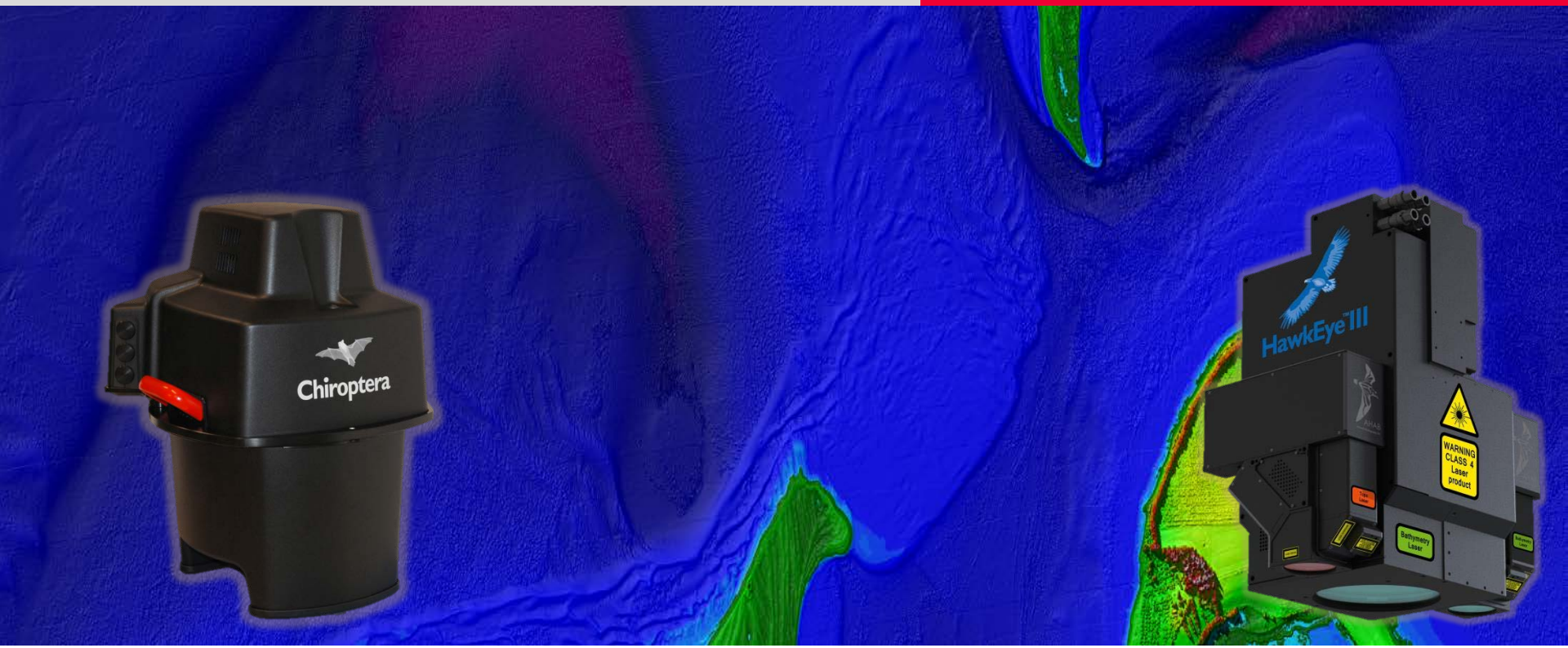

Leica - AHAB

Topo / Bathy LIDAR lidar sensors and applications

Anders Ekelund

JALBTCX seminar 2014

Date: 10.6.2014

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Airborne Hydrography AB

World recognised manufacturer of Airborne LIDAR systems

Founded 2002

Technology based on Swedish defense developments in bathymetric LIDAR during 1980s and 1990s

Since October 2013 part of Leica Geosystems

Leica Geosystems - when it has to be right + AHAB Airborne Hydrography AB

AHAB - Leica integration

- **Leica Geosystems received**
  - Immediate aceess to world class bathymetric LIDAR portfolio
  - Advance waveform electronics technology
  - Advance waveform processing software
- **AHAB received**
  - Immediate access to Leica world wide sales organisation
  - Immediate access to Leica support organisation
  - Financing to take the bathymetric LIDAR technology to commodity
- **Common immediate synnergies**
  - Leica medium format camera RCD 30
  - Flight management, Mission planning and Intertia navigation
  - Leica workflow
  - PAV 100 gyro stabilzed mount
  - **<u>Doubled resources within Airborne LIDAR R&D</u>**

Leica Geosystems - when it has to be right

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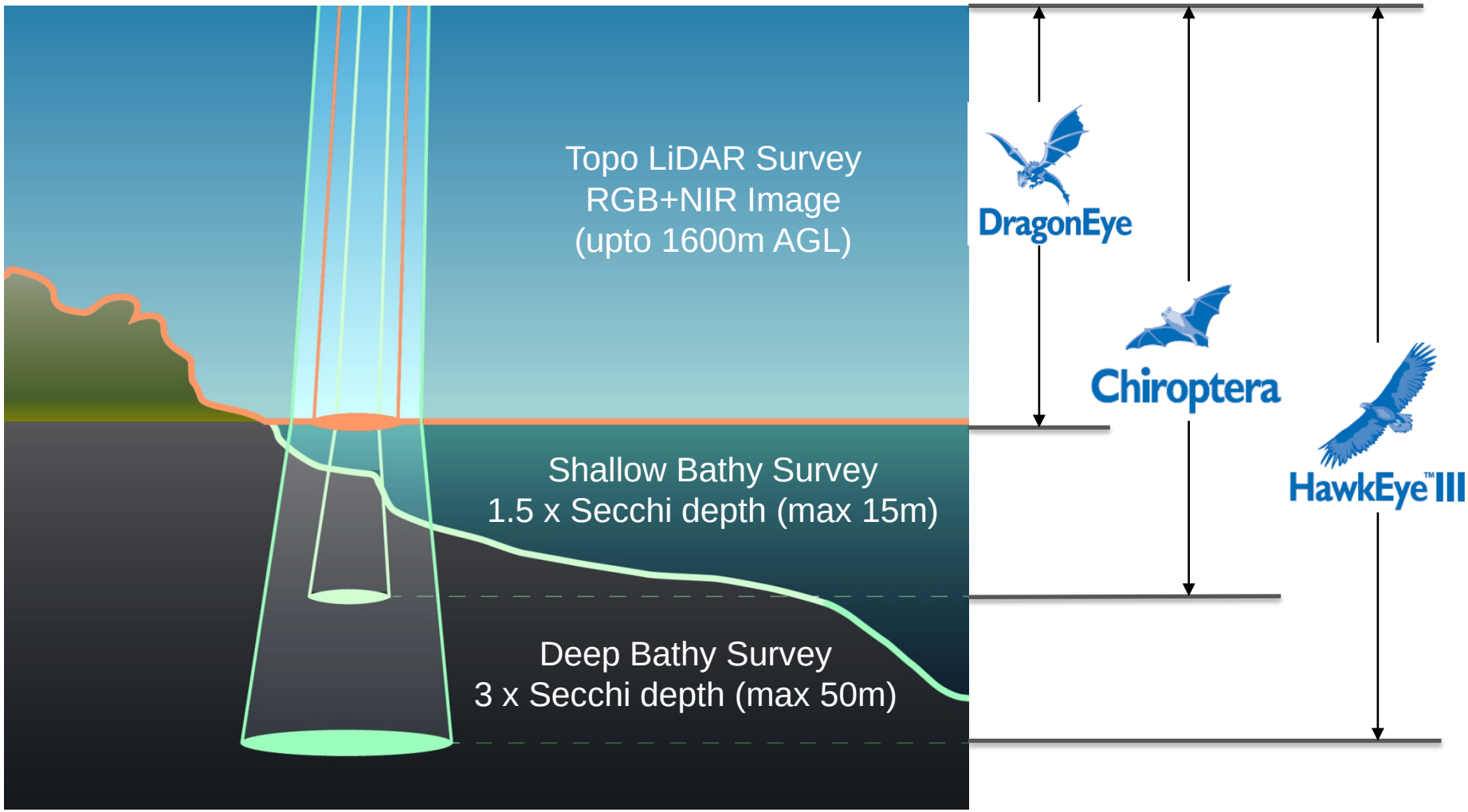
Airborne LiDAR Systems from AHAB



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HawkEye II => HawkEye III

HawkEye II

HawkEye III

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HawkEye$_{II}$ vs HawkEye$_{III}$

HawkEye $_{II}$

- **Bathymetric data capture**
  - Deep: 4 KHz (1 KHz prf, 4 pixel receiver)
  - Shallow: 4 KHz (1 KHz, 4 pixel receiver)
  - Full waveform, both channels
  - Depth penetrion K_d x D_{max} > 4 (about 3 secchi)
- **Topographic data capture**
  - 128 KHz (16 KHz, 8 pixel receiver)
  - Discrete return system
  - Max altitude: 500 m

HawkEye$_{III}$

- **Bathymetric data capture**
  - Deep: 10 KHz (10 KHz, single receiver)
  - Shallow: 35 KHz (35 KHz, single receiver)
  - Full waveform, both channels
  - Real time waveform analysis
  - K_d x D_{max} > 4 (about 3 secchi)
- **Topographic data capture**
  - Up to 500 KHz (Single receiver)
  - Full waveform capture
  - Real time waveform analysis
  - Max altitude: 1.6 Km
- **Mid format camera**
  - 80 MPIX, RGB +IR

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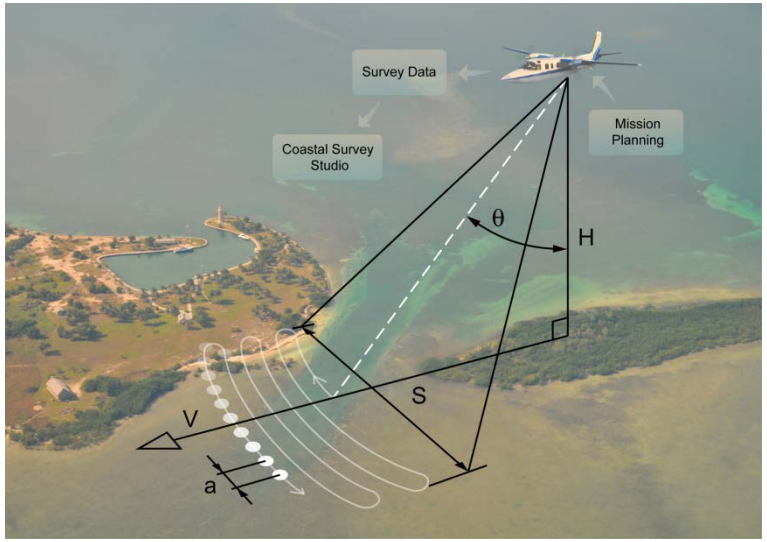
HawkEye II vs HawkEye III

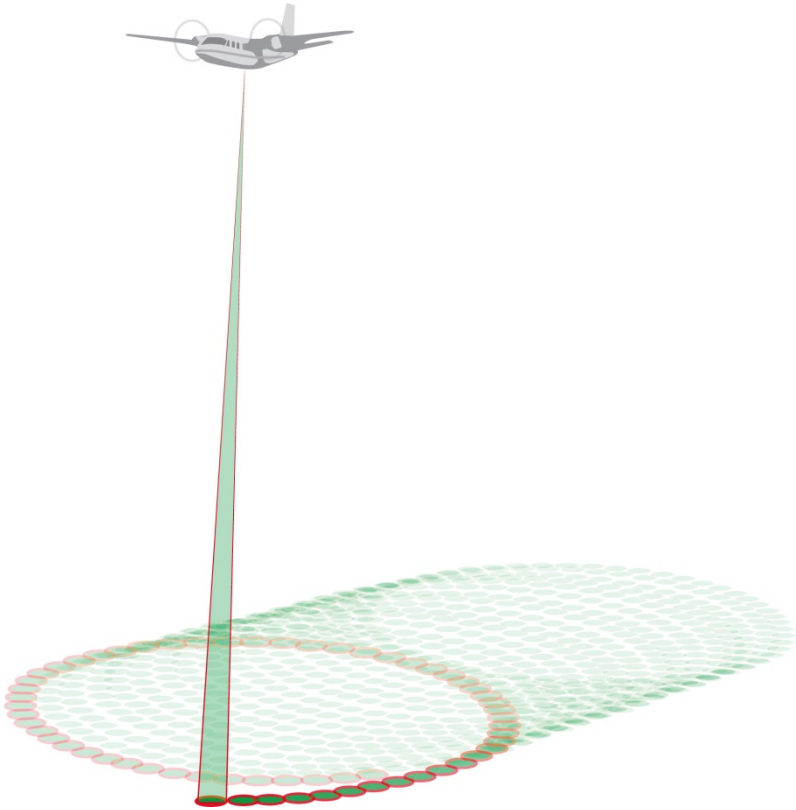
HawkEye II – Scan mechanism

- 2 axis controlled scanner mirror



HawkEye III – Scan Mechanism

- Oblique LIDAR



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Chiroptera $_{I \text{ to } II}$ – Improvements

- **Increased altitude range topo**
  - 600 m ➔ 1.600 m
- **Increased PRF in topo**
  - 400 KHz ➔ 500 KHz
- **Increased depth penetration**
  - $K_d x D_{max} > 2$ ➔ $K_d x D_{max} > 2.2$
- **80 MPIX RCD 30 camera integrated**
  - Four band RGB + IR
- **PAV 100 gyro stabilized mount**
  - 35% overlap ➔ 15% overlap
- **Leica components and Leica software integrated**

Chiroptera$_I$

Chiroptera$_{II}$

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Chiroptera$_{II}$

Chiroptera interface
- Gyro stabilized PAV 100 mount
- Roll: ± 7˚
- Pitch: -6˚ to +8 ˚
- Yaw: : ± 30˚

Q/Acamera
- 5 MPIX
- Images available during survey and in LIDAR data processing tool

Bathymetric LIDAR
- 35 KHz
- Depth penetration $K_d x D_{max}$ >2.2

Leica RCD 30 camera
- Up to 80 MPIX
- Four channels RGB+IR collected coaligned
- Motion compensation

Topographic LIDAR
- Up to 500 KHz
- Up to 1 600 m altitude

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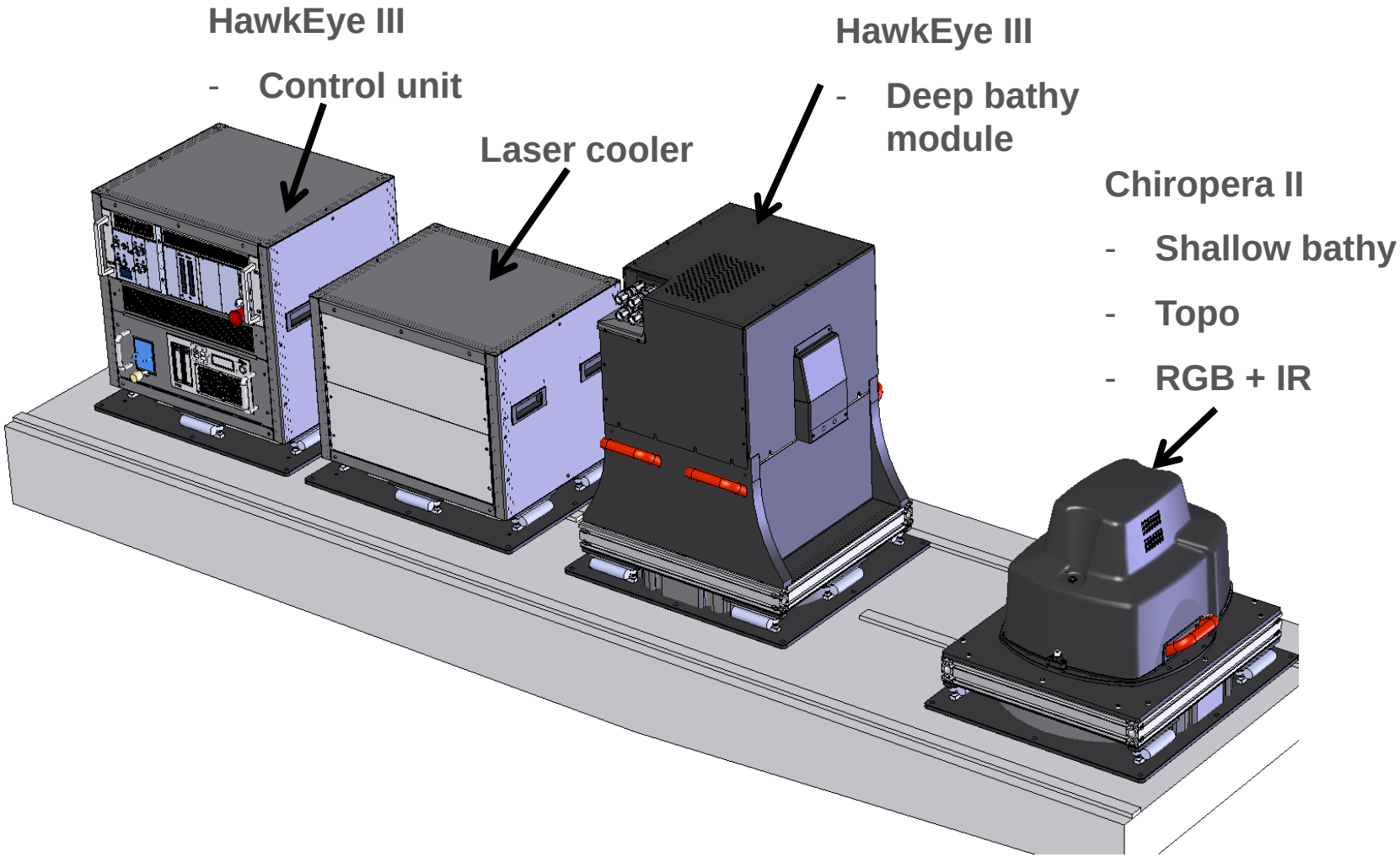
HawkEye III - Two port installation



