QUANTIFICATION OF CH4/CO2 GAS BUBBLES LEAKAGE USING MULTI-ELEMENT ULTRASOUND IMAGING

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Revisão Bibliográfica

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Introduction

- Project initial objective - CO2 leakage detection.
- Project modification - CO2 leakage quantification.

Leakage Detection

- Workshop 2017, 2018 - Building capability for in situ quantitative characterisation of the ocean water column using acoustic multibeam backscatter data.

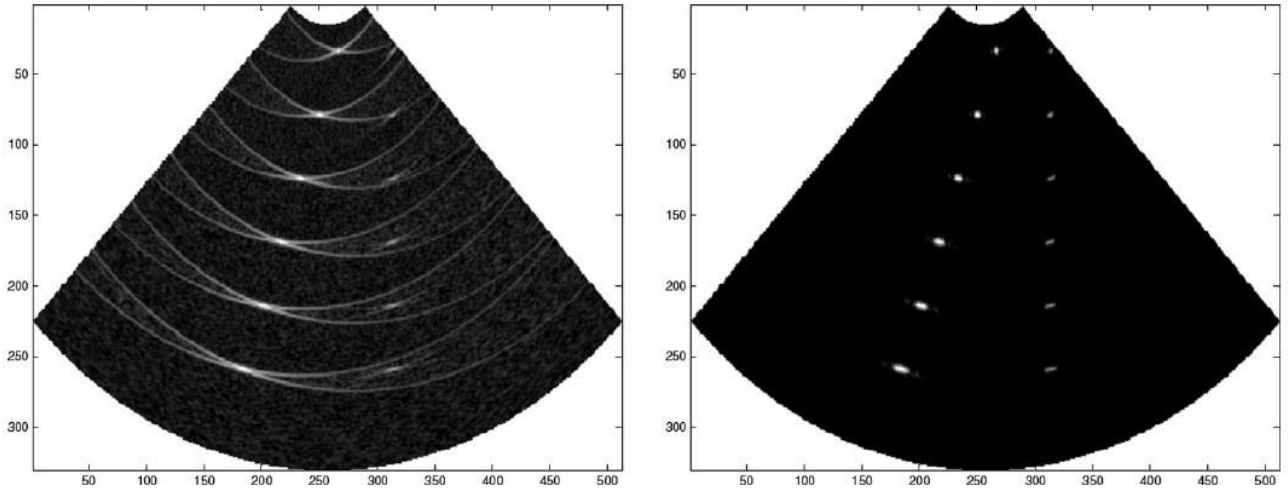
- STEMM-CCS - Strategies for Environmental Monitoring of Marine Carbon Capture and Storage (http://www.stemm-ccs.eu/)

Leakage Quantification

- Use of a side scan sonar with multi beam echo sounder to quantify CO2 leakages.
- Find a relationship between the bubble size and the CO2 volume.
- Estimate the CO2 volume from the bubble rise velocity.

Noise Reduction (coherence factor)

- Compares the phases of the signals captured by each transducer element. When the phases are almost the same: factor near 1. When the phases are very different: factor near 0.
- The image is multiplied by the factor, reducing the noise.



Noise Reduction (Inverse problem)

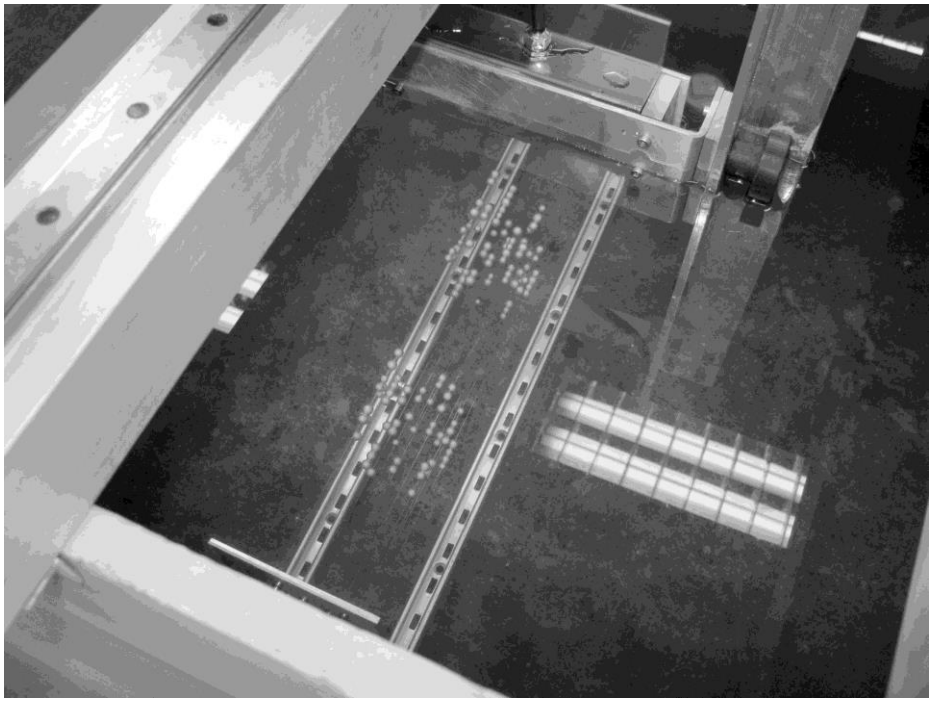
- Given an image, search for a spacial distribution of reflectors that generate a simulated image nearest to the input image (optimization problem).
- Possibility of quantitative results (reflectivity).
- Reduction of side lobe noise.
- Challenges: Sonar images are very large, and the medium is not uniform (e.g. variation in temperature).

