



EF
NDT
European Federation for
Non-Destructive Testing



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HF.1 Qualification, Certification, Standards and Training

Digital Training: How can simulators enhance trainees' learning?

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EXTENDE
CIVA

OUTLINE

- | INTRODUCTION
- | NDT training challenges and benefits of simulators
- | Requirements for simulators
- | Conclusion

This presentation focuses on two methods:

- Ultrasonic Testing
- Radiographic Testing

Introduction

- | NDT-NDE operations requires specific and quite high-level skills
- | Learning NDT includes a combination of :
 - Theoretical aspects generally relying on slide shows
 - Practice on real work pieces
- | The use of simulation (whether it means modelling software or simulators) is still quite limited today ... whereas simulators are widely employed in numerous other domains: flight simulators for aircraft pilots, medical applications and surgery, welding simulators, cars or construction vehicles driving, etc.

About Simulator

| What is a simulator ?

« A device that enables the operator to reproduce or represent under test conditions phenomena likely to occur in actual performance. »

Flight Simulator



Medical Simulator



State of the art (non exhaustive)

In UT:

- **UTman :**

Simple User Interface, probe is moved with the mouse, educational illustration

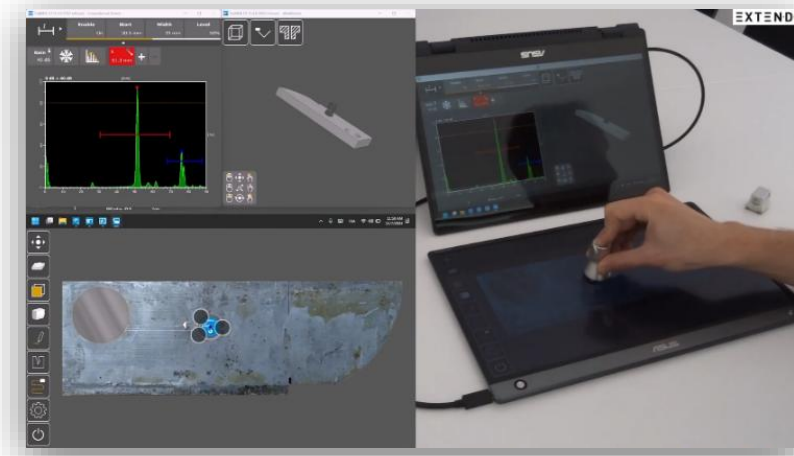
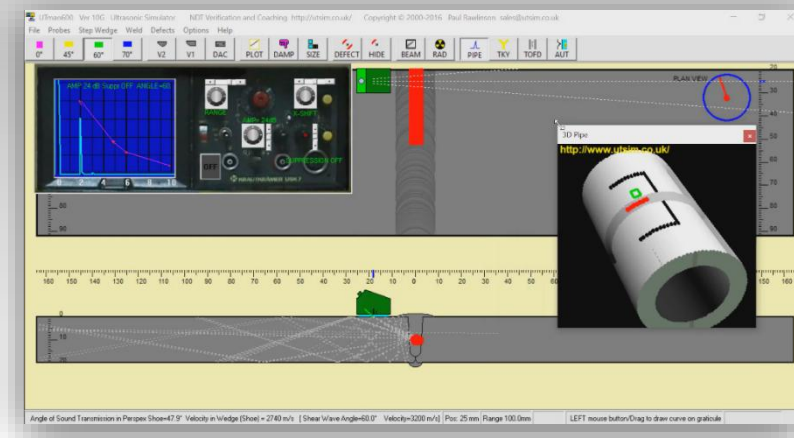
- **Virtual Non-Destructive Evaluation system (EPRI) :**

Tracks in real time the location of a dummy probe on a (3D printed) plastic mock-up of a component and display of the corresponding signals on a computer screen.

- **TraiNDE UT (EXTENDE):**

Tracks in real time the location and orientation of a dummy probe on a tactile screen with the picture of the component and display of the corresponding signals on a laptop or real flaw detector.

