

GTB 300

MEASURING OF BEVEL GEARS with single-flank rolling method

GEARTEC.CZ, 2017





Technical data

Diameter of bevel gear, max.	300 mm
Diameter of spindle bore for wheel	60 mm
Diameter of spindle bore for pinion	60 mm
Mounting distance for wheel, max.	275 mm
Mounting distance for pinion, max.	250 mm
Hypoid offset range - optional	± 50 mm
Shaft angle - optional	0° - 180°
Rotations, max.	300 U/min
Measuring speed, max.	30 U/min
Load torque, max.	15 Nm
Weight of wheel, max.	20 kg
Weight of the machine	1 300 kg
Accuracy	DIN 3965 / Q1

BEVEL GEAR

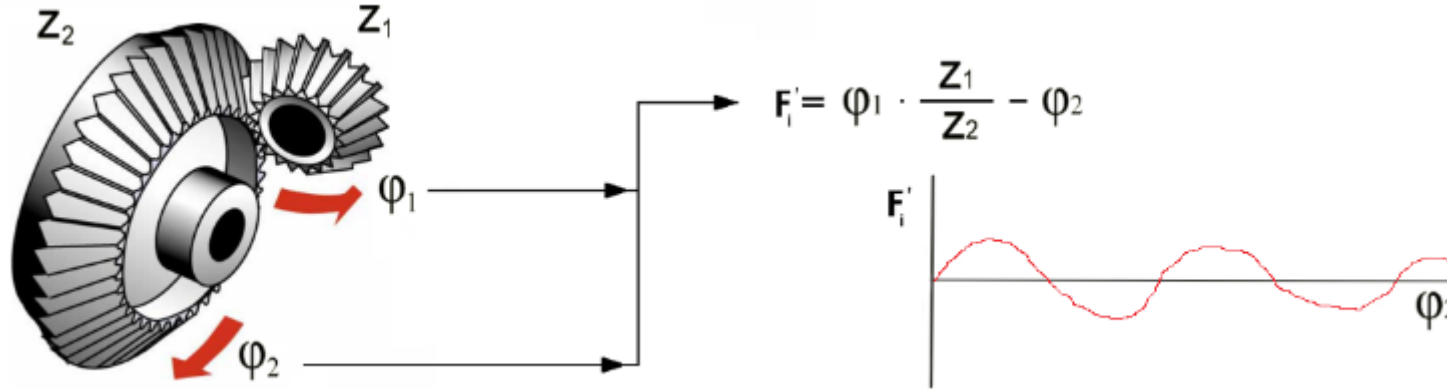
Main requirements in gear production:

- DIN Quality
- Defined backlash
- Low level of noise / high lifespan
- Influence of assembly precision
- Contact pattern, V-H characteristics
- Where error comes from (pinion/wheel)



**All these parameters are measured and checked by our
single-flank inspection machine GTB300**

SINGLE-FLANK METHOD - PRINCIPLE



- Mounting distance during testing is static
- Left and right flanks are tested separately
- Accurate rotary encoders
- Accuracy app. 1 second of arc ($5 \mu\text{rad}$) $\sim 1 \mu\text{m}$ on diameter of 200 mm
- Deviations and tolerances in: DIN 3965, AGMA, ISO

DEVIATIONS

Single flank deviations

- F_i' - Tangential composite deviation
- f_i' - Tooth to tooth composite deviation
- f_l' - Longwave component
- f_k' - Shortwave component
- j - Backlash

Pitch deviations of pinion and gear

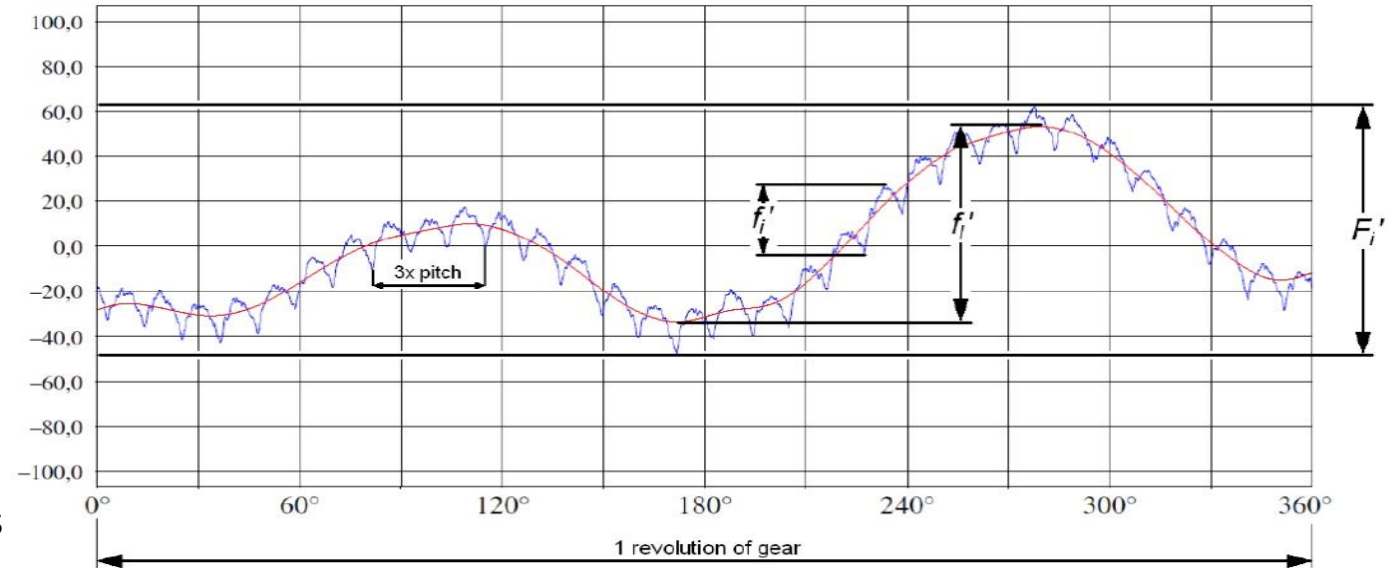
- F_p - Total pitch deviation
- f_{pt} - Adjacent pitch deviation
- f_u - Difference between adjacent pitches
- F_r - Radial run-out

