CIVA
N·D·E 2025

Overview of CIVA 2025

EXTE|N·D·E
CIVA

CIVA 2025

- Next major release expected for summer 2025

CIVA N·D·E 2025

- A wide range of evolutions in the different modules:

- The roadmap of future developments will be provided tomorrow (CEA presentation)

CIVA UT

What's new?

Main topic :

New FEM Perspective

Weld modelling and complex Materials

New Probe and wedge options

New Defects

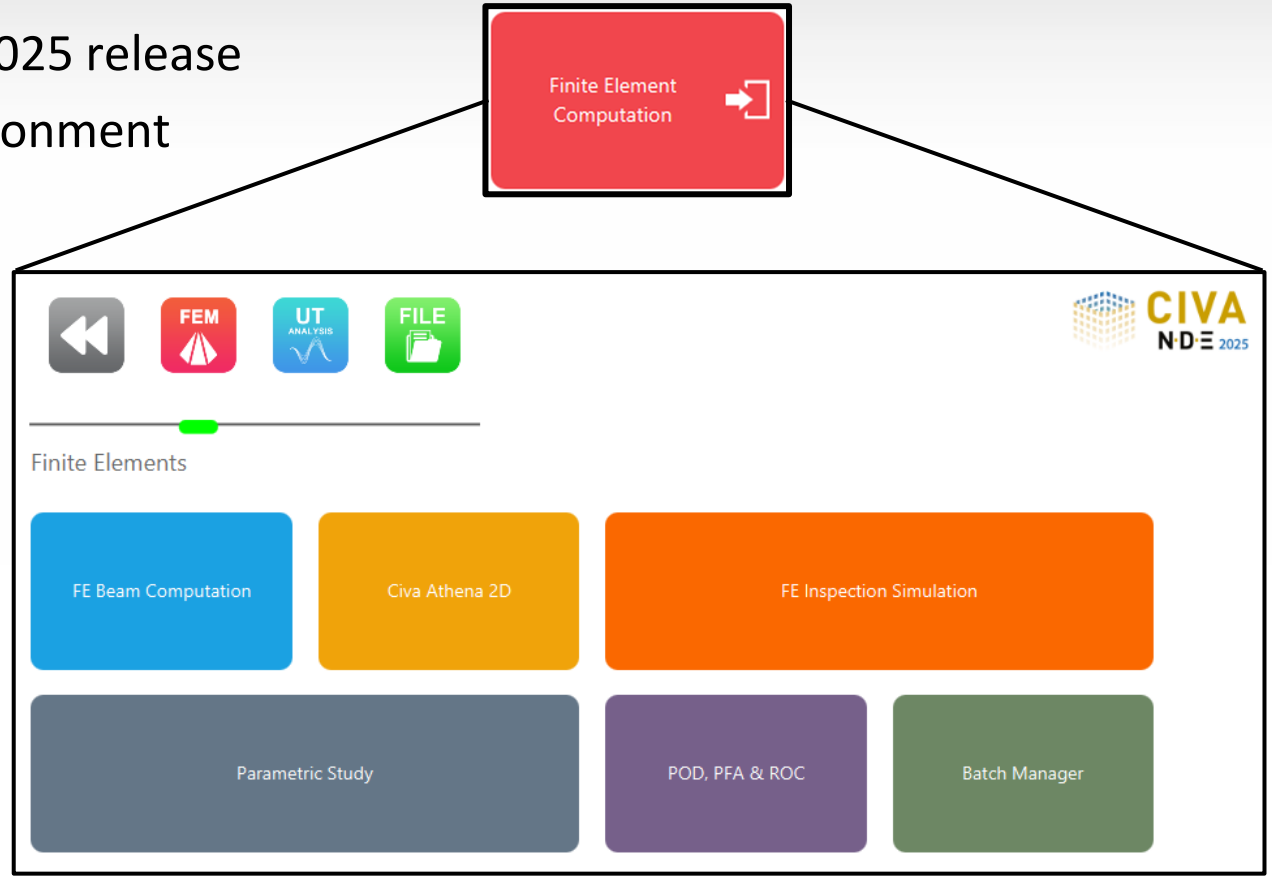
New **Beam simulation** options

CIVA UT - FEM

CIVA is now (also) a Finite Element Software!

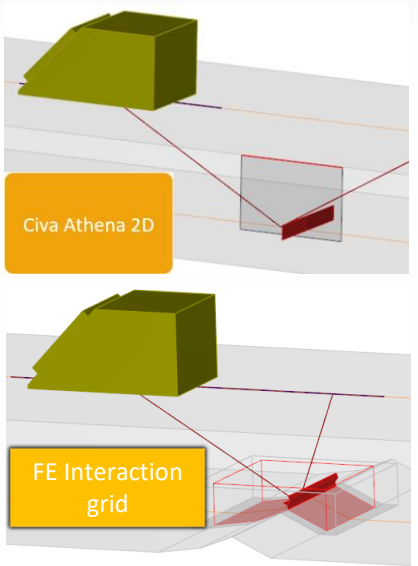
- It's not an add-on:
  Directly available for all CIVA UT users with CIVA 2025 release
- Dedicated tile in UT desk to access CIVA FEM environment

- Modules within Finite Element perspective:
  - FE Beam Computation
  - FE Inspection Simulation
  - Compatible with generic CIVA features
    (Parametric study, POD, Batch, CIVA Script)

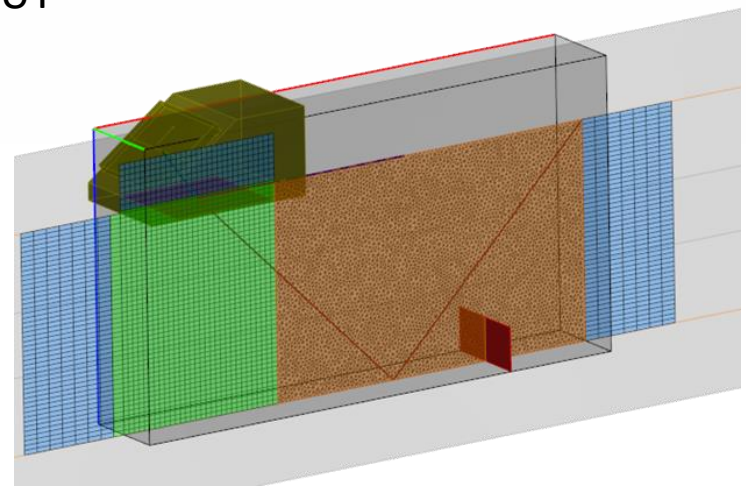


CIVA UT - FEM

- CIVA UT's most used and historical models are **Semi-Analytical** (SA):
  - Pencil, Kirchhoff, GTD, SOV, etc.: A mix of geometrical (ray-based), integral and analytical approaches
  - Fast and reliable computations in many cases …. but semi-analytical models have some limits,
  - Thus, Finite Elements models have already been implemented several years ago:
    Hybrid approach using pencil method (SA) for the beam propagation,
    and Finite Element (FE) local box around the interaction region:
    - **CIVA Athena 2D** : Add-on feature based on EDF code ATHENA 2D
    - **FE Interaction grid**: Specific flaw type within CIVA UT



- New FEM modules:
  - **"Full" Finite Element modelling**:
    - The entire scene is modelled using FE, including the wedge-coupling to specimen refraction area
    - Only the source field and propagation in the couplant and wedge volumes remains SA



CIVA UT - FEM

- FEM Module – **Benefits**:
  - Full Finite Element Simulation in 2D or 3D : FEM is widely **recognized** as a reference numerical method
  - **Validating** semi-analytical models and **exploring** beyond their limits:
    - Handling complex welds and materials (strong anisotropy)
    - Avoid Ray/Beam artefacts
    - Beyond the limits of semi-analytical flaw responses (small features vs wavelength, around critical angles, etc.)
    - Better understanding of beam interaction phenomena
  - User's experience:

Unsettling

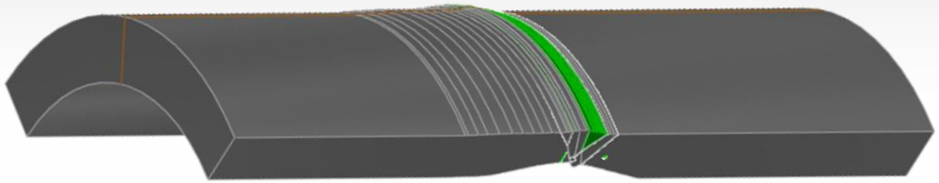
Powerful

Unique and Required

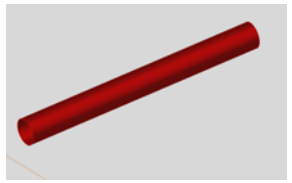
Reassuring and Essential

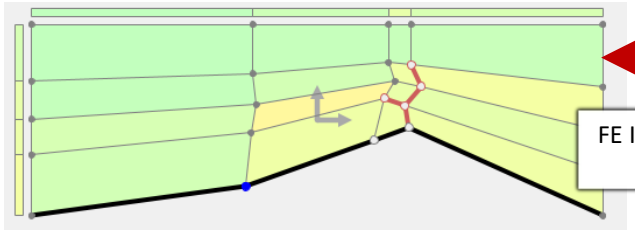
CIVA UT - FEM

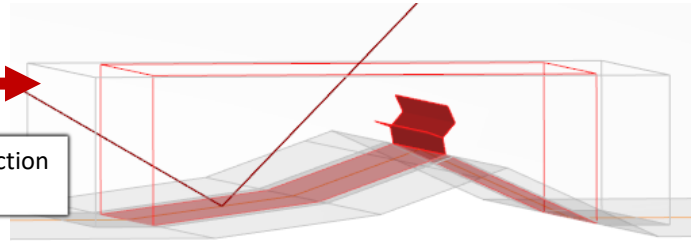
- FEM Module – **Scope**: Same User Interface, same panels
  - **Geometries:** Planar, Cylindrical (single/multi-layer), Welds, 2D CAD, Homogeneous and Heterogeneous ("2.5D like" geometries: no 3D CAD, no nozzle,…)

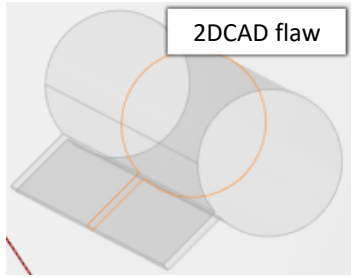


  - **Materials:** All Isotropic and Anisotropic materials (except composites). Account for attenuation
  - **Probes:** All (except EMAT)
  - **Flaws:** Planar rectangular, Side-Drilled Hole, FE Interaction zone, Defects drawn in 2DCAD editor





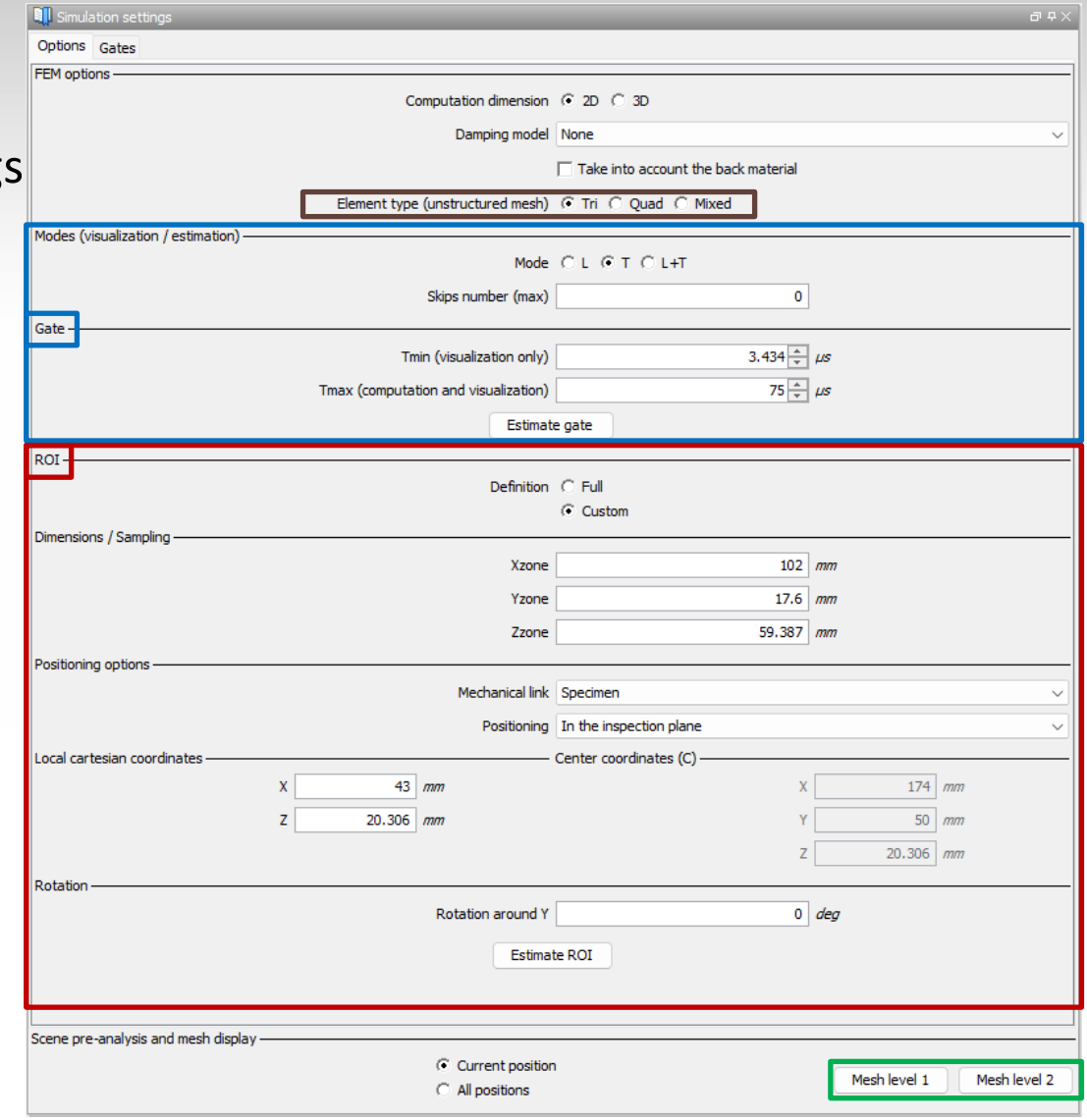




CIVA UT - FEM

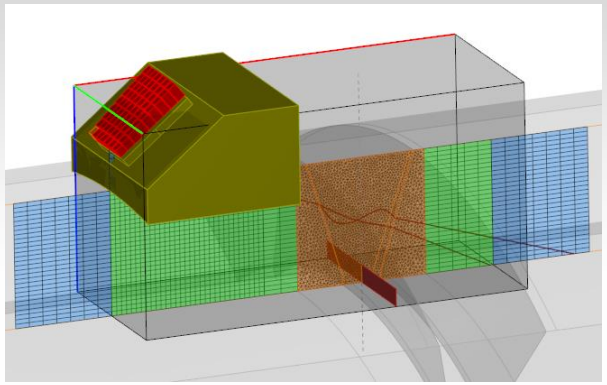
FEM Module – **Simulation settings**:

- New “philosophy” compared to SA models -> easier settings
  - No need to choose UT modes and computation models : <u>All acoustic phenomena are simulated</u>
  - Mesh is defined and generated automatically
- Pay attention to:
  - Gate is required = Observation time
    - Auto gate feature: Using the selected mode
    - And/or “manually”, using ray-tracing and 3D view
  - ROI (Region Of Interest): Will adapt the mesh for a given use case (Automatic ROI available)
  - Meshing type selection (‘Tri’ advised)
  - Checking tools : Absolutely necessary
    Double-check your settings and visualize the mesh !

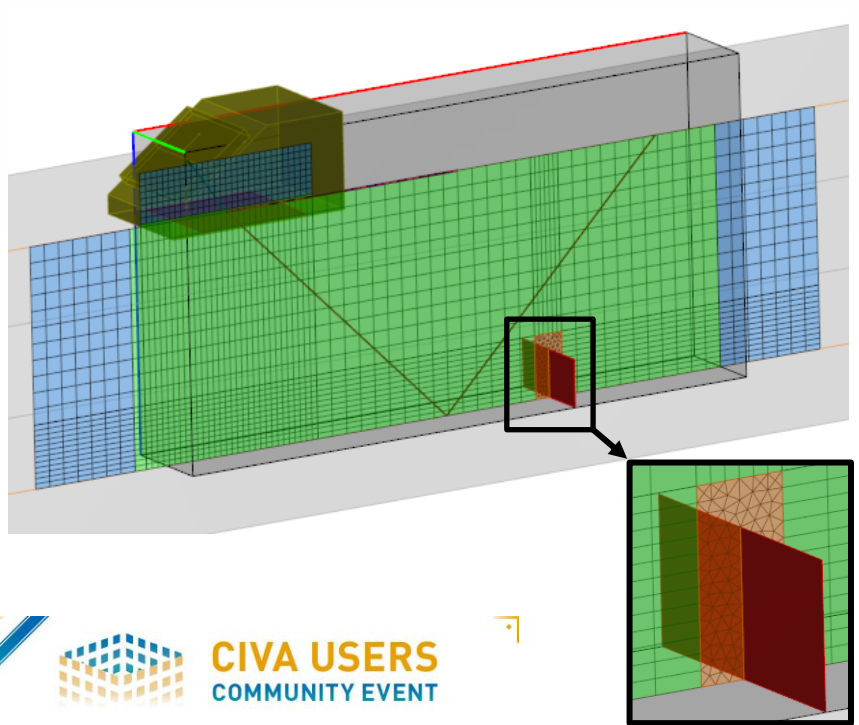


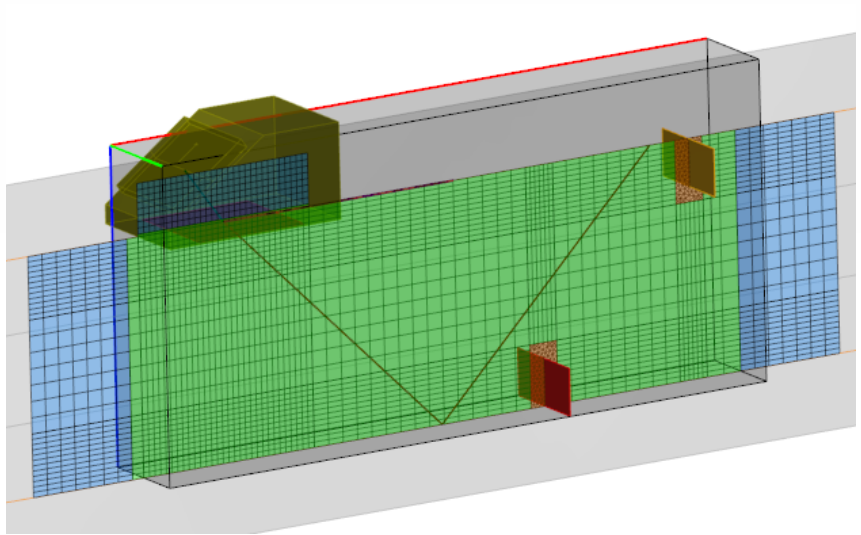
CIVA UT - FEM

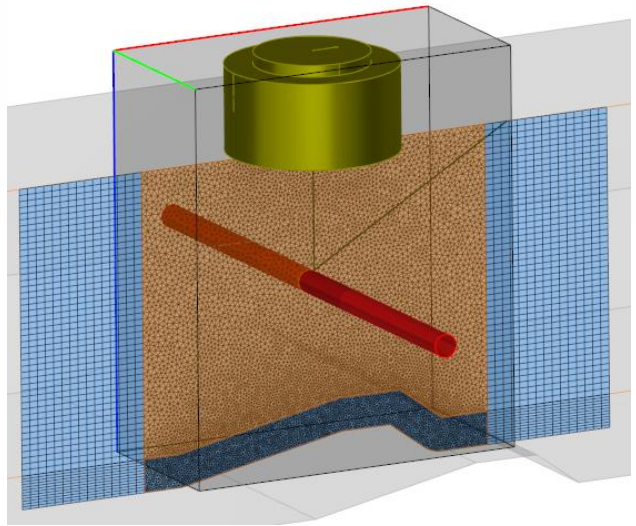
- Automatic meshing of the entire scene using the ROI feature:



- **Orange meshing:** Thinner mesh for accuracy around flaw(s), discontinuity(es)
- **Green meshing:** Simplified mesh (when relevant)
- **Blue meshing:** “Damping” mesh (“Absorbing conditions”)







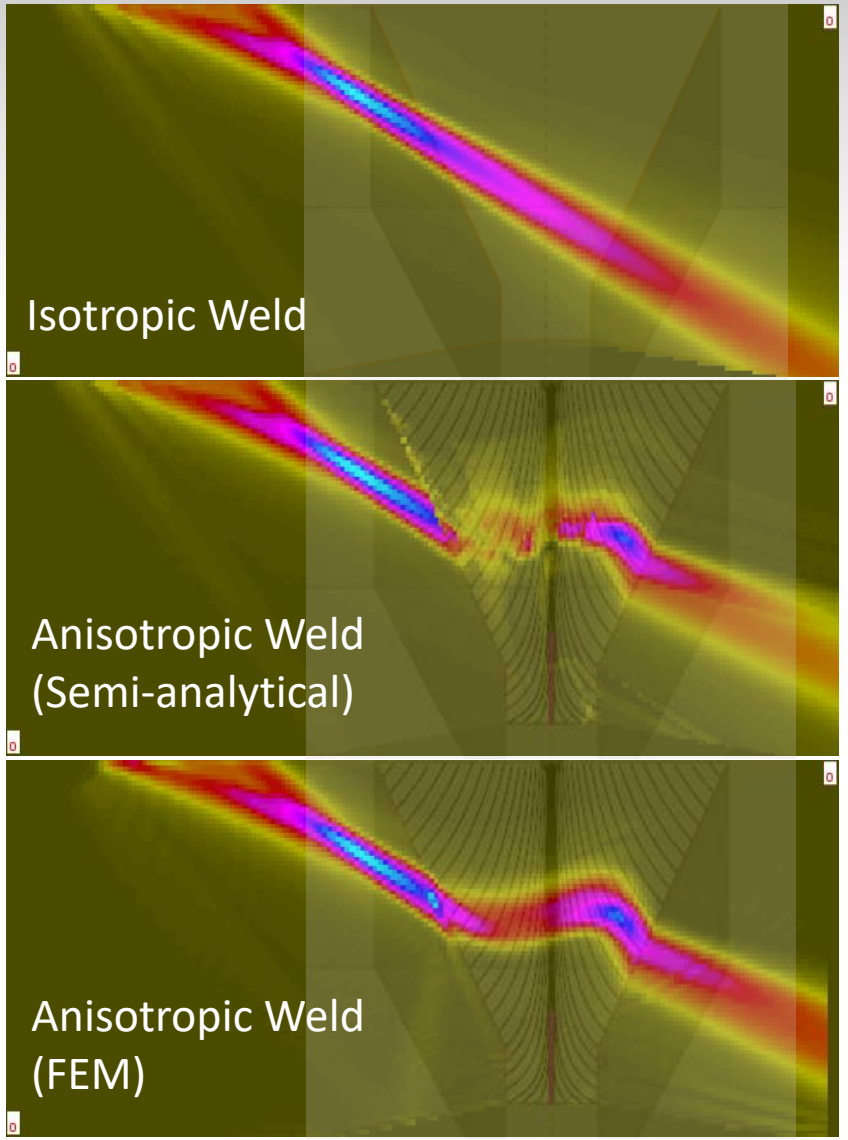
Bottom medium properties can be considered (**Blue meshing** below the specimen)

CIVA UT - FEM

- Example cases of improvements brought by FEM Module:
  - In strongly anisotropic/heterogenous/**complex materials**:

Example given through an **austenitic weld**

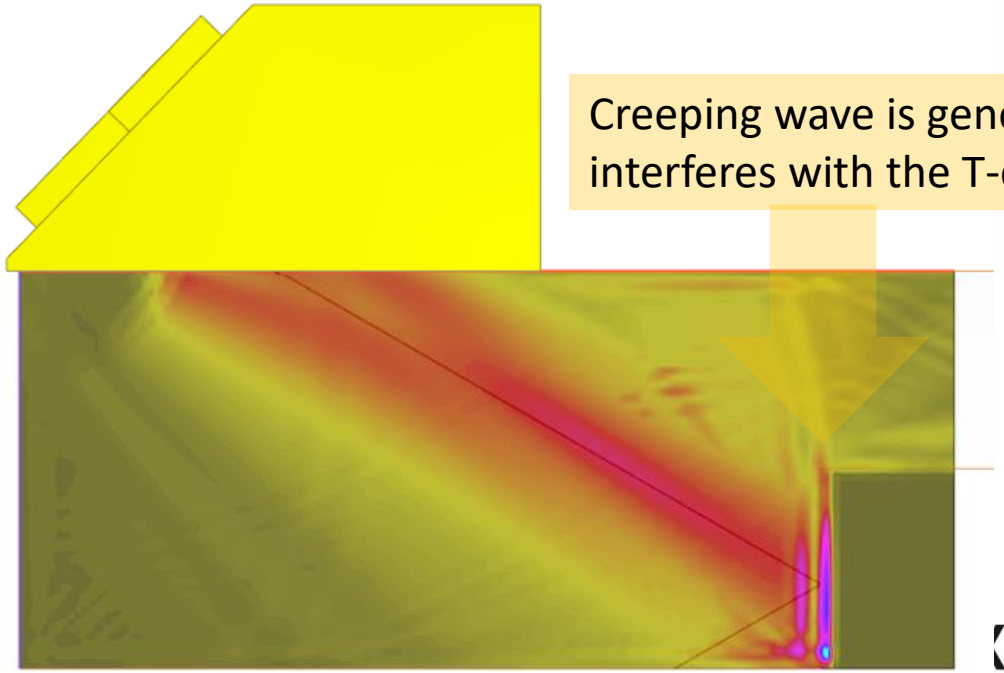
- More accurate beam deviation (especially for qT waves)
- Might help better understand beam propagation through anisotropic materials



CIVA UT - FEM

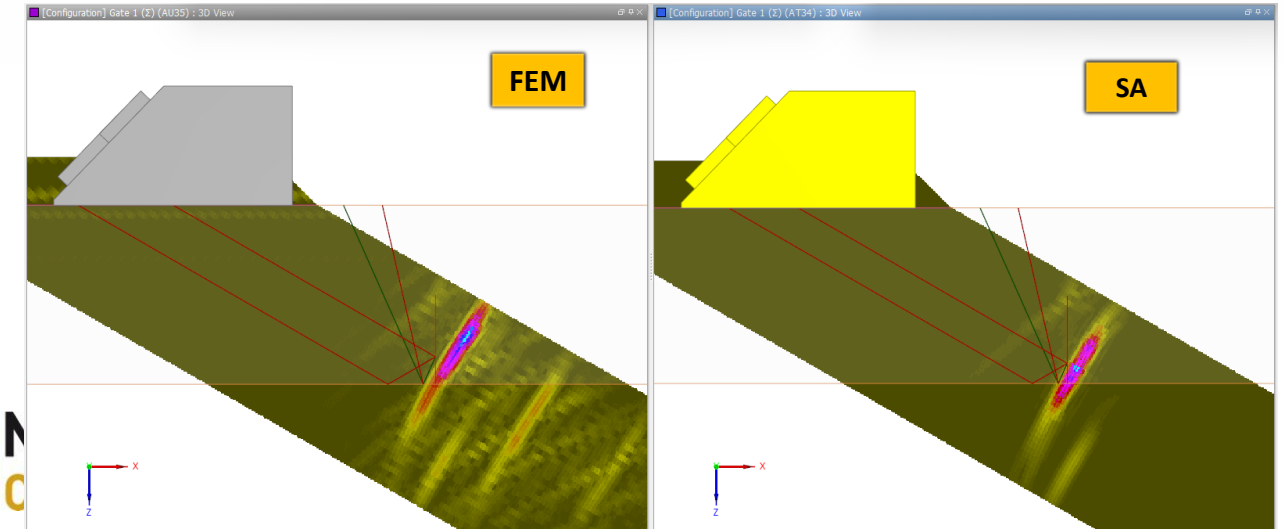
- Example cases of improvements brought by FEM Module:
  - Better modeling of **creeping/surface waves** phenomena

T60 refraction angle: Creeping waves for T30° incidence on vertical flaw (corner echo)



Creeping wave is generated and interferes with the T-corner echo

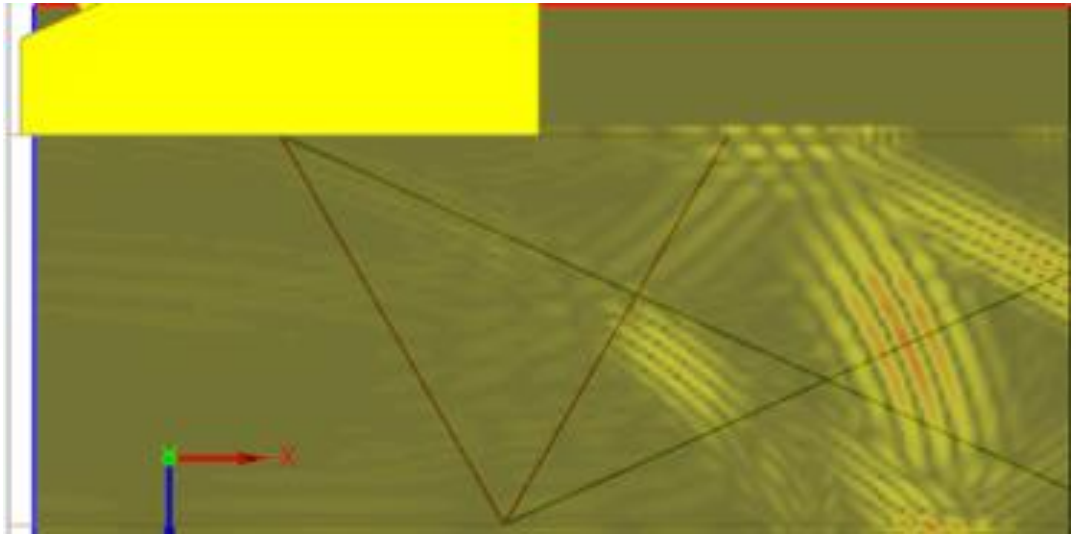
Flaw response



CIVA UT - FEM

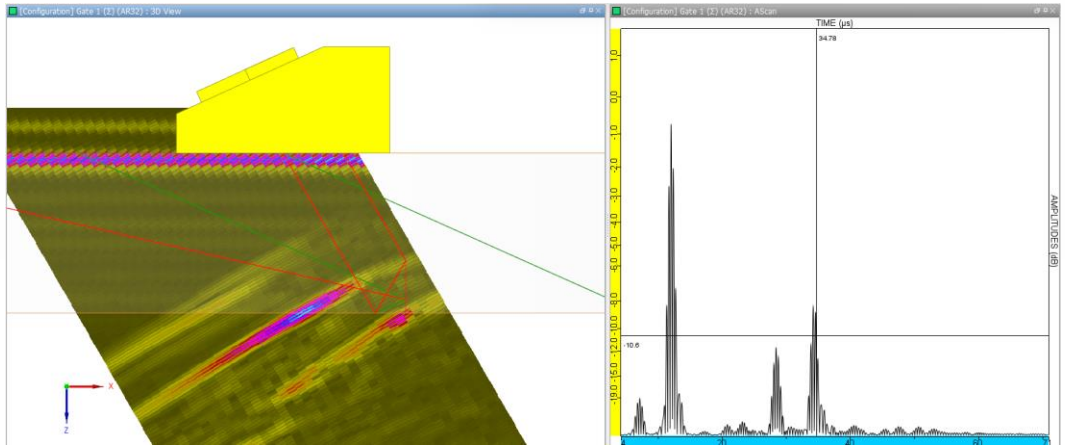
- Example cases of improvements brought by FEM Module:
  - Better modeling of **creeping/surface waves** phenomena

Creeping wave generated at the back wall reflection



Creeping wave at back wall

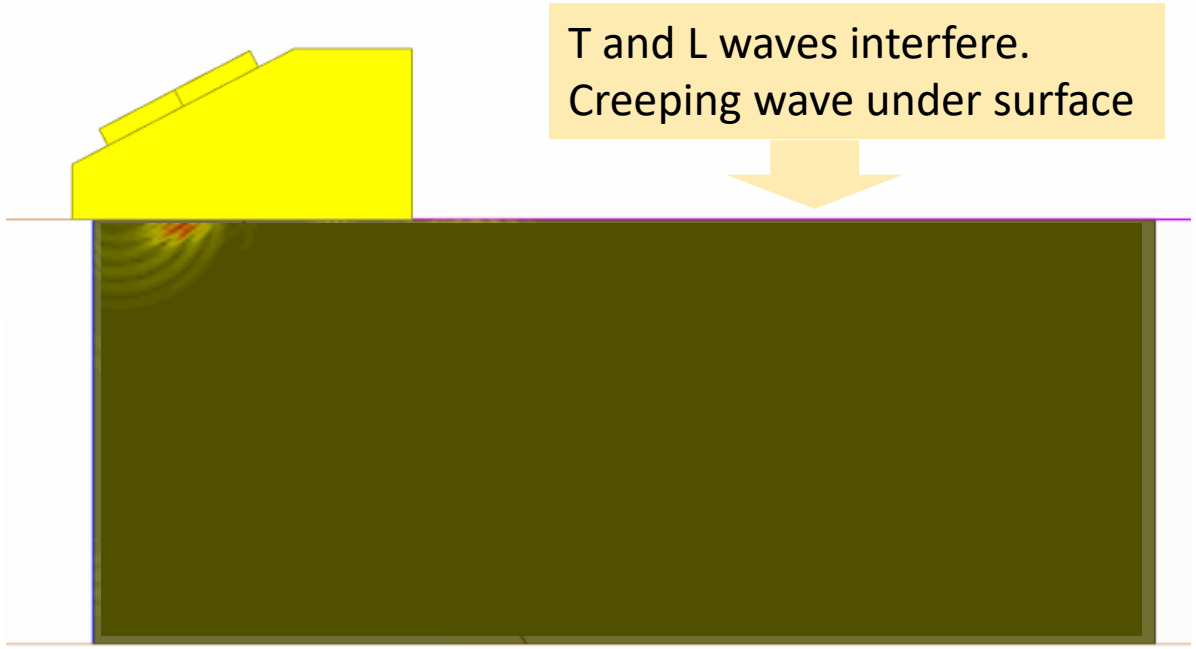
Flaw response



CIVA UT - FEM

- Example cases of improvements brought by FEM Module:
  - Better modeling of **creeping/surface waves** phenomena

Around 1st critical angles : Generating L waves at « 90° »

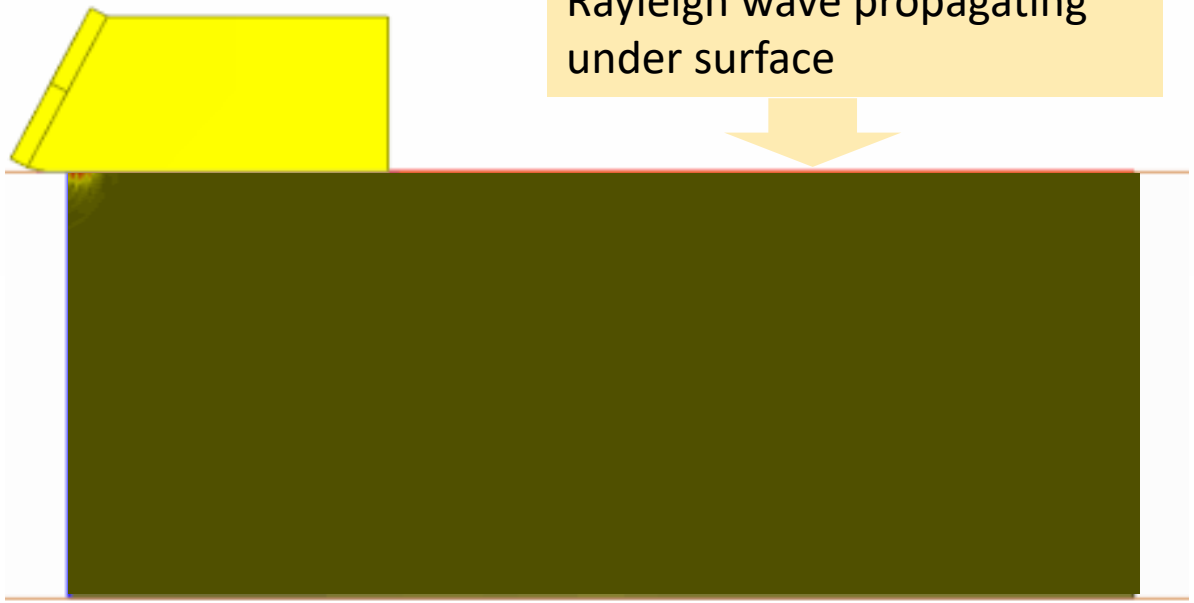


CIVA UT - FEM

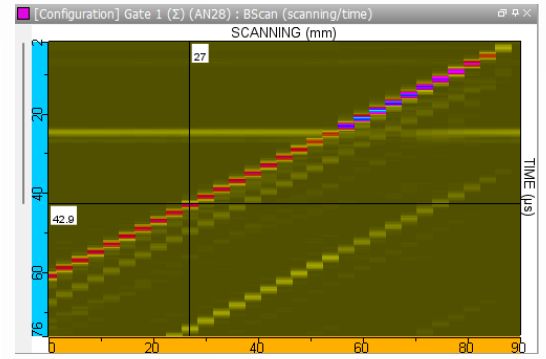
- Example cases of improvements brought by FEM Module:
  - Better modeling of **creeping/surface waves** phenomena

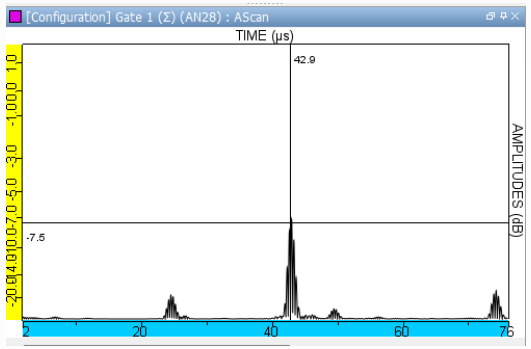
Around 2nd critical angles : Rayleigh waves

Rayleigh wave propagating under surface



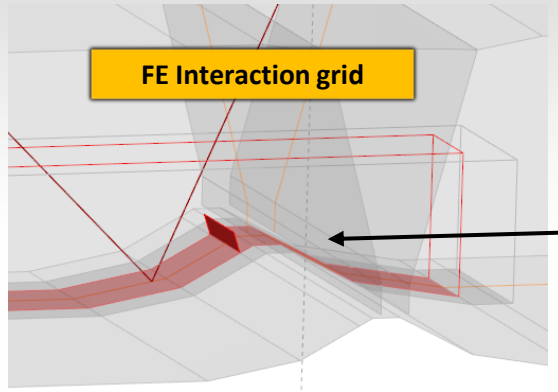
Flaw response

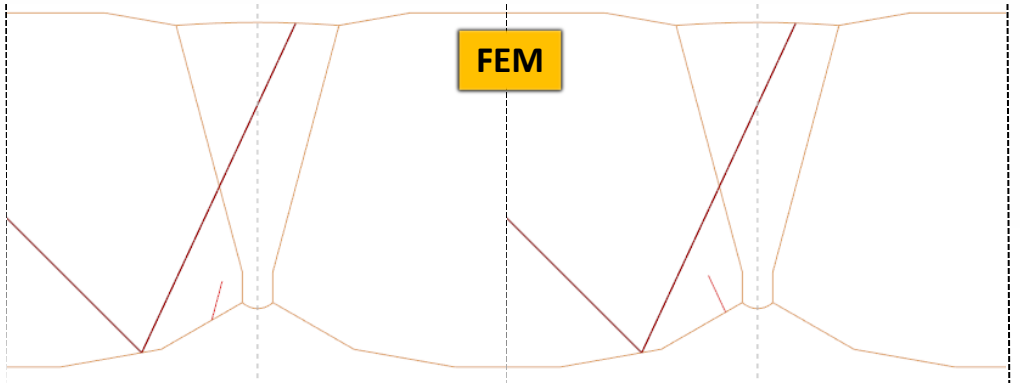


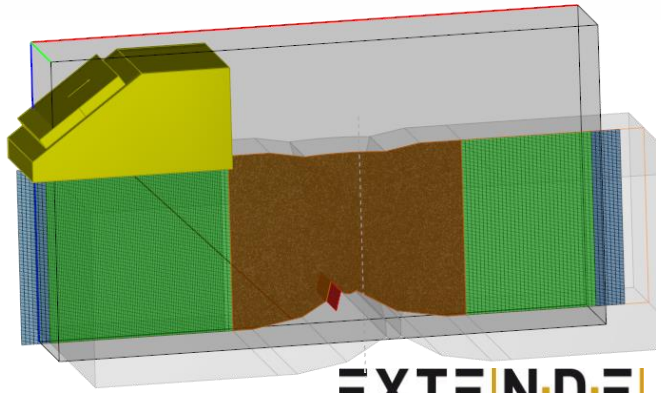


CIVA UT - FEM

- Example cases of improvements brought by FEM Module:
  - Better versatility than FE Interaction Grid feature:
    - Easier setting and variation of parameters:
      - No need to draw “manually”
      - Complex specimen geometries can be parameterized using CAD and parametric geometries
      - Flaw positioning / orientation can be parameterized
      - Flaw can also be in the specimen CAD model
    - Still possible to use FE Interaction Grid in FEM
    - Meshing visualization

