A Tool for Insertion of Simulated Flaws on Real Acquisition Files

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Outline

Context

Description of the Augmented **A**cquisition by **S**imulation tool (A²S tool)

Application of the A²S tool

- *Application on the inspection a surface breaking notch*
- *Application on the inspection of a lack of fusion: notch along a welding bevel*
- *Application on the inspection of breaking backwall notch*

Conclusion

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Context

In the framework of Automated UT inspection, the success of data analysis is related to (at least) two factors

- **The technique:**
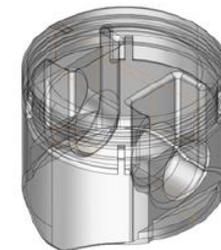 - Existing solutions
  - Experiments and/or simulation

- **The experience and the skills of the analysts:**
  - Training operators on many realistic cases
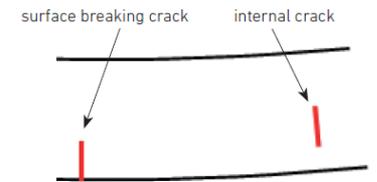   - Challenging
    - Costly

surface breaking crack   internal crack

Machining of several mock-ups and defects
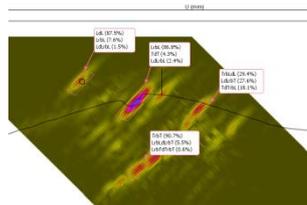
Complex physical phenomena

Complex components

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Context

| EXTENDE proposes a tool based on NDT simulation that allows increasing significantly the number of practical cases for analysts training

| Requirements of such a tool:

- **VALIDATED**, you must trust the simulated results

- **REPRENSATITIVE** of real experiments, able to deal with multiple NDT applications

- **REACTIVE**, able to provide you with new analysis scenarios within a reasonable time

| The **A**ugmented **A**cquisition by **S**imulation tool (A²S tool) satisfies these conditions using the CIVA software simulations capacities

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CIVA software

CIVA N·D·E | **Leader software for NDT simulation**

| 25 years of experience with model validations

| The industrial software (easy and fast parametric studies)

| Different simulation modules (UT, ET, RT, CT, GWT)

| Analysis module for UT acquisition data :
  - extraction of advanced information
  - connection with the simulation part of CIVA

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Description of the A²S tool

- A²S tool : **A**ugmented **A**cquisition by **S**imulation
  - Output : real experimental data augmented by the insertion of the acoustical signature of virtual defects.

- A²S allows :
  - efficient training on realistic data
    - real structural noise
    - real geometry echoes

  - Creation of several configuration cases from a single acquisition
    - several flaws at different locations in the specimen

- A²S can be used with :
  - M 2 M and OLYMPUS files that can be opened in CIVA
  - Generalization to other files possible thanks to plugin

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Description of the A²S tool

A²S input data :

- Acquisition file with known structure
- Simulation file
- Files description : number of shots, increment, time gate, sampling frequency,…

Acquisition file
(*.m2k; *.rdt, …)

Simulation file
(*.civa)

Description of the files (# shots, increments, sampling frequency,…)

Defining the part of the acquisition that will be augmented

Operator
addition
subtraction
substitution

A²S file (*.civa)

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Description of the experimental set-up

| Component representative of classical NDT configuration

| Cylindrical welded specimen (OD 850mm): 297mm×186mm×18mm

| homogeneous stainless steel
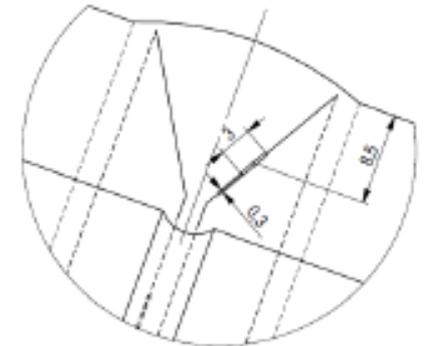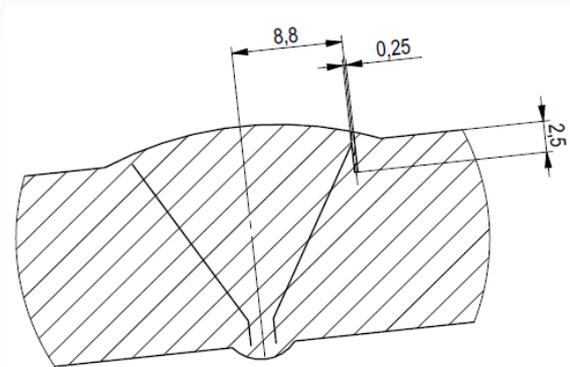
| Control in immersion

