Boresight alignment method for mobile laser scanning systems

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Contents

- A new principle of boresight alignment for mobile Laser scanning systems
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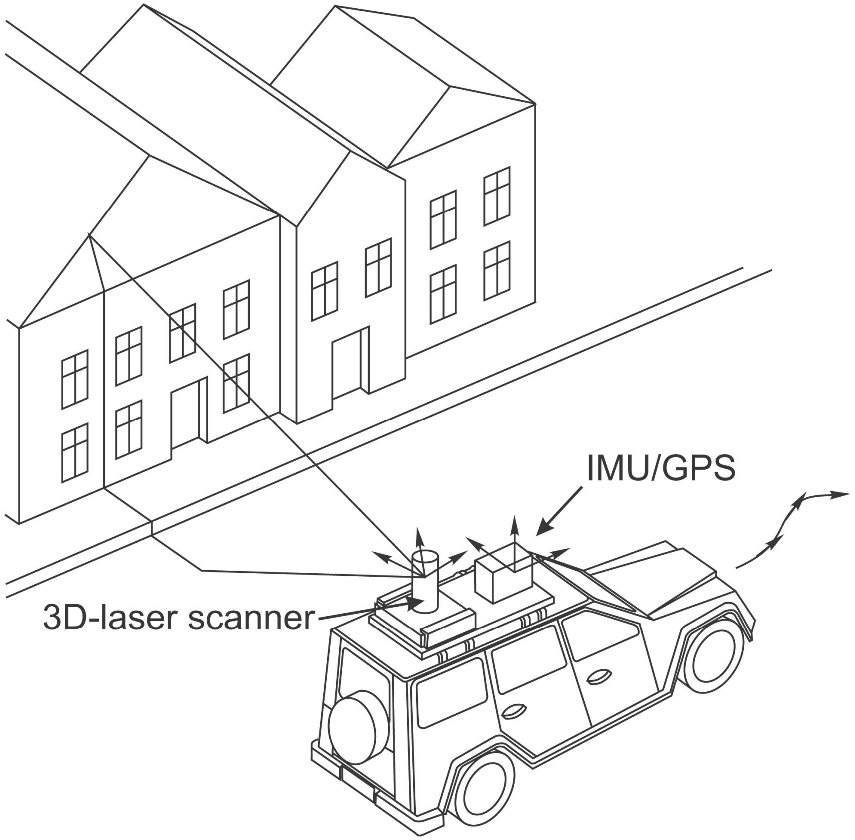
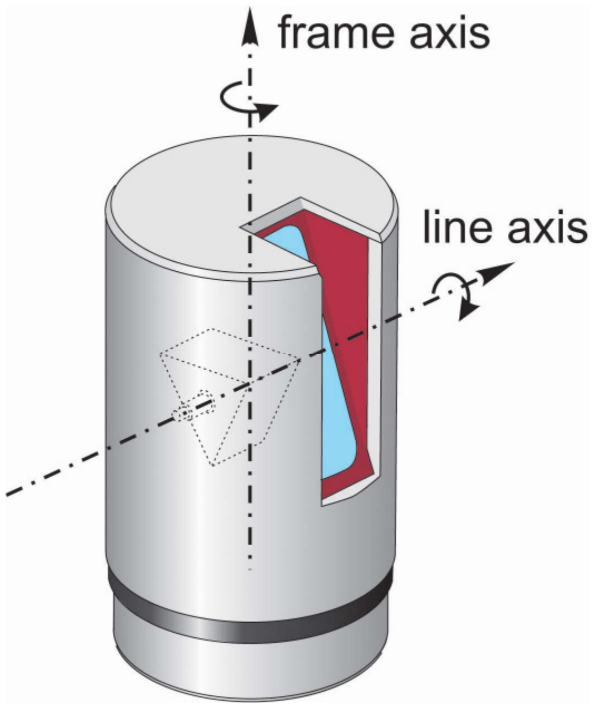
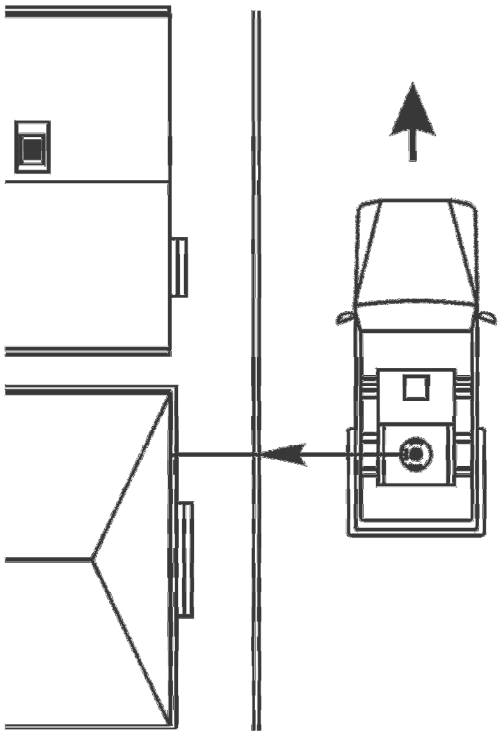