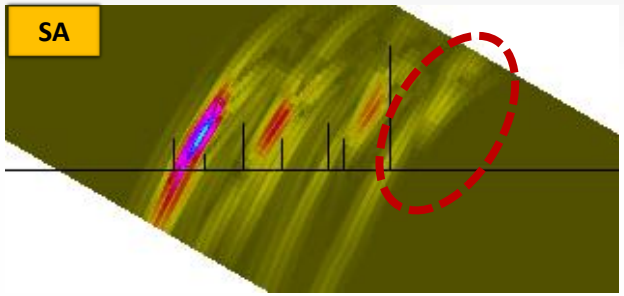


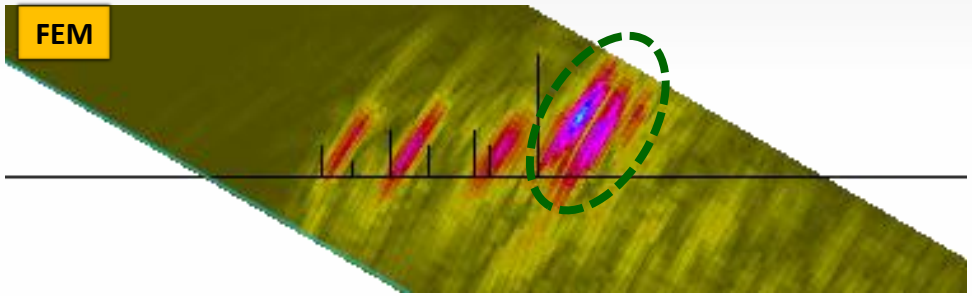




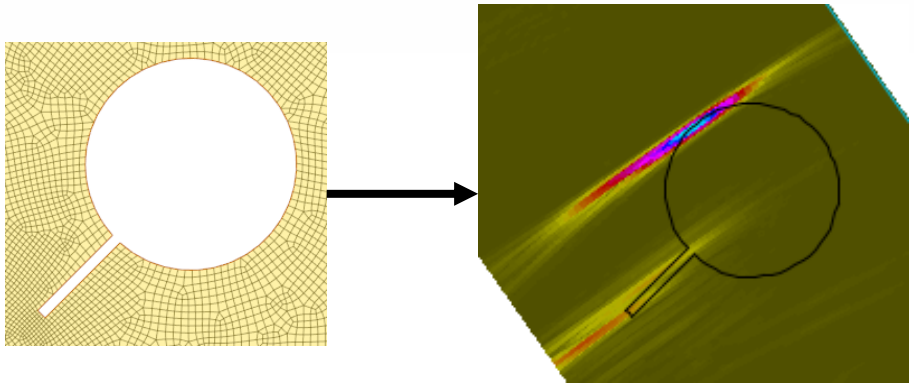
CIVA UT - FEM

- Example cases of improvements brought by FEM Module:
  - Cluster of flaws

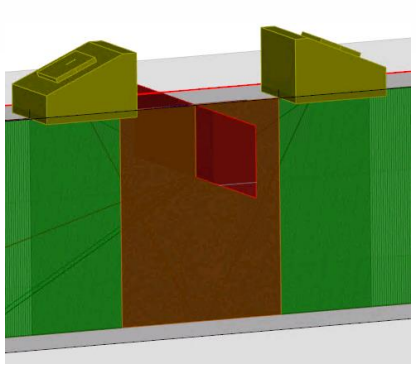


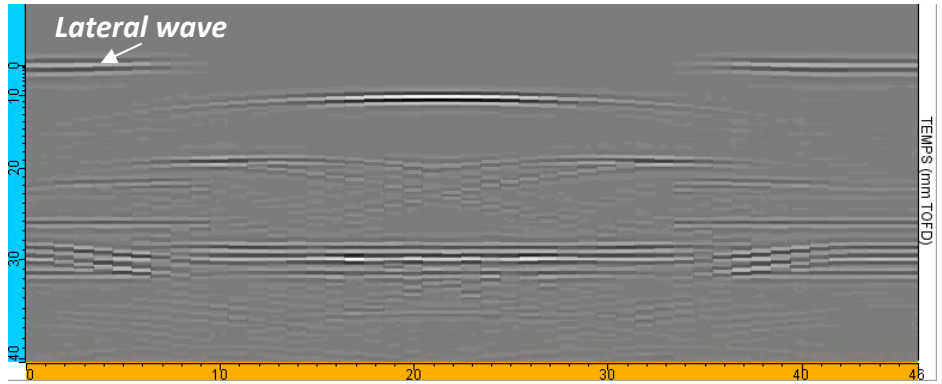


  - 2D CAD flaw (example of a ‘fishplate hole’)

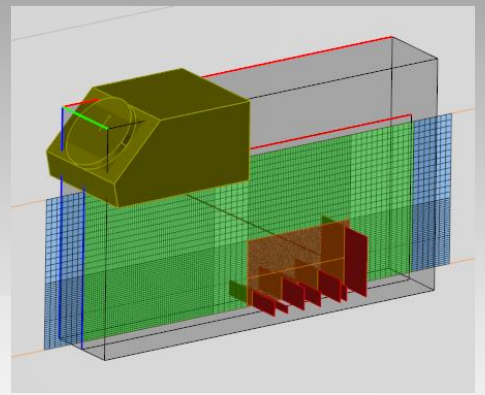


  - Lateral waves in TOFD, better amplitude accuracy

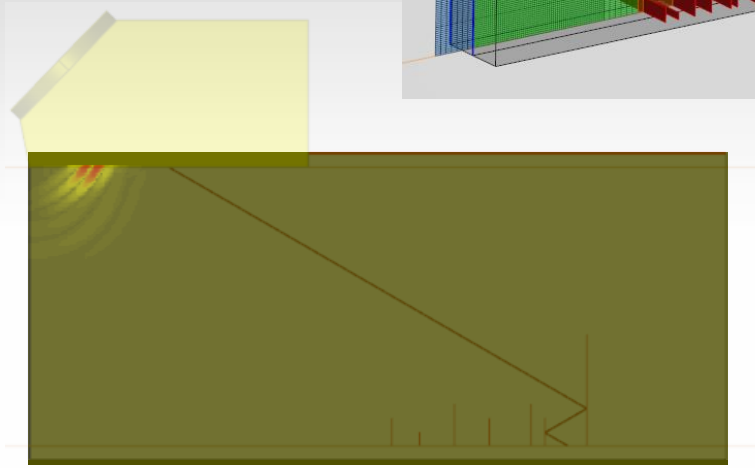




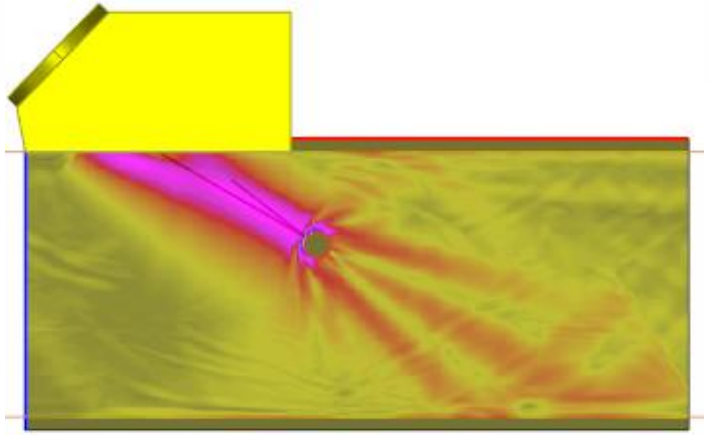
CIVA UT - FEM

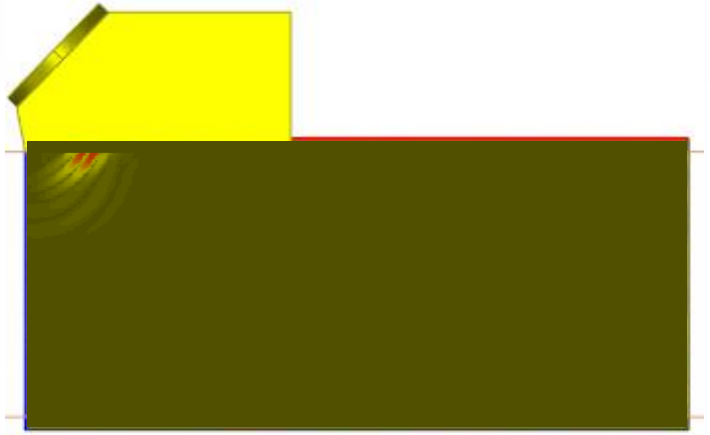


- Example cases of improvements brought by FEM Module:
  - Beam interaction with flaws:
    - Visualization of beam/flaw interaction
      (ex: multiples skips on a cluster of flaws)



    - Shadowing effect from flaws





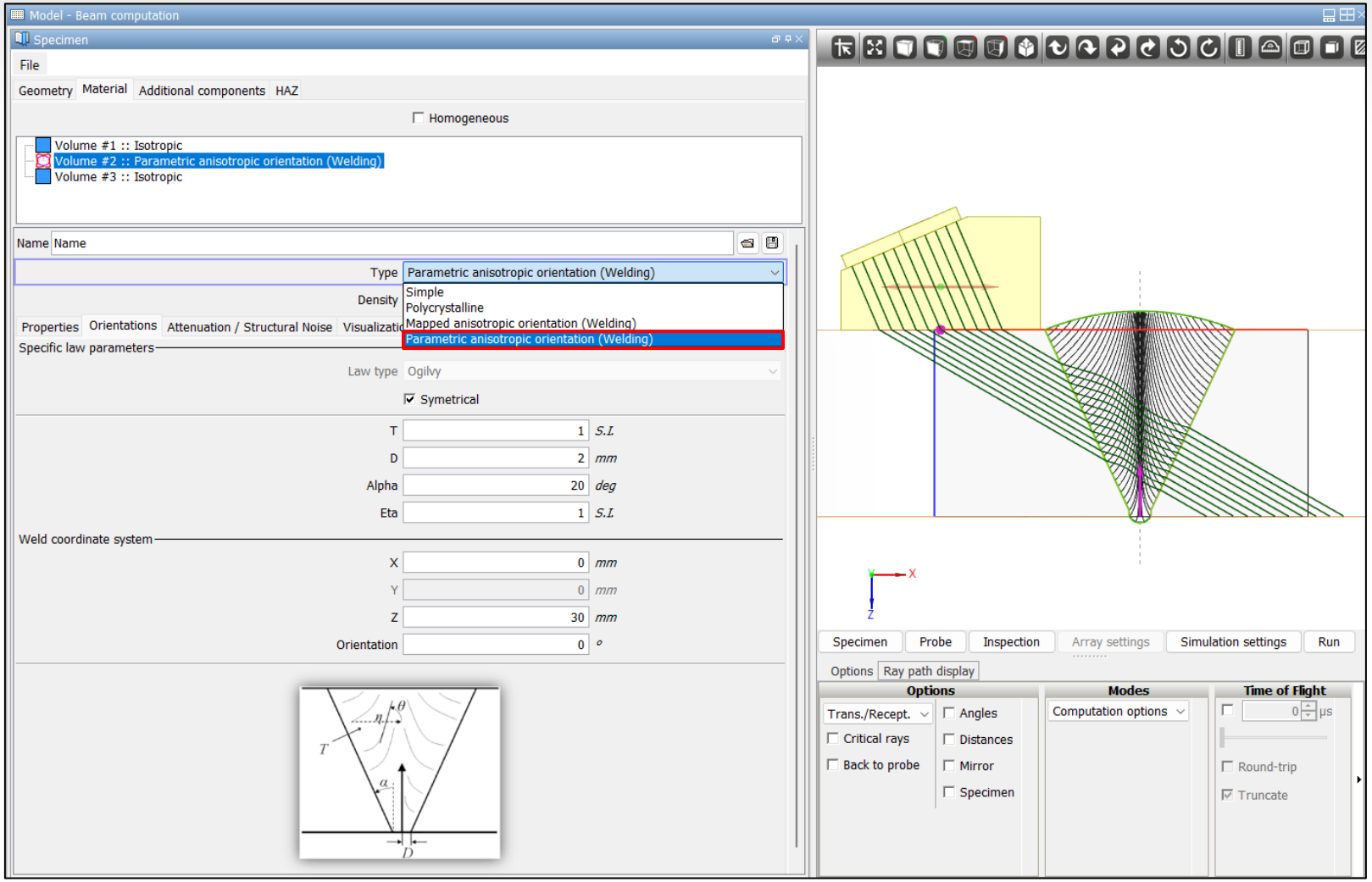
CIVA UT - FEM

- FEM Module – Synthesis:
  - A new reference tool helpful for **validation** and tackle **new application cases**
  - First release of CIVA UT FEM: Of course, it will continue to evolve !
    - Transmission applications
    - Complex materials: Composites materials, Heterogeneous concrete materials
    - Other geometries

    -- > Future of CIVA, see CEA presentation tomorrow
  - Computation performances:
    - 2D calculation time remains really reasonable (but generally longer than 3D SA simulations)
    - 3D can be “really” long (even if competitive compared to general purpose FEM software)
      - To be used for tailored target cases, not yet suitable for large scale simulations or parametric studies
      - Optimization will come
      - High Power Computing solutions will come in the near future (service, with add-on CIVA features)

CIVA UT – Complex Weld Modeling

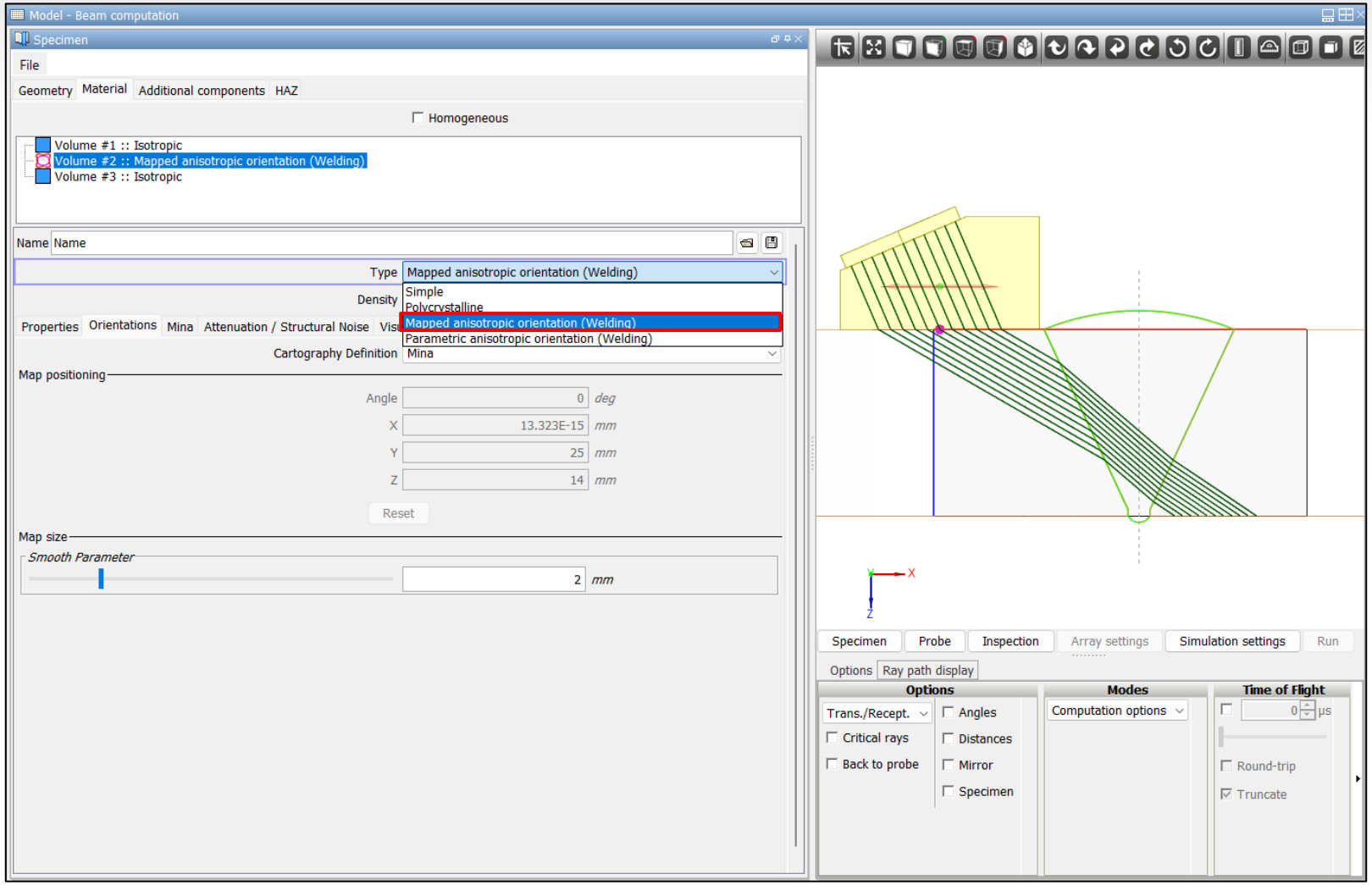
- Current methods in CIVA 2023:
  - Unidirectional anisotropy in a given volume
  - **Ogilvy** (parametric anisotropic orientation welding)



CIVA UT – Complex Weld Modeling

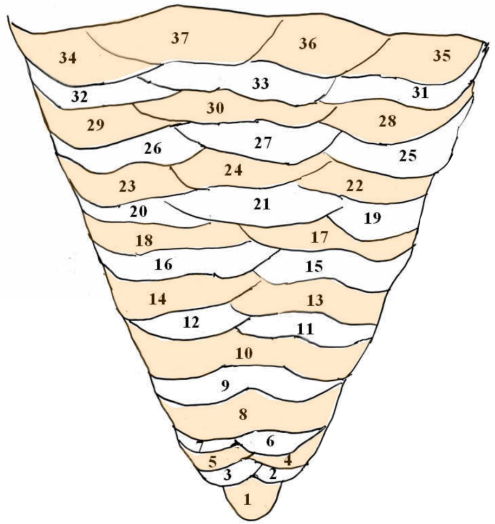
- New method in CIVA 2025:
  - **MINA**
    (Mapped anisotropic orientation welding)

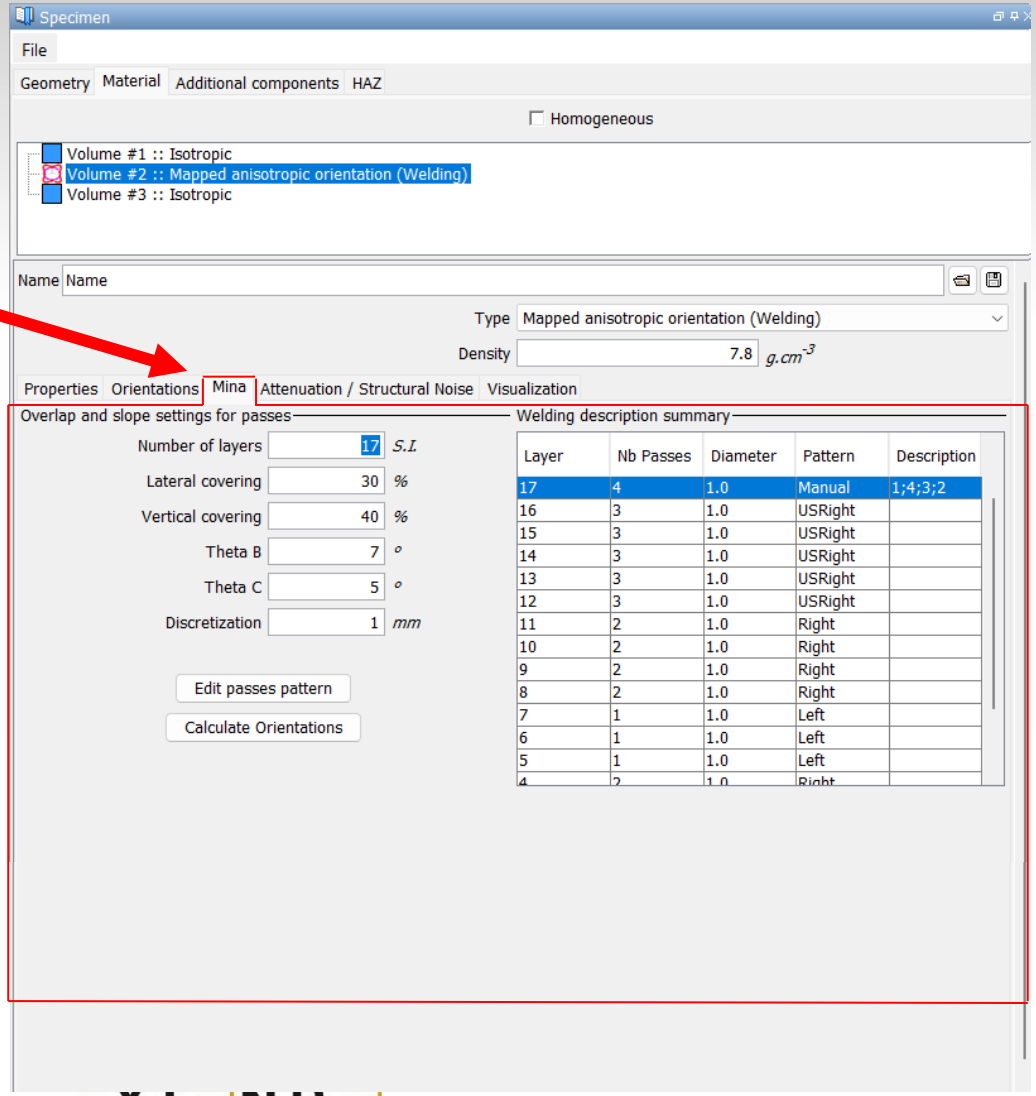
New approach:
Acoustic properties computed from the **welding process** definition



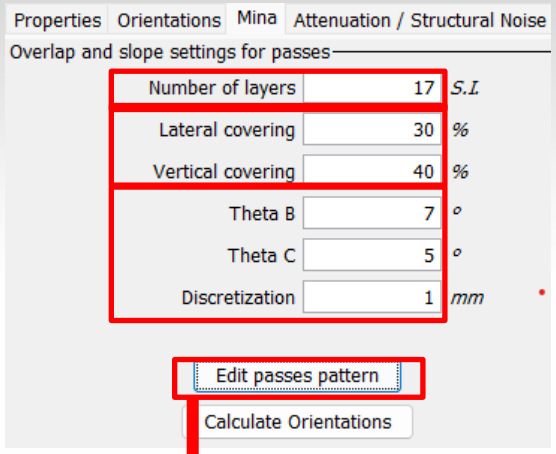
CIVA UT – Complex Weld Modeling

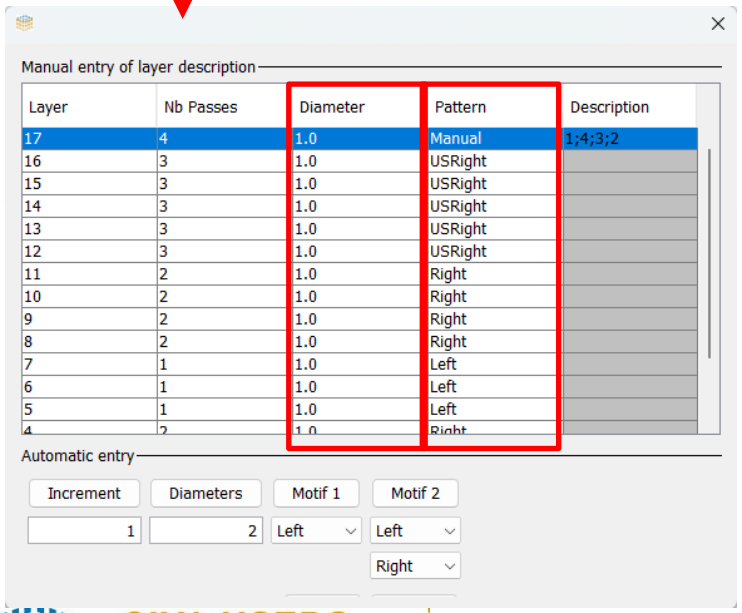
- New Tab « Mina »:
  - Passes parameters definition
  - Calculation and visualization of weld mapping





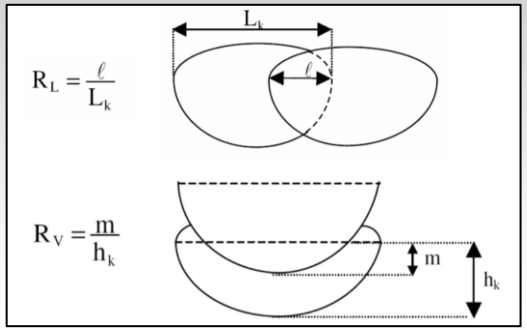
CIVA UT – Complex Weld Modeling

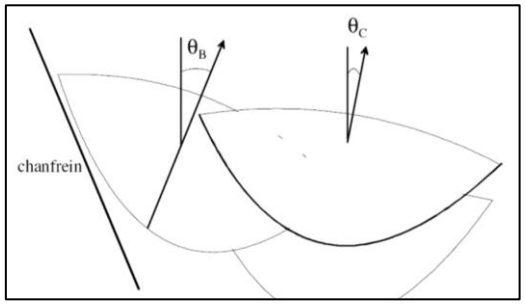




- Parameters:
  - Number of layers
  - Lateral and vertical covering
  - Tilt angles :
    - θ_B : edge angle
    - θ_{B2} : other edge angle

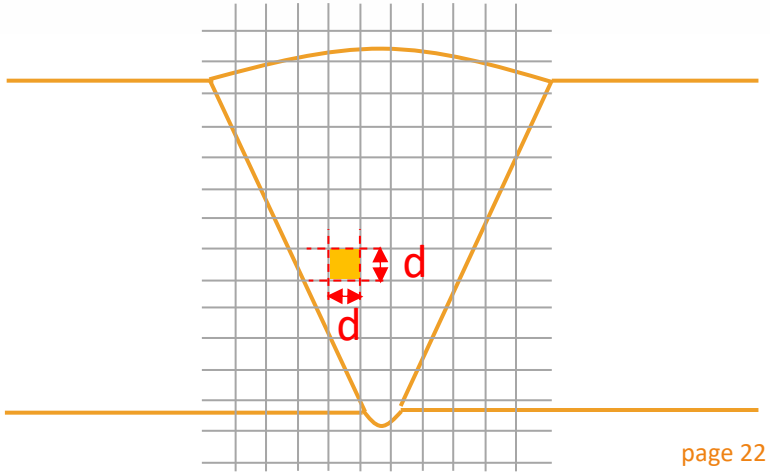
    (for asymmetrical weld)
    - θ_C : center angle





- Discretization (d)
- Electrode Ø
- Editable passes patterns

(left, right, manual…)

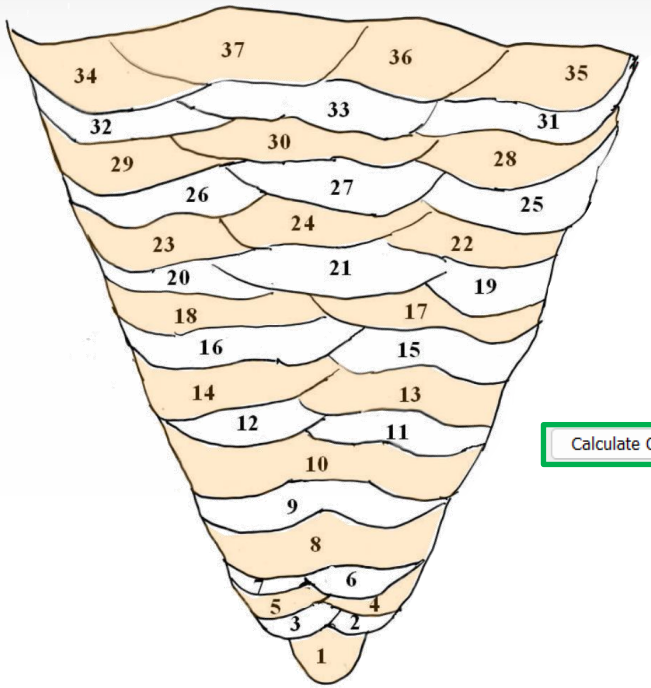


EXTENDE CIVA

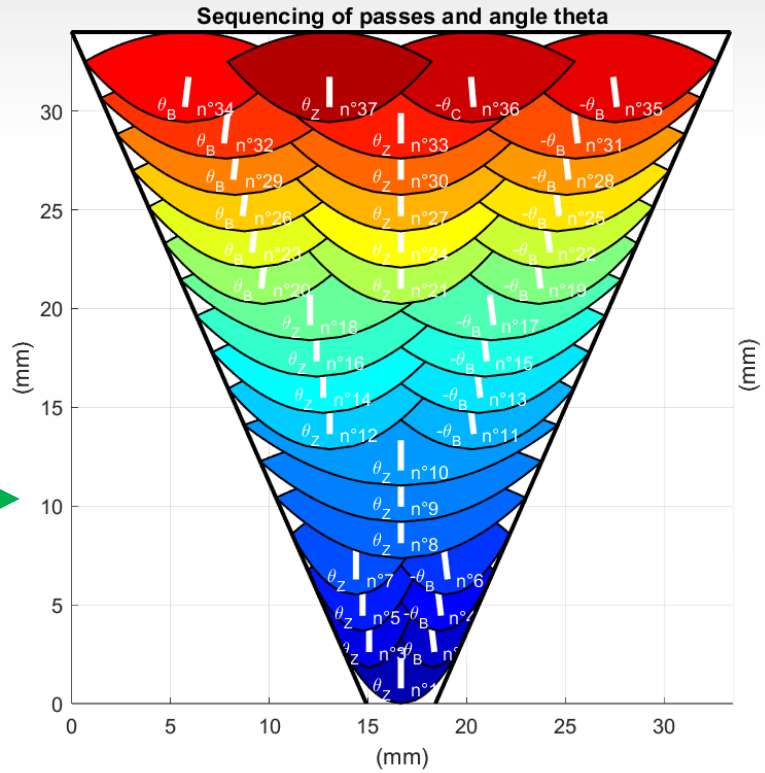
CIVA USERS COMMUNITY EVENT

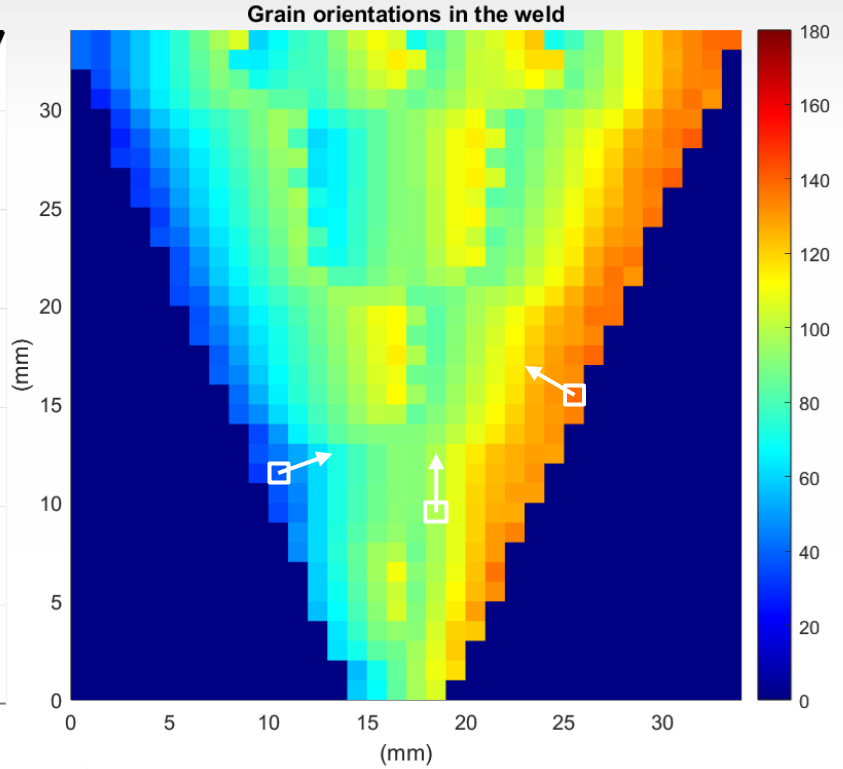
CIVA UT – Complex Weld Modeling

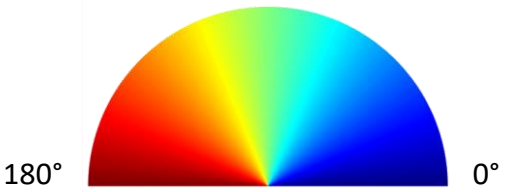
- Weld orientation mapping



Calculate Orientations

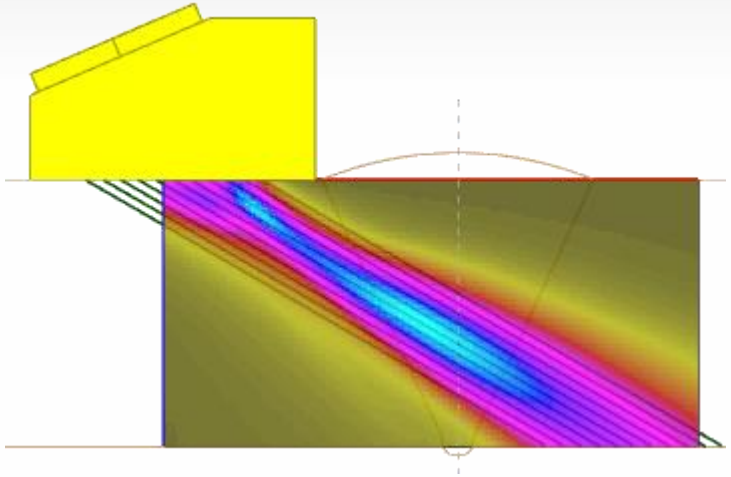




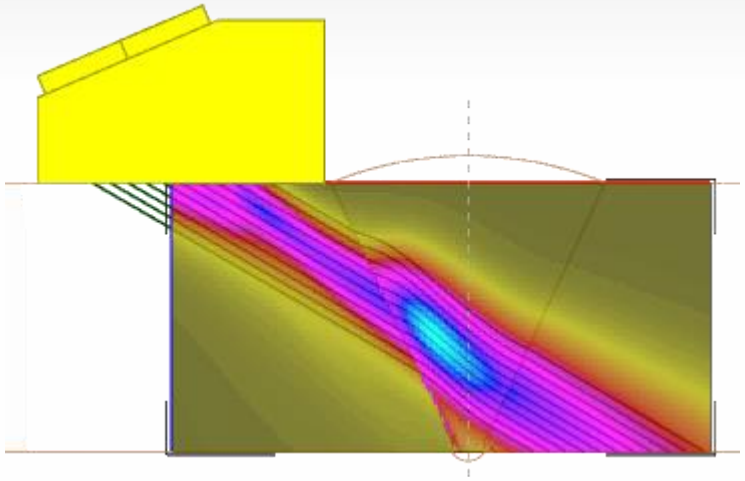


CIVA UT – Complex Weld Modeling

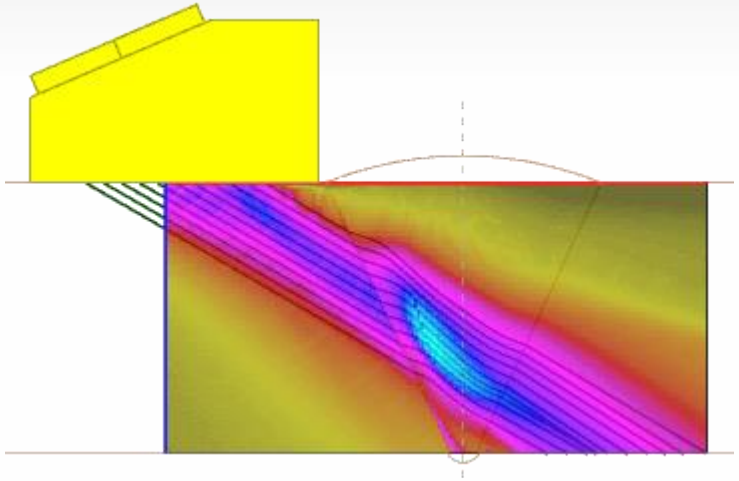
- Beam computation examples:



Homogeneous medium



Ogilvy

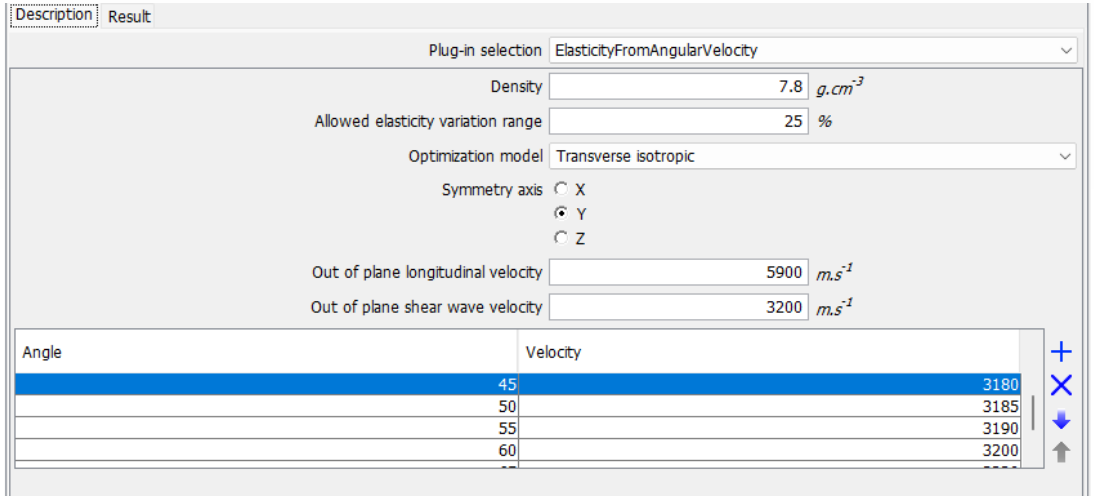


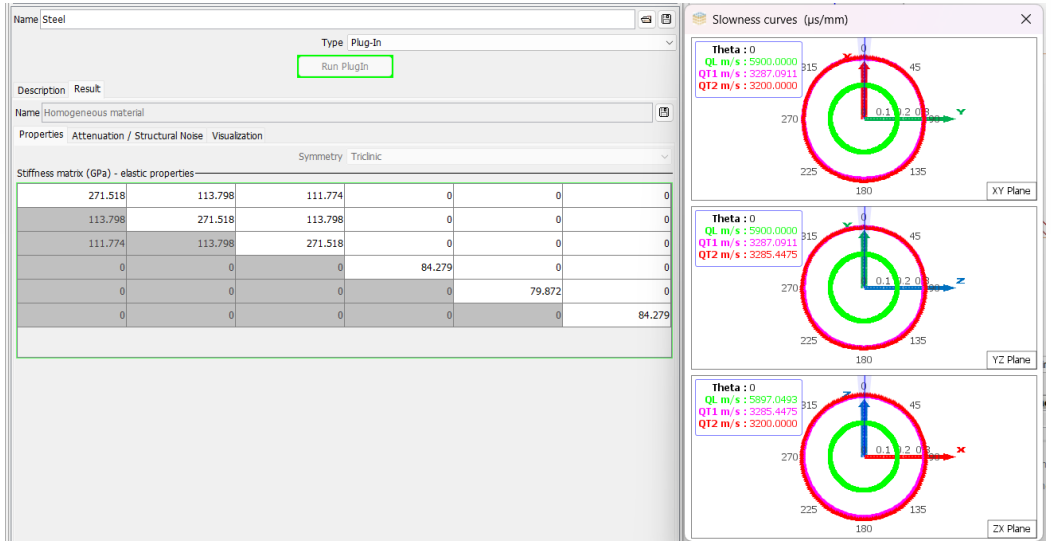
MINA

- Also available in Inspection simulation, both in UT-SA and UT-FEM

CIVA UT – Anisotropy definition

- Anisotropy can be now defined from a list of velocities versus angle rather than Cij elastic coefficients:
  - Easier input parameters for users, can be based on measurements
  - Can be adapted to define slightly anisotropic materials such as TMCP steels (Thermo-Mechanical Controlled Process) pipe
  - For “2D” anisotropy, i.e., “Transverse isotropic” materials
  - CIVA computes the “equivalent” Cij matrix



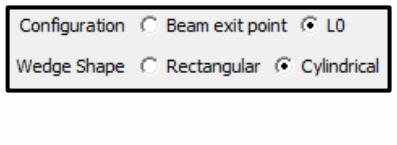


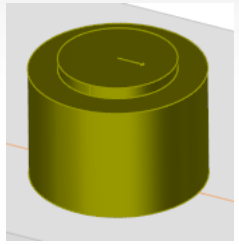
CIVA 2025 - UT

- Other new features in CIVA UT:

