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Dispersion management of the front end in SULF

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Recently, the race to build a petawatt or even higher-power laser system with the pulse duration of few tens of femtosecond is initiated worldwide. Such ultrahigh-peak-power laser systems are greatly benefit for fundamental research areas, such as accelerating the charged particles (electrons and protons), and generating high-energy photon (X-ray and γ-ray) sources. The Shanghai Super-intense Ultrafast Laser Facility (SULF) is a large-scale project aimed at delivering 10 PW laser pulses. The CPA Ti: sapphire laser system consists of a front end, a power amplifier, a final three-pass booster amplifier, and a grating compressor .The front end starts from a commercial 1 kHz CPA laser system (Astrella, Coherent Inc.) delivering 95 μJ-level sub-30 fs pulses. The pulses are injected into the pulse cleaner based on cross-polarized wave (XPW) generation. The spectral width of the cleaned pulses is over 65 nm (FWHM), which can support sub-15fs pulse duration [1]. The cleaned pulses with an energy of 20 μJ are stretched to about 2ns by an aberration-free Öffner-triplet-type stretcher with a 1480 lines/mm gold-coated grating (Jobin Yvon, Inc.). Following the stretcher, the stretched pulse is amplified in the regenerative amplifier and three-stage multi-amplifier such that the energy reaches 7 J at a 1 Hz repetition rate.

To balance the spectral phase in the laser system, a double-pass grism pair is inserted into the petawatt laser system to compensate the residual dispersion up to the fourth order.The inserted position of the grism is between the stretcher and regenerative amplifier. Using this technique, the spectral phase distortion over the spectrum is less than 2.5 rad. The pulse duration is compressed to 22.2 fs, which is only 1.03 times that of the Fourier-transform-limited pulse.Experimental results show that near Fourier-transform-limited pulse can be achieved. In our next work, the grism pair and the main compressor will be used cooperatively to achieve the dispersion management of the 10 PW laser system.

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