Typical configuration of a MLS system
comprising a 3D-laser scanner and a IMU/GPS sub-system



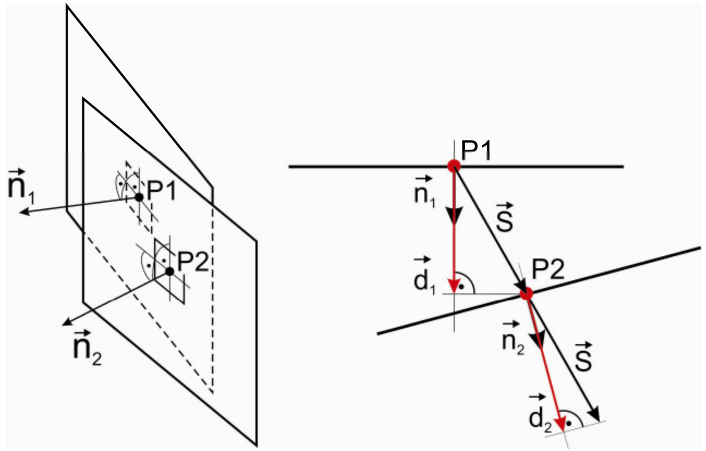
Mobile scanning of facades from different driving- and scanning directions.

$$\vec{d}_1 = (\vec{P}_2 - \vec{P}_1) \cdot \vec{n}_1$$

$$\vec{d}_2 = (\vec{P}_2 - \vec{P}_1) \cdot \vec{n}_2$$

$$\sigma = \sqrt{\frac{\sum_{i=1}^{n} \left(\frac{d_1 + d_2}{2} \right)^2}{n}}$$

Mean square residual error distance of all corresponding planar surfaces.



Planar surfaces detected inside the point cloud are represented by their location and their normal vector.

"Corresponding planar surfaces"

V-Line of 2D- and 3D laser scanners

Airborne Scanning

RIEGL VQ-480

Scan Range: • 60 deg
Laser Clock: • 200 kHz
Max. Range: • 600 m (60%)

Mobile Scanning

RIEGL VQ-180

- 100 deg
- 200 kHz
- 500 m (20%)

RIEGL VQ-250

- 360 deg
- 200 kHz
- 300 m (80%)