  - **Probe/wedge:**

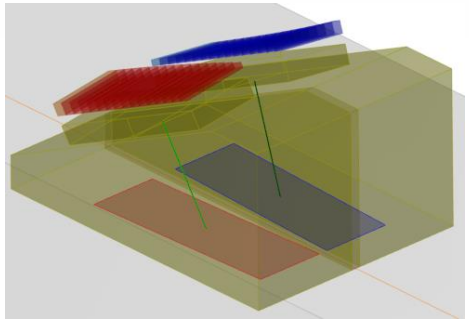
    - Cylindrical L0° wedge

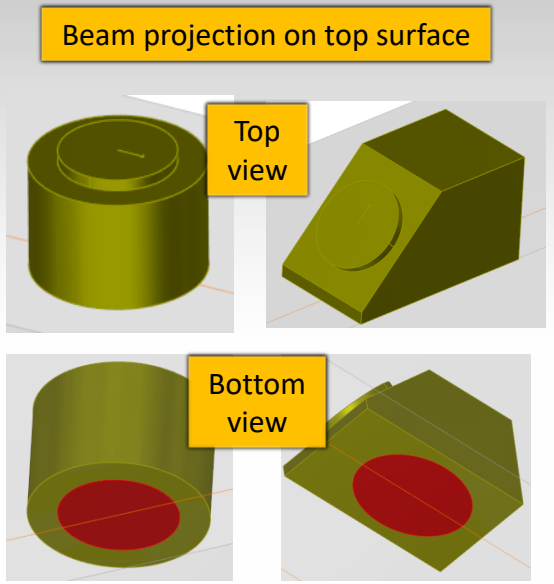


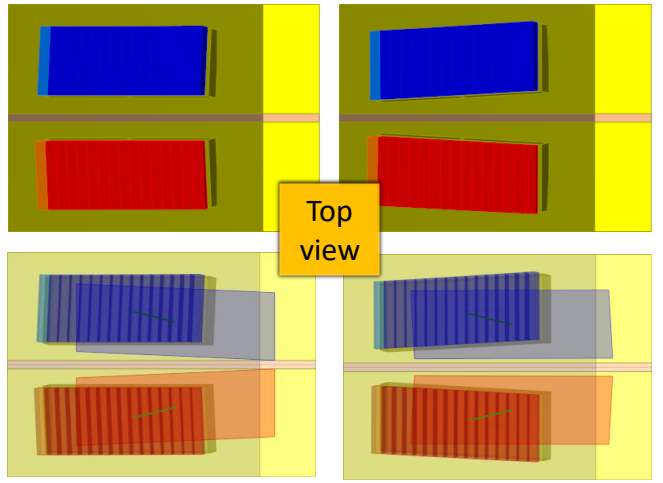


    - Beam projection on the top surface on the component:

TRL probes : Better understanding of transmitted beam
(Beam can cross the acoustical separation,
rotation of the elements can prevent that)





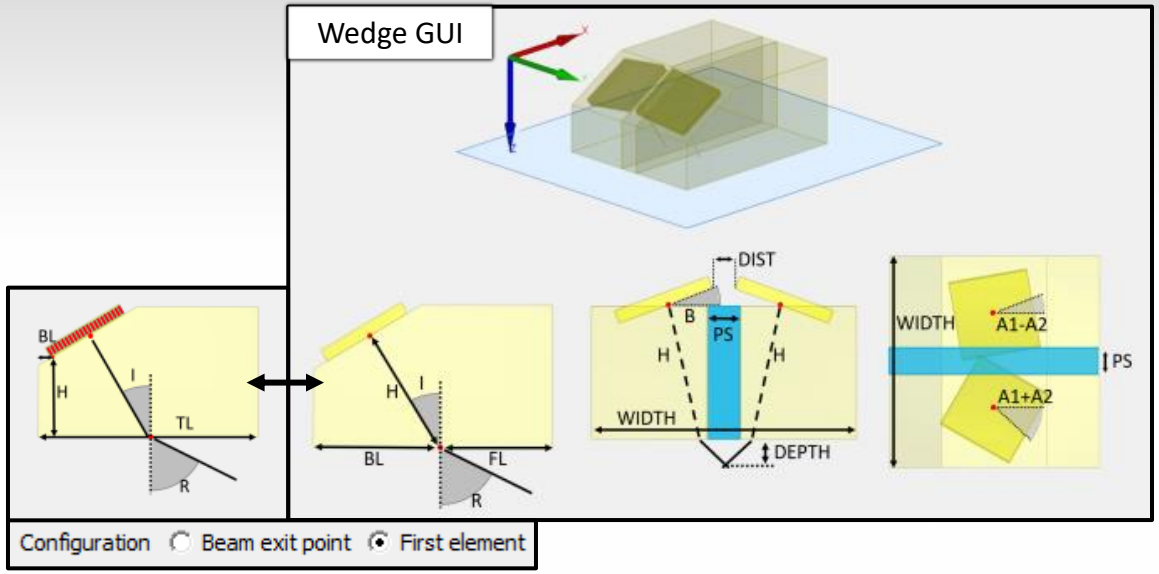


CIVA 2025 - UT

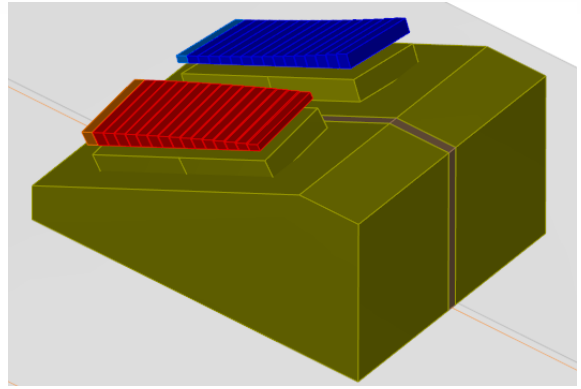
- Other new features in CIVA UT:

  - **Probe/wedge:**

    - New Wedge definition :
      Allows users to place the probe's active elements **in relation to the 'first' element**



    - Acoustical/physical separation in TRL probe wedge (=PS in GUI)



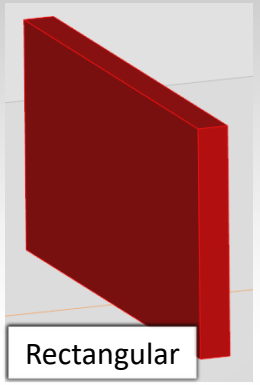
CIVA 2025 - UT

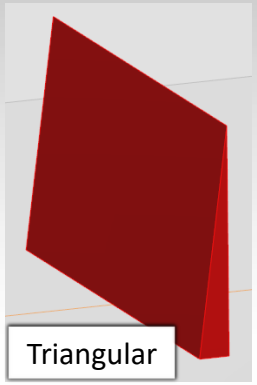
- Other new features in CIVA UT:

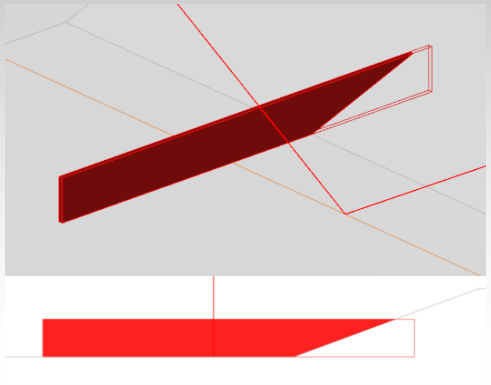
  - **Flaws:**

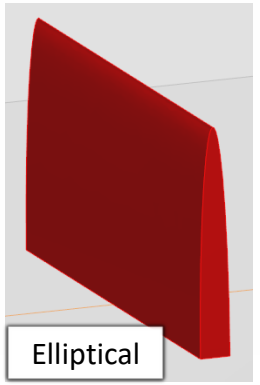
    - "Complex" Notch:
      - Rectangular, Triangular, Elliptical, Pencil profiles
      - Follows specimen profile
      - Considers intersections with the specimen

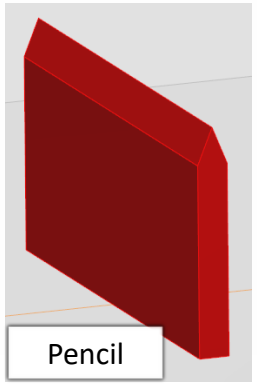
    - FE Interaction Grid:
      - Now available in heterogeneous specimen
      - Extension follow along cylindrical curvature

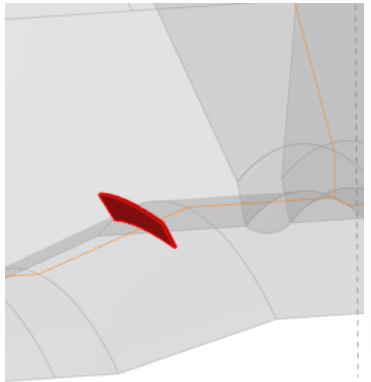


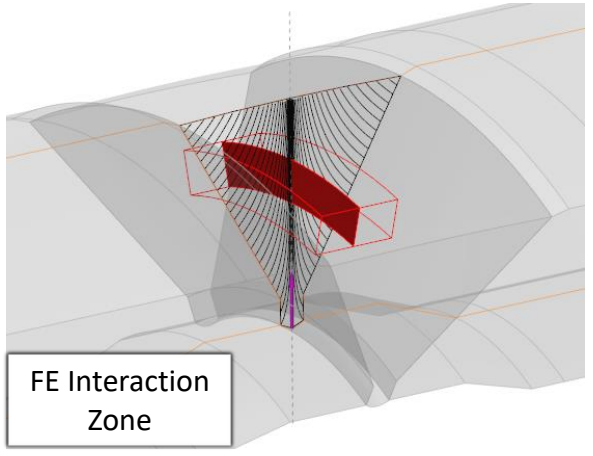






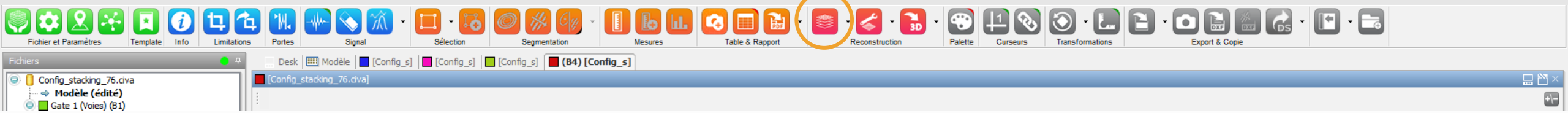




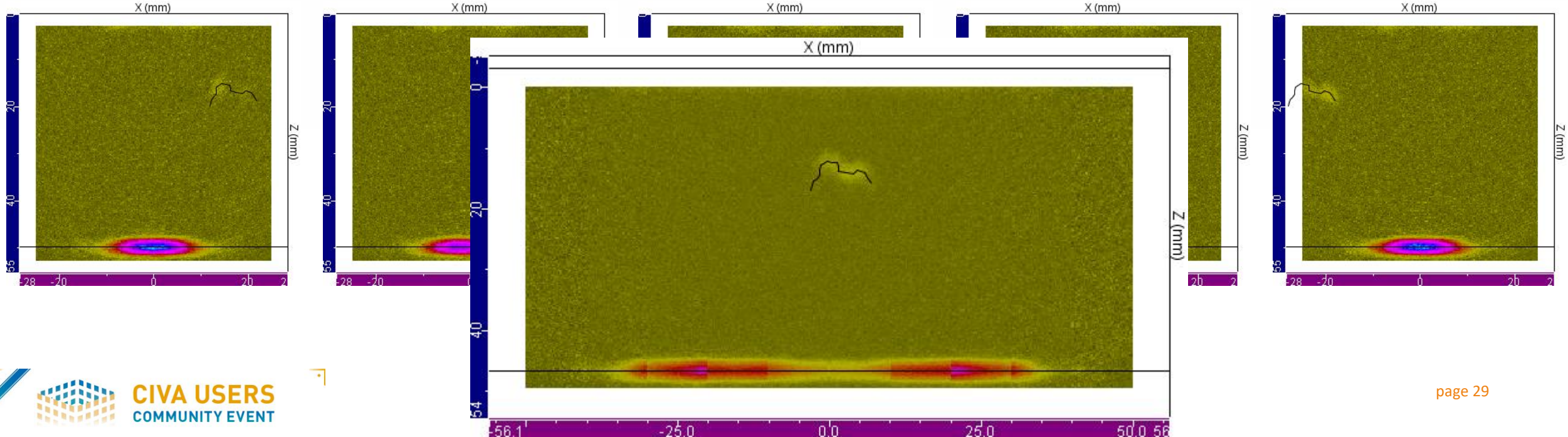


CIVA Analysis – TFM Stacking plugin

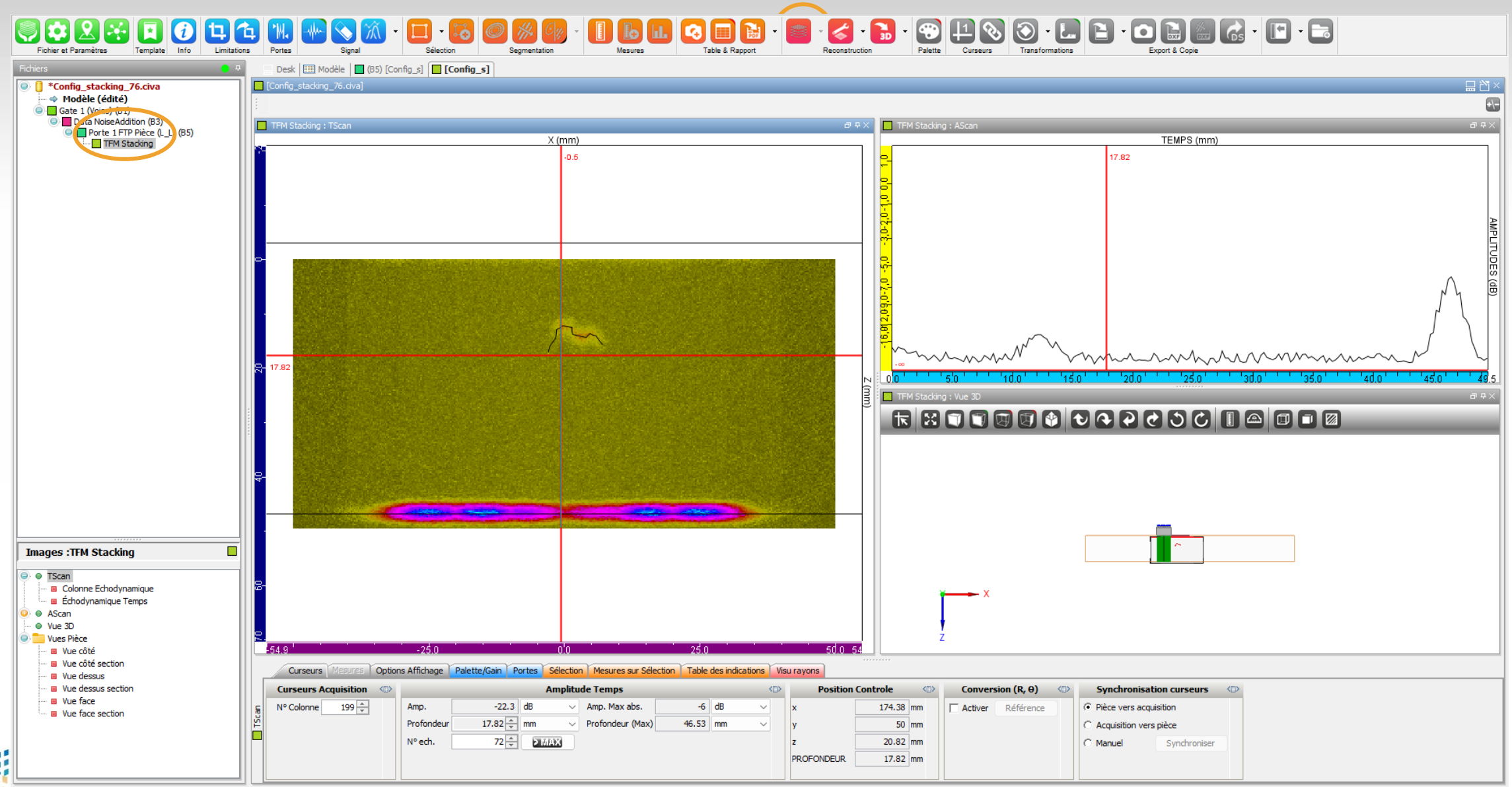
- New **plugin** available in CIVA UT Analysis available from the **toolbar**



- Create 1 TFM image from a **batch of TFM images** (probe scanning) with controlled **overlap**

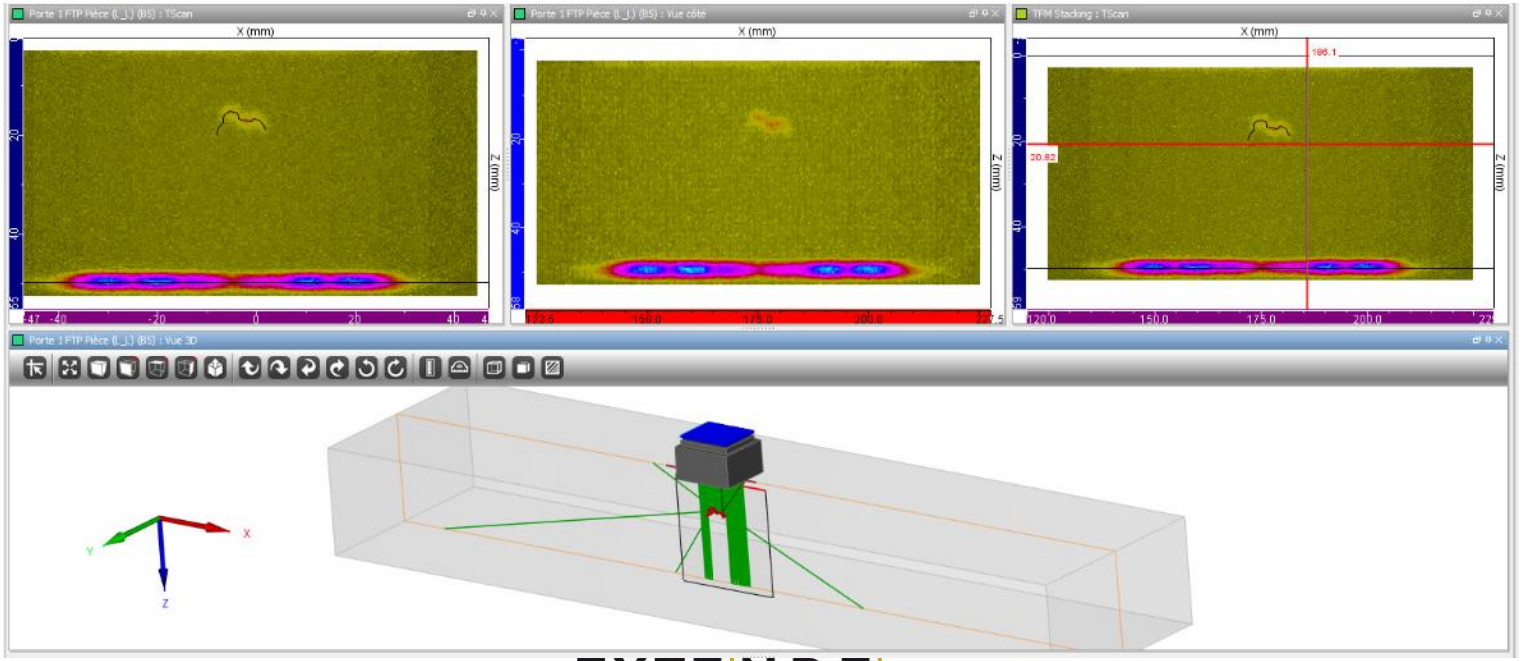


CIVA Analysis – TFM Stacking plugin

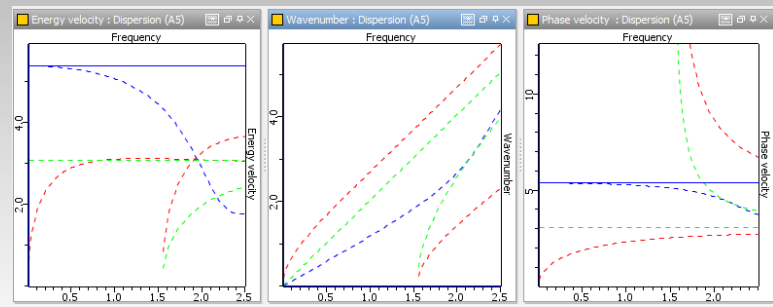


CIVA Analysis – TFM Stacking plugin

- **Comparison** compared to other views (specimen and cumulated views)
  - All give similar visualization
  - TFM Stacking generates a **new dataset**
    - Possibility to export stacked data (txt, hdf5)
    - Optimized for large acquisition files
    - Access to sub views and cursors
    - Access to merge strategy (max, min, mean)

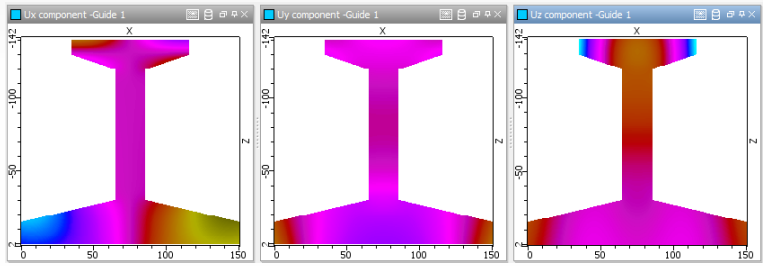


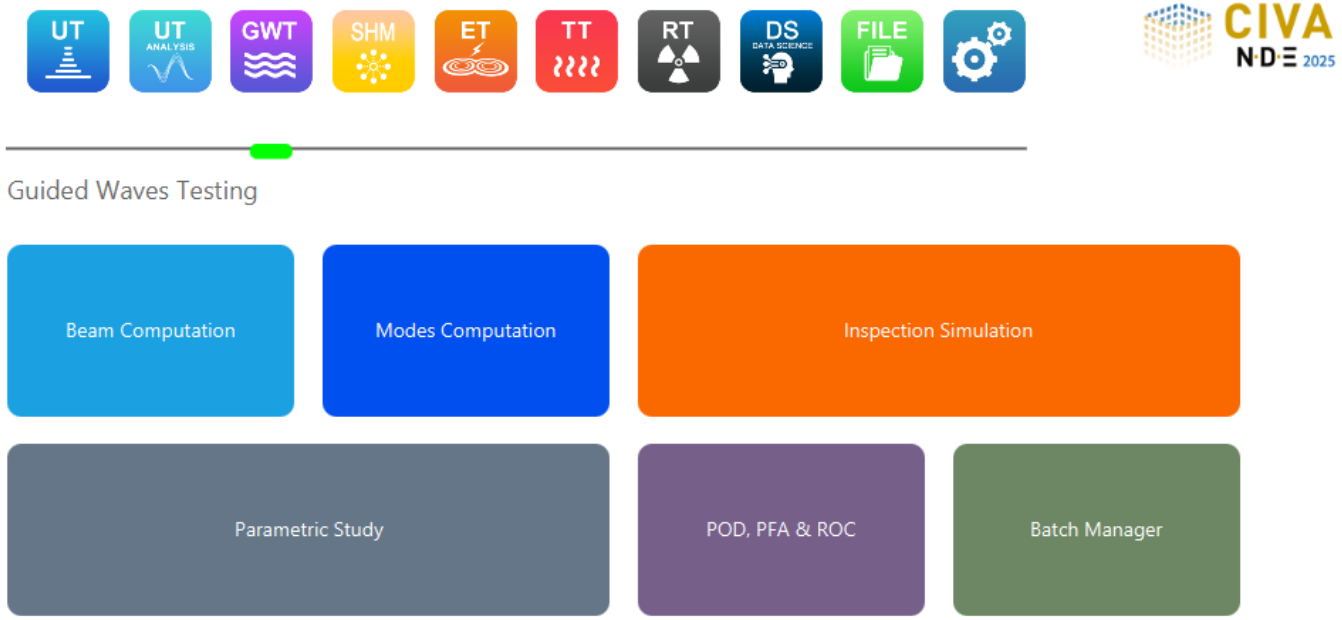
CIVA GWT

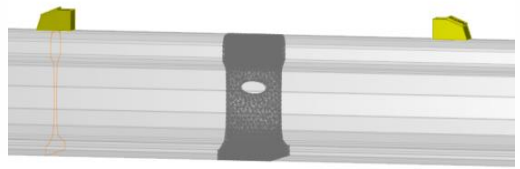


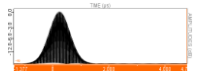
Guided Wave Testing module:

- Still structured with 3 main simulation tools:
  - **Mode computation**: Dispersion curves for a given component geometry and materials
  - **Field computation** :
    Flaw-free simulation considering GWT probe transduction: Emitted modes, displacements in the component section
  - **Inspection Simulation** : Echo received from discontinuity(ies):
    Flaw, geometrical change (section, junctions, weld, etc.)



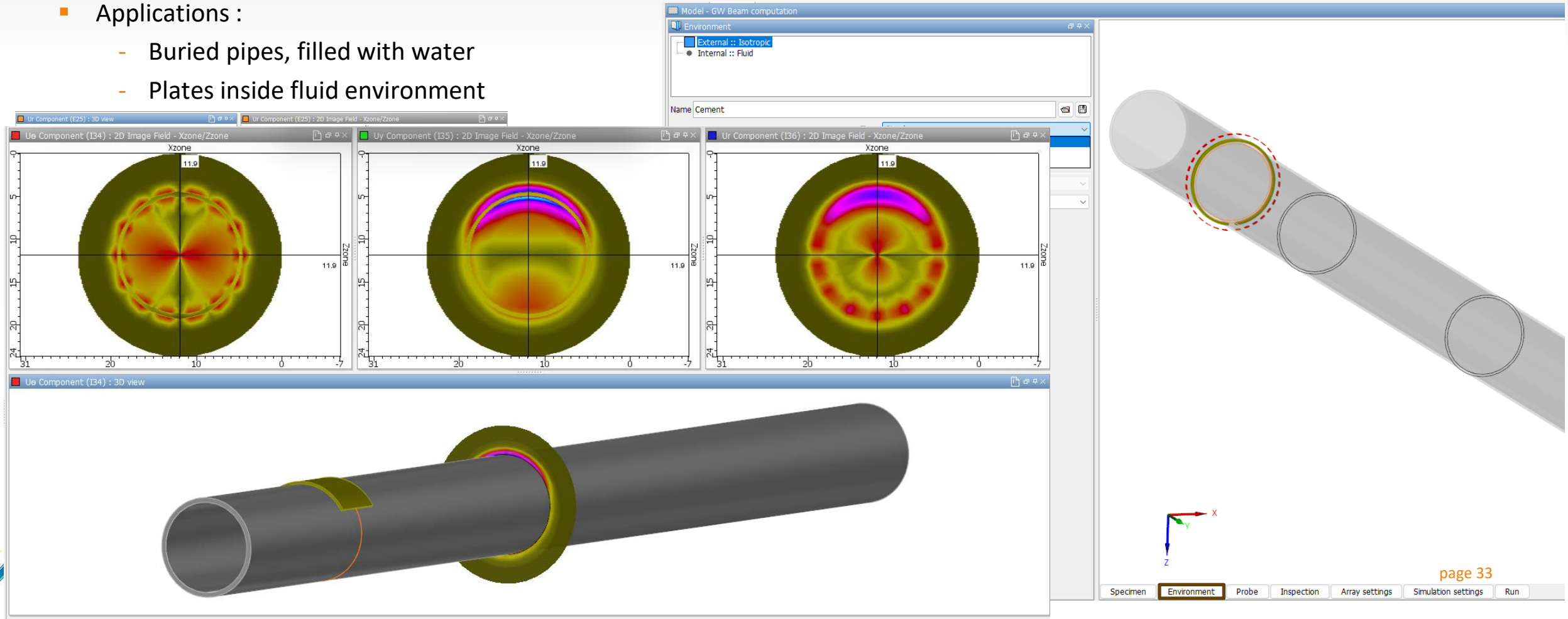






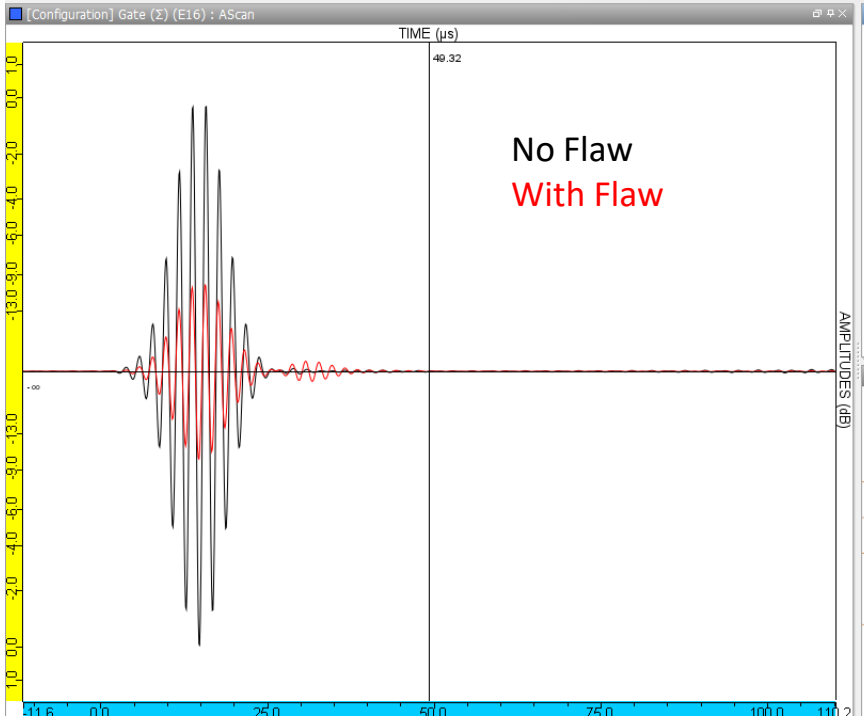
CIVA GWT

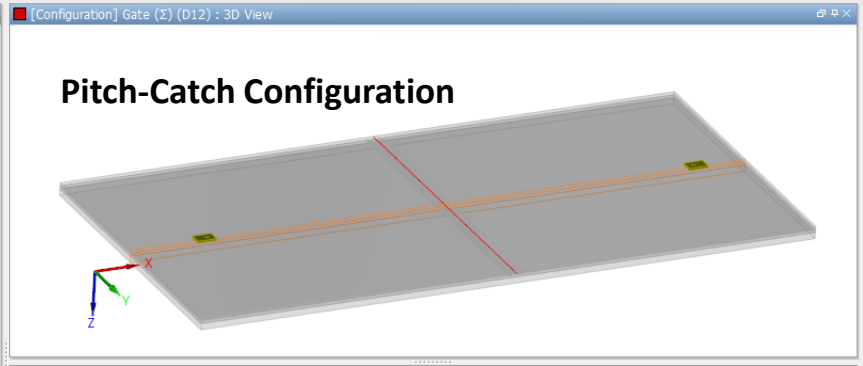
- **Surrounding media** can be accounted for in **Field Computations**:
  - Used to be limited to mode computation (or just inner fluid in a pipe for field and inspection simulation)
  - Now available until field computation for plates and cylindrical components, both external and internal media
  - Applications :
    - Buried pipes, filled with water
    - Plates inside fluid environment



CIVA GWT

- **Surrounding media** can be accounted for in **Field Computations**:
  - Used to be limited to mode computation (or just inner fluid in a pipe for field and inspection simulation)
  - Now available until field computation for plates and cylindrical components, both external and internal media
  - Applications :
    - Buried pipes, filled with water
    - Plates inside fluid environment
- **Fluid layer bounded by solid « plates » :** Available all the way to **Inspection Simulation**
  - Defined through 2D CAD junctions
  - Bounding plates can have an irregular profile

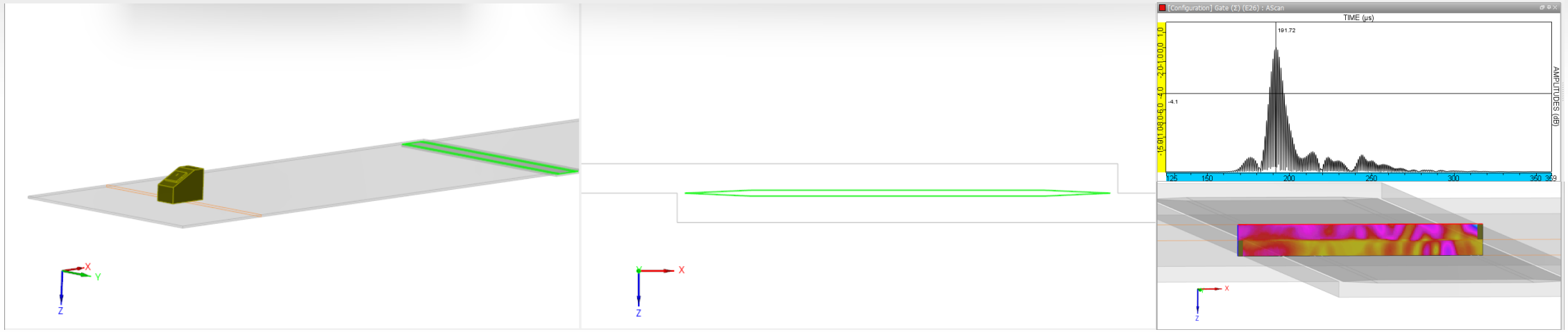




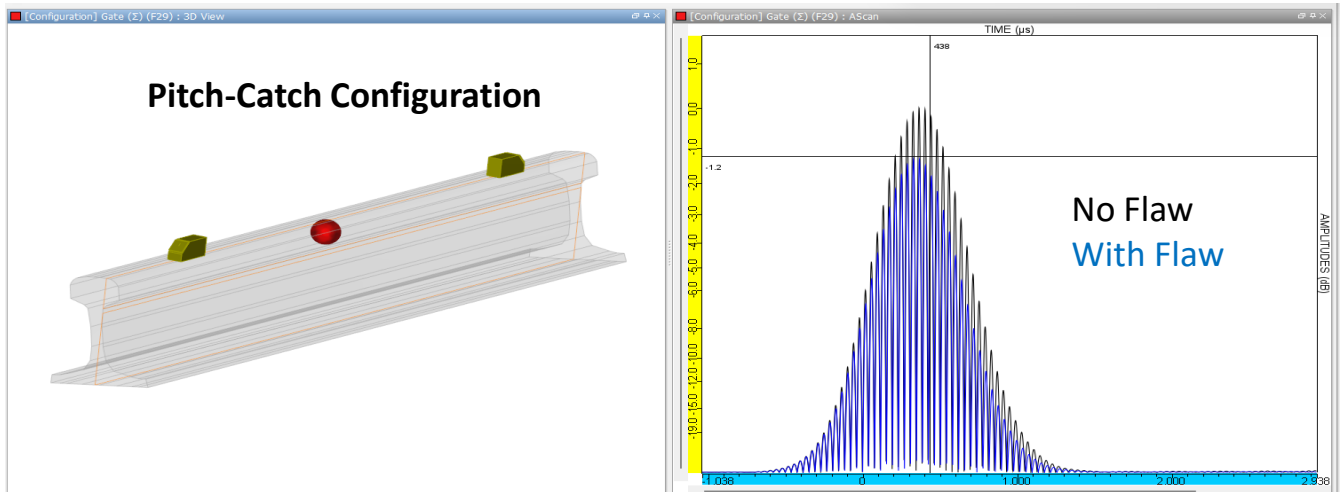
CIVA GWT

Solid Inclusions (Inspection Simulation)

- Can be defined in **2D models** through 2D CAD junctions (already available in CIVA 2023 SPx)



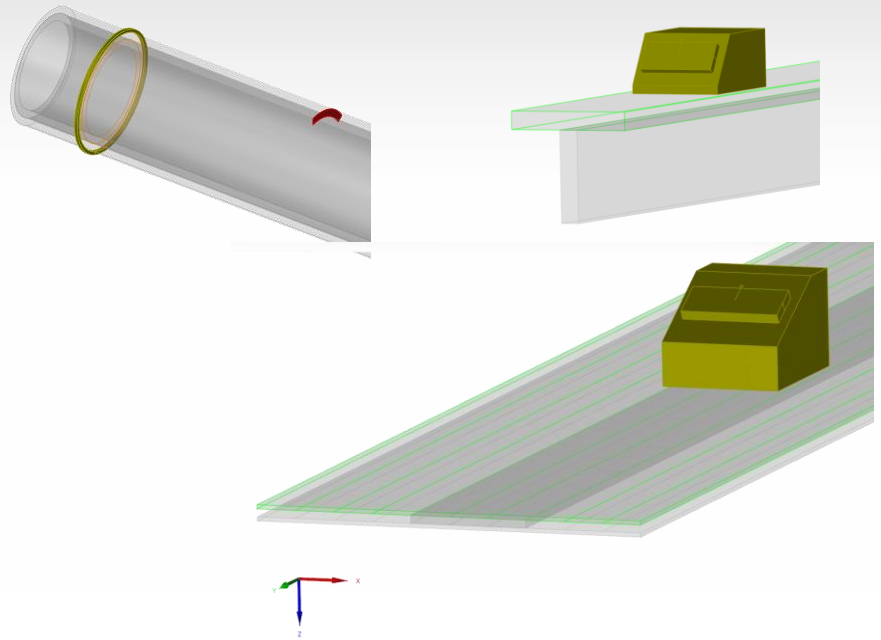
- Also available now in **3D models** (2D CAD section component)



CIVA GWT

2D CAD heterogeneous component : Available all the way to **Inspection Simulation (2025 SP2)**

- Used to be limited to mode and field computations
- Applications :
  - Complex assembly made of different materials
  - Coated pipes (and possibility to simulate any types of flaws)



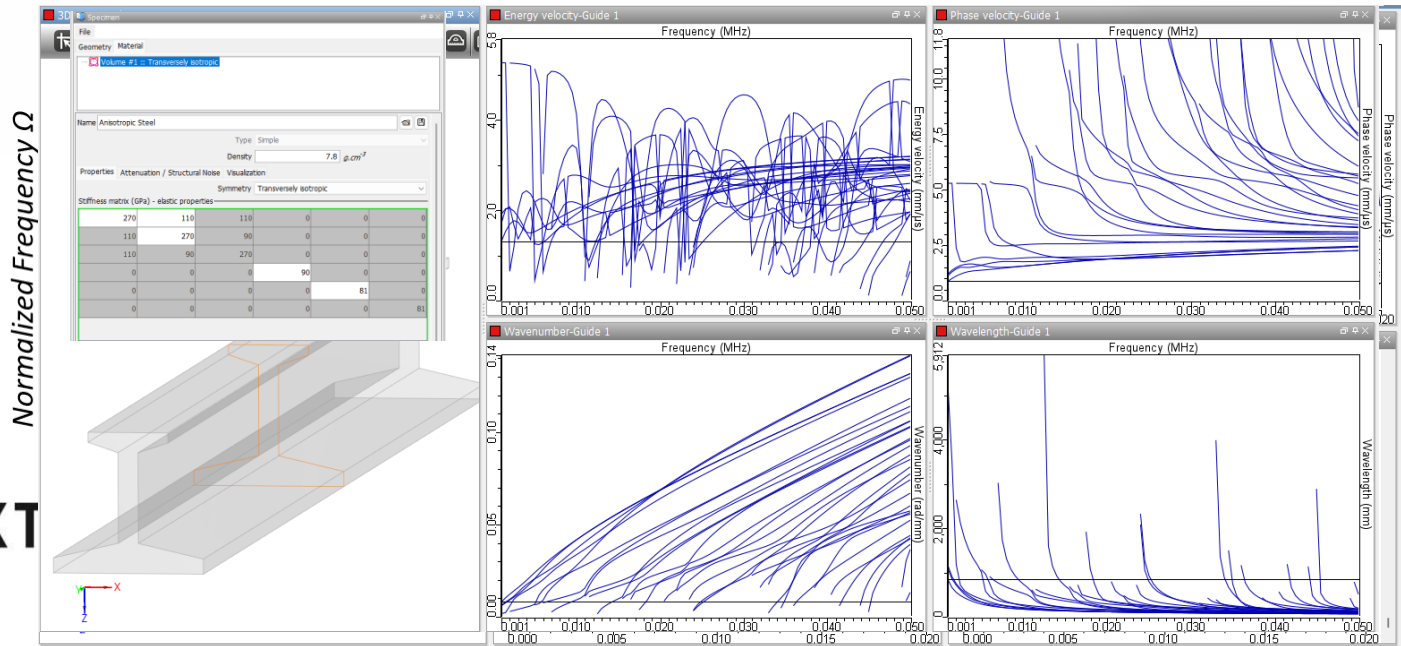
CIVA GWT

2D CAD heterogeneous component : Available all the way to **Inspection Simulation (2025 SP2)**

- Used to be limited to mode and field computations
- Applications :
  - Complex assembly made of different materials
  - Coated pipes (and possibility to simulate any types of flaws)

2D CAD component with anisotropic materials: Available in **Mode computation**

- Anisotropy used to be limited to planar and cylindrical components
- Applications:
  - Complex component sections (such as Rail track) with anisotropic properties
  - Validation case on a bilayer component made of 2 Transversely isotropic materials



CIVA GWT

Performance improvement

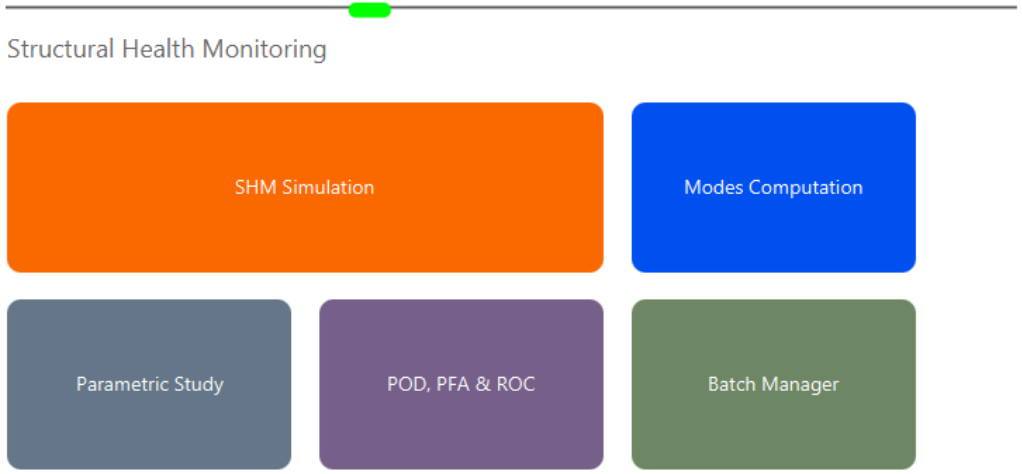
- Faster computation times for inspection simulations
- Can go up to a factor 2 (depending on computer and case)

