

An aerial photograph of a dry lake bed, showing a large, flat, light-colored area of exposed earth and sand. The lake bed is surrounded by a dense forest of green trees. A blue semi-transparent banner is at the top, and a green line is at the bottom.

skyability

Vom Ufer bis zur Gewässersohle

Ein Praxisbericht zur Laserbathymetrie in Binnengewässern

skyability

Wir bieten:

- Datenerfassung
- Daten-Processing
- Ableiten von Informationen
- Datenservice

Wir stehen für:

- 10+ Jahre Erfahrung & Know-How
- Berührungslose Präzision
- Kundenzufriedenheit



WARUM Laserbathymetrie



WARUM Laserbathymetrie

„Wer vermisst den Bereich zwischen Land und Wasser?“

- Landvermessung ✓
- Echolot ✓
- Flachwasser ✕



WARUM Laserbathymetrie

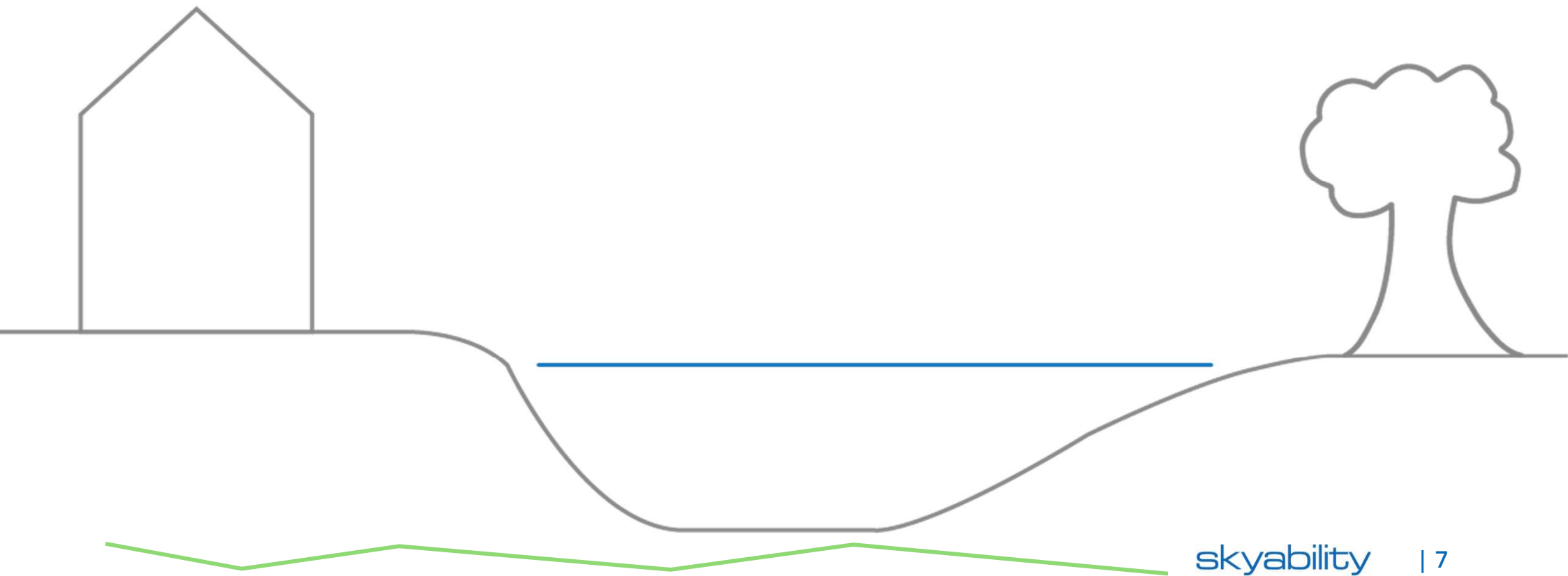
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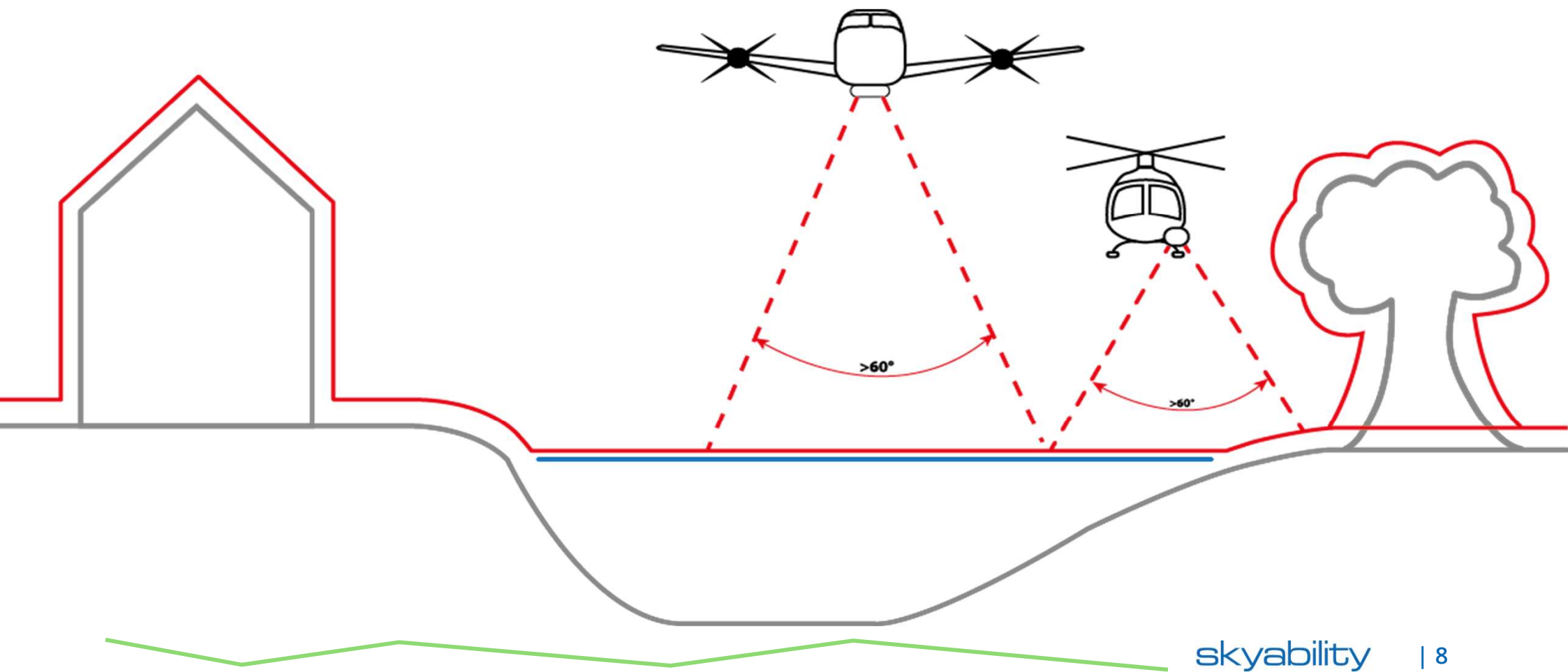
Laserbathymetrie verbindet beide Welten.

- Nahtlose Erfassung des Land-Wasser-Übergangs
- Flächenhafte Vermessung großer Gebiete
- Effiziente Datenerfassung aus der Luft
- Einheitliches digitales Geländemodell

