GTWG600

Inspection of worm gears by single and double flank testing machine

GEARTEC.CZ, 2017

geartec.cz

Why single flank testing?

Main requirements in worm gear production

- quality (DIN standard)
- defined backlash
- low noise / high lifetime
- influence of assembly precision
- contact pattern
- pitch deviation of worm gear

All these parameters are measured by single flank testing machine GTWG600

geartec.cz

GTWG600 Single flank testing machine

Manufactured by GEARTEC.CZ in 2010

geartec.cz

Machine parameters

Diameter of worm gear, max.	600 mm
Lenght of worm gear, max.	500/1000 mm
Diameter of worm, max.	100 mm
Center distance	0-400 mm
Vertical position	0-250 mm
Measuring speed	5-60 ot./min
Brake, max.	2,5 Nm
Weight of worm gear, max.	200 kg
Weight of worm, max.	10 kg

geartec.cz

Machine can measure

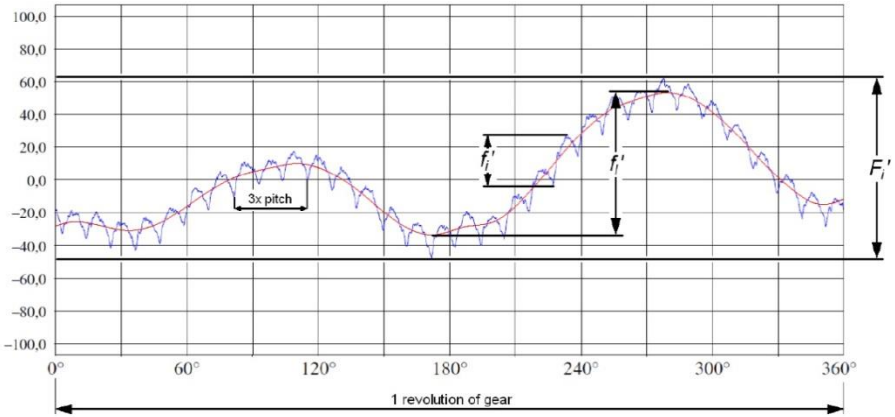
Standards: DIN 3974, ISO 1328

Single flank deviations of worm gears

F_i' - Tangential composite deviation
f_i' - Tooth to tooth composite deviation
f_l' - Long wave component of tangential composite deviation
f_k' - Short wave component of tangential composite deviation
j - backlash

Pitch deviations of gear and worm

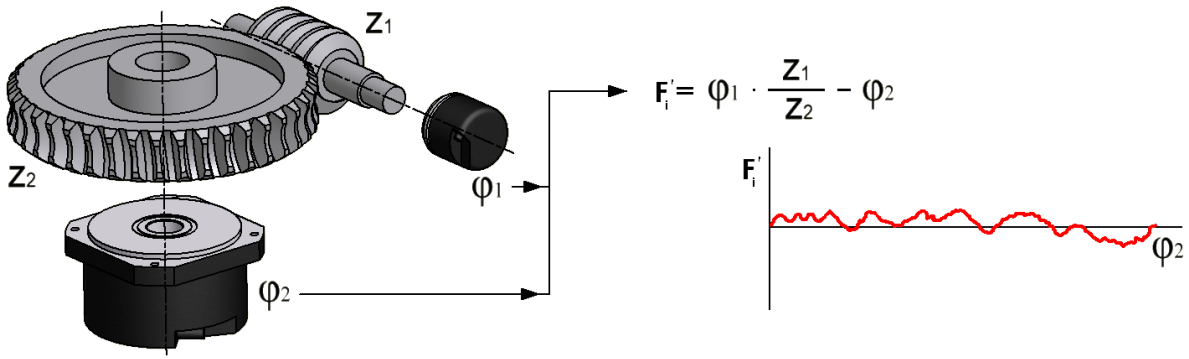
F_p - Total pitch error
f_{pt} - Adjacent pitch error
f_u - Diff. between adjacent pitches
F_r - Radial runout



Contact pattern
FFT analysis
Roundness, eccentricity of gear and worm

geartec.cz

Principle of single flank testing



- mounting distance during testing is static
- left and right flanks are tested separately
- two accurate angle encoders
- accuracy up to 1 arc second (5 micro rad)
  ~ 1 µm on radius 200 mm
- results is transmission error
- deviation and tolerances according to DIN 3974 standard

geartec.cz

Inspection certificates (header)

Worpiece data

Customer's logo

Single flank composite measurement, Worm gears

gtwg 600

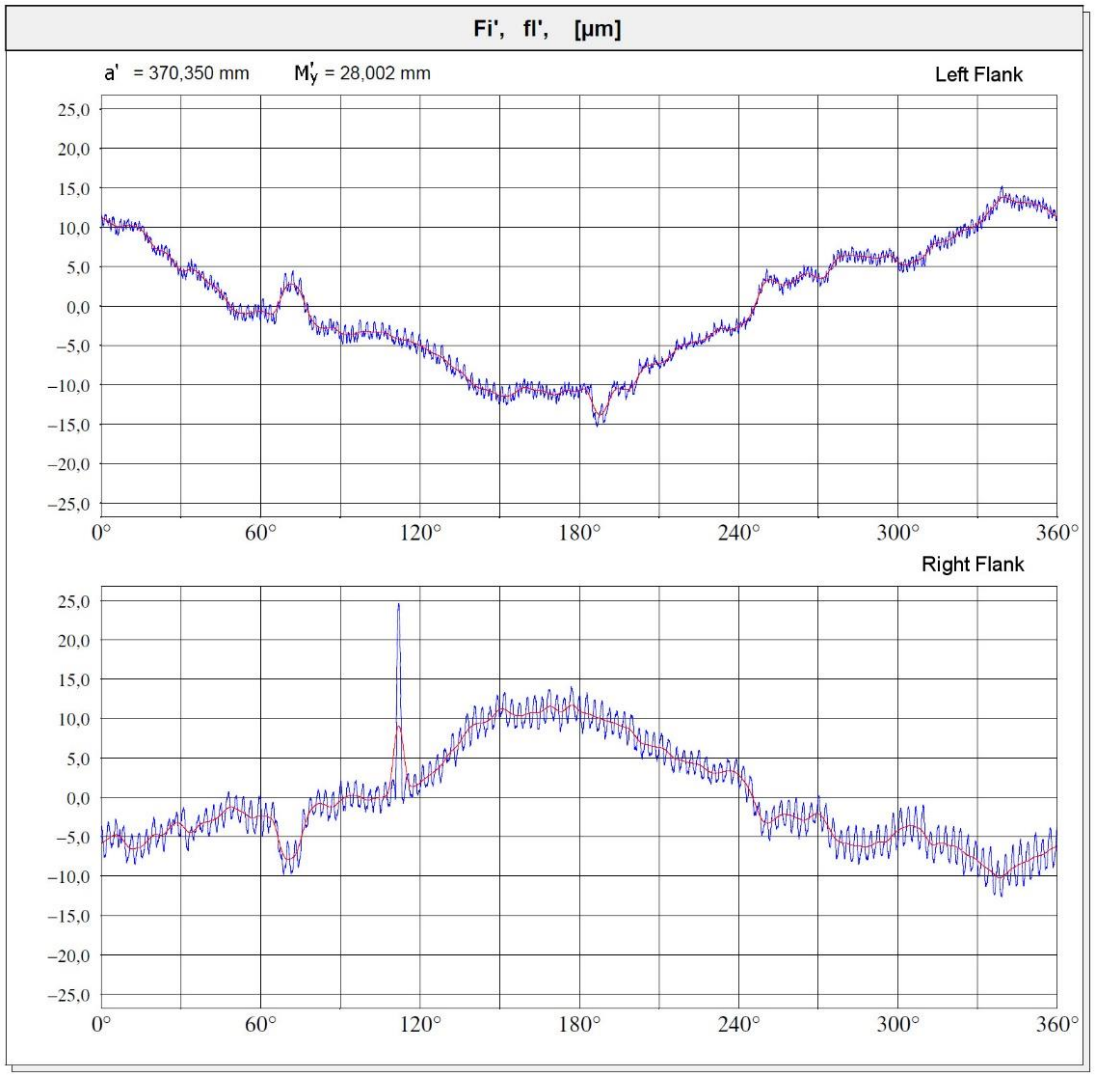
6991 HR GEARTEC

geartec.cz

Worm		S0131011a	Wormgear		S0131011a	Measured points	8000
Number of teeth	z	1 / R	Number of teeth	z	90	Part No.	
Axial module	m_x	3.200	Pitch diameter	d_m	290.000 mm	Contract No.	
Pressure angle	α_n	15.0000°	Shaft angle	W	0.0000°	Machine No.	
Pitch diameter	d_m	70.000 mm	Worm position	M'_y	0.000 mm	Date	5/17/2013 12:29
Centre distance	a'	180.200 mm	Worm position	M'_z	130.000 mm	Checked by	Richter
Measuring speed		20rpm	Load torque		0.00 Nm	Note	

geartec.cz

Inspection certificates - chart



geartec.cz

Measurment evulation

Allowed values according to DIN 3974

Left and right flank

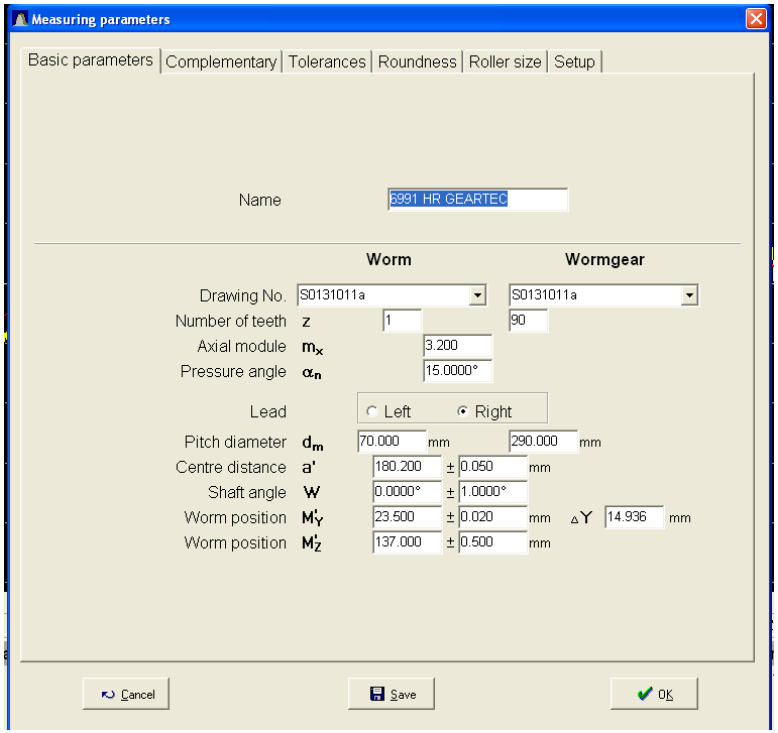
Standard: DIN 3974	F-factor 25%		Allowed	Measured	
Total composite deviation	F'_i	[µm]	17.8 | 3	11.3 | 2	10.9 | 2
Single flank composite dev.	f'_i	[µm]	6.7 | 3	4.4 | 2	5.6 | 3
Mean value	$f'_{i,m}$	[µm]		3.5 | 1	4.4 | 2
Max value	$f'_{i,max}$	[µm]		4.6 | 2	6.8 | 4
Long wave component	f'_l	[µm]	10.0	7.1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

