time delay introduced across the beam due to difference in group velocity and phase velocity of the pulse inside the medium. When such a beam with tilted pulse-front is focused, the resultant intensity may become much smaller than that expected due to temporal broadening of the pulse in the focal plane. It is therefore important to have diagnostic systems to detect and measure the pulse-front tilt so as to eliminate / minimize the same.

A setup was developed for simultaneous quantitative measurements of pulse-front tilt and pulse duration of ultra short laser pulses using a modified single shot autocorrelator. This is based on non-collinear second harmonic generation by overlapping an ultra short laser pulse with its spatially inverted replica in a non-linear crystal. The scheme used for recording single shot second order autocorrelator with spatial inversion is shown in Fig. L.7.1. The input laser beam is split into two equal intensity beams using a 50% reflectivity beam splitter. One of the two beams is horizontally retro-reflected, and the other vertically retro-reflected. The latter is once again reflected by a 100% reflecting mirror to direct it towards a type I phase matched KDP crystal. This arrangement introduces spatial inversion (left-right) in the first beam and up-down inversion in the second beam. The two beams are then made to overlap in a vertical plane in the KDP crystal at a small cross over angle. The spatial distribution of the second harmonic radiation is recorded with a CCD camera. In the absence of pulse front tilt, the harmonic emission image on the CCD camera has shape of an elongated ellipse. A scan in the direction of the minor axis of this ellipse gives information of pulse duration. In the presence of pulse front tilt, this ellipse gets rotated and from the angle of rotation, tilt angle can be determined.

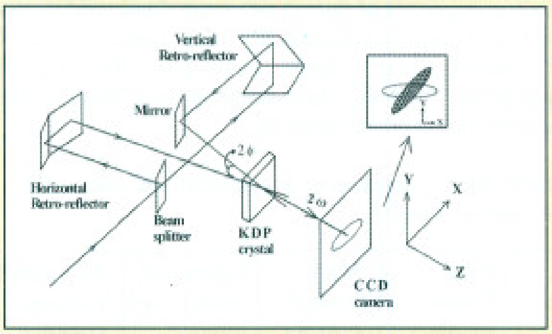

Fig. L. 7.1 Pulse-front tilt cum pulse duration measurement set-up

For the purpose of capability demonstration, a known pulse-front tilt was introduced in a laser beam. This was done by propagating the laser pulses through a prism. The tilt angle of the pulse-front was calculated to be ~16.8mrad. The pulse-front tilt angle measured by the setup was ~17.3mrad, very close to the expected value. Pulse duration of 255±10 fs was also deduced. This is close to the expected value of 250fs for the mode-locked pulses of the Nd: glass laser used. This system can serve as a valuable tool for simultaneous quantitative measurements of pulse-front tilt and pulse duration.

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L. 8 Time resolved optical shear interferometer for laser-produced plasmas

Measurement of time evolution of electron density profile in laser produced plasmas is a pre-requisite for understanding the dynamics of laser - plasma interaction. This task is rendered rather formidable due to small spatial length scale (~10 to 100μm) and fast time scale (~10's ps to few ns) of the plasma involved. A time - resolved optical shear interferometer (Fig. L.8.1) has been set up. It consists of an indigenously built cyclic- type interferometer, which provides equal path lengths in the two arms. A second harmonic laser beam (λ = 532nm), produced by frequency up conversion of a part of the high power Nd: Glass laser output, using a phase – matched KDP crystal, probes the plasma. The interference fringe pattern (Fig L.8.1-inset) is detected using an in-house developed S-20 optical streak camera and recorded by a CCD camera – frame grabber system

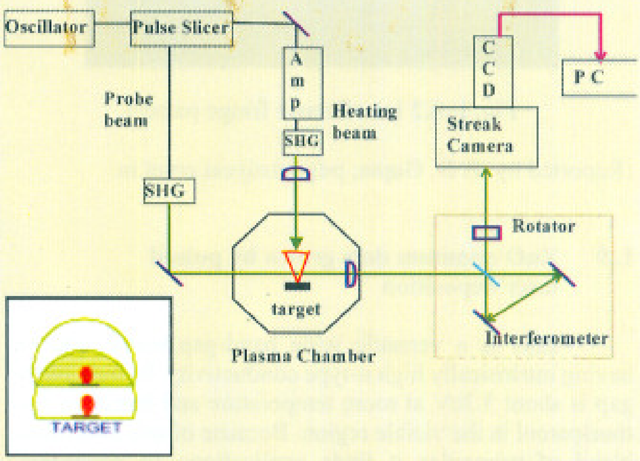

Fig. L.8.1 Schematic diagram of the time resolved optical shear interferometer

The above interferometer has been used to study expansion of an aluminum plasma produced by 4J, 5ns Nd glass laser (2ω) pulses. Fig. L.8.2 shows a typical time resolved interference fringe pattern for the time duration of 16ns of the probe beam up to a distance of 300μm from the target.

