

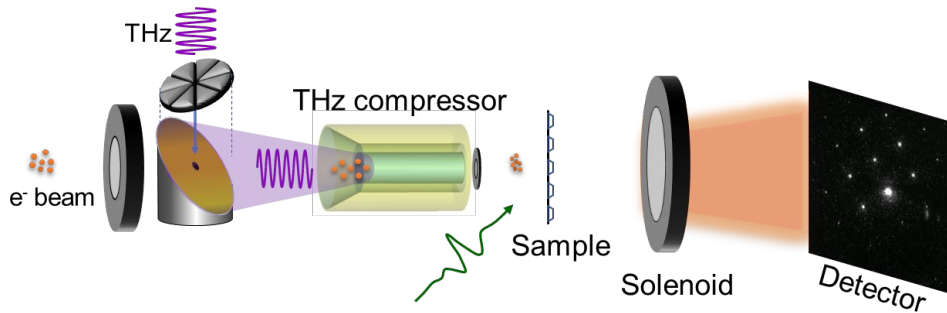
# THz-enhanced ultrafast electron diffraction

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Ultrafast electron diffraction (UED) has gained tremendous interest in the ultrafast community in the last decades because of the ability to provide atomic-level material structure information on the femtosecond time scale. Terahertz laser-based accelerators are prominent candidates for driving next-generation compact light sources, promising high-brightness, ultrashort x-ray and electron pulses. Here, I will present on the development of key components in the development of THz based electron sources. Different THz based devices that are capable of performing multiple high-field operations on the 6D-phase-space of ultrashort electron bunches will be introduced, that includes electron acceleration, compression, focusing and streaking [1,2].

The first application with THz-powered electron source in ultrafast electron diffraction will be discussed [3]. In proof-of-principle experiments, we leverage high-field THz pulses to compress the electron bunches by 10x to  $\sim 180$  fs. The high-quality diffraction patterns and enhanced temporal resolution are benchmarked using ultrafast structural dynamics measurements of silicon. We show that optimization of this technology may enable temporal resolution in the few-fs regime.



**FIGURE 1.** THz-enhanced UED setup. A small fraction of the 1030 nm infrared optical beam is converted to 257 nm based on two-stage second harmonic generation. The 257 nm UV pulse is directed onto a gold photocathode generating electron pulses, which are accelerated to 53 keV by the DC electric field. The same infrared laser also drives a multicycle THz generation stage, two single-cycle THz stages, and pump laser for the electron manipulator, the streaker, and sample excitation, respectively. The streaker and the sample are on the same manipulator which can be exchanged for checking the pulse duration at the sample position or performing the ultrafast electron diffraction experiment.

## REFERENCES

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