“Mobile Laser Scanning” Anwendungen

Oldenburger 3D Tage 2007

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RIEGL Laser Measurement Systems GmbH
www.riegl.com

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“Mobile Laser Scanning” Anwendungen

- Grundlagen
- Mobile Laser Scanning am Auto (2D Scanner, Japan)
- Mobile Laser Scanning am Auto (3D Scanner, Österreich)
- Airborne Laser Scanning kombiniert mit Terrestrischem Laser Scanning (Österreich)
- Mobile Laser Scanning am Boot (2D Scanner, Frankreich)

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	TLS Terrestrisches Laser Scanning	**MLS** Mobiles Laser Scanning	**ALS** “Airborne” Laser Scanning
Datenformat	Bild basierend	Linien basierend	Linien basierend
Registrierung	Per Reflektoren oder Nutzdaten	• online per INS/GPS Aufnahme • Sensoren wie z.B. Rad Sensor	online per INS/GPS Aufnahme der Trajektorie
Messentfernung	1m – 1000m	typ. bis 200m	500m – 1500m
Registriergenauigkeit	typ 5mm	typ 2cm (DGPS)	typ 10cm (bis 2cm bei ICP auf Referenzmodelle)
Aufnahmeart	stop-and-go		go

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Einteilung TLS / MLS / ALS

	TLS Terrestrisches Laser Scanning	**MLS** Mobiles Laser Scanning	**ALS** “Airborne” Laser Scanning
Registrierung	• mit vielen Reflektoren (per Totalstation ect.) • mit einem Reflektor (back sighting) & Eigenposition • ohne Reflektoren per ICP (iterative closest point) Algorithmus ect.	• Aufnahme der Laser Daten inklusive Zeitstempel • Aufnahme der Trajektorie (per INS/GPS) • Verbesserung der Registrierung durch Ausgleichung an stationär aufgenommenen Referenzobjekten	• Aufnahme der Laser Daten inklusive Zeitstempel • Aufnahme der Trajektorie (per INS/GPS) Verbesserung der Registrierung durch Streifenausgleich: 1. Zur internen System-kalibrierung (6 Parameter) 2. Nutzdatenverbesserung (3 Translation- & 3 Rotations Parameter je Flugsteifen) 3. Ausrichtung an stationär aufgenommenen Kontrollobjekte

Definition Trajektorie: Ort und Orientierung als Funktion der Zeit (zeitdiskret)

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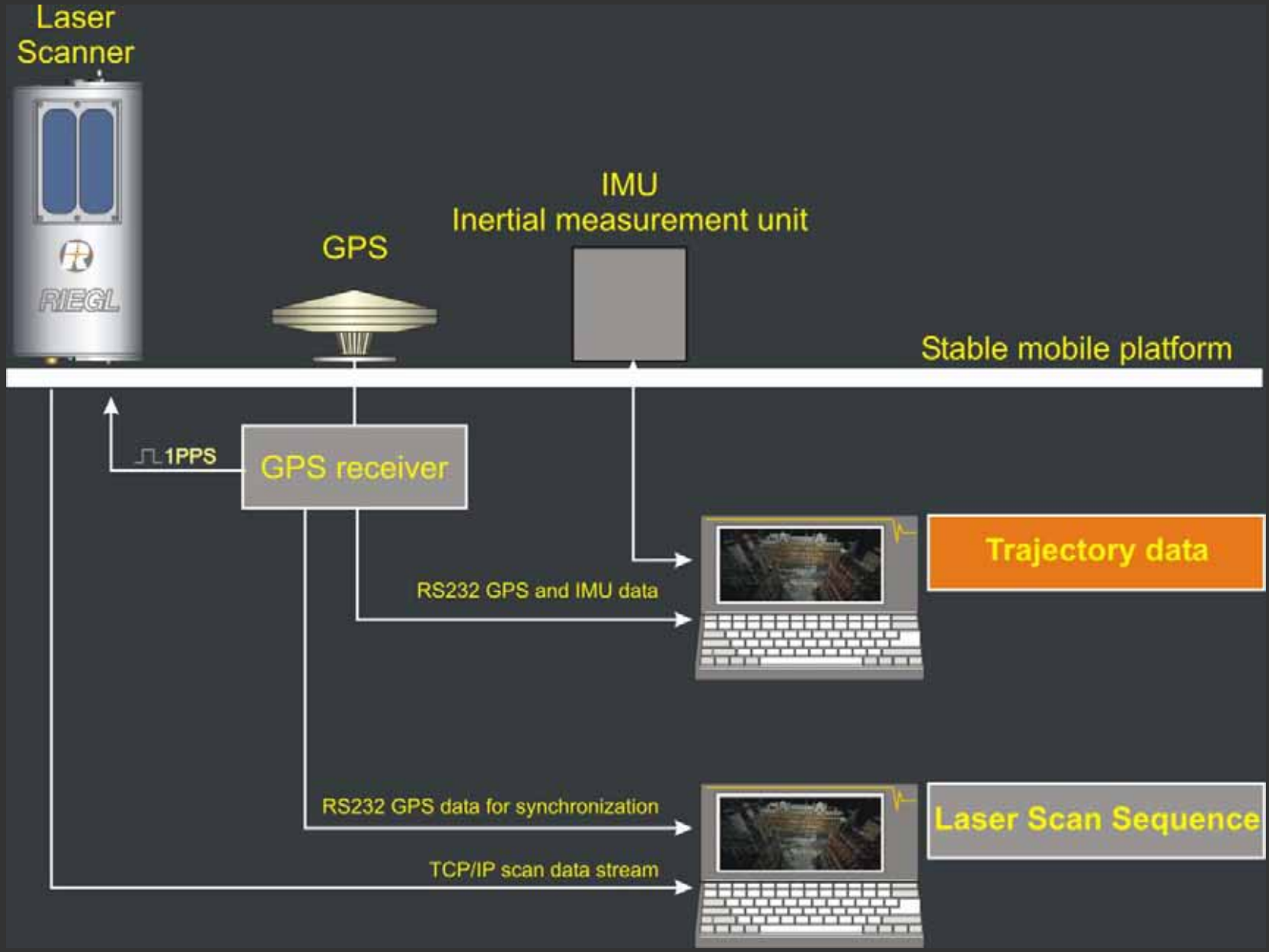
Registrierung TLS / MLS / ALS



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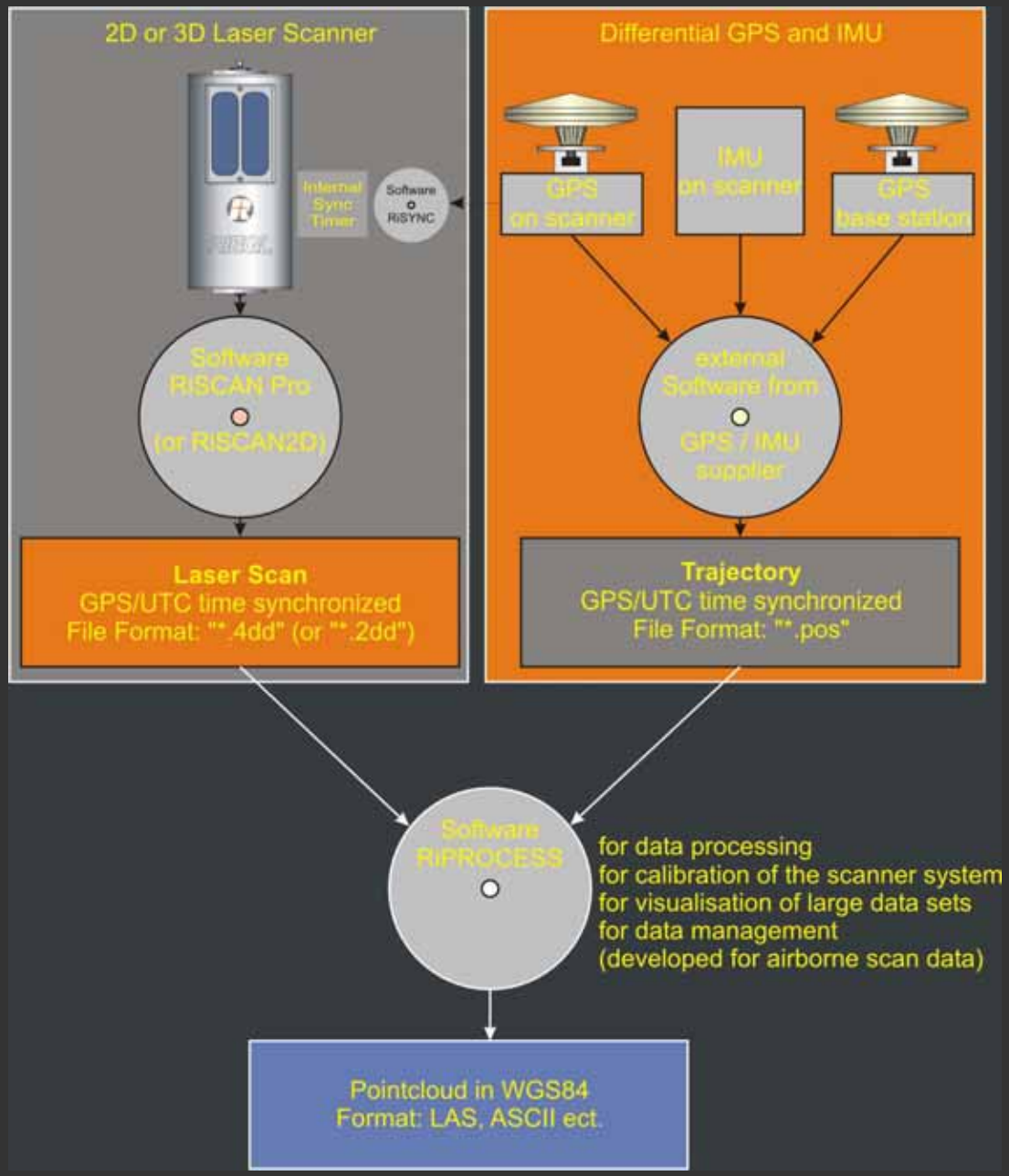
MLS System Konfiguration



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MLS Workflow

Trajectory File (*.pos)

The *.pos file contains information about the position and the orientation of the moving platform. The default setup is as follows:

1. Column: UTC timestamp in seconds [seconds of day]
2. Column: Latitude [deg]
3. Column: Longitude [deg]
4. Column: Height [m]
5. Column: Roll [deg]
6. Column: Pitch [deg]
7. Column: Yaw [deg]

The values are separated by blanks

Example:
50759.0010 48.33841614 15.93149532 471.005 -0.8156 7.1238 71.1383
50759.0020 48.33841616 15.93149556 471.004 -0.8118 7.1230 71.1393
50759.0030 48.33841617 15.93149579 471.002 -0.8081 7.1214 71.1409
50759.0040 48.33841619 15.93149602 471.000 -0.8039 7.1195 71.1411

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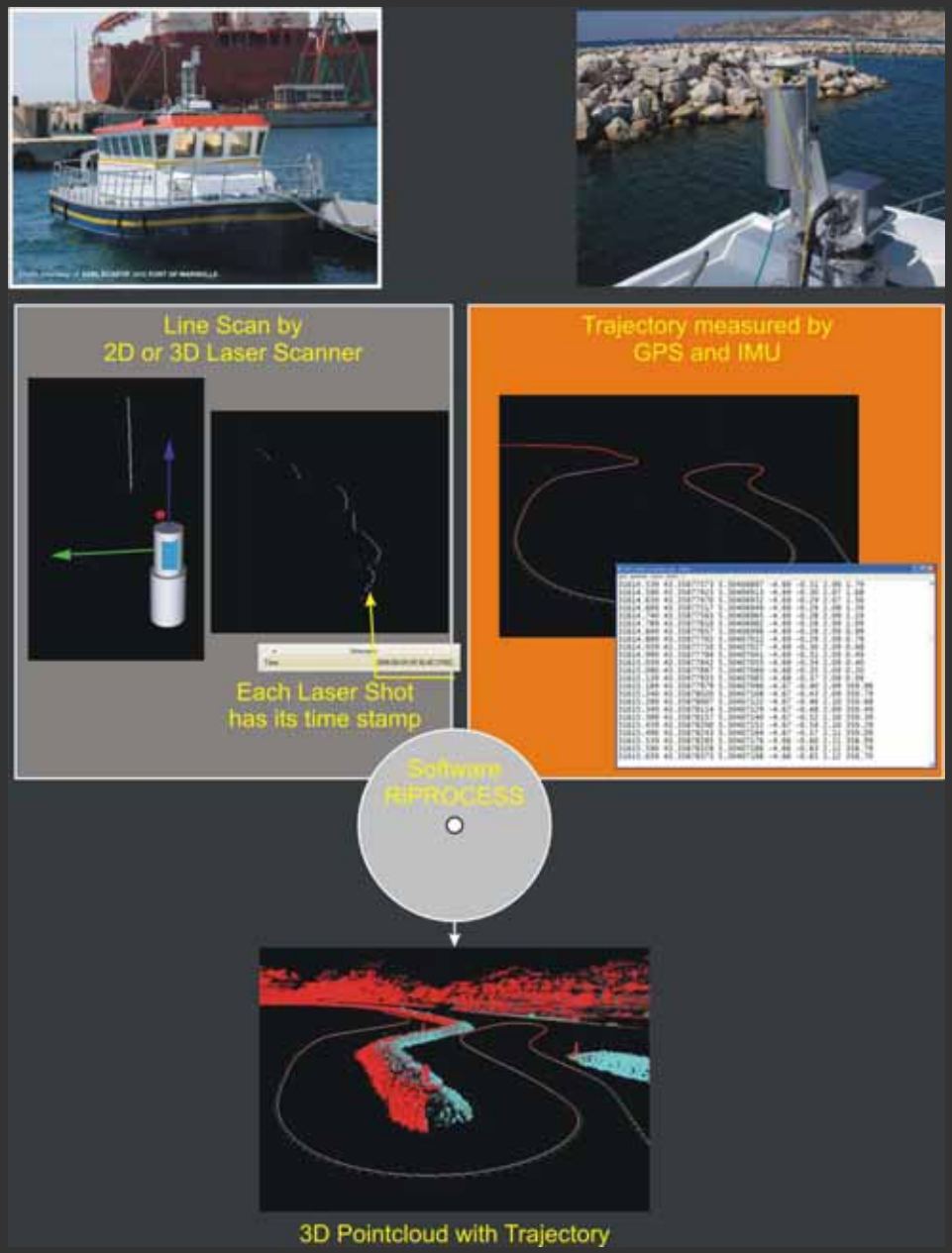

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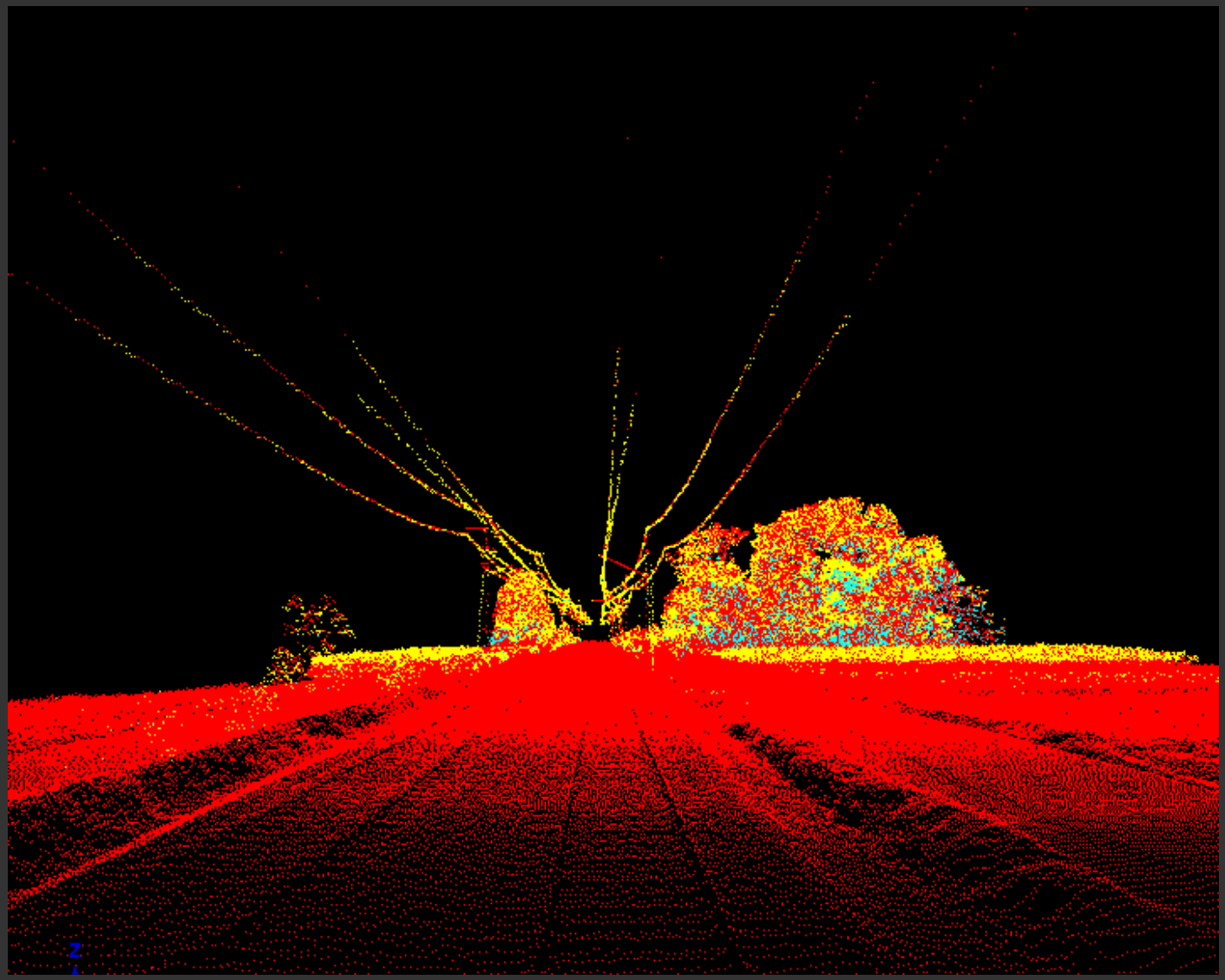
MLS Beispieldaten



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Punktewolkendaten, aufgenommen von einem Helikopter

MLS 2D Laser Scanner Q560 am Auto (Japan)

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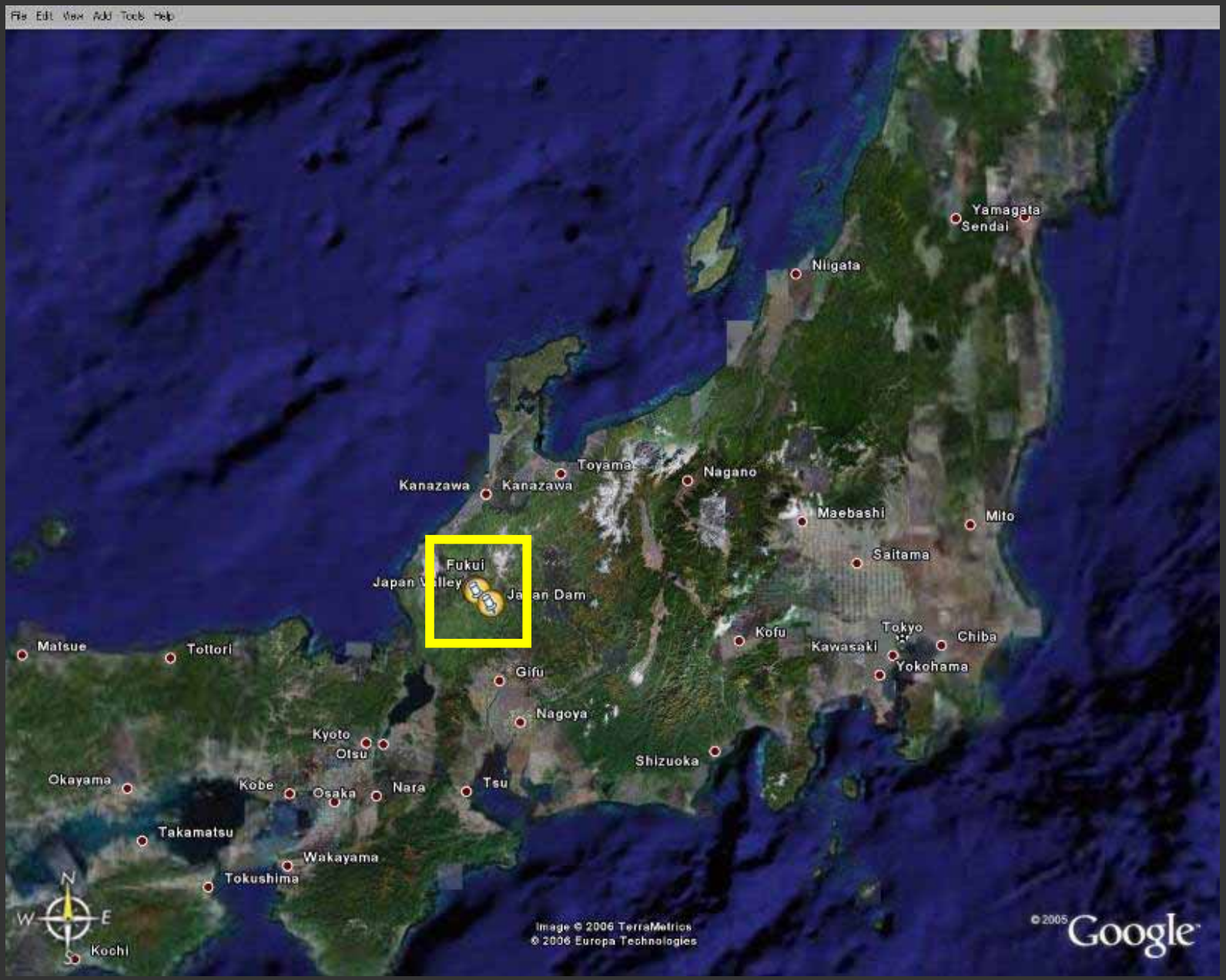