Numeric simulation

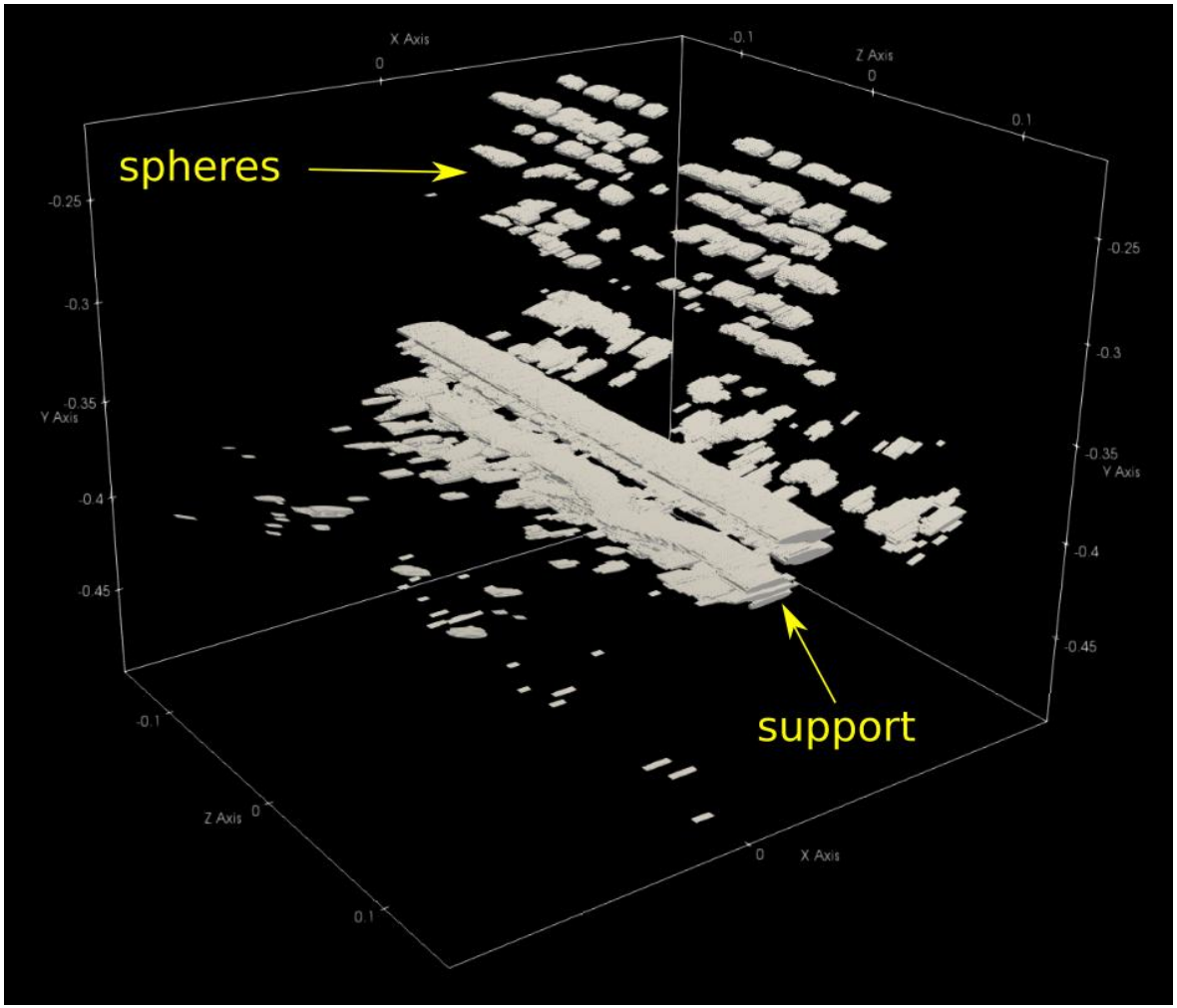
- The development of a simulation of acoustic signals generated by a sonar has been started.
- Uses the properties of a linear system (superposition).
- Decomposes the transducer and the reflector into a set of point sources/reflectors/receivers.

