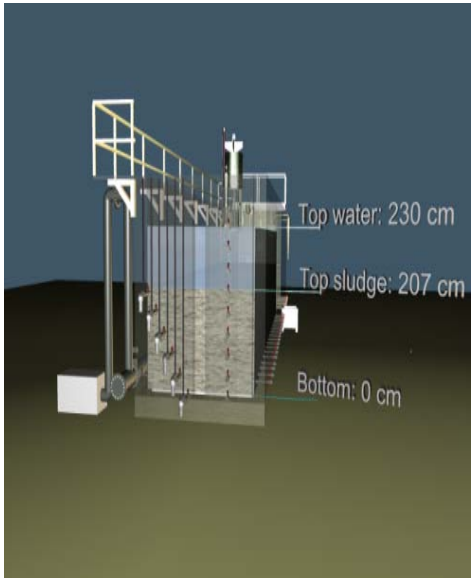
Re-thinking cohesive sediment dredging management; a combination of fundamental and pragmatic research.

- **Renaat De Sutter, Styn Claeys, Thomas Van Hoestenberghe (Antea group)**
- **Toon Verwaest, Joris Vanlede, Jeroen Verwilligen, Guillaume Delefortrie (FHR)**
- **Peter Staelens, Jan Van Roeijen (Dotocean)**



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Content

- **Introduction & overview**
- **Laboratory tests and protocols**
  - Density
  - Rheology
- **Sludge test tank**
  - Pro's and con's
  - In-situ tests
- **Scenario testing tools**
  - STT
  - Consolidation columns – tracers – scans
- **Conclusion**

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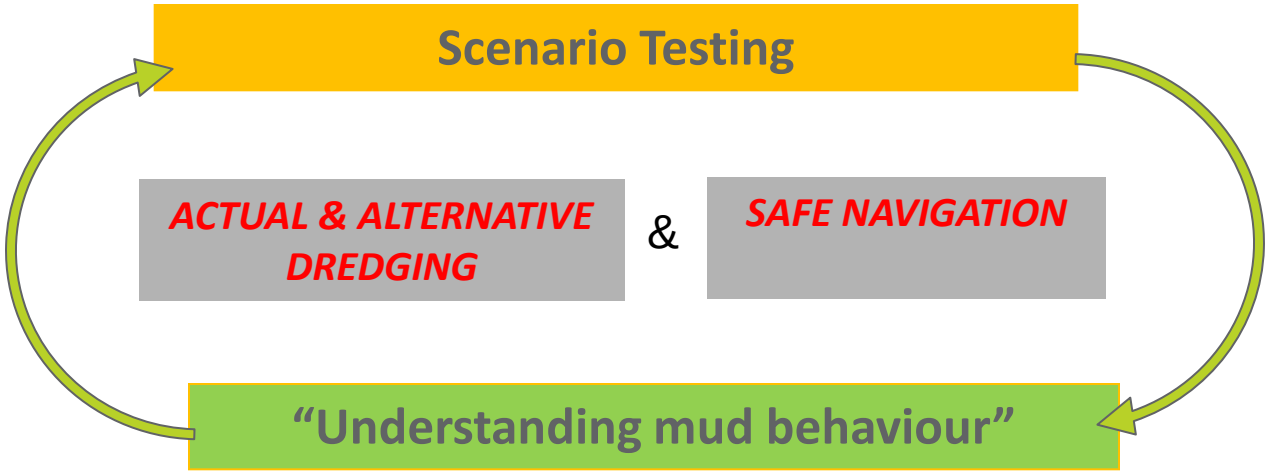
Measuring the Nautical Bottom: a challenge



