



The Faculty of Civil Engineering,
University of Belgrade

DETERMINING TEMPERATURE DEPENDENCE OF COLLIMATION ERROR OF DIGITAL LEVEL LEICA DNA 03

Jelena GUČEVIĆ, Siniša DELČEV, Vukan OGRIZOVIĆ



Metrological Laboratory for Angle and
Length Calibration, ML160

1



2

Content

1. BASIC CHARACTERISTICS OF THE LEICA DNA 03
2. THEORETICAL POSTULATES
3. EXPERIMENT
4. CONCLUSION

3

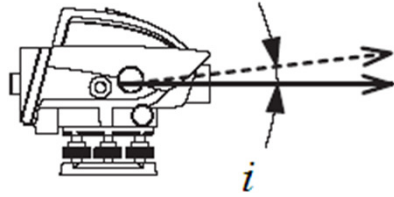
1. BASIC CHARACTERISTICS OF THE LEICA DNA 03

The technical characteristics of the level DNA-03



Electronic measurements:	
with Invar staffs	0.3 mm
with standard staffs	1.0 mm
Optical measurements	
Distance measurement (standard deviation)	2.0 mm (electr.) 1 cm/20 m (500 ppm)
Range:	
Electronic measurement	1.8 m – 110 m
Optical measurement	from 0.6 m
Electronic measurement:	
Resolution height measurement	0.01 mm
Time for single measurement	Typically 3 seconds
Telescope magnification	24x
Compensator:	
Type	Pendulum compensator with magnetic damping
Slope range	10'
Compensator setting accuracy	0.3"
Environmental conditions:	
Working temperature	-20 C to +50 C
Storage temperature	-40 C to +70 C
Humidity	95%, non condensing

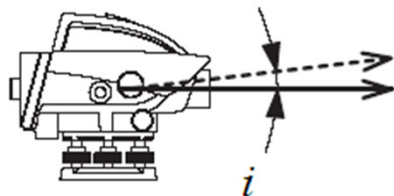
2. THEORETICAL POSTULATES



- From the centre
- Kukkamäki
- Förstner
- Näbauer

5

2. THEORETICAL POSTULATES



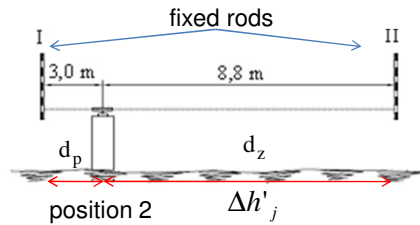
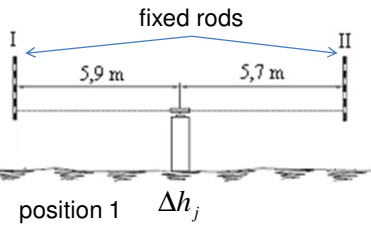
- From the centre
- Kukkamäki
- Förstner
- Näbauer



6

2. THEORETICAL POSTULATES

From the centre polygon of the Metrological Laboratory (ML160)



$$i_j = \frac{\Delta h'_j - \Delta h_j}{d_p - d_z} \rho'' , j = 1, \dots, 4$$

$$\bar{i} = \frac{\sum i_j}{4} ,$$

$$v_j = \bar{i} - i_j$$

$$\sigma_i = \sqrt{\frac{\sum v_j^2}{3 \cdot 4}} , j = 1, \dots, 4$$

$$\bar{i} \geq t_p \cdot \sigma_{\bar{i}}$$

$$\bar{i} \pm \sigma_{\bar{i}}$$

$$1 \text{ mm} \sqrt{\text{km}} \text{ is } 5''$$

7

3. EXPERIMENT

The measuring equipment



DNA-03 instrument



invar rod No. 23829

8

3. EXPERIMENT

- 10 measurements were carried out for each degree of temperature **cooling** in the range of **3°C to 25°C**
- the results of the measurements are free from gross errors
- the calculation of the angle "i" was carried out for each reading

$$i'' = \frac{\bar{X}_{t=j^\circ} - \bar{X}_{t=h^\circ}}{d} \cdot \rho''$$

$\bar{X}_{t=j^\circ}$ is the reading at the temperature, **j=3°C,... 25°C**

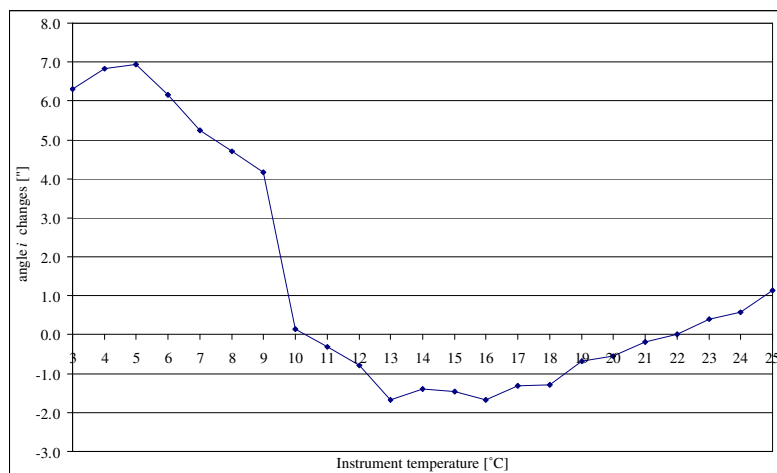
$\bar{X}_{t=h^\circ}$ is the reading at the temperature of **22°C**

d is horizontal length from the instrument to the rod.