| Phased-array probe

| Active aperture adapted to SW45° or SW60°

| Complex profile acquired by laser profiling
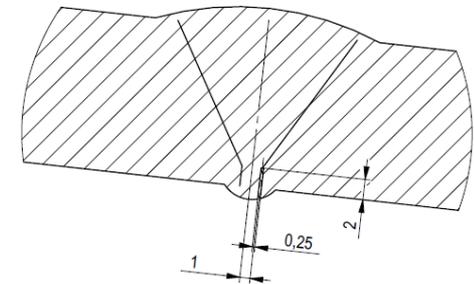
Example n°1: inspection of a surface breaking notch
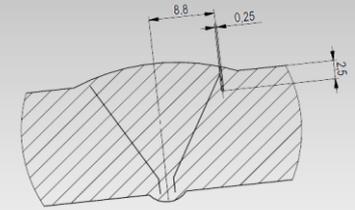
- Comparison of experimental and simulated Cscans and Bscans
- Simulated **flaw identical to real one**

Experimental results
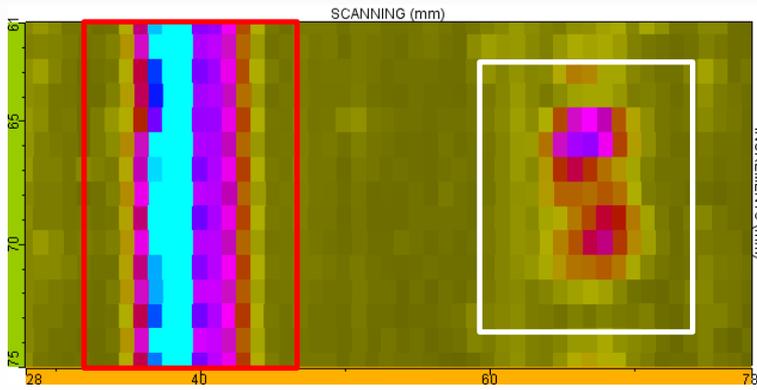
Simulated results before A²S
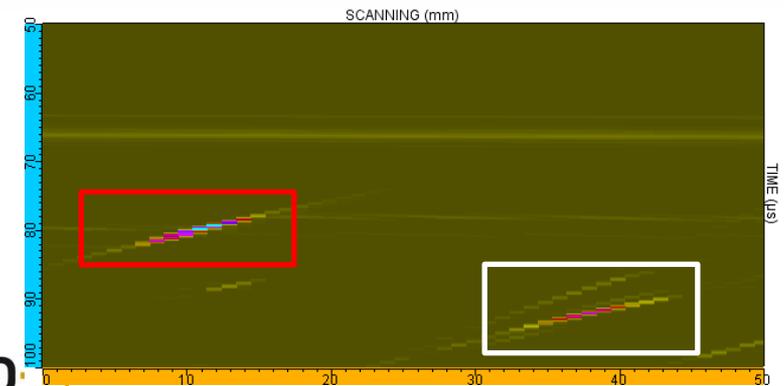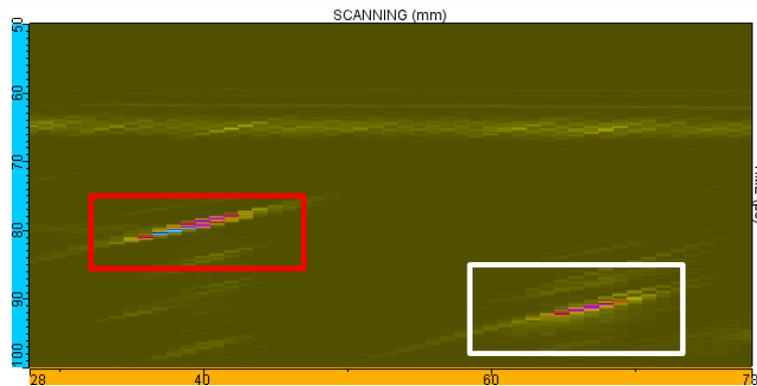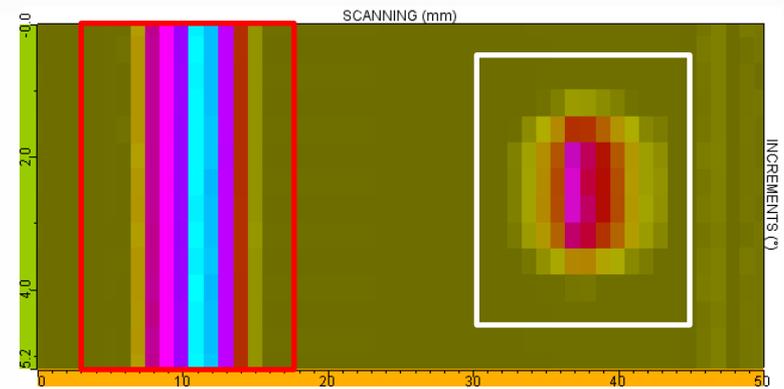
Example n°1: inspection of a surface breaking notch