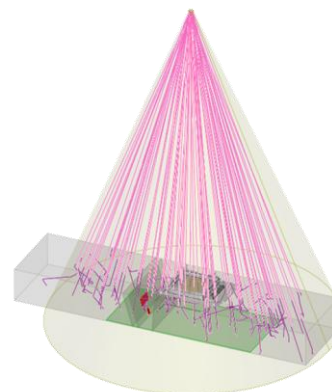
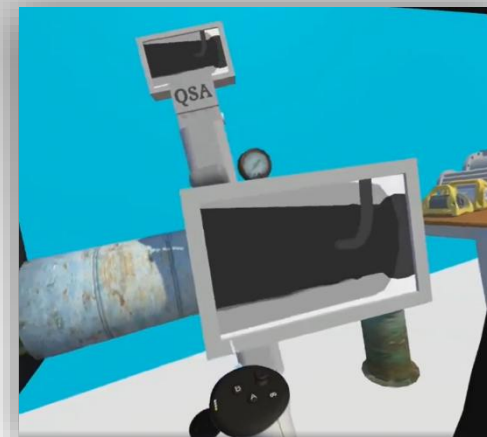
- Let's also mention modelling software such as **CIVA Education** to illustrate and understand physical phenomena



State of the art (non exhaustive)

In RT:

- D. Hoke develops Virtual Reality (VR) applications to introduce radiographic testing for newcomers.
- TraiNDE RT (EXTENDE):
You can prepare the RT inspection of components in an immersive way (in VR or with a PC) using X-Ray or gammagraphy, define shots parameters and analyse the obtained radiogram.
- Let's also mention modelling software such as **CIVA Education** to illustrate and understand physical phenomena (e.g. impact of scattering radiation, etc.)



NDT Training Challenges

| Trainees shall learn and understand a lot of important aspects, let's mention:

- Understand physical principles,
- Understand inspection parameters and inspection devices settings,
- Follow and reproduce the inspection procedure and gesture,
- Analyse observed signals and images,
- Provide a diagnostic and create reports.

... using potentially heavy equipment's, considering safety aspects and in a quite limited amount of time.

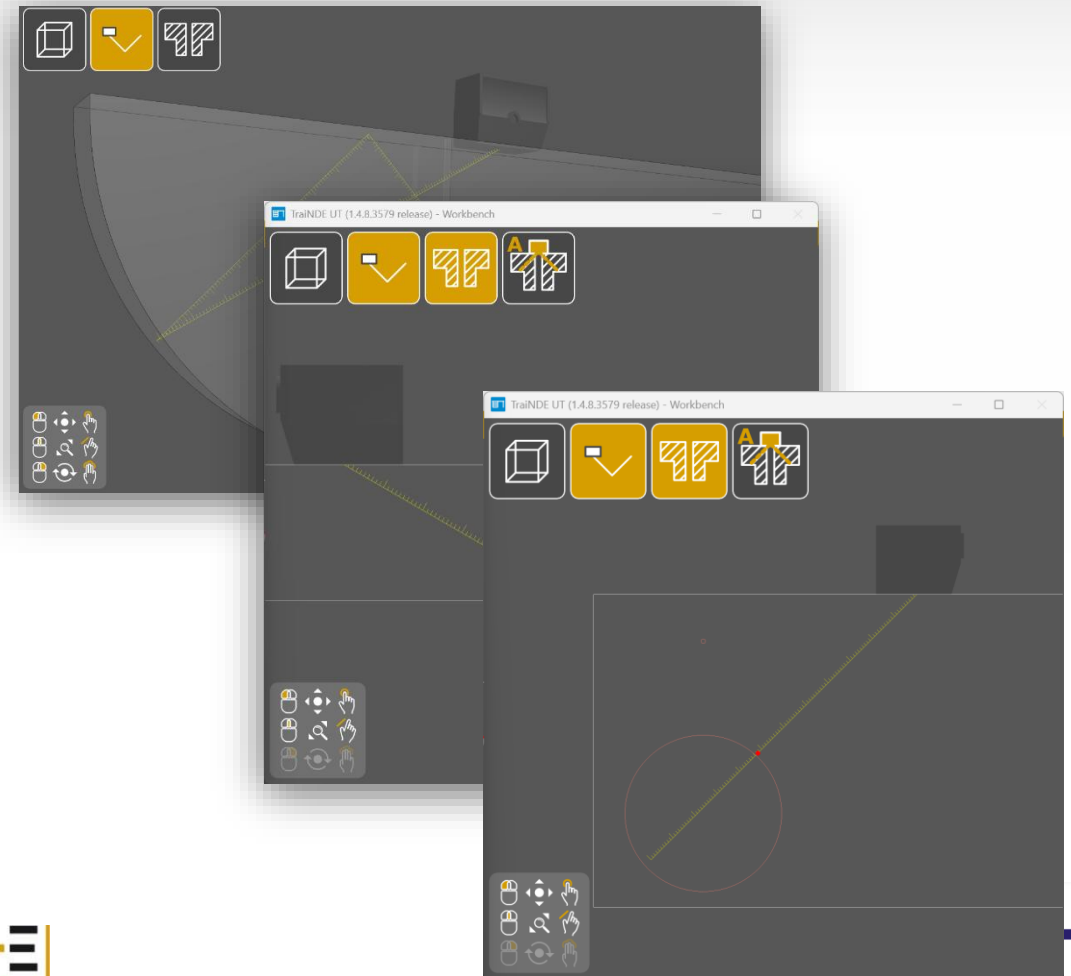
| Simulators shall help to tackle these challenges !

