

FIRST MEETING OF ITER TEST BLANKET WORKING GROUP

by Dr. E. Proust, Chairman

The first meeting of the Test Blanket Working Group (TBWG) was held on 19–21 July 1995 at the ITER Garching Joint Work Site.

This Working Group was established by the ITER Council with the scope of

- ◆ "... developing a co-ordinated blanket test program and addressing the interface between the machine and test objects including auxiliaries, facilities, machine operation, safety, reliability, and maintenance requirements. The test program must be consistent with the ITER mission as specified by Special-Working-Group-1 (SWG-1):
 'ITER should test design concepts of tritium breeding blankets relevant to a reactor. The tests foreseen on modules include the demonstration of a breeding capability that would lead to tritium self-sufficiency in a reactor, the extraction of high-grade heat and electricity generation';
- ◆ reviewing the blanket testing plans by each Party and consider possible actions to promote co-ordination between these plans;
- ◆ considering the blanket development plans of each Party with the view to
 - a) inject appropriate expertise and to ensure that results of these developments are available to the ITER EDA development of a breeding blanket for the ITER Enhanced Performance Phase;
 - b) promote co-ordination between the Parties' respective development plans."

The TBWG membership consists of:

- three representatives from each Party, namely Drs. S. Booth, M. Dalle Donne and E. Proust for the EC, Drs. T. Kuroda, H. Takatsu and T. Tanaka for JA, Drs. I.G. Kirillov, Y.G. Strebkov and V.N. Tebus for the RF, and Prof. M. Abdou and Drs. T. Hua and L. Waganer for the US;
 - four representatives from the Joint Central Team (JCT): the Deputy Director in charge of the blanket program within the JCT, Dr. R. Parker, and Drs. Gohar, Haange and Saaji.
- Drs. E. Proust and R. Parker have been appointed Chair and Co-Chair by the ITER Director, in consultation with the ITER Parties' Program Directors.

The first TBWG meeting was the opportunity for each Party to present the status and prospects of their national DEMO blanket development programs, and their preliminary views on blanket concept in ITER testing strategies and associated requirements on ITER design/operation. The JCT presented an overview of the ITER design with emphasis on machine/test blanket interfaces and associated constraints on test object design and operation.

The JCT also presented the status of the ITER breeding blanket design.

Following the advice of the ITER Director, the TBWG assigned as its first priority the identification of possible constraints from blanket module testing upon the ITER design, so as to enable the JCT to take them into account well before such design be finalized. Thus the TBWG agrees to provide, in the format established by

the Project (input to GDRD, DDD, ...), documentation concerning the Test Blanket Program (TBP) including requirements (those placed on the ITER device by the TBP as well as those placed on the TBP by the ITER device), design description of proposed test articles, a plan for implementation of the test program, interface documents, and additions to the ITER Work Plan as required by the TBP. The time table for initial work aims at producing agreed GDRD and approved DDD by Spring '96.

The second priority for the TBWG to be addressed will be to clarify whether a breeding blanket with a breeding ratio >0.8 could be designed with the same cooling, shielding capability, dimensions and architecture as the shielding blanket at present envisioned for the Basic Performance Phase of ITER.

SECOND WORKSHOP OF THE ITER EXPERT GROUP ON CONFINEMENT AND TRANSPORT

by Dr. V.S. Mukhovatov, ITER Joint Central Team, and Dr. M. Wakatani, Kyoto University

The 2nd Workshop of the ITER Expert Group on Confinement and Transport was held in Princeton, USA, on 21–23 September 1995, adjoined to the IAEA Technical Committee Meeting and the US-Japan Workshop on H-mode Physics. 13 members of the Expert Group and 22 technical specialists including 5 members of the Confinement Modeling and Database Expert Group attended the Expert Group Workshop. The main topics discussed at the Workshop were:

- ◆ Progress achieved during 1995 in accomplishing the ITER Research Needs in an area of plasma confinement and transport; definition of new emphases and priorities for research in this area for 1996.
- ◆ Preparation of a document "ITER Physics Basis".
- ◆ Plasma diagnostic requirements for ITER specified by the Diagnostics Expert Group and Joint Central Team (JCT).
- ◆ Plan for future work.

