Semester S1 -COHERENT PHOTONICS

PROPAGATION IN OPTICAL WAVEGUIDE

TUTORIAL #1

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Exercise I

We use an optical fiber whose the chromatic dispersion coefficient D_1 is given by the supplier to be equal to 250 ps nm^{-1} km^{-1} with a 4% uncertainty.
In order to control this value, we send in a L_1=20 km long fiber some wavelength tunable optical pulses and we measure the group time T_{gi} for few wavelengths λ_i . Results are presented in the following table.

λ_i(nm)	**1496**	**1498**	**1500**	**1502**	**1504**
T_{gi}(ns)	**95980.4**	**95990.2**	**96000.0**	**96009.8**	**96019.6**
Vg(m.s^{-1})					

1. Calculate the group velocities $v_g(\lambda)$ for each wavelength λ_i.

2. Calculate the real value of D_1. Compare with the expected value.

3. We need to compensate totally the chromatic dispersion of this link with a L_2=1 km long fiber. What must be its dispersion coefficient D_2 value?

Exercise II

A laser emits non-chirped Gaussian-like light pulses with full width at half-maximum of the intensity $\Delta T_{FWHMI}(z=0)$ is equal to 50 ps. Their central wavelength is λ_0=1550 nm. These light pulses propagate in an optical fiber whose the dispersion coefficient D is 17 ps nm^{-1} km^{-1}.

1. Find the relation between $\Delta T_{FWHMI}(z=0)$ and the corresponding T_0 pulsewidth parameter of the complex modulation envelop a(z=0,t).

$$a(0,t) = A_0 e^{-(1-jC_0)\frac{t^2}{2T_0^2}}$$

2. Calculate the FWHMI pulsewidth after propagation in 5, 10 , 20, 50 and 100 km of fiber.

3. Compare those results with the results that we could have with the relation $\Delta T = L.D.\Delta\lambda$.

Exercise III

An optical short pulse emitted at the central wavelength λ_0=1500 nm is defined by its gaussian-like complex modulation envelop :

$$a(0,t) = A_0 e^{-(1-jC_0)\frac{t^2}{2T_0^2}}$$

at the position z=0

and presents a linear frequency drift

$$\partial\nu/\partial t = 4{,}5\ 10^{21}\ \text{Hz/s}.$$

1. For the case T_0 = 10 ps, calculate the chirp parameter value C_0 at z=0.

2. What is the maximal compression ratio T_0/T_m we may reach for this pulse during the propagation in an optical fiber.

3. What should be the length L_m of an optical fiber with a chromatic dispersion coefficient D = 25 ps/nm/km to achieve this compression ratio?

4. What fiber length ℓ must we use to get a compression ratio equal to 2? Calculate the length ℓ -L_m.

5. Plot the pulsewidth as a function of the propagation length z.

6. What is the pulsewidth T_1 after a propagation along a distance L = 2 L_m ? What is the difference between the input pulse and the output one?