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Proton Therapy Physics goes beyond current books on proton therapy to provide an in-depth overview of the physics aspects of this radiation therapy modality, eliminating the need to dig through information scattered in the medical physics literature. After tracing the history of proton therapy,

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the book summarizes the atomic and nuclear physics background necessary for understanding proton interactions with tissue. It describes the physics of proton accelerators, the parameters of clinical proton beams, and the mechanisms to generate a conformal dose distribution in a patient. The text

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then covers detector systems and measuring techniques for reference dosimetry, outlines basic quality assurance and commissioning guidelines, and gives examples of Monte Carlo simulations in proton therapy. The book moves on to discussions of treatment planning for

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single- and multiple-field uniform doses, dose calculation concepts and algorithms, and precision and uncertainties for nonmoving and moving targets. It also examines computerized treatment plan optimization, methods for in vivo dose or beam range verification, the safety

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of patients and operating personnel, and the biological implications of using protons from a physics perspective. The final chapter illustrates the use of risk models for common tissue complications in treatment optimization. Along with exploring quality assurance issues and

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biological considerations, this practical guide collects the latest clinical studies on the use of protons in treatment planning and radiation monitoring. Suitable for both newcomers in medical physics and more seasoned specialists in radiation oncology, the book helps readers understand the

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uncertainties and limitations of
precisely shaped dose distribution.

Expanding on the highly successful first edition, this second edition of Proton Therapy Physics has been completely restructured and updated throughout, and includes several new

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chapters. Suitable for both newcomers in medical physics and more seasoned specialists in radiation oncology, this book provides an in-depth overview of the physics of this radiation therapy modality, eliminating the need to dig through information scattered across medical physics literature. After tracing

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the history of proton therapy, the book explores the atomic and nuclear physics background necessary for understanding proton interactions with tissue. The text then covers dosimetry, including beam delivery, shielding aspects, computer simulations, detector systems and measuring

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techniques for reference dosimetry. Important for daily operations, acceptance testing, commissioning, quality assurance and monitor unit calibrations are outlined. The book moves on to discussions of treatment planning for single- and multiple-field uniform doses, dose calculation

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concepts and algorithms, and precision and uncertainties for nonmoving and moving targets. Imaging for treatment guidance as well as treatment monitoring is outlined. Finally, the biological implications of using protons from a physics perspective are discussed. This book

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is an ideal practical guide for physicians, dosimetrists, radiation therapists, and physicists who already have some experience in radiation oncology. It is also an invaluable reference for graduate students in medical physics programs, physicians in their last year of medical school or

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residency, and those considering a career in medical physics. Features: Updated with the latest technologies and methods in the field, covering all delivery methods of proton therapy, including beam scanning and passive scattering Discusses clinical aspects, such as treatment planning and quality

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assurance Offers insight on the past, present, and future of proton therapy from a physics perspective

Matthias Würfl presents two essential steps to implement offline PET monitoring of proton dose delivery at a clinical facility, namely the setting up of

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an accurate Monte Carlo model of the clinical beamline and the experimental validation of positron emitter production cross-sections. In the first part, the field size dependence of the dose output is described for scanned proton beams. Both the Monte Carlo and an analytical computational beam

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model were able to accurately predict target dose, while the latter tends to overestimate dose in normal tissue. In the second part, the author presents PET measurements of different phantom materials, which were activated by the proton beam. The results indicate that for an irradiation

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with a high number of protons for the sake of good statistics, dead time losses of the PET scanner may become important and lead to an underestimation of positron-emitter production yields.

Hadron Therapy is an advanced

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radiotherapy technique for cancer treatment. It offers a better irradiation ballistic than conventional techniques and therefore requires appropriate quality assurance procedures. In this work, we upgraded the GEANT4-based GATE Monte Carlo platform in order to recalculate the

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TPS dose distributions in view of further benchmarking. In a first step, we selected an appropriate simulation environment (physics models and parameters) in order to produce accurate and efficient simulations. GATE simulations were validated using measurements and other Monte

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Carlo codes for depth-dose and transverse profiles. While a good agreement was found for depth-dose profiles, larger discrepancies were pointed out for transverse profiles. In a second step, we developed a modeling method to simulate active scanning beam delivery systems,

