

11th NDE

11th International Conference on Non Destructive Evaluation
in Relation to Structural Integrity for Nuclear and Pressurized Components

**Advanced Tools based on Simulation for
analysis of Ultrasonic Data**

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**EXTEN·D·E
|CIVA|**

Outline

- | Introduction
- | The process of UT data analysis
- | Analysis tool n°1: Segmentation
- | Analysis tool n°2: Simulation on Acquisition
- | Conclusion

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CIVA in a few words

| Software platform dedicated to NDE modeling

| Multi-techniques :

- UT: Ultrasound
- GWT: Guided Wave
- RT-CT: Radiography (X-rays & Gamma Rays) & Computed Tomography
- ET: Eddy Current
- Analysis & reconstruction tools

| Developed by CEA LIST

- Research Centre in NDE: 100 people
- CIVA Development & validation: 30 people

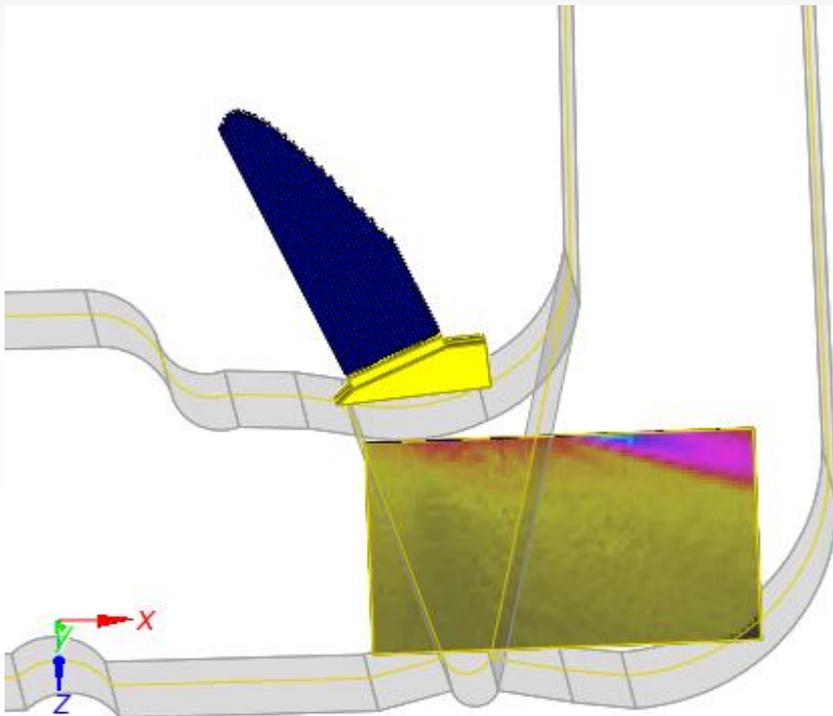


| Distributed and supported by EXTENDE

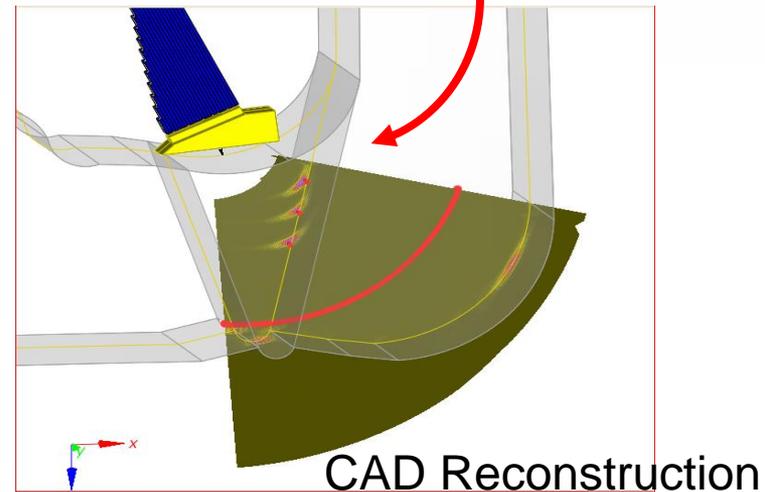
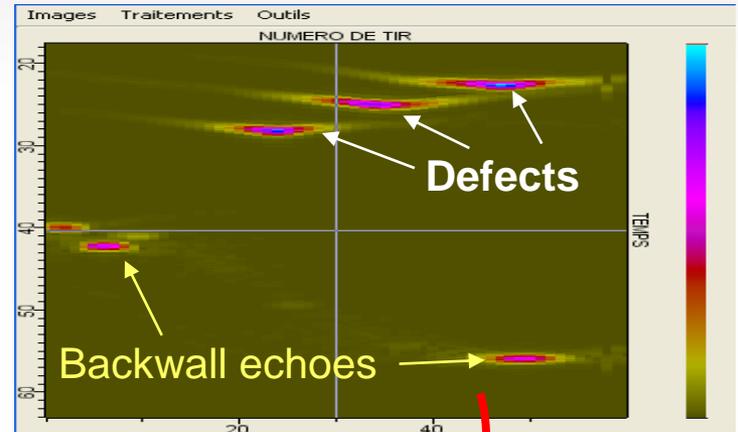
- 14 people
- 10 people for technical support