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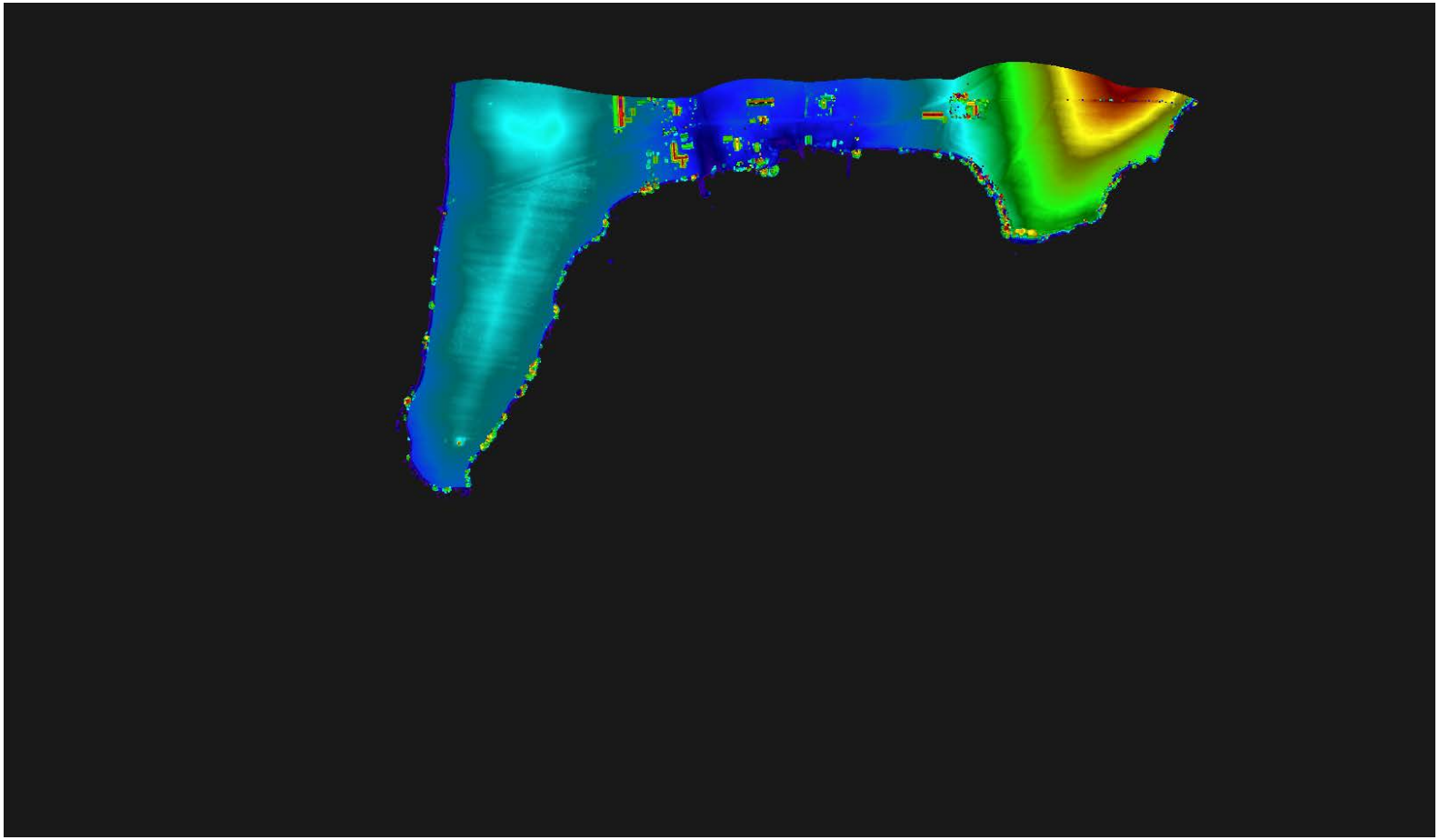
HawkEye III – Pure Topo



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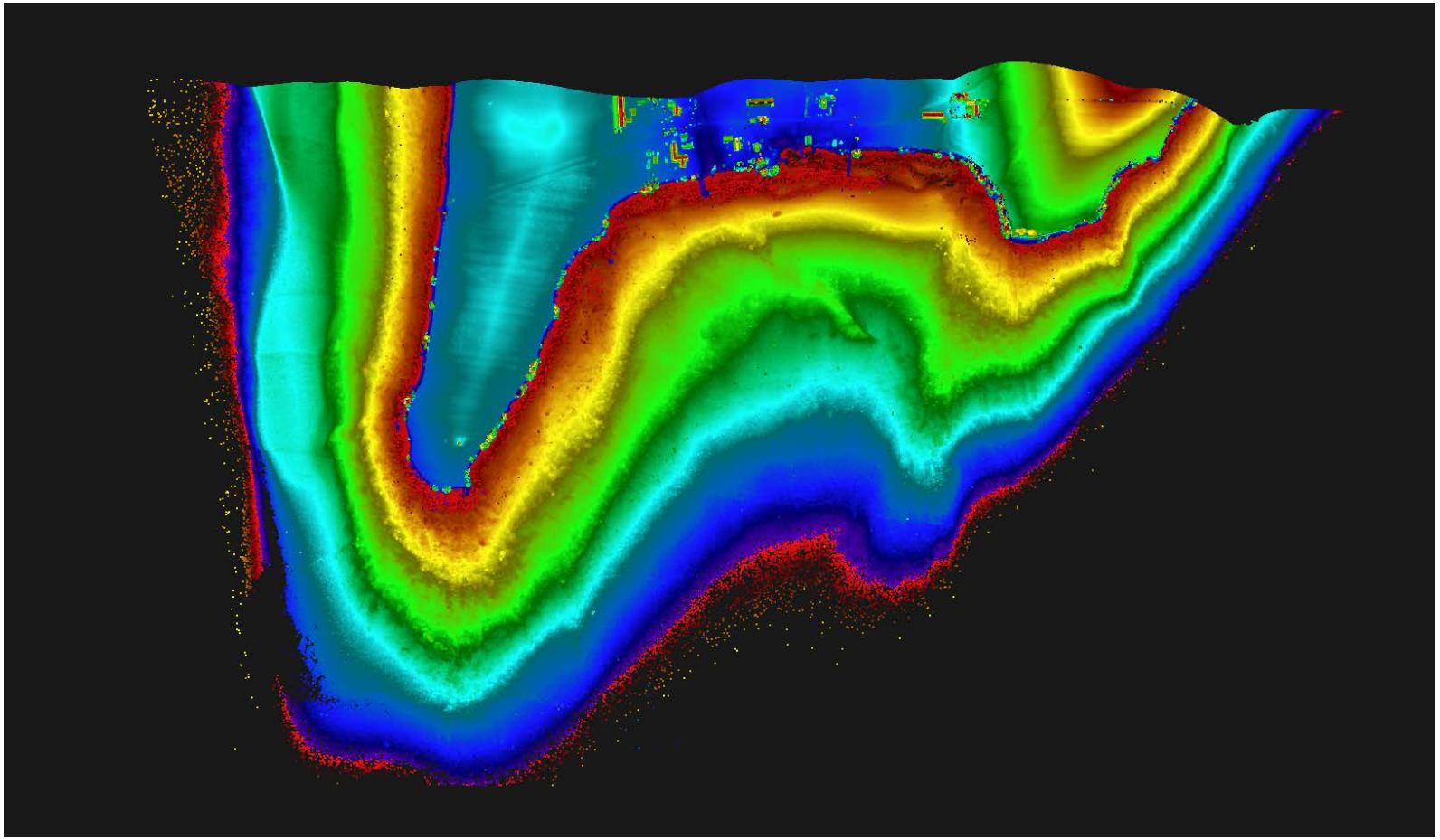
HawkEye III – Topo and Shallow



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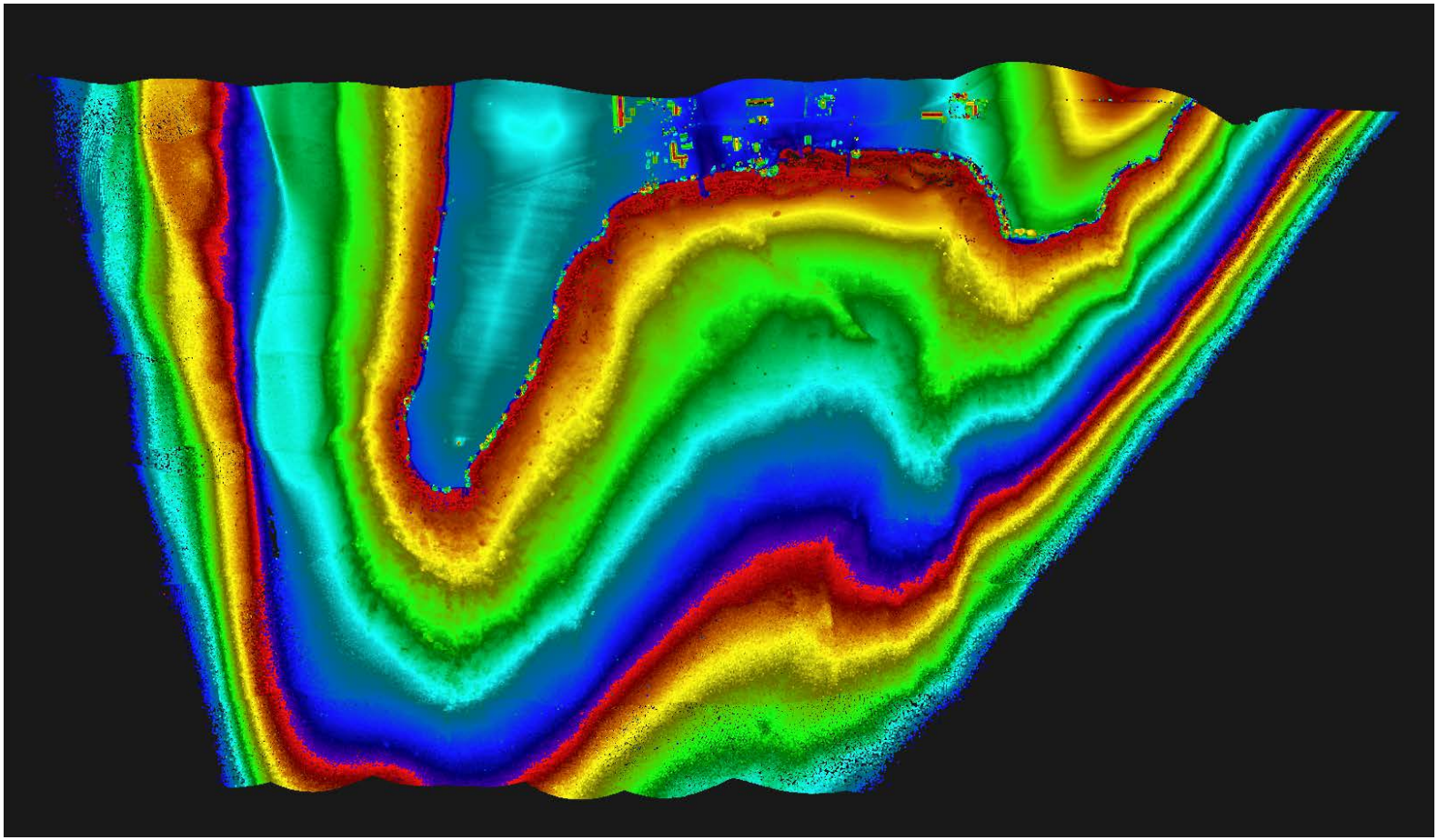
HawkEye III – All Channels



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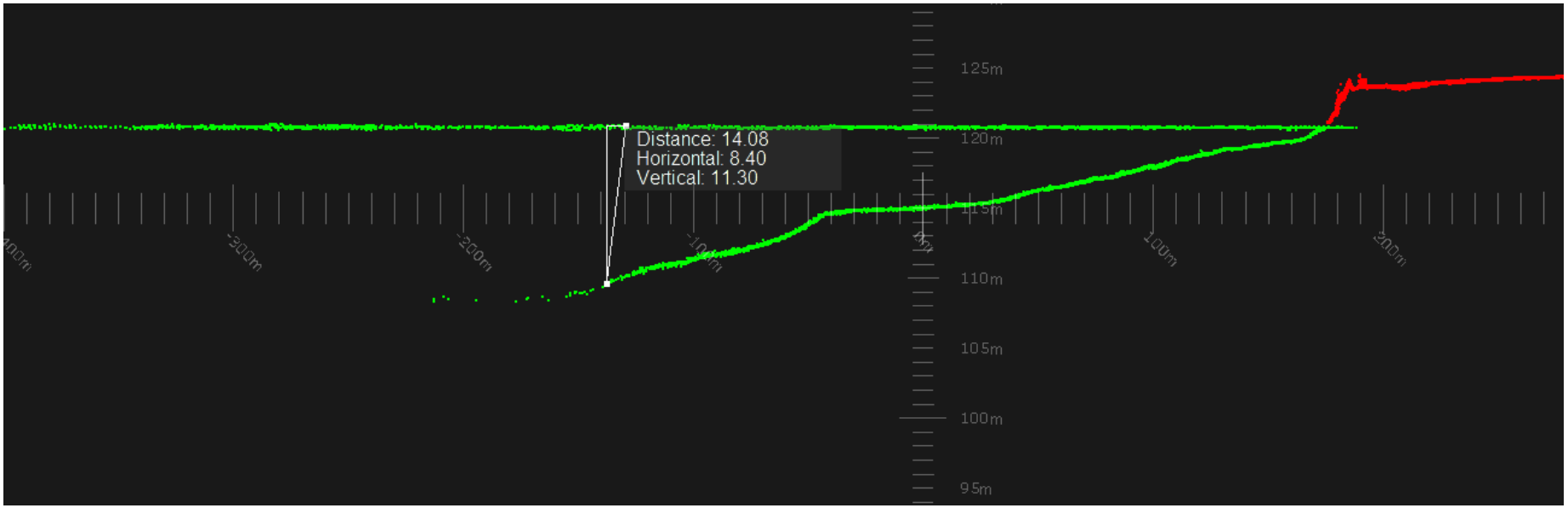
HawkEye III - Topo and Shallow



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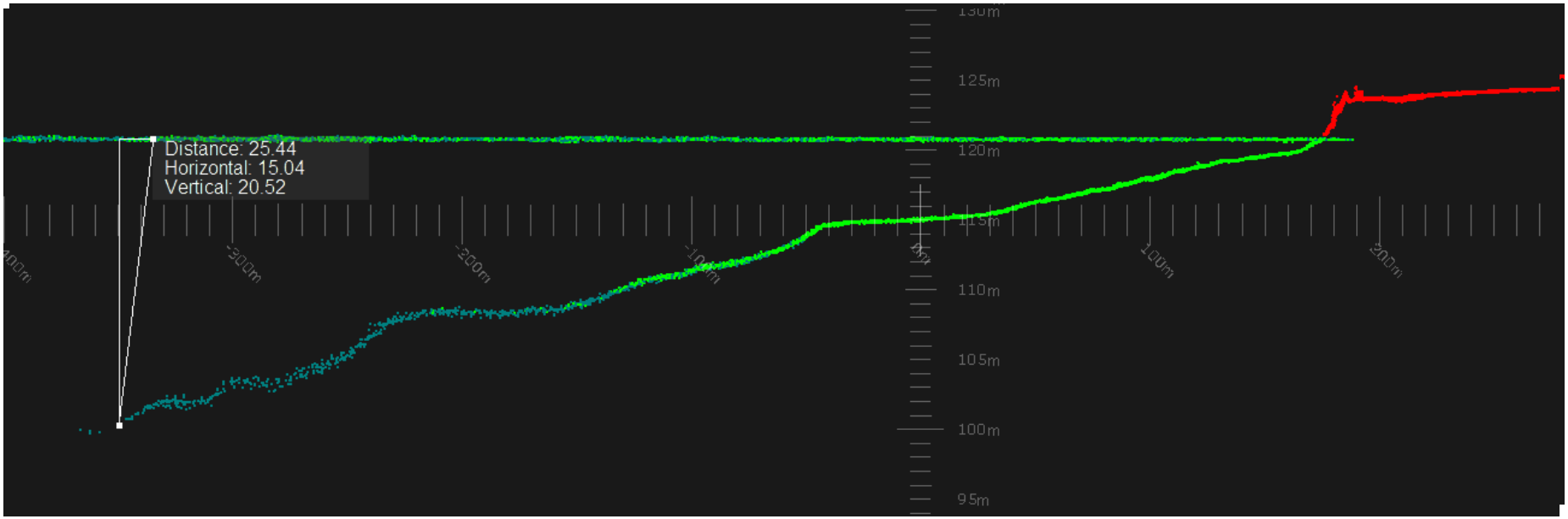
HawkEye III – Topo, Shallow and Deep



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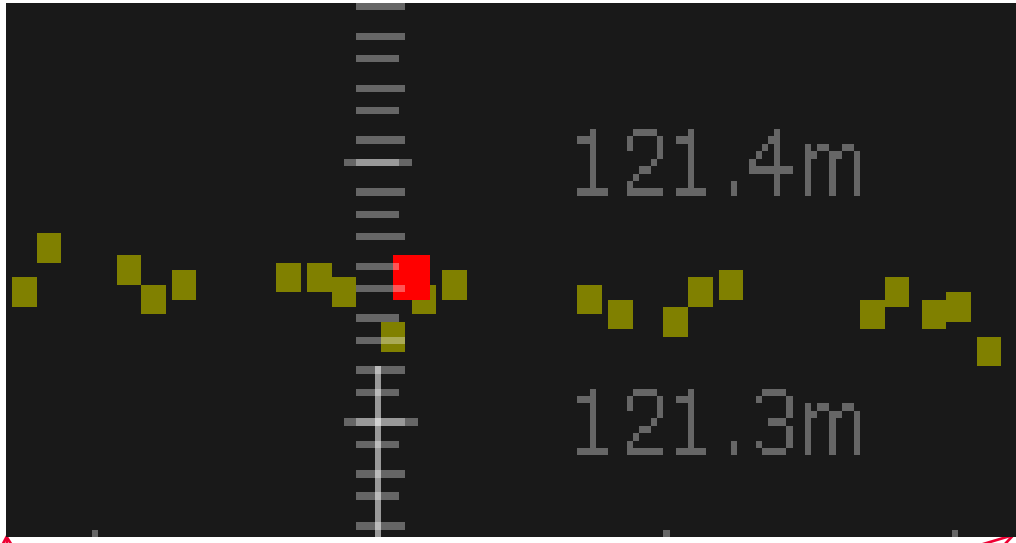
Control points on a pier