Contact pattern

V-H cycle

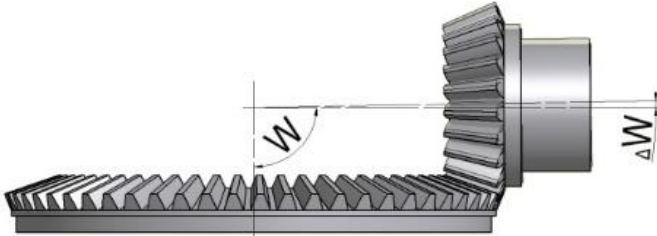
FFT Analyse

Roundness and eccentricity

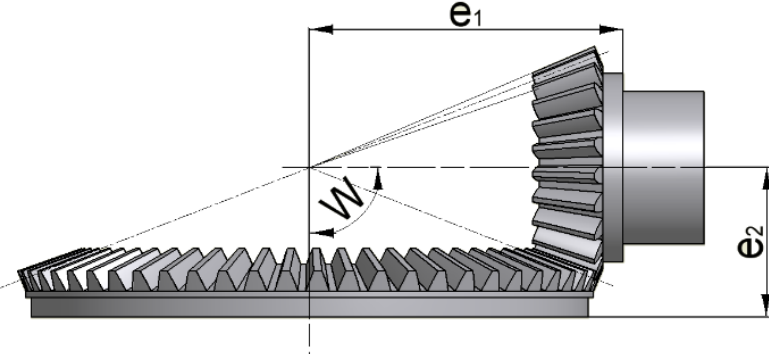


OTHER OPTIONS – INFLUENCE OF ASSMEBLY

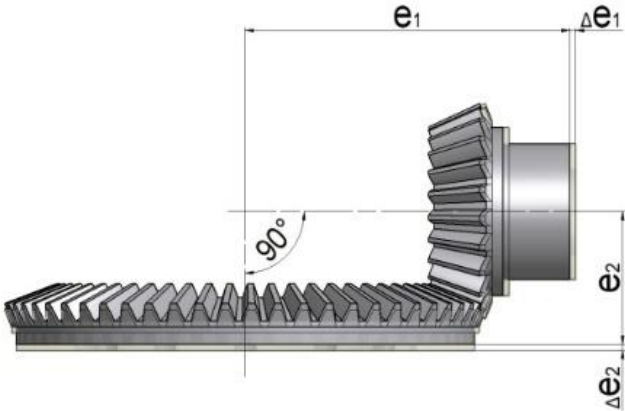
Angular displacement



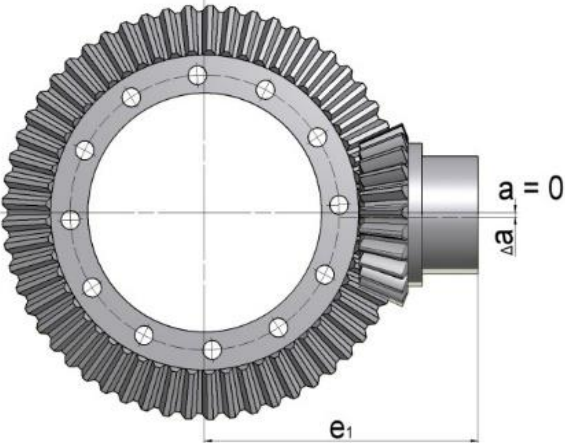
Correct position



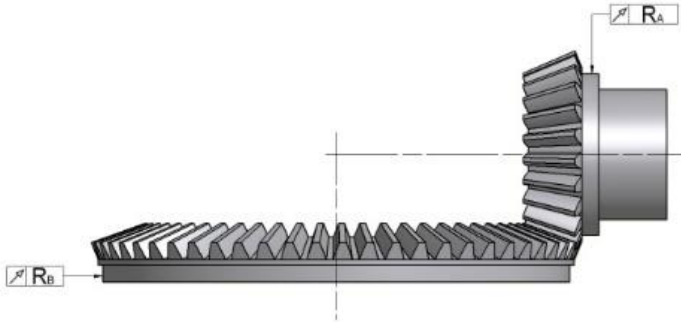
Mass installation



Hypoid offset



Concentricity



MACHINE VARIANTS

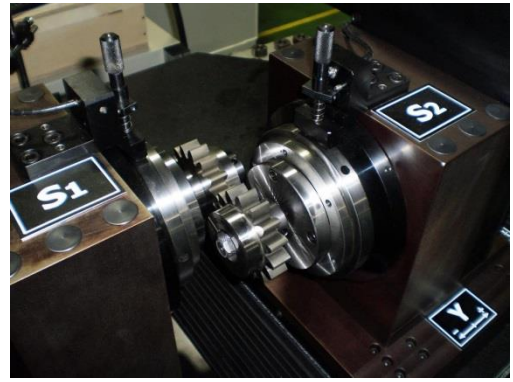
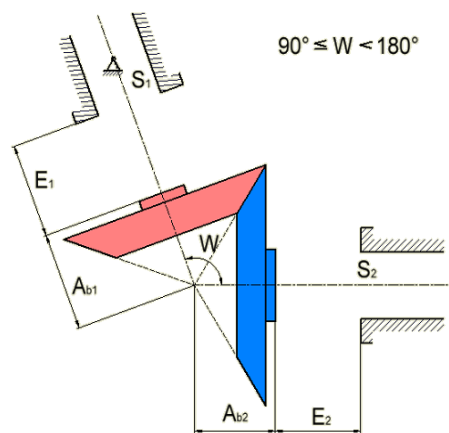
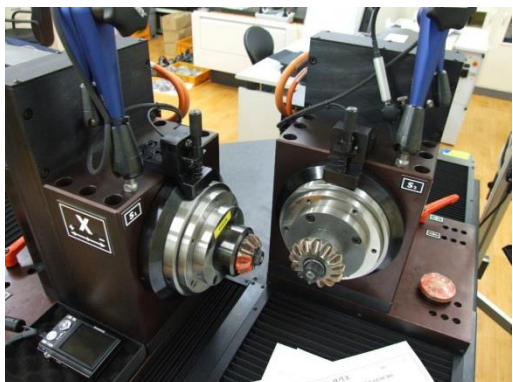
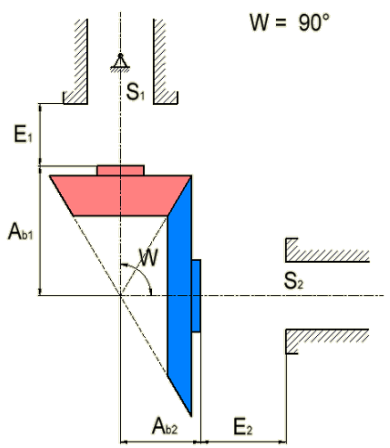
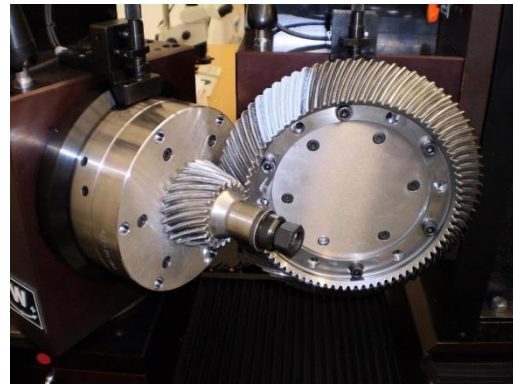
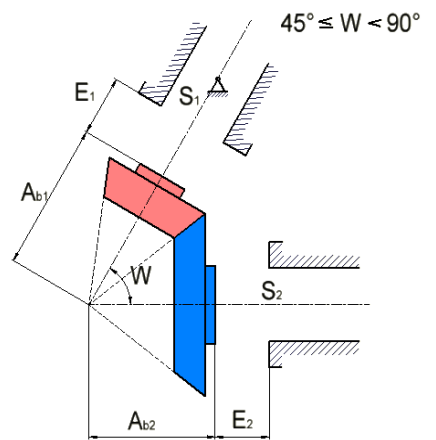
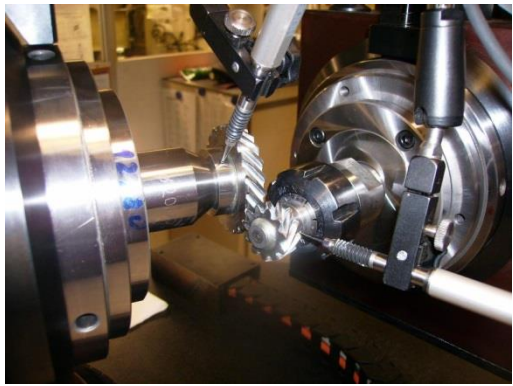
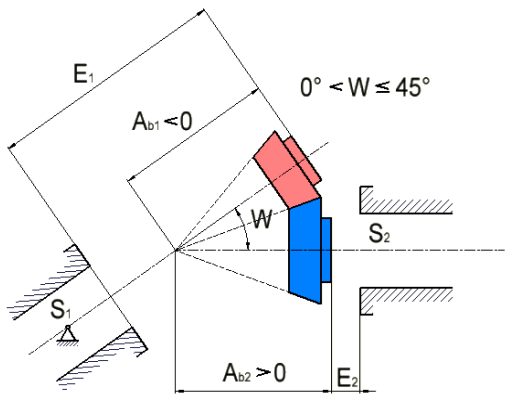
GTB 300 HW – with hypoid offset ($\pm 50\text{mm}$) and variable shaft angle from $0^\circ - 180^\circ$

