TAW Pulse stretcher upgrade

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Introduction

To increase the energy capability of Target Area West (TAW) it was necessary for the CPA process through Vulcan to undergo a major upgrade. The requirement to attain a 500 J pulse in only 10 ps meant that the current pulse chirp of ~157 ps/nm was not sufficient to prevent damage to the system.[1]

Consequently the current stretcher layout (figure 1) was to be re-designed and the dimensions between its optical components re-configured to increase the chirp to ~400 ps/nm. This was the calculated pulse chirp that would safely pass through Vulcan and deliver the required energy to target. The increased chirp rate was achieved by reversing the grating geometry and double passing the stretcher.

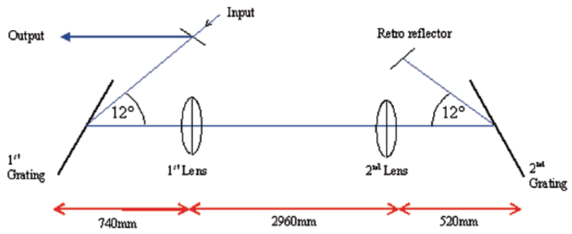

Figure 1. Layout of original pulse stretcher showing all key dimensions.

Reversed geometry

It was decided that the basic stretcher layout (figure 1) should remain the same and the 12° angle of separation between the incident and diffracted light from each grating should be maintained. This was to minimise the overall disruption to the grating layout and to ensure a smooth transition between grating configurations. The preservation of the 12° angle was achieved by reversing the grating geometry (figure 2) thereby reversing the incident and diffraction angles and maximising the bandwidth through the system.

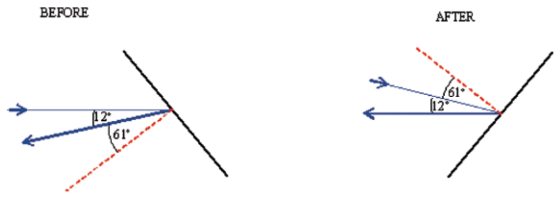

Figure 2. Before and after comparison of grating angles.

The double pass stretcher

If the stretcher was operated in a single pass then spectral clipping would occur between the second lens and the output from the second grating as shown in figure 3.

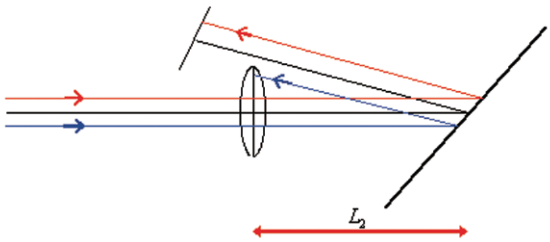

Figure 3. The spectral clip between the 2nd grating and 2nd lens.

By introducing a second pass the distance between the 2nd grating and the 2nd lens () could be increased. This would therefore eliminate the spectral clip while maintaining the increased chirp. The double pass resulted in the stretcher output returning along the same path as the input and required a Faraday isolator to capture the output beam. The final layout of the upgraded stretcher is shown in figure 4.

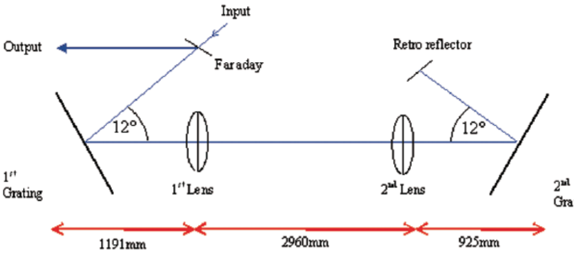

Figure 4. Layout of upgraded stretcher dimensions.

Results

The stretched pulse was then fed into a test compressor built to emulate the exact dimensions and angles of the new TAW compressor. The pulse was then aligned into an autocorrelator, set up to measure the pulse duration after compression. Initially the beam was too weak so the radius of the input beam to the stretcher was to increase the reduced intensity. This was achieved by reducing the focal length of the 2nd lens in the input spatial filter. Further optimisation was preformed and the signal was further improved eventually yielding an autocorrelation of ~0.9 ps which equates to ~675 fs pulse duration.

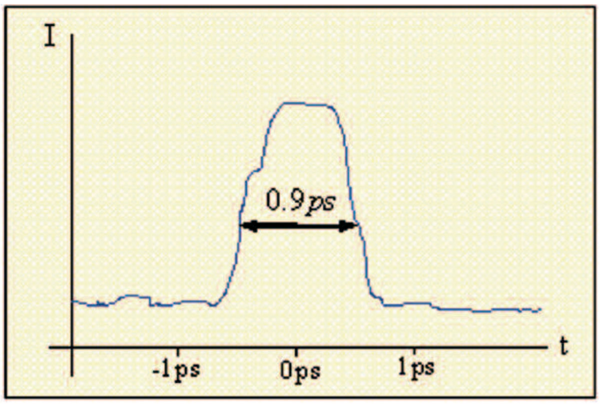

Figure 5. Autocorrelation showing 0.9 ps readout.

Conclusions

In conclusion we have presented a modification to the TAW stretcher to increase the chirp rate. We have demonstrated that we can compress the stretched pulse to below the 1 ps required for TAW. The difference between the input and output pulse duration is due to high order phase errors. These differences can be corrected by further optimisation processes such as those already undertaken. The closer the parallism of the gratings the stronger the signal and the smaller the measured autocorrelation will be.

References

1. http://www.clf.rl.ac.uk/Facilities/vulcan/projects/taw_concept.htm