Teledyne Geospatial

TELEDYNE OPTECH TELEDYNE CARIS, Inc.

Justin Hornby – Regional Sales Manager EMEA

Bathymetric LIDAR CZMIL

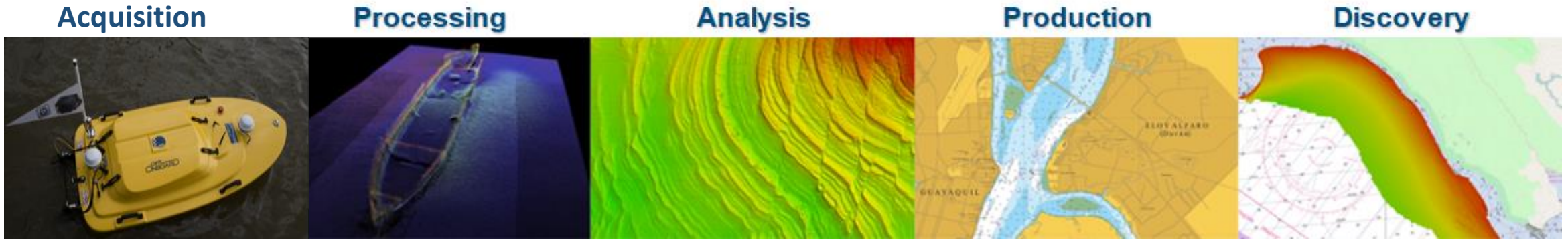
SAIHC18

About Teledyne CARIS

- Providing GIS solution for the marine community for 40 years
- **CARIS software is used in over 100 Countries**
  - 90% of IHO Member States use some CARIS Software
  - HPD/BDB used by over 35 Hydrographic Offices, smaller HO's use desktop tools (S-57 Composer / BASE Editor)
  - 3000+ HIPS and SIPS licenses globally
- **Approx. 120 employees in total between Canada, Netherlands, USA, Australia, China and the UK**
- Industry leading team of technical support professionals with industry experience and academic backing
- 15 official distributors globally
- ISO 9001 certified since 2006
- **Focused on the use of international / industry GIS standards and development of interoperable marine GIS solutions**
  - IHO S-57 and S-100, ISO/TC211, OGC, MSDIWG and others

Teledyne CARIS

- **CARIS** is the only organization able to **offer the marine community** a **complete** and streamlined GIS solution from **Ping-to-Chart**
  - Data processing through to chart production and subsequent distribution of the marine information and chart products
  - Seamless data transfer and interoperability for increased efficiencies
- **S-100 product readiness** (S-101, S-102, S-121, S-122, S-401 etc)

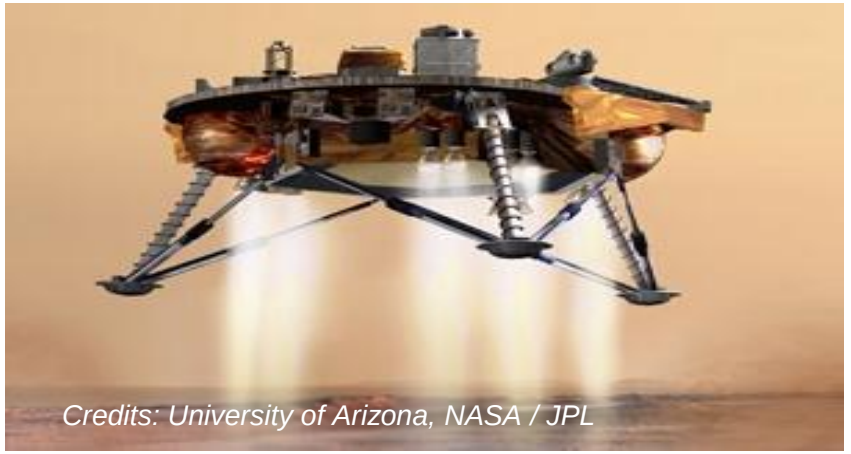


About Teledyne Optech

A world leader in **high-accuracy lidar survey systems**, integrated cameras, and productivity-enhancing workflows.

Solutions for:

- airborne topographic lidar
- **airborne bathymetry lidar**
- mobile mapping
- terrestrial laser scanning
- mine cavity monitoring
- space-proven sensors



Credits: University of Arizona, NASA / JPL

TELEDYNE OPTECH

TELEDYNE CARIS, Inc.

Lidar & Integrated Camera Systems

Multiple Platforms

- Airborne

- Mobile

- Terrestrial

Galaxy

POWERED BY PulseTRAK™ SwathTRAK™

CZMIL

Lynx HS

Compact Lidar

CMS

Polaris

What is LIDAR?

- **Lidar**, which stands for **Light Detection and Ranging**, is a remote sensing method that **uses light in the form of a pulsed laser to measure ranges** to the Earth. These light pulses—combined with other **data recorded by the airborne, mobile or static systems** — generate precise, three-dimensional information about the shape of the Earth (**both topo and seafloor**) and its surface characteristics.

- **A lidar sensor** principally consists of a **laser scanner, sensor, IMU and a specialized GPS receiver**. Airplanes and helicopters are commonly used platforms for acquiring lidar data over broad areas. **Two types** of lidar are **topographic and bathymetric**. Topographic lidar typically uses a **near-infrared laser** to map the land, while bathymetric lidar uses water-penetrating **green laser** to also measure seafloor and riverbed elevations

Why Bathymetric LIDAR?

- **Effective and cost-efficient** manner of acquiring both topography and bathymetry **simultaneously** along a coastline. (detailed 3D models/point clouds)
- Highly effective in **remote or challenging coastal areas.**
- Surveying of **coastal intertidal** areas. (beach and surf zones)
- Generating **multiple products** from one sensor (including elevation and environmental)
- CZMIL is a flagship sensor, not all HO's have the **budget** for these. We do however have customers who specialize in these applications/surveys.

