RIEGL Bathymetry Hard- and Software Solutions

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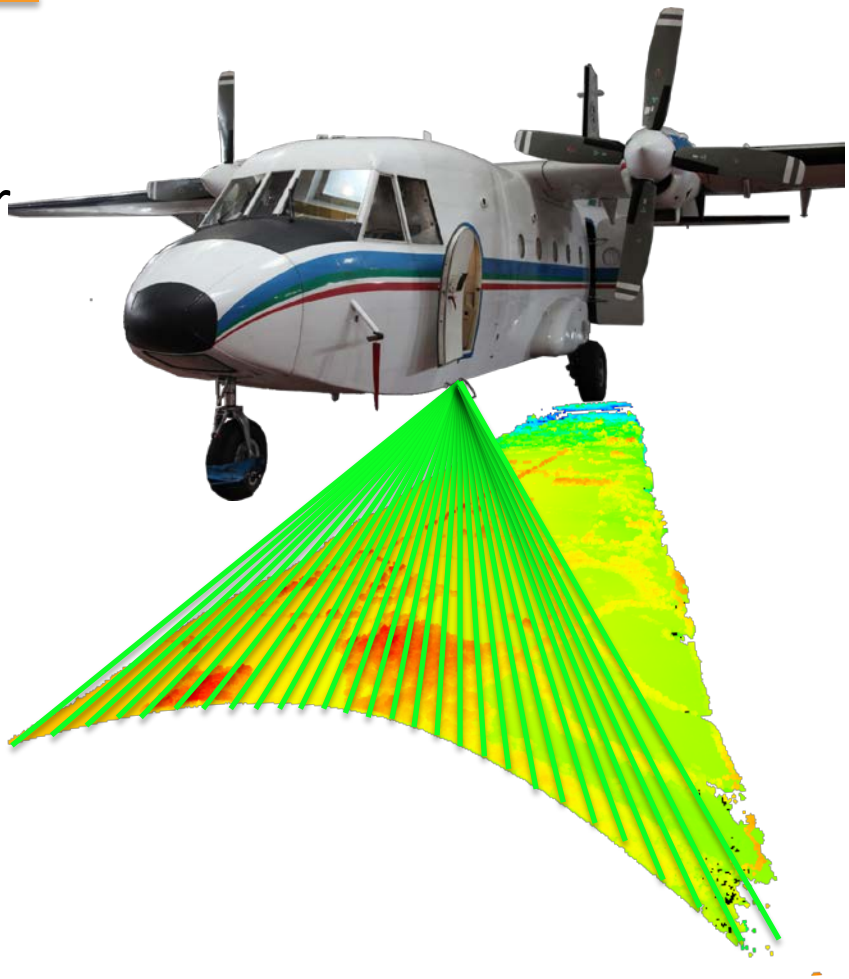
RIEGL Laser Measurement Systems

AGENDA

- Introduction
- *RIEGL* VQ-820-G topo-bathy laser scanner
  - product specifications
  - system integration
  - results
- software for hydrography
- new developments



Innovation in 3D

RIEGL®
LASER MEASUREMENT SYSTEMS

TLS Terrestrial Laser Scanning

ALS Airborne Laser Scanning

MLS Mobile Laser Scanning

ILS Industrial Laser Scanning

Airborne Laser Scanning

Airborne Laser Scanning is a rapid, highly accurate and efficient method of capturing 3D data of large areas, such as agricultural or forestry sites, urban areas, industrial plants, power line or railway corridors, etc.

Airborne Scanners for planes (LMS-Q Line):

With automatic Multiple-Time-Around (MTA) processing and full waveform analysis for an unlimited number of target echoes.

Airborne Scanners for helicopters (VQ-Line):

All types with echo digitization, online waveform processing, and Multiple-Time-Around (MTA) processing

Complete „turnkey" airborne laser scanner solutions for various types of planes, helicopters, and UAVs, including the ***RIEGL*** scanner itself, IMU/GNSS, digital and/or thermal camera, mission planning and flight guidance, ALS Software, pilot operator, and data processing training.

Fully integrated Airborne Mapping System:

RIEGL LMS-Q1560
Dual LiDAR Channel System

- for large scale, high altitude, complex environment mapping
- operating flight altitude up to 15,500 ft AGL
- laser pulse repetition rate up to 800 kHz
- up to 532,000 meas./sec on the ground
- unrivaled scan pattern for best point spacing on the ground
- forward/backward looking capability for collecting data of vertical structures
- straight-forward flight planning, increased flight safety
- IMU/GNSS, medium format and IR camera integrated
- suited for gyro-stabilized leveling mounts

Airborne Scanners for planes & helicopters:

RIEGL LMS-Q780

- flight altitude up to 15,500 ft
- Laser PRR up to 400 kHz
- automatic Multiple-Time-Around (MTA) processing
- full waveform analysis for an unlimited number of target echoes

RIEGL LMS-Q680i

- full waveform analysis
- operating flight altitude up to 5,000 ft AGL
- Laser PRR up to 400 kHz, practically eyesafe Laser Class 3R

RIEGL VQ-820-G

- for coastline and shallow water mapping
- visible green laser beam for water penetration
- Laser PRR up to 520 kHz, Laser Class 3B

RIEGL VQ-580

- for measurements on snow and ice
- operating flight altitude up to 4,000 ft AGL
- Laser PRR up to 380 kHz, Laser Class 3B

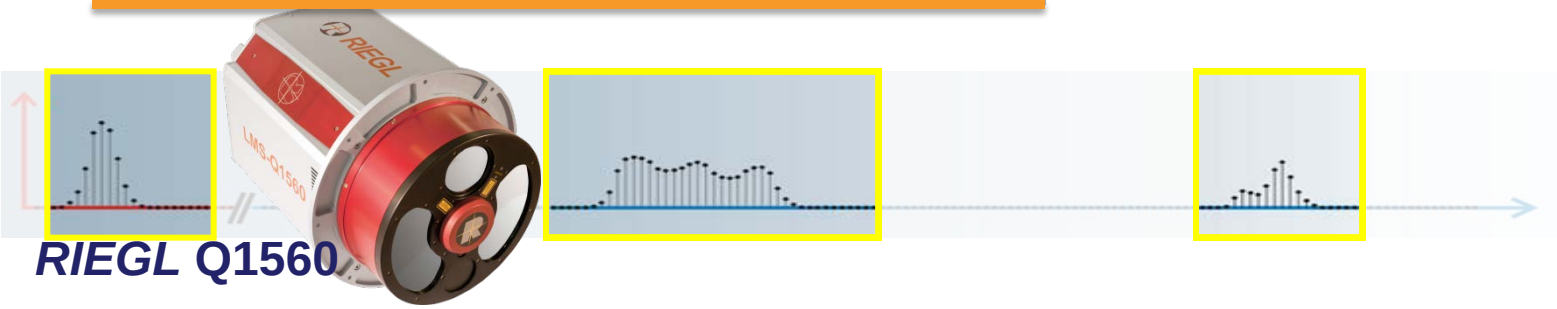
RIEGL VQ-480i

- operating flight altitude up to 3,450 ft AGL
- Laser PPR up to 550 kHz
- eyesafe Laser Class 1

RIEGL VQ-480-U

- operating flight altitude up to 2,450 ft AGL
- Laser PPR up to 550 kHz, eyesafe Laser Class 1
- very lightweight, approx. 7.5 kg

Categories of waveform data



***RIEGL* Q1560**

full waveform data

no precise ranging

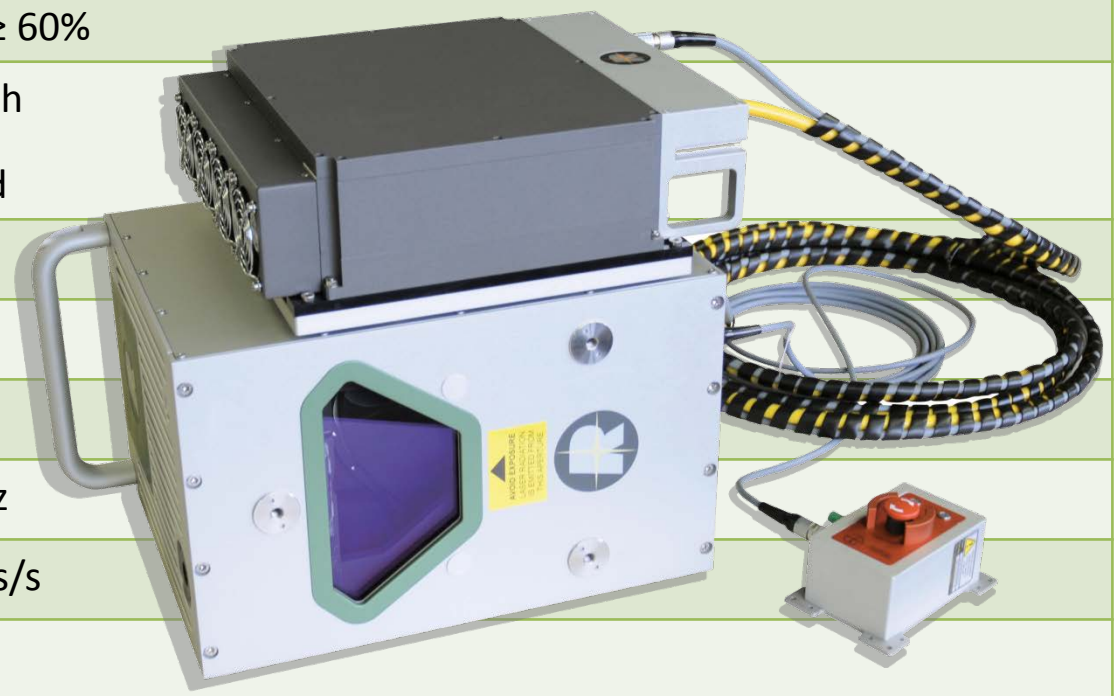
RIEGL®

RIEGL VQ-820-G

laser scanner for combined topographic and bathymetric applications

VQ-820-G product specifications

wavelength	532 nm (visible green light)
measurment range topography	1500 m at ρ ≥ 20% 2500 m at ρ ≥ 60%
water penetration	1 Secchi depth bright ground
ranging accuracy	25 mm
FOV	42°
beam divergence	1 mrad
net measurement rate	up to 195 kHz
scan speed	50 – 200 lines/s
laser Safety	laser class 3B
multiple time around	yes, up to 4 pulses in the air



VQ-820-G features

- excellently suited for combined hydrographic and topographic airborne survey
- high-accuracy ranging based on **echo digitization** and **online waveform processing** with multiple target capability
- high spatial resolution due to narrow laser beam and high pulse repetition rate up to 520 kHz, high scanning speed up to 200 scanlines/second and a wide field of view 42°
- compact, rugged and light-weight modular configuration, compatible with standard airborne platforms.
- **waveform data output**, data accessible via RiWAVELiB
- seamless integration with other *RIEGL* ALS Systems and software packages

