# Nitrogen gas-cluster target as coherent terahertz radiation source under relativistic laser-plasma interaction

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The efficient generation of secondary radiation through intense laser–plasma interaction in gas-cluster targets is of great interest for ultrafast spectroscopy and plasma physics. We report coherent transition radiation in the terahertz (THz) range produced via femtosecond laser interaction with nitrogen cluster targets (irradiation wavelength 800 nm, pulse duration 30 fs, energy up to 310 mJ, intensity up to $5 \times 10^{18}$ W/cm$^2$) during electron acceleration [1]. For the first time for this type of source, temporal and spatial characteristics of THz radiation at relativistic intensities were measured using electro-optic sampling, the results obtained are consistent with theoretical calculations [2]. Characterization of the emitted radiation reveals highly coherent THz emission with energies up to 10 $\mu$J, spectral bandwidth up to 2 THz, conical radiation pattern with divergence $\sim 20^\circ$, and dominant radial polarization component. Parametric variation of the gas pressure reveals correlated power-law dependencies in the energetic electron charge distribution, THz energy output, and broadband optical emission, pointing to a common underlying mechanism. The coincident generation of THz, electron, and optical radiation in a single interaction region enables multimodal pump–probe studies of ultrafast plasma dynamics.

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[2] ZHANG Y, LI K and ZHAO H 2021 *Frontiers of Optoelectronics* **14**(1) 37–63