1. ITER Confinement Research Needs

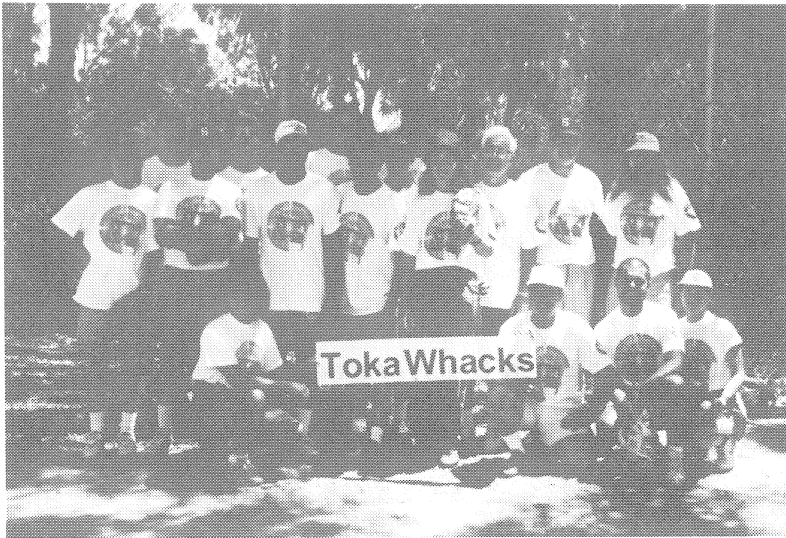
About 90% of the Workshop time was devoted to this topic. Thirty reports were presented and discussed. Progress in fulfilling the ITER Urgent and High-Priority Research Needs as well as new emphases and priorities were discussed at a special session.

There was a very good response from major tokamaks around the world to the 1995 ITER Confinement Research Needs.

Seven tokamaks, i.e., JET, JT-60U, DIII-D, ASDEX Upgrade, Alcator C-MOD, COMPASS-D and JFT-2M, carried out series of experiments in the ITER-like configuration to investigate the H-mode power threshold (1995 Urgent Need 3.1). Though a good progress has been made on the L-H transition database effort, the scaling of the H-mode power threshold with plasma parameters is not yet determined as would be required. Taking account of a large uncertainty in the L-H and especially in H-L power thresholds, most experts agreed that, if a recommendation had to be made at this time, it would be that ITER should plan on the heating power of 150 MW. More data and further analyses are needed to reduce the uncertainty in projection to ITER. This Need has been classified as an "Urgent" one for 1996 with an emphasis on size scaling and effects of edge neutral pressure on the power threshold.

Four tokamaks, i.e., JET, JT-60U, DIII-D and Alcator C-MOD, have made contributions to the non-dimensional transport experiments (1995 Urgent Need 3.2). A preliminary conclusion emerging from these experiments is that of favourable gyro-Bohm confinement scaling for heating powers well above the H-mode power threshold and of unfavourable Bohm/MHD scaling when the power level is near the threshold. Further experiments on the above machines and on other tokamaks (ASDEX Upgrade, Compass-D) are necessary to clarify the change in confinement near the L-H and H-L power thresholds and the effect of $\beta = 8\pi \bar{p}/B_T^2$ on confinement. Confinement behaviour should be tested also at plasma densities above the "ohmic" (Greenwald) limit. The priority of this need for 1996 remains "Urgent".

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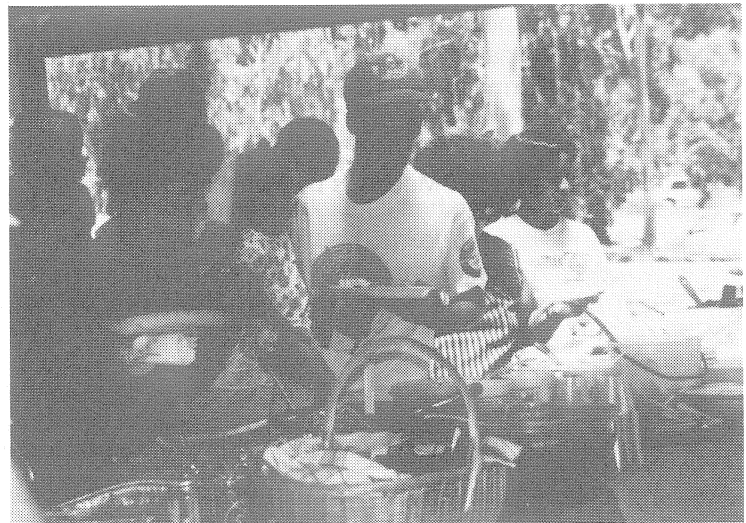
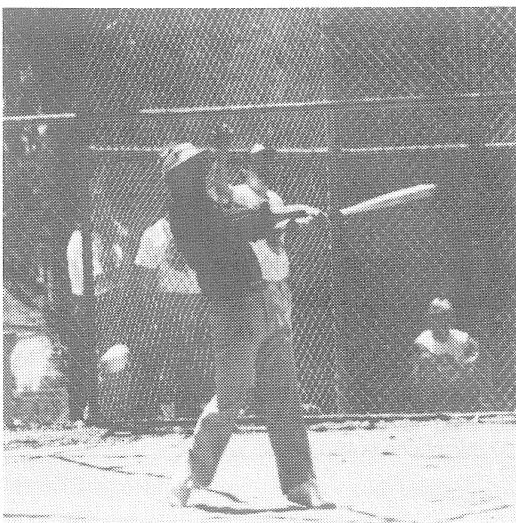
Families of the San Diego ITER JCT and support staff gathered for the Third Annual Summer Picnic and Softball Challenge on Saturday, 22 July. The event, one of four major annual events sponsored by Science Applications International Corporation (SAIC), was organized by the volunteer SAIC Recreation Committee, chaired by Barbara Lee. Sporting activities and children's entertainment were plentiful; a feast of hamburgers, hot dogs, and barbecued chicken cooked over an open grill combined with a delicious selection of home-made international dishes were consumed to enhance the enjoyment of a beautiful, sunny San Diego afternoon.