A²S results; Simulated flaw identical to real one
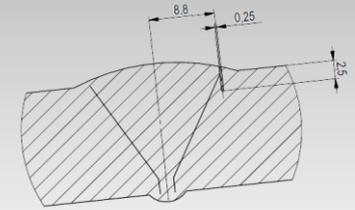
experimental

Simulated after A²S
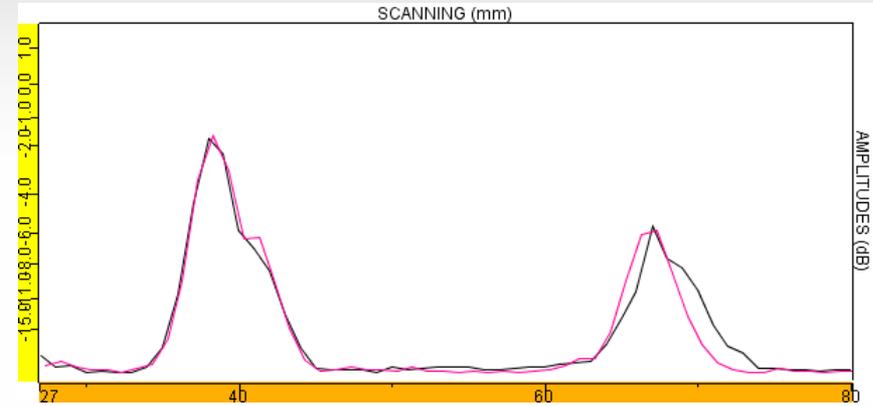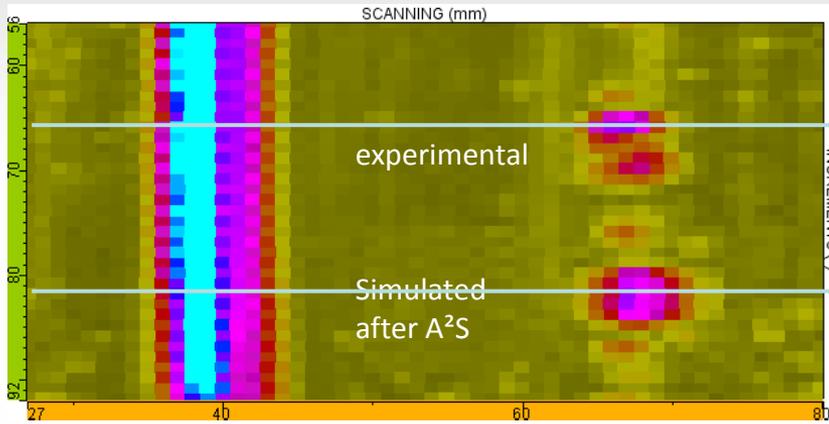
experimental
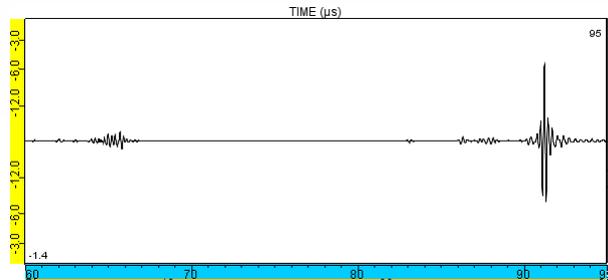
Simulated after A²S
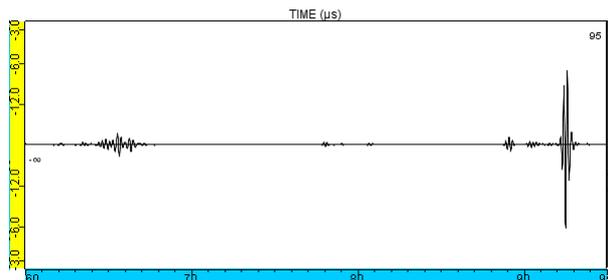
Difficult to make the difference between the real echo and the simulated one.

