University Participation in ITER and Organization of the US ITER Management Structure

University Fusion Association
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Executive Summary

This white paper from the University Fusion Association outlines university community recommendations regarding the US involvement in ITER. Members of the University fusion community are enthusiastic about participating in ITER and have been deeply involved in the process by which a national consensus was formed to enter the ITER negotiations. The decision to proceed with a burning plasma experiment has arisen through broad community support-its implementation should continue to be a community effort.

This white paper serves two purposes. First, we make known our intentions to participate in the exciting burning plasma science that ITER will undertake. Universities seek to be equal partners with national laboratories and industry in this endeavor, and plan to participate at all levels in the ITER project. Second, several recommendations on the organization of ITER are made that will make it possible for all partners to contribute optimally. The organization of the US participation in ITER (or any burning plasma endeavor) should be multi- institutional at all levels; this will advance fusion science and technology most effectively. These recommendations are:

1. The scientific leadership for US participation in ITER should be a multi-institutional organization with membership from national labs, universities and industry. The UFA proposes that a National Burning Plasma Research Council be formed, for directing the US involvement in ITER. We urge FESAC to recommend at the earliest juncture the structure of this council and its responsibilities for leading the ITER participation.

2. The ITER negotiating team should include a balanced team of technical advisors from universities, national labs, and industry.

3. To support the negotiations on US ITER involvement, DoE should encourage a research forum to be held soon to educate the community on opportunities and to facilitate developing white papers from universities, national labs, and industry describing future proposals for construction activities and science and technology programs on ITER. The UFA stands ready to help organize and sponsor this ITER Research Planning Forum.

Background

The US Fusion Energy Sciences Program has been built as a partnership between universities, industry, and national laboratories. Each type of institution has contributed to the past successes of the program, and will do so in the future. The University fusion community and the University Fusion Association has enthusiastically supported and actively worked with the other participants in the US fusion energy science community to document the present scientific basis of a burning plasma through the UFA hosted Burning Plasma Workshops of 2000 and 2001 and to assess the burning plasma experiment options at Snowmass in 2002 that led directly to the FESAC strategy for moving forward with a burning plasma experiment. This FESAC burning plasma strategy recommends pursuing an international partnership in ITER, while maintaining the domestic based FIRE experiment as an alternative. All this effort by the community was rewarded on Jan 30, 2003 when the Secretary of Energy and the White House announced the US would join the ITER negotiations.

The US participation in ITER (or other burning plasma experiment) should continue to build on the broad consensus that has been established in the community supporting a burning plasma experiment and draw on representatives from universities, industry, and national laboratories to engage in the discussions about the possible US contributions to the ITER program. In particular, given the US decision to join the ITER negotiations, consideration needs to be given now to the roles that US Universities will play in the US participation in ITER construction and operation.

The Role of Universities and University Involvement in ITER

The universities will continue to exercise their essential role for the development of the broad fields of plasma and fusion science and engineering. These wide-ranging activities complement the capabilities of other US institutions and are crucial to the future success of the ITER project. Through its work, the university community can provide, in addition to its other scientific and engineering output, advanced physics and technology capabilities appropriate for ITER. Some specific examples of potential university contributions to ITER are described in the next section. Furthermore, universities will also play a major role in theory and computation, basic plasma science, materials and technology, and innovation and optimization of fusion configurations, a role which is strategically essential for eventual energy production.

An equally important and crucial function is the training of the scientific and engineering personnel essential to carry out the ITER project. This issue deserves special attention. Should ITER promptly move forward into construction, it is likely to begin operation around 2015. The key scientific program will then be carried out during the period from 2015 to 2025 or so---a period of time 12 to 22 years in the future. At present the typical scientist or engineer in the US fusion community is approximately 50 years old; as a result a significant number of present-day US fusion scientists will be at the end of their active research careers at the time when ITER is beginning operations. The generation of

scientists and engineers needed to make ITER a success will therefore be trained by the present-day cadre of university faculty and research staff. If the present-day US university faculty and staff are closely connected to the US ITER effort now, then they will be in a position to train the younger cadre of workers who will carry the ITER project forward to completion.

A unique aspect of the fusion energy sciences program is its dual nature: the underlying physics base is plasma physics, which forms the broad intellectual base of research ranging from computer microchip processing to astrophysics; at the same time, there is a definite goal – the attainment of controlled fusion for energy. As such, another aspect of the role of universities relates to the nature of training offered to its students. It is generally agreed that the most effective training for R & D scientists and engineers is one which provides broad knowledge and wide experience in the field of study. With a mix of basic and goal-oriented studies offered within the dual nature context of fusion science, universities are ideally equipped to carry out this function.

The ITER project is a large-scale technological undertaking requiring close cooperation among universities, industry, and national laboratories distributed across the world. In addition to the broad university contributions as above, members of the University fusion community also desire to be involved in a range of activities and to be partners with national labs and industry in several aspects of ITER: universities seek to be involved in the high level management, desire equal access for bidding on and opportunity to lead the effort on procurement packages, and are eager to collaborate with partners in national labs and industry.

University involvement in ITER can occur in varied ways. Individual university groups could work independently or in collaboration with other partner institutions. Present-day implementations of this model typically have the industrial or national laboratory partner hold responsibility for major hardware elements and the university group provides unique diagnostic, analysis, and/or theoretical capability. This has been effective and much of the university involvement in ITER will be of this type. In general, several interested university groups could also consort to hold responsibility for major components in a large scientific research facility. An expanded role of this sort may also be desirable to universities participating in research on ITER

Where should the universities get involved?