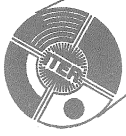
The day was highlighted by the enthusiastic sounds of softball fans as they cheered Jim "Mad Dog" Magnuson's "TokaWhacks" to victory. It was a hard won fight as the runner up teams, the Critical Mess, the Middlesex Cricket Club, and the B.E.A.R.S. (Burning Engineers and Reactor Specialists), comprised of players of all ages and nationalities, played tough three inning matches. Yoshimura-san surprised himself with a double play at second, and Kaia Gantzel was outstanding – catching pop flies and hitting a three base run. Doug Post's remarkable free form pitching style challenged batting skills. Alan Costley and Maurice Sabado also showed unique playing forms before qualifying for the walking wounded.

Volleyball and horseshoes kept the less active picnic competitors busy and the younger set was entertained by Just 4 Kidz Entertainment from San Diego. The blue butterflies and red roses decorating the faces of Katherine Putvinskaya and Alex and Valerie Piet were just a few of the designs the children sported, and even the youngest attendee, Bill Dales' son Cameron, 7 months, appeared to enjoy the activities.

Sunny blue skies, cool ocean breezes, sounds of laughter, the buzz of conversation, the crack of the bat, and the smell of barbecue...it's safe to say a good time was had by all.

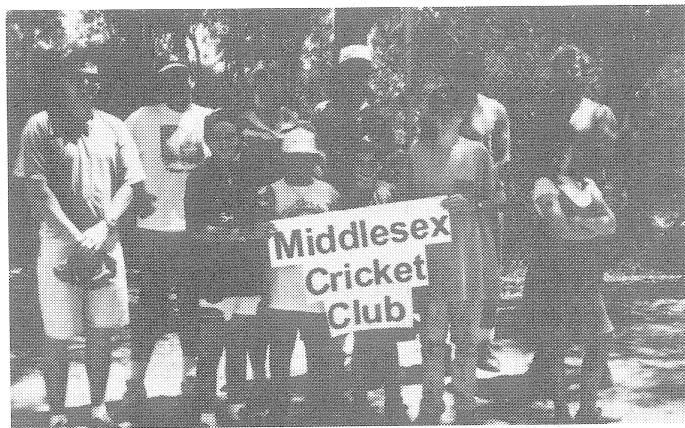
By K. Knouse and N. Carroll, ITER San Diego JWS





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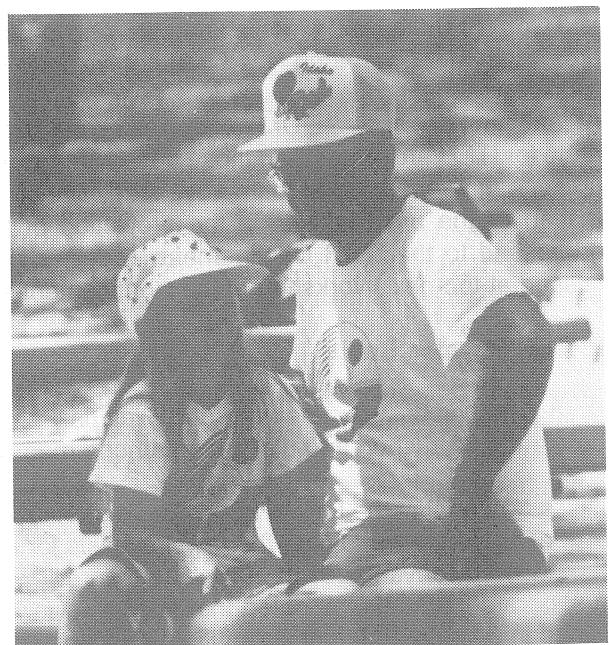
JULY 22, 1995