CZMIL SuperNova

Coastal Zone Mapping & Imaging Lidar

Next Generation Topo-Bathy Lidar

CZMIL SuperNova

High-power green laser

- Direct beam green laser 532 nm
- Max depths ~70 meters – water clarity and bottom reflectivity dependent
- 9 Channels (7 shallow, 1 deep and 1 topo)
- Flagship top of the range sensor

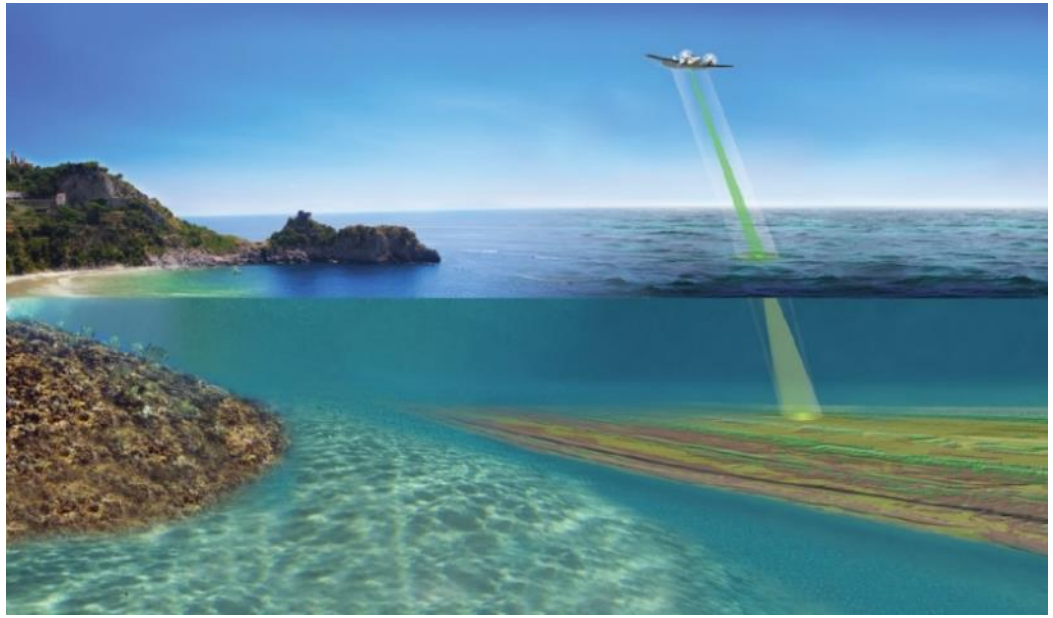
Adjustable Laser PRF

- 10 kHz
- 20 kHz
- 30 kHz

Bathymetric Performance Coefficient
K_d. D max

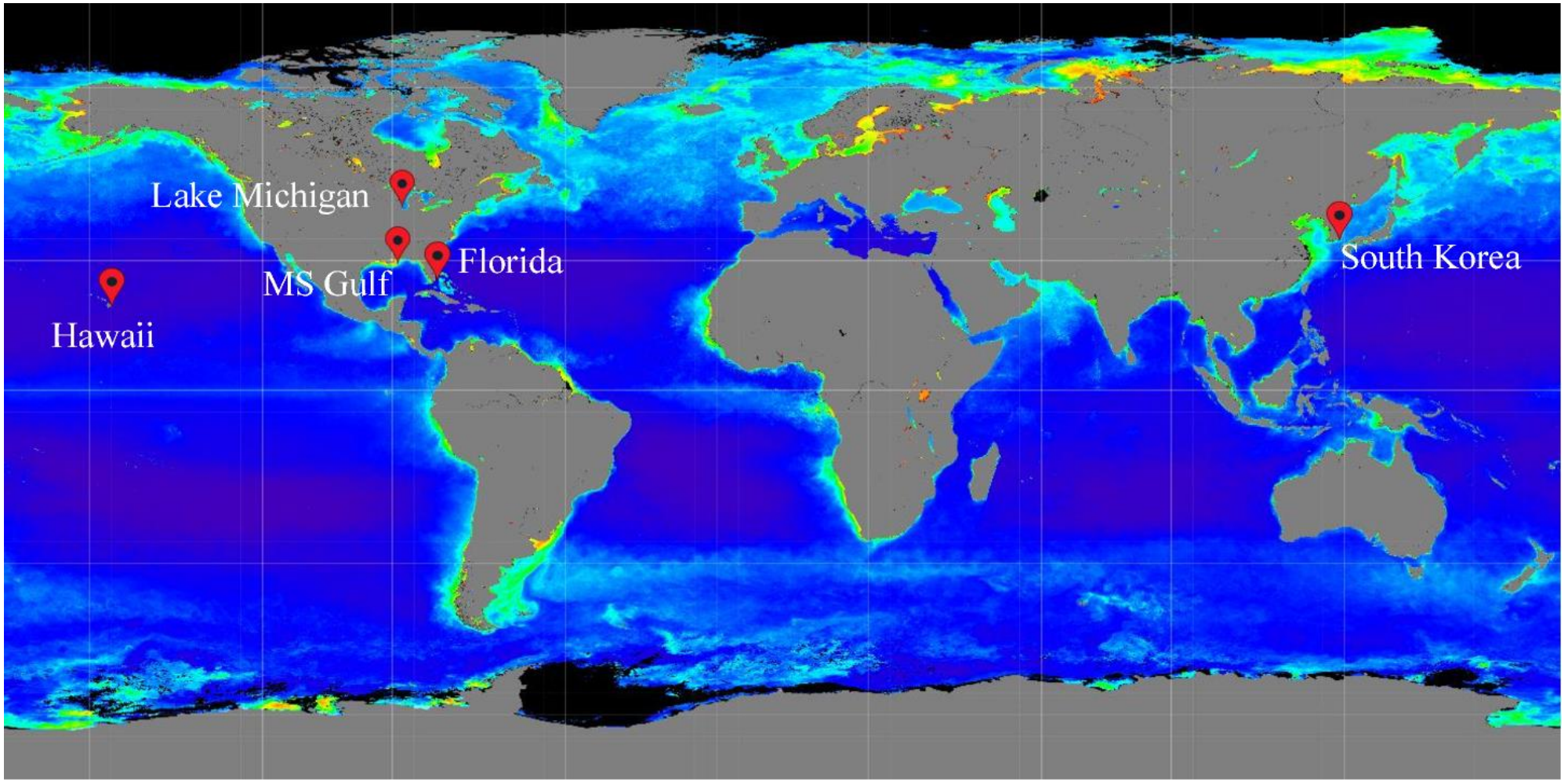
K_d is the diffuse attenuation coefficient (measure of water column optical properties)