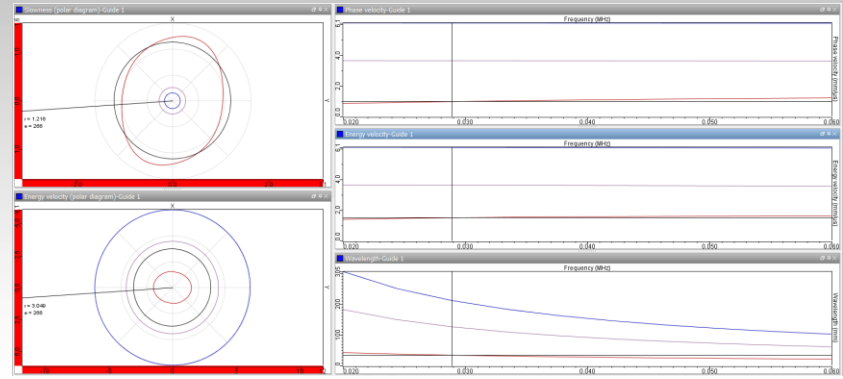
A few test cases performed at CEA	CIVA 2023	CIVA 2025
Tube with Array probe 8 éléments	12’13’’	11’28’’
Groove geometry without flaw (planar extrusion)	1’51’’	1’03’’
2D Cad junction with flaw (planar extrusion)	2’32’’	1’44’’
Rail example – Pulse Echo	3’05’’	1’50’’
Weld with flaw (cylindrical extrusion)	22’’	20’’
Rail example – Pitch-Catch	9’21’’	6’28’’
3 layers cylinders with 10° sectorial flaw	2H6’52’’	1H42’14’’

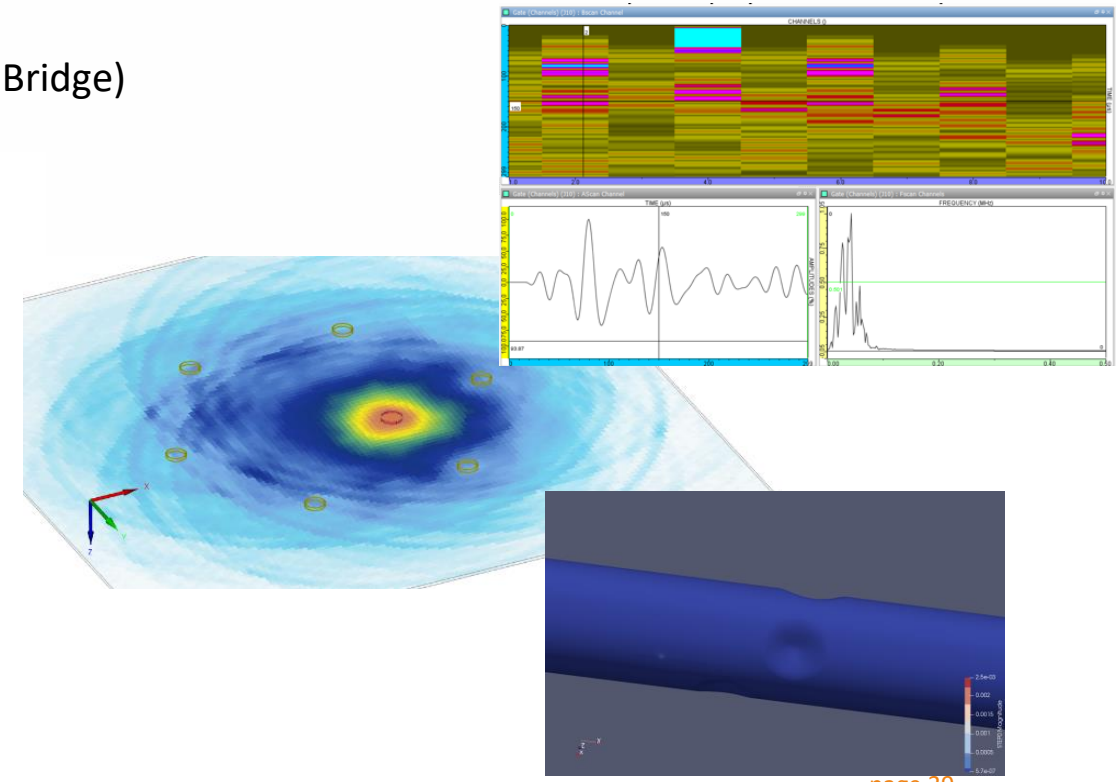
CIVA SHM

SHM module (Structural Health Monitoring):

- Structured with 2 main simulation tools:
  - **Mode computation**: Dispersion curves for a given component geometry & materials
  - **SHM Simulation** :
    - Echoes received from the network of sensors with/without defect(s)
    - “Tomographic” imaging reconstruction on 3D view
    - Full Field animation available in external VTK viewer (Paraview Bridge)
    - 3D FEM approach



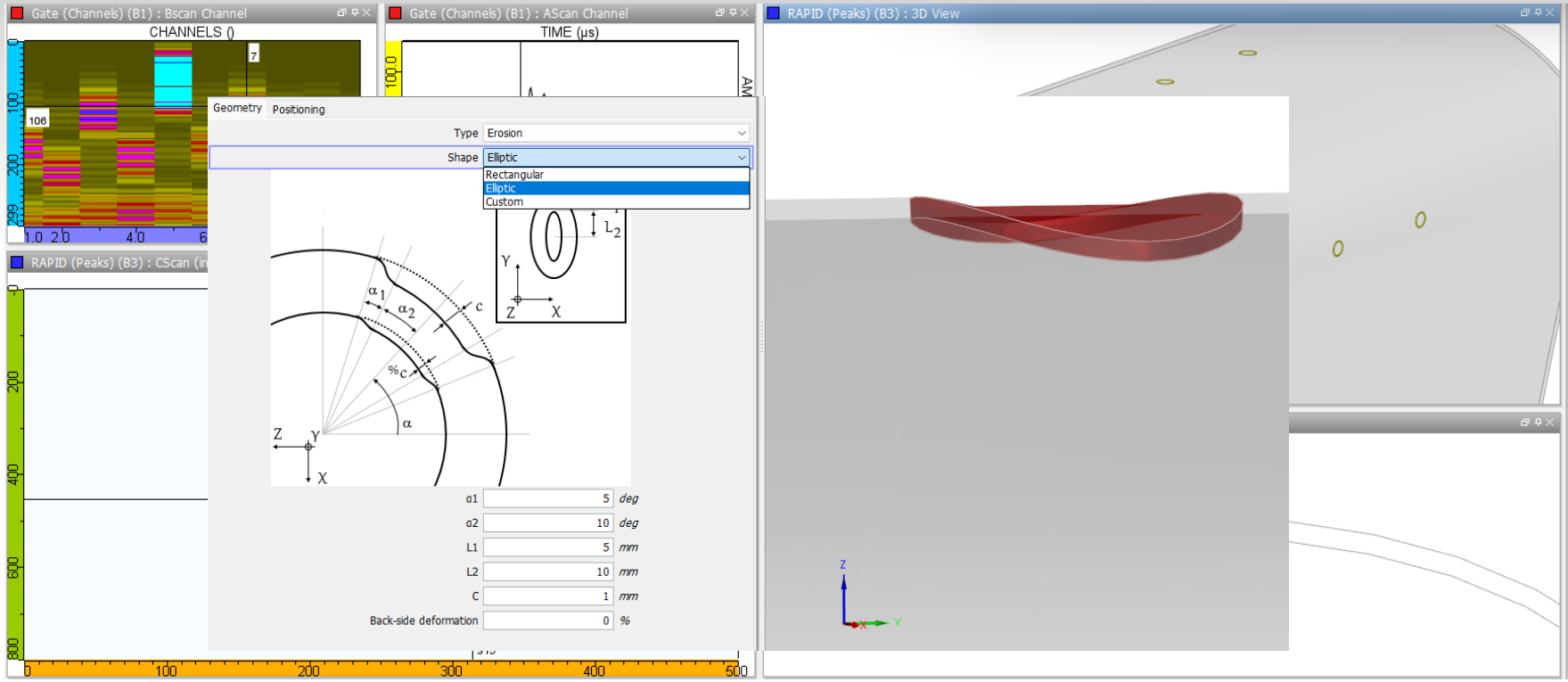




CIVA SHM

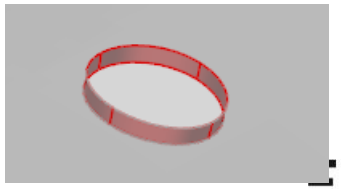
New « flaws » :

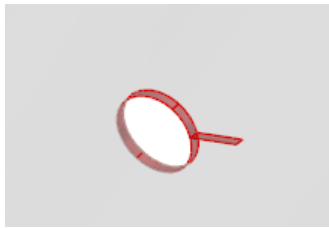
- Flat Bottom Hole

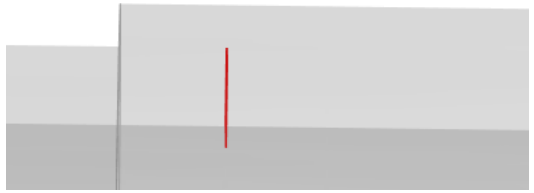


- Erosion/Corrosion flaw in all structures (including multi-layers)

- Other defect types already available in CIVA 2023 : Delamination, Through Wall Hole, Hole with crack, vertical crack, inclusion

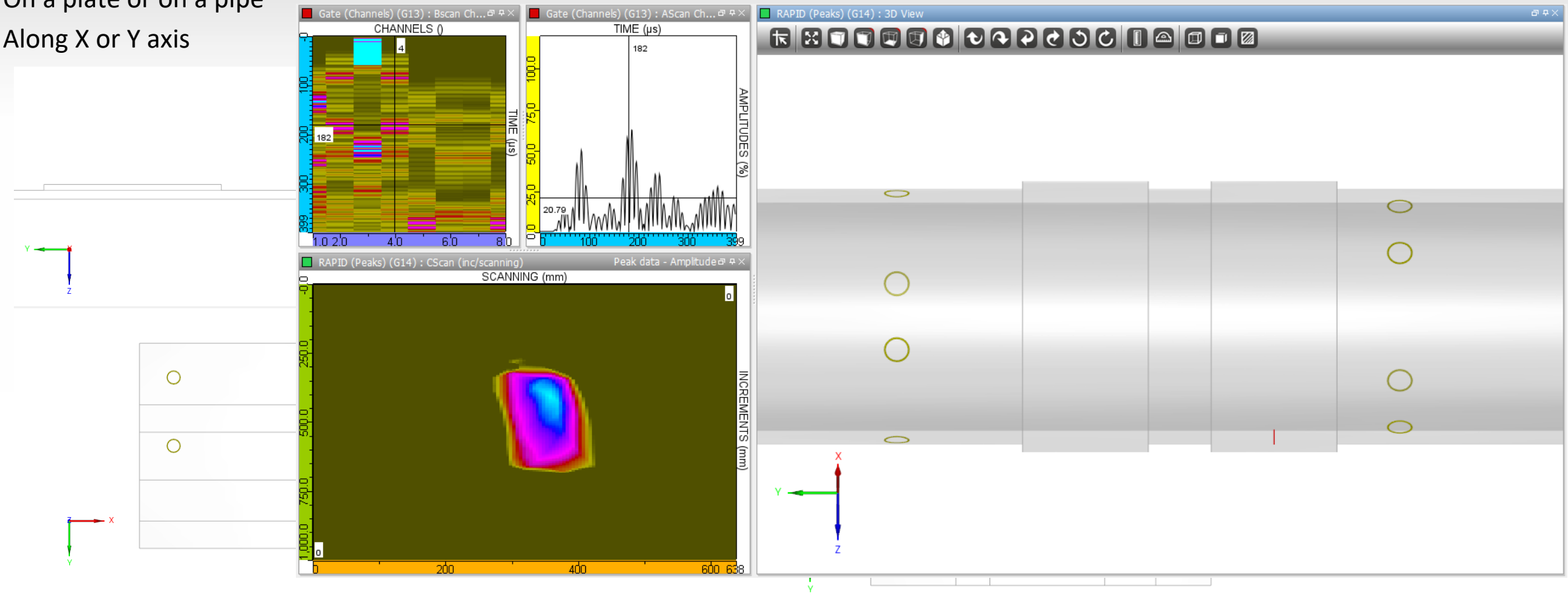






CIVA SHM

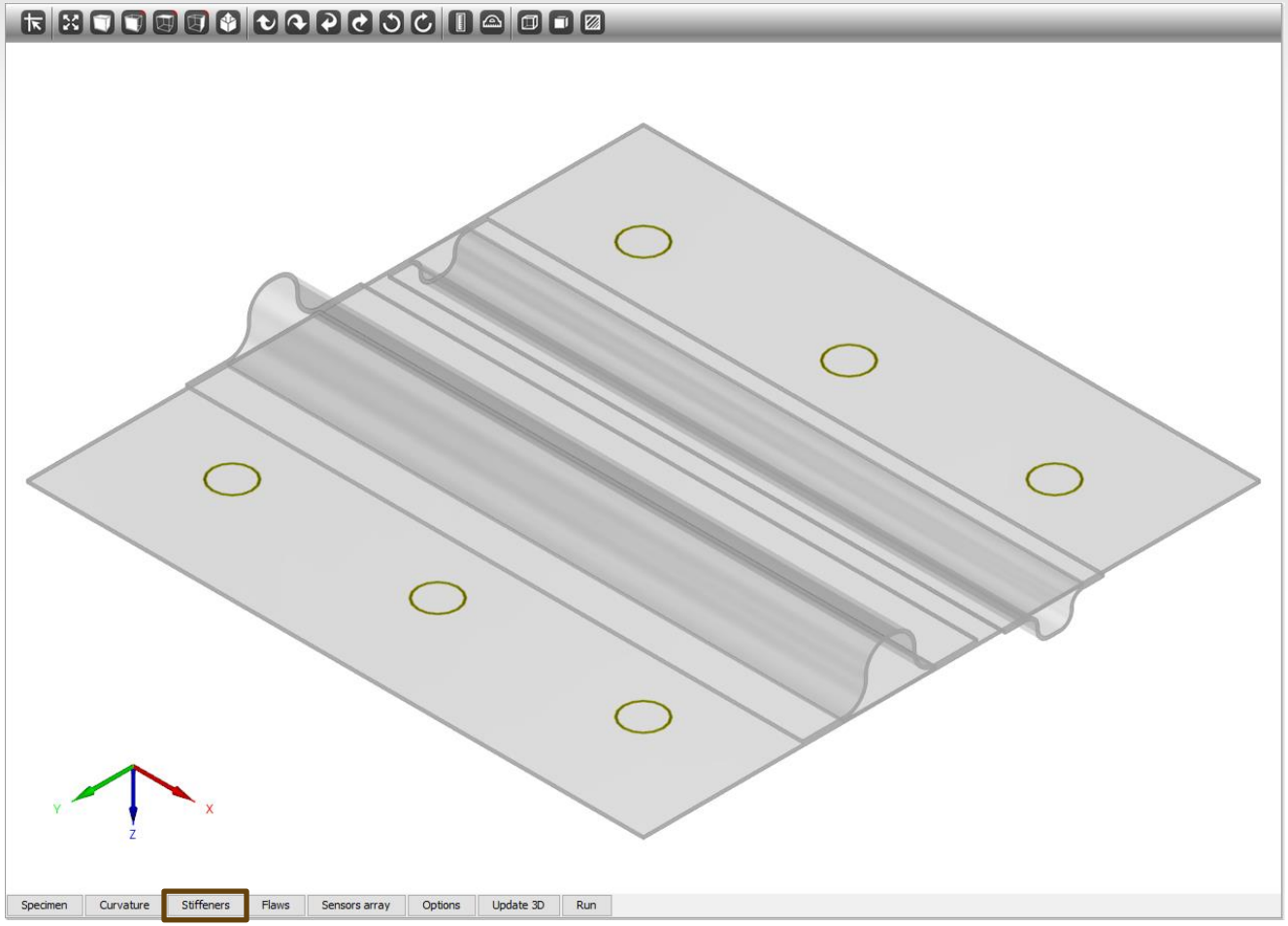
- **Several « Sleeves »** can be defined in the model:
  - On a plate or on a pipe
  - Along X or Y axis

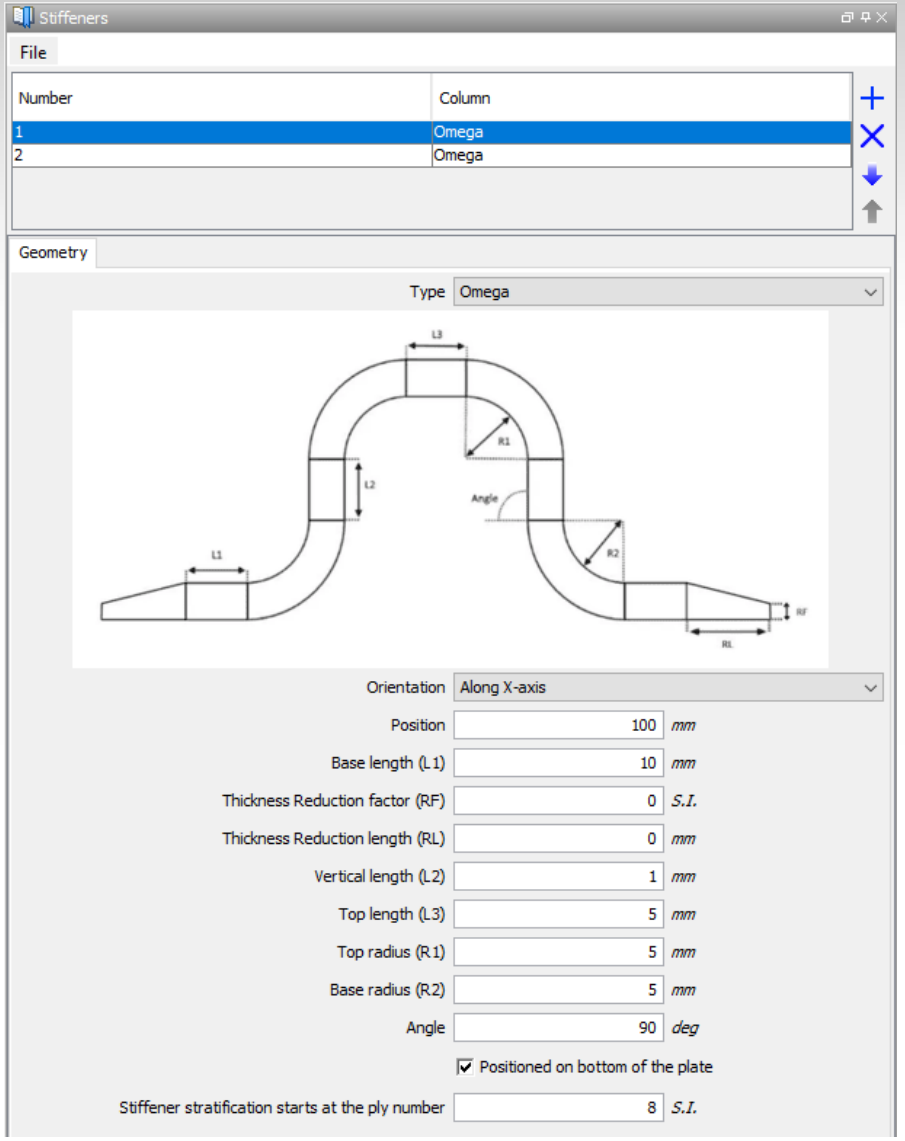


SHM

CIVA SHM

- **Several Stiffeners** can be defined in the model:

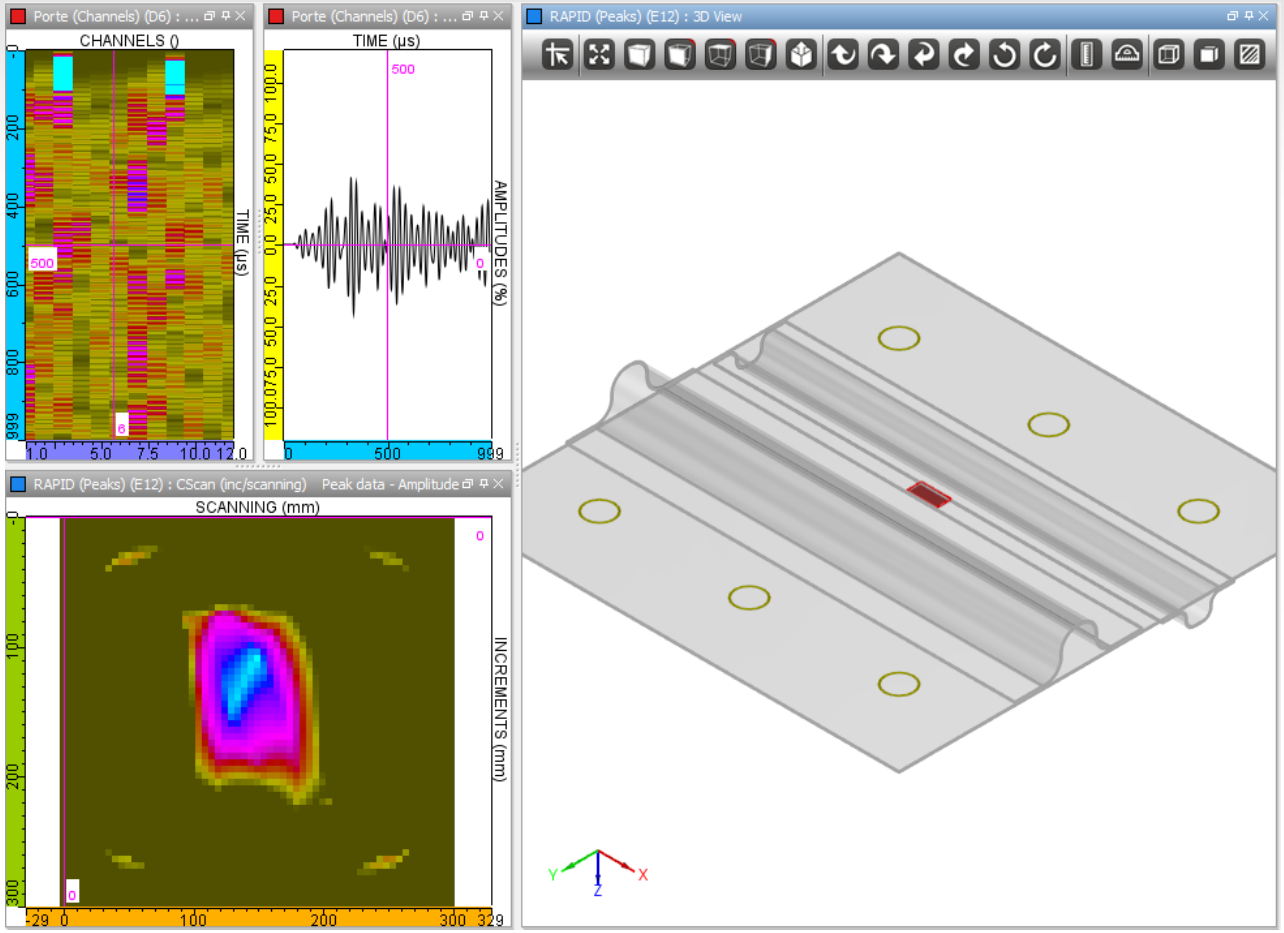


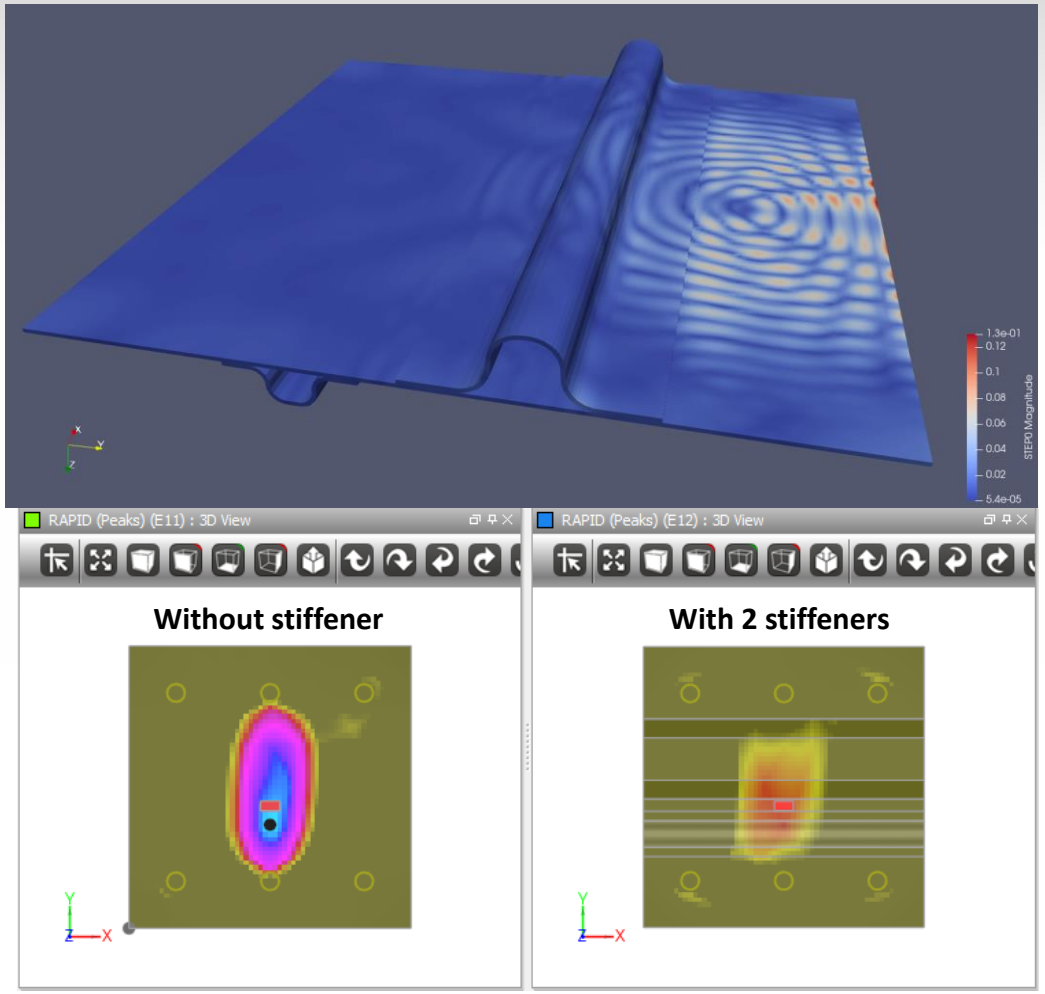


SHM

CIVA SHM

- **Several Stiffeners** can be defined in the model:

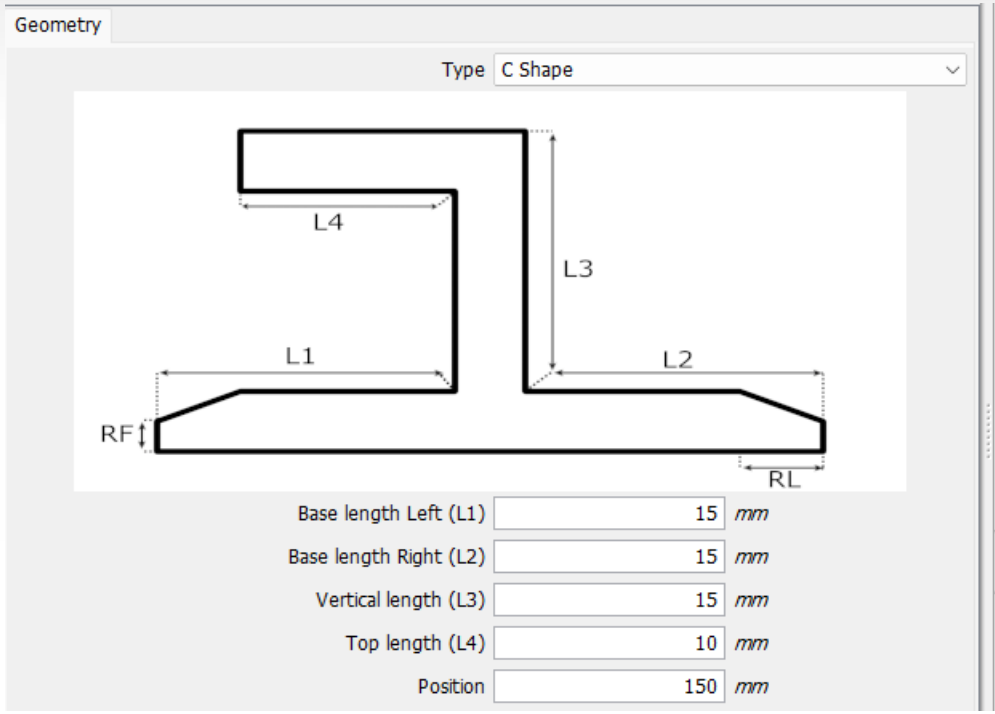


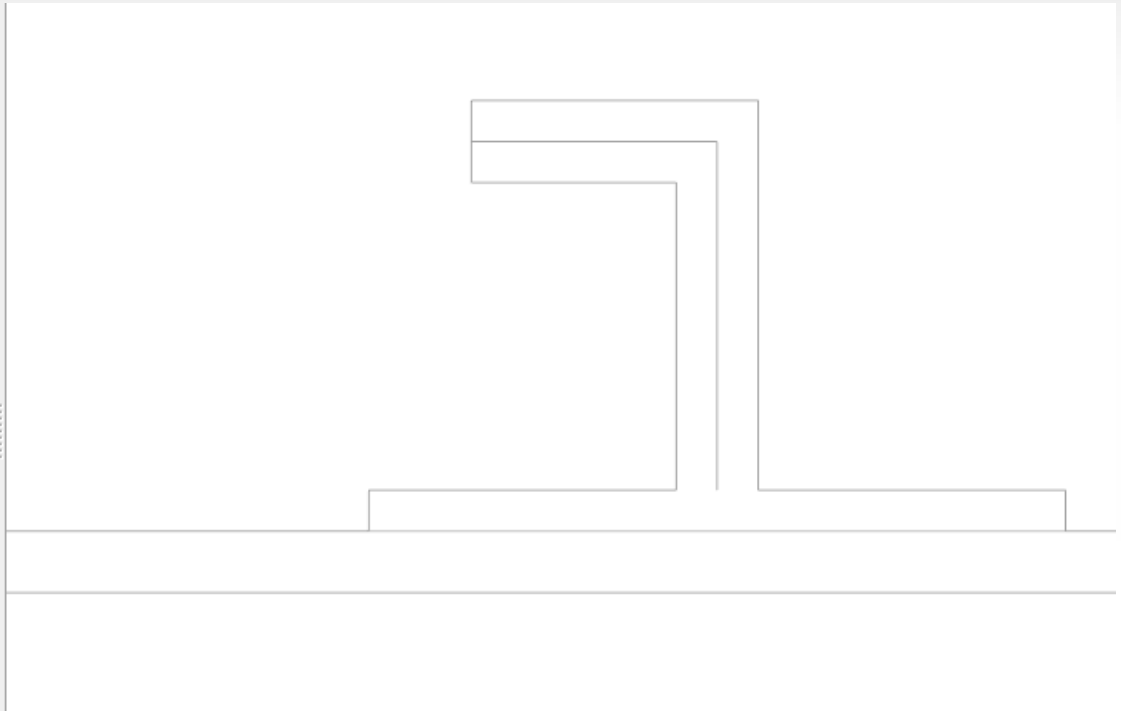


CIVA SHM

A new « C-Stiffener » geometry is available :

- In addition to the « Omega » stiffener already available



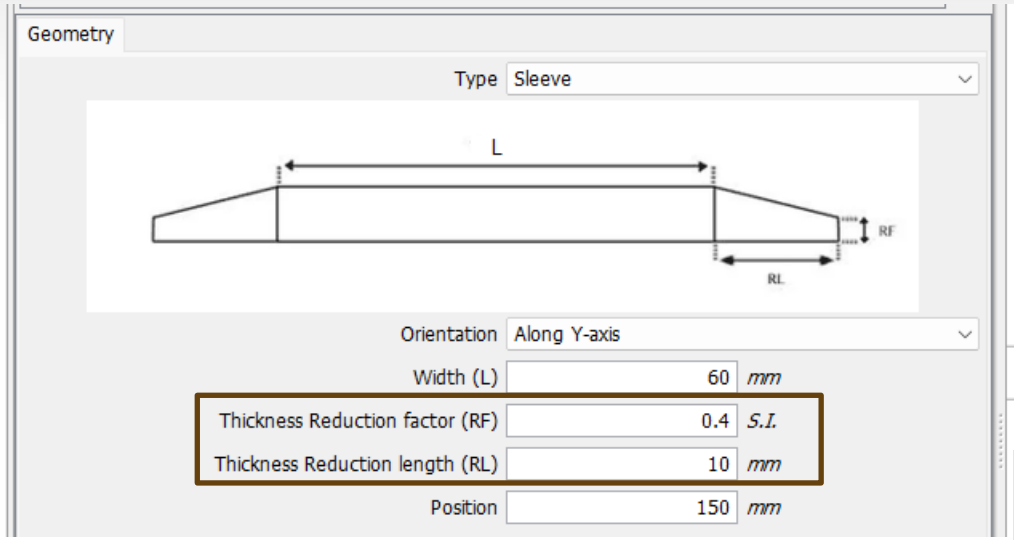


SHM

CIVA SHM

Sleeves and stiffeners thickness can be reduced on their edges:

- A « Reduction Factor » is applied on a certain length



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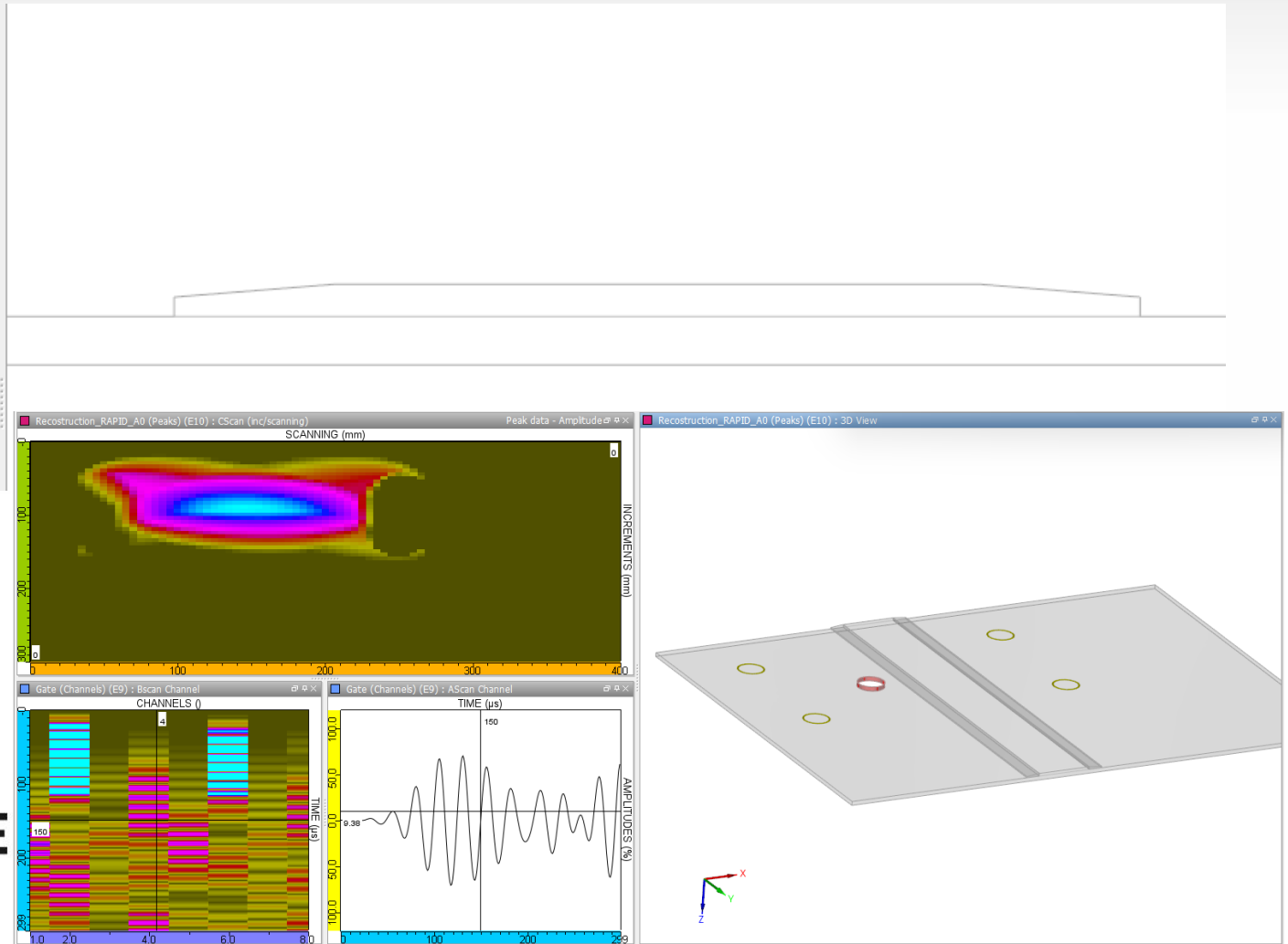
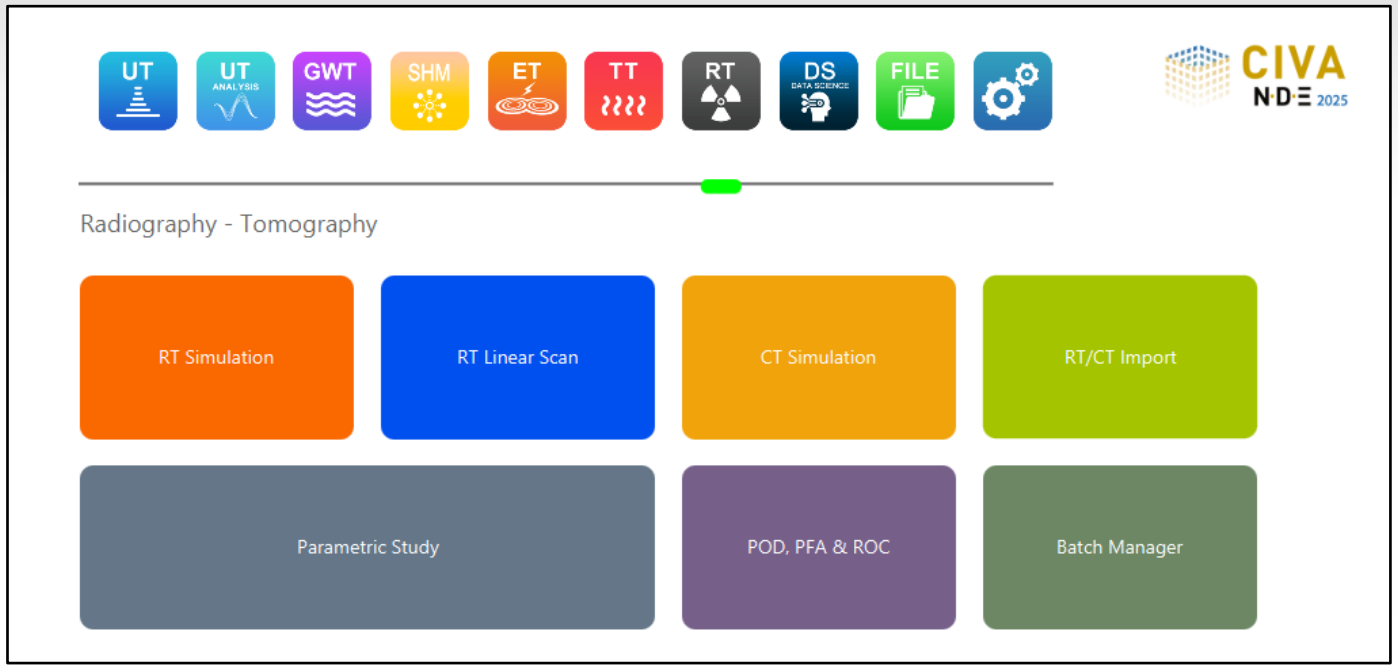


CIVA RT/CT

What's new?



