Laser scanners with echo digitization for full waveform analysis

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Project Management
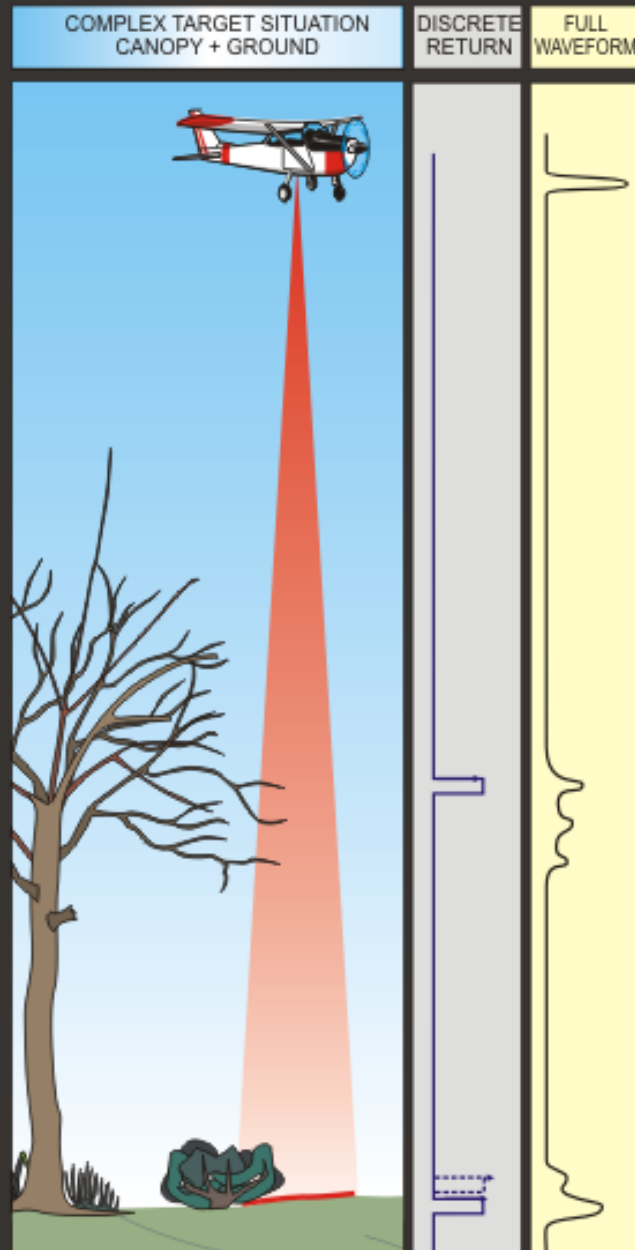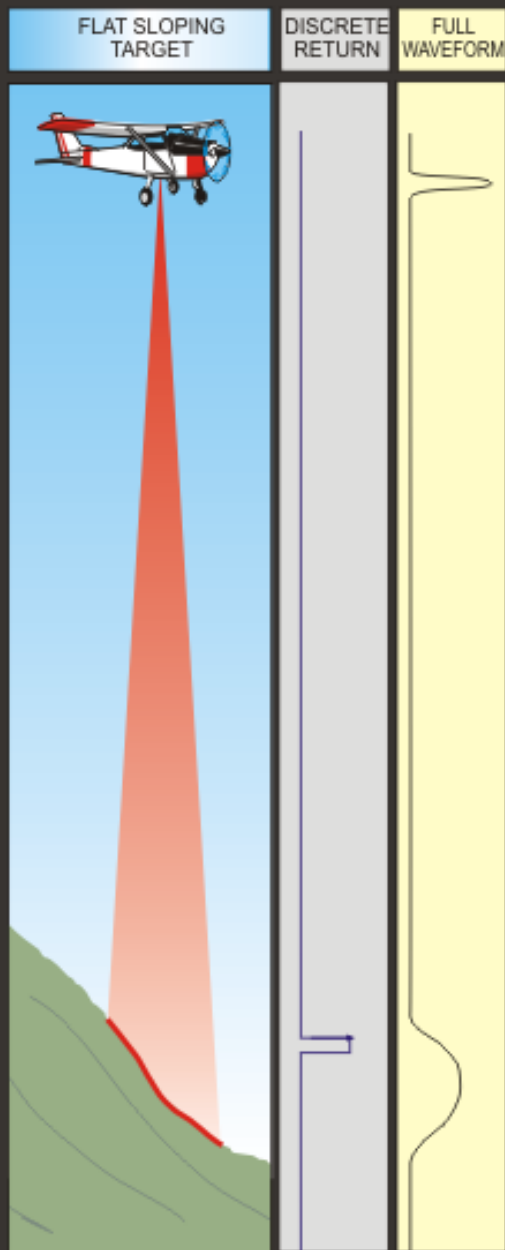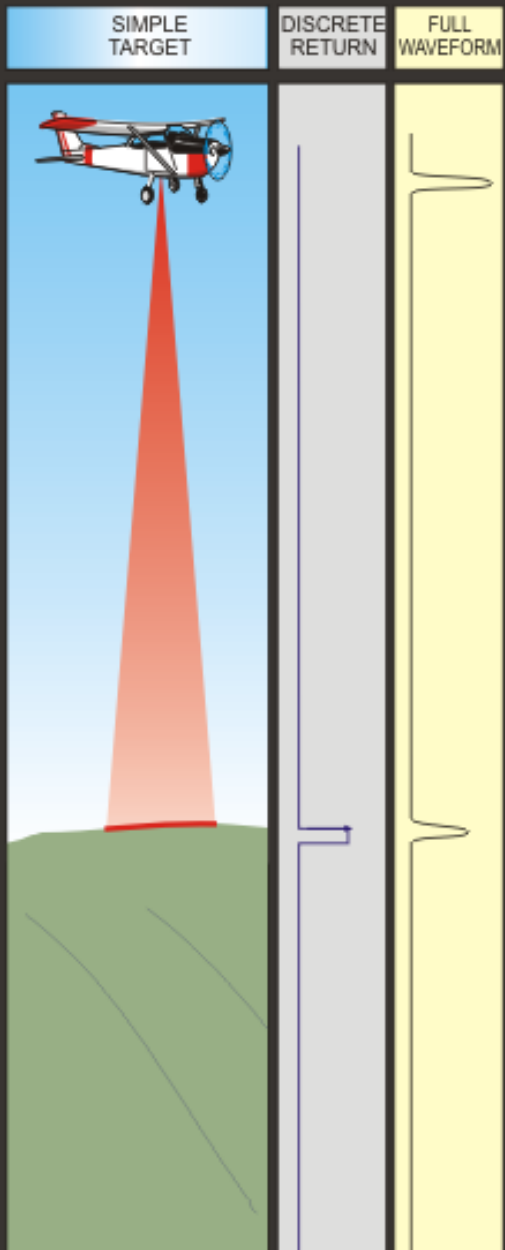RIEGL LMS GmbH
A-3580 HORN

