



its

SEE INSIDE YOUR  
PROCESS

# DEVELOPMENT AND DEPLOYMENT OF A NON-NUCLEAR DENSITOMETER, BASED ON ELECTRICAL RESISTANCE TOMOGRAPHY

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**INDUSTRIAL TOMOGRAPHY SYSTEMS PLC**

**[www.itoms.com](http://www.itoms.com)**

**WODCON XXI**

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# ABOUT ITS

Manchester University spin-out

Approx. 20 staff

Commercialised

- Electrical resistance tomography
- Electrical capacitance tomography

Key markets

- Pharmaceuticals / speciality chemicals
- FMCG
- Petrochem
- Niche (dredging, nuclear waste management)
- Research institutions

Units installed round the world

# MOTIVATION TO REPLACE NUCLEAR SOURCE

## Operational benefits

- Lower cost maintenance
- Eliminates local compliance rules, regulations
- Simpler transport and installation
- Reduced whole life cost
- Additional information

## CSR (Corporate responsibility and risk) benefits

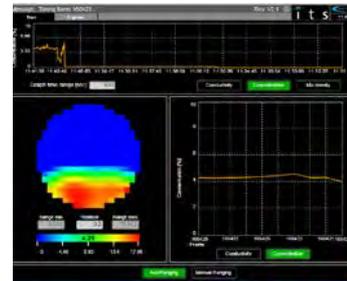
- Sustainable – no nuclear source in operations
- No remainder disposal
- Eliminates risk
- Simplifies working procedures



