

GTM

single flank inspection - hobbing machine

SOLUTION BY GEARTEC.CZ, 2016



Why single flank testing?

Quality problems in building of new machines

Quality problems in retrofiting of old machines

Problems with quality of gears

Diagnostic of the manufacturing process

Hob instrument and quality of gear

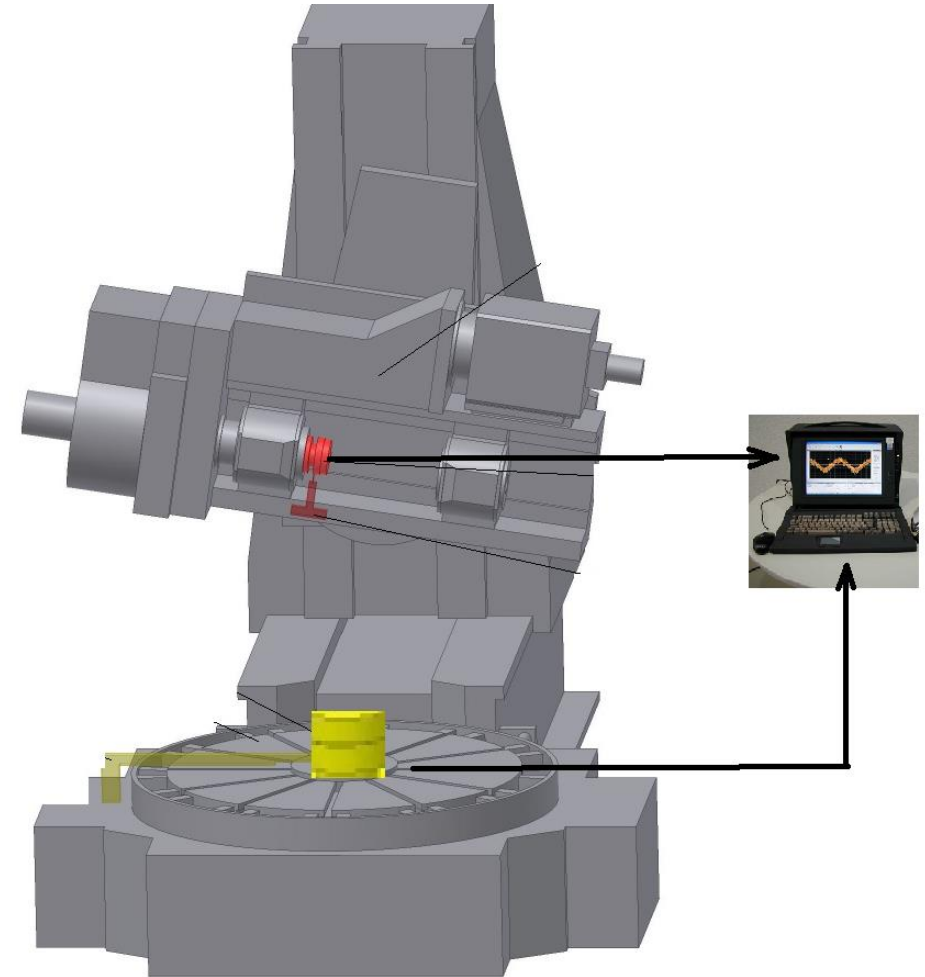
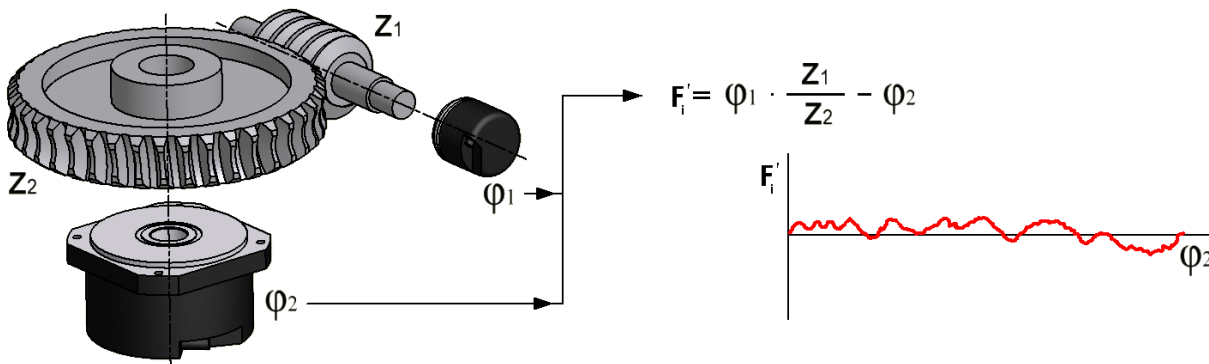
Clamping and quality of gear

Change gears and quality (classical machine)