Amplitude and width of the signals in very **good agreement**
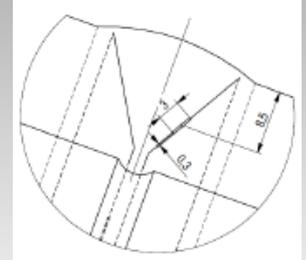
A²S file very realistic !

Example n°1: inspection of a surface breaking notch

| Comparison of experimental and simulated Cscans and Bscans

| Simulated **flaw with 30° tilt instead of 0°**
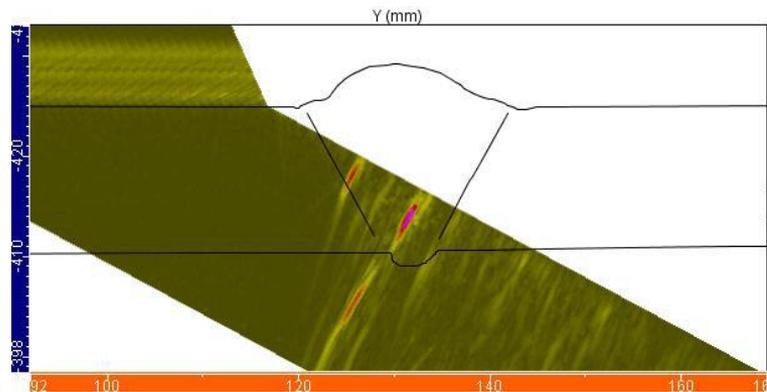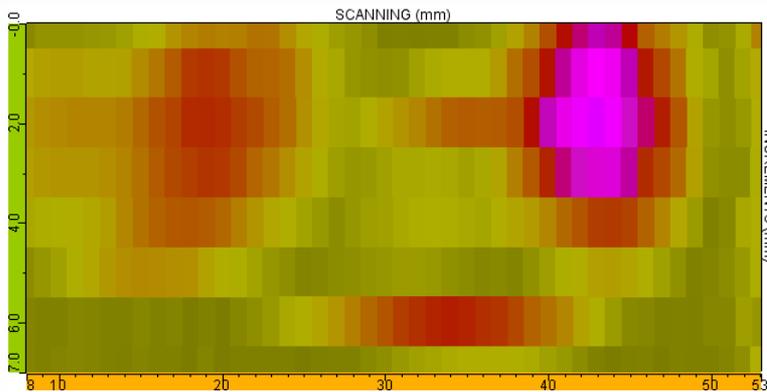
| A²S allows creation of several and different cases
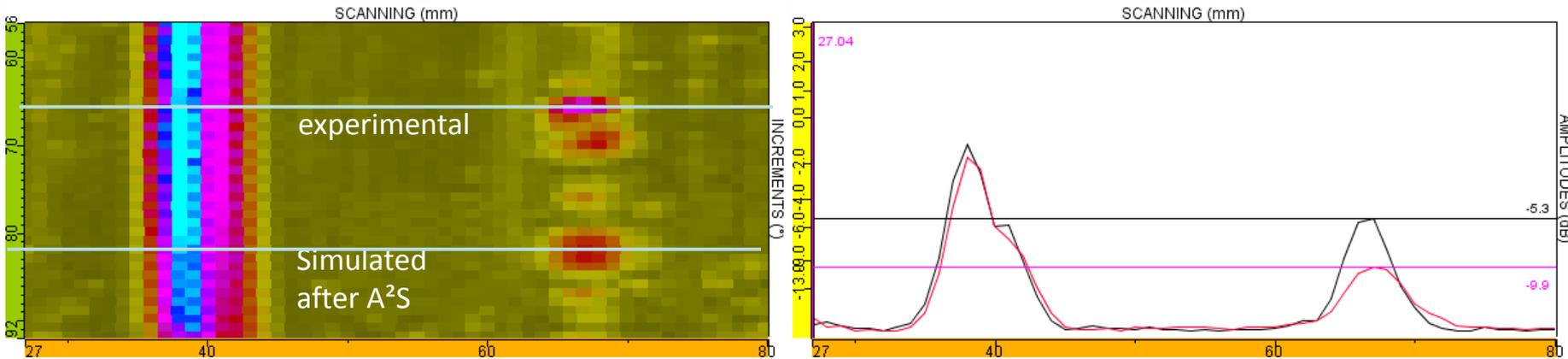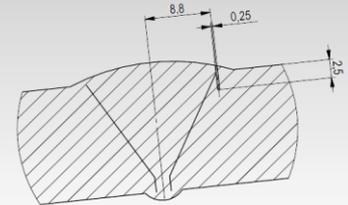
| Loss of amplitude due to the tilt

| A²S avoids machining of several defects by changing the flaw characteristics

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Example n°2: inspection of a lack of fusion

