures detected by sensors 1 and 3 is used for the correction. Sensors 4 and 5 are not connected. Sensor 2 is deactivated.

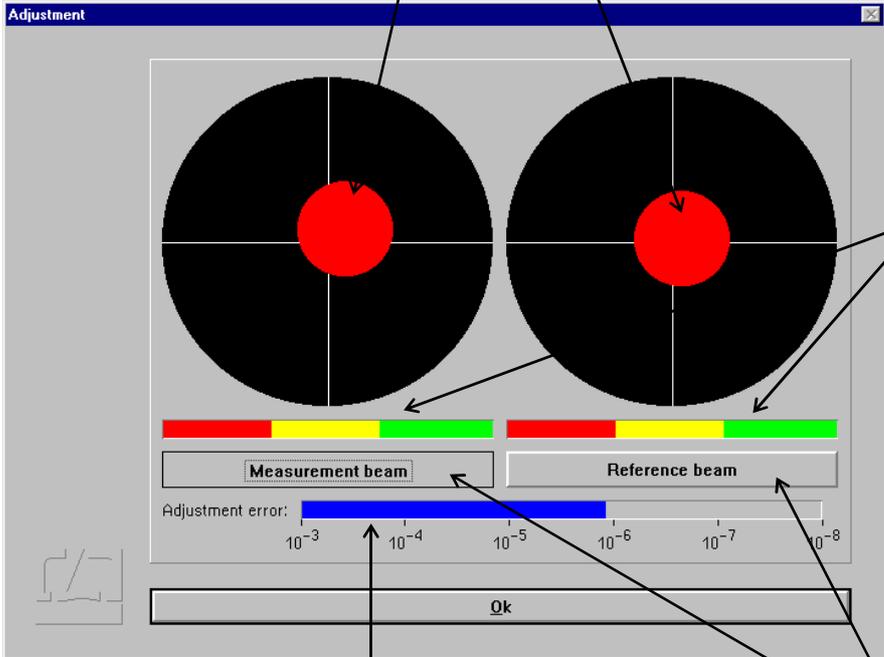
## G 2.5 Measurement

### G 2.5.1 Laser aligning aid

The laser head of the ZLM 500 contains two quadrant detectors. This feature allows alignments to be made and aligning errors to be estimated even over great distances.

Click the  button to open the "Alignment" window.

The upper two fields in this window indicate the positions of the re-entering measurement and reference beams. In a standard setup, the left-hand figure represents the measurement beam, and the right-hand one the reference beam. When aligning the laser, try to keep the two red spots at the centres of the crosshairs throughout the distance travelled. See the Basic Equipment manual for the aligning elements to be used for aligning the laser head.



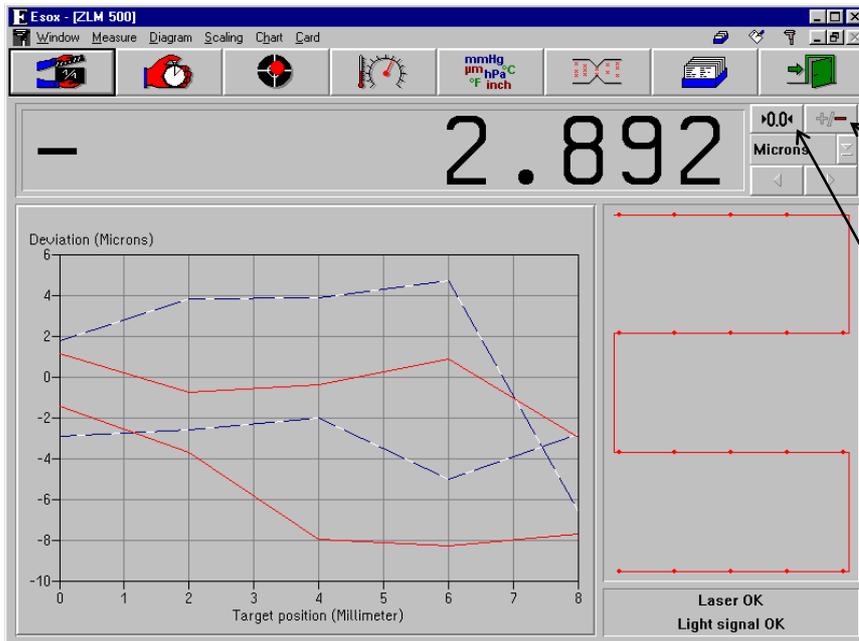
Whenever the beam passes an optical element, a slight portion of the light energy will get lost. The two intensity display bars indicate whether the light intensities of the measurement and reference beams are sufficient for the system to operate without errors. If one of the bars extends into the red range only, the respective beam is too weak.

