

German laser bathymetry project: results and experiences

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Outline

- Project
- Results
 - Coverage Sea Bed
 - Point Densities
 - Accuracy
 - Obstacles
 - Full Waveform Analysis
- Conclusions & Outlook



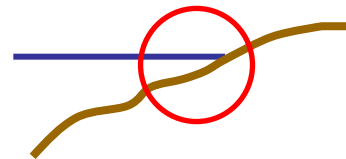
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Project

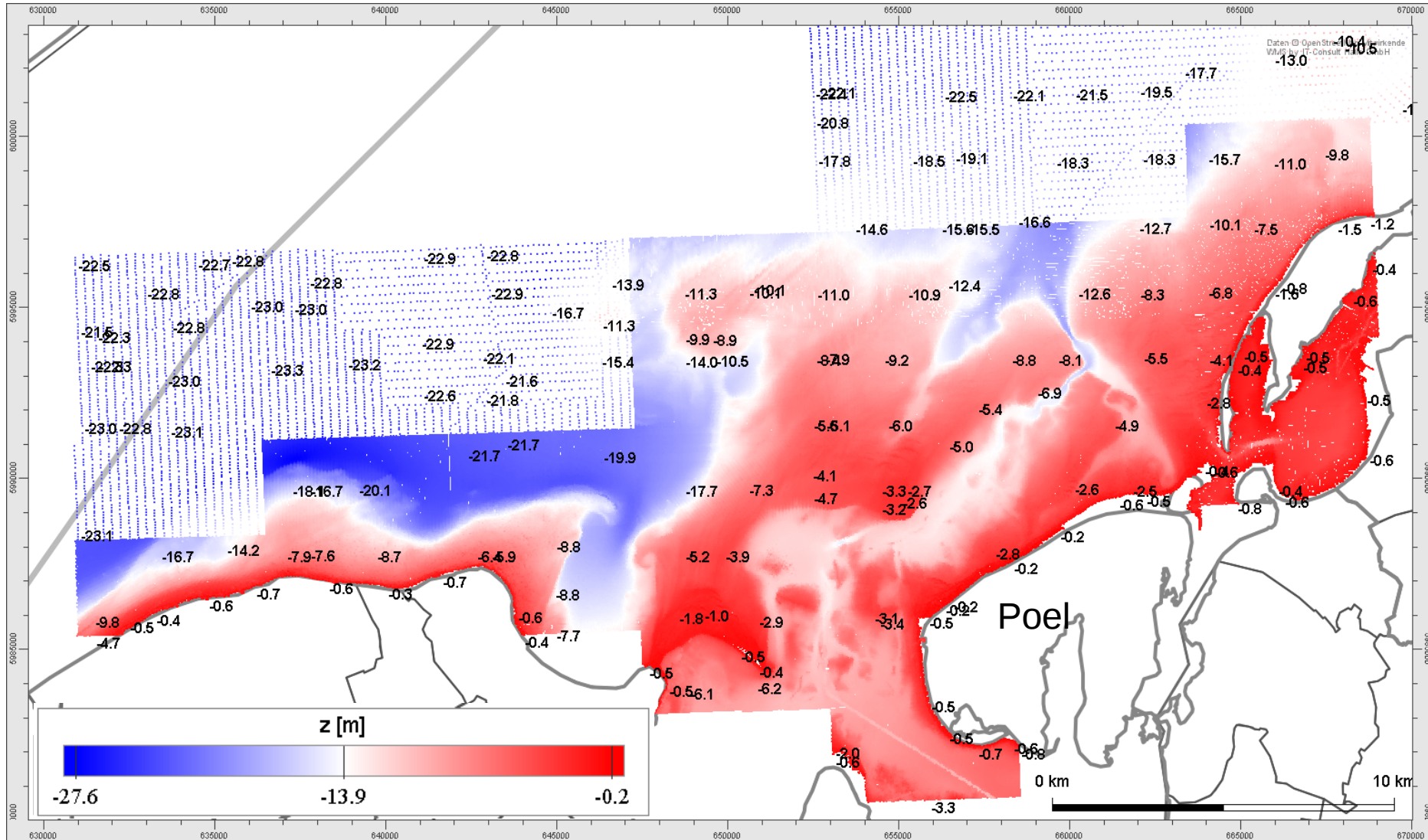
- Basic concepts
 - Conduct three independent annual flight campaigns
 - We want to determine limitations of technique
- BSH and IPI both validate geometric accuracy
- IPI will investigate full waveform data
- Special interests
 - Detection of small obstacles
 - Shallow areas and transition zone to shore



