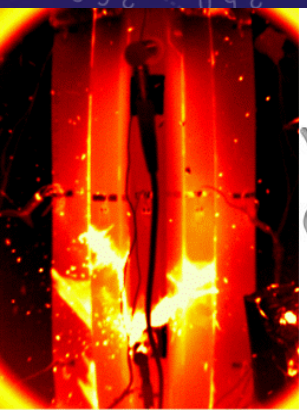
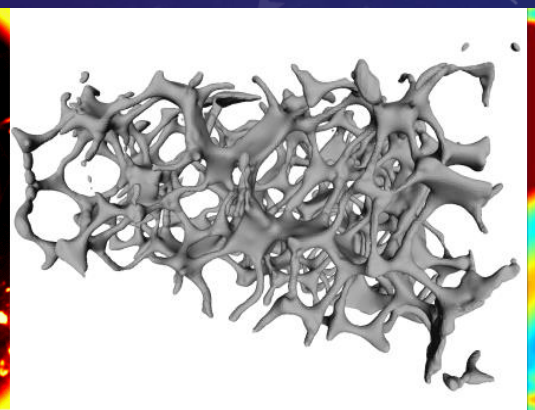
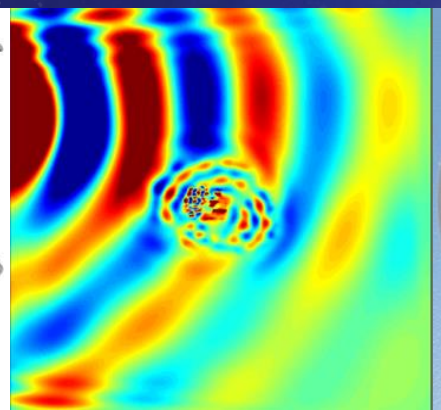
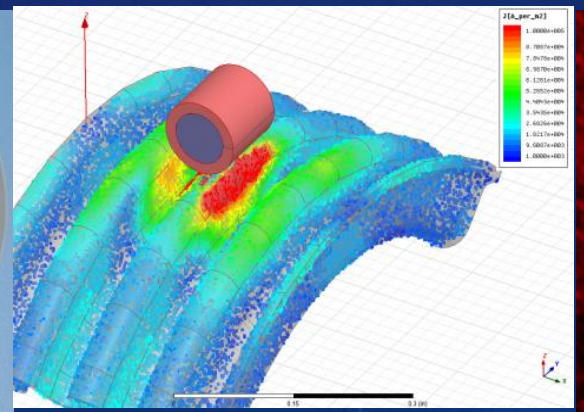
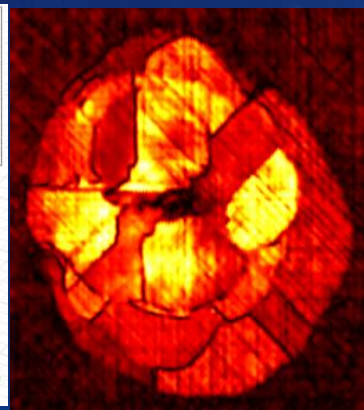
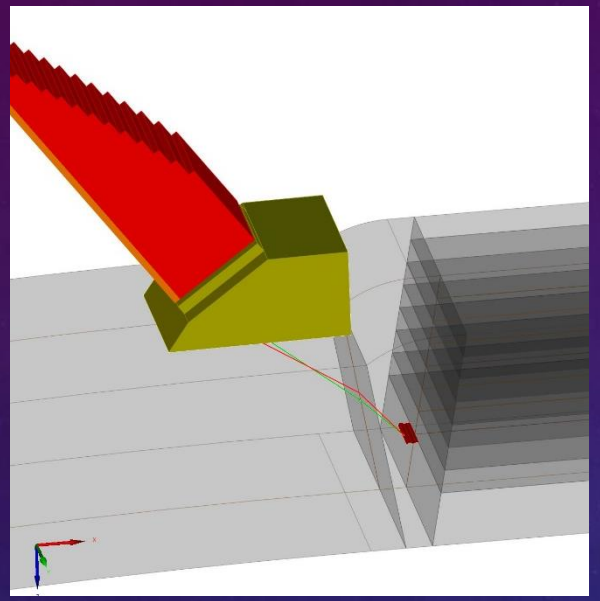
COMPUTATIONAL NONDESTRUCTIVE EVALUATION CASE STUDIES AT NASA

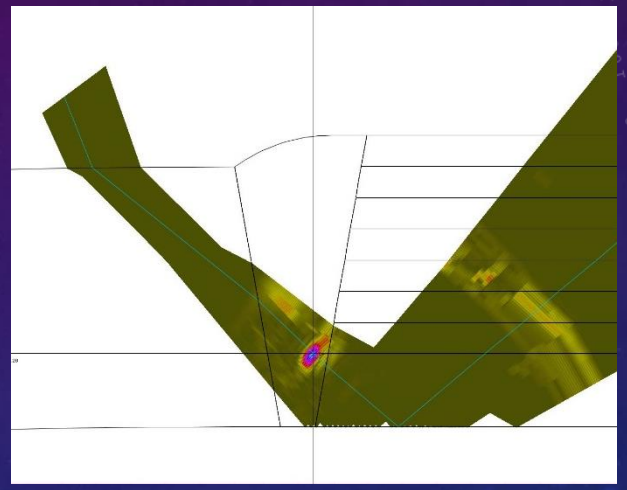
Peter D. Juarez
Research Engineer
Nondestructive Evaluation Sciences Branch
NASA Langley Research Center