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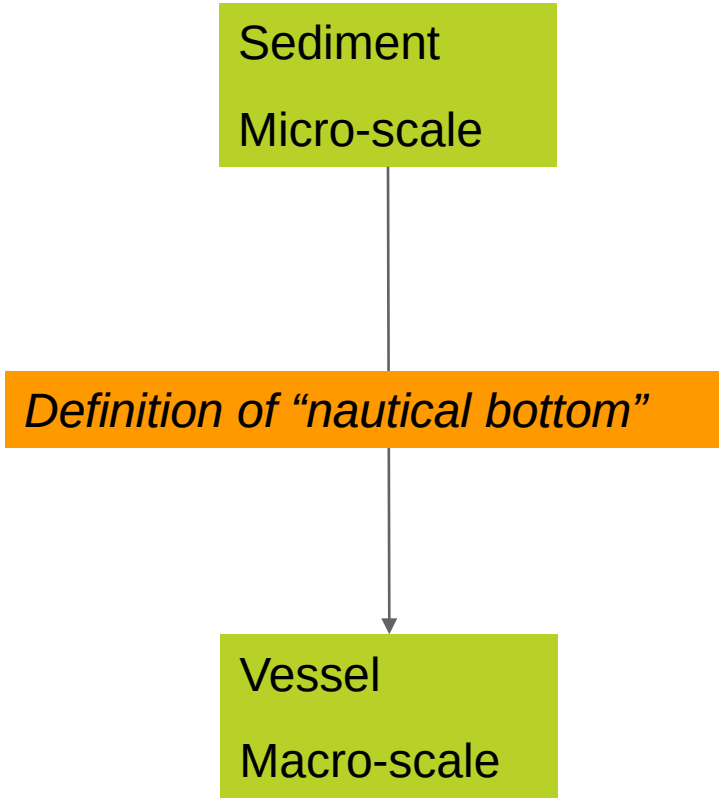
Understanding mud behaviour via an extensive measuring program

- Laboratory environment
  - **Density**
  - **Rheology**
- In-situ measurement devices
  - **Density**
  - **Rheology**
- Physical tools
  - **Towing tank**
  - **Sediment test tank**
- Numerical tools
  - **CFD**



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LABORATORY

- Density

Gamma (Cs 137)
densitoscan

Anton Paar DMA 35

Pycnometer

Fig. 1. The Pycnometer

Accuracy = f(viscosity, large grains and bubbles); OK till 1,25 g/cm^3

- Rheology

Anton Paar MCR301

Shear Stress/rate controlled

Changes in techniques

- no spring in new generation
- open cup (large gap)
- new protocol needed → see next

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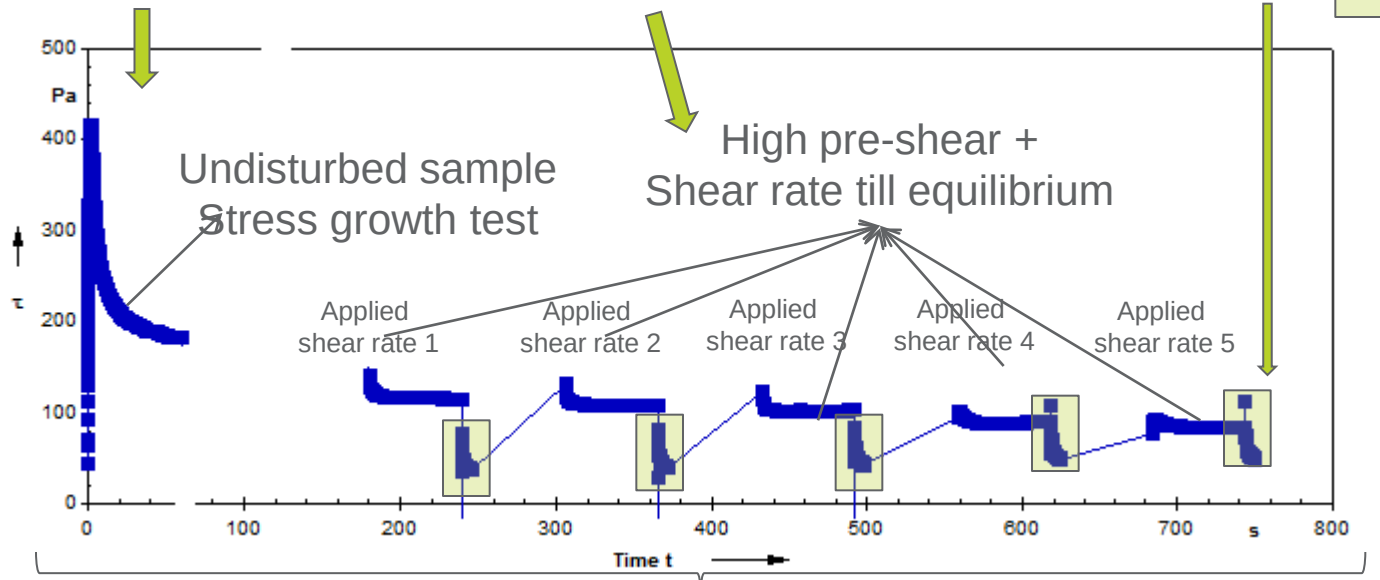
Rheology Lab Protocol

