Design, characterization and application of an erbium-doped fiber laser for the study of cancer cells

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This project is a continuation of the work "*Design, characterization and application of an erbium-doped fiber laser for the study of cancer cells"* started last year by A. Cabedo, C. Pericas, S. Sempere and A. Silva-Santisteban. The already working laser has been tuned up in order to enhance its performance. Its characteristic behaviour has been studied both by developing a numerical model and through experimental measures in the lab. In addition, a MATLAB software has been developed so the generated pulses can be easily controlled.

EDFA Laser Model

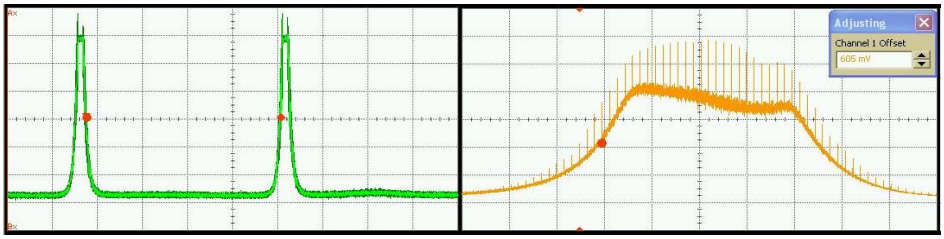
The main objective of this part of our project is to model the behavior of an EDFA laser and implement a Matlab program to see the theoretical results and compare them with the experimental ones. To do so, we have solved our model equations for different inputs.

$$\frac{dN(t)}{dt} = Wp \cdot \left(N_T - N(t)\right) - \frac{N(t)}{tc} - B \cdot S(t) \cdot N(t)$$

$$\frac{dS(t)}{dt} = \left[\frac{Va \cdot B \cdot N(t)}{1 + eps \cdot S(t)} - \frac{1}{tp}\right] \cdot S(t)$$

Gain-switched Laser

The gain switched pulses take advantage of the transient response of the laser; the result is a pulse with around five times more power than that of the continuous mode witha duration of 4 μs and a frequency of 11 kHz.Once the filter is added, the output spectrum is 1nm wide and, although we still can generate the pulses they have lost their well-defined shape,moreover some secondary pulses with 200ps duration appear.



4μs Gain-switched pulses of 11.1kHz (without filter) Gain-switched pulse with filter with 200ps overlapping pulses

Q-switch Laser

The Q-switching technique leads to higher pulse energies, longer pulse durations and much lower pulse repetition rates. In our case, Q-switching has been performed by adding a saturable absorber into the laser's loop.The pulse duration of the laser is in the ns range and we achieved a repetition rate of 8.5MHz. By adding the tunable filter, we obtain μs pulses and the 8.5MHZ rate is reduced to 5MHz.