Europlanet TA Scientific Report

PROJECT LEADER

Project number: 20-EPN-027
Name: Giuseppe Mongelluzzo
Home Institution: INAF – Astronomical Observatory of Capodimonte, Naples, Italy
TA Facility visited: Planetary Environment Facilities-PEF (DK)

Project Title: Characterization of the response of an Optical Particle Counter in a simulated Martian environment

Scientific Report Summary.
(plain text, no figures, maximum 250 words, to be included in database and published)

The characterization of dust is paramount in the understanding of Martian climatology. Dust significantly influences Mars global climate, interacting with the incoming solar radiation, altering the atmospheric temperature budget. Local and global dust storms can cover the planet for weeks, influencing the correct functioning of scientific instruments on the surface (The Rover "Opportunity" is the most famous example). The dynamics of dust lifting is strictly related to the wind velocity field, so its characterization would provide important information on the characteristics of Martian winds. The proposing team has developed an Optical Particle Counter (OPC) aimed at providing direct measurements of grain concentration and size distribution on Mars, which would be the first ever accomplished outside of Earth. The instrument is able to detect dust grains in the 0.4-20 µm diameter range. Both the breadboard and the flight model versions of the instrument have been tested in Martian environment, showing good performances. The trip to the Planetary Environment Facilities at the University of Aarhus has allowed the verification that the instrument is correctly able to sample dust grains in its upper sensible range (up to 20 µm in grain diameter) also in presence of winds up to 20 m/s. A sandbed with embedded dust has also been created inside the Martian wind tunnel, allowing the simulation of natural saltation conditions. The instrument has been able to retrieve dust grains in all simulated conditions, both for monodispersed calibrated dust samples and for polydisperse samples.

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The characterization of dust is an important aspect in the research field related to Martian climatology. Dust significantly influences the planet's climate. The atmospheric temperature budget is altered by the interaction of dust with solar radiation, and phenomena like dust devils and dust storms are extremely frequent. The latter can become global and cover the planet for weeks, influencing the correct functioning of scientific instruments on the surface. The dynamics of dust lifting is strictly related to the wind velocity field, so its characterization would also provide important information on Martian winds.
Our team has developed an Optical Particle Counter (OPC) for Mars atmosphere. The instrument is aimed at direct measurement of Martian dust at the surface, providing significant information about dust lifting on Mars and about dust phenomena which shape the Martian surface. In previous test campaigns, we have already verified the OPC's ability to determine the size of suspended dust grains in Martian conditions.
During this campaign at the Planetary Environment Facilities, we have tested out the OPC in windy conditions, to complete the characterization of our instrument. We have started the campaign by testing the Flight Spare model of our Martian OPC with monodispersed samples in the 8-16 µm diameter range, by varying the wind speed from 0.5 to 25 m/s. The grains have been injected inside the chamber through a gate valve on the side of the chamber. We put particular emphasis on testing the instrument behaviour with large grains because they are the toughest to collect, given their significant inertia.
Figure 1 shows an example of size distribution histograms obtained in the most challenging tested scenario, that is 16 µm particles and 25 m/s wind speed. A histogram peaked around the nominal value of dust grain size is obtained. It can also be appreciated that a significant sample of grains is collected. Similar tests have been repeated for polydisperse grains, peaked around 34 µm, confirming the instrument ability to sample the grains reproducing a realistic size histogram.

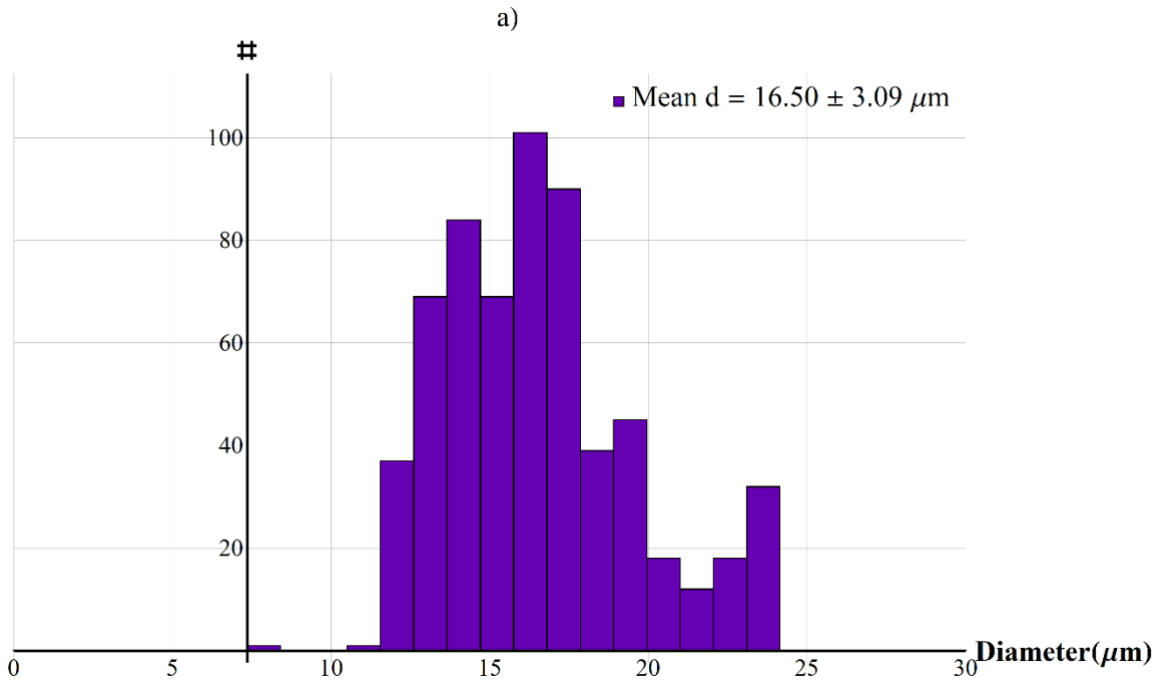

Figure 1 The size distribution relative to the injection of 16 µm grain at 25 m/s , obtained with a preliminary calibration.