In all these cases,
the device **GTM**
will help

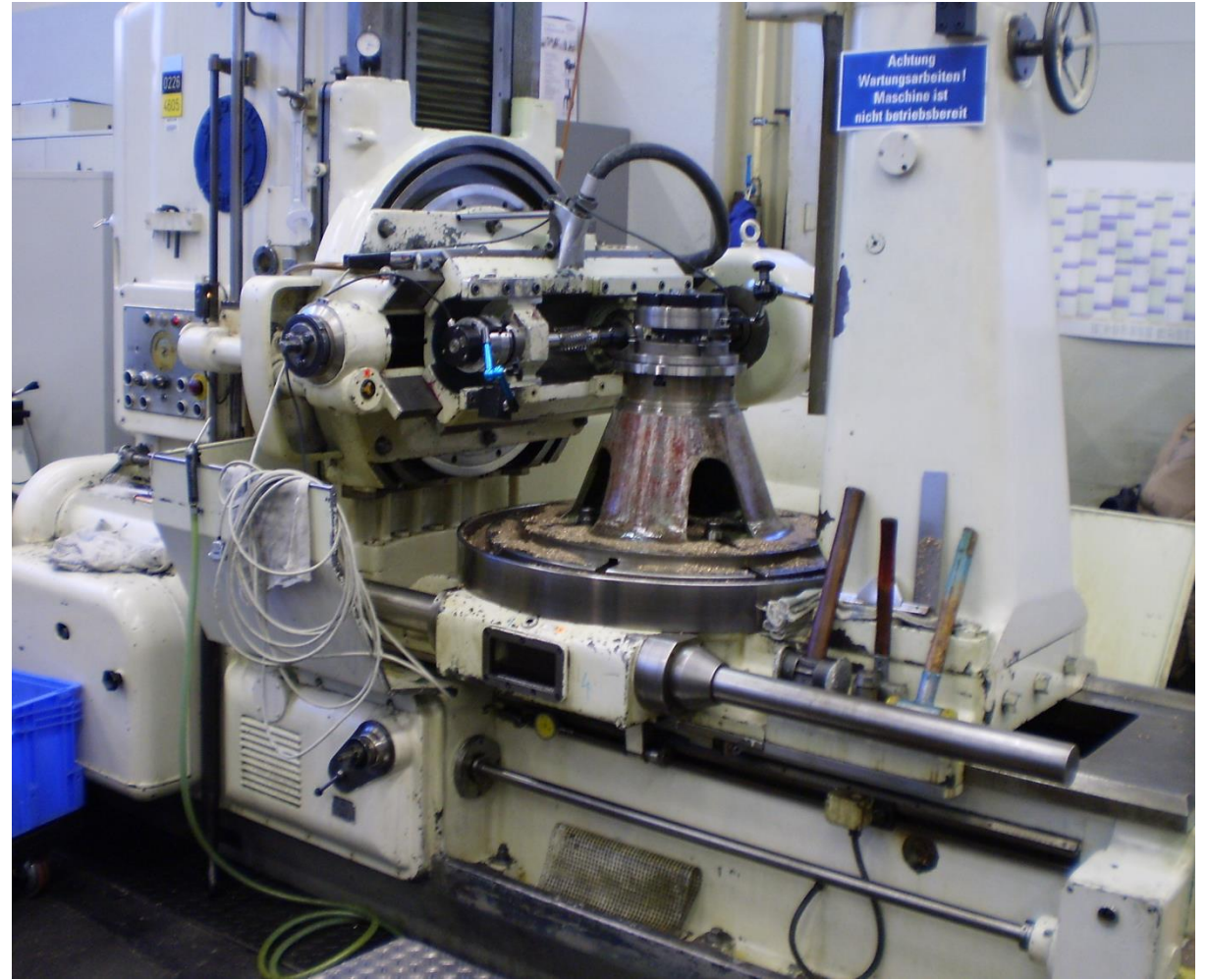
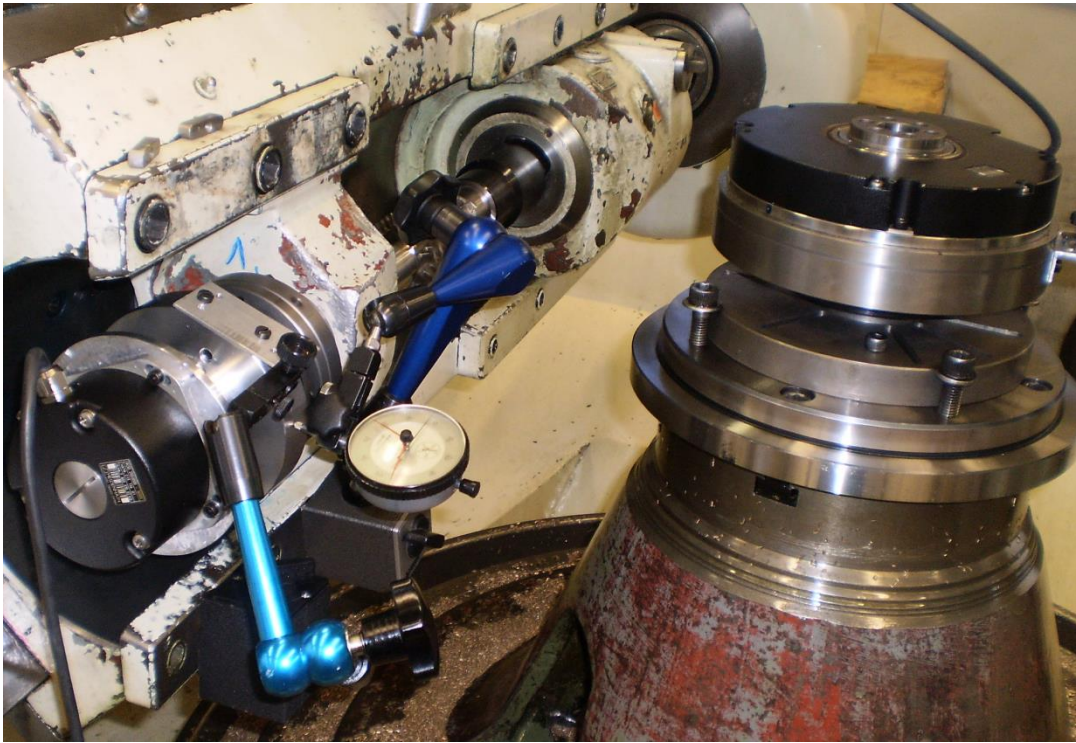
Principle of single flank testing

- measurement directly on the machine
- left and right flanks are tested separately
- two high-accurate angle encoders
- accuracy up to 1 arcsec (5 micro rad) ~ 1 μm on radius of 200 mm
- results in transmission error
- deviation and tolerance according to DIN 3974 Standard

