

## **Spectral dynamics in build-up femtosecond pulse with time stretch spectroscopy**

Masayuki Suzuki, Associate professor (Ph.D.)  
Faculty of Science and Engineering, Doshisha University  
1-3 Tatara Miyakodani, Kyotanabe-shi, Kyoto 610-0394 Japan  
e-mail: masuzuki@mail.doshisha.ac.jp,

### Abstract:

Mode-locked fiber lasers can produce a broadband spectrum and ultrashort pulse with compact size, environmentally stable operation and alignment-free. The mechanism of mode-locked femtosecond laser is theoretically well-established, an experimental observation of a spectral dynamics between cw and mode-locked operations, however, still remain because a conventional spectrometer cannot directly measure the single-shot spectrum in real time. Thanks to the single-shot spectrum measurement of a photonic time stretch spectroscopy [1], the single-shot spectrum is enabling to observe in real time. In our recent studies, we have successfully measured the 7220 consecutive single-shot spectra over a 100 $\mu$ s time window in real-time with time stretch dispersive Fourier transform (TS-DFT). As a novel result, we demonstrate the first observation of periodic spectrum changing via soliton explosion in a homemade passively mode-locked Yb fiber laser by a nonlinear polarization evolution [2]. By optimizing the intracavity condition in fiber laser, the periodic spectrum changing could be controlled between two stable mode-locked condition. In contrast, to directly observe the birth of femtosecond pulse in the cavity, we have measured the spectral dynamics from cw to mode-locked in a homemade Yb fiber laser with saturable absorber mirror by using TS-DFT. As an initial result, a dissipative soliton motion has experimentally observed before onsetting stable mode-locked state. In this seminar, we present on our recent result of spectral dynamics in mode-locked fiber lasers, and our research plan of an ultrafast spectroscopy with TS-DFT.

[1] A. Mahjoubfar, D. V. Churkin, S. Barland, N. Broderick, S. K. Turitsyn, B. Jalali, *Nat. Photon.* 11(6) 341-351 (2017).

[2] M. Suzuki, O. Boyraz, H. Asghari, P. Trinh, H. Kuroda, and B. Jalali, "Spectral periodicity in soliton explosions on a broadband mode-locked Yb fiber laser using time-stretch spectroscopy," *Opt. Lett.* 43(8), 1862-1865 (2018).

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