SCREENING AND CHARACTERIZATION OF THE FLIGHT LASER MODULES FOR THE EXOMARS RAMAN LASER SPECTROMETER

P. Rodríguez [1], A. Marín [2], M. Benito [2], J.A.R. Prieto [2], A. Moral [1], R. Canchal [1], P. Gallego [1]

(1) Instituto Nacional de Técnica Aeroespacial (INTA). Torrejón de Ardoz (Spain). *rodriguezpp@inta.es*
(2) Ingeniería de Sistemas para la Defensa de España, S.A (ISDEFE). Madrid (Spain)

Abstract

The flight and flight spare models (FM and FS) of the laser module for the Raman Laser Spectrometer (RLS) instrument of the ExoMars mission have been delivered by INTA after a complex manufacturing and testing campaign comprising an extensive optical characterization as well as acceptance environmental tests. The data obtained through the campaign permitted the selection of the FM, that successfully passed the subsequent test campaigns at higher levels (RLS instrument and Analytical Laboratory Drawer) providing the required performances.

1. Introduction

The RLS laser module is a redundant, hermetically sealed diode-pumped solid state laser source providing an excitation wavelength of 532nm with a linewidth below 70pm, all in a reduced envelope (<52x42x12 mm^3) and a mass close to 60g [1]. Due to its manufacturing complexity, the flight batch comprised an elevated number of units (more than 10 laser heads). Mechanical and thermal screening tests were performed to select the flight candidates. The objective was to discard units whose behavior was to some extent affected by the mission environmental conditions. The remaining units were afterwards thoroughly characterized so that the best ones, in terms of output power, spectral performance and overall reliability, were selected for FM and FS. Final performance was evaluated through stability tests. Additional opto-electronic characterization tests were performed for system level purposes.

2. Manufacturing campaign

The RLS laser module comprises two main elements: the laser head, an AlN substrate with the micro-optical components soldered on metallic pads, and the laser housing, that guarantees the thermal and mechanical integrity of the laser head and provides structural support for additional components, such as the electrical and optical feedthroughs and the two monitoring photodiodes (for feedback and autofocus). The laser head (Fig. 1, left) was subcontracted to a Spanish laser company (Monocrom). Achieving the required optical element positioning accuracy and stability was possible thanks to the use of an advanced soldering technology provided under subcontract by the Fraunhofer Institute of Jena [2].

The housing was subcontracted to the Spanish company LIDAX, that was in charge of populating it with the aforementioned components, integrating the laser head (Fig. 1, right) and hermetically sealing it.

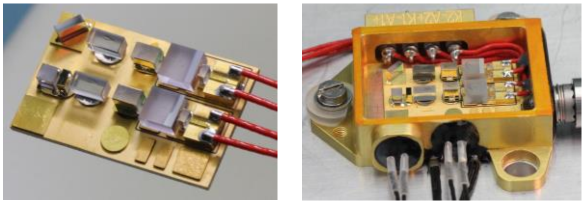

Figure 1. *Flight batch laser head (left) and unsealed module (right).*

INTA performed a close supervision of all the activities performed by these subcontractors, being also responsible of the electrical connections.

3. Screening tests

Screening tests were conducted before sealing the units so that the subsequent characterization effort was focused in just a handful of units. Screening consisted in mechanical and thermal testing at acceptance levels. Basic functionalities and output power were checked before and after each test. The former comprised diodes and photodiodes health check and thermal stabilization through both nominal and redundant sensors. A light-intensity (LI) curve at a fixed, pre-defined working temperature was also recorded to check laser cavity alignment status.

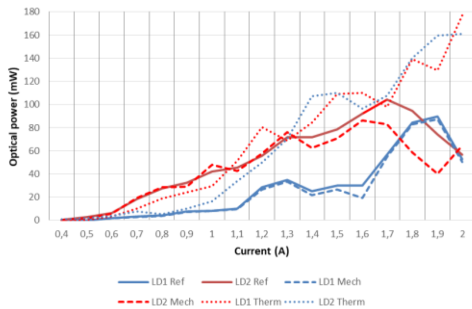

Figure 2. *Screening LI curves for one flight batch unit.*

The reason for discarding some units was a sub-optimal robustness against thermal cycling that occasioned optical power fluctuations and indicated that the optical cavity was too sensitive to small misalignments.