Ver. 2.6.9.1

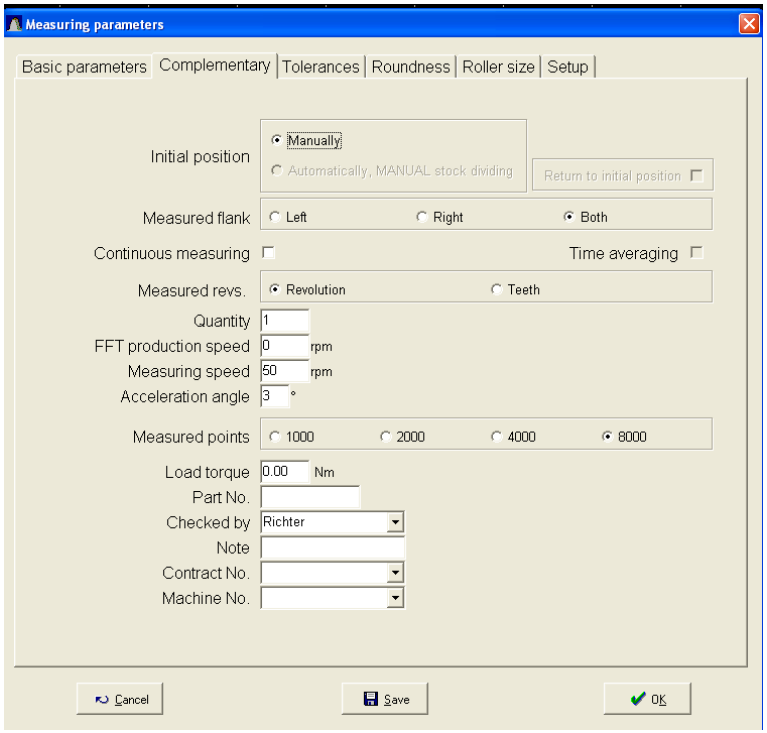
Measured values

geartec.cz

Software interface



Basic object parameters

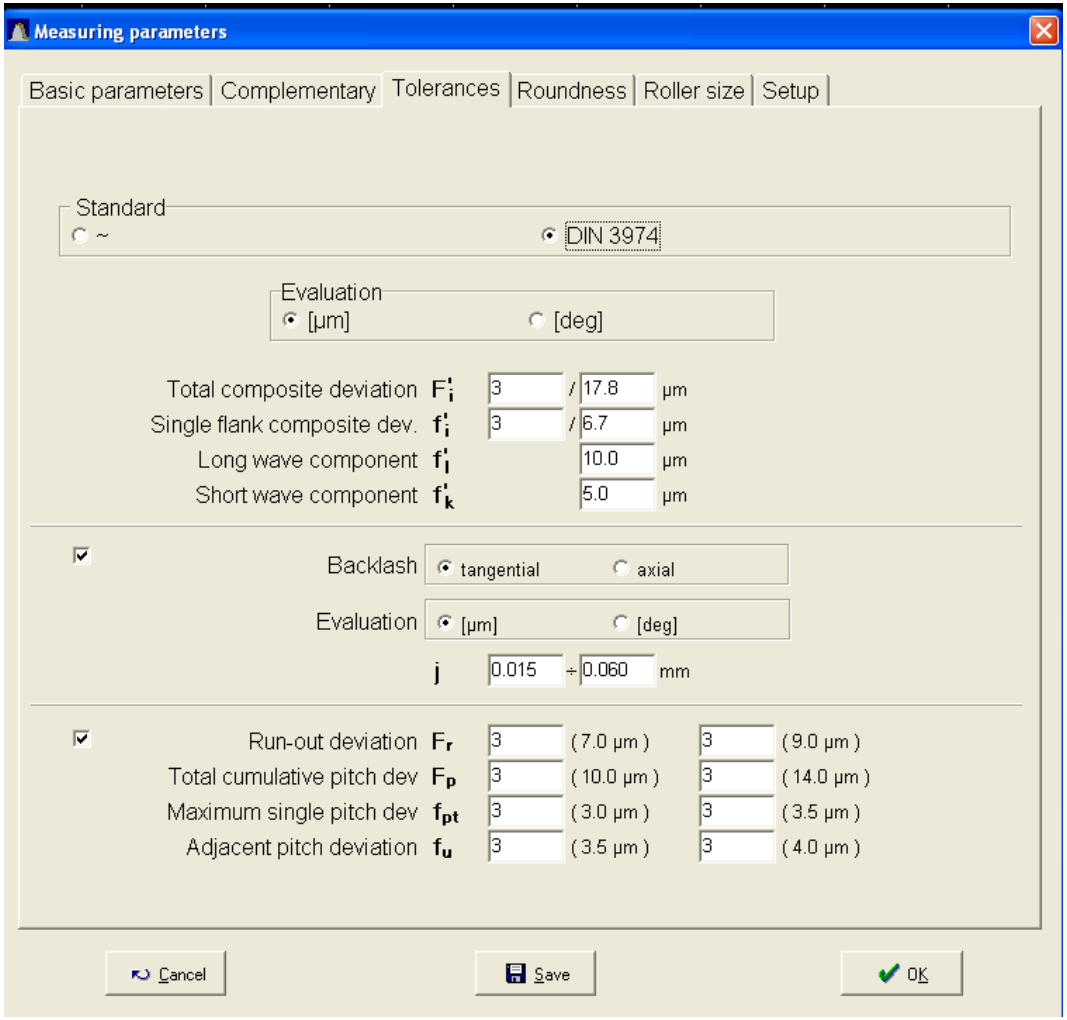


Complementary object parameters

Measuring software is user-friendly requiring no special or advanced PC knowledge. It can communicate in many languages and runs under Windows.

geartec.cz

Tolerances



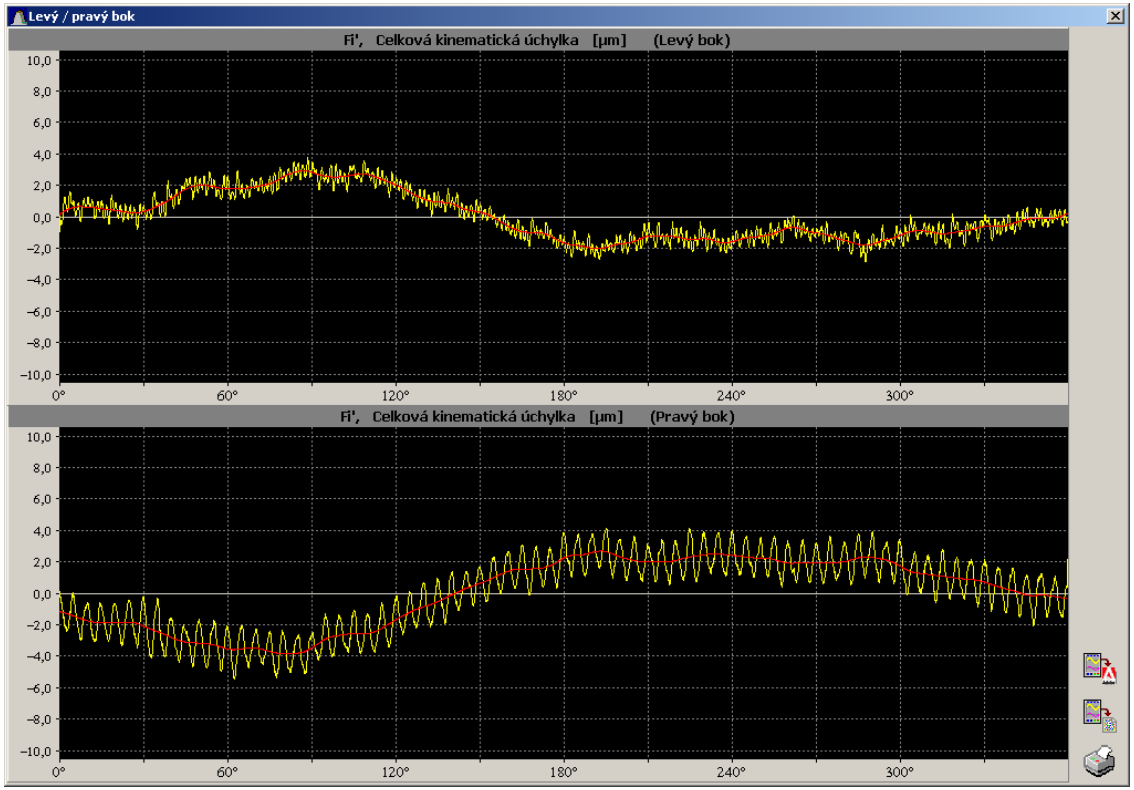
Tolerances

geartec.cz

Example 1: Profile error

Worm gear set, gear ratio 1:72

- Tooth to tooth deviation 0.003 mm on Right flank
- Left flank is DIN1, right flank is DIN2