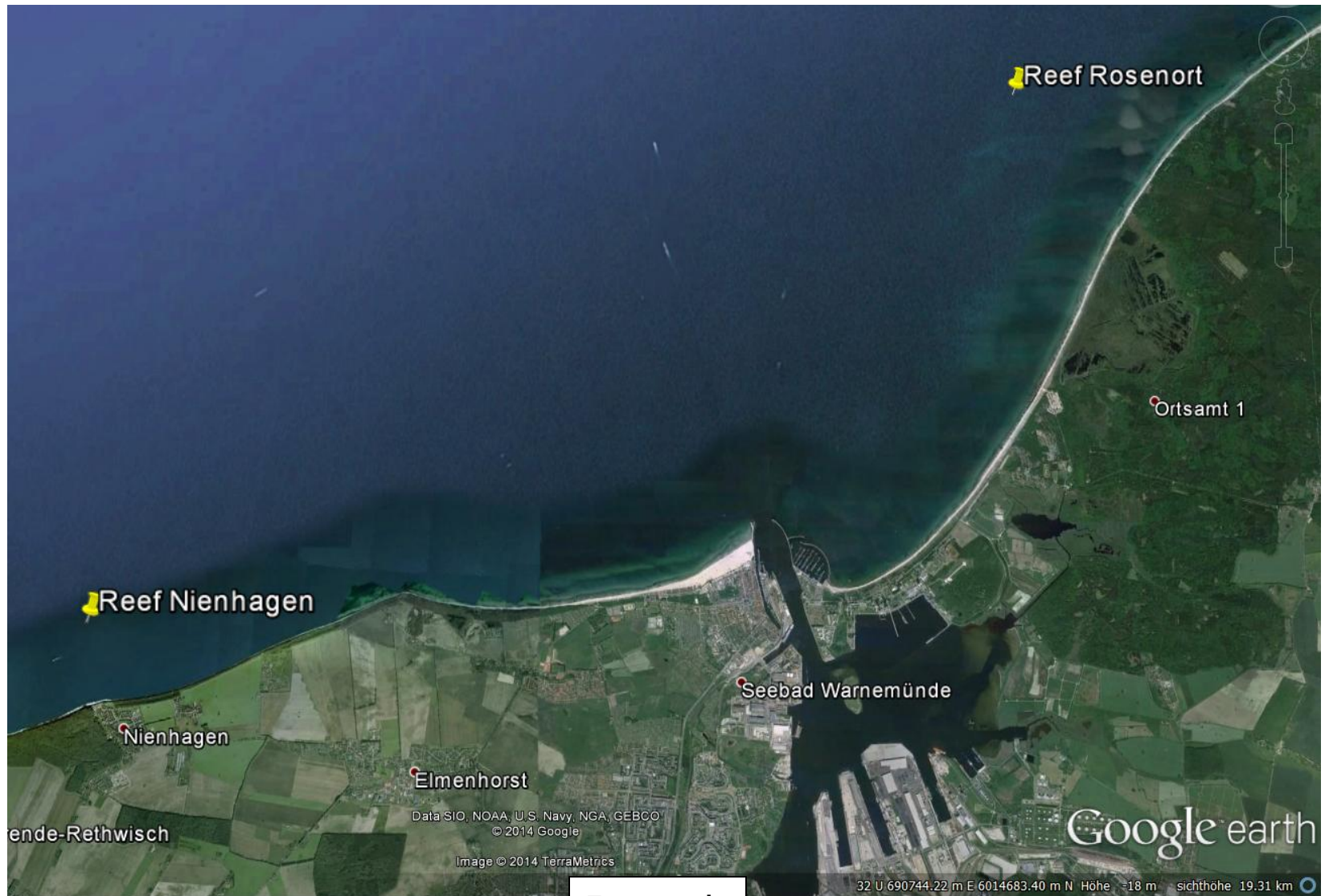
Test Site: Poel



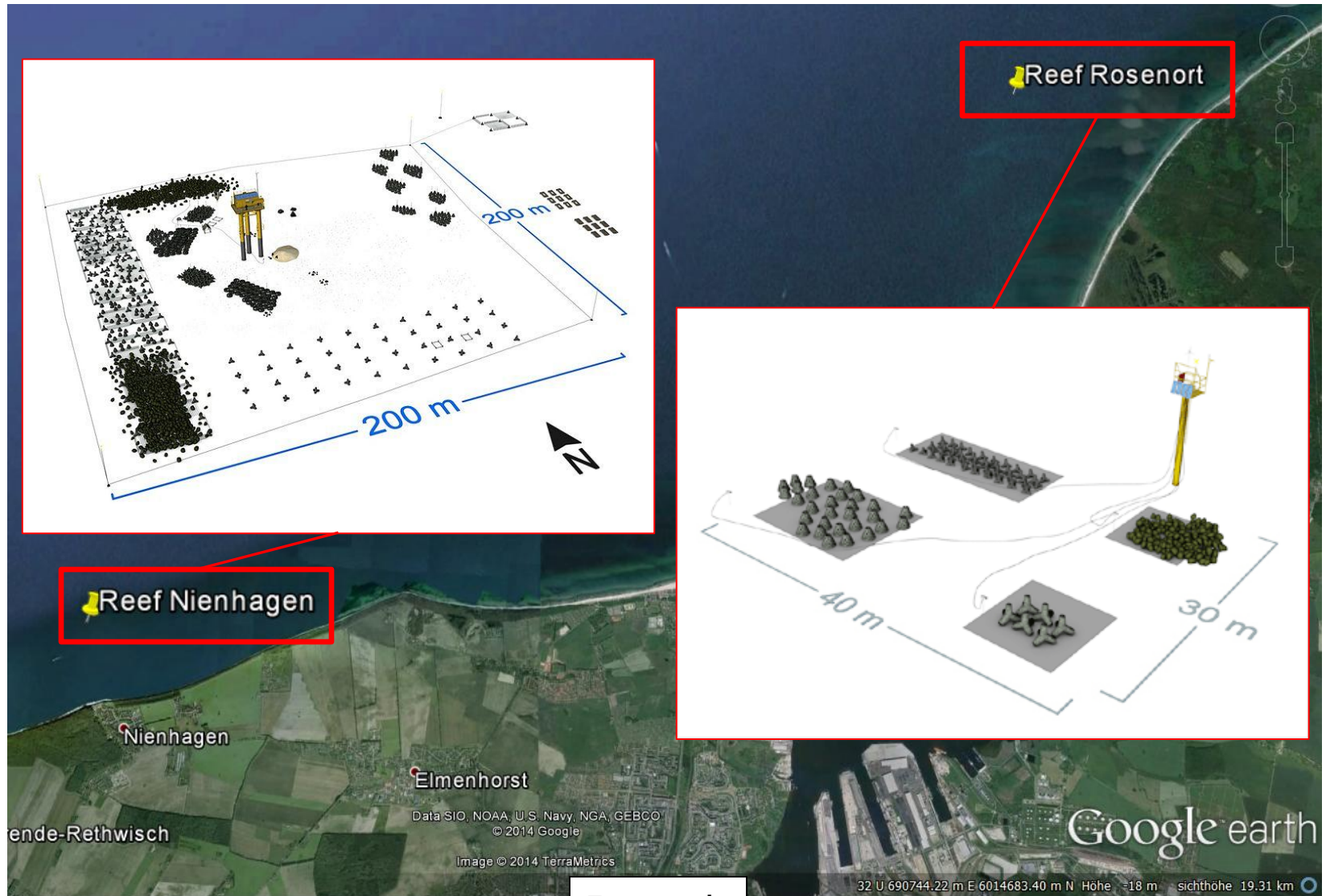
Test Site: Poel



Test Site: Artificial Reefs

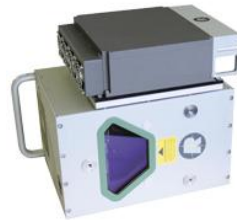


Test Site: Artificial Reefs



Overview Flights

	2012
<i>Acquisition</i>	31 Oct.– 11 Nov.
<i>Altitude [m]</i>	300, 500, 700
<i>Sensor</i>	Riegl VQ-820G
<i>Depth</i>	1x Secchi
<i>Measurement rate</i>	149 kHz
<i>Sensor</i>	
<i>Depth</i>	
<i>Measurement rate</i>	

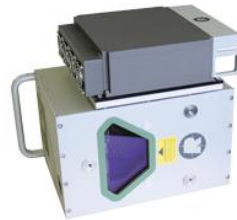


riegl.com



Overview Flights

	2012	2013
<i>Acquisition</i>	31 Oct.– 11 Nov.	28 -29 Sept.
<i>Altitude [m]</i>	300, 500, 700	400
<i>Sensor</i>	Riegl VQ-820G	AHAB Chiroptera
<i>Depth</i>	1x Secchi	1x Secchi
<i>Measurement rate</i>	149 kHz	18 kHz
<i>Sensor</i>		AHAB HawkEye II
<i>Depth</i>		3x Secchi
<i>Measurement rate</i>		4 kHz



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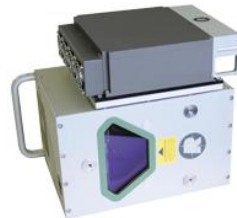
airbornehydro.com



Overview Flights

* Additional flight
with HawkEye III
in autumn 2014

	2012	2013	2014
<i>Acquisition</i>	31 Oct.– 11 Nov.	28 -29 Sept.	5-13 May*
<i>Altitude [m]</i>	300, 500, 700	400	400
<i>Sensor</i>	Riegl VQ-820G	AHAB Chiroptera	AHAB Chiroptera
<i>Depth</i>	1x Secchi	1x Secchi	1x Secchi
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Overview Flights

* Additional flight
with HawkEye III
in autumn 2014

	2012	2013	2014
Acquisition	 		5-13 May*
Altitude [m]			400
Sensor	Riegl VQ-820G	AHAB Chiroptera	AHAB Chiroptera
Depth	1x Secchi	1x Secchi	1x Secchi
Measurement rate	149 kHz	18 kHz	18 kHz
Sensor		AHAB HawkEye II	
Depth		3x Secchi	
Measurement rate		4 kHz	
	 riegl.com	  airbornehydro.com	 airbornehydro.com

Overview Flights

- 1st flight 
 - Secchi depth ~ 6m
 - Achieved depths ~4.5m
- 2nd flight 
 - Secchi depth ~ 6m
 - Achieved depths:
 - Chiroptera ~6.5m & HawkEye II ~14m
 - Delivery of processed data: End of April 2014
 - depths still up to 70 cm to high

Outline

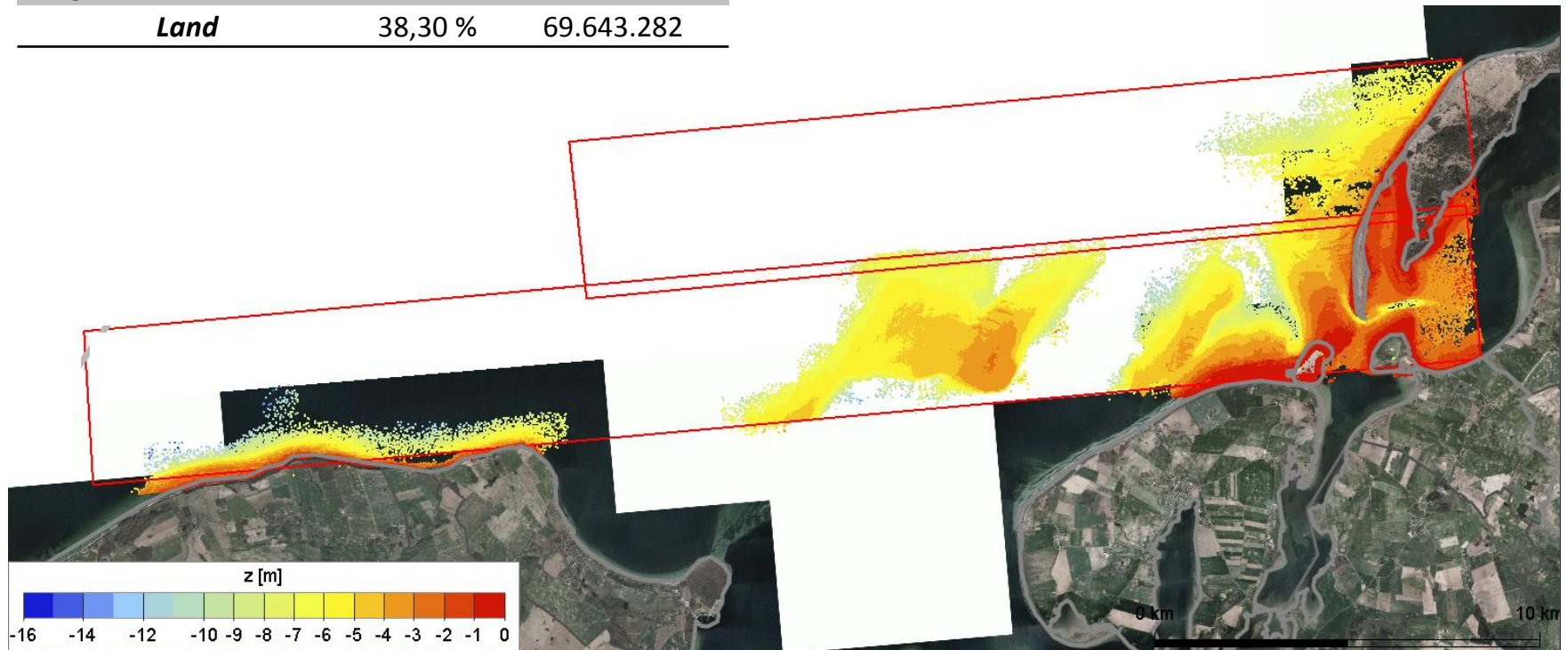
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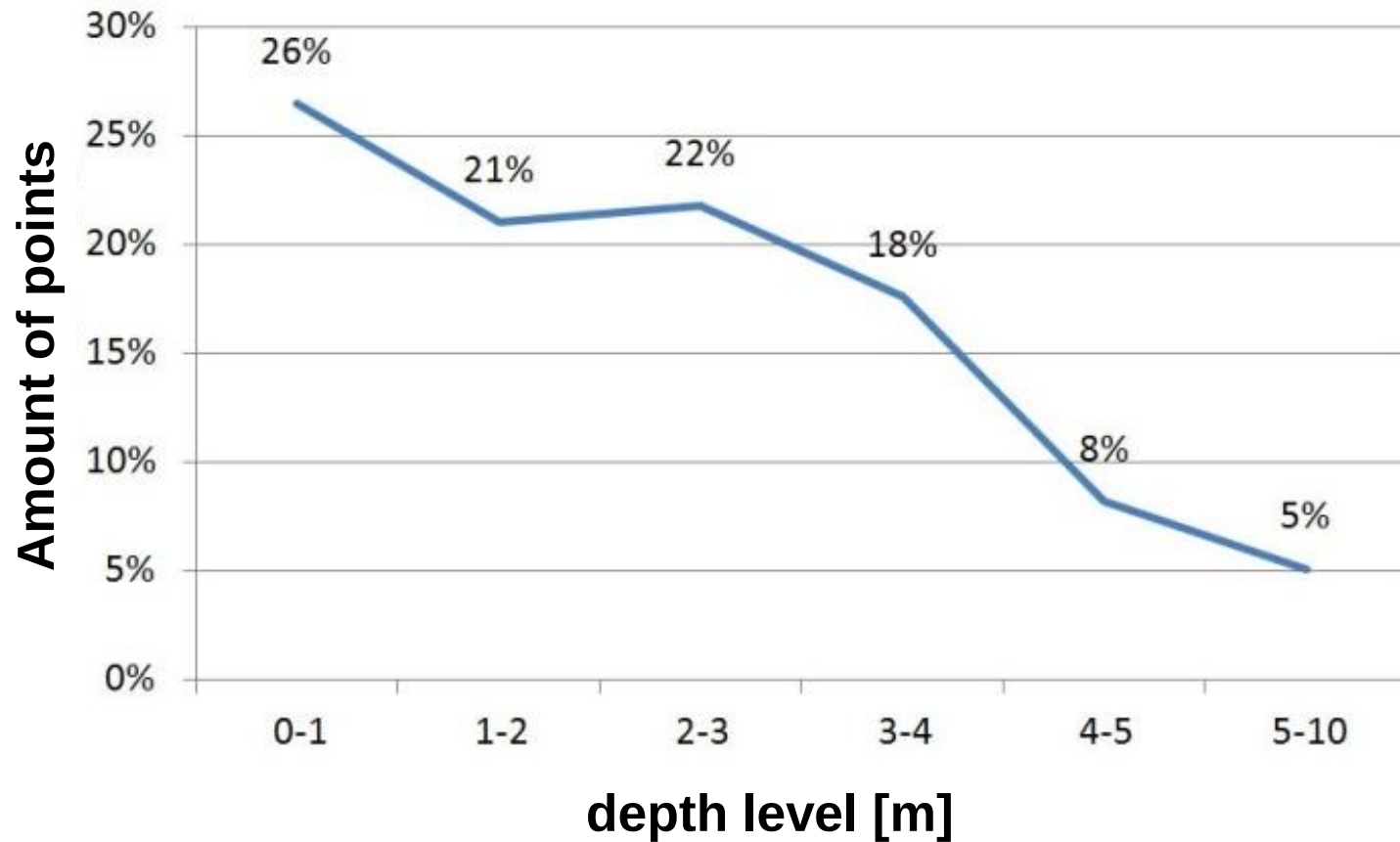
Point distribution



