Hybridize experimental and simulated signals to accelerate the creation of database for virtual training tools of UT operators

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EVIDENT

20th WCNDT
20th World Conference on Non-Destructive Testing
Songdo Convensia, Incheon, Korea
27-31 May 2024

Ministry of Science and ICT
Incheon Metropolitan City
Incheon Tourism Organization
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Contents

Training, certification and skills maintenance

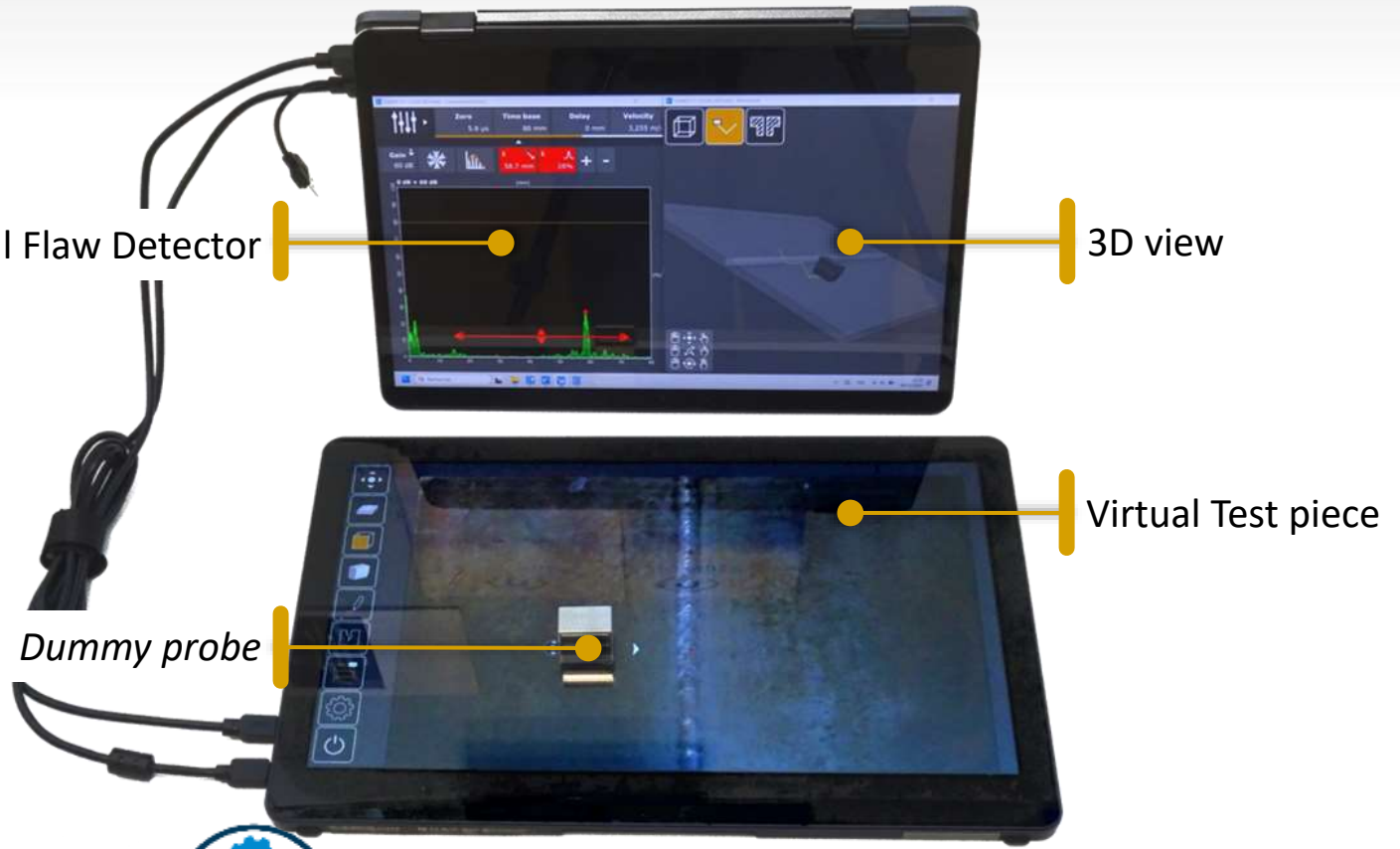
- Companies need to train and certify **quickly and efficiently** their NDT controllers
- Controllers must maintain their **skills**

- **Limitations**
  - shipping costs (off-site trainings)
  - block manufacturing costs (specific specimens and flaws)
  - the lack of existing block (i.e. HTHA samples)

