

Sub-2-cycle pulses with 10 mJ energy enabled by post-compression in multiple thin plates

Szabolcs Tóth^{1,2}, Roland S. Nagymihály^{1,2}, Imre Seres^{1,2}, Levente Lehotai², János Csontos¹, Ádám Börzsönyi¹, and Károly Osvay^{2,3}

¹ELI-ALPS Research Institute, ELI-HU Non-Profit Ltd., Wolfgang Sandner utca 3, 6728 Szeged, Hungary; ²National Laser-Initiated Transmutation Laboratory, University of Szeged, Dugonics tér 13, 6720 Szeged, Hungary; ³Department of Optics and Quantum Electronics, University of Szeged, P.O. Box 406, 6701 Szeged, Hungary

Box 406, 6701 Szeged, Hungary

*Corresponding author: Roland.Nagymihaly@eli-alps.hu

Post-compression of laser pulses containing many optical cycles with μJ to mJ energy to few-optical cycles has been achieved with the well-established hollow fiber and multipass cell techniques [1] over a wide repetition rate range. Scaling of post-compression to high peak power pulses in the multi-TW to 100 TW range was demonstrated with multi-cycle output pulses [2], whereas single-cycle duration was only achieved with sub-mJ energy by using the multiple thin plate technique [3].

Here we propose a novel arrangement of the multiple thin plate method adapted for pulse energies beyond the few mJ limit. We performed an experimental campaign by using the spatially filtered beam of the SEA laser system of ELI-ALPS [4], where the setup was enclosed in a vacuum chamber with a footprint of 4 x 1 m. We injected 12 mJ energy pulses with 12 fs duration to the spectral broadening stage, consisting of three fused silica plates with 200 μm thickness. The plates were mounted on linear translation stages, by which they were moved in respect to the focus positions, thus the peak intensity was tuned separately. Spectral broadening was optimized after inserting each plate to the beam, where we achieved a transmission of 87% in our setup, resulting an output energy of 10.4 mJ. Sampled pulses were sent through a 1 mm thick fused silica window and compressed in air by using only 2 bounces in total from a pair of PC1702 (UFI) type chirped mirrors. The compressed pulses were characterized by a single-shot D-scan (S-Shot B, Sphere Ultrafast Photonics), and also by amplitude calibrated spectrometers.

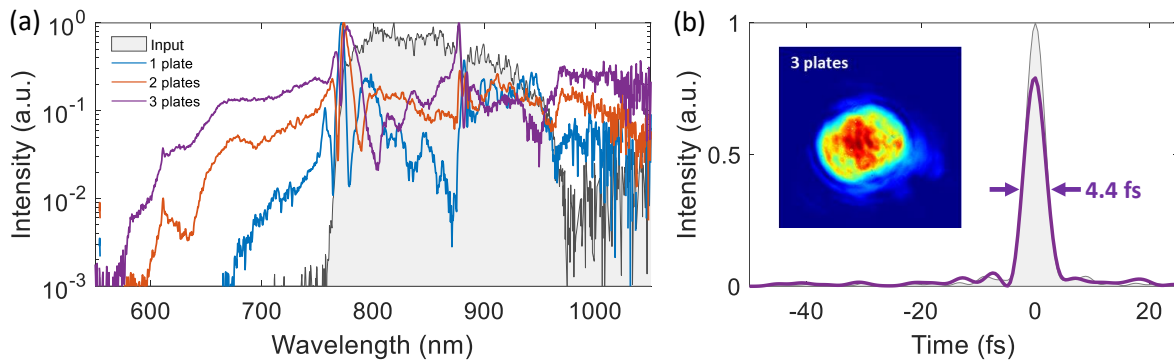


Fig. 1. Measured spectrum of the input, and with 1, 2, and 3 plates (a). Transform limited (grey) and retrieved 4.4 fs (FWHM) pulse (purple) with 3 plates (b). Inset: near field profile of the output with 3 plates.

Spatial homogeneity of the spectrum was also analyzed. We achieved 6 fs, 5.3 fs, and 4.4 fs compressed FWHM pulse duration with 1, 2 and 3 plates, respectively.

References

- [1] T. Nagy et al, Advances in Physics: X, 6, 1845795 (2020).
- [2] J. I. Kim et al, Opt. Express 30, 8734-8741 (2022).
- [3] M. Stanfield et al, Opt. Express 29, 9123-9136 (2021).
- [4] Sz. Tóth et al, J. Phys. Photonics 2 (2020) 045003.