Amount of points	181.876.581	
Area [km²]	220	
<i>Noise</i>	0,31 %	568.358
<i>Water surface</i>	22,08 %	40.159.065
<i>Sea bed</i>	39,29 %	71.460.309
<i>Vegetation underwater</i>	0,03 %	45.566
<i>Land</i>	38,30 %	69.643.282



Amount of sea bed points



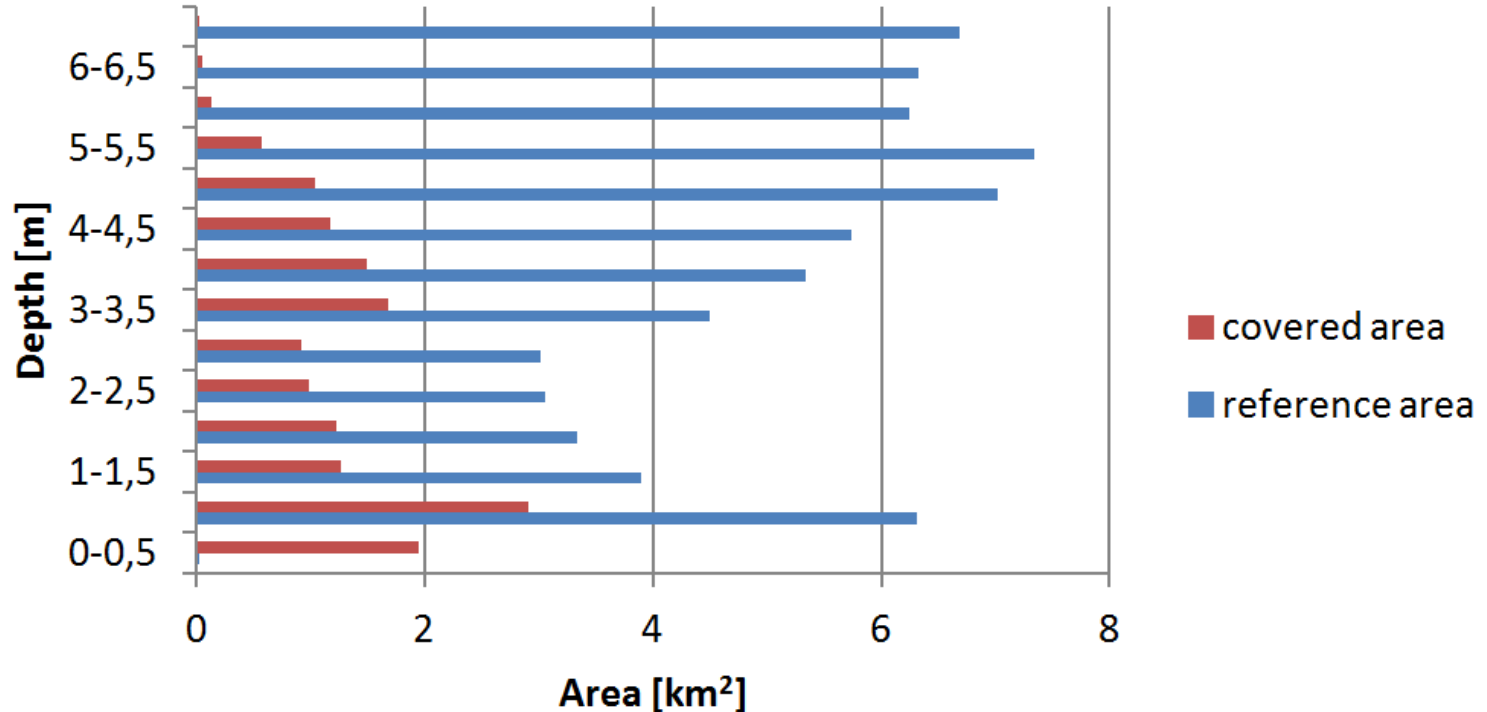
- normalized by area of each depth level



Covered area



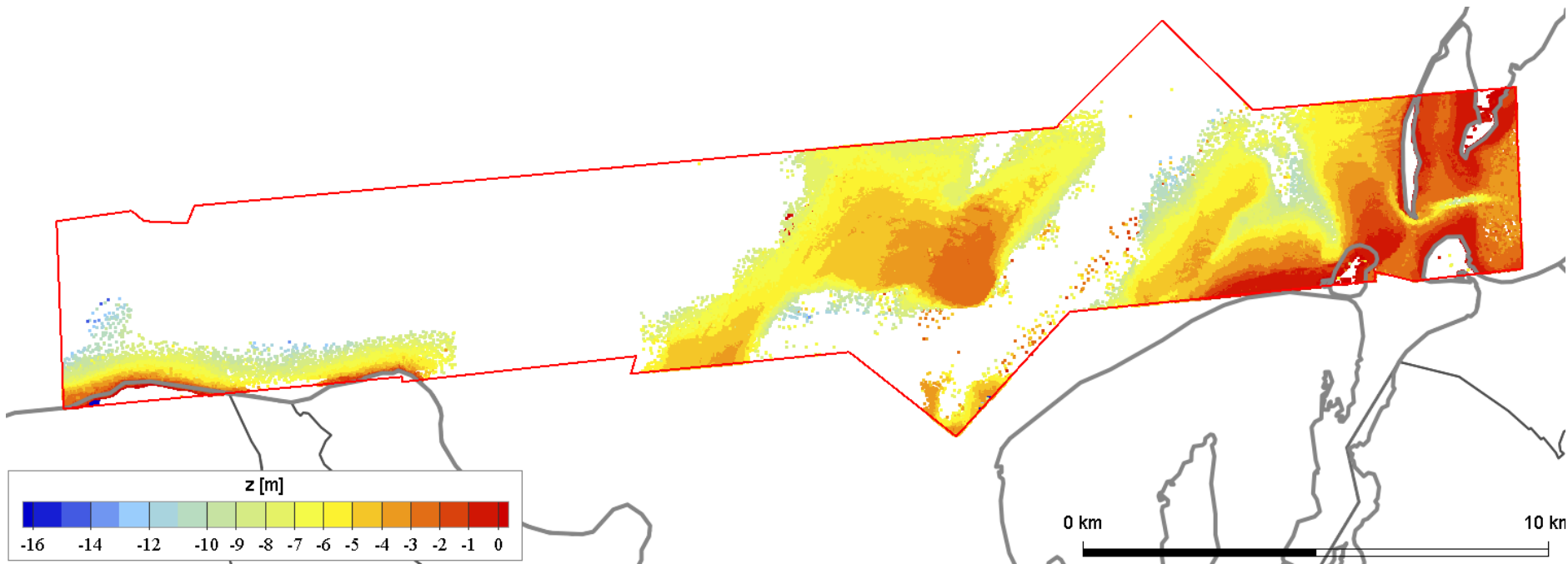
- Actually covered area compared to approximated area (from echo sounding) in each depth level
- Rough approximation!



