

Autore

MASTURZO, LUIGI

Titolo

Towards the first Italian clinical trial of FLASH radiotherapy (ULISSE): technological and dosimetric challenges for its implementation

Relatori

Dott. Di Martino, Fabio

Riassunto

Radiotherapy plays a crucial role in cancer treatment, either for curative purposes or to alleviate symptoms. In clinical practice, however, the radiation dose delivered to surrounding healthy tissues and organs at risk remains a key limiting factor. To effectively target the tumor, radiation beams must pass through healthy tissues, making radiotherapy a balancing act between optimal tumor coverage and sparing of normal tissues. A promising, perhaps even unique, approach to this challenge lies in the clinical application of a radiobiological phenomenon known as the FLASH effect. Studies on cell cultures and animal models have shown that when radiation beams have certain “extreme” characteristics, they can achieve therapeutic isoeffectiveness on tumors while sparing healthy tissues. Experimental data suggest that a FLASH treatment requires a dose-per-pulse above 1 Gy and an average-dose-rate exceeding 40 Gy/s, translating to treatment times under 200 ms. While the mechanisms behind the FLASH effect are not yet fully understood (remaining the subject of numerous hypotheses), its clinical feasibility can be investigated through clinical trials. The purpose of this thesis is to introduce the first Italian clinical trial, ULISSE (ultra-high dose-rate single fraction for squamous and basal skin cancer), set to take place in Pisa, and to outline the strategies and solutions developed to address the technological, dosimetric and clinical challenges of using ultra-high dose-rate radiation in the clinical framework. After an initial section reviewing the current state of both preclinical and clinical research, the focus will shift to the technological aspects of the clinical implementation of FLASH radiotherapy, which consists in beam monitoring and beam shaping. Subsequently, the dosimetric aspects of UHDR/UHDP beams will be discussed. In this context, I will address the technical issues encountered, detailing the chosen solutions and the criteria behind these choices, with particular attention to the role and potential applications of conventional ionization chambers. Finally, after presenting an overview of the trial design, initial simulation tests will be shown.