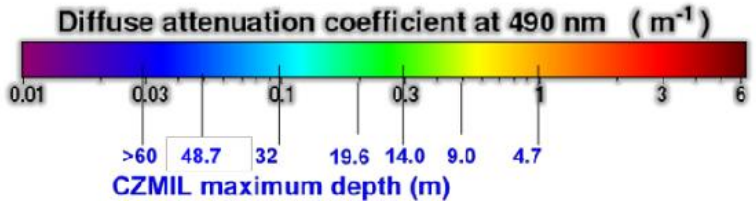
D max is the maximum detectable depth



Highest bathymetric depth performance

- Deep channel: 4.4/ K_d
- Shallow channels = 3.0/ K_d





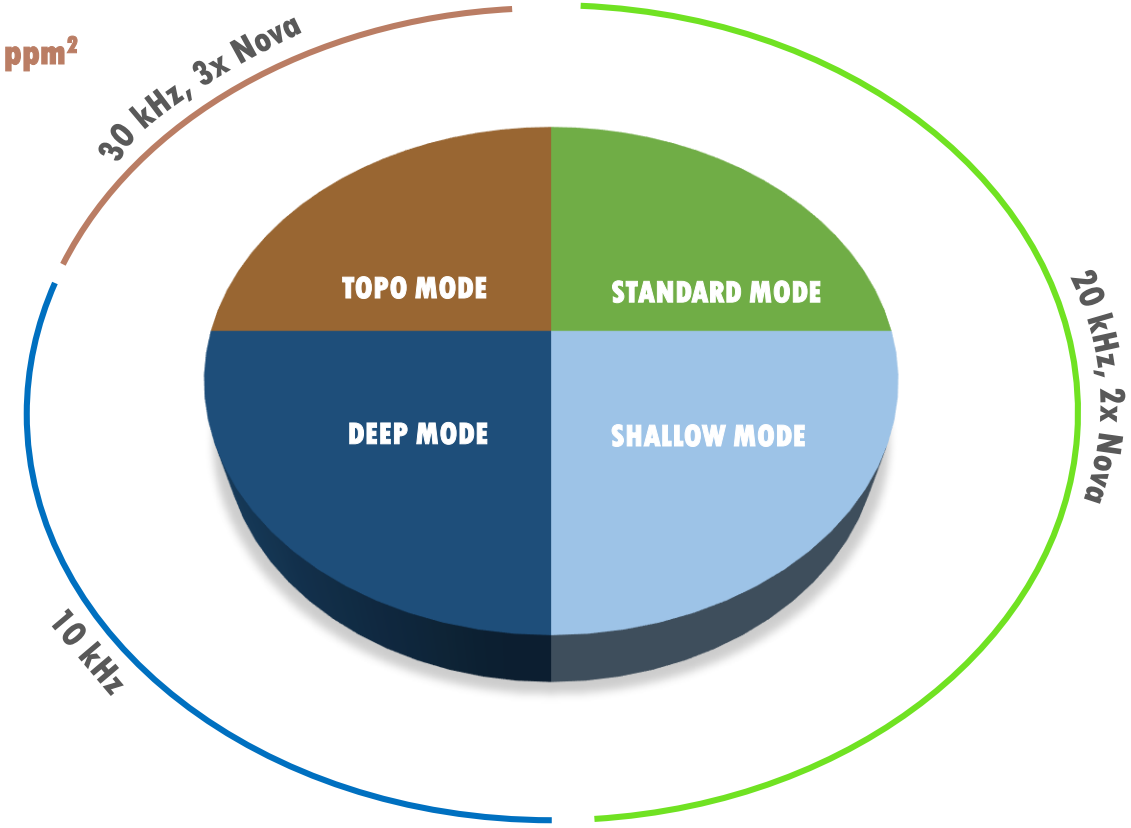
Example 20 kHz:
3.0/0.1 DAC= 30m

Sensor Modalities

TO SUIT DIFFERENT USER APPLICATIONS

Field programmable

Average point density > 12 ppm²



$K_d \cdot D_{max}$

Shallow	Deep
2.4	4.3

$K_d \cdot D_{max}$

Shallow	Deep
-	4.4

