Spectral monitoring of the mixed glass rod chain

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Introduction

Since the introduction of the Mixed Glass Rod Chain in Vulcan [1], the gain of the disc amplifier chain for the TAP configuration is usually between 160 and 190. However, during an experiment this year, the gain was seen to drop and plateau at ~140. This was despite high energies at the input of the rod amplifier chain from the OPCPA system. Higher than expected fluctuations in the output energy were also observed in comparison to previous experiments. To investigate whether the change in gain as well as energy instability was being caused by a shift in wavelength of the spectrum, a spectrometer was installed at the end of the rod amplifier chain.

The TAP beamline consists of a mixture of Neodymium doped Phosphate and Neodymium doped Silicate glass. The phosphate glass has an optimum gain at 1053nm whilst the silicate glass has an optimum gain at 1060nm. The combination of these two types of glass increases the gain bandwidth of the OPCPA output through the rod amplifiers from 2.8nm (purely phosphate) to 5.5nm and occurs early in the system (as a 9mm and 16mm amplifiers).

Setup and operation

A spectrometer exists at the output of the OPCPA system in the Vulcan Front-End. This is used to centre the spectrum at 1055nm. An Ocean Optics HR-4000 [2] was setup after the mixed glass rod amplifier chain to monitor the spectrum before it is injected into the phosphate disc amplifier chain. With the HR-4000, the spectrums of both outputs could be compared and the effect of the rod chain on the injected spectrum could now be examined.

Figure 1 shows a spectrum that was recorded at the beginning of the March 2007 experiment. It can be seen that the spectrum is centered at the longer wavelengths. This would mean that the gain would be higher through the Silicate glass, resulting in relatively high energy after the rod amplifiers. However, since the Silicate glass pulled the spectrum towards the longer wavelengths, when the pulse traveled through phosphate disc amplifiers in the chain to TAP, the overall gain was lower than expected (~140 instead of ~180).

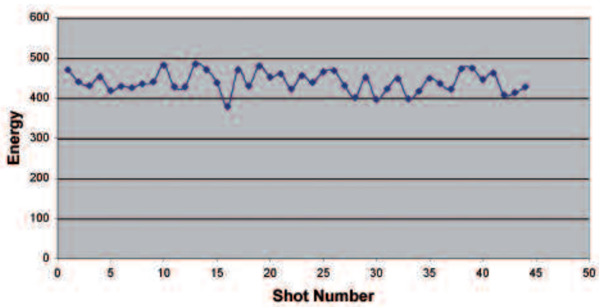

Figure 1. Initial spectrum measurement.

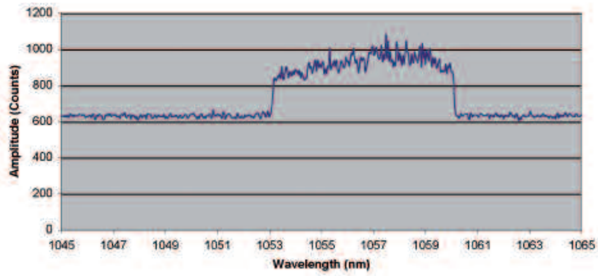

Figure 2. Final spectrum measurement.

A series of shots were taken, with the position of the spectrum being adjusted. When centering the spectrum at the lower end of the scale (~1053nm), the energy after the rod amplifiers was lower, however the overall gain was higher (~170).

By iterating this process of adjusting the spectrum and getting a measure for the overall gain of the system, an optimal spectral position was obtained, as shown in figure 2.

This now gave a good balance to the system, having good output from the rod amplifiers (3-4J) and good overall gain through the system (~170 – 180).

On some experiments, there can be issues with shot stability to TAP. This can be caused by a myriad of reasons, including fluctuations in oscillator output energies, alignment and spectral positioning.

On previous experiments, shot stability was in the order of 83%. However, due to various improvements and by investigating the spectral issue, the shot stability for the experiment during March and April was increased to 93%.

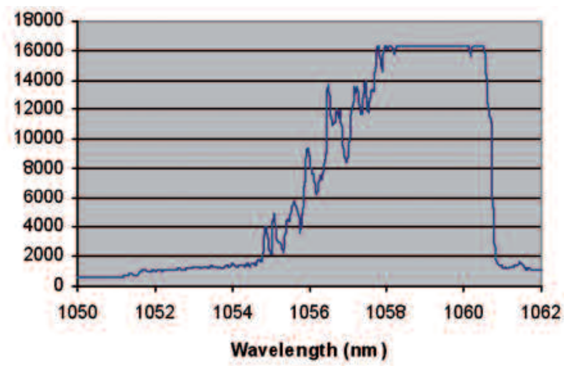

Figure 3. Shot stability to TAP (March - April 2007).

Conclusions

This increase in shot stability led to a very successful experiment in TAP and improved the overall running of the system to TAP.

The procedure for setting up the OPCPA system through Vulcan has also changed, in that now the spectrum is tuned in the front-end to be positioned between 1053nm and 1060nm after the mixed glass chain. This was found to be the optimal position.

References

1. S Hawkes *et al.*, *Mixed glass rod amplifier chain – design and implementation*, CLF Annual Report 2003/04, p169.
2. Ocean Optics, HR-4000 High Resolution Spectrometer, www.oceanoptics.com, Catalog p21.