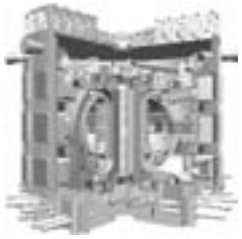

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EIGHTH ITER NEGOTIATONS MEETING (N-8)

by Dr. V. Korzhavin, Deputy Head, Department of Atomic Science and Technology, Minatom, Moscow

A very important milestone was reached at the Eighth ITER Negotiations Meeting, held on 18–19 February 2003, when delegations from the People's Republic of China and the United States of America joined those from Canada, the European Union, Japan and the Russian Federation in their efforts to reach agreement on the implementation of the ITER project. St. Petersburg, Russia, celebrating its 300th anniversary this year, was the site of the Meeting. Members from the ITER International Team and an IAEA Representative also participated in the meeting. Mr. Igor Borovkov, First Deputy Minister of the Russian Federation on Atomic Energy, welcomed all the delegates, noting the significance of the addition of China and the USA in the Negotiations. The delegations accepted Dr. Vladimir Kuchinov as Moderator, and Dr. Vladimir Vlasenkov as Secretary, assisted by Ms. Christa Basaldella.

In their opening statements, the Heads of Delegation of both China and the USA declared their countries' commitment to developing fusion energy as a potential source of safe, secure and environmentally friendly energy. Delegations fully endorsed and welcomed the entry of China and the USA to the Negotiations, noting the significant domestic fusion programmes of both.

The Head of the Chinese Delegation indicated that China, as the largest developing country in the world, has a great need to pursue alternative energy sources. China believes that ITER can potentially lead to new forms of energy and contribute to the peaceful and sustainable development of the world in the long term. China expressed its strong wish to be a valuable member of the ITER family, to make joint efforts with the other partners for the successful exploitation of fusion energy.

The US Head of Delegation noted that President Bush had announced on January 30, 2003, that the USA would join ITER. In his statement, the President said: "The results of ITER will advance the effort to produce

Participants in the Meeting

Group of participants at a reception at the Grand Duke Vladimir's Palace

clean, safe, renewable, and commercially available fusion energy by the middle of this century." The USA remarked on the extensive reviews undertaken by their scientific and technical communities in arriving at the conclusion to join the ITER Negotiations.

To express the support of the community for the Canadian host site, the Canadian Delegation included John Mutton, the Mayor of the Municipality of Clarington, and Roger Anderson, Chair of the Region of Durham. Mayor Mutton emphasized the excellent technical and sociocultural characteristics of the Canadian site and the enthusiasm of the local community for hosting ITER.

The EU Delegation informed the meeting that France has confirmed, at the level of Prime Minister Raffarin, its offer of hosting ITER in Cadarache as the European site, taking advantage of its well-known scientific, technical and socio-economic environment. The local authorities have expressed, in partnership with the government, their strong commitment, with respect to financial, educational, cultural and all other aspects, to provide the best working and living conditions for ITER staff. The EU Delegation also informed the meeting that the Spanish Secretary of State for Science and Technology, Mr. Morenès, headed an official delegation to meet with Commissioner Busquin to personally re-iterate the firm commitment of all levels of the Spanish government and society to the success of ITER in Vandellos. An announcement was also made of the important step of starting the official licensing procedure for ITER in Spain, two months in advance of the previously presented schedule.

The Head of the Japanese Delegation reported that Prime Minister Koizumi, while visiting Russia on 10 and 11 January, referred to the importance of ITER, both in the Summit meeting with President Putin and in his speech at the Kurchatov Institute (for details please see ITA Newsletter No. 1, January 2003). Mr. Kimura, Governor of the Aomori Prefecture, attending the meeting, promised to establish an international school and stressed the recent and future improvement of public transportation, including an extension of a bullet train line and planned direct flights from Narita Airport Tokyo to Aomori.

The RF Delegation confirmed that the ITER activities are conducted according to the Federal Programme which runs through 2005 and includes the start of industry involvement in ITER. Therefore, it is important to bring the Negotiations to a timely conclusion.

