which can be easily analytically evaluated. The minimization can be achieved either by varying the fiber parameters or/and the launch point.

To double check the optimization we used the data obtained from Eq. (4) for a specific system and solved numerically Eq. (1). The pulse shapes at the end of each unit cell were used as initial "potential" of the Zakharov–Shabat scattering problem. The complex, discrete eigenvalue λ corresponds to the velocity and amplitude of the soliton, respectively. The deviation of $Im(\lambda)$ from $Im(\lambda) = 0.5$ is a measure of the distortion of the shape or the radiation. Without dispersion management the creation of a considerable amount of radiation can be recognized (Fig. 1).

As an example we have optimized the system in varying the launch point. We found two distances $z_0 = z_{01} =$ and $z_0 = z_{02}$ where $F(z_0) = 0$. In Fig. 2 the clear improvement of the system performance is displayed for the case when the amplifier is located after the DCF as well as before the DCF.

As reported previously the former configuration has a clear edge if no optimization is performed.[4] We mention that a similar upgrading can be achieved for a launch point $z_0 = 0$ if one varies the DCF length.

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CWF63

Low latency, ultrafast fiber loop mirror switch with 1.2 ps timing jitter tolerance

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Nonlinear optical loop mirrors (NOLMs) are well known as ultrafast all-optical switches for high-speed optical time division multiplexed (OTDM) systems. Such loop mirrors also have applications in timing jitter recovery,[1] optical logic gates,[2] and wavelength shifting for wavelength-division multiplexed (WDM) systems.[3] One drawback of NOLMs has been that they required either long fiber lengths or nonfiber nonlinear elements such as semiconductor amplifiers, resulting in either large latency or high cost and coupling losses.

In this paper we present measurements of an all-fiber NOLM of total length 8 meters based on collisions between orthogonally polarized signal and control soliton pulses in
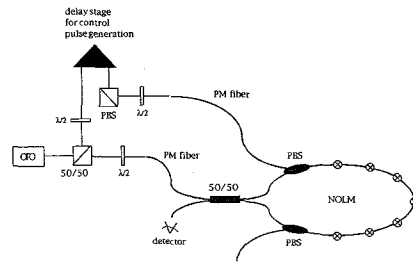
CWF63   Fig. 1   Experimental configuration of the cross-spliced orthogonally polarized soliton collision NOLM.
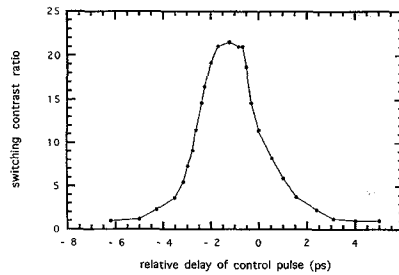
CWF63   Fig. 2   Switching contrast ratio as a function of relative delay between control and signal pulses. ON/OFF ratio is maintained for 1.2 ps delay, demonstrating tolerance to timing jitter.

highly birefringent (i.e., polarization maintaining) fiber.[4] We employ a cross-splicing technique to achieve repeated collisions between the control and signal pulses. These collisions result in an accumulation of the net nonlinear collisional phase shift.[5] The cross splice is achieved by rotating one fiber 90° with respect to the other fiber before fusion splicing.

We have extensively modeled single collisions between control pulses of first or high order solitons and first order signal solitons in polarization maintaining fiber with a birefringence $\Delta n \approx 5 \times 10^{-4}$ and dispersion parameter $D \approx 15$ ps/nm km. The results, reported elsewhere,[5] indicate that the pulse shape of the signal is virtually unaffected by the collision, and acquires a collisional phase shift, $\Delta\phi_{coll}$, approximated by

$$\Delta\Phi_{coll} \approx \frac{1.17\lambda^2|D|A^2}{\pi\Delta n\tau},$$

where A is the soliton amplitude (normalized to $N = 1$ solitons) of the control pulse, λ is the wavelength, and τ is the pulsewidth (FWHM). We have experimentally and numerically confirmed the validity of this analytic expression in the regime $A < 3.5$.[4] We have also numerically simulated eight continuous collisions between two first order orthogonally polarized solitons in a cross-spliced NOLM. We found the accumulated nonlinear phase shift is 0.6 π.

Based on our modeling, we have constructed the NOLM shown in Fig. 1. The NOLM contains seven cross splices, which provides eight collisions between the control and the clockwise-propagating component of the signal pulse. The source for both signal and control pulses is an optical parametric oscillator producing pulses with $\tau = 160$ fs at $\lambda = 1.55$ μm at a repetition rate of 80 MHz.

We have achieved an ON/OFF ratio of 22:1 with the cross-spliced NOLM. Since each collision takes place in 50 cm of fiber and can occur anywhere within the individual fiber sections, the NOLM has some tolerance to timing jitter between the control and signal pulses. In our case, each fiber section is approximately 1 m and the entire loop is only 8 m long. We demonstrate the timing jitter tolerance by scanning the relative delay of the control. Figure 2 shows the switching contrast ratio as a function of delay. The ON/OFF switching ratio of 22:1 is maintained for approximately 1.2 ps.

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Time jitter in optically amplified dispersion-compensated links

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Recently, considerable attention was attracted to the design and use of the so-called dispersion management to improve generation, compression, and transmission of pulses in optical fibers.[1-3] The objective of this work is to put forward an explanation of the jitter behavior in links with dispersion management, based on the combination of a simple analytical approach and numerical simulation. Previous works showed how the dispersion management method with zero average group velocity dispersion (GVD) was fundamental to transmit high capacity non-return-to-zero signals.[4] We show that this propagation regime permits us to improve also the performance of return-to-zero (RZ) systems since the time jitter can be deeply reduced without use of any in-line control devices.

In a linear system with zero average GVD, supposing that the average baricenter of the RZ pulse is located at the zero time position, and indicating with ΔT the time shift of the pulse, the variance of the time jitter in presence of ASE noise is given by

$$\langle\Delta T^2\rangle = \frac{\left\langle\left[\int_{-T/2}^{T/2}t\left|u(t)+n(t)\right|^2dt\right]^2\right\rangle}{P+P_{ASE}}$$
$$\approx \frac{2P_{ASE}\tau_{FWHM}}{P}, \qquad (1)$$

where $u(t)$ is the signal field, $n(t)$ the ASE contribution, T the bit time, τ_{FWHM} the FWHM time duration of the pulse, P the pulse average power, and P_{ASE} is the ASE power that in opti-