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ITER EXPLORATIONS STARTED

by Dr. L. Golubchikov, RF Contact Person

The technical challenge of realizing ITER and its estimated cost and duration make ITER one of the most significant single civil R&D projects in the world, and calls for a pooling of technical expertise and sharing of resources world-wide.

Taking into account the genesis of ITER as an initiative at summit level, in 1985 and 1986, and at the Birmingham G8 Meeting (May 1998), the international nature of both the energy/environment problem and the fusion research effort so far, and the success of international collaboration on ITER phases of "Conceptual Design Activities" and the ongoing "Engineering Design Activities" (EDA), the ITER Parties' activities should now aim at focusing on joint implementation of the Construction, Operation, Exploitation and Decommissioning Activities of ITER.

The Chair of the ITER Parties' Grenoble Meeting (July 1999) proposed to take the initiative in facilitating the start of "explorations to prepare for possible future negotiations towards ITER construction."

Responding to this proposal, Professor E. Adamov, Minister of the Russian Federation for Atomic Energy, addressed Mr. Philippe Busquin, Commissioner for Research, European Commission, and Mr. Hirofumi Nakasone, Minister of State for Science and Technology, by similar letters and received positive responses (see extracts on page 2).



Participants in the Meeting

EXTRACT FROM MINISTER ADAMOV'S LETTER OF INVITATION

"We understand that the joint technical work currently performed within the ITER EDA collaboration is progressing successfully.

I am also pleased to acknowledge that the joint preparatory discussions to pave the ground for possible future multipartite negotiation towards ITER construction are now reaching the point of maturity.

Therefore, I would now like to convey an invitation to start exploratory discussions among the EU, Japan and the Russian Parties to prepare for possible negotiations on a joint implementation of the ITER project. We believe that these discussions could benefit from some kind of involvement of other possible parties."

At their Tokyo Meeting (January 2000), the ITER Parties were pleased to note this initiative. Also noted were the actions and expectations by the Parties to complete positive response thereto as soon as possible.

EXTRACT FROM COMMISSIONER BUSQUIN'S RESPONSE

"Thank you for your letter concerning preparatory discussions to pave the ground for possible future decisions on the ITER project. I share the view that the complexity of the tasks to be undertaken before eventually deciding on ITER construction requires the greatest attention.

In my opinion, the ITER partners should start by exploring the critical issue of the legal framework before addressing other issues. This should be no means prejudice future decisions on whether and where ITER should be built."

EXTRACT FROM MINISTER NAKASONE'S RESPONSE

"Thank you for your letter concerning exploratory discussions to prepare for possible negotiations on joint implementation of the ITER project. I very much appreciate your initiative toward the complete realisation of ITER.

I also share your view that the joint technical work of the ITER EDA is being successfully carried out, and I believe that the promotion and completion of the ITER EDA will eventually provide a sound technical basis for the construction of ITER.

I am very pleased to learn - in connection with the ITER EDA - that the ITER-FEAT Outline Design Report was accepted and that the Report of the ITER SWG-P2 on Joint Implementation of ITER was endorsed for transmission to the Parties at the ITER Meeting in Tokyo, 19 and 20 January 2000. Following this Meeting, internal discussions and review procedures within the government of Japan have begun towards the initiation of the Explorations. In my view, this progress of international discussions could encourage the participation of other countries to this project.

I believe that the aspirations of the parties concerned toward the realisation of fusion power and the understanding fostered by the ITER EDA will lead the ITER Project to a great success."

On 11 February, Minister Adamov also wrote a letter to Mr. B. Richardson, the US Secretary of Energy, saying that considering the current state of ITER, which is outside of the frames of the international agreements and common joint projects currently in force, it would seem timely to start consultations with representatives of the interested countries on practical steps leading to the construction of a thermonuclear reactor with joint effort. He wrote that *"based on this understanding, I would like to invite the interested countries to take part in the consultations on the issue in the middle of April 2000 in Moscow."* (Inofficial translation from Russian).

Minister Adamov emphasized in his above letter that Russia seriously considers the Thermonuclear Reactor as the most acceptable source of energy for the environment. He said that he sincerely hoped that Russia and the US would continue the joint co-operation in solving one of the most important scientific and technological problems of the 21st century.

EXTRACT FROM US SECRETARY OF ENERGY RICHARDSON's RESPONSE

"Although the Department of Energy is no longer a partner in the ITER project, we recognize the potential value of ITER in developing the scientific basis necessary to the development of fusion as a commercially viable energy source.

Although we are not prepared to participate in any consultations on ITER at this time, if the current ITER partners decide to pursue construction and to enter into substantive negotiations we would, after consultation with Congress, reassess the possibility of a U.S. role in the project.

