

AHAB Bathymetric LiDAR Systems



AHAB
Airborne Hydrography AB

- when it has to be **right**

Leica
Geosystems

Airborne Hydrography AB

World recognised manufacturer of Airborne LIDAR systems

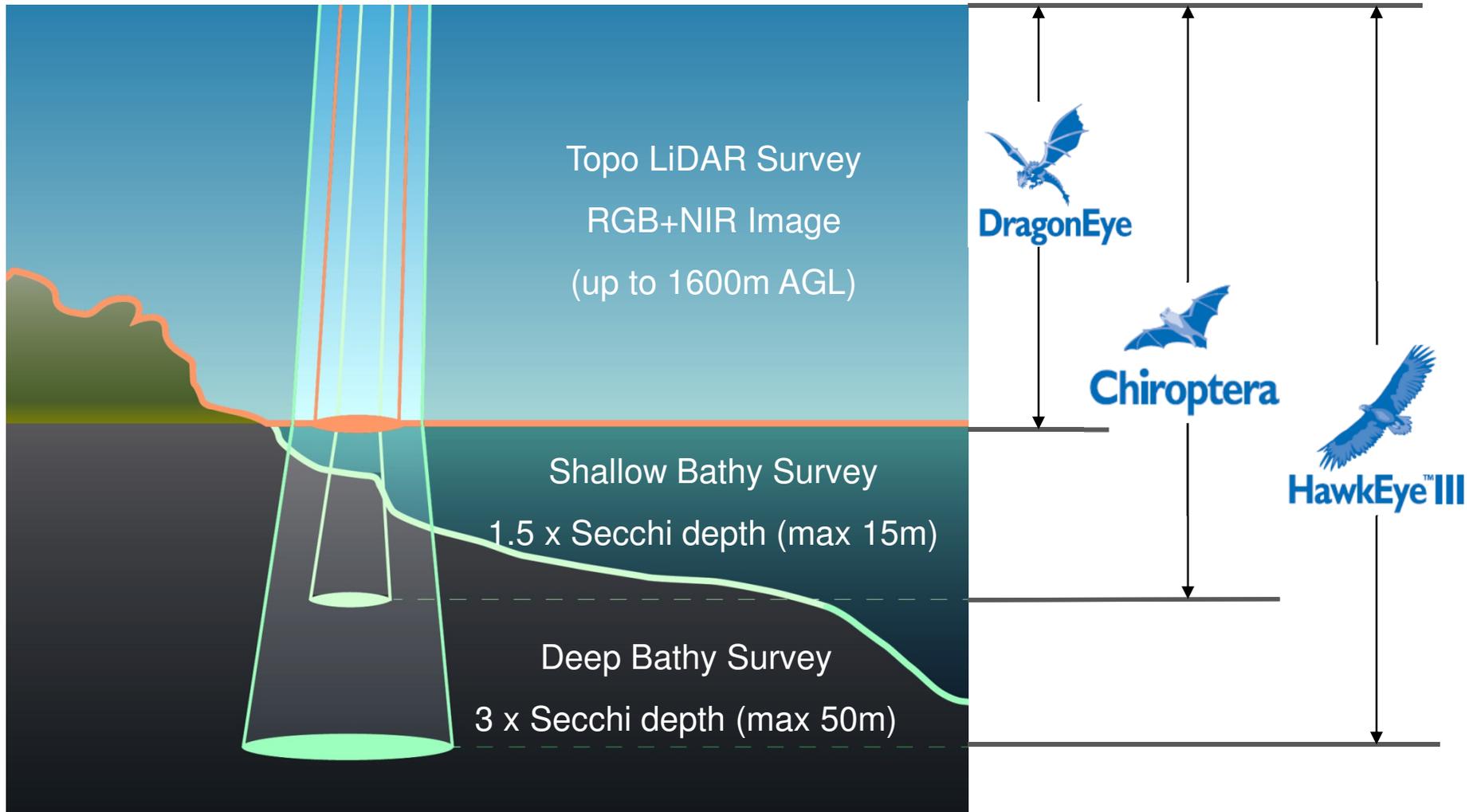
Founded 2002

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

Since October 2013 part of
Leica Geosystems



AHAB LiDAR Systems



AHAB products

Chiroptera_{II} – Shallow bathymetric LIDAR

Leica FMS Leica: Mission pro Leica: Flight pro	AHAB Operators Console Operator LIDAR interface Touchscreen
Leica Camera Leica RCD 30 80 MPIX RGB+IR	AHAB LiDAR Control Unit Full waveform 1,8 GSa/s, 170 Gflops 12 bit digitization
Topo-scanner 500 kHz 1,6 km	Shallow Bathy 35 kHz 1,5 Secchi



LIDAR Survey Studio™ 2.0
- LiDAR processing software

Output data



Chiroptera Sensor head



- when it has to be **right** 

AHAB products

HawkEye_{III} – Deep penetrating bathy LIDAR

Leica FMS Leica: Mission pro Leica: Flight pro		AHAB Operators Console Operator LIDAR interface Touchscreen	
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Output data



HawkEye III Sensor head



- when it has to be **right** **Leica**
 Geosystems

Three Channel LIDAR – Why ?

- Each sensor optimised for its tasks
 - Laser divergence
 - Laser energy
 - Receiver sensitivity
 - Receiver field of view
 - Aperture size
 - Receiver type
 - Laser pulsewidth
 - PRF
 - Scanner speed
 - Optics



Three Channel LIDAR – Why ?

Topo

No water surface interference

No broadening of the beam due to water volume scattering

No losses due to water volume attenuation

Shallow Bathymetry

Full water surface interference

Some broadening of the beam due to water volume scattering

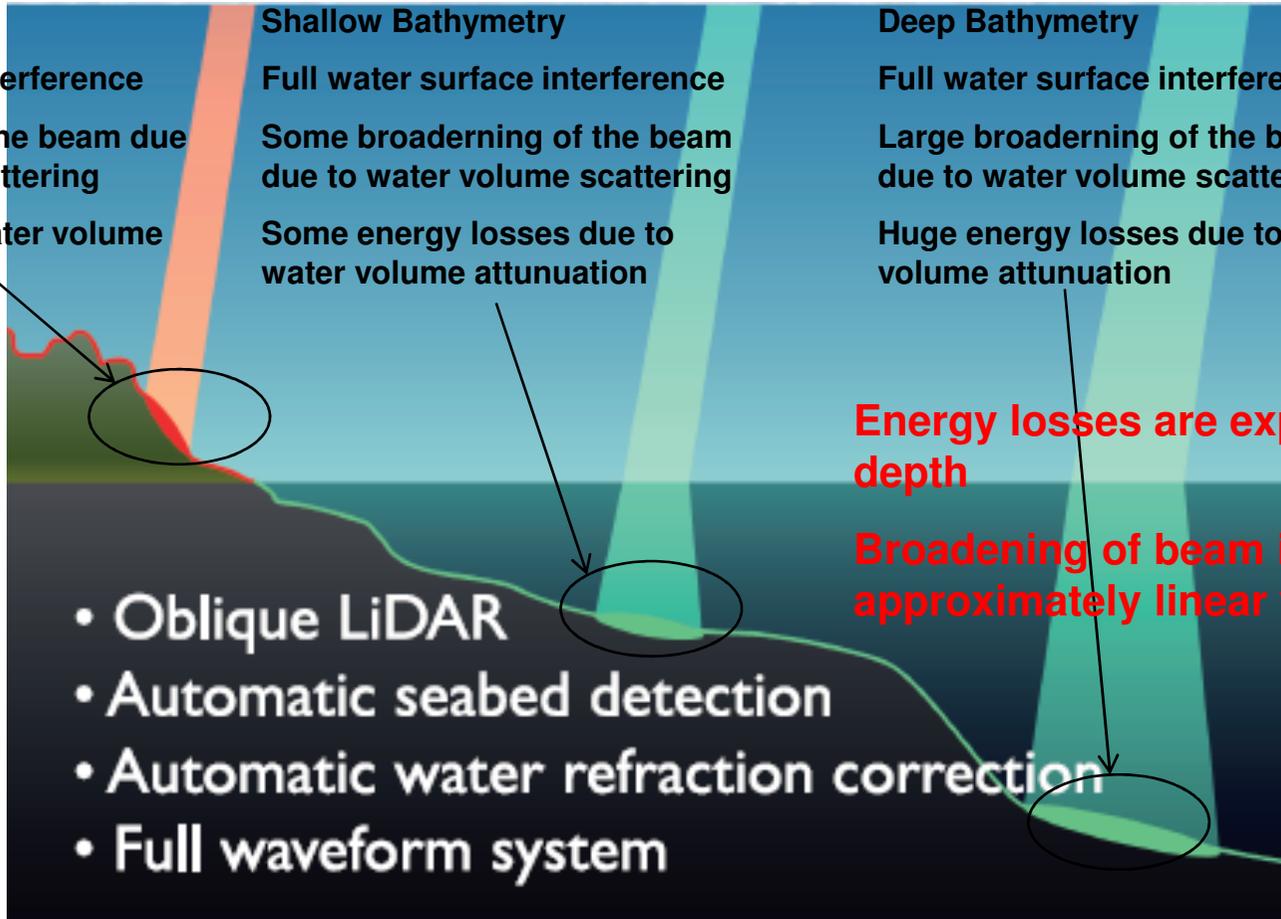
Some energy losses due to water volume attenuation

Deep Bathymetry

Full water surface interference

Large broadening of the beam due to water volume scattering

Huge energy losses due to water volume attenuation



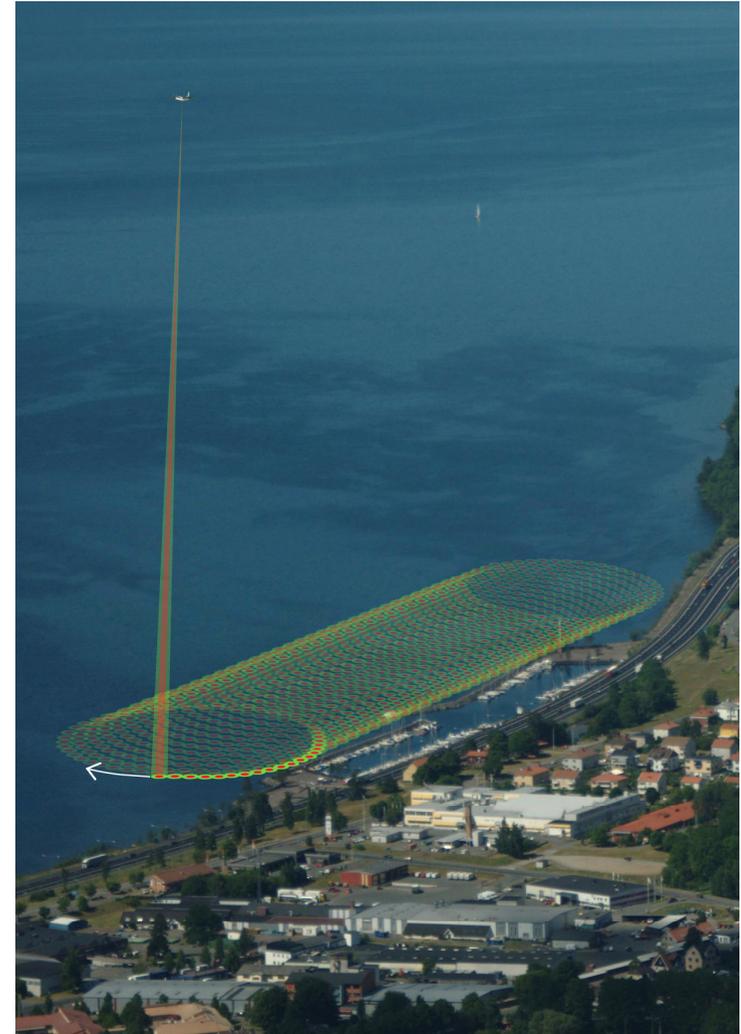
Energy losses are exponential with depth

Broadening of beam is approximately linear with depth

- Oblique LiDAR
- Automatic seabed detection
- Automatic water refraction correction
- Full waveform system

