Characterization of a new fibre laser oscillator for the Vulcan laser

I. O. Musgrave, D. Canny and C. Hernandez-Gomez
Central Laser Facility, STFC, Rutherford Appleton Laboratory, Chilton, Didcot, Oxfordshire, OX11 0QX, UK

Main contact email address **I.O.Musgrave@rl.ac.uk**

Introduction

When chirped pulse amplification was first implemented on Vulcan in the early 1990s, an additive pulse mode locked Nd:YLF (APM Nd:YLF) laser was used [1]. This laser generated pulses with 2ps duration that were stretched to 80ps before amplification in Vulcan to 40J. After amplification, the pulses were compressed back to the 2ps and 30J was delivered to target. This heralded a new dawn for Vulcan allowing the development of ultra high intensities. Although, the APM Nd:YLF laser is capable of delivering these pulses it has often been prone to instability and has been the cause of several days of down time during experiments. There was therefore the requirement of an alternative source. One potential solution to this is to use a stretcher installed after one of the existing short pulse oscillators to replicate the APM Nd:YLF's performance and this will be also be implemented. But an alternative solution is to investigate novel sources. In this paper we report on the characterization of a fibre laser that will replace the APM Nd:YLF laser.

Background

In recent years there have been significant advances in the area of fiber lasers. These have been driven in part by the advent of low loss fibers and the improvement in coupling techniques for the pump diodes. Today the spectrum of commercially available fiber lasers almost matches that of traditional free space solid-state devices with advances even being made in the area of high pulse energy devices and fiber CPA schemes published. A distinct advantage of fiber sources over their bulk cousins is that the laser mode is confined within the fiber. The fiber therefore governs the properties of the laser beam consequently they are less susceptible to the deleterious effects of thermal aberrations.

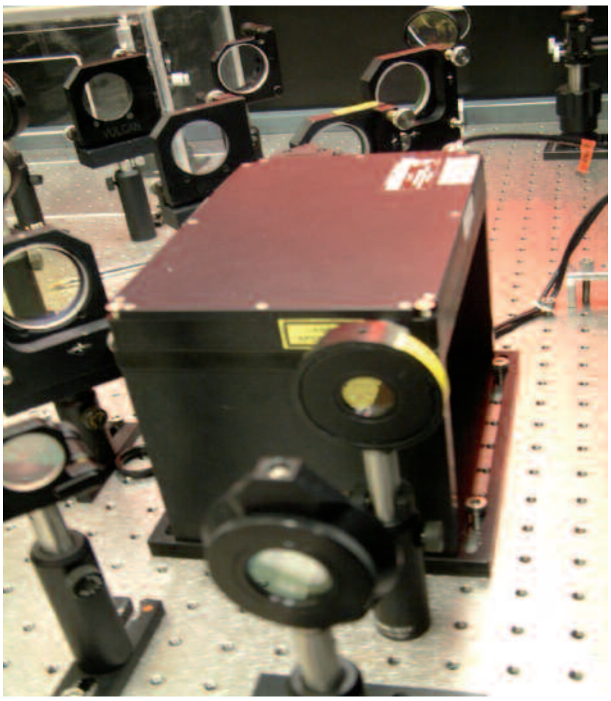

Figure 1. Fianium FemtoMaster Oscillator.

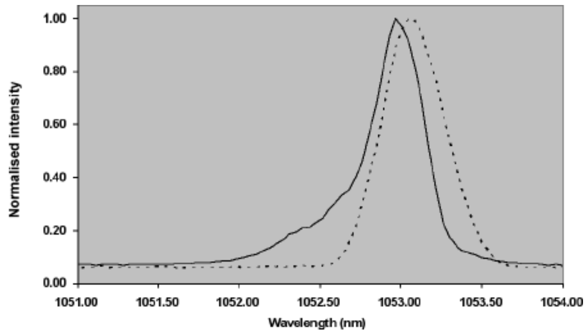

Figure 2. Comparasion of the spectra of the fibre (solid line) and APM Nd:YLF (dashed line) oscillators.

The fiber laser that the results of this report are based on is a FemtoMaster 1053 Mode locked Fiber Laser from Fianium [2] as shown in figure 1. The laser is passively mode locked using a saturable absorber mirror to initiate soliton mode locking. A comparison of the spectra produced by the two oscillators is shown in figure 2. In figure 2 the solid line is that of the fibre laser and the dashed line is that of the APM Nd:YLF oscillator. As can be seen the widths of the two spectra are comparable although there is a slightly longer tail to the shorter wavelengths for the fibre laser. The output of the fibre laser was then injected into the stretcher for the APM Nd:YLF laser to be amplified through Vulcan. When the stretched pulse was measured using a streak camera after the 9mm pre-amplifiers it was found to have a pulse duration of 80ps and is the same as that of the APM Nd:YLF laser.

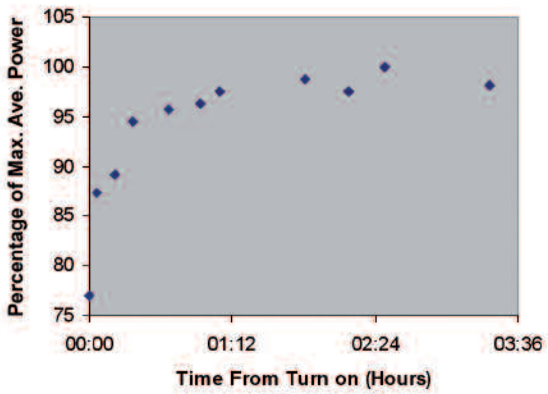

Figure 3. Variation of the percentage of the maximum power of the laser to measure the warm up time of the laser.

An important property of the laser that we have to know about is the time required for it to warm up. Figure 3 shows the percentage of the maximum average power sampled at a number of times over several hours. As can be seen from this graph when the laser is first switched on the average power is about 75% of normal operating value. However within the space of 10 minutes the laser has reached 95% of it's typical operating value.

Conclusion

In conclusion we have incorporated a novel seed source into the Vulcan laser for 80ps experiments to reduce the downtime that the original CPA seed source was beginning to introduce.

References

1. C. N. Danson *et al.*, SPIE Vol. 1860 Short-Pulse High-Intensity Lasers and Applications II (1993) p10.
2. Fianium Ltd, 20 Compass Point, Ensign Way, Southampton, SO31 4RA, UK