RIEGL®

system integration

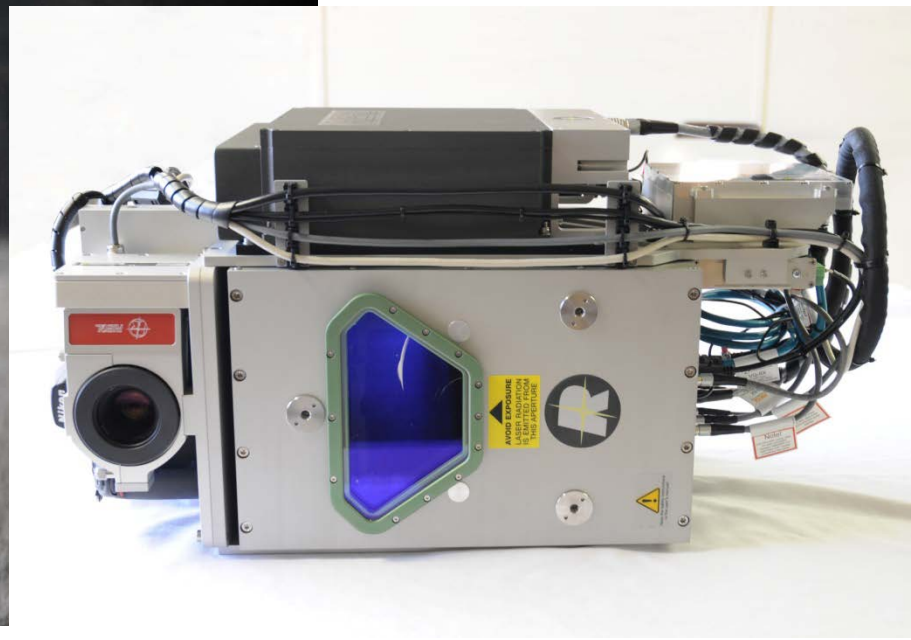
helicopter

Tecnam P2006T

RIEGL®

CASA 212

UAV – Schiebel Camcopter



results

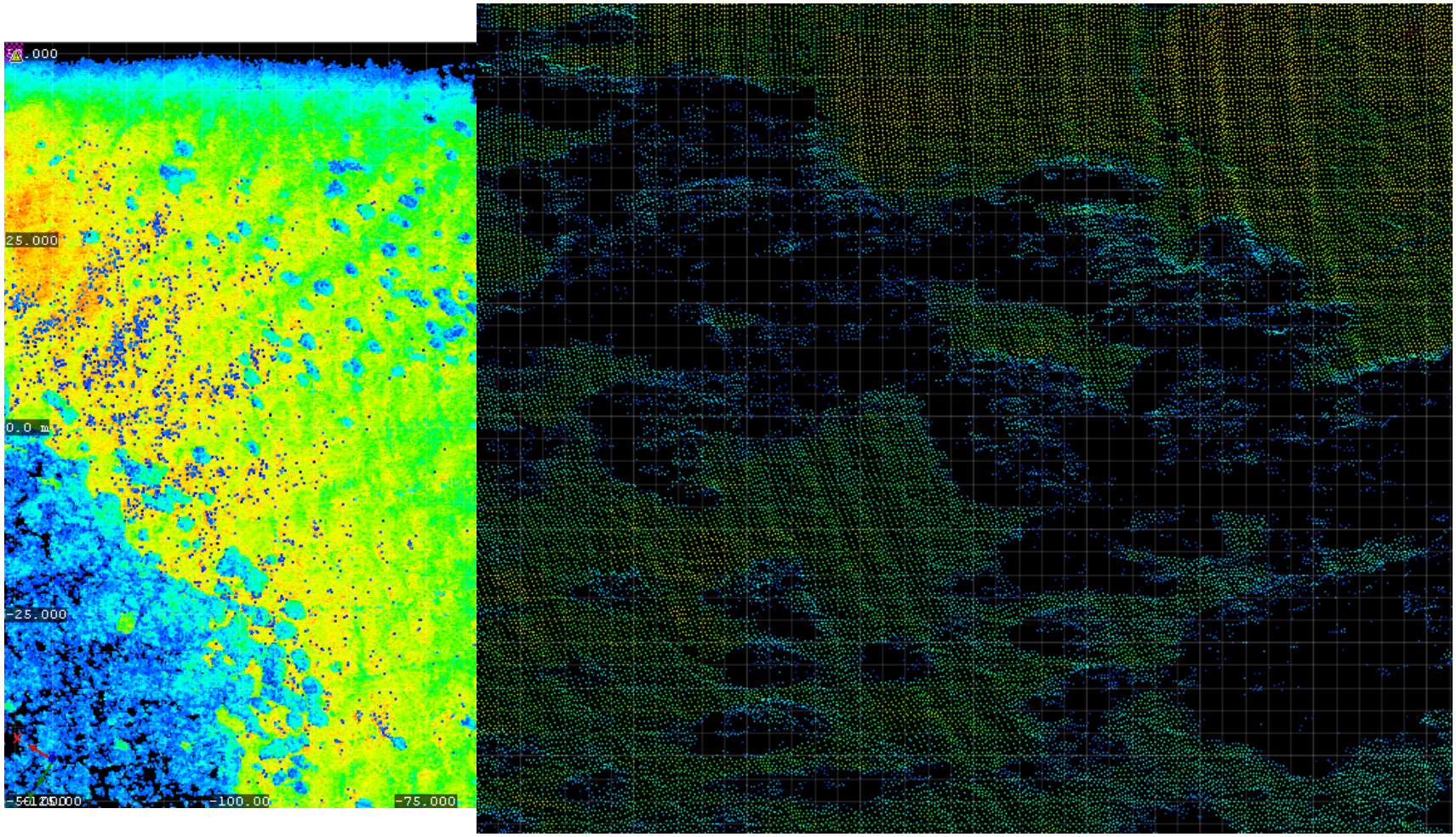
Baltic sea, Atlantic
floodplains, rivers

