WYLER AG
Im Hölderli
CH-8405 WINTERTHUR
Switzerland

Tel. 0041 (0) 52 233 66 66
Fax. 0041 (0) 52 233 20 53

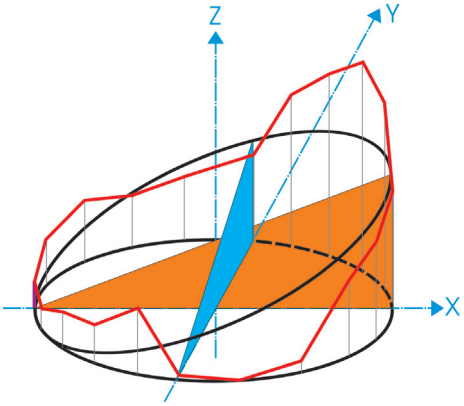
Homepage: http://www.wylerag.com
E-Mail: wyler@wylerag.com

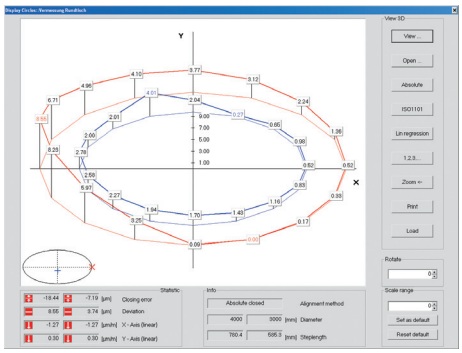
MANUAL

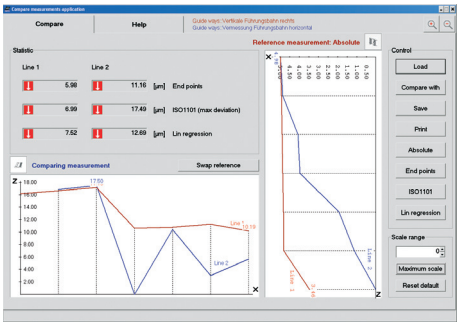
SOFTWARE FOR THE DEFINITION OF MACHINE TOOL GEOMETRY

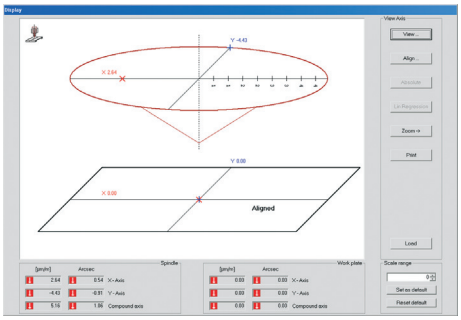
MT-SOFT
(MACHINE TOOLS INSPECTION SOFTWARE)

with WyBus-Technology









CONTENT

Änderungen / Modifications:

Datum / Date	Geändert durch Modified by	Beschreibung der Änderung Description of modifications
14.7.2005	HEH / MO	1. Version
19.12.2005	HEH / MO	New: Exporting measurement data / Export file
14.2.2006	HEH / MO	Pt. 5.3. Rotation of machine elements and Pt. 5.4 Surfaces new Various adjustments
12.5.2006	HEH / MO	Adaptation Version 1.3.010
20.1.2009	HEH / TRA	New with WyBus-Technology

INDEX

1. INTRODUCTION

Thank you for choosing the WYLER-Measuring software MT-Soft (Machine Tool Inspection Software)

For additional Information concerning not only the software but also the corresponding instrumentation we kindly ask you to look up our homepage: www.wylerag.com. There you will always find the latest news and software updates.

It is our constant aim to serve you with the latest technologies on inclination measurement. We appreciate your comments to the software MT Soft and to our highly specialised hardware. Your information is of great importance to us, so we ask for your feedback via our website or through our distribution partner in your country.

Thank you for your support.

Sincerely

The management of WYLER AG

1.1 PREFACE

For a highly skilled, specialized mechanic with a long time experience it was quite clear how and where he was supposed to measure a machine tool in order to take the necessary corrective action, mostly by mechanical adjustment and by scraping. The objects machined today are getting more and more complex and the quality requirements are increasing constantly. This situation has called for larger, more powerful and more complex machine tools with the respective requirements for higher accuracy. The geometry checking of a machine as a fundamental pre-condition for a high quality machine tool brings the testing staff and the classically used instrumentation to their limitation.

A number of methods are presently available for the determination of the total system error of a machine. It is however very demanding to find the existing source of the possible errors in order to make the necessary corrections.

The major goal for developing the software MT-Soft was exactly to fill this gap and to supply the engineer with a tool with which he can take the necessary measurements and actions not only in the early stage of the manufacturing process of a new machine tool but also during the final assembly and in the maintenance and repair phase.

The newly developed software MT-Soft allows to measure independently various geometrical elements of a machine with standard inclination measuring instruments. The individual measuring results can be saved and consolidated in space on demand for the conclusion of the total error of the machine. A simple example of the great variety of the possibilities of the software is e.g. the measurement of the vertical spindle in relation to a horizontal guide way of a machine tool. The logical layout and the clear structure of the software allow daring to go to more complex and demanding measuring tasks.

1.2 INSTALLATION OF THE SOFTWARE MT-SOFT

1.2.1 BASIC INFORMATION CONCERNING THE SETUP

To legally use the software MT-SOFT it is required to activate the software after installation with a Validation code. Basically two options are possible.

a. Using a fully licensed software MT-SOFT for test purposes / without license
You have the opportunity to test this software extensively as a **fully licensed version during a period of 14 days**. During or after expiry of this testing period you have the possibility to buy a full user license. After purchasing the license you will obtain a validation code which you can enter as described here after. This will enable you to change the timely limited test license into a fully licensed version without uninstalling the programme.

b. Using a fully licensed software MT-SOFT for unlimited use / with license
In this case it is necessary to purchase an official software license through your local WYLER distribution partner **within 14 days**. After installation you will receive from WYLER SWITZERLAND a validation code to use the software.

The following options of the license modules inclusive license for the data base are available:

I. Complete license consisting of the modules
- i. Measurements of guide ways
- ii. Measurement of surfaces
- iii. Measurement of circles and circular areas
- iv. Measurement of rotating axis
- v. Measurement of rotation of machine tool elements
- vi. Comparison of measured elements
- vii. LEVELSOFT PRO

or

II. Basic license consisting of the modules
- i. Measurements of guide ways
- ii. Measurement of rotating axis

Additional modules may be purchased individually.

FOR FURTHER DETAILS REGARDING
I. INSTALLATION / BASIC INSTALLATION
II. TRANSFER THE SOFTWARE MT-SOFT FROM ONE COMPUTER TO ANOTHER
III. EXTENSIONS / UPGRADE
IV. UPDATE / INSTALLATION OF A NEW VERSION
SEE SEPARATE MANUAL "INSTALLATION_MT_SOFT_EN.PDF"

In case of difficulties please contact WYLER SWITZERLAND

WYLER AG, CH 8405 WINTERTHUR
TEL +41 52 233 66 66
FAX +41 52 233 20 53
E-MAIL wyler@wylerag.com

1.2.2 REGISTRATION

You will also find enclosed the "**REGISTRATION CARD"**. Please fill it in and return it by fax.

With the returning of the card you will have the following benefits:

- You will receive first hand information about our new developments and activities
- You will receive latest information about software updates
- You will help us and our partners to improve the support about our products and services

We thank you for your cooperation

1.2.3 SOFTWARE LICENSE AGREEMENT

The following is our standard licence agreement. The licence issued with each product will have the product name (e.g. MT-SOFT, LEVELSOFT, LEVELSOFT PRO or DYNAM) substituted by the words "the program" where they appear below.

1 WYLER AG licences you to use the program (including the installation program) provided that you comply with the following:

1.1 You (or your duly authorised employees) will be the only person to use the program. Employees authorised by you are permitted to use the program for your purposes only.

1.2 You only copy the program onto the hard disk of your computer. That where the software is installed on any multi-user or networked computer system, you will purchase a separate licence for each computer that will access to the program.

1.3 That at any one time the program (or any part of it) does not exist in the memory (ROM or RAM, or any other type of memory) of more than one computer.

1.4 That you do not alter, modify, reverse engineer, reverse assemble or reverse compile the program or the Install program.

1.5 That you do not assign, sell or otherwise transfer the program to another person or allow another person to use it.

1.6 That you use the program in accordance with the instructions provided

2 Subject to the existing laws, by the giving of the licence WYLER AG IS NOT:

2.1 Giving you any title to or ownership in the program

2.2 Accepting any responsibility for any damage caused by, or as a consequence of the operation of the program.

3 WYLER AG makes the program available in good faith and believes that it functions as described in the documentation. While we intend to continue developing the program, and would like to know of any problems that you experience with it, we are not undertaking in this licence to fix those problems. We reserve the right, in our absolute discretion, to fix any problems.

4 Should the distribution media supplied prove to be faulty then we will replace it provided it is returned within thirty days of us sending it to you.

5 This licence is and will be governed and interpreted according to the law of SWITZERLAND.

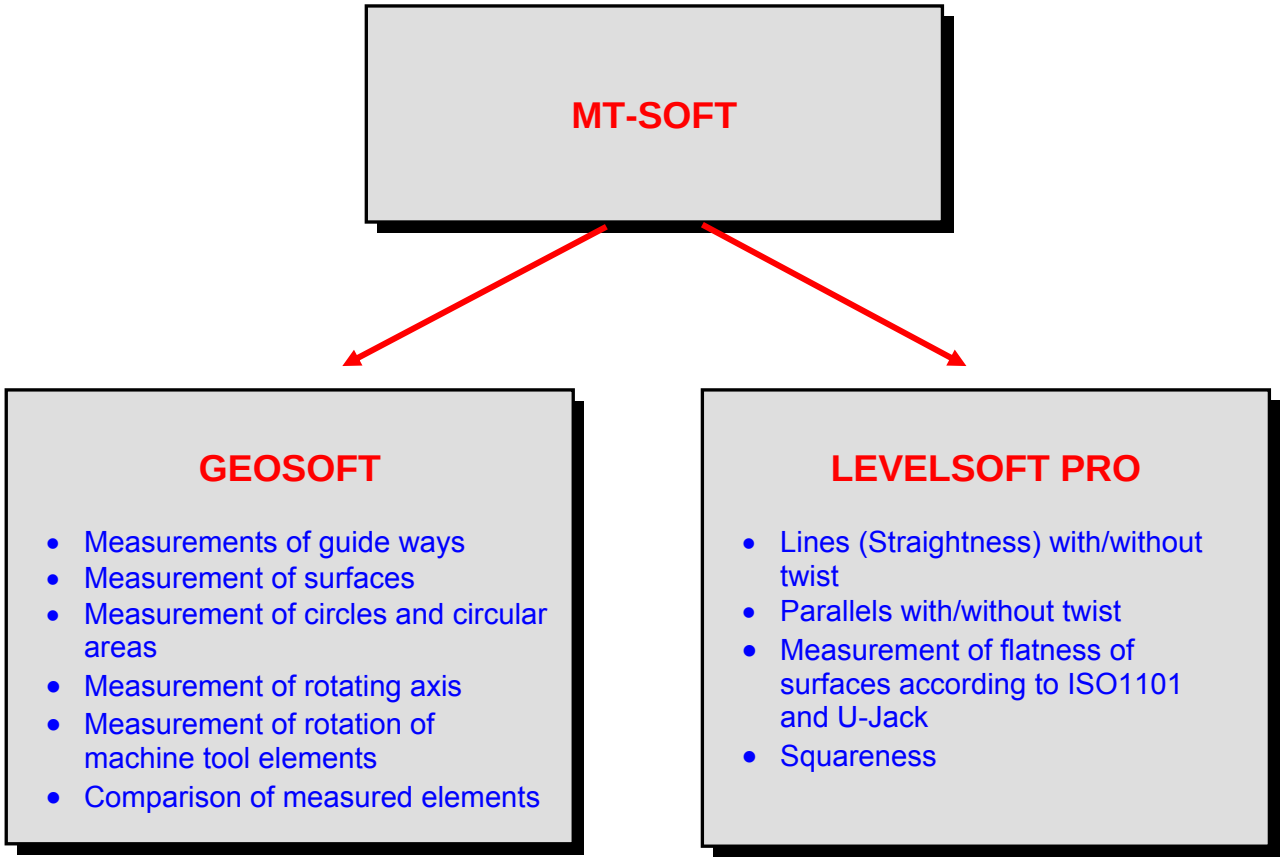
IT IS A BREACH OF THE COPYRIGHT ACT TO COPY THE PROGRAM WITHOUT OUR PERMISSION. THE ACT PROVIDES FOR A FINE TO BE IMPOSED ON ANY PERSON WHO COPIES THE SOFTWARE WITHOUT PERMISSION. WE WOULD ALSO BE ENTITLED TO SEEK DAMAGES IN THOSE CIRCUMSTANCES. IF PEOPLE MAKE USE OF THE PROGRAM WITHOUT PAYING THE LICENCE FEE THEN WE WILL BE DEPRIVED OF INCOME AND THE PROGRAM MAY NOT BE DEVELOPED FURTHER.

2. BASICS FOR THE CORRECT USE OF MT-SOFT

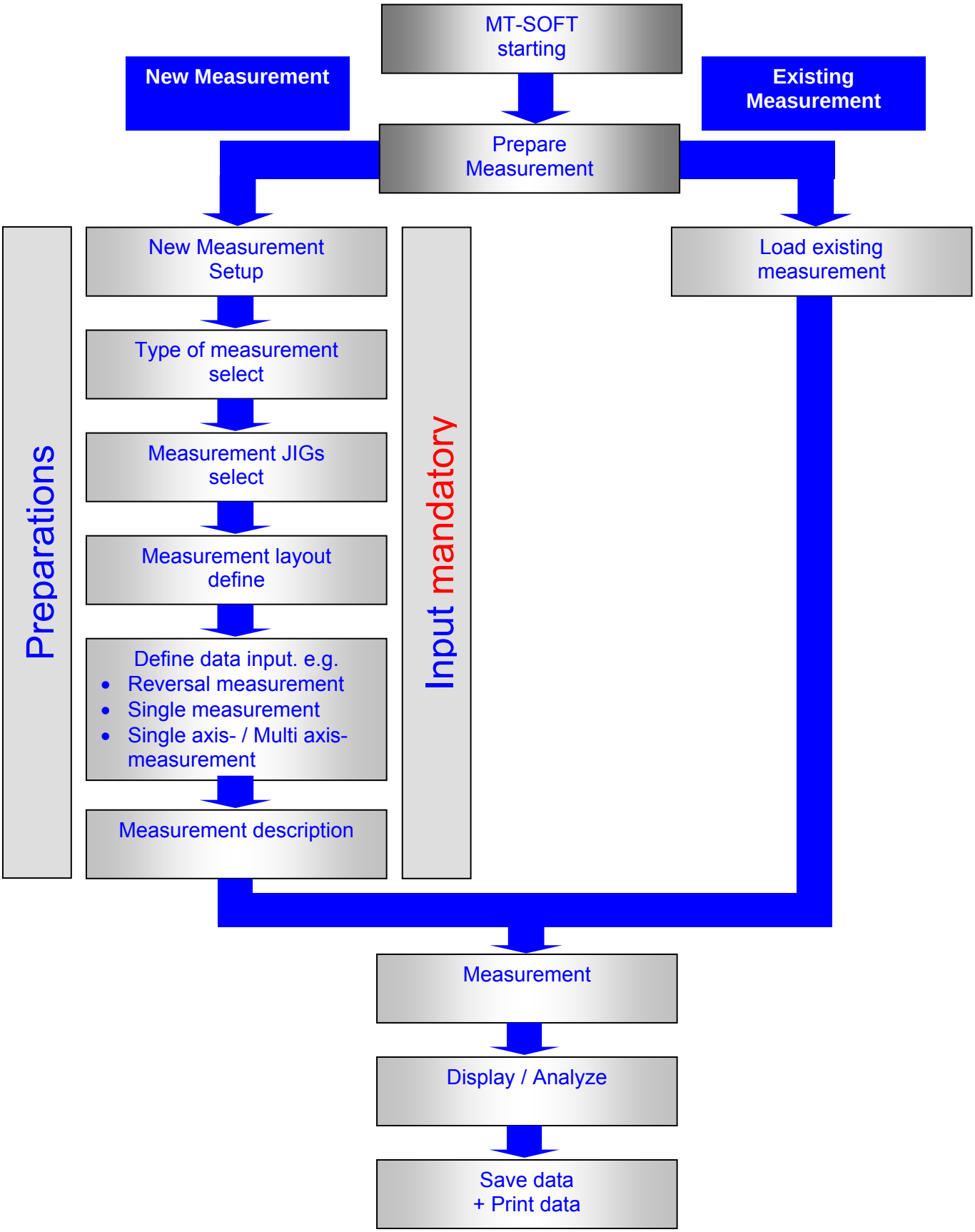
2.1 STRUCTURE MT-SOFT

Together with the inclination measuring instruments of WYLER SWITZERLAND the software MT-SOFT is the ideal system for measuring the geometry of machine tools and respective subassemblies.

The complete software MT-SOFT consists of the following integrated software programs:

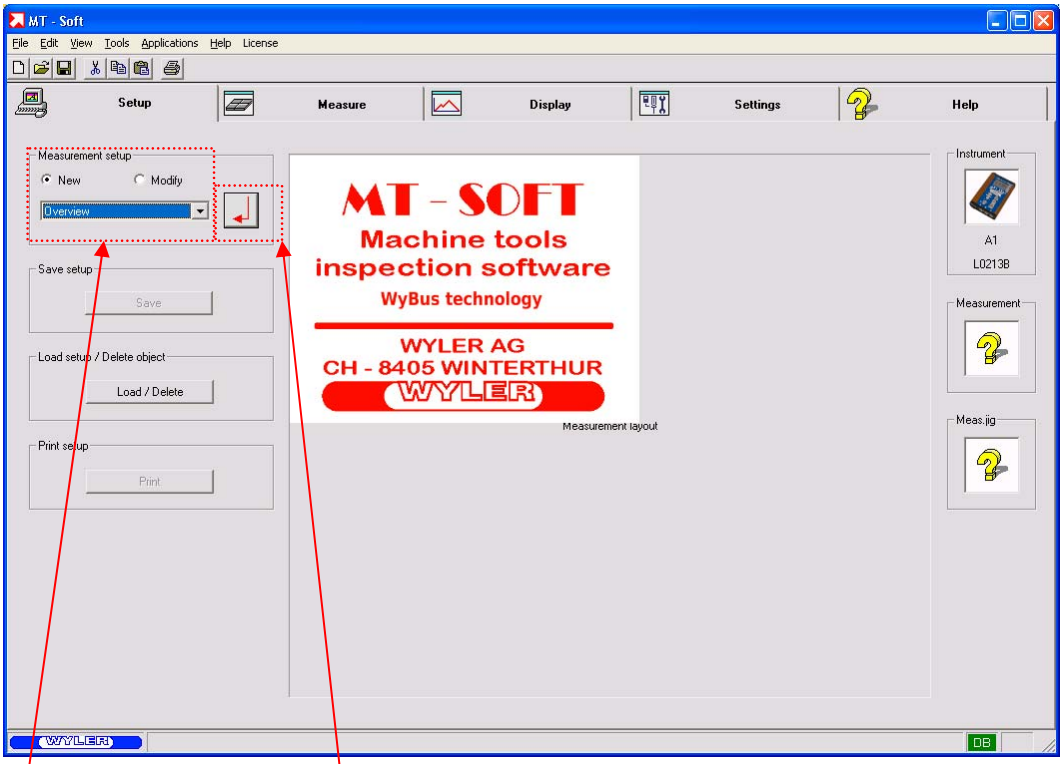


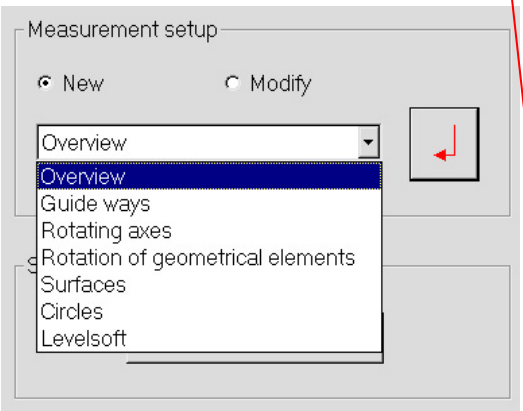
2.1.1 SOFTWARE BLOC DIAGRAM



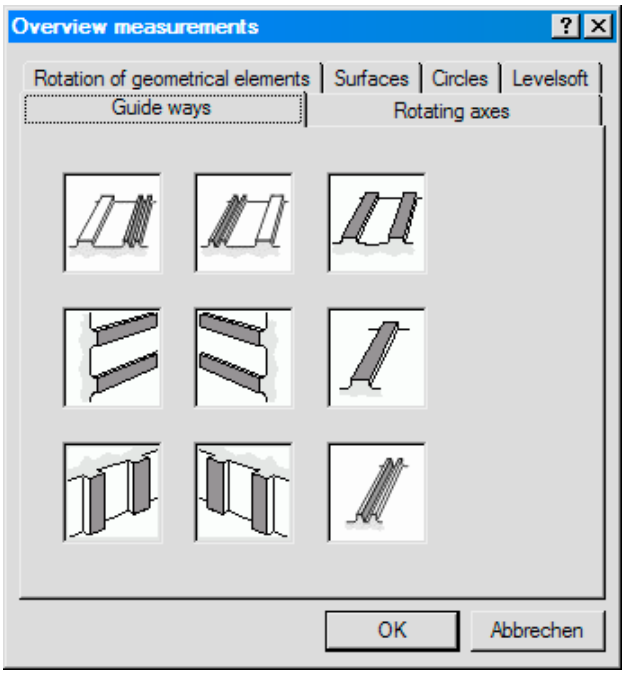
2.2 WHAT KIND OF MACHINE TOOL ELEMENTS CAN BE MEASURED WITH MT-SOFT MEASUREMENTS / SELECTION OF ELEMENTS TO BE MEASURED

The following window appears after starting the software MT-SOFT





The pull-down menu gives a first overview of the possible elements that can be measured



When clicking the function key a detailed overview of the possible measurements appears

The following measurements can be done

2.2.1 GUIDE WAYS

1 

Measurement of guide ways in two directions with inclination measuring instruments. The prismatic-guide way – here the rear guide way and defined as reference is measured in the longitudinal direction. By measuring the cross direction (roll) the flatness (parallelism) of the flat guide way as well as the guide way system is defined

2 

Measurement of guide ways in two directions with inclination measuring instruments. The prismatic-guide way – here the front guide way and defined as reference is measured in the longitudinal direction. By measuring the cross direction (roll) the flatness (parallelism) of the flat guide way as well as the guide way system is defined

3 

Measurement of guide ways in two directions with inclination measuring instruments. One of the two flat guide ways, defined as reference, is measured in the longitudinal direction. By measuring the cross direction (roll) the flatness (parallelism) of the second guide way as well as the guide way system is defined

4 

Partial measurement of horizontally oriented guide ways placed in a vertical plane with inclination measuring instruments. The angular deviation between the two guide ways (roll) is measured as well as the parallelism between the two surfaces. Angular deviations in longitudinal directions measured with other e.g. optical instruments may be manually entered via keyboard. The data may be used for defining the flatness of the reference guide way as well as for the complete guide way system

5 

Partial measurement of vertically placed guide ways with inclination measuring instruments. The angular deviation between the two guide ways (roll) is measured as well as the parallelism between the two surfaces. Angular deviations in longitudinal directions measured with other e.g. optical instruments may be manually entered via keyboard. The data may be used for defining the flatness of the reference guide way as well as for the complete guide way system

6 

Measurement of a single flat guide way in longitudinal direction with inclination measuring instruments

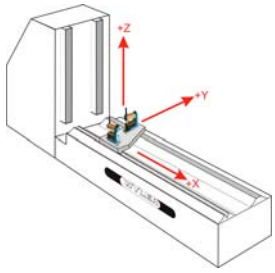
7 

Measurement of a single prismatic guide way in longitudinal direction with inclination measuring instruments.

8

Horizontal guide way runs from left to right, vertical guide way is on the left hand side of the horizontal guide way. (see picture)

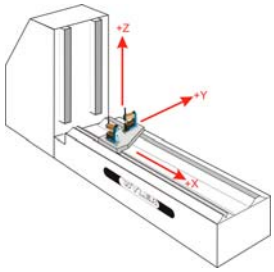
Measurement of vertically oriented guide way system measured in vertical direction on both guide ways with inclination measuring instruments. For the definition of the parallelism and the flatness of the guide way system the guide way on the left hand side (no.1) is the reference guide way



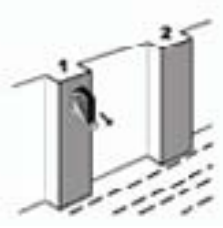
9

Horizontal guide way runs from left to right, vertical guide way is on the left hand side of the horizontal guide way. (see picture)

Measurement of vertical guide way system measured on both guide ways in vertical direction oriented on the side of the guide way with inclination measuring instruments. For the definition of the parallelism and the flatness of the guide way system the guide way on the left hand side (no.1) is the reference guide way

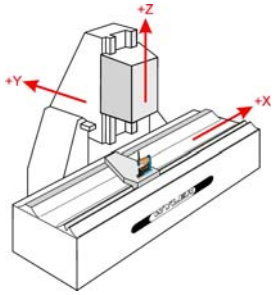


10



Horizontal guide way runs from left to right, vertical guide way is oriented crosswise to the horizontal guide way. (see picture)

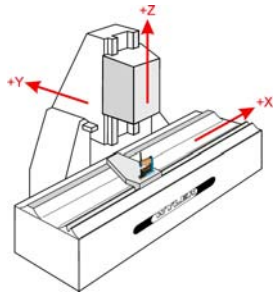
Measurement of vertically oriented guide way system measured in vertical direction on both guide ways with inclination measuring instruments. For the definition of the parallelism and the flatness of the guide way system the guide way on the left hand side (no.1) is the reference guide way



11

Horizontal guide way runs from left to right, vertical guide way is oriented crosswise to the horizontal guide way. (see picture)

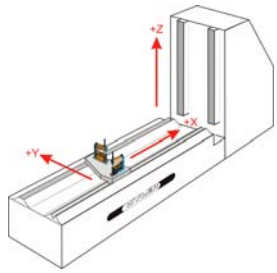
Measurement of vertical guide way system measured on both guide ways in vertical direction oriented on the side of the guide way with inclination measuring instruments. For the definition of the parallelism and the flatness of the guide way system the guide way on the left hand side (no.1) is the reference guide way



12

Horizontal guide way runs from left to right, vertical guide way is on the right hand side of the horizontal guide way. (see picture)

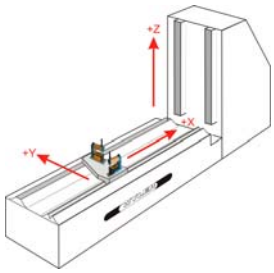
Measurement of vertically oriented guide way system measured in vertical direction with inclination measuring instruments. For the definition of the parallelism and the flatness of the guide way system the guide way on the right hand side (no.1) is the reference guide way



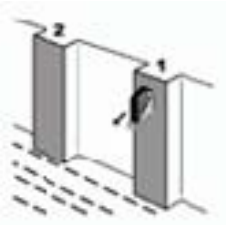
13

Horizontal guide way runs from left to right, vertical guide way is on the right hand side of the horizontal guide way. (see picture)

Measurement of vertical guide way system measured on both guide ways in vertical direction oriented on the side of the guide way with inclination measuring instruments. For the definition of the parallelism and the flatness of the guide way system the guide way on the right hand side (no.1) is the reference guide way

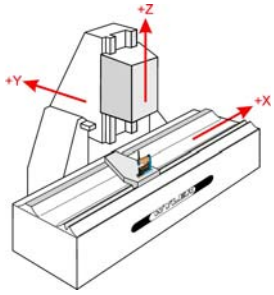


14

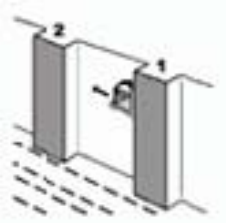


Horizontal guide way runs from left to right, vertical guide way is oriented crosswise to the horizontal guide way (see picture).

Measurement of vertically oriented guide way system measured in vertical direction with inclination measuring instruments. For the definition of the parallelism and the flatness of the guide way system the guide way on the right hand side (no.1) is the reference guide way

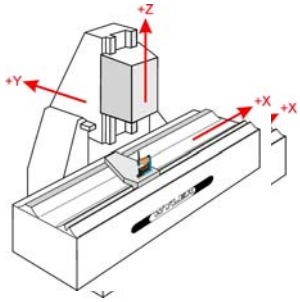


15



Horizontal guide way runs from left to right, vertical guide way is oriented crosswise to the horizontal guide way (see picture).

Measurement of vertical guide way system measured on both guide ways in vertical direction oriented on the side of the guide way with inclination measuring instruments. For the definition of the parallelism and the flatness of the guide way system the guide way on the right hand side (no.1) is the reference guide way

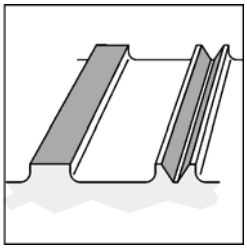


For measuring guide ways **specific measuring JIGs** are required. It is possible that the end user is manufacturing these JIGs but it is also possible to supply such equipment by WYLER SWITZERLAND

See some examples below

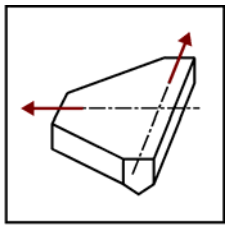
Possible measuring JIGs

JIGs suitable for the measurement of guide ways in two directions. The pitch of the prismatic guide way is measured in longitudinal direction with inclination measuring instruments. The measurement of the flat guide way (roll) is measured by measuring the inclination between the two guide ways.

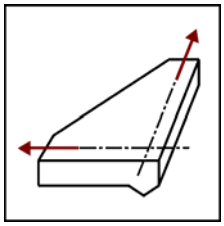


Measurement of guide ways in two directions with inclination measuring instruments. The prismatic-guide way – here the rear guide way and defined as reference is measured in the longitudinal direction. By measuring the cross direction (roll) the flatness (parallelism) of the flat guide way as well as the guide way system is defined

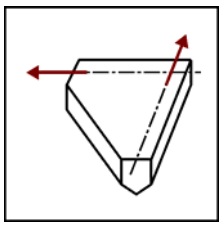
JIG with symmetrical base plate (position of cross direction at the centre of base plate) for the roll measurement and prismatic guide on one side

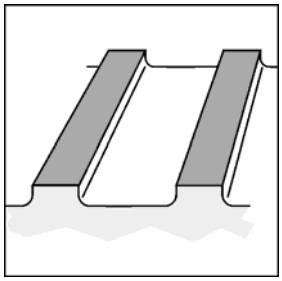


JIG with asymmetrical base plate (position of cross direction at the beginning of the base plate) for the roll measurement and prismatic guide on one side



JIG with asymmetrical base plate (position of cross direction at the end of base plate) for the roll measurement and prismatic guide on one side





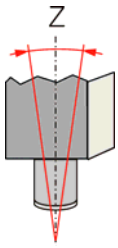
Measurement of guide ways in two directions with inclination measuring instruments. One of the two flat guide ways defined as reference is measured in the longitudinal direction. By measuring the cross direction (roll) the flatness (parallelism) of the second guide way as well as the guide way system is defined

measuring JIG for the measurement on two flat guide ways

Granite straight edge, both ends flat

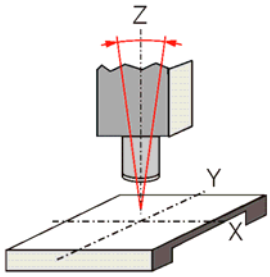
2.2.2 ROTATING AXIS

10



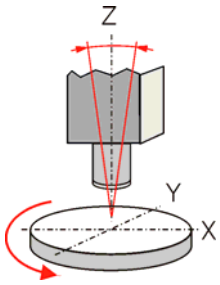
Defining the angular deviation of a vertical spindle from the true vertical

11



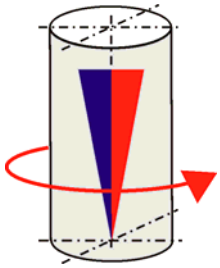
Definition of the rectangularity between the surface of a machine table and the vertical spindle. Comparison in both directions X and Y

12



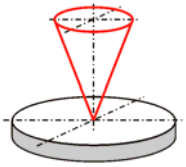
Definition of the parallelism between two rotating axis, e.g. between a rotating table and the spindle. The deviation from the true vertical of both elements is compared.

13



UNDER CONSTRUCTION
Definition of a wobbling error of a rotating spindle

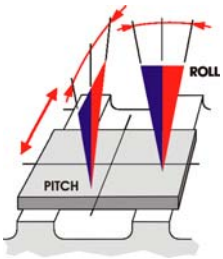
14



UNDER CONSTRUCTION
Definition of a wobbling error of a rotating table

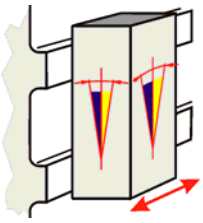
2.2.3 ROTATION OF MACHINE ELEMENTS

15



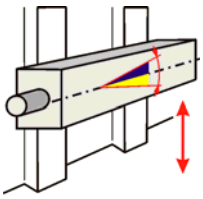
Measurement of geometry error pitch and roll of a machine element moving horizontally.

16



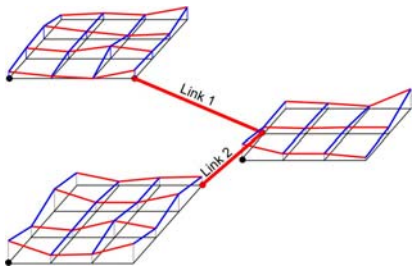
Measurement of geometry error pitch and roll of a machine element moving horizontally where the two guide ways are mounted one above the other.

17

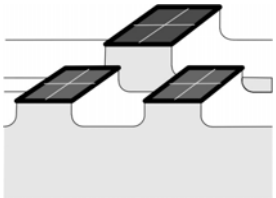


Measurement of geometry error pitch of a machine element moving vertically where the two guide ways are mounted vertically one beside the other.

2.2.4 SURFACES

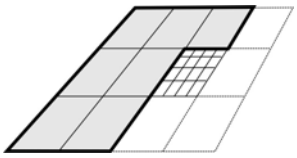


18



Flatness measurement of horizontal surfaces in space and comparison of the position of various such surfaces (co-planarity). Partial surfaces compared to an overall surface including all partial surfaces.

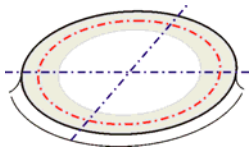
18



Flatness measurement of horizontal surfaces in space and comparison of the position of various such surfaces (co-planarity). Partial surfaces compared to an overall surface including all partial surfaces.

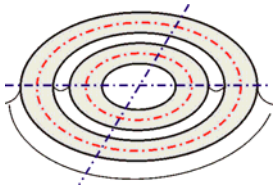
2.2.5 CIRCULAR OBJECTS / CIRCLES

19



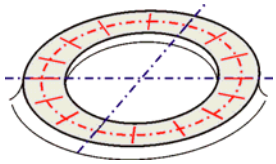
Flatness and position of a circular area in space. Deviation from the true vertical X and Y-axis.
Practical example:
Mounting surface for the bearing of a round table.

20



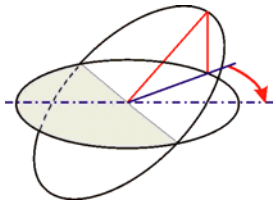
Flatness and position of two circular areas in space. Deviation from the true vertical X and Y-axis of the outer circle and definition of the co-planarity of the two circles.
Practical example:
Mounting surfaces of two bearing supports of a large round table.

21



Flatness measurement of a horizontal circular area and defining the deviation from the true vertical X and Y-axis

22

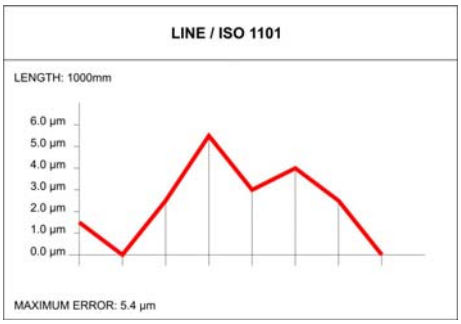


Flatness measurement of a horizontal circular area and defining the deviation from the true polar coordinate system.
Practical example:
Mounting surface for the bearing of large telescopes, gun supports of large gun carriages

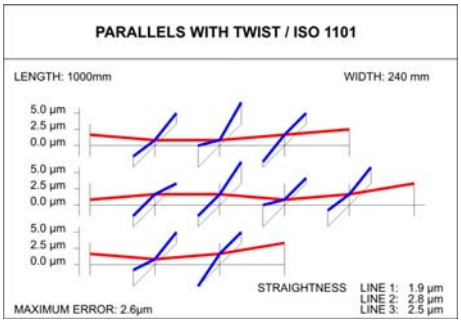
2.3 LEVELSOFT PRO

The well known software **Levelsoft PRO** is part of the MT-Soft and can be started directly from the Set up Menu > Measurement Set-up

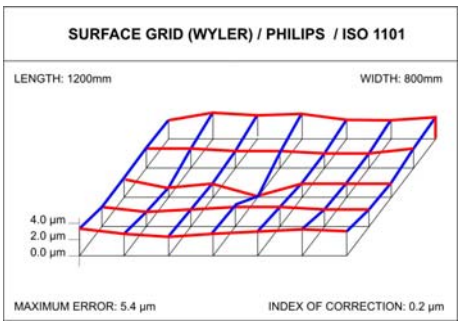
Lines with and without twist according to ISO 1101



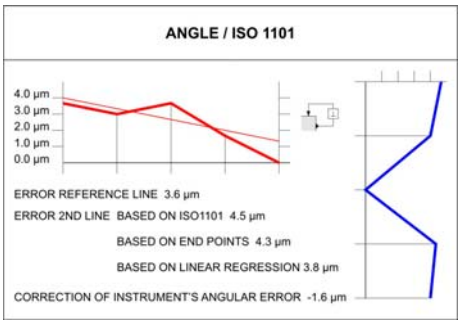
Parallels with and without twist according to ISO 1101



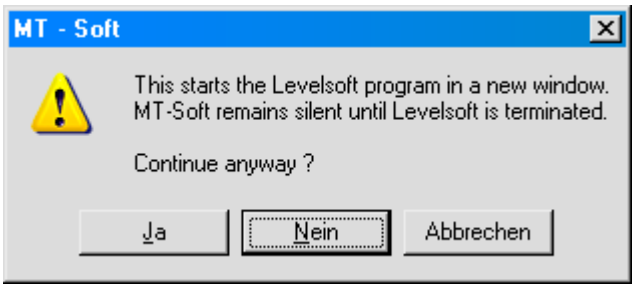
Measurement of flatness of surfaces according to ISO 1101

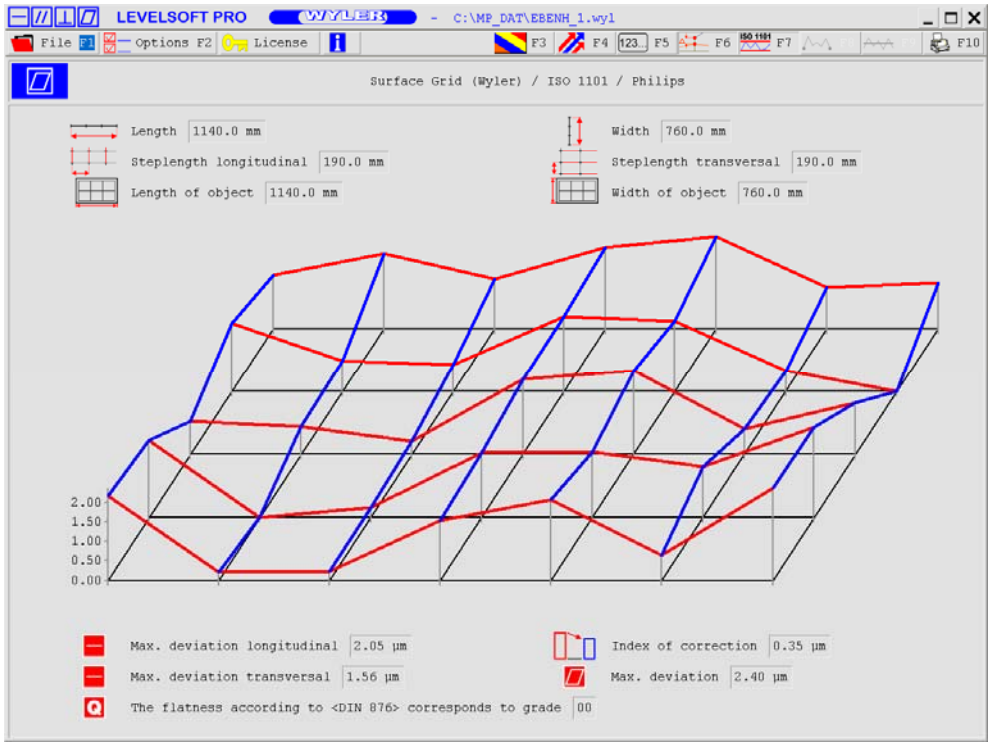


Squareness according to ISO 1101



Before the start of the software LEVELSOFT PRO it is indicated that this software is started with another interface and it is mentioned that the software MT-Soft remains active in the background. When closing the software Levelsoft PRO the MT-Soft becomes active again in the foreground.





The following tasks may be done with the WYLER FLATNESS MEASUREMENT SOFTWARE **LEVELSOFT PRO** and the correct measuring instruments:

- **Lines (Straightness)**
- **Lines with twist (Torsion)**
- **Parallels**
- **Squareness**
- **Measurement of flatness of surfaces**
- **Measurement of machine tool geometry** (ordinary elements only)

2.4. MEASURING INSTRUMENTS AND CONFIGURATIONS

The inclination measuring instruments BlueLEVEL, BlueLEVEL BASIC, MINILEVEL, LEVELTRONIC and NIVELTRONIC are especially well suited for all kind of measurements. Not only simple definitions of an inclination angle but also more complex measurements of straightness of lines, guide ways of machine tools with twist or surface flatness of small and large areas can be done. This is possible with a single or differential measurement

The advantage of electronic instruments is the rapid availability of measured results with the possibility of further treatment in computers with suitable software.

Training seminars for the use of hardware and software are available at WYLER AG. Also training courses are possible at the users premises with detailed know how transfer specifically suited for the user's needs. Please contact your local WYLER representative for additional information and useful dates.

WYLER MEASURING-CONFIGURATION

A **typical measuring system** usually consists of the following components:

- One or two **electronic inclination measuring instruments** including cables or wireless data transmission modules
- **BlueMETER, Levelmeter 2000** or **Leveladapter 2000** as Interface between the measuring instruments, respectively the display unit, and the Computer
- **Computer** or **Laptop**
- Software **MT-SOFT** with the well proven measuring software **LEVELSOFT PRO** as an integral part

Remarks regarding the components

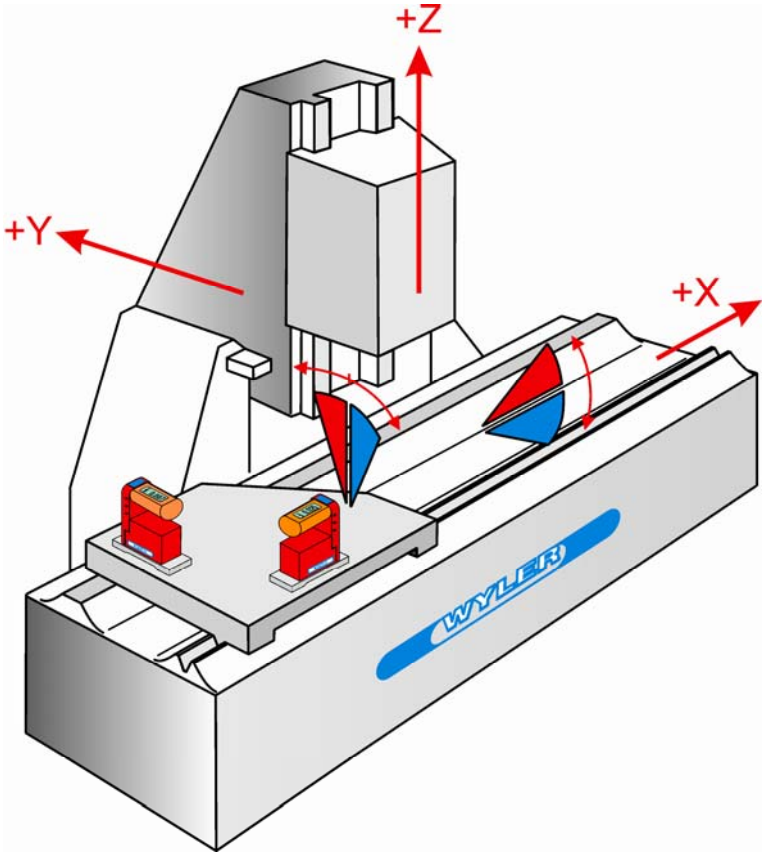
- <u>Electronic inclination measuring instruments</u> with calibrated analogue output or with digital output measures slightest angular deviations in relation to the centre of gravity and delivers a corresponding signal to the analysing system
- Interface
  - With the instruments of the **BlueSYSTEM family** the **BlueMETER** serves as the Interface to the PC
  - **Leveladapter 2000**/ Interface Box, converts analogue signals into digital signals comprehensive for the analysing system and compares in the differential mode the two oncoming signals. The signals are transmitted via a RS 232 cable to any COM port of a computer
  - With the measuring instruments of the "NT series" a specially developed cable assembly is available, enabling the direct connection from the **LEVELMETER 2000** to a serial port of a PC

Additional configurations see **Appendix / Point A**

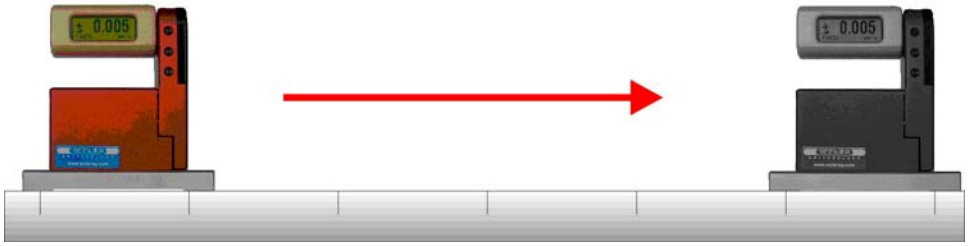
2.5. MEASUREMENT BASICS

In order to receive satisfactory results it is important to observe a few hints before starting to measure with the software **MT-SOFT**.

2.5.1 MEASUREMENT STRATEGY / ORIENTATION OF MEASURING



- Touch the instrument only at the handle (Temperature!!))
- Measurement always from left to right and from near to far
- Cable always in measuring direction, in case of wireless transmission, connector in measuring direction



2.5.2 CHOICE OF THE MEASURING BASE

Measuring bases for the measurement of surface plates and other flatness measurements:

For flatness measurements, especially the measurement of surfaces over-defined by using geometrical grids, the use of measuring bases with sufficient area for overlapping are recommended. For this reason prismatic bases are not ideal.

The **hardened steel measuring bases with knife-edged type, approx. 1 mm broad dust grooves** at 45 deg. angle to the measuring direction, have proven specially suitable for measuring on surface plates of Diabas

The following table gives an insight into dimensions and application ranges:

Length of measuring base	Width of measuring base	Length of contact of base section	Optimal measuring step length	Recommended range of measuring step length
[mm]	[mm]	[mm]	[mm]	[mm]
110	45	20	90	85 - 105
150	45	24	126	120 - 145
200	45	30	170	160 - 190

The **WYLER Flexbase** is equipped with 3 contact points in the size of 10 mm diameter (0.4”) whereas the length distance between the two major contact points can be adjusted according to the requirements. Excellent results can be achieved with this measuring base on granite surface plates. When the measurements are done according to the U-Jack method, respectively according to the US Specs GGG-P-463b the **WYLER Flexbase** is a must! With the software LEVELSOFT PRO all the necessary requirements for this type of flatness measurements are also incorporated

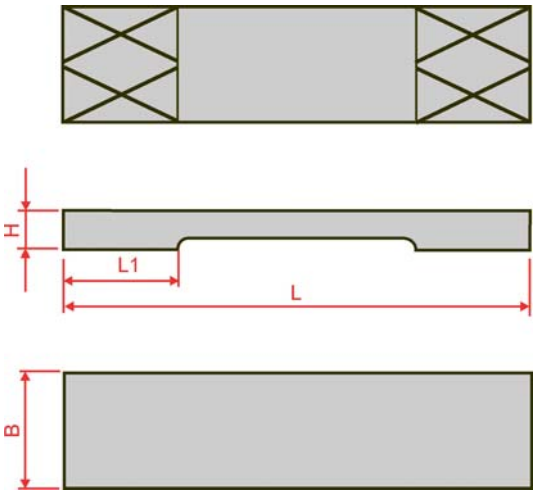
Measuring bases for measurements on horizontal guide ways

For measurements on machine tool guide ways made of steel or cast iron hardened steel bases with sharp edges are not very useful because of the possible scratches when moving a measuring instrument on the surface of the guide way.

Especially recommended for the measurement of finely ground or scraped surfaces **granite bases** are highly recommended. For the measurement of larger ranges granite screw on bases in the size of 200, 250, and 500 mm length are readily available, other dimensions are manufactured according to the requirements.

Most machine constructors have suitable equipment and well trained specialists available which enable the in house manufacture of suitable measuring bases of cast iron, adapted to the measuring object, for their production and maintenance needs.

Examples of suitable measuring bases:



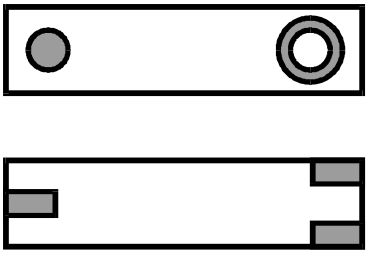
It is important to make sure that a measured difference in height at the two measured points are resulting in an angular difference

Examples of incorrectly designed bases

Absolutely flat base

Error:

- No clearly defined contact points.
  Full surface contact
- Tendency to wobble on uneven work piece surface, >> resulting in large measuring error.



Measuring surfaces not covering the same surface area

Error:

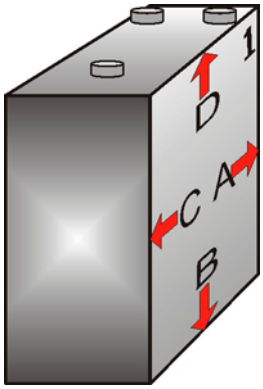
- measuring errors by line- and flatness-measurements

When designing and manufacturing specific measuring bases suited for clearly defined machine elements, it is useful to include positioning aids. Such positioning aids are particularly useful when the instrument must be guided parallel to another measured line or when, in defined distances, threads or holes are in the way. In these cases it is worthwhile to spend some time in the proper jig in order to drastically reduce the measuring time as well as to improve the accuracy.

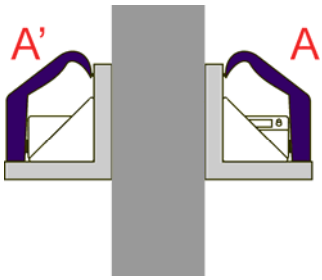
Measuring bases for vertical measurements

Different types of standard measuring bases suitable for horizontal and vertical measurements are available. If no measurements are planned on shafts or other cylindrical elements, it is recommended to abstain from the use of prismatic bases.

Angular measuring instruments with bases with magnetic inserts should possibly not be used for flatness measurements as the handling gets rather difficult. Bases with magnetic inserts should be used for placing the instrument at a specific spot for a certain time. Such a case could be the measurement of roll and pitch on a machine tool element.



Vertical measurements, where the results are later used for determination of rectangularity or for comparison with the geometry of other elements, should always be done in the absolute mode. This means the result must be a possible deviation of the true vertical.



For a precise vertical measurement it is inevitable to perform with the measuring instrument a reversal measurement using the vertical measuring base. For such a reversal measurement a calibration element with two absolute vertically parallel surfaces is required.

Such granite squares are available at WYLER's

Length of measuring bases:

For straightness measurements of guide ways and for flatness measurements of surfaces the following criteria should be observed:

- Short measuring bases detect short waves (local error) and generate thus a dense information content
- Short measuring bases require more time during the measurement and create thus higher costs
- Short measuring bases used on large work pieces end up in a large number of measurements (Increases the total measuring error)
- Long measuring bases detect only long-wave errors
- Long measuring bases reduce the measuring time required and thus save costs
- Long measuring bases require a smaller number of measurements, thus reducing the possibilities for measuring errors. Therefore the measuring uncertainty in respect of the total dimension of a measured object is drastically reduced

Medium Information density
Short waves of 50 to 200 mm length.
These can be the result of unsuitable machining methods in production, e.g. when too small lapping tools are used for the lapping of a surface plate.
Local wear can also lead to errors of this type.
This category of errors is interesting for the flatness measurement.

Example of an ideal measuring base
Instrument with flat base with dust grooves

Low Information density
Long waves over the whole surface.
The general shape of a surface.
Reasons for this category of errors are:

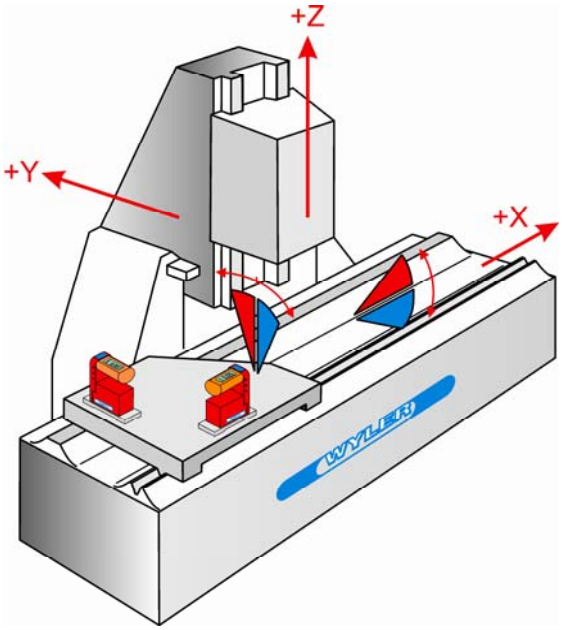
- Copied geometrical errors originating from the production machine
- Deformation due to clamping and support
- Distress of the material
- Thermal lamination within the work piece
- Deflection (bending) by the own weight

Example of an ideal measuring base
Instrument with flat base mounted on a granite base

2.5.3 MEASURING JIG FOR MEASUREMENT OF MACHINE TOOL GUIDE WAYS

When measuring a guide way a specialised JIG is required

Example: asymmetrical JIG for measuring a guide way



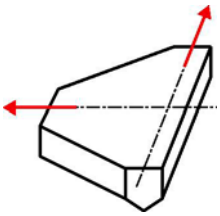
The JIG required for measuring this guide way must have one prismatic and one flat base.

With **MT-Soft** and two measuring instruments, one for the X-direction and one for the Y-direction, both guide ways can be defined in **one run of measurements.**

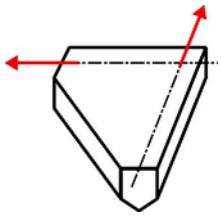
When one instrument only is available the same measurement with the same JIG can be done in **two measuring runs**.

Usually these JIGs are designed and manufactured by the machine tool manufacturer. It is however possible to be supplied by WYLER AG.

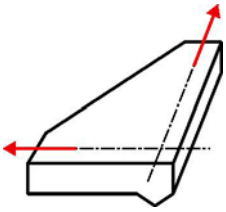
Other examples of possible JIGs



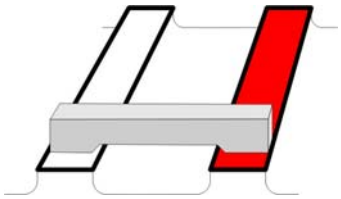
JIG with symmetrical base plate (position of cross direction at the centre of the base plate)and prismatic guide on one side



JIG with asymmetrical base plate “right” (position of cross direction at the end of the base plate) and prismatic guide on one side



JIG with asymmetrical base plate “left” (position of cross direction at the beginning of the base plate) and prismatic guide on one side



Granite straight edge, both ends flat

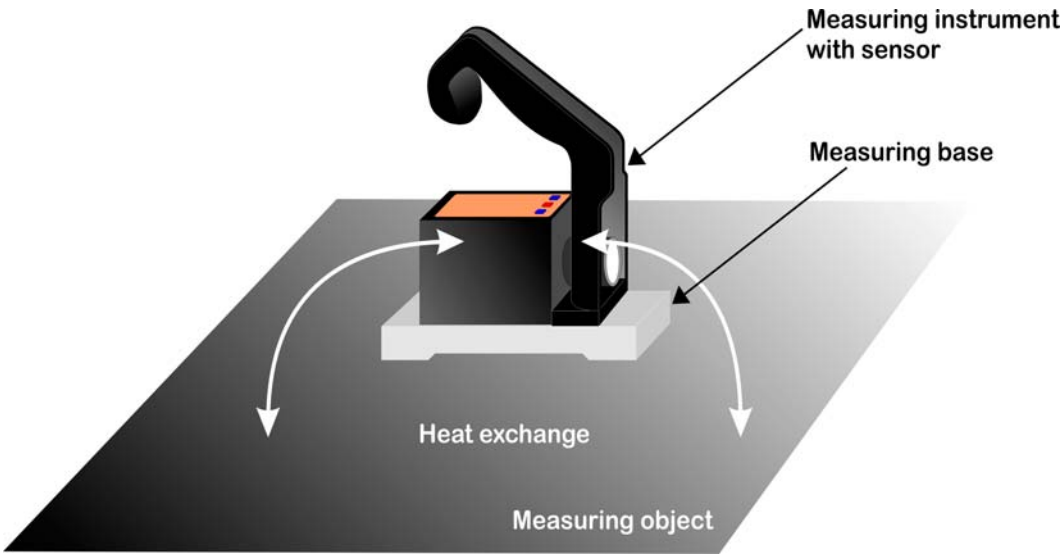
In this case three options of JIGs are possible. The pictures speak for themselves.

2.5.4 INFLUENCE DUE TO TEMPERATURE DIFFERENCES

Temperature difference within the work-piece or between the work-piece and the measuring base have a great influence on the accuracy of the measuring results.

The following chapter will deal with some of these coherent problems.

Influence of temperature differences between the measuring base and the object to be measured



A temperature difference between the measuring base and the object to be measured will cause a heat flow. The amount of such a heat flow is depending on the area of contact, the difference in temperature, the materials of base and object as well as on the base length and the cross section of the measuring base.
In the base a temperature lamination will occur which will bend and warp the base because of material expansion. This will result in constantly changing the area of contact, which on the other side again will change the flow of heat. These partially brisk motions can be observed by the continuous changing of the instrument's display value. The temperature dependant changes of the base's dimensions itself are also visible in the instrument's display value

Important:

- Before conduction of a precision measurement the temperature of the instrument and the object must be checked
- The time for temperature acclimatisation of the instrument's base is depending on the temperature difference and the material used and will be between ½ and 2 hours

Influence of temperature differences within the measuring object

Similar statements are true of the temperature stability of the object to be measured, e.g. machine tool. Such temperature changes have a great impact on the quality of the measurement. It is therefore important to make sure to eliminate or minimize temperature changes during the measurements.

2.5.5 DIFFERENTIAL MEASUREMENT / REFERENCE MEASUREMENT

Measurements conducted with the differential method allow the compensation of slight changes of an object's orientation during the measurement and the compensation of low frequency vibrations.
These compensations are only satisfactory if the measuring object is of rigid design and the supports are of the three-point type. Also the surface on which the reference instrument is placed must be a solid part of the object to be measured and of good flatness so that the reference instrument is not wobbling. If these conditions are not fulfilled the planned compensation cannot be achieved.

Remarks:
Measurements **in absolute mode can not be** done in combination with a **reference instrument**

Attention
Long machine beds with several bearing points have the tendency of following the shape of the foundation, this will also give false compensation readings. By this the reference instrument placed on the machine bed will supply incorrect values. In these cases it is not recommended to apply the differential measuring method.

2.5.6 MEASURING ERRORS

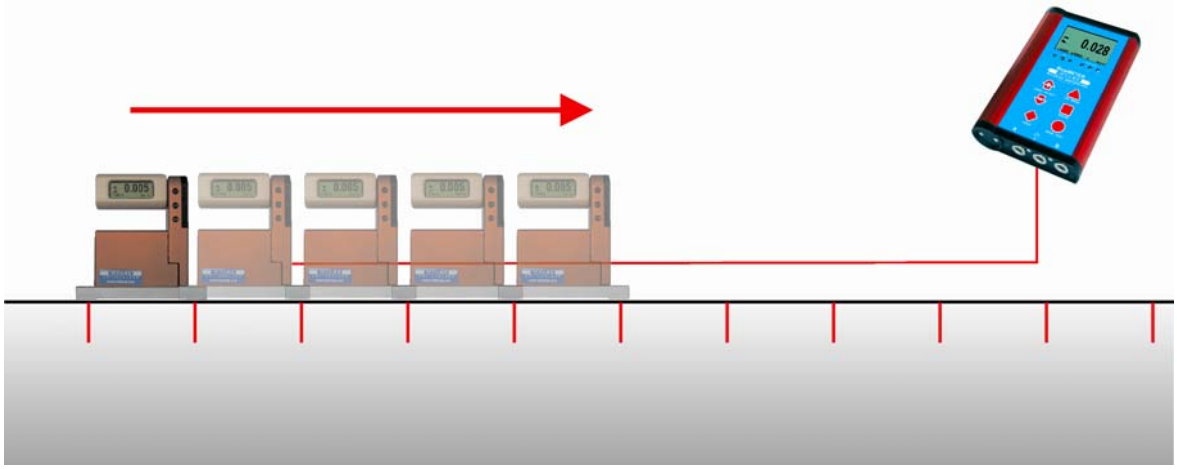
Possible causes of measuring errors, respectively closure errors of surface flatness measurements or poor repetition when measuring straight lines are:

- Temperature difference between measuring base and measuring object.
- Tilting of the object to be measured and/or vibrations during the measuring process.
- Careless measurement
- Dirt
- actuating the remote trigger before the instrument's read-out is stable
- insufficient overlapping of the measuring steps during the measurement
- careless positioning of the measuring instrument
- warped, worn or damaged measuring base
- uneven, short waved surface, bumps and burrs which cannot be covered accurately by the measuring base or result in wobbling of the measuring instrument

2.5.6 MEASUREMENT / LAYOUT OF MEASURING PATTERN

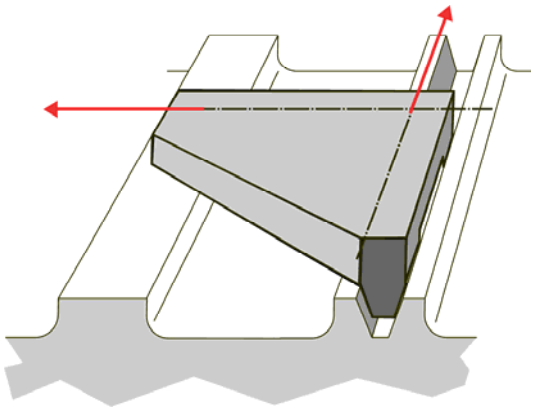
The object to be measured must be adjusted horizontally in both directions (longitudinal and transversal) as well as possible (within approx. 50 µm/m). If not done so measuring errors (**Twist error**) may occur if the measuring instrument is not placed exactly in line with the measuring direction. The use of a ruler or a straight edge may be helpful.

The object must now be divided in equally long measuring steps. The step length has to be such that an equal dimension of overlapping of the base length with each step is possible. See graph below.

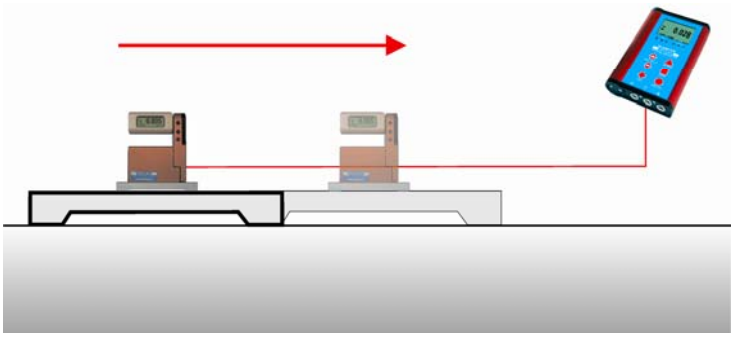


The definition of the overlapping is usually a compromise between the optimal step length as earlier described and the total distance to be measured.

The same applies when using a measuring JIG with an instrument placed on top. See below.



Measuring JIG for the measurement of a guide way



Side view of the JIG with instrument placed. The measuring steps must be overlapping

2.5.8 METHODS OF ALIGNMENT

In the WYLER software the following methods of aligning the measuring objects are possible:

- Alignment **"ABSOLUTE"**
- Alignment according to the method **"ENDPOINTS"**
- Alignment according to the method **"ISO 1101"**
- Alignment according to the method "**LINEAR REGRESSION"**

The different methods are described next and a number of graphs are used for better understanding. The same applies to the following measuring objects:

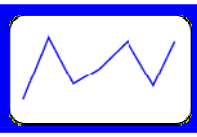
By aligning surfaces instead of straight lines flat surfaces are applied as borders.

Procedure of the measurement:

1. All the measuring parameters like e.g. step length, number of measurements etc. are entered.
2. At the end of the measurement the result may be viewed using the Menu point "Display".
3. The required alignment method may be set

Methods for aligning measuring objects, Overview:

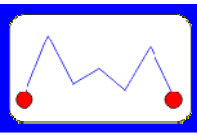
Alignment **"ABSOLUTE"**

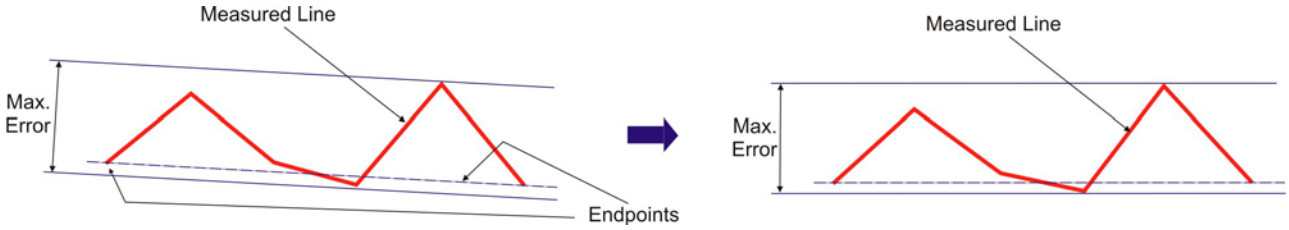


The method **"ABSOLUTE"** is important to use when elements of a machine must be compared at a later stage. Only in the absolute mode it is guaranteed that the individual positions can be compared.

Precondition for a measurement in the absolute mode is the performance of a reversal measurement with the measuring instrument. The **reversal measurement is a part of the measurement procedure**.
Additional details see point 2.5.11 Absolute measurements / Absolute mode

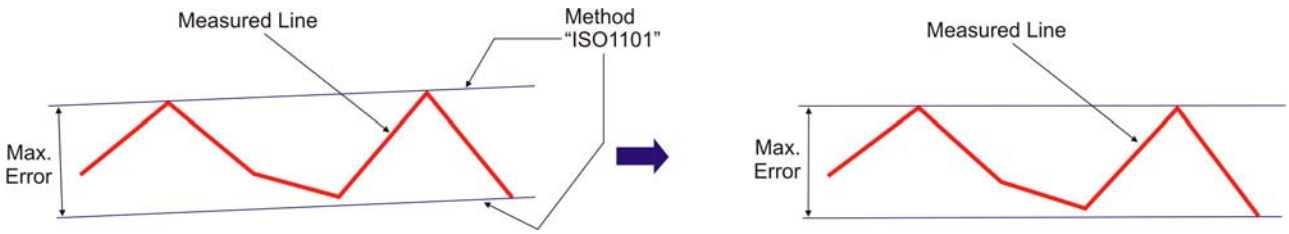
Alignment according to the method **"ENDPOINTS"**





In this method the first and the last measured point are connected by a straight line. The whole figure is now turned horizontally. The connecting line is moved **parallel** to the highest and the lowest point of the object. The **vertical distance** between the two lines is the maximum error calculated according the method “Endpoints”.

Alignment according to the method **"ISO 1101"**



In the method **ISO1101** two parallel lines are aligned in such away that the distance between them is the least possible.
The **vertical distance** between the two lines is the smallest possible error according the method "ISO 1101"

Alignment according to the method **"LINEAR REGRESSION"**

Using the method "linear regression" a straight line is calculated out of a number of measuring points according to the method of least squares.
The so calculated line is moved **parallel** to the highest and the lowest point of the object. The **vertical distance** between the two lines is the maximum error calculated according the method "Linear regression".

2.5.9 REMARKS CONCERNING THE "LIMIT OF VARIATION"

Every measured value is computed out of a number individual values. The limit of variation is acting like a filter using only these values, which are within the set limit of variation.
During a measurement under true practical conditions a number of vibrations may be influencing the measurement in a way that the limit of variation needs to be adjusted. In most of the cases where such periodical vibrations are present this is a very efficient way to receive good measuring results because it will prevent relying on one individual measurement at a crucial time.
Under such measuring conditions it is recommended to start with a limit of variation of 5 µm/m. In case a series of measured values are rejected the system will repeat the measurement up to 5 x.

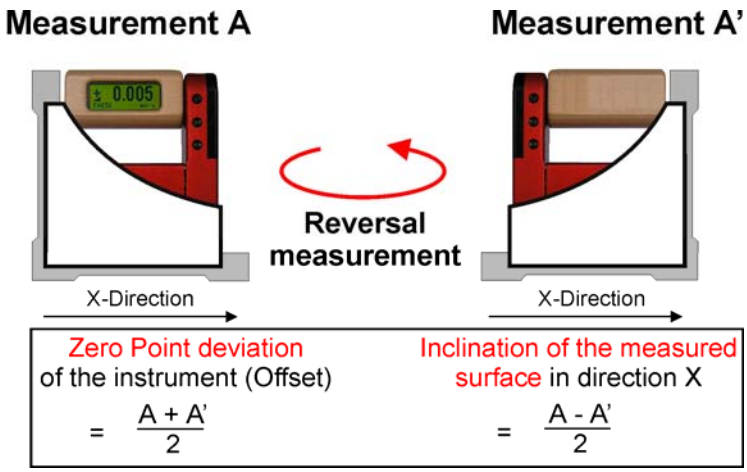
2.5.10 ABSOLUTE MEASUREMENTS / ABSOLUTE MODE

2.5.10.1 ABSOLUTE ZERO SETTING BY REVERSAL MEASUREMENT IN HORIZONTAL POSITION

Machine tool inspection is usually done by measuring in the **ABSOLUTE mode**. By doing so the true position of the objects to be measured are determined. This measurement in the absolute mode is inevitable when e.g. a horizontal guide way must be compared with a vertical spindle. When comparing the elements by using the MT-SOFT both elements must use the same machine serial number and saved by the same service engineer's name.

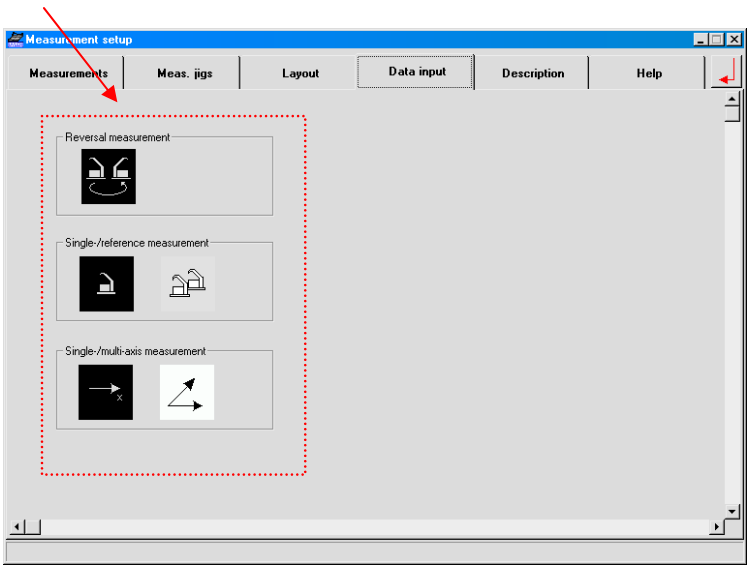
In contrary to the above said it is useful to measure an individual guide way by means of **differential measurement**. By doing so, e.g. existing vibrations in the surrounding of the measurement can be eliminated. However, such a measurement can not be compared later with other elements of a machine.

For the absolute measurement it is, as mentioned, inevitable to adjust the measuring instrument before the measuring task by doing a reversal measurement. See the description below:



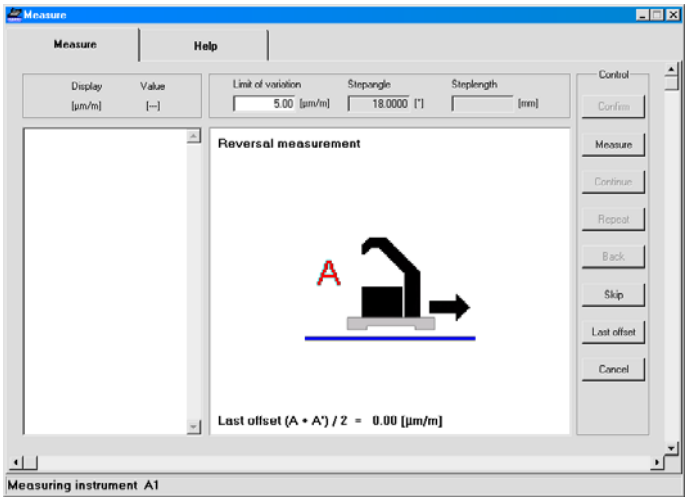
Principle of the reversal measurement

When setting up a measurement task in ABSOLUTE MODE it is important to select "Reversal Measurement" in the Menu <**DATA INPUT**>

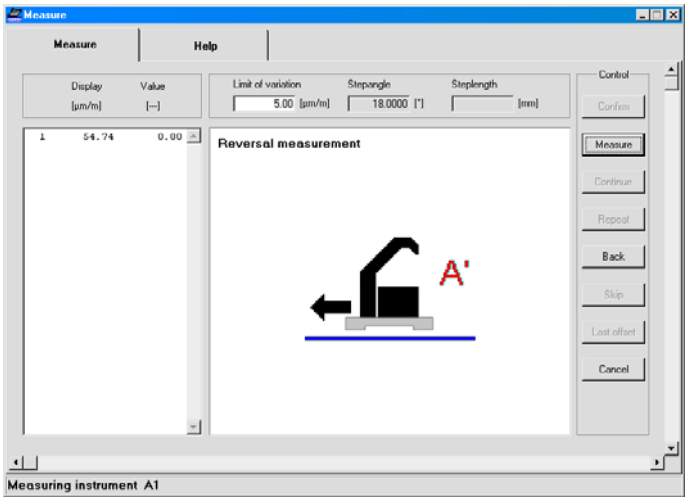


After starting the first measurement a reversal measurement must be done. The first measurement with the instrument is measurement "**A**“.

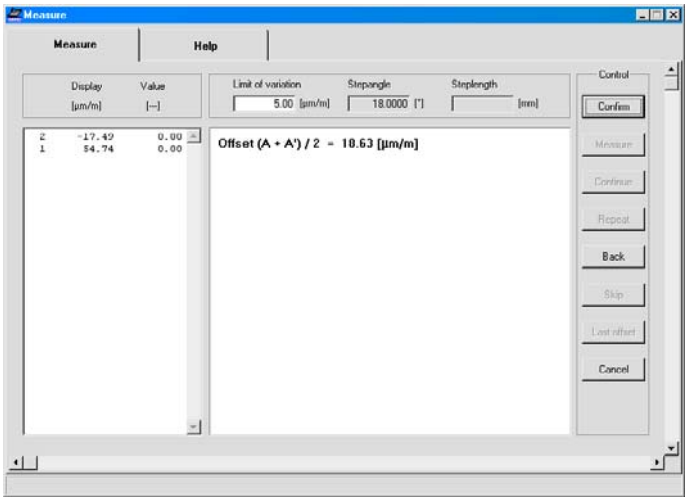
In order to eliminate any errors from the surrounding the **REVERSAL MEASUREMENT** should be done on a best possibly horizontal surface with smallest horizontal flatness errors. Ideally the position of the instrument should be marked on the surface. For the second measurement the instrument must be placed at exactly the same position on the surface but turned horizontally by 180°.



During the data collection of the first measurement the remark “please wait” is displayed. When finished the second measurement must be done, measurement **"A’"**



After the second reading the zero offset of the instrument is automatically calculated
zero offset = {measurement <A> + measurement <A’>} / 2 and displayed. This value must be confirmed by pressing [confirm]



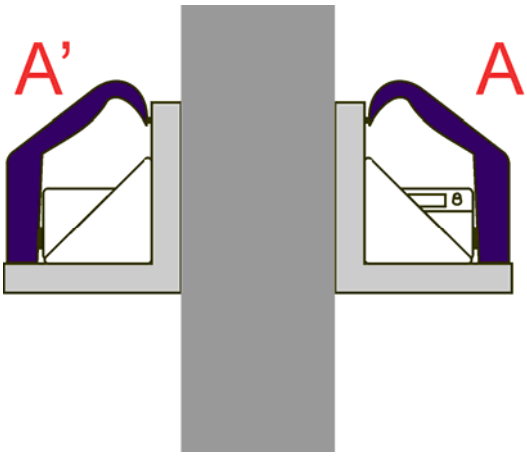
When the **reversal measurement is finished** the intended measurement of the object can be started.

2.5.10.2 ABSOLUTE ZERO SETTING BY REVERSAL MEASUREMENT IN VERTICAL POSITION

When measuring a vertical guide way it is important to perform an **ABSOLUTE MEASUREMENT** when this measuring result should later be compared with any other object on the same machine such as e.g. a horizontal guide way in order to define the squareness.

Two options are possible to determine the angular error of the instrument

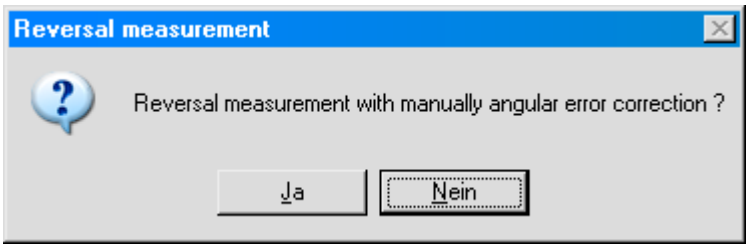
Option 1
Ideally a vertical reversal measurement is done. This requires a high precision granite square block with two exactly parallel surfaces with none or smallest possible surface error. With this procedure it is possible to calculate the vertical zero offset of the instrument and, when previously the horizontal reversal measurement was done, **the angular error of the instrument is automatically determined**.



Option 2
In case no high precision square block is available the zero setting can be done by applying the horizontal reversal measurement only, best possible on a granite setting plate.
After that the **angular error of the instrument can be applied by manual input**. The value of the angular error can usually be found on a calibration certificate. Is no calibration certificate available the only way is to enter the value "0" as angular error of the instrument. When doing so it must be noted that the measuring uncertainty is larger.

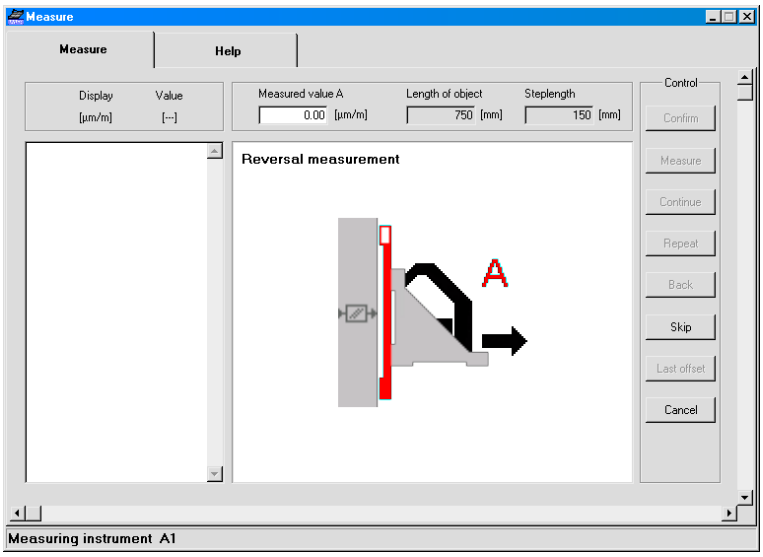
Procedure Option 1/
Automatic definition of the angular error and the zero offset of the instrument.

After starting the measurement by pressing [ENTER] the following dialogue box appears with the inquiry "Reversal measurement with manual angular error correction?"



In option 1 the reversal measurement is done by means of a square block therefore the answer to the question is <NO>.

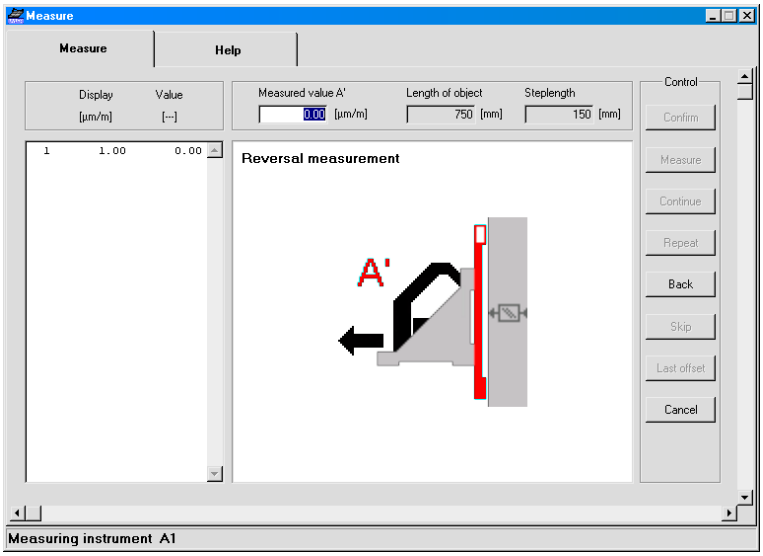
After selection <NO> the procedure for the vertical zero setting is started. The first measurement with the instrument is measurement “**A**”.



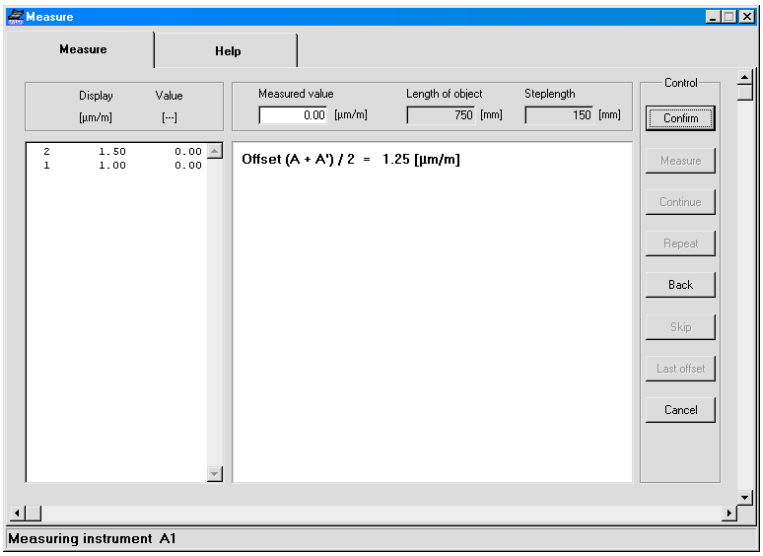
During the data collection of the first measurement the remark “please wait” is displayed. When finished the second measurement must be done, measurement “**A’**”

Remarks:

- Applying the key [Skip} the existing angular correction is set to “0”
- Applying the key [Last offset] the existing value from the last measurement will be applied.



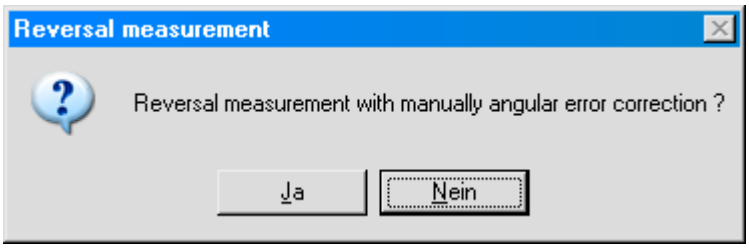
After the second reading the zero offset of the instrument is automatically calculated
offset = {measurement <A> + measurement <A'>} / 2 and displayed. This value must be confirmed by pressing [confirm]



The angular error of the instrument is now defined and the zero error is compensated, the measurement can be started.

Procedure option 2
Automatic definition of the zero offset and manual setup of the angular error

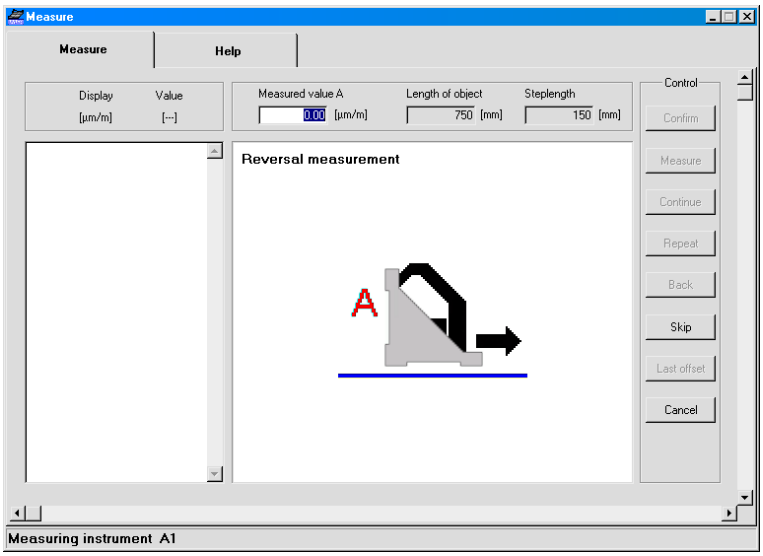
After starting the measurement by pressing [ENTER] the following dialogue box appears with the inquiry "Reversal measurement with manual angular error correction?"



In option 2 the manual correction of the angular error is entered manually. The answer to the question is <YES>.

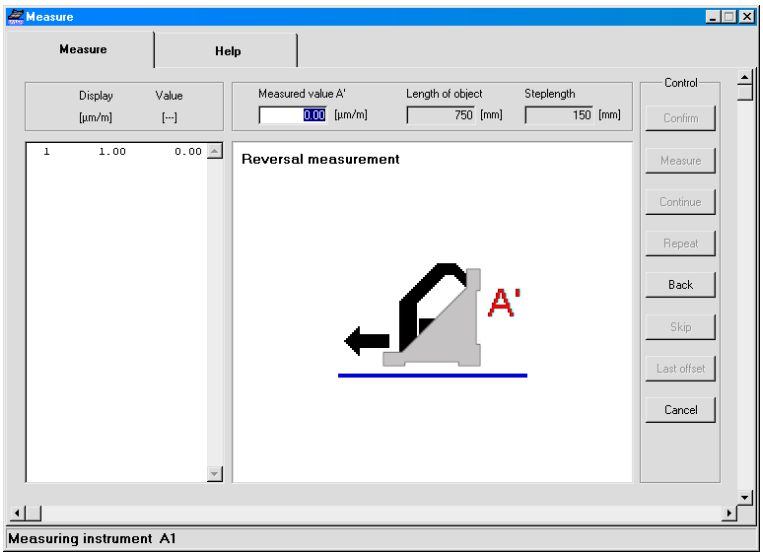
After selection <YES> the procedure for the horizontal zero setting is started.

The first measurement with the instrument is measurement "**A**".



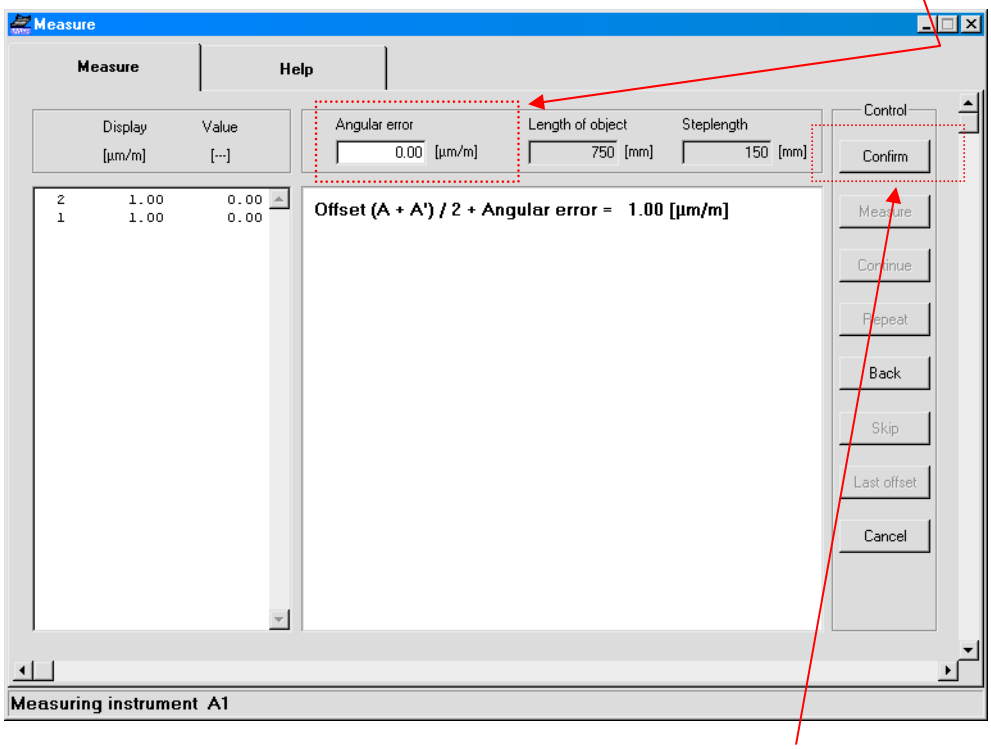
This reversal measurement is for the definition of the zero offset of the instrument only

During the data collection of the first measurement the remark “please wait” is displayed. When finished the second measurement must be done, measurement “**A’**”.



After the second reading the zero offset of the instrument is automatically calculated **without definition of the angular error**. **Offset = {measurement <A> + measurement <A’>} / 2** and displayed.

As the next step the **angular error of the instrument** must be entered manually (see the following remarks concerning “angular error of an instrument”). The value of the angular error can usually be found on a calibration certificate. Is no calibration certificate available and if this value is not known or no square block for the definition is available the value “0” should be entered.

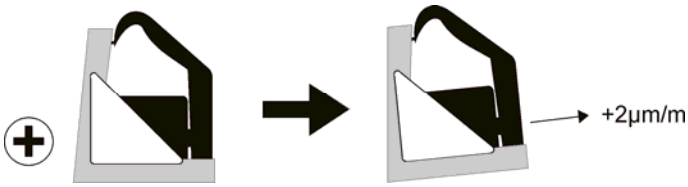


After manually entering the angular error and the zero offset have to be accepted by pressing [confirm]

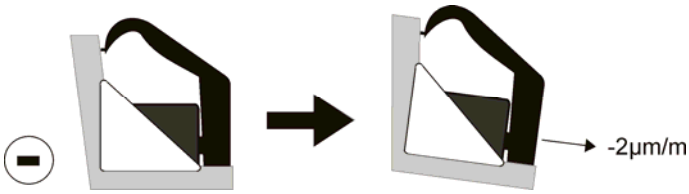
The planned measurement can now be started.

Remarks concerning “**ANGULAR ERROR**” of an instrument

Checking the squareness of an instrument with angular base

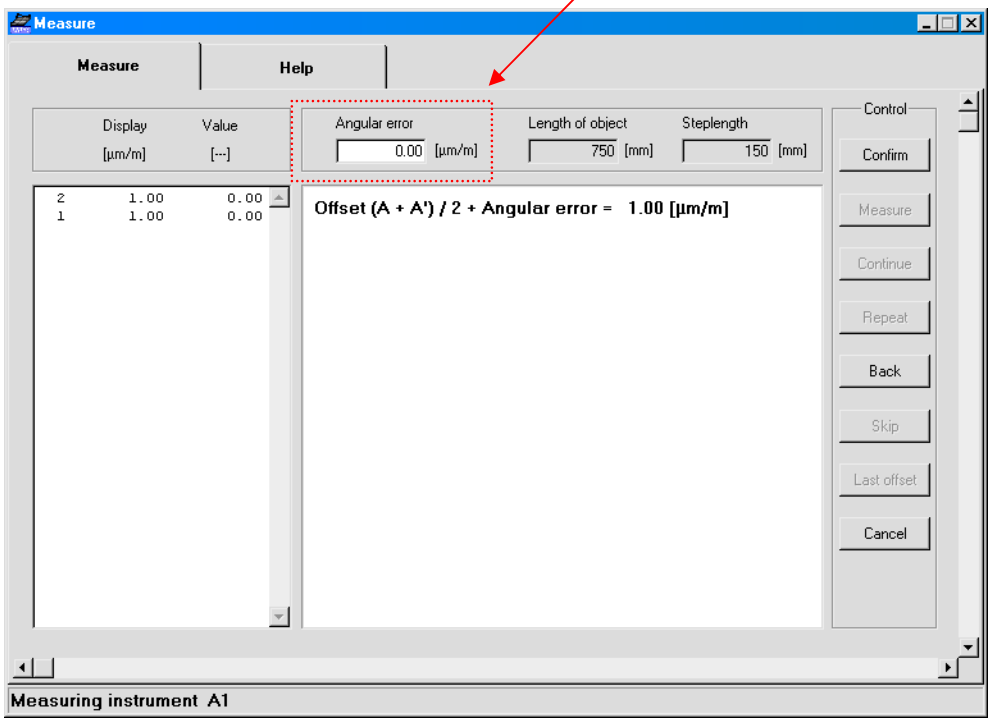


The angular error of a measuring instrument is “tapered off“. This is the case when the instrument is attached with the vertical base to an exactly vertical surface and the result would be without angular correction e.g. +2 µm/m



The angular error of a measuring instrument is “obtuse“. This is the case when the instrument is attached with the vertical base to an exactly vertical surface and the result would be without angular correction e.g. -2 µm/m

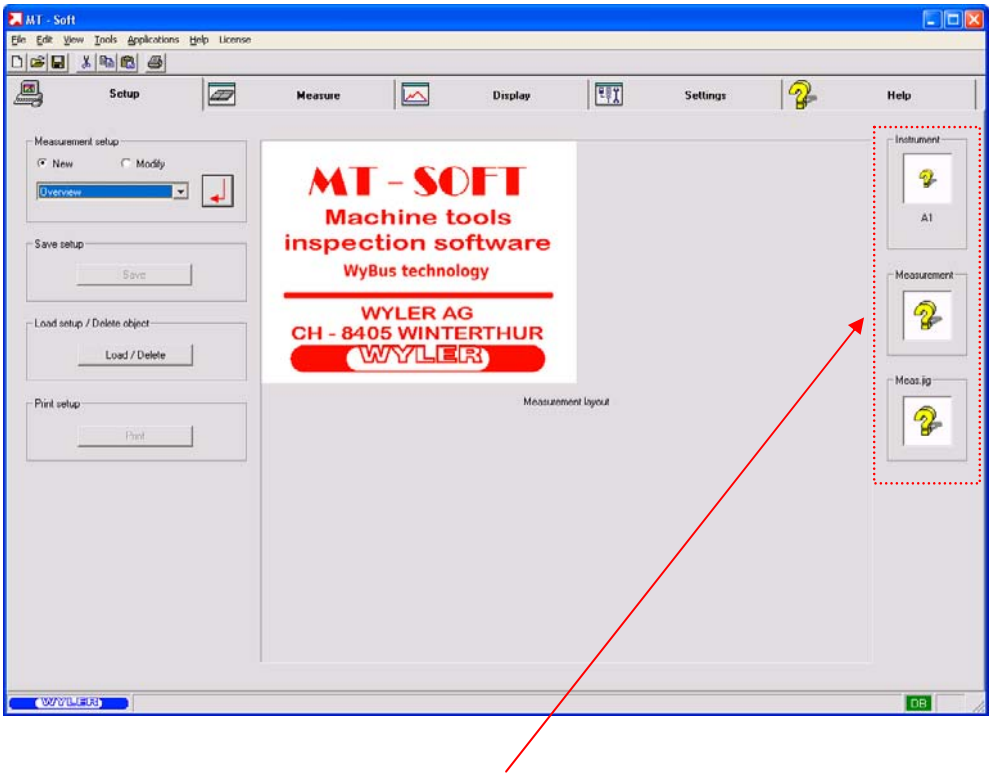
In the certificates of WYLER SWITZERLAND this value can be found in "Angular error vertical surface to surface horizontal". The determined value should be entered in the respective place <**ANGULAR ERROR**>. It is important to check the correct sign!!



3 INTRODUCTION TO MT-SOFT

3.1 BASIC ELEMENTS

When starting the software the following window appears:

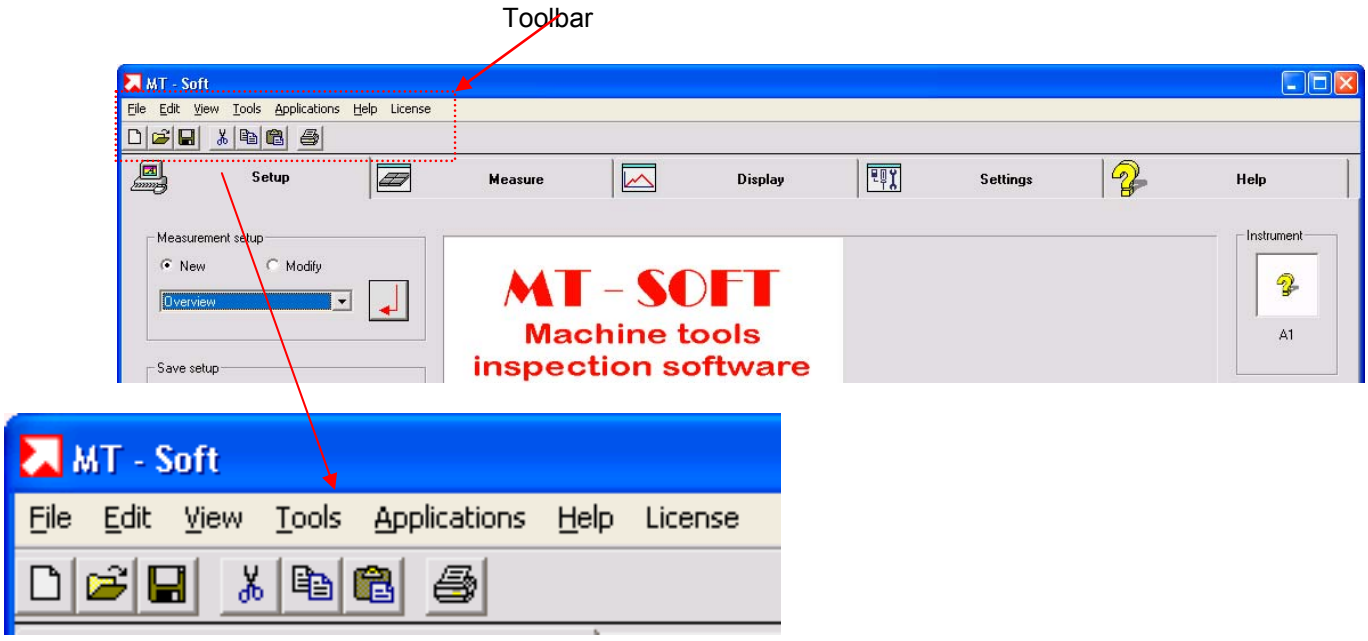


The information provided shows that neither the measuring instruments nor the measurement are defined.

There are two possibilities now

- Start a new measurement by using "Measurement Setup"" and "New"
  or
- use an existing measurement by applying “Load Setup/ Delete Object” and [Load/Delete]

3.2 MENU STRUCTURE AND OPTIONS



3.3 MENU {FILE}

3.3.1 NEW DB / DATABASE

Create a new Data Base: name ...*.dbs

3.3.2 OPEN DB / DATABASE

Open an existing Data Base: name ...*.dbs

3.3.3 SAVE DB / DATABASE

Save the actual Data Base: New name ...*.dbs

3.3.4 REORGANIZE DB

Two fragmentations are influencing the performance and the size of the data:

- Fragmentation of the database (*.dbs) file.
  Applied when the database does not have enough successional space

- Fragmentation of the spread sheets (tables) within the data base
  The tables may be fragmented after a certain time of use

For the data base it is possible to use the disk drive defragmenting software. The data base should be saved first.

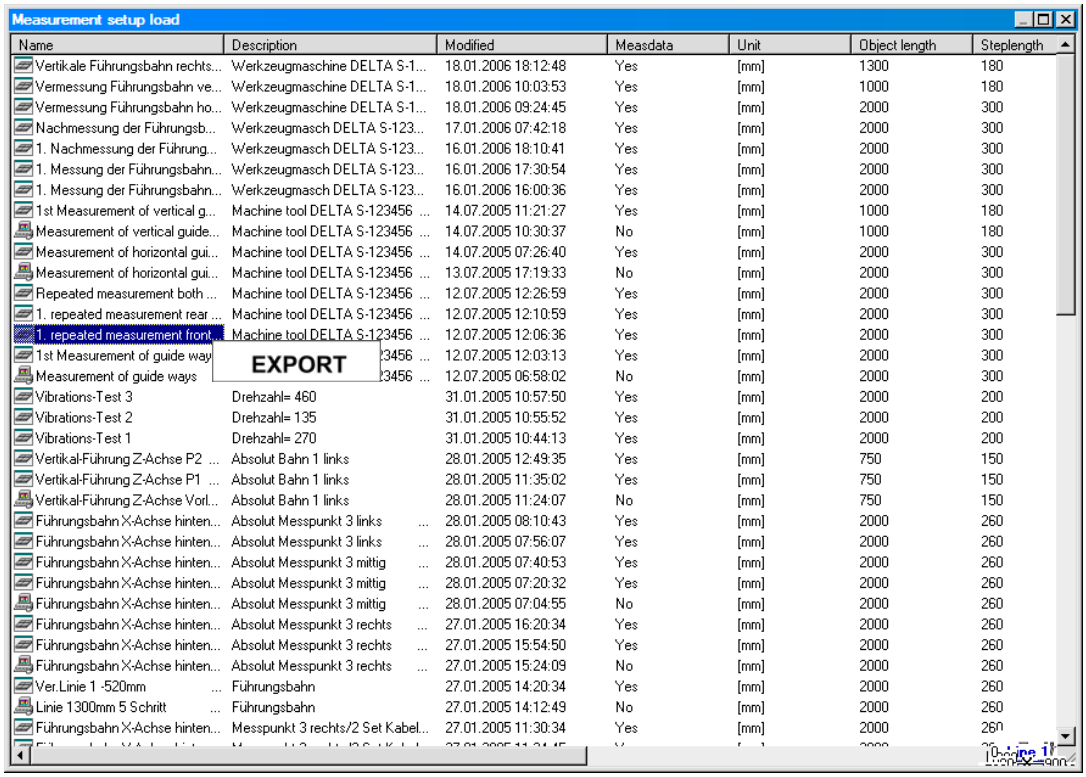
For defragmenting the tables the function "Reorganize DB is used.

3.3.5 IMPORT OBJECT… / IMPORTING A MEASUREMENT / IMPORTING A MEASURED FILE

In the menu {file} the submenu {Import object…} is found. With this menu previously exported and saved measurements / measurement files with the ending *.sql can be imported.

EXPORTING MEASUREMENT DATA / EXPORT FILE

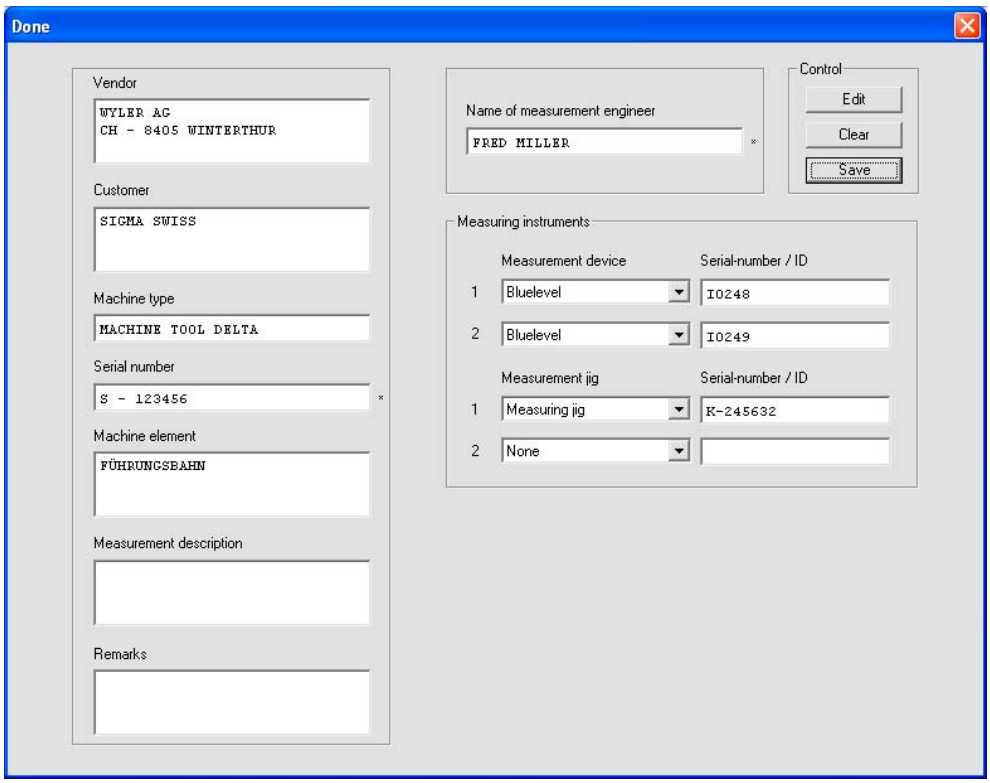
Under [Setup] / [Load setup / Delete object] / [Load / Delete]
or under [Measure] / [Load / Delete measurement / [Load / Delete]
or under [Display] / [Load measurement] / [Load]
Right mouse-click to the file to be exported. The following information is displayed: "Export".
A mouse-click to this information will export the file to the directory: …\Program\MT-SOFT\Exports*.sql



Name	Description	Modified	Measdata	Unit	Object length	Steplength
Vertikale Führungsbahn rechts...	Werkzeugmaschine DELTA S-1...	18.01.2006 18:12:48	Yes	[mm]	1300	180
Vermessung Führungsbahn ve...	Werkzeugmaschine DELTA S-1...	18.01.2006 10:03:53	Yes	[mm]	1000	180
Vermessung Führungsbahn ho...	Werkzeugmaschine DELTA S-1...	18.01.2006 09:24:45	Yes	[mm]	2000	300
Nachmessung der Führungsb...	Werkzeugmasch DELTA S-123...	17.01.2006 07:42:18	Yes	[mm]	2000	300
1. Nachmessung der Führung...	Werkzeugmasch DELTA S-123...	16.01.2006 18:10:41	Yes	[mm]	2000	300
1. Messung der Führungsbahn...	Werkzeugmasch DELTA S-123...	16.01.2006 17:30:54	Yes	[mm]	2000	300
1. Messung der Führungsbahn...	Werkzeugmasch DELTA S-123...	16.01.2006 16:00:36	Yes	[mm]	2000	300
1st Measurement of vertical g...	Machine tool DELTA S-123456 ...	14.07.2005 11:21:27	Yes	[mm]	1000	180
Measurement of vertical guide...	Machine tool DELTA S-123456 ...	14.07.2005 10:30:37	No	[mm]	1000	180
Measurement of horizontal gui...	Machine tool DELTA S-123456 ...	14.07.2005 07:26:40	Yes	[mm]	2000	300
Measurement of horizontal gui...	Machine tool DELTA S-123456 ...	13.07.2005 17:19:33	No	[mm]	2000	300
Repeated measurement both ...	Machine tool DELTA S-123456 ...	12.07.2005 12:26:59	Yes	[mm]	2000	300
1. repeated measurement rear ...	Machine tool DELTA S-123456 ...	12.07.2005 12:10:59	Yes	[mm]	2000	300
1. repeated measurement front...	Machine tool DELTA S-123456 ...	12.07.2005 12:06:36	Yes	[mm]	2000	300
1st Measurement of guide way	3456 ...	12.07.2005 12:03:13	Yes	[mm]	2000	300
Measurement of guide ways	3456 ...	12.07.2005 06:58:02	No	[mm]	2000	300
Vibrations-Test 3	Drehzahl= 460	31.01.2005 10:57:50	Yes	[mm]	2000	200
Vibrations-Test 2	Drehzahl= 135	31.01.2005 10:55:52	Yes	[mm]	2000	200
Vibrations-Test 1	Drehzahl= 270	31.01.2005 10:44:13	Yes	[mm]	2000	200
Vertikal-Führung Z-Achse P2 ...	Absolut Bahn 1 links	28.01.2005 12:49:35	Yes	[mm]	750	150
Vertikal-Führung Z-Achse P1 ...	Absolut Bahn 1 links	28.01.2005 11:35:02	Yes	[mm]	750	150
Vertikal-Führung Z-Achse Vorl...	Absolut Bahn 1 links	28.01.2005 11:24:07	No	[mm]	750	150
Führungsbahn X-Achse hinten...	Absolut Messpunkt 3 links ...	28.01.2005 08:10:43	Yes	[mm]	2000	260
Führungsbahn X-Achse hinten...	Absolut Messpunkt 3 links ...	28.01.2005 07:56:07	Yes	[mm]	2000	260
Führungsbahn X-Achse hinten...	Absolut Messpunkt 3 mittig ...	28.01.2005 07:40:53	Yes	[mm]	2000	260
Führungsbahn X-Achse hinten...	Absolut Messpunkt 3 mittig ...	28.01.2005 07:20:32	Yes	[mm]	2000	260
Führungsbahn X-Achse hinten...	Absolut Messpunkt 3 mittig ...	28.01.2005 07:04:55	No	[mm]	2000	260
Führungsbahn X-Achse hinten...	Absolut Messpunkt 3 rechts ...	27.01.2005 16:20:34	Yes	[mm]	2000	260
Führungsbahn X-Achse hinten...	Absolut Messpunkt 3 rechts ...	27.01.2005 15:54:50	Yes	[mm]	2000	260
Führungsbahn X-Achse hinten...	Absolut Messpunkt 3 rechts ...	27.01.2005 15:24:09	No	[mm]	2000	260
Ver.Linie 1 -520mm ...	Führungsbahn	27.01.2005 14:20:34	Yes	[mm]	2000	260
Linie 1300mm 5 Schritt ...	Führungsbahn	27.01.2005 14:12:49	No	[mm]	2000	260
Führungsbahn X-Achse hinten...	Messpunkt 3 rechts/2 Set Kabel...	27.01.2005 11:30:34	Yes	[mm]	2000	260

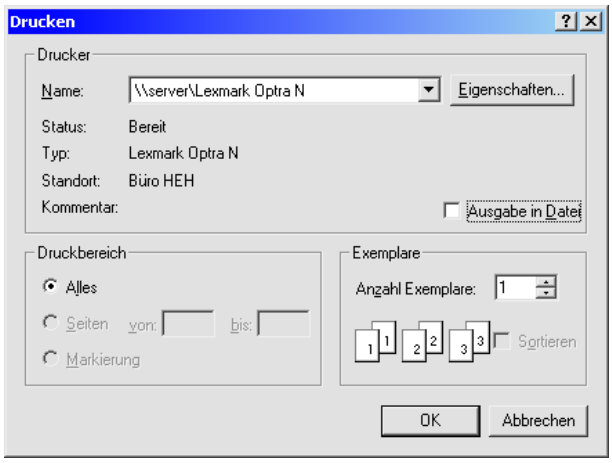
3.3.6 PRINT.... / PRINTING THE DATA OF A MEASUREMENT WITH VARIOUS OPTIONS

Printing a template or a measurement (if available).
Entrance mask for defining the measuring task

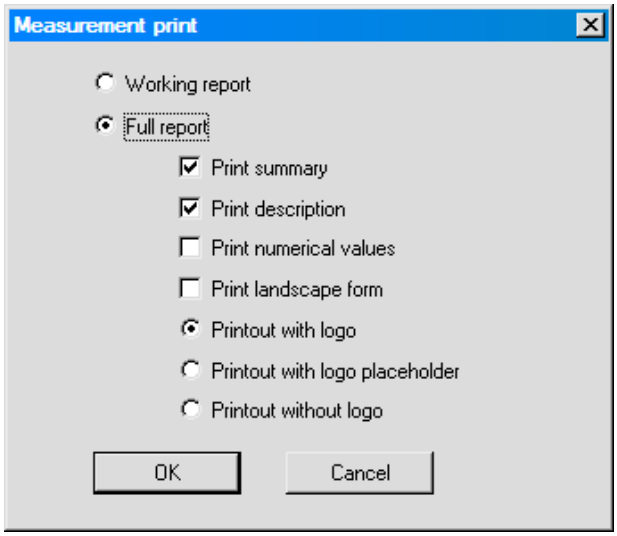


[Confirm]	Continue the measuring task
[Clear]	Existing data is deleted, new data can be entered
[Replace]	The displayed information can be replaced by an existing one. The description of the measuring task is done in the menu [Settings] Message description template

After confirming with [Confirm] the respective printer may be chosen



Using the menu bar always the setup of the measurement (1st run) as well as the measured results according to the preset options (2nd run) are printed.



When choosing the Menu <**PRINT**> in the View <**DISPLAY**> the printing measurement printing setup is defined

- Working report: Definition of measuring task and measuring figure
- Full report
  - Print summary
  - Print description
  - Print numerical values
  - Print landscape form (additional print of figure in landscape mode)
  - Print with Logo (The Logo defined is printed, see <Settings> for changing the Logo
  - Print with Logo place holder
  - Print without Logo

3.3.7 PRINTER SETUP

Choice of printer
A window opens for setting up the correct printer and the printer parameters

3.3.8 PRINT FONT SETUP

Selection of print fonts
A window opens for the selection of the fonts, their size and the colour

3.3.9 EXIT

Terminate MT-Soft without terminating the data base

3.3.10 EXIT (DEFAULT VALUES)

Terminate MT-Soft and reinstall the default values

Default values are:

Language	English
Window X position	window Default
Window Y position	window Default
Window width	smallest size
Window height	smallest size
Measuring unit	[mm]
Measuring display unit	[mm/m]
Limit of variation	5.0 µm/m
Scale range	0
Limit of variation	5.0 µm/m
Scale range	0
Manual input	
Manual input unit	[mm]
Sensitivity	1.0 µm/m

Leveladapter:

Measuring instrument	MINILEVEL
Output	1 mV/Unit
Sensitivity	1.0 µm/m

3.3.11 EXIT (SHUTDOWN DB SERVER)

Terminating MT-Soft and shut down the data base ("Server Task").