- Comparison of experimental and simulated Cscans and Bscans
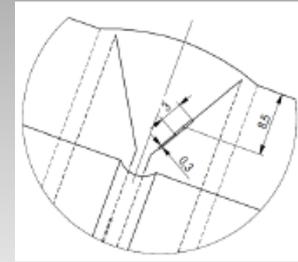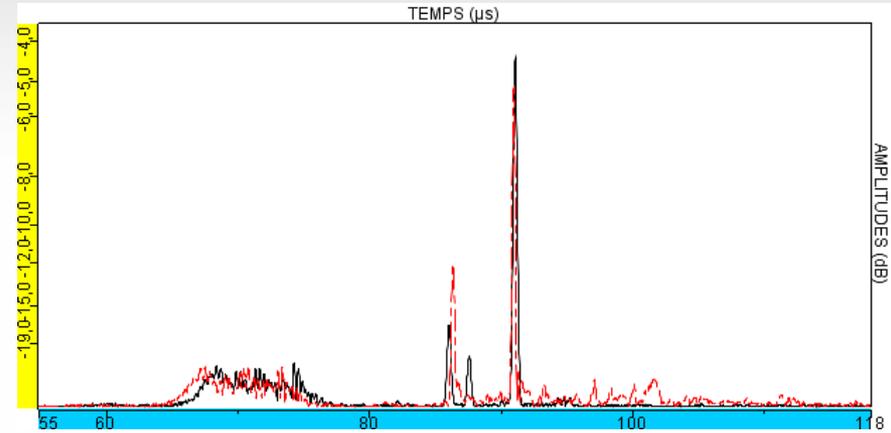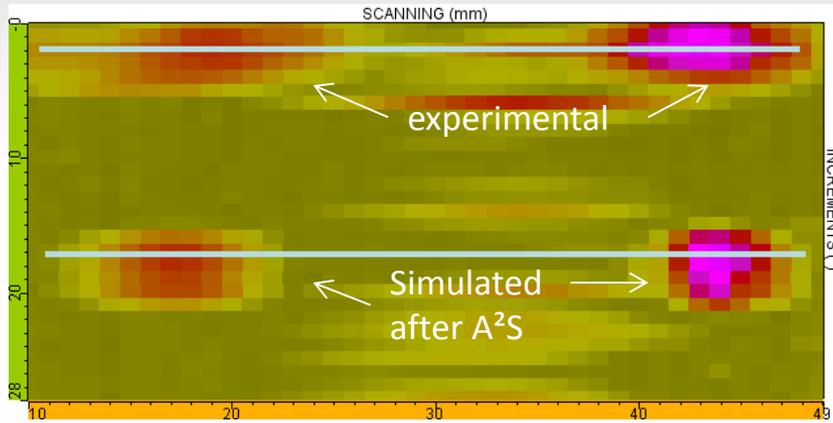- Simulated **flaw identical to real one**