9

3. EXPERIMENT

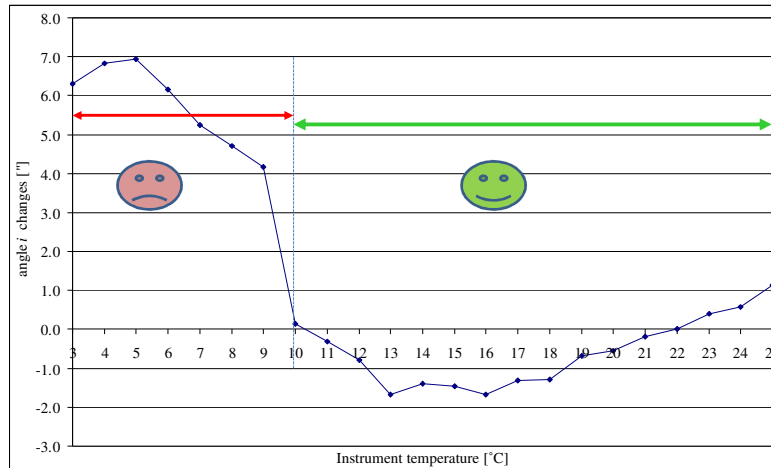
The diagram of the change, for the temperature range from 3°C to 25°C.



10

3. EXPERIMENT

The diagram of the change, for the temperature range from 3°C to 25°C.



11

3. EXPERIMENT

- 10 measurements were carried out for each degree of temperature **heating** in the range of **38°C to 28°C**
- the results of the measurements are free from gross errors
- the calculation of the angle "i" was carried out for each reading

$$i'' = \frac{\bar{X}_{t=j^\circ} - \bar{X}_{t=h^\circ}}{d} \cdot \rho''$$

$\bar{X}_{t=j^\circ}$ is the reading at the temperature, **j=38°C,... 28°C**

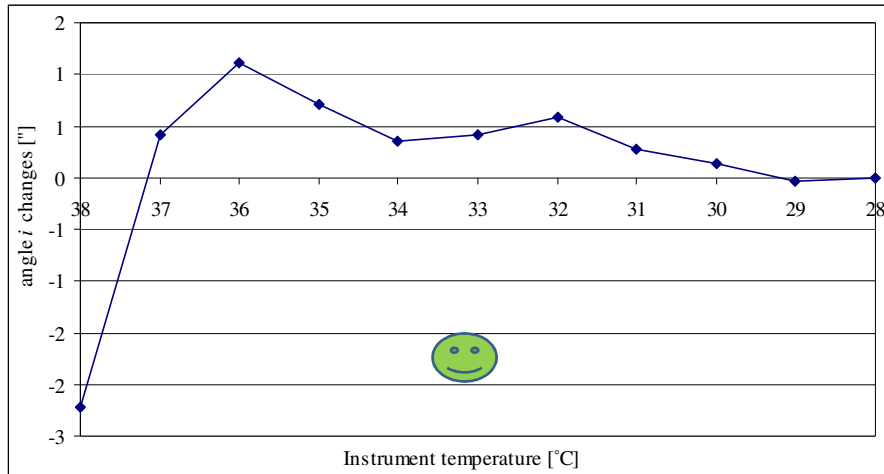
$\bar{X}_{t=h^\circ}$ is the reading at the temperature of **28°C**

d is horizontal length from the instrument to the rod.

12

3. EXPERIMENT

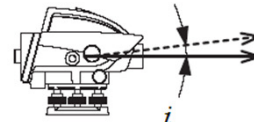
The diagram of the change, for the temperature range from 38°C to 28°C.



13



4. CONCLUSION



- Leica DNA 03 level is the instrument of modern design that largely facilitates the work of geodetic professionals.
- The change of the collimation error ranging from +10°C to +40°C is not significant.
- At the temperatures under +10°C there are significant changes of the collimation error *i* and their values should be considered.
- While working at low temperatures (up to -20°C), the value of the collimation error should be specially determined so that corrections could be entered into the measurement results.

The technical characteristics of the level DNA-03

Environmental conditions:	
Working temperature	-20 C to +50 C
Storage temperature	-40 C to +70 C
Humidity	95%, non condensing

14

Thank you all for listening!

Jelena GUČEVIĆ, Siniša DELČEV, Vukan OGRIZOVIĆ



15