ONET TECHNOLOGIES

Journée technique sur les CND robotisés
-13 octobre 2016-

COMEX NUCLEAIRE

3D analysis software for ultrasonic testing on a component with complex geometry

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CONTEXT

COMEX-NUCLEAIRE was awarded to develop and to implement on site an automated NDE-UT process to inspect the internal corner region of a “pipe to dome” nozzle of a nuclear component.

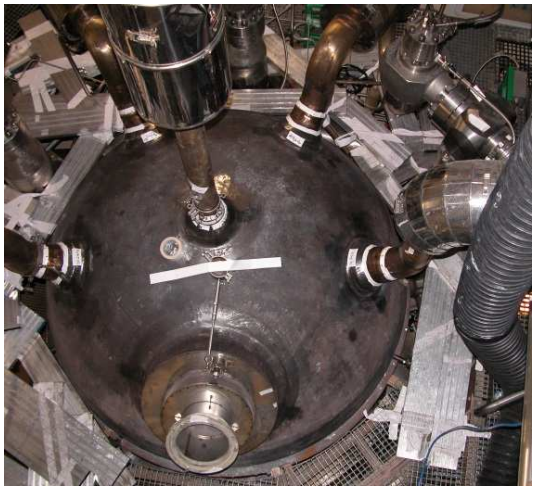
The project is engaged on exploratory basis (expertise mode) and is not submitted for qualification but NDE development has been instructed close to conventional qualification’s method.

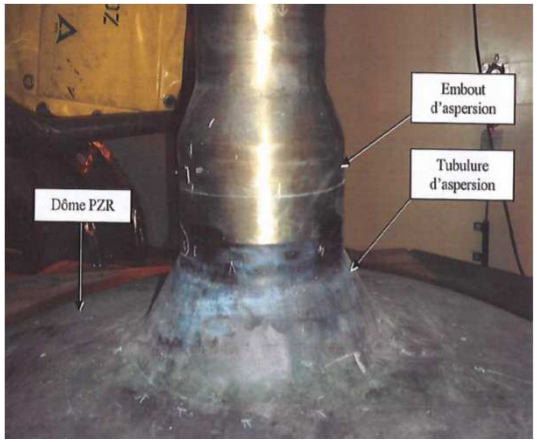
Inspection performed as part of the “defense-in-depth”. It does not search for particular defects but disorders are possible to first seek out in the radial plane of the nozzle (the most restrictive to the mechanical strength of the nozzle in the presence of discontinuities).

NDE implemented on 5 selected NPP (4 x 900MW NPP and 1 x 1450MW NPP).

COMPONENT

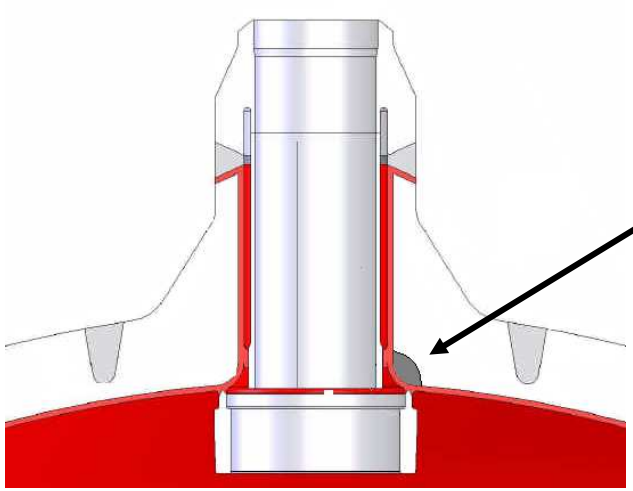
- Height: 15m
- Diameter: 2,5m
- Weight: 100T
- Material: low alloy steel (16MND5 type) with stainless steel internal cladding (AISI 308L/309L type)
- Nozzle Diameter: 4’’ or 6’’



