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Intense Terahertz Sources and their Applications at the Advanced Laser Light Source

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Tabletop sources of high-field terahertz (THz) pulses are currently a hot topic, which is being pursued by many groups around the world. While the favourite method for intense THz generation is optical rectification in nonlinear crystals, research on using other novel methods have shown promising results, including those using air-plasmas, relativistic laser-solid interactions, and large aperture photoconductive antennas. At the Canadian Advanced Laser Light Source, we have built an array of intense THz sources with different central frequencies, with peak THz electric fields ranging from few 100 kV/cm to few MV/cm. In parallel, we have used these sources to study the nonlinear THz response of various materials.
In this talk, I will first quickly review the various components of the "intense THz rainbow"at ALLS. I will then describe more in detail our recent results on intense THz sources based on relativistic laser-solid interactions, and the use of nanorod targets to increase the THz conversion efficiency by 28 times. This provides us with an excellent opportunity for multi-mJ THz sources, which when focused could reach peak intensities of $10^{14} W cm^{-2}$. Finally, I will present our recent results on the nonlinear THz spectroscopy of monolayer graphene. By using gated graphene samples to control their Fermi level energy, we show that their nonlinear response in the THz regime changes drastically when the Fermi level is at or away from the charge neutral point. Comparison with simulations reveals the mechanism involved in such changes.

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