HawkEye_{III} Key features

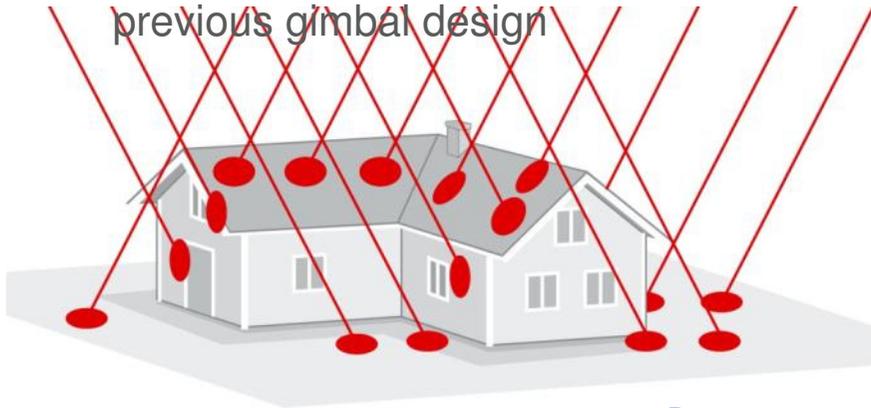
- **Bathymetric data capture Deep Channel**
 - Deep: 10 KHz, single receiver
 - Full waveform capture, oblique scanner
 - Real time waveform analysis
 - Depth penetration about 3 Secchi or 50m
- **Bathymetric data capture Shallow Channel**
 - Shallow: 35 KHz, single receiver
 - Full waveform capture, oblique scanner,
 - Real time waveform analysis
 - Depth penetration about 1,5 secchi or 15m
- **Topographic data capture**
 - Up to 500 KHz Single receiver
 - Full waveform capture, oblique scanner
 - Real time waveform analysis
 - Max altitude: 1600 m



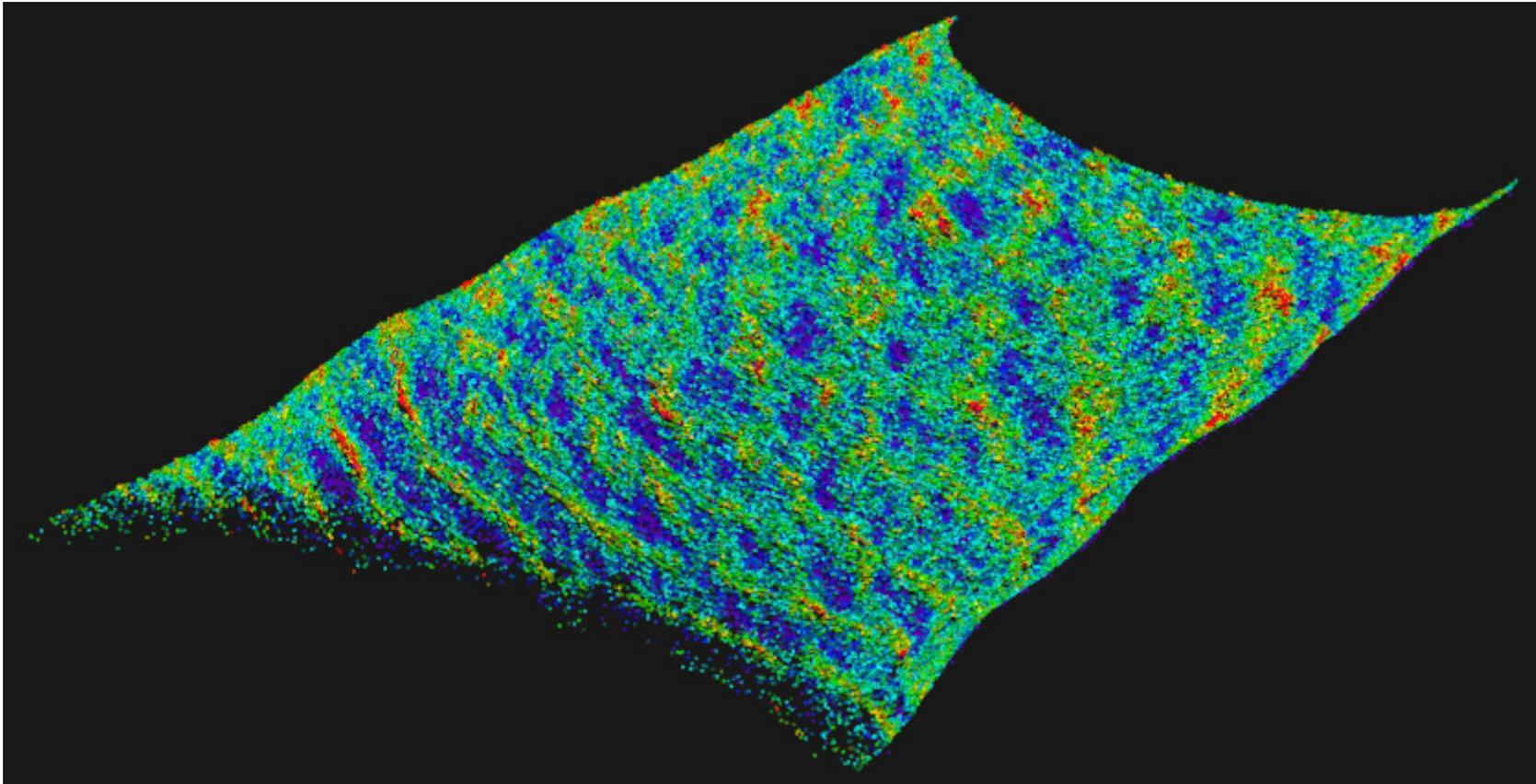
Oblique LIDAR

Oblique LIDAR - elliptical LiDAR scanning

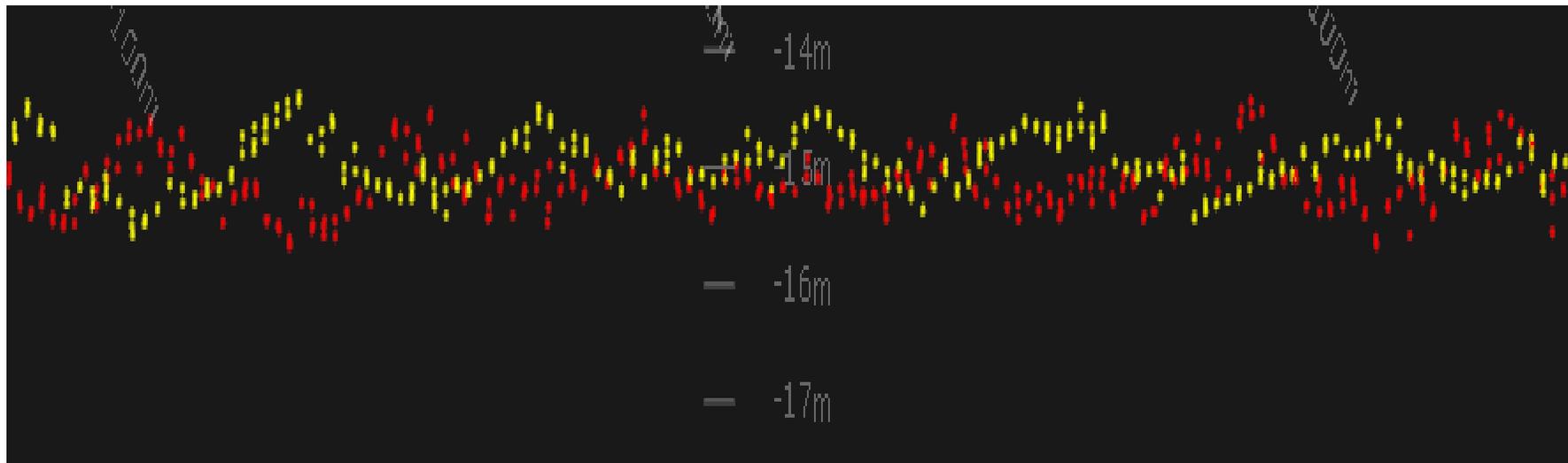
- Superior coverage of vertical and tall objects such as buildings, walls, piers, poles
- Less shadow effects in the data
- Less sensitive for surface wave interaction
- LiDAR waveform capture from two different angles
- Increased accuracy compared to the previous gimbal design



Water surface measurement



Water surface measurement



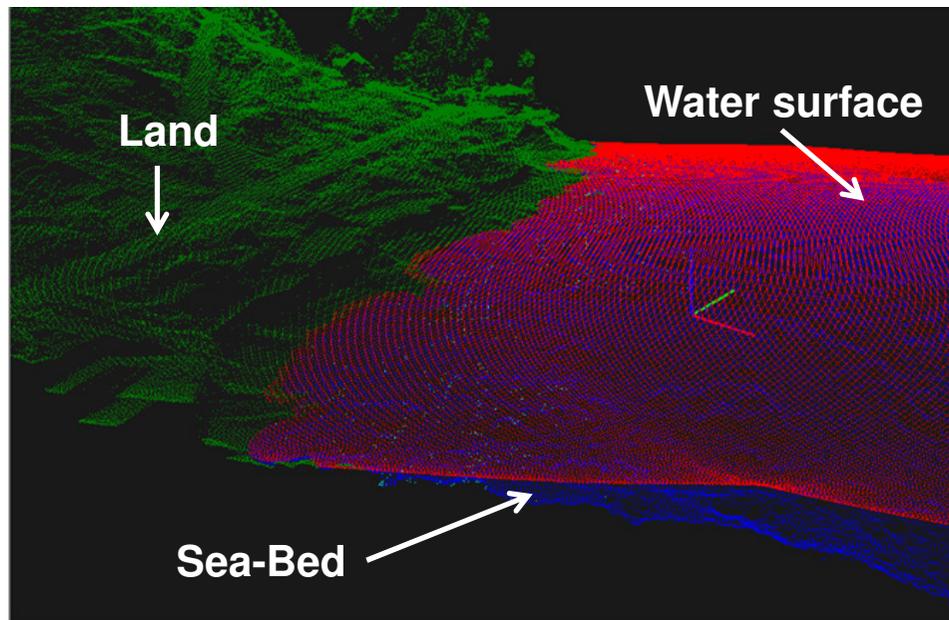
1 meter waves => corresponds to about 25 cm variation on sea bed if a mean water surface is used for the refraction correction

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

Key performance of a bathymetric LIDAR system

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

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



LIDAR Survey Studio™

- LiDAR processing software

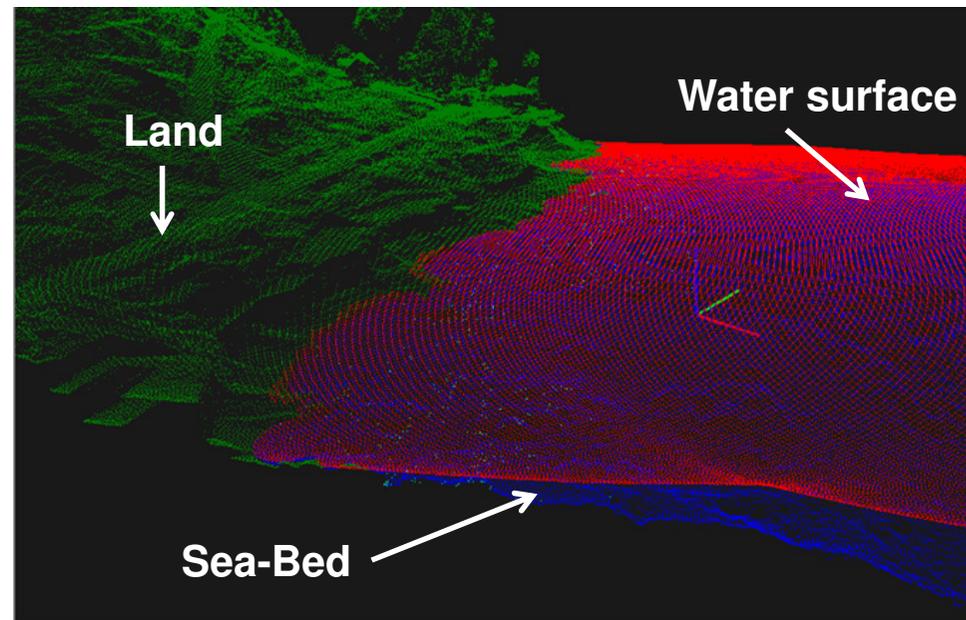


- **LiDAR processing software for all AHAB products**

- DragonEye, Chiroptera, HawkEye
- 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



