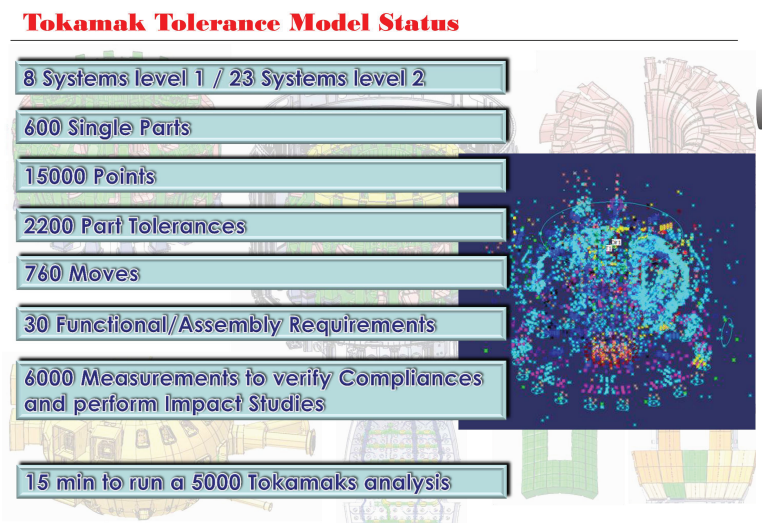
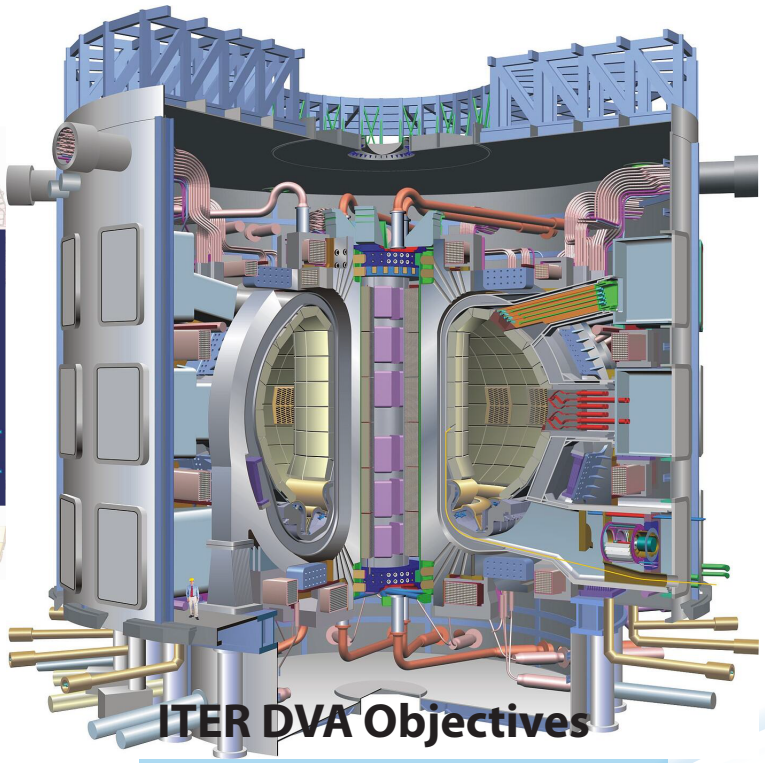
ITER - Tokamak Fusion Reactor

3DCS Use Case & Customer Story

Dimensional Management of Large, Single Production Assemblies





Production of One Analysis Key to Final Assembly

ITER is a global collaboration – involving China, the European Union (represented by EURATOM), India, Japan, Korea, Russia and the U.S. – formed to test the feasibility of fusion as a potential large-scale commercial energy source for the future.

In terms of the tokamak, 3DCS Variation Analyst is being used for both risk assessment and determining compliance due to alterations in dimensions that result from heat and structural changes. The model being used has over 600 plus parts with more than 15,000 points and 760 functional moves. This is believed to be the first ever application of tolerance analysis for this type of product.

As the dimensional team at ITER continues to find success, they have continually advanced the model over the last 10+ years incorporating additional analysis and modules to improve their results, and reduce their analysis run time.

ITER DVA Objectives

Create a functional Tokamak Tolerance Model for two purposes:

1. Configuration Management

a. Meet tolerance requirements for function and assembly

b. Compliance Status at non-standard scenarios, during operation, and maintenance.

