Survey Innovations

1st FIG Young Surveyors European Meeting (Lisbon)

DRAVOSA Survey Department
17-18 october 2013

DRAVOSA

Van Oord

PUMA Survey Innovations

VanOord Survey Department
17 october 2013

PUMA Organization

PUMA
Projectorganisatie Uitbreiding Maasvlakte

- Boskalis 50%
- Van Oord 50%

Koninklijke
Boskalis Westminster nv

Van Oord

Port investments Rotterdam

- MV2 — 2,9 billion (total till 2030) including connection with MV1, including PUMA
- Contract PUMA — 1,1 billion (Construction 1st fase) including 200 million BAVO-MV2

Contract 1 – 2013
Seawall Defence and Port Reclamation (Phase 1)

Final Phase - 2030

Maasvlakte 2 in 2030

December 2008

January 2010

January 2011

February 2012

February 2012

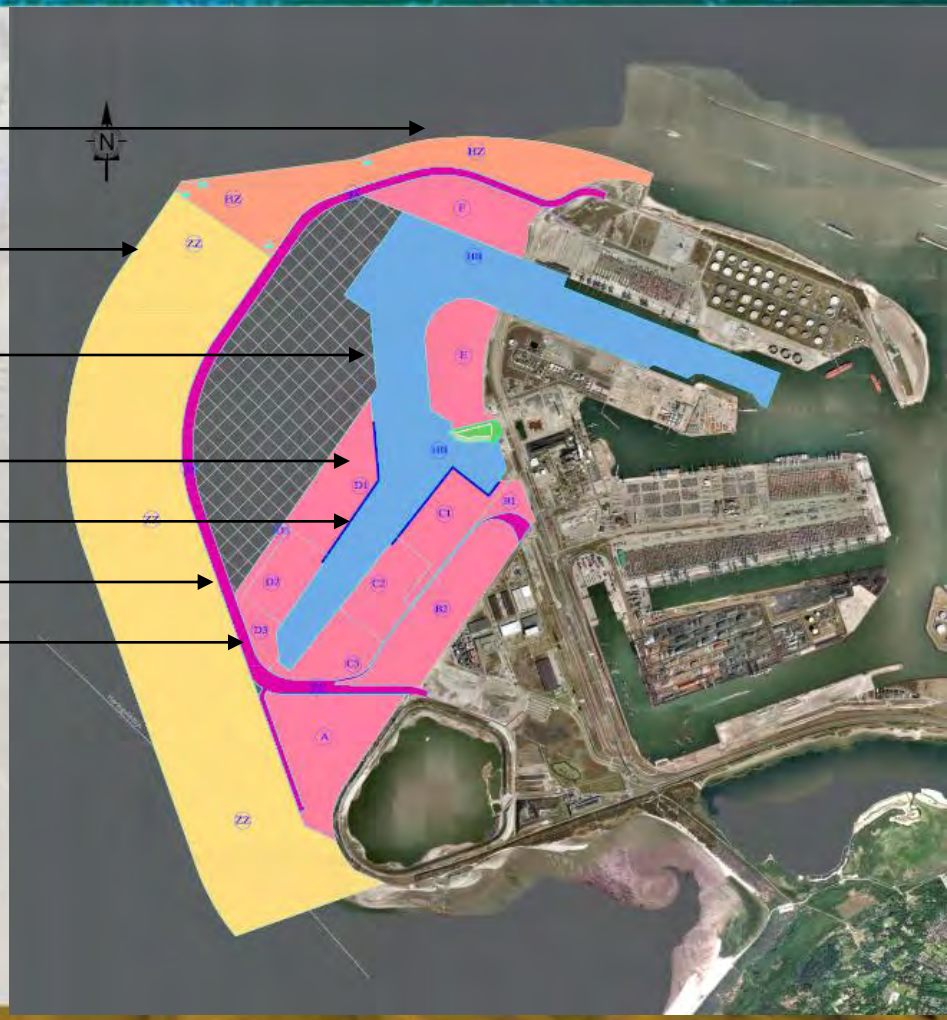
July 2012

Contract 1

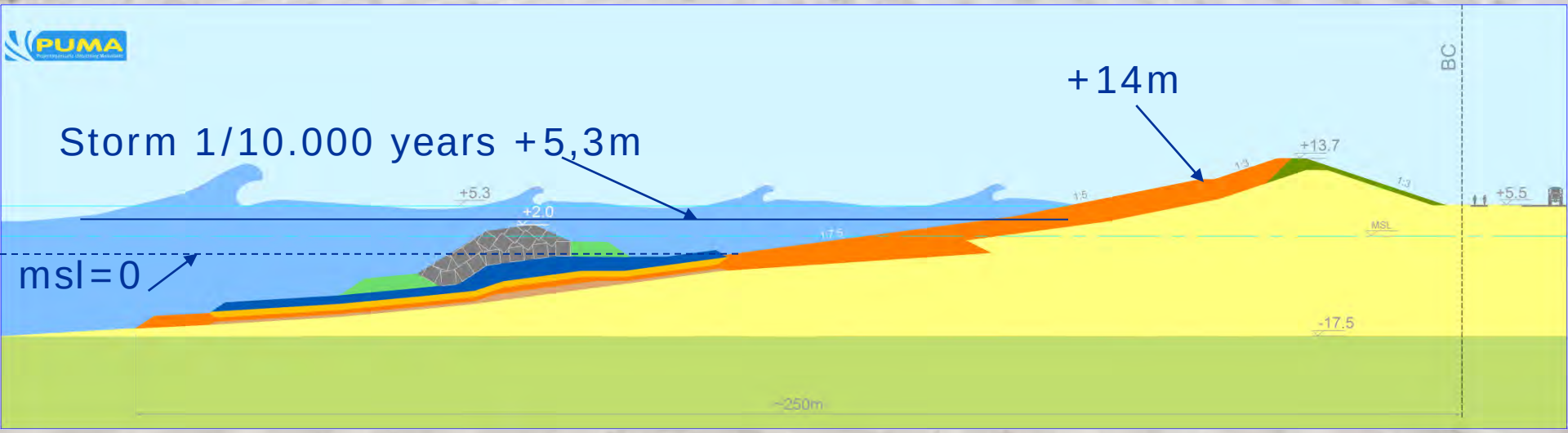
Seawall Defence and Port Reclamation (Phase 1)

Hard Seawall Defence	3.5 km
Beach and dunes	7.3 km
Harbour basins	530 ha
Port Reclamation	700 ha
Quaywalls	3.5 km
Roads	13 km
Railroads	14 km

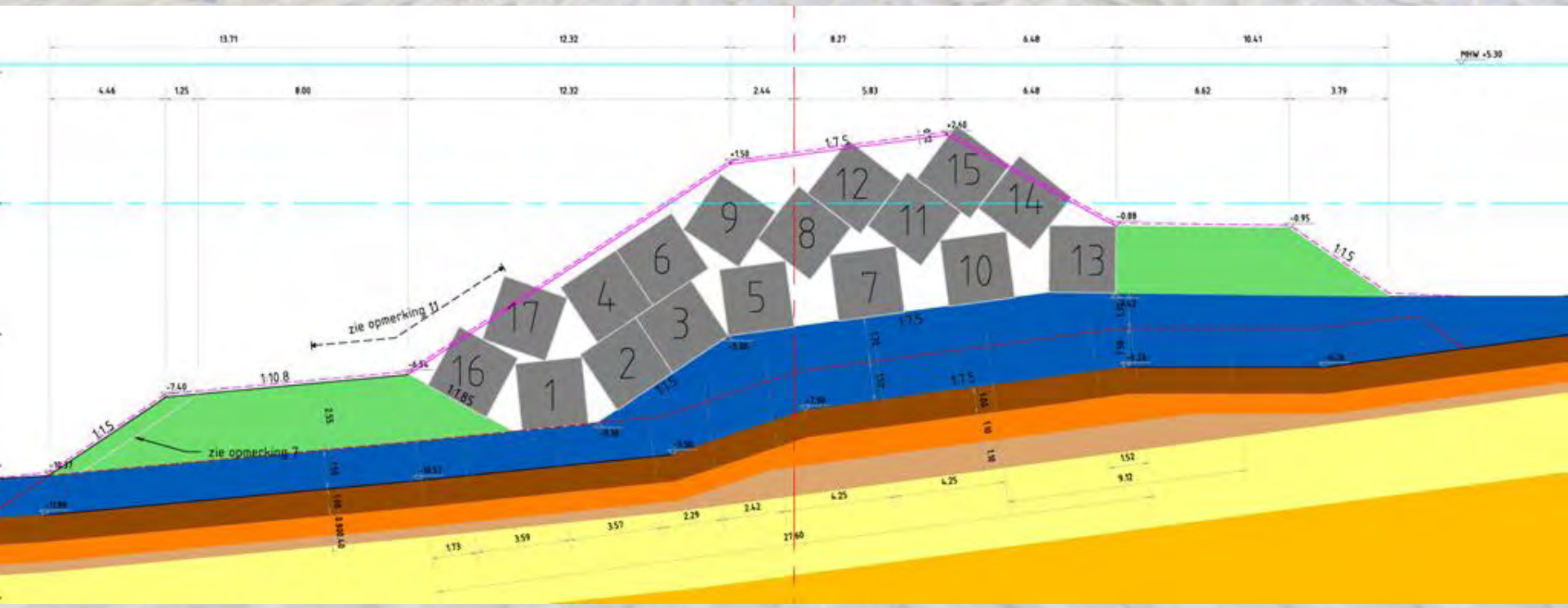
- 240 million m3 sand
- 7 million ton stone
- 20.000 concrete blocks (40T/piece)



Hard Seawall Defence
Total length 3,5 km

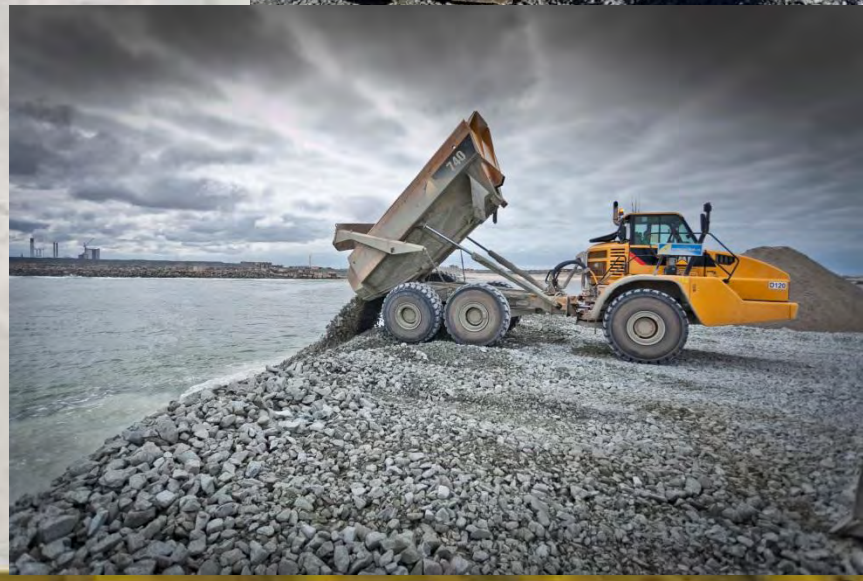


Theo Model


zie opmerking 11
zie opmerking 7
1:10.8
1:1.5
1:1.85
1:1.75
MHW +5.30
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17