$K_d \cdot D_{max}$

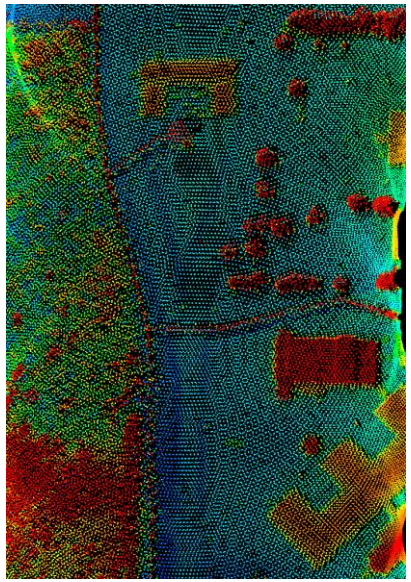
Shallow	Deep
3.0	0 – 4.0

400m AGL, 60 m/sec, 20 kHz; bottom reflectivity ≥ 15%

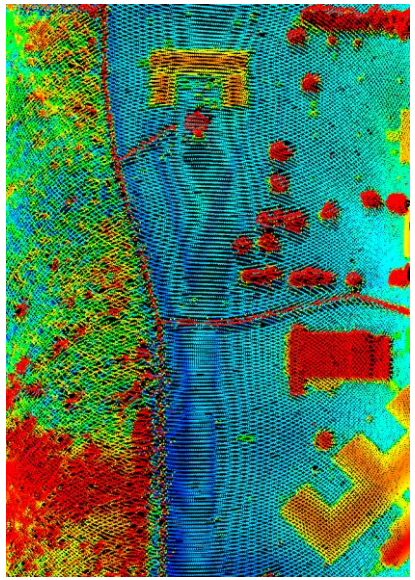
*Preliminary estimations

Up to 3× CZMIL Nova Point Density

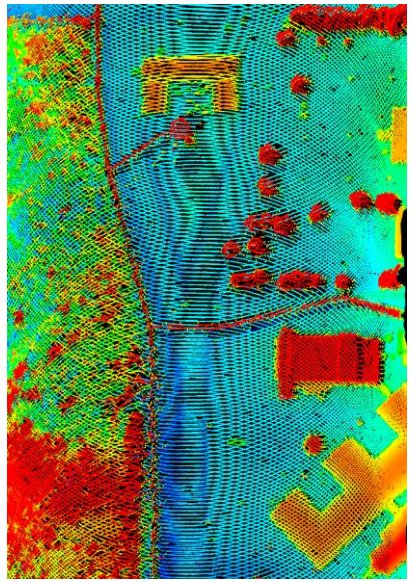
NOVA



2X NOVA



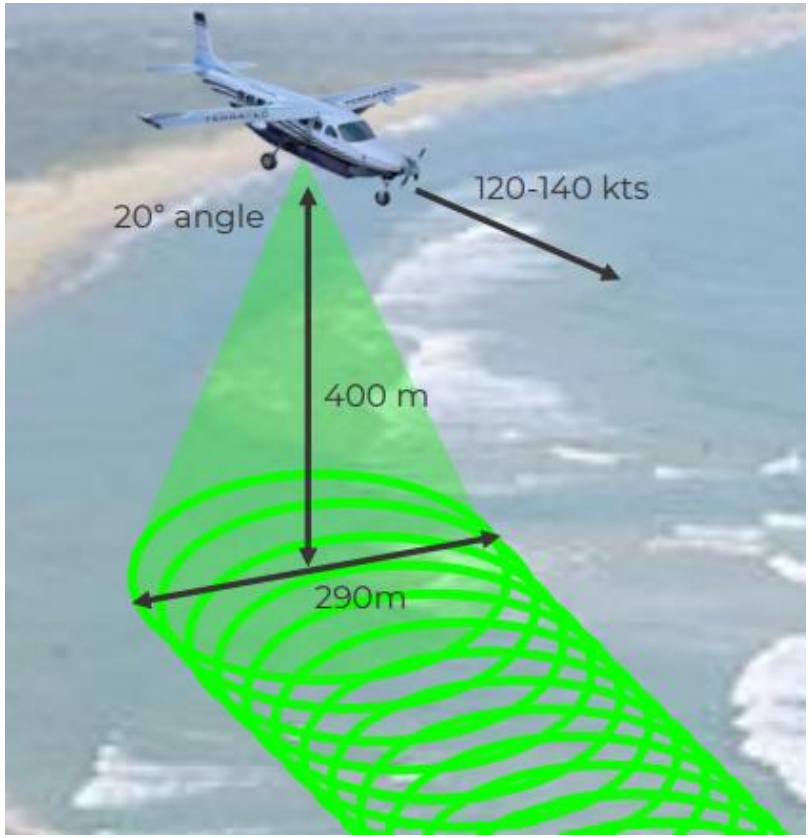
3X NOVA



Deep water point density (ppm²)	>1
Shallow water point density (ppm²)	> 8
Topographic point density (ppm²)	>12

