MTW Offner Stretcher

The ultrafast optical parametric amplifier (UOPA) output pulse is stretched to ~1.8 ns (FWHM) in the Offner stretcher with a positive dispersion of ~300 ps/nm. Chirped-pulse–amplification systems traditionally use a static stretcher and set the pulse width by adjusting the compressor's parameters, such as the grating separation and incidence angle. A static design was chosen for OMEGA EP's large-scale vacuum compressor, however, to minimize its optomechanical complexity, and therefore pulse-width adjustments had to be made using the Offner stretcher. MTW, as the prototype front end for OMEGA EP, was used to develop this approach. After the MTW picosecond compressor is aligned in air, the vacuum chamber is closed, pumped down, and no further adjustments are made. All modifications for optimizing pulse compression for the shortest pulse or increasing it up to 200 ps are made using the Offner stretcher.

The stretcher is shown in Fig. 1 and uses a single-grating, double-pass geometry with a roof mirror (i.e., the beam diffracts four times off the grating). The gold-coated grating (165 mm × 220 mm) has a line density of 1740 lines/mm. An image of the grating is formed using a spherical-mirror Offner telescope with a negative slant distance, as required to produce positive dispersion that is matched to MTW's material dispersion and compressor. The telescope's concave primary and convex secondary mirrors are mounted on a single translation stage, allowing the telescope to be moved over the range of +200/–150 mm from the best-compression position with micron accuracy to change the separation between the grating and its image. This changes the stretch ratio (SR), and consequently the compressed pulse duration, and either sign of chirp can be achieved.

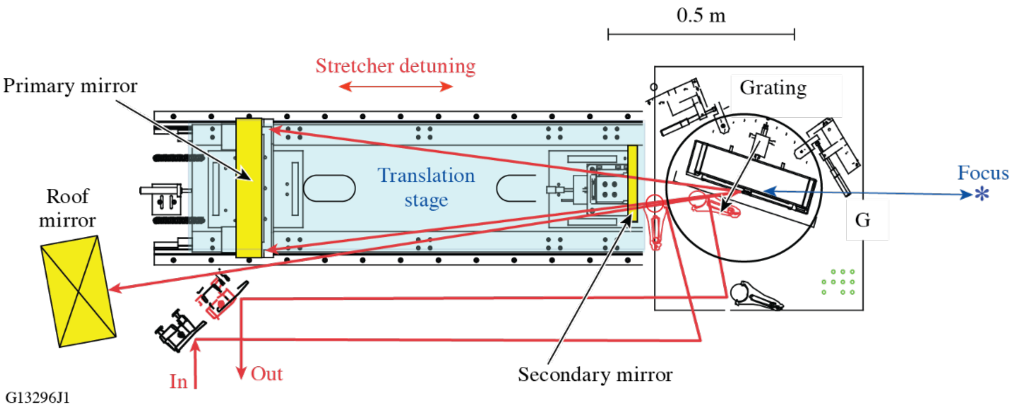

Fig. 1. Stretcher setup. *G* is the distance between the focus of the mirrors and the grating.

We measured the SR at different positions of the stretcher base with two pins installed in front of the secondary mirror of the stretcher to block portions of the spectrum. The SR was determined from their separation in time and wavelength from the pulse and spectrum, respectively. Typical measurements are shown in Fig. 2.

The SR in units of ps/nm is calculated as

$$\mathrm{SR} = 2G\frac{\lambda d^2}{c * \cos^2\left[\theta_\mathrm{d}\left(\omega_0\right)\right]},$$

where *G* is the distance between the grating and the focus focal spot of the primary mirror in the stretcher; *d* is the grating line density; $\theta_{\mathrm{d}}\left(\omega_0\right)$ is the diffraction angle at the central frequency; and λ_0 is the central wavelength.

The calculated stretch ratios were compared with measured stretch ratios at different base positions. The stretcher varies not only the pulse duration, but also the sign of the chirp, which is critical for experiments in a gas jet, for example.

A Pockels cell selects a single stretched pulse from the 76-MHz train if the UOPA stage is bypassed. Finally, a 2-m-long telescope adjusts the beam size at the first optical parametric chirped-pulse–amplification stage

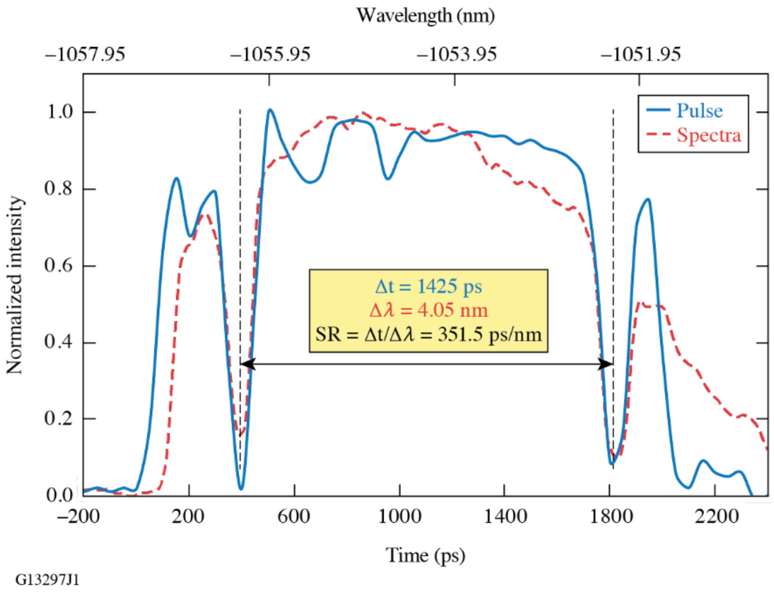

Fig. 2. SR measurements.