



# GEAR INSPECTION MACHINES

## GT 150 KW

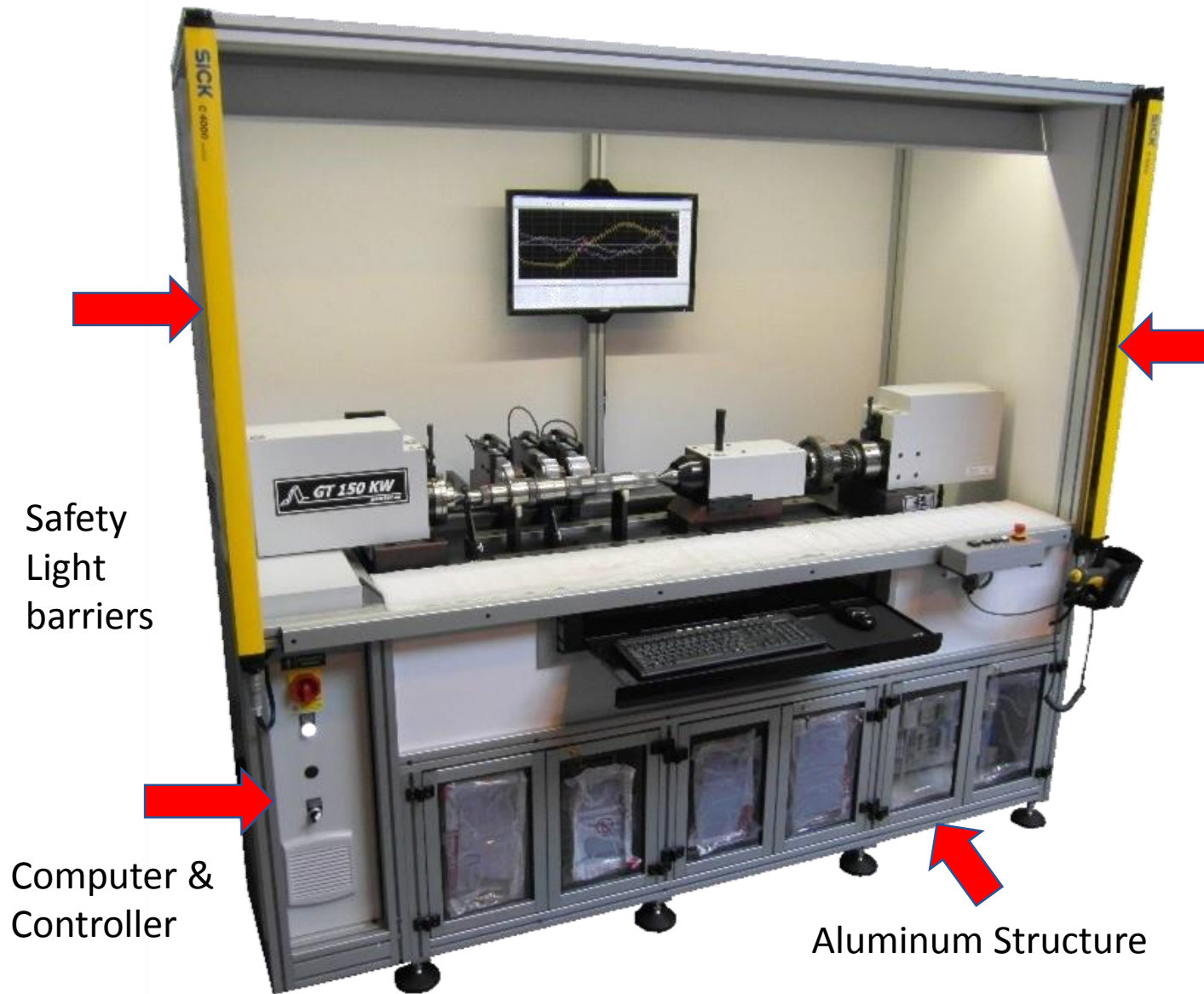
Double flank inspection machine

for simultaneous measurement of  
up to 4 parts  
**for automotive & motorcycle ind.**

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**GEARTEC.CZ**

Mouse click to continue



Safety  
Light  
barriers

Computer &  
Controller

Aluminum Structure

## Overall view

Generic Overview of  
the machine's main  
capabilities

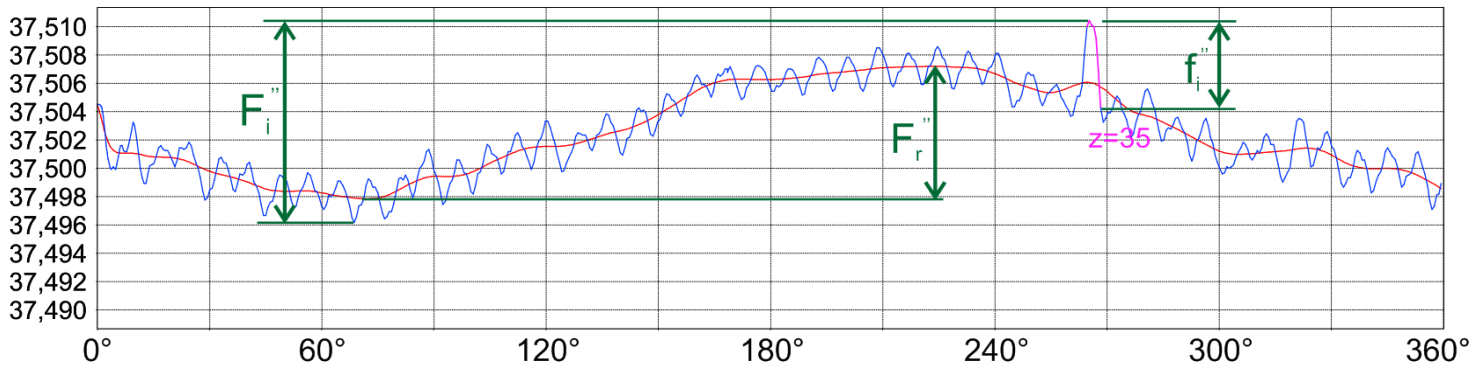
Safe  
Compact  
Save Time  
Automatic  
Software  
Precise  
Adaptive

# Available Standards

## DIN, ISO, AGMA, BS, JGMA, JIS

## Measurement capabilities

The machine has the possibility to measure all required parameters indicated by gear's designers concerning Double Flank rolling method measurement.



### Double flank deviations

- $F_i''$  - Total composite error
- $f_i''$  - Tooth to tooth error
- $F_r''$  - Radial runout

### Other measurable deviations

- $j$  - backlash
- $A_a$  - Fluctuation of axis distance
- $M_z$  - Measure over teeth
- $M_{dk}$  - Measure over pins

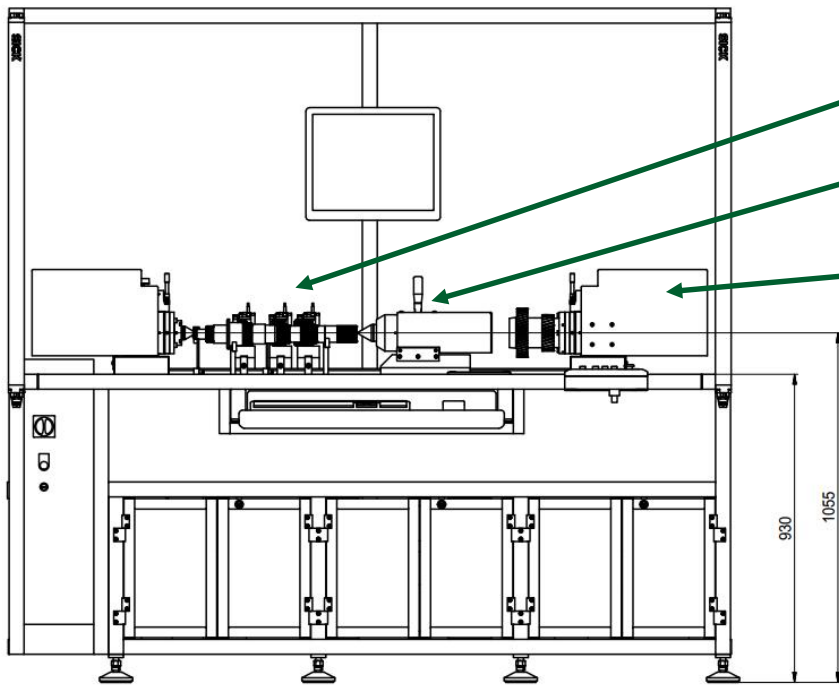
## MACHINE PARAMETERS & LAYOUT

Diameter of measured gear, max.	<b>285 mm</b>
Diameter of master gear, max.	<b>150 mm</b>
Center distance (between master gear axis and test gear axis)	<b>60 - 130 mm</b>
Length of shaft (max)	<b>700 mm</b>
Space between two adjacent master gear stations, min.	<b>3 mm</b>
Weight of gear, max.	<b>20 kg</b>
Measuring force, max. (adjustable)	<b>50 N</b>
Weight of the machine	<b>1250 kg</b>
Repeatability of measurement	<b>up to 1 <math>\mu</math>m</b>

Above parameters may change based on customer's requirements

### Machine's parameters and construction details

Some of machine's constructive parameters are standard and proper to all GT150KV while others can be adapted or modified upon customer's requirement



## Front View

Main shaft-spindle

Shaft- tailstock

Stand-alone motor spindle for gears clamped fleetingly

## Machine's layout (standard)

The shown layout is based on existing machine, equipped with several options as an independent spindle able to clamp spur gears fleetingly and measure them stand-alone.