UT Training – Physical principles

| Learn and understand physical and mathematical principles by **“showing the invisible”** :

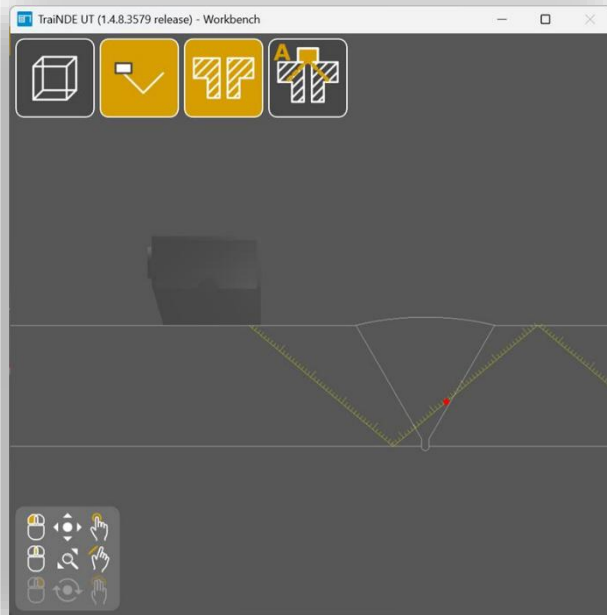
- Trigonometry and Snell-Descartes law
- Interaction of UT beam and components
- Flaw visualization

Dynamic 3D and section views and the positioning of the gate triggering point in the “spatial scene” will greatly help the “mental visualization” and thus the understanding.

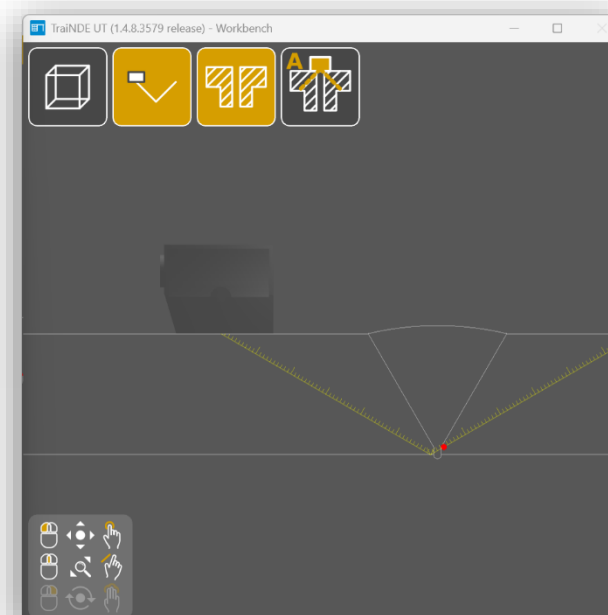


UT Training – Inspection settings

- Display in real time the probe position and the sound path will clearly illustrate the impact of settings parameters defined in the device such as : Probe angle, Index point, “Zero”, UT waves speeds, etc.



