MTW Integrated Front End Source (IFES)

The IFES generates shaped pulses for each mode of MTW operation with high stability, turn-key operation, and low maintenance. It starts from a compact, stable, single-frequency distributed feedback commercial fiber laser (Adjustic/Koheras). This 10-mW continuous-wave (cw) laser is wavelength-stabilized to the gain peak of the main Nd: YLF amplifiers (~1053 nm) via temperature control of an intracavity fiber Bragg grating. The exact wavelength is tuned to match the unseeded emission from the Nd: YLF regen, which can fluctuate slightly (~0.2 nm) depending on humidity-sensitive optics and the temperature of the gain crystal.

An integrated unit composed of two lithium-niobate ($LiNbO_3$) Mach–Zehnder modulators (MZM's) is used for pulse-shaping. The first MZM is driven by a Kentech arbitrary waveform generator (AWG) that carves a shaped optical pulse out of the cw output from the fiber laser. The second MZM is driven by a square pulse to increase the temporal contrast of the optical pulse by temporal gating. The AWG has a 100-ps sample separation for creating pulse shapes that are pre-compensated for the transmission nonlinearity of the $LiNbO_3$ modulator and the square-pulse distortion of the regen and CLARA. The programmable control provided by the AWG is critical for setting the temporal profile of the OPCPA pump pulse and, therefore, the bandwidth of the OPCPA amplifiers for MTW and OPAL. A library of tens of pulse shapes allows easy modification of the output pulse shape for different applications. A picojoule pulse from the $LiNbO_3$ modulator is amplified in a high-gain (23-dB) polarization-maintaining, double-pass, ytterbium-doped fiber amplifier for seeding the regen. Figure 1 shows examples of output pulses for the standard OPCPA configuration, for which pulse shaping allows for the generation of an amplified 2.8-ns flat-in-time super-Gaussian pump pulse by precompensation of square-pulse distortion in the laser amplifiers.

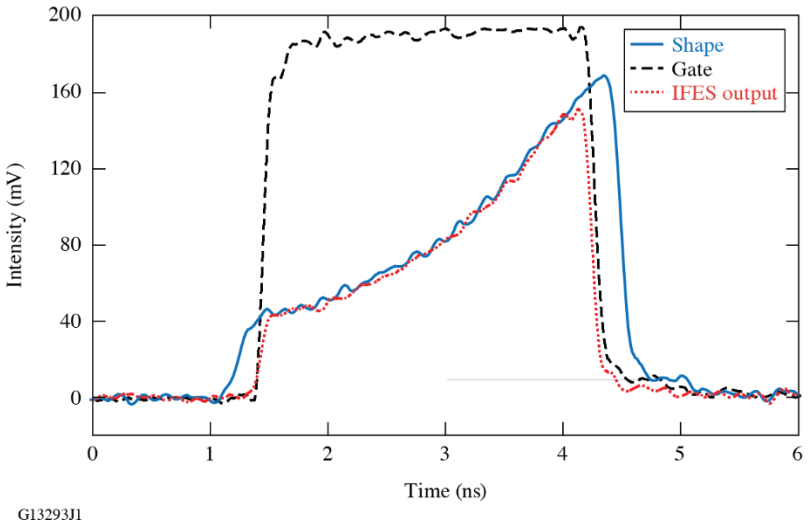

Fig. 1. IFES pulse shapes. The first "shaped" pulse is formed by the first arm amplitude modulator, the second "gate" pulse by the second arm, and the third one is the resulting pulse when both modulators are driven.