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Principle of Echo Digitization and Full Waveform Analysis

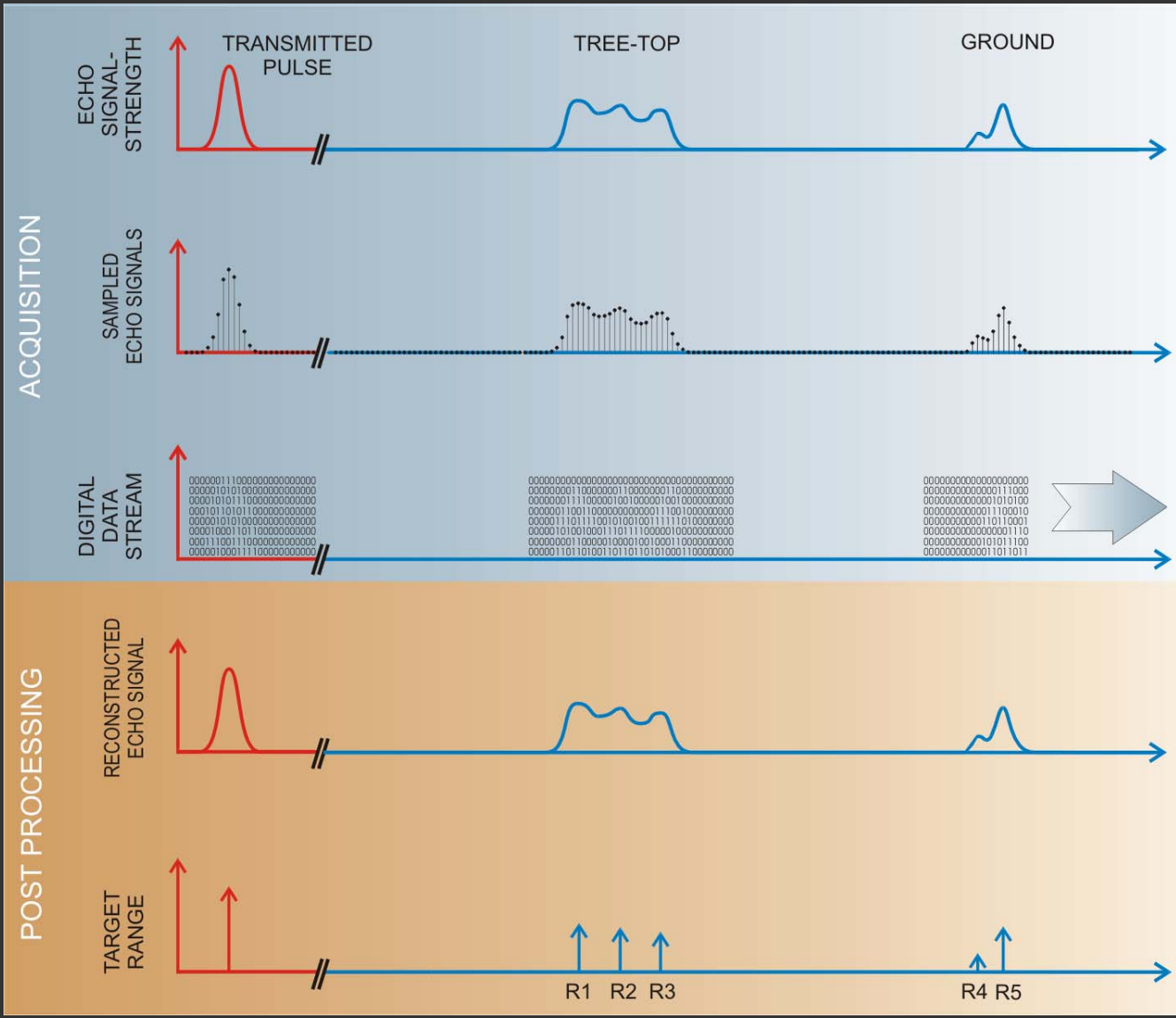**Laser Scanner System Description**

Example of Airborne Data

Summary

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Contents

SIMPLE TARGET	DISCRETE RETURN	FULL WAVEFORM
FLAT SLOPING TARGET	DISCRETE RETURN	FULL WAVEFORM
COMPLEX TARGET SITUATION CANOPY + GROUND	DISCRETE RETURN	FULL WAVEFORM