Teaching and learning UT

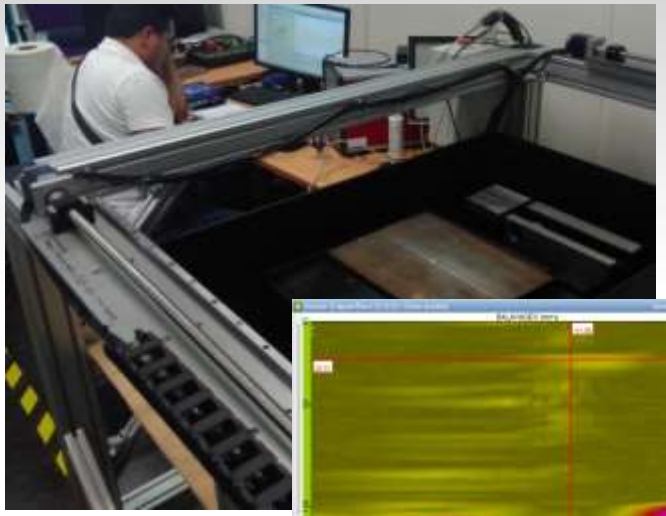
- Link **theory** and **practice**
- Attract **young** people
- Mimic **onsite** practice
- **Easier** practice
- Multiple **cases**
- **Evaluate** controller skills

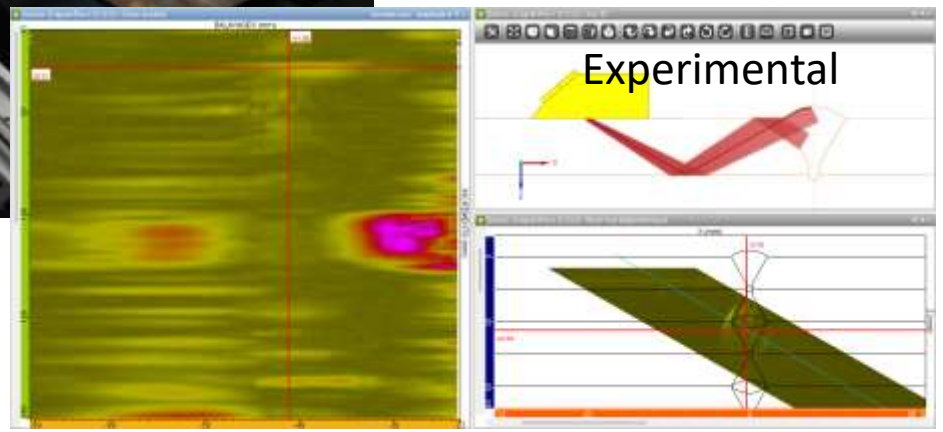
EXTENDE has developed **TraiNDE UT**

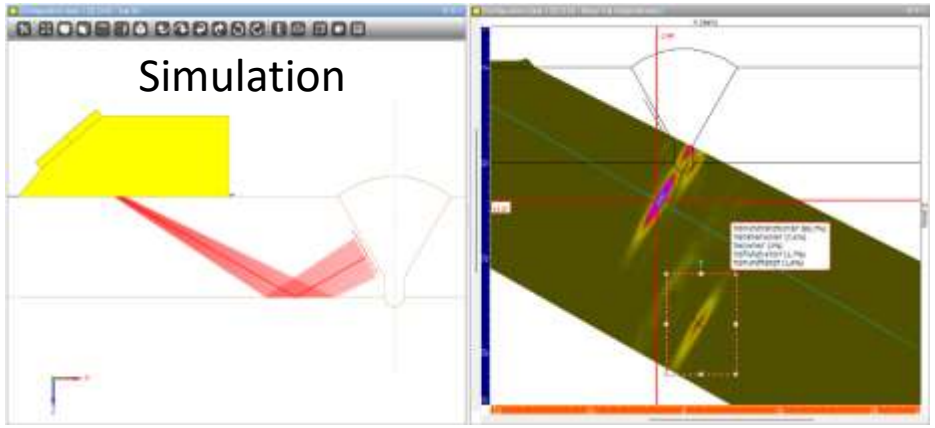


Signal databases

- Display the signal in **real time** at the **position** and **skew** of the dummy probe
- Need for **large storage**
- Collect experimental data
  - Need for **clean** data
  - Requires samples, probes, electronics,...
- Simulate data
  - Need for **realistic** data
  - Requires all-in-one model and accurate descriptions







Why hybrid signal database?

