CAD MODEL UPDATE ON AS-BUILT GEOMETRIES WITH MORPHING TECHNIQUE: ITER WINDING PACK

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Introduction

In the industry 4.0 Digital Twin models, together with Reverse Engineering techniques, allow tracking components performances during production and along the component lifetime.

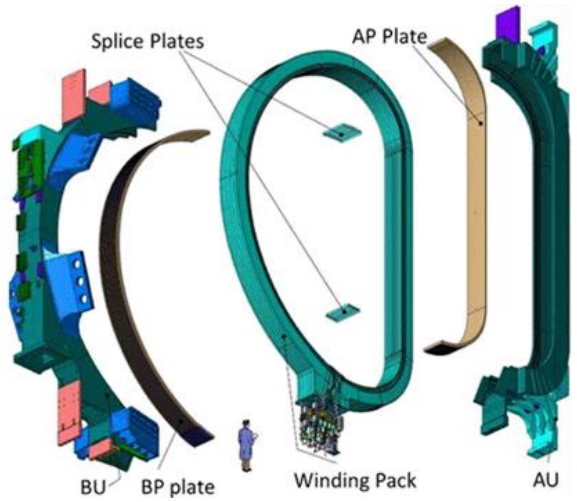
RBF mesh **morphing technique** is a valuable alternative to conventional RE techniques:

- capability to produce an updated shape with the initial **CAD topology**
- reduced **computational time**
- possibility to generate a displacements field without a **reference geometry**

Introduction

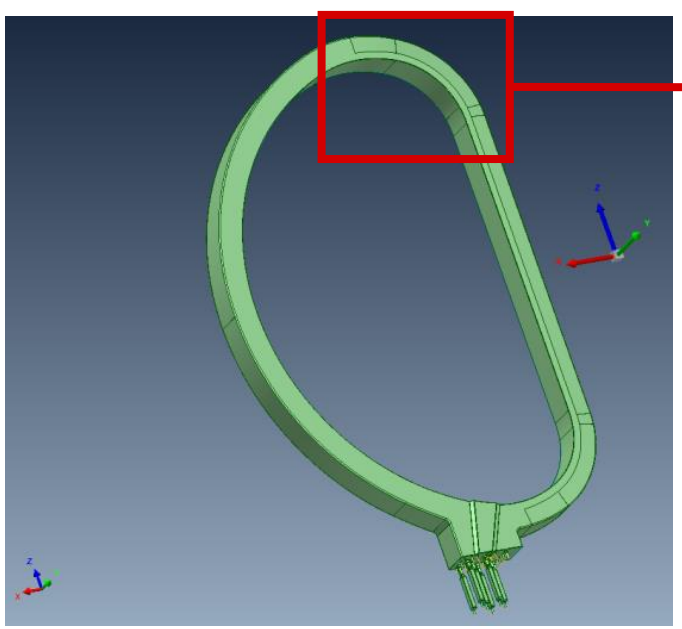
In the TFC assembly stages a comparison with the as-built geometries of the sub-components is often needed.

Development of a workflow for **CAD/CAE as-built model generation** by the usage of Reverse Engineering techniques in conjunction with mesh morphing, providing a tool for the control of ITER components in the manufacturing phase.

