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# VERIFICATION OF LASER COMMUNICATION TERMINALS FOR CUBESATS AS PREPARATION FOR MISSIONS PIXL-1 AND QUBE UNDER ATMOSPHERIC CONDITIONS

**Abstract**

Laser communication enables high-rated and secure communication even on smallest satellites like CubeSats. German Aerospace Center (DLR) already demonstrated the capabilities and advantages of Free Space Optical (FSO) communication in the PIXL-1 mission, with the first OSIRIS4CubeSat (O4C) payload in space. As O4C is a pure transmitter for classical optical communication, OSIRIS4QUBE (O4Q) marks the first evolution of O4C towards Quantum Key Distribution (QKD). The goal in the QUBE project is to transmit, in addition to the classical optical signal, experimental QKD signals from a 3U CubeSat to the Optical Ground Station Oberpfaffenhofen Next Generation (OGSOP NG). The QUBE mission foresees that Ludwig-Maximilian University of Munich (LMU) and Max Planck Institute for the science of light (MPL) provide experimental QKD signals from their in house developed payloads which are coupled into O4Q using a fiber network. To prepare the laser communication terminals for the operation in space and to verify their functionalities, DLR tests its terminals during ground test campaigns. Therefore, a tracking and communication test over a 3km free space track is performed which includes the final infrastructure at the receiver side and replicates the conditions of the final mission. Each test includes the Engineering Qualification Model (EQM) of the payload and one of DLR's Optical Ground Stations (OGS). Both OGS' are equipped with the optical uplink beacon system which is also be used during the operational missions. EQM and Flight Model (FM) of each terminal are identical to ensure that the measured acquisition and tracking behavior represents the final behavior. The free space channel over the test track includes atmospheric effects, which can hardly be replicated in a laboratory. All laser signals are optically attenuated to the respective power, which represents the distances between OGS and the satellite during the final mission. This ensures signal integrity as all systems can operate at nominal power. A hexapod on the transmitter side is used to rebuild the satellites trajectory according to the expected movements. This paper describes the setup on the transmitter and the receiver side for both campaigns O4C and O4Q. The goal of the campaigns is to verify the acquisition and tracking behavior under realistic conditions and to verify the reliable data reception at the optical ground station. It discusses the calculated attenuations and the assumptions. The results of both ground test campaigns are shown, which proves that both terminals can fulfill their functionalities in space.