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Spectral broadening and nonlinear limitation in the amplification of partially coherent pulses in high power amplifiers

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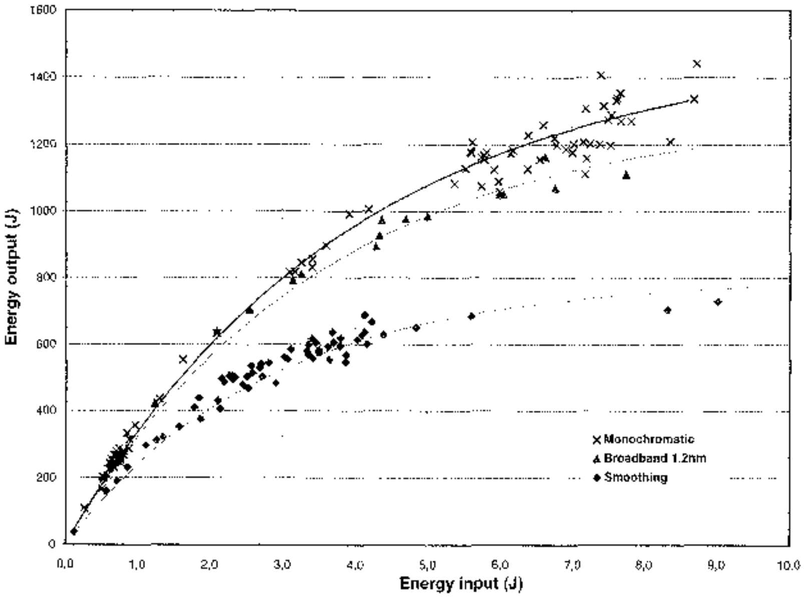
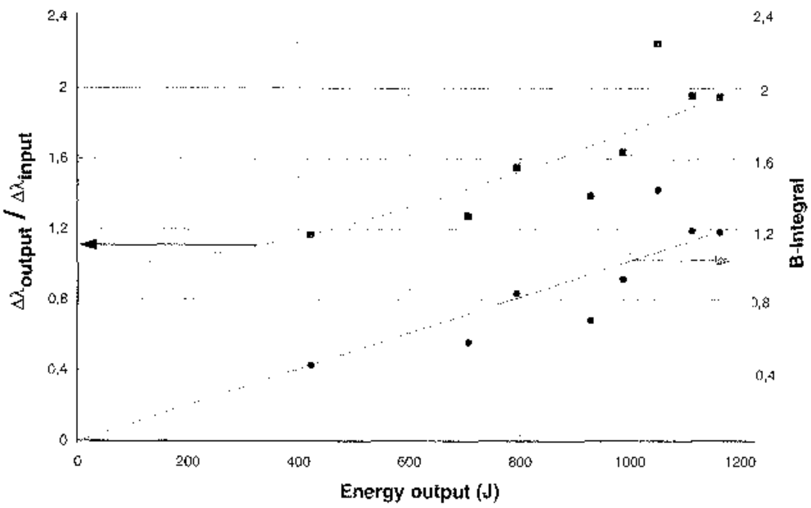
The development of the coming generation of Megajoule-class laser requires optical smoothing to obtain a focal spot with good uniformity. Optical smoothing techniques were proposed few years ago, such as smoothing by



CThJ6 Fig. 1 Experimental energy output as a function of mid-chain energy input, in the case of a monochromatic pulse (cross), a broadband pulse of bandwidth (FWHM) 1.2 nm (triangle), and a smoothed pulse (square).



CThJ6 Fig. 2 Experimental spectral broadening (square) and calculated B integral (circle) as a function of energy output with a broadband pulse of bandwidth (FWHM) 1.2 nm. The curves are a $\sqrt{1 + aE^2}$ and linear law best fits.

optical fiber (SOF),[1] smoothing by spectral dispersion (SSD),[2] and smoothing by transverse spectral dispersion (STSD).[3] SOF seems to be an efficient method concerning the limit contrast, shape, and control of the focal spot, and the smoothing of low spatial frequencies. But first experiences with SOF technique have shown a limitation in term of the amplification performance.[4]

In this paper we present recent results obtained on the backlighter beamline of the Phebus facility, which delivers up to 1.5 kJ at 1053 nm on a 19-cm diameter beam in a 1.3-ns square pulse. Figure 1 shows the output energy as a function of input energy for different configurations. The upper curve corresponds to a monochromatic pulse, the intermediate one to a spatially coherent broadband pulse ($\Delta\lambda$ = 1.2 nm), and the lower one to the incoherent pulse ($\Delta\lambda$ = 0.6 nm) obtained by the SOF technique. It shows a loss of 40% for the performance in the latter case.

We first analyze the amplification of spatially coherent monochromatic pulses versus broadband noisy pulse. Figure 2 shows the observed output amplified spectra versus input energy. The main observation is that gain broadening takes over the expected gain narrowing effect. To explain these data, we have developed a statistical model of incoherent field amplification in presence of Kerr nonlinearity.[5] If we use as a parameter the usual B integral, we find that the spectral broadening $\alpha = \Delta\lambda_{output}/\Delta\lambda_{input}$ is approximately given by $\alpha = \sqrt{1 + 2B^2}$ and is associated to a gain loss estimated to be $2\epsilon^2 B^2$, where $\epsilon = T_2/\tau_c \ll 1$, T_2 being the amplifying medium dephasing time and τ_c the broadband pulse coherence time. This corresponds in our experimental case to a decrease of 10% for the maximum input of Fig. 1 in good agreement with the experimental data.

The lower curve of Fig. 1 represents the amplification of an incoherent beam, which shows a much more important decrease of performance. These data are compared with a model that takes into account the speckled characteristics of the light. We shall discuss the implication of this model and in particular the importance of controlling the intensity contrast of the beam in the amplifier. Recent data with broader bandwidth (8 nm) will also be presented.

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1. D. Veron, H. Ayral, D. Husson, O. Martin, B. Meyer, M. Rostaing, C. Sauteret, Opt. Commun. **65** (1) (1988).
2. S. Skupsky, R. W. Short, T. Kessler, R. S. Craxton, S. Letzring, J. M. Soures, J. Appl. Phys. **66** (8) (1989).
3. LLE Review 36.
4. D. Veron, G. Thiell, C. Gouedard, Opt. Commun. **97**, 259–271 (1996).
5. "Amplification of broadband incoherent light in homogeneously broadband media in presence of Kerr nonlinearity," J. Garnier, C. Gouedard, O. Bonville, D. Boisgard, J. P. Fouque, A. Migus, submitted.