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Terahertz and Ultrashort Electromagnetic Pulses for Biomedical Applications

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Editors

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Introduction

The terahertz (THz) region of the electromagnetic (EM) spectrum is defined as frequencies ranging from 0.1 to 10 THz (1 THz = 10^{12} Hz = 1 ps). Historically, few sources have been available to efficiently generate THz radiation; however, several recent technological advances have resulted in the unprecedented development of many new types of THz sources and components. These technologies are now being used as tools for a plethora of novel basic science investigations, and they are increasingly being integrated into innovative sensing and imaging operational schemes, which are finding widespread use in a host of medical, military, and defense applications.

Ultrashort electromagnetic pulses (USEP) are defined as pulses with duration below one microsecond and a rise time at or below a nanosecond. Direct application of USEP on tissue has been shown to elicit an array of biological effects including plasma membrane breakdown, cellular swelling, nuclear granulation, and initiation of apoptotic death. These observed phenomena have spawned quick advancement of USEP-based techniques into clinical devices to treat both superficial and deep cancers. USEP-based technologies have a distinct advantage of causing desired effects only within the profile of the electric field with little to no thermal footprint. Future technology is pushing beyond direct application into shorter pulse regimes (picoseconds) to enable free field propagation of USEP into deep tissue. These efforts have required advancements in pulse generators and antenna construction. The drive to shorter pulse duration bridges the gap between electrical pulses and those commonly generated by THz sources.

Fundamental knowledge gaps exist regarding how electric fields with frequency components from the MHz to the THz interact with biological structures. This conference aims to highlight USEP and THz source development, biological applications, and fundamental interactions with tissues, cells, and biomolecules.