L.3 : Single shot tilted pulse-front autocorrelator for diagnostics of ultra short pulse laser beams

Ultra-intense laser systems essentially involve ultrashort laser pulses. They necessarily use one or more dispersive elements such as prisms, gratings, tilted optical windows etc, in their set-up. This makes these systems quite susceptible to pulse-front tilt (PFT). The latter is the angle between the phase-front (which is always perpendicular to the direction of propagation) and pulse-front of an ultrashort pulse laser beam. PFT may arise either due to angular dispersion caused by a single disperser, imperfect alignment of a double disperser or due to the simultaneous presence of spatial and temporal chirps even in absence of angular dispersion. In particular, PFT can cause significant increase of the effective laser pulse duration at the focus, resulting in a decreased intensity. On the other hand, PFT in laser beams may be useful in several applications such as travelling wave pumping of x-ray lasers and dye lasers, optical parametric amplifiers, efficient harmonic generation, THz generation etc. Quantitative measurement of the pulse-front tilt in ultrashort pulse laser beams and its sign is essential for introducing an optimum PFT in laser beams for the applications mentioned above or in eliminating it altogether for some other applications.

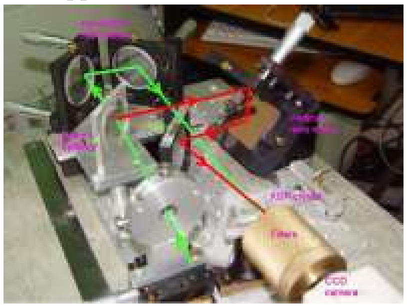

Fig.L.3.1 Setup of tilted pulse front autocorrelator

A simple, low cost, single-shot tilted pulse front autocorrelator (TPFAC) has been developed in-house at the Laser Plasma Division. Fig.L.3.1 shows a photograph of the setup. It has been used for the detection and the quantitative estimation of the PFT in a 200fs pulse duration laser beam from a cw mode-locked Nd:glass oscillator. A single prism and an inverted pair of identical prisms were used for generating PFT with and without angular dispersion respectively. Using this setup, it has been demonstrated that TPFAC can also be used to detect the sign of the PFT in a visually straight forward manner.

Fig.L.3.2a depicts a typical autocorrelation (AC) trace recorded when the laser beam was incident on a single SF10 prism at a propagation distance of 1m. It is seen that the AC trace lies in the 1^{st} and 3^{rd} quadrants of the Cartesian co-ordinate system. AC traces were also recorded at different propagation distances and also when the laser beam was incident on an inverted prism pair. The AC trace in Fig.L.3.2b shows a PFT obtained in the case of an inverted prism pair with an inter-prism separation of 3.4m. It is seen that the AC trace now lies in the 2^{nd} and 4^{th} quadrants. The sign of PFT is opposite in the two cases. The effects of beam size and propagation distance on the PFT have also been studied experimentally. A theoretical model has been developed which predicts quite accurately the observed experimental results.

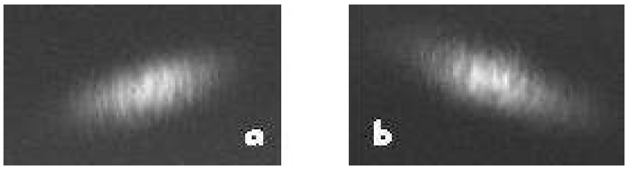

Fig.L.3.2: Typical AC traces for the case of (a) a single prism; (b) a pair of prisms

The sensitivity of the PFT measurement for a given beam crossover angle was also studied. In our case, it was calculated to be 0.0042 fs/mm for a beam cross-over angle of 6^{0}. The minimum detectable rotation angle of the AC trace depends on the spatial resolution of the CCD camera used to record the AC trace. [For more details, see : *A.K. Sharma, R.K.Patidar, M.Raghuramaiah, P.A.Naik, and P.D.Gupta, Optics Express 14, 1313, 2006 ; also linked in Virtual J. Ultrafast Science 6, 2007].*

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L.4 : Deposition of metal nanoparticles using multi-picosecond laser pulses

Nanostructures of different materials are of great interest in nonlinear optics due to their special properties arising due to their physical dimensions being much smaller than the light wavelength. Pulsed laser deposition is used as the standard technique for nanoparticle deposition. It is well accepted that when a solid target is ablated by the laser radiation, the ablating material is in the form of atoms, ions (and electrons), and clusters. These atoms and clusters tend