Bad settings

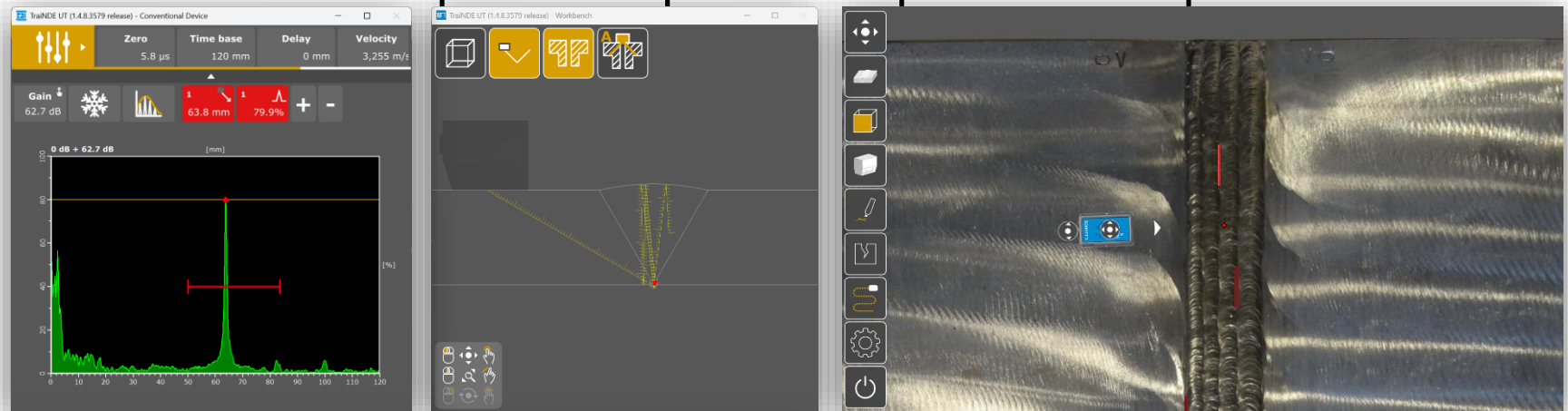


Good settings

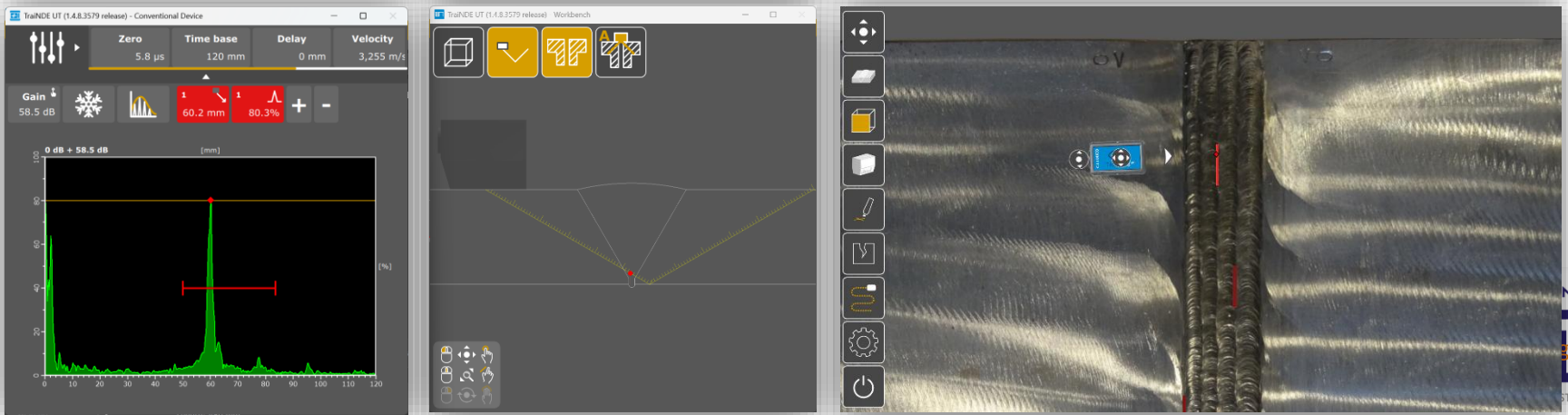
UT Training – Analysis

- Quite difficult to differentiate echoes from different origins for trainees (geometry, planar flaws, volumetric flaws, etc.) : Cross-section view, triggering point, flaws visualization and relevant example cases provide a precious help :

