R005-06
B 会場 ：9/24　 PM1 （13:45-15:30）
15:00～15:15

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A self-build FPGA-based data acquisition system for an upgrade of the Tromsoe sodium lidar

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The sodium (Na) resonance scattering lidar is a laser remote sensing system that can detect Na in the upper mesosphere and lower thermosphere (80-110 km altitudes). The Na lidar installed in Tromsoe, Norway, is equipped with a laser diode (LD)-pumped laser system, which is highly stable and long-lifetime. The power of the LD laser is 4 W with a repetition rate of 1 kHz. Because of such a high-power laser, the Tromsoe lidar is capable of simultaneous five-beam observations in five directions. The inter-pulse period (IPP) is 1 msec, so the corresponding height coverage of this lidar is 0-150 km. Thus, the Tromsoe lidar is designed for observations of Na layers at 80-110 km, so-called the normal Na layers. On the other hand, recent observations by other lidars have revealed low-density Na events at higher altitudes (above 110 km, up to 170 km). Such Na events are expected to provide good opportunities for observations at the thermospheric heights. However, the current height coverage of the Tromsoe Na lidar is insufficient for observations of such Na events at higher altitudes.

To improve the height coverage of Tromsoe Na lidar, we propose a time-delayed multi-beam observation method. In the conventional method (i.e., the simultaneous multi-beam method), the laser pulses are split into multi directions, and each pulse is transmitted in each direction simultaneously. In contrast, in the proposed method, laser pulses are transmitted in each direction with a time delay. As a result, longer IPP can be obtained, which allow us to have a larger height coverage. Moreover, the laser pulses do not have to be split in this method, and thus the signal-to-noise ratio (SNR) can be improved, compared with the conventional method. These improvements are expected to be effective for observations of low-density Na events at upper altitudes. In order to implement this method, we need a more flexible data acquisition system, which fits to such a time-delayed multi-beam observation. In addition, a system for high-speed switching in the laser pulse direction is also needed.

In the present work, we have been working on a self-build FPGA-based system that includes a multi-channel data acquisition system and a precise time delay control system. In the initial stage, we developed an FPGA-based data acquisition system, which has the same functions as the commercial data acquisition system. As a performance test of the developed system, test observations were conducted by using the Na lidar at Tromsoe in mid-February 2023. From comparisons between the developed and the commercial systems, it is found that Na signals were successfully detected by the developed system, and its obtained signals were well consistent with those from the commercial system. Furthermore, as for the limit in the counting of faster signals, the developed system achieved a limit of ~17,000, while the commercial system had a limit of ~15,000. These results suggest that the developed system has a better dynamic range than the commercial system. In the presentation, we will show an overview of the proposed method and the results of the performance tests in the developed system. The current status of further developments for additional functions will be also reported.