What a vessel feels at first contact with undisturbed mud - ***What a vessel (different parts) feels when mud is moving (disturbed mud)*** - ***What the next vessel could feel***

True Yield (Static yield) + *EFC* + *Retained stress*



Worrall-Tuliani model
4 parameters

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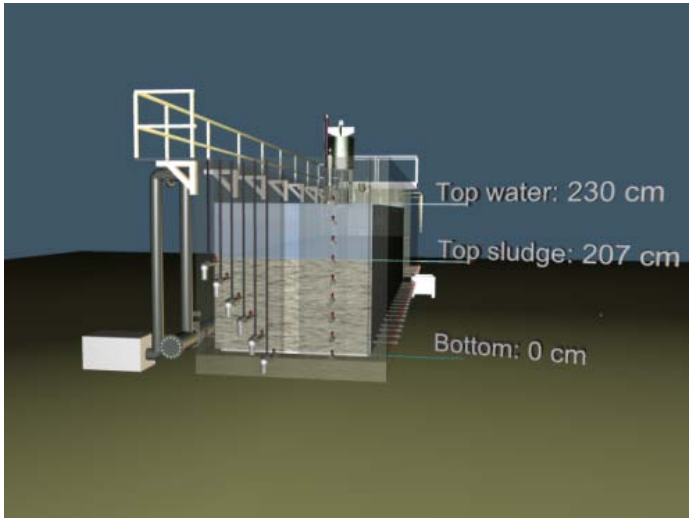
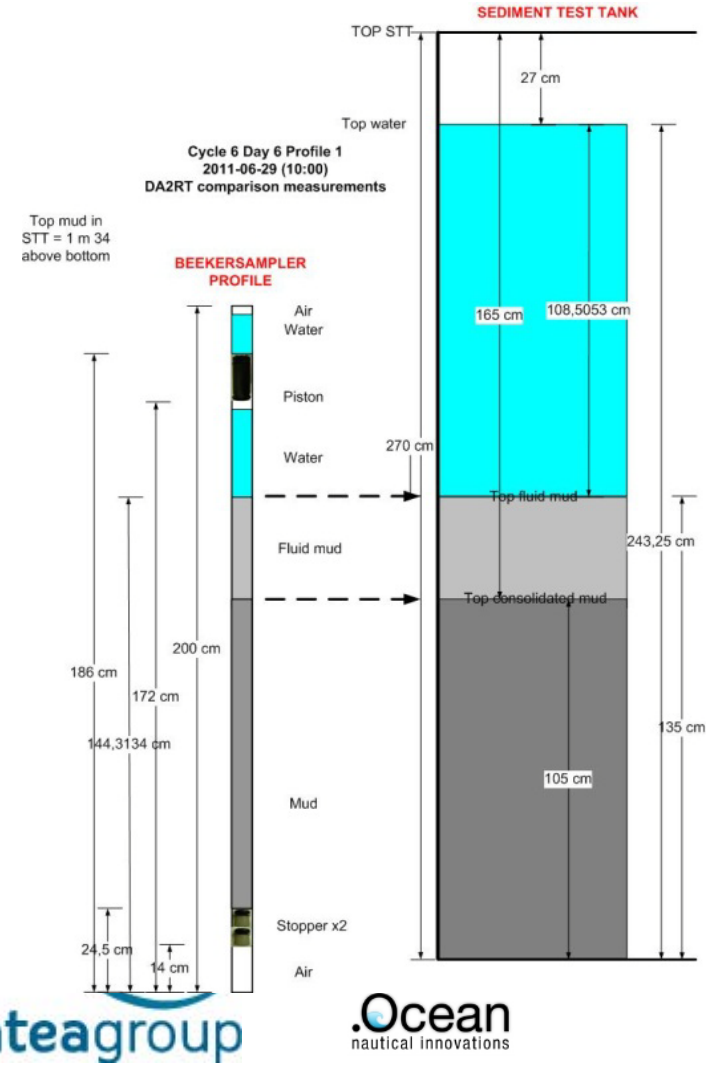
“IN-SITU” = Sediment test tank

Controlled comparison





- Representative mud-sampling
- Distinct layers
- Quick analysing (transport)
- But … no tide