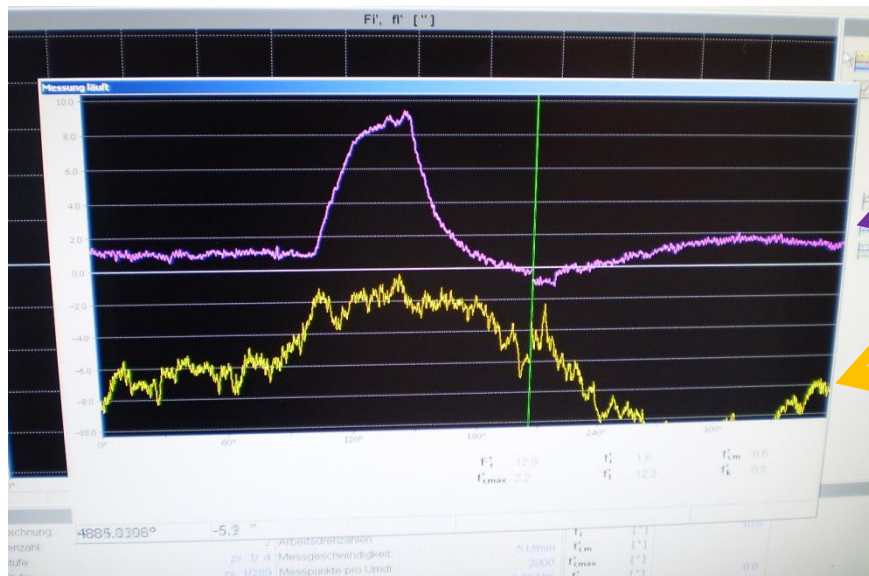


Measurement of very old Pfauter machine

- before disassembling DIN9
- after retrofit DIN6

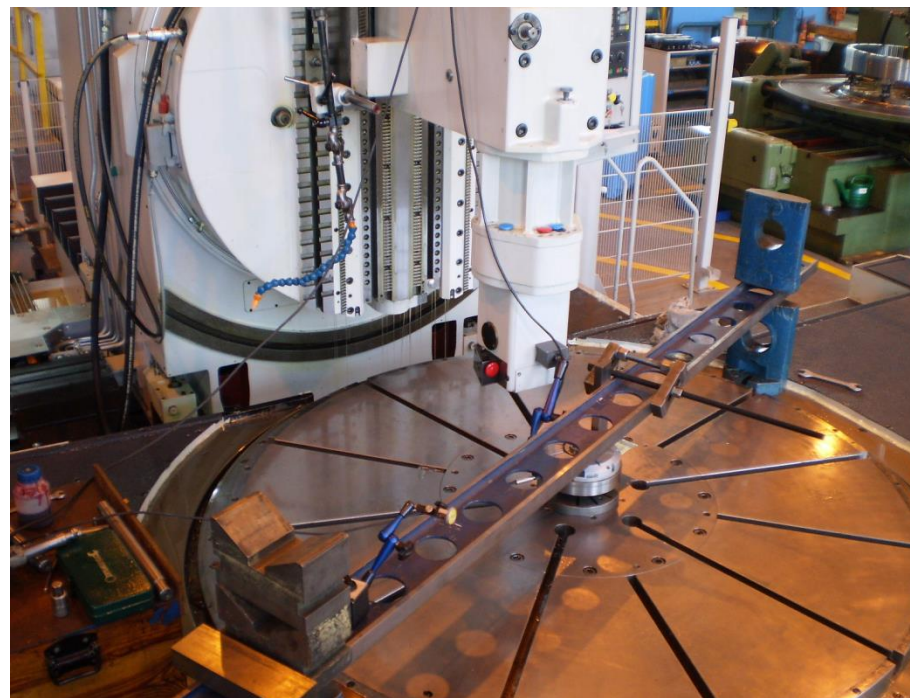


Measurement of MAAG after retrofit

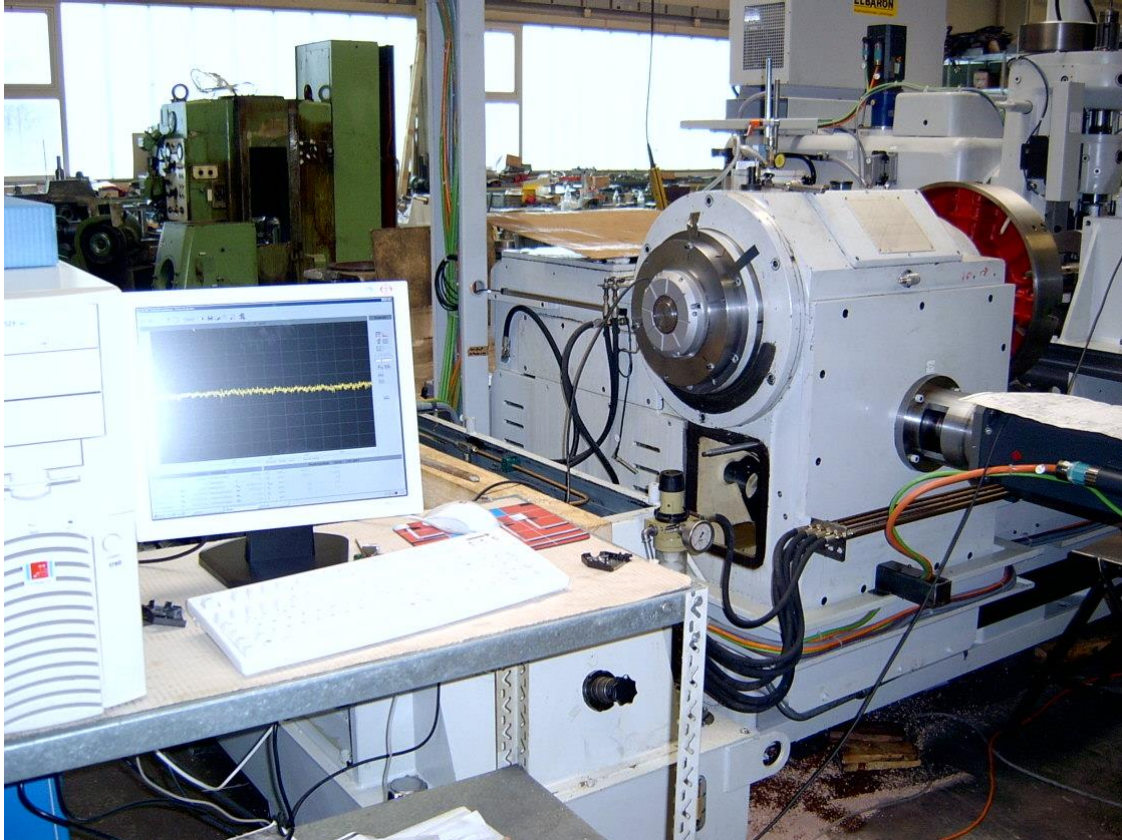


- Table axis, impulse from hydrostatic bearings

- Transmission error –single flank



Vertical CNC machine



Hoffler 3000 machine



Machine can measure

Standards: DIN 3974, ISO 1328

SINGLE FLANK DEVIATIONS between hobs and table

F_i'	Tangential composite deviation
f_i'	Tooth to tooth composite deviation
f_l'	Long wave component of tangential comp. deviation
f_k'	Short wave component of tangential comp. deviation
j	Backlash

PITCH DEVIATIONS of worm and worm gear

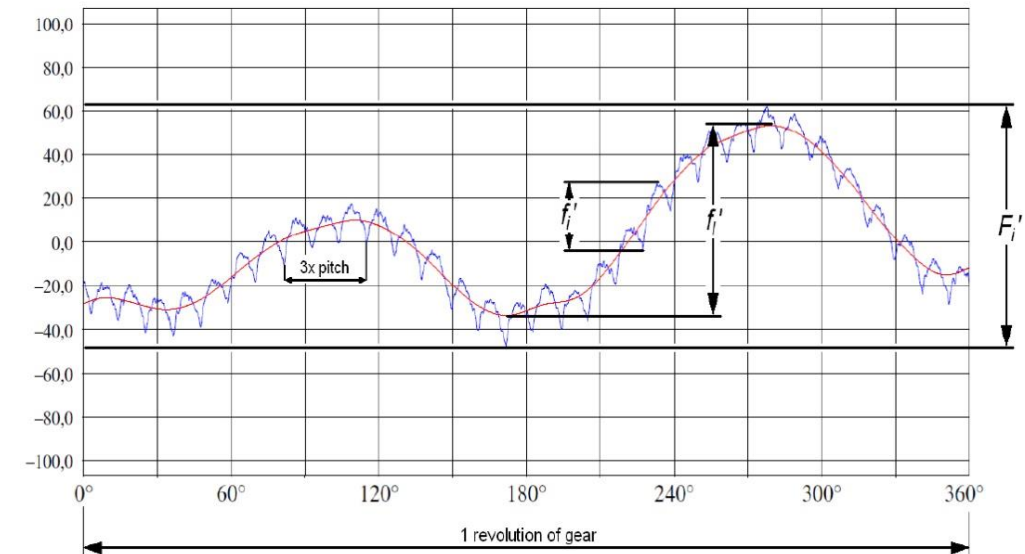
F_r	Runout deviation
F_p	Total cumulative pitch deviation
f_{pt}	Single pitch deviation
f_u	Adjacent pitch deviation