When the measuring reflector is moved, the program can compute the alignment error from the change in position of the returning beam portions and the distance travelled. An alignment error of  $1 \cdot 10^{-6}$  means that misalignment between the laser beam and the travelling path causes a measurement error of  $1 \mu\text{m}$  per  $1 \text{ m}$  of distance. This alignment error is allowed for and displayed at every reversal of the travelling direction. In order to obtain highly reliable information on alignment, move the measuring reflector back and forth several times without keeping it at prolonged standstills between the strokes.

The ZLM 500 Laser Interferometer operates at two different wavelengths. In precise measurements ( $< 1.4 \mu\text{m/m}$ ), you need to tell the program which beam is used as the measurement beam. To do so, simply intercept the measurement beam with your hand, so that one of the two red spots disappears from the screen. Click on the button on the respective side so that it reads "Measurement beam". With a standard optical arrangement, the measurement beam is invariably shown on the left side.

### G 2.5.2 Synchronizing the displays

Before you can start a measurement, make sure that the numerical displays of the laser interferometer and the tested object are in synchronism.



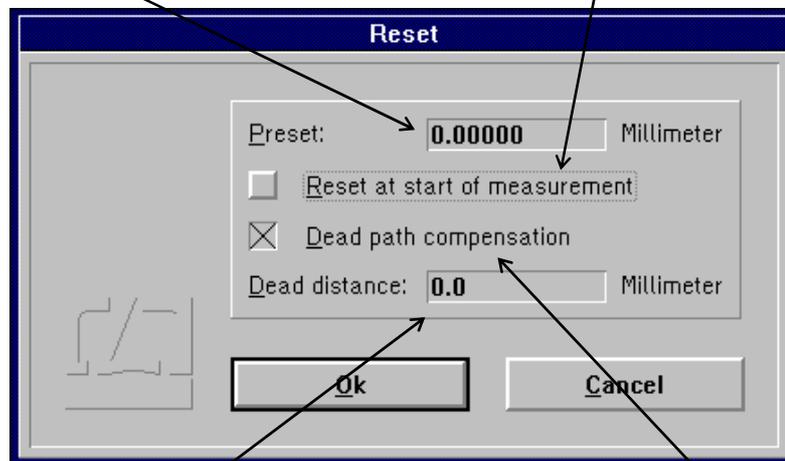
First check whether object travel in positive direction increases the readout of the laser interferometer. If necessary, change the sign of the interferometer display.

Then move the object to the first nominal position.

Click on the  button or select "Reset" in the "Measure" menu to open the "Reset" dialog box.

In the "Preset" text box enter the current readout displayed on the tested object.

If the button "Reset at start of measurement" is on , the preset value will be displayed by the interferometer immediately before the measurement starts.



In the "Dead distance" box you can enter the distance between the reflectors. See Annex III for a detailed explanation of the term "dead distance".

The dead distance is of significance only in high-accuracy measurements with the environmental properties changing during the measurement. If you specify a dead distance, mind the correct sign. Specify the dead distance so that, after resetting, the sum of measurement readout and dead distance has always the same amount as the distance between the two reflectors.

If it can be assumed that the environmental conditions will not change during a measurement, the "Dead path compensation" button can be switched off ()

The reference point is only assigned when the  button is activated.