Weld root echo



Lack of Fusion echo
next to the root



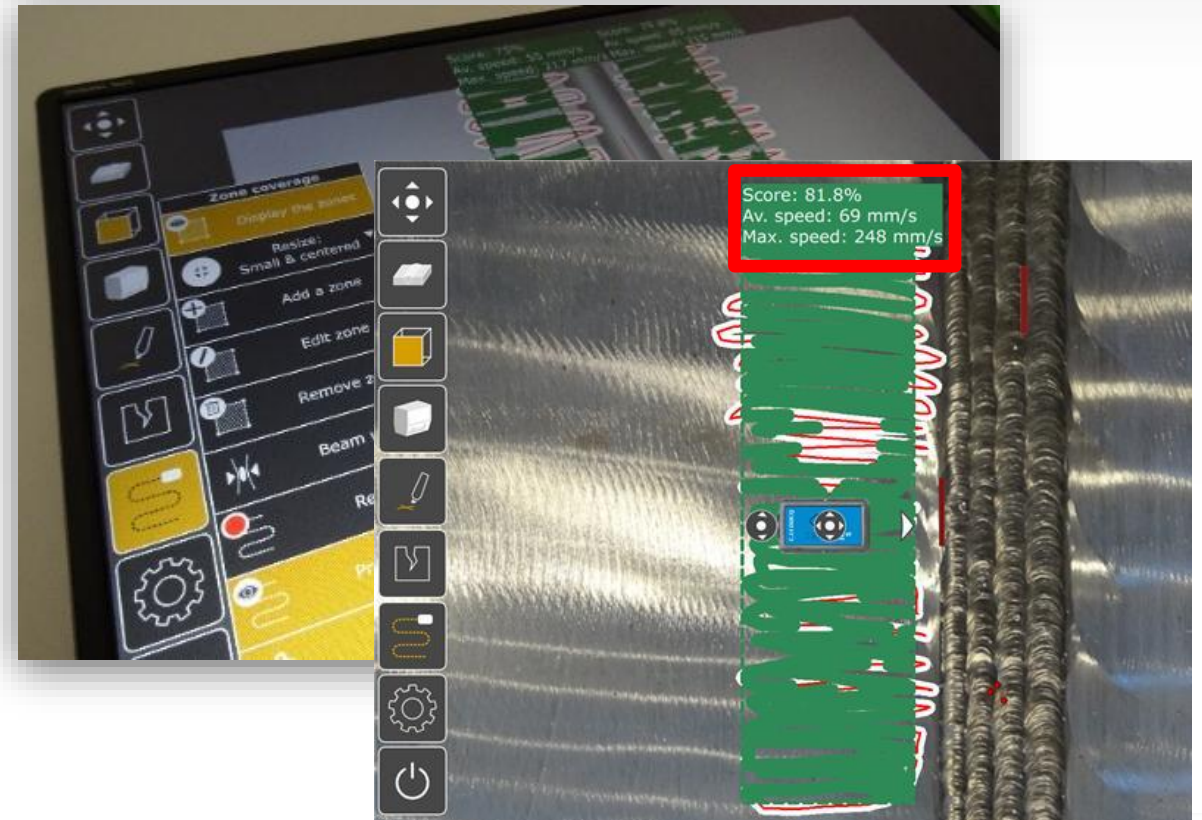
UT Training – Gesture

| To efficiently perform a manual scan is essential and requires practice :
... but it is difficult on a real trial to get a clear feedback on the performed scan
and to improve oneself:

Simulators can:

- Display the scan path with the relevant beam width,
- Evaluate the coverage;
- Indicate scanning speed,
- Identify with different colours missed or poorly scanned zones

With such immediate and visual feedback,
you can really **learn from your mistakes** !



RT Training – Radioprotection

Strong radioprotection constraints for RT operators :

- It is indeed necessary to know and consider them to be an NDE inspector.
- But, in the meantime, it significantly limits the possibility to multiply the number of trials and to focus on the understanding of shots parameters and physical principles.

Simulators allow to get rid of radioprotection constraints to practice much more without any risk.