	Experimental	Simulation
Pro	Considers all the physics Easy to source wholesome blocks	Easy to add flaws Many types of flaws
Cons	Complex and costly to add flaws Experimental uncertainties	Time consuming to simulate all modes Too perfect

Hybridize

- *experimental signals for the geometry echoes of the specimen*

with

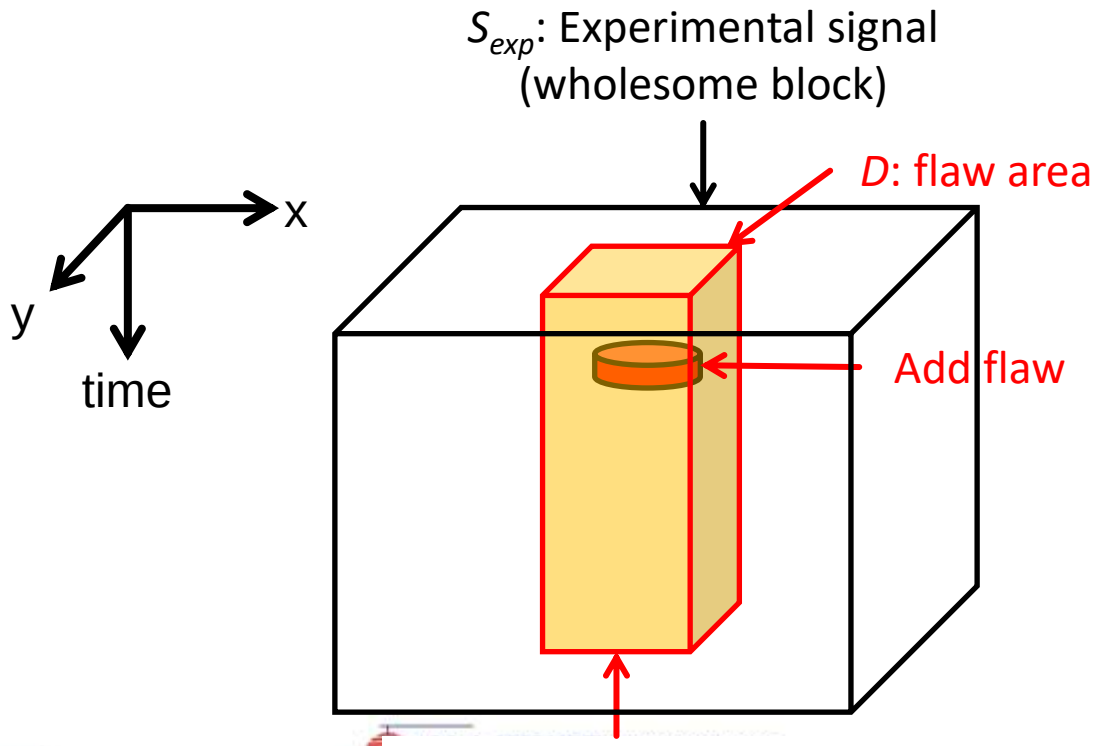
- *simulated signals for the flaws*

EXTENDE CIVA TRAINDE UT

How to create hybrid signal database?

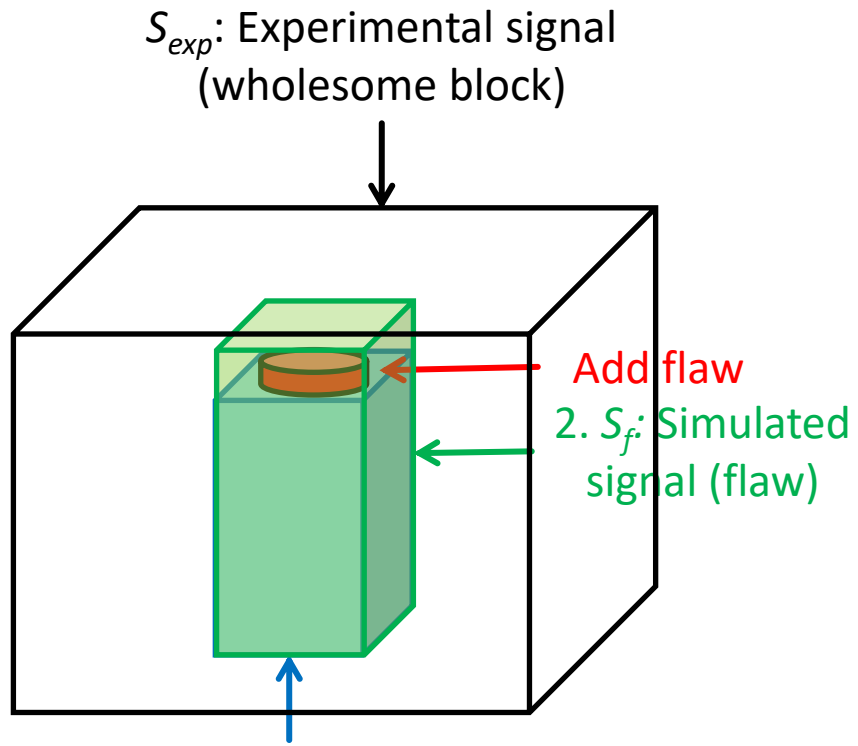
Insertion

$$S(x,y) = \begin{cases} S_{sim}(x,y) & if\,(x,y) \in D \\ S_{exp}(x,y) & otherwise \end{cases}$$



