Preface

The concept of the Institutes for Advanced Optical Technologies developed out of SPIE's desire to foster increased interaction and collaboration among researchers working in emerging optical technologies. The Institutes provide a forum for experts in these areas to analyze and document the state of the art and to point toward future trends and applications. Institute topics are selected for their timeliness as well as their significance to future progress in the application of optics. Institute organizers invite selected experts to participate as paper contributors and discussion participants. It is intended that the interaction generated by the small group structure in a retreat-type setting will foster productive discussions that are beyond the scope and possibility of a regular conference format.

Each Institute has two primary objectives: first, that the interactions and dialogue stimulate technical advancement, and second, that the publication of the Institute book results in an authoritative collection of significant papers covering key topics in the field. While each editor and committee has unique criteria for determining the acceptability of contributions, it is intended that the Institute process itself will establish the worth and appropriateness of the individual contributions. Each contributor is asked to prepare a draft manuscript and circulate it to the other participants in advance of the Institute. The editor/chair organizes an agenda for discussing critical technical issues. The interactions and congenial discussions by the Instituite members are the basis for the ensuing Institute volume. The final action of the Institute is to decide the scope of the volume and what material is to be included and what other material is to be added and by whom.

This volume exemplifies the second goal of the Institute, which in this case is to present an authoritative publication emphasizing the dosimetry and tissue interaction of laser radiation. Sections cover laser-tissue interaction, laser systems and delivery systems, photodynamic therapy, national and international laser safety regulations and standards, therapeutic guidelines, and training issues.

In November-December 1988 the participants met during a three-day period in Berlin for this Institute on Dosimetry of Laser Radiation in Medicine and Biology. Individual participants led discussions based on their expertise and interests. These discussions permitted all participants to reinforce, disagree, or gain new insights into this important field. It also gave contributors and the editorial committee opportunities to assess how close the overall contributions came to their expectations.

Roy F. Potter
General Editor, SPIE Institute for Advanced Optical Technologies

Dosimetry of Laser Radiation in Medicine and Biology, edited by Gerhard Mueller, David Sliney, Roy Potter, Proc. of SPIE Vol. 10305 (Vol. IS05), 1030501 · © (1989) 2017 SPIE
CCC code: 0277-786X/17/$18 · doi: 10.1117/12.2283582

Other publications in the SPIE Institutes for Advanced Optical Technologies series:

Transformations in Optical Signal Processing, William T. Rhodes, James R. Fienup, Bahaa E. A. Saleh, Editors, 1984, SPIE Volume 373 (Out of print)

Optical and Hybrid Computing, Harold H. Szu, Editor, 1987, SPIE Volume 634

Photonics: High Bandwidth Analog Applications, James Chang, Editor, 1987, SPIE Volume 648

Large-Area Chromogenics: Materials and Devices for Transmittance Control, Carl M. Lampert, Claes G. Granqvist, Editors, 1989, Volume IS 4

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Dosimetry of Laser Radiation in Medicine and Biology

Introduction

Since 1962, laser radiation has been used in various clinical fields for treatment. From the beginning, clinicians looked for immediate evidence of laser-tissue interaction, for example, coagulation indicated by blanching of the irradiated tissue, some informatory response indicated by reddening of the tissue, or, in the worst case, the occurrence of blisters. At higher power densities, laser radiation has been used for tissue evaporation (cutting), indicated by the amount of tissue removed and by charring at the cutting edges. Even in relatively new applications such as photodisruption in ocular treatment, the physician looks for microscopic disruption and removal of the target tissue.

During these 27 years of laser treatment in medicine, only a very few papers have pointed out the need for on-line measurements of the laser-induced biological result in order to develop a closed-loop system to achieve a higher safety standard and reproducibility of therapeutic guidelines for the administration of laser power. Conversely, the question of dosimetry for ionizing radiation has been investigated extensively in the field of x-ray diagnostics and treatment. Also, a large number of papers have discussed safety hazards to the eye and the skin at high power levels of laser radiation, indicating thresholds for injury and long-term disease. Therefore, for the safe use of laser treatment in the future there is a real need to agree on the problem on an international basis, to define the effective dose of laser radiation for each individual type of interaction, and to describe an appropriate measurement technique to predict the clinical result in terms of laser power administered, or, better yet, to develop an on-line feedback signal to control the laser output continuously in terms of the desired medical and biological result.

This Institute was devoted to establishing a basic platform of knowledge in this new field of research with a goal toward stimulating physicians and physicists to investigate the real mechanisms of laser-tissue interaction and further stimulating R&D engineers in industry to develop smart systems with built-in process control, taking into account the results of laser hazards investigations, the basic knowledge of radiometric and photometric values, the experience of process modeling for various types of laser-tissue interaction, as well as results of investigations in the field of applied dosimetry.

As the editors for this Institute, we would like to express our special thanks to SPIE for organizing and supporting this endeavor. We are particularly indebted to Dr. Roy F. Potter, the general editor for the SPIE Institute Series, as well as to Ms. Dipl.-Phys. Brita Schaldach for organizing this event. Throughout the editorial process, Ms. Schaldach was the center for all communication among participants, and her skill and expertise have added greatly to the successful completion of this book. In addition, we thank Mrs. Schwark and Mrs. Schulz from the Laser-Medizin-Zentrum for editing and retyping the entire manuscript. We also express our gratitude to the Berlin Senate for sponsoring this Institute. With this wealth of support, we were able to assemble the most reknowned scientists currently working in this field and to establish a basic reference for the very important field of dosimetry of nonionizing radiation. This result could not have been possible without the extensive efforts required of each Institute participant. Finally, we thank Professor V. S. Letokhov and Dr. Franco Docchio for accepting our invitation to be guest contributors and for submitting valuable papers to complete the desired framework of this book.

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