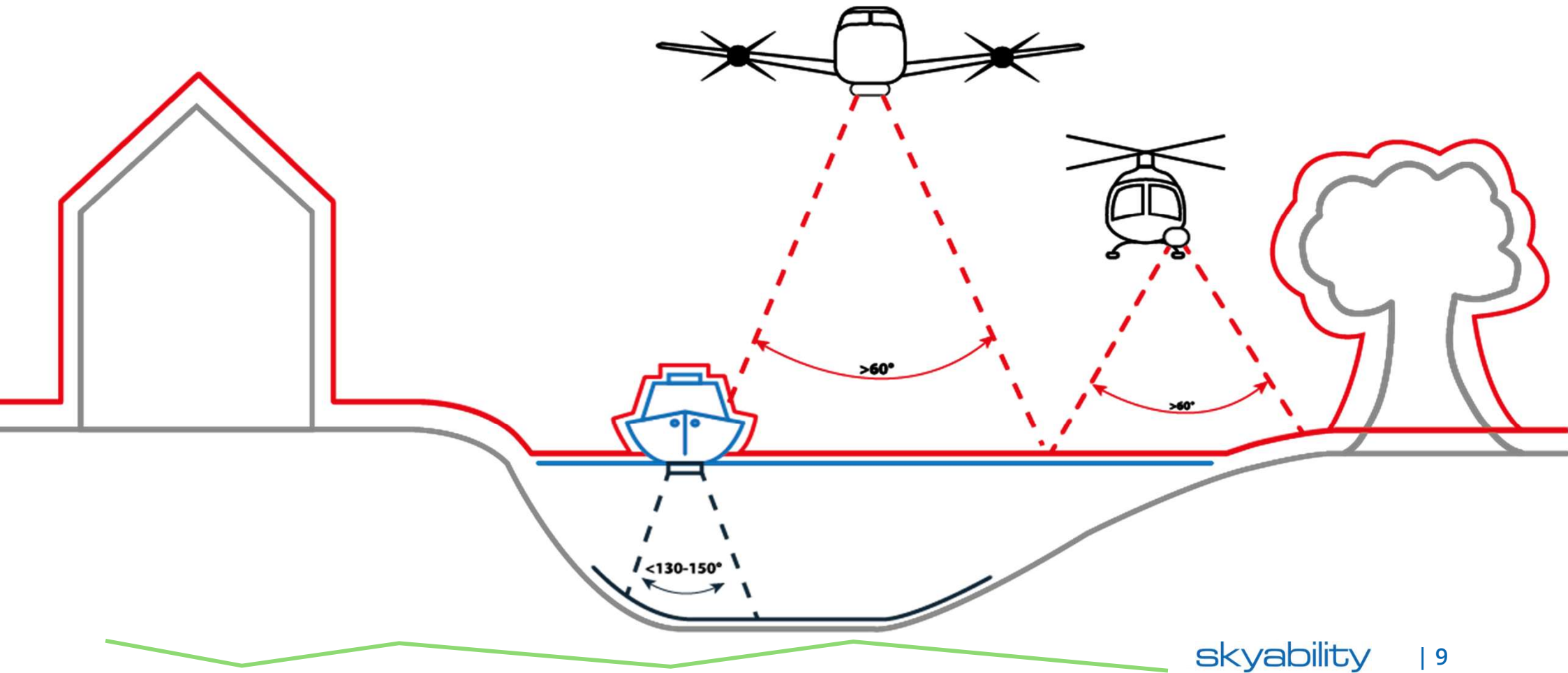
WARUM Laserbathymetrie



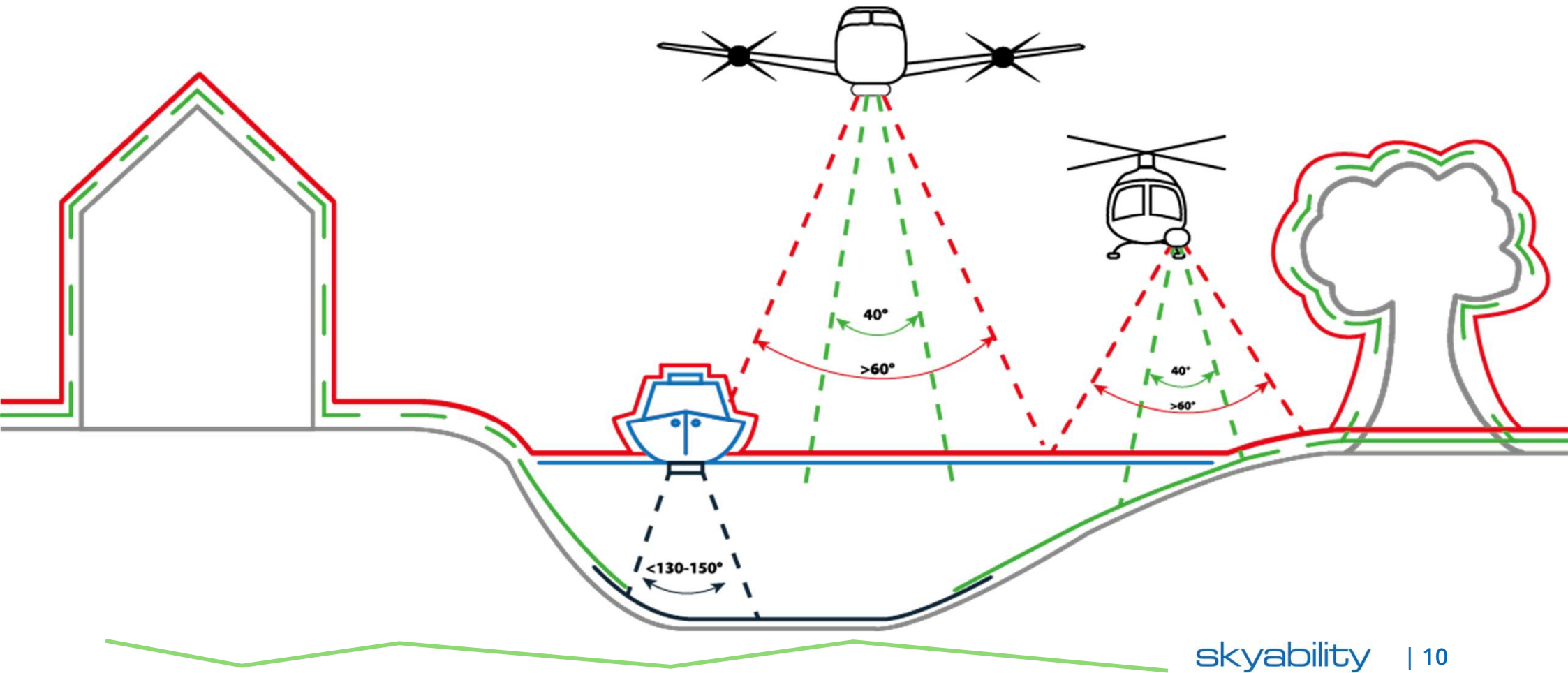
WARUM Laserbathymetrie

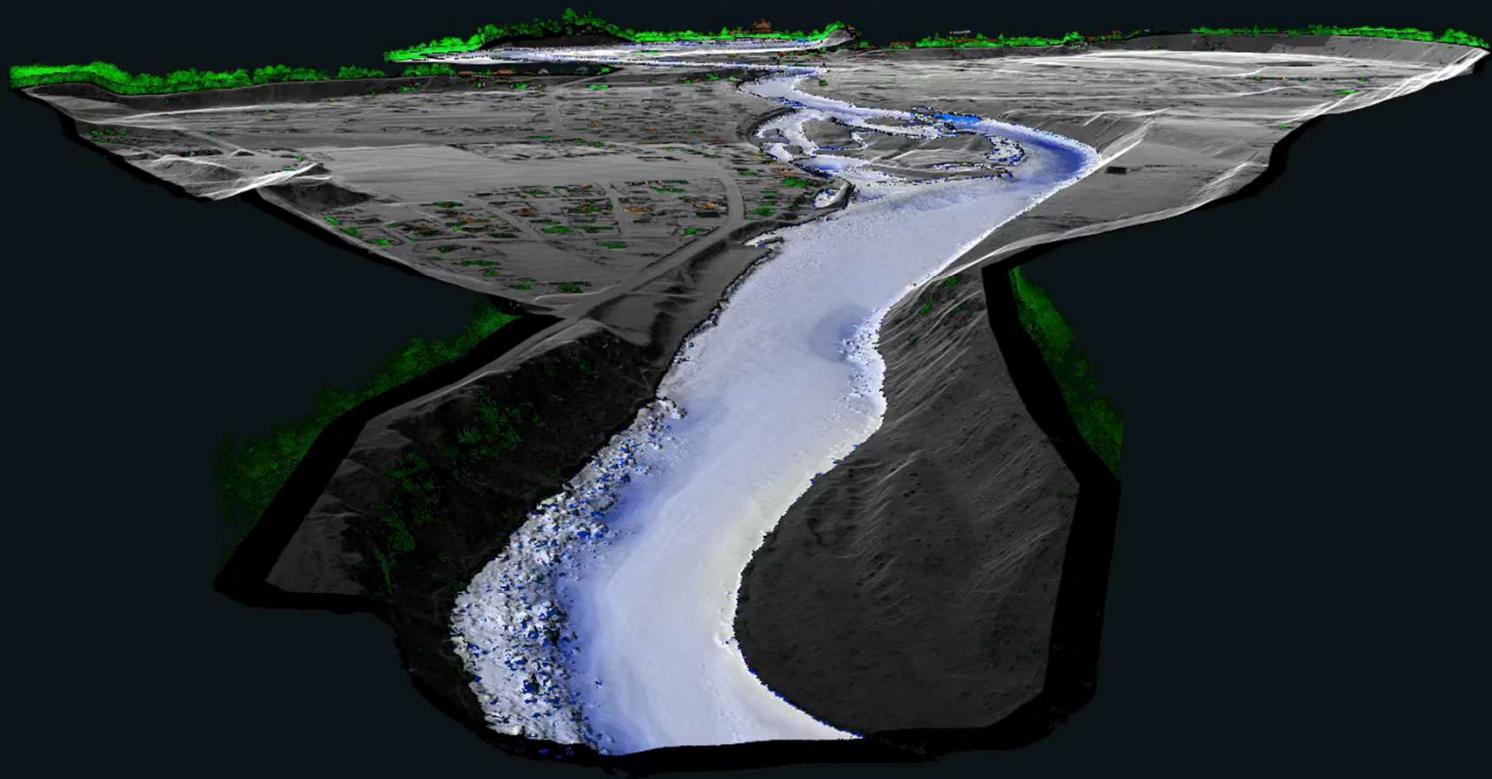


WARUM Laserbathymetrie



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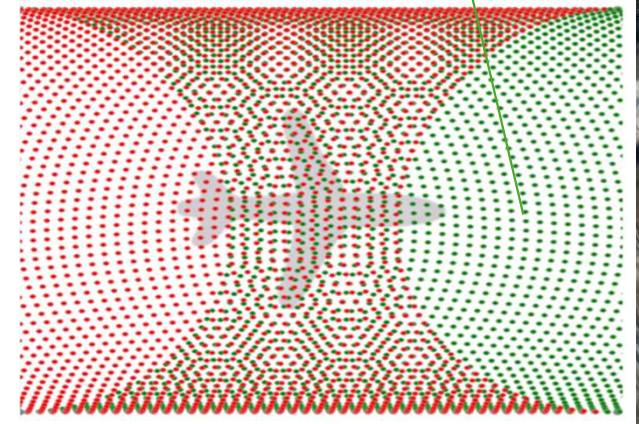
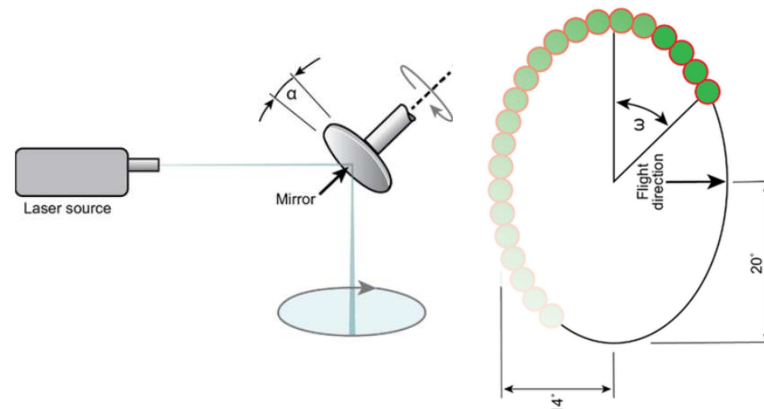




WAS ist Laserbathymetrie

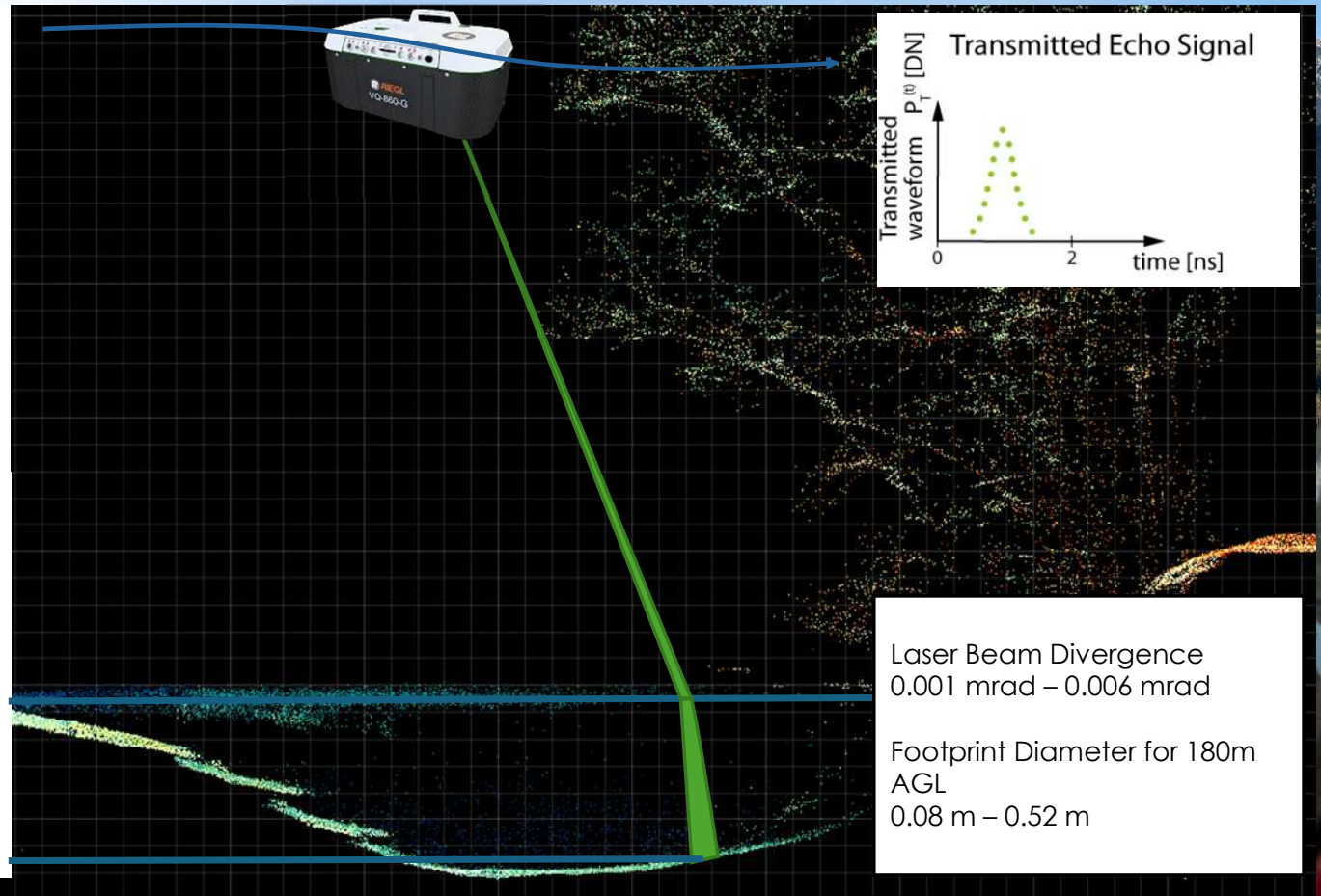
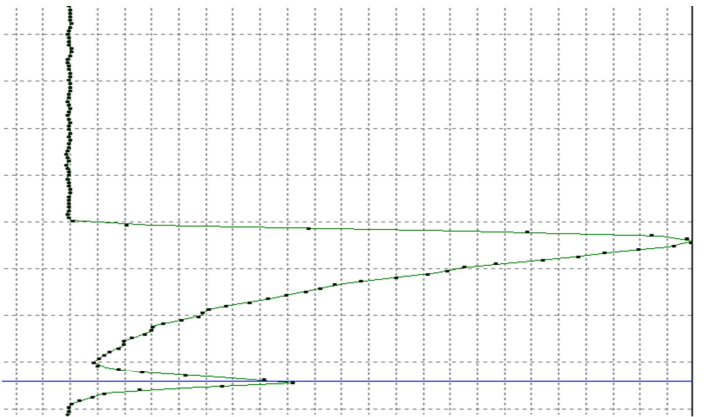
RIEGL VQ-860-G

- GPS / IMU / Transmitter / Receiver
- 355nm / **532 nm** / 690nm / 905nm / 1064nm / 1540nm : „green and visible“
- Elliptic Scanpattern “**Palmer Scanner System**”
- Typ. Footprint 8 - 50 cm
- max. Water Depth Penetration in Secchi Depths 2.0 (*2.5 with PP)
- **Laser Class 3B**



WAS ist Laserbathymetrie

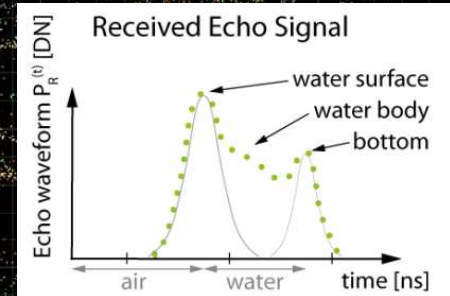
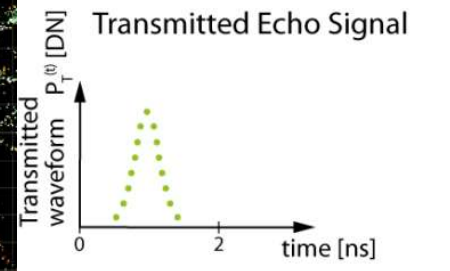
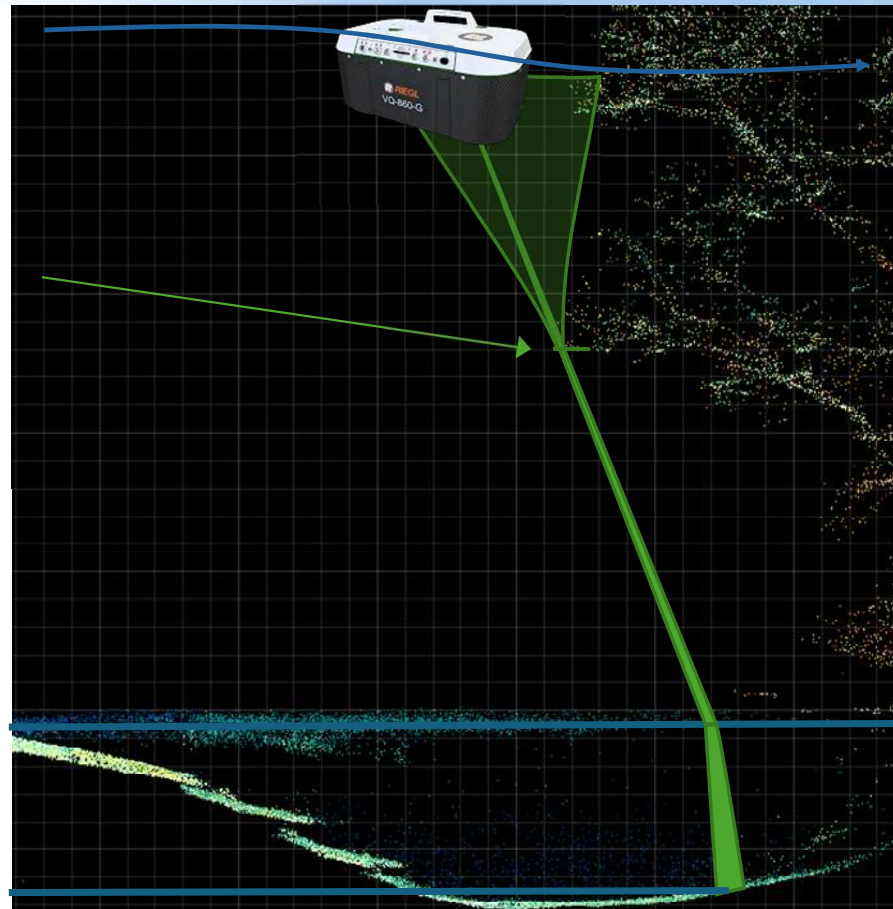
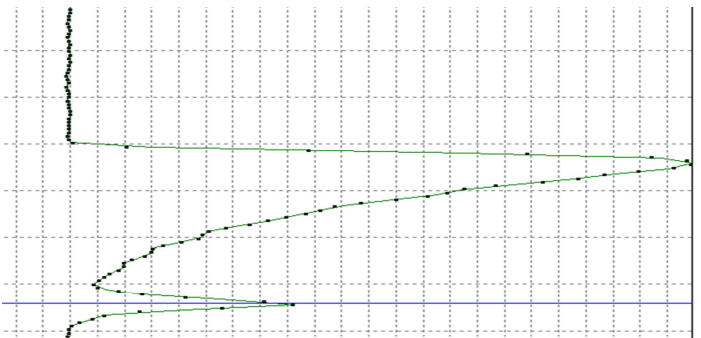
Transmitted Echo Signal:
pulses with PPR 50 kHz to 200kHz