# PROCESS TOMOGRAPHY - A NEW MEASUREMENT METHODOLOGY

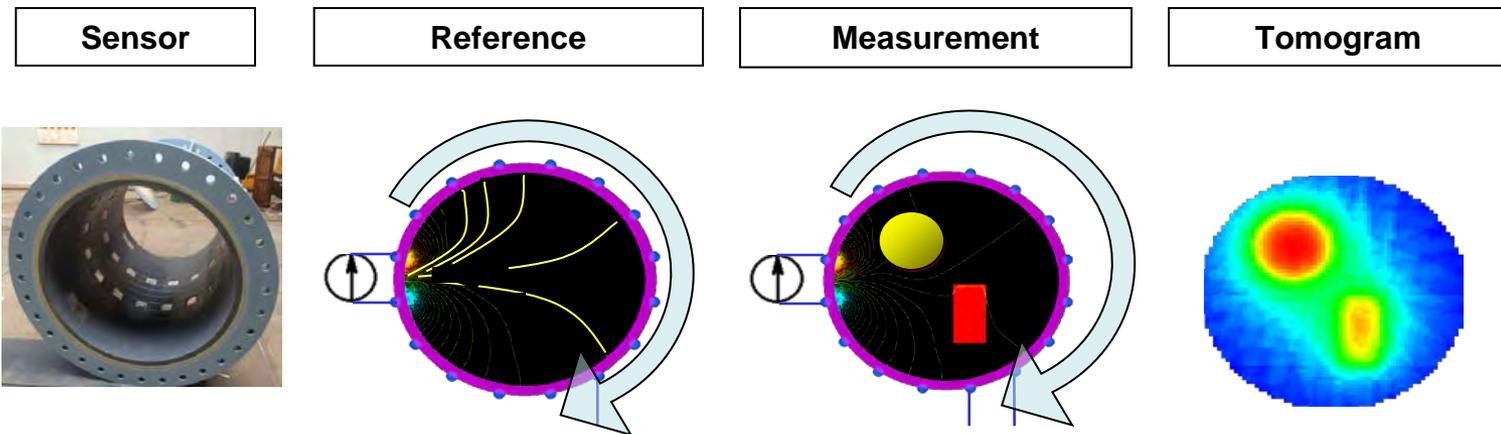


Combines measurements from distributed sensors to determine internal conditions



# MEASUREMENT PRINCIPLES

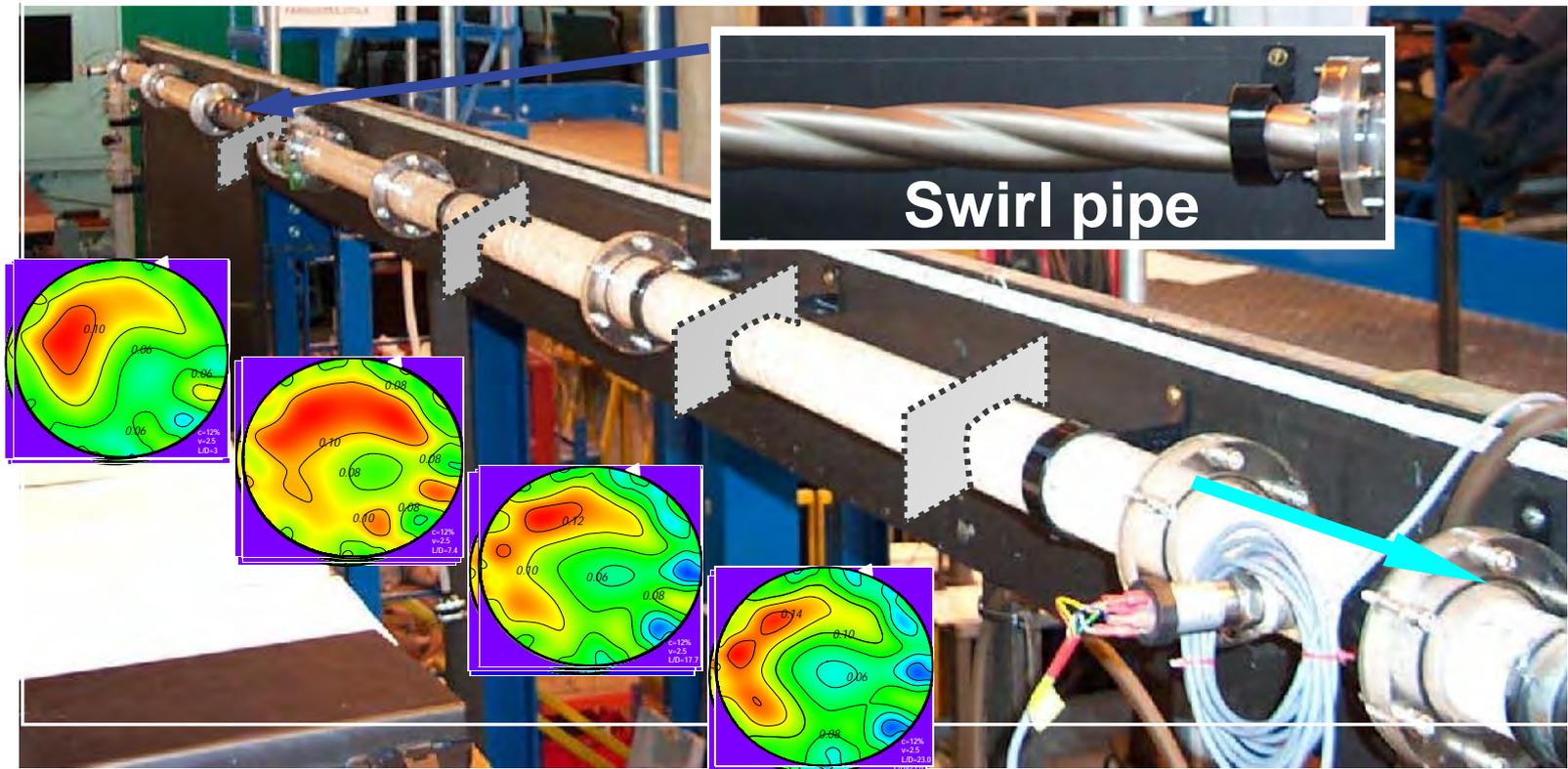
- Conductivity scan across electrode array
- Compare to reference
- Algorithm to map conductivity
- Conductivity map produces solids concentration



# VISUALISATION OF SLURRIES

Solid volume distribution at downstream positions