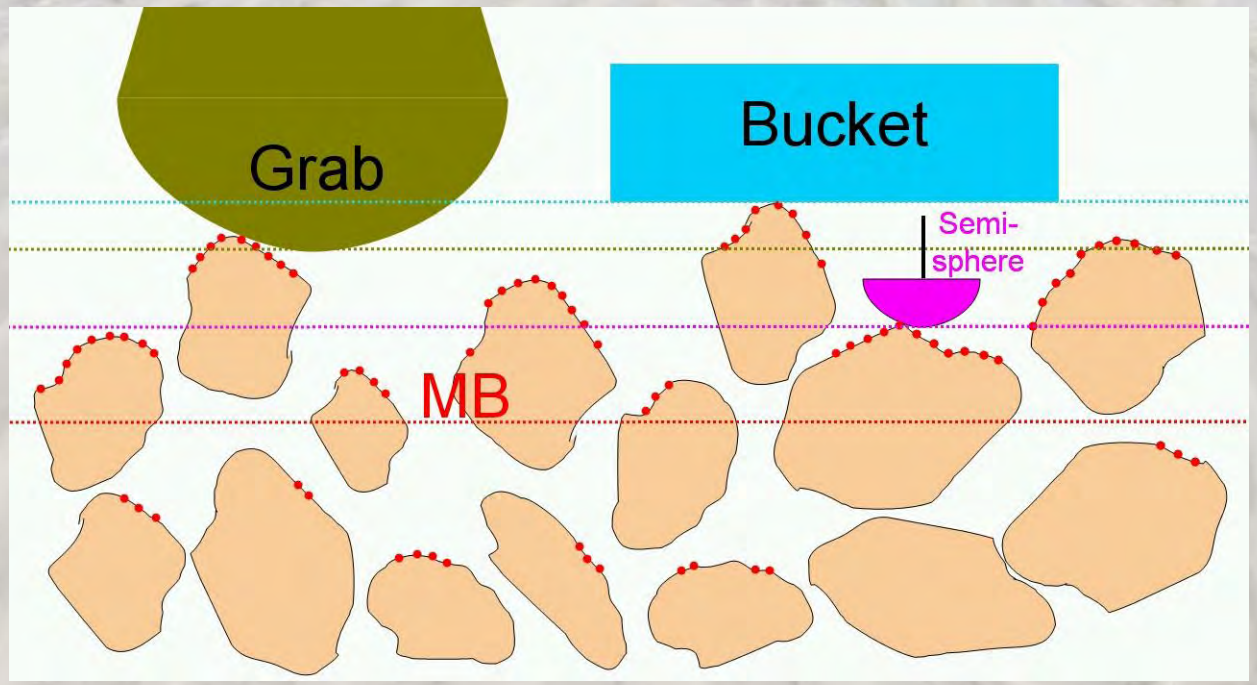
Rock Works

- Approximately 5.5 million tons of rock from european stone quarries.
- About 1.6 million tons of reuse stone from MV1 block dam.
- 9,558 concrete blocks reused from MV1 block dam



Measurement methods on rock placement

Understanding the differences in measurements of the average bed elevation between different measurement systems, that can possibly be used on the construction of the Hard Seawall

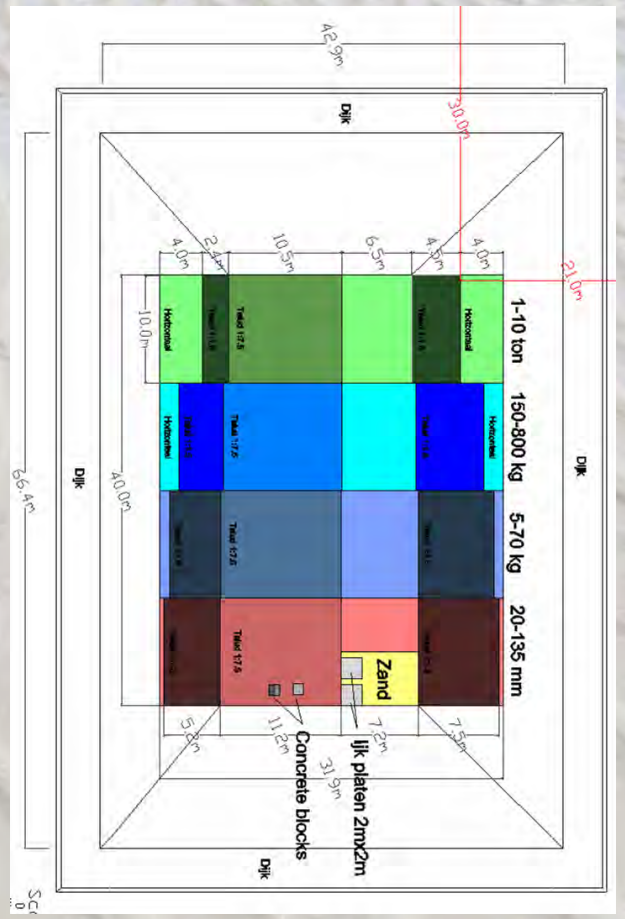


Test Pit

Comparison of different topographical - and contact measurement methods, acoustic measurement techniques, and laser techniques

- Dry Excavation - Hard Seawall 1:1 scale
- Start construction end of 2009

Test Pit PUMA 2010 & Verolme dock 1999



Test Pit – Dry Measurements

- Semi-spherical measurement
  - Diameter of the half-sphere is equal to the half of the nominal stone diameter.
  - Measurements are carried out in a 1m x 1m grid
- Point measurement

Test Pit – Dry Measurements

- Plate measurements
  - 1m x 1m tot 150-800kg
  - 2m x 2m voor 1-10 ton

Test Pit – Dry Measurements

- Grab measurement
- Bucket measurement

Test Pit – Dry Measurements

- One size bigger!

Test Pit – Dry Measurements

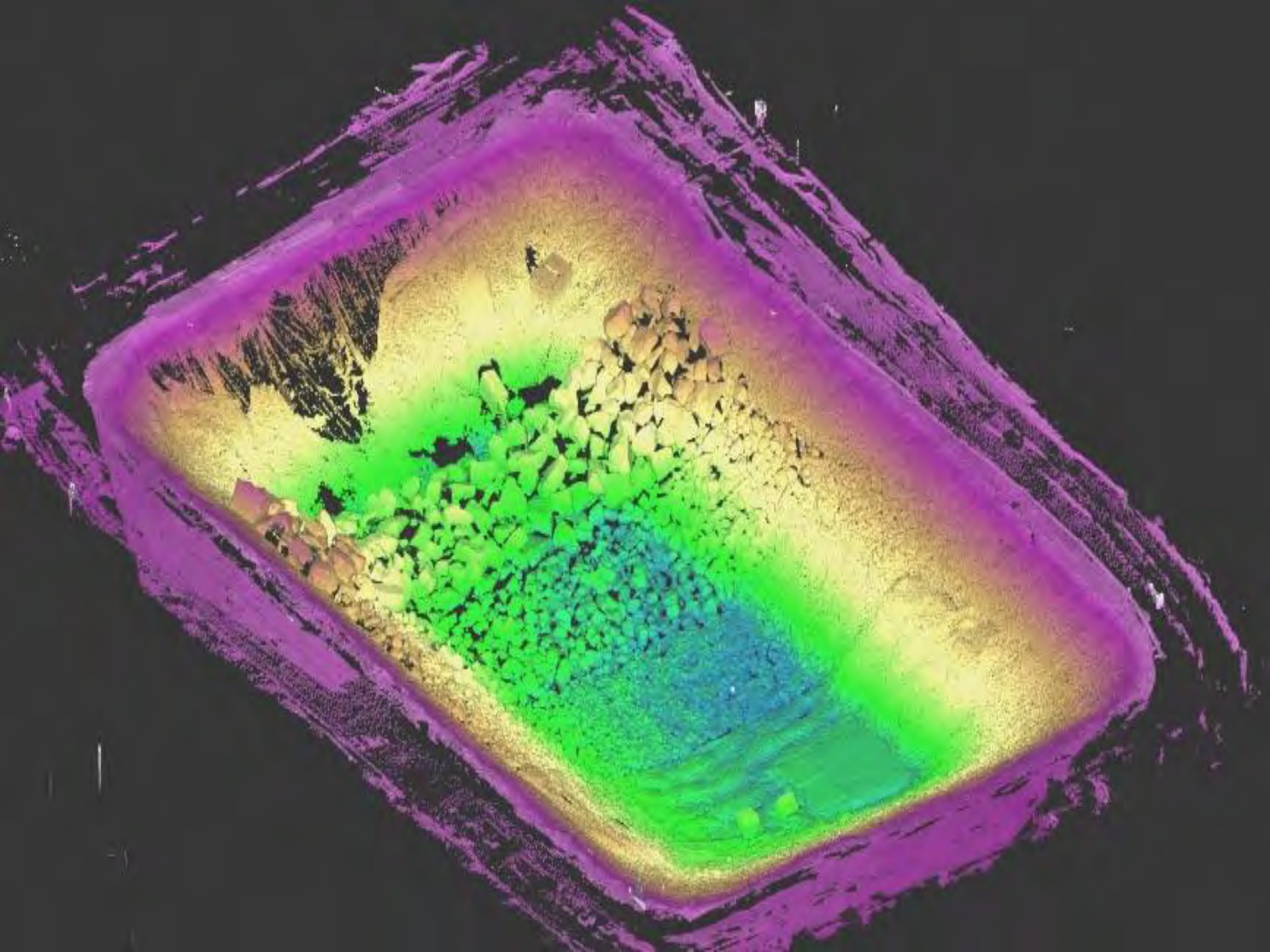
- Static Laser Scan measurement
- Mobile Laser Scanning measurement
- Fli-map

FUGRO Fli-map

MDL LacerACE

Leica

SICK LMS151



Test Pit – Underwater Measurements

- Multi-beam Reson Seabat 8125
- Multi-beam Reson Seabat 8101

- Multi-beam R2Sonic 2024
- Multi-beam R2Sonic 2022

- Multi-beam Kongsberg EM3002

- Multi-beam Odom ES3

- Echoscope CodaOctopus-II (375 KHz & 610 KHz)

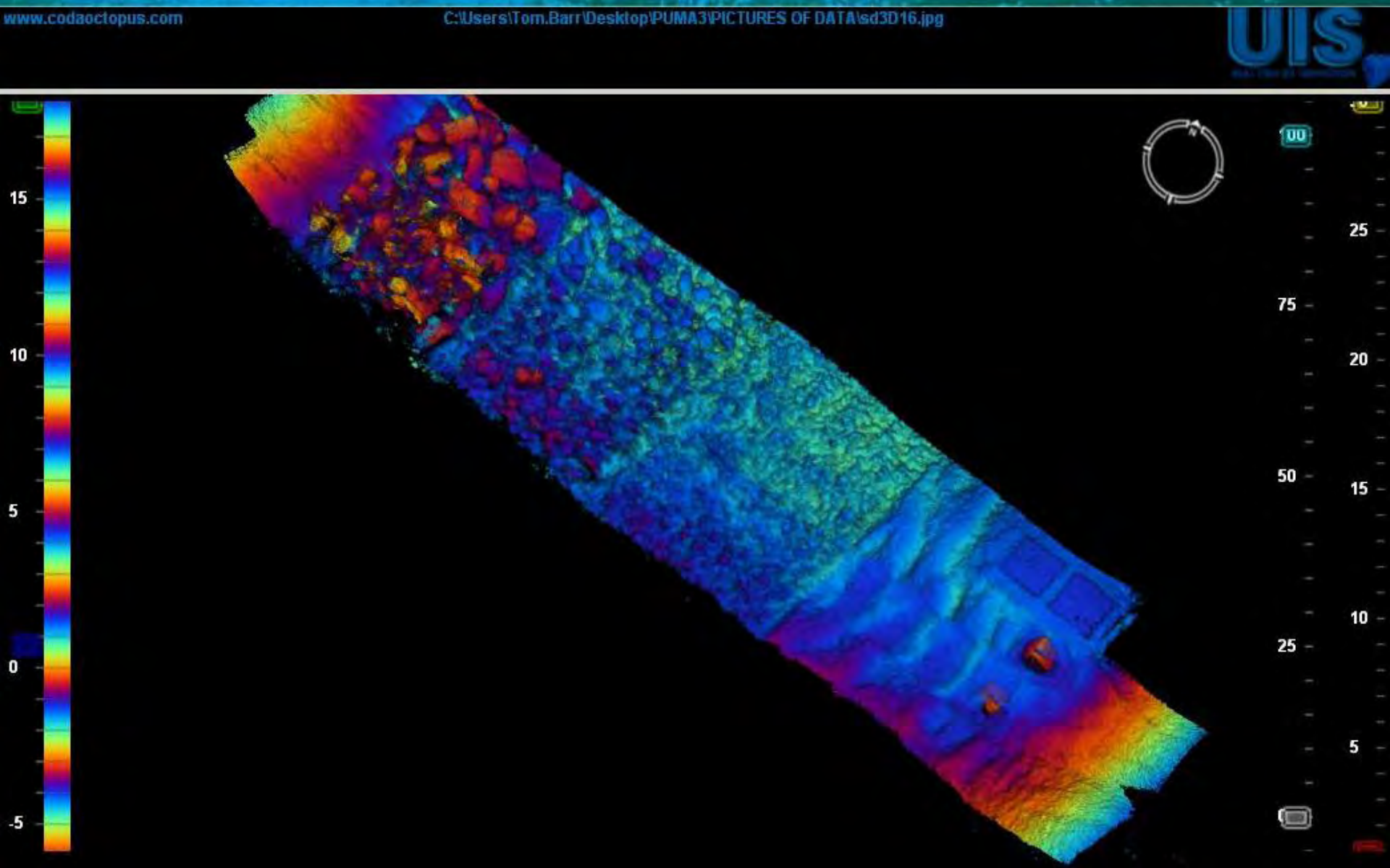
- Single-beam Reson Navisound 215, 200 KHz met 3º en 9º Δ