WAS ist Laserbathymetrie

Transmitted Echo Signal:
pulses with PPR 50 kHz to 200kHz

Received Echo Signal
Multiple Targets (1 single shot)
first : **tree echo** ->



Laser Beam Divergence
0.001 mrad – 0.006 mrad

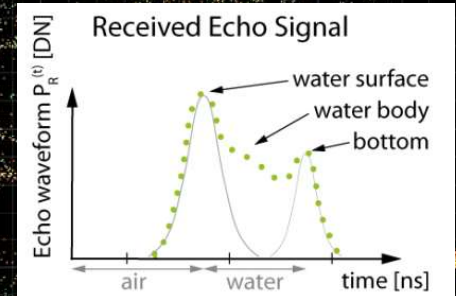
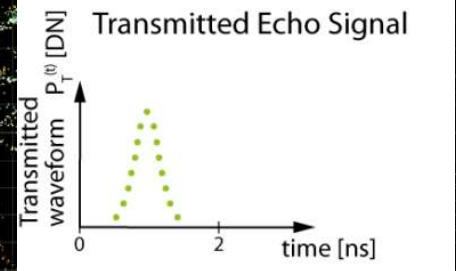
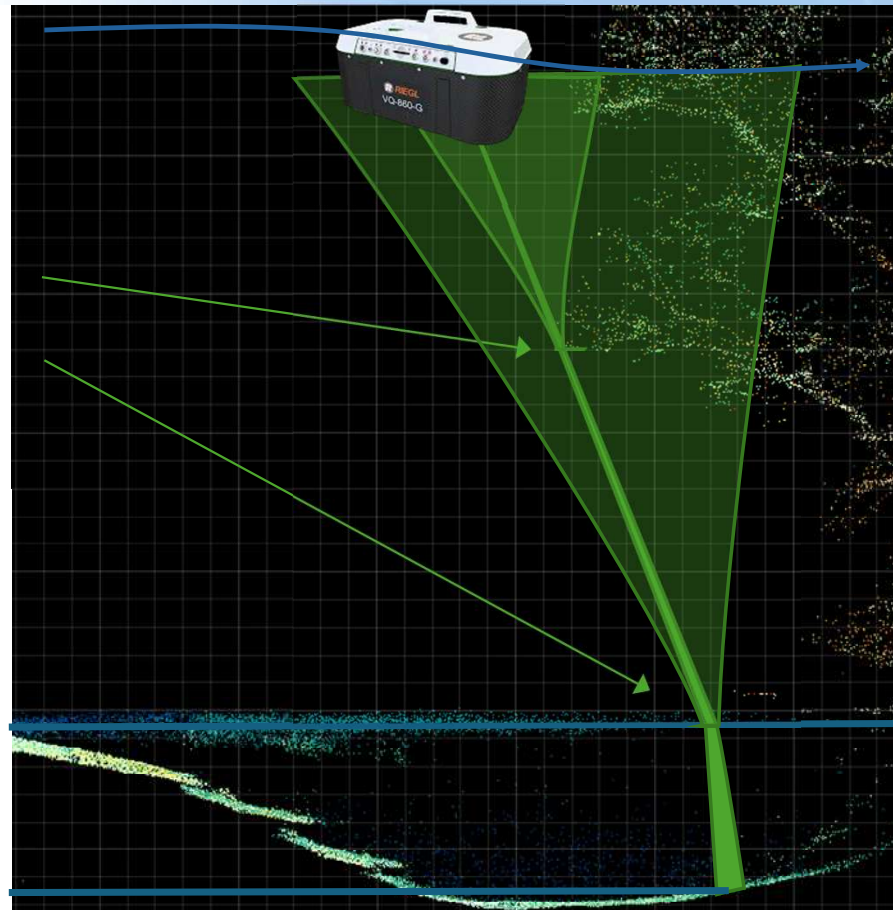
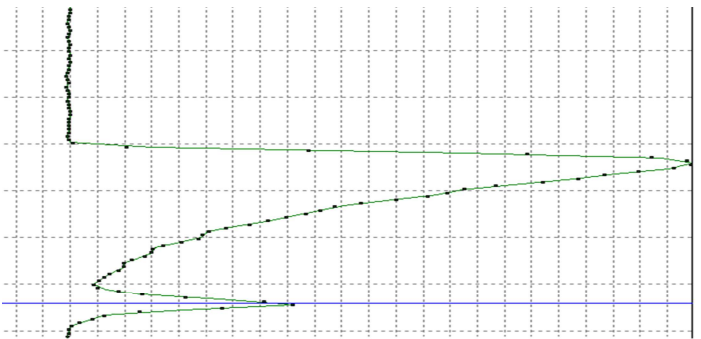
Footprint Diameter for 180m
AGL
0.08 m – 0.52 m

WAS ist Laserbathymetrie

Transmitted Echo Signal:
pulses with PPR 50 kHz to 200kHz

Received Echo Signal
Multiple Targets (1 single shot)
first : **tree echo** ->

intermediate : **watersurface echo** ->



Laser Beam Divergence
0.001 mrad – 0.006 mrad

Footprint Diameter for 180m
AGL
0.08 m – 0.52 m

WAS ist Laserbathymetrie

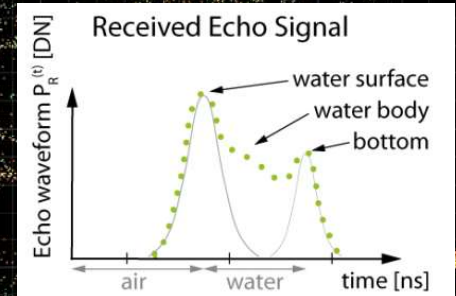
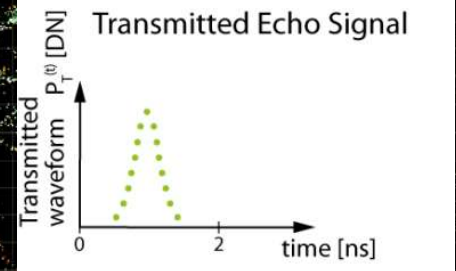
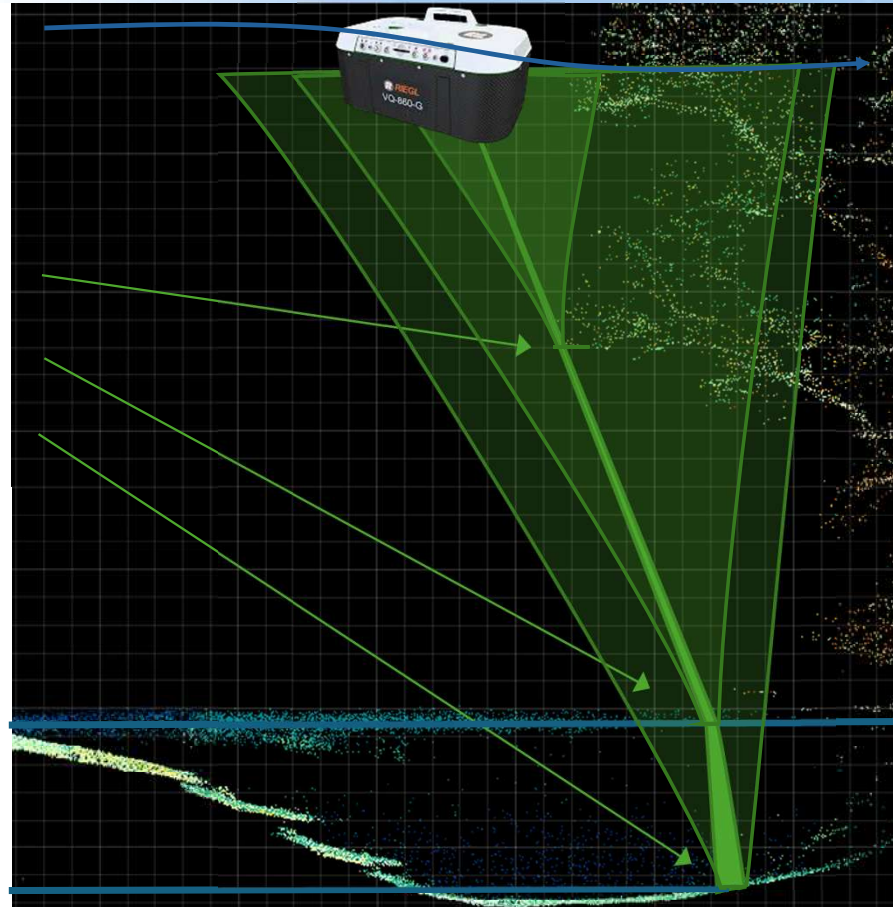
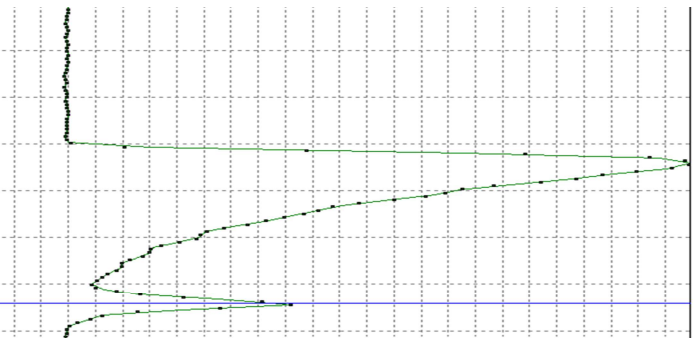
Transmitted Echo Signal:
pulses with PPR 50 kHz to 200kHz

Received Echo Signal
Multiple Targets (1 single shot)
first : **tree echo** ->

intermediate : **watersurface echo** ->

last : **bottom echo** ->

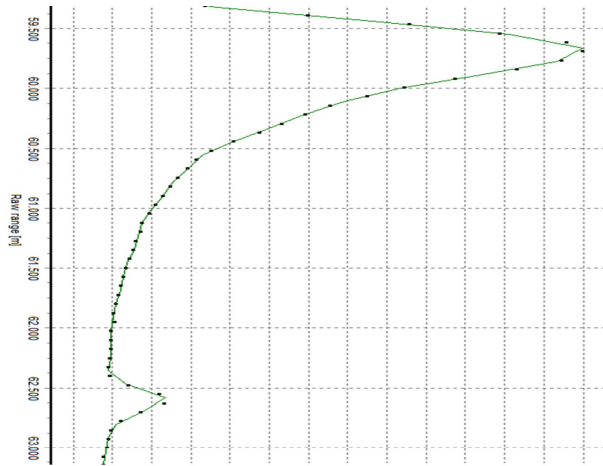
OWP vs. FWA (echo digitalisation)



Laser Beam Divergence
0.001 mrad – 0.006 mrad

Footprint Diameter for 180m
AGL
0.08 m – 0.52 m

Echo Extraction

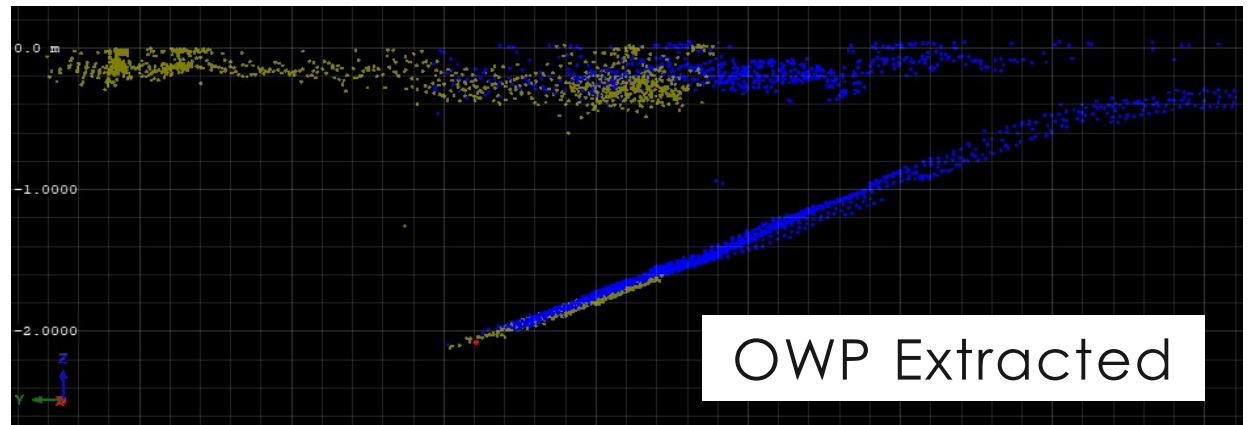
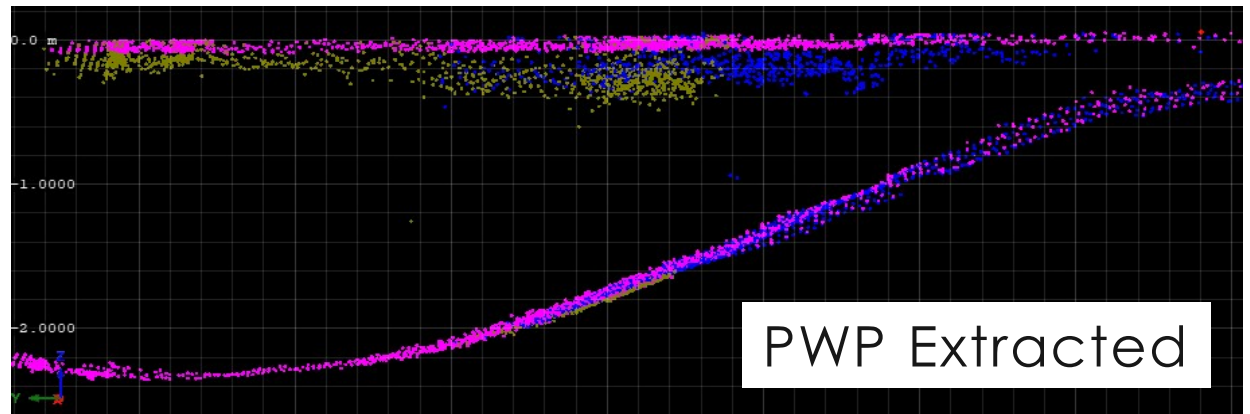


