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Prospects of dielectric terahertz-driven accelerators in medicine.

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Throughout the last century, the field of medicine has greatly benefited from particle accelerator technologies. Thanks to the advances in accelerator science in the last decades, accelerators have become important tools in modern medicine. The most common uses of accelerators are oncological treatment, advanced imaging, isotope production, and sterilization. Although conventional accelerators have proven to perform their job quite well, there are still certain limitations in the machinery and gaps that need to be addressed to further improve the performance of accelerators in medicine. It must also be taken into account that the introduction of new technologies and improved systems in medicine is not only related to performance, but also to economic, infrastructural, and administrative aspects.

New accelerators based on novel accelerating concepts are currently under development to overcome some of the issues posed by conventional accelerators. The most popular among them are laser-plasma accelerators, terahertz-driven LinAcs, and dielectric laser-driven accelerators (DLAs). The relatively new sub-field of dielectric terahertz-driven accelerators (DTAs), combining terahertz (THz) technology and DLA, has also gained relevance in recent years.

In this talk, the applications of DTAs and their related technologies in the medical field are explored. Thanks to the shorter wavelengths employed by DTAs, a significant size reduction can be achieved in several radiotherapy facilities, while also providing a more cost-effective solution. Furthermore, the shrinkage of the accelerator could potentially transform the field of intraoperative radiation therapy (IORT). The acceleration concept used in dielectric accelerating structures enables the acceleration of positively charged particles, such as protons, helium, carbon, and heavier ions. Therefore, the extension of these accelerators could also be transformative for hadrontherapy.

Regarding imaging techniques, THz radiation, also known as T-rays, could provide high-brilliance, compact X-ray sources and improve inverse-Compton scattering (ICS)-based compact light sources. Thanks to the development of high-intensity THz sources and detection systems, the field of THz imaging is also becoming of great interest for medical applications. Lastly, both electron beam sterilization techniques and radiobiology could benefit from terahertz-driven structure-based accelerators.

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