Covered area - Flight 1

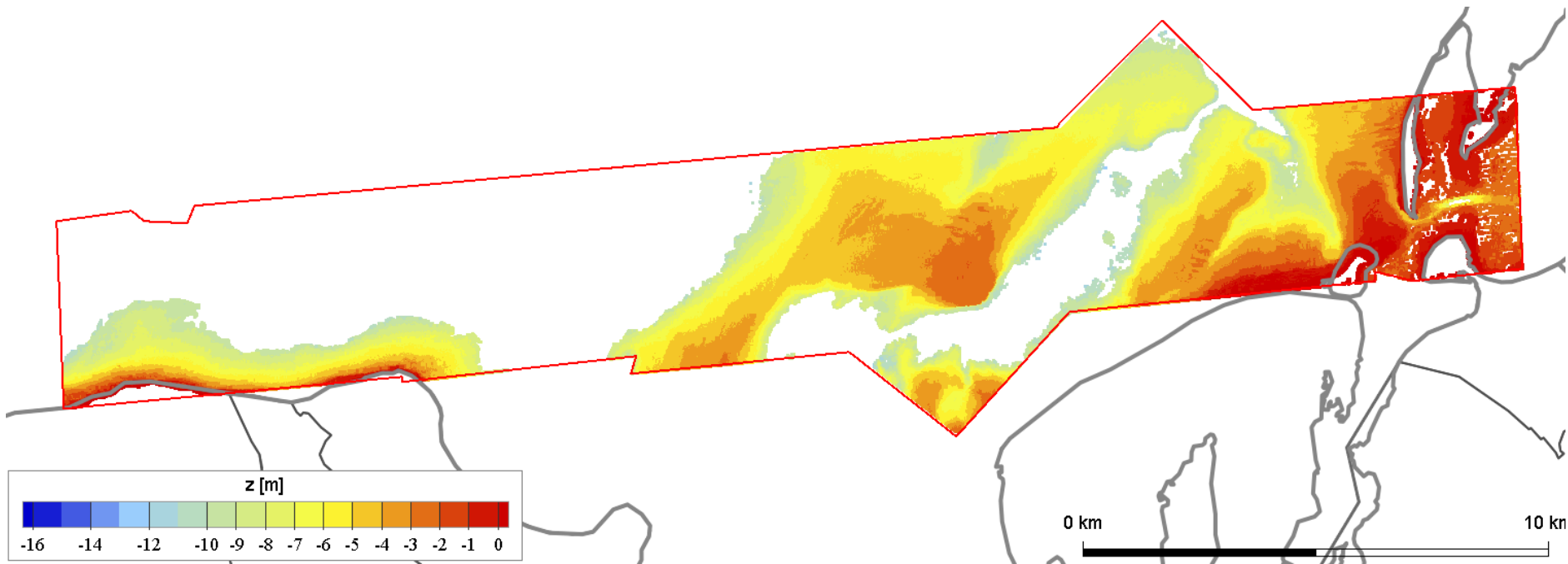


- Riegl: 70,607,093 points



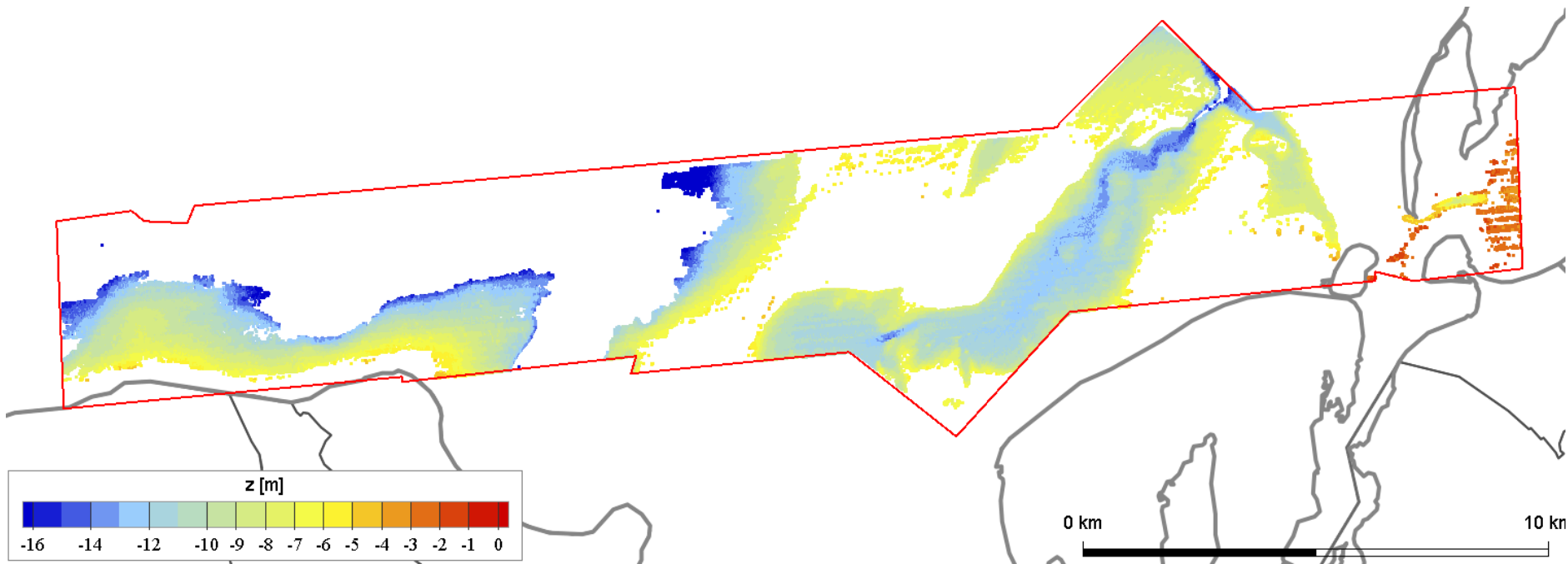
Covered area - Flight 2

- Chiroptera: 140,910,079 points



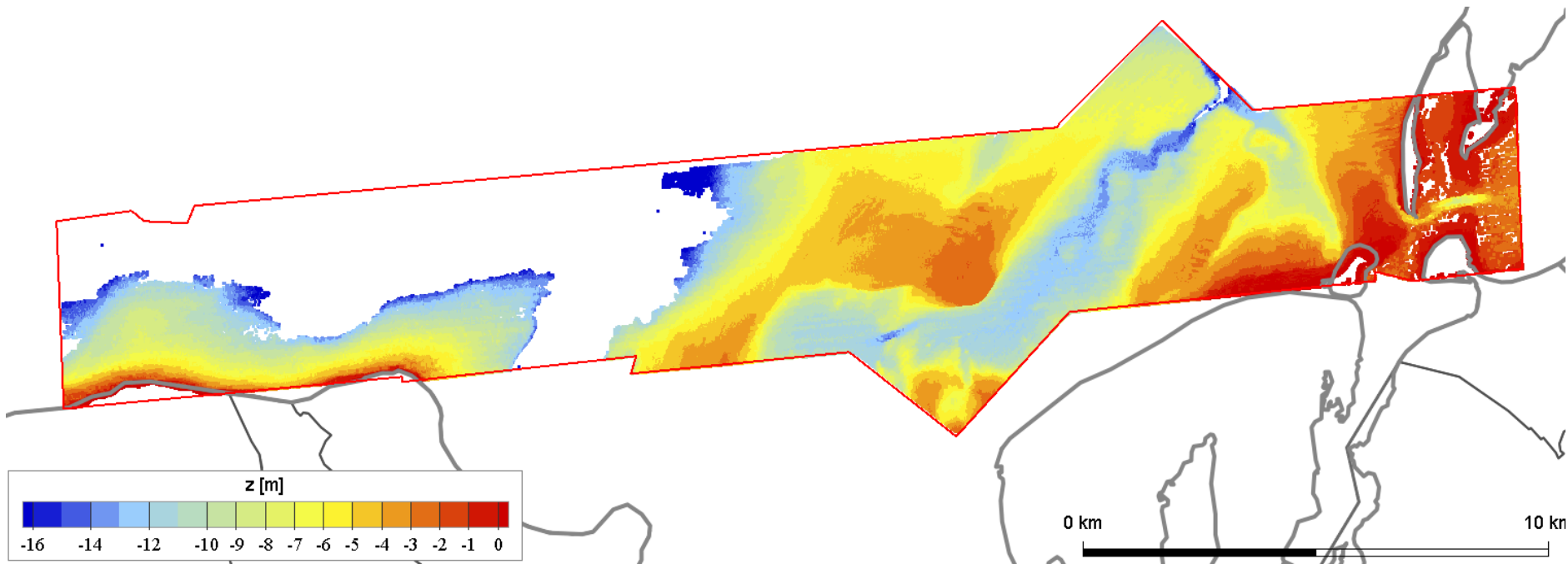
Covered area - Flight 2

- HawkEye II: 6,880,026 points
- Mean: ~ 9.8 m (offset ~70 cm)



