Generation and characterization of erbium-Raman noise-like pulses from a figure-eight fibre laser

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Abstract

We report an experimental study of the noise-like pulses generated by a ~300m long passively mode-locked erbium-doped figure-eight fibre laser. Non-self-starting mode locking yields the formation of ns scale bunches of sub-ps pulses. Depending on birefringence adjustments, noise-like pulses with a variety of temporal profiles and optical spectra are obtained. In particular, for some adjustments the Raman-enhanced spectrum reaches a 10 dB bandwidth of ~130 nm. For the first time to our knowledge, we extract information on the inner structure of the noise-like pulses, using a birefringent Sagnac interferometer as a spectral filter and a nonlinear optical loop mirror as an intensity filter. In particular we show that the different spectral components of the bunch are homogeneously distributed within the temporal envelope of the bunch, whereas the amplitude and/or the density of the sub-pulses present substantial variations along the envelope. In some cases, the analysis reveals the existence of an intermediate level of organization in the structure of the noise-like pulse, between the ns bunch and the sub-ps inner pulses, suggesting that these objects may be even more complex than previously recognized.