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Target situations

position of echo pulse and transmitted pulse
⇨ absolute target range

distance between echo pulses
⇨ high-accuracy object/target height

width of echo pulse
⇨ surface roughness, slope of target depth of target

amplitude / intensity
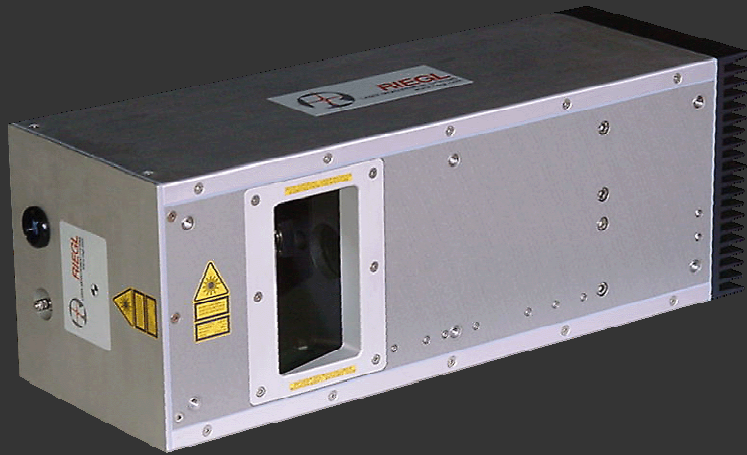⇨ target's laser radar cross-section, reflectance for extended targets

Echo digitization and Full Waveform Analysis

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Full Waveform Analysis gives access to

- almost unlimited number of returns per shot

- high multiple-target resolution (down to 0.5 m for *RIEGL* LMS-Q560)

- estimates of surface roughness and slope

- estimates of target's laser radar cross section

Full Waveform Analysis provides

- details on canopy, sub-canopy structures, and ground vegetation

- high-resolution detection of discontinuities and break lines

- transparent accuracy analysis due to user-definable
  target detection method and range calculation in post-processing

Advantages of Full Waveform Analysis

RIEGL LMS-Q560 with Data Recorder DR560

Specifications *RIEGL* LMS-Q560

Measurement range	30 m - 1500 m at ρ = 80% 30 m - 850 m at ρ = 20%
Ranging accuracy	20 mm
multi-target resolution	down to 0.5 m
Measurement rate	100 000 meas/ s (burst rate) up to 66 000 meas/ s (average)
Scan range	45°(up to 60°)
Scan speed	Up to 160 lines / sec
Synchronization	GPS PPS & serial IF
Time stamping	resolution 1 µsec, depth > 1 week
Size / weight	560 x 200 x 217 mm / 20 kg
Laser safety	Laser class 1 / wavelength near infrared

- High speed, high performance 2D laser scanner
- Combination with IMU & GPS yields a state-of-the-art airborne laser scanner system
- High measurement rate and linear scan lines with high scan rate gives superior density and evenly-distributed ground coverage
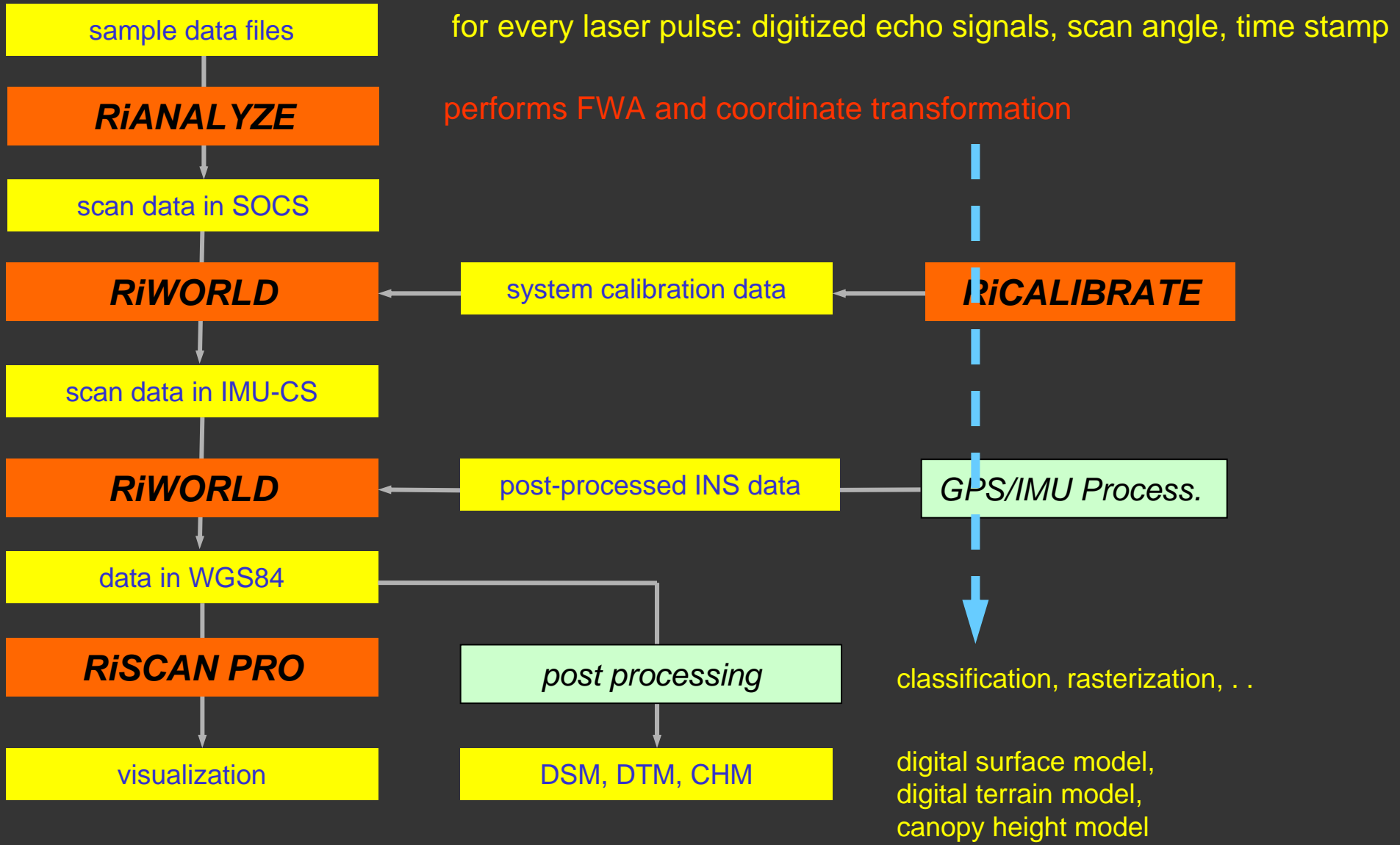
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FWA laser scanner decription