The following presentations summarizing the status of the Negotiations were made by the "old" participants:

- Structure of the Negotiations
- JASS Process
- Agreement
- Procurement Allocation
- Management Structure of the Organization
- Work Plan and Milestones
- ITER Transitional Arrangements.

Dr. Muraviev, Moderator of the Seventh Meeting of the Negotiations Standing Sub-Group (NSSG-7), held in St. Petersburg on 26-28 January 2003, introduced the progress report of the NSSG. The delegations commended the NSSG for the significant progress made in drafting the ITER Agreement and charged the Group to elaborate further the Agreement and Related Instruments.

The delegations took note of the progress of discussions on procurement allocations and encouraged the participants to continue their interactions in this area, taking account of the new participants' expressions of interest in contributing. The delegations also noted the actions on ITER decommissioning issues, management structure and intellectual property rights, and asked the NSSG to present a report on progress at N-9.

The Negotiators approved the Report on the Joint Assessment of Specific Sites. It was completed within the framework of the Negotiations, following detailed reviews and visits to all four potential locations: Clarington in Canada; Cadarache in France; Vandellos in Spain; and Rokkasho-mura in Japan. The report confirms that all four sites meet the criteria established for the location of the ITER project, although there are different strengths and weaknesses for each site. For the Summary of the report, please see the next issue of this Newsletter. The complete report can be found on the ITER Website (www.iter.org/jass).

The delegations noted the report on the start of the ITER Transitional Arrangements (ITA), including the first meeting of the ITER Preparatory Committee. The delegations also noted that China has stated its willingness to participate in the ITA and that the USA is considering participation.

Support staff of the Meeting

FIRST MEETING OF THE ITER PREPARATORY COMMITTEE

by Dr. V. Vlasenkov, RF Contact Person

ITER Transitional Arrangements (ITA) have been established by Participants in the ITER Negotiations with the objective of preparing for an efficient start of the ITER Joint Implementation, if and when so decided, and of maintaining the integrity of the ITER Project.

In accordance with the Terms of Reference for the ITA, the ITER Preparatory Committee, composed of two members from each ITA Participant, has the responsibility for the overall direction of the arrangements and exercises supervision of their implementation.

The Committee held its first meeting on 17 February 2003 in St. Petersburg, Russian Federation. Delegations from Canada, the European Union, Japan and the Russian Federation participated in the meeting. Representatives of the new Participants in the ITER Negotiations, China and the USA, were also present at the meeting, as observers pending decision by their respective authorities on joining the ITA.

The Committee accepted its Rules of Procedure, under which, inter alia, the Chair of a meeting will be nominated by the Participant that is hosting the meeting, from among the members of that Participant's delegation. Subsequently, the delegations accepted Dr. Yu. Sokolov as Chair of the meeting.

The delegations took note that, with the completion of an exchange of letters between the IAEA and Participants, the ITA have entered into force as of 1 January 2003 in accordance with the Terms of Reference.

The delegations confirmed designations within the structure of ITA as follows:

Members of the Committee:

Canada: Mr. J. Campbell, Dr. M. Stewart
European Union: Dr. U. Finzi, Dr. J.-P. Rager
Japan: Mr. T. Sugawa, Dr. S. Matsuda
Russian Federation: Acad. E. Velikhov, Dr. Yu. Sokolov

Contact Persons:

Canada: Ms. K. Moshonas
European Union: Mr. M. Drew
Japan: Dr. T. Tsunematsu
Russian Federation: Dr. V. Vlasenkov
International Team: Dr. P. Barabaschi

Dr. R. Aymar, as the Interim Project Leader of the ITA International Team (till 30 June 2003), and Dr. Y. Shimomura as the Co-Leader (till 30 June) and Leader from 1 July 2003.

Participant Team Leaders:

Canada: Dr. M. Stewart
European Union: Dr. R. Andreani
Japan: Dr. M. Mori (Dr. E. Tada, Acting PT Leader)
Russian Federation: Dr. O. Filatov

The Committee confirmed that the main objectives of the technical activities in the ITA phase are:

- Maintaining the documented design basis for ITER, completed to a level where all interfaces and configuration are maintained at an acceptable level of continuity;
- Establishing the technical specifications for all the procurement contracts during the first 2-3 years of construction;
- Establishing a resource loaded schedule for construction and agreed procurement scheme, procedures and arrangements, introducing project management systems and tools.

