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OPTICAL QUANTUM TECHNOLOGY IN SPACE USING SMALL SATELLITES

Abstract

Frequency stabilized laser systems are one of the key elements in modern precision experiments using large baseline interferometry, atom interferometry, and optical (atomic) clocks. Future space missions for gravity mapping, tests of the equivalence principle or the detection of gravitational waves require complex but robust and compact laser technologies. Our laser systems are based on a micro-integrated laser technology platform developed at the Ferdinand-Braun Institute in a joint lab activity with Humboldt-Universität zu Berlin, providing compact, robust and energy-efficient semiconductor laser modules. They operate in several cold atom experiments at the Bremen drop tower. Moreover, laser payloads for operation on sounding rockets have been developed and reached TRL 9 on such sub-orbital vehicles through flight qualification and successful mission operation. With these results, our laser technology is ready for in-orbit tests on satellites. Due to the vast increase in performance and comparatively low mission costs, nano- and microsatellites have recently gained more and more attention in and outside the space community. The technological advancement this satellite class has seen over the past decade is mainly attributed to the use of components and development approaches from the information and communications technology (ICT) industry. Besides cost and performance, here especially the possibility to realise extremely short mission development times makes this satellite class predestined for demonstrating science and enabling technologies in space. Technische Universität Berlin has a long tradition of conducting successful small satellite missions. To date eleven satellites have been launched and six additional spacecraft are at various stages of their completion. Recently, Technische Universität Berlin developed TUBiX20, a modular satellite platform suitable for missions of roughly 20 kg. Due to its modular architecture, this platform is well suited to support small science missions as key performance parameters can be adapted to comply with the payload's requirements. This paper examines the use of small satellites for the demonstration and application of optical quantum technology in space. We will discuss scenarios to study laser systems and related technologies in orbit, specifically regarding long-term performance, radiation effects, and autonomy. Such missions complement existing drop tower and sounding rocket heritage and, more importantly,

close the gap towards higher maturity of laser system technology for future long-term missions on large satellites.

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