Some Calibration Results of Digital Levelling Systems

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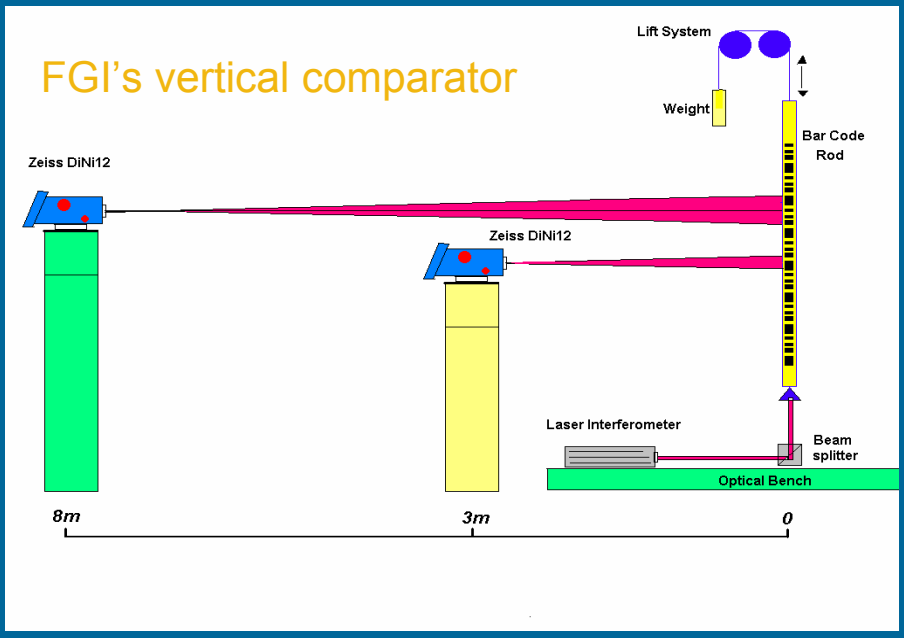
Role of Calibration

- Modern precise levelling: digital level and bar code invar rod together form height measuring system.
- Quality of calibration sets the limit to performance of levelling equipment.
- In laboratory we should test system with wide range of temperatures.

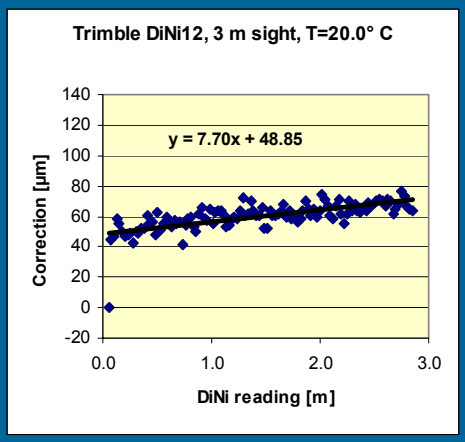
Background

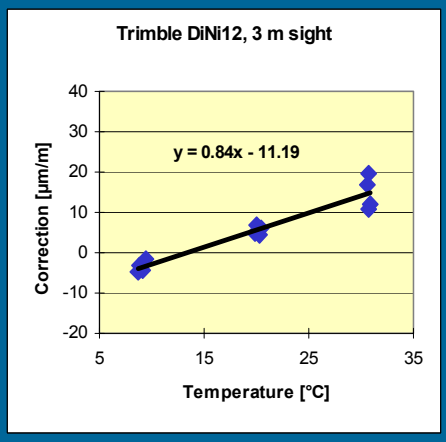
- For traditional levelling only rod calibration is needed.
- With digital levelling rod calibration is replaced or supplemented by system calibration.
- Digital level may have its own scale and temperature behaviour.
- Trimble and Leica systems were studied in FGI's vertical comparator 2006-2008.

