

When the next refurbishment and enhancement phase of the JET Facility starts this year, the staff of the **Remote Handling** group will be extremely busy. The whole task is carried out by remote **manipulation**, a technique in which JET has acquired a unique expertise over many years. Remote Handling is not a fully robotic system. There is always an **operator** involved.

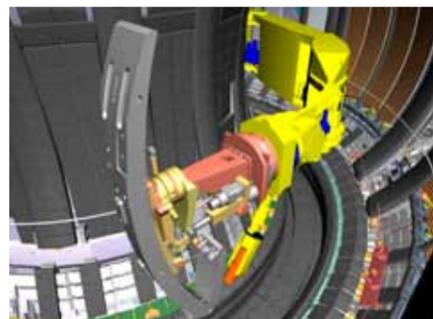
Always a **man** in the loop



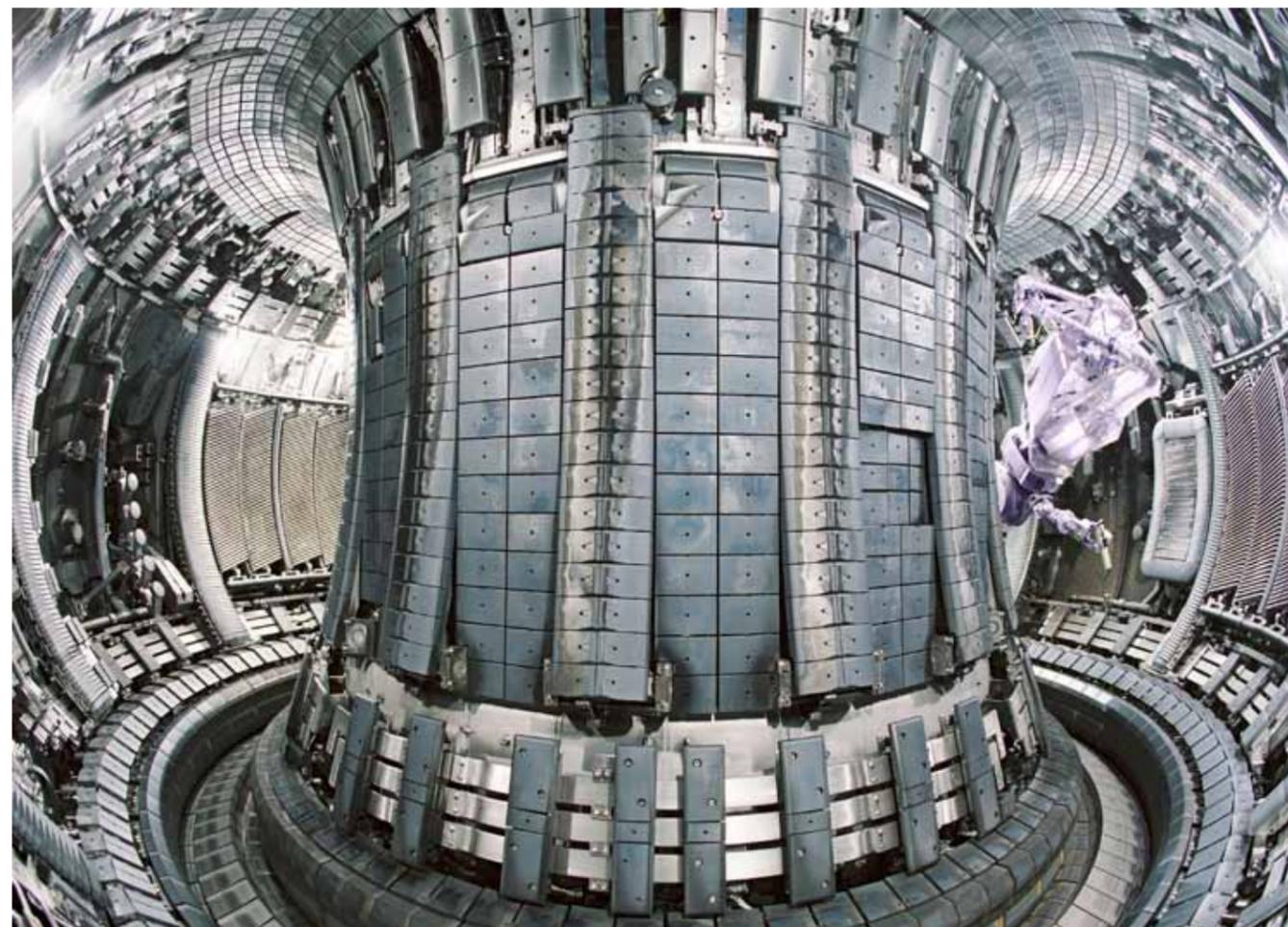
Operator in action in the remote handling control room.