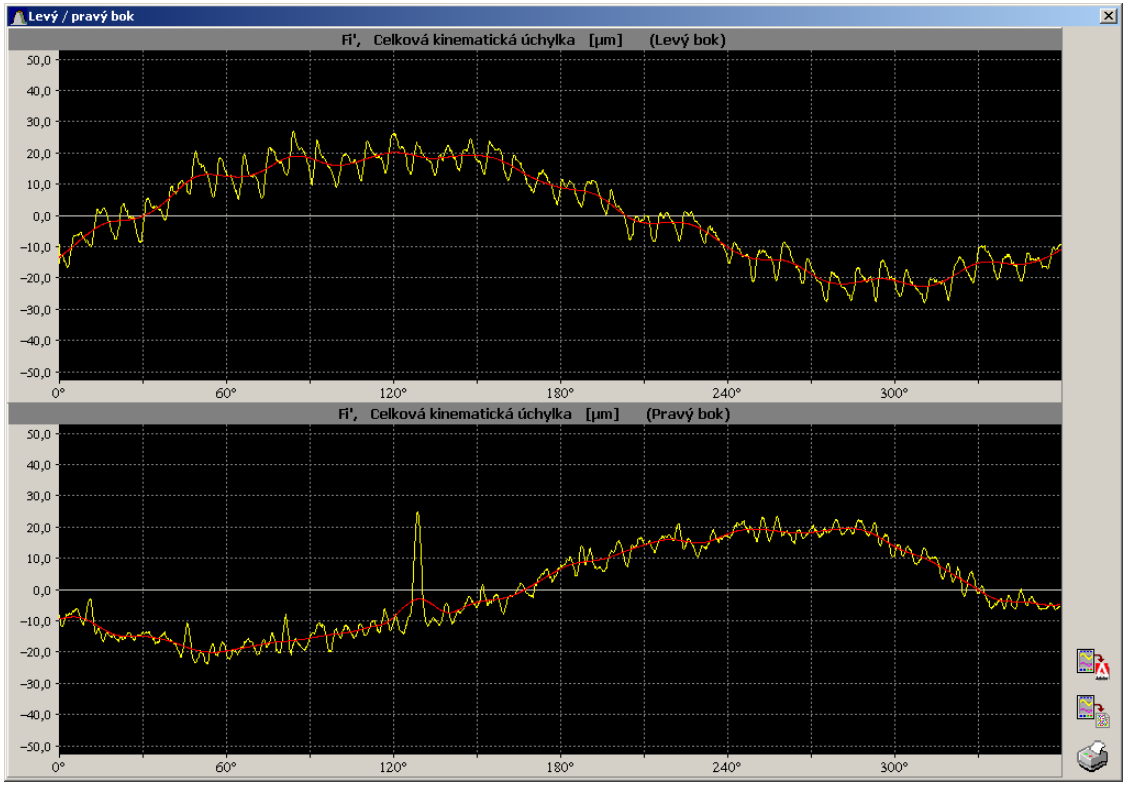


geartec.cz

Example 2: Run-out & nick

Worm gear set, gear ratio 1:41

- Run-out of gear about 0.020mm
- Righ flank has a nick 0.035 mm on tooth no. 15

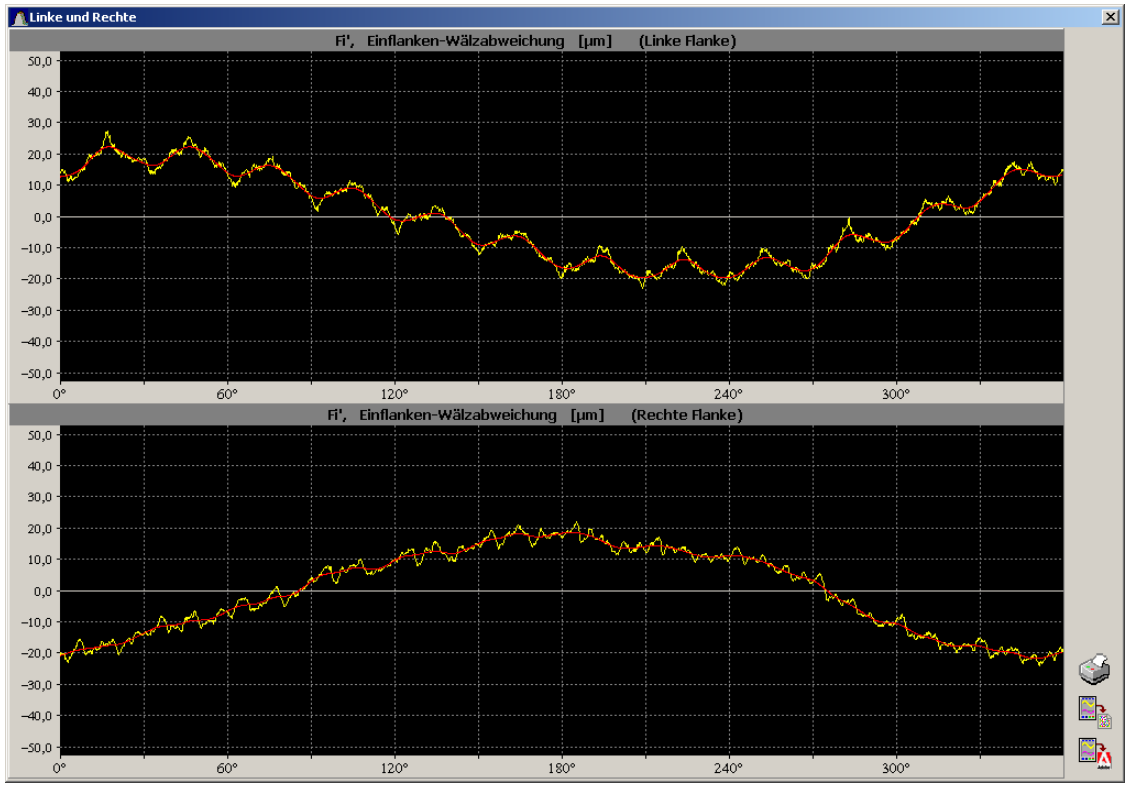


geartec.cz

Example 3: Different flanks

Worm gear set, gear ratio 5:61

- Run-out of gear about 0.020 mm
- Worm´s left flank has run-out 0.010 mm

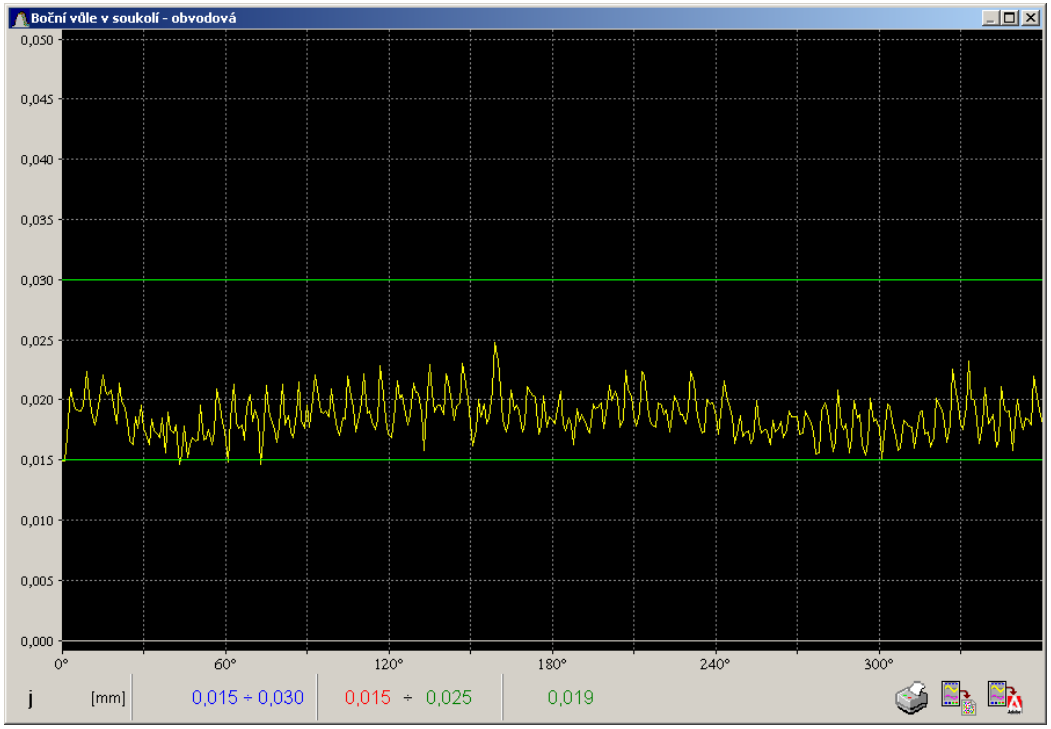


geartec.cz

Example 4: Backlash

Continuous measuring of backlash

- Chart of backlash for 1 revolution of gear
- Backlash is changing over tooth contact