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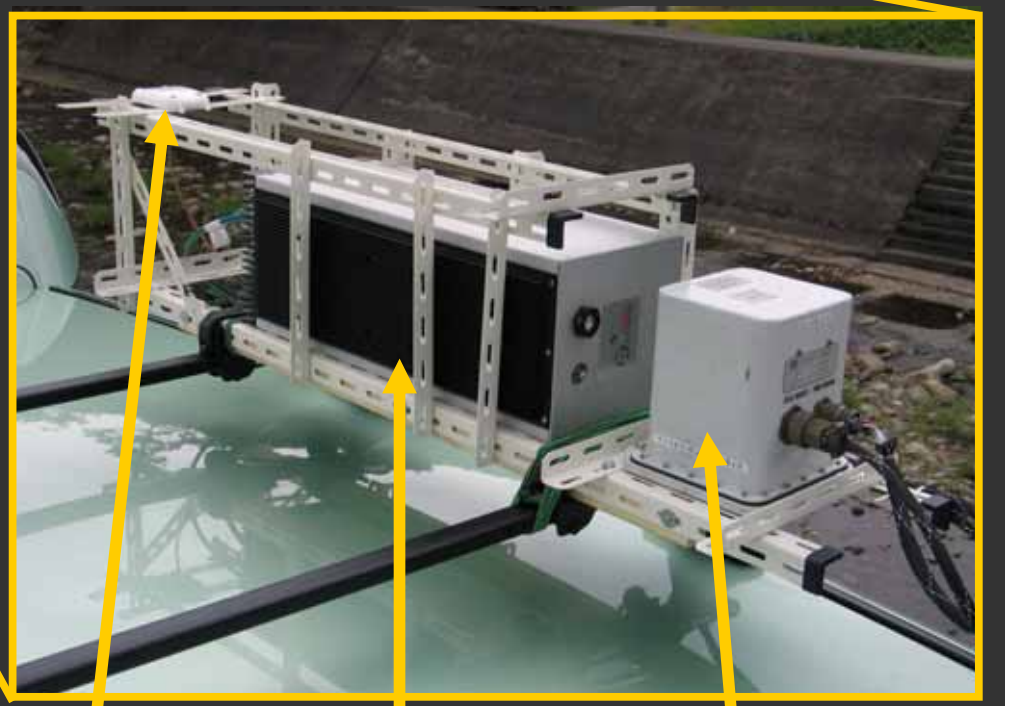
Fallbeispiel MLS am Auto



GPS

Laser Scanner Q560

IMU Applanix

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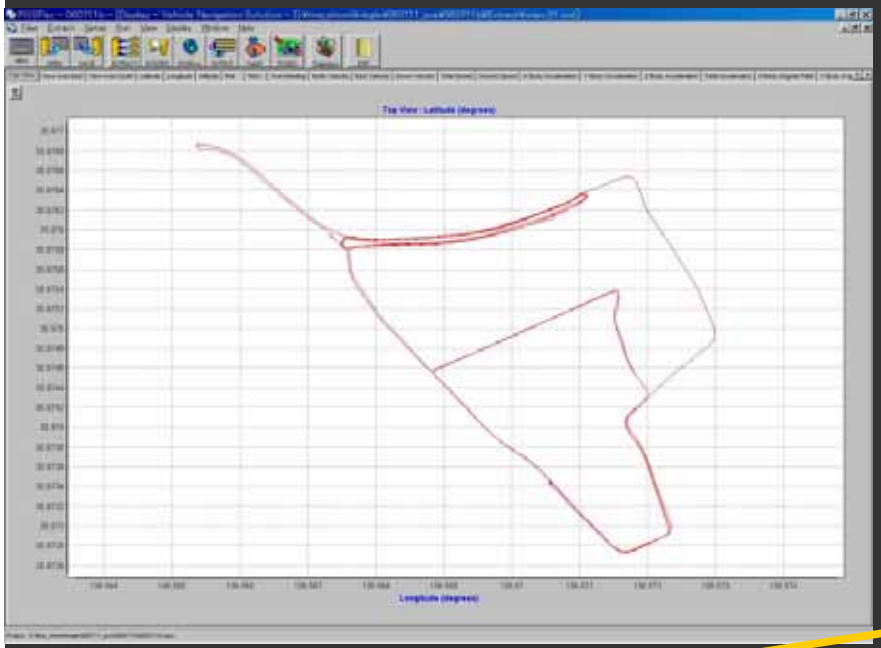
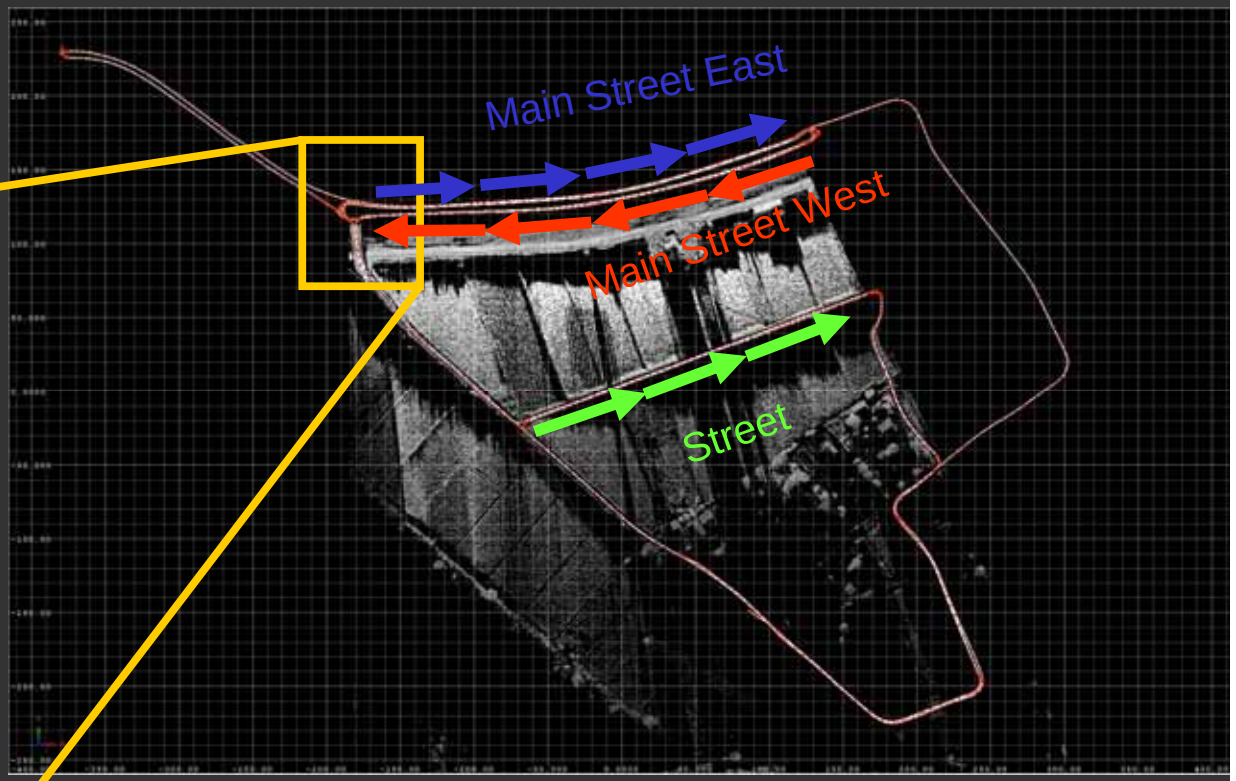
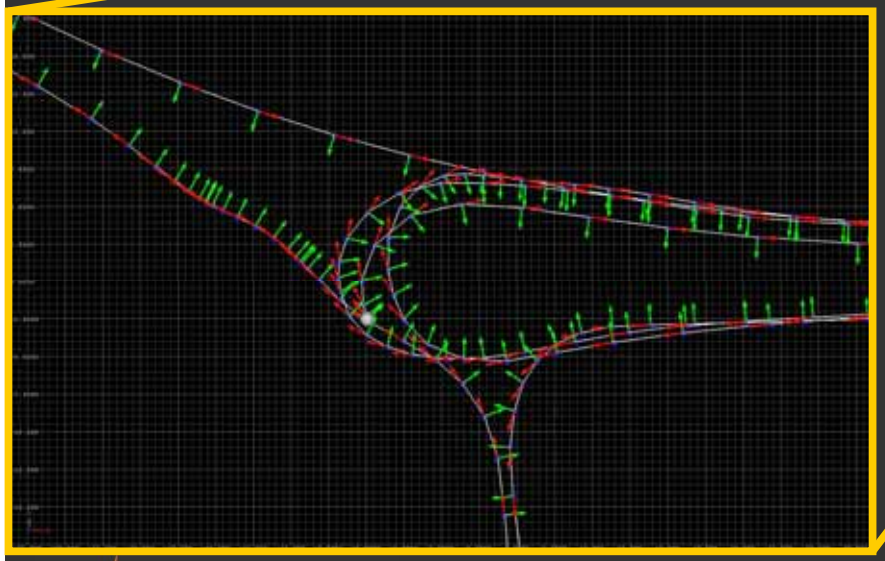
Team & System Konfiguration

Applanix View of Trajectory



RiSCAN PRO View of Trajectory





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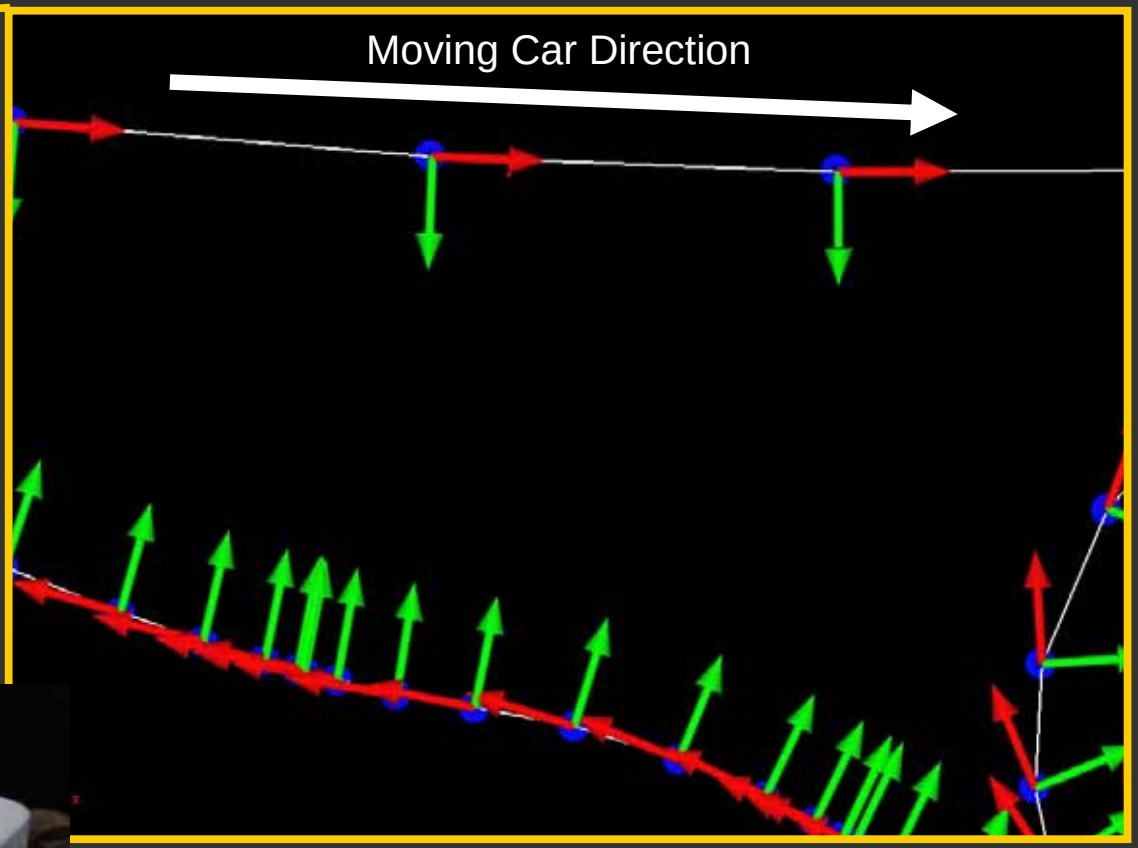
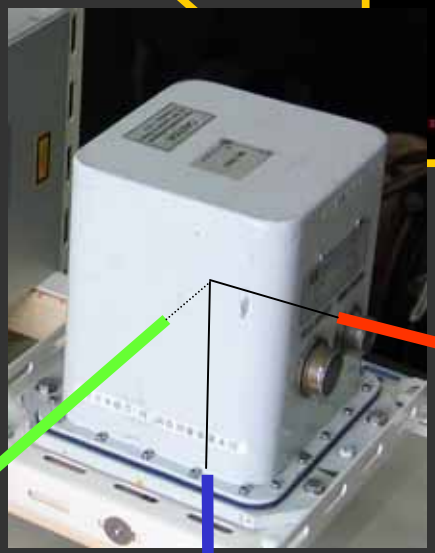
Trajektorie





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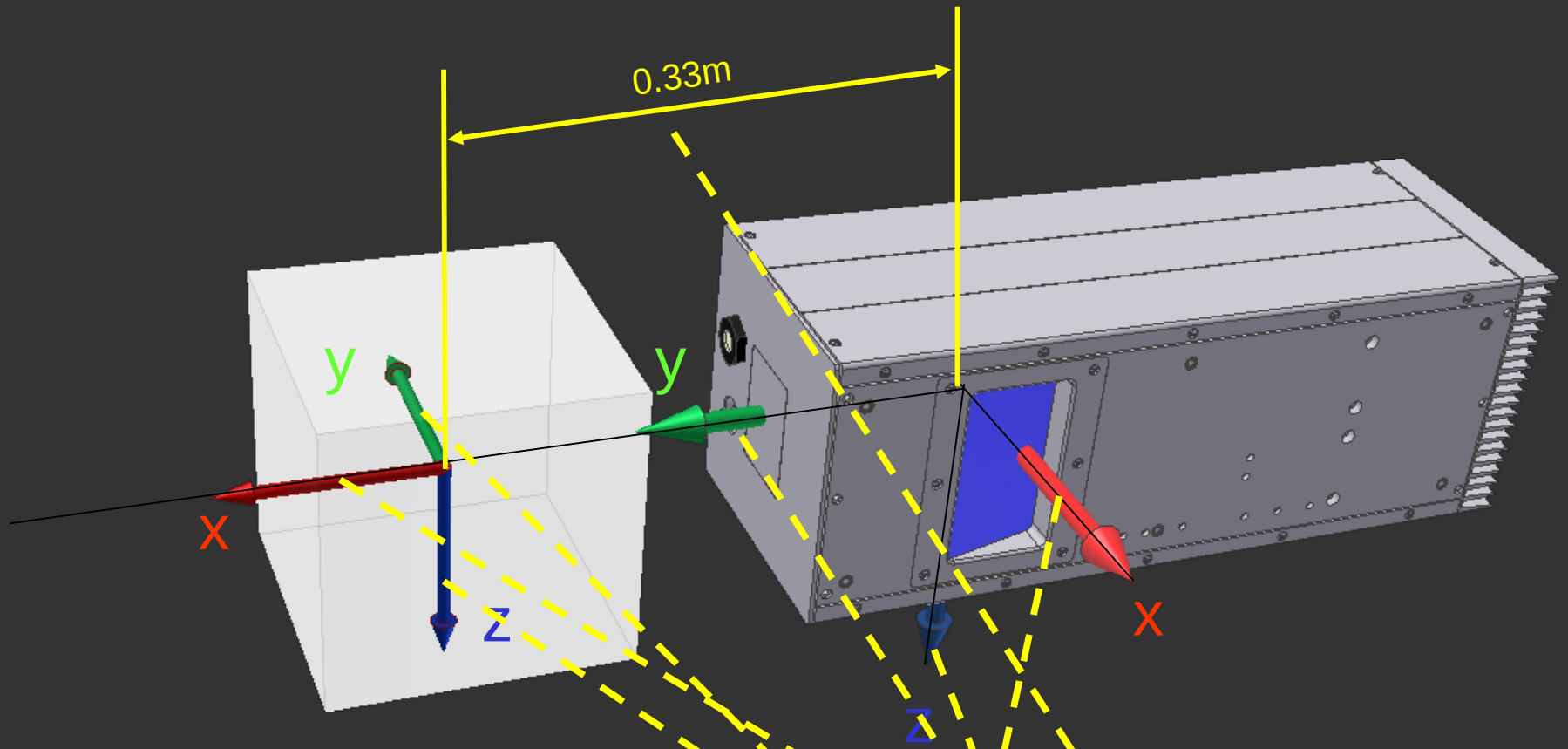
Trajektorie



$$C_{IMU}^{SOCS} = \begin{pmatrix} x^T & y^T & z^T & \begin{matrix} x_{TRA}\ \text{Ximu} \\ y_{TRA}\ \text{Yimu} \\ z_{TRA}\ \text{Zimu} \end{matrix} \\ 0 & 0 & 0 & 1 \end{pmatrix} = \begin{pmatrix} 0 & 1 & 0 & -0.33 \\ -1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix}$$

delta Ximu

Rotation Translation

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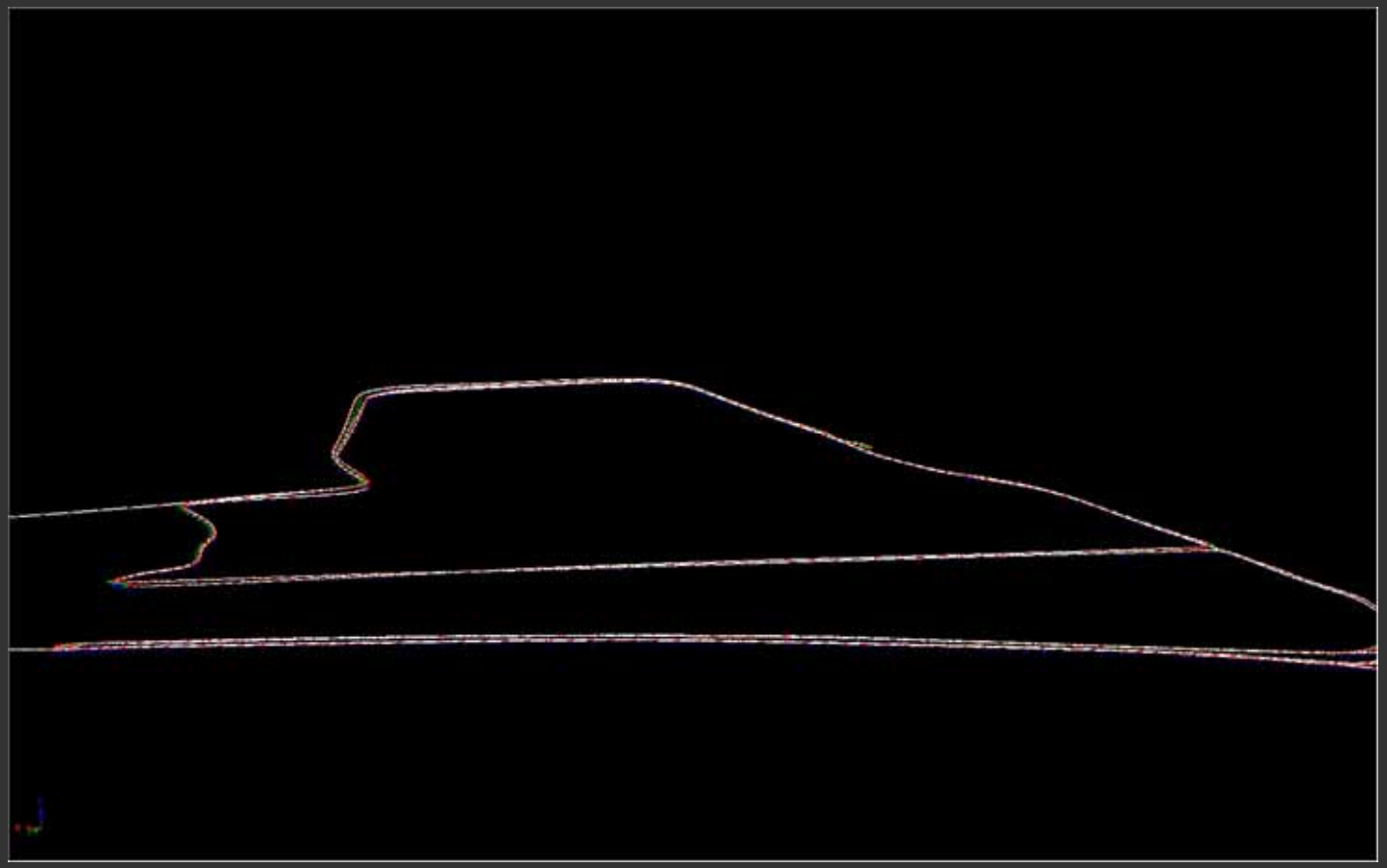
Transformation Matrix – IMU / Scanner Own Coordinate System



