




**HCU** HafenCity Universität  
Hamburg

Universität für Baukunst  
und Raumentwicklung

**HAMBURGS NEUE UNIVERSITÄT**  
Europas erste Hochschule für die gebaute Umwelt

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**Geometrical Building Inspection by  
Terrestrial Laser Scanning**



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**Outline of Presentation**

- Introduction
- Terrestrial Laser Scanning System Trimble GS100
- Water Tower - Geometrical Inspection of Elements
- Underground Tunnel - Positioning of Elements
- Conclusions & Outlook



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## Introduction

- Deployment of laserscanning technology since 2003
- Laserscanning in building inspection
- Derivation of geometries of buildings with the aid of laserscan data?
- Accuracy and potential?
- Experience?
- Co-operation between university and surveying companies!

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## Terrestrial Laser Scanning System Trimble GS100

### *Hardware (technical data)*

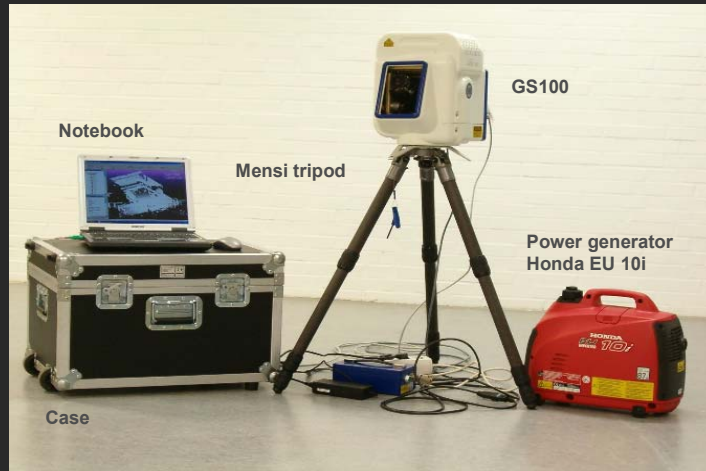
Distance measurement	Time of flight
Wave length	532nm (green)
Field of View	360°horizontal, 60° vertical
Best range	2 – 100m
Angular resolution	0,0018° (~1,6mm / 50m)
RMS single distance	6 mm
Focusable laser beam!	



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## Terrestrial Laser Scanning System Trimble GS100

### *Equipment*



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## Water Tower - determination of geometries

Cooperation partner

**SBI** Spanheimer Bornemann Ingenieure  
Beratende Ingenieure für Bauwesen und Vermessung GmbH



*Conversion of the water tower in Sternschanzenpark, Hamburg into a Möwenpick-Hotel*

*Problem: will the pre-fabricated concrete floor elements fit into the gutted interior of the tower?*

*Solution:*

*Determination of the inner geometry of the tower by laserscanning and comparison against CAD*

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## Water Tower - determination of geometries

