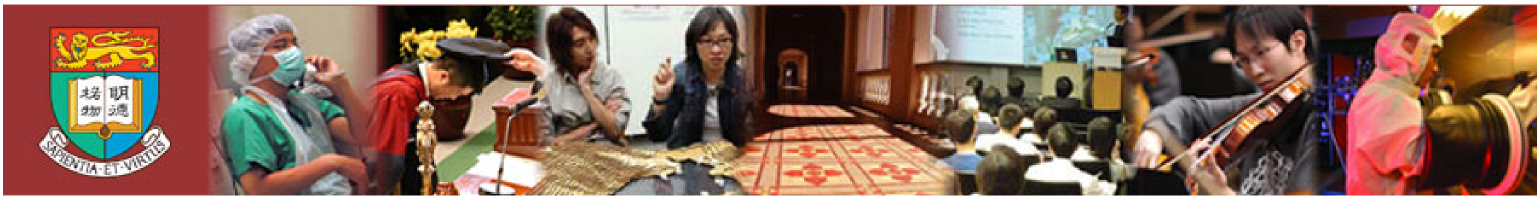

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A Comprehensive Experimental Investigation on Wavelength Exchange Type II

Xing Xu, Xie Wang, T. I. Yuk, and Kenneth K. Y. Wong*
Photonics System Research Lab, Department of Electrical and Electronic Engineering
The University of Hong Kong, Pokfulam Road, Hong Kong S.A.R. China
*Email: kywong@eee.hku.hk

Abstract
Wavelength exchange type II has been comprehensively investigated through experiment, nearly-symmetric power transfer (~90% conversion efficiency) is reached between two signal probes when using two orthogonally-polarized pumps.

1. Introduction

Wavelength exchange (WE), based on four-wave mixing (FWM) in highly-nonlinear dispersion-shifted fibers (HNL-DSF), has been extensively studied in recent research [1]–[6]. During the WE process [1], simultaneous conversion of two signals can be achieved [2], wherein two pumps (ω_1 and ω_2) are symmetric of the signal and idler (ω_s and ω_i) with respect to the zero-dispersion frequency ω_0: $\omega_1 + \omega_i = \omega_2 + \omega_s = 2\omega_0$. In face of the rapid growing demand for communication network bandwidth, high-speed signal switching techniques become more and more important. While WE in the HNL-DSF, with its characteristics of signal modulation format transparency [3] and ultrafast response, can easily find applications in wavelength conversion, data exchange [3], [4] and signal de-multiplexing [5]. Comparing to other WE schemes [6], WE type II (WE$_{II}$), with both pump in the anomalous-dispersion region of the HNL-DSF, can effectively avoid the pump-induced Raman effect on the signals. Hence nearly-complete signal conversion can be achieved. While here in this paper, we demonstrate the comprehensive experimental investigation for WE$_{II}$ with nearly symmetric conversion between two signal probes (~ 90% conversion efficiency).

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2. Experimental Setup

As shown in Fig. 1, two tunable laser sources (TLS1, 2), at 1549 and 1554 nm, were serving as pumps. After phase-modulated (PM) by 10 Gb/s 2^{23}-1 pseudorandom bit sequence (PRBS) to suppress stimulated Brillouin scattering (SBS), two stages of erbium-doped fiber amplifiers (EDFA) was adopted. Divided by wavelength division multiplexing coupler (WDMC1), pumps were filtered out separately by tunable bandpass filters (TBPF) to reduce the amplified spontaneous emission (ASE) noise from EDFA1. Two polarization controllers (PC3 and 4) were used to control the state of polarization (SOP) of the pumps such that orthogonal pump configuration can be achieved by minimizing the power of the spurious FWM components. On the signal branch, TLS3 and 4, at 1534 and 1529 nm, were separately intensity modulated by 10 Gb/s 2^{31}-1 PRBS through Mach-Zehnder modulator (MZM). PC1 and 2 together with PC5 and 6 were adjusted to minimize the insertion losses through the PM and the MZM, respectively. After combination, pumps and signals were launched into the HNL-DSF (zero dispersion wavelength (ZDW) λ_0: 1541 nm, dispersion slope: 0.03 ps/nm^{2}km and γ = 12 W^{-1}km^{-1}).