Automatic data classification

LIDAR Survey Studio™

- LiDAR processing software



Lidar Survey Studio - Untitled

File Edit Settings View Tools Process Help

Unknown UTM zone

Height

3D Lidar Dataset

2 Cross section Viewer

File

Cross section tool

Chiroptera Waveform

Lidar Waveform

Autosize Raw Filtered

Peaks Surface Thresholds

Saint_Tropez_SaintTropez_20130423_091902_DIG1_000_FL3_00

Time: 206363.144481 Return number: 2

Picture

RGB Image

image_0007.bmp Lat: 0.000000 Long: 0.000000

Version 1.00.29 32.40 million points loaded into memory Point: (0.00, 0.00, 0.00) Distance: 20.64, Horizontal: 16.41, Vertical: 12.52

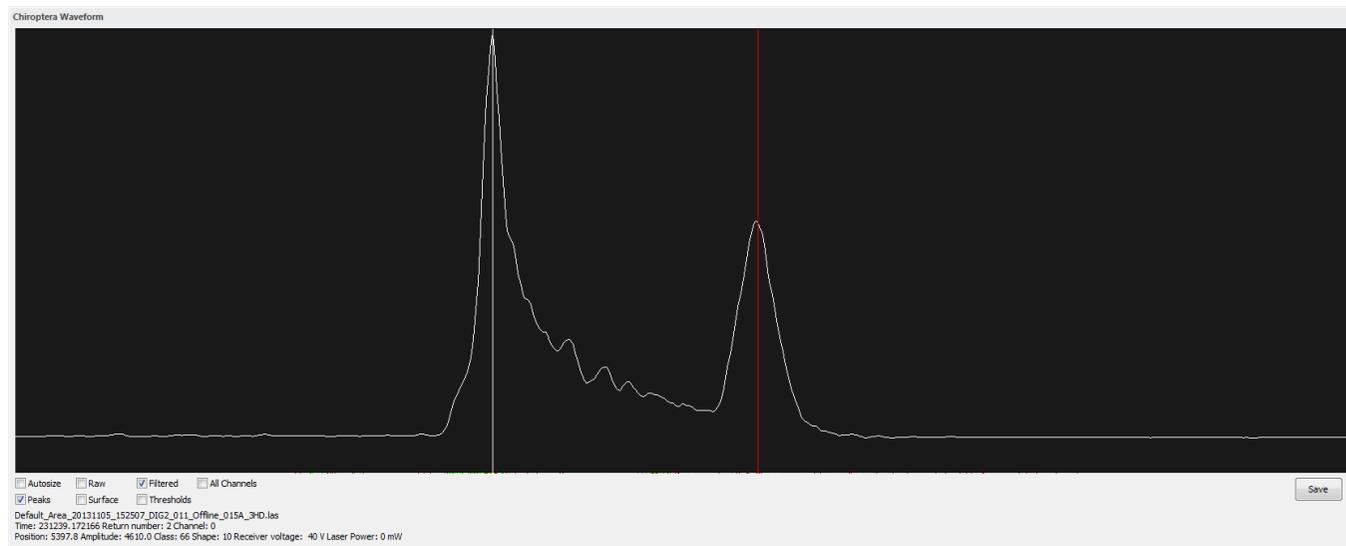
SV 12:03 2013-08-07

LIDAR Survey Studio™

- LiDAR processing software

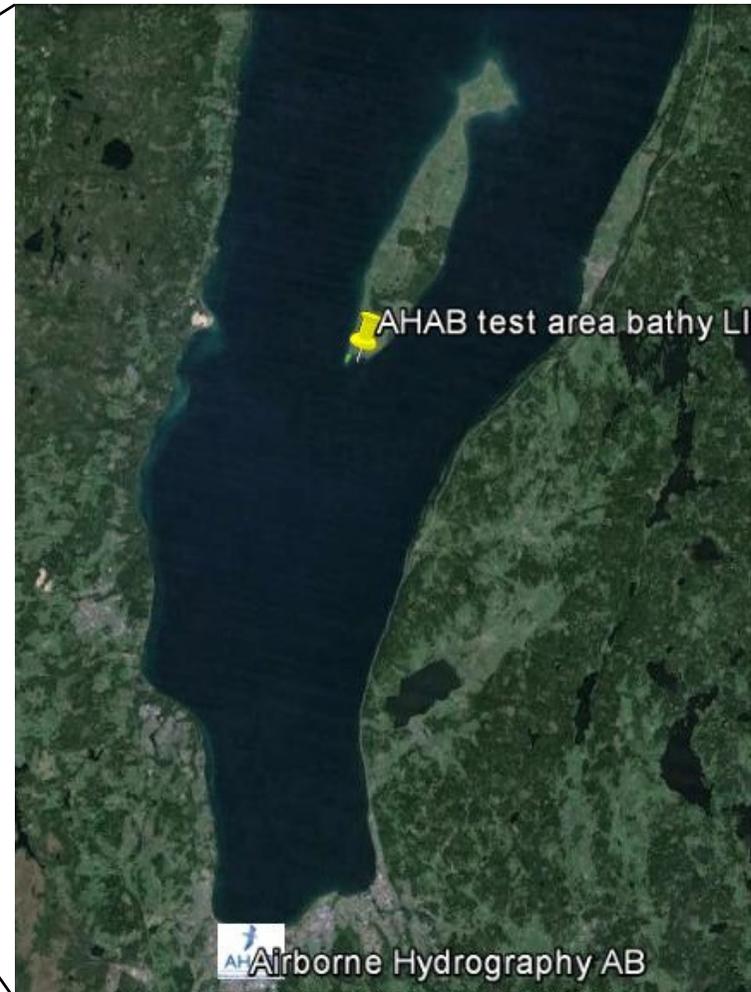
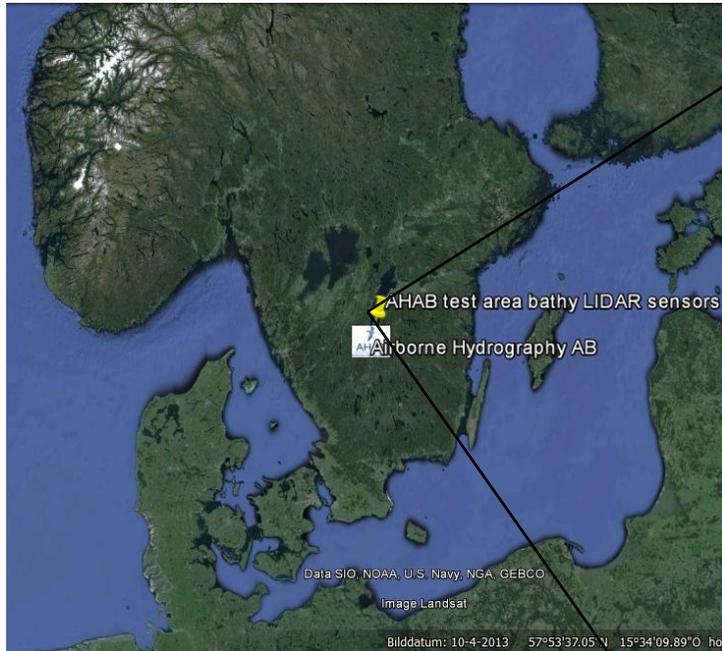


- **LiDAR waveform viewer**
 - HawkEye III and Chiroptera stores all bathymetric waveforms
 - Viewing all bathymetric LIDAR waveforms
 - Local water surface altitude for each waveform



HawkEye III – Deep channel waveform

AHAB test area for bathy LIDAR



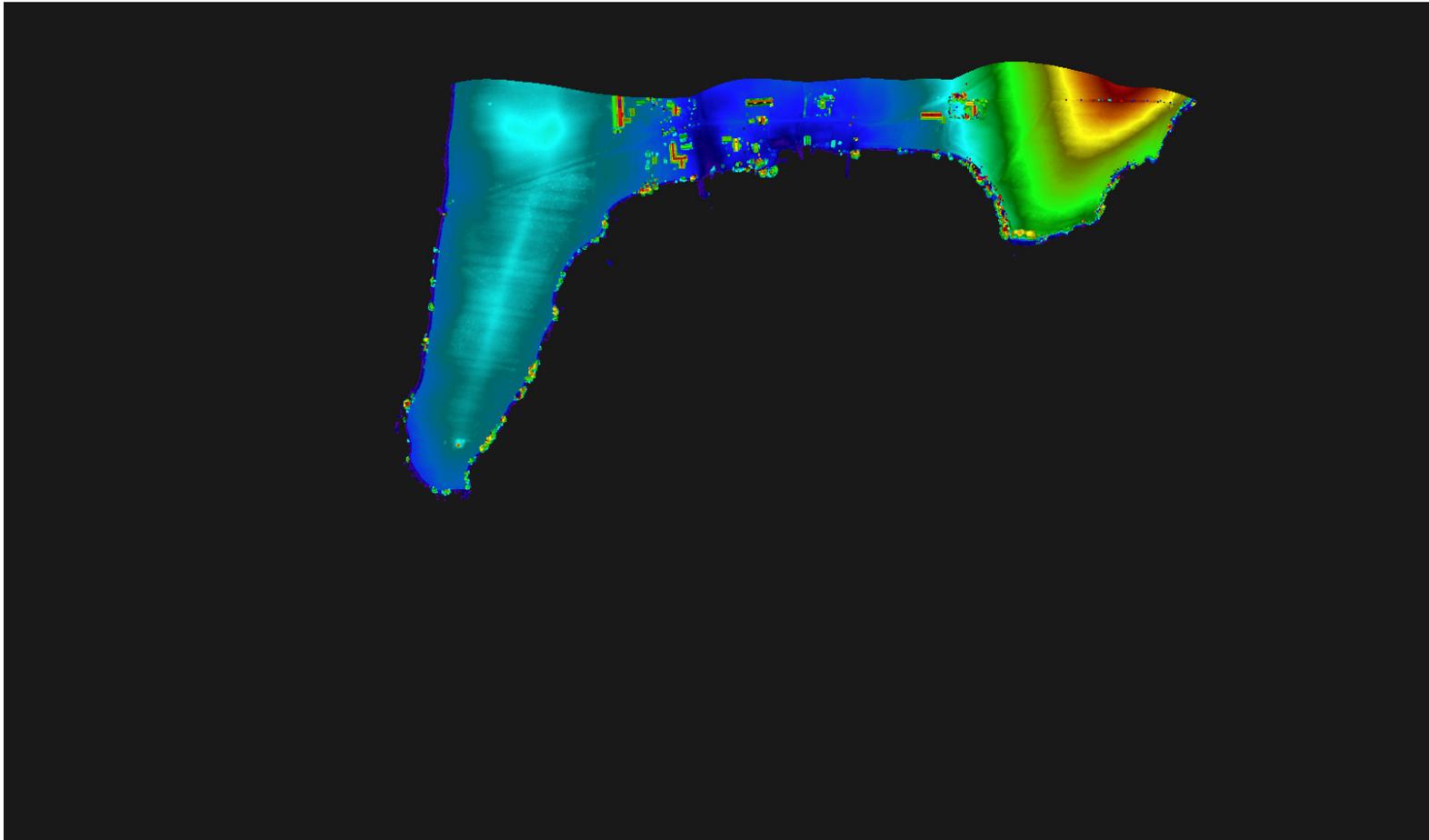
Lake Vättern (Sweden)