I appreciate the close and highly beneficial cooperation that has existed between our fusion programs for the past 25 years and wish you every success in your consultations."

The first meeting of the three Parties' Explorers was held in Moscow at the Business Centre "Volynskoe-2 Atom" (formerly country residence of J. Stalin), on 13-14 April.

Opening this first Explorers' Meeting, Minister Adamov welcomed the participants, thanked the ITER Parties for their positive response to his invitation and expressed the desire of the Russian Federation to see ITER realized, stressing the importance of continued progress with the project as an outstanding example of international scientific co-operation.

The Parties' Delegations shared the views that Explorations are non-committal, exploratory discussions among the interested Parties, which should be aimed at reaching sufficient common understanding, so as to allow interested Parties to enter negotiations on key elements of the ITER Joint Implementation Agreement.

During the Meeting, the exploration tasks were discussed and agreed upon, as well as the work plan and schedule.

The Explorers decided to finish their work before the end of the year, preparing a Report, which will include material necessary for the start of the process of negotiations on further steps in the ITER activities. To facilitate the preparation of this Report, it was decided to set up a standing supporting Sub-Group, which was asked to address higher-priority issues, identified by the Explorers, and to report back to the Explorers.

ITER CENTRAL SOLENOID MODEL COIL SUCCESSFULLY ACHIEVED ITS 100% DC OPERATION

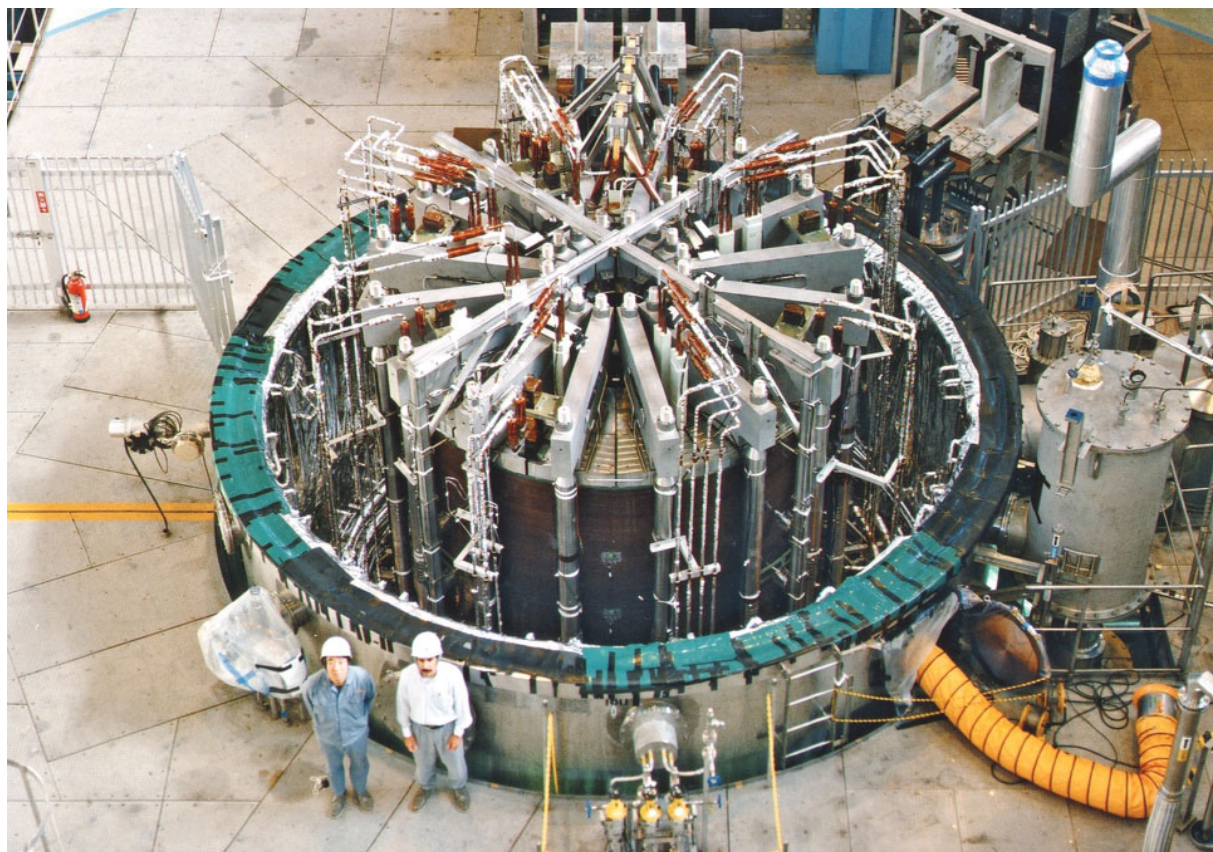
by Dr. H. Tsuji, Head, Superconducting Magnet Laboratory, JAERI Naka

On April 19, 2000, at JAERI Naka Fusion Research Establishment, the international experimental team consisting of the members from the USA, Italy, Germany, France and Japan succeeded in the first attack to 100% operation of the Central Solenoid (CS) Model Coil, achieving a maximum magnetic field of 13T at a current of 46KA, storing an energy of 640 MJ, without any quench of the superconducting coil.