Control points measured on a pier

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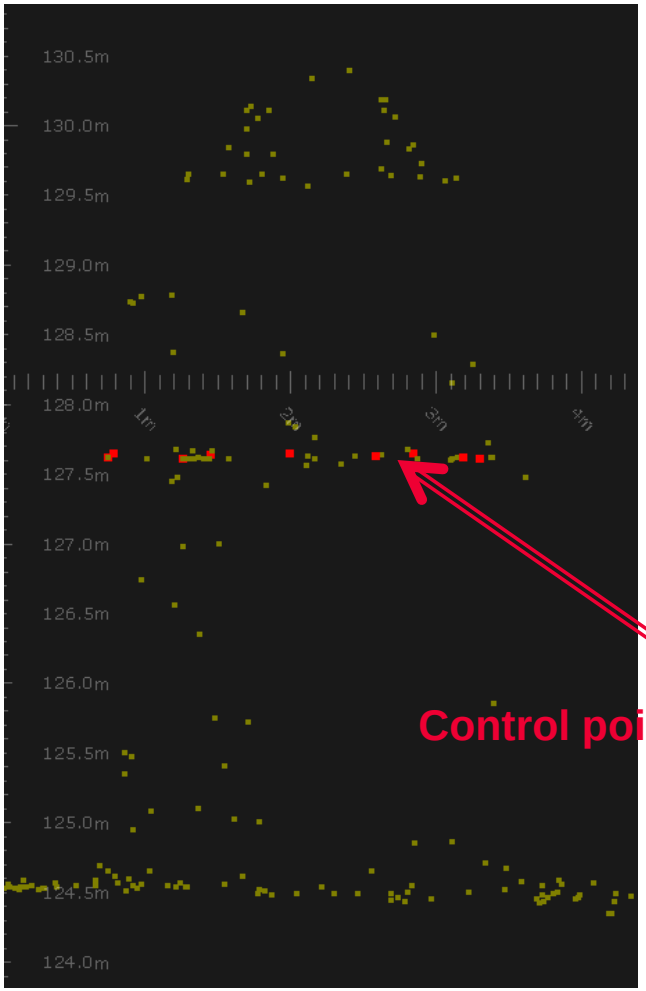
Control points on a light house



Control points measured on light house

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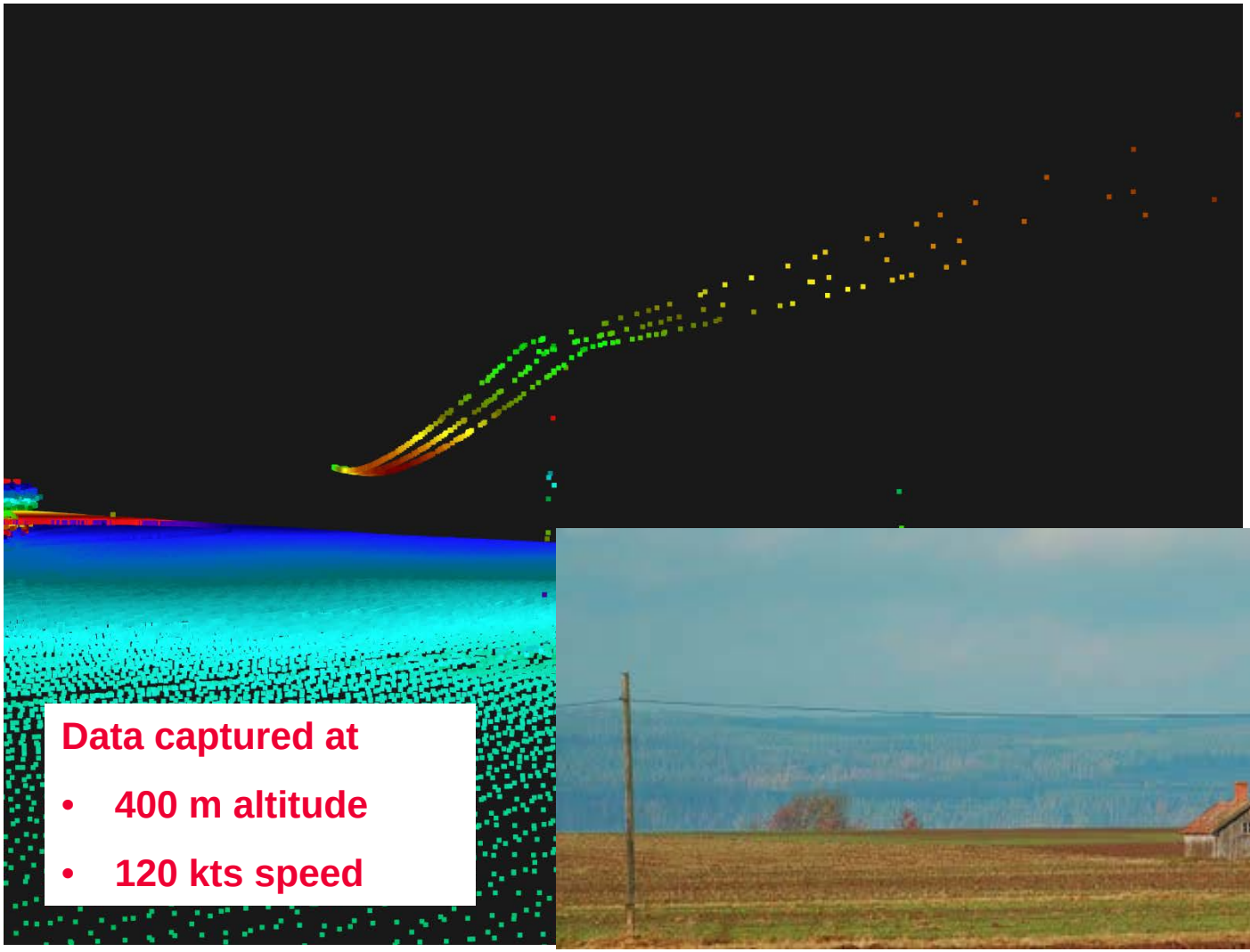
HawkEye III – Sensitivity Powerline Detection



Data captured at

- 400 m altitude
- 120 kts speed

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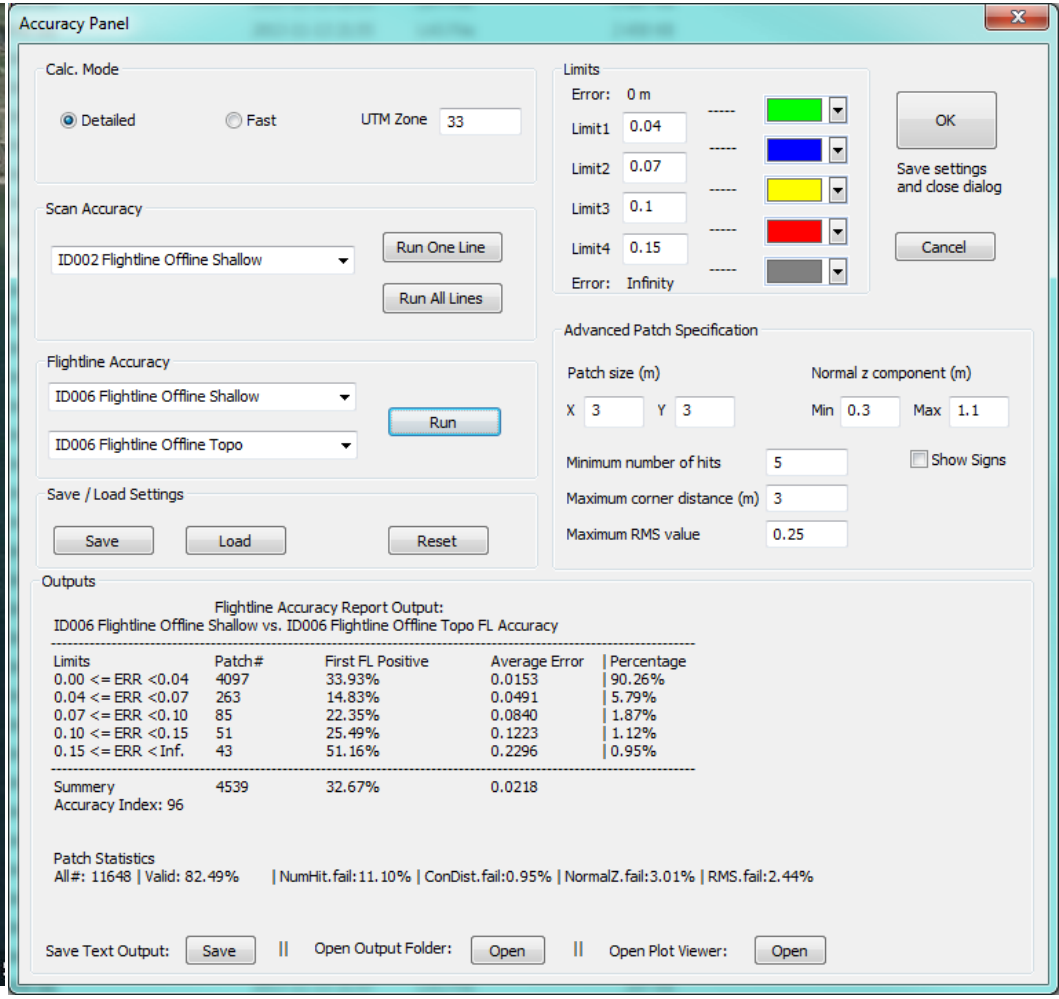
Accuracy - Topo vs Shallow channel



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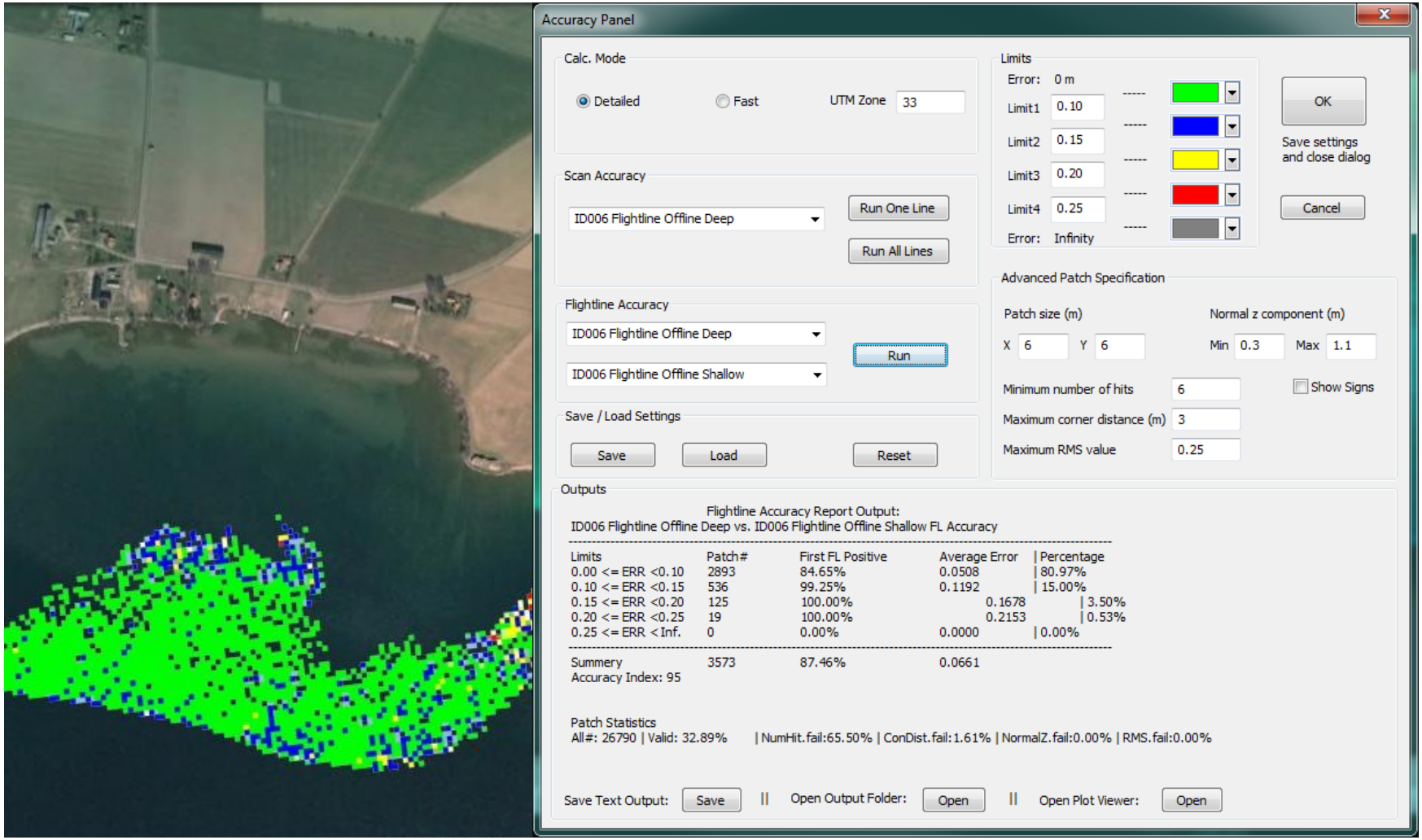
Accuracy – Deep vs Shallow



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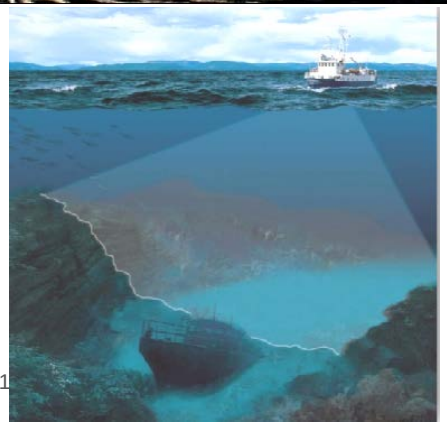
Multibeam reference data - Bathymetry

- **Multibeam reference dataset**
  - Simrad EM 3002 D, 300 KHz, 508 beams
  - Applanix POS MV positioning



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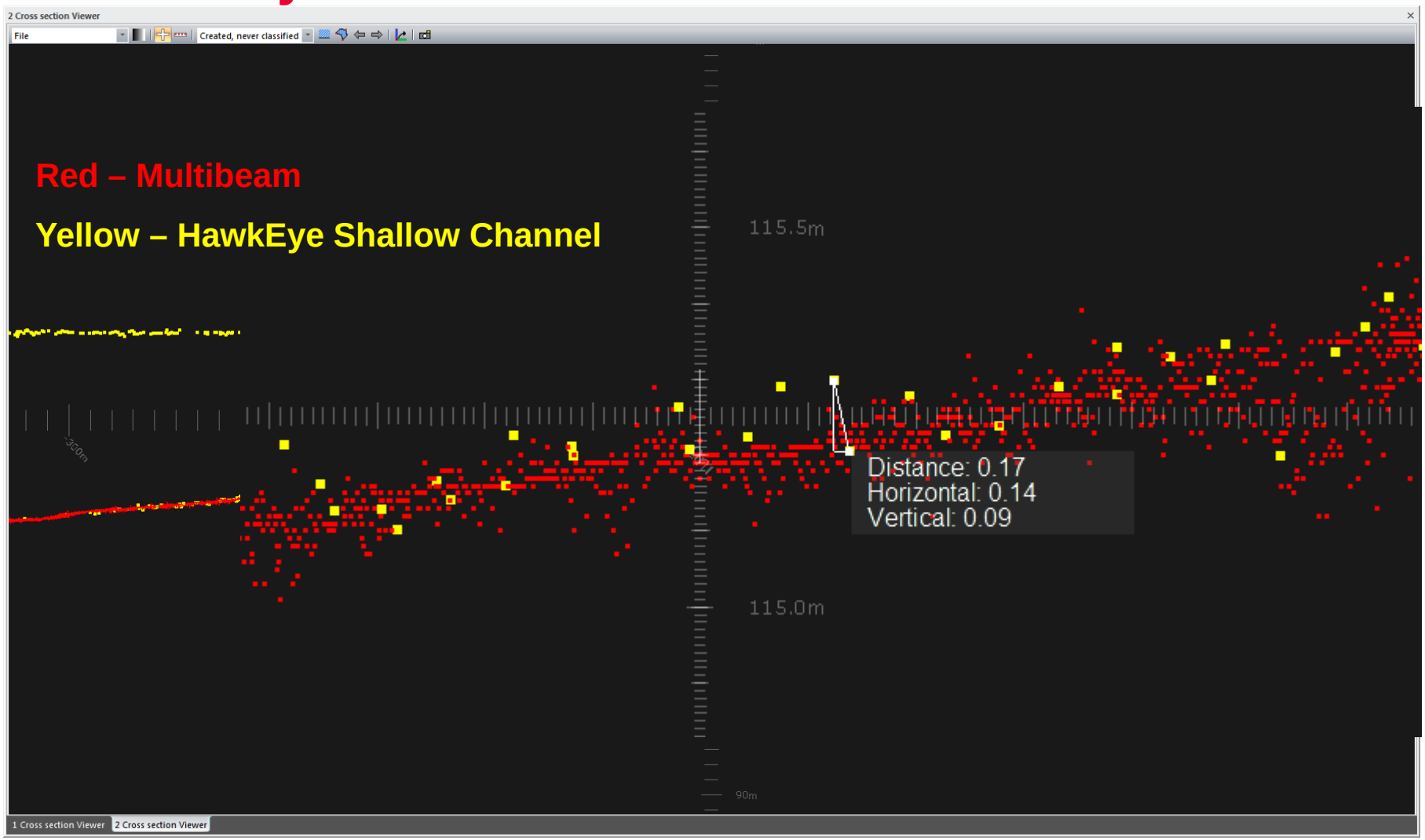
Accuracy – Shallow vs Multibeam reference