The second part of the campaign has been focused on testing the instrument in conditions reproducing a natural dust lifting process. The test is important to verify MicroMED behaviour in expected operative conditions, but also to have a glimpse of the environment that our instrument will face during Martian operations. By using a convergent duct section installed inside the Martian wind tunnel, we have been able to test the OPC for speeds up to 30 m/s. On the base of the section we have created a mixed bed of sand and dust, made with fine sand with a size distribution peaked at 90 µm, with a polydisperse sample of dust, peaked at around 11 µm, juxtaposed on the top of the sandbed.
Figure 2 shows the size distribution obtained by the OPC during such tests for a wind flow speed of ~ 15 m/s. A main peak around 11-12 µm is visible, corresponding to the sample dust fraction, then the size distribution decreases with a tail up to ~ 24 µm. This confirms that even at wind speeds higher than what expected during Martian operations (average wind speed on Mars is expected to be at about 7 m/s, with gusts over 10 m/s), the OPC is able to aspire dust grains of even larger size than the nominal operational range.

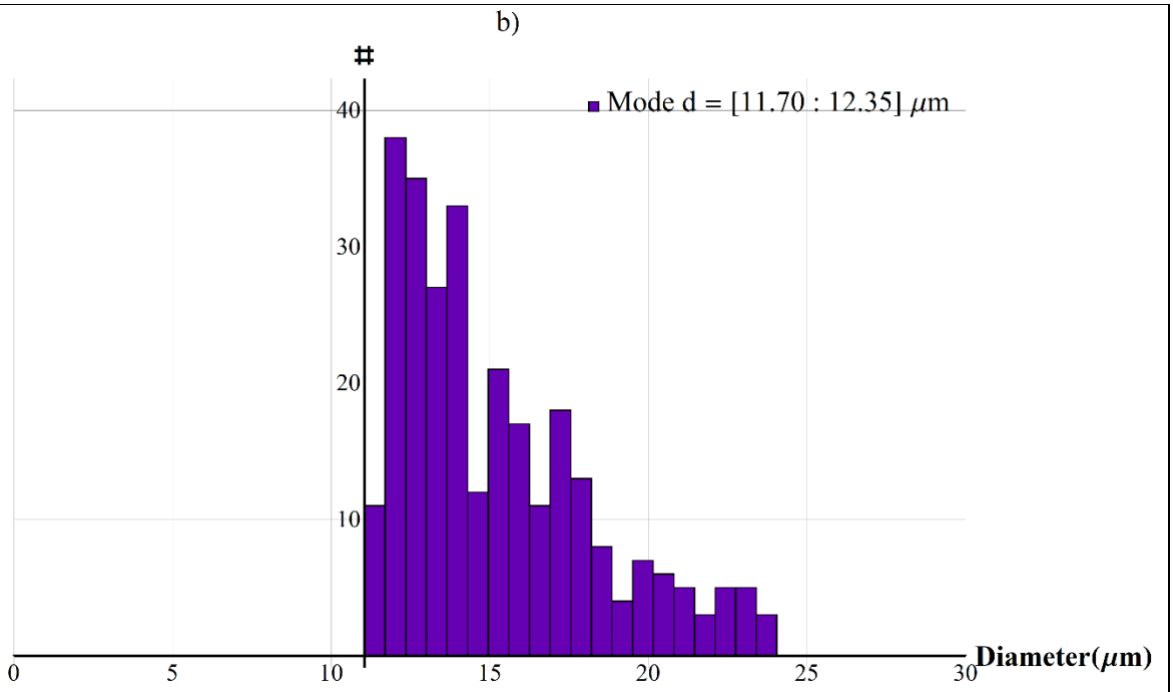

Figure 2 Size distribution obtained at ~15 m/s for the mixed sand and dust sample.

As a result of the test, we have also observed the formation of hydrodynamic ripples (Figure 3) on the surface of the sandbed, which are interesting features to be analysed in other fields of Martian research.

Figure 3 Example of hydrodynamic ripples produced on the simulated sandbed by high wind speed.

We plan to submit 1-2 proceedings paper to be presented at international conferences regarding the results of this campaign. The Metrology for Aerospace international conference (https://www.metroaerospace.org/) and the Italian Annual Planetology Conference (https://www.scienzeplanetarie.it/xviii-congresso-nazionale-perugia-2023/, link in italian) are potential candidates. We also plan to extend the proceedings to full papers, submitted to special issues linked to the conferences. It is also possible that results are published as part of research papers submitted to journals linked to planetary science. A potential choice could be Planetary and Space Science.

- Host confirmation

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Dates for travel to accommodation for TA visit (if physical visit by applicant)	Start Date of TA project at facility	Number of lab/field days spent on TA Visit pre-analytical preparation	Number of days in lab/field site for TA Visit	Number of days spent in lab for TA Visit data analysis	End Date of TA project at facility	Dates for travel home (if physical visit by applicant)
Departed: 04-09-22 Arrived: 05-09-22	05-09-22	0	5	0	09-09-22	Departed: 09-09-22 Arrived: 11-09-22

The host is required to approve the report agreeing it is an accurate account of the research performed.

Host Name	**Jon Merrison**
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Date	**23-02-2023**

- Project Leader confirmation

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Project Leader Name	Giuseppe Mongelluzzo
Project Leader Signature	
Date	February 23, 2023