Covered area - Flight 2

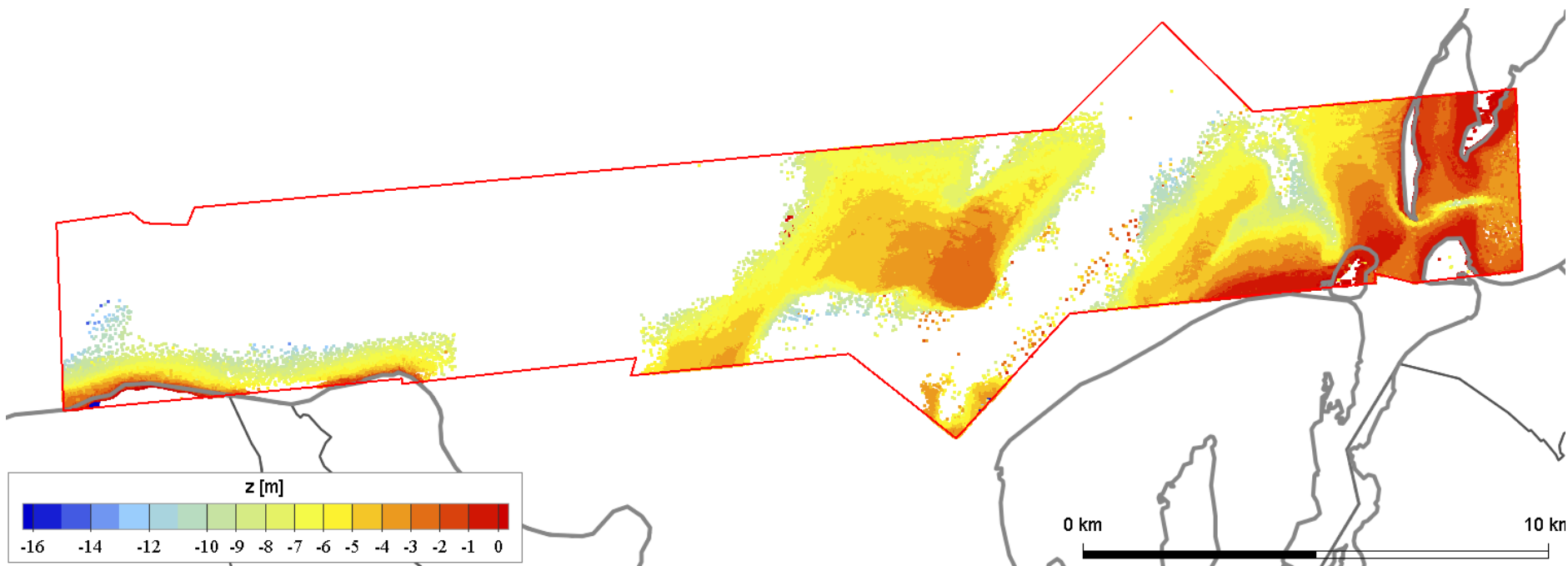
- Chiroptera & HawkEye II: 147,790,105 points



Covered area - Flight 1



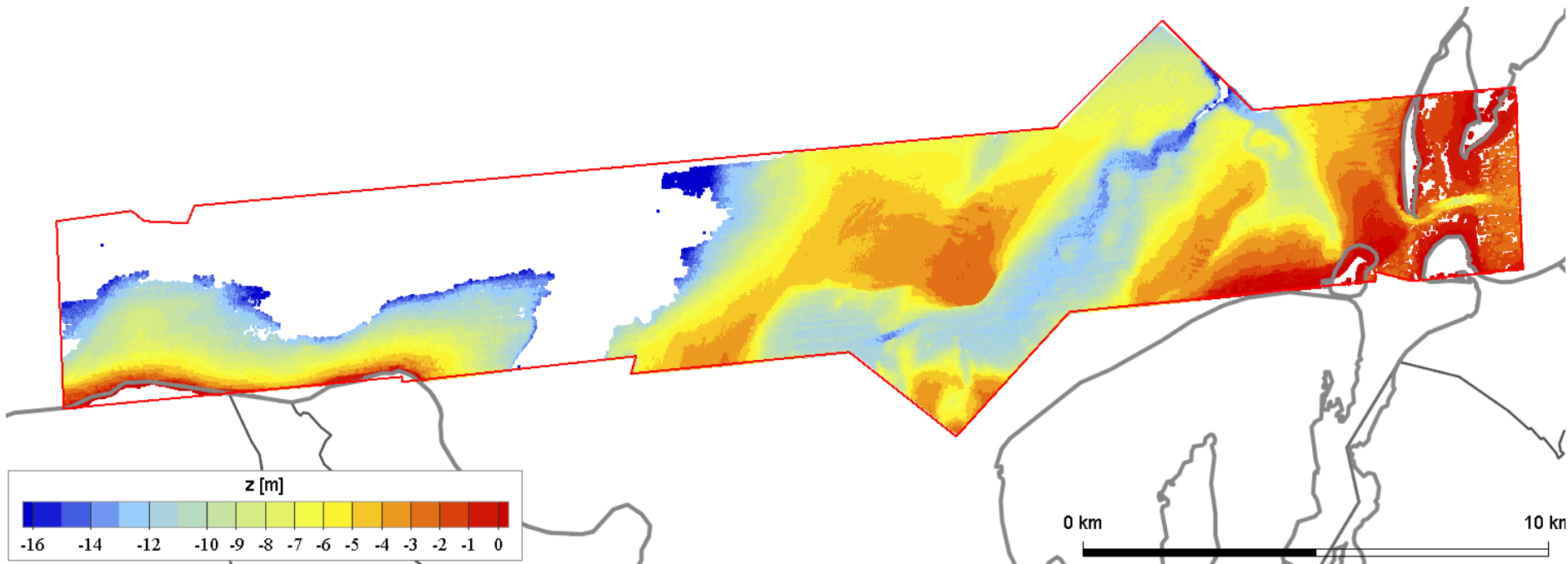
- Riegl: 70,607,093 points



Covered area - Flight 2

- Chiroptera & HawkEye II: 147,790,105 points

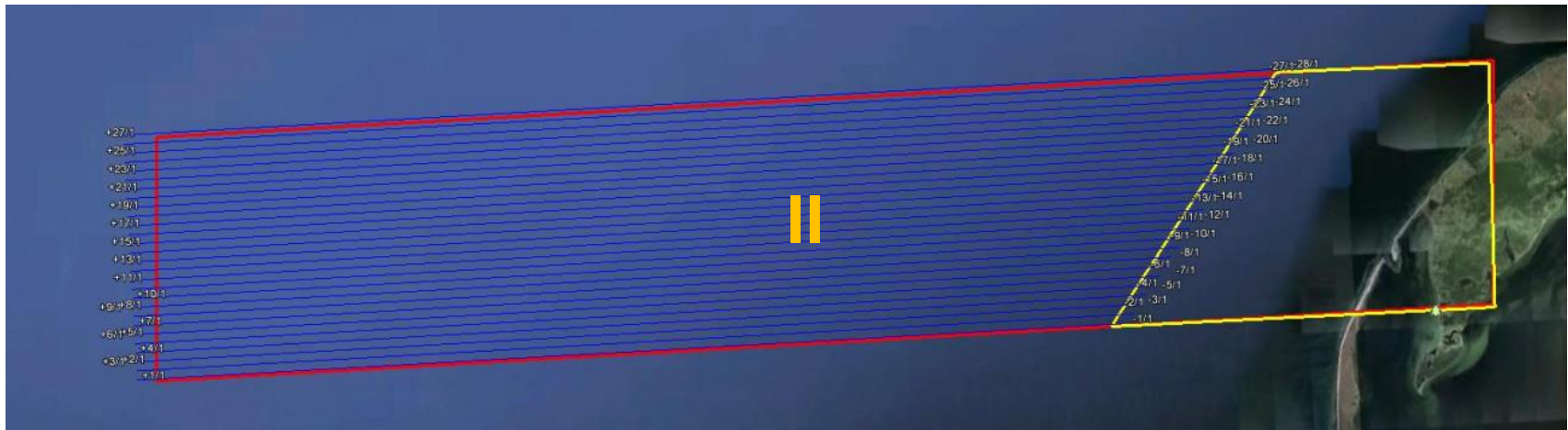
Good results by combining sensors for shallow and deep water



Remarks (1)



- No flight permission for lowest altitude (300 m) of Area II in highlighted part due to migrating birds

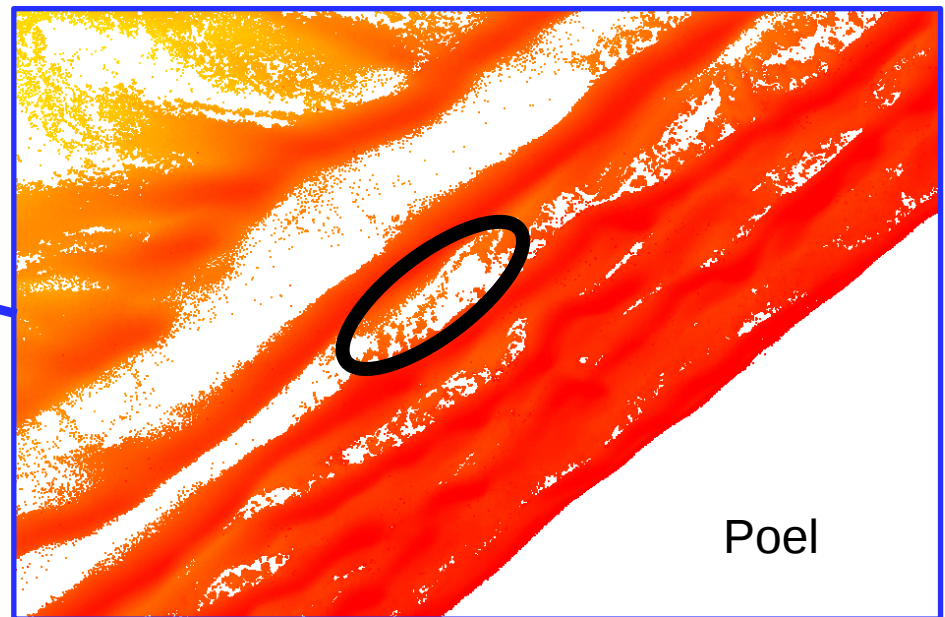


- Flight altitude proposed by company seems to offer a good cost-benefit ratio



Remarks (2)