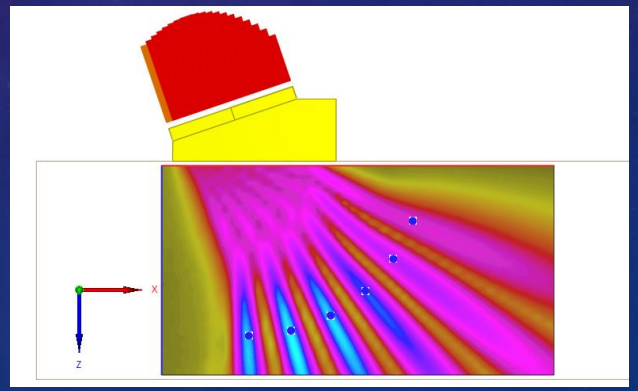




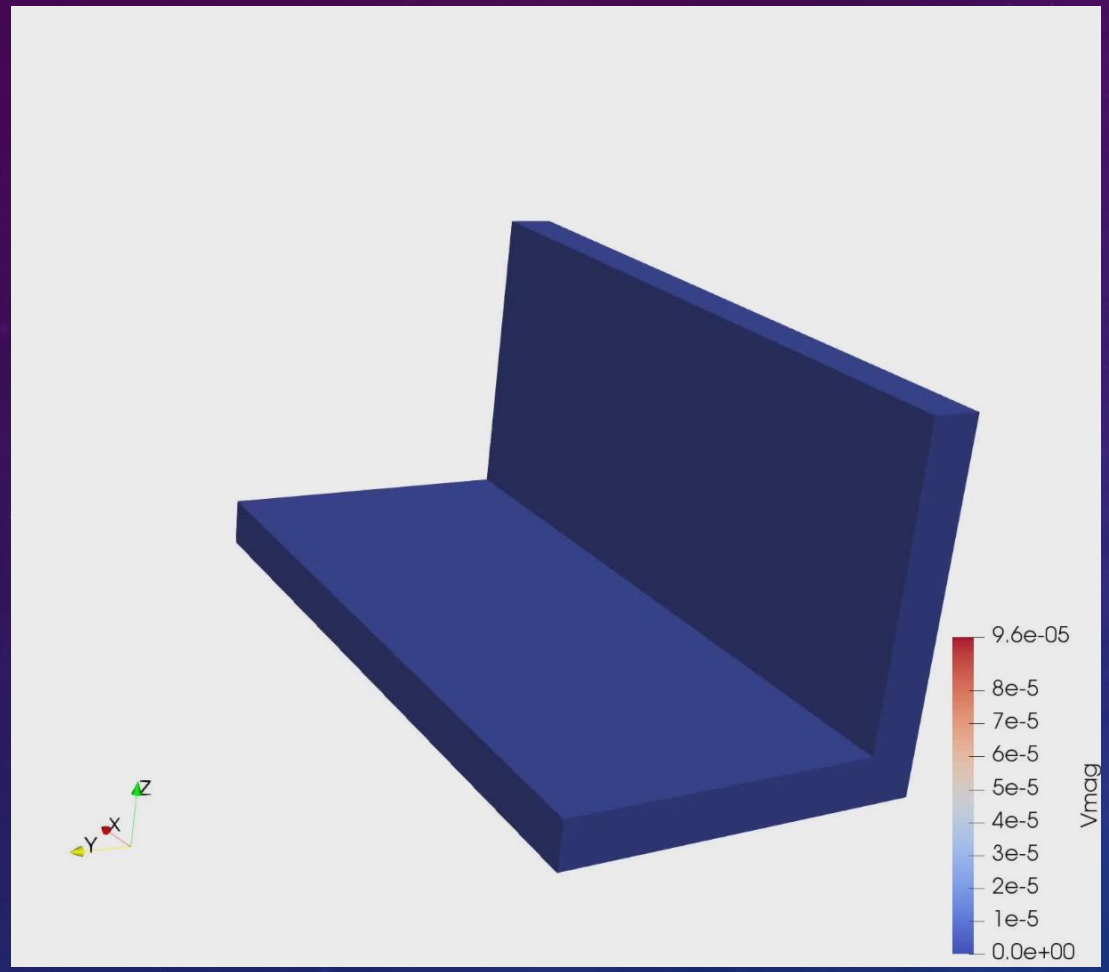
CIVA Simulation software

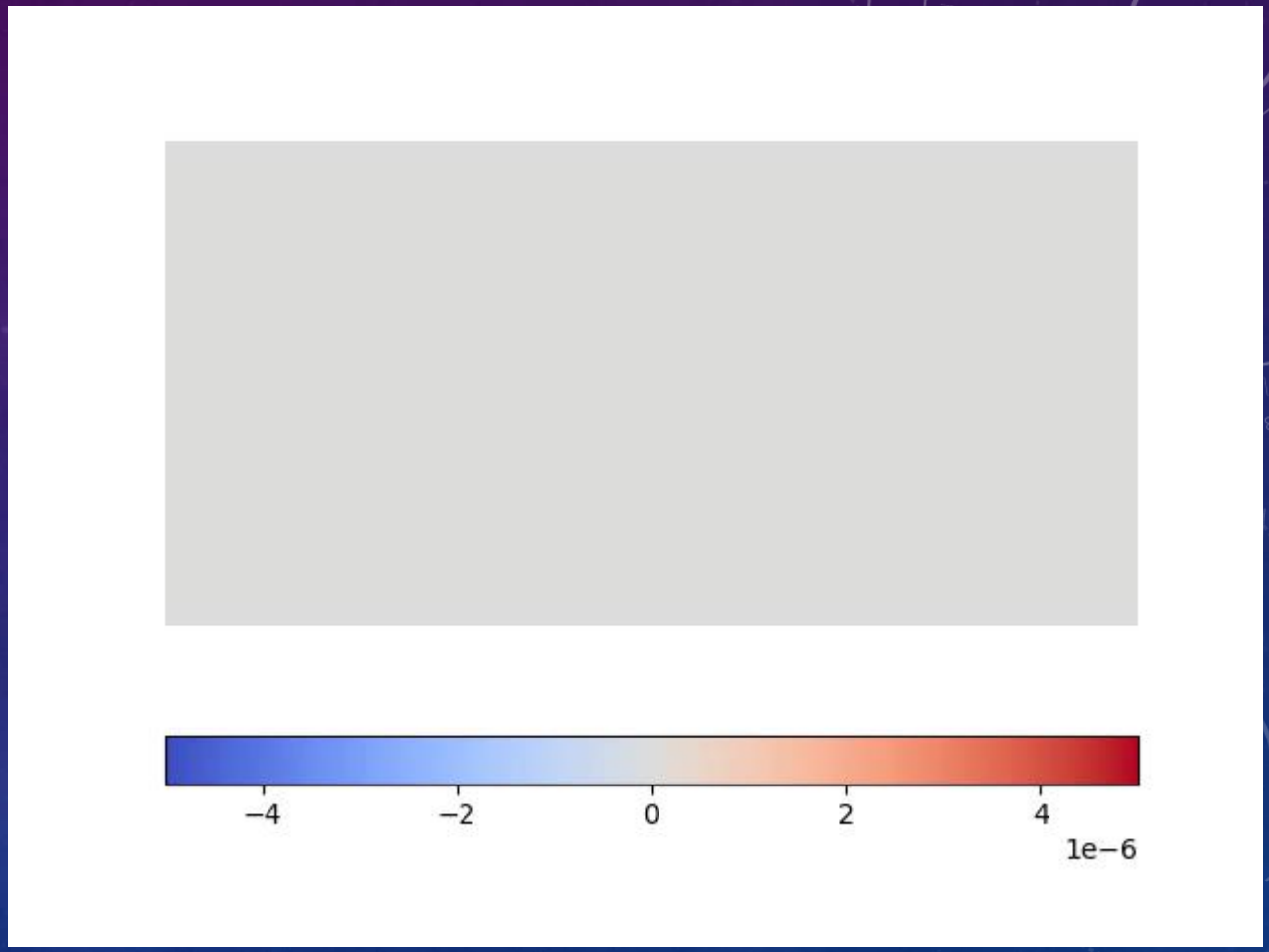






In house code





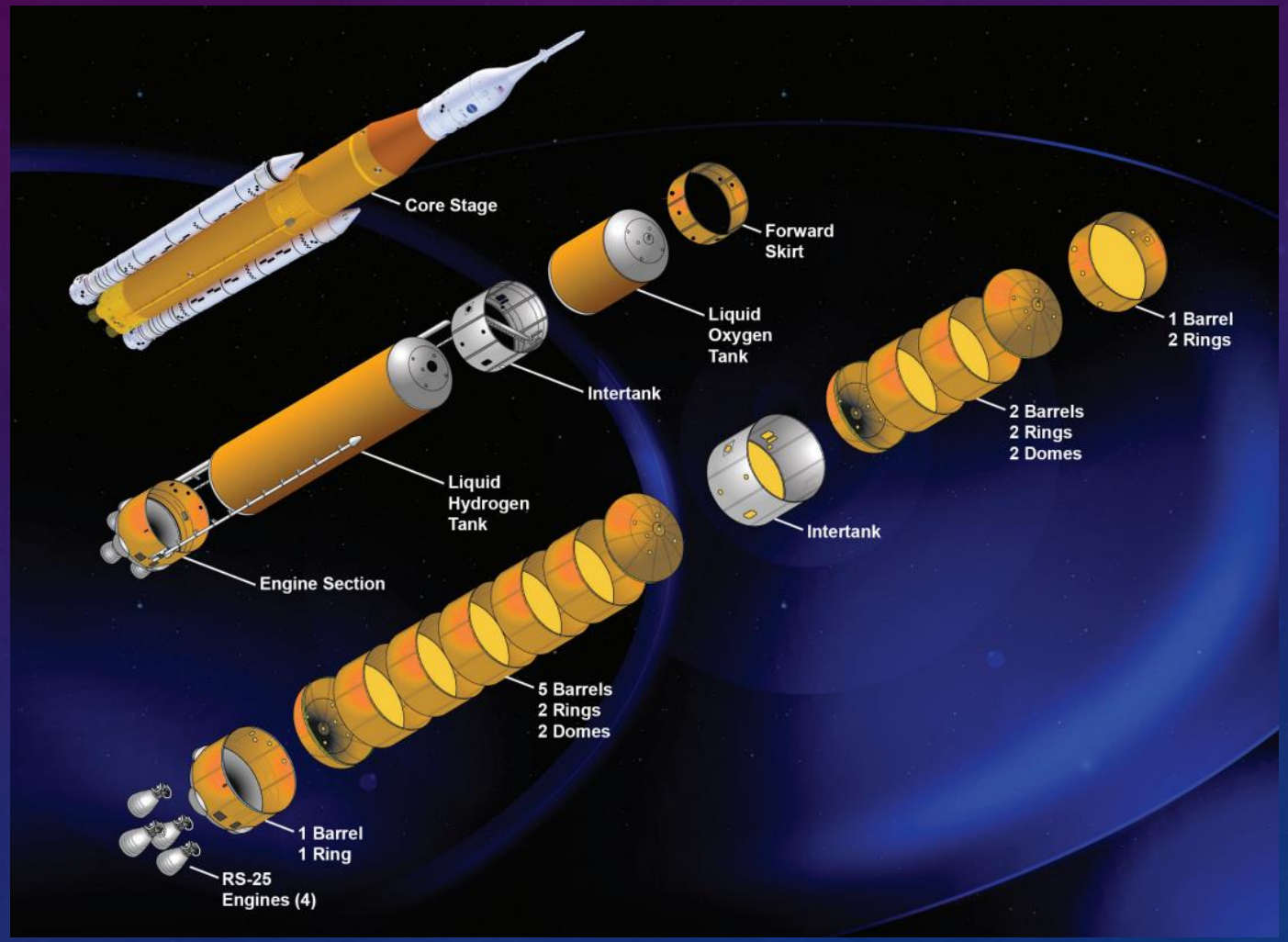
Three applications for simulation

1. You can’t physically perform the inspection yet.
2. You can perform the inspection, but don’t know how.
3. You can perform the inspection, you know how you will inspect, but you want to know more about the resulting data.