AGL: 400m, Aircraft speed: 60 m/sec

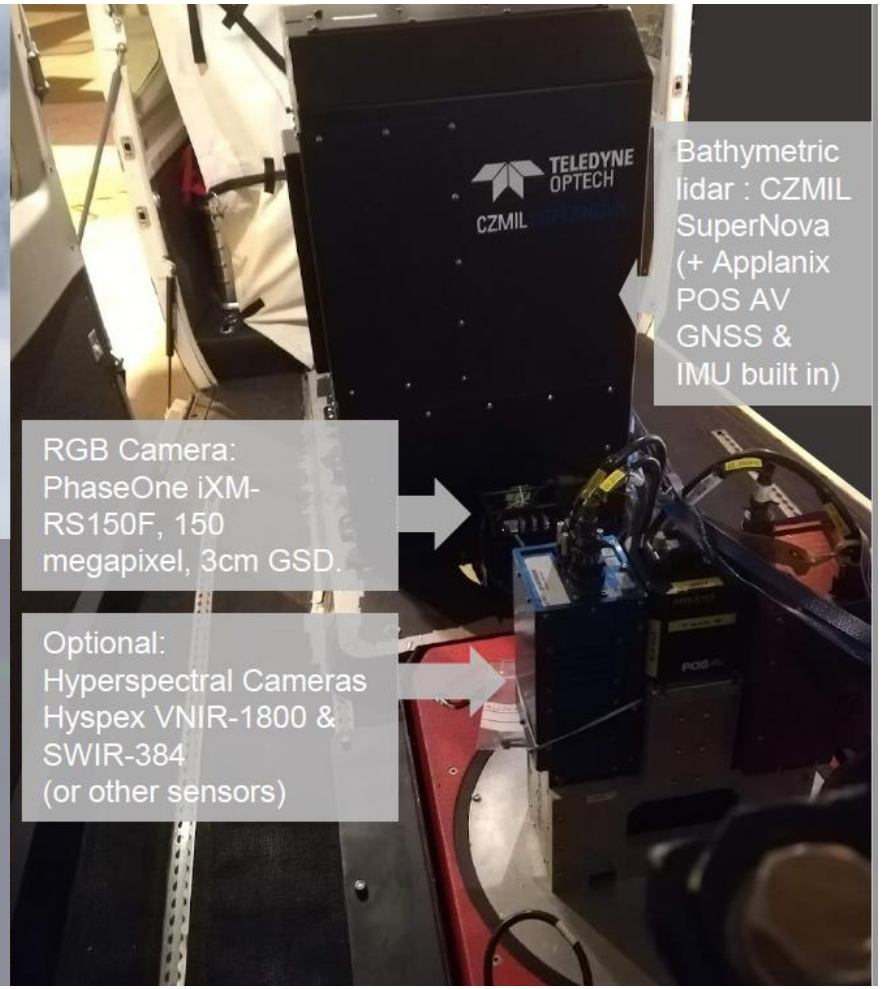
CZMIL sensor



CZMIL SuperNova Specifications

General Specifications	Operating altitude	400 m -600 m AGL
	Aircraft speed	120 - 140 kts
	Digital cameras	Phase One iXM-RS150F
	Positioning & GPS/GNSS	Applanix POS AV™ 610 with PPRTX subscription
Lidar Hydrographic Mode	Shallow channels measurement rate	Up to 210,000 Hz
	Shallow channels maximum depth	3.0/K_d (bottom reflectivity >15%)
	Deep channel measurement rate	Up to 30,000 Hz
	Deep channel maximum depth	4.4/K_d (bottom reflectivity >15%)
	Depth measurement accuracy	$\sqrt{(0.3^2+(0.013d)^2)}$ m, 2σ
	Horizontal accuracy	(3.5 + 0.05d) m, 2σ
	Scan angle	20° circular
	Swath width	70% of operating altitude
	Laser classification	Class 4 laser product: IEC 60825-1 Ed. 3.0 2014
Lidar Topographic Mode	Measurement rate	Up to 240,000 Hz
	Horizontal accuracy	±1 m, 2σ
	Vertical accuracy	±15 cm, 2σ
Physical	Power requirements	85 A for Lidar/camera @ 28 VDC
	Operating temperature	0°C to 40°C
	Storage temperature	-10°C to +60°C
	Humidity	0-95% non-condensing
	Sensor head	89 W x 60 D x 90 H cm; 175 kg
	Control & operations rack	59 W x 56.5 D x 106 H cm; 112 kg

CZMIL configurations and operations



BASE EDITOR

Data Analysis and management tools for the future

» Work with GIS datasets alongside high-resolution point clouds and rasters

» Visualize, QC, classify and understand your data

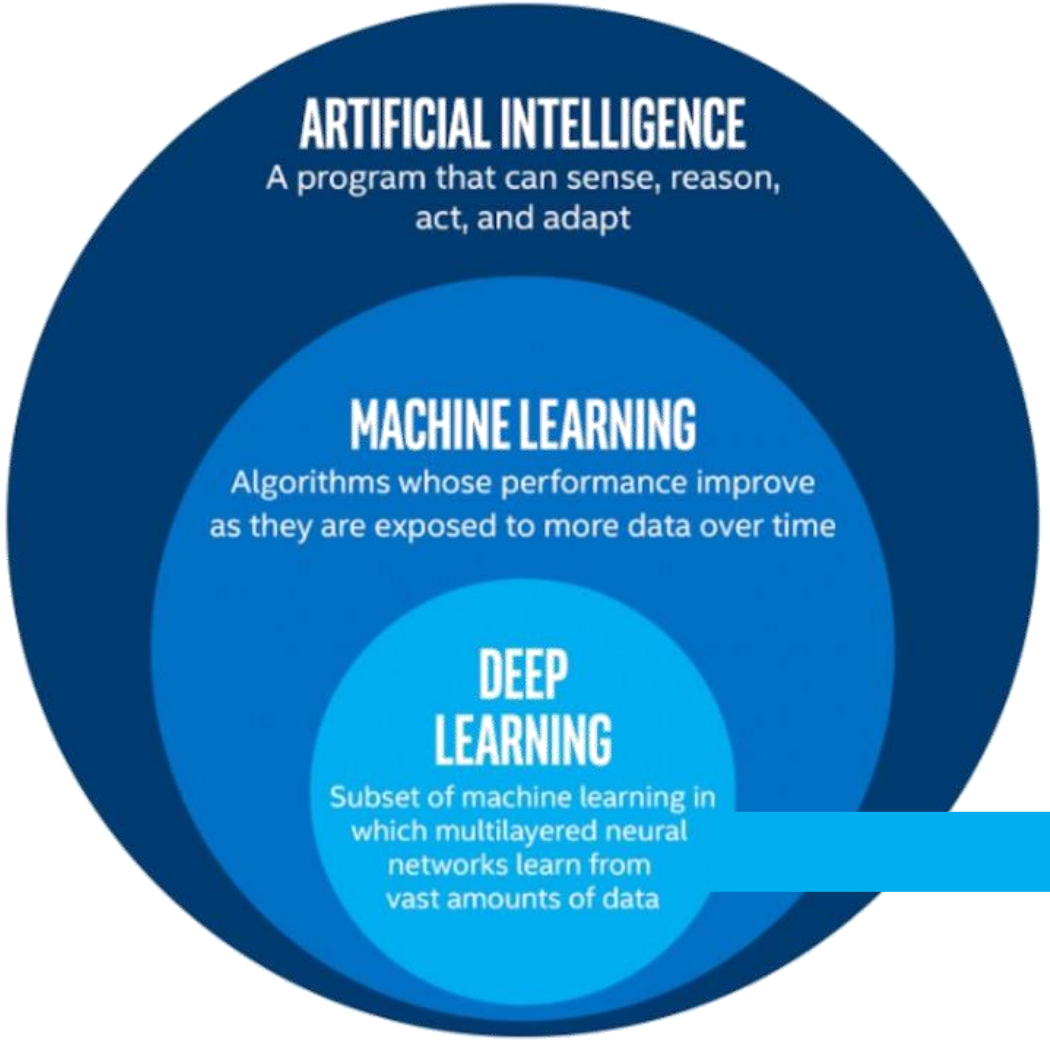
» Manipulate and model data into cohesive and continuous coverages