CIVA UT

| Beam calculation:



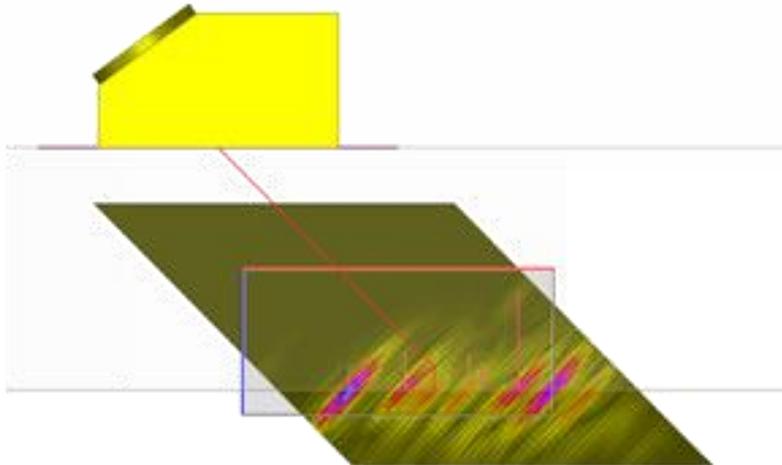
| Interaction with defects:
(Images Ascan-Bscan-Cscan, etc...)



CIVA ATHENA2D

I Module CIVA ATHENA 2D:

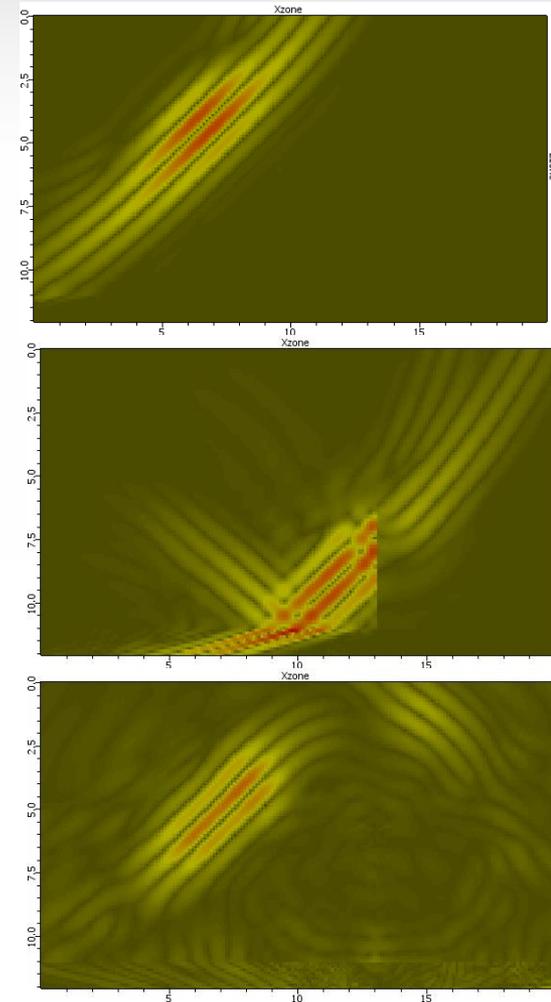
- Hybrid computation CIVA (semi-analytical)/ ATHENA 2D (FEM code from EDF)
- Accounts for all field/flaw interaction phenomena in a FE box defined around flaw(s)
- Computation time is efficient (2D code, reduced size of the FE box)