Transmitted Echo Signal:
pulses with rep.rate 50 kHz to 200kHz

up to 78 m Range
Sample rate = 0.503 ns
→ 0,15 m air / 0,11 m water
300 GB/h

SNR challenging

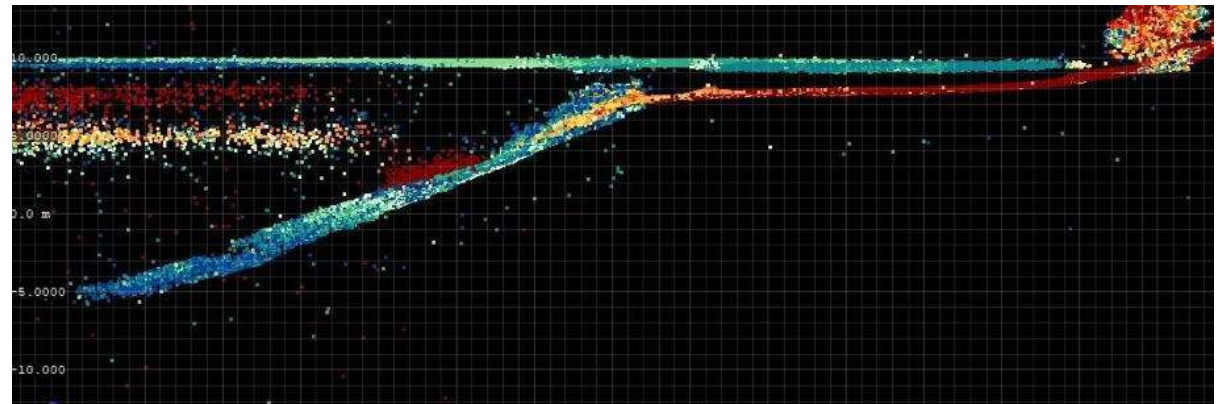
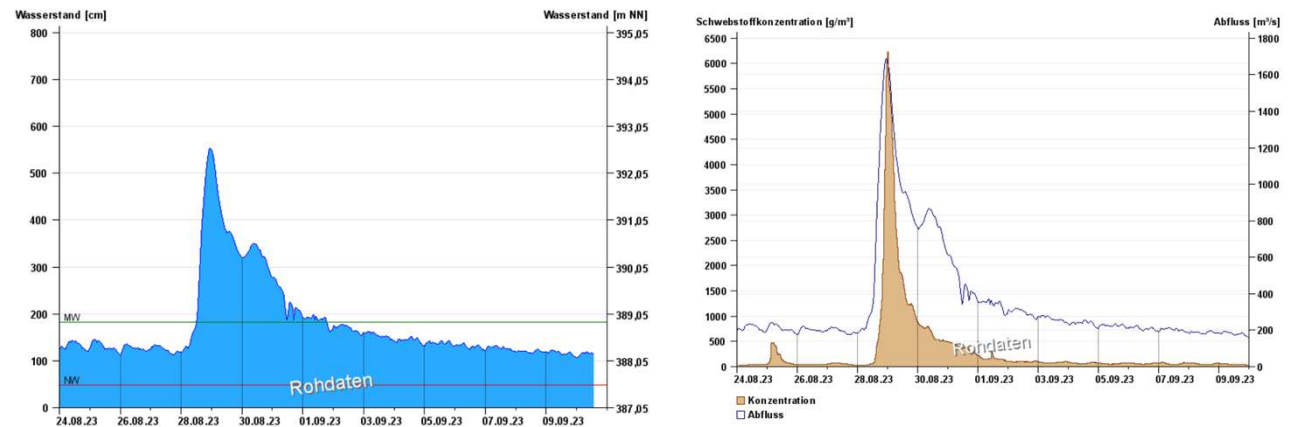
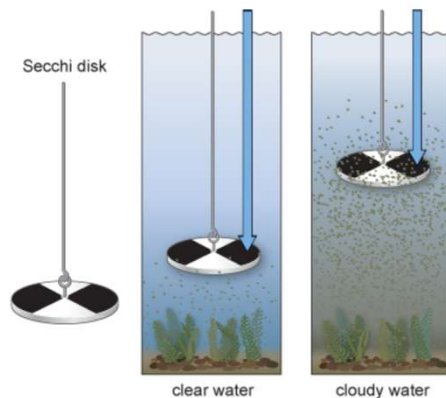
XDC / SVB / FULL WAVEFORM STACKING



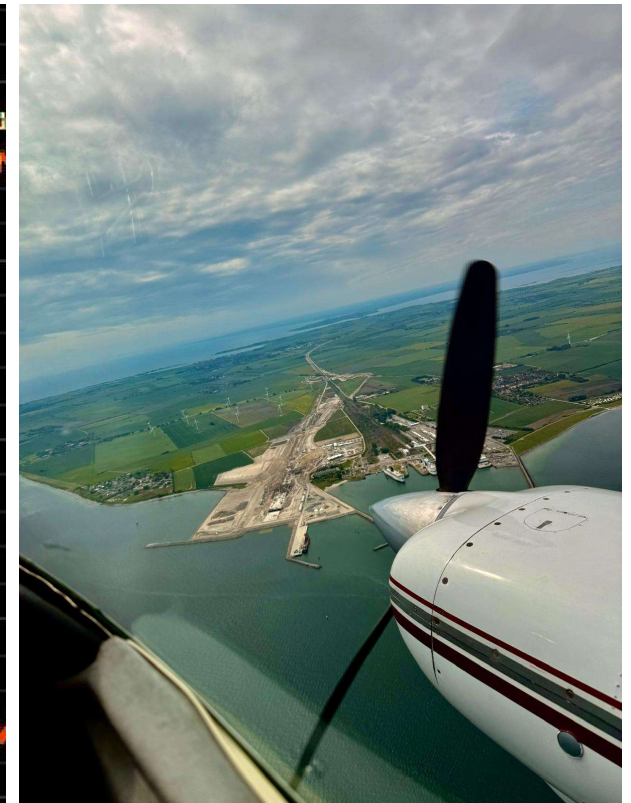
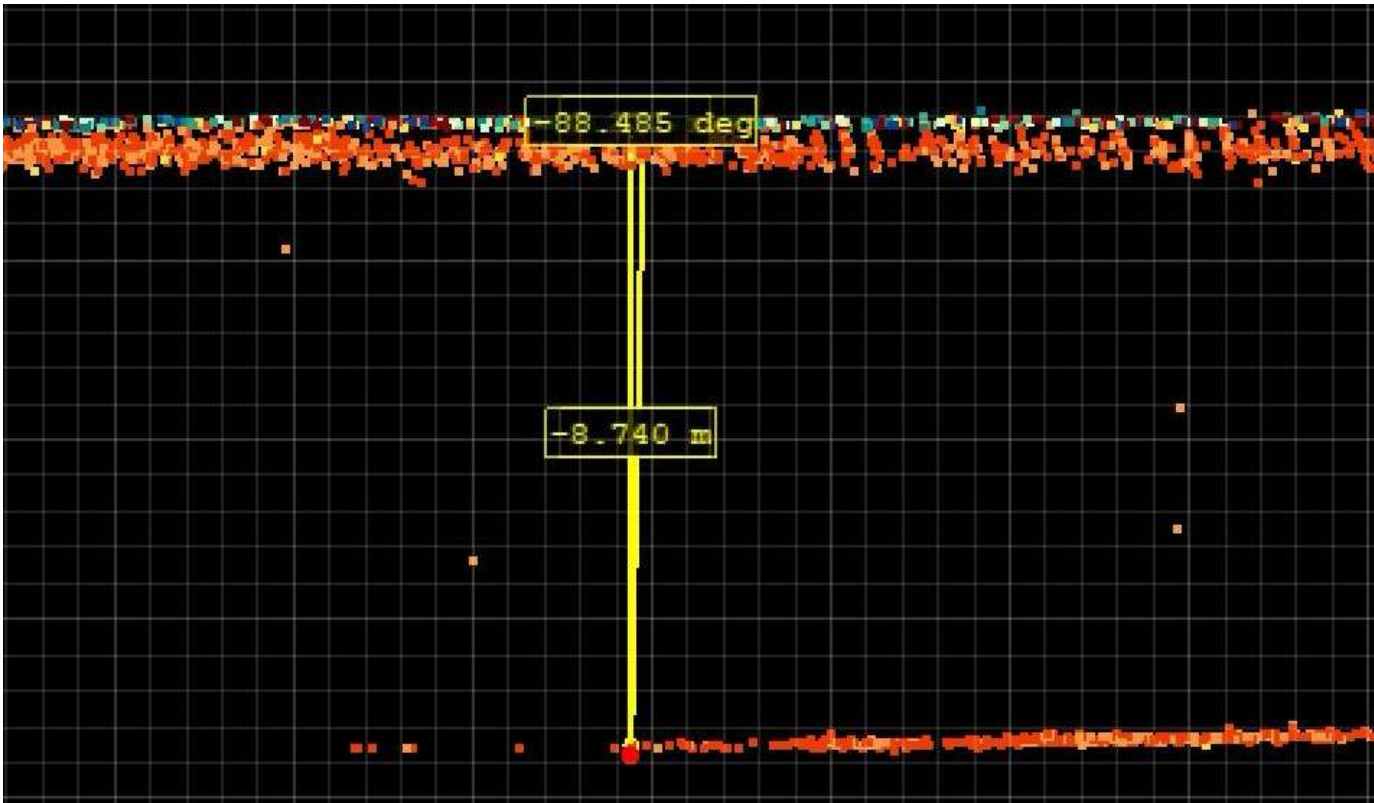
Echo Extraction Max Water Depths

Secchi is not always the truth

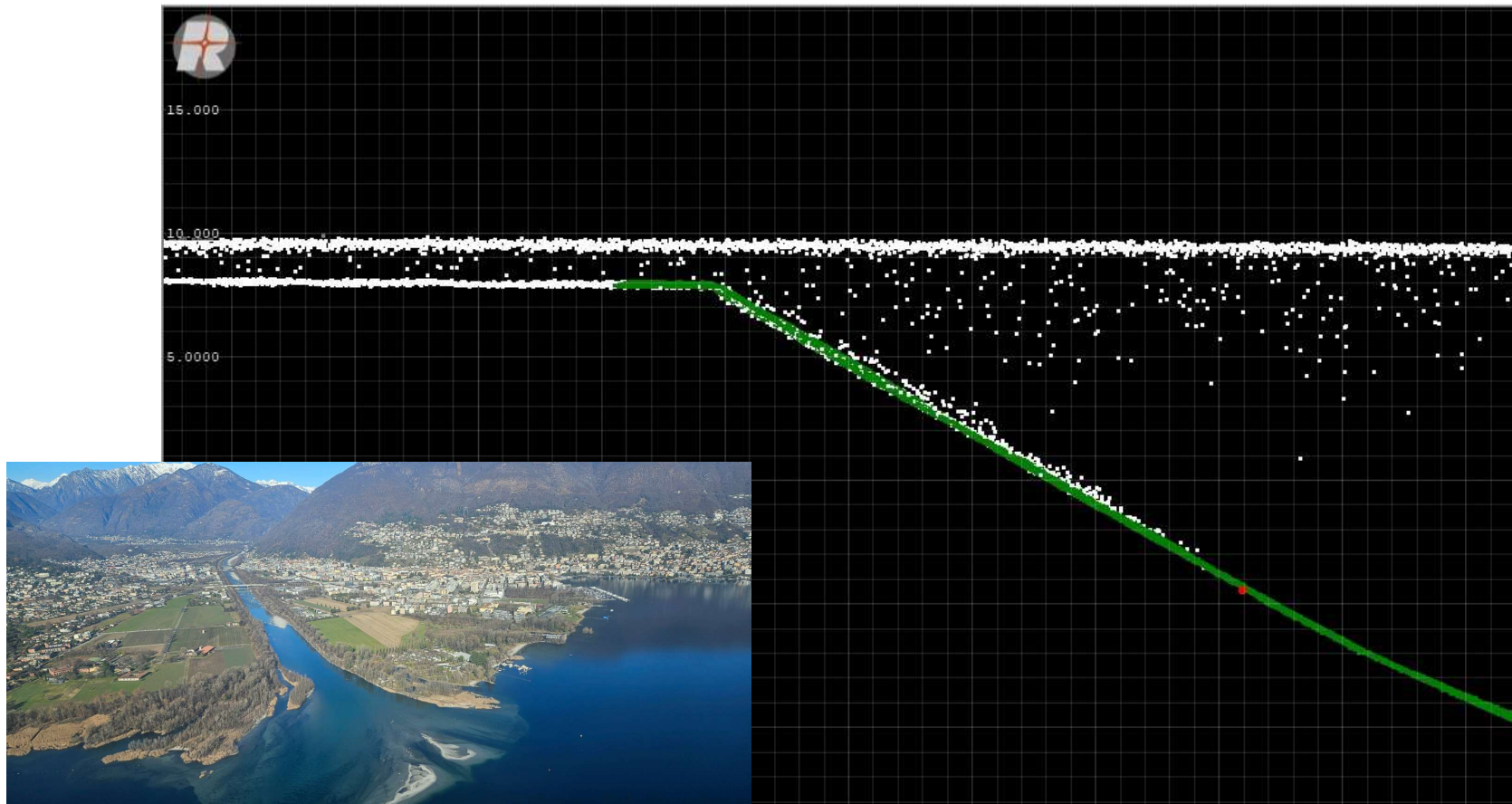
- daylight / air quality
- water quality (often inhomogeneous)
 - watersurface
 - dirt / texture / white water
 - volume
 - turbidity / Vegetation / Fisch
- reflectivity of target (ground/ bottom)
- scanner parameter (NOHD / ENOHD)