GTB 300 H – with hypoid offset ($\pm 50\text{mm}$) , fixed shaft angle to 90°

GTB 300 W – without hypoid offset and variable shaft angle from $0^\circ - 180^\circ$

GTB 300 – without hypoid offset and fixed shaft angle to 90° for bevel gears,
or with angle adjustment to 180° for spur/helical gears

PRINCIPLE OF MEASURUNG – VARIABLE SHAFT ANGLE



MEASURING APPLICATION

Parametry objektu

Základní | Doplnkové | Úchytky | Cyklus V/H | Zabíhací mod | Kruhovitost | Nastavení

Název soukolí:

Pastorek: Číslo výkresu: pinion, Počet zubů z_1 : 36, Věvec: Číslo výkresu: gear, Počet zubů z_2 : 88

Modul normálový m_n : 4,5560, Modul čelní m_t :
Úhel záběru α_n : 20,0000°, Úhel ozubení α : 20,0000°
Šířka ozubení b : 75,0000 mm
Osové přesazení a : 0,0000 ± 1,0000 mm
Úhel šroubovice β_m : 35,0000°, Smysl stoupání: L, P
Výkresová vzdálenost e_1 : 283,600 mm, e_2 : 130,000 mm
Montážní vzdálenost e_1 : 283,504 ± 5,000 mm, e_2 : 129,454 ± 5,000 mm
Velikost podložky A_{b1} : 175,050 mm, A_{b2} : 159,950 mm
Úhel os Σ : 90,0000° ± 0,0000°, Poloměr nástroje r_c : 0,000 mm
Boční vůle j : obvodová, normálová, 0,500 mm

Zpět Ulož OK

Parametry objektu

Základní | Doplnkové | Úchytky | Cyklus V/H | Zabíhací mod | Kruhovitost | Nastavení

Norma: User Free, DIN 3965, ISO 1328, AGMA 17485
Vyhodnocení úchytky: délkové, úhlové [wsec]

Celková kinematická úchytky F_i' : 6 (79,0 μ m)
Místní kinematická úchytky f_i' : 6 (31,0 μ m)
Pomalá složka odvalu f_i' : 6 (81,0 μ m)
Rychlá složka odvalu f_k' : 6 (39,0 μ m)

Tolerance vůle j : obvodová, normálová, 0,400 + 0,500 mm
Roztečný průměr, Hlavový průměr

Radiální házení F_r : 6 (35,0 μ m), 6 (40,0 μ m)
Součtová úchytky F_p : 6 (48,0 μ m), 6 (55,0 μ m)
Úchytky čelní rozteče f_{pt} : 6 (13,0 μ m), 6 (14,0 μ m)
Úchytky sousední rozteče f_u : 6 (16,0 μ m), 6 (17,0 μ m)

Párování: Levý bok, Právý bok

Zpět Ulož OK

Parametry objektu

Základní | Doplnkové | Úchytky | Cyklus V/H | Zabíhací mod | Kruhovitost | Nastavení

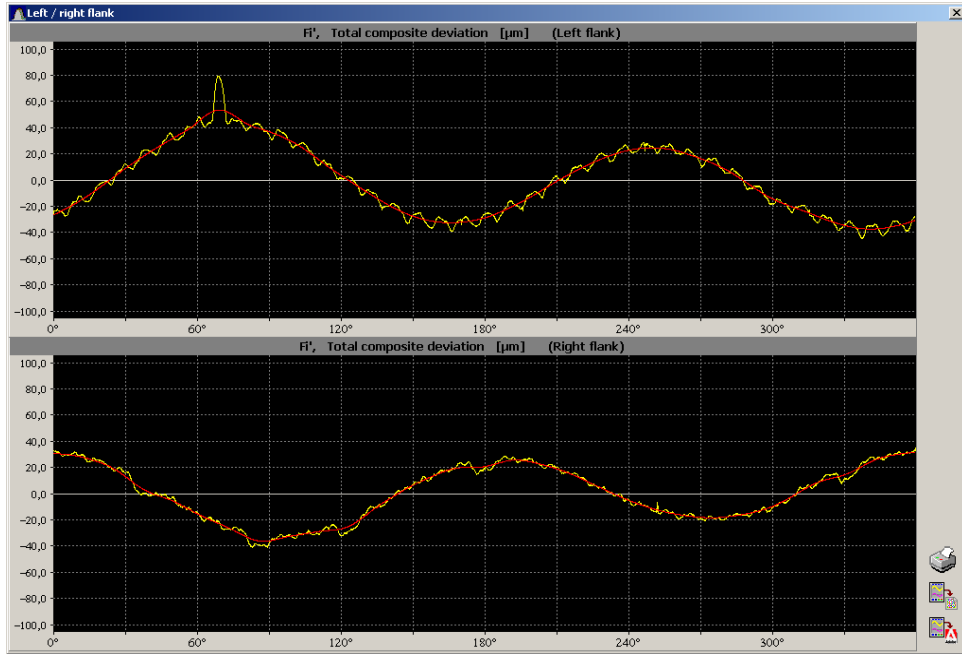
Výběr typu protokolu: Základní, Zkrácený, Doplnkový, Boční vůle, Kruhovitost, Fotografie, Úchytky roztečí

Skutečná osová vzdálenost: Automatické ukládání: Ano, Ano + PDF protokol, Dotaz, Dotaz + PDF protokol, Ne, Dotaz - Výrobní data
Automatické číslování: Automatický export dat (*.CSV), Automatický export dat (QS-STAT), Měřicí perioda: 60 min

Zpět Ulož OK

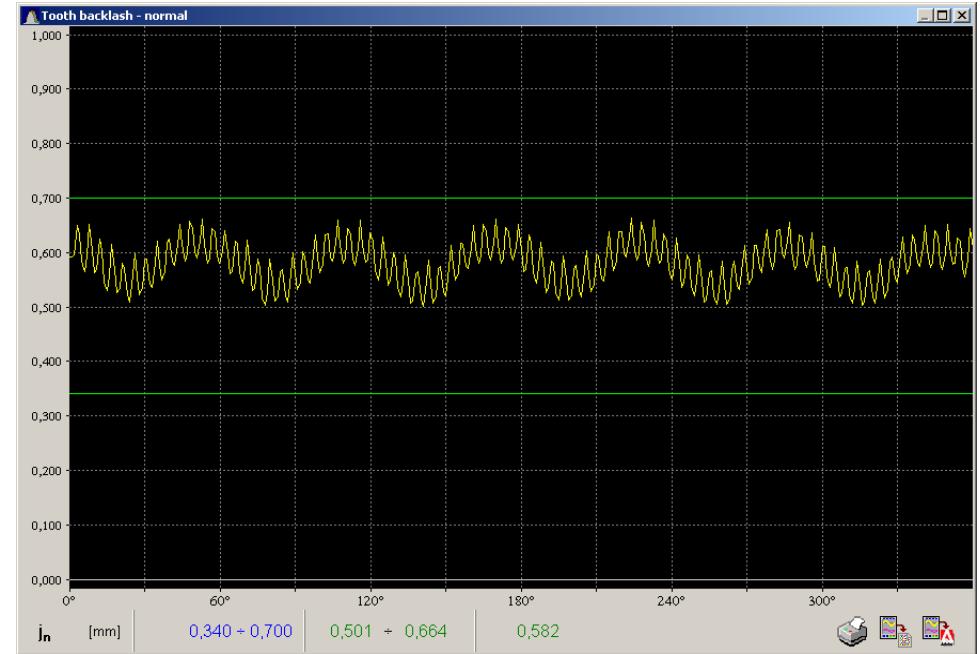
Measuring application is user-friendly requiring no special PC knowledge. It can communicate in many languages and runs under Microsoft Windows operation system. All measured results are saved into local databank system. Time needed for preparing of measurement is shortened to minimum.

