

BPO Operations & Control Breakout Session Summary

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Executive Summary

The Operations and Control Breakout session considered the six key charge questions as related to machine and plasma control for a burning plasma device (primarily ITER): progress in control since Snowmass 2002, control needs of ITER, resources available in the US, and recommendations for structuring the Burning Plasma Organization with regard to operations and control. Overall participation included ~20 people at various times throughout the breakout session day, impacted by the strong overlap with many other topical groups, which drew potential participants to other parallel sessions. This overlap reflects the cross-cutting nature of the control topic, and emphasizes the relevance of control to many areas of burning plasma physics.

Among the key conclusions of the session were that ITER control design needs remain substantial, that US control resources can provide many elements essential to ITER, and that the BPO should form an Operations and Control Topical/Working Group to address burning plasma control problems. Formation of the BPO presents an opportunity to focus US control resources for ITER solutions. An Operations and Control Topical/Working Group can enhance US impact on ITER control by providing a channel for communication among US/international control task participants and the ITER IT, helping to coordinate effective application of US resources, and encouraging standards for interoperability to increase efficiency in those applications.

Since the 2002 Snowmass Fusion Summer Study Meeting, the US has continued to make progress in control development, primarily in support of operational needs for present experiments. For example, world leadership has been firmly established in control of resistive wall modes (RWM), neoclassical tearing modes (NTM), and ELMs (the latter principally through edge stochastic field application in the US), along with mitigation of disruption effects through massive impurity injection. In addition, control modeling, design, and simulation tools have been extensively developed in support of operating devices, the FIRE burning plasma experiment design, and international next-generation superconducting tokamaks such as KSTAR and EAST.

Control design needs of ITER remain significant. Many of these are presently outstanding ITPA tasks, including specification of noise effects on axisymmetric control,

demonstration of q-profile regulation, demonstration of RWM, NTM, and ELM control solutions, and demonstration of effective disruption mitigation methods.

Consequences of failure to resolve these and other outstanding ITER control issues are severe, some resulting in failure of the project. For example, insufficient NTM control will possibly lead to unacceptable disruptivity in high-beta advanced scenario operation. Failure to control ELM frequency and divertor heat loads will jeopardize machine availability and divertor lifetime.

The central control issue to be resolved by ITER is the viability of controlled thermonuclear fusion itself. A successful ITER experiment will demonstrate the potential of sustained, high reliability control of a tokamak reactor with attractive economic performance. Several areas unique to a fusion reactor, including burn control and relevant fault detection and responses, must be demonstrated. In most areas, however, control should be viewed as an enabling field for ITER, rather than a field in which fundamental issues are to be resolved by experimental operation of the device.

The US can make extensive contributions to ITER control, beginning with the use of a broad portfolio of tokamaks and other relevant experimental platforms. These devices provide key resources for obtaining critical physics understanding, performing model validation, and developing and demonstrating specifically relevant control approaches. Areas of particular strength in US experimental control resources and experience include RWM, NTM, ELM, and advanced axisymmetric control, as well as disruption mitigation. A vast array of computational resources essential to control also constitute a key strength of the US, including MHD stability analysis and model generation codes, integrated scenario simulation codes, and controller design tools. In addition, the US has extensive software infrastructure expertise for support of realtime control needs, including realtime networking, database management, control interfaces, and demonstrated ITER-relevant realtime algorithms.

Consideration of BPO organizational options in the breakout session determined that an Operations and Control Topical Group is needed in order to respond effectively to ITER control tasks, to improve efficiency in the use of limited funding by coordinating US resources and involvement in control tasks while encouraging standards for interoperability, and to facilitate communication with the ITER IT, ITER Parties, BPO Topical Groups, and within the US control community. It is recommended that the Ops/Control Topical Group include representation from all other Topical Groups, with need for particularly strong and early involvement from Macroscopic Stability, Integrated Scenarios, Diagnostics, and Boundary Topical Groups.