BOSKALIS
UASC
UASC
SeaPilot
12-19-YD

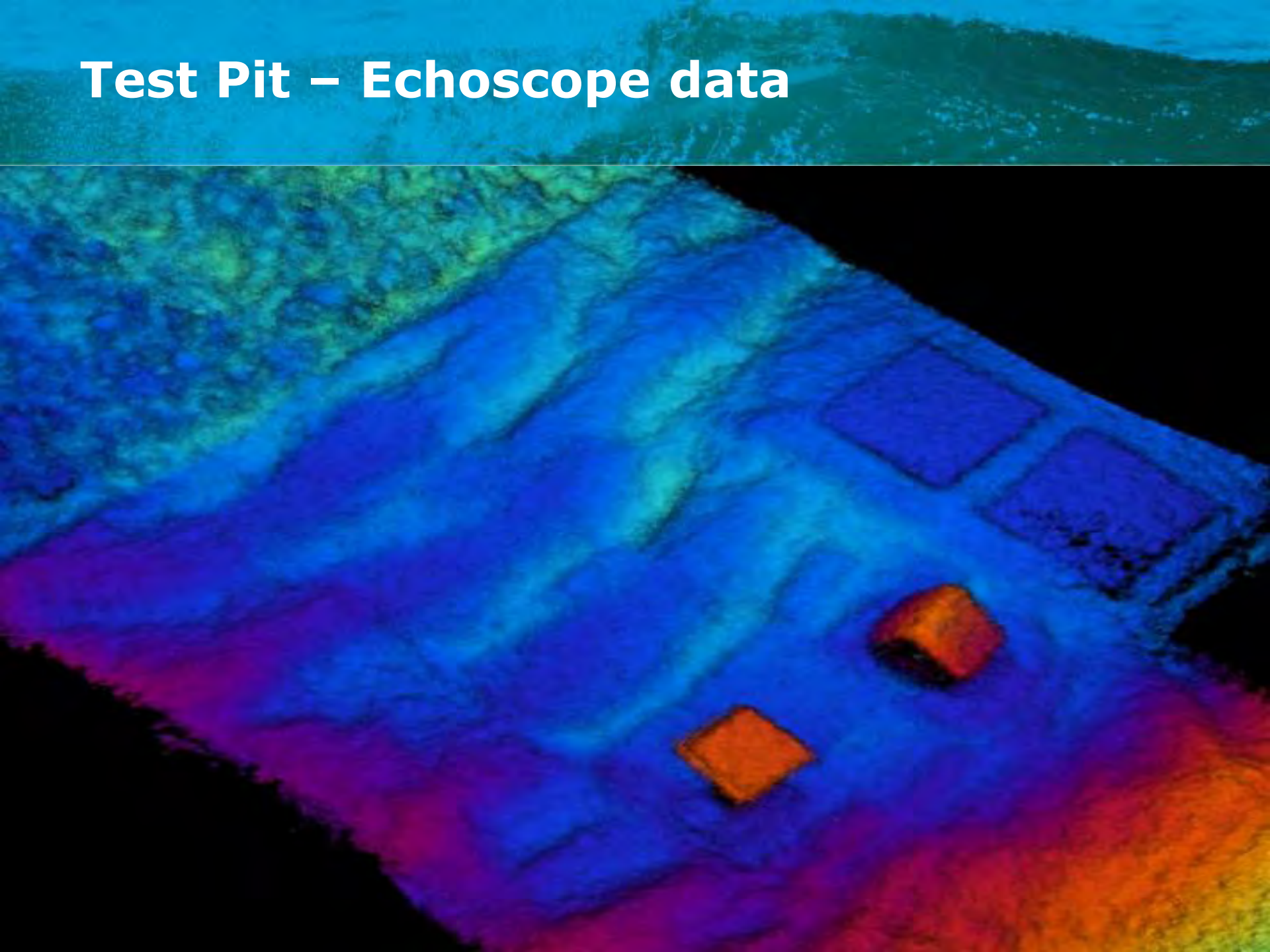
Test Pit – Underwater Measurements

•Setup measurments and Calibration on dry, with different equipment.

Test Pit – Echoscope data



Test Pit – Echoscope data



Test Pit – Results

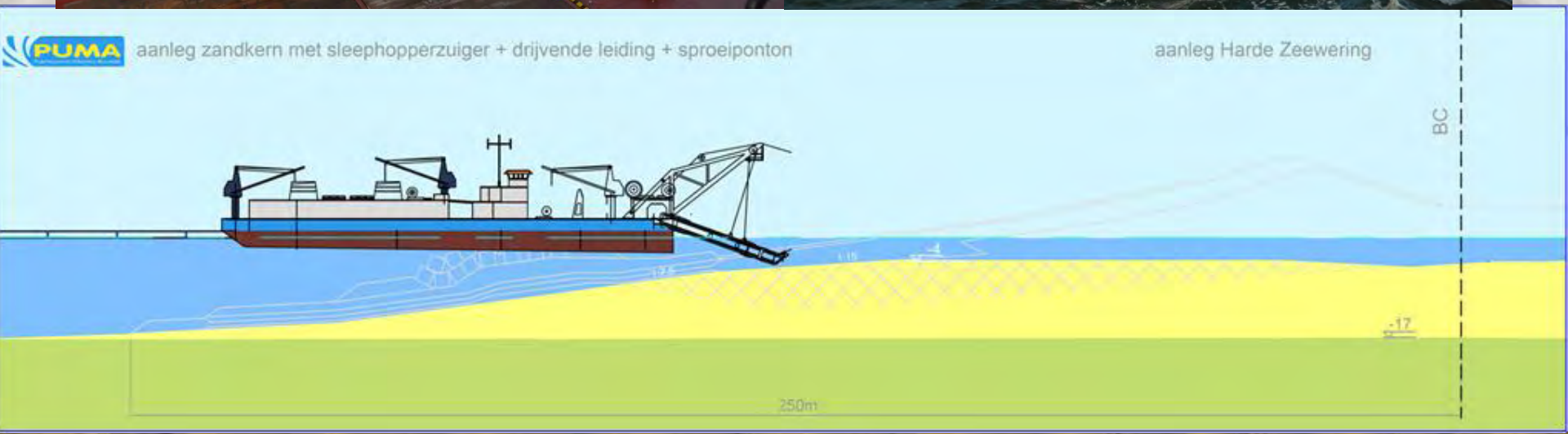
Survey System	Sand		20-135 mm		5 - 70 kg		150 - 800 kg		1 - 10 t	
	Systematic Error	Precision	Systematic Error	Precision	Systematic Error	Precision	Systematic Error	Precision	Systematic Error	Precision
Total station – plate	n.a.	n.a.	0.07	0.08	0.12	0.09	0.14	0.15	0.11	0.17
Total station – point	n.a.	n.a.	n.a.	n.a.	-0.07	0.07	-0.13	0.19	-0.27	0.51
Excavator – bucket[1]	n.a.	n.a.	0.17	0.13	0.14	0.15	0.34	0.27	0.32	0.40
Excavator - orange peel[2]	n.a.	n.a.	0.17	n.a.	0.08	0.11	0.18	0.21	0.20	0.36
Excavator – sorting	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	0.14	0.22	0.18	0.32
Single-beam	0.01	0.03	0.08	0.08	0.08	0.11	0.09	0.18	0.06	0.26
Multi-beam / Echo-scope	-0.01	0.02	-0.03	0.06	-0.11	0.09	-0.19	0.15	-0.38	0.26
Static laser	-0.01	0.05	-0.01	0.06	-0.04	0.10	-0.05	0.15	-0.18	0.23
Crane based laser	0.02	0.05	0.04	0.07	-0.01	0.10	-0.08	0.15	-0.25	0.24
Fli-map laser	0.00	0.06	-0.06	0.09	-0.12	0.10	-0.17	0.18	-0.36	0.27

Test Pit – Final Results

Results are included in the new edition of "Make and Measurement Accuracies in the execution of dredging and rock placement" ”

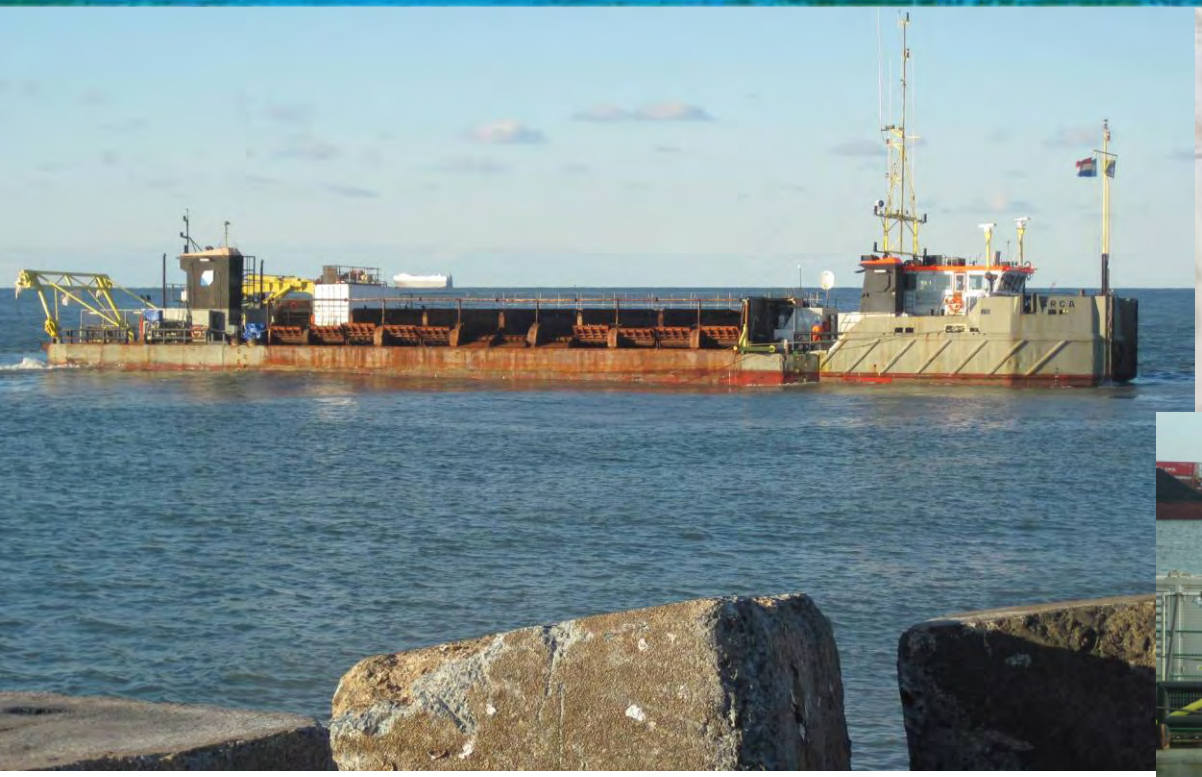
Sand – 240 million m^3 for fase 1

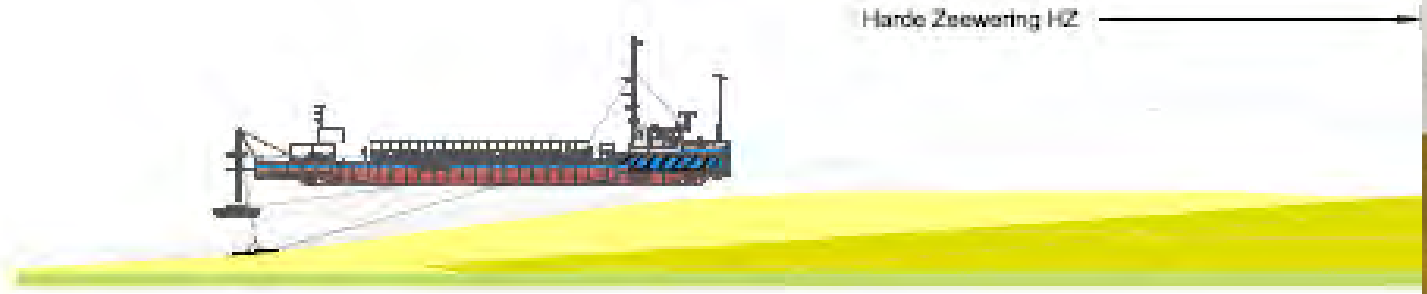
Construction hard seawall
Building sand profile