PHOTOS

- Team pictures: "TokaWhacks" (Captains: M. Scharff and J. Magnuson); "Bears" (Captain: D. Dilling); "Middlesex Cricket Club" (Captain: M. Mills); "Critical Mess" (Captain: K. Rogne)
- A. Kostrubala prepares to hit a home run
- Yoshimura-san hitting a fast ball
- S. and J. Murdock (as well as many others not shown) enjoying the array of international dishes by JCT families and SAIC
- Children marvel at clown entertainment
- S. Piet and daughter Valerie briefly resting

Photos courtesy of L. Miller and S. Carroll



For the brief technical summary of deliberations on both 1995 Urgent Needs (3.1 and 3.2) see the following box:

Research Area 3.1; H-mode Power Threshold. The best fit to existing data is a scaling with a strong size dependence of the threshold power, $P_{thr} \approx 0.3 \bar{n}_e B_T R^{2.5}$ (MW, $10^{20} m^{-3}$, T, m), where \bar{n}_e is the line-averaged plasma density, B_T is the toroidal magnetic field and R is the major radius of the plasma. This scaling projects to a power requirement in ITER of 150 MW at a density of $0.5 \times 10^{20} m^{-3}$. On the other hand, a direct comparison of similar discharges in JET and DIII-D indicates a weaker size scaling, i.e., $P_{thr} \sim S^{0.7}$, where S is the plasma surface. Assuming $\bar{n}_e B_T$ is correct, this leads to the scaling $P_{thr} = 0.169 \bar{n}_e B_T S^{0.7}$, which predicts 72 MW for ITER, i.e., about a factor 2 lower than the previous one.

Research Area 3.2; Tokamak Demonstration Discharges with ITER Non-Dimensional Parameters. The dimensionless scaling experiments were focused on a size scaling of confinement, i.e., variation in transport coefficients with $\rho = p_i/\alpha$, where p_i is the ion gyroradius and α is the minor radius of the plasma. Other dimensionless parameters, such as β , plasma collisionality ν^* , safety factor q , aspect ratio R/α , and plasma elongation K , being kept constant. A preliminary comparison of a pair of discharges in DIII-D and JET with all dimensionless parameters identical, but all engineering parameters different, shows that dimensionless approach is valid although more detailed analysis is required to validate this conclusion. The ρ^* scaling studies of H-mode discharges in DIII-D at heating powers well above the H-mode power threshold demonstrated a gyro-Bohm behaviour of electrons and ion thermal diffusivities supporting a gyro-Bohm like character of the ITERH-93 global confinement scaling. However, similar studies on JET and JT-60U at smaller ρ^* with heating powers close to the H-mode threshold ($P_{AUX}/P_{thr} = 1.5-2$) showed a Bohm like behaviour. Because the ρ^* scaling of the threshold power is stronger than that of heating power required to obtain given values of β , ρ^* and ν^* , this may prevent extrapolation to ITER based on the favourable gyro-Bohm confinement scaling. These preliminary results suggest that the main uncertainty as far as ITER projections are concerned is at present the scaling of the H-mode power threshold.

The Expert Group concluded that the 1995 High-Priority Need 3.3: "Differential Transport of Helium and Hydrogen Isotopes" was successfully completed. An adequate helium exhaust has been demonstrated on a variety of machines, i.e., DIII-D, JET, JT-60U, TFTR, ASDEX Upgrade, TEXTOR, in a variety of conditions including ELMing H-mode. These data indicate that sufficient helium exhaust will be possible in ITER.

New results relating to ELM control were presented from DIII-D, ASDEX Upgrade, COMPASS-D, JT-60U and JFT-2M (1995 High Priority Need 3.4). On the recommendation of the ITER Physics Committee, this Need is now under the direction of the ITER Divertor Database Expert Group.

Reports on discharges with an improved confinement without transition into the H-mode (1995 High Priority Need 3.5) were presented from ASDEX Upgrade (H-factor up to 1.5) and from DIII-D ($H \geq 2$). A new scaling for the thermal energy confinement time based on analysis of the updated L-mode database was obtained which for ITER predicts a 1.5 times higher energy confinement time compared to the ITER89-P global scaling.

