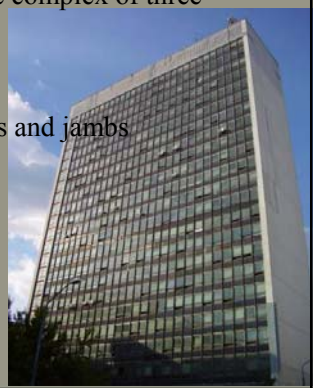
Monitoring of High-Rise Building

A. Kopáčik, A. Hostinová

SLOVENSKÁ TECHNICKÁ UNIVERZITA V BRATISLAVE
Stavebná fakulta
SLOVAK UNIVERSITY OF TECHNOLOGY IN BRATISLAVA
Faculty of Civil Engineering

Description of the measured structure

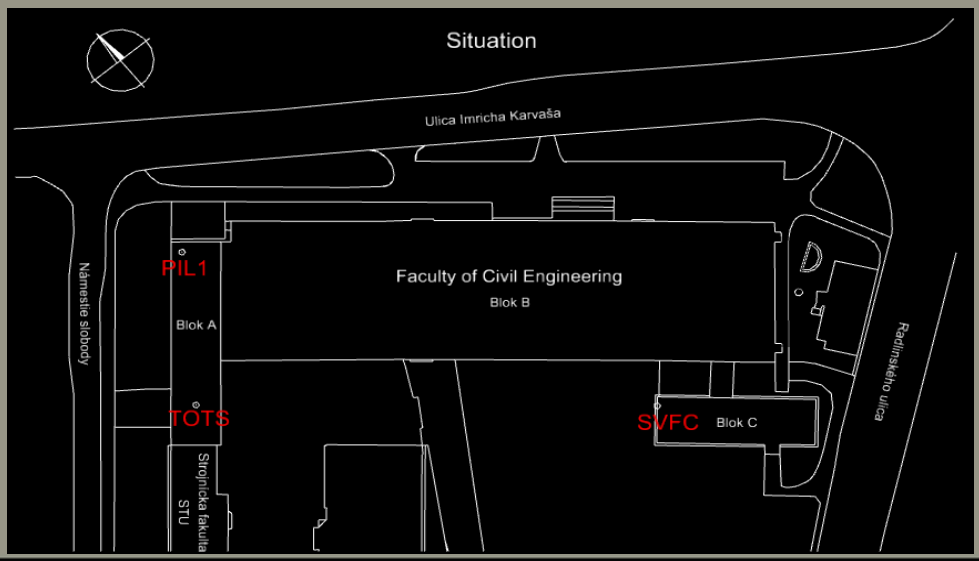
- administrative high-rise building of the Faculty of Civil Engineering of the SUT in Bratislava is one (block C) from the complex of three buildings, in which resides the FCE SUT,
- building has 24 above ground floors,
- its structure is created from ferro concreted walls and jambs completed with brick stall,
- entire high of the building is 76,42 m



Basic description of the experiment

from 3:30 pm CET 2. 3. 2007 to 3:30 pm CET 3. 3. 2007

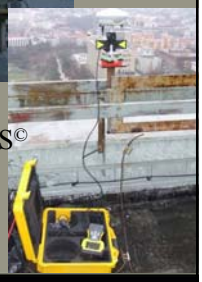
Monitoring system consists of :
- GNSS receiver and antenna Trimble R8,
- Robotic universal measuring station (UMS) Leica TCA 1101 with special prism,
- Two inclinometers Libela 2800 with I/O devices AE 2 DN,
- Measuring amplifier HBM Spider 8,
- Digital thermometers GREISINGER GFTH 200 and GPB 1300,
- Personal computer (PC) .



Two technologies of monitoring

-by **UMS Leica TCA 1101**

-by **GNSS receiver Trimble R8**



Two variants of reference station
- var. N1 - exploitation of permanent GNSS network – *SK*POS©
- var. N2 - exploitation of own reference station

Analysed time series

Variant	Recording frequency	Beginning of time series	End of time series
Variant N.1 (*SK*POS©)	10 min	15:30:00 2.3.2007	15:30:00 3.3.2007
	1 s	17:00:00 2.3.2007	18:00:00 2.3.2007
	1 s	6:00:00 3.3.2007	7:00:00 3.3.2007
Variant N.2 (own ref. station)	10 min	15:30:00 2.3.2007	15:30:00 3.3.2007
	1 s	17:00:00 2.3.2007	18:00:00 2.3.2007
	1 s	6:00:00 3.3.2007	7:00:00 3.3.2007