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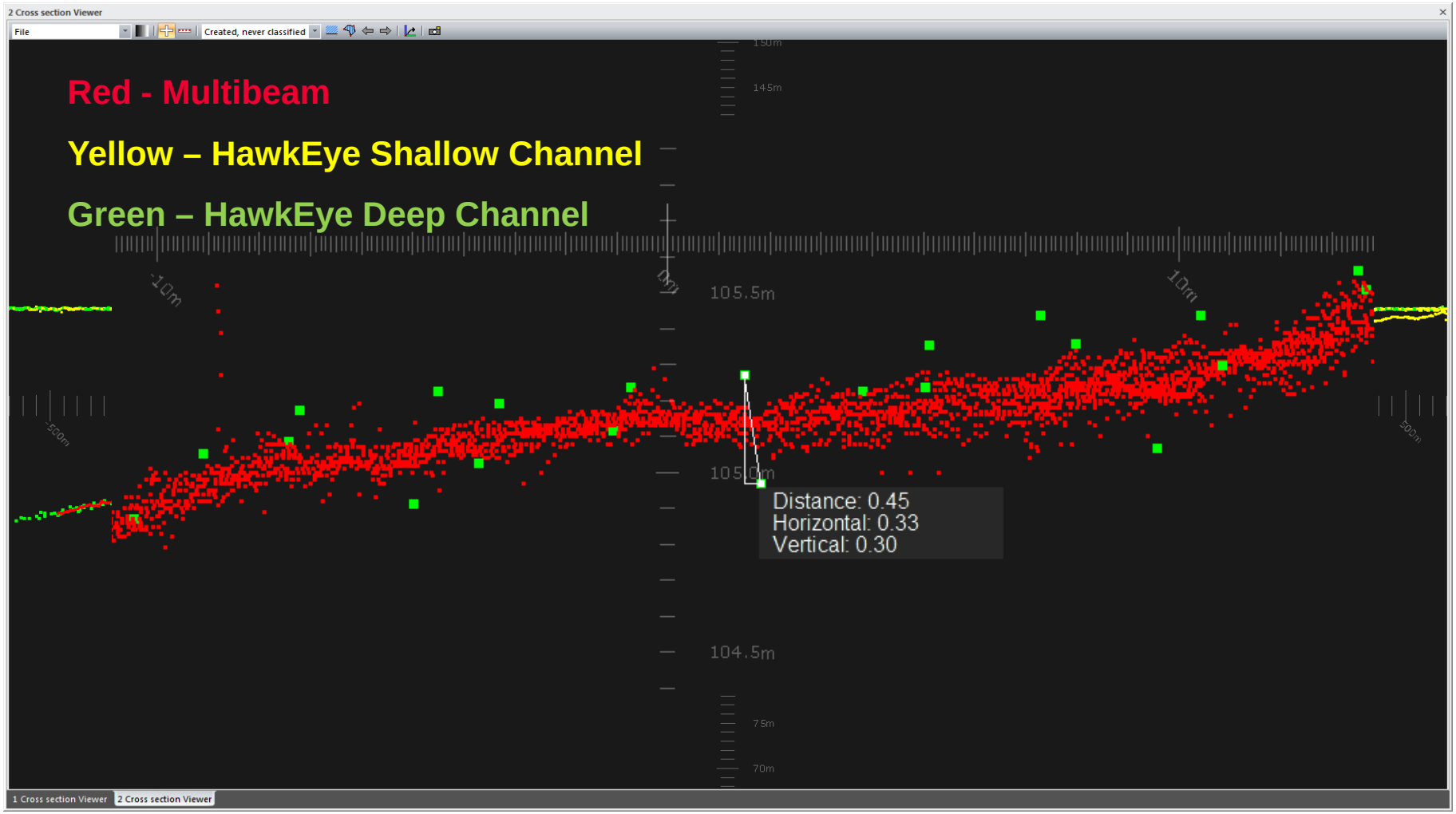
Accuracy – Deep vs Multibeam reference (Zoom)



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Key performance – Collected datasets

- **The Chiroptera / HawkEye simultaniously collects**
  - Topographic LIDAR – to the highest accuracy and data density in class
  - Bathymetric LIDAR – to the highest accuracy and depth penetration in class
  - Mid format RGB images 80 megapixel
  - Mid format CIR images 80 megapixel (coaligned with RGB)
- **All datasets from one single capture**

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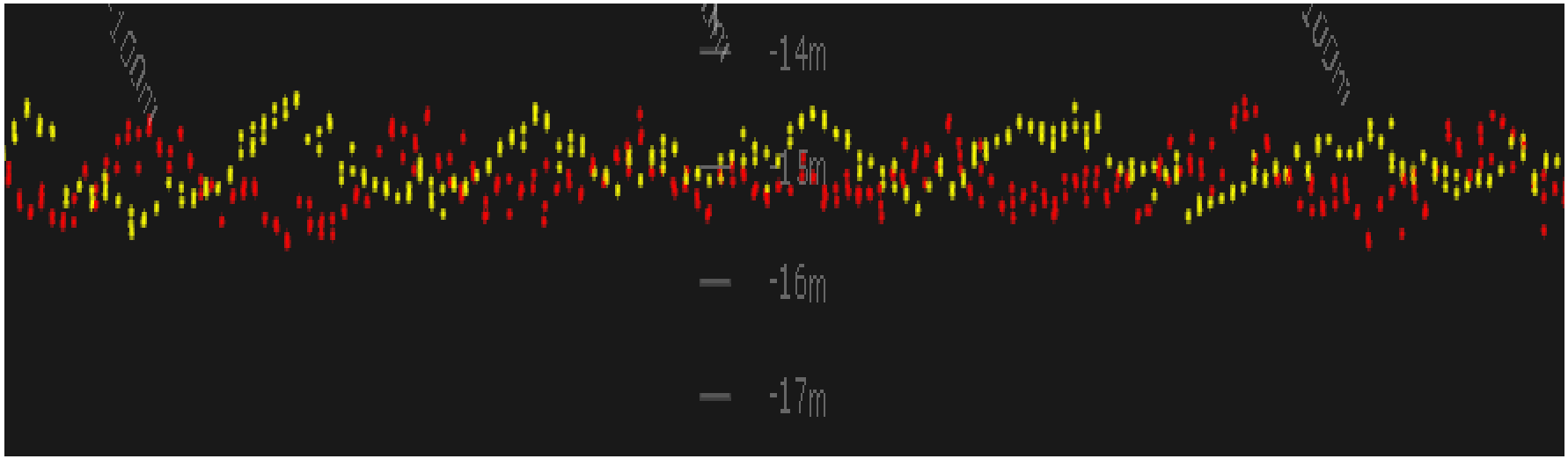
Key performance – Water surface measurement

Correctly measure water surface level

- **Water refraction**
  - Change of speed of light: $v_{water} \approx v_{air} / 1.33$
  - Change of direction of light: $\tan(\alpha_1) \approx 1.33 * \tan(\alpha_2)$
  - Water refraction correction is needed both in depth and in northing easting
- **=> Automatical measurement of the local water surface level**
  - Handle water surface gradient between elipsoid and geoide plus swell in ocean environment'
  - Handle slooping water surfaces typical in river environments
  - Measure hight of local gravity waves for increased accuracy

Key performance - Water surface measurement



1 meter waves => correpsonds to about 25 cm variation on sea bed if a mean water surface is used for the refraction correction

By local water surface elevation measurement this variation can to a large extent be eliminated

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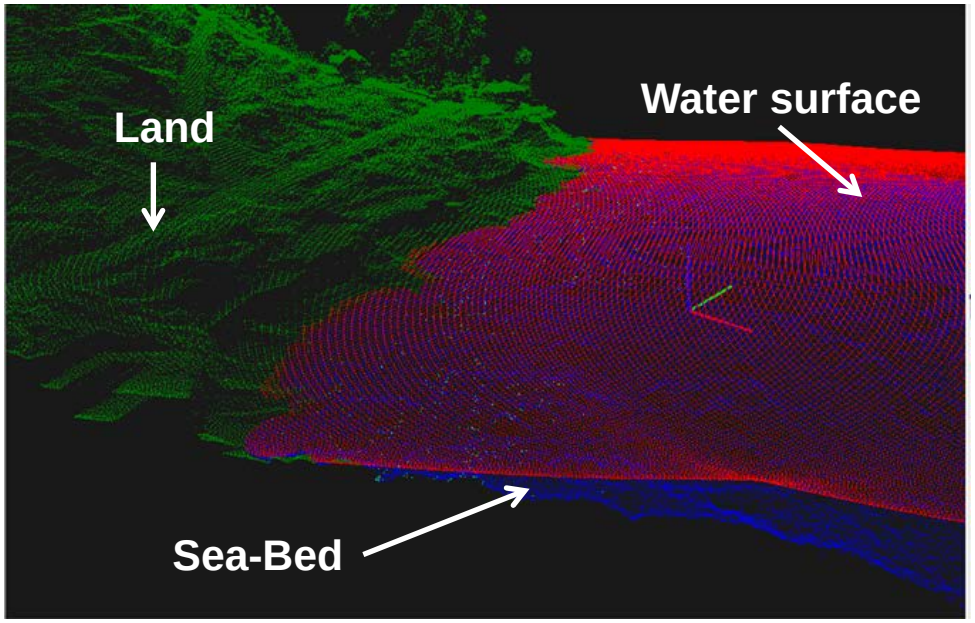
Key performance – Automatical classification

Distinguish between green returns on land, green returns from water surface and green returns within the water volume (sea-bed)

- **=> Automatical classification of land, surface and sub-surface returns**



Inland water
- Alaska, Deadhorse creek

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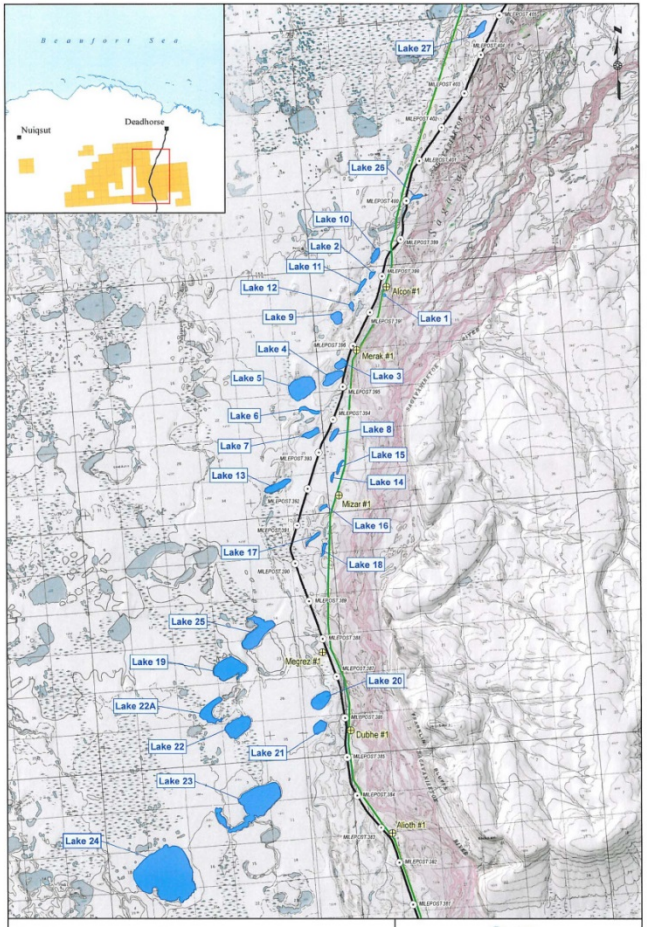
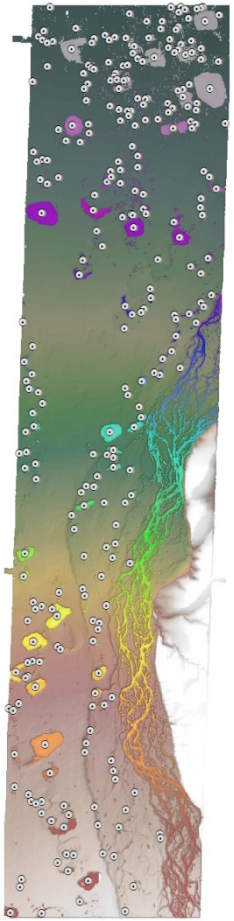
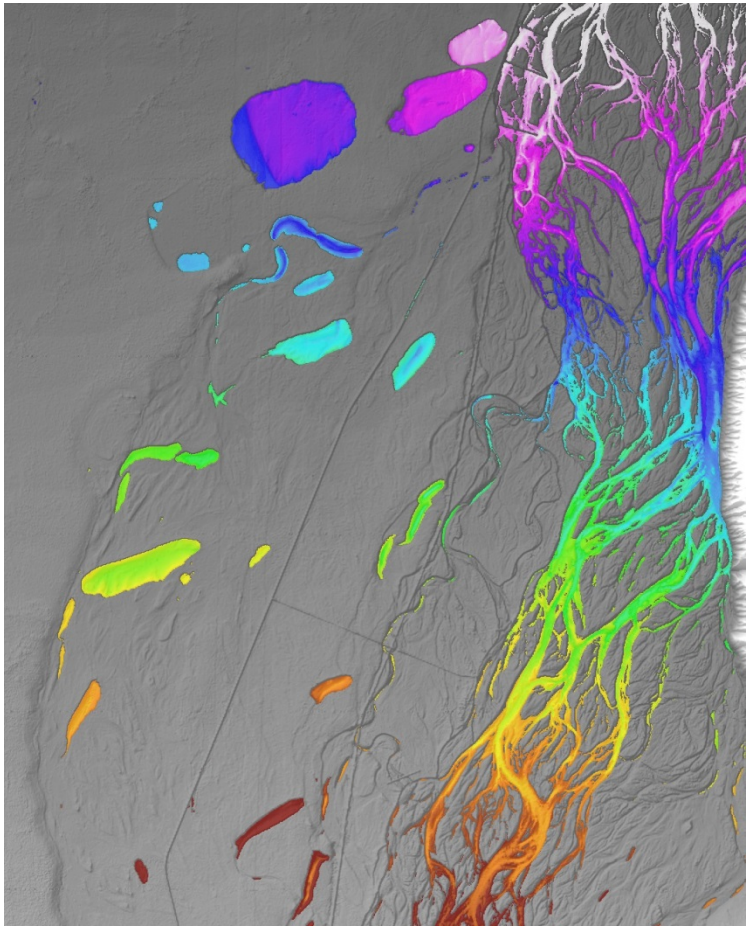
Inland water
- Alaska, Deadhorse creek







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Key performance – Target detection and Shallow water

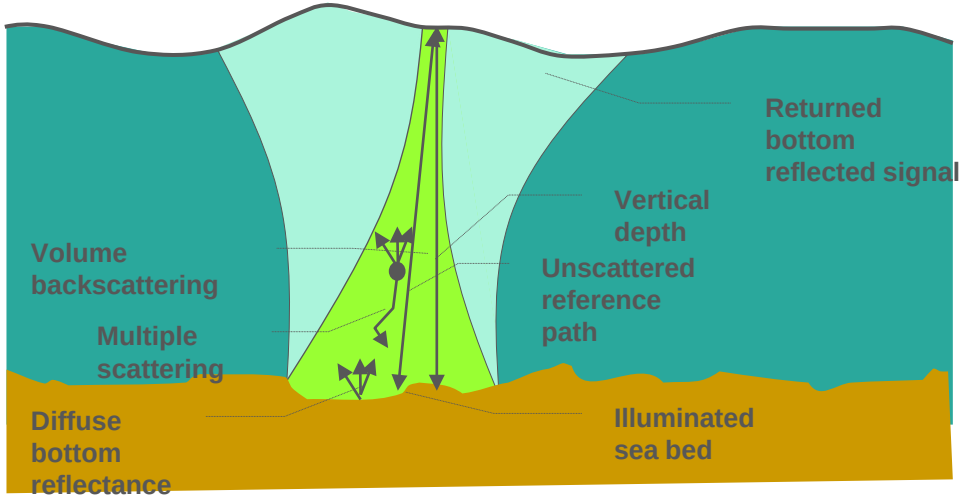
Due to the scatting in water volume small targets are much smaller than the illuminated footprint at sea-bed

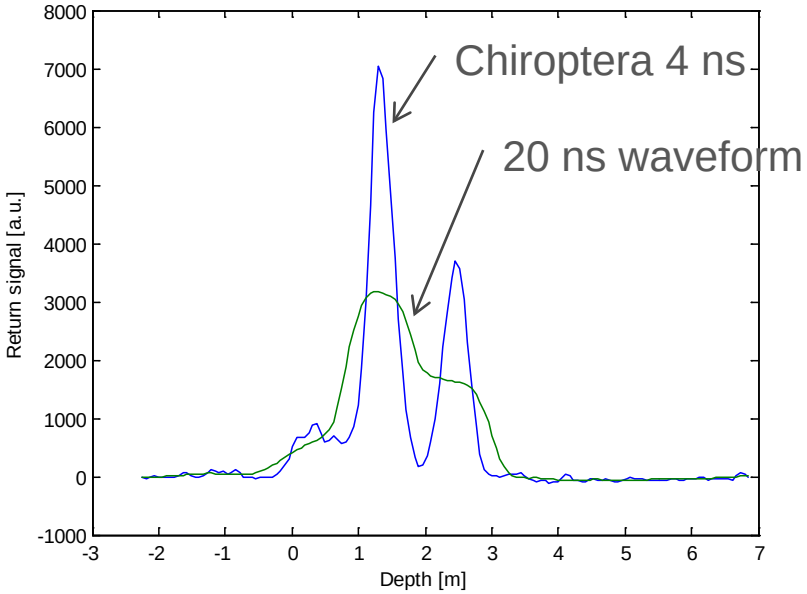
➔ Sufficient laser energy is needed due to losses in water column