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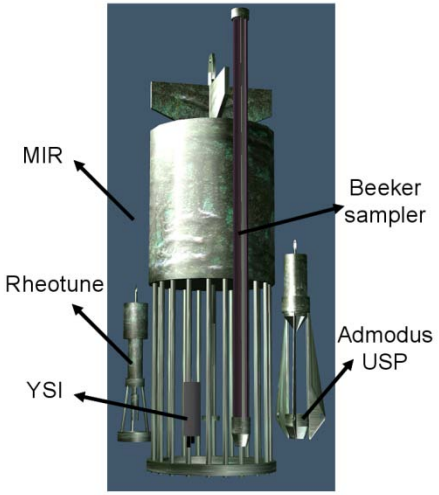
“IN-SITU = Zeebrugge” comparison

In-situ

Un-controlled comparison



- Representative mud-sampling ?
- Distinct layers ?
- Lateral variation?
- Quick analysing (transport) ?
- But … in situ

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IN-SITU / Sediment Test Tank

- Comparison **density** devices

2009-2010
*In-situ **Density***
"All instruments measure density correct till 1,25 g/cm³"

Densitune/Rheotune

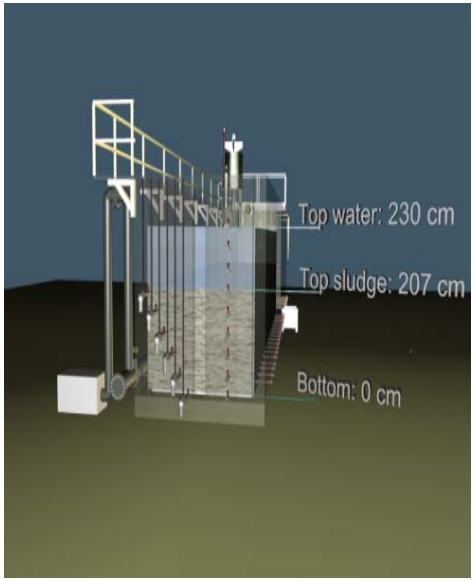
Navitracker 2011

Navitracker

Admodus USP pro

DART & DA2RT

DRDP



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IN-SITU / Sediment Test Tank

- Comparison **rheological** devices

- Instruments individually tested in STT
- Measuring (artificial) rheological transitions
- Only 1 point on the rheogram (behaviour ?)

MIR

Graviprobe

Rheotune

Rheocable

Admodus USP pro

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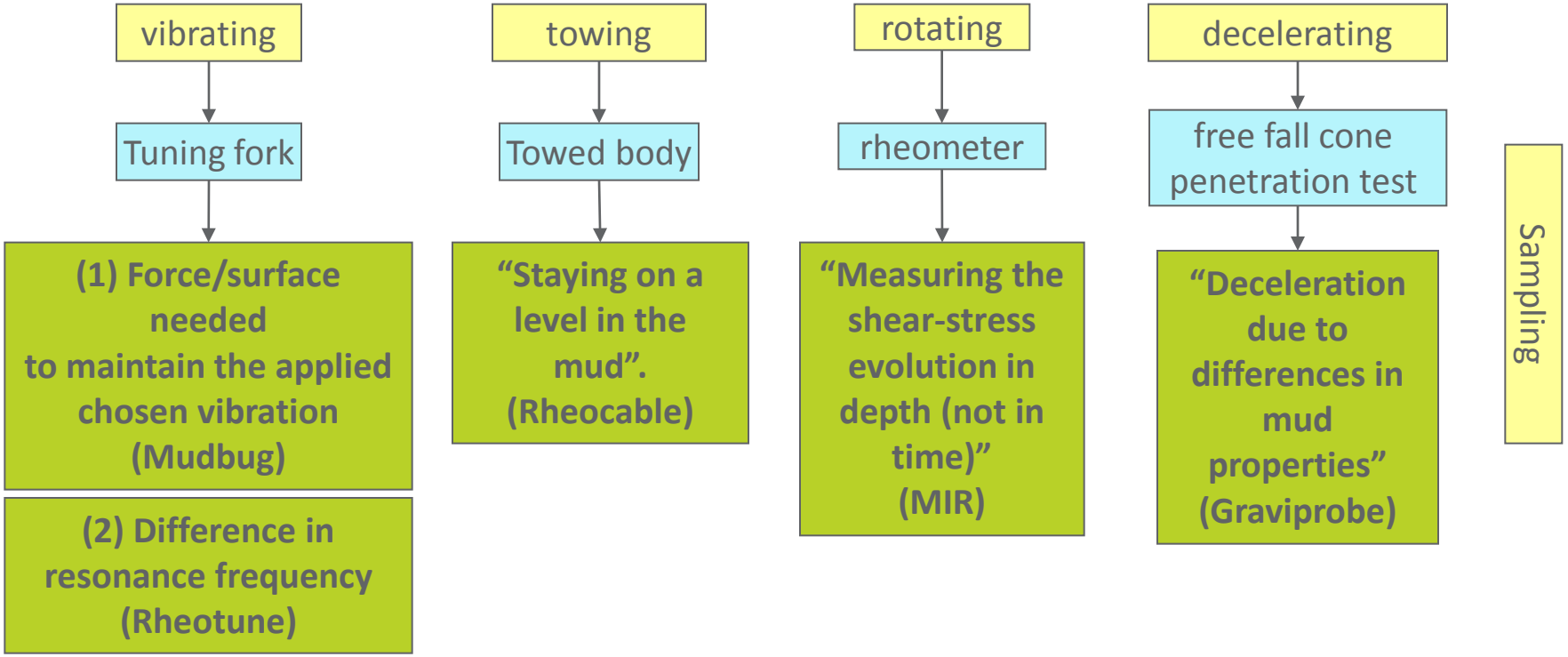
Rheology - Mechanical measurement principle = “feeling the mud”