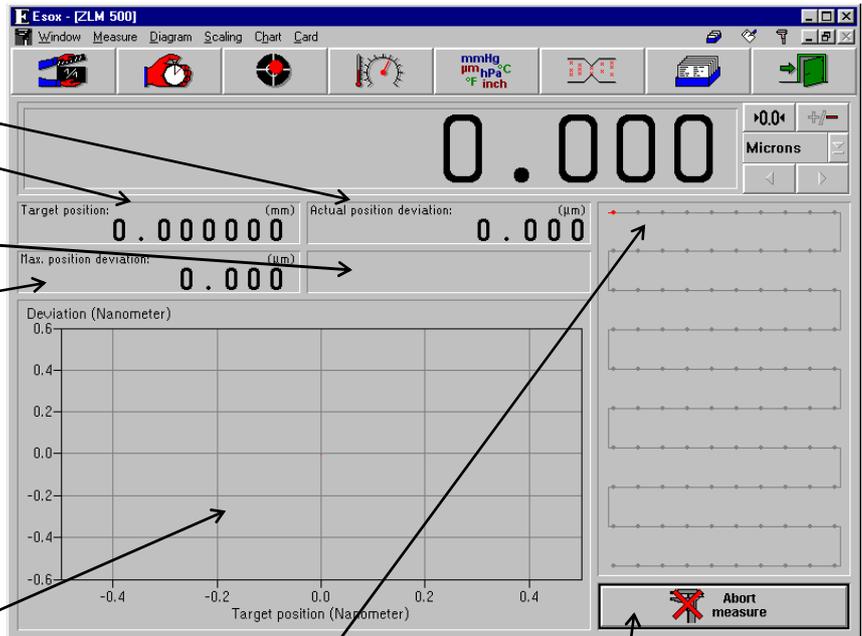
### G 2.5.3 Starting the measurement

You can start a measurement by opening the "Measure" menu and choosing the "Start measure" option or by clicking the  button.

The screen now presents additional displays for

- Current position deviation,
- Next target position,
- Minimum dwell time for the readings taken so far (in automatic measurement only),
- Maximum position deviation for the readings taken so far.

Minimum dwell time and maximum position deviation tell you whether any problems were encountered during measurement.

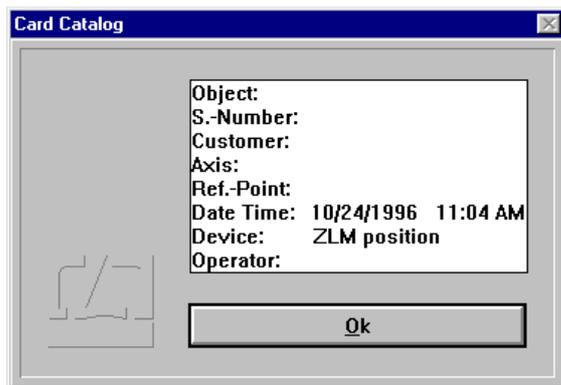


The diagram shows the position deviations so far recorded.

The positions already measured are shown in red.

Click this button if you want to abort the measurement.

After a successful measurement, the measured values are saved on a card of the card file. For this purpose, a dialog box "Card Catalog" is displayed, containing already entries for the measuring instrument used and the date and time of the start of the measurement. You can type in the remaining items via the keyboard.



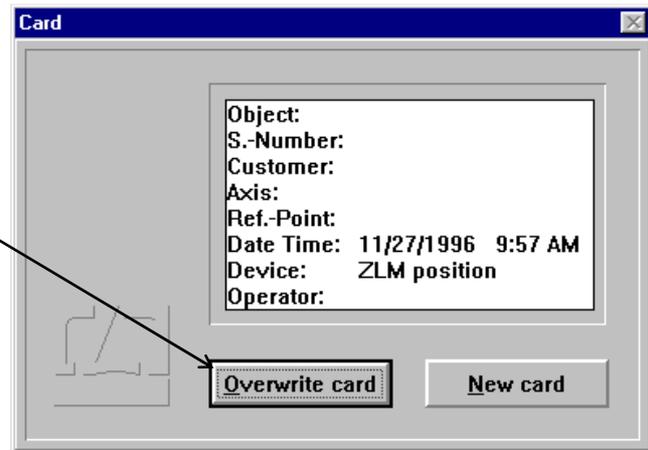
Annex II contains the list of special function keys and key combinations for typing in text boxes.