- L/D=3.0, 7.4, 17.7 and 23
- Water flow velocities of 1, 1.5, 2.0 and 2.5 m/s



# TECHNOLOGY READINESS LEVELS

Technology Readiness Level	Description
TRL 1.	basic principles observed
TRL 2.	technology concept formulated
TRL 3.	experimental proof of concept
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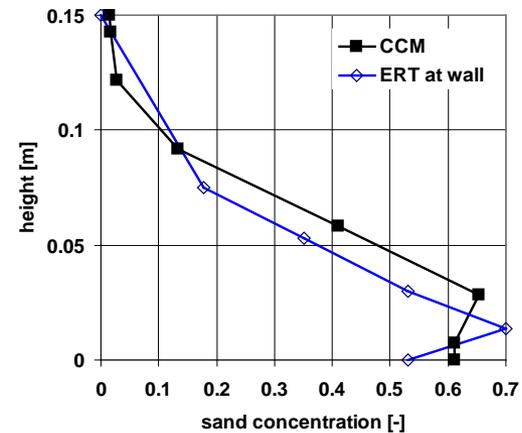
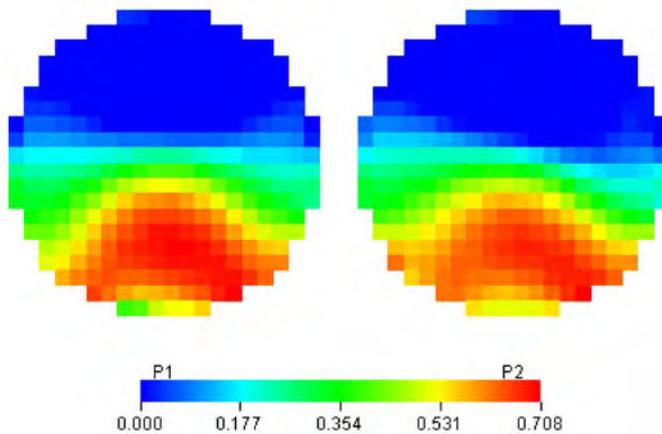
# TECHNOLOGY VALIDATION

