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Large scale metrology experience at ITER project

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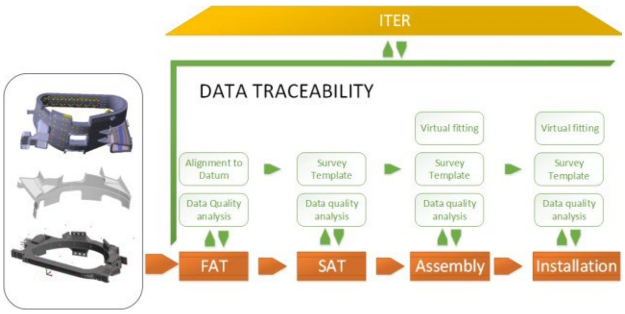
Abstract
Metromecanica is a company based in Zaragoza, Spain, the main business of the company is to provide large scale metrology services for sectors such as aerospace and energy. For 10 years one of the main projects in which it has been participating is at ITER, which is an experimental machine designed to harness the energy of fusion. ITER will be the world's largest Tokamak, with a plasma radius of 6.2m and a plasma volume of 84m3. Metromecanica is developing services onsite in the field of metrology control, divided into Data Quality, Survey Activities and Metrology Strategy.

3D Metrology, Large Scale Metrology, ITER, Laser Tracker, Automation

1. Data Quality

The goal of Data Quality process is to ensure that the as built data collected is valid for analysis and alignment purposes, from its origin to its final position [1].

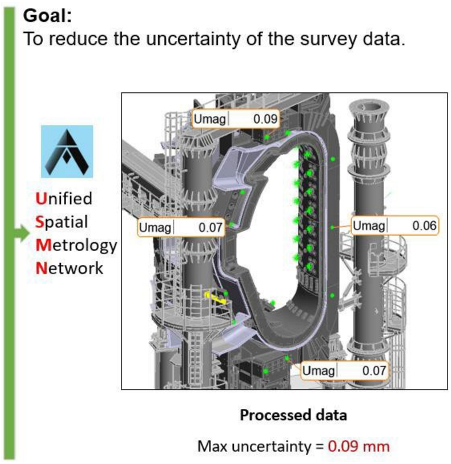


Relevant parameters affecting Data Quality are that ITER is an international project with multiple metrology services suppliers across the world [2]; there are metrology services differences related to experience, environment, equipments; data traceability is an important parameter implying complex assembly process from manufacturing to installation [1]; the ITER machine is composed of large parts with uncertainty requirements, deformations, hidden interfaces, temperature oscilations.

Before survey activities it is needed to perform field checks, get temperature stability, selection of measuring devices with specifications acceptable for the uncertainty required, and to create specific survey protocol considering tolerances and measuring environment.

During the survey activities it is needed to apply the best measuring practices to achieve good results in large scale metrology such as reference network evaluations, periodic drift checks, periodic temperature probing and survey data scaling, measured points with acceptable RMS values, references repeatability and with more than one observation form different instrument positions.

Post-Processing analysis is followed by the uncertainty analysis to ensure acceptable values with respect to the tolerance required, best fit errors to references or datum observed, and ensuring that all required data has been collected and provided.



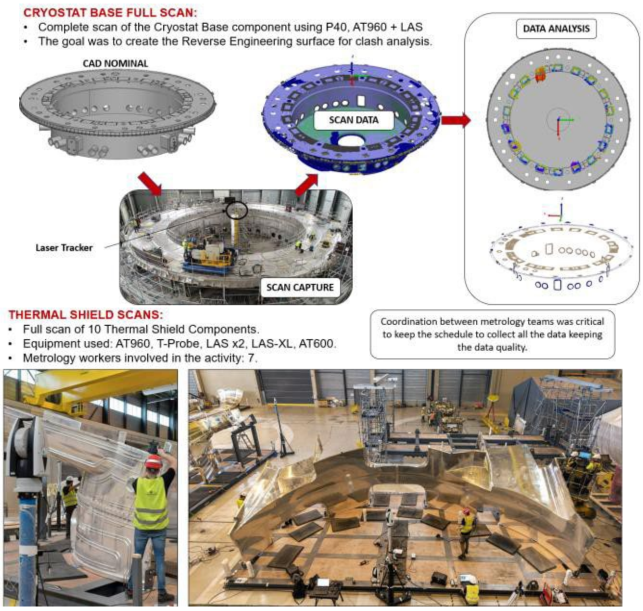
The total uncertainty budget in 2σ must be at most 20% of the feature tolerance, the uncertainty is influenced by the measuring device uncertainty, global uncertainty in survey session, temperature, alignment errors to references networks or datum and drift check errors.