Composite fusion

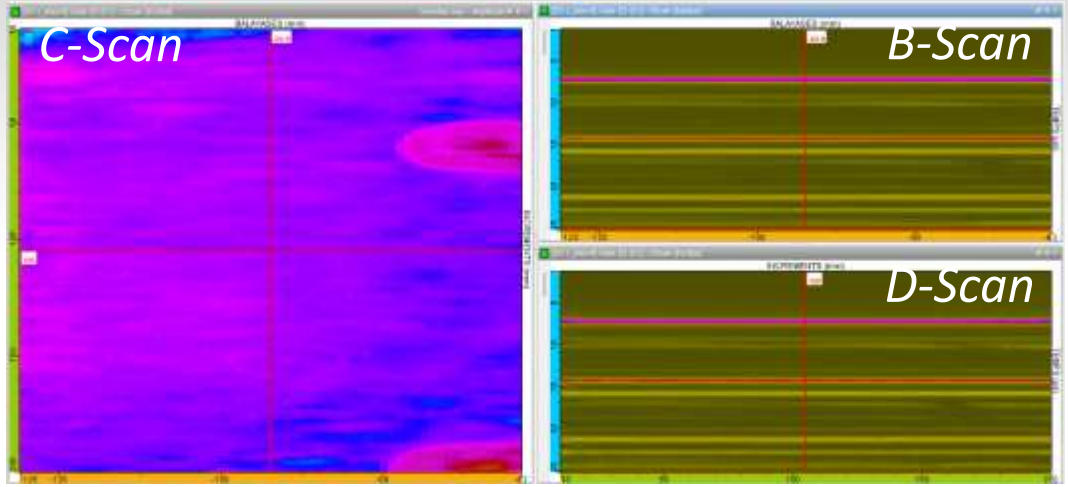
$$S(x,y) = T_{shad}(x,y) \cdot S_{exp}(x,y) + S_f(x,y)$$



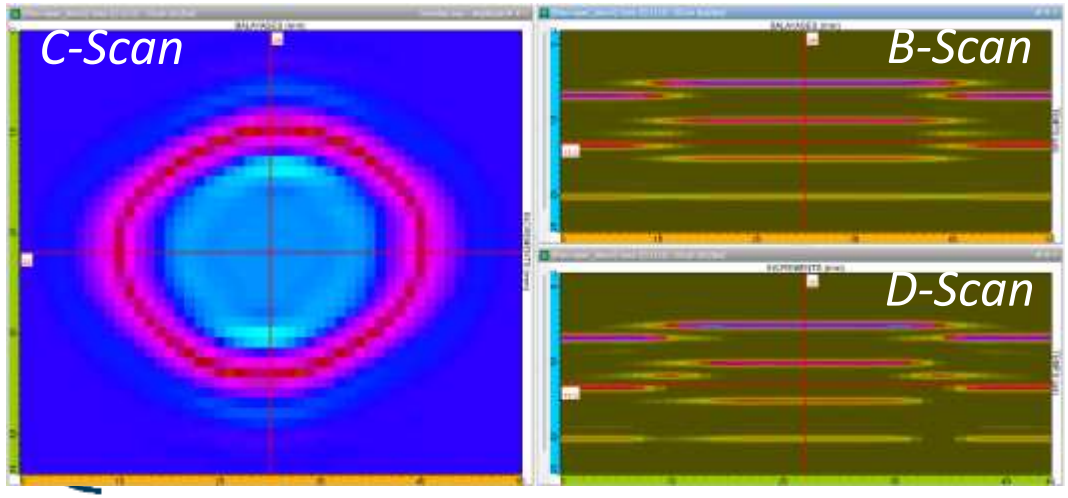
Straight probe application

- Probe: « MSEB » type
  - 4 MHz – L wave
  - Dual Element
  - Crystal 3.5 x 10 mm
- Specimen: Plate
  - 20 mm thick
  - Carbon Steel
- Simulated flaw (CIVA): Delamination
  - ~ 25 x 30 mm
  - 15 mm deep
  - with experimental specimen description
  - only L waves (no T wave / mode conversion)

