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Author: Prof.Dr. Diego Scaccabarozzi
Politecnico di Milano, Italy, diego.scaccabarozzi@polimi.it

Mr. Kirill A. Potemkin
Politecnico di Milano, Italy, kirill.potemkin@polimi.it

MILI PROJECT, THERMO-MECHANICAL DESIGN OF A MINIATURIZED LIDAR FOR MARS ADVANCED ATMOSPHERIC RESEARCH

Abstract

In this work, the thermo-mechanical design of MiLi (Miniaturized Lidar for Mars Advanced Atmospheric Research) is described, addressing the design challenges posed by the Martian environment. Atmospheric lidars could be used to examine atmospheric dust and ice-based clouds on Mars, but typically those instruments are heavy and defined by a high power consumption, therefore less attractive as payloads for landers and rovers. The EU-funded MiLi project aims to close this gap, designing a compact, low-power LIDAR that will provide a precise characterization of the suspended dust and clouds in the Martian atmosphere.

MiLi proposes to higher the TRL of three basic technologies to enable the construction of the miniaturized LIDAR for the Mars atmospheric research, i.e. the semiconductor lasers and new Si-PMTs (Silicon Photomultipliers) detectors, free-form optical technology, and low CTE materials. The target mass is about 4 kg and the overall power consumption less than 15W respectively. The instrument should be moreover capable of surviving and operating at very low atmospheric temperatures, to minimize the requirements for its accommodation in any lander/rover.

The thermo-mechanical feasibility study encompasses the design requirements, materials selection, and evaluation of different design solutions to ensure the instrument's performance and survival in these extreme conditions, allowing the definition of the instrument's mechanical architecture. Overall design strategy was based on the tradeoff between the mass budget and the instrument performance. Validation of the mechanical resistance and thermal design requirements fulfilment was performed by developing finite element models of the main instrument components, designed by using numerical quasi-static, modal, and thermo-elastic analyses. The major result of the research is the detailed instrument design posing the basis for the subsequent project phases, i.e. the manufacturing of an instrument mockup and testing in representative environmental conditions.