OTHER

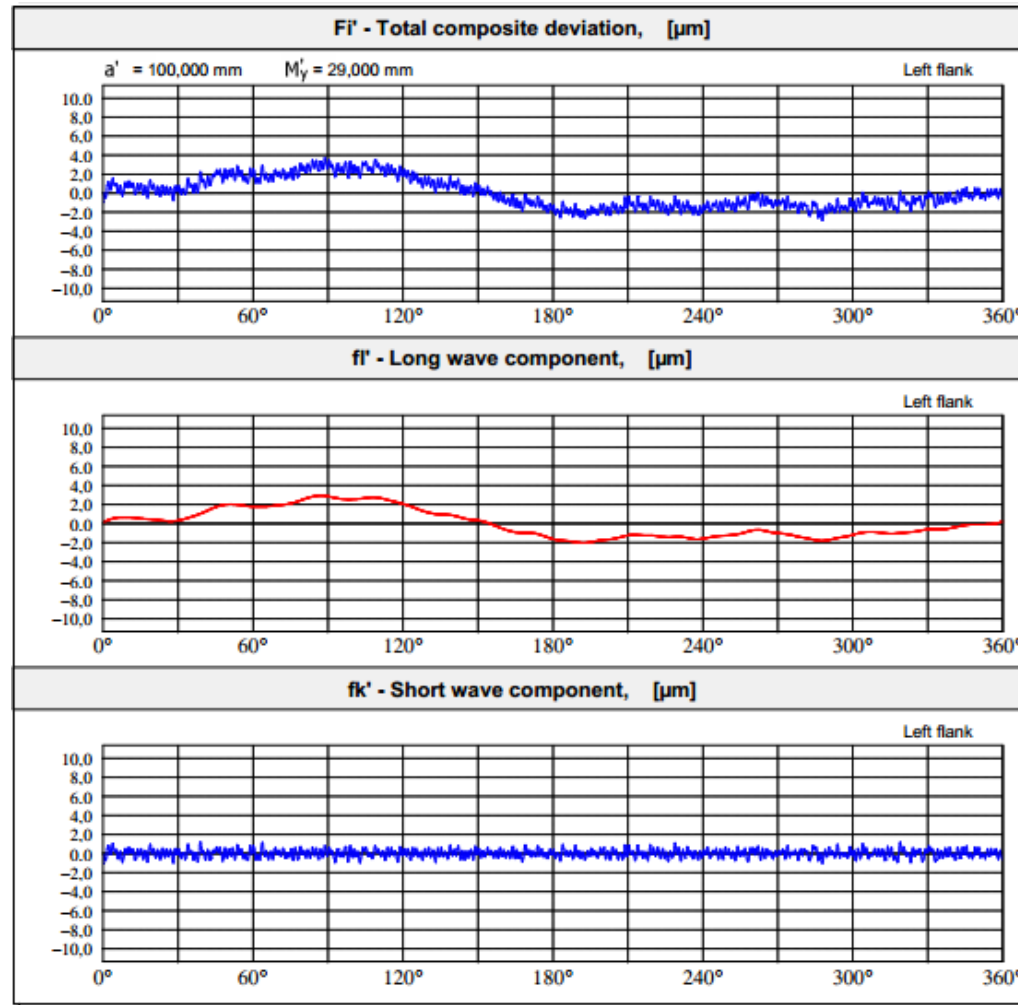
Contact pattern

FFT analysis

Roundness, eccentricity of worm gear and worm



Inspection report - results of measurement



Deviation $F_t' + f_t'$

Deviation f_t'
can be
eliminated

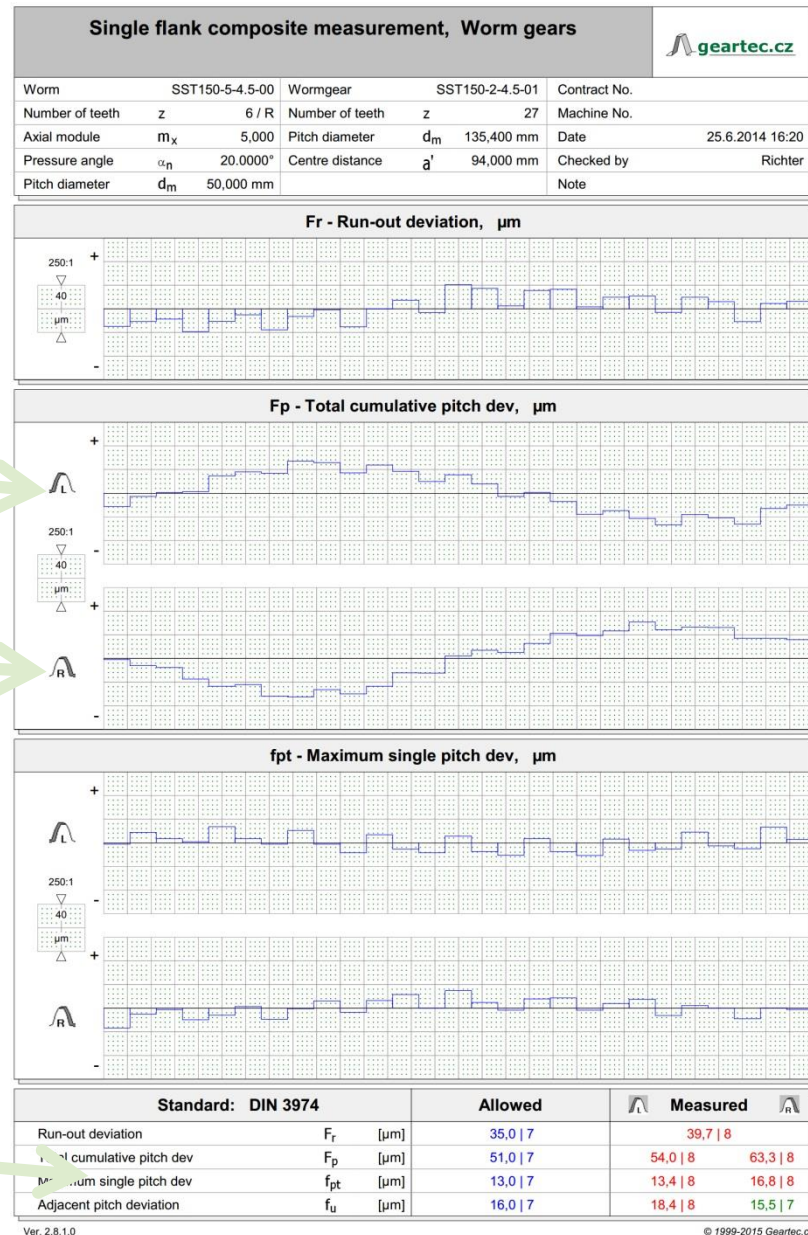
Deviation f_k'

Pitch error

Left flank

Right flank

Evaluation



Runout (F_r)

Total pitch error (F_p)

Single pitch error (f_{pt})

Inspection report (evaluation)

Standard

Deviation in μm

DIN - Quality

Standard: DIN 3974	F-factor 25%	Allowed	 Measured 
Total composite deviation	F'_i [μm]	17.8 3	11.3 2 10.9 2
Single flank composite dev.	f'_i [μm]	6.7 3	4.4 2 5.6 3
Mean value	$f'_{i,m}$ [μm]		3.5 1 4.4 2
Max value	$f'_{i,max}$ [μm]		4.6 2 6.8 4
Long wave component	f'_l [μm]	10.0	7.1 6.3
Short wave component	f'_k [μm]	5.0	4.2 5.1
Backlash - tangential	j [mm]		

Ver. 2.6.9.1

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Measured values

Input parameters – measurement

Measuring parameters

Basic parameters | Complementary I | Complementary II | Tolerances | Roundness | Setup