EXAMPLE



RUNOUT AND BUMP

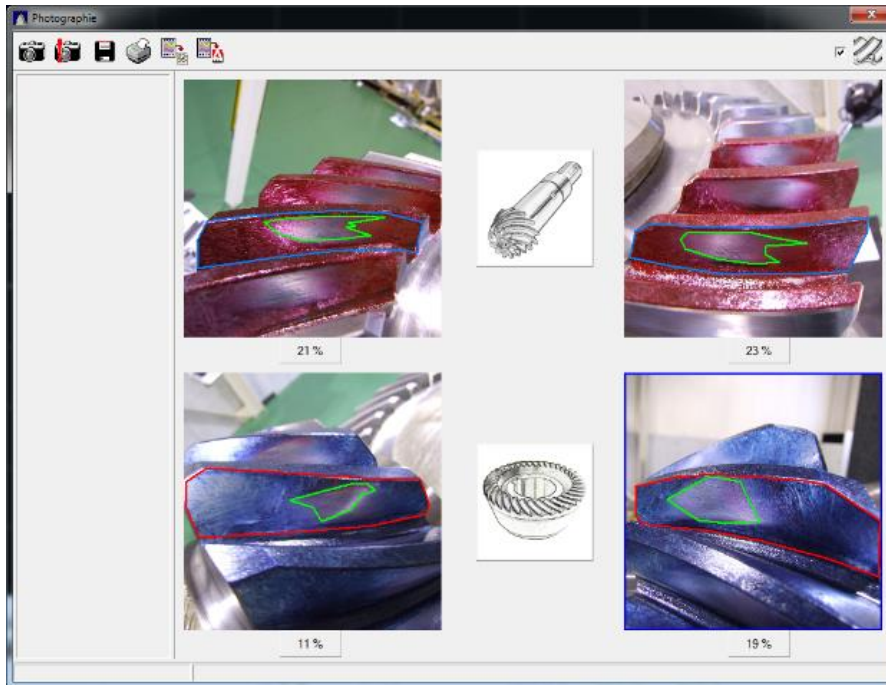
- Diagram of single flank (left and right flank), gear ratio 19/38
- Relatively large runout of pinion
- Tooth No 8 has a bump on the left flank



BACKLASH

- For one complete rotation of wheel
- Backlash is influenced by pinion runout
- It is also available to check value of backlash in a single position

EXAMPLE



CONTACT PATTERN

- Stored in a databank with measured results
- Ratio of contact pattern surface to total tooth surface in %

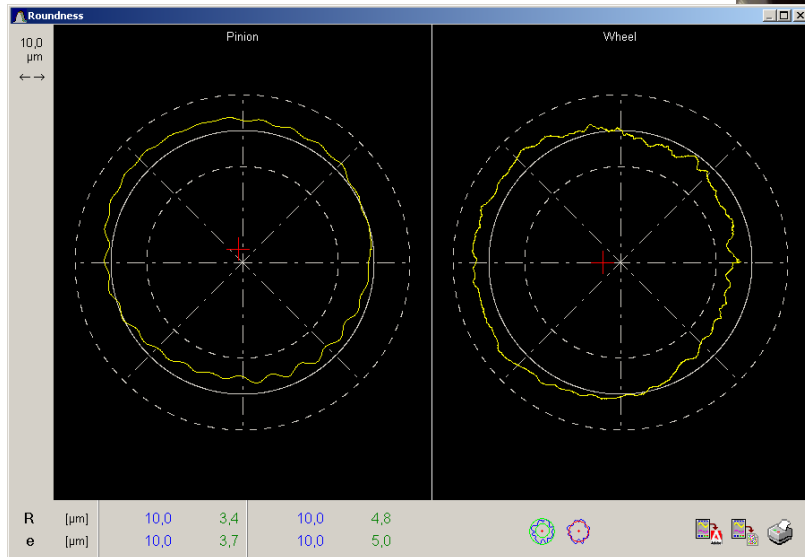
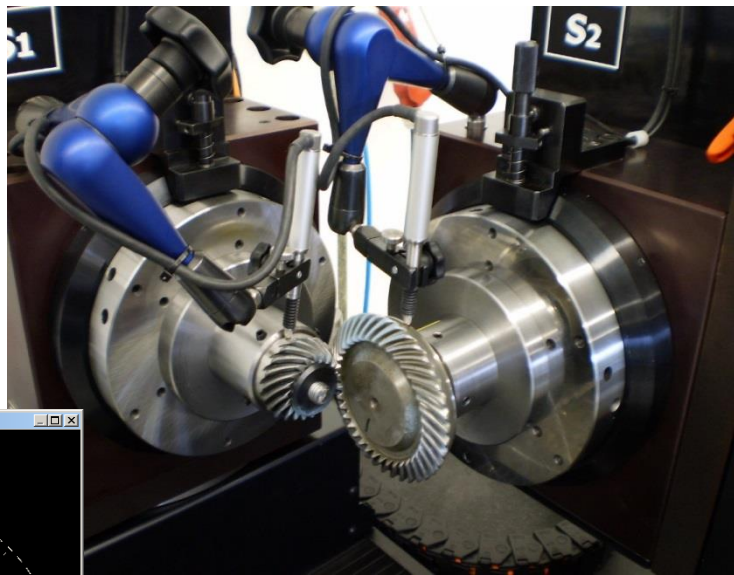
Single flank composite measurement, bevel gears				geartec.cz	
GTB 1250					
Pinion	246-6762	Wheel	246-6763	Measured revs	4
Number of teeth	z_1 29	Number of teeth	z_2 37	Serial No.	
Transverse module	m_t 22,038	Spiral angle	β_m 23.0000° /L	Contract No.	
Pressure angle	α_n 22.5000°	Hypoid offset	a 0,000 mm	Machine No.	
Spiral angle	β_m 23.0000° /R	Drawing distance	e_1 380,914 mm	Date	12.11.2009 09:47
Load torque	50,00 Nm	Drawing distance	e_2 331,400 mm	Checked by	
Measuring speed	20rpm	Shaft angle	Σ 89.9999°	Note	

V/H cycle		
Convex side of pinion	Concave side of pinion	
Level 1	V = -0,32000 inch	H = -0,14200 inch PH = 0,08500 inch
Level 2	V = 0,25200 inch	H = 0,11000 inch PH = 0,08500 inch