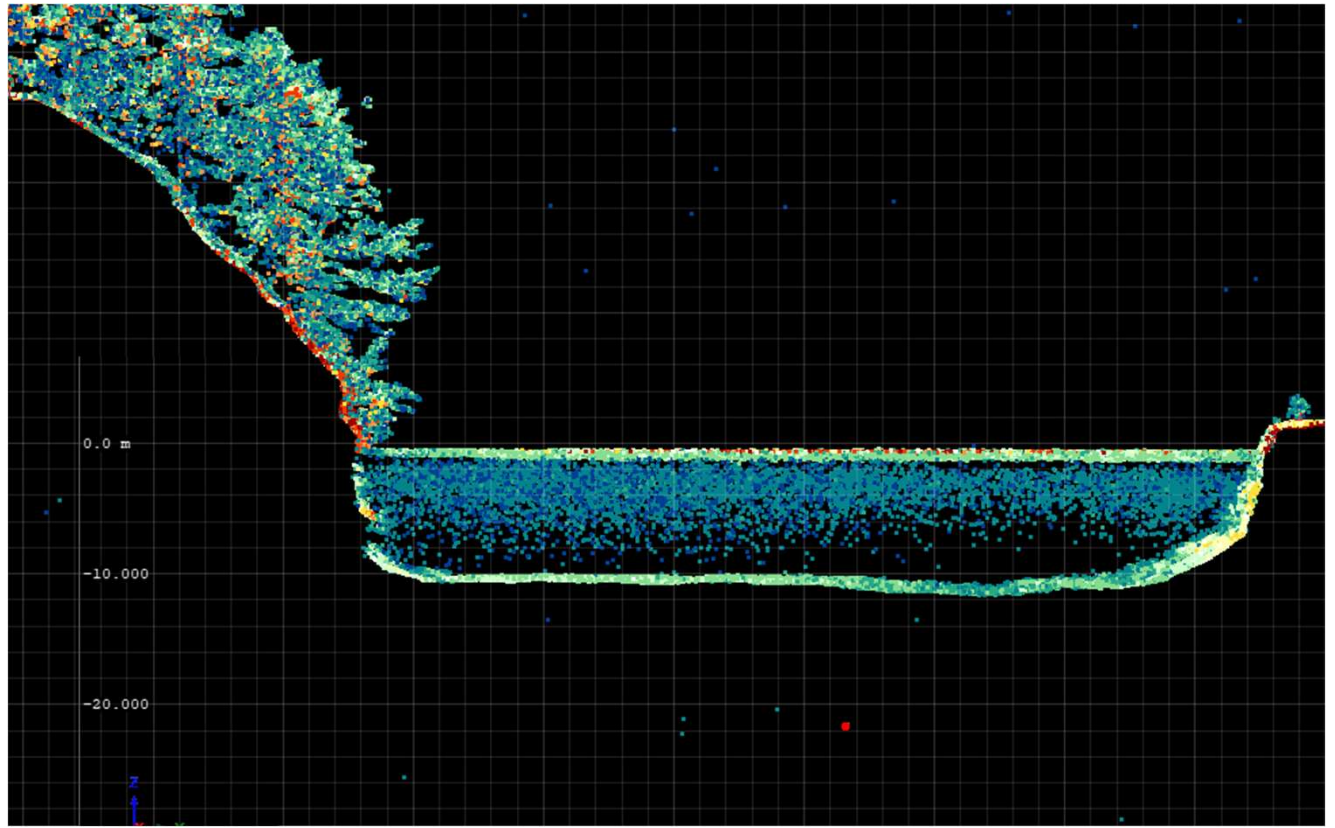
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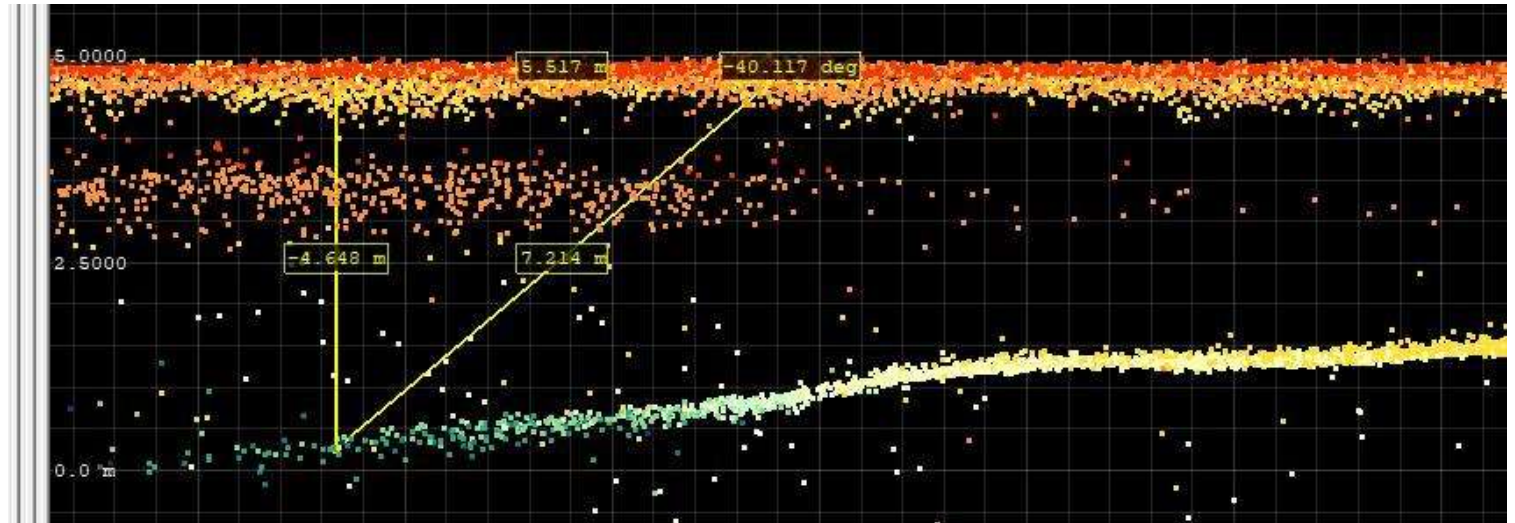
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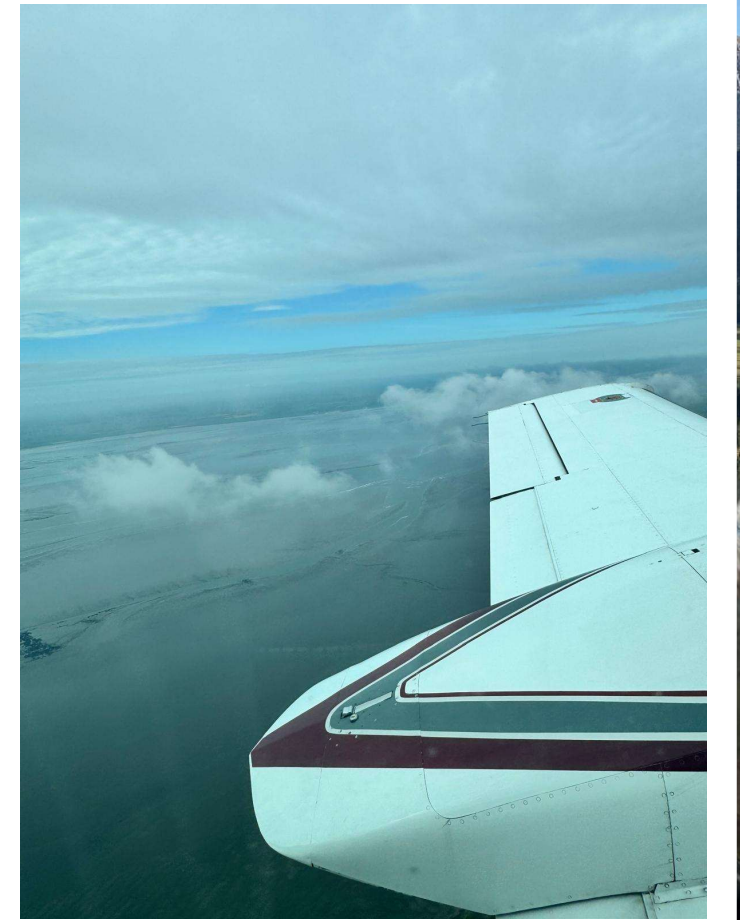
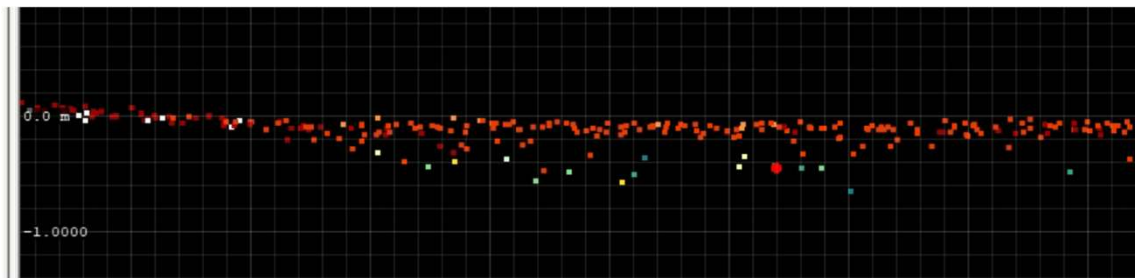
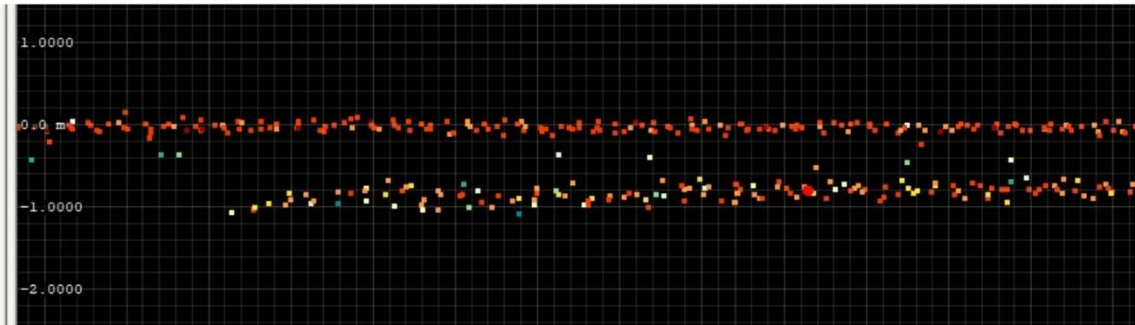
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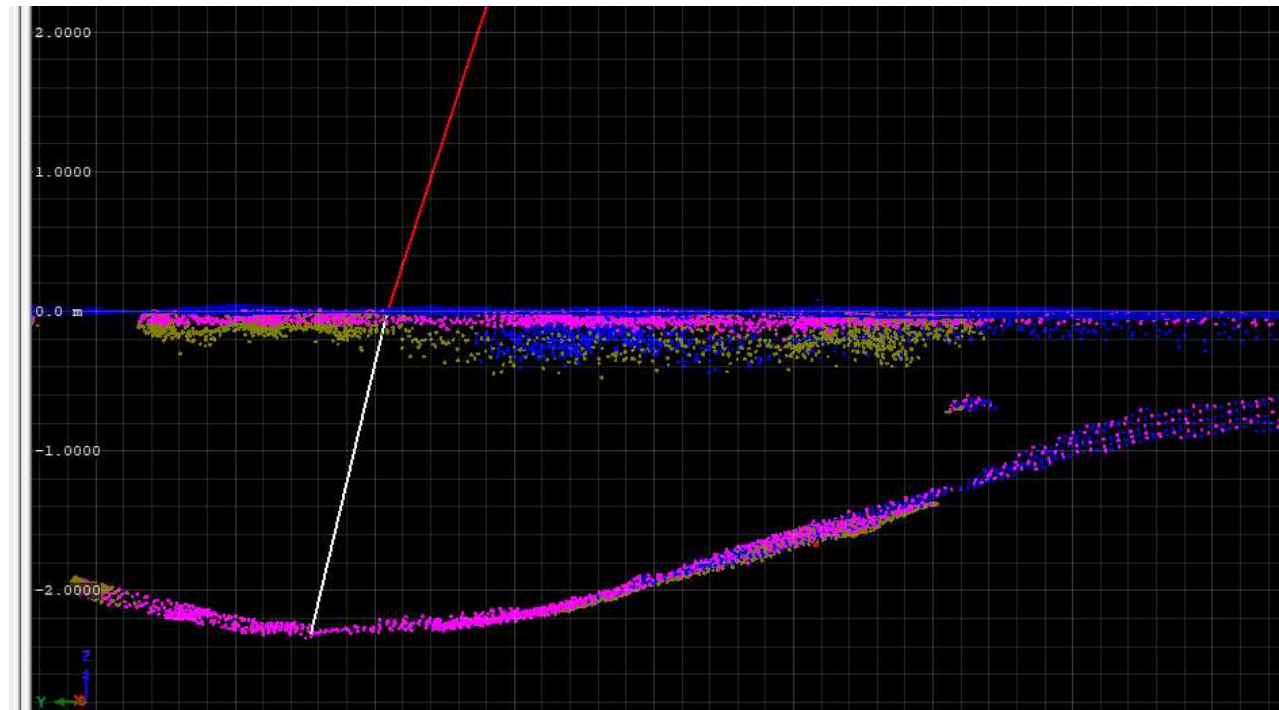


Refraction

... brings a lot of **challenges**

- water surface detection
 - not detected
 - not extractable
 - Underestimation
- static vs. dynamic
 - lake / river / ocean
- water surface model
 - strip wise
 - merged
- calibration of refraction parameter
 - ground truthing
- Speed of light
 - $c \approx 299\,702\,550\text{ms}^{-1}$ in air
 - $c \approx 230\,610\,000\text{ms}^{-1}$ in water

water surface intersection brings change in **range** and laser beam **direction**

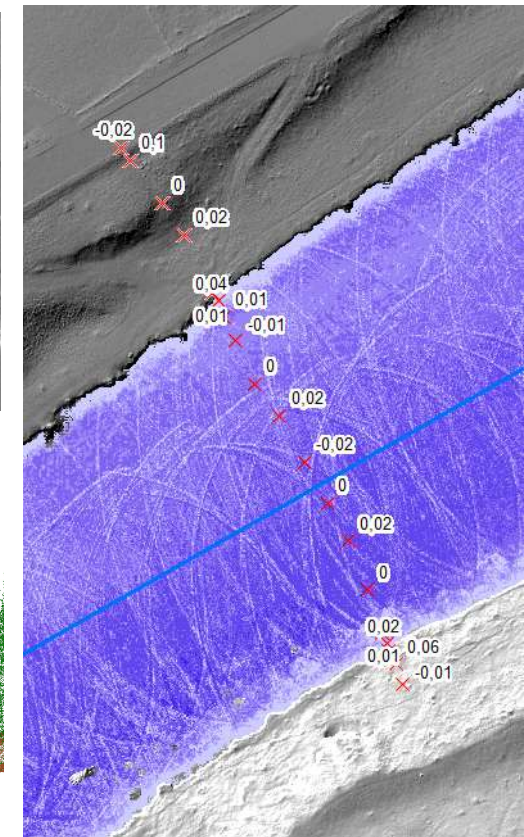
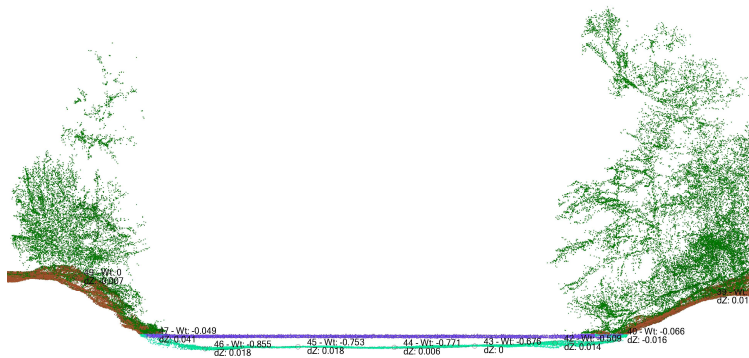
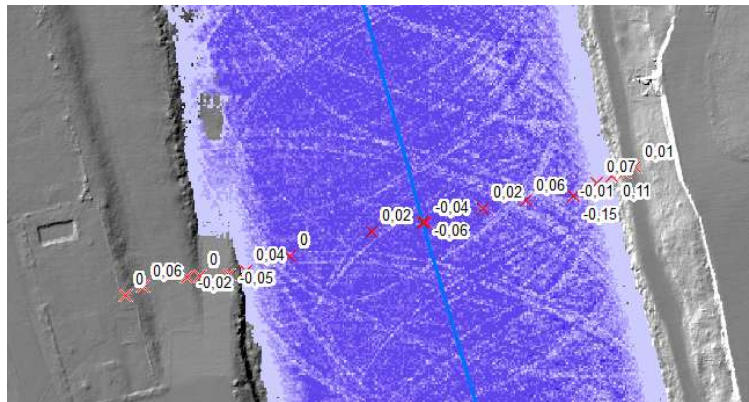


