Pulse spectrum simulation using optical heterodyne interferometry

Miki Nishimura[1], Takuya D. Kawahara[1], K. Tsuno[2], M. Ejiri[3], T. Ogawa[2], S. Wada[2] and S. Nozawa[4]

[1]*Faculty of Engineering, Shinshu University*
[2]*RIKEN Center for Advanced Photonics*
[3]*National Institute of Polar Research, Japan*
[4]*ISEE, Nagoya University*

We have been continuing wintertime wind/temperature lidar observations of the MLT region (upper mesosphere and lower thermosphere) since October 2012 at Tromsø (69.6N, 19.2E), Norway [Nozawa *et al*., 2014]. With the highly advanced lidar technique, wind velocity in the range of 80-115 km can be measured by detecting the frequency difference between the laser and the returned photon frequency in an accuracy of ~1 MHz [Kawahara *et al*., 2017]. The observed nightly-averaged vertical wind velocities seem large systematic wind bias of ~12 m/s, although it is expected be 0 m/s. One possible reason we haven't consider is the asymmetry of the pulsed laser spectrum. The asymmetry may lead the false wind velocities even though the peak frequency is targeted one. On the basis of this background, measuring pulsed laser spectrum is a key technique to confirm it. However, there is no spectrometer to measure such an ultra-narrow bandwidth of 0.01 picometer. An optical heterodyne method is one of the possible measurements for the pulse laser spectrum measurements. In the first stage, simulations of the spectrum measurement are carried out (Figure 1). The assumption is that we measure 589 nm broadened pulse using narrowband continuous 589 nm laser as a reference which is separated by 315 MHz from the pulse peak. The pulse spectrum is replaced by a set of five narrow-band single spectra, and the beat signals are calculated by the combination of all lines including the reference laser. Then by an FFT method, we obtained spectral feature of the pulse laser. This result simulates the spectral analysis of the beat measurements using the pulsed and the reference laser.

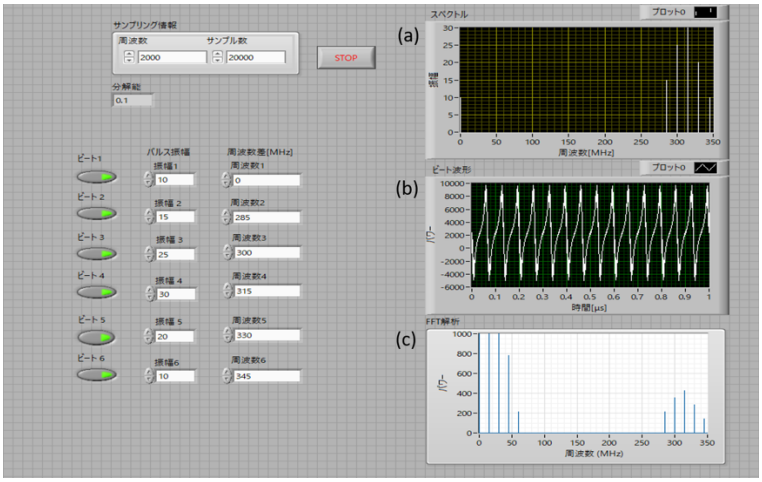

Figure 1. Simulation of the pulse laser spectrum measurement. (a) initial laser lines, (b) beat signal of all the lines, (c) results of FFT analysis.

References

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