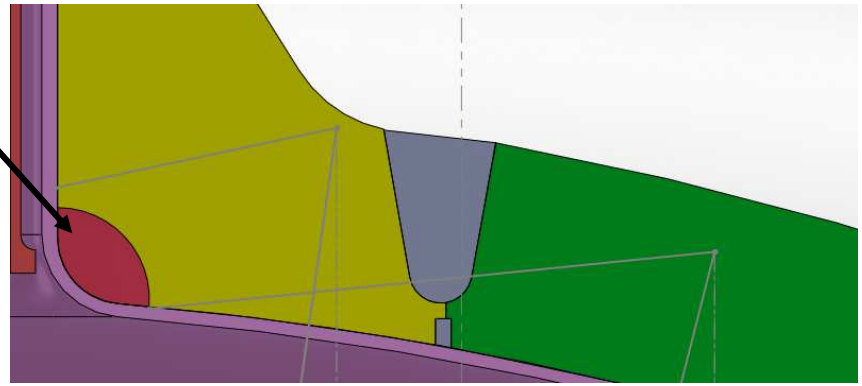


AREA TO INSPECT

NDE process needs insonification of an annular volume of at least 35mm in radius at the corner region of the nozzle, for 360° .



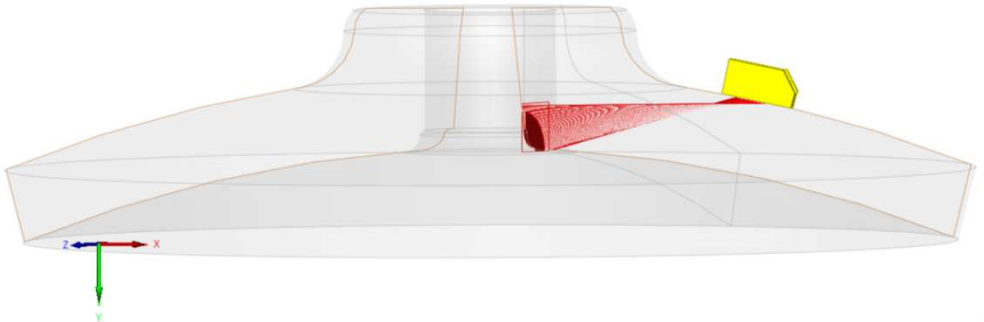
Area to inspect
R35 x 360°

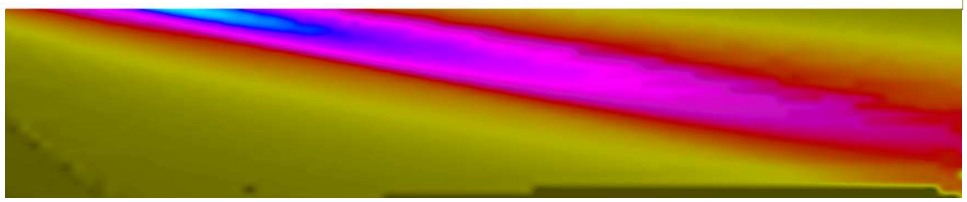


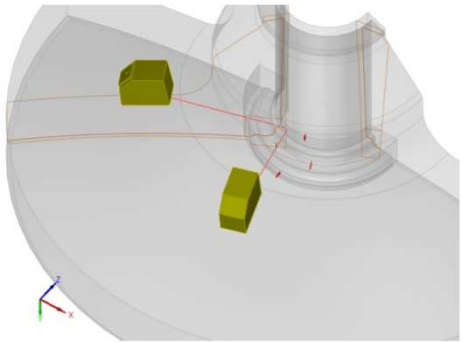
DEVELOPMENT – UT

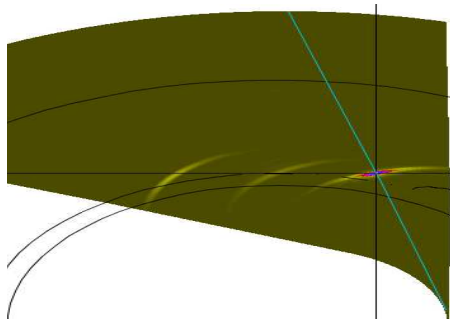
Development and design using **CIVA 10**

- Validation mockup modeling
- Defect implementation
- UT probe definition
- Refracted et skew angles
- Frequency
- Size of the crystal
- Scanning movements
- Analysis of UT indication responses