Terrestrial Scanning

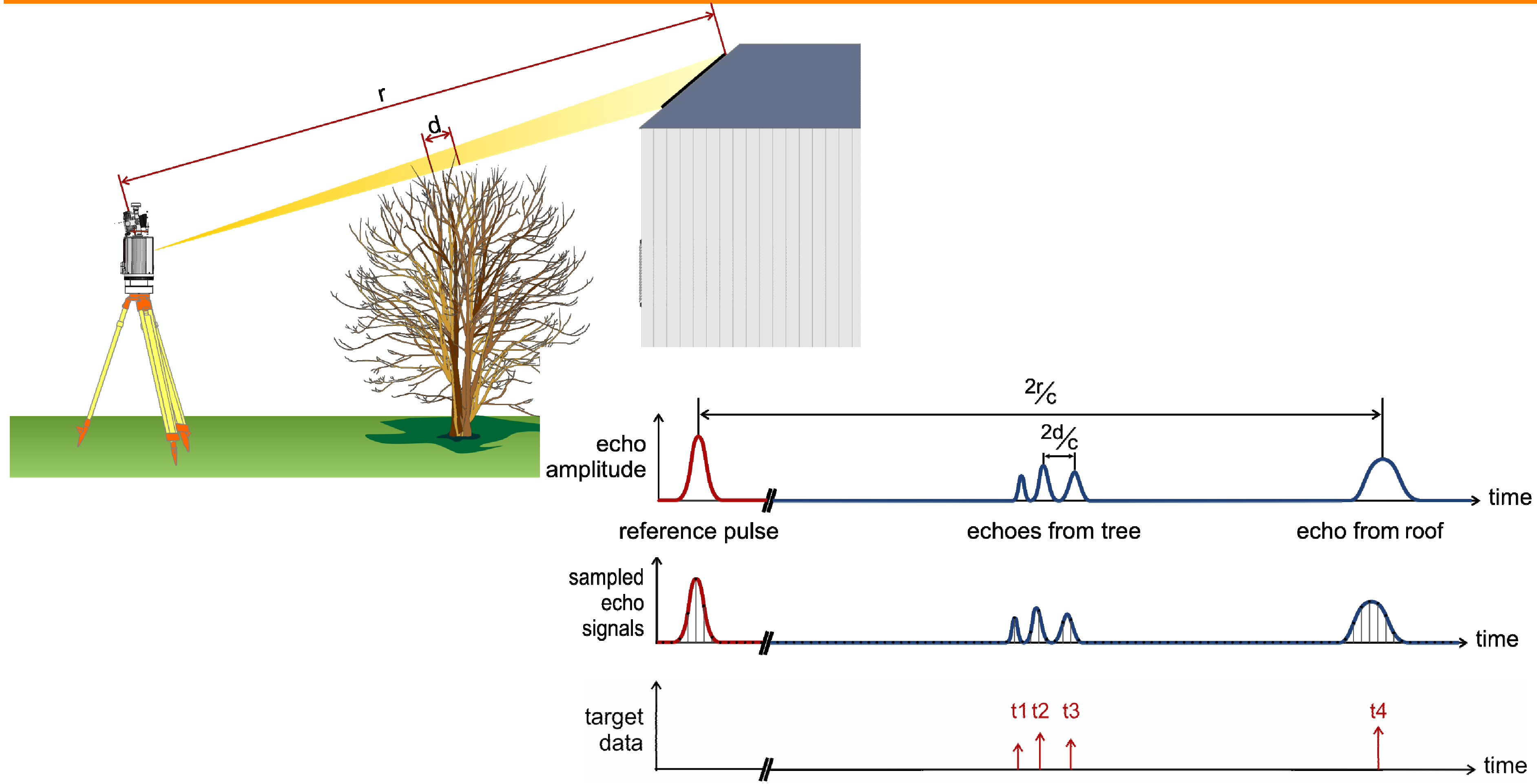
RIEGL VZ-400

- 100 x 360 deg
- 100/300 kHz
- 500 m (80%)

