# Ultrafast X-ray Sources Driven by Laser–Plasma Interactions: Recent Progress

The ultra-microscopic spatiotemporal structure (~μm scale) and ultra-high acceleration gradient (~100 GV/m) of laser-plasma acceleration enable the generation of femtosecond (fs) pulse width, high peak brightness, and laboratory-scale ultrafast light sources. These unique characteristics make it highly suitable for constructing fs-level time-resolved diagnostic platforms, serving as a supplement and capacity extension to existing large-scale radiation sources. At SECUF in Beijing, our team has established China’s first user facility that provides fs X-ray pulses generated through high-power fs laser-plasma interactions as an open-access resource.

For the established XRD application platform, we are upgrading its pump capabilities and sample environment, including strong-field THz pulse, high-energy optical parametric amplifier system (OPA), and cryogenic sample stage. Recently, we have also expanded the variety of X-ray sources by using petawatt (PW) lasers to develop high-conversion-efficiency synchrotron-like source (Betatron radiation) and all-optical inverse Compton scattering gamma-ray source. Compared with laser-driven K-alpha sources, these newly developed sources are directional and broadband, making them more suitable for ultrafast X-ray absorption fine structure (XAFS) spectroscopy and high-resolution imaging.Our goal is to construct an advanced application research platform that integrates ultrafast XRD, XAFS and high-resolution imaging capabilities.