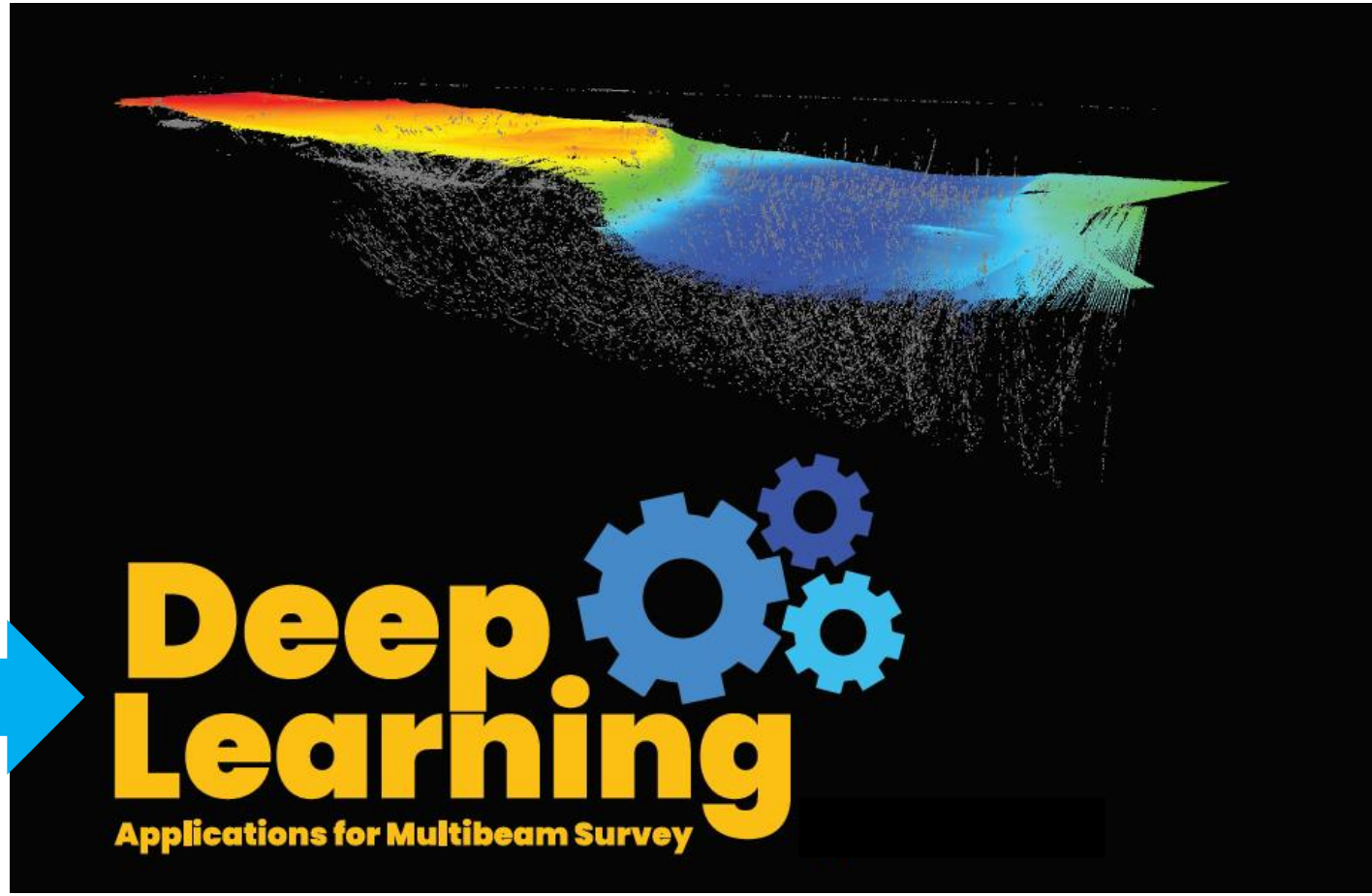
» Compile bathymetry and features for products

» Calculate volumes and profiles to monitor changes in the environment

» Manage surveys and features in a relational database

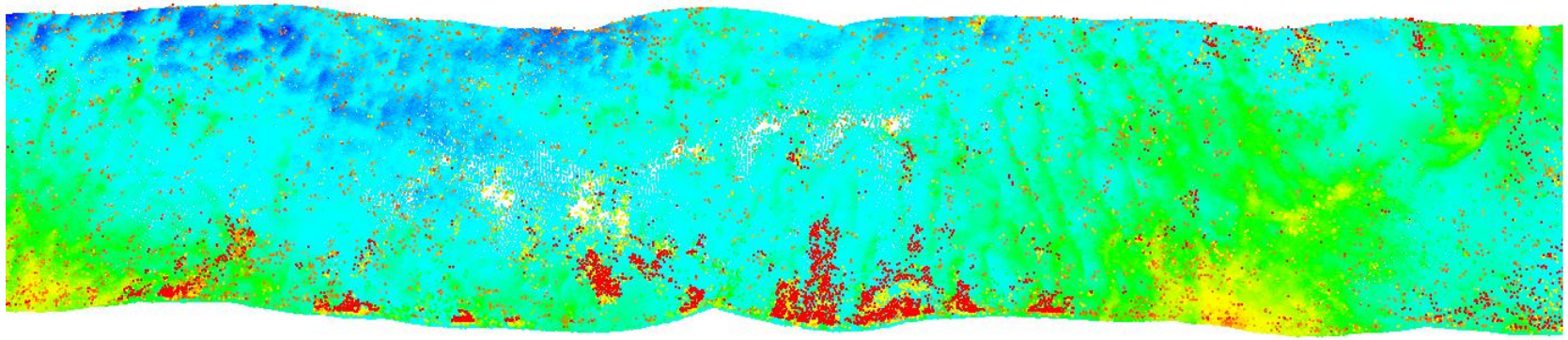
The next step in processing survey data: using Artificial Intelligence