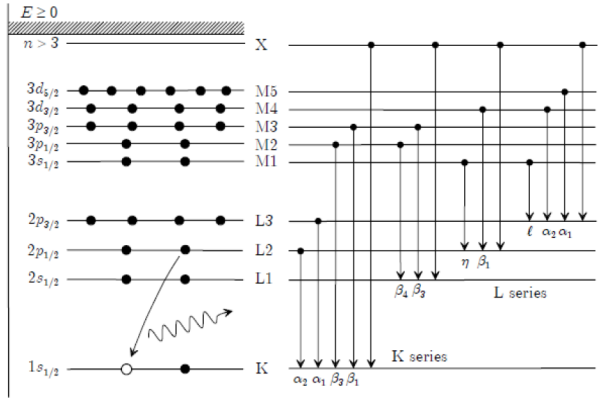
Main topic :

- New Physical models
- New Defects
- Augmented Imaging
- Photon Counting Detector

CIVA RT/CT

Improvements of physical models

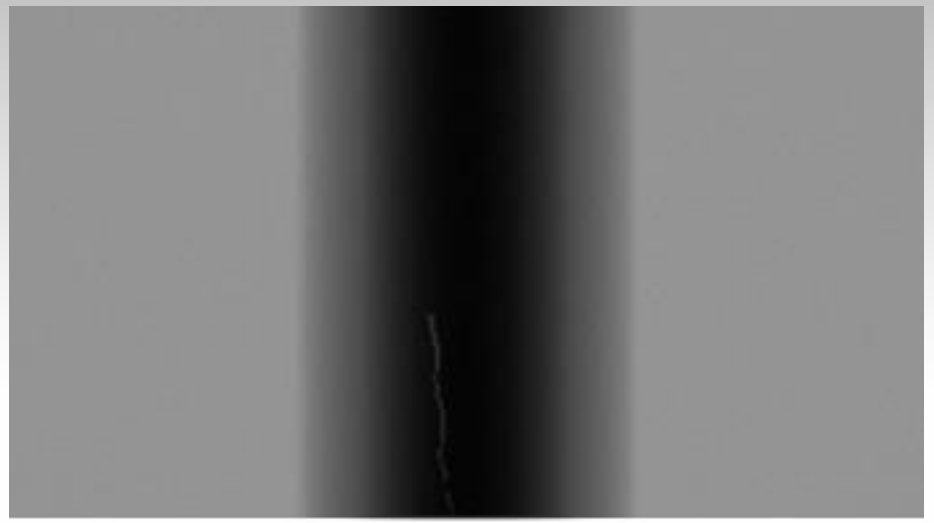
- New cross sections material database from NIST and ENDF libraries
- New RX generator spectrum (from SPEKPY) replacing the previous version
- **Monte-Carlo calculation** (scattered radiation) **improved** including:
  - Bremsstrahlung interaction in the specimen (mainly for high energy sources and thick specimen),
  - X-ray Fluorescence interaction in the specimen (mainly for heavy materials)
  - Model optimization for faster convergence through variance reduction, thus reducing computing time

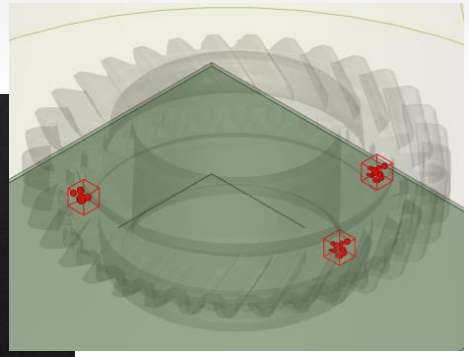


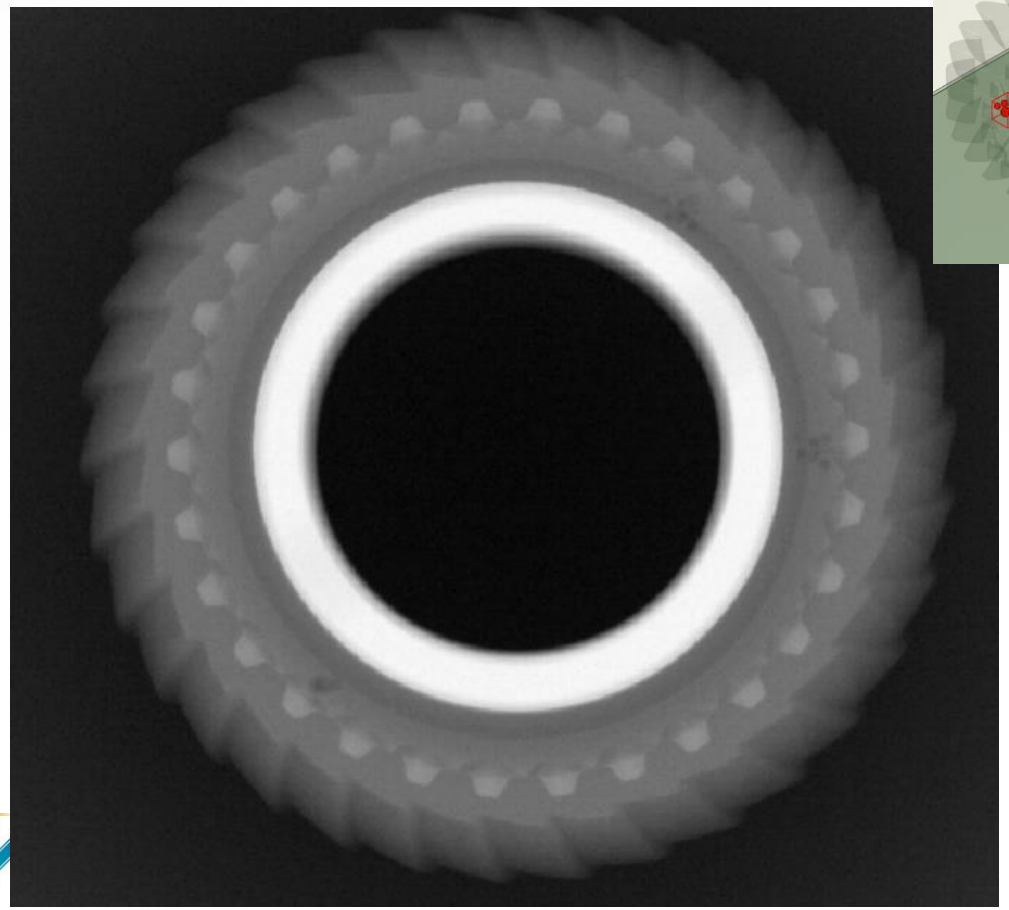
Case	Time calculation reduced by:
Weld / Ir192 / Silver film	2
Planar specimem / 450 keV / DR	3
Planar specimen / Co^{60} / DR	2
Planar specimen / betatron 2MeV / DR	4
Nozzle / 9 MeV / Silver film	4

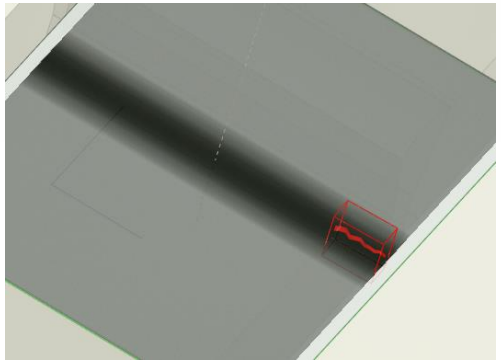
CIVA RT/CT

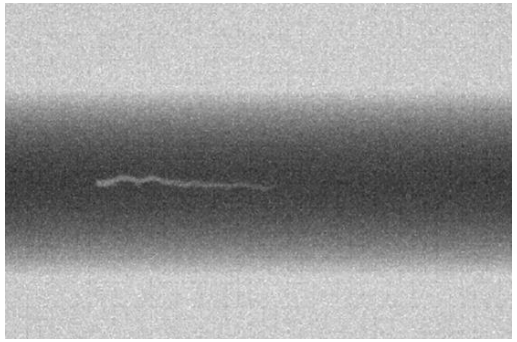
- New types of predefined defects
  - “Cluster of spherical porosities” and “parametric cracks”

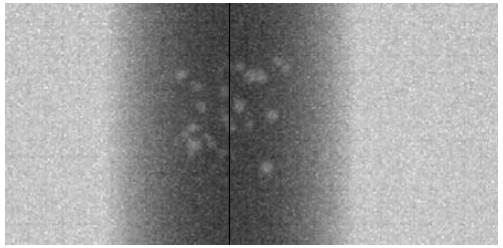


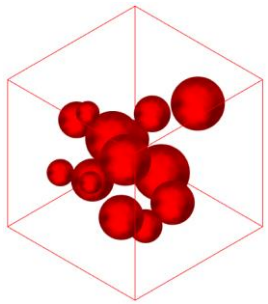


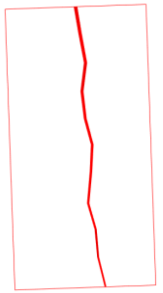


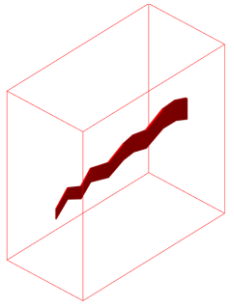








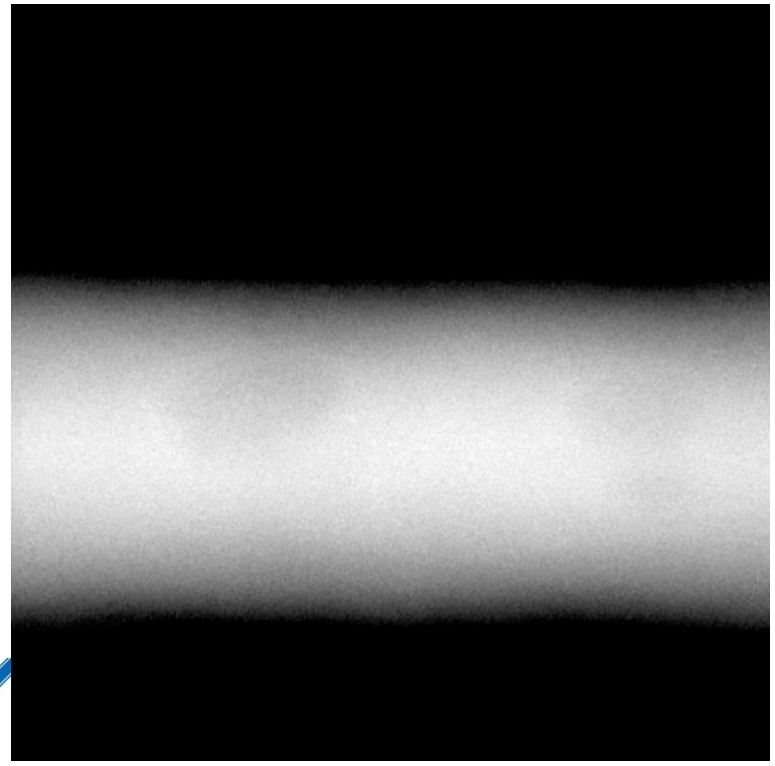




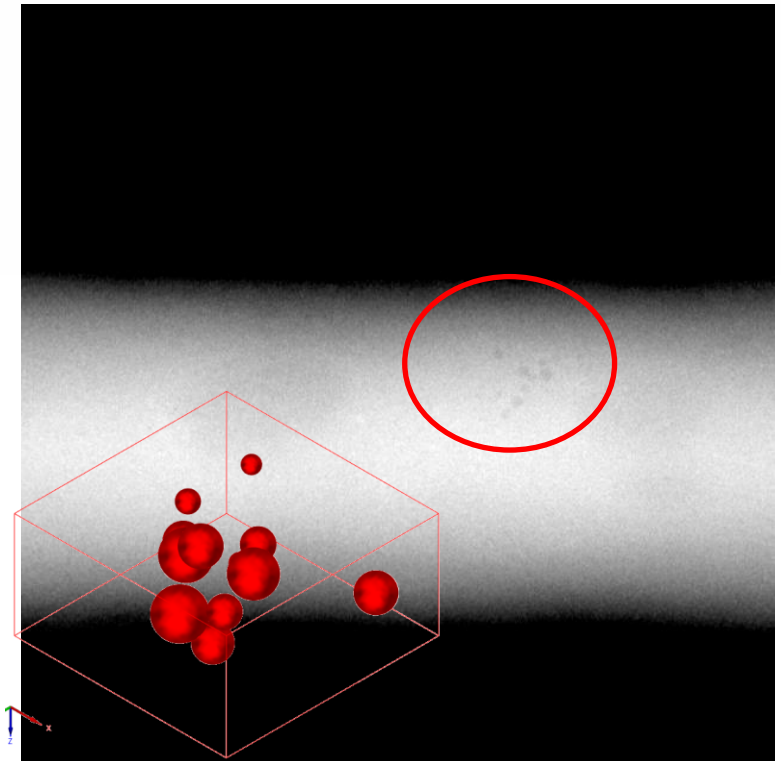
CIVA RT/CT

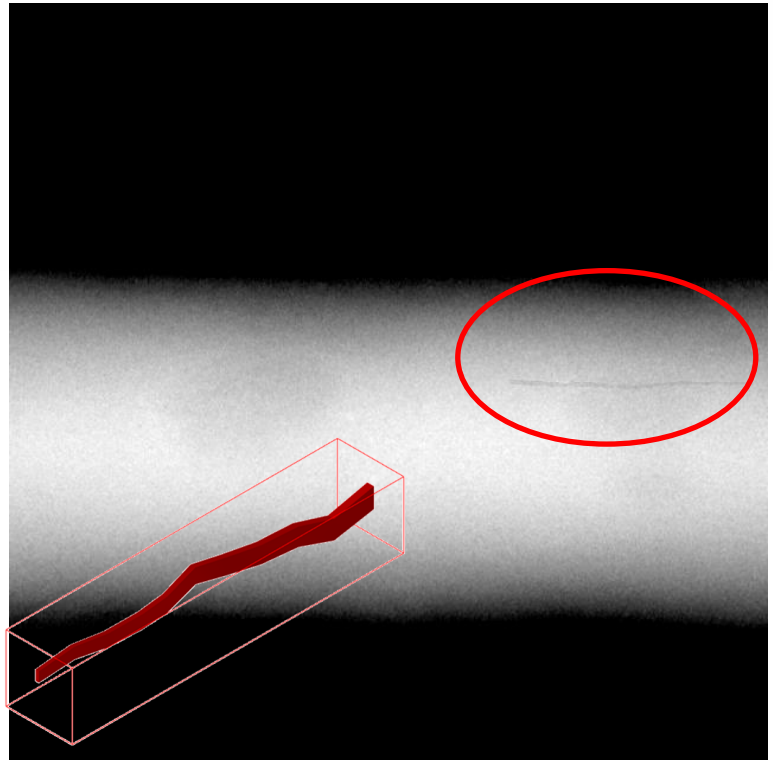
- Augmented imaging:
  - Specific merge to insert virtual defects into real images
    - Available for a « simple » RT simulation or using DS module (for machine learning, AI…)
  - For RT module, prepare a single CIVA configuration with defect and select an experimental image to import

Experimental image



Merged images





CIVA RT/CT

available in a coming 2025 SPX

New type of detector

- Photon counting detector (PCD): Spectral detector for processing the energy of incident photons improving the sampling of the X-ray spectrum in multiple energy bins: including a new 3D matrice data set with a profile in « Energy », Post processing sampling options to modify the energy thresolds (min/ max) to:
  - Cuts off scattered radiation,
  - Improve the contrast,
  - Use the energy discriminating capability of the PCDs for materials separation purposes,
  - Get better spectral images.

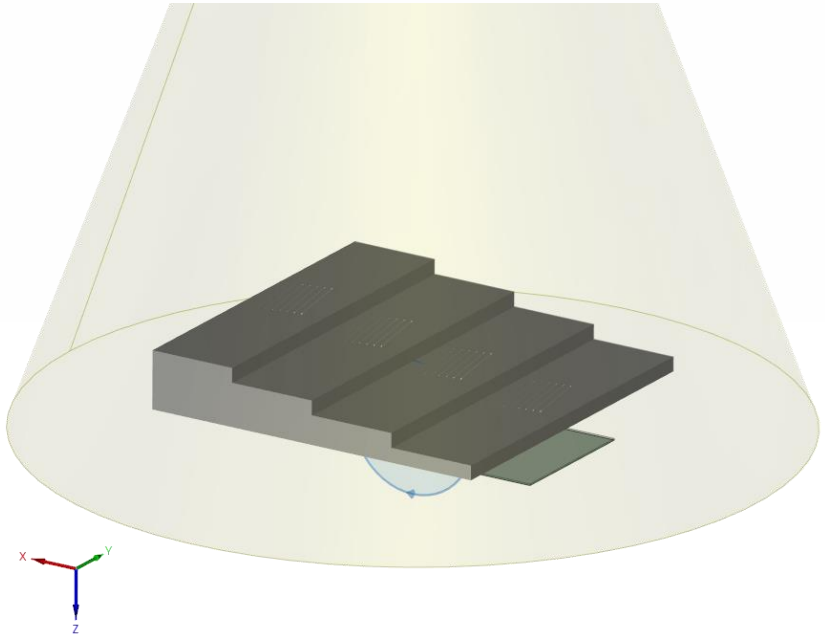
CIVA RT/CT

available in a coming 2025 SPX

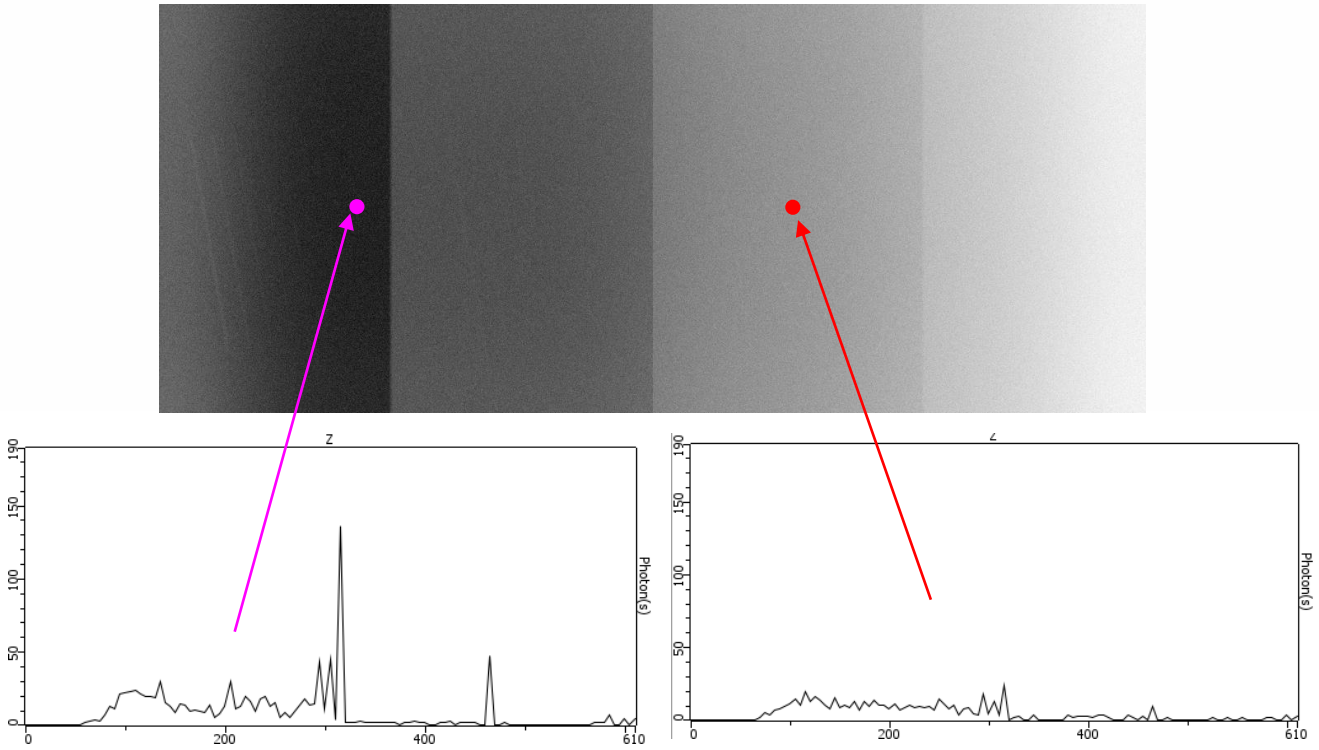
New type of detector: PCD

- Illustration: Cuts off scattered radiation

Stainless Steel step wedge (10 to 40mm thickness)
Ir^{192} source (E_{max} = 612 keV)
Photon counting detector (Al and C front filter)



New image: number of photons integrated for each pixel



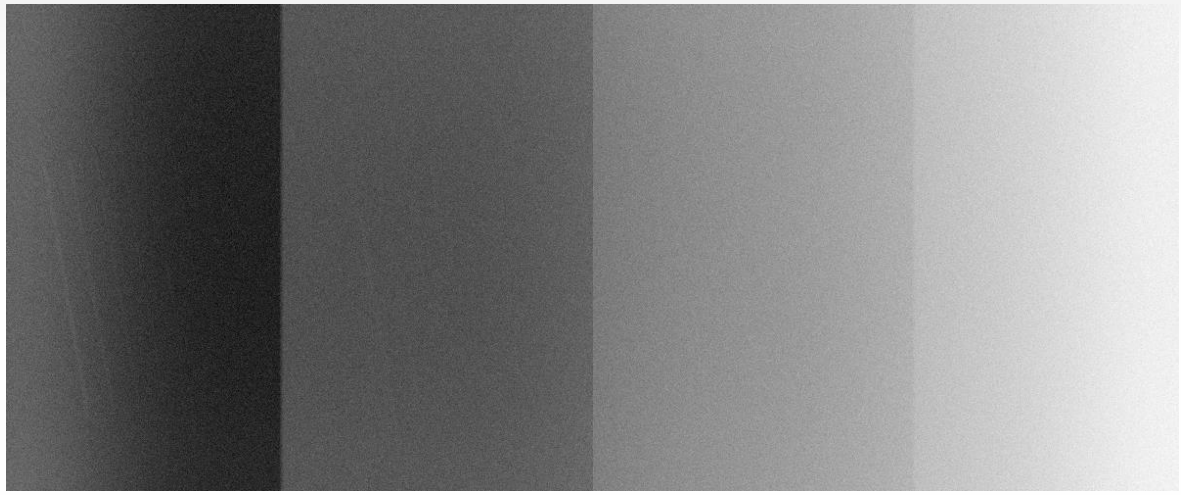
New profile line: number of photons integrated for each energy channel

CIVA RT/CT

available in a coming 2025 SPX

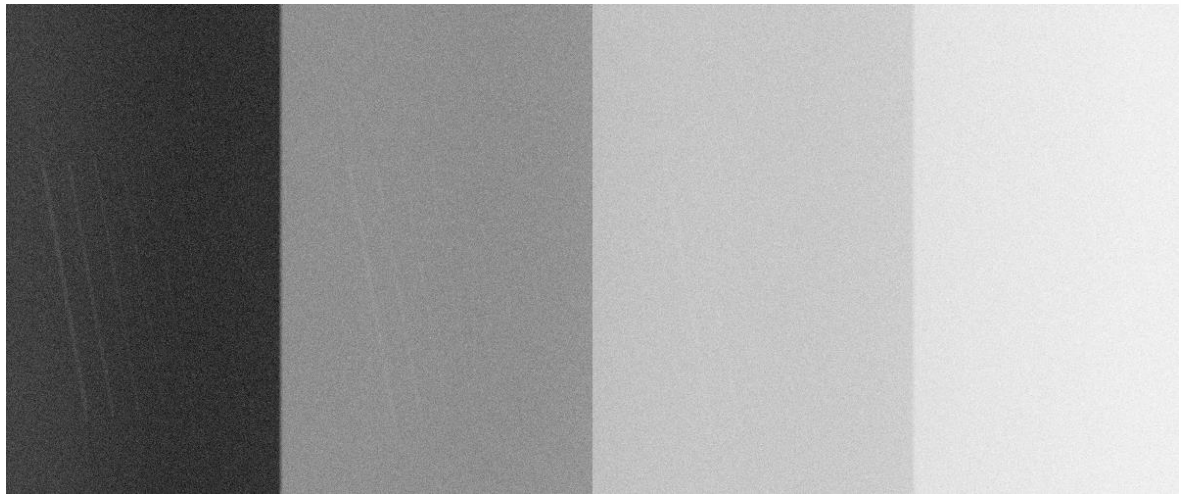
- New type of detector: PCD
  - Illustration: Cuts off scattered radiation

Number of photons integrated for each pixel for all energies



Number of photons integrated for each pixel for energies upper to 280 keV

Better discrimination of IQIs



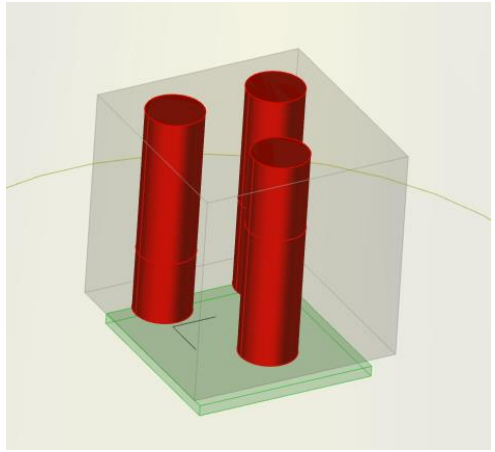
CIVA RT/CT

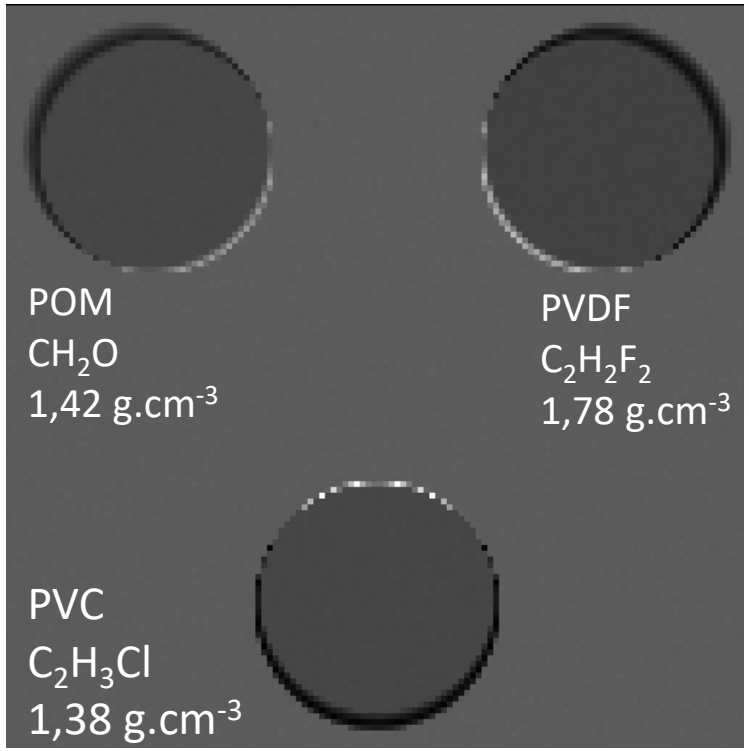
available in a coming 2025 SPX

New type of detector: PCD

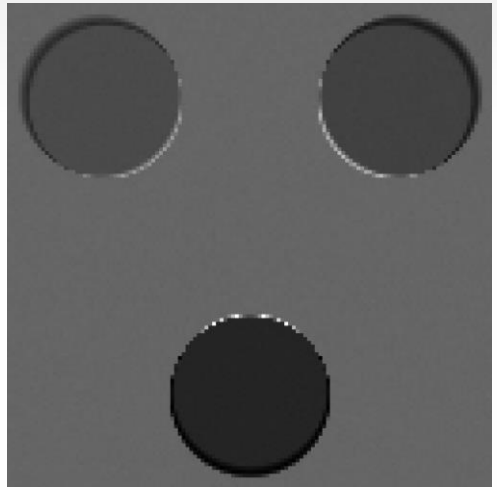
- Illustration: Material discrimination in spectral imaging

Cube with polymer inserts
X-ray source (E_{max} = 120 keV)
Photon counting detector (CdTe sensitive layer)

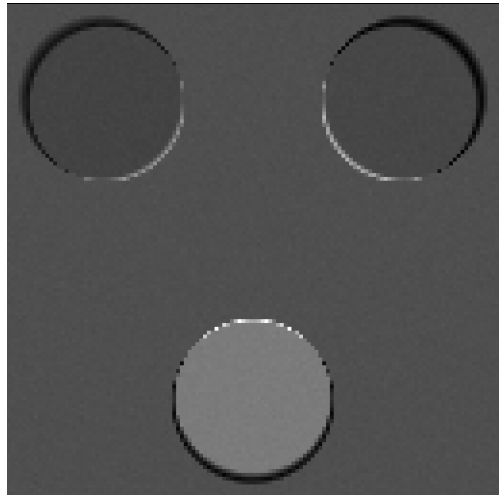




Number of photons integrated for each pixel for all energies



Number of photons integrated for each pixel for energies from 0 to 50 keV



Number of photons integrated for each pixel for from 50 to 120 keV

CIVA ET

What's new?

Main topic :

Wider scope of applications for Steam Generator Inspection

New Probe Response module

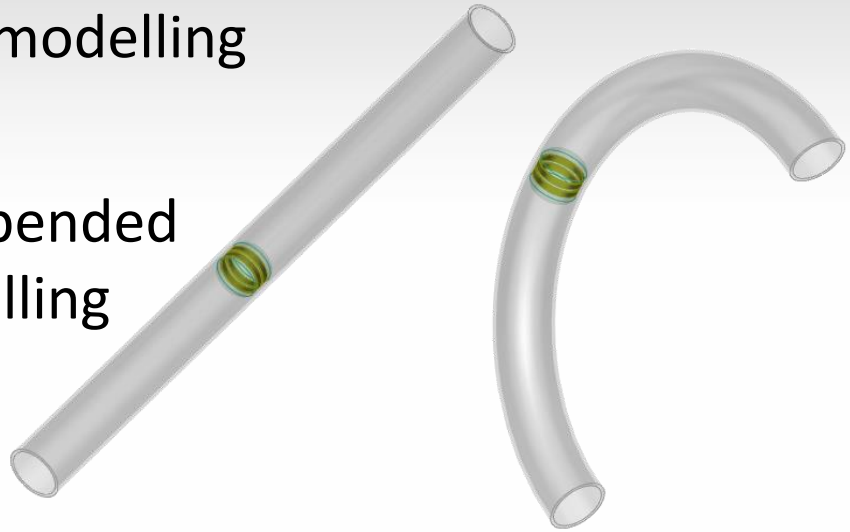
New 1D Plotting tool

New features for management of complex geometries in Inspection Simulation 3D

CIVA ET - SG Tube

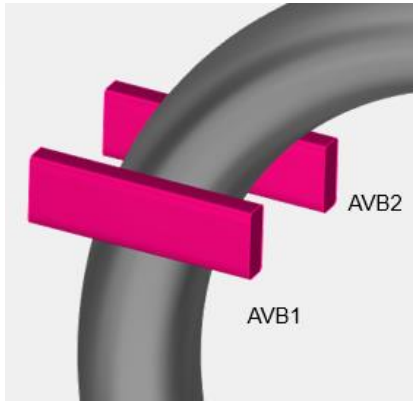
- Module fully based on a numerical method and dedicated to Steam Generator Tube inspection modelling

- Straight & bended parts modelling



- Expanded zone

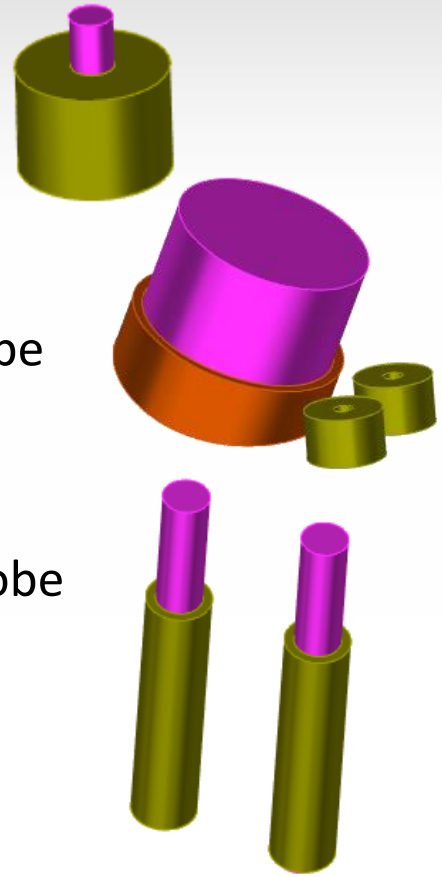
- With additional objects
  - Foiled plate
  - AVB
  - Deposit



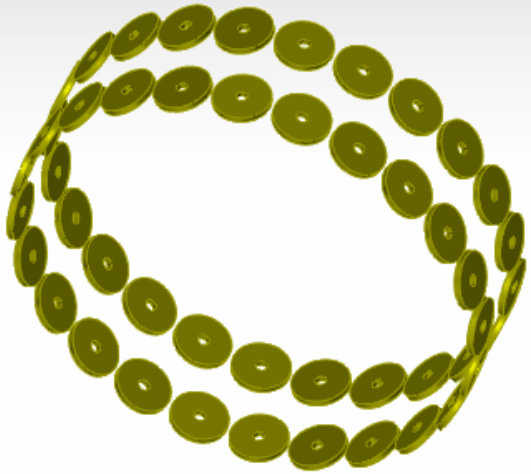
Only for axial probe in Civa 2023

CIVA ET - SG Tube

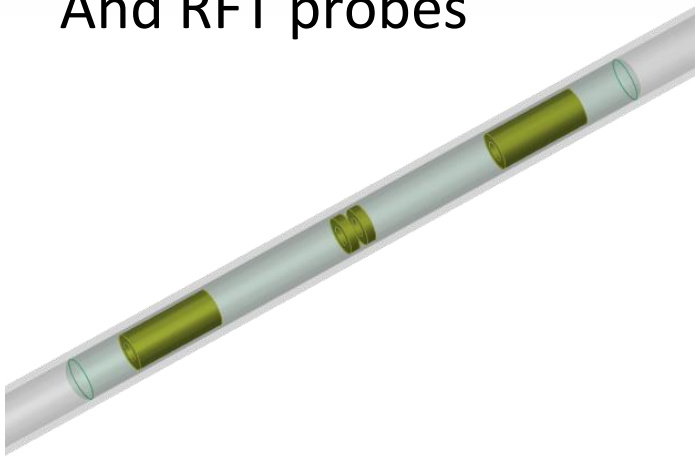
- Rotating probes are planned for Civa 2025
  - Simple rotating probe
  - Transversal rotating probe
  - Longitudinal rotating probe
  - +Point