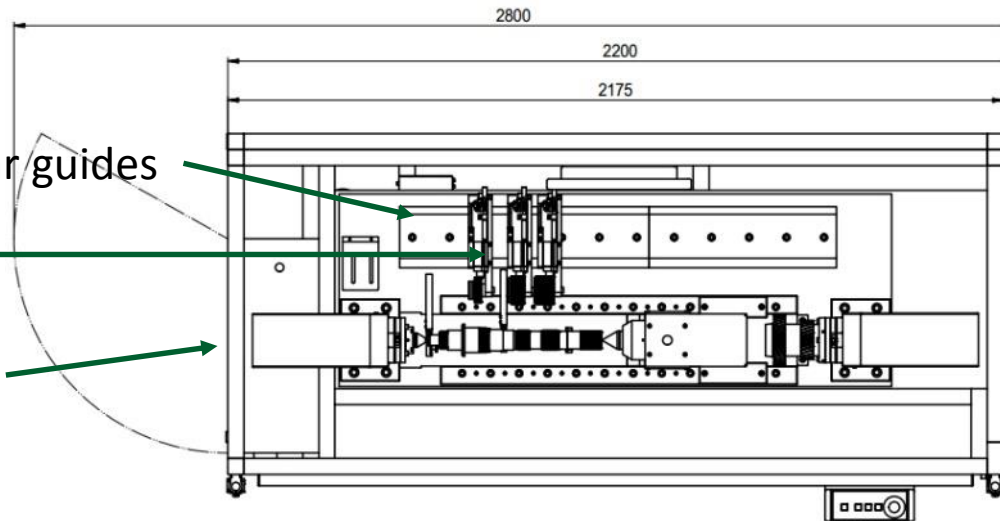
Different configurations may lead to different overall sizes.

## Top View

Master-Station linear guides

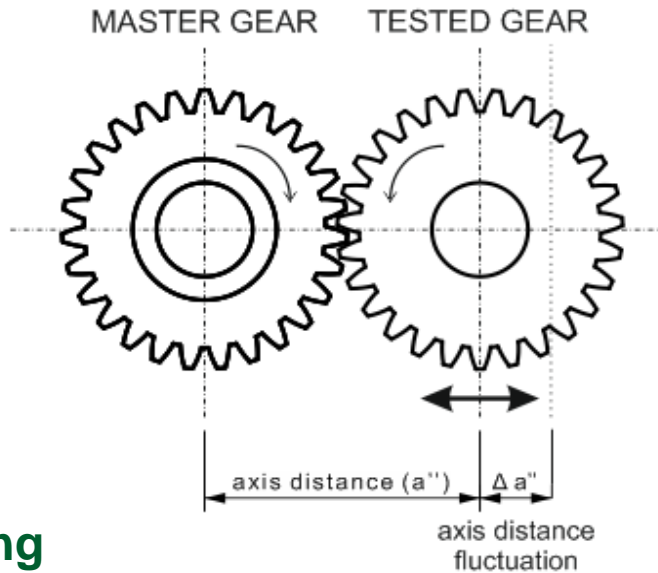
Master-stations

Control & electronic cabinet



## Measuring principle

- Measured gear is pressed by a defined force into a mesh / contact with a master gear.
- Master gear rotates and the measured part is driven accordingly, the rolling movement creates a linear fluctuation that is analysed and processed.
- Fluctuation of axis distance is observed, recorded and evaluated during rolling.



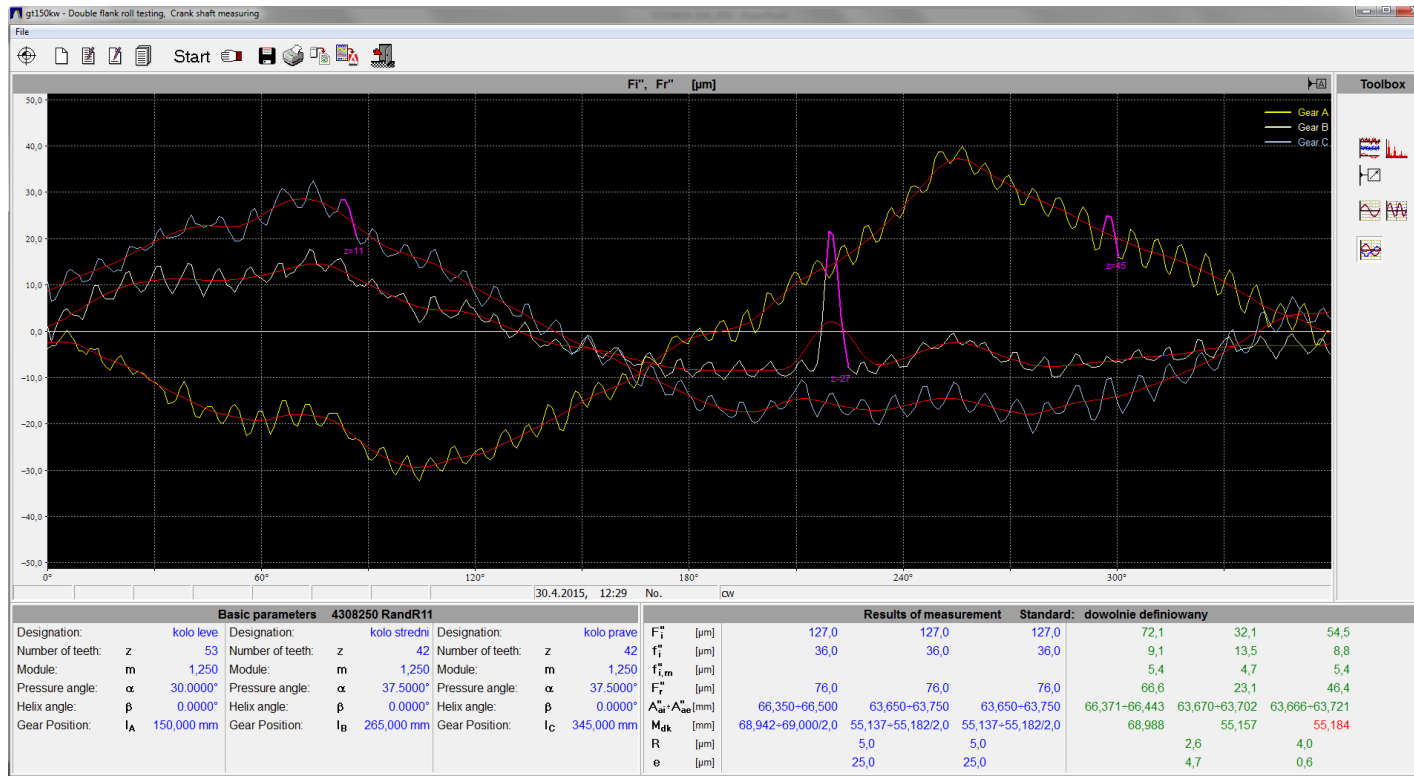
## Double Flank measuring principle

Here is explained, simply, how the Double-flank rolling method consists and how the measurement are performed.

## Advantages of double flank rolling

- Short time needed for measuring
- If a gear is OK with double flank inspection, other deviations of shape and position are fine, too.
- Price of such a machine is lower in a multiple manner in comparison with other measuring methods.
- Suitable for 100% check in a mass production.
- Capable of measuring gears with small modules ( $m \geq 0,05$  in reality).
- Fast and reliable identification of bad parts.
- Enable measuring in production process.
- Does not need any air-conditioned measuring room.
- Easy and user-friendly operation

# EVALUATION SOFTWARE



## Evaluation Software

In this slide you can see how the measurements are represented just after the full run. All data are shown in the chart, standard values and (on demand) other values as, for example, diameters and runouts.

The measuring software is under WINDOWS environment and remote web-service is always possible.

**Multilingual**

English standard, other languages on demand

**Intuitive**

Icon-based software user friendly

**Easy to understand**

Minimal training necessary for medium-experts

**Database of results**

All results will be saved on electronic data-bank

**Permanent license**

SW license is a property not a time-based lease

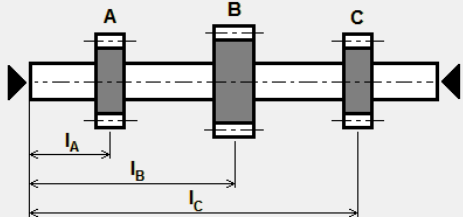
# SOFTWARE INTERFACE

Measuring parameters

Basic parameters | Complementary | Tolerances | Roundness | Setup

Drawing No. 4308250 RandR10

Clamping  
 between centers  expandable collet



Gear	A <input checked="" type="checkbox"/>	B <input checked="" type="checkbox"/>	C <input checked="" type="checkbox"/>
Designation	Gear A	Gear B	Gear C
Number of teeth z	53	42	42
Module m	1,250	1,250	1,250
Pressure angle $\alpha$	30.0000°	37.5000°	37.5000°
Helix angle $\beta$	0.0000°	0.0000°	0.0000°
Profile correction xm	0,000 mm	0,000 mm	0,000
Gear Position $l_A$	150,000 mm	$l_B$ 265,000 mm	$l_C$ 345,000 mm
Master gear-Number of teeth z	52	60	60
Master gear-Profile correction xm	0,701 mm	-0,038 mm	-0,044 mm
Control surface diameter $\phi D$	56,020 mm	52,010 mm	52,010 mm

Cancel Save OK

## Software Interface

All parameters needed, machine setups, Master's data Gear designations and other values are simply and clearly shown in windows.

A minimal degree of expertise is necessary to insert the data (operator level) but no high-level knowledge of any programming language is needed so the software is really user-friendly.

