Laboratory of Metrology and Information Treatment

DETECTION OF ACCIDENTAL FISH DEFROSTING USING NON-DESTRUCTIVE ULTRASONIC TECHNIQUE

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- Objectives
- Materials and Methods
- Results and Discussions
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Introduction

- Fresh fish quality is highly alterable,
- It's more and more preserved by deep or quick freezing,
- Keeping qualities depend largely upon storage temperatures.

Objectives

- To test the feasibility of ultrasonic waves to control fish quality,
- To have information from the study of freezing/thawing of the fish,
- To detect whether or not the frozen fish has suffered a partial or total accidental defrosting.

Materials and Methods

Fillets of 2 cm path were cut in cubes and were placed directly to freezer for a minimum of 24 hours.

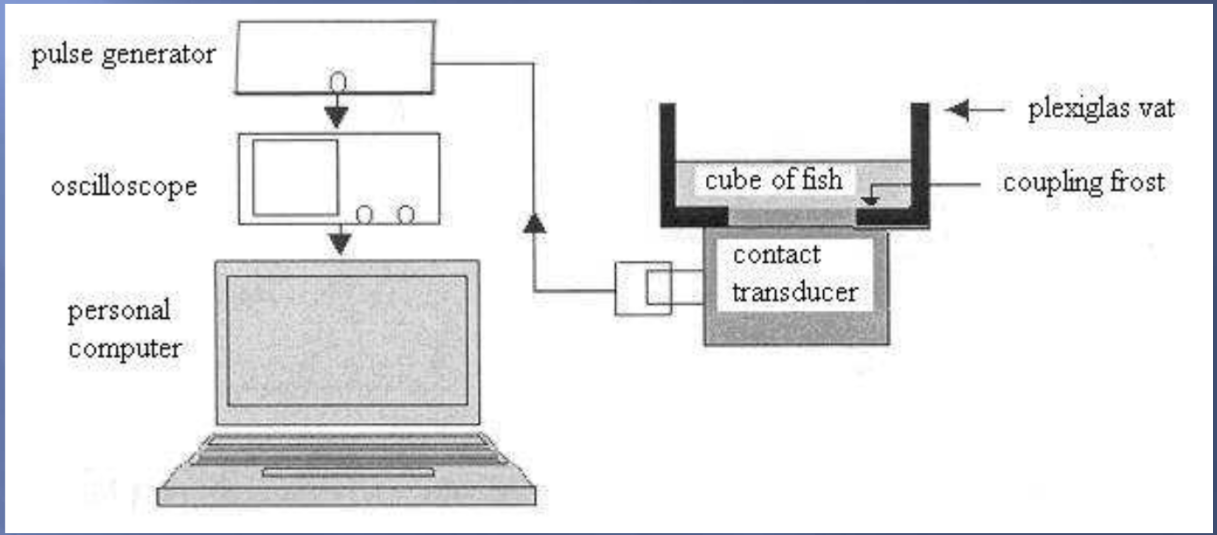

Fig. 1. Experimental device

- Transducer (central frequencies: 500 KHz, 5 MHz)

- Genarator (Sofranel 5100)

- Digital oscilloscope (LeCroy 300 MHz)