3. You can perform the inspection, you know how you will inspect, but you want to know more about the resulting data.

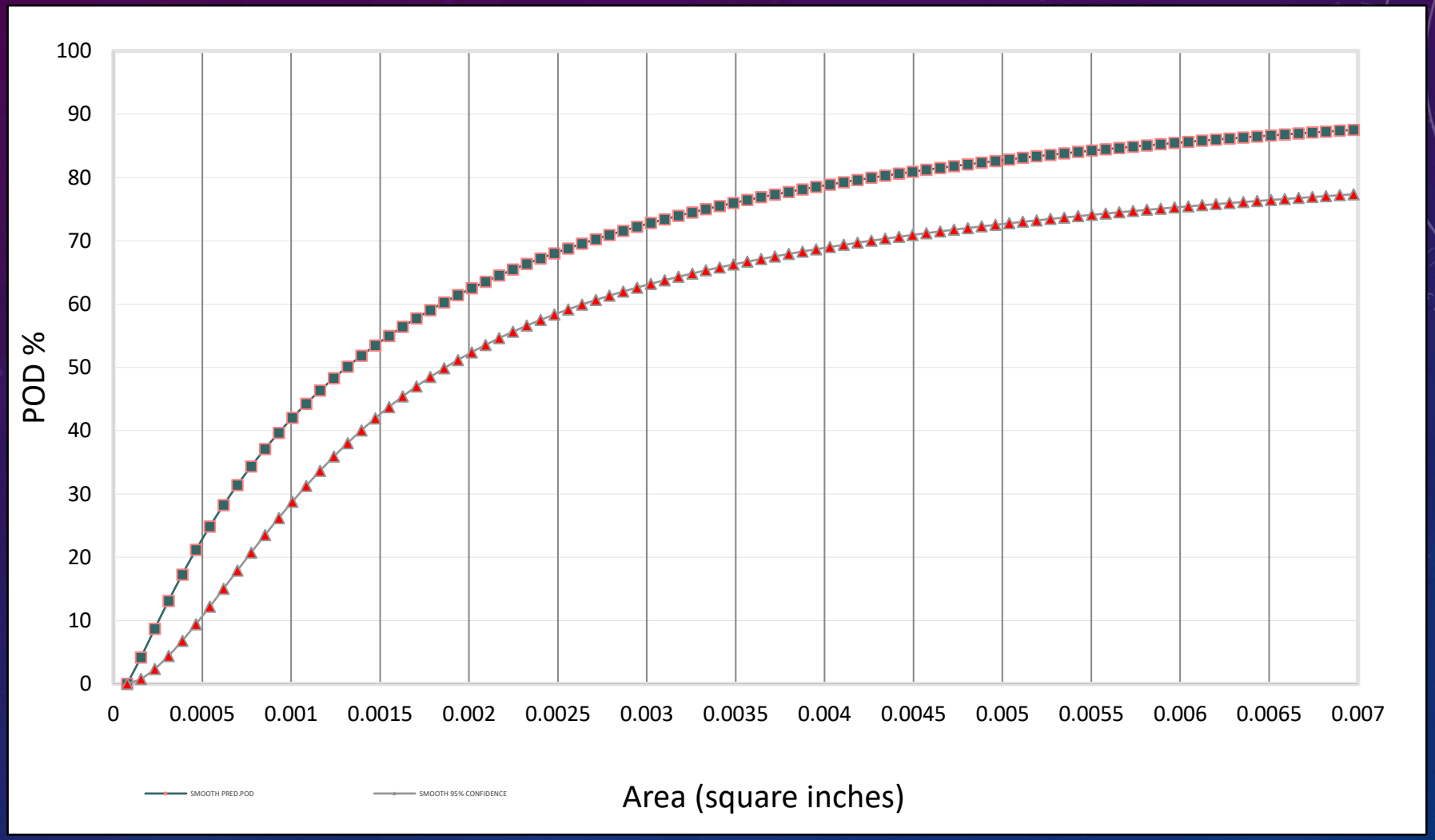
Example: Probability of detection study on friction stir welded panels

Friction Stir Welding

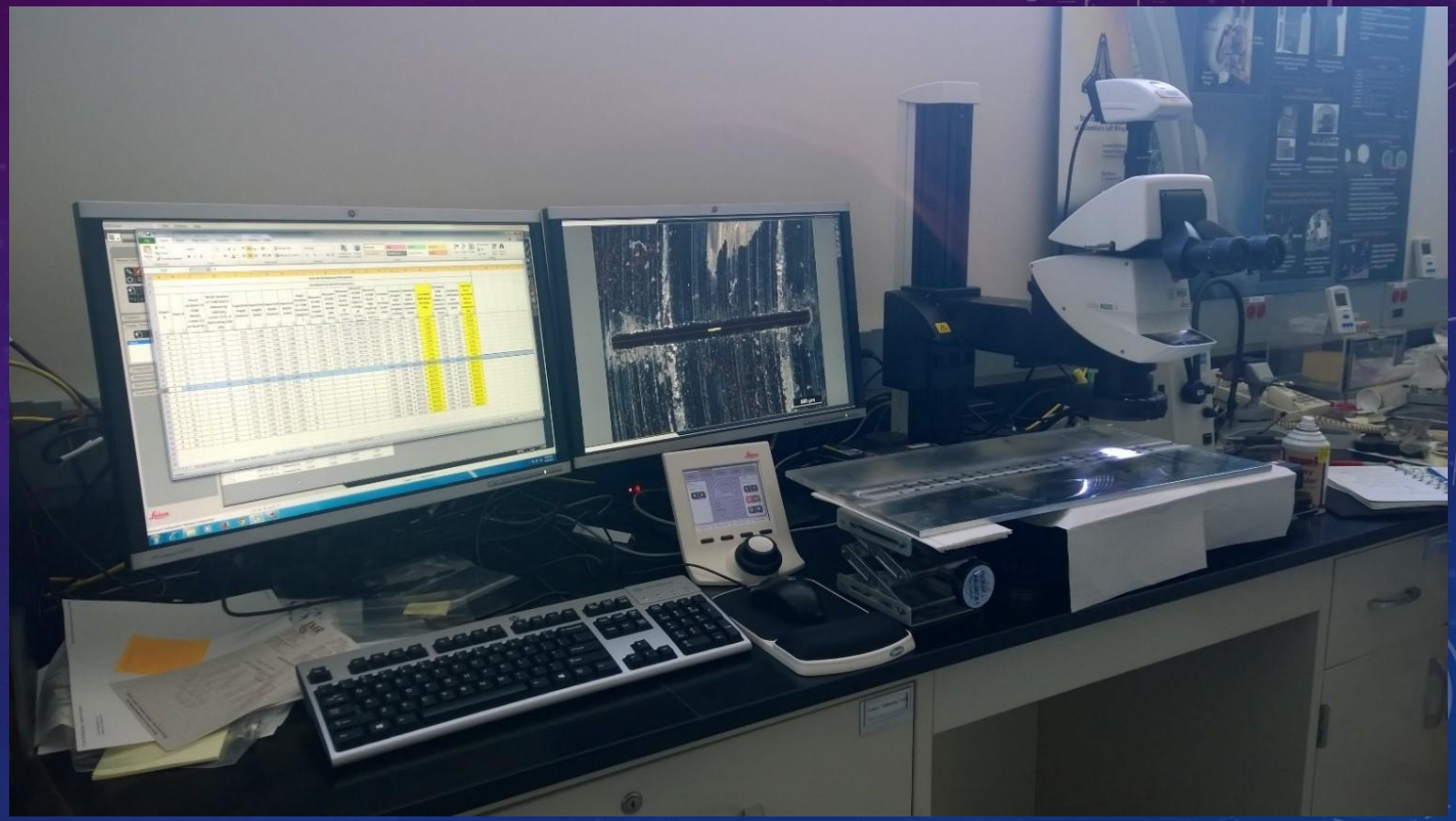


Core stage Space Launch System (SLS)