$$K_d = 0.2$$

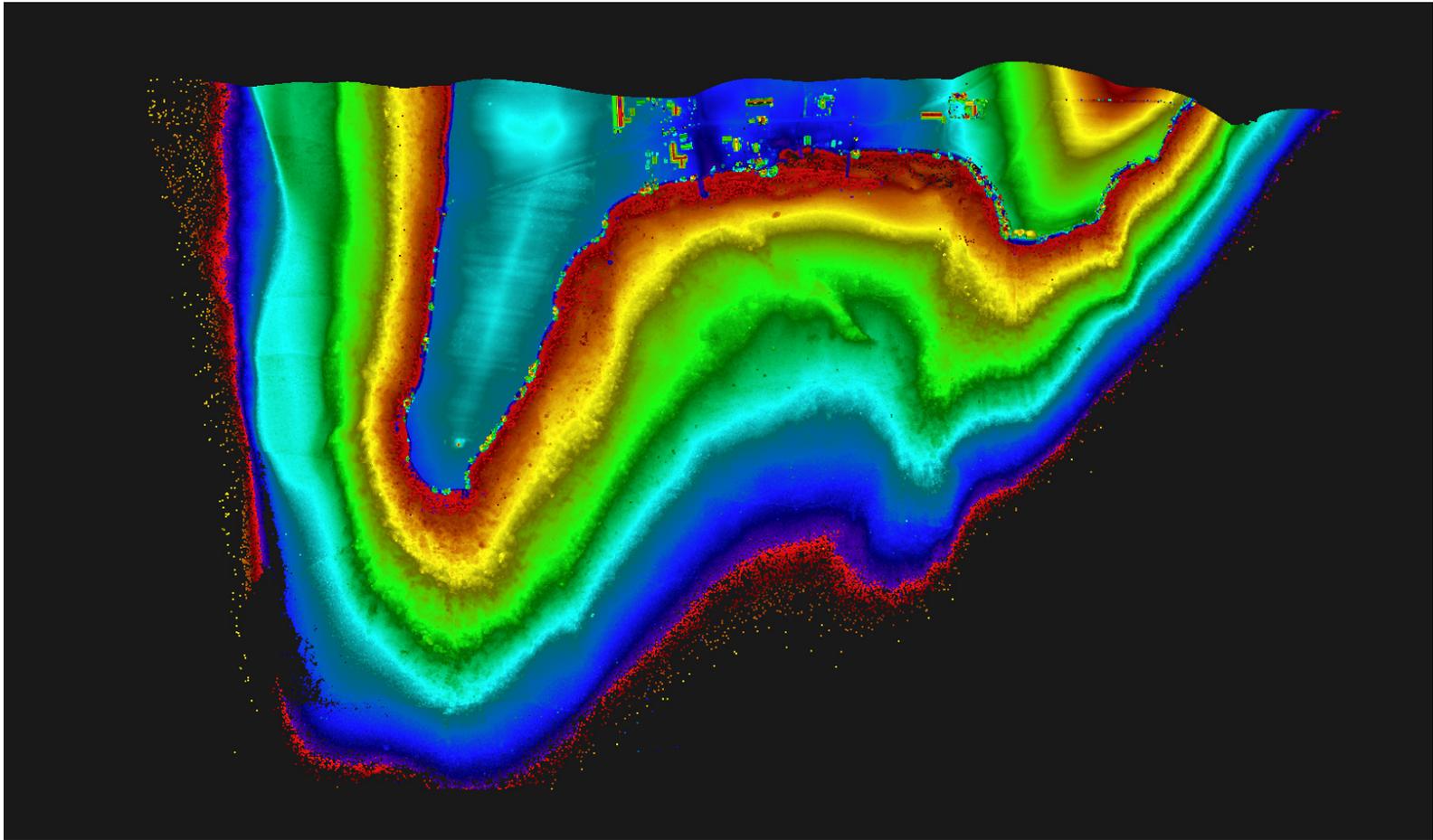
AHAB test area for bathy LIDAR



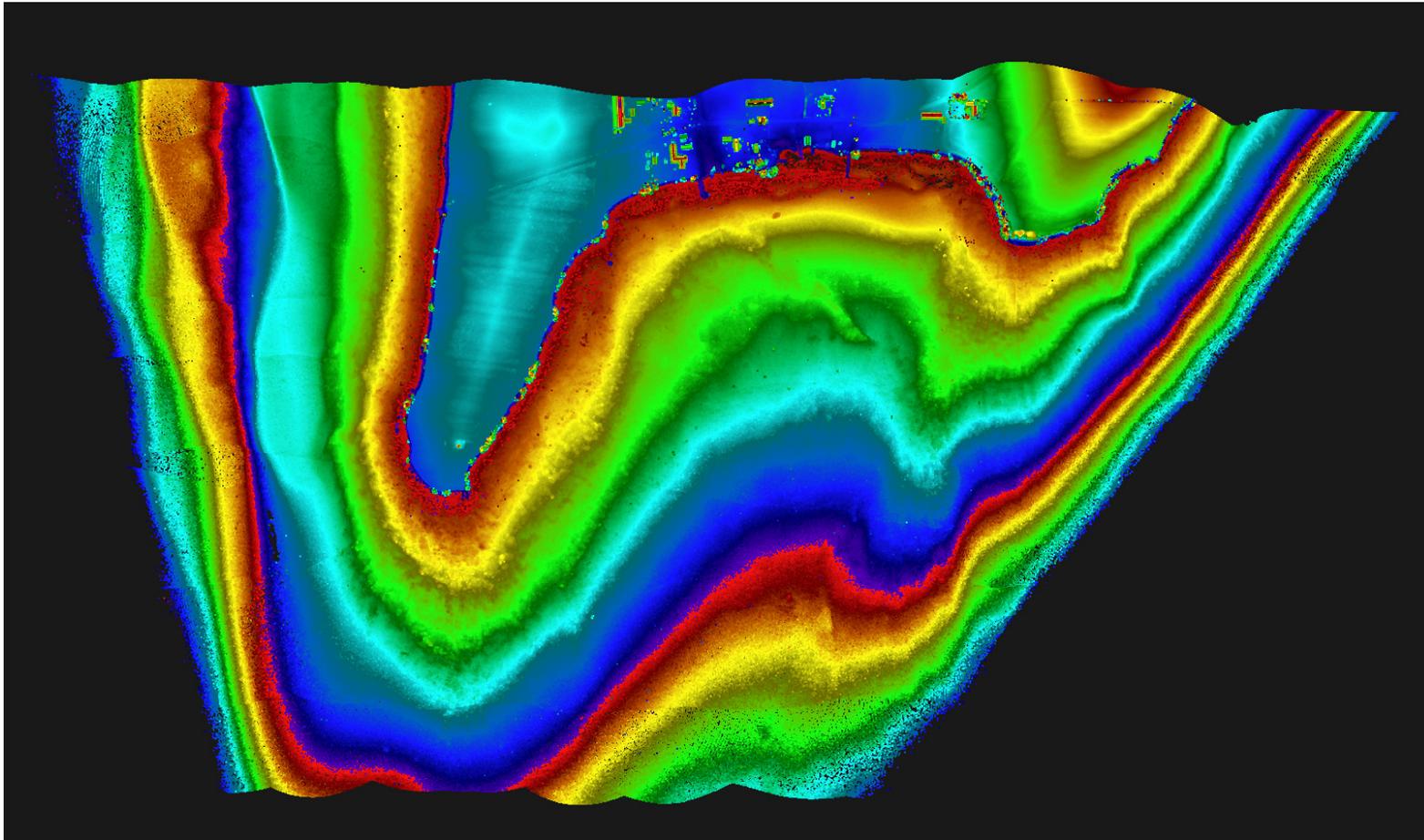
HawkEye_{III} – Pure Topo



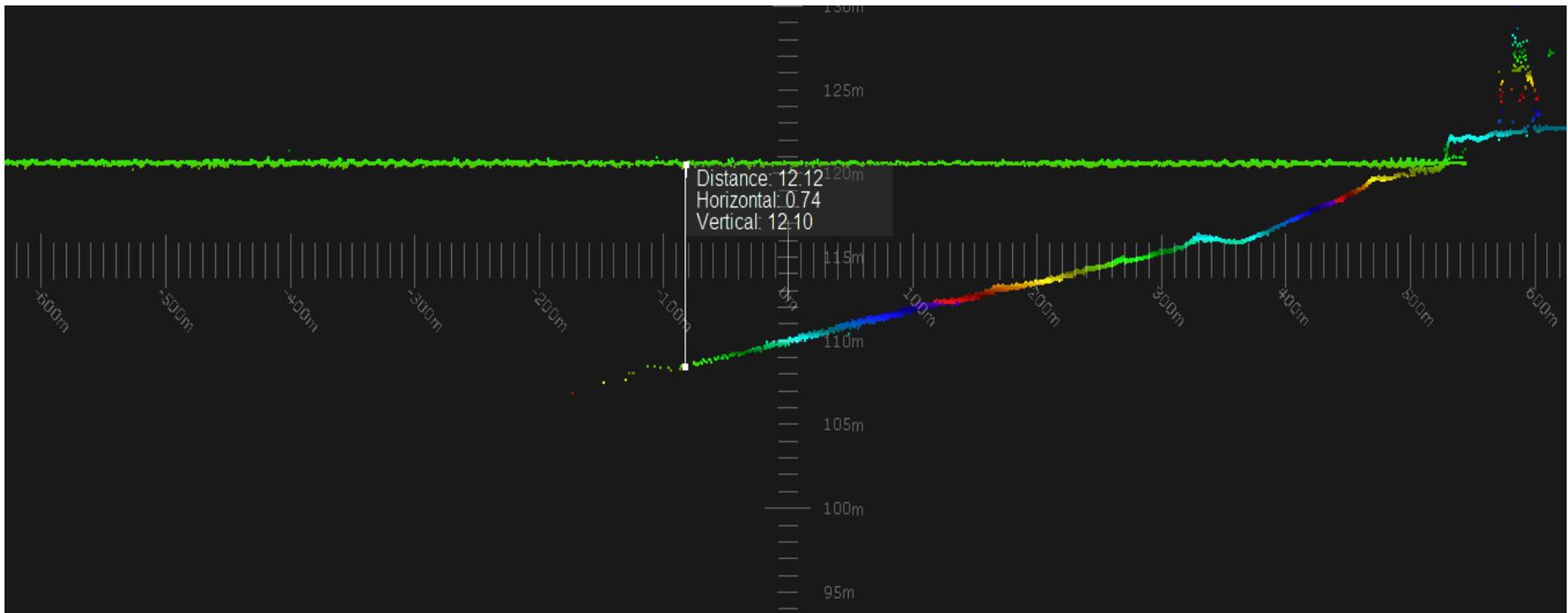
HawkEye_{III} – Topo and Shallow



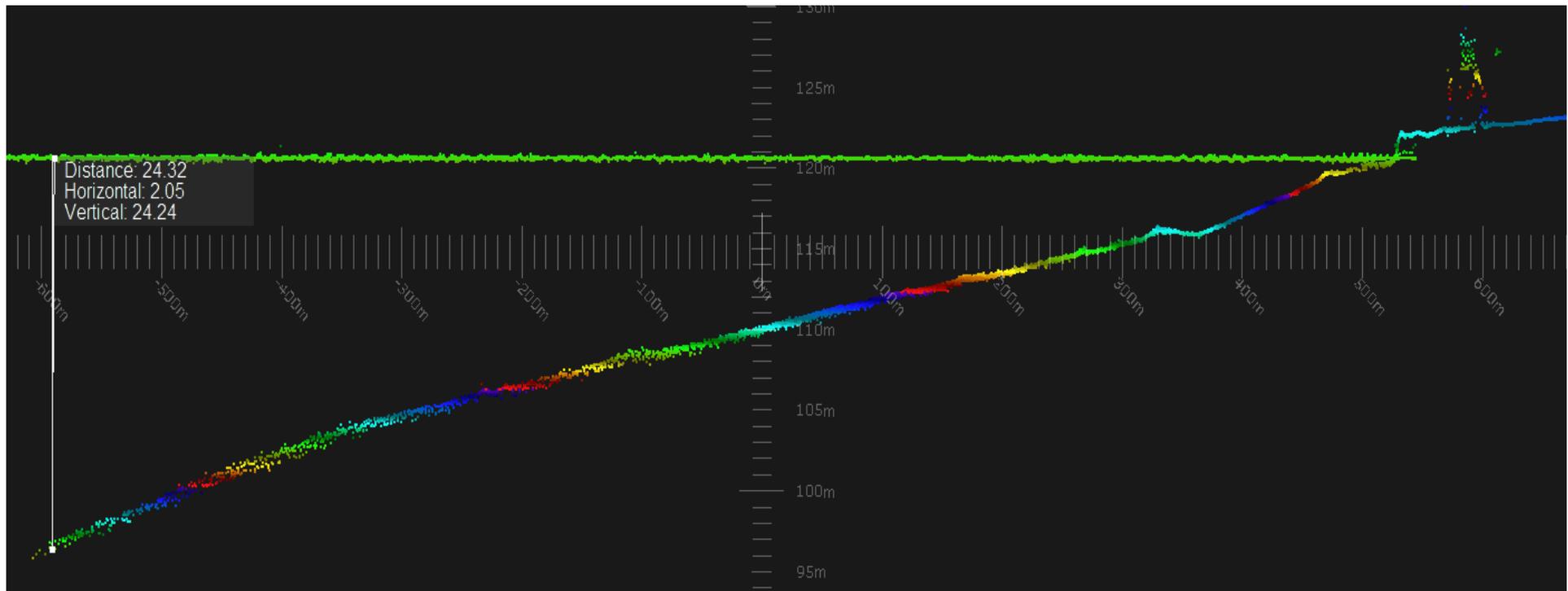
HawkEye_{III} – All Channels



HawkEye_{III} - Topo and Shallow



HawkEye_{III} – Topo, Shallow and Deep

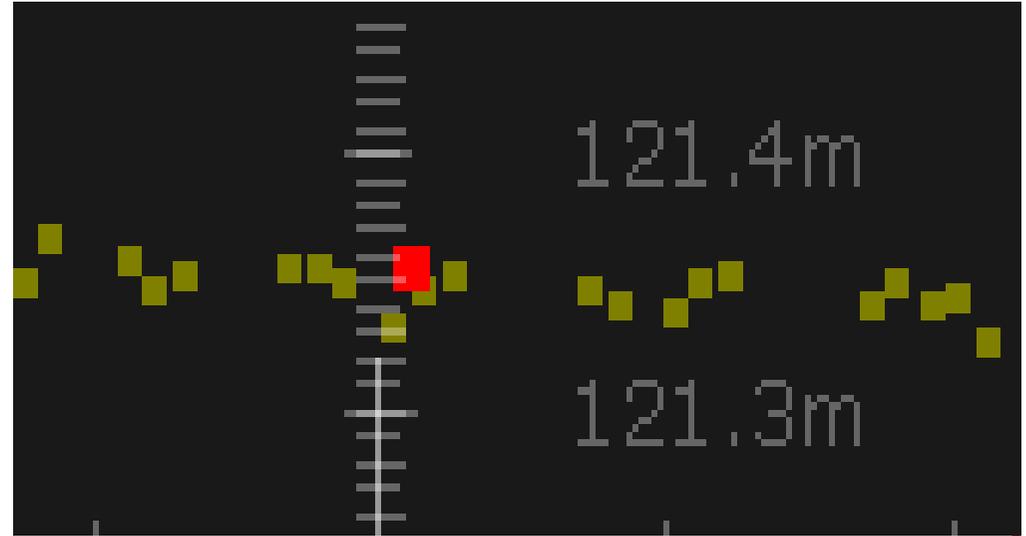


Reference data - Topography

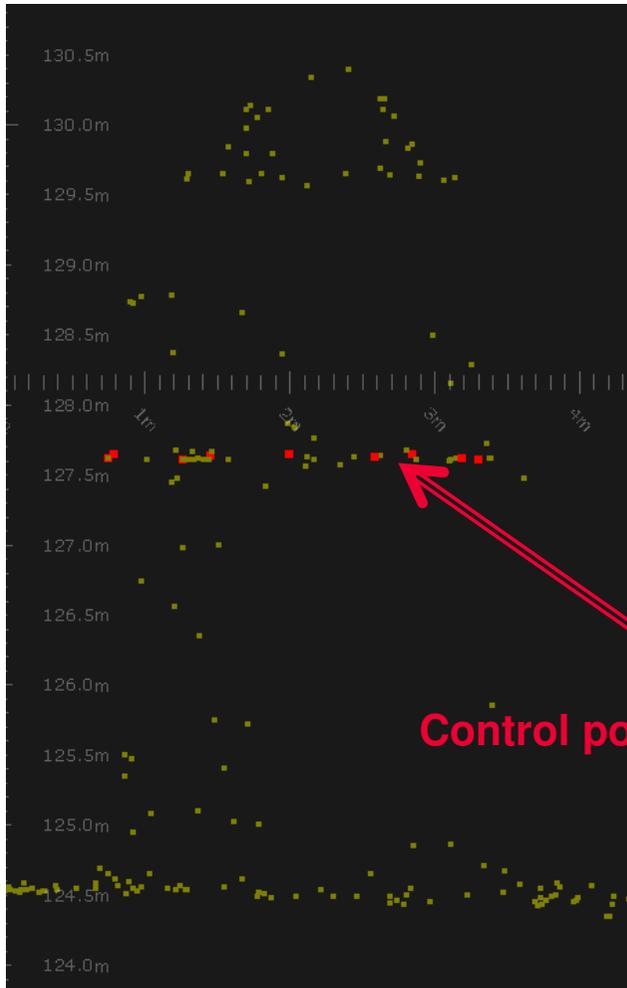
- Leica Viva GS14, GNSS
- Calibration tool



Control points on a pier

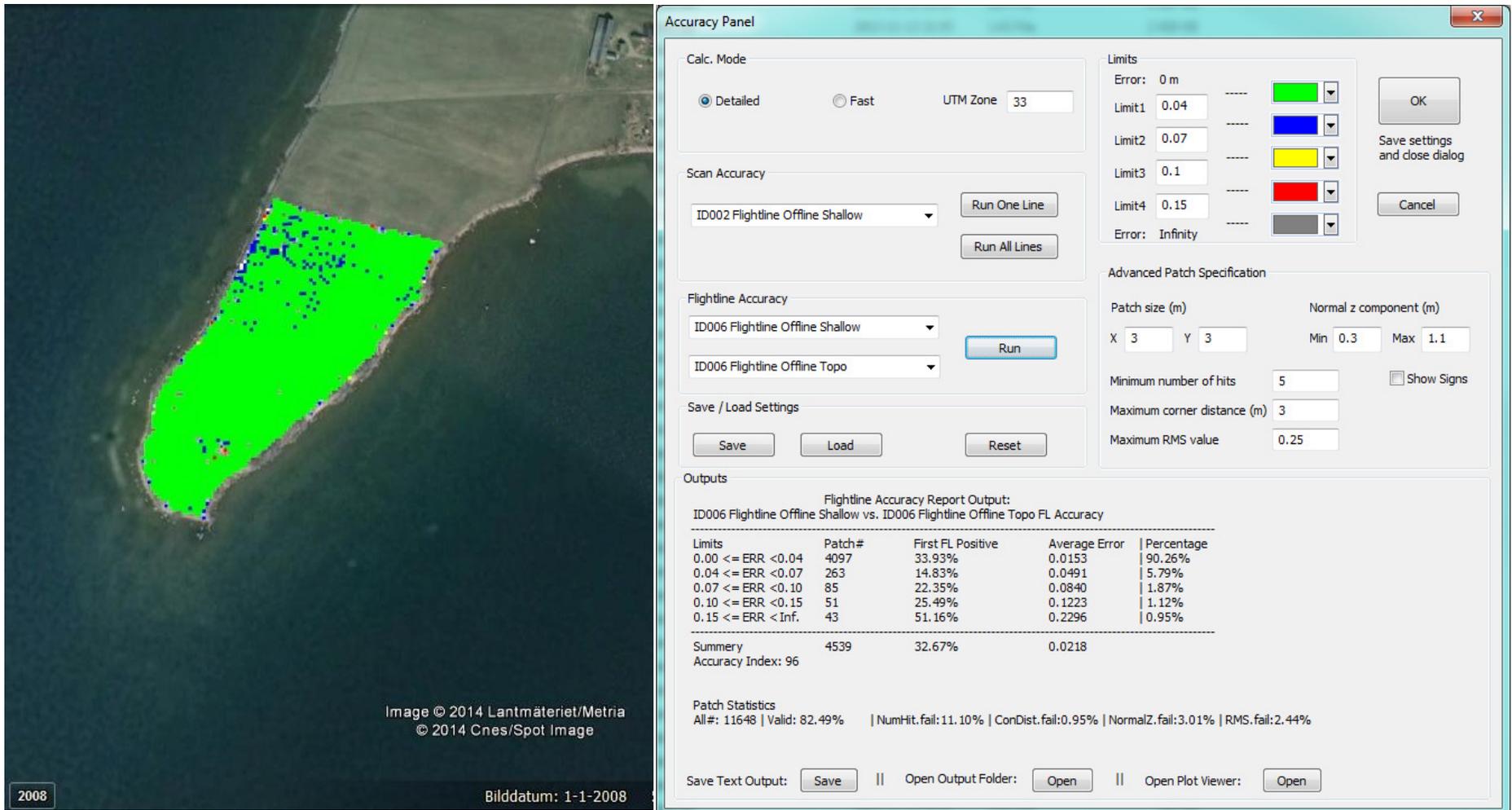


Control points on a light house



Control points measured on light house

Accuracy - Topo vs Shallow channel



Accuracy – Deep vs Shallow

Accuracy Panel

Calc. Mode: Detailed Fast UTM Zone: 33

Scan Accuracy: ID006 Flightline Offline Deep
 Run One Line
 Run All Lines

Flightline Accuracy: ID006 Flightline Offline Deep