User-friendly

No special PC knowledge required

Running under MS Windows OS

Selectable Standards

*Basic parameters of tothing, description of clamping fixtures*



# SOFTWARE INTERFACE

The screenshot shows a software window titled 'Measuring parameters' with several tabs: 'Basic parameters', 'Complementary', 'Tolerances', 'Roundness', and 'Setup'. The 'Basic parameters' tab is active. It features a 'Standard' dropdown menu with options: 'dowolnie definiowa', 'DIN 3963', 'DIN 58405', 'AGMA2000', 'ISO 1328', 'BS 4582', and 'BS 978'. Below it is an 'Evaluation' dropdown with 'um' and 'mm' options. The main area is a table with columns for 'Gear', 'A', 'B', and 'C'. The table contains parameters like Total composite error, Tooth to tooth error, Runout, Centre distance deviation, and Checking dimensions (Measurement over teeth and Measure over ball). Each parameter has input fields for values and units. At the bottom, there are 'Cancel', 'Save', and 'OK' buttons.

	Gear	A	B	C
Total composite error $F_i''$	14,0 $\mu\text{m}$	14,0 $\mu\text{m}$	14,0 $\mu\text{m}$	
Tooth to tooth error $f_i''$	6,0 $\mu\text{m}$	6,0 $\mu\text{m}$	6,0 $\mu\text{m}$	
Runout $F_r''$	12,0 $\mu\text{m}$	12,0 $\mu\text{m}$	12,0 $\mu\text{m}$	
<input checked="" type="checkbox"/> Centre distance deviation $A_{ai}''$	66,350 mm	63,650 mm	63,650 mm	
$A_{ae}''$	66,500 mm	63,750 mm	63,750 mm	
<input checked="" type="checkbox"/> Checking dimensions				
<input type="checkbox"/> Measurement over teeth $M_z$	0,000 $\pm$ 0,000 mm	0,000 $\pm$ 0,000 mm	0,000 $\pm$ 0,000 mm	
$z_m$	26	21	21	
<input checked="" type="checkbox"/> Measure over ball $M_{dk}$	68,942 $\pm$ 69,000 mm	55,137 $\pm$ 55,182 mm	55,137 $\pm$ 55,182 mm	
$\phi d_k$	2,000 mm	2,000 mm	2,000 mm	

## Software Interface

Most common Standards available on a simple click. Values automatically calculated and inserted in the appropriate fields.

Possibility to insert customized standards or individual values requested by gear's designers.

In case of a complete "Group-oriented" standard it can be created separately.

**Automatic Standard Parameters**

**Possibility to insert customized parameters**

**More Standards available on demand**

**Easy understandable needed data**

*Option of standards and a degree of accuracy for each deviation*

# INSPECTION REPORTS (HEADER)

Workpiece data

Customer's logo

## Inspection Report

All gear's data are clearly visible on the report's header.

Company's logo can be printed on all reports.

Along with single gears' data some other common data are visible as part number, contract nr. machine ID, date, operator and notes. These data will also be saved in the data-base.

Double flank roll testing, Crank shaft measuring

 gt 150kw

Drawing No.: 4308250 RandR11

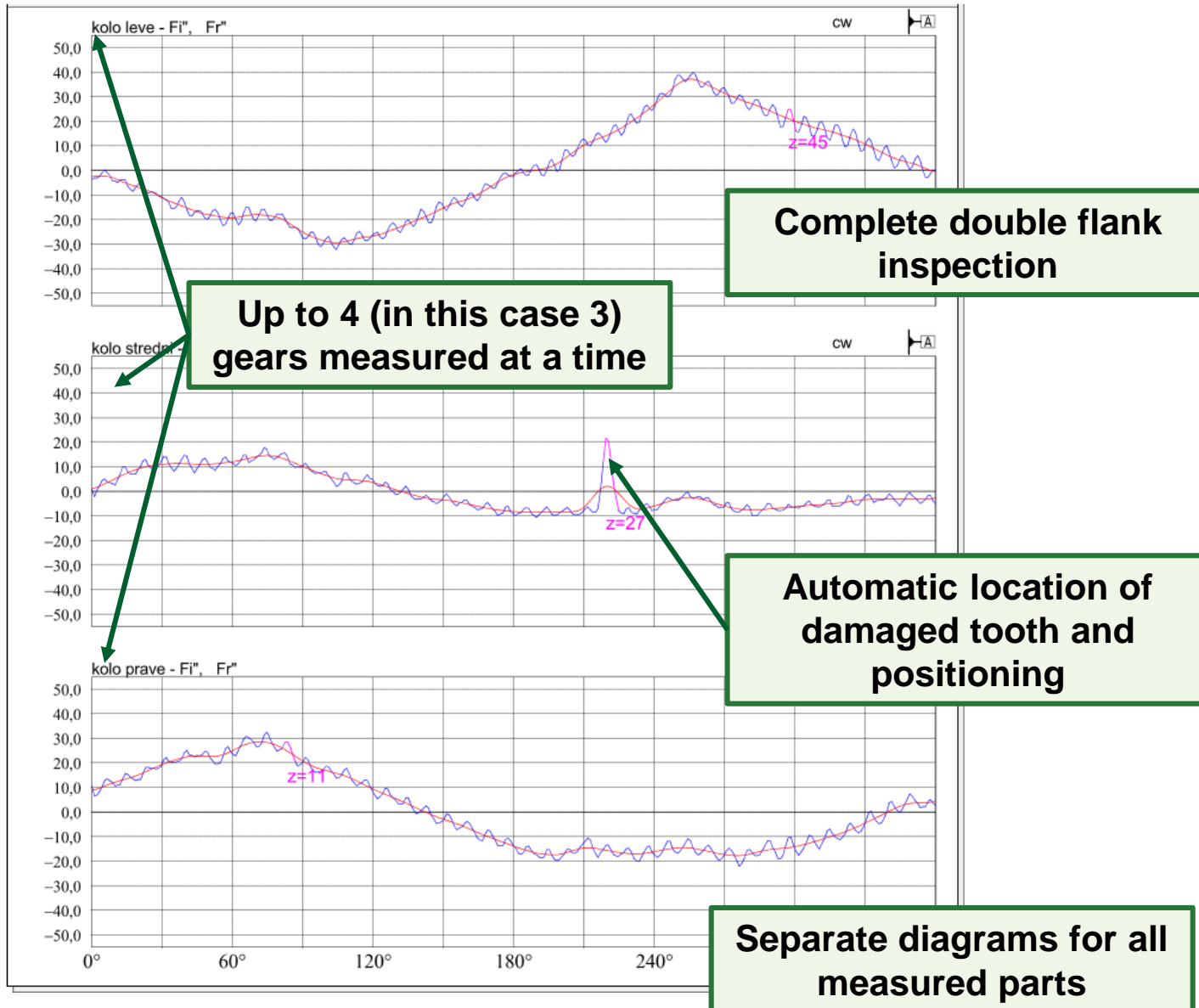


Designation	kolo leve		kolo stredni		kolo prave	Part No.	
Number of teeth	z	53	z	42	z	42	Contract No.
Module	m	1,250	m	1,250	m	1,250	Machine No.
Pressure angle	$\alpha$	30.0000°	$\alpha$	37.5000°	$\alpha$	37.5000°	Date 30.4.2015 12:29
Helix angle	$\beta$	0.0000°	$\beta$	0.0000°	$\beta$	0.0000°	Checked by
Gear Position	I <sub>A</sub>	150,000 mm	I <sub>B</sub>	265,000 mm	I <sub>C</sub>	345,000 mm	Note

Internationally understandable terminology

Additional information

# INSPECTION REPORTS (CHARTS)



## Report's charts

After the measurement the diagrams are separately available on screen and on reports.

Single examined waves can be easily evaluated.

# INSPECTION REPORT (EVALUATION)

Allowed values according to DIN 3963

Measured values

## Evaluation of measured Data

The footer of the report shows all measured characteristics.

International nomenclature of measuring parameters with selectable units.

Allowed values calculated by selected Standard's Norm.

True measured values of the selected gears.

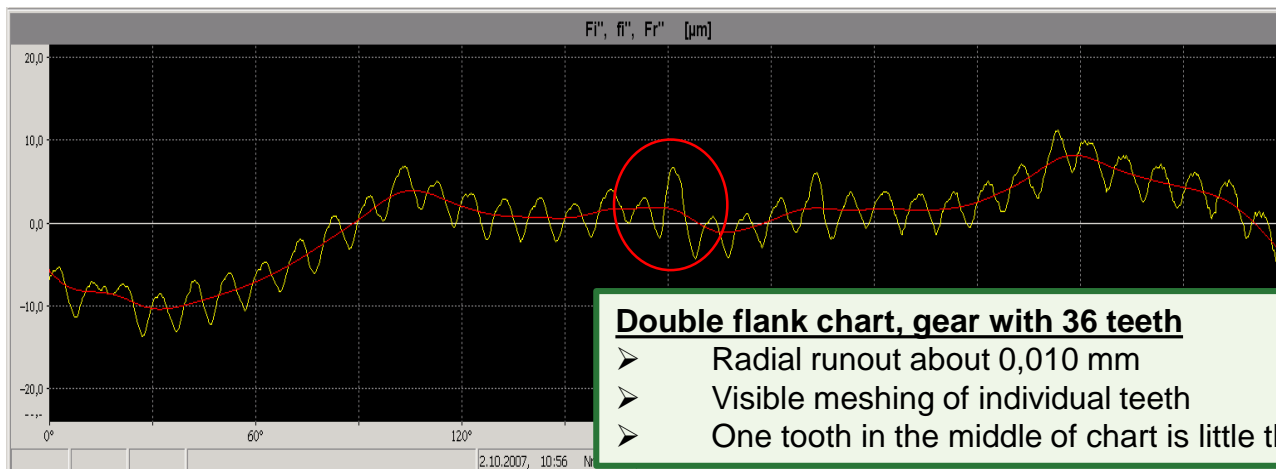
Differences from nominal to measured values.