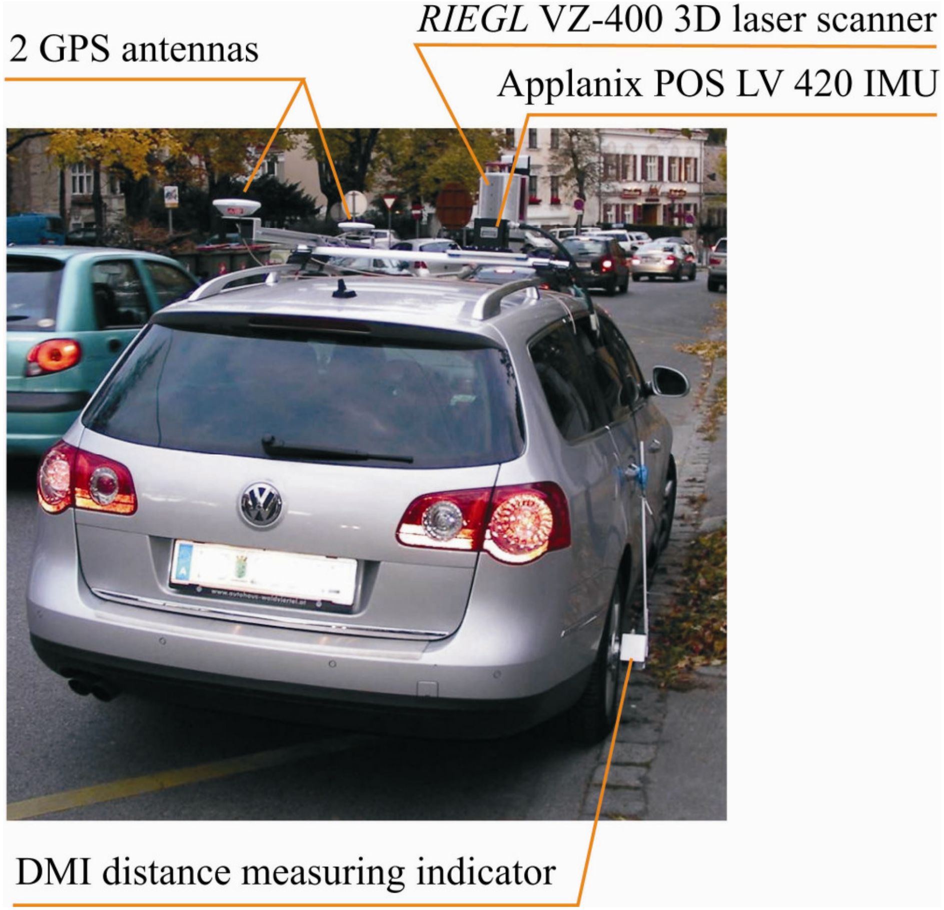
	measurement range	up to 500 m (80%) @ laser class 1, invisible laser beam
	repeatability and accuracy	better 5 mm
	effective measurement rate	up to 125.000 meas./sec
	field of view	100 deg x 360 deg

RIEGL VZ-400 Specification


RIEGL
LASER MEASUREMENT SYSTEMS


r
d
2r/c
2d/c
echo
amplitude
time
reference pulse
echoes from tree
echo from roof
sampled
echo
signals
time
target
data
t1 t2 t3
t4
time


σ = 4 mm
7200 pts
σ = 5 mm
10000 pts
σ=2.6 mm
5600 pts
Z
X
Y
Single Target
First Target
Last Target
Other Targets



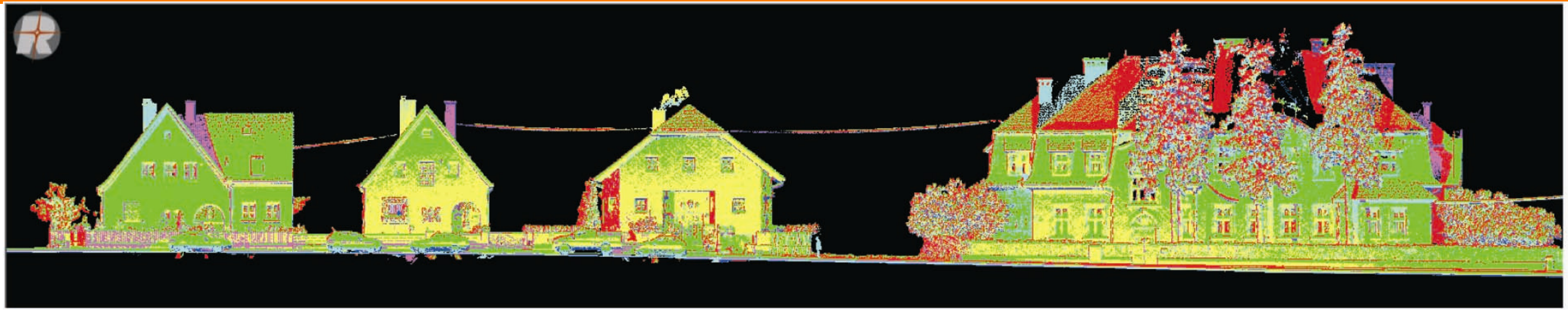
Experimental mobile laser scanning system mounted on a car

average measurement distance	approx. 30 m
average point spacing @ 30m	5 cm
speed of the car	approx. 20 km/h
angular resolution of two subsequent laser measurements within one line scan	0.1 deg
scanning rate	120 line scans per second