Trajectory of the Car

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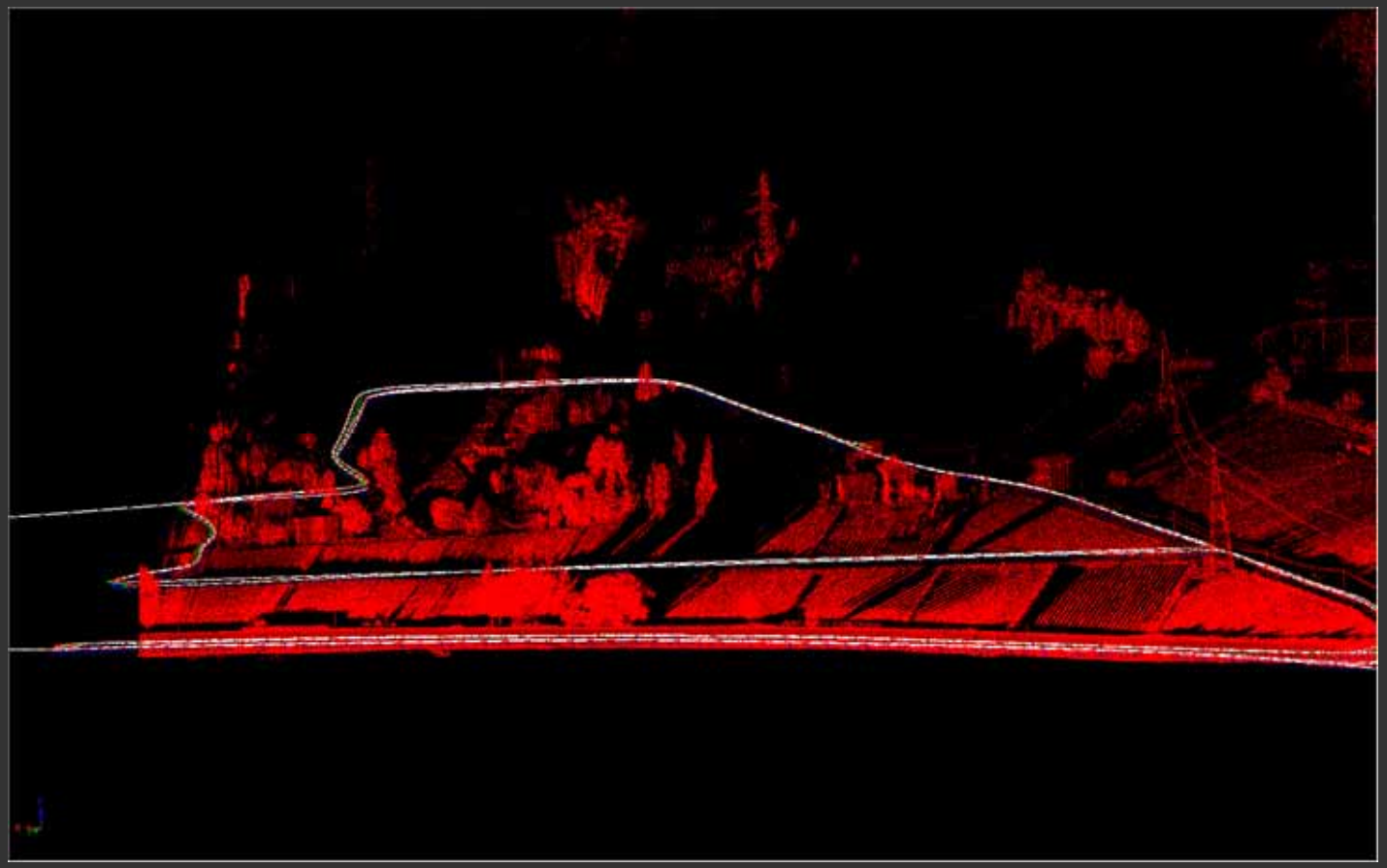
Trajektorie



Trajectory of the Car & Main Street West

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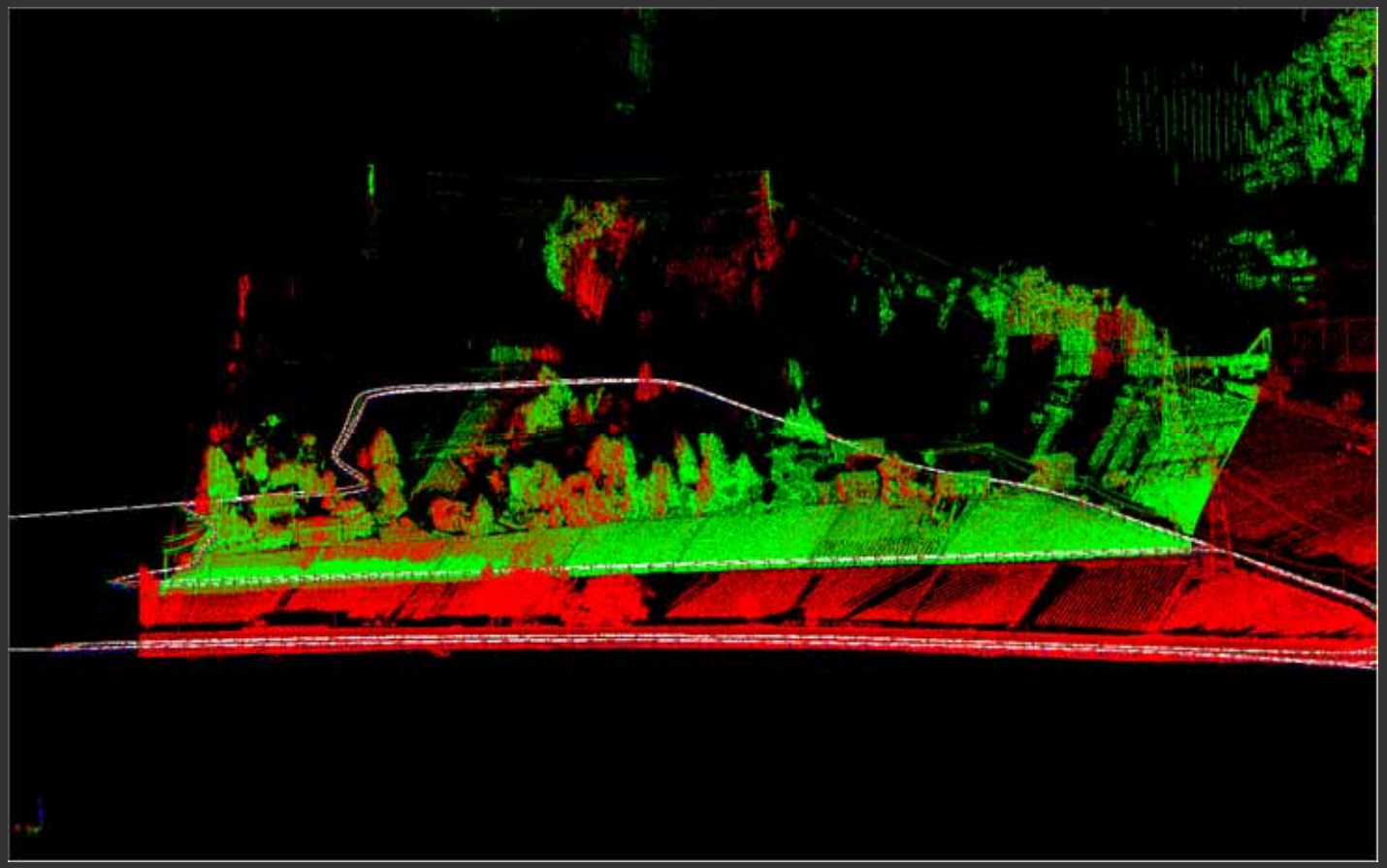
MLS Scan



Trajectory of the Car & Main Street West & Street

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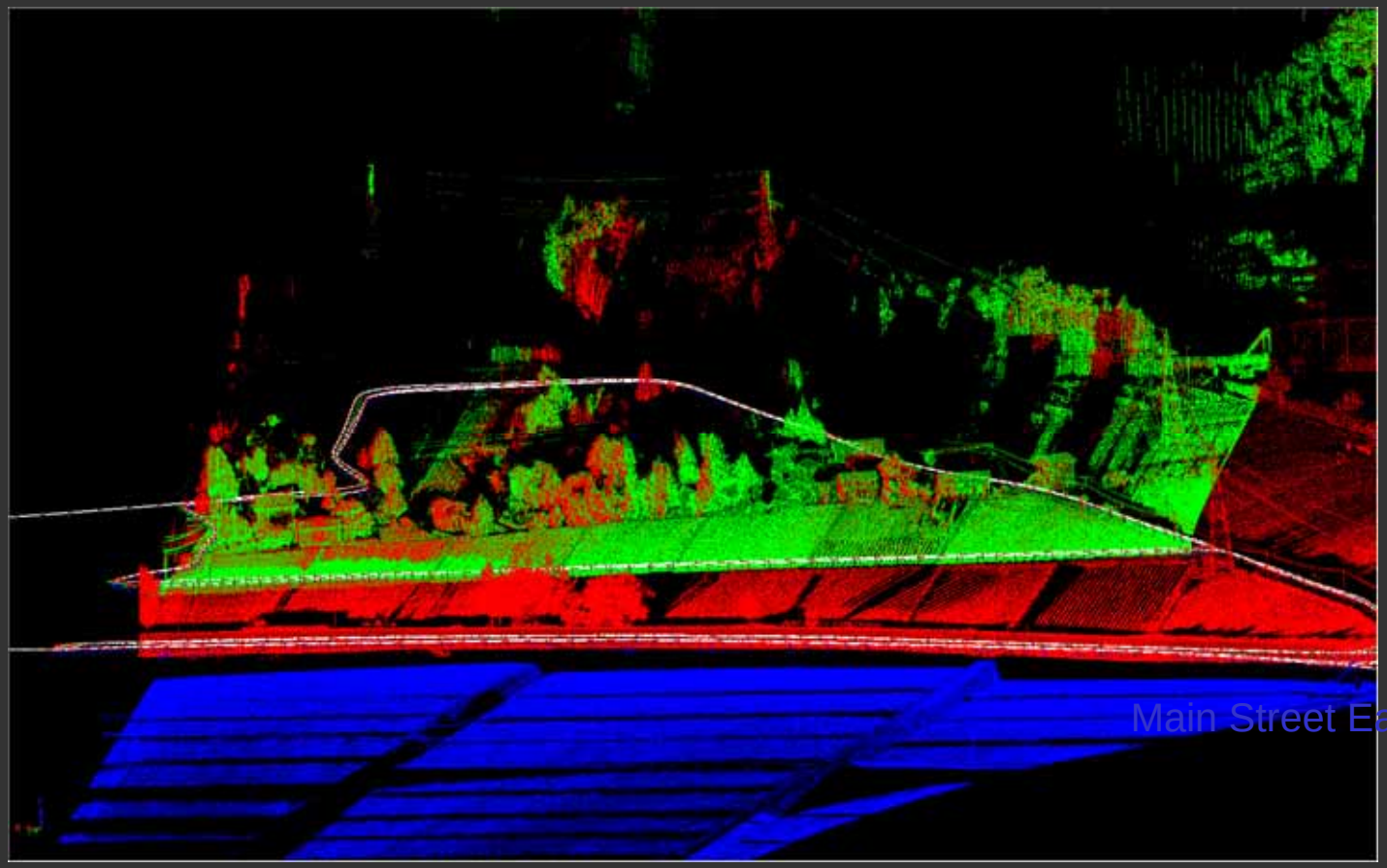
MLS Scan



Trajectory of the Car & Main Street West & Street &

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Erstes Ziel

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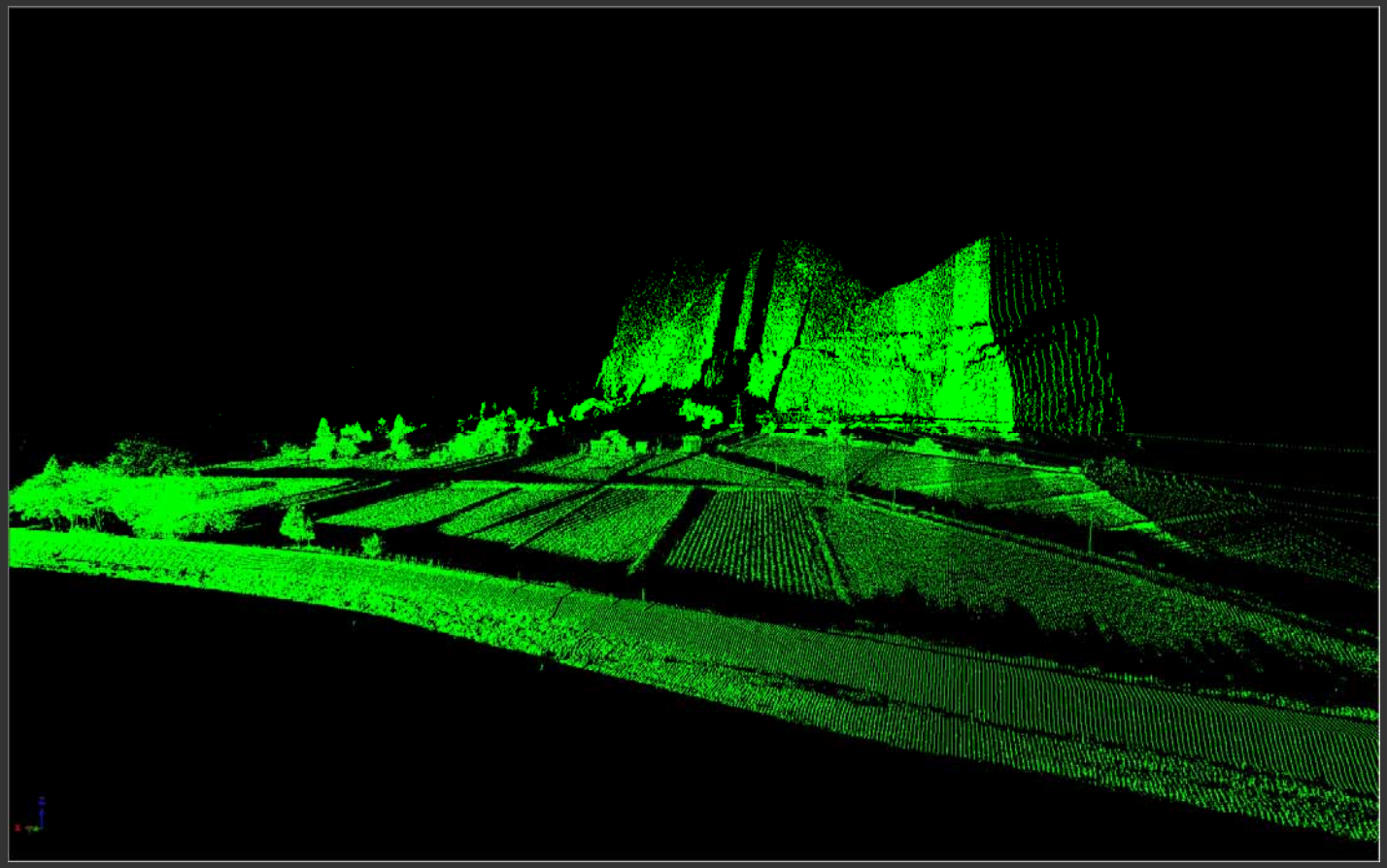
“Full Waveform” Analyse



Letztes Ziel

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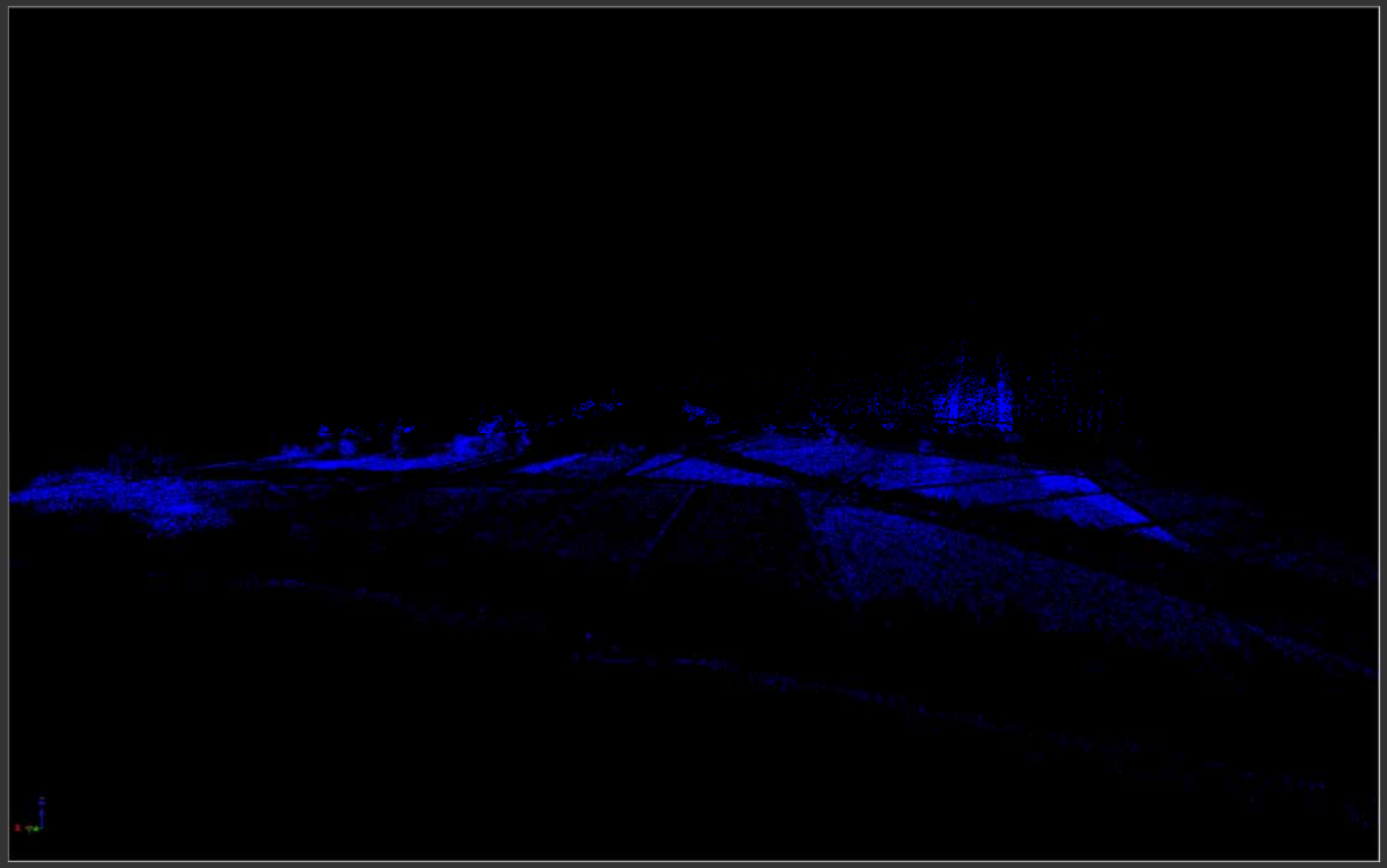
“Full Waveform” Analyse



Alle anderen Ziele

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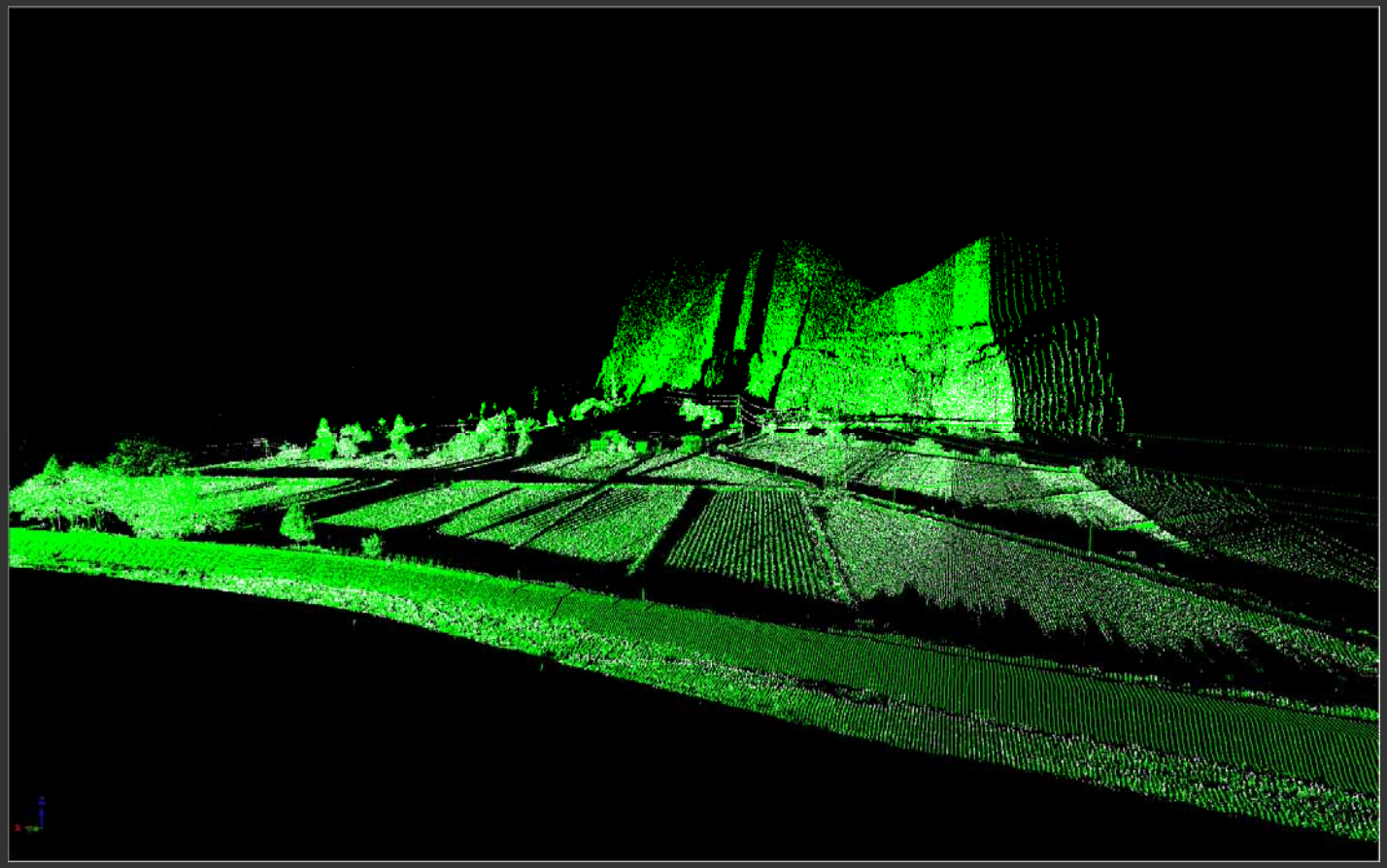
“Full Waveform” Analyse



