Analytical Dependence of Time Contrast Ratio on Surface Imperfection of Optics in Femtosecond Lasers

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The power contrast ratio (PCR) always measured in experiments is the same in the near and far fields. We have obtained expressions for the PCR as a function of the power spectral density of the compressor/stretcher grating surface and transport optics for 2D diffraction, taking into account all dispersion orders. The only approximation is that the spatial scale of the surface profile is much smaller than the beam diameter. It is shown that PCR is independent of the dispersion of all orders except the first one. Allowance for diffraction leads to the violation of the parity of the PCR(t) function and to the appearance of the cutoff time below which PCR=0. For all optical elements except the second and third gratings, the cutoff time is zero, and they contribute to PCR only at t>0. This explains the fact that the measured pre-pulse is always smaller than the postpulse. Exceptions are the elements (if any) whose images are related to a plane located farther than the PCR measurement plane; they contribute to PCR only at t<0. Although the scattered radiation can overtake the main pulse, this time is insufficient for the plasma to enter the focal region of the main pulse before its arrival.