- 2 phase loop
  - Sand – median density 350 micron, up to 30% solids
  - Water - plant
- Closed loop circuit
  - $\varnothing$  150mm
  - Slurry velocity from 1-10  $\text{ms}^{-1}$
- Instrumentation
  - Temperature
  - Slurry density
  - Flow (emf)
  - Conductivity concentration measurement



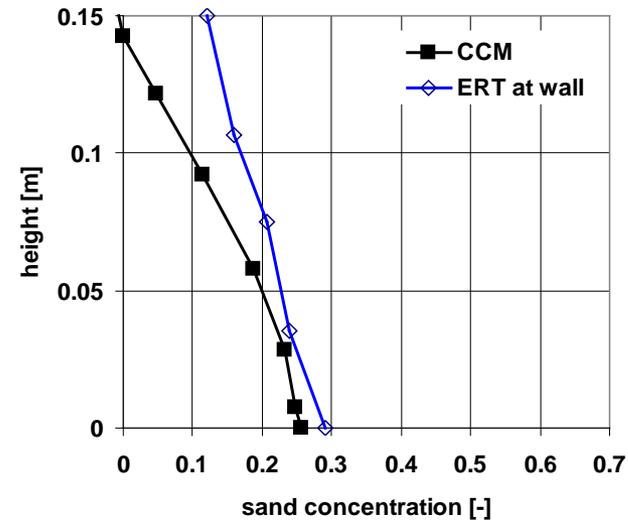
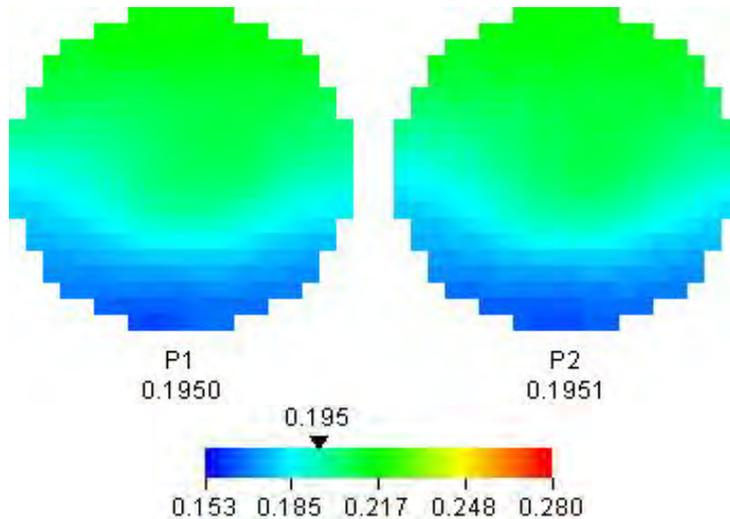
# TECHNOLOGY VALIDATION

- 1.6 ms<sup>-1</sup>
  - Concentration - solids 20%
  - Distributed as stationary bed

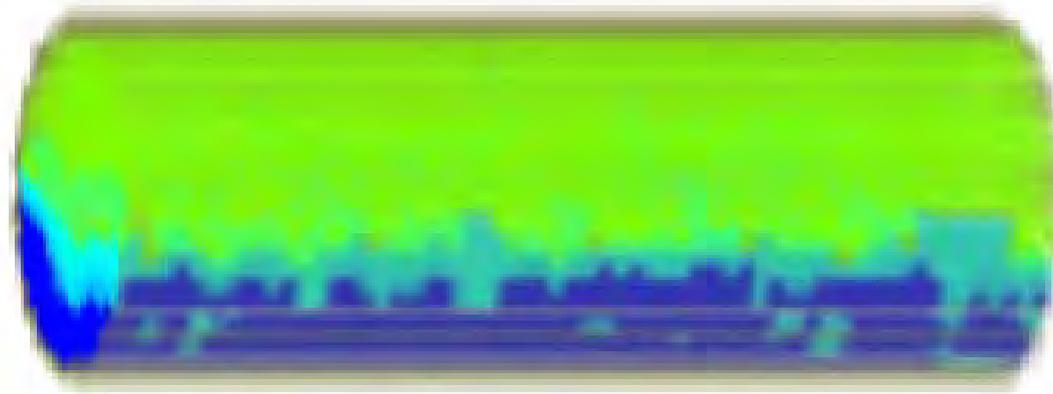
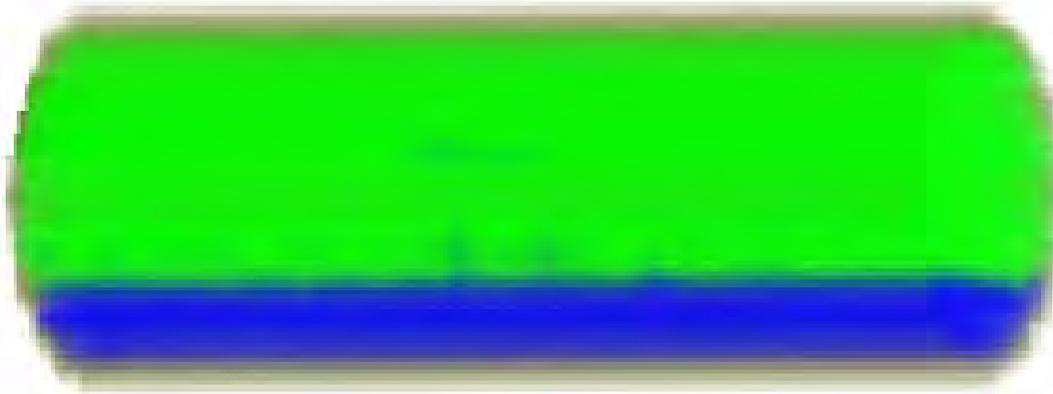


