Reconfiguration of the Vulcan pre-amplifiers

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Introduction

The 9mm pre-amplifier for the Vulcan CPA system is used to amplify the stretched pulses from the oscillator from the nano joule regime to the sub 100 micro joule level. When the Vulcan oscillators were re-located to a dedicated front end room, this resulted in a large and convoluted increase in the path length from oscillator to the pre-amplifiers. As a result the time taken to align the pre-amplifiers impacted heavily on the availability of Vulcan. The existing pre-amplifier also had a high static losses, due to a lack of image relaying through the two amplifiers and over filling of the amplifiers. In order to improve the efficiency of the laser system a re-design of the pre-amplifier was made.

Design

The redesigned Vulcan Pre-amplifier required a number of design features to improve the performance of the 100TW beamline of Vulcan. The pre-amplifier was re-located to reduce the beam path from the oscillator room from over 20 metres to less than 10 . Losses due to over filling of the amplifiers was largely due to the fact that the beam from the oscillator room had a small but finite degree of divergence as it entered the laser room. This was then coupled with the long beam paths and lack of image relaying resulted in over an order of magnitude in losses. A telescope was installed on the input to the new pre-amplifier to allow the diverging beam to be collimated for amplification in the rods, see figure 1. A Spatial filter was initially installed between the two rod amplifiers to provide cleaning for near field uniformity and image relaying between the two amplifier stages. However, in the commissioning phase strong self lasing was observed, largely as a result of image relaying properties between the amplifier stages. With the installation of restricting apertures and the removal of inter amplifier spatial filter this was eliminated. A further telescope was installed on the output to the pre-amplifier in order to produce the correct beam size and collimation for the main Vulcan amplifier chain. The mirror mounts used in this design were the stainless steel Newport Ultima series, the stainless steel construction has much improved pointing stability with respect to any changes in temperature. Isolation between the two amplifiers is provided by two Pockels cells, these also temporally gate the seed pulse from the oscillator pulse train for injection to Vulcan. Additional protection against back reflections is provided by a faraday isolator. Quad cells for automated alignment[1] were included in the original design, but will not be implemented until further offline tests

Results

Having overcome the initial self lasing issues the new design pre-amplifier was found to have a much lower loss level than the previous configuration. This has allowed for the pump voltages to be reduced on the two amplifiers while still maintaining the same output energy. This will result in less gain narrowing in the early part of the amplifier chain and reduce any pump induced aberrations from the amplifiers. Further operational experience of the re-configured pre-amplifiers has demonstrated an improvement in beam pointing stability. The greatly reduced path lengths coupled with the improved thermal stability of the mirror mounts is largely to account for this.

Conclusions

A new pre-amplifier for the Vulcan 100TW beam has been designed and implemented. This has resulted in an improved performance and reliability of the laser system.

References

1. A Dunster *et al.*, Automatic alignment system testing for Vulcan, CLF Annual Report 2004/05, p 208

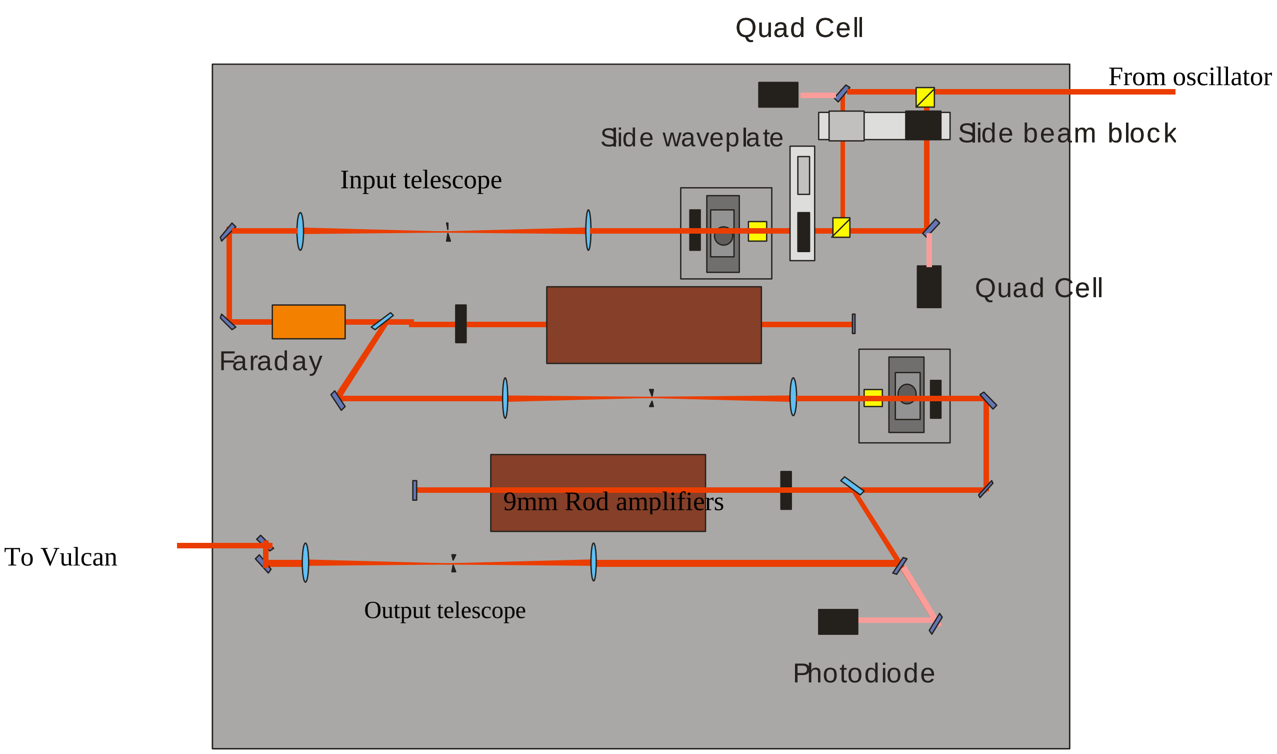

Figure 1. Re-designed Vulcan 100TW pre-amplifier.