

# Optical Performance Measurements of the BELA EQM and FM Transmitter Laser during AIV

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## Abstract

The BepiColombo Laser Altimeter (BELA) onboard the Mercury Planetary Orbiter is Europe's first built Laser Altimeter for a planetary mission. Its main objectives are global mapping of Mercury's topography as well as measuring its tidal deformations to learn about the internal structure of this small terrestrial planet [1]. Crucial part of the instrument for this task is the transmitter laser. It must withstand all mission phases till operation in orbit and work within tight parameter margins. To ensure this a dedicated verification program has been performed at DLR Institute for Planetary Research Berlin which is described in the present paper.

## 1. Introduction

The BepiColombo Laser Altimeter (BELA) consists of electronic boxes, a receiver telescope and a transmitter laser. The transmitter laser – a Nd:YAG laser emitting light at 1064 nm – provides light pulses which are reflected at Mercury's surface, received and detected by the receiver telescope with a Si-APD. To achieve a good accuracy of the altitude measurement highly demanding requirements for alignment, alignment stability, divergence, pulse energy, shape and length and other parameters must be fulfilled. Furthermore the environmental conditions during the mission are relatively harsh which stresses the instrument and thus might deteriorate the performance. In order to ensure that this does not occur a thermal-vacuum combined optical verification campaign for the EQM and FM has been conducted at DLR Institute for Planetary Research in Berlin. The FS campaign will follow later in 2014.

## 2. Test Configuration

The Transmitter – consisting of Laser Head Box (LHB), Laser Electronics Unit (LEU), Electronics Unit (ELU) and Analog Electronics Unit dummy (AEU dummy) are integrated in very clean (plasma cleaned) TV chamber (see Fig. 1). All the integration tasks were performed under a laminar flow box in ISO 5 environment. In the EQM campaign the laser was firing directly horizontally through a window onto an optical bench where the beam was analyzed before, during and after thermal cycling. Due to problems in accurately measuring the beam pointing and beam pointing stability in this configuration, the FM LHB was mounted in a vertical position with a 90° tilt mirror for its measurement campaign.

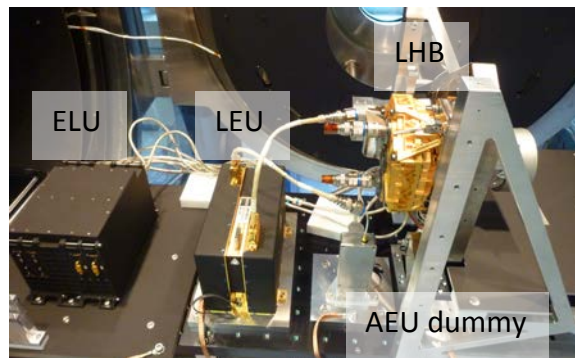


Figure 1: The BELA EQM Laser horizontally mounted in the TV chamber.

## 3. Measurement of Optical Performance

The LHB was aligned using a reference mirror on the baseplate dummy on which the LHB was mounted with its bipod mounts. This alignment was performed using a red diode laser beam. This was necessary to ensure that the BELA laser beam hits a CCD detector

on the optical bench for beam analysis and pointing evaluation. Furthermore the red laser beam serves as a reference for the beam pointing and stability measurements which were conducted. Also pulse energy, wavelength, pulse shape (temporal and spatial), diameter, divergence were recorded simultaneously. The optical measurement setup is located in an ISO 5 environment. A scheme is depicted in Figure 2.

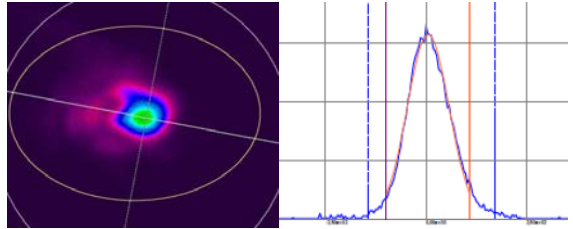


Figure 3: Pulse profile of the EQM Transmitter Laser (main). Gaussian shape requirement is fulfilled.

## 5. Summary and Conclusions

The EQM laser did undergo two planned thermal-vacuum cycles and a third additional one at DLR, all of them at qualification level. The FM laser did undergo two thermal-vacuum cycles at acceptance level. The measurements showed that the transmitter can be operated in the thermal environment required and the optical beam parameters stay within the acceptance margins. It was observed that the laser shows a temperature dependent behavior, which was expected, regarding pulse energy and wavelength. But the measured values are within the specification. The pulse shape varies slightly but remains Gaussian in all temperature conditions. This is valid for EQM and FM laser which were successfully verified. The FS laser campaign is going to be conducted middle of 2014.

## Acknowledgements

The authors wish to acknowledge the persons at DLR Berlin who were involved in development, design and setup of the optical test bench and the appropriate TV chamber with special cleanliness specifications. Furthermore special thanks to the operations and software team who operated the laser and made effort to solve issues as fast as possible.

## References

[1] N. Thomas, T. Spohn, J.-P. Barriot: The BepiColombo Laser Altimeter (BELA): Concept and baseline design, Planetary and Space Science 55 (2007) 1398–1413.