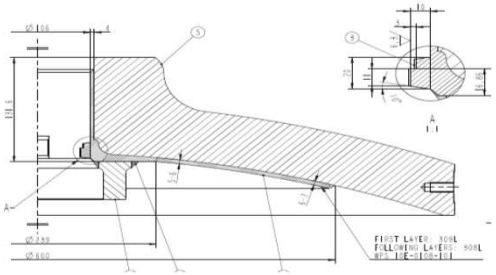


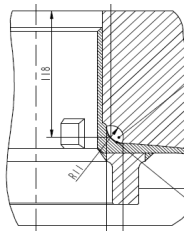
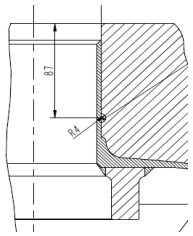
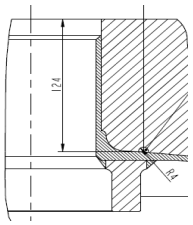


DEVELOPMENT – VALIDATION MOCKUP

- mockup : representative of a 900MW NPP configuration of the upper part of the dome and nozzle, including cladding and pins. A 4'' pipe is added to support the scanner.

Some EDM notches were manufactured in dedicated area of the mockup, top, middle and bottom of the **R35** area to inspect, with variable tilts and skews. Some surface defects were also performed.

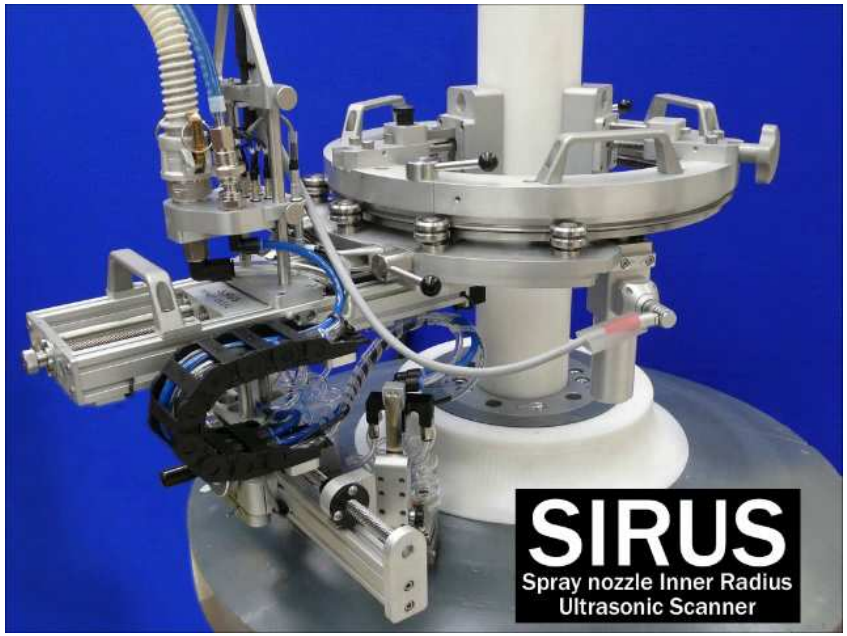


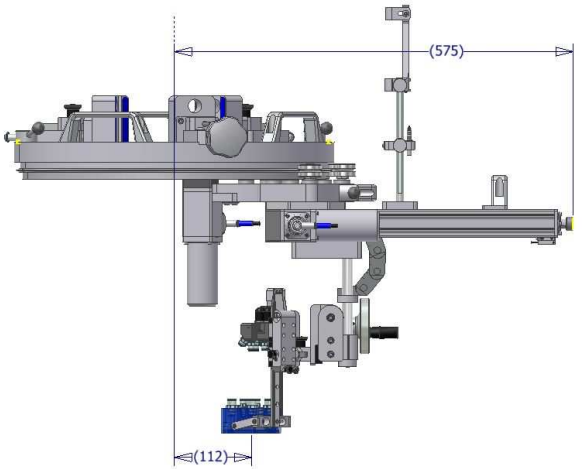
Critical blind planar defect, in radial direction from axis of pipe, located in the middle of area to inspect.		*Blind planar defect, in radial direction from axis of pipe, located in the upper part of area to inspect*		*Blind planar defect, in radial direction from axis of pipe, located in the lower part of area to inspect*	
Radius= 11mm / width= 200µm Surface: 190mm²		***Radius= 4mm / width= 200µm Surface: 25,1 mm²***		***Radius= 4mm / width= 200µm Surface: 25,1 mm²***	

