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HIGH-THROUGHPUT LASER COMMUNICATION WITHOUT ADAPTIVE OPTICS : EXPERIMENTAL DEMONSTRATION AND ROADMAP

Abstract

With the emergence of telecommunication constellations and high-resolution Earth observation, LEO satellites generate an increasing amount of data that must be brought back to Earth for processing and analysis. To meet the needs of these very high-speed communication links, from 10 Gbps to 1 Tbps, optical technologies are becoming essential. However, such data rates require small detectors, high performance amplifiers or coherent modulation schemes that require coupling inside single mode fibers and therefore mitigation of atmospheric turbulence.

We have developed a unique technology for turbulence compensation using passive Multi-Plane Light Conversion device followed by an active all optical recombiner. The MPLC demultiplexes the incoming turbulent beam into a set of Gaussian beams whose relative energy distribution and relative phase evolve according to turbulence fluctuations. These signals are then sent into an active system based on a photonic integrated chip where the channels are optically recombined two-by-two in separate Mach-Zehnder interferometers.

In this paper, we investigate laser communication using our MPLC-based turbulence mitigation device in the C- or L-band. To confirm performances, the system was first tested on a 200 m link at the Cailabs facility at data rates from 10 to 50 Gbps. Other series of tests were then performed at DLR on a 10 km continuous signal link. Various configurations were evaluated, including several levels of turbulence. The first link showed a high level of phase degradation on the received beam while on the second link the main effect of atmospheric turbulence was scintillation inside the pupil. In both cases, coarse pointing error was compensated by an auxiliary system.

In the meantime, Cailabs is building its first Optical Ground Station for LEO-to-ground optical link. We will present first experimental results obtained and roadmap for satellite to earth communication.