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UPGRADING THE SYNCHRONISATION AND TRIGGER SYSTEMS ON THE VULCAN HIGH-POWER Nd:GLASS LASER

D. A. Pepler, I. O. Musgrave and P. B. M. Oliveira, STFC Rutherford Appleton Laboratory, Harwell Campus, Didcot, OXON. OX11 0QX, UK

Abstract

The Vulcan Neodymium-Glass High-Power Laser Facility at the Central Laser Facility [1] in the UK has been operational for over 40 years providing a world-leading and high-profile service to the international researchers in the field of Plasma Physics. Over that time the facility has had many modifications and enhancements to the buildings, the laser hardware and to the computerised control, synchronisation and timing systems.

As the laser systems have developed and the user experiments have continued to become much more complex and demanding, many new operational conditions have been required. The use of four independent laser oscillators with different properties - including temporal, spectral and operating frequencies - have meant that the optical and electrical multiplexing and the timing and synchronisation systems have all had to be adapted and extended to cope with these additional needs. However, these changes have resulted in the build-up of the overall system jitter to ± 250 ps between long (nanosecond) and short (picosecond) optical pulses and this is a limiting factor for time-critical experiments.

This paper will present some of the key changes and improvements that have recently been made.

INTRODUCTION

To significantly enhance the performance of the laser a number of key elements have had to be addressed - the number of different short-pulse oscillators have been reduced to two, namely a Spectra Physics [2] Tsunami Titanium: Sapphire oscillator and a Spectra Physics InSight DS oscillator and also the synchronisation and electronic timing systems have been replaced.

With the use of a commercial “Lok to Clock®” system on the Tsunami oscillator, the number of RF frequencies have effectively been reduced to one as this oscillator is now forced to operate at and in phase with the 79.926 MHz ± 80 Hz RF provided by the InSight oscillator.

This has enabled the fundamental timing system to be replaced with a commercial Master / Slave system from Greenfield Technology Ltd [3]. Figure 1 shows a schematic of the laser facility complex and the distribution of the new timing system. The system comprises of a model GFT 3001 Master Oscillator and