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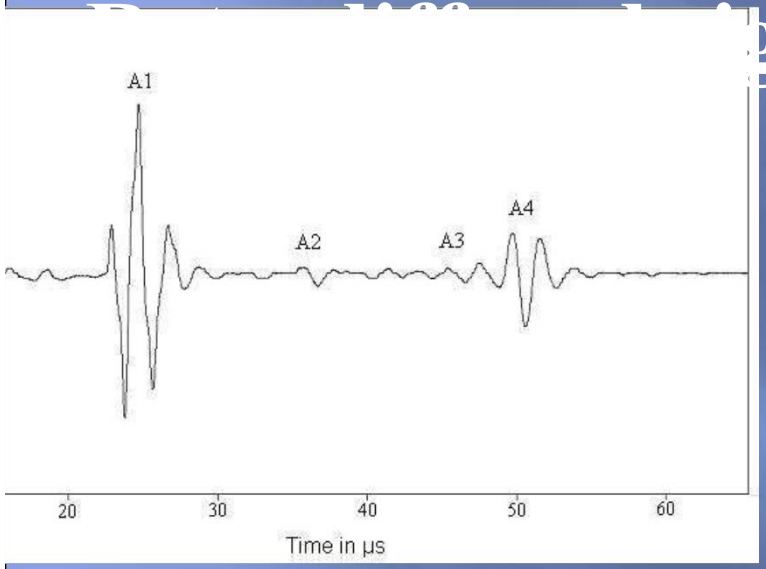

Fig. 2. Type of the retrodiffused signal by fish during its defrosting

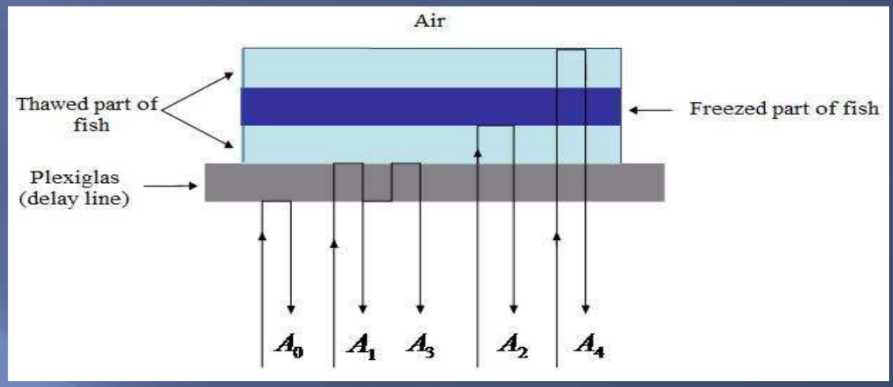

Fig. 3. Type Propagation paths in fish during defrosting (A_0 to A_4 are observed echoes)

A_1 is the retrodiffused signal by the interface plexiglass/ thawed part of fish.

A_2 is the retrodiffused signal by the interface thawed part of fish / freezed part of fish.

A_3 is the second back-and-forth in the plexiglass.

A_4 is the retrodiffused signal by the interface thawed part of fish/air.

➡ The superposition of these retrodiffused signals allows to control defrosting.

Results and Discussions

First defrosting:

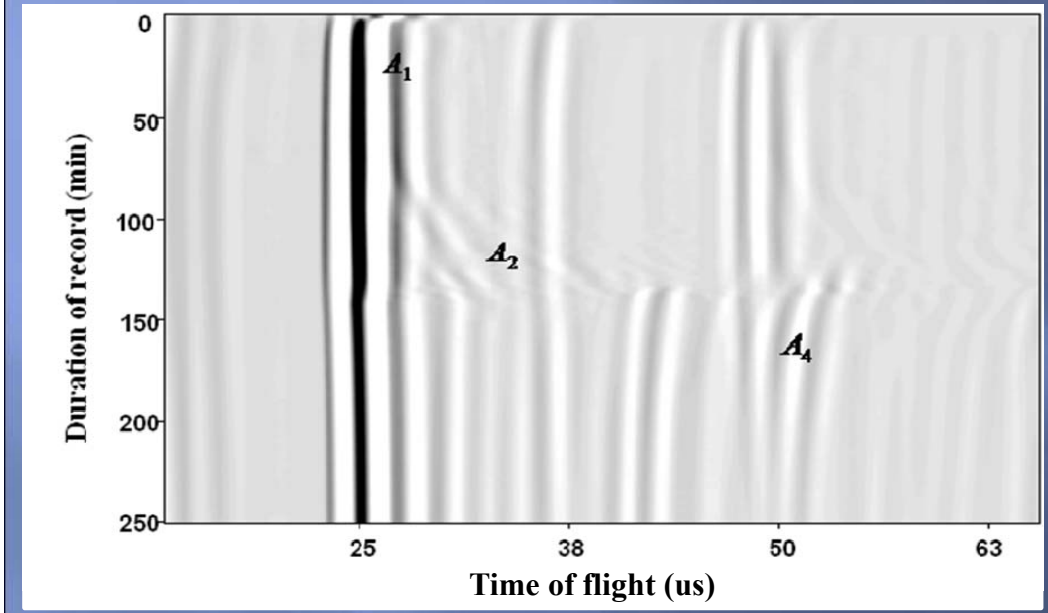

Fig. 4. Superposition of the retrodiffused signals during hake first defrosting; transducer 500 kHz

- The position of the A_1 echo does not change.
- The A_2 echo appears after 60 min (beginning of thawing).
- The A_2 echo change during the thawing.
- The A_2 echo disappears after 136 min (end of thawing).

- The A_4 echo appears in the same time (136 min).
- The A_4 echo stabilizes when the hake temperature becomes equal to the external medium temperature.

Second defrosting:

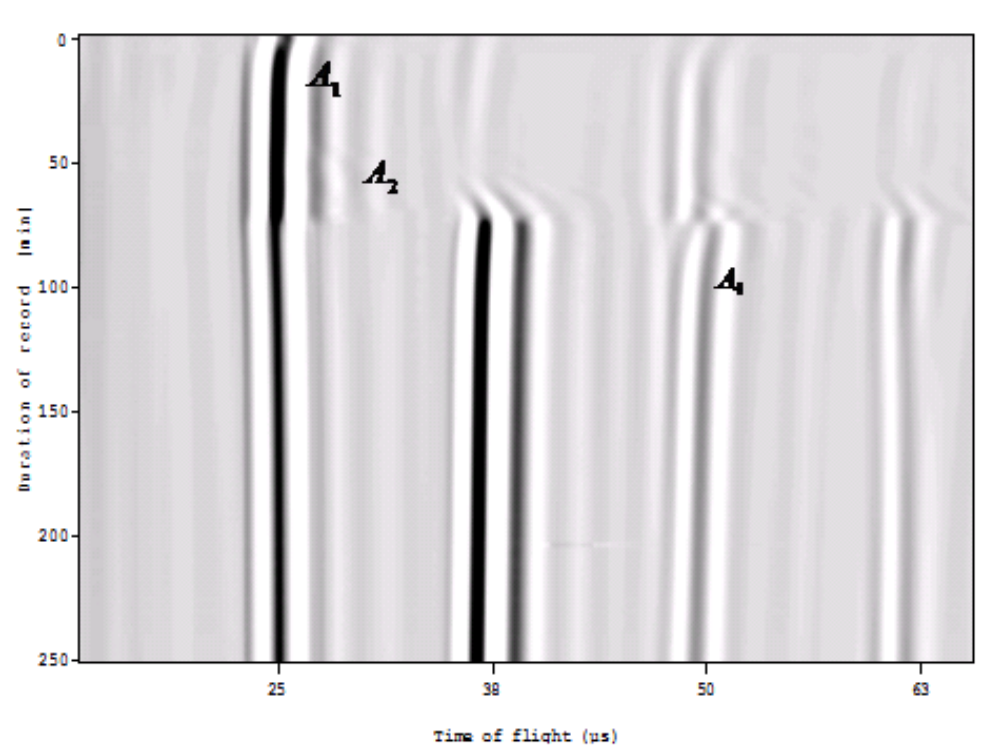

Fig. 5. Superposition of the retrodiffused signals during hake second defrosting; transducer 500 kHz

- The second hake thawing starts at 50 min.

- The total duration of defrosting is (23 ± 3) min.

Comparison between the first and the second defrosting:

- The total duration of defrosting (time between the beginning and the end of fish defrosting) is strongly reduced passing from (76 ± 3) min in first defrosting to (23 ± 3) min in the second one.