Remarks

When more than one MT-Soft was started the "Server Task" remains active until the last program was terminated.

3.4 Menu [Edit]

- Undo
- Cut
- Copy
- Paste

Remarks

The "Edit" functions can always be used in the main window where entrance boxes are available. In most cases a right mouse click opens a popup window.

3.5 Menu [View]

- Tool Bar (The display of the tool bar may be set to On or Off)
- Font Size (The font size can be changed)

3.6 MENU [TOOLS]

In the submenu [Options] a number of settings are possible, such as

Set Language for choosing the language required

3.7 APPLICATIONS

- Compare measurements
  Comparison of different measurements of parallelism and rectangularity done on the same or similar objects

- Set absolute ZERO
  Defines the ZERO offset by means of a reversal measurement and stores the new value in the instrument

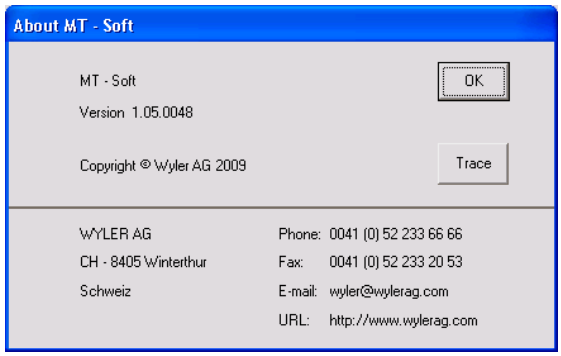
3.8 MENU {HELP}

3.8.1 HELP

Help file when using the software. Manual in pdf-format.

3.8.2 ABOUT MT-SOFT

This gives information on the used software MT-SOFT version and manufacturer/supplier data

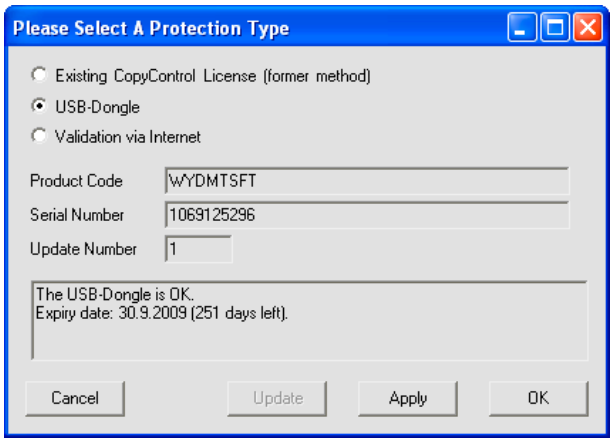


3.9 LICENSING

In the menu {Licensing} the present license is displayed. For the licensing, information like

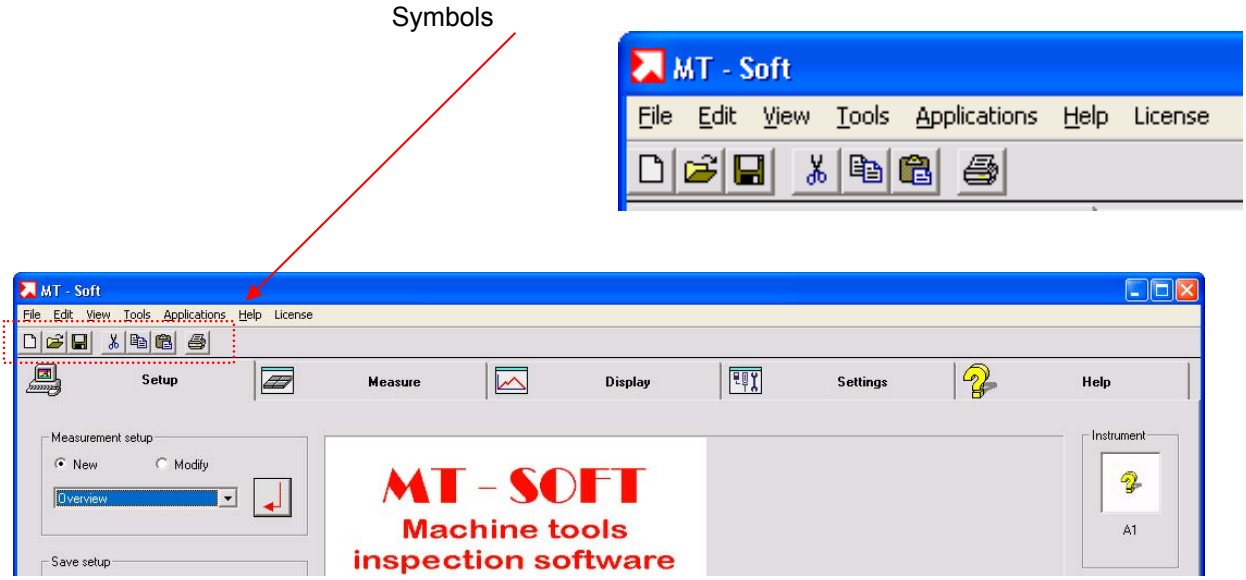
- Product-Code
- Serial Number

is important. This information must be communicated to WYLER SWITZERLAND for the licensing of the product (validation code). For further details please consult the information brochure "Installation of the software MT-SOFT"



3.10 OVERVIEW REGISTER

The mostly used commands can be activated by either using on e of the buttons or using the menus.



3.10.1 NEW DB / DATABASE

Create a new Data Base: name ...*.dbs

3.10.2 OPEN DB / DATABASE

Open an existing Data Base: name ...*.dbs

3.10.3 SAVE DB / DATABASE

Save the actual Data Base: New name ...*.dbs

3.10.4 CUT

3.10.5 COPY

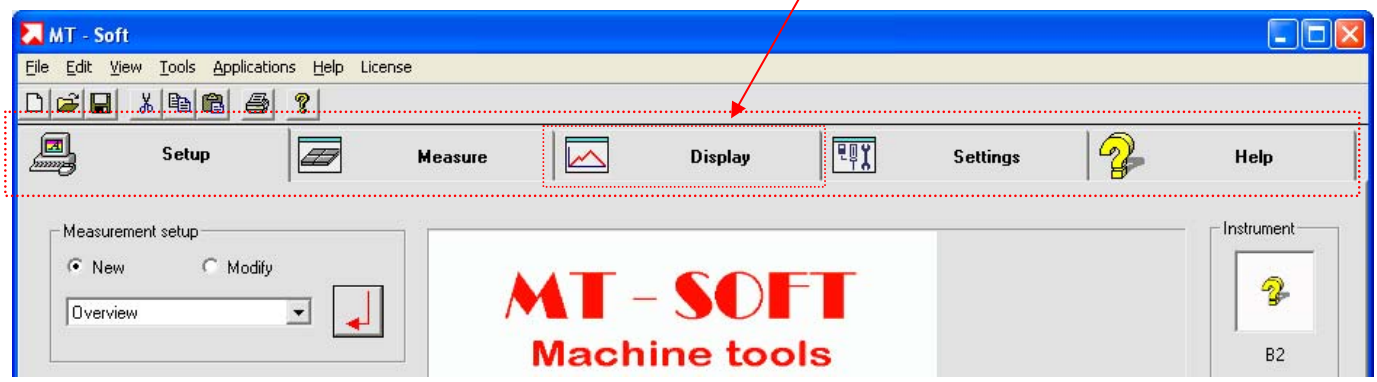
3.10.6 PASTE

3.10.7 PRINT

Print the data of a measurement / details see 4.2.3

3.11 OVERVIEW REGISTER

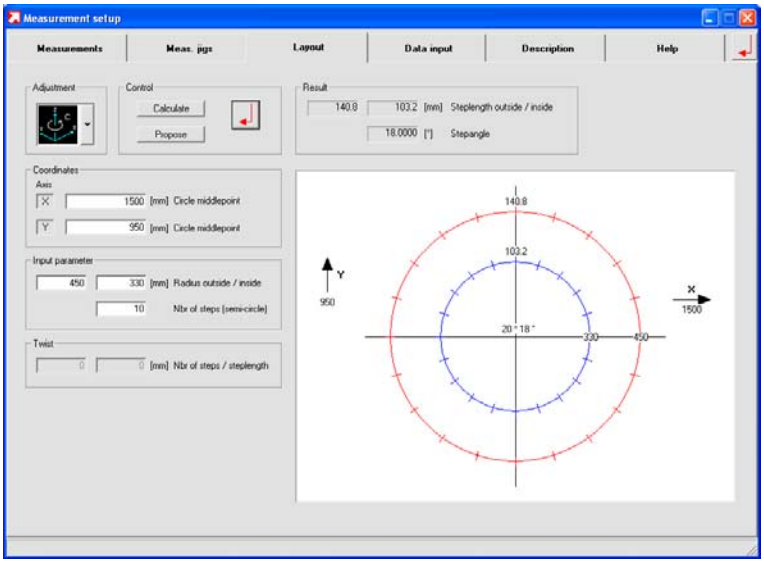
Register, e.g. <DISPLAY>



3.11.1 REGISTER <SETUP>

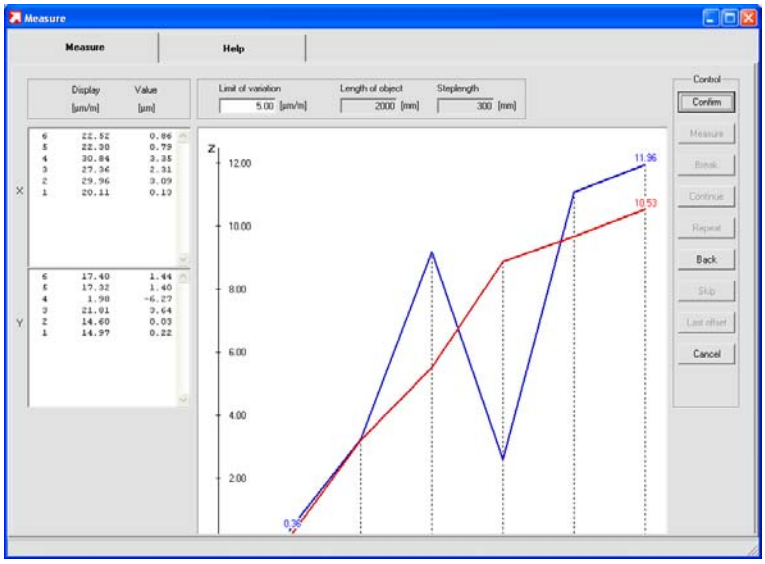
- Overview of all possible measurement setup groups
- Selection of a specific measurement setup
- Configuration of a specific measurement setup such as:
  - Measuring object
  - Measuring JIG
  - Layout of the measurement with coordinates (Length of object, measuring steps etc.)
  - Configuration of measuring instruments (Measuring instrument with/without reference instrument, Reversal measurement Yes/No, for absolute measurement, measurement of one or two axis)
  - Description of the measuring task (Identification of the Engineer in charge is mandatory)
  - Saving the setup as template
  - Load or delete an existing setup

example "Circles"



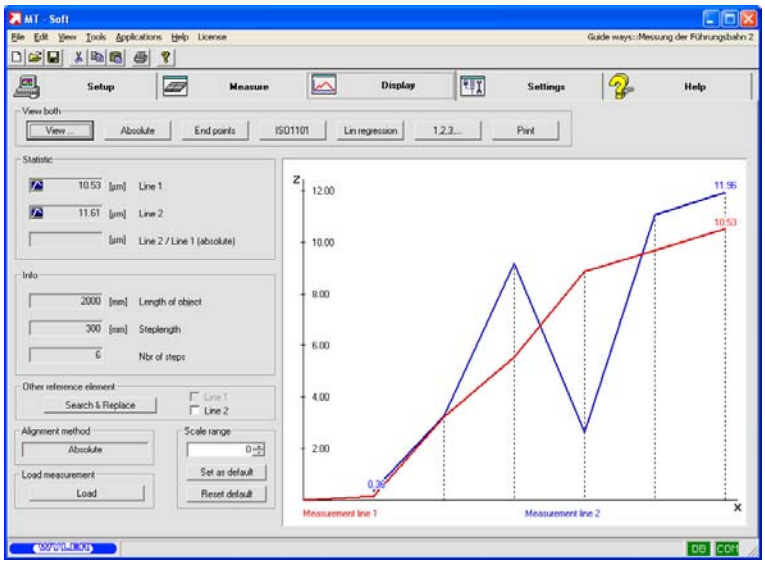
3.11.2 REGISTER <MEASURE>

- Start measurement
- Adjust additional parameters such as X and Y-axis simultaneously
- Refresh the actual measuring instrument's configuration
- Saving the actual measurement
- Loading an existing saved measurement
- Graphical display of the actual measurement with additional information such as flatness, straightness etc.



3.11.3 REGISTER <DISPLAY>

- Analyzing possibility of the measured results
- Display of measurement statistics such as straightness, flatness, closure error etc.
- Selection of measured object's data when more than one curve is included
- Display of the measurement in the Absolute mode
- Display of the measurement according to different alignment methods
  - Method **Absolute**
  - Method **End points**
  - Method **ISO1101**
  - Method **Linear regression**
- Zooming the graphic display (Zoom)
  - Individual display of the curves available
  - Definition of the scale
  - Display of measured numerical values (different options)
  - Print setup of the measurement information

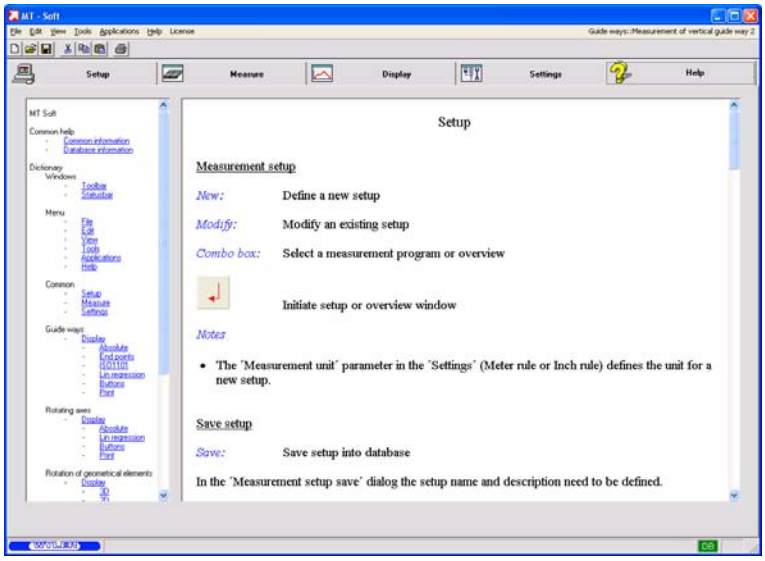


3.11.4 REGISTER <SETTINGS>

- Definition of the measurement unit (metric rule, inch rule)
- Definition of the measuring display unit (µm/m, Arcsec., inch/10inch, inch/12inch, mRad)
- Definition of the limit of variation
- Definition of the measuring instrument's sensitivity for instruments not automatically recognised or when using instruments other than WYLER make
- Definition of the input unit if console input is chosen
- Definition of the content of the measurement description template (Manufacturer, customer, machine type, identification of measurement engineer, etc.
- Definition of Logo (customer supplied)

3.11.5 REGISTER <HELP>

To the most important questions a Help file is installed



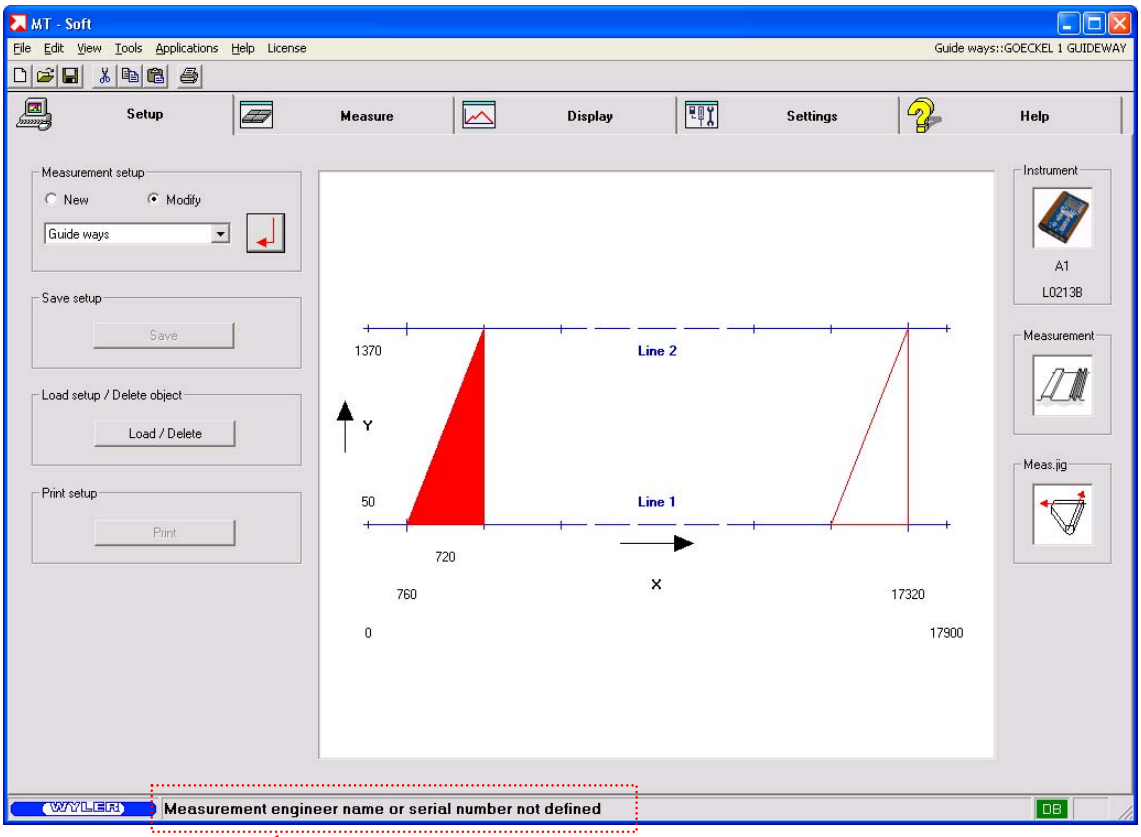
3.12 STATUS BAR

The status bar is divided in three sections

- left — WYLER Logo
- Centre — Display of software status, error messages, information required. Important messages are flashing
- right — Messages concerning Data Base activities

  DB (green) Data Base started and active

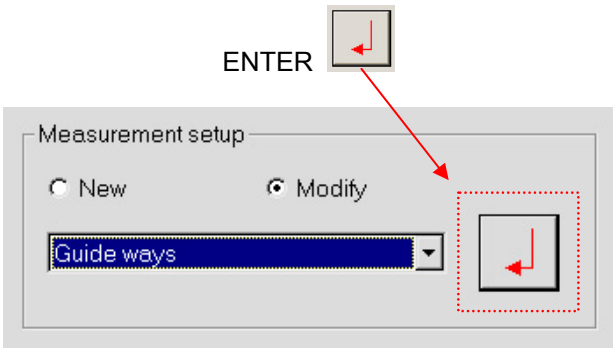
Under "measuring instrument" the actually used interface is displayed.



Status display error message

4 DEFINITION OF A NEW MEASUREMENT AND STARTING THE MEASUREMENT (EXAMPLE MEASUREMENT OF CIRCLES)

In the register Setup, see below Measurement Setup, the pull down menu can be used to change to “Circles” and confirm with



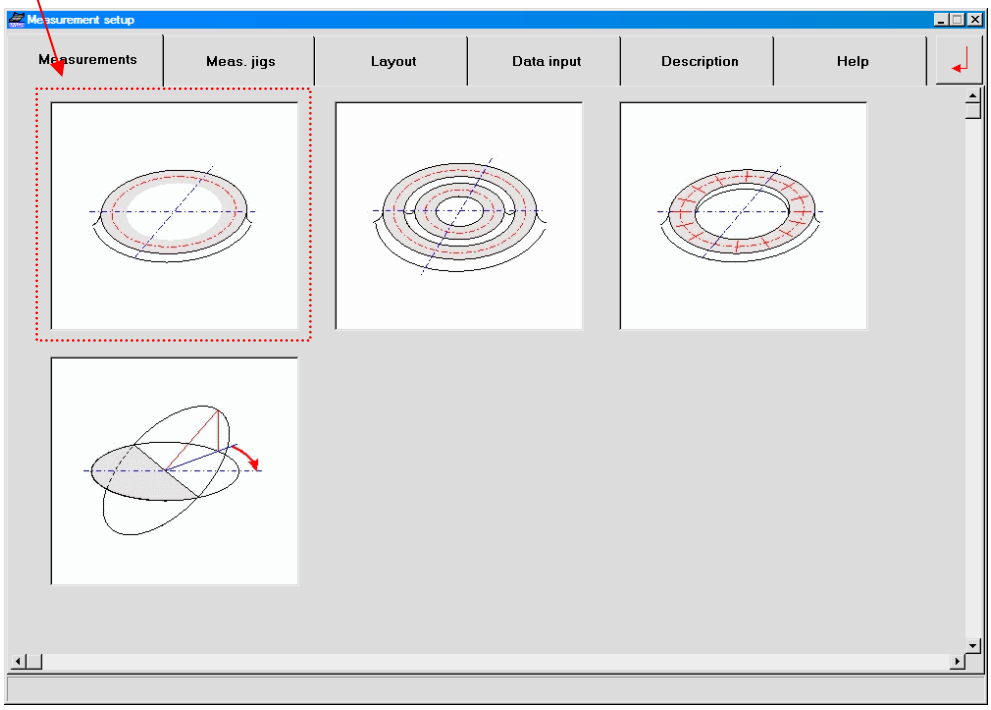
Two possibilities are available:

- Install a completely new configuration by using <New> / [ENTER]
- Modification of an existing setup by using <Modify> / [ENTER]

4.1 SETUP / MEASUREMENT SETUP / MEASUREMENT

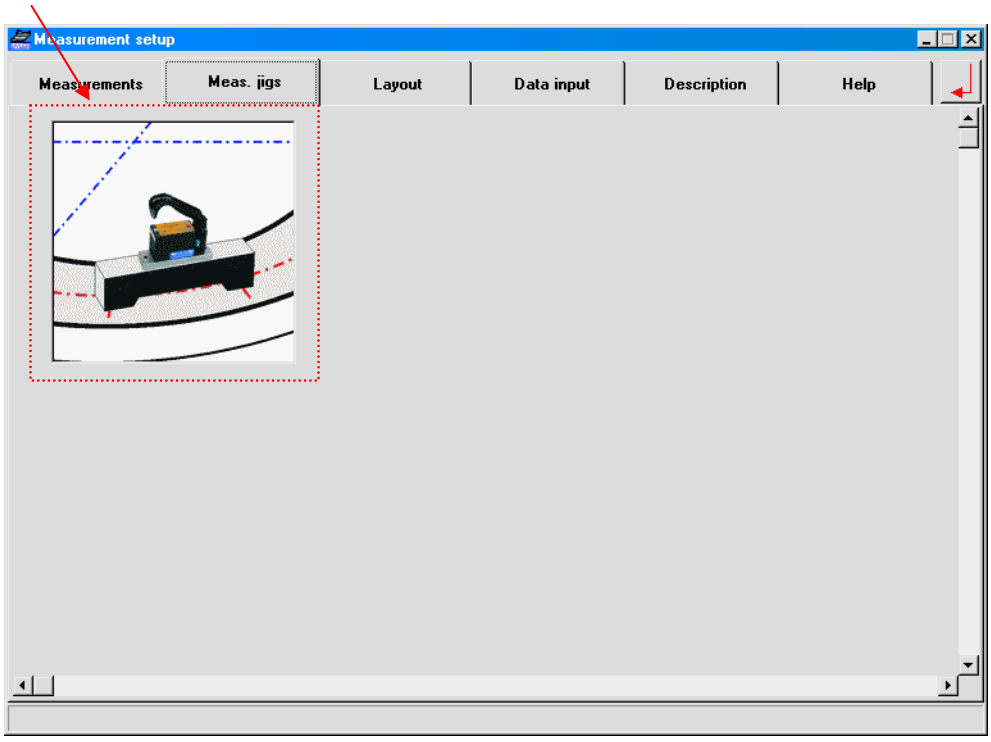
The definition of the configuration can now be done

The required pattern can be chosen by mouse click to the respective picture. In our example we chose the first figure



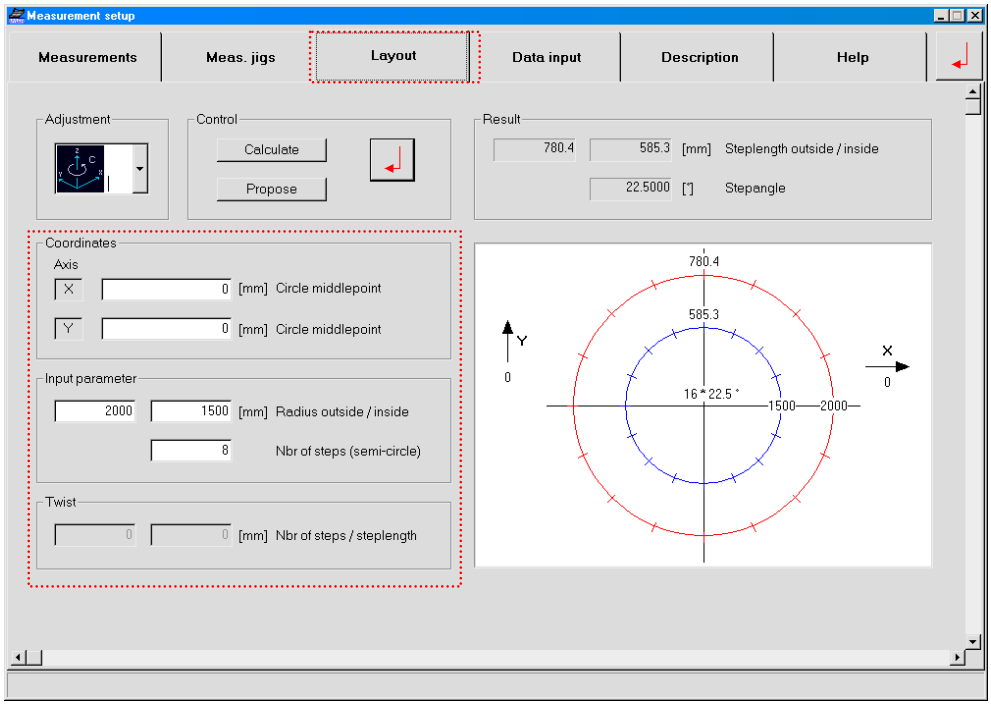
4.1.1 DEFINITION OF THE MEASURING JIG / MEASURING DEVICE

In the example “circles” only one JIG is available. The figure shows one individual base which can be the instrument's base or a granite straight edge. The JIG is selected by mouse click (Black background)

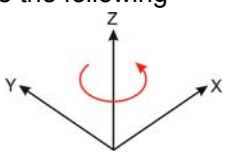


4.1.2 MEASUREMENT SETUP / LAYOUT

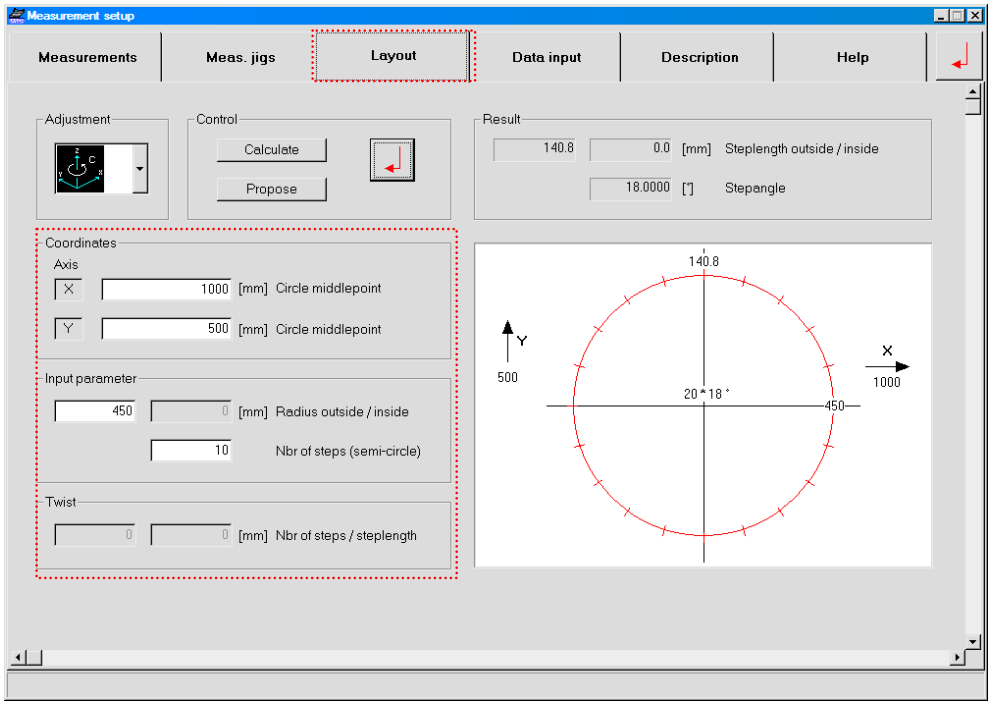
Clicking to the sub register [Layout] opens the input window for the measurement configuration



- The first step is to define the X / Y / Z coordinates (See also DIN 66 217 / ISO 841-1974 Numerical control of machines). The standards are defined by the machine setup. For our example the following applies
  - **X-axis**: positive direction from left to right
  - **Y-axis**: positive direction from near to far
  - **Z-axis**: positive direction from bottom to top



- The next step is to define the position and dimensions of the circle and the number of measuring steps



In our example:

X-axis coordinate:	1000mm (Distance from the ZERO-point of the machine in X-direction)
Y-axis coordinate:	500mm (Distance from the ZERO-point of the machine in Y-direction)
Outside radius:	450mm
Number of steps per semi circle:	10 (total 20 steps)

X-axis coordinate: 1000mm (Distance from the ZERO-point of the machine in X-direction)
Y-axis coordinate: 500mm (Distance from the ZERO-point of the machine in Y-direction)
Outside radius: 450mm
Number of steps per semi circle: 10 (total 20 steps)

It is also possible to let the software **show a number of possibilities** by using the button [Propose]

Circle grid proposal

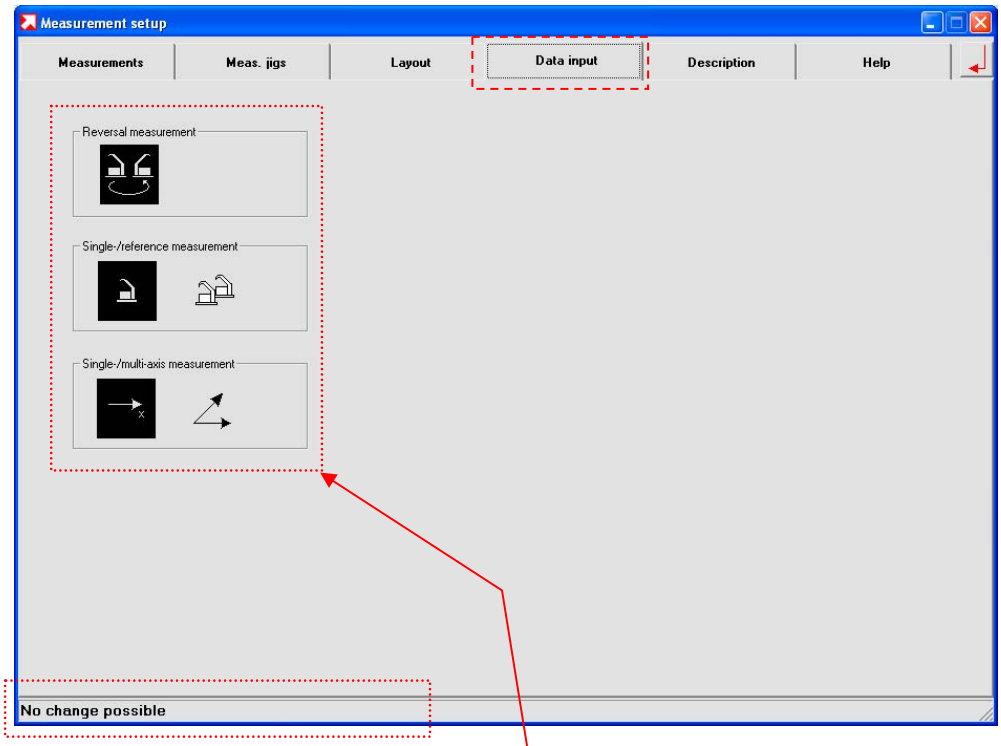
Nbr of steps	Stepangle	Steplength o...	Steplength in...	Length 1 (ma...	Radius 1 (ma...	Length 2 (ma...	Radius 2 (ma...
2	90.0	636.4	0.0	635.0	449.0	640.0	452.5
3	60.0	450.0	0.0	445.0	445.0	450.0	450.0
4	45.0	344.4	0.0	340.0	444.2	345.0	450.8
5	36.0	278.1	0.0	275.0	445.0	280.0	453.0
6	30.0	232.9	0.0	230.0	444.3	235.0	454.0
8	22.5	175.6	0.0	175.0	448.5	180.0	461.3
9	20.0	156.3	0.0	155.0	446.3	160.0	460.7
10	18.0	140.8	0.0	140.0	447.5	145.0	463.5
12	15.0	117.5	0.0	115.0	440.5	120.0	459.7
15	12.0	94.1	0.0	90.0	430.5	95.0	454.4
18	10.0	78.4	0.0	75.0	430.3	80.0	458.9
20	9.0	70.6	0.0	70.0	446.1	75.0	478.0
30	6.0	47.1	0.0	45.0	429.9	50.0	477.7
36	5.0	39.3	0.0	35.0	401.2	40.0	458.5
45	4.0	31.4	0.0	30.0	429.8	35.0	501.4
60	3.0	23.6	0.0	20.0	382.0	25.0	477.5
90	2.0	15.7	0.0	15.0	429.7	20.0	573.0

If correct confirm with [Enter] 

On the screen the preview of the setup is displayed

4.1.3 MEASUREMENT SETUP/DATA INPUT

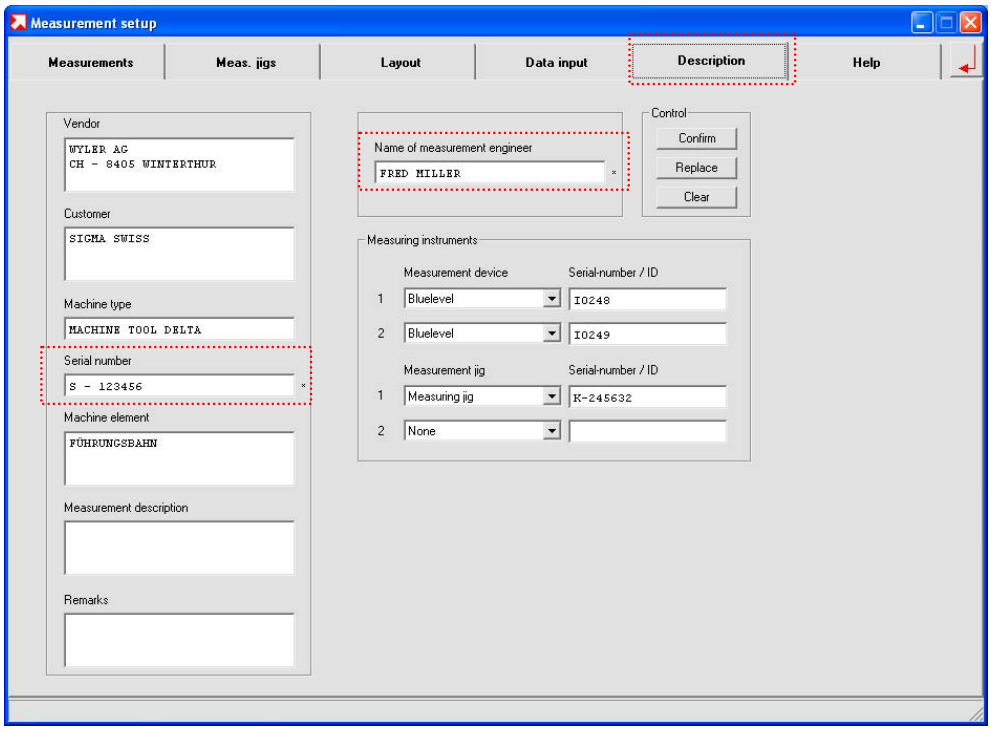
The configuration for the <DATA INPUT> must now be defined. When doing an absolute measurement it is required to first perform a reversal measurement with the instrument. In case of measuring a circle one instrument only measuring in absolute mode is possible. A reversal measurement is an absolute **MUST**. In our example the message is flashing “No change possible”



Note: In this configuration no modification is possible, e.g. when measuring a circle no differential measurement is possible, as the measurement must be performed in Absolute mode with a reversal measurement to start.

The selected settings are displayed with black background

4.1.4 MEASUREMENT SETUP / DESCRIPTION



In this dialogue box all the necessary data for defining the planned measurement can be entered.

- **The name of "Measurement Engineer"**
  and
- **the serial number of the object to be measured**

  are mandatory

All the rest of the information is free to fill in. At the end press the button [confirm]

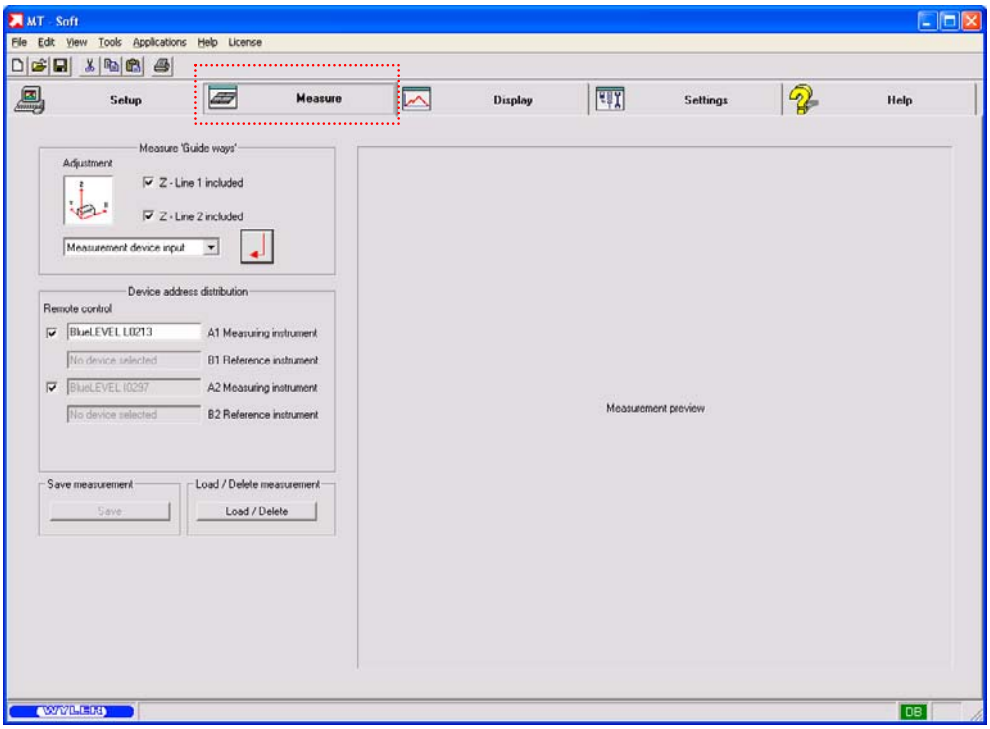
4.1.5 FINALIZE MEASUREMENT SETUP

When all the data is correctly filled in press the [Enter] button  (top right). After that the window will be closed

4.2 EXECUTE A MEASUREMENT

4.2.1 START A MEASUREMENT

After termination of the SETUP the actual measurement can be started. Select the register [Measure]



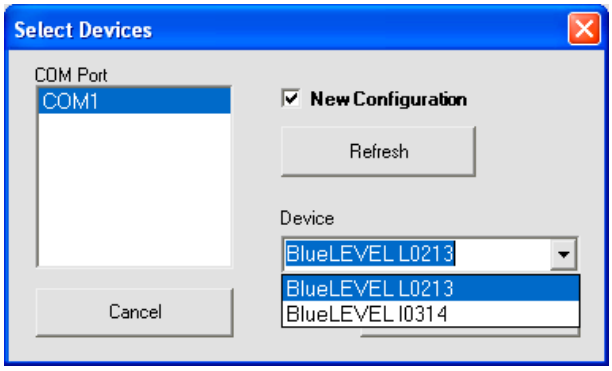
In this dialogue box you find the following information respectively selection options:

- typo of measurement (**manual entry** or measurement directly through the **measuring instruments**)
- connection of measuring instruments (in this example only one BlueLEVEL is connected)

In case **no instrument is displayed**, proceed as follows. Click in the area "Device address distribution" in the field "A1 Measuring instrument", where you would like to enter the measuring instrument. Make sure that the instruments are switched on and correctly connected to the PC.

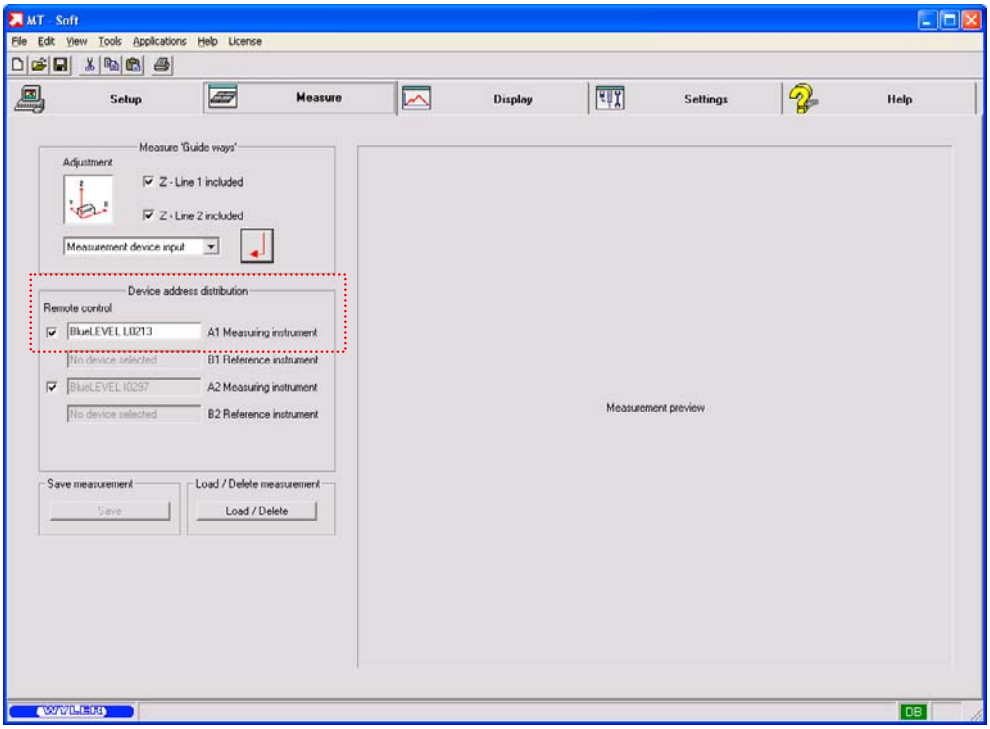
Tick "New Configuration" and click on the button [Refresh]. Under "COMport" all COM-ports available on your PC/Laptop will be displayed. Under "Device" all measuring instruments connected and available for the present measurement will be displayed. In our example it is a BlueLEVEL with the serial number L0213 and a BlueLEVEL with the serial number I0314

Select now the measuring instrument you intend to use for the forthcoming measurement and click on [OK].

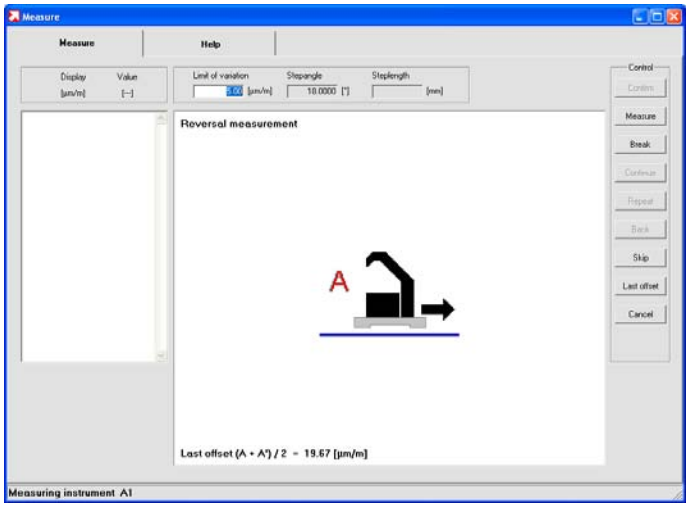


In case you use a USB-port take care of the correct COM port.

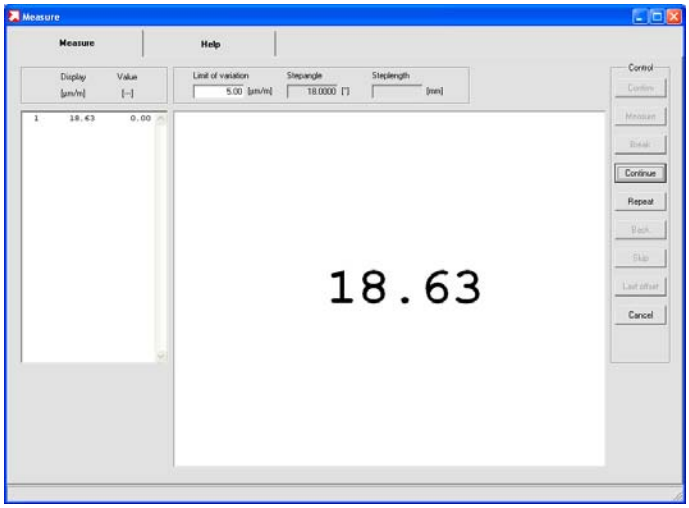
After confirmation with [OK] the measuring instrument selected will be displayed under "Device address distribution" in the field "A1 Measuring instrument"



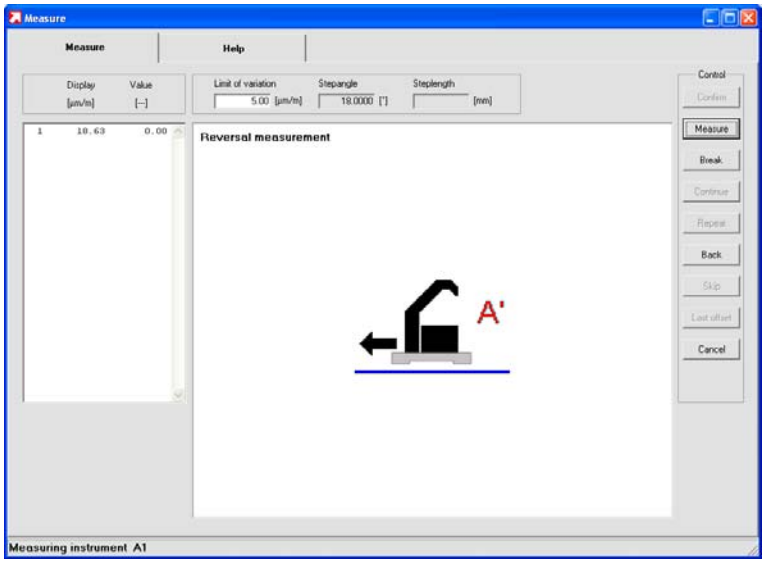
By clicking on the button  the measurement will be started. In our example at first a reversal measurement must be performed in order to use the instrument in the Absolute mode.



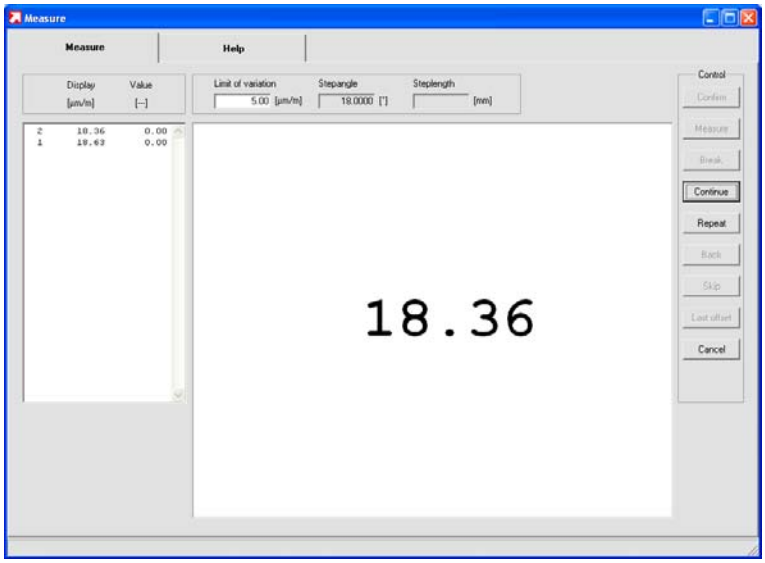
The position of the instrument for the first measurement is displayed



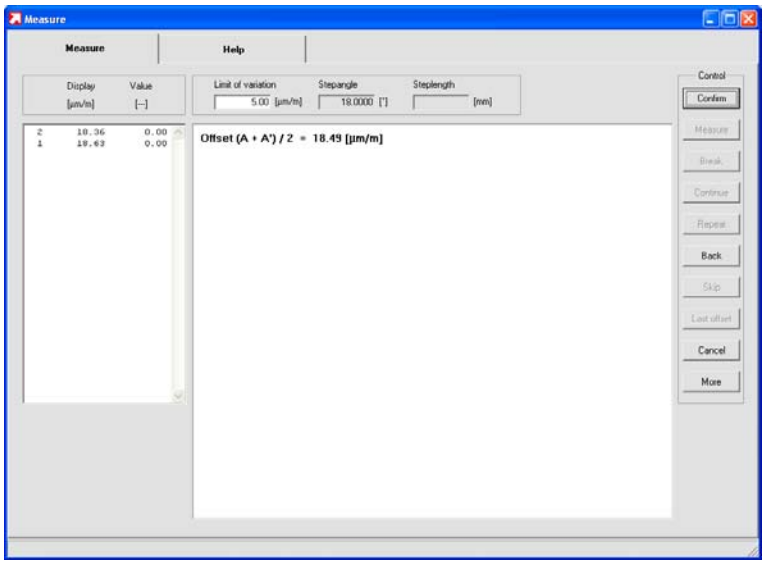
The first measured value is displayed
Using [Continue] will collect the first measuring value and lead to the next step



The position of the instrument to collect the second value is displayed, press [Measure]

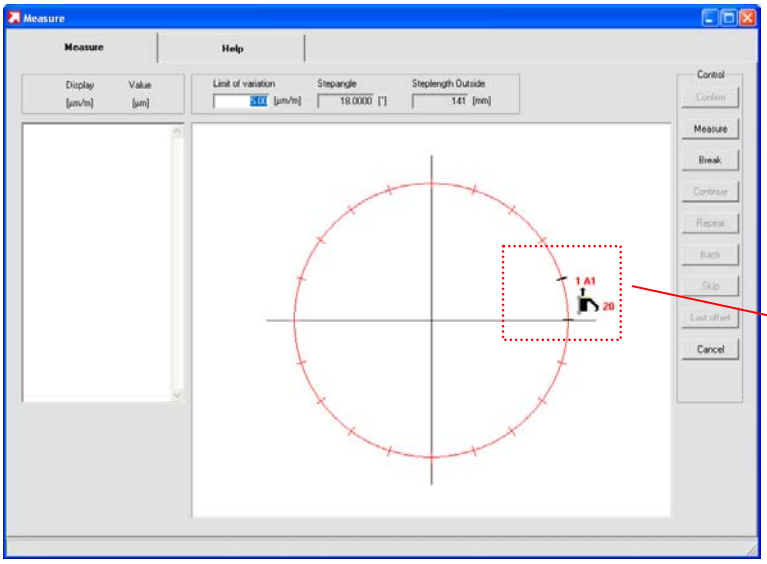


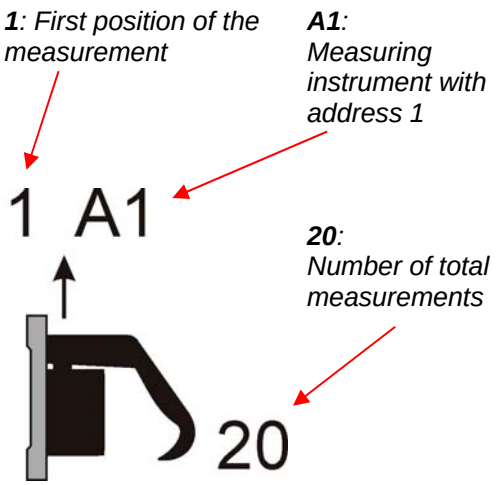
The second measured value is displayed. Using [Continue] will display the ZERO offset of the instrument. (Using manual input the value is not displayed largely but automatically transferred to the display)



With the button [Confirm] the value "Offset" is accepted and considered for the following measurement.

Via the button [More] further reversal measurements can be performed. If the device is already fully acclimatized the offset value is changed only minimally. The resulting offset is then calculated as the average of all reversal measurements.





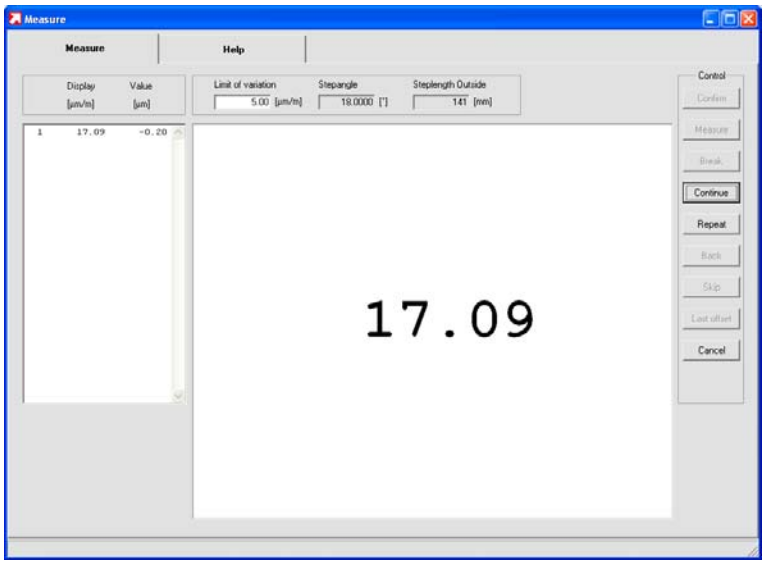
***1**: First position of the measurement*

***A1**: Measuring instrument with address 1*

***20**: Number of total measurements*

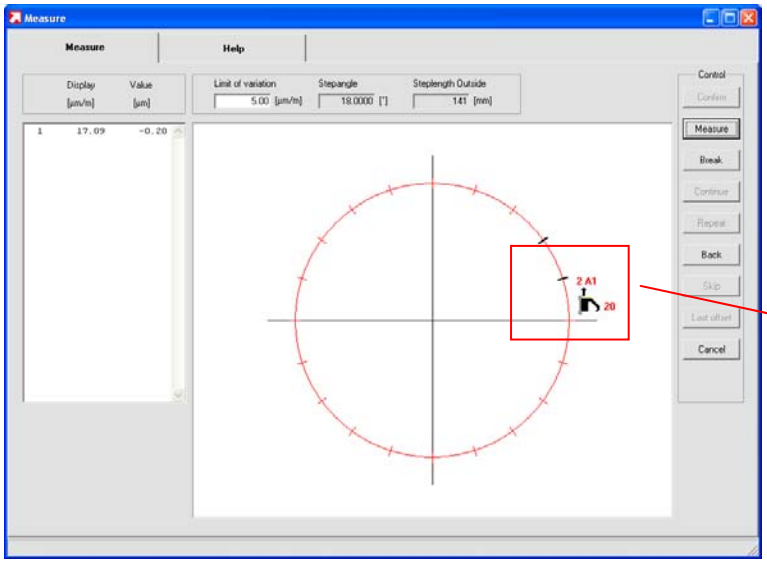
Remark: Instrument "A": connected to port "A"

Back to the measurement setup the position to place the measuring instrument is shown. Place the instrument at this position and start the measurement. (Due to better overview the instruments icon remains in place)



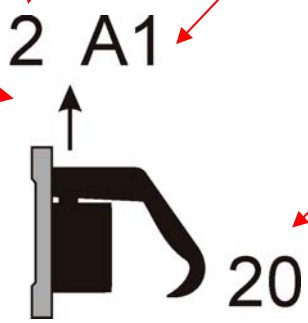
The first measuring value will de displayed and can be accepted with [Continue]

With [Repeat] the measurement can be repeated



***2**: Second position of the measurement*

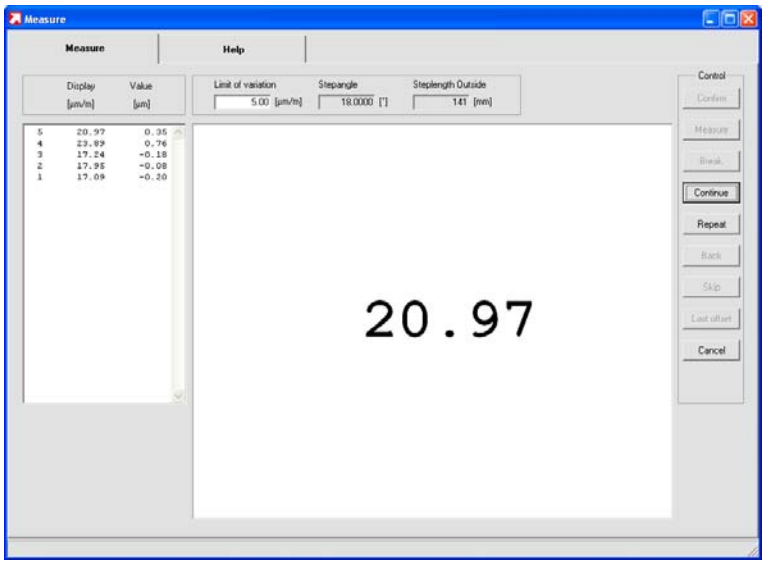
***A1**: Measuring instrument with address 1*



***20**: Number of total measurements*

Remark: Instrument "A": connected to port "A"

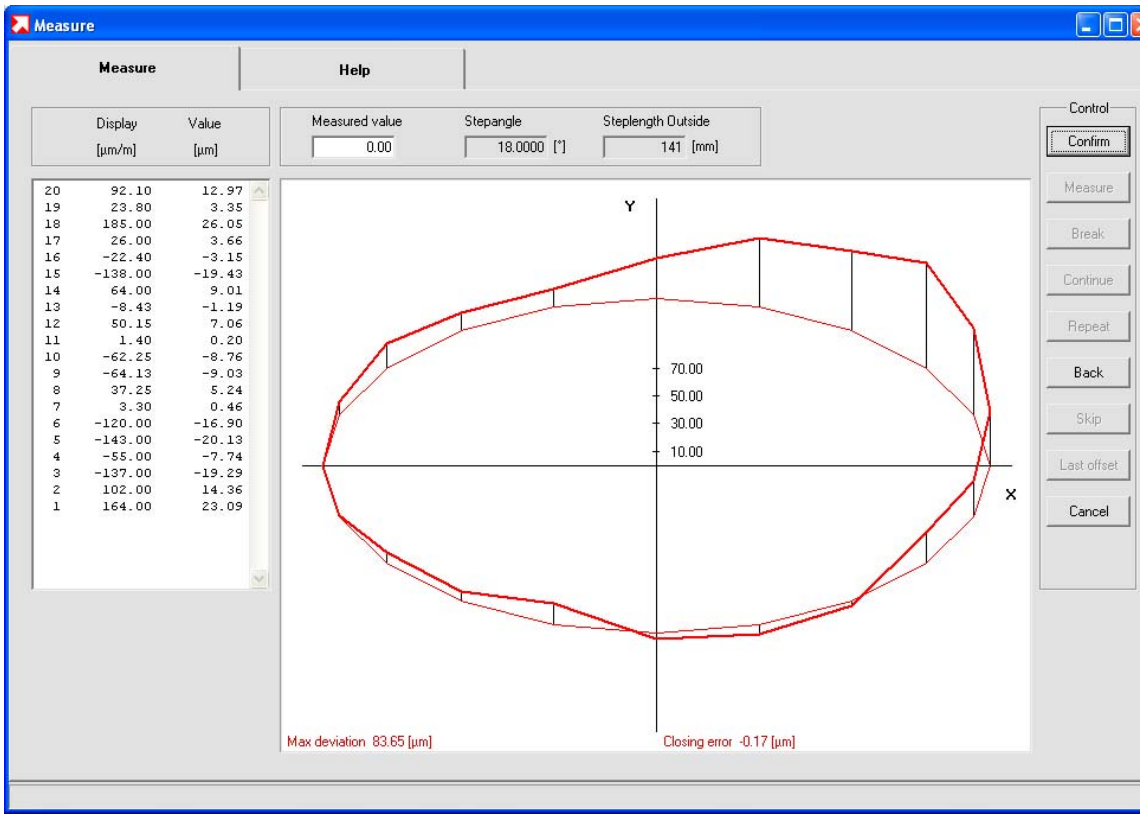
The next position to place the instrument is displayed by the two marks (Due to better overview the instruments icon remains in place) Using [BACK] the measurement up to now can be repeated



Further measuring values will de displayed and can be accepted with [Continue]

With [Repeat] the measurement can be repeated

At the end of the measurement the complete measured figure is displayed in graphical form.

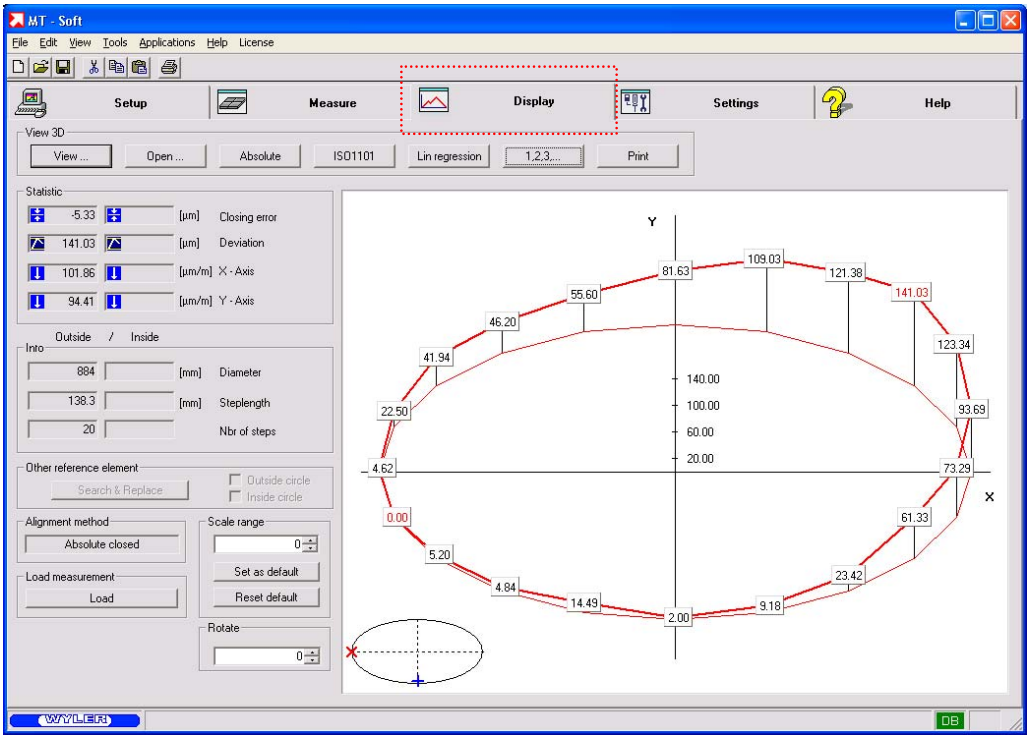


Because the measurement is done in absolute measuring mode the **graphic shows the true position in space (ABSOLUTE MODE)**.

Use [Confirm] to continue with saving the measurement

4.2.2 DISPLAY OF THE MEASURING RESULTS

In the register <**DISPLAY**> the result of the measurement is visualized for examination under different conditions. The measured figure is raised in a way that all measured points have positive values. The shape of the measured object is not changed



Above picture is showing the "**ABSOLUTE MODE**"

The following alignment methods are possible

- Alignment according to the method "**Absolute**"
- Alignment according to the method "**ISO 1101**"
- Alignment according to the method "**Linear Regression**"

The method used is mentioned below the graphic

Details on the monitor information:

- Button "View…" — allows a variety of display options such as display the circular line in two sections from position 0°to 180° and from position 180° to 360° or in perspective view
- Button "Open…" — changes the display to show whether there is a closure error or not
- Button "Absolute" — display in absolute mode
- Button "ISO 1101" — display in the mode ISO1101
- Button "Lin. Regression" — display the method "Linear Regression"
- <1,2,3,…>: — Display numerical value of the individual measurements
- Button "Print" — Printing the measurement in a number of different possibilities such as print numerical values, print with/without Logo etc.

Information concerning the **methods of alignment** see Pt. 2.5.8

Displayed information below "Statistic"

- Closing error: -5.33 µm
- Deviation flatness: 141.03 µm, only when using "Absolute"
  43.95 µm, only when using "ISO1101"
  50.24 µm, only when using "Lin regression"
- X-axis 101.86 µm/m, deviation from the true vertical
- Y-axis 94.41 µm/m, deviation from the true vertical

With a right mouse click the display may be copied to the clip board

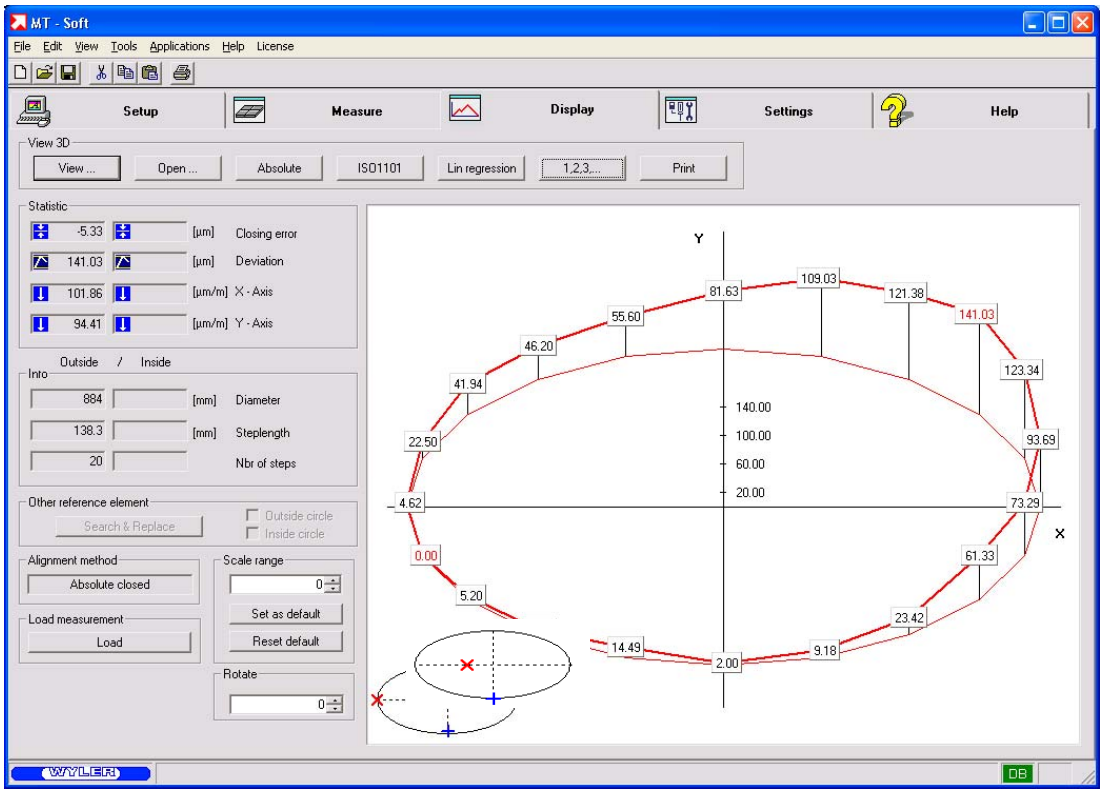
Details on the monitor information:

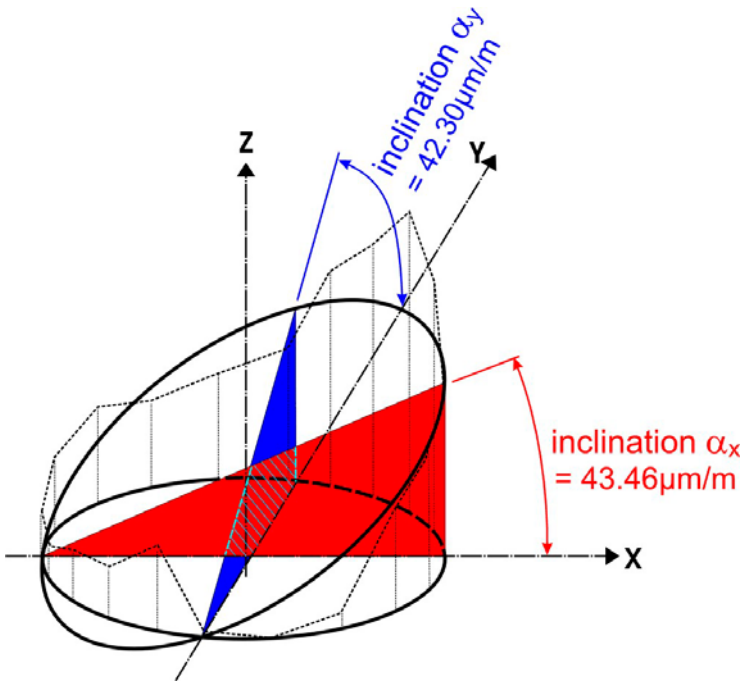
- **Closing error**
  This value represents the difference between the starting point and the end point of the measurement. In the closing error all measurement errors are included. This value is an important indicator on the quality of the measurement. Ideally, the closure error is much smaller than the deviation.

- **Deviation**
  In our example the displayed value indicates the flatness error (deviation)

Explanations to the inclination (Deviation of the virtual plane from the true vertical)

Display: measured circle / **3D-display / alignment method "<u>ABSOLUTE</u>"**





The figure (left) shows the plane in linear regression form, based on the enclosed measured circle.

The inclination of this plane in the two axes X and Y is:

$$\alpha_x = 43.46\mu m/m$$

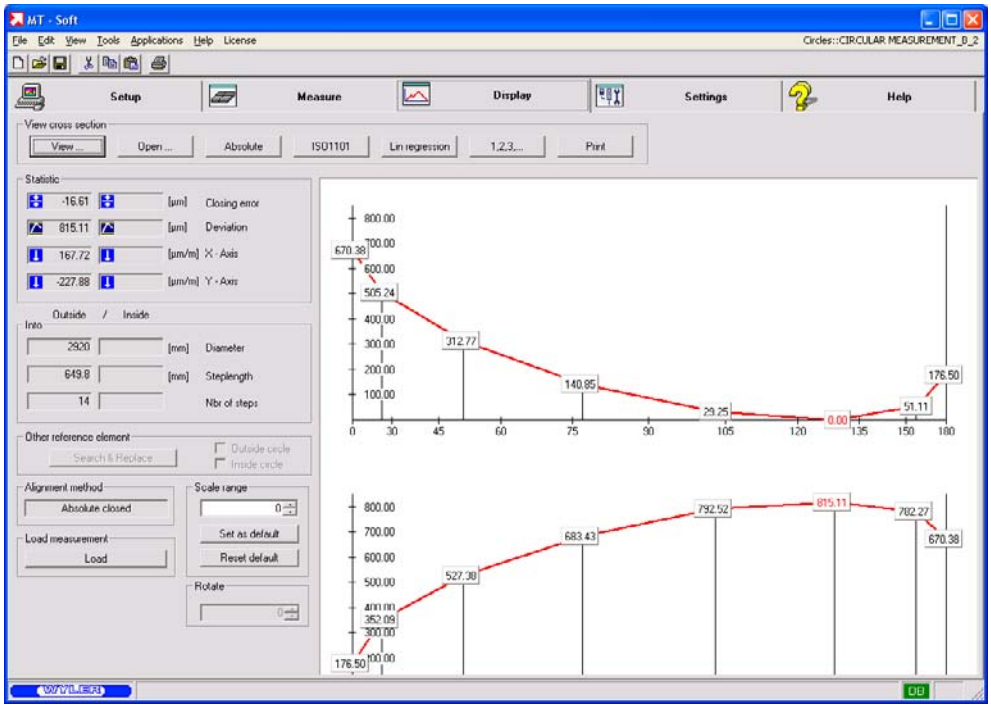
and

$$\alpha_y = 42.30\mu m/m$$

The displayed values (X-Axis, Y-Axis) below "Statistic" in the display window are the **deviation from the true vertical.**

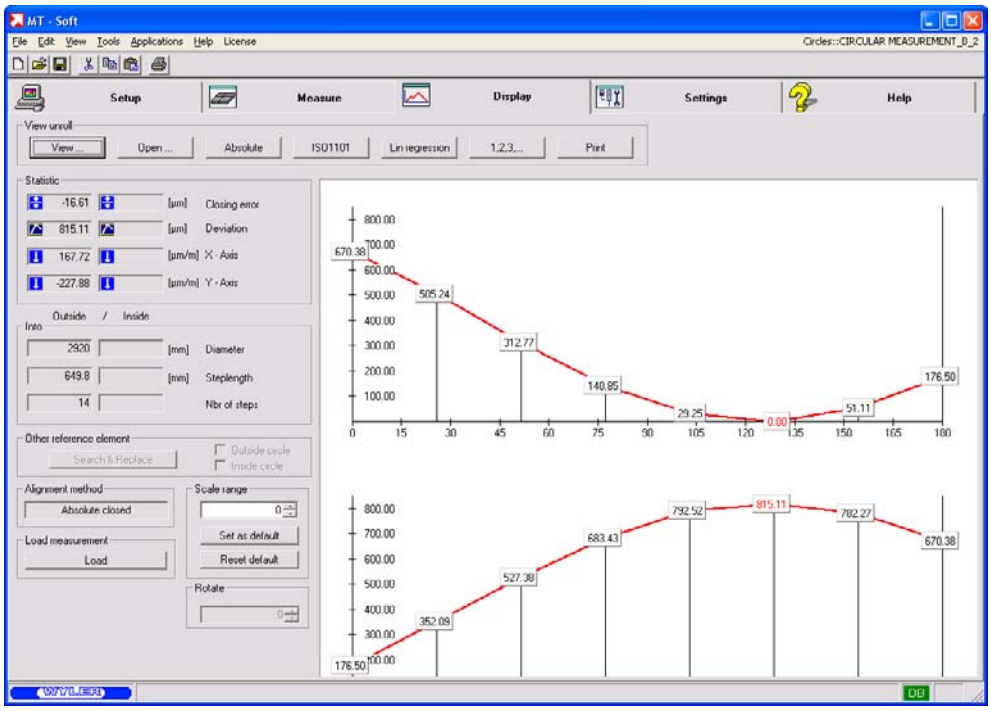
Cross section display surface / Selection using "VIEW"

[View] / The “View surface” is displayed in two sections 0….180° and 180….360°



Cross section display circle / Selection using "VIEW"

[View] / By a further click on [Display] the graph will be converted to "wind up".
The “View circle” is displayed in two sections 0….180° and 180….360°,
the scale is displayed in linear form

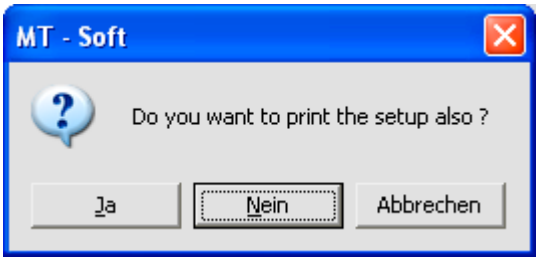


By a further click on [Display] the graph will be converted to "Prospect".

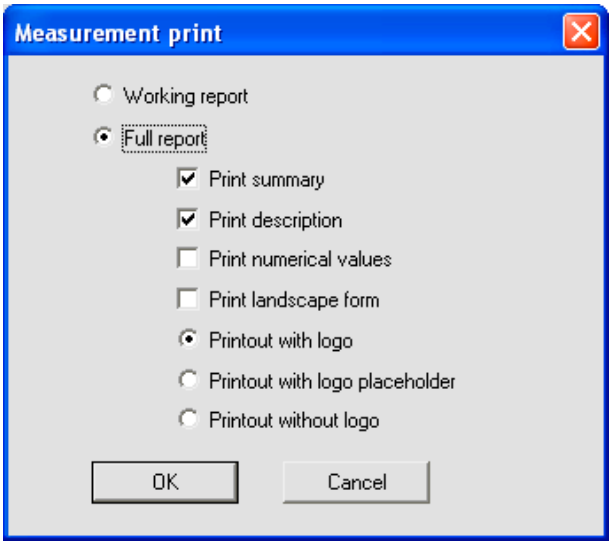
4.2.3 PRINT THE DATA OF A MEASUREMENT

The same setup is used as it was in the last print job. This is especially to check in the points “Alignment method”, “scale” and with/without “closure error”

With "Yes" you can also print the measuring configuration without measuring data



Afterward the required data sheets can be printed according to the description here after



The **following setup** is possible

- Working report:
  Short form printing, printed are
  - Description of measuring task, machine type, serial number, elements
  - Dimensions of the object
  - Closure error, deviations
  - Graphical display of the object, setup information such as alignment method numerical display etc. is taken from the screen display

- Full report
  - Print summary
    - Logotype, if activated
    - Measuring and print date
    - Dimensions of the object
    - Closure error, deviations
    - Graphical display of the object, setup information such as alignment method numerical display etc. is taken from the screen display

  - Print description
    - Logotype, if activated
    - Header file with customer, machine type, serial number name of engineer
      no measuring data

  - Print numerical values
    - Logotype, if activated
    - All measured values in numerical form

  - Print landscape form (additional print of figure in landscape mode)
    - Graphical display of the object, setup information such as alignment method numerical display etc. is taken from the screen display
    - Display of alignment method
    - Closure error
    - Dimensions of the object

  - Print with Logo
    - The Logotype defined is printed,
      see <SETTINGS> for changing the Logo

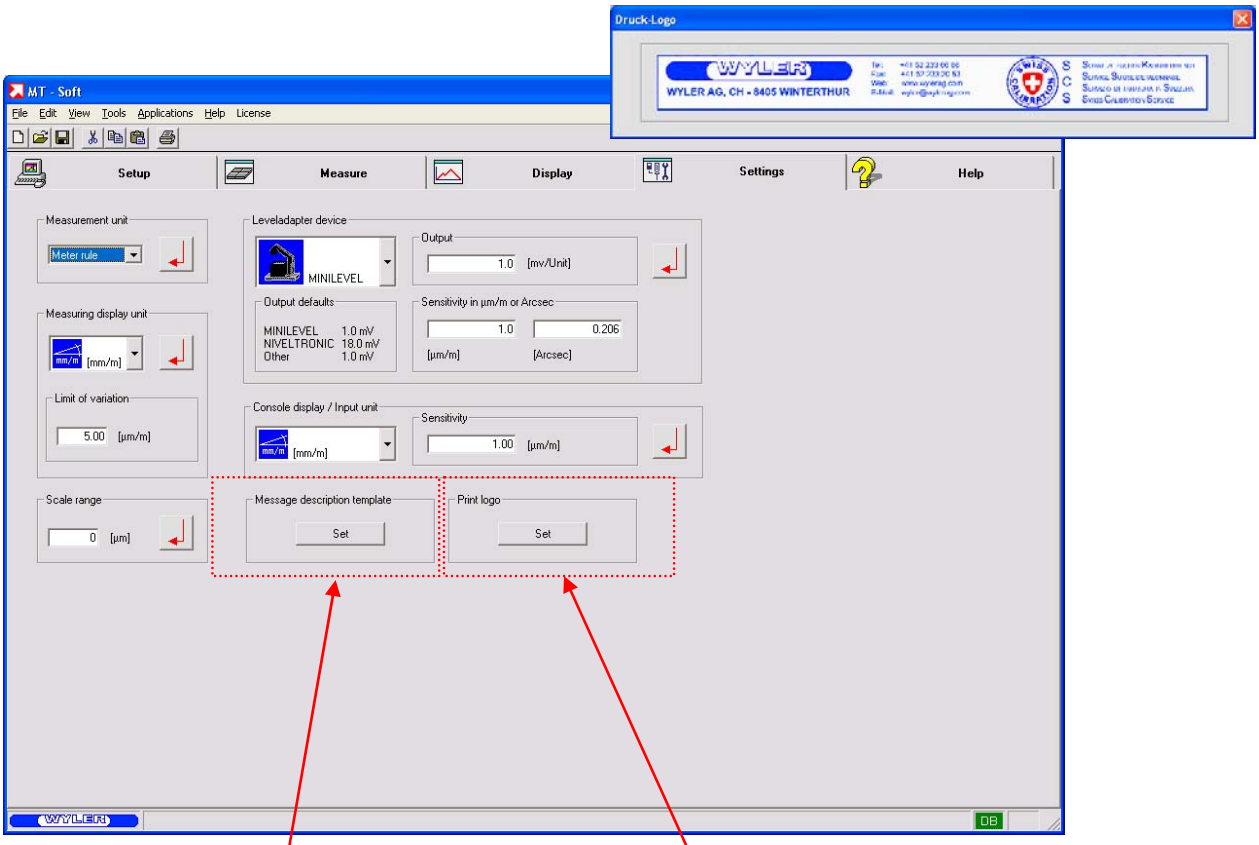
- Print with Logo place holder
  - In case company paper is used the logotype must not be printed

- Print without Logo
  - print is without logotype

After entering the options for the print the **Measurement description template** is opened again for checking the data before printing. After confirmation the data is saved.

Remarks concerning the "Print logo" option:

- Any logotype can be used. The **size must be 200 mm (length) x 20 mm (height)** and the type must be **bitmap (*.bmp)** and the logotype should be saved in the main menu of MT-SOFT
- The logotype is activated in the menu MT-SOFT <**SETTINGS**>
- Click to <**SET**> opens the active logotype. When clicking to the opened logotype the Windows explorer will be opened for selecting another logotype.



Input "message description template" Input "Print Logo"

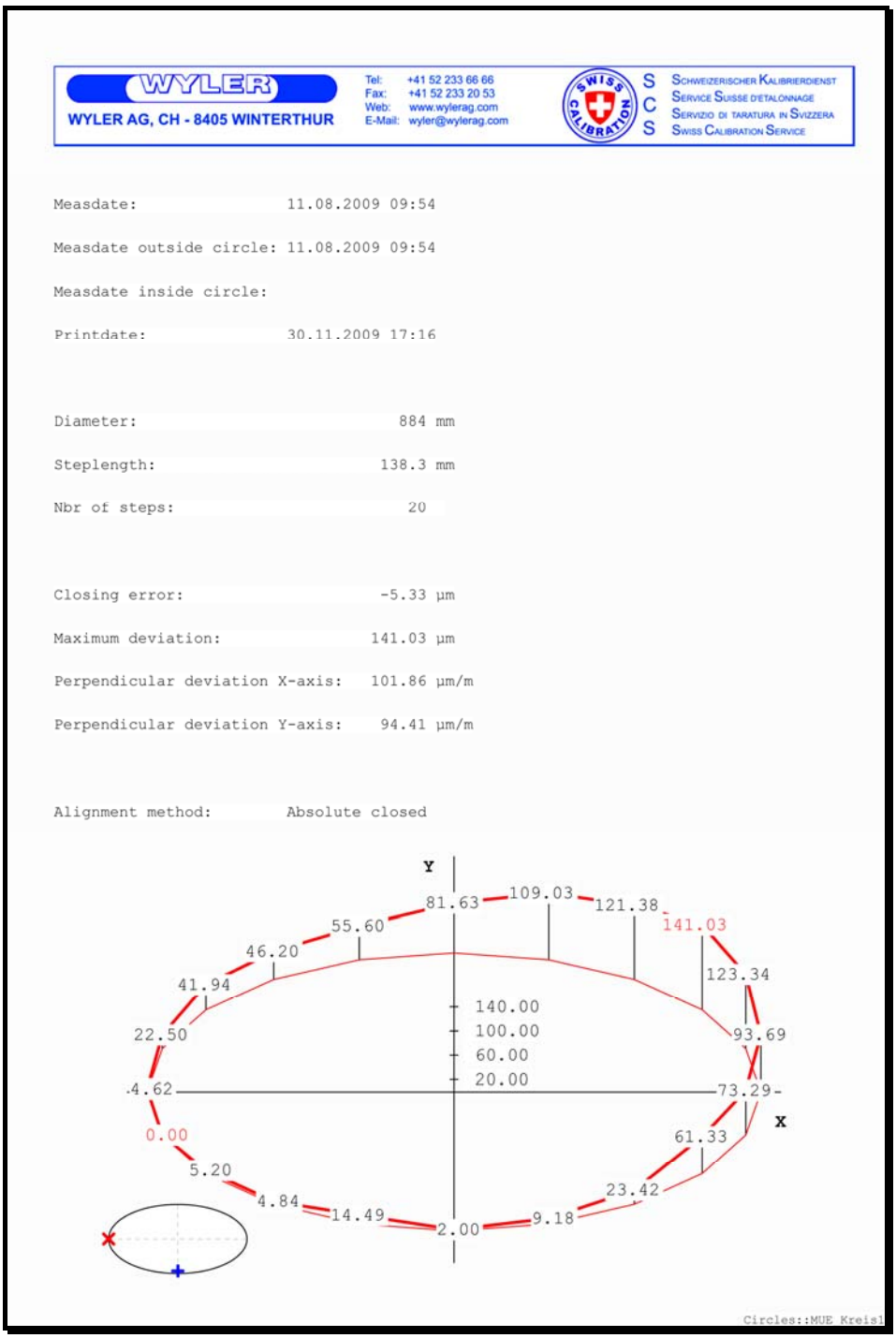
Remarks concerning "Message description template"

- A basic setting can be made in the tab <**ADJUSTMENTS**> in the area "Message description Template" / [Set]. Click on [Set] to see the logotype set before or as a default an empty mask for entering your selected logotype will open
- Here the required information for the measurement can be entered.
- Before printing the data may be adjusted/changed

Printout of the measurement

Depending on the setup the required data is printed such as:

- Measurement data (date of measurement, date of print, dimensions)
- Measuring results (Closure error, deviations)
- Alignment method
- Graphic with coordinates



WYLER

WYLER AG, CH - 8405 WINTERTHUR

Tel: +41 52 233 66 66
Fax: +41 52 233 20 53
Web: www.wylerag.com
E-Mail: wyler@wylerag.com

SCS Schweizerischer Kalibrierdienst
Service Suisse d'etalonnage
Servizio di taratura in Svizzera
Swiss Calibration Service

Measdate: 11.08.2009 09:54

Measdate outside circle: 11.08.2009 09:54

Measdate inside circle:

Printdate: 30.11.2009 17:16

Diameter: 884 mm

Steplength: 138.3 mm

Nbr of steps: 20

Closing error: -5.33 µm

Maximum deviation: 141.03 µm

Perpendicular deviation X-axis: 101.86 µm/m

Perpendicular deviation Y-axis: 94.41 µm/m

Alignment method: Absolute closed

Example of a printout with the corresponding information

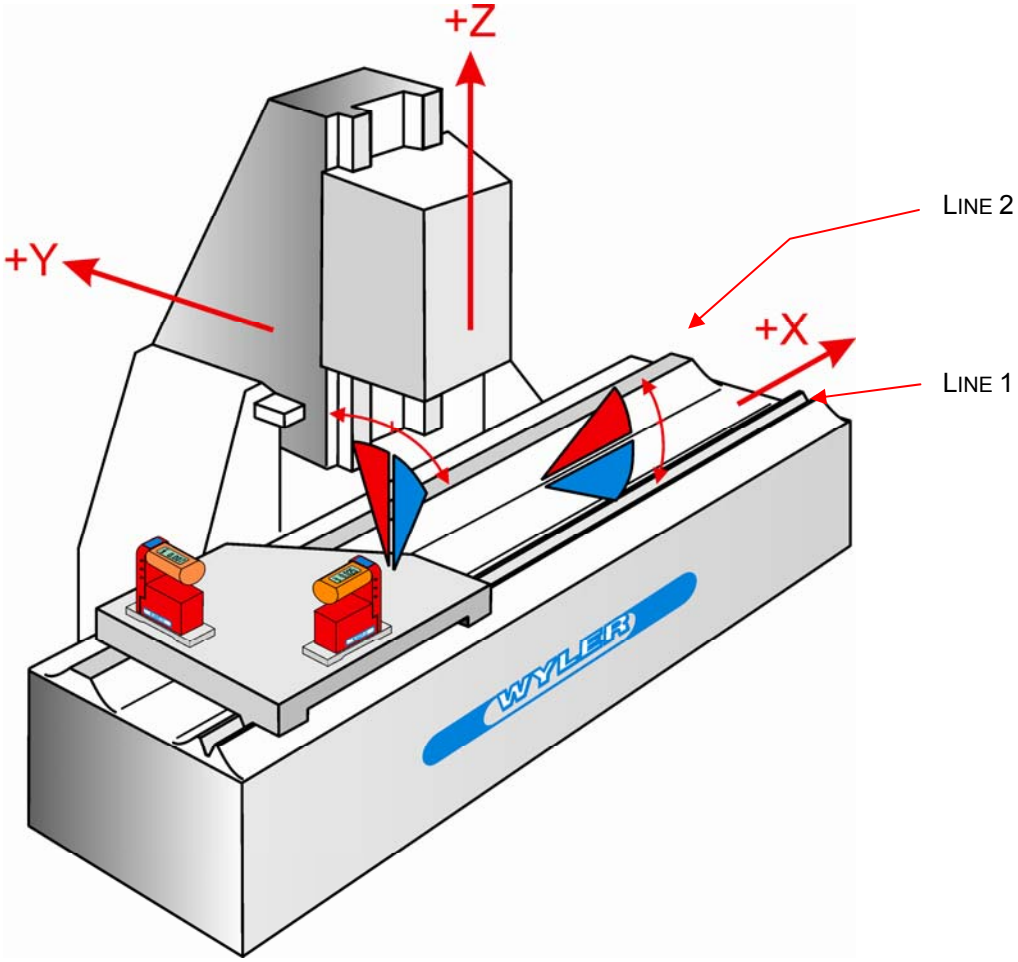
5. THE POSSIBLE MEASURING FIGURES IN DETAIL

5.1 GUIDE WAY

Example
The guide ways for the table of a machine tool bed must be inspected. The bed has a prismatic and a flat guide way.

The prismatic guide way is defined as the reference guide way and named LINE 1. The straightness deviation in longitudinal direction is measured with Inclination measuring instruments.

The horizontal deviation of the second, flat, guide way is measured by using an inclination measuring instrument in cross direction. In this way the shape of the reference line is an integral part of the measurement. For this type of measurement a special JIG is required.



The distance between the two guide ways is 500 mm, the length of the guide ways is 1500 mm.

Before starting the measurement the definition of the axis coordination and the directions of the movements must be defined. (Work piece coordination)

In our example the X, Y, Z definitions are as follows, see picture above:

- Guide way length direction: left to right +**X-Axis**
- Spindle horizontal movement: near to far +**Y-Axis**
- Spindle vertical movement: bottom to top +**Z-Axis**

Additional information concerning the “coordinate system” see the following chapter.

The **zero position of the coordinates X / Y / Z** must be defined

In our example the X/Y/Z zero position is placed slightly above the centre of the reference guide way. (see Sketch below)
The definition of this point is important because when creating the measurement layout this point must be clearly defined. Usually this definition is done by the machine manufacturer.

COORDINATE SYSTEM

The careful definition of the coordinate system is worthwhile
With MT-Soft it is under certain conditions possible to make use of existing object's data as well as the comparison between earlier measurements. Precondition to do so is the correct definition of the coordinates. The coordinates are also used in the further computing of the results and naturally are also displayed on the monitor or printed for further analysing.

Coordinate system
MT-Soft requires the data entering in form of coordinates using the **work piece coordinates**.

In order to make optimal use of the existing conditions the basic coordinates in space are free to define. By defining the system please note:

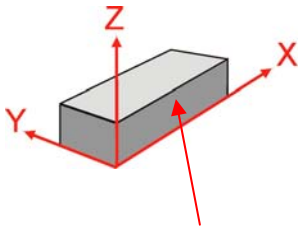
Relative movements of the spindle in relation to the work piece use the same work piece coordinates, in our case these are the axis Y and Z.

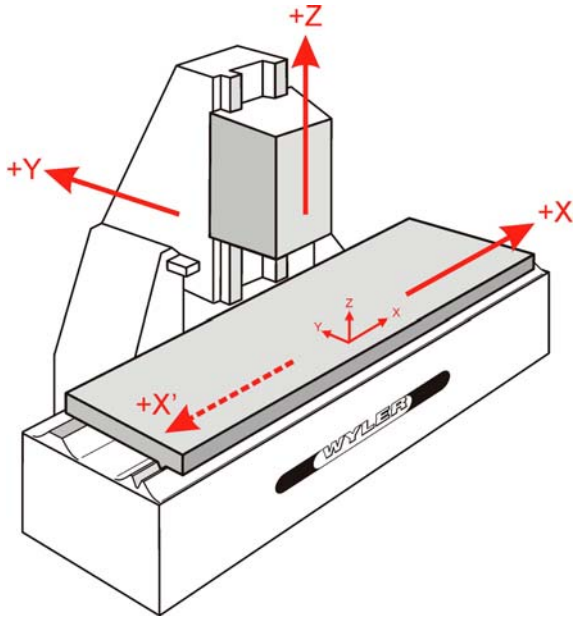
Relative movements of the work piece in relation to the (fixed) spindle are movements opposite to the work piece coordinates. In our example this concerns the X-axis. A work piece coordinate changement in +X directions means a **table movement** in -X direction!

Zero position of the coordinates
MT-Soft allows the implementation of negative figures. This means the zero position of the axes in space is free to choose.

Important is that all the measurements on one machine use all the same coordinates. In our example we choose the zero position for Y and Z at the front edge of the table and the X position in the centreline of the machine / turret

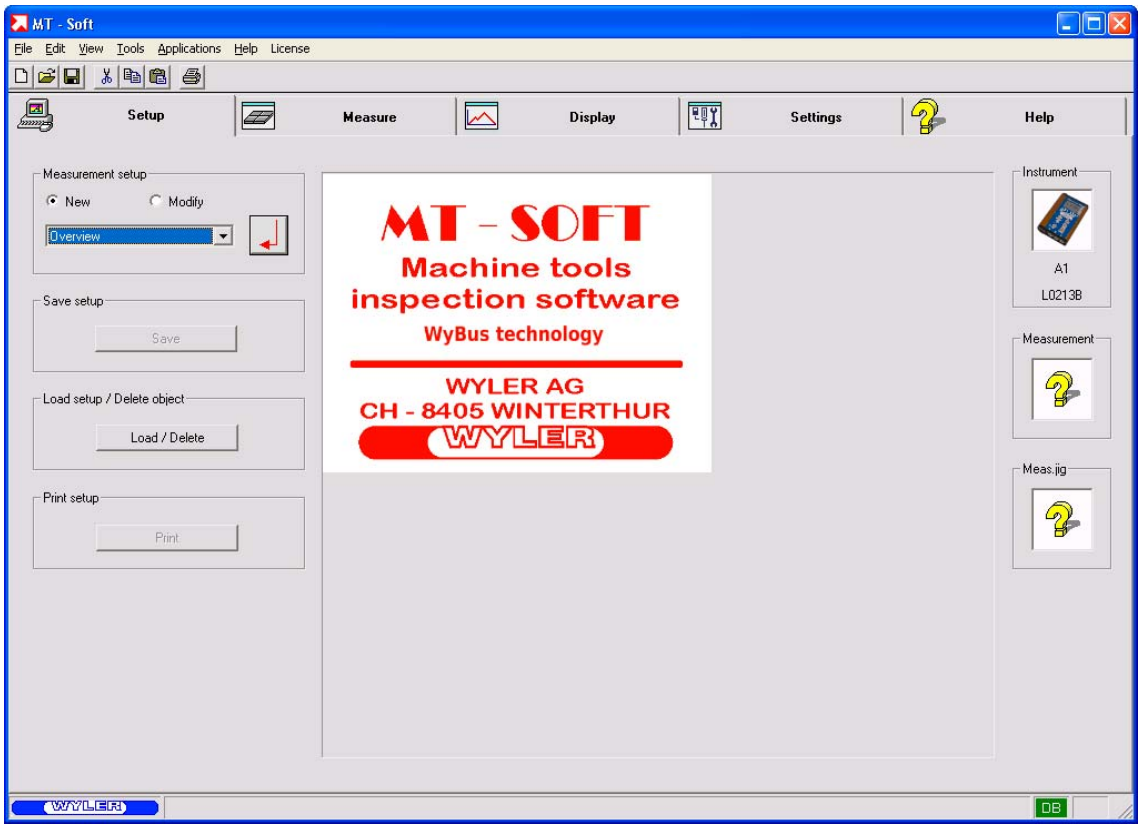
work piece coordinates





Coordinate system
+X: work piece coordinates X-axis
+X': table movement

After starting MT-Soft the following picture appears:



The measurement example

- **Type of measurement** **Guide ways**
  Front guide way "prismatic"
  Rear guide way "flat"
- **First cross section** measurement at the end of the measuring JIG

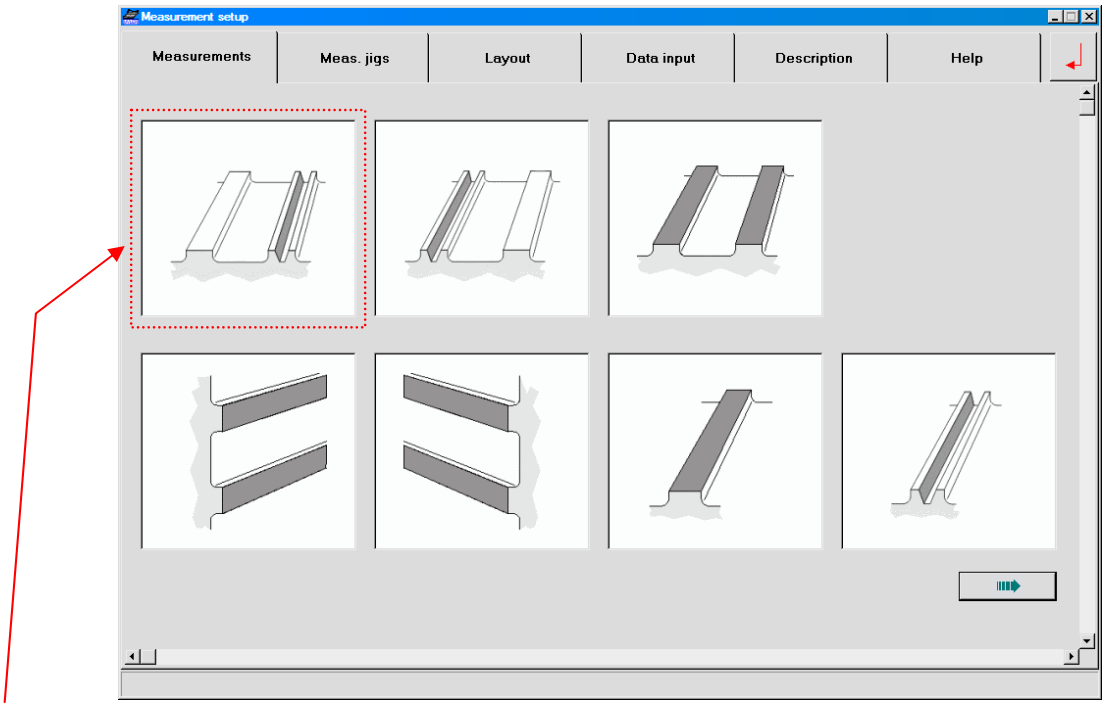
- **Work piece coordinates**
  - X-axle coordinate/(Object beginning): -1000 mm
  - X-axle coordinate/(Object end): 1000 mm
  - X-axle coordinate/(First measuring point): -900 mm
  - X-axle coordinate/(Last measuring point): 900 mm
  - X-axle coordinate/(Step length): 300 mm (depending on JIG available)

  - Y-axle coordinate (Line 1) : 0 mm
  - Y-axle coordinate (Line 2) : 500 mm

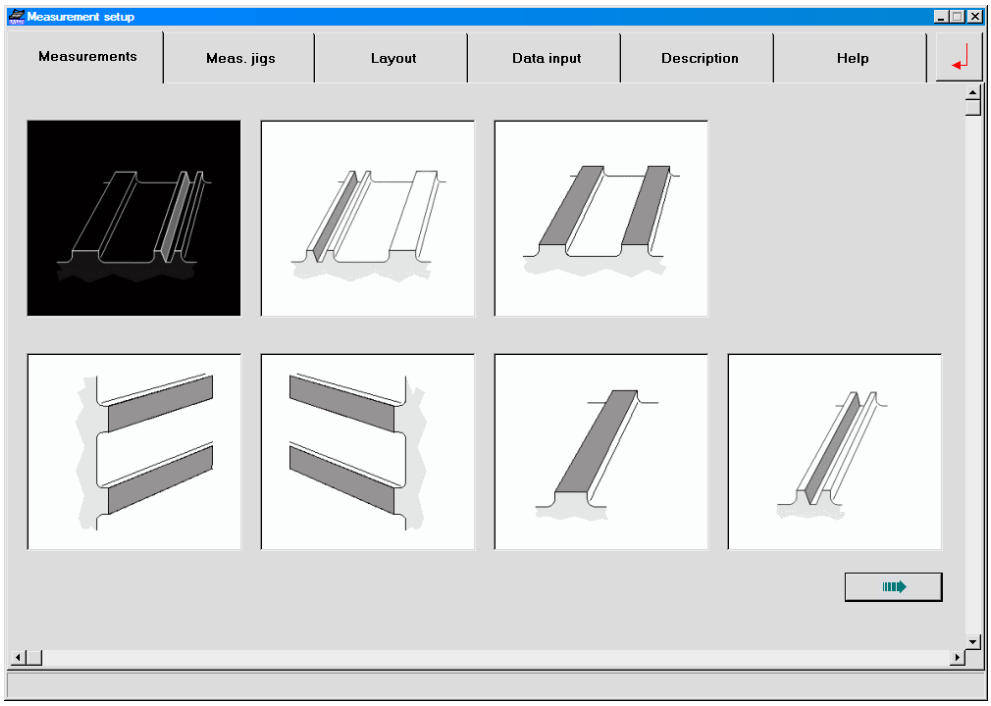
- **Measuring setup:**
  - The measurement of the guide ways should later be used in comparing the table with the vertical spindle. In order to do so it is required to measure in the **absolute mode**. An absolute mode measurement requires before the measurement a reversal measurement with the instrument.
  - The measurement is done **with a single instrument**. This means the first step is measuring the X-axis and as a second step measuring the Y-axis.

In the register "Setup", below Measurement Setup the pull down menu can be used to change to “Guide ways” and confirm with [Enter] 

A number of different possibilities for the **type of guide ways** is displayed under <**MEASUREMENTS**>

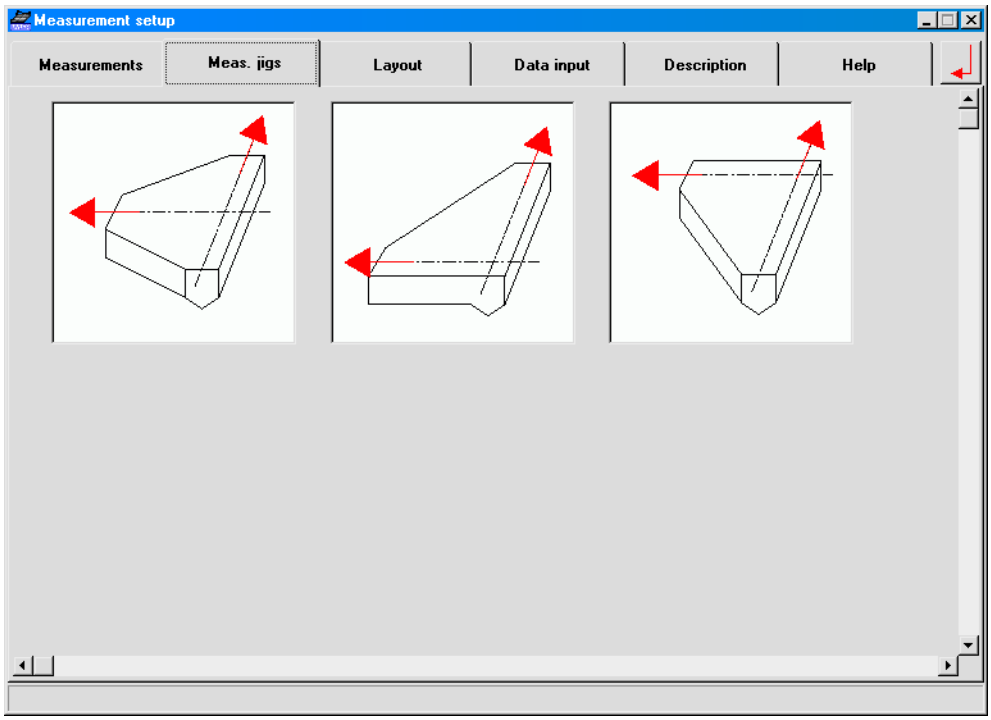


In our example we chose the first option. (Front, near, guide way prismatic, back, far, guide way flat).



After the selection by mouse click the background becomes black.

Change to the sub register **Measuring JIG**

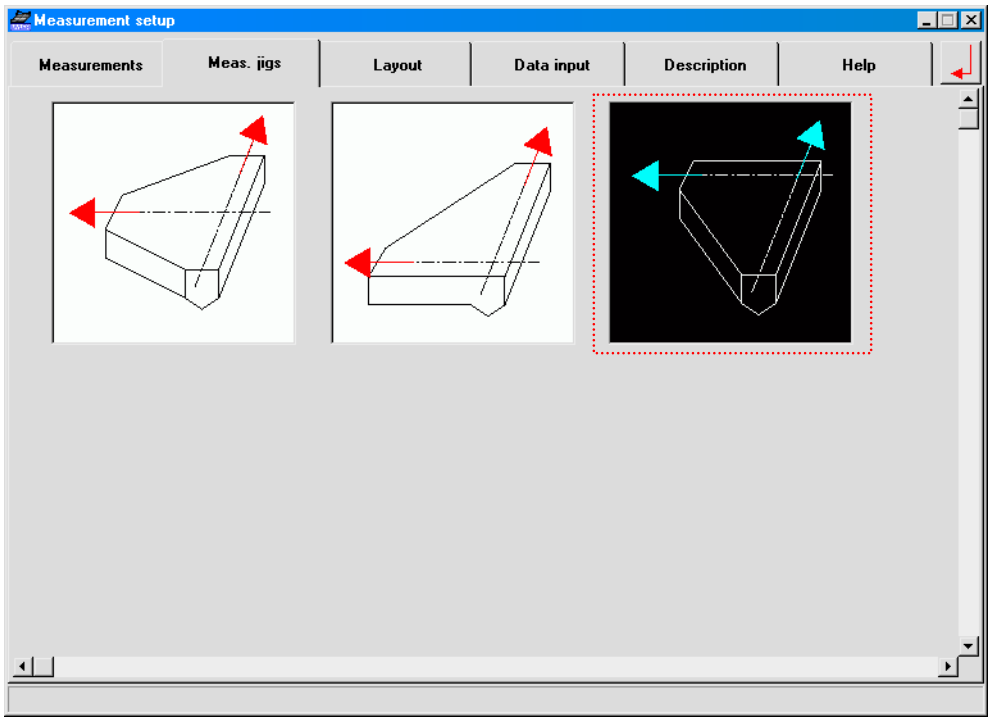


Here three options are available

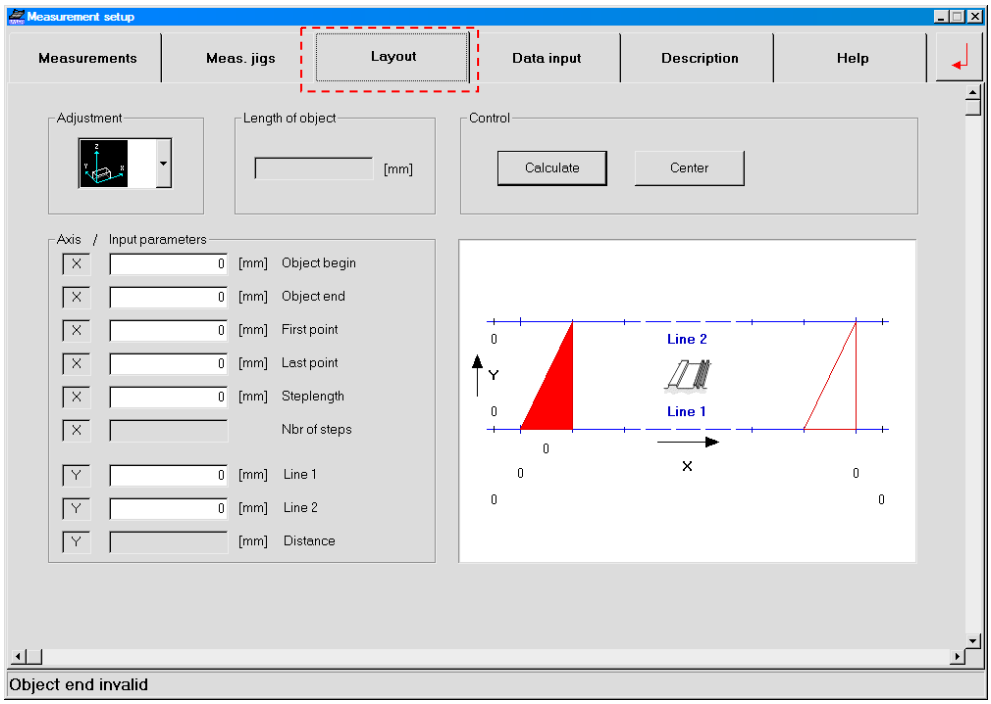
- JIG with symmetrical base plate (position of cross direction at the centre of the base plate)
- JIG with asymmetrical base plate (position of cross direction at the beginning of the base plate)
- JIG with asymmetrical base plate (position of cross direction at the end of the base plate)

Remark
The measuring JIGs are usually supplied by the user as the JIGs are depending on the type and shape of the machine. WYLER AG however is glad to quote and supply any JIG required. (See also chapter Measuring base)

In our example we chose the JIG with asymmetrical base plate (position of cross direction at the end of the base plate)

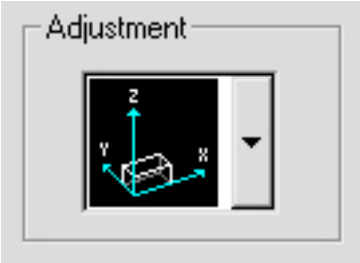


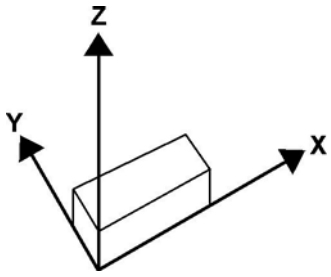
Change to the sub register **Layout**



Firstly under <**ADJUSTMENT**> the coordinate system (**work piece coordinates**) must be defined.

For our example we choose the following adjustment:



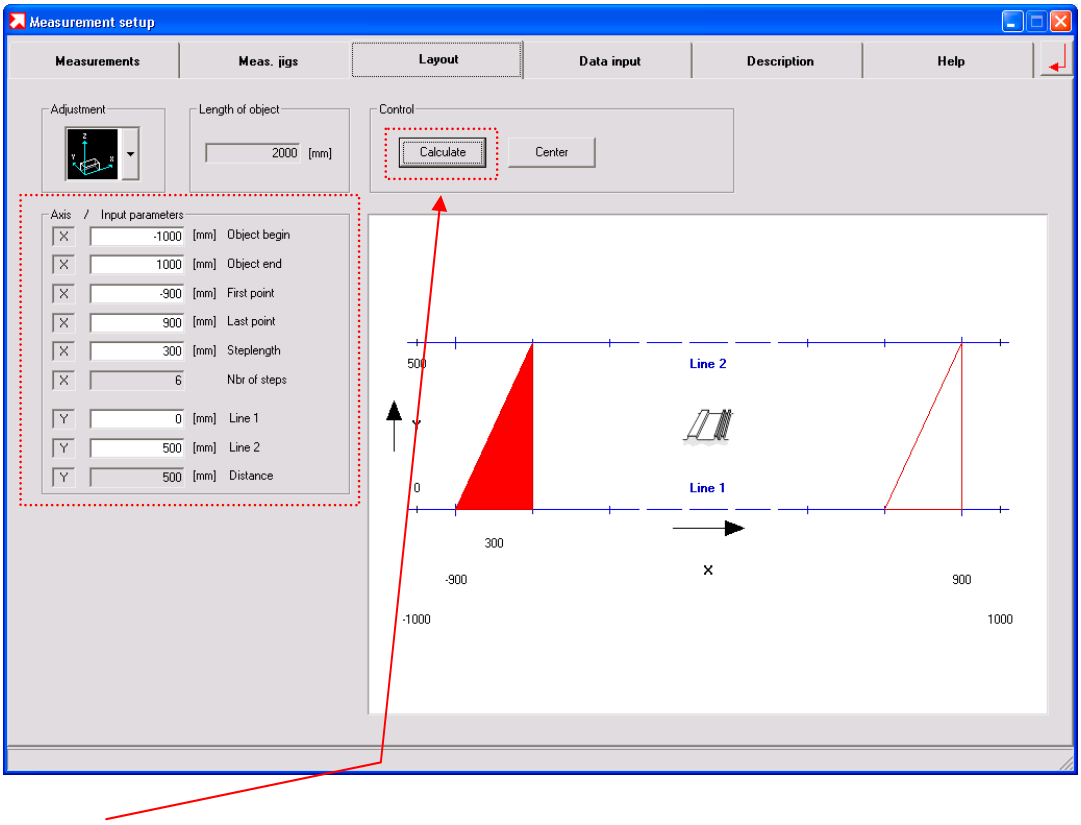


Next the coordinates must be entered. (IMPORTANT: **WORK PIECE COORDINATES**)

- X-axle coordinate/(Object beginning): -1000 mm
- X-axle coordinate/(Object end): 1000 mm
- X-axle coordinate/(First measuring point): -900 mm
- X-axle coordinate/(Last measuring point): 900mm
- X-axle coordinate/(Step length): 300 mm (Depending on JIG available)

- Y-axle coordinate (Line 1) : 0 mm
- Y-axle coordinate (Line 2) : 500 mm

It is important to check all the displayed data for their correctness.