Components of an
Experimental
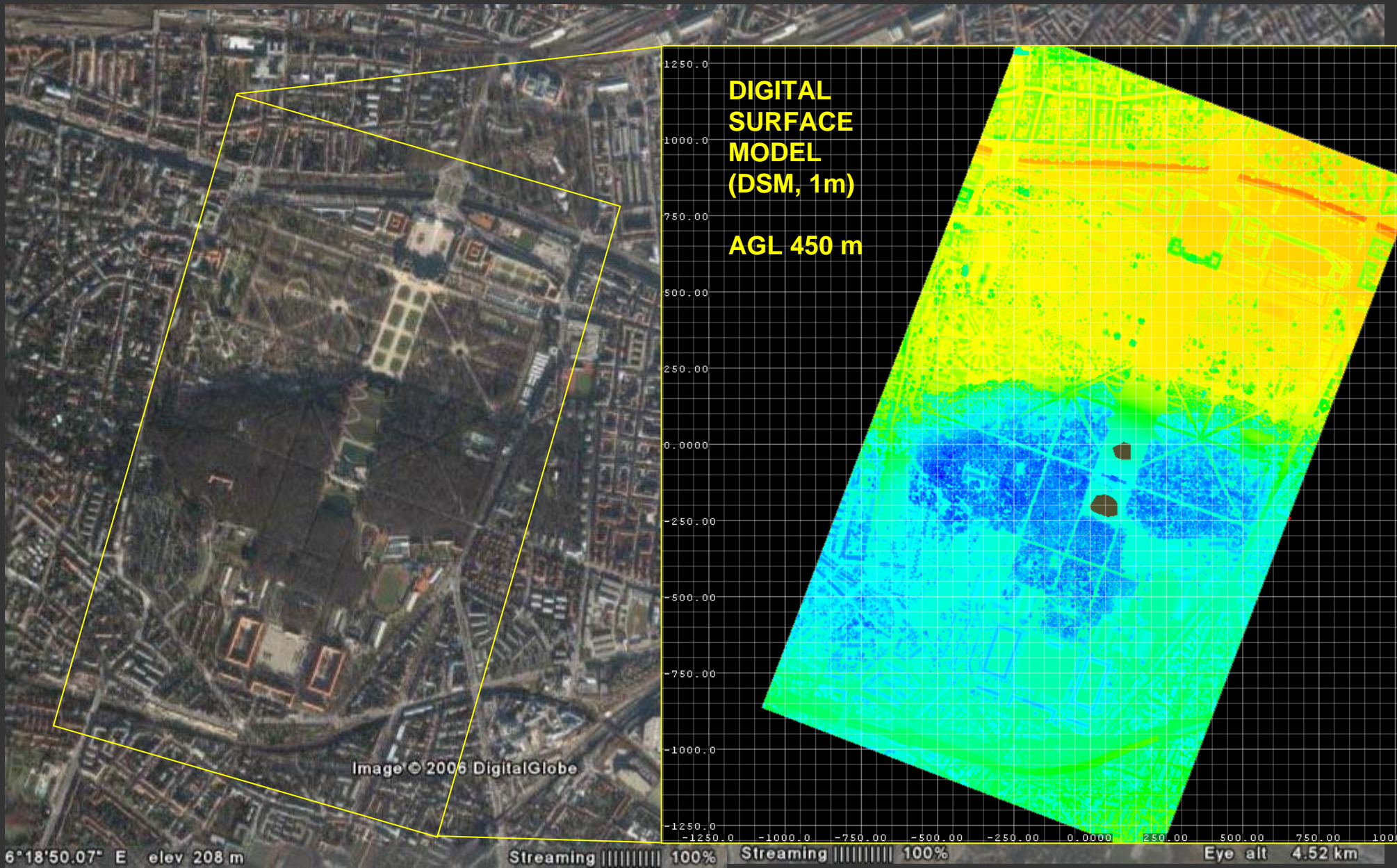Airborne Laser
Scanner System