- As well as array probes

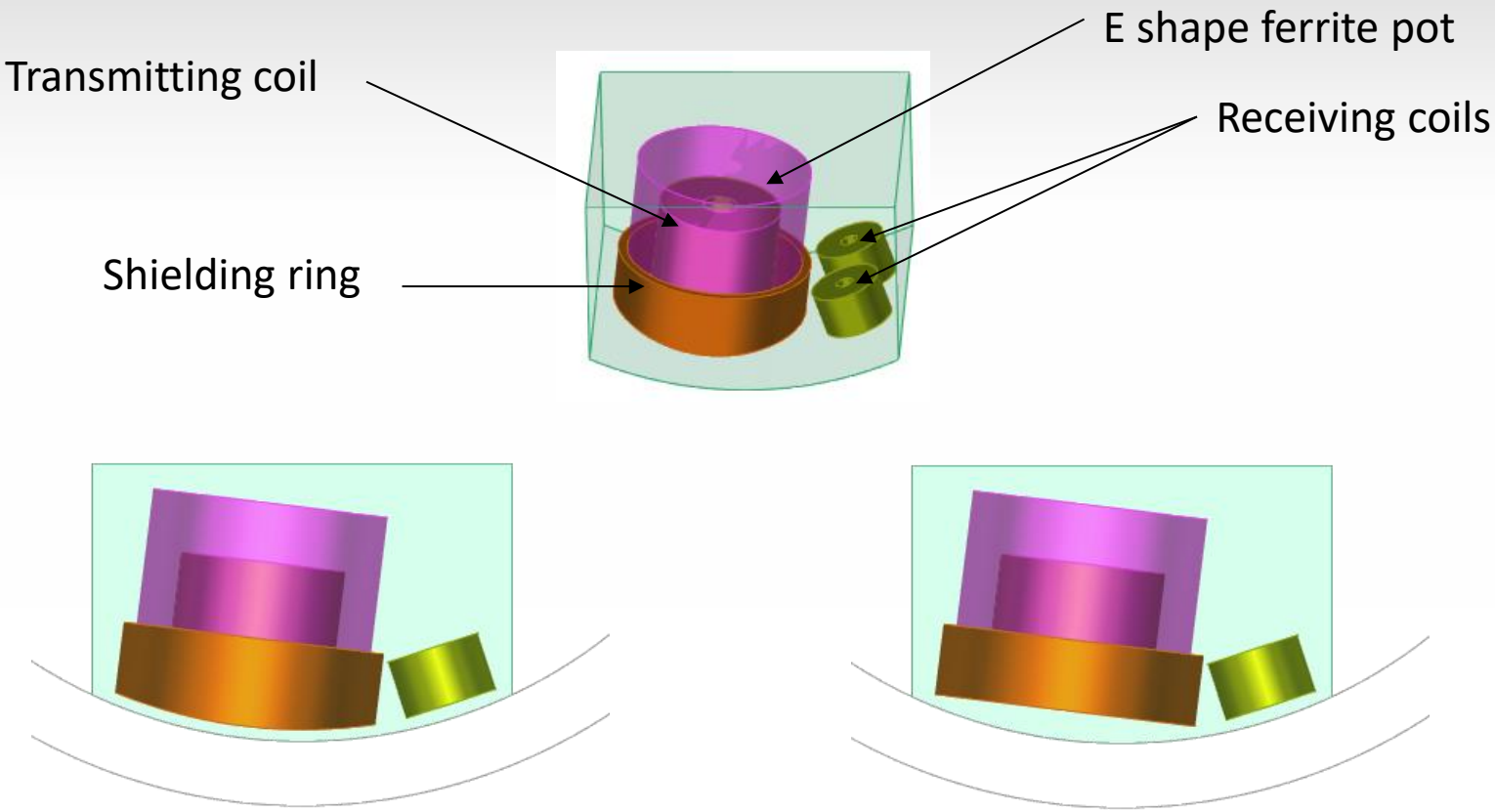


- And RFT probes



CIVA ET - SG Tube

- Transversal rotating probe



Differential and absolute channels

	Current	Recept
C1	+inj	
C2		+1
C3		-1

V1. Differential

	Current	Recept
C1	+inj	
C2		+1
C3		

V2. Transmit 1 – Receive 2

	Current	Recept
C1	+inj	
C2		
C3		+1

V3. Transmit 1 – Receive 3

	Current	Recept
C1	+inj	+1
C2		
C3		

V4. Absolute 1

	Current	Recept
C1		
C2	+inj	+1
C3		

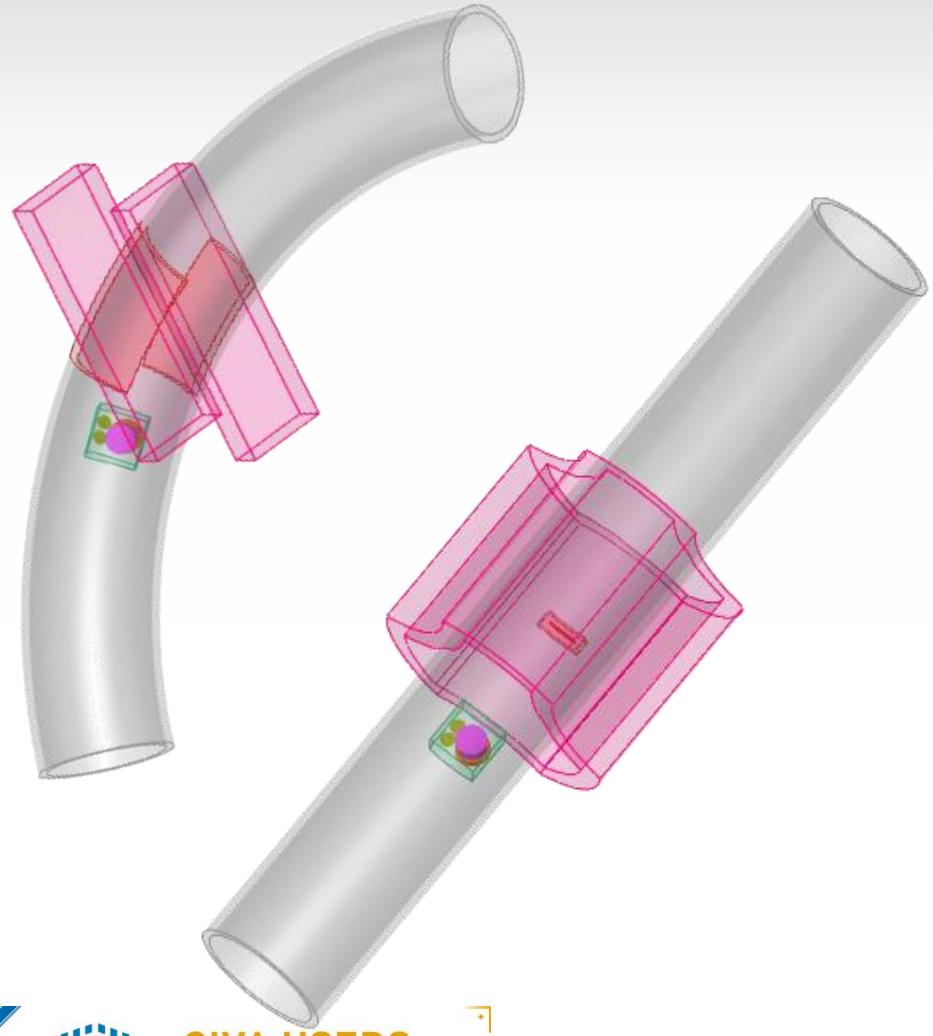
V5. Absolute 2

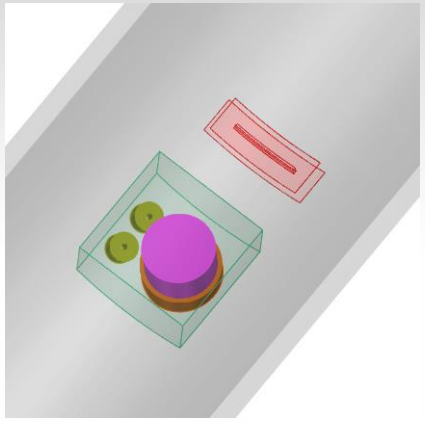
	Current	Recept
C1		
C2		
C3	+inj	+1

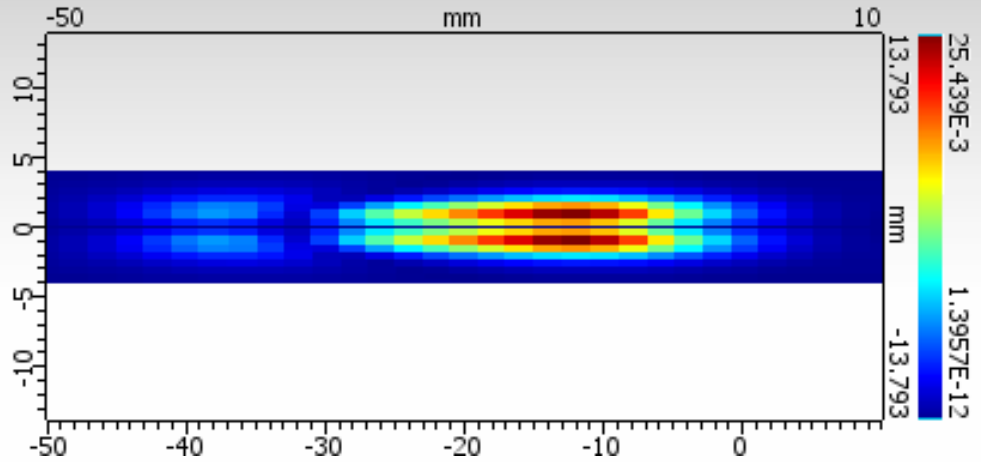
V6. Absolute 3

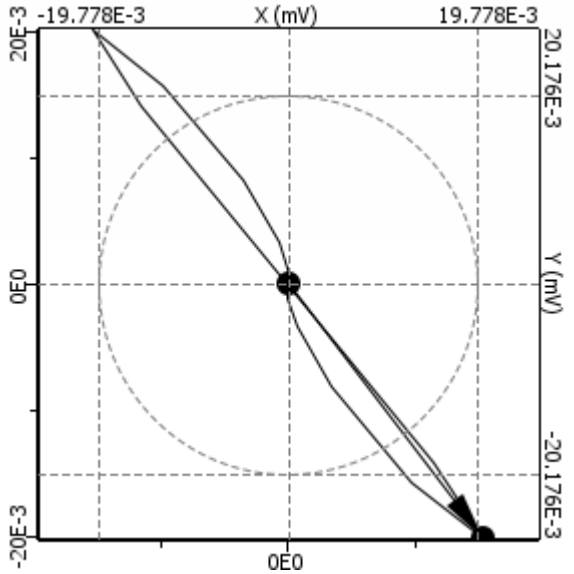
CIVA ET - SG Tube

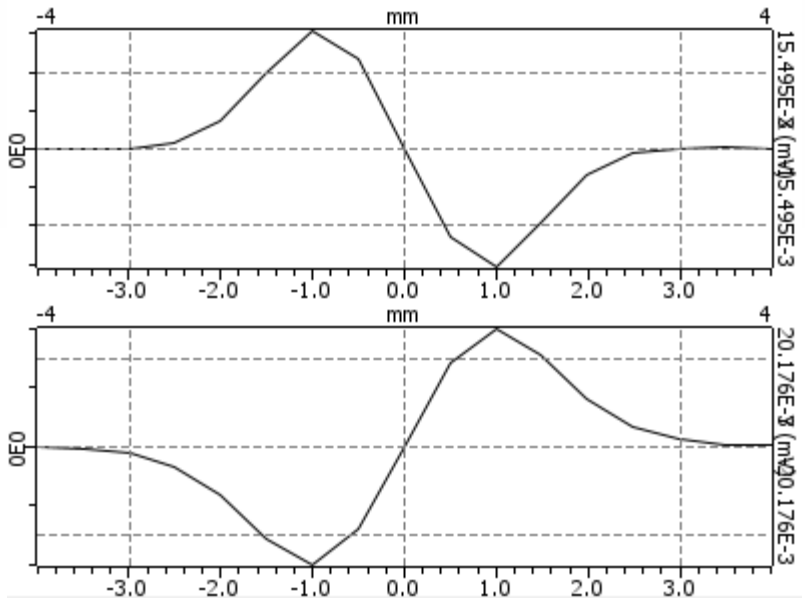
- Transversal rotating probe









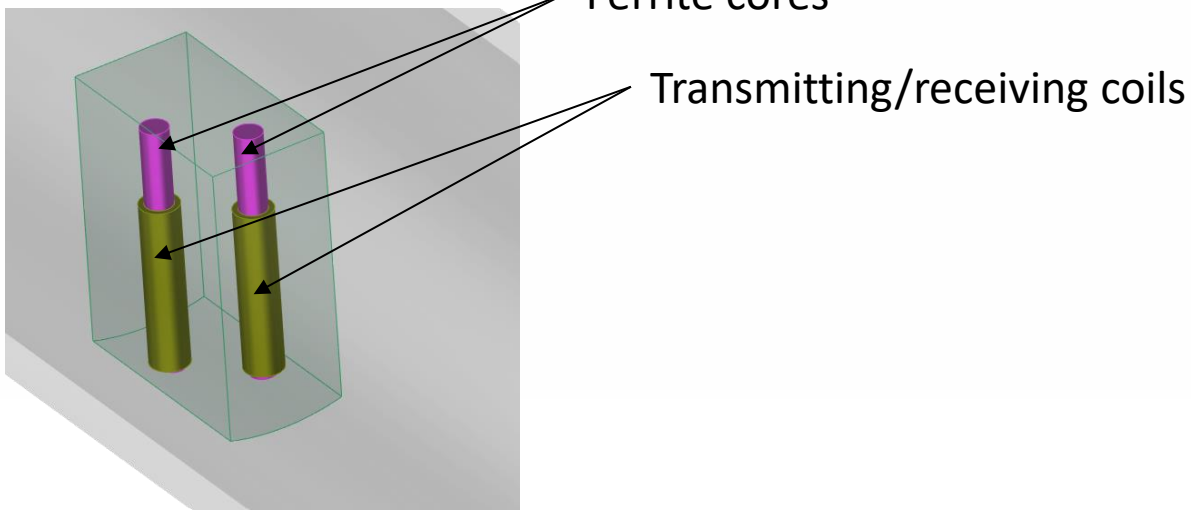


EXTENDE CIVA

CIVA USERS COMMUNITY EVENT

CIVA ET - SG Tube

- Longitudinal rotating probe



Absolute and differential channels

	Current	Recept
C1	+inj	+1
C2		

V1. Absolute 1

	Current	Recept
C1		
C2	+inj	+1

V2. Absolute 2

	Current	Recept
C1	+inj	+1
C2	+inj	

V3. Absolute 12

	Current	Recept
C1	+inj	
C2	+inj	+1

V4. Absolute 21

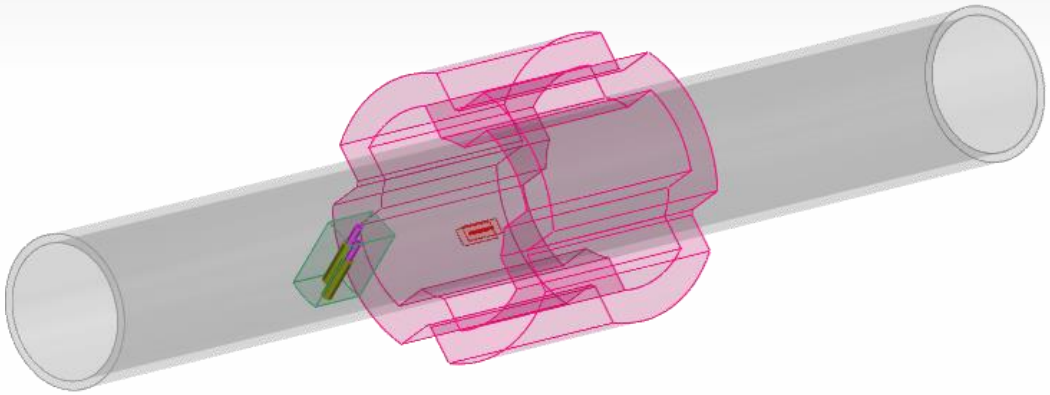
	Current	Recept
C1	+inj	+1
C2	+inj	-1

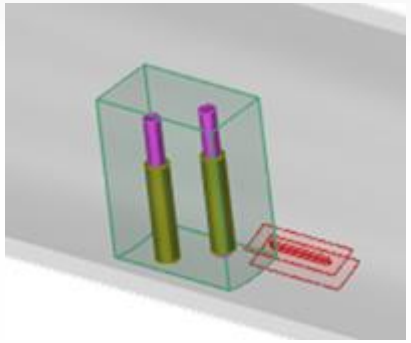
V5. Differential

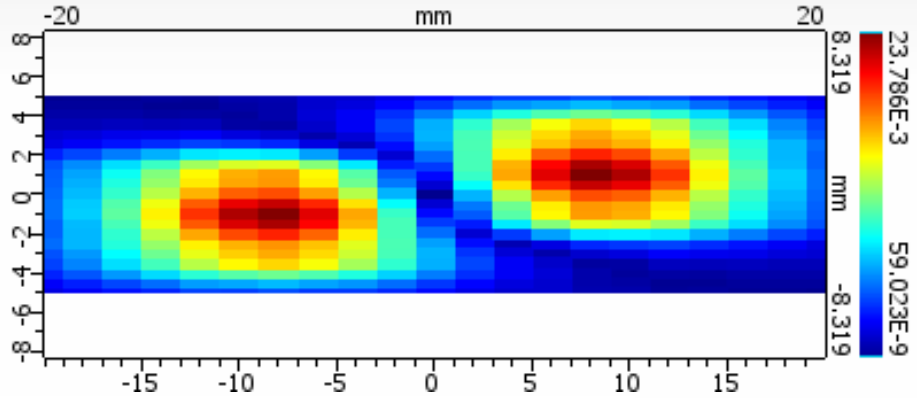
CIVA ET - SG Tube

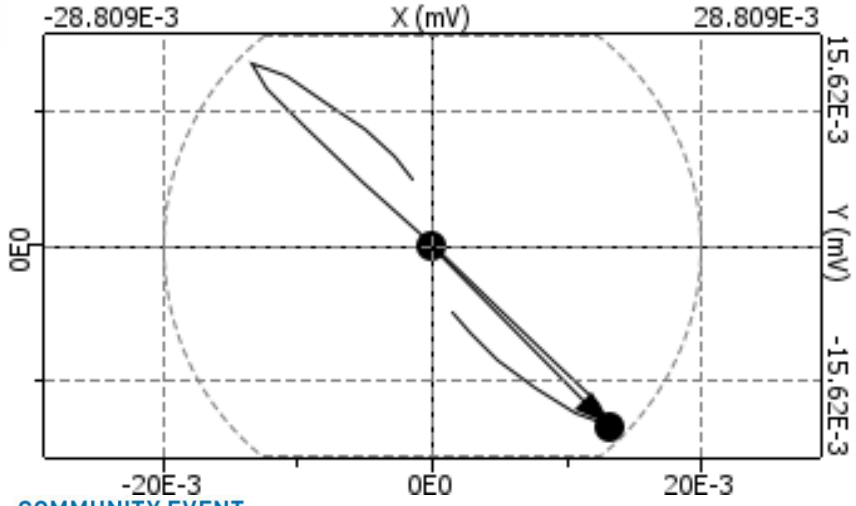
- Longitudinal rotating probe

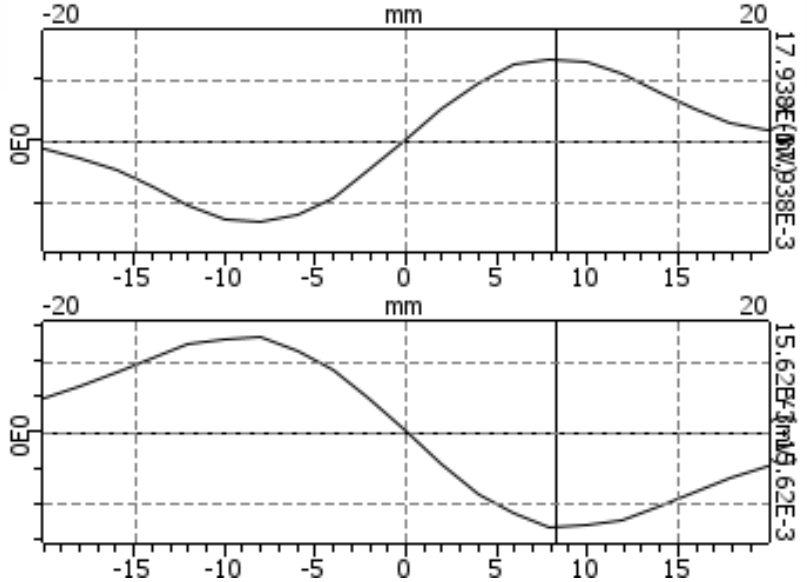
Differential channel





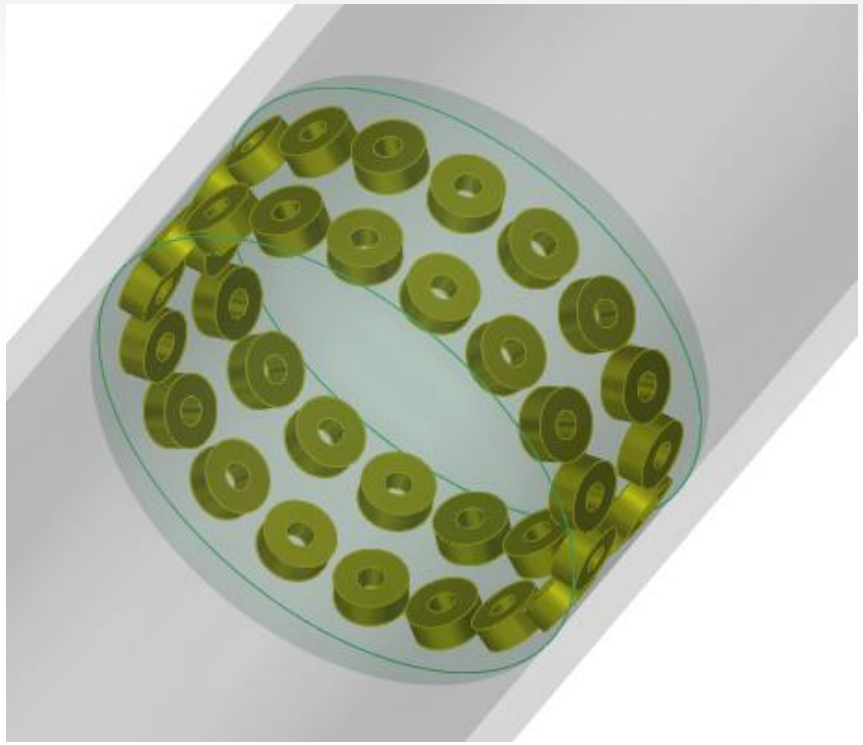




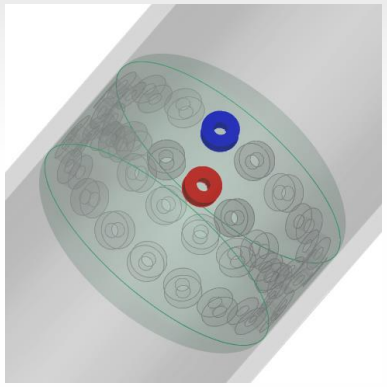


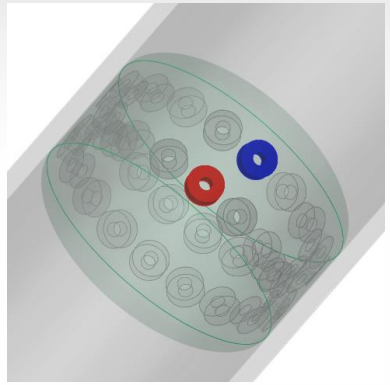
CIVA ET - SG Tube

- Array probe

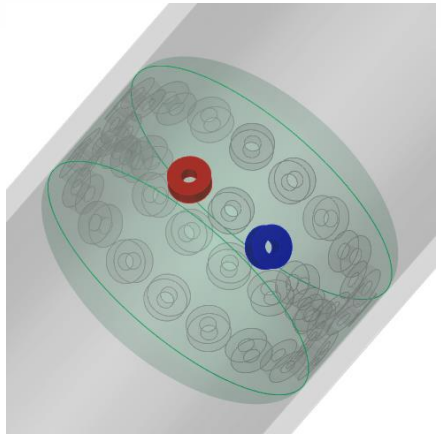


Axial channels





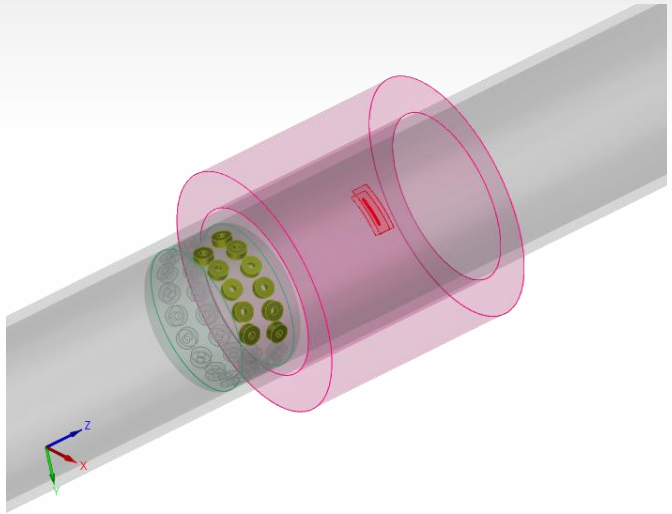
Circumferential channel

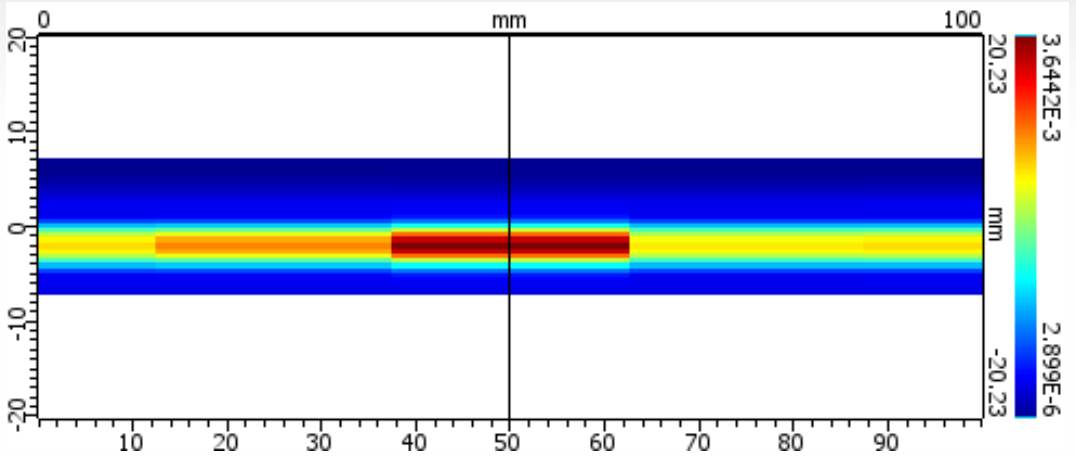


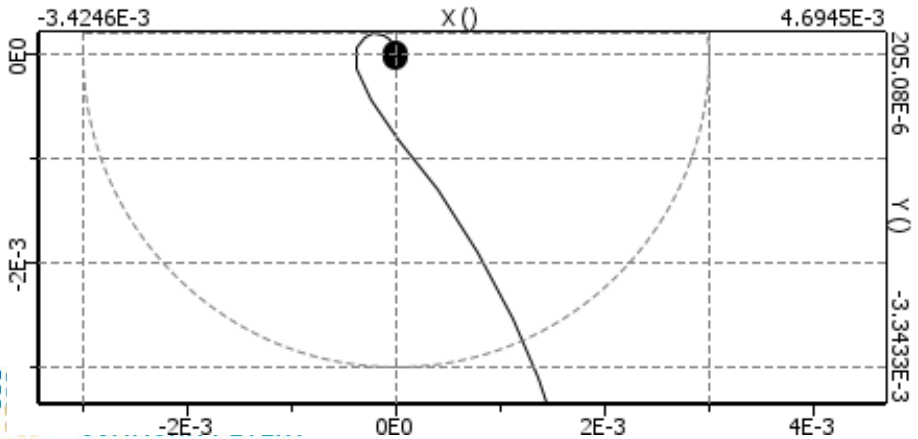
CIVA ET - SG Tube

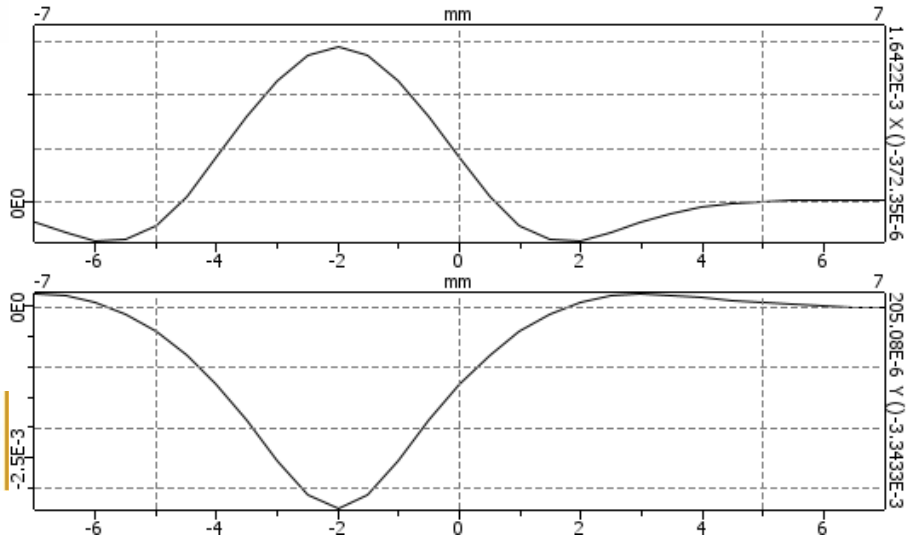
- Array probe

Circumferential channel



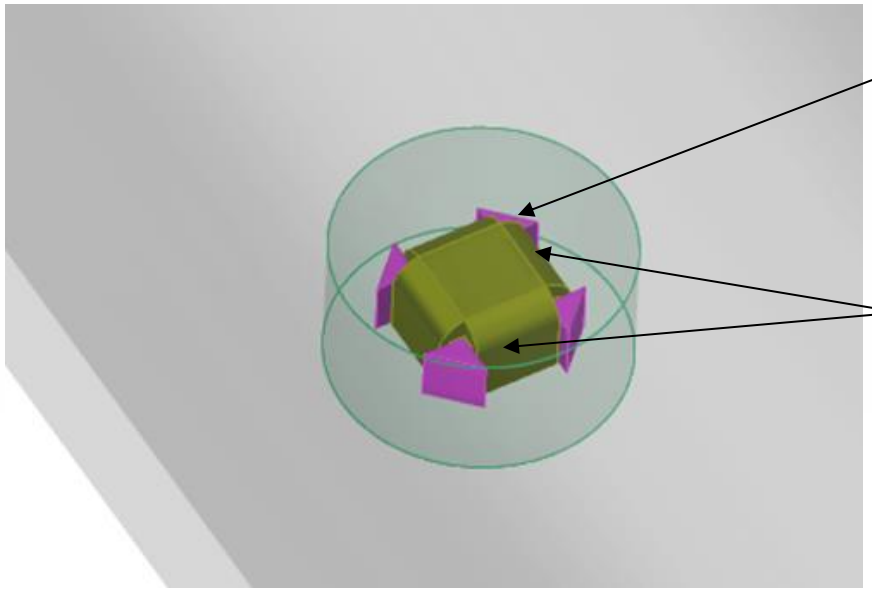






CIVA ET - SG Tube

- +Point probe



Absolute and differential channels

	Current	Recept
C1	+inj	+1
C2		

V1. Absolute 1

	Current	Recept
C1		
C2	+inj	+1

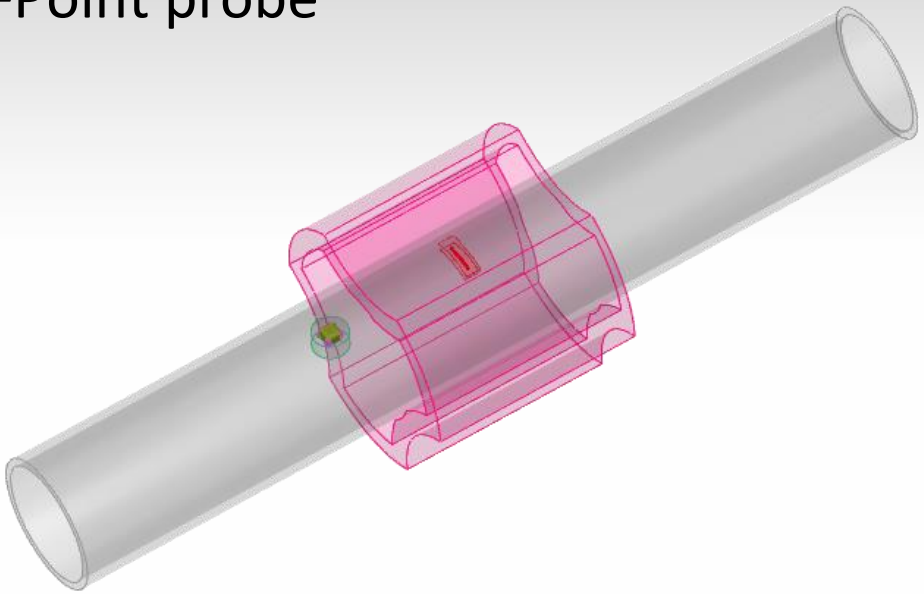
V2. Absolute 2

	Current	Recept
C1	+inj	+1
C2	+inj	-1

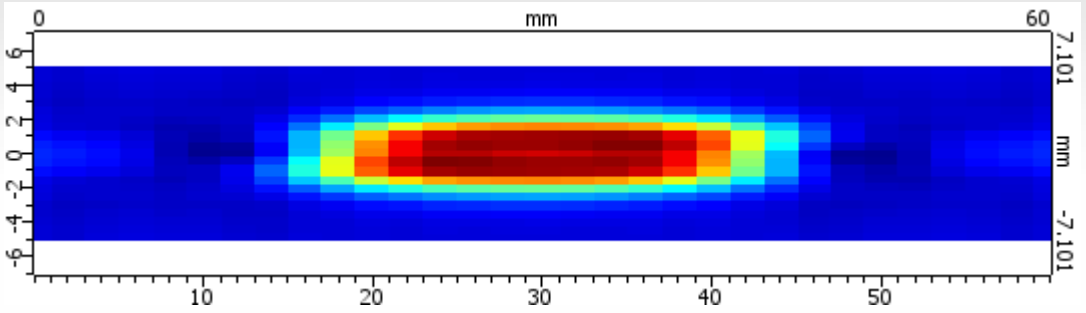
V3. Differential

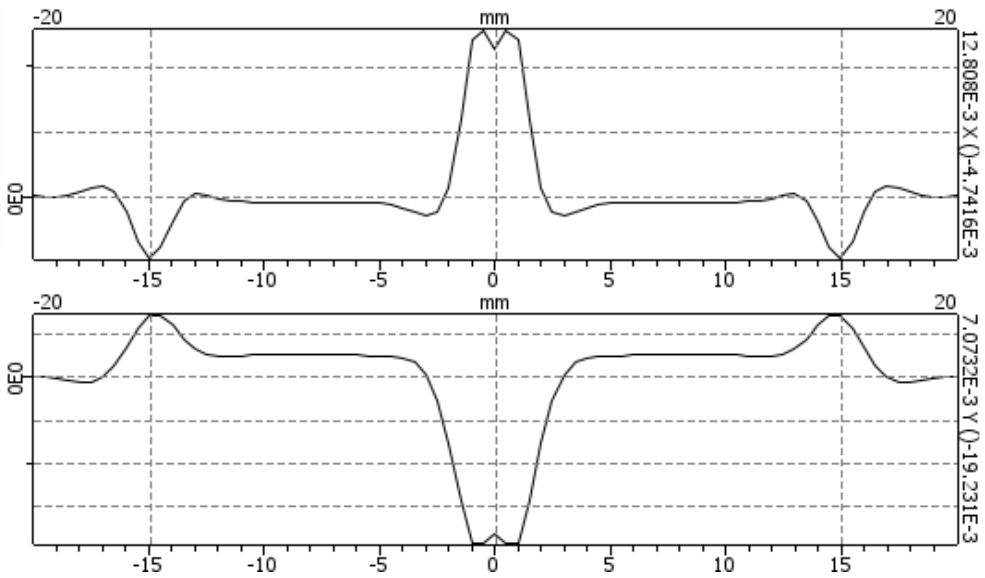
CIVA ET - SG Tube

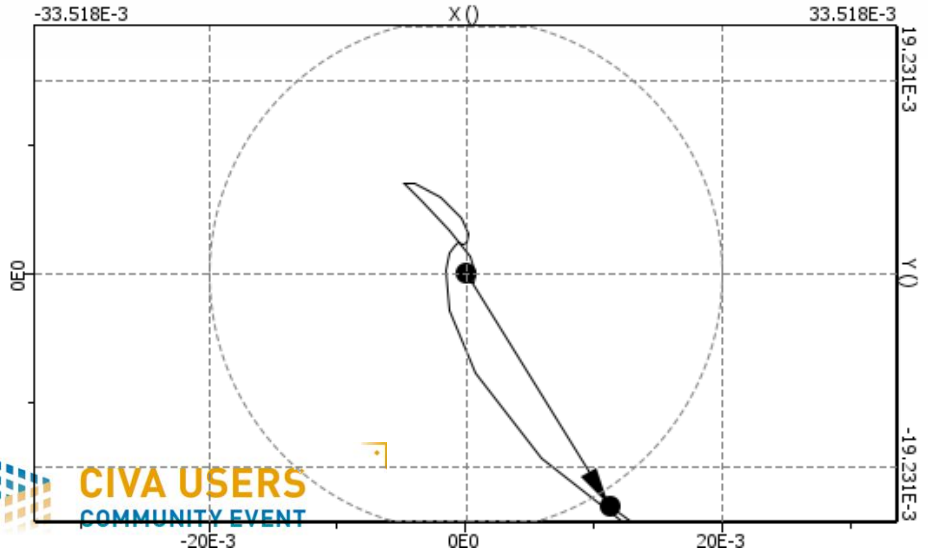
- +Point probe



Differential channel

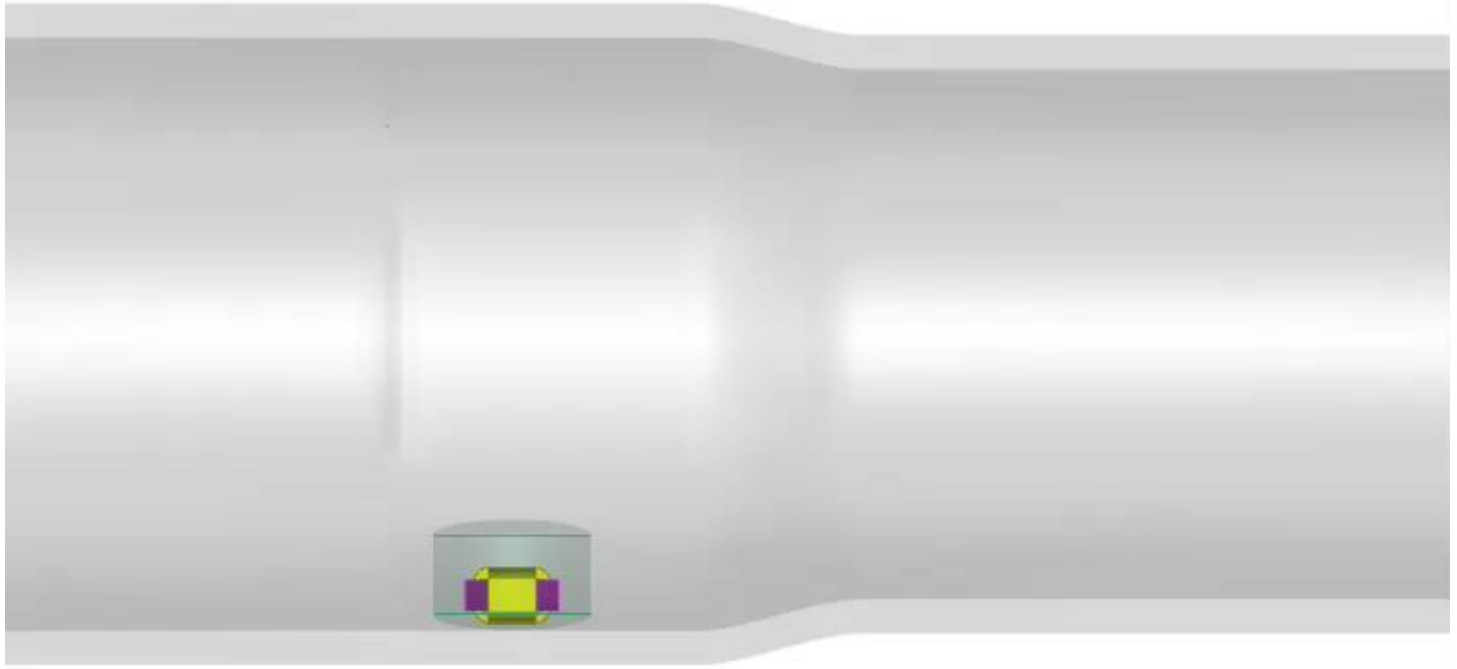






CIVA ET - SG Tube

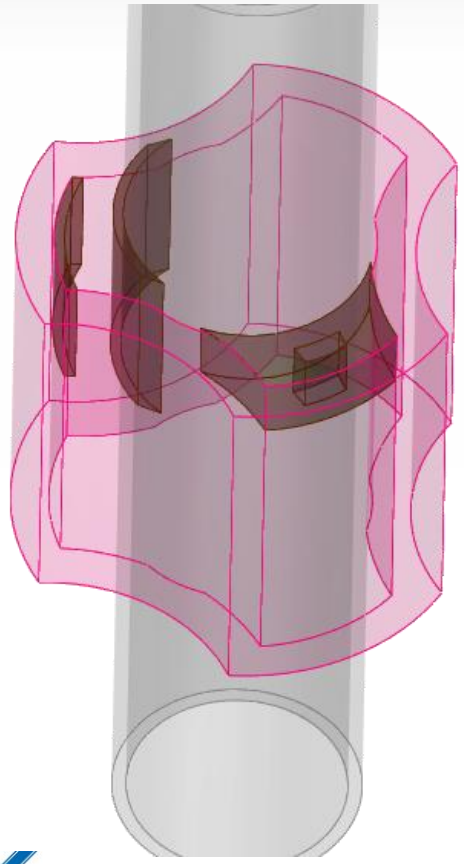
- Rotating probe trajectory
  - Probe pressed against the tube inner wall
  - Landing algorithm that account for the probe tilting