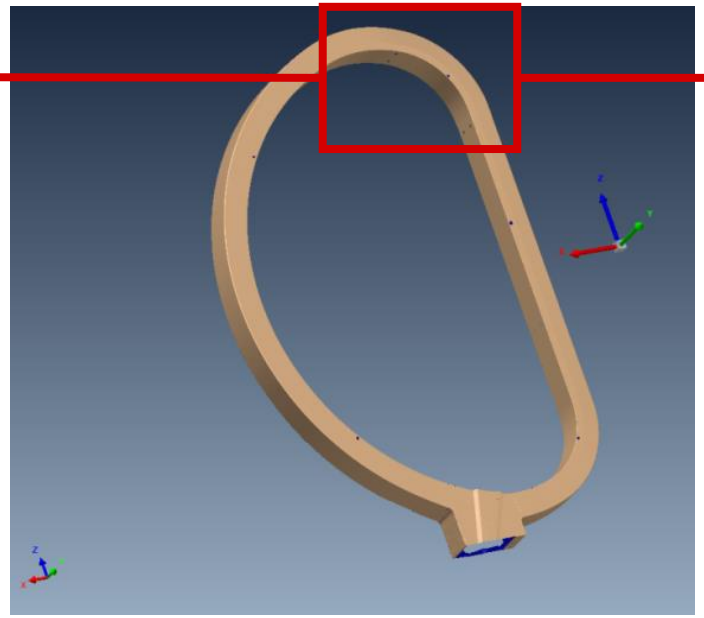


Testing environment

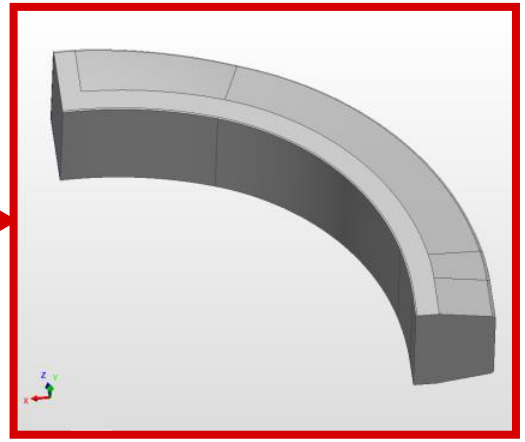
A portion of the Toroidal Field Coil Winding Pack has been used in the test:



CAD nominal



Scan data



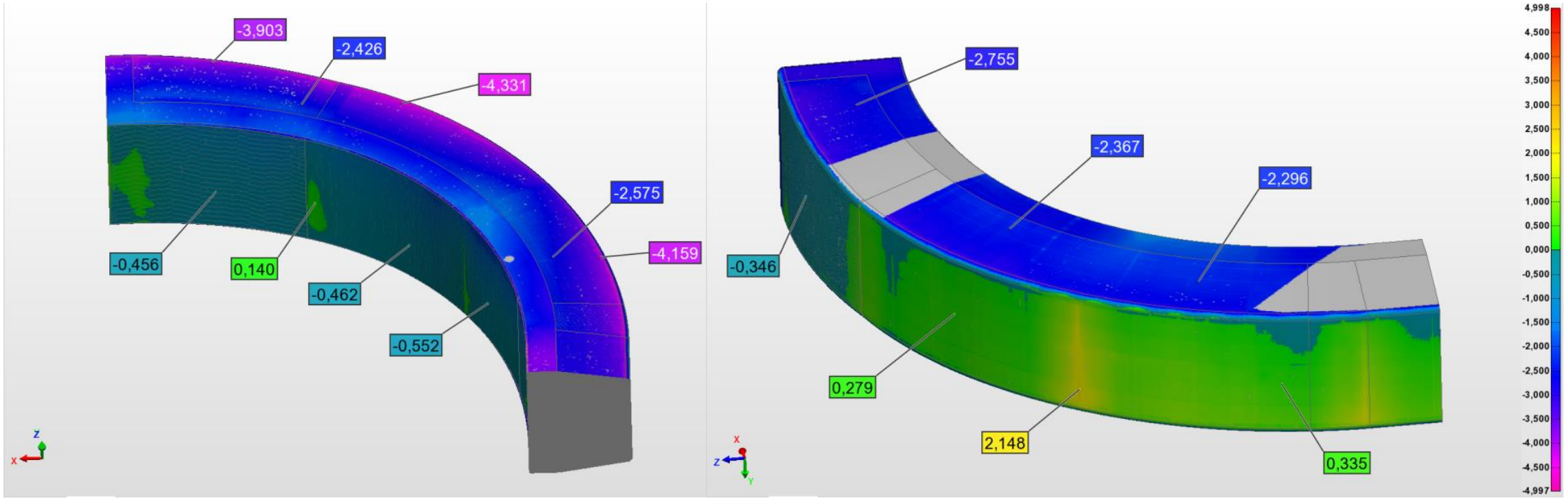
Sample part:

- Several surfaces
- Section transition

Scan process uncertainty: ± 0.1 mm

Scan data deviation from nominal CAD

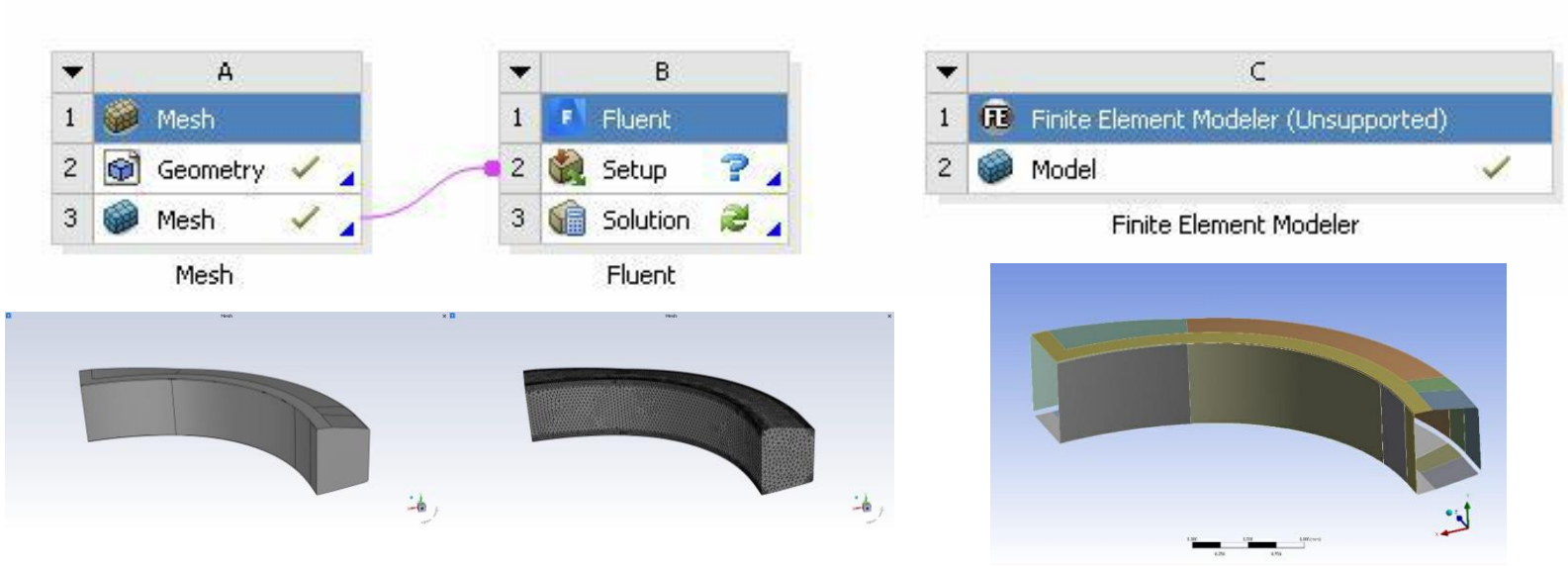
Top and bottom surfaces are thinner than nominal due to optimization of the Double Pancakes stacking.



Morphing setup

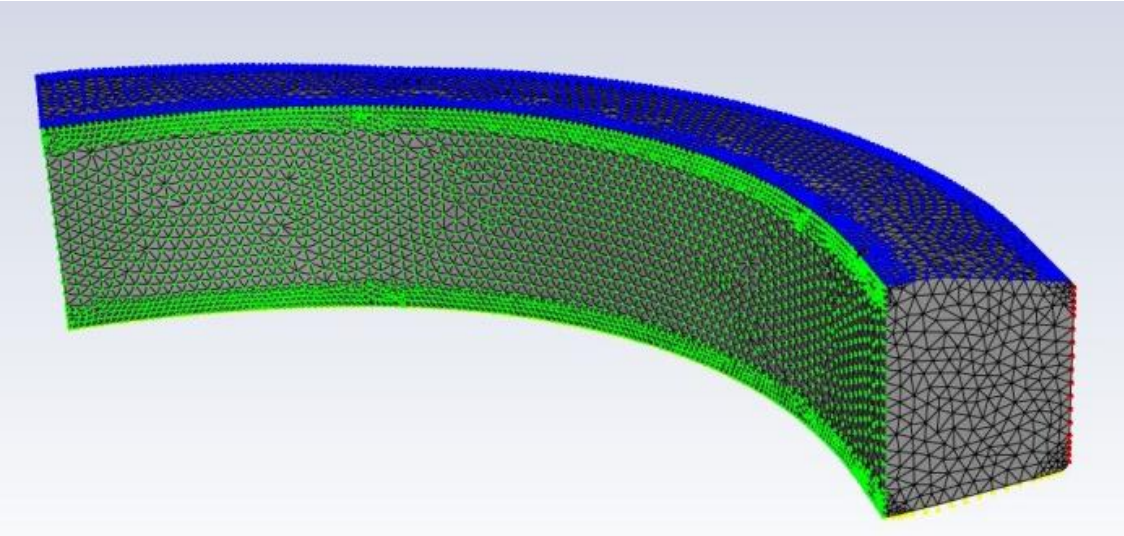
The Workbench routine foresees the following steps:

- Generation of a mesh from the CAD nominal geometry (A)
- Morphing of the mesh on the actual scan data (B)
- Reconstruction of the CAD model from the morphed mesh (D)



Morphing setup

Four sets of nodes are used to control the morphing of the component.



