

Editorial Preface

This is the second volume of the journal *Reviews of Accelerator Science and Technology*. While the previous volume gave an overview of the accelerator field, this volume (and all later ones) is focused on a specific sub-field. The theme of this volume is *Medical Applications of Accelerators*. We chose this theme because of its enormous importance to human health and its deep impact on our society.

Ever since the discovery of x-rays more than a century ago, people began to contemplate using them for medical purposes. The invention of particle accelerators in the early 20th century created a whole new world for producing energetic x-rays, electrons, protons, neutrons and other particle beams. Immediately these beams found applications in medicine. There are two important yet distinct medical applications. One is that accelerators produce radioisotopes for various medical tests in nuclear medicine and positron emission tomography (PET) used to diagnose millions of patients each year. The other is that accelerators produce particle beams for radiation therapy for the treatment of cancer. The particle beams can be x-rays (generated by high-energy electrons), protons, neutrons or heavy ions such as carbon. Today there are more than 5,000 accelerators routinely used in hospitals all over the world for nuclear medicine and cancer therapy.

The great potential of accelerator applications in medicine can hardly be exaggerated. Take proton therapy as an example. Because the Bragg peak of protons in the human body is much sharper than for x-rays, treatment can be localized, tumor targeting accuracy improved, and the irradiation of sensitive neighboring tissues and side effects reduced. However, despite these indisputable advantages the number of proton therapy patients is much smaller than the number treated using x-rays. Each year several million cancer patients receive x-ray treatment. In contrast, the number of patients treated by protons, neutrons and ions over the past several decades is less than 50,000. The reason is simple — an x-ray therapy machine can readily fit in a hospital room, whereas a proton (or ion) therapy facility occupies an entire building. If future proton therapy machines can be made as small and cheap as x-ray machines so that every hospital could afford one, this would revolutionize oncology!

This volume contains fourteen articles, all written by distinguished scholars. The first three articles are overviews by physicians (Suit *et al.*, Ruth, and Slater *et al.*). They review the status of radiation therapy, radioisotopes in nuclear medicine and hospital-based facilities, respectively. The following six articles describe in detail various types of accelerators used in medicine: electron linacs for x-ray therapy (Whittum), accelerator systems for heavy particle radiotherapy (Tsujii *et al.*), high frequency linacs for hadrontherapy (Amaldi *et al.*), medical cyclotrons (Friesel *et al.*), synchrotrons for hadrontherapy (Pullia), and beam delivery systems (Schippers). They are followed by three articles discussing future medical accelerators: laser acceleration of ions (Tajima *et al.*), FFAG (Trbojevic) and the dielectric wall accelerator (Caporaso *et al.*). There is also an important article on the Superconducting Super Collider (Wojcicki), which is a continuation of the first part published in Volume 1.

In each volume we dedicate one article to a prominent figure of the accelerator community. In Vol. 1, it was Pief Panofsky. In this volume, it is Robert Wilson. Wilson is selected because of his 1946 seminal paper “Radiological use of fast protons” that began the whole field of proton therapy. This important event in accelerator history is described in Slater’s article. But Wilson is

chosen for much deeper reasons. From his unique close association with Wilson over many years, Ned Goldwasser in his article vividly portrays Wilson as a charismatic and imaginative leader. His article is not a chronological biography of Wilson, nor is it intended to be, but a beautiful piece that presents an illuminating sketch of a great man. We feel it fits perfectly in this volume.

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