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which does not require to simulate the components of the treatment nozzle. The method has been successfully applied to an IBA proton therapy system and validated against measurements for complex treatment plans. Interfaces have also been developed in order to link DICOM RT

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ION PLAN and DICOM RT DOSE with GATE. Finally, we compared in a third step the TPS and Monte Carlo dose distributions in homogeneous and heterogeneous configurations. The beam models of both dose engines were in satisfactory agreement, allowing further evaluation of clinical

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treatment plans. A two-field prostate plan has been evaluated, showing a satisfactory agreement between the TPS and Monte Carlo, and demonstrating the novel capabilities of the platform for the evaluation of the TPS. To summarize, we selected an appropriate simulation environment for

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proton therapy, proposed a modeling method for active scanning systems and presented a method to compare the TPS and Monte Carlo dose distributions. All tools developed in GATE were or will be publicly released. A detailed validation stage of the system including absolute

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dosimetry is still necessary, in order to quantitatively evaluate its accuracy in various homogeneous and heterogeneous configurations. In this thesis, we have demonstrated that the GATE Monte Carlo platform is a good candidate for the simulation of active scanning delivery systems, allowing

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further TPS benchmarking. Moreover, the GATE platform also handles imaging applications, such as PET or prompt-gamma imaging towards online treatment monitoring and paves the way of interdisciplinary research advances.

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Modern cancer treatment relies on Monte Carlo simulations to help radiotherapists and clinical physicists better understand and compute radiation dose from imaging devices as well as exploit four-dimensional imaging data. With Monte Carlo-based treatment planning tools now available

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from commercial vendors, a complete transition to Monte Carlo-base

Thoroughly updated throughout, this second edition of Monte Carlo Techniques in Radiation Therapy:

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Applications to Dosimetry, Imaging, and Preclinical Radiotherapy, edited by Joao Seco and Frank Verhaegen, explores the use of Monte Carlo methods for modelling various features of internal and external radiation sources. Monte Carlo methods have been heavily used in the field of

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radiation therapy in applications such as dosimetry, imaging, radiation chemistry, modelling of small animal irradiation units, etc. The aim of this book is to provide a compendium of the Monte Carlo methods that are commonly used in radiation therapy applications, which will allow students,

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postdoctoral fellows, and university professors to learn and teach Monte Carlo techniques. This book provides concise but detailed information about many Monte Carlo applications that cannot be found in any other didactic or scientific book. This second edition contains many new chapters on topics

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such as: Monte Carlo studies of
prompt gamma emission

Developments in proton imaging

Monte Carlo for cone beam CT

imaging Monte Carlo modelling of

proton beams for small animal

irradiation Monte Carlo studies of

microbeam radiation therapy Monte

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Carlo in micro- and nano-dosimetry
GPU-based fast Monte Carlo
simulations for radiotherapy This book
is primarily aimed at students and
scientists wishing to learn and improve
their knowledge of Monte Carlo
methods in radiation therapy.

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This book serves as a practical guide for the use of carbon ions in cancer radiotherapy. On the basis of clinical experience with more than 7,000 patients with various types of tumors treated over a period of nearly 20 years at the National Institute of Radiological Sciences, step-by-step

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procedures and technological development of this modality are highlighted. The book is divided into two sections, the first covering the underlying principles of physics and biology, and the second section is a systematic review by tumor site, concentrating on the role of

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therapeutic techniques and the pitfalls in treatment planning. Readers will learn of the superior outcomes obtained with carbon-ion therapy for various types of tumors in terms of local control and toxicities. It is essential to understand that the carbon-ion beam is like a two-edged

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sword: unless it is used properly, it can increase the risk of severe injury to critical organs. In early series of dose-escalation studies, some patients experienced serious adverse effects such as skin ulcers, pneumonitis, intestinal ulcers, and bone necrosis, for which salvage surgery or

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hospitalization was required. To preclude such detrimental results, the adequacy of therapeutic techniques and dose fractionations was carefully examined in each case. In this way, significant improvements in treatment results have been achieved and major toxicities are no longer observed. With

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that knowledge, experts in relevant fields expand upon techniques for treatment delivery at each anatomical site, covering indications and optimal treatment planning. With its practical focus, this book will benefit radiation oncologists, medical physicists, medical dosimetrists, radiation

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therapists, and senior nurses whose work involves radiation therapy, as well as medical oncologists and others who are interested in radiation therapy.

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