2. Risk Assessment

a. Identify risk of non-compliant scenarios

b. Quanification of probably of occurance and risk impact

c. Identification and assessment of mitigation strategies

We identify what are the risks, so for instance if we have an issue with one part, we can see where the impact is and determine the risk of failing to meet requirements.

Pierric Leonard, ITER Sr. Dimensional Engineer

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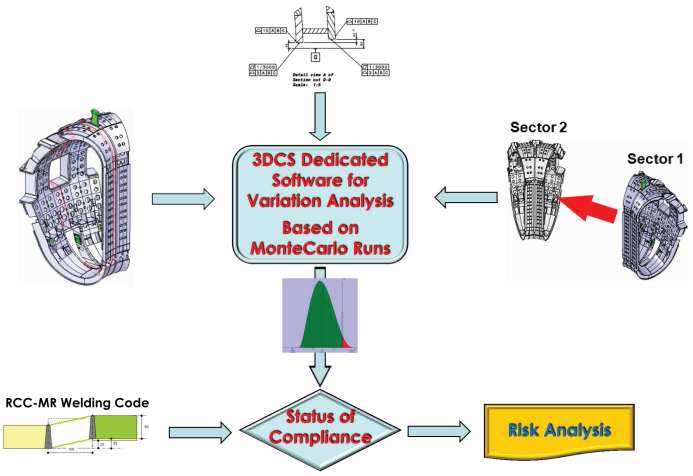
Concerns in Creating the World's Largest Tokamak Fusion Reactor

Precision Engineering on a Massive Scale

This project is meant to serve as a prototype for the mass production of tokamaks (which would make a viable alternative to, or replacement of, current fission based nuclear power plants), it is vital that the machine be manufacturable. That is to say, the model cannot be designed with only the nominal build in mind and as a prototype only; no product will be built without variation, and the tokamak is no exception. It must therefore be able to function with tolerances that are large enough to manufacture en masse, but small enough to accommodate the device's structural needs.

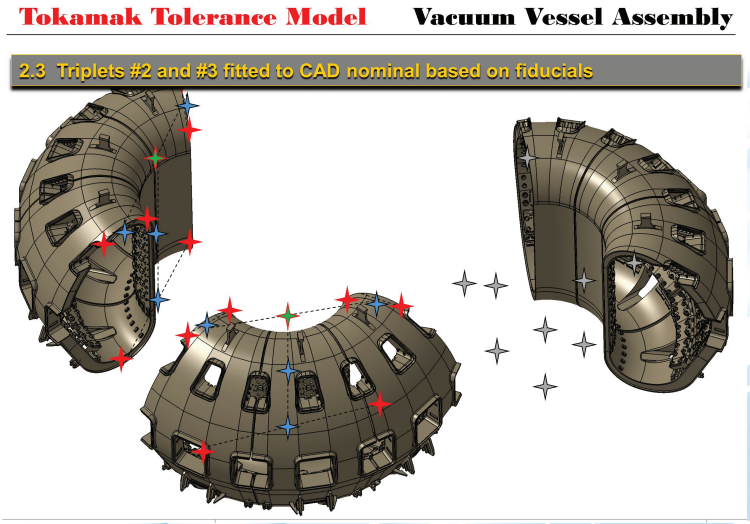
ITER must also ensure proper assembly of the structure, as unprecedented power, heat and magnetic strength of the fusion reaction and system operation will cause extreme stress to the device's structure. During operation, forces inherent to the device will tend to squeeze and pull parts of the structure in, closing gaps between them. Those gaps must be precise enough to uniformly close, leaving the parts to be largely self-supporting after steady-state operation is reached.

Especially important components to consider in this precision are the eighteen "D" shaped electromagnets around the outside of the device vacuum chamber, each of which stands 14-meters tall. They require very precise tolerances (+/- 0.5 mm) for the nominal toroidal gap, in order to align and lend structural support when energized. If the gap uniformity is not within specification, the stresses from the process may pull the magnets out of alignment, possibly causing damage to the



ITER is now finding that many of its engineers now prefer to wait for analysis results before their "next move" as the data helps to "drive the decision making process.

Jens Reich, ITER Project Office, Design Integration



DCS is a software developer providing tolerance analysis and quality inspection solutions to the automotive, aerospace, medical device, electronics and energy industries. With more than 20 years' experience, DCS has grown to include clients from every region of the globe including companies like Airbus, BMW, GM, LG, Jaguar Land Rover, Phillips, Sony, Textron Aviation and Volkswagen. As a quality solution provider, DCS prides itself on providing clients not just software, but services, staffing and dedicated support to guarantee the success of their quality initiatives.