Erstes & Letztes Ziel

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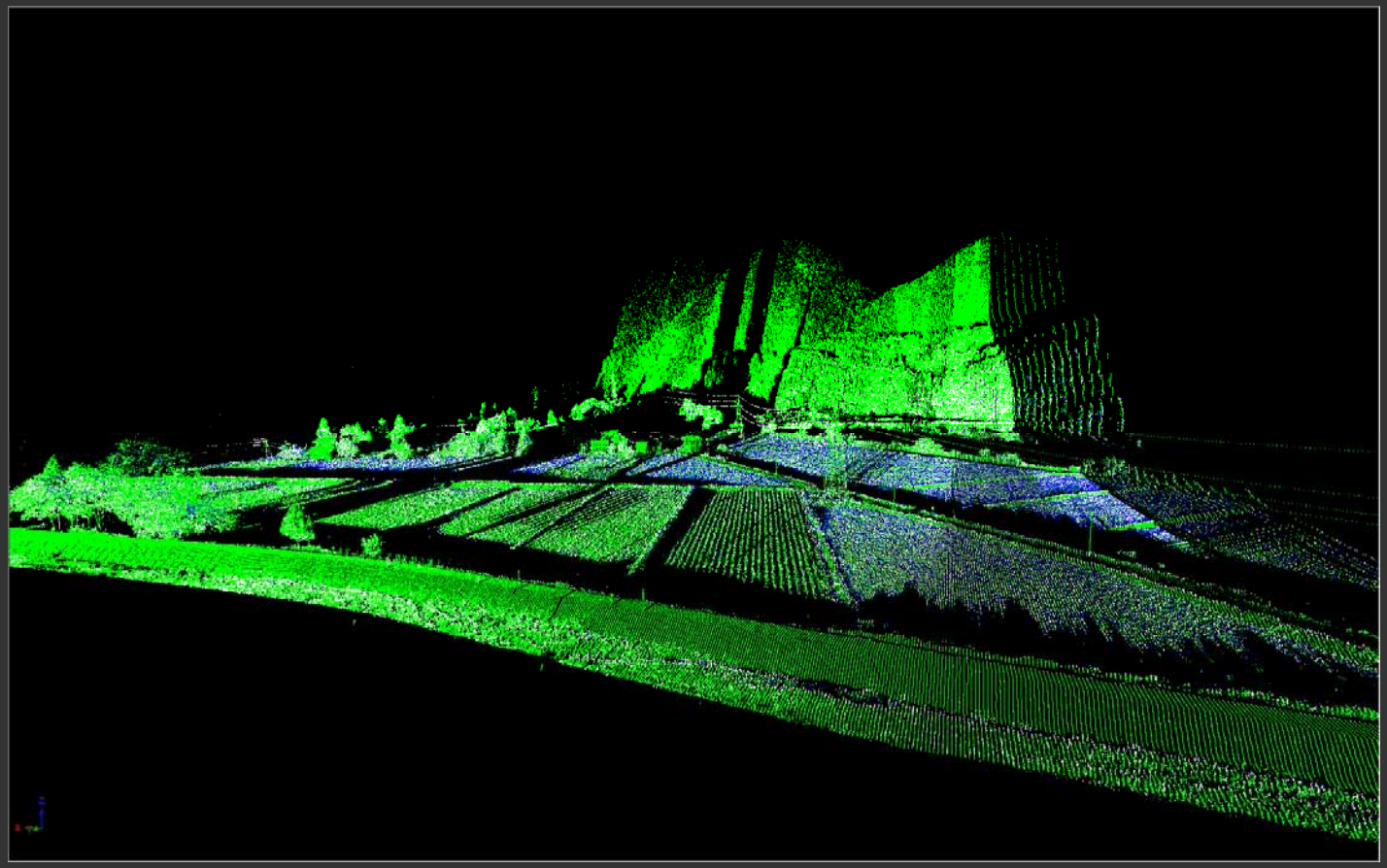
“Full Waveform” Analyse



Alle Ziele

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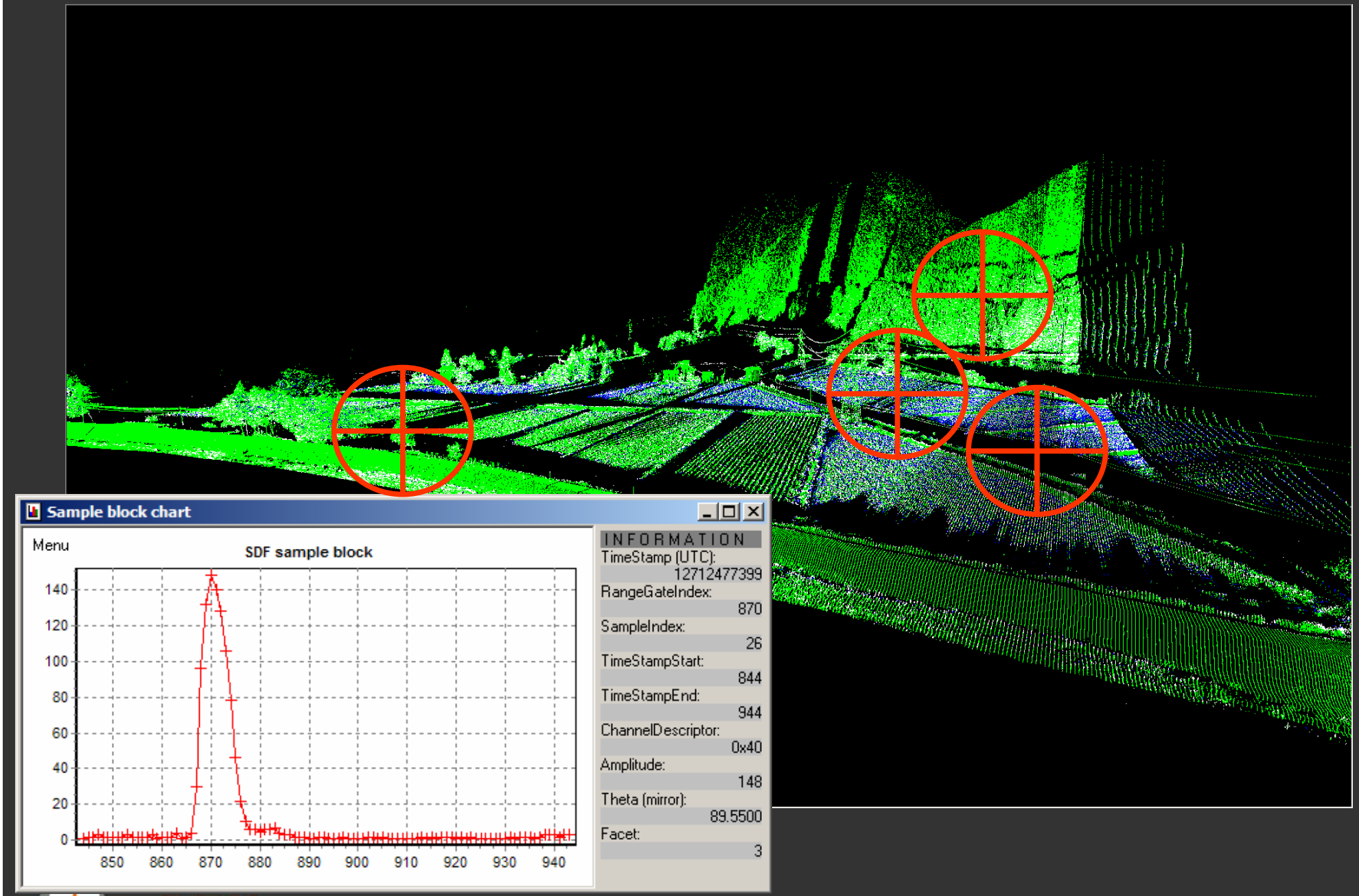
“Full Waveform” Analyse



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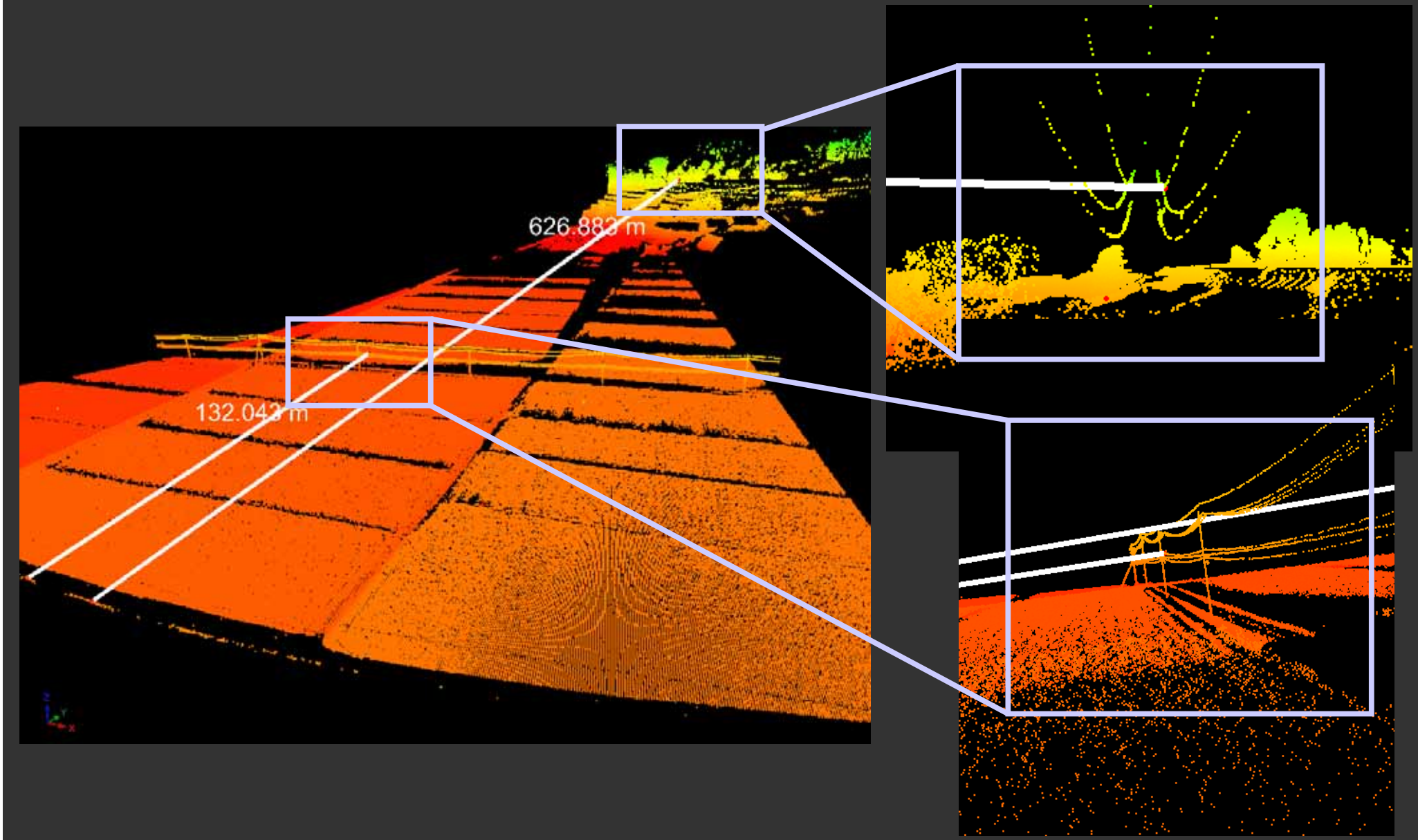
“Full Waveform” Analyse



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Maximale Reichweite zu Hochspannungleitungen (50kHz)

MLS 3D Laser Scanner Z420 am Auto (Österreich)

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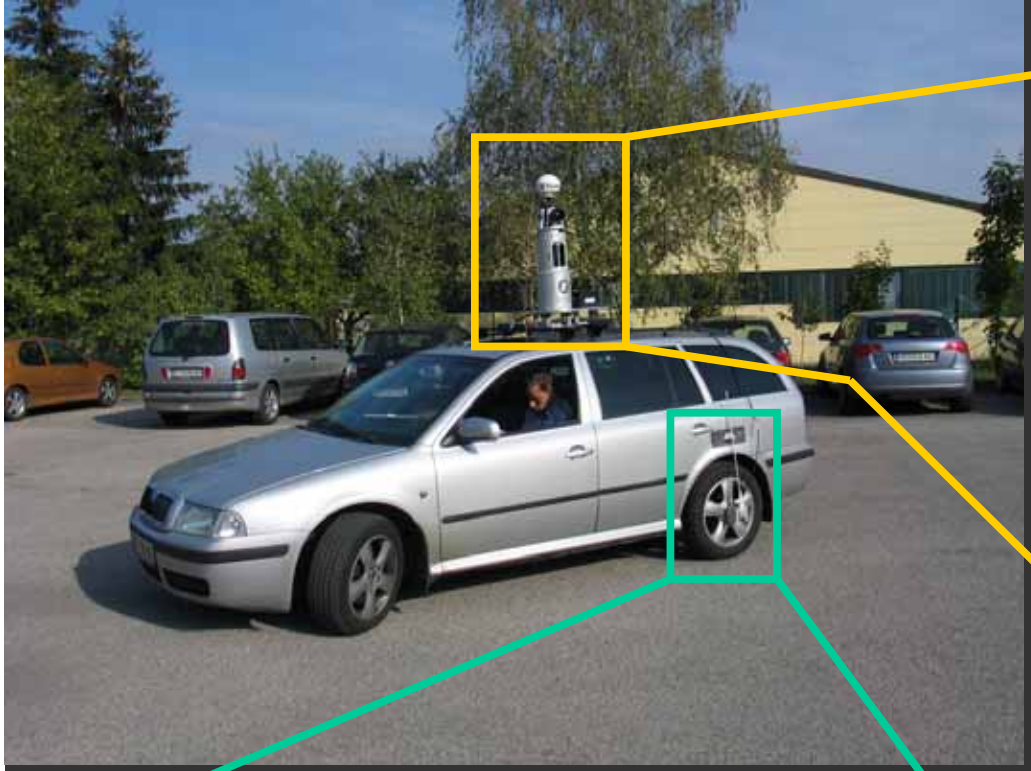

GPS

3D Laser Scanner Z420i

IMU Applanix

Rad Sensor

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MLS 3D Laser Scanner Z420 am Auto

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MLS 3D Laser Scanner Z420 am Auto

ALS 2D Laser Scanner Q560
kombiniert mit TLS 3D Laser Scanner Z420 (Österreich)

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Schlüsselfertiges System für ALS

1-2 Laser Scanner
INS/GPS System
Mittelformatkamera
Flugzeug (DA42)

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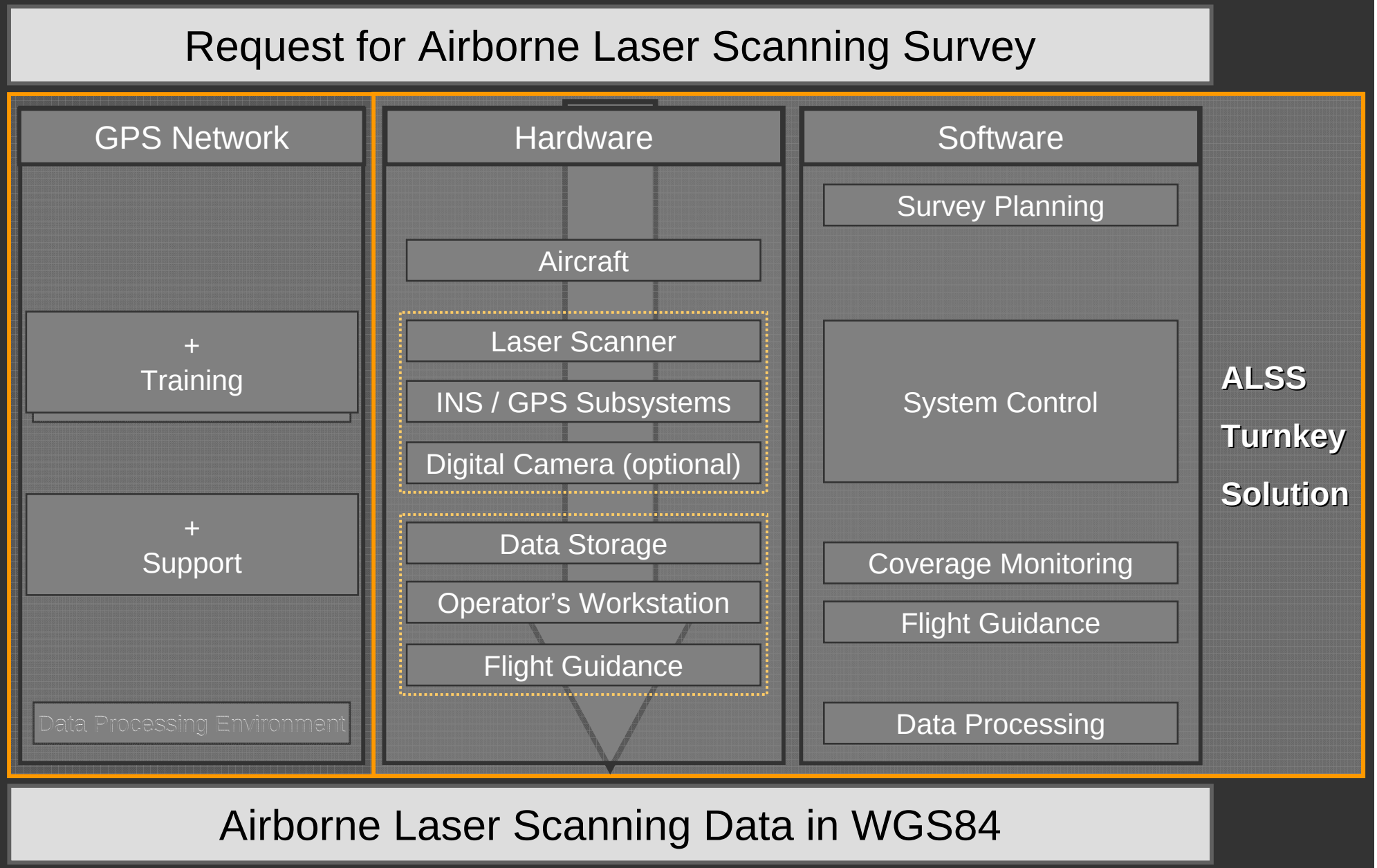
AIRBORNE SENSING



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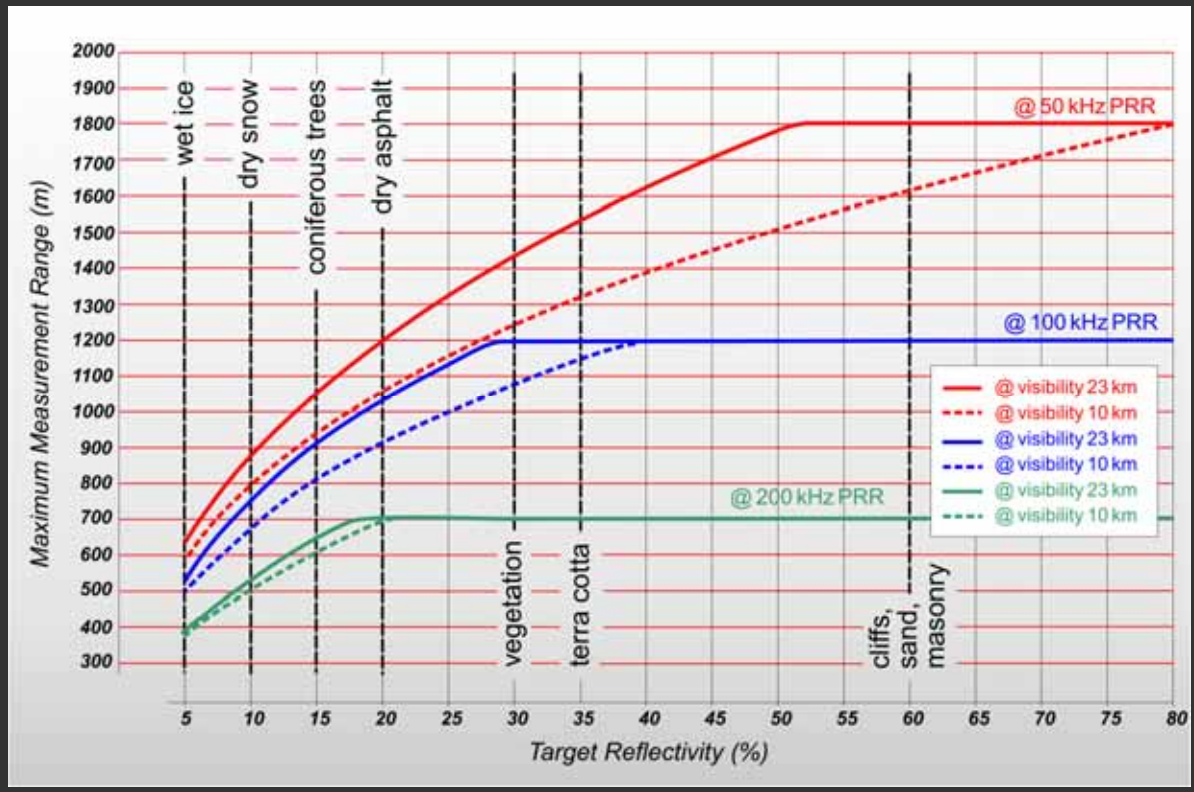
ALS System Komponenten

