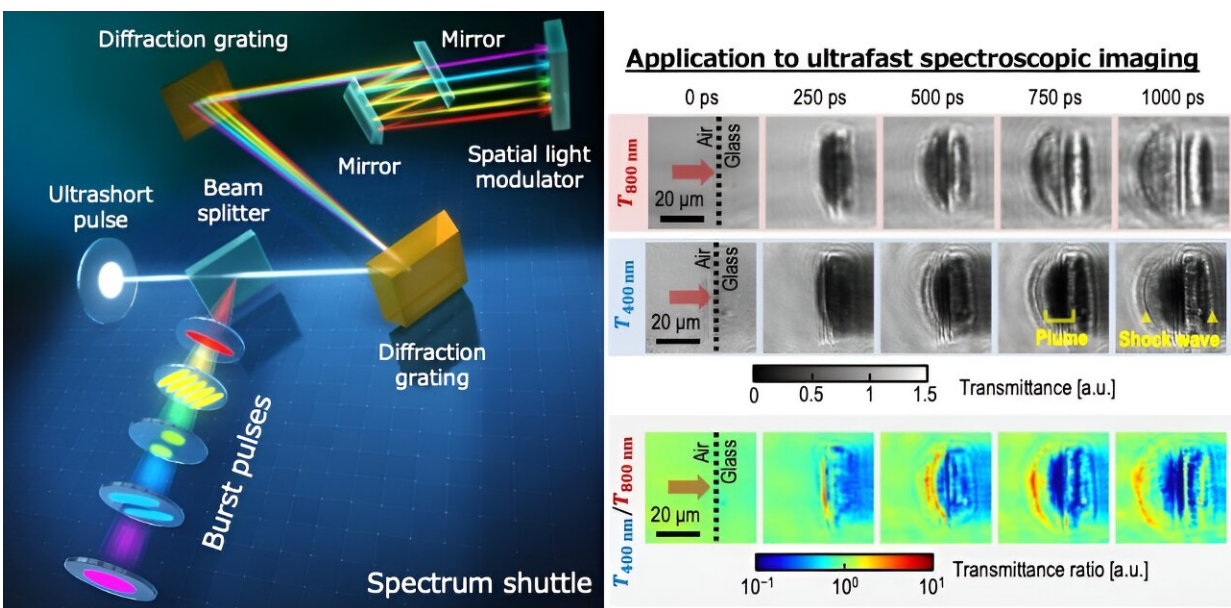


# Research team develops optical technique for simultaneously producing and shaping gigahertz burst pulses

December 19 2023



The proposed "spectrum shuttle" method produces gigahertz (GHz) burst pulses from an ultrashort pulse, with each pulse having a different wavelength and a customizable spatial profile. These GHz burst pulses open pathways to a multitude of optical applications, including ultrafast imaging in the GHz range and high-quality and high-throughput laser processing with bursts of ultrashort laser pulses. Credit: K. Nakagawa (University of Tokyo).

The generation and manipulation of high-repetition pulses hold great

promise across various applications, including high-speed photography, laser processing, and acoustic wave generation. Gigahertz (GHz) burst pulses, with intervals ranging from ~0.01 to ~10 nanoseconds, are particularly valued for visualizing ultrafast phenomena and improving laser processing efficiency.

While methods for producing GHz burst pulses exist, challenges persist, such as low throughput of pulse energy, poor tunability of pulse intervals, and the complexity of existing systems. Furthermore, shaping the spatial profile of each GHz burst pulse faces limitations due to the inadequate response of spatial light modulators.

Addressing these challenges, a research team from the University of Tokyo and Saitama University has developed an innovative optical technique named "spectrum shuttle," which enables simultaneously the production of GHz burst pulses and the individual shaping of their spatial profiles.

The method involves dispersing an ultrashort pulse horizontally through diffraction gratings, spatially separating the [pulse](#) into different wavelengths using parallel mirrors. These vertically aligned pulses undergo individual spatial modulation using a spatial light modulator. The resulting modulated pulses, with varied time delays in the GHz range, yield spectrally separated GHz burst pulses, each uniquely shaped in its spatial profile.

[As reported in \*Advanced Photonics Nexus\*](#), the proposed method successfully produced GHz burst pulses with discretely varied wavelengths and temporal intervals. It demonstrated the shaping of spatial profiles, including position shifts and peak splitting.

The method's application in ultrafast spectroscopic imaging showcased its ability to simultaneously capture dynamics in different [wavelength](#)

bands.

The method facilitates ultrafast imaging within subnanosecond to nanosecond timescales, enabling the analysis of rapid, non-repetitive phenomena. Its potential applications include uncovering unknown ultrafast phenomena and monitoring fast physical processes in industrial settings. The ability to shape GHz burst pulses individually also holds promise in precision laser processing and laser therapy.

Notably, the compact design of the proposed method enhances its portability, making it applicable across scientific research facilities and various industrial technology sectors.

"Our unique optical configuration allows for the manipulation of ultrashort pulses with a three-dimensional optical path, enabling unprecedented spatial manipulation of GHz burst pulses," says Keitaro Shimada, a Ph.D. candidate in the Department of Bioengineering at the University of Tokyo.

"Spectrum shuttle offers a wide range of GHz burst pulses with intervals ranging from 10 picoseconds to 10 nanoseconds. I believe that applications based on our technique, aimed at various targets such as plasmas, metals, and cells, will accelerate scientific discoveries and technological innovations in industry and medicine."

The innovative technique opens avenues for advancing ultrafast imaging, with implications for both scientific research and industrial applications. Its ability to simultaneously produce and shape GHz burst pulses introduces a versatile tool for studying rapid phenomena and enhancing laser-based processes.

**More information:** Keitaro Shimada et al, Spectrum shuttle for producing spatially shapable GHz burst pulses, *Advanced Photonics*

*Nexus* (2023). [DOI: 10.1117/1.APN.3.1.016002](https://doi.org/10.1117/1.APN.3.1.016002)

Provided by SPIE

Citation: Research team develops optical technique for simultaneously producing and shaping gigahertz burst pulses (2023, December 19) retrieved 28 April 2024 from <https://phys.org/news/2023-12-team-optical-technique-simultaneously-gigahertz.html>

This document is subject to copyright. Apart from any fair dealing for the purpose of private study or research, no part may be reproduced without the written permission. The content is provided for information purposes only.