Europlanet TA Scientific Report

PROJECT LEADER

Project number: 20-EPN2-116
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Home Institution: Osservatorio Astronomico di Capodimonte, Napoli, INAF
TA Facility visited: TA2.7 University of Kent Light Gas Gun Laboratory, UK

Project Title: HIDISCC (Hypervelocity Impacts for DISC Calibration)

Scientific Report Summary.

The Comet Interceptor space mission is to launch in 2029 to study a dynamically new comet. Two of the three spacecraft involved will host copies of the Dust Impact Sensor and Counter (DISC), which will measure the physical properties of cometary dust.
The spacecraft's velocity (7-70 km/s) will result in hypervelocity dust impacts on DISC. Combined with the range of dust particle sizes, this will create a wide range of impact momentum (10^{-11}–10^{-3} kg/m/s).
To cover the upper part of the momentum range, DISC calibration will be performed with hypervelocity simulated impacts induced by lasers. To perform DISC characterization and calibration in the lower momentum range, we carried out experiments at the Light Gas Gun Impact Facility at the University of Kent (UK).
To calibrate DISC and check the sensing element formed by the aluminum plate and the piezoelectric transducers:

- We performed 9 shots at the Light Gas Gun Impact Facility at the University of Kent. We used different particle sizes and materials and different speeds, utilising different approaches, i.e. single particles with diameters down to 400 nm and buck-shots of a mixture of minerals and very light hollow spheres.
- The signals from the piezoelectrics will be used to verify DISC estimated performance and enable a generally-valid impact sensor calibration procedure.

All 9 shots provided signals, this was for both single impacts and multiple buck- shot impacts. The results of the experiment confirmed the capability of the instrument to measure the momentum of particles impacting in the hypervelocity range.

Full Scientific Report on the outcome of your TNA visit

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To cover the upper part of the momentum range, DISC calibration will be performed with hypervelocity simulated impacts induced by lasers. To perform DISC characterization and calibration in the lower momentum range, we carried out an experiment at the Light Gas Gun Impact Facility operational at the University of Kent (UK) Figure 1.
The full list of shots performed is reported in Table 1:

Table 1 Shot details for DISC HVI tests at Kent.

Date	Time	Shot Number	Proj.	Speed (km s^{-1})
28/3/23	15:00	1	0.5 mm glass	4.174
29/3/23	12:30	2	0.5 mm salt	4.277
29/3/23	16:00	3	0.5 mm glass	4.178
30/3/23	11:40	4	Jadite (150 – 250 µm) plus bubble glass (600 µm)	4.180
30/3/23	14:40	5	0.4 mm salt	3.961
22/5/23	14:40	6	Fosterite (250 – 500 µm) plus bubble glass (600 µm)	4.403
23/5/23	11:00	7	Fosterite (250 – 500 µm) plus bubble glass (600 µm)	4.011
23/5/23	14:40	8	0.3 mm st. st.	5.370
24/5/23	10:10	9	0.3 mm st. st.	4.576

All the shots performed were detected by the DISC breadboard data acquisition system. Thes shots reached a series of goals and aims:

1. Verify the capability of the DISC design to measure hypervelocity speed impacts ;
2. Demonstrate that the sensing element after a damage due to large impact is still able to detect impact of other particles as shown by the signal recorded by the sensor after the first shot (Figure 2);
3. Verify operationally that the PZT selected as replacement of the GIADA Impact Sensor piezo-electrics are suitable for the DISC application both from the point of view of the resonance frequency of the acquired signal that for what concern the sensitivity Figure 3, Figure 4 and Figure 5;
4. Additional analysis on the acquired signal will allow a first estimation/calibration of:
    - Impact position reconstruction accuracy
    - Instrument response function

The results obtained fully answer the questions and aims of the proposal, the small modification to the test plan originally applied had very minor impact. We consider the test campaign successful and with a great impact in the activities of development and tuning of the performance for the DISC instrument. In addition the result will be used to integrate and probably plan a calibration campaign of the final instrument with the use of a Light Gas Gun facility. Additional analyses will be carried out by means of numerical simulation of impacts in order to reproduce the performed tests.