Multiple scattering with clusters of flaws

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CIVA

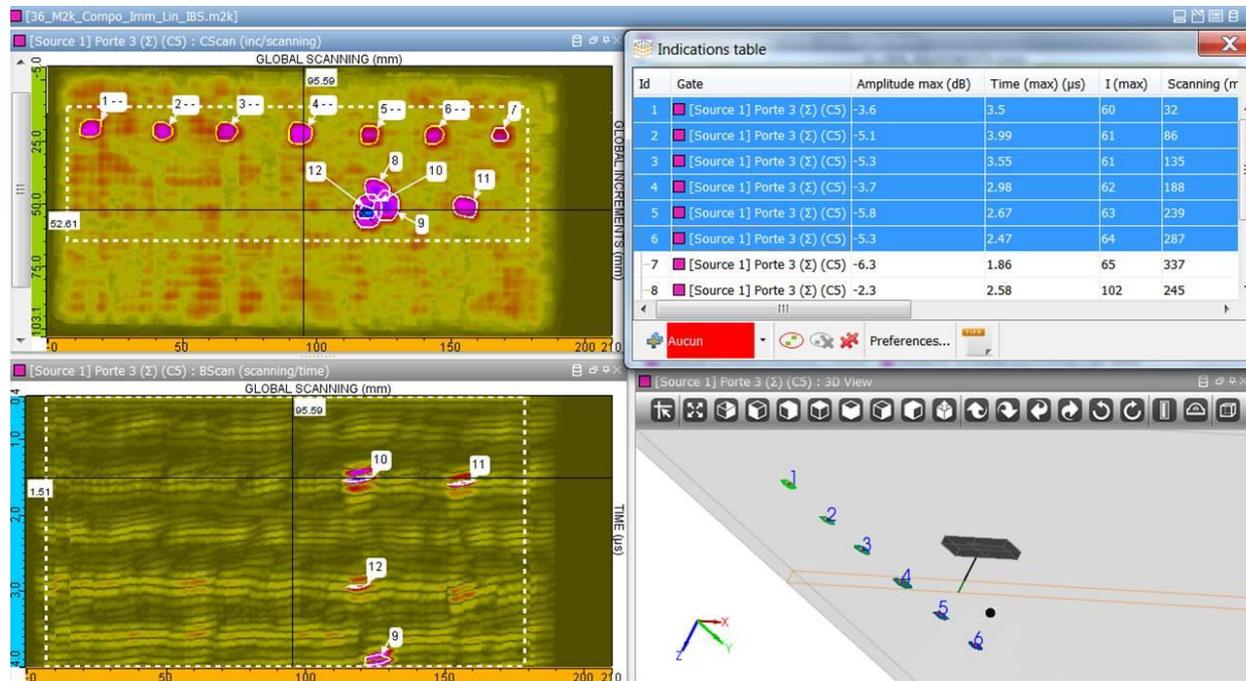
Beam/Flaw Scattering



CIVA UT Analysis

UT data analysis:

- A set of « 1 click Tools » for fast and easy extraction of indications from UT Data
- Advanced and Cutting-edge tools:
 - Segmentation, Reconstruction, Signal Processing, Simulation on Acquisition, ...



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The process of UT data analysis

- | Objective of the analysis: to obtain an examination report that lists the operating conditions and the indications present in the inspected component
- | Analysis can be performed following several steps:
 - Validation of the acquisition
 - Preliminary signal processing : application of DAC correction; reconstruction of the data in the relevant frame
 - Application of detection and characterization thresholds → eliminate false calls or small defects
 - Clustering or segmentation algorithms: fast determination of the echoes of interest
 - Indication table

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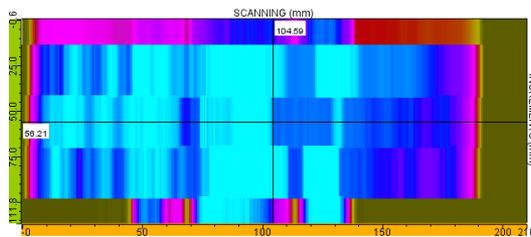
Segmentation