By this achievement, the ITER engineering design of the CS coil was experimentally validated as far as its difficult DC performance is concerned.

The program of development and testing of the CS Model Coil has been carried out since the beginning of the ITER EDA in 1992 within the ITER EDA framework to develop the advance technology, as well as its fabrication technology and to validate the Engineering Design of the ITER CS coil. In this program, under the coordination of the JCT, research institutes, universities and industries from the EU, Japan, Russia and US participated and made their distinguished contributions to open a new era in the superconducting magnet technology.

In November 1998, the fabrication of the CS Model Coil Outer Module was completed in Japan, and in May 1999, the CS Model Coil Inner Module fabricated by the US and the CS Insert Coil fabricated in Japan arrived at JAERI Naka Fusion Research Establishment where the newly constructed CS Model Coil Test Facility is located. Installation and assembling of the three coil modules (see photo on the next page) took several months; many unexpected technical problems were solved by the collaboration of the JA and US installation teams headed by Takashi Kato, JAERI, JAHT, and Rui Vieira, MIT.



CS Model Coil and CS Insert Coil after the completion of installation

Cool-down of CS Model Coil and CS Insert Coil, the winding weights of which, including the supporting structures, are 110 and 180 tons, respectively, was started on March 13, 2000, and transition of all coils into the superconducting state was clearly observed at 0 a.m. on April 4, 2000 at a temperature of 17.5K. The cool-down was continued until the whole system reached the cryogenic state of around 4.5K.



*Hiroshi Tsuji (JAERI) and Mario Ricci (ENEA)
In the background the successful
achievement of 13.0 T and 46.0 kA is
indicated.*

The charging experiment of the CS Model Coil was initiated on April 11, 2000 by the international Test Group headed by Nicolai Martovetsky of LLNL and the test facility operation team headed by Hideo Nakajima of JAERI, JAHT. The Test Group consisted of members from France, Germany, Italy, Japan and the US. The US participated in this experiment in the frame work of the US-Japan Collaboration with the agreement by EUHT, RFHT and JAHT. In total, about 50 staff members, including the operation team, carried out the experiment at the Naka Fusion Research Establishment of JAERI.

The charging current of the CS Model Coil was raised carefully, step by step, from 5% of the designed nominal. Finally, at 14:20 hrs on April 19, 2000, we were in a position to attack successfully the top of the mountain by the DC charging of the Central Solenoid (CS) Model with the goal of 46 kA, 13 T and 640 MJ.

Major results obtained during this experiment:

1. Achievements on April 19:

- a) Charging up to 100% (46 kA) was achieved without any quench.
- b) Maximum field of 13.0 T and stored energy of 640 MJ were achieved.
- c) All 38 conductor joints worked as designed, generating around 4W per joint, under a current of 46 kA.
- d) The coil was dumped from 46 kA with a time constant of 17.7 sec and the coil was safely returned to 0 A.

2. Mechanical disturbances observed during the charging up to 80% current that the coil had experienced by April 18, low Acoustic Emissions (AE) and no major voltage spike due to micro-movement of the winding were found. At above 80 %, which the coil experienced for the first time, active emission of AE and voltage spikes due to the micro-movement of the conductor in the winding were found in the first run. However, they were not observed, except for a very limited number of voltage spikes, in the second run up to 100% current, suggesting that micro-movements of the conductors in the winding found their mechanically stable positions.

Number of Major Voltage Spikes due to conductor movement

	In the first run	in the second run
From 0% to 80%	0	0
80% to 91%	18	0
91% to 100 %	37	3

3. Performance in a dump from 46 kA and 640 MJ

- a) Measured dump time constant 17.7 s
- b) Maximum voltage: 1420 V
- c) Maximum temperature increase at the outlet of He coolant: 1.4 K
- d) Maximum pressure increase at the outlet of He coolant: 0.28 MPa