- Laser scanner
  RIEGL LMS-Q560
- Data Recorder
  RIEGL DR560
- INS iMAR iNAV-
  RQH-AIRSURV
- GPS JAVAD
  Lexon-GGD
- Vibration isolated
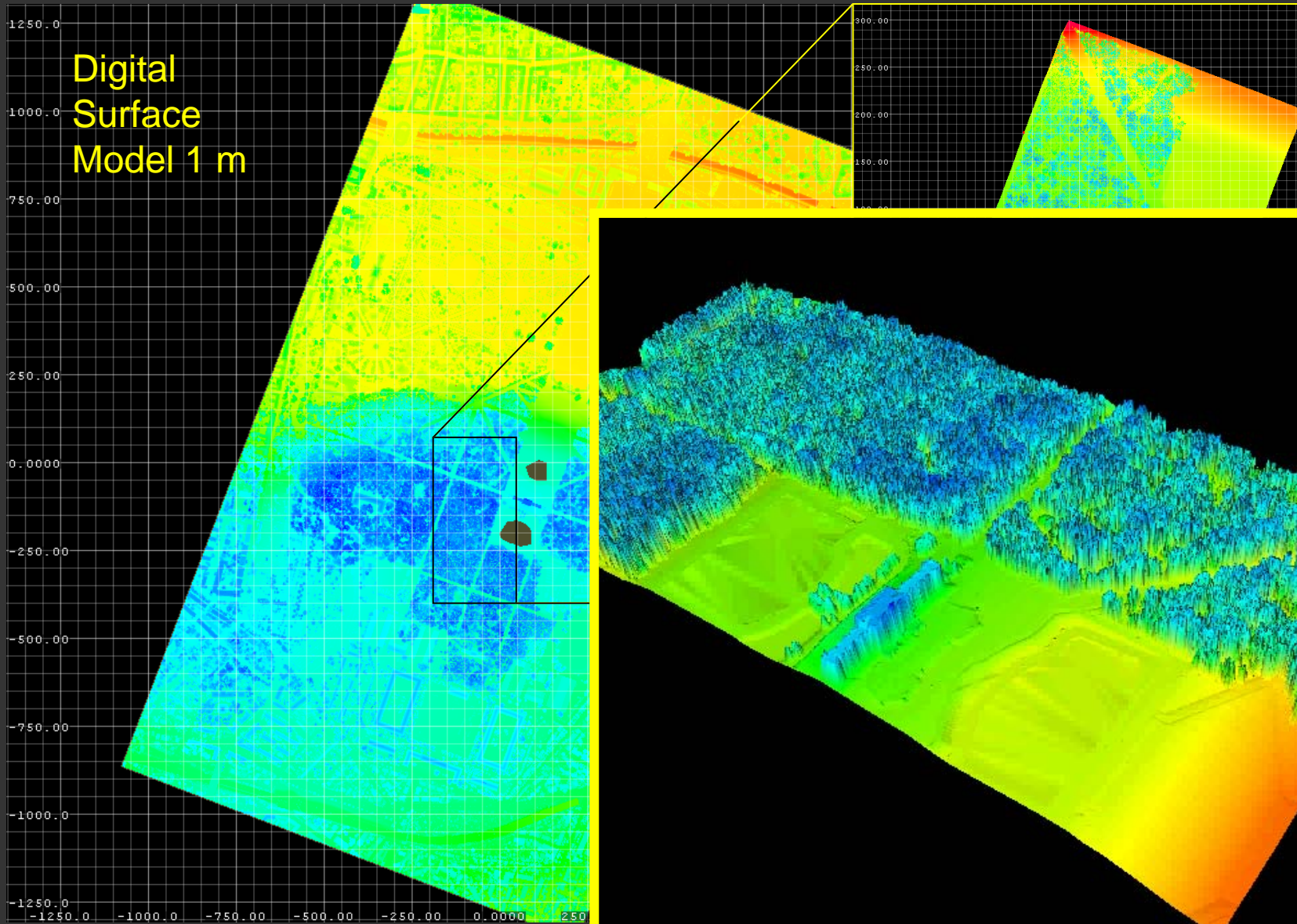 breadboard MR560
- Mounted on
  Eurocopter
  EC135

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Example of ALS system integration

sample data files

for every laser pulse: digitized echo signals, scan angle, time stamp

RiANALYZE

performs FWA and coordinate transformation

scan data in SOCS

RiWORLD	←	system calibration data	←	***RiCALIBRATE***

scan data in IMU-CS

RiWORLD	←	post-processed INS data		*GPS/IMU Process.*

data in WGS84

RiSCAN PRO		*post processing*

classification, rasterization, . .

visualization		DSM, DTM, CHM

digital surface model,
digital terrain model,
canopy height model

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Flow of ALS data processing with FWA