Measuring Parameters			Allowed			Measured		
Total composite error	$F_i''$	[ $\mu\text{m}$ ]	127,0	127,0	127,0	72,1	32,1	54,5
Tooth to tooth error	$f_i''$	[ $\mu\text{m}$ ]	36,0	36,0	36,0	9,1	13,5	8,8
Mean value	$f_{i,m}''$	[ $\mu\text{m}$ ]				5,4	4,7	5,4
Runout	$F_r''$	[ $\mu\text{m}$ ]	76,0	76,0	76,0	66,6	23,1	46,4
Centre distance deviation	$A_{ai}'' \div A_{ae}''$	[mm]	66,350+66,500	63,650+63,750	63,650+63,750	66,371+66,443	63,670+63,702	63,666+63,721
Measure over ball	$M_{dk}$	[mm]	68,942+69,000/2,0	55,137+55,182/2,0	55,137+55,182/2,0	68,988	55,157	55,184
Roundness - Bearing A-B	R	[ $\mu\text{m}$ ]	5,0	5,0		2,6		4,0
Eccentricity - Bearing A-B	e	[ $\mu\text{m}$ ]	25,0	25,0		4,7		0,6

Selectable units

Graphical differentiation

## EXAMPLE OF RESULTS



### Double flank chart, gear with 36 teeth

- Radial runout about 0,010 mm
- Visible meshing of individual teeth
- One tooth in the middle of chart is little thicker

## Result's analysis

The chart, along with numerical values, can give to the operator good indication of what is wrong and where.

During the training some suggestions on the result's analysis are given.



### Tooth No.9 is damaged on tip

- Gear has axial runout

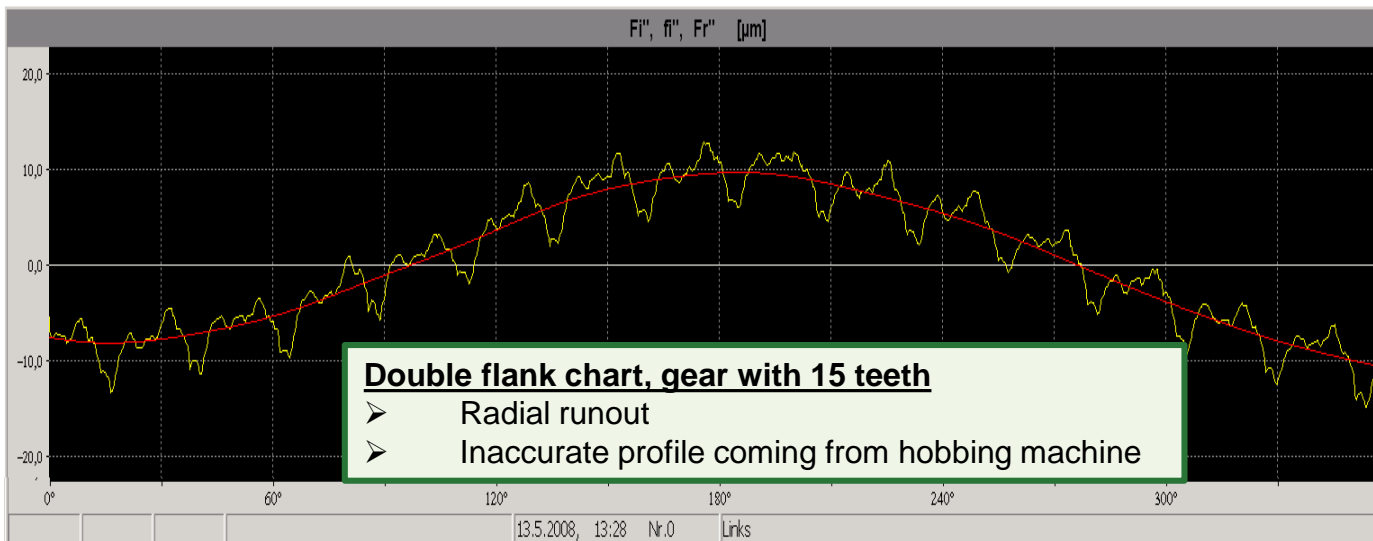
# EXAMPLE OF RESULTS



## Result's analysis

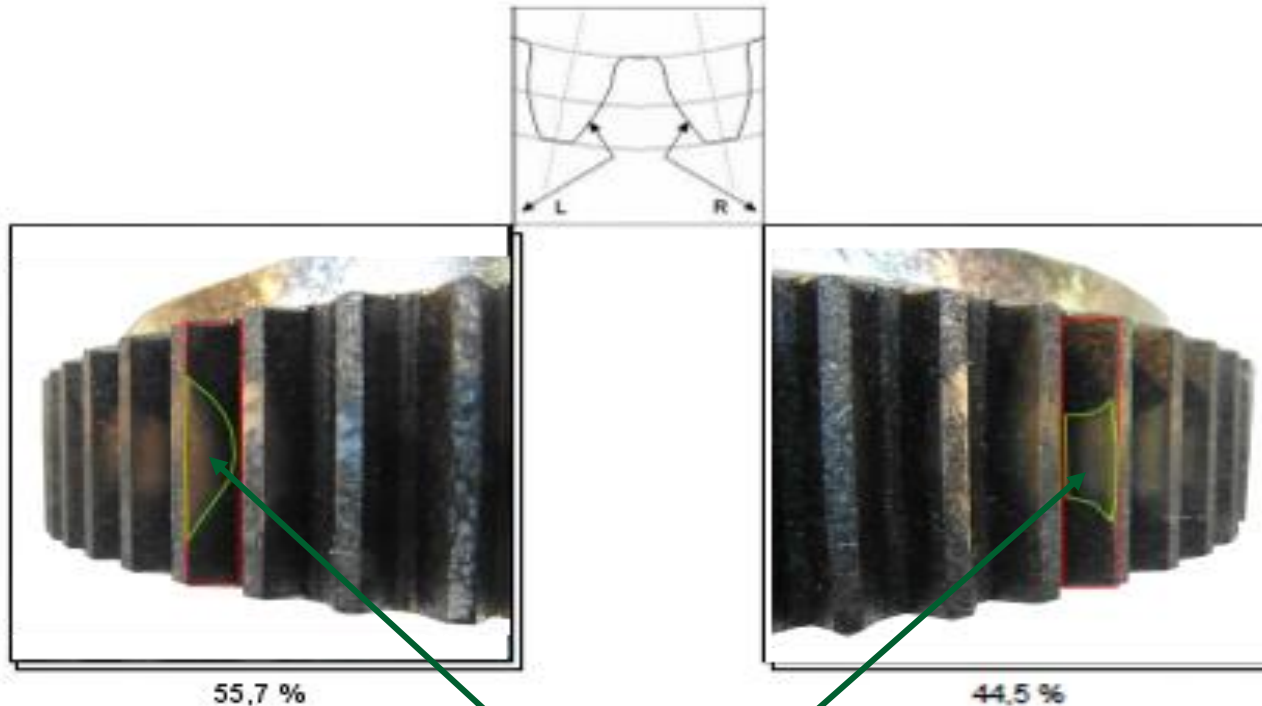
The chart, along with numerical values, can give to the operator good indication of what is wrong and where.

During the training some suggestions on the result's analysis are given.



# CONTACT PATTERN

## Contact Pattern



Values of contact pattern calculated and shown in %  
Photos are stored in database along with measuring results

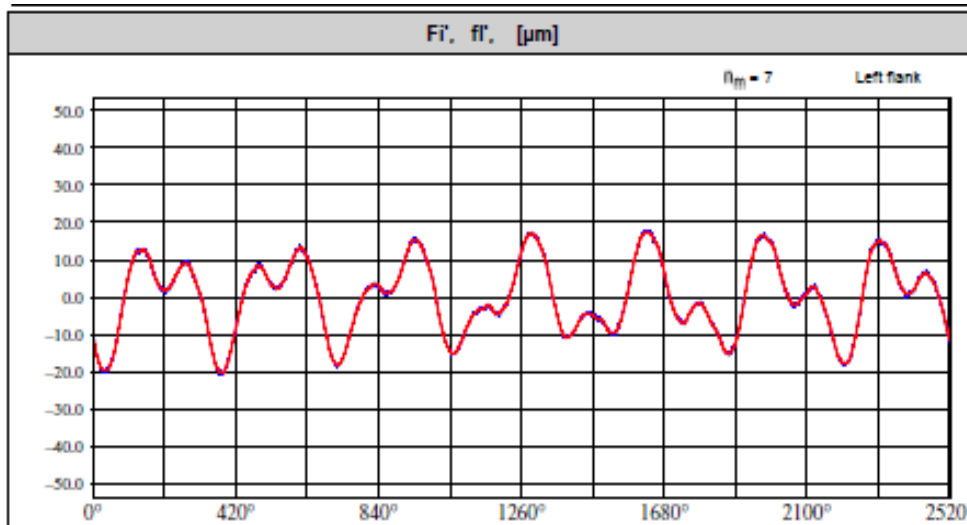
This analysis requires human intervention.

Special paint or paste needs to be applied on the part before meshing with the master (that has to be cleaned after the measurement).

The meshing of master and workpiece transfers the paint on the teeth and where there is contact the paint is not present.

