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Commissioning report for high temperature measurements & delivery to TA2

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Dissemination level		
PU	Public	x
PP	Restricted to other programme participants (including the Commission Service)	
RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for members of the consortium (excluding the Commission Services)	

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Abstract: The purpose of this deliverable is to report on the improvements made to the Planetary Emissivity Laboratory facility at DLR under the activity JRA2 and verify the transfer of these new capabilities to the TA2 activities.
All of the envisioned improvements/developments to this facility have been implemented and successfully tested. There have been three major improvements to the facility implemented under JRA2, they are;
1. Definition of spectrometer requirements,
2. Spectrometer system design
3. Optimize spectral range extension & validate.
These upgrades are considered functional and available for scientific studies (under TA2 access). Advertisement of these new capabilities will be communicated to potential users for future TA2 calls (conferences, home pages, personal communications).

In this deliverable the improvements made to the Planetary Emissivity Laboratory (PEL), DLR will be presented. These were made under the activity JRA2 resulting in verification of the transfer of these new capabilities to the TA2 activities.
There have been three major improvements to the facility (PEL) implemented under JRA2, they are; 1) Definition of spectrometer requirements, 2) Spectrometer system design, and 3) Optimize spectral range extension & validate.
These upgrades are now functional and available for scientific studies (under TA2 access). Advertisement of these new capabilities will be communicated to potential users for future TA2 calls (conferences, home pages, personal communications).

All of the envisioned improvements/developments to this facility have been implemented and successfully tested ahead of schedule by DLR internal projects. They are outlined individually below:

1) **Defining measurement requirements, developing measurement protocols and verification procedures**. (Deliverable; Milestone 71 under Task 8.3.1).
Alessandro Maturilli (DLR), Jörn Helbert (DLR), Thomas Widemann (LESIA), Sabrina Ferrari (University of Padua)

The teams at DLR and LESIA have defined the measurements requirements and protocols, including the definition of verification protocols and selected a set of analogue samples (in collaboration with the colleagues from the University of Padua) for the first series of test measurements, including slabs and powdered samples (Milestone MS71: Definition of spectrometer requirements (PEL)).

2) **Designing optical setup, identify necessary components and assessing spectral sensitivity** (Deliverable; Milestone 72 under Task 8.3.2).
A. Maturilli, J. Helbert (DLR), T. Widemann (LESIA), S. Ferrari (University of Padua), D. Wendler (DLR)

Upgrading the spectrometer to increase the signal-to-noise ratio at radiation wavelengths below 1 µm was a very straightforward task. After discussion with the spectrometer provider and with planning by the optical and detector engineers at LESIA, it was decided that, among the possible technical solutions, an InGaAs detector would offer the best efficiency in the required spectral range. Implementing this detector inside the laboratory spectrometer required an upgrade of the spectrometer electronics as well as the installation of an adapted beamsplitter (the optimal solution being a Si on CaF_2 optical unit). All tasks were performed by a Bruker technician together with the PEL laboratory manager (A. Maturilli).

3) **Implementing set-up changes at PEL** (Deliverable; Milestone 73 under Task 8.3.3)

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The last task was upgrading the external chamber to adapt to emissivity measurements under Venus conditions. This proved more challenging than expected. Previously we measured samples holding them in Stainless steel cups, because we use an induction system to heat our samples to very high temperatures. Steel, when heated to the high temperatures needed to bring the granular sample surface to above 700K, glows strongly and adds a large amount of radiation in the measured visible spectral range (see Fig 1). After some tests performed with DLR thermal engineers, a ceramic enclosure was built into which the steel disk was embedded. This allows the sample to be heated but effectively the back ground emission of the steel is shielded.

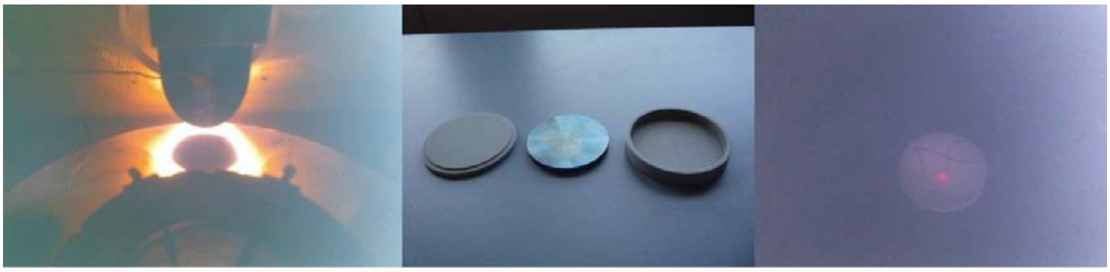

Figure 1 - Left: Webcam picture of steel disk glowing when heated above 700K. Centre: Steel disk and the ceramic enclosure used to mask its glowing in the visible spectral range. Right: Webcam picture for the ceramic enclosure heated at 750K. The ceramic enclosure is slightly emitting in the visible spectral range, but much lower than the steel disk used previously.

