

Field Procedures for Testing Terrestrial Laser Scanners (TLS) – A contribution to a future ISO standard

Reinhard GOTTWALD, Switzerland

- **Test Procedures for TLS ?**
- **ISO17123 – Structure & Basic Philosophy**
- **A Contribution to a new ISO Standard ‘TLS’**
 - Simplified Test Procedures
 - Full Test Procedures
- **Conclusions & Recommendations**
- **Special thanks**

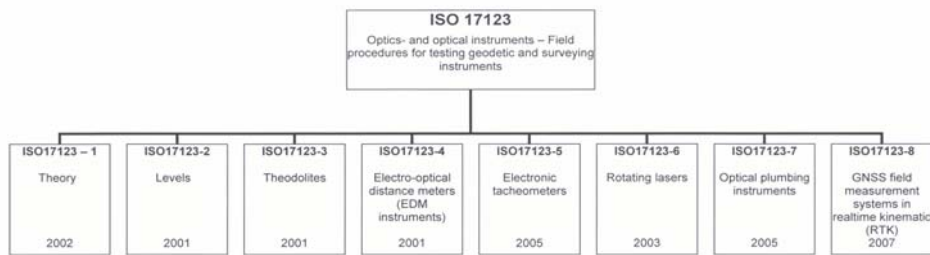
• **Existing & published Test Procedures for TLS**

- prove the limits and metrological particularities of TLS
- show valuable perceptions for the practical use of TLS
- are more or less time-consuming
- are hardly suitable for a simple and quick system test by the user on site

• **Fields Test Procedures for TLS should**

- prove the performance of TLS within the given specifications
- be performed quickly and easily on site
- need no special test equipment
- follow the ISO 17123 basic philosophy

ISO 17123



Simplified test procedures

- (much) reduced time consumption for measurements and evaluation
- the special test equipment used are standard deviations are significant for the
- evaluation of standard deviations are based on a small sample size
- significant deviations are allowed

ISO 17123_9 ?

Simplified test procedures (focus)

Following the ISO 17123 basic philosophy, these boundary conditions were given for the development of possible simplified test scenarios for TLS:

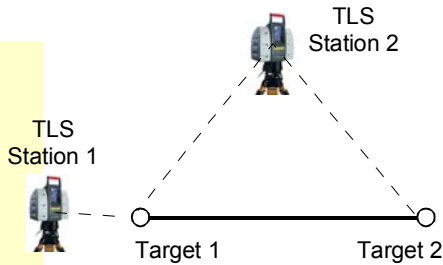
- independent of the functional principle (panoramic-, camera-view-, time of flight-, phase measurement-TLS)
- secure detection of distance and/or angle deviations
- use of standard measurement equipment only (i.e. no use of additional reference sensors, e.g. total station or special test equipment)
- maximum time needed for measurements, evaluation and final decision less than 1 hour

Simplified test procedures

- the given boundary conditions have to be fulfilled
- test measurements were carried out with
Leica ScanStation 2
Leica HDS6000
Leica ScanStation 2 (not calibrated)
- tolerances are calculated to a point accuracy of 4.0 mm for a scanned target at a significance level of $S = 99\%$

Simplified test procedures for TLS - test scenarios

Single Distance Procedure (SDP)



Set up test line 1 – 2; distance 1 – 2 according to the desired range (SDP1: 1 – 2 nearly horizontal; SDP2: 1 – 2 with a significant height difference)

TLS in station 1 in line with target 1 and 2; measure targets 1 and 2 (setup 1)

TLS in station 2 perpendicular to line 1 – 2; measure targets 1 and 2 (setup 2)

Simplified test procedures for TLS - test scenarios

Single Distance Procedure (SDP)

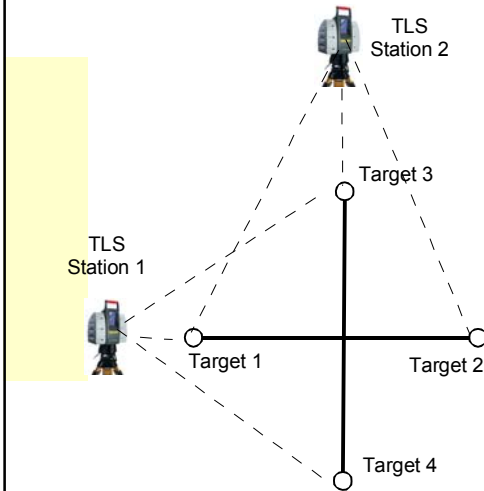
Procedure	TLS	Line	TLS Station 1 [m]	TLS Station 2 [m]	$\Delta=S1-S2$ [mm]	Tolerance S=99% [mm]	Reference TCRP1201 [m]
SDP1	SS2	1-2	44.198	44.199	-1	14	44.203
SDP2	SS2	1-2	44.900	44.899	1	14	44.905
Total time required	< 60 min						

- + independent of the functional principle; use of standard measurement equipment only; easy to perform; total time required < 60 minutes
- no redundancy; no independent control

TLS SS2 - Leica ScanStation2
6000 - Leica HDS6000
SS2nc - Leica ScanStation2 (not calibrated)

Simplified test procedures for TLS - test scenarios

Crossed Double Distance Procedure (CDP)