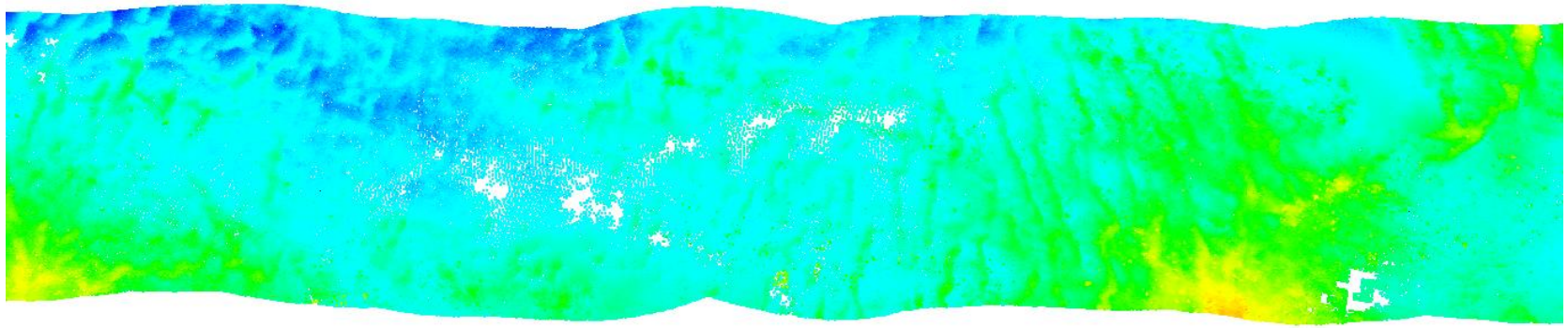
AI Driven NOISE removal

BEFORE FILTERING



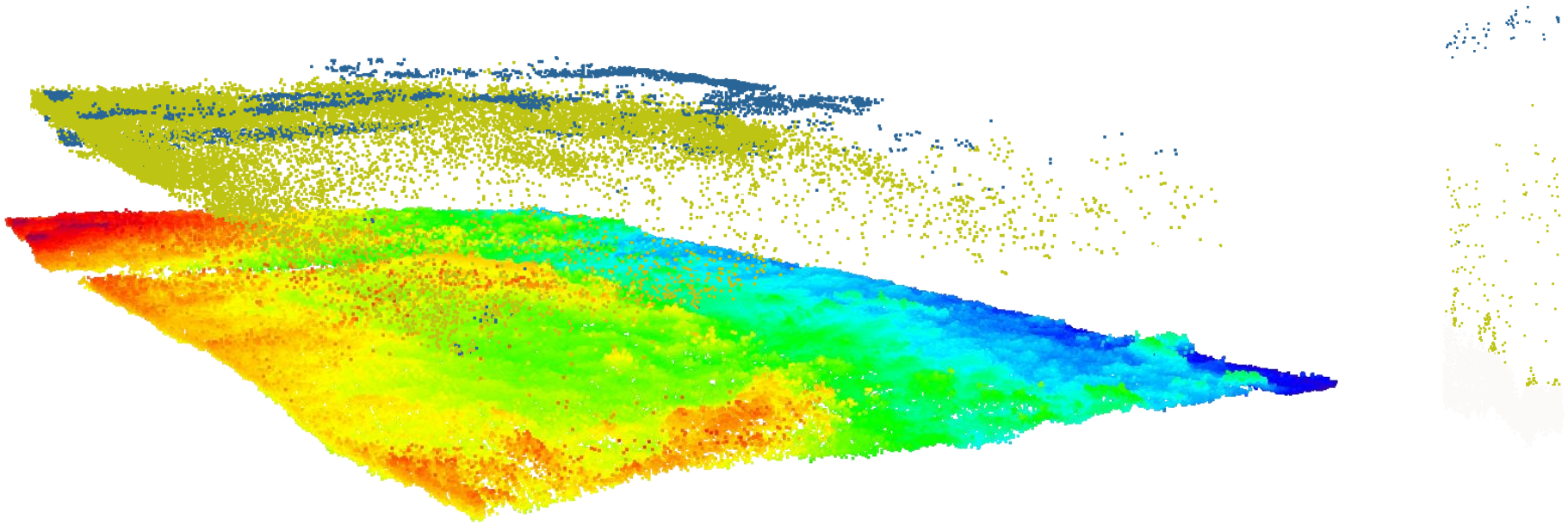
"Noise" points in the water column

AFTER FILTERING



Deep Learning automates the point cloud manual editing tasks

AI for Lidar - Noise Removal (Terrestrial & Bathymetric)