 ID006 Flightline Offline Shallow
 Run

Save / Load Settings: Save Load Reset

Limits: Error: 0 m
 Limit1: 0.10
 Limit2: 0.15
 Limit3: 0.20
 Limit4: 0.25
 Error: Infinity

Advanced Patch Specification: Patch size (m) X: 6 Y: 6 Normal z component (m) Min: 0.3 Max: 1.1
 Minimum number of hits: 6 Show Signs
 Maximum corner distance (m): 3
 Maximum RMS value: 0.25

Outputs: Flightline Accuracy Report Output: ID006 Flightline Offline Deep vs. ID006 Flightline Offline Shallow FL Accuracy

Limits	Patch#	First FL Positive	Average Error	Percentage
0.00 <= ERR <0.10	2893	84.65%	0.0508	80.97%
0.10 <= ERR <0.15	536	99.25%	0.1192	15.00%
0.15 <= ERR <0.20	125	100.00%	0.1678	3.50%
0.20 <= ERR <0.25	19	100.00%	0.2153	0.53%
0.25 <= ERR <Inf.	0	0.00%	0.0000	0.00%
Summery	3573	87.46%	0.0661	
Accuracy Index:	95			

Patch Statistics: All#: 26790 | Valid: 32.89% | NumHit.fail:65.50% | ConDist.fail:1.61% | NormalZ.fail:0.00% | RMS.fail:0.00%

