Temporal and spatial cleaning of KrF laser pulses

István B FÖLDES[1], Barnabás GILICZE[2], Zsolt KOVÁCS[1], Rita DAJKA[2]
and Sándor SZATMÁRI[2]
1) Wigner Research Centre for Physics of the HAS, Hungary
E-mail: foldes.istvan@wigner.mta.hu
2) University of Szeged, Hungary

Two methods are presented for the improvement of the contrast of ultrashort laser pulses even in the ultraviolet. The pedestals originating from the short pulse KrF amplifiers are coming from the ASE due to the applied direct amplification. Plasma mirrors are overall applied in solid state laser systems operating in the infrared [1]. The high photon energy of the laser requires prepulses kept lower than 10^7 W/cm^2 intensity of 15 ns prepulse duration. Due to the large penetration depth of the UV radiation plasma mirrors have not been applied for KrF systems so far. Herewith up to 70% efficiency of the plasma mirror is demonstrated which was obtained by controlling the initial beam shape. Thus the 2 orders of magnitude contrast improvement allows its applicability in the ultraviolet [2]. We show alternative schemes for its integration into the laser system. It can be used either in front of the final amplifier, keeping the intensity and the contrast on the plasma target high, or in the full beam for which scheme the limited intensity on the plasma mirror target is obtained by using a random phase plate.

An alternative method is the nonlinear Fourier filtering technique. Whereas plasma mirrors are based on amplitude modulation, Fourier filtering is a phase modulation which enables simultaneous spatial contrast improvement as well [3]. A gas jet plasma is generated in the central plane of a confocal telescope surrounded by a conjugated beam-block filter pair. The phase modulation by the plasma in the Fourier plane results in directional and temporal modulation due to constructive interference. ~40% throughput is demonstrated with more than 10^3 contrast improvement. The contrast improvement can be further enhanced by using apodization of the laser beam, thus controlling the high spatial frequency components of the imaging system. The advanced arrangement demonstrated 5 orders of magnitude contrast improvement, and it opens the possibility of up to 7 orders of magnitude improvement.

Whereas the applicability of plasma mirrors are extended to the ultraviolet, the Fourier filtering technique can be widely applied for any high-power laser system due to broad applicable spectral range and the power durability of the optical arrangement.

References

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