The final solution of the heating system (steel disk enclosed in ceramic jacket) met the requirements of as little perturbation as possible coming from the heating system on the emissivity measurements of Venus analogue slabs in the visible spectral range.

A modified version of the ceramic enclosure was developed to allow measurements of powder samples. We produced one design for single samples and one that could contain two separate samples (see Figure 2), for a better calibration of an imaging spectrometer working in the VIR/NIR spectral range.

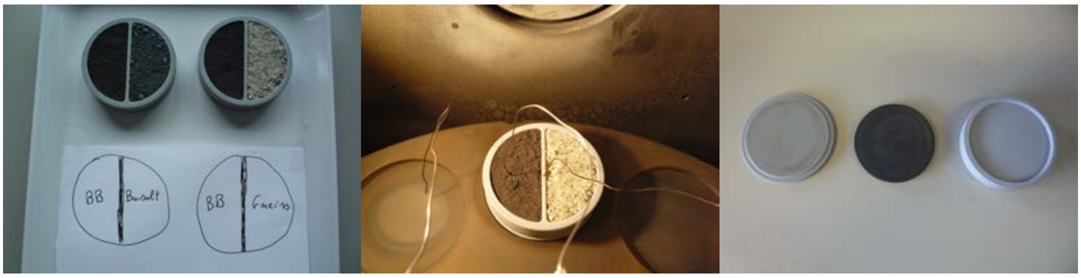

Figure 2 - Left: Set of ceramic enclosures containing two different samples. Centre: Ceramic enclosure for 2 samples in the emissivity chamber, prepared for measurements (see the temperature sensors on one sample and the

splitting wall in the ceramic cup). Right: The ceramic enclosure, its bottom and a steel disk to be used for measuring emissivity of powder samples in the VIS/NIR under Venus conditions.

The spectrometer system was successfully tested by measuring the emissivity spectra for a range of Venus analogues (Figure 3) and the Milestone was completed and the facility declared fully available for use.

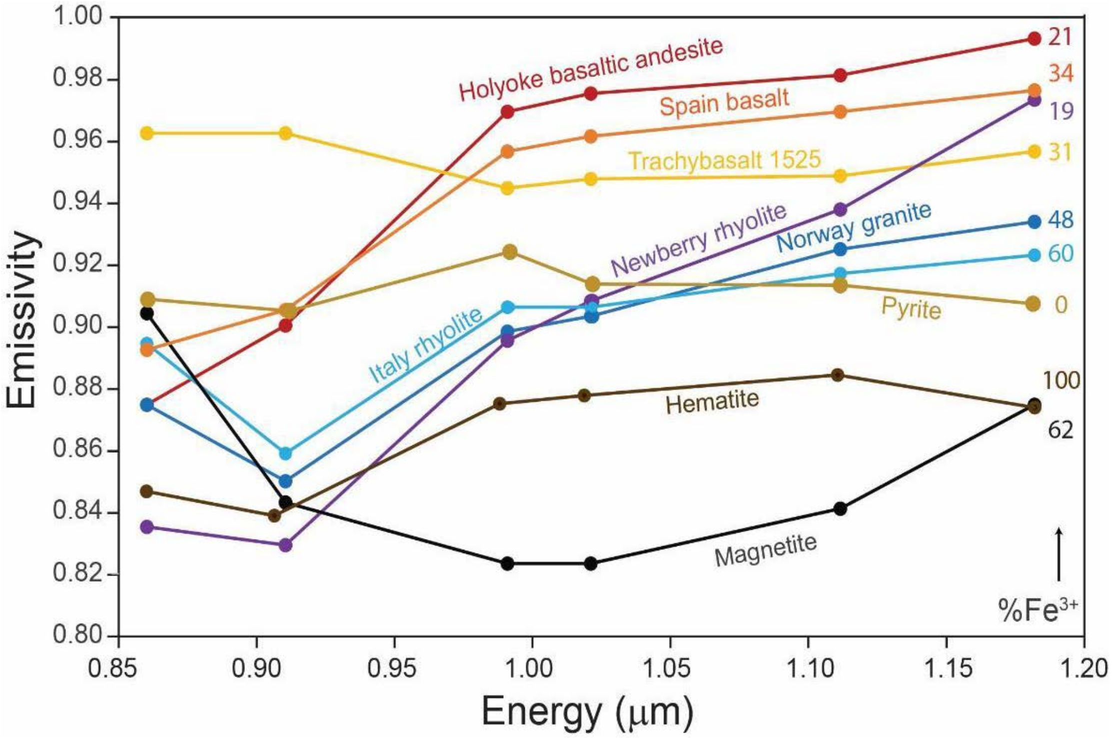

Figure 3 - First set of test measurements for a range of Venus analogues