# TECHNOLOGY VALIDATION

- 6 ms<sup>-1</sup>
  - Concentration - solids 20%
  - Heterogeneous suspension



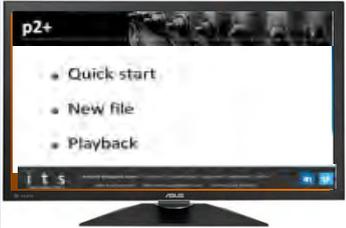
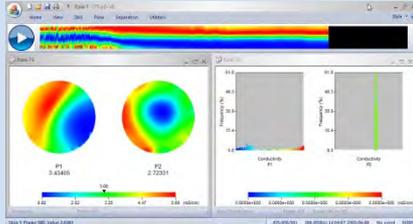
# CONTRASTING FLOW RATES



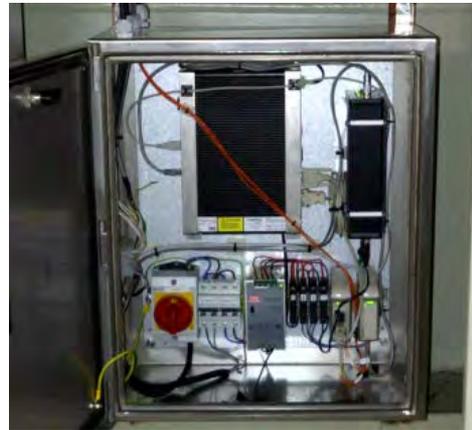
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# SYSTEM OVERVIEW

<b>Instrument</b>	<b>Lab / pilot plant Optimisation</b>	
<b>PC/ Processor</b>	<b>PC Microsoft</b>	
<b>Sensor</b>	<b>Optimised for temp, pressure &amp; chemistry</b>	
<b>Process data</b>	<b>Flexible Research tool</b>	

# ELECTRONICS PLATFORM



# SENSOR DEVELOPMENT

Initial deployment in subsea rock installation on RoV

Challenges:

- Field deployment at 1000m water depth
- Salt water (high conductivity)
- Diameter (1600 mm)
- Steel pipe



# SENSOR DEVELOPMENT

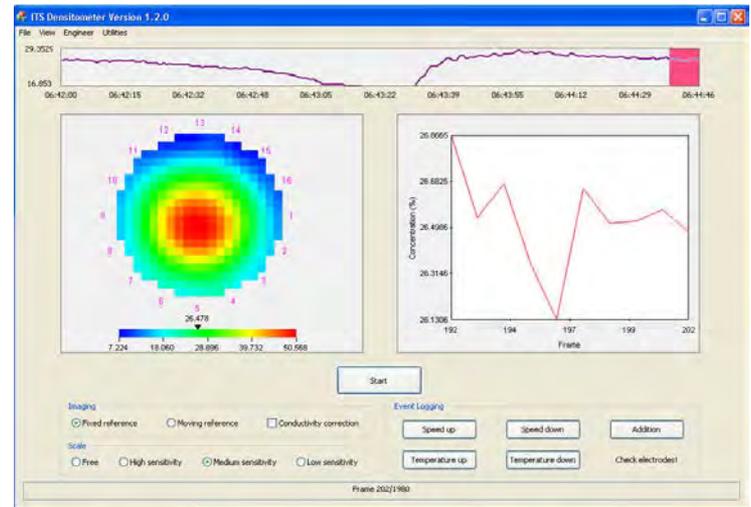
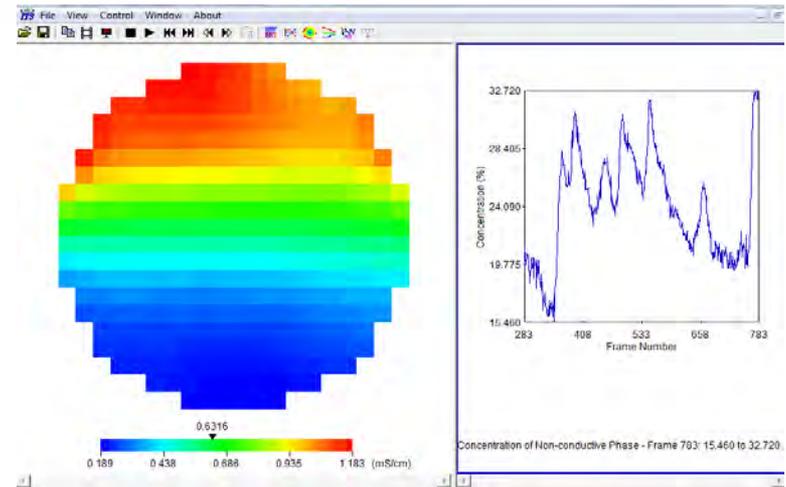