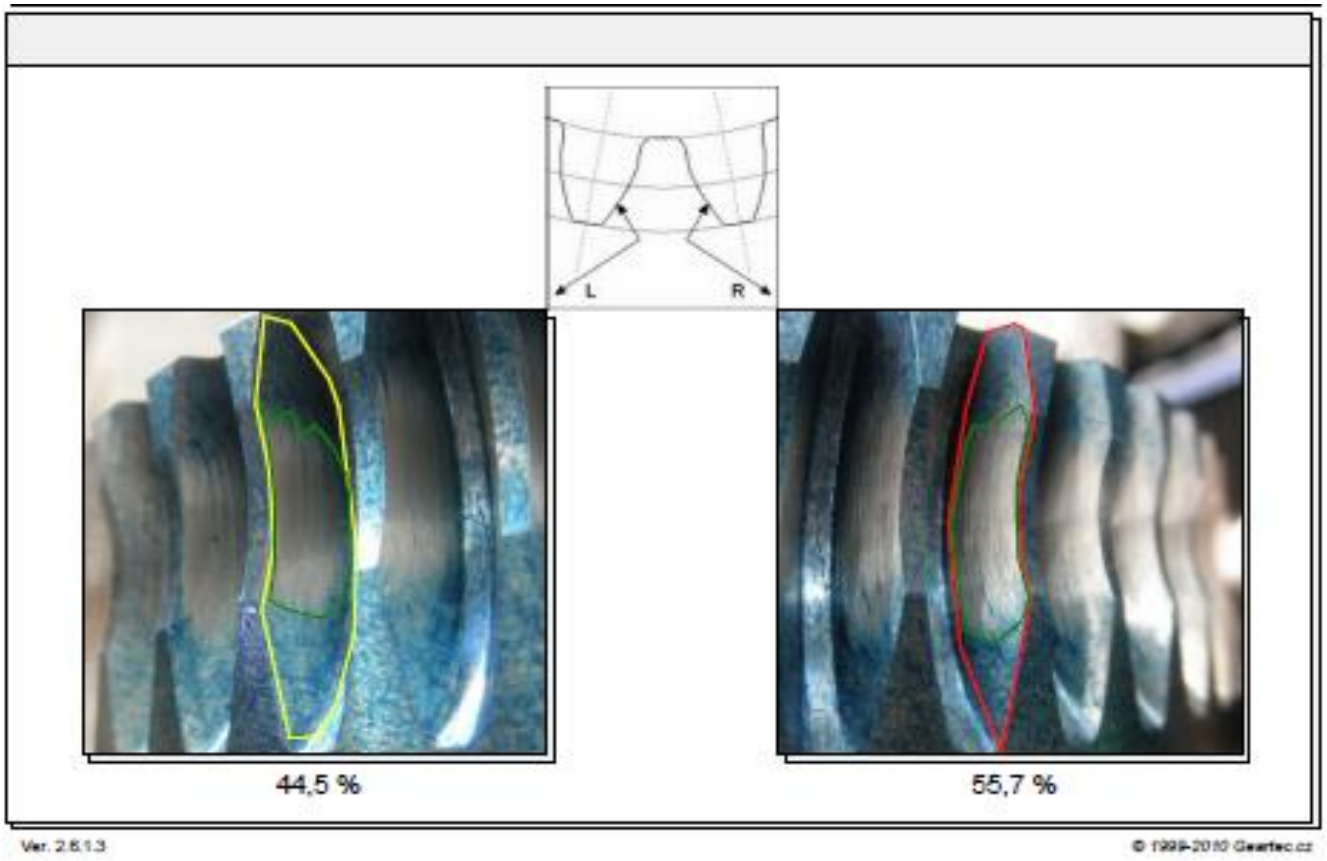


geartec.cz

Example 5: Contact pattern

Digital image of contact pattern

- Stored in database with measuring results

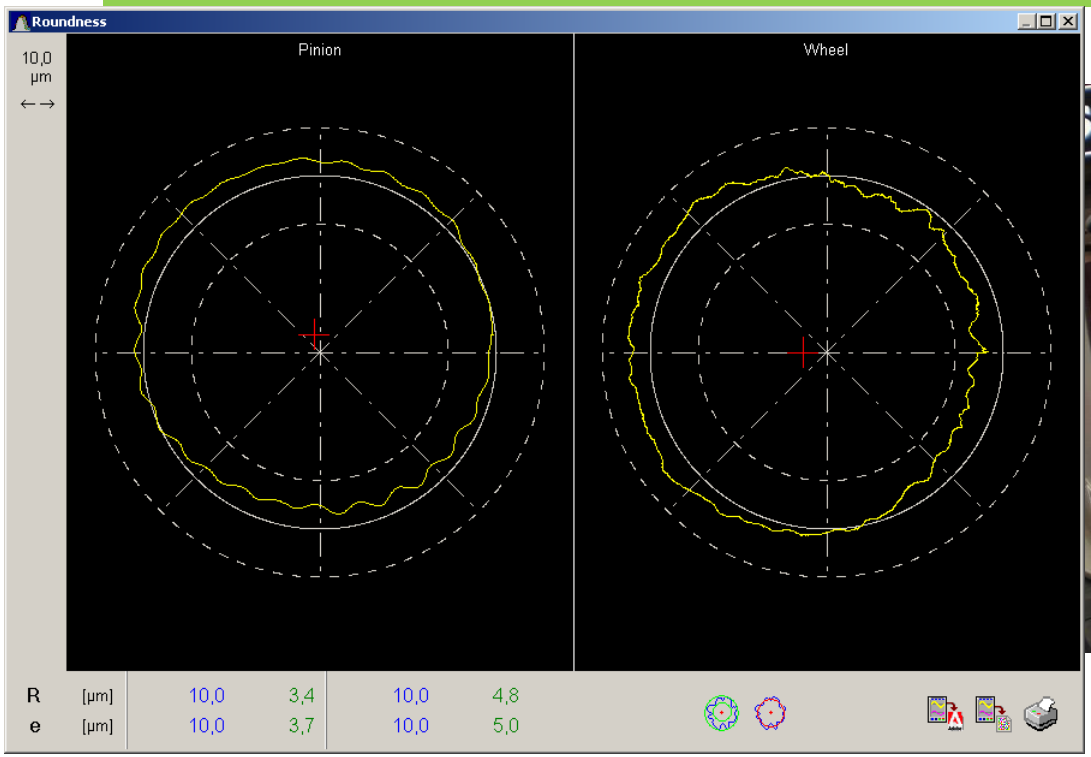


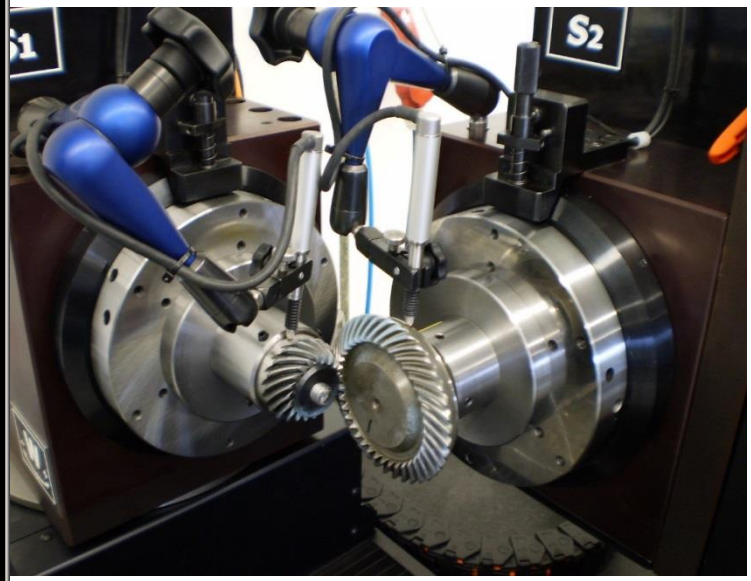
geartec.cz

Example 6: Run-out and roundness

Measuring of control rings

- Run-out of worm shaft and worm wheel
- Elimination of run-out error





geartec.cz

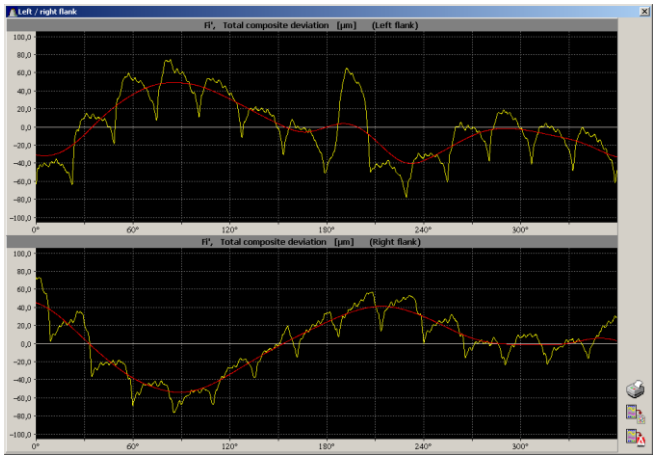
Example 7: FFT analysis and noise

Calculated acceleration spectrum of signal

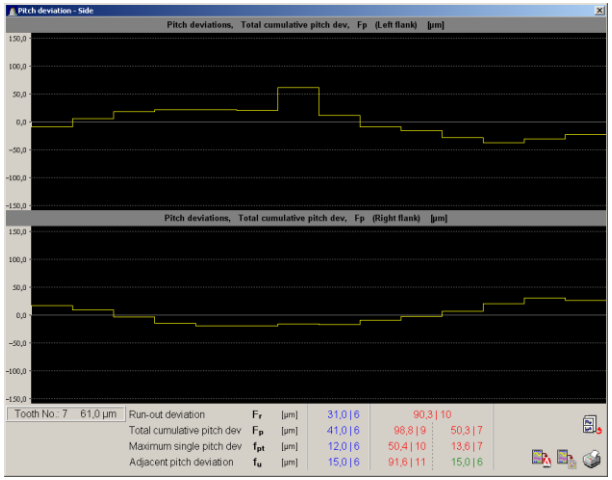
geartec.cz

Example 8: Pitch deviation of gear

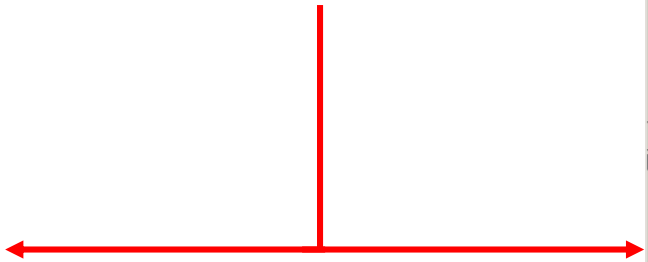
Calculated diagram of pitch deviation



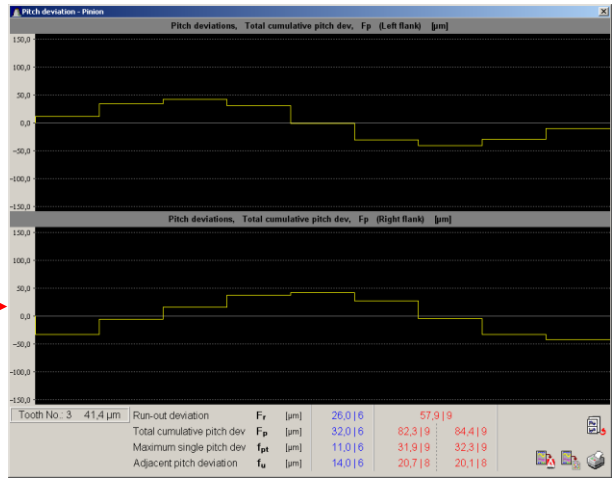
Wromgear



Decomposition of single flank test

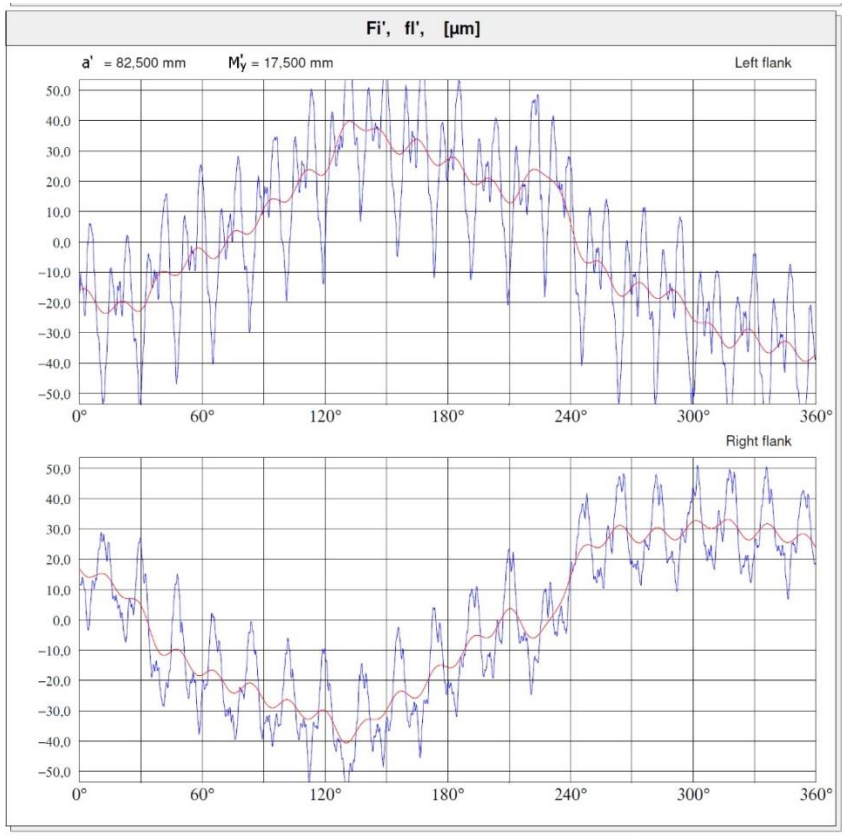


Worm



geartec.cz

Example 9: Worm with a splitting error



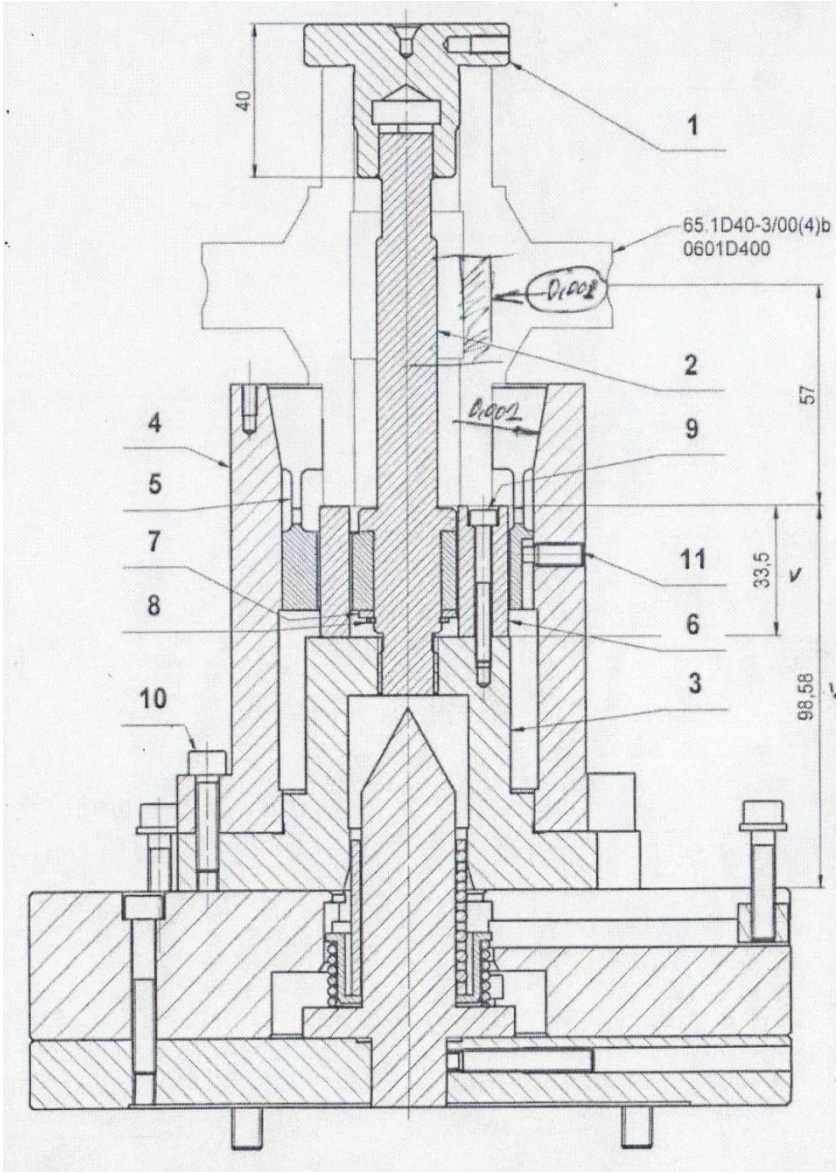
Standard: DIN 3974	F-factor 25%		Allowed	Measured	
Total composite deviation	F'_i	[µm]	84,6 | 8	136,9 | 10	110,4 | 9
Single flank composite dev.	f'_i	[µm]	36,1 | 8	64,5 | 10	46,1 | 9
Mean value	$f'_{i,m}$	[µm]		48,1 | 9	30,3 | 8
Max value	$f'_{i,max}$	[µm]		72,4 | 10	49,7 | 9
Long wave component	f'_l	[µm]	45,0	79,2	73,7
Short wave component	f'_k	[µm]	30,0	58,2	37,6
Backlash - tangential	j	[mm]	0,100 ÷ 0,150	0,097 ÷	0,198

Ver. 2.6.9.0

There is not 180 deg. between tooth Nr. 1 and Nr. 2, but 180 deg and cca 99 wsec.