DIGITAL
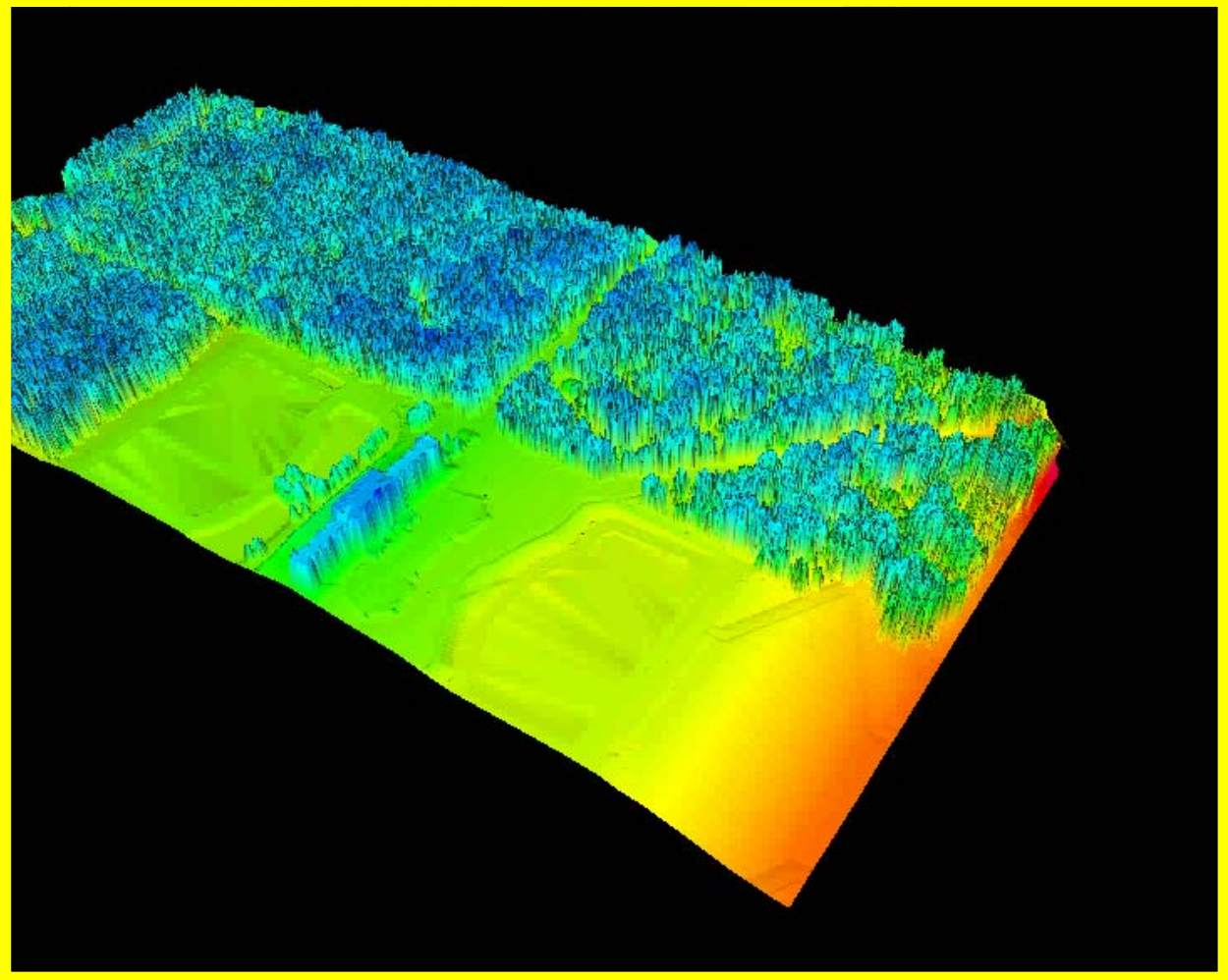SURFACE
MODEL
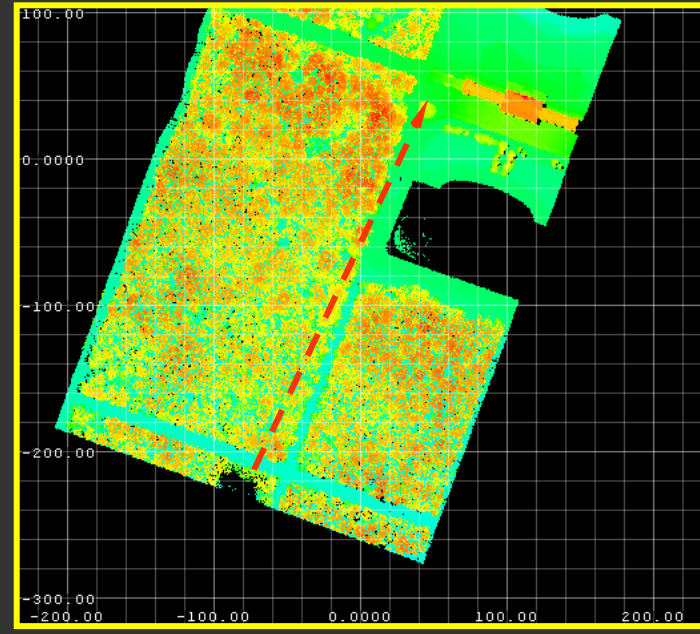(DSM, 1m)

AGL 450 m
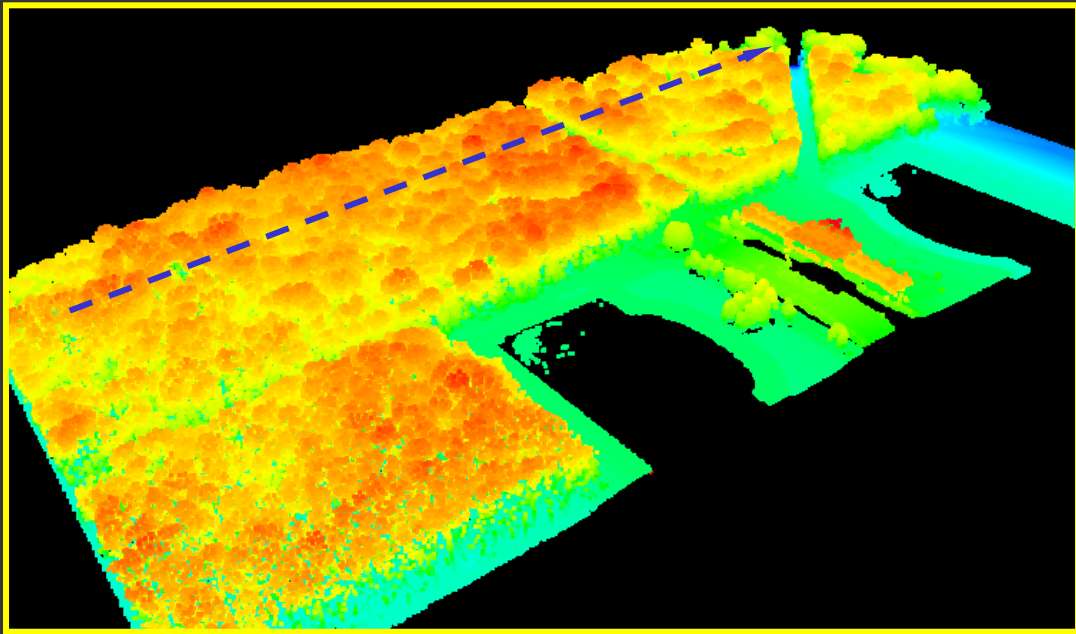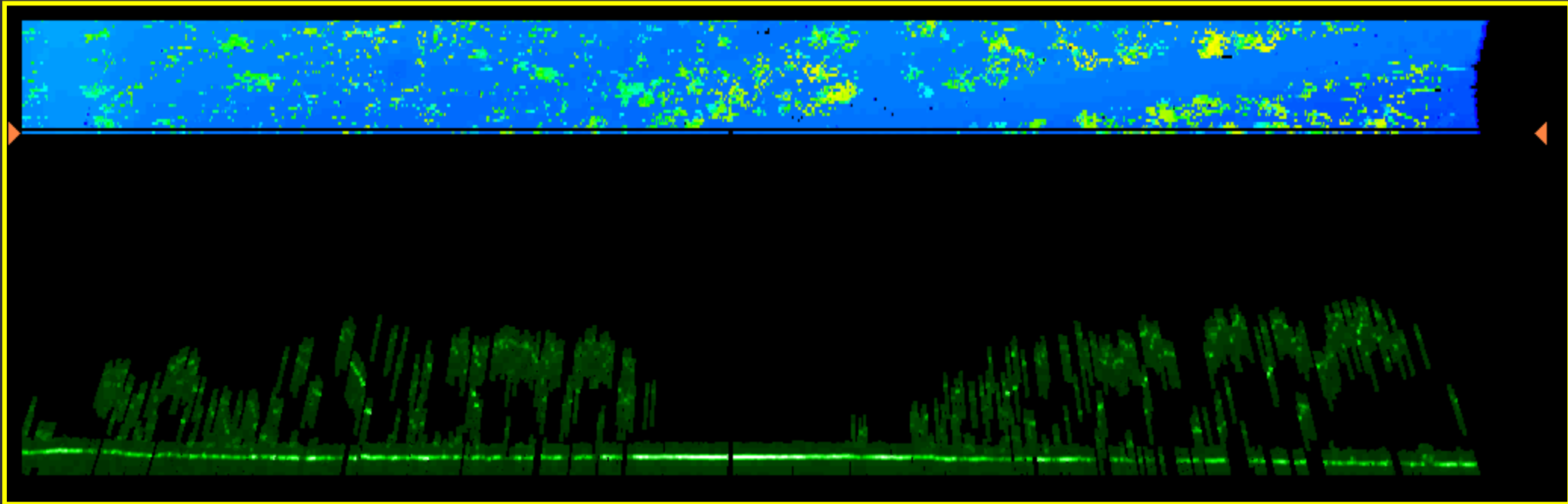
Example data Vienna, Austria