Specifications *RIEGL* LMS-Q560

Measurement range	30 m - 1800 m at ρ = 80% 30 m - 1200 m at ρ = 20%
Ranging accuracy	20 mm
multi-target resolution	down to 0.5 m
Measurement rate	50 000 - 200 000 meas/s (burst rate) up to 133 000 meas/ s (average)
Scan range	45°(up to 60°)
Scan speed	Up to 160 lines / sec
Synchronization	GPS PPS & serial IF
Size / weight	560 x 200 x 217 mm / 20 kg
Laser safety	Laser class 1 / wavelength near infrared

Maximum Measurement Range vs Target Reflectivity and Measurement Rate



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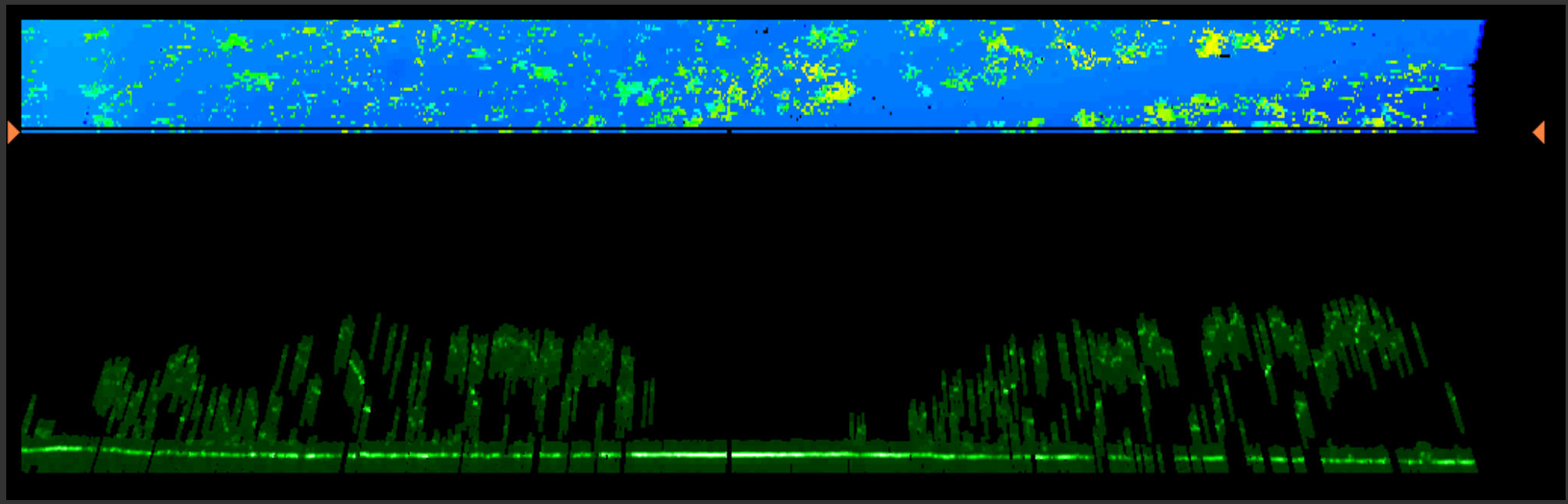
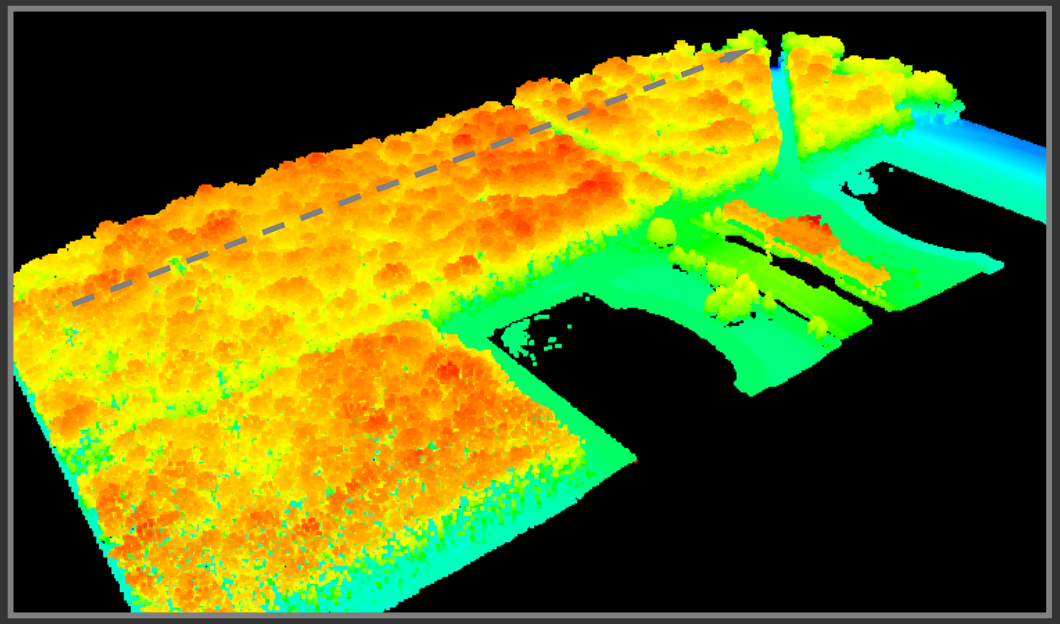
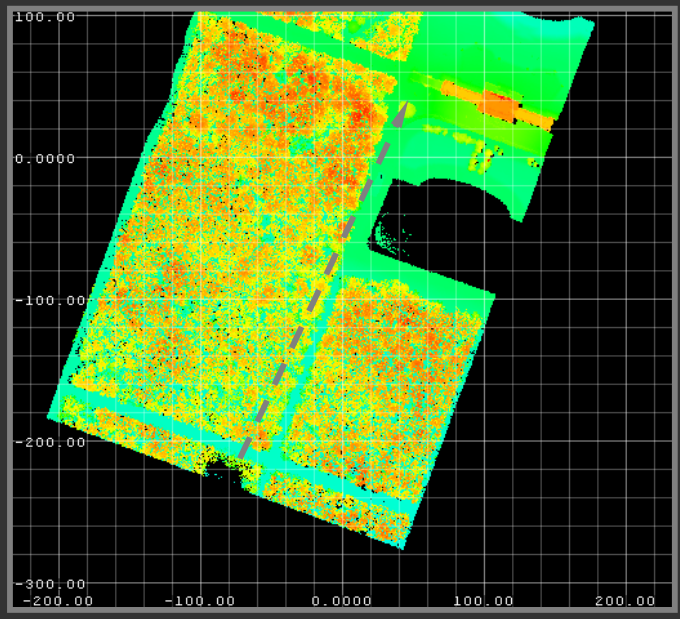
Laser Scanner Spezifikation *RIEGL* LMS-Q560







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Darstellung der Echosignale pro Scanlinie

ALS Fallbeispiel aus dem Paper
„Full-waveform airborne laser scanning
as a tool for archaeological reconnaissance“

In: Campana S., Forte M. (eds.), FRom Space to Place.
Proceedings of the 2nd International Conference on
Remote Sensing in Archaeology.
BAR International Series 1568, 2006, 99-106.

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Michael Doneus [michael.doneus@unvie.ac.at]
Christian Briese [cb@ipf@tuwien.ac.at]

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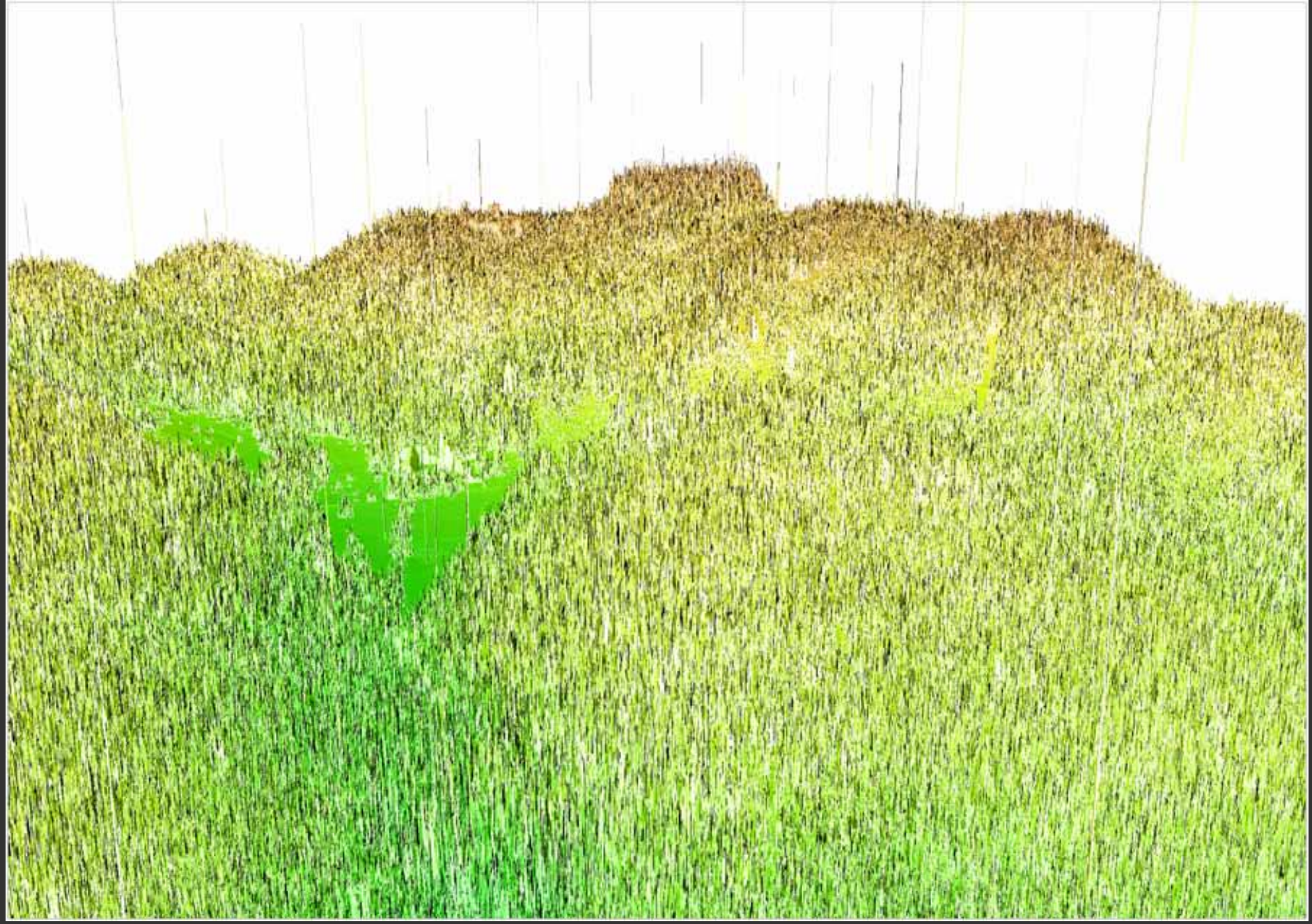
ALS Fallbeispiel mit Full Waveform DSM



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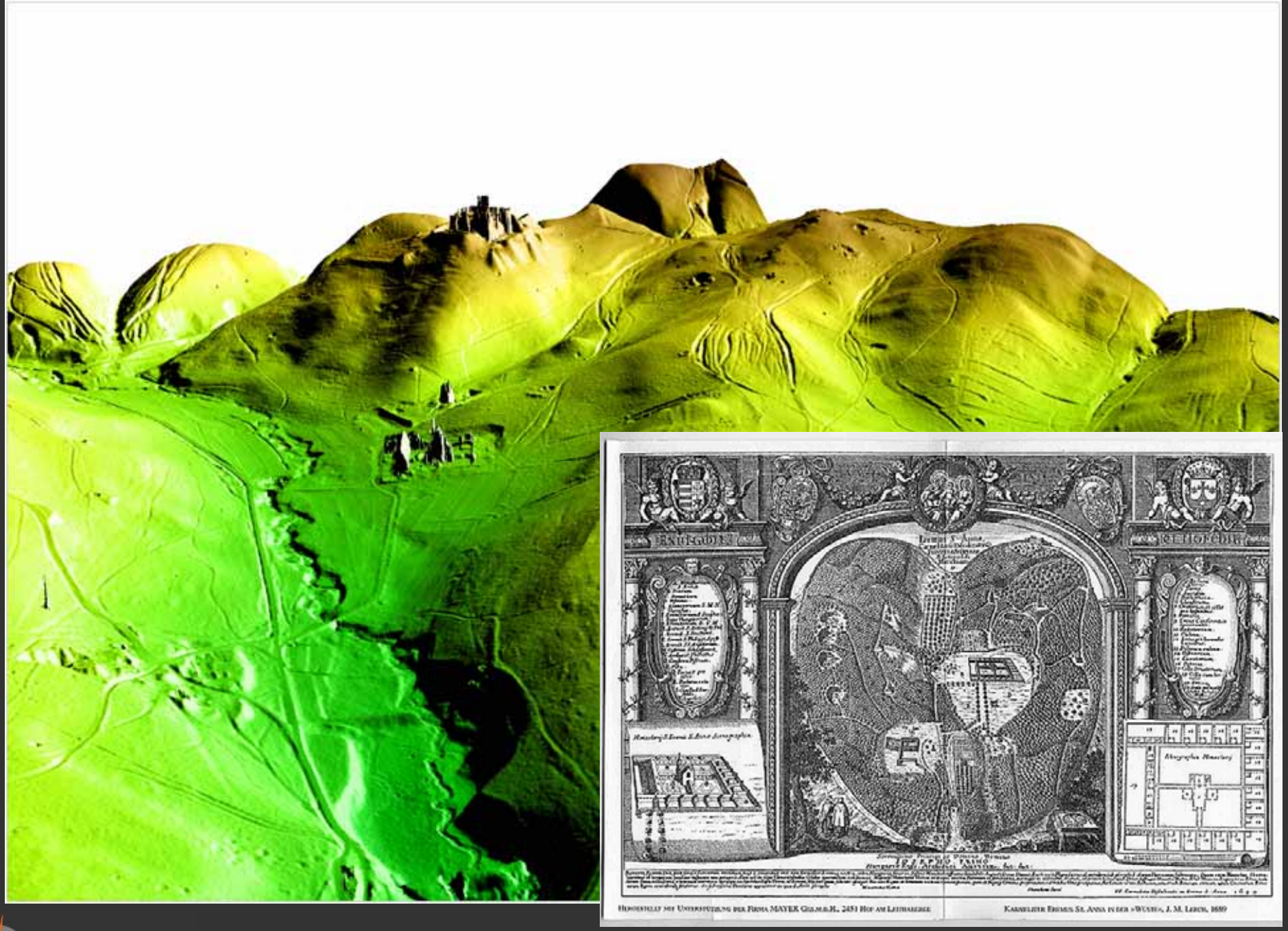
ALS Fallbeispiel mit Full Waveform DSM



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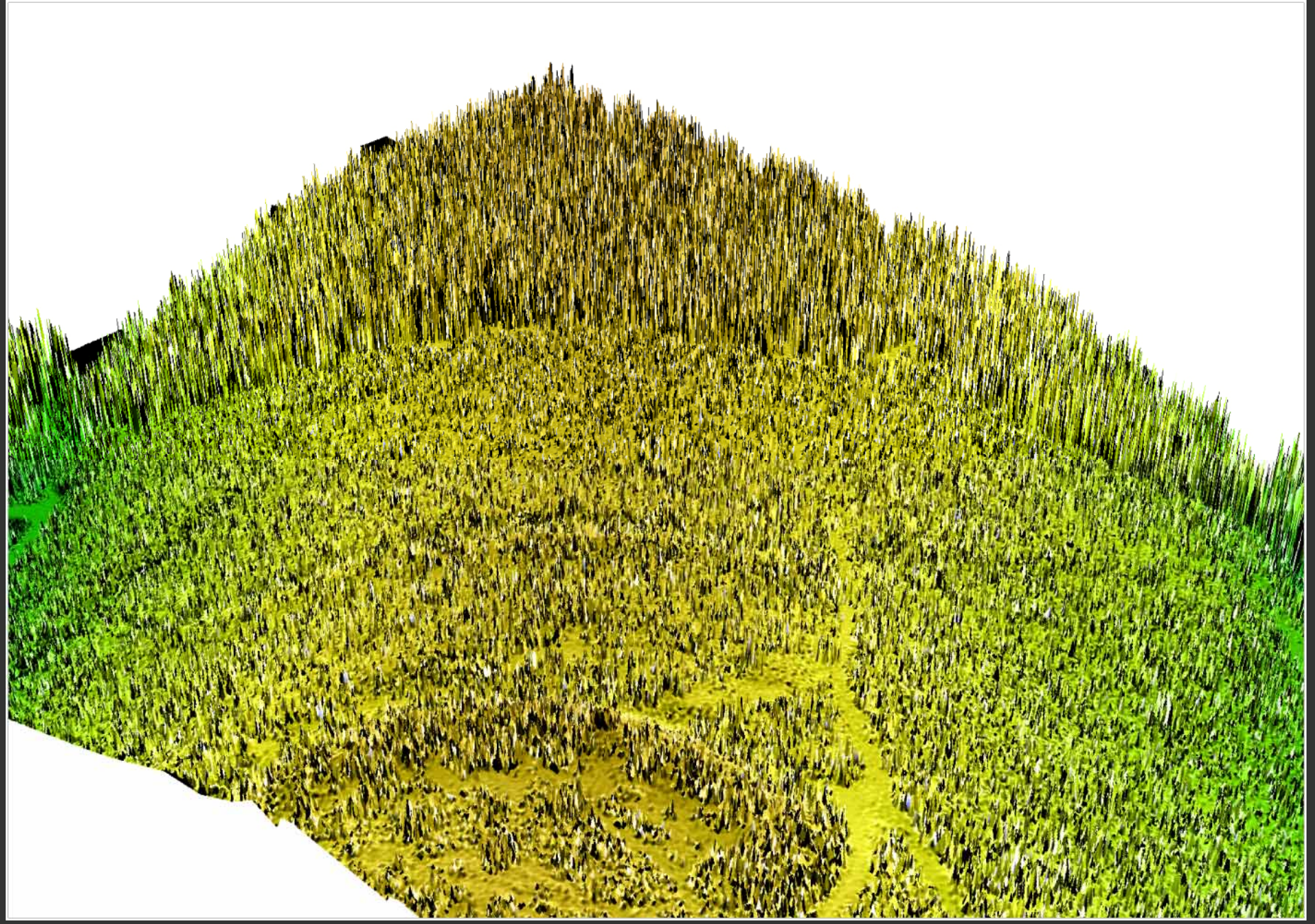
ALS Fallbeispiel mit Full Waveform DSM