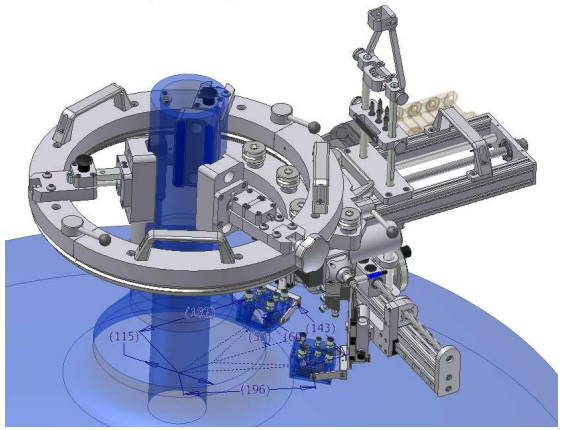
DEVELOPMENT - SCANNER

For the inspection of this nuclear component, a scanner named **SIRUS** was developed.

Spray-nozzle **I**nner **R**adius **U**ltrasonic **S**canner

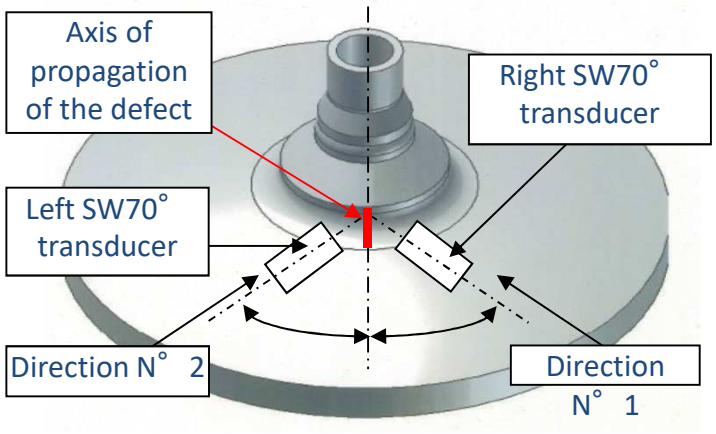






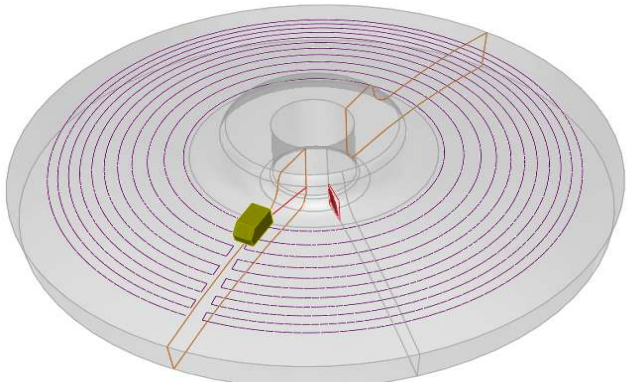
UT CONFIGURATION

Probes are using **45°** & **30°** skew angle from axis preferentially searched defect propagation (radial from the axis of the nozzle).



This configuration will:

- Ensure maximum cover of the area to inspect
- Optimize the “corner echo” and specular effect
- Confirm the presence of an indication according to 2 different directions of inspection
- Optimize the reflectivity of an indication with orientation



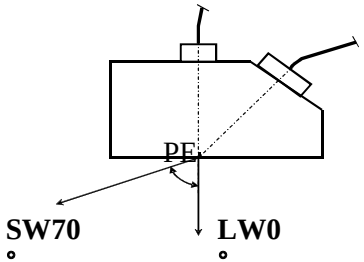
UT CONFIGURATION

Complementary inspections

Complementary inspections are performed with **45°** angle skew (and different probe separation values). Aims of these configurations are:

- to accurately cover top and bottom of the area to inspect
- to confirm the indication by varying skew angle ±15°
- to obtain complementary information for the characterization of the indication (confirmation of diffraction echo, sizing, artifact/defect discrimination, etc)

To monitor the ultrasonic coupling, a 0° Longitudinal Wave probe is embedded with the 70°

