

## Global Coordination at ITER

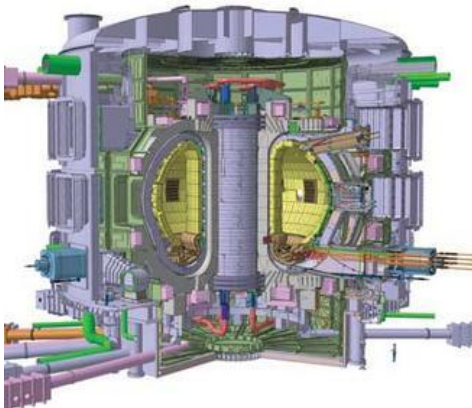
*I/T resources must deliver a unified vision at the world's largest fusion research project.*

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ITER is a large-scale scientific experiment that aims to demonstrate that it is possible to produce commercial energy from fusion.

If you haven't yet heard about the organization, that will likely change in the near future. The scale and scope of the ITER project—originally called the International Thermonuclear Experimental Reactor—rank it among the most ambitious scientific endeavors of all time. With the organization comprising contributors from around the world and the initial site work completed, scientists are now poised to begin construction on the buildings that will house the ITER fusion experiments.

In ITER, the fusion reaction will be achieved in a device called a "tokamak" that uses magnetic fields to contain and control the hot plasma. (See Figure 1.) The fusion between deuterium and tritium (D-T) will produce one helium nuclei, one neutron and energy. The helium nucleus carries an electric charge that will respond to the magnetic fields of the tokamak and remain confined within the plasma. However, some 80 percent of the energy produced is carried away from the plasma by the neutron that has no electrical charge and therefore is completely unaffected by magnetic fields.



*Figure 1 The World's Largest Tokamak*

*The ITER machine is based on the "tokamak" concept of magnetic plasma confinement, in which the fusion fuel is contained in a doughnut-shaped vessel. With a height of 29 metres and a diameter of 28 metres, ITER will be the world's largest tokamak. Diagram, ITER Organization.*

The neutrons will be absorbed by the surrounding walls of the tokamak, transferring their energy to the walls in the form of heat. This heat will then be dispersed through cooling towers. In the demonstration fusion plant prototype and in future industrial fusion installations, the heat will be used to produce steam and via turbines and alternators, electricity.

During its operational lifetime, ITER will test key technologies necessary for the next step—the demonstration fusion power plant that will capture fusion energy for commercial use.

### Organization Overview

Nuclear fusion is the energy source of the sun and stars. Harnessing it as a new energy source for mankind is the goal of ITER, the largest fusion energy research project in history. First discussed in 1970, its objective is to build a demonstration fusion power plant capable of producing electricity in a safe and environmentally friendly way.

ITER is an international organization comprised of the central ITER body and seven domestic agencies: the People's Republic of China, the European Union, India, Japan, the Republic of Korea, the Russian Federation and the United States. Eventually, ITER will employ approximately 700 people.

Each domestic agency will be responsible for developing different elements of the ITER power plant. The plant will cost 10 billion euros (US\$14.7 billion) to construct and operate and will be located in the town of Cadarache in southern France. As of 2008, construction on the plant began and tokamak assembly is scheduled to begin in 2012. Plasma operations could commence in 2018.

## Cooperation and Collaboration are vital

The key business challenge facing ITER is to orchestrate a pioneering international scientific research project via a small central team. The project's end product is a one-of-a-kind fusion plant that will become a global energy showcase and have an indelible impact not only on global energy advancement but also on the domestic agencies and their people. The whole world will be watching to see whether this high-risk venture succeeds. Conversely, if the project fails it will represent a monumental setback—not exactly the “average” business problem.

Real-time global coordination and collaboration are vital to ITER's success. The project's political organization spans the globe and procurement packages break down along geopolitical rather than functional lines. All seven domestic agencies may simultaneously work on a single component of the project; however, even this is overshadowed by the coordination challenges of designing a complex facility made up of 10 million separate parts that in turn must be reconciled with extremely rigorous quality requirements. Even the slightest mistake can wreak significant damage. Varying time zones certainly don't help.



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*An aerial view of the ITER construction site in Cadarache, France. At the far end of the platform, the tokamak pit can be discerned. Photo, Agence ITER France.*

Without a doubt, collaboration isn't an expendable choice; the whole premise of the project is predicated upon the idea of international knowledge-sharing, synthesizing the very best practices and scientific ideas from a variety of specialties and anthropological lenses. ITER is at the forefront of nuclear fusion research and each of its many research partners is highly knowledgeable in a particular domain. Bringing together that expertise to optimize development of the tokamak and plant presents a formidable challenge. ITER must foster a mindset of cooperation and provide the means for concurrent, collaborative work across the domestic agencies, most of which do not share a common language other than the passion for nuclear physics.