V-H CYCLE

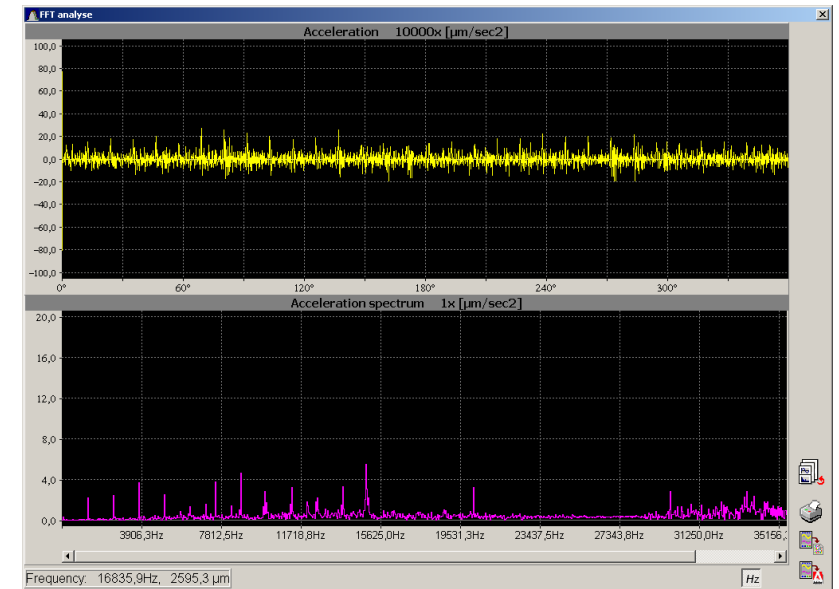
- Digital image of contact pattern shown in more positions on pinion and wheel
- Fully automatic cycle

EXAMPLE



ROUNDESS AND ECCENTRICITY

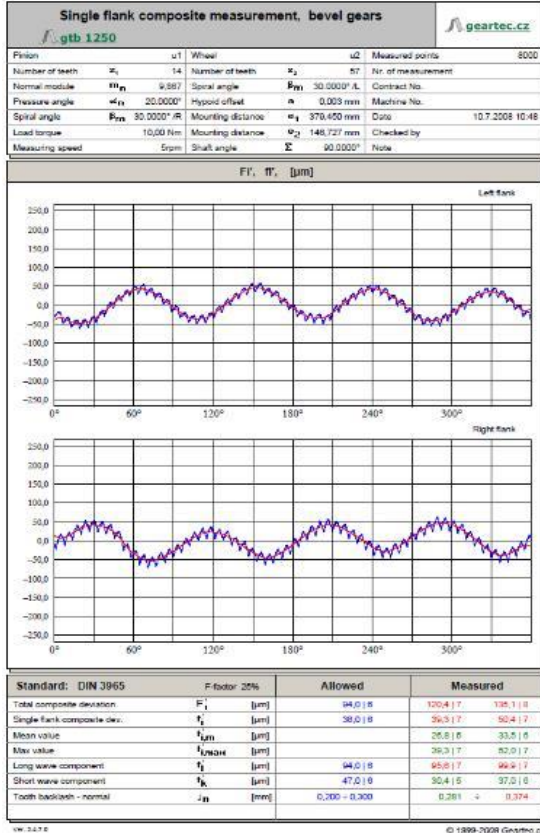
- Measuring of roundness and eccentricity
- Measured eccentricity can be mathematically eliminated from measured results



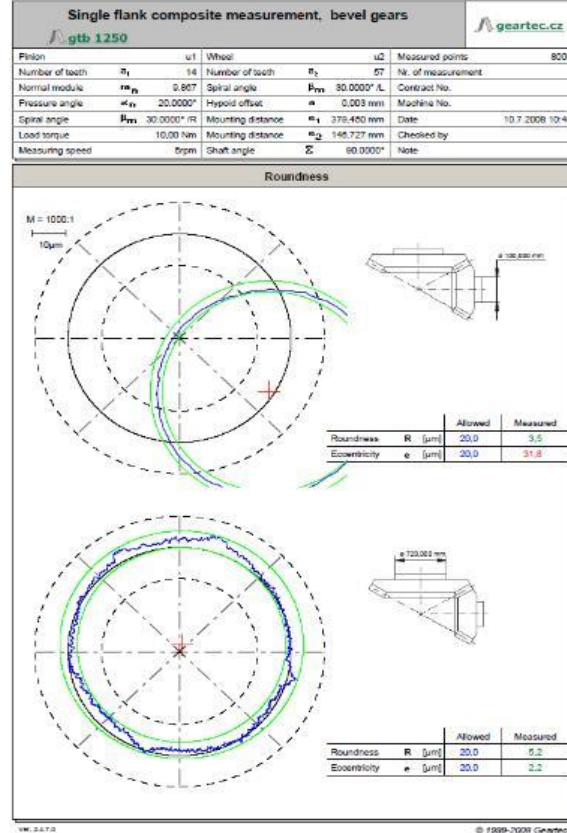
FFT ANALYSE

- Analysis of measured data and its classification into frequencies
- Noise analysis

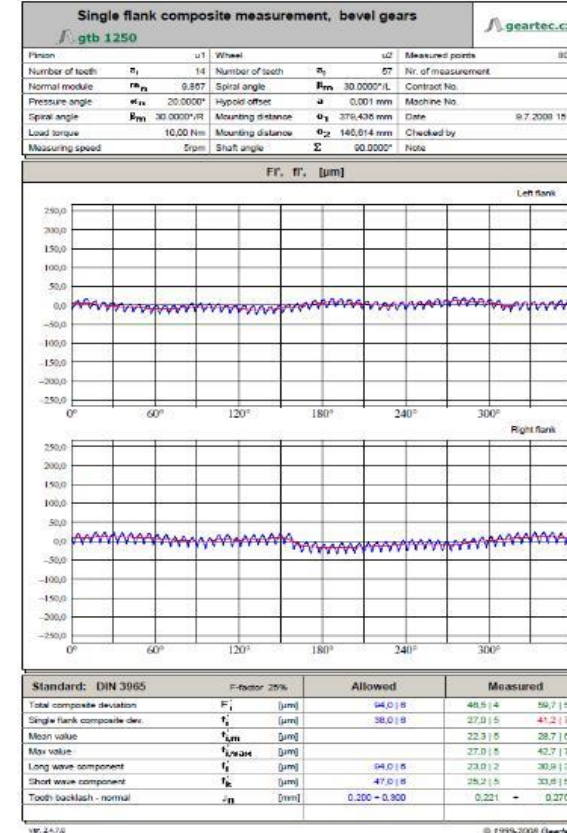
EXAMPLE



Measured without runout compensation



Measured with runout compensation



EXAMPLE

QUESTION: which gear causes big deviation on single flank results?