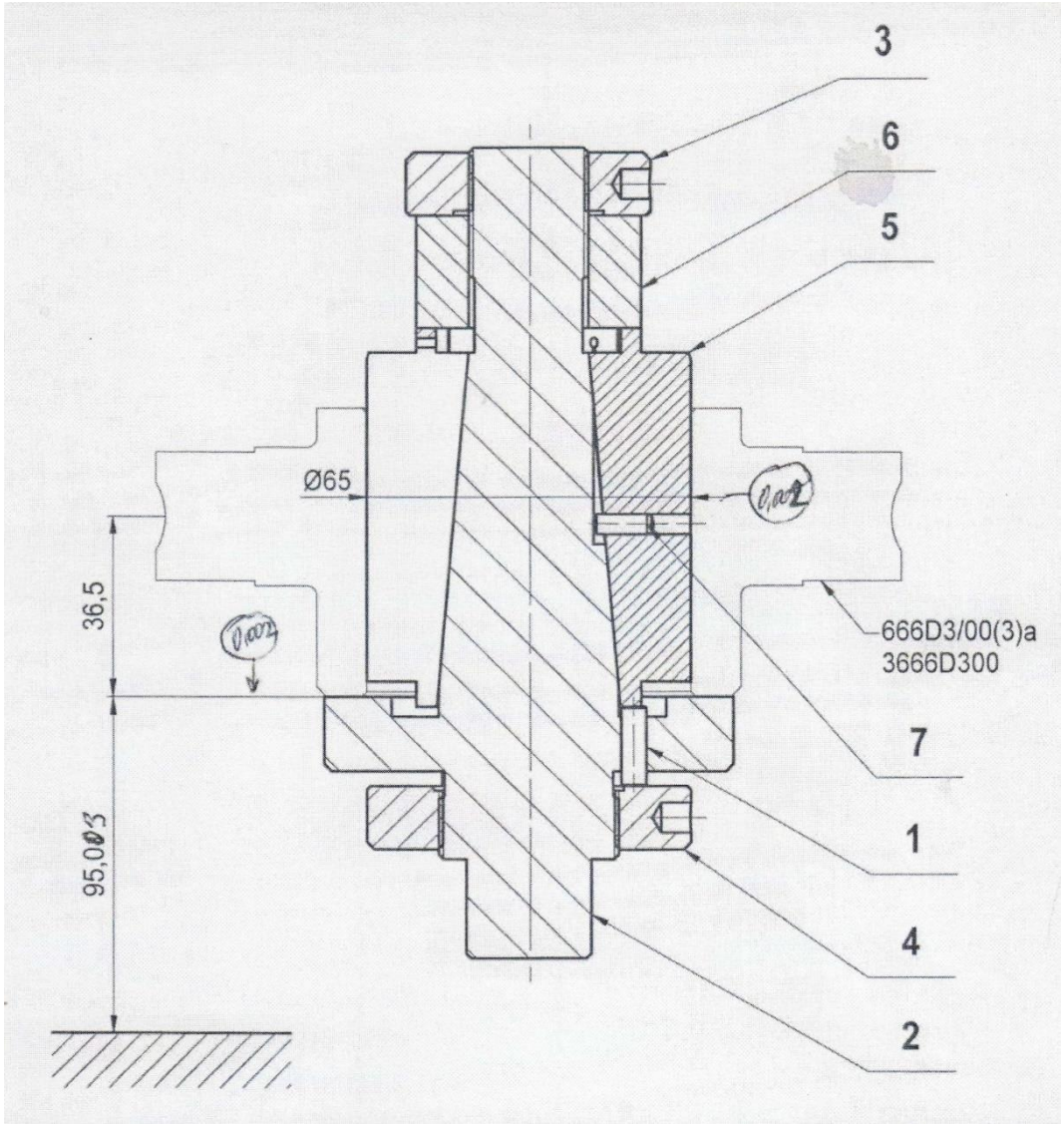
Right flank has wavy surface, cca 5 µm

geartec.cz



Worm gear is clamped by outside diameter

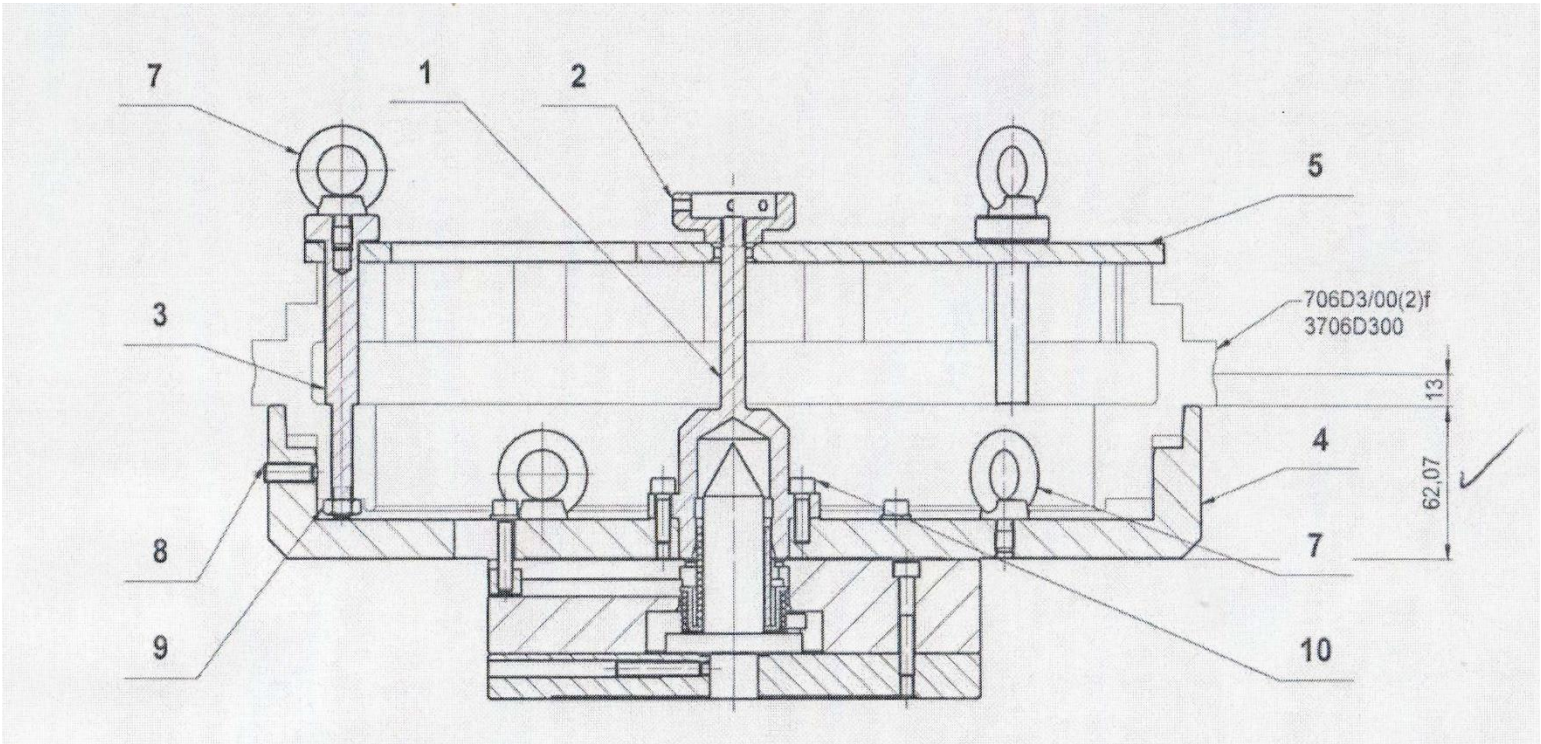
geartec.cz

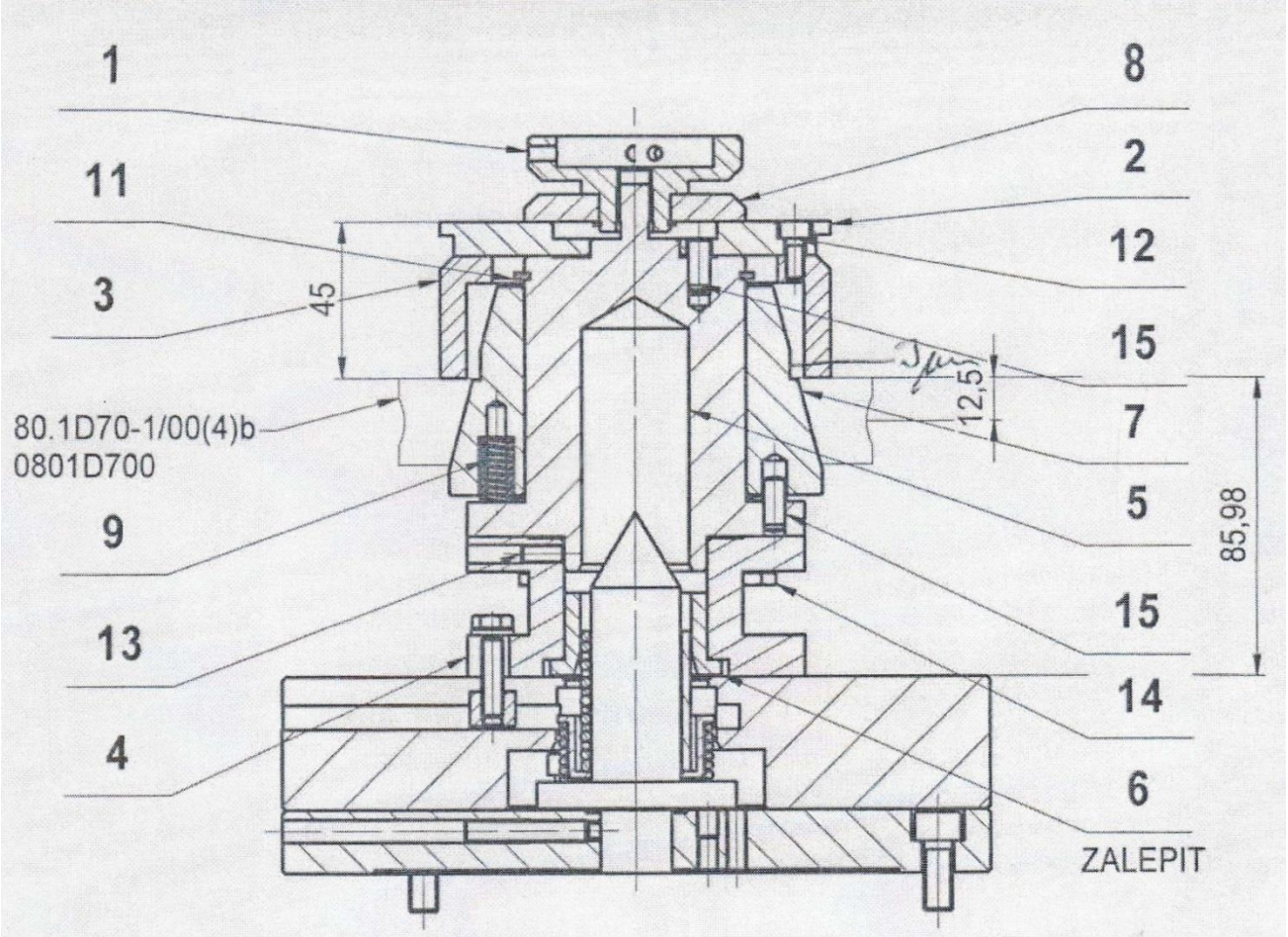


Worm gear is clamped by inner diameter

geartec.cz

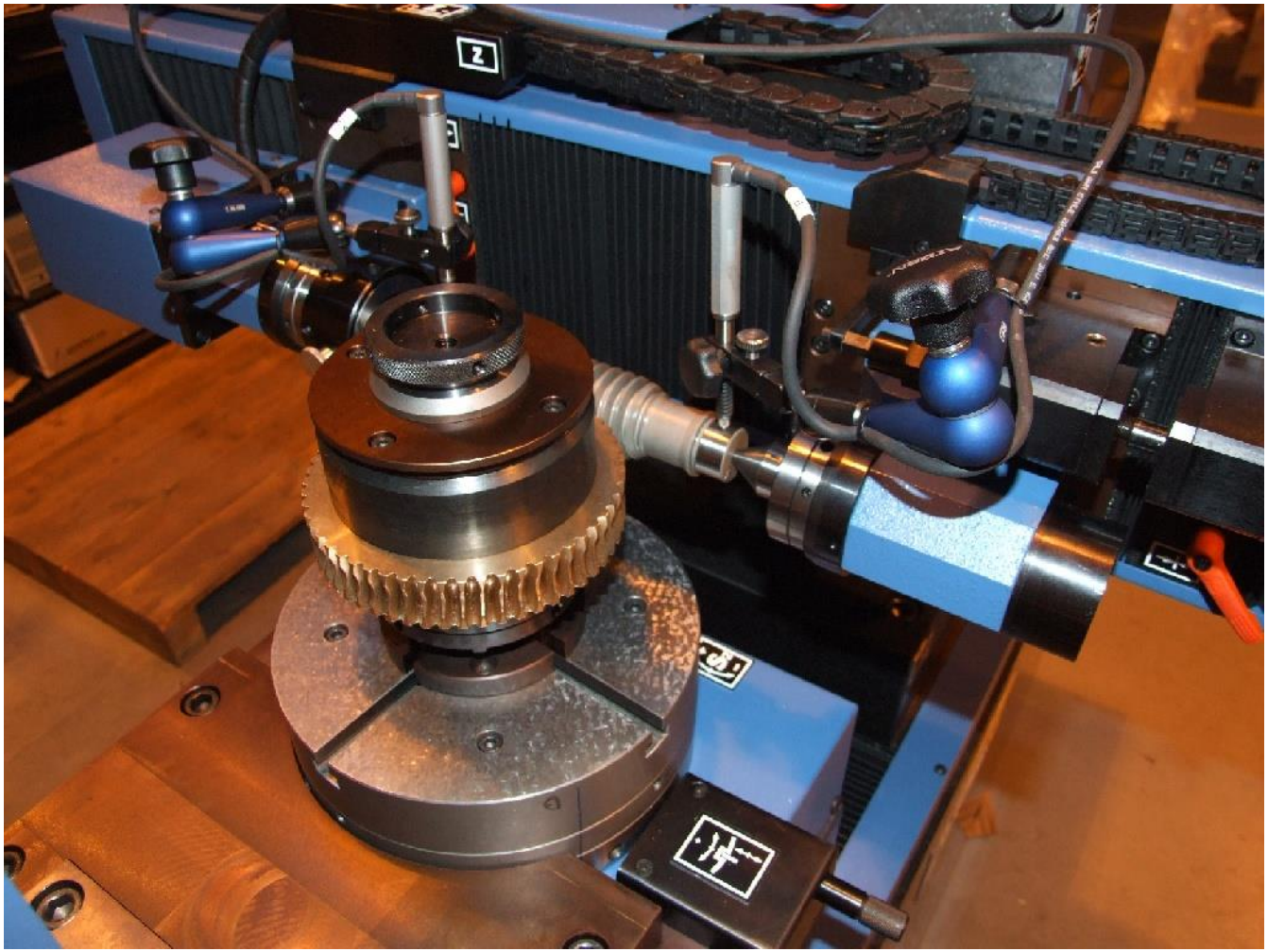
