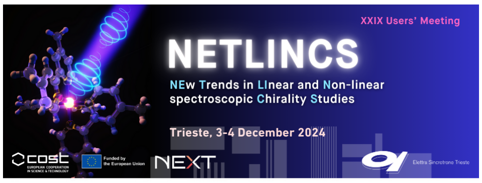

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Investigating the Spatiotemporal Dynamics of Laser-Induced Plasma Absorption in Skin Tissues

During the 1980s, the study of laser-induced damage (LID) gained prominence in biophysics and bioengineering, leading to innovative clinical applications centered around laser-tissue interactions. Despite extensive investigations into the origins of LID in biological tissues and the nature of the laser-induced breakdown (LIB) process, key aspects of the underlying mechanisms remain elusive. Challenges in understanding the structural breakdown during tissue ablation stem from the intricate interplay of laser characteristics and the dynamic interactions between plasma and particles. This study introduces a spatial-temporal model that revises the traditional rate equation to incorporate the effects of tunneling, cascade, and chromophore ionization during ultrashort laser pulse propagation. Additionally, it examines electron loss processes, including diffusion from the focal volume and recombination. The model is used to explore how the threshold intensity for plasma formation varies with laser pulse duration, revealing that the critical free-electron density decreases with longer pulses, following a power-law decay. These findings align with experimental observations and enhance our understanding of the conditions necessary for plasma formation in biological tissues under varying laser parameters.

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