➔ Small targets needs to be separated in the time domain, not in the spatial domain

➔ The system response time is cruical for distinguish between close targets in the LIDAR waveform

- Water surface and Sea-bed at shallow waters
- Small targets on the sea-floor





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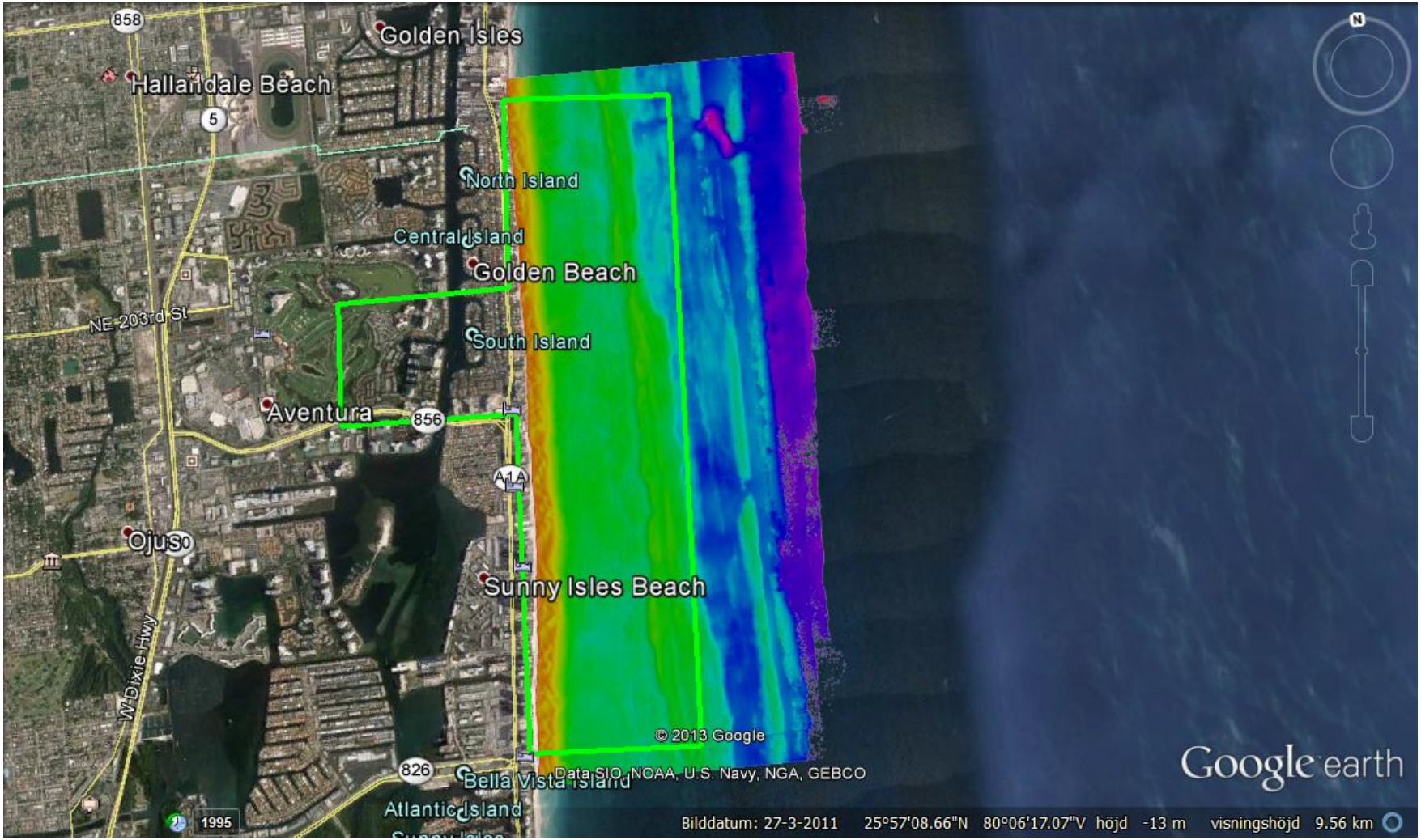
Ft Lauderale - demo



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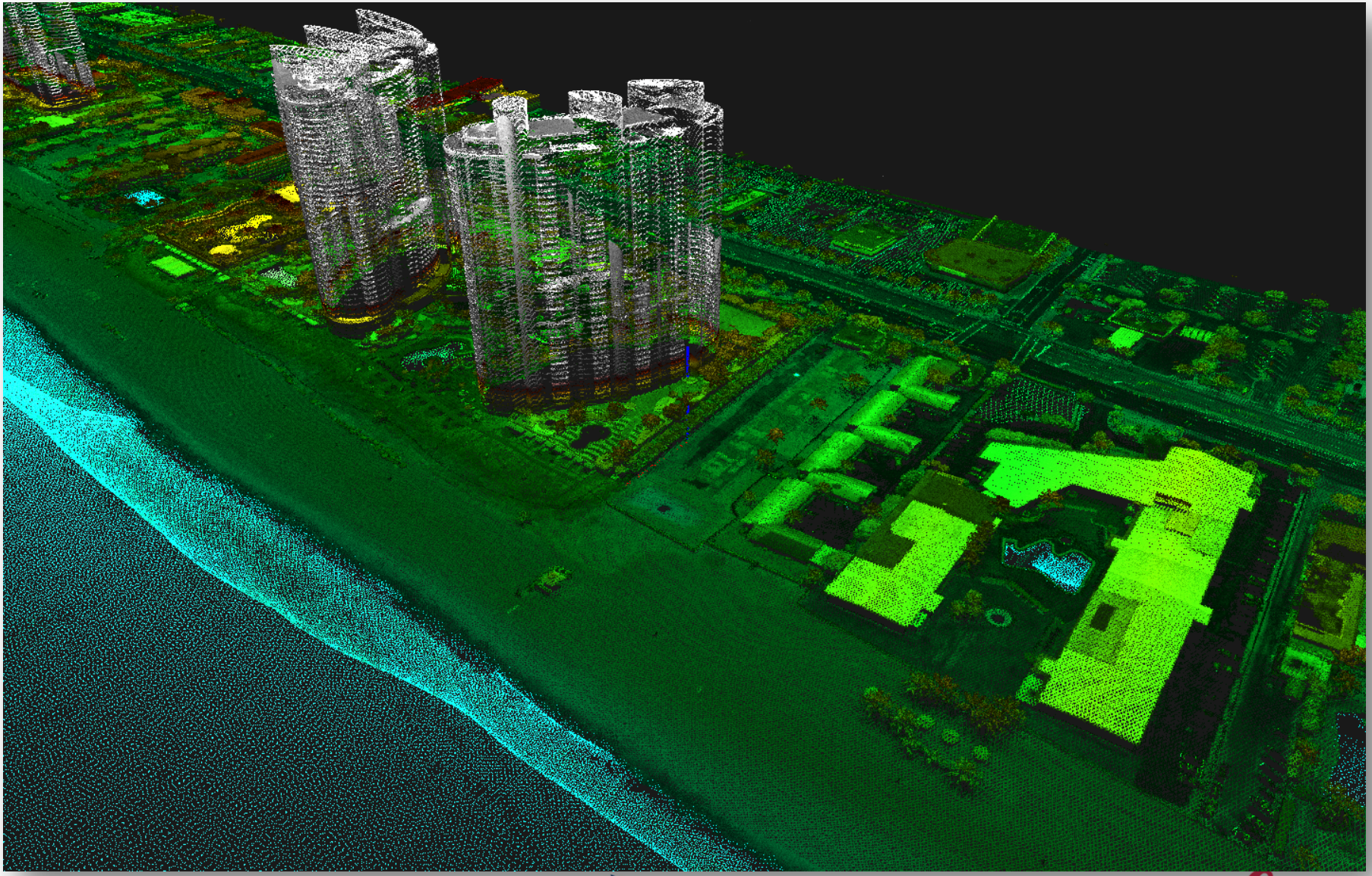
Fort Lauderdale – Oblique scan



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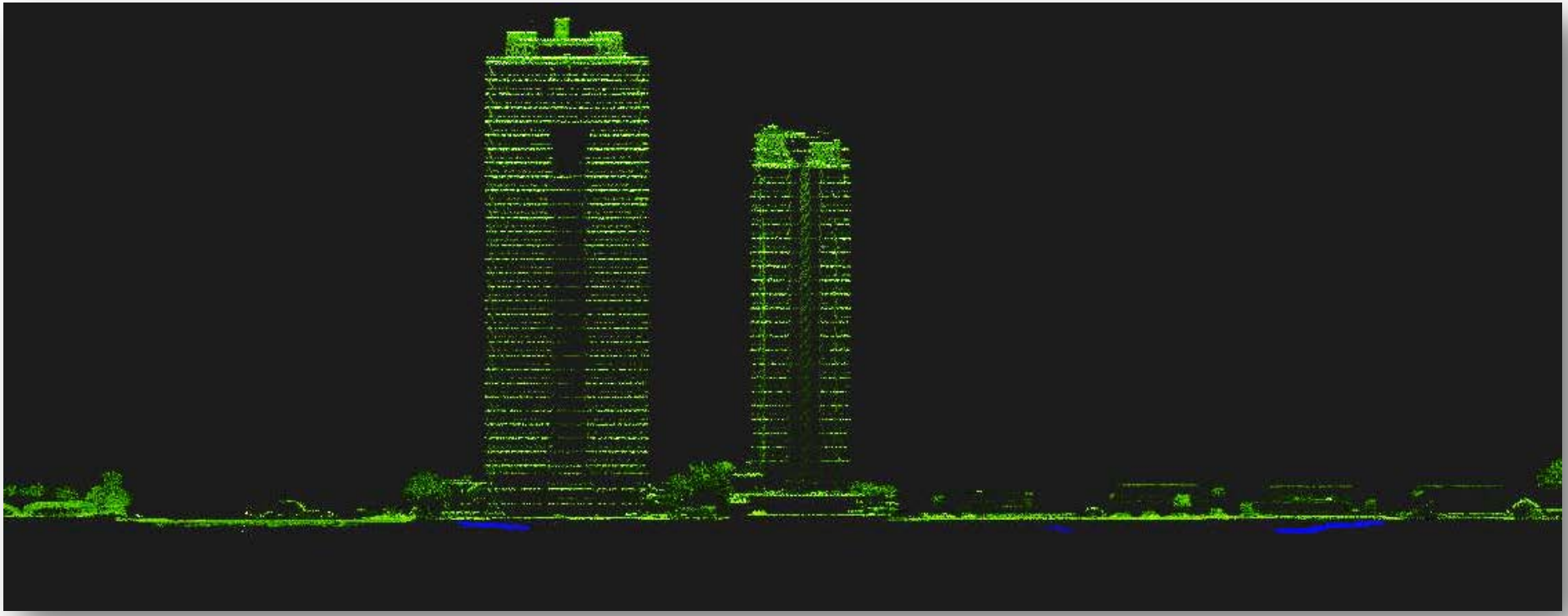
Fort Lauderdale – Swimming pools



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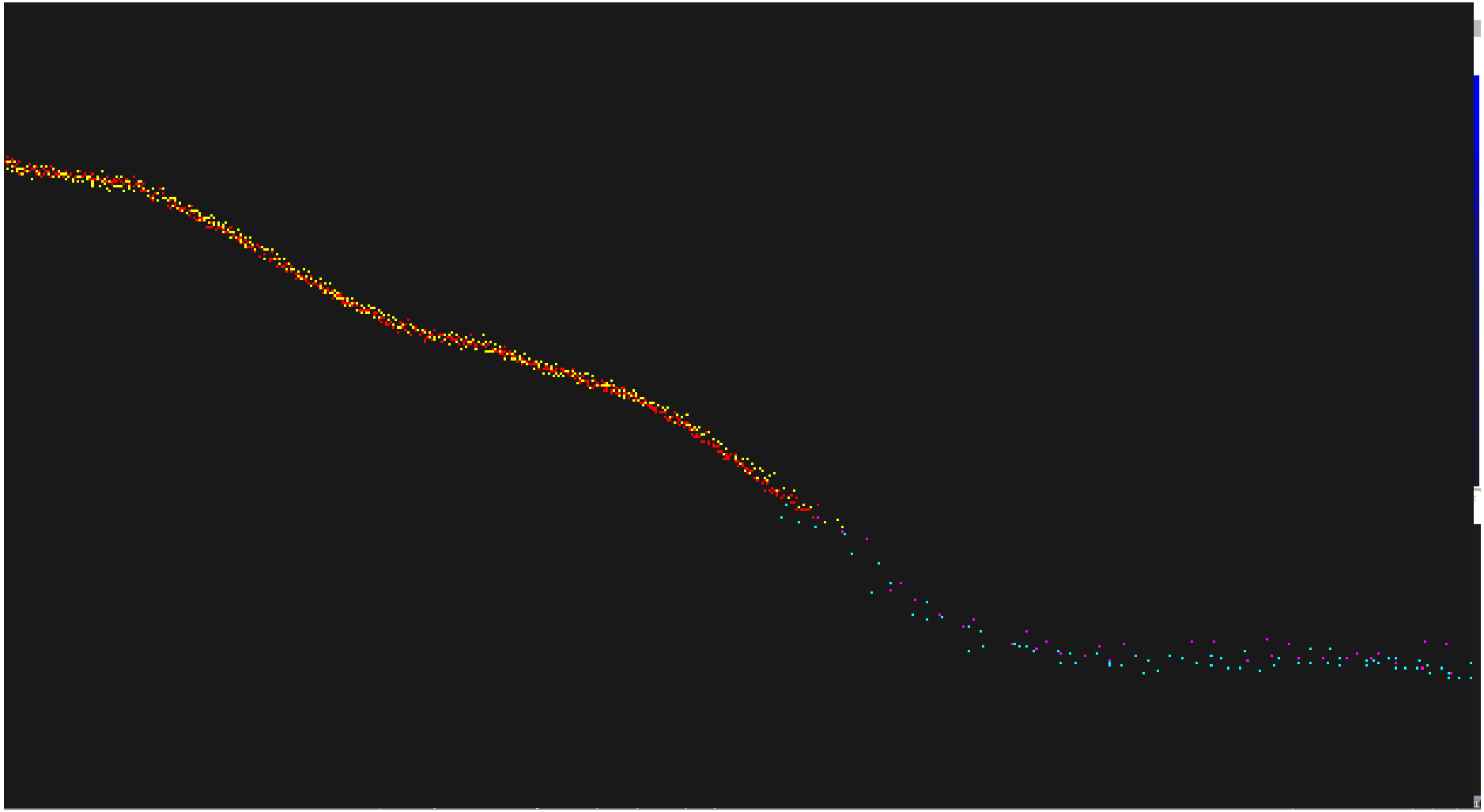
Fort Lauderdale: Land – Water interface



