PREFACE

SPECIAL ISSUE ON HEAVY-ION FUSION SYSTEMS AND THEIR ASSESSMENT

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It has been an honor and a pleasure to serve again as guest editor of *Fusion Technology* (*FT*). This heavy-ion fusion (HIF) special issue arose out of a conversation with George Miley over a year ago, at which time I suggested the present topic and one on KrF lasers for inertial confinement fusion.[a] An intense interest in HIF arose as a result of the Heavy-Ion Fusion Systems Assessment (HIFSA) project, which was drawing to a close at the time of the suggestion. Since then the HIFSA project has been discussed at international meetings and at the ANS Seventh Topical Meeting on the Technology of Fusion Energy, held in Reno, Nevada, in June 1986. An arrangement was made to have the written papers from the latter meeting published in this special issue of *FT*. Thus, this special issue serves partially as an extension of the proceedings of the Reno meeting, as well as to cover additional aspects of HIF.

The lead paper of our special issue is a review of the HIF accelerator research program by Walter Polansky, the U.S. Department of Energy program manager for HIF research. As Polansky notes, the program is one of *accelerator* research only, with the goal "...to acquire an appropriate data base for future decisions on heavy-ion inertial fusion." In order to understand the context of the HIFSA study, it is important to note that there is no U.S. program for developing HIF technology *per se*, except for accelerator development. That is, the HIFSA project was a limited term, *ad hoc* effort that primarily drew on past technology developments, but also attempted to fill in gaps in the suite of technical knowledge where it appeared essential for a credible study. Examples of the technology developments specific to the HIFSA project that are presented in this special issue include the target fabrication and cost model by Pendergrass et al.; some of the heavy-ion target characterizations by Magelssen and by Bangerter; and the analysis of beam transport in reactor cavities by Peterson. In addition, a major update of the heavy-ion accelerator design/cost model and wide-ranging applications of it undertaken specifically for the HIFSA project are presented by Hovingh et al. Other equally important technical questions addressed for the project but not appearing here in papers were the final beam transport and focus, beam streaming instabilities in reactor cavities, charge and current neutralization, and beam/plasma interaction. All these topics are, however, addressed fully in the project final report.[2]

A brief survey of the project history, motivation, organization, and selected key results is presented in the HIFSA project overview paper. However, the most comprehensive discussion of the study methodology, systems modeling, costing basis, and results appears in the paper by Zuckerman et al. Another paper evolving from the HIFSA project is the one by Pendergrass on HIF reactors. This paper goes beyond just reviewing the reactor concepts used for the project, giving in addition a comprehensive review of myriad other fusion plant considerations—technical, economic, environmental, safety, management, etc.

Independent of the HIFSA project, this special issue has perforce served to provide a global review of HIF target and target interaction physics, including work in Europe by Arnold and by Deutsch et al. In a

[a] A controversy still rages, however, over "who 'volunteered' whom!" to serve as guest editor.[1]

closing of the loop, so to speak, the HIFSA study also stimulated Wilson et al. to examine the implications of the study (specifically the systems model) on target design directions.

Perhaps it is appropriate to say a few things here about the outcome of the HIFSA study. First, the organization of the project (given in the overview paper) attests to the breadth of technical expertise and institutional viewpoints brought to bear on the assessment. It is worth noting that many participants on the project team were not "advocates" for HIF and thus brought a relatively unbiased perspective to the study. At the risk of oversimplifying the general conclusions of the study, one can say that a general consensus ensued among the project team regarding the promising potential of HIF, and induction Linac drivers in particular. Multiple-beam induction Linacs are unique among drivers in that they appear to satisfy relatively easily three difficult requirements for a viable commercial ICF driver—high efficiency, high repetition rate, and reliability. Other requisites, such as flexible pulse shaping and dynamic range, efficient target coupling, and feasible scaling path to the several megajoule energies expected to be required for high target yields, also appear within our technical reach. As mentioned in the Preface of the KrF laser special issue, a driver must meet these requirements with an acceptable capital cost, and the papers in that issue supported achievement of these goals. Similarly, a basic conclusion from the HIFSA study is that multiple-beam induction Linacs have a good shot at achieving the cost as well as technical goals and requirements. The papers presented in this special issue lend support to this basic conclusion. Several of the research and development (R&D) tasks necessary to validate the study conclusions are identified in the HIFSA project overview paper, as well as in many of the other papers herein. In his paper, Polansky discusses a specific program to address some of the accelerator-related R&D needs.

As George Miley so aptly pointed out in his "Comments" for the KrF special issue, "... the time is rapidly approaching when a workable laser driver (versus the single-pulse, low-efficiency, glass lasers currently used for implosion experiments) must be developed, or the hope for a practical laser driver in time to compete for reactor use will vanish." George was referring specifically to lasers, but I believe that his quote applies equally to heavy-ion drivers. The lack of a program to develop HIF technologies in the United States, other than the relatively small but effective accelerator development program at Lawrence Berkeley Laboratory, is lamentable. This state of affairs is demoralizing to many of the participants in the HIFSA project, some of whom became enthusiastic advocates of HIF during the course of the study.

Without the foresight and initiative of two individuals it is almost certain that there would have been no HIFSA project. Credit for the initial proposal, promotion, organization, and leadership of the project belongs to Bill Herrmannsfeldt and Bill Saylor. Bill Herrmannsfeldt served throughout as chairman of the Project Steering Committee, always gentle but firm at the helm as he set the course of the study. Unfortunately, Bill Saylor had to give up leadership of the project upon his transfer to a new and very challenging leadership role in strategic defense systems.

In any endeavor such as producing a journal special issue, there are many people who contribute selflessly of their time and professional skills. Especially lacking in recognition are the paper reviewers, who unavoidably must remain anonymous. One enlightening aspect of serving as guest editor was witnessing the transition of papers to a much higher quality of technical accuracy, presentation, and clarity as a result of the peer review process. Those who can be explicitly acknowledged include George Miley's most able editorial assistant, Chris Stalker, whose patience and good nature were tried and not found wanting in the process of meeting the journal's editorial requirements. As with the KrF laser special issue, the deadlines would not have been met, nor would the quality of the issue have been as exemplary, had it not been for the conscientious efforts of Dave Harris. As assistant guest editor he really did most of the work for which I get credit. Other significant contributions from the Los Alamos staff were the editorial assistance of Wilma Bunker and the cover artwork by James Cruz. In summary, I take this opportunity to thank all these people for their respective contributions.

REFERENCES

1. See "Comments" and "Preface" of the special issue on KrF lasers, *Fusion Technol.*, **11**, 475 and 479 (1987).

2. D. J. DUDZIAK, Ed., "HIFSA: Heavy-Ion Fusion Systems Assessment Project Technical Analyses," LA-11141-MS, Vol. II, Los Alamos National Laboratory (Dec. 1987).