the visible and near-IR fiber communications bands. Further improvements are required in packaging to implement a compact, robust unit. Wavelength capacity for such a switch is AOTF device design limited, and 32-wavelength processing is achieveable.

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Optical Means of Generating Time-aligned Picosecond Data Pulses[2] and Producing Enhanced Pulse Compression[3] on WDM Beams in a Nonlinear Fiber

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In spite of the intrinsically small value of the nonlinearity coefficient in fused silica, due to low loss and long interaction length, the nonlinear effects in optical fibers made with fused silica cannot be ignored even at relatively low power levels. This nonlinear phenomenon[1] in fibers has been used successfully to generate optical solitons, compress optical pulses, transfer energy from a pump wave to a Stokes wave through the Raman gain effect, transfer energy from a pump wave to a counter-propagating Stokes wave through the Brillouin gain effect, produce four-wave mixing, and dynamically shepherd pulses. We have found a fundamentally new way to optically generate time-aligned picosecond data pulses on WDM beams in a single-mode fiber[2] and a new method to enhance or generate pulse compression of co-propagating pulses on different WDM beams in a single fiber.[3]

Time-aligned picosecond optical pulses are the backbone for the future ultra-high-speed bit-parallel WDM fiber communication system. A high-power, picosecond pulse, called the shepherd pulse, is launched on a given beam. A number of low-power beams selected based on the WDM format are launched without any signal pulses into a single-mode nonlinear fiber. These beams copropagate with the beam carrying the shepherd pulse in this fiber. Time-aligned pulses will appear on these low-power WDM beams. The nonlinear cross phase modulation (CPM) effect in a single-mode fiber is instrumental in the generation of these time-aligned pulses. Using external modulators, these time-aligned pulses on WDM beams can be used directly as sources for the bit-parallel WDM communication system.[4]

A way to optically compress pulses on WDM beams has also been found. The usual soliton-effect compressor,[1] which makes use of higher-order (or higher amplitude) solitons supported by fiber as a result of interplay between self-phase modulation and anomalous group-velocity dispersion (GVD), is well known. One notes here that the interplay between CPM and GVD may also provide similar pulse compression effect. The significant difference is that pulse compression can take place for pulses on a different wavelength beam. The high-power pulse on one wavelength beam may be used to provide high compression to a low-power pulse on another wavelength beam.[3] One shepherd pulse can cause the compression of all the other wavelength pulses, thereby improving their pulse widths as well as the separation of different pulses. Furthermore, since the longer wavelength pulses are compressed at a rate different from the shorter wavelength pulses, one can conceivably make all pulses have the same time width, which may make detection and discrimination easier to accomplish.

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DIFFRACTIVE OPTICS

Wavelength Compensation of Broadband Light Diffraction

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Propagation of electromagnetic waves in free space is a physical phenomenon that explicitly depends on the wavelength of the light radiation. This fact results in the chromatic dispersion of the optical field diffracted by an aperture illuminated with a broadband source. The above situation severely restricts the spectral bandwidth of the illumating source that can be used in a diffraction-based optical system. If our interest is that all the spectral components produce the same effect, broadband-dipersion compensation is then required. The milestone of the compensation procedure lies in achieving the incoherent superposition of the monochromatic versions of a selected diffraction pattern in a single plane, with the same scale for all the wavelengths of the incident light. Achromatic diffraction systems meet the above requirement in a first-order approximation.

The chromatic compensation procedure we developed takes advantage of the chromatic aberrations associated with diffractive lenses. In particular, we demonstrated the achromatic Fourier-transforming capability of an air-separated diffractive lens doublet.[1] Figure 1a (page 20) shows this easy-to-implement optical setup. DL_1 and DL_2 are diffractive lenses and the input transparency is illuminated with a broadband spherical wavefront beam converging toward the point source S, placed at the optical center of DL_2. The achromatic