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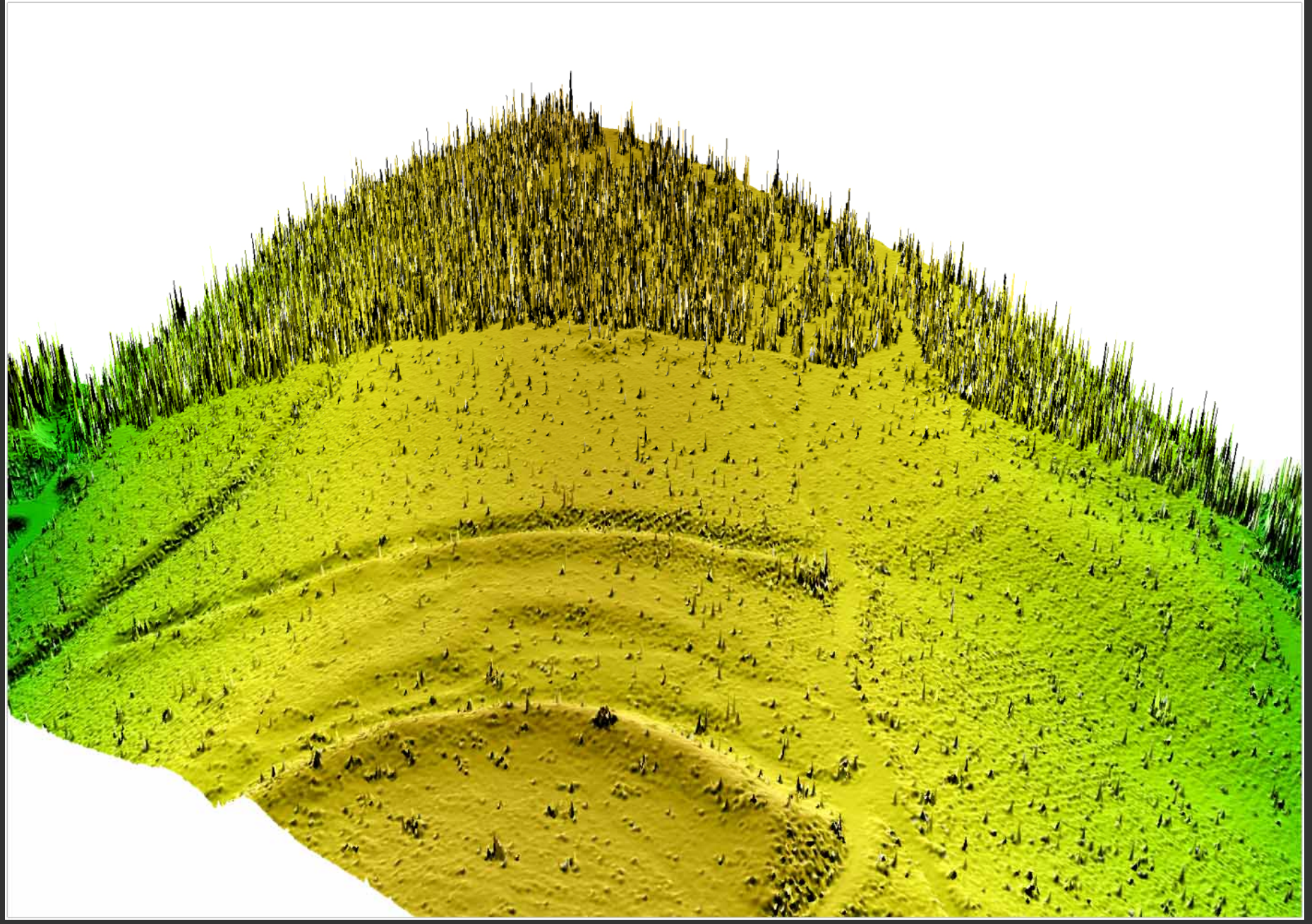
3D-Ansicht von runden Wällen- DSM



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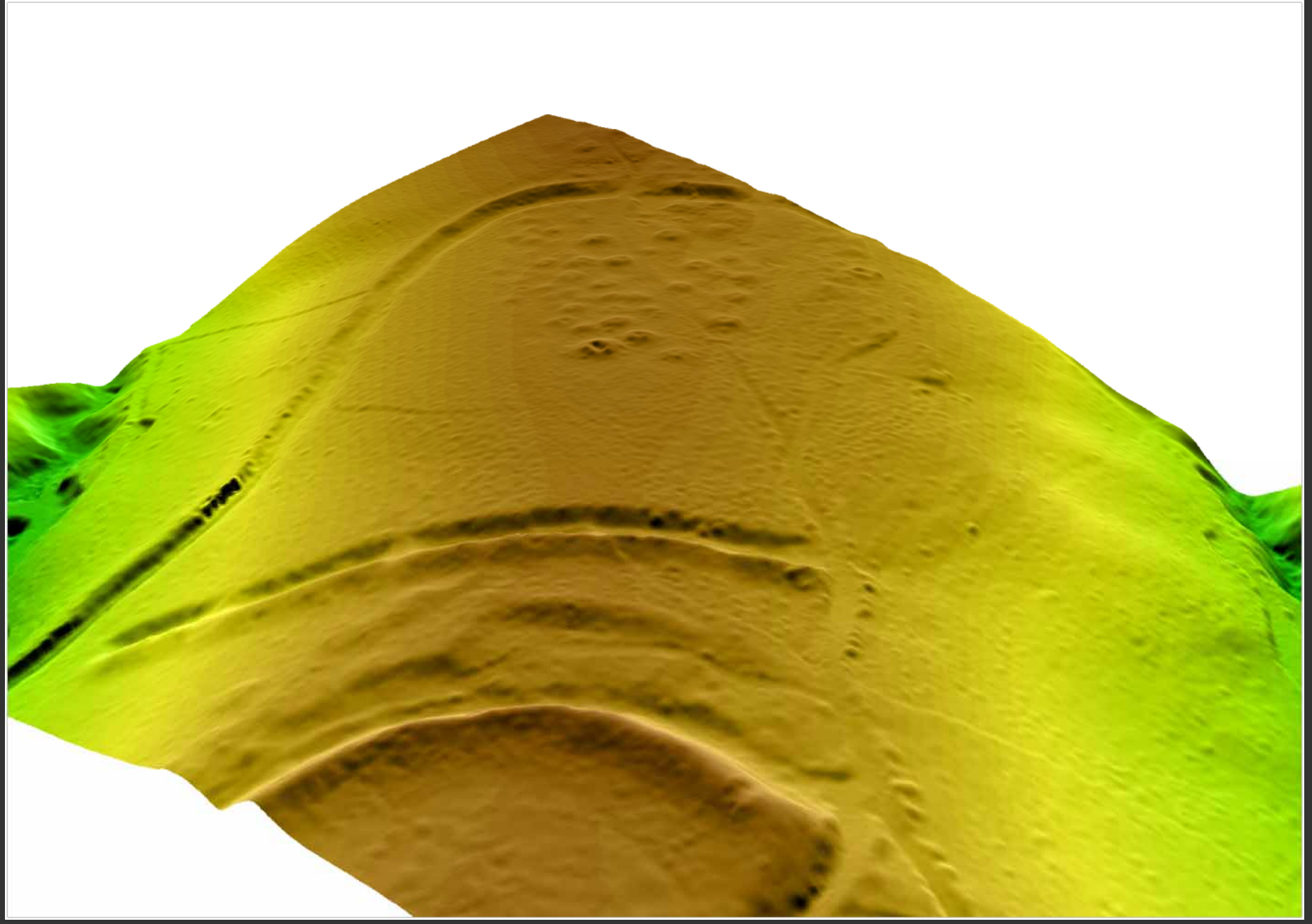
3D-Ansicht von runden Hügelgräber - ungefiltertes DTM



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3D-Ansicht von runden Hügelgräber - gefiltertes DTM (Impulsbreite)

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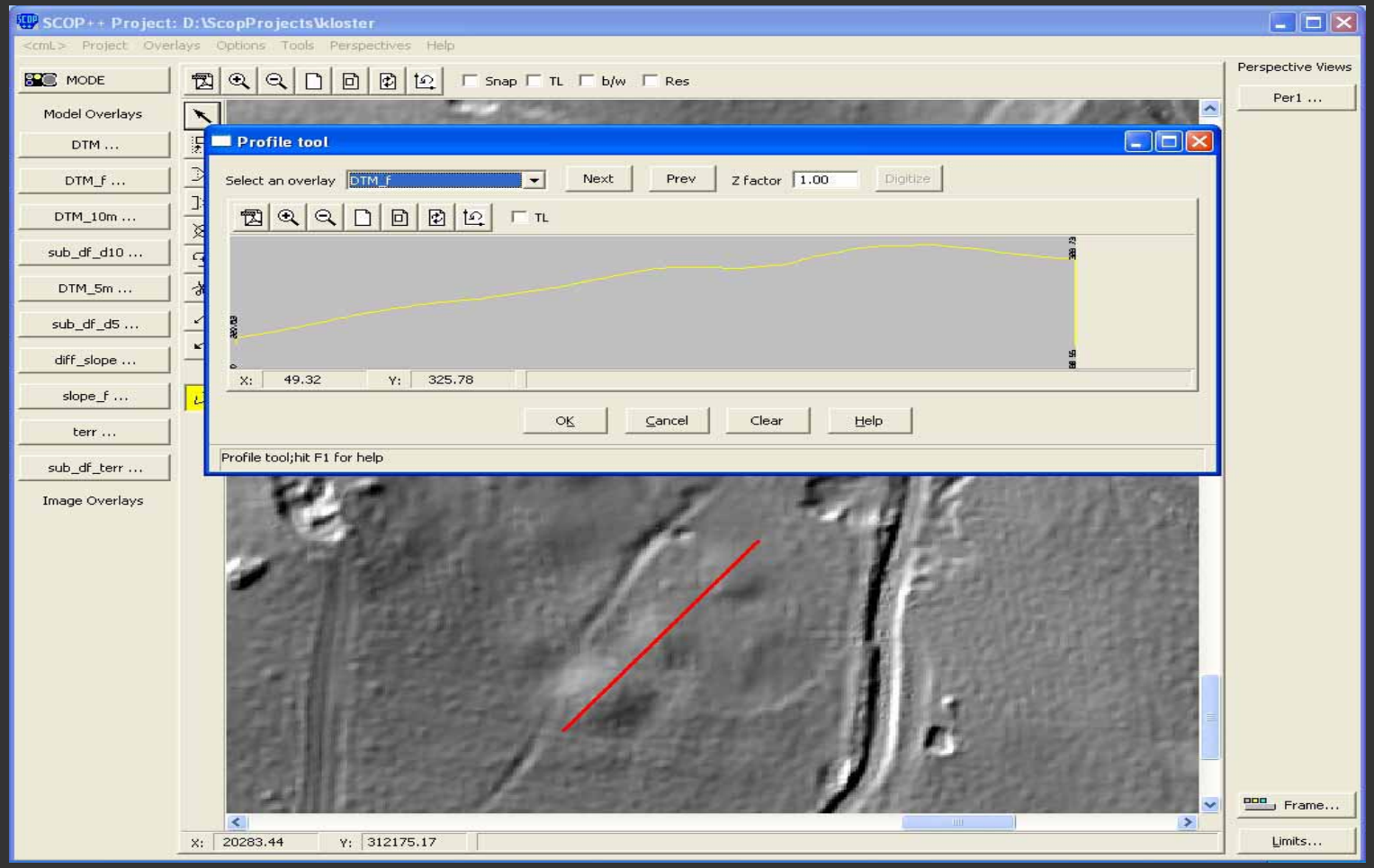
3D Punktwolke nach Entfernung von Echo Signalen
mit großer Impulsbreite in ein Luftbild eingeblendet



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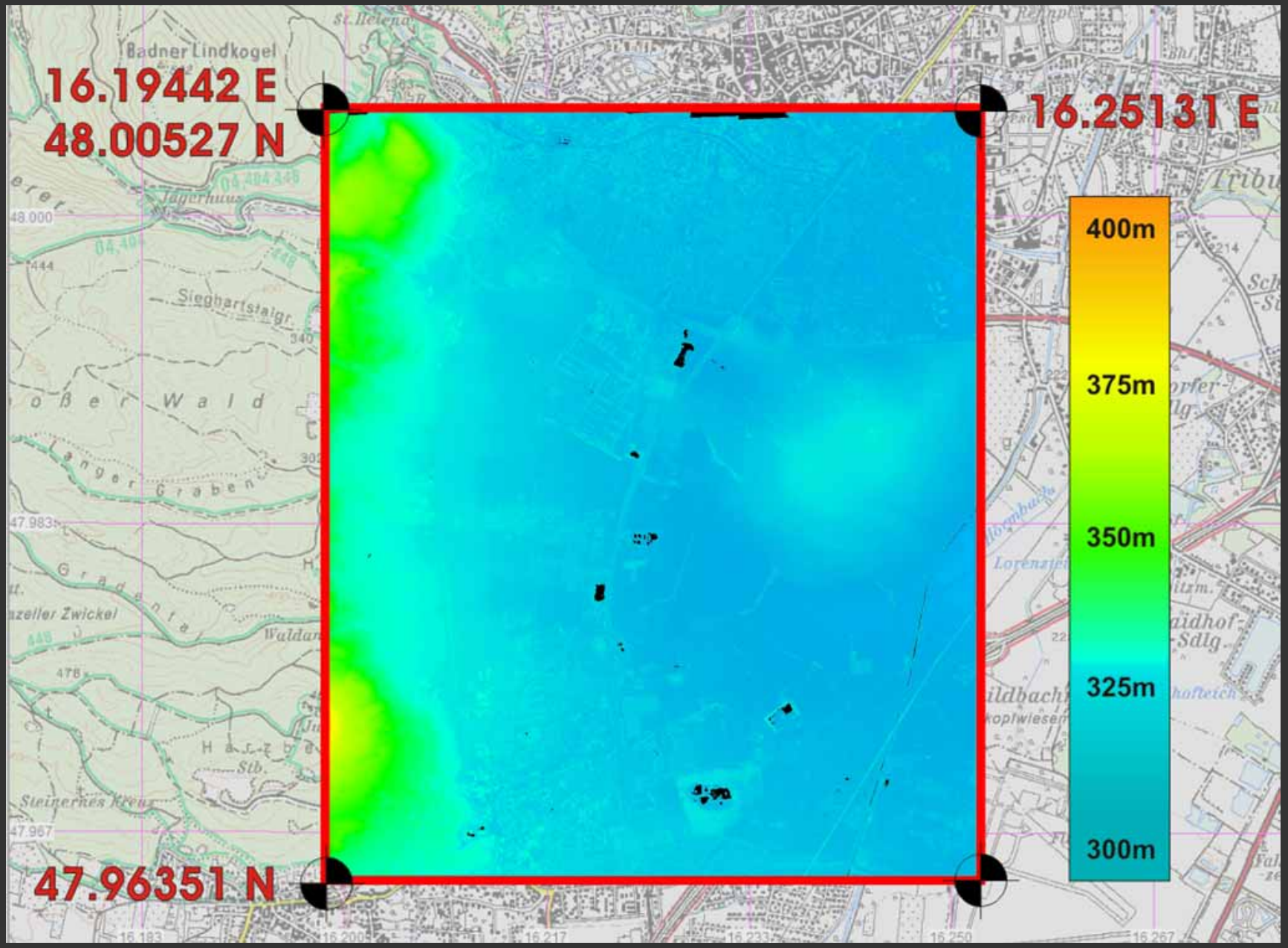
Runde Hügelgräber - Querschnitt

Survey Evaluation – height color-coding (DSM)



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Diamond AIRBORNE SENSING

Beispieldaten

Turnkey Solution for Airborne Laser Scanning		
aircraft	Diamond DA42 MPP	
air speed	40 m/s - 80 m/s	
laser scanner	RIEGL LMS-Q560, full waveform capabilities	
spatial density, 40 m/s (2 laser scanner)	AGL = 500 m	AGL = 800 m
@ 2 x 50 kHz PRR	3 meas / m²	1.8 meas / m²
@ 2 x 100 kHz PRR	6 meas / m²	3.6 meas / m²
@ 2 x 200 kHz PRR	12 meas / m²	7.2 meas / m²
storage capacity	> 8 hours of full waveform data recording	
ranging accuracy	2 cm	
geo-referenced accuracy	10 cm experimental data: less than 3 cm (1σ) with reference objects, after post-processing	
approvals	certification category EASA part 23 (Europe), FAR23 (USA) , enables worldwide operation	

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Diamond AIRBORNE SENSING

Spezifikation des ALS Gesamtsystems

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ALS & TLS Gesamtsystem (11. & 15. 1. 2007)

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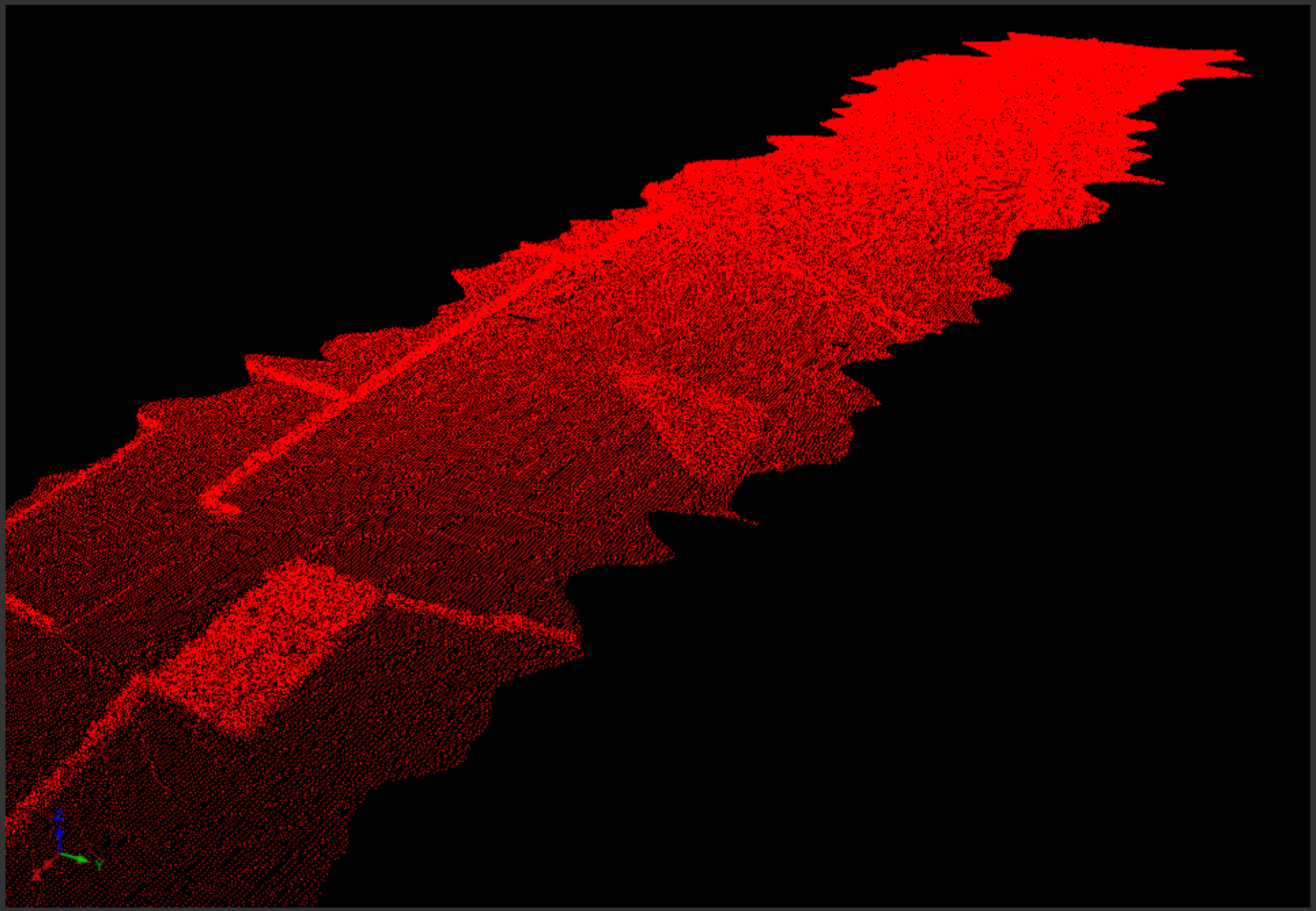
LOAG Flugplatz Krems Gneixendorf / Österreich



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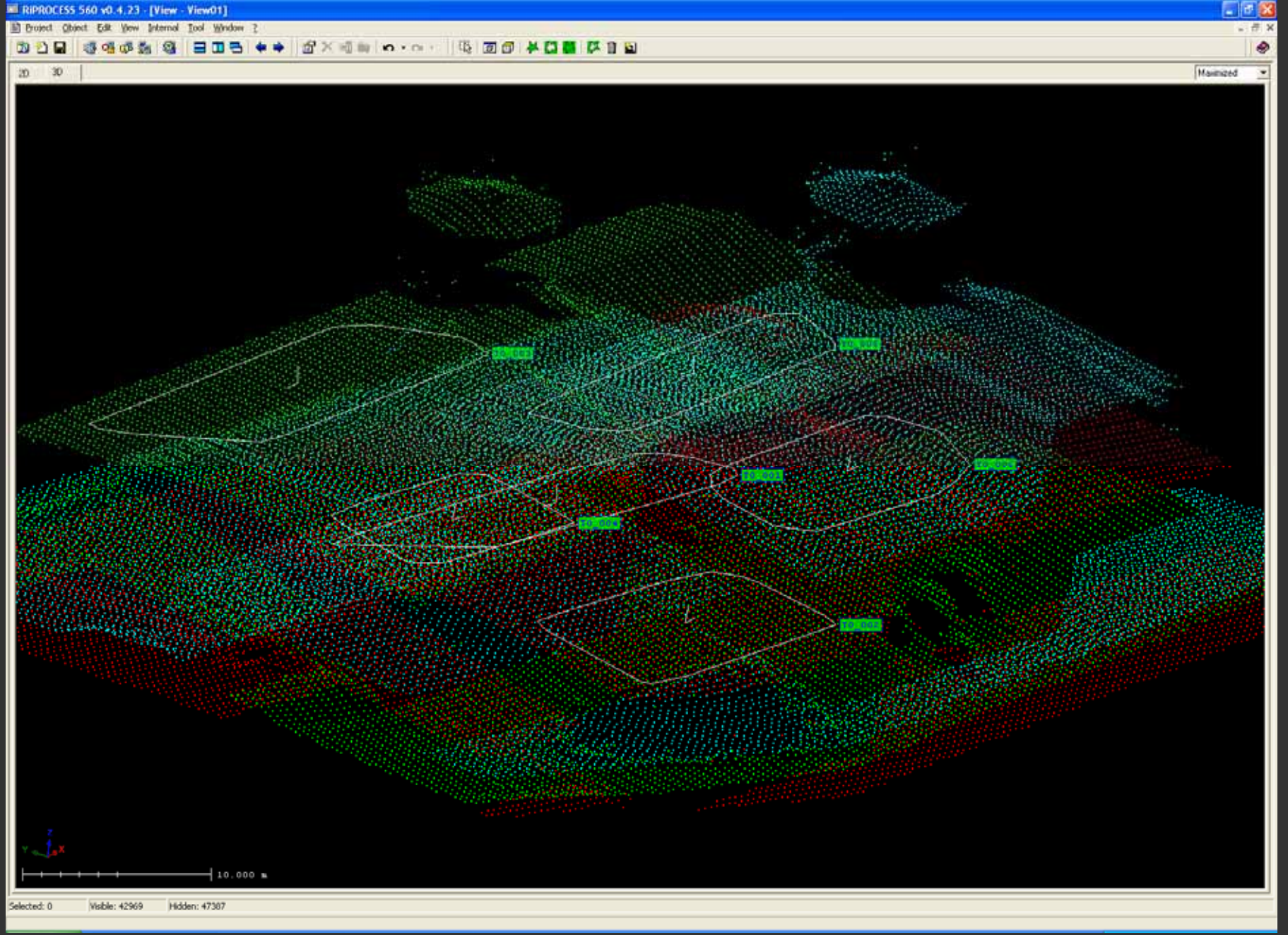
LOAG Flugplatz Krems Gneixendorf / Österreich