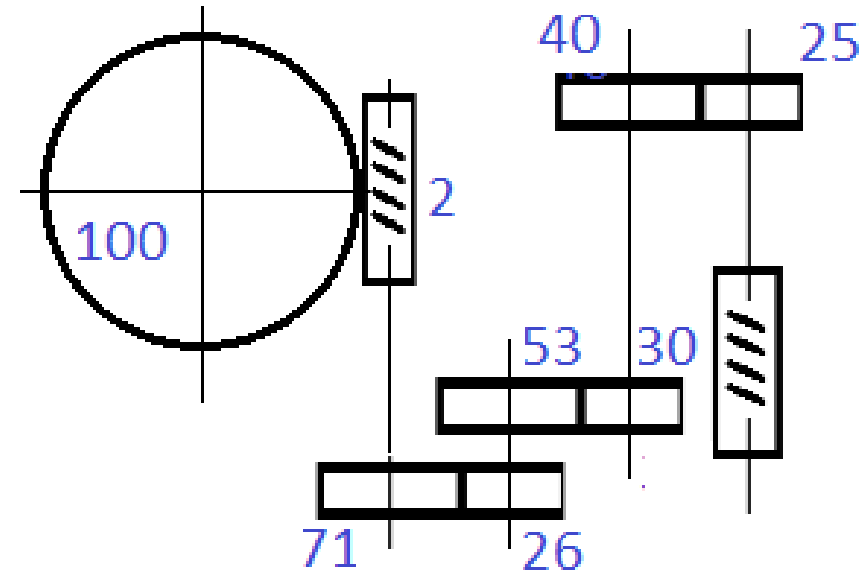
Designation: FO 75

Speed: 4

Diagram showing a gear train with input grade z_1 and output grade z_2 .

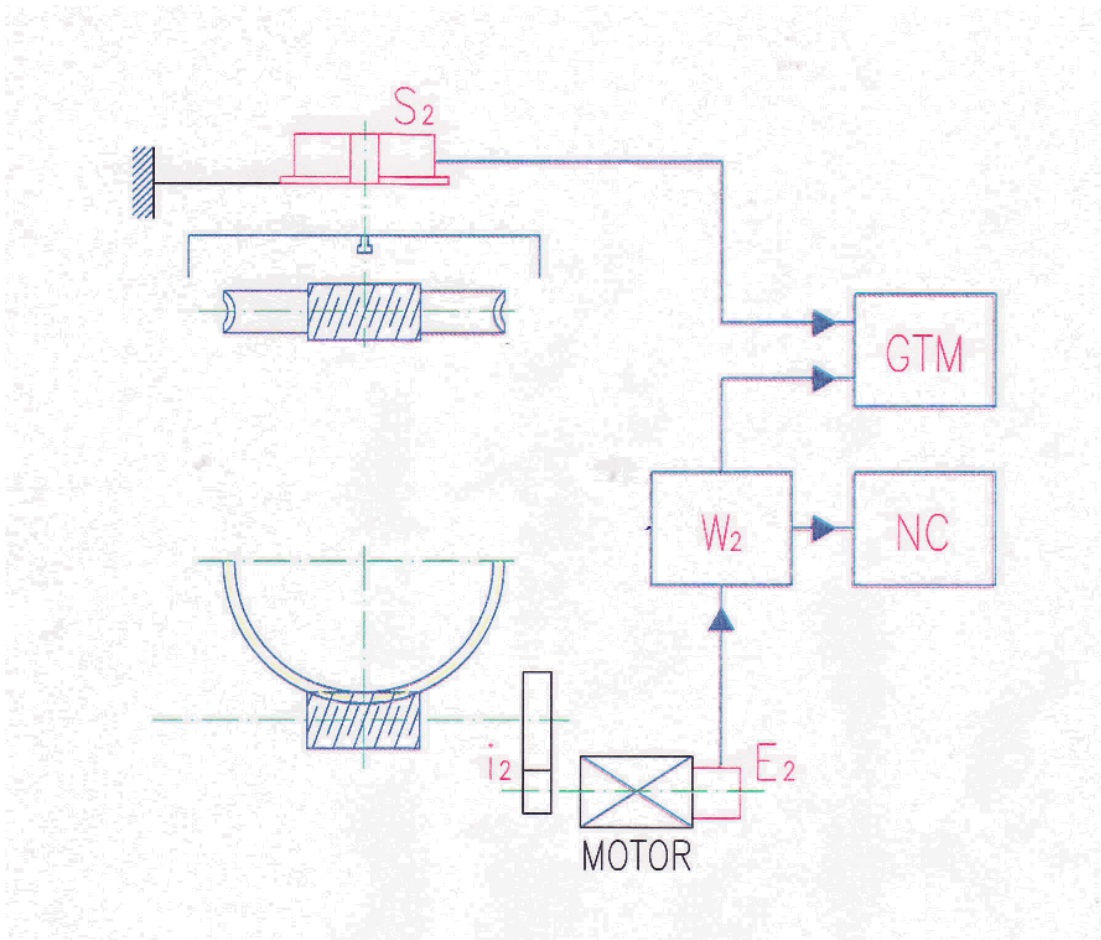
	Input grade	Output grade	Modul
1st stage	z_1 25	z_2 40	m 2,500
2nd stage	z_1 30	z_2 53	m 2,000
3rd stage	z_1 26	z_2 71	m 2,000
4th stage	z_1 2	z_2 100	m 3,200

Buttons: Cancel, Save, OK



Measuring software to control the machine has been developed by GEARTEC.CZ company. It is a window-based application which is user-friendly and very intuitive.