Save Text Output: Save || Open Output Folder: Open || Open Plot Viewer: Open

Poel, Baltic Sea

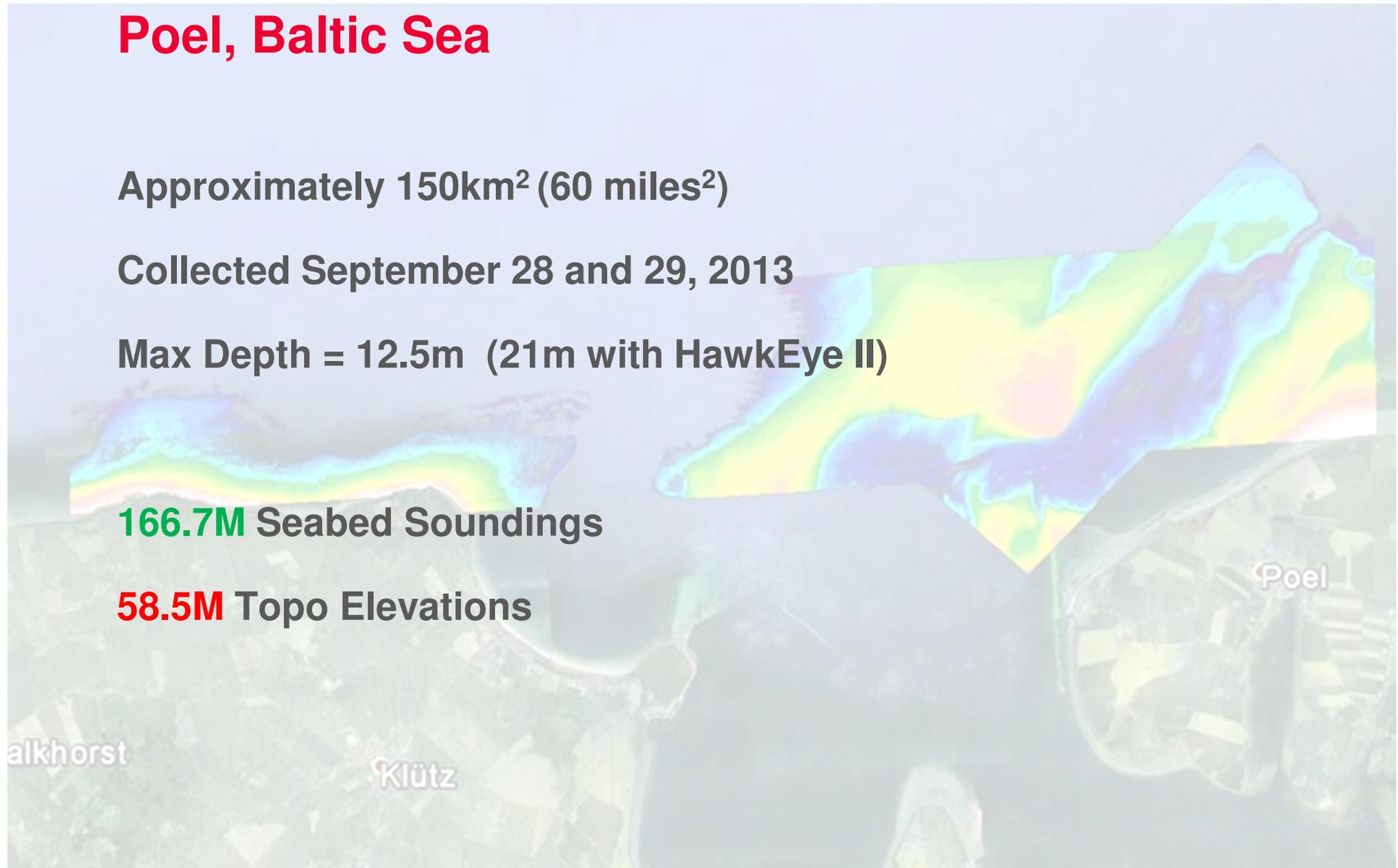
Approximately 150km² (60 miles²)

Collected September 28 and 29, 2013

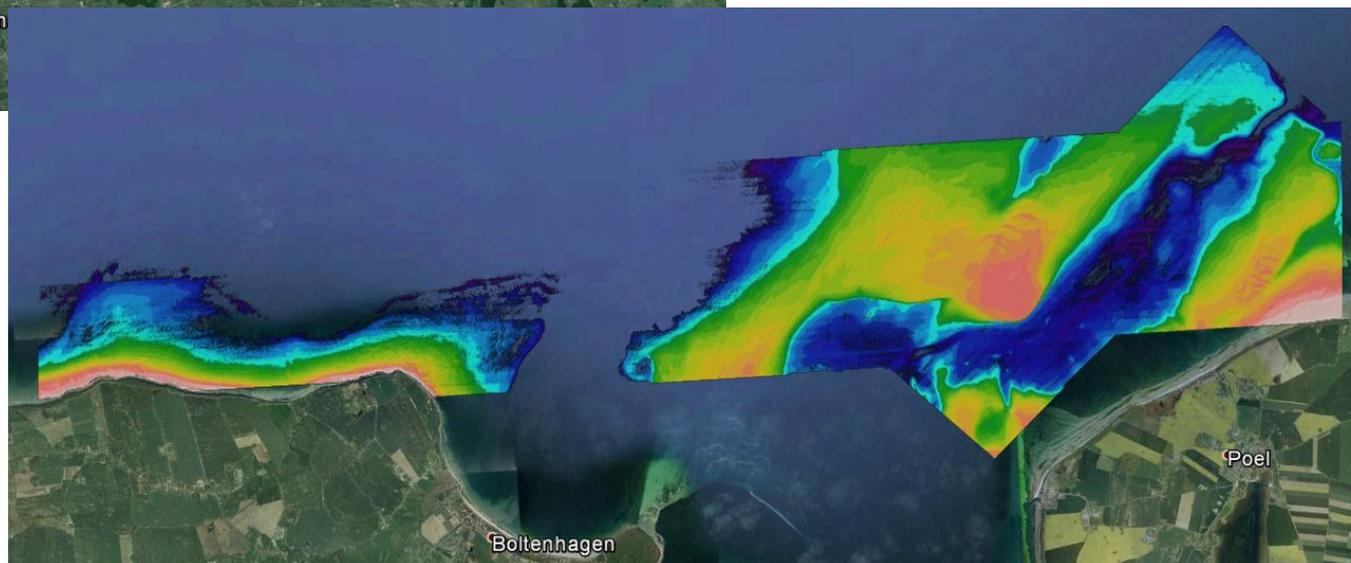
Max Depth = 12.5m (21m with HawkEye II)