Data processing

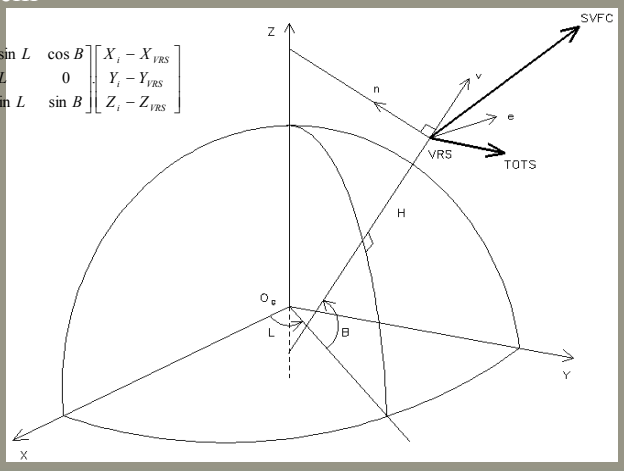
Leica Geo Office

- Transformation from the geodetic Cartesian system to local topocentric system

- Transformation from the local topocentric coordinates n, e to coordinates x, y

Transformation from the geodetic Cartesian system to local topocentric system

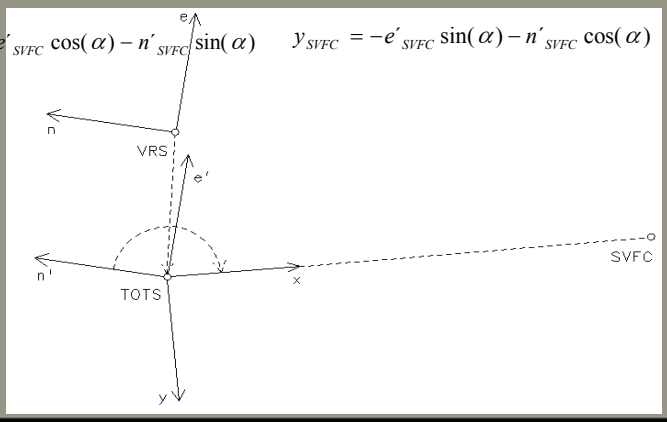
$$\begin{bmatrix} n \\ e \\ v \end{bmatrix} = \begin{bmatrix} -\sin B \cos L & -\sin B \sin L & \cos B \\ -\sin L & \cos L & 0 \\ \cos B \cos L & \cos B \sin L & \sin B \end{bmatrix} \begin{bmatrix} X_i - X_{VRS} \\ Y_i - Y_{VRS} \\ Z_i - Z_{VRS} \end{bmatrix}$$



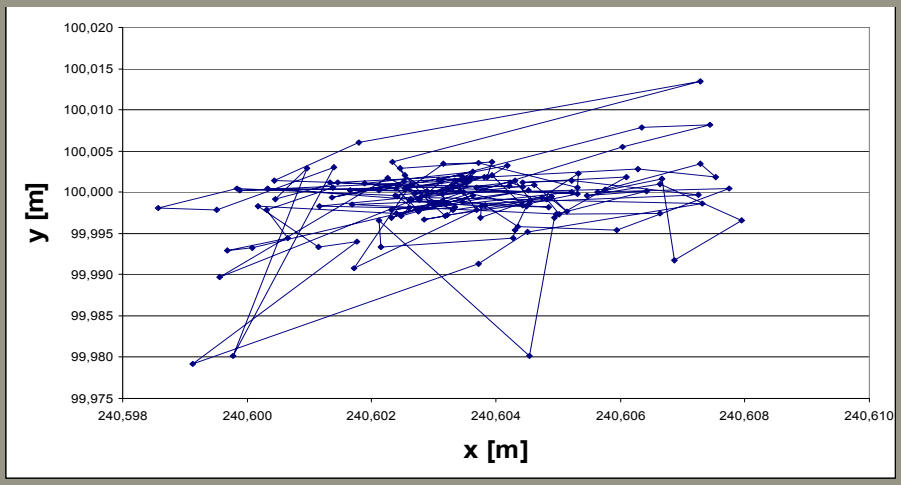
Transformation from the local topocentric coordinates n, e to coordinates x, y