By camera (standard along Contact pattern software) pictures are taken and the software evaluates the contact areas.

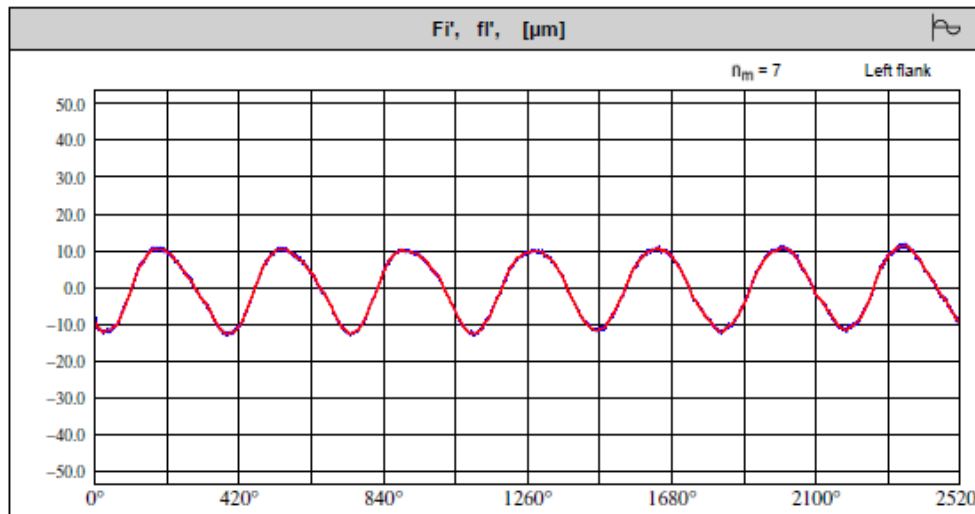
# MASTER GEAR ERROR ELIMINATION



Results **without** master gear error compensation



Results **with** master gear error compensation



## Master Gear error elimination

Although a master gear is a perfect gear, it brings its inaccuracy (as of DIN class 3 / 4) into measurement and can influence the measured part.

Using our deep knowledge of frequency analysis, we can deduct a complete master gear error (namely its radial runout, shape errors) from measured results.

It works fully automatically and the results can be seen without compensation and/or with compensation by one click in the software.



# FFT ANALYSIS

A **fast Fourier transform (FFT)** is an *algorithm* that computes the discrete Fourier transform (DFT) of a sequence.

Fourier analysis converts a signal from its original domain (often time or space) to a representation in the frequency domain and/or vice versa.

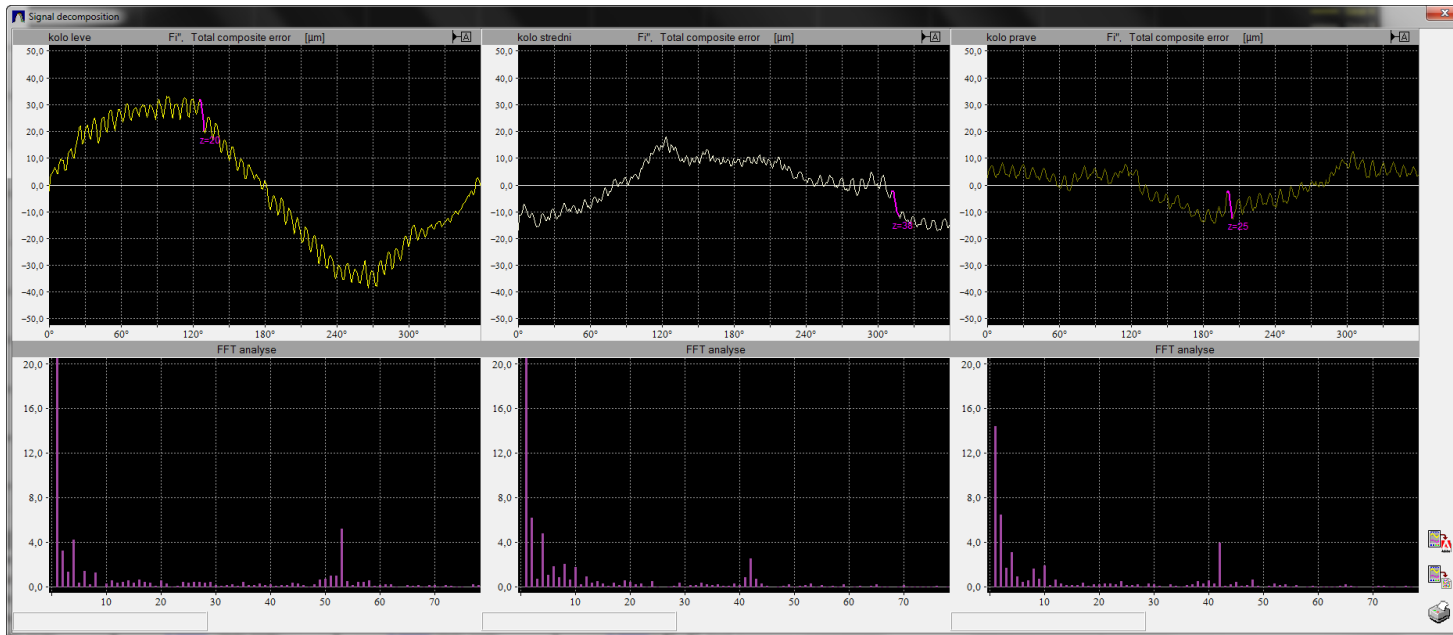
The DFT is obtained by decomposing a sequence of values into components of different frequencies.

## Fast Fourier Transform

FFT analysis available for any single measured part.

Separate diagrams are shown and can be evaluated.

Scale can be selected for a better view of results.



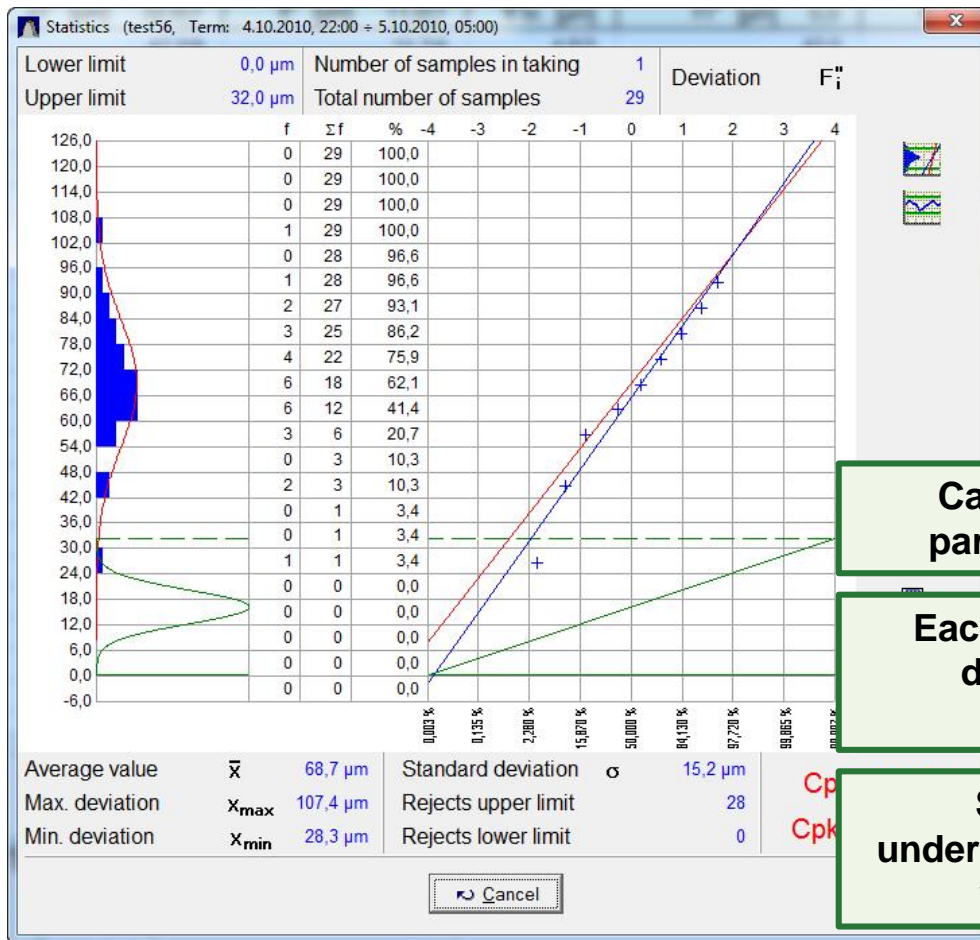
FFT analysis calculation for each gear separately

Selectable scale

Shows harmonic orders up to 550th stage

# BASIC STATISTICAL EVALUATION (SPC)

## SPC software



Calculates  $c_p$  and  $c_{pk}$  parameters of a batch

Each or all double flank deviations may be considered

Shows clear and understandable overview of your production

Shows histogram and time course diagram

Separate calculations for each measured part

GEARTEC SPC is a basic SPC (Statistical evaluation software) able to analyze series of measurement (already saved on internal data-base) for Statistical purposes.

Results are both graphic and numeric, all printable.

## CONTROL PANEL

Double-button panel

**Emergency stop button integrated**

**Main machine functionalities placed handy**

**Additional safety measure with double-button start**

**Visible indication of machine power-on status**

## Controls

GEARTEC GT150KV is a machine mostly used for 100% checking so the interaction between the operator and the measuring system is constant and has to follow the highest standards of safety.