Big worm gear is clamped by outside diameter



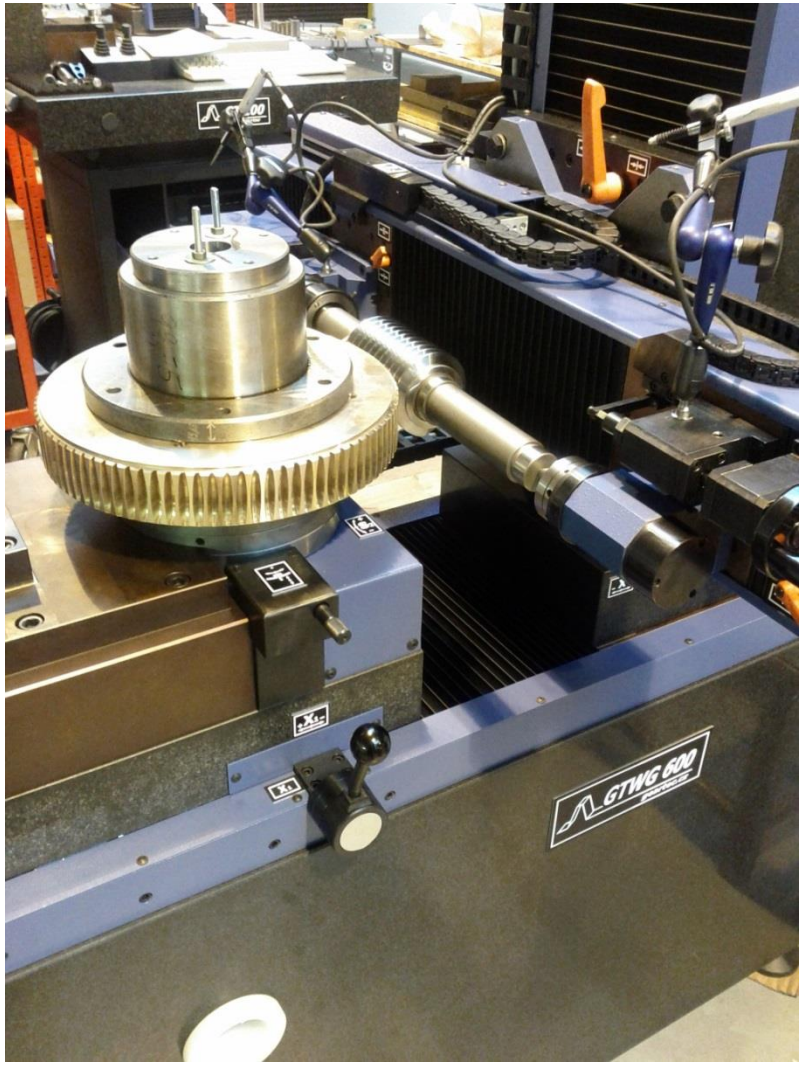


Worm gear is clamped by inner cone surface

The gear is clamped behind the bore by a precise fixture



geartec.cz



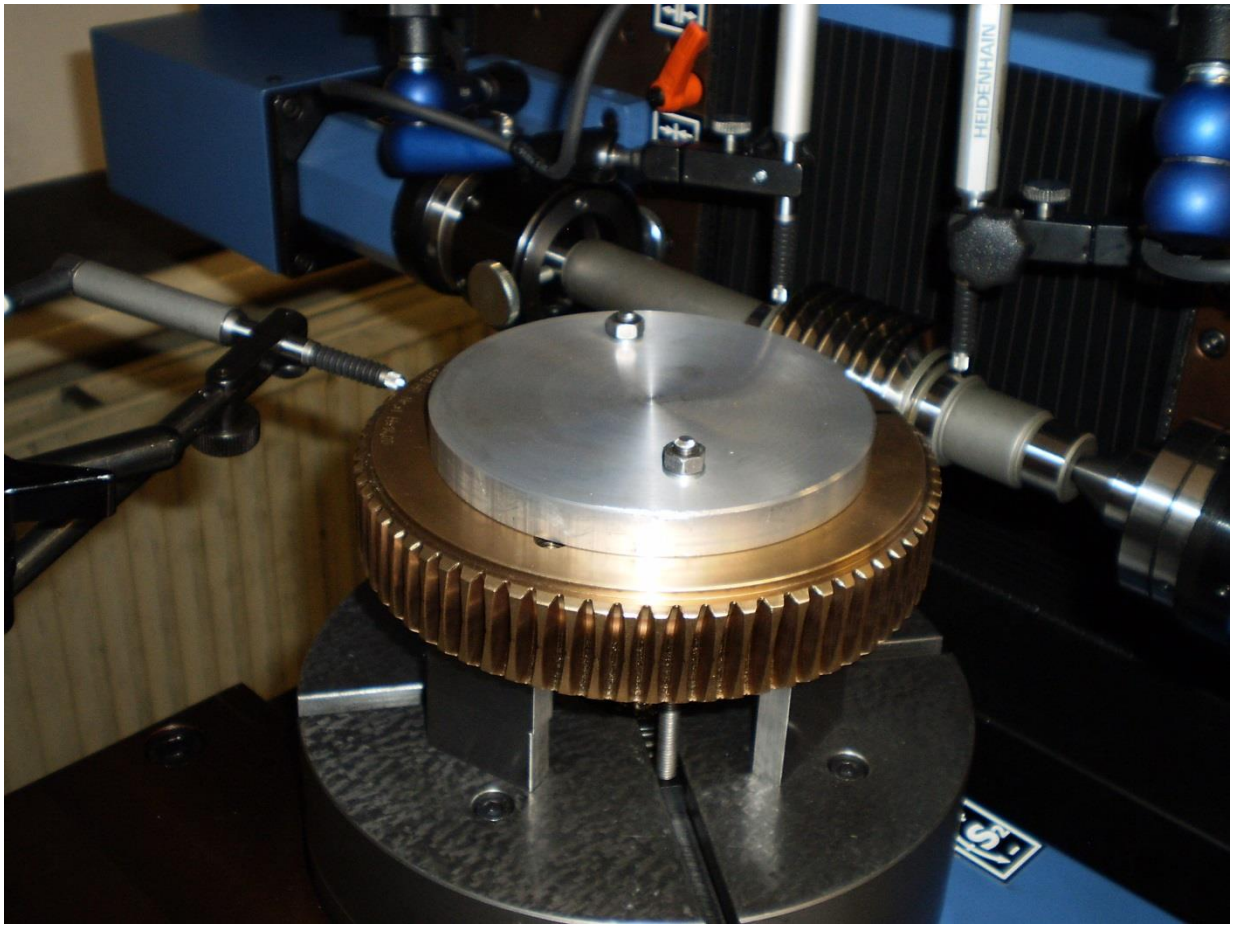
The gear with a control diameter is clamped behind the bore.