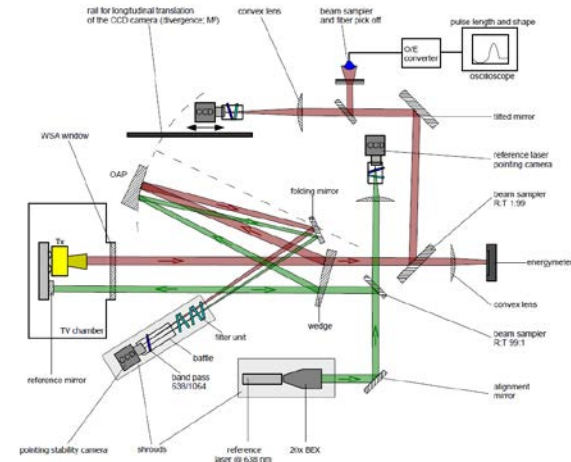


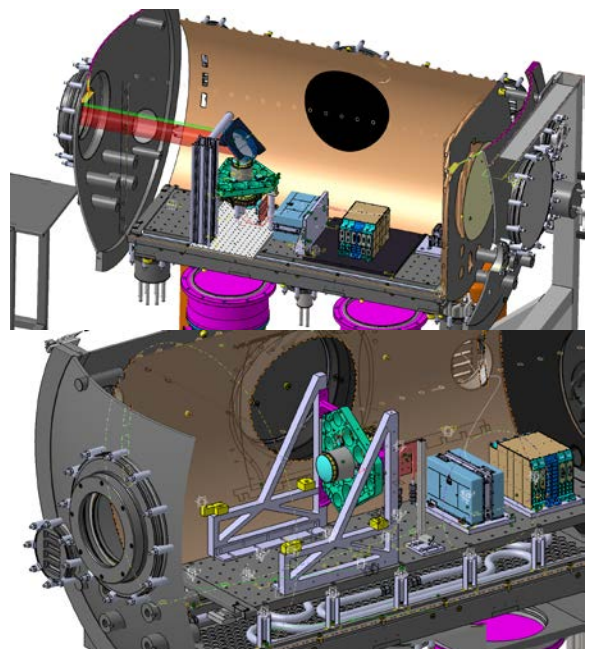
Figure 2: Scheme of the optical bench for simultaneous measurement of the beam parameters during TV cycling (BELA laser beam is red coloured; reference laser beam in green).

## 4. Some Results

Some results of the EQM Transmitter Laser are shown below in Table 1. Pointing stability could not be measured accurately for the EQM. This has been done for the FM though. Final results for this are still outstanding but first assessment shows that the stability criterion is met.

Table 1: Some results of the EQM campaign for the main laser (3<sup>rd</sup> TV cycle).

Property	Specification	EQM TOP max	EQM TOP min
Pulse Energy	>50 mJ (BOL)	55.9 mJ	50.3 mJ
Pulse length	5.5 ns ± 2.5 ns	4.4 ns	4.0 ns
Divergence	50 μrad ± 10 μrad	60 μrad	61 μrad
Wave-length	1064.53 nm ± 0.25 nm	1064.64 nm	1064.33 nm



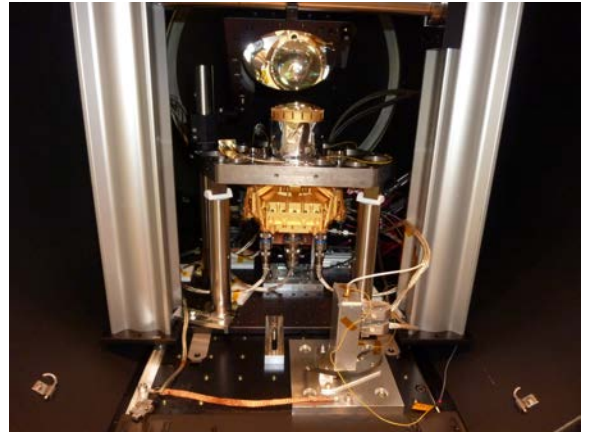
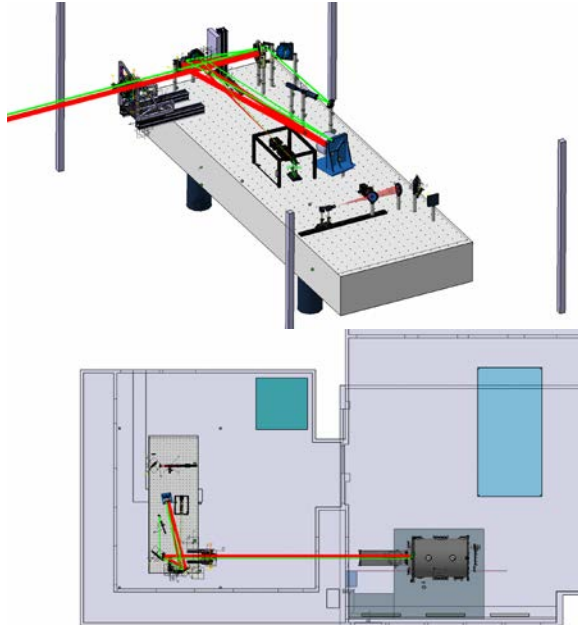
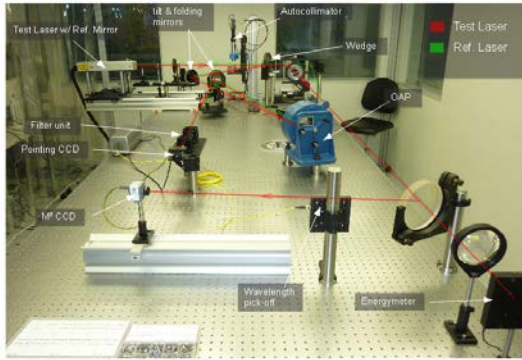


Figure 1: The BELA Laser vertically mounted in the TV chamber with a 90° tilt mirror above.