Assembly work during boom extension.



Virtual Reality Simulation showing the Remote Handling Mascot Manipulator carrying a Poloidal Limiter inside the Vacuum Vessel of the Joint European Torus Facility.



The Mascot Servo-manipulator (coloured) Inside the JET vessel.

When the next refurbishment and enhancement phase of the JET facilities starts this year, the staff of the Remote Handling group will be extremely busy. The whole task is carried out by remote manipulation, a technique in which JET has acquired a unique expertise over many years. Remote Handling is not a fully robotic system. There is always an operator involved.

The task is to replace about 4,500 tiles within the vessel of Europe's largest fusion device, JET. The operator in the control room uses the handles of a servo-manipulator master called Mascot. His actions are performed by the slave which is positioned inside the Torus using a 10 metre long articulated boom. The surface of the new tiles is made predominantly of beryllium which is a relatively fragile material. Scratches or marks cannot be tolerated. He feels the weight of the tile he lifts although he has nothing but the manipulator in his hands. A quick button push and the computer removes the virtual weight from his arms. The smoothness of the system helps him to forget how far he is from the scene of action. In addition, his imagination is enhanced by Virtual Reality. The operator feels as if he is standing inside the torus, but he is actually in the Remote Handling control room, using more than 20 different camera views to follow his actions.

So, Remote Handling isn't a fully robotic system. Automation is used in a minimum number of tasks. In all the rest there is always a man in the loop.

This scenario will happen this year during the next shutdown of the fusion device: 7 days a week, 20 hours a day with two shifts and three teams handing over to each other. "Shutdown means the period where we close the machine down and undertake maintenance and refurbishment," explains Tony Loving, Remote Handling Group Leader at JET. He continues, "so we can have new experiments pushing fusion forward".



Tony Loving, Remote Handling Group Leader

This shutdown is centred on the installation of an ITER-like wall in JET. ITER, the next generation fusion experiment, will use beryllium and tungsten as first wall materials within the torus. This combination of materials has never been tested in a tokamak with a

geometry and plasma parameters close to those of ITER. A key aim of the experiments with the ITER-like wall will be to develop regimes of operation for ITER compatible with beryllium and tungsten as first wall materials.

Thirty nine people work in the Remote Handling group with a wide range of different skills sets. The work needs mechanical, operational knowledge as well as electrical, electronical and software development expertise. The preparation of this "ITER-like wall shutdown" has taken more than 18 months. Tony explains how many tasks his group is involved in, "Our experience has to go into the design of the components, of the tooling, and in the management of the delivery of all these different bits". Alan Rolfe, Remote Handling group leader at JET for 20 years and since 2000 Managing Director of Oxford Technologies Ltd, divides this technique in two aspects: technology and management. "Apart from the boom which is a completely novel design," he says, "the manipulators and other systems are designs based on proven and reliable technologies integrated in a rational and efficient way". In this regard Virtual Reality is an impressive example. In the beginning, this technique was nothing more than green cathode ray tubes. Since then it is developed into multicoloured almost three-dimensional images of the

JET torus. This development is being driven by the games market. "Remote Handling is for me," Alan continues, "the integration and management of all: the technology, the people, and the structure. That makes Remote Handling what it is."

The first time Remote Handling was used fully during a shutdown at JET was in 1998. Alan Rolfe remembers: "The whole fusion community was looking and a lot of them said it couldn't be done." But the group succeeded. "We developed the set up, which means how to organise it, from nothing", he adds. Tullio Raimondi started his career at the very beginning of JET in 1973. The engineer, who retired in 1997 as leader of the Remote Handling Development group, remembers: "My enthusiastic assistant during the design phase was the late Tom Arthur and our mini-group was irreverently referred to by some sceptical engineers, who were struck by the size of the task, as Don Quixote and Sancho Panza." Nowadays the whole group has gained an international reputation and self confidence.

The forthcoming shutdown is the fifth Tony Loving has been involved in. "Historically," he says, "our operations were on time. So I'm confident that we will be equally successful this time".



Assembly work on Boom extension.

The preparation of the ITER-like wall shutdown started with an assessment of how to improve the procedures that have to be followed. During this stage the idea of extending the capabilities of the second boom emerged. The task of the second boom is to serve as the equipment or tooling deliverer for the working manipulator. The vast benefit for JET is saving time. Tony explains: "What we are going to do now is bringing the store to the man, remotely. We developed a container with a cabinet of trays to store the tools the manipulator needs." With the second boom the shutdown needs up to 30 per cent less time; this allows 30 per cent more time to do research. Tony adds: "And this might even be a pessimistic amount. There is some evidence that we might be better than that".

