



**HAL**  
open science

## **Processing and Calibration for the WISDOM Radar Applied to Field Measurements**

Dirk Plettemeier, Christoph Statz, Yun Lu, Wolf-Stefan Benedix, Valérie Ciarletti, Alice Le Gall, Charlotte Corbel, Yann Herve

► **To cite this version:**

Dirk Plettemeier, Christoph Statz, Yun Lu, Wolf-Stefan Benedix, Valérie Ciarletti, et al.. Processing and Calibration for the WISDOM Radar Applied to Field Measurements. European Planetary Science Congress 2018, Sep 2018, Berlin, Germany. pp.EPSC2018-1023. insu-04415735

**HAL Id: insu-04415735**

**<https://insu.hal.science/insu-04415735>**

Submitted on 24 Jan 2024

**HAL** is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

# Processing and Calibration for the WISDOM Radar Applied to Field Measurements

**Dirk Plettemeier** (1), Christoph Statz (1), Yun Lu (1), Wolf-Stefan Benedix (1), Valérie Ciarletti (2), Alice Le Gall (2), Charlotte Corbel (2) and Yann Hervé (2)  
 (1) Technische Universität Dresden, 01062 Dresden, Germany. (dirk.plettemeier@tu-dresden.de)  
 (2) UVSQ/LATMOS, 78280 Guyancourt, France

## Abstract

The capabilities of the WISDOM GPR, which is part of the 2020 ExoMars rover payload, are demonstrated on field test data from two different sites. The objectives of this paper are calibration, data processing and polarimetric classification of buried scatterers.

## 1 Introduction

The WISDOM GPR is part of the 2020 ESA-Roscosmos ExoMars rover payload. It operates at frequencies between 500 MHz and 3 GHz yielding a centimetric resolution and a penetration depth of about 3 m in Martian soil. Its primary scientific objective is the detailed characterization of the material distribution within the first meters of the Martian subsurface as a contribution to the search for evidence of past life [1]. In addition to the primary scientific objectives, the WISDOM data is supposed to be embedded in terrain visualizations [2] in order to support the drilling operations [5].

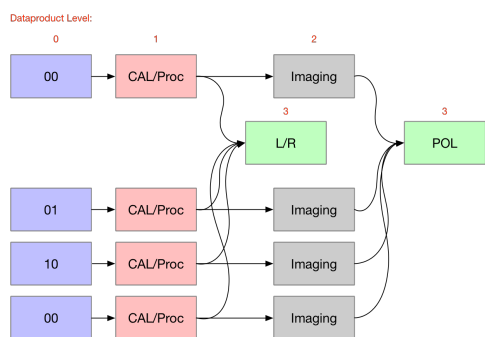


Figure 1: WISDOM calibration and data processing scheme.

## 2 Calibration and Processing

The WISDOM data measured along the rover path is subjected to calibration and pre-processing (removal of ringing artifact). From the fully polarimetric measurements a left-right discrimination [4] and classification of the buried scatterers is possible. The processing scheme is depicted in Fig. 1. The processing consists of a calibration using freespace laboratory measurements of the WISDOM antenna pattern, time-domain transform of the measured data, removal of ringing artifacts, spatial high-pass filtering, imaging (Stolt) and subspace projection. The processed results are decomposed using Entropy- $\alpha$  analysis for classification.

## 3 Field Data

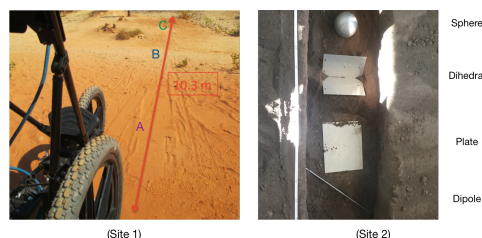


Figure 2: Depiction of the test sites. Left: Site 1, right: Site 2.

The WISDOM data processing, calibration and analysis has been tested on different occasions, e.g. during the SAFER experiments [3].

