Picosecond contrast measurement of the Vulcan Petawatt facility

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Introduction

Vulcan delivers focused intensities in the range of 10^{21} Wcm^{-2} in the Target Area Petawatt (TAP). These intensities are used in the study of plasma formation in solid or gas targets. The level of pre pulse as well as its pulse shape is of paramount importance in understanding the physics involved in the interactions.

The laser configuration for the Target Area Petawatt (TAP) uses an Optical Parametric Chirped Pulse Amplification (OPCPA) preamplifier[1)] as the first stage of amplification prior to injecting the seed pulse into a Nd:Glass amplifier system. Using the (OPCPA) technique in the Front End[2)] means that the contrast level and shape is dependant on a process (Fluorescence) different to the conventional amplified spontaneous emission. Because of the different nature of these two processes, there has been a great interest on the pre pulse level and pulse shape.

In this publication we show the results of a picosecond contrast investigation carried out recently as well as those obtained in a preliminary study 2 years ago, while the Petawatt beam line was being commissioned. The data concerning the nanosecond contrast is reported in a separate article[3)]. We concentrate on the contrast close to the pulse in this article.

Experimental set up

The measurements were taken after the compressor and a focusing parabola in TAP. A pulse is stretched and then amplified by the OPCPA preamplifier to ~13 mJ level and then propagated through the Vulcan laser system and finally compressed. The whole compressed beam was de-magnified to 20 mm by using the combination of the off axis parabola and a lens. The beam was directed out of the interaction chamber through a telescope that further de-magnified the beam to 5 mm diameter.

We used a third order scanning cross correlator[4)] to perform the measurements. The amplified pulses have a repetition rate of 10 Hz when only the OPCPA preamplifier is selected. Therefore it is relatively easy to carry out a scanning cross correlation. This system was automated and has a dynamic range of 8 orders of magnitude. It was built as a part of the European SHARP program to investigate different techniques to improve and to measure contrast. A computer program controls the scanning process and records the average provided by a Boxcar Integrator used to collect the data points.

Results

The scan shown in Figure 1 indicates that at 60 ps ahead of the main pulse the contrast is six orders of magnitude below the main peak and the trend is a slow decrease of the intensity away from the peak. At this low level of signal it was verified that the data recorded was real signal and not a limit of the instrument. The bandwidth of the amplified pulses is 13nm centered at 1055nm. The small peaks are artifacts of the instrument.

This scan can be compared to that taken 2 years ago, shown in Figure 2, whilst the Vulcan Petawatt was still under commissioning and the bandwidth available from the OPCPA was limited to 8 nm FWHM centered at 1053 nm. This scan was taken using the same third order auto correlator located at the same position after the compressor. The contrast level is comparable to that shown in Figure 1, but there is a noticeable difference between both shapes. The instrument's photomultipliers were tested to ensure there was no aging in the system that could induce a difference. The test proved that the gains had not changed significantly since the system was originally built.

Conclusion

The contrast level has been measured to be 6 orders of magnitude lower than the main peak ~60 ps ahead of the main pulse, however it has been noticed that the contrast level close to the pulse has deteriorated. The cause of this change is under investigation.

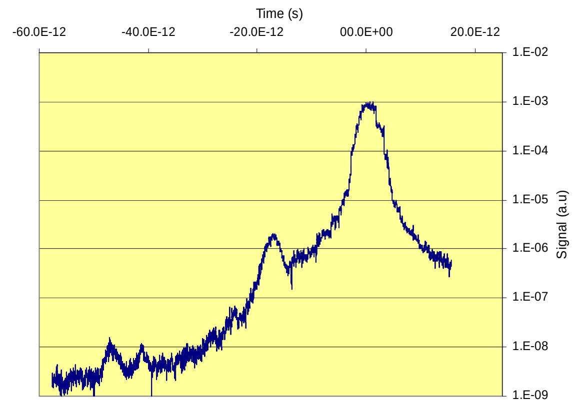

Figure 1. Cross correlation obtained in TAP with OPCPA bandwidth of 13nm.

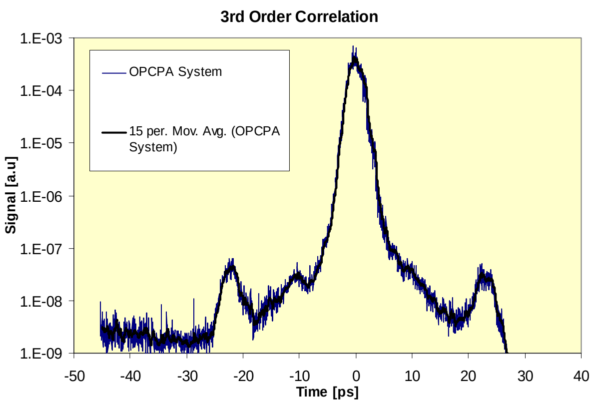

Figure 2. Cross correlation obtained in TAP in 2003 with OPCPA bandwidth of 8 nm.

References

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