ANSWER: use our decomposition of single flank test

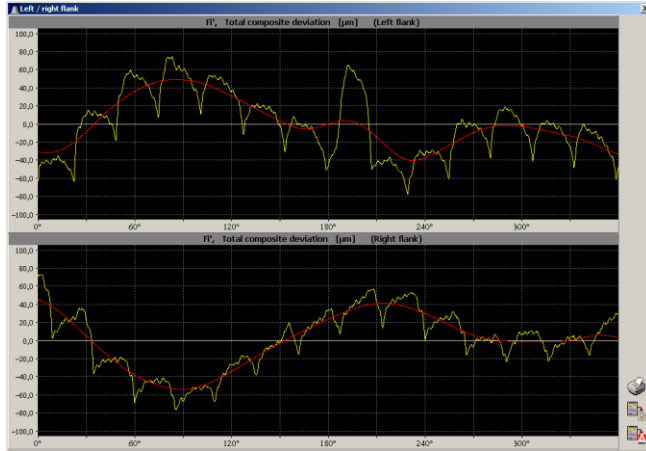
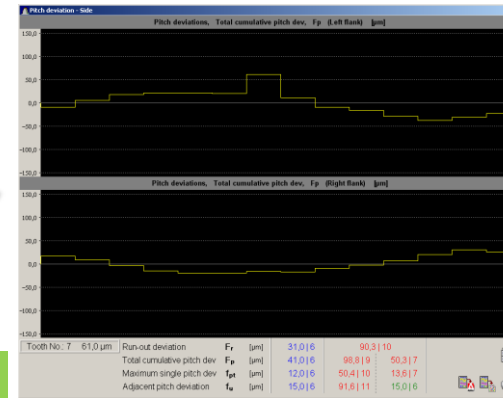
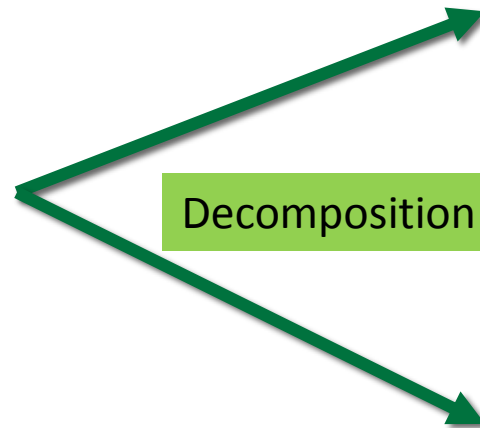
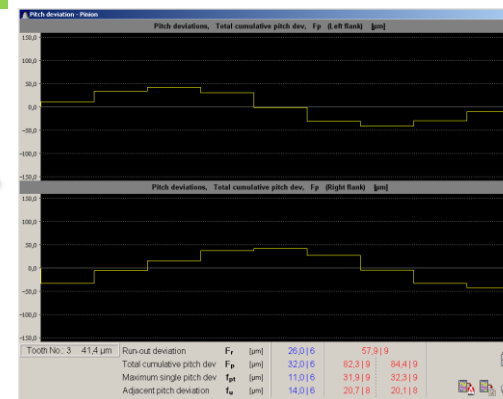


Diagram of single flank (left and right flanks are depicted)



