MTW Broadband Front End

The broadband front end is based on a mode-locked laser, providing seed pulses to an optical parametric amplifier (OPA) pumped by a short optical pulse (Fig. 1). This architecture has been demonstrated as a means to significantly improve the temporal contrast of optical pulses because the instantaneous gain from the OPA temporally gates the seed pulses and restricts the generated incoherent fluorescence to a narrow time window. This allows the subsequent amplifiers, which are pumped by longer pulses, to operate at a lower gain, thereby generating less fluorescence and improving the temporal contrast. After initial prototyping, front ends based on this concept have been deployed on the MTW and OMEGA EP lasers, and similar systems are being used in other laser facilities. The ultrafast OPA (UOPA) deployed on MTW has a similar design and performance to the units deployed on OMEGA EP, as described in Fig. 1.

- A commercial mode-locked laser (GLX-200, Lumentum) provides seed pulses synchronized to the master reference clock doubled to 76 MHz at an average power of 200 mW. The 250-fs pulses (FWHM bandwidth equal to 6 nm at 1053 nm) are stretched to a few picoseconds by a two-grating stretcher for better temporal overlap with the pump pulse in the UOPA crystal.
- A diode-pumped Nd: YLF regenerative amplifier operating at 5 Hz amplifies one pulse from the 76-MHz train to ~0.5 mJ. Spectral gain narrowing reduces the bandwidth to 0.15 nm, which corresponds to a pulse duration of the order of 10 ps. This regenerative amplifier is similar to the one described in the Sec. 2.3, except for the compensation of self-phase modulation via intracavity-cascaded second-order nonlinearities. That pulse is frequency doubled with a 70% conversion efficiency and temporally synchronized with the seed pulse at the UOPA crystal. Coarse timing is performed using the Vernier effect between cavity round trip in the regenerative amplifier and the mode-locked laser, which are of the order of 13 ns but differ by approximately 300 ps, and fine tuning is done with a remotely controlled fiber delay line with a range of 330 ps.
- Parametric amplification in a 5-mm BBO crystal yields signal pulses at the 10-μJ level.

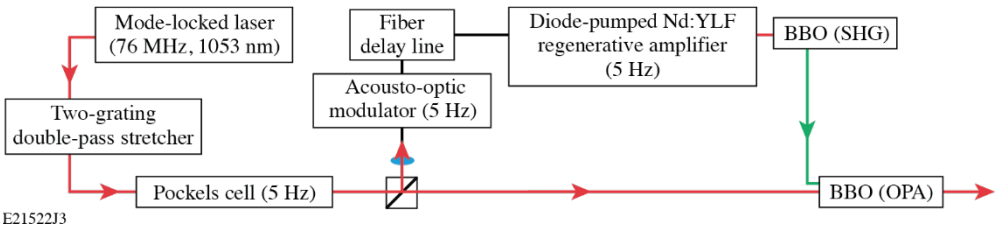

Fig. 1. Block diagram of the broadband front end.

The UOPA provides approximately four orders of magnitude energy amplification while restricting the associated parametric fluorescence to a few picoseconds around the output pulse. This makes it possible to reduce the required gain in the OPCPA stages, where the pump pulse has duration of a few nanoseconds, and therefore significantly reduces the level of the contrast degradation resulting from nanosecond fluorescence.