costal survey example data – Baltic Sea

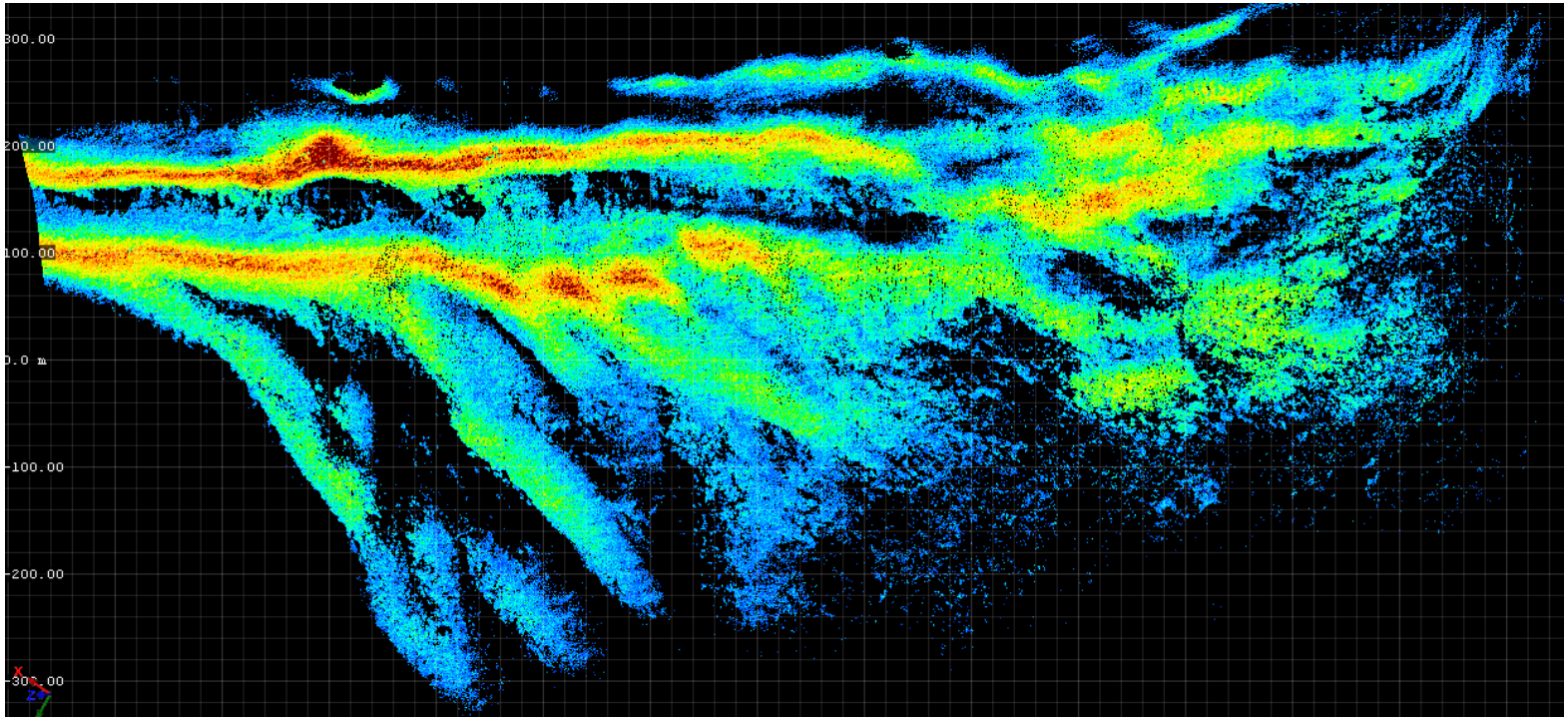
surf zone and beach

near Rostock/Germany

sand banks in 4m depth from low altitude

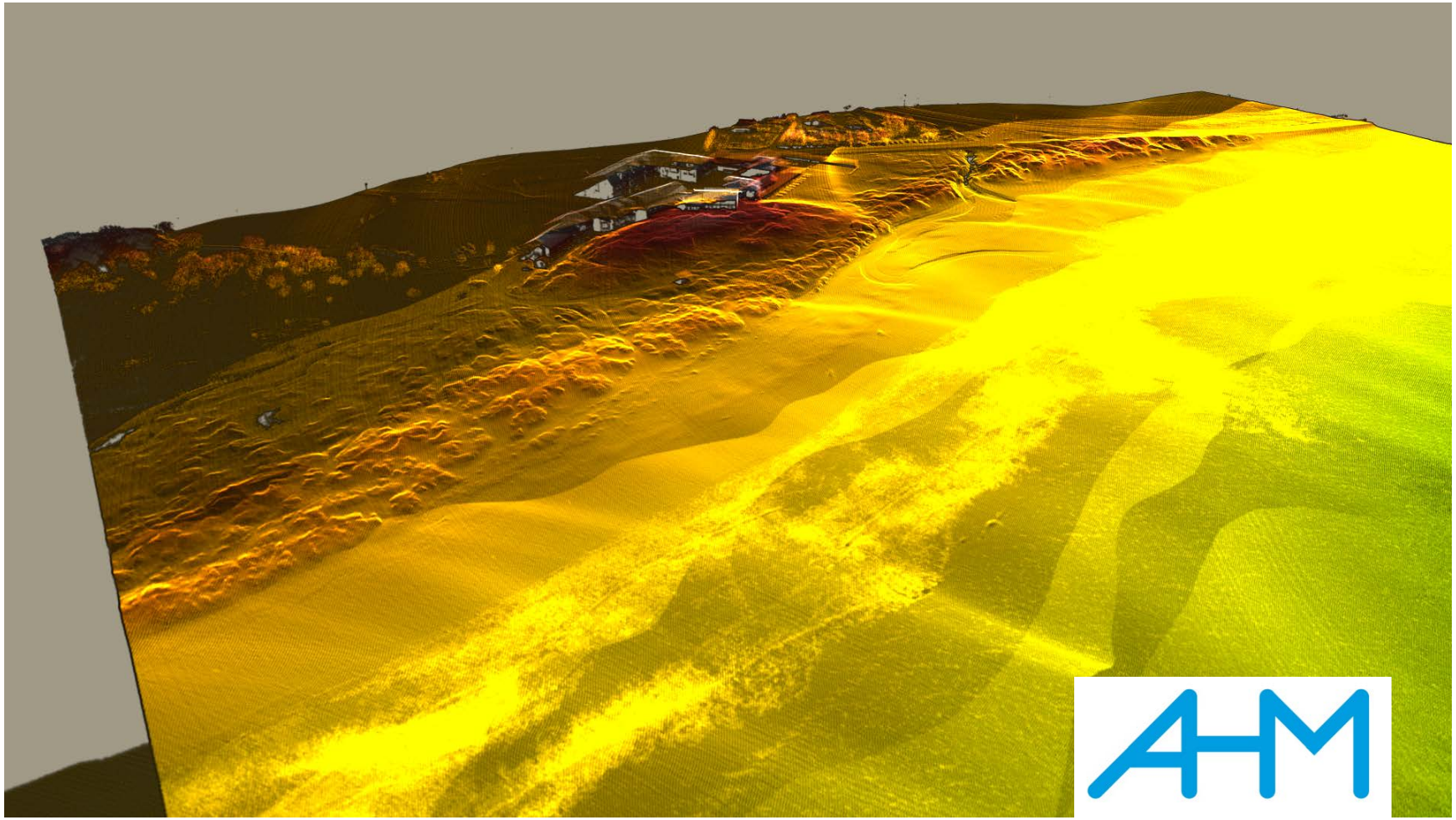


… and from 600 m height

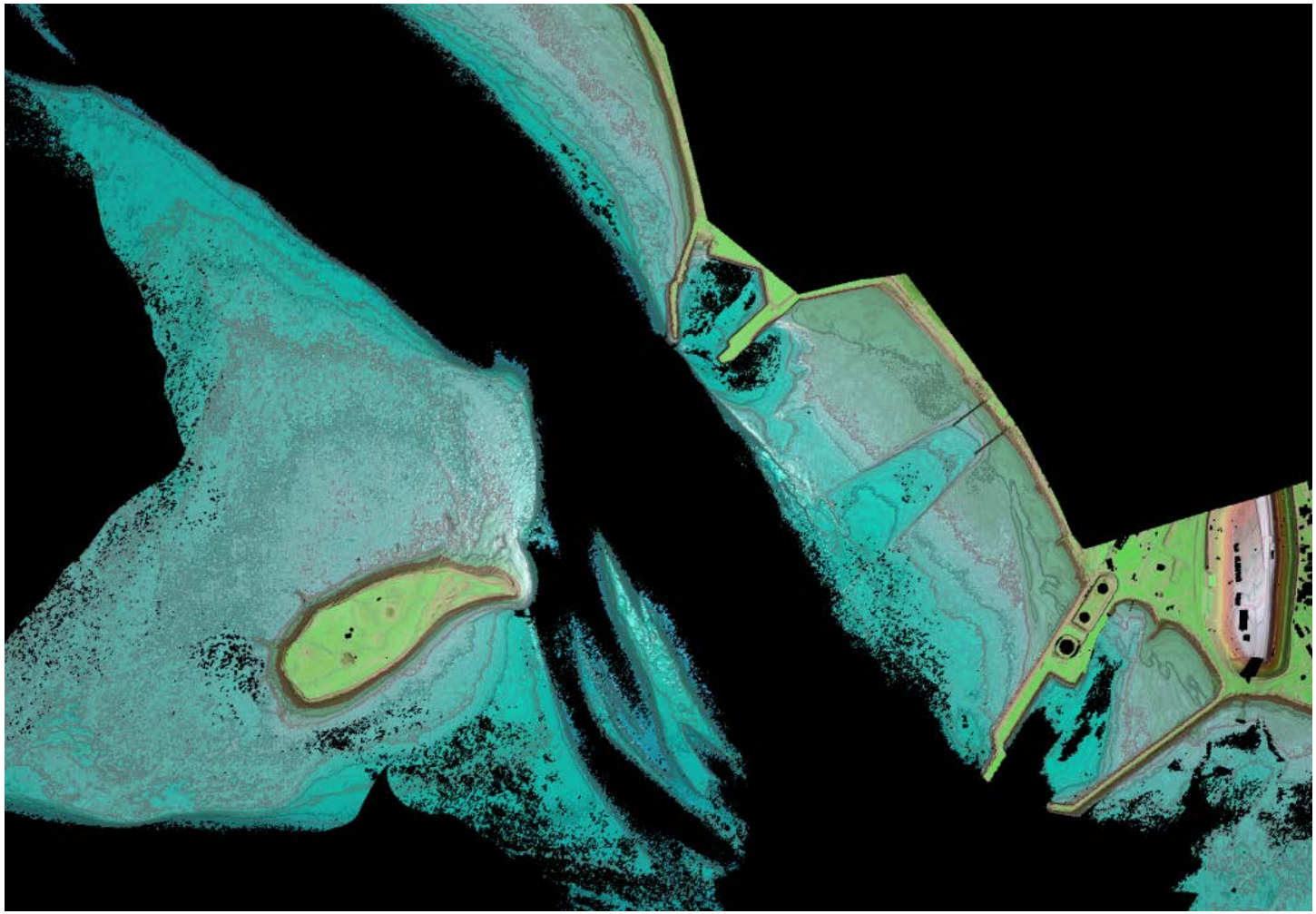


- broad flight strip from 600 m AGL
- detailed wide area-capture of ground structure