The Committee noted that the secondment process of the International Team (IT) staff is under way.

It was agreed to establish a system of task agreements, similar to the process used during the EDA, between the IT and the Participant Teams (PT) in order to specify and co-ordinate tasks of the joint work programme.

The work programme proposed by the IT was endorsed in general, including the preliminary list of task allocations. The IT and PTs were asked to jointly develop it further, giving priority status to non-site-specific items and to feasibility issues. The Committee also asked the IT Leader to organize regular IT/PT meetings to ensure the co-ordination and progress of the work programme.

The Committee welcomed China's expression of willingness to participate in the ITA, noting that such participation also constitutes the most effective way for new Participants to familiarize themselves with the project and with their contribution priority areas.

THIRD MEETING OF THE ITPA CO-ORDINATING COMMITTEE

by Dr. D.J. Campbell, EFDA CSU, Garching, and Dr. M. Shimada, ITER JWS, Naka

The Third Meeting of the International Tokamak Physics Activity (ITPA) Co-ordinating Committee (CC) was held on 24-25 October 2002 at the Max-Planck-Institut für Plasmaphysik, Garching. Dr. D. Campbell, Chair of the CC, expressed his pleasure at the significant enhancement of the physics basis for burning plasma experiments, which had been achieved via the ITPA collaboration. He was pleased to report that the recent initiative to assess the ITER diagnostics requirements through the ITPA Topical Groups had been very successful and he called for continued support of this activity. In addition, he recommended that the opportunity for collaboration with the International Energy Agency (IEA) should be vigorously pursued to promote co-ordinated research on the High Priority Research Areas.

Dr. R. Aymar, ITER International Team Leader, summarized the status of ITER. Dr. Aymar commented that he is very pleased with recent progress made through the ITPA activities in the areas of transport, pedestal, and ELM and disruption mitigation, which had increased confidence in the achievement of ITER's goals, and he encouraged continued efforts to improve understanding of the underlying physics processes, which would further increase confidence in ITER's performance margins.

The Topical Group (TG) Chairs and Co-chairs reported on the most significant recent developments in their areas of responsibility as follows:

Diagnostics (A.J H Donné, A. Costley)
Interactions with other TGs on measurement requirements and their justification have been enhanced. This has led to recommendations for higher resolution in the measurement of several key parameters (T_e, n_e, T_i, v_{rot}, q, etc.). Because of the promising developments in the "advanced tokamak" operating modes, it will be necessary to determine the minimum requirements for supporting this operation (to avoid over-specification of the measurement requirements) and to assess the performance of possible measurement techniques. In the last TG meeting, stronger EU and US participation would have been desirable. Additional resources are necessary to support the development of BPX-relevant diagnostics on present-day devices.

MHD, Disruptions and Control (O. Gruber, Y. Gribov)
Sawtooth control has been shown to influence the onset of neoclassical tearing modes (NTMs). Benign ELMs (type II ELMs) are observed at q > 3.5 and in plasma equilibria close to double null in AUG and JT-60U at higher densities. Active control of ELM frequency and amplitude was demonstrated by pellet injection in AUG. Strong noble gas puffing was effective for mitigation of forces and heat loads in disruptions while suppressing runaway electron generation (DIII-D, AUG). The DINA code (disruption simulation code) has been tested against many experiments, including DIII-D, JT-60U, TCV and AUG. A broad heat deposition is observed during the disruption thermal quench in AUG and DIII-D.

Steady State Operation and Energetic Particles (C. Gormezano, K. Miyamoto, S. Ide)
Electron cyclotron current drive (ECCD) stabilization of the m=2/n=1 NTM at r/a = 0.66 was achieved in DIII-D. A very good database on off-axis ECCD efficiency has been established showing that the measured efficiencies are in reasonable agreement with modelling predictions. Lower hybrid current drive has sustained discharges for up to 4 minutes in Tore Supra. Real time control of the normalized parameter ρ/L_{Te} has been demonstrated in JET, sustaining a neutron yield of 10^{16}/s for 7.5 s. Good alignment of bootstrap current and pressure profiles, as well as q_{min}, are key features of candidate steady state scenarios for burning plasma experiments. Shallow shear at $q_0 = 1$ (AUG, DIII-D) and shallow shear at q_{min} around 2 (DIII-D, JET, JT-60U) appear to be the best candidates for steady state scenarios.

