4 SIMULATIONS OF RAYLEIGH SCATTERING AND COHERENT RAYLEIGH NOISE

4.1 INTRODUCTION

This chapter presents the synthesis of modeling and simulation results of the Rayleigh scattering mechanism in optical fibers. In addition, the influence of Coherent Rayleigh Noise (CRN) on backscattered signal is thoroughly analyzed for various system operating conditions.

4.2 MATLAB SIMULATIONS

In MATLAB, the codes for calculating the Rayleigh power along an optical fiber can be written as follow:

```
zmax = 12e3; % km – maximum length
N1 = 200;
zstep = zmax/(N1-1);
z1 = 0:zstep:zmax;
for k1 = 1:N1
   Pr1(k1) = rayleigh(z1(k1));
end
```

where the Rayleigh equation is represented by the following codes:

```
function Pr = rayleigh(z)
Gamma = 4.6e-5; % /m - Rayleigh scattering coefficient
r0 = 1e-3; % Watts - Initial backscattered Rayleigh power
Pr = Pr0*exp(-2*Gamma*z);
end
```

In the simulations, the value of γ_R (Gamma) is taken as 4.6 x 10-5 m-1. The generated graph of Rayleigh power as a function of distance along an optical fiber is shown in Figure 4.1(a). The simulation result is also compared the published measurement in [M.N. Alahbabi (2004)], as shown in Figure 4.1(b). The two graphs match perfectly, thus indicating that the developed MATLAB simulation codes are absolutely correct.

The influence of CRN can be incorporated into the MATLAB simulation by adding the following codes, which is based on equation. Firstly, the root-mean-square (*rms*) value of the percentage CRN is calculated using equation (2.17), and is subsequently multiplied with the MATLAB code `randn` which randomly generates numbers with mean zero, variance one and standard deviation one to imitate CRN.

```
vg = 2e8; % m/s - group velocity
dv = 0.3e9; % Hz - signal linewidth
dz = 40; % m - spatial resolution
randn('state',0);
fCRN = sqrt(vg/(4*dv*dz)); % percentage CRN
CRN = Pr1.*fCRN.*randn(size(Pr1)); % absolute CRN
Pr2 = Pr1 + CRN;
```