Application of adaptive optics on the satellite laser communication ground station

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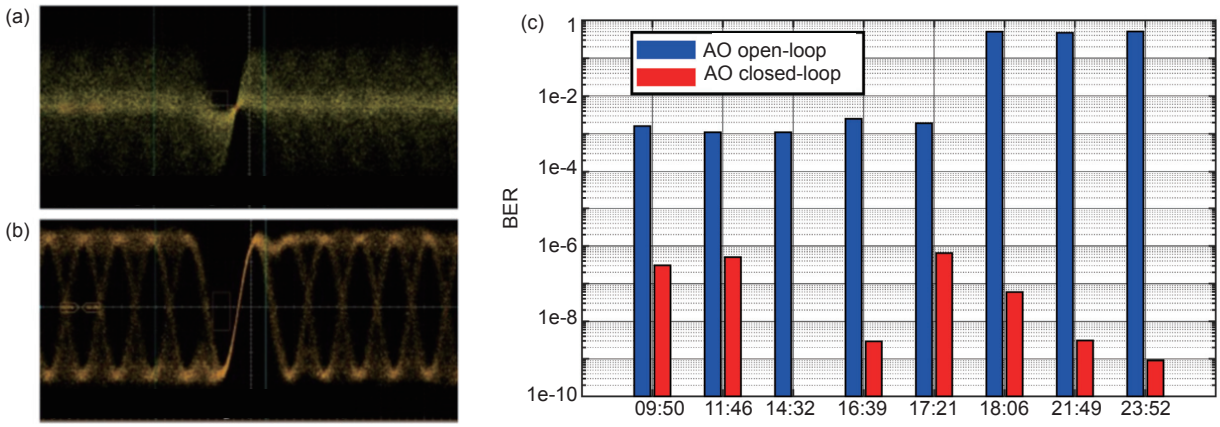

The eye patterns and BER at 5 Gb/s. (a) Without AO correction (09:50 am); (b) With AO correction (09:50 am); (c) The BER results

Overview: The advance of satellite to ground laser communication station using adaptive optics (AO) is summarized. Adaptive optics is the dominant technology to solve the atmosphere induced coherence degradation and availability reduction in the America and Europe researching relay satellites. Key technologies, such as adaptive optics, muti-ground station receiving in day and night, and coherent communication are planned to test in these projects. It indicates that the satellite to ground laser communication is advancing to the engineering application with high date rate coherence and round-the-clock high availability. According to these system designs, it can be found that the laser communication AO system has many new challenges over the astronomical AO system, such as day and night wavefront correction, high fiber coupling efficiency, high velocity and low elevation angle tracking. Meanwhile, the laser communication AO system needs to pay more attention on the instantaneous and statistical property of the corrected facula strehl ratio (SR) because of the high data rate. For these reasons, high spatial resolution deformable mirror (DM) and close loop bandwidth are required for the laser communication AO system. Two deformable mirrors with actuators 12×12 and 32×32 are used for low and high spatial resolution correction in the America laser communication relay demonstration (LCRD) project, and the wavefront sensor frame rate is about 10 kHz. The AO system can provide high precision tracking and wavefront correction for more than 50% fiber coupling efficiency at the elevation angle of 20°.

Several satellite to ground laser communication experiments have been successfully carried out in domestic, and the high availability coherent laser communication test is in progress. Adaptive optics technology has been applied in several ground stations in the key laboratory on adaptive optics of Chinese Academy of Sciences. A Φ0.6 m telescope with 145 actuators AO and a Φ1.8 m telescope with 357 actuators AO for laser communication have been established. Free space coherent laser communication has been carried out using the Φ0.6 m ground station in a >0.5 km horizontal link and pretty results are obtained in the preliminary experiment. The results show that the mean fiber coupling power is about -42.3 dBm when the AO is closed, and 7.4 dB power gain is obtained compared with the AO open loop. The communication bit error decreases from 10^{-3} to 10^{-6} and the eye patterns are open when the AO is closed. The coherent laser communication system with AO can achieve low bit error ($<10^{-6}$) and high data rate (>5 Gb/s) in the moderate atmospheric turbulence.

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