4.2 PW, 20 fs Ti:sapphire CPA laser

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Ultra-high intensity lasers have been developed for the investigations of novel physical phenomena such as laser-driven particle acceleration, laser-induced nuclear transition, and astrophysical process. We recently upgraded one of two petawatt (PW) beamlines [1, 2] to a 4 PW laser for exploring superintense laser-matter interactions [3]. In this talk, the development of the 20 fs, 4.2 PW Ti:sapphire laser will be presented.

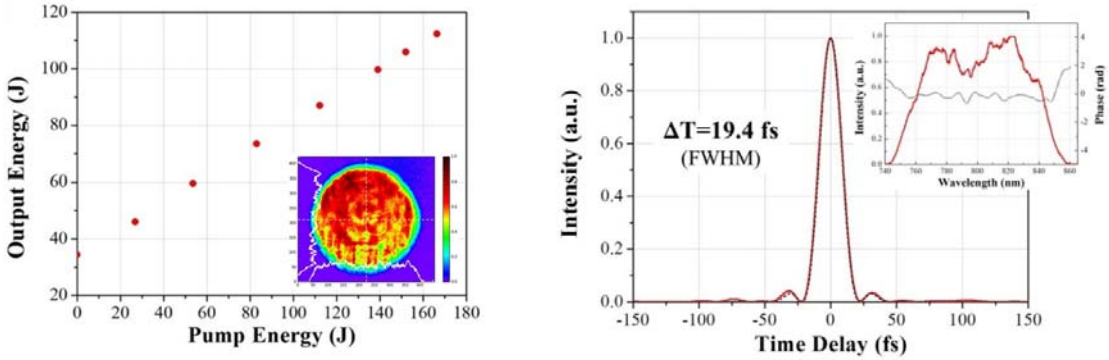

Figure 1: Measured output energy as a function of pump energy in the final booster amplifier (left) and reconstructed temporal profile of the 4 PW laser (right).

For the laser upgrade, the existing 1.5 PW beamline has been significantly modified. We, firstly, reduced the pulse duration of the laser and then boosted the output energy. For the reduction of the pulse duration, the spectral width was broadened by adopting the XPW and the OPCPA techniques, and the final spectral width was maximized by limiting the gain depletion of subsequent amplifiers. The output energy was boosted by adding a high energy booster amplifier, and the temporal profile was optimized by minimizing the spectral phase error with a spectral shaping device. With all the modification, we achieved the final compressed laser energy of 83 J and the pulse duration of 19.4 fs, producing the 4.2-PW laser pulses at the repetition rate of 0.1 Hz with the low energy fluctuation of 1.5% rms. This upgraded laser has been operated for a series of commissioning experiments; it is a powerful tool for exploring novel physical phenomena in the unprecedented intensity regime.

References

[1] J. H. Sung *et al*, Opt. Lett. **35**, 3021 (2010)

[2] T. J. Yu *et al.*, Opt. Express 20, 10807 (2012).

[3] J. H. Sung *et al.*, Opt. Lett. (accepted).