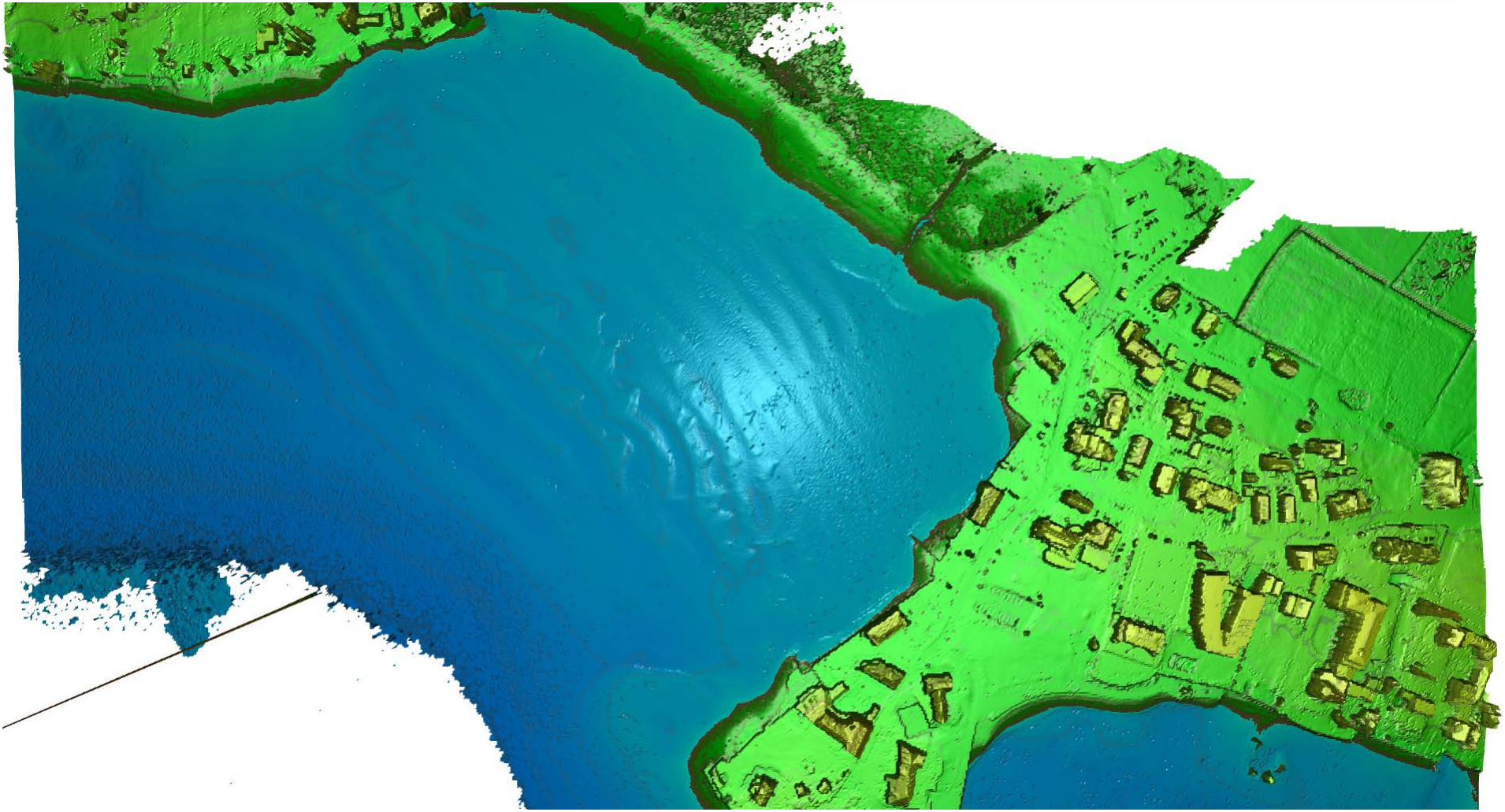
Fjord Mapping – near Stavanger



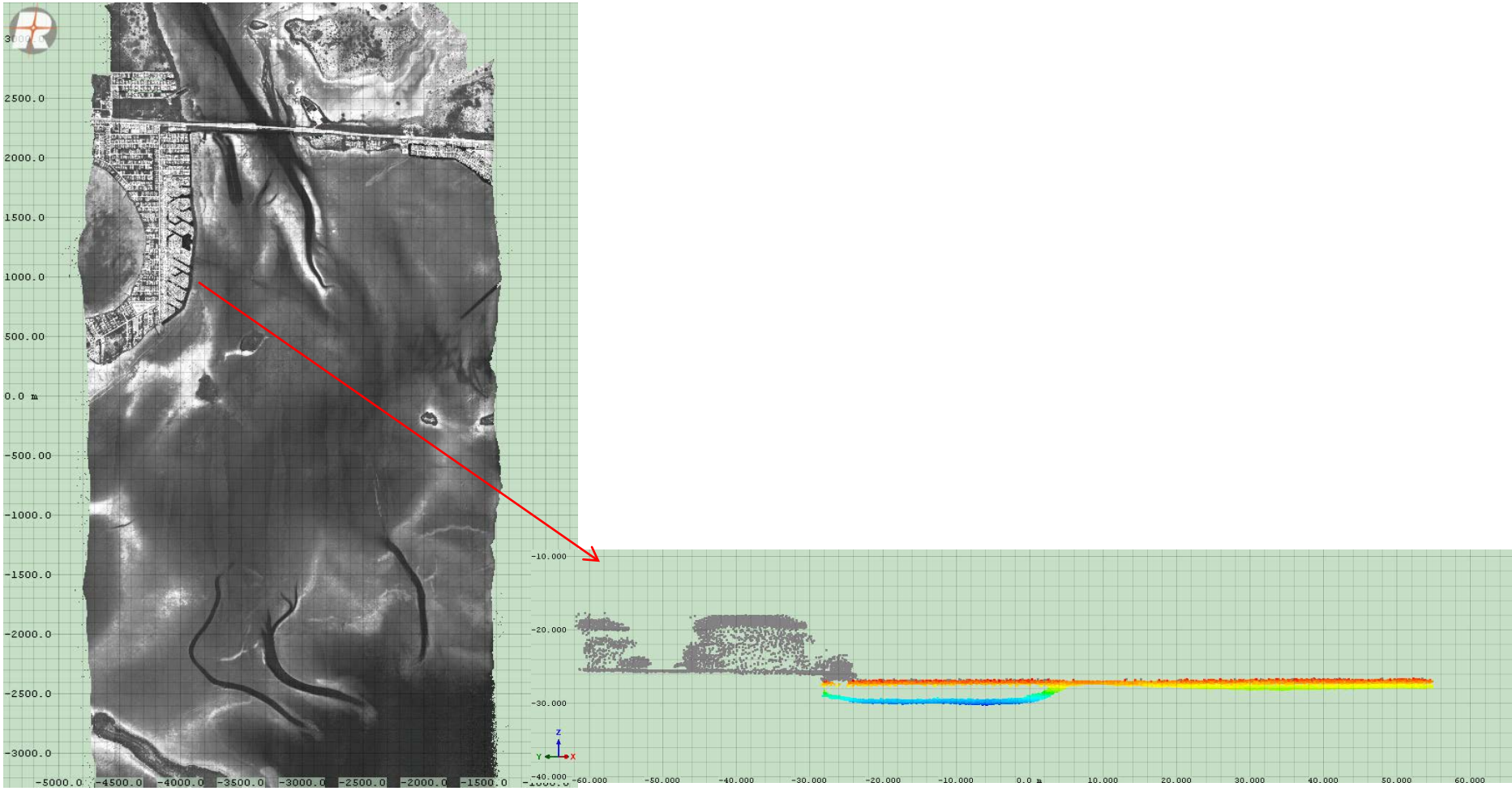
Denmark



Lake Constance

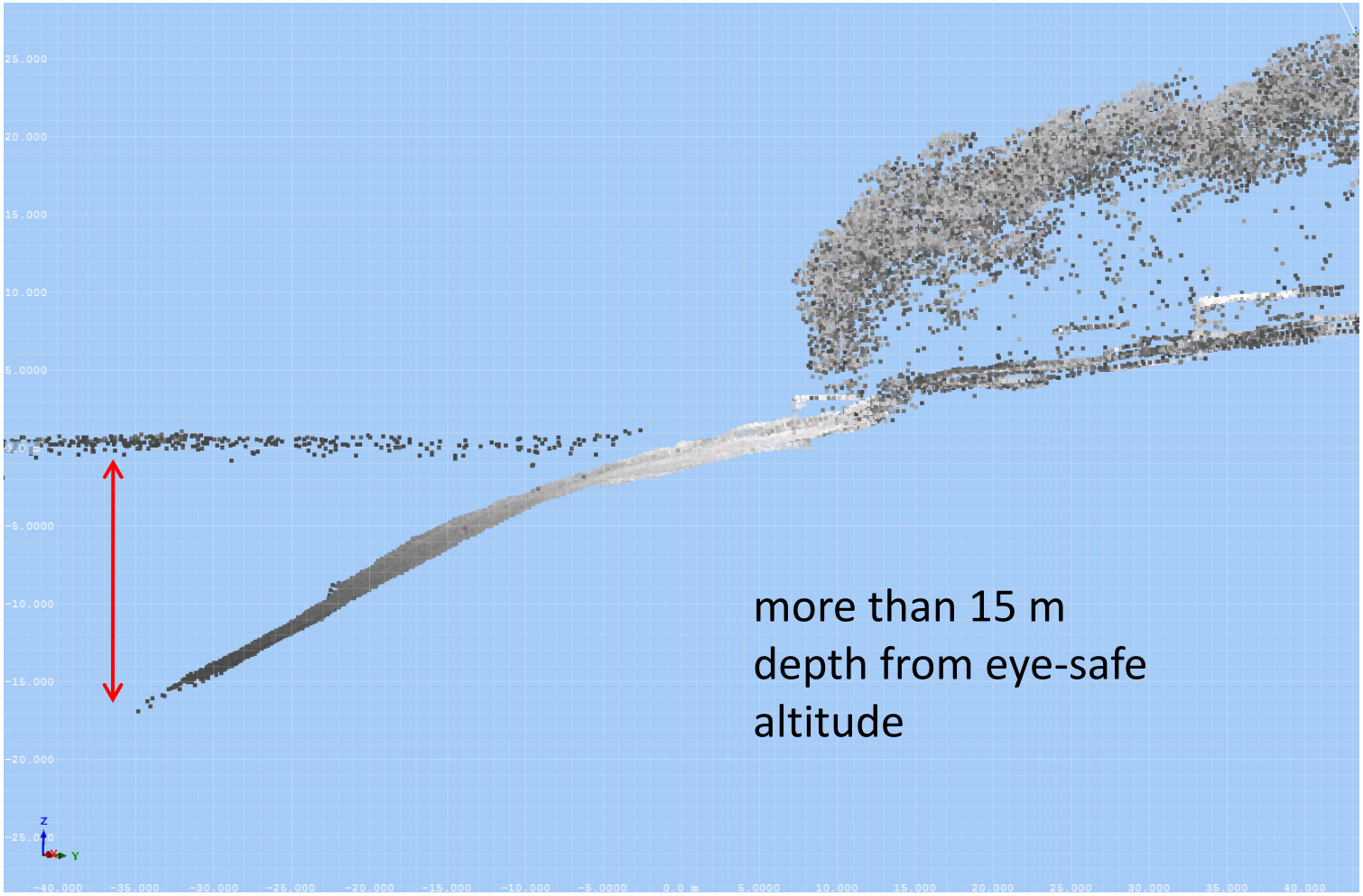


Florida Keys

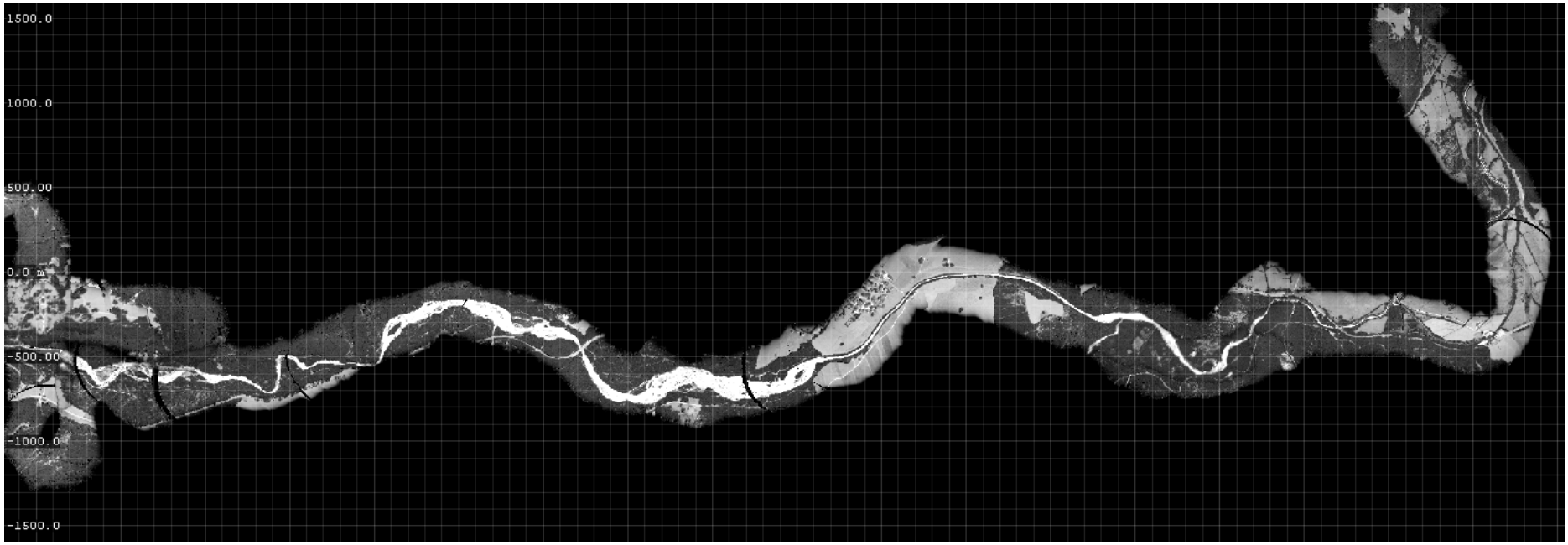


Adriatic Sea

Adriatic Sea

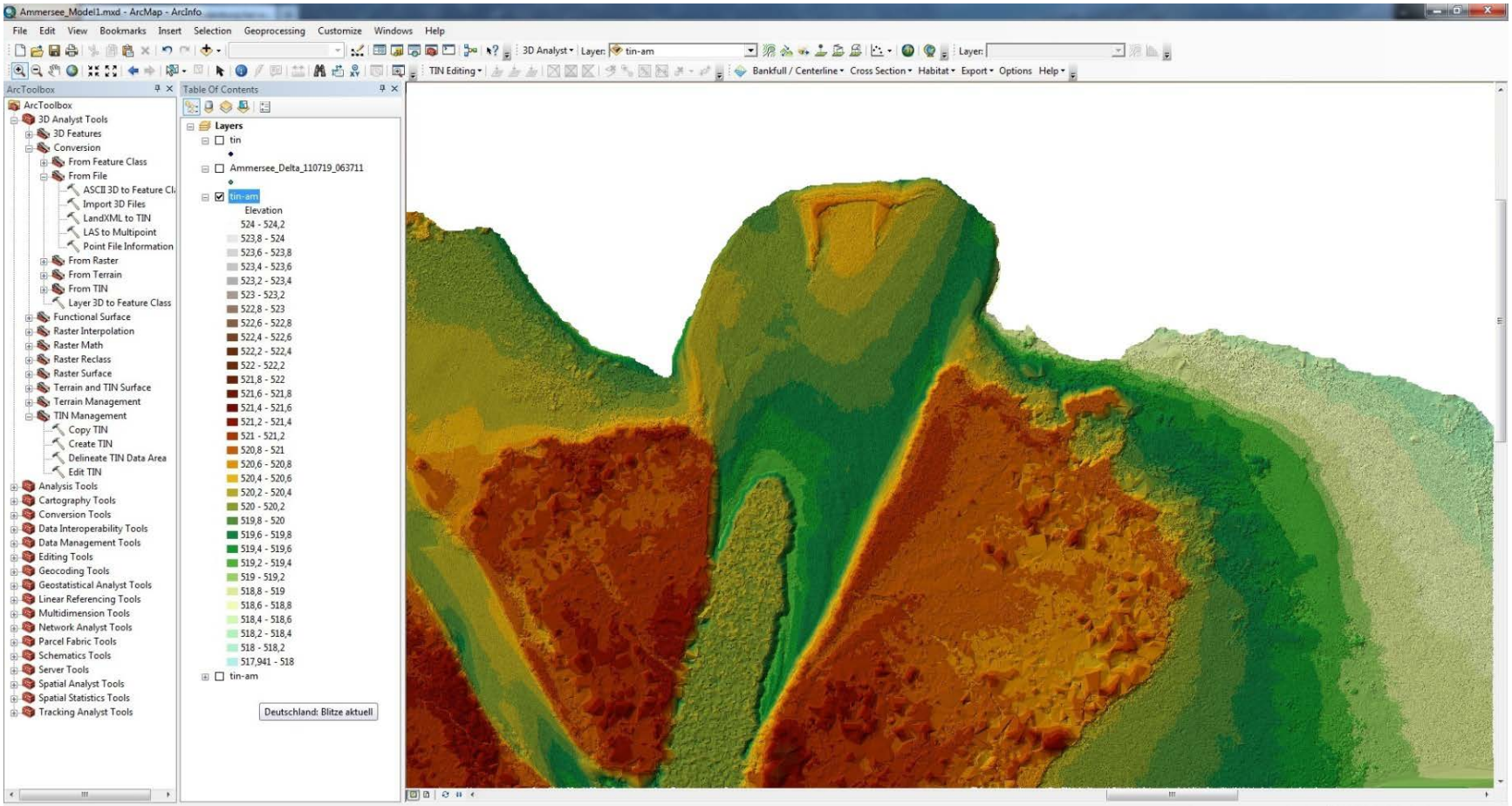


large-scale surveying of rivers



- full coverage of riverbed, riverbank, and surrounding area
- requires careful planning concerning precipitation, snowmelt etc.

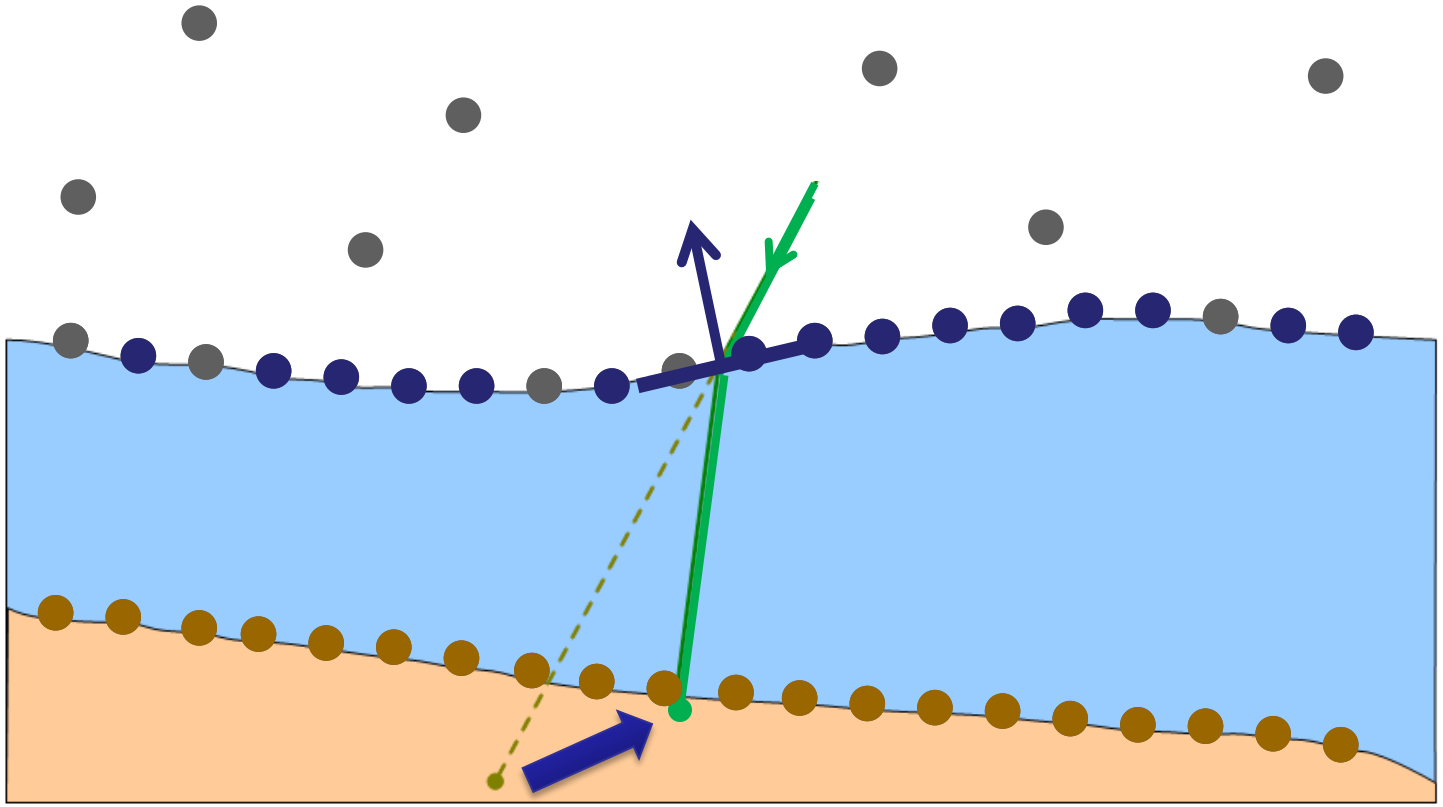