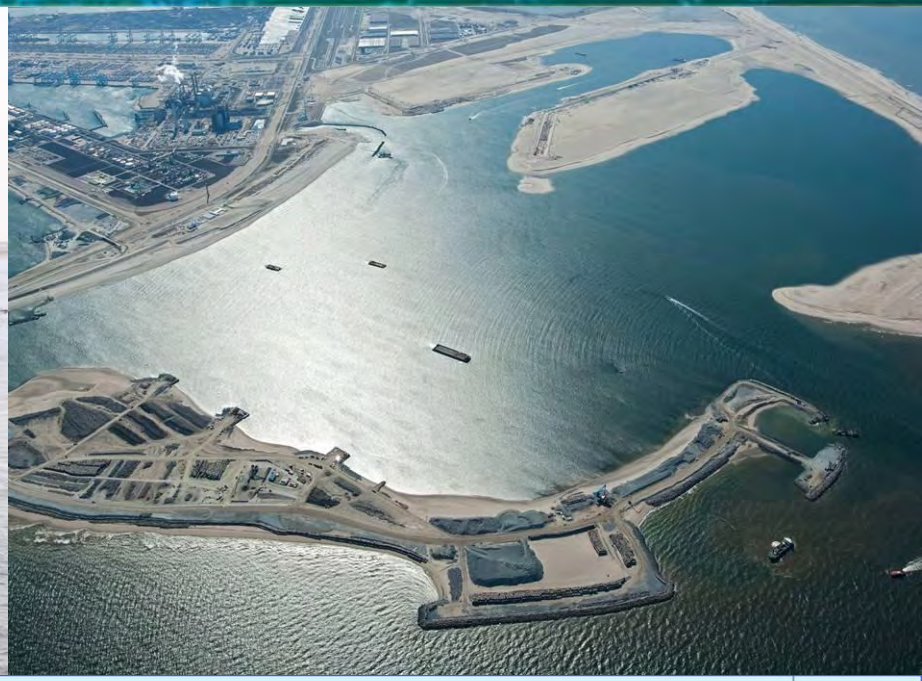
Construction hard seawall
Rock dumping underwater

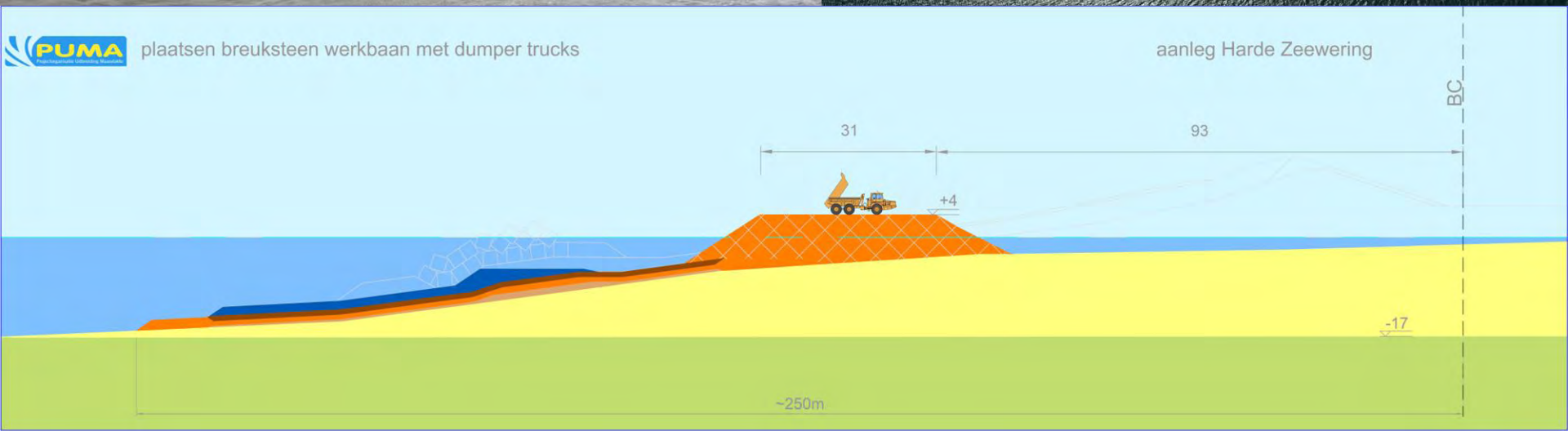
Profiling sand and stone
Plough Ship – Arca

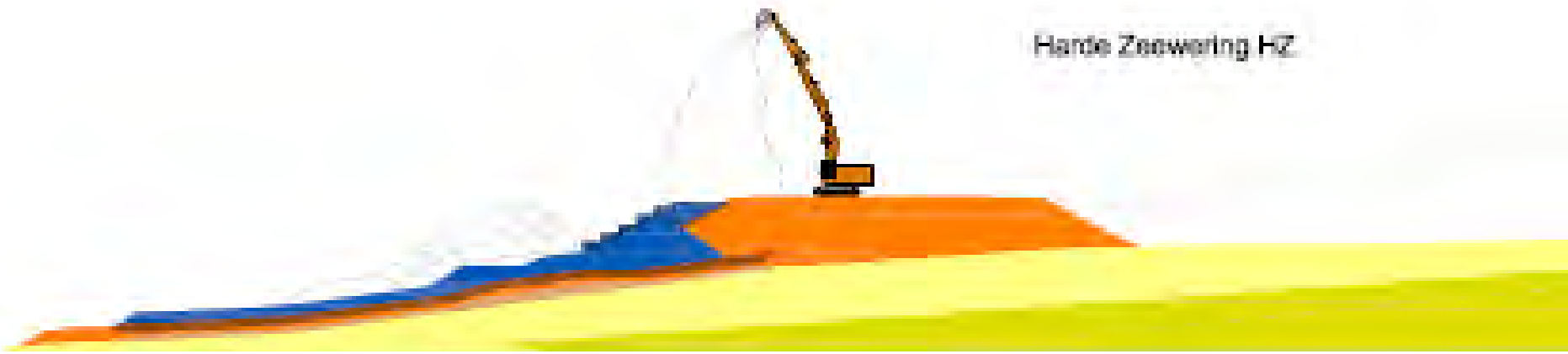


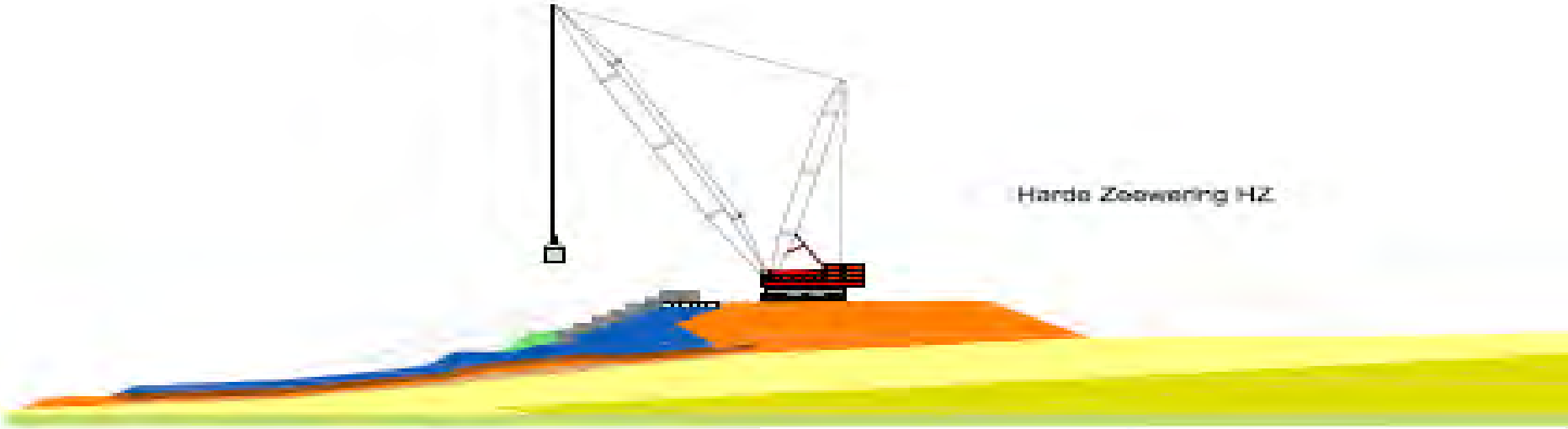


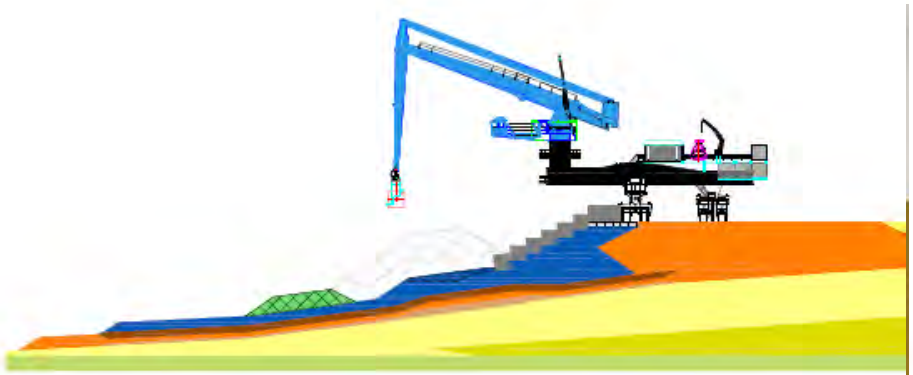
Construction hard seawall
Construction temporary work acces