4. Optical characterization

Optical characterization focused on optical power and spectral performance. Extensive tests were performed covering the unit operational temperature range (from 20ºC to 30ºC) and the expected polarization current range (from threshold up to 1,5A). The objective was to identify areas where each laser could provide both the required output power (min. 20mW; max. 30mW) and an adequate suppression of secondary wavelength emissions (-20dB). Additional constraints were imposed by the laser flight driver, since both nominal and redundant lasers shared a common electronic configuration (i.e. minimum and maximum currents and feedback current setpoint). This further limited the options available to accomplish with the requirements simultaneously in both cavities. This characterization was essential to determine which one of the flight candidates provided the overall better performance within the mentioned constraints. Examples of the data matrices obtained for the FM are displayed in Fig. 3 and Fig. 4.

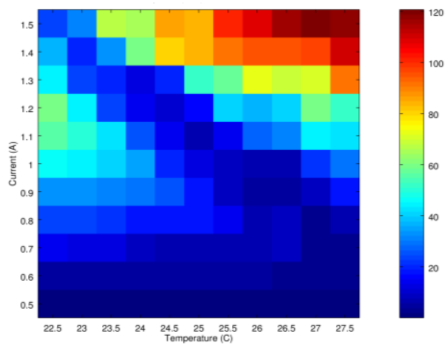

Figure 3. *Output power (mW) 2D mapping.*

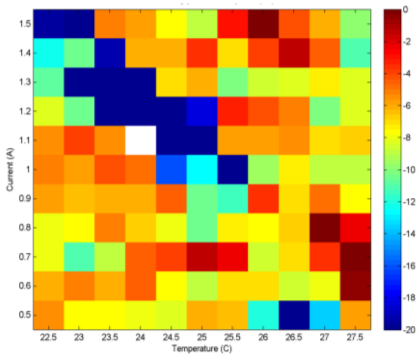

Figure 4. *Secondary emissions relative power (dB) 2D mapping.*

In addition to the laser optical characterization, feedback (FB) and autofocus (AF) photodiodes were measured in order to tune the feedback electronic setpoint and to provide inputs at instrument level.

5. Final performance testing

Final flight units performance was evaluated through short-term stability tests at the working setpoints, defined by temperature and current. Measurements included optical power, spectrum, and AF and FB photocurrents.

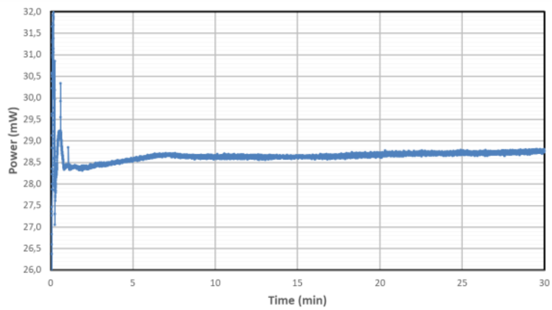

Figure 5. *FS redundant channel optical power stability at its selected working setpoint.*

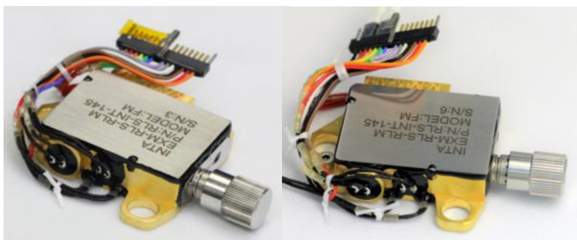

Figure 6. *RLS laser FM (left) and FS (right) at delivery.*

6. Acknowledgements

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7. References

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