Lake Ammersee, Estuary



RIEGL Software Hydrography Addons

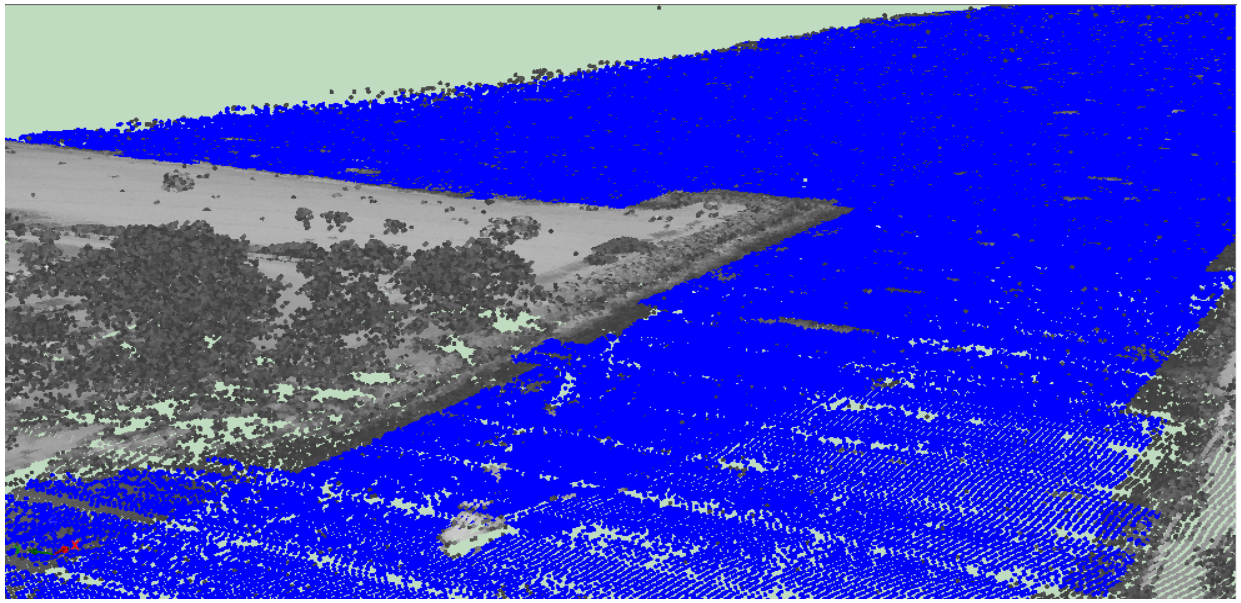
point cloud classification
refraction correction

what it's all about…

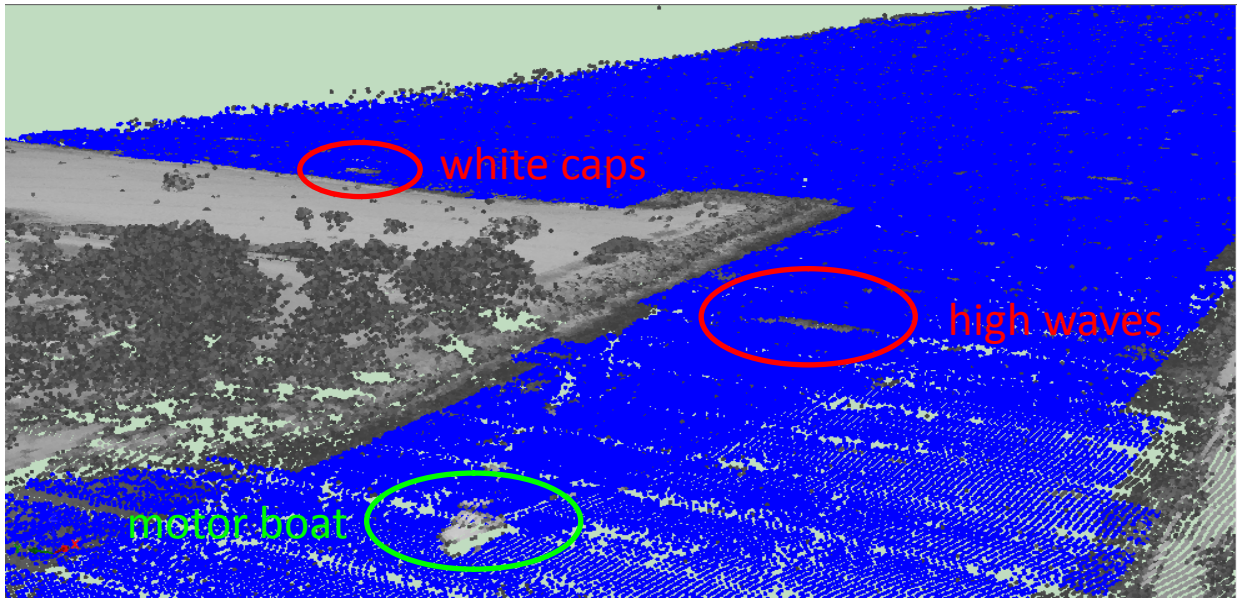


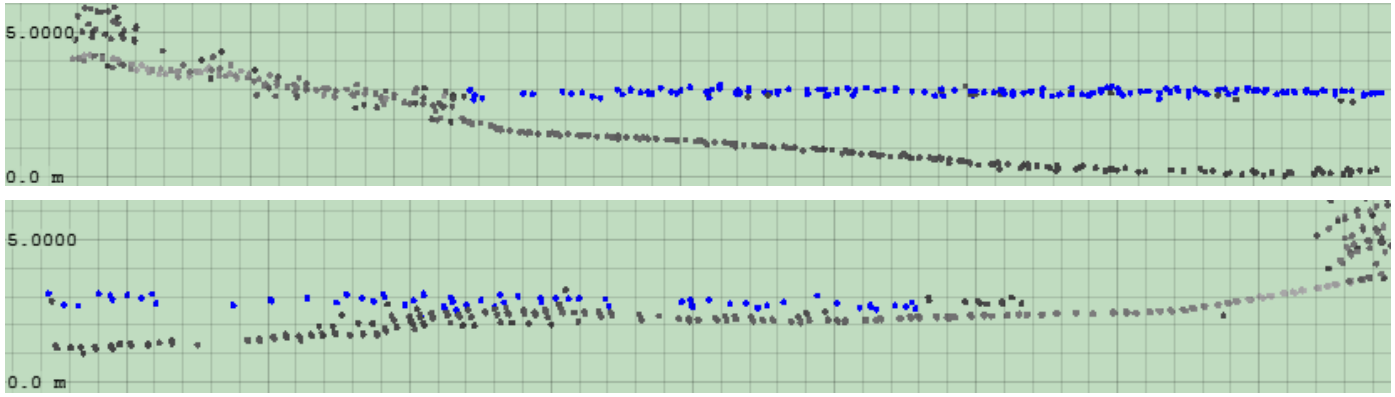
classification of water surface points

- each scan line (strip) is processed independently
- input:
  - geo-referenced scan line from VQ-820-G with sufficient density of surface returns
  - optionally: scan data from additional laser scanner