Petra Nieckchen

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On the front page you can find a new Remote Handling section. Find out more about the Mascot servo-manipulator and its slave as well as the booms. See impressive movies showing the capability of Remote Handling. In addition you can read the full interview with Tullio Raimondi, former leader of the Remote Handling Development group and a pioneer of this technique! In the section "JET & ITER" you will find out more information about the ITER-like wall project itself.

JET Insight

Quarterly News & Views of Europe's largest Fusion Device

March 2009

New staff at the Close Support Unit

Tell us about your contribution to the JET programme



"Returning to JET after an absence of nine years comes with a certain sense of déjà vu. Everything looks familiar until, suddenly, something appears that isn't as it was before. In my new role as Head of the Close Support Unit Operation and Enhancements Department, I am looking forward to seeing in person how the new things contribute to successful operation of JET and, hopefully, to contributing to the further improvement of the facility via the latest round of the enhancements. Already in my first months I have found the job challenging but the reception of colleagues at JET, both old and new and both in the CSU and with the Operator, to be very positive. Working in such a stimulating international atmosphere is for me a highlight of the EU fusion programme in general and of JET in particular"

Lorne Horton
Head of Operations & Enhancements



"Coming to JET has given me the opportunity to discover how fascinating it is to work on Operations, mixing engineering and physics together as well as working with the most diversified people."

Isabel Nunes
Operations & Enhancement Department



"My contribution is the experience that I had at the JET Undertaking from 1988 until 1999 and the 10 years I worked at ASDEX Upgrade. This and my experience in international cooperations like ITPA groups would be useful for planning of the experimental campaigns"

George Sips
Programme Department



"I came to JET some years ago and during this time I have worn many hats such as diagnostic responsible officer, project leader, diagnostic and scientific coordinator and Diagnostics Task Force deputy. This has given me the opportunity to observe how JET operates from different perspectives and I have seen first-hand the benefits of team work. I hope this will help me in my new role in the Enhancement Department where I will be working with the rest of the JET team to provide the best possible diagnostic support for the JET programme."

Elena de la Luna
Operations & Enhancement Department



"I have previously been working at JET for twelve years. I used to work on the lower hybrid and plasma control systems. Now, I will look after the heating systems and in particular studying the feasibility of installing ECRH on JET. I also hope to complete my training as a session leader."

Morten Lenholm
Operations & Enhancement Department



"I was employed at JET from 1981 until 1994, leaving to lead the ITER Divertor Group. Then I spent 12 months designing the Wendelstein 7-X divertor before returning to JET in November 2008. My new role here is to lead the Torus and Operations Group and to support the JET Operation Contract in logistics and planning for the Enhancements Programme 2."

Richard Tivey
Operations & Enhancement Department



"I will participate in the ILW, providing scientific and technical advice, and operational support. I will also be making recommendations on how JET might be able to support the overall fusion programme in a coherent way in the future. I hope that my experience at JET and ITER has put me in a good position to perform these functions."

Chris Lowry
Operations & Enhancement Department



"I've been working for JET for more than 10 years in short time periods. Now I will be here for the next 4 years. This long period enables me to bring more consistency into my work so that my contribution to the JET programme will gain a deeper quality."

Fernanda Rimini
Programme Department



A busy day during operations in the control room at JET. The success of the next experimental campaign will be partly the result of a well planned and focused programme.

"More than 100 scientists from European fusion Associations participated in the three day General Planning Meeting at JET."

Planning for Success

How do you plan an Experimental Campaign on JET? From selecting the right experiments to identifying the key people able to complete the studies successfully it requires a wide knowledge of topical fusion physics issues and of JET capabilities and limitations. Planning for C27, a Campaign focusing on plasma isotopic effects, the preparation of operation regimes for the ITER Hydrogen/Helium non-activated phase and final preparations for operating JET with an all-metal wall, is no exception.

That is why JET organised, hosted a General Planning Meeting at JET in January to which all users of the JET facilities were invited. More than 100 scientists from the European fusion Associations participated in the three day workshop, presenting their views on which physics

issues should be investigated and discussing how to optimise and combine experimental ideas into scientifically fruitful experiments.

The final selection of C27 experiments by the JET Task Force leaders and the Close Support Unit at Culham is now under way. Priority is being given to experiments expected to answer relevant ITER questions and to studies that must be completed before the new ITER-like wall is installed later this year. The experiments will then be arranged in phases of Deuterium, Hydrogen and Helium operation. Once the Programme has been finalised the Associations will be invited to propose their scientific participation in C27. Already 215 scientists from 20 Associations have expressed their interest!

Martin Laxåback

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Main article in this issue
"Always a **man** in the loop"