166.7M Seabed Soundings

58.5M Topo Elevations



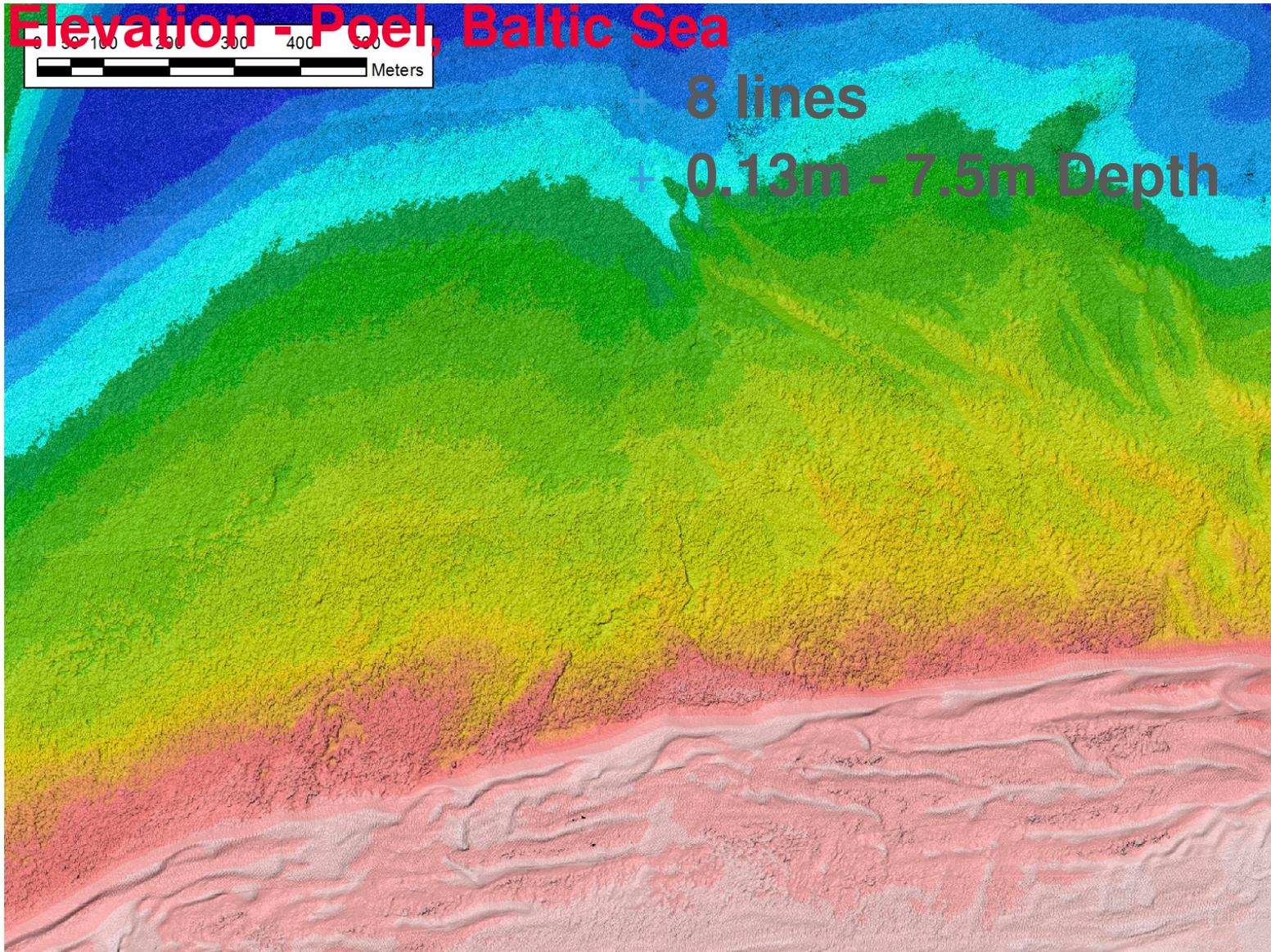
Poel, Baltic Sea



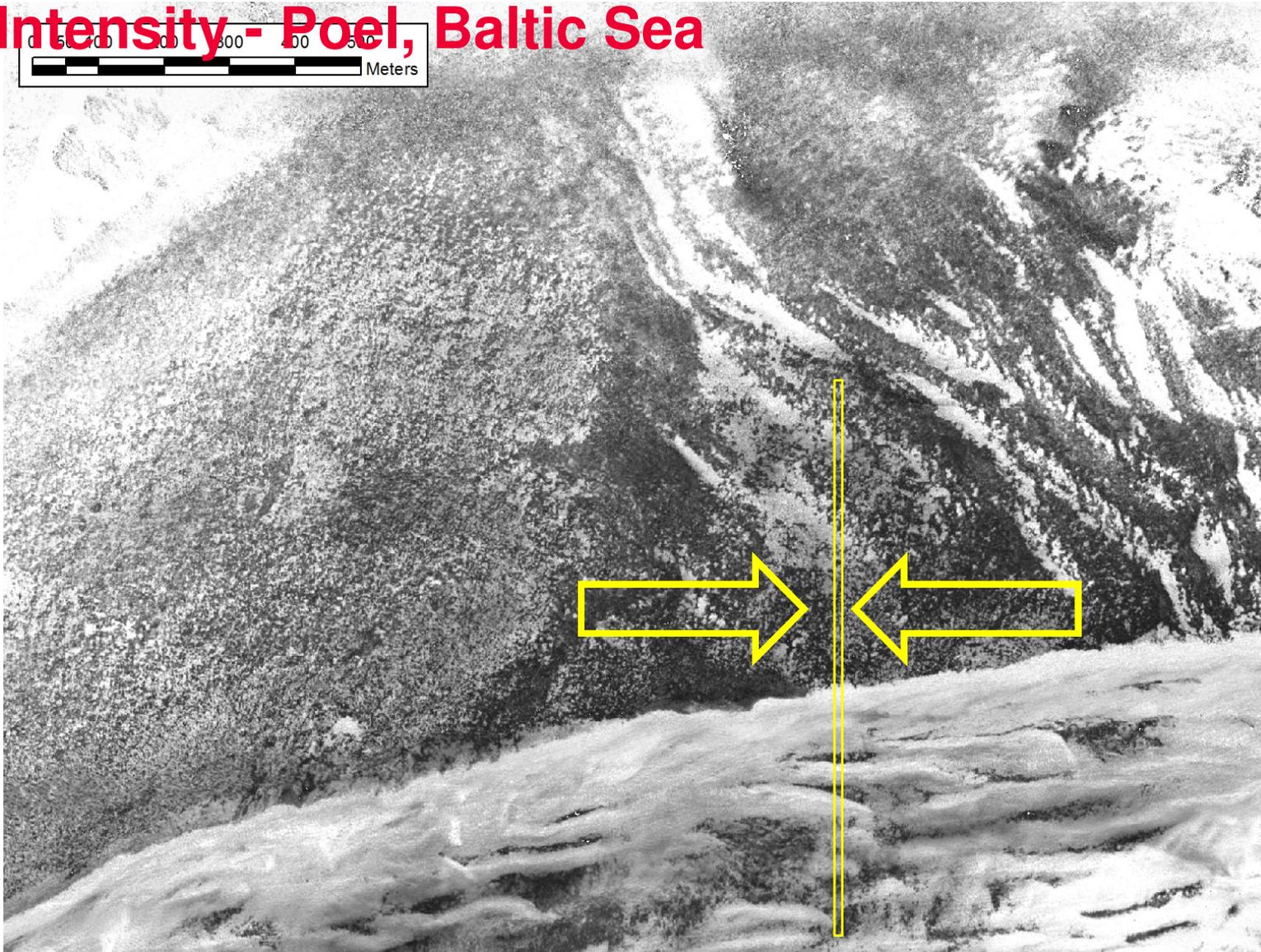
Elevation - Poel, Baltic Sea



+ 8 lines
+ 0.13m - 7.5m Depth



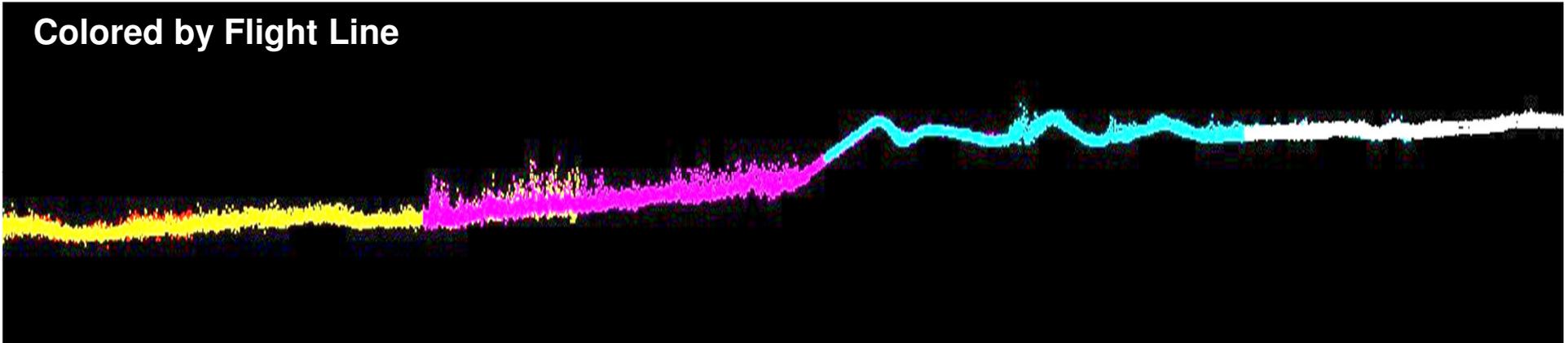
Intensity - Poel, Baltic Sea



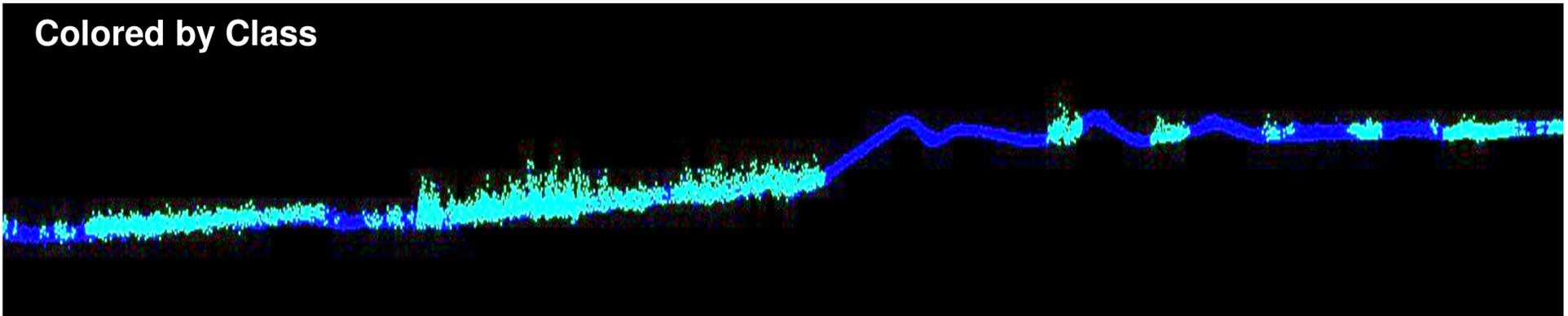
Cross Section - Poel, Baltic Sea

- + 20x Vertical Exaggeration
- + Sea grass is approximately 25cm high

Colored by Flight Line

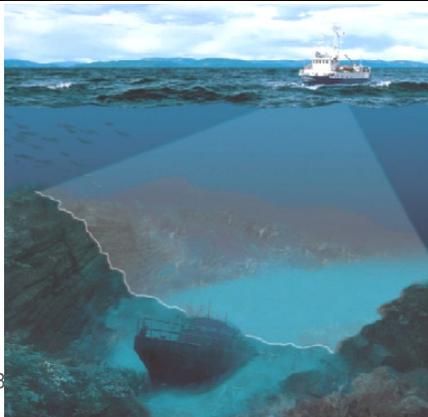


Colored by Class

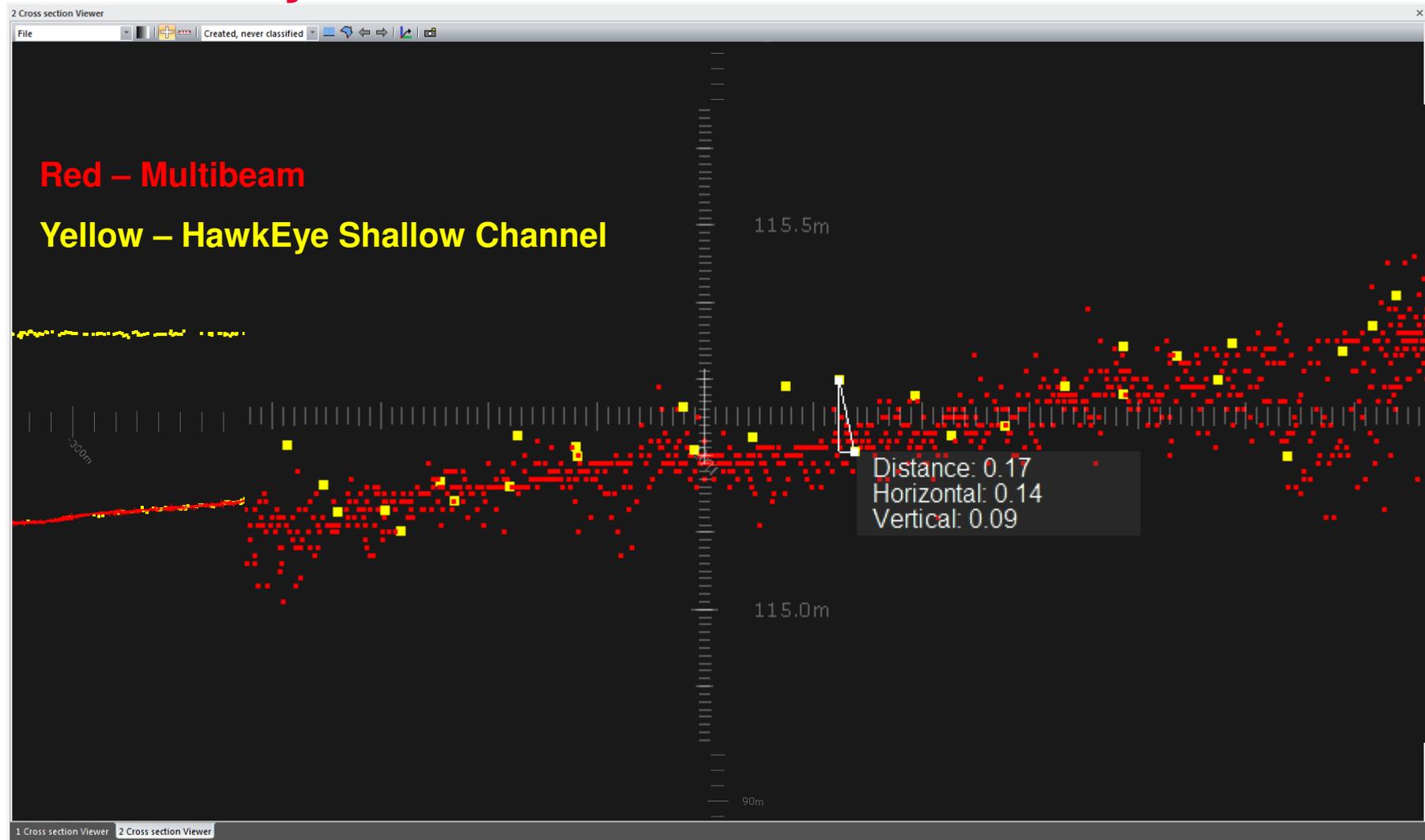


Multibeam reference data - Bathymetry

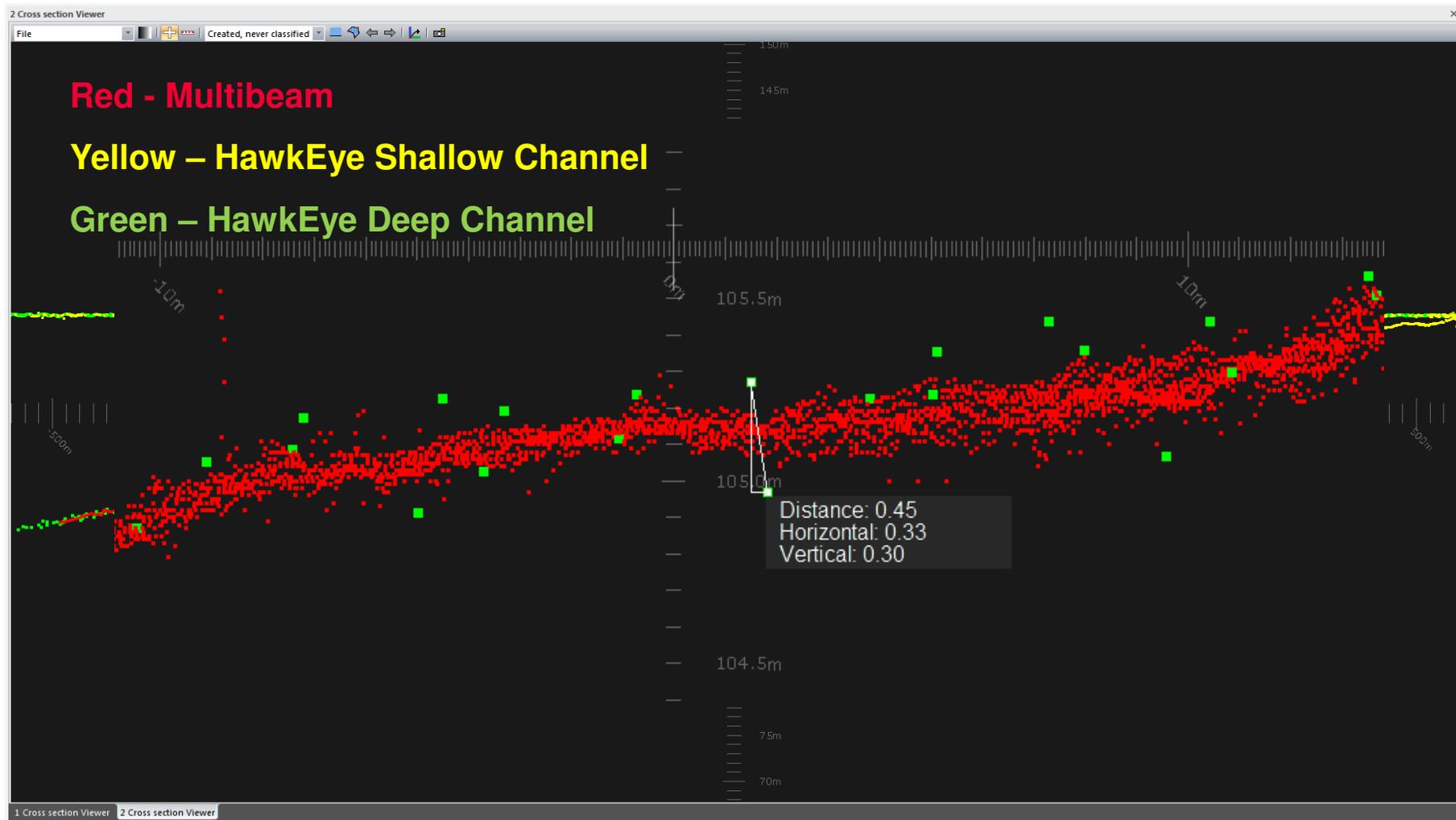
- **Multibeam reference dataset**
 - Simrad EM 3002 D, 300 KHz, 508 beams
 - Applanix POS MV positioning