Experimental simulation

- Bubbles simulated using expanded polystyrene spheres supported by stainless steel wires.



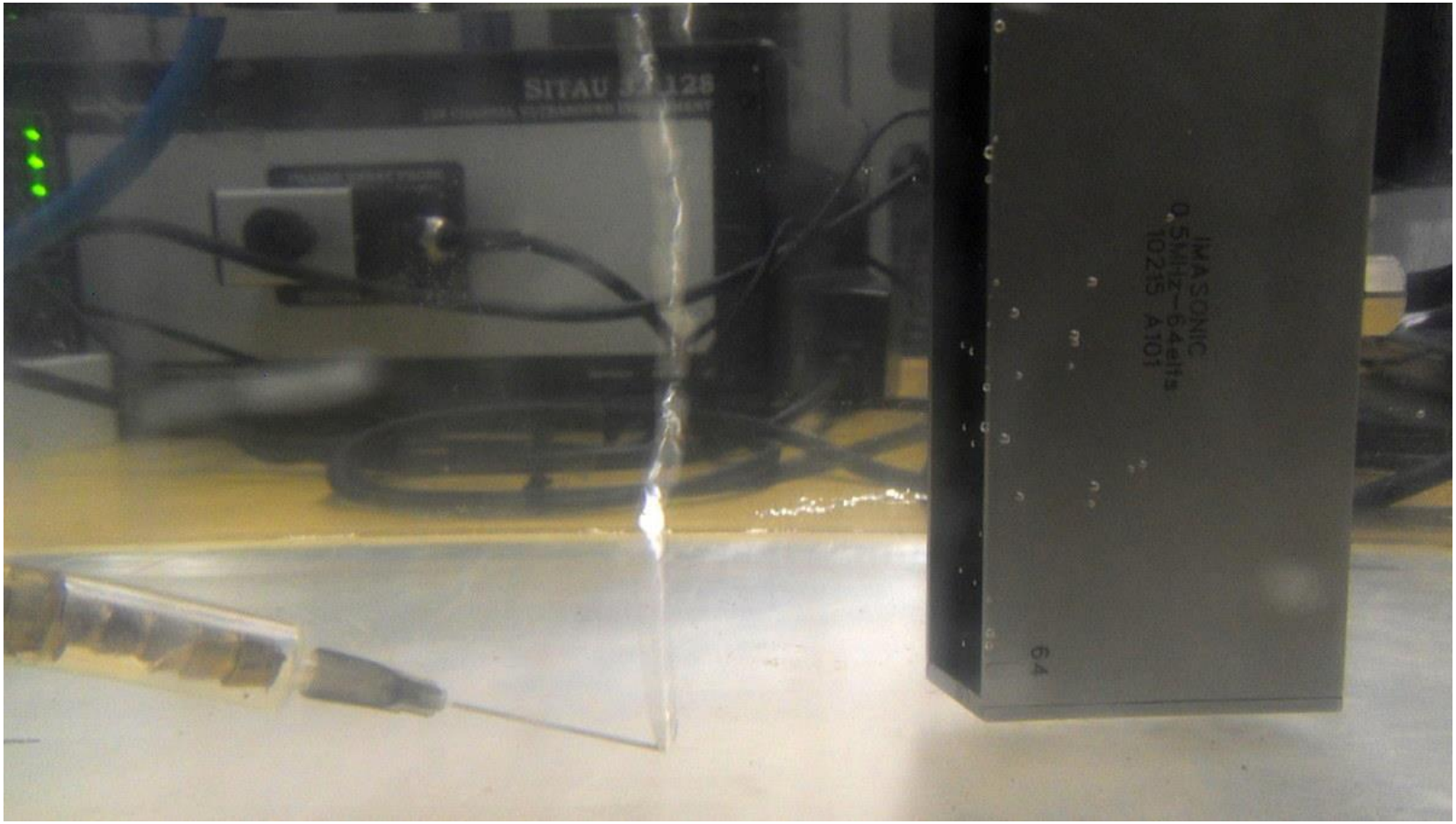
Experimental simulation



Experimental simulation

- Controlled injection of air bubbles using syringe needles with different internal diameters.
- Amount of air injected controlled by a pressure valve.

Experimental simulation



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