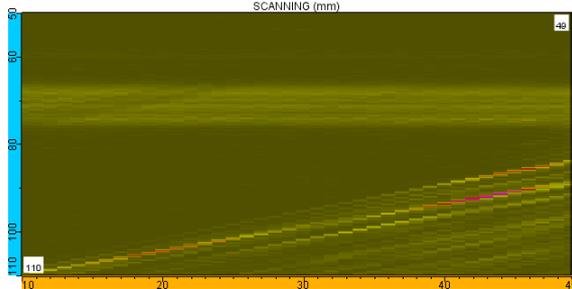**Experimental results**

Simulated results before A²S
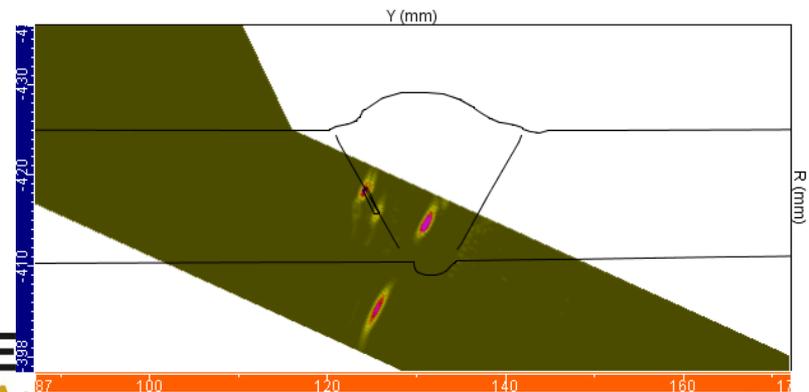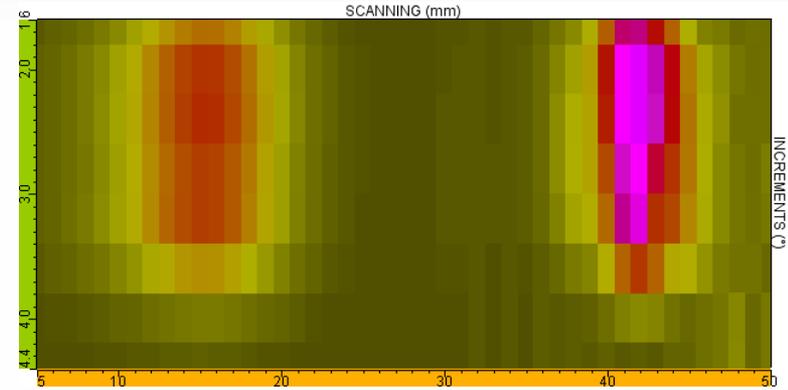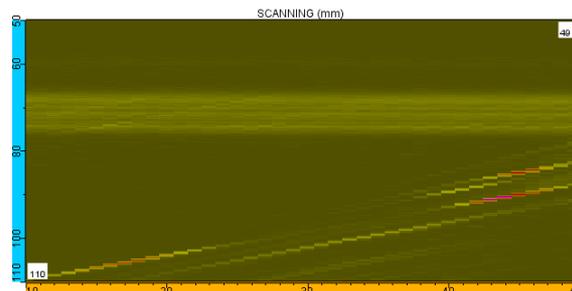
Example n°2: inspection of a lack of fusion

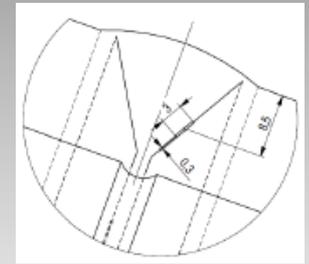**A²S results; Simulated flaw identical to real one**
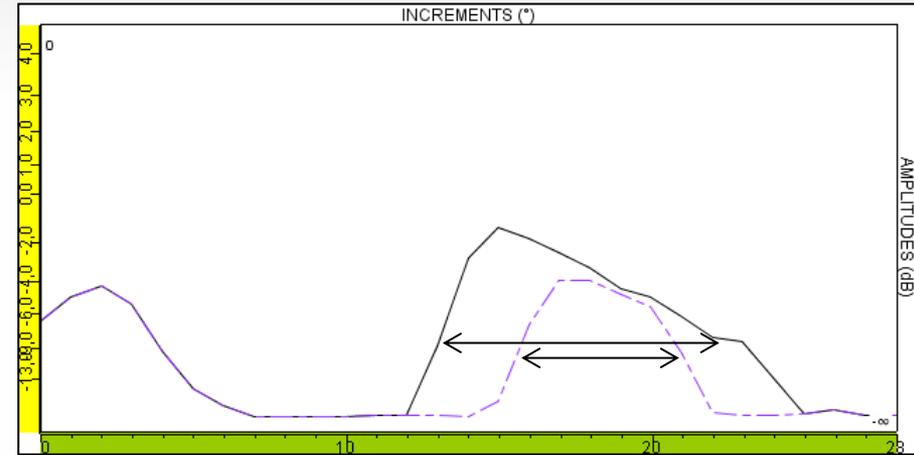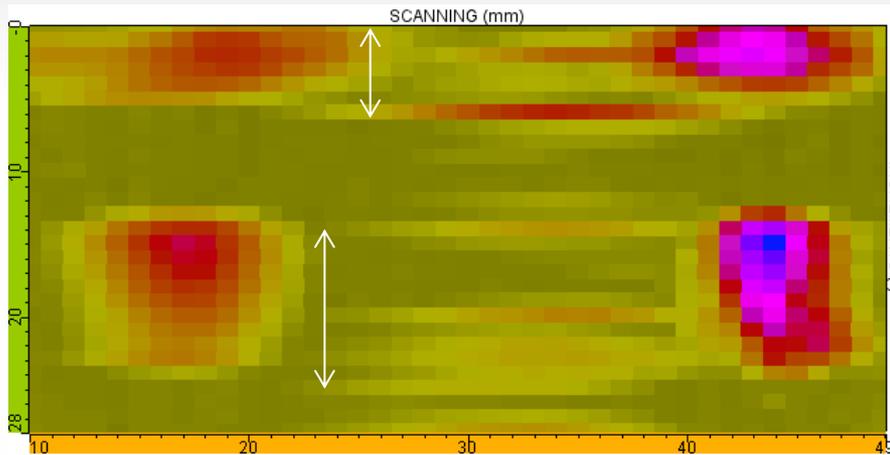