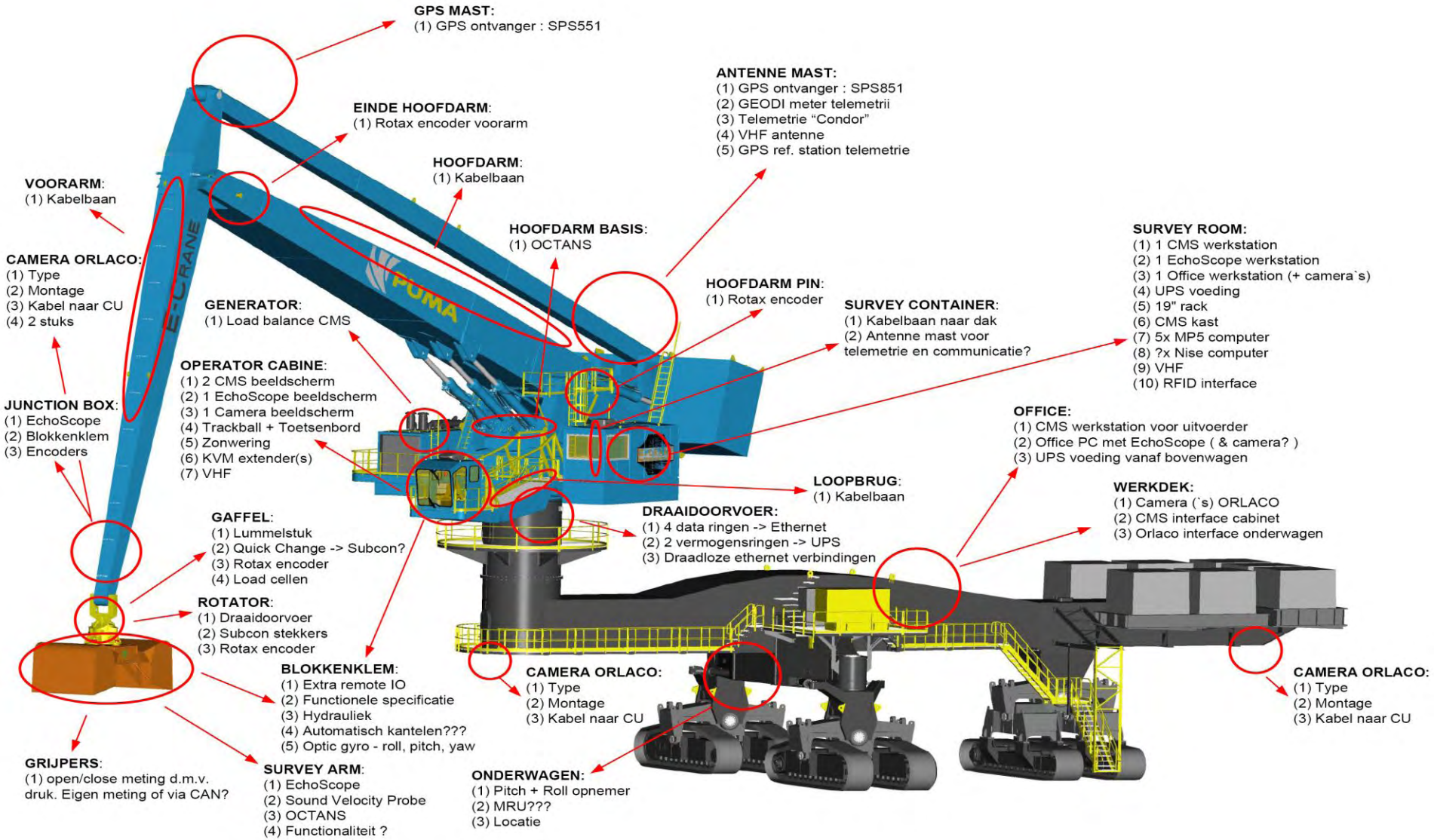



Harde Zeewering HZ


Harde Zeewering HZ

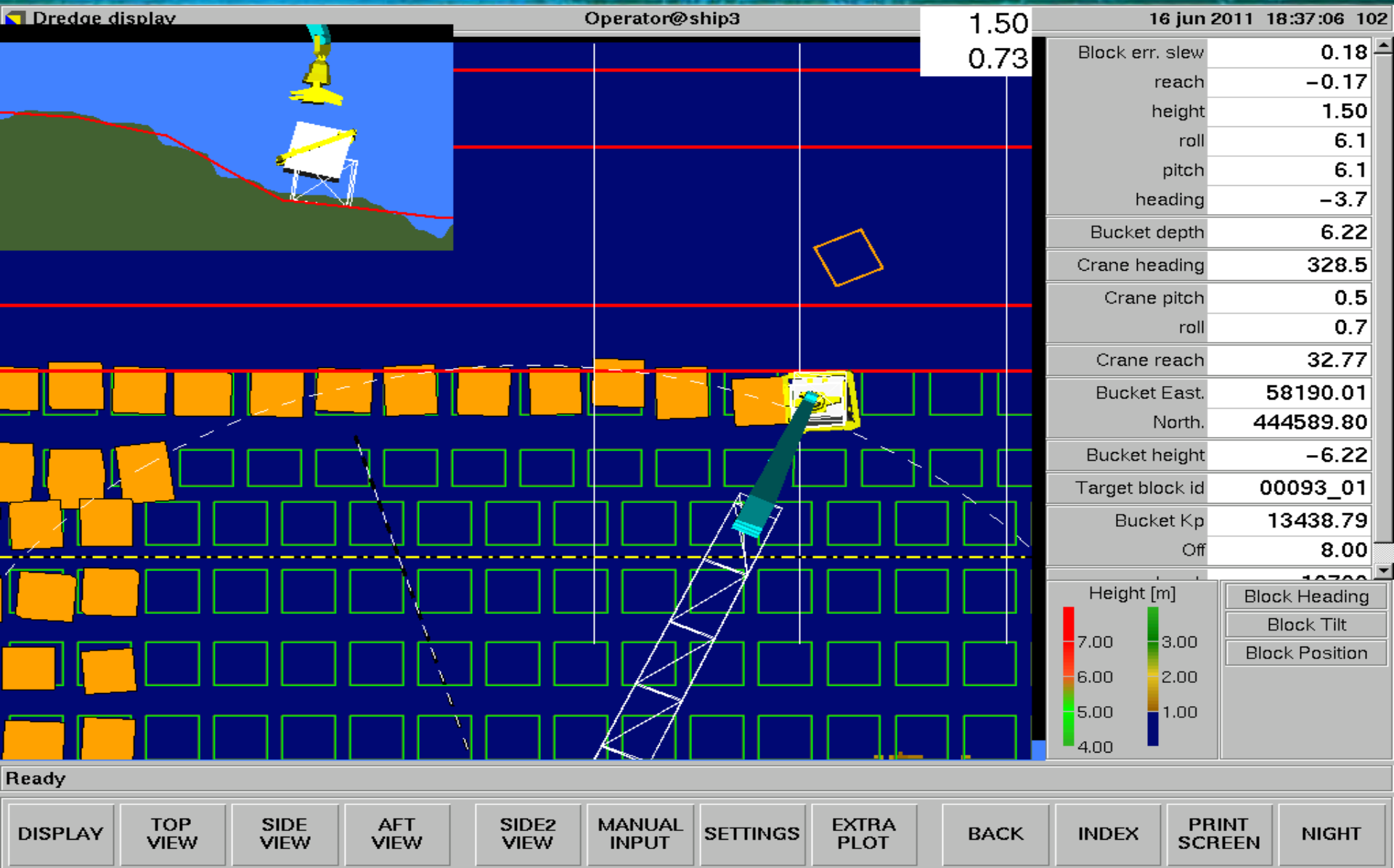


Blockbuster – Function overview




PUMA
BLOCKBUSTER

Blockbuster Crane Monitor System



Blockbuster position calculation system

Blockbuster in action

Blockbuster innovations

- Places blocks of 40 tons at 50m distance
- Horizontal and vertical accuracy <0.10m
- Crane monitoring system with 3D presentation of blocks
- Gyroscopes that measures the position of the clamp after the placement
- Linking crane monitoring system to PLC for automation purposes
- Automatic calculation of weight to be placed using an integrated grid cell.
- Sensors that monitor the inclination of the chassis
- Direct connection with recording computers for transfer measurement results

How do we measure this now??

Objectives:

- Measuring in shallow water to determine layer thickness of the quarry run.
- Measurement of the crown in order to determine altitude.

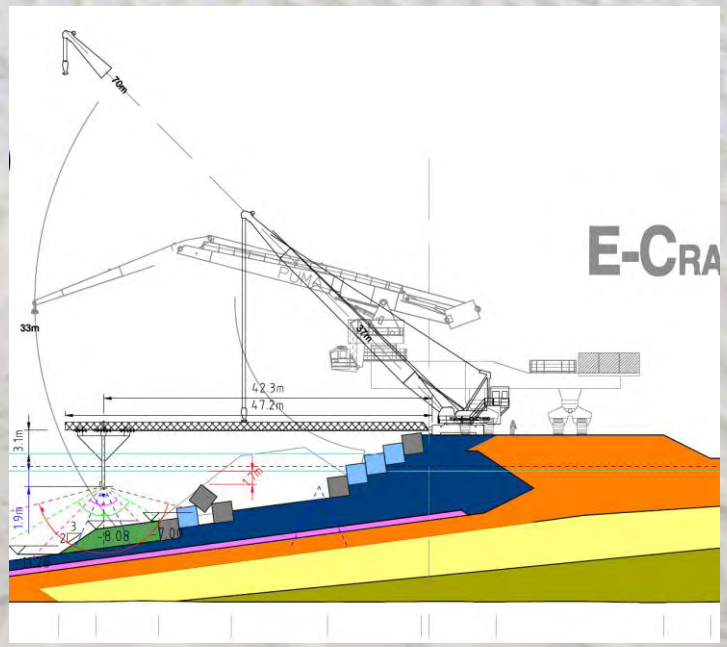
Which must be taken into account:

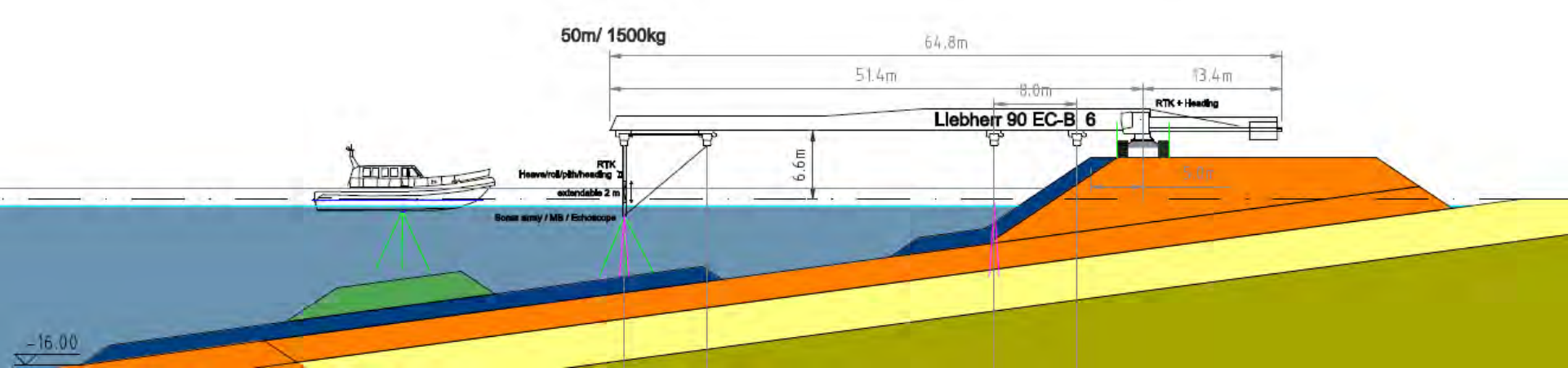
- High accuracy
- poor weather conditions

Progress of Blockbuster must be guaranteed!

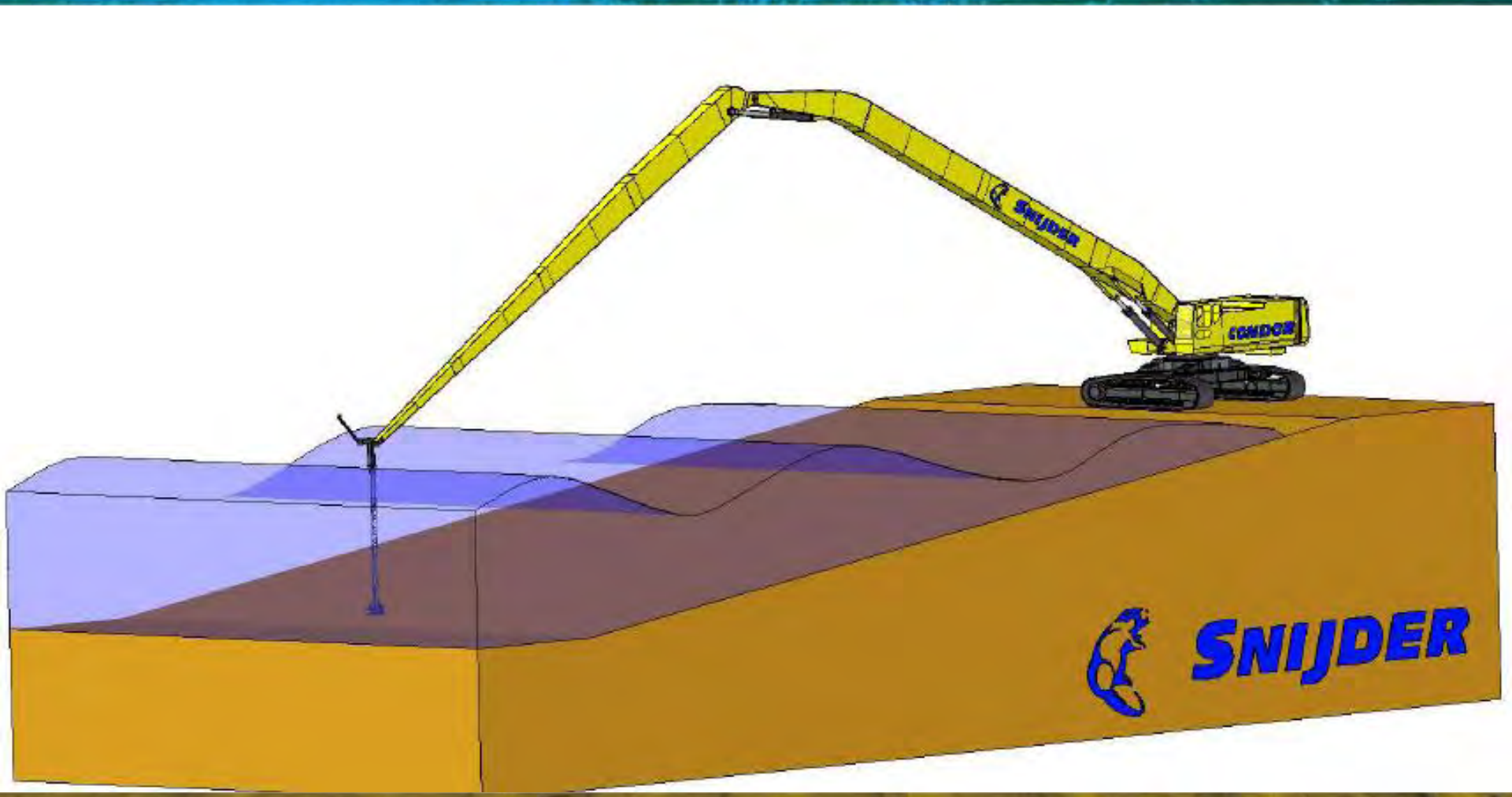
With what kind of crane?