Scientific expertise for a burning plasma experiment is distributed among the many institutions within the US fusion community, and an important part of that expertise is at the universities. Of course, the UFA recognizes that the US must have a broad ranging participation in most scientific activities on ITER and that universities are not leaders in all areas of concern to ITER. However, there are essential physics areas where universities can take a leadership role within the ITER project. As an illustrative list, the following are topical areas in which universities have technical expertise:

1. Study of turbulent transport in presence of strong α-heating. Universities are involved in state-of-the-art diagnostic development and scientific discovery in the area of turbulence measurements. Universities also are advancing the theory of turbulence in fusion plasmas and deeply involved in advanced scientific computation.
2. Study of α-particles and α-particle driven instabilities. Some university programs, both experimental and theoretical, are focused on the study of fast particle instabilities. Expertise in α particle diagnostics also exists in academic institutions.
3. Active control of β limiting instabilities in burning plasmas. Universities have led the national effort to observe and understand neoclassical tearing modes, and are leading the program in understanding and controlling the resistive wall mode in tokamaks using active feedback.
4. The mitigation of disruption damage using high-pressure gas jets. Universities are leading the scientific development on the physics understanding and extrapolation to burning plasmas of the gas jets. This area will be critical for the operational success of ITER and future high energy-density devices.
5. Erosion of plasma-facing components and Tritium retention. Universities are at the forefront of understanding the physics of plasma-surface interaction and the complex pattern of plasma impurity transport that leads to severe operational constraints in D-T burning plasmas.
6. Superconducting magnets. Universities have been central to technology development of superconducting magnets and other technology areas and hope to continue to be involved in the ITER magnet program.
7. The ITER blanket test module program could involve significant university involvement as a majority of the chamber technology research is now carried out at universities.

Effective leadership roles in any of the areas listed above will require involvement at many levels. The goal for any of these efforts would be for university scientists to be planning and then carrying out experiments on ITER in the 2015-2020 time frame. However, effective participation in ITER's future will require involvement starting as soon as possible.

ITER Management

As the US enters negotiations, the UFA recommends that certain aspects of ITER management be addressed early in the negotiation process such that the ultimate management structure is open to all interested parties. In order to best serve the broad fusion community, the program should be multi-institutional at all levels. It is in this spirit that we make the following recommendations:

1. A National Burning Plasma Research Council should be formed to be the scientific leadership of the US for participating in ITER.

US participation in ITER is a broad national program. As such, the US ITER Program should not be predominantly associated with a single national laboratory or industrial group. Even a perception of single institution predominance is not beneficial. The management for ITER involvement must be from a range of institutions, and the process by which decisions are made (decisions about issues ranging from funding of construction projects to experimental priorities) should be transparent.

The decision to proceed with a burning plasma experiment has arisen through broad community support—its implementation should be a community effort. The UFA proposes that a National Burning Plasma Research Council should be formed, with rotating leadership, to direct the US involvement in ITER. This council should not simply be advisory, it should lead the program. We urge FESAC to formulate recommendations on the structure of this council and on the council's responsibilities for leading the ITER participation. This council should establish the process by which requests for proposals will be made and assure that the implementation of a peer reviewed selection process allow equal opportunity for all parties to bid for the US ITER procurement packages.

While the scientific leadership of ITER must be distributed amongst a number of institutions, the UFA recognizes the utility of a central administration for the US ITER team. We suggest that the technical and financial management should be centralized, to carry out the program defined by the research council. This management should not be directed by any existing plasma institution, rather should answer directly to OFES and the National Burning Plasma Research Council.

2. A broad range of technical advisors, representing industry, national labs, and universities, should be part of the ITER negotiation team.

As US participation in the ITER negotiations begins, it is important to recognize that our European and Japanese colleagues have spent considerable effort developing a strategy for entering negotiations and have planned for the eventuality of the US entering the negotiations. The European and Japanese negotiating teams are large and have sound scientific support from a number of technical advisors. In a similar way, the US negotiating team should include a number of technical advisors representing the broad range of scientific and technical activities that underlie a burning plasma experiment; several of these should be drawn from universities.

3. **A research forum should be organized soon to educate the community on opportunities and to facilitate developing white papers describing future proposals for construction, science, and technology programs on ITER.**

Independent planning and discussions for ITER participation are under way at numerous institutions. This planning is hampered by the lack of a forum for exchanging views, forming institutional teams, and proposing potential plans and activities. The DoE and the negotiators will need concrete proposals to act upon so that an appropriate set of procurement packages can be brought to the ITER negotiations by the US. The UFA strongly believes that the process for awarding bids must be open and transparent, such that all parties can compete for these packages.

To facilitate this planning, DoE should encourage, preferably before the next negotiators meeting, that **a research forum** be held together with a **call for white papers** from universities, national labs, and industry describing future proposals for construction activities and science programs on ITER. This research forum would serve to inform the community of opportunities. A set of informal proposals such as this would provide much needed information to the negotiating team. The UFA stands ready to help organize and sponsor this ITER Research Planning Forum. This first general research forum could then be followed by subsequent meetings in the areas of diagnostics, heating and current drive systems, magnets, etc. to further refine the proposals.

This research forum could be the first step in ultimately awarding contracts for construction packages and for carrying out the research needed to make ITER a reality with effective US participation.