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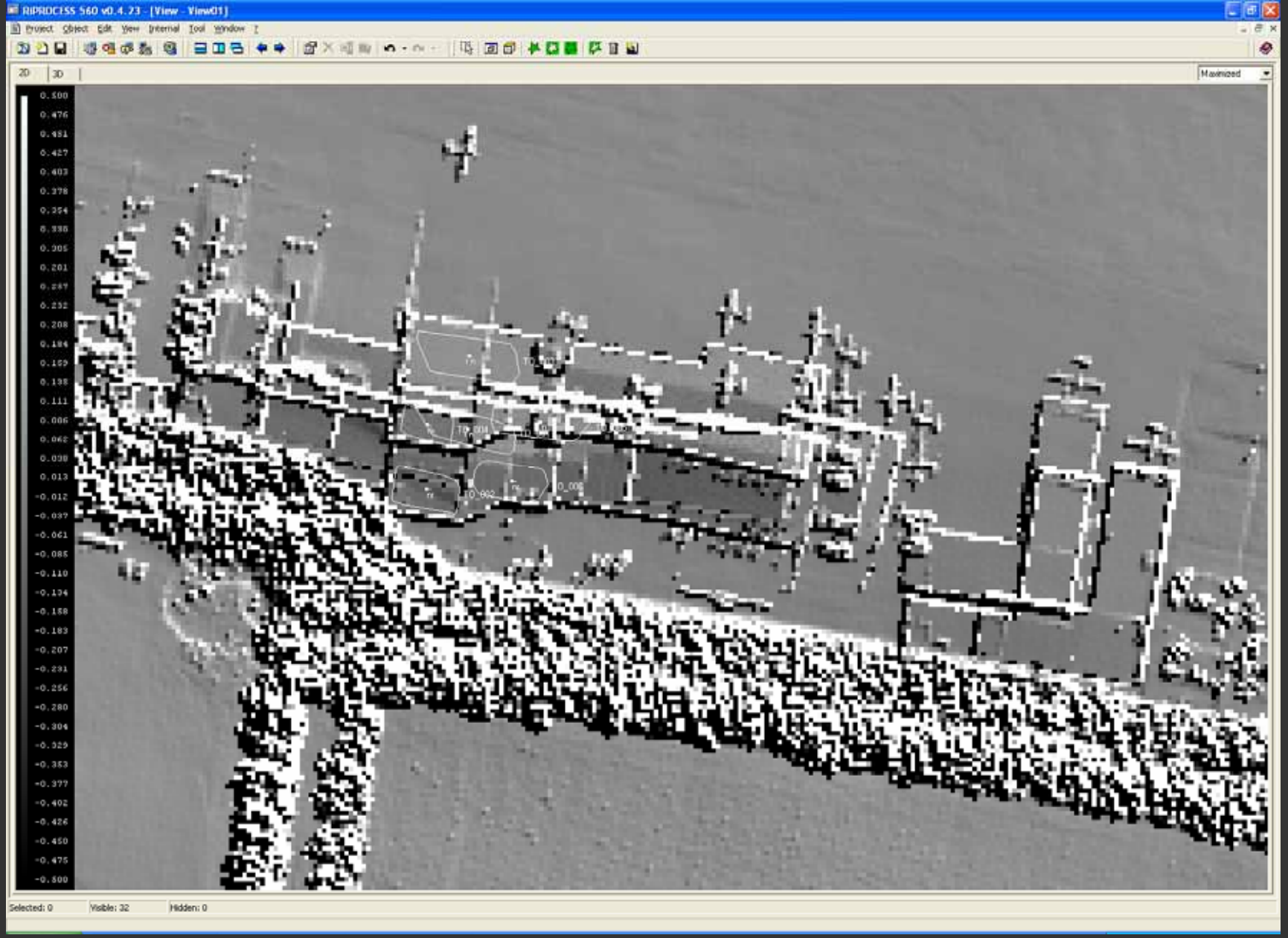
„Plane Patches“ vor dem Streifenausgleich, Punktewoken



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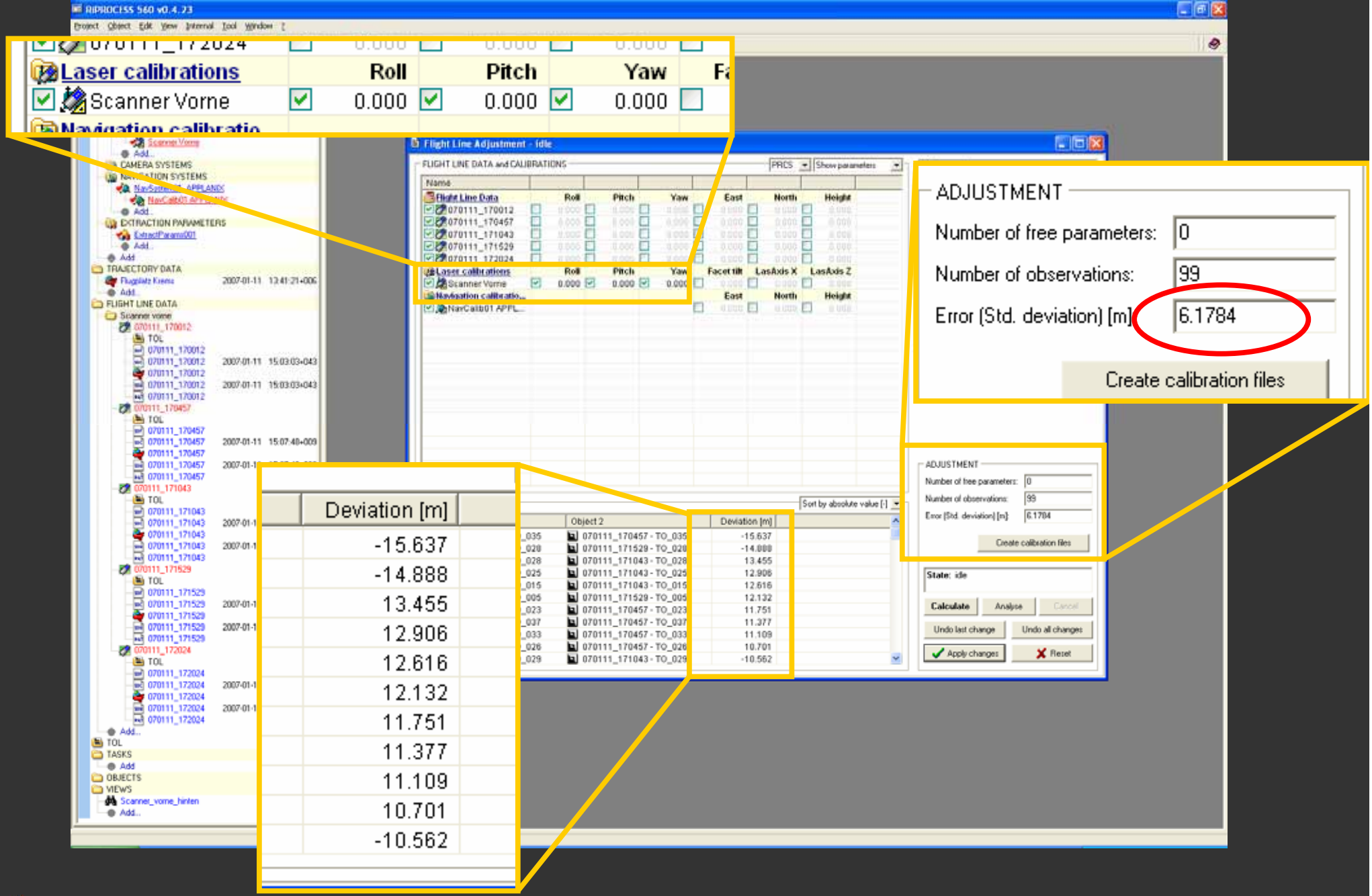
„Plane Patches“ vor dem Streifenausgleich, schattierte Ansicht von oben



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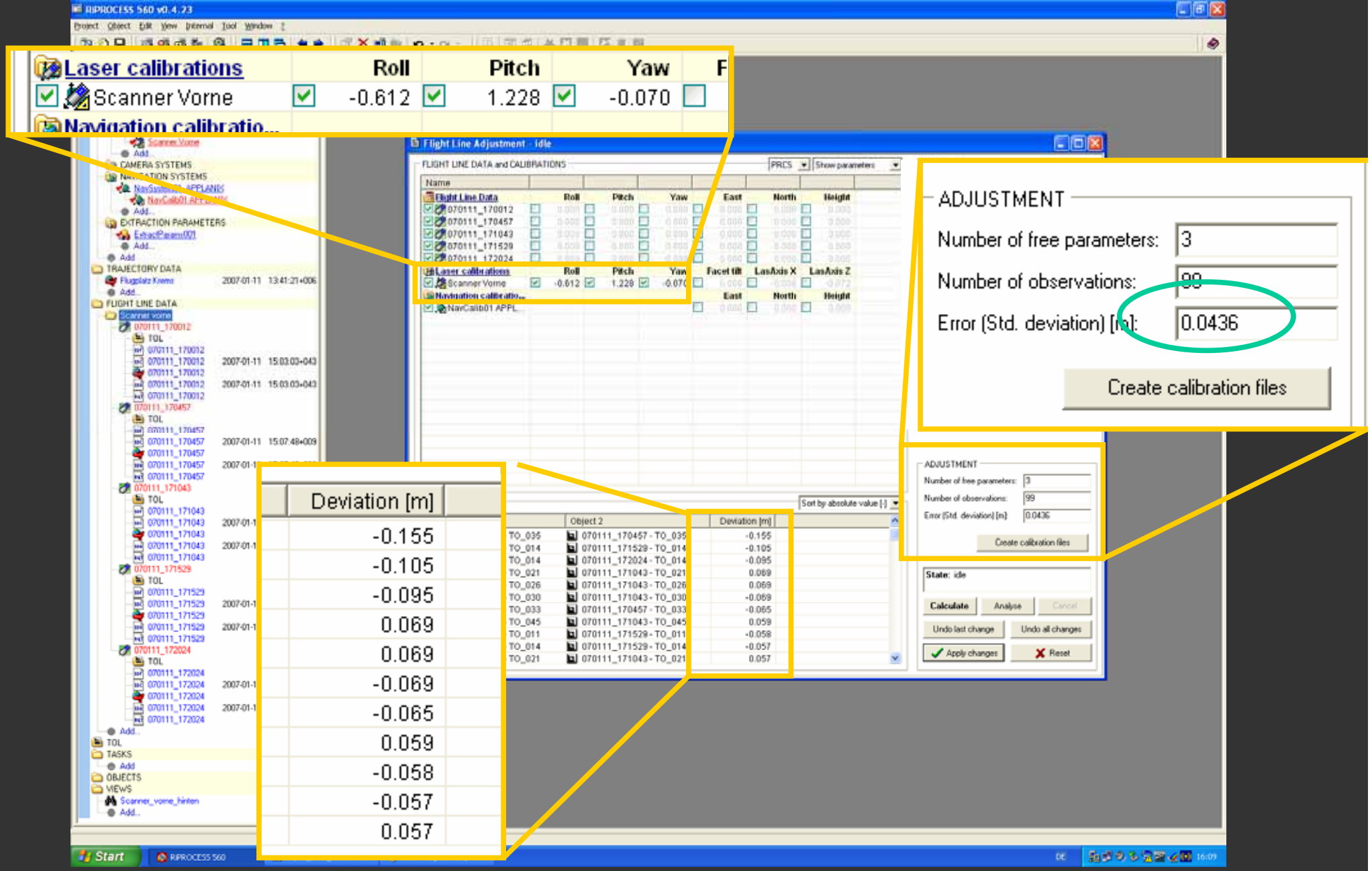
Vor simultanem Streifenausgleich



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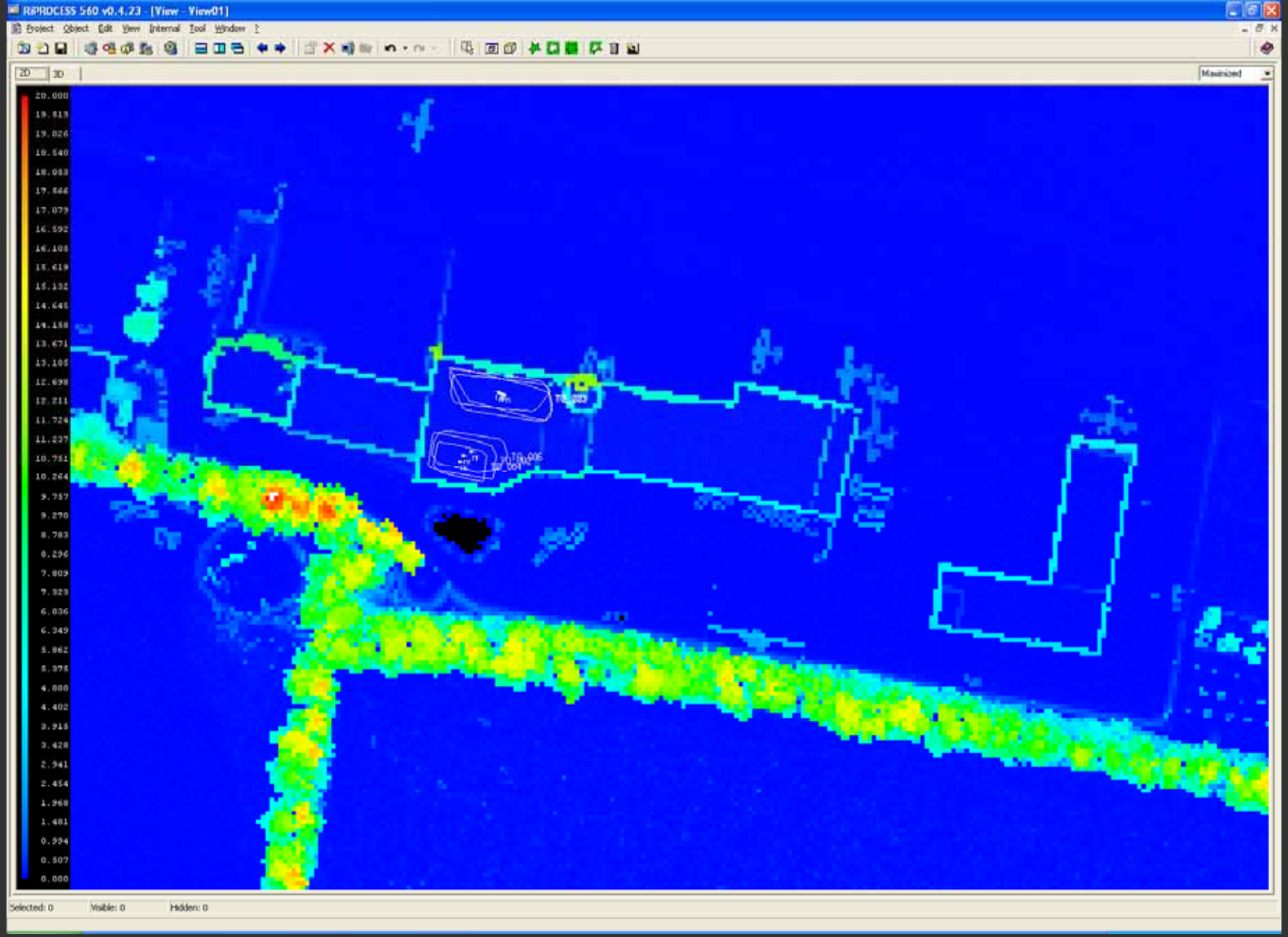
Nach simultanem Streifenausgleich und Einbaulage-Kalibrierung



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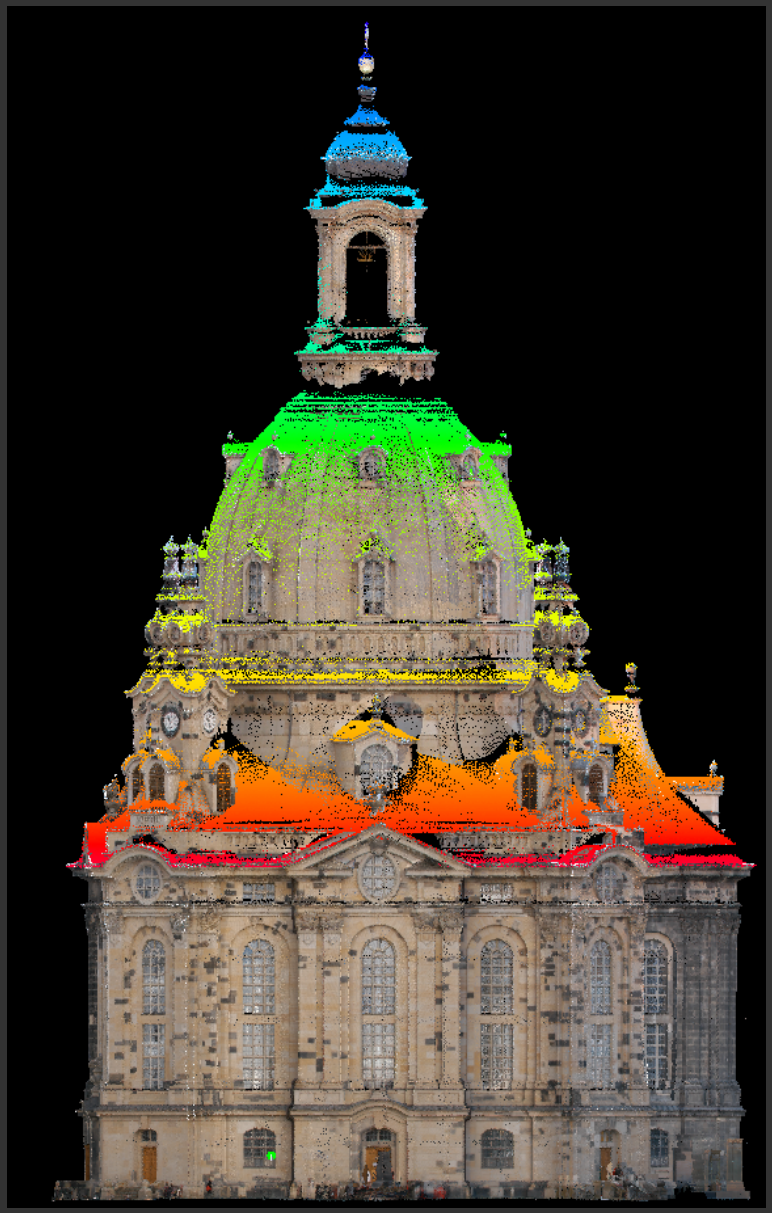
Nach simultanem Streifenausgleich und Einbaulage-Kalibrierung