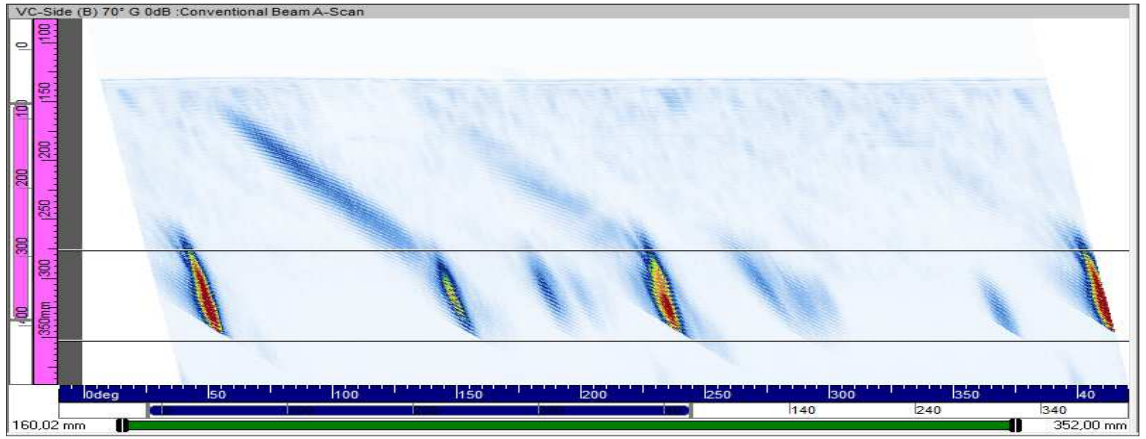


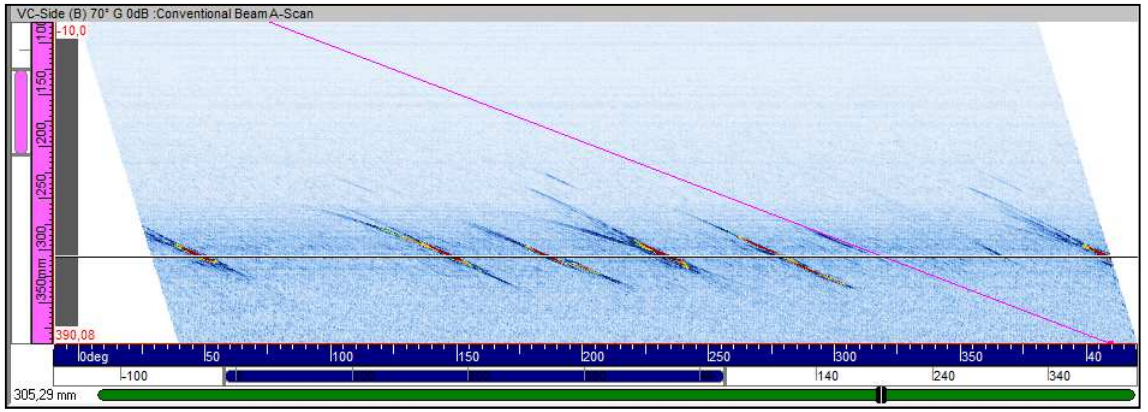
UT DATA ACQUISITION

Data ACQUISITION is performed using **Advanced UT System** and **UT Analysis** software with 3D module.

Data from all inspections (skew 30° and skew 45°) are used for the analysis, with :

