

Development of a self-build FPGA-based data acquisition system for the Tromsø sodium lidar and its test observation

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The sodium (Na) resonance scattering lidar is a laser sensing system to detect Na that is mainly distributed in the upper mesosphere and lower thermosphere at altitudes of 80-110 km. The Tromsø Na lidar, one of the cutting-edge Na lidar systems, has the capability of five-directional observation with a highly stable and high repetition laser diode (LD)-based laser system. Since the laser repetition frequency is 1 kHz, which corresponds to 1 ms of the inter-pulse period (IPP), the height coverage of the lidar observation is 0-150 km. Thus, the Tromsø Na lidar system designed for Na distributing at 80-110 km. On the other hand, after the development of the Tromsø Na lidar, the recent observation from the other Na lidar revealed low-density Na event at upper altitudes (above 110 km, up to 170 km). Such Na events can provide good opportunities to expand the observation height range to the thermosphere, but the current Tromsø lidar system is insufficient to observe such Na events because of the limitation in the height coverage of 0-150 km.

To improve the height coverage of the Tromsø Na lidar, in the present study, we propose a time-delay five-directional laser pulse transmission method. In the current system, five pulses are split by power from the 1-kHz laser pulse, and those pulses are transmitted to each direction at the same time. In the proposed method, the 1-kHz laser pulse are transmitted to five directions with time delays. As the result, the height coverage can be 0-750 km because the laser repetition rate for a single direction can be down to 200 Hz (5 ms of the IPP). Furthermore, the laser pulse is not split by power, and thus signal-to-noise ratio (SNR) can be also improved. This improvement of SNR would be helpful for observations of such low-density Na events at upper altitudes. To realize this proposed method, a high-speed data acquisition system including a function of precise time-delay control is needed, and thus we have been working on a self-build field-programmable gate array (FPGA)-based data acquisition system for Tromsø Na lidar. In the presentation, we will describe our proposed method, and report the current status in the development of our self-build system.

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