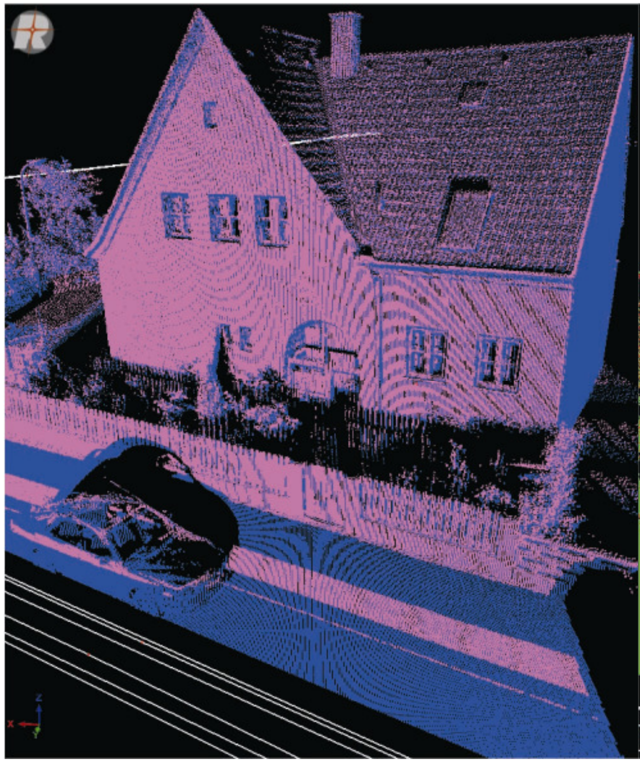
Used parameters for the surveying drive

RiPROCESS, *RIEGL's* software solution for processing the mobile scan data, covers four major tasks:

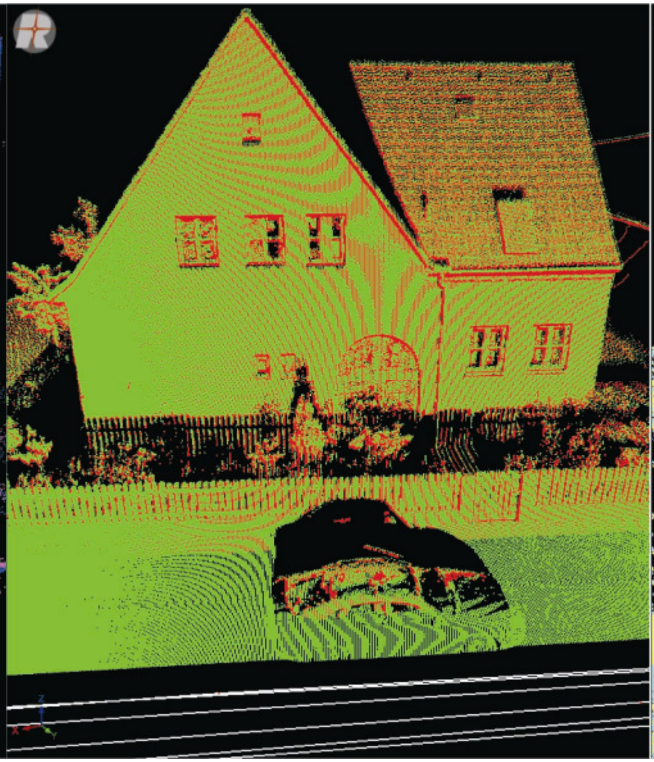
- Organize, process, and archive all data related to a single project.
- Visualize data on different scales, i.e., on a large scale as rasterized data, on a small scale as point clouds in 3D
- Calibrate the system and/or adjust the scan data to minimize inconsistencies in the laser data, also addressed as strip adjustment.
- Export data in widely supported formats for further processing