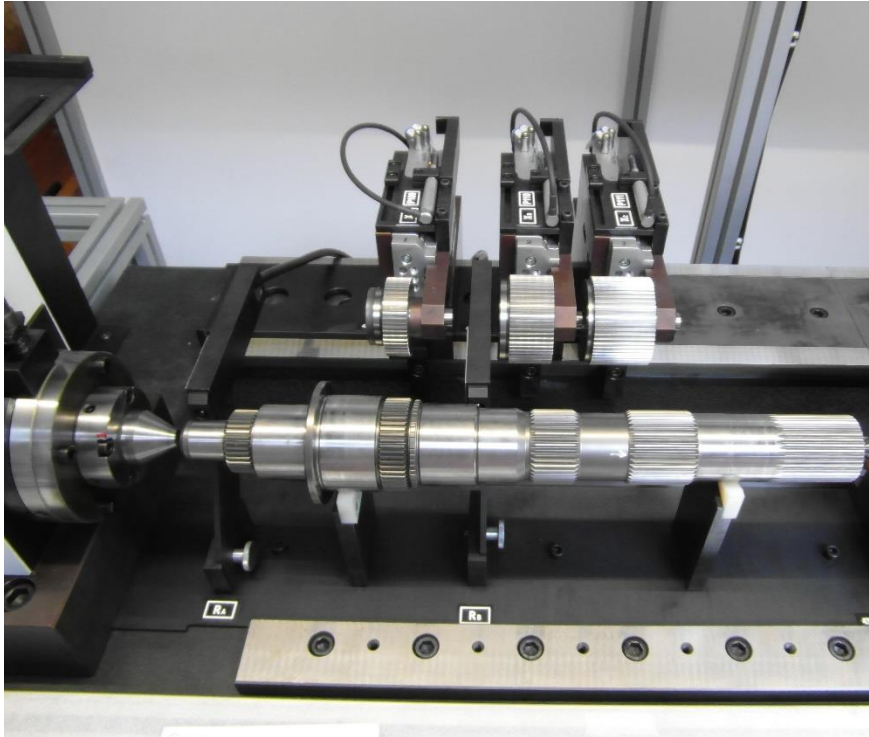
The automatic measuring cycle can be started by pushing a single button START or, on demand, a DOUBLE-BUTTON panel.

Apart from the light-barrier Emergency buttons are built-in on both available panels.

Standard panel



# POSITION BEFORE START OF THE MEASUREMENT



**Tested part shaft placed on a support between centers**

**Master gear axis (3) in their initial position**

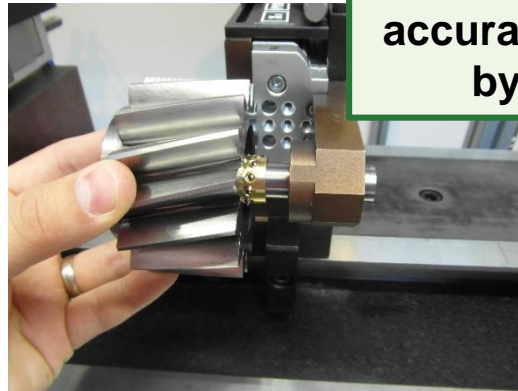
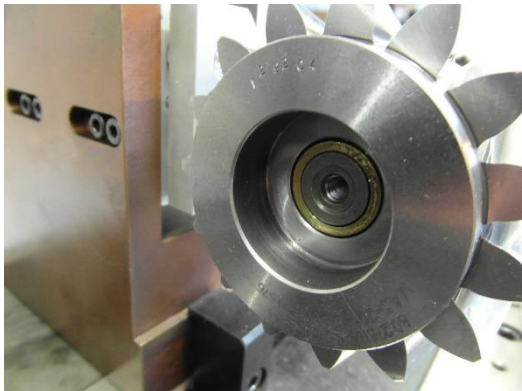
**Master gears fixed on precise ball-cages**

**Pneumatically controlled movements of both centers**

**Double flank deviations recorded by highly accurate length probes by Heidenhain**

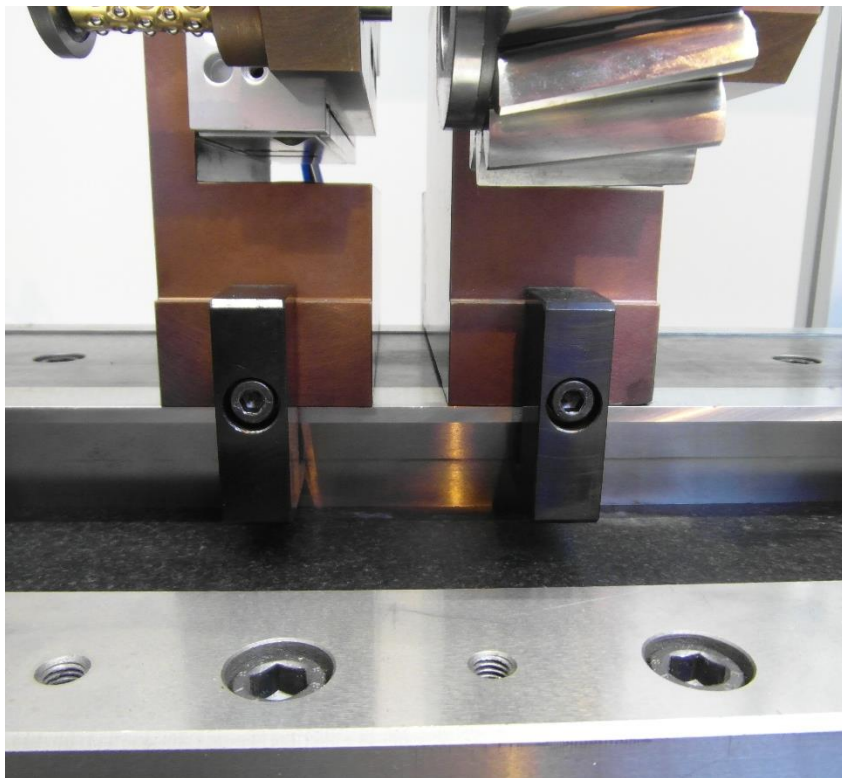
## Machine setup procedures

Some basic operations have to be performed before starting the measuring sessions





# MASTER GEARS STATIONS



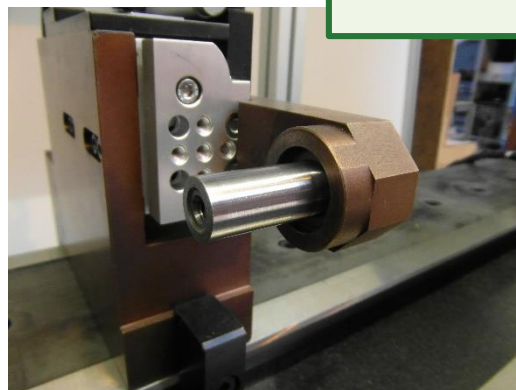
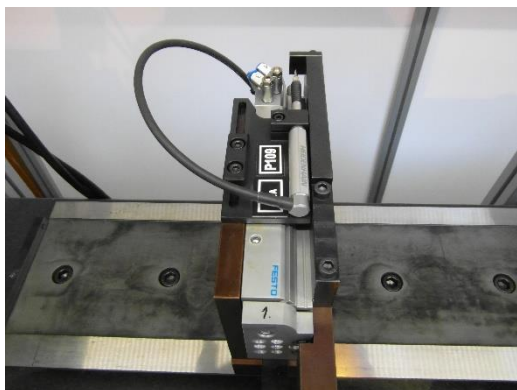
**Position of master gear axis can change**

**Number of master gear axis can change (up to 4)**

**Simultaneous measurement of up to 4 gears**

**Easy and quick assembly**

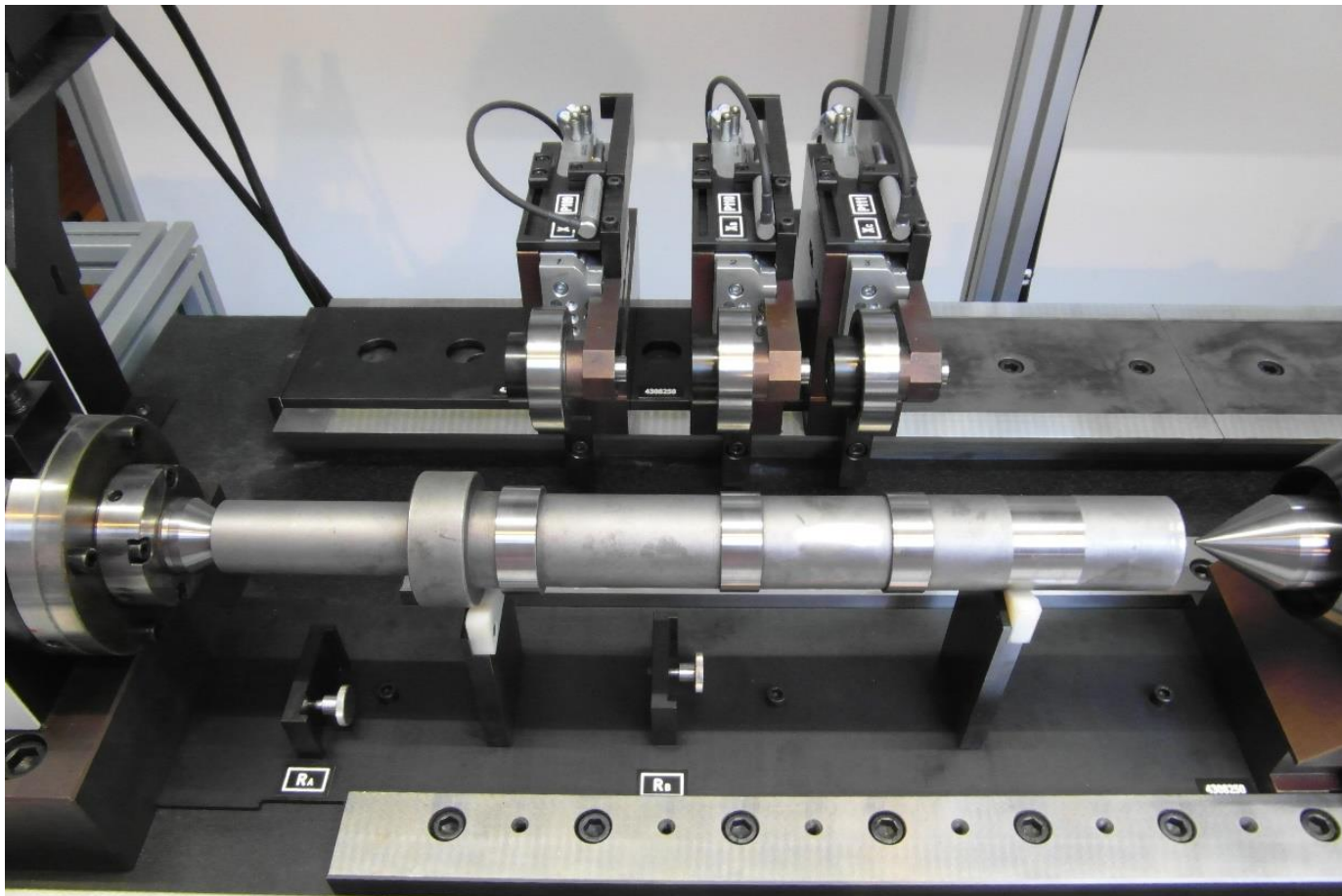
**Pneumatically / electrically controlled movement of all master gears**