S_{exp} : Wholesome plate



S_{sim}: Delamination



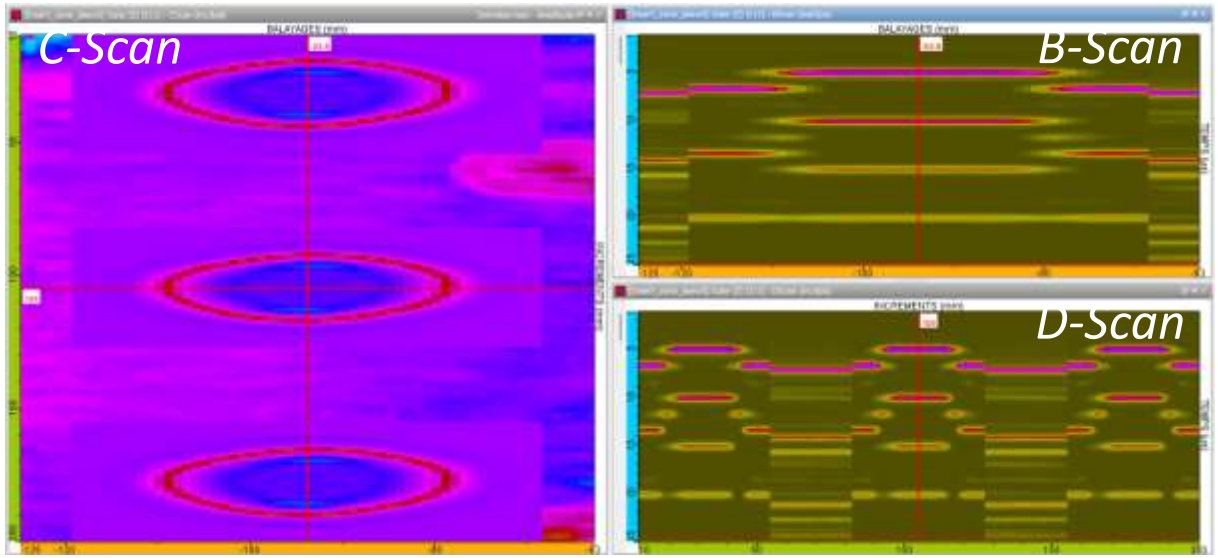
Straight probe hybrid signal database

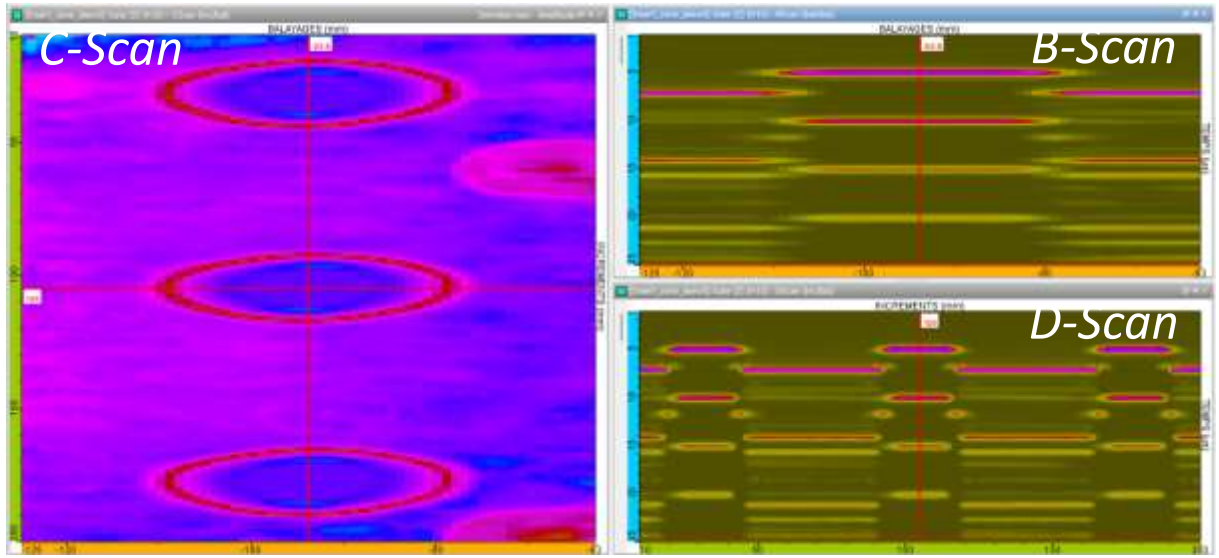
Insertion

- Discontinuities (amplitude, time of flight & modes)
- Requires accurate modeling

Composite fusion

- Account for experimental variations
- Smooth integration
- Compensates for modeling imprecision