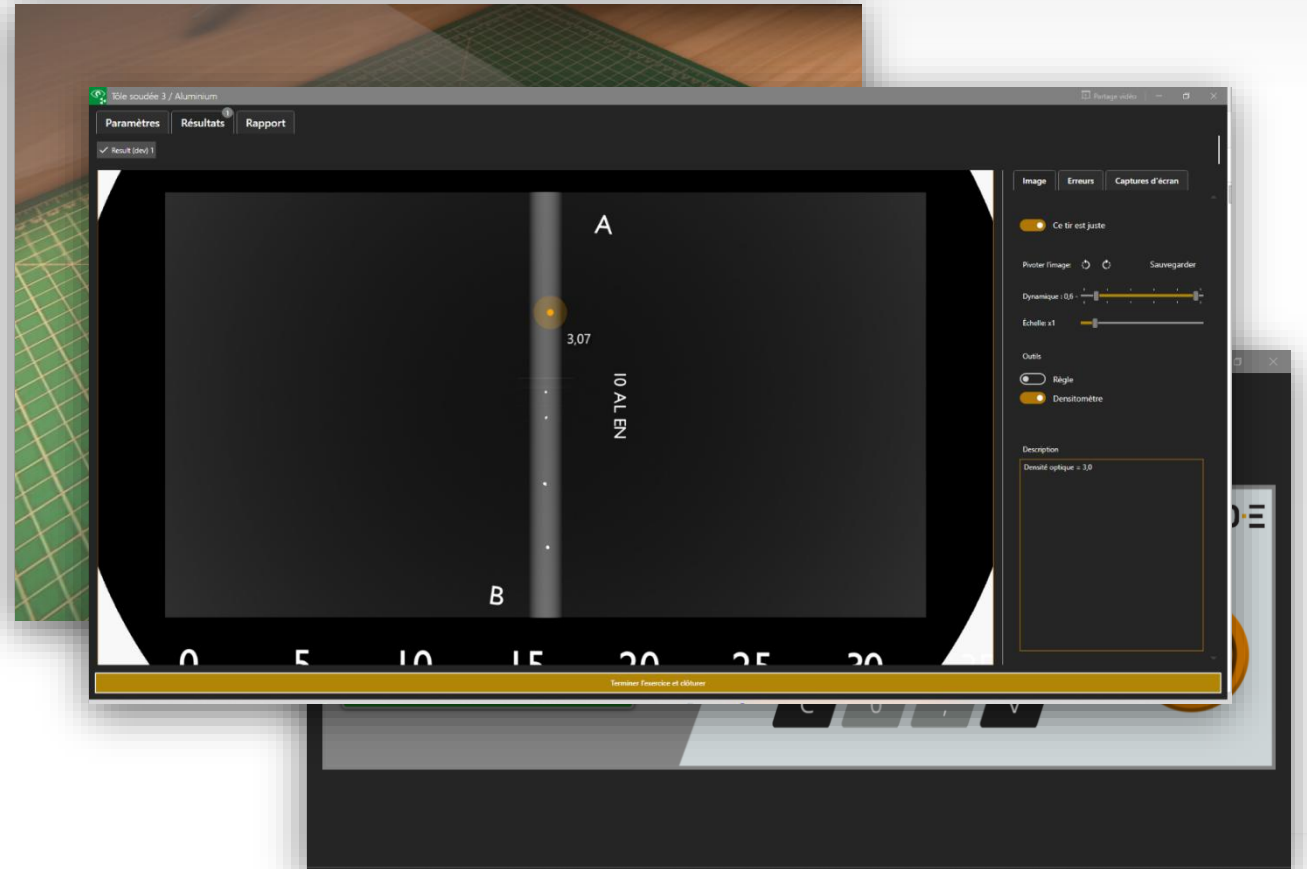
RT Training – Availability

- RT Testing hardware and facilities are quite heavy and with a limited availability which has an impact on the effective practice time during training sessions.

With simulators: No access constraints, no conflict with hardware needed for field inspections, no time needed for film development, full-time availability.

This leads to :

- A dramatic increase of practice time and trials,
- An “immediate feedback” which really allows to try and understand the impact of each shot parameter (voltage, intensity, activity, exposure time, Source to film distance, etc.)