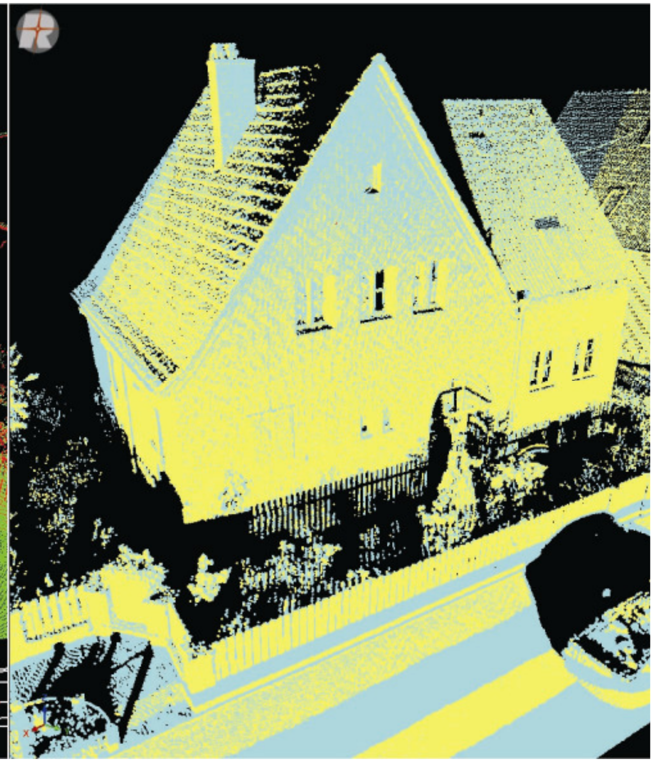
Orthogonal view of the common point cloud of 6 different scans



Point cloud of the scan
to left backwards (120 deg) and
to right forwards (300 deg)
with respect to the car



Point cloud of the scan
to the left (90 deg) and
to the right (270 deg)
with respect to the car



Point cloud of the scan
to left forwards (60 deg) and
to right backwards (240 deg)
with respect to the car

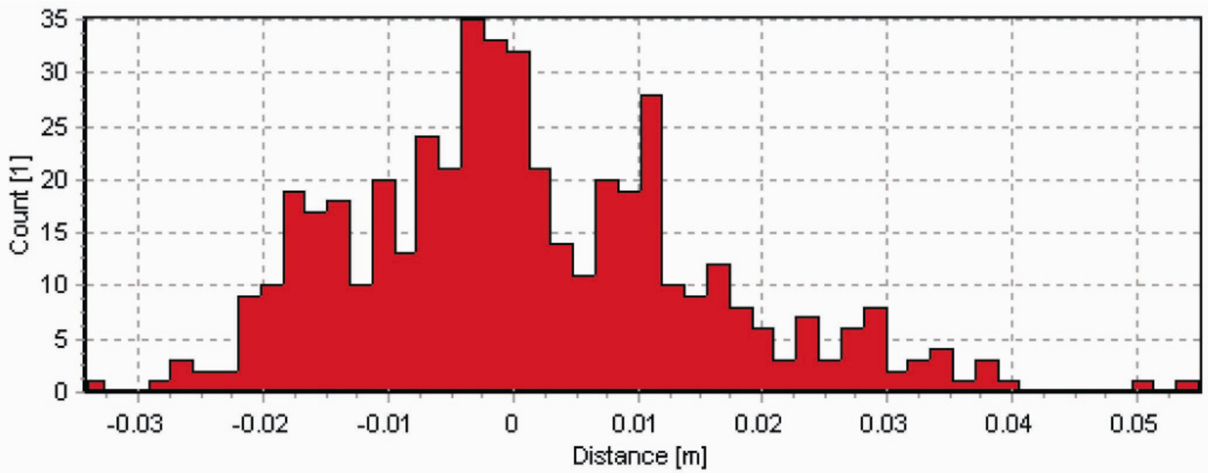
Calculation mode:	Adjustment (least square fitting)
Calculation time:	8 secs, 79 msecs
Min. change of error [m]:	0.000100
Search active:	True
Search radius [m]:	1.000
Angle tolerance [deg]:	5.000
Max. normal dist. [m]:	1.000
Quadtree cells - active:	True
Quadtree cells - count:	629

Calculation results

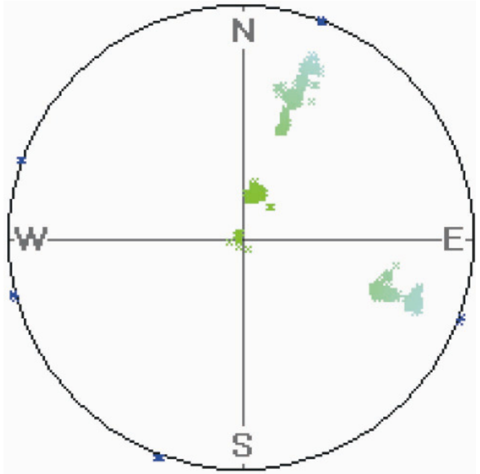
Number of observations:	471
Error (Std. deviation) [m]:	0.0143

