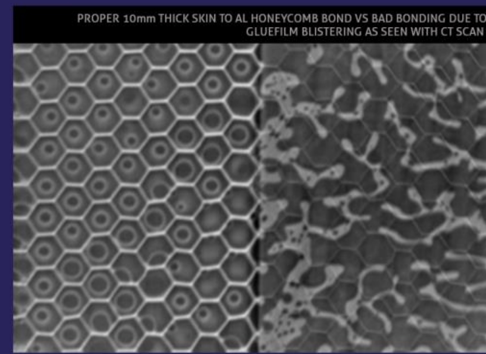
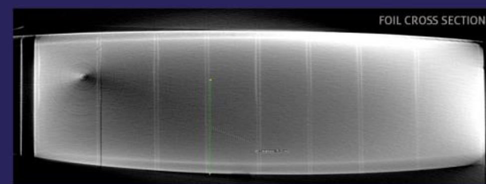
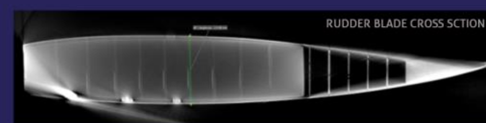
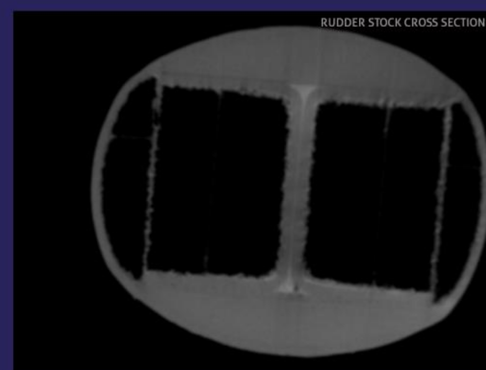
TOMOGRAPHIC INSPECTION OF A FOIL

Newsletter oct.2020









New NDI frontiers for foils inspection

History of the Inspection

QI COMPOSITES

1999-2019

20th anniversary

New NDI frontiers for foils inspection at QI Composites

Even if the hydrofoil technique has been known for over 70 years, it is only with the recent editions of the America's Cup and Vendee Globe that research and engineering experimentation are growing really fast. Carbon fiber materials enable to produce resistant and very light wing foils producing a vertical thrust lifting the boat from the water. Boats can get a significant increase in speed (up to three times the one of wind) drastically reducing the hydrodynamic drag. Thanks to the use of composite materials it's possible to maximize weight containment and optimize performances.

It is widespread and consolidated practice, for the development and quality control of the production processes of composite components, the use of NDI (Non-destructive Inspection) in order to identify building and sailing defects and to characterise them to finally decide their conformity.

NDI techniques apply for two different purposes:

• in the production phase, for the development of the production process, the monitoring of the production process and the acceptance of the components produced;

• in the framework of inspections "in service", to monitor/ascertain the degradation of components in working conditions, ascertain any post-accident damage, and/or validate the correct repair.

This illustrates the important role of NDI techniques, which in other words, in production processes and structural diagnostics "in service" have the objective of providing information on defects/internal damage to components that could potentially affect both short-term behaviour (resistance, elasticity, etc.) and long-term behaviour (fatigue life, resistance to the environment, fracture mechanics, etc.).

Starting from the available technological panorama, the theme of the selection of the types of techniques to be used is first addressed. Such selection is inevitably subordinated to multiple considerations inherent in the geometries & dimensions of the components to be inspected, the materials and the production processes used in their realisation, the type of defects/damages expected, and finally estimates of time and cost associated with such practices.