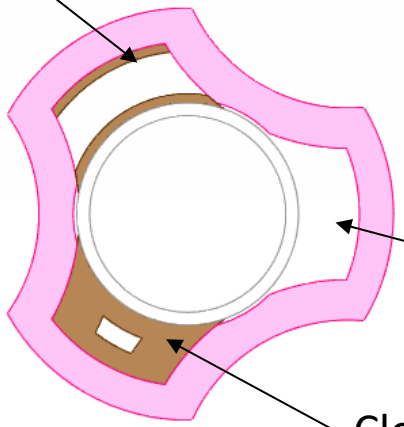
CIVA ET - SG Tube

Clogging

- Specific clogging for each foliage



Clogging shape 1

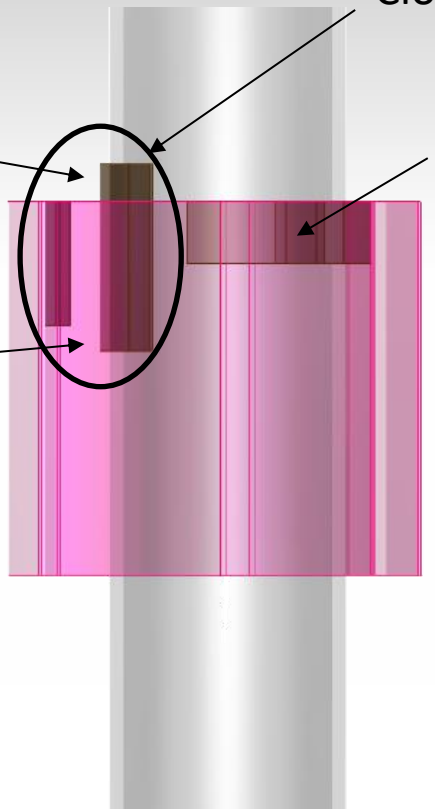


Without clogging

Clogging shape 2

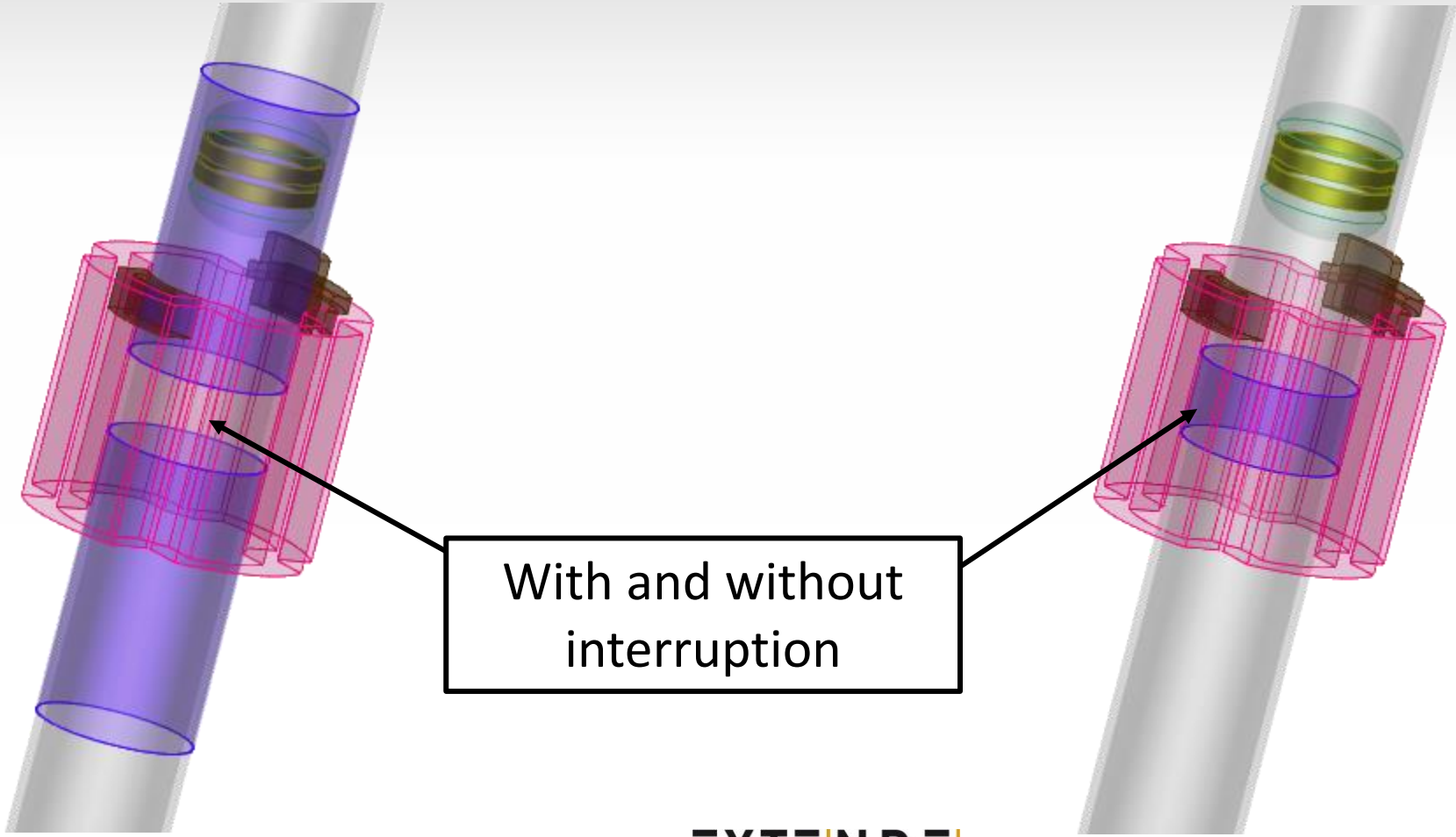
Offset on the tube side is possible

Additional height on the tube side



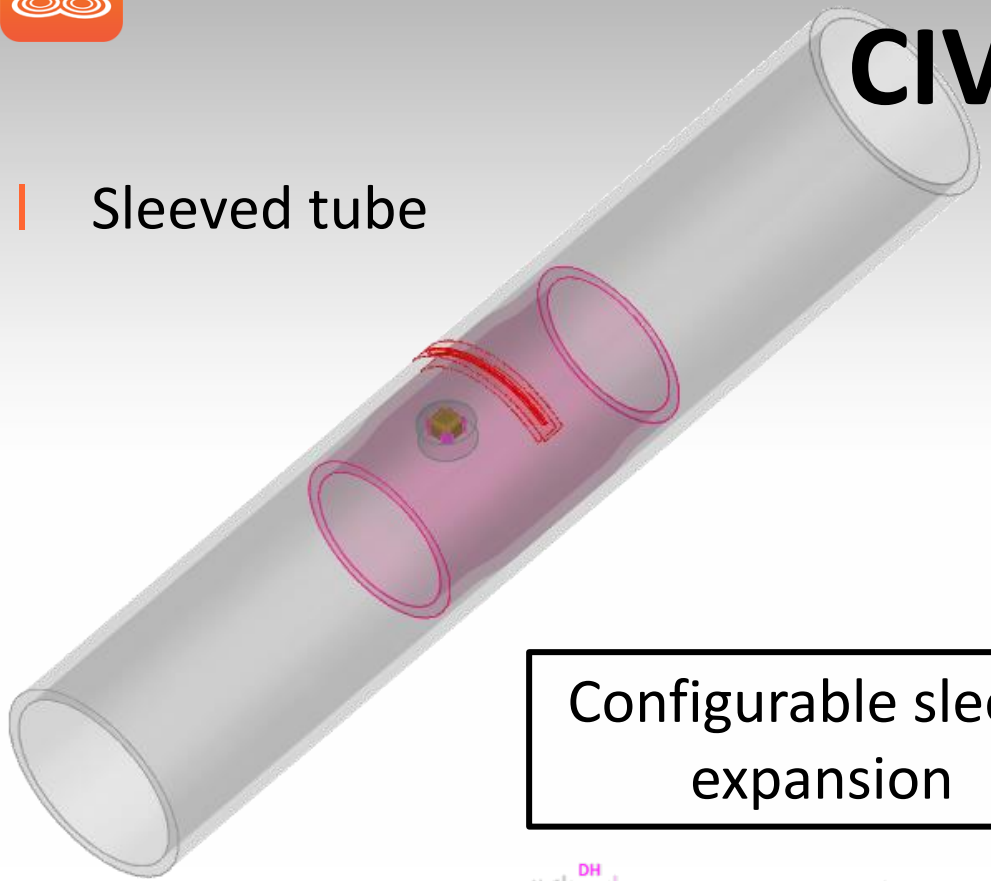
CIVA ET - SG Tube

- Local deposit on tube straight part

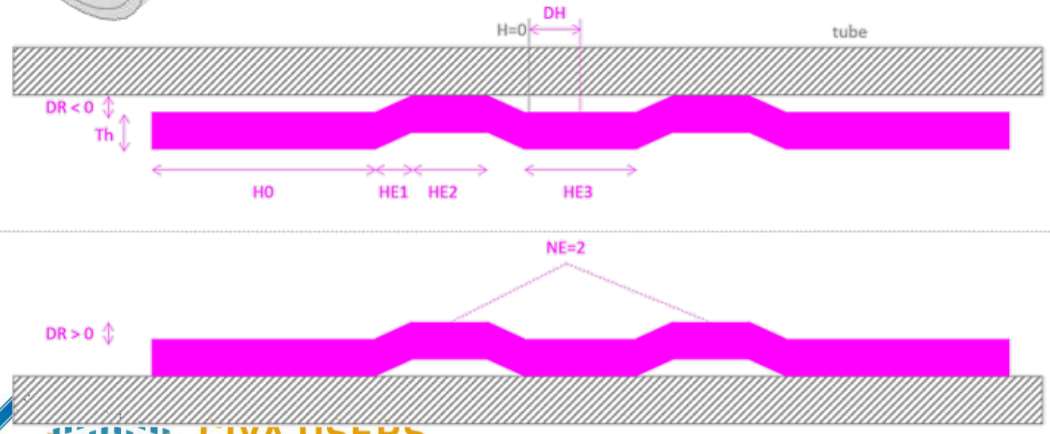


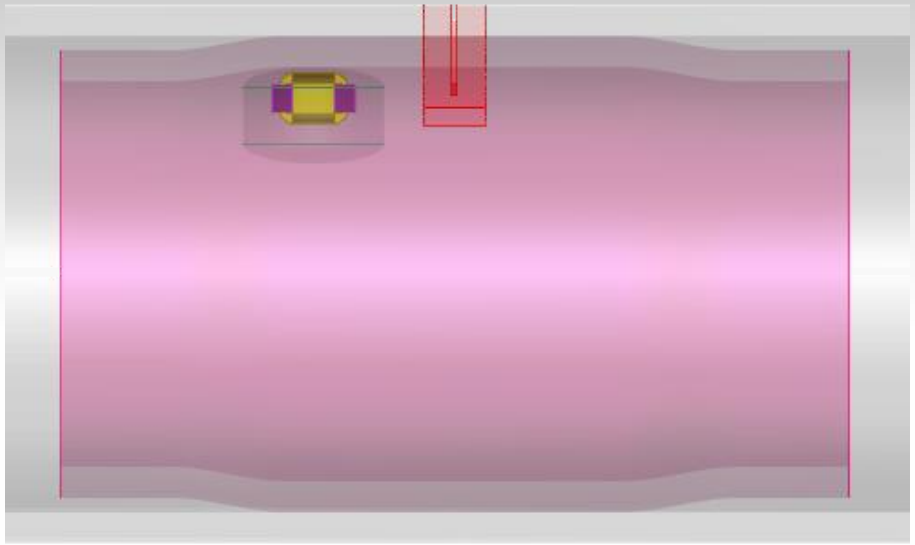
CIVA ET - SG Tube

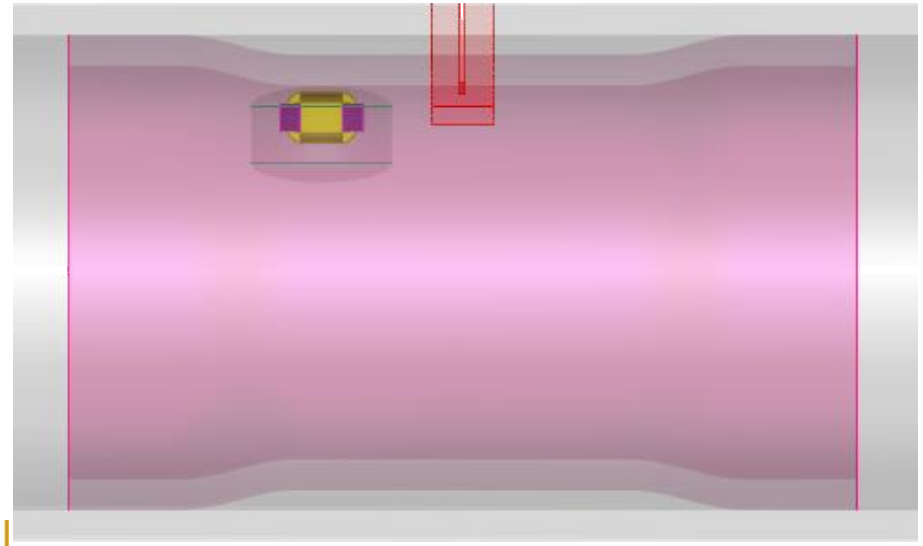
- Sleeved tube



Configurable sleeve expansion







CIVA ET

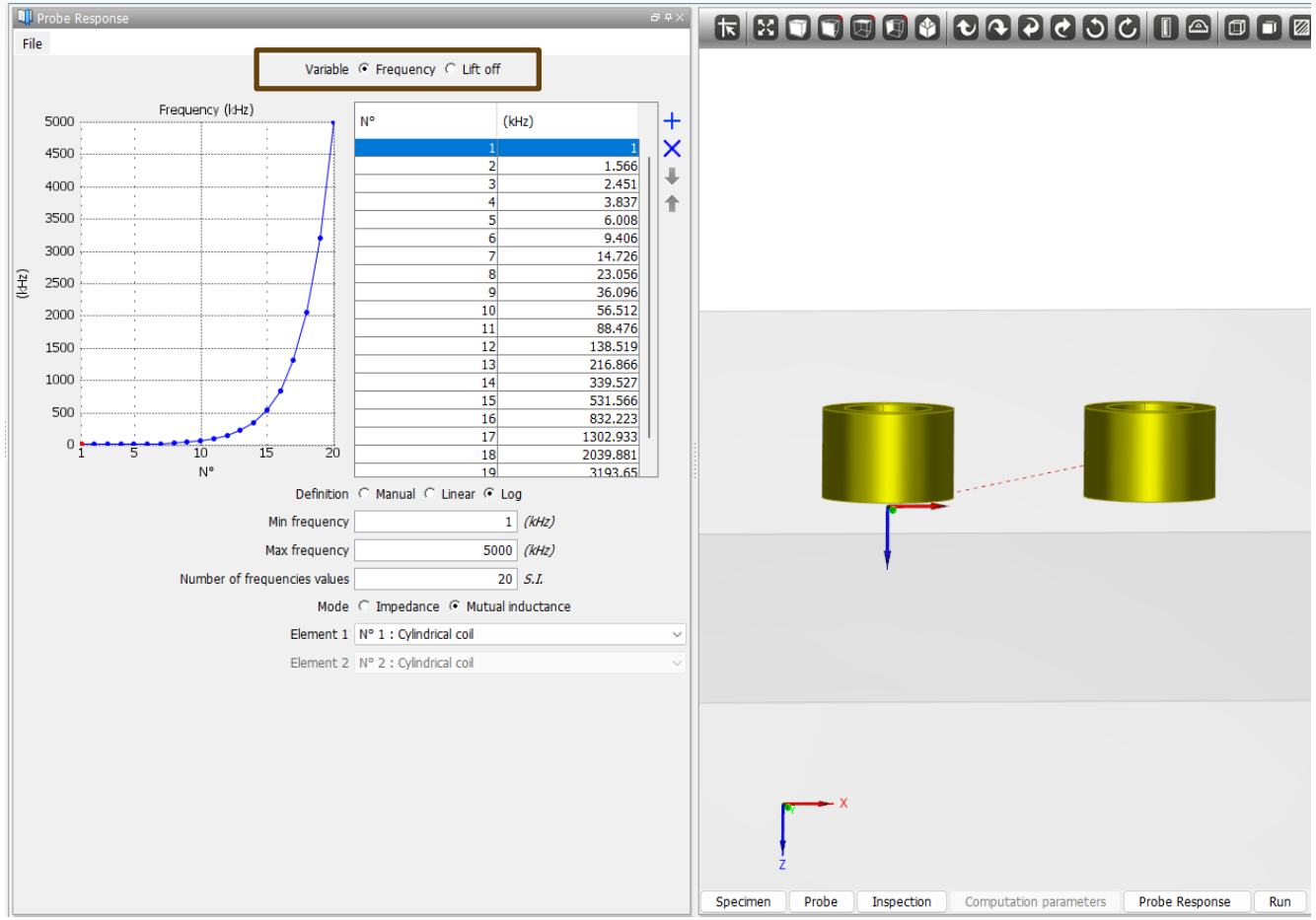
Probe Response is now a real « module » in CIVA ET

- It gives the possibility to compute **Impedance diagrams of** Eddy Current probes versus frequency and **lift-off signals**
- Was formerly a part of « Field Computation » …but no possibiity to save your results, no possibility to run batch computations 😖
- Now available as a real module, a tile that you can access from the CIVA Desk !

CIVA ET

Probe Response is now a real « module » in CIVA ET:

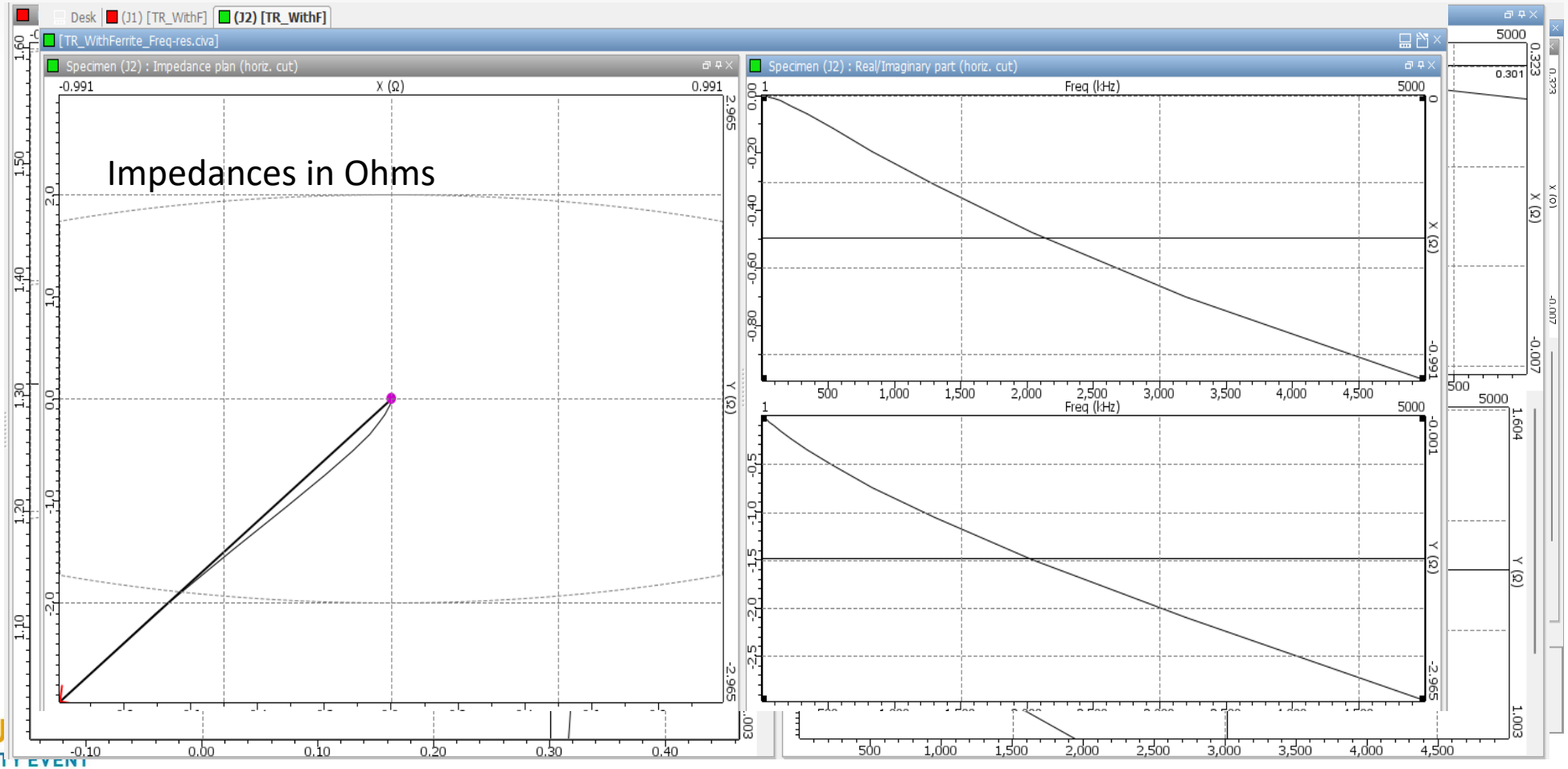
- Input parameters are specimen and probe data then :
- Probe Response panel **: Frequency** or **lift-off** diagrams will be selected with a variation range



CIVA ET

Probe Response is now a real « module » in CIVA ET:

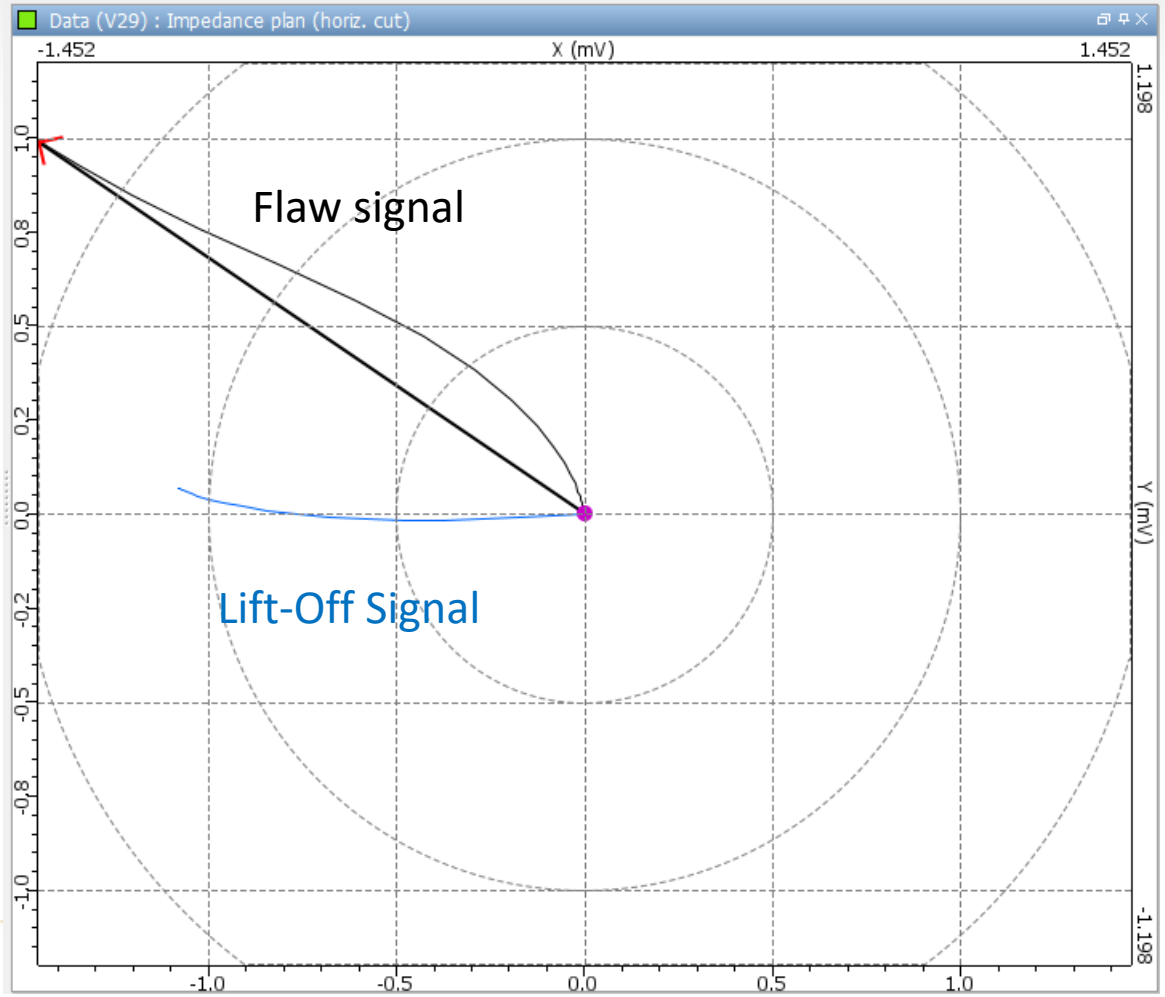
- Results can be saved
- A « real » analysis environment is now available with 2 Impedance datasets : Normalized values or in Ohms (same for lift-off signal)



CIVA ET

Probe Response is now a real « module » in CIVA ET:

- Lift-off Signal and Flaw signal can now be superimposed on the same graph



CIVA ET

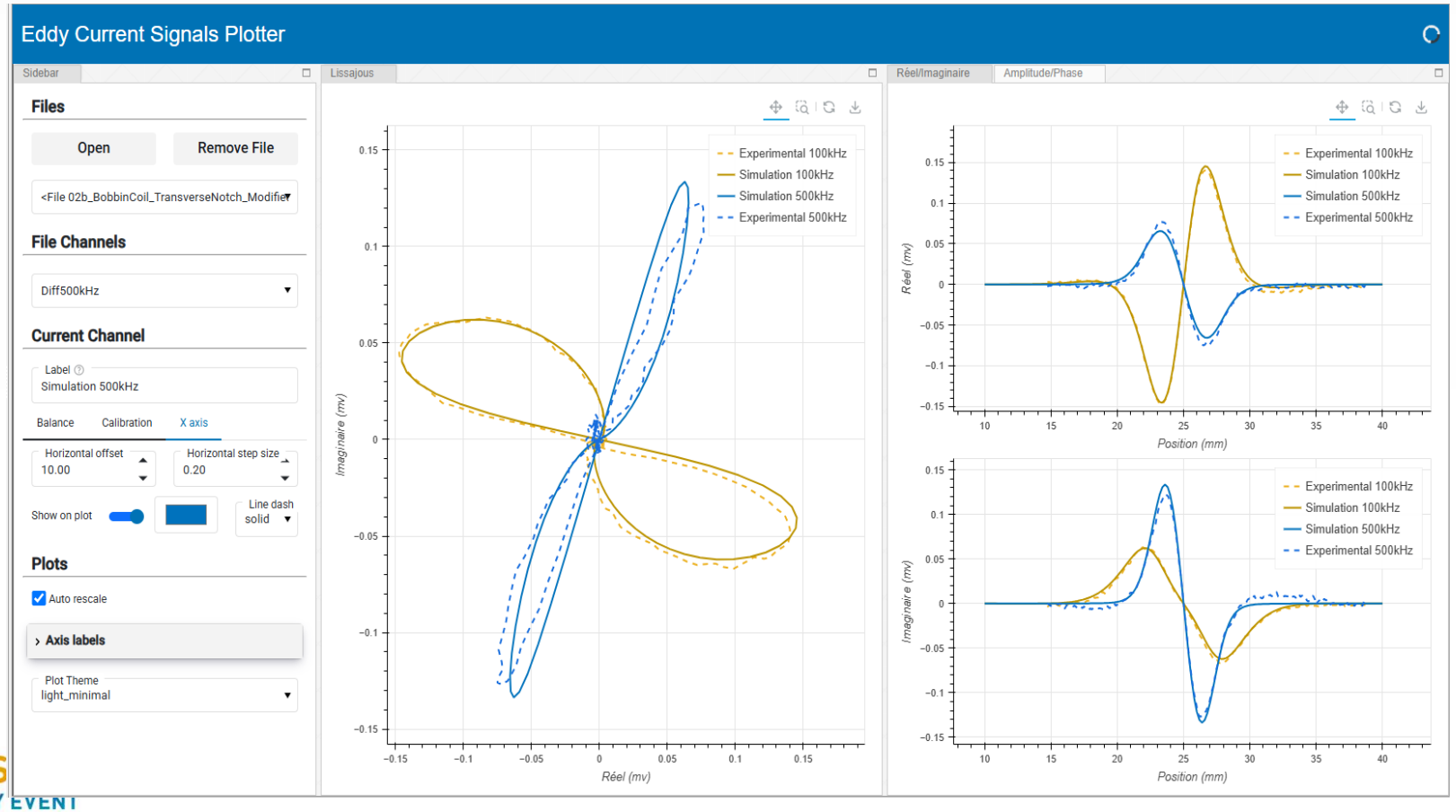
A new « 1D Plotting » tool is available :

- A new « WebApp » to analyse eddy current signals curves

CIVA ET

A new « 1D Plotting » tool is available :

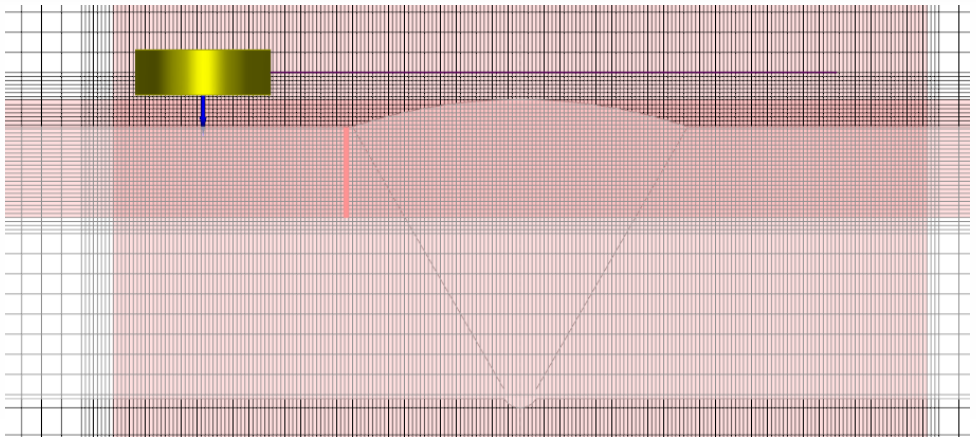
- Easier to superimpose different channels,
- Easier to superimpose flaw signals and complete signals
- Easier zoom, navigation, scale modifications, offsets, etc.

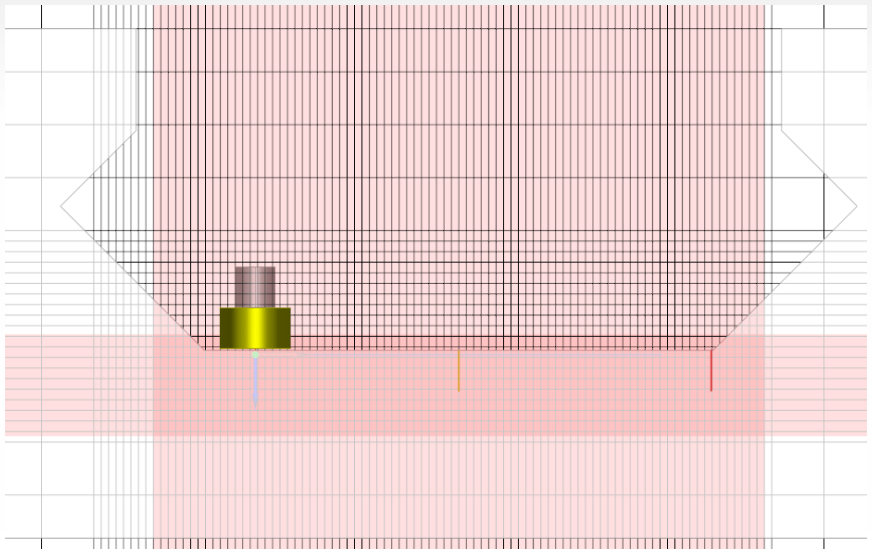


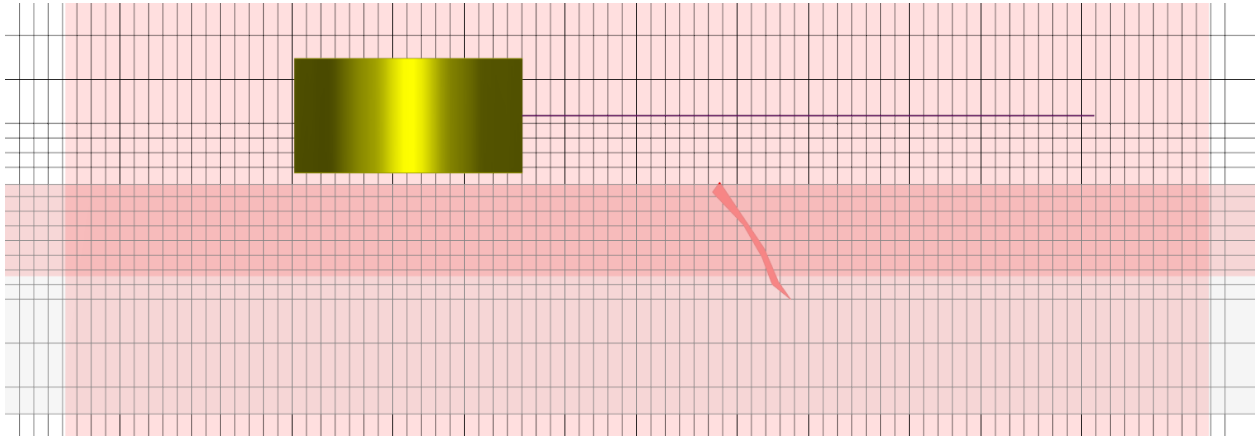
CIVA ET

Complex and 2D CAD geometries : Mesh display

- Since CIVA 2023, Inspection Simulation 3D module can handle 2D CAD and some complex parametric geometries (invariant along Y axis)
- Enables Finite Integration Technique requiring a mesh of the model section
- CIVA 2025 integrates the mesh visualization for easier checkings and adjustments



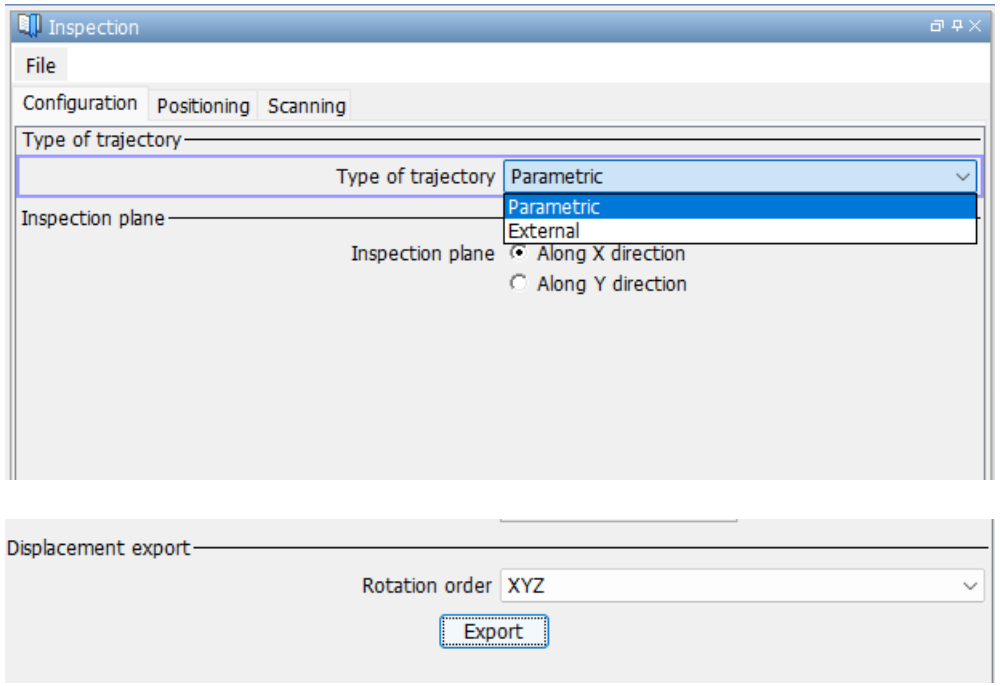


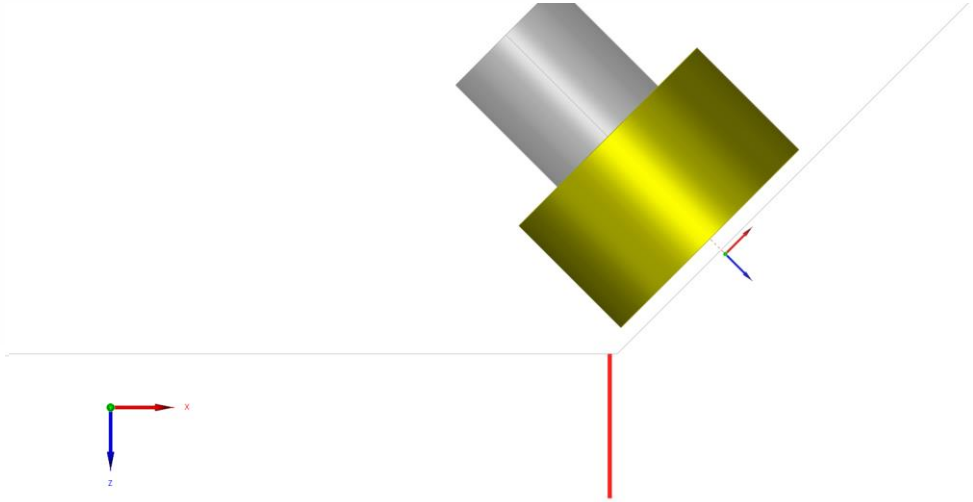


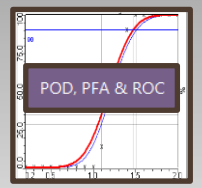
CIVA ET

Complex and 2D CAD geometries : External trajectories

- Instead of parametric « Raster scanning » trajectoris, an external scanning patterne can be loaded
- An ASCII files (*.trj) describes probe position and orientation
- To help getting the file format, you can first create a classical trajectory then use the “export” menu in the **scanning** tab



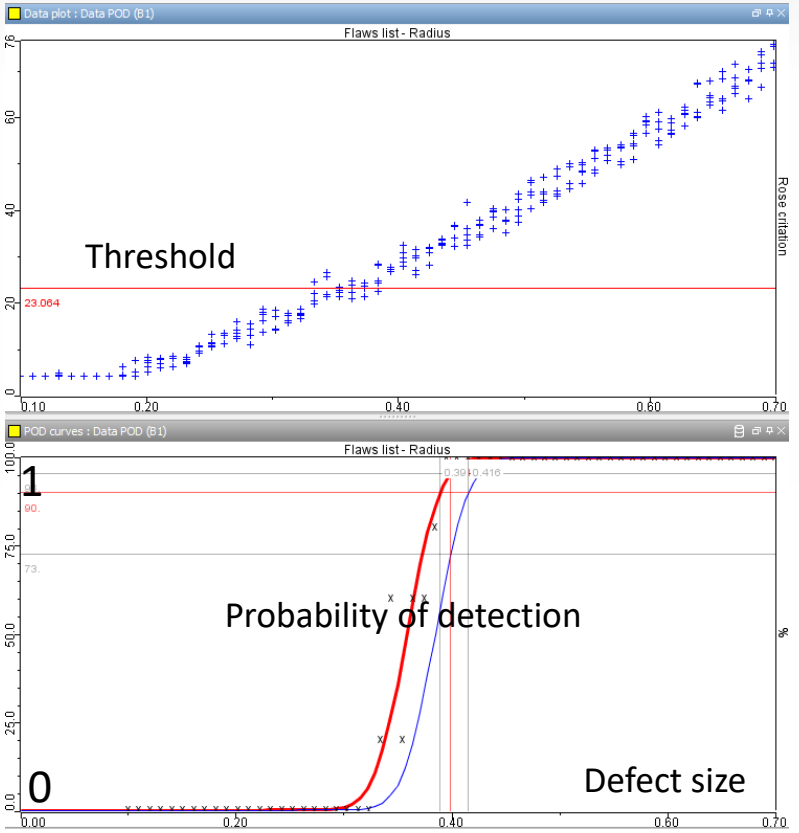


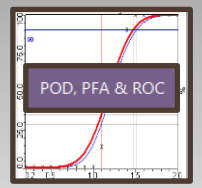


CIVA – POD Analysis

CIVA offers a POD Analysis environment

- POD = Probability Of Detection
- POD curves relate the detectability of a flaw to its **size,** or another geometrical parameter linked to its criticality
- POD curves capture the impact of NDE variability (uncertain parameters) on the ability for a NDT process to cross the detection threshold
- Needs quite large data set, well suited for a modelling approach: Model Assisted POD (MAPOD)

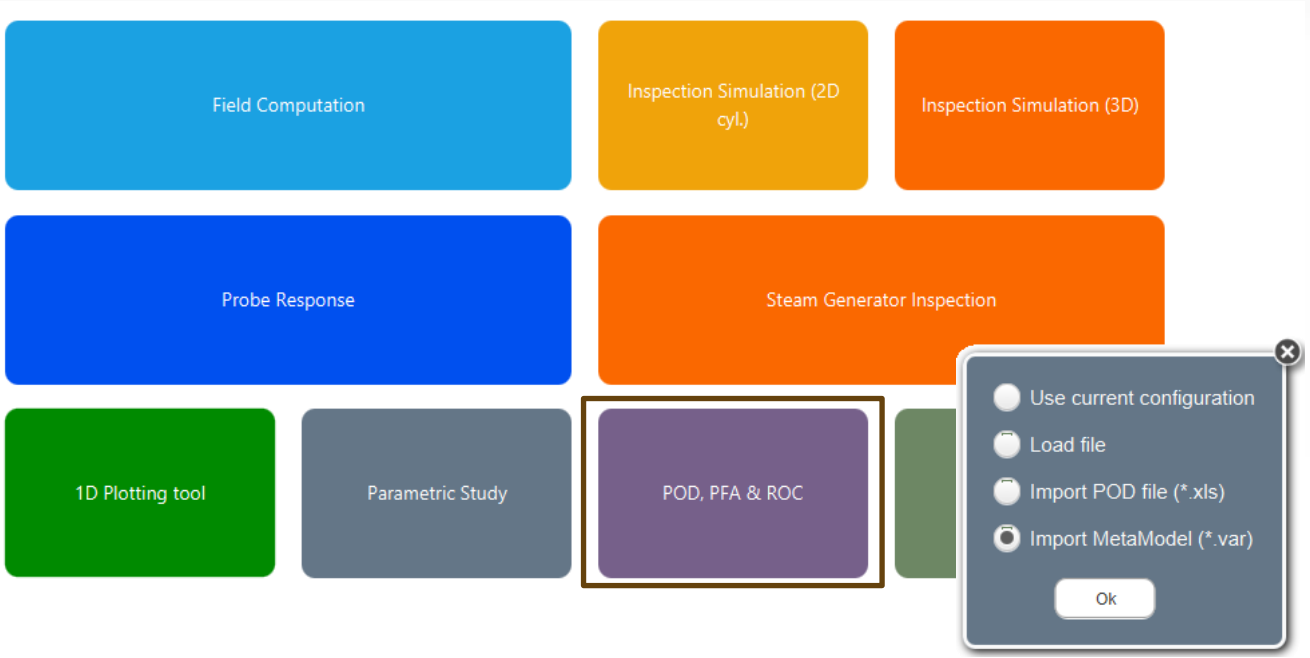




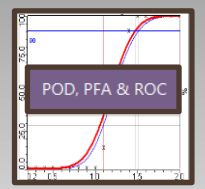
CIVA – POD Analysis

New ergonomy for POD Analysis with new tools and new models:

- Available from the desk of any CIVA modules
- Available for different types of data :



- **CIVA** POD study based on a **single data set**
- Import of **CIVA metamodel** *.Var file: POD analysis can be **resampled on demand and in real time**
- Import of « any » data (i.e. **experimental**) from an Excel spreadsheet (Signal Response or Hit/Miss data)



CIVA – POD Analysis

New statistical « models » available for POD curves:

- Until CIVA 2023, the following models are included:

Standard parametric models

Signal Response
(*Military Handbook 1823*)

Hit-Miss
(*Military Handbook 1823*)

Link Functions:
Logit Probit

Link Functions:
Loglog ClogLog

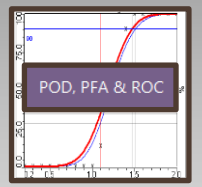
Floor Ceiling model
Signal Response or Hit Miss

Hit-Miss
NordTest TR394
(*DNV Standards*)

Non-Parametric model

Based on Kernel regression
(valid for large datasets for each flaw size)

- CIVA 2025 brings new statistical models:
  - **Floor-Ceiling** model: More accurate when data are such that POD does not start at 0% and does not finish à 100%
  - Another Hit-Miss model based on **NordTest TR 394** technical (reference for DNV standards)
  - New Link functions for Hit-Miss model



CIVA – POD Analysis

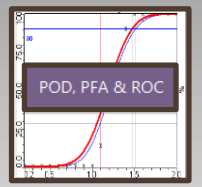
Better ergonomy of the POD page:

Easy creation of a new POD page from the file manager

All tables and graphs can be displayed/removed from the scan explorer

POD parameters definition then « Apply »
→ No need to create a « New page »

Access to the different statistical models

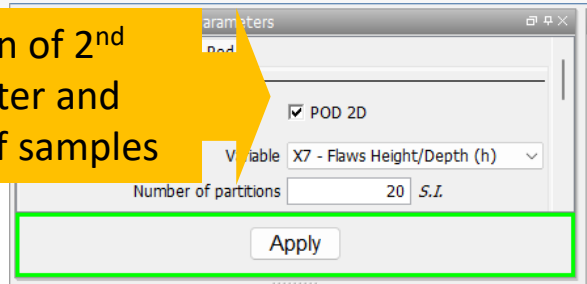


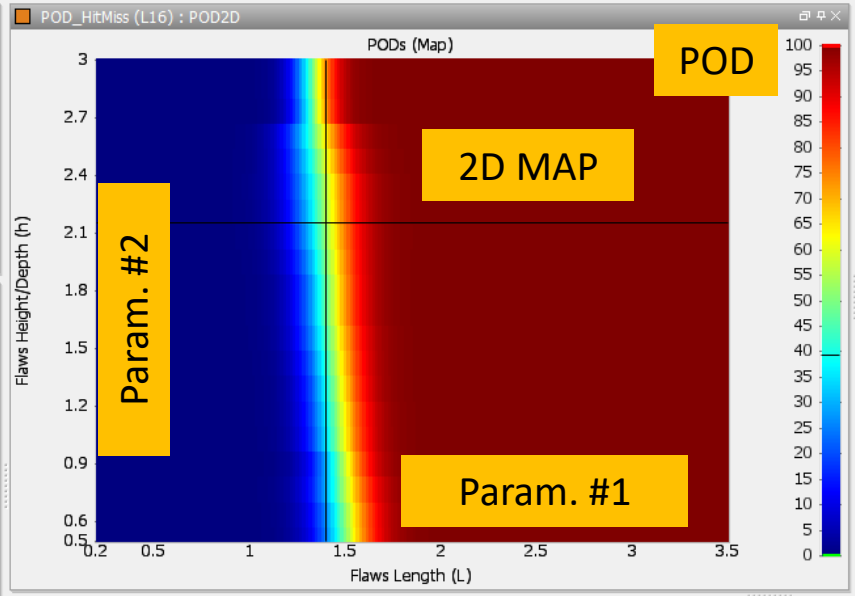
CIVA – POD Analysis

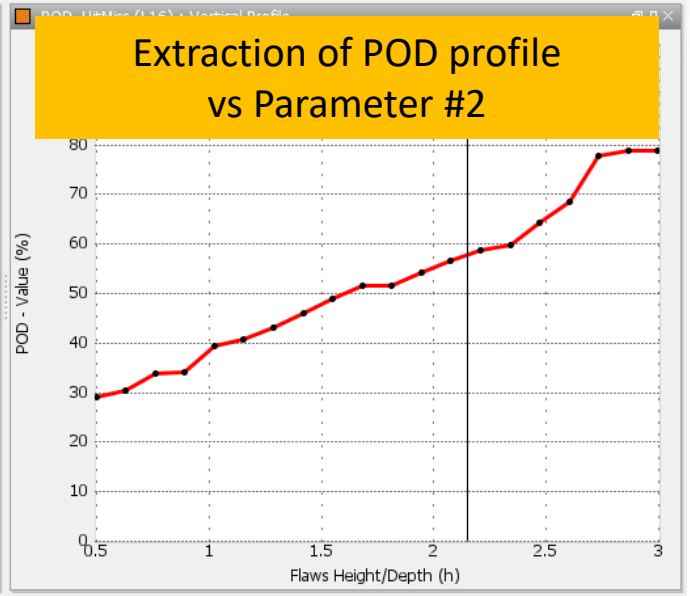
« 2D POD » :