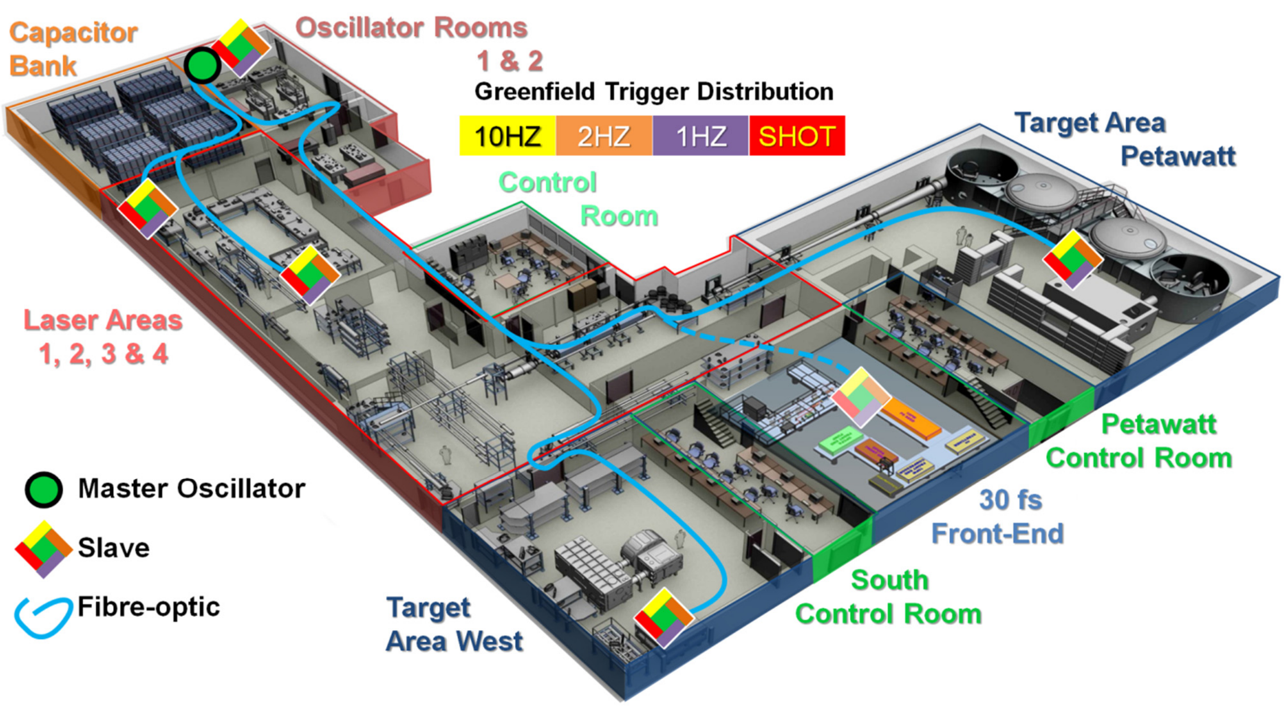

Figure 1: Schematic of the Vulcan Laser Facility showing the installation of the new trigger system. The Greenfield GFT 3001 Master Oscillator is located in Oscillator Room 2 with the GFT 1004 Digital Delay Generator modules widely distributed around the Facility and interconnected to the Master by a network of fibre optics.

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multiple GFT 1004 Digital Delay Generators (Slave) units. The installation has been carefully managed and for comparison purposes was initially arranged to be able to be operated in parallel with the existing timing system.

INSTALLATION

Figure 2 shows a photo of the Master Oscillator, single Slave, fibre-optic splitter and distribution modules installed near to the InSight and Tsunami oscillator table.

Figure 2: Installation of the GFT 3001 Master Oscillator and GFT 1004 Digital Delay Generator in Oscillator Room 2.

The testing revealed a number of issues to do with the frequency of the external oscillator that was being used to source the Master's external RF clock, occasional timing jumps of a few ns on some output channels and some inconsistencies with the single-shot sequences. However, we have always found Greenfield very responsive to investigating these problems and making firmware updates to resolve the issues.

COMMISSIONING

Following an extensive period of testing, the system was able to be switched to full operational status with minimal disruption to the user experimental programme. The system now provides options for 1 kHz, 100 Hz, 10 Hz, 2 Hz and 1 Hz repetitive signals as well as having single-shot capability.

A number of fibre-optics have been installed around the Facility, both within the laser bays and the target areas to accommodate the distribution of the Slave units.

CONCLUSION

The timing system is now much more immune to electrical noise; is also being integrated into the Vulcan Computer Control systems and provides a vastly superior performance in that the timing jitter is now sub 25 ps rms - a full order of magnitude reduction, as shown in Fig. 3.

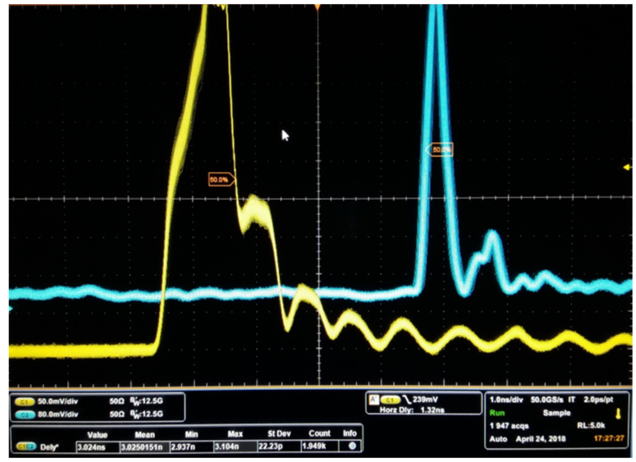

Figure 3: Oscilloscope traces of photo-diode signals comparing the relative timing of a short (ps) and long (ns) optical pulse demonstrating the jitter to be sub 25 ps rms.

As more Slave units are commissioned to replace other lower performance timing hardware, further timing improvements and possibilities for expansion are anticipated.

REFERENCES

[1] Central Laser Facility, www.clf.stfc.ac.uk

[2] Spectra-Physics, www.spectra-physics.com

[3] Greenfield Technology, www.greenfieldtechnology.com