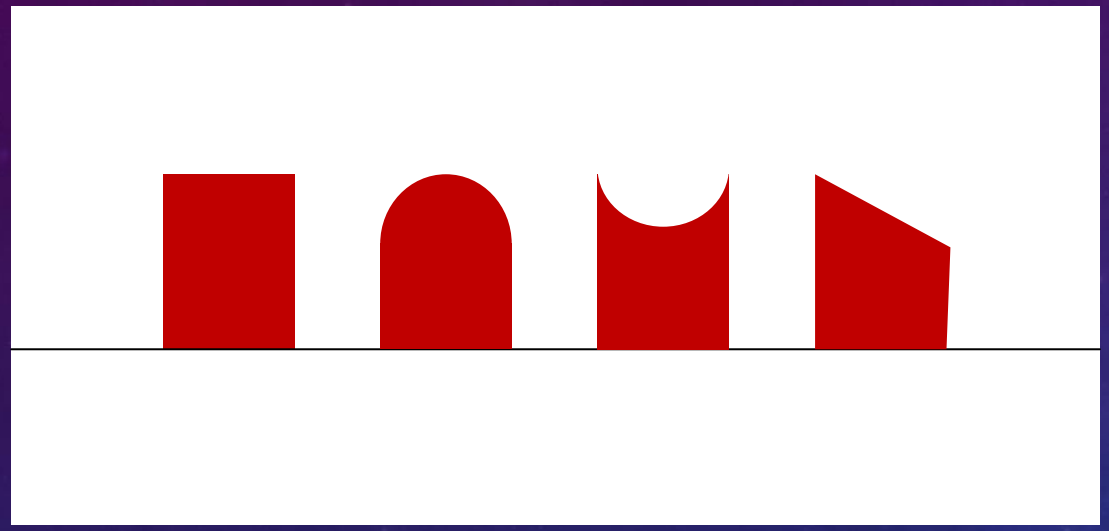
Probability Of Detection (POD) Curve



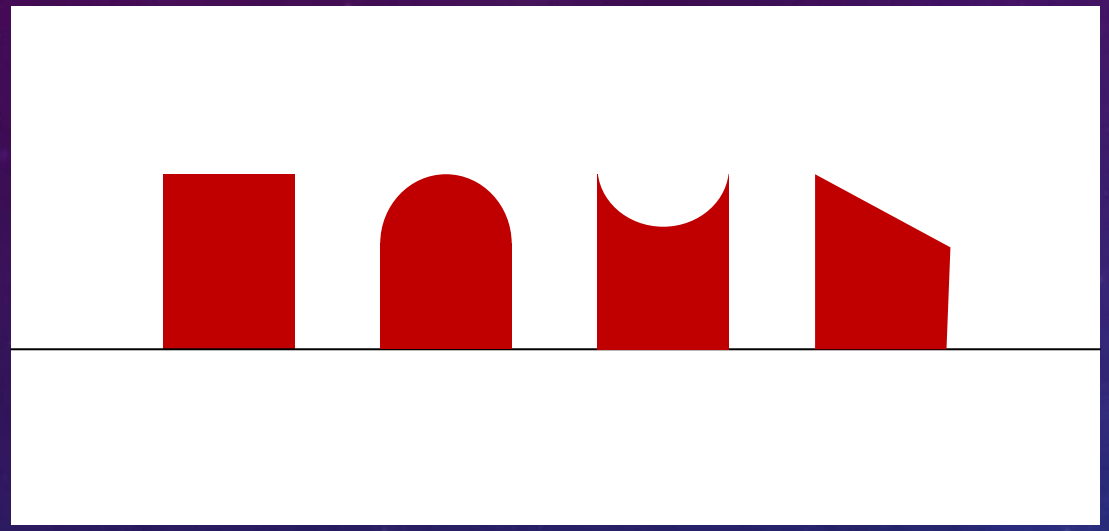
Probability Of Detection (POD) Curve

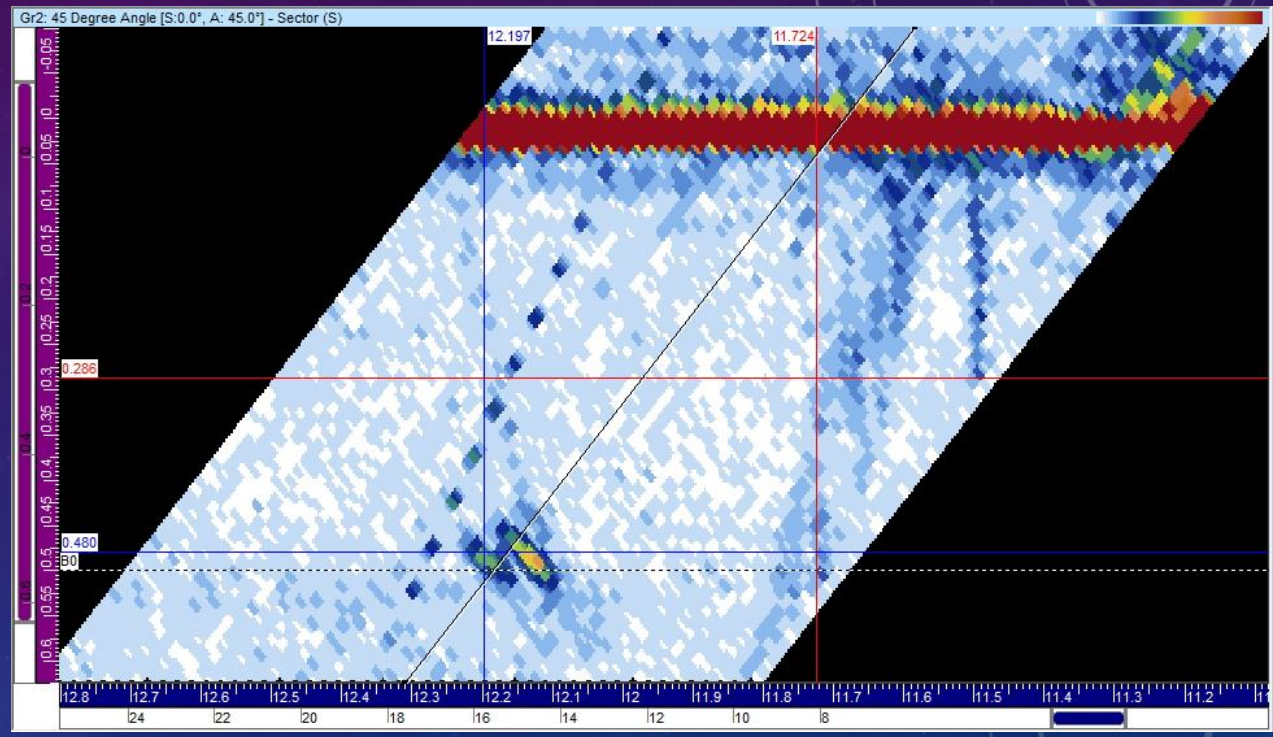


Electric Discharge Machining Notch Geometry

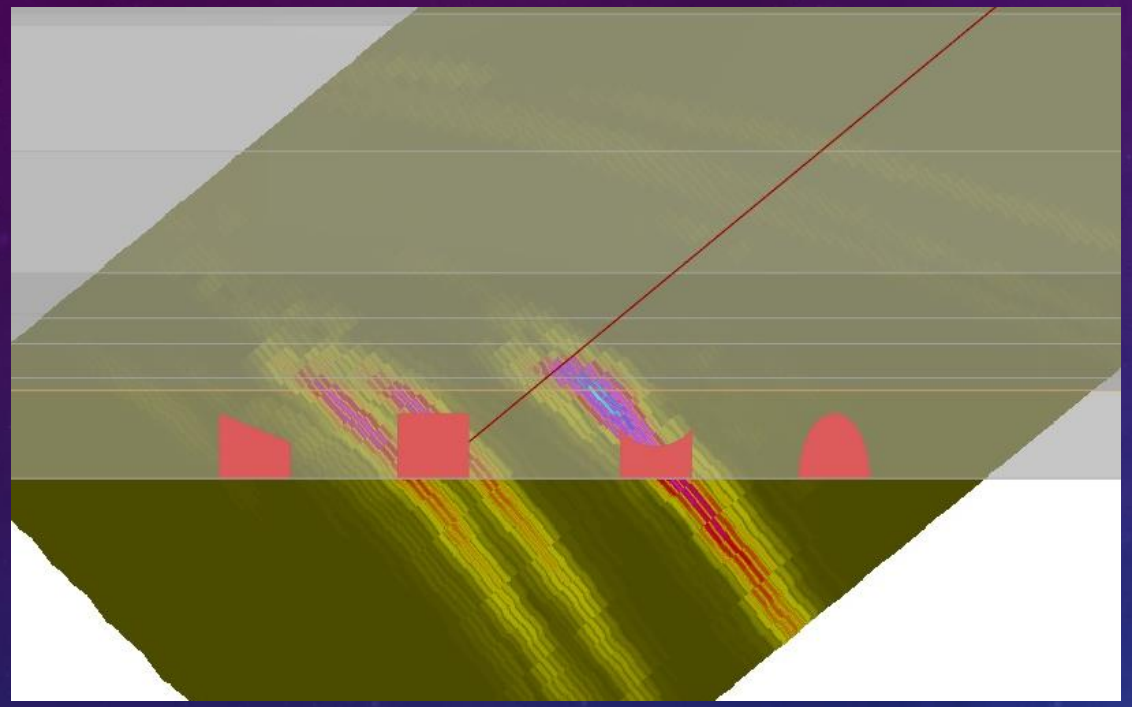