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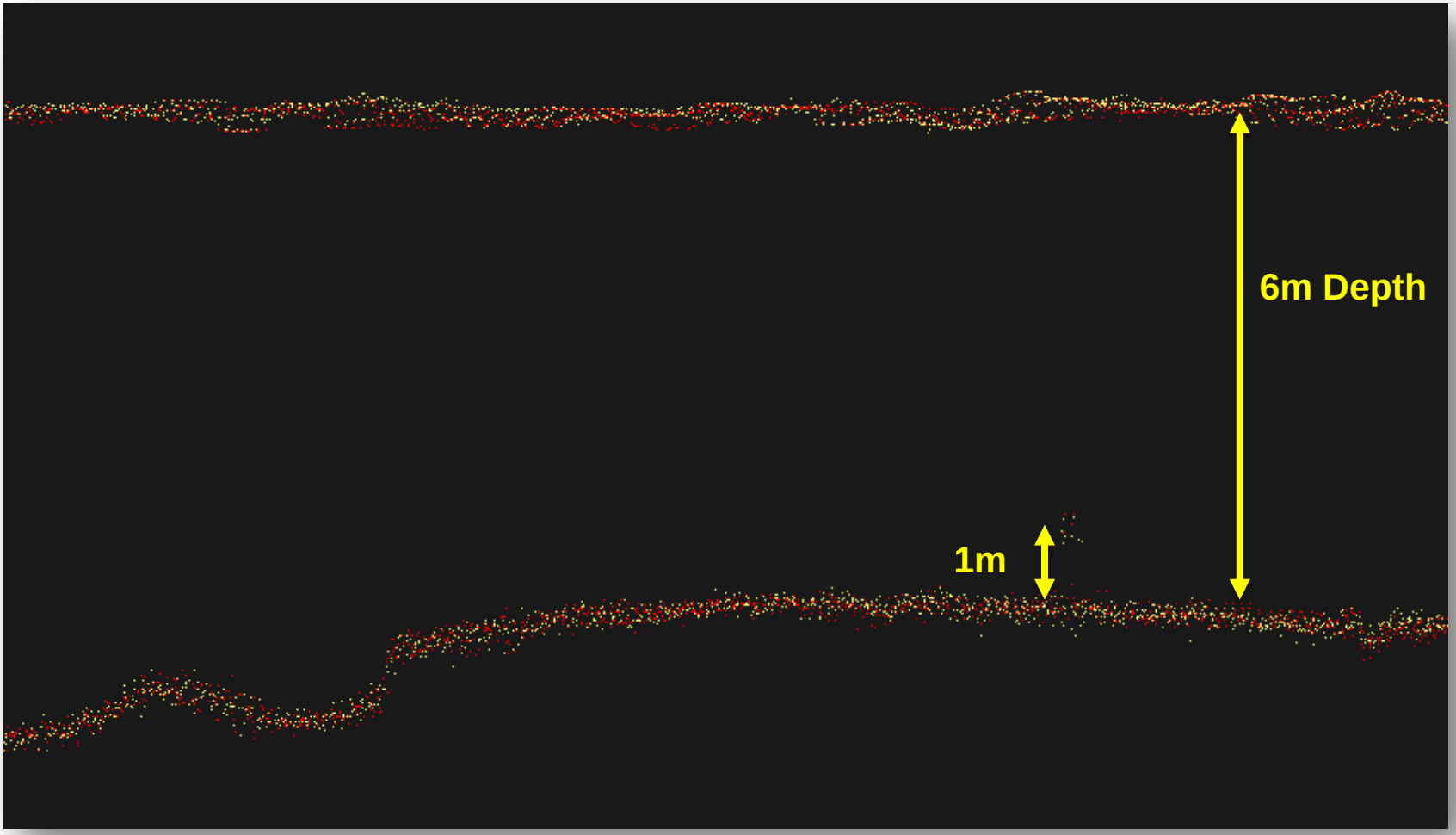
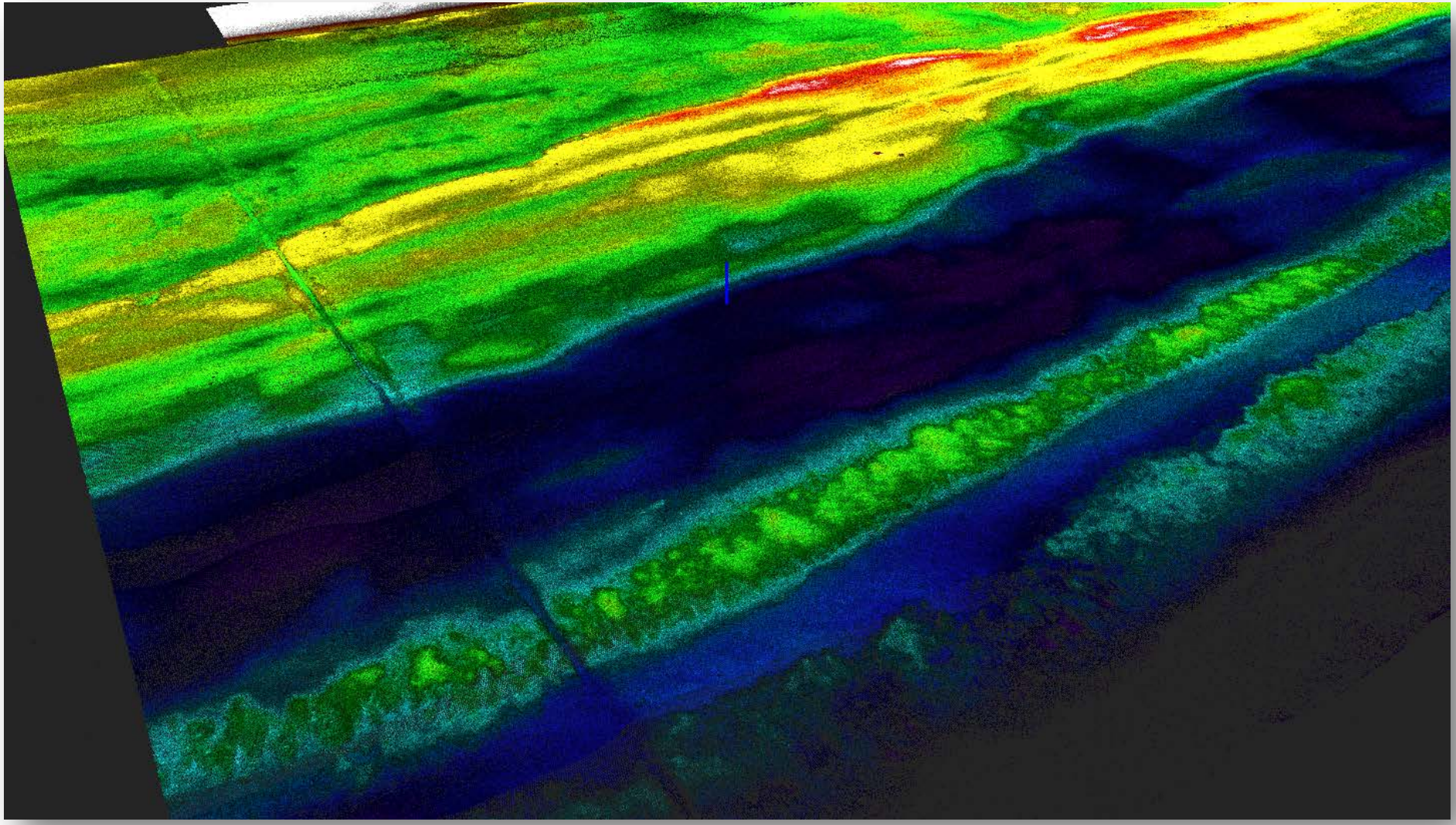
Ft Lauderdale – Target detection



Fort Lauderdale – Dredged pipeline



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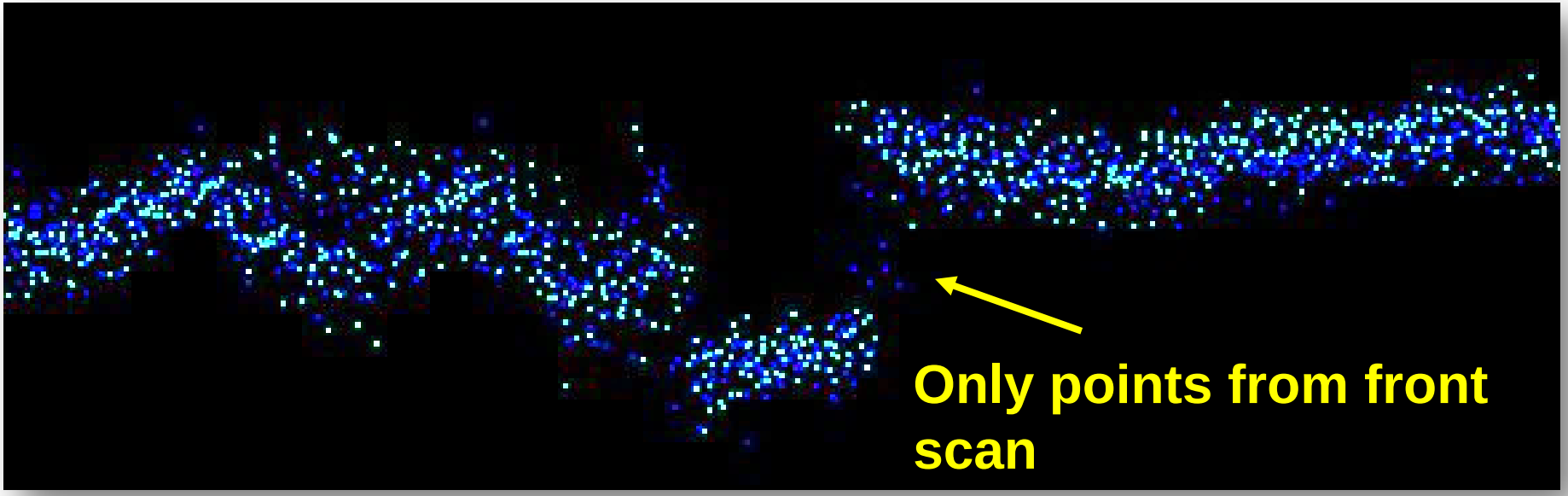
Fort Lauderdale – Dredged pipeline

+ 60cm drop over 8cm horizontal



Complex archipelago
- Bulandet Norway

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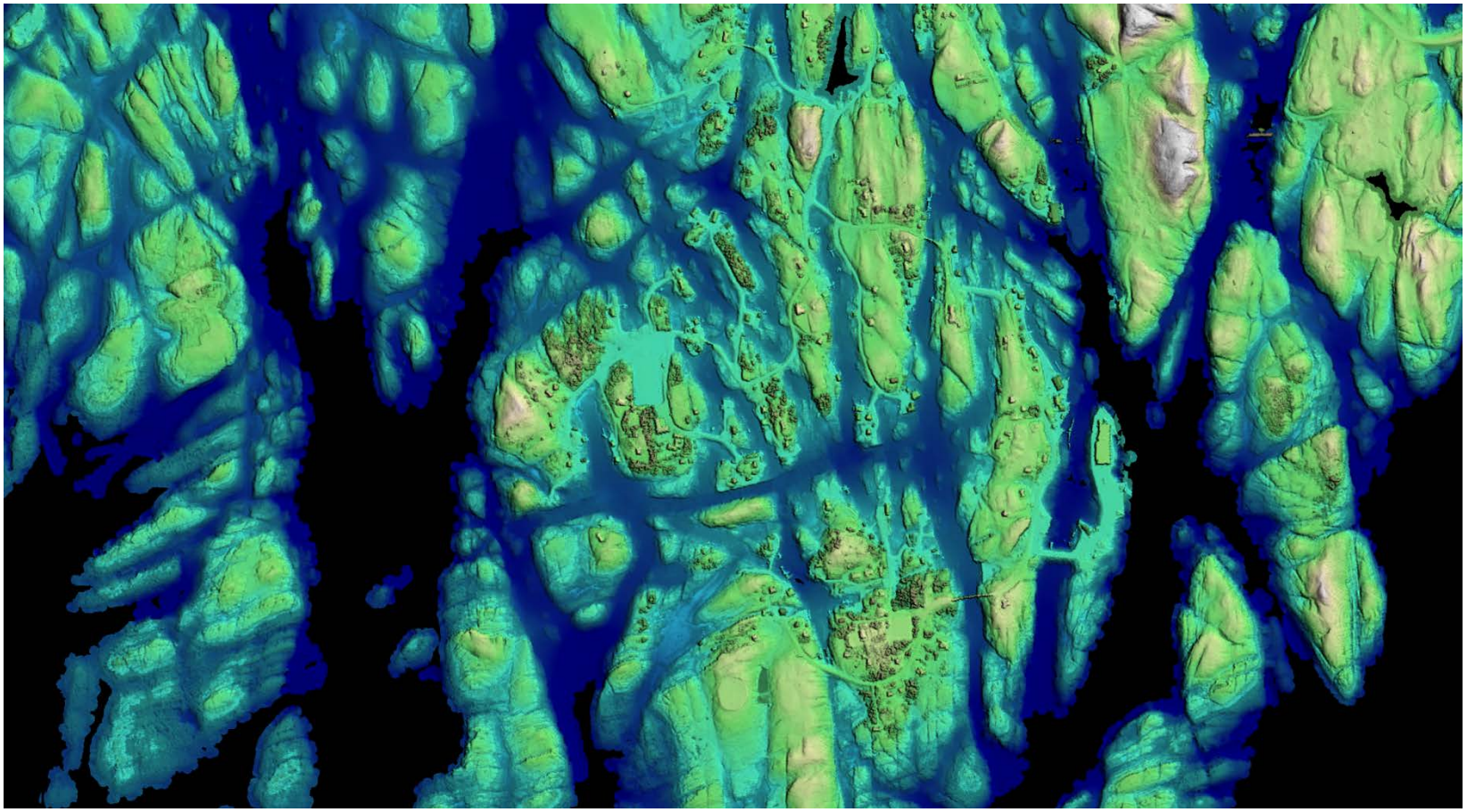
Complex Archipilago
- Bulandet Norway



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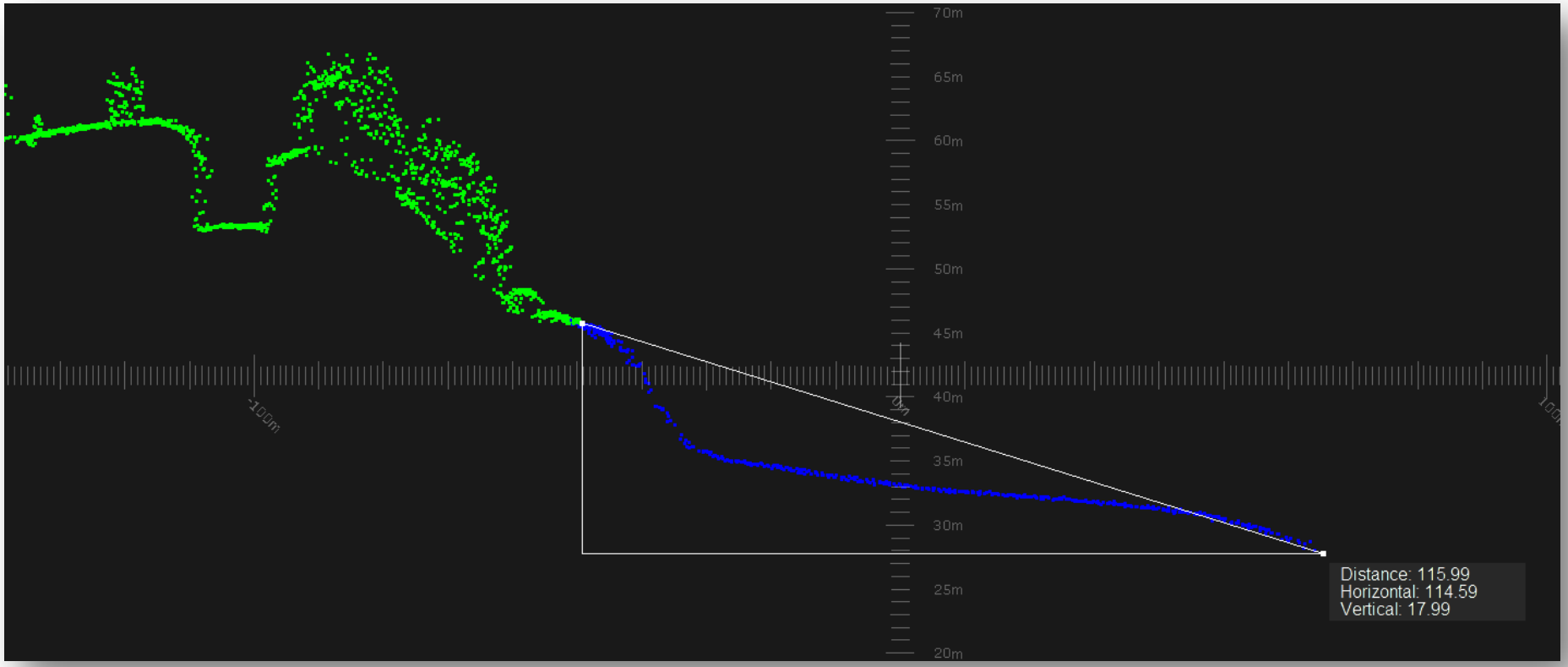
Complex Archipilago
- Bulandet Norway



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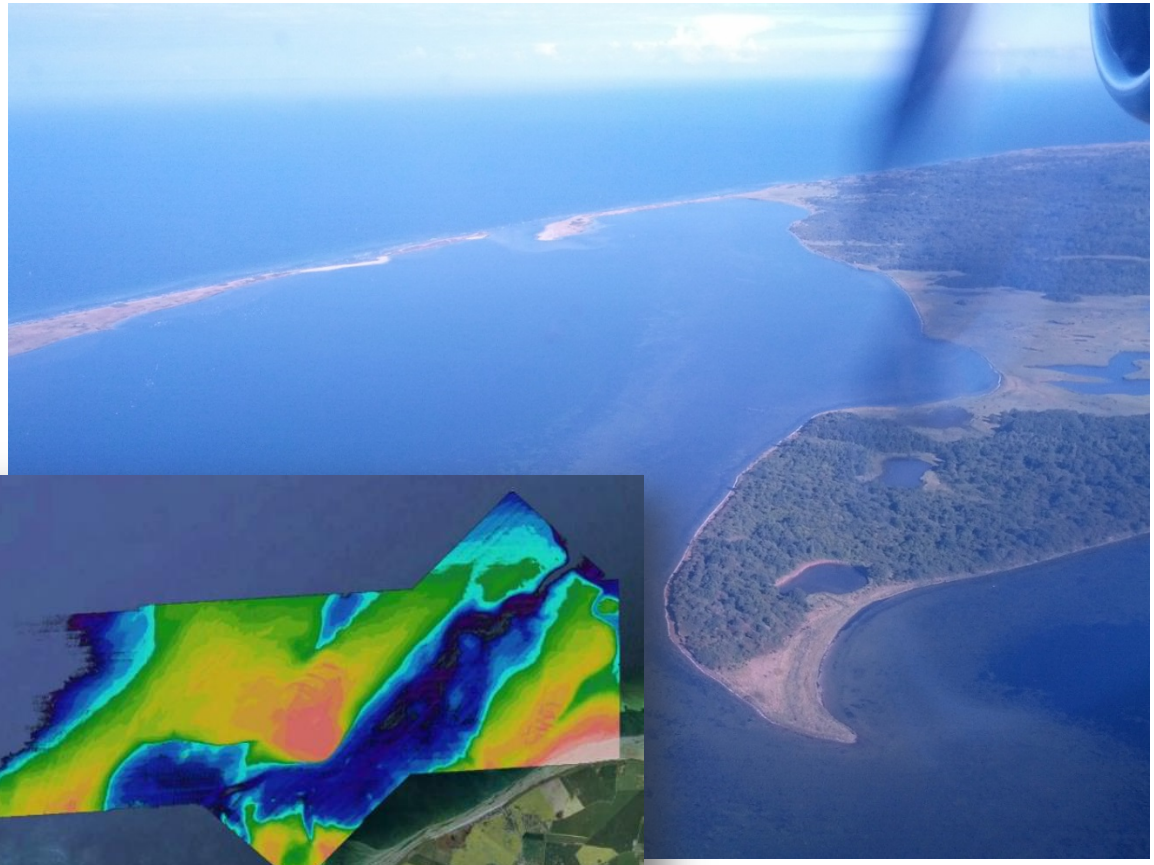
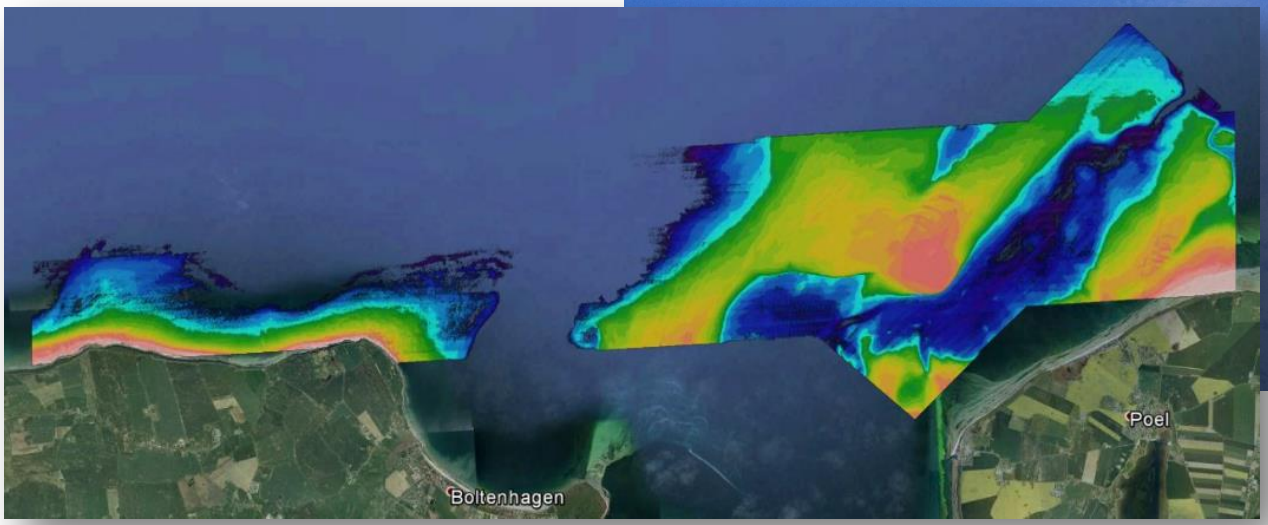
Hydrographic and environmental
- Poel, Germany