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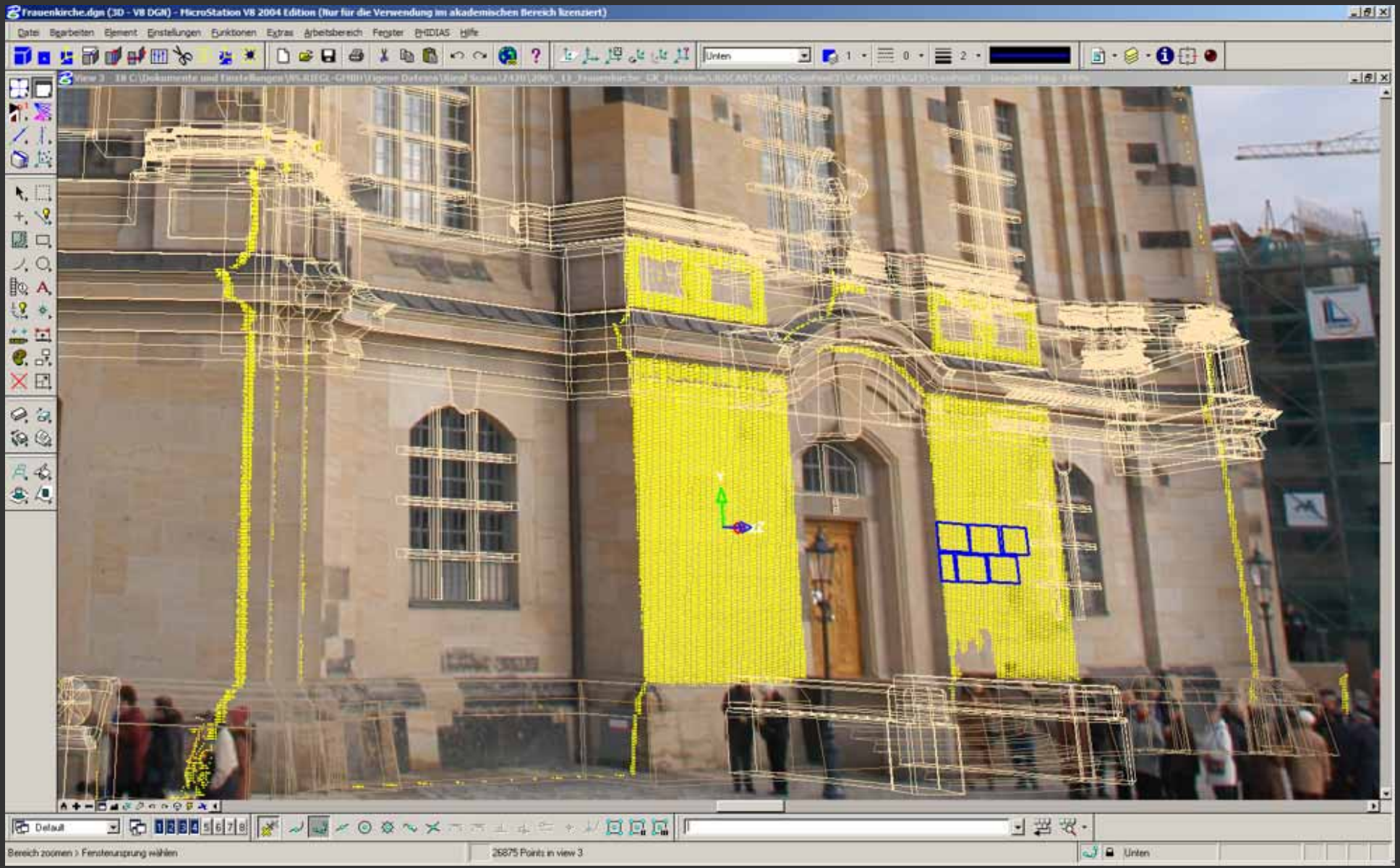
TLS (Echtfarbe) kombiniert mit ALS (farbkodiert)



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3D CAD Modellierung mithilfe von 3D Monoplotting (Phidias)

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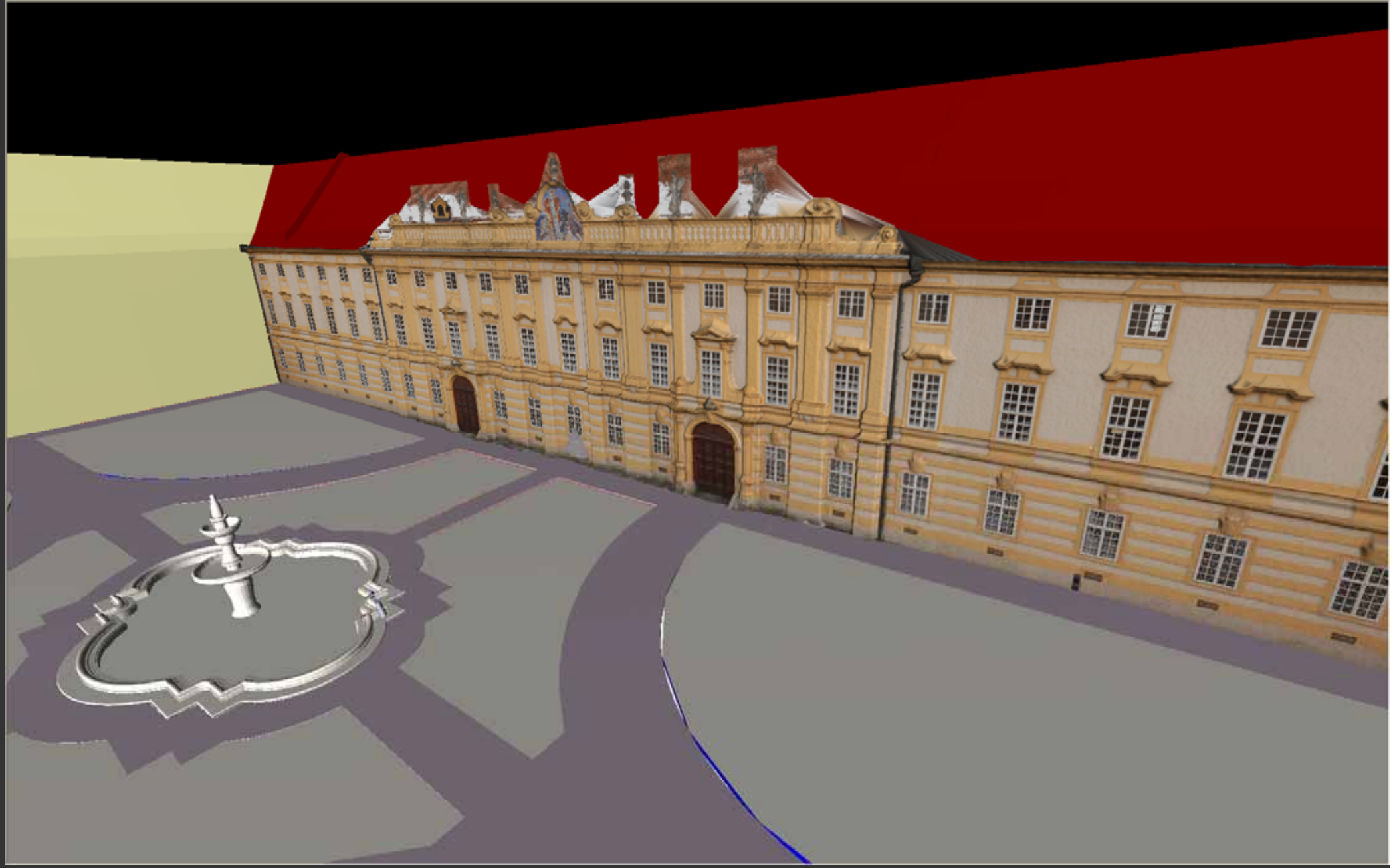
3D CAD Modell aus TLS und ALS Laser Scandaten



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Beispiel TLS Scan – 3D Modell

MLS 2D Laser Scanner Q240 am Boot (Frankreich)

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MLS am Meßschiff (Hafen von Marseille)

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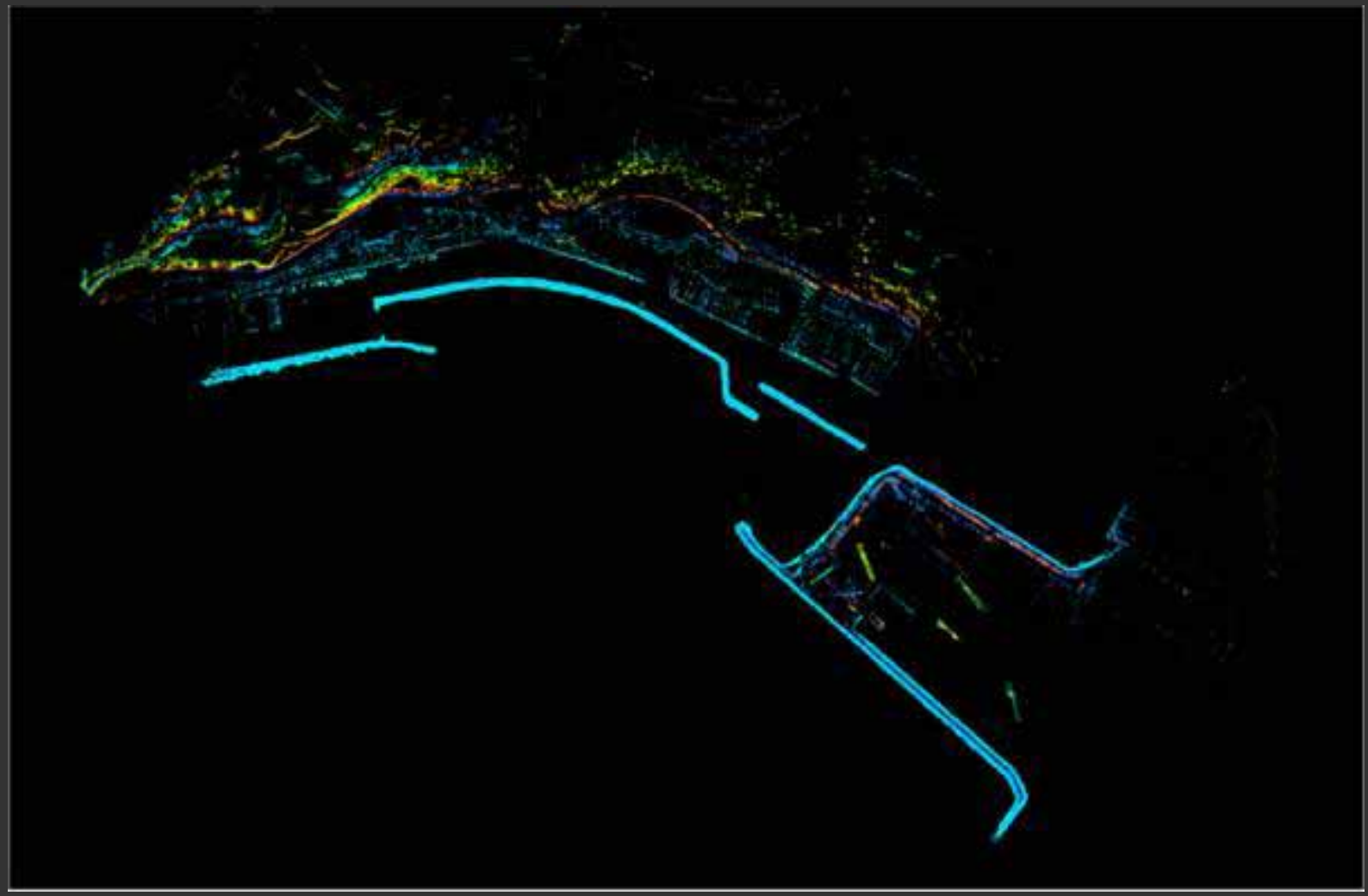
Google Earth: Hafen von Marseille



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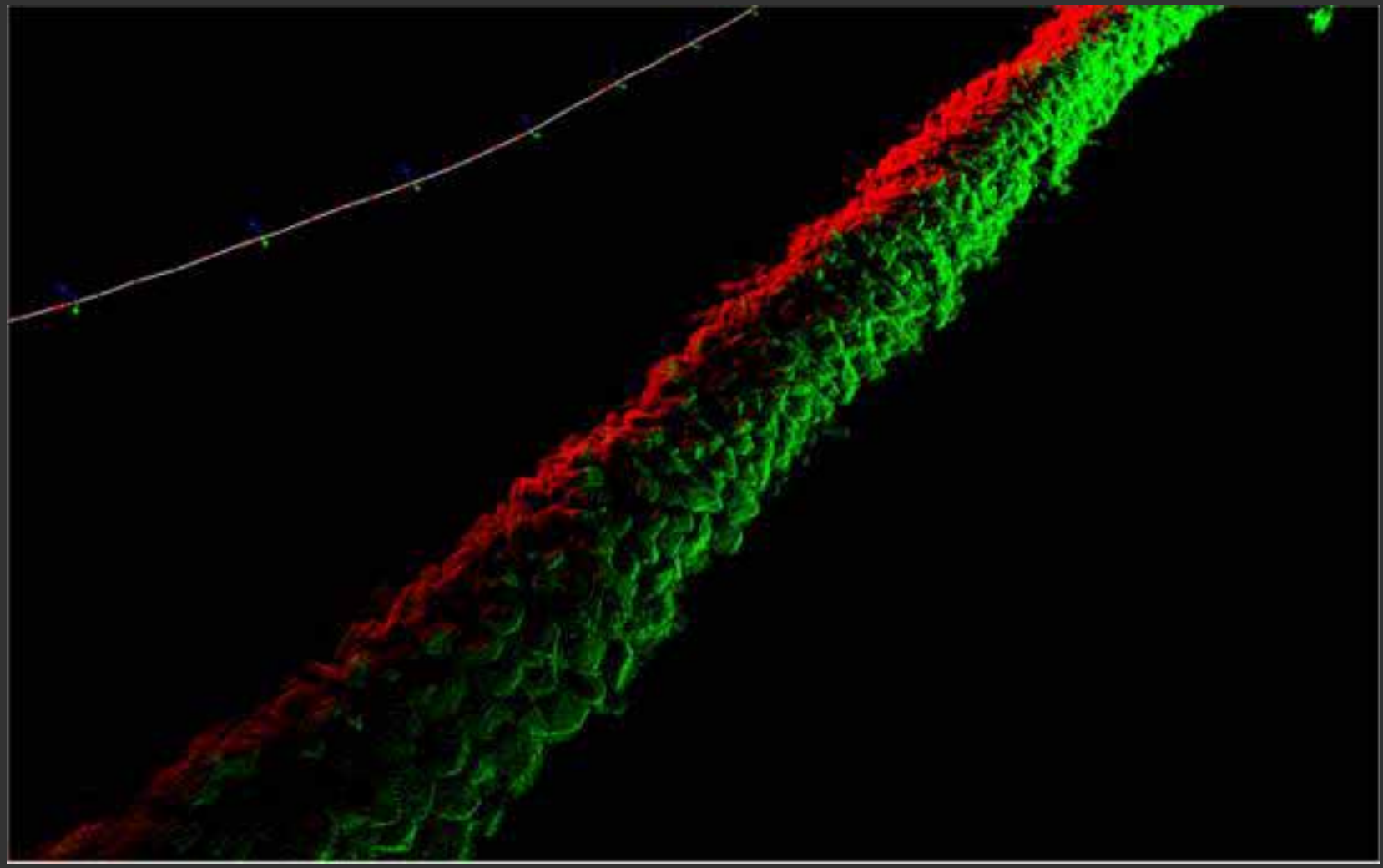
RiSCAN PRO: Hafen von Marseille



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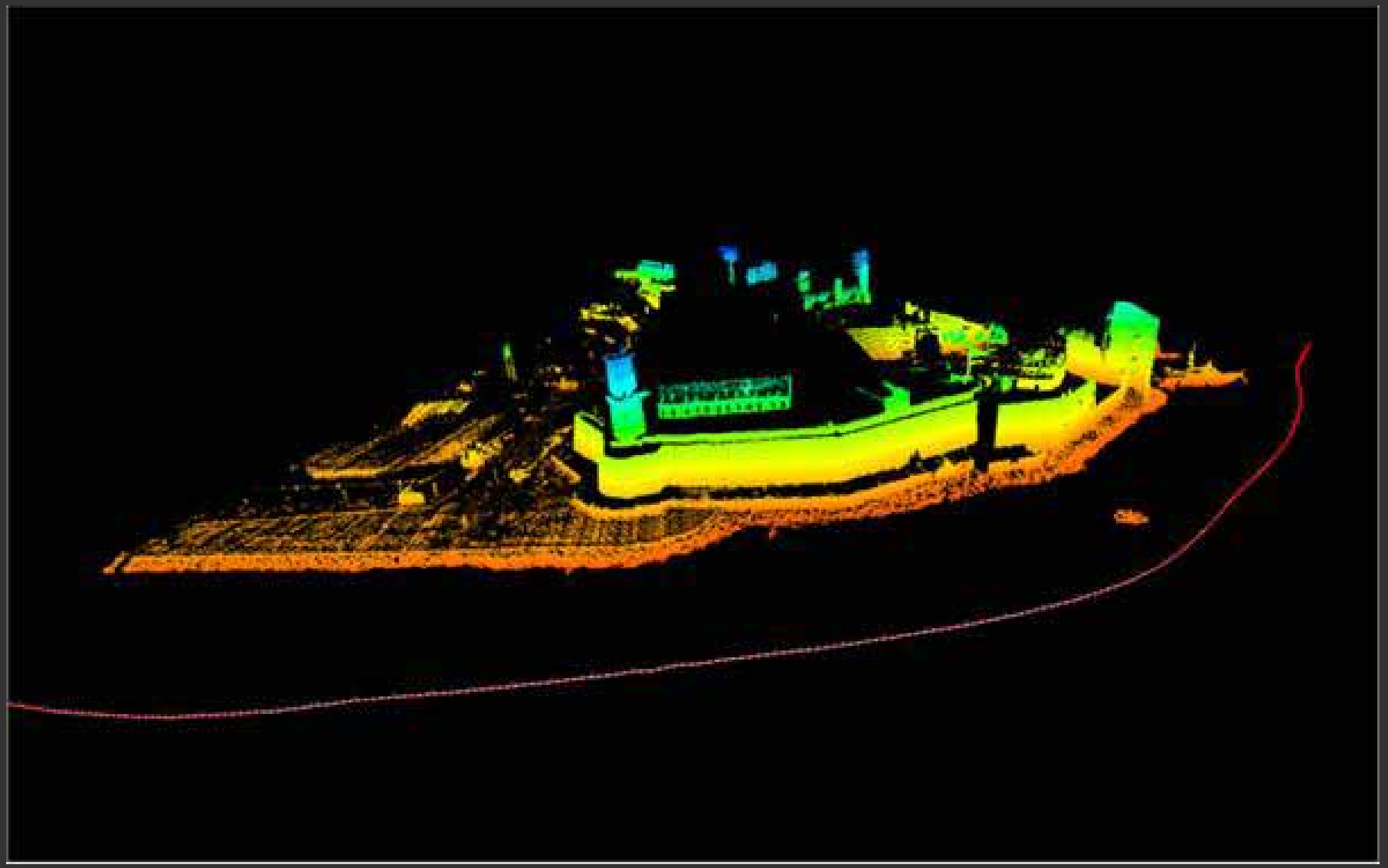
MLS Meßdaten mit Trajektorie des Meßschiffes



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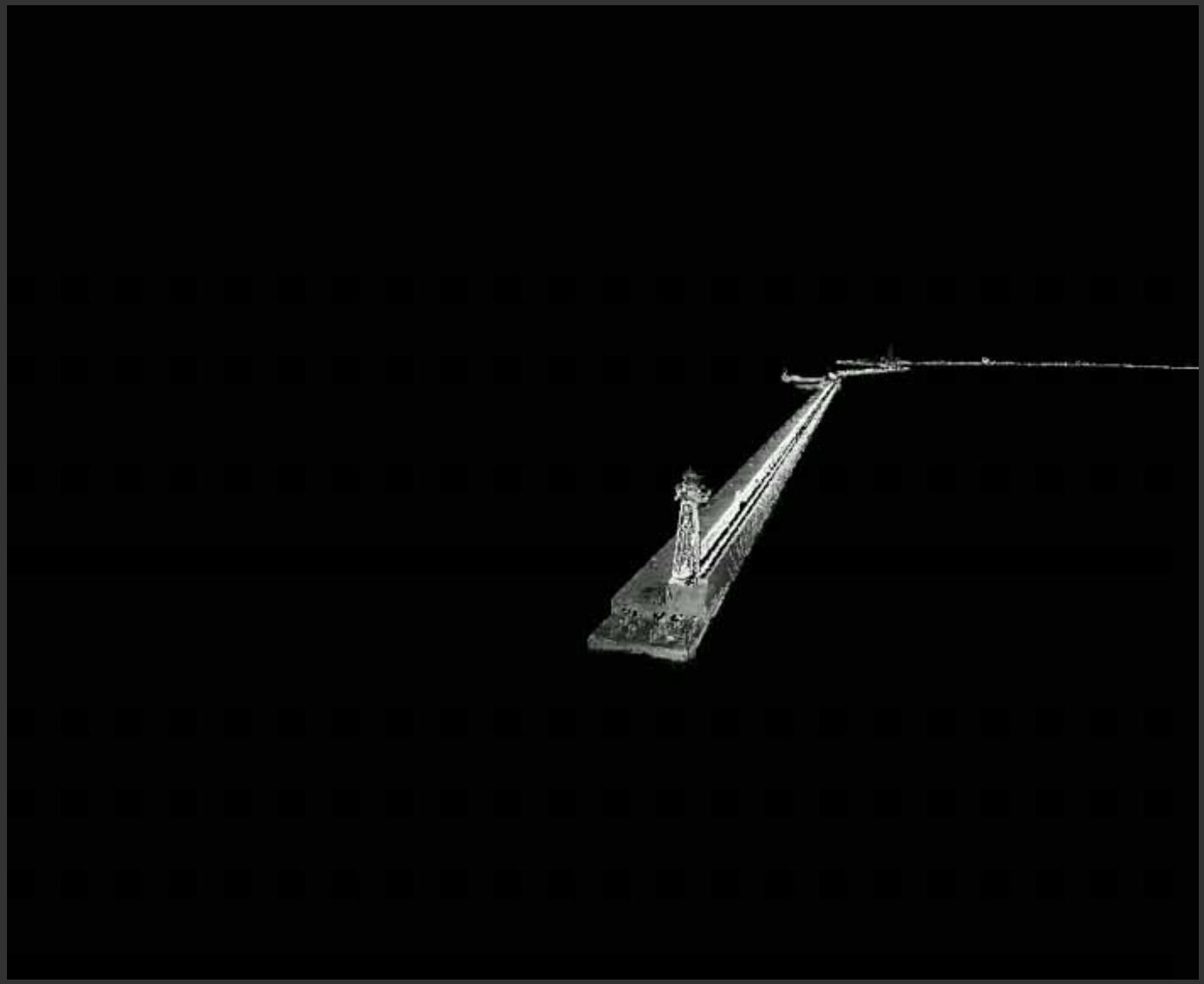
MLS Meßdaten mit Trajektorie des Meßschiffes



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MLS Meßdaten

Vielen Dank für Ihre Aufmerksamkeit!

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Port of Marseille (Hafen von Marseille)

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