IMPROVED PULSE CONTRAST ON THE TEXAS PETAWATT LASER

E. Gaul[1], M. E. Donovan[1], T. Toncian[1], M. Martinez[1], J. Gordon[1], M. Spinks[1], G. Dyer[1], N. Truong[1], C. Wagner[1], T. Ditmire[1], B. M. Hegelich[1]
[1]Center for High Energy Density Science, University of Texas, Austin, TX, 78712 USA
gaul@physics.utexas.edu

Center for High Energy Density Science researchers have completed a year-long project to improve the main-pulse to pre-pulse ratio (a.k.a. pulse contrast) on the Texas Petawatt Laser. This improvement enables the use of thin and reduced mass targets for ion acceleration, and reduces pre-plasma effects on all experiments.

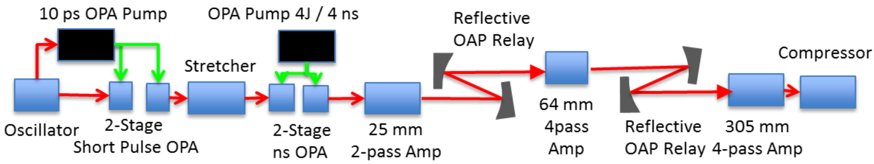

Figure 1. Schematic layout of the Texas Petawatt Laser, starting with the oscillator on the left and moving through four OPCPA amplifiers, a 25-mm Nd:silicate glass amplifier, a 64-mm Nd:silicate glass amplifier, and a 305-mm Nd:phosphate glass amplifier.

Pre-upgrade, the Texas Petawatt Laser used three stages of optical parametric chirped-pulse amplification (OPCPA) to amplify a 1054 nm wavelength seed pulse by approximately nine orders of magnitude. The high gain gave rise to parametric fluorescence during the duration of the pump pulse (~4 ns) that did not compress and left a contrast pedestal. The new design started with two BBO-based OPCPA stages pumped by an optically synchronized 8 ps pump laser. These stages amplify slightly chirped few ps pulses by six orders of magnitude and reduce the contrast pedestal width to a few ps. Next there are two LBO-based OPCPA stages that are pumped by 4 ns pulses. These have much less gain and the overall reduction in parametric fluorescence is about three orders of magnitude.

The Texas Petawatt utilizes a multipass architecture to efficiently extract energy from the several glass amplifiers. Sequential use of Nd:silicate and Nd:phosphate glass maintains broad bandwidth. Prior to the upgrade, lenses in the multipass relay telescopes caused ghost reflections which arrived as pencil beam prepulses on target. Since tilting or wedging lenses was not a viable option for a broadband CPA laser, we replaced all lenses in the glass amplifiers with off axis parabolic mirrors. This eliminated all the discrete prepulses attributed to lenses. Residual contrast peaks are attributed to surface scattering of the retro mirror and other optics into a different amplification pass.

We also eliminated all wave plates and thin transmissive optics in the laser to eliminate post pulses that would result in prepulses by nonlinear (B-integral) conversion. This required us to reduce from eight passes to four passes in the 64 mm glass amplifier and to add a two-pass 25 mm “booster amplifier.”

As a final upgrade we added an Acousto-Optic Programmable Dispersive Filter to improve fourth order dispersion and steepen the rising edge of the compressed pulse.

[1] E. Gaul et al., “Demonstration of a 1.1 petawatt laser based on a hybrid optical parametric chirped pulse amplification/mixed Nd:glass amplifier,” *Appl. Opt.* **49**, 1676 (2010).