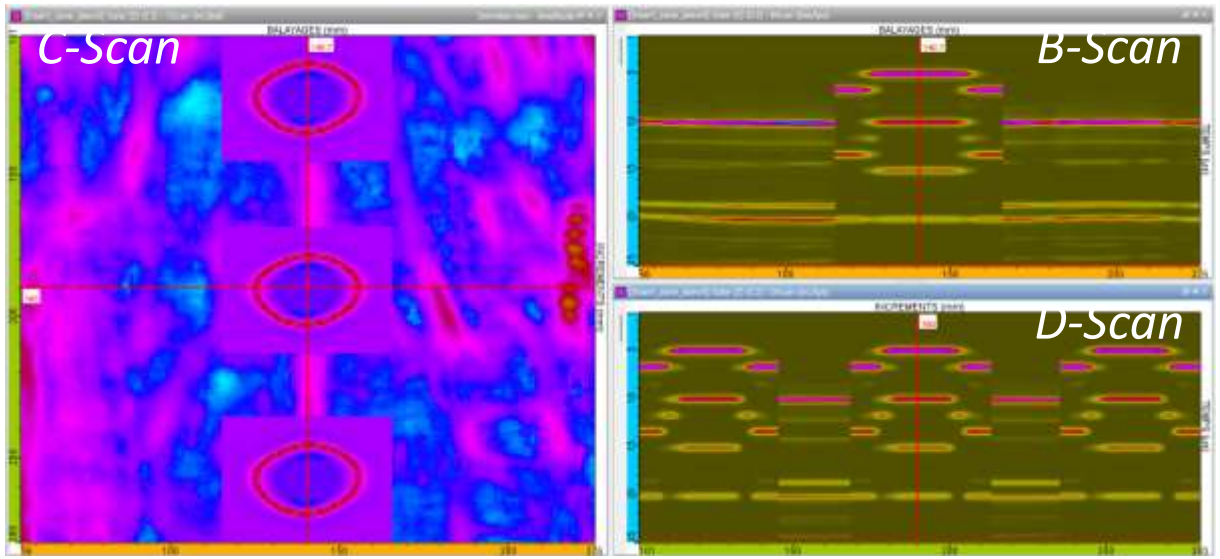


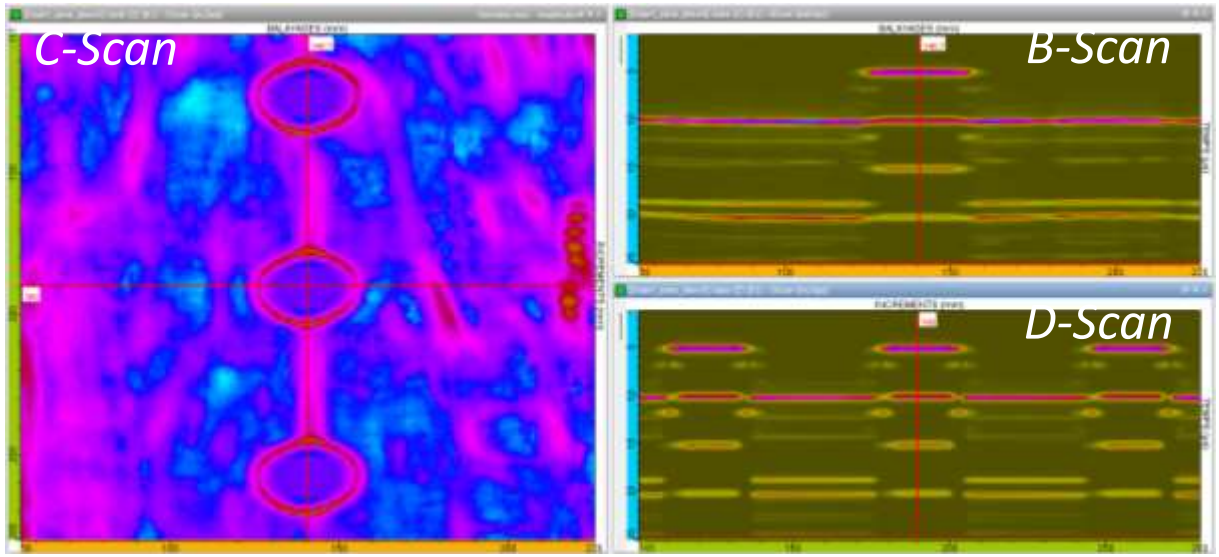


Robustness to thickness changes

- S_{exp}: Wholesome plate 30 mm thick
- **Insertion**
  - Requires accurate modeling → Cannot apply to plate thickness changes

- S_{sim}: Delamination at 15 mm deep in 20 mm thick plate
- **Composite fusion**
  - Smooth integration
  - Realistic merge of flaw repetition and backwall echoes