Mesh details:

340k nodes

Overall element sizing: 0,05 m

Morphing details:

Type: STL target

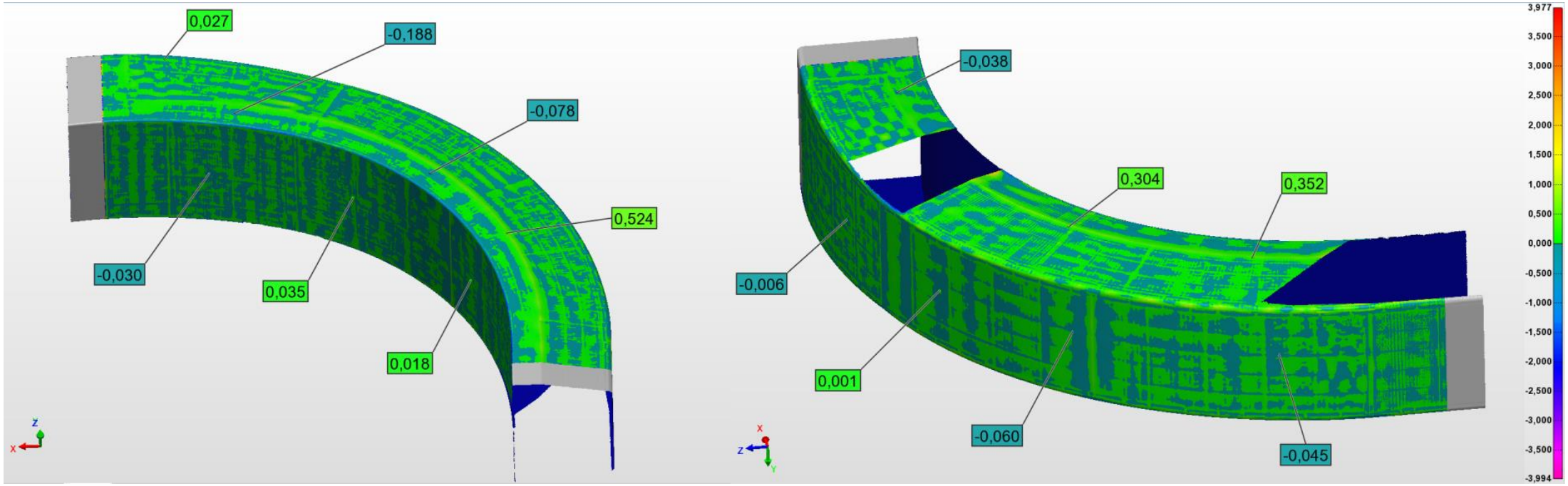
Scan points sampling distance: 0,02 m

Top nodes and bottom nodes sets: displacement of 2-4 mm to adapt to the scan

Inboard nodes and outboard nodes sets: 0,5-2 mm adjustments

Scan data deviation from morphed CAD

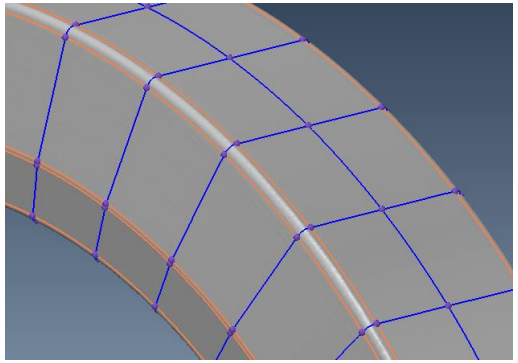
The morphing and surfaces reconstruction respected the initial CAD topology, and adapted it to the actual manufactured shape.



Scan data deviation from morphed CAD

Results are comparable to conventional RE methods (NURBS patching)

Method	CAD morphing	NURBS patching
StdDev	0.221 mm	0.087 mm
Pts within +/-(1 * StdDev)	86.41%	82.36%
Pts within +/-(2 * StdDev)	94.60%	94.99%
Pts within +/-(3 * StdDev)	97.58%	98.22%
Pts within +/-(4 * StdDev)	98.64%	99.28%
Pts within +/-(5 * StdDev)	99.26%	99.68%
Pts within +/-(6 * StdDev)	99.69%	99.85%



NURBS patching method

Conclusions

RBF mesh morphing guarantees high accuracy and flexibility in geometrical reconstruction problems providing the capability to significantly reduce the effort if compared to a model reconstruction procedure adopting RE software.

The morphing procedure can be applied when deviations of the manufactured components from the nominal do not require the generation of new features.

Future applications entail the possibility of the implementation of both methodologies in a RE workflow.

THANK YOU FOR YOUR ATTENTION!

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