Transport and Internal Transport Barrier (ITB) (E. Doyle, V. Mukhovatov)
Quasi-steady-state operation (7.5 s) with real time ITB and q-profile control was demonstrated on JET. ITB plasmas having $T_e \sim T_i$ using dominant electron heating were achieved in JT-60U. Full non-inductive operation (i.e. with a non-inductive current fraction of >90%) was achieved with ITBs on JT-60U, JET and DIII-D. Off-axis ECCD resulted in ITB formation in DIII-D advanced tokamak plasmas. High-Z impurity accumulation in plasmas with ITBs has been mitigated by central heating. Theory-based modelling studies highlight the need for a predictive model of the H-mode edge pedestal. Three conference papers have been presented, at the US TTF Meeting, EPS 2002, and the 19th IAEA FEC.

Confinement Database and Modelling (W. Houlberg, A. Polevoi)
The following High Priority Research Topics have been recommended for international collaboration: 1) confinement studies with pellet injection (including pellet-induced ELMs); 2) further studies on the isotope dependence of confinement; 3) investigation of the confinement scaling with β- the database should be extended over a broader range of ρ^* and ν^*; and 4) extended measurements of pedestal data, including scaling experiments and a database of core plus pedestal analy-

sis. Although ion transport is reasonably well described by physics models, electron transport needs further work. Validation of predictive transport codes is in progress. Three papers were published at the 19th IAEA FEC.

Pedestal and Edge (Y. Kamada, T. Osborne)
The origin of type I and type II ELMs in many tokamaks appears to be explainable in terms of the stability of edge peeling/ballooning modes. DIII-D data shows that the conducted ELM power decreases toward higher density or collisionality, but that the convected ELM power is almost constant, which is in contrast to JET results. Establishment of a scaling for the pedestal width is an urgent issue. Several pedestal scalings have been proposed, projecting to 2-4 keV in ITER. An assessment of the diagnostics requirements for the pedestal region in ITER has been made, resulting in a recommendation for higher spatial resolution (a/400) at the plasma edge (> 0.8a).

Divertor and SOL (N. Asakura, B. Lipschultz)
The rise time of the ELM divertor heat flux pulse has been observed to be of the order of the ion transport time parallel to the magnetic field, implying that the acceptable type I ELM heat load is a factor of two higher than the previous estimate. Only 50-80% of the ELM energy lost from the core appears at the divertor targets in JET and AUG, which necessitates further studies on power accountability. There are similar uncertainties in relation to the disruption heat loads. In dimensionless scaling experiments, appropriately normalized SOL profiles and derived radial transport coefficients have been found to be similar in DIII-D and C-Mod. Further studies on tritium retention should be encouraged. Three papers were given at PSI-2002 and one at the 19th IAEA FEC.

Reporting on the activities of the Database Oversight Group, W. Houlberg outlined the status of the ITPA Profile Database (IPDB). This database is structured with common formats and tools to facilitate collaborative projects between TGs. Modern architecture and data organization are employed. It was proposed that a Governing Committee should be established to ensure that a wide variety of needs are met, and that responsibilities are distributed to reduce bottlenecks. This, together with detailed elements of the proposal, was approved by the Co-ordinating Committee.

EU, JA, the RF and the US briefly reported on the status and plans for their R&D programmes.

EU (D. Campbell). The EFDA Technology budget includes increases for Design and R&D in ITER H&CD and diagnostics. A new EU task force has been established to address PWI issues for ITER, with a focus on erosion, redeposition and tritium retention. The EU fusion programme is addressing a wide range of issues associated with the ITPA High Priority Research Areas.