- Improved manufacturing
- Simpler maintenance
- Integrated electronics
- Higher pressure performance
- Twin rings



# SOFTWARE DEVELOPMENT #1

- Auto-calibration
- Algorithm development
- Optimized data collection
- Communication protocols
- Tailored GUI



# SOFTWARE DEVELOPMENT #2

## Modular unit

- C++ programming
- HTML interface
- Replaces PC and I/O module
- Integrated communications
  - field busses (Profibus, Profinet, Ethercat,...)
  - Additional i/o eg RS232, Ethernet, USB, UTP
  - Analog 4-20mA input and output

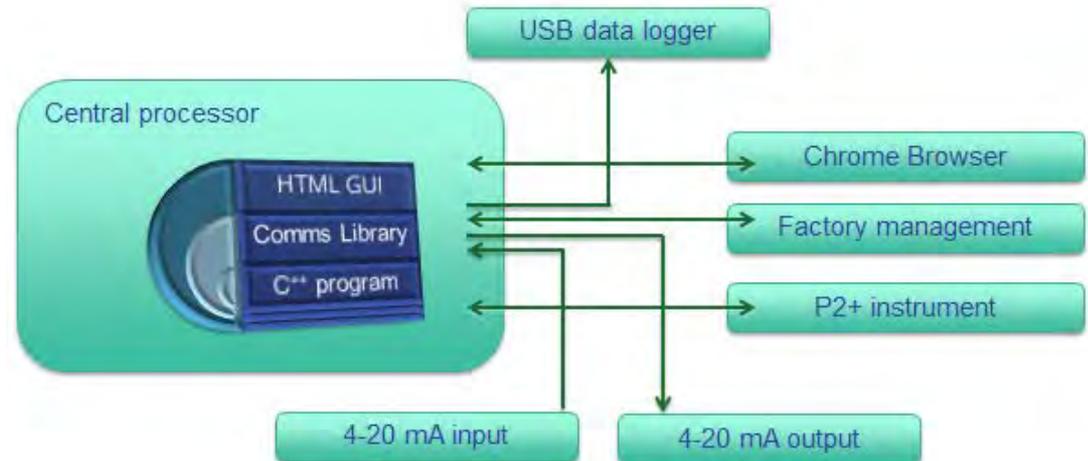
Processor modules  
MC200 series



Analog input modules  
AI20x/SI

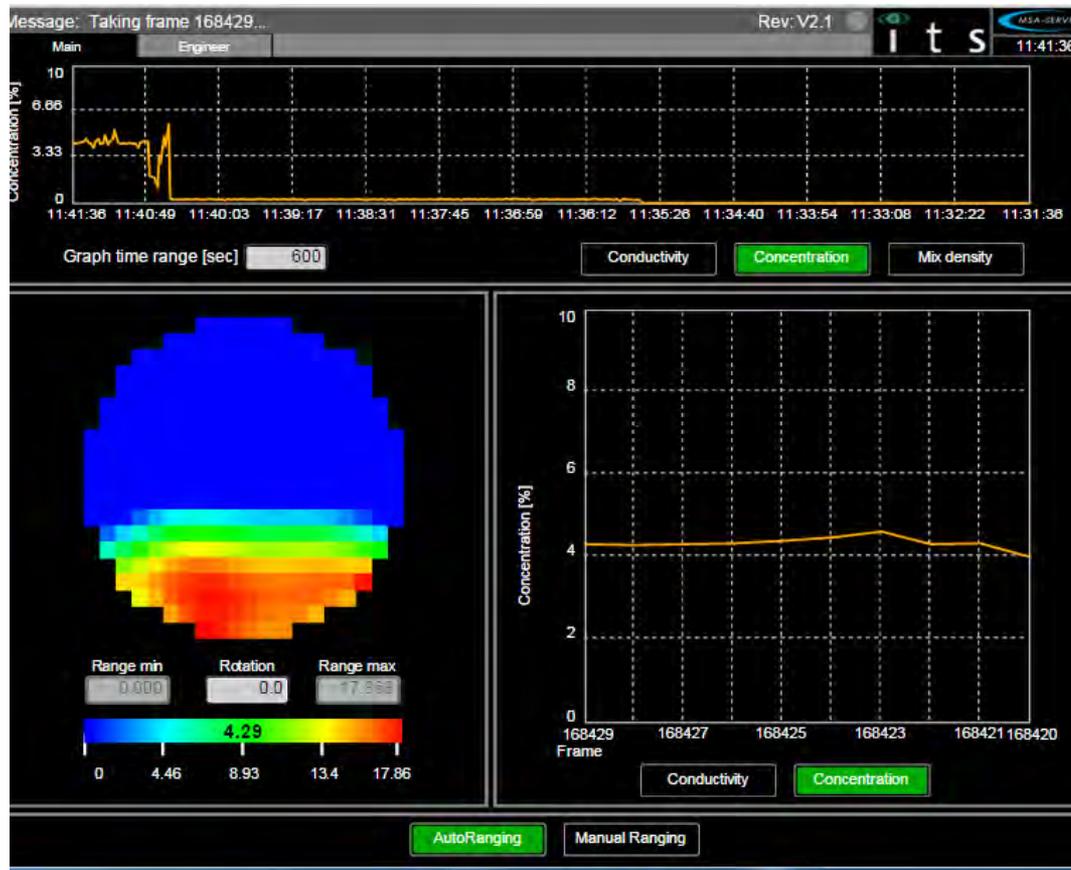


Analog output modules  
AO20x/SI



# HTML INTERFACE – MAIN SCREEN

- Instrument operates in background – PC viewer optional



# ENGINEERING PANELS

The image displays several overlapping screenshots of the 'its' software interface, which is used for data acquisition and analysis. The interface includes a top navigation bar with tabs for 'Main', 'Engineer', 'Setup DAS', 'Calibration', 'Analog input/output', 'Logging', 'Raw data', and 'Change password'. The 'its' logo and 'MSA-SERVICE' are visible in the top right corner of each window.

Key panels shown include:

- Configuration Panel:** Contains 'DAS Settings' such as 'Number of sensing planes', 'Electrodes per plane', 'Samples per frame', 'Frames per download', 'Injection current [mA-ab]', 'Excitation frequency [Hz]', 'Starting plane (1-8)', 'Delay cycles', 'Electrical properties', 'Continuous phase [mS/cm]', 'Second phase [mS/cm]', 'Conversion', 'Density solid [t/m<sup>3</sup>]', and 'Density liquid [t/m<sup>3</sup>]'. An 'Ok' button is present at the bottom.
- Calibration Panel:** Shows 'Resistor [Ohm]' and 'Gain : 0,0,0,1,1'. It includes an 'Input' section with a list of channels (I1-I8) and an 'Output' section with a list of channels (O1-O4).
- Data collection Panel:** Features 'Sampling time interval (ms)' set to 10 and 'Maximum number of frames' set to 500.
- Measurement Graphs:** Three vertically stacked plots showing 'Measured Voltage [mV]', 'Reference Voltage [mV]', and 'Relative Changes [%]' over 10 frames. The 'Measured' plot shows a peak of 3165.4 mV. The 'Reference' plot shows a peak of 2817.4 mV. The 'Relative' plot shows a peak of 0.43%.
- Data Table:** A table at the bottom right provides 'Voltage measurement pairs' and 'Current injection pairs' for various frame numbers.

Message: Taking frame 315... Rev: V2.7  
 Message: Taking frame 328... Rev: V2.7  
 Message: Taking frame 347... Rev: V2.7  
 Message: Taking frame 360... Rev: V2.7  
 Message: Taking frame 373... Rev: V2.7