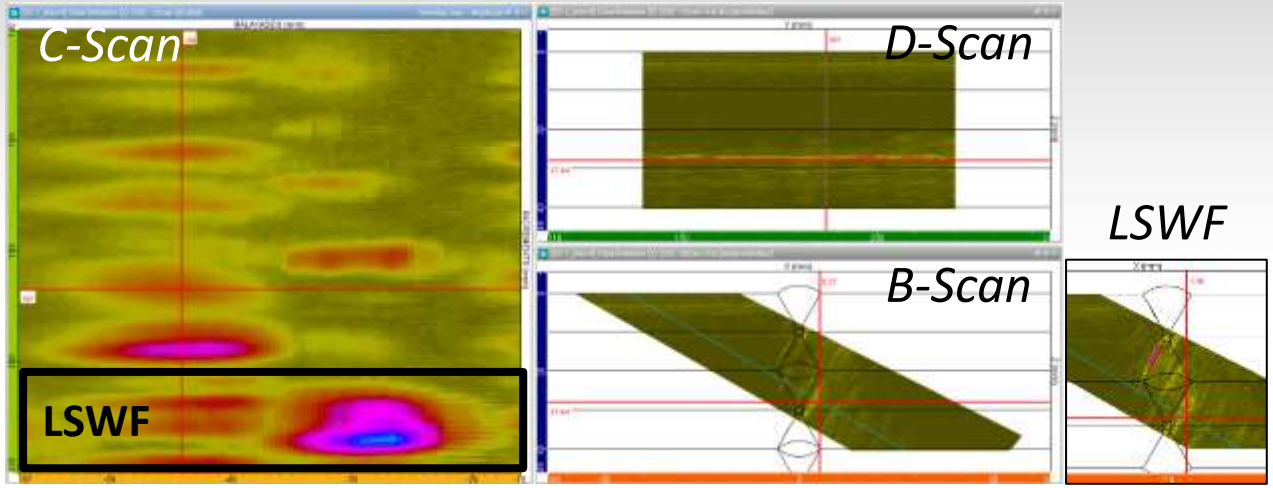




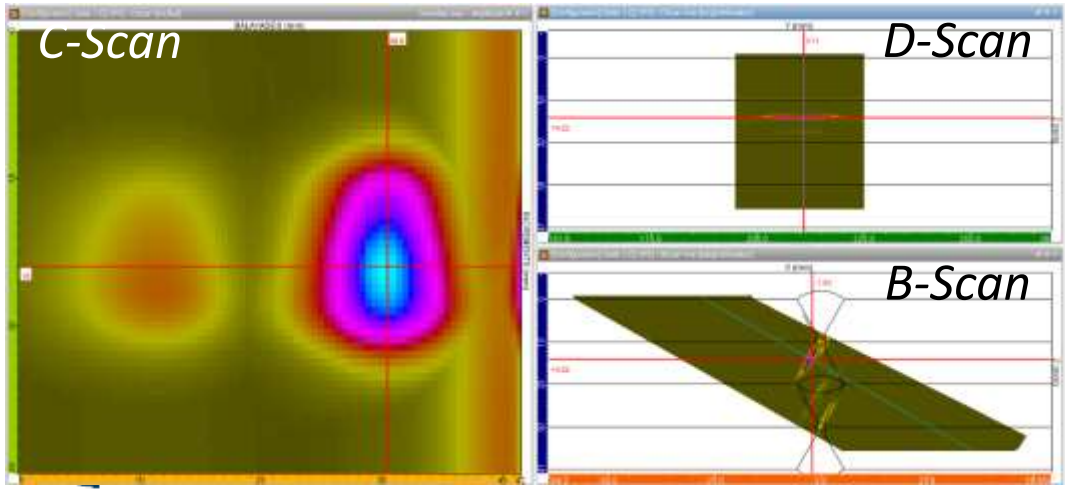
Angle probe application

- Probe: « MWB » type
  - 4 MHz – T wave
  - Single Element
  - Crystal 8 x 9 mm
- Specimen: V weld
  - 10 mm thick
  - Carbon Steel
- Simulated flaw (CIVA): LSWF
  - ~ 12 x 5 mm
  - 5.5 mm deep
  - with experimental specimen description
  - only T waves (no L wave / mode conversion)

S_{exp} : Wholesome weld



S_{sim}: Lack of Side Wall Fusion (LSWF)