- The duration of thawing appears to be a good indication to distinguish between the first and the second defrosting.

Amplitude:

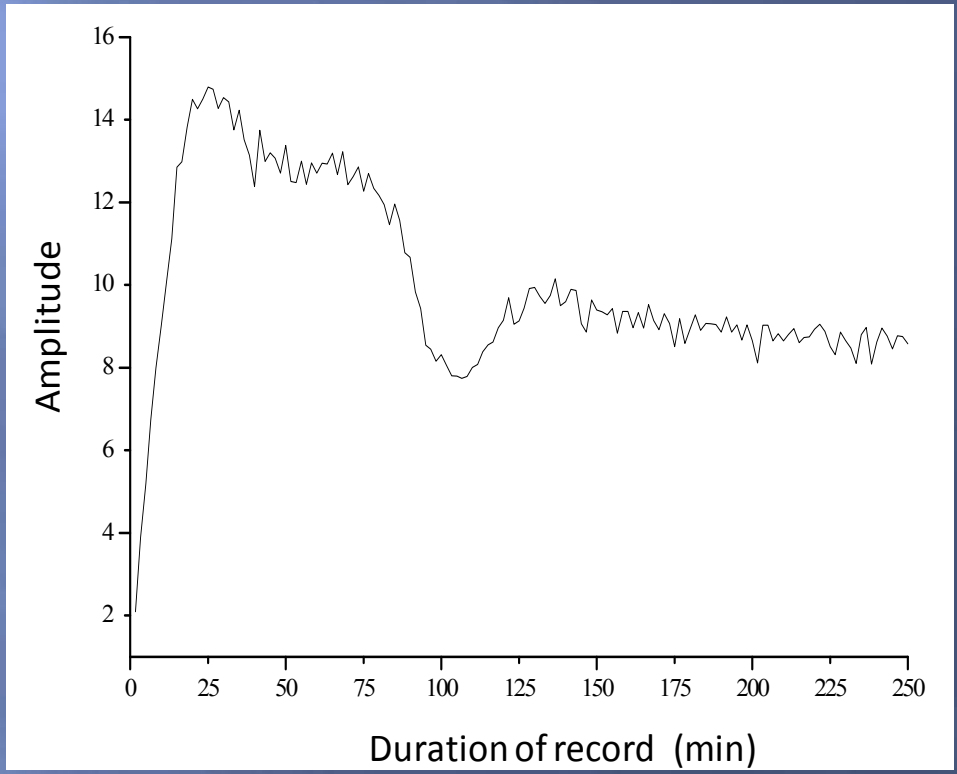

Fig. 6. Peak to peak amplitude of the retrodiffused signals during hake first defrosting; transducer 500 kHz

-The amplitude of the A_1 echo depends on the state of the interface between the fillet fish and the delay line.

-The decrease of amplitude is relatively regular.

Amplitude:

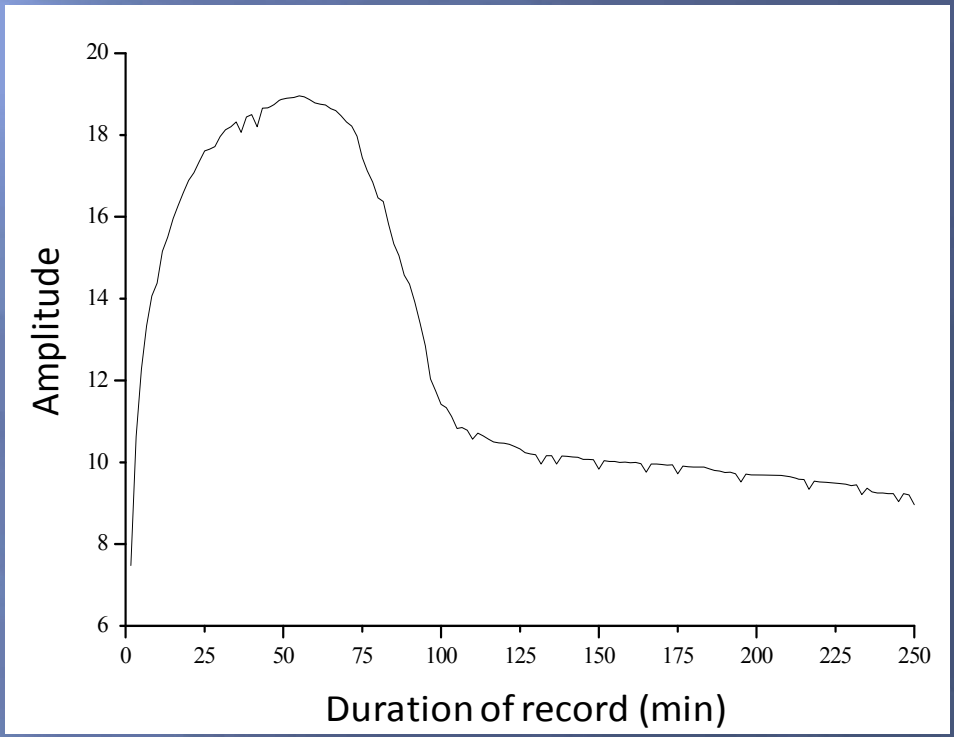

Fig. 7. Peak to peak amplitude of the retrodiffused signals during hake second defrosting; transducer 500 kHz

- The decrease of amplitude is more drastic during the second defrosting.

Water influence:

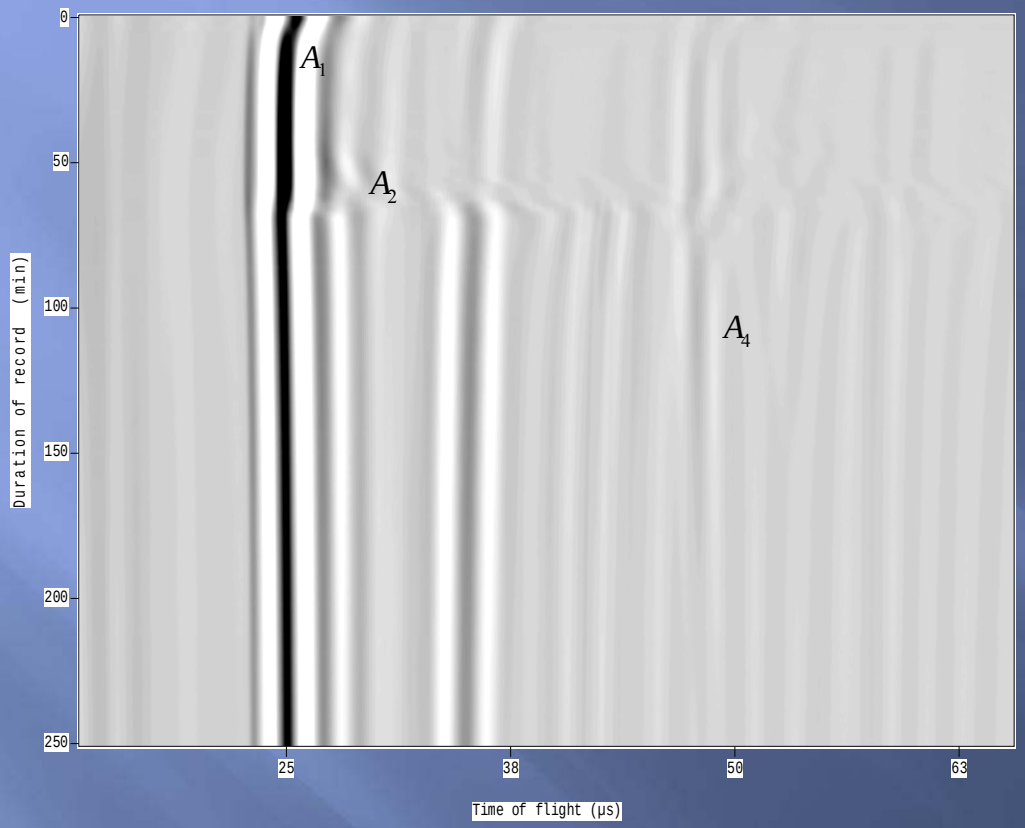

Fig. 8. Superposition of retrodiffused signals during hake third defrosting; transducer 500 kHz

- The thawing duration is 13 min.

- The evaluation of the freezing/thawing process in fish can be reduced to the water contents evaluations.

Water influence:

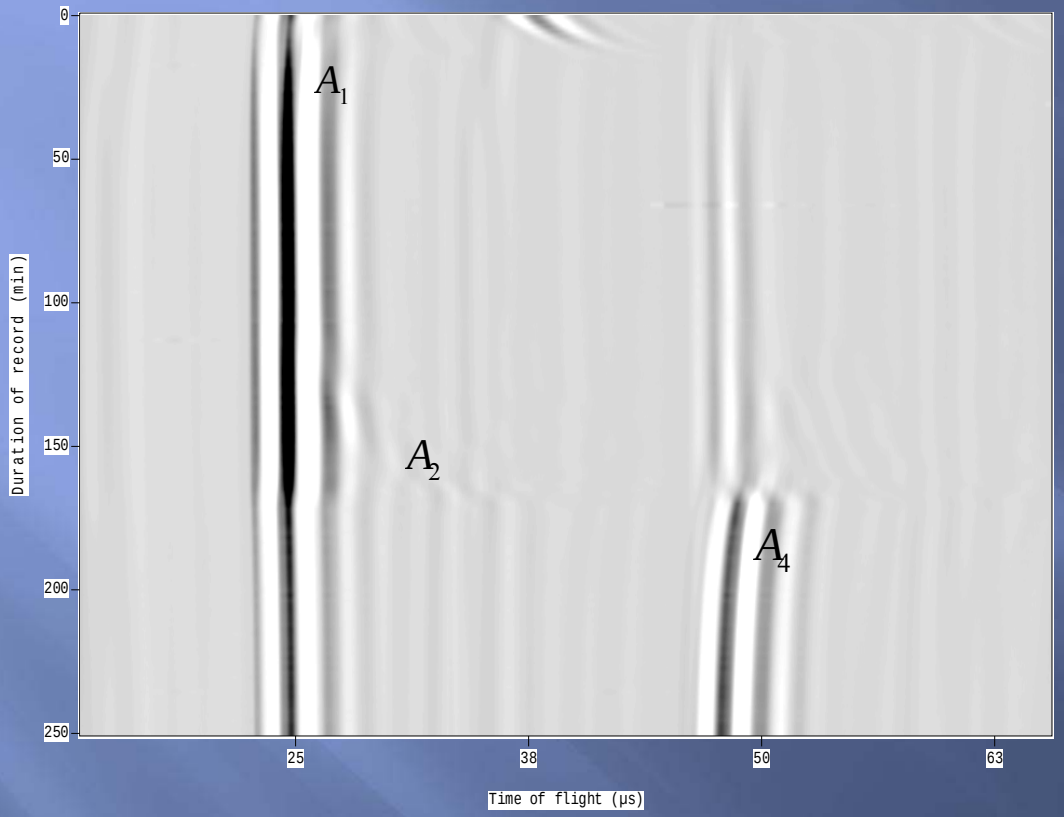

Fig. 9. Superposition of retrodiffused signals during hake plunged in water second defrosting : transducer 500 kHz

- The thawing duration is increasing from 23 to 32 min.

- This duration is less than the first defrosting one (76 min).

-The thawing duration is significant and can not be obtained if we try to replace the water lost during the first defrosting.