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# MARINE PERFORMANCE

Long term trials shown equivalent to gamma

- Comparable performance 1 – 5%

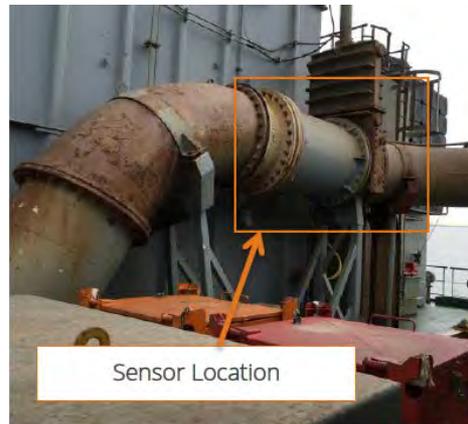
Independent of flow conditions

Measures 360° - full volume

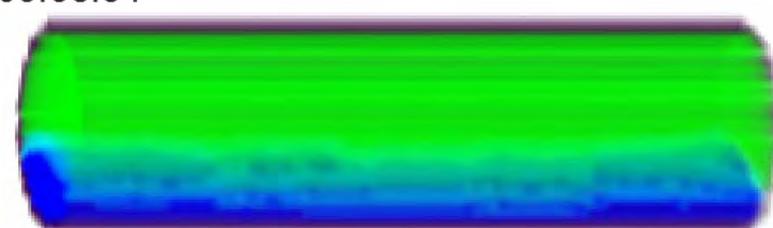
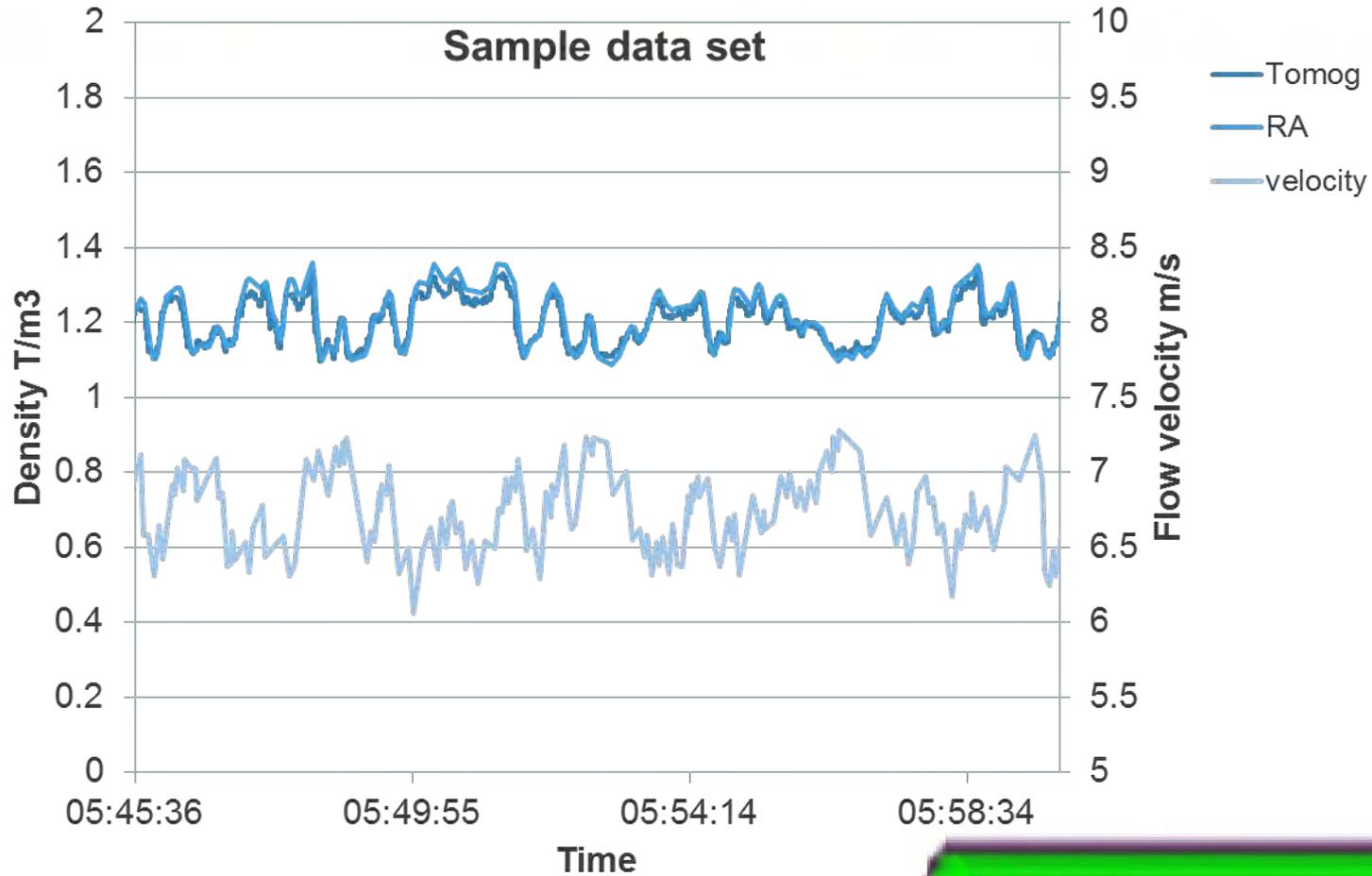
Easy to calibrate in-line