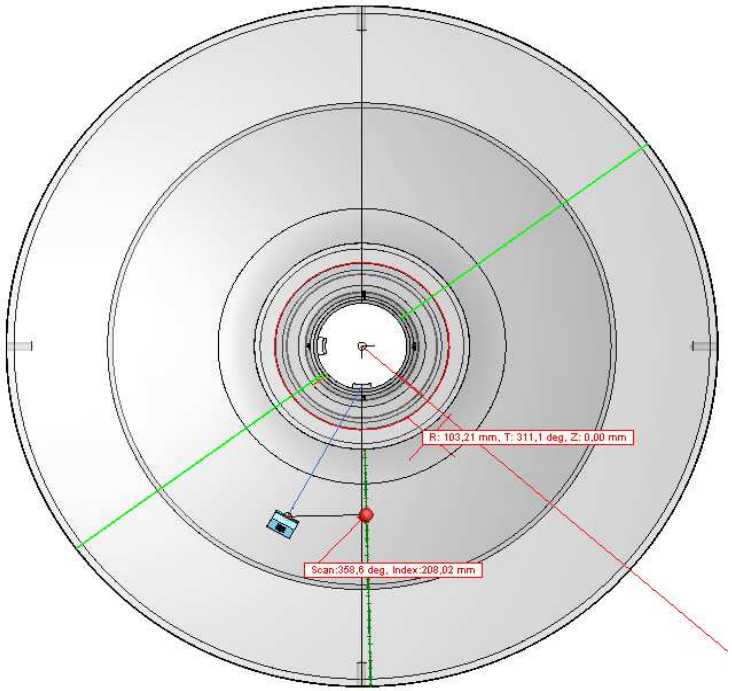
- A-scan
- B-scan
- C-scan



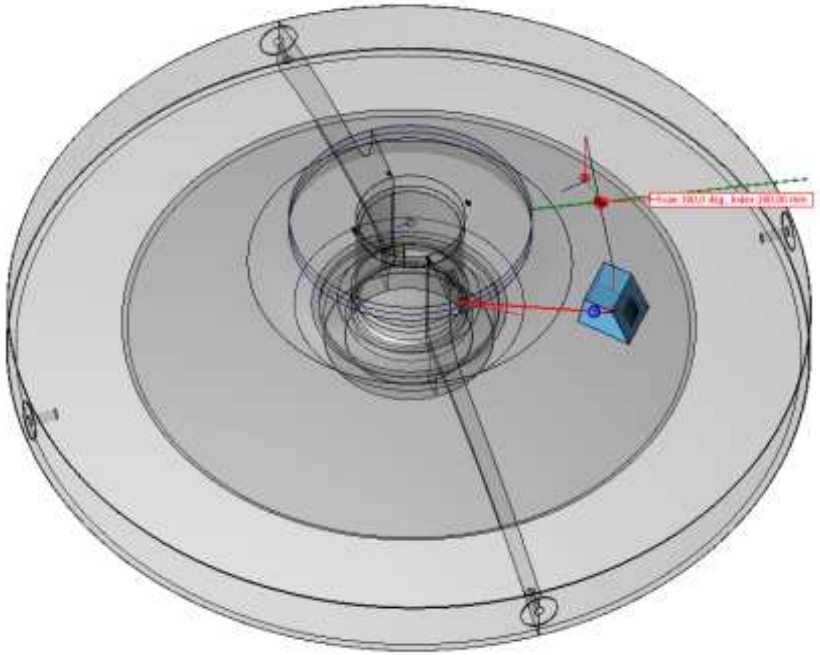


UT DATA ANALYSIS

- Component setting
- Scanner setting

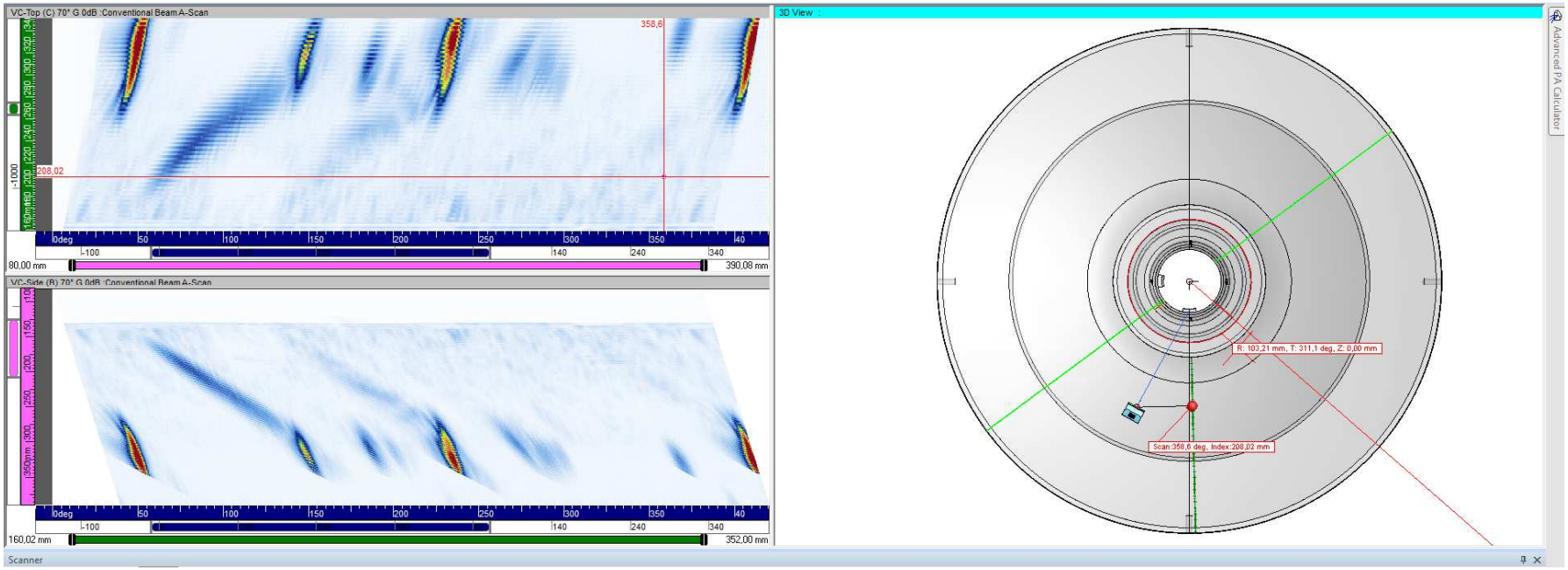


- UT setting
- Displacement setting



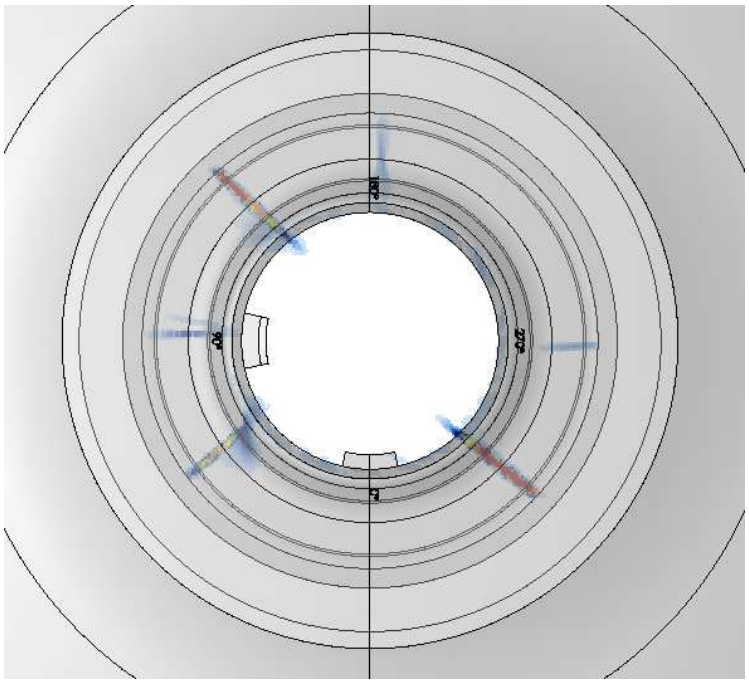