Measurement method – table / CNC machine

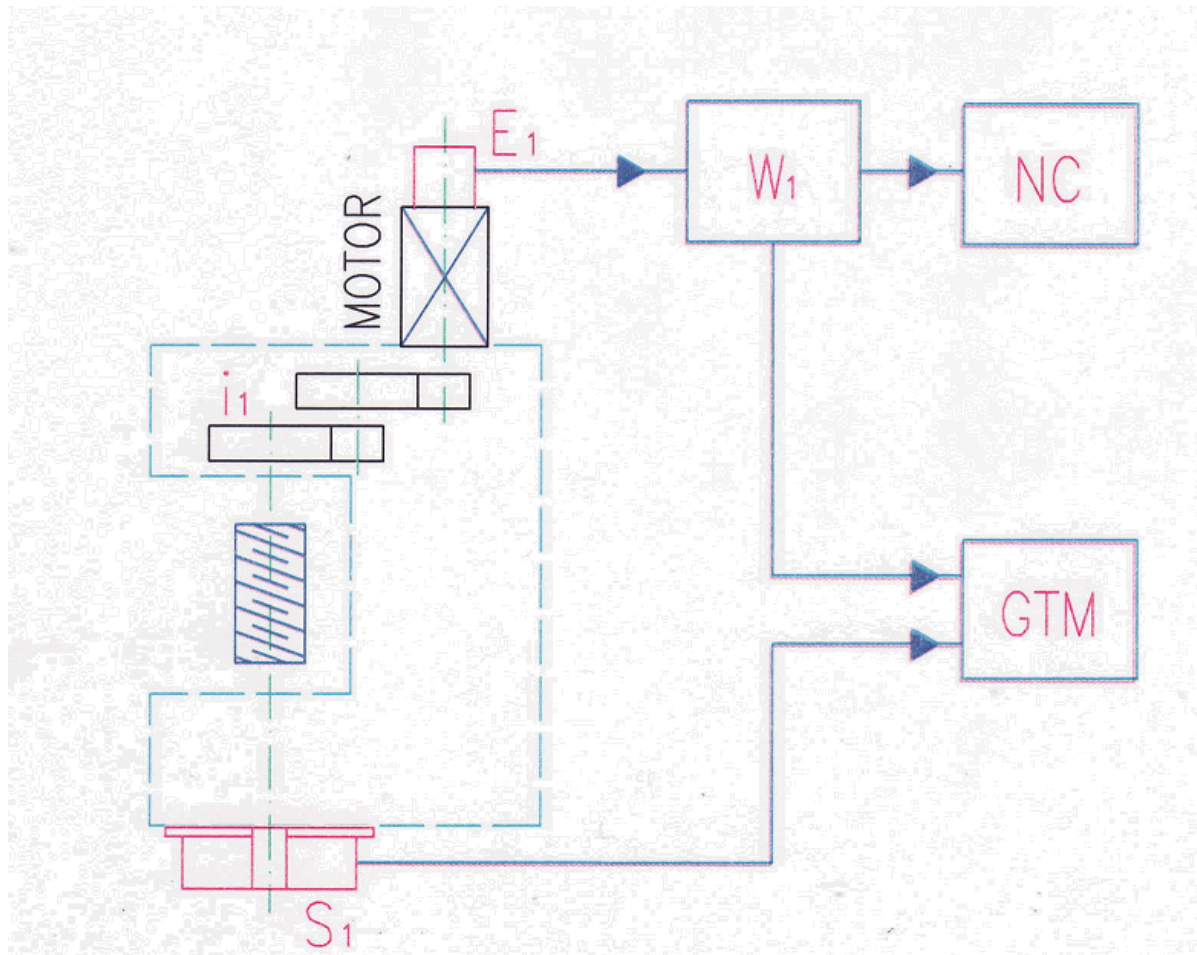


S2 – high accuracy encoder / GTM

E2 – rotary encoder / motor

W2 – electronic switch / GTM fch

Measurement method – hob axis / CNC machine

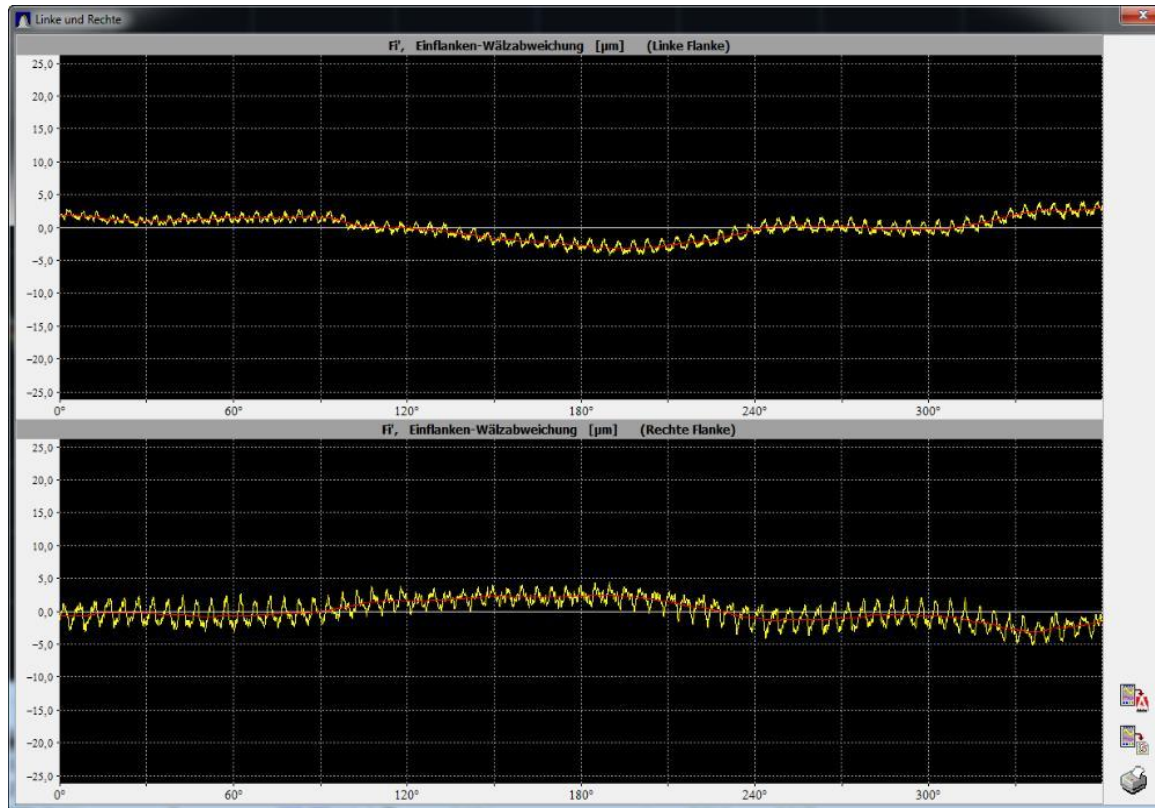


S1 – high accuracy encoder / GTM

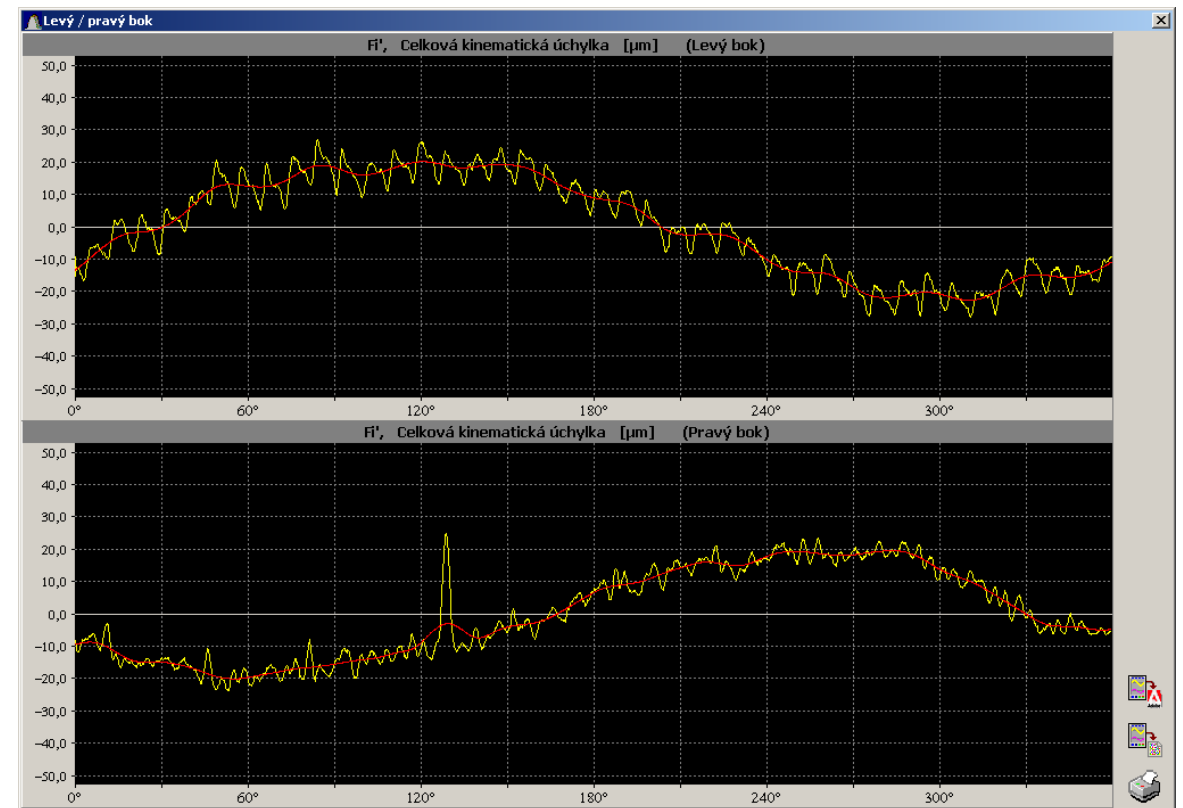
E1 – rotary encoder/ motor

W1 – electronic switch / GTM fch

Measuring software – examples of charts

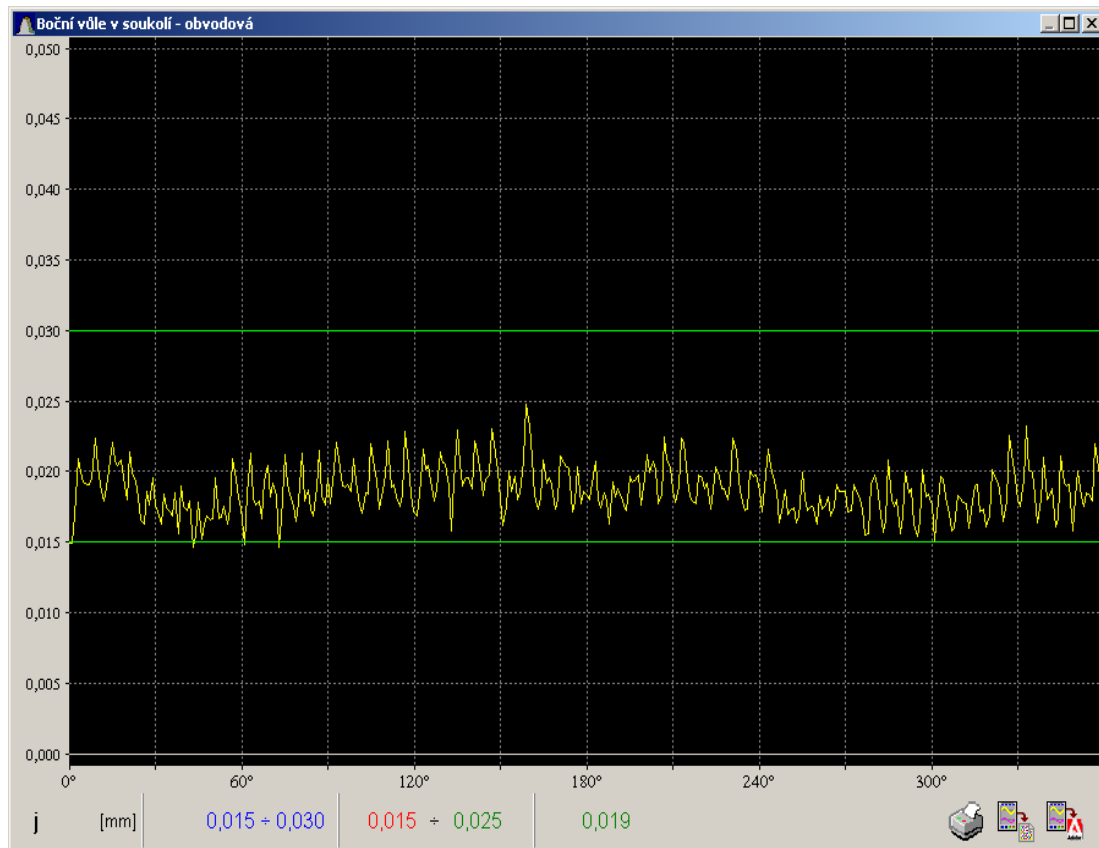


- Machine in very **good** condition

