PREFACE

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This volume of *Fusion Science and Technology* (*FS&T*) summarizes the contributions of the DIII-D program that are particularly relevant to achieving a burning plasma. The world fusion program is ready to make the significant step to construct a burning plasma fusion experiment. The European Union, Japan, China, Russia, South Korea, and the United States are currently negotiating an agreement to build a new large tokamak, ITER, to address this challenge. This effort is the culmination of a broad and varied program of tokamak fusion research that has been ongoing for over 50 years. The DIII-D research program, located at General Atomics and presently funded by the U.S. Department of Energy, has made extensive and seminal contributions to this effort.

The roots of the DIII-D program go back to the 1968 demonstration in the Doublet I device of stable confinement in a highly noncircular tokamak plasma configuration with conducting wall. A "doublet" is a two-lobed toroidally symmetric plasma whose cross section contains an internal separatrix in the shape of a figure eight. Doublet II extended this idea to a larger device with conducting walls, and Doublet IIA demonstrated that highly noncircular plasmas could be shaped with external coils while the plasma was maintained away from the walls with a limiter. Doublet III extended this concept to a large-size device ($R = 1.43$ m) with neutral beam heating in 1978, and confinement in a diverted configuration was first demonstrated. The early history of the fusion program at General Atomics is summarized in a paper by M. W. Maisel et al., *Nucl. Fusion*, Vol. 25, p. 1113 (1985). Doublet III was converted into a large D-shaped device, DIII-D, in 1986. In the intervening years, significant additional capability has been added including new divertor configurations, ion cyclotron radio frequency and electron cyclotron radio frequency heating and current drive, and precision plasma control. An ever-increasing diagnostic capability provides a wealth of information for understanding the plasmas.

Unique features of the DIII-D device have been at the foundation of many of the DIII-D program contributions to fusion energy. The simple continuous shell plasma chamber has provided a strong foundation for in-vessel hardware. A wide range of highly elongated D-shaped and diverted plasmas can be readily produced. The vessel has provided excellent access for ever more sophisticated diagnostic and plasma heating systems. The 18-coil closely coupled plasma shaping coil set allows plasmas to be precisely shaped and has allowed DIII-D to readily mimic the discharge shape of other devices for comparative studies. An evolving plasma control system demonstrates many of the capabilities that will be needed in a larger device.

The DIII-D program has also led the way in collaboration with other programs and training of new scientists. The collaboration with the Japan Atomic Energy Research Institute in joint operation of Doublet III in 1979 was the first major international collaboration in the world fusion program, and it set the stage for an extremely broad and collaborative program at laboratories worldwide. At DIII-D, this has expanded to collaborations representing 18 countries and includes over 41 universities, 34 national laboratories, and 15 industries. Work on DIII-D has also provided the basis for faculty research, doctoral theses, postdoctoral studies, and student interns from the associated universities.

It is against this backdrop and looking forward to a new and exciting program of burning plasma research that this summary of the work at DIII-D is presented. It is our hope in doing this to pull together the work published in a broad array of venues over the past twenty years and organize it in a way that will be most useful to ongoing fusion research. This special issue is divided into seven sections. The first section begins with a summary of the results, a brief introduction to the DIII-D device, and a discussion of the diagnostic systems. The detailed results are then presented in the remaining 31 papers, each reviewing the work in a given area, organized into six topical areas. These papers are often prepared by one or a few authors, but each paper represents the work of a large team of scientists and engineers working over a span of more than twenty years. The DIII-D Team members and their affiliations are listed in the Appendix of this special issue.

Lastly, The DIII-D Team and I would like to take this opportunity to thank Nermin Uckan, Editor of *FS&T*, for her support and patience in developing this special issue, the many reviewers for their insightful help, the production staff at the American Nuclear Society, and the Fusion Publications Group at General Atomics (headed by Woodie Jarrett).