- Tower crane
- Crawler crane
- Hydraulic crane
- Telescope crane





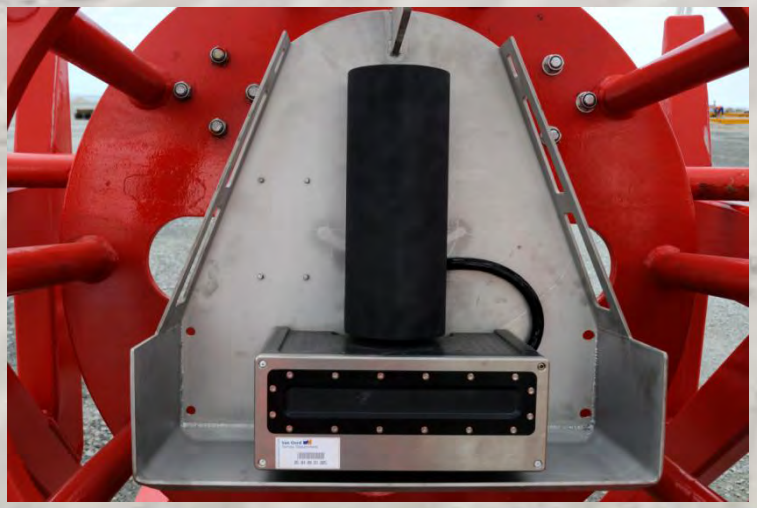
Condor
CAT 385, 46.5m



Condor
…. other dimensions ….

Condor – no more seasickness

Condor - Measuring Equipment



Condor - Measuring

Multibeam survey after the placement of the first 3blocks.

Multibeam survey on the 1-10 tonne toe structure and the second layer of blocks below the waterline

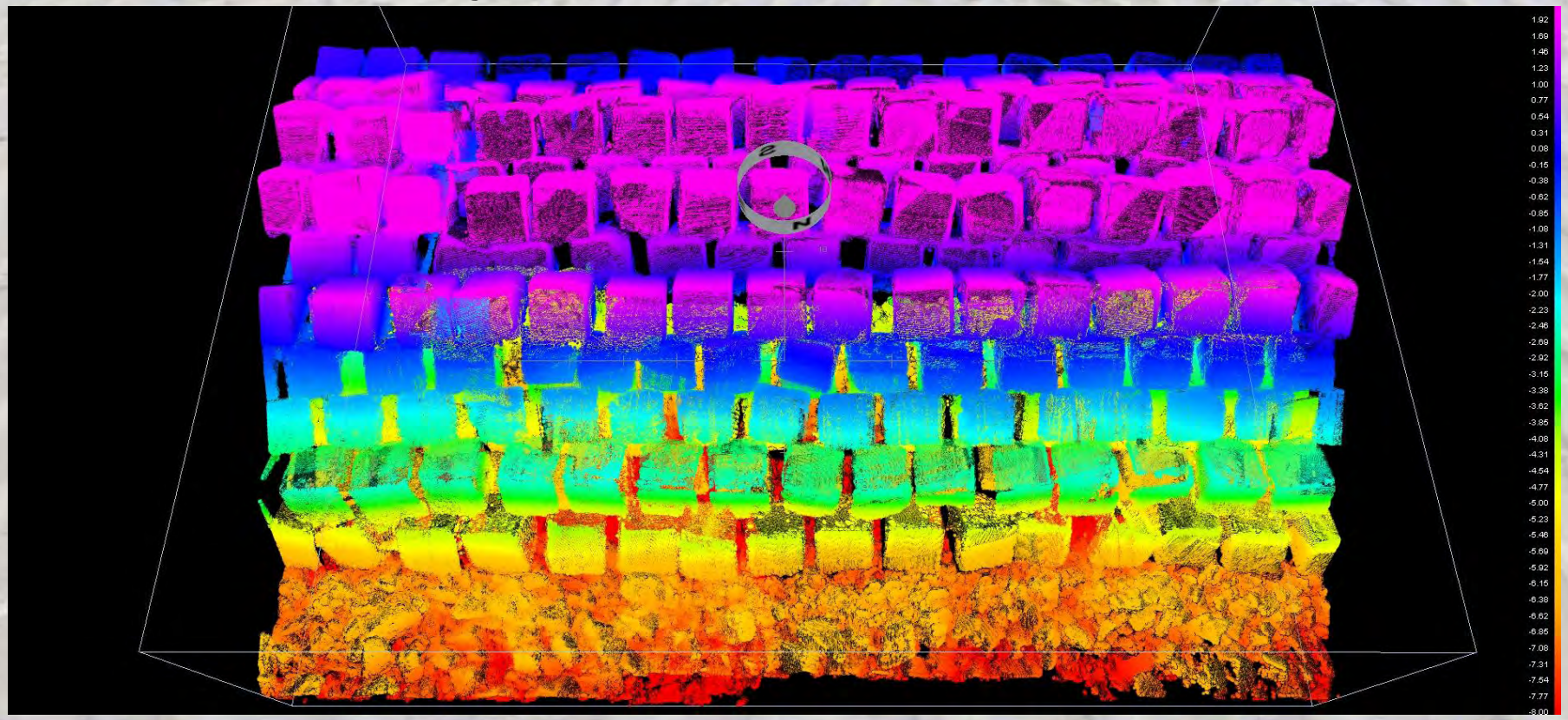
Laser scan survey of the crest blocks. Additionally the survey vessel will survey the remaining part of the 1-10 tonne toe structure.

Condor – In action

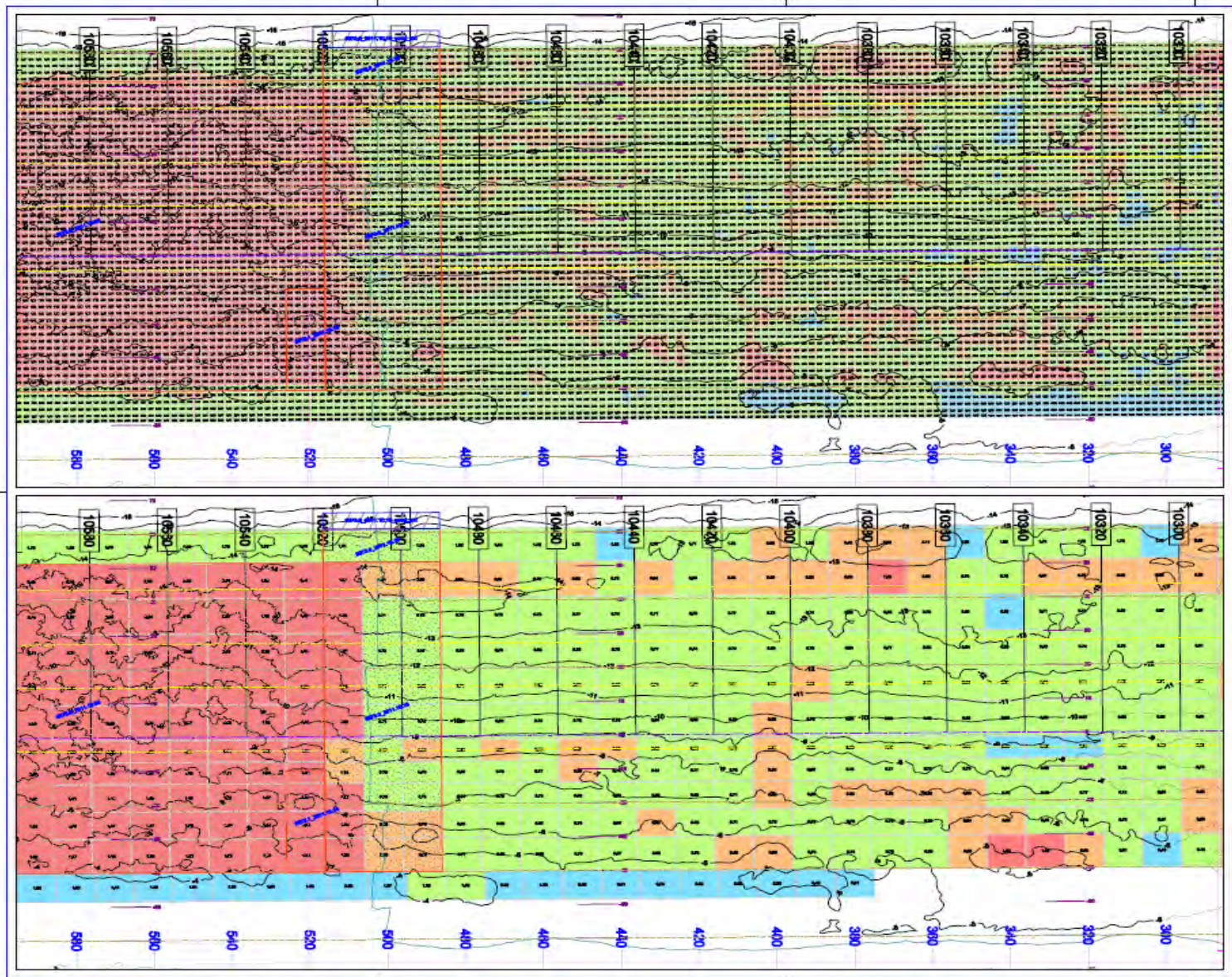
Condor – Echoscope Data

Condor - results

Combined survey with Multi-beam and laser scan data



Condor – Combined bathymetry results

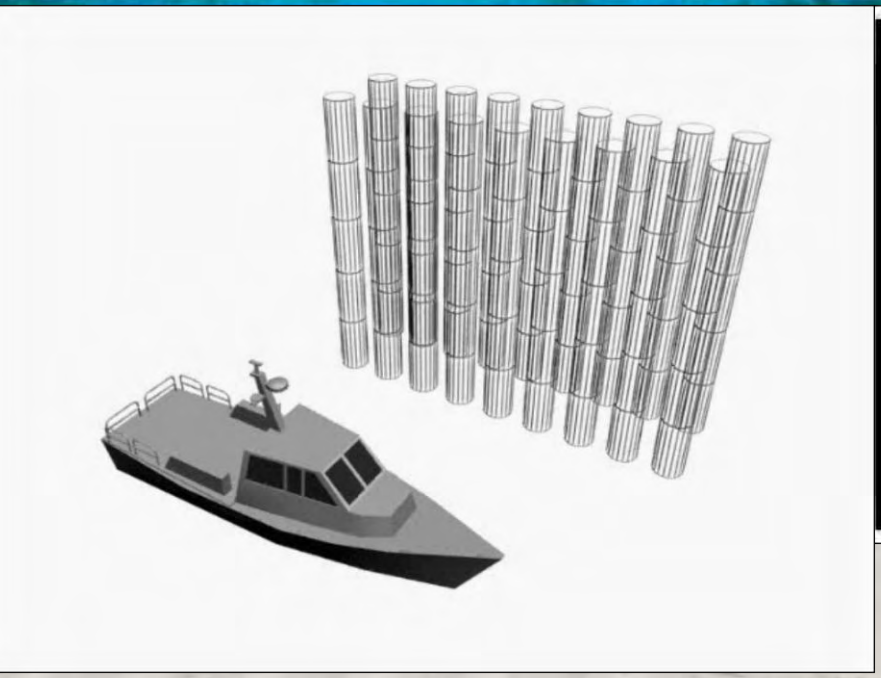


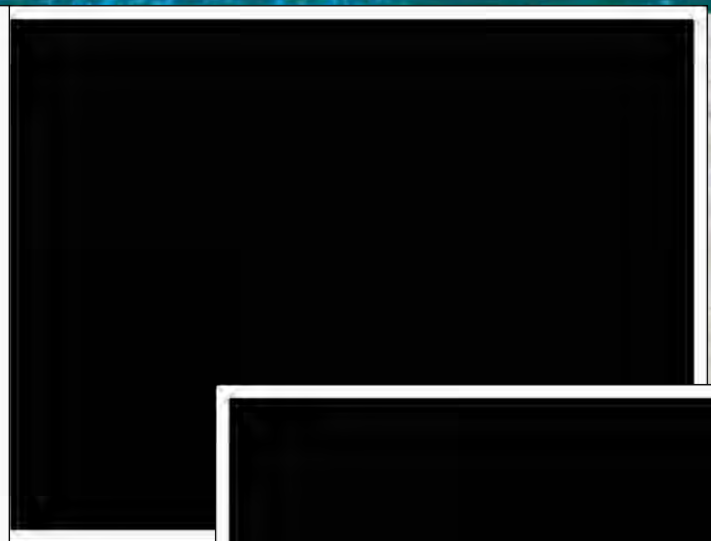
Condor - innovations

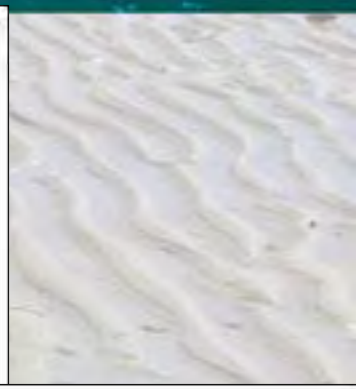
- Unprecedented range of 46.5 m
- Integrated Laser Scan for measuring crown blocks
- Multi-beam measurements to ± Hs 2m,and 0.5m water depth under the Multi-beam
- High measurement accuracy by mounting all sensors on a single pole
- Camera for visibilty