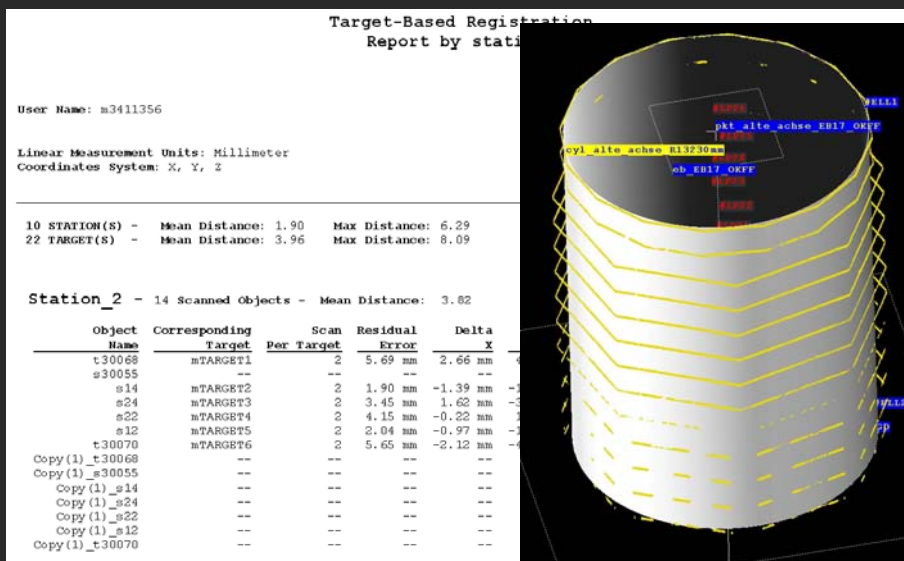


### Measurements / laserscanning:

- Laserscanning of the interior of the tower: 5 scanner positions in 2 levels
- Determination of reference points within the coordinate system of the construction site by total station (Leica TCRP1201)
- Setup of the scanner with special tripod (horizontal turning axis)

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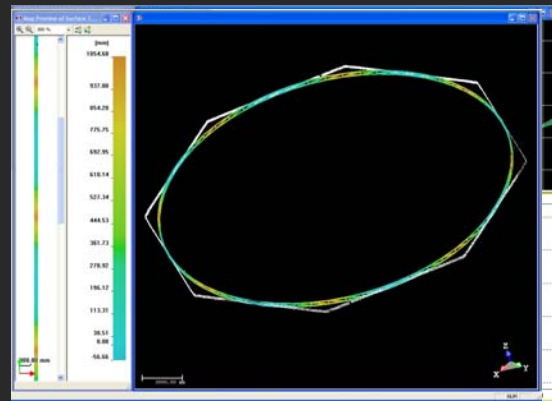
## Water Tower – determination of geometries



## Water Tower – determination of geometries

### *Data processing:*

- Import of CAD-data (floor elements) into the point cloud
- Determination of collisions
- Result: colour-coded representation of collisions

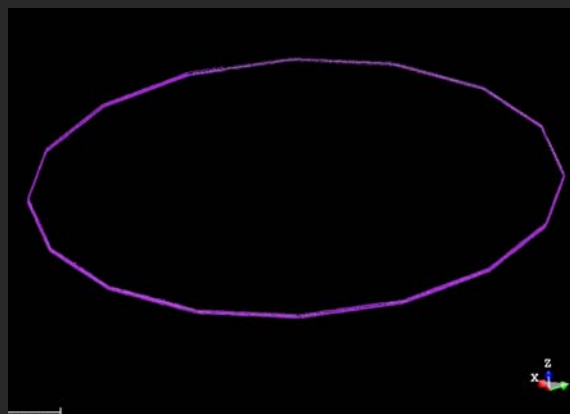


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## Water Tower – determination of geometries

### *Data processing:*

- Creation of polylines derived from scan data at the level of floors 5 – 17 for verification of CAD
- Final check after installation of floor elements



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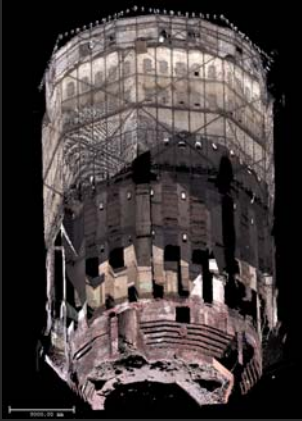


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## Water tower – determination of geometries

*Data processing time*

- Laserscanning and determination of reference points: 8 h
- Geo-referencing, determination of main axis, collision detection, generation of polylines: 5 h

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## Underground tunnel – Positioning of construction elements



Cooperation partner:

**SBI** Spanheimer Bornemann Ingenieure  
Beratende Ingenieure für Bauwesen und Vermessung GmbH

**Job:**  
*Determination of position of flange bolts*

**Problem:**  
*Leaking sealing between tunnel elements, fitting of new gasket and flange elements*

**Solution:**  
*Laserscanning of the bolts and fitting of primitives (spheres) in point cloud*

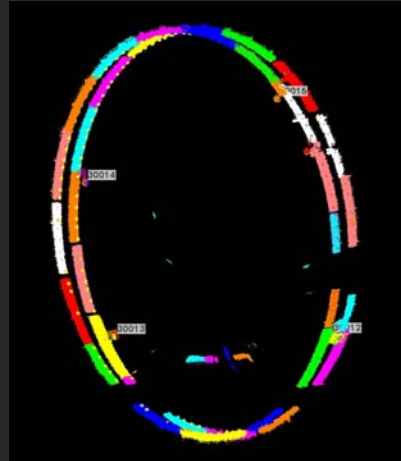



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## Underground tunnel – Positioning of construction elements

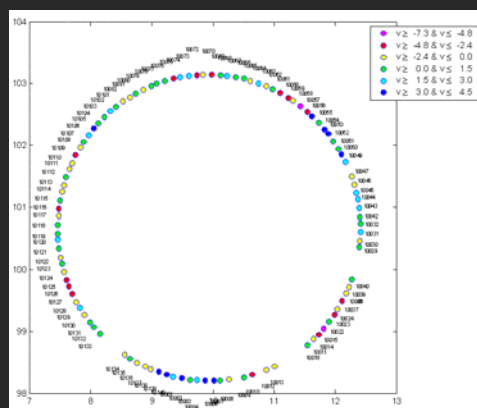
### Measurement / laserscanning:

- Laserscanning during nocturnal break (3h)
- Max. resolution of scan depends on time window
- Scanning of 214 control points
- Fitting of spheres
- Control points determined by total station



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## Underground tunnel – Positioning of construction elements



### Data processing

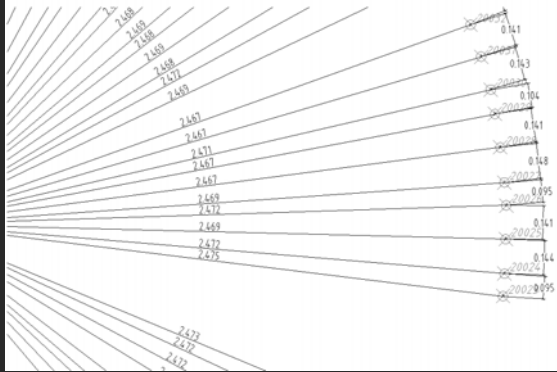
- Time used: 8h
- Determination of deviations of control points against circle and plane
- No satisfactory representation within 3Dipsos software
- colour coded representation of deviations of control points against plane in Matlab software

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## Underground tunnel – Positioning of construction elements

- Determination of coordinates x,y,z of heads of bolts within coordinate system of the tunnel
- Deviation against position determined by total station:  
Ø 3-4mm (40 points)



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## Conclusions & Outlook

- Laserscanning is an appropriate method for capturing 3D-data of objects with complex and irregular shape
- Advantage: capturing of areas instead of single points, thus many possibilities of data processing
- Achievable accuracy: +/- 3mm
- Reliable geodetic network is necessary to fulfil demands on high accuracy
- Low scanning speed when high resolution is demanded
- Multiple tools for analysis in Trimble's RealWorks Survey software
- More flexibility with "third party software" (Matlab, TerraScan)
- Request for enhanced automation in data processing (point cloud → CAD)

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# 3rd Hamburg's User Forum Terrestrial Laser Scanning

**DVW**

**DGPF**

June 16, 2009

[www.hcu-hamburg.de/geomatik/tls2009/tls\\_2009.htm](http://www.hcu-hamburg.de/geomatik/tls2009/tls_2009.htm)

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**Thank you very much  
for your attention**

[www.hcu-hamburg.de/geomatik](http://www.hcu-hamburg.de/geomatik)