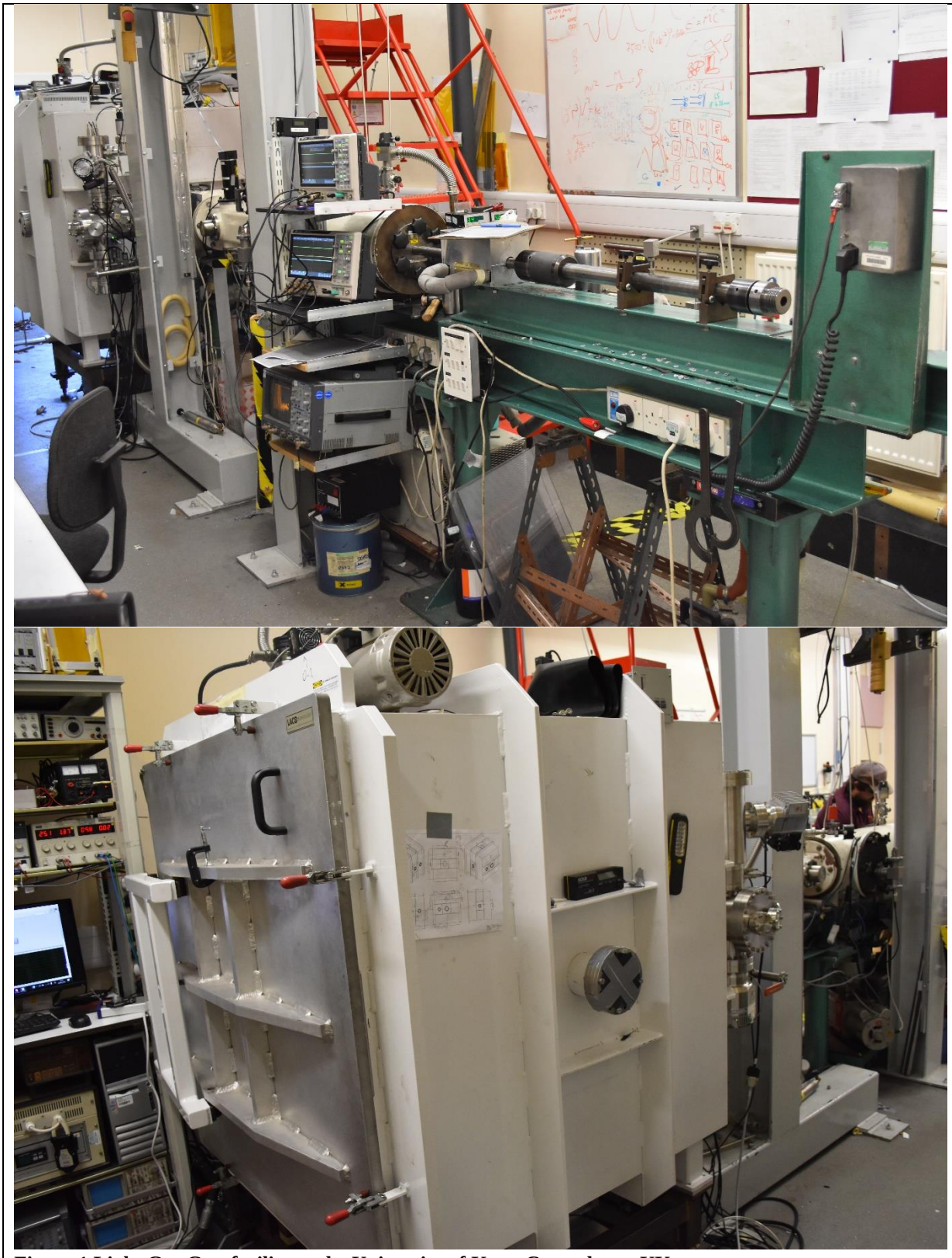


Figure 1 Light Gas Gun facility at the University of Kent, Canterbury, UK

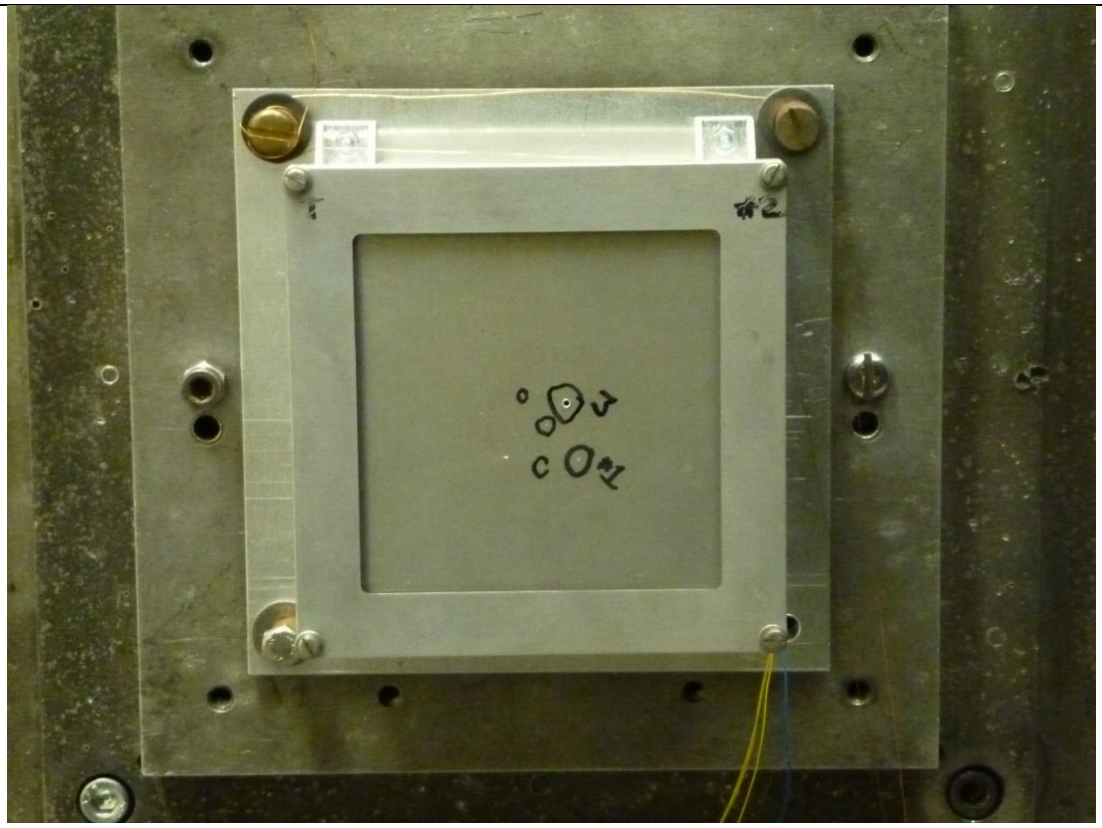


Figure 2 DISC breadboard mounted in the test chamber after 2 different shots, in the dark circle are marked the impact point of the previous tests.

