【Grant-in-Aid for Young Scientists(S)】
Science and Engineering (Engineering I )

# Title of Project : Generation of Ultrahigh-speed Optical Parabolic Pulses and Their Applications to Optical Transmission and Signal Processing

Toshihiko Hirooka
(Tohoku University, Research Institute of Electrical Communciation, Asociate Professor)

Research Area : Communications and Network Engineering

Keyword : Transmission systems (wireless, wired, satellite, optical, mobile), signal processing

## 【Purpose and Background of the Research】

In order to meet an increasing demand for high-capacity optical network due to the rapid increase of data traffic, ultrahigh-speed OTDM (optical time-division multiplexed) transmission using ultrashort optical pulses and ultrafast all-optical signal processing technologies have been intensively studied. This research is aimed to demonstrate ultrahigh-speed optical pulse generation having a parabolic waveform and develop a novel transmission and signal processing technologies. Parabolic pulses are attractive as a control optical pulse in the optical signal processing, as it enables us to apply a parabolic phase modulation, i.e., an ideal linear chirp to a signal pulse. This allows us significant performance improvement of the optical signal processing such as optical Fourier transformation and pulse compression.

## 【Research Methods】

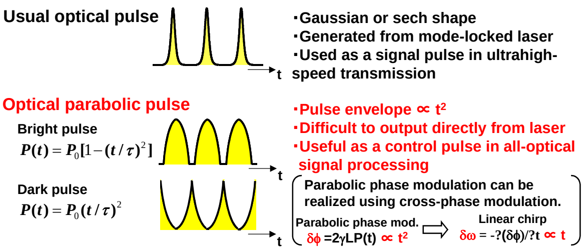


Figure 1 Features of optical parabolic pulse.

Features of optical parabolic pulses are summarized in Fig. 1. Unlike usual optical pulses such as Gaussian or sech pulses, it is difficult to obtain such a pulse directly from a laser output. Therefore, we first develop a technology to convert the Gaussian or sech pulse to a parabolic shape. Specifically, the pulse is shaped in the frequency domain using an optical filter, and precise control of the pulse shape is carried out by carefully tuning the amplitude and phase of each longitudinal mode by using an arrayed waveguide grating. Using the generated parabolic pulse as a control pulse, we realize an all-optical parabolic phase modulation (linear chirp) using cross-phase modulation. We then apply this technique to an ideal all-optical Fourier transformation and demonstrate 160 Gbit/s distortion-free transmission. Furthermore, we develop a wide range of applications of the parabolic pulse as shown in Fig. 2, in which the ideal linear chirp plays an important role.

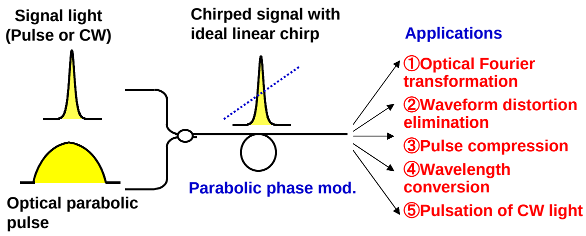


Figure 2 Applications of optical parabolic pulses to all-optical signal processing.

## 【Expected Research Achievements and Scientific Significance】

The main subject of this research is to realize an ideal completely linear chirp using a ultrahigh-speed parabolic pulse. This indicates that it becomes possible to convert time and frequency in a 1:1 correspondence. This opens up new possibilities in the all-optical signal processing as described above, which are expected to make significant contributions in future high-capacity optical networks.

## 【Publications Relevant to the Project】


- T. Hirooka and M. Nakazawa, “Optical adaptive equalization of high-speed signals using time-domain optical Fourier transformation,” J. Lightwave Technol., vol. 24, pp. 2530-2540 (2006).
- T. Hirooka, M. Nakazawa, and K. Okamoto, “Bright and dark 40 GHz parabolic pulse generation using a picosecond optical pulse train and an arrayed waveguide grating ,” Opt. Lett., vol. 33, pp. 1102-1104 (2008).


【Term of Project】 FY2009-2013

【Budget Allocation】 76,900 Thousand Yen

【Homepage Address and Other Contact Information】

http://www.nakazawa.riec.tohoku.ac.jp