## Master-gears Stations

Up to 6 configurable stations (2 with linear probe able to measure run-outs and bearing surfaces' diameters and 4 equipable with MASTER Gears) can be used on GT150KV reducing the measuring time considerably as well as costs.

# CALIBRATION



**Automatic calibration as well as  
axis distance verification**

**Control shaft and control  
rings**

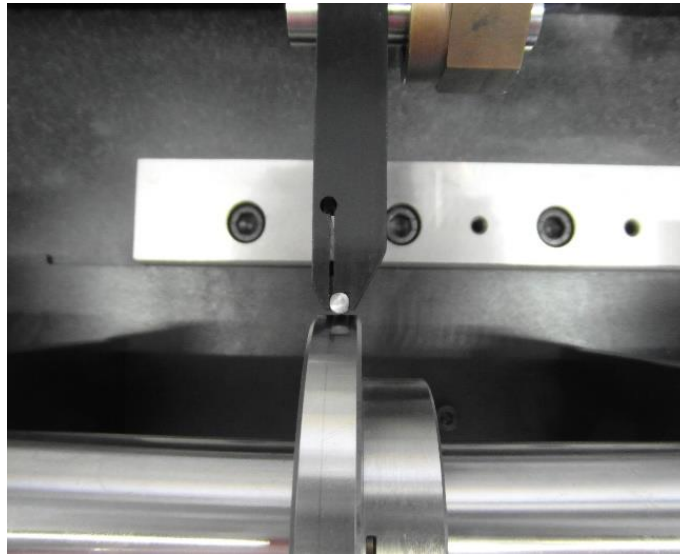
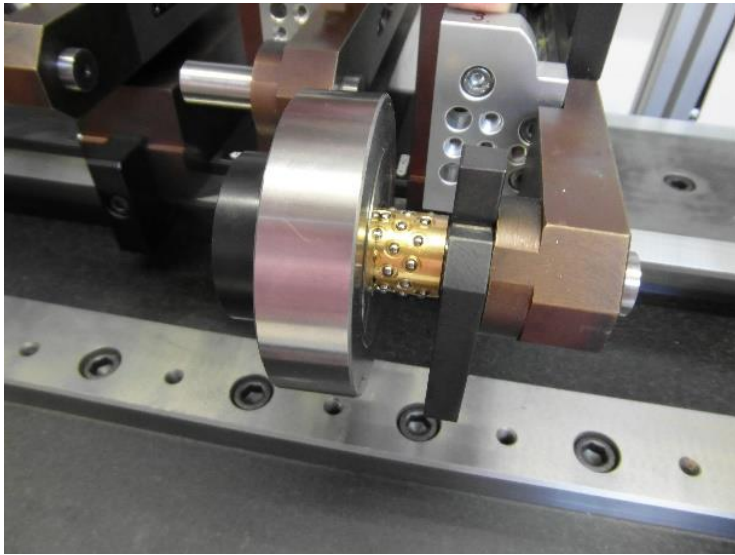
## Machine Setup

One of the possible measurements of GT150KV is the Center Distance and to achieve a precise result a calibration procedure has to be performed.

A finely worked master shaft and precise control rings (made upon Master-gears' data) have to be meshed up to get precise position for all master-gears' stations.

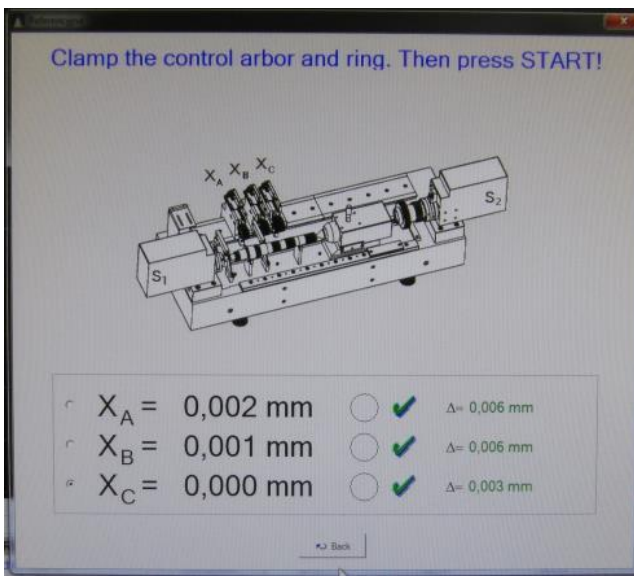
Both shaft and rings can be supplied by GEARTEC as well as done by the customer.

# CALIBRATION



## Machine Setup

Master-stations are software controlled, positions precisely stated and to be verified before starting a measurement' process.



**Ball-cages on control rings and masters for best performances**

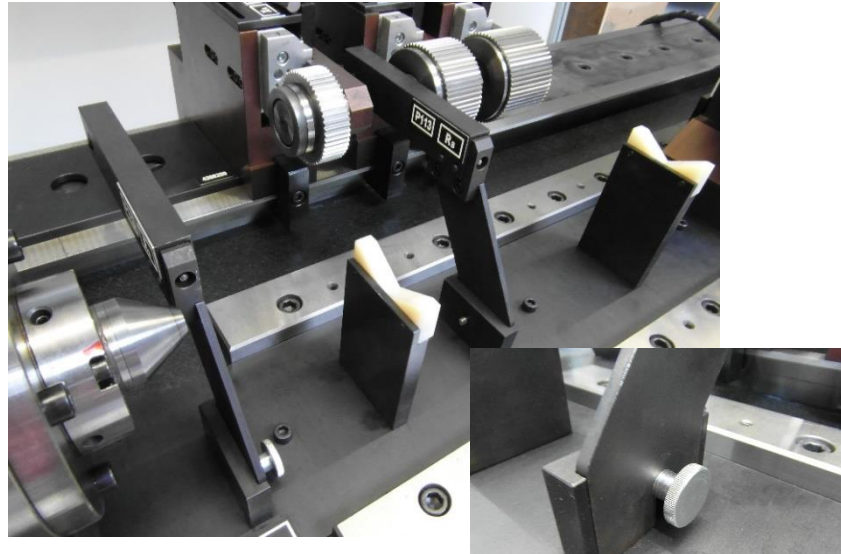
**Precise linear encoders for run-out and diameter checks**

**Laboratory certified values**

**Software controlled**



# CHECKING OF CONTROL SURFACES



**Additional probes for checking of control surfaces (up to 2)**

**Inspection and evaluation of eccentricity and roundness**

**Fully automatic measurement**

**Possibility of diameter check**

**Adjustable position**

**Quick and easy assembly**

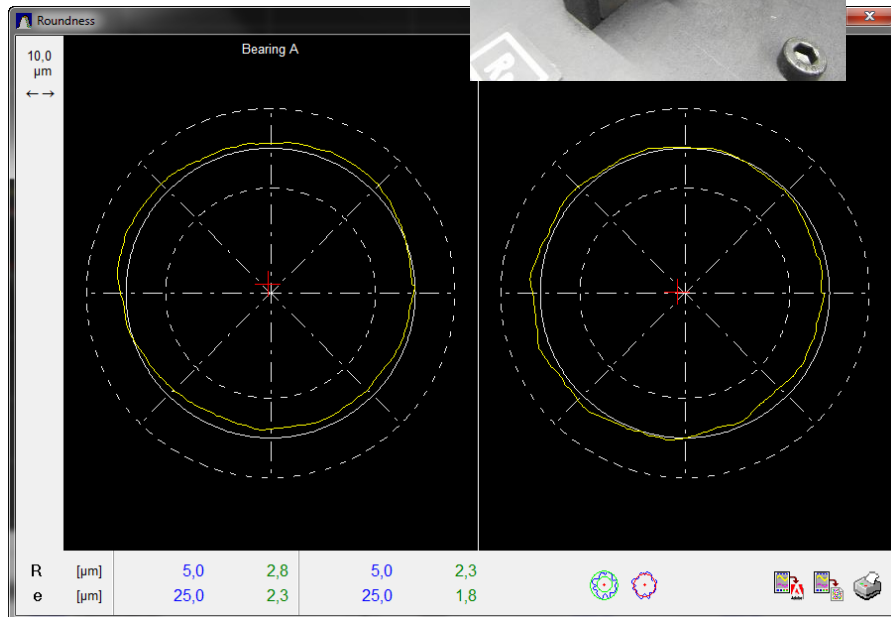
**Fully automatic mathematical compensation**

## Control-surface checks

2 optional checking stations to control the bearing surfaces can be installed on the machine.