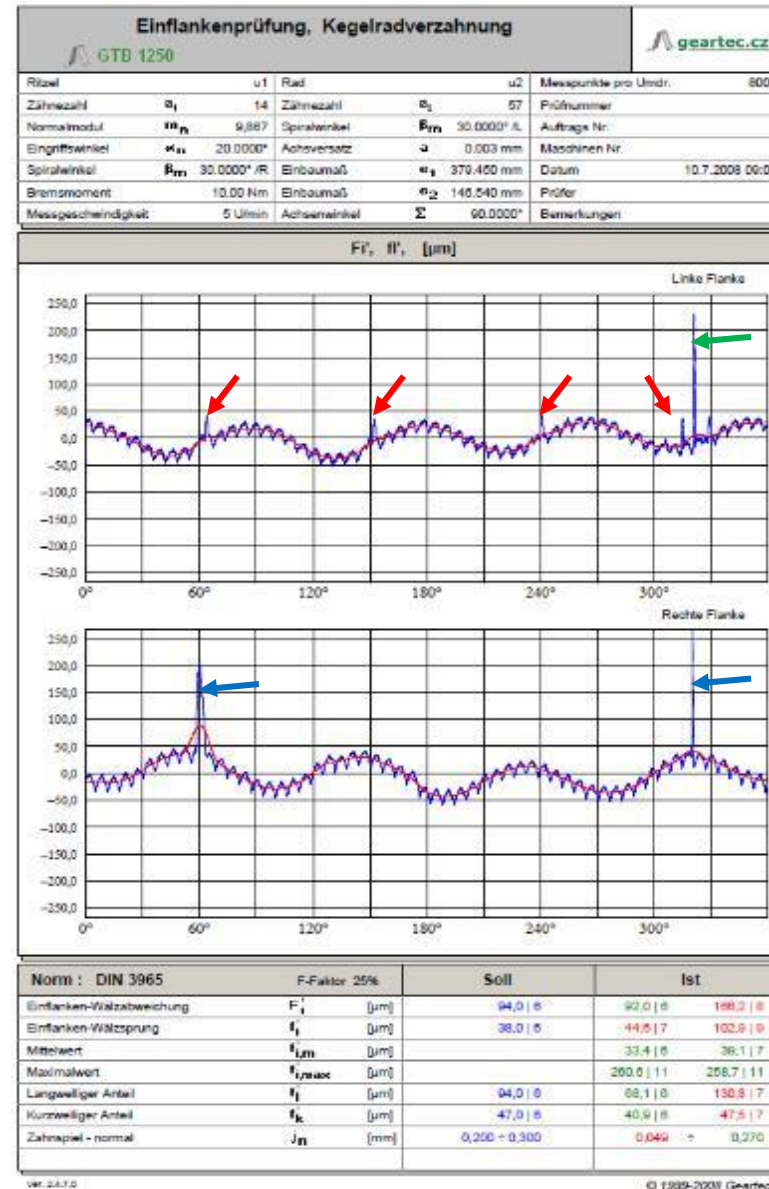
Received diagram of deviations on wheel



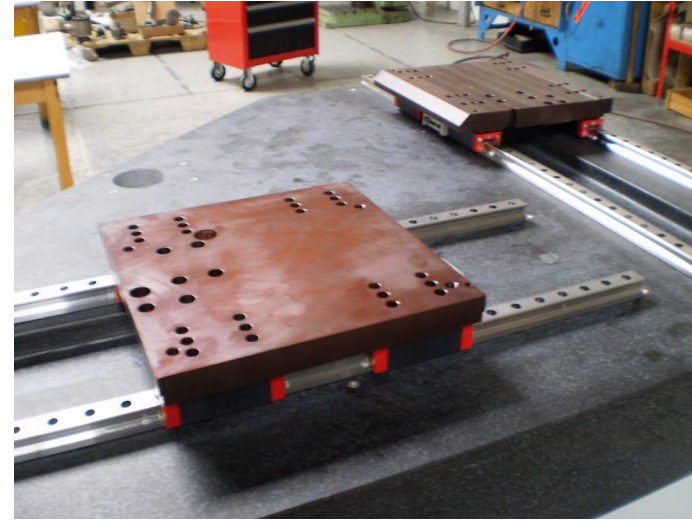
Received diagram of deviation on pinion

EXAMPLE

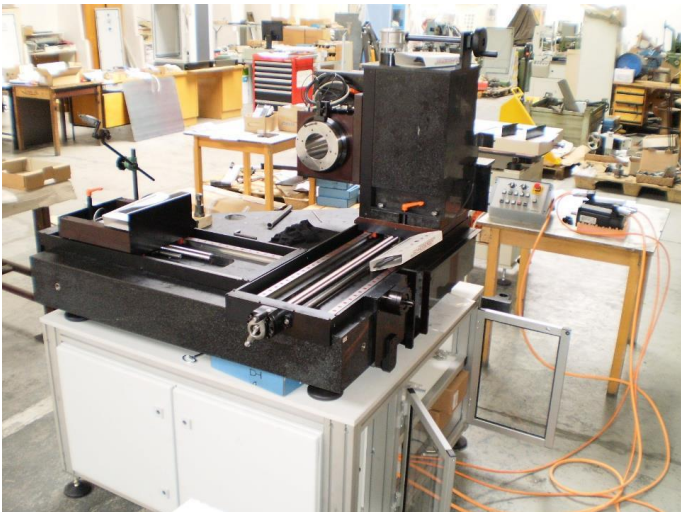
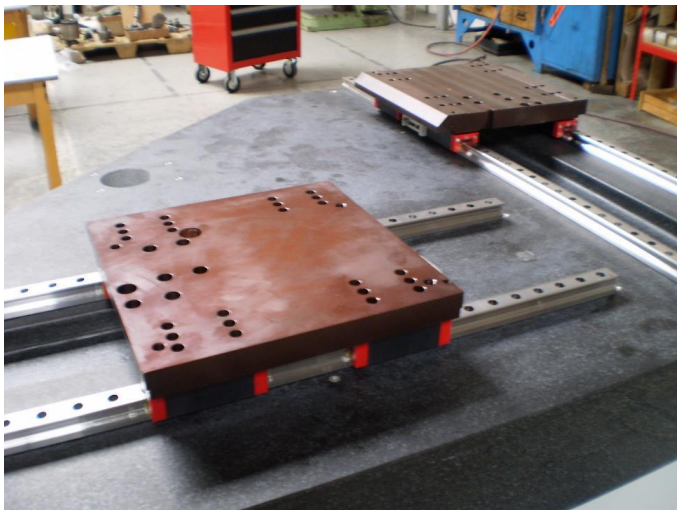
- Left flank pinion with radial run-out, **red** arrows point to local damage on pinion,
- Left flank, **green** arrow points to local damage on wheel,
- Right flank, **blue** arrows point to local bumps on the right flank of the wheel



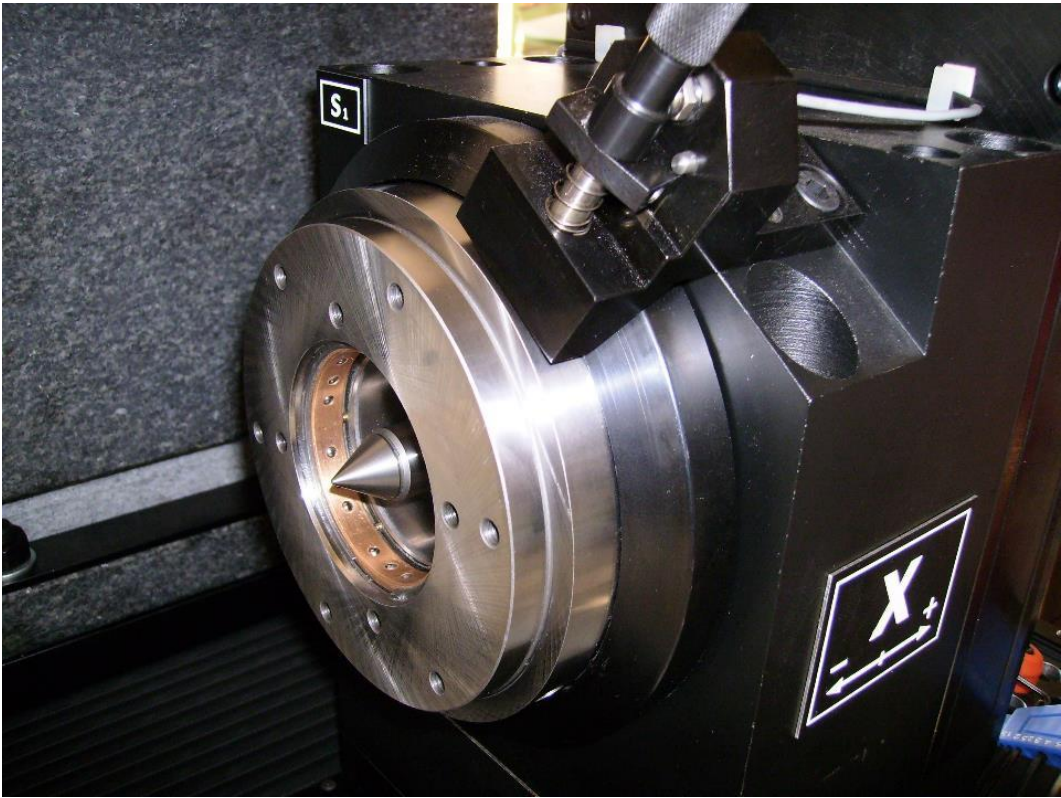
ASSEMBLY



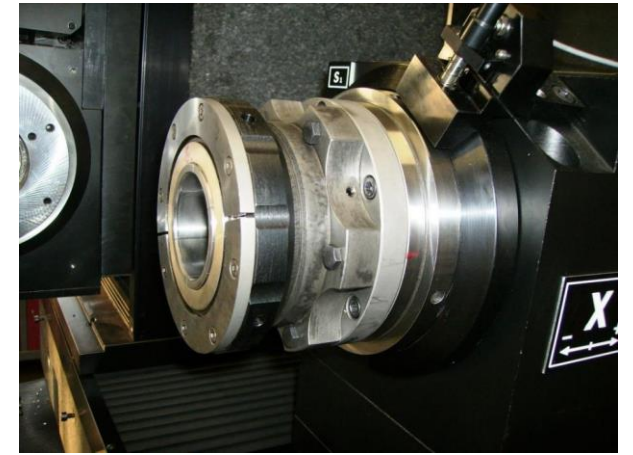
ASSEMBLY



ASSEMBLY – SPINDLE BODIES FOR WHEEL AND PINION

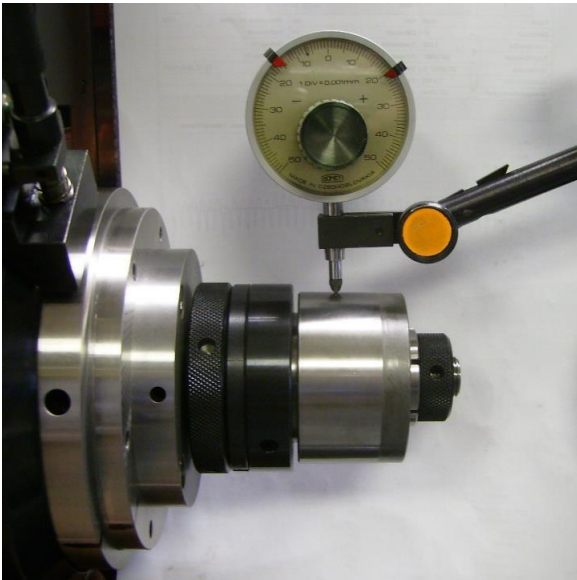
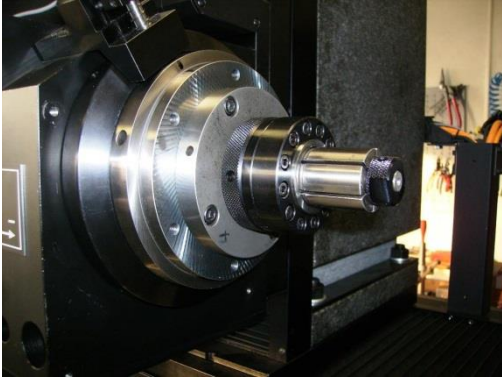