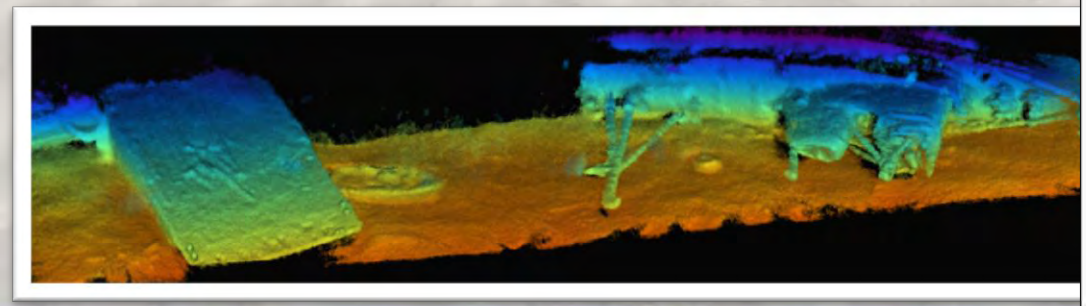
Removal Concrete Blocks on MV1

Echoscope as “underwater camera”

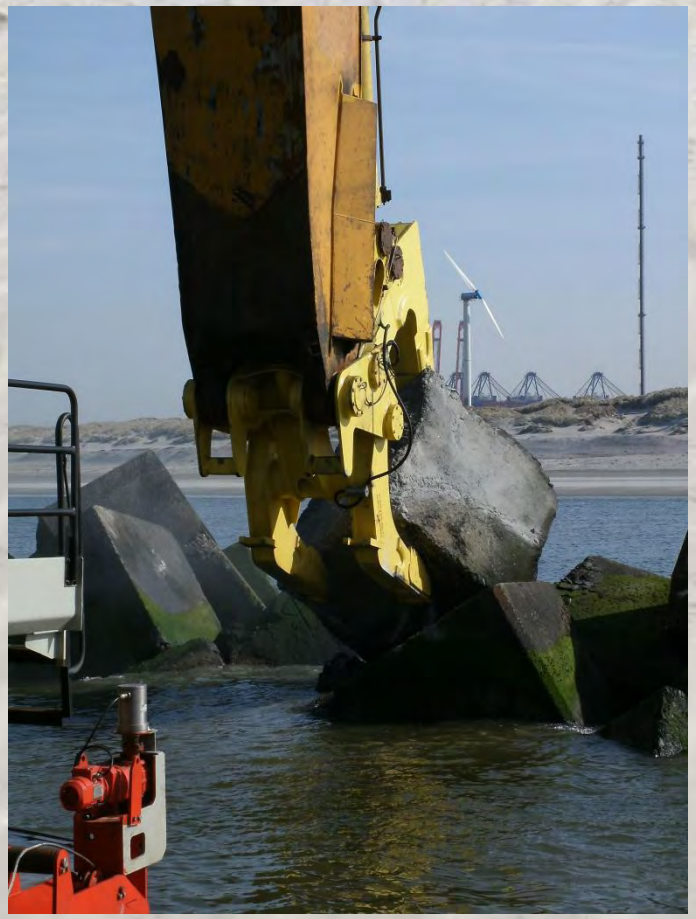


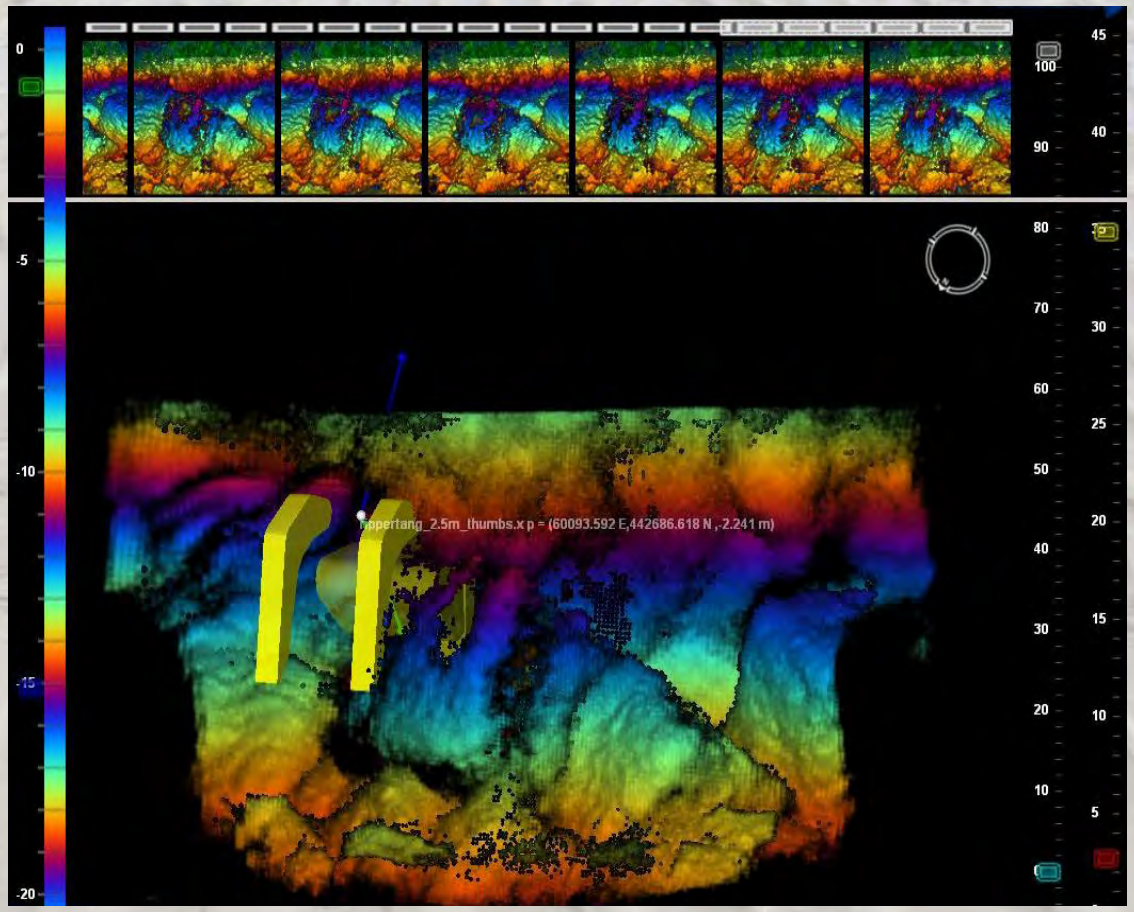




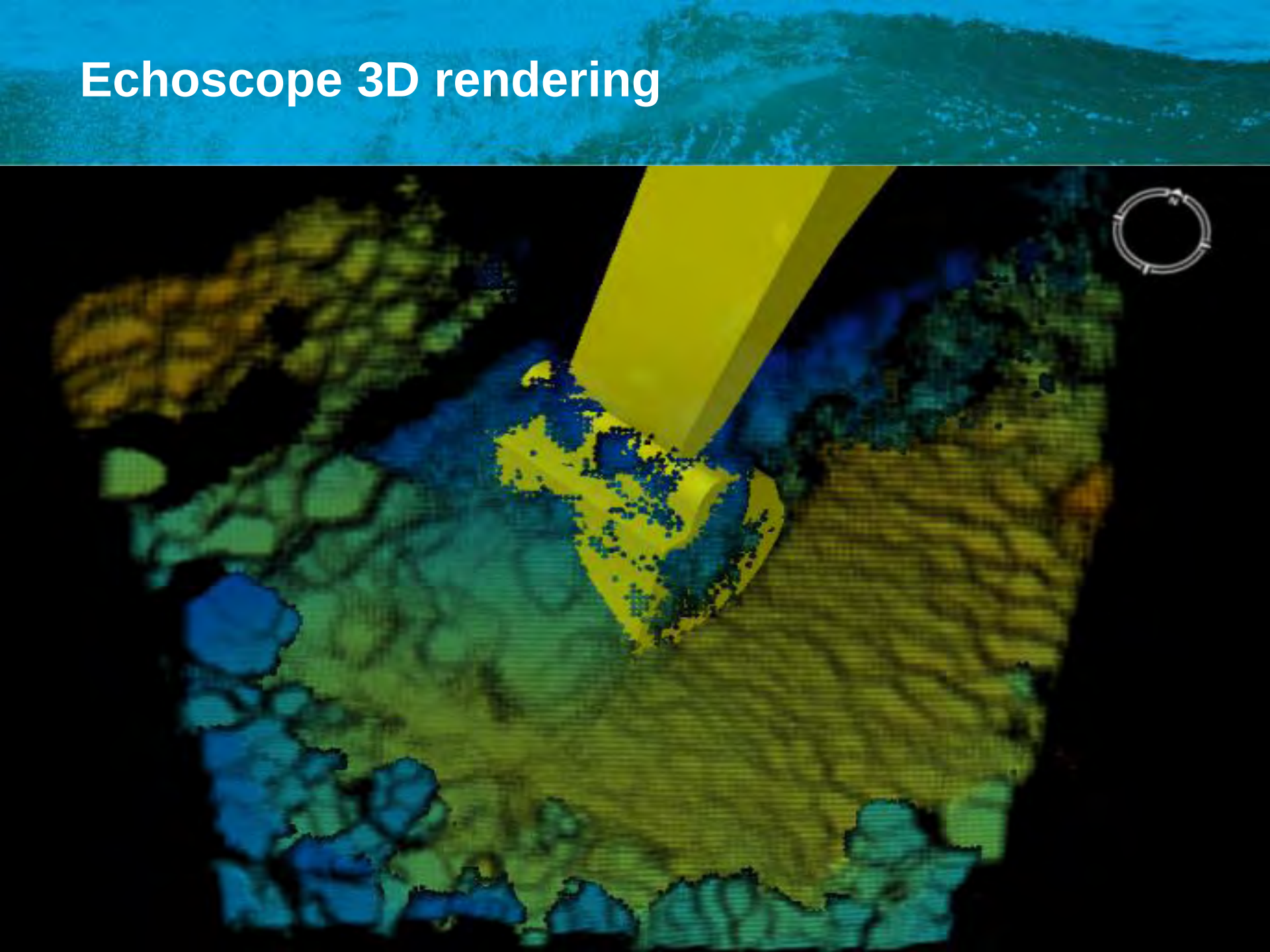


Echoscope as “underwater camera”