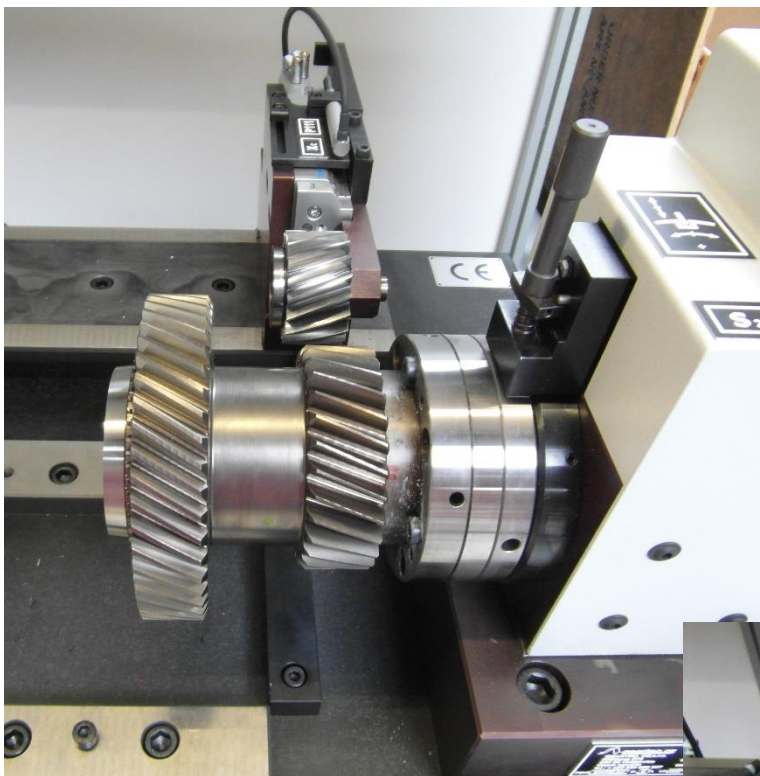
The 2 mentioned stations are fully configurable on position and dimensions thanks to the control shaft previously described.

The run-out and diameter measurement are automatically done during the measuring process, measurements will be printed as well.





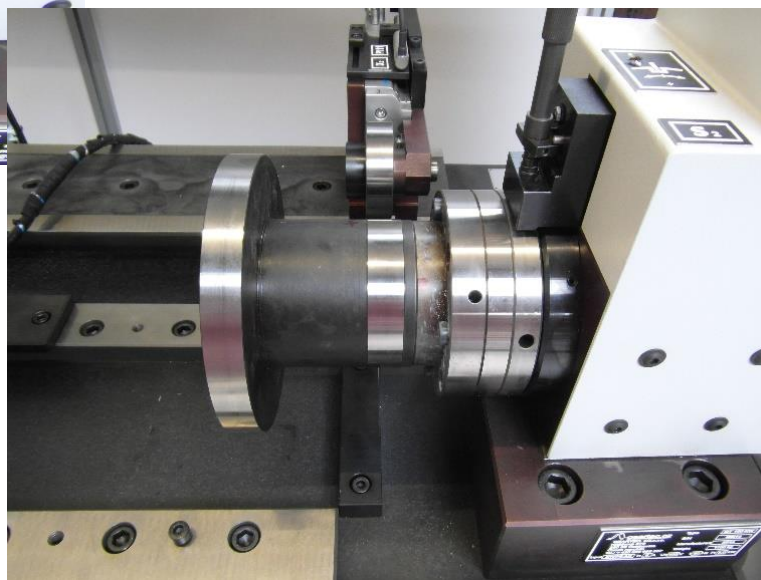
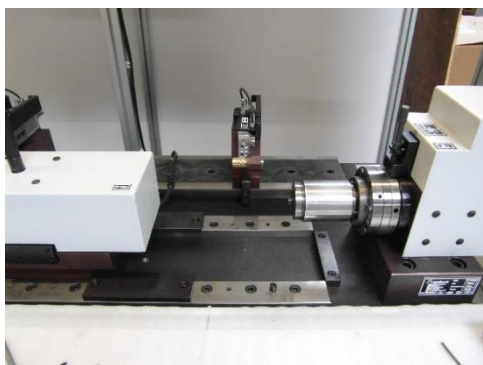
## ADDITIONAL MEASURING STATION



**Allows to measure gears  
clamped fleetingly**

**Pneumatically  
expendable collets used**

**Extends usage of the  
machine**



### Stand-alone additional measuring

Sometime the customers have the necessity to measure normal spur-gears to be clamped fleetingly and not in shaft, in this case we can equip the GT150KV by a separate stand-alone spindle with possibility for single-clamping.

Dedicated clamping can be supplied by GEARTEC on customer's specifications.

Master-gear stations are usable for these measurements. Calibration procedures are the same as previously described

# MEASURING OF CRANKSHAFTS

**Suitable for motorcycle industry**

**Axial runout measurement**

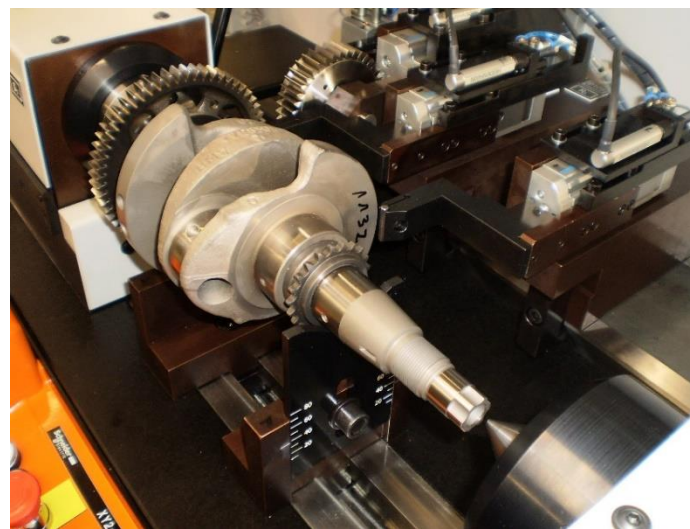
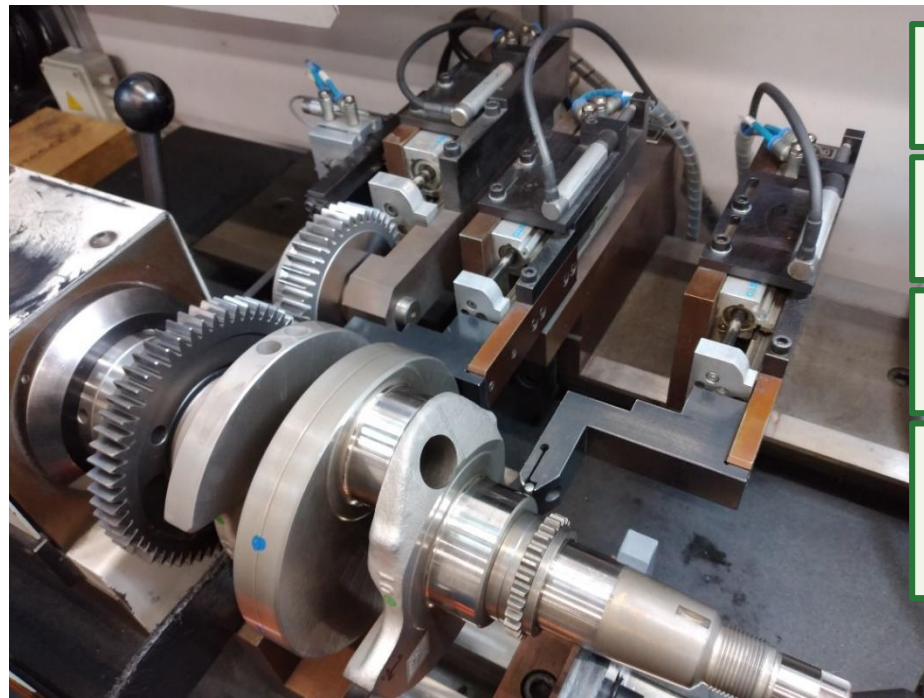
**Control surface diameter measurement**

**Noise analysis available through integrated FFT analysis**

## Crankshafts measurements

GEARTEC GT150KV is extremely configurable for many different purposes.

Here one example used by a very famous motorbike's producer in Europe who uses the machine to measure gears and bearing surfaces on crankshafts.





# PNEUMATIC UNIT / WIRING BOX



**Machine is CE Certified**

**Complies with the most stringent European standards**

**Digitally controlled units with safety elements**

**Adjustable pressure for individual measuring station**

**Controllable compressed-air units by Festo**

## Controls and Power units

All control elements (from PC to PLC systems, to Pneumatic controls) are FIRST QUALITY ONLY.

All systems are from Europe or USA.

GEARTEC uses only the best available devices available on high-end market ensuring quality, durability and TOP satisfaction to our customers since more than 20 years.





# GEAR INSPECTION MACHINES

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