Additionally, the following keys can be used:

-  - moves the text cursor to the next entry of the file card in the same line.
-  - moves the text cursor down to the next entry of the file card.
-  - moves the text cursor up to the previous entry of the file card.

On clicking the  button, the file card is created. Filing of file cards is handled by the "Cardfile" program module (see Section K).

If a card already exists, the program provides the possibility to overwrite this card with new measured values.



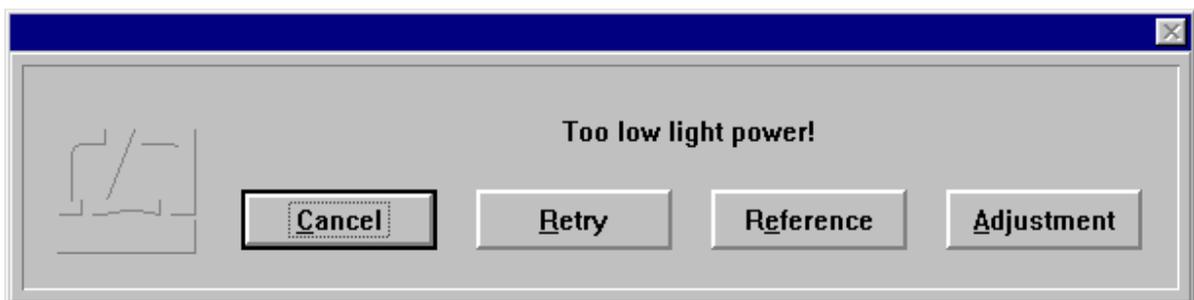
#### G 2.5.4 Errors occurring during a measurement

By clicking the  button you can abort a measurement. If by that time a sufficient number of readings have been taken to make an analysis meaningful, you have the option to save the readings already taken.

In the following cases the program stops the measurement before all readings have been taken:

- The laser is unstable or becomes unstable while the measurement is running.
- The light power at the receiver is too low or becomes too low while the measurement is running.
- An error occurred during the measurement and you have selected the option of having it reported by a message (see section G 2.4.1 - Parameter setting for measurement data acquisition).

If the program stops the measurement, a dialog box is displayed, which describes the error that occurred.

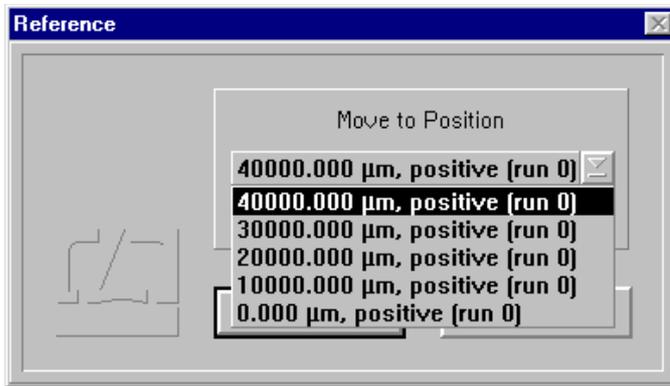


You can either abort the measurement or ignore the error.

In case of measurements that take a long time it seems reasonable to continue a measurement even if a serious error occurs. It may happen, e.g. that the laser beam is interrupted just before the last reading in a many hours' measurement job is to be taken.

In such a case, click the **Adjustment** button to make sure that the laser is still properly aligned. Then click the **Retry** button to continue.

In case of a beam interruption it is to be assumed that the display of the laser interferometer is no longer correct. It is therefore necessary to re-reference the displayed value to the readings taken so far.



To do this, click the **Reference** button and select a position that has already been measured. Travel to this position in the same manner as when you first measured this position, confirm with click the **Ok** -button.

Then click the **Retry** button to continue the measurement.

The program then compares the "old" reading with the "new" one and corrects the display accordingly.