JA (M. Wakatani and H. Ninomiya). JT-60 terminated its 2002 experiments in July. In 2003, experiments are proposed on performance improvement and physics studies in advanced tokamak plasmas with the aim of contributing to the ITPA research priorities. JAERI expects at least 8 weeks of operation in 2003, but the available experimental time depends on the budget. JFT-2M will be shut down in 2003, but its operation will be resumed in 2004.

RF (N. Ivanov). The T-15M Tokamak, a device with copper coils and a non-circular cross-section, is being designed. Theory and modelling work are contributing to ITER analysis in many areas, including ripple losses, resistive wall mode feedback stabilization, neoclassical tearing mode control, disruption simulations with the DINA code, plasma transport and ideal stability analysis using the ASTRA code, and FW heating and current drive using the ICRF antenna.

US (E. Oktay)**.** The US community is embarked on the process of development of an agreed strategy for the study of burning plasmas, most notably through the Snowmass Meeting in July 2002, and a FESAC Burning Plasma Strategy Panel. A principal recommendation emerging from this process is that the USA should join ITER as a full partner. The National Research Council has established a study committee to assess a programme of burning plasma experiments, and a progress report is expected in December 2002. FESAC and NRC recommendations are critical to the US decision regarding the possible participation of the US in ITER Negotiations.

M. Shimada discussed the objectives and scope of the proposed “Tokamak Physics Basis”, together with a possible schedule for its completion. The “ITER Physics Basis”, which is a valuable knowledge resource and has provided a useful methodology for projection to burning plasma experiments, including ITER, is now five years old and some sections should be updated to reflect the progress made in that period. It was noted that a positive decision on ITER site selection and construction could have a positive impact on the motivation for such a revision and it was agreed that M. Shimada and D. Campbell should work out a well-defined scope for the document and distribute it for discussion among the CC and TGs.

ITPA High Priority Research Areas 2002-2003

Diagnostics	• Review requirements for measurements of neutron/α-particle source profile and assessment of possible methods of measurement. • Determination of MINIMUM requirements necessary to support advanced tokamak operation and control, and assessment of the possible measurement techniques. • Assess impact of RIEMF on magnetic measurements and perform improved measurements on prototype coils. • Determination of lifetime of plasma facing mirrors used in optical systems. • Development of methods of measuring the energy and density distribution of confined and escaping α-particles.
MHD, Disruption and Control	• MHD stability analysis of H-mode edge transport barrier under type I and tolerable ELM conditions. • NTMs: island onset threshold, stabilization of (3,2) and (2,1) NTM islands at high β and β recovery, possible operation with benign NTMs (FIR, seed island control); identify requirements for reactor plasmas. • RWMs: analysis, experimental verification of control, role of plasma rotation and error fields, control system requirements for diagnostics. • Construction of new disruption DB including conventional and advanced scenarios and heat loads on wall/targets. • Development of disruption mitigation techniques, particularly noble gas injection.
Steady State Operation and Energetic Particles	• Multi-machine assessment of candidate steady state and hybrid scenarios. • Install steady state scenario development database. • Explore and develop plasmas with very high bootstrap content. • H&CD code benchmarking on ICRH, NBCD, LHCD and ECCD. • Start assessment of reversed shear operational space: modelling codes for EP collective modes, experiments including mainly quantitative measurements. • Assess proposed q-profiles for steady state and hybrid scenarios.
ITB and Transport	• Improve experimental characterization and understanding of critical issues for reactor relevant regimes with ITBs, including: • Continue to optimize and improve ITER-hybrid and AT operation demonstration discharges, • Obtain $T_e \sim T_i$ at higher performance, • Impurity accumulation (low- and high-Z), • Compatibility with edge conditions (ELMs, density,). • Develop, manage and analyse the new international experimental ITB database in order to test predictive theory-based models and ITB formation conditions. • Study experimental plasma results that challenge whether ion transport is fully understood, such as flat core profiles, etc. • Test simulation predictions via comparisons with measurements of turbulence characteristics, code-to-code comparisons and comparisons to transport scalings.
Confinement Database and Modelling	• Assemble and manage multi-machine databases, analysis tools, and physics models. • Evaluate global and local models for plasma confinement by testing against the databases. • Use the models to predict the performance of Burning Plasma Experiments, including an estimate of the uncertainty of the predictions.
Pedestal and Edge	• Improve predictive capability of pedestal structure through profile modelling. • Construct physics-based and empirical scaling of pedestal parameters. • Improve predictive capability for ELM size and frequency and assess accessibility to regimes with small or no ELMs.
Divertor and SOL	• Understand the effect of ELMs/disruptions on divertor and first wall structures. • Tritium retention and the processes that determine it. • Improve predictive capability of pedestal structure through profile modelling. • Better prescription of SOL perpendicular transport coefficients and boundary conditions for input to BPX modelling.