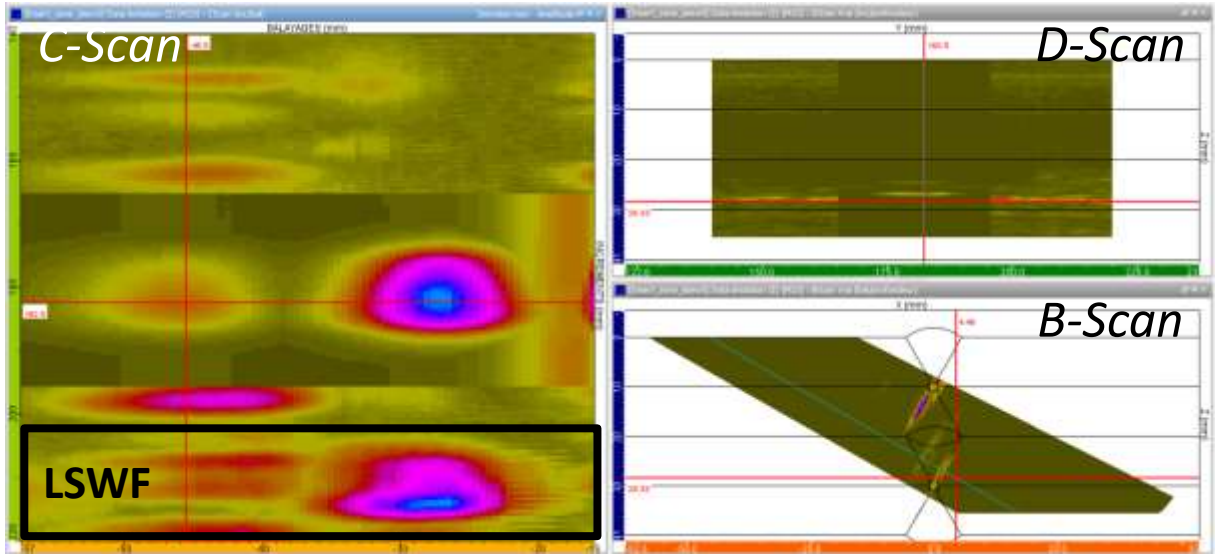
Angle probe hybrid signal database

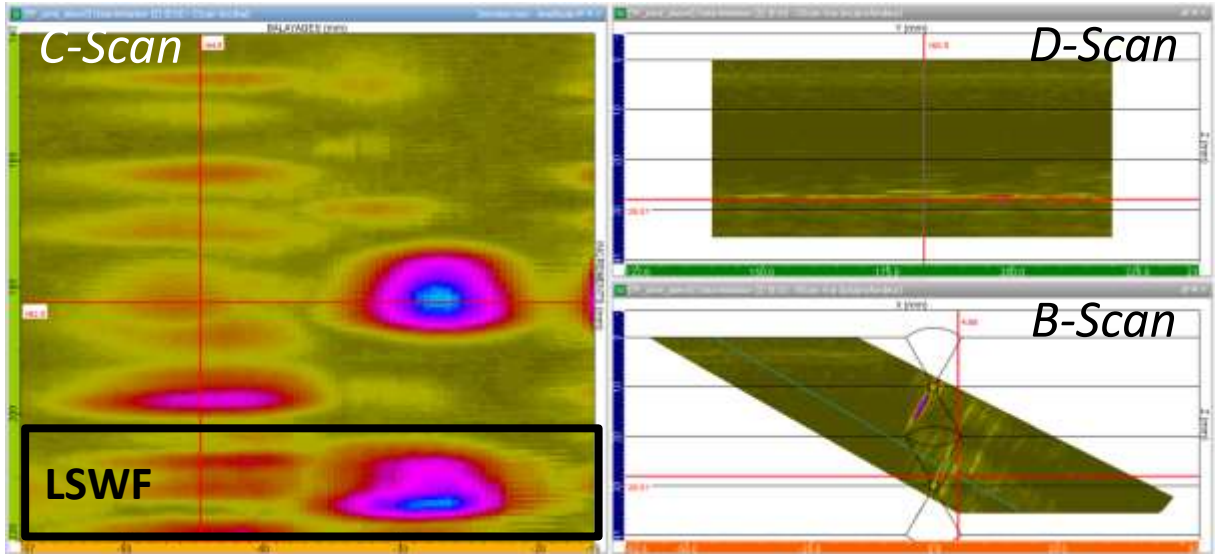
Insertion

- Discontinuities
- Requires accurate modeling
- Cannot reproduce weld cap and root variations

Composite fusion

- Comparable to actual flaw
- Smooth integration





Conclusion

- TraiNDE UT is a simulator for controller training and skills maintenance
- Need for modern and flexible training tools
- Make the most of experimental and simulated signal database
- Composite fusion is a robust method, applicable in real-time
- Integration in progress inside TraiNDE UT (come to test it at our **Booth A16**)
- Will allow to accelerate the creation of exercises for TraiNDE UT