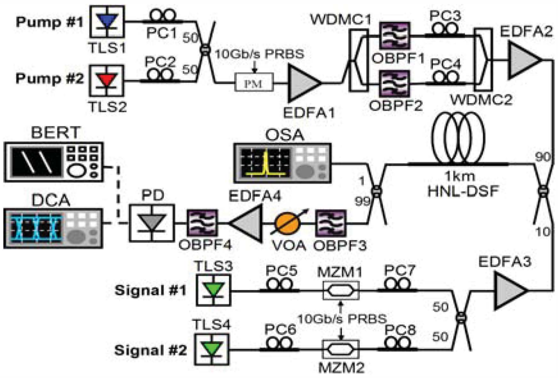

Fig. 1. Experimental setup for WE$_{II}$.

3. Results and Discussion

During the first part of our experiment, only one signal was turned on: (1) Signal @ 1534 nm; or (2) Signal @ 1529 nm. The generated idler was located at 1529 nm (for 1534 nm signal) and 1534 nm (for 1529 nm signal), respectively. Eye-diagrams for the idlers and original signals are shown in Fig. 2. While the corresponding BER curves are also shown in Fig. 2, with ≤ 1.53-dB power penalty.

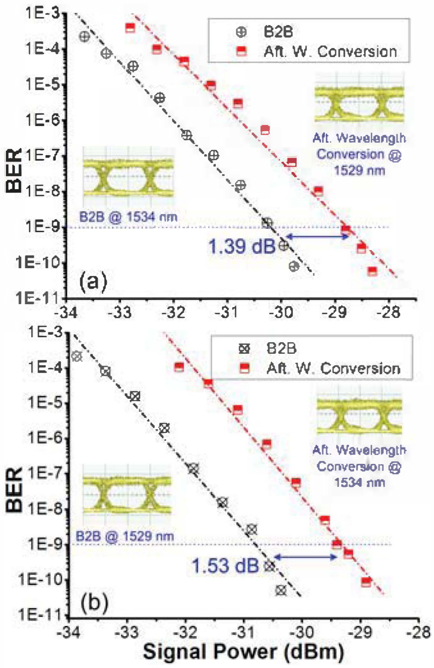

Fig. 2. BER plots with eye-diagrams.

Different from the previous part, both signals at 1534 and 1529 nm were turned on such that they experience exchanging process. The insets of Fig. 3 represent the signal eye-diagrams before and after WE*II* at 1534 and 1529 nm, which illustrate successful WE*II* process, with the BER curves shown in Fig. 3. In order to quantitatively evaluate the power transfer efficiency, the output powers for signal and idler were measured with the increment of total pump powers. The corresponding results are shown in Fig. 4, which demonstrates that nearly symmetric power transfer characteristics can be obtained during WE*II* (~ 90% conversion efficiency). The remain asymmetry in Fig. 4 is mainly due to the ZDW fluctuation along the HNL-DSF, which could be further improved by polarization-diversity scheme [6].

4. Conclusions

We have demonstrated a comprehensive experimental study on WE*II*. Less than 2-dB power penalty was achieved for both the wavelength conversion and the wavelength exchange process. Nearly symmetrical power transfer characteristic was successfully obtained with ~90% conversion efficiency.

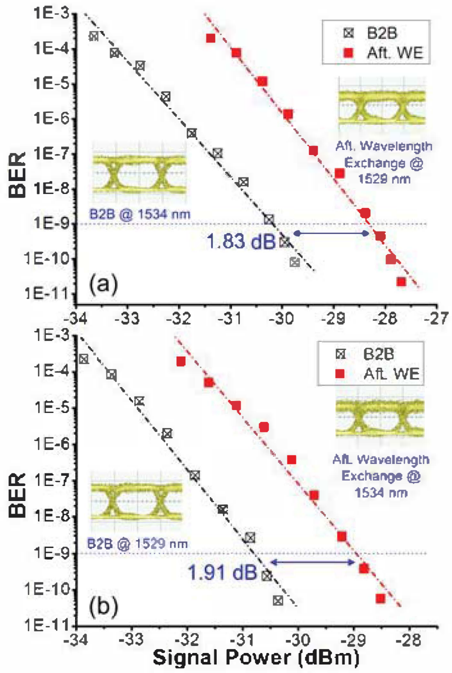

Fig. 3. BER plots with eye-diagrams.

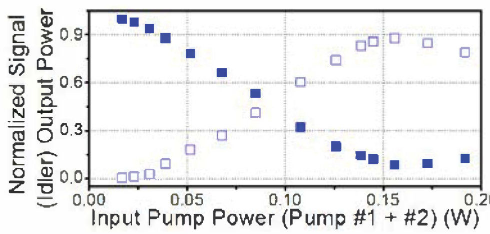

Fig. 4. WE power transfer characteristics.

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