Continuing progress is observed in the development of transport models, e.g., Ion Temperature Gradient (ITG) and Current Diffusive Ballooning models, and in further development of the Multi-mode Transport Codes. This area of activity (Research Need 3.6) continues to be of High Priority for 1996.

At the summary session, Dr. B. Carreras expressed the view that the uncertainties of the present ignition scenario for ITER are larger than those based on a simple statistical analysis of the available database, and back-up scenarios are needed to improve credibility of the present ITER design. It was agreed that a better estimation of the uncertainties in the projection of ITER performance may be possible, and this issue was addressed to the ITER Confinement Modeling and Database Expert Group. Relevant results will be discussed at the next Workshop of the Confinement and Transport Expert Group.

2. ITER Physics Basis

Draft Chapter II: "Confinement and Plasma Performance" for ITER Physics Basis was partially prepared before the Workshop and distributed among members of both Confinement Expert Groups for comments.

It was agreed that the ITER Physics Basis should be a technical review of the ITER physics issues rather than a general article explaining the physics basis for magnetic fusion. It was suggested to consider the advantages and disadvantages of publishing this review in Physics Reports. One clear advantage is that it will be a separate book. It was noted that such a review could be accompanied by a simplified version to be published in Physics Today or Scientific American.

3. Diagnostic Requirements

Plasma diagnostic requirements prepared by the ITER Diagnostics Expert Group and JCT were discussed. The following comments were made: (a) the neutral density between plasma and first wall should be measured; (b) measurement of electric field should be shifted from category (iii) to category (ii); (c) more attention should be paid to measurements at the plasma start-up phase. Some remarks referred to time resolutions and accuracies of measurements. A detailed report on the discussion will be presented at the 4th Diagnostic Expert Group Workshop in Moscow (February 22–23, 1996).

4. Future Plans

The 3rd Workshop of the Confinement and Transport Expert Group (Montreal, October 14–17, 1996) adjoined to the 16th IAEA Conference on Plasma Physics and Nuclear Fusion Research (was recently renamed "IAEA Fusion Energy Conference") was proposed with a provision for an additional Workshop (if needed) in Spring 1996.

LIST OF PARTICIPANTS

EU:	RF:	US(cont'd.):
H.-S. Bosch, Garching	V.E. Golant, Ioffe Inst.	T.C. Luce, GA
D.J. Campbell, JET	S.V. Lebedev, Ioffe Inst.	T.H. Osborne, GA
J.W. Connor, Culham		J.A. Snipes, MIT
J.G. Cordey, JET	US:	E.J. Synakovski, PPPL
X. Garbet, Cadarache	G. Bateman, PPPL	W.M. Tang, PPPL
E. Righi, JET	K.H. Burrell, GA	N. Uckan, ORNL
R. Ryter, Garching	C.E. Bush, PPPL	M. Wade, ORNL
	T.N. Carlstrom, GA	S.M. Wolfe, MIT
JA:	B.A. Carreras, ORNL	P.N. Yushmanov, UCSD
H. Shirai, JAERI	W. Dorland, IFS	
M. Mori, JAERI	P. Gohil, GA	JCT:
K. Toi, NIFS	M. Greenwald, MIT	D. Boucher
K. Tsuchiya, JAERI	W.A. Houlberg, ORNL	V.S. Mukhovatov
M. Wakatani, Kyoto Univ.	W.W. Lee, PPPL	F. Perkins

ITER EVENTS *)

Energetic Particles, Heating and Current Drive Expert Group Workshop, Moscow, RF, 2–6 October
4th Technical Meeting on Safety and Environment, San Diego, USA, 9–13 October
3rd Confinement Modelling and Database Expert Group Workshop, Naka, Japan, 16–19 October
3rd Divertor Physics Expert Group Workshop, Naka, Japan, 16–20 October
1st Technical Meeting on Quality Assurance, San Diego, USA, 26–28 October
MAC-9, St. Petersburg, RF, 3 November
TAC-9, Garching, Germany, 27–29 November
ITER Physics Committee Meeting, Garching, Germany, 30 November–1 December
Tritium Plant Technical Meeting combined with Fuelling & Pumping Meeting, Naka, Japan, 4–8 December
IC-9, Garching, Germany, 12–13 December

*) Attendance at all ITER Meetings by invitation only.

Items to be considered for inclusion in the ITER Newsletter should be submitted to B. Kouvchinnikov, ITER Office, IAEA, Wagramerstrasse 5, P.O. Box 100, A-1400 Vienna, Austria, or Facsimile: (+43 1) 237762; phone (+43 1) 2060 26392.

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