SPACE COMMUNICATIONS AND NAVIGATION SYMPOSIUM (B2)
Advanced Systems (1)

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RESULTS OF KIRARI OPTICAL COMMUNICATION DEMONSTRATION EXPERIMENTS WITH THE NICT OPTICAL GROUND STATION (KODEN) AIMING FOR FUTURE CLASSICAL AND QUANTUM COMMUNICATIONS IN SPACE

Abstract

Phases 1, 2, and 3 of bi-directional ground-to-satellite laser communication experiments were successfully performed in March, May, and September of 2006. These experiments involved communication between the optical ground station developed by the National Institute of Information and Communications Technology (NICT), located in Koganei of downtown Tokyo, and a low earth orbit (LEO) satellite, the Optical Inter-orbit Communications Engineering Test Satellite (OICETS) "Kirari." These experiments were made in cooperation with the Japan Aerospace Exploration Agency (JAXA), and were called the Kirari Optical communication Demonstration Experiments with the NICT optical ground station (KODEN). The ground-to-OICETS laser communication experiment was the first in-orbit demonstration with respect to the LEO satellite. The Phase-1 laser communication experiment was conducted in March, 2006, and a downlink bit error ratio (BER) of around 1e-5 was measured. Multi-beam laser transmission was used for the uplink from the optical ground station to the OICETS satellite in order to reduce the intensity fluctuation of the optical signal due to atmospheric turbulence. The fluctuation of the received signal power was effectively minimized by using four-beam laser transmission. The Phase-2 laser communication experiment was performed in May, 2006, but there was no significant improvement, due to bad weather. Uplink and downlink BERs of 1e-4 1e-7 were simultaneously measured in Phase-3 experiment in September, 2006, with an uplink of 2 Mbps and a downlink of 50 Mbps. The Phase-4 experiment began in October, 2008. The laser beam propagation characteristics were measured and new fast steering mirrors were tested to couple the downlink laser beam into the single mode optical fiber. Low Density Parity Check (LDPC) codes were designed for the ground-to-OICETS laser communications links and tested. The polarization characteristics of an artificial laser source in space were measured through space-to-ground atmospheric transmission paths. Stokes parameters and the degree of polarization of the laser beam transmitted from the satellite were measured. As a result, the polarization was preserved within an rms error of 1.6 deg, and the degree of polarization was 99.4 percent through the space-to-ground atmosphere. These results contribute to the link estimation for quantum key distribution via space and provide the potential for enhancements in quantum cryptography worldwide in the future. Thus, the applicability of the onboard optical terminal was demonstrated, aiming not only for geostationary earth

orbit (GEO)-LEO links but also for ground-to-LEO optical links. This paper presents the results of the KODEN experiments.