- Data gaps in the north of Poel
 - Depth 1-2m; sea bed points detected only rarely
 - Riegl VQ-820G and HawkEye II



Remarks (2)

- Data gaps in the north of Poel
 - Depth 1-2m; sea bed points detected only rarely
 - Riegl VQ-820G and HawkEye II
 - **Reason: underwater vegetation**

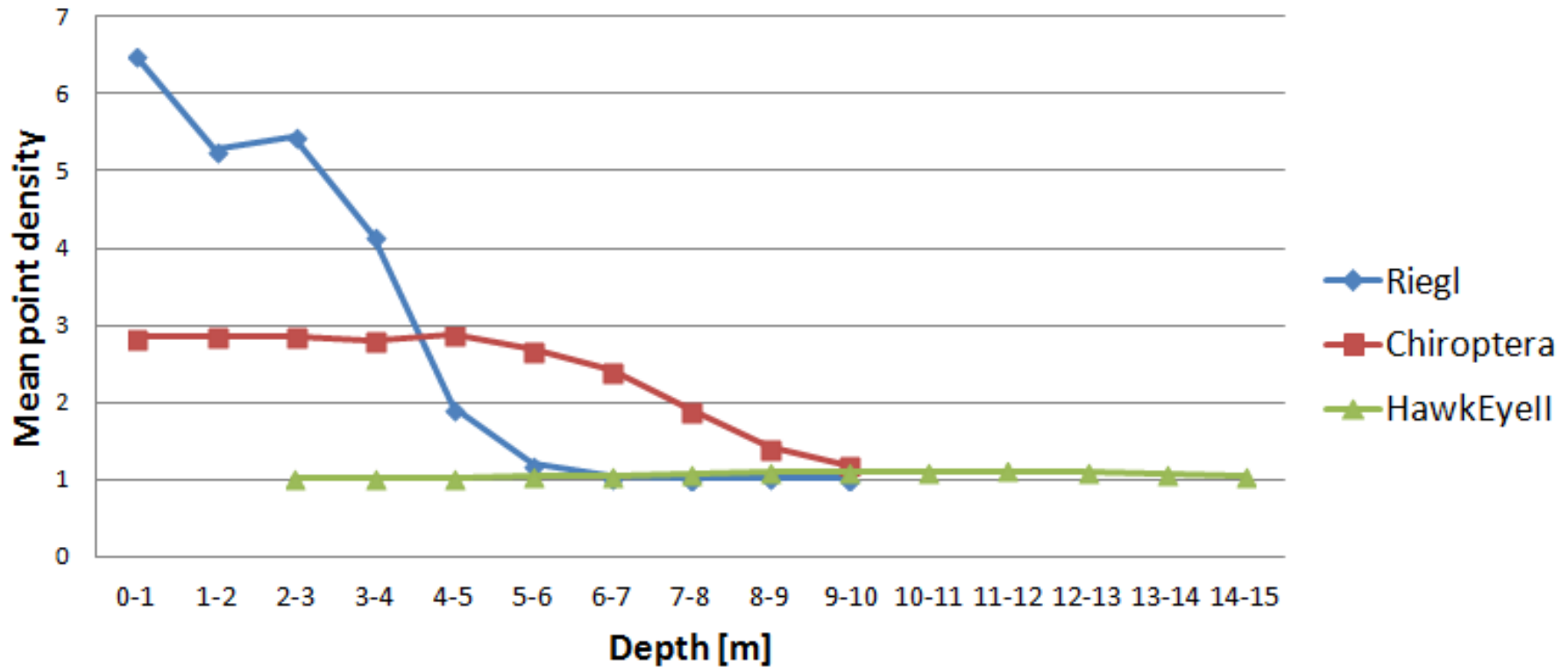


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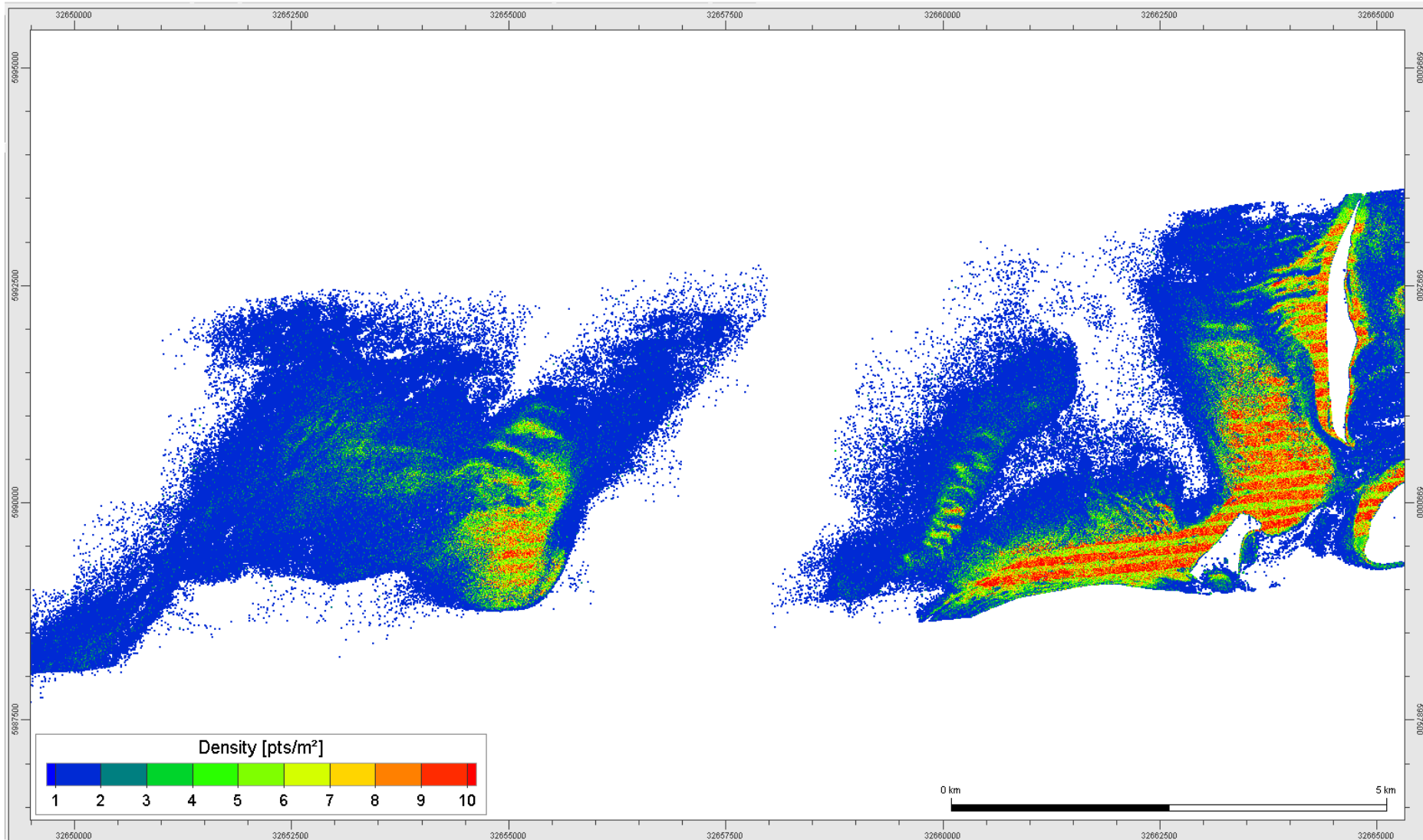
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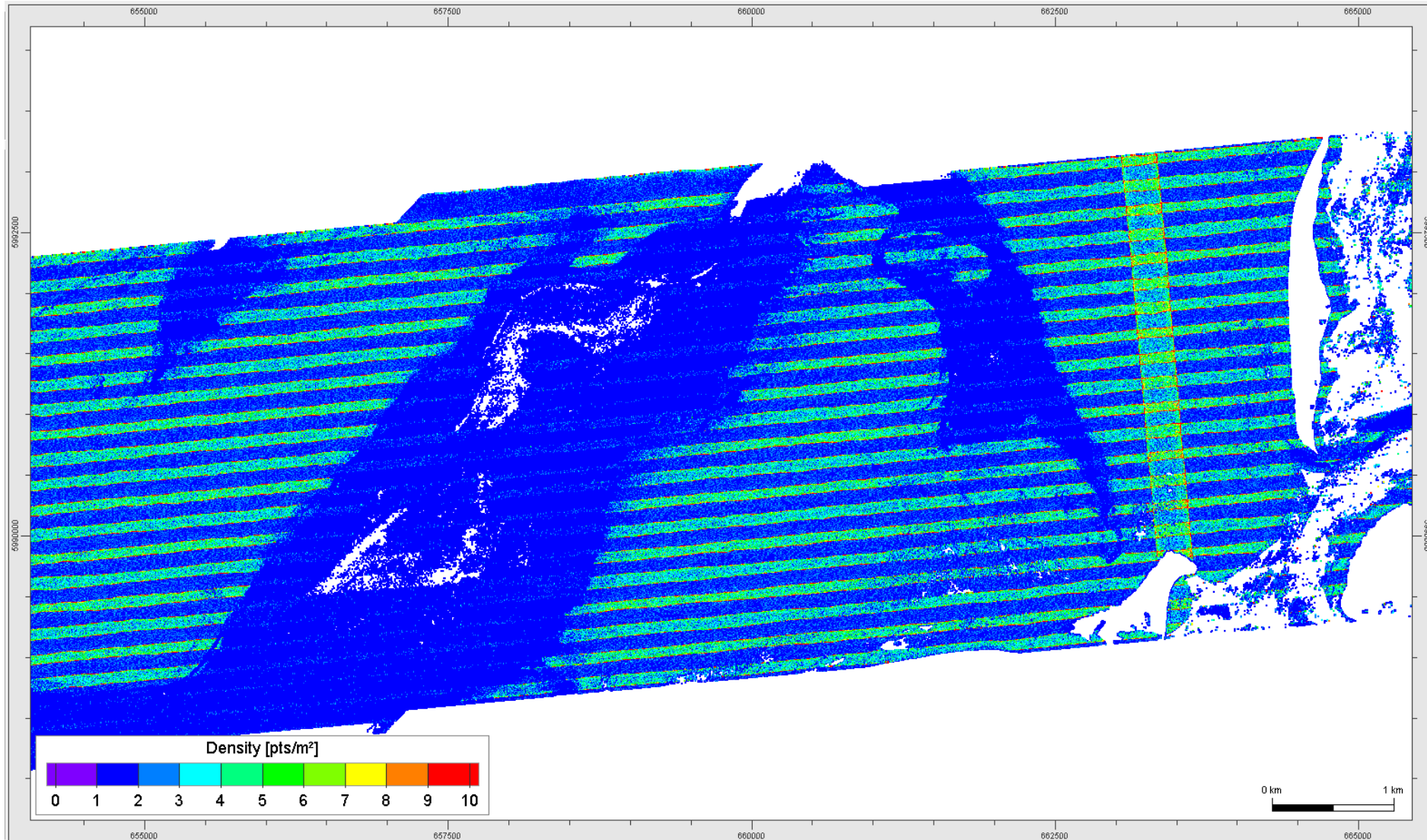
Point Density