UT DATA ANALYSIS

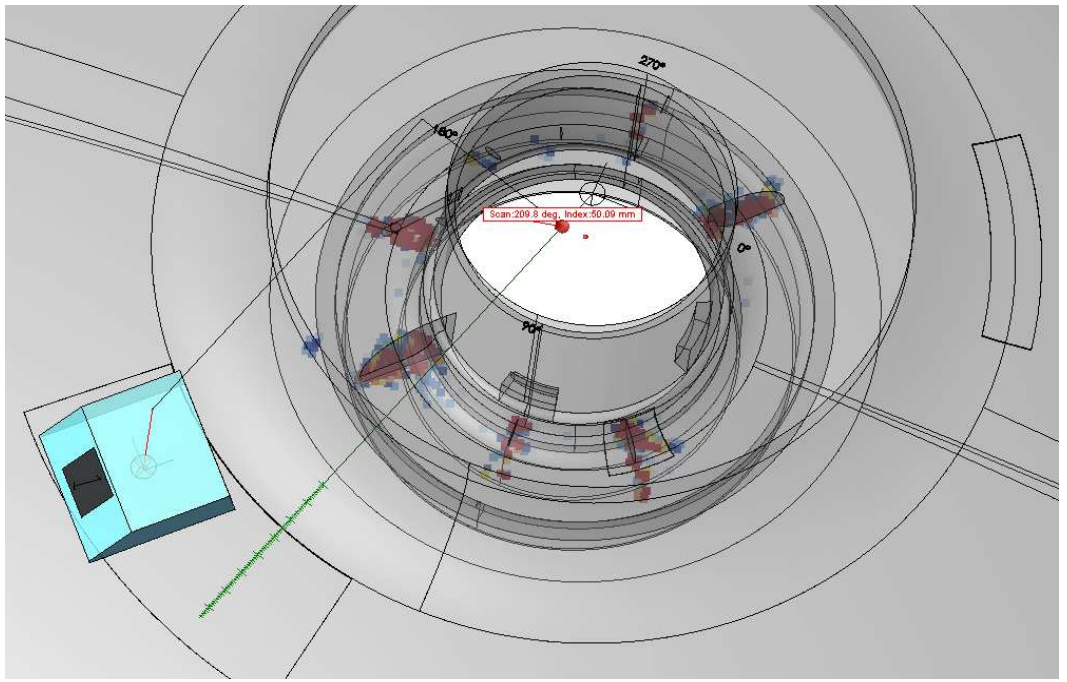
Threshold configuration



UT DATA ANALYSIS

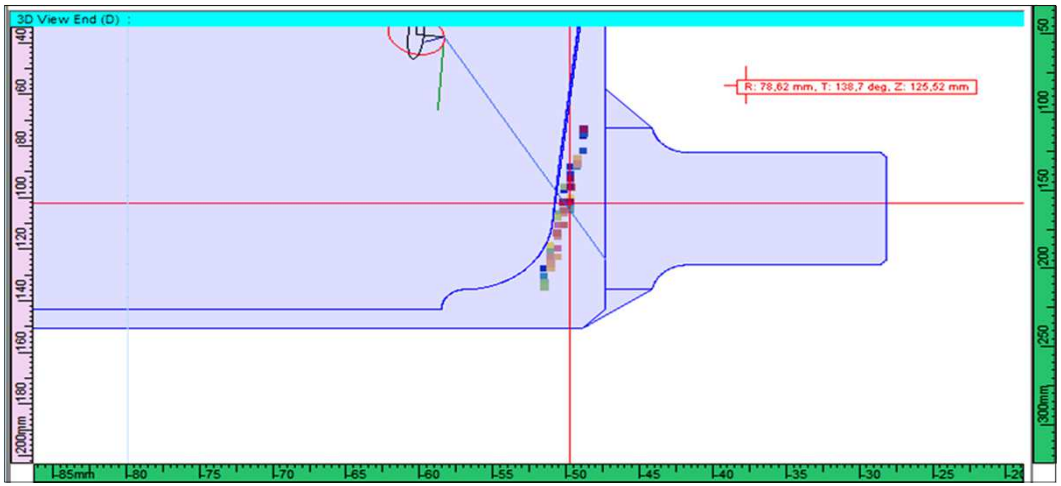
3D plot

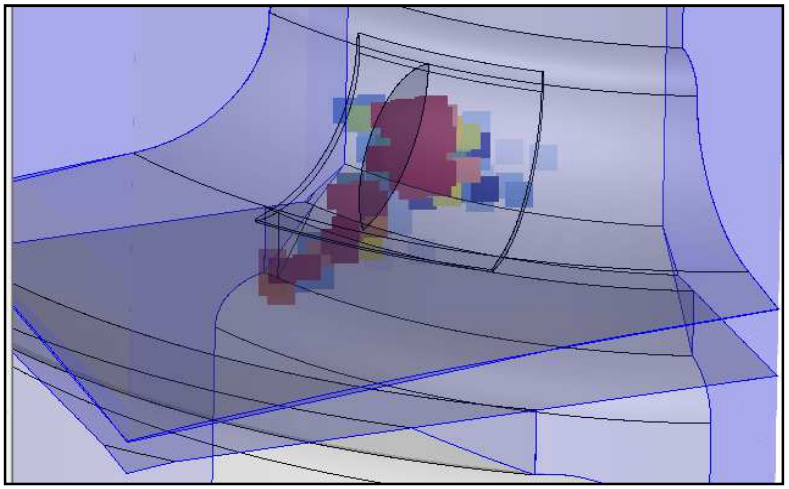




UT DATA ANALYSIS

3D plot





CONCLUSIONS

Advantages in using 3D analysis software tools for an inspection in complex geometry:

- localization of the indication in the area to inspect.
- time of flight (beam path)
- reflectivity of the indication
- sizing of the indication
- Discrimination artifact/defect

Thank You

Questions ?