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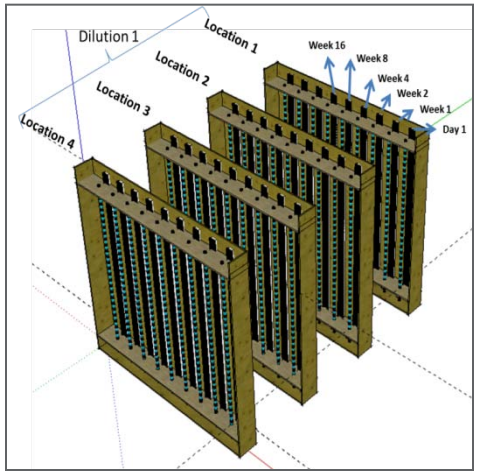
Scenario Testing Tools

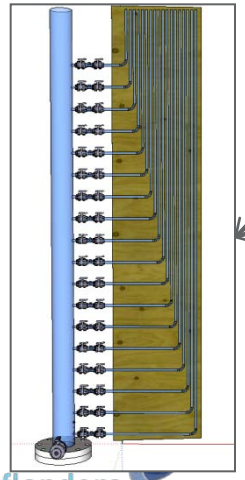
"Knowing the cohesive sediments"

Sediment Test Tank

Preparing sediment and testing devices

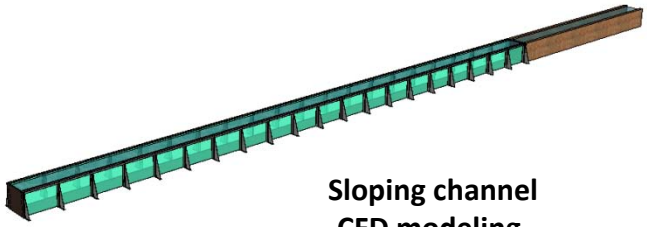
Consolidation Columns
& tools: tracer / structure-scan





Scenario Testing

Towing in real mud



Sloping channel
CFD modeling

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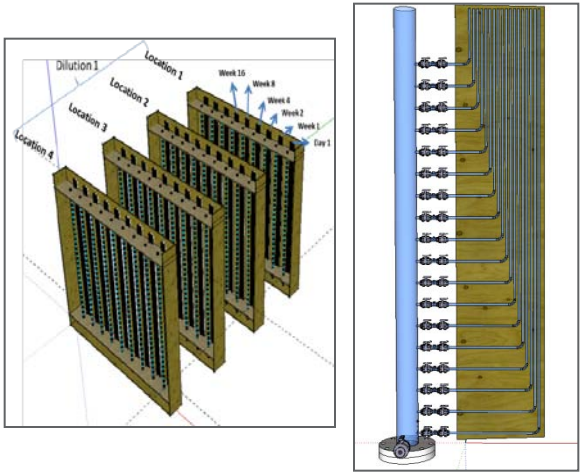
“Knowing the cohesive sediments”