In pursuing a solution for its collaboration and communication challenges, ITER specifically looked to companies with a cross-cultural, authentically international operations structure. With scientists and researchers using a particular product in different parts of the world, there would undoubtedly be a need for extensive support and regional liaison. Furthermore, ITER sought an integrated solution that could deliver a unified vision of the mechanical and plant design data, enable concurrent engineering over a widely distributed network and ensure control by a small central design team.

ITER collectively decided to use three elements of Dassault Systèmes Product Lifecycle Management (DS PLM) technology suite, a virtual design tool to structure design methodology for the project, a global collaborative PLM tool to ensure long-term data interoperability across

the organization and a virtual construction planning tool to engineer the tokamak and the plant.

Additionally, ITER chose a Microsoft platform for the organization's underlying IT backbone. "We needed a single, stable, easy-to-administrate system that complies with standards and fits into the global desktop environment," said Hans Werner Bartels, senior technical officer for IT, ITER.

## **Maximizing IT Efficiency**

ITER opted to build its information processing resources around the Microsoft Windows Server System and is an early adopter of Microsoft's 64-bit architecture. The platform includes Microsoft Exchange Server, Microsoft SQL Server and Windows Server.

ITER uses CATIA as the master 3D design solution for both the tokamak and the plant that will house it. The ITER design office creates what it calls a plant breakdown structure up to the "build-to-print" level, at which point it is ready to be engineered. Domestic agencies then take over the design of specific components.

Using the 3D solution's digital mock-up (DMU) capabilities, the design office ensures that the millions of complex critical parts in and around the tokamak will interface clash-free at assembly time.

ITER is introducing DELMIA as its process analysis platform to optimize resource usage throughout assembly and maintenance. The process detailing features, including tools for defining equipment kinematics and robotics, will allow deeper analysis of critical processes and the associated equipment, using 3D models directly linked to the latest digital mock-up. By linking with Primavera, the solution also simulates and validates critical parts of the assembly schedule and ITER is considering a possible integration to provide remote-handling supervision tools. To simulate collision-free paths in the assembly and maintenance context, ITER works with Kineo CAM, a Dassault Systèmes software partner.

ENOVIA, installed on the Microsoft Windows Server, acts as a single repository for all design and engineering data. It enables engineers to work together on the most current designs within the context of a part, a large assembly or an entire product. These are important capabilities that both improve decision-making and promote design reuse.

The product also provides integral search capabilities. For example, plant design engineers use virtual "room books" that provide full details of all assemblies and systems found in a given "room" (otherwise defined as a physical demarcation) within the plant. This enables the engineers to use 3D to search and download all of the components for a given room, simplifying the impact of a design change and helping to verify whether components are compliant with one another.

While ensuring data interoperability seems like a tangential back-end PLM task beyond the actual process of design and simulation, it is absolutely crucial to solving ITER's actual business problem. By regulating and organizing version control, when designers update or discard design iterations every team member in every domestic agency now knows what the correct version is and can easily access it.

ITER design office engineers use virtual design to create "skeletons" or design templates. By providing a structured yet flexible framework to the actual subcontractors who will manufacture the millions of complex components of the tokamak and plant, these skeletons are completely compliant with pre-determined quality standards. The reuse of design skeletons also reduces the time needed to make duplicate components, since designers don't have to spend time "recreating the wheel."

Concurrent design also permits ITER to keep the size of its design office to a minimum.

Using PLM, the ITER design office provides master designs to distributed teams of designers, engineers and subcontractors around the world. The ability to delocalize has given domestic agencies a sense of local ownership of their work. It is also crucial in a project where fusion expertise is rare and cooperation among multi-national teams is essential.

PLM offers multiple ways for distributed stakeholders to consult the project database for a 3D perspective on progress. By ensuring constant product structure congruency, PLM enables everyone, from designers to procurement officers and non-technical domestic agency executives, to easily access up-to-date product information and evaluate milestones in real time. And with 64-bit design software running on Microsoft-based 64-bit workstations, ITER can manage its large assemblies rapidly with no memory limitations.

## **The Future**

ITER plans to expand its multi-faceted solutions to drive the project forward and further optimize control over the data and its distribution. For example, it will use a single source database to provide the backbone for a procurement tool, enabling bidding agencies to have upstream access to complex data.

The organization is also investigating the use of other tools to manage project workflows and as a repository for all engineering data, including product/geometry breakdown structure views, documents, configurations, requirements, 2D/3D coherency, and more, in a collaborative mode.

Finally, a key element of the digital assembly and manufacturing implementation will be to verify virtually whether the intended plant assembly will operate to specifications. This could save hundreds of millions of euros in testing the project's numerous interfaces before building begins.