Name	Roll	Pitch	Yaw
VZ-400 (VZ400, 9996063)	-0.032	0.209	-0.868

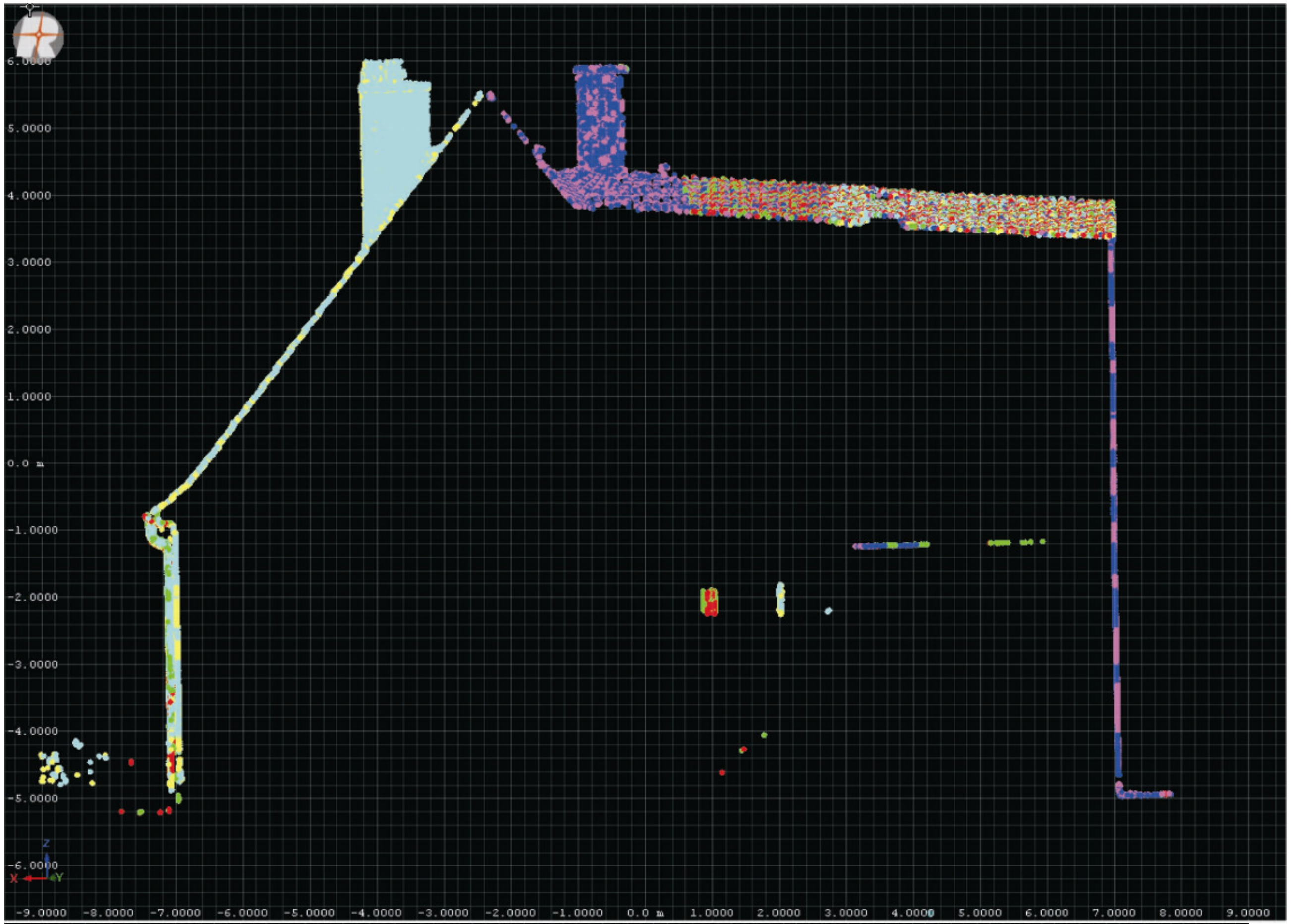
RiPROCESS Scan Data Adjustment Protocol



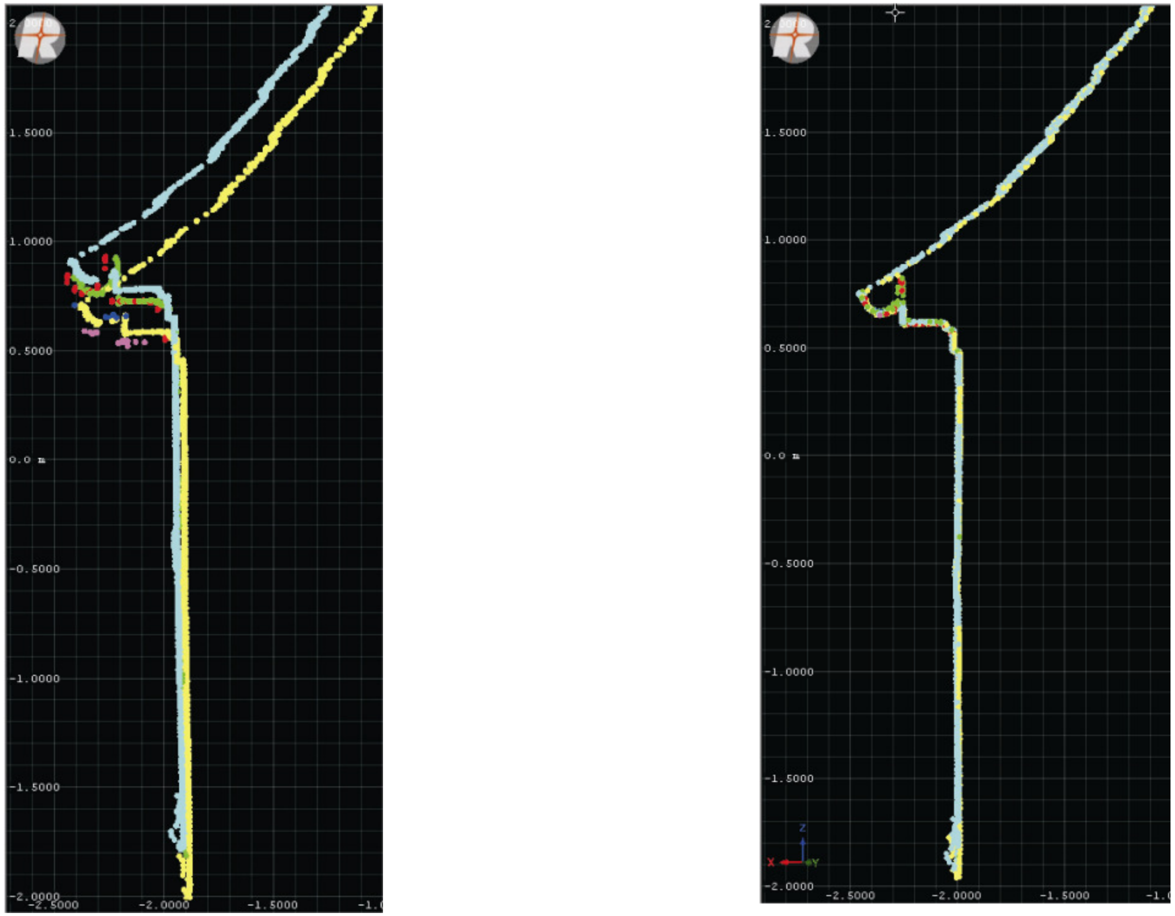
Histogram of residues



Orientation chart



Composite pointcloud cross section of the house before & after the boresight alignment



Detail of the left facade before & after the boresight alignment

Conclusion

- 3D scanner in MLS is a new technique, data suitable for determination of boresight alignment
- High pulse rate & real-time waveform technique provides high point densities covering surfaces even hidden behind vegetation
- Common planar surfaces are input to the subsequent scan data adjustment algorithm which enables a robust estimation of the systems boresight angles
- The accuracy of the estimated boresight calibration values depends strongly on the quality of the position and attitude data
- MLS key components: IMU/GPS system of high long term measurement accuracy & fast and accurate 3D laser scanner
- Advantage of the proposed method: the possibility of determining the boresight angles by analyzing (user) scan data acquired in any desired area providing at least some common planar surfaces

Thank you!