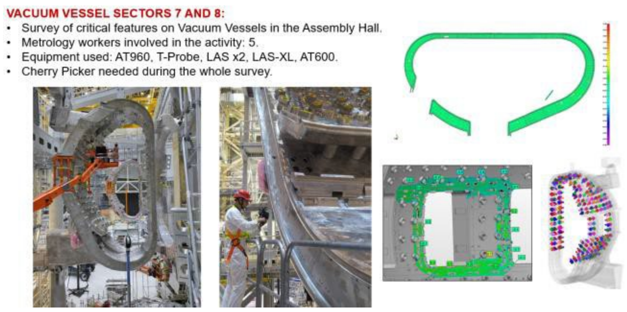
2. Survey Activities

Important aspects to consider for surveys in ITER site are regarding accessibility with scaffolds, cherry pickers, reduced oxygen space areas, clean areas and metrology equipment transport and set up. Also, the safety question, evaluate environment with ITER safety in advance, collective and individual protective measures. That is called internally as logistics evolving coordination meetings onsite for coactivities, work permission registered in ITER Data System, awareness of coactivities from other suppliers, availability of the equipment needed, coordination and transferring data between different metrology teams working in the same activity. Schedule, generally tight schedule, delays are costly due to stopping several activities from suppliers, going back to re-measure is not an option in general.

Dimensional inspections include site acceptance tests, CMM measurements, missions off site, horizontal to vertical state, supports levelling or adjusting, specific interfaces during assembly, large volume scans of rooms, buildings, outside areas [3].

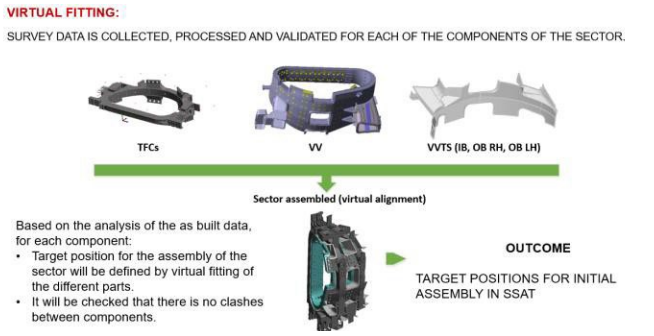
Monitoring during assembly or installation includes as an example the metrology control of cryostat base, cryostat lower cylinder, sectors assembly in assembly hall and tokamak building, measurement of additional components as feeders, thermal shield pannels, verification of supplier´s activities including the validation of components aligned by external suppliers. Measuring network references, extension of reference network and linking new areas, monitoring and update of current existing networks.



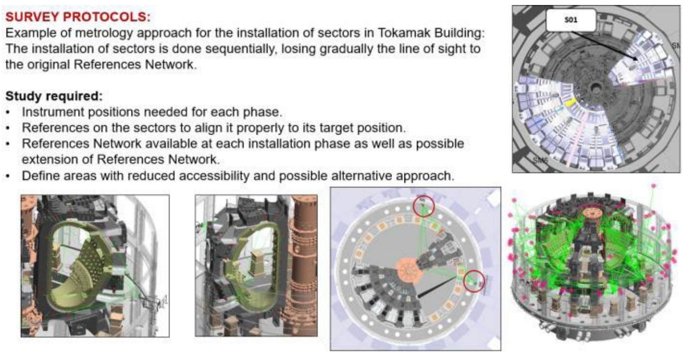


3. Data Traceability

As an example next is described the operation of virtual fitting operation for a sector assembly virtual alignment:



Example of survey protocols:



4. References

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