Point Density



Point Density



Outline

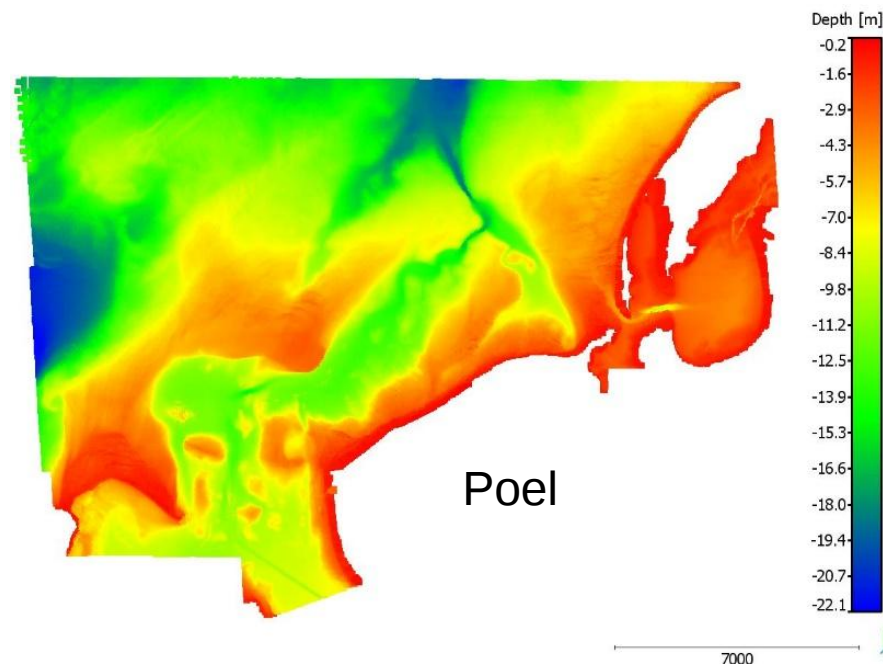
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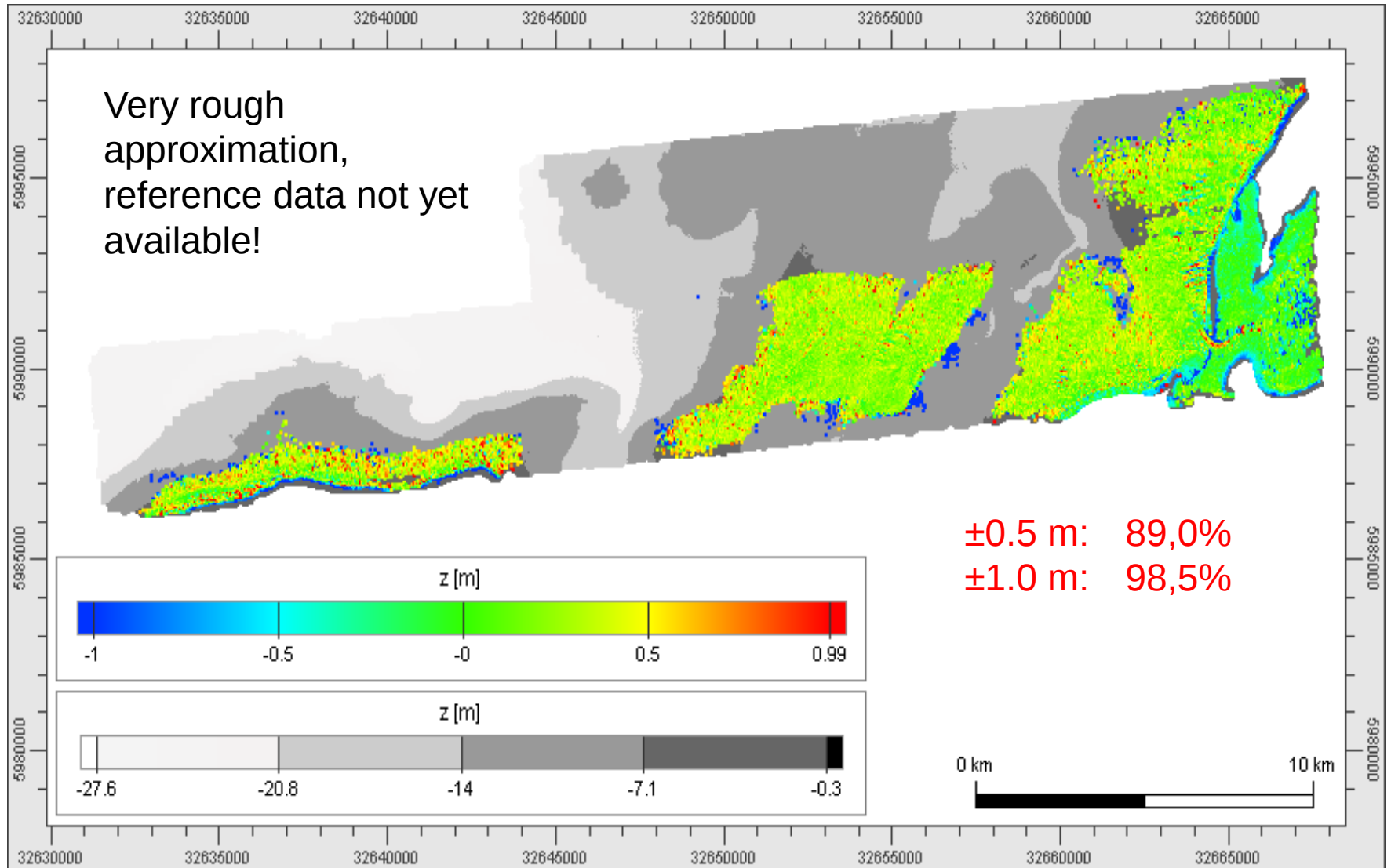
Comparison single beam



- Reference: 2 m grid echo sounding
- Grid of laser data (2m)
- Difference: reference – laser grid



Comparison single beam



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 - **Obstacles**
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Detection of Obstacles

-  – No obstacles detected (no points close to objects from database)
-  Chiroptera & HawkEye II (preliminary)
 - Some objects identified
 - Some object points are wrongly classified
- Development and improvement of (automatic) classification algorithms necessary!