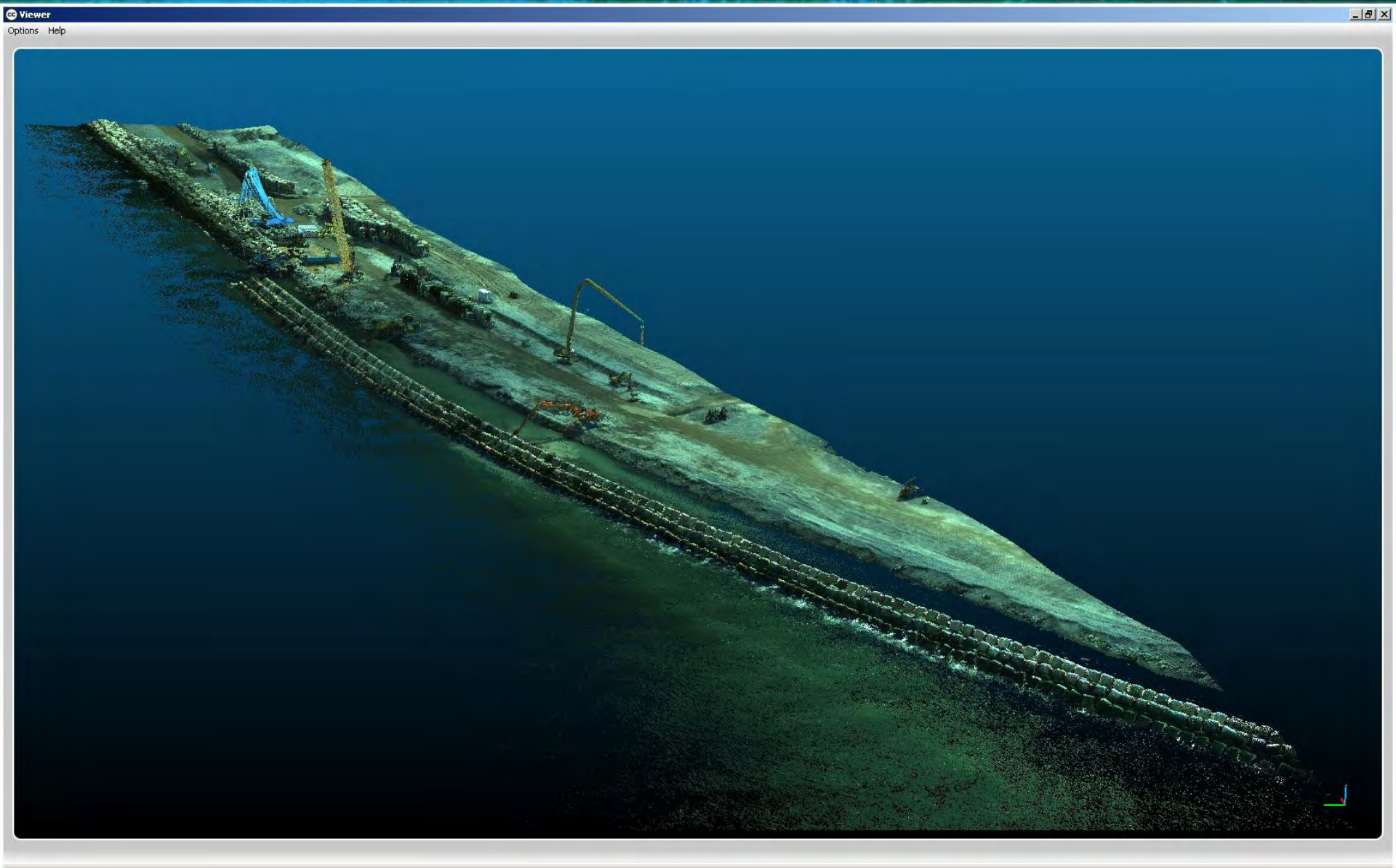
Echoscope 3D rendering



Echoscope innovations

- 3D Underwater camera to support the crane operator.
- 3D rendering of the ripper for better interpretation of the scope echo image.
- Ability to load a 3D model as reference layer.
- Automatically tracking the ripper by coupling with crane monitoring system
- Implementation of sound profile readings for accurate measurement
- Using Echo Scope as a survey instrument

FUGRO Fli-Map



Alternative : Gatewing X100

Gatewing X100
Autodesk infrastructure modeler

Evolution of mobile measurement methods on PUMA

ARGO amphibian

Evolution of mobile measurement methods on PUMA

Quad Yamaha Grizzly 350 4WD

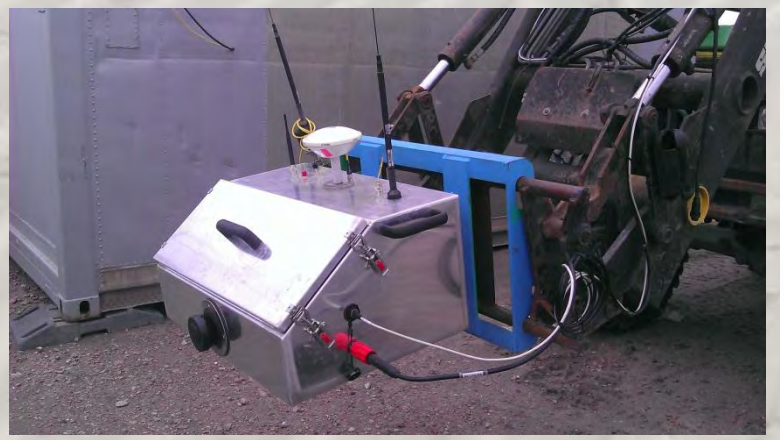
Evolution of mobile measurement methods on PUMA

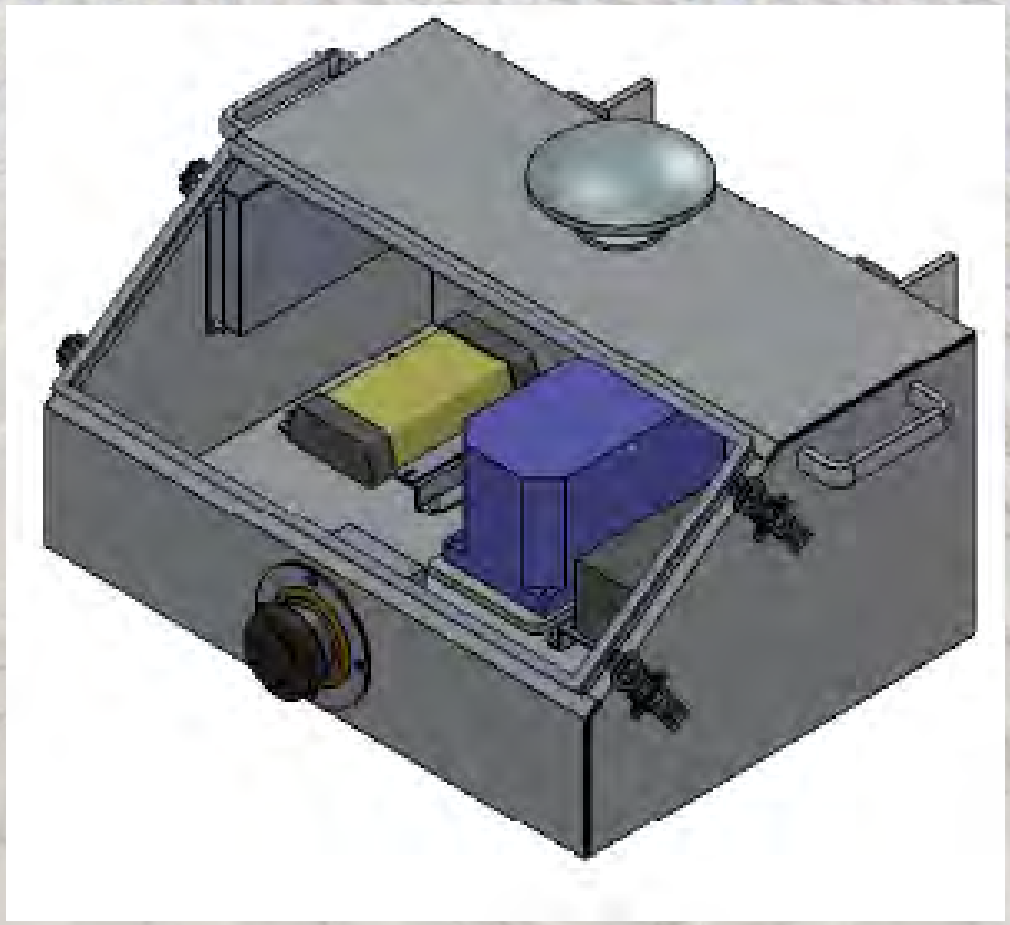
Opps!!….

Evolution of mobile measurement methods on PUMA

Mobile SICK

- Design
  - SICK LMS151
  - Trimble SPS851
  - Octans IV
  - WiFi





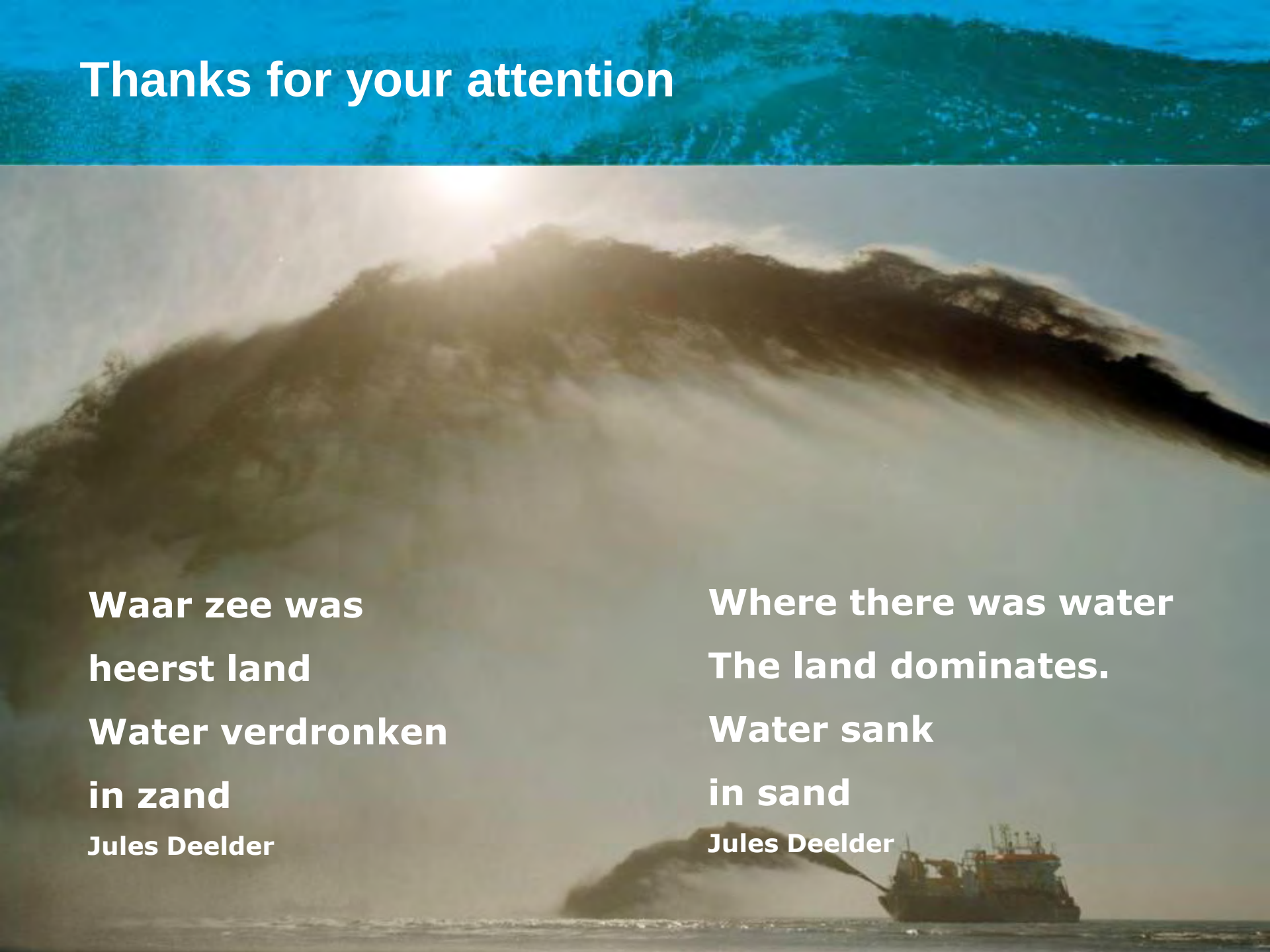
Mobile SICK - innovations

- Cheap (3500,- EURO)
- Small and robust
- Easy interfacing through existing software (PDS2000)
- Quick measurement of large surfaces
- Safe measuring coarse stone gradations
- Measuring stone depots

Survey Innovations Resume

- The development of a unique Crane Monitoring System (CMS)
- A new feature was added to the Echoscope to present the stick and ripper tool as 3D models
- Survey crane Condor with a massive 46.5 m reach was constructed.
- Recycling the block dam required special use of acoustic viewing systems as underwater cameras.
- Airborne systems like the Gatewing x100 represent a breakthrough which can clearly be applied to future projects.

Thanks for your attention



Waar zee was

heerst land

Water verdronken

in zand

Jules Deelder

Where there was water

The land dominates.

Water sank

in sand

Jules Deelder