Combined imaging and energy monitoring system for the Vulcan laser

J. Baxter and A. K. Kidd

Central Laser Facility, STFC, Rutherford Appleton Laboratory, Chilton, Didcot, Oxfordshire OX11 0QX, UK

Main contact email address **A.K.Kidd@rl.ac.uk**

Alignment System

A camera system was developed to monitor the output of the Vulcan rod amplifier chain, with the main aim being to aid alignment by producing a live image of the CW alignment laser, as well as capturing an image of a laser pulse when fired.

The alignment procedure for the Vulcan laser consists of placing photographic paper in the beam, firing the whole rod amplifier chain and taking a burn of the near field of the beam at the rod chain output. Mirror adjustments are then made to align the beam. While this method is reliable, it is time-consuming, and given the time constraints of the experimental groups it was suggested that a digital image of the beam would save operator time in alignment. In addition to this, because the CCD chips in these cameras are much more sensitive to infra-red light than the photographic paper, a much lower energy shot could be fired into them for alignment purposes. This would, in theory, reduce the alignment shot time from around ten minutes to thirty seconds, as operators would not have to wait for the rod amplifiers to cool down.

Figure 1 shows the system set up to image the plane at which the photographic paper is usually placed, by taking leakage from one of the beam-path mirrors.

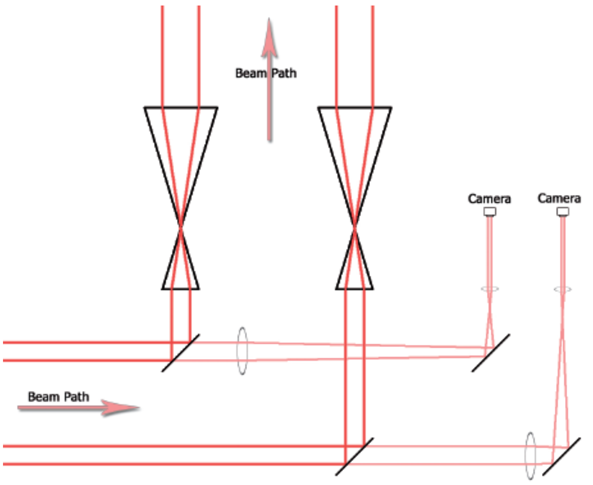

Figure 1. Schematic of Corner Camera System.

The level of filtering depends on the shot type – from CW to a rod shot is three orders of magnitude in energy – a protective mechanism needed to be introduced that adjusted the filtering based on the power level of the laser shot. This was achieved by introducing a rotating filter holder.

This system receives commands from the Central Control program [1], giving it essential information on which Target Area is currently active, and what type of shot mode is currently selected. This information allows the program to choose the filtering levels based on which rod chain, active area and shot mode, and in doing so becomes a fully automated system with no daily human input required.

This fully automated 'Corner Camera System' continues to be a critical aid in laser alignment and diagnostics. Pseudo-colouring of images proved to be extremely beneficial when aligning the laser, as with a monochrome image it can often be difficult to distinguish local areas of intensity maxima, particularly when the overall image intensity is quite low, as shown in Figure 2.

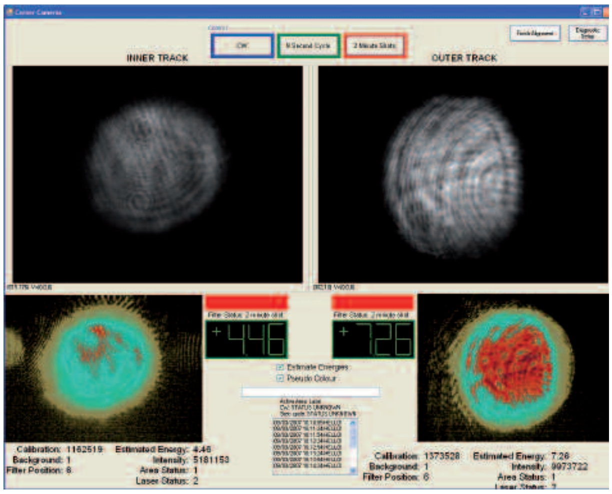

Figure 2. GUI of the Corner Camera Program.

Energy monitoring

Within the laser system, a series of calibrated calorimeters are used to measure beam energy at certain points along the beam-path. As long as the cameras do not saturate in intensity, they can be used as calorimeters as well as beam profilers by reading the total intensity of the captured image. Calibrated against a Gentec [2] calorimeter, this method gave consistent readings of energy within 1-2% of the expected value, a successful proof-of-concept for this to be used elsewhere.

Figure 3 shows the first results taken using this system in the rod chain output the linear relationship showing the success of the system and giving a calibration value for future results.

With this algorithm in place, it could be added to any cameras in the system. One of the main advantages of this system is its dual functionality. All cameras and calorimeters rely on 'leakage' of laser light through the back of a mirror. In the laser amplifier chain there is a limited space for diagnostics. Combining diagnostics in this manner minimizes amount of space required, which is important if further diagnostics are to be added.

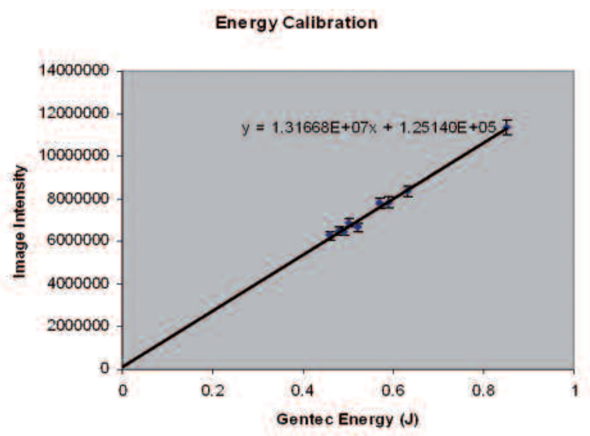

Figure 3. Calibration of the Camera Calorimetry.

References

1. J. Baxter and A. Kidd, *Automated Image Diagnostic System*, CLF Annual Report 2006-2007.
2. Gentec Electro-Optics Inc, Quebec, Canada. www.gentec-eo.com.