# FIBRES, PHOTONS AND FEMTOSECONDS

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The development of erbium-doped optical fibre amplifiers with gain in excess of 40dB and a bandwidth exceeding 40nm has revolutionised optical communications systems planning. When combined with the wide range of fibre components now available (couplers, isolators, filters, modulators, gratings), this simple component can also form the basis of complex, functional, all-fibre circuits which are robust, stable and potentially inexpensive. Of particular interest is the relative ease with which femtosecond pulses at a wavelength of 1.55$\mu$m can be generated using nothing more than a handful of fibre components spliced together to form one of many possible integrated laser-resonator configurations.

The power of the fibre environment for short-pulse generation lies in its tight mode confinement which, together with the long interaction lengths, leads to numerous non-linear effects at average powers of only a few mW, eg self-phase-modulation, cross-phase-modulation and Raman self-scattering. These effects can readily be used for passive mode-locking, pulse switching, shaping and compression. Most significant however is the natural tendency of the fibre to sustain transform-limited soliton pulses. The fibre prefers pulses (solitons) which propagate stably without broadening owing to an artful balance between non-linear and dispersive effects. For this reason, future ultra-high bit-rate telecommunications systems are likely to use soliton pulses to overcome dispersion problems.

We review here short-pulse generation in fibre circuits, considering the applications, characteristics and potential of each device. Both passively and actively mode-locked fibre lasers are discussed, together with soliton switching, amplification and compression. We conclude with a discussion of a new all-fibre-based technique for the generation of ultra-high repetition rate ($>$50GHz) soliton pulse streams.