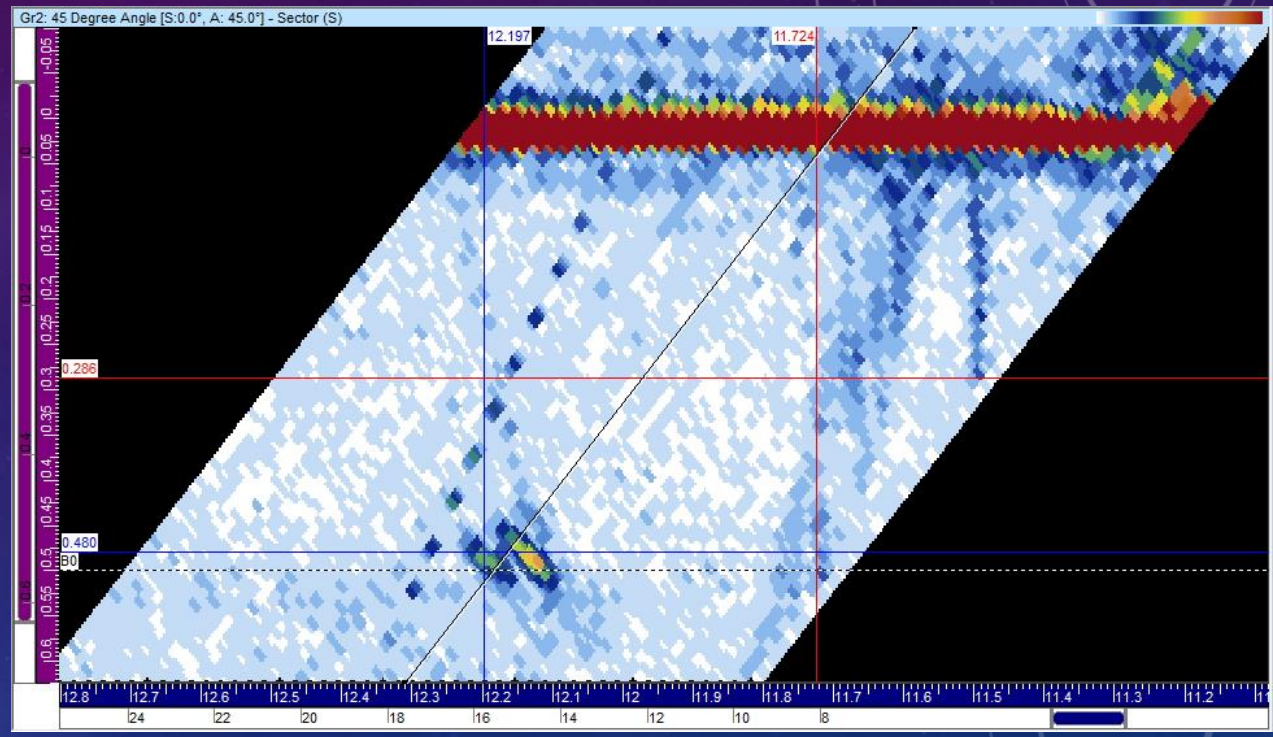
Electric Discharge Machining Notch Geometry





Electric Discharge Machining Notch Geometry



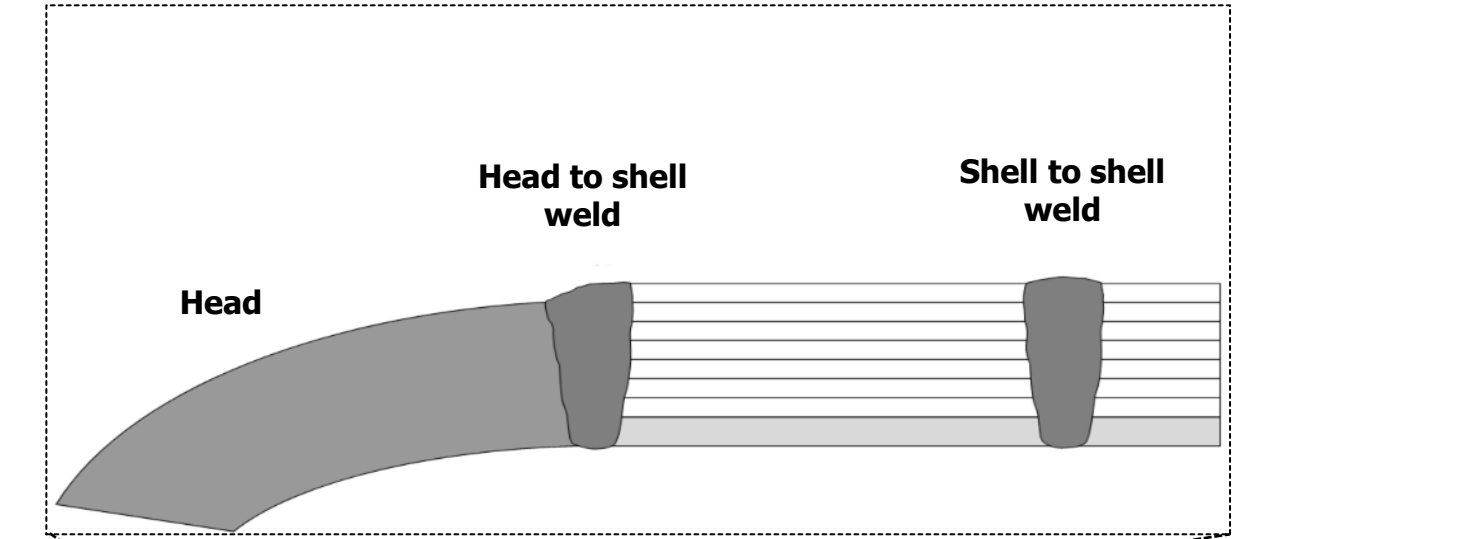


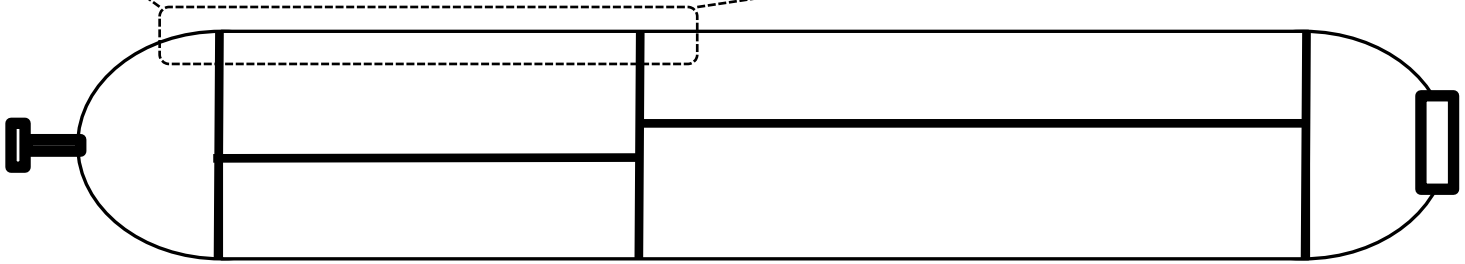
2. You can perform the inspection, but don’t know how.