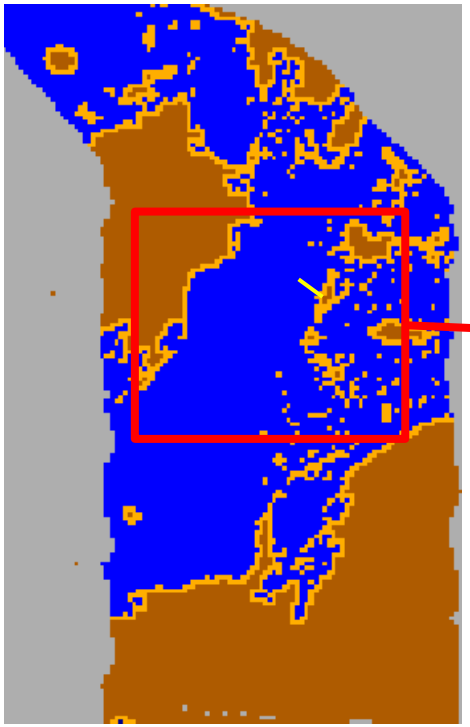
classification of water surface points – examples



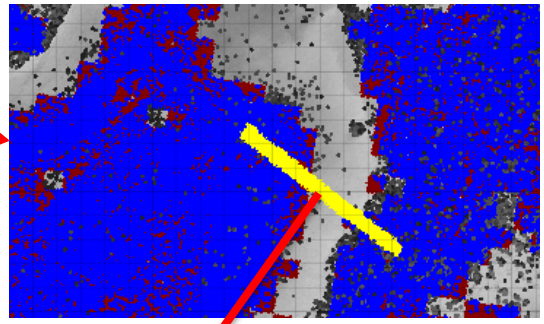


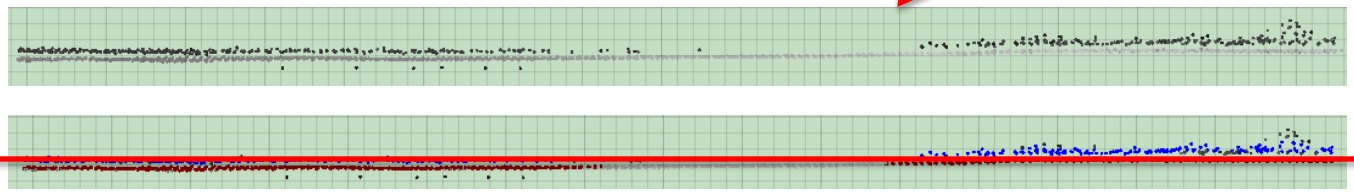
typical profiles crossing coast line

classification of water surface points – examples (2)



Aerial image



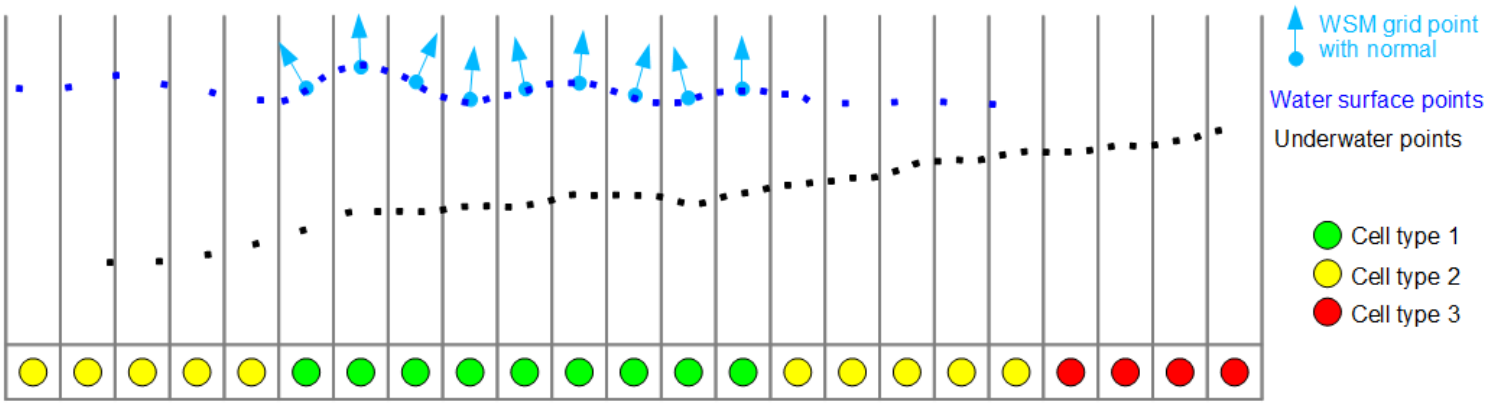


water surface (left) vs. low vegetation (right)

generation of WSM – outline of the methode

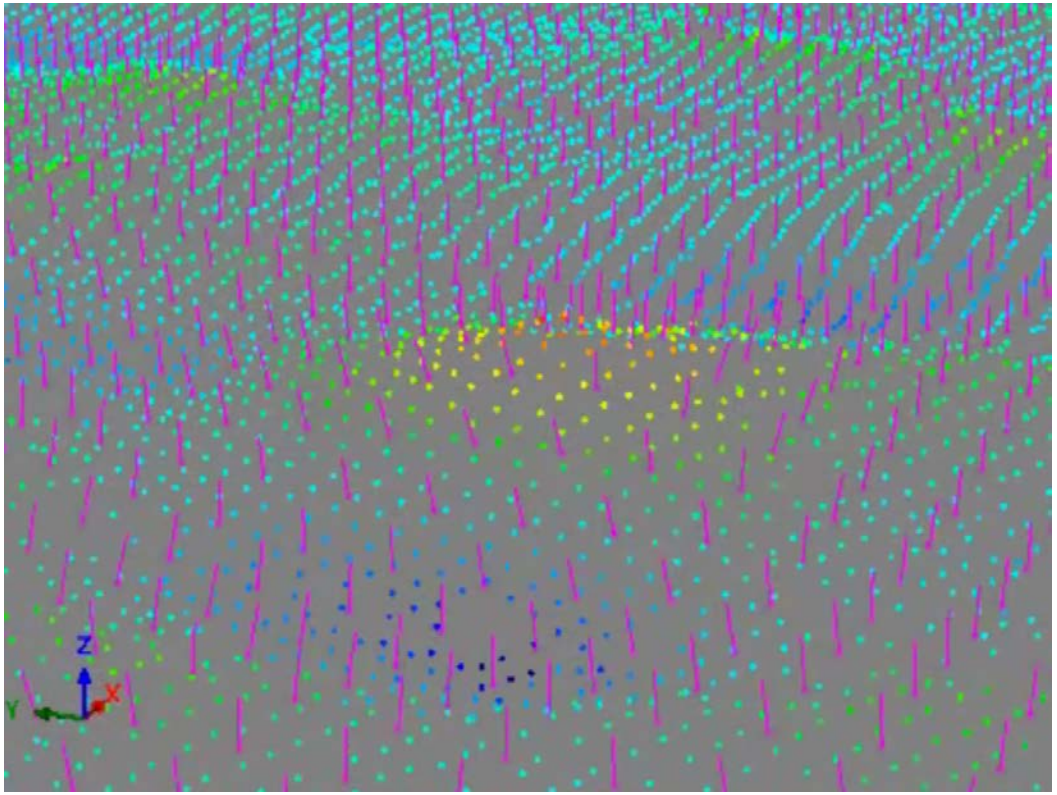
step 1: consider only cells within regions of sufficiently high point density

- for each cell, fit a plane to all nearby water surface points
- criteria for a successful reliable plane fit:
  - enough points (at least a predefined minimum number)
  - suitable point distribution (i.e. no collinear arrangement)
  - low gradient (plane must not exceed a given maximum tilt angle)
- if plane fit successful (cell type 1):
  - determine height of plane at cell's center → z_{WSM}
  - store it together with normal vector $\mathbf{n}_{WSM}$
- otherwise: cell type 2 (if containing water surface point(s)) or cell type 3

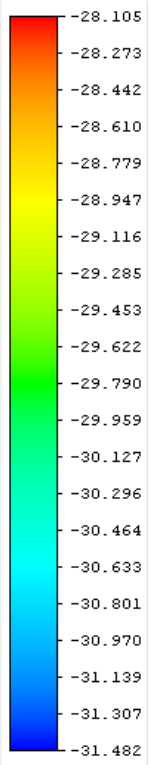


generation of WSM – results (1)

WSM in case of high waves (ocean mode):