Orientation

- Vertical
- Inclined
- Horizontal



# SYSTEM PERFORMANCE



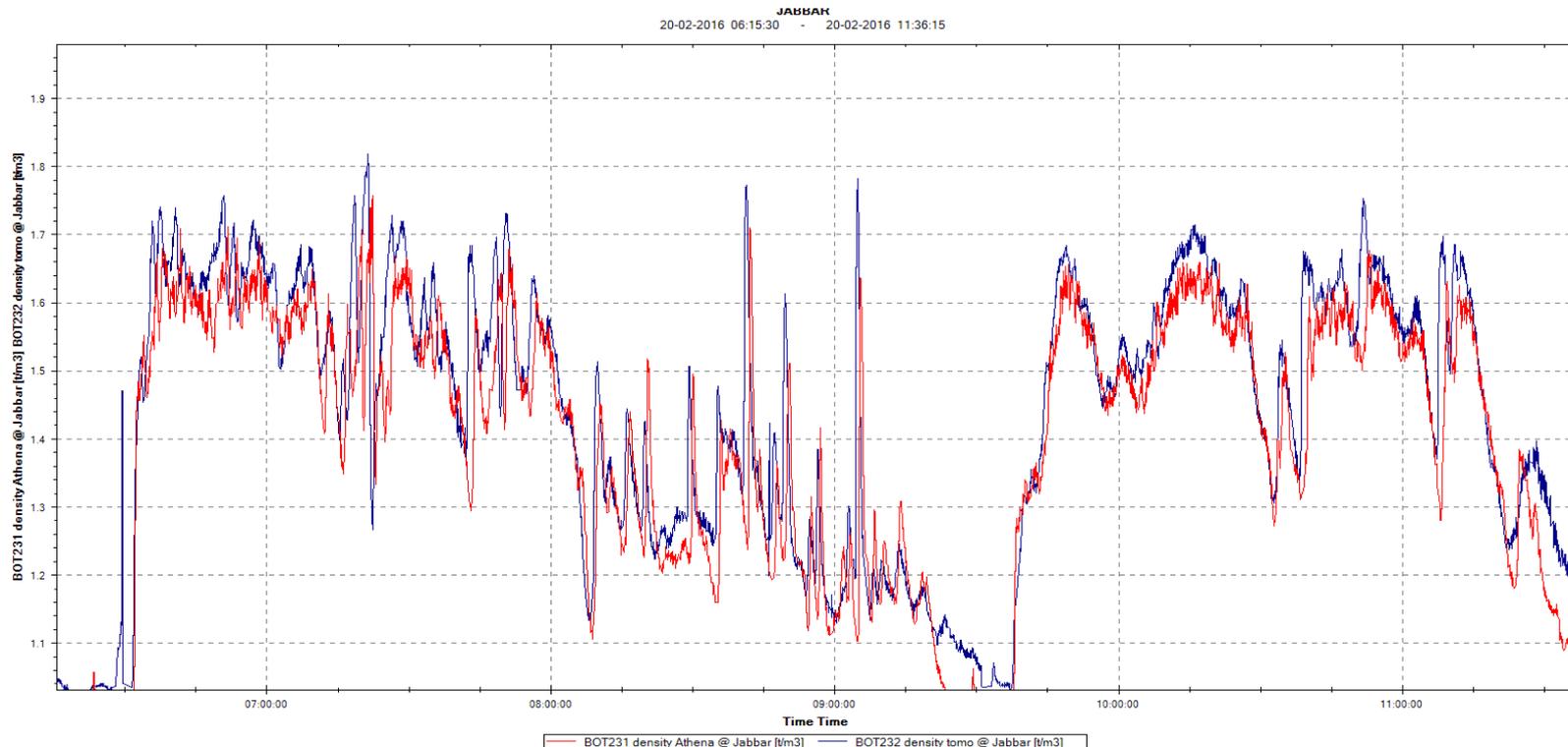
# LAND-BASED PERFORMANCE

- Installation successfully completed within 24 hrs. due to excellent preparation VO and ITS
- Sensor placed 100 meter from land booster (centrifugal pump)
- 6 months 24/7 operation 26 million cubic meters material transported



# CONSISTENT PERFORMANCE

- Comparable Results with Nuclear Source on vessels
  - Trend & level
- Robust sensor



# SYSTEM OVERVIEW

## Pipe

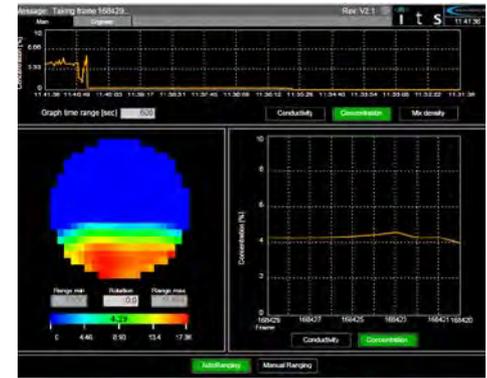
- Diameter 35cm – 1.2m
- Length 50cm – 2.5m

Operating pressure 12-30 bar

Temp vs. conductivity compensation

## Liner

- PU (grains)
  - Ceramic (hard rocks)
- Data format 4-20mA (standard)  
Cable length 2.5m (standard)



# KEY BENEFITS

## Operational

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- Eliminates local compliance rules, regulations
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## CSR (Corporate responsibility and risk) benefits

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- No remainder disposal
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# ACKNOWLEDGEMENTS

Van Oord  
University of Delft  
Pullen  
MSA  
ITS  
Leeds University

its

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THANK YOU FOR LISTENING – ANY QUESTIONS?**

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