PREFACE

PLASMA HEATING AND CURRENT DRIVE

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We are pleased to have a special section on Plasma Heating and Current Drive in this issue of *Fusion Technology*. Among the various areas covered by fusion technology, heating and current drive for magnetic confinement devices have undergone one of the more radical changes in recent years. Only a few years ago, neutral beam injection was viewed as the preferred route to heating. Current drive was not receiving much attention. However, recent reactor design studies such as STARFIRE placed emphasis on the need for alternate heating methods and for noninductive current drive technique to provide an approach to steady-state operation in tokamaks. These findings, along with continued improvements in experimental results from radio-frequency (rf) and wave excitation techniques, have caused a shift in emphasis away from neutral beams. The special section in this issue, then, examines some aspects of the new direction that have resulted.

In the introduction, P. Colestock of Princeton Plasma Physics Laboratory provides a comprehensive overview of the current status of rf heating and current drive for tokamaks. He considers the use of ion and electron cyclotron waves for heating and lower hybrid (LH) waves for combined heating and current drive. Applications to the INTOR design are also discussed. This overview should help the reader by putting the various approaches in perspective and by also providing a good set of references for those interested in more detail. The three following papers provide further focus on both theory and experiments of ultimate significance to fusion reactor design. Z. Zhang and C. Chen from the Institute of Physics, Beijing, China, review key aspects of electron cyclotron heating (ECH) with emphasis on aspects that are ultimately important for the design of a reliable system for reactor application. J.-G. Wégrowe of the NET team provides a very interesting and important comparison of theoretical and experimental results for various regimes of interest for reactor applications. Finally, a comprehensive review of electron cyclotron resonance heating results from WENDELSTEIN VII-A is presented by V. Erckmann and collaborators from the University of Stuttgart and from the Max-Planck-Institut für Plasmaphysik.

The remaining papers provide important results on various specific problems involved in this technology. R. McWilliams and Y. Mok of the University of California-Irvine describe the launching of a fast wave near the LH frequency, which is of interest for ultimate use in large tokamaks. Two papers stress nonlinear aspects. V. Chan and C. Liu of GA Technologies, Inc. consider the case where the wave energy of LH current drive exceeds the threshold for decay into the ion cyclotron quasi-mode. J. Sperling of JAYCOR considers the injection of two primary waves that can result in strong nonlinear interactions when frequency differences equal the two ion hybrid on LH frequencies. The resulting "internal antenna" effect could possibly alleviate undesirable surface interactions in reactor applications.

K. Itoh, S. Itoh, and A. Fukuyama from Japan Atomic Energy Research Institute, Hiroshima University, and Okayama University, respectively, consider the launching of ion cyclotron waves with a waveguide antenna. They investigate the dependence of the transmission coefficient on plasma parameters and also

evaluate nonplasma losses. E. Morse and Z. Mikic describe a computer code that integrates the ray equations to study the performance of LH waves and ECH waves in toroidal geometry with examples based on compact torus.

On a related topic, R. Schneider and P. Handel from the Universities of Florida and Missouri, respectively, discuss the experimental observations of neutron emission from rf-driven deuterium discharges. They postulate that this may be the localized resonant nonlinear plasma structure due to a special type of caviton.

We are grateful to the authors of these papers for the effort they put into them. This special section should be of considerable interest to readers involved in current and heating technologies and in fusion reactor design studies. Also, it is hoped that this will stimulate others working on these technologies to consider presentation of their results in future issues of *Fusion Technology*.