Example: Inspection of high capacity multi layer pressure vessels

High Capacity Multi Layer Pressure Vessels

Layered Pressure Vessel

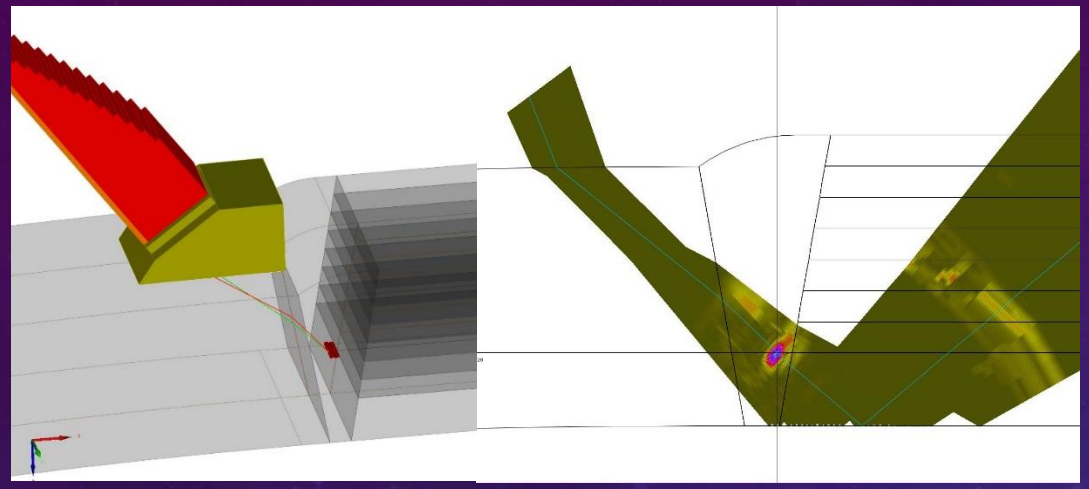




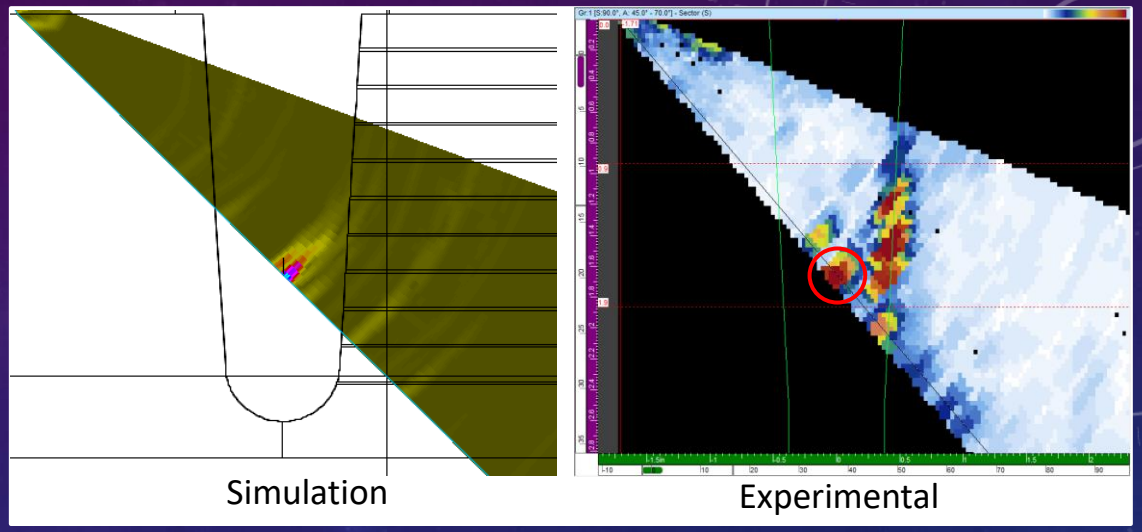
Layered Pressure Vessel

Shell to shell weld cross section

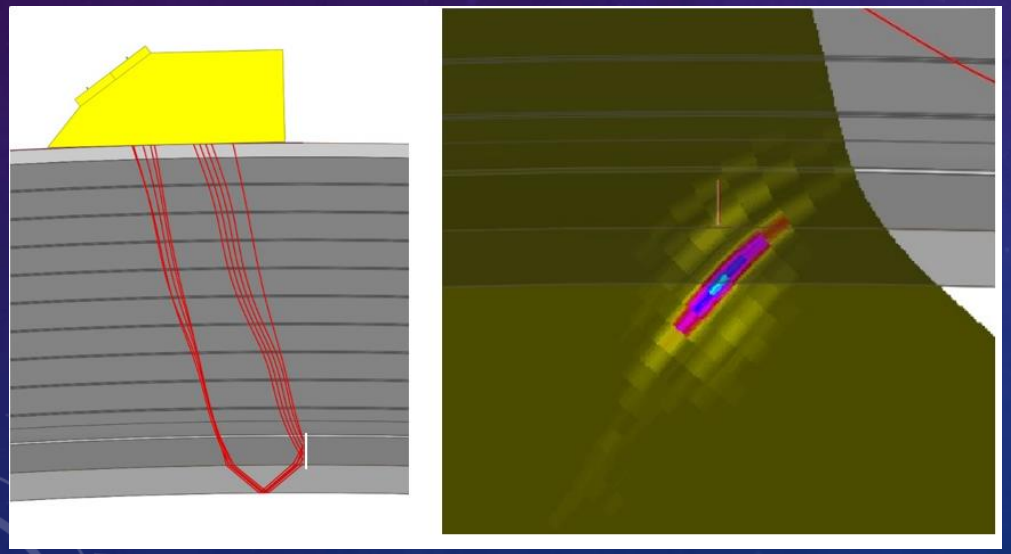
LPV Simulation Results



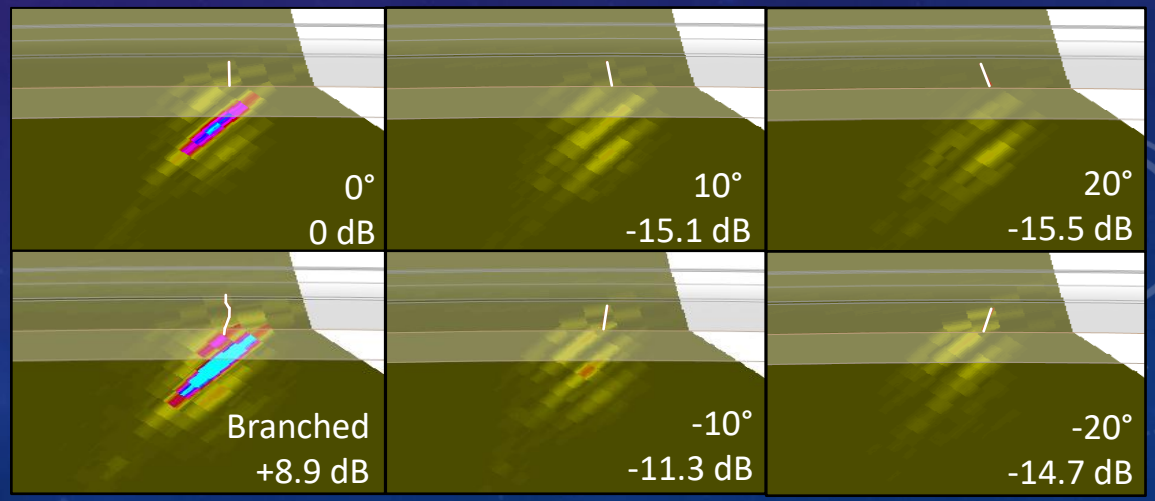
Simulating PAUT for finding a weld crack in a head to shell weld.



Validating simulation against experimental results



Simulating finding a weld crack in a shell to shell weld.

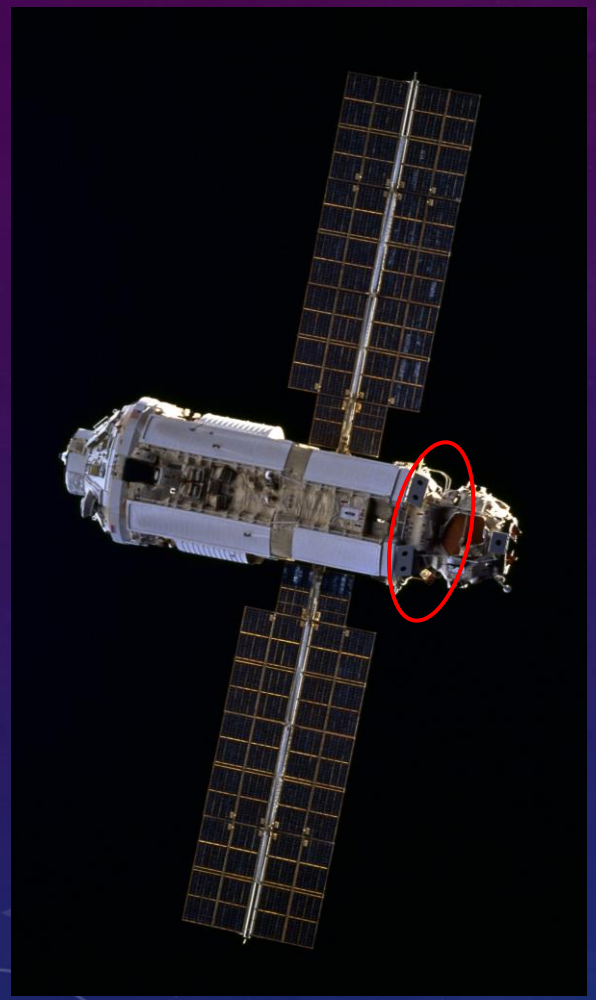


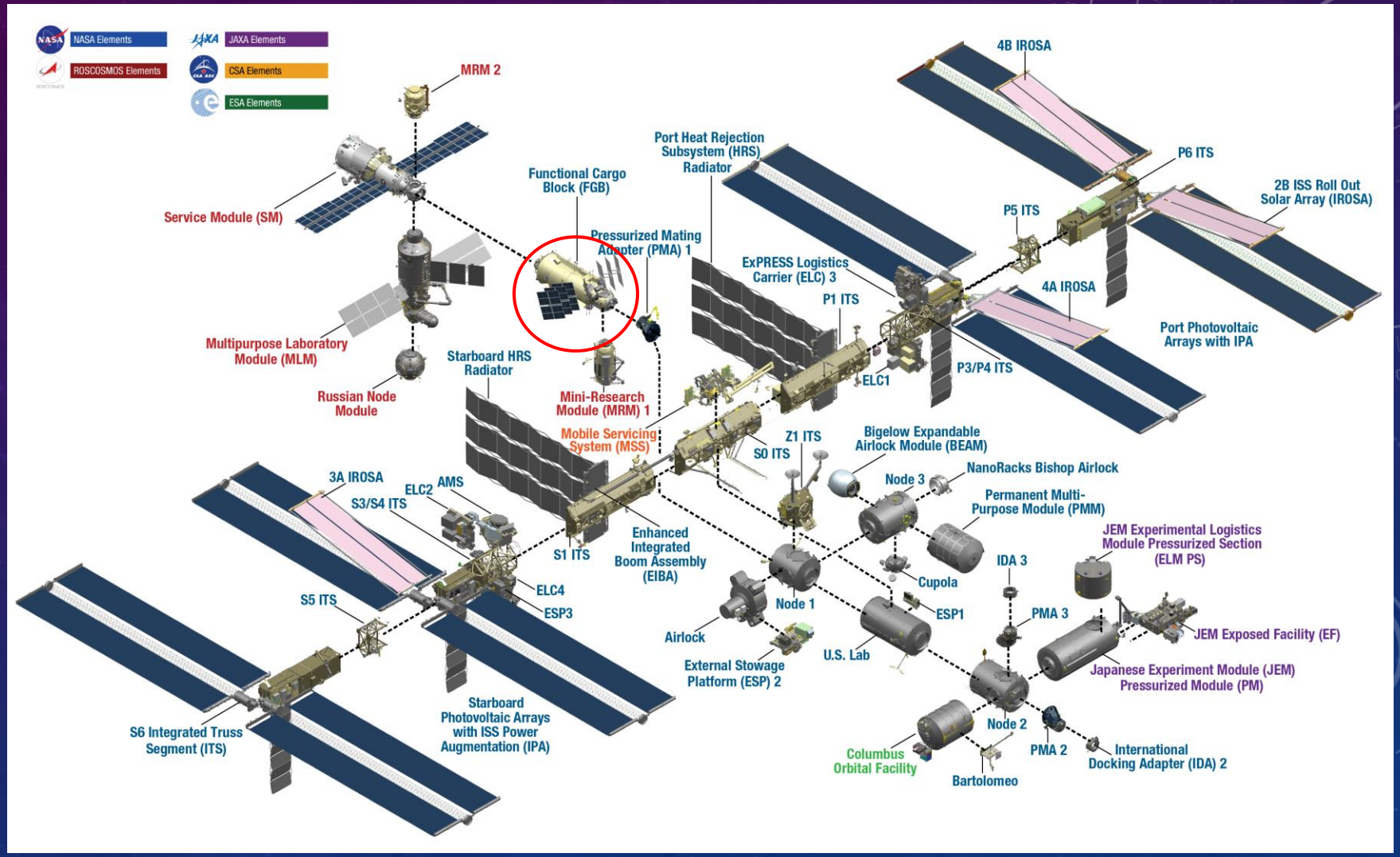
Testing effects of crack angle on signal response strength