shift $n' = n_{SVFC} - n_{TOTS}$ $e' = e_{SVFC} - e_{TOTS}$

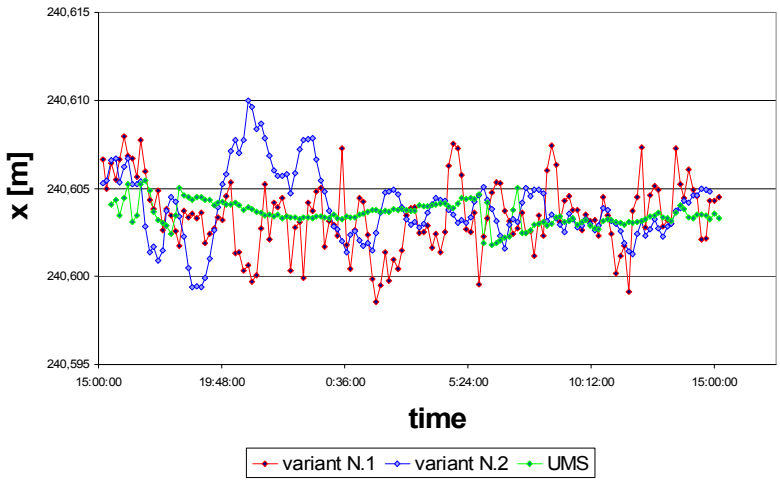
rotation $x_{SVFC} = e'_{SVFC}\cos(\alpha) - n'_{SVFC}\sin(\alpha)$ $y_{SVFC} = -e'_{SVFC}\sin(\alpha) - n'_{SVFC}\cos(\alpha)$



