

Achieving Multi-Terabit FSO Capacity with Coherent WDM Transmission over a 1.8 km Field Trial

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FIGURE 1
Field trial of multi-Terabit WDM coherent transmission over a 1.8 km FSO between IT-Aveiro and PCI-Ílhavo.

FIGURE 2
Electrical SNR per channel obtained from multi-terabit WDM transmission over a 1.8 km FSO-link.

Free-space optics (FSO) is becoming popular for next-generation wireless networks, bringing virtually unlimited bandwidth in an unlicensed spectrum, improved security due to high beam directivity and immunity to electromagnetic interference. However, this technology requires tight and precise alignment. Moreover, direct optical fiber coupling makes the receiver sensitive to angle-of-arrival fluctuations. In outdoor weather-exposed wireless optical links, the interplay between pointing errors and atmospheric turbulence can lead to strong scintillation and power losses^[1]. Tackling the deployment of terrestrial optical wireless links, we have conducted a field trial in Aveiro, Portugal, connecting two buildings with a 1.8 km FSO-link. This trial was established through an international collaboration with Aircision BV, a Dutch start-up that developed a set of FSO optical heads capable of automatic beam alignment and direct air-to-fiber coupling (<https://www.aircision.com/unique-technology>). Exploiting automatic optical gain adjustment at the receiver side, we demonstrate effective mitigation of atmospheric turbulence effects, achieving a reduction of one order of magnitude in the measured Rytov variance. Moreover, resorting to coherent optics and wavelength division multiplexing (WDM), and using soft-decision

forward correction (FEC) codes, we found the optimum FEC overhead that maximizes the overall system throughput^[2,3]. With this methodology we were able to demonstrate 4 Tbps (10 x 400 Gbps) transmission over a 1.8 km FSO channel (between IT-Aveiro and PCI-Ílhavo), establishing a new record on the experimentally demonstrated FSO capacity using commercial FSO optical heads for terrestrial applications. To better grasp the impact of the obtained results, consider that the achieved 4 Tbps would enable the simultaneous streaming of 80 thousand 4K videos, the transmission of 420 holographic videos or downloading all currently available YouTube videos in less than 3h.

References

[1] M. M. Freitas et al., "Requirements and Solutions for Robust Beam Alignment in Fiber-Coupled Free-Space Optical Systems" in *Photonics* 10, no. 4: 394.
[2] M. A. Fernandes et al., "Achieving Multi-Terabit FSO Capacity with coherent WDM Transmission over a 1.8 km Field Trial," 49th European Conference on Optical Communications (ECOC 2023), Hybrid Conference, Glasgow, UK, 2023, pp. 1238-1241, doi: 10.1049/icp.2023.2515.
[3] M. A. Fernandes et al., "4 Tbps+ FSO Field Trial over 1.8 km with Turbulence Mitigation and FEC Optimization," in *Journal of Lightwave Technology*.