Unser System



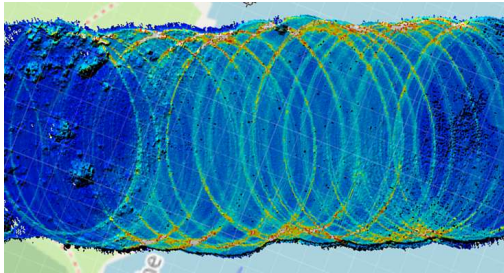
Point Cloud Quality

- Range performance
 - 15 mm precision
 - 20 mm accuracy
- Footprint / complex target situation
 - interpretation / position quality
- GNSS / IMU System
 - 0.02 – 0.05 m position
 - 0.015 deg roll/ pitch
 - **0.035 deg yaw**
- **Complex strip adjustment**
 - narrow strip with
 - inhomogeneous point density
 - **2 media challenge**
- Overall Performance
 - $s = \sqrt{s_1^2 + s_2^2 + \dots + s_n^2}$
 - $2 \times z = x, y$
- Vegetation penetration

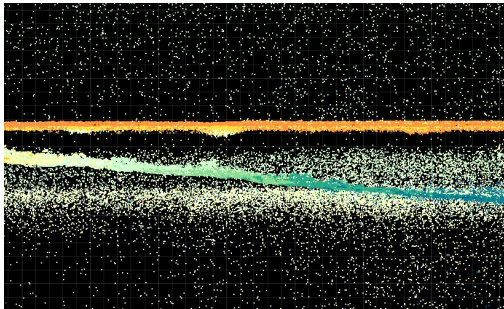


Point Cloud Quality

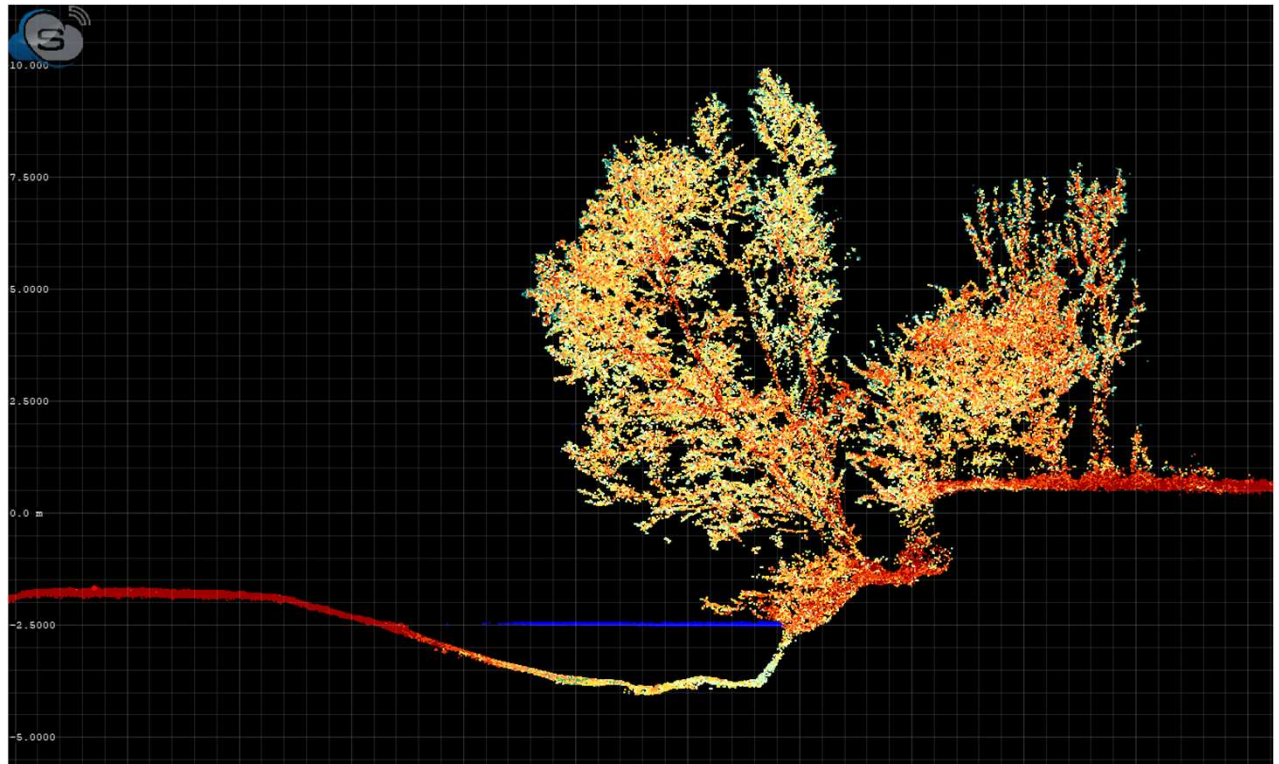
- Point density (194 – 286 – 4588 pts/m²)



- Noise

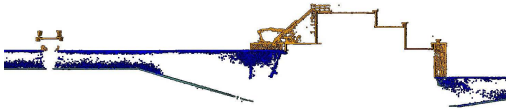


- Vegetation Penetration

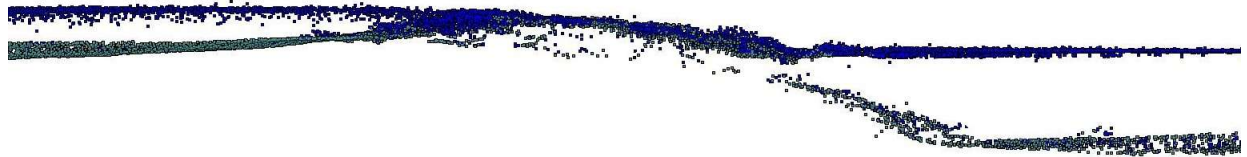


Point Cloud Quality

- Complex situations



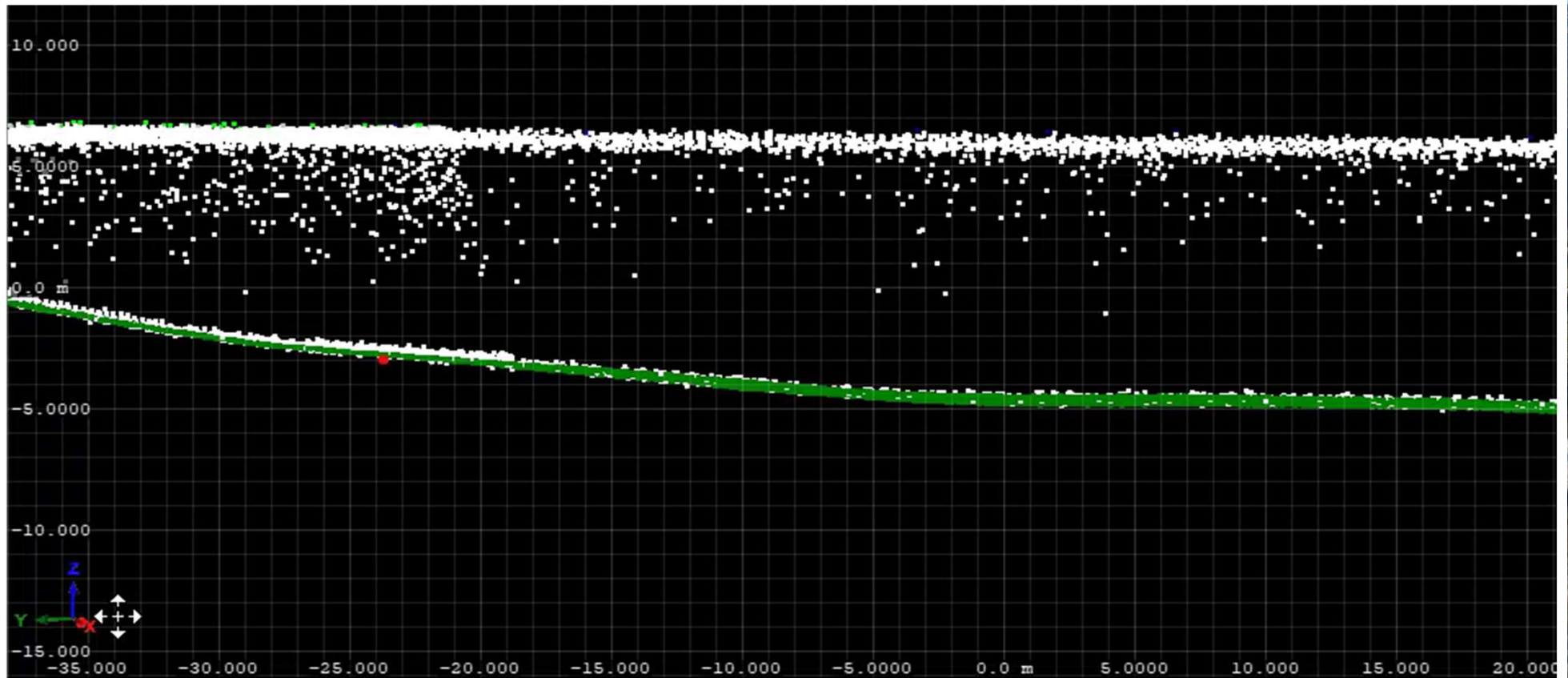
- white water



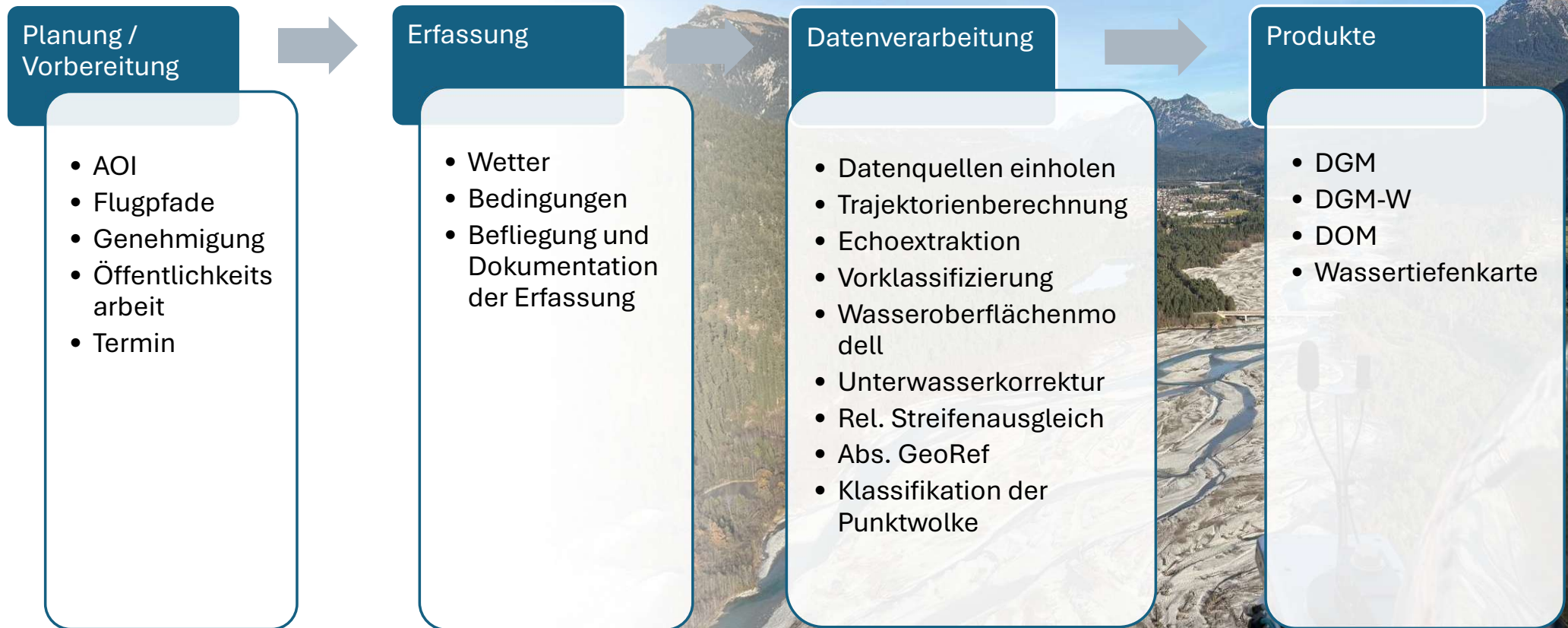
- Mapping efficiency



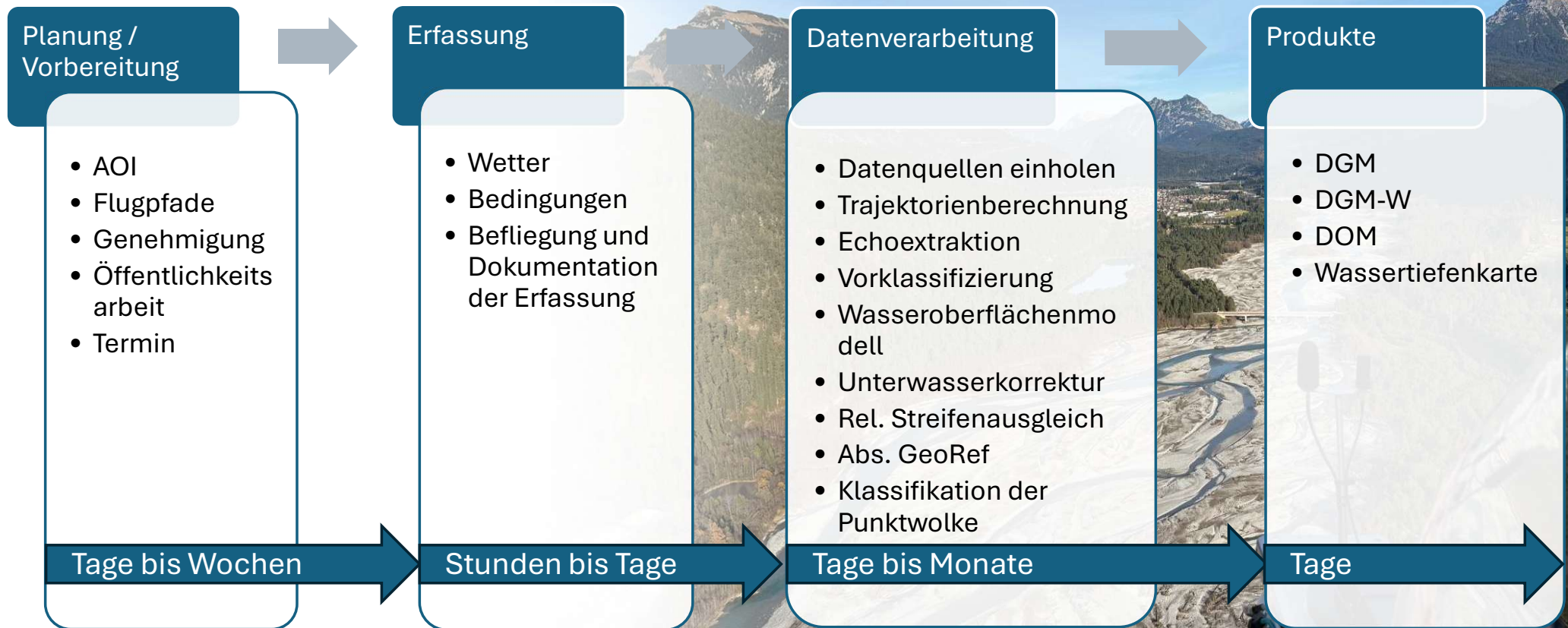
ALB Punktwolke vs Sonar (-Raster)