The accuracy of clamping was manually checked.

geartec.cz

The gear is clamped between centers

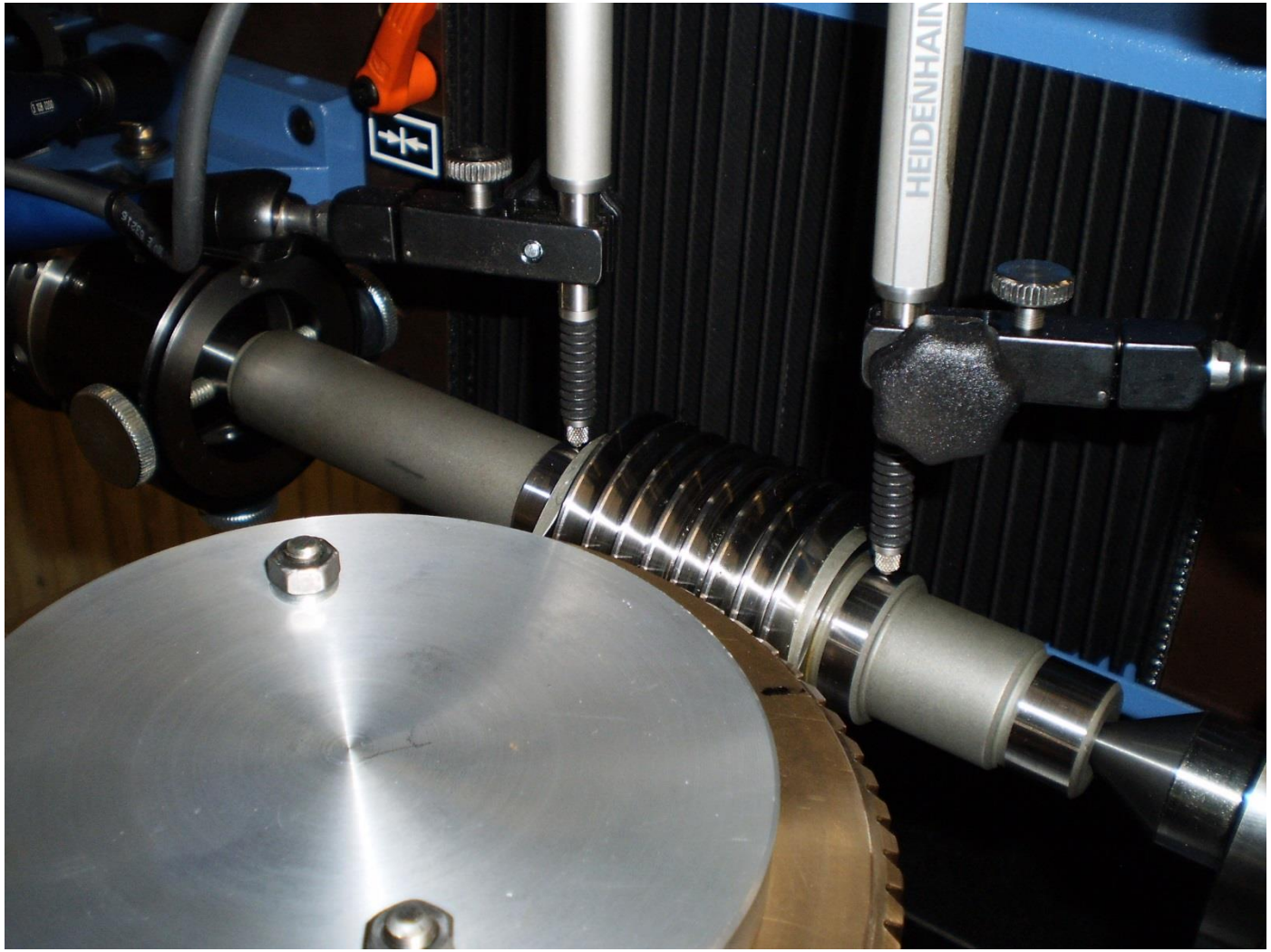
The gear with a control diameter is clamped behind the bore



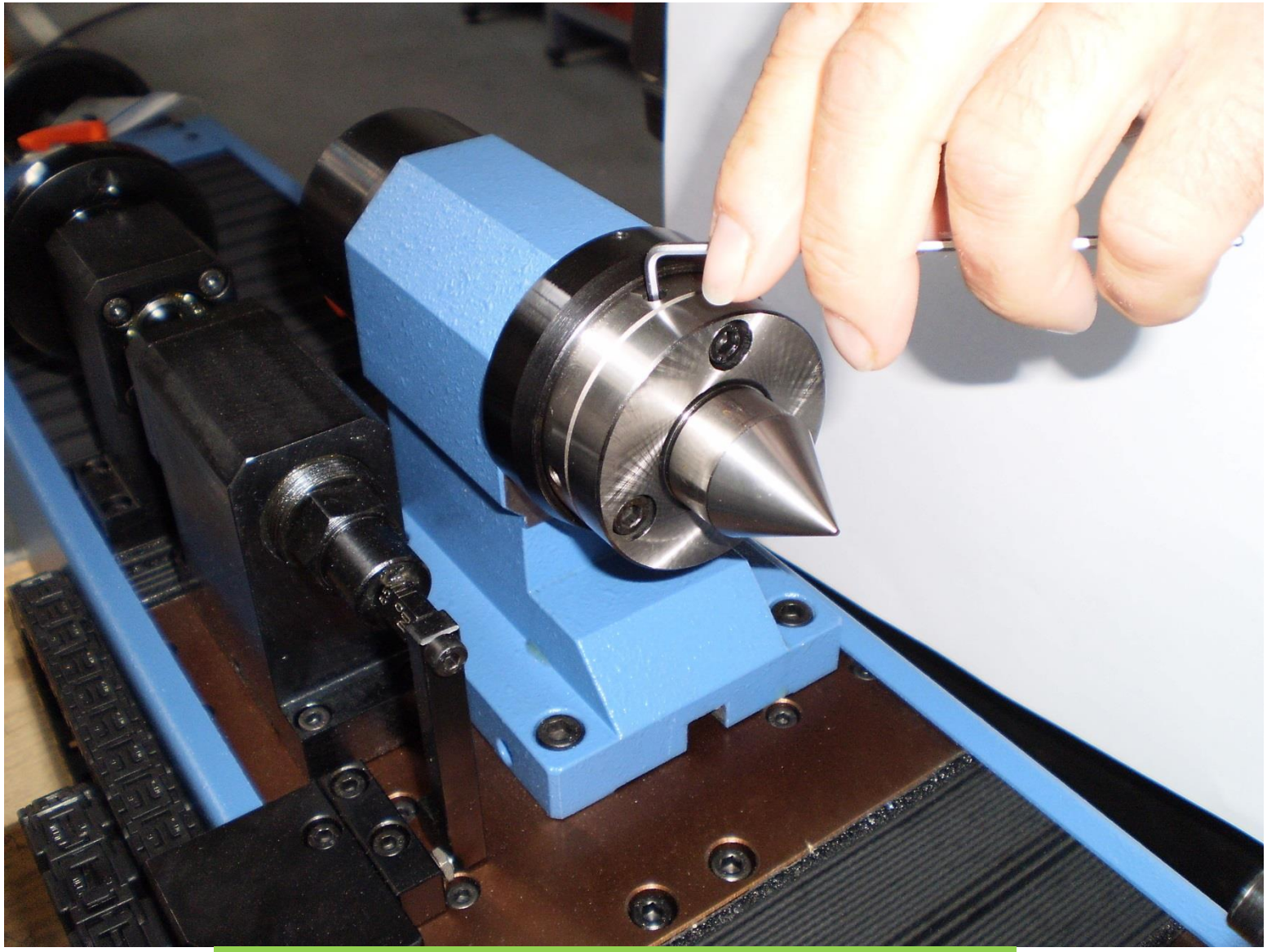
Inaccuracy of clamping is measured and mathematically compensated accordingly