PINION – EXAMPLE OF CLAMPING FIXTURES



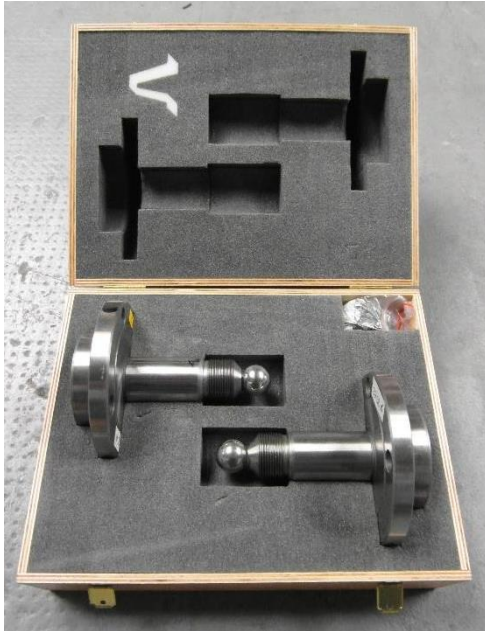
Clamping fixtures – custom design

WHEEL – EXAMPLE OF CLAMPING FIXTURES

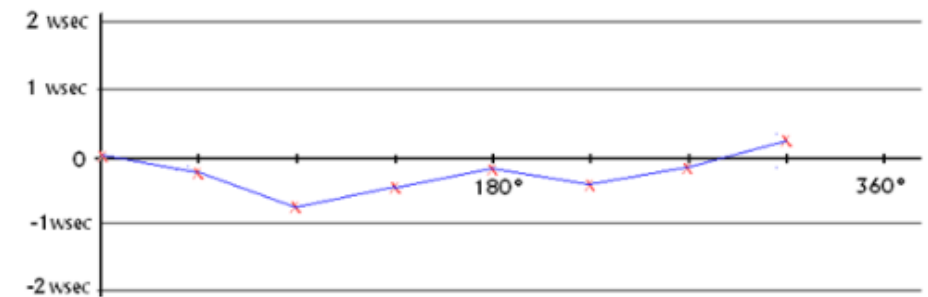


Clamping fixtures – custom design

INSPECTION OF MACHINE GEOMETRY ACCURACY

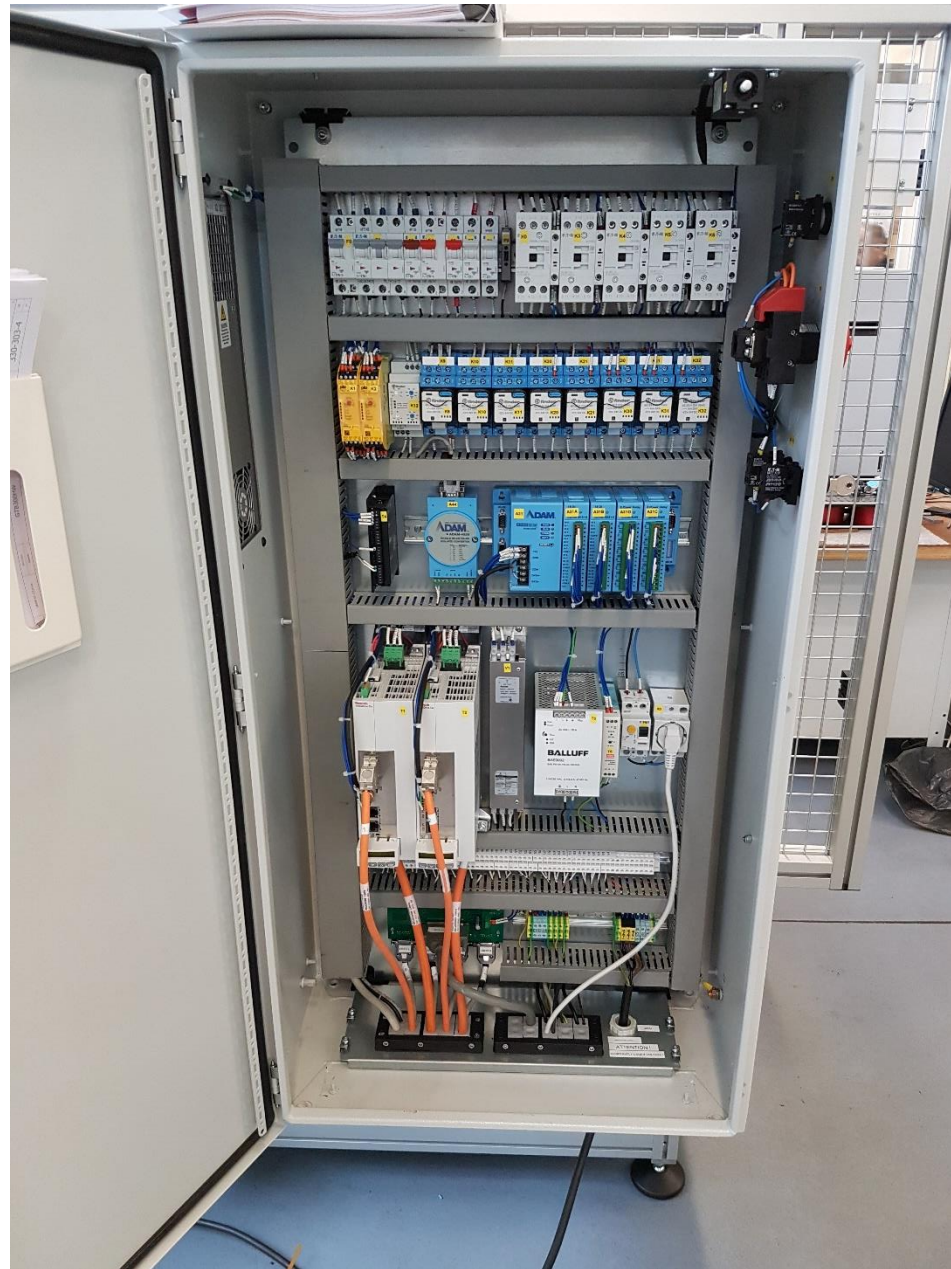


INSPECTION OF ROTARY TABLE ACCURACY

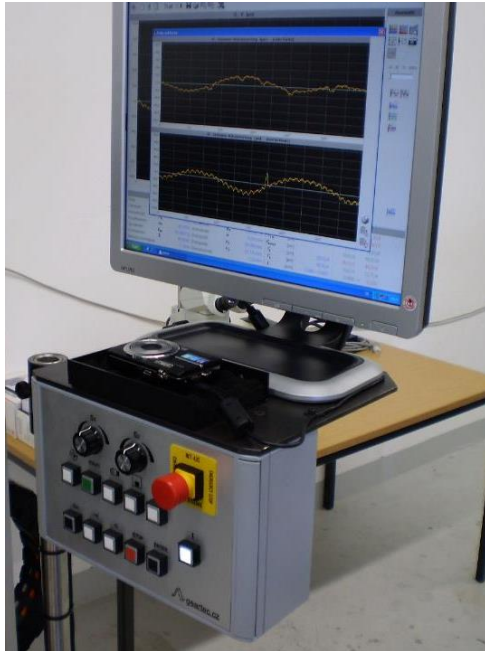


WIRING BOX

- Complete wiring box
- Quality products of EATON, SICK, PILZ ...
- Air-conditioned, artificial LED light



MANUAL PANEL



- Knob for continuous regulation of motor revolutions in manual mode
- TOTAL STOP button
- Most of functionalities can be controlled on the panel

THANK YOU FOR YOUR ATTENTION

