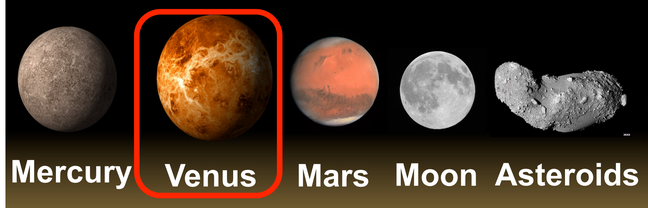
The Venus Emissivity Mapper (VEM) Prototype



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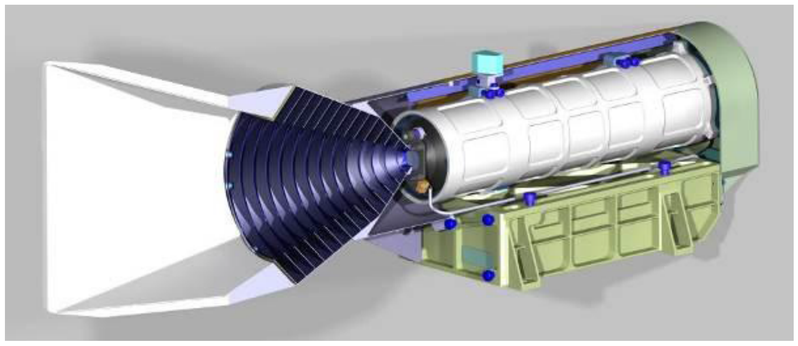
Introduction

The Venus Emissivity Mapper (VEM) is a multispectral imager in the visible and near infrared spectra. The instrument recently completed a Phase A study for the NASA Discovery VERITAS proposal [1]. VEM is a push broom multi-spectral imager specifially designed to map the surface composition from orbit [2]. As the Venus atmosphere is opaque in the visible spectra, surface observations are typically only be obtained with radar missions, which can provide only very limited information on the surface material or composition.

VIRTIS on the VenusExpress mission was able to map the southern hemisphere of Venus the first time from orbit through spectral windows located around 1µm [3,4]. As VIRTIS was not build for this purpose, there were mainly challenges, however it provided a proof-of-concept. VEM is specifically built to observe the surface using all known atmospheric windows. This allows to map surface mineralogy on a global scale [5,6].



The VEM Design [2] uses a multi vane baffle and a filter array consisting of 14 narrow bands located between 0.79 and 1.51µm. The Indium-Gallium-Arsenide-detector is optimized for this spectral range. Electronics, software and structural design are directly inherited from MERTIS.

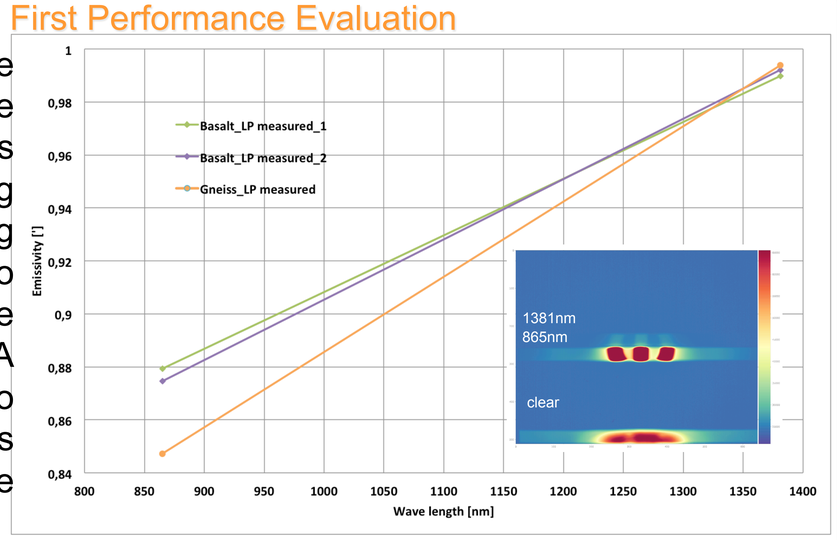
Laboratory Prototype

To prove the capabilities of the proposed camera, a laboratory prototype (LP) has been built, following an earlier VEM breadboard, using the optics and detector [2,6].

The LP is representing a simplified version of the VEM flight model (FM), using an OEM module of the proposed flight detector while the filter array of the optic consist of two bands, located at 865nm as well as 1381nm, one transparent window and masked areas.

First Performance Evaluation

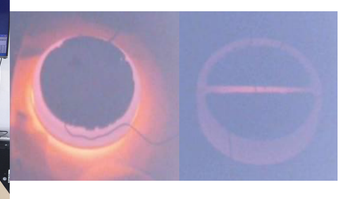
A first performance evaluation of the VEM LP was performed using two Venus analog samples heated to Venus surface temperatures. A simple ratio algorithm was used to derive emissivity.



The retrieved emissivities match the laboratory values and the error from a single exposure is less than 0.35%

LP @ PEL

After the assembly and first test phase, the LP has been taken into the DLR Planetary Spectroscopy Laboratory (PSL). The PSL can heat minerals to Venus surface temperatures and measure the emissivity in the spectral range from 0.7-1.5µm [4,5]. A newly developed ceramic sample cup was used to measure granular samples.



Measurements

Slabs and granulated samples, for e.g. a basalt-calcite combination (left), a blackbody-basalt split sample (middle) and a blackbody-gneiss split sample (right), have been measured. All samples have been heated to Venus temperatures and measured at different temperature levels, where the LP has taken images without using stacking, binning or other processes.

Conclusion & References

The LP proves not only the concept but shows the already advanced status of the VEM development.

The test program will continue with more samples and configurations. Step by step the LP will be upgrade to an engineering prototype, using VEM flight-like software and front-end electronics.

[1] Smrekar S. et al. (2016) LPSC.;[2] Helbert et al. (2016), SPIE 9973 . [3] Mueller, N. et al.(2008). Journal of Geophysical Research 113; [4] Helbert, J., et al. (2008). Geophysical Research Letters 35(11). [5] Helbert J. et al. (2017) this meeting. [6] Dyar M. et al. (2017) this meeting. [7] Wendler D. et al (2015) http://elib.dlr.de/101033/.