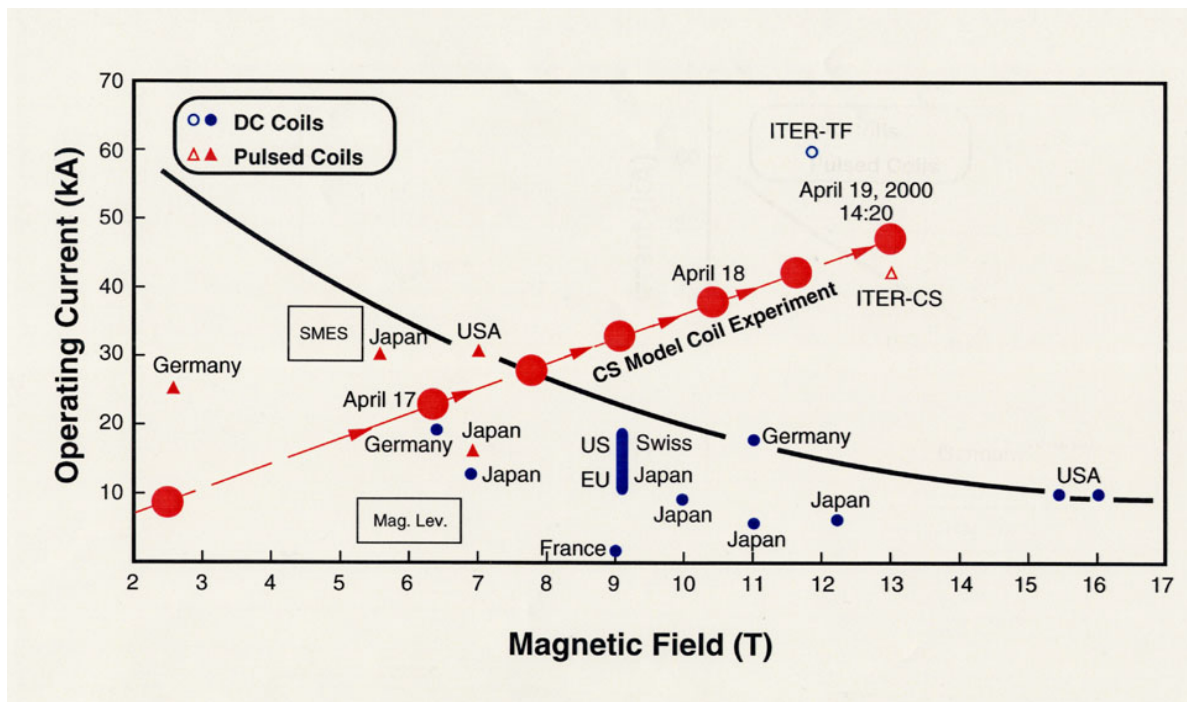
4. Road to the top

This process is shown as a function of coil current and maximum magnetic field on the chart below, which shows that the CS Model Coil opened a new era and completely realized a new frontier in the world's superconducting magnet technology. This was achieved by significant contributions from all the several hundreds of international colleagues who, for 8 years, since 1992, have participated in the design, development and fabrication of the superconducting strands, cabling, jacketing, winding, activation heat treatment and final insulation of the coil, safe transportation across the ocean, installation and assembling of the coil modules, its initial cool down experiment and charging experiment. Let me express sincere thanks to all the colleagues who have made indispensable contributions in the CS Model Coil Program.

5. Experiments planned

From now on we will perform the following experiments until August 2000:

- Coil performance tests at an elevated inlet temperature of He coolant to measure the operational margin of the coil so as to reflect the results into the final design of the ITER Central Solenoid Coil
- Pulsed charging tests by using the JT-60 power supply in May and July
- Detailed performance test of the CS Insert Coil
- Fatigue test by 10,000 cyclic test



Achievements and goals of the superconducting magnet technology and the road to the new achievement at the CS Model Coil in April 2000



At the party celebrating the achievement of 13 T on April 19, 2000: Yasuo Shimomura (Deputy to the ITER Director), Michel Huguet (Deputy Director, Head, ITER Naka Joint Work Site) and Members of the Teams who contributed to the successful 100% charging of the CS Model Coil.

Smiling winners in front of the indication of the successful achievement of 13.0 T and 46.0 kA
 Upper photo, from left: Yoshikazu Takahashi (JAERI), Philip Michael (MIT), Nicolai Martovetsky (LLNL), Makoto Takayasu (MIT), and Toshinari Ando (JAERI); Lower photo, from left: Gernot Zahn (FZK), Mario Ricci (ENEA), Laura Savoldi and Roberto Zanino (Trino University)



Items to be considered for inclusion in the ITER Newsletter should be submitted to B. Kuvshinnikov, ITER Office, IAEA, Wagramer Strasse 5, P.O. Box 100, A-1400 Vienna, Austria, or Facsimile: +43 1 2633832, or e-mail: c.basaldella@iaea.org (phone +43 1 260026392).

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