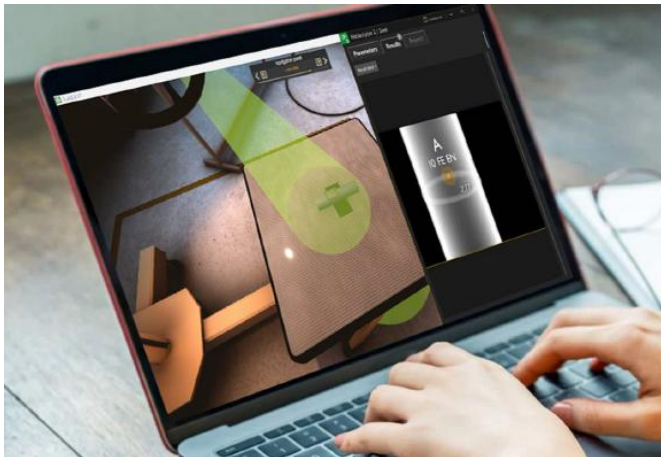


Remote training – E-learning

Online courses generally consists in theoretical presentations but no or few “practice” tools :

➔ To provide a remote access to simulators will let trainees initiate practical trials and also allows trainers to monitor the practice performed out of a training centre:

- Sessions can be prepared and customized to purpose (learning, exam', type of specimens, etc.),
- Practice time, exercises performed, number of trials can be retrieved to justify practice level,
- Digital examination reports can be created.



⚙ User settings **Records** ↻

30/04/2026 11/05/2026

Welded pipe 2 / Steel X-ray tube / M100 0h 2mn 14s



Position type: Ellipse
Source position: Beta: -170mm, G: 823,95mm, Gamma: -15°
Parameters: 160kV 5mA 00:02:00s
Description:



GET REPORT

Welded pipe 4 / Steel Gamma Ir192 / M100 0h 2mn 35s

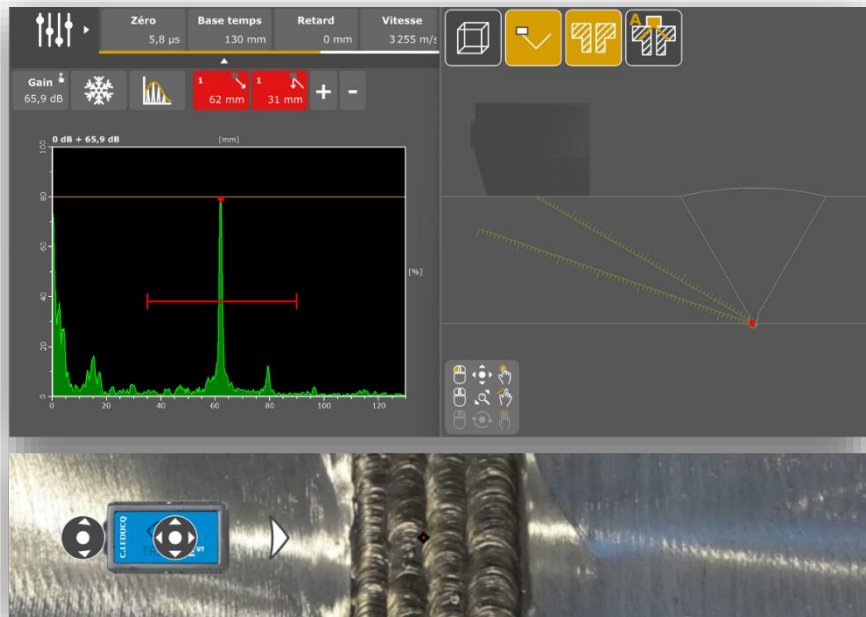


Position type: Internal
Source position: Beta: -0mm, G: 140,2mm, Gamma: 90°
Parameters: K=4,4, d(m)=0,14, DO=3, e(mm)=26,75, A(TBq)=1,27, Texp=00:05:02
Description:

GET REPORT

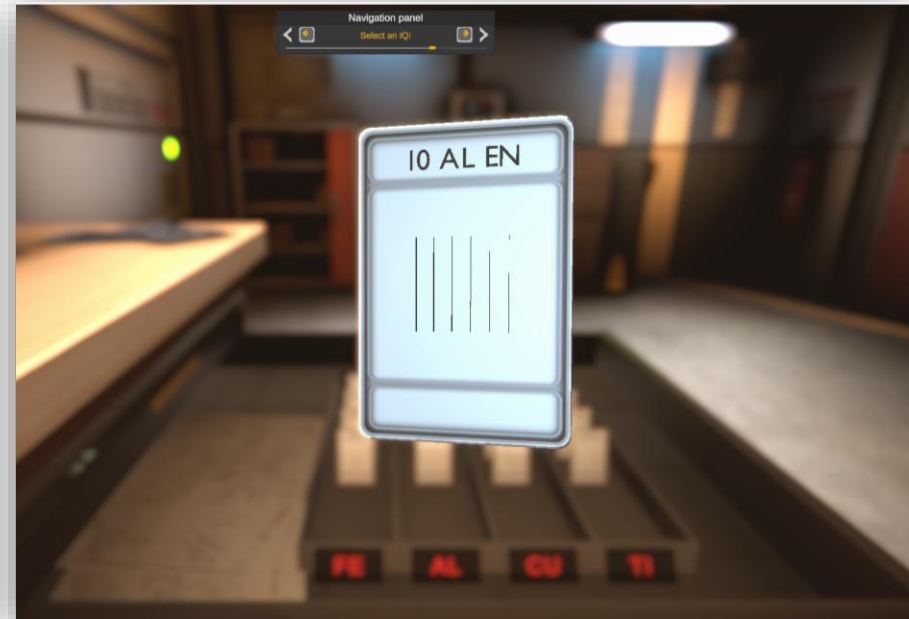
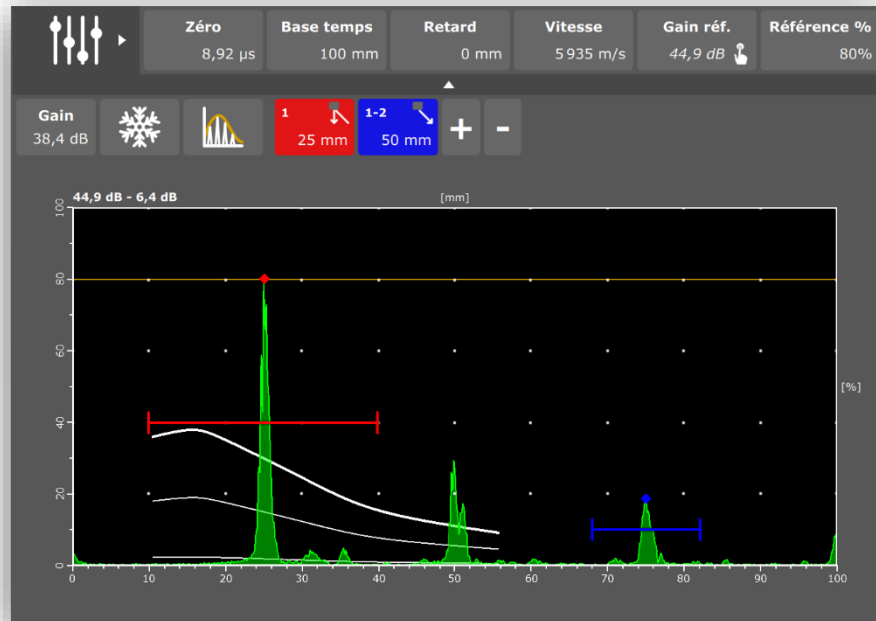
More benefits from simulators

- | An easy equipment to “carry” in an external facility or at home
- | Innovative and digital tools
= A key aspect for **NDE profession attractivity** for young people



Simulators requirements

- | A realistic environment : to look “as real” : Equipment, working place, components



Simulators requirements

| Realistic data/signals/images.

Several methods available to generate training data :

- ➔ Experimental acquisitions: To build databases from real trials: « Guaranteed » realism... but databases size can be an issue (to produce, storage, download, etc.)
- ➔ Using simulation with realistic models: You can easily generate massive signals/images databases, you can play with the data (randomly moves or remove/create flaws, etc.). But signals should “look real” for an effective training
- ➔ Hybrid, mixing both approaches (real data “augmented” with synthetic ones) to benefit from the best of each one.

Conclusion

- | Non-Destructive Testing is nontrivial: Understanding physical phenomena is absolutely necessary to ensure that inspectors will have enough skills to operate efficiently for various applications on the field and therefore is a necessity for the safety and preservation of assets.
- | Simulators provides visual insights, dynamic and interactive tools and an easy and fast access to multiple applications and results. Trainers can use them to help the understanding, safely, and multiply the number of trials.
- | Of course, **it is still necessary to practice on a real hardware !**
Simulators allow to practice more and better and make the real practice more efficient, but will not replace them.
- | It is time to move on for the use of such tool and attract young practitioners in NDE.
NDT societies might help to push the acceptance of such tools for the NDE community.