PREFACE

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The Alcator tokamak program began at the Massachusetts Institute of Technology (MIT) in the early 1970s, and the activity forms the cornerstone of the Plasma Science and Fusion Center (PSFC), home of MIT's research activities in plasma and fusion science, its applications, and related technology. The PSFC has been in existence for nearly 30 years and coordinates nearly all plasma and fusion-related research on the MIT campus, including the thesis research work of nearly 60 PhD students from 6 academic departments. The most important activity at the PSFC has been fusion-relevant research on magnetically confined plasmas in the Alcator series of tokamaks, which are compact in physical size but operate at very high magnetic fields. (Alcator is an acronym derived from the Italian words *Alto Campo Torus*, meaning high field torus). The Alcator C-Mod tokamak is the third in the series of high magnetic field machines built at MIT, starting with circular cross section Alcator-A, which operated in the 1970s, and the similar but larger Alcator-C, which operated in the 1980s. Alcator C-Mod, which has been operating since the early 1990s, is a modern diverted tokamak with a flexible plasma shape, and it operates at on-axis magnetic fields above 8 T, plasma currents to 2 MA, and densities up to 10^{21} m^{-3}. In particular, it can readily duplicate the plasma shape, magnetic field (5.3 T), and operating density (1×10^{20} m^{-3}) of ITER for timescales of order of the L/R time (full current relaxation time), at nearly equilibrated electron and ion temperatures. Therefore, research carried out on Alcator C-Mod is particularly timely now that the ITER Agreement was signed by the seven parties to the agreement in Paris on November 21, 2006, to establish the international organization to implement the ITER fusion energy project.

Alcator C-Mod is particularly suitable for establishing ITER-relevant operating plasma scenarios since C-Mod uses high-Z metallic plasma-facing components, is heated with ion cyclotron resonance frequency (ICRF) power (8 MW source power) with negligible momentum input, and operates with collisionally equilibrated electrons and ions with high power densities and particle fluxes, typical of ITER regimes. In addition to being able to study ITER-relevant plasma heating, stability, transport, boundary and surface physics, disruptions, and fast particle driven modes, we have installed a lower-hybrid microwave current drive system (LHCD) at 4.6 GHz for advanced tokamak (AT) studies based on current (and thereby pressure) profile control. The initial results have been very encouraging. At present, 3 MW of source power is installed, and this will be upgraded to 4 MW over the next 2 years. We believe that with the combination of the ICRF heating system and the LHCD system, we can access, and in fact exceed, the target ITER AT modes of operation with completely relaxed current profiles. We also note that C-Mod's 4.6-GHz LHCD source frequency is near optimum for ITER, and therefore, our current profile studies will be highly relevant to establishing the suitability of LHCD physics and technology for ITER. The goal is to demonstrate the feasibility of ITER-relevant target AT operation with fully noninductive current and high bootstrap current fraction.

The Alcator C-Mod program is carried out by a dedicated staff of nearly 120 personnel at MIT, plus a large number of collaborators, a truly national facility in the United States, and as such it welcomes visiting scientists from around the world. MIT recognizes the important role Alcator C-Mod plays in the world fusion program and proudly supports our activities, including financial support for constantly improving the infrastructure. MIT is an educational institute that recognizes the exceptional value of Alcator C-Mod as an educational facility, with typically 30 PhD graduate students on site at any one time, working side by side with some of the world's best fusion research scientists. Graduate students are fully integrated into the C-Mod's research program and constitute more than half of the research team. Fusion is a long-term research and development program, and it will succeed only if we continually train the next generation of fusion scientists. However, with the increasing recognition by society of the need for pollution-free, abundant, and safe energy, the future looks bright, and we can anticipate increased public support and ultimate success for fusion.

In closing, I wish to thank Dr. John Rice for his hard work coordinating the entire process of preparation and

submission of all of the manuscripts in this special issue. Finally, I thank Dr. Nermin Uckan, Editor of *Fusion Science and Technology*, for undertaking this major task of publishing the research output from some of the world's major fusion-oriented magnetic confinement projects. I would particularly like to thank her for giving us at MIT the opportunity to present the extensive results from Alcator C-Mod in one publication. This issue represents the monumental work over the past decade of all the scientists, engineers, and graduate students associated with the C-Mod project.

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