- | Goal: grouping signals coming from the same defect or part of a defect
- | The algorithm
 - Can be 2D or 3D
 - Grouping based on physical behavior of the ultrasound wave
- | Multiple indications can be, if wished, grouped as one (ex: tip diffraction echoes from a crack)
- | Creation of an examination report

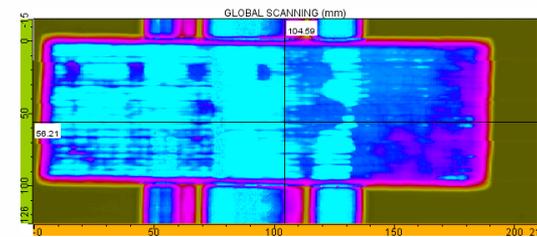
Application to composite immersion inspection

- Acquisition: electronic scanning of 16 elements with null delay law and 1 element step is associated with a Cscan displacement of the probe
- Step 1 : Link the data = combination of electronic and mechanical scanning along the same axis

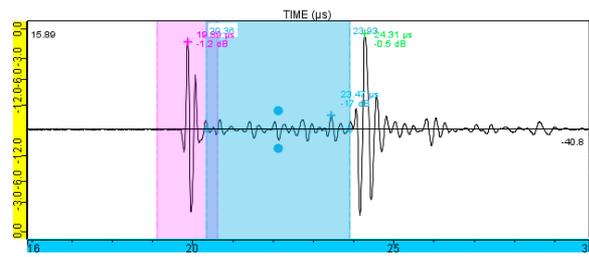
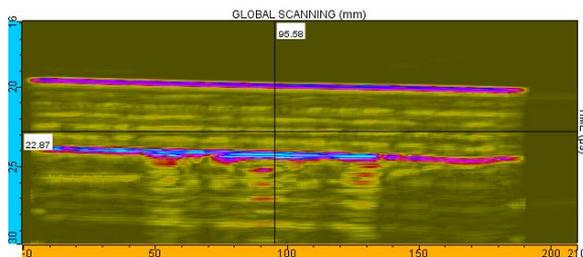
Before link



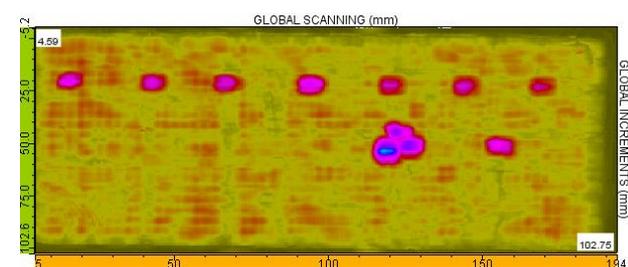
After link



- Step 2 : Isolate the flaw's responses with temporal gates



After time gating



Application to composite immersion inspection

Step 3: Defining a Region Of Interest (ROI) for analysis



CIVA_Analysis_Segmentation_in_one_click.mp4

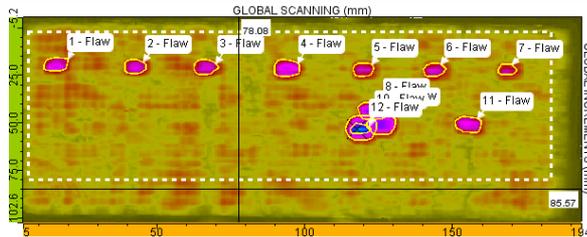
Step 4: Activate the Segmentation



- Amplitude threshold: level above which the signal will be taken into account during the analysis
- Spatial resolution: number of successive shots considered to group information
- Temporal resolution: time window in which the processing will join two points of consecutive shots by a segment
- Temporal parameter: time window for each Ascan in which we keep only the absolute maximum(s)