experimental

Simulated after A²S

- Simulation does not consider variations in the specimen geometry along extension → small differences on the echoes associated with skips on the backwall

- On the overall : A²S file is very realistic
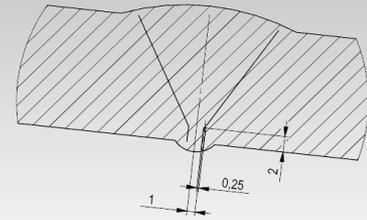
Example n°2: inspection of a lack of fusion

**|** A²S results; Simulated flaw **longer than the real one** (l=30mm vs 15 mm)

| The superposition of the echodynamic increment shows the difference between the initial flaw and the larger one

| On the overall : A²S file is very realistic

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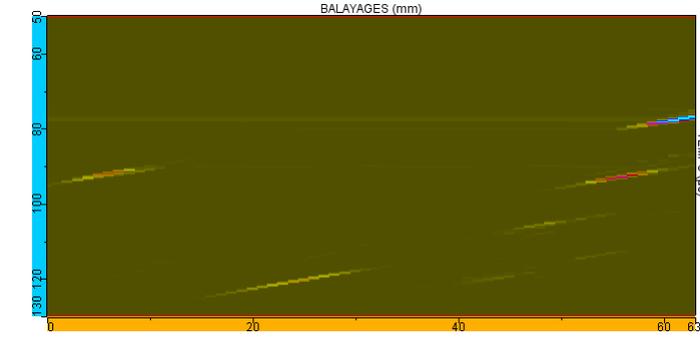CIVA

Example n°3: inspection of breaking backwall notch
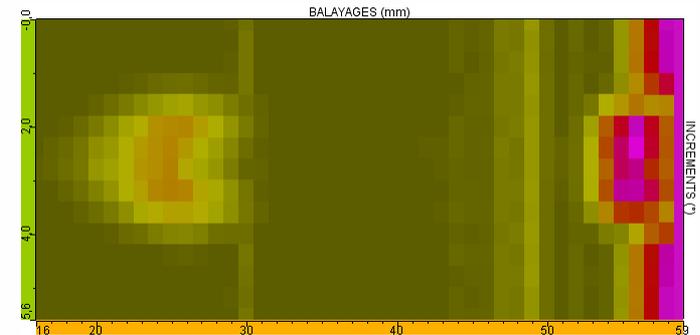

- Comparison of experimental and simulated Cscans and Bscans
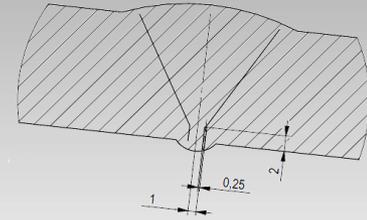- Simulated **flaw identical to real one**