1. You can’t physically perform the inspection yet

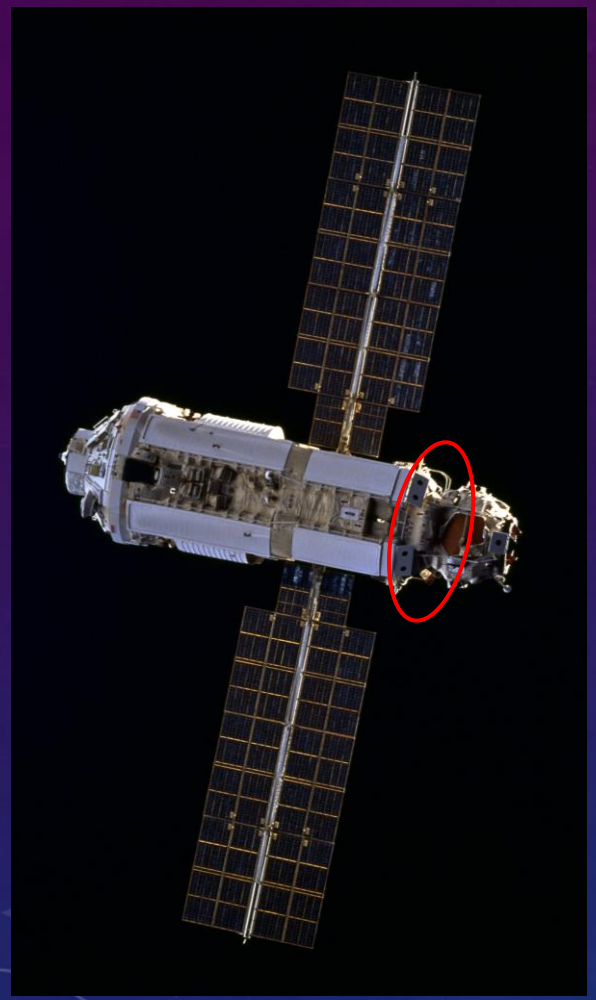
Example: On orbit inspection of welds on the International Space Station

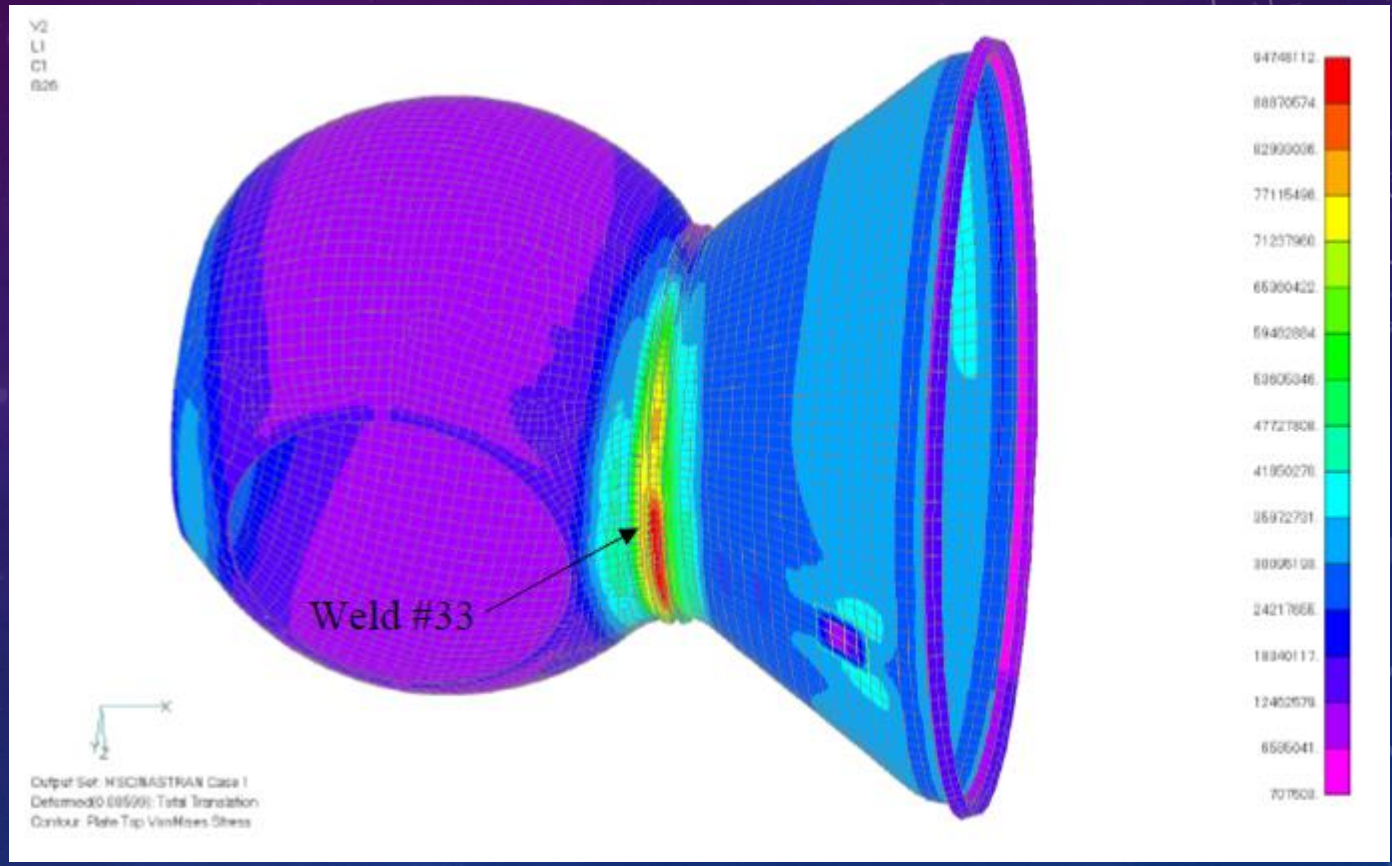
On-Orbit Inspection for the International Space Station