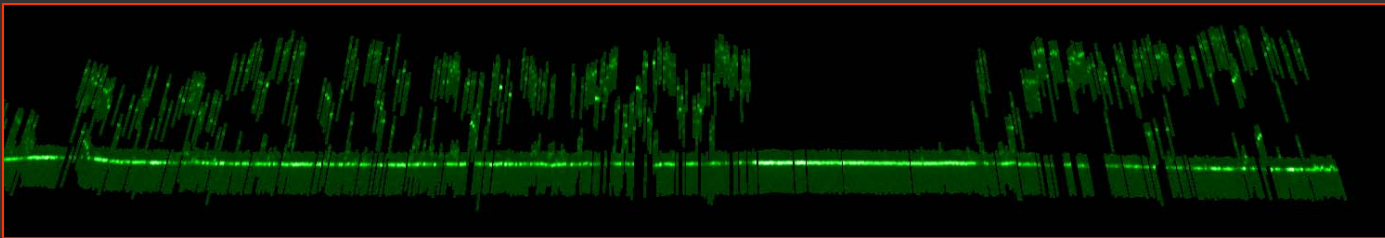Digital
Surface
Model 1 m

Digital
Surface
Model 0.25 m

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Example data continued
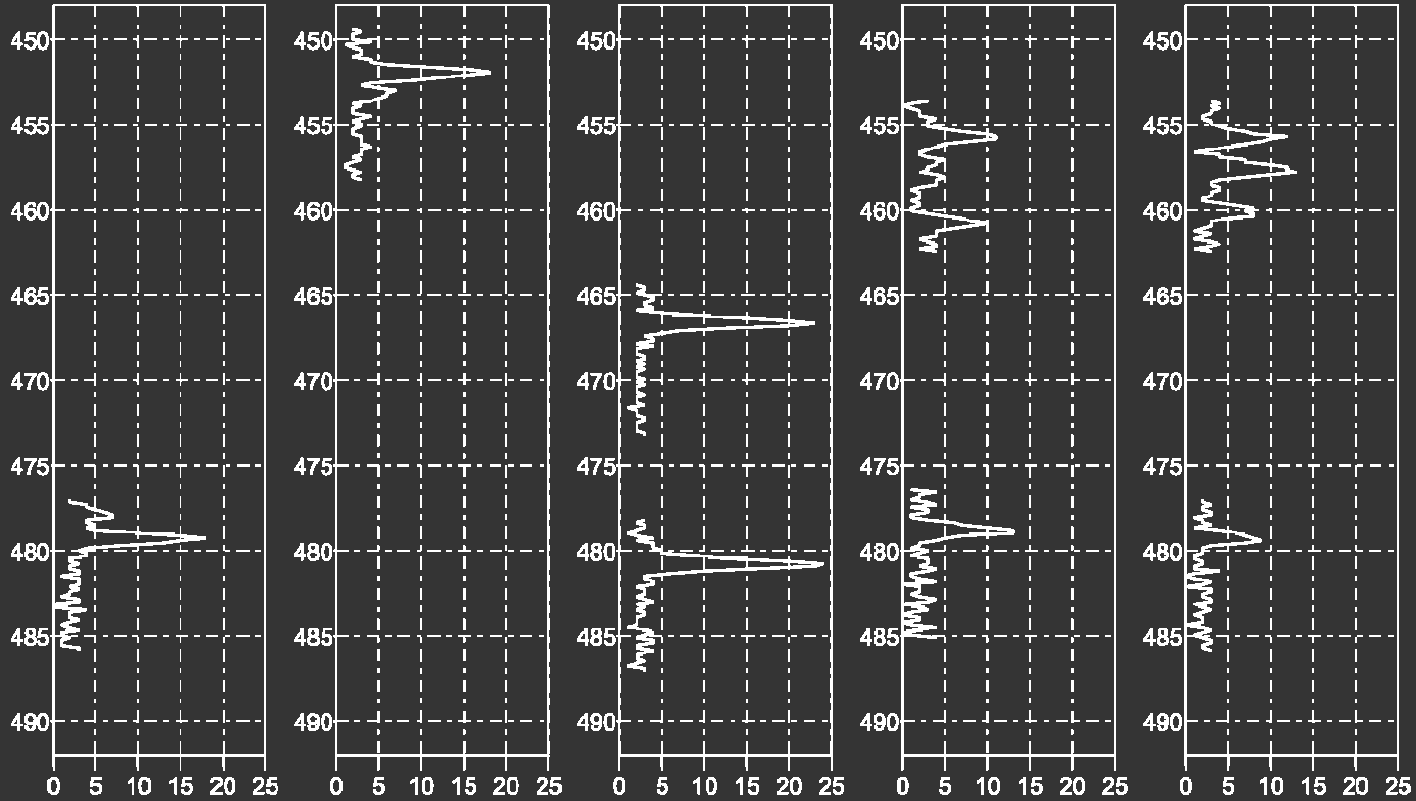
Visualizing echo signals per scan line