Should be in accordance with procedure and noise level

Relevant values by default, adjust if necessary



Id	Gate	Visibility	Locked indication	Comment	Type	Amplitude max (dB)	Time (max) (µs)	DX (st)	DY (st)	DZ (st)
1	[Source 1] Gate 3 (2) (C10)	👁	🔒		Flaw	-3.6	3.5	7.2	8	0.24
2	[Source 1] Gate 3 (2) (C10)	👁	🔒		Flaw	-5.1	3.99	7.2	7	0.05
3	[Source 1] Gate 3 (2) (C10)	👁	🔒		Flaw	-5.3	3.55	7.8	8.5	0.21
4	[Source 1] Gate 3 (2) (C10)	👁	🔒		Flaw	-3.7	2.98	9	8.5	0.23
5	[Source 1] Gate 3 (2) (C10)	👁	🔒		Flaw	-5.8	2.67	7.2	7	0.21
6	[Source 1] Gate 3 (2) (C10)	👁	🔒		Flaw	-5.3	2.47	7.2	7.5	0.21
7	[Source 1] Gate 3 (2) (C10)	👁	🔒		Flaw	-6.3	1.86	5.4	6	0.05
8	[Source 1] Gate 3 (2) (C10)	👁	🔒		Flaw	-2.3	2.58	8.8	9.5	0.12
9	[Source 1] Gate 3 (2) (C10)	👁	🔒		Flaw	-2.1	3.97	12	9.5	0.23
10	[Source 1] Gate 3 (2) (C10)	👁	🔒		Flaw	-0.6	1.53	13.2	10.5	0.09
11	[Source 1] Gate 3 (2) (C10)	👁	🔒		Flaw	-4.3	1.6	8.4	9	0.03
12	[Source 1] Gate 3 (2) (C10)	👁	🔒		Flaw	-5.3	2.97	5.4	7	0.07

Step 5: Creation and export of an indication table



Outline

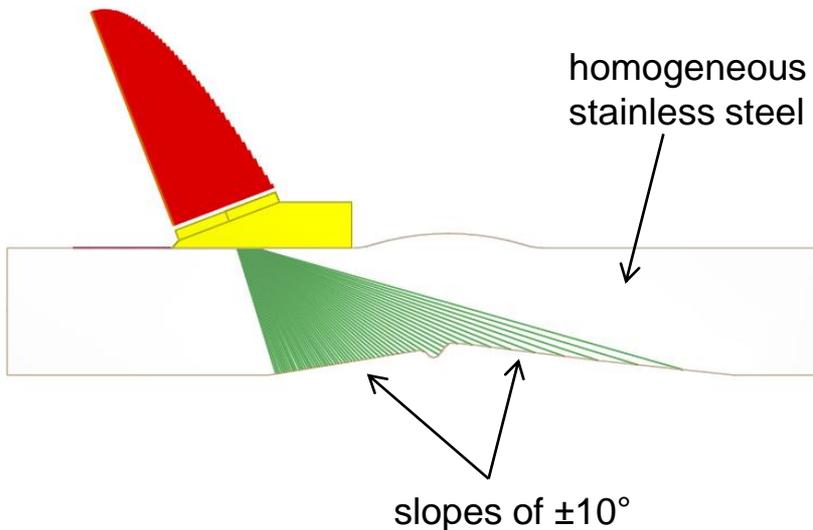
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Simulation on acquisition

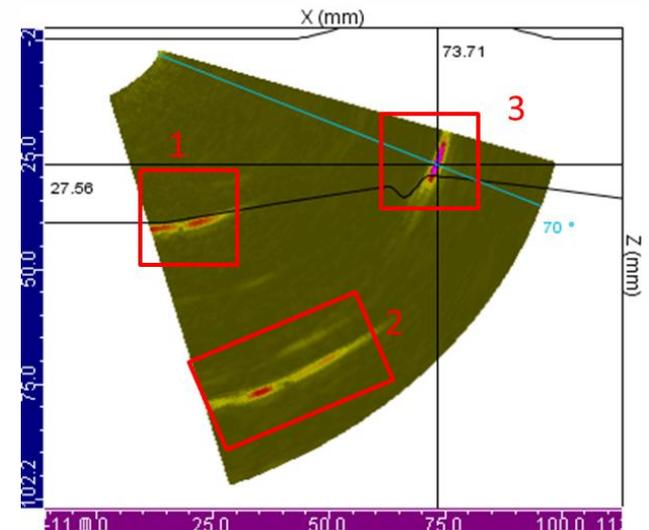
- | CIVA UT Analysis module also proposes to perform a simulation in a ROI of the acquisition in order to enhance diagnosis.