Projektablauf



Projektablauf



Geometrische Erfassung der Bereiche außerhalb der Fahrrinne zwischen Rhein-km 508,00 und 557,00

Wasserstraßen- und Schifffahrtsamt Rhein

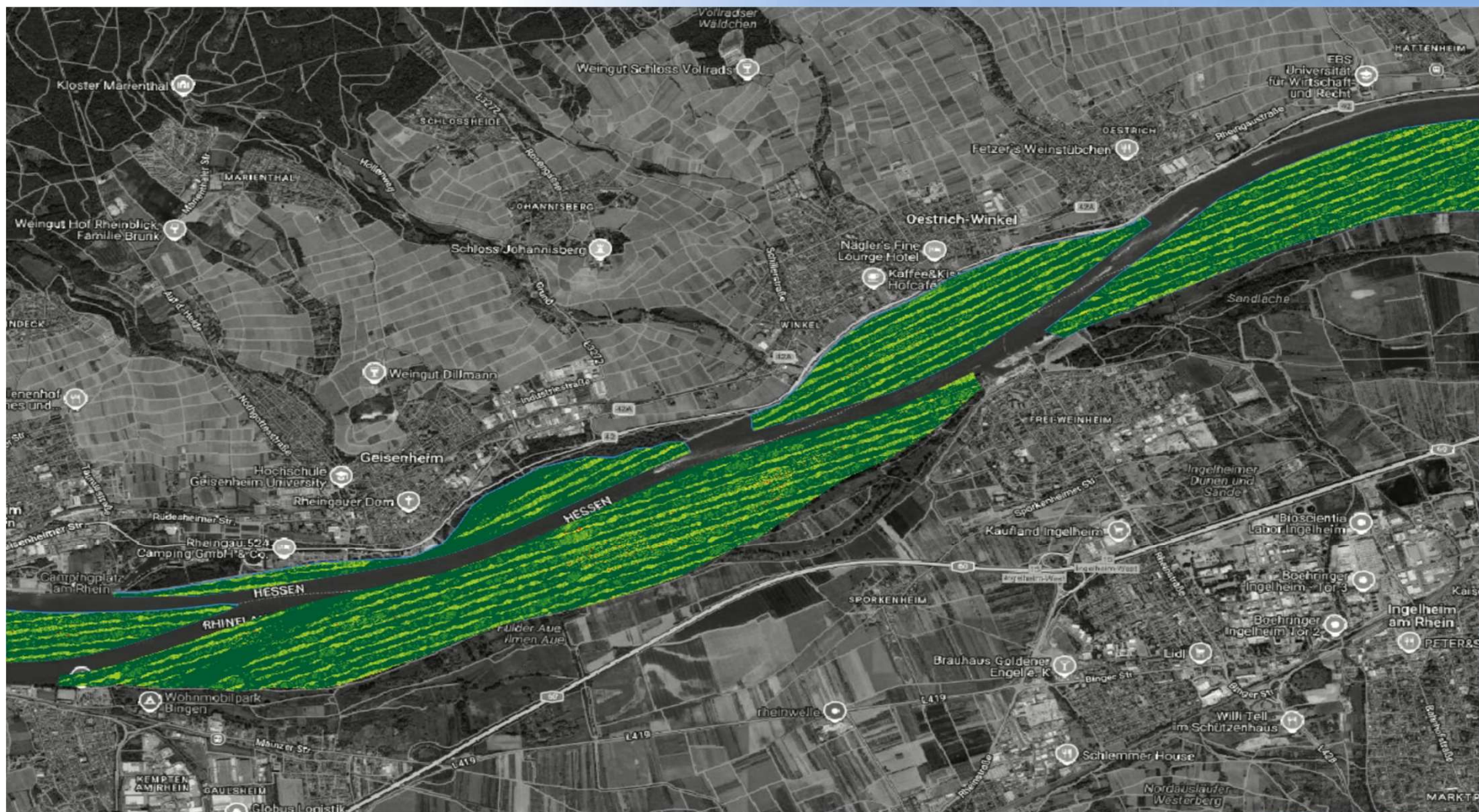
- ALB- und RGB-basierte Erfassung
- 2024✓ / 2025 ✓ / 2026 / 2027 / 2028
- Herbst – Niedrigwasser,
- CTR-Frankfurt / Bingen Topografie