Here we present further data from field measurements. The two test sites are depicted in Fig. 2. At site 1, the measured track is approx. 10m across plain and flat terrain with limited vegetation and surrounding scatterers. The regions relevant for the radargram processing are marked A, B and C. Feature B seems to

be a channel with distinctive material properties and structure. At site 2 the measured track is approx. 2m across plain soil inside a concrete channel. Inside this channel different scatterers have been buried.

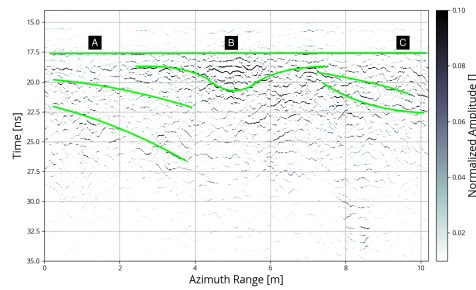


Figure 3: CS (subspace projection) processed radargram of site 1 with marked features.

The processed radargram result of site 1 is depicted in Fig. 3. After processing, the channel B is clearly visible in the data. In region A the signature of a descending subsurface horizon is visible. Region C exhibits different surface structure and density. The classification results of site 2 are depicted in the Fig. 4 and Fig. 5. The buried scatterers are clearly visible in the C-scan and correctly classified in the Entropy- $\alpha$ -plane.

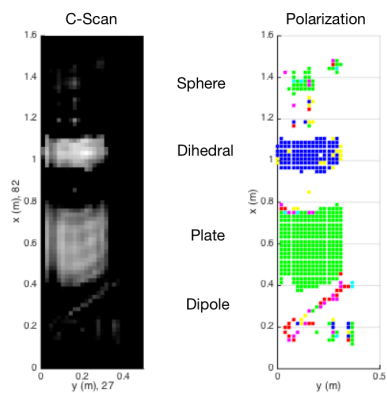


Figure 4: C-Scan and polarization of measurement site 2.

## 4 Conclusions

The derived WISDOM calibration and processing scheme yields stable results at the expected resolution.

The processed data can be embedded in a terrain visualization, aiding in the selection of viable drill sites.

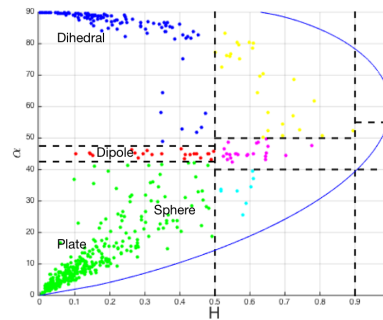


Figure 5: Polarization behavior of site 2. The buried objects are classified correctly in the expected regions.

## Acknowledgements

The research on WISDOM is supported by funding from the Centre National d'Etudes Spatiales (CNES) and the Deutsches Zentrum für Luft- und Raumfahrt (DLR).

## References

- [1] V. Ciarletti, C. Corbel, D. Plettemeier, P. Cais, S. M. Clifford, S.-E. Hamran, "WISDOM GPR Designed for Shallow and High-Resolution Sounding of the Martian Subsurface", Proceedings of the IEEE, Vol. 99, Issue 5, pp. 824-836, May 2011.
- [2] G. Paar, G. Hesina, C. Traxler, V. Ciarletti, D. Plettemeier, C. Statz, K. Sander and B. Nauschnegg, "Embedding Sensor Visualization in Martian Terrain Reconstructions", ASTRA2015, May 2015
- [3] S. Dorizon, V. Ciarletti, A.-J. Vieau, D. Plettemeier, W.-S. Benedix, M. Mütze, R. Hassen-Kodja and O. Humeau, "WISDOM GPR subsurface investigations in the Atacama desert during the SAFER rover operation simulation", EGU2014, Vienna, May 2014
- [4] D. Plettemeier, V. Ciarletti, W.-S. Benedix, S. M. Clifford, S. Dorizon and C. Statz, "ExoMars WISDOM Left-Right-Evaluation of Subsurface Features", EGU2013, Vienna, April 2013
- [5] V. Ciarletti, S. Clifford, D. Plettemeier and the WISDOM Team, "The WISDOM Radar: Unveiling the Subsurface Beneath the ExoMars Rover and Identifying the Best Locations for Drilling", Astrobiology, Vol. 17, No. 6-7, July 2017