

# Experimental Investigation of Coherent and Incoherent Interferometric Noise in 2-D Optical CDMA Networks

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In Optical Code Division Multiple Access (OCDMA) networks, many optical signals can be sent on one fiber, giving the system the potential to accommodate many users. The OCDMA system used was a 2D wavelength-hopping time-spreading approach that divides both the frequency and time spectrums into slots in order to give users unique codes. When the cross-correlation from one or more interferers falls under the auto-correlation peak of the user, beating occurs since the wavelengths of the peaks are the same or near each other on the electromagnetic spectrum, causing interferometric noise. We investigated the extent to which various types of beat noise degrade a signal of interest and found that interferometric noise severely degrades a signal and cannot be neglected. We set up a two-user system with a single optical source consisting of four distributed feedback lasers (DFB). Cases of coherent, partially coherent, and incoherent interferometric noise were all considered. The data signal is split to become the two users and travels through two fiber Bragg grating (FBG) encoders. The signal simulating first user is sent to decoder 1, which has the complementary delays as encoder 1. The signal simulating the interferer (user 2) passes through a delay line and a polarization controller before going to decoder 1. These allow us to align the auto-correlation and cross-correlation peaks in order to simulate beat noise for the worst-case scenario. The two users travel the same distance in the coherent case. We added a 20-m fiber to user 1 for the partially incoherent case and a 1986-m fiber for the incoherent case. Figure 1(a) below shows the auto-correlation peak of user 1 without the interferometric noise, only other types of noise such as multiple access interference (MAI), thermal, and shot noise are present. Compared with figure 1(b-d), which show the signal with interferometric noise, figure 1(a) does not have very much noise suggesting that interferometric noise is a significant part of the noise and cannot be ignored when using OCDMA systems. In Figure 2 we see that the coherent and partially incoherent cases have the same error floor, here  $5 \times 10^{-5}$ , and the incoherent case also has an error floor at  $7 \times 10^{-6}$ . These two figures demonstrate the prevalence of coherent, partially coherent, and incoherent beat noise in a two-user OCDMA network.

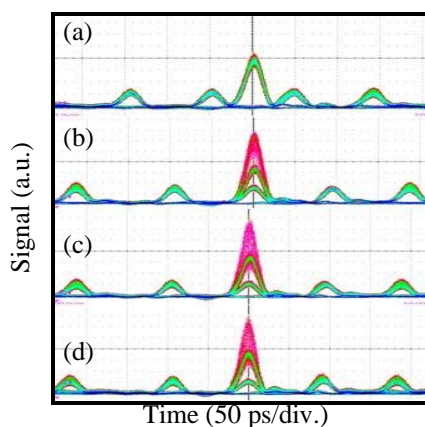


Figure 1

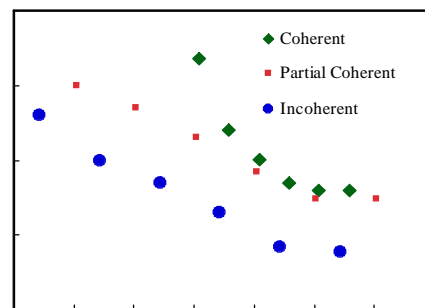


Figure 2

**Fig. 1.** a) Decoded signal with auto-correlation and cross-correlation peaks. b) Signal with coherent interferometric noise. c) Signal with partial coherent interferometric noise. d) Signal with incoherent interferometric noise. **Fig. 2.** Bit Error Rate (BER) measurements of different types of interferometric noise when the main data user and the interfering user have the same optical intensity.