- | Demonstration:

2MHz, 48 elements

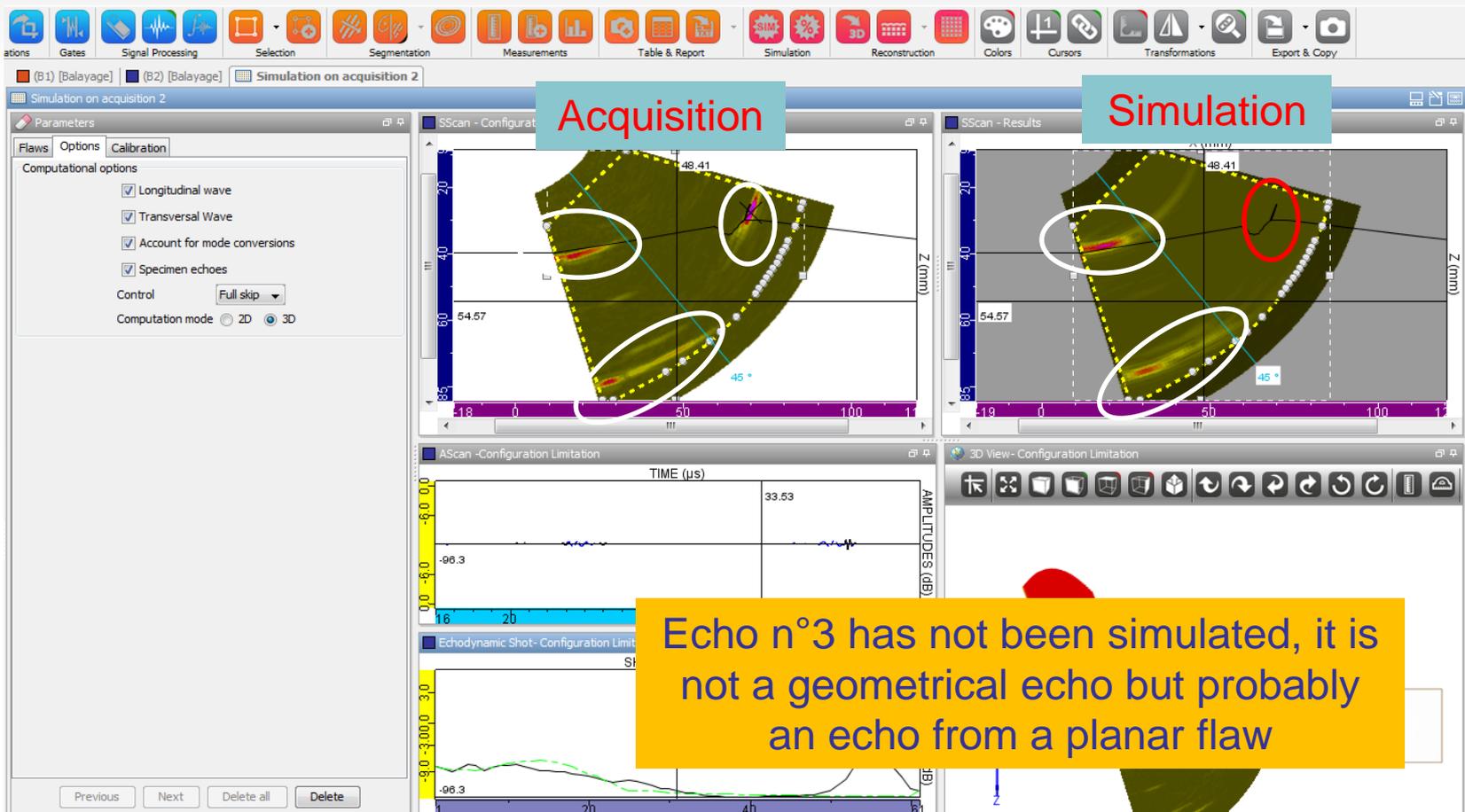


What is echo n°3, geometry or defect echo ?