Frequency influence:

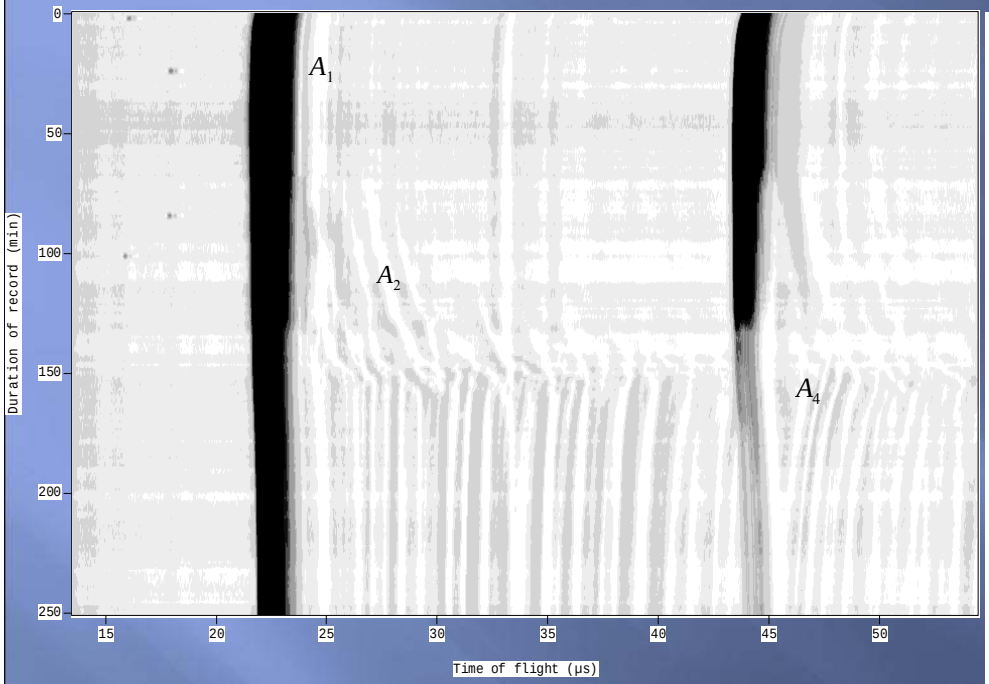

Fig. 10. Superposition of signals Hilbert transforms during hake first defrosting; transducer 5 MHz