geartec.cz

The way of worm clamping control



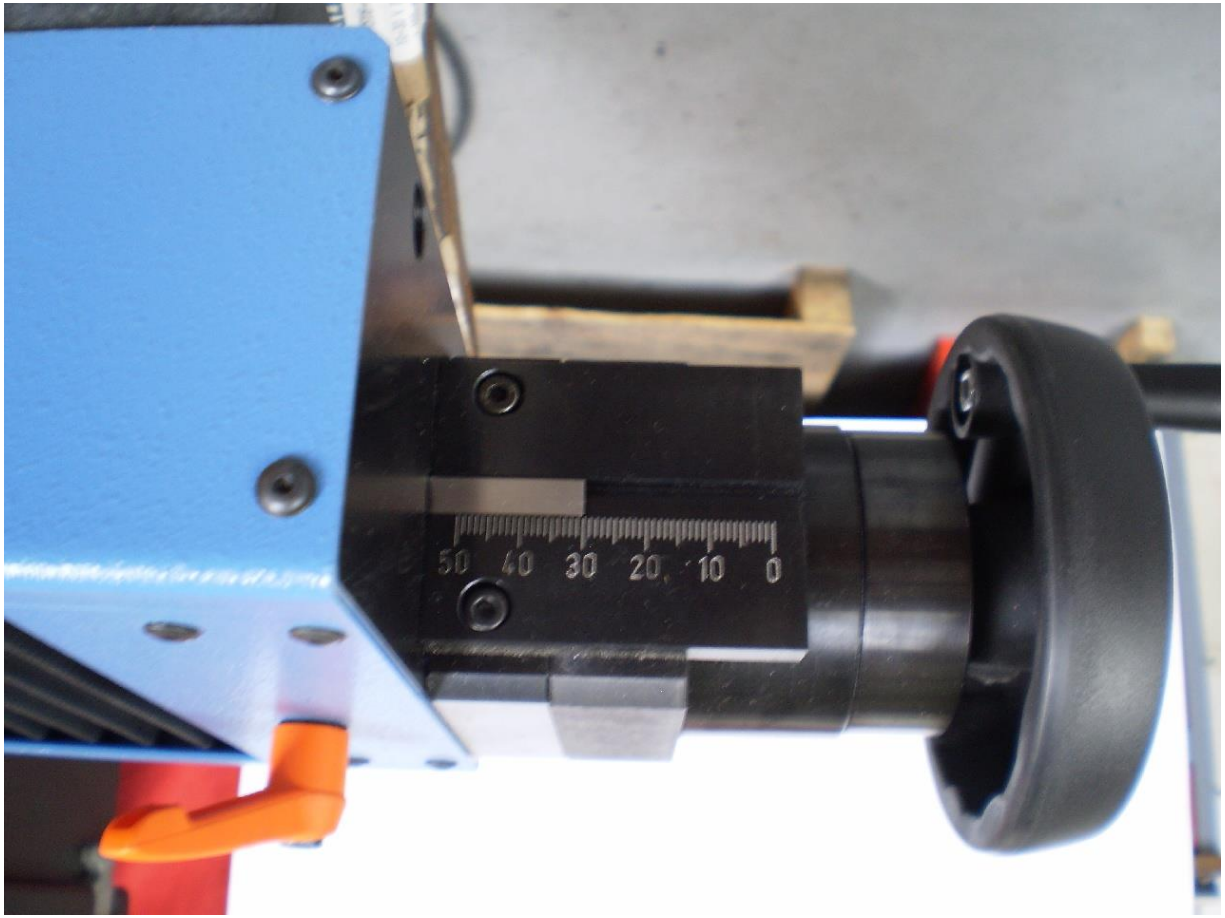
geartec.cz



The way of centers lining up

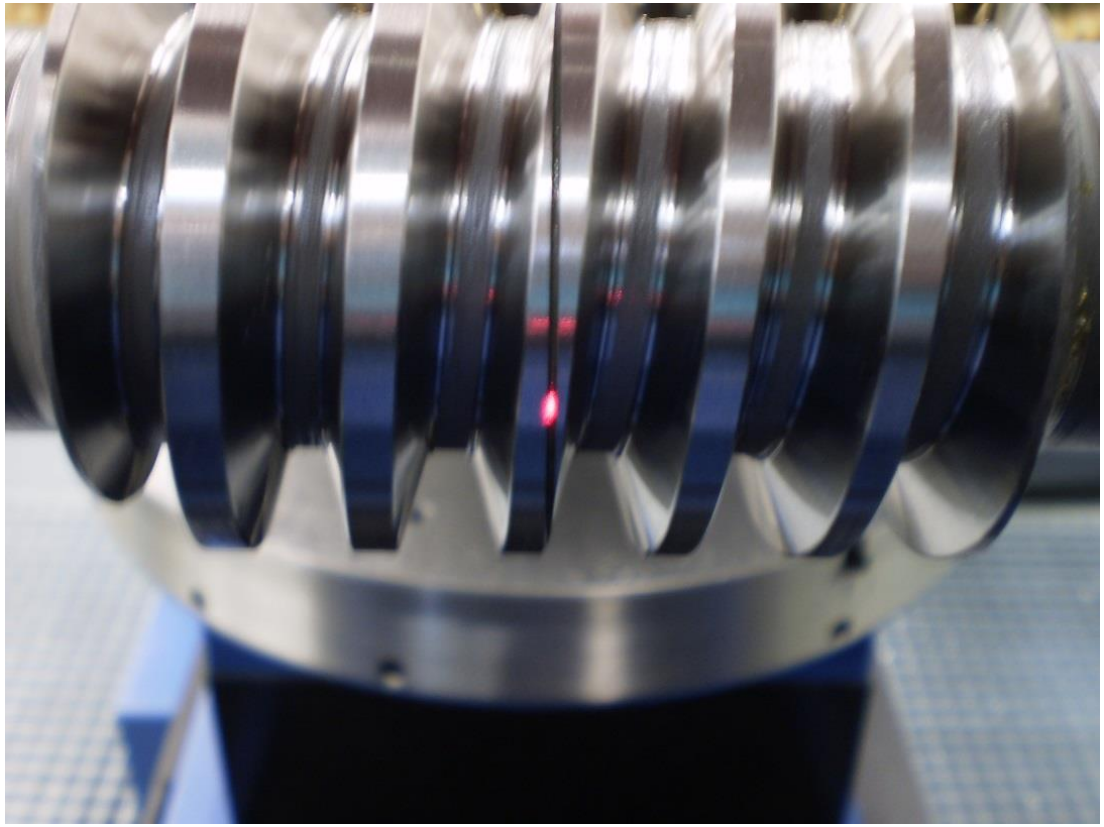
geartec.cz

Position of the worm is manual controlled

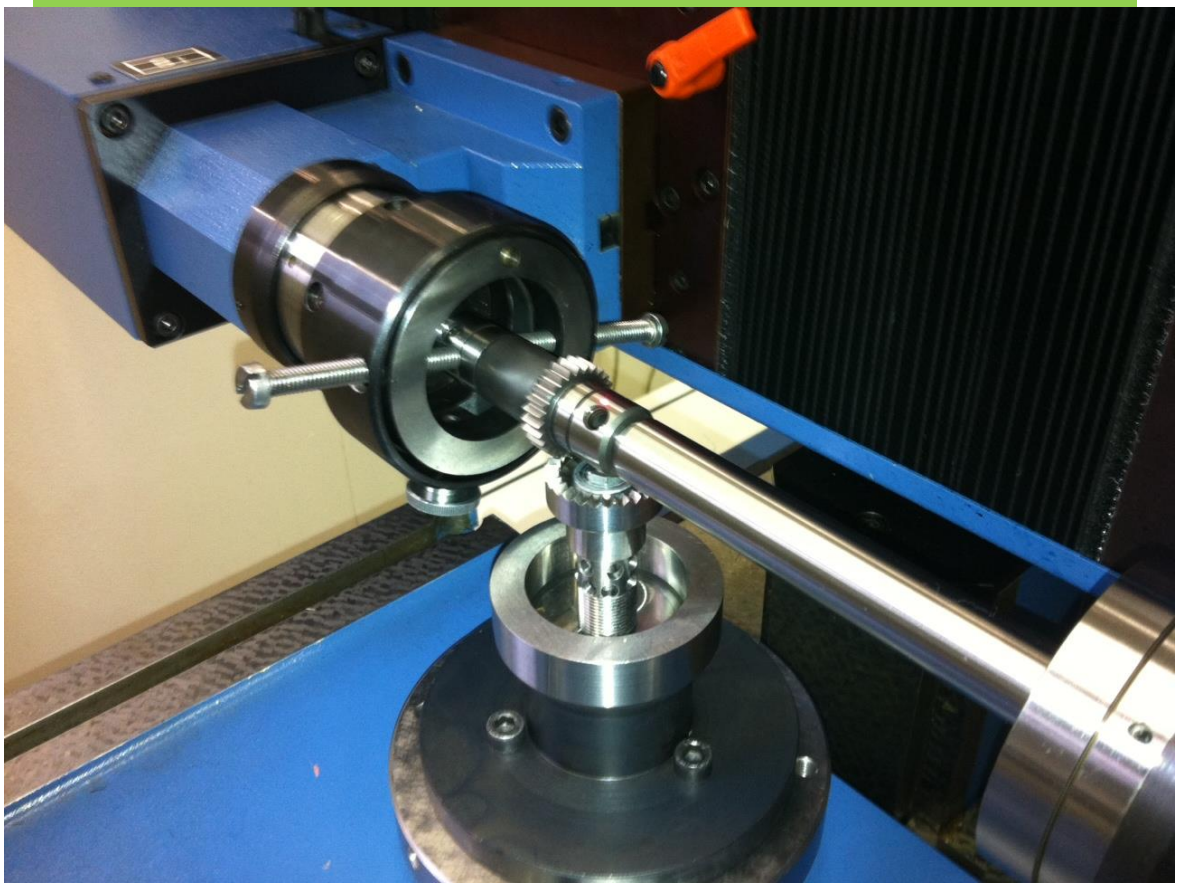


geartec.cz

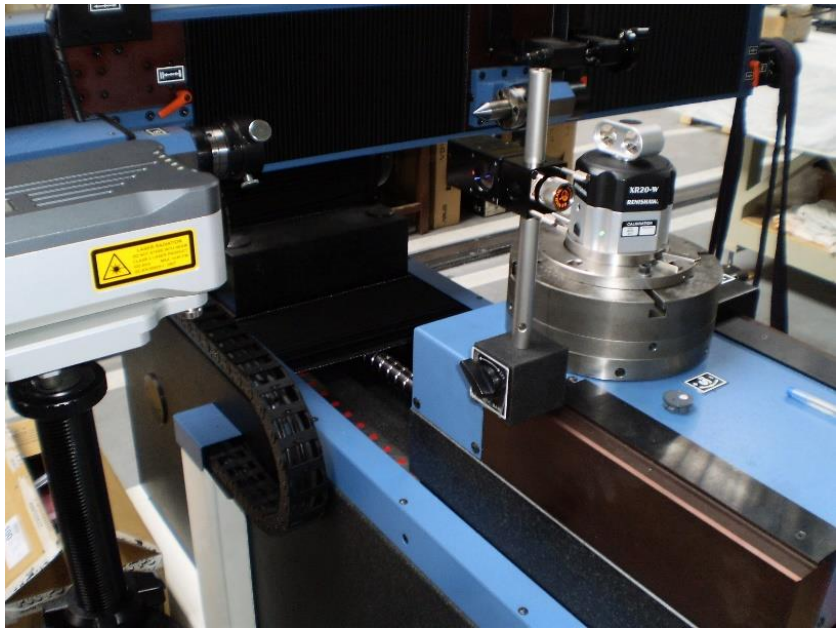
Position of the worm center is controlled by a laser sensor

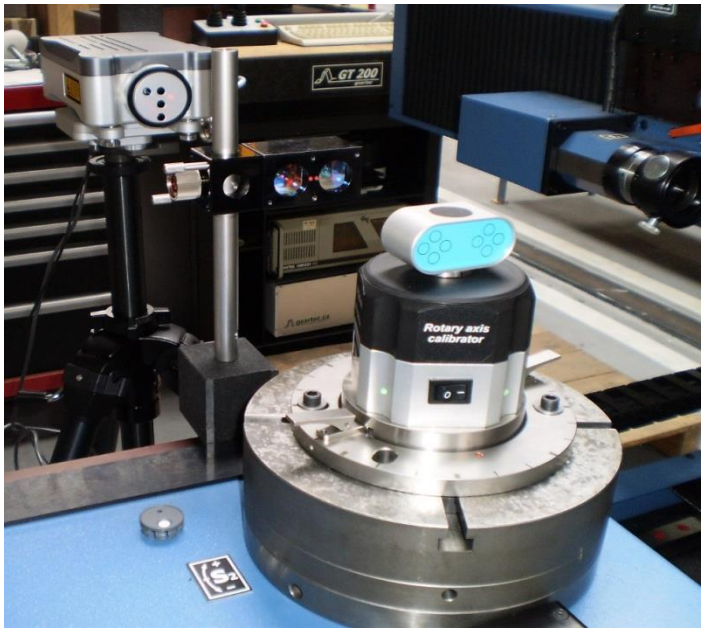


Bevel gears are also possible to measure



Measuring of accuracy with laser



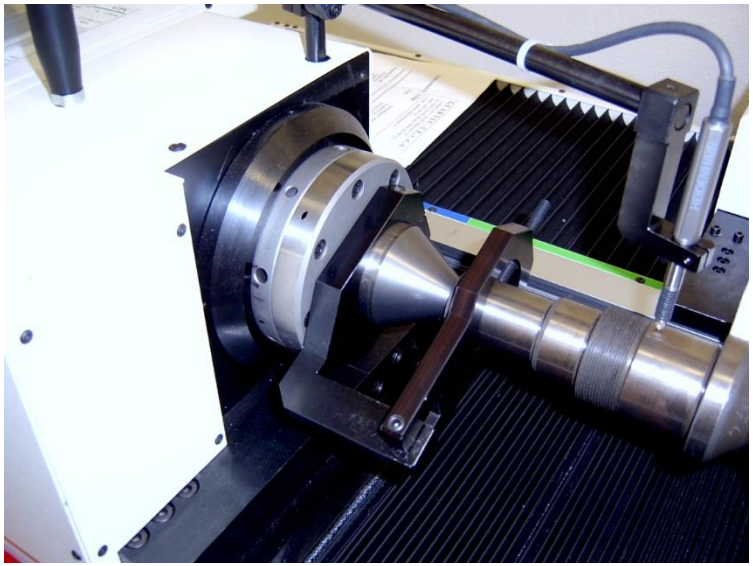


GTWG600 is also capable of measuring by laser technology.

geartec.cz

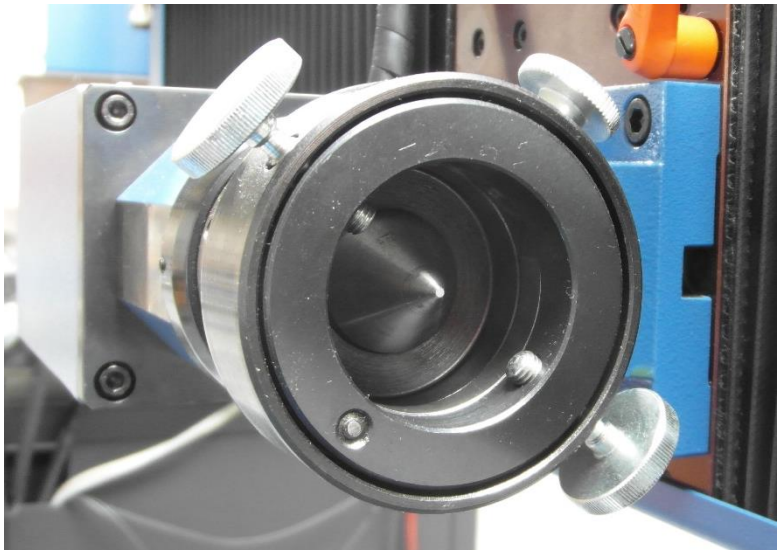
Accessories - Clamping

Two standard fixtures



Clamping range 0 – 20, 0- 40 mm
Intended for users with common accuracy measurement

Special fixtures



Clamping range 0 – 40 mm
Intended for users with higher accuracy measurements

geartec.cz

Accessories – Calibration

Calibration arbor & Master worm gears (DIN3)

Single flank testing

Advantages:

1. Measures and controls quality of production
2. Helps to improve gear quality
3. Optimization of gear parameters
4. Quick measuring and results

geartec.cz

Thank you.

GEARTEC.CZ, s.r.o.
Křižíkova 270
250 88 Čelákovice
Česká republika

info@geartec.cz

www.geartec.cz