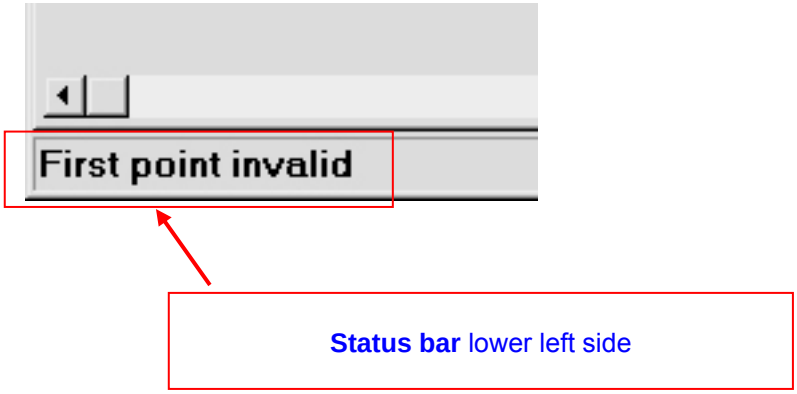


After entering the data confirm with [Calculate]
The graphic will be finalized and additional data is entered automatically.

- Length of object 2000mm
- Distance Line 1 to Line 2 500mm
- Number of steps 6

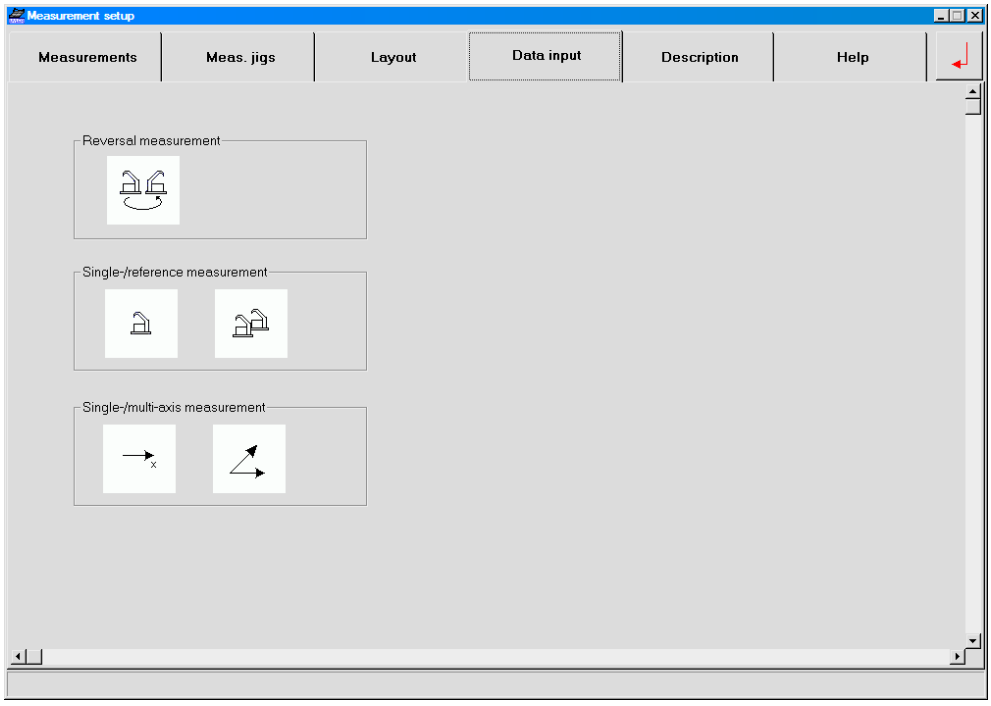
Information on incorrect or missing values is displayed in the status bar

Example



Also displayed are the graphic layout and the numerical figures. This should be checked before proceeding.

Change to <**DATA INPUT**>
In this selection, specific procedures for the data input are defined.



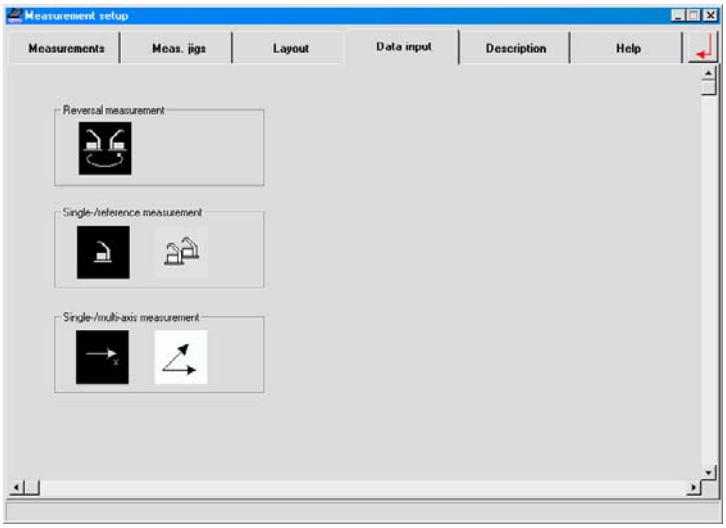
Here only the type of measurement can be entered. The following options are available:

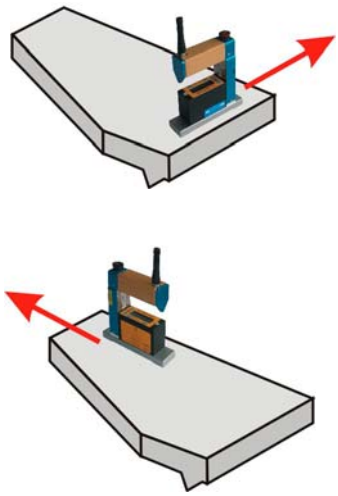
- **Reversal measurement**
  This mode is used for “absolute” measurements and for the measurement of different individual objects to be compared at a later stage

- **Single/reference measurement**
  Selection between one individual instrument is used or two instruments in differential mode are used. (Value = A-B). Differential measurement does not allow “reversal measurement”

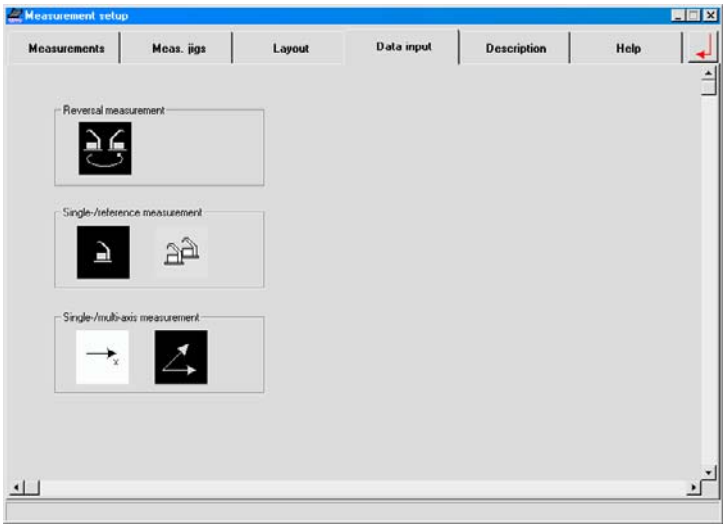
- **Single / multi-axis measurement**
  Selection of measurement procedure such as measurement first in one direction X and after that in a second run the Y-axis is measured. Alternatively both axis may be measured simultaneously with two instruments

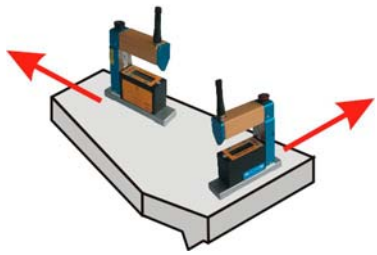
- **Reversal measurement** / Single Instrument (Absolute mode). This means one direction (X) is measured at one time only. In a second step the cross direction (Y) is measured



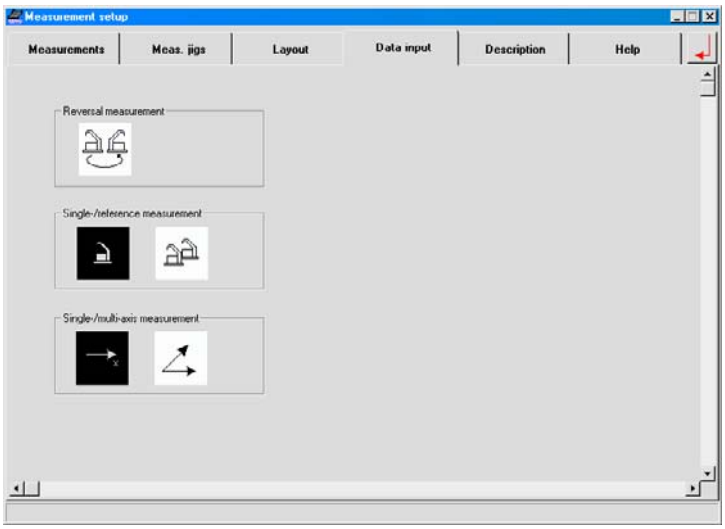


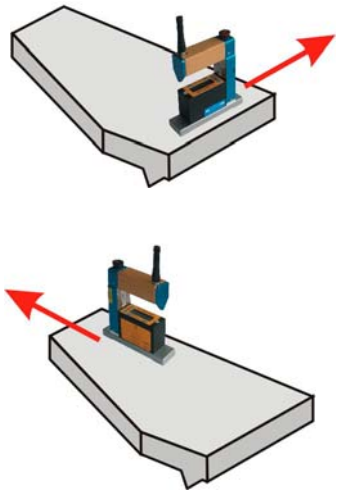
- **Reversal measurement** / One Instrument per direction (Absolute mode). This means measurements in X-direction and in Y direction **simultaneously**



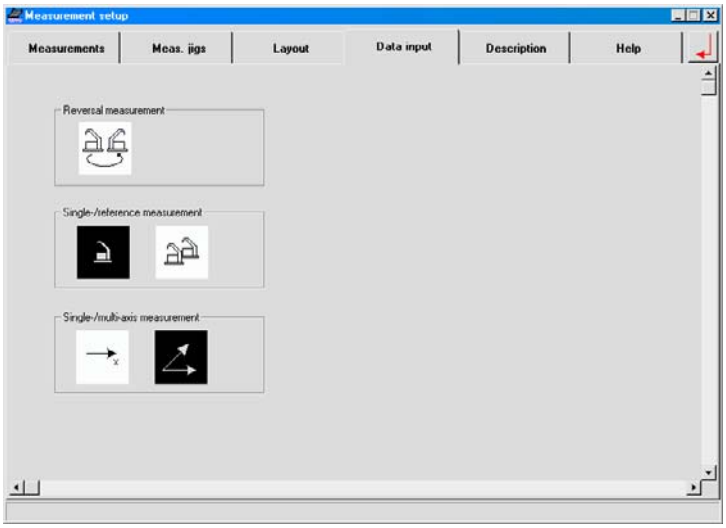


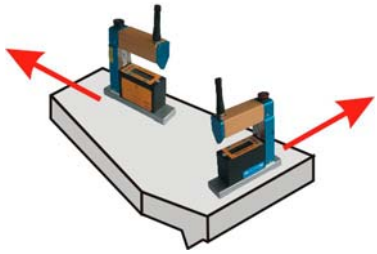
- **Without** reversal measurement / **Single Instrument** (**Relative mode**). This means in a first step measurements in X-direction only and in the second step measurement in Y direction only



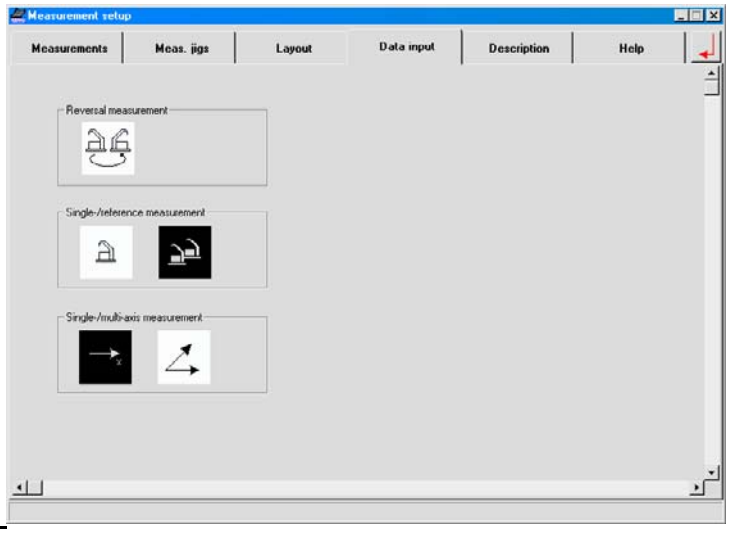


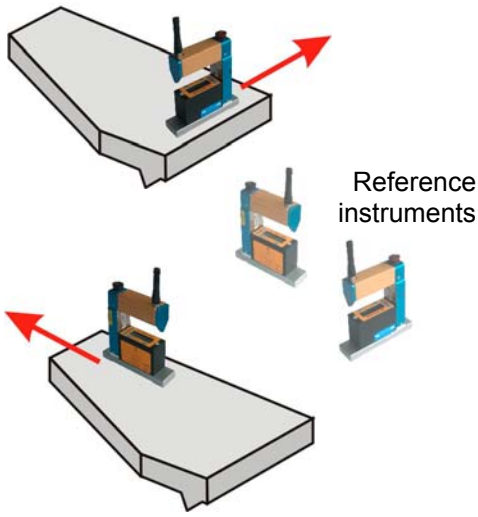
- **Without** reversal measurement / One instrument per direction (**Relative mode**). Measurement in X and Y direction **simultaneously**. (One instrument means one instrument in any chosen direction)



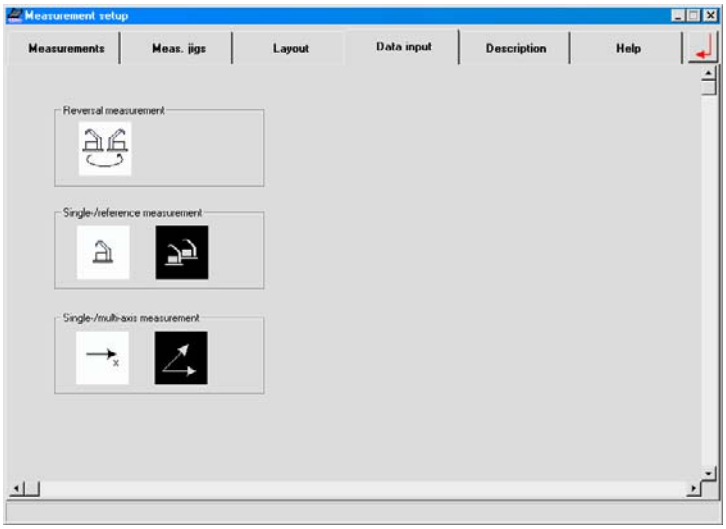


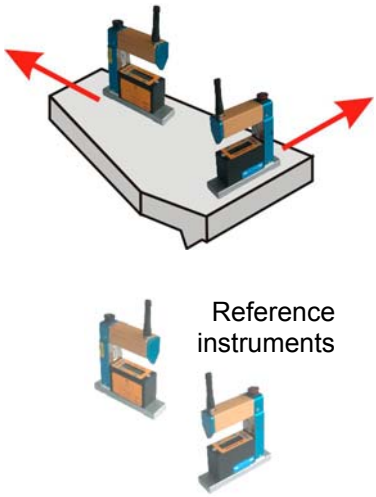
- **Without** reversal measurement / Two Instruments (**Relative mode**, Measuring and reference instrument). This means in a first step measurements in X-direction only and in the second step measurement in Y direction only





- **Without** reversal measurement / Two Instruments (**Relative mode**, Measuring and reference instrument). Measurement in X and Y direction simultaneously

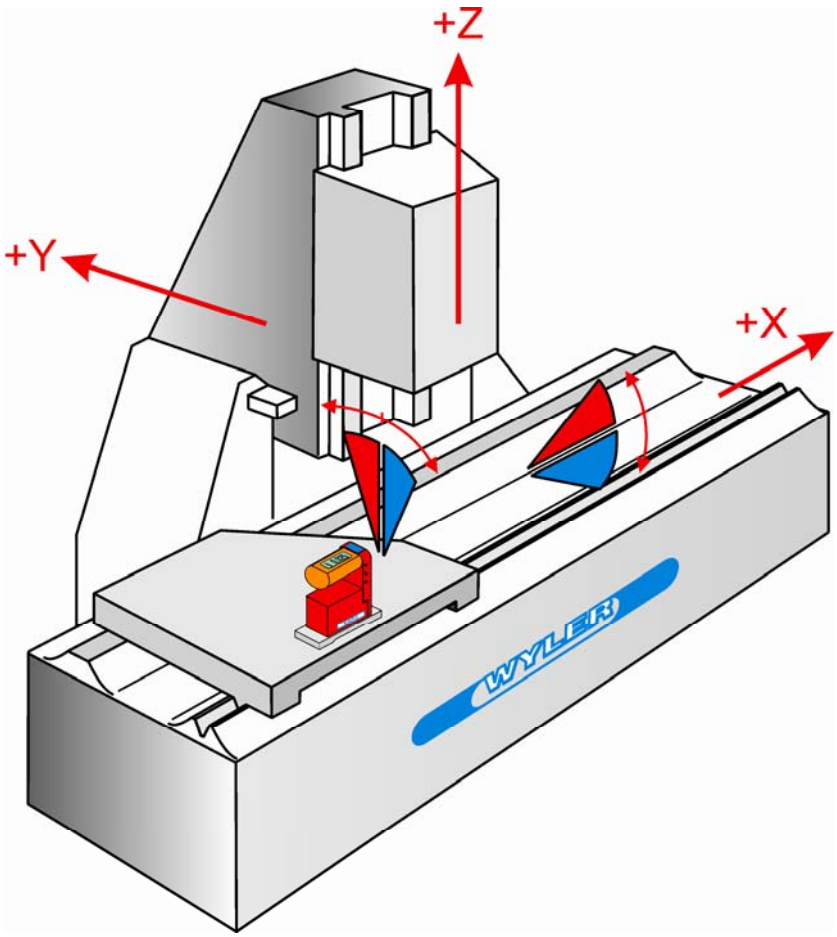


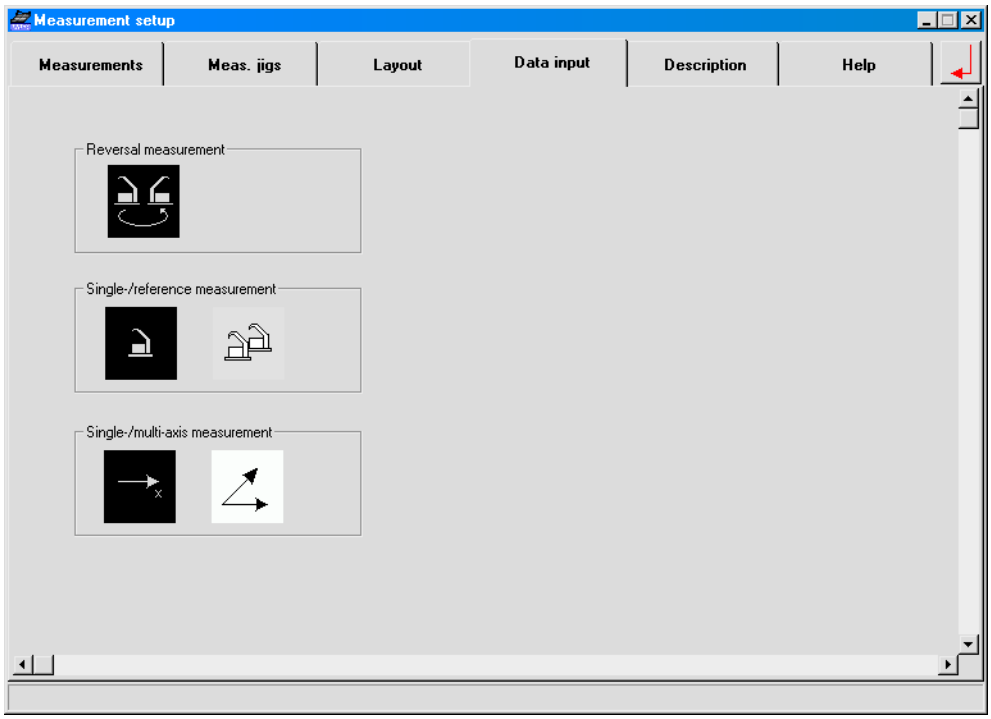


Important
When using a **LEVELMETER 2000** or a **BlueMETER** it is possible to measure the two axis X and Y simultaneously as long as no reference mode is activated.

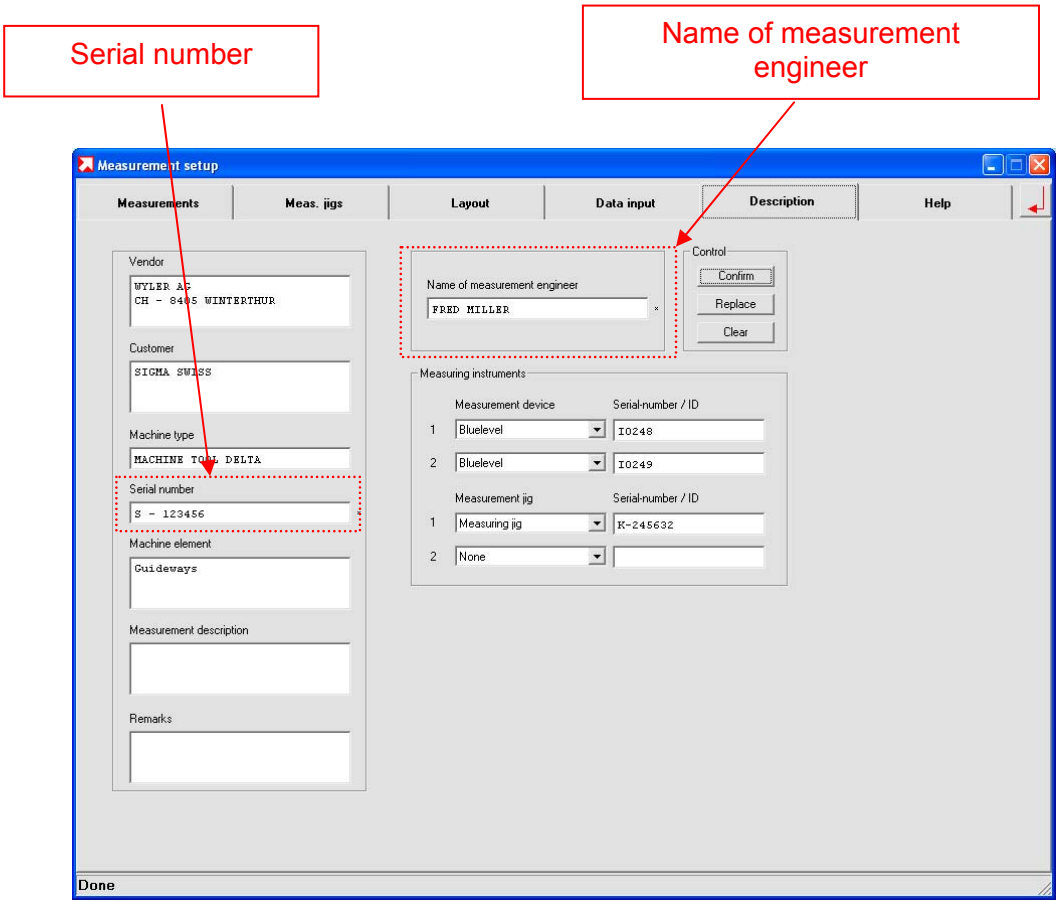
When measuring simultaneously in both directions X and Y using LEVELADAPTER 2000, two **LEVELADAPTER 2000** are required and must be connected to separate serial ports of the computer (COM 1 and COM 2)

In our **example** we chose
Reversal measurement / Single Instrument (Absolute mode). This means in the first step measurements in X-direction only and in the second step measurement in Y-direction only.





Next the **Description** must be done



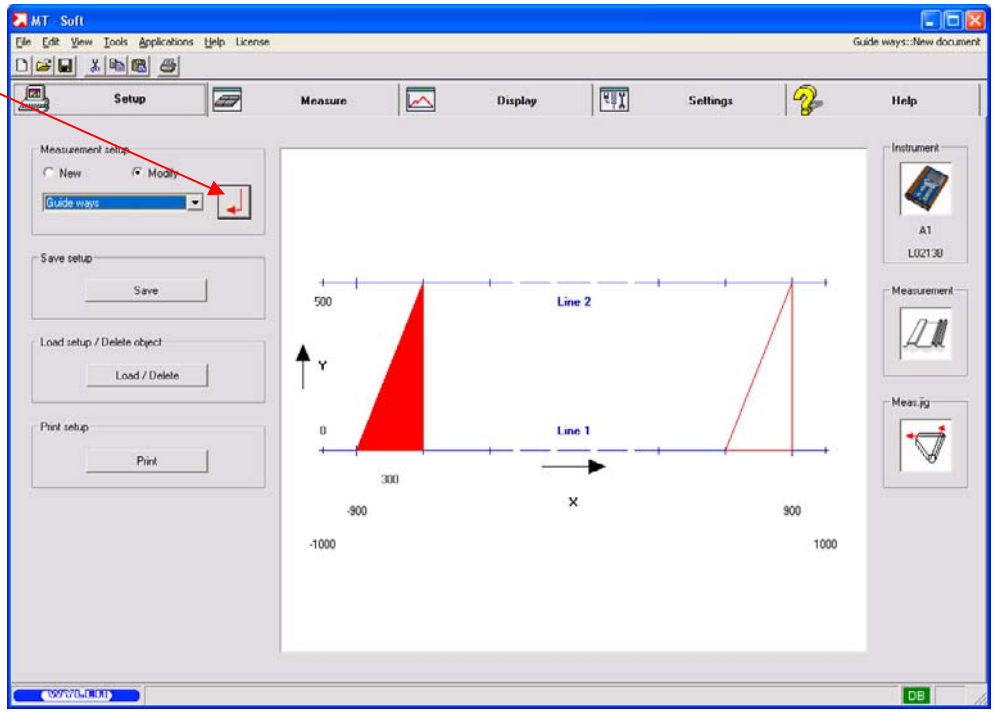
The description is to define exactly the measuring task and the identification of the objects.
In this dialogue box all the necessary data for defining the planned measurement can be entered. The **Name of measurement Engineer** and the **Serial number** of the object to be measured are **mandatory**. The rest of the information is free to fill in.

The text can also be integrated from an existing template by using the <**REPLACE**> button. v

It is still possible to make changes in the setup registers.

Confirm your entries with the [Confirm] button, then complete the measuring configuration with [ENTER 

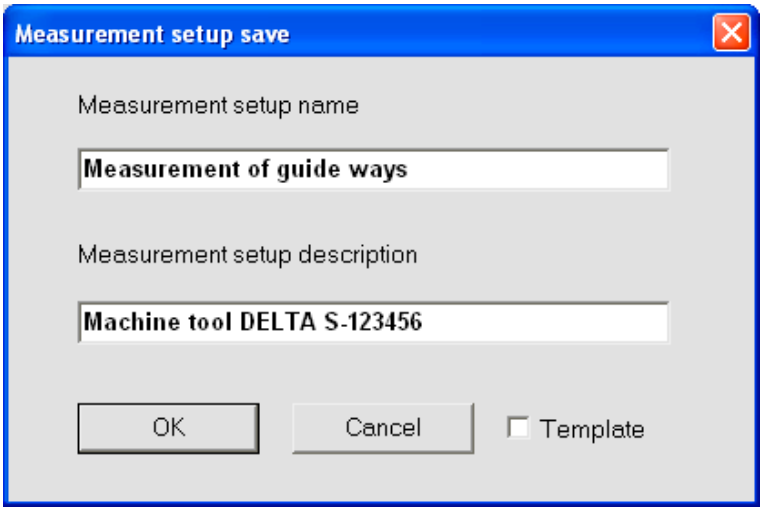
Now the actual measurement can be started. When all the data is correctly filled in press the [Enter] button



The following information is displayed:

- Object to be measured, in our case "Guide Ways"
- On the right side of the window
  - o Instrument: The connected instrument respectively Interface
  - o Measurement Type of Guide way
  - o Meas. JIG Type of JIG specified

- Under "Save Setup" the button “save” opens a dialogue box. The setup may be saved as **template,** e.g.:
  - o Measurement setup name: **"Measurement of guide ways"**
  - o Measurement setup description: **"Machine tool DELTA S-123456"**

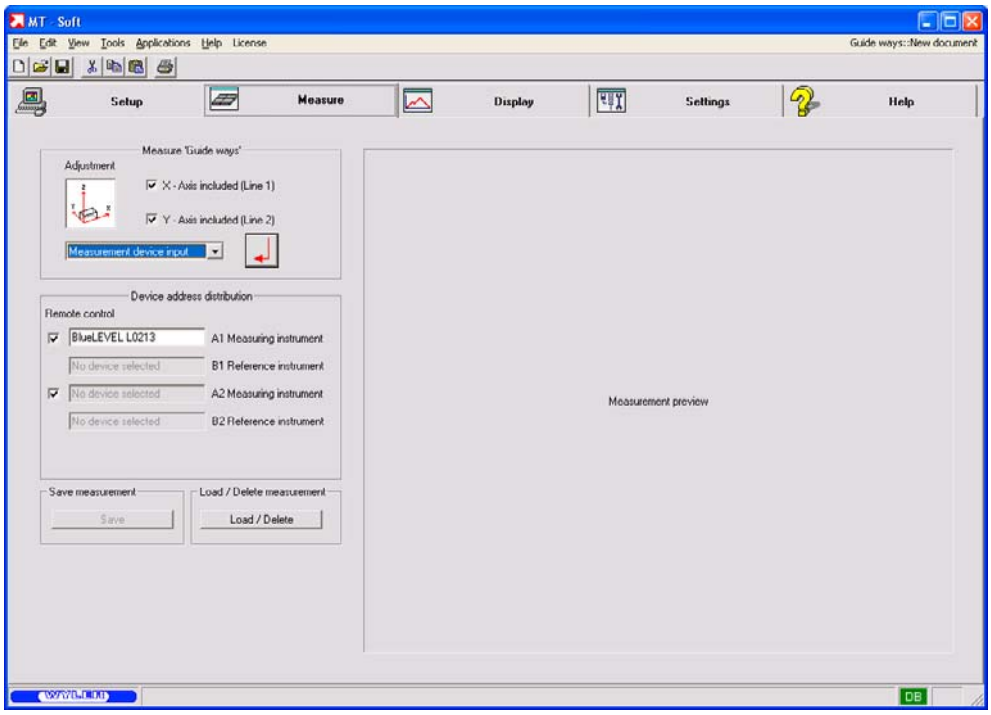


Under" Load Setup / Delete Object" the button "Load/Delete" allows to open an existing setup template or delete an object.

- Using the button "Print Setup" / [Print] allows to print the actual measurement setup template

For **starting the measurement** the register <**MEASURE**> must be activated

In case the measuring instruments are not defined yet or if you want to change the instruments, you can still do this under "Device address distribution"



In this register the following input is possible:

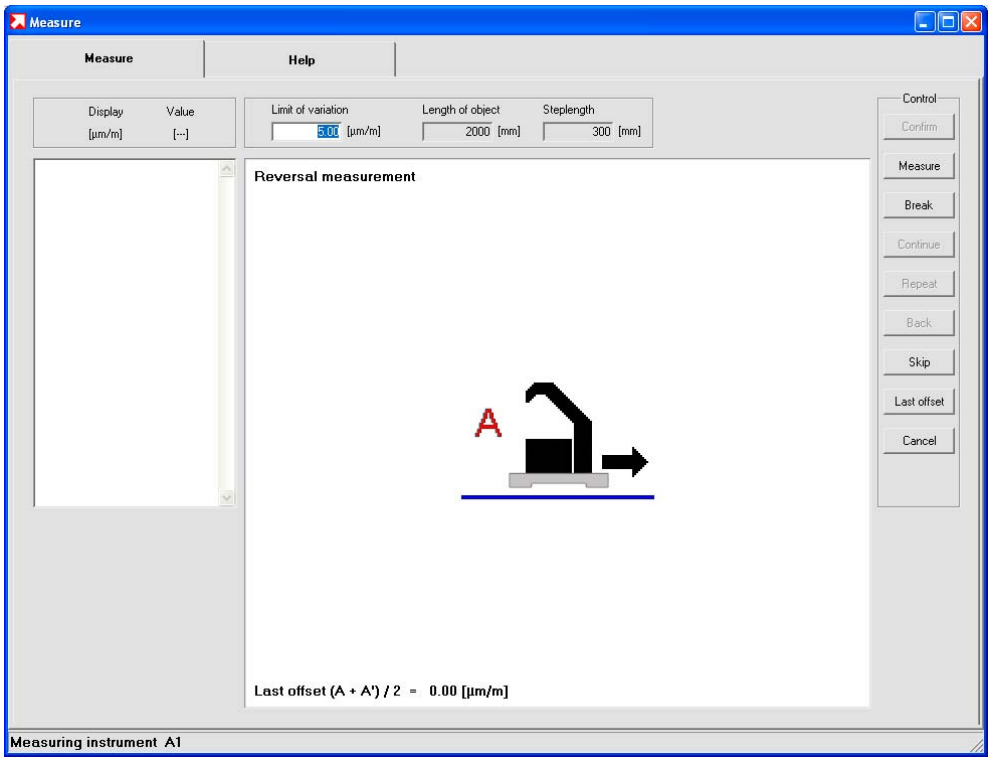
- Below Measure Guide Ways it is possible to change between Input device, directly from interface to PC or manual input via Console Input

- Below Measure Guide Ways it is also possible to define, if both axis (X and Y) are to be measured or one axis only. This allows for example to start with one axis until the result is satisfactorily after the necessary adjustments. In such a situation only the one axis is marked. (X-Axis included)
  In a later step only “Y-axis included” is activated and possibly adjusted. At the end it is still possible to measure both axis.

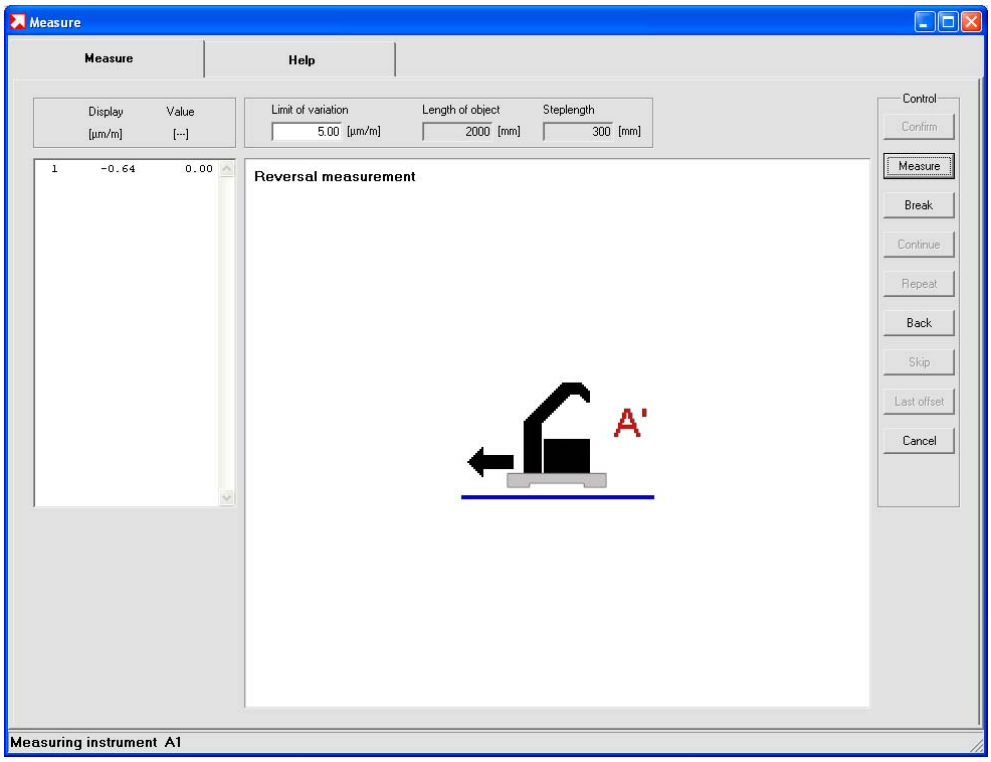
In our example we chose X- and Y- axis included and select <**MEASUREMENT DEVICE INPUT**>. To start the measurement [Enter]  must be confirmed

Because in our example we measure in the “absolute mode” a reversal measurement is to be performed first. The first measurement done is the measurement “**A**”

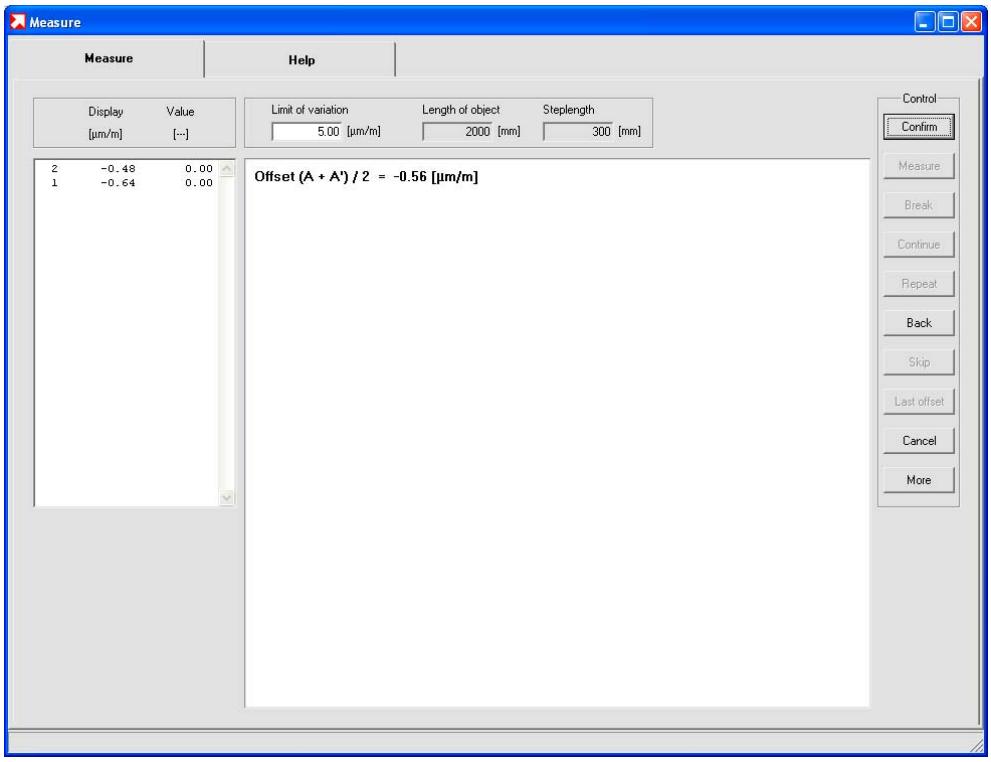
The **reversal measurement** should best be done on a horizontally adjusted granite surface plate. Ideally for collecting the first value the first setting position of the instrument should be marked on the plate. For collecting the second value the instrument must be turned by gliding 180° without lifting from the plate.



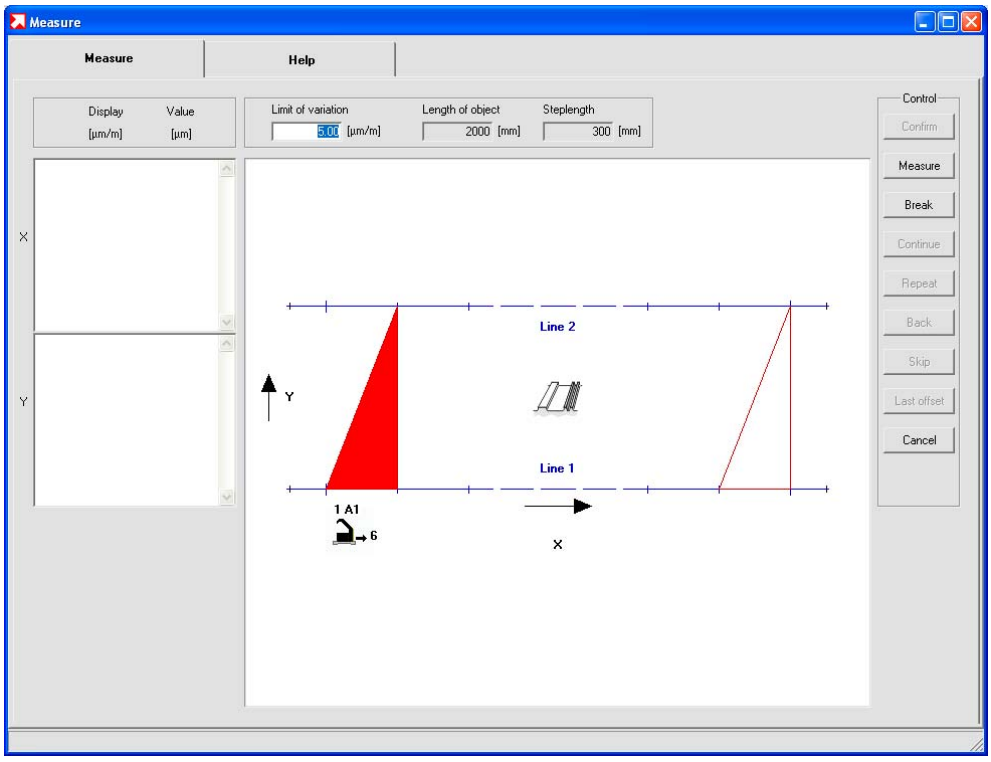
During the collecting of the first measuring value the remark appears “Please wait” The first measured value is displayed. When finished the second value "**A’ "** is collected Using [Continue] will show the next step



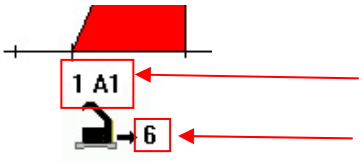
After the second measured value the ZERO offset of the **instrument Offset = {Value <A> + Value <A'>} /2** is displayed. Using [Confirm] the displayed value is accepted and will be used in the measurements to come.



After the **reversal measurement** has been completed the actual measurement of the guide ways can be started.



The first position of the instrument is indicated. The instrument must be placed there. After the required settling time use [Measure] to collect the first measuring data.



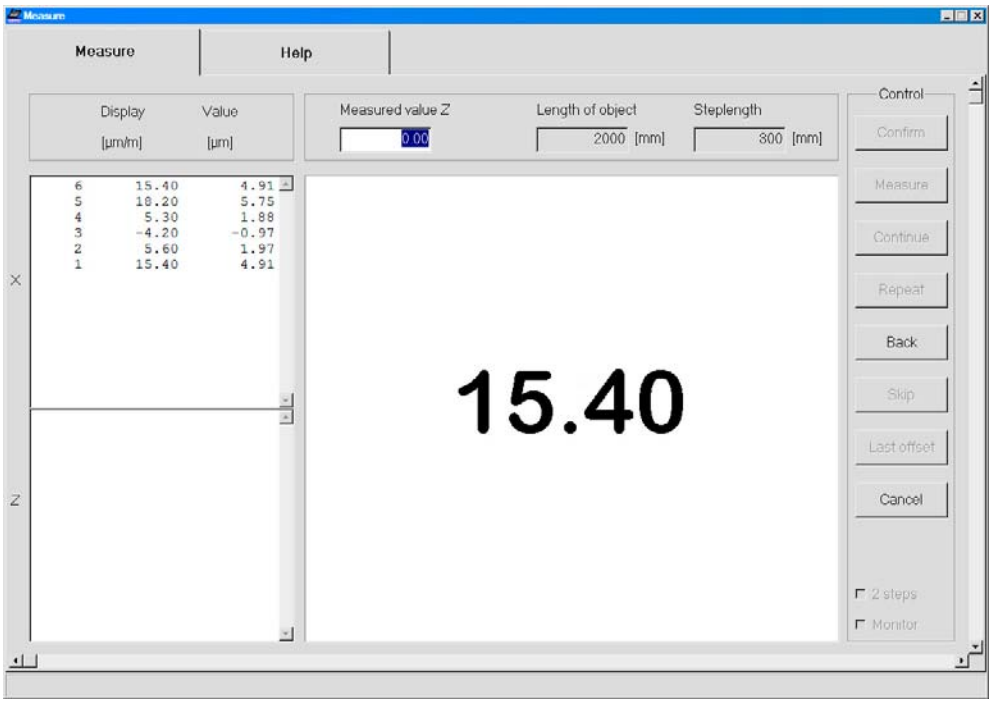
On the screen additional information is displayed

1. Measurement with Single instrument A1

Number of measurement steps

After all 6 steps in longitudinal direction the JIG must be returned to the starting position and the instrument must be placed correctly in Y direction.

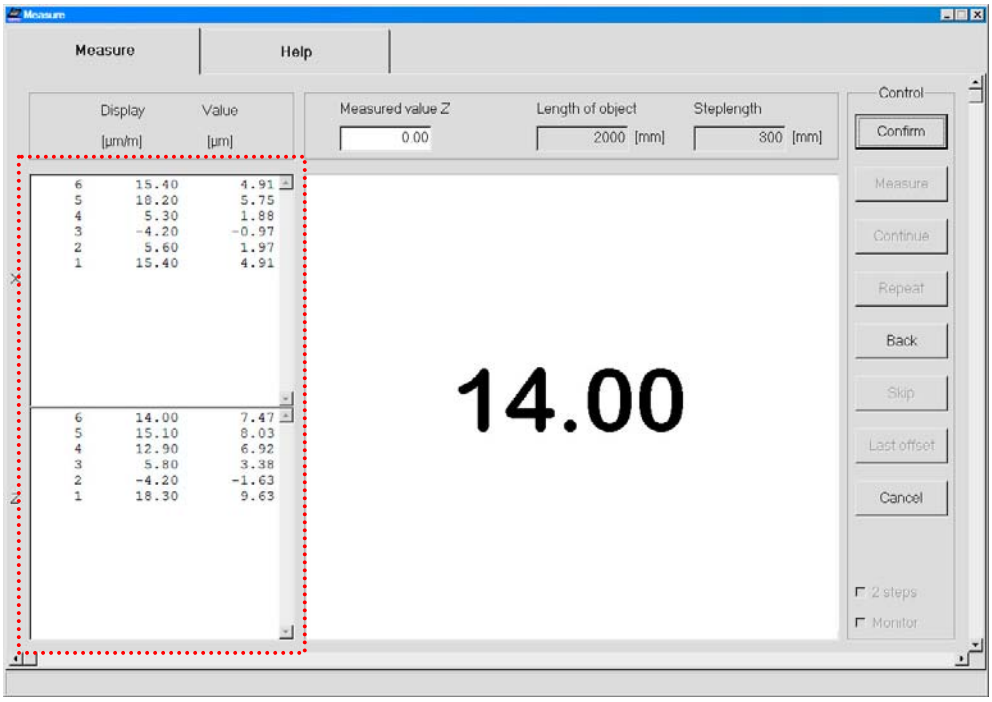
Attention **Instrument must always be placed with the connector in measuring direction**



Information between measurements
After the data is collected the measured value is displayed on the screen in large figures and the following options are available:

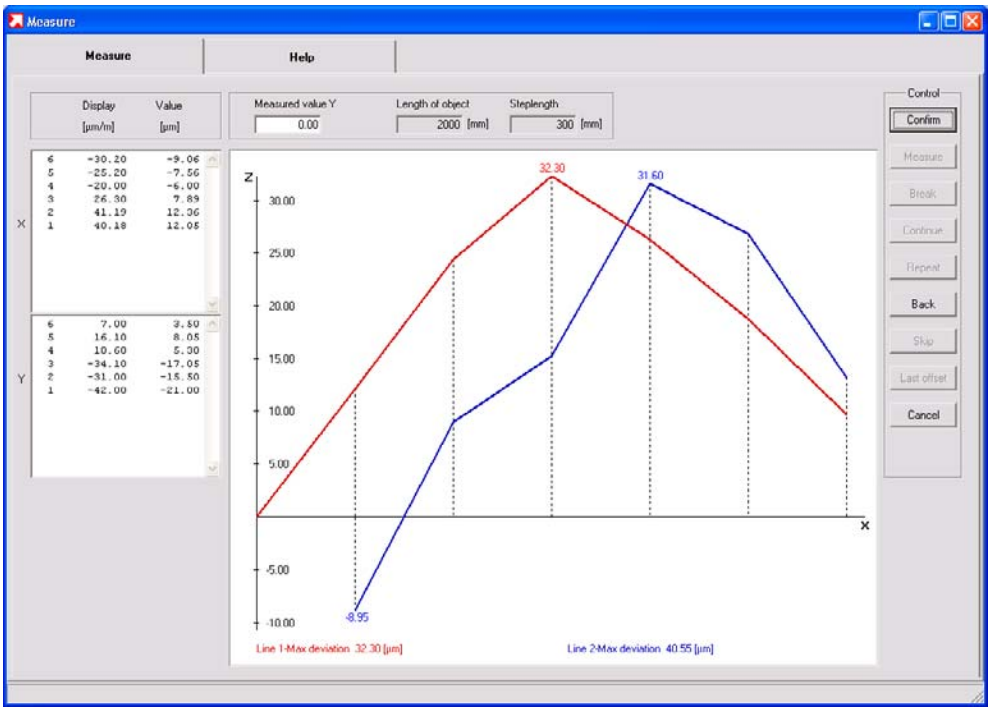
- Continue measurement
- Repeat measurement
- Cancel measurement

On the left side of the screen the numerical values in X and Y direction are displayed



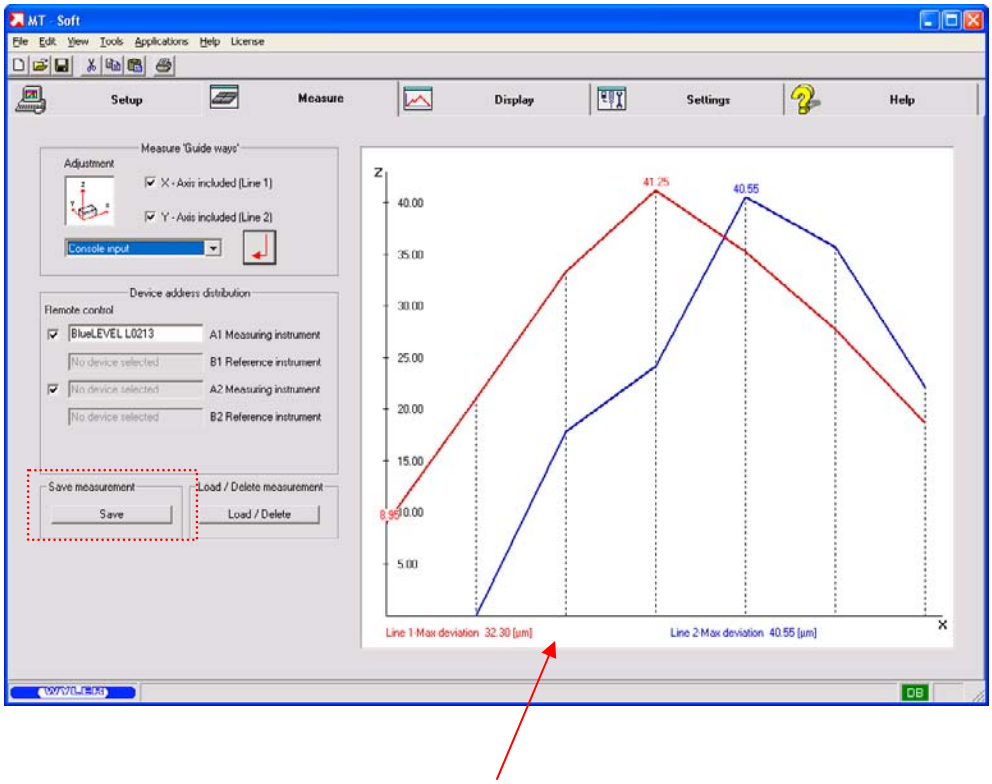
Remarks:
When using “Console Input” no large display is shown the values entered are immediately taken to the display on the left hand side

After the last measurement the result of the measurement is displayed in graphical form.



Using [Confirm] means the measurement is accepted. If not the button [Back] goes back step by step through the measurement for possible repetition.

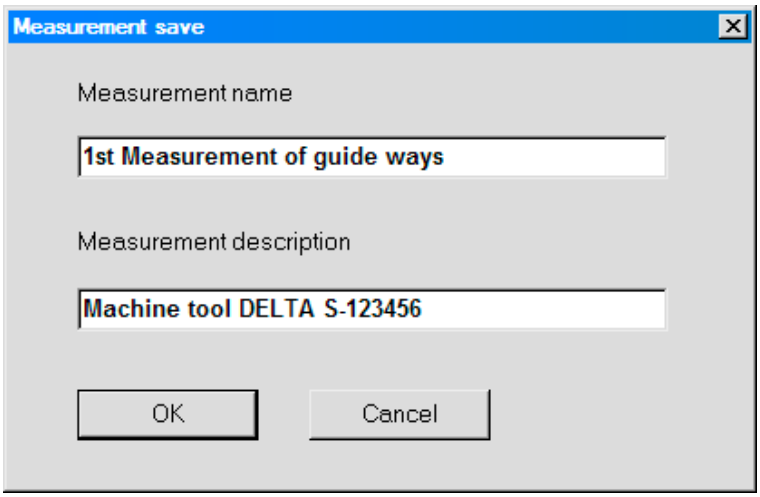
After [Confirm] is pressed the measurement is definitively finished and the following window appears.

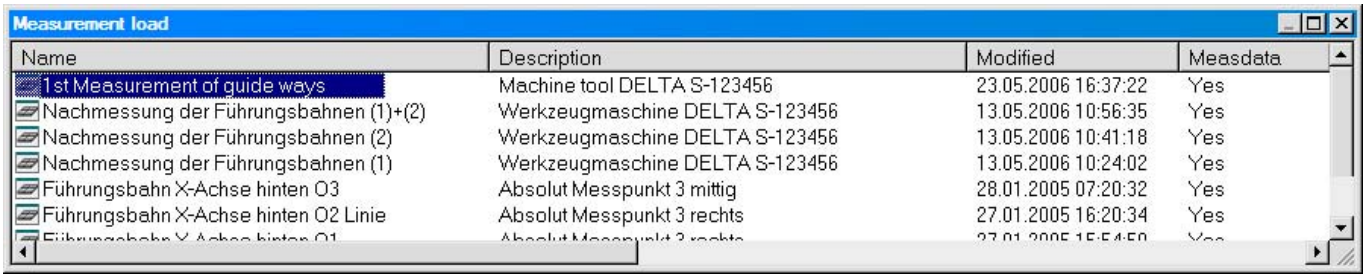


Save the measurement

If the measurement is correct it should be saved e.g.:

- o Measurement setup name: **"1st Measurement of guide ways"**
- o Measurement setup description: **"Machine tool DELTA S-123456"**

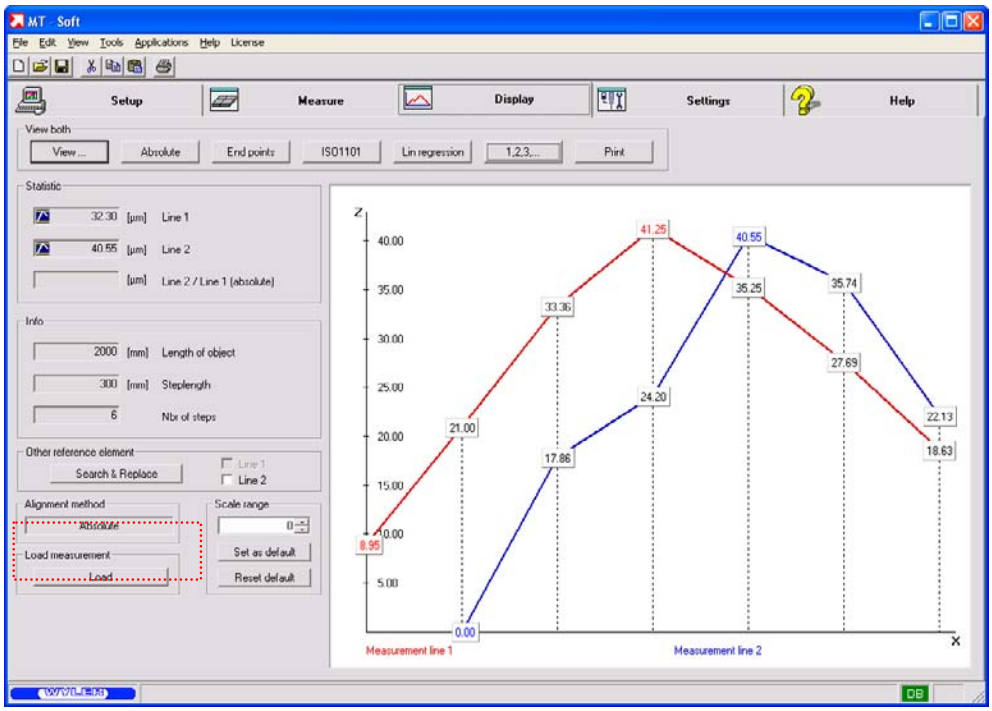




It is useful to save the data with a clearly defined name for finding the measured information later in an easy way.

For detailed analysing of the measurement the register <**VIEW**> can be activated

Using the register <**DISPLAY**>  the taken measurement can be viewed and judged under different aspects. The measured result will be "lifted" (exception alignment method Lin. regression) so that all measured values are positive. The position in space will not be altered by this lifting.



Display is possible according to the different alignment methods

- Method **Absolute**
- Method **End points** (reference is the first line)
- Method **ISO1101** (reference is the first line)
- Method **Linear regression** (reference is the first line)

The actual method is seen below the graphic.

Additional information seen under MT_SOFT / Display

- [View…] shows the different views of the object measured, such as 1st line, 2nd line, all lines
- [Absolute] alignment method Absolute
- [End points] alignment method End points
- [ISO1101] alignment method ISO1101
- [Lin. regression] alignment method Linear regression
- [Zoom->] Opens a window for different view modes
- [Print] Printing the measured data according to the setup

For Information on the **various alignment methods** see **chapter 2.5.8**

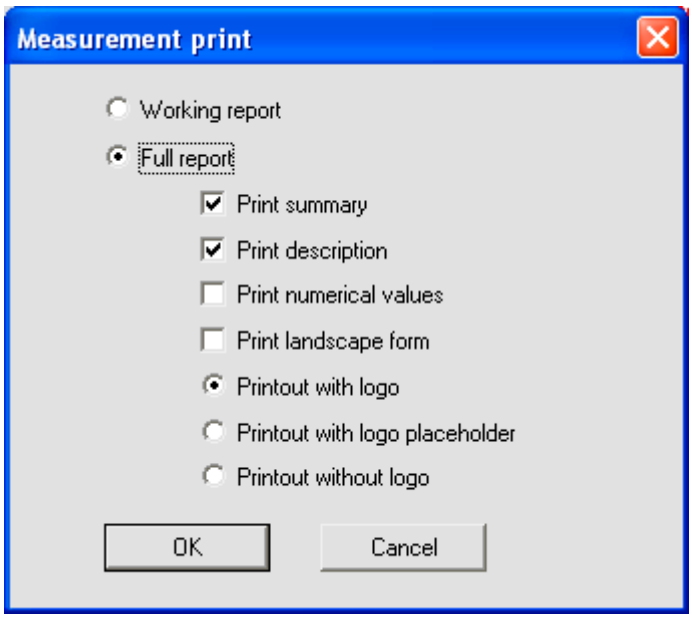
Displayed values:
a) Statistic:

	Alignment method in [µm]			
	Absolute	**End points**	**ISO 1101**	**Lin. Regression**
Straightness line 1	32.30	27.46	27.46	27.55
Straightness line 2	40.55	27.27	27.27	28.74
Flatness line 1 / line 2		14.06	35.71	3.97

b) Info

- Length of Object (2000mm)
- Step length (300mm)
- Number of steps (6)

Print the data of a measurement
The same setup is used as it was in the last print job. This is especially to check in the points “Alignment method”, “scale” and with/without “closure error”



The **following setup** is possible

- Working report:
  Short form printing, printed are
  - Description of the measuring task, machine type, serial number, elements
  - Dimensions of the object
  - Closure error, deviations
  - Graphical display of the object, setup information such as the alignment method, numerical display, etc. is taken from the screen display

- Full report
  - Print Summary
    - Logotype, if activated
    - Measuring and print date
    - Dimensions of the object
    - Closure error, deviations,
    - Graphical display of the object, setup information such as the alignment method, numerical display, etc. is taken from the screen display

  - Print description
    - Logotype, if activated
    - Header file with customer, machine type, serial number and name of engineer
    - no measuring data

  - Print numerical values
    - Logotype, if activated
    - All measured values in numerical form

  - Print landscape form (additional print of figure in landscape mode)
    - Graphical display of the object, setup information such as the alignment method, numerical display etc. is taken from screen display
    - Display of the alignment method
    - Closure error
    - Dimensions of the object

  - Print with Logo
    - The Logotype defined is printed, see <Settings> for changing the Logotype

- Print with Logo place holder
  In case company paper is used the logotype must not be printed
  - Print without Logotype

- Print without Logo
  - print is without logotype

After entering the options for the print the **Measurement description template** is opened again for checking the data before printing. After confirming the data is saved.

Remarks concerning the "Print logo" option

- Any logotype can be used. The size must be 200mm (length) x 20mm (height) and the type must be bitmap (*.bmp) and the logotype should be saved in the main menu of MT-SOFT.
- The logotype is activated in the menu MT-SOFT <**Settings**>
- Click to <Set> opens the active logotype. When clicking to the opened logotype the Windows explorer will be opened for selecting another logotype.

Additional information see chapter 4 "Definition of a new measurement and starting the measurement"
Example measurement of Circles

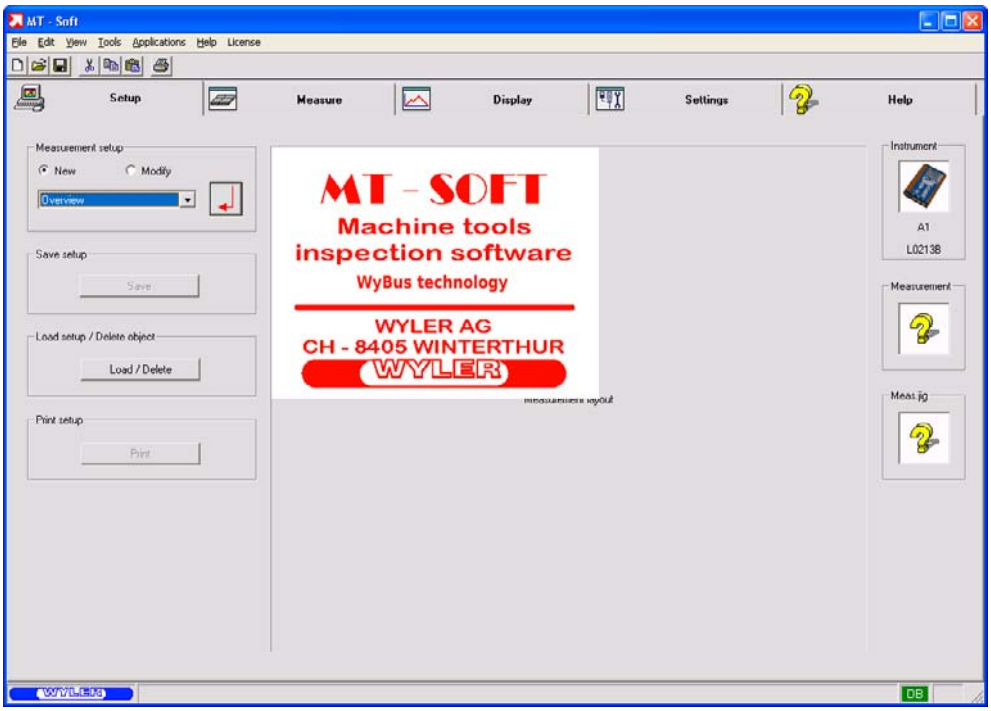
Re-measuring of guide ways of a machine tool respectively measurement of the two guide ways in 2 steps

Starting position:
The previous example showed a final measurement on a machine tool ready for delivery. During the set up of the machine it is, however, necessary to measure each guide way separately and to readjust it again and again until a satisfying result has been achieved.

For this case the following procedure must be performed.

1. Reprocess the measurement of the machine as a template (see example here after)
2. Measurement and readjustment of the front guide way until the result is satisfactory.
   Then save the result.
3. Measurement and readjustment of the rear guide way until the result is also satisfactory.
   Save the result as guide way 2.
4. Integrate the guide way 2 in the main measurement.

After starting the measuring software MT-Soft the following overview appears:



Our example for the measurement

- **Type of measurement**: **"Guide ways"**
  - Front guide way "**prismatic**"
  - Rear guide way "**flat**"
- **First cross section** measurement at the end of the measuring JIG

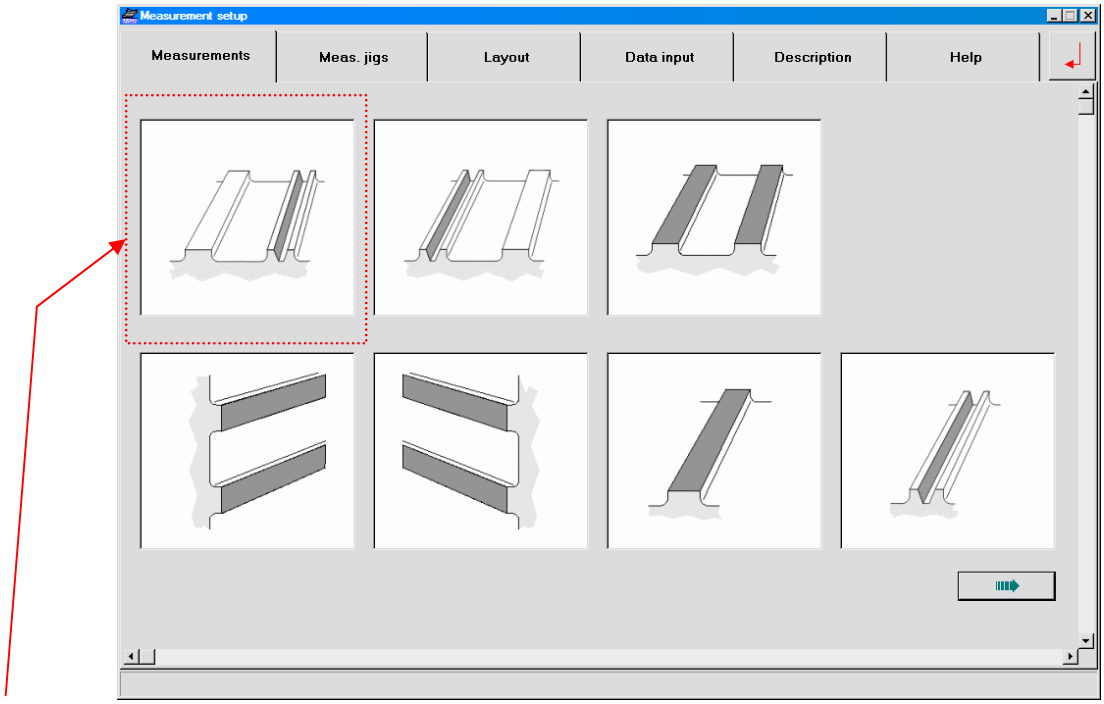
- **Work piece coordinates**
  - X-axle coordinate/(Object beginning): -1000 mm
  - X-axle coordinate/(Object end): 1000 mm
  - X-axle coordinate/(First measuring point): -900 mm
  - X-axle coordinate/(Last measuring point): 900 mm
  - X-axle coordinate/(Step length): 300 mm (depending on JIG available)

  - Y-axle coordinate (Line 1) : 0 mm
  - Y-axle coordinate (Line 2) : 500 mm

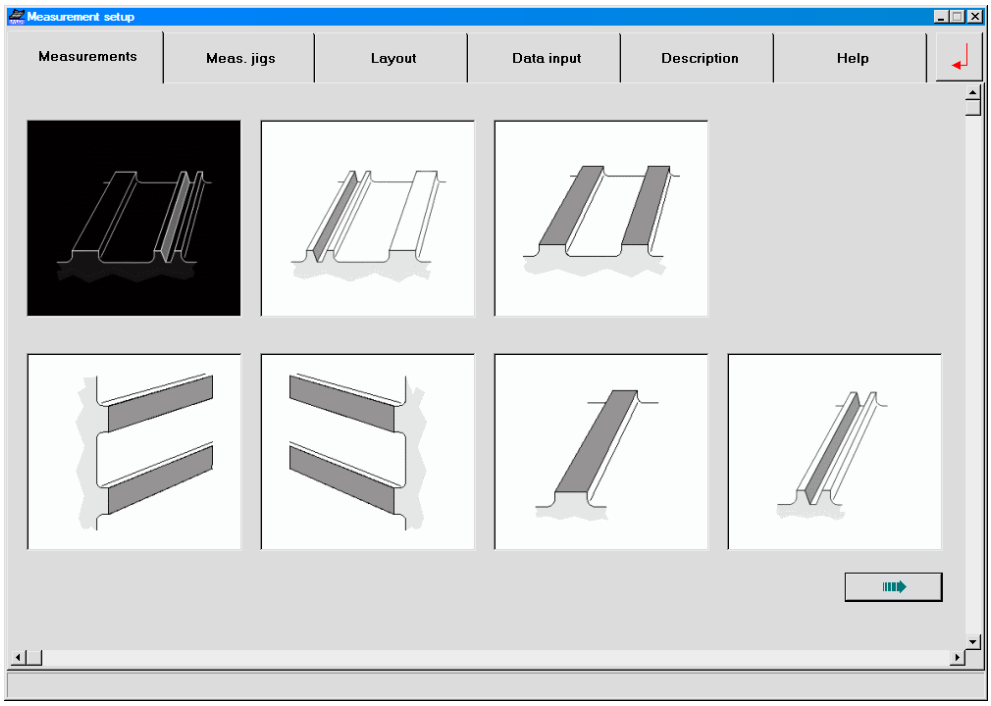
- **Measuring setup:**
  - The measurement of the guide ways should later be used in comparing the table with the vertical spindle. In order to do so it is required to measure in the **absolute mode**. An absolute mode measurement requires before the measurement a reversal measurement with the instrument.
  - The measurement is done **with a single instrument**. This means the first step is measuring the X-axis and as a second step measuring the Y-axis.

In the register "Setup", we select the submenu “Guide ways” and confirm this selection with [Enter] 

The dialogue for the selection of the **TYPE OF THE GUIDE WAY** appears under **<MEASUREMENTS>**

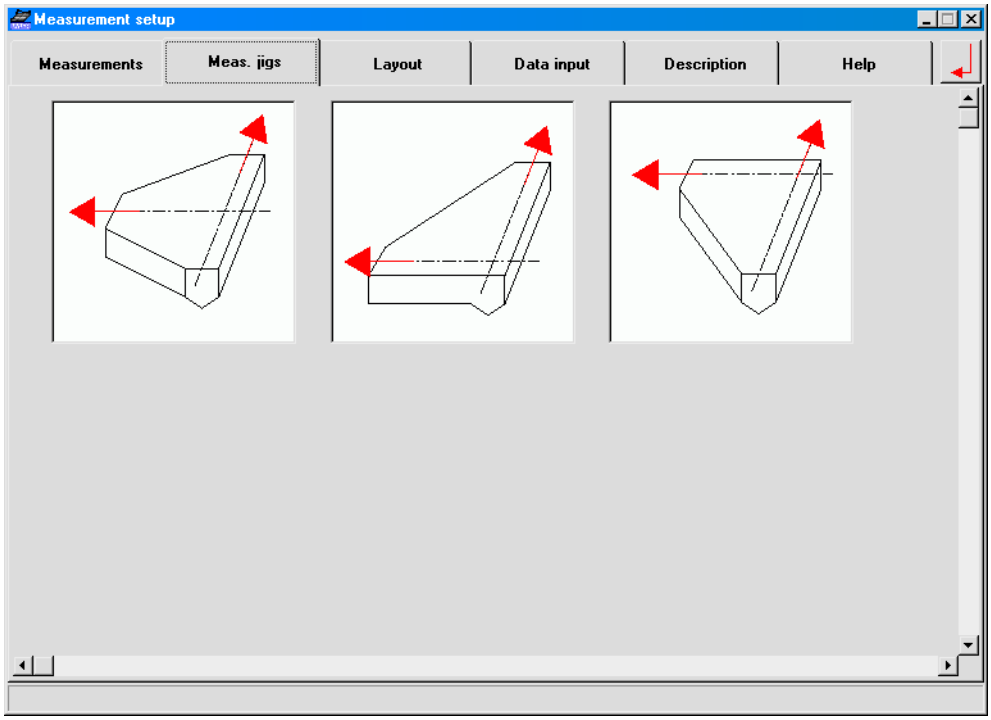


In our example we select the first picture (front guide way with V-groove (prismatic), rear guide way flat.



After the selection the background of the selected picture becomes dark.

The next selection deals with the **Measuring JIG**



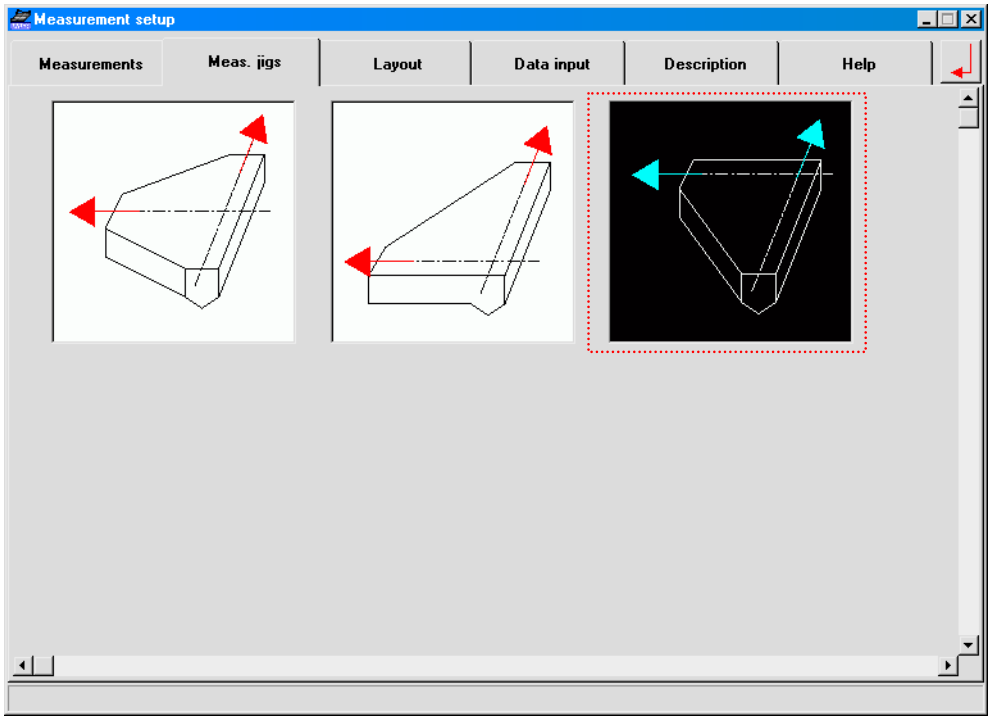
In this case three options of measuring JIGs are available. The pictures are self explanatory.

- Left picture: Cross direction measurement in the middle
- Middle picture: Cross direction measurement at the beginning of the measuring JIG
- Right picture: Cross direction measurement at the end of the measuring JIG

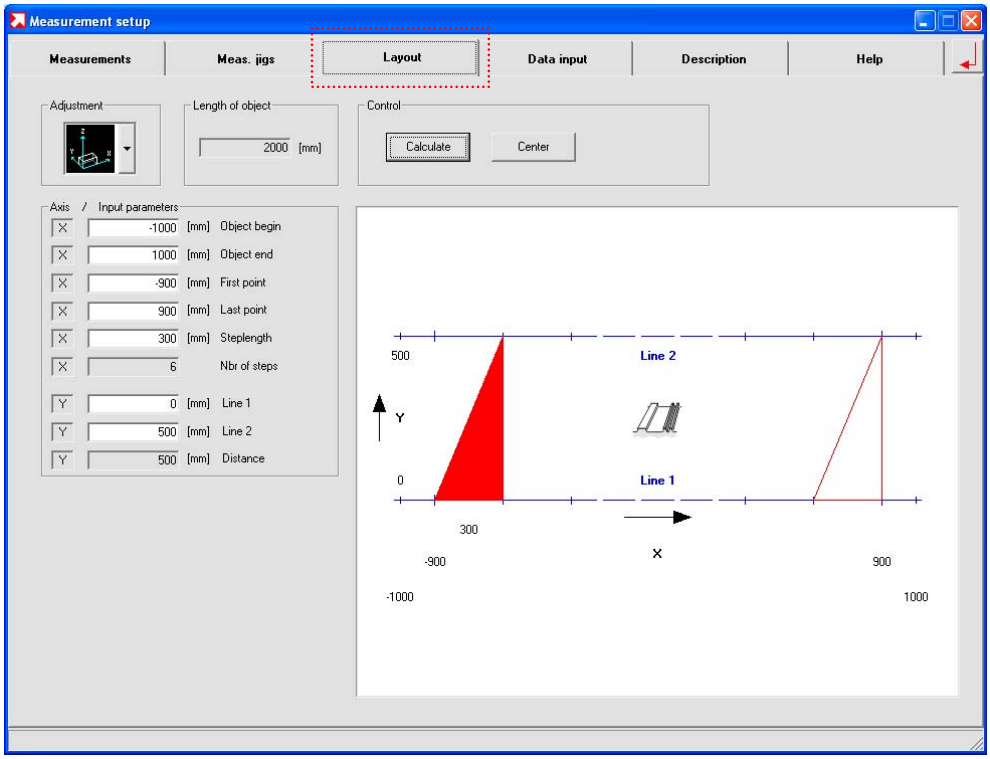
Remark

The measuring JIGs are usually supplied by the user. Of course, WYLER SWITZERLAND is also prepared to quote and supply any JIG required. (See also chapter "Measuring bases")

In our example we chose the third JIG (cross direction measurement at the end of the base plate)

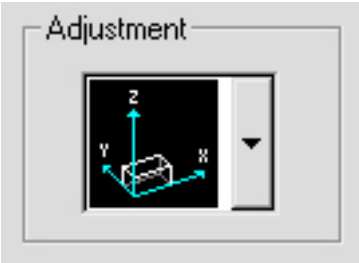


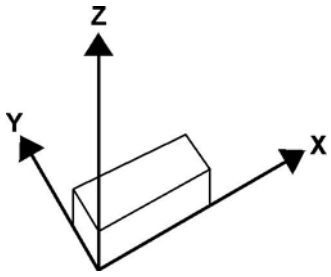
The next selection to be taken is the **LAYOUT**



Firstly under <**ADJUSTMENT**> the coordinate system (**work piece coordinates**) according to the set up of the machine must be defined.

For our example we choose the following adjustment:





For the definition of the position and dimensions of the guiding elements the relevant entries (**WORK PIECE COORDINATES**) are necessary

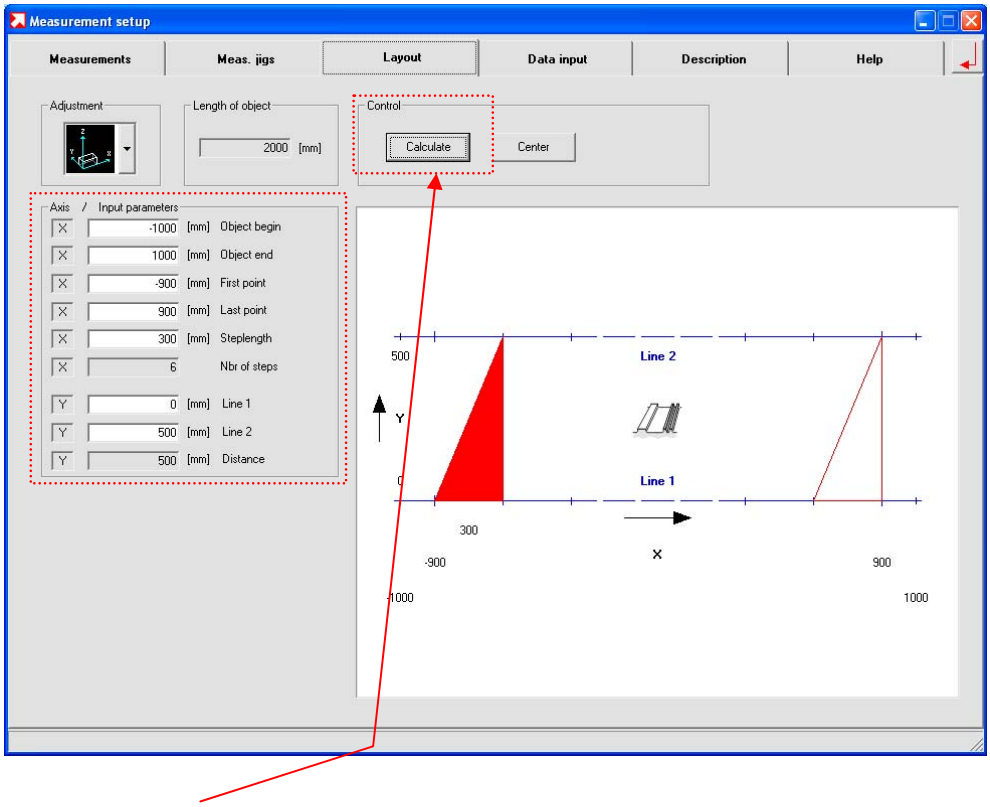
- X-axle coordinate/ Beginning of object: -1000 mm
- X-axle coordinate/ end of object: 1000 mm
- X-axle coordinate/(First measuring point): -900 mm
- X-axle coordinate/(Last measuring point): 900mm
- X-axle coordinate/(Step length): 300 mm (Depending on JIG available)

- Y-axle coordinate (Line 1) : 0 mm
- Y-axle coordinate (Line 2) : 500 mm

As soon as all active fields contain a valid value [Calculate] can be performed.
Thereby the graphic will be completed and additional data is entered automatically.

- Length of Object (2000mm)
- Number of steps (6)
- Distance (line 1 to line 2 = 500mm)

Important: check all the entries created on their compliance with the measuring object and the JIG.

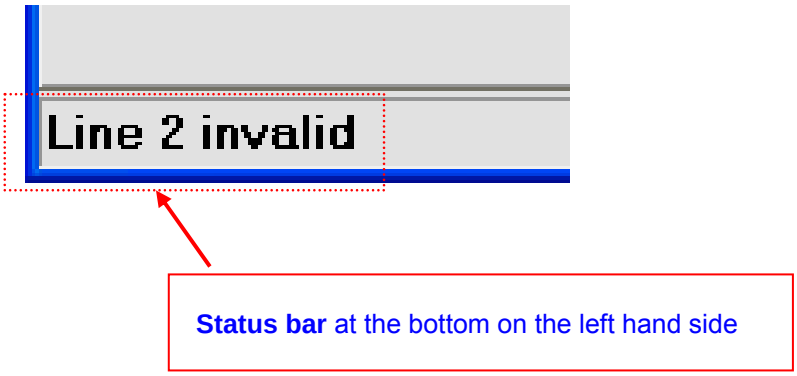


After confirming with [Calculate] the following additional information is displayed

- Length of object (2000mm)
- Distance Line 1 to Line 2 (500mm)
- Number of steps 6

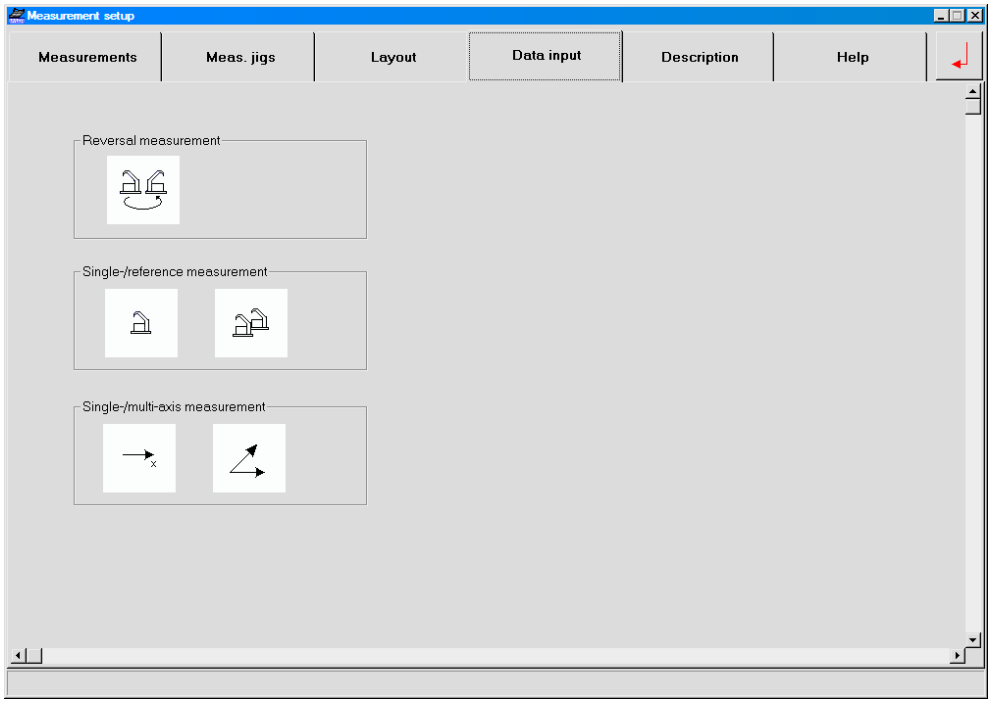
Information on invalid or missing values is displayed in the status bar

Example of a missing or wrong entry:



In the preview window the graphic layout and the numerical figures are visible. It is important to recheck these data before proceeding.

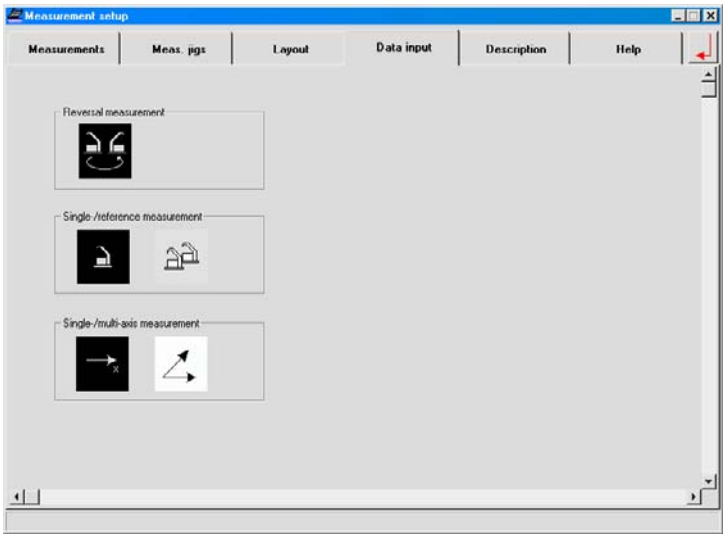
The next selection deals with the <**DATA INPUT**>
This selection describes specific procedures for the data input.

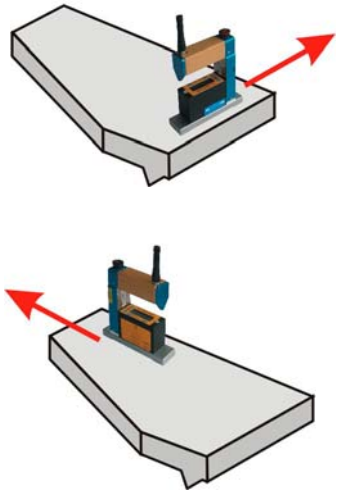


Here the type of measurement can be entered. The following options of instrument configurations are possible:

- **Reversal measurement**
  This mode is precondition for “absolute” measurements and for the measurement of different individual objects to be compared at a later stage
- **Single/reference measurement**
  Selection whether the measuring values are taken directly from one instrument or whether the difference of the measuring values of two instruments in differential mode is taken, whereby one measuring instrument serves as the reference.
  (Value = A-B). Differential measurement does not allow “reversal measurement”
- **Single / multi-axis measurement**
  Selection whether, as in our example, inclinations in X and Y directions are measured with one instrument first in one direction X and after that in a second run in Y direction is measured, or whether with two instruments set up in X and Y direction both axis are measured in one run.

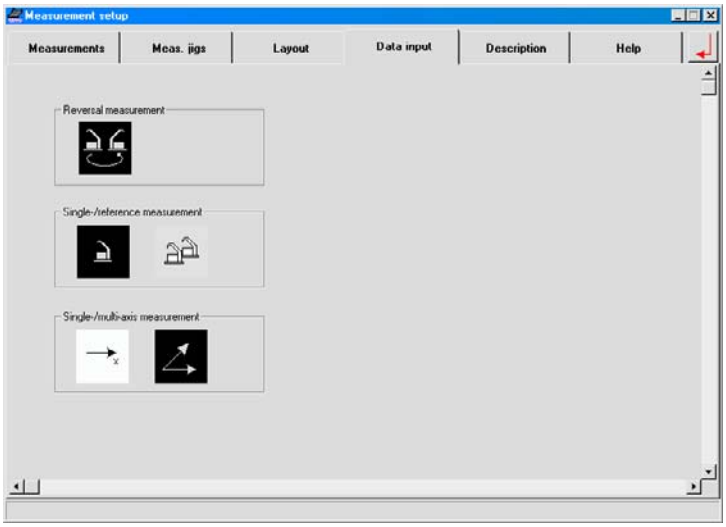
- **Reversal measurement** / Absolute measurement with on Instrument. This means one direction (X) is measured at one time only. In a second step the cross direction (Y) is measured

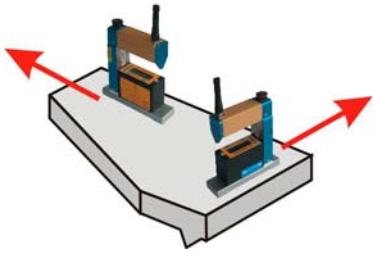




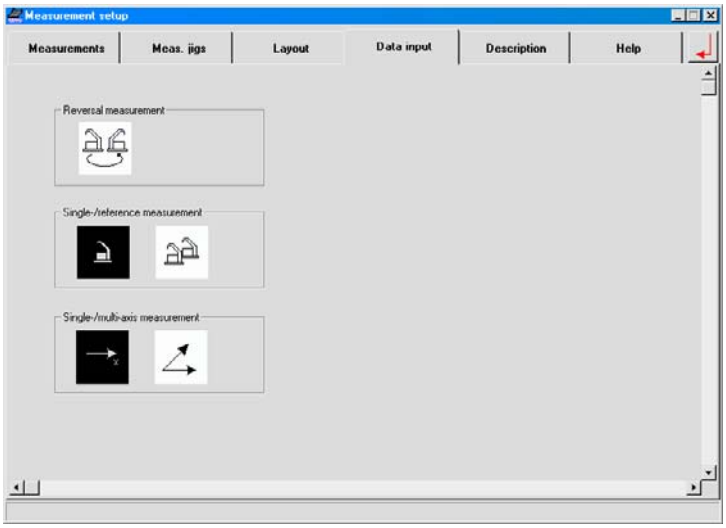
Note:
Invalid entries have a light grey background

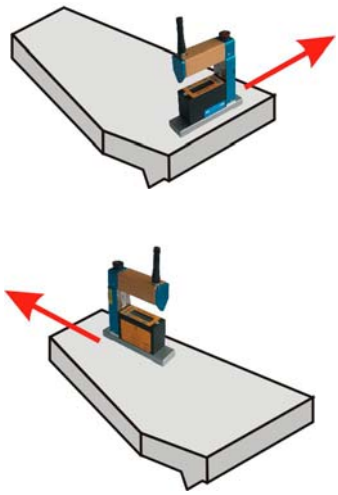
- **Reversal measurement** / Absolute measurement with on Instrument. Measurements in X-direction and in Y direction with one instrument each **simultaneously**



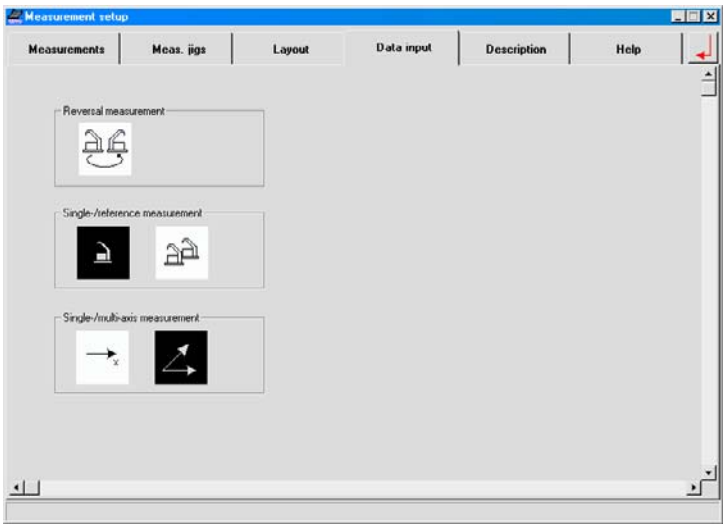


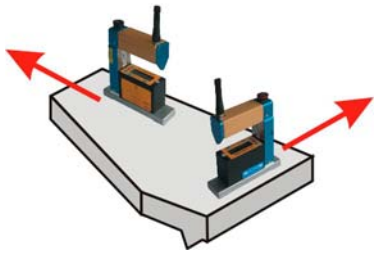
- **<u>Without</u>** reversal measurement / **Relative measurement** with one instrument. In a first step measurements in X-direction, in a second step measurement across in Y direction



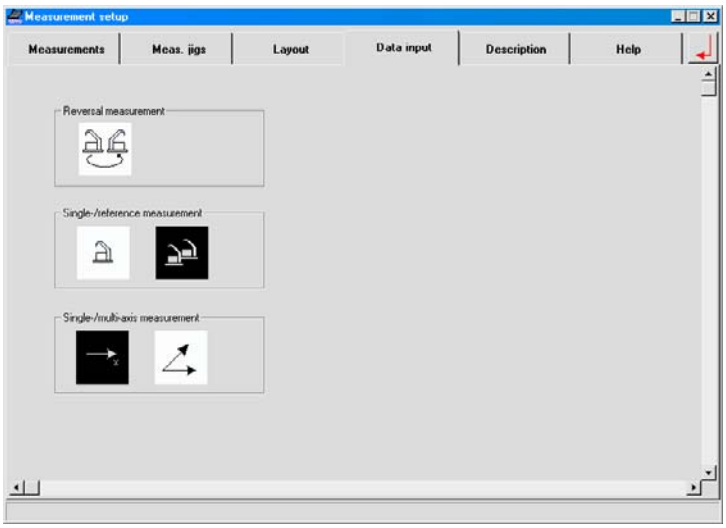


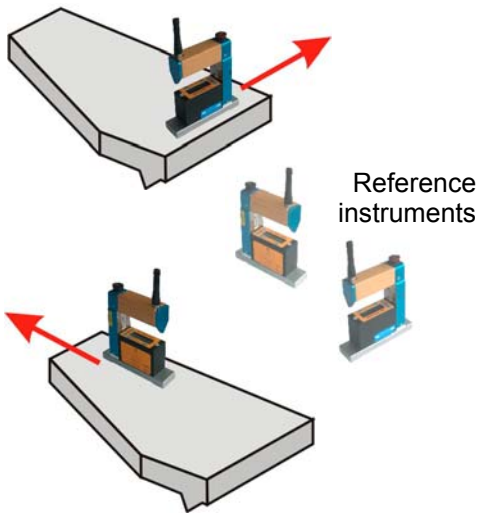
- **<u>Without</u>** reversal measurement / **Relative measurement** with one instrument per direction. Measurements in X and Y direction **simultaneously**.



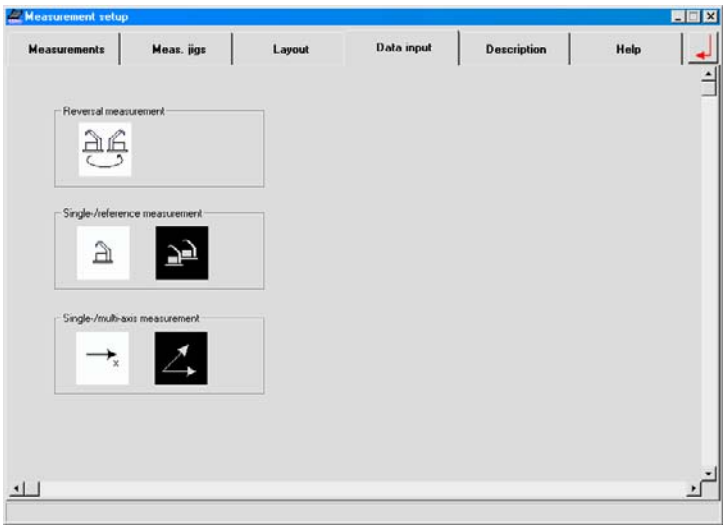


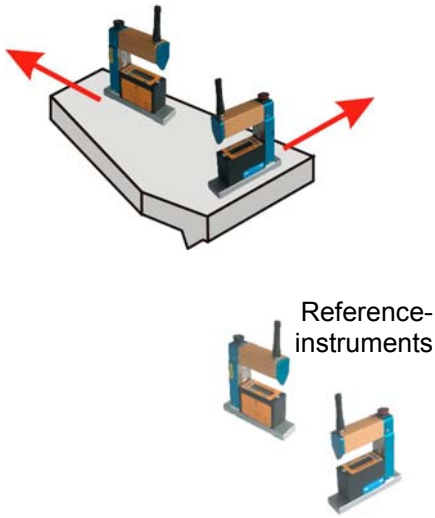
- **<u>Without</u>** reversal measurement / **Relative measurement** with 2 instruments (measuring / reference instrument). In a first step measurements in X-direction, in a second step across in Y-direction





- **<u>Without</u>** reversal measurement / **Relative measurement** with 2 instruments each (for each axis a measuring and reference instrument). Measurement in X and Y direction simultaneously



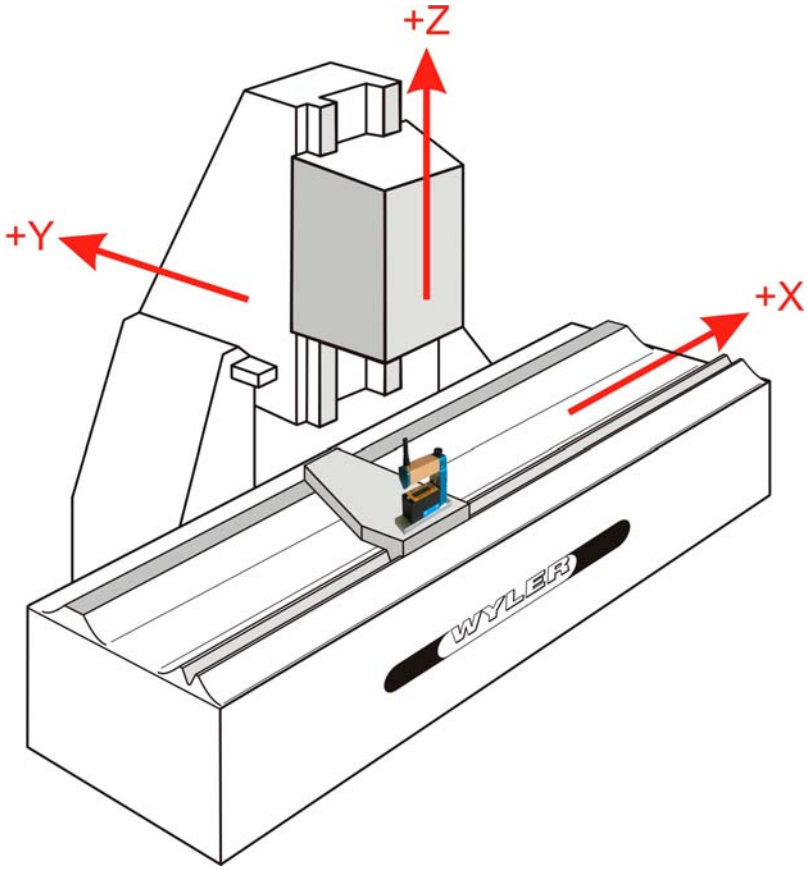


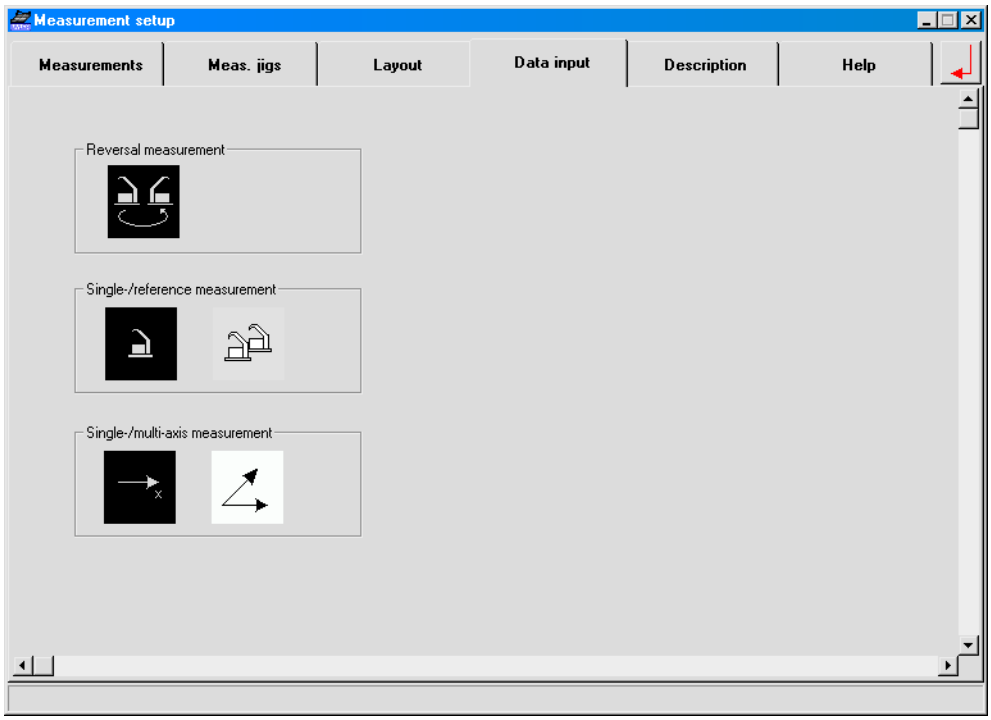
Important

- o When using a LEVELMETER 2000 or a BlueMETER 2 separate measuring channels allow to measure the two axis X and Y simultaneously as long as no reference mode is activated.

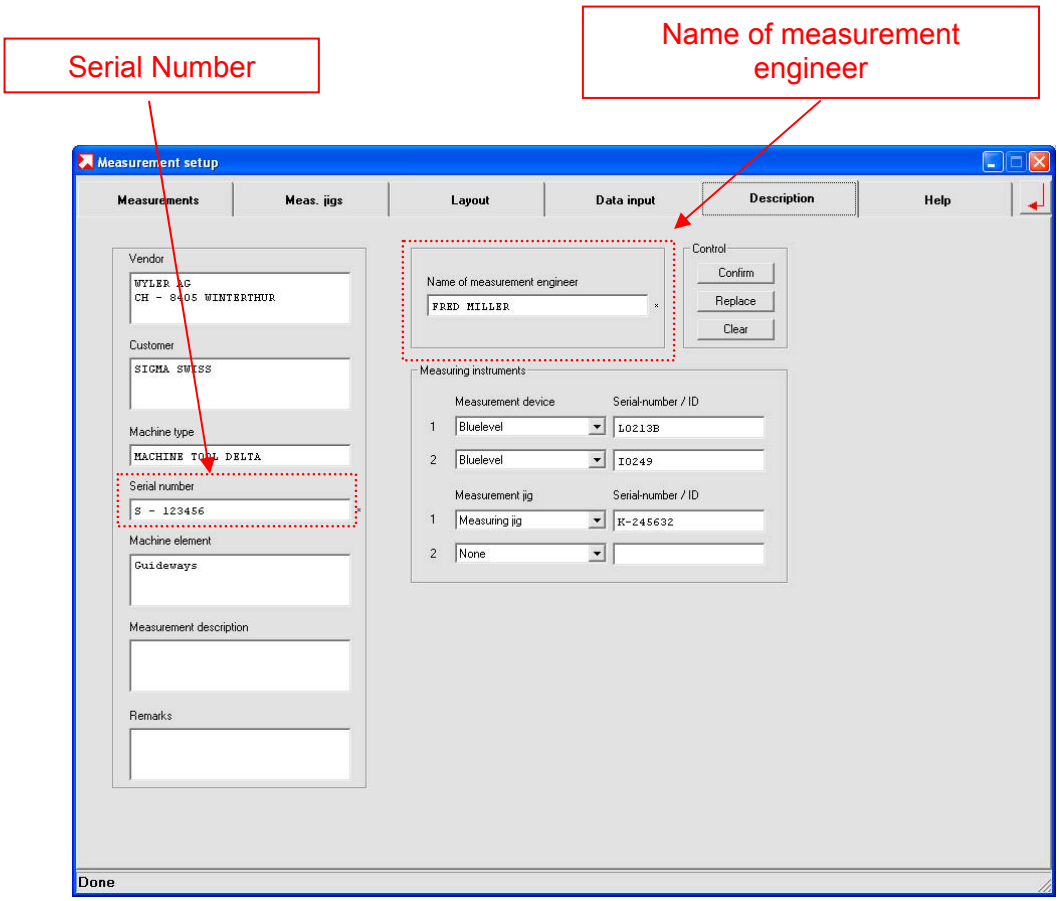
- o When using LEVELADAPTER 2000, the measurement of inclinations in X and Y directions simultaneously two LEVELADAPTER 2000 are required and must be connected to two separate serial ports of the computer (COM 1 and COM 2)

In our **example** we chose **Absolute measurement with one instrument.** In the first step measurements in X-direction only and in the second step measurements across in Y-direction (single axis measurement).





The next selection deals with the **DESCRIPTION OF THE MEASUREMENT**



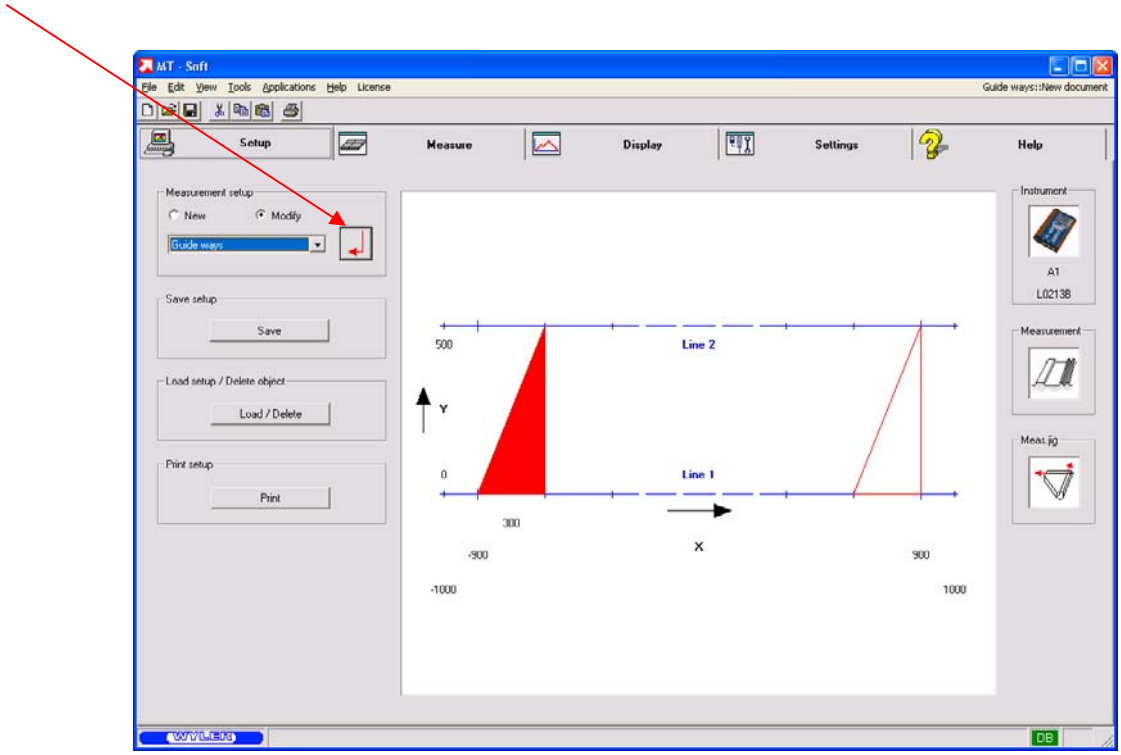
The measuring description serves for the error free identification of the measuring object. In connection with the comparison of other elements of the same machine, e.g. horizontal guide way compared with vertical spindle, the **Name of measurement Engineer** and the **Serial number of the object** are **mandatory**.

The rest of the information is useful but not necessary. The text can also be integrated from an existing template by using the <**REPLACE**> button.

It is still possible to make changes to the layout in the individual setup registers.

Finally the entries can be confirmed with the [Confirm] button

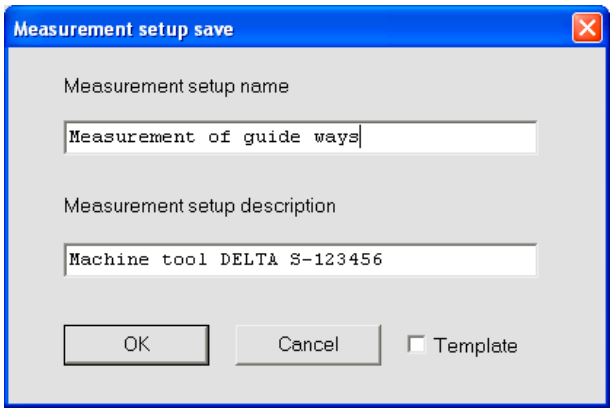
Now the **actual measurement** can be. After confirmation with the [ENTER] button the following screen appear



The following information is displayed:

- Object to be measured, in our case "Guide Ways"
- RIGHT SIDE of the window
  - o Measuring Instrument: The connected instrument respectively Interface
  - o Measurement Type of Guide ways selected
  - o Meas. JIG Type of JIG specified

- Under "Save Setup" the button / [Save] the setup may be saved as a **template,** e.g.:
  - o Measurement setup name: **"Measurement of guide ways"**
  - o Measurement setup description: **"Machine tool DELTA S-123456"**

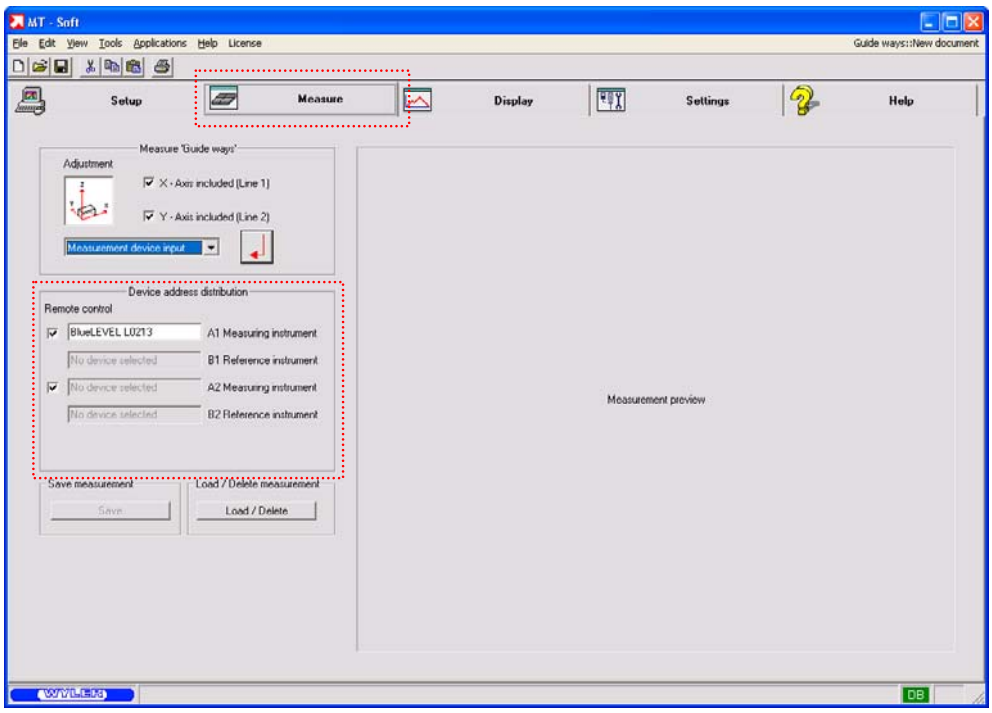


Under" Load Setup / Delete Object" / [Load/Delete] an existing setup template can be loaded respectively deleted.