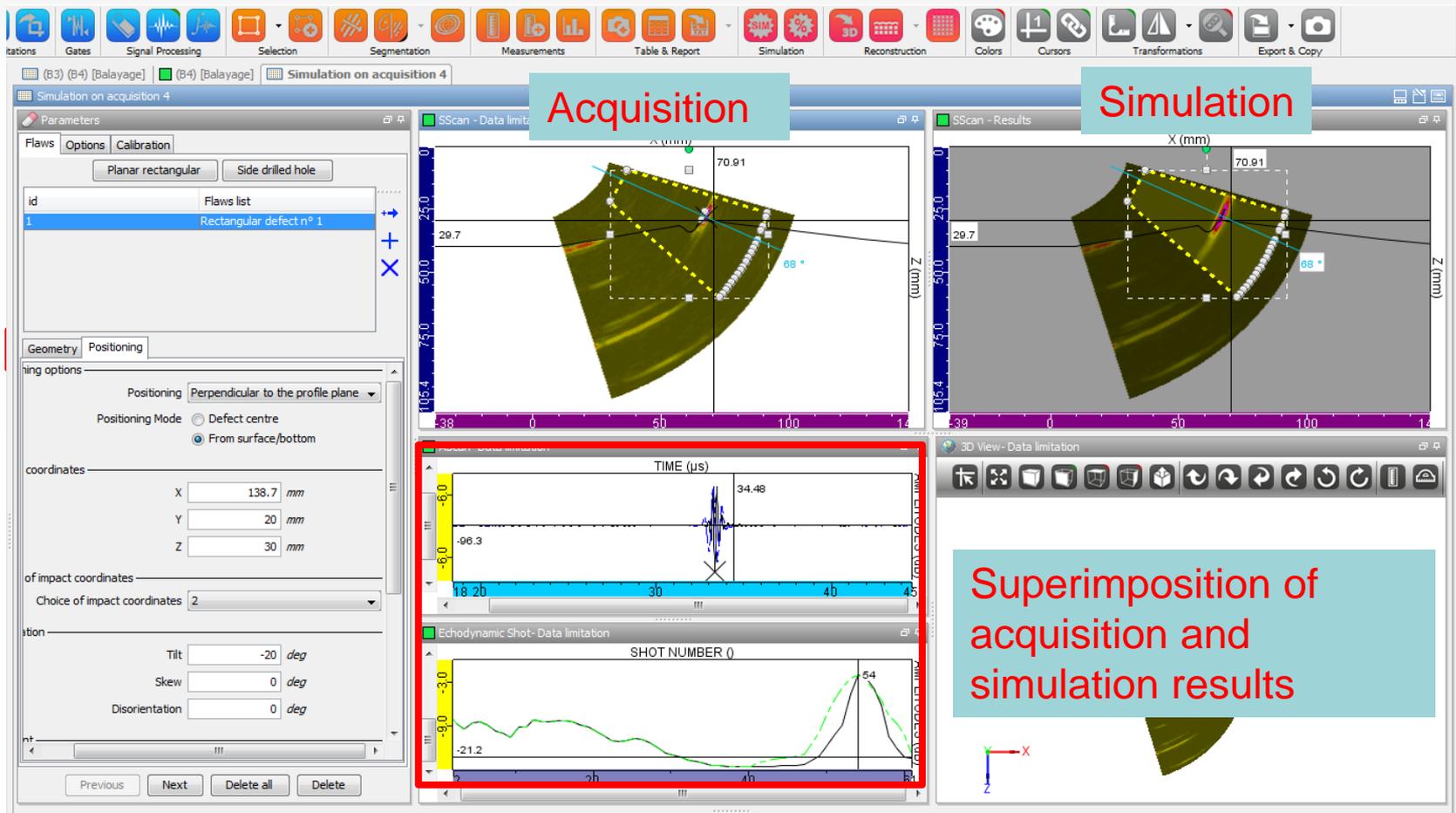
Identification of echo n°3

- | Echoes n°1 and n° 2 are geometry echoes but is it the same for echo n°3 ?
- | The simulation on acquisition tool lets you simulate geometry echoes in a ROI



Identification of echo n°3

- I We suspect Echo n°3 to be a planer flaw. Let's use the simulation on Acquisition tool to verify it



Conclusion

- | UT Analysis tool :
 - Helps to quickly evaluate and record indications
 - Included in CIVA 2015 UT **or** available as a separate module
 - Segmentation in « one click »
 - « Simulation on Acquisition » tool
 - Provides **manual data inversion** assisted by **simulation**

- | Facilitates processing acquisition data from:
 - M2M systems (MultiX++, Gekko)
 - Olympus (TomoView[®], OmniScan[®])
 - Compatibility with other formats being currently studied

- | Additional **demonstration** videos available on YouTube:
<https://www.youtube.com/user/extendechannel>