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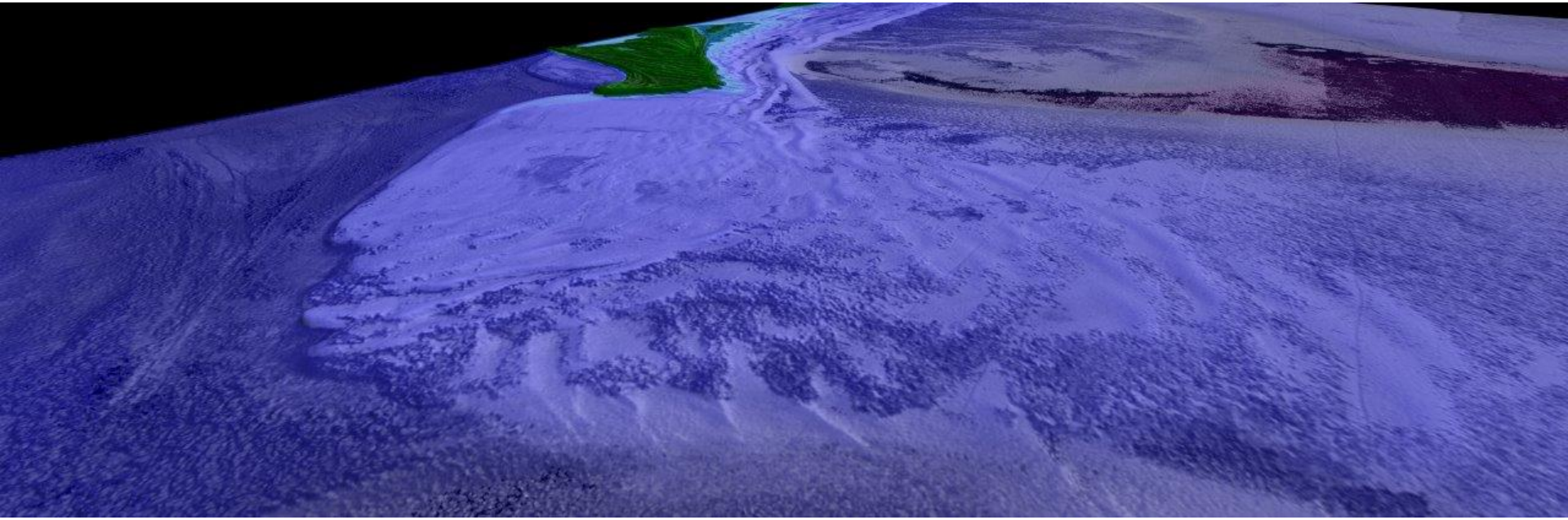
Hydrographic and environmental
- Poel, Germany



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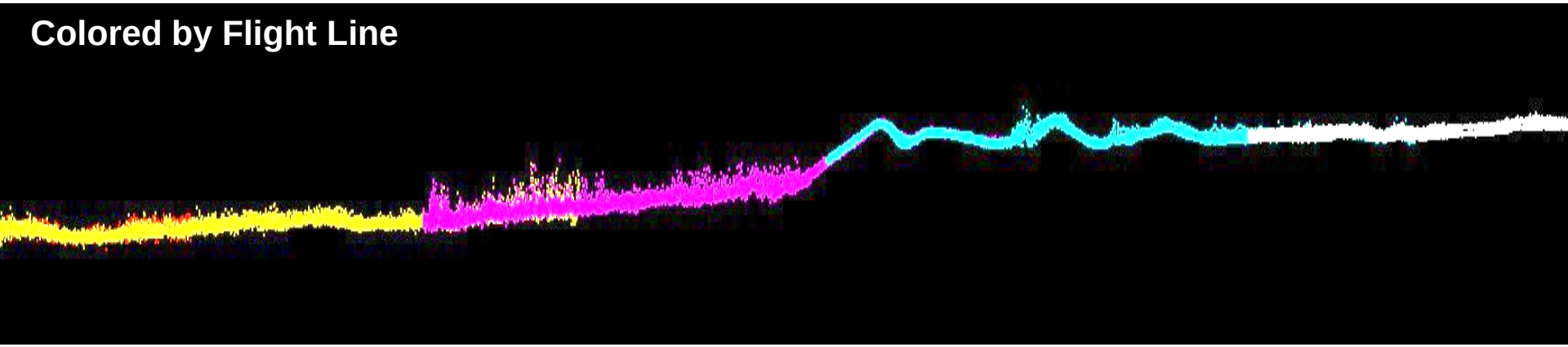
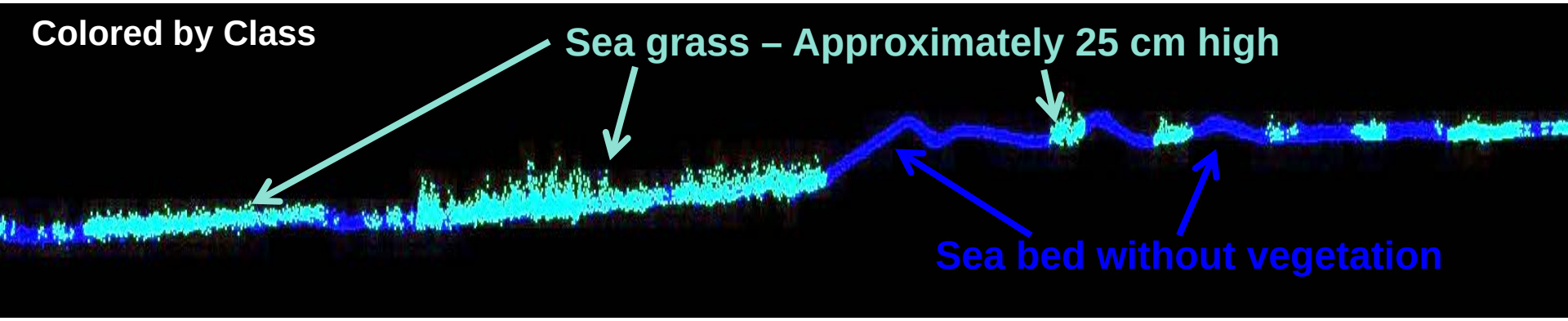
Sea-grass classification
- Poel, Germany





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Introducing world-leading 1 MHz topo LiDAR

DragonEye Dual Head

- **Dual-channel LiDAR system**
  - 1 MHz effective measurement rate
- **Full waveform capture**
  - Real time processing
  - Up to 15 returns per shot, user selectable
  - Full waveform storage, user selectable
- **MPiA technlogy**
- **RCD30 - 80 megapixel camera integrated**
- **Leica workflow + LiDAR Survey Studio software**

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Unique Obliqe scan pattern

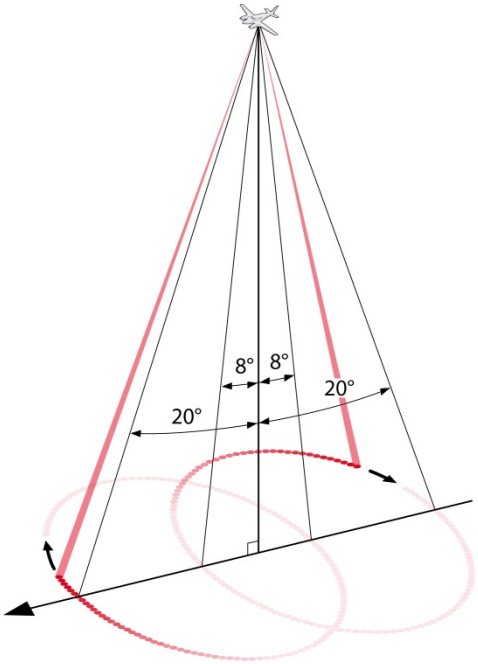
Oblique and near-nadir looking scan

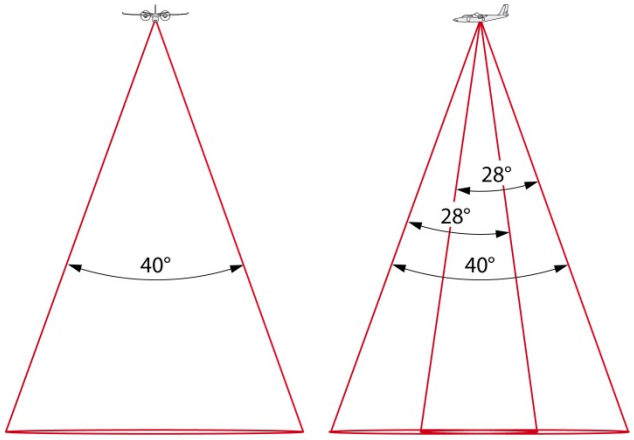
Complete and overlapping scans

Surface and ground covered 4 times

Maximum reduction of shadowing in complex areas;

- Urban areas, city modeling
- Infrastructure (roads and bridges, railways, power lines and more)
- Forrests





Across track
Field of View

Along track
Angles of incidents

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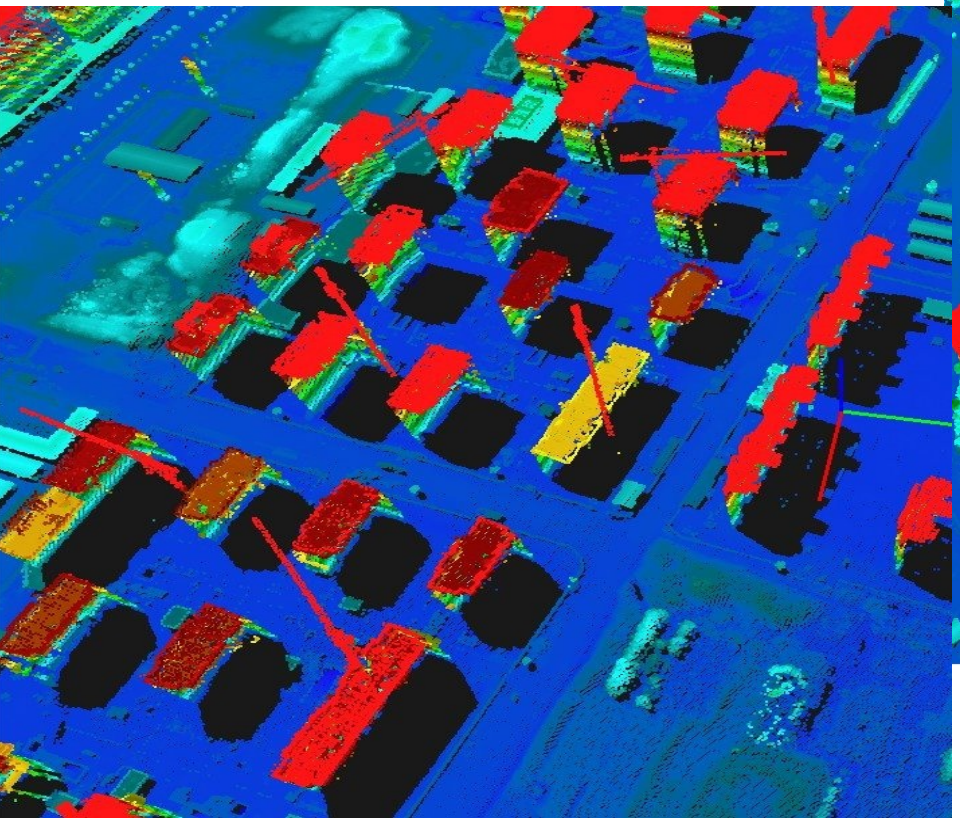
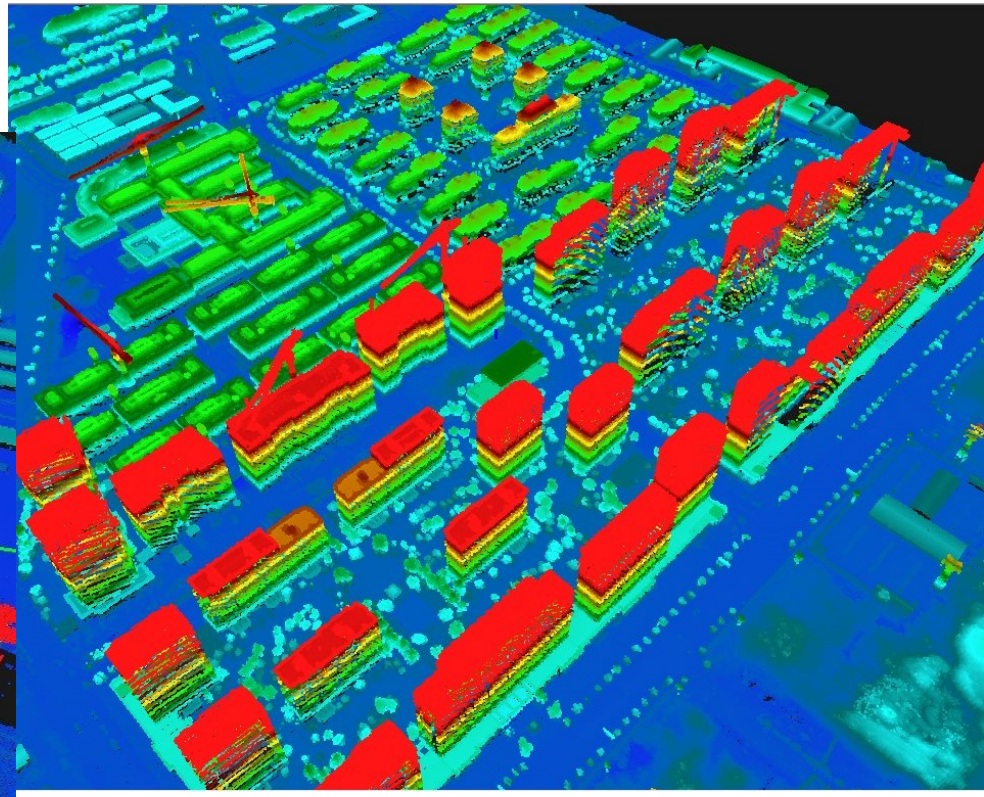
Non-oblique vs Oblique LIDAR

Non-oblique LiDAR: shadow in the back side of the buildings





Oblique LiDAR: no shadow, great vertical surface definition in one fly over

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Integrates with the PAV100 gyro-stabilized mount

Easy installation and integration with most aircrafts with and without mount.