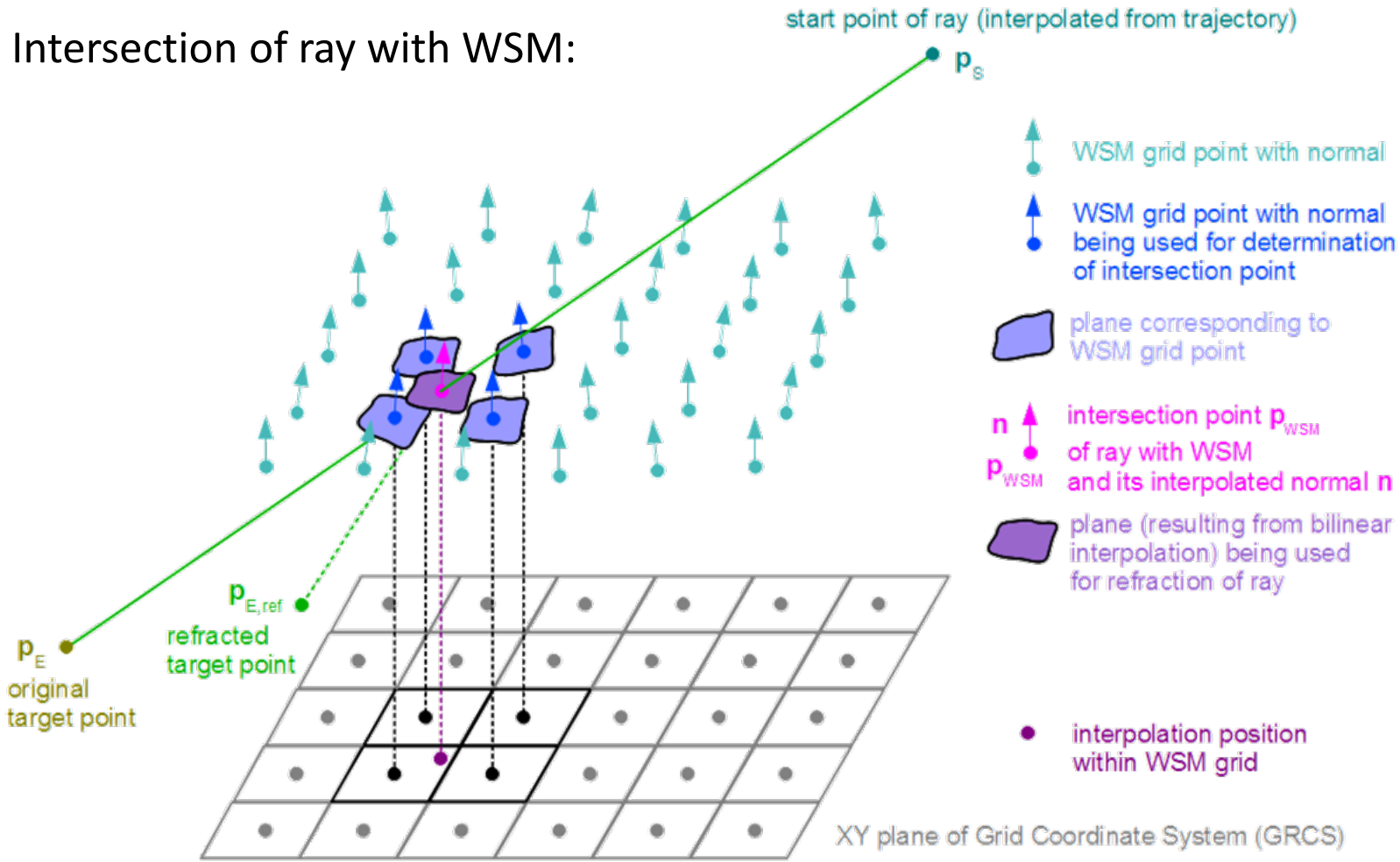
elevation



WSM (displayed as normal vector field) and water surface points (z-color-coded)

refraction correction (1)

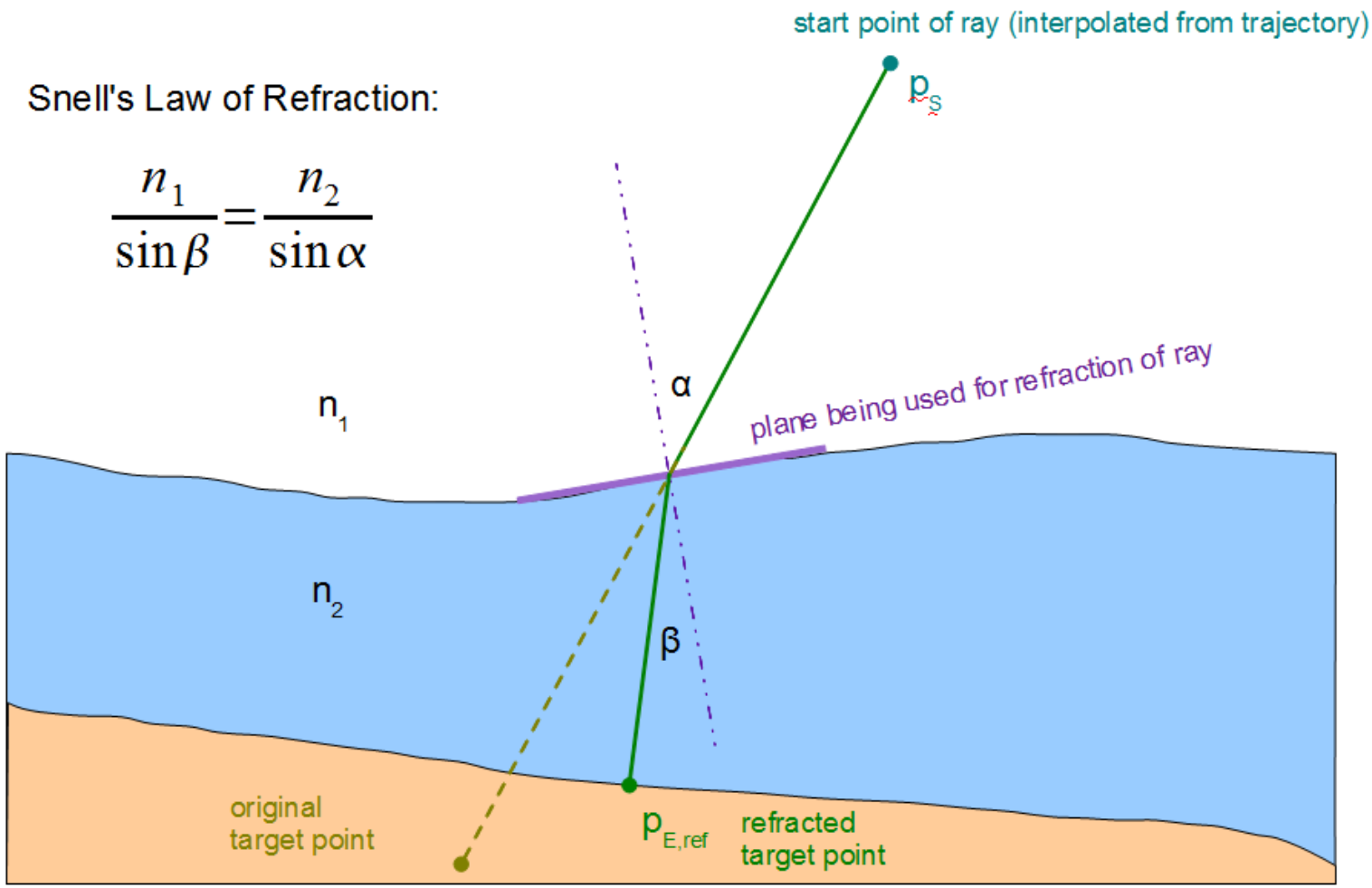
Intersection of ray with WSM:



refraction correction (2)

Snell's Law of Refraction:

$$\frac{n_1}{\sin\beta} = \frac{n_2}{\sin\alpha}$$



RIEGL®

RIEGL VQ-880-G

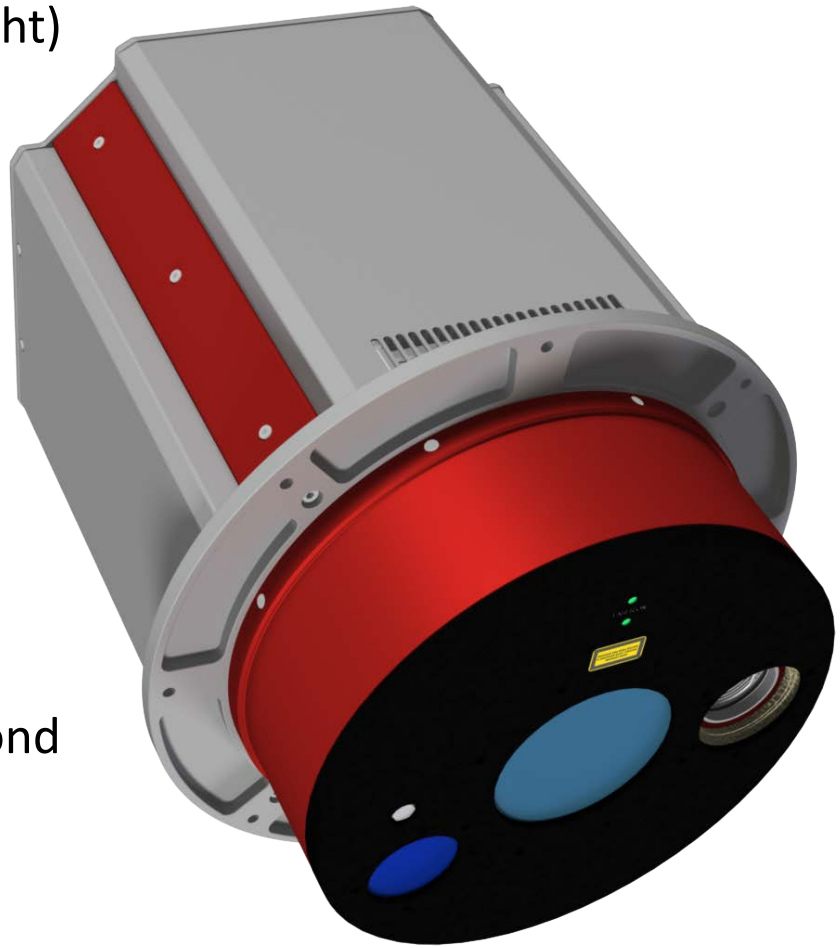
laser scanning system for combined topographic and bathymetric applications

In a nutshell…

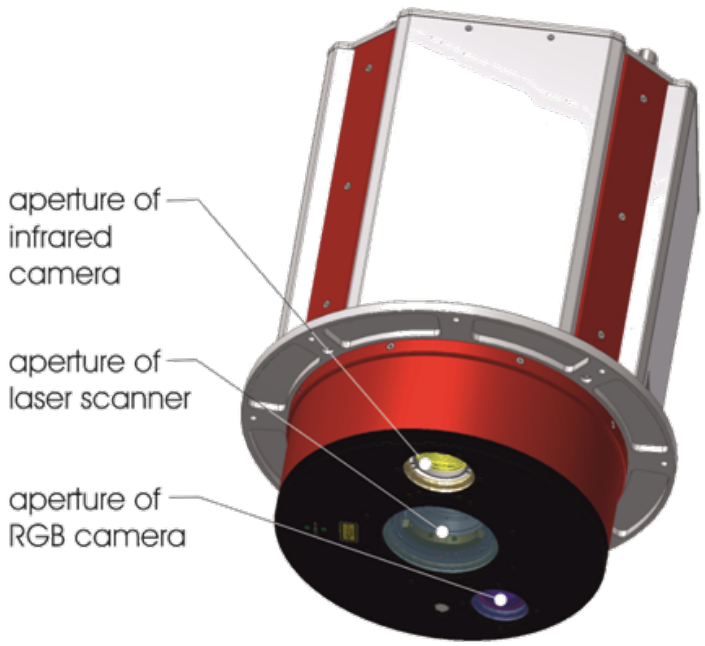
- based on *RIEGL* LMS-Q1560 platform
- fully integrated turn-key solution
- new scan mechanism
- improved measurement rate
- improved penetration
- full waveform recording for every laser shot