FGI's vertical comparator



System calibration data



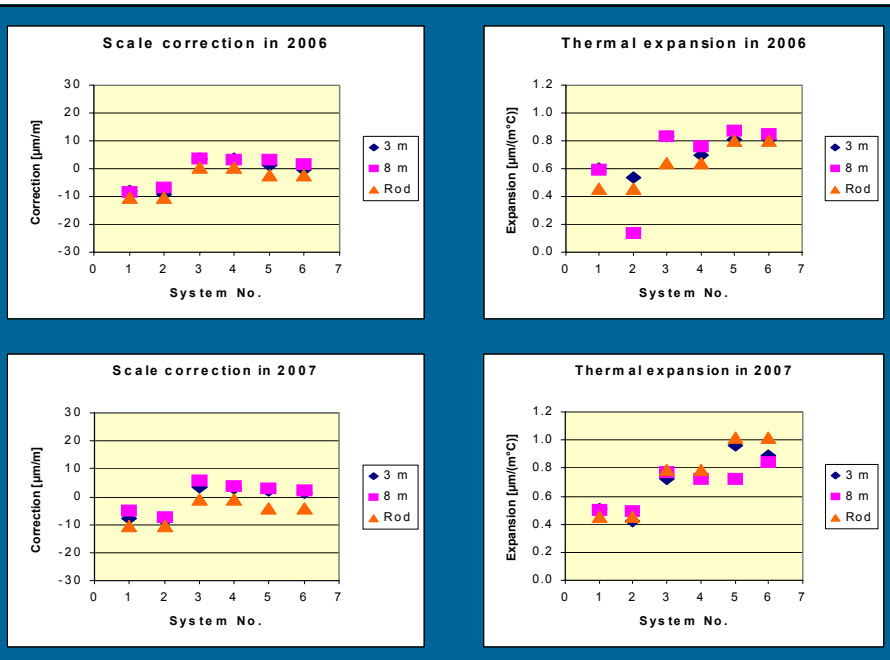


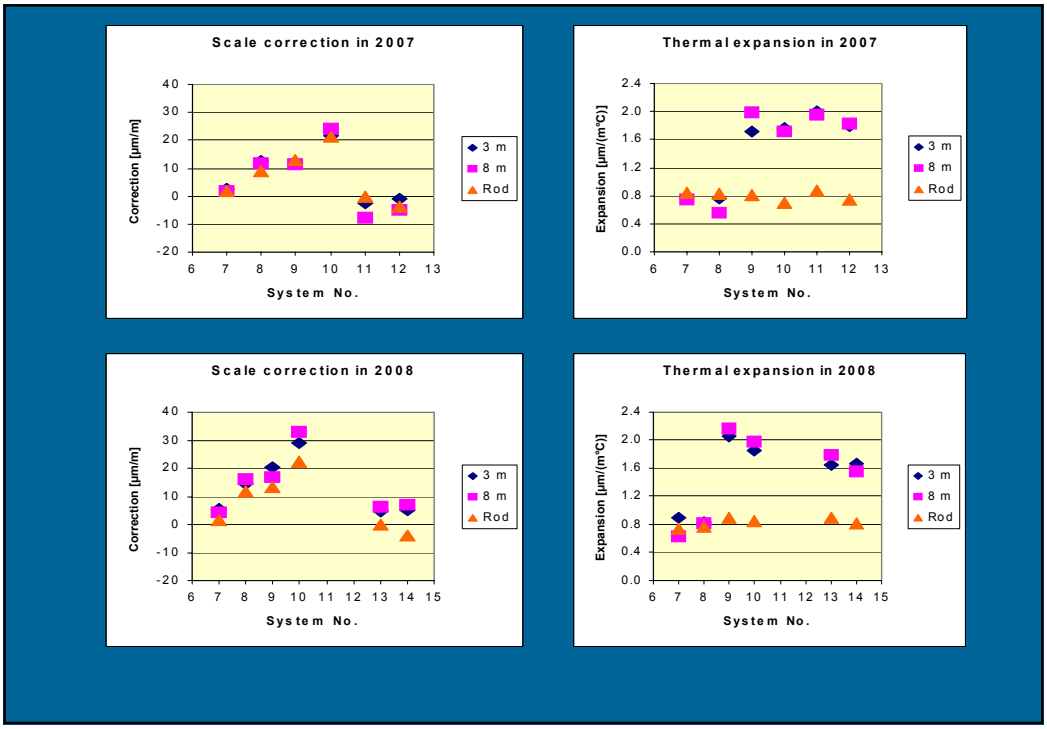
Calibration parameters

- **$L = L_O * [A + B (T-20)]$** , where
- L is corrected reading,
- L_O observed reading,
- A correction factor of scale, it is 1 + scale correction in temperature of 20° C,
- B thermal expansion coefficient, ~ 10^{-6} [1/°C]
- T ambient temperature [° C].

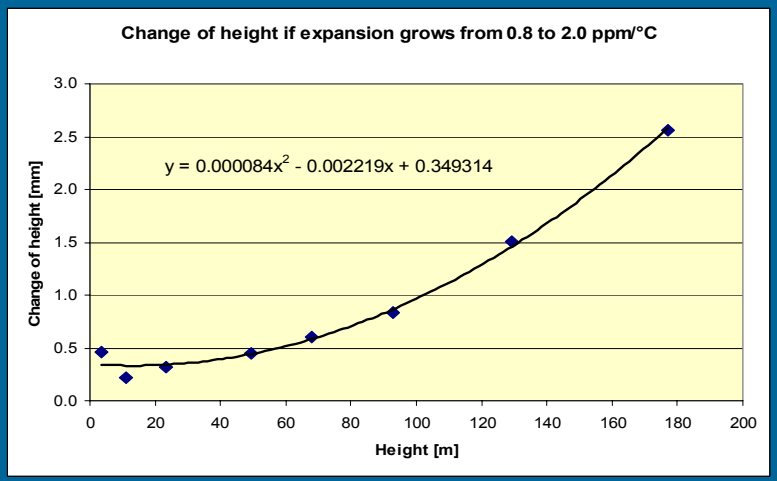
Levels and rods

System	Level	No.	Rod	No.	Year
1	Trimble DiNi12	701742	LD13	10803	2006, 2007
2	Trimble DiNi12	701743	LD13	10803	2006, 2007
3	Trimble DiNi12	701742	LD13	14605	2006, 2007
4	Trimble DiNi12	701743	LD13	14605	2006, 2007
5	Trimble DiNi12	701742	LD13	14620	2006, 2007
6	Trimble DiNi12	701743	LD13	14620	2006, 2007
7	Trimble DiNi12	320204	LD13	13815	2007, 2008
8	Trimble DiNi12	320204	LD13	13830	2007, 2008
9	Leica NA3000	89687	GPCL3	27961	2007, 2008
10	Leica NA3000	89687	GPCL3	9543	2007, 2008
11	Leica NA3000	90848	GPCL3	26484	2007
12	Leica NA3000	90848	GPCL3	28870	2007
13	Leica NA3003	93475	GPCL3	26484	2008
14	Leica NA3003	93475	GPCL3	28870	2008





Propagation of error



Conclusions

- Our tests show that the accuracy of system calibration is satisfactory (3-5 ppm).
- Small systematic error ~ 1 µm/(m °C) of thermal expansion may cause several millimetres error when height difference is hundreds of meters.
- System + rod calibration = “total calibration” gives tool to figure out how level and rod work

Thank you!

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