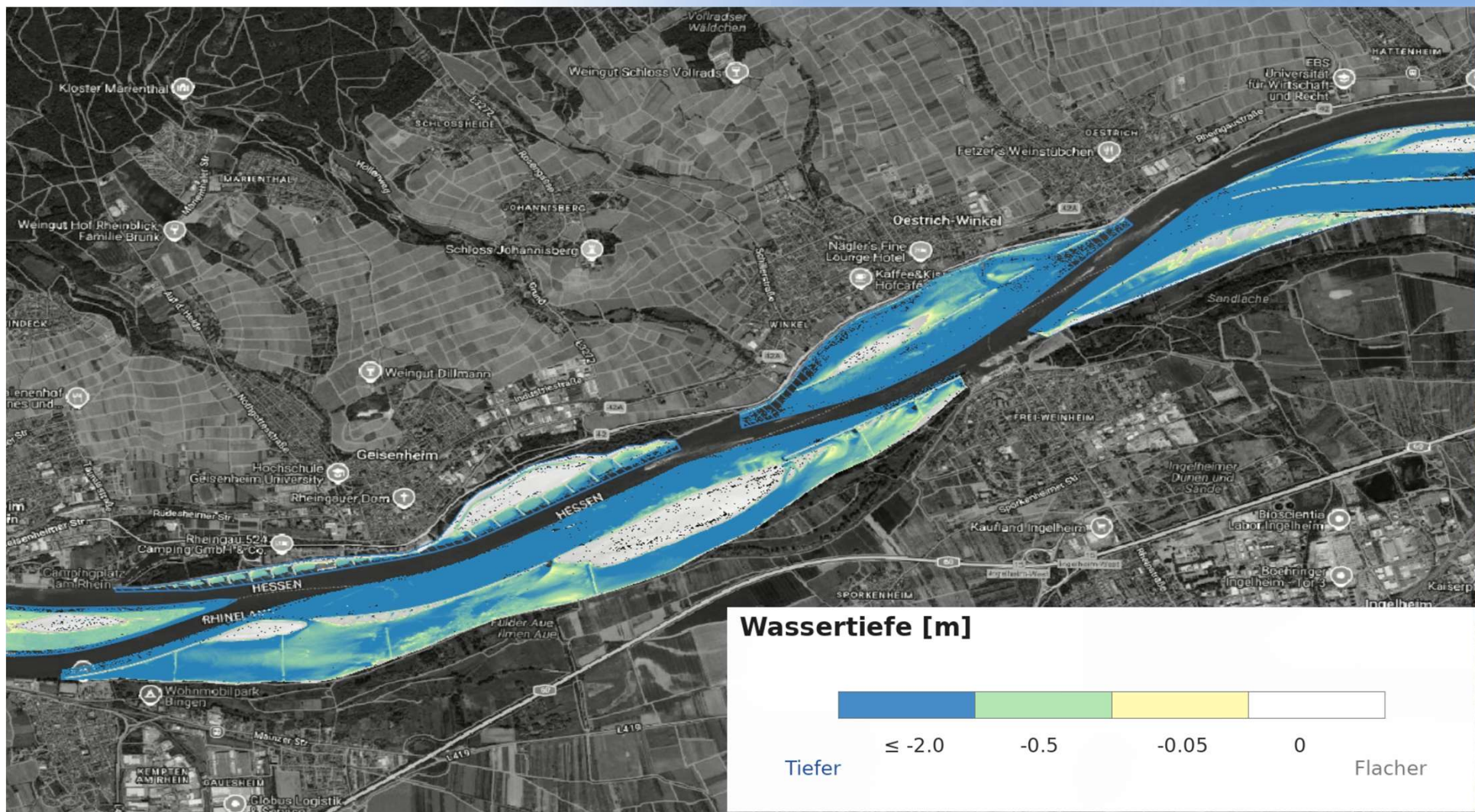


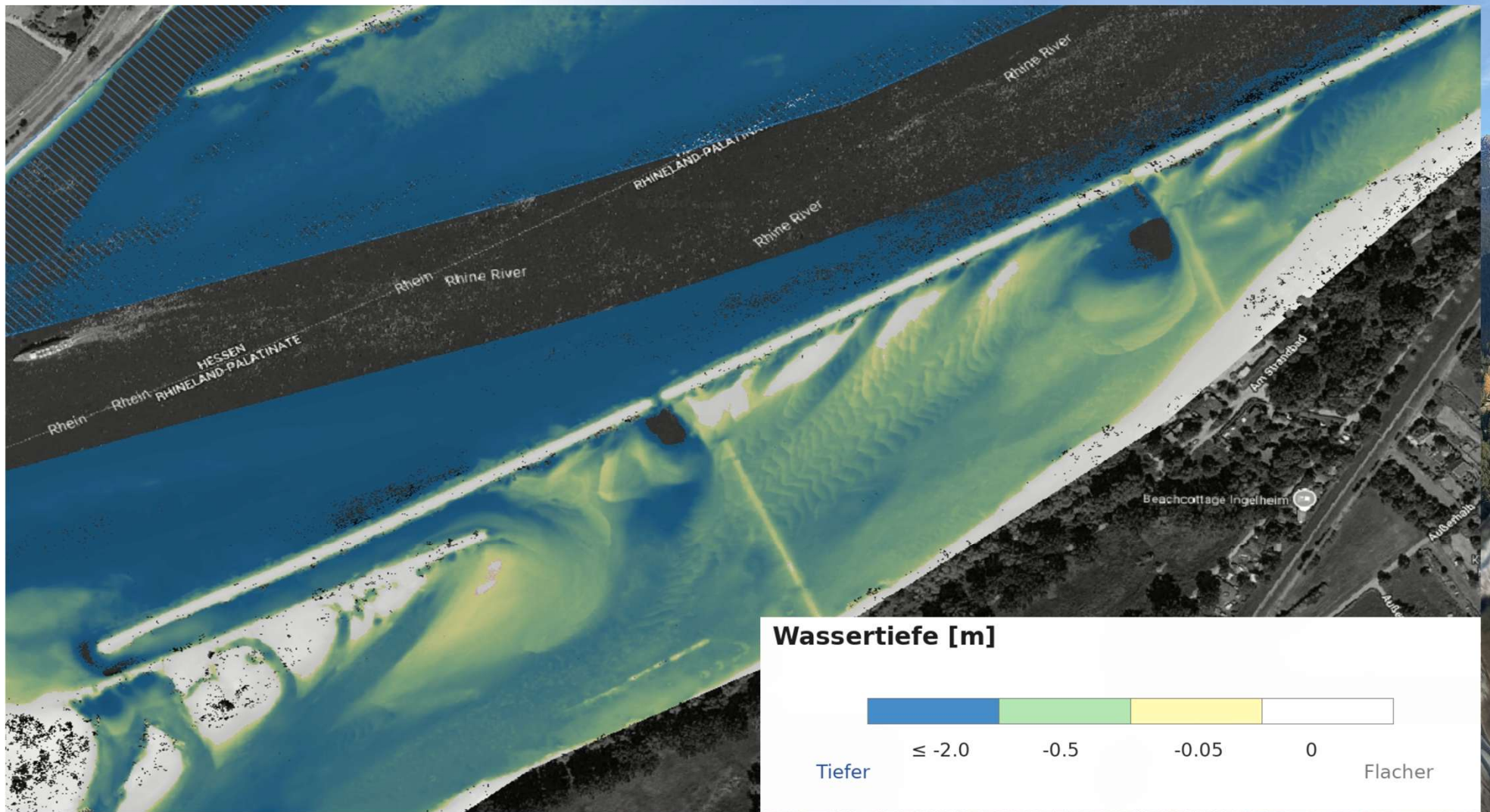


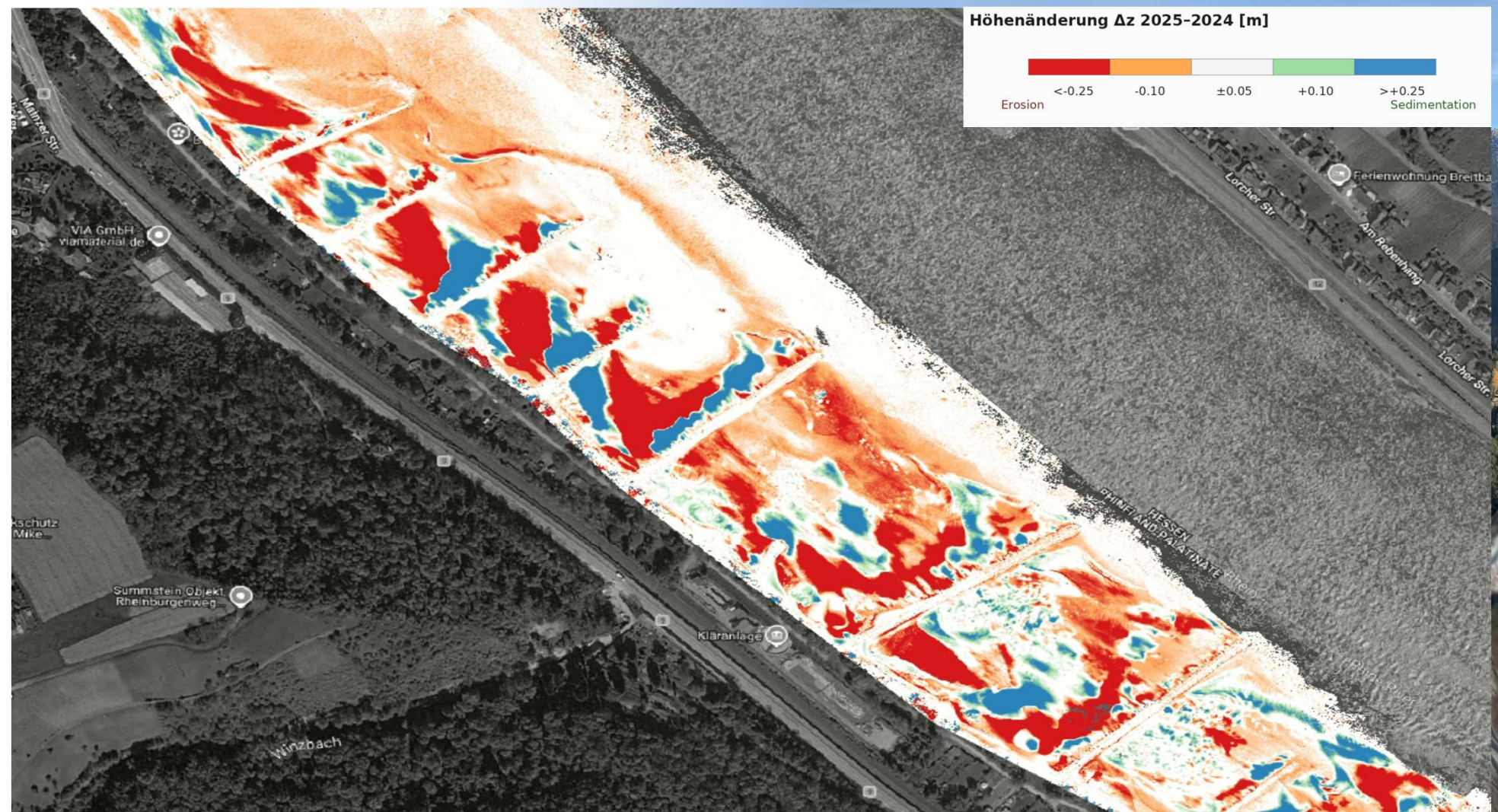


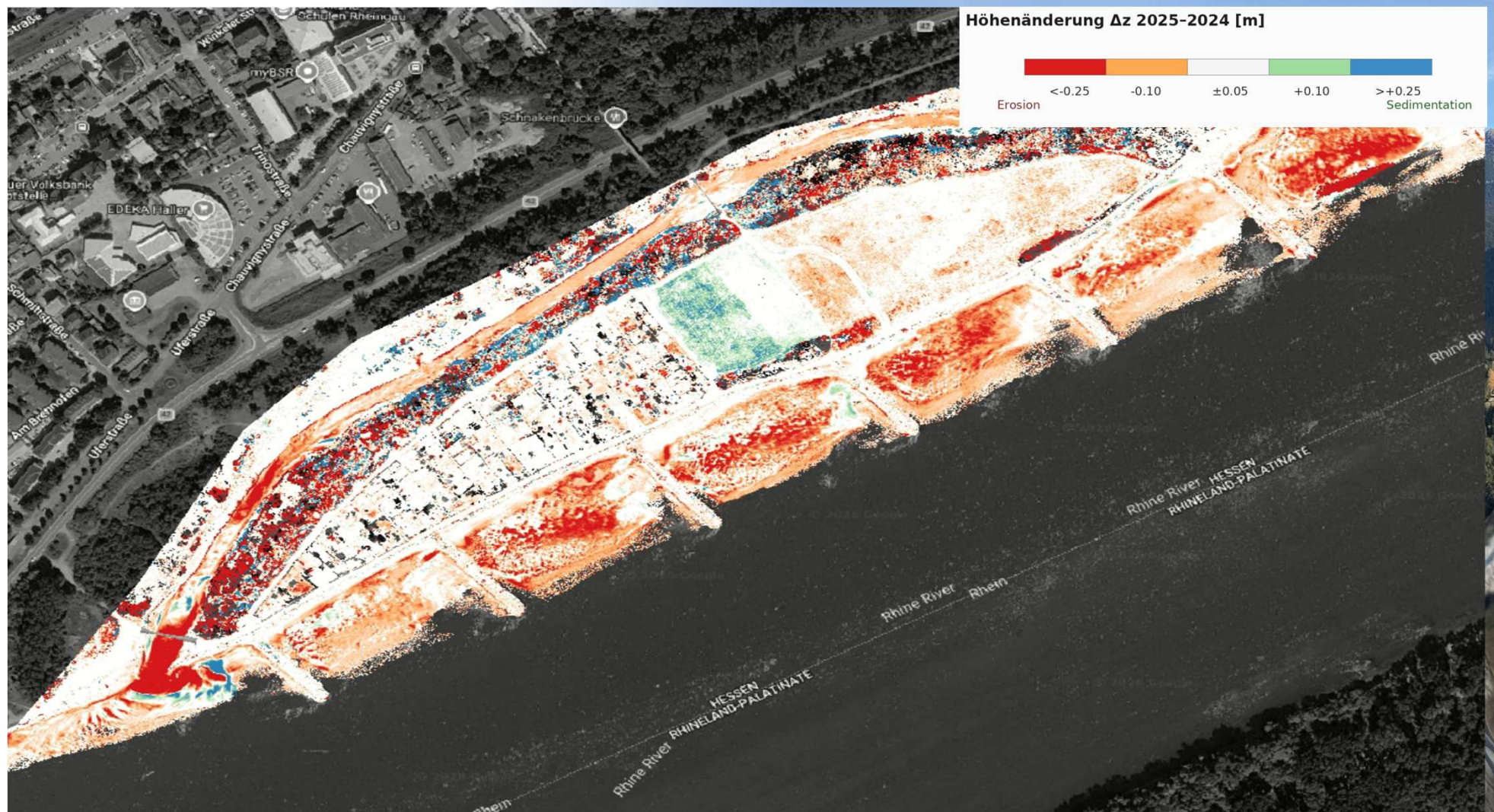


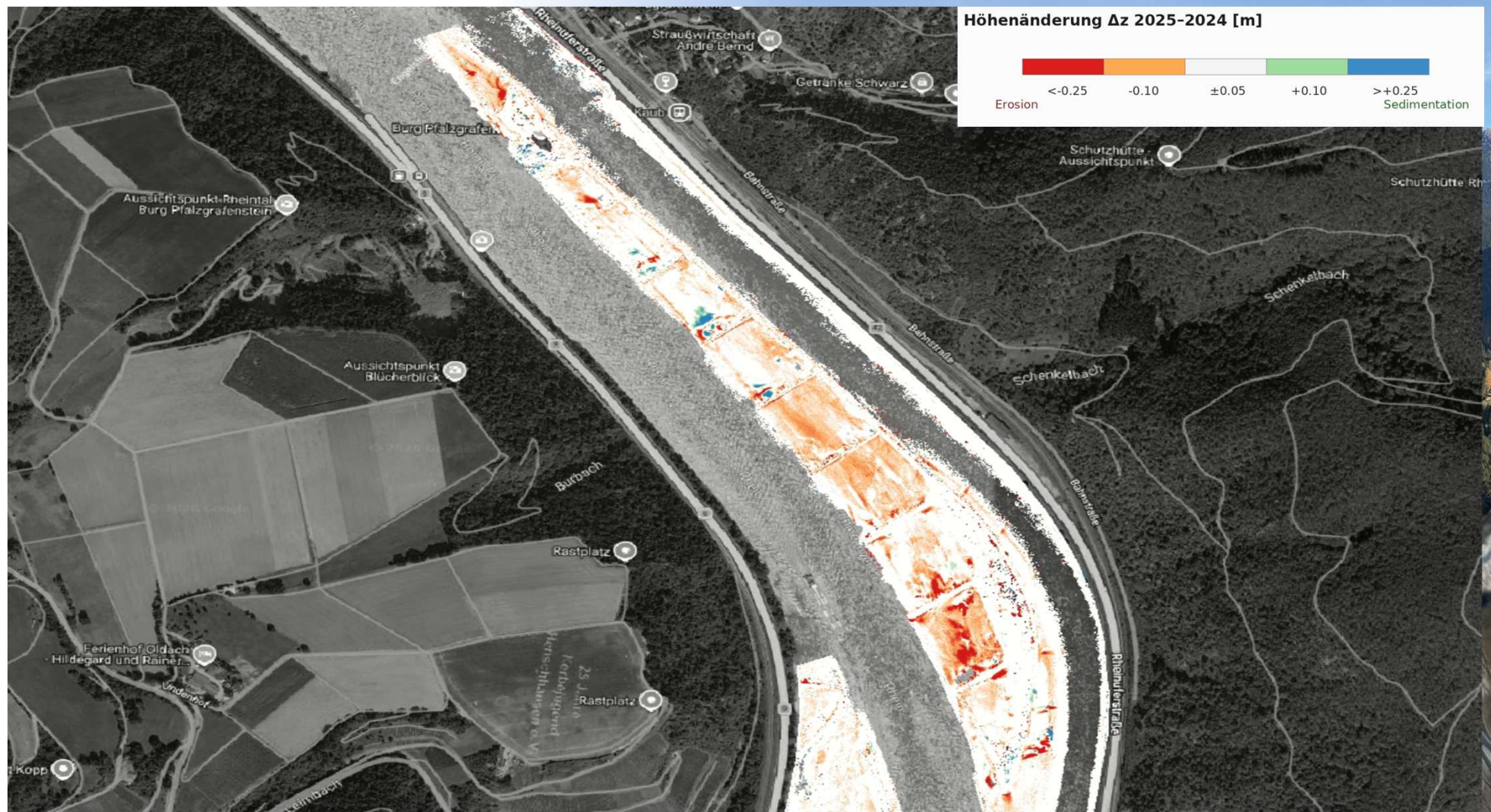


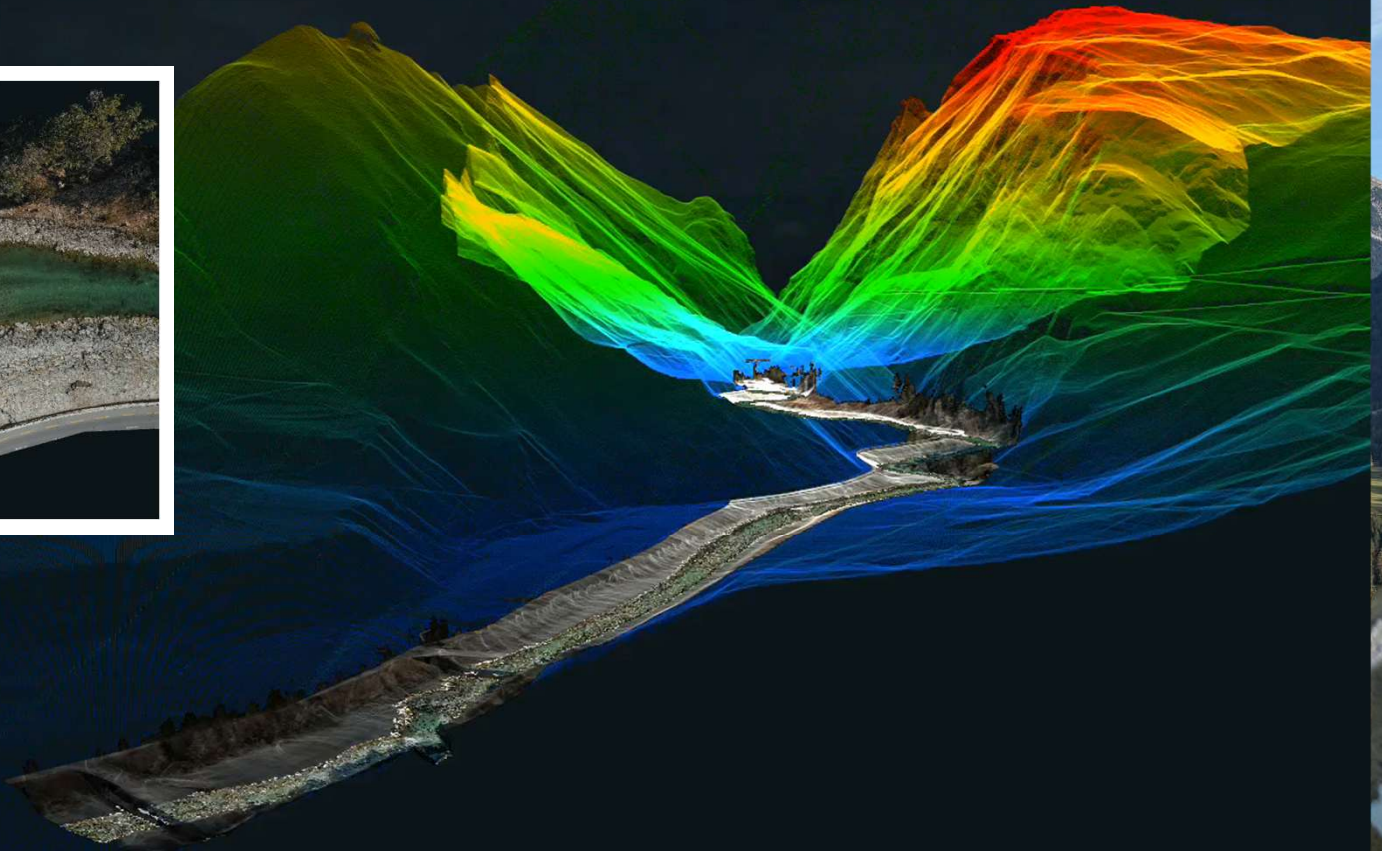












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