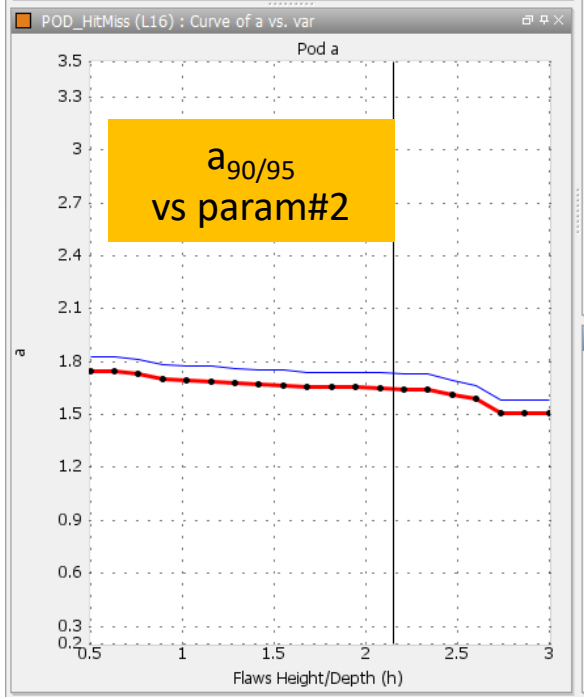
- Only a « beta » version was available until now
- Possibility to plot a POD curve versus two characteristic criteria (i.e.: Length and Height, or Size and Position)

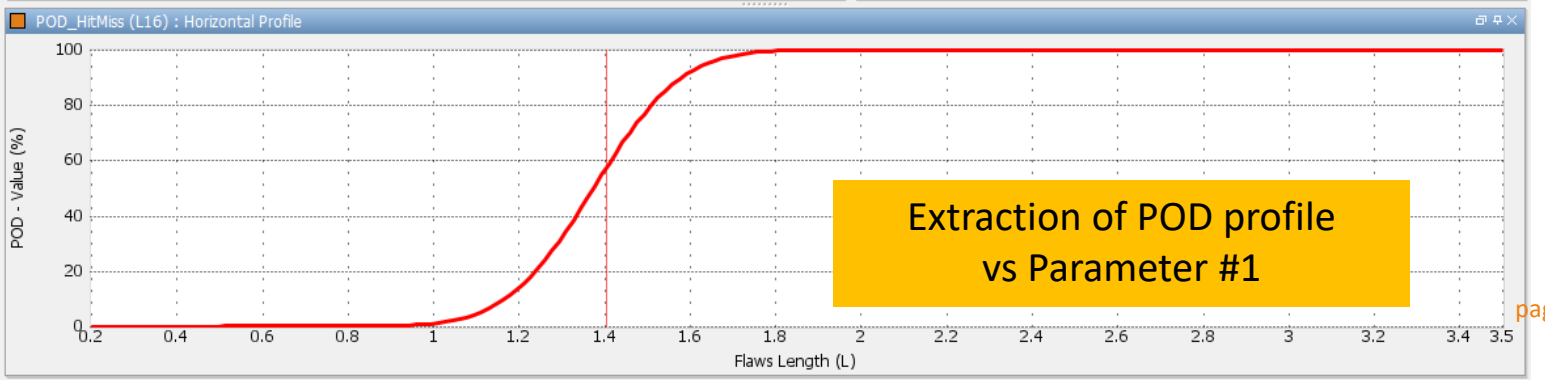
Selection of 2nd parameter and number of samples

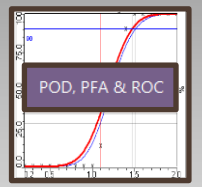








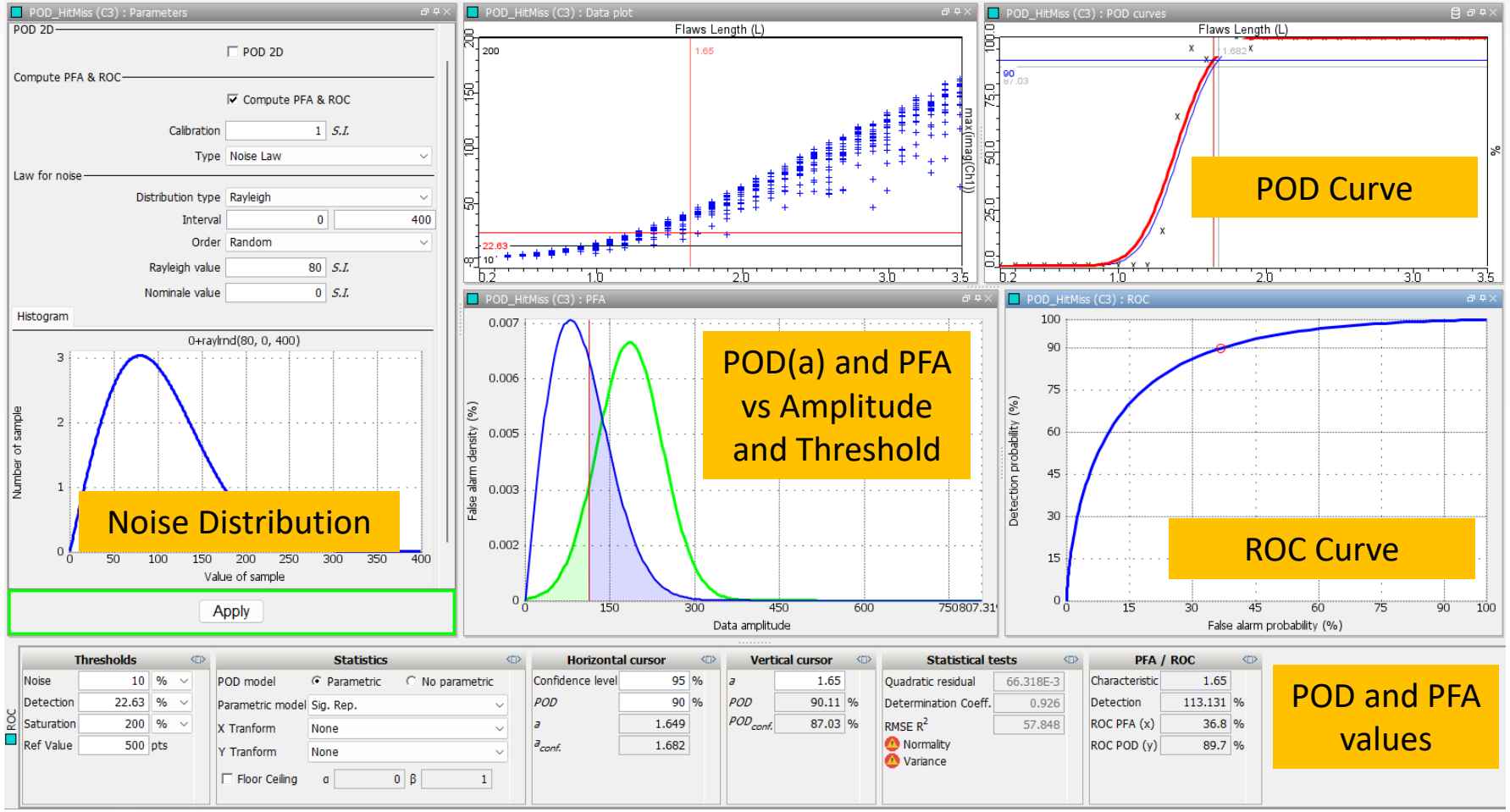


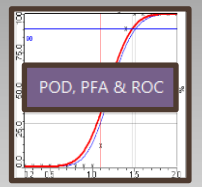


CIVA – POD Analysis

PFA and ROC Curves:

- **PFA** computes the Probability of False Alarms based on background noise level and distribution
- **ROC curve** link PFA and POD (for a given flaw size) vs detection threshold





CIVA – POD Analysis

Interested in Reliability and POD?

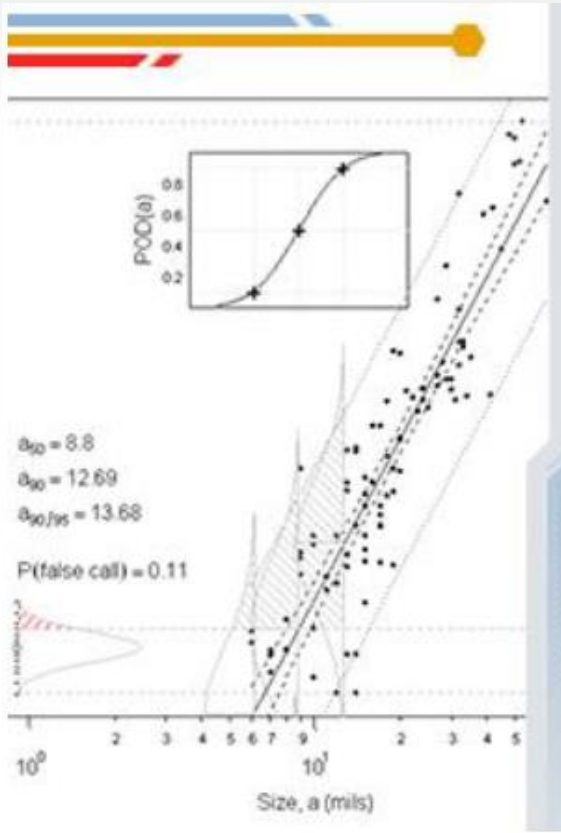
- Join our « Reliability in NDE » training sessions!

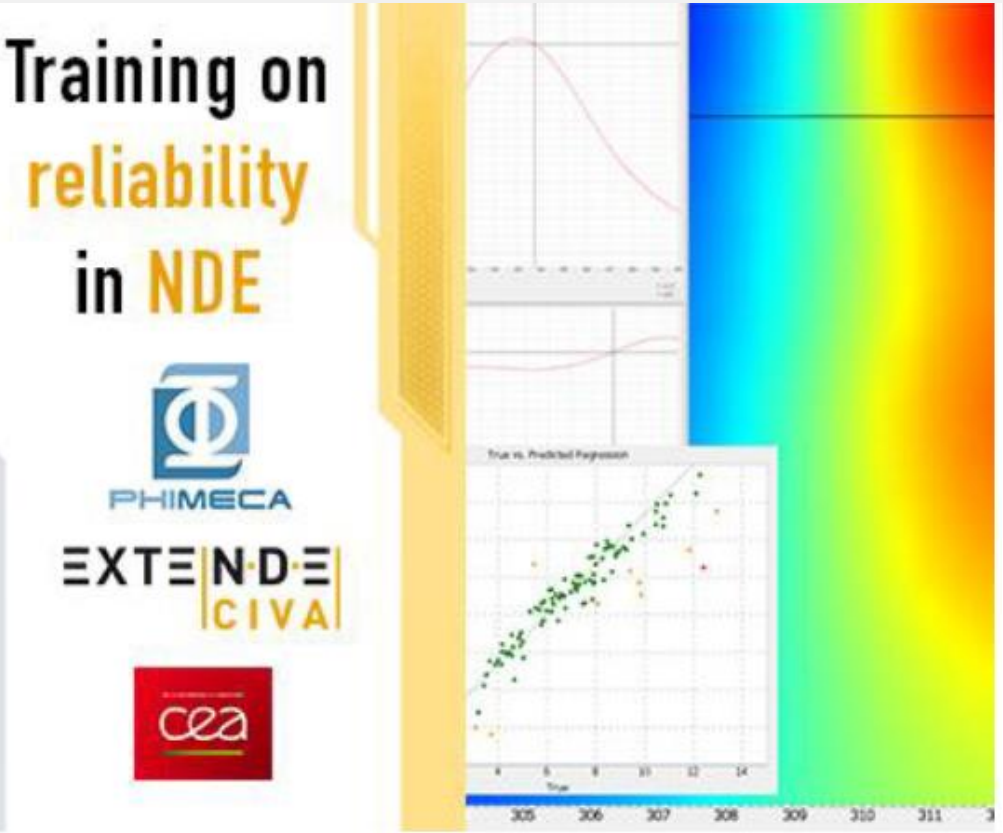
- In Massy (France):
  - May 13th - 16th , 2025

    (in English)

  - October 14th - 17th , 2025

    (in French)





CIVA Script

- **CIVA UT ANALYSIS** becomes **available** with **CIVA Script**!
  - Drive CIVA UT ANALYSIS without the Graphical User Interface:
    - Load UT experimental and simulated data
    - Apply CIVA Template (execute sequence of actions: layout / plugin / signal processing)
    - Extract results and export images

- **CIVA Script** still supports **all CIVA techniques**, with **new improvements**:
  - Process binary files with improved way and extended metadata in Python:

```
from CivaScript import database_api
```

  - CEA's Notebooks to manage binary files (read, write, export, merge)
  - New capabilities through *.xml programming
  - Python version updated: 3.12

CIVA Data Science

Overview

Data bases & Metamodels:
- Collect data (sim. + exp.)
- Generate metamodels
- Check data consistency

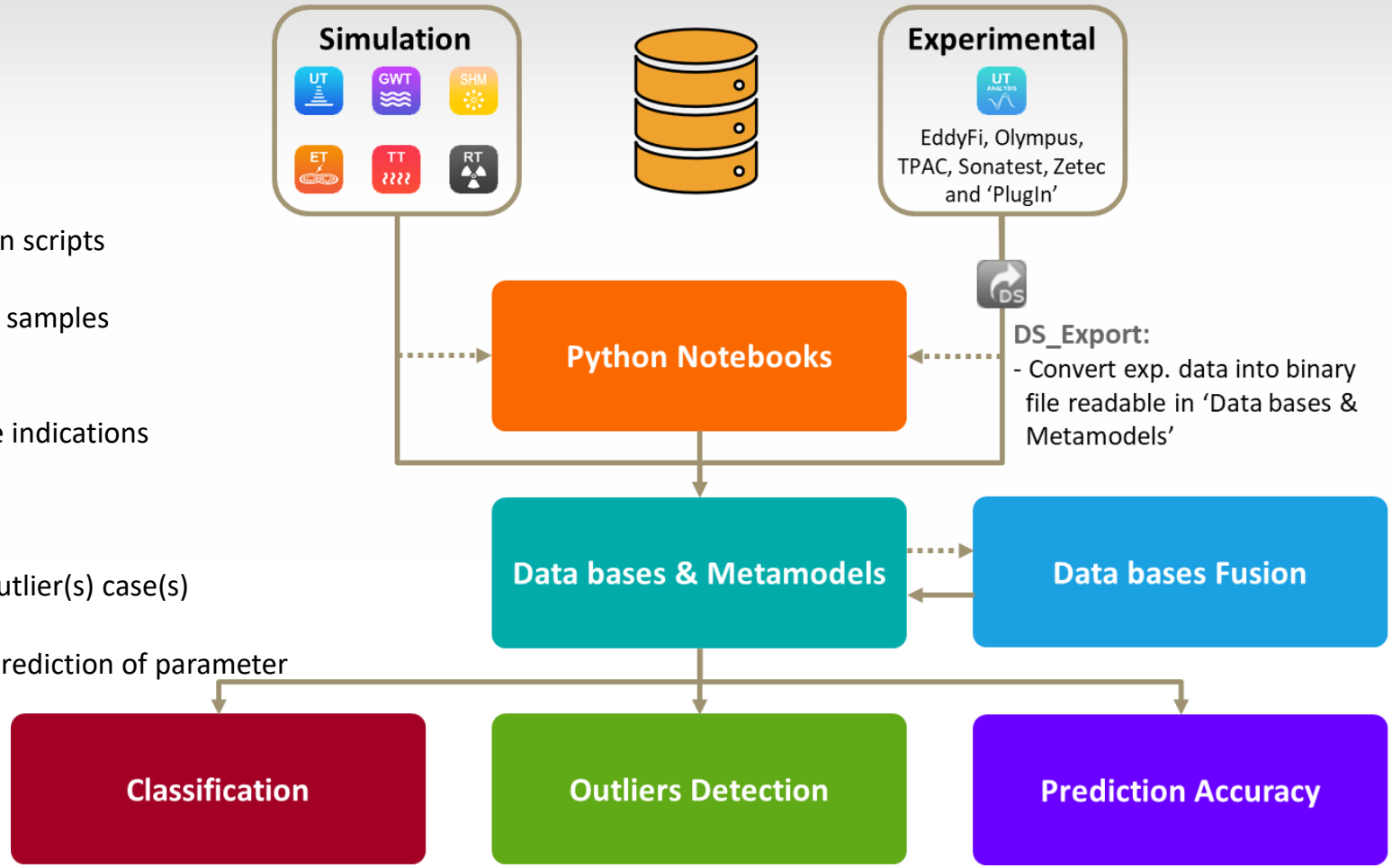
Python Notebooks:
- Customize data sets with Python scripts

Data bases Fusion:
- Merge data sources to increase samples and / or stack the criterion

Classification:
- Define and assign classes to the indications
- Pre-analyze data on 2D plots
- Train and evaluate AI model

Outliers Detection:
- Single class training to detect outlier(s) case(s)

Prediction Accuracy:
- Compute a statistical study of prediction of parameter

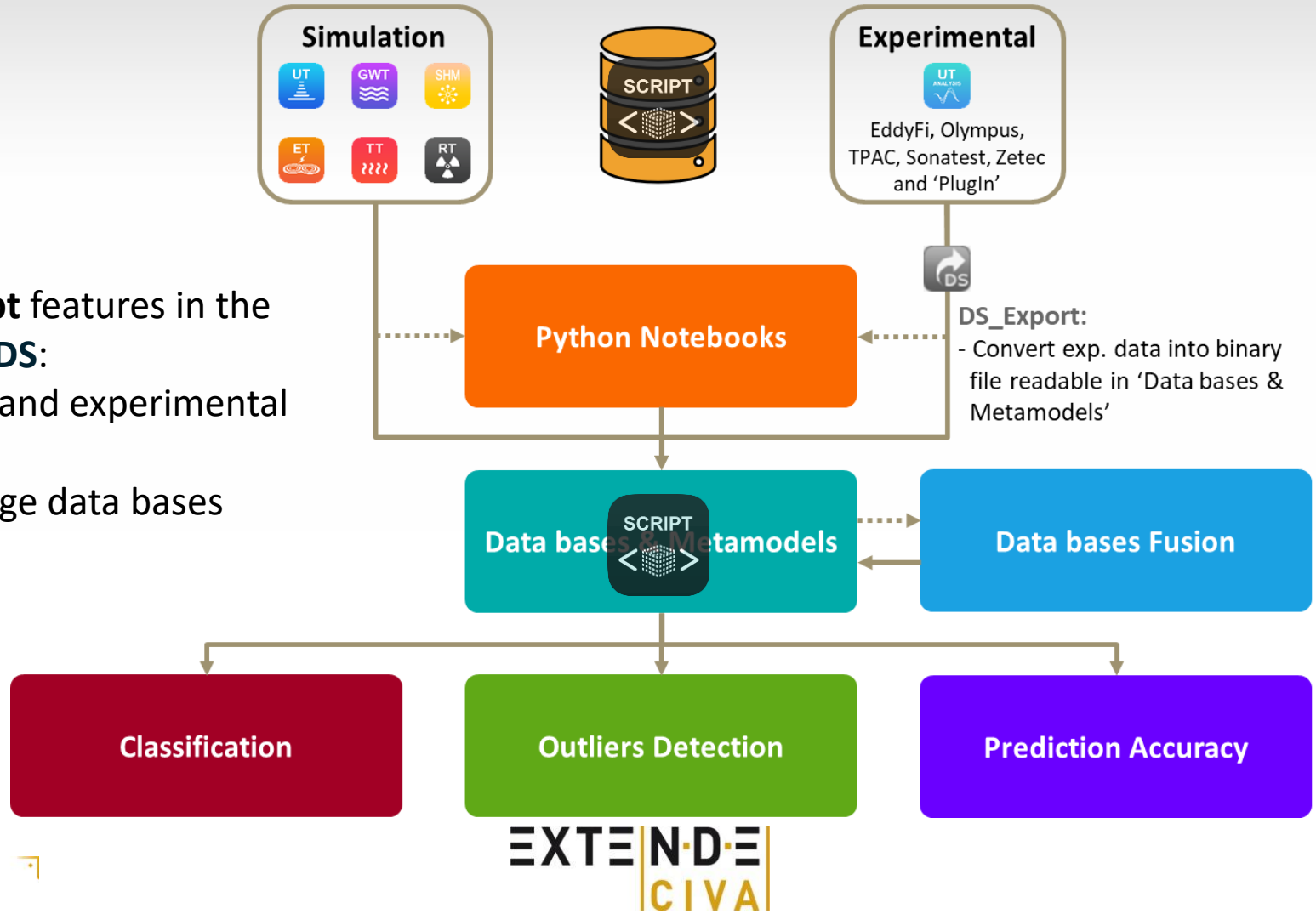


CIVA Data Science

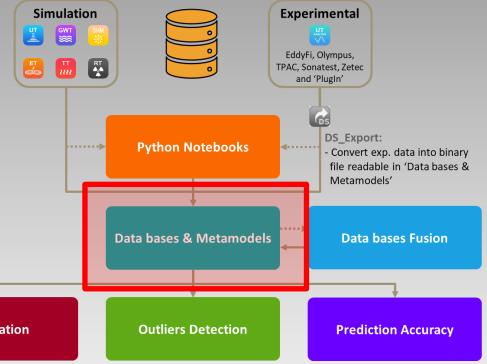
Overview

Use the new **CIVA Script** features in the various stages of **CIVA DS**:

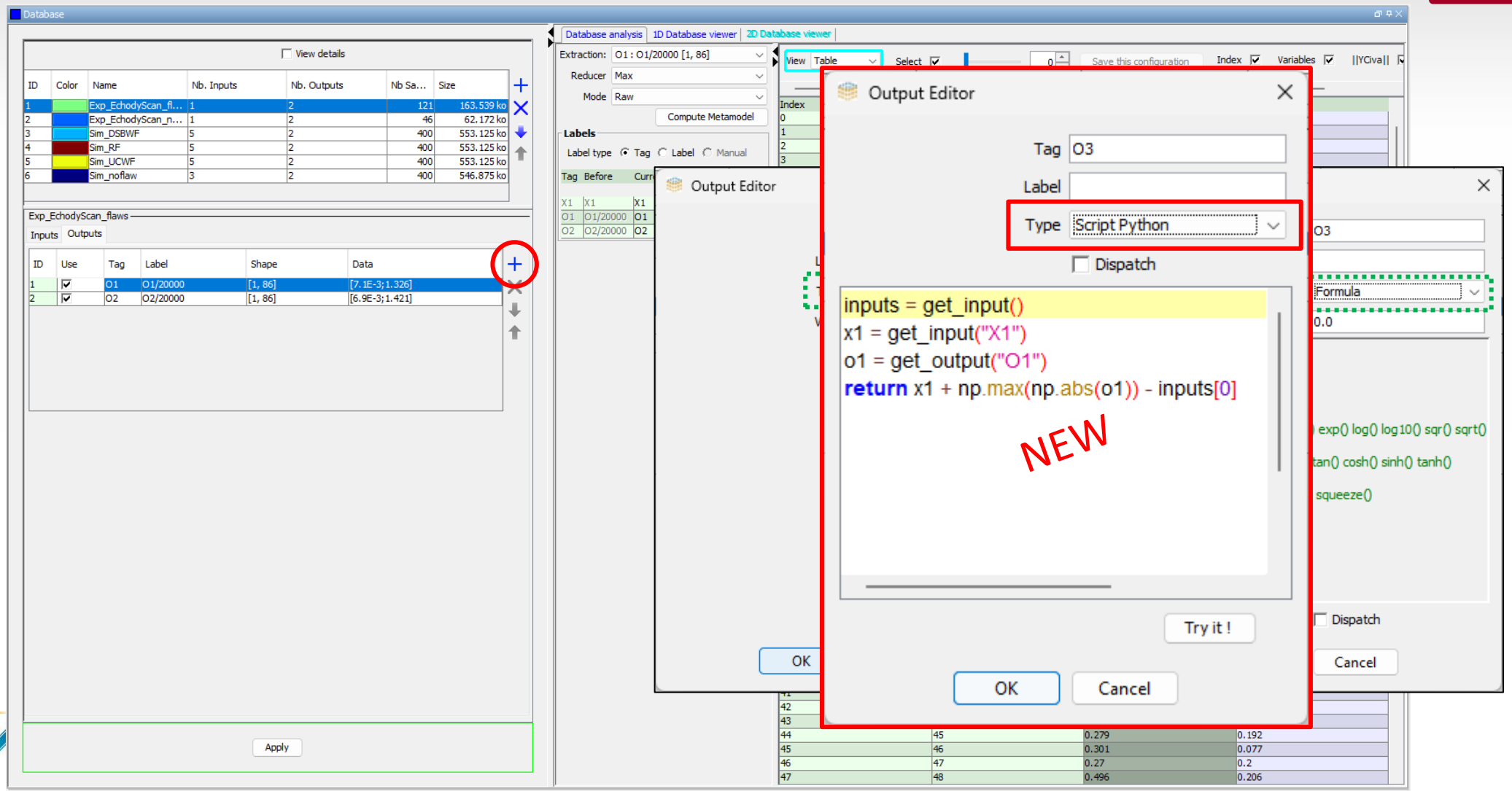
- Manage simulation and experimental results
- Generate and manage data bases



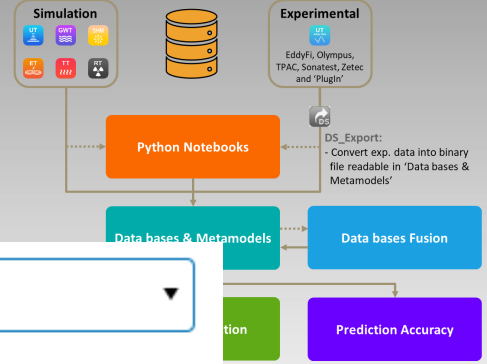
CIVA Data Science



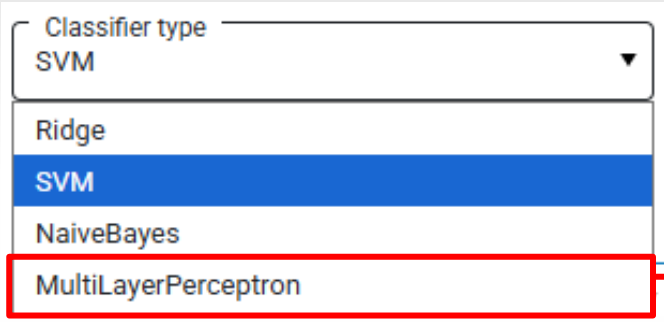
- Edit the database Output with python scripts:



CIVA Data Science

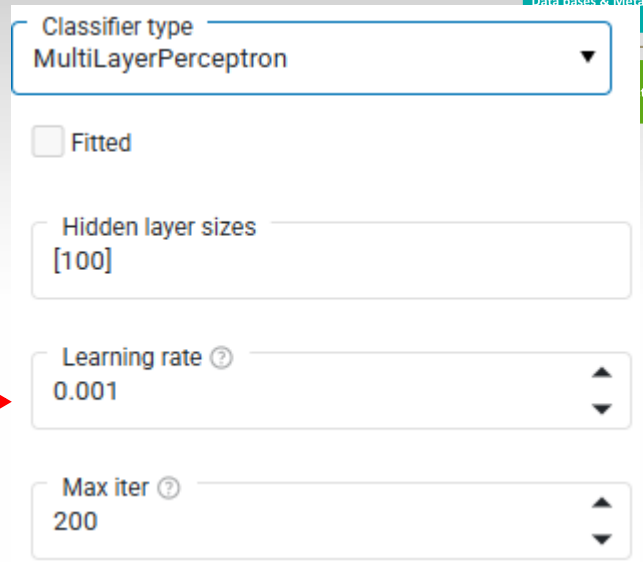


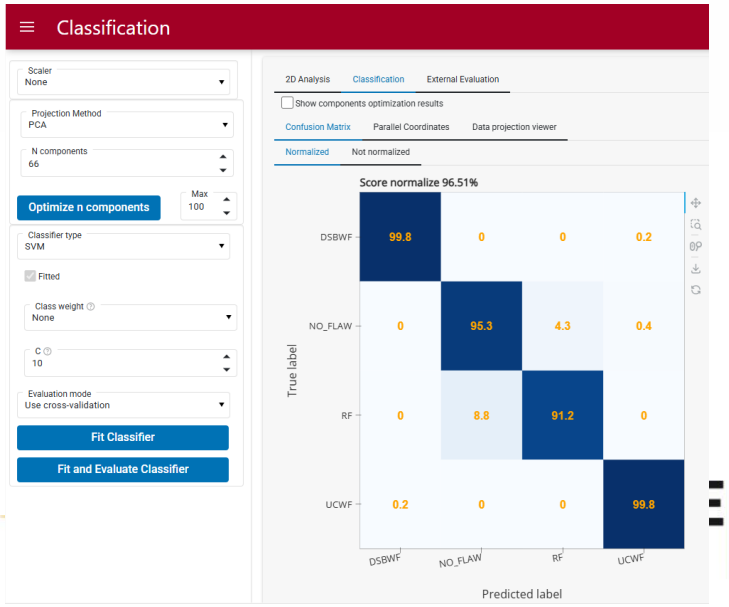
- New classifiers (MultiLayer Perception ; Time Series Correlation) :

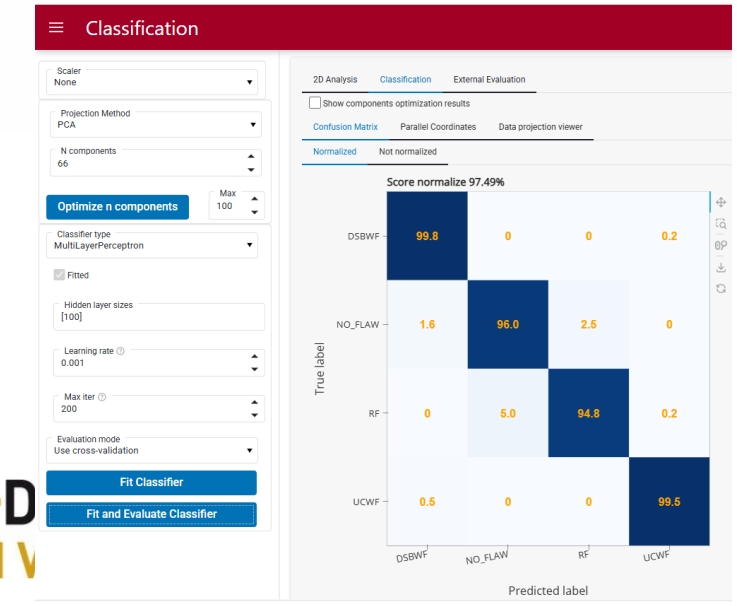


Machine Learning

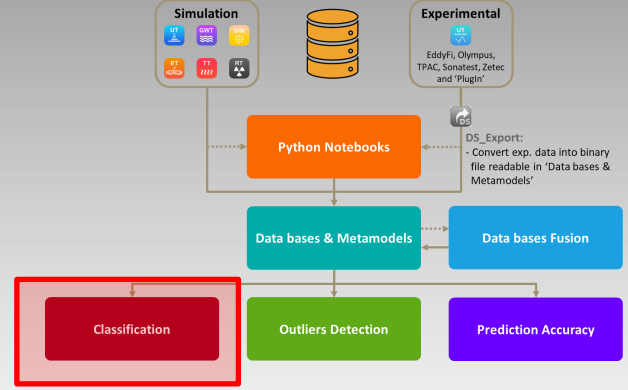
Deep Learning (NN)





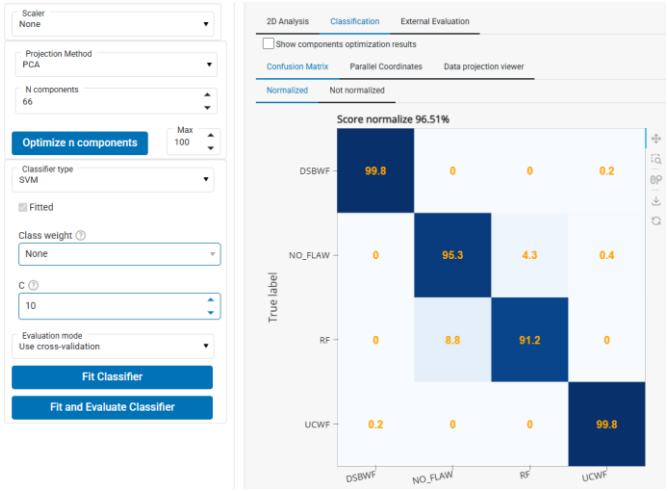


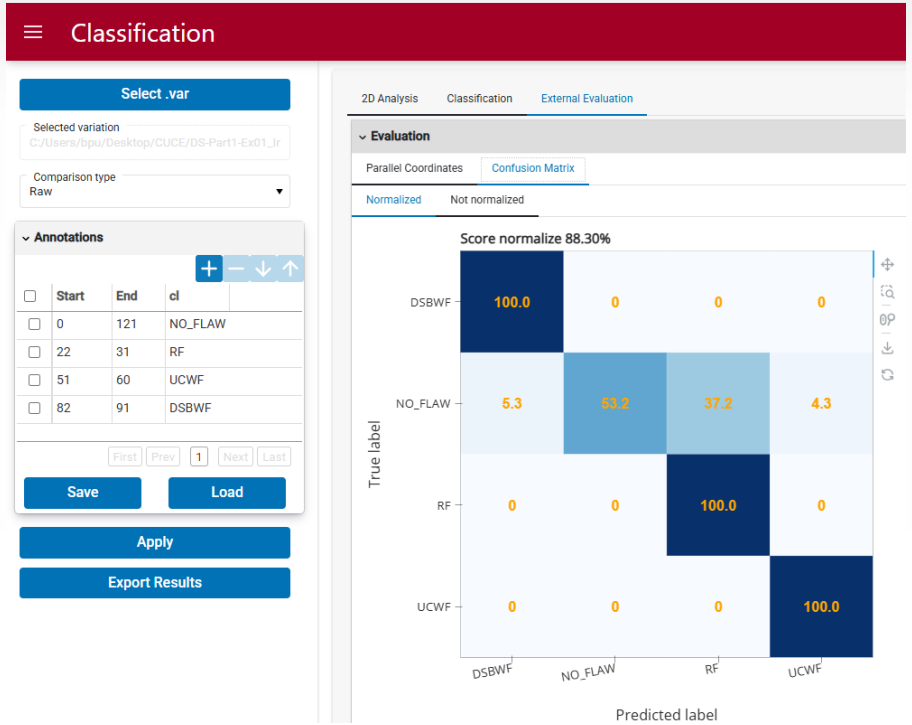
CIVA Data Science



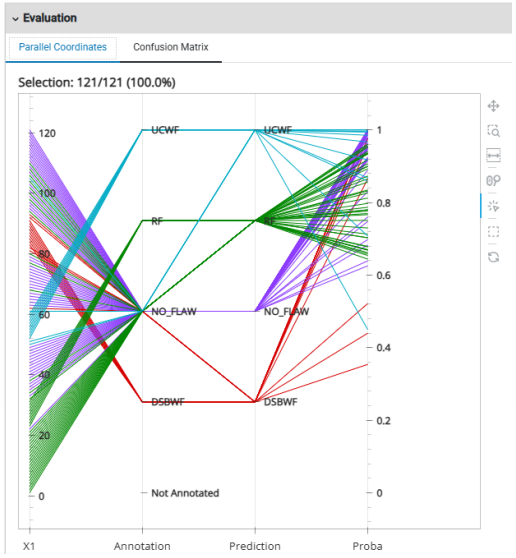
Confusion matrix on external evaluation

To compare with learning confusion matrix

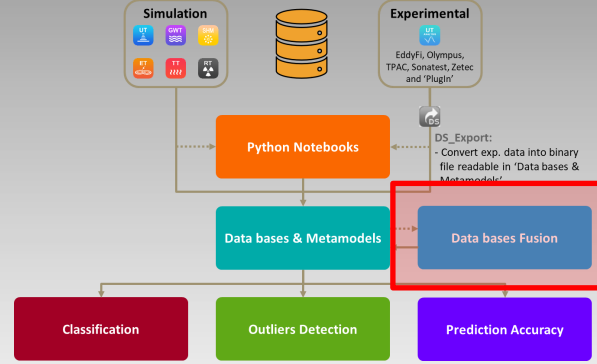


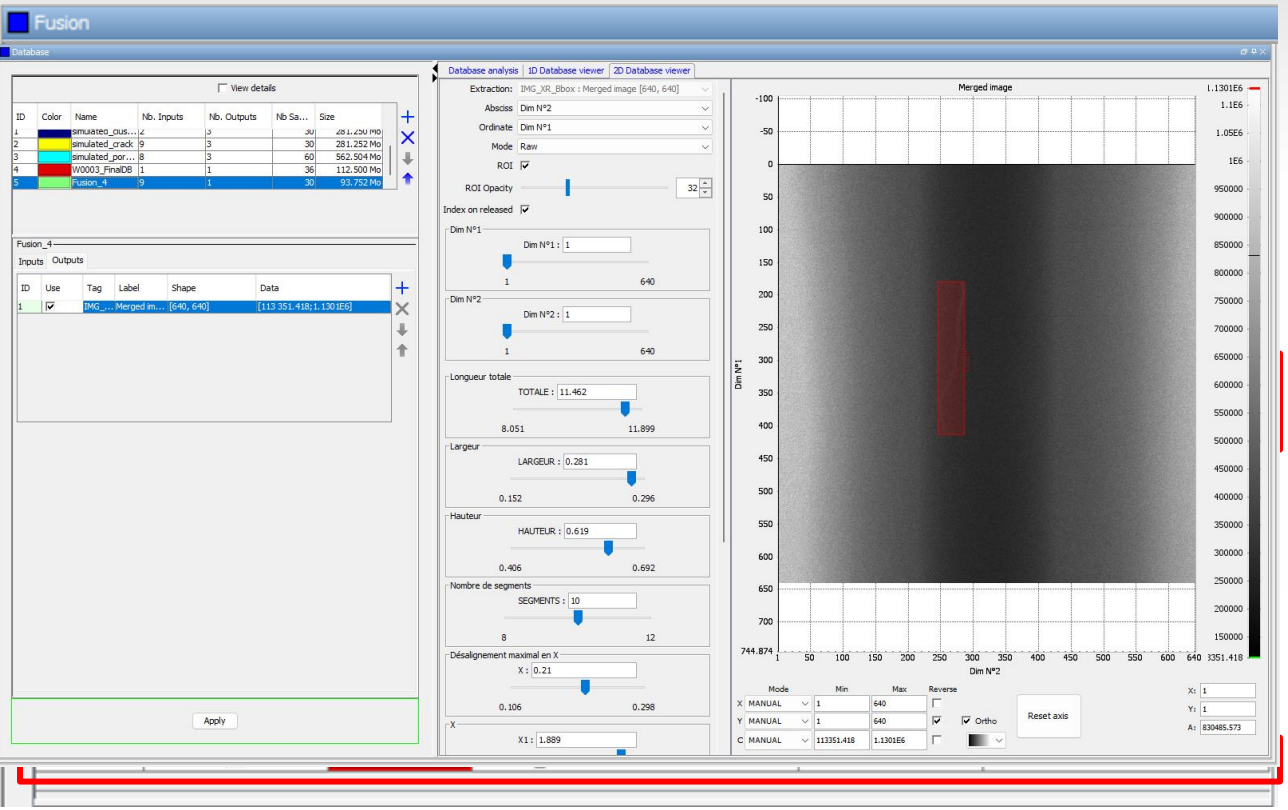


To complement the parallel plot



CIVA Data Science





- **New fusion** type for RT: **batch** insertion of simulated flaws into experimental images
- **Create database** from **experimental** images (TIFF format)
- Select **simulated flaws** database (.var)
- **Merging** parameters (with physical meaning)
- **Display** the fusion + ROI for all generated images

Simple fusion (1 simulated flaw + 1 experimental image) also available in RT Module

THANK YOU FOR YOUR ATTENTION !

- Quite a rich new version!
- Several additional features have not been presented (parametric study, UT beam calculation options, boundary absorbing layers in SHM, etc.): More details will come with the release.
- Join us for a training session to discover these new features !