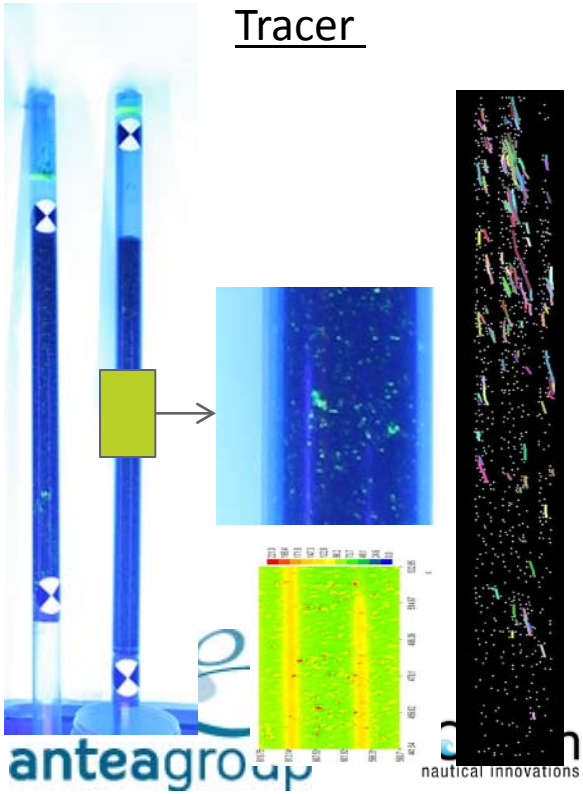
Tools to “follow up”, “predict” and “adapt”

Visualisation tools to follow up consolidation and structure

Consolidation Columns

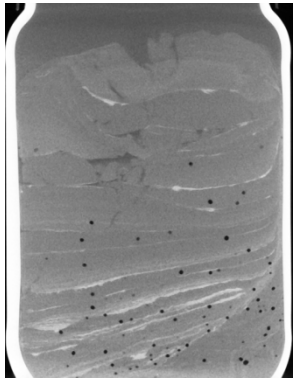


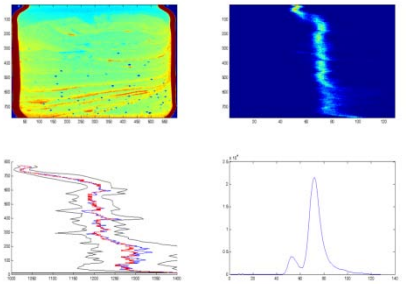
Tracer



Structure-scan

Acoustic CT-scan





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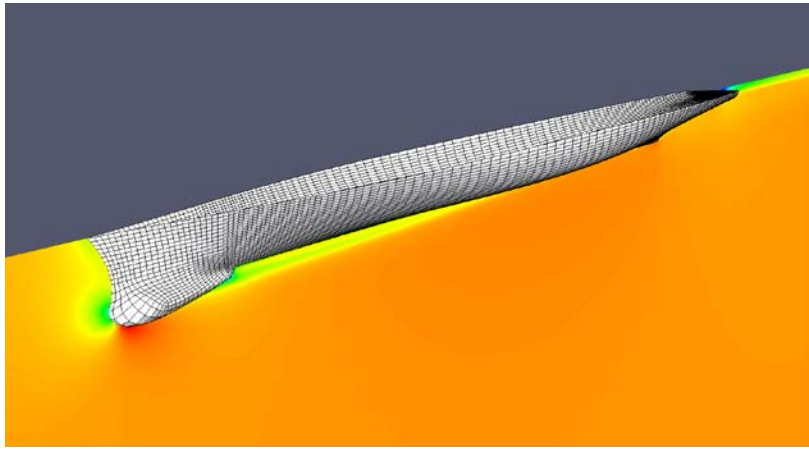
CFD

- Feasibility study (FHR-Antea Group - Kuleuven)
- “Can CFD be used as a tool to model forces on a vessel manoevring through mud?”
- Towing simplified geometry as a testcase
- Open Foam (Open Source CFD Software)
- Delivered end 2014



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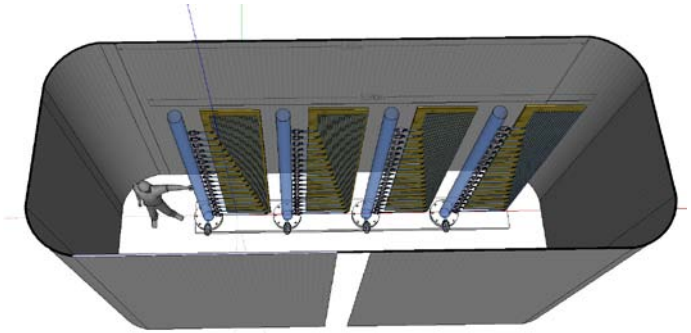
Conclusions

- Mud behaviour at micro-scale / ship behaviour at macro-scale
- New developments
- Alternative dredging scenario’s
- Nautical bottom definition



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