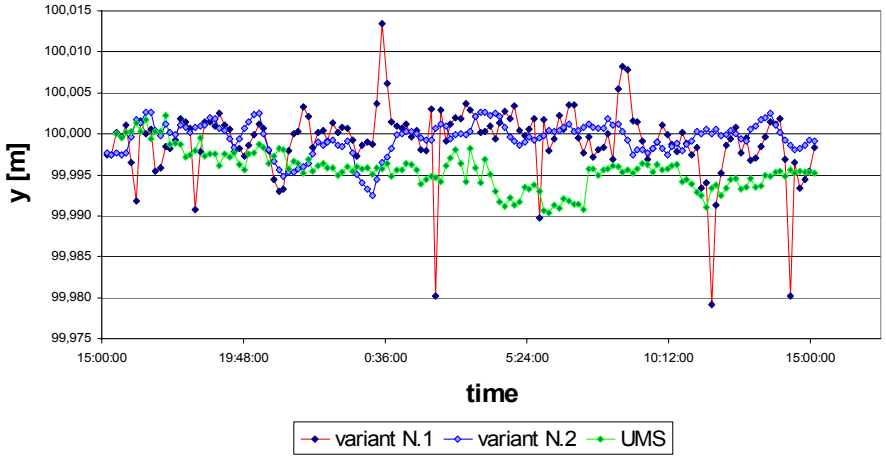
24-hours measurement

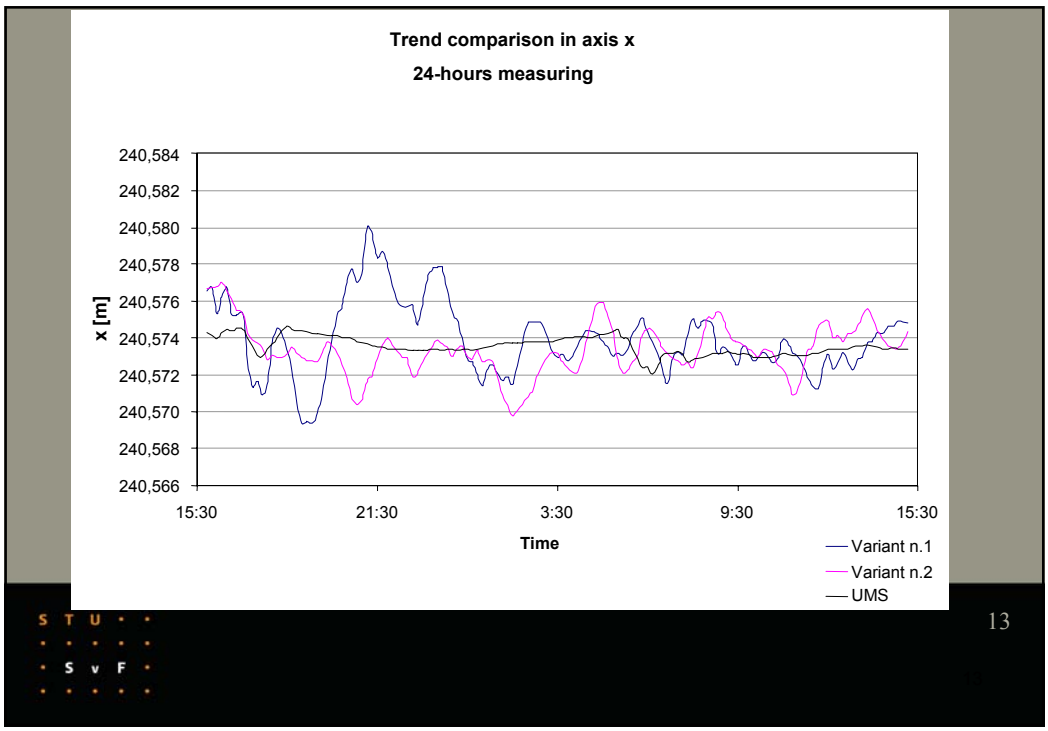


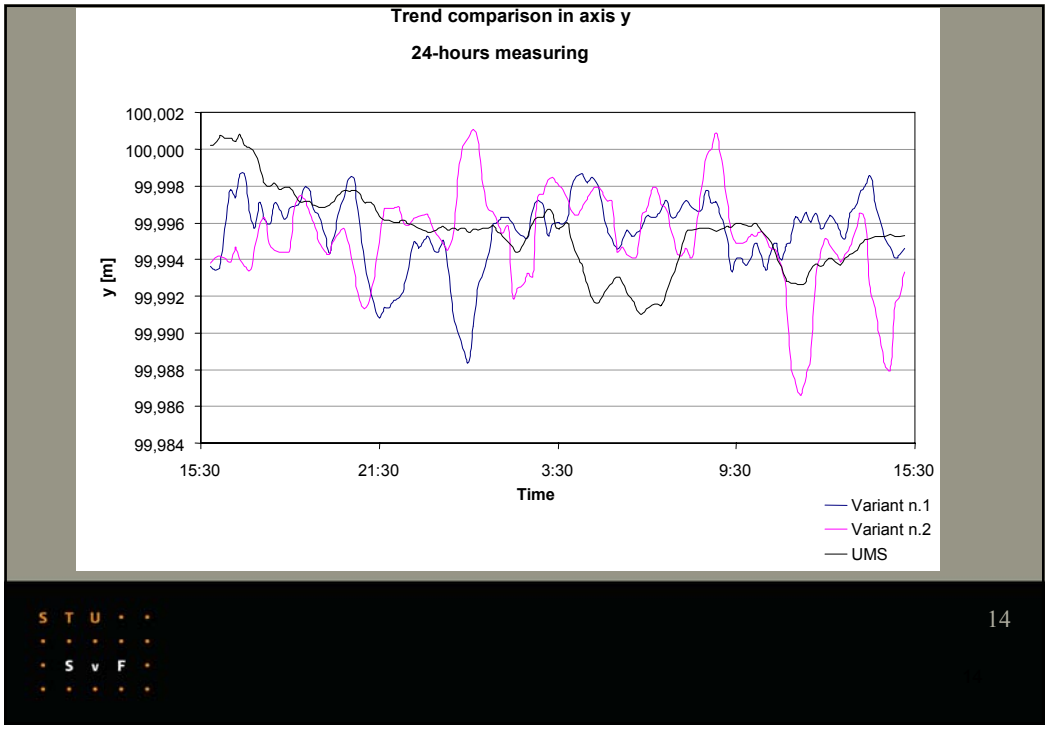
Graphical representation of initial time series