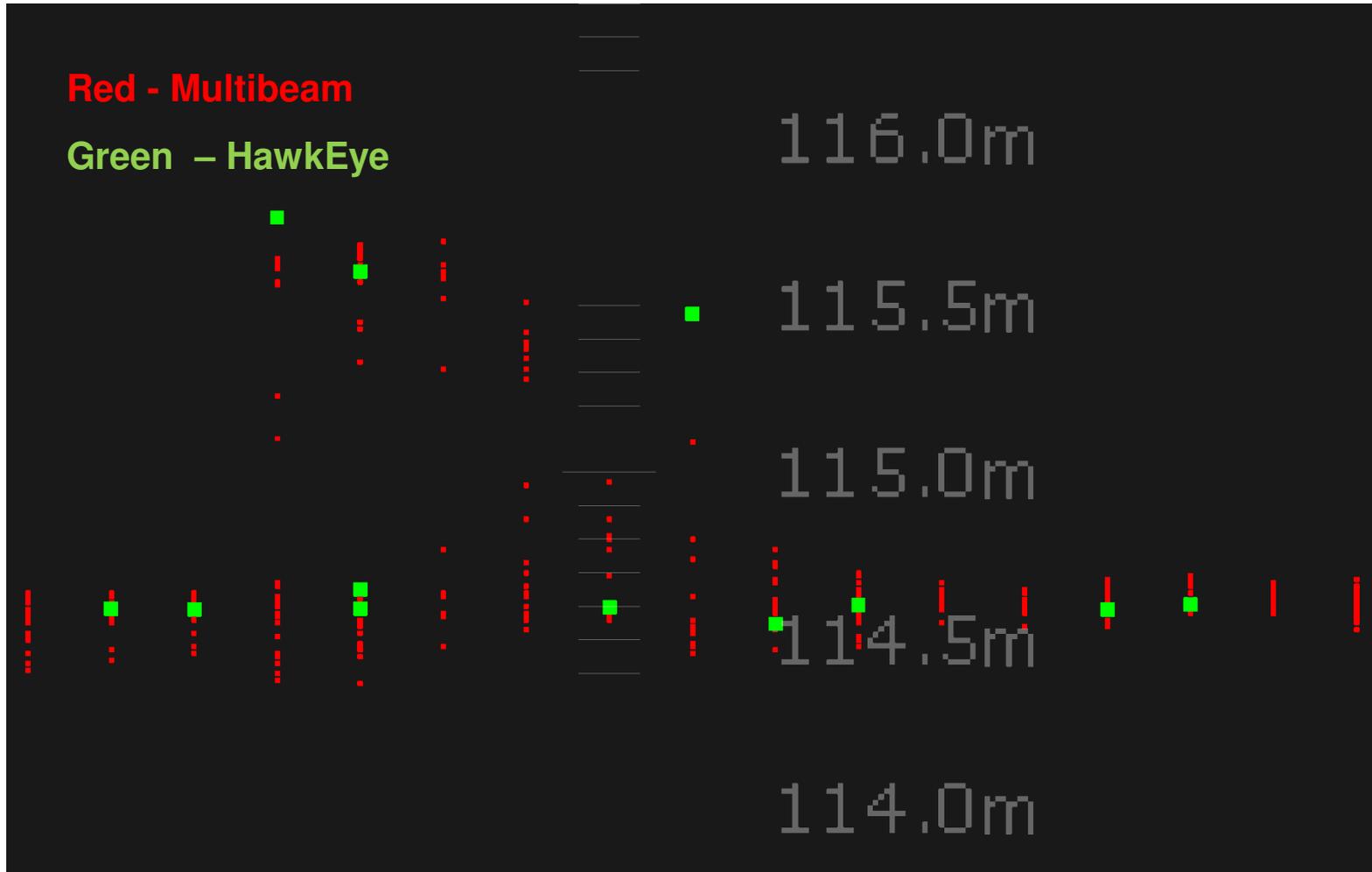
Accuracy – Shallow vs Multibeam reference



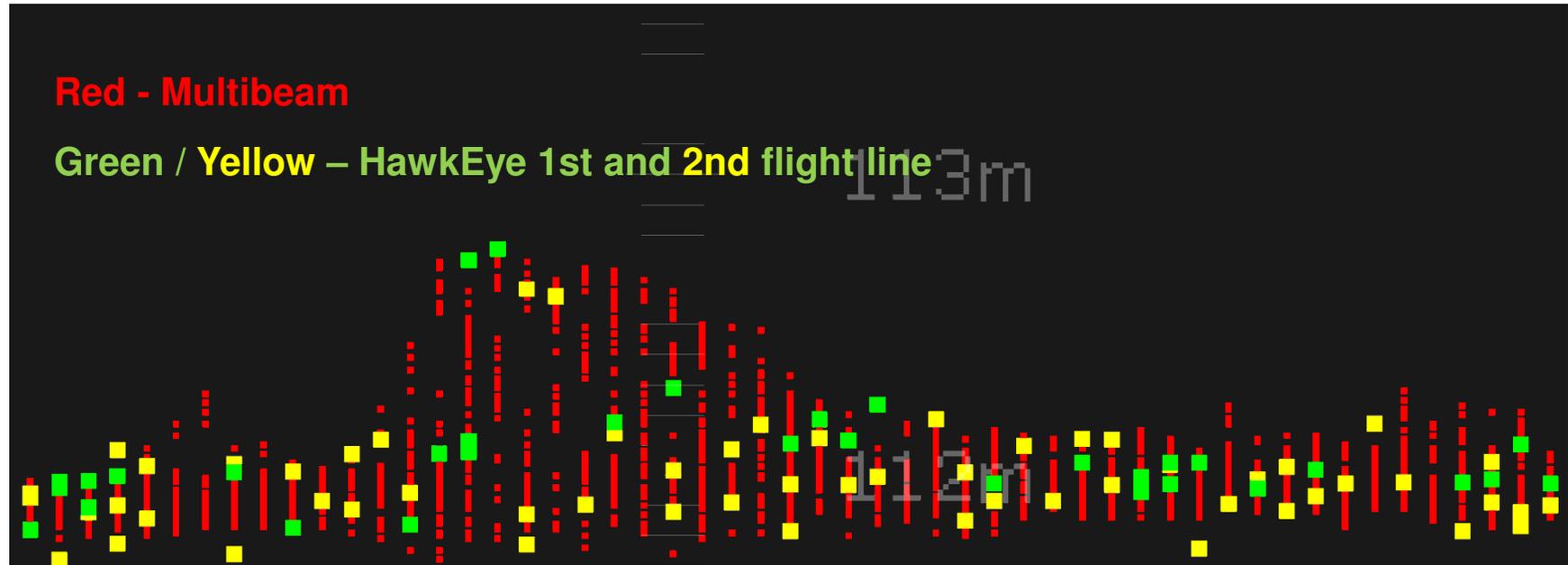
Accuracy – Deep vs Multibeam reference (Zoom)



Natural Boulder – 1 meter high 6 meters depth



Natural Boulder – 1 meter high 7 meters depth

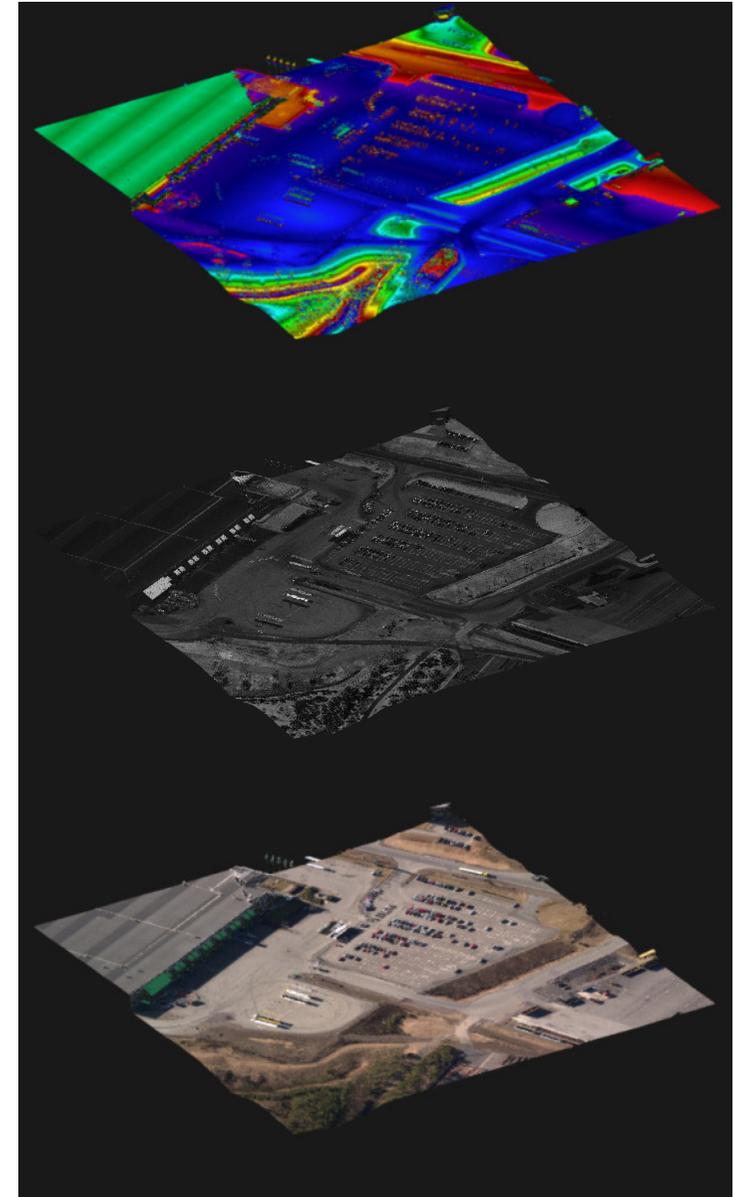


HawkEye capable of finding IHO Special order sized targets on shallow depths

HawkEye_{III}

- Summary

- **HawkEye III is a new deep penetrating bathy LIDAR**
 - Shallow channel: 1,5 x secchi
 - Deep channel: 3 x secchi
- **HawkEye III has similar topo and shallow channels as AHAB Chiroptera and DragonEye products.**
 - A deep channel has been added
- **HawkEye III utilizes AHAB LIDAR survey studio processing software**
 - Automatic classification bathy/topo
 - Automatic refraction
- **HawkEye III provides the highest accuracy**
 - IHO special order on shallow depths
 - IHO order 1 at deeper depths



Thanks!

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