

Dispersion management of the front end in SULF



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Introduction

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. The Shanghai Super-intense Ultrafast Laser Facility (SULF) is a large-scale project aimed at delivering 10 PW laser pulses. The front end starts from a commercial 1 kHz CPA laser system (Astrella, Coherent Inc.) After the stretcher, the regenerative amplifier and the three-stage multi-amplifier, the energy reaches 7 J at a 1 Hz repetition rate. Dispersion management, especially the high-order dispersion management, is of great significance for such ultrahigh-power systems.

Method

To balance the spectral phase in the petawatt laser system, a double-pass grism pair is inserted into the petawatt laser system to compensate the residual dispersion up to the fourth. The inserted position of the grism is between the stretcher and regenerative amplifier. Given a certain incident angle of the grism, the spectral phase of the grism pair could be calculated using the ray tracing method. Then we could adjust the incident angle and the grating separation in the compressor to cancel the second- and third-order dispersion of the laser system.

Results

To illustrate the validity of the method, a pre-compressor is aligned after the third multi-amplifier.

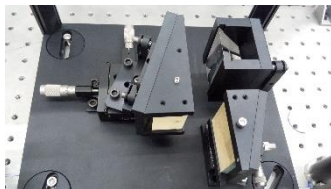


Fig.1. the photograph of the grism pair

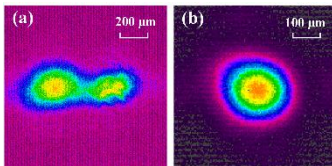


Fig.2. Patterns of the output beam on the focal plane when (a) there are alignment errors of the grism pair and (b) the alignment errors are removed.

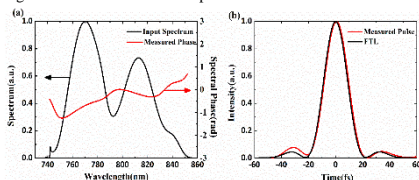


Fig.3. Characteristics of the compressed beam. (a) The spectrum and the phase of the pulse. (b) The temporal profile of the measured pulse and the transform-limited pulse.

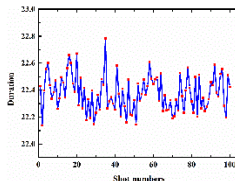


Fig. 4 The variation of pulse durations for 100 shots.

Conclusion Acknowledgement

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In conclusion, a grism pair is fabricated in the front end of the laser system to compensate the material dispersion. 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.