scan line

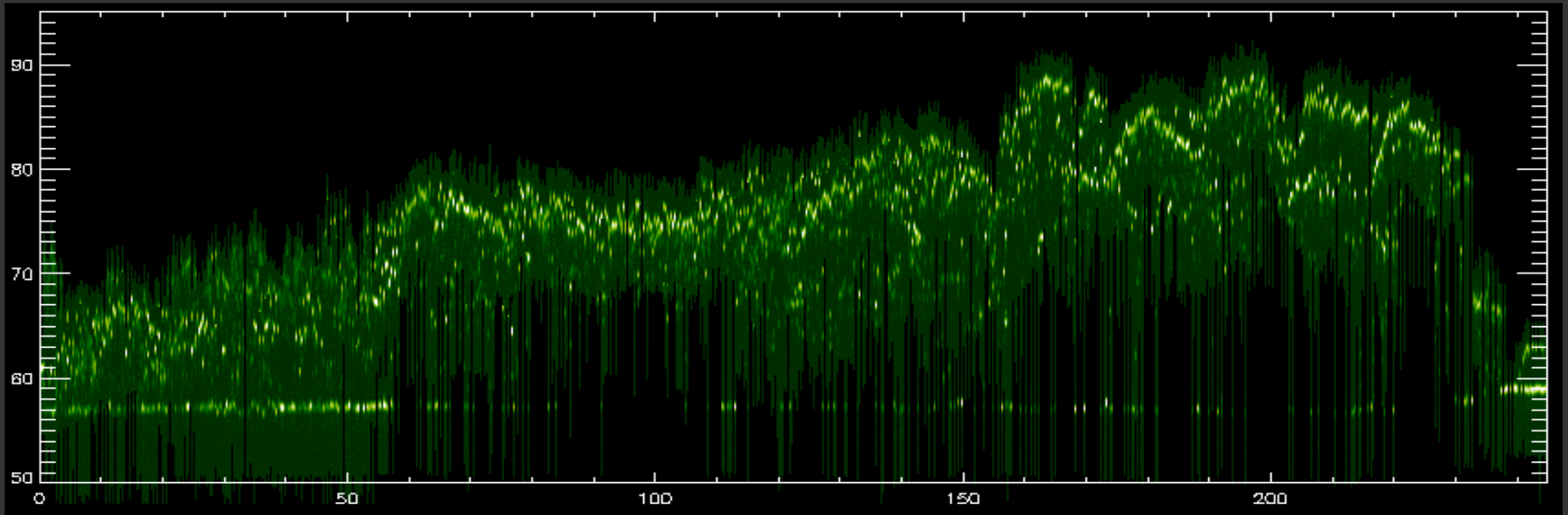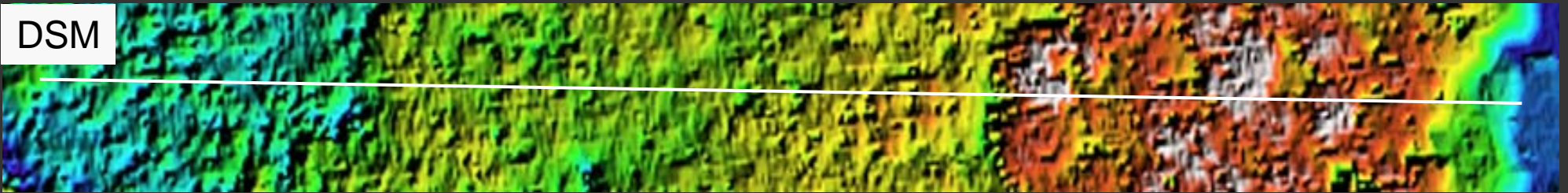examples of waveforms

range to target

signal strength

Single scan line with echo signals

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camera image

DSM

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Profile on deciduous forest (summer)

Fields of Application

- **forestry / agriculture monitoring**
  vegetation height, canopy structure,
  plant health, biomass, and more

- **high-resolution mapping of
  urban area**
  3D modelling of buildings, vegetation,
  fusion with terrestrial laser scan data

- **high-accuracy flood-plain mapping**
  high quality DTM generation,
  discrimination capability of even low
  vegetation

- **infrastructure planning/maintenance**
  power lines, pipelines, railroads,
  highways

Summary

- **Test data demonstrate high quality
  of recorded waveforms**
  low noise, high dynamic range, high
  resolution

- **Vegetation registration**
  Excellent range resolution reveals
  much more vegetation details
  compared to discrete return system

- **Surface features**
  Low noise of ranging reveals high
  degree of detail on edges und small
  surface features

- **Echo Digitizing *RIEGL* LMS-Q560**
  adds a new dimension in ALS

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Summary