Proc. Conference Lasers and Electro-Optics (CLEO/Europe '03), Munich/Germany, paper CJ3-4-TUE

Fast saturable absorber based on the excitation and filtering of quadratic spatially trapped beams in Ti:PPLN planar waveguide at 1550 nm

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Abstract: We experimentally and numerically studied, in the picosecond regime, a fast nonlinear saturable absorber based on quadratic spatial trapped propagation in a Ti:PPLN waveguide at 1550nm combined with spatial filtering.

The principle of a saturable absorber using the combination of self trapped propagation with a filtering slit has been already carried out in a bulk KTP crystal at 1064 nm [1]. This kind of processing is particularly interesting for high bit rate optical communication links where it could achieve all-optical reshaping of distorted pulses at very high speeds. The technique has been improved here in several ways: it was adapted to the communication band (1550 nm), the trapping intensity threshold was reduced by use of an efficient nonlinear medium (58 mm long Ti:PPLN z-cut planar waveguide), and the processing speed was increased by an order of magnitude. We demonstrate here the cleaning of distorted pulses of 4 ps duration by pedestal suppression.

In the experiments we used an all fiber laser system delivering 4 ps pulses at 1547 nm. The laser beam was shaped in an elliptical gaussian spot (56µm x 3.9µm). The crystal length corresponded to 5.6 times the FF diffraction length and the temporal walk-off (between FF and SH) was 5.4 times larger than the incident pulses. Self-trapped (quasi-soliton) propagation was obtained for positive phase mismatch values only, because of a large temporal walk off compared to the pulse duration. We modified the adjustments of our laser system to get pulses with a trailing pedestal. A first experiment was performed at T=143°C ($\Delta kL \sim 15\pi$) and using a slit width close to the input beam size. In linear regime, the profile of the autocorrelation was close to the input's one and exhibited large shoulders. When the intensity was high enough to reach self trapping, the pedestal in the autocorrelation trace almost completely disappeared (figure1).

The best filtering occurred for input power slightly higher than the self trapping threshold (250MW/cm²). But for higher intensities, the autocorrelation showed the growing of the pedestal and the reshaping efficiency decreased. The filtering also depended on the aperture width (figure 2). The temporal reshaping only appeared in the part of the beam corresponding to the soliton, i.e., for a slit broader than the output soliton width the pedestal reappeared and the efficiency of the device decreased. For narrower apertures, the efficiency stayed high but the transmitted power decreased as the slit width reduced.

Numerical simulations show that the filtering mechanism can be accomplished also with more general noisy pulses, for example in the presence of additive gaussian white noise.

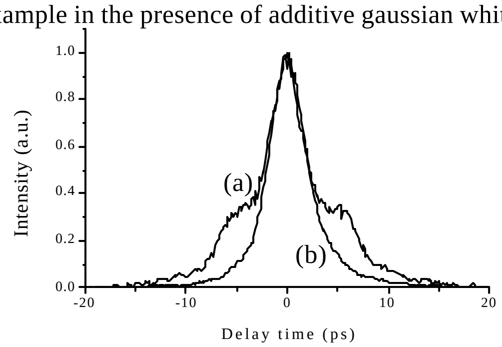

Fig.1: Autocorrelation traces before (a) and after (b) temporal reshaping.

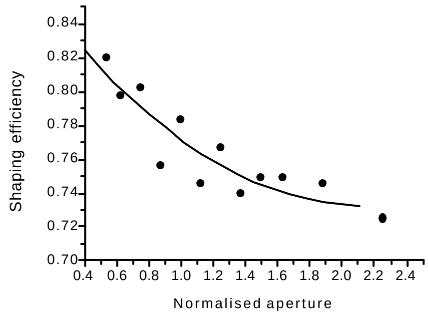

Fig.2: Filtering efficiency versus normalized aperture

Conclusion: We demonstrated that spatial self-trapped propagation in a Ti:PPLN waveguide with an adjusted slit at the output can operate as an ultra-fast temporal saturable absorber. The efficiency of the reshaping depended both on the intensity and the aperture width.

[1] C. Simos et al.; IEEE Phot. Tech. Lett., Vol 14, N°5, Mai 2002.