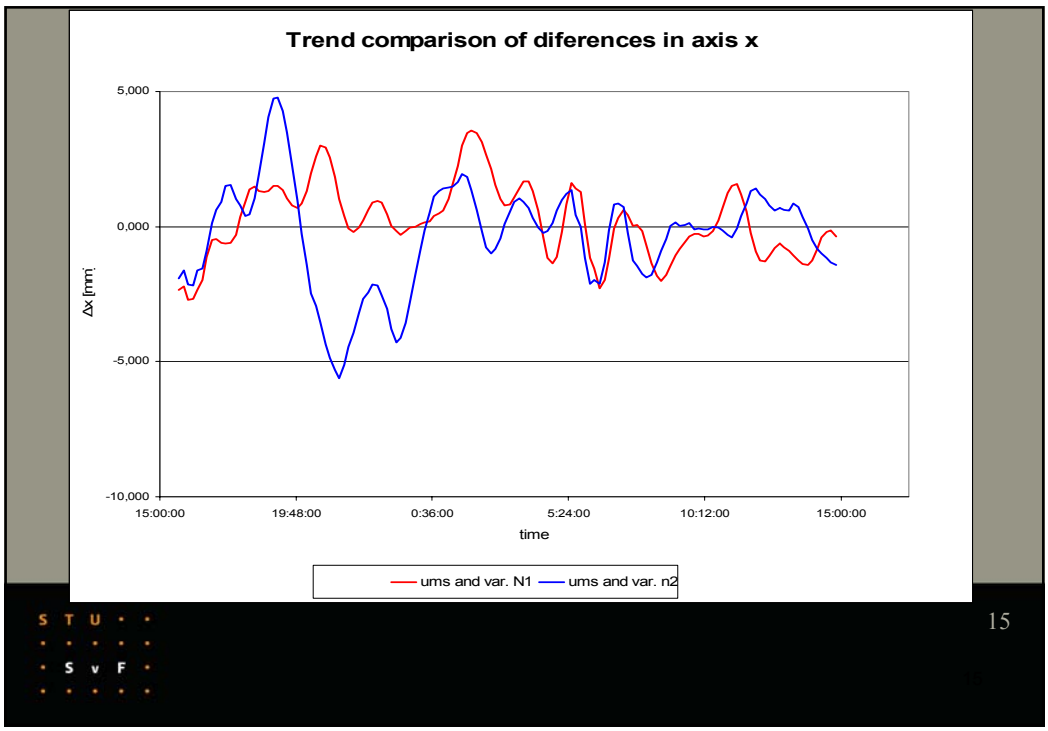


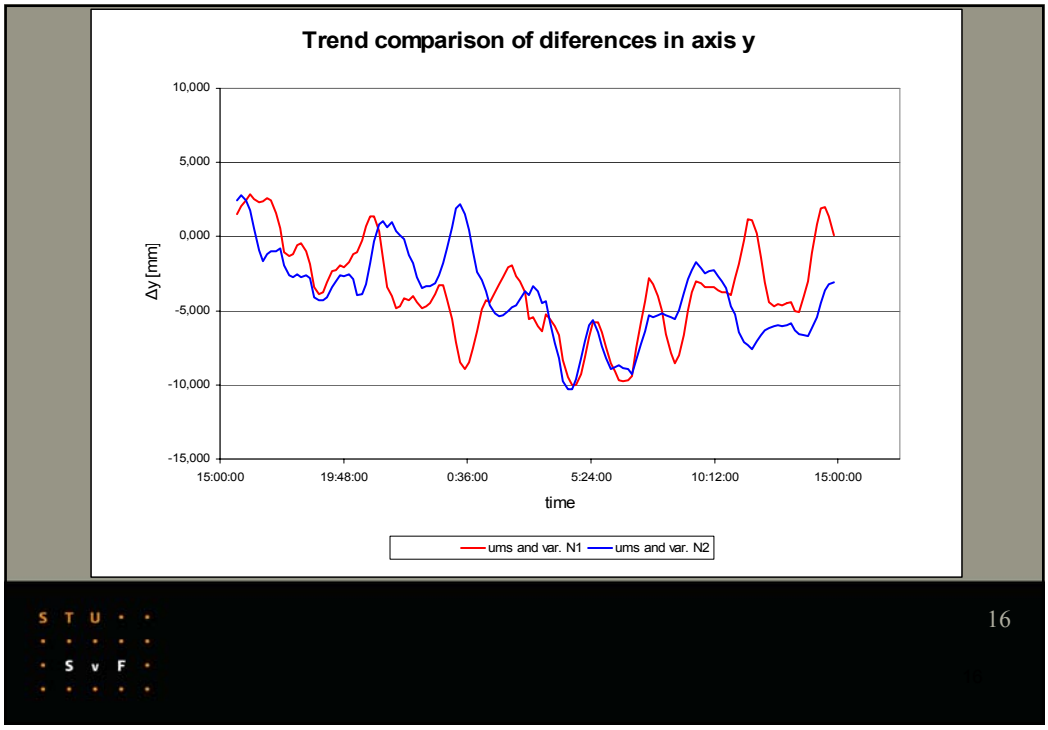
Graphical representation of initial time series




Trend comparison in axis x
24-hours measuring
240,584
240,582
240,580
240,578
240,576
240,574
240,572
240,570
240,568
240,566
x [m]
15:30
21:30
3:30
9:30
15:30
Time
Variant n.1
Variant n.2
UMS