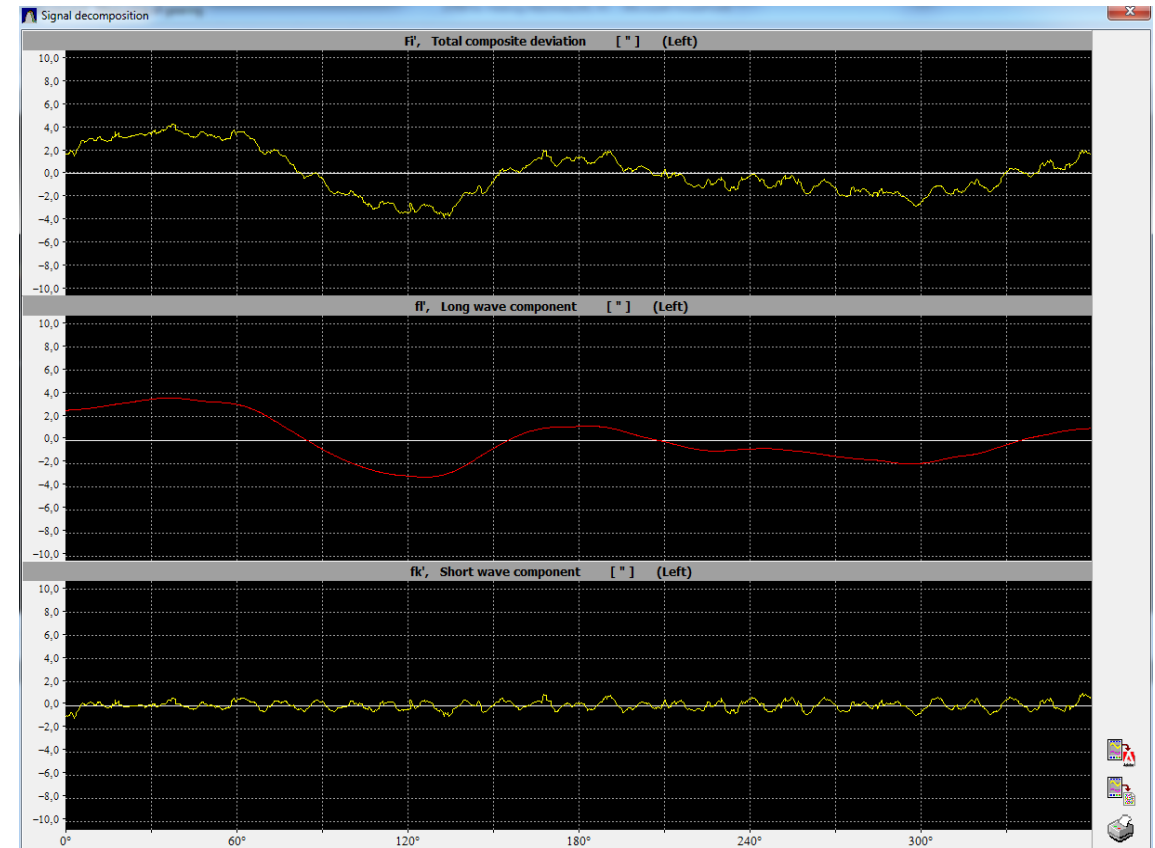


- Machine is **not good**
- Too big runout (wrong assembly?) and damage

Measuring software – examples of charts

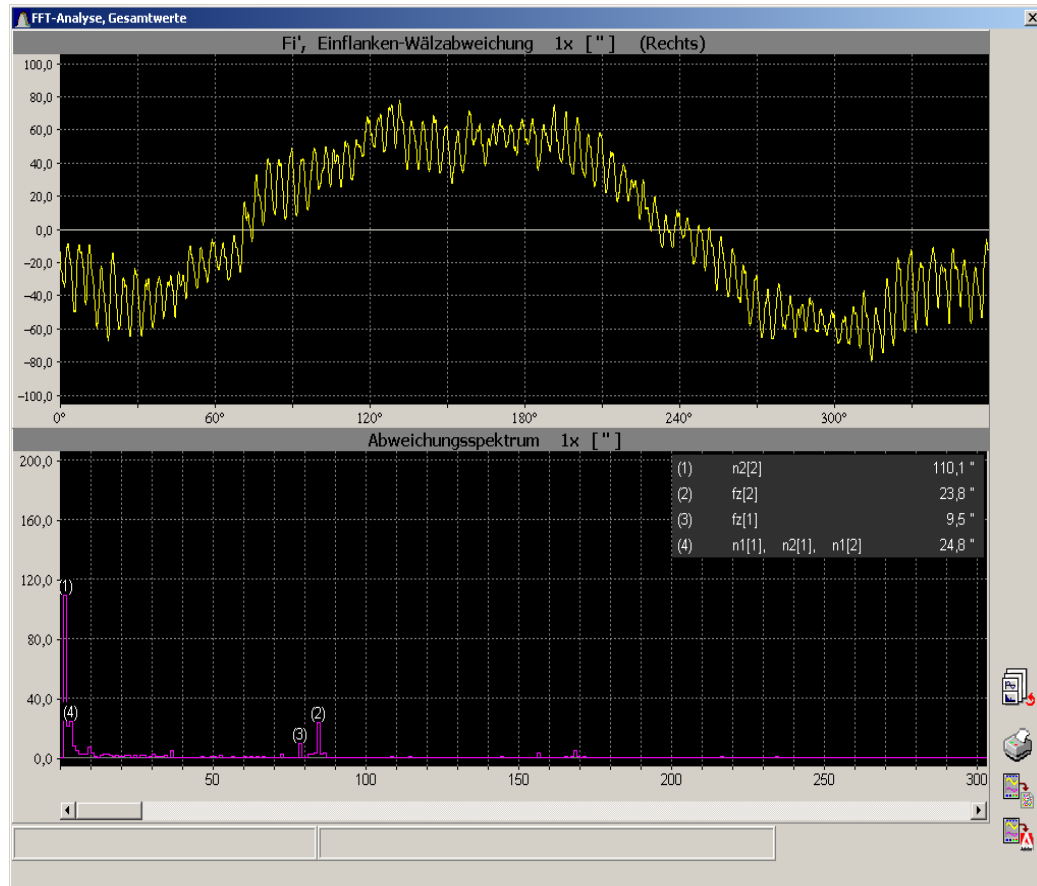


➤ Machine is **good**



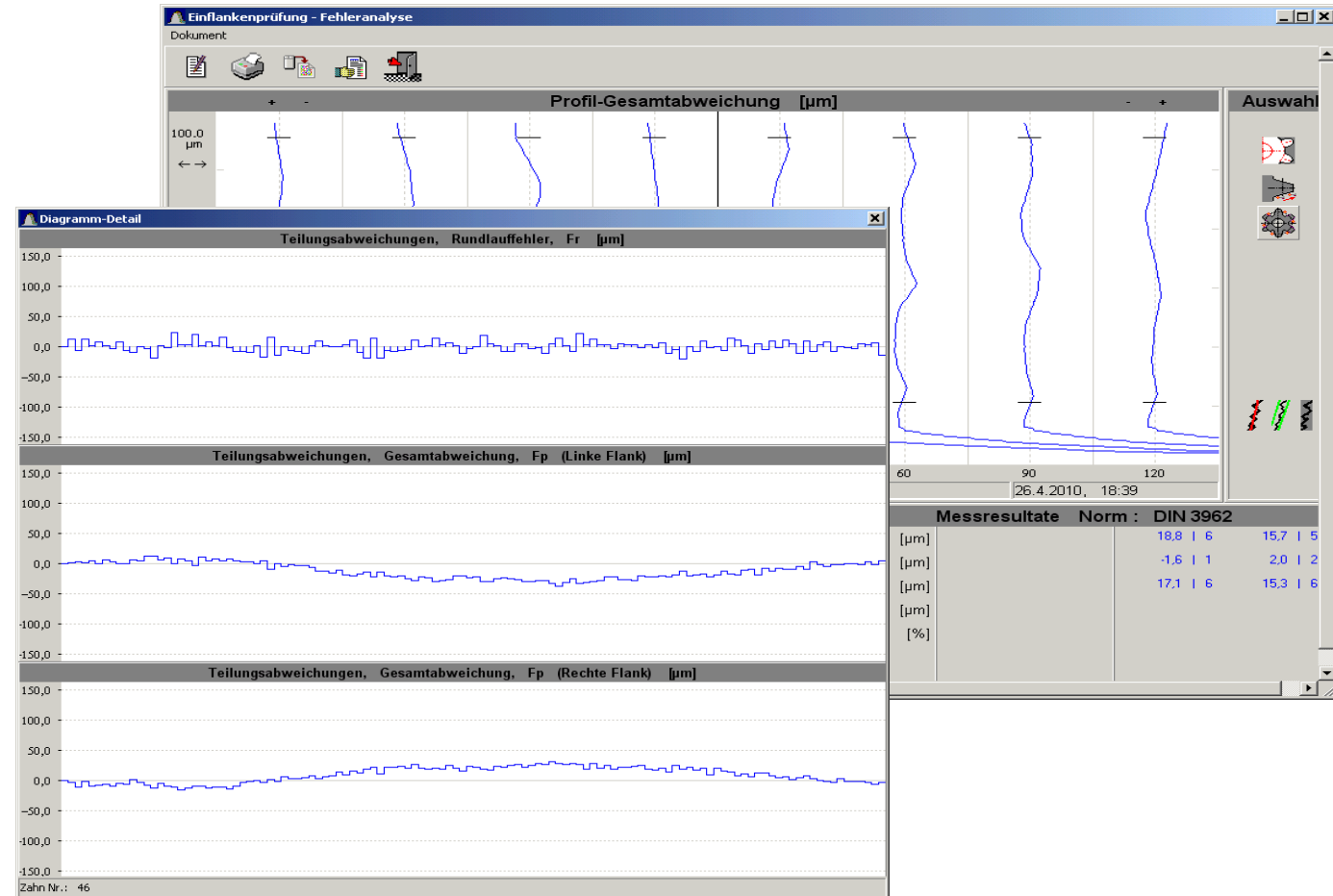
➤ Runout and **roundness** are too big
➤ **Can be** subsequently mathematically **eliminated**

Measuring software – examples of charts



➤ FFT analysis of measured data

Mathematical simulation of quality



Control computer



It is based on high performance military computer

Measuring cards by Heidenhain

Control I/O cards by Advantech for communication with proper hardware - optional

GTM instrument contains

Special industrial computer

including measurement cards

Precision rotary sensor head

for measurement of transmission error, 2 pcs

Precision linear sensors, 2 pcs

for measurement of table stability, 2 pcs

Measuring software

Expert-system for gear hobbing machines

Installation, customer training

Thank you for your attention