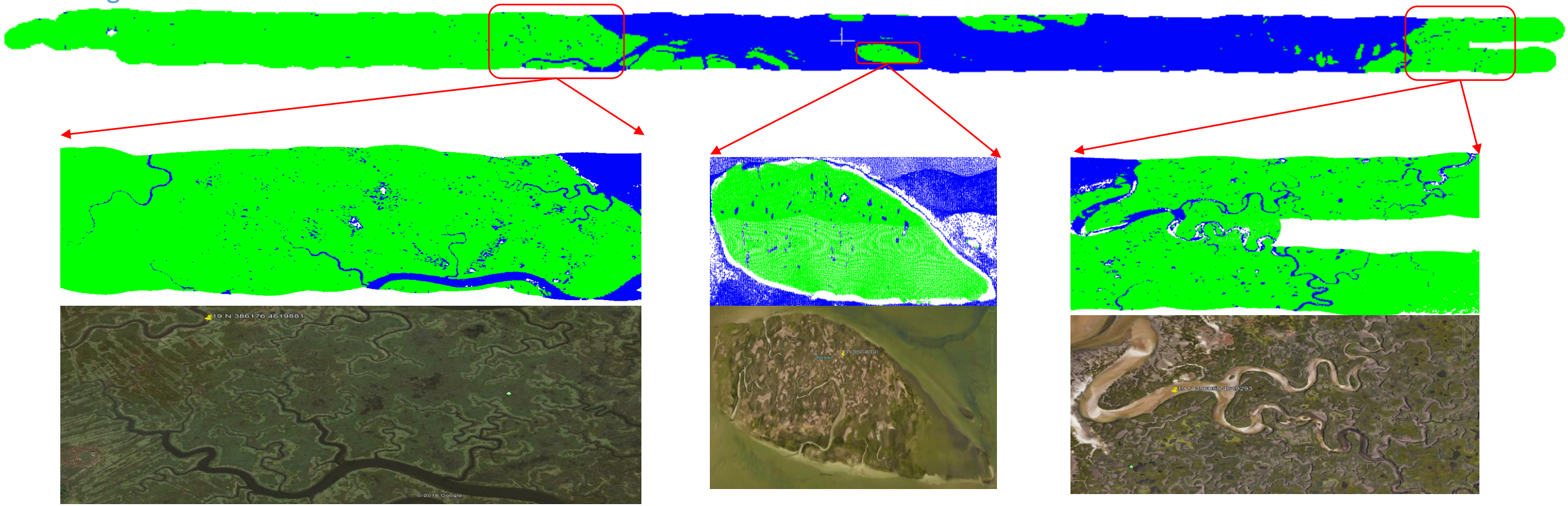
Water surface

WC Noise

AI for Lidar – Land/Water classification

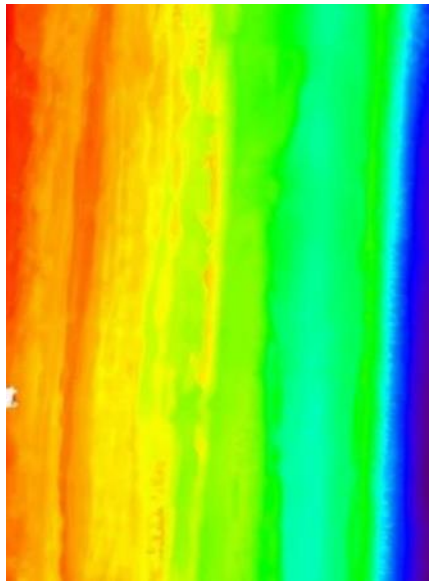
Coastal environment

AI algorithm



Typical Bathy LIDAR products:

TOPO-BATHY DEM



WATER TURBIDITY MAPS

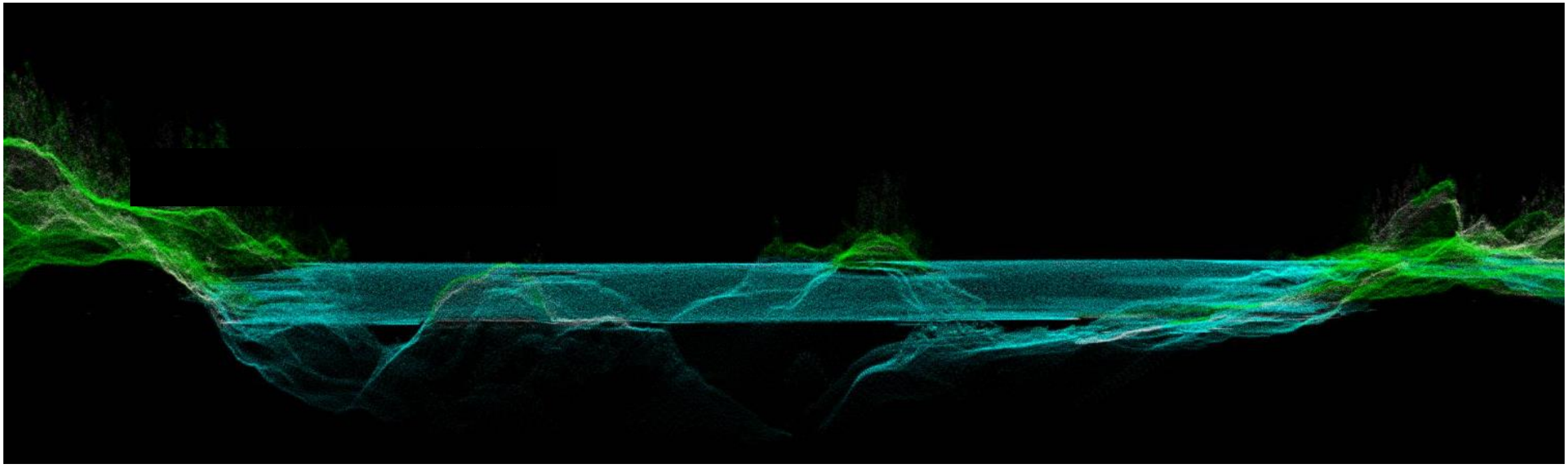
SEAFLOOR REFLECTANCE

RGB IMAGE FRAMES

SHORELINE VECTOR

Key product deliverables:

- Combined Topo/Bathy elevation charts
- Vertical accuracy at cm-level
- Seafloor reflectance images
- Sufficient point density and accuracy to meet stringent IHO and national specifications (Order 1A)
- Water quality information
- Vegetation maps
- Fusion with other sensors **(RGB, hyperspectral, thermal)**



Thank you for your attention.