Set up two perpendicular test lines (1 - 2, 3 - 4); distances according to the desired range (CDP1: targets 1 - 4 in a nearly horizontal plane; CDP2: target 2 or 4 at a significantly different height than the other 3 targets)

TLS in station 1 in line with target 1 and 2; measure targets 1 - 4 (setup 1)

TLS in station 2 in line with target 3 and 4; measure targets 1 - 4 (setup 2)

Simplified test procedures for TLS - test scenarios

Crossed Double Distance Procedure (CDP)

Procedure	TLS	Line	TLS Station 1 [m]	TLS Station 2 [m]	$\Delta=S1-S2$ [mm]	Tolerance S=99% [mm]	Reference TCRP1201 [m]
CDP2	SS2	1-2	43.046	43.046	0	14	43.049
		3-4	43.078	43.081	3		43.083
	6000	1-2	43.050	43.048	2	14	43.049
		3-4	43.083	43.083	2		47.481
	SS2nc	1-2	42.812	42.724	88	14	42.925
		3-4	43.006	47.905	299		43.028
Total time	≈60 min						

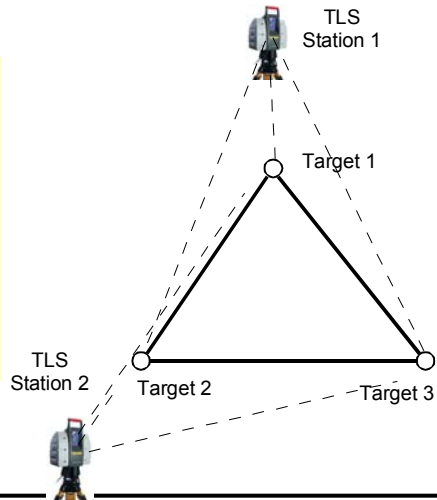
+ independent of the functional principle; use of standard measurement equipment only; easy to perform; total time required ≈ 60 minutes, independent control

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TLS SS2 - Leica ScanStation2
6000 - Leica HDS6000
SS2nc - Leica ScanStation2 (not calibrated)

Simplified test procedures for TLS - test scenarios

Triangle Procedure (TP)



Set up three targets in a nearly equilateral triangle; distances according to the desired range; (one of the corner points should be at a significantly different height = TP2)

TLS in station 1; measure targets 1 – 3 (setup 1)

TLS in station 2; measure targets 1 – 3 (setup 2)

Simplified test procedures for TLS - Suggestions

Triangle Procedure (TP)

Procedure	TLS	Line	TLS Station 1 [m]	TLS Station 2 [m]	$\Delta=S1-S2$ [mm]	Tolerance S=99% [mm]	Reference TCRP1201 [m]
TP2	SS2	1-2	45.595	45.598	-3	14	45.597
		2-3	45.078	45.081	0		45.083
		3-1	36.058	36.059	1		36.062
	6000	1-2	45.599	45.598	1	14	45.597
		2-3	45.085	45.088	2		45.083
		3-1	36.062	36.060	6		36.062
	SS2nc	1-2	42.674	42.671	3	14	42.787
		2-3	45.006	47.903	297		45.026
		3-1	36.286	36.736	-795		36.936
Total time	≈60 min						

+ independent of the functional principle; use of standard measurement equipment only; easy to perform; total time required ≈ 60 minutes, independent control

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 TLS SS2 - Leica ScanStation2
 6000 - Leica HDS6000
 SS2nc - Leica ScanStation2 (not calibrated)

Full test procedures for TLS

The following boundary conditions are given for a full test procedure for TLS:

- more or less independent of the functional principle of the tested TLS
- use of reference sensor systems and/or fixed test setups is possible
- significant evaluation of accuracy und systematic deviations based on statistical processes
- maximum time needed for measurements, evaluation and final decisions less than ½ day

Full test procedures for TLS

The most important parameters to be determined are:

- probing error
- spacing error
- flatness measurement error
- target error
- angle measurement deviation
- zero point error (range finder)
- scaling error (range finder)
- target offsets and sphere diameter

Full test procedures for TLS

It is suggested that a modular approach be used to enable also scanner-specific tests.

Basic module

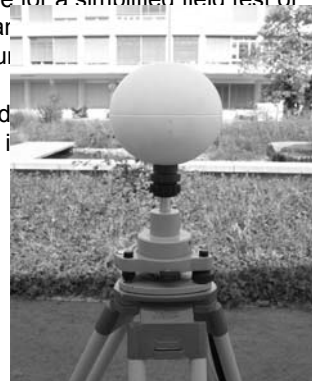
- use of a specific 3D test net
- covers the determination of the following deviations:
probing error, spacing error, target error, angle measurement deviation

Add-on modules

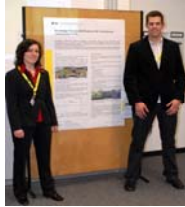
- covering the characteristics of specific scanner types and TLS sensor components
- determination of test parameters which are not covered by the basic module

Conclusion & Recommendations

- It is possible to set up suitable simplified and full test procedures for TLS following the ISO17123 basic philosophy
- It is favorable to use sphere targets instead of plane targets
- Both multiline-procedures (CDP, TP) are suitable for a simplified field test of TLS (preferable use setup CDP2 with a significant number of targets)
- Use a modular approach for the full test procedure and include it as a separate module in an ISO standard
- Test procedures based on the new ISO standard should be implemented then by the system manufacturers



Special thanks to ...



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