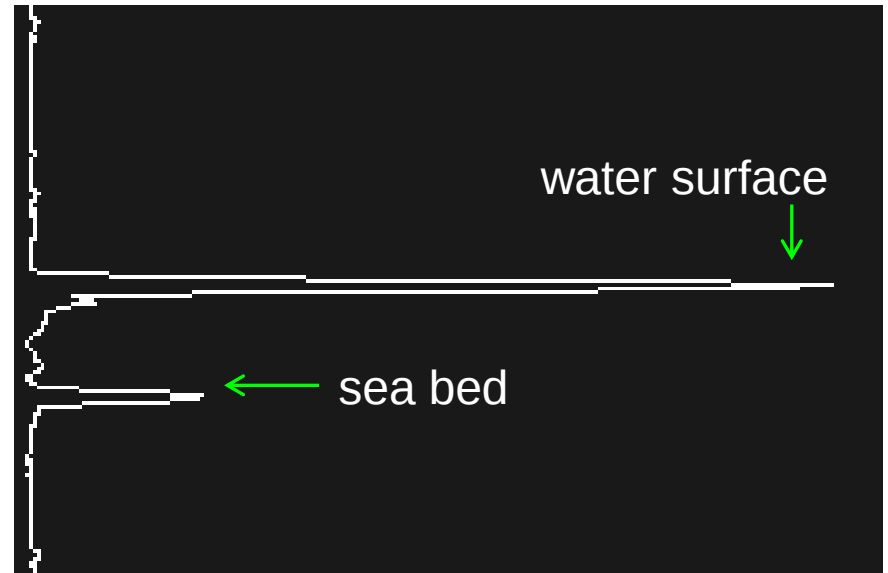
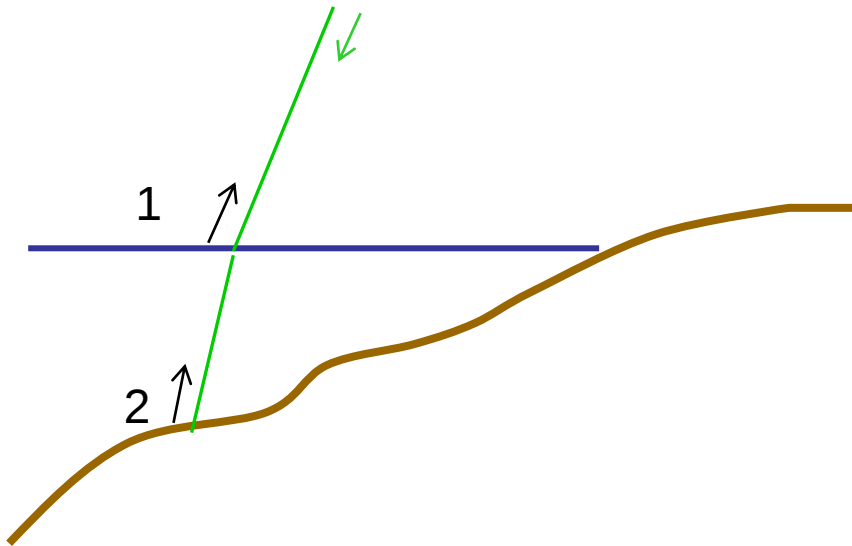
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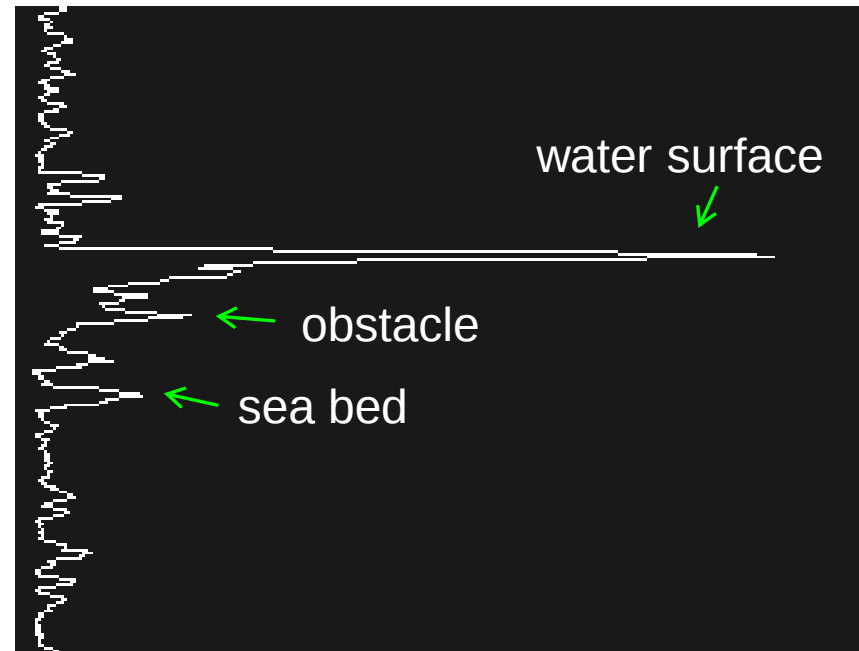
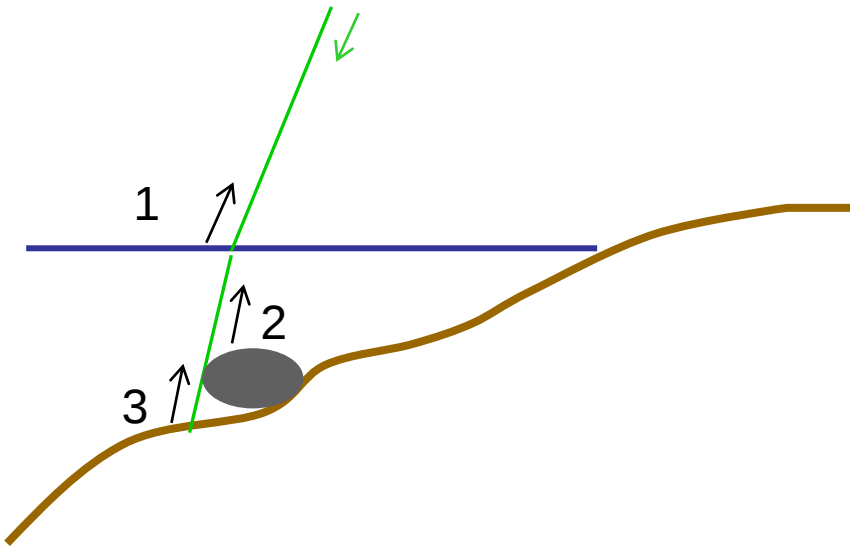
Full Waveform Analysis

- Standard



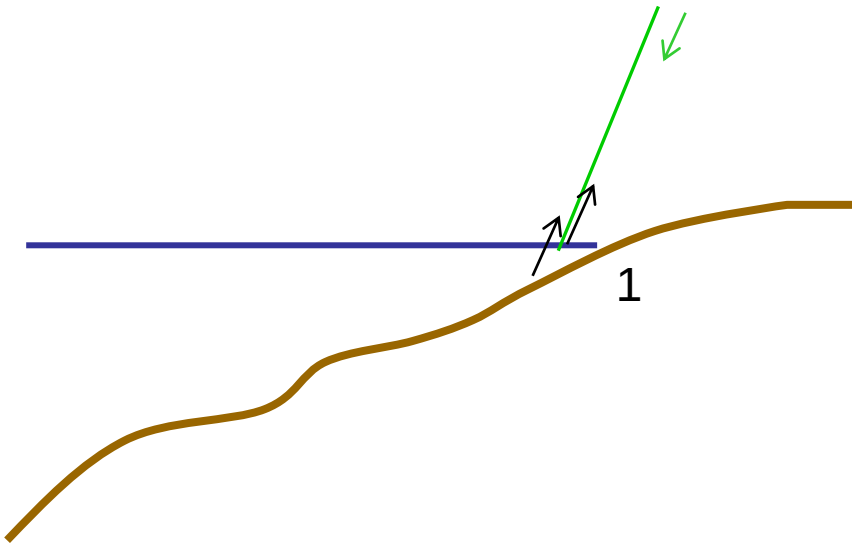
Full Waveform Analysis

- Obstacle



Full Waveform Analysis

- Very shallow water

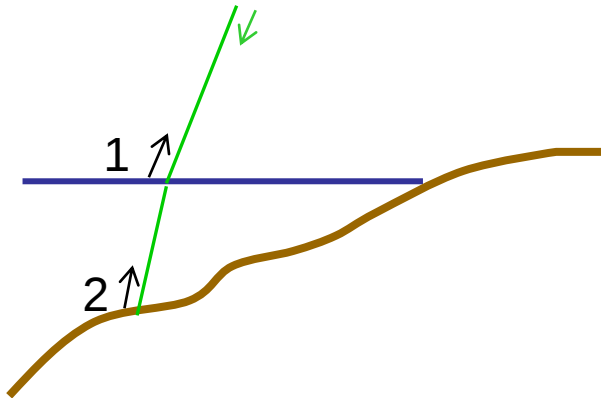


- No separation of echoes possible
- One peak from water surface and sea bed

Full Waveform Analysis



- In most cases of water surface and sea bed points only one return

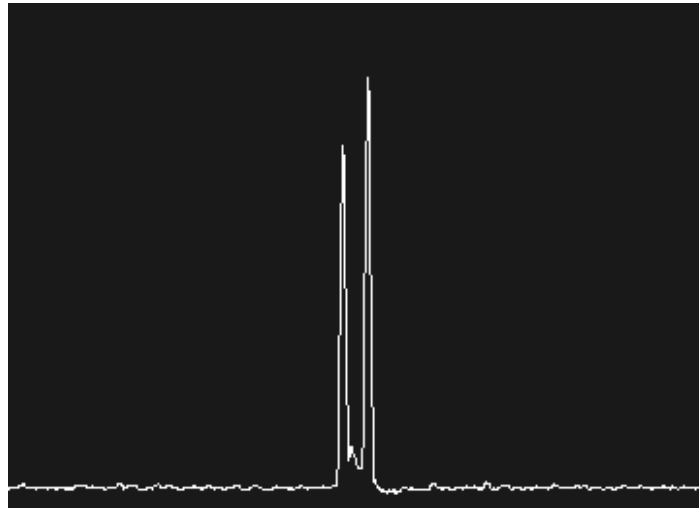


	Water surface	Sea bed
points	40,123,429	71,449,969
single returns	96.7 %	95.2 %



Full Waveform Analysis

- Waveforms are accessible by AHAB Software LiDAR Survey Studio
- Seems to be promising
- Future work: Detection of small objects possible?



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Conclusions

- Laser bathymetry interesting for shallow regions
- Combination of shallow and deep water sensors yields good results.
- Sensors are also able to acquire topographic data
→ cooperation with other authorities possible



Outlook

- Evaluation of 2nd and 3rd flight
- Analysis of full waveform data
- Economic efficiency of laser bathymetry compared to echo sounding