Straight-line fringes are observed when the probe beam does not encounter any plasma in its path. Analysis of the shifted fringe pattern is being carried out to derive the time resolved electron density profiles of the plasma.

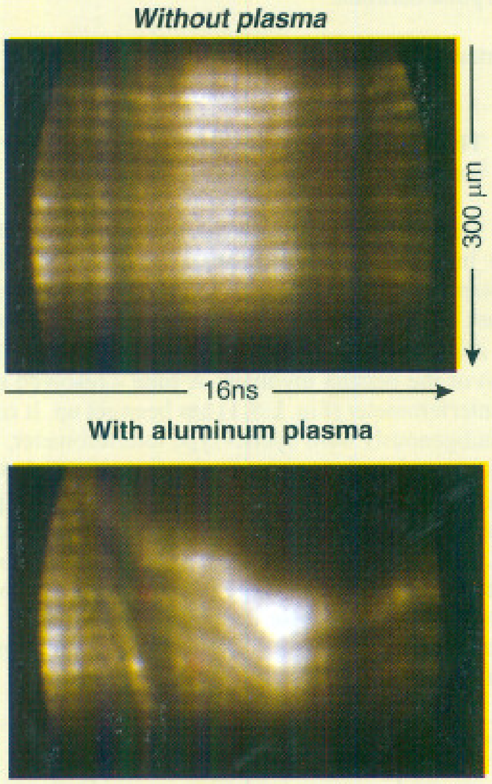

Fig. L.8.2 Interference fringe pattern

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L.9 ZnO quantum dots grown by pulsed laser deposition

ZnO is a versatile wide band-gap semiconductor having intrinsically high n-type conductivity. Its bulk band-gap is about 3.3eV at room temperature and therefore it is transparent in the visible region. Because of this interesting blend of properties it finds applications as transparent conducting electrodes for solar cells, surface acoustic wave devices, UV screens, gas sensors etc. ZnO is particularly attractive for applications in nuclear environments because it is radiation hard.

To develop the next generation ZnO based devices where size and band-gap engineering are prerequisites, it is advantageous to grow the quantum dots of this compound. We have grown, to the best of our knowledge for the first time, a multilayer structure of ZnO quantum dots capped by the separator layers of alumina using an in-house developed methodology of Pulsed Laser Deposition. Using optical absorption spectroscopy, the band edge of the quantum dots ensemble was found to shift from about 3.35 to 4.5eV when the mean in-plane size was decreased from about 3.6 to 1.8nm. The mean dot size and the size distribution were measured using Transmission Electron Microscope. The chemical composition of the dots was confirmed by selective area electron diffraction pattern. This opens up the possibility of developing ZnO quantum dot devices such as oxygen sensors, laser diodes etc.

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L.10 Development of IGBT based pulse power supply for copper vapor laser

Insulated gate bipolar transistor (IGBT) based pulse power supply for 30W average power copper vapor laser has been developed. This power supply will replace conventional thyratron based power supply. In conventional thyratron based power supply, hydrogen thyratron is used as the high voltage, high power and fast switch. The hydrogen thyratron has typical life of 1200 hours, after which the thyratron has to be replaced. The thyratron is imported and costly component and is subjected to export restrictions from the country of origin. The IGBT based power supply uses industry standard IGBTs (EUPEC BSM400GA120 DN2) rated for 1200V, 400A and magnetic pulse compressors. A step up pulse transformer is used to change the voltage level from 1kV to 22kV. The IGBTs have much longer MTBF as compared to the thyratron and thus operating expenses of the copper vapor laser system due to switch will reduce substantially (see Table L.10.2). The IGBT based power supplies have given the same laser output power from the corresponding laser head as that of the conventional power supplies.

Table L.10.1. Comparison of conventional and IGBT based power supply.

Sr. No	Pulse Power supply circuit	Main Switch cost Rs.	Estimated Switch life time	Estimated running cost due to switch
1	Thyratron based	2,50,000	1200hrs	Rs 208 per hour
2	IGBT based	30,000	250000hrs	Rs. 0.12 per hour

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