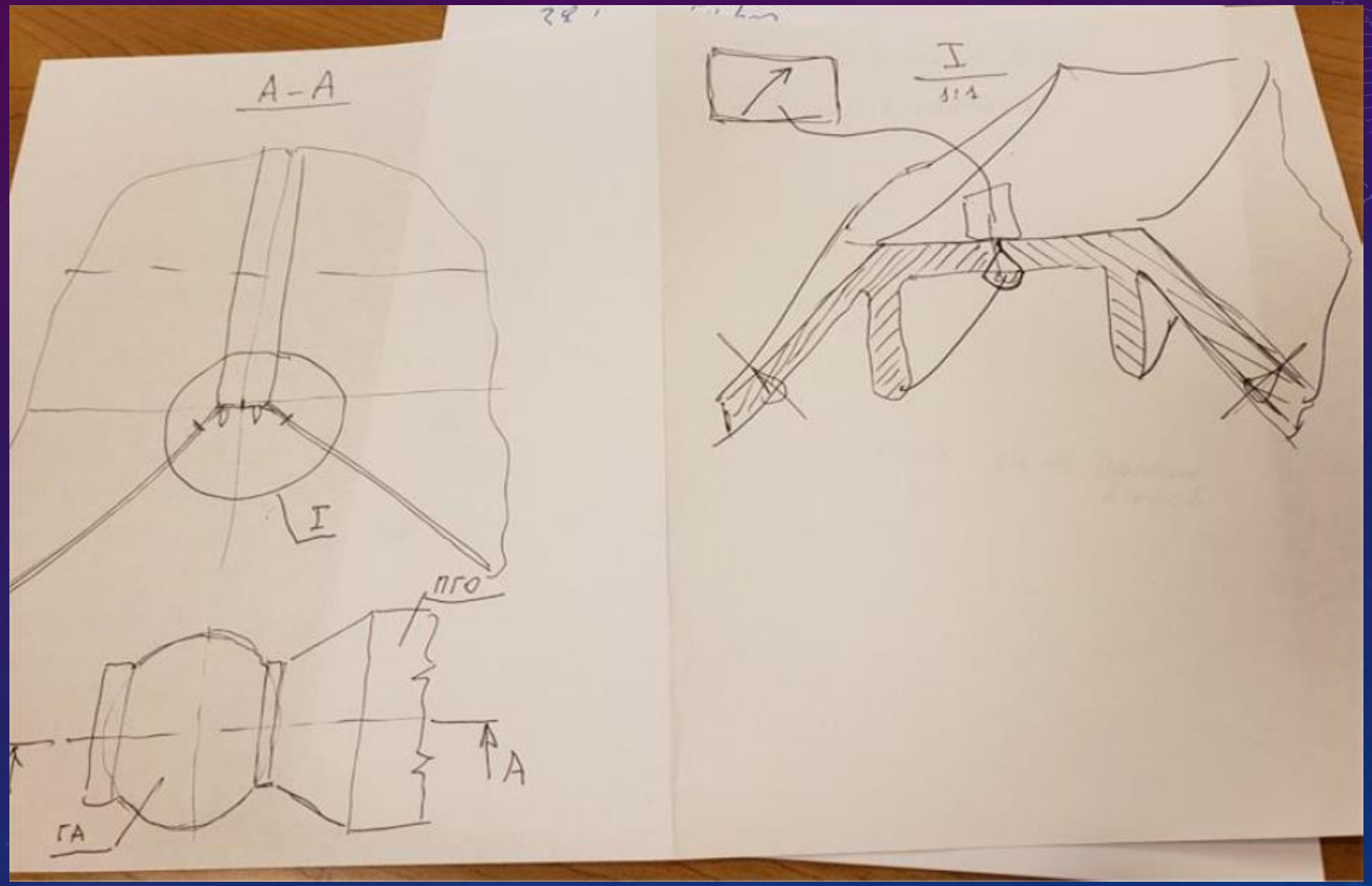


On-Orbit Inspection for the International Space Station



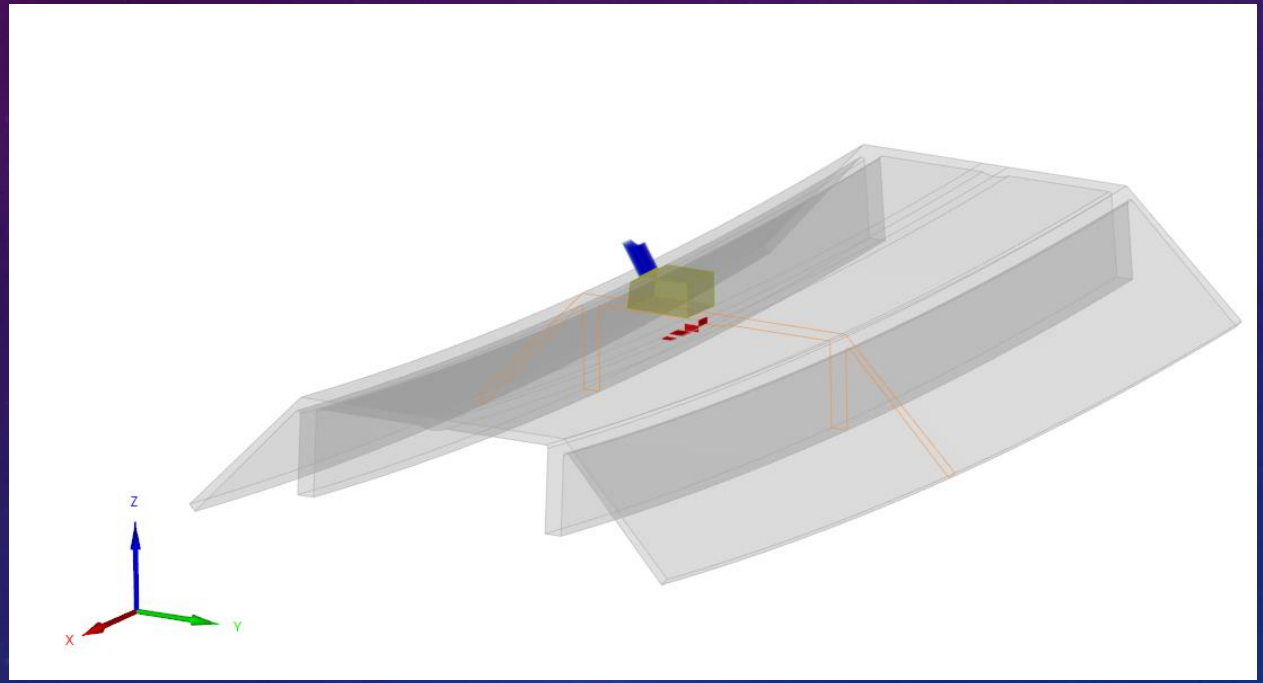


Working with incomplete information



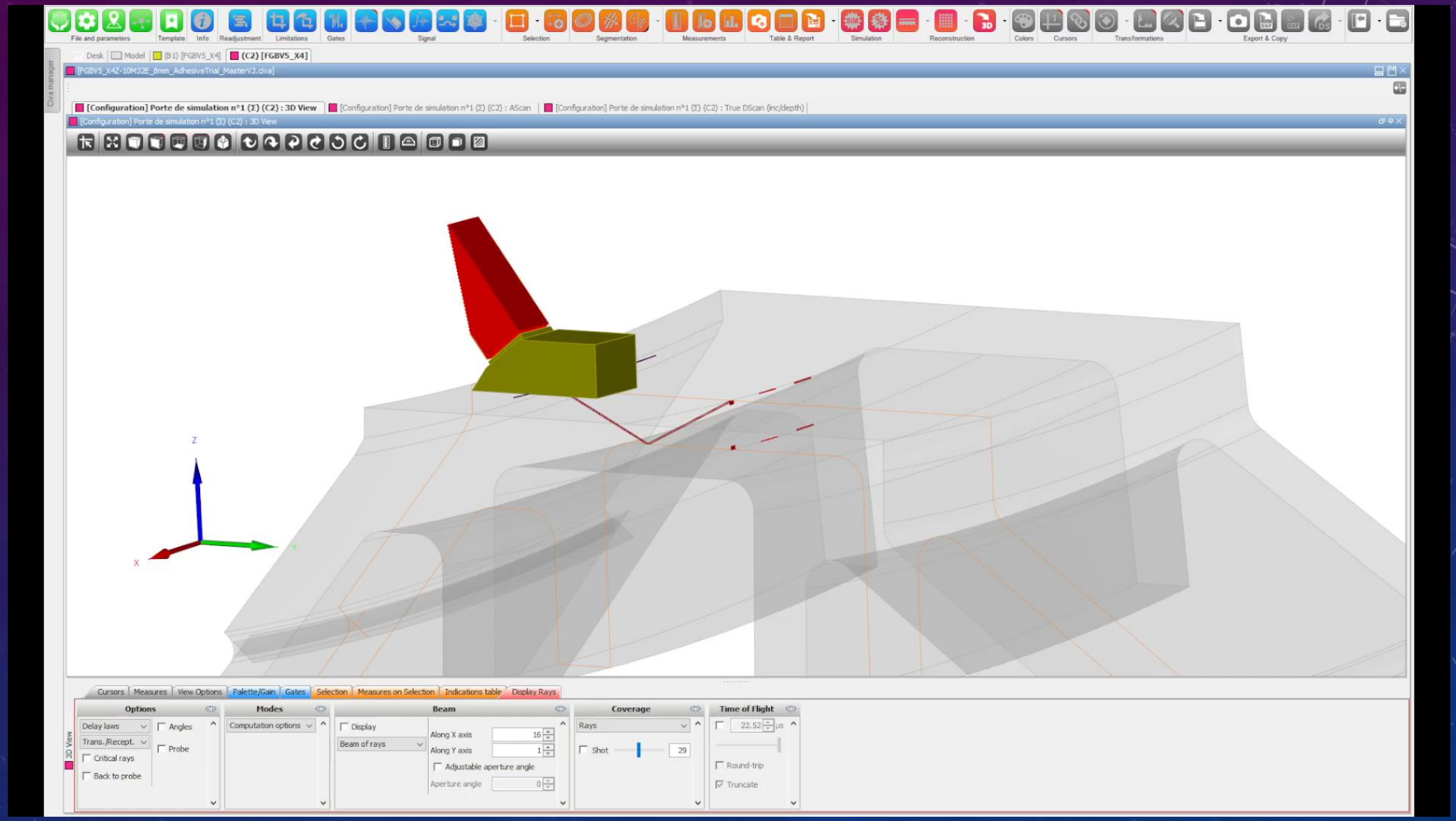
Working with incomplete information

CIVA Model Live Demo



Models used in these demos are not the same as the real structure, just artificial representations. These were generated to demonstrate the concept.

CIVA Model Recorded Demo



Summary

Numerical simulation of inspection has been the subject of research for several decades. Only relatively recently has the technology matured to the point where we can start using these tools to integrate into and solve real world problems, we just need to figure out the best way how.

Simulations offer several new and expanded capabilities, including:

- Reduce time by finding the optimal equipment configuration, instead of trial and error
- Produce estimated results to help prepare procedures and show inspectors what they can expect in the field
- Help plan for eventualities that would normally cause delays
- Help process the data by matching inspection results to simulated defects (inverse problem)

Things that we need to work on to further mature the application NDE simulations

- Optimize integration into existing workflows
- Focus and filter strategy for result delivery, making cross-discipline communication more efficient
- Rapid and efficient verification/validation (V&V) strategies, and identifying what we can do prior to V&V