Experimental results
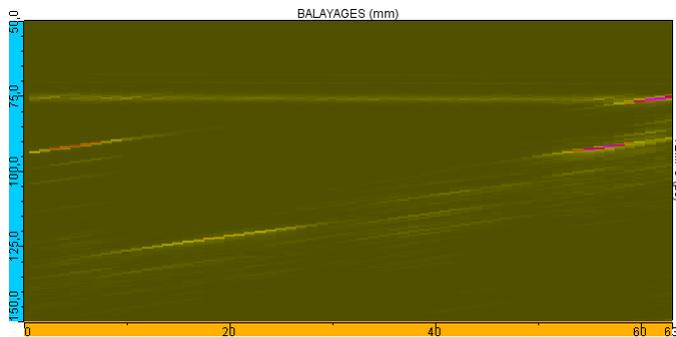
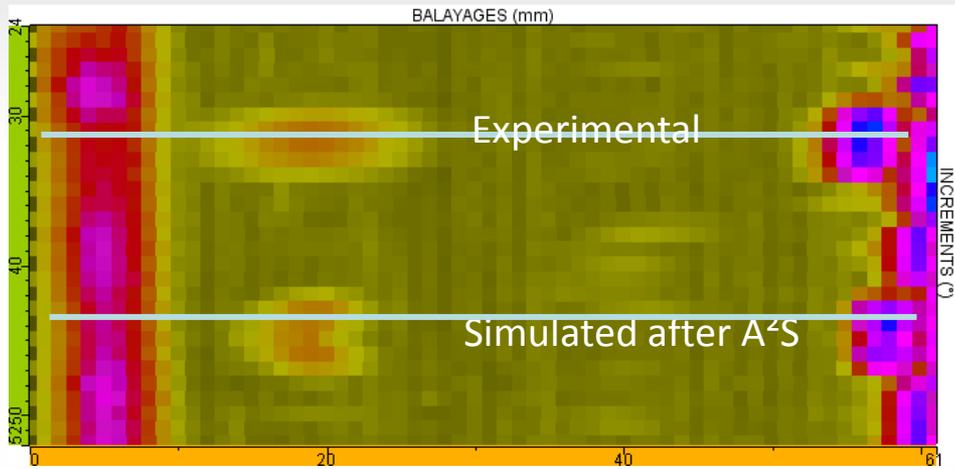**Simulated results before A²S**

Example n°3: inspection of breaking backwall notch

I A2S results; Simulated **flaw identical to real one**

Experimental

Simulated after A²S

I Small differences on the spreading of the echo

I Same width defect

I A²S file is realistic

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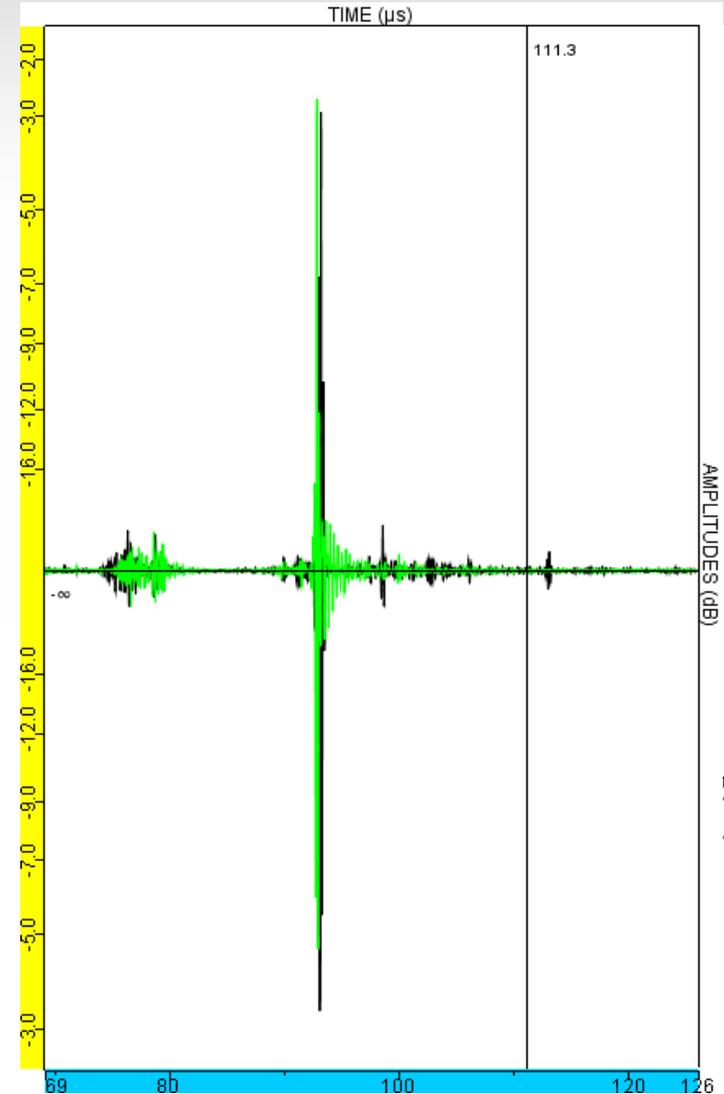
Conclusion

| A²S improves and lowers costs of NDT training by providing experimental files augmented by simulation

- training to characterization by changing the flaw characteristics
- save the manufacturing of several mocks-up and machining of artificial defects

| Files mixing both acquisition results and simulated echoes

| Augmented data realistic

| Can be opened and analyzed in CIVA or CIVA Analysis software

- efficient tools for analysis and understanding of the results

| EXTENDE thanks for lending us the specimen

contact@extende.com

CIVA