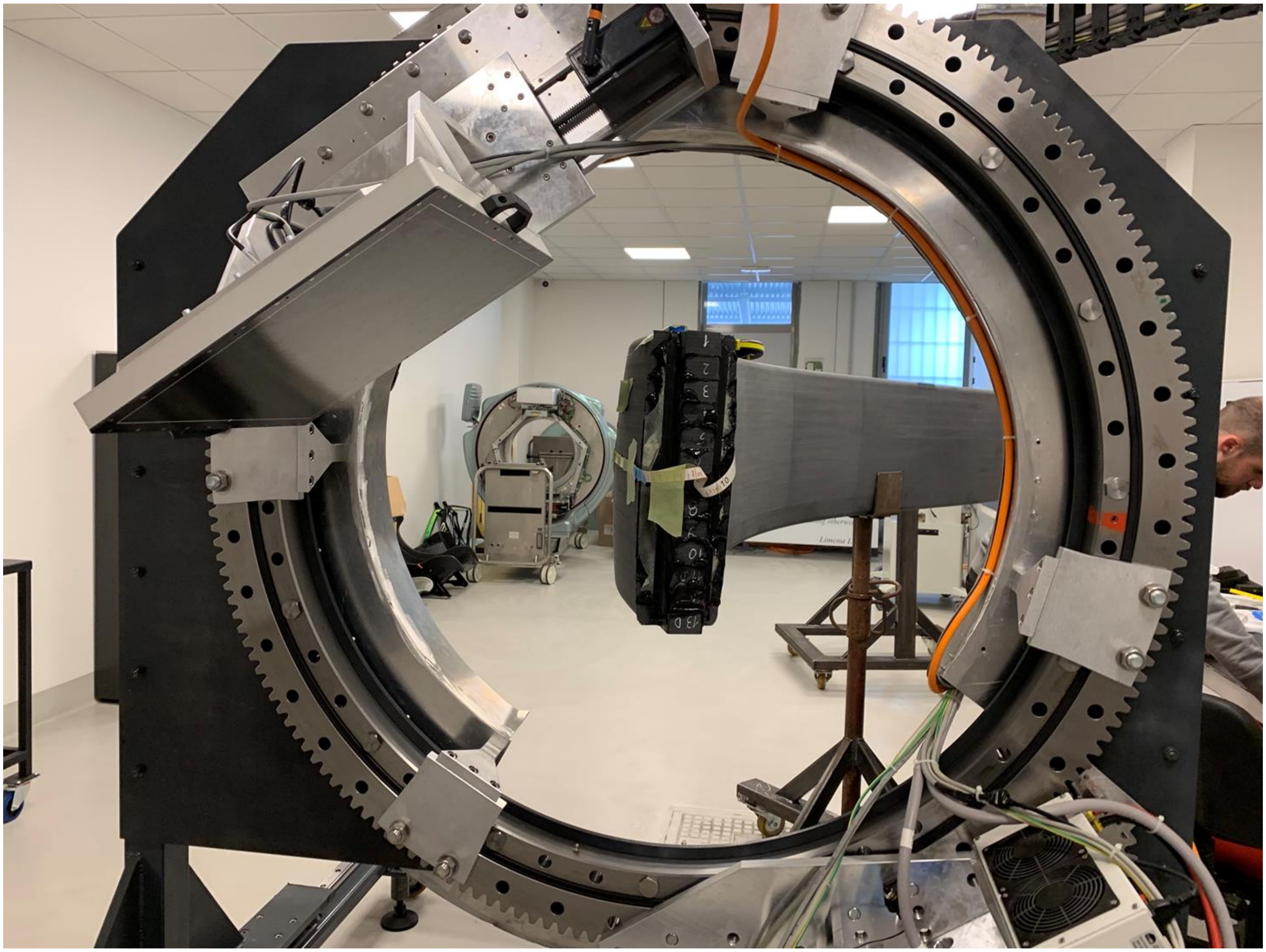
Beyond the already mentioned thermographic and ultrasound techniques, it is interesting to note that the tomographic one until today would be excluded, despite its excellent ability to detect different types of defects within structures and to identify sub-millimetric discontinuities. The cause of the exclusion is due to the construction characteristics of the typical CT instruments that are generally made with a suitably shielded box structure inside which there are an X-ray generator opposed to a sensor (detector) and in the middle a rotating plate on which the component to be inspected is placed. Such positioning, and the fact of rotating the object, impose limits on its shape and size. The CT systems commonly used enable to scan objects of volume inscribed in a cylinder of about diam=600 mm and l=1 mt. Of course, the most common primary structures in the marine sector are elongated in shape and far exceed the metre of length (for ex. competition foils).

So how can we fully benefit from the potential of the tomographic survey by applying it to real marine structures (and not sampling of a few decimetres)?

A clever solution is identified with STG-1 Model. This system was designed with an innovative configuration that enables the inspection of elongated structures of several meters, without being rotated. Although with a more complicated mechanics and acquisition system, the "gantry" configuration which sees X-ray generator and sensor opposite rotating around the object to be inspected, guarantees remarkable scanning opportunities. This kind of architecture is effectively solving the problem of the limitations posed by standard CT systems (closed-box), giving the possibility to take advantage of the benefits of tomographic scans also to sectors, such as marine - aeronautics, often characterised by large structures.