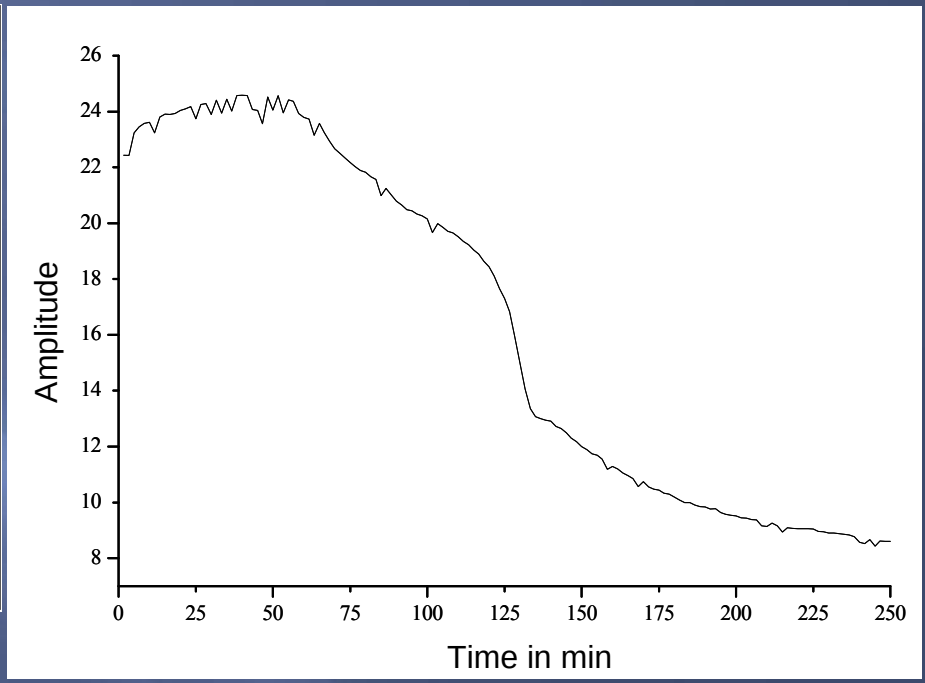

Fig. 11. Peak to peak amplitude of the retrodiffused signals during hake first defrosting ; transducer 5 MHz

- The total duration of the corresponding echo is reduced.

- This increase of frequency leads to a decline of the signal levels caused by the larger viscous attenuation.

Comparison between the first and the second defrosting:

Fig. 12. Superposition of signals Hilbert transforms during hake second defrosting; transducer 5 MHz

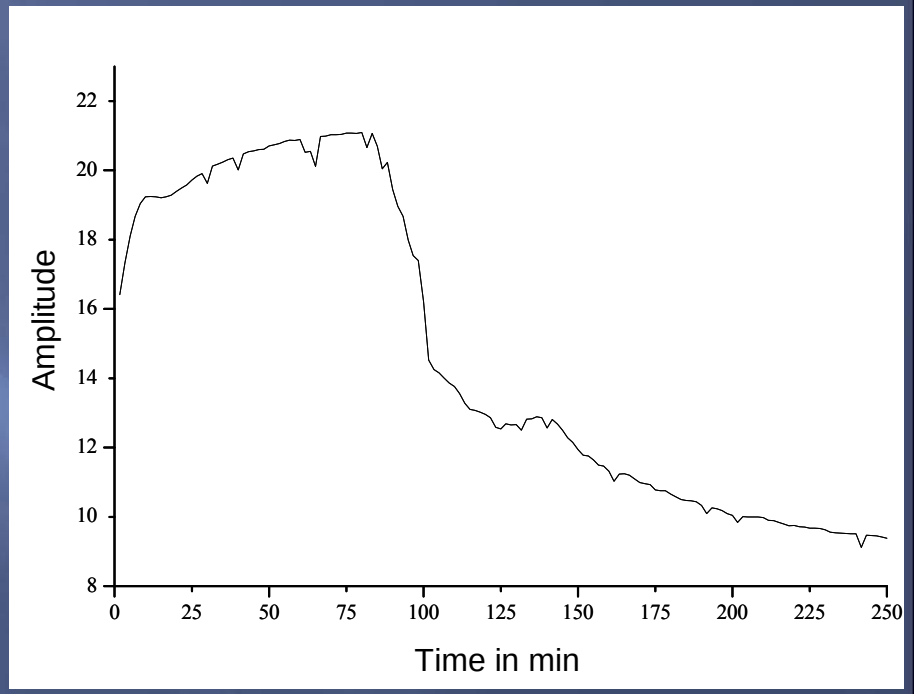

Fig. 15. Peak to peak amplitude of the retrodiffused signals during hake second defrosting; transducer 5 MHz

- We observe qualitatively the same differences between the first and the second defrosting as in experiments with 500 kHz transducer.

Conclusion:

-The thawing duration (time between the start and the finish of thawing) appears to be a good indicator to distinguish between the first and the second defrosting.

-The measurements indicate that the fish defrosting process is characterized by the loss of the water content during the first defrosting.

-The ultrasonic technique used in this work allows to detect whether or not water was added by defrauder to the fish after its defrosting.

Perspectives:

- To study several types of fish by using various frequencies.

- To try to find a compromise enters the loss of energy and the reduction of the duration of echo By increasing the frequency

- To control if the fish is fresh or if it was previously frozen.

Thank you for your attention