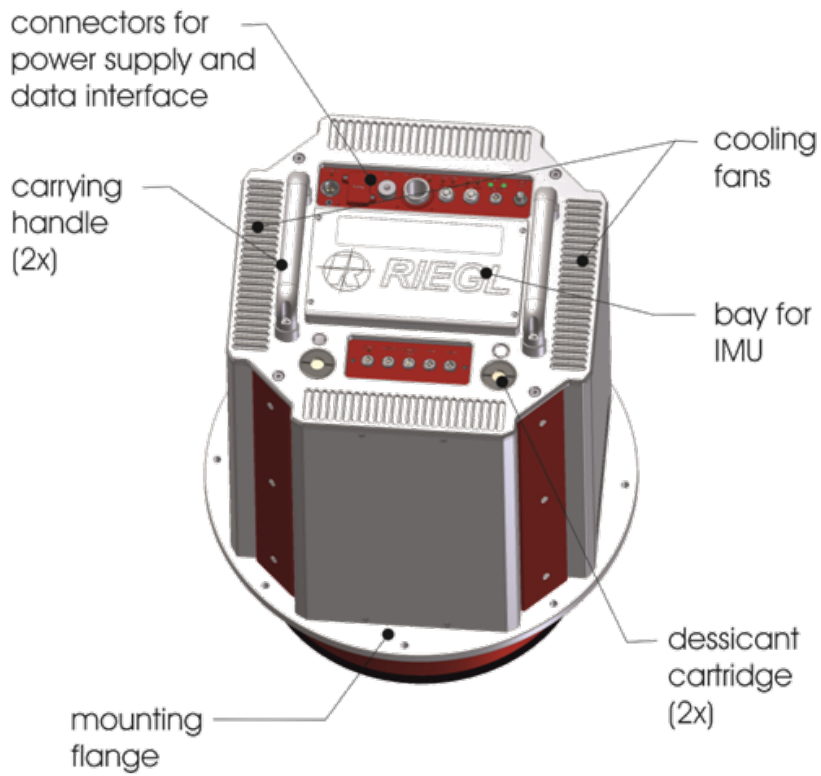
Key specifications

wavelength	532 nm (visible green light)
measurment range topography	2500 m at ρ ≥ 20% 3600 m at ρ ≥ 60%
measurment range hydrography	>1 Secchi depth bright ground
ranging accuracy	25 mm
FOV	+/- 20°
beam divergence	selectable, 0.7-2 mrad
measurement rate	520 kHz
scan speed	10 – 80 revolutions/second
laser safety	Laser Class 3B
multiple time around	yes



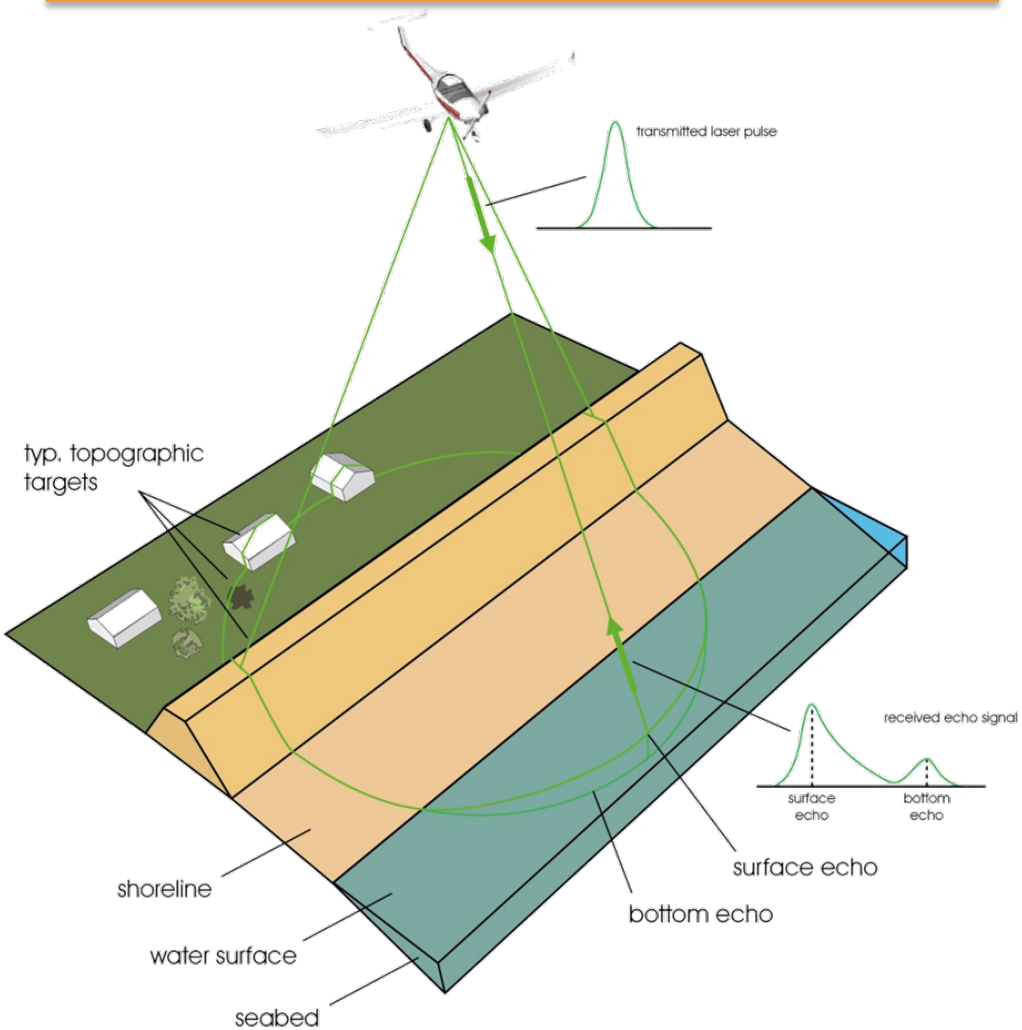
VQ-880-G features

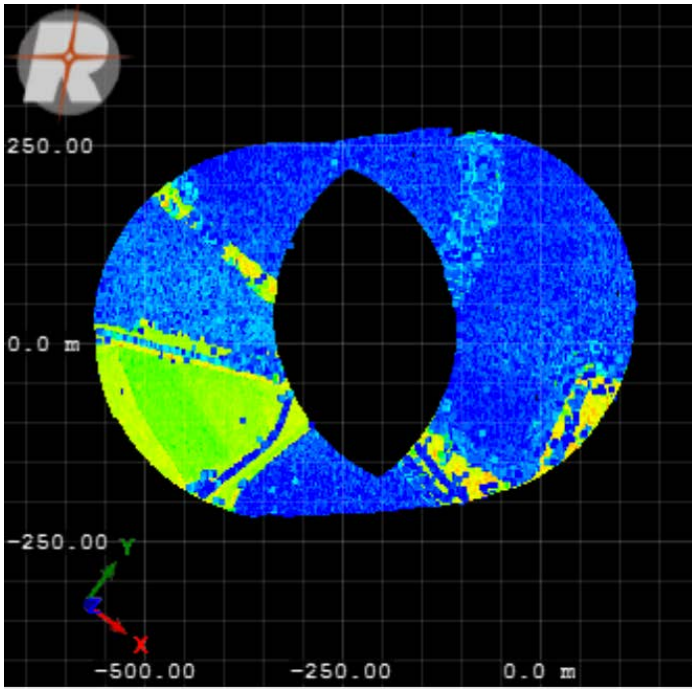




- power consumption: 550W
- weight: 60 kg
- dimensions: 444 x 444 x 615 mm³

Scan pattern



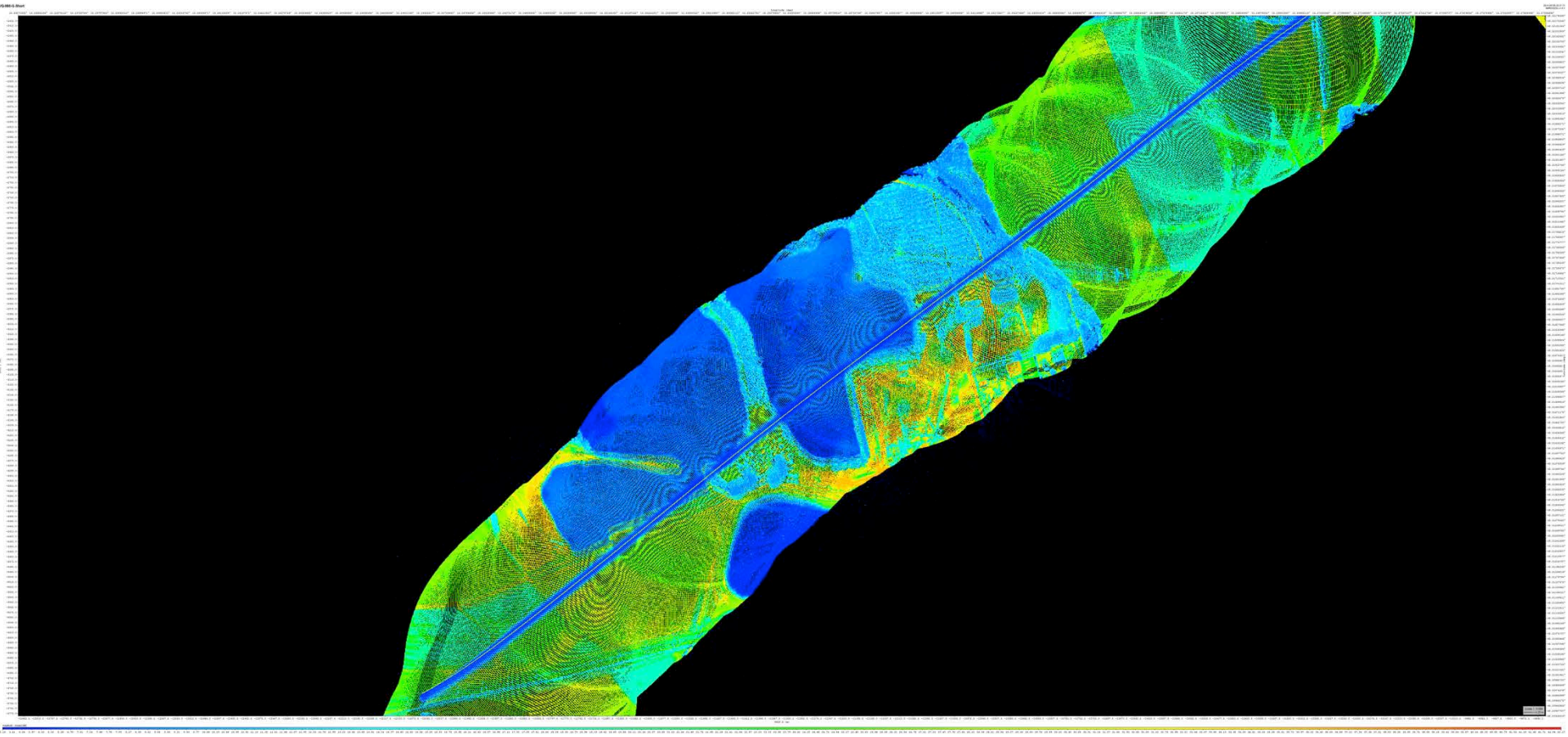


Interfaces and system components

- Gbit Ethernet
- High-speed fiber link to RIEGL DR1560 data recorder
- 18-32 V DC power supply

- integrated digital camera (29 Mpixel RGB)
- integrated IMU/GNSS
- *RIEGL* DR1560 for data storage

Results



Innovation in 3D

Thank you for your kind attention!

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Innovation in 3D