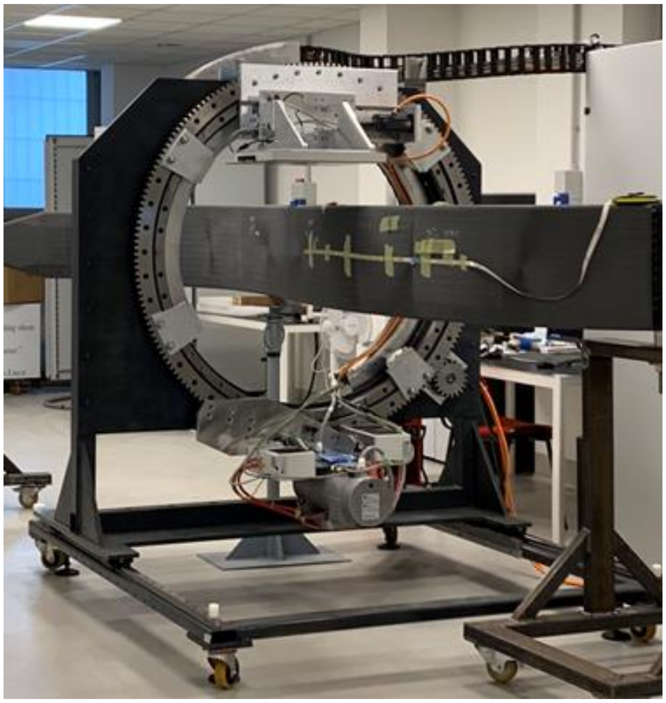
Another common requirement to various sectors of the industry is the timing of analysis and the usability of data. The racing world in particular needs very fast component lead times and test results must be available with the same immediacy. To meet this requirement too, the hardware structure of the STG-1 and the post-processing phase have been calibrated to be as efficient as possible and can ensure responsiveness in a few hours, in some cases minutes, since the end of the data acquisition.

The example in question concerns the scanning of a foil for racing boats with chord and a span of around 5 mt. The test was carried out in Venice with the STG-1 Plus equipment.



HISTORY OF THE INSPECTION

The foil was received 8:30 am and after about 40 minutes was unloaded, unpacked, positioned and prepared for inspection. After a quick warm-up procedure and the launch of the calibration cycle to verify the sensor/system settings, the scanning process was carried out.



9:35 am: start of scanning - sector 1.

11:50 am: launch the sector 4 scan, volume reconstruction of sectors 1-2 completed and file transfers for the post-process phase.

2:25 pm: scan phases complete, volume reconstruction of sectors 3-4 complete, post-processing of sectors 1-2 complete.

3:15 pm: foil out of the bunker and ready for delivery.

4:40 pm: wing delivered, volume reconstructions complete, post-processing activity about 80%.

6 pm: tomographic analysis complete. Defect mapping and sizing done, start drafting reports.

In summary, a team of 2 technicians (and an assistant for logistics), in less than 10 hours the inspection of a 5 mt long foil structure has been completed, from reception to delivery including all the Tomographic activities (scan-reconstruction-post-processing). Internal volumes have been carefully analysed ensuring the detection of defects starting from 1 mm in diameter. This examination has now been included by QI Composites in the validation cycle of all the ONE DESIGN ARMS made for the 36th America's Cup.

Resume of primary targets accomplished:

- monitoring of the qualitative level of production of the supplier (of the spars) through the precise identification of the shape-dimension-position of any relevant defects;
- dimensional check of the component (external surfaces) including any internal structures (spars, etc.);
- precise verification of the thicknesses in all areas of the component, with a 3D map;
- defect assessment of all the bonding interfaces, with a clear Top View map;
- database archived of all the "tomographic data" useful for further re-processing activities or monitoring purpose (e.g. maintenance program, comparison during mechanical tests, after race);
- detection in detail of any defect that by orientation and position could not be detected by other kind of analysis;
- 3D rendering with map thicknesses.

All available after little more than a working day.

QI portfolio includes

America's cup
2003 – 2018 Team Luna Rossa, Mascalzone Latino, +39, Oracle, Victory, Desafio, Team New Zealand, Shosholoza, Alinghi, Team Artemis (NDT and R&D), ACM, BAR, Team France, Artemis.
2018 - 2021 Team Luna Rossa and Challenge of Record NDT supplier for One design Arms

Volvo Ocean Race
Team Ericsson SWE, Telefonica blue SPA, Puma USA, Camper NZL, Groupama FRA, Abu Dhabi
For the 2014-15 and 2017-2018 editions with the V65 one design class QI has been the official NDT choice for the whole boats fleet. QI has been in charge of the new fleet construction quality control, acceptability criteria definition and monitoring during the whole training and racing.

Wind energy
Gamesa Eolica and Sorgenia

Automotive
Ferrari F1 and Ferrari F150, Rimac C two, Alfa 4C

Sailing yacht yards
Wally, Nautor, Baltic, Mylius, Southern Wind, Performance, King Marine, Vitters, Perini,Persico….

Q.I. Composites S.r.l. is approved as laboratory for Non-Destructive Testing in the Field of Motor and Sailing Yachts and Composite Parts by DNV-GL - Certificate no. AOSSOOOOFWF.
Approval of Service Suppliers for mechanical and analytical testing, in accordance with Class Programme DNVGL-CP-0484.