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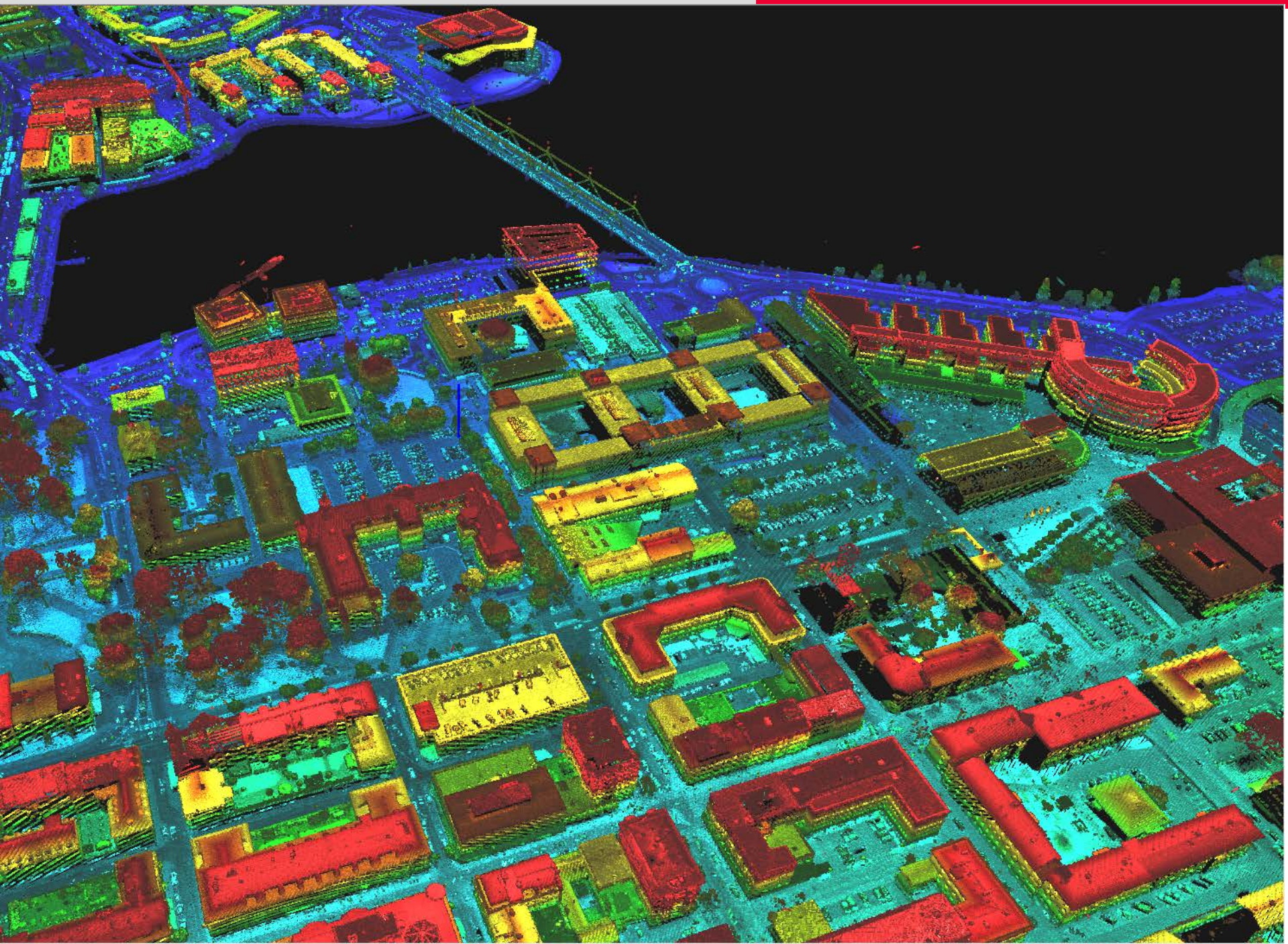

Oblique scanning

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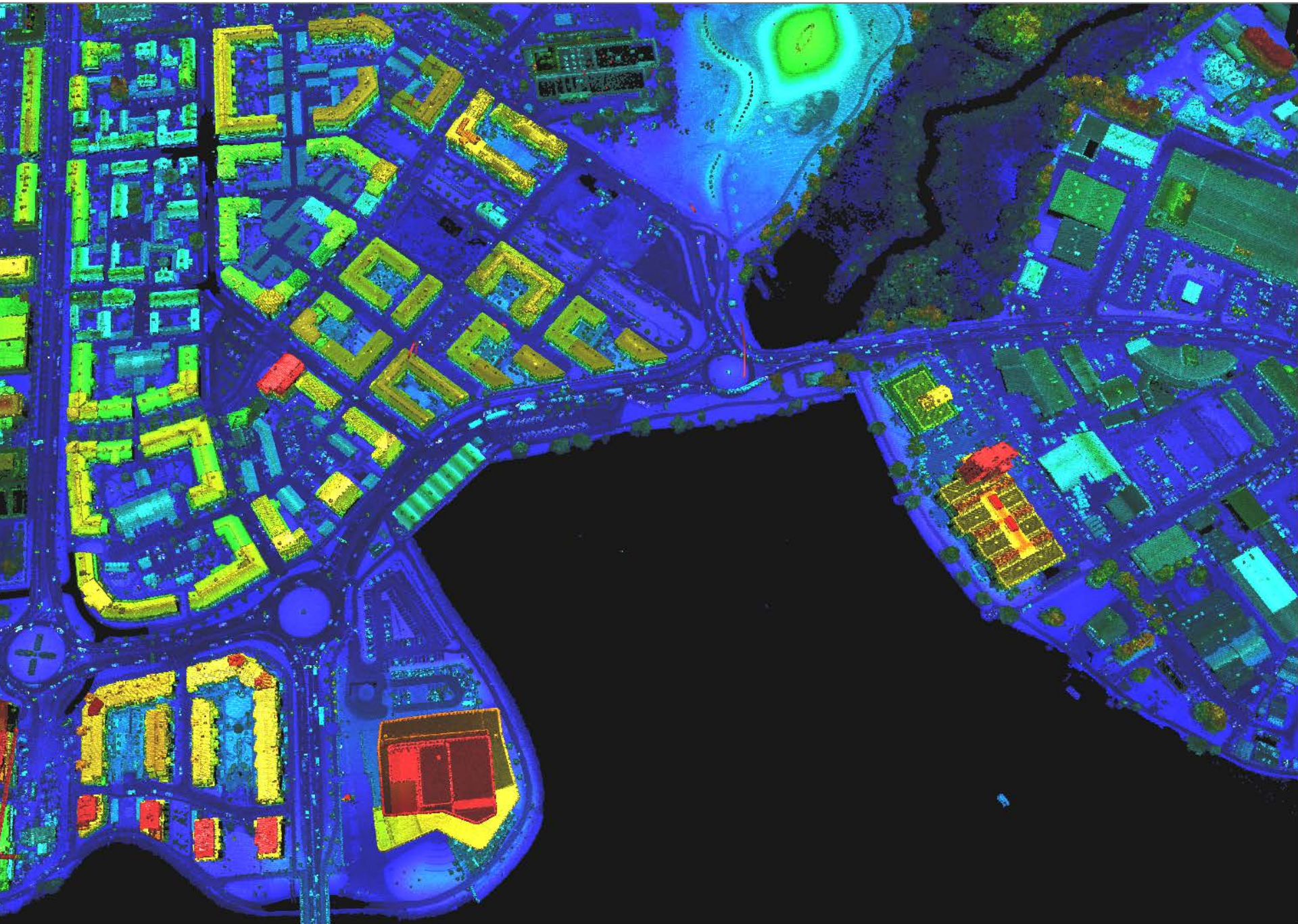

LIDAR Survey Studio™ - LiDAR processing software

- **LiDAR processing software**
  - Conversion of all LiDAR waveforms to LiDAR returns
  - Flight trajectory import
  - Automatic water refraction correction
  - Automatic LIDAR data classification
- **3D viewer / editor**
  - 3D visualisation (zooming, panning, rotating ....)
  - Viewing LiDAR data by classes
  - Cleaning / Editing Lidar data
- **Export**
  - Las 1.4, Las 1.2
  - AHAB open format

RGB coloured point cloud

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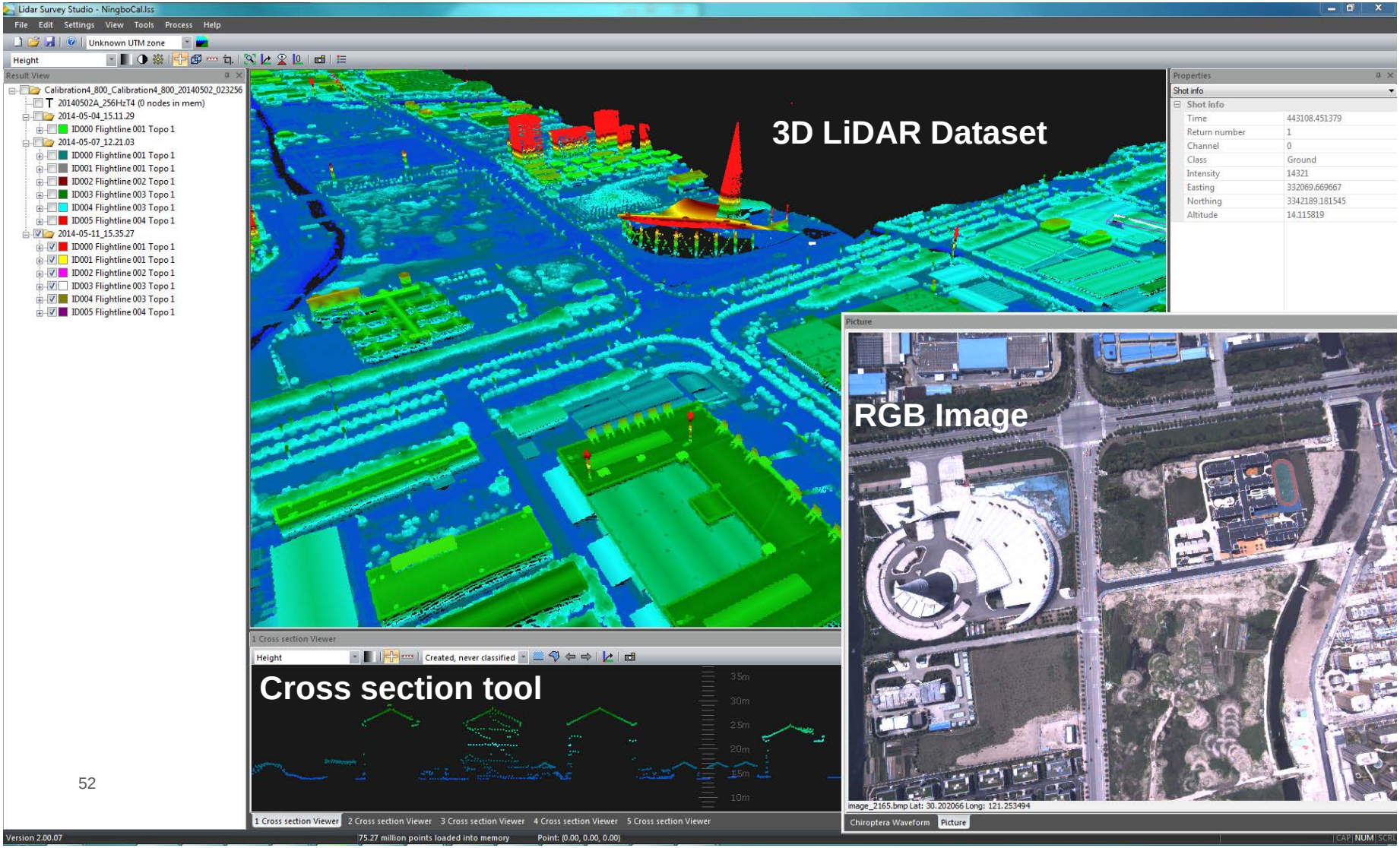
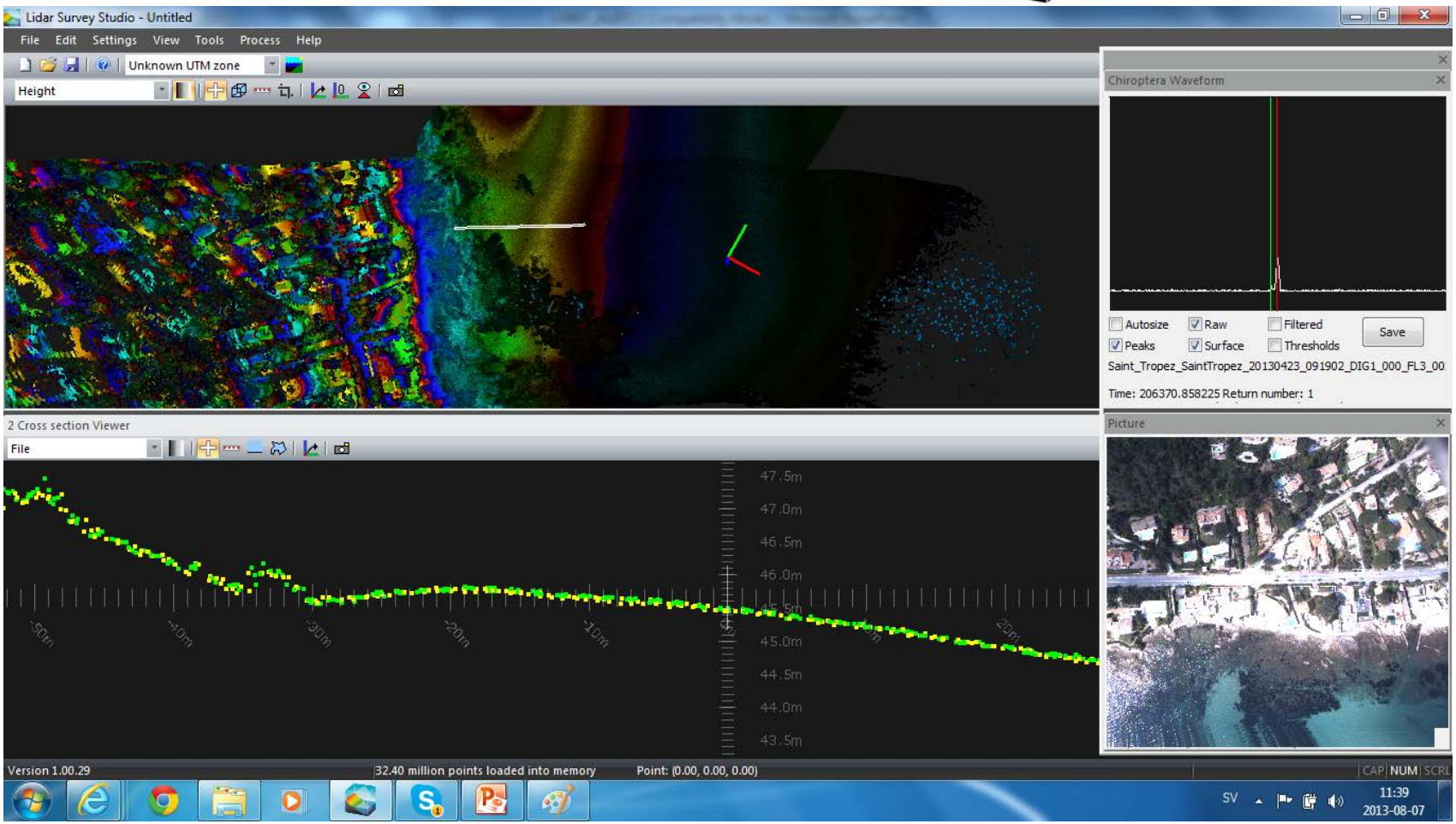
LIDAR Survey Studio™
- LiDAR processing software



LIDAR Survey Studio™
- LiDAR processing software



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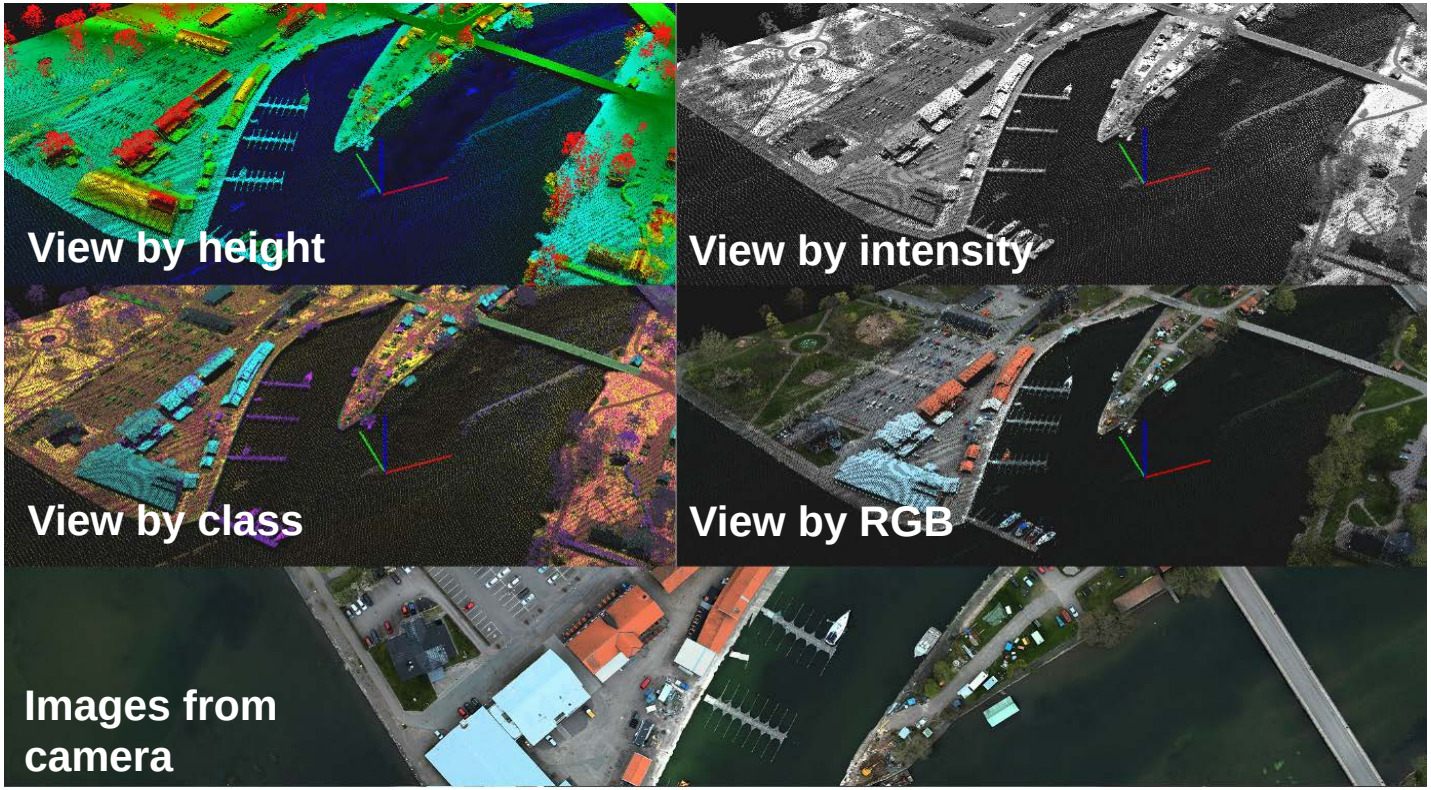
LIDAR Survey Studio™ - Views



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Thanks

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