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Ultra-fast x-ray-dynamic and ultra-fast electron diffraction experimental subsystems

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The ultrafast laser-produced x-ray and electron sources can provide an alternative to accelerator-based light and electron sources owing to their compactness and high brightness, making them practical for widespread applications in fundamental science, industry, and medicine.[1-3] Compared to x-ray tubes, they have the advantages of ultra-fast characteristic and high brightness. Moreover, a very important advantage of the laser-driven x-ray/electron source is the precise natural synchronization between the laser and generated x-ray/electron. Therefore, this would be very suitable and convenient for time-resolved x-ray or electron pump–probe studies, such as time-resolved x-ray/electron diffraction and x-ray absorption spectroscopy. In order to promote the applications of ultra-fast x-ray/electron source, the China's national large scientific device "Synergetic Extreme Condition User Facility" has included ultra-fast x-ray source and ultra-fast electron diffraction(UED) as two subsystems in the construction.

In this talk, we introduce the design and specification of these two subsystems named "Ultra-fast x-ray-dynamic experimental subsystem" (hereinafter referred to as the Ultra-fast x-ray subsystem) and "UED subsystem".

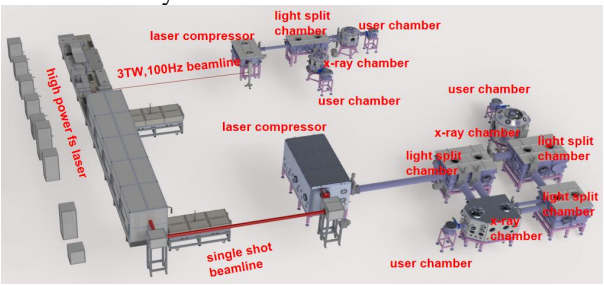

Figure 1. the design of Ultrafast x-ray subsystem

The design of ultra-fast x-ray subsystem is shown in Figure 1. It can provide hard femtosecond x-ray in both 100-Hz and single-shot modes. The main specifications of Ultra-fast x-ray subsystem are listed in Table 1.

Table 1. the x-ray and laser output of Ultra-fast x-ray subsystem.

X-ray output	
100 Hz beamline	X-ray photon energy 1-60 keV，photon yield > 10^8/shot
Single shot beamline	X-ray photon energy 3-20 keV，photon yield >10^{11}/shot
Laser output	
100 Hz beamline	Peak power 3TW, pulse duration 20fs, central wavelength 800nm, 100Hz
Single shot beamline	Peak power 1PW, pulse duration 25fs, central wavelength 800nm, 1shot/min

The work scheme of the UED subsystem is shown in Figure 2.

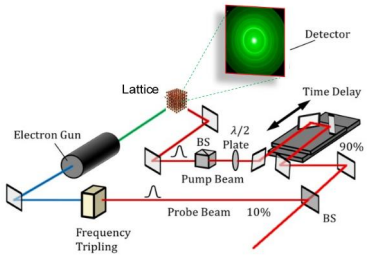

Figure 2. The work scheme of UED sybsystem.

The main specifications of UED subsystem are listed in Table 2.

Table 2. The main specifications of UED subsystem.

electron energy	20 keV-100 keV
electron number	10^4 -10^6/shot
beam size at target	~100 μm
temporal resolution	~300 fs

Both subsystems are complete and passed the technical acceptance in July 2022. Figure 3 shows the photos of laboratories of the two subsystems. Users from all over the world are welcome to carry out cooperative research in the subsystems.

Figure 3. The photos of laboratories of Ultrafast x-ray subsystem (left) and UED subsystem (right).

References

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