Trend comparison in axis y
24-hours measuring
100,002
100,000
99,998
99,996
99,994
99,992
99,990
99,988
99,986
99,984
y [m]
15:30
21:30
3:30
9:30
15:30
Time
Variant n.1
Variant n.2
UMS


Trend comparison of diferences in axis x
5,000
0,000
-5,000
-10,000
Δx [mm]
15:00:00
19:48:00
0:36:00
5:24:00
10:12:00
15:00:00
time
ums and var. N1
ums and var. n2


Trend comparison of diferences in axis y
10,000
5,000
0,000
-5,000
-10,000
-15,000
Δy [mm]
15:00:00
19:48:00
0:36:00
5:24:00
10:12:00
15:00:00
time
ums and var. N1
ums and var. N2

Fisher test

Variant	Time interval	Length of time series	Coordinate	Superior standard deviation **s** [mm]			Appeared the most significant period	Fisher test (for α=0,01)		
				Time series				Test. statistics	Critical value	Zero hypothesis
				Initial	After trend elimination	After cyclical element elimination	**T**	**W**	g_F	$Y_t=\varepsilon_t$
N1	10 min	24 h	x	2,9	2,2	-	36 min	0,092	0,123	don't´t refused
			y	3,1	2,4	30.10^{-6}	37 min	0,132	0,123	refused
	1s	1 h (6:00 - 7:00)	x	3,5	0,1	1.10^{-6}	47 s	0,009	0,007	refused
			y	4,0	1,8	1.10^{-6}	56 s	0,009	0,007	refused
	1s	1 h (17:00 - 18:00)	x	4,8	1,9	1.10^{-6}	59 s	0,012	0,007	refused
			y	5,3	2,3	1.10^{-6}	54 s	0,012	0,007	refused
N2	10 min	24 h	x	2,0	1,2	-	40 min	0,095	0,123	don't´t refused
			y	4,2	3,0	-	40 min	0,106	0,123	don't´t refused
	1s	1 h (6:00 - 7:00)	x	2,0	1,3	1.10^{-6}	29 s	0,010	0,007	refused
			y	4,0	2,5	1.10^{-6}	24 s	0,017	0,007	refused
	1s	1 h (17:00 - 18:00)	x	2,4	1,6	1.10^{-6}	36 s	0,009	0,007	refused
			y	3,4	2,0	1.10^{-6}	60 s	0,010	0,007	refused

Conclusion

Variant N.1 (permanent station)
- 11 mm in axis x
- 13 mm in axis y

Variant N.2 (own reference station)
- 7 mm in axis x
- 14 mm in axis y

} standard deviation 1-3 mm

UMS
- 3 mm in axis x
- 10 mm in axis y

} standard deviation 1mm

Thank you for your attention

Univ.-Prof. hab. Alojz Kopáčik, PhD., Ing. Anna Hostinová
Department of Surveying, SUT Bratislava
Radlinského 11
Bratislava
SLOVAKIA
Tel. +421 2 5927 4391
Fax + 421 2 5296 7027
Email: alojz.kopacik@stuba.sk, anna.hostinova@stuba.sk
Web site: www.stuba.sk

SLOVENSKÁ TECHNICKÁ UNIVERZITA V BRATISLAVE
Stavebná fakulta
SLOVAK UNIVERSITY OF TECHNOLOGY IN BRATISLAVA
Faculty of Civil Engineering

Invitation to

4th International Conference on Engineering Surveying

INGEO 2008

October, 23-24, 2008
Hotel Holiday Inn, Bratislava, Slovakia

http://web.svf.stuba.sk/kat/GDE/Ingeo2008/Ingeo.html

4th International Conference on Engineering Surveying

INGEO 2008

October, 23-24, 2008 Bratislava, Slovakia

Topics of the conference

- present-day problems of engineering surveying,
- methods and technologies, trends in development of engineering surveying,
- engineering surveying procedures for industry (power plants, nuclear facilities, etc.)
- industrial metrology in production, assembling and finishing processes, in-situ calibration of used technology
- lasers and laser measurement systems, with special emphasis on terrestrial laser scanning
- new technology for deformation measurement,
- new techniques for as-built documentation and facility inventory,
- data integration in facility management, exchange, provision and presentation of facility management data in computer networks,
- industrial and city information systems.

STU SvF

http://web.svf.stuba.sk/kat/GDE/Ingeo2008/Ingeo.html