CIVA SHM: Structural Health Monitoring thanks to simulation!

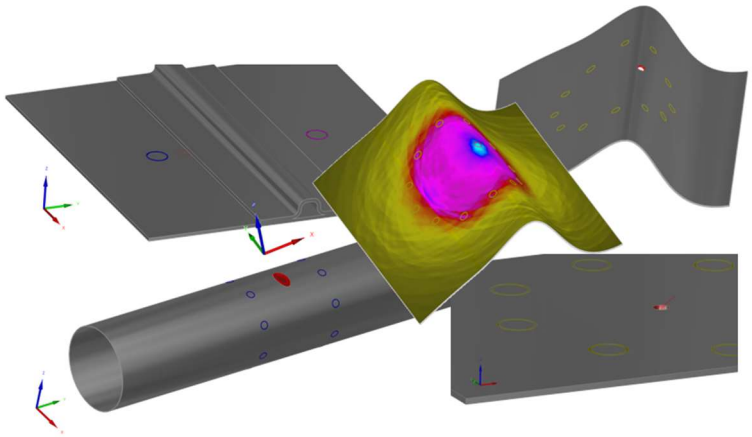
Structural Health Monitoring sensors are embedded in the monitored structure. It is even more important than in traditional NDE to design and qualify them carefully before implementation: **Simulation is a must have!** CIVA now includes a new module to model SHM by Guided Waves.

Design monitoring strategy:

Assessing damage in a structure involves a large set of transducers. It is then crucial to optimize the **choice and distribution of these sensors** for detection of critical flaws, while limiting their number and thus the whole cost. **Simulation is a key and low-cost step** in selecting relevant strategies before preparing prototypes and then embedding sensors in a real structure… For life!

Demonstrate monitoring performance:

To be implemented in relevant industrial structures, SHM must prove its efficiency, reliability and its complementarity to traditional NDE. A rigorous **performance demonstration campaign** is needed. This involves an exhaustive study of **influential parameters,** covering many situations and rapidly becomes prohibitive with experimental campaigns. Simulation will greatly reduce the need for costly mock-ups, limiting their number to a relevant sampling. This saves time as well as money. It is much quicker to simulate a part than to manufacture one. The SHM-GW module is connected to the powerful tools provided by CIVA for parametric studies to perform efficient **sensitivity analysis** evaluation!

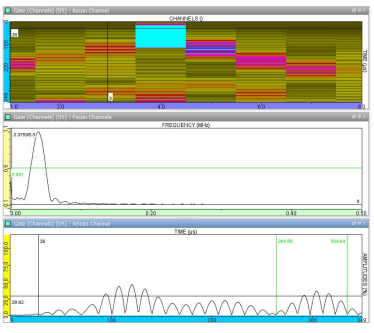


Provide data sets for Probability of Detection (POD) evaluation:

Contrary to NDE, there is no inspector or analyst “eye” in SHM to distinguish real defect and false alarm signals. It is therefore even more crucial to carefully establish the detection threshold and design the sensors to limit the number of false alarms while maximizing the Probability Of Detection. POD studies need a **large amount of data** to provide reliable metrics, which is even more costly in SHM as sensors are embedded in the structure. **A model assisted POD approach is then cost-efficient to test many sensors and defect scenarios** while an experimental approach can focus on studying the influence of environmental parameters (temperature, etc.) in an unflawed component.

Understand better SHM signals:

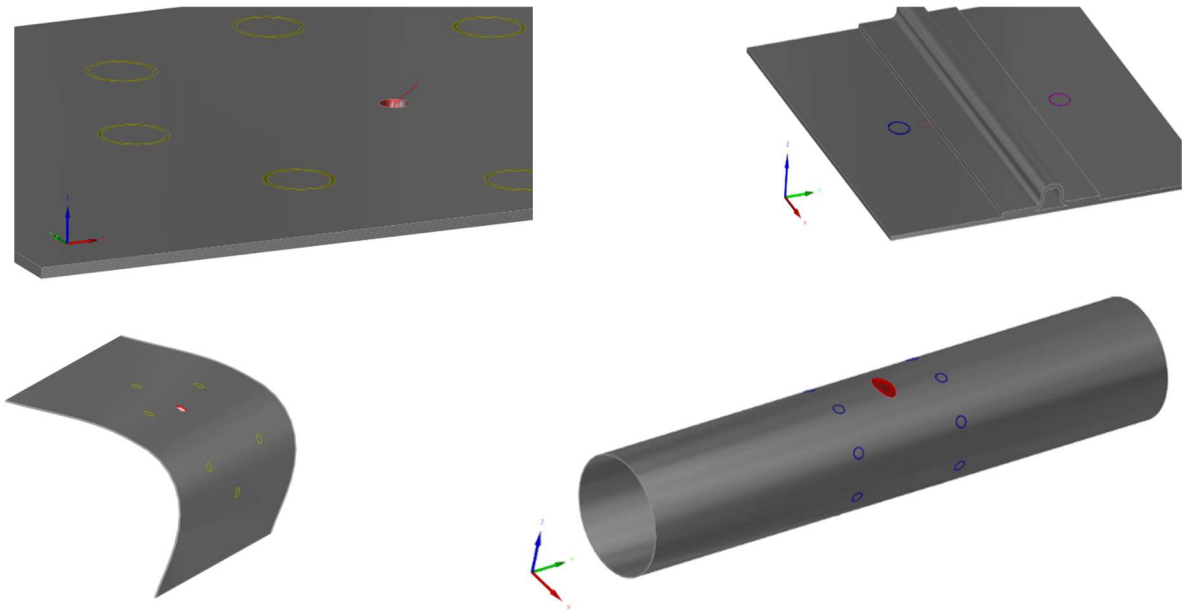
By nature, **SHM-GW provides complex signals** (several modes, several sensors, influence of component features and edges, etc.). Extracting the relevant information from the whole signal is not obvious nor is comparing it to a non-defective situation. It is therefore important to define relevant processing strategies to extract the useful information for diagnosis from the very large amount of data generated by SHM devices. CIVA simulations provide a way to cover a large range of situations in a very competitive computation time. This should help to **improve our mastering** of the SHM technique as well as **generating large data sets** to train deep learning algorithms in the context of an on-going Machine Learning approach of SHM analysis.



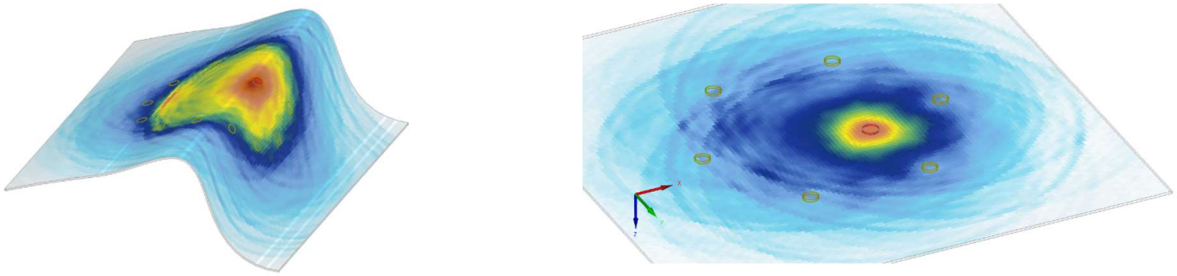
INSIDE CIVA SHM…

Built from an **optimized FEM technique** (Spectral Finite Element Method), CIVA SHM by Guided Waves shows **very competitive performances**, with much faster calculation times than traditional Finite Element software. Based on parametric geometries, CIVA SHM fully **automates the mesh generation** and thus does not require any specific FEM skills from the user.

CIVA SHM can address **metallic piping** structures and also **metallic or composite panels** which can include **curvatures** or a stiffener. A set of defects can be added such as hole, delamination, crack and corrosion/erosion or bump profiles.



An **array of Guided Wave sensors** can be defined around the defective zone and work in Round Robin or custom scan mode. Radial, normal or custom excitation profiles can be assigned to the sensors. Inspection simulation tools will compute the signals received on each sensor. From these results, an **imaging reconstruction algorithm** (“Delay and Sum”) is available to process these results and give an image of the defect impact displayed on the 3D view for the different wave modes.



Local fields of displacement and stress can be extracted for further visualizations. CIVA SHM also includes a semi-analytical tool for dispersion curve computation and analysis.