Definition of High Priority Research Areas: a small number of R&D issues which provide a focus for the Topical Group's activities in a timeframe of 1-2 years and which should be determined on the basis of their likely importance, both in increasing understanding of fusion plasmas and in providing increased confidence in achieving significant fusion gain in proposed long-pulse burning plasma facilities, as well as of probability of thier achieving significant progress within this timeframe.

Discussion on issues relevant to the Structure of the ITPA included the following topics:

Structure and Activities of the Topical Physics Groups. Dr. D. Campbell expressed the Committee's appreciation for the contribution of Prof. Kenro Miyamoto during his time as Co-Chair of the Steady State Operation and Energetic Particles Topical Group and welcomed Dr. S. Ide, JAERI, as the new Co-Chair of the TG. To reinforce this TG's work in the key Energetic Particles area, it was decided to ensure that each participant is represented by at least two experts active in this area (if necessary, by new nominations) to allow the formation of an Energetic Particles working group within the TG.

It was suggested that a joint session to discuss plasma control issues should be held during the Diagnostics TG meeting on 14-18 July 2003, in St. Petersburg or in Moscow. The focus of the meeting would be physics-related requirements on control. The role of rotation in influencing plasma performance has been highlighted increasingly as it influences transport and stability. However, the physics understanding of rotation is limited: the present theory does not explain cases in which significant plasma rotation is observed with no momentum input (e.g. with ICRF in C-Mod). The need for continued code benchmarking of ECCD stabilization of NTMs was highlighted in the discussion.

Participation of the Stellarator Community in the ITPA. An 'informal' proposal for participants from the stellarator community, one for each TG, had been received. This list was approved by the CC. The CC confirmed that it is not the intention to modify the scope of the ITPA through the participation of the stellarator community. It is expected, rather, that the participation of the stellarator community will be beneficial for developing an improved understanding of the physics relevant to a tokamak BPX and that the stellarator community will gain from the extensive physics basis which has been assembled for a tokamak BPX.

Progress on the ITPA Website (http://itpa.ipp.mpg.de/). H. Zohm reported that uploading of files will be possible in the near future. TG members are encouraged to use this site as much as possible to enhance communication among the members. Suggestions for improvement are welcome and should be mailed to H. Zohm (zohm@ipp.mpg.de).

Proposals for High Priority Research Areas 2002-2003 were made on behalf of each TG and reviewed by the CC. The final list of agreed areas is shown in the table on page 7.

The CC members expressed satisfaction with the progress achieved in the ITPA over the last 12 months. It was agreed that the Contact Persons will discuss the possibility of extending the ITPA framework for up to two years with their respective administrations.

Participants in the Meeting

EU: D. Campbell, F. Romanelli, H. Zohm, A.J. Donné, C. Gomezano, O. Gruber
JA: H. Ninomiya, S. Takamura, M. Wakatani †, N. Askura, Y. Kamada
RF: N. Ivanov, S. Konovalov, S. Mirnov
US: E. Oktay, N. Sauthoff, R. Stambaugh, E. Doyle, W. Houlberg
IT: R. Aymar, M. Shimada, A. Costley, Y. Gribov, V. Mukhovatov, A. Polevoi

† The members of the ITPA Co-ordinating Committee and the ITPA Topical Physics Groups wish to express their sadness at the sudden death of Prof. M. Wakatani of the University of Kyoto. Prof. Wakatani's significant contributions to the work of the ITER Physics Expert Groups and to that of the ITPA are greatly appreciated by all of his colleagues.

Items to be considered for inclusion in the ITER CTA 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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