- Using the button "Print Setup" / [Print] the configured respectively the actual measurement setup template can be printed

For **STARTING THE MEASUREMENT** we activate now the register <**MEASURE**>

In case the measuring instruments are not defined yet or if you want to change the instruments, you can still do this under "Device address distribution"

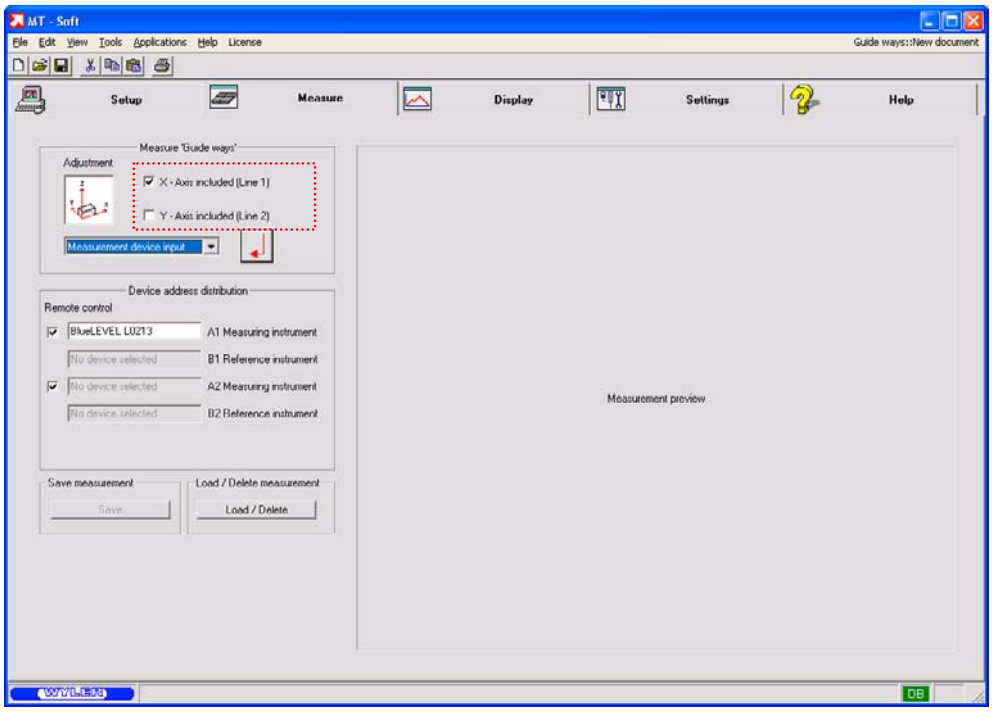


Here the following input options are possible:

- In the field <**MEASURE GUIDE WAYS**> it is possible to select the input device, directly from the measuring instrument / interface to the PC "Measurement device input" or manual input via the keyboard of the computer "Console Input"

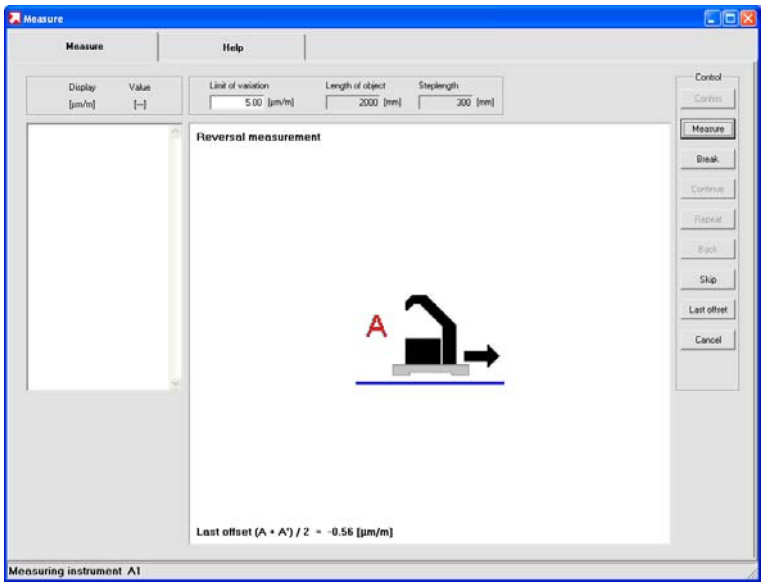
- In the field <**MEASURE GUIDE WAYS**> it is also possible to define, whether a complete measurement with inclination values in both axis (X and Y) shall be performed of whether the measuring values for one axis or the other should be replaced by Zeroes. Active fields = perform measurement. Replacing the measuring values by Zeroes can reduce the measuring time for some tasks considerably, e.g. when the present attention is only on one of the two guide ways. - When measuring values for one direction will be integrated from a measurement completed before.

As in this example want in a first Step to measure the **front guide way** only, we deactivate the measurement of the Y-axis (line 2) by removing the tick.

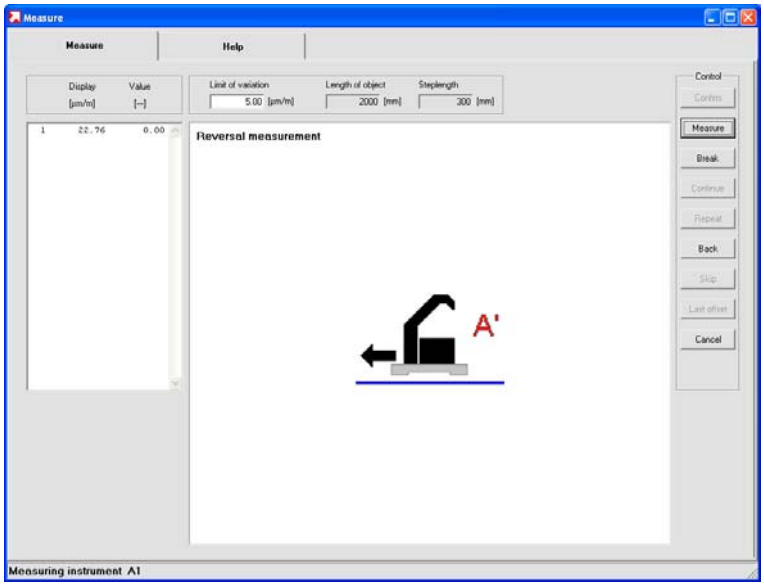


In our example we select from the pulldown menu "Measurement device input". The measurement will be started with the [ENTER] button 

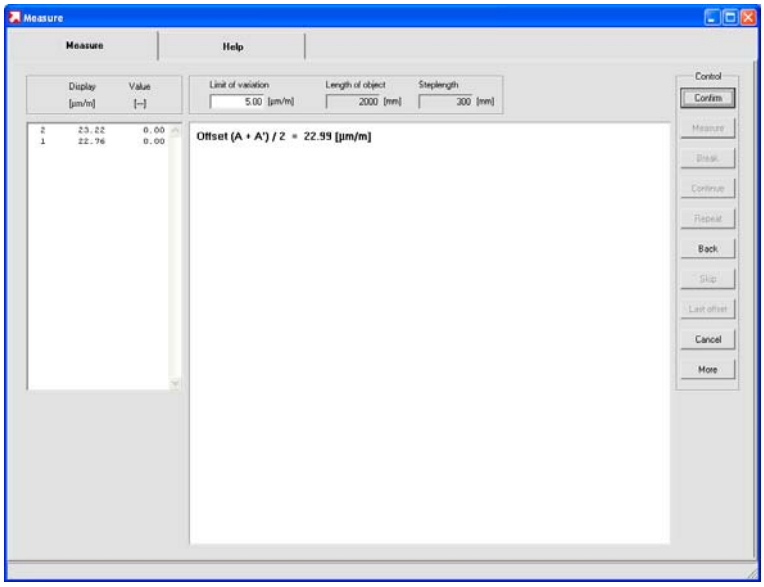
Reversal measurement for the determination of the Zero Offset value (mandatory for Absolute measurement)



Measurement "A"

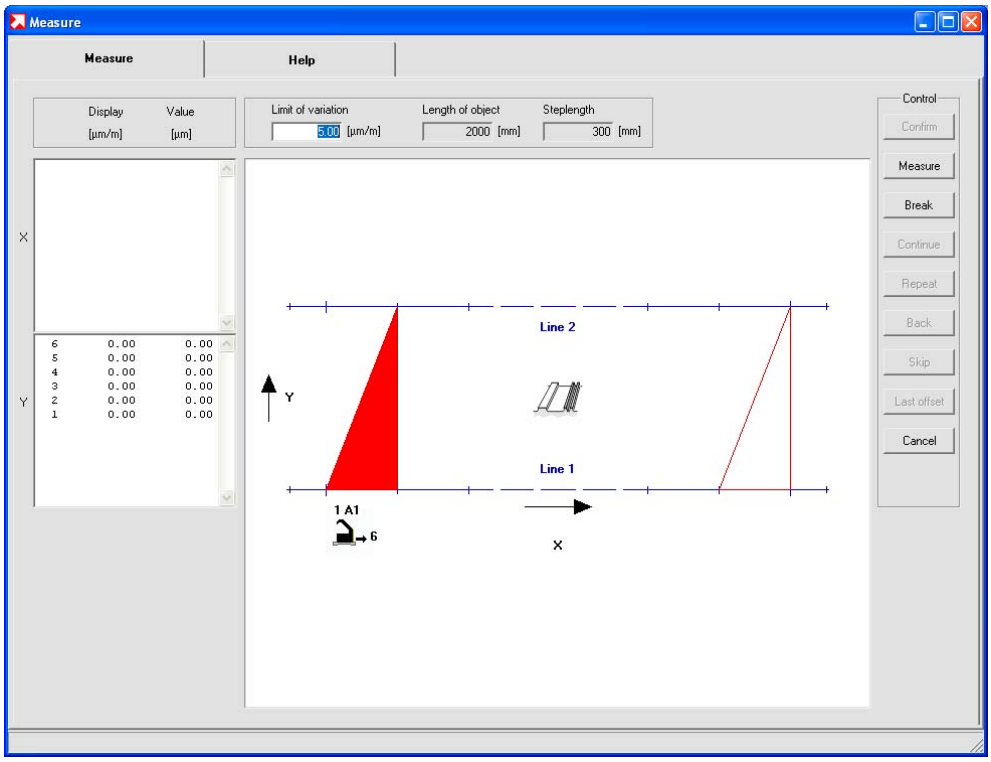


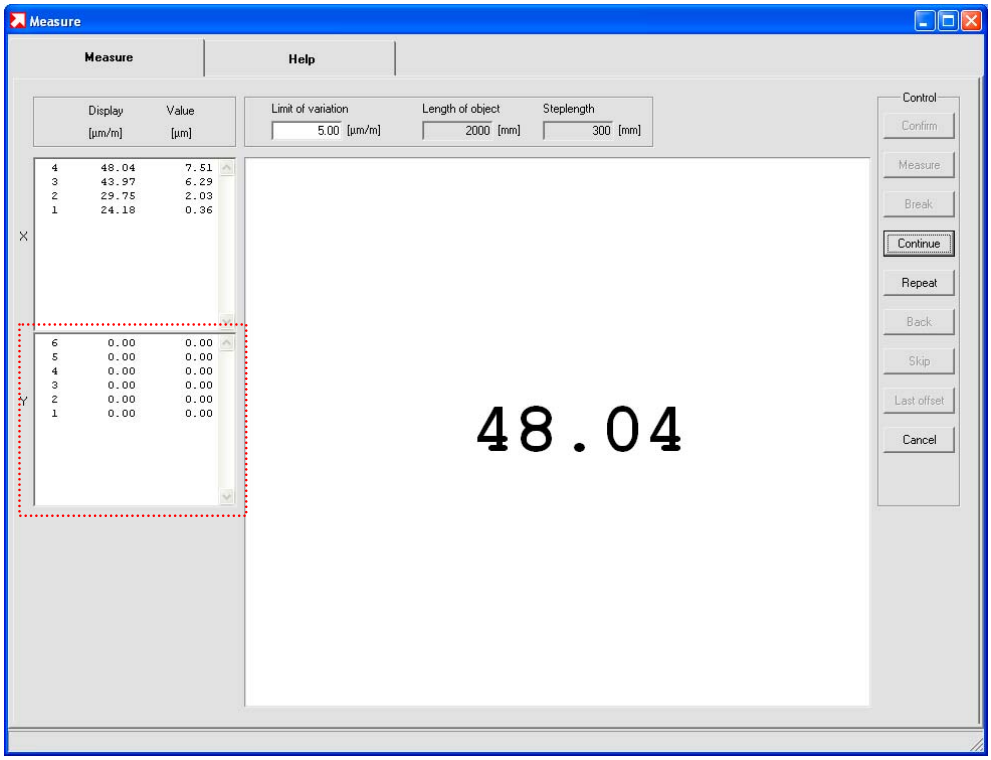
Measurement "A' "



After the second measurement **ZERO offset = {Value <A> + Value <A'>} /2**
is determined and displayed. This value must be accepted with the [Confirm] button.

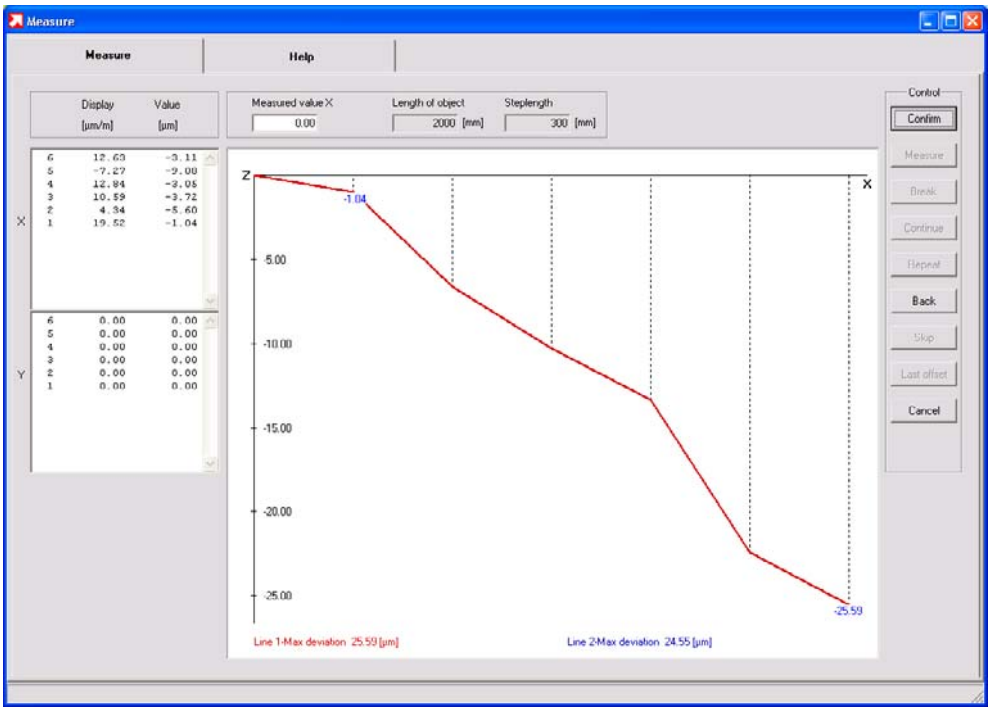
Start of the measurement of the front guide way (Line 1)





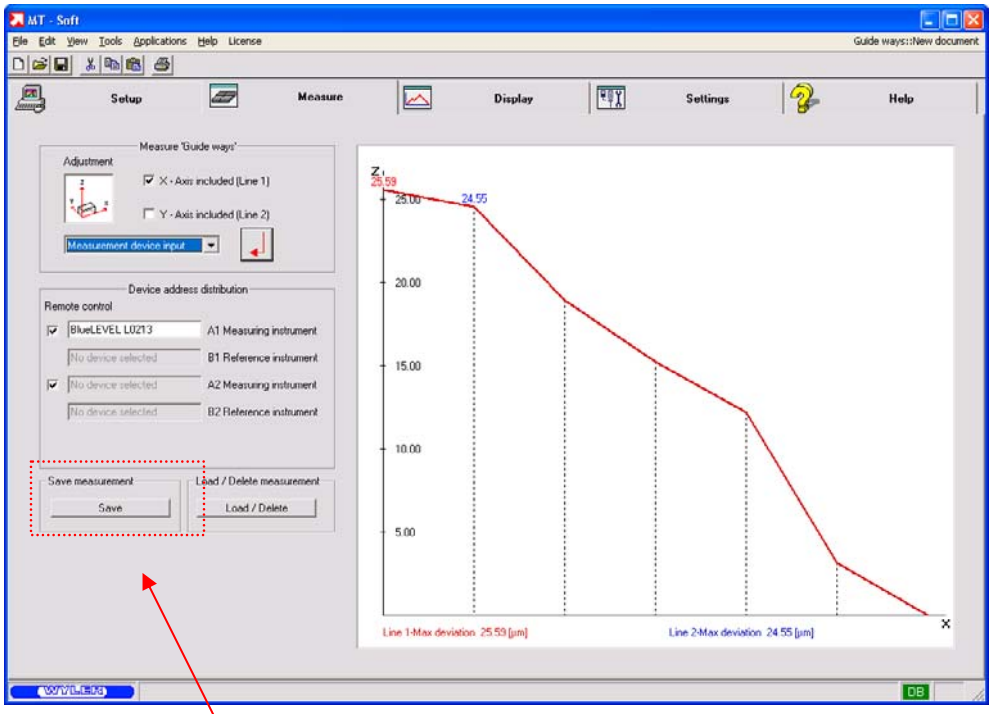
The measuring values of the guide way not measured at the moment are listed with the value "0"

After the last measurement the graphic display of the guide way 1 measured will appear



If the measuring results are satisfactory, we confirm the measurement with the [Confirm] button.

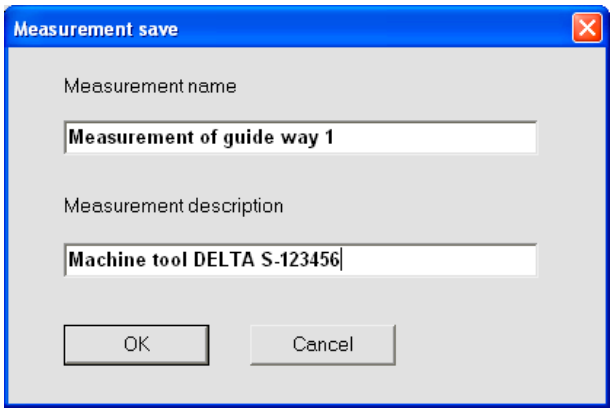
After confirmation with [Confirm] the measurement is definitely terminated and the following picture will appear:



Save the measurement

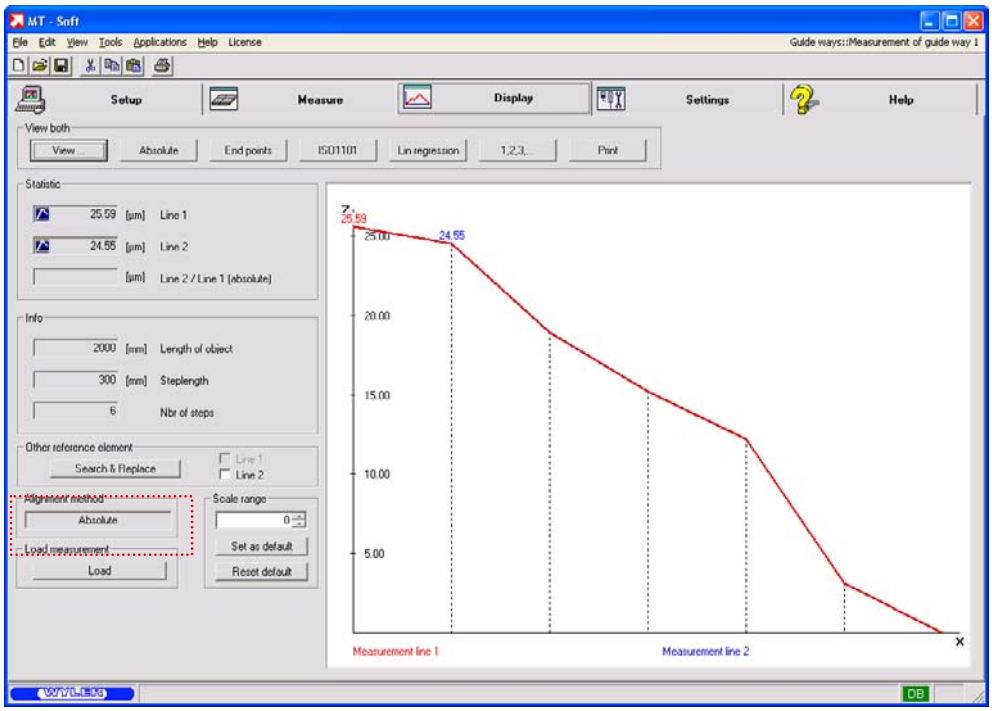
If you agree with the measurement, save the measurement to avoid loss, e.g. as:

- o Measurement setup name: **"Measurement of guide way 1"**
- o Measurement setup description: **"Machine tool DELTA S-123456"**



For analysing the measurement we now click on the register <**VIEW**>

Using the register <**DISPLAY**> the measurement taken can be viewed and judged under different aspects. The measured result will be "lifted" (exception alignment method Lin. regression) so that all measured values are positive. The position in space will not be changed by this lifting.



This analysis can be made by using the different alignment methods.

The following alignment methods are possible

- Method **ABSOLUTE**
- Method **END POINTS** (reference is the first line)
- Method **ISO1101** (reference is the first line)
- Method **LINEAR REGRESSION** (reference is the first line)

The actual method is displayed below the graphic.

Additional information regarding the various displays under **"Display"** / “Statistic”

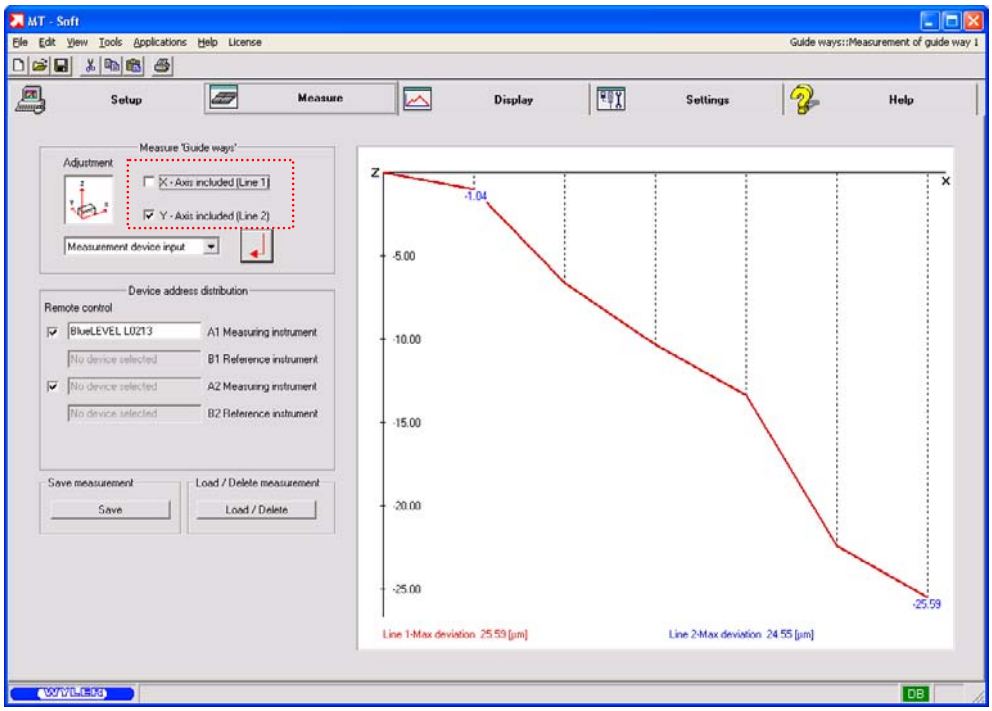
- [Display]: shows the different views of the object measured, Display of both lines, Display of individual lines
- [Absolute]: Display according to alignment method ABSOLUTE
- [End points]: Display according to alignment method END POINTS
- [ISO 1101]: Display according to alignment method ISO 1101
- [Lin Regression]: Display according to alignment method LIN. REGRESSION
- [Zoom->]: Opens a enlarged display of the analysis
- [Print]: Prints the measuring results with various options in the presentation mode selected

Displayed values

a) Statistics:

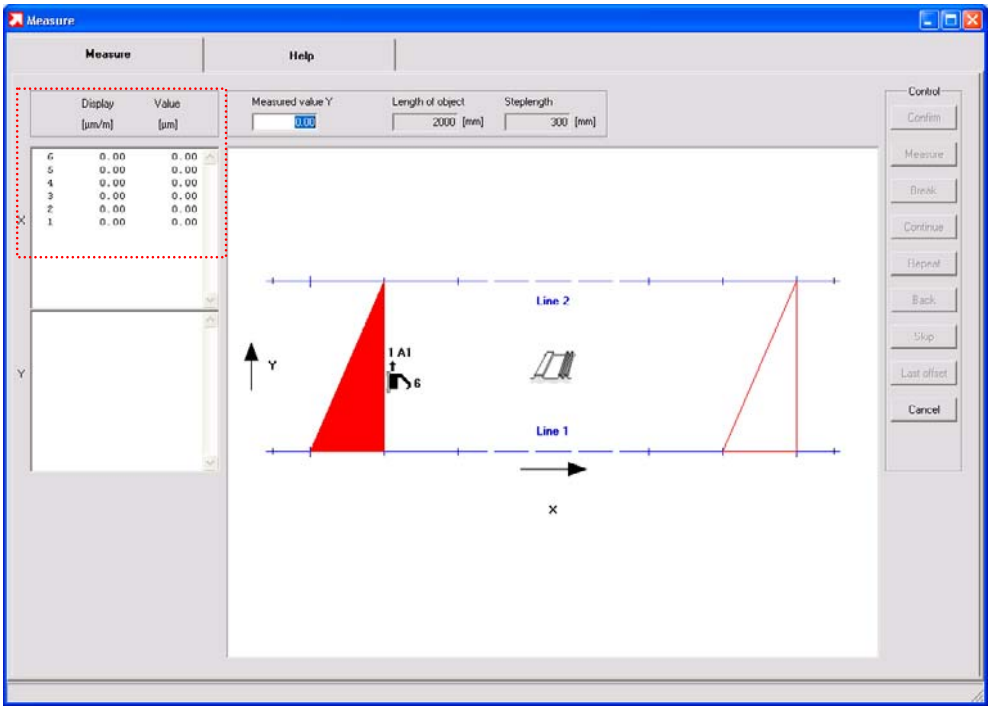
	Alignment method (guide way 1) in [µm]			
	Absolute	**End points**	**ISO 1101**	**Lin. Regression**
Straightness line 1	25.59	4.81	4.58	4.66

Now we can measure and adjust the second, the **rear guide way** (line 2), until the values meet the requirements. For this we deactivate the measurement of the X-axis (line 1) by removing the tick.

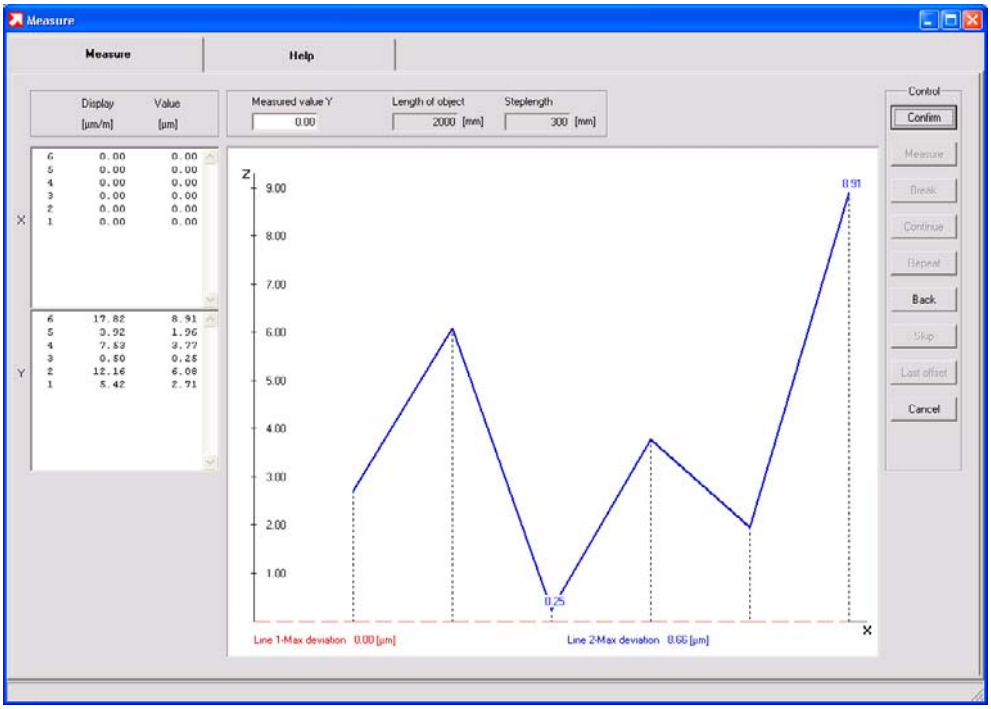


In our example we select from the pulldown menu "Measurement device input". The measurement will be started with the [ENTER] button 

The measurement will be performed in the same manner as for the front guide way (line 1). We renounce on repeating the detailed procedure.

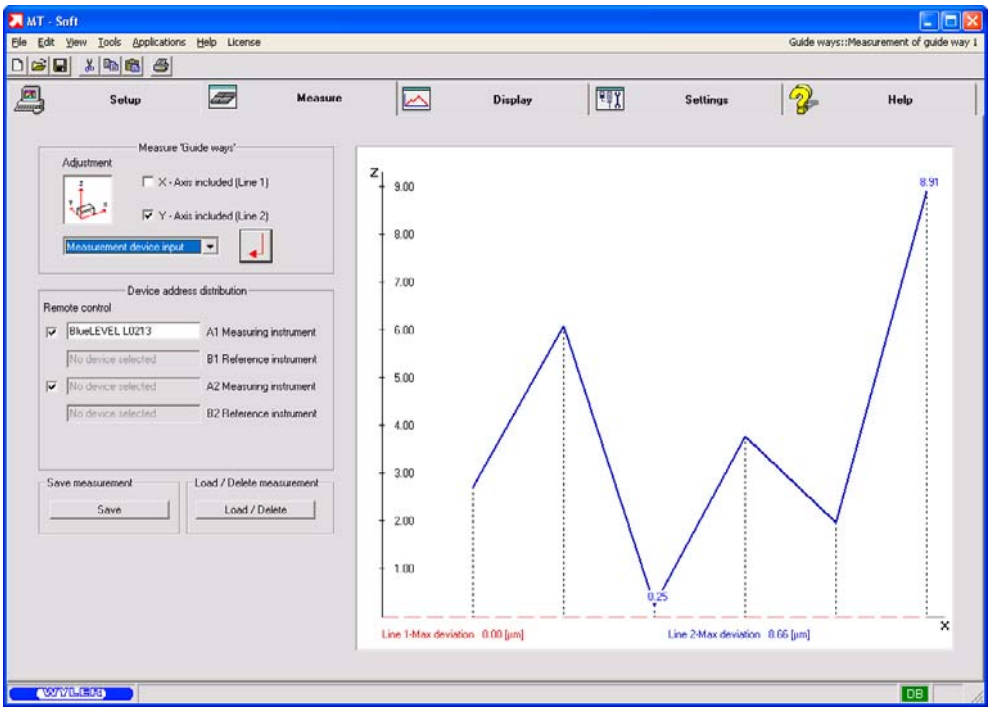


The measuring values of the guide way not measured at the moment are listed with the value "0"



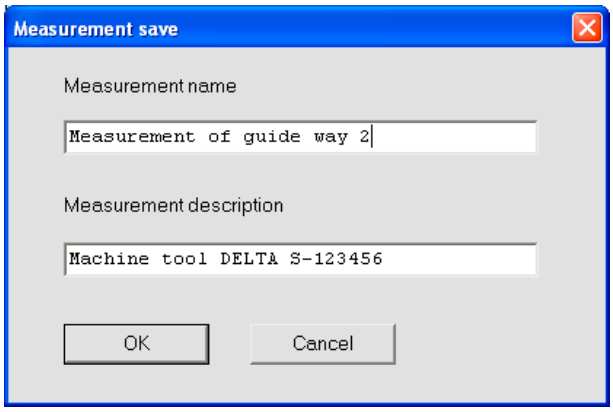
If the measurement shows satisfactory results, we confirm the measurement with the [Confirm] button.

After confirmation with [Confirm] the measurement is definitely terminated and the following picture will appear:



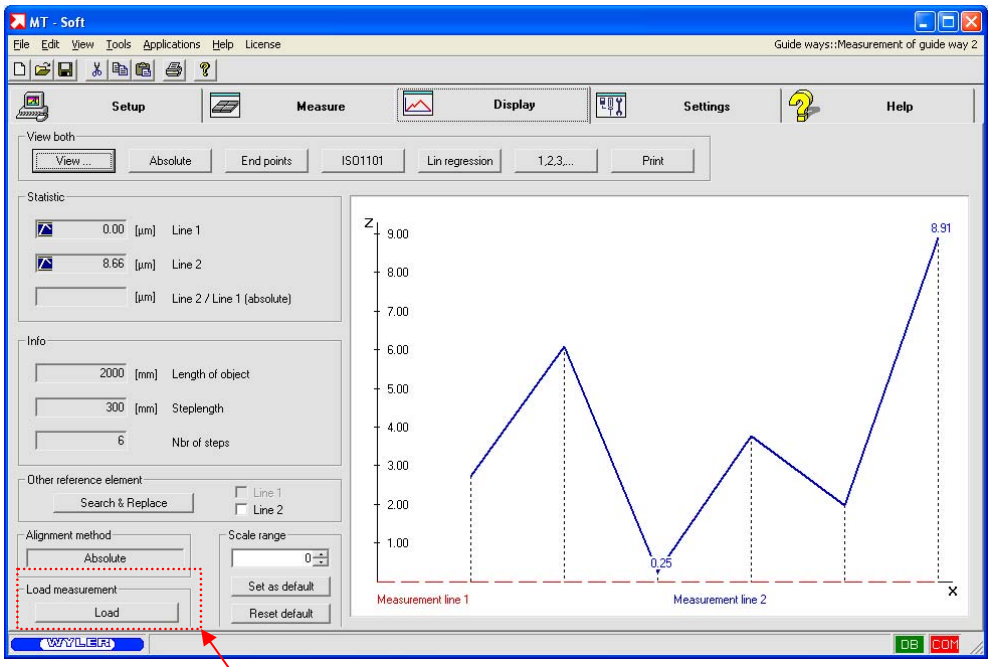
If you agree with the measurement, save the measurement to avoid loss, e.g. as:

- o Measurement setup name: **"Measurement of guide way 2"**
- o Measurement setup description: **"Machine tool DELTA S-123456"**

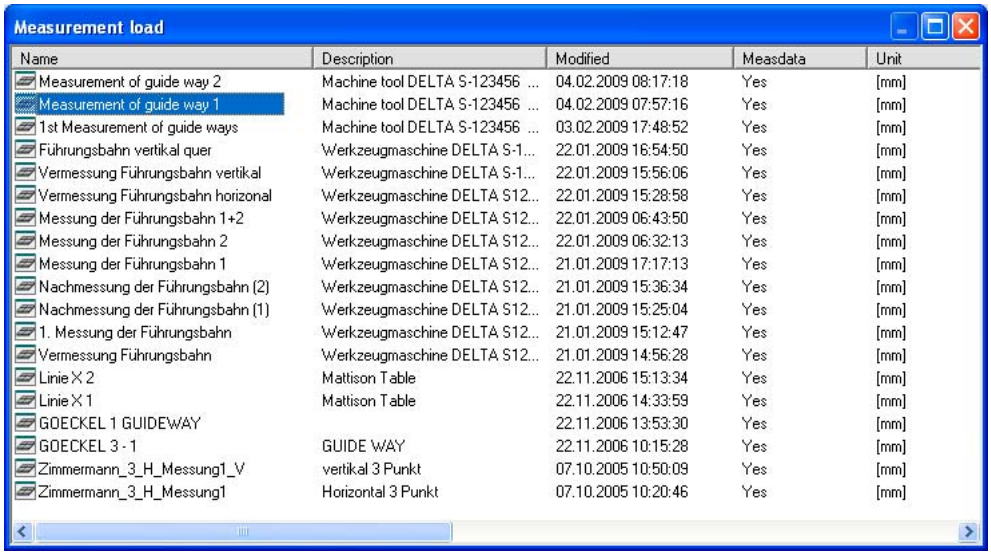


For analysing the measurement we now click on the register <**VIEW**>

Using the register <**DISPLAY**> the measurement taken can be viewed and judged under different aspects. The measured result will be "lifted" in the display (exception alignment method Lin. regression) so that all measured values are positive. The position in space will not be changed by this lifting.

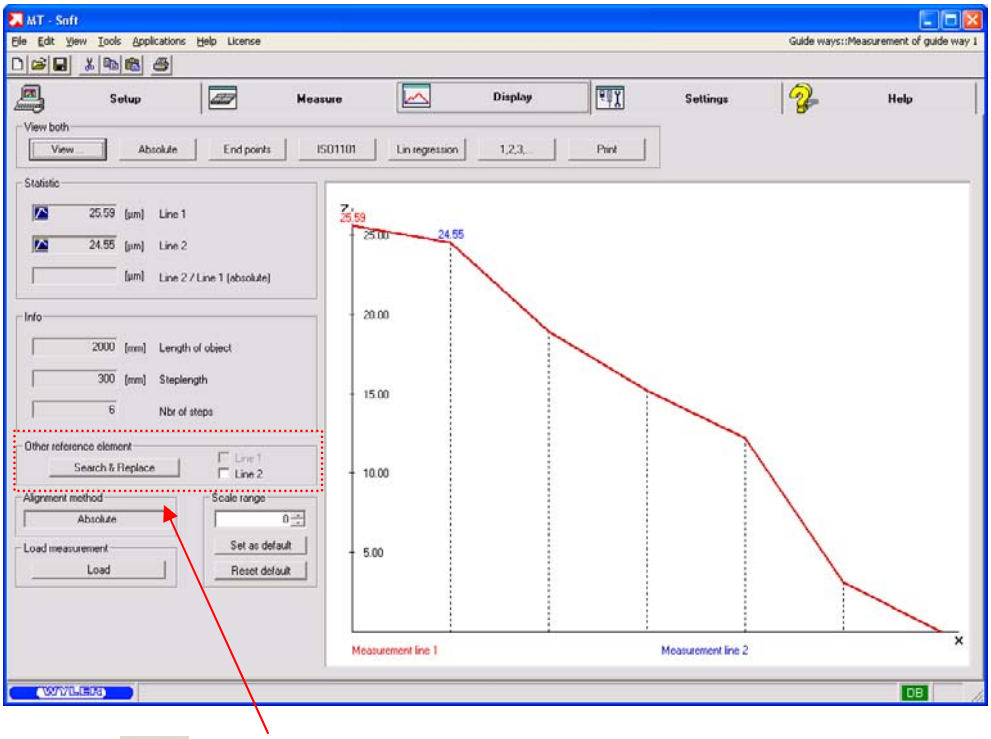


In the register <**DISPLAY**> we load now the previously measured data of the guide way 1 with the file name "Measurement of guide way 1"

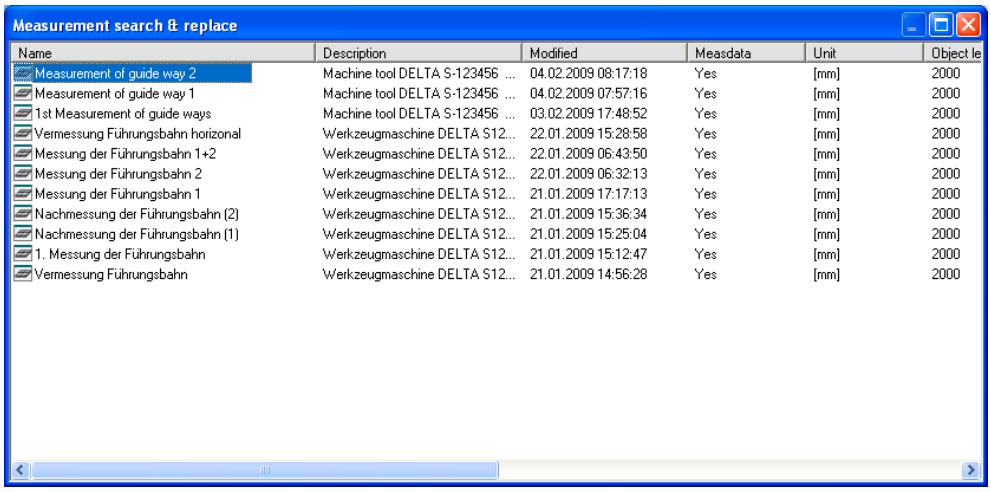


Measurement load

Name	Description	Modified	Measdata	Unit
Measurement of guide way 2	Machine tool DELTA S-123456 ...	04.02.2009 08:17:18	Yes	[mm]
Measurement of guide way 1	Machine tool DELTA S-123456 ...	04.02.2009 07:57:16	Yes	[mm]
1st Measurement of guide ways	Machine tool DELTA S-123456 ...	03.02.2009 17:48:52	Yes	[mm]
Führungsbahn vertikal quer	Werkzeugmaschine DELTA S-1...	22.01.2009 16:54:50	Yes	[mm]
Vermessung Führungsbahn vertikal	Werkzeugmaschine DELTA S-1...	22.01.2009 15:56:06	Yes	[mm]
Vermessung Führungsbahn horizonal	Werkzeugmaschine DELTA S12...	22.01.2009 15:28:58	Yes	[mm]
Messung der Führungsbahn 1+2	Werkzeugmaschine DELTA S12...	22.01.2009 06:43:50	Yes	[mm]
Messung der Führungsbahn 2	Werkzeugmaschine DELTA S12...	22.01.2009 06:32:13	Yes	[mm]
Messung der Führungsbahn 1	Werkzeugmaschine DELTA S12...	21.01.2009 17:17:13	Yes	[mm]
Nachmessung der Führungsbahn (2)	Werkzeugmaschine DELTA S12...	21.01.2009 15:36:34	Yes	[mm]
Nachmessung der Führungsbahn (1)	Werkzeugmaschine DELTA S12...	21.01.2009 15:25:04	Yes	[mm]
1. Messung der Führungsbahn	Werkzeugmaschine DELTA S12...	21.01.2009 15:12:47	Yes	[mm]
Vermessung Führungsbahn	Werkzeugmaschine DELTA S12...	21.01.2009 14:56:28	Yes	[mm]
Linie X 2	Mattison Table	22.11.2006 15:13:34	Yes	[mm]
Linie X 1	Mattison Table	22.11.2006 14:33:59	Yes	[mm]
GOECKEL 1 GUIDEWAY		22.11.2006 13:53:30	Yes	[mm]
GOECKEL 3 - 1	GUIDE WAY	22.11.2006 10:15:28	Yes	[mm]
Zimmermann_3_H_Messung1_V	vertikal 3 Punkt	07.10.2005 10:50:09	Yes	[mm]
Zimmermann_3_H_Messung1	Horizontal 3 Punkt	07.10.2005 10:20:46	Yes	[mm]

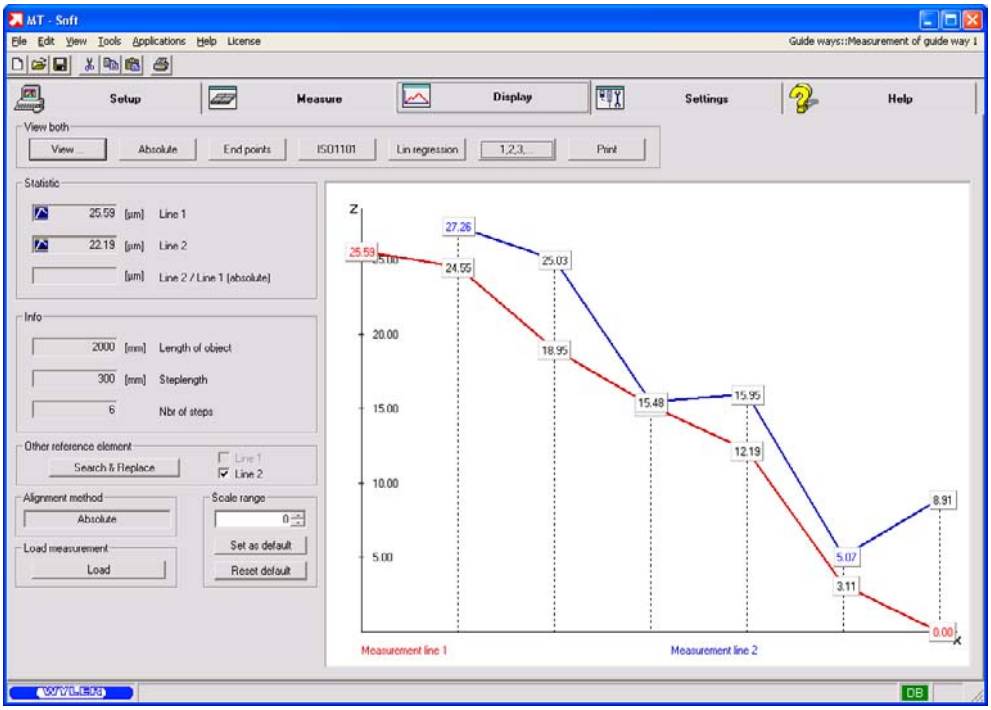


In the register <**DISPLAY**>  we load now again the data of the guide way 2 measured in the second step with the file name "Measurement of guide way 2" under "Other reference element"



Measurement search & replace

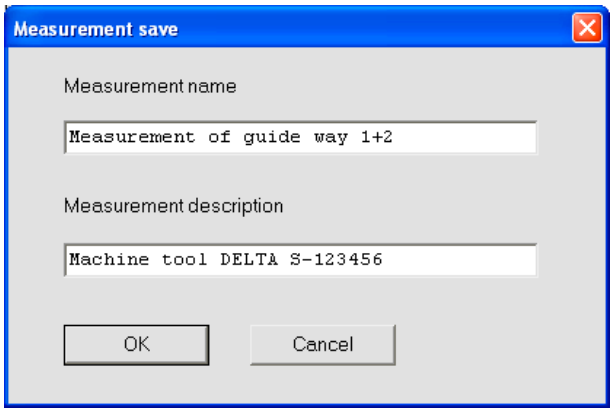
Name	Description	Modified	Measdata	Unit	Object le
Measurement of guide way 2	Machine tool DELTA S-123456 ...	04.02.2009 08:17:18	Yes	[mm]	2000
Measurement of guide way 1	Machine tool DELTA S-123456 ...	04.02.2009 07:57:16	Yes	[mm]	2000
1st Measurement of guide ways	Machine tool DELTA S-123456 ...	03.02.2009 17:48:52	Yes	[mm]	2000
Vermessung Führungsbahn horizonal	Werkzeugmaschine DELTA S12...	22.01.2009 15:28:58	Yes	[mm]	2000
Messung der Führungsbahn 1+2	Werkzeugmaschine DELTA S12...	22.01.2009 06:43:50	Yes	[mm]	2000
Messung der Führungsbahn 2	Werkzeugmaschine DELTA S12...	22.01.2009 06:32:13	Yes	[mm]	2000
Messung der Führungsbahn 1	Werkzeugmaschine DELTA S12...	21.01.2009 17:17:13	Yes	[mm]	2000
Nachmessung der Führungsbahn (2)	Werkzeugmaschine DELTA S12...	21.01.2009 15:36:34	Yes	[mm]	2000
Nachmessung der Führungsbahn (1)	Werkzeugmaschine DELTA S12...	21.01.2009 15:25:04	Yes	[mm]	2000
1. Messung der Führungsbahn	Werkzeugmaschine DELTA S12...	21.01.2009 15:12:47	Yes	[mm]	2000
Vermessung Führungsbahn	Werkzeugmaschine DELTA S12...	21.01.2009 14:56:28	Yes	[mm]	2000



You get now a graphic overview of the guide ways "1" and "2" and can analyse these using the different alignment methods.

If you agree with the measurement, save the measurement in the tap <**Measure**>to avoid loss, e.g. as:

- o Measurement setup name: **"Measurement of guide way "1" + "2"**
- o Measurement setup description: **"Machine tool DELTA S-123456"**



The following alignment methods are possible

- Method **ABSOLUTE**
- Method **END POINTS** (reference is the first line)
- Method **ISO1101** (reference is the first line)
- Method **LINEAR REGRESSION** (reference is the first line)

The actual method is displayed below the graphic.

Additional information regarding the various displays under "View"

- [Display]: shows the different views of the object measured, Display of both lines, Display of individual lines
- [Absolute]:- Display according to alignment method ABSOLUTE
- [End points]: Display according to alignment method END POINTS
- [ISO 1101]: Display according to alignment method ISO 1101
- [Lin Regression]: Display according to alignment method LIN. REGRESSION
- [Zoom->]: Opens a enlarged display of the analysis
- [Print]: Prints the measuring results with various options in the presentation mode selected

For further information on the Alignment methods please see chapter 2.5.8 "Methods of Alignment"

Displayed values

a) Statistics:

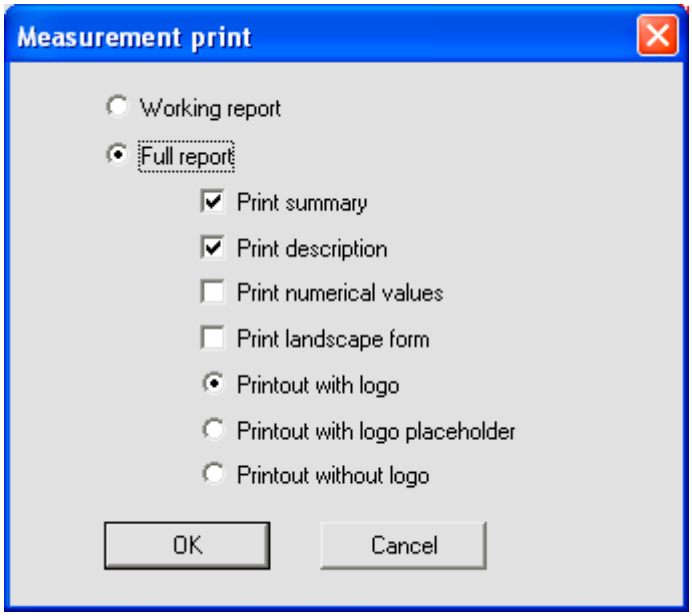
		Alignment method (guide way1) in [µm		
	Absolute	**End points**	**ISO 1101**	**Lin. Regression**
Straightness line 1	25.59	4.81	4.58	4.66
Straightness line 2	22.19	8.96	7.87	8.16
Flatness Line 1 / Line 2		2.98	8.34	4.31

b) Information

- Length of Object (2000mm)
- Step length (300mm)
- Number of steps (6)

Print the data of a measurement

The same setup is used as it was selected in the display. This mainly refers to the points “Alignment method”, “scale” and with/without “closure error”



The **following setup for the print out** can be selected

- Working report:
  Short form printing, printed are
  - Description of the measuring task, machine type, serial number, elements
  - Dimensions of the object
  - Closure error, deviations, deviations from the true vertical, etc.
  - Graphical display of the object, setup information such as the alignment method, numerical display, etc. is taken from the screen display

- Full report
  - Print Summary
    - Logotype, if activated
    - Measuring and print date
    - Dimensions of the object
    - Closure error, deviations, deviations of the true vertical, etc.
    - Graphical display of the object, setup information such as the alignment method, numerical display, etc. is taken from the screen display

  - Print description
    - Logotype, if activated
    - Header with manufacturer, customer, machine type, serial number, name of engineer, etc.
    - without measuring data

- Print numerical values
  - Logotype, if activated
  - All measured values in numerical form

- Print landscape format
  - Graphical display of the object, setup information such as the alignment method, numerical display etc. is taken from screen display
  - Indication of the alignment method
  - Closure error
  - Dimensions of the object

- Print with Logo
  - The Logotype defined is added in the printout

- Print with Logo place holder
  - In case company paper with pre-printed logotype is used, this option should be selected

- Print without Logo
  - print is without logotype

After entering the options for the print the **Measurement description template** is opened again for checking and modifying the data before printing. Modifications will be saved after confirming with the [Confirm] button.

Remarks concerning the "Print logo" option

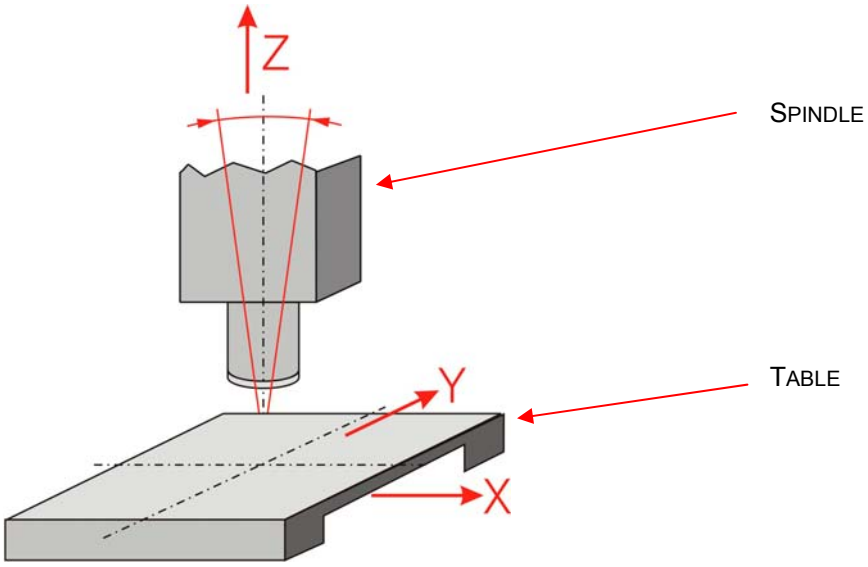
- Any logotype can be used. The size must be 200mm (length) x 20mm (height) and the type must be bitmap (*.bmp) and the logotype must be saved in the main menu of MT-SOFT.
- The logotype is activated in the menu MT-SOFT <**Settings**>
- Click to <Set> opens the active logotype. When clicking to the opened logotype the Windows explorer will be opened for selecting another logotype.

Additional information see chapter 4 "DEFINITION OF A NEW MEASUREMENT AND STARTING THE MEASUREMENT"
Example measurement of Circles

5.2 ROTATING AXIS

Example for measurement:
The position of the vertical spindle of a machine tool is to be defined in relation to the horizontally positioned table. The measurement is done with an inclination measuring instrument MINILEVEL or LEVELTRONIC

For this type of measurement no measuring JIG is needed.



Before starting the measurement the definition of the axis coordination and the directions of the movements must be defined. (Work piece coordination)

In our example the X, Y, Z definitions are as follows, see picture above:

- Guide way length direction: left to right +**X-axis**
- Spindle horizontal movement: near to far +**Y-axis**
- Spindle vertical movement: bottom to top +**Z-axis**

Additional information concerning the “coordinate system” see the following chapter.

The **zero position of the coordinates X, Y, Z** must be defined

In our example the X/Y/Z zero position is placed slightly above the centre of the reference guide way. (see Sketch below)
The definition of this point is important because when creating the measurement layout this point must be clearly defined. Usually this definition is done by the machine manufacturer.

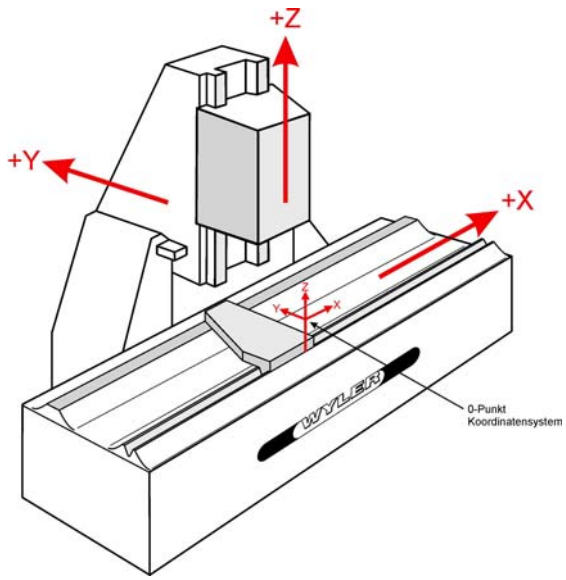
COORDINATE SYSTEM

The careful definition of the coordinate system is worthwhile:
With MT-Soft it is under certain conditions possible to make use of existing object's data as well as the comparison between earlier measurements. Precondition to do so is the correct definition of the coordinates. The coordinates are also used in the further computing of the results and naturally are also displayed on the monitor or printed for further analyzing.

Coordinate system
MT-Soft requires the data entering in form of coordinates using the **work piece coordinates**.

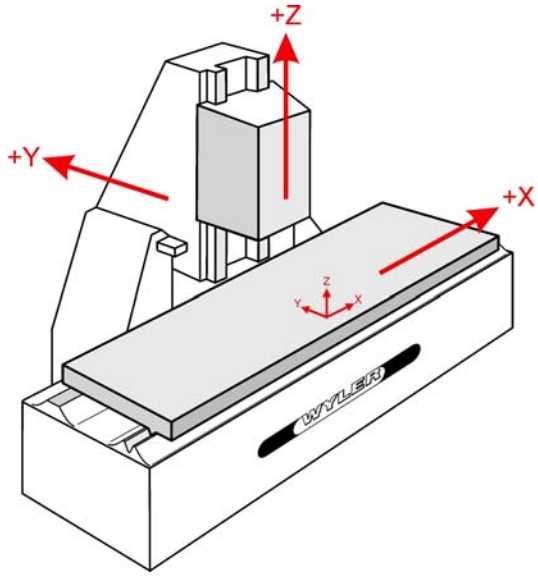
In order to make optimal use of the existing conditions the basic coordinates in space are free to define. By defining the system please note:

Relative movements of the spindle in relation to the work piece use the same work piece coordinates, in our case these are the axis Y and Z.
Relative movements of the work piece in relation to the (fixed) spindle are movements opposite to the work piece coordinates. In our example this concerns the X-axis. A work piece coordinate changement in +X directions means a **table movement** in -X direction!

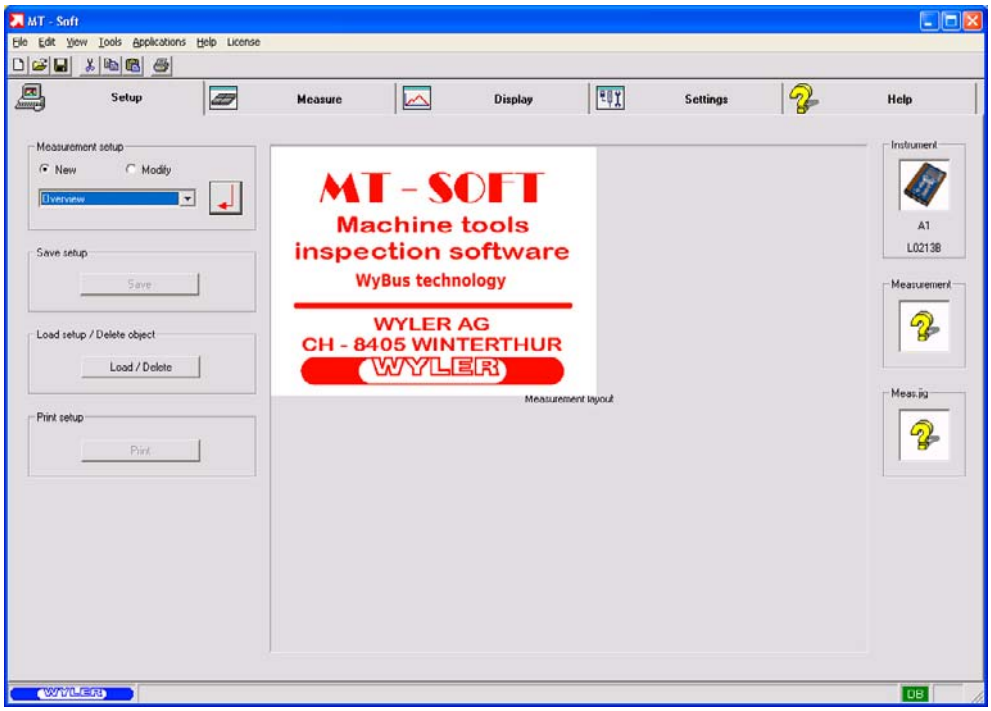


Zero position of the coordinates
MT-Soft allows the implementation of negative figures. This means the zero position of the axes in space is free to choose.

Important is that all the measurements on one machine use all the same coordinates. In our example we choose the zero position for Y and Z at the front edge of the table and the X position in the centreline of the machine / turret.



After starting MT-Soft the following picture appears:



The measurement example

- **Type of measurement**: Rotating Axis (Position of spindle to table)

- **Work piece coordinates**
  - Centre line spindle X-direction 1200mm
  - Centre line spindle Y-direction 800mm

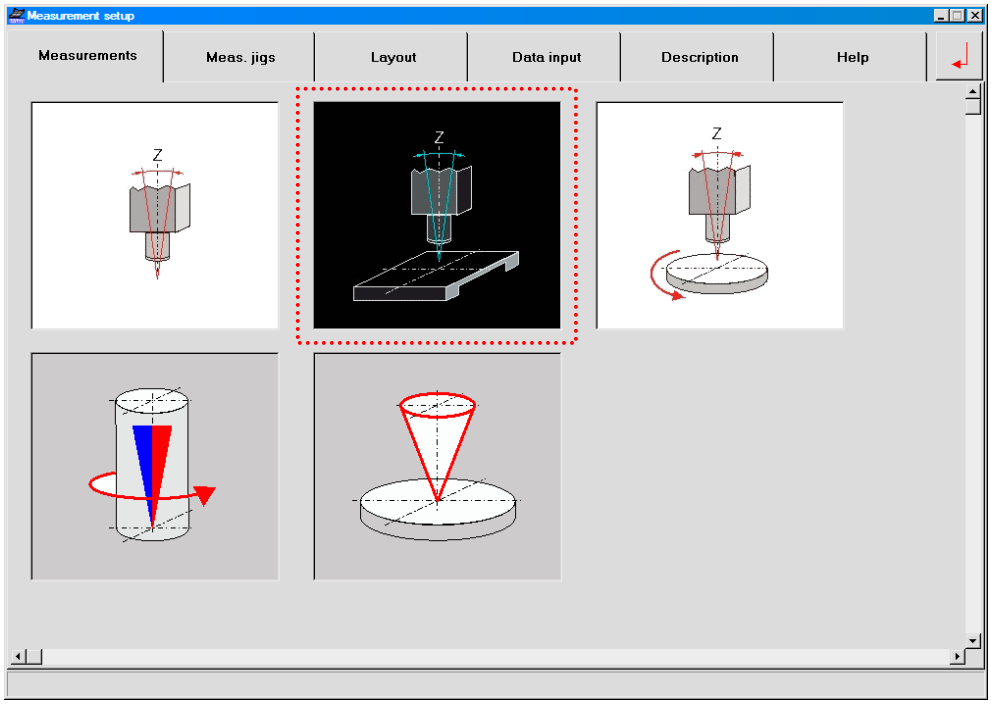
  - Step length X-direction (depending on measuring instrument's base) 150mm
  - Step length Y-direction (depending on measuring instrument's base) 150mm

  - Number of steps on table X-direction 6
  - Number of steps on table Y-direction 6

- **Measuring setup:**
  - The measuring result should at a later stage be compared to a vertical guide way of the machine tool. In order to do so it is required to measure in the absolute mode. An absolute mode measurement requires before the measurement a reversal measurement with the instrument.
  - **Measurement with one instrument** means that in the first step the spindle and in the second step the axis X and Y of the table are to be measured.
    The process of the spindle measurement is identical to a vertical reversal measurement. No additional reversal measurement on the vertical base is therefore needed.

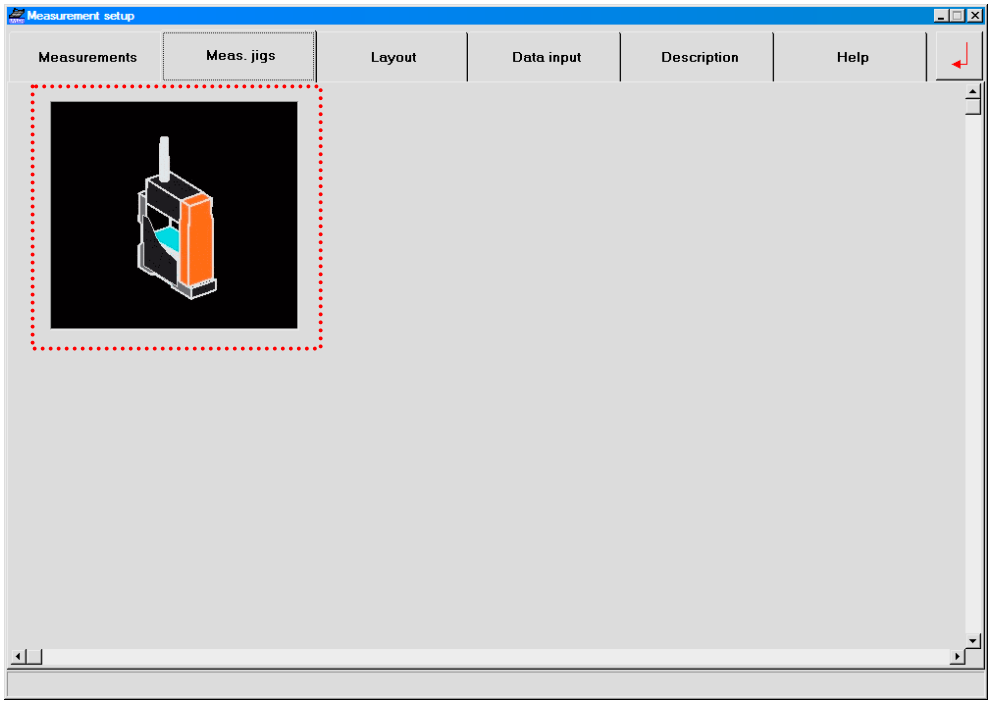
In the register Setup, below Measurement Setup the pull down menu can be used to change to "Rotating Axes" and confirm with [Enter] 

A number of different possibilities for the type of Rotating Axes are displayed under <**MEASUREMENT SETUP**>



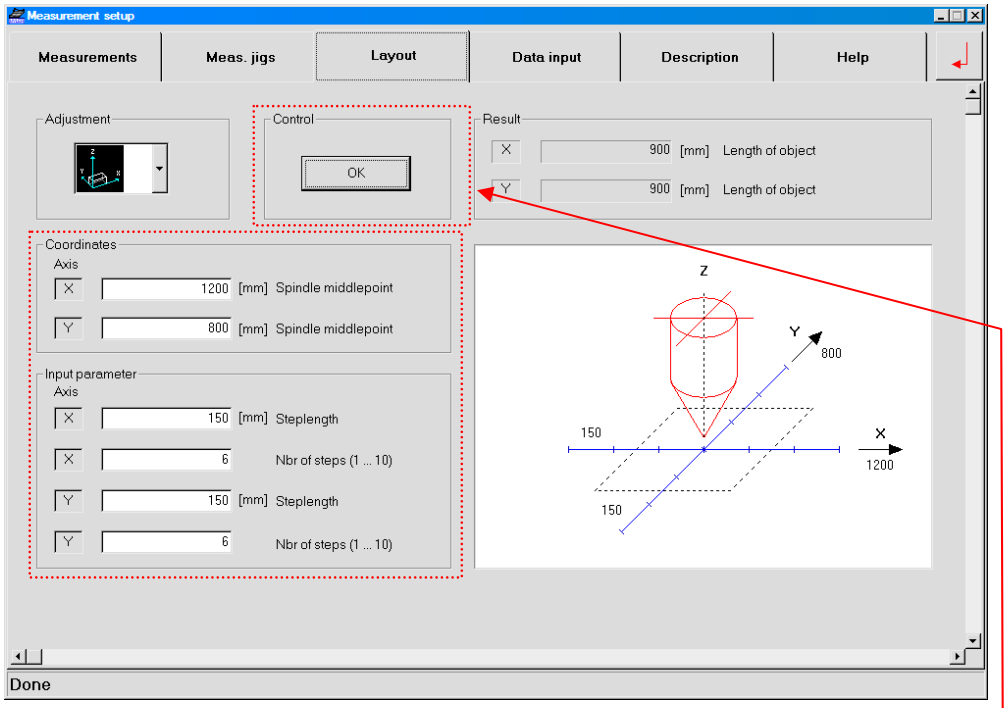
In our example we choose the layout top centre

Selecting <**MEAS. JIGS**> only the measuring instrument appears without additional JIGs



The selection must be marked

Change to the sub register <**LAYOUT**>



Next the coordinates must be entered. (IMPORTANT: WORK PIECE COORDINATES)

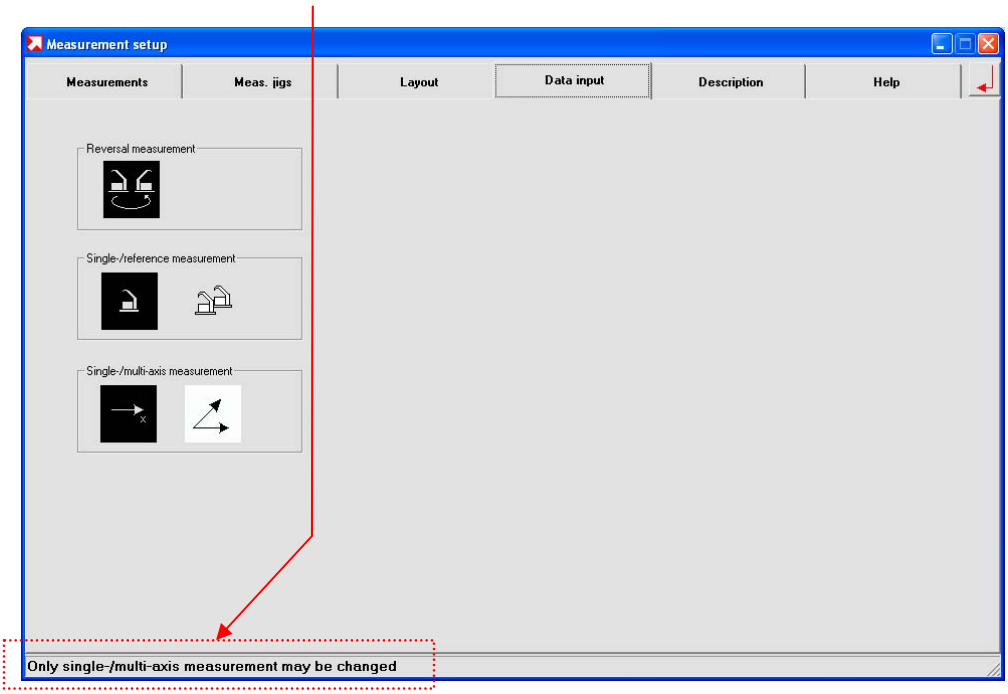
- Centre line spindle X-direction -1200mm
- Centre line spindle Y-direction 800mm

- Step length X-direction (depending on measuring instrument's base) 150mm
- Number of steps on table X-direction 6

- Step length Y-direction (depending on measuring instrument's base) 150mm
- Number of steps on table Y-direction 6

After entering the data confirm with [OK] in the area "Control"

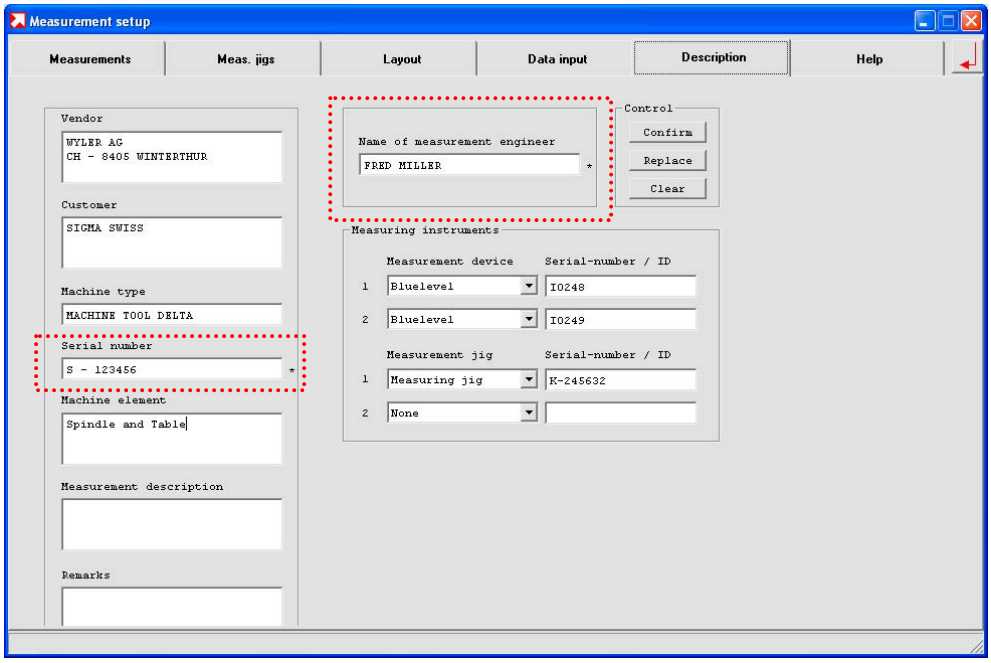
As a next step the selection of the "Data Input" (measuring method) must be taken. The measurement can be performed as single or multi axis measurement, i.e. with two measuring instruments simultaneously.



Setup is:

- **Reversal measurement**,
  Measuring the vertical spindle is automatically done like a reversal measurement and therefore the absolute mode is defined.
- **Single measurement**,
  One single instrument is used
- **Single axis measurement**,
  The X- and Y- measurement on the table are done in two separate steps

Next change to <DESCRIPTION> and enter the required information,
such as Vendor, Customer; Machine element, Name of measurement Engineer and the Serial number

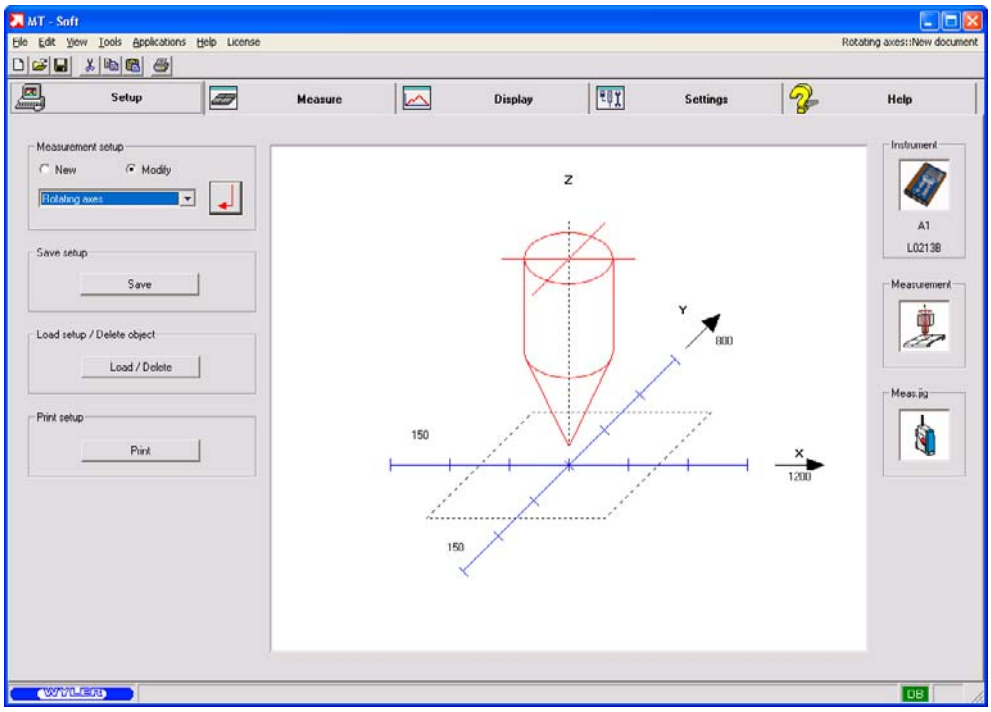


The descriptions is to define exactly the measuring task and the identification of the objects
In this dialogue box all the necessary data for defining the planned measurement can be entered. The **Name of measurement Engineer** and the **Serial number** of the object to be measured are **mandatory**. All the rest of the information is free to fill in.

The text can also be integrated from an existing template by using the [Replace] button

It is still possible to make changes in the setup registers.
If not required press the button [confirm]

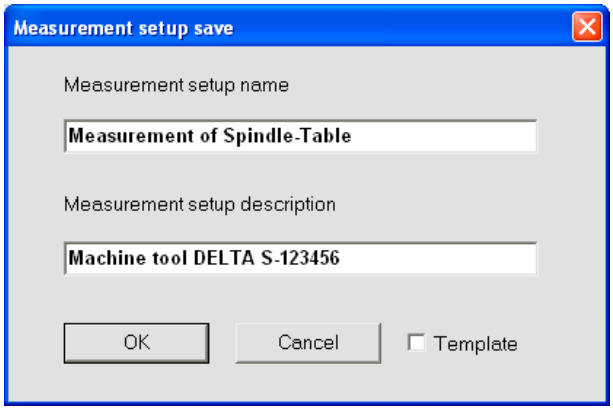
Now the actual **measurement can be started**. When all the data is correctly filled in press the [Enter] button



The following information is displayed:

- Object to be measured, in our case "Rotating Axes"
- On the right side of the window
  - o Instrument: The connected instrument respectively Interface
  - o Measurement Type of Rotating Axes
  - o Meas. JIG Type of JIG specified, in our case Measuring instrument

- Under Save Setup the button “save” opens a dialogue box. The setup may be saved **as template** e.g.:
  - o Measurement setup name: “**Measurement of Spindle-Table**”
  - o Measurement setup description: “**Machine tool DELTA S-123456**”

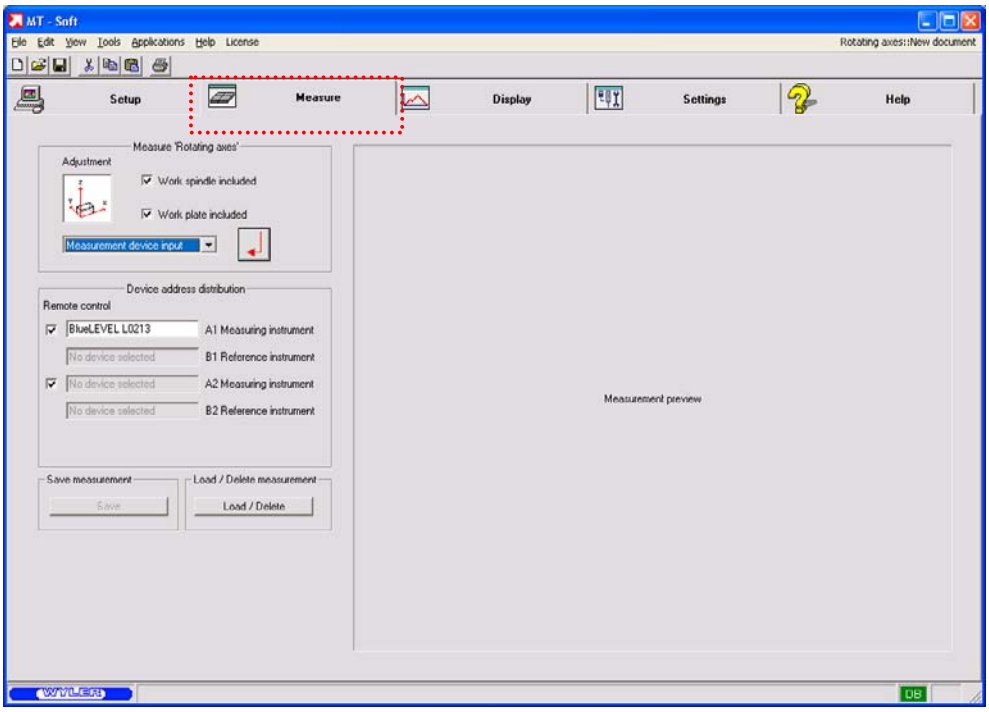


- Under <**LOAD SETUP / DELETE OBJECT**> the button [Load/Delete] allows to open an existing setup template or delete an object.

- Using under <**PRINT SETUP**> the button [Print] allows to print the actual measurement setup template

For **starting the measurement** the register <**MEASURE**> must be activated

In case the measuring instruments are not defined yet or if you want to change the instruments, you can still do this under "Device address distribution"



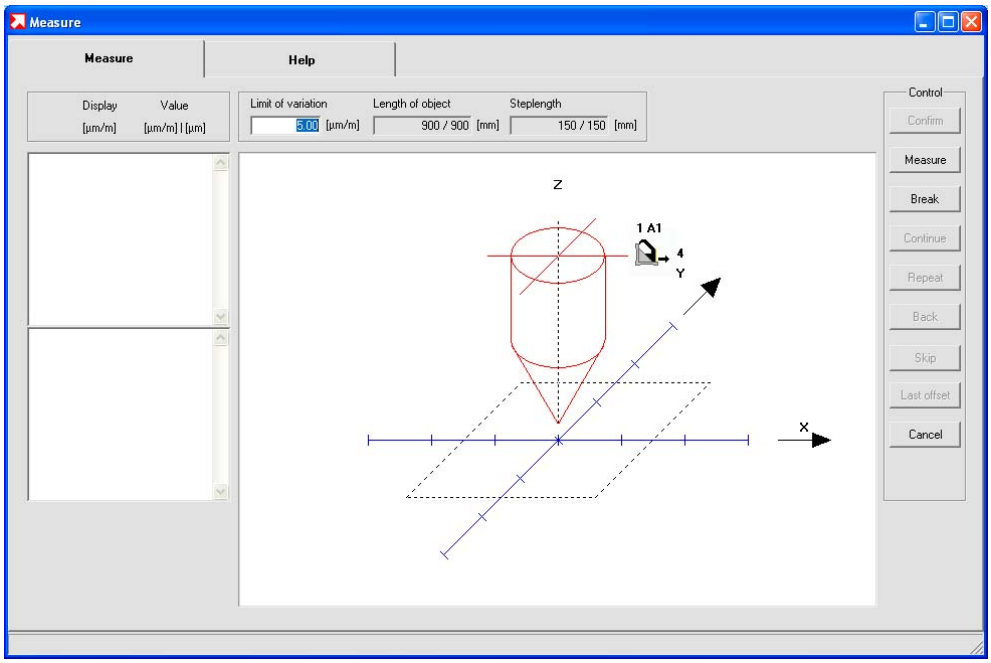
In this register the following options are possible:

- Below Measure “Rotating Axes" it is possible to change between "Input device", directly from interface to PC or "manual input" via Console Input.

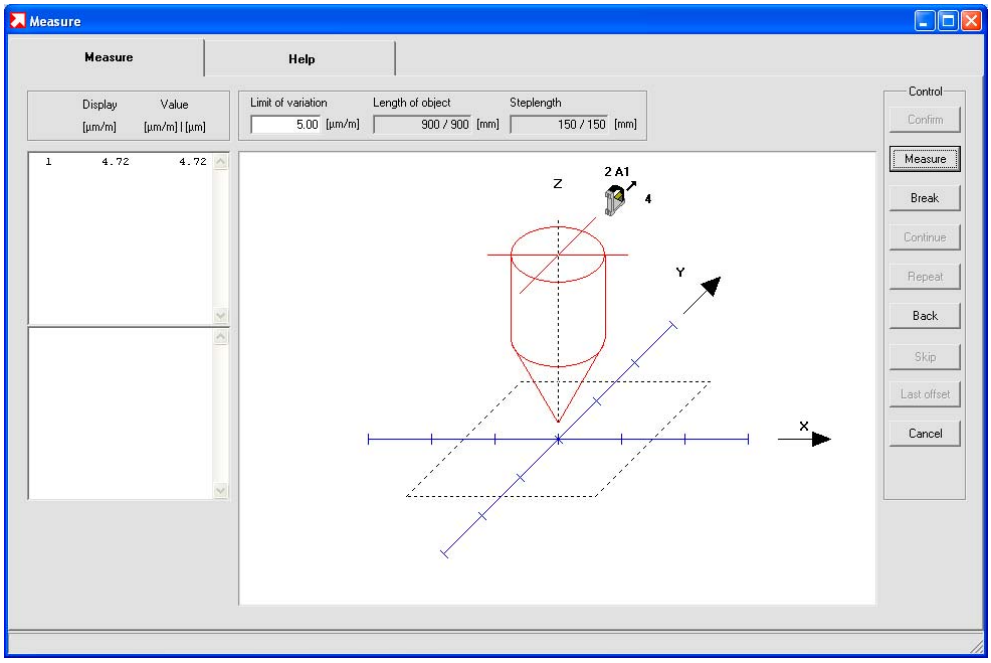
- Below Measure <**ROTATING AXES**> it is possible to select the type of measurement. If a complete measurement (spindle and work plate) should be done or a partial measurement (spindle only, work plate only) can be selected by **activating the boxes**.

In our example we activate both boxes for a complete measurement, we also choose “Measurement Device Input” and confirm with [Enter] 

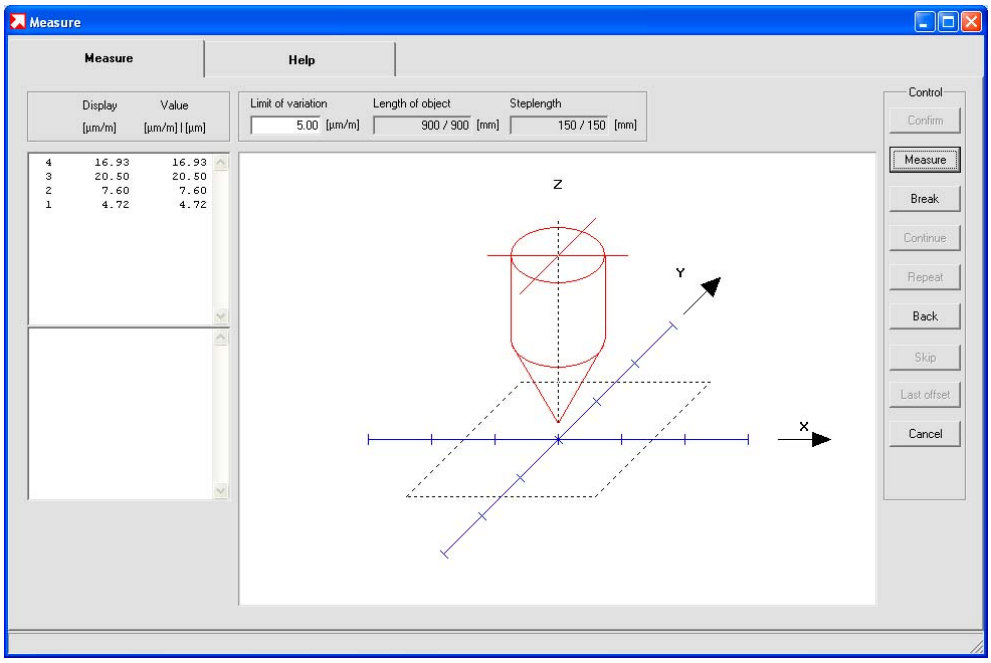
First measurement on the spindle in the direction X:



The graph shows the second position of the measuring instrument. This means the second vertical measurement is to be done on the spindle in the direction Y.



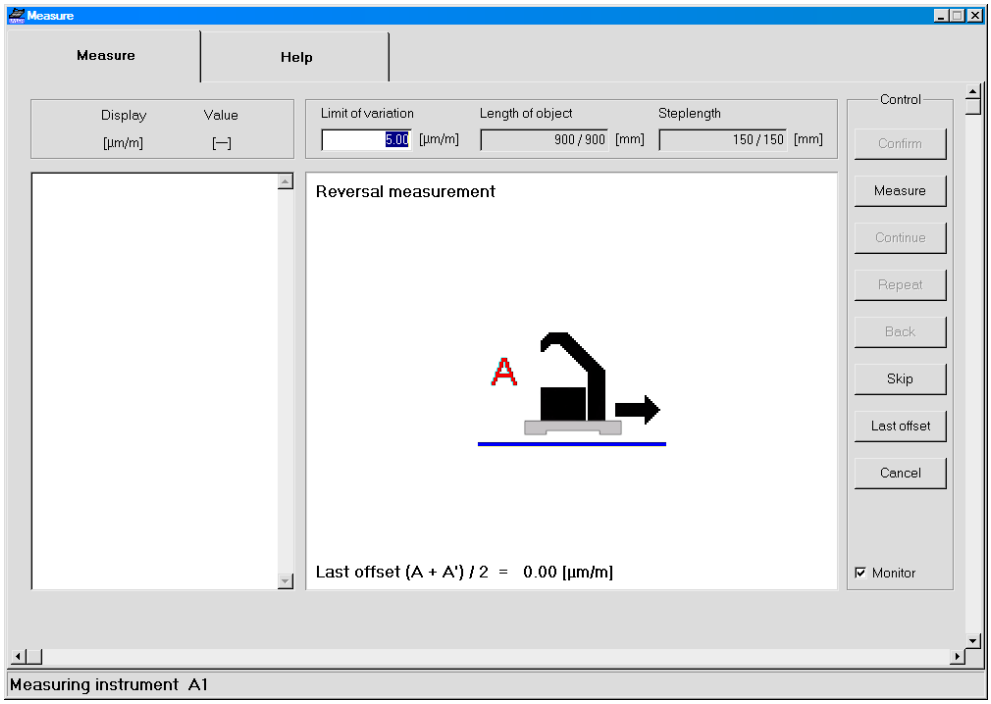
After the end of the measurement on the spindle (4 measurements) all the four results (X; Y; X'; and Y') are displayed and
must be confirmed by applying the button [Confirm] below "Control".

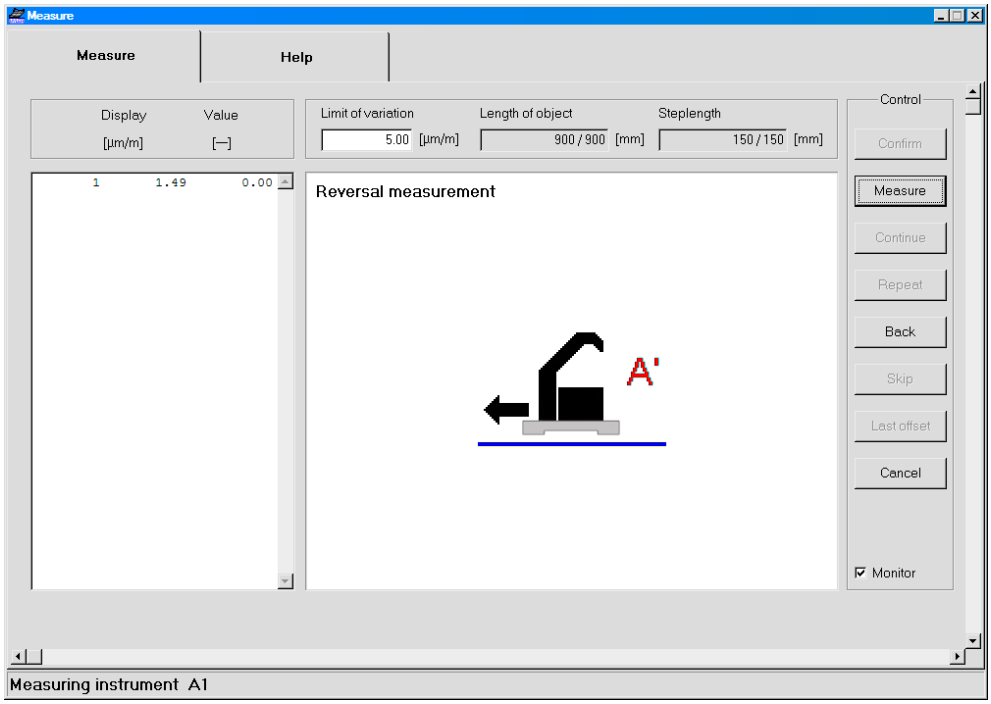


After the spindle measurement a **reversal measurement** on the table must be done in order to eliminate possible Zero point errors of the instrument.

The reversal measurement should best be done on a horizontally adjusted granite surface plate. Ideally for collecting the first value the first setting position of the instrument should be marked on the plate. For collecting the second value the instrument must be turned by gliding 180° without lifting from the plate.

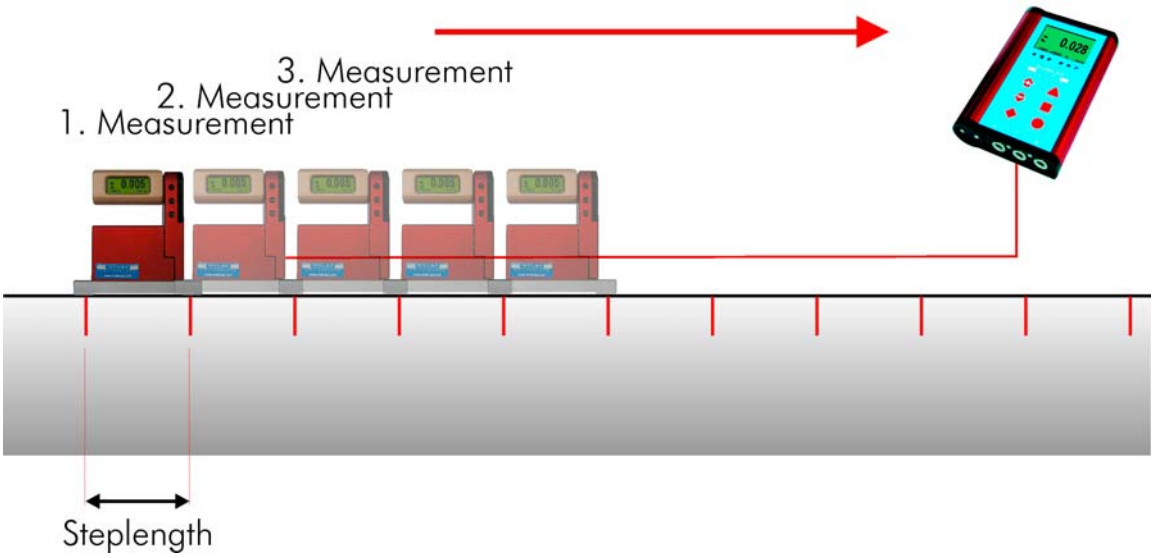
The reversal measurement can now be performed as described here after.

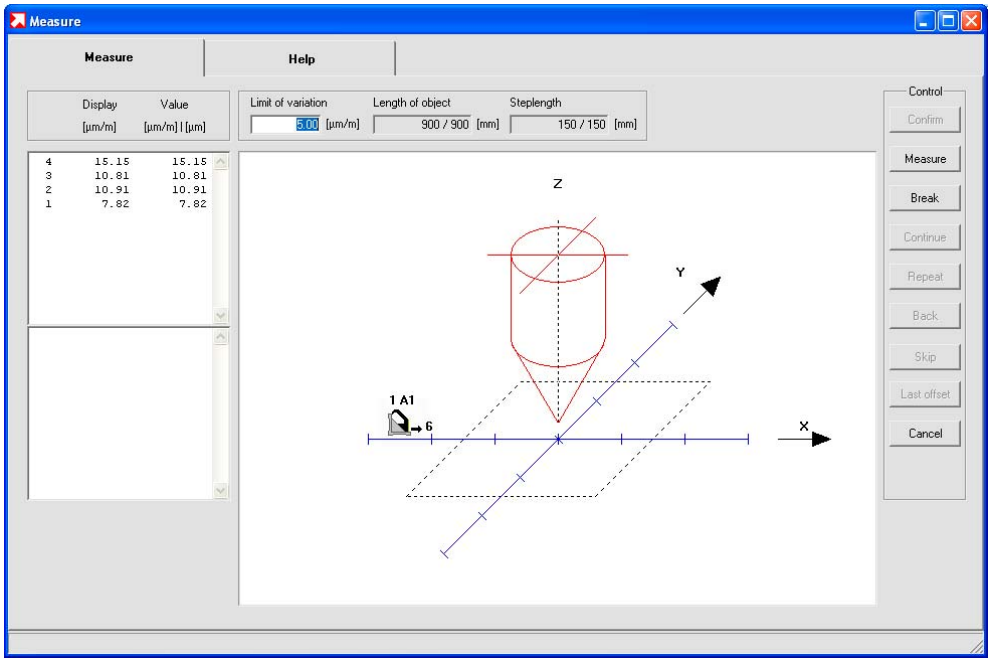




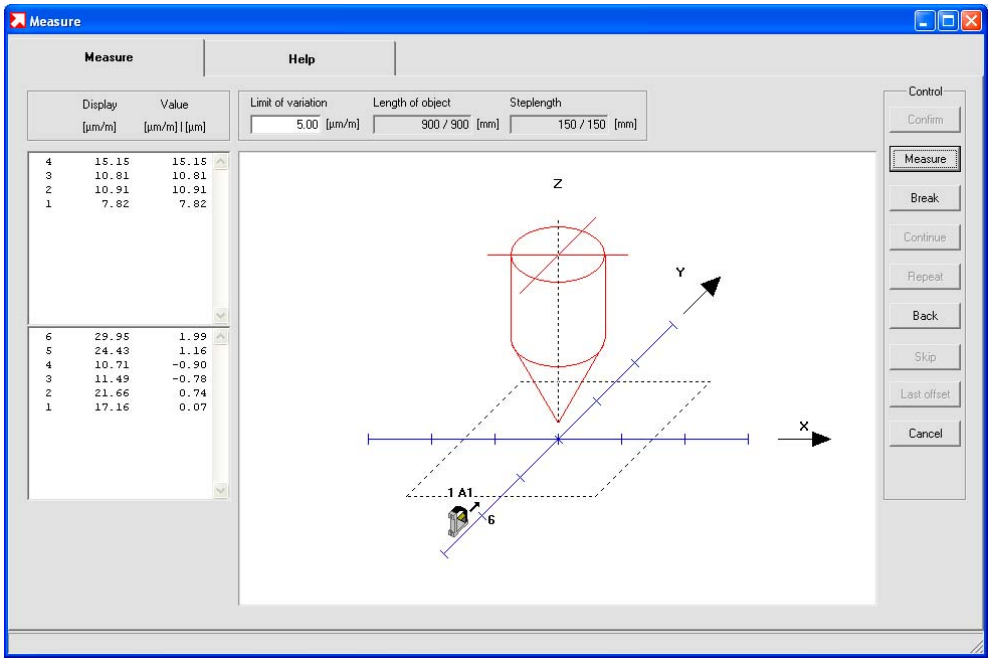
The reversal measurement is now done as described earlier

Now the measurement of the spindle table in X and Y directions is performed in 6 steps each with a step length of 150 mm. Please make sure that the measuring steps must be overlapping, i.e. the start point of the second measurement must be identical to the end point of the first measurement.



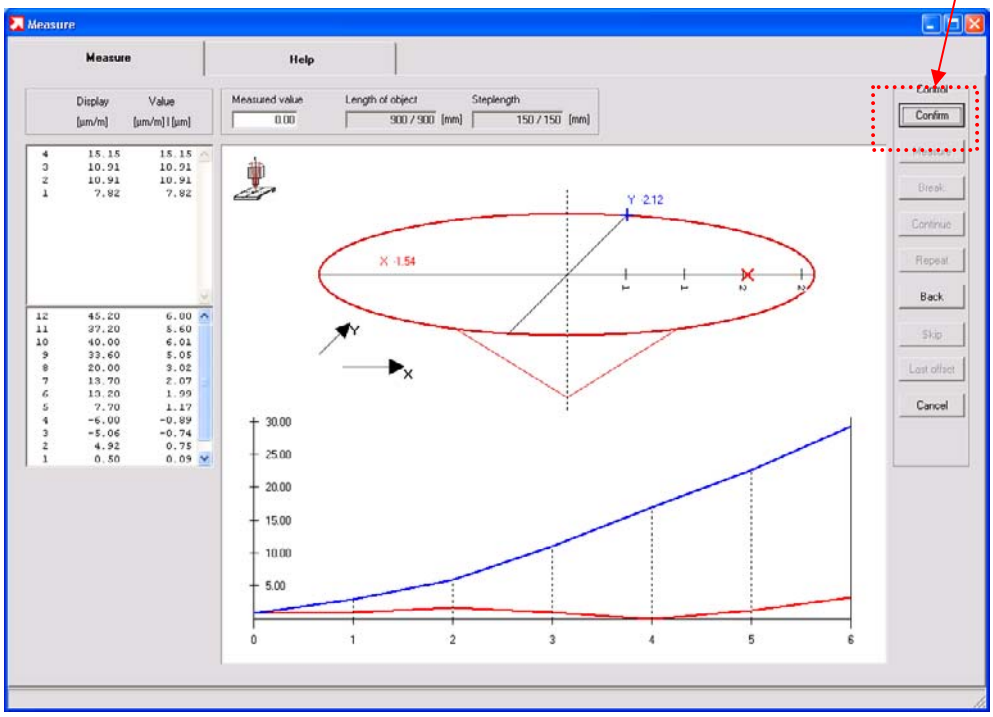


Follow the displayed procedure by placing the instrument to the position shown



On the left graph the measured values are displayed and can be checked.

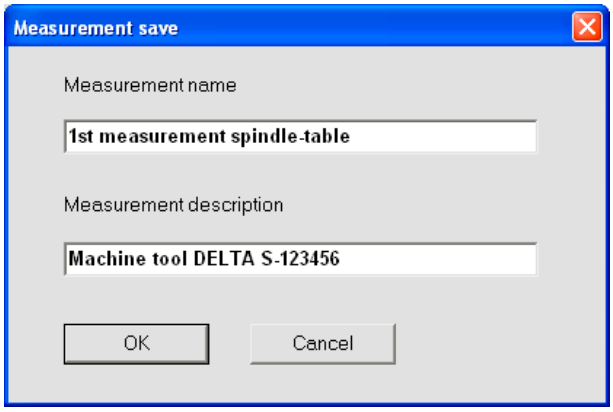
After the last measurement the following graph is displayed. The result can be confirmed with [Confirm] or using the button [Back] can be repeated step by step.



The displayed information is not yet sufficient so we change after [Confirm] to the submenu <**DISPLAY**>

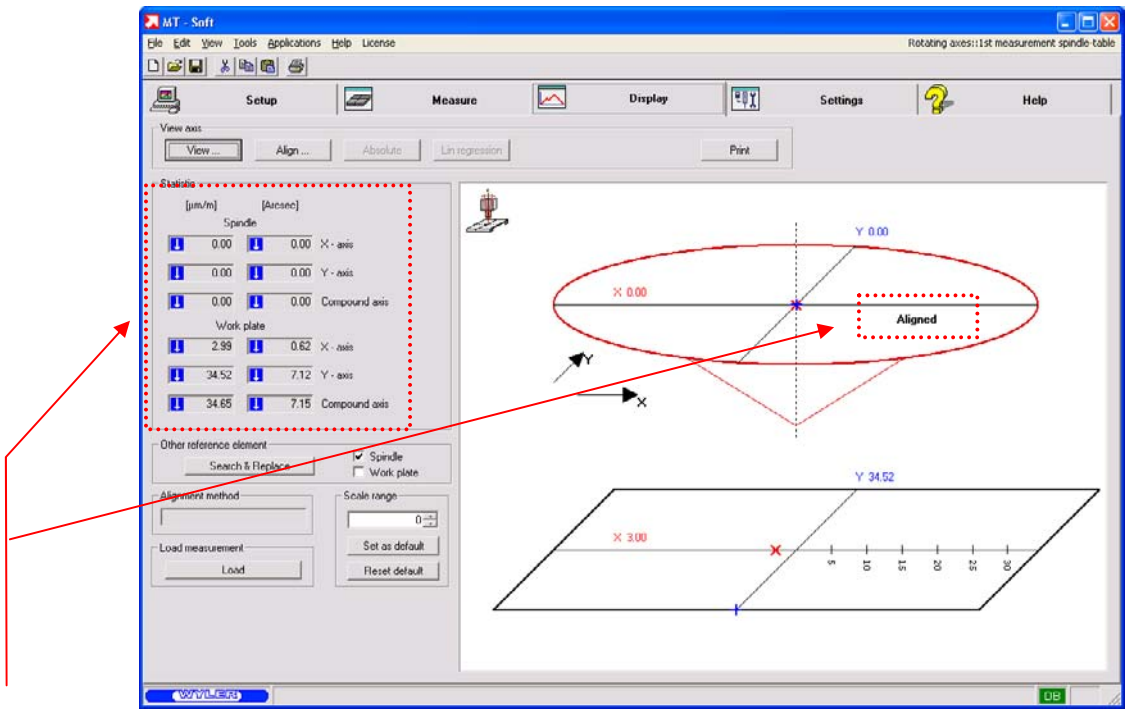
Before proceeding to further analysis save the measurement performed in the tab <**MEASURE**>, e.g. as

- o Measurement setup name:: **"1st measurement spindle-table"**
- o Measurement setup description: **"Machine tool DELTA S-123456"**



The significance of the graph is not very big yet. We change after [Confirm] the view by selecting the tab <**DISPLAY**>

Quite a **few possibilities exist** in the sub register display
a) Use the [View] or the [Align …] button below [View Axis]



After pressing the button [Align...] the <u>spindle is aligned</u> to the absolute vertical position, which is seen because

- X-direction is 0.00 µm/m
  and in
- Y-direction is 0.00 µm/m

This can be seen also because the crosses of the X-axis and the Y-axis are concentrically placed.

The table position in relation to the spindle shows the following deviations

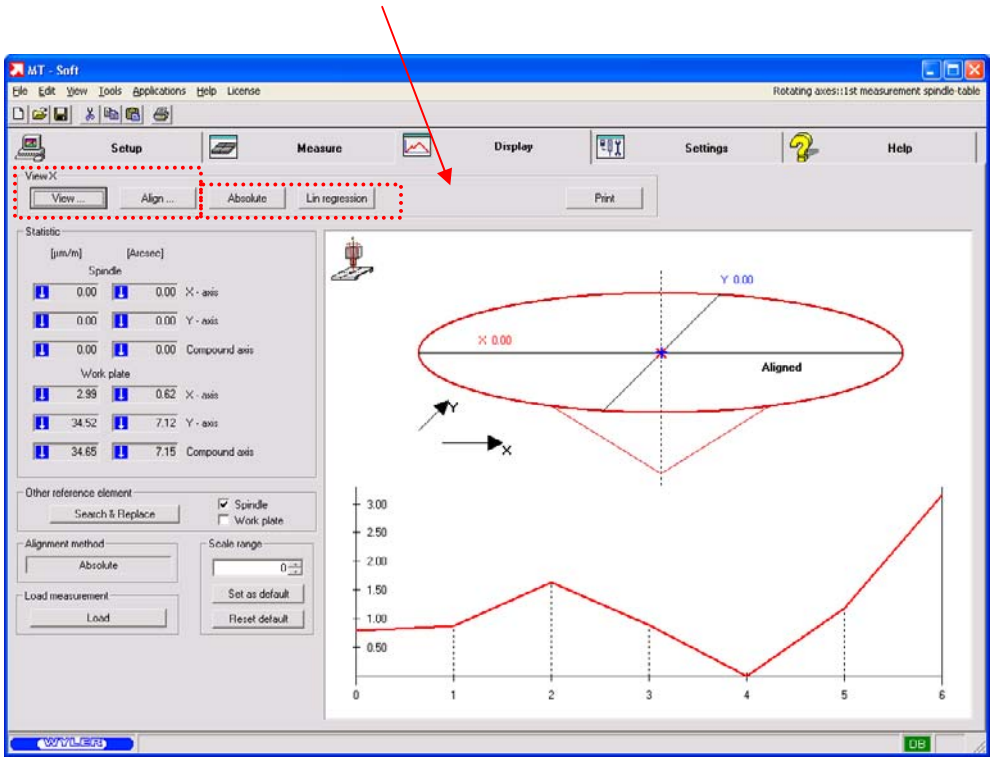
- X-direction is +2.99 µm/m
  and in
- Y-direction is +34.52 µm/m
  and
  in the axis absolute +34.65 µm/m

This means that when the spindle is absolutely vertical positioned the table is tilting in the

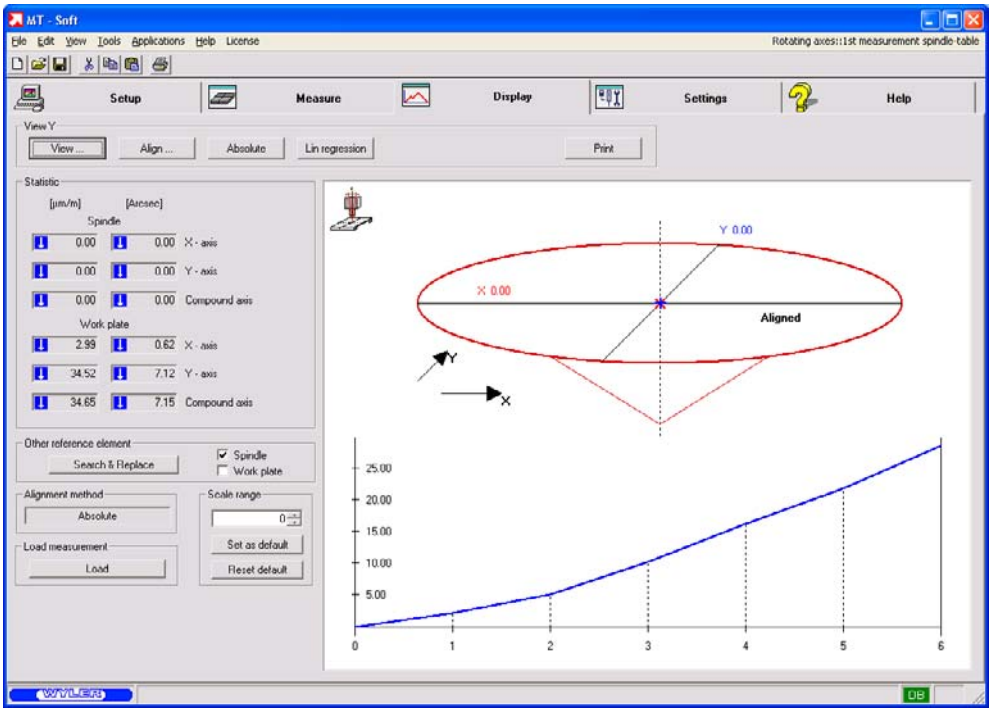
- **X-direction by +2.99 µm/m** (**inclined** to the right side)
  and in the
- **Y-direction by +34.52 µm/m** (**inclined** towards the back)
- and the **largest inclination** of the axis in space is absolute **+34.65 µm/m**

Repeatedly pressing the button [View] alternative views are possible. Correctly the results remain the same.

The first option shows the X-direction line of the table. The possible alignment methods are “Absolute” and “Lin Regression”.

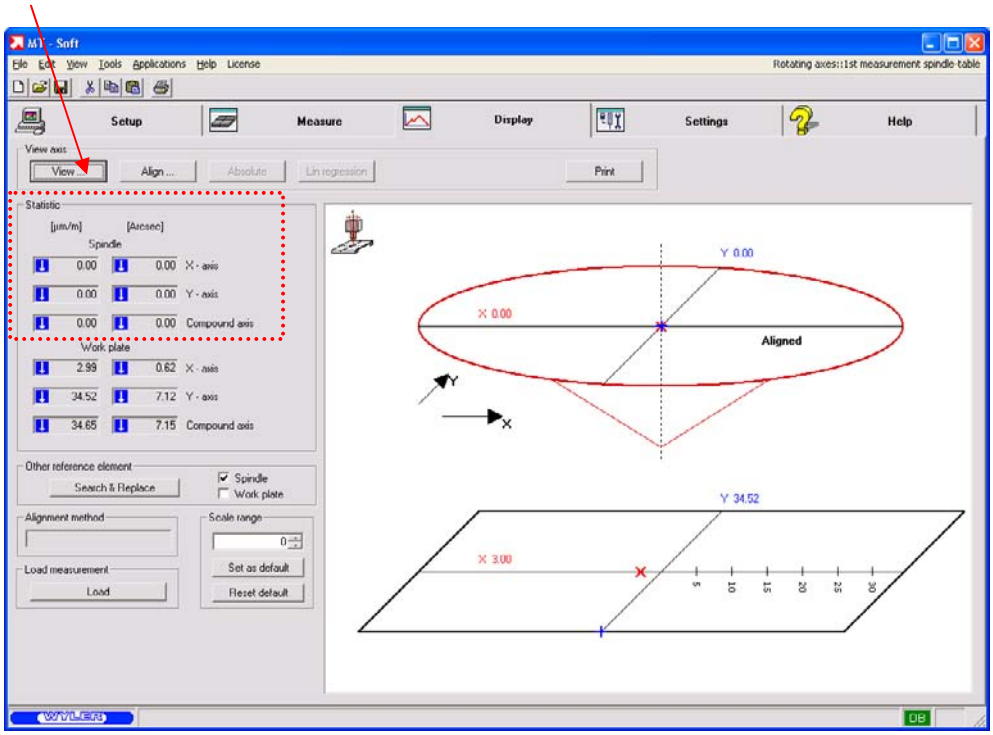


The second option shows the Y-direction line of the table. The possible alignment methods are “Absolute” and “Lin Regression”.

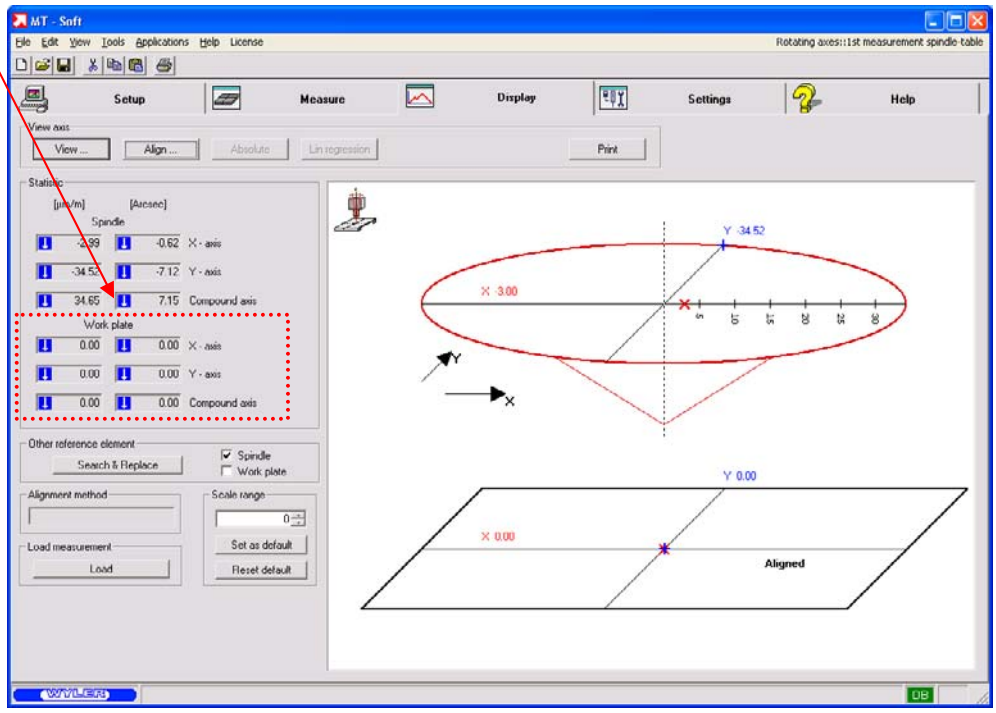


b) Use the [Align...] button below <**VIEW AXIS**>

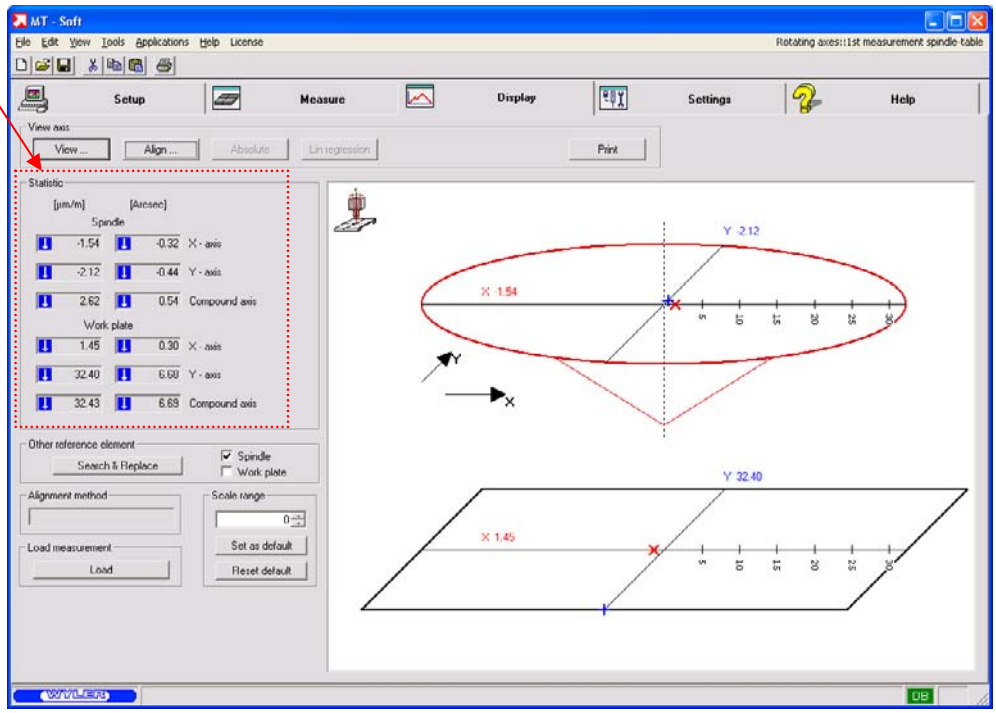
The picture shows the spindle and the table in absolute measured position. That means the position the measurement took place. **The spindle is vertically aligned**, the table is aligned accordingly.



The second picture shows the spindle and the table in absolute measured position. That means the position the measurement took place. **The table is horizontally aligned**, the spindle is aligned accordingly,
This is seen because all the “work plate” deviations are “0”.



The third picture shows the spindle and the table in **absolute measured** position **without any alignment**. The deviations from the zero positions are marked with crosses on the axis and are seen in the statistic portion of the window.



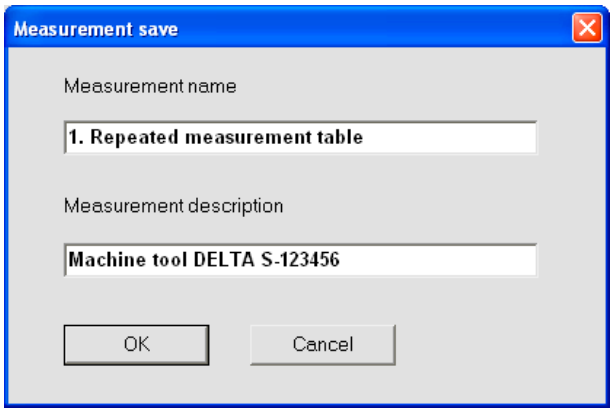
For additional details see also chapter "4. DEFINITION OF A NEW MEASUREMENT AND STARTING THE MEASUREMENT" (EXAMPLE MEASUREMENT OF CIRCLES)

Repeating the measurement of individual elements

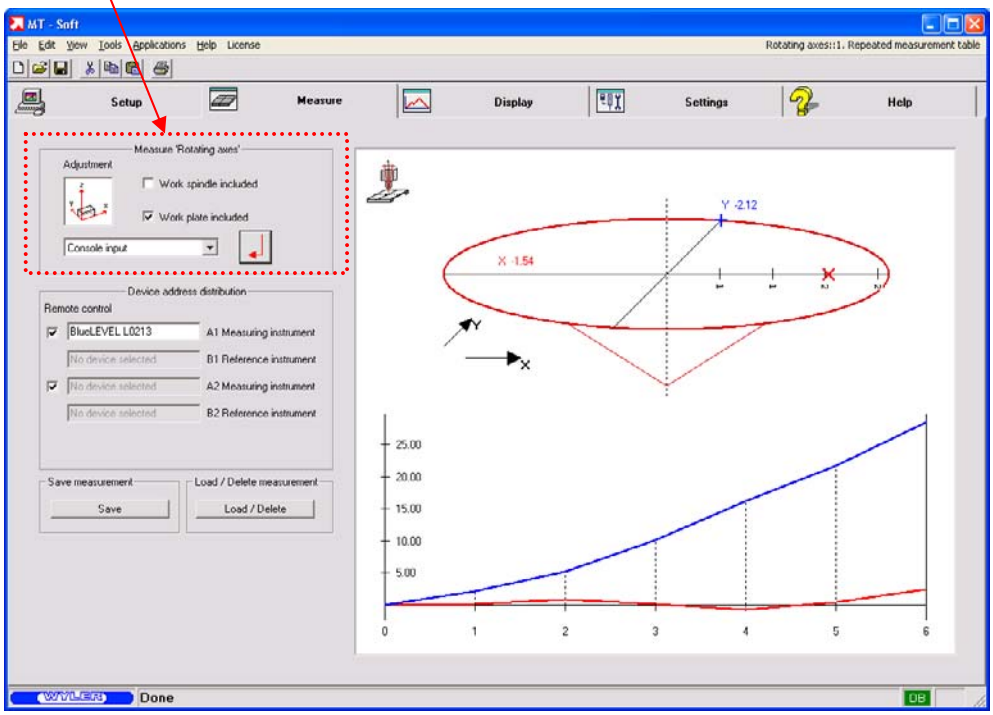
Task
Both axes and table have been measured and the result is not yet satisfactory. The table must be adjusted and the result measured from new.

Procedure

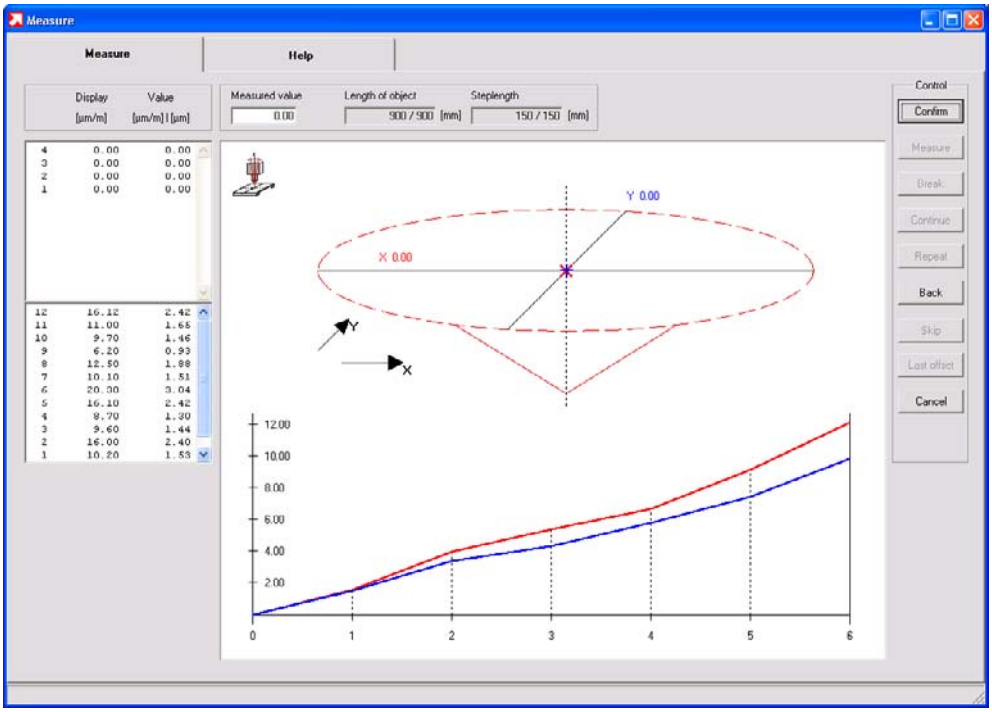
I. The **first measurement** is e.g. saved as "**Measurement spindle table"**
The new measurement has to be in the submenu <MEASURE> / <SAVE> e.g. as follows
Measurement setup name: **"1. Repeated measurement table"**
Measurement setup description: **"Machine tool DELTA S-123456"**



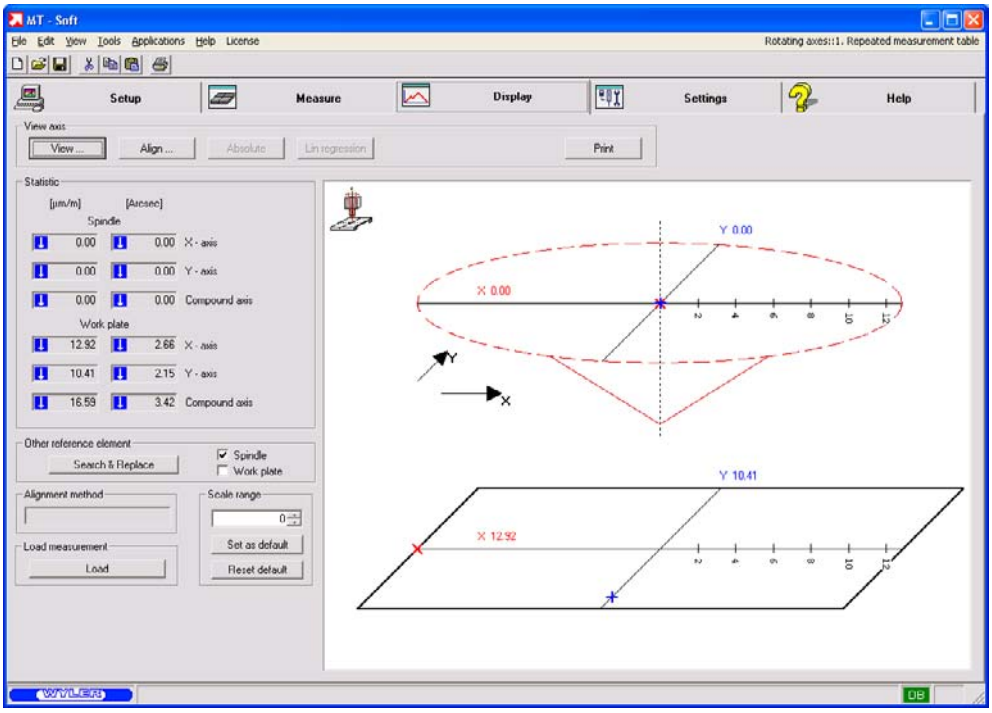
II) The table is adjusted from new and a new measurement is done by switching to the submenu [Measure] and by activating only the box “Work plate included”. The measurement can be started immediately.



The process is to be repeated until the result is satisfactory.



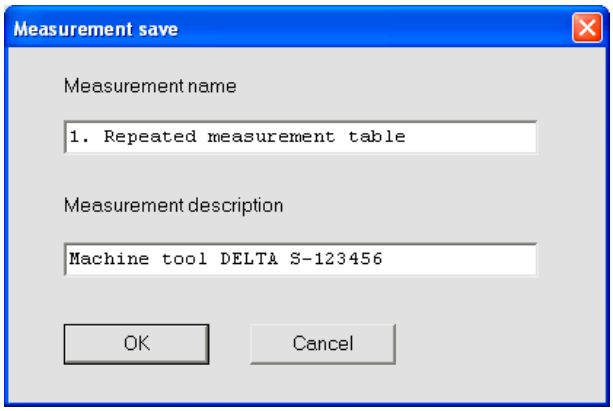
The measurement is accepted by using the button [Confirm]



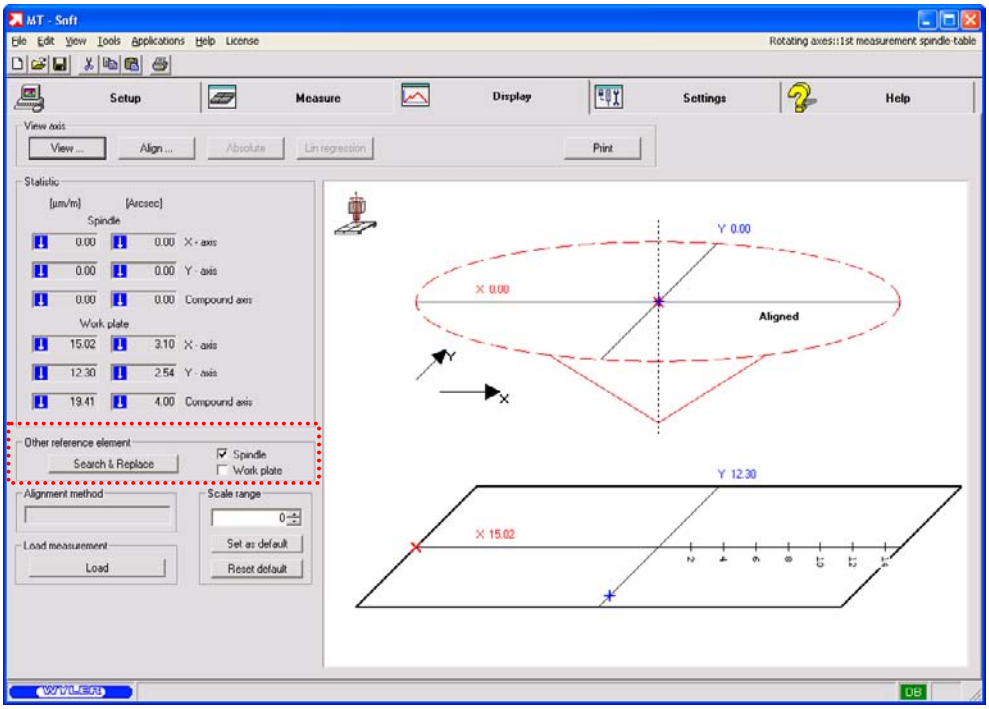
The "final result" is shown above.

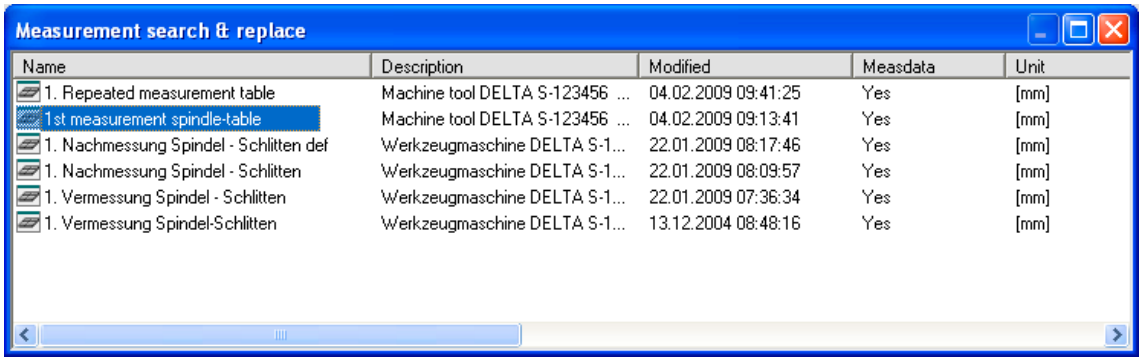
The measured result is saved again in the submenu <**MEASURE**> / <**SAVE**>:

- o Measurement setup name: **"1. Repeated measurement spindle table"**
- o Measurement setup description: **"Machine tool DELTA S-123456"**

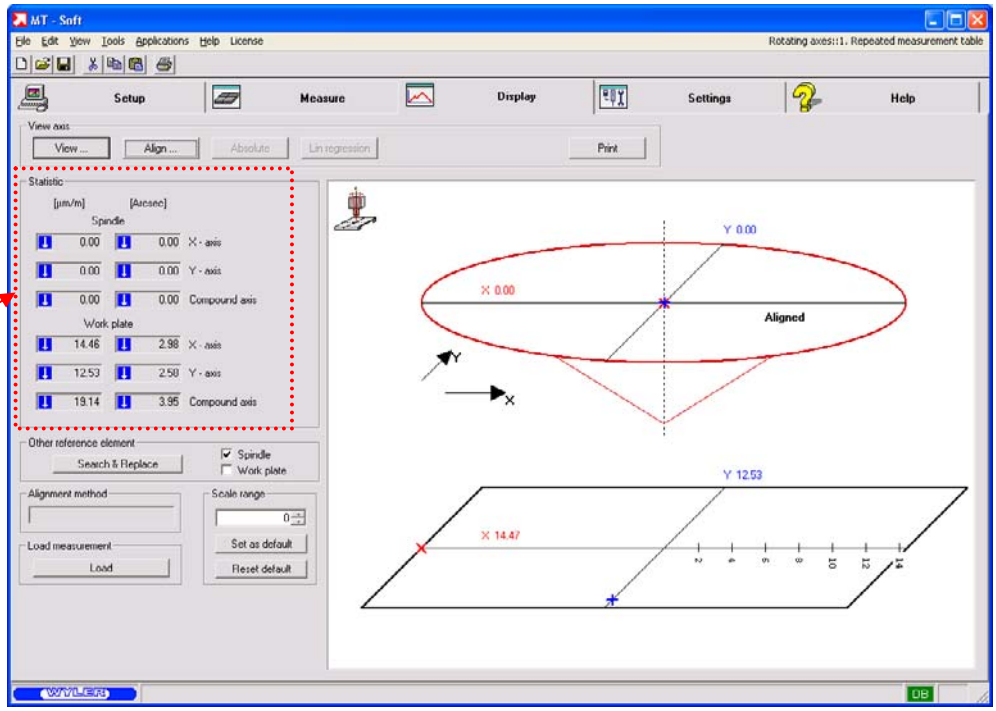


III) Now the original measurement of the spindle is to be integrated in the measurement. The Spindle box must now be activated under “Other Reference-Element” and the [Search & Replace] button is to be activated.





From the file selection window opened mark the file "1st Measurement spindle-table". The measurement of the spindle-table will be transferred to the graph and shows now the actual picture after the re-adjustment of the table.



Picture <u>after re-adjustment</u> of the table:

After pressing the button “Align...” the spindle is aligned to the absolute vertical position, which is seen because

- X-direction is 0.00 µm/m
  and in
- Y-direction is 0.00 µm/m
  and
- resulting inclination is 0.00 µm/m

This can be seen also because the crosses of the X-axis and the Y-axis are concentrically placed.

The **table** position in relation to the spindle is after the adjustment

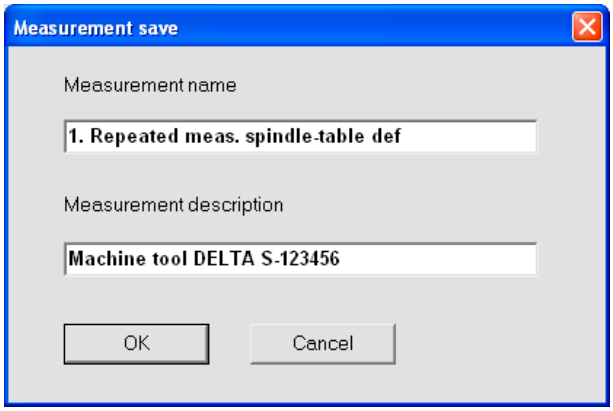
- X-direction is new +14.46 µm/m, before 2.99 µm/m
  and in
- Y-direction is new +12.53 µm/m, before 34.52 µm/m
  and
- resulting inclination is now 19.14 µm/m, before 34.65 µm/m

This means that when the spindle is absolutely vertical positioned, the table is tilting in the

- **X-direction by +14.46 µm/m** (inclined from left to the right side)
  and in the
- **Y-direction by +12.53 µm/m** (inclined from front towards the back)

The measured result is saved again before any other analyses are done in the submenu <**MEASURE**> / <**SAVE**>

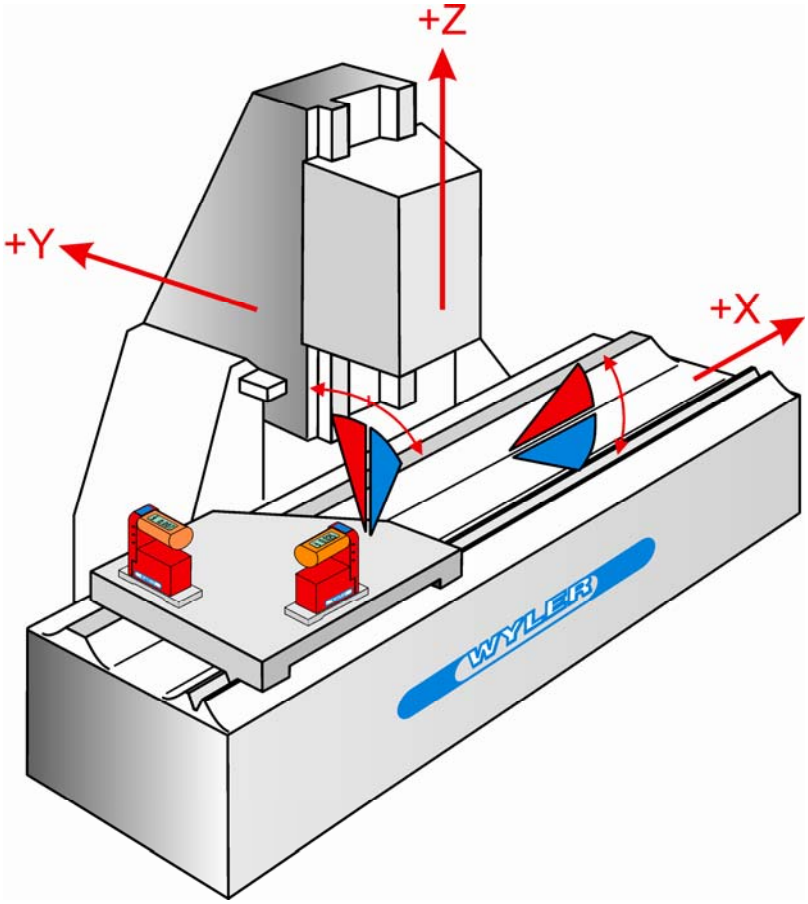
- o Measurement setup name: **"1. Repeated meas. spindle-table def"**
- o Measurement setup description: **"Machine tool DELTA S-123456"**



5.3 ROTATING MACHINE ELEMENTS

Measuring example:
Measurement of geometry error pitch and roll of a machine element moving horizontally.

For this planned measuring task a measuring jig is required.



Before starting the measurement the definition of the axis coordination and the directions of the movements must be defined. (Work piece coordination)

In our example the X, Y, Z definitions are as follows, see picture above:

- Guide way length direction: left to right +**X-Axis**
- Spindle horizontal movement: near to far +**Y-Axis**
- Spindle vertical movement: bottom to top +**Z-Axis**

Additional information concerning the “coordinate system” see the following chapter.

The **zero position of the coordinates X / Y / Z** must be defined

In our example the X/Y/Z zero position is placed slightly above the centre of the reference guide way. (see Sketch below)
The definition of this point is important because when creating the measurement layout this point must be clearly defined.

COORDINATE SYSTEM

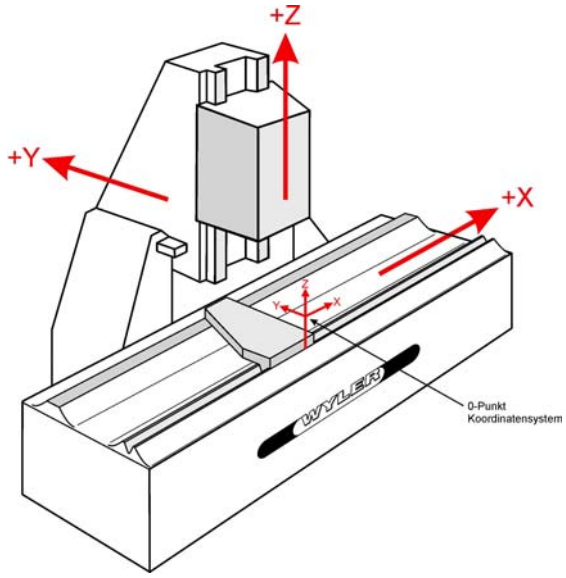
The careful definition of the coordinate system is worthwhile
With MT-Soft it is under certain conditions possible to make use of existing object's data as well as the comparison between earlier measurements. Precondition to do so is the correct definition of the coordinates. The coordinates are also used in the further computing of the results and naturally are also displayed on the monitor or printed for further analyzing.

Coordinate system
MT-Soft requires the data entering in form of coordinates using the **work piece coordinates**.

In order to make optimal use of the existing conditions the basic coordinates in space are free to define. By defining the system please note:

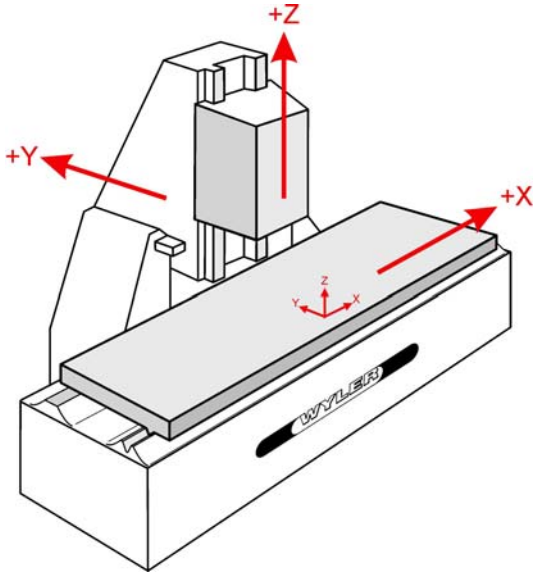
Relative movements of the spindle in relation to the work piece use the same work piece coordinates, in our case these are the axis Y and Z.

Relative movements of the work piece in relation to the (fixed) spindle are movements opposite to the work piece coordinates. In our example this concerns the X-axis. A work piece coordinate changement in +X directions means a **table movement** in -X direction!

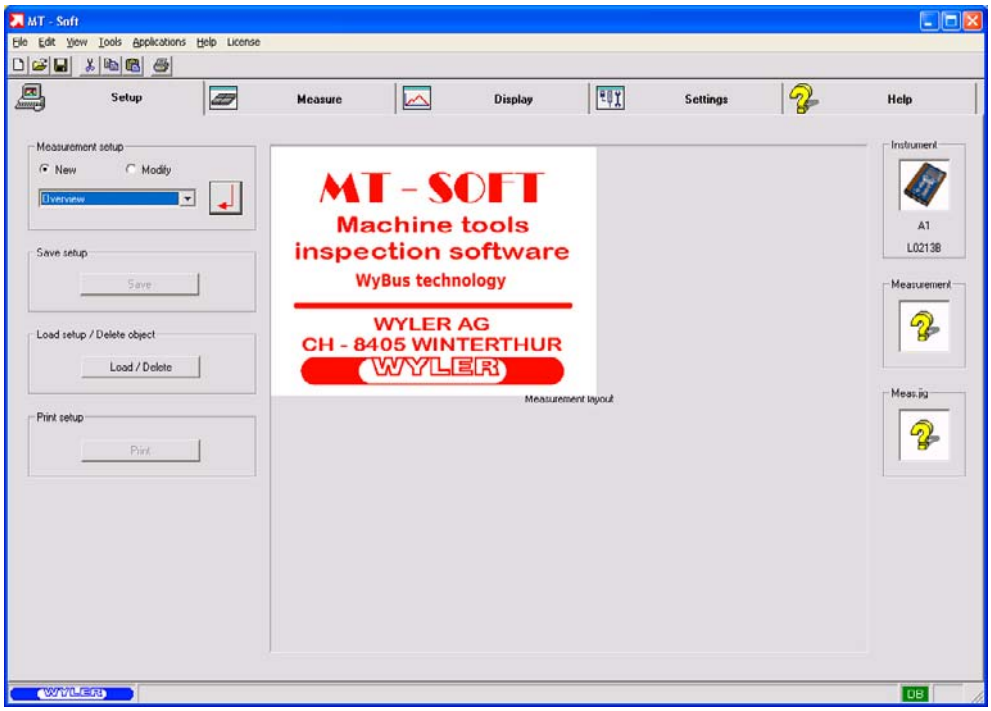


Zero position of the coordinates
MT-Soft allows the implementation of negative figures. This means the zero position of the axes in space is free to choose.

Important is that all the measurements on one machine use all the same coordinates. In our example we choose the zero position for Y and Z at the front edge of the table and the X position in the centreline of the machine / turret



After starting MT-Soft the following picture appears:



The measurement example

- **Measuring task**
  Measuring and recording geometry errors (Pitch and roll) of the machine tool guide way system

- **Axes and step length**
  - X-axis minimum: 100 mm
  - X-axis maximum: 1000 mm
  - Step length in X- direction, matching the instrument: 150 mm

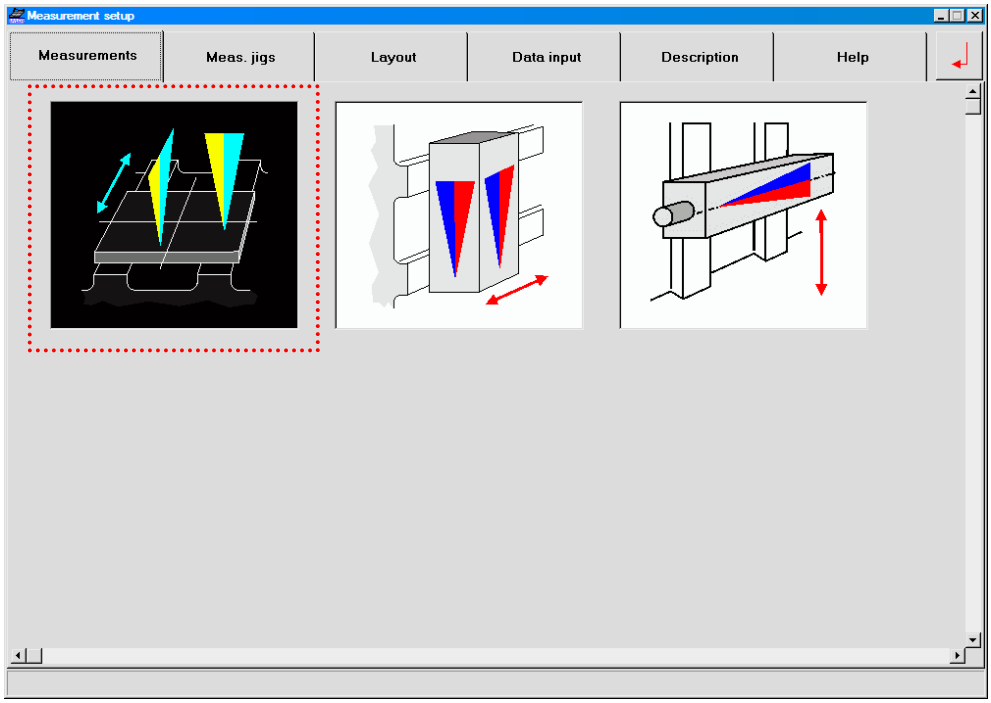
  - **Type of measurement:**
    Workpiece is moving (The instrument is directly placed onto the table. For the measurement the table is moved along the X- axis in X-direction (X-coordinate)

    Remarks:
    If on the machine tool the spindle is moving instead of the table, the measuring instrument must be placed on the spindle. In this case “Moving tool” must be selected in measurement layout.

- **Measurement setup:**
  Measuring setup with <u>two</u> instruments, i.e. both axis (X and Y axis) are measured simultaneously. The measurement is performed as a relative measurement, i.e. a reversal measurement before starting the measurement is not necessary.

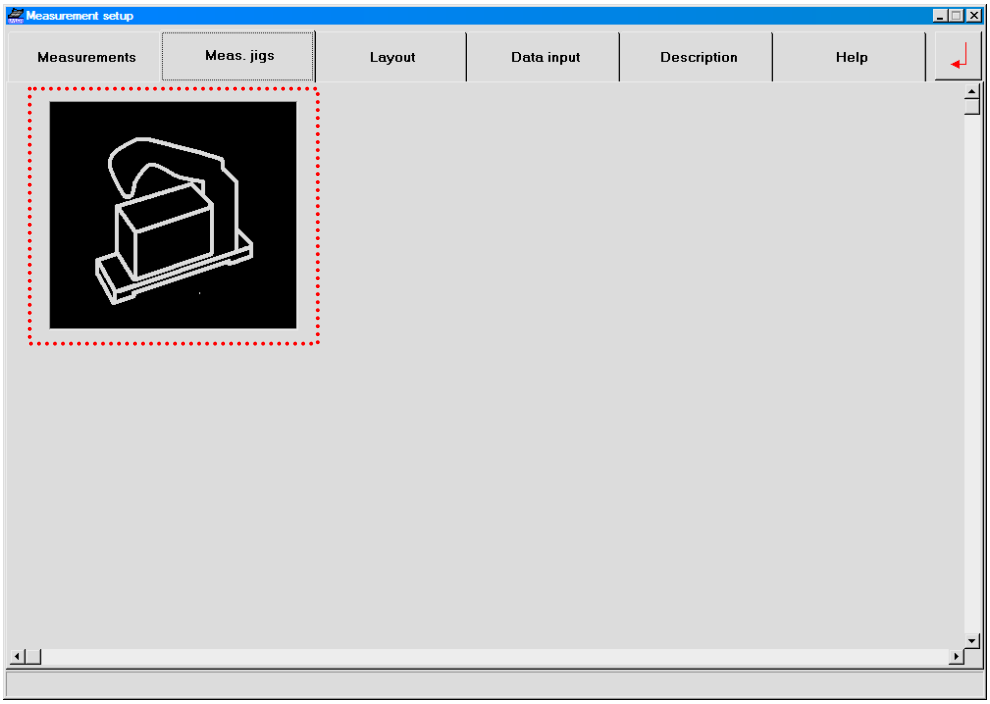
In the register “Setup”, below Measurement Setup the pull down menu can be used to change to “Rotation of geometrical elements” and confirm with [Enter] 

A number of different possibilities are displayed under <MEASUREMENTS>



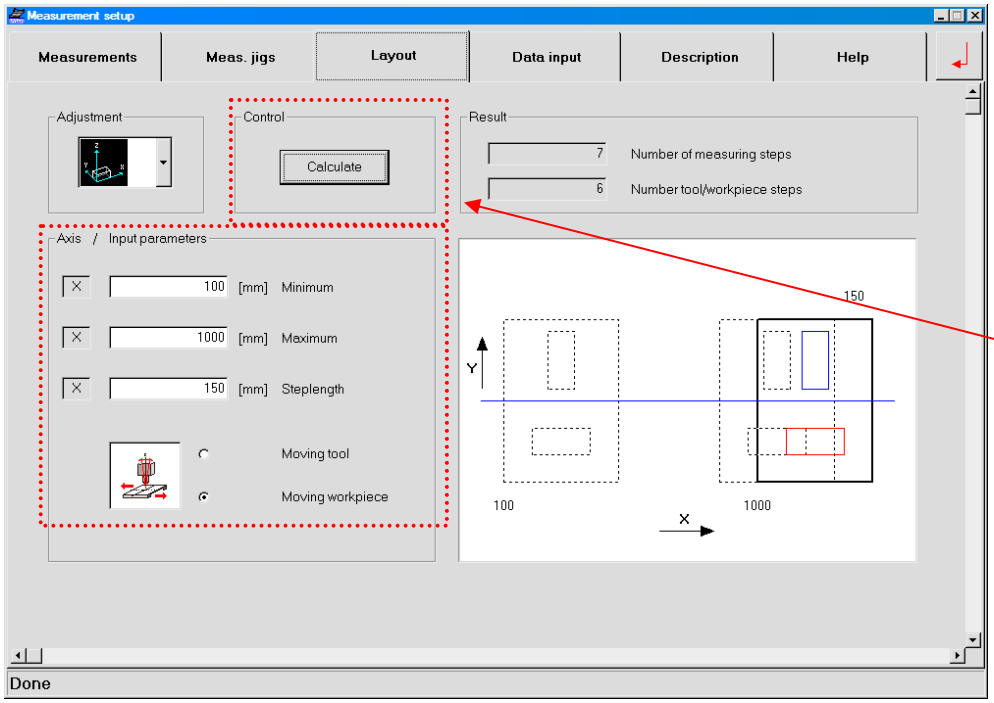
In our example we chose the first option, left side.

Under measuring jigs only the measuring instrument is displayed, no jig available.



After the selection by mouse click the background becomes black.

Change to the sub register **Layout**



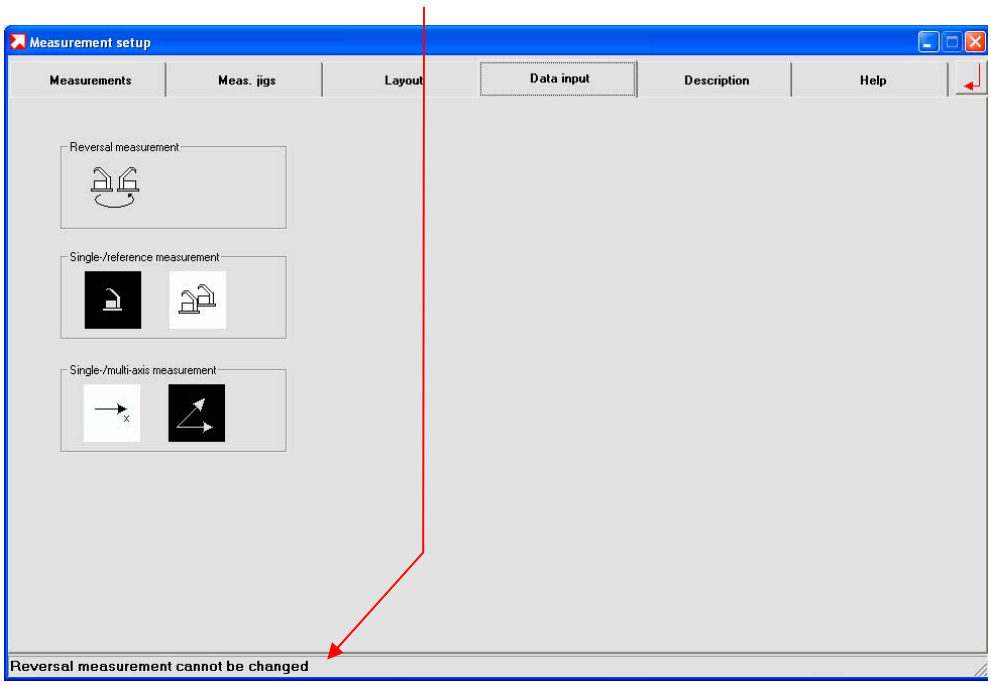
Next the coordinates must be entered. (IMPORTANT: **WORK PIECE COORDINATES**)

- X-axis minimum 100mm
- X-axis maximum 1000mm

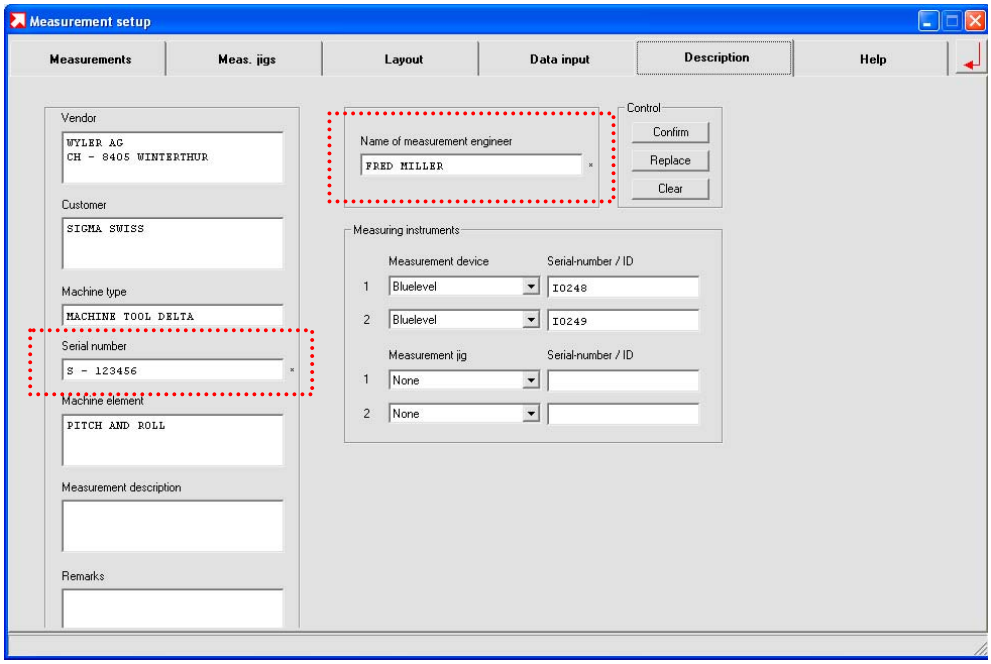
- Step length in X-direction, matching the instrument: 150mm
- Type of measurement: 150mm

After confirming with [Calculate] the following additional information is displayed after changed to <**DATA INPUT**>

As a next step the selection of the measuring method must be taken. For our example we select "Measurement with two instruments" but without reference. (The selection of a reversal measurement is not possible).



Next the **Description** must be done



The descriptions is to define exactly the measuring task and the identification of the objects
In this dialogue box all the necessary data for defining the planned measurement can be entered. The **Name of measurement Engineer** and the **Serial number** of the object to be measured are **mandatory**. All the rest of the information is free to fill in.

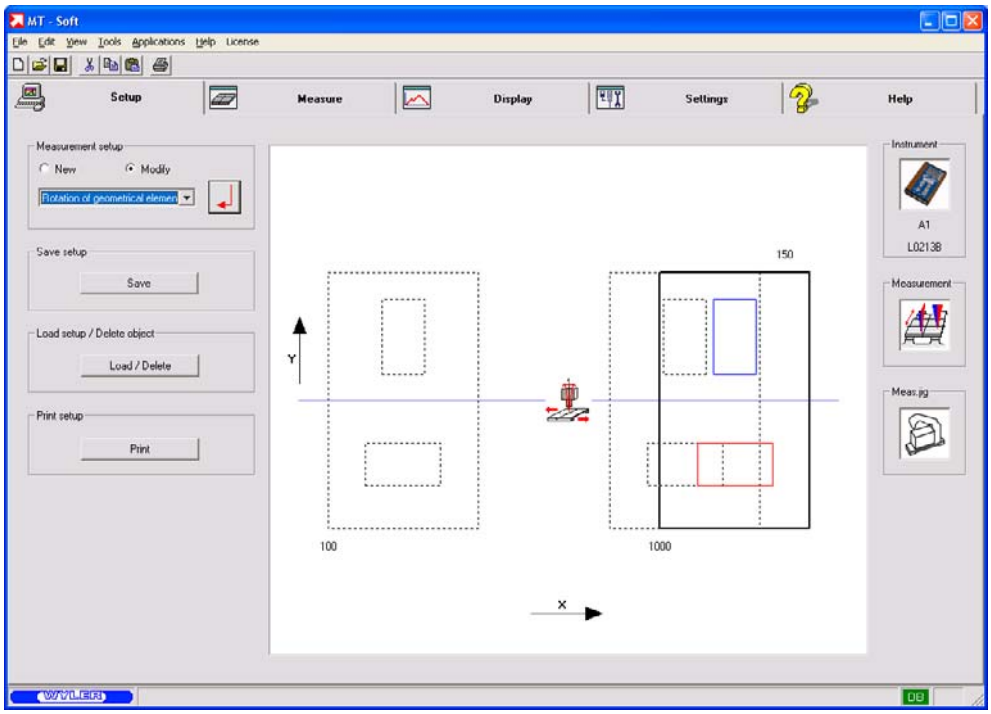
The text can also be integrated from an existing template by using the <**REPLACE**> button

It is still possible to make changes in the setup registers.

If no changes are required, press the button [confirm]

Accept with [ENTER] 

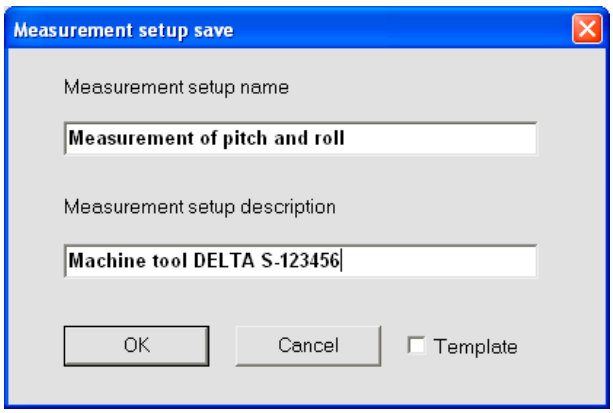
Now the actual measurement can be started. When all the data is correctly filled in press the [Enter] button, the following picture appears:



The following information is displayed:

- Object to be measured, in our case "Rotation of geometrical elements"
- On the right side of the window
  - Instrument: The connected instrument respectively Interface
  - Measurement Selected measurement
  - Meas. JIG Type of JIG specified, (instrument only)

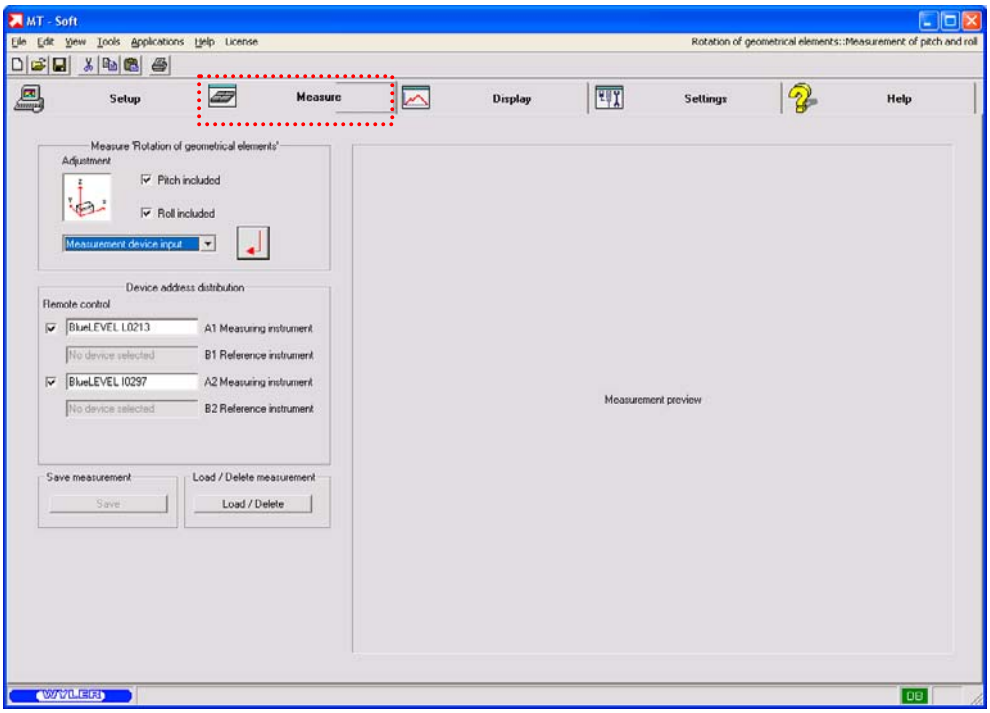
- Under "Save Setup" the button “save” opens a dialogue box. The setup may be saved as **template,** e.g.:
  - o Measurement setup name: **"Measurement of pitch and roll"**
  - o Measurement setup description: **"Machine tool DELTA S-123456"**



- Under Load Setup / Delete Object the button Load/Delete allows to open an existing setup template or delete an object.

- Using the button “Print Setup” / [Print] allows to print the actual measurement setup template

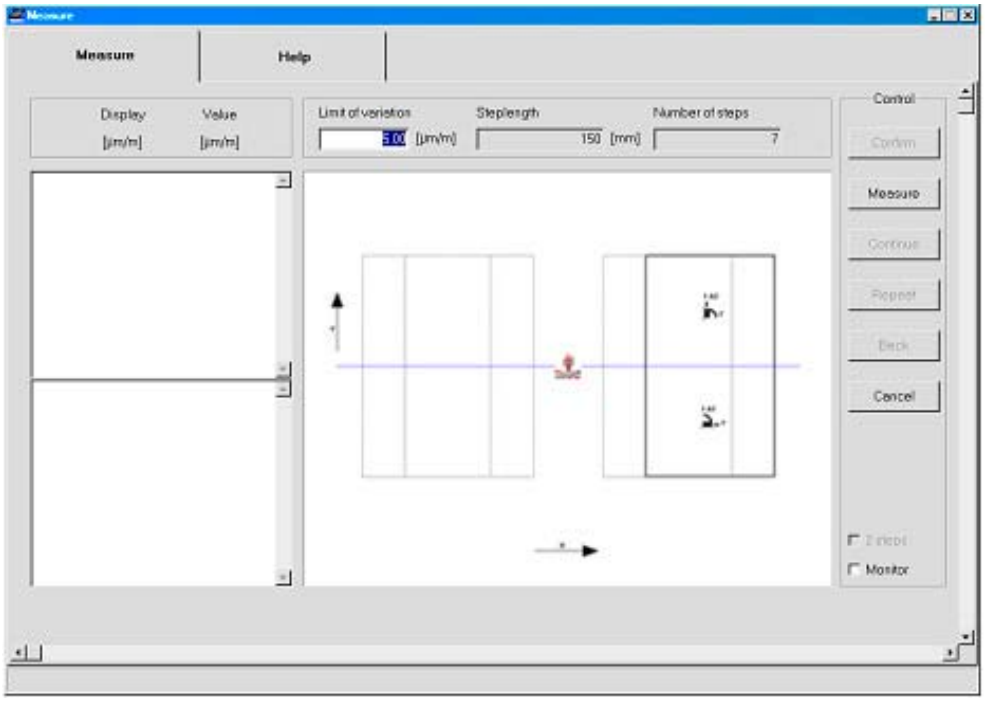
For **starting the measurement** the register <**MEASURE**> must be activated
In case the measuring instruments are not defined yet or if you want to change the instruments, you can still do this under "Device address distribution"

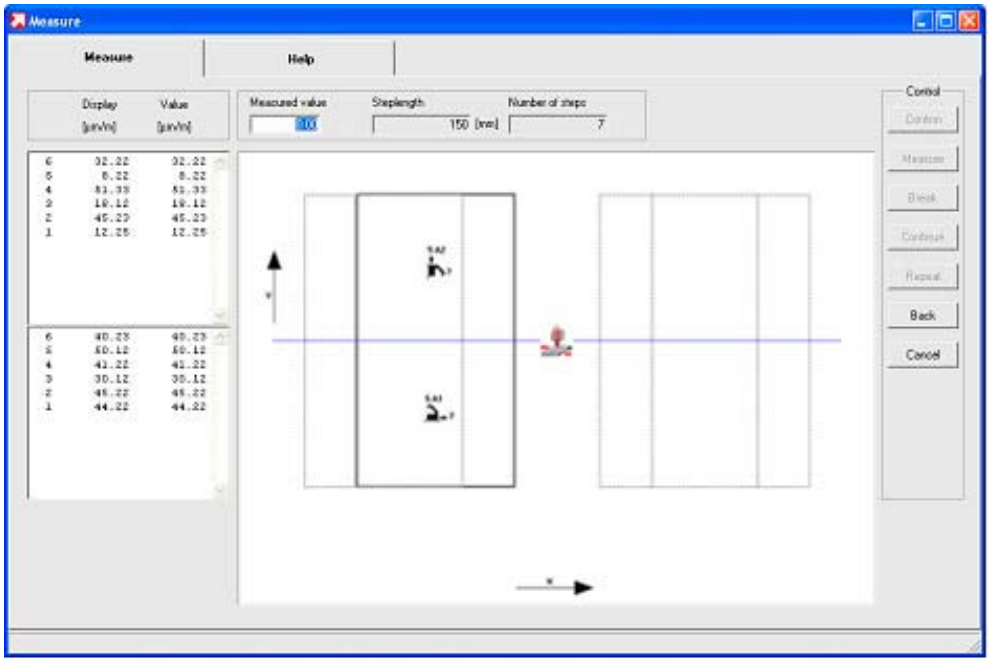


In this register the following input is possible:

- Below <Rotation of geometrical elements> it is possible to change between "Measurement device input“, "directly from interface to PC" or manual input via "Console Input"
- Below <Rotation of geometrical elements> it is also possible to define, if a complete measurement should be done pitch and roll included. Depending on the box marked it is possible to use "Pitch included" and/or "Roll included". Both axis (X and Y) are to be measured or one axis only. This allows for example to start with one axis until the result is satisfactorily after the necessary adjustments. In such a situation only the one axis is marked. (X-Axis included)
  In a later step only “Y-axis included” is activated and possibly adjusted. At the end it is still possible to measure both axis.

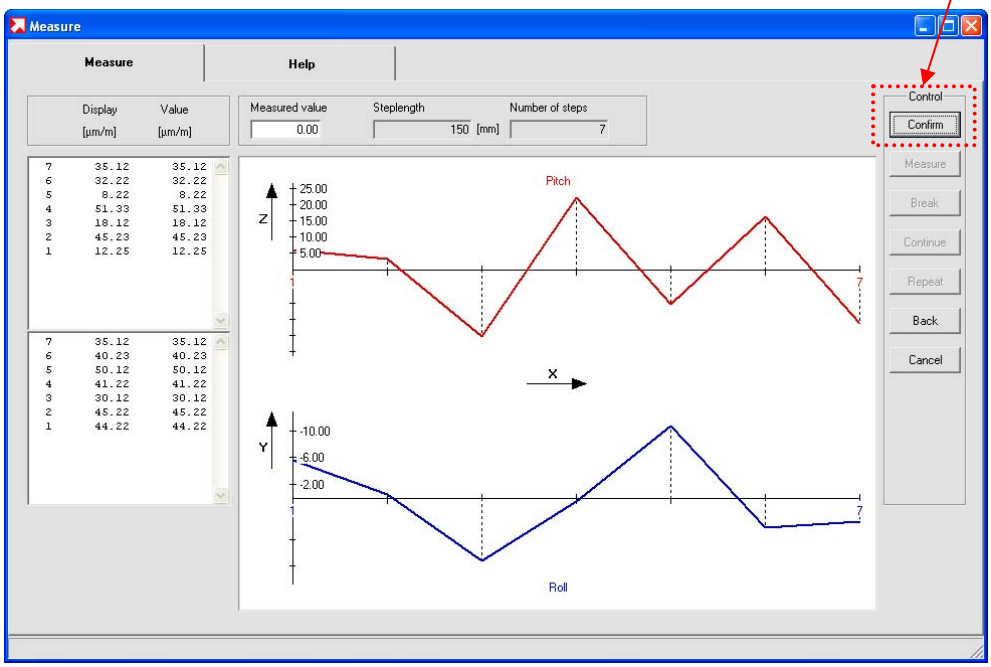
In our example we activate both boxes and select <**MEASUREMENT DEVICE INPUT**> to start the measurement [Enter] must be confirmed. The graph shows the first position of the slide with the measuring instruments set on top.





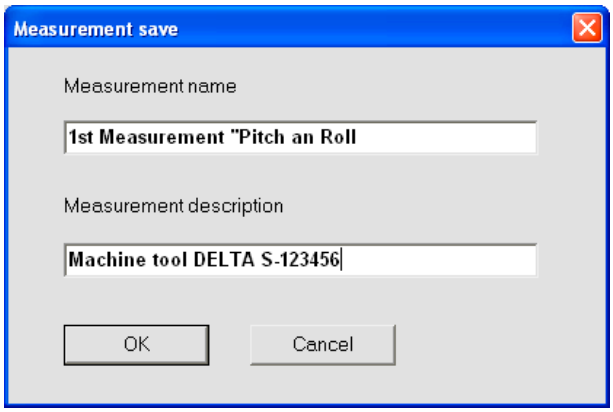
On the left graph the measured values are displayed and can be checked.

After the last measurement the following graph is displayed. The result can be confirmed with [Confirm] or using the button [Back] can be repeated step by step.



Before we continue the measurement should be saved.

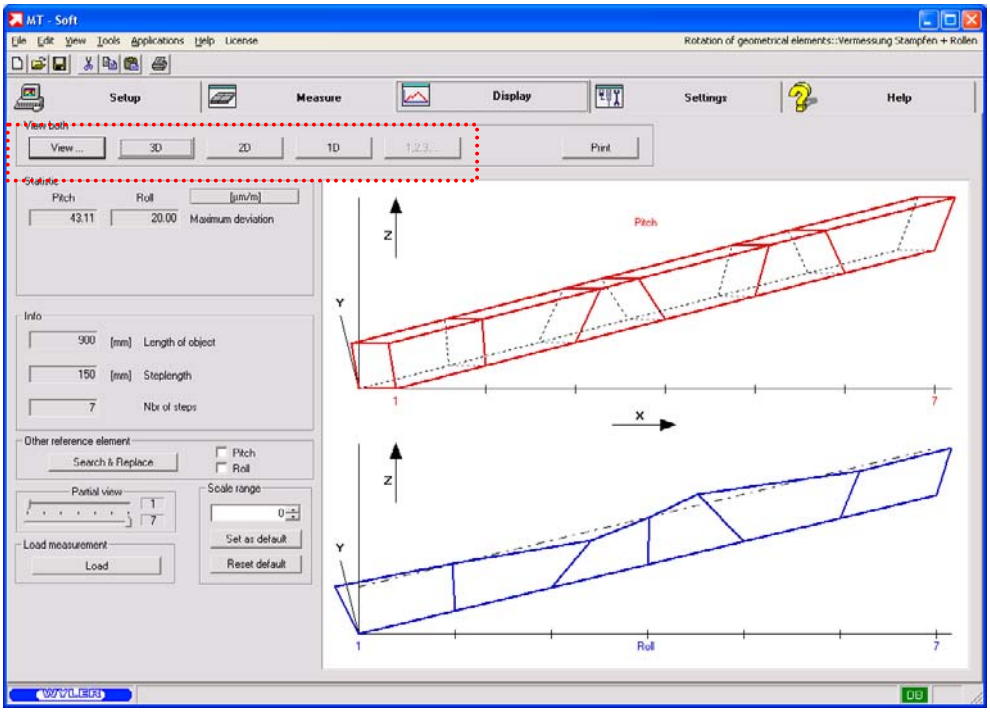
- o Measurement setup name: **"1st Measurement "Pitch an Roll""**
- o Measurement setup description: **"Machine tool DELTA S-123456"**



The expressiveness of the displayed figure is not very helpful yet. After [Confirm] we change to the menu “Display”

The display can be changed to **various options** by switching to the respective buttons [View...] or [3D] / [2D] / [1D]

a) When [View...] is chosen:



Display in 3D format

The presented picture allows an easy view of the “Pitch" and “Roll” situation. In the “Statistic” section the following information is seen:

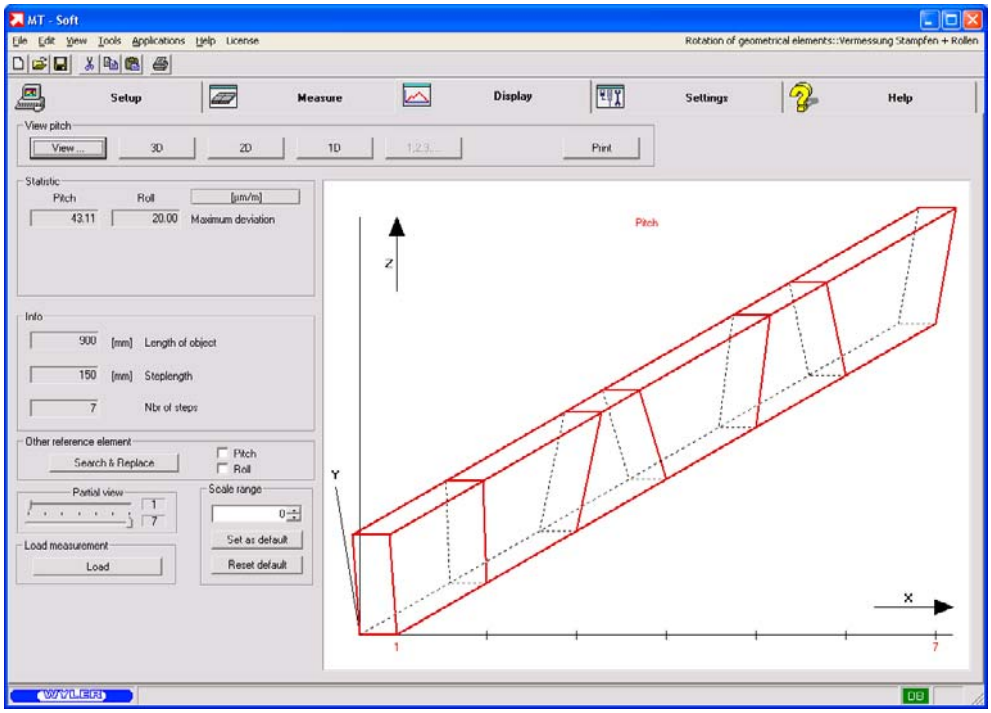
- Maximum deviation “Pitch” and “Roll” in µm/m 43.11 / 20.00 µm/m

By using the slide button "Partial view" the required section may be enlarged.

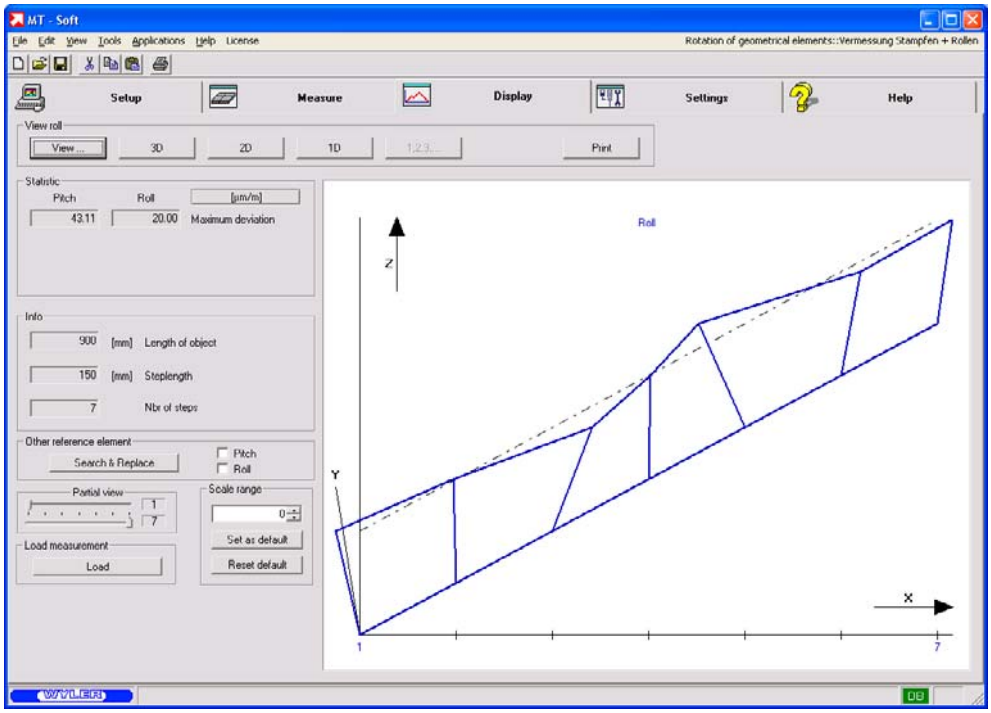
Remarks

In probability and statistics, the **standard deviation** is the most commonly used measure of statistical dispersion. The standard deviation is defined as the square root of the variance. This means it is the root mean square (RMS) deviation from the average. It is defined this way in order to give us a measure of dispersion that is (1) a non-negative number, and (2) has the same units as the data. The basic formula is

$$\sigma_x := \sqrt{\frac{1}{N-1}\sum_{i=1}^{N}(x_i - \bar{x})^2}$$

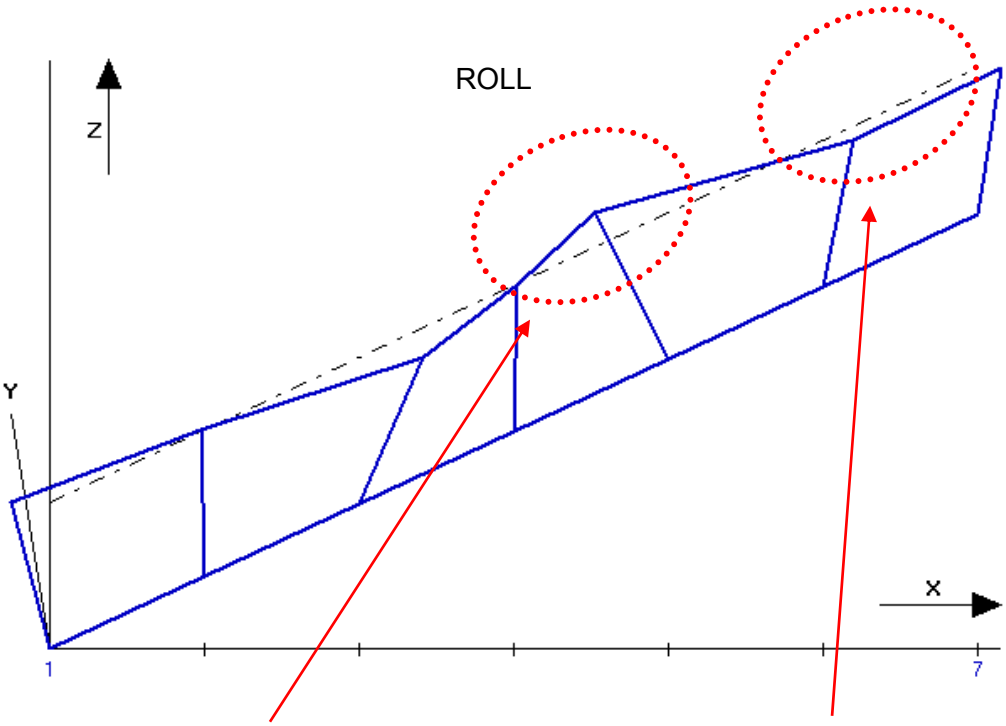


Individual view “Pitch”



Individual view “Roll”

Interpretation of the graphic "Roll"



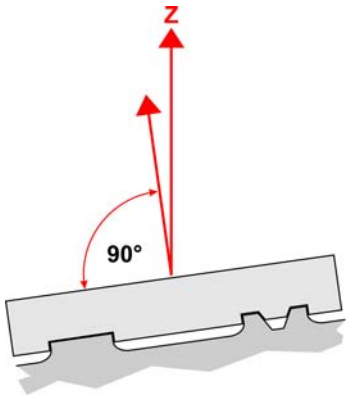


Table is tilting backwards

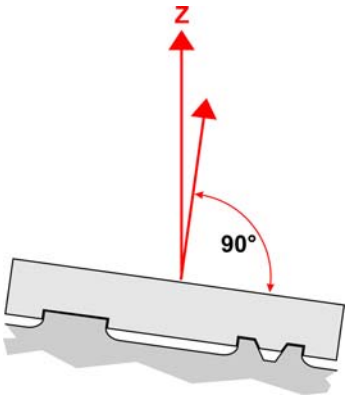
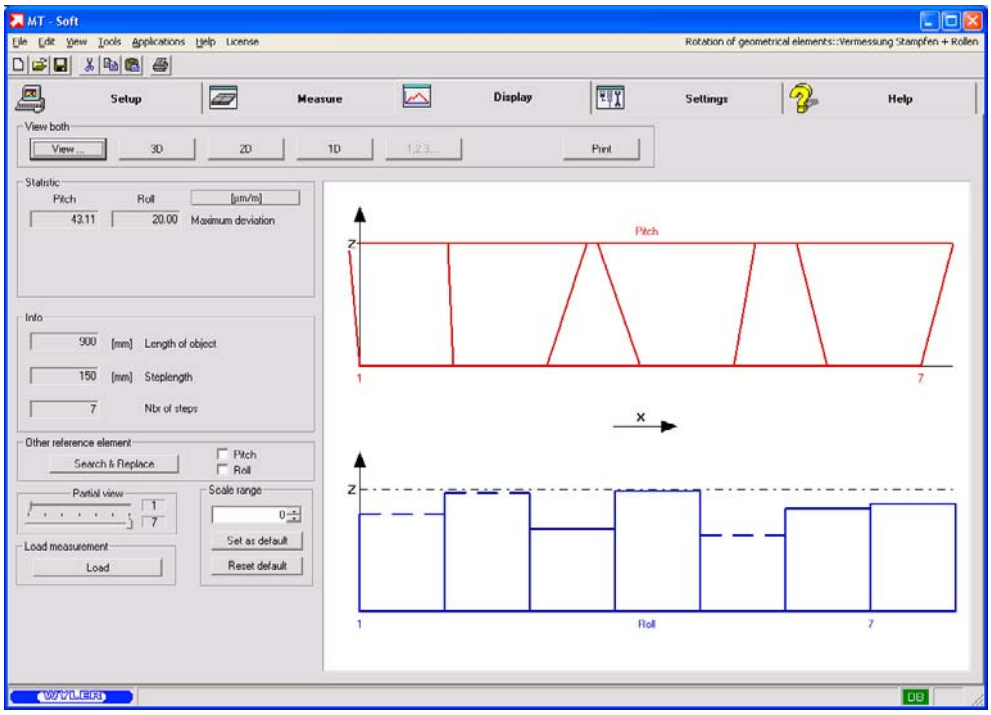


Table is tilting forward

Centre line: Average of all the transversal inclinations

b) When [1D / 2D] is chosen:



Display in 2D format

Interpretation of the graphic "Roll"

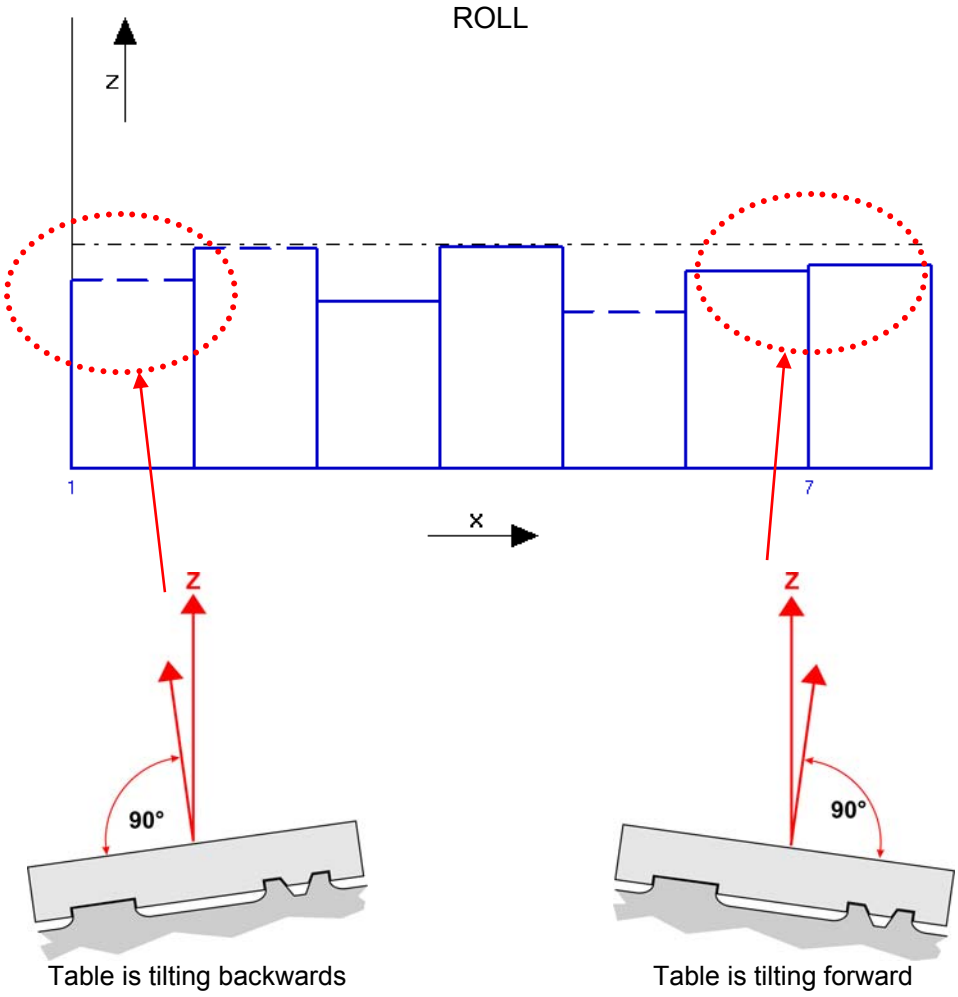
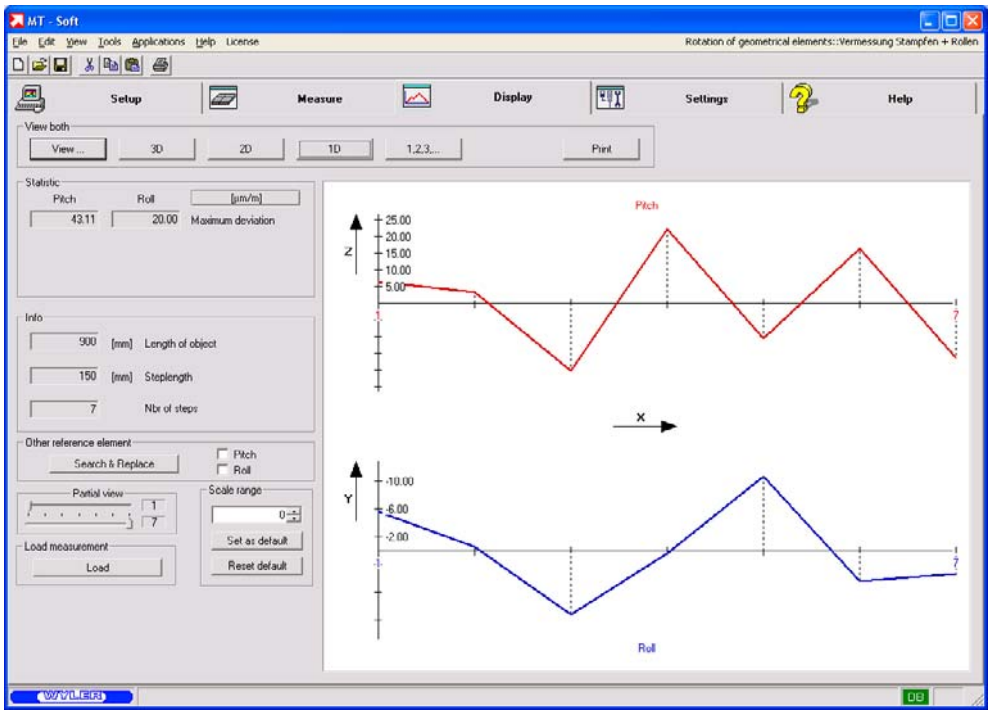


Table is tilting backwards

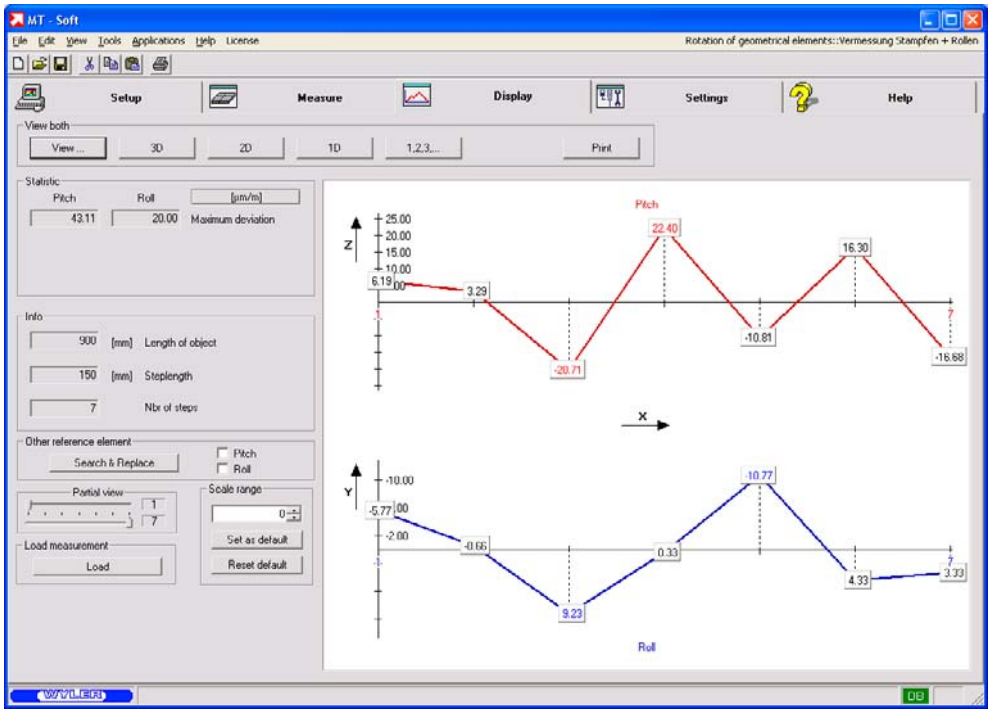
Table is tilting forward

Centre line: Average of all the transversal inclinations

c) When [1D] is chosen:



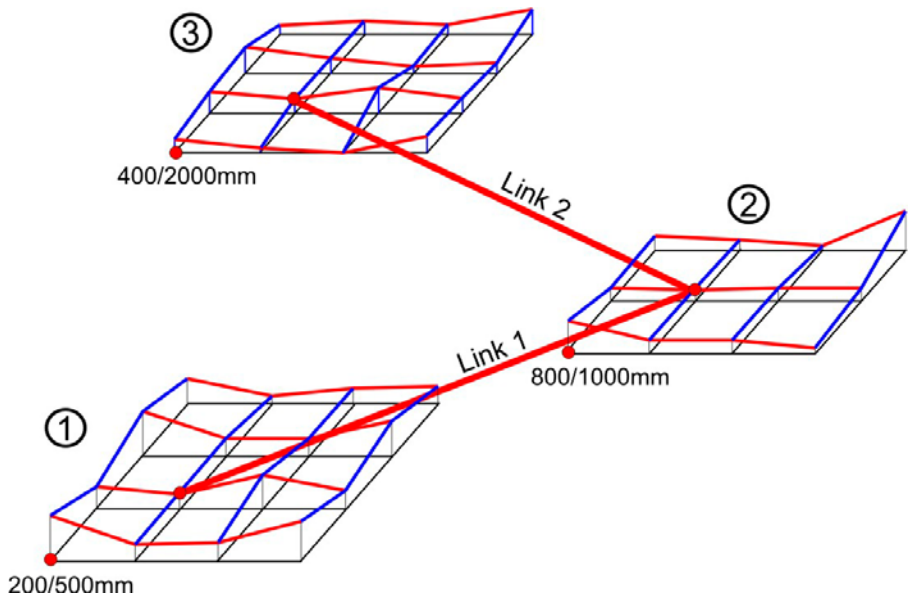
Display in 1D format



View in 1D format
with indication of measuring values

5.4 SURFACES

Measuring example:
Flatness measurement of horizontal surfaces in space and comparison of the position of various such surfaces (co-planarity). Partial surfaces compared to an overall surface including all partial surfaces.

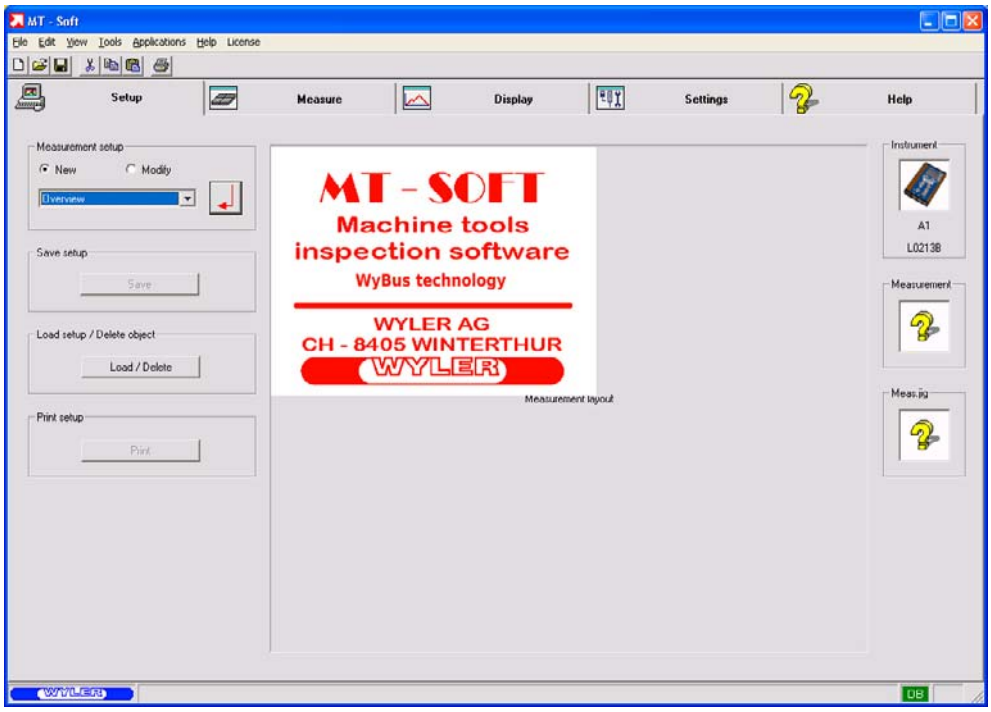


Before starting the measurement the definition of the axis coordination and the directions of the movements must be defined. (Work piece coordination)

In our example the X, Y, Z definitions are as follows, see picture above:

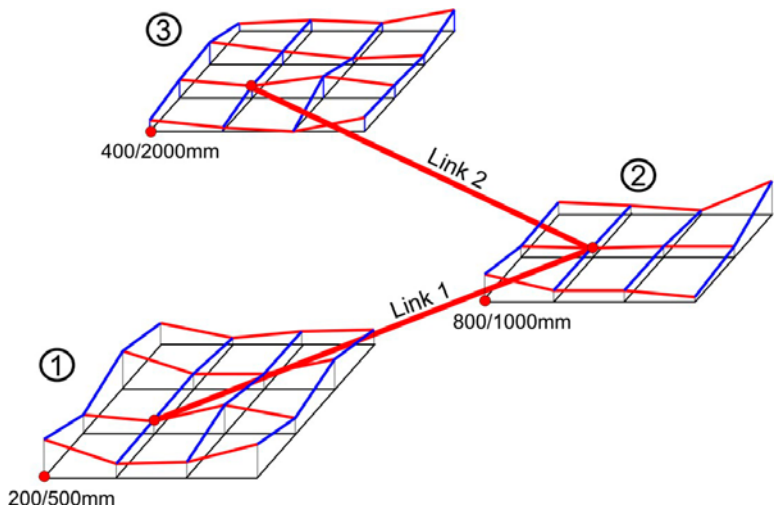
- Guide way length direction: left to right +**X-Axis**
- Spindle horizontal movement: near to far +**Y-Axis**
- Spindle vertical movement: bottom to top +**Z-Axis**

After starting the MT-Soft the following picture appears:



The measurement example

Measuring the flatness and the horizontal position of three (partial-) surfaces and defining the co-planarity



- **Measuring task**: Position and flatness of the individual surfaces

- **Coordinates of the partial surfaces**
  - Surface 1: X-direction 200 mm
  - Surface 1: Y-direction 500 mm

  - Surface 2: X-direction 800 mm
  - Surface 2: Y-direction 1000 mm

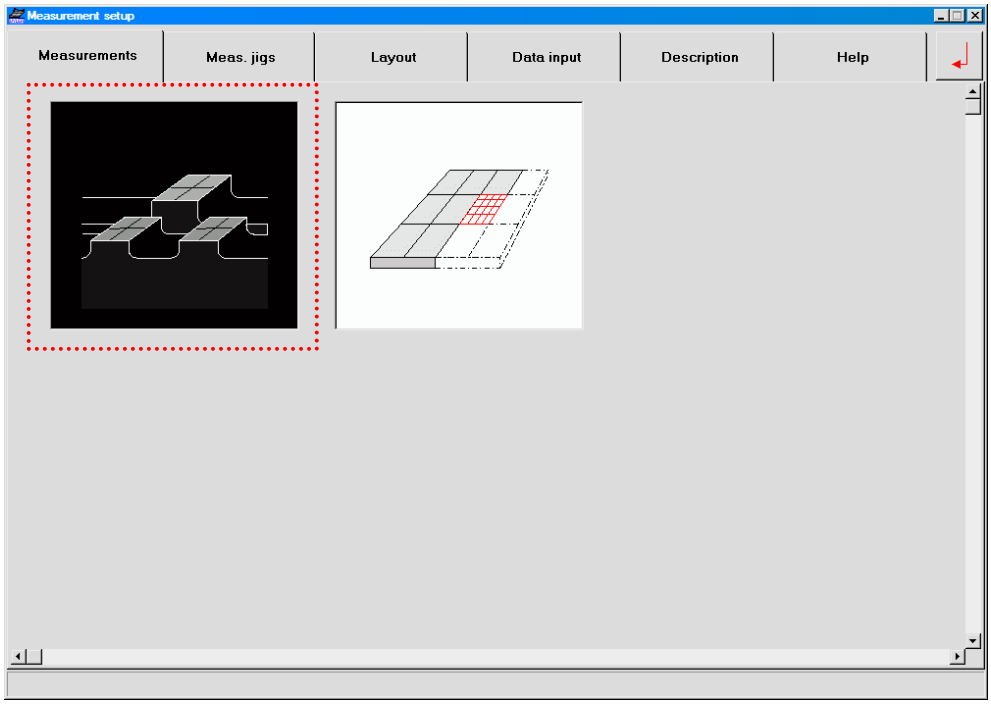
  - Surface 3: X-direction 400 mm
  - Surface 3: Y-direction 2000 mm

- **Plate size**
  - Surface 1: 500 x 500 mm
  - Surface 2: 500 x 400 mm
  - Surface 3: 500 x 550 mm

- The measurement is done **with a single instrument**, this means in a first step the X-direction is measured and in the second step the Y-direction.
  The measurement is done as an **absolute measurement**, which requires a reversal measurement

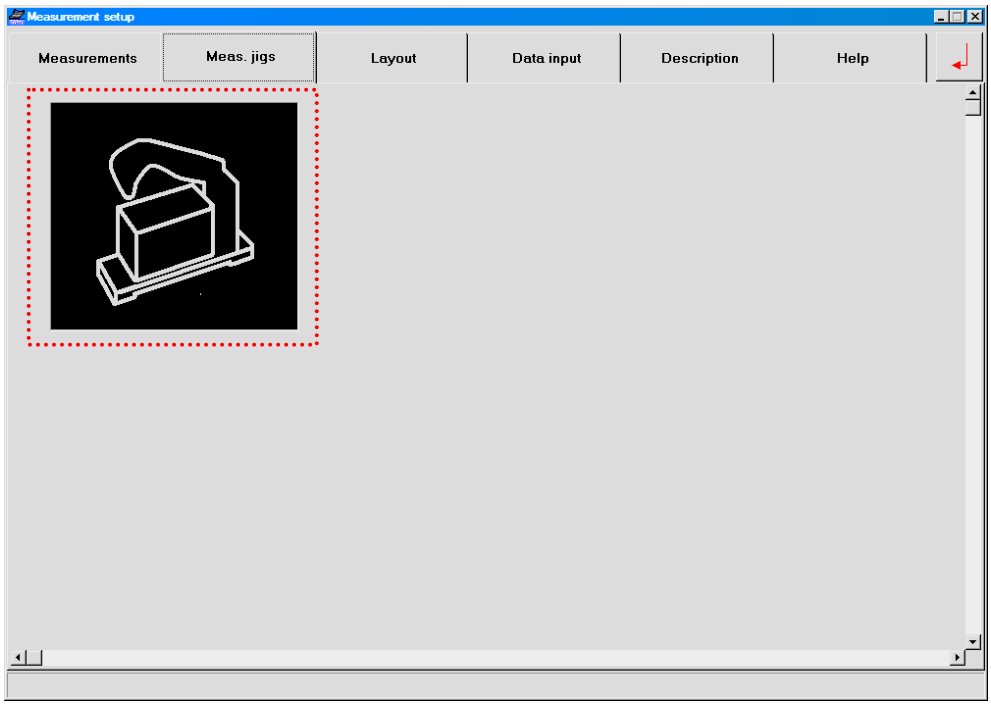
In the register “Setup”, below Measurement Setup the pull down menu can be used to change to “Surfaces” and confirm with [Enter] 

A number of different possibilities are displayed under <**MEASUREMENTS**>



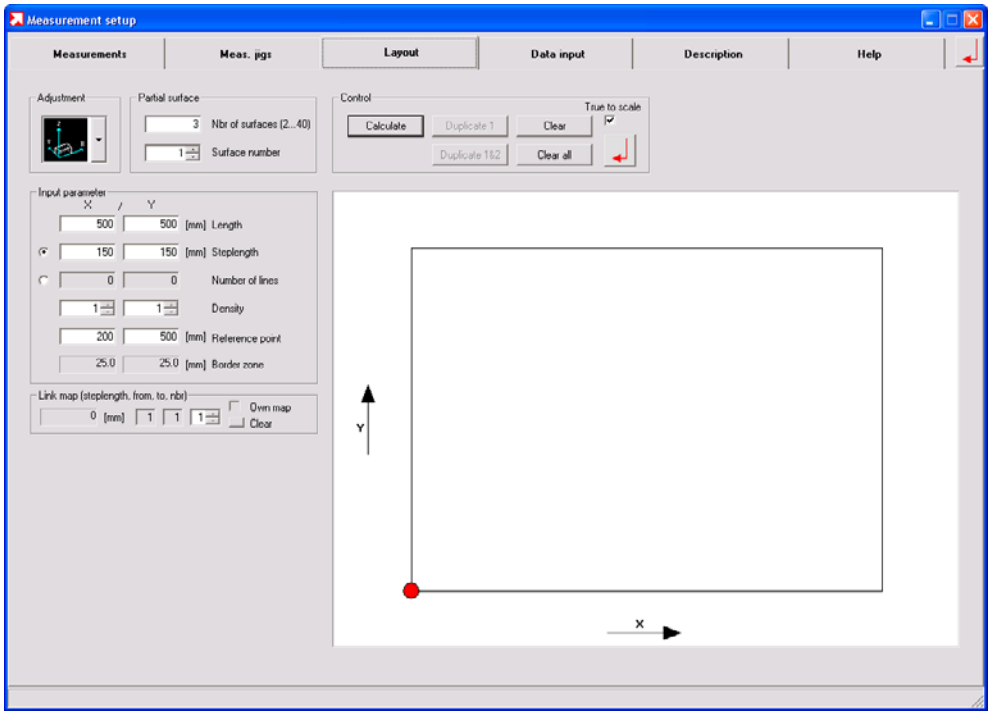
In the example “Surfaces” we choose the type shown top left. It is possible to measure from **2 to maximum 40 surfaces**.

Under <Measuring jigs> only the measuring instrument is available, no additional jigs can be selected.



The selection is done by mouse click (Black background)

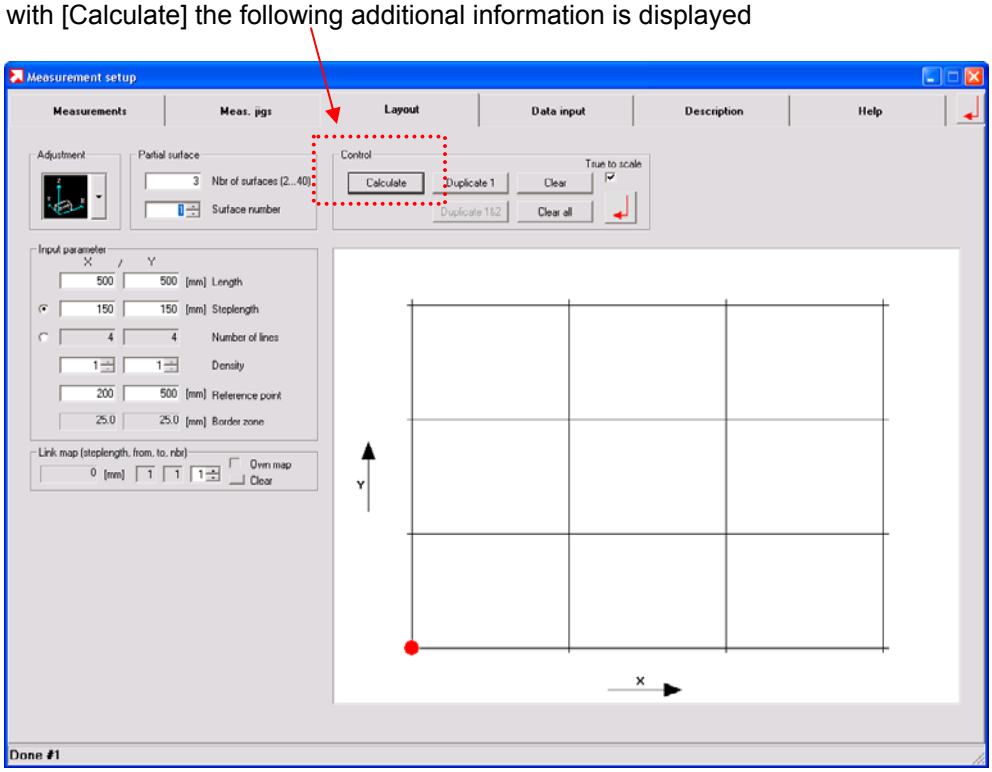
Clicking to the sub register Layout opens the input window for the measurement configuration to enter the dimensions and coordinates of the individual surfaces



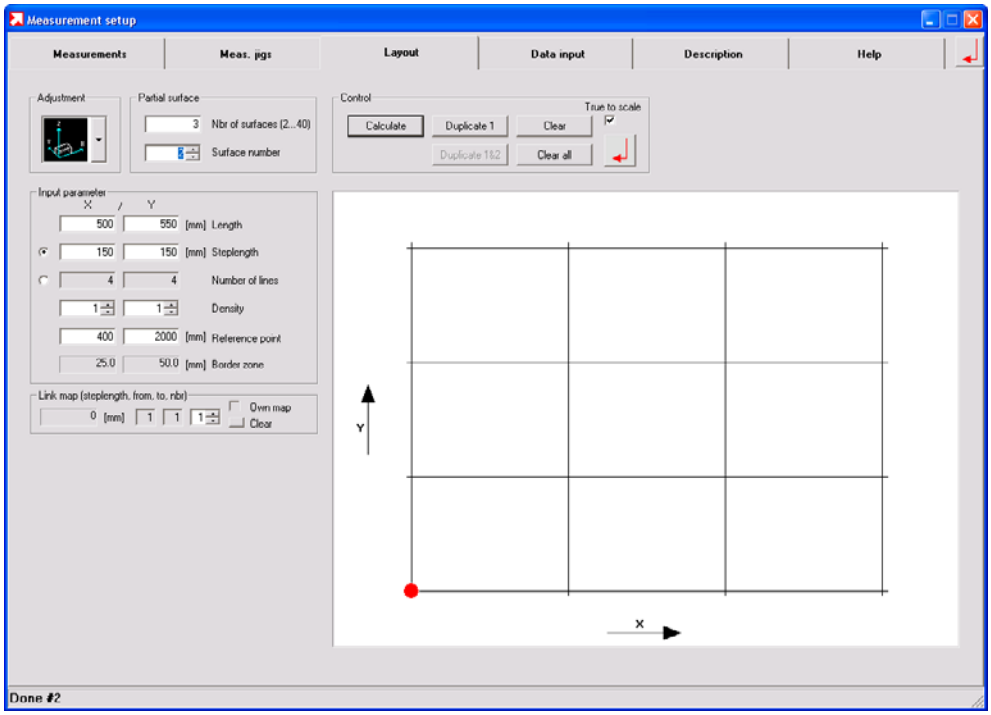
The respective data must now be entered

- Number of partial surfaces 3
- First number to define (Surface number) 1
- Size of surface no. 1 to be measured 500 x 500 mm
- Step length X and Y 150 mm
- Density X and Y 1
- Coordinates of the partial surface1
  - Surface 1: X-direction 200 mm
  - Surface 1: Y-direction 500 mm
- Step length (for all) 150 mm

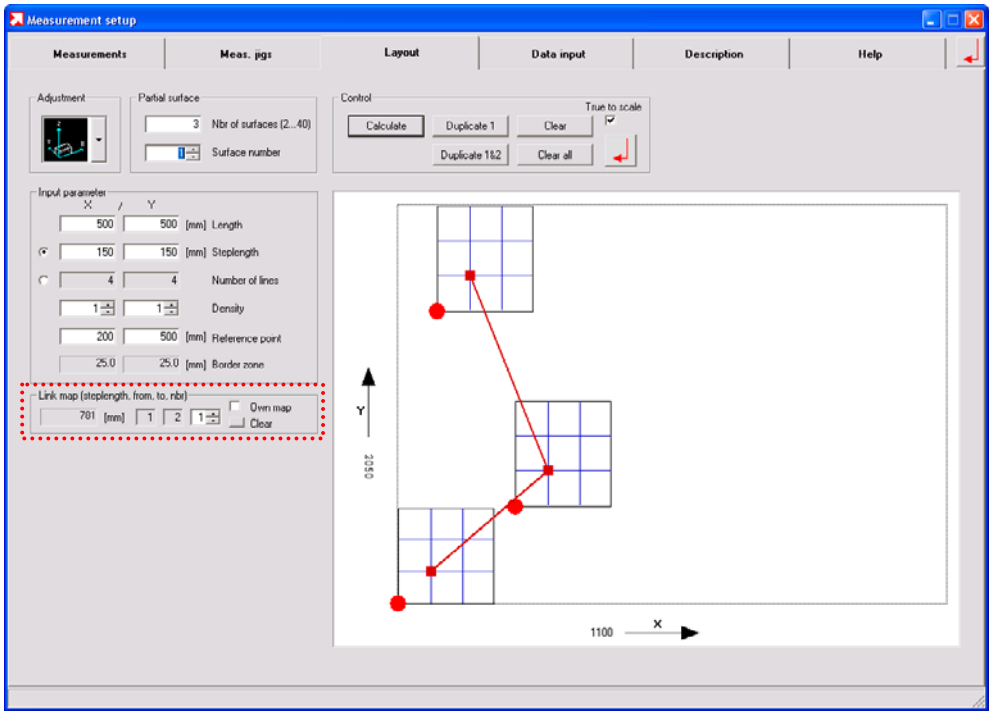
After confirming with [Calculate] the following additional information is displayed



Repeat the procedure for the other two remaining surfaces similarly and activate the data with [Calculate]
After completion confirm with [ENTER]



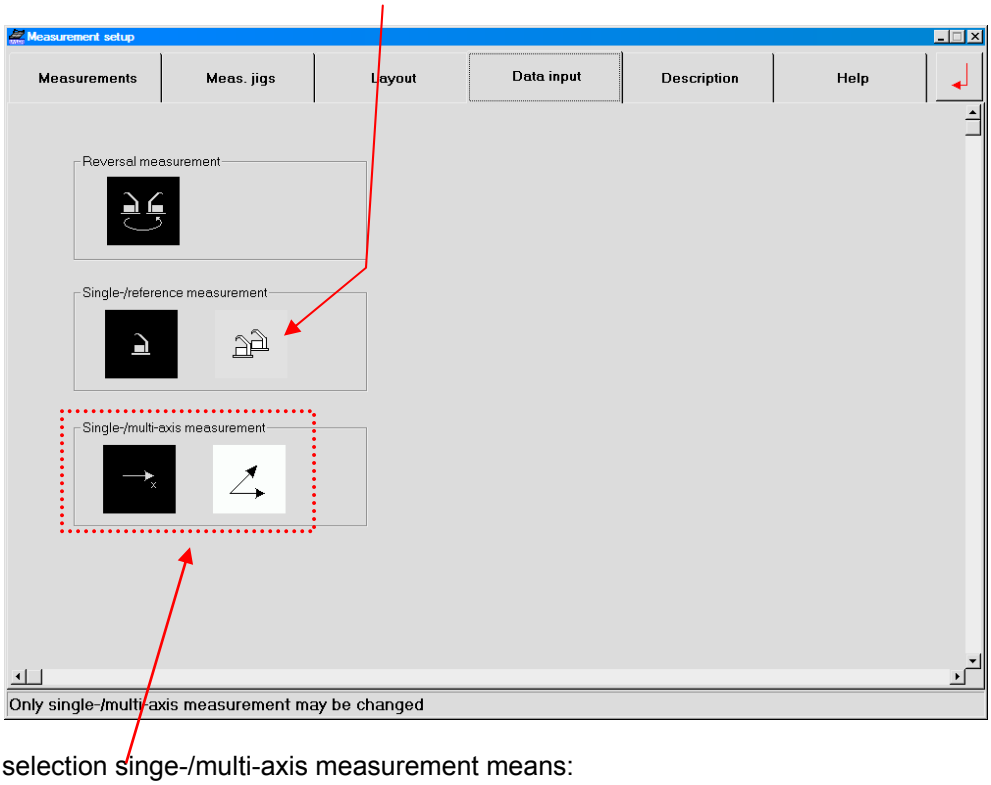
The following display appears after the last confirmation with [ENTER]. The surfaces are displayed in the coordinate system



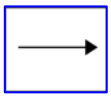
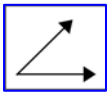
With this module [Link map] it is possible to select the way how the links must be placed

In our example a link is set from surface 1 to surface 2 and from 2 to 3. Other combinations are also possible, e.g. link 2 may be set from surface 1 to surface 3. If you change the setting you have to mark the box “Own map”

We chose “Single measurement”, no reference instrument (Displayed in the status bar is “Only singe-/multi-axis measurement may be changed”

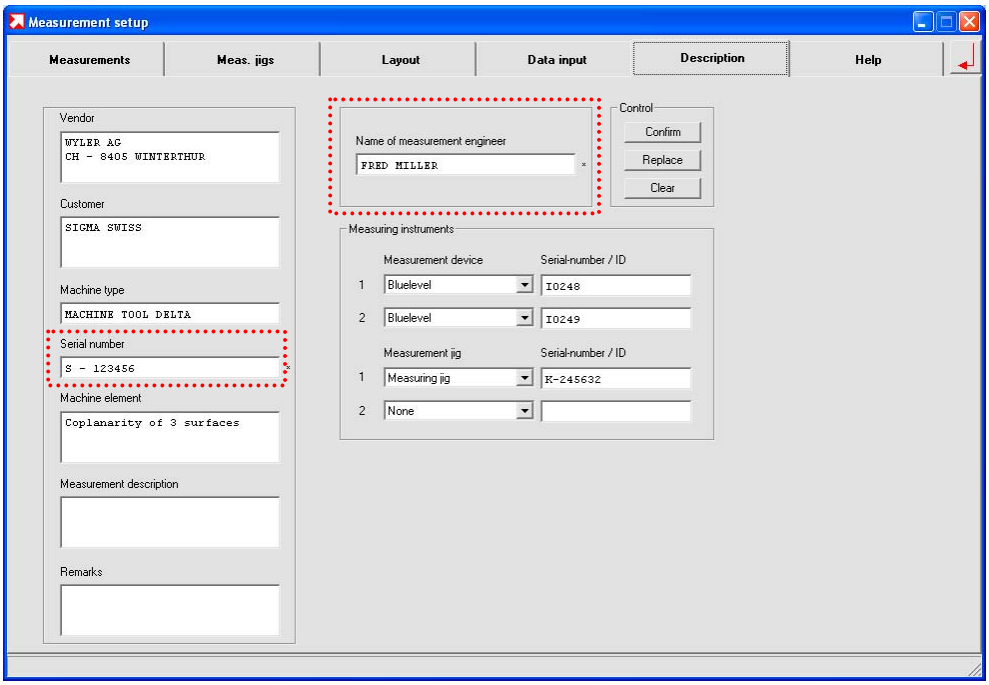


In this case the selection singe-/multi-axis measurement means:

-  measurements (X- and Y-Axis) are done with one instrument with the same base length
-  for the length (X-axis) and the transversal direction (Y-axis) different instruments with different base length are used

The second selection is mainly useful when long and narrow surfaces are to be measured

Next the **Description** must be done



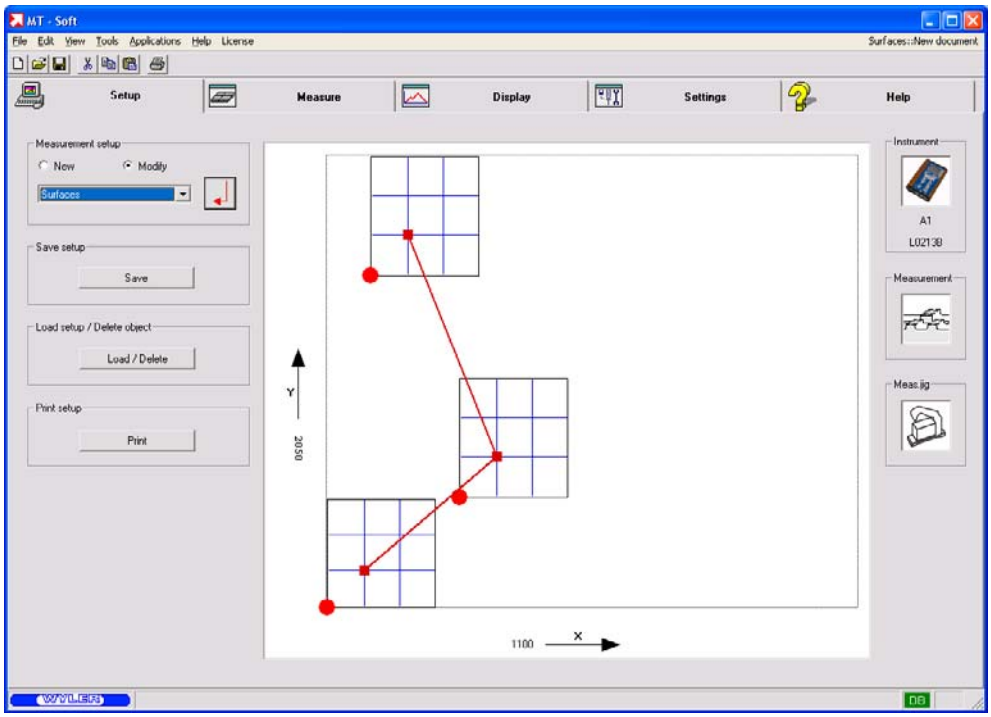
The descriptions is to define exactly the measuring task and the identification of the objects
In this dialogue box all the necessary data for defining the planned measurement can be entered. The **Name of measurement Engineer** and the **Serial number** of the object to be measured are **mandatory**. All the rest of the information is free to fill in.

The text can also be integrated from an existing template by using the <**REPLACE**> button

It is still possible to make changes in the setup registers.

If no changes are required, press the button [confirm]

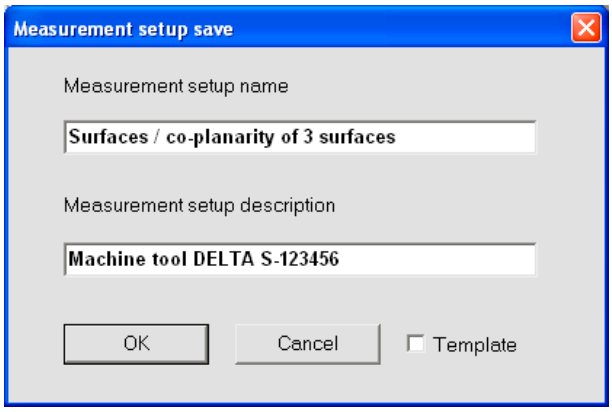
Accept with [ENTER] 



The following information is displayed:

- Object to be measured, in our case "Surfaces / co-planarity of 3 surfaces"
- On the right side of the window
  - o Instrument: The connected instrument respectively Interface
  - o -Measurement Selected measurement
  - o -Meas. JIG Type of JIG specified, (instrument only)

- Under "Save Setup" the button “save” opens a dialogue box. The setup may be saved as **template,** e.g. as:
  - o Measurement setup name: **"Surfaces / co-planarity of 3 surfaces"**
  - o Measurement setup description: **"Machine tool DELTA S-123456"**

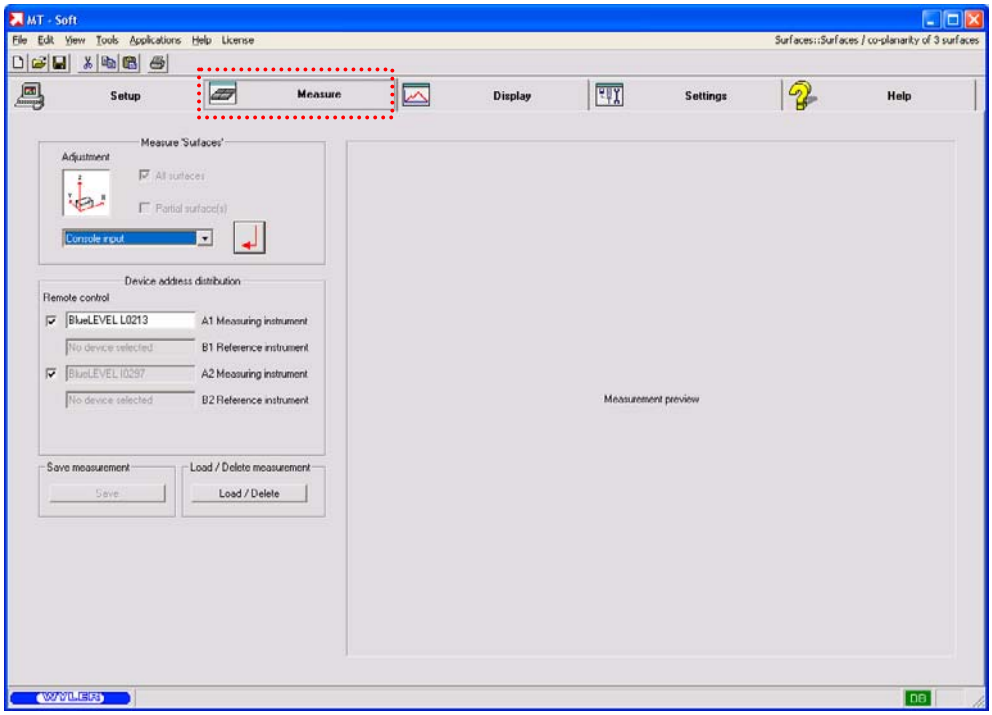


- Under Load Setup / Delete Object the button Load/Delete allows to open an existing setup template or delete an object.

- Using the button “Print Setup” / [Print] allows to print the actual measurement setup template

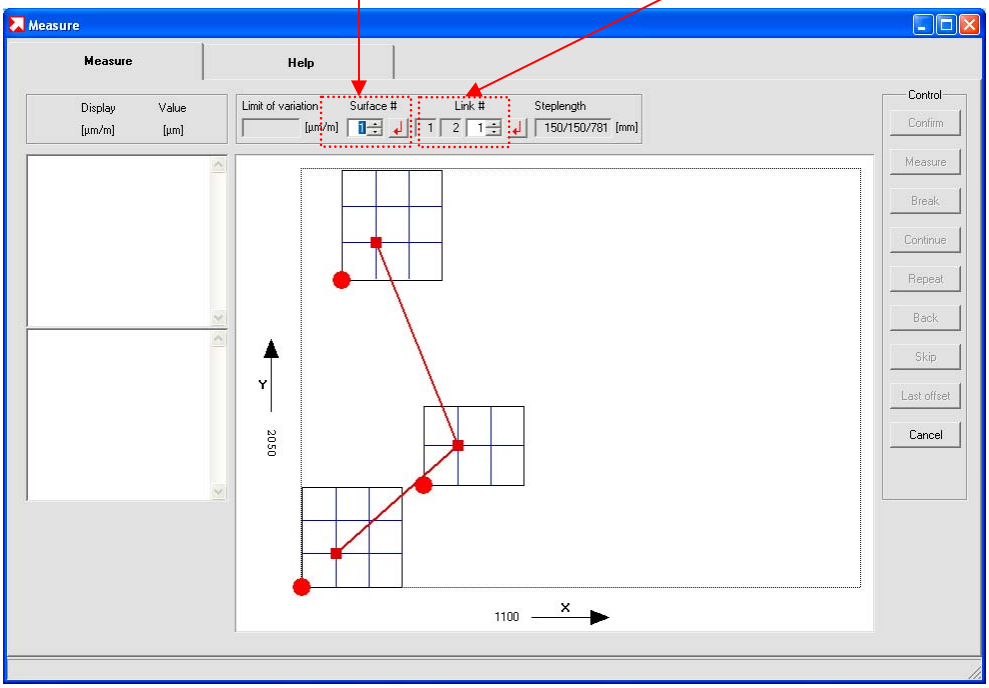
Now the **actual measurement** can be started.
In case the measuring instruments are not defined yet or if you want to change the instruments, you can still do this under "Device address distribution"

For **starting the measurement** the register <**MEASURE**> must be activated



Selection of **Surface** / start measurement with [ENTER]

Selection of **Link** / start measurement with [ENTER]



First Step: Detection of the level difference between the different planes.

Two options are possible.

1. Detection of the level difference by a reversal measurement of the **measuring instrument with a straight edge**.
2. **Manual entry of the level difference,** useful particularly for large distances.

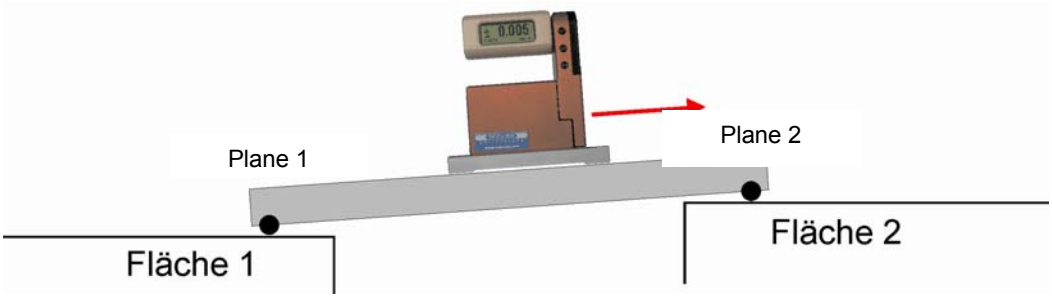
Detection of the level difference by a reversal measurement of the **measuring instrument with a straight edge**

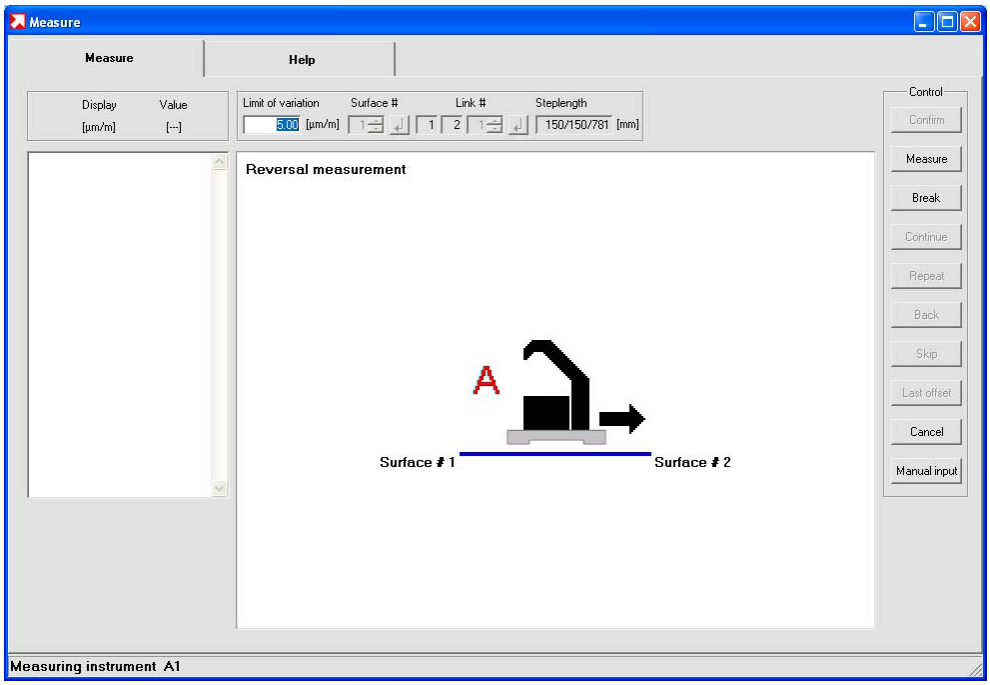
Starting the measurement of the Link 1 (Link 1 = inclination absolute from surface 1 to surface 2 by reversal measurement)

- Selection of the link to be measured e.g. Link 1
- Confirm with [ENTER] 

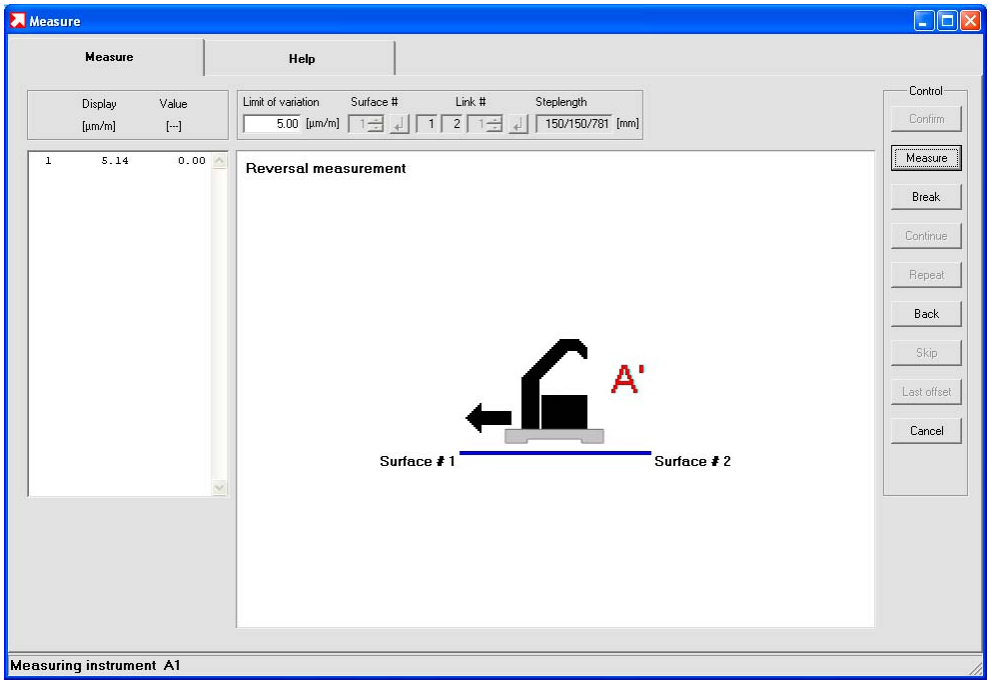
Remarks: The sequence of the measurements of the various elements like surfaces and links is not important. The measured elements are marked **green** after the end of the measurement.

In order to determinate the inclination between the two surfaces 1 and 2 it is best to use a straight edge which is set so that the red marked points are matched. The instrument is now placed on top of the straight edge and the first measurement of the reversal measurement is performed.



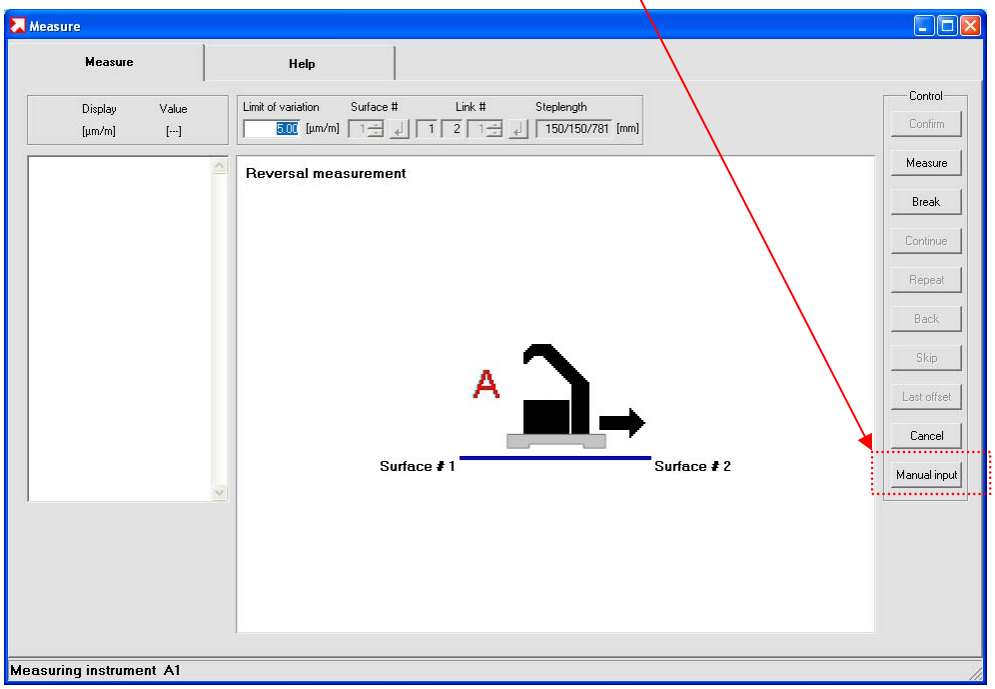


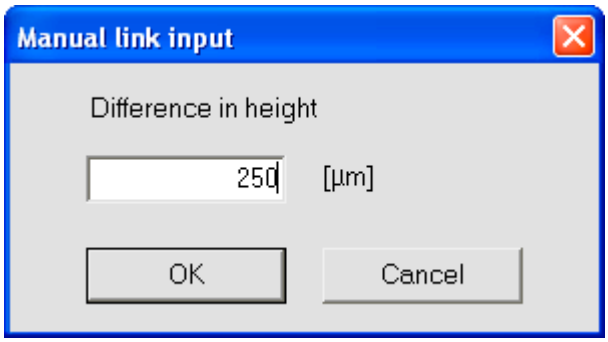
IMPORTANT:
For this reversal measurement the **measuring instrument and the straight edge** (measuring JIG) **must be reverted together** to eliminate possible parallelism errors of the straight edge.



Manual entry of the level difference between surface 2 and surface 3
(Link 2 = Inclination absolute from surface 2 to surface 3)

- Selection of the Link to be measured, e.g. Link 2
- Confirm with the [ENTER] button



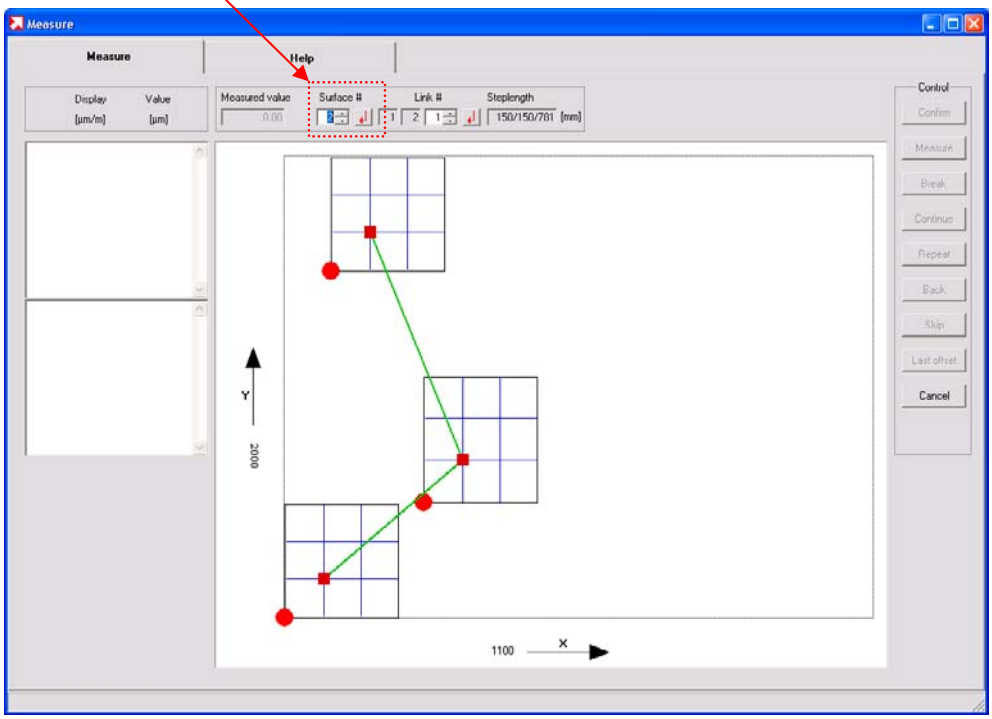


Entry of the level difference between surface 2 and surface 3 in [µm]. Confirm with [OK]

Remarks: The sequence of the measurements of the various elements like surfaces and links is not important. The measured elements are marked **green** after the end of the measurement.

Second step: Measurement of the three planes respectively surfaces

Select now plane 1 and confirm this selection with [Enter]

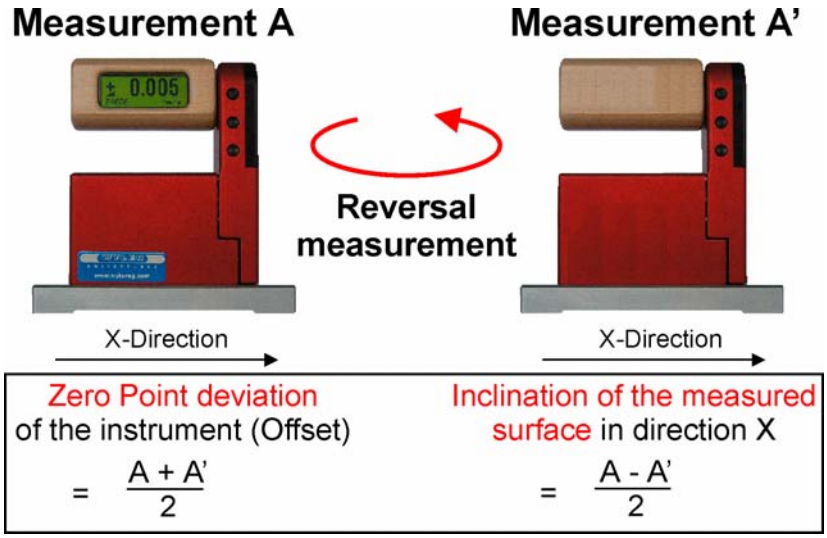


Now the three surfaces / planes are measured.

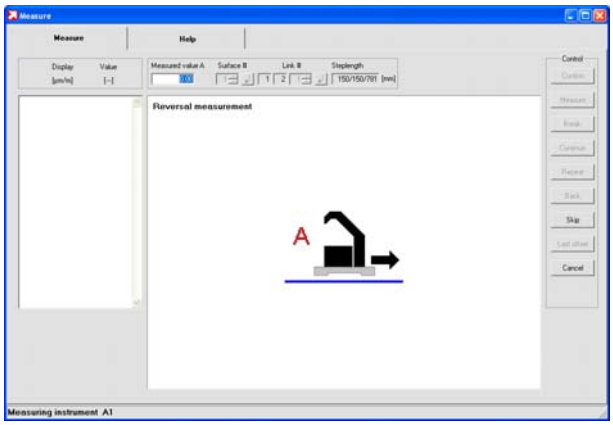
As the inclinations and the position of the surfaces / planes are measured in absolute mode, again a reversal measurement must be performed before starting. In this case the reversal measurement serves for determining the Zero offset and all the subsequent measurements will be performed in ABSOLUTE mode.

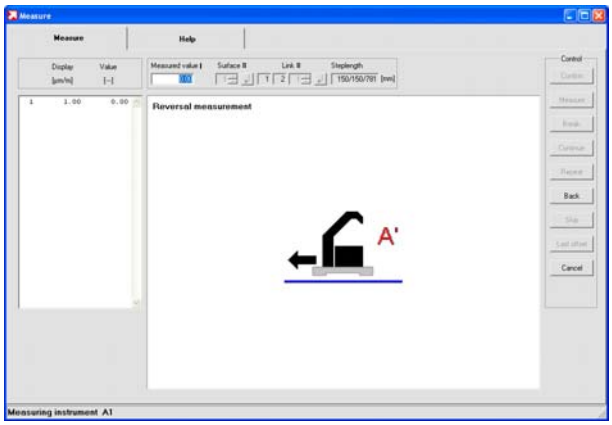
For determining the inclination absolute both values A and A’ are now subtracted and the result divided by 2. See graphic below)

Remarks:
The zero point deviation detected is not displayed in the instrument’s display. The zero point deviation is only considered when the angle is converted to the inclination per step length



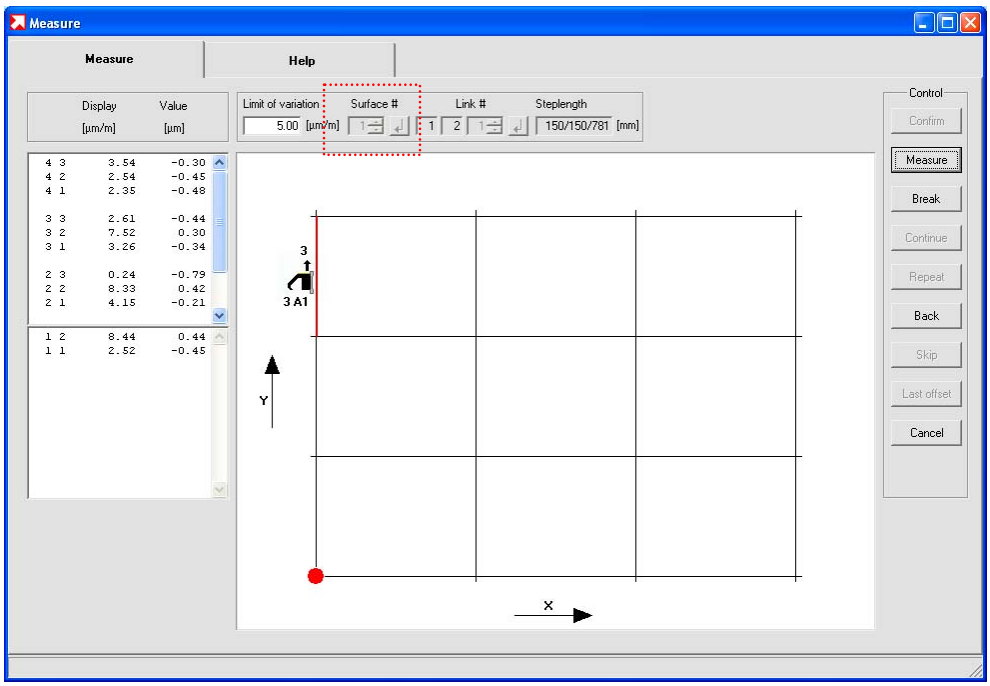
The reversal measurement must finally be confirmed with [Confirm]





Now you can start with the measurement of surface / plane 1.

The measuring instrument must be positioned as shown in the graph. First the surface / plane is measured in X-direction and then in Y-direction.

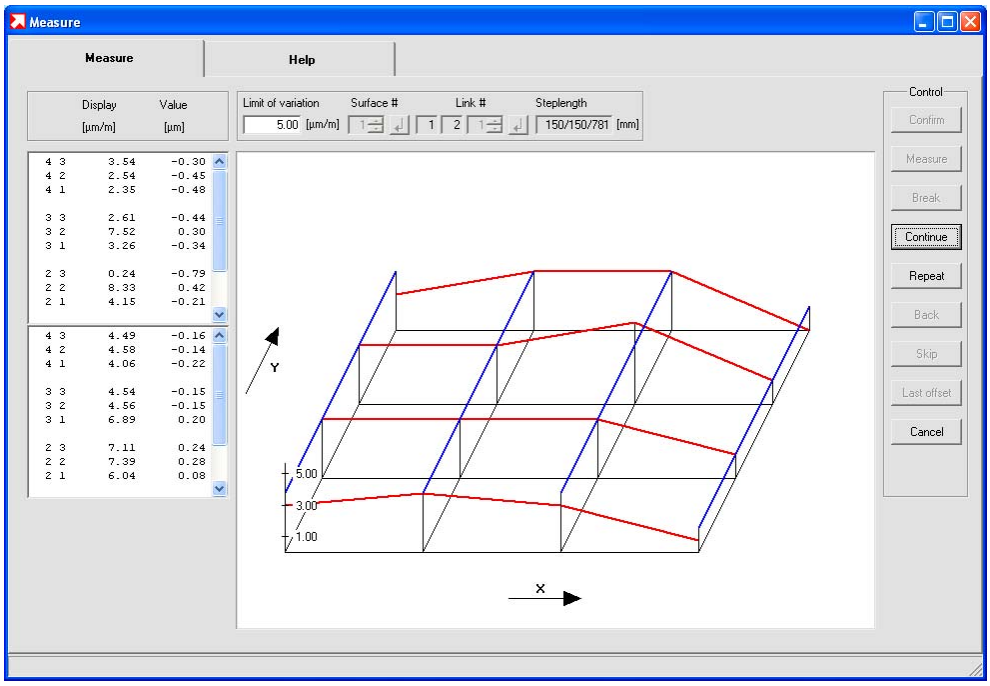


Information between the measurements.
After the data is collected the measured value is displayed on the screen in large figures and the following options are available:

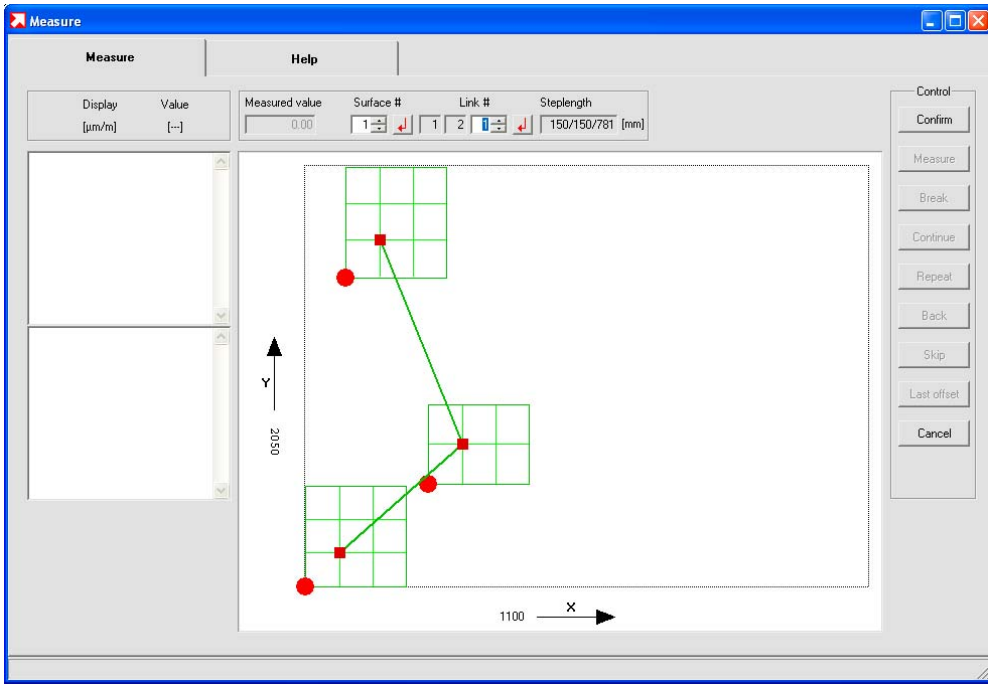
- Continue measurement [Measure]
- Repeat measurement [Repeat]
- Cancel measurement [Cancel]

On the left hand side of the screen the measuring values in X and Y direction are displayed numerically. In the left column the measuring value shown on the instrument is displayed. In the right column the inclination in reference to the step length and under consideration of the Zero offset of the measuring instrument is displayed. The Zero offset has been determined before with a reversal measurement.

After completing the measurement the flatness and the position of the surface / plane in space are displayed.

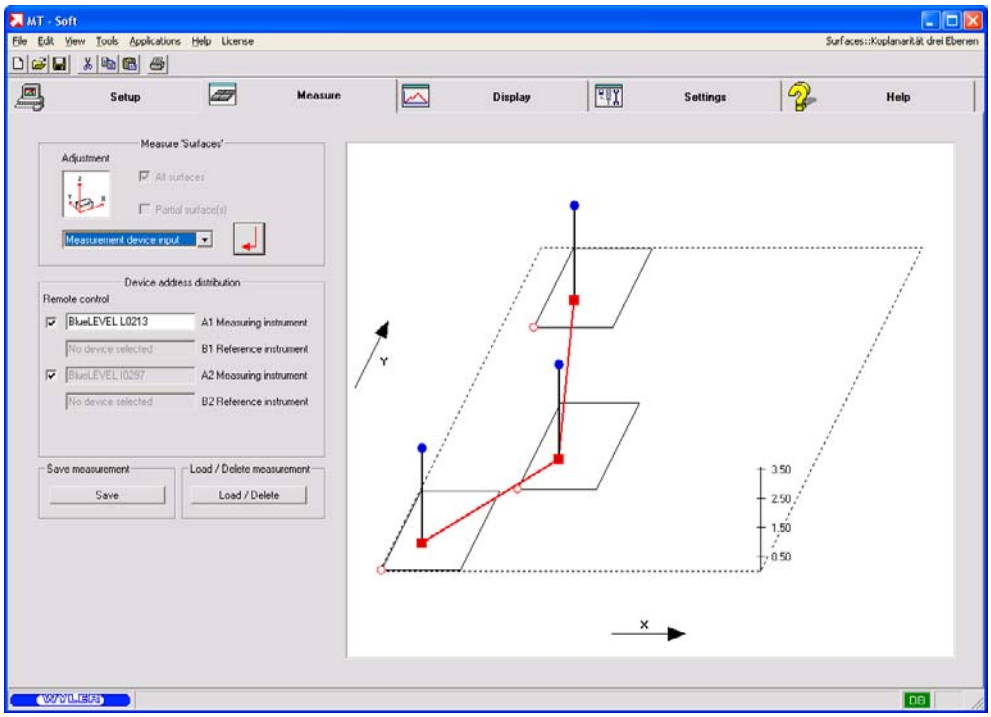


This measurement must now be repeated also for all the other surfaces / planes.

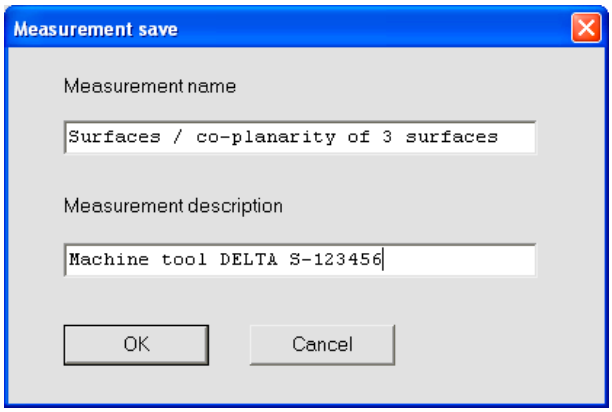


After completion of the last measurement the above graph will appear. The elements measured are marked in **green**. If all elements have been measured the measurement can be terminated with [Confirm].

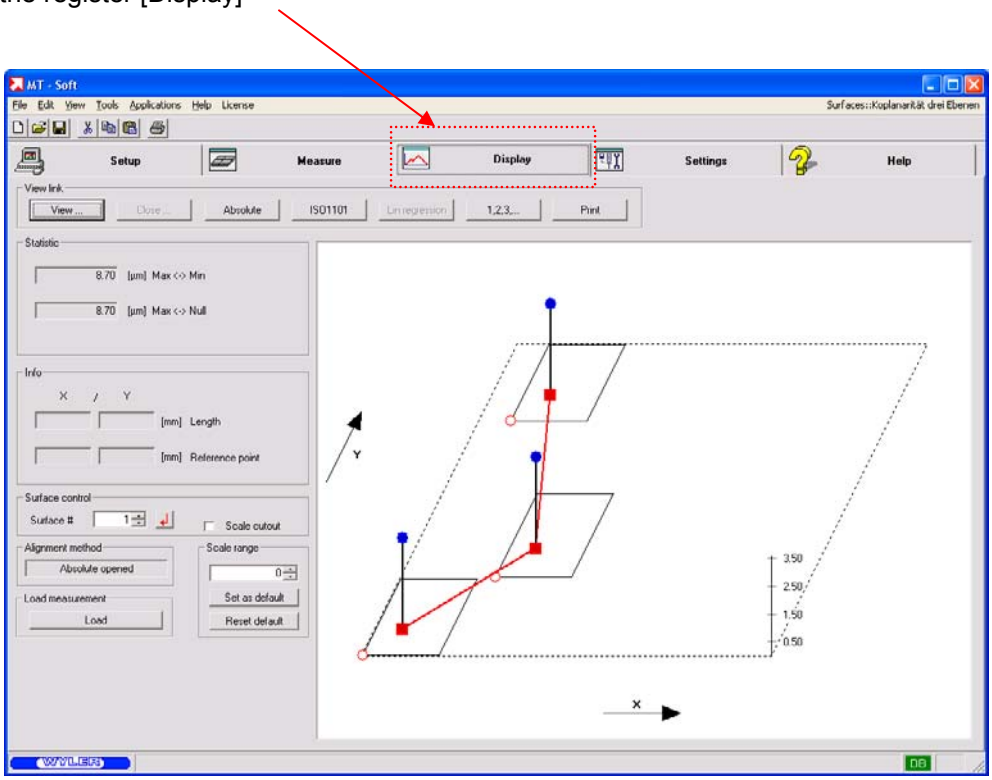
The following graph appears:



To avoid loosing the measurement, it is recommended to save the data.

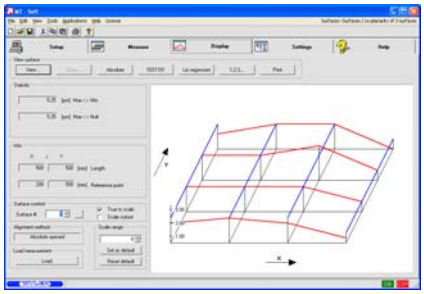


Change now to the register [Display]

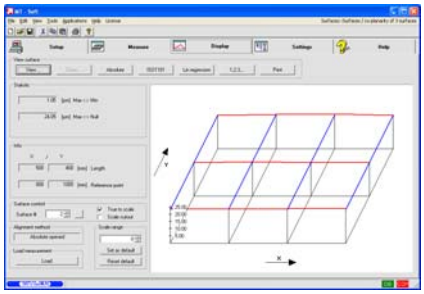


Using the button [Display] the measurement can by analysed under various aspects.

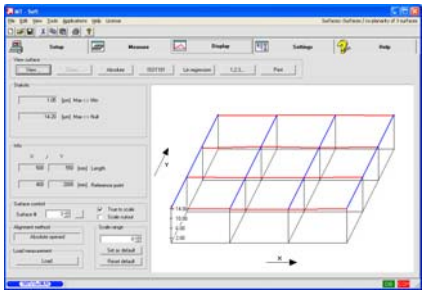
A first simple analysis is possible already. The points over the surfaces show the relative position in space. Using the [Display] button, apart from the position in space each individual plane can be viewed.



Surface / plane 1
Position in space and shape



Surface / plane 2
Position in space and shape

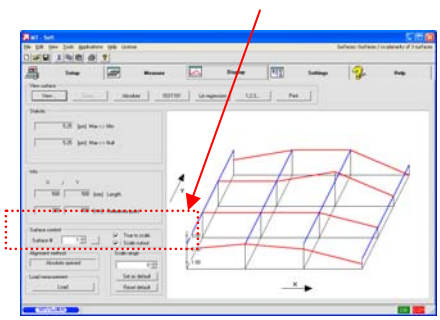


Surface / plane 3
Position in space and shape

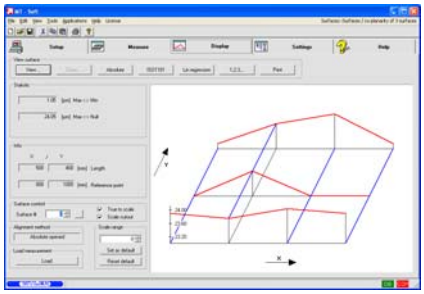
Furthermore the surfaces can be aligned according to various alignment methods:

- Absolute
- ISO 1001
- Linear Regression

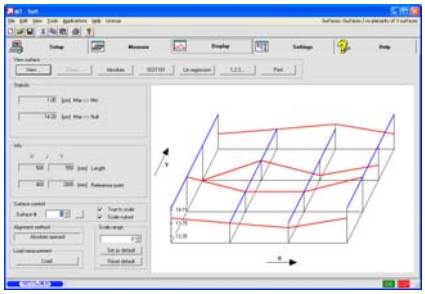
Using the selection "Surface Control" the lowest point of each individual plane can be set to ZERO, in order to allow a better judgment of the shape.



Surface / plane 1



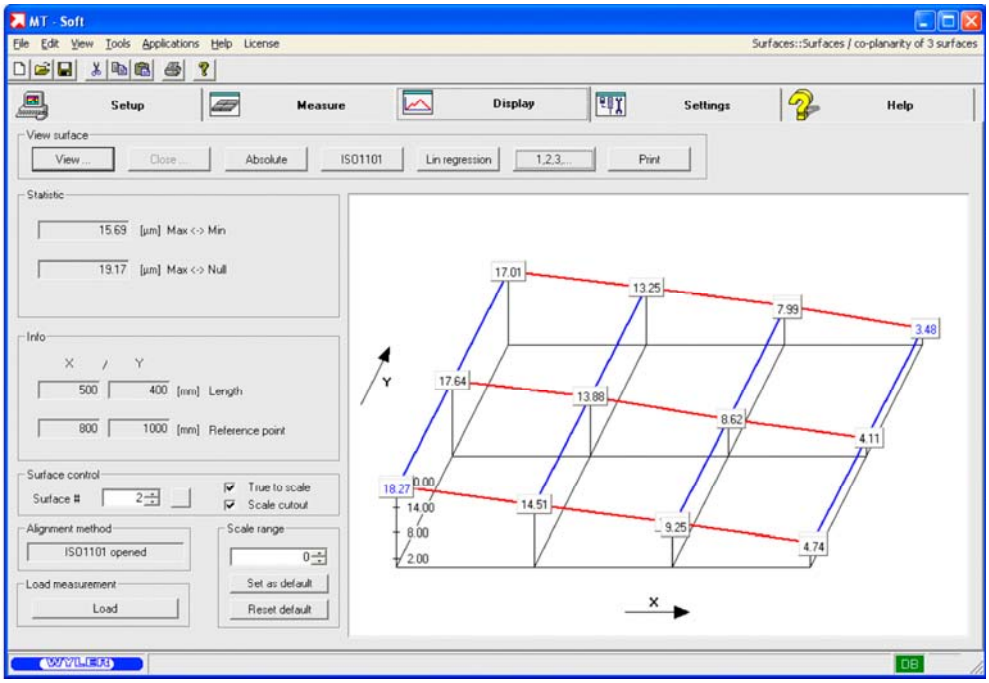
Surface / plane 2



Surface / plane 3

By clicking on the button [Display] the overview of all surfaces/planes as well as each individual surface/plane can be displayed and tagged with coordinates (Z-values).

Under "Statistics" the lowest and the highest point of each surface can be seen. These may change depending on the alignment method selected.



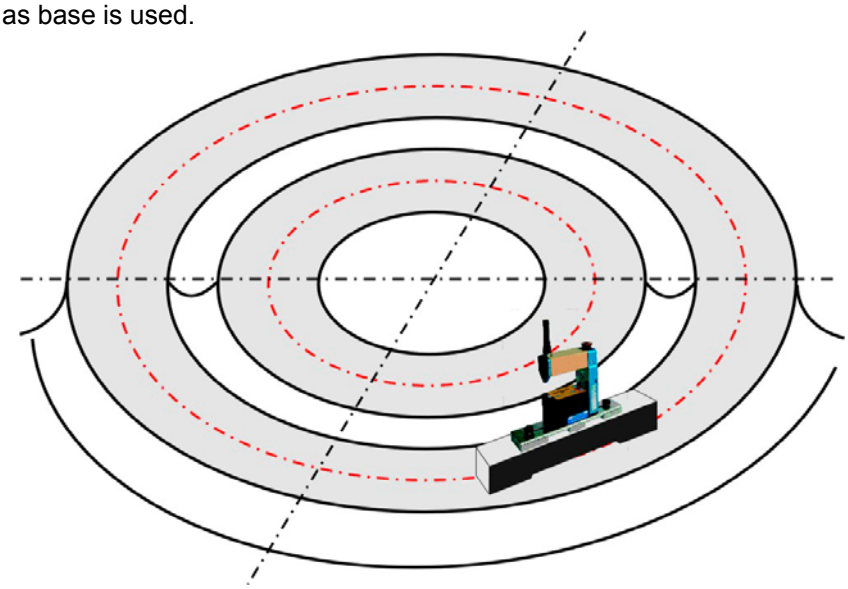
Under "Statistics" the following information is visible:

- Max <-> Min: Difference from the lowest to the highest point of the surface, varying depending on the alignment method
- Max <-> Null: Difference from the Zero point to the highest point of the surface, varying depending on the alignment method
- Alignment method: as selected
- Length: Length and width of the surface
- Reference point: Reference point of the surface in the coordinate system

5.5 CIRCULAR OBJECTS

Example
The position and the flatness of a round table with two concentrically circular lines on a machine tool must be measured. The measurement is to be done with electronic inclination measuring instruments MINILEVEL or LEVELTRONIC.

Because of the large dimensions of the circles and the resulting step length an instrument with a screwed on granite straight edge as base is used.

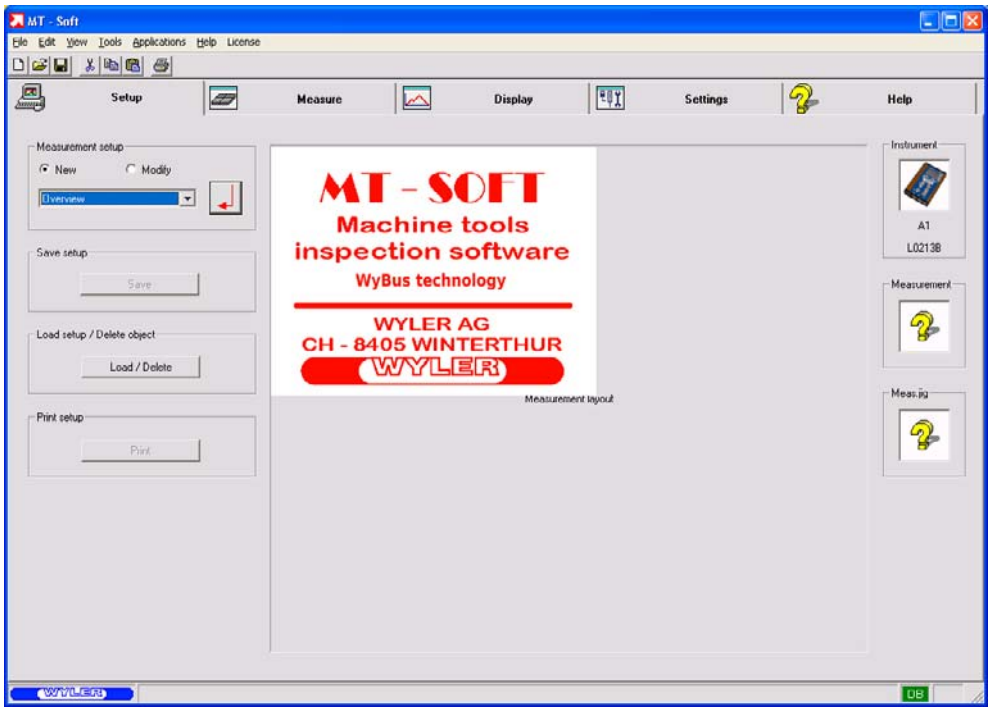


Before starting the measurement the definition of the axis coordination and the directions of the movements must be defined (Work piece coordination).

In our example the X, Y, Z definitions are as follows, see picture above:

Guide way length direction: left to right +X
Spindle vertical movement: bottom to top +Z
Spindle carriage horizontal movement: near to far +Y

After starting MT-Soft the following picture appears:



The measurement example

- **Type of measurement: Absolute position and flatness of a round table**
- **Work piece coordinates**
  - Centre line circle X-direction 1500mm
  - Centre line circle Y-direction 950mm

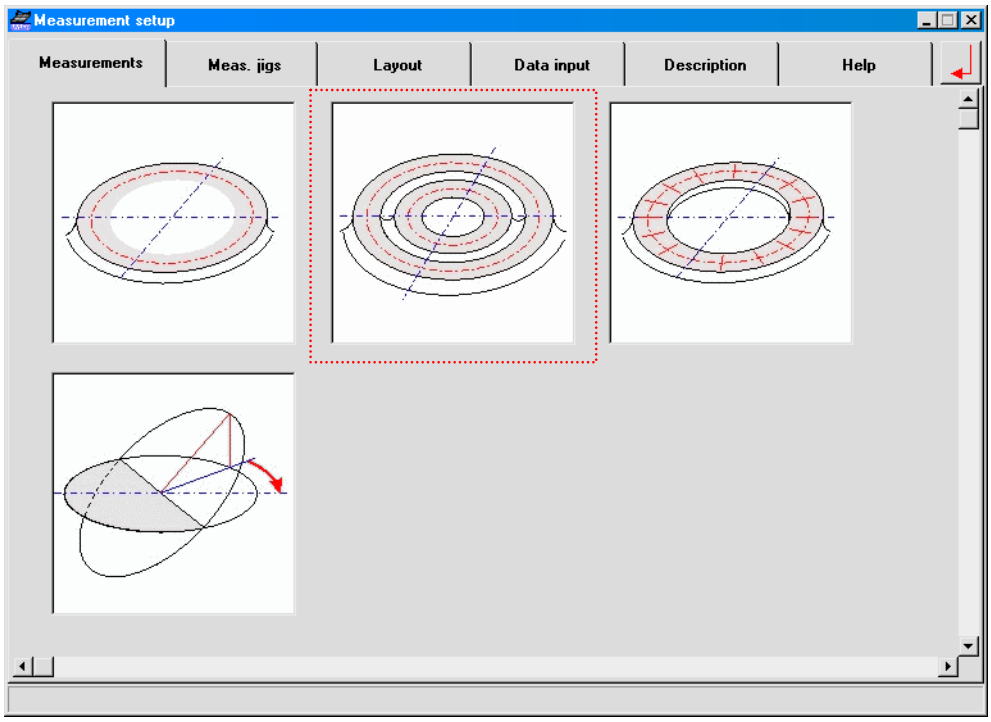
  - Radius outer circle 442 mm
  - Radius inner circle 398 mm

  - Number of steps on a semi-circle 10

- **Measuring set-up**
  - During the measurement of a circular element the direction of the measuring instrument is continuously changing. Therefore this measuring must imperatively be done in the absolute mode. This means that the error of the Zero point of the instrument must be determined prior to the measurement. The fact that the measurement is done in the absolute mode enables an analysis in relation to a vertical guide way.
  - Measurement with one instrument only, i.e. both circles are measured with one and the same measuring instrument.

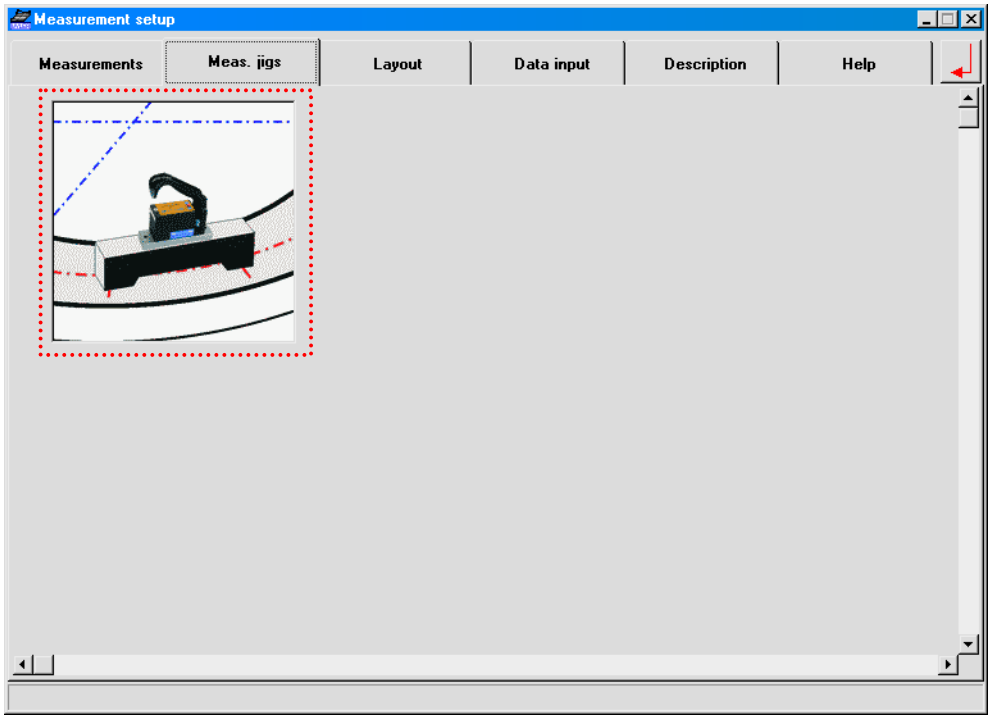
In the register Setup, below <**MEASUREMENT SETUP**> the pull down menu can be used to change to <**CIRCLES**> and confirm with [Enter]

A number of different possibilities for the type of Circles are displayed under <**MEASUREMENT SETUP**>



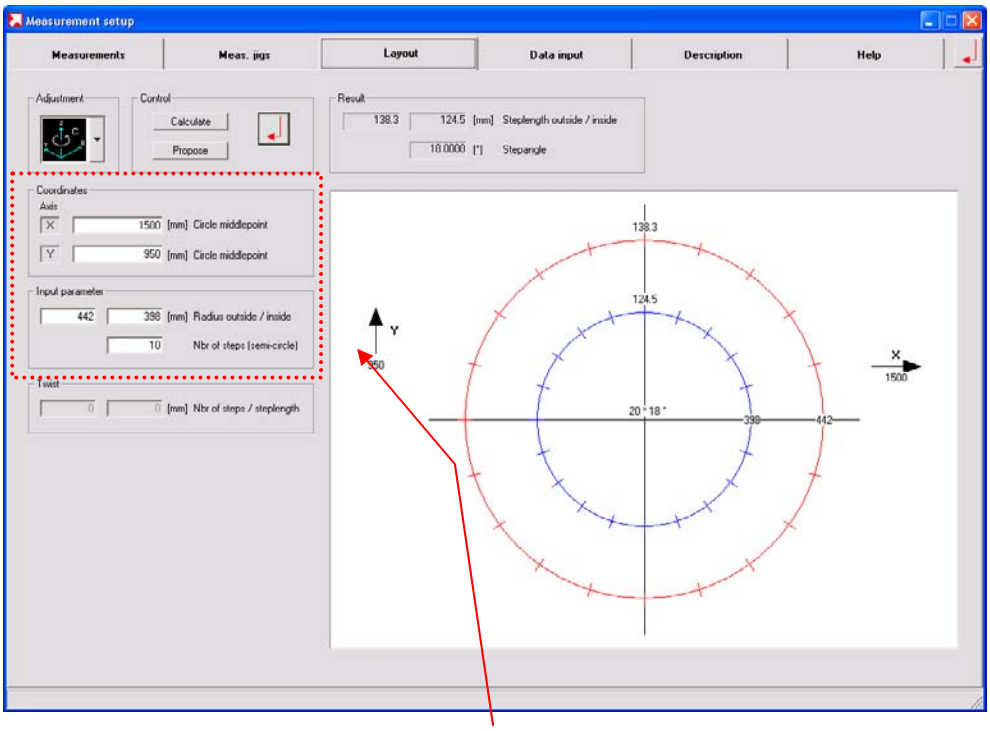
For our example we choose the top centre picture (Measurement with two circles)

Selecting <**MEAS. JIGS**> only the measuring instrument with a screw on base is displayed without additional JIGs



The selection must be marked

Change to the sub register Layout



Next the coordinates must be entered.

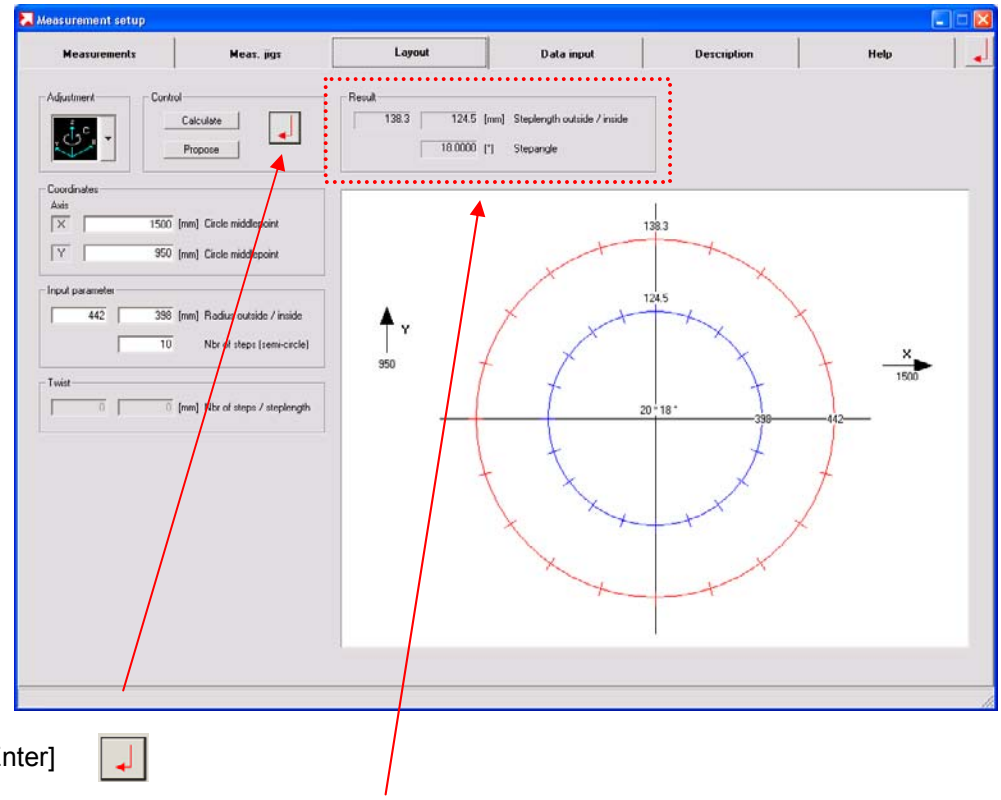
- Centre line circle X-direction 1500mm
- Centre line circle Y-direction 950mm

- Radius outer circle 450 mm
- Radius inner circle 330 mm

- Number of steps on a semi-circle 10

If the number of steps, respectively the step length is not known, press [Propose] and select one of the variants proposed by double-clicking.

Afterwards confirm the entries with [Calculate]. On the monitor the measuring object is displayed. This must be checked before further actions.



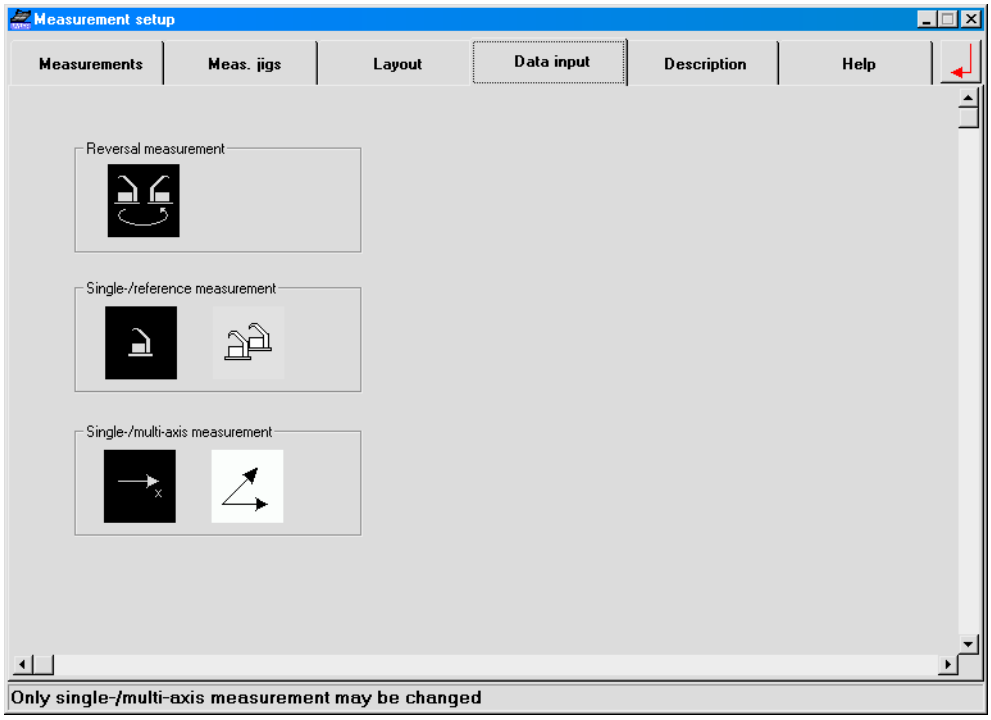
Confirm with [Enter]

In the field “Result” the computed step length of the inner and outer circles are displayed.

- Step length outer circle 138.3 mm
- Step length inner circle 124.5 mm
- Step angle 18°

Change to <**DATA INPUT**>

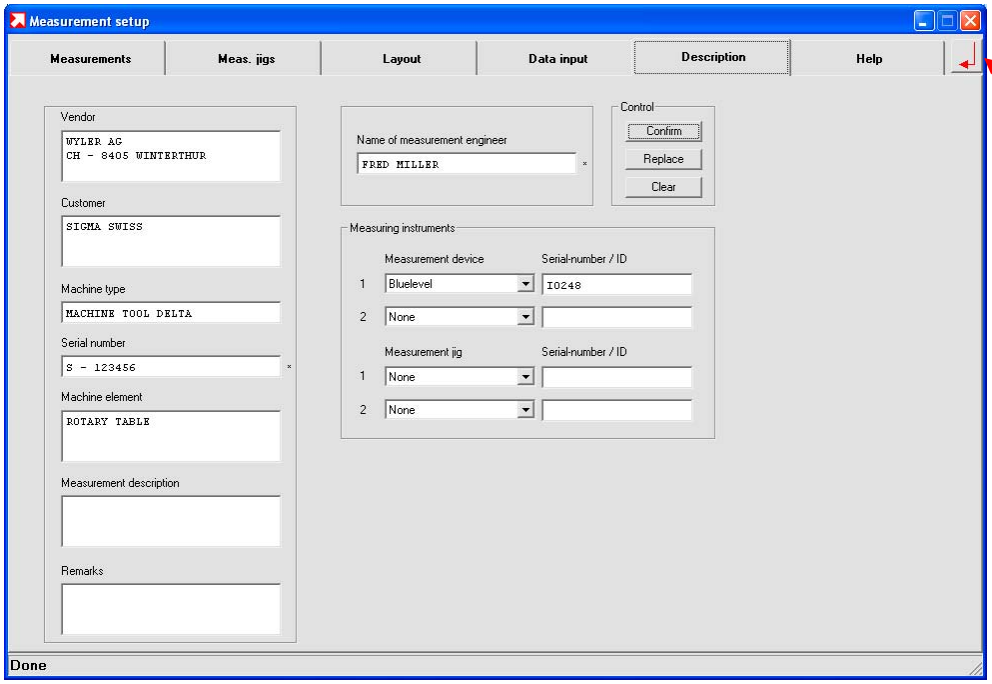
No data input is required because in this specific layout the setup is obvious.



Pre-fixed parameters are:

- Reversal measurement,
  Prior to starting the measurement the Zero offset of the measuring instrument must be determined.
  No option as the direction of the measuring instrument changes during the measurement.
  Measurement with one instrument only.
  Differential measurement in the absolute mode is not possible, No option.
- Single Axis measurement.
  Only one single measuring instrument is used. The selection <X-Y> is here used without actually being related tot he two axes X and Y, if 2 circles ore a circle with twist two different instruments are used. (Changing the instruments between the elements is allowed.)

Next change to <**DESCRIPTION**> and enter the required information,
such as Vendor, Customer; Machine element, Name of measurement Engineer and the Serial number



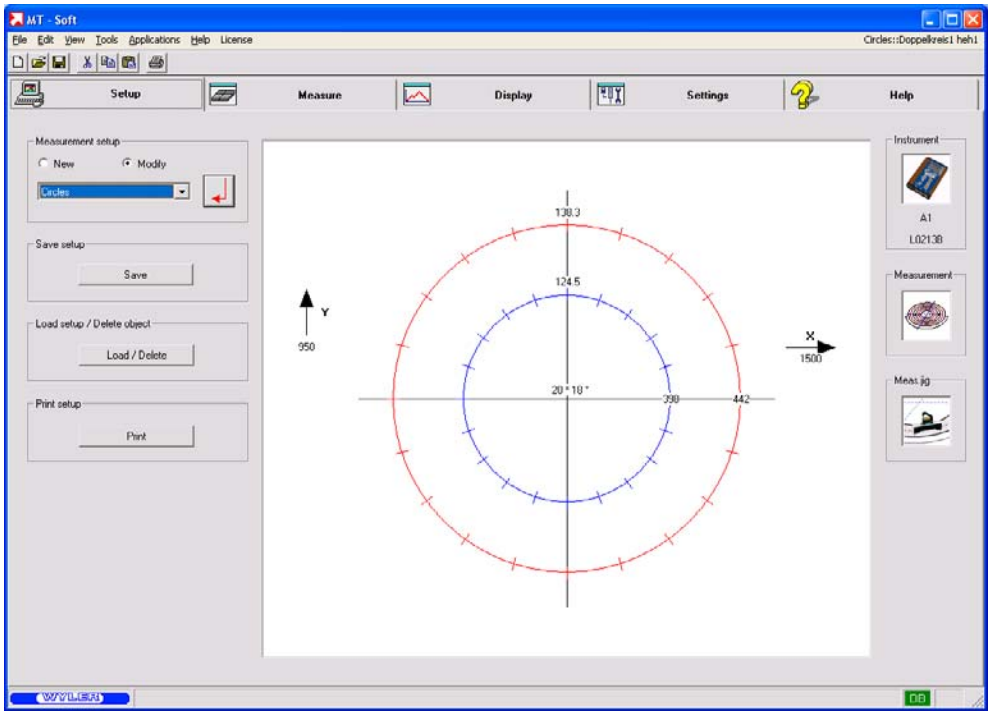
The description is to define exactly the measuring task and the identification of the objects
In this dialogue box all the necessary data for defining the planned measurement can be entered.
The **Name of measurement Engineer** and the **Serial number** of the object to be measured are **mandatory**. All the rest of the information is free to fill in.

The text can also be integrated from an existing template by using the [Replace] button

It is still possible to make changes in the setup registers.

If not required press the button [confirm]

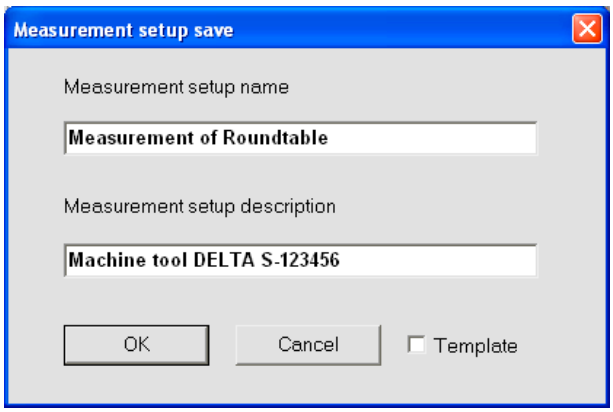
Now the actual measurement can be started. When all the data is correctly filled in press the [Enter] button



The following information is displayed:

- Object to be measured, in our case "Circles"
- On the right side of the window
  - Instrument: The connected instrument respectively Interface
  - Measurement Type of Circles
  - Meas. JIG Type of JIG specified, in our case Measuring instrument with granite base

- Under "Save Setup" the button “save” opens a dialogue box. The setup may be saved as **template**, e.g. as:
  - Measurement setup name: **"Measurement of Roundtable"**
  - Measurement setup description: **"Machine tool DELTA S-123456"**

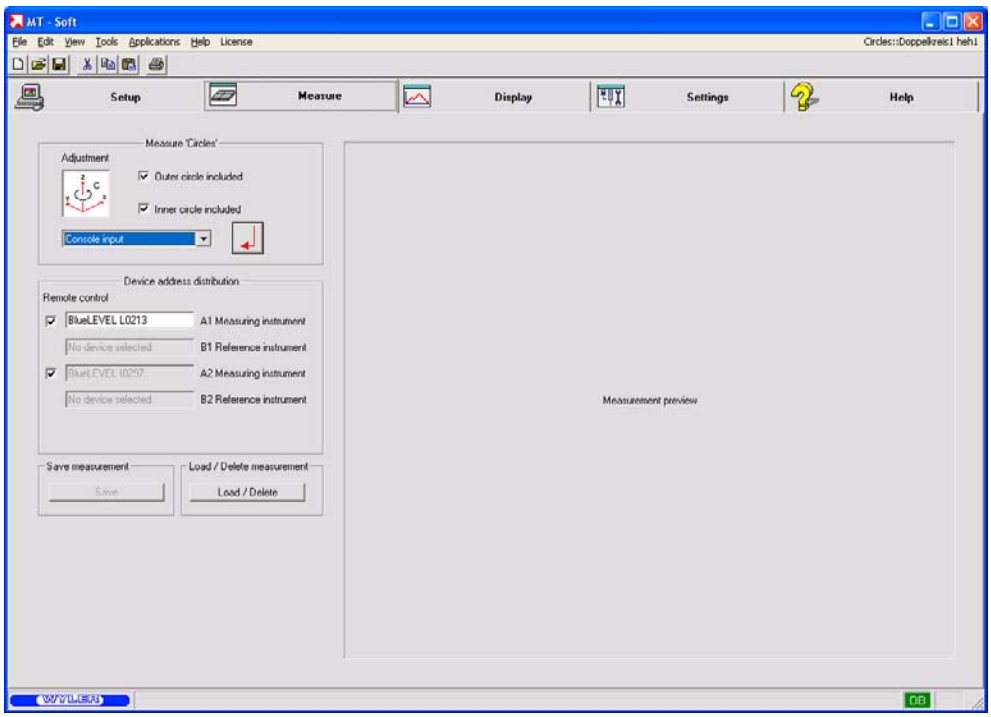


- Under "Load Setup / Delete Object" the button [Load/Delete] allows to open an existing setup template or delete an object.

- Using the button [Print] allows to print the actual measurement setup template

For **starting the measurement** the register <**MEASURE**> must be activated.

In case the measuring instruments are not defined yet or if you want to change the instruments, you can still do this under "Device address distribution"



Here the following options are available:

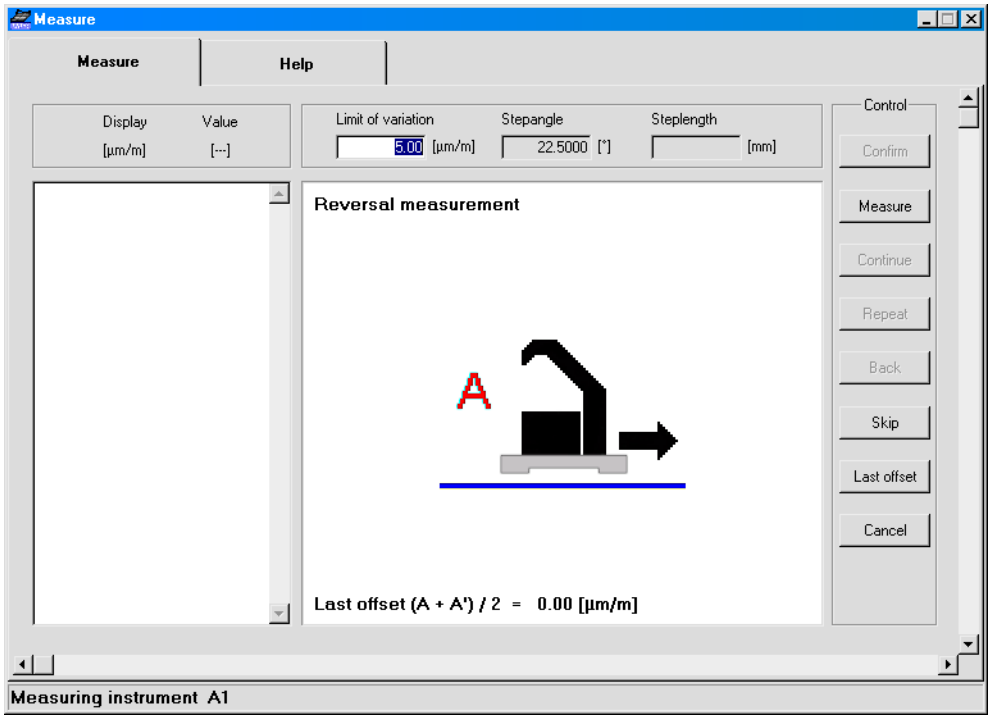
- In the field "Measure Circles" you can choose the Input device, either the transfer of measuring values directly from the measuring instrument / interface or "manual input" via Console Input

- In the field "Measure circles" it can further be defined whether a complete measurement, i.e. inner and outer circle in one measurement will be performed, or whether each circle will be measured individually.
  Active boxes = perform measurement.

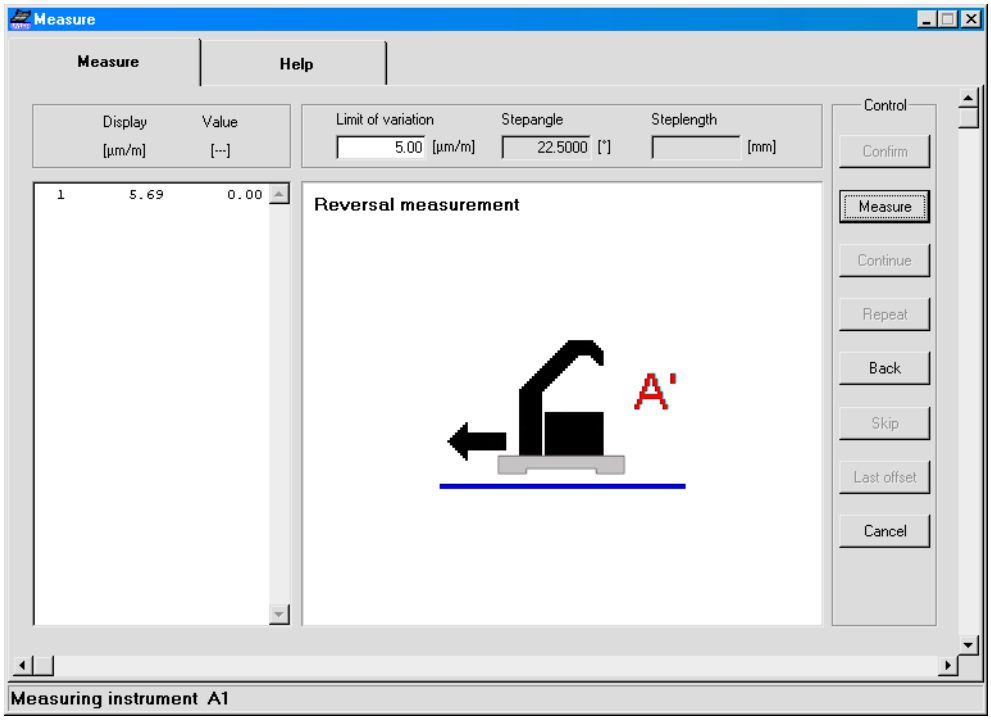
In our example we activate both boxes for a complete measurement, we also choose “Measurement Device Input” and confirm with [Enter]

In a first step the reversal measurement as described before will be performed.

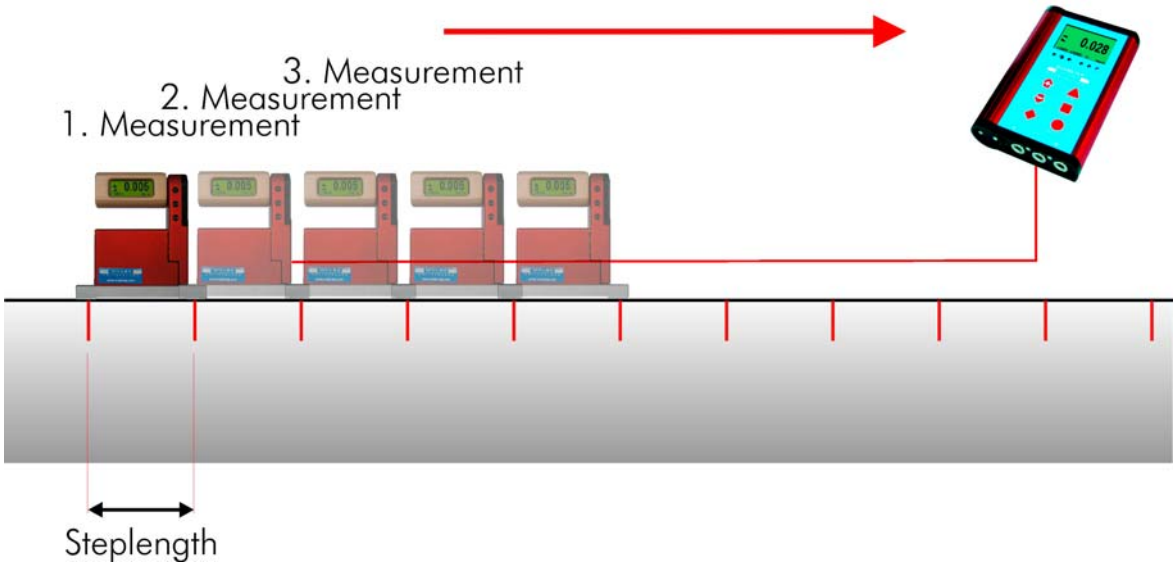
To avoid measuring errors the **reversal measurement** should best be done on a horizontally adjusted surface with minimum flatness error. Ideally for collecting the first value the first setting position of the instrument should be marked on the plate. For collecting the second value the instrument must be turned by gliding 180° without lifting from the plate and properly aligned on the same spot.

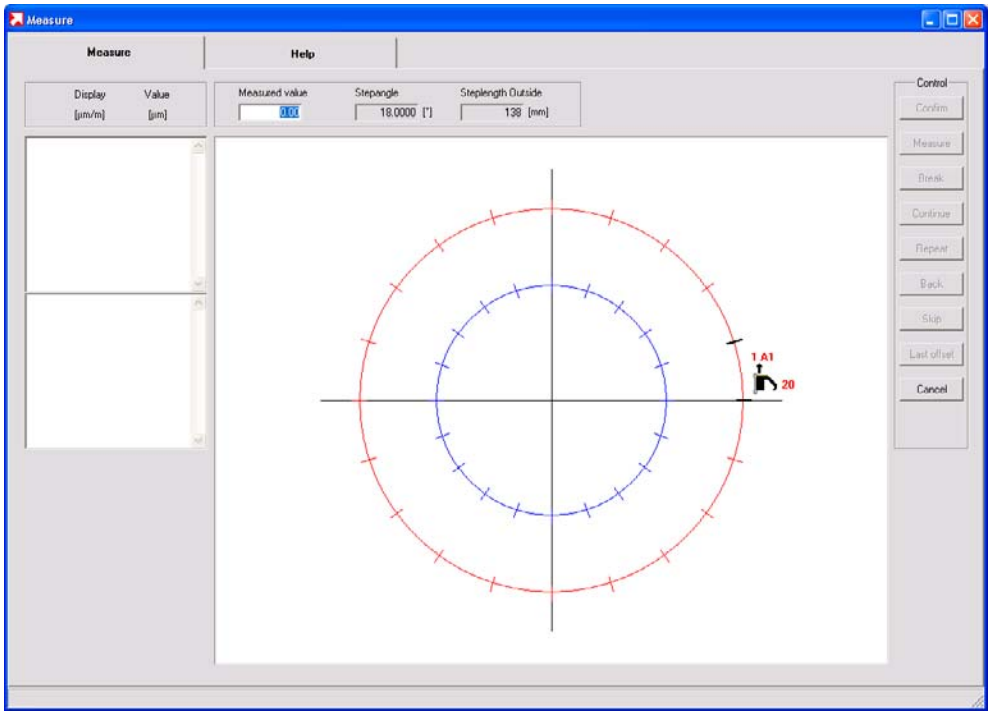


The reversal measurement is now to be perfumed as earlier described.



Now the measurement of both circles in 20 steps each can be done. It is important to make sure that the measuring steps are overlapping. The end point of one step must be identical with the starting point of the following step.



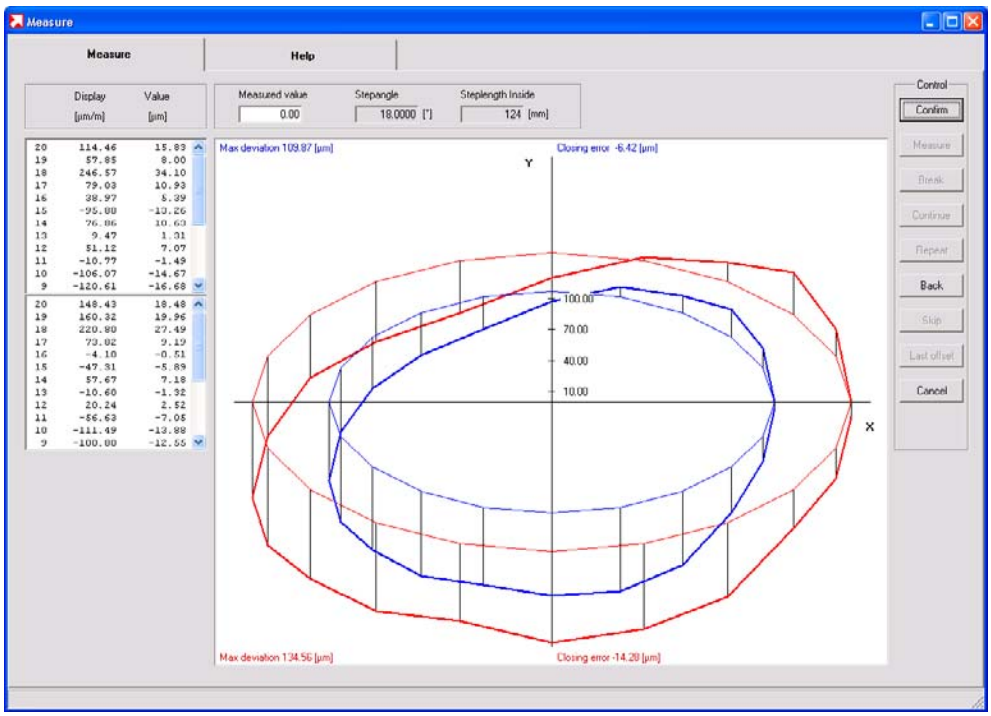


Follow the displayed procedure by placing the instrument to the position shown, by starting with the outer circle and proceeding with the inner circle.

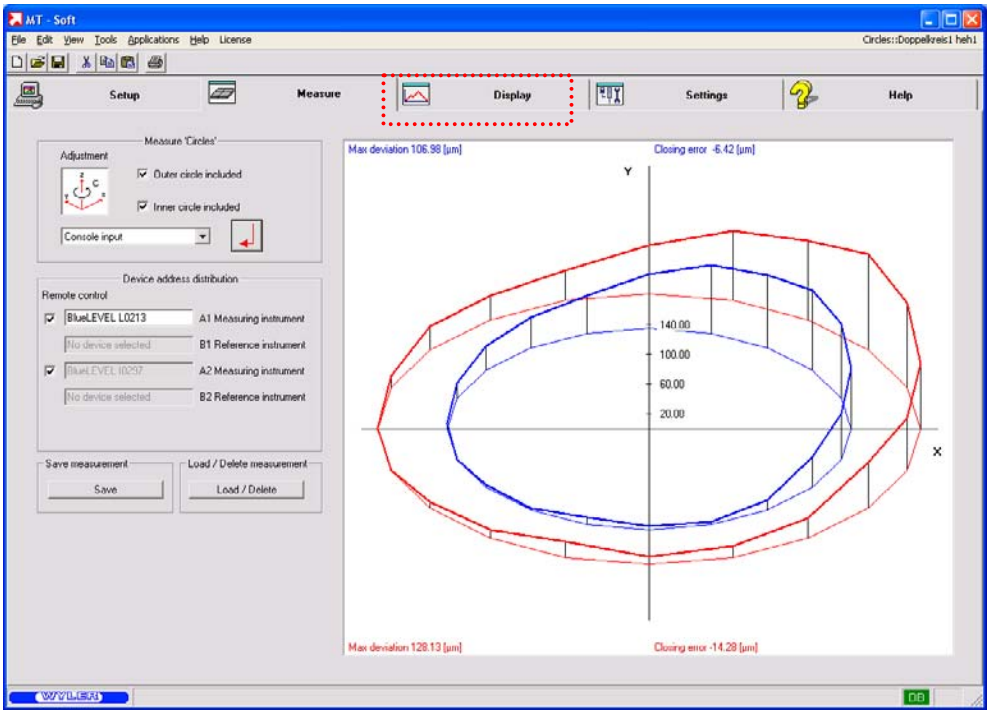
On the left graph the measured values are displayed and can be checked.

On the left graph the measured values are displayed and can be checked.

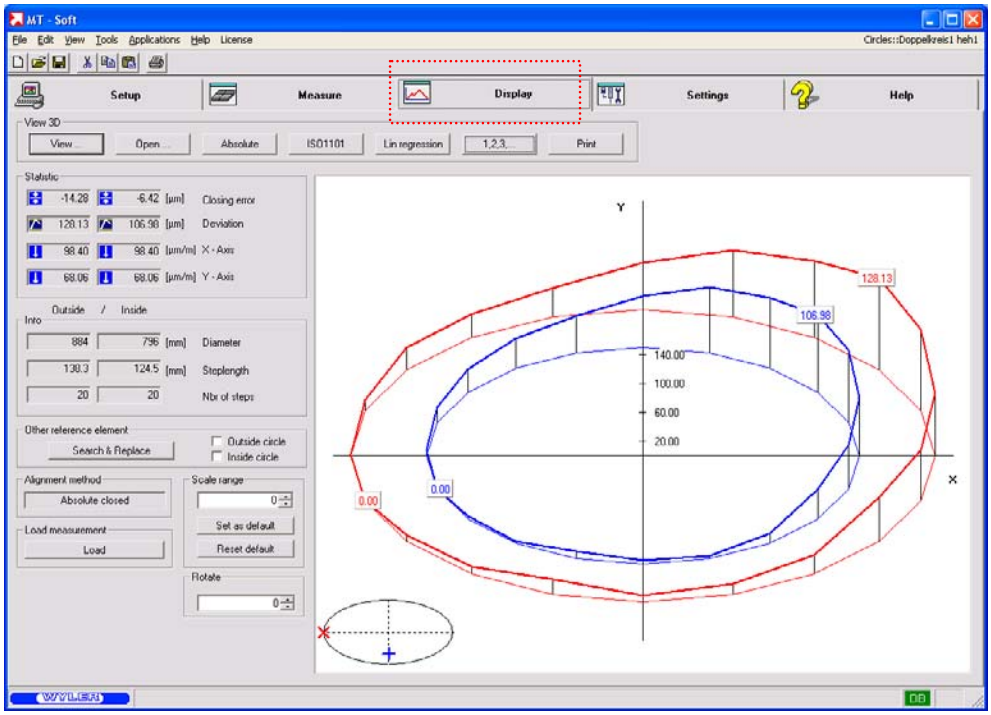
After the last measurement the following graph is displayed. The result can be confirmed [Confirm] or using the button [Back] can be repeated step by step.



Using [Confirm] the displayed value is accepted and will be used in the measurements to come.



The displayed information is not yet sufficient so we change to the submenu <**DISPLAY**>



Using the register <**DISPLAY**>  the taken measurement can be viewed and judged under different aspects. The measured result will be “lifted” (exception alignment method Lin. regression) so that all measured values are positive. The position in space will not be changed by this lifting.

Display is possible according to the different alignment methods

- Method **Absolute**
- Method **ISO1101** (of the first line)
- Method **Linear regression** (of the first line)

The actual method is seen below the graphic.

Additional information seen under MT_SOFT / Display 2.5.8

- [View…] shows the different views of the object measured, such as 1st line, 2nd line, all lines
- [Absolute] alignment method Absolute
- [End points] alignment method End points
- [ISO1101] alignment method ISO1101
- [Lin. regression] alignment method Linear regression
- [Print] Printing the measured data according to setup

Information on the various **alignment methods** are described in chapter 2.5.8.

Displayed values

	outer circle	inner circle
closure error	-14.28µm	-6.42µm
maximum deviation	128.13µm	106.98µm
deviation from true vertical X-Axis	98.40µm/m	98.40µm/m
deviation from true vertical Y-Axis	68.06µm/m	68.06µm/m

Details on the monitor information:

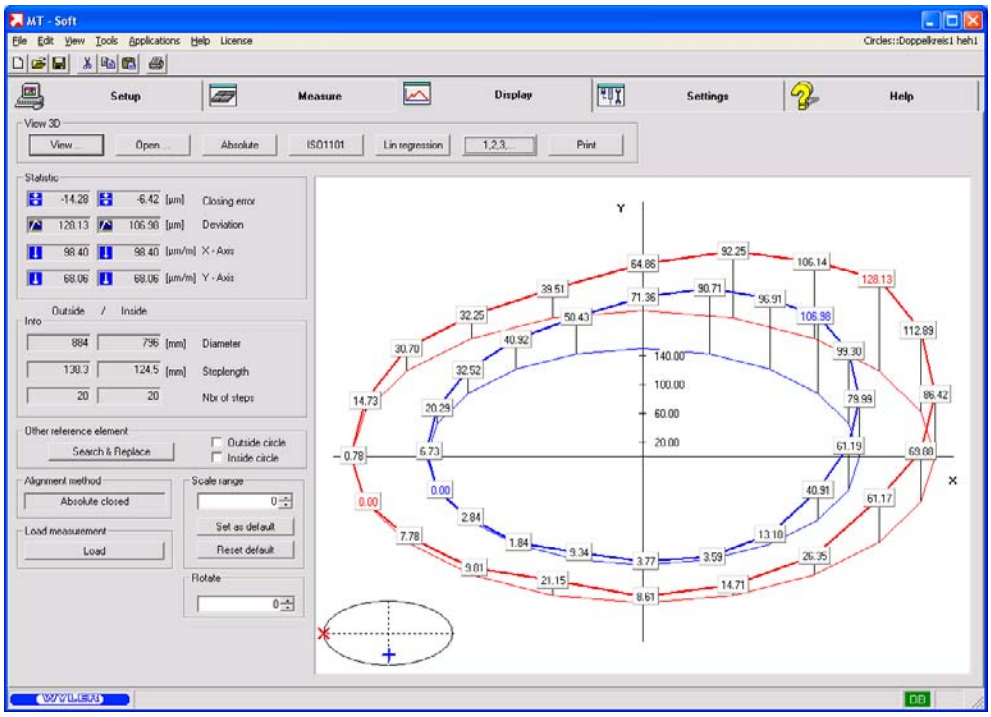
- **Closing error /** This value represents the difference between the starting point and the end point of the measurement. In the closing error all measurement errors are included. This value is am important indicator on the quality of the measurement.

- **Deviation /** In our example the displayed value indicates the flatness error (deviation)

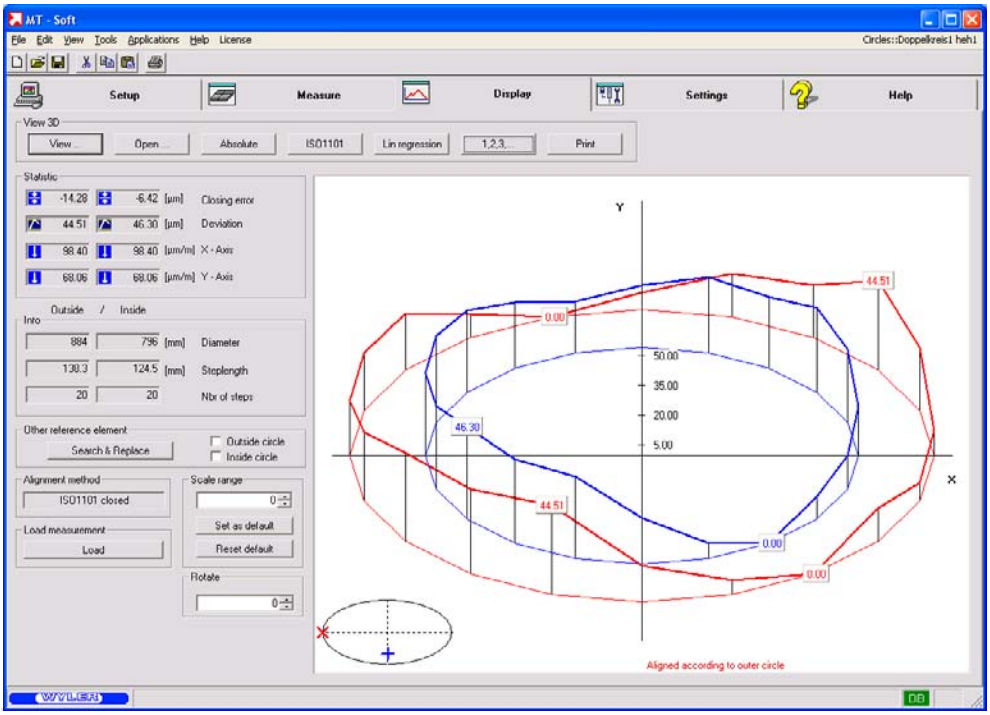
Further display and alignment options:

In the window the presentation of the graph can be changed using the button [Display]. You have the possibility to show the graph in the following ways:

- Perspective Presentation
- Presentation as a profile in the form of a "projection"
- Presentation as a profile in the form of an "unwinding"



In this picture the measured **object** is presented **perspectively**. Alignment **"Absolute"**



In this picture the measured **object** is presented **perspectively**. Alignment **"ISO 1101"**

Additional information seen under MT_SOFT / Display

- [View…] shows the different views of the object measured, such as 3D, "projection / cross section" and "developed view"
- [Closed / Open] The measured lines may be shown with/without closure error
- [Absolute] alignment method **Absolute**
- [ISO1101] alignment method **ISO1101**
- [Lin. regression] alignment method Linear regression
- [1,2,3]… The individual values in figures are displayed. Numbers can be increased, decreased. Max- and Min-values are coloured.
- [Print] Printing the measured data according to setup
- [Load] Load an existing data file

Available information in the field **"Statistics"**, depending on the alignment method

- **Closing error**
  This value represents the difference between the starting point and the end point of the measurement. In the closing error all measurement errors are included. Only visualised in the graphic display in the mode "open"
- **Deviation**, depending on the alignment method
  - Alignment according to the method "Absolute" Straightness of the circular line
  - Alignment according to the method "ISO 1101" Flatness deviation
  - Alignment according to the method "linear Regression" Flatness deviation
- **X-Axis** value
  - deviation of surface from the true vertical in the X-direction
- **Y-Axis** value
  - deviation of surface from the true vertical in the Y-direction

Additional information below "**Info**"

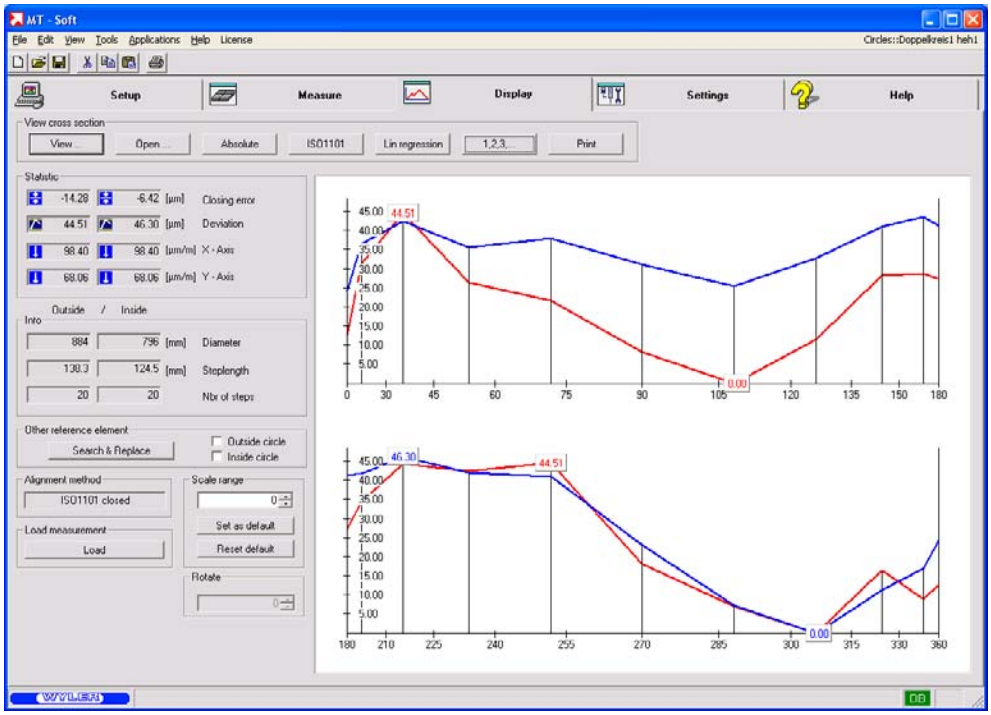
- **Alignment method** used
  - actual alignment method used
  - diameter of the measured object
  - step length used

Additional information below "**Scale range**"

- With **scale range** the scale of the display may be chosen as required

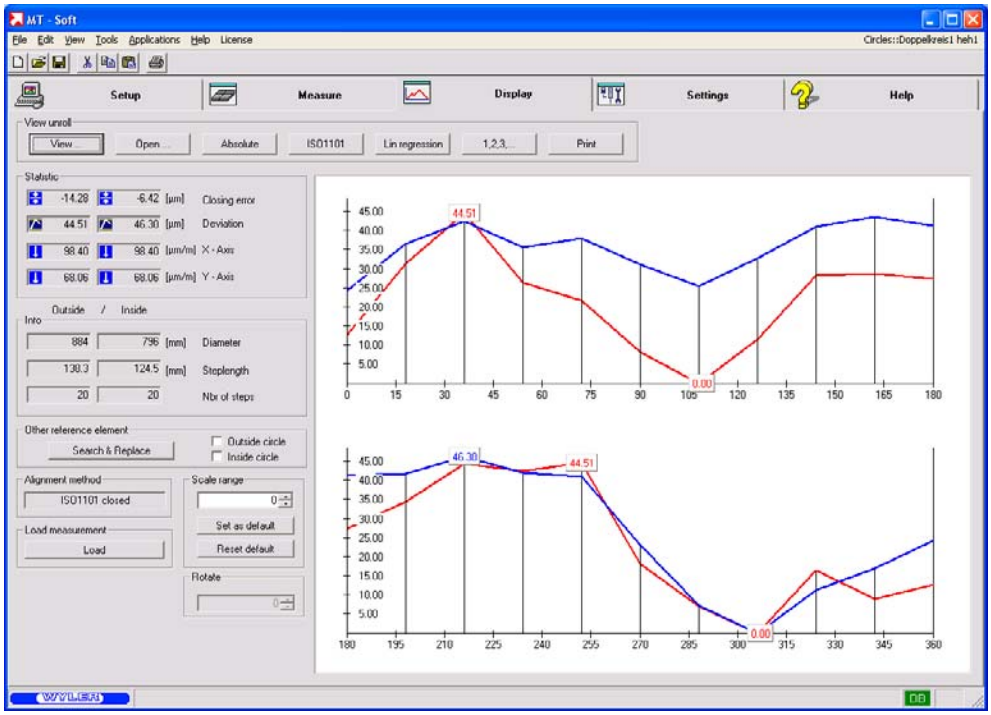
Presentation as a profile in the form of a "Projection", respectively "Profile". (Alignment "Absolute" / can be selected using [Display]

Display / The circle measured is presented from 0 ... 180° and from 180 … 360°

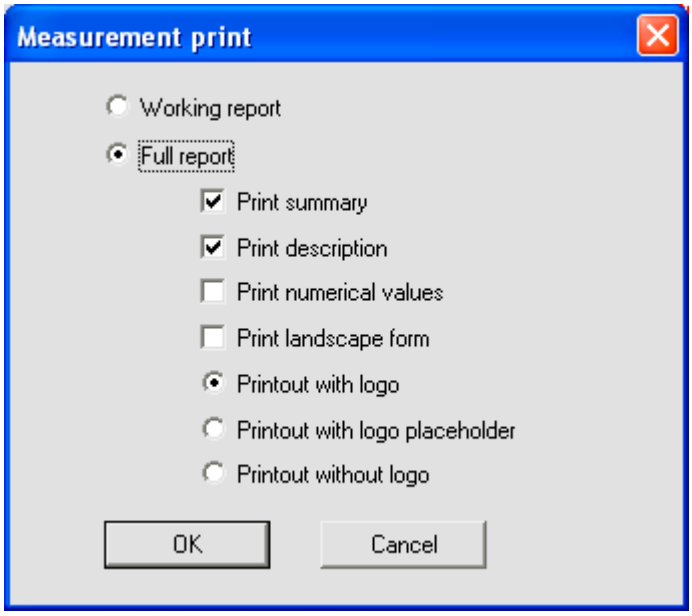


"Developed view" (view circle) / Selection using [VIEW…], Alignment method "Absolute"

The “View circle” is displayed in two sections 0….180° and 180….360°, the scale is displayed in linear form



Print the data of a measurement
The same setup is used as it was in the last print job. This is especially to check in the points “Alignment method”, “scale” and with/without “closure error”



The **following setup** is possible

- Working report:
  Short form printing, printed are
  - Description of measuring the task, machine type, serial number, elements
  - Dimensions of the object
  - Closure error, deviations
  - Graphical display of the object, setup information such as alignment method numerical display etc. is taken from the screen display

- Full report
  - Print summary
    - Logotype, if activated

    - Measuring and print date
    - Dimensions of object
    - Closure error, deviations
    - Graphical display of the object, setup information such as alignment method numerical display etc. is taken from the screen display

- Print description
    - Logotype, if activated
    - Header file with customer, machine type, serial number name of engineer without measuring data

- Print numerical values
    - Logotype, if activated
    - All measured values in numerical form

- Print landscape form (additional print of figure in landscape mode)
    - Graphical display of the object, setup information such as alignment method, numerical display, etc., is taken from screen display
    - Display of alignment method
    - Closure error
    - Dimensions of the object

- Print with Logo
    - The Logotype defined is printed, see <**SETTINGS**> for changing the Logotype Chosen logotype is printed

- Print with Logo place holder
    - In case company paper is used the logotype must not be printed

- Print without Logo
    - print is without logotype

Remarks concerning the "Print logo":

- Any logotype can be used. The size must be 200mm (length) x 20mm (height) and the type must be bitmap (*.bmp) and the logotype should be saved in the main menu of MT-SOFT
- The logotype is activated in the menu MT-SOFT <**SETTINGS**>
- Click to <**SET**> opens the active logotype. When clicking to the opened logotype the Windows explorer will be opened for selecting another logotype.

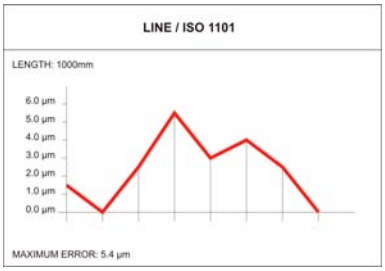
5.6 LEVELSOFT PRO

Measuring possibilities

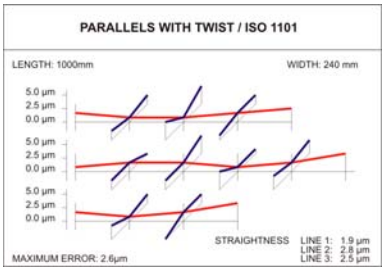
- Lines (Straightness)
- Lines absolute
- Lines with twist (Torsion)
- Parallels
- Squareness
- Measurement of surface flatness
- Measurement of single parts of machine tools

The well proven Software **LEVELSOFT PRO** is an integrated part of the Software MT-SOFT and can be started directly in the menu <**MEASUREMENT SETUP**>

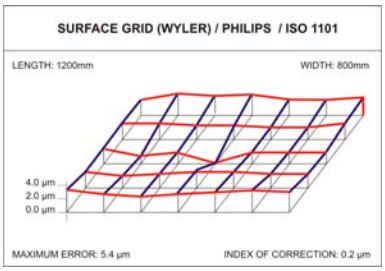
Lines with and without twist according to ISO 1101



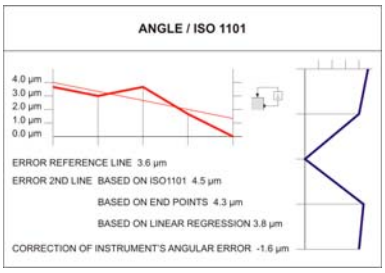
Parallels with and without twist according to ISO 1101



Measurement of flatness of surfaces according to ISO 1101



Squareness according to ISO 1101



For detailed instruction see separate manual "LEVELSOFT PRO"

6 APPLICATIONS / COMPARISON OF MEASURED OBJECTS

6.1 COMPARISON OF A HORIZONTAL WITH A VERTICAL GUIDE WAY AS PER PICTURE BELOW

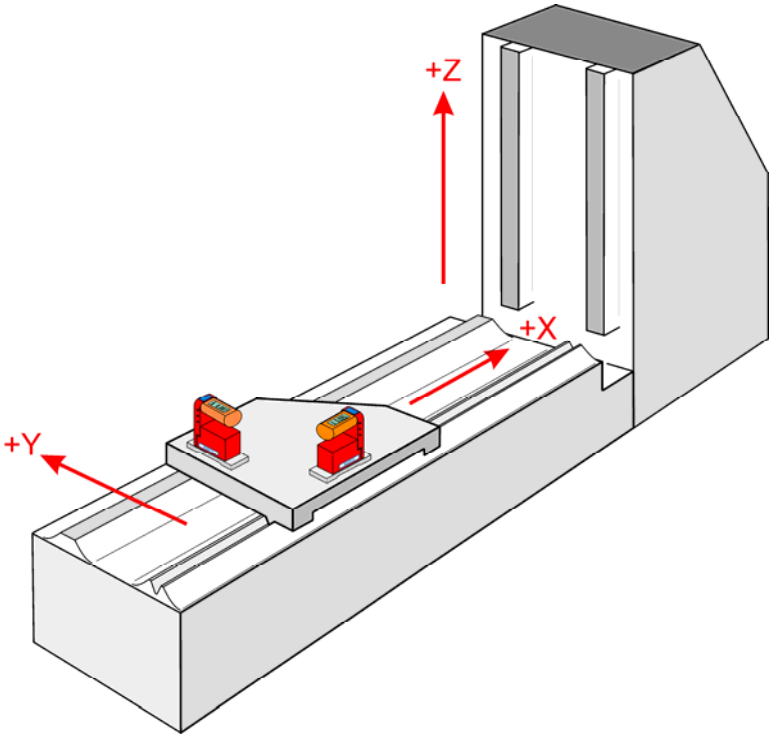
Since the different measurements have been done in absolute mode, it is possible to compare measured results of different elements at a later stage.

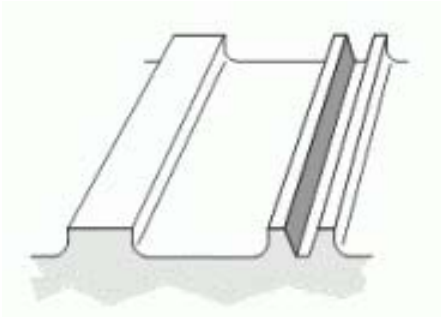
In order to measure in the absolute mode a reversal measurement with the instrument is required before the measurement. For details see pt. 2.5.10

For a better understanding we take a closer look at the following example:

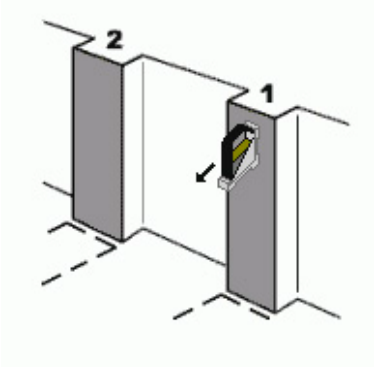
Measuring task:

- First a **horizontal guide way** of a machine tool is measured





- Second the **vertical guide way** of the spindle of the machine tool is measured



IMPORTANT

Elements of a machine may only be compared when

- the **serial number** defined under measurement description and
- the **coordinate system** of both elements are identical

6.1.1 MEASUREMENT OF THE HORIZONTAL GUDE WAY

The measurement example:

- **Type of measurement** Guide way horizontal
  - Front guide way "**prismatic**"
  - Rear guide way "**flat**"

- **First cross section measurement** at the end of the measuring JIG

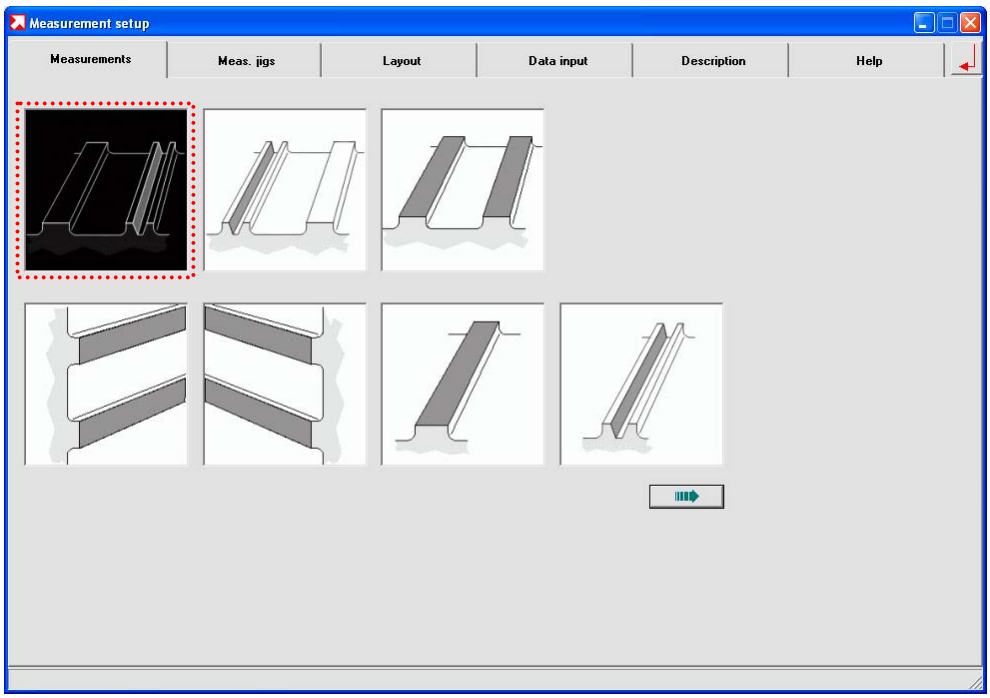
- **Work piece coordinates**
  - X-axle coordinate/(Object beginning): -1000 mm
  - X-axle coordinate/(Object end): 1000 mm
  - X-axle coordinate/(First measuring point): -900 mm
  - X-axle coordinate/(Last measuring point): 900mm
  - X-axle coordinate/(Step length): 300 mm (Depending on JIG available)

  - Y-axle coordinate (line 1) : 0 mm
  - Y-axle coordinate (line 2) : 500 mm

- **Measuring setup**
  - The measurement of the guide ways should later be used in comparing the table with the vertical spindle guide way. In order to do so it is required to measure in the **absolute mode**. An absolute mode measurement requires before the measurement a reversal measurement with the instrument.
  - The measurement is done **with a single instrument**. This means the first step is measuring the X-axis and as a second step measuring the Y-axis.

Procedure:
In the register <**SETUP**>, below <**MEASUREMENT SETUP**> the pull down menu can be used to change to "Guide ways" and confirm with [Enter] 

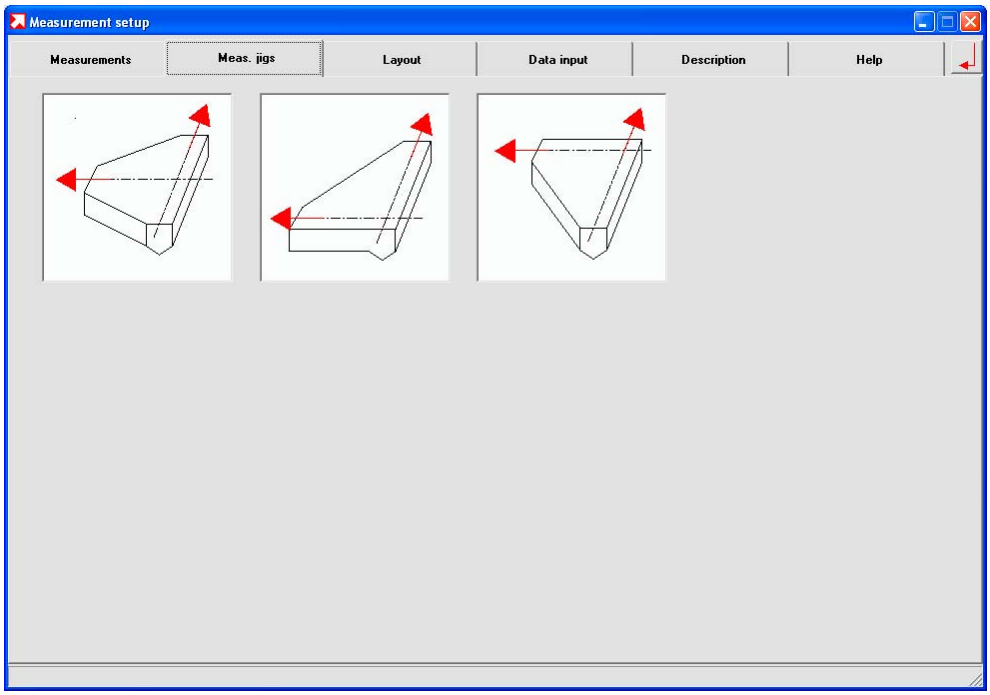
A number of different possibilities for the **type of guide ways** is displayed under <**MEASUREMENTS**>



In our example we chose the first option.
(Front (near) guide way prismatic, back (far) guide way flat)

After the selection by mouse click the background becomes black.

Change to the sub register **<MEAS. JIG>**

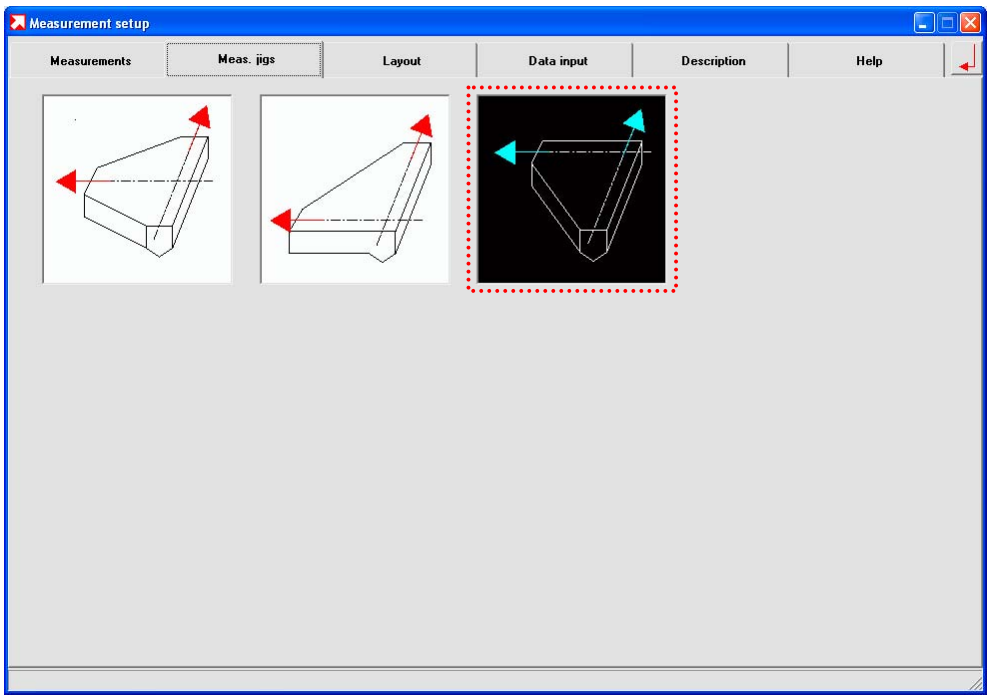


Here three options are available

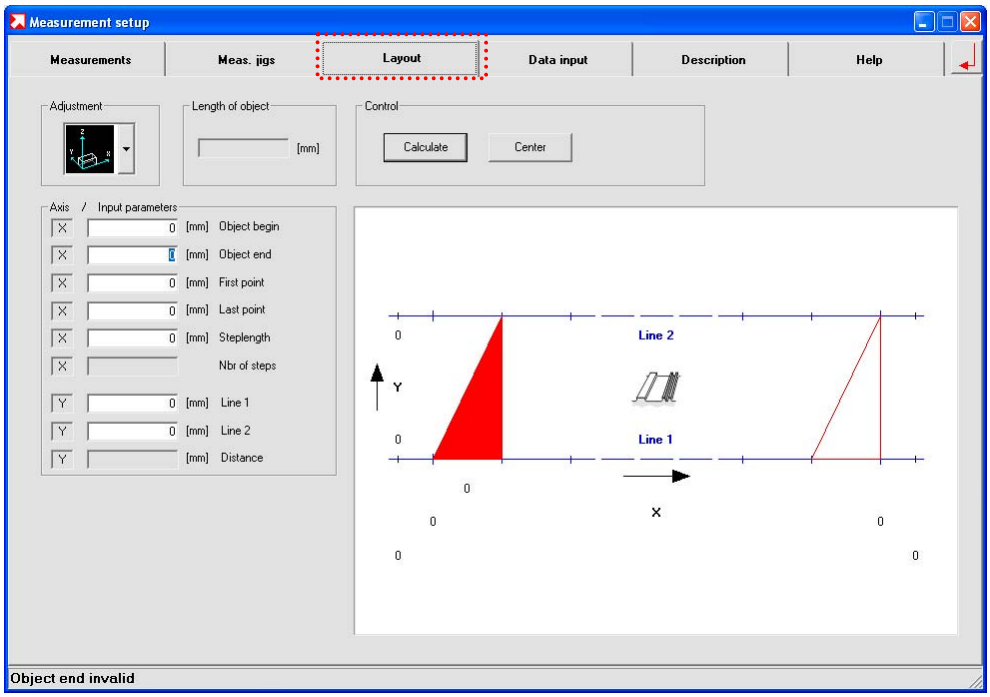
- JIG with symmetrical base plate (position of cross direction at the centre of the base plate)
- JIG with asymmetrical base plate (position of cross direction at the beginning of the base plate)
- JIG with asymmetrical base plate (position of cross direction at the end of the base plate)

Remark
The measuring JIGs are usually supplied by the user as the JIGs are depending on the type and shape of the machine. WYLER AG however is glad to quote and supply any JIG required. (See also chapter “Measuring base”)

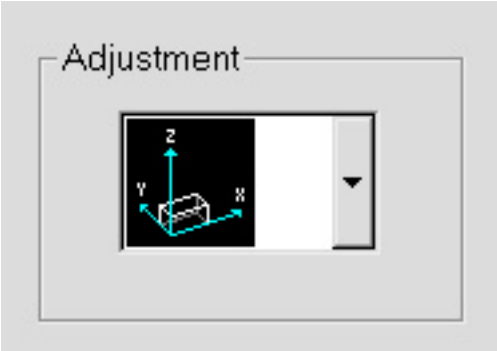
In our example we chose the JIG with asymmetrical base plate (position of cross direction at the end of the base plate)

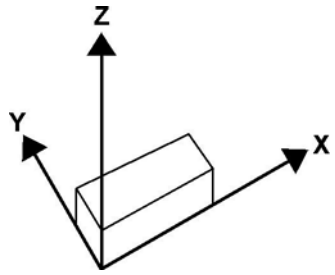


Change to the sub register **<LAYOUT>**



Firstly under <**ADJUSTMENT**> the coordinate system (**work piece coordinates**) must be defined. In our example we chose





Next the coordinates must be entered. (IMPORTANT: **WORK PIECE COORDINATES**)

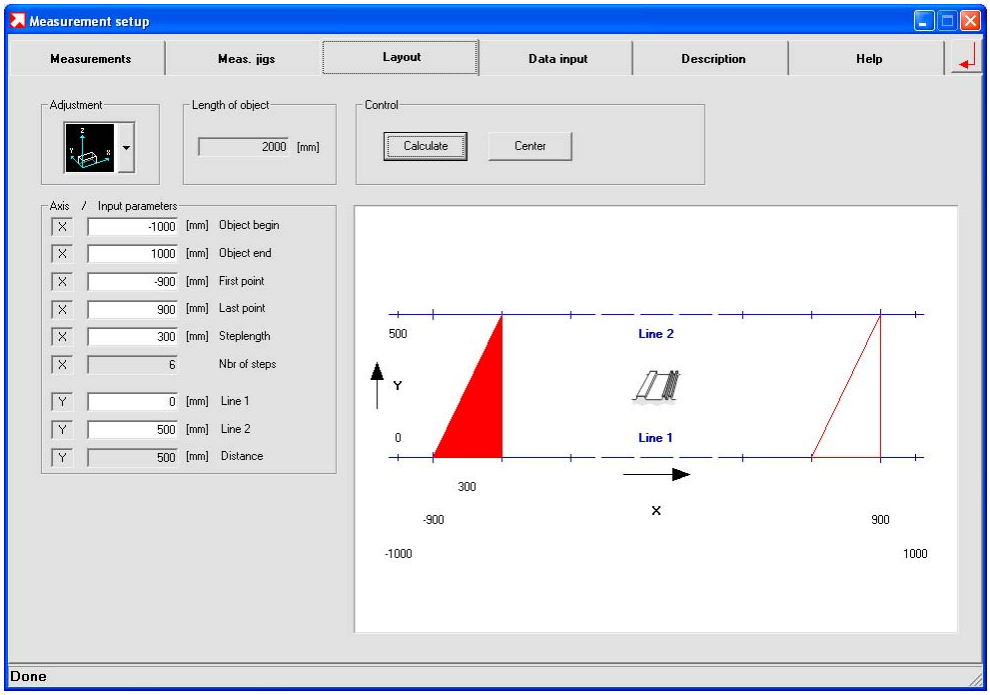
- X-axis coordinate/(Object beginning): -1000 mm
- X- axis coordinate/(Object end): 1000 mm
- X- axis coordinate/(First measuring point): -900 mm
- X- axis coordinate/(Last measuring point): 900 mm
- X- axis coordinate/(Step length): 300 mm (Depending on JIG available)

- Y-axle coordinate (Line 1) : 0 mm
- Y-axle coordinate (Line 2) : 500 mm

After entering the data confirm with [Calculate] the graphic will be finalized and additional data is entered automatically.

- Length of Object 2000mm
- Number of Steps 6
- Distance line 1 to line 2 = 500mm

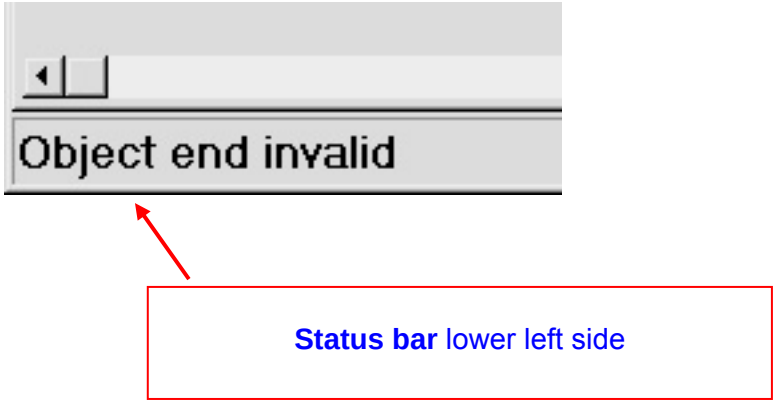
It is important to check all the displayed data for their correctness.



After confirming with [Calculate] the following additional information is displayed

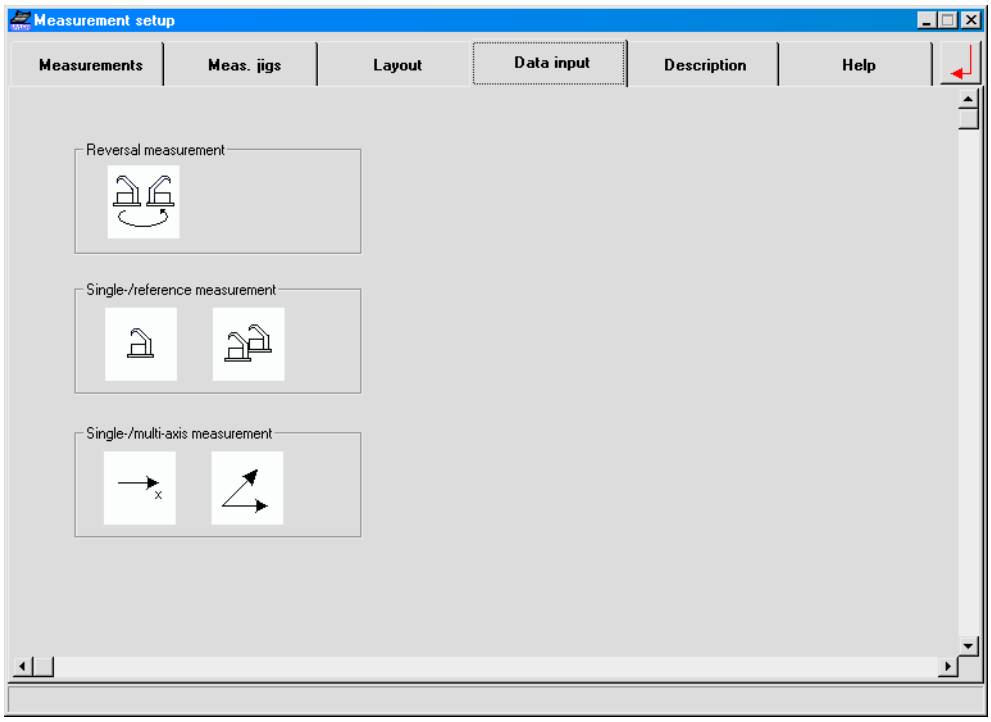
- Length of Object 2000mm
- Distance (line 1 to line 2) = 500mm

Information to incorrect or missing values is displayed in the status bar
Example



Also displayed are the graphic layout and the numerical figures. This should be checked before proceeding.

Change to <**DATA INPUT**>
In this selection specific procedures for the data input is defined.



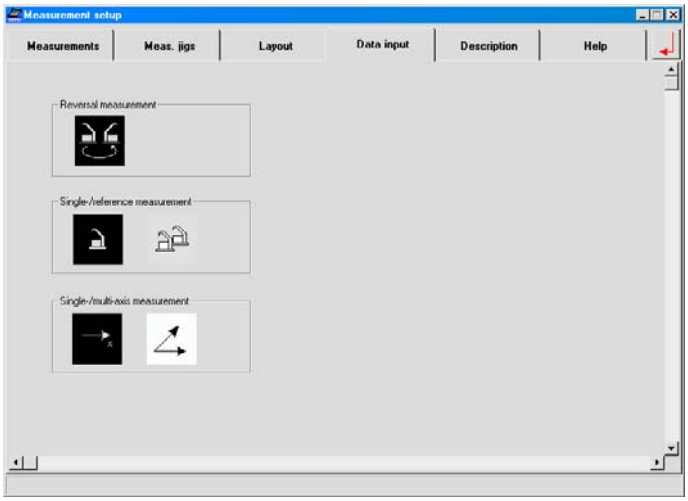
Here only the type of measurement can be entered. The following options are available:

- **Reversal measurement**
  This mode is used for “absolute” measurements and for the measurement of different individual objects to be compared at a later stage

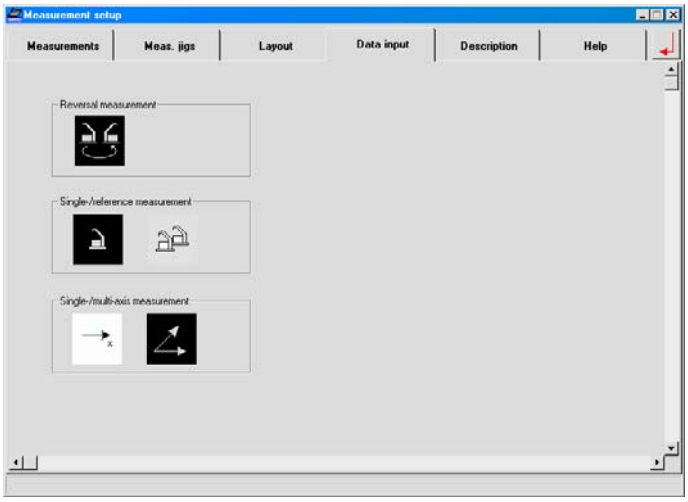
- **Single/reference measurement**
  Selection whether one individual instrument is used or two instruments in differential mode are used. (Value = A - B). Differential measurement does not allow “reversal measurement”

- **Single / multi-axis measurement**
  Selection of measurement procedure such as measurement first in one direction X and after that in a second run the Y-axis is measured. Alternatively both axis may be measured simultaneously with two instruments

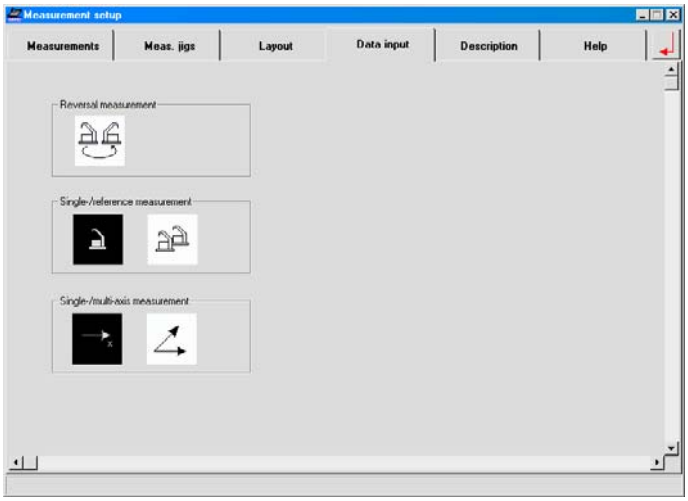
- **Reversal measurement** / Single Instrument (**Absolute mode**). This means one direction (X) is measured at one time only. In a second step the cross direction (Y) is measured.



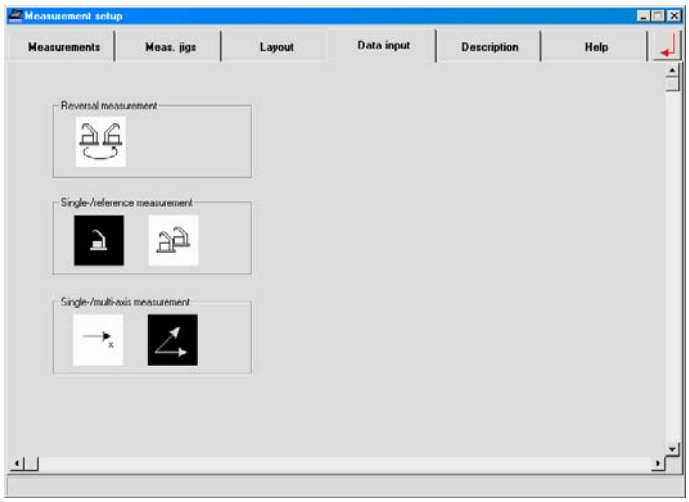
- **Reversal measurement** / One Instrument per direction (**Absolute mode**). This means measurements in X-direction and in Y direction simultaneously



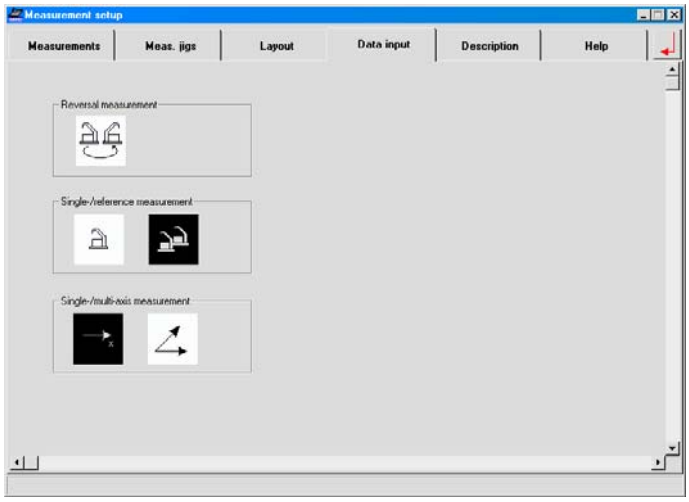
- **<u>Without</u> reversal measurement** / Single Instrument (**Relative mode**). This means in the first step measurements only in X-direction and in the second step measurements in Y direction only



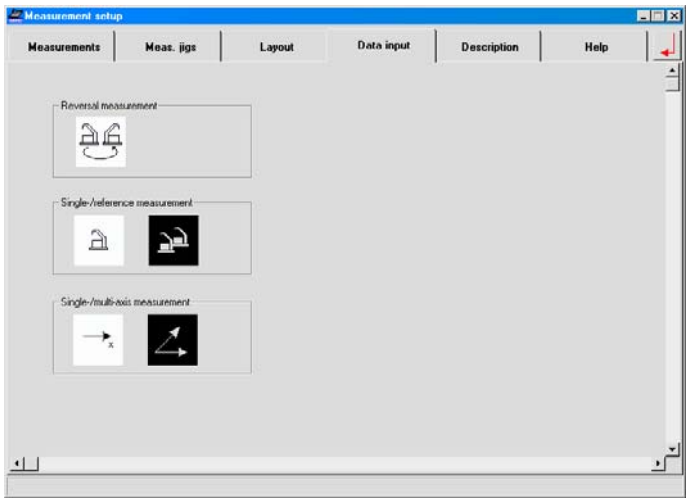
- **<u>Without</u> reversal measurement** / Single Instrument (**Relative mode**). This means in the first step measurements only in X-direction and in the second step measurements in Y direction only.



- **<u>Without</u> reversal measurement** / One instrument per direction (**Relative mode**). Measurements in X and Y direction simultaneously. (One instrument means one instrument in any chosen direction)



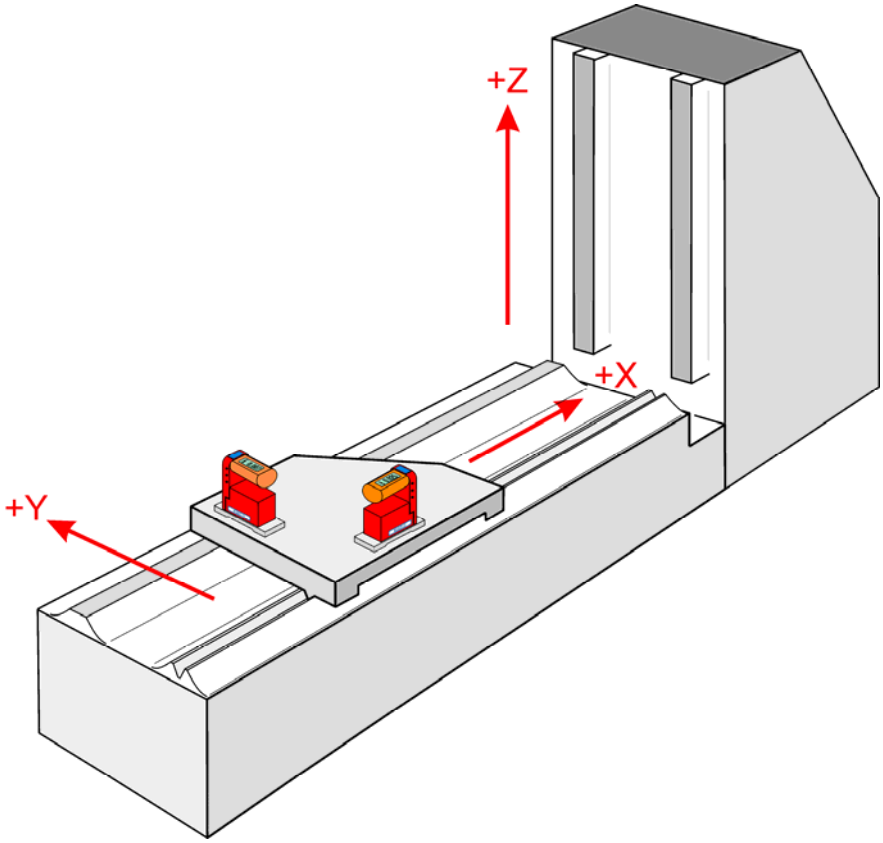
- **<u>Without</u> reversal measurement** / Two Instruments (**Relative mode, Measuring and reference instrument**). This means in the first step measurements only in X-direction and in the second step measurement in Y-direction only.

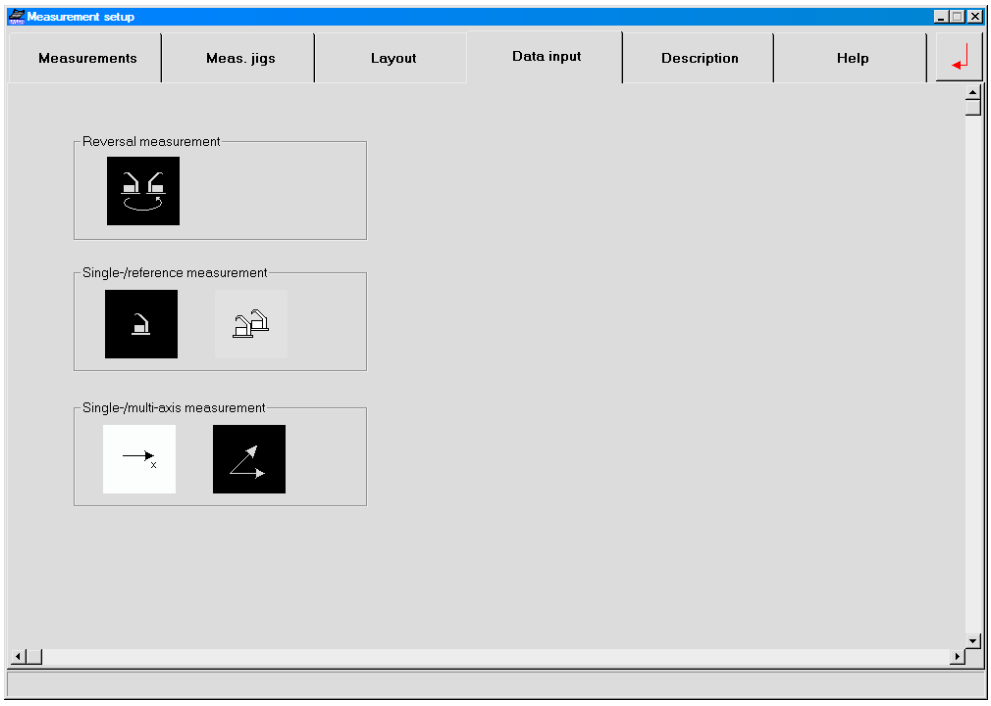


Important
When using a **LEVELMETER 2000** or a **BlueMETER** it is possible to measure the two axis X and Y simultaneously as long as no reference mode is activated.

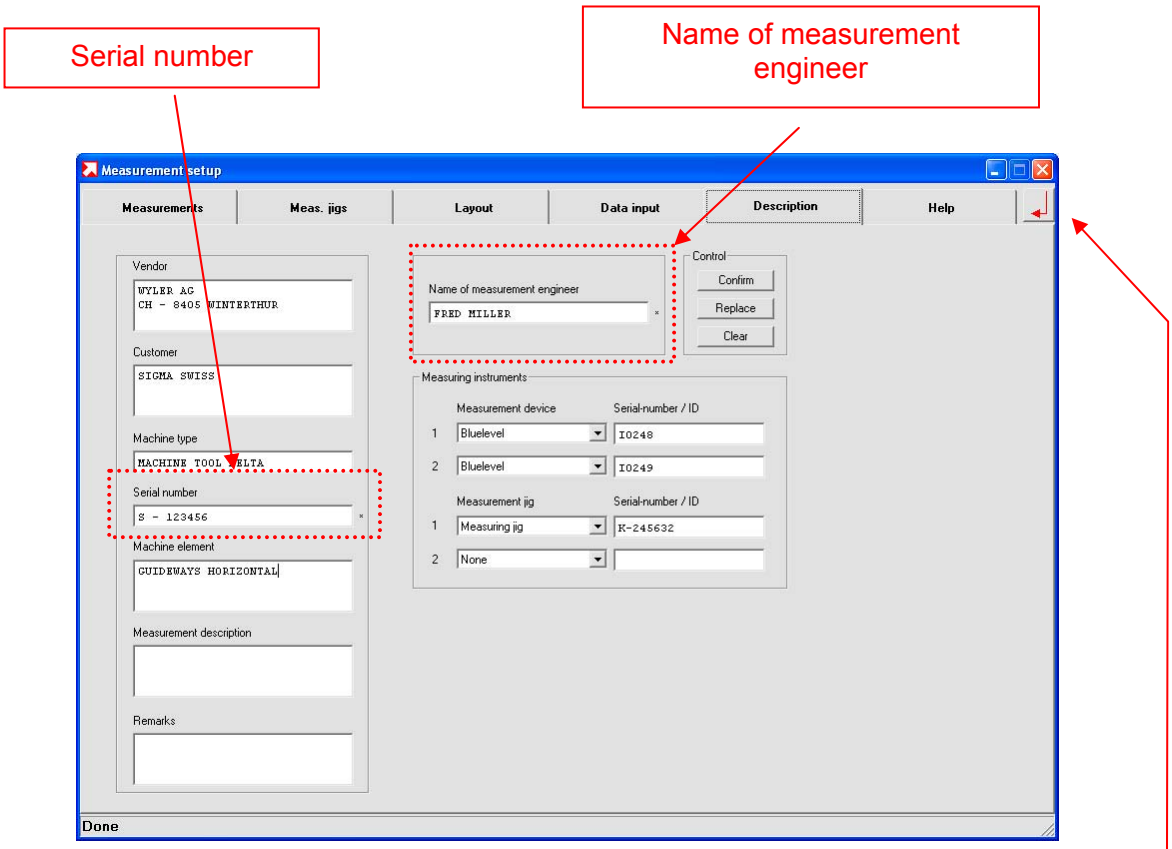
If a **Leveladapter 2000** is used and it is meant to measure in both directions X and Y simultaneously it is in any case necessary to measure with two Leveladapter 2000 and two different COM ports on the computer are required

In **our example** we chose
Absolute mode (Reversal measurement) with two instruments. This means that we measure the two **axis X and Y simultaneously**.





Next the <DESCRIPTION> must be done

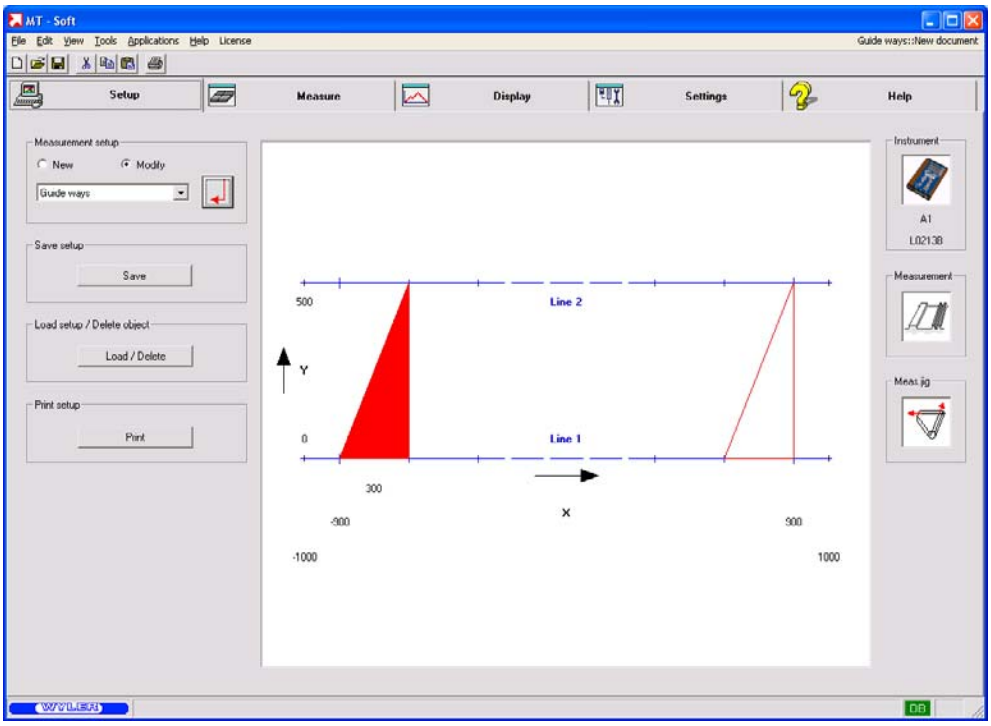


The description is to define exactly the measuring task and the identification of the objects.
In this dialogue box all the necessary data for defining the planned measurement can be entered. The **Name of measurement Engineer** and the **Serial number** of the object to be measured are **mandatory**.
All the rest of the information is free to fill in.

The text can also be integrated from an existing template by using the [Replace] button

It is still possible to make changes in the setup registers.
If not required press the button [Confirm] and then the button [Enter] 

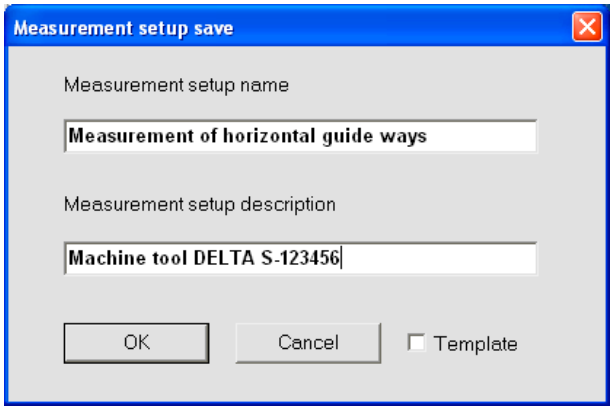
The configuration for the **measurement** is prepared now.



The following information is displayed:

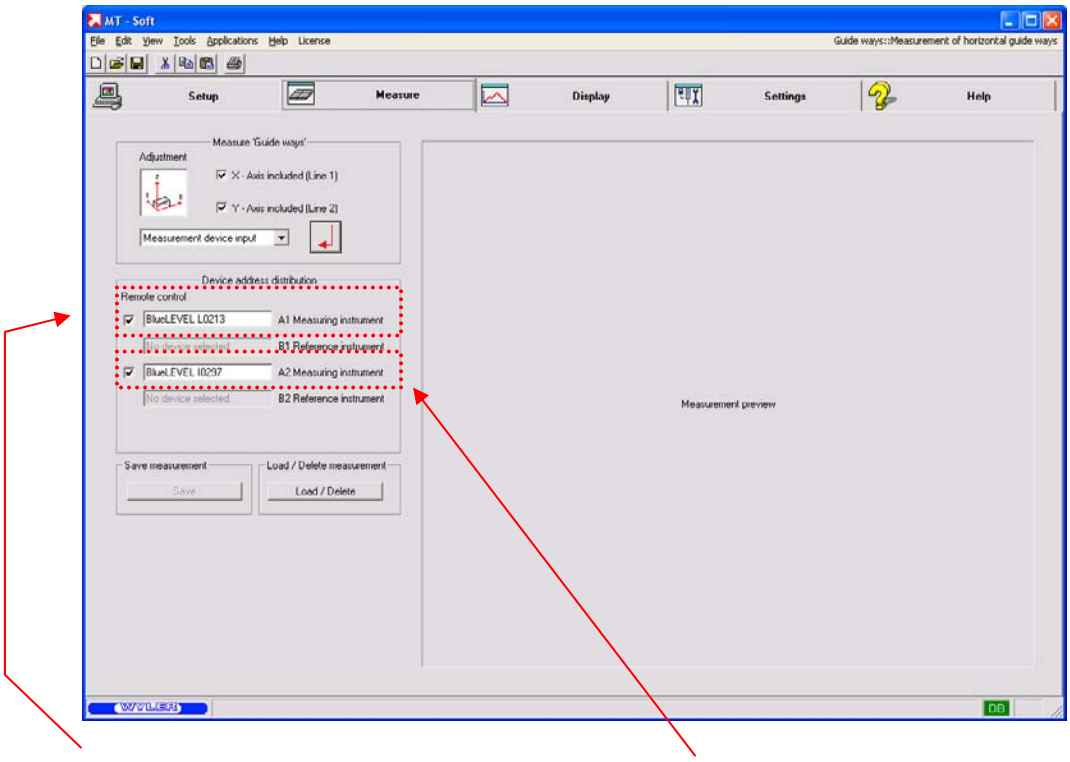
- Object to be measured, in our case “Guide Ways”
- On the right side of the window
  - o Instrument: The connected instrument respectively Interface
  - o Measurement Type of Guide way (horizontal, symbol)
  - o Meas. JIG Type of JIG specified

- Under "Save Setup" the button “save” opens a dialogue box. The setup may be saved as **<u>template,</u>** e.g. as:
  - o Measurement setup name: **"Measurement of horizontal guide ways"**
  - o Measurement setup description: **"Machine tool DELTA S-123456"**



- Under “Load Setup / Delete Object” the button [Load/Delete] allows to open an existing setup template or delete an object.
- Using the button [Print] allows to print the actual measurement setup template

For **starting the measurement** the register <**MEASURE**> must be activated



Measuring instrument A1 with serial number L0213 for the measurement of the front guide way (X-axle)

Measuring instrument A2 with serial number I0314 for the measurement of the rear guide way (Y-axle)

In this register the following input is possible:

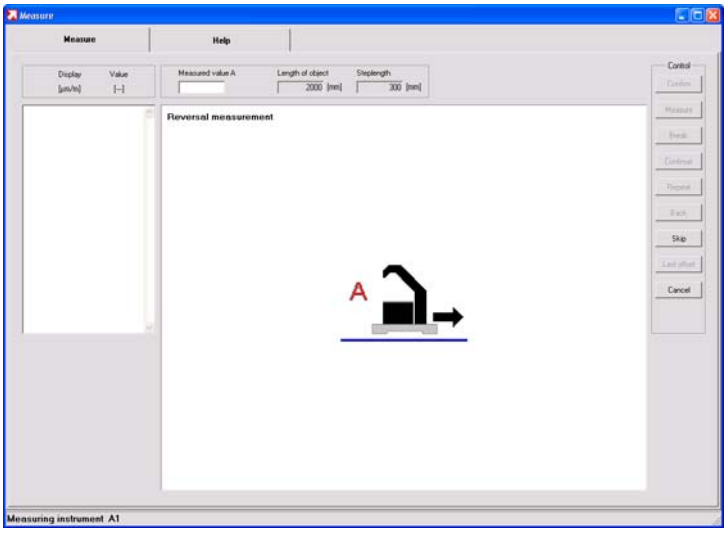
- Below "Measure Guide Ways" it is possible to change between "Input device", directly from interface to PC or "manual input" via Console Input

- Below Measure Guide Ways it is also possible to define if both axis (X and Y) are to be measured or if the values of one or the other axis should be set to zero.
  Active boxes = Make measurement
  Setting values to zero may be a considerable time saving factor, specifically if the present interest is mainly in one specific axis or when the results of this axis has been previously measured.

In our example we chose X- and Y- axis included and select “Measurement Device Input”. To start the measurement [Enter]  must be confirmed

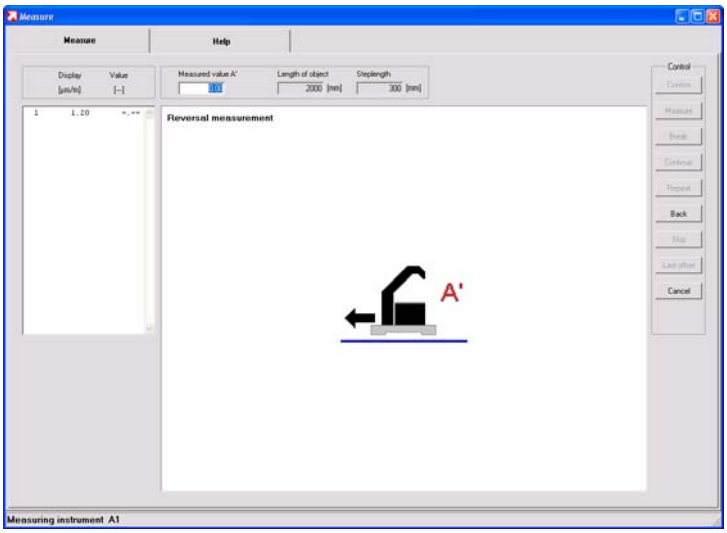
First step with instrument A1
Because in our example we measure in the “absolute mode” a reversal measurement is to be performed first. The first measurement done is the measurement **"A"**

The **reversal measurement** should best be done on a horizontally adjusted granite surface plate. Ideally for collecting the first value the first setting position of the instrument should be marked on the plate. For collecting the second value the instrument must be turned by gliding 180° without lifting from the plate.

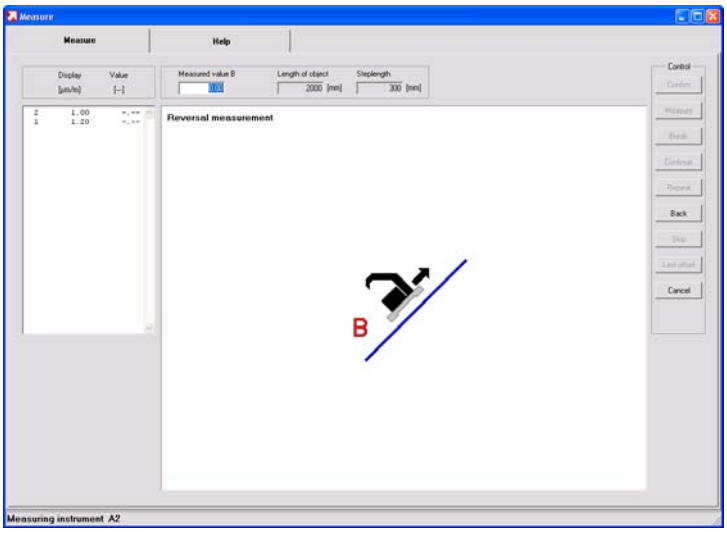


During the collecting of the first measuring value the remark appears “Please wait” The first measured value is displayed.

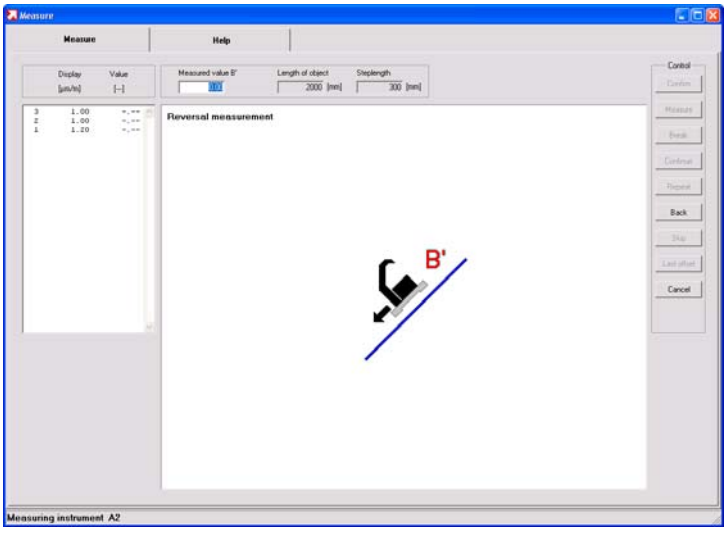
When finished the second value **"A’ "** is collected Using [Continue] will show the next step



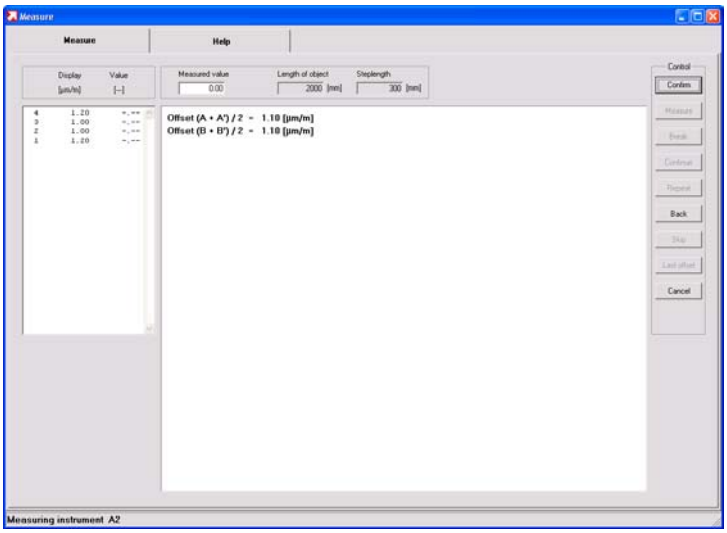
Second step is done with instrument A2. The first measurement with this instrument is **"B"**.



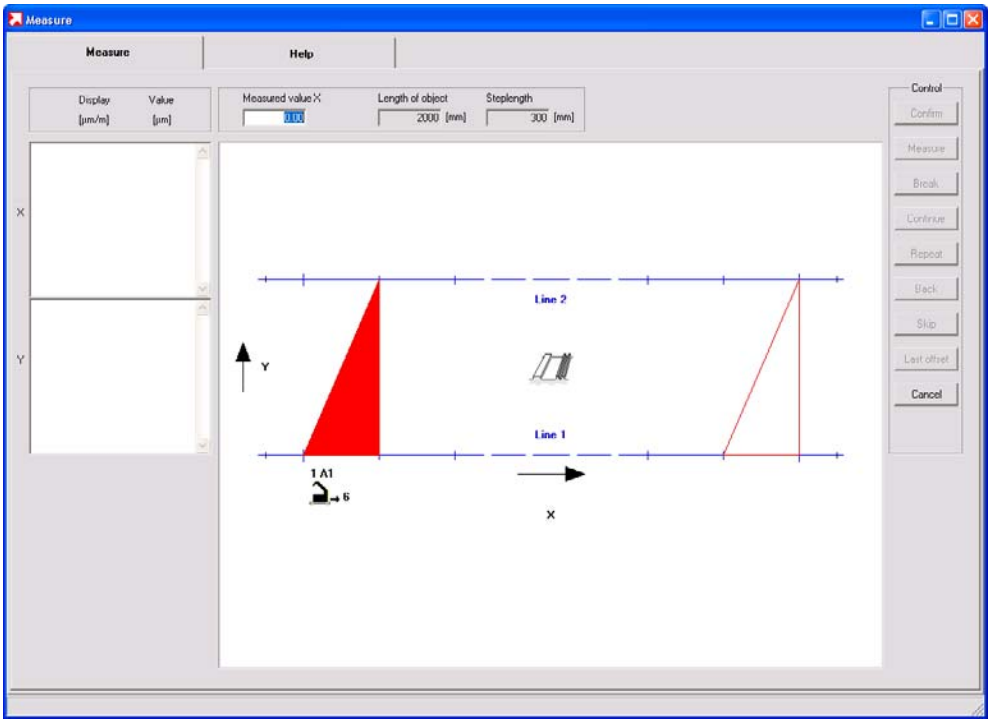
During the collecting of the first measuring value the remark appears “Please wait” The first measured value is displayed.
When finished the second value **"B’ "** is collected. Using [Continue] will show the next step



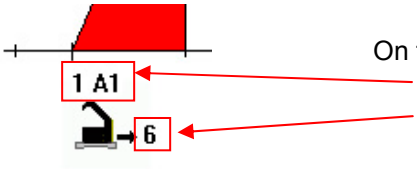
The Offset of the X- and Y-axle will be determined and displayed.



After the reversal measurement has been completed the **actual measurement of the guide ways can be started**



The first position of the instruments is indicated. The instruments and the jig must be placed there. After the required settling time use <**MEASURE**> to collect the first measuring data.

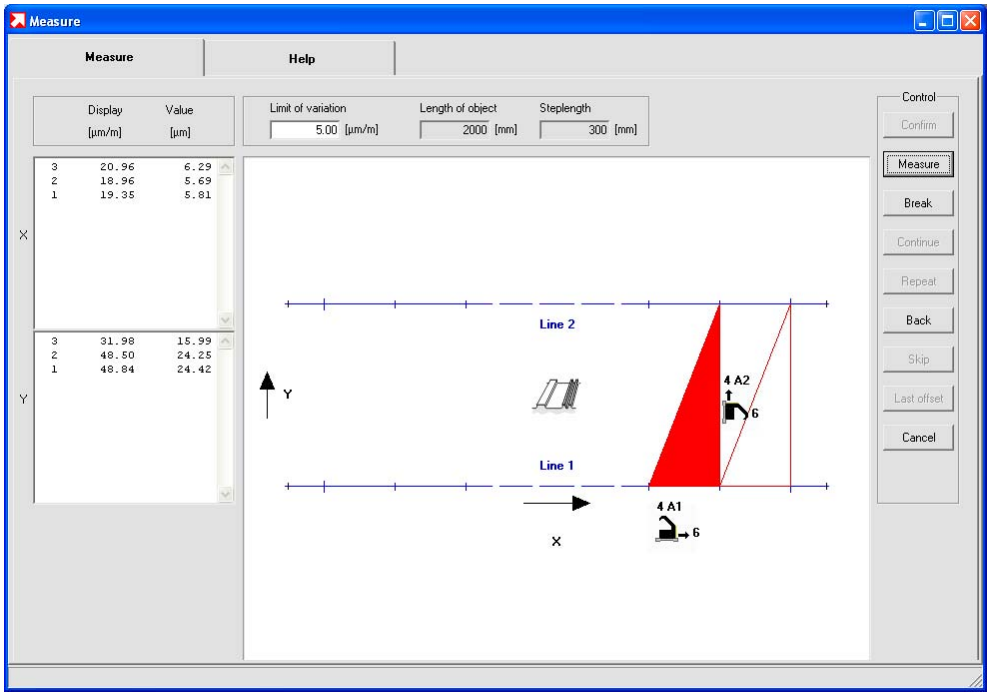


On the screen additional information is displayed

- First measurement with instrument A1
- Number of measurement steps

The measurements are now taken immediately on the same position in the direction X and Y one after the other. After the collection of the data the jig must be moved one step ahead.

Attention **Instrument must always be placed with the connector in measuring direction**

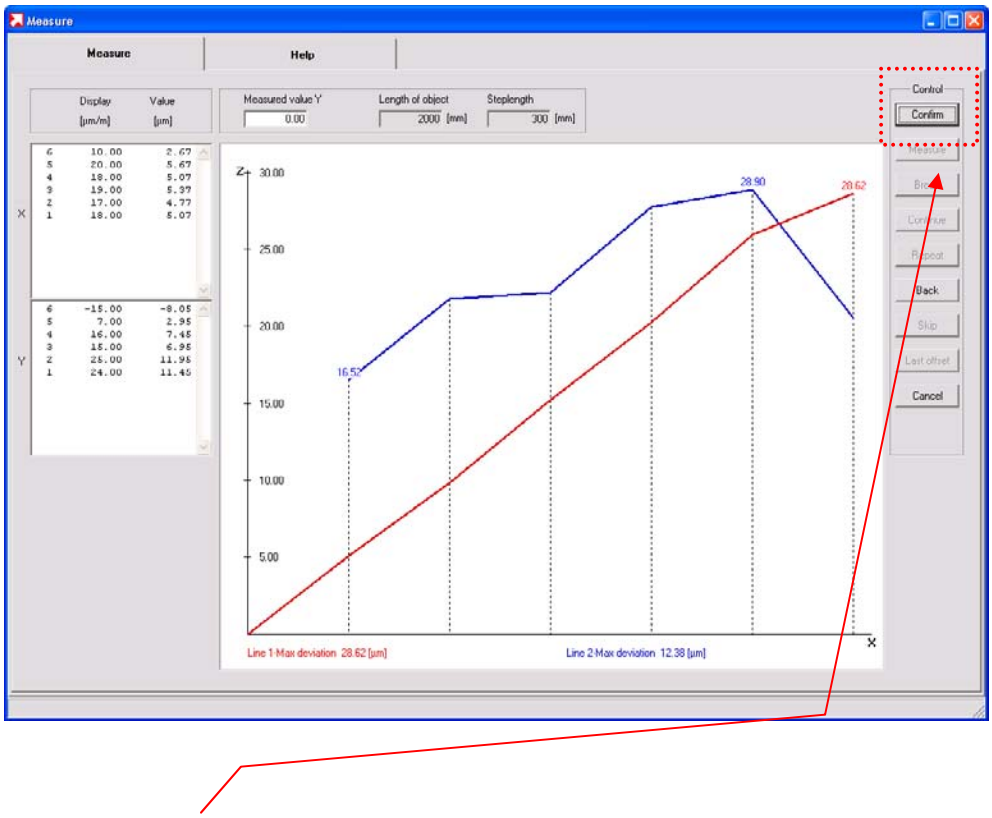


Information between the measurements
After the data is collected the measured value is displayed on the screen in large figures and the following options are available:

- Continue measurement
- Repeat measurement
- Cancel measurement

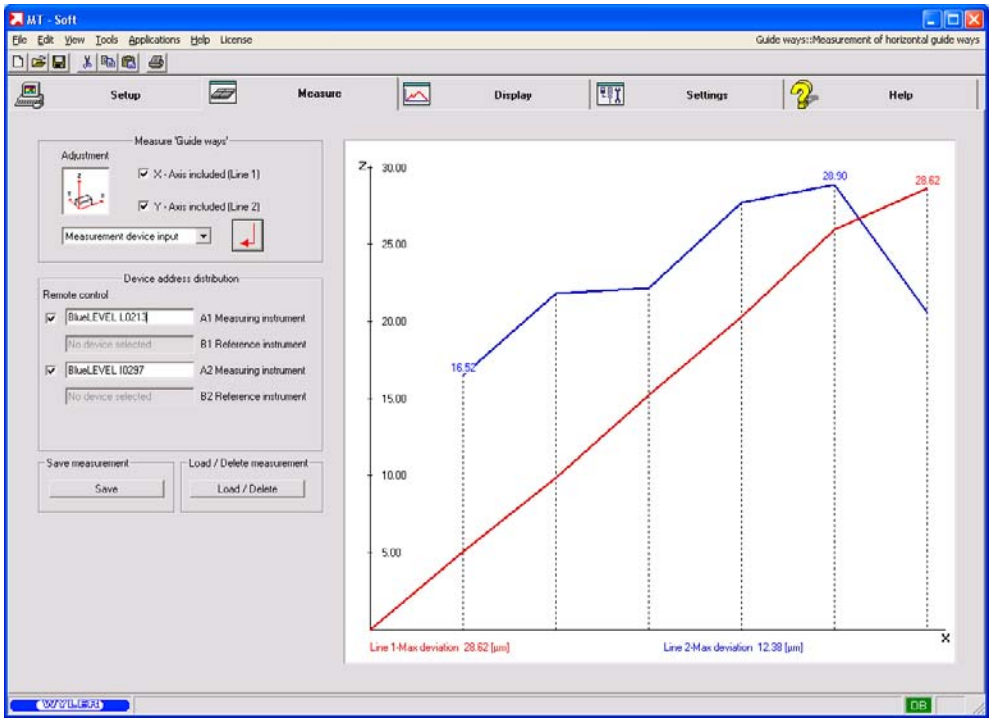
On the left side of the screen the numerical values in X- and Y-direction are displayed

After the last measurement the result of the measurement is displayed in graphical form



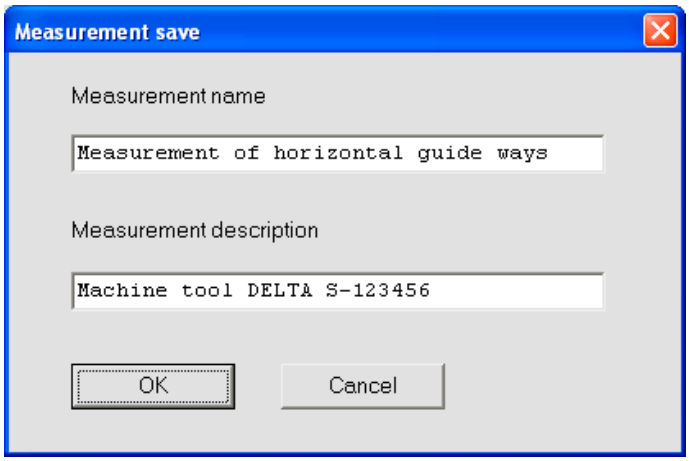
Using [Confirm] means the measurement is accepted. If not the button [Back] goes back step by step through the measurement for possible repetition.

After [Confirm] is pressed the measurement is definitively finished and the following window appears.



If the measurement is correct it should be saved, e.g. as:

- Measurement setup name: **"Measurement of horizontal guide ways"**
- Measurement setup description: **"Machine tool DELTA S-123456"**



It is useful to save the data with a clearly defined name for later easily finding the measured information.

Next the result may be analysed or printed

6.1.2 MEASUREMENT OF THE VERTICAL SPINDLE GUIDE WAY

The measurement example:

Type of measurement Guide way vertical

- Front guide way (1) "**flat**"
- Rear guide way (2) "**flat**"

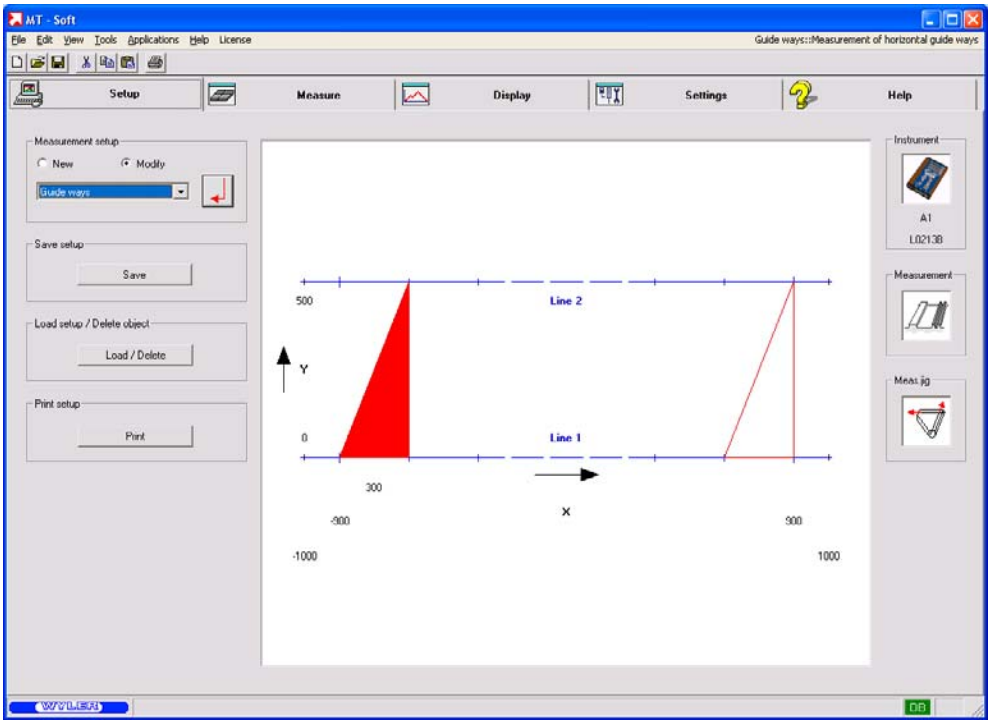
- **Work piece coordinates**

o Z-axle coordinate/(Object beginning):	-800 mm
o Z-axle coordinate/(Object end):	1800 mm
o Z-axle coordinate/(First measuring point):	-900 mm
o Z-axle coordinate/(Last measuring point):	1700 mm
o Z-axle coordinate/(Step length):	180 mm (Depending on JIG available)
o x-axle coordinate (Line 1) :	800 mm
o X-axle coordinate (Line 2) :	1200 mm

- **Measuring setup**
  - o The measurement of the vertical guide ways should later be used in comparing the table with the horizontal guide way. In order to do so it is required to measure in the **absolute mode**. An absolute mode measurement requires before the measurement a reversal measurement with the instrument.
  - o The measurement is done with a **single instrument with an angular base**. This means both guide ways are measured one after the other.

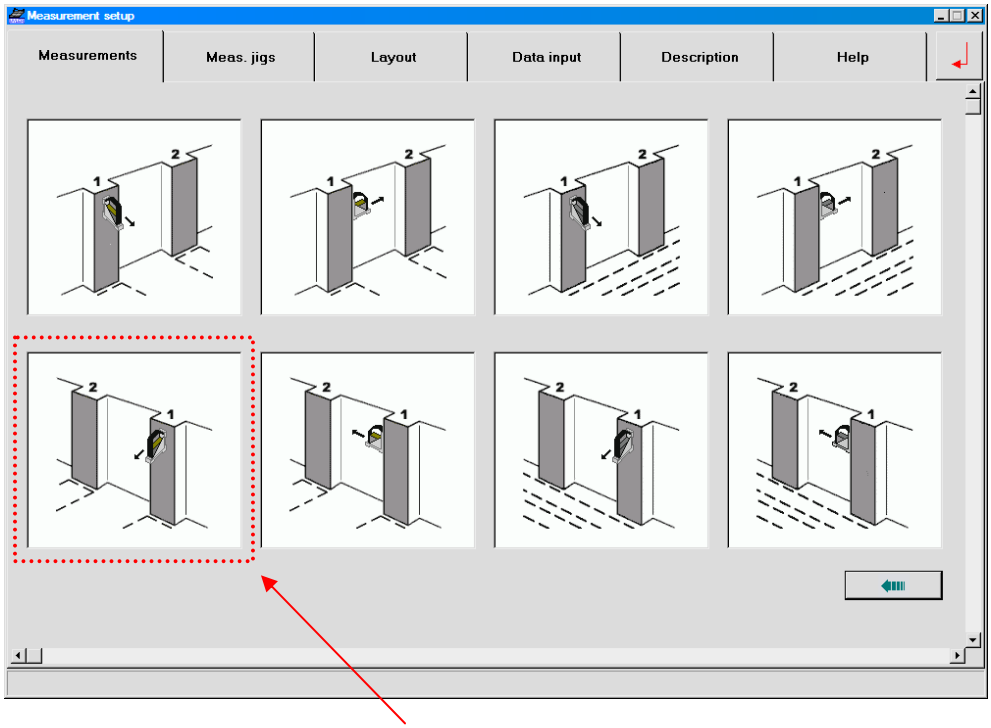
Procedure:

Go back to the submenu <**SETUP**>
The layout of the previous measurement is still displayed



Below Measurement Setup the pull down menu can be used to change to "Guide ways" / "**NEW**" and confirm with [Enter] 

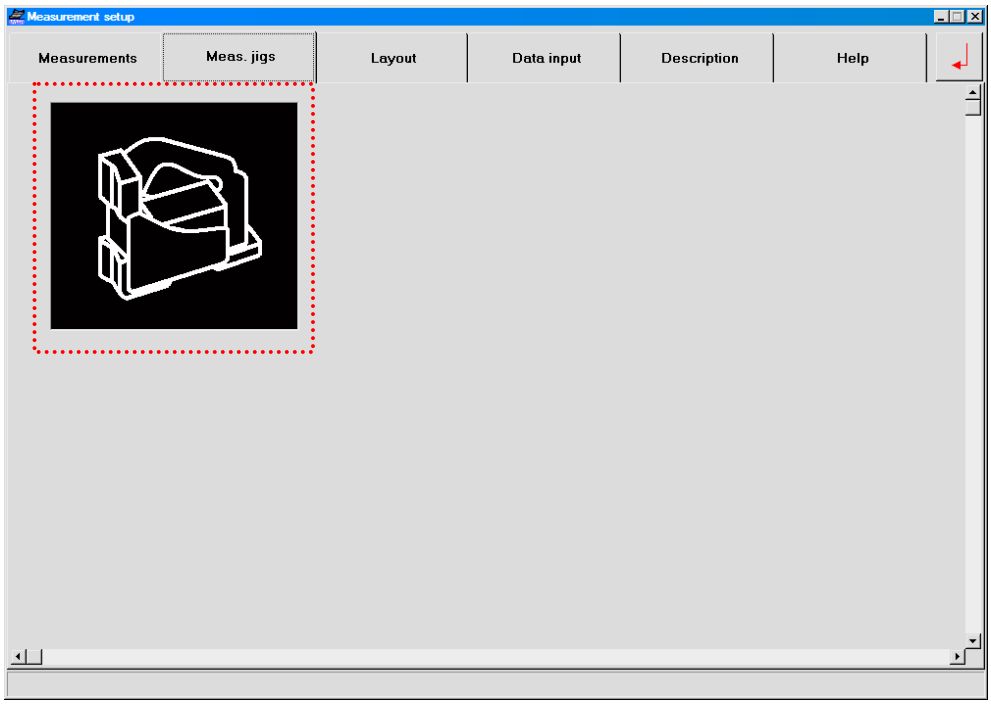
A number of different possibilities for the **type of guide ways** is displayed under **<MEASUREMENT SETUP>**



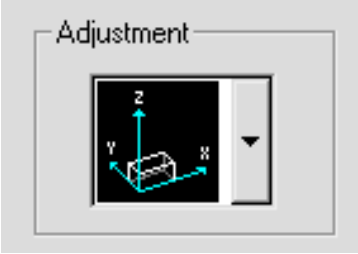
In our example we chose the option two vertical guide ways.

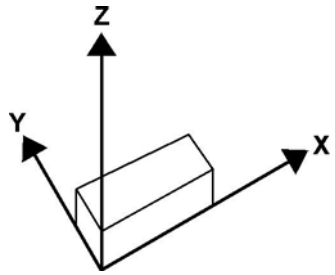
Attention
This option requires possibly the use of the **scroll bar**!

Selecting Meas. JIGs only the **measuring instrument / <MEAS JIGS>** appears without additional JIGs



The next selection is the definition of the layout.
Next under <**LAYOUT**> / "**Adjustment**" the coordinate system (**work piece coordinates**) must be defined.
In our example we chose

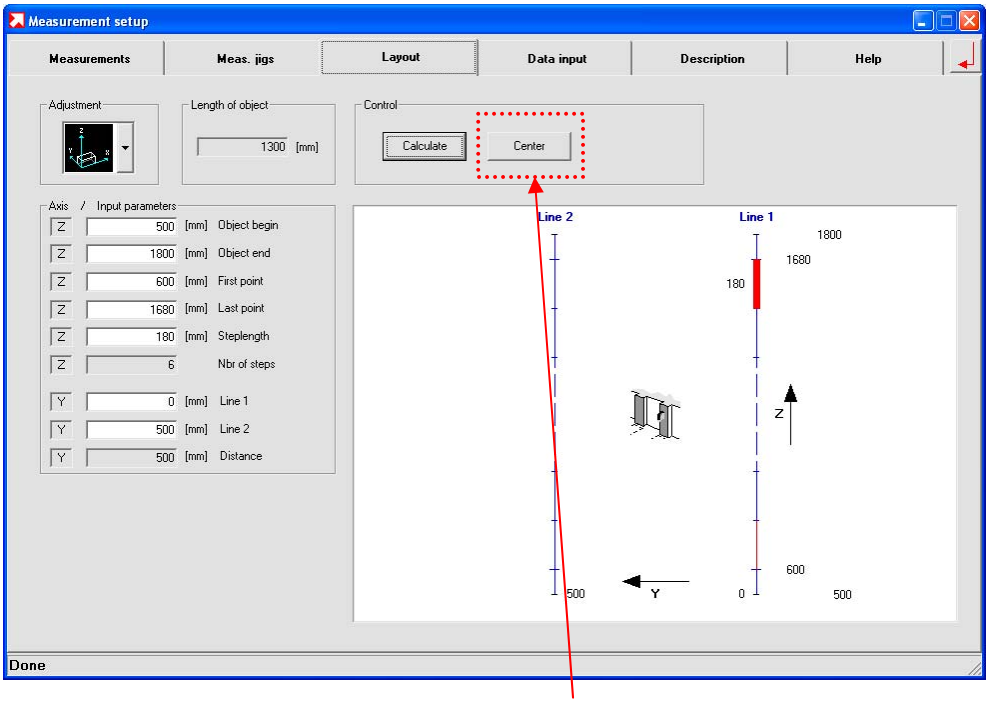




Next the coordinates must be entered. (IMPORTANT: **WORK PIECE COORDINATES**)

- **Work piece coordinates**
  - Z-axis coordinate/(Object beginning): 500 mm
  - Z- axis coordinate/(Object end): 1800 mm
  - Z- axis coordinate/(First measuring point): 600 mm
  - Z- axis coordinate/(Last measuring point): 1700mm (1680mm)
  - Z- axis coordinate/(Step length): 180 mm (Depending on JIG available)

  - X- axis coordinate (Line 1) : 0 mm
  - X- axis coordinate (Line 2) : 500 mm



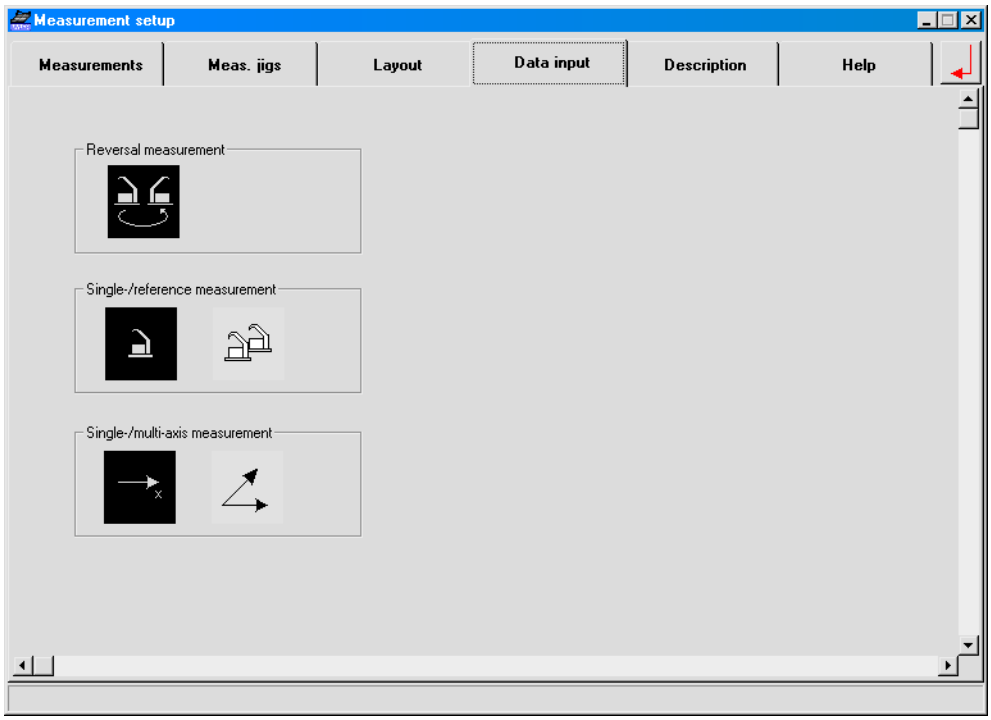
Confirm with [Calculate]

After entering the data confirm with [Calculate]
the graph will be finalised and additional data is entered automatically.

- Length of Object (1000mm)
- Number of steps (6)
- Distance (line 1 to line 2 = 500mm)

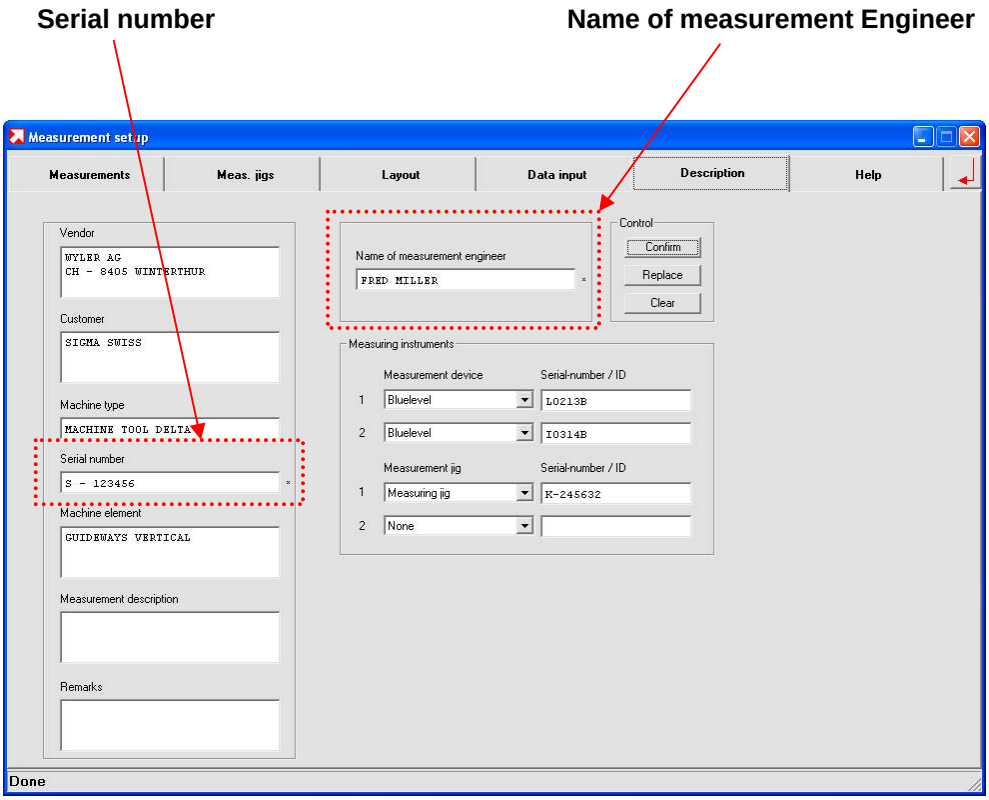
It is important to check all the displayed data for their correctness. !

Change to <**DATA INPUT**>
In this selection specific procedures for the data input are defined.



In our **example** we chose:
Reversal measurement / Single Instrument (**Absolute mode**). This means in the first step we measure the vertical guide way no. 1 and in the second step we measure the guide way no. 2.

Next the <**DESCRIPTION**> must be done

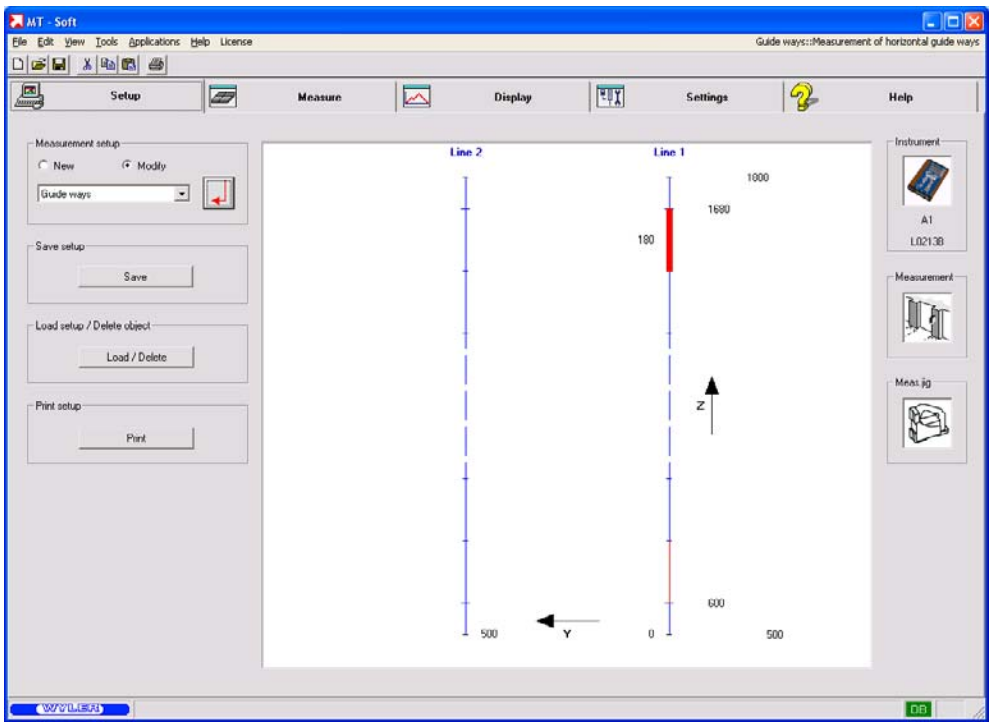


The description is to define exactly the measuring task and the identification of the objects
In this dialogue box all the necessary data for defining the planned measurement can be entered. The **Name of measurement Engineer** and the **Serial number** of the object to be measured are **mandatory**.

All the rest of the information is free to fill in.
The text can also be integrated from an existing template by using the [Replace] button

It is still possible to make changes in the setup registers.
If not required press the button [confirm] 

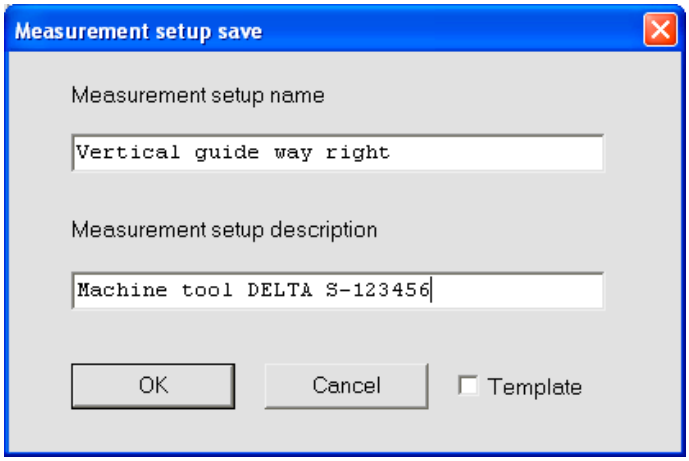
The actual measuring-configuration is finished now.



The following information is displayed:

- Object to be measured, in our case "Guide Ways"
- On the right side of the window
  - -Instrument: The connected instrument respectively Interface
  - -Measurement Type of Guide way (vertical, symbol)
  - -Meas. JIG Type of JIG specified

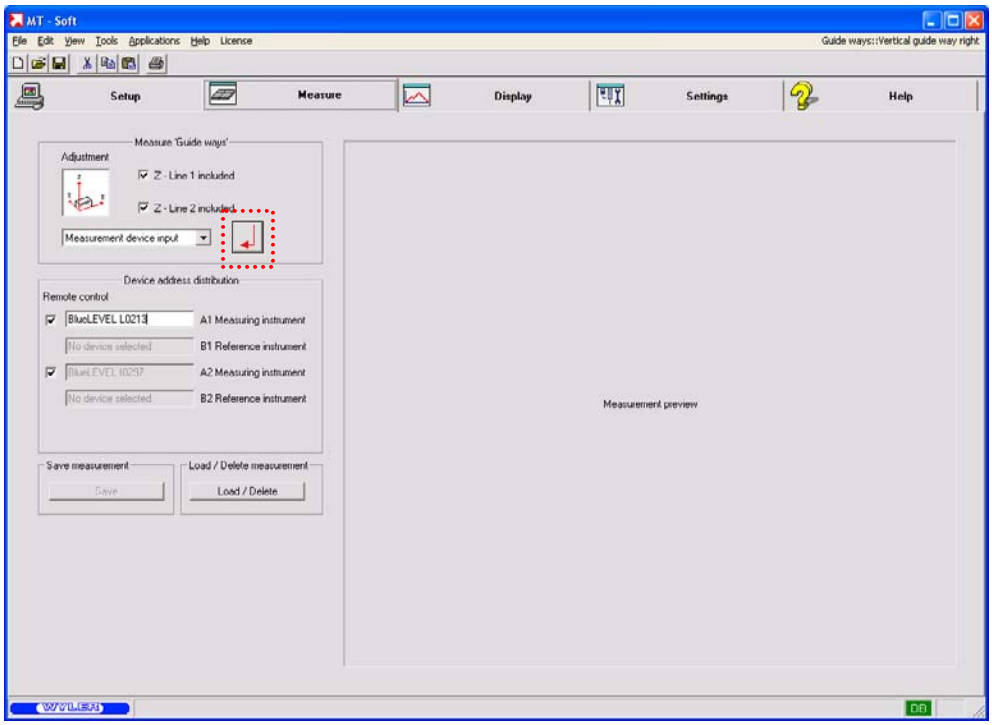
- Under "Save Setup" the button “save” opens a dialogue box. The setup may be saved as **"Template",** e.g. as:
  - Measurement setup name: **"Vertical guide way right"**
  - Measurement setup description: **"Machine tool DELTA S-123456"**



- Under <**LOAD SETUP / DELETE OBJECT**> the button [Load/Delete] allows to open an existing setup template or delete an object.

- Under <**PRINT SETUP**> the button [Print] allows to print the actual measurement setup template

For **starting the measurement** the register <**MEASURE**> must be activated



In this register the following input is possible:

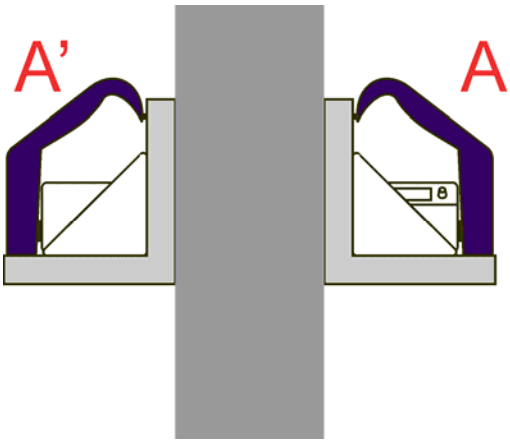
- Below <**MEASURE GUIDE WAYS**> it is possible to change between "Input device", directly from interface to PC or "manual input" via Console Input

- Below Measure Guide Ways it is also possible to define whether a complete measurement of both guide ways should be performed or not.

We activate both boxes for our measurement and select <**MEASUREMENT DEVICE INPUT**>. To start the measurement [Enter]  must be confirmed

Two options are possible to determine the angular error of the instrument.

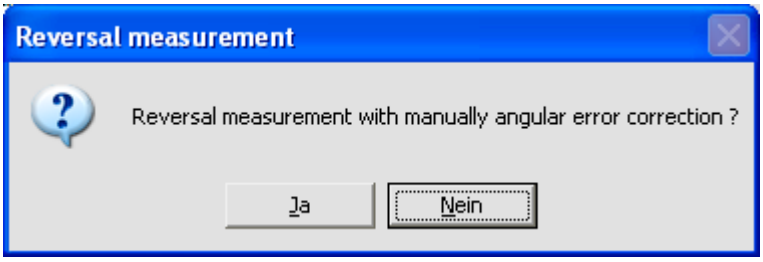
- **Option 1**
  Ideally a vertical reversal measurement is done. This requires a **high precision granite square block with two exactly parallel surfaces** with none or smallest possible surface error. With this procedure it is possible to calculate the **vertical zero offset** of the instrument and, when previously the horizontal reversal measurement was done, the **angular error of the instrument** is automatically determined.



- **Option 2**
  In case no high precision square block is available the zero setting can be done by applying the horizontal reversal measurement only, best possible on a granite setting plate.
  After that the **angular error of the instrument can be applied by manual input**. The value of the angular error can usually be found on a calibration certificate. Is no calibration certificate available the only way is to enter the value “0” as angular error of the instrument. When doing so it must be noted that the measuring uncertainty is larger.

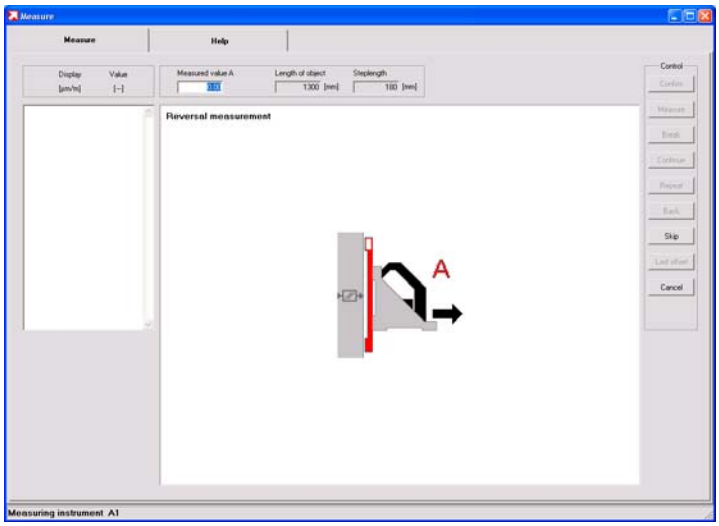
Procedure Option 1
Automatic definition of the angular error and the zero offset of the instrument.

After starting the measurement by pressing [ENTER] the following dialogue box appears with the question "Reversal measurement with manual angular error correction?”

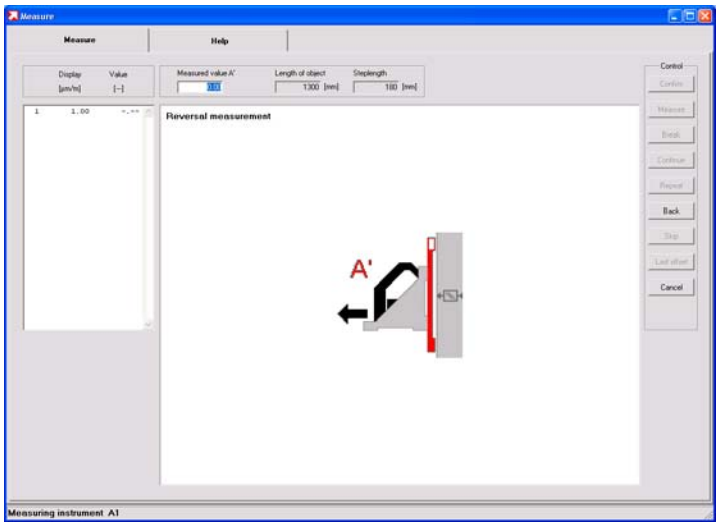


In **option 1** the reversal measurement is done by means of a square block therefore the answer to the question is [NO].

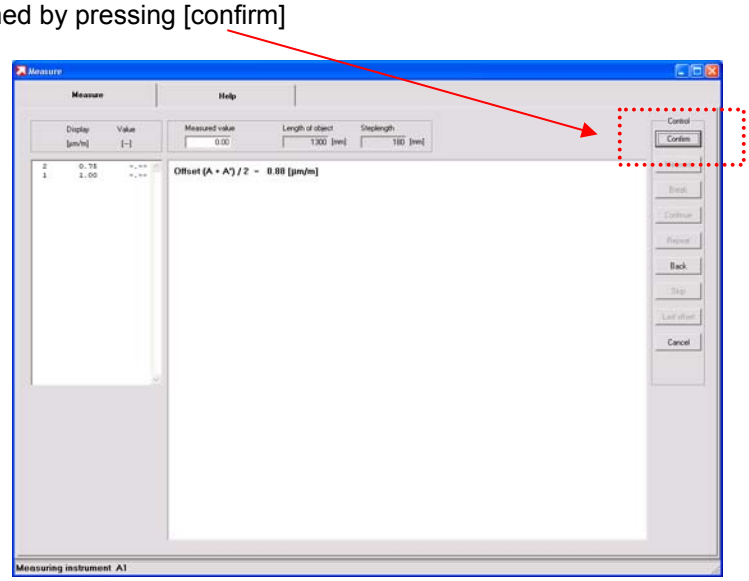
After selection [NO] the procedure for the vertical zero setting is started. The first measurement with the instrument is measurement “**A**”.



During the data collection of the first measurement the remark “please wait” is displayed. When finished the second measurement must be done, measurement “**A’** ”.



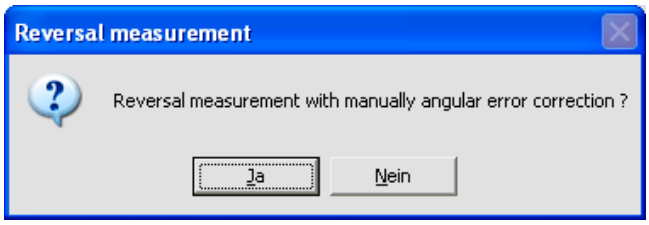
After the second reading the zero offset of the instrument is automatically calculated
offset=(measurement <A> + measurement <A’>) / 2 and displayed.
This value must be confirmed by pressing [confirm]



The Zero offset in relation to the vertical measuring base is thus compensated. Thus the instrument is ready for the measurement.

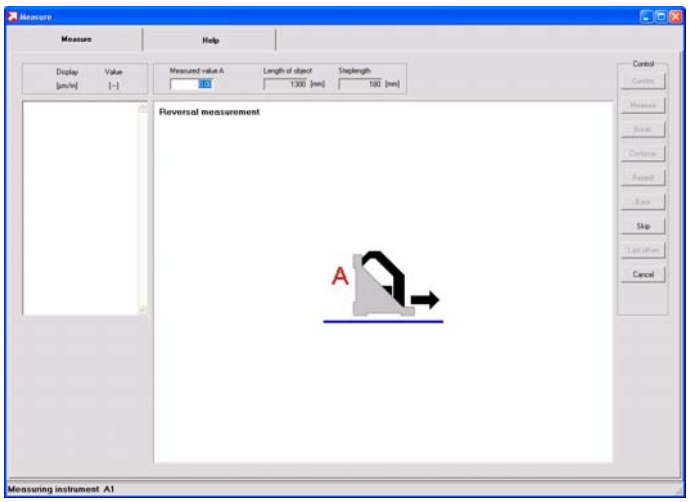
Procedure option 2
Automatic definition of the zero offset and manual setup of the angular error

After starting the measurement by pressing [ENTER]  the following dialogue box appears with the question ”Reversal measurement with manual angular error correction?”



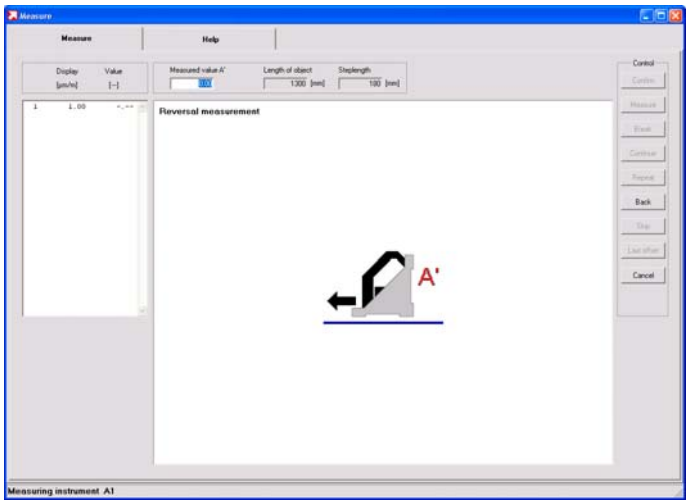
In **option 2** the manual correction of the angular error is entered manually. The answer to the question is [YES]. In order to eliminate any errors from the surrounding the reversal measurement should be done on a best possible horizontal surface with smallest horizontal flatness errors.

After confirming with [Yes] the horizontal reversal measurement on an horizontally adjusted setting plate is performed. The first measurement with the instrument is measurement "**A**"..



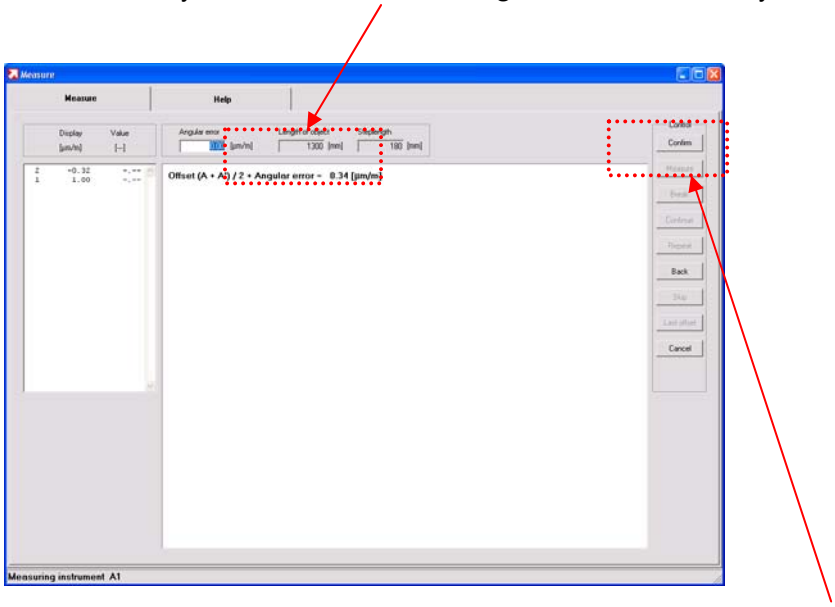
As you can see from the picture, in this case only a reversal measurement on a horizontal plane is required. This reversal measurement serves only for the compensation of the Zero offset in relation to the horizontal measuring base.

During the data collection of the first measurement the remark “please wait” is displayed. When finished the second measurement must be done, measurement “**A’** ”



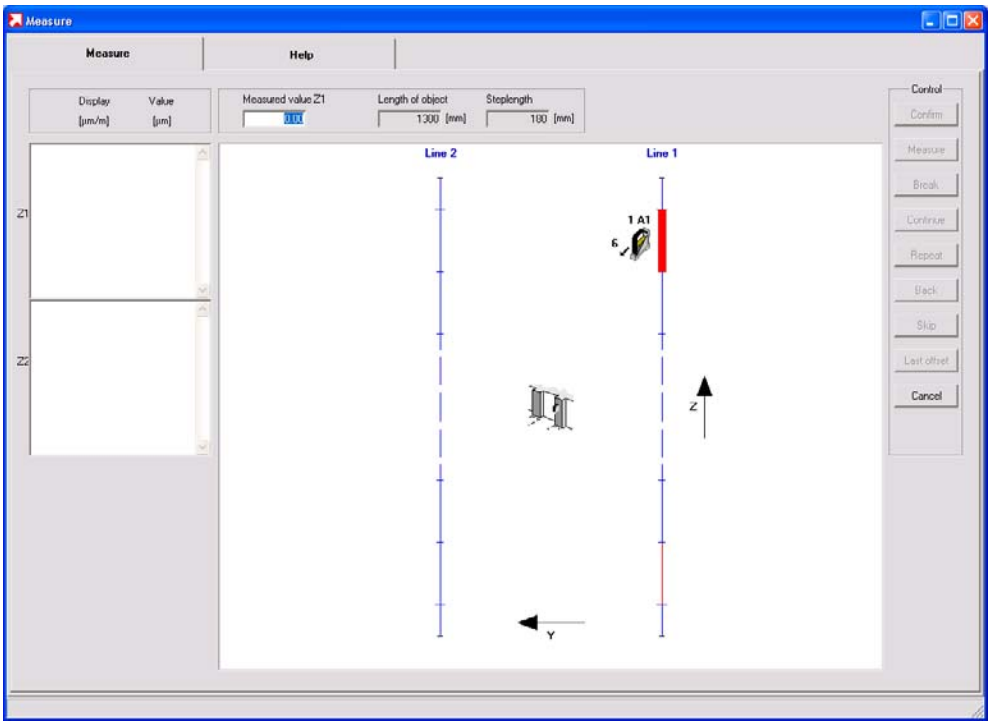
After the second reading the zero offset of the instrument is automatically calculated without definition of the angular error Offset**= {measurement <A> + measurement <A’>} / 2** and displayed.

The angular error may be entered manually now. The value of the **angular error** can usually be found on a calibration certificate.



After manually entering the angular error and the zero offset have to be accepted by pressing [confirm]

After the **reversal measurement finished** the actual measurement of the guide ways can be started.

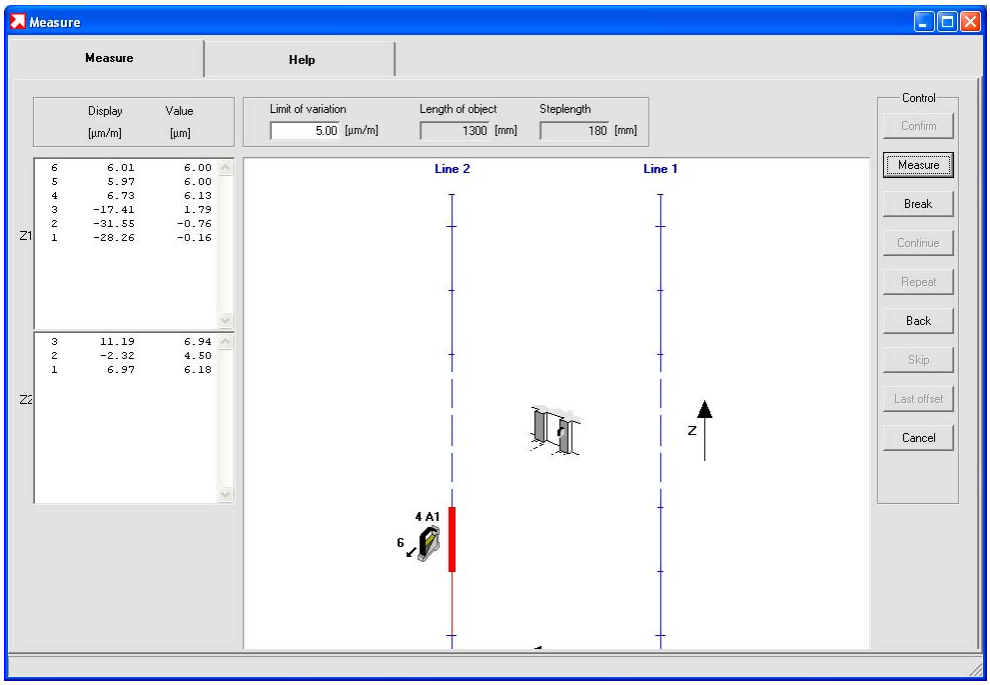


The first position of the instrument is indicated. The instrument must be placed there. After the required settling time use <**MEASURE**> to collect the first measuring data. Check the direction of the measurement!!

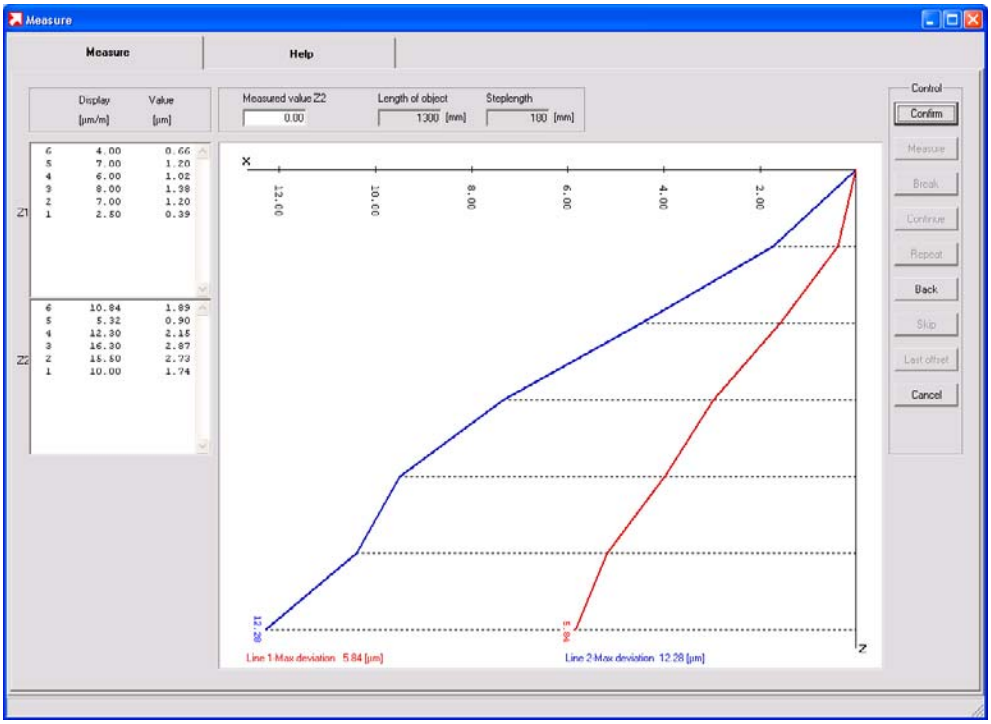
Information between the measurements
After the data is collected the measured value is displayed on the screen in large figures and the following options are available:

- Continue measurement
- Repeat measurement
- Cancel measurement

On the left side of the screen the numerical values of the axes Z (Z1 + Z2) are displayed

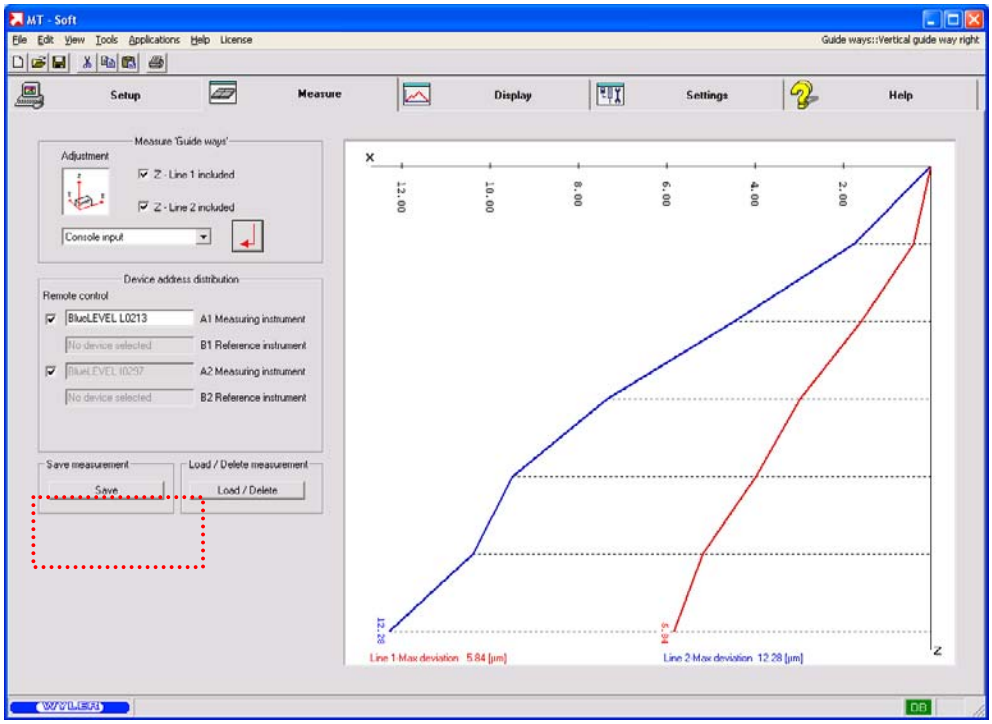


After the last measurement the result of the measurement is displayed in graphical form.



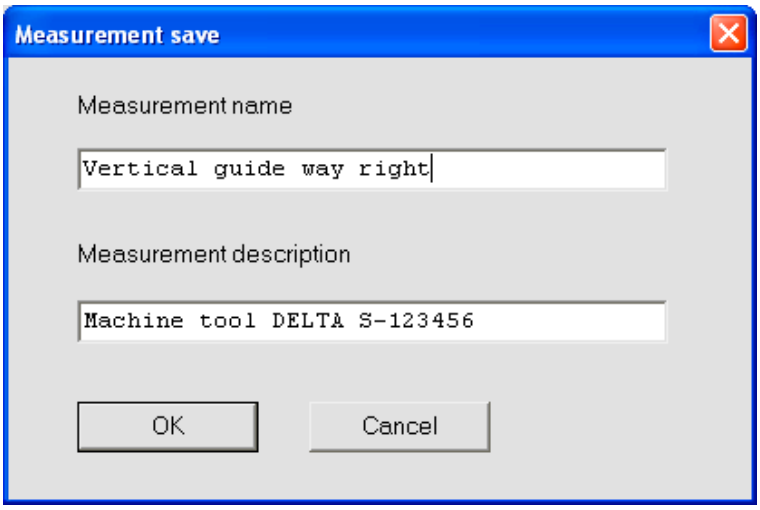
Using [Confirm] means the measurement is accepted. If not the button [Back] goes back step by step through the measurement for possible repetition.

After [Confirm] is pressed the measurement is definitively finished and the following window appears.



If the measurement is correct it should be saved, e.g. as:

- Measurement setup name: **"Vertical guide way right"**
- Measurement setup description: **"Machine tool DELTA S-123456"**

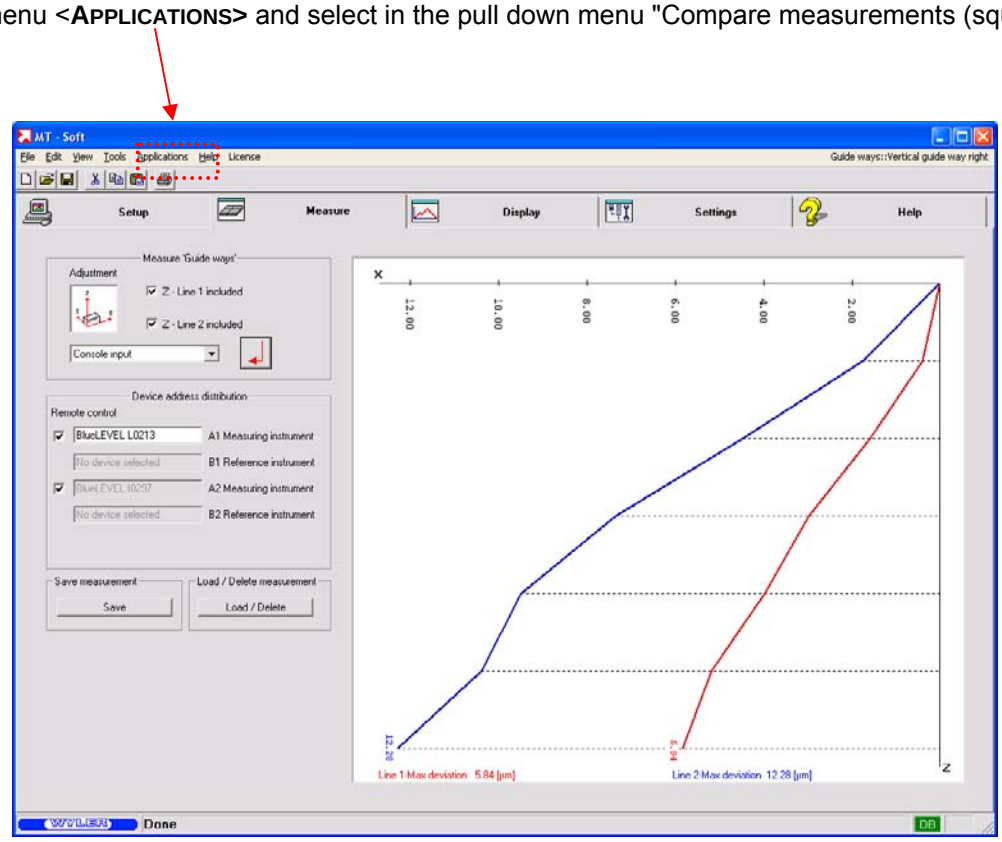


It is useful to save the data with a clearly defined name for later easily finding the measured information.

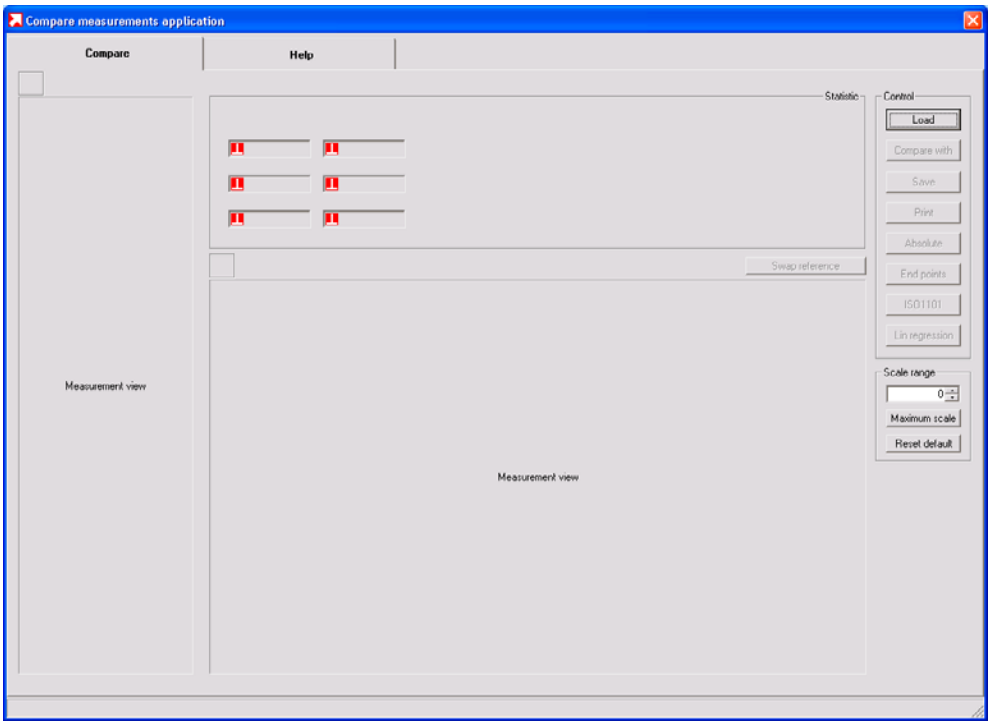
Next the result may be analysed or printed

6.1.3 COMPARISON OF THE GUIDE WAYS HORIZONTAL AND VERTICAL

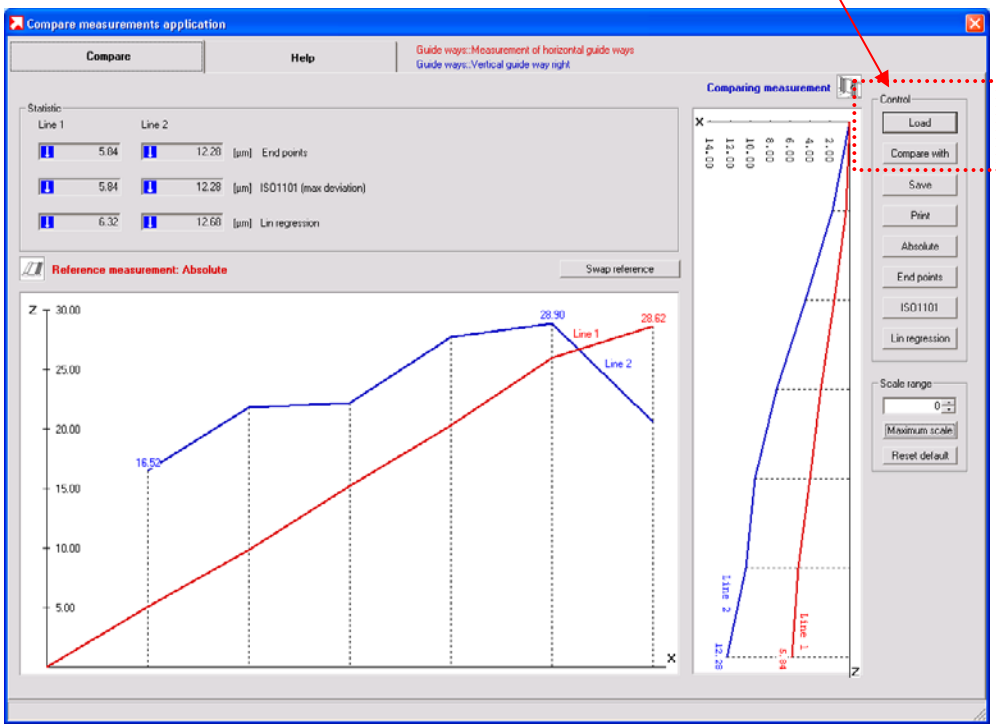
Go to the submenu <**APPLICATIONS**> and select in the pull down menu "Compare measurements (squareness)"



The following window is displayed.



Load now the measurements of the vertical guide way using the button [Load]
You will then find a list of all measurements relevant respectively available for this machine (identical serial number). After that you select the horizontal guide ways via [compare with].



When both the guide ways are activated, the results may be aligned according to the available alignment methods, such as:

- Method "**Absolute**"
- Method "**End points**"
- Method "**ISO1101**"
- Method "**Linear regression**"

and then displayed and analysed.

The following values are displayed in numerical form for the Lines 1 and 2:

The reference measurement is displayed according **Absolute**. The horizontal guide way / Line 1 (front guide way) is defined as reference line. According to this setup the results for the vertical guide ways Line 1 and Line 2 are as follows:

Squareness	Line 1	Line 2
Endpoints	**5.84 µm**	**12.28 µm**
ISO 1101	**5.84 µm**	**12.28 µm**
Lin. Regression	**6.32 µm**	**12.68 µm**

The reference line may be changed by using the button [Swap reference] below "Statistic".

Depending on the alignment method and the selected reference line the results may be slightly different.

6.2 COMPARISON OF A HORIZONTAL WITH A VERTICAL GUIDE WAY (AS PER PICTURE BELOW)

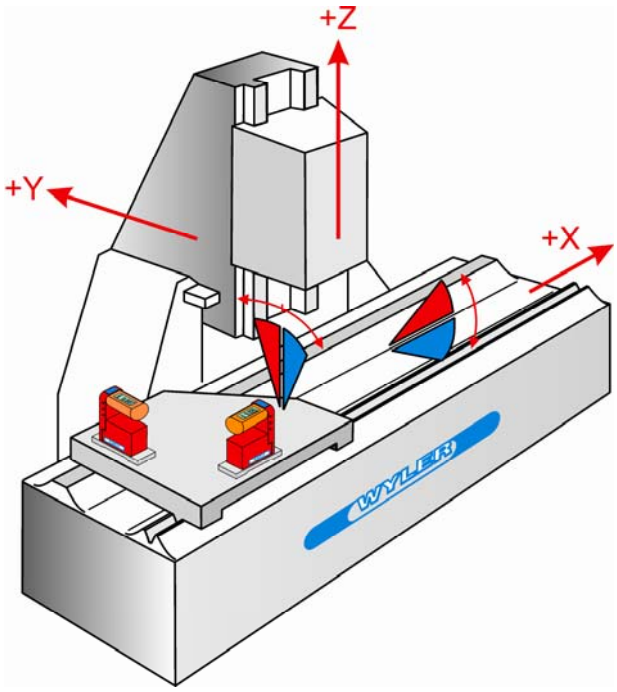
Since the different measurements have been done in absolute mode, it is possible to compare measured results of different elements at a later stage.

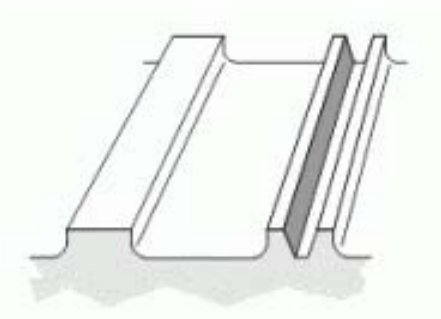
In order to measure in the absolute mode a reversal measurement with the instrument is required before the measurement. For details see pt. 2.5.10

For a better understanding we take a closer look at the following example:

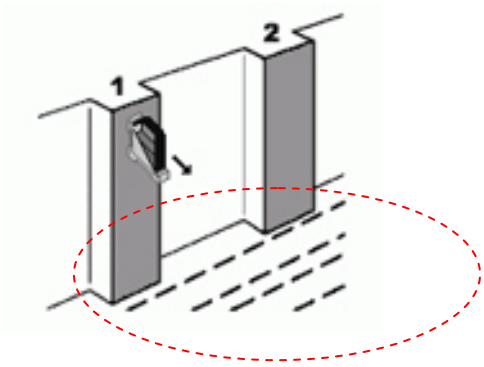
Measuring task:

- First a **horizontal guide way** of a machine tool is measured





- Second the **vertical guide way** of the spindle of the machine tool is measured



Attention:
In this example the vertical guide way is at the side of the horizontal guide way (in Y direction.

IMPORTANT
Elements of a machine may only be compared when

- the **serial number** defined under measurement description
  and
- the **coordinate system** of both elements are identically

6.2.1 MEASUREMENT OF THE HORIZONTAL GUDE WAY

The measurement example:

- **Type of measurement** Guide way horizontal
  - Front guide way "**prismatic**"
  - Rear guide way "**flat**"

- **First cross section measurement** at the end of the measuring JIG

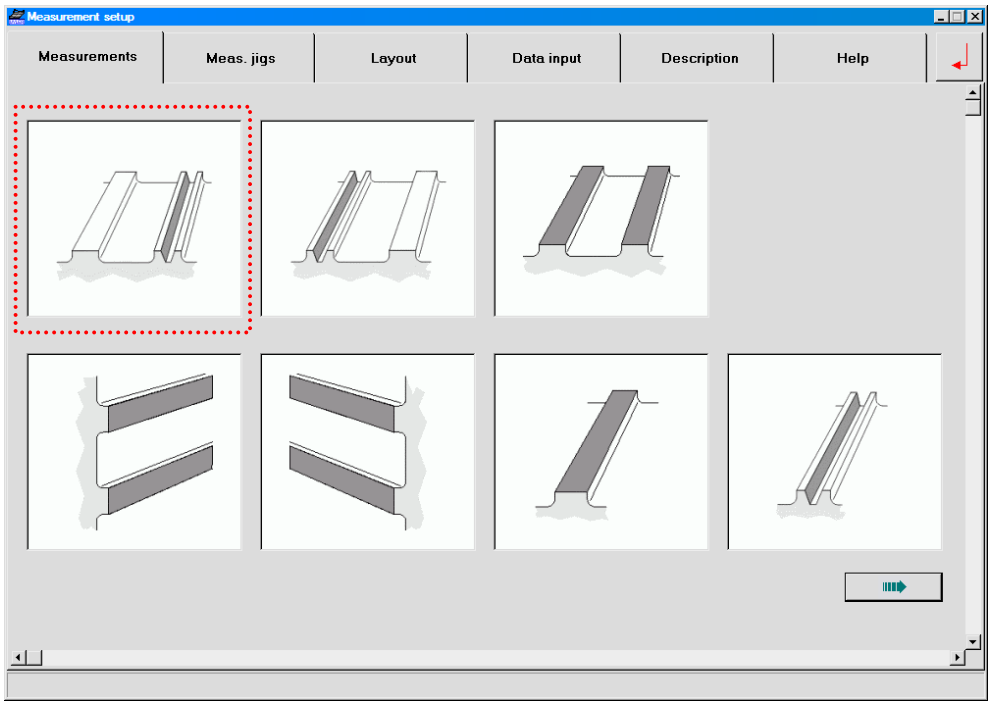
- **Work piece coordinates**
  - X-axle coordinate/(Object beginning): -1000 mm
  - X-axle coordinate/(Object end): 1000 mm
  - X-axle coordinate/(First measuring point): -900 mm
  - X-axle coordinate/(Last measuring point): 900mm
  - X-axle coordinate/(Step length): 300 mm (depending on JIG available)

  - Y-axle coordinate (line 1) : 0 mm
  - Y-axle coordinate (line 2) : 500 mm

- **Measuring setup**
  - The measurement of the guide ways should later be used in comparing the table with the vertical spindle guide way. In order to do so it is required to measure in the **absolute mode**. An absolute mode measurement requires before the measurement a reversal measurement with the instrument.
  - The measurement is done **with two instruments**. This means that we measure the two **axis X and Y simultaneously**.

Procedure:
In the register <SETUP>, below <MEASUREMENT SETUP> the pull down menu can be used to change to "Guide ways" and confirm with [Enter]

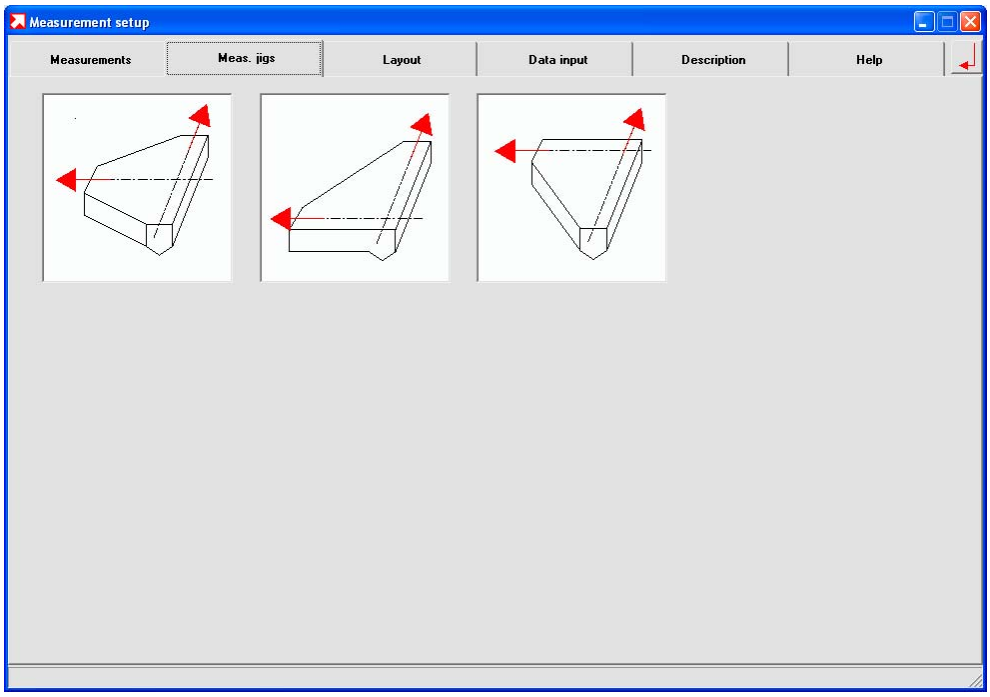
A number of different possibilities for the **type of guide ways** is displayed under <MEASUREMENTS>



In our example we chose the first option.
(Front, near, guide way prismatic, back, far, guide way flat)

After the selection by mouse click the background becomes black.

Change to the sub register **<MEAS. JIG>**

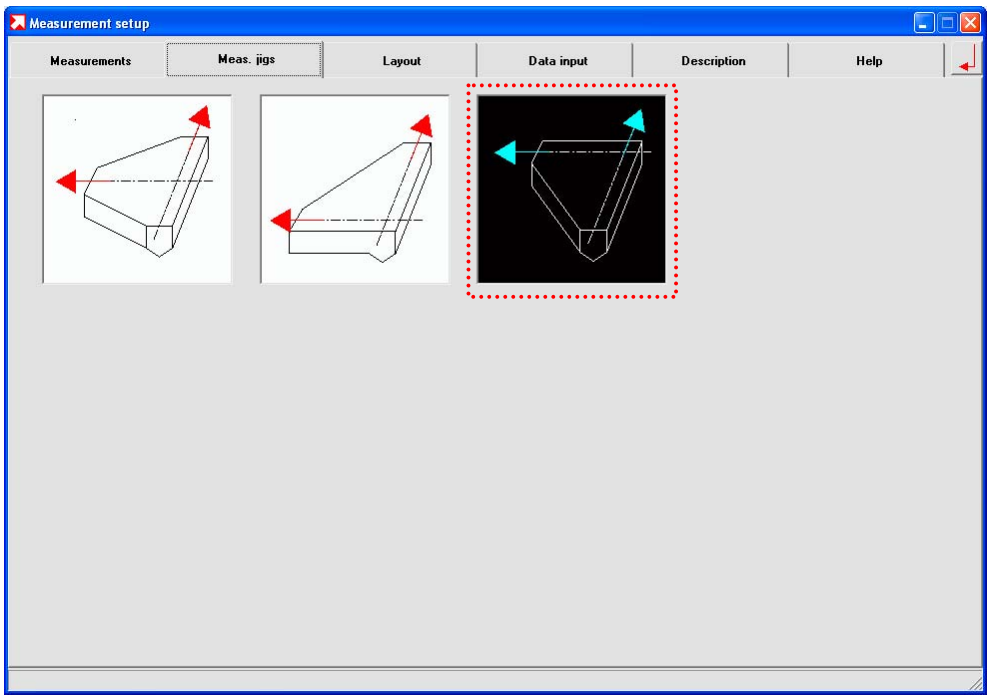


Here three options are available

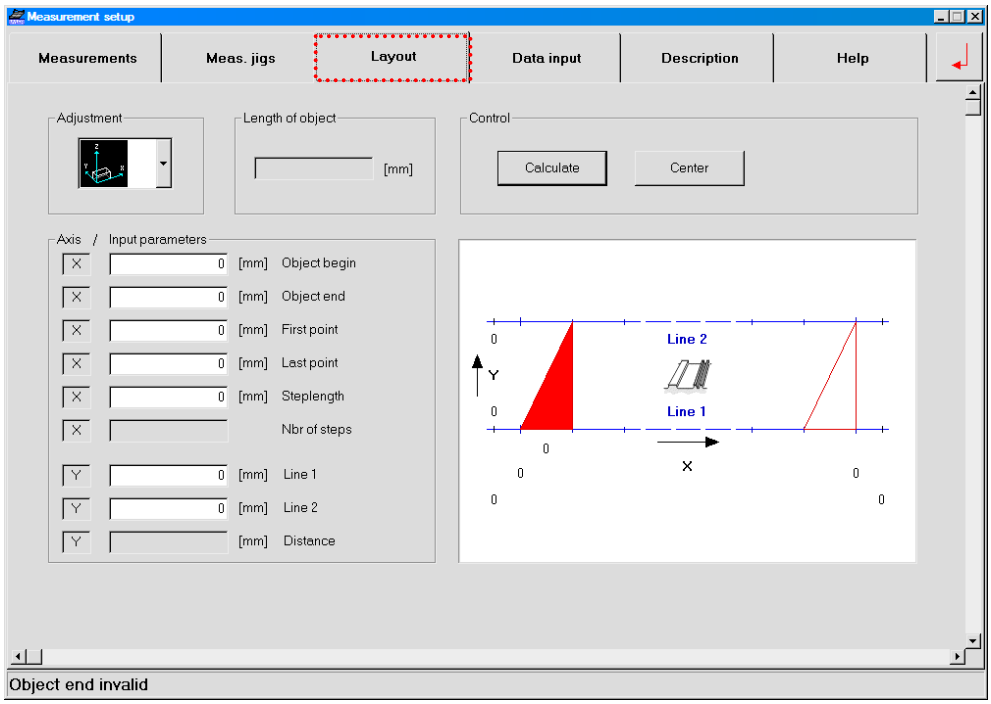
- JIG with symmetrical base plate (position of cross direction at the centre of the base plate)
- JIG with asymmetrical base plate (position of cross direction at the beginning of the base plate)
- JIG with asymmetrical base plate (position of cross direction at the end of the base plate)

Remark
The measuring JIGs are usually supplied by the user as the JIGs are depending on the type and shape of the machine. WYLER AG however is glad to quote and supply any JIG required. (See also chapter “Measuring base”)

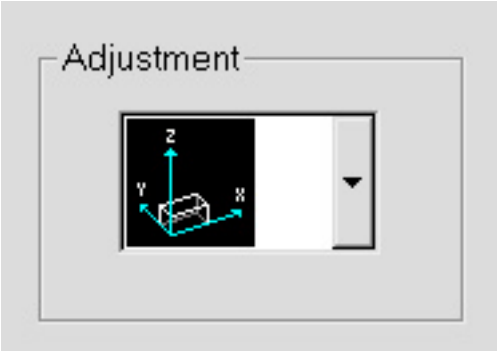
In our example we chose the JIG with asymmetrical base plate (position of cross direction at the end of the base plate)

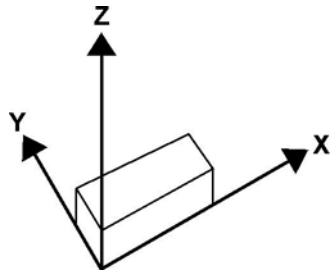


Change to the sub register **<LAYOUT>**



Firstly under <**ADJUSTMENT**> the coordinate system (**work piece coordinates**) must be defined. In our example we chose





Next the coordinates must be entered. (IMPORTANT: **WORK PIECE COORDINATES**)

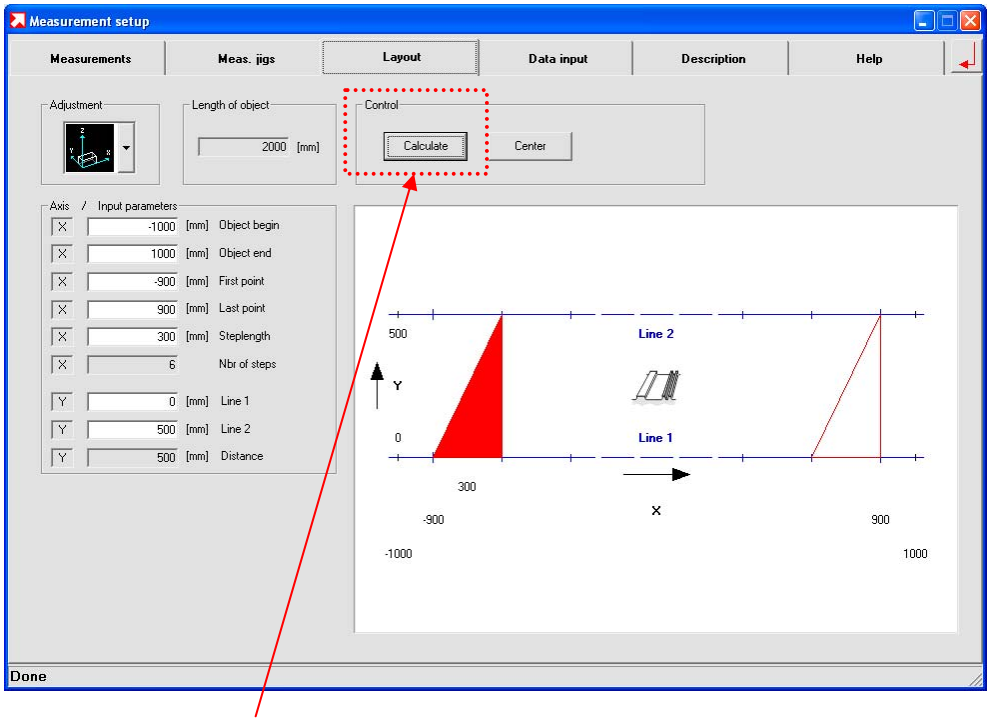
- X-axis coordinate/(Object beginning): -1000 mm
- X- axis coordinate/(Object end): 1000 mm
- X- axis coordinate/(First measuring point): -900 mm
- X- axis coordinate/(Last measuring point): 900 mm
- X- axis coordinate/(Step length): 300 mm (depending on JIG available)

- Y-axle coordinate (Line 1) : 0 mm
- Y-axle coordinate (Line 2) : 500 mm

After entering the data confirm with [Calculate]
the graph will be completed and additional data is entered automatically.

- Length of Object: 2000mm
- Number of Steps: 6
- Distance line 1 to line 2 = 500mm

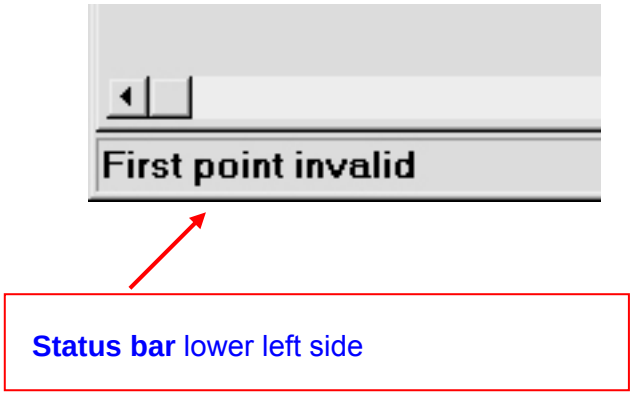
It is important to check all the displayed data for their correctness.



After confirming with [Calculate] the following additional information is displayed

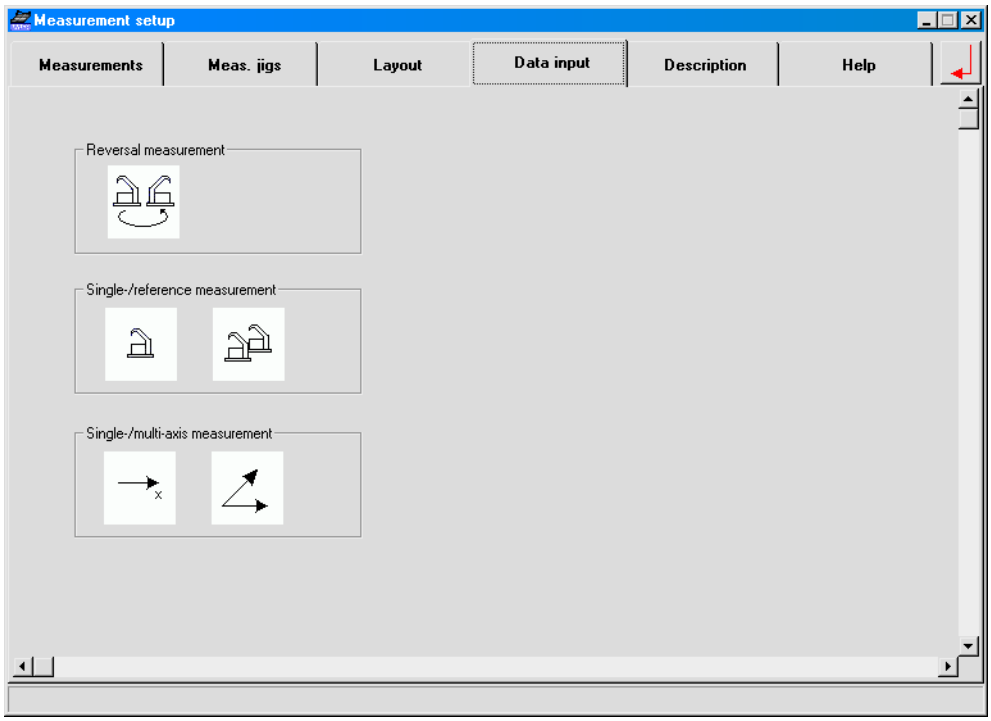
- Length of Object 2000mm
- Distance (line 1 to line 2) = 500mm

Information to incorrect or missing values are displayed in the status bar
Example



Also displayed are the graphic layout and the numerical figures. This should be checked before proceeding.

Change to <**DATA INPUT**>
In this selection specific procedures for the data input are defined.



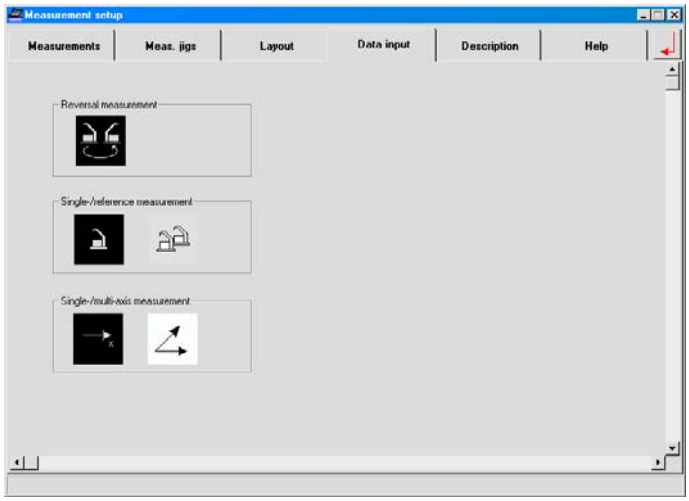
Here only the type of measurement can be entered. The following options are available:

- **Reversal measurement**
  This mode is used for “absolute” measurements and for the measurement of different individual objects to be compared at a later stage

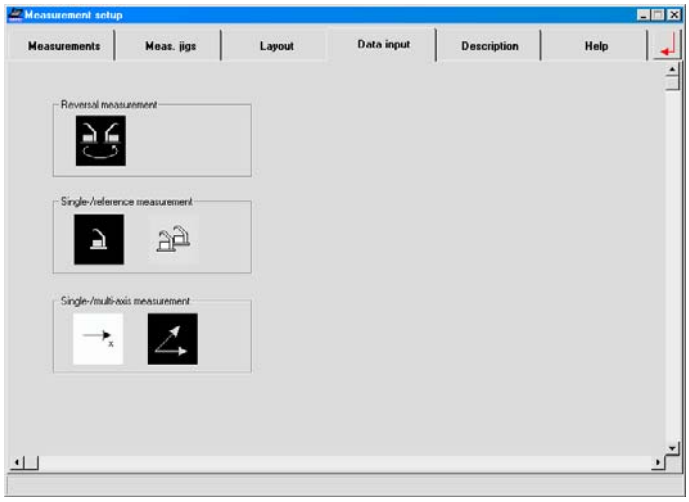
- **Single/reference measurement**
  Selection whether one individual instrument is used or two instruments in differential mode are used. (Value = A - B). Differential measurement does not allow “reversal measurement”

- **Single / multi-axis measurement**
  Selection of measurement procedure such as measurement first in one direction X and after that in a second run the Y-axis is measured. Alternatively both axis may be measured simultaneously with two instruments

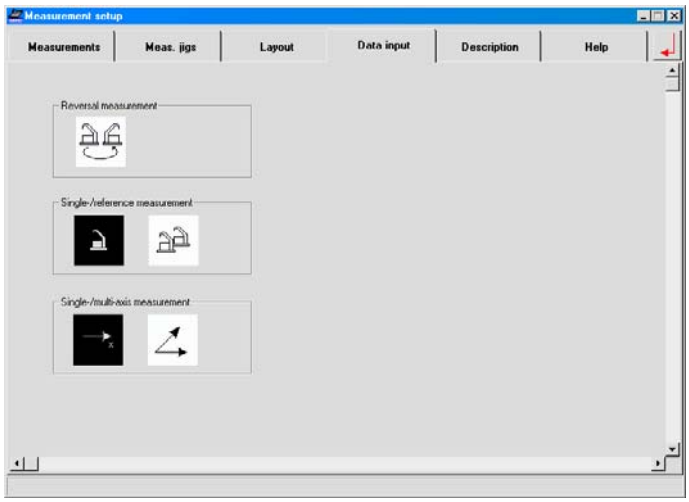
- **Reversal measurement** / Single Instrument (**Absolute mode**). This means one direction (X) is measured at one time only. In a second step the cross direction (Y) is measured.



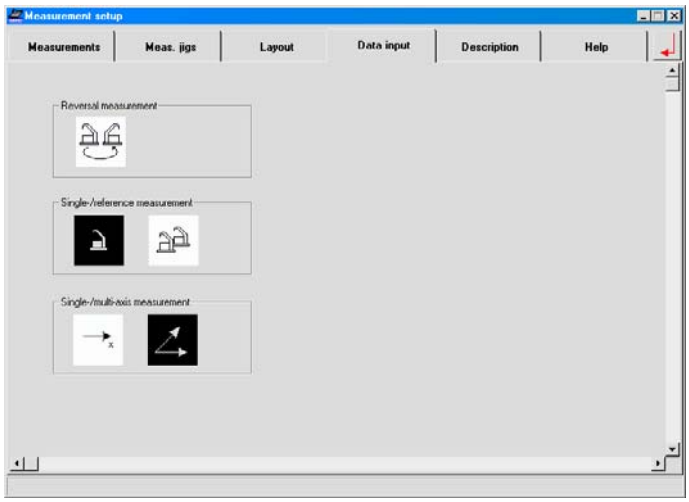
- **Reversal measurement** / One Instrument per direction (**Absolute mode**). This means measurements in X-direction and in Y direction simultaneously



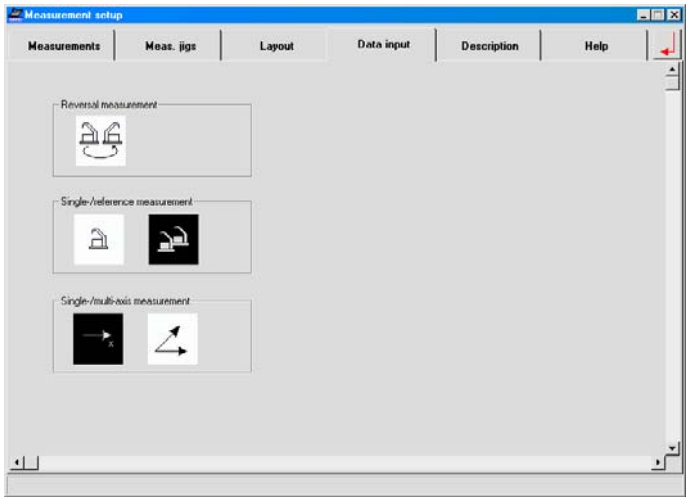
- **<u>Without</u> reversal measurement** / Single Instrument (**Relative mode**). This means in the first step measurements only in X-direction and in the second step measurements in Y direction only



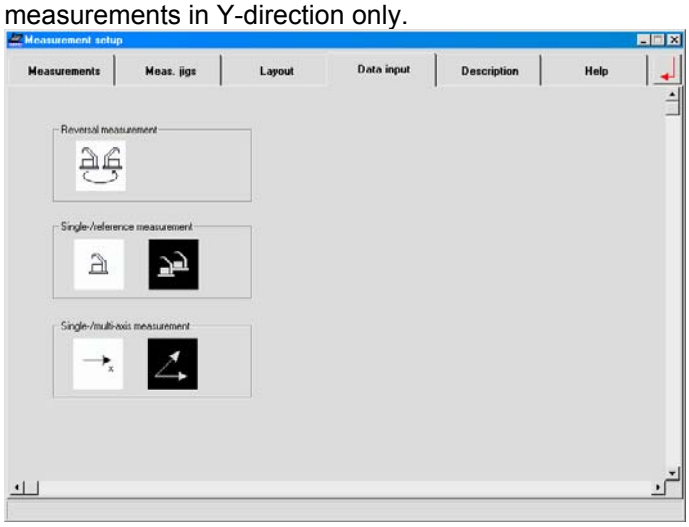
- **<u>Without</u> reversal measurement** / Single Instrument (**Relative mode**). This means in the first step measurements only in X-direction and in the second step measurements in Y direction only.



- **<u>Without</u> reversal measurement** / One instrument per direction (**Relative mode**). Measurement in X and Y direction simultaneously. (One instrument means one instrument in any chosen direction)



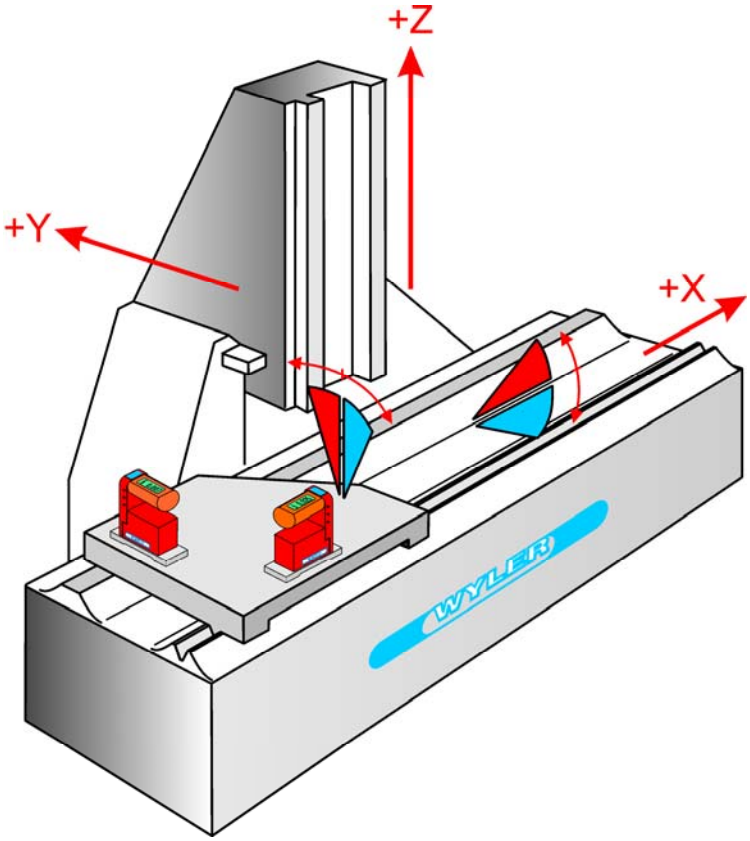
- **<u>Without</u> reversal measurement** / Two Instruments (**Relative mode, Measuring and reference instrument**). This means in the first step measurements only in X-direction and in the second step measurements in Y-direction only.

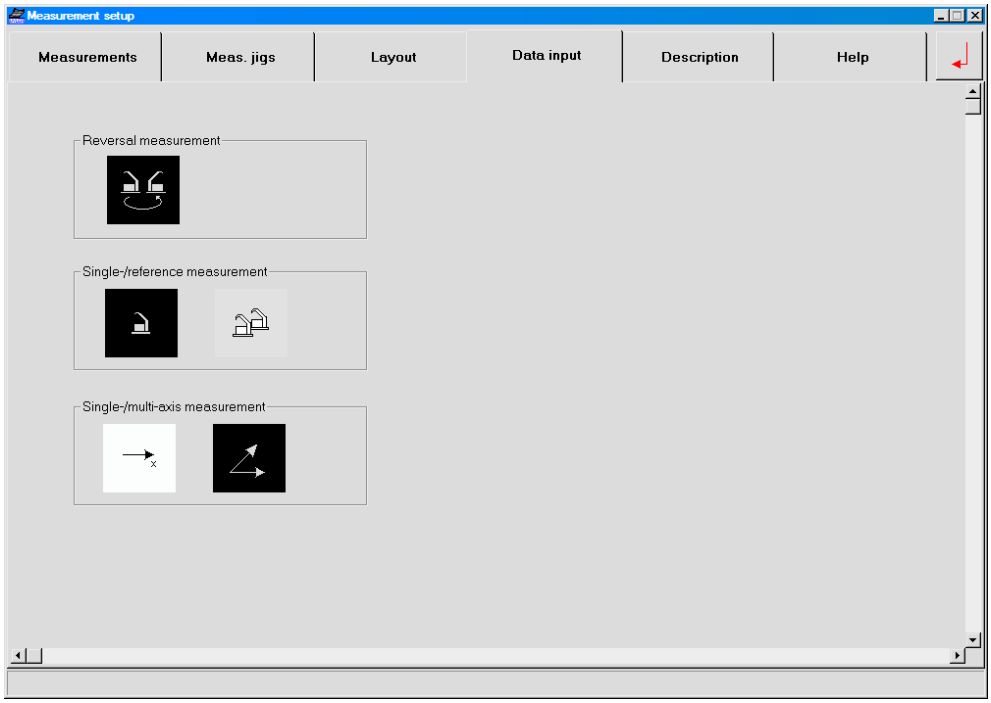


Important
When using a **LEVELMETER 2000** or a **BlueMETER** it is possible to measure the two axis X and Y simultaneously as long as no reference mode is activated.

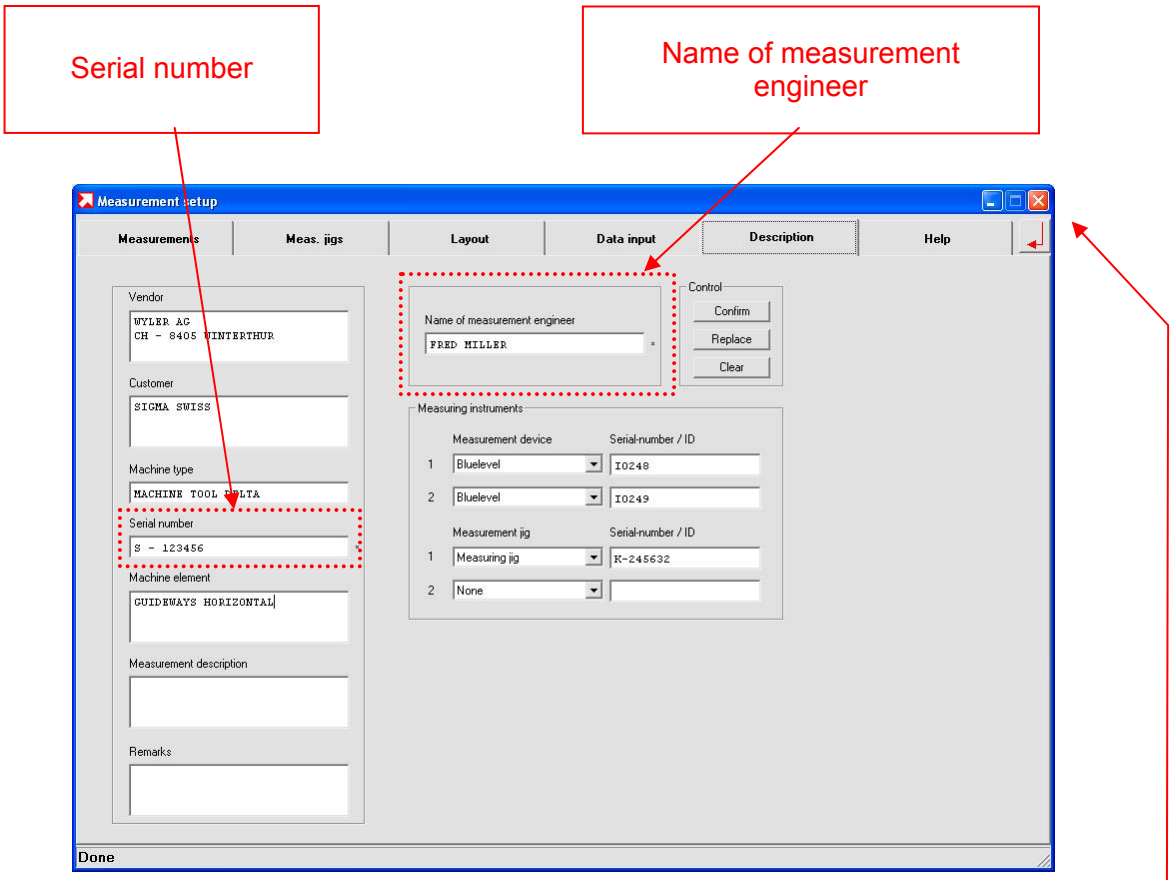
If a Leveladapter 2000 is used and it is meant to measure in both directions X and Y simultaneously, it is in any case necessary to measure with two Leveladapter 2000 and two different COM ports on the computer are required

In **our example** we chose
Absolute mode (Reversal measurement). This means that we measure the two **axis X and Y simultaneously**.





Next the <DESCRIPTION> must be done

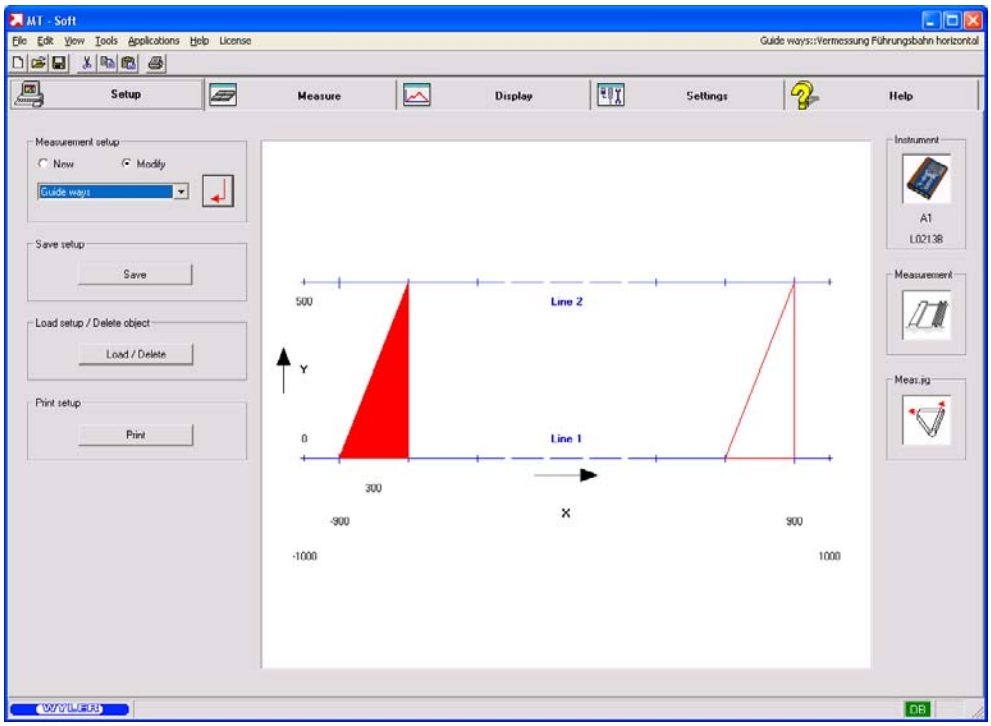


The description is to define exactly the measuring task and the identification of the object.
In this dialogue box all the necessary data for defining the planned measurement can be entered. The **Name of measurement Engineer** and the **Serial number** of the object to be measured are **mandatory**.
All the rest of the information is free to fill in.

The text can also be integrated from an existing template by using the [Replace] button

It is still possible to make changes in the setup registers.
If not required press the button [Confirm] and then the button [Enter]

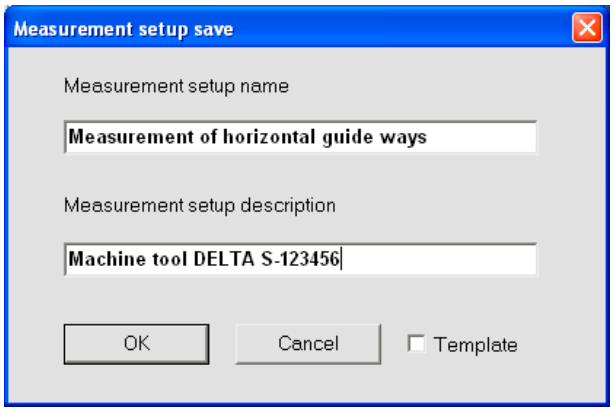
The configuration for the **measurement** is prepared now.



The following information is displayed:

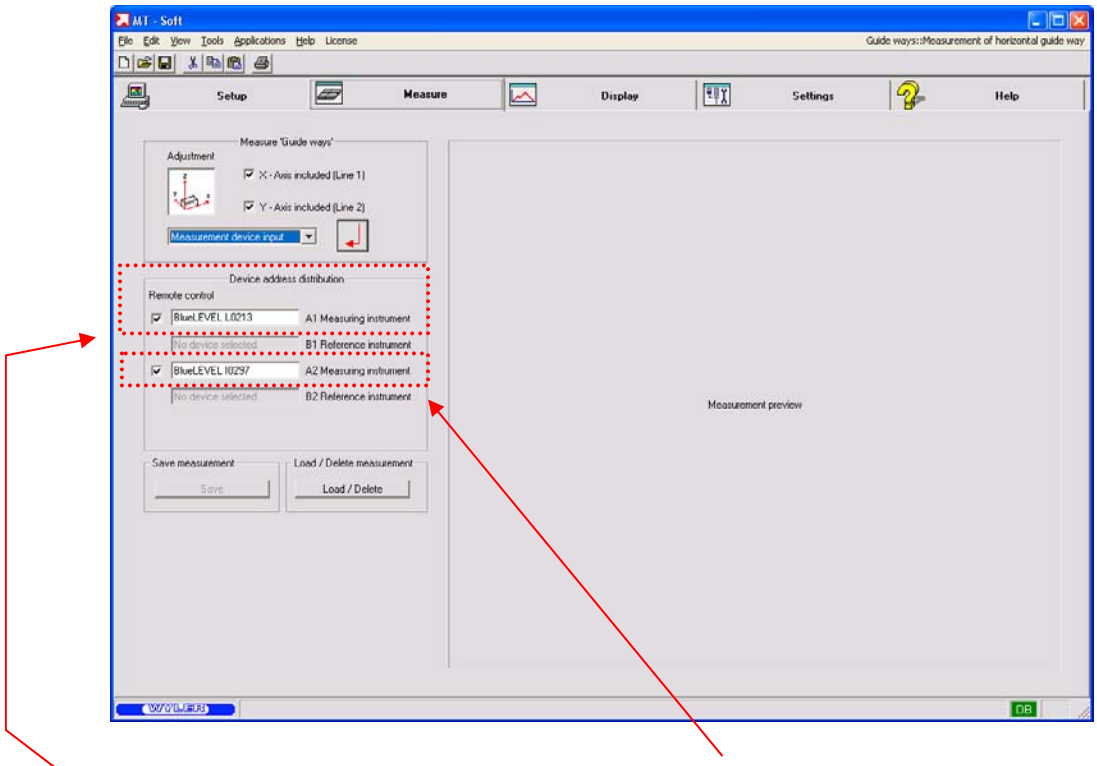
- Object to be measured, in our case “Guide Ways”
- On the right side of the window
  - Instrument: The connected instrument respectively Interface
  - Measurement Type of Guide way (horizontal, symbol)
  - Meas. JIG Type of JIG specified

- Under "Save Setup" the button “save” opens a dialogue box. The setup may be saved as **template,** e.g. as:
  - Measurement setup name: **"Measurement of horizontal guide way"**
  - Measurement setup description: **"Machine tool DELTA S-123456”**



- Under “Load Setup / Delete Object” the button [Load/Delete] allows to open an existing setup template or delete an object.
- Using the button [Print] allows to print the actual measurement setup template

For **starting the measurement** the register <**MEASURE**> must be activated



Measuring instrument A1 with serial number L0213 for the measurement of the front guide way (X-axle)

Measuring instrument A2 with serial number I0314 for the measurement of the rear guide way (Y-axle)

In this register the following input is possible:

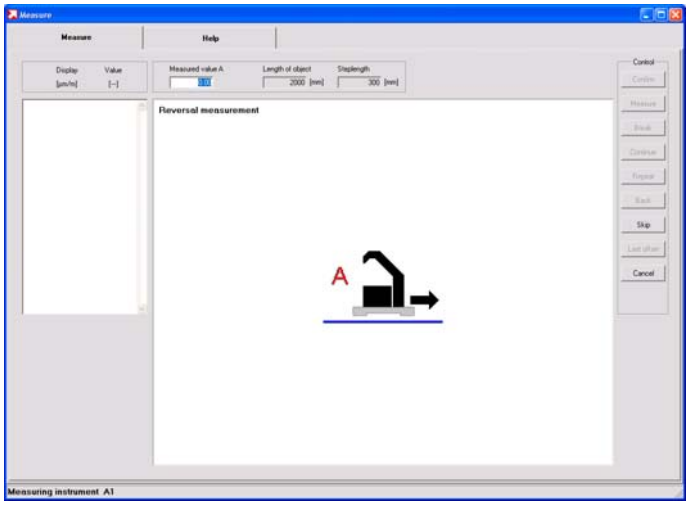
- Below "Measure Guide Ways" it is possible to change between "Input device", directly from interface to PC or "manual input" via Console Input

- Below "Measure Guide Ways" it is also possible to define if both axis (X and Y) are to be measured or if the values of one or the other axis should be set to zero.
  Active boxes = Make measurement
  Setting values to zero may be a considerable time saving factor, specifically if the present interest is mainly in one specific axis or when the results of this axis has been previously measured.

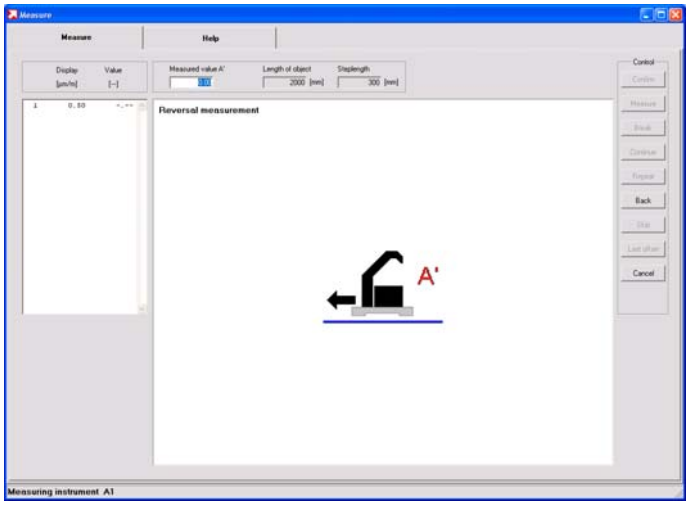
In our example we chose X- and Y- axis included and select “Measurement Device Input”. To start the measurement [Enter]  must be confirmed

First step with instrument A1
Because in our example we measure in the “absolute mode” a reversal measurement is to be performed first. The first measurement done is the measurement **"A"**

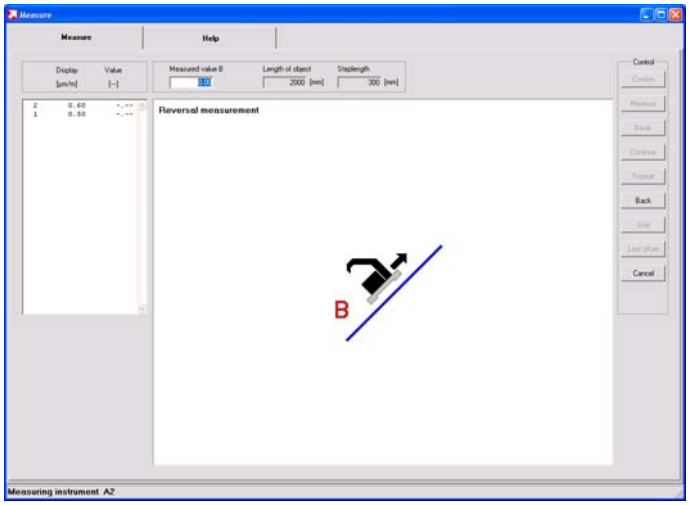
The **reversal measurement** should best be done on a horizontally adjusted granite surface plate. Ideally for collecting the first value the first setting position of the instrument should be marked on the plate. For collecting the second value the instrument must be turned by gliding 180° without lifting from the plate.



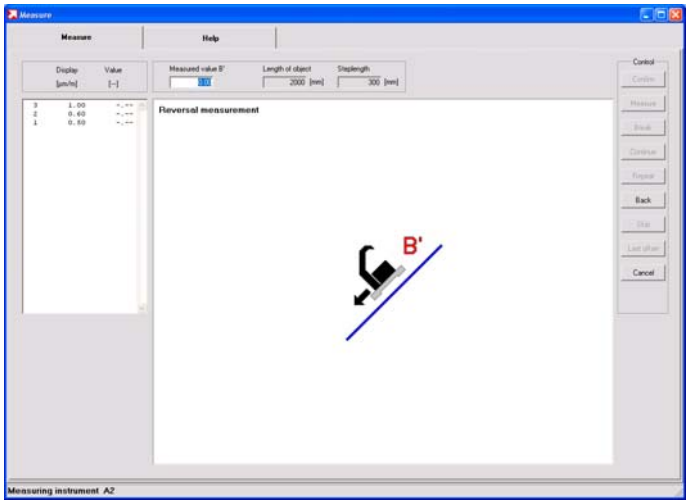
During the collecting of the first measuring value the remark appears “Please wait”. The first measured value is displayed.
When finished the second value **"A’ "** is collected. Using [Continue] will show the next step



Second step is done with instrument A2. The first measurement with this instrument is **"B"**.



During the collecting of the first measuring value the remark appears “Please wait”. The first measured value is displayed.
When finished the second value **"B’ "** is collected. Using [Continue] will show the next step

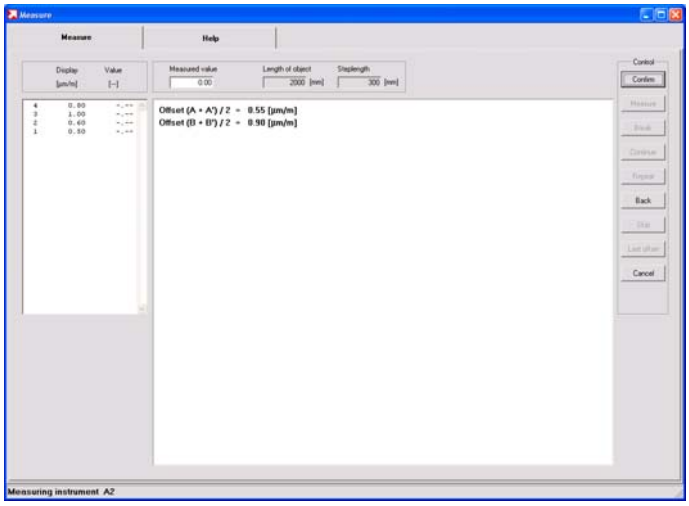


After the second measured value the ZERO offset of the instrument A1 is displayed

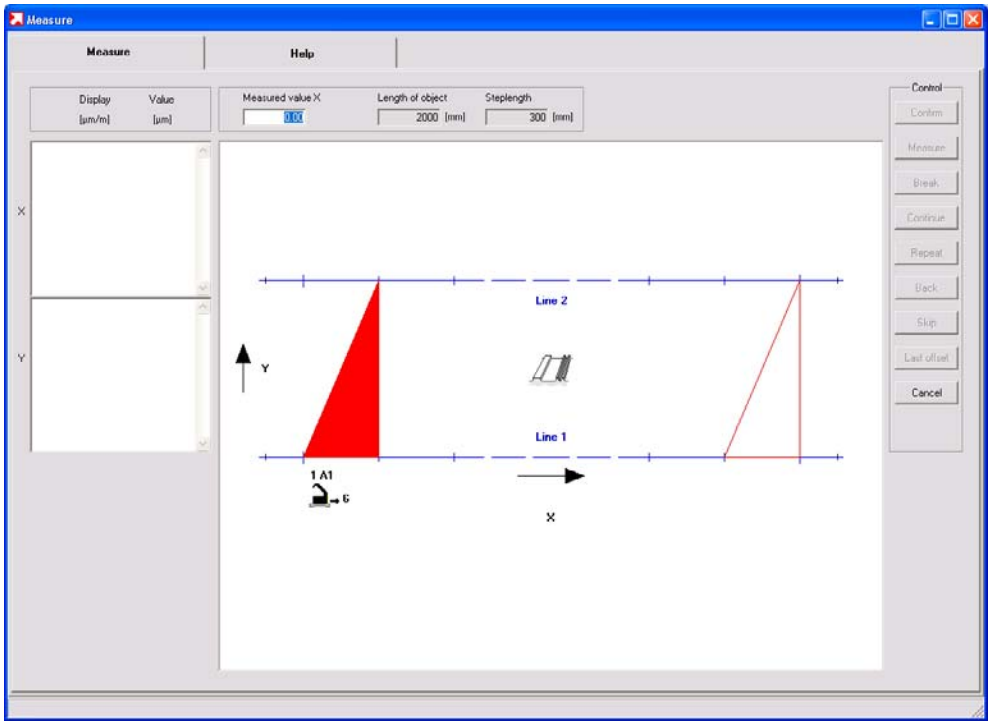
Offset A1 = {Value <A> + Value <A’>} / 2. and for the instrument A2

Offset A2 = {Value <B> + Value <B’>} / 2.

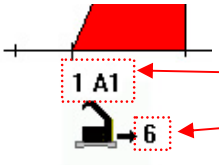
Using [Confirm] the displayed value is accepted and will be used in the measurements to come.



After the reversal measurement has been completed the **actual measurement of the guide ways can be started**



The first position of the instruments is indicated. The instruments and the jig must be placed there. After the required settling time use <**MEASURE**> to collect the first measuring data.

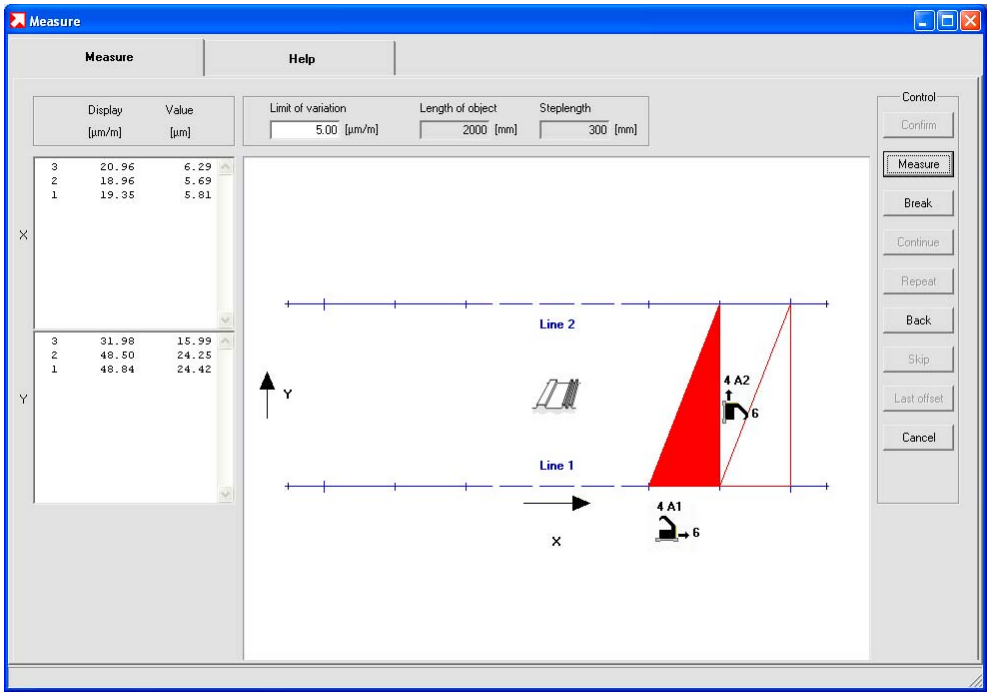


On the screen additional information is displayed

- First measurement with instrument A1
- Number of measurement steps

The measurements are now taken on the same position in the direction X and Y one after the other. After the collection of the data the jig must be moved one step ahead.

Attention **Instruments must always be placed with the connector in measuring direction**

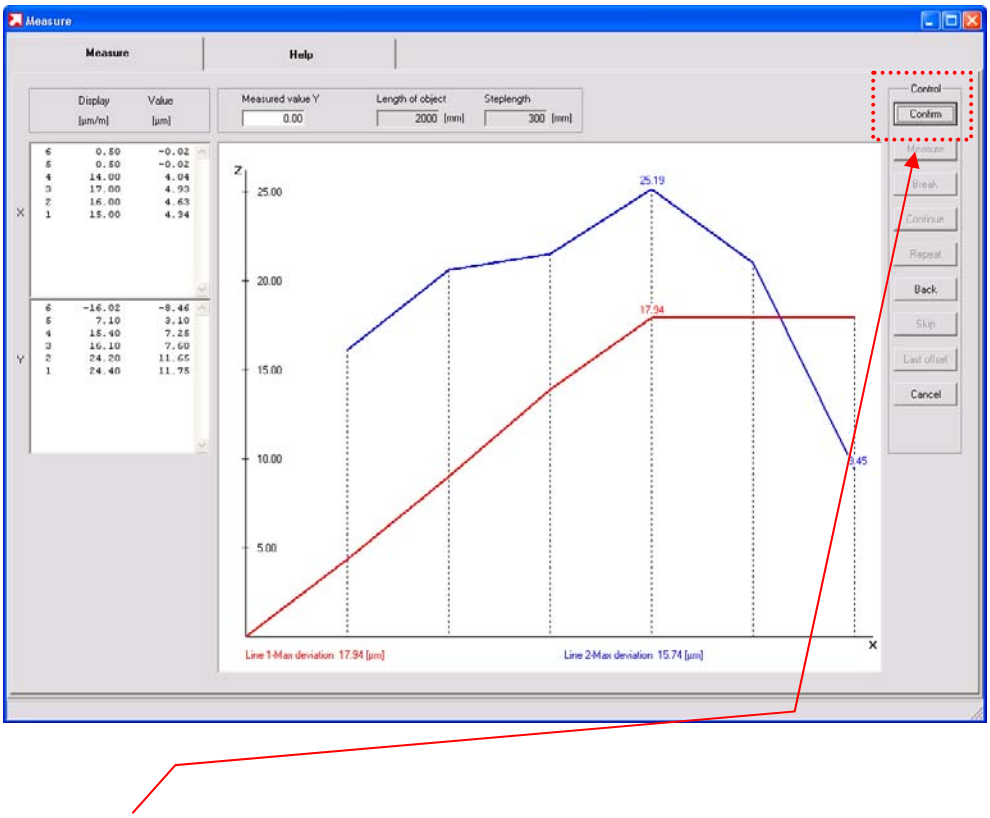


Information between the measurements
After the data is collected the measured value is displayed on the screen in large figures and the following options are available:

- Continue measurement
- Repeat measurement
- Cancel measurement

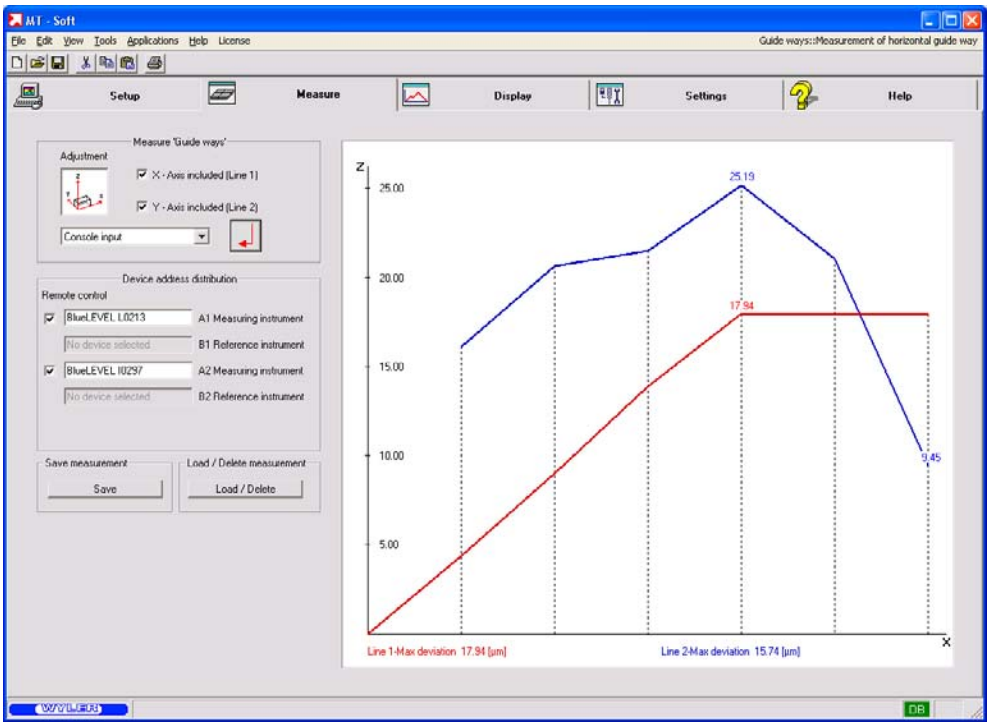
On the left side of the screen the numerical values in X- and Y-direction are displayed

After the last measurement step the result of the measurement is displayed in graphical form



Using [Confirm] means the measurement is accepted. If not, the button [Back] goes back step by step through the measurement for possible repetition.

After [Confirm] is pressed the measurement is definitively finished and the following window appears.

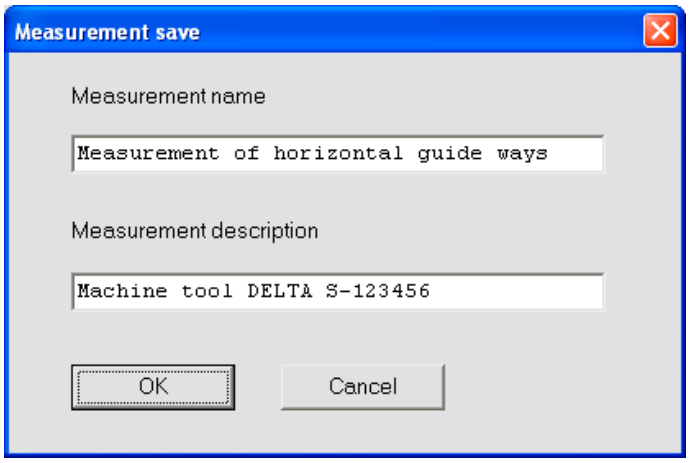


Using [Confirm] means the measurement is accepted. If not, the button {Back] goes back step by step through the measurement for possible repetition.

After [Confirm] is pressed the measurement is definitively finished and the following window appears.

If the measurement is correct it should be saved, e.g. as:

- Measurement setup name: **"Measurement of horizontal guide ways"**
- Measurement setup description: **"Machine tool DELTA S-123456"**



It is useful to save the data with a clearly defined name for later easily finding the measured information.

Next the result may be analysed or printed

6.2.2 MEASUREMENT OF THE VERTICAL GUIDE WAY

The measurement example:

- **Type of measurement** Guide way vertical
  - Front guide way (1) "**flat**"
  - Rear guide way (2) "**flat**"

- **Work piece coordinates**
  - Z-axle coordinate/(Object beginning): -800 mm
  - Z-axle coordinate/(Object end): 1800 mm
  - Z-axle coordinate/(First measuring point): -900 mm
  - Z-axle coordinate/(Last measuring point): 1700mm
  - Z-axle coordinate/(Step length): 180 mm (depending on JIG available)

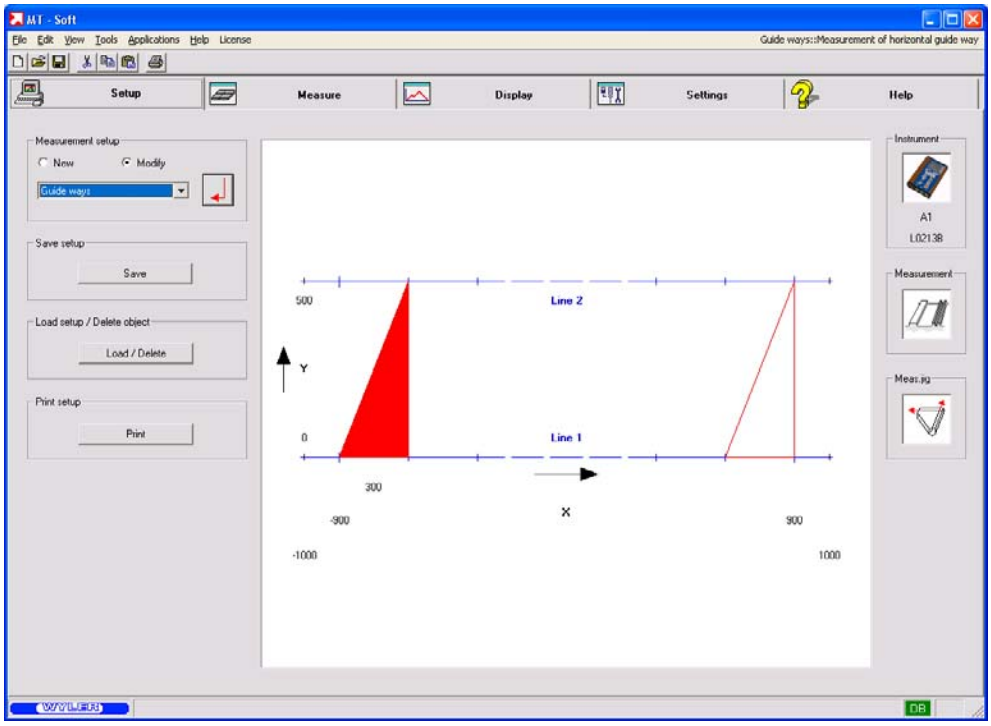
  - x-axle coordinate (Line 1) : 800 mm
  - X-axle coordinate (Line 2) : 1200 mm

- **Measuring setup**
  - The measurement of the vertical guide ways should later be used in comparing with the horizontal guide way. In order to do so it is required to measure in the **absolute mode**. An absolute mode measurement requires before the measurement a reversal measurement with the instrument.

  - The measurement is done with a **single instrument with an angular base**. This means both guide ways are measured one after the other.

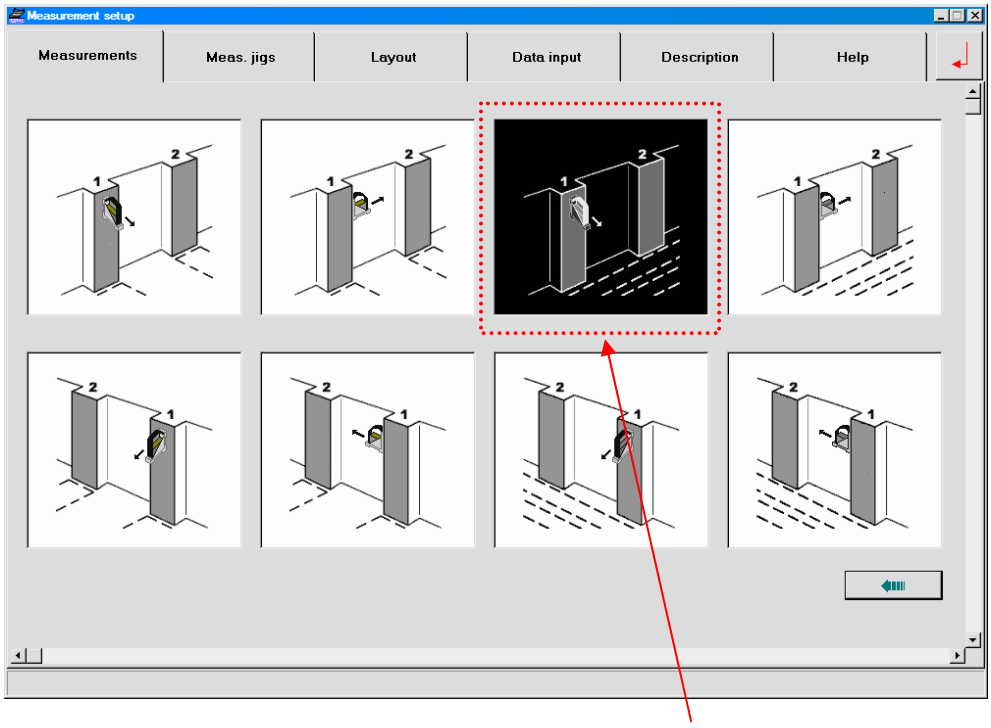
Procedure:

Go back to the submenu <**SETUP**>
The layout of the previous measurement is still displayed



Below Measurement Setup the pull down menu can be used to change to "Guide ways" / "**NEW**" and confirm with [Enter] 

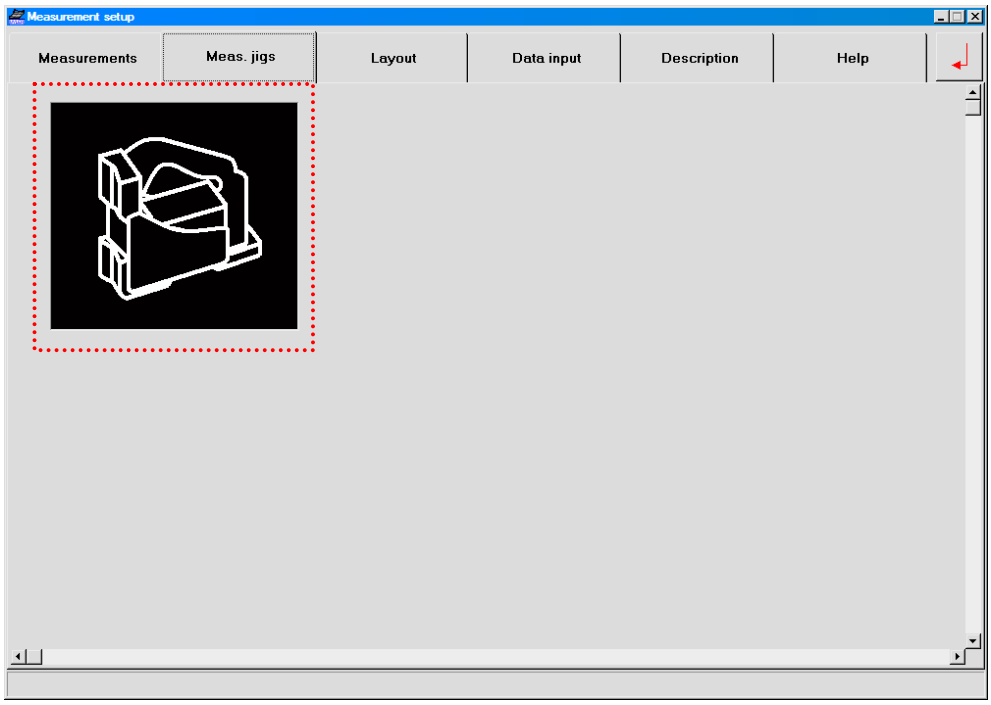
A number of different possibilities for the **type of guide ways** is displayed under **<MEASUREMENT SETUP>**



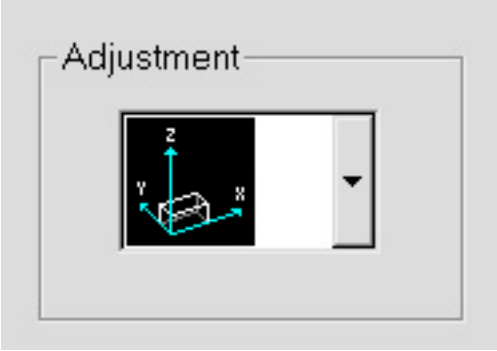
In our example we chose the option two vertical guide ways.

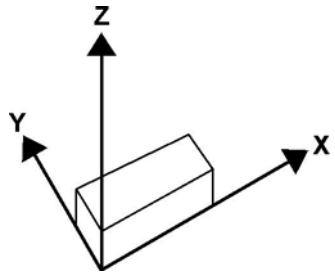
Attention
This option requires possibly the use of the **scroll bar**!

Selecting Meas. JIGs only the **measuring instrument / <MEAS JIGS>** appears without additional JIGs



The next selection is the definition of the layout.
Next under <LAYOUT> / "**Adjustment**" the coordinate system (**work piece coordinates**) must be defined.
In our example we chose

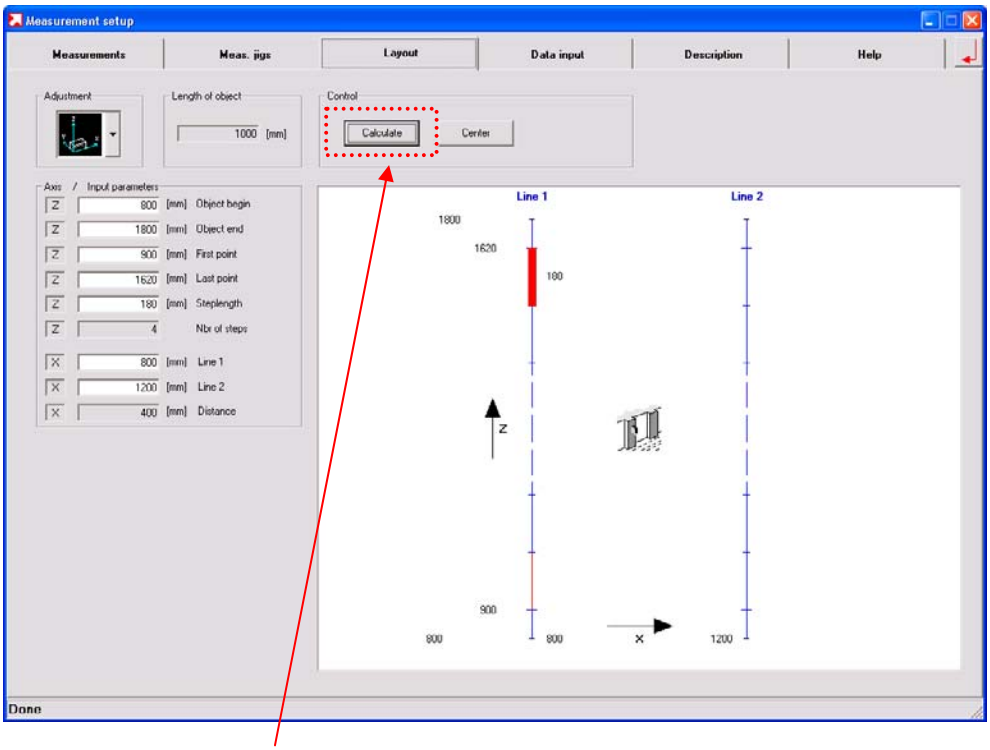




Next the coordinates must be entered. (IMPORTANT: **WORK PIECE COORDINATES**)

- **Work piece coordinates**
  - Z-axis coordinate/(Object beginning): 800 mm
  - Z- axis coordinate/(Object end): 1800 mm
  - Z- axis coordinate/(First measuring point): 900 mm
  - Z- axis coordinate/(Last measuring point): 1700mm (1620 mm)
  - Z- axis coordinate/(Step length): 180 mm (Depending on JIG available)

  - X- axis coordinate (Line 1) : 800 mm
  - X- axis coordinate (Line 2) : 1200 mm

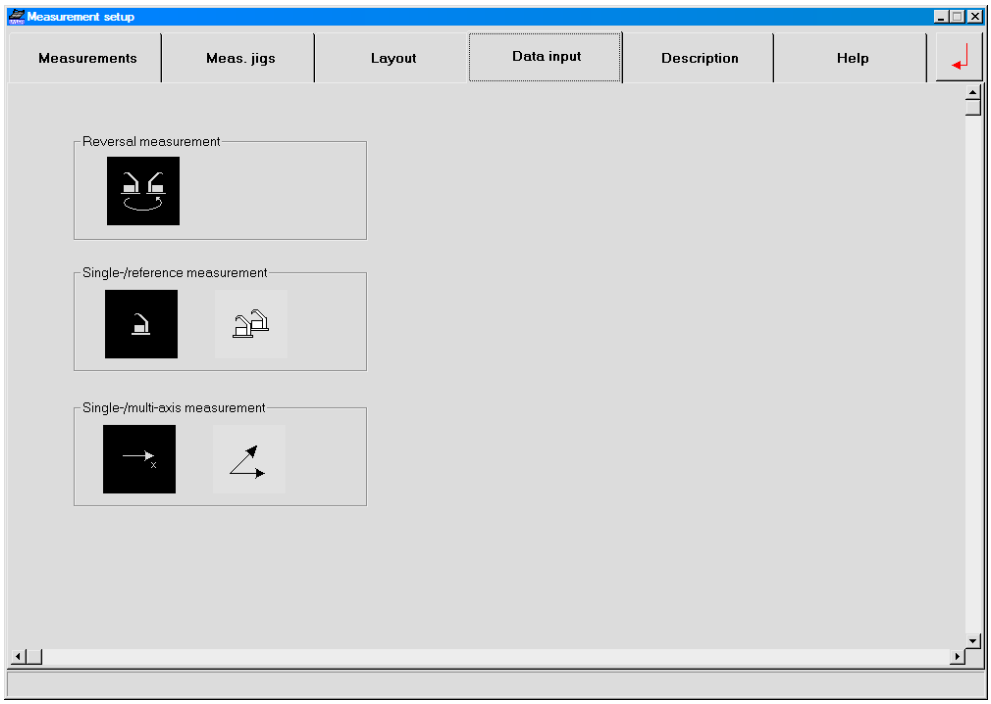


After entering the data confirm with [Calculate]
the graphic will be finalized and additional data is entered automatically.

- Length of Object (1000mm)
- Number of steps (6)
- Distance (line 1 to line 2 = 500mm)

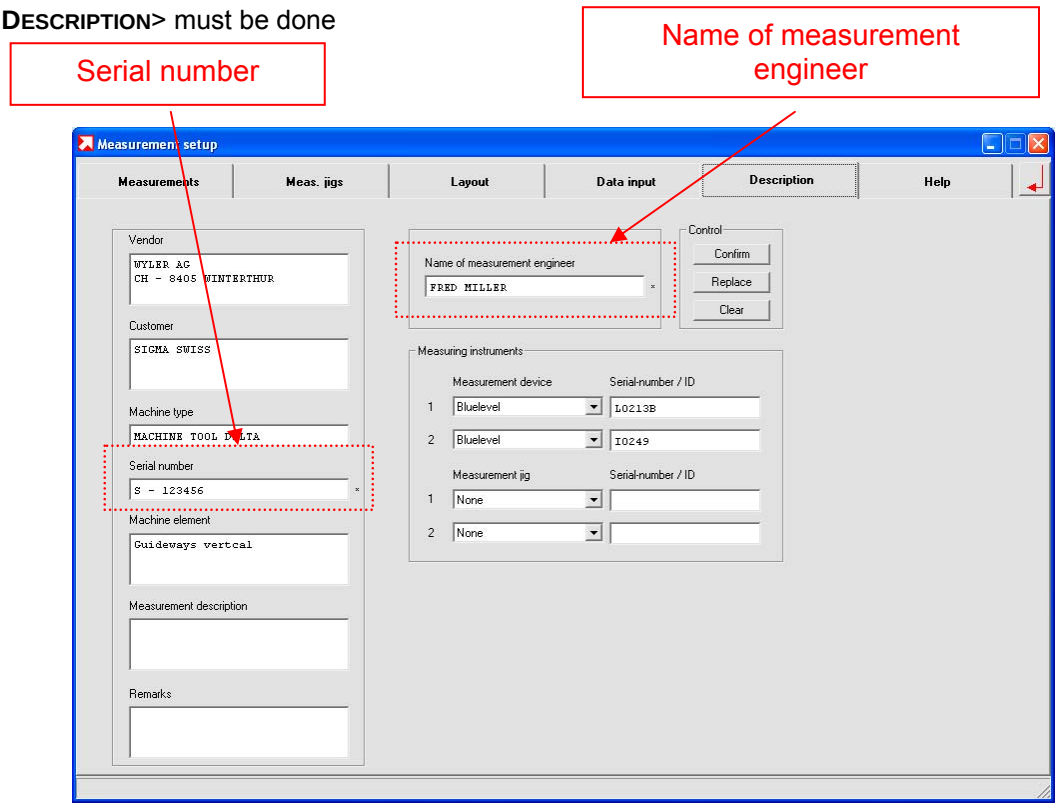
It is important to check all the displayed data for their correctness. !

Change to <**DATA INPUT**>
In this selection specific procedures for the data input are defined.



In our **example** we chose:
Reversal measurement / Single Instrument (**Absolute mode**). This means in the first step we measure the vertical guide way no. 1 and in the second step we measure the guide way no. 2.

Next the <**DESCRIPTION**> must be done

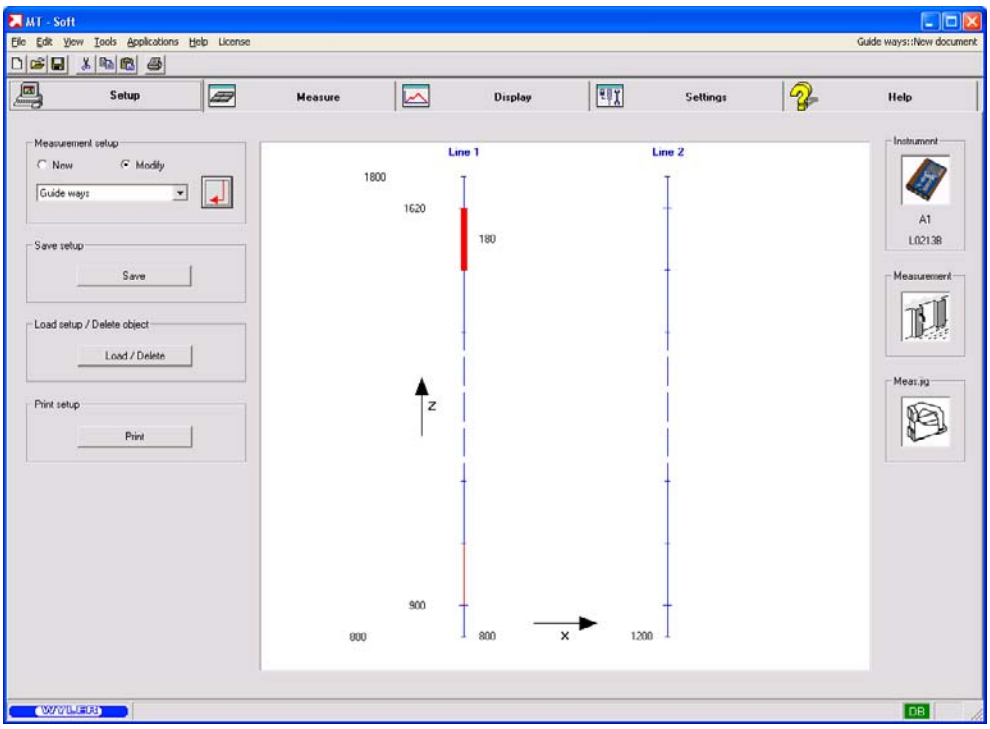


The description is to define exactly the measuring task and the identification of the object.
In this dialogue box all the necessary data for defining the planned measurement can be entered. The **Name of measurement Engineer** and the **Serial number** of the object to be measured are **mandatory**.

All the rest of the information is free to fill in.
The text can also be integrated from an existing template by using the [Replace] button

It is still possible to make changes in the setup registers.
If not required, press the button [confirm] 

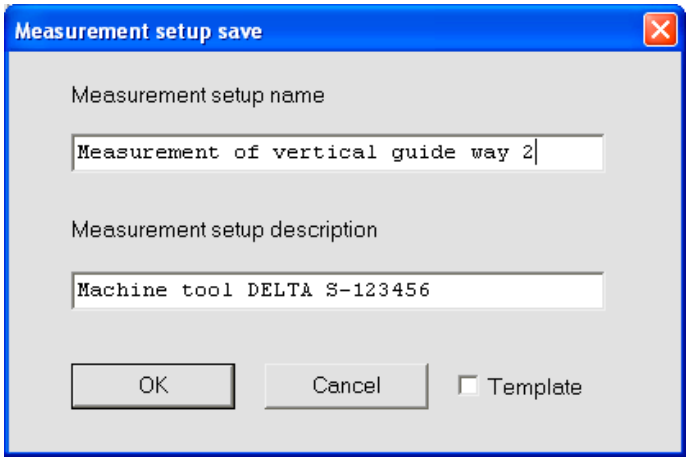
The configuration for the **measurement** is prepared now. 



The following information is displayed:

- Object to be measured, in our case *Guide Ways"*
- On the right side of the window
  - -Instrument: The connected instrument respectively Interface
  - -Measurement Type of Guide way (vertical, symbol)
  - -Meas. JIG Type of JIG specified

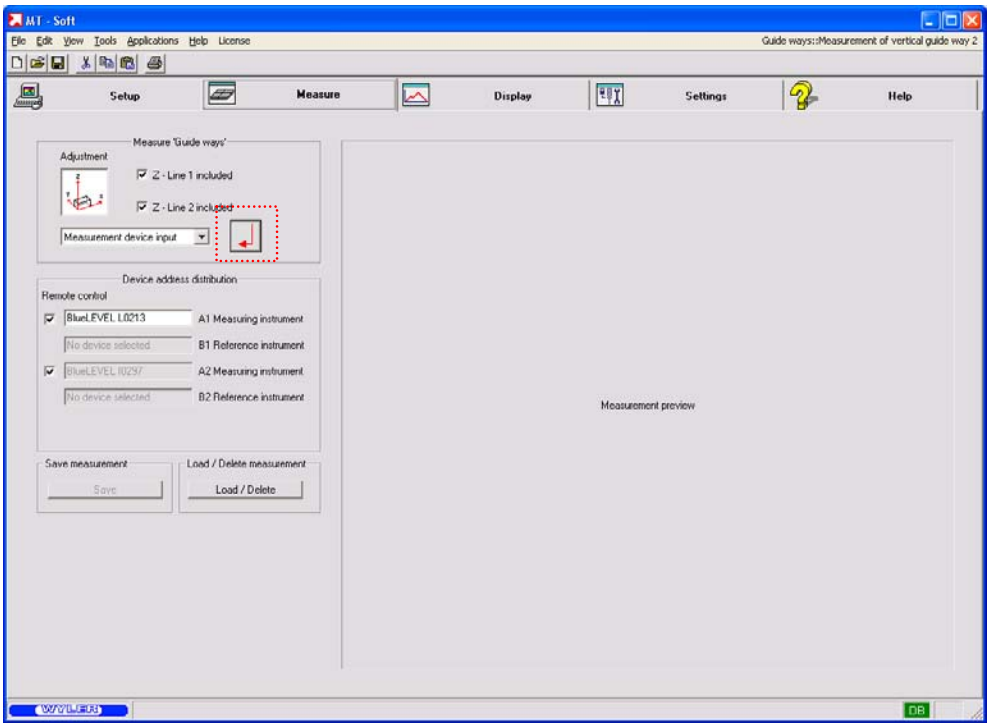
- Under "Save Setup" the button “save” opens a dialogue box. The setup may be saved as **"Template",** e.g. as:
  - Measurement setup name: **"Measurement of vertical guide way 2"**
  - Measurement setup description: **"Machine tool DELTA S-123456"**



- Under <**LOAD SETUP / DELETE OBJECT**> the button [Load/Delete] allows to open an existing setup template or delete an object.

- Under <**PRINT SETUP**> the button [Print] allows to print the actual measurement setup template

For **starting the measurement** the register <**MEASURE**> must be activated



In this register the following input is possible:

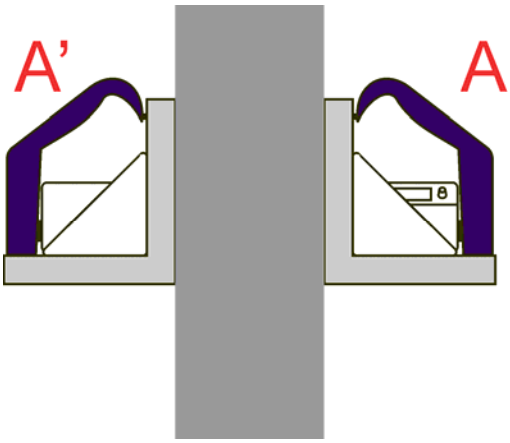
- Below <**MEASURE GUIDE WAYS**> it is possible to change between "Input device", directly from interface to PC or "manual input" via Console Input

- Below "Measure Guide Ways" it is also possible to define whether a complete measurement of both guide ways should be performed or not.

We activate both boxes for our measurement and select <**MEASUREMENT DEVICE INPUT**>. To start the measurement [Enter] must be confirmed

Two options are possible to determine the angular error of the instrument.

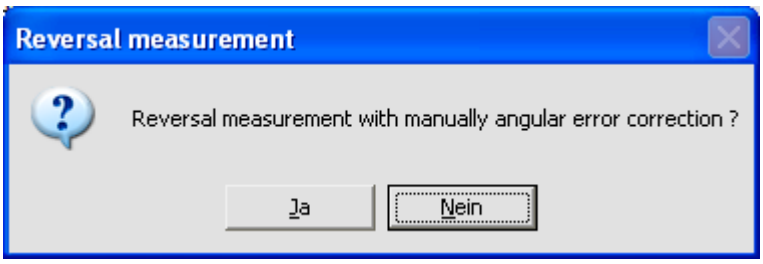
- **Option 1**
  Ideally a vertical reversal measurement is done. This requires a **high precision granite square block with two exactly parallel surfaces** with none or smallest possible surface error. With this procedure it is possible to calculate the **vertical zero offset** of the instrument and, when previously the horizontal reversal measurement was done, the **angular error of the instrument** is automatically determined.



- **Option 2**
  In case no high precision square block is available the zero setting can be done by applying the horizontal reversal measurement only, best possible on a granite setting plate.
  After that the **angular error of the instrument can be applied by manual input**. The value of the angular error can usually be found on a calibration certificate. Is no calibration certificate available the only way is to enter the value “0” as angular error of the instrument. When doing so it must be noted that the measuring uncertainty is larger.

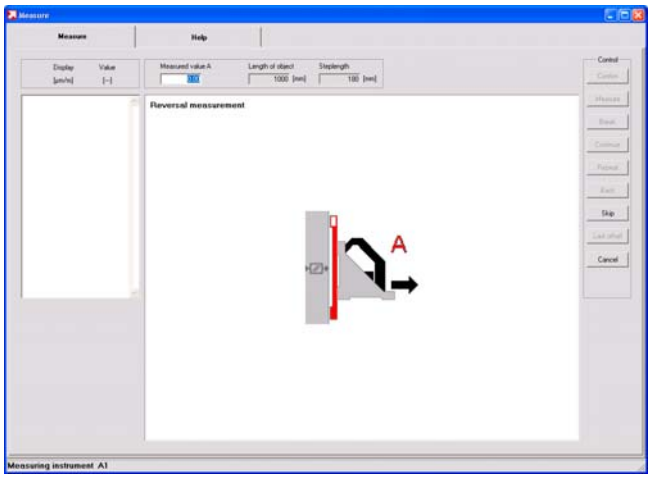
Procedure Option 1
Automatic definition of the angular error and the zero offset of the instrument.

After starting the measurement by pressing [ENTER] the following dialogue box appears with the question "Reversal measurement with manual angular error correction?”

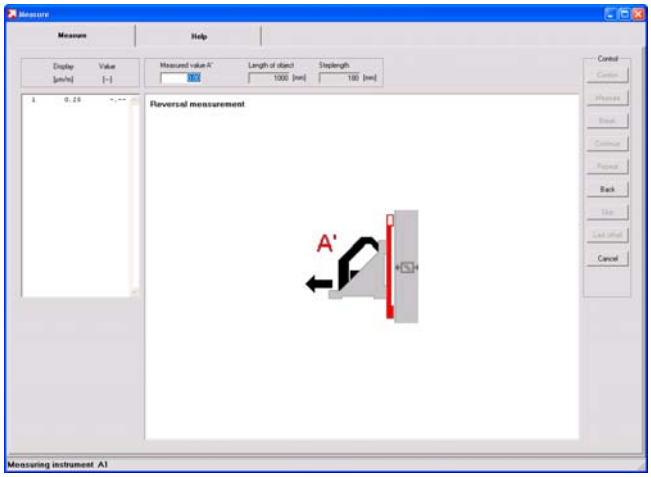


In **option 1** the reversal measurement is done by means of a square block therefore the answer to the question is [NO].

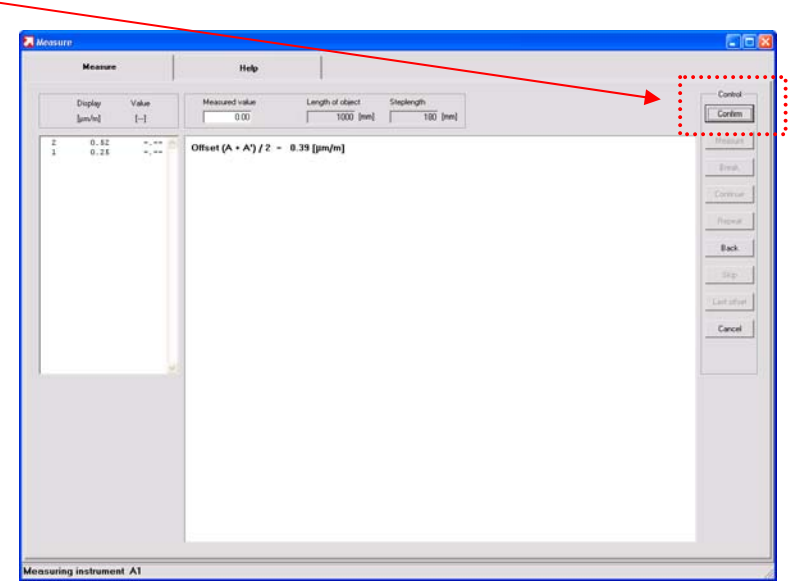
After selection [NO] the procedure for the vertical zero setting is started. The first measurement with the instrument is measurement “**A**”.



During the data collection of the first measurement the remark “please wait” is displayed. When finished the second measurement must be done, measurement “**A’** ”.



After the second reading the zero offset of the instrument is automatically calculated
offset= (measurement <A> + measurement <A’>) / 2 and displayed. This value must be confirmed by pressing [confirm]

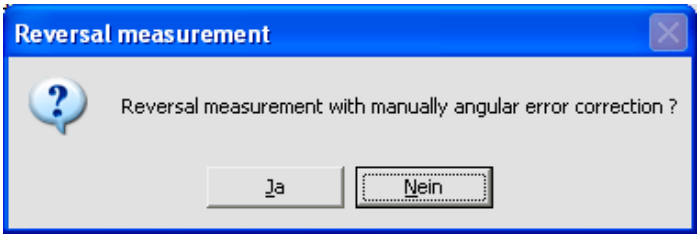


The angular error of the instrument is now defined and the zero error is compensated, the measurement can be started.

Procedure option 2
Automatic definition of the zero offset and manual setup of the angular error

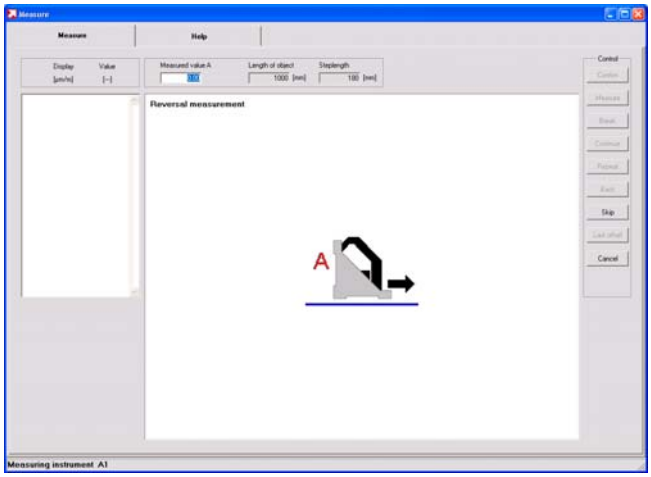
After starting the measurement by pressing [ENTER]  the following dialogue box appears with the question

”Reversal measurement with manual angular error correction?”



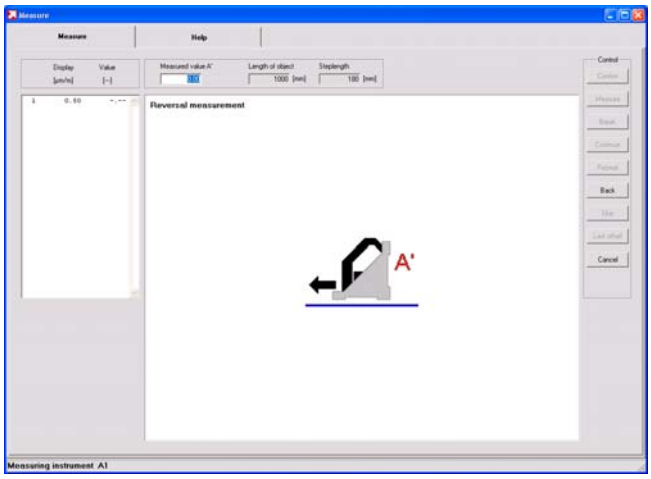
In **option 2** the manual correction of the angular error is entered manually. The answer to the question is [YES].

In order to eliminate any errors from the surrounding the reversal measurement should be done on a best possible horizontal surface with smallest horizontal flatness errors. After selection [YES] the procedure for the horizontal zero setting is started. The first measurement with the instrument is measurement “**A**”.



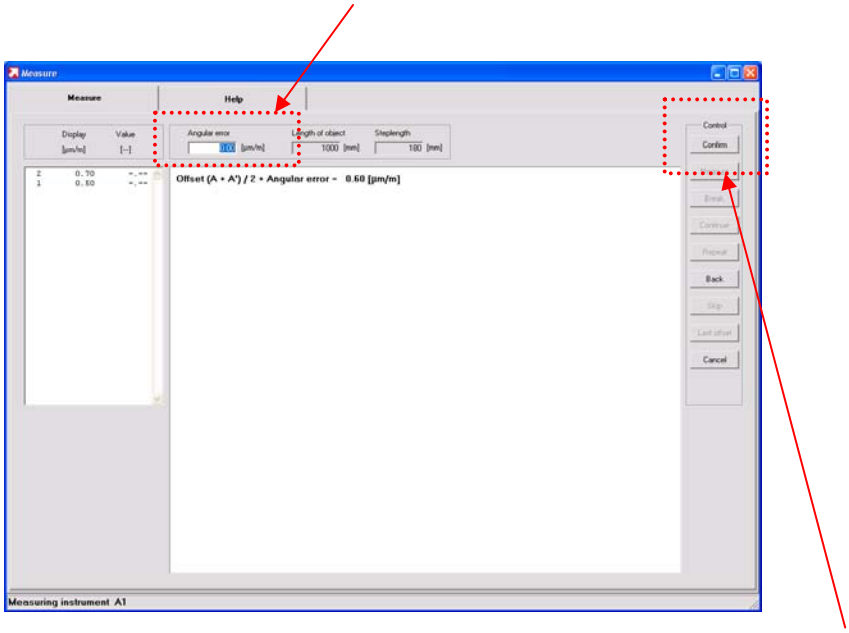
The reversal measurement is done on a horizontal surface and is only used for the compensation of a possible zero-offset of the instrument.

During the data collection of the first measurement the remark “please wait” is displayed. When finished the second measurement must be done, measurement “**A’** ”



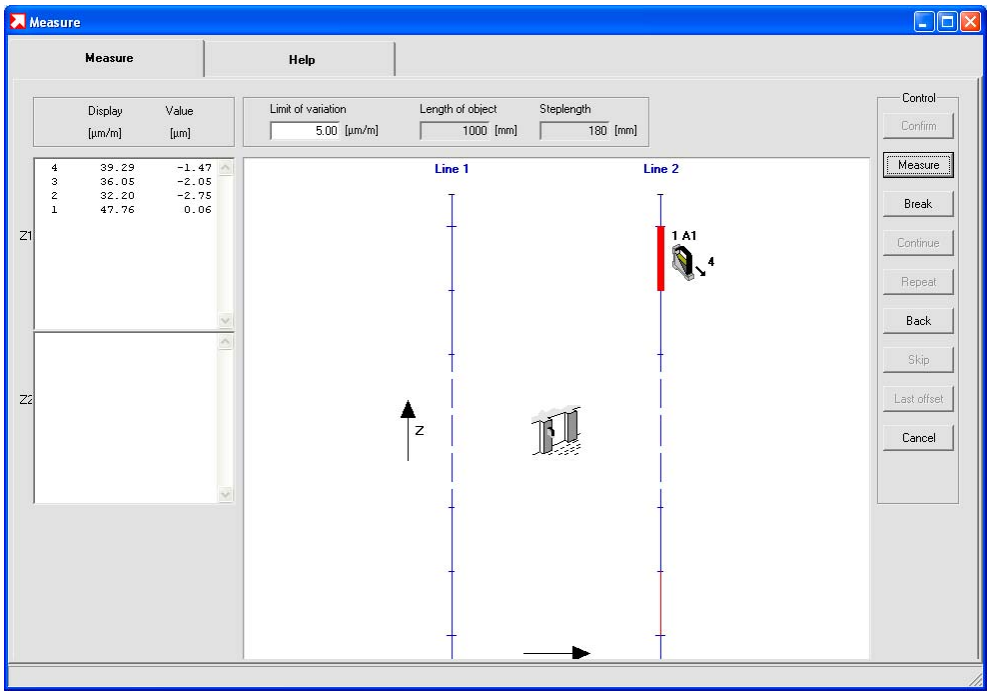
After the second reading the zero offset of the instrument is automatically calculated without definition of the angular error **Offset= {measurement <A> + measurement <A’>} / 2** and displayed.

The angular error may be entered manually now. The value of the **angular error** can usually be found on a calibration certificate.



After manually entering the angular error and the zero offset have to be accepted by pressing [confirm]

After the **reversal measurement completed** the actual measurement of the guide ways can be started.

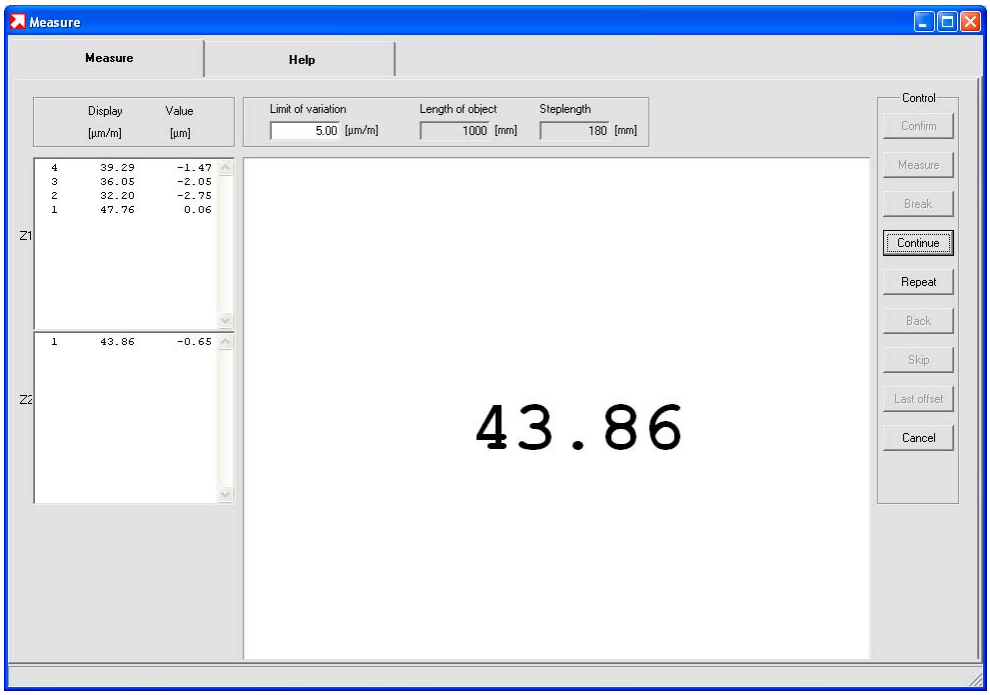


The first position of the instrument is indicated. The instrument must be placed there. After the required settling time use <**MEASURE**> to collect the first measuring data. Check the direction of the measurement!!

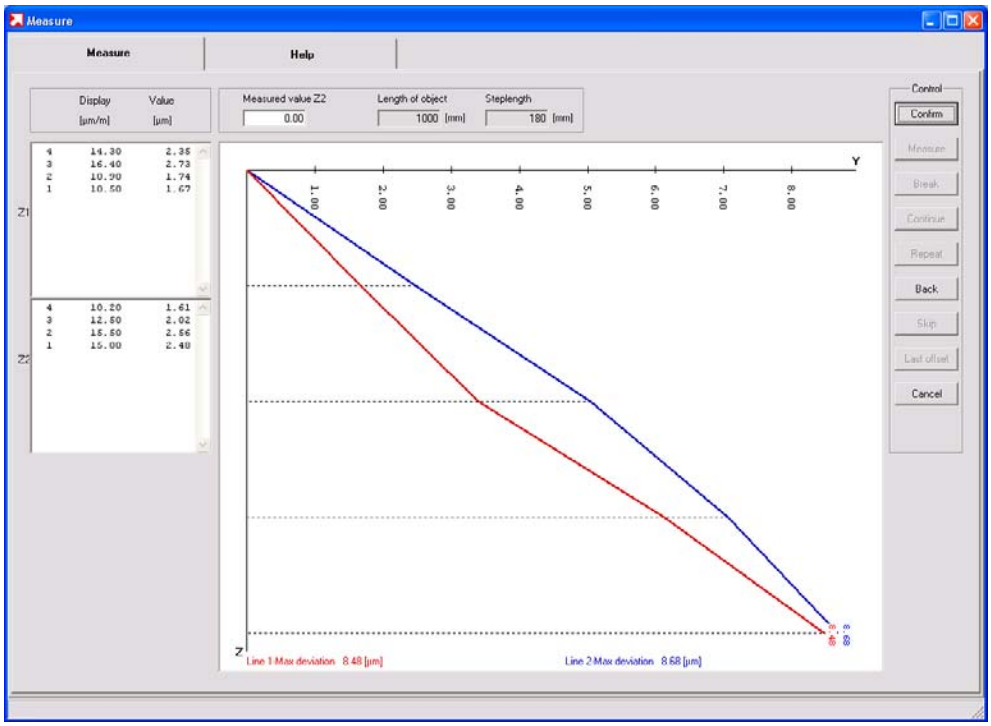
Information between the measurements
After the data is collected the measured value is displayed on the screen in large figures and the following options are available:

- Continue measurement
- Repeat measurement
- Cancel measurement

On the left side of the screen the numerical values of the axes Z (Z1 + Z2) are displayed

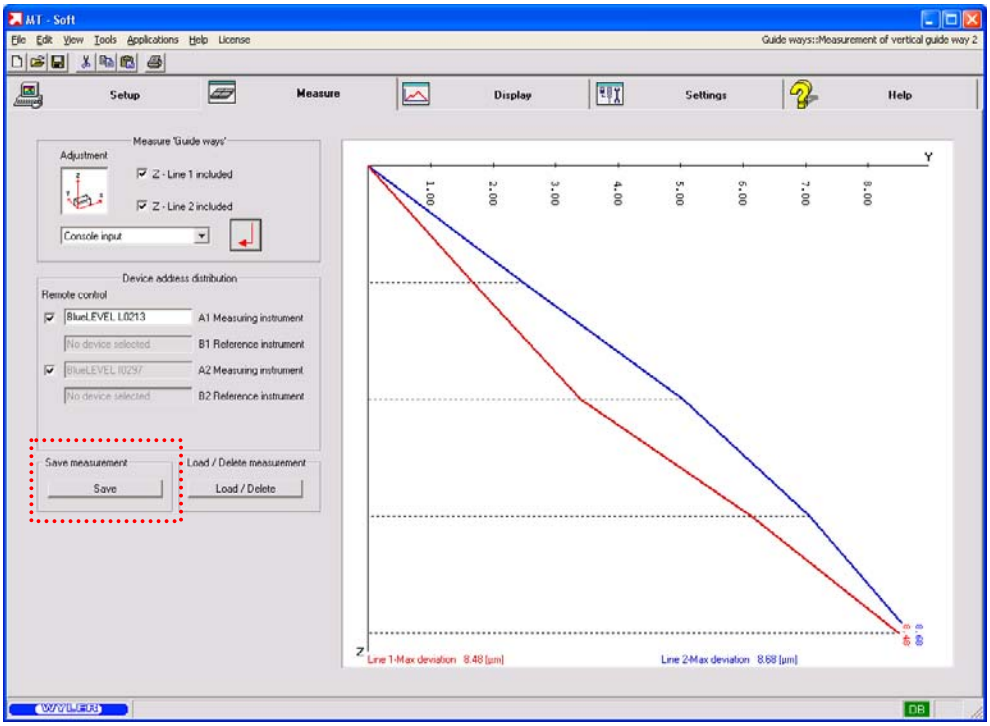


After the last measurement the result of the measurement is displayed in graphical form.

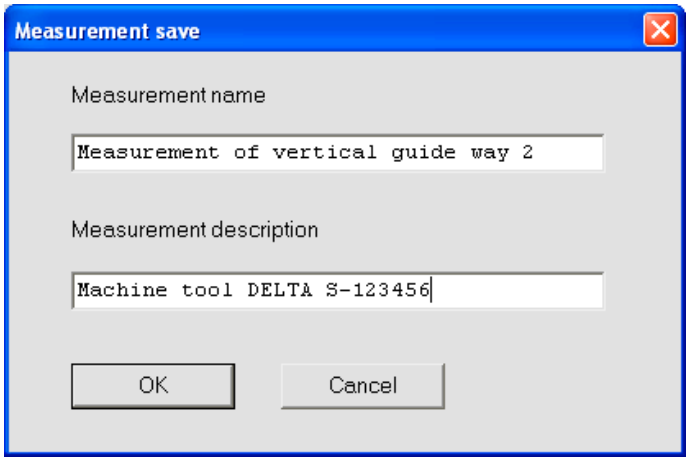


Using [Confirm] means the measurement is accepted. If not, the button [Back] goes back step by step through the measurement for possible repetition.

After [Confirm] is pressed the measurement is definitively finished and the following window appears.



- Measurement setup name: **"Measurement of vertical guide way 2"**
- Measurement setup description: **"Machine tool DELTA S-123456"**

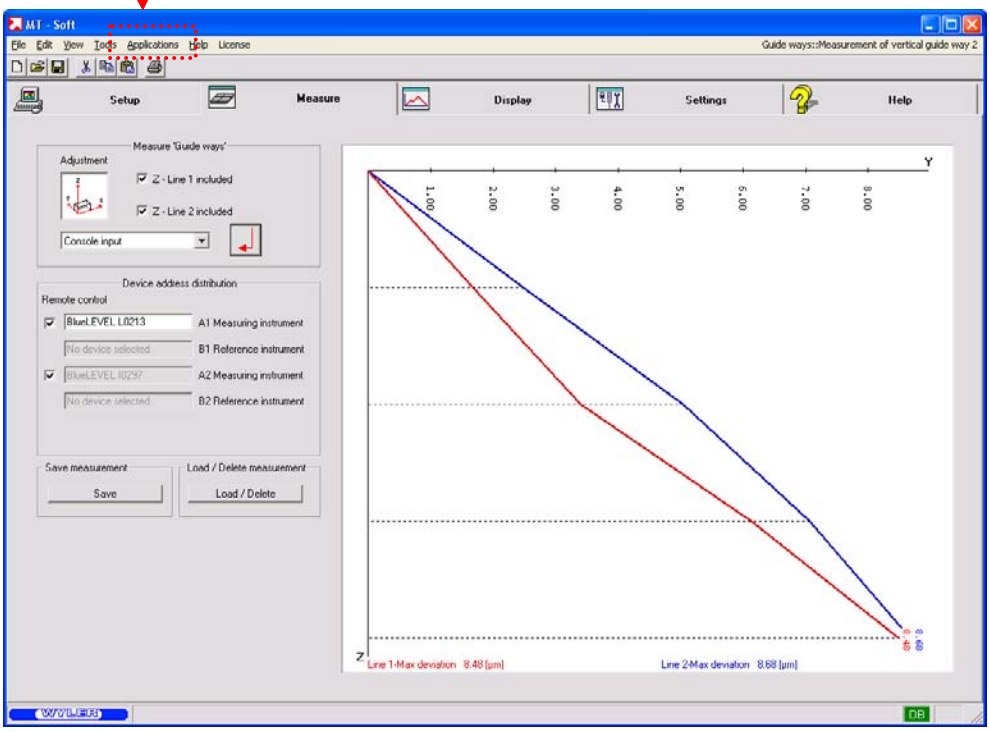


It is useful to save the data with a clearly defined name for later easily finding the measured information.

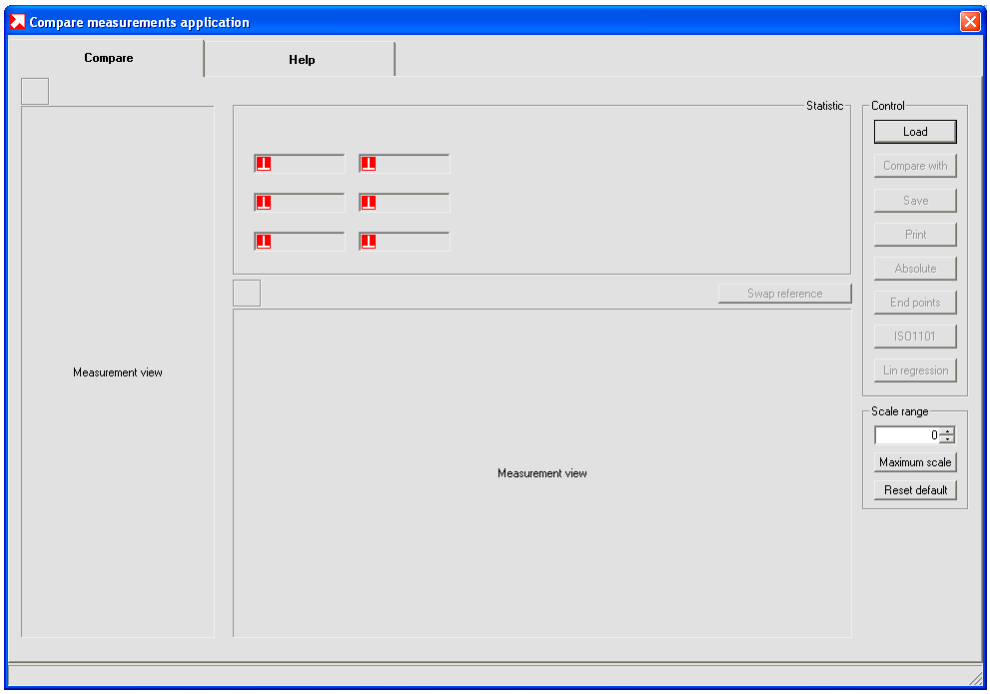
Next the result may be analysed or printed

6.2.3 COMPARISON OFTHE HORIZONTAL AND THE VERTICAL MEASUREMENT

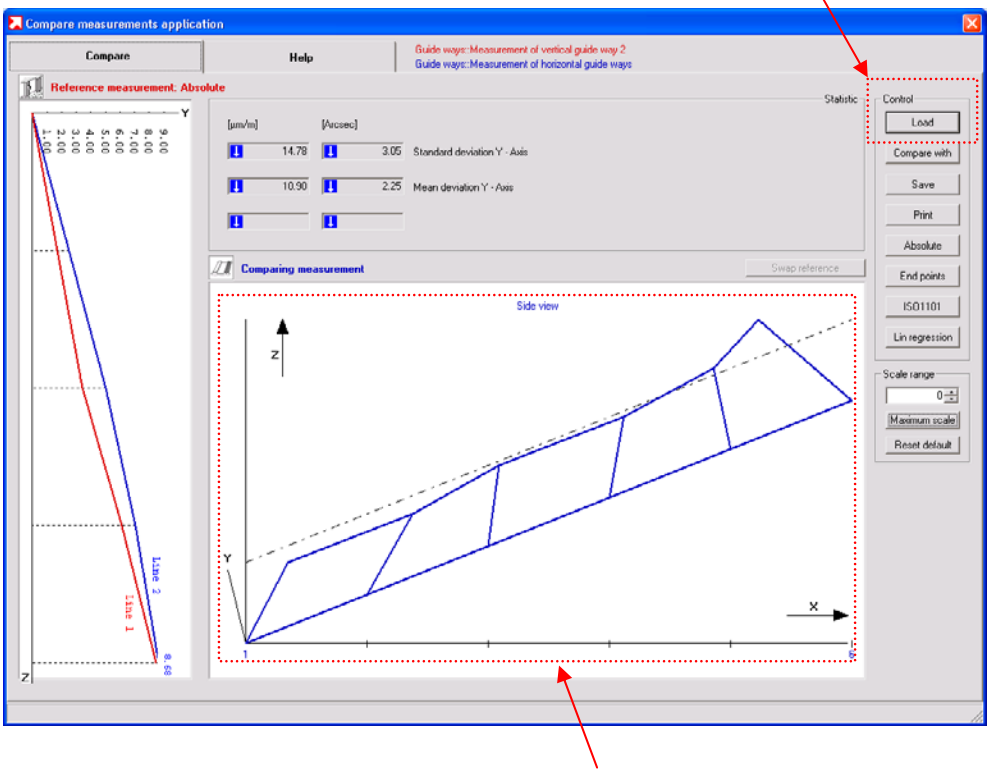
Select <APPLICATION> from the tool bar and activate “Compare measurements (squareness)”



Then the following window appears:



Load now the measurements of the vertical guide way using the button [Load]
You will then find a list of all measurements relevant respectively available for this machine (identical serial number). After that you select the horizontal guide ways via [compare with].



When the cursor is moved to the picture with the horizontal guide way the “hand” icon is displayed. A left mouse click changes the display.

The picture above shows the perspective view of the horizontal guide way. In the sector “statistic” the angle between the vertical guide way and the mean value of the horizontal guide way (Standard deviation Y-axis) is shown.

When both measured data are recorded, the results may be aligned according to the available alignment methods, such as:

- Method “**Absolute**”
- Method “**End points**”
- Method “**ISO1101**”
- Method “**Linear regression**”

and then displayed and analysed.

In the example the values are as follows

- Method **Absolute**:
  - Standard-Deviation Y-Axis: 14.78 µm/m, resp. 3.05 Arcsec
  - Mean deviation Y-Axis: 10.90 µm/m, resp. 2.25 Arcsec
- Method **End points**:
  - Deviation Y-Axis: 37.45 µm/m, resp. 7.73 Arcsec
  - Mean deviation Y-Axis: 10.90 µm/m, resp. 2.25 Arcsec
- Method **ISO1101**:
  - Deviation Y-Axis: 37.45 µm/m, resp. 7.73 Arcsec
  - Mean deviation Y-Axis: 10.90 µm/m, resp. 2.25 Arcsec
- Method **Linear regression**:
  - Deviation Y-Axis: 37.58 µm/m, resp. 7.75 Arcsec
  - Mean deviation Y-Axis: 10.90 µm/m, resp. 2.25 Arcsec

APPENDIX

A. MEASURING INSTRUMENTS AND MEASURING CONFIGURATION

Additional information about the possible WYLER measuring configuration

A1) CONFIGURATION WITH THE INSTRUMENTS OF THE "CLASSIC" LINE

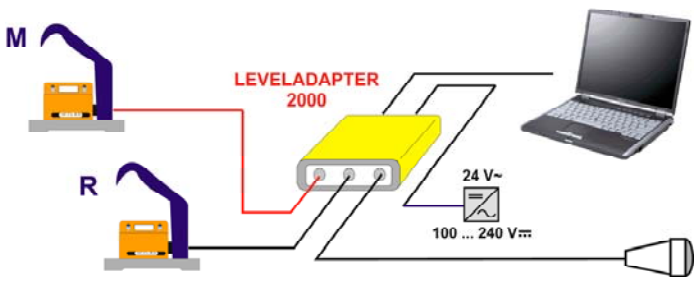
Remarks concerning the Leveladapter 2000

Besides other tasks the adapter is transferring an analogue signal delivered by the instrument(s) in a digital signal in the format RS232.
The signal is limited to a maximum of 400 mV.
This means that the maximum possible transfer signal of a Minilevel with two ranges are as follows:

Example Minilevel with sensitivity of 1µm/m

Range II:	1µm/m per mV	→	max. 400µm/m
Range I:	10µm/m per mV	→	max. 4000µm/m

Measurements with MINILEVEL "classic" and Leveladapter 2000,
Differential measurements with two MINILEVEL "classic"

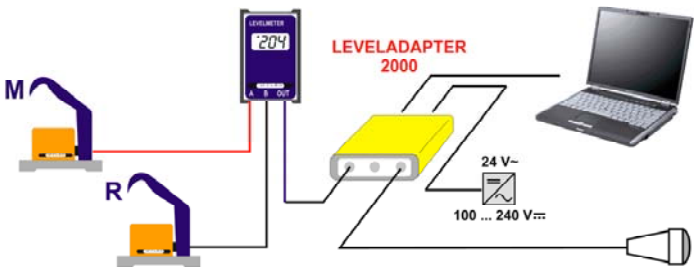


The measuring level (M) has to be connected to the Port (A) of the LEVELADAPTER 2000 and the reference level (R) must be connected to the Port (B) of the LEVELADAPTER 2000.

Before starting the computer the power of the LEVELADAPTER 2000 must be "ON" as this is important in order that the software MT-SOFT recognises the adapter.

Attention:
All batteries must be removed as the power supply is done through the LEVELADAPTER 2000.
The correct setting of the sensitivity must be checked

Measurement with LEVELTRONIC "classic" – LEVELMETER 25 and Leveladapter 2000,
Differential measuring with two LEVELTRONIC's and one LEVELMETER 25



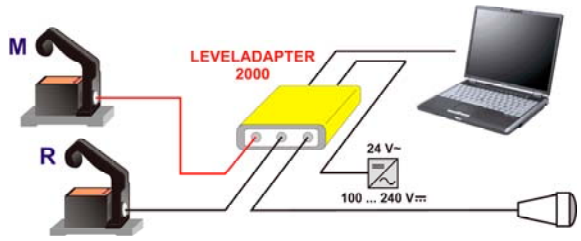
The connection from Levelmeter 25 port "Power/Out" must be to the port (A) of the LEVELADAPTER 2000. The measuring instrument (M) has to be connected to connector "A" and the reference instrument (R) to the connector "B" of the Levelmeter 25.

Before starting the computer the power of the LEVELADAPTER 2000 must be "ON" as this is important in order that the software MT-SOFT recognises the adapter.

Attention:
Never connect a LEVELTRONIC directly to the LEVELADAPTER 2000 or to the computer. The electronics of the instrument may be damaged!
All the **batteries** must be **removed**.

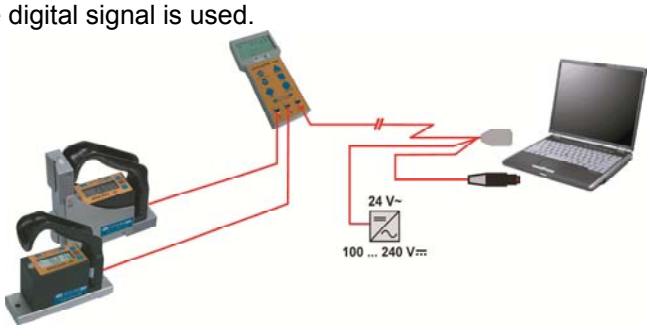
A2) WYLER MEASURING INSTRUMENTS "NT" SERIES

Measuring with MINILEVEL NT and Leveladapter 2000, The analogue signal is used.



Before starting the software MT-SOFT the power of the LEVELADAPTER 2000 must be "ON" as this is important in order that the software recognises the adapter.
This configuration can be set-up with one or two instruments

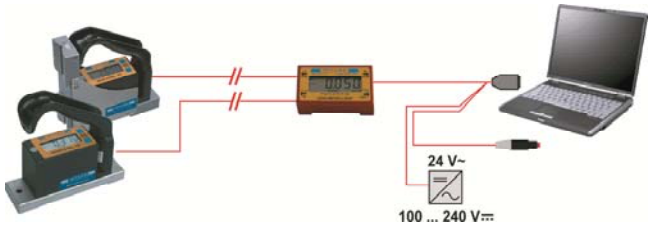
Measuring with MINILEVEL/LEVELTRONIC NT and LEVELMETER 2000 direct connection
The digital signal is used.



Before starting the software MT-SOFT the power of the LEVELMETER 2000 must be "ON" as this is important in order that the software recognises the interface.

This configuration can be set-up with one or two instruments.

Measuring with MINILEVEL/LEVELTRONIC NT and LEVELMETER "LIGHT", direct connection
The digital signal is used.

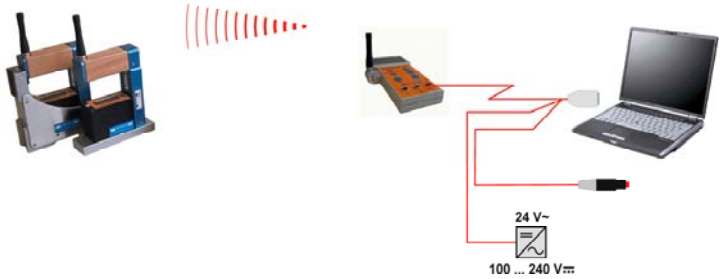


ONLY POSSIBLE WITH CABLE CONNECTION

Before starting the software MT-SOFT the power of the LEVELMETER “light” must be "ON" as this is important in order that the software recognises the adapter.

This configuration can be set-up with one or two instruments

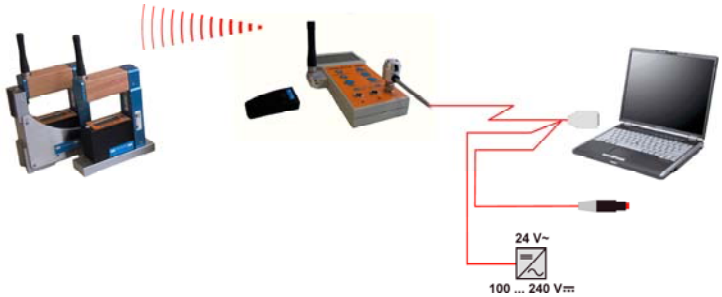
Measuring with MINILEVEL/LEVELTRONIC NT and **LEVELMETER 2000 via radio module**
The digital signal is used.



Before starting the software MT-SOFT the power of the LEVELMETER 2000-F must be "ON" as this is important in order that the software recognises the adapter. This configuration can be set-up with one or two instruments

The Levelmeter 2000 requires an external power supply 24V.

Measuring with MINILEVEL/LEVELTRONIC NT and **LEVELMETER 2000 via radio module and "zapper"**
The digital signal is used.



Before starting the software MT SOFT the power of the LEVELMETER 2000-F must be "ON" as this is important in order that the software recognizes the adapter.

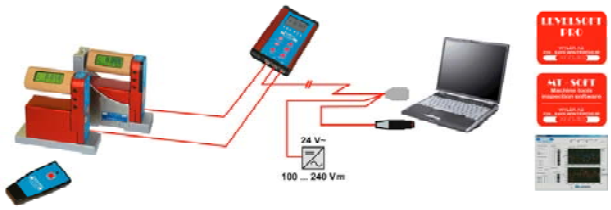
The Levelmeter 2000 requires an external power supply 24V.

Important:
In case of failure of the IR-Zapper the signal may be transmitted/confirmed by pressing the key ■ **ENTER** on the LEVELMETER 2000.

A3) CONFIGURATIONS WITH THE "BLUESYSTEM" FAMILY

Measuring with instruments of the BlueSYSTEM family

Measuring with BlueLEVEL and BlueMETER with cable connection

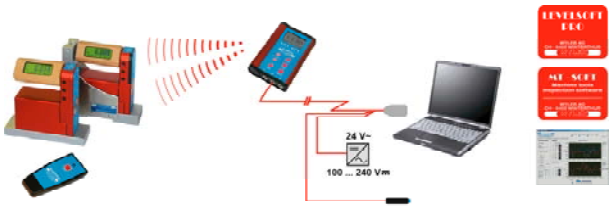


WITH CABLE CONNECTION

Before starting the software MT-SOFT the BlueMETER and the measuring instruments connected must be "ON" as this is important in order that the software recognises the adapter.

This configuration can be set-up with one or two instruments

Measuring with BlueLEVEL and BlueMETER with wireless data transmission

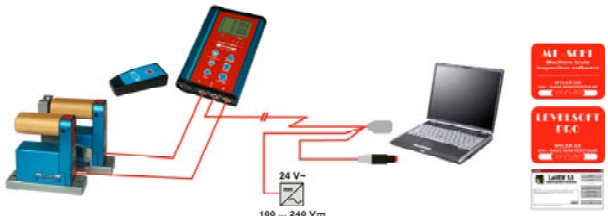


WITH WIRELESS TRANSMISSION

Before starting the software MT-SOFT the BlueMETER and the measuring instruments connected must be "ON" as this is important in order that the software recognises the adapter.

This configuration can be set-up with one or two instruments

Measuring with BlueLEVEL BASIC and BlueMETER BASIC with cable connection

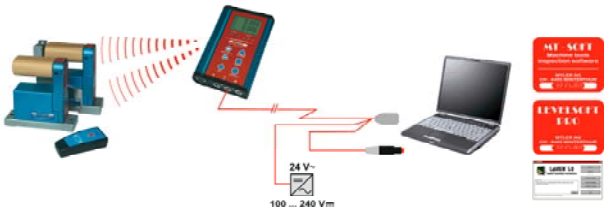


WITH CABLE CONNECTION

Before starting the software MT-SOFT the BlueMETER BASIC and the measuring instruments connected must be "ON" as this is important in order that the software recognises the adapter.

This configuration can be set-up with one or two instruments

Measuring with BlueLEVEL BASIC and BlueMETER BASIC with wireless data transmission



WITH WIRELESS TRANSMISSION

Before starting the software MT-SOFT the BlueMETER BASIC and the measuring instruments connected must be "ON" as this is important in order that the software recognises the adapter.

This configuration can be set-up with one or two instruments.

WYLER AG
Im Hölderli
CH-8405 WINTERTHUR
Switzerland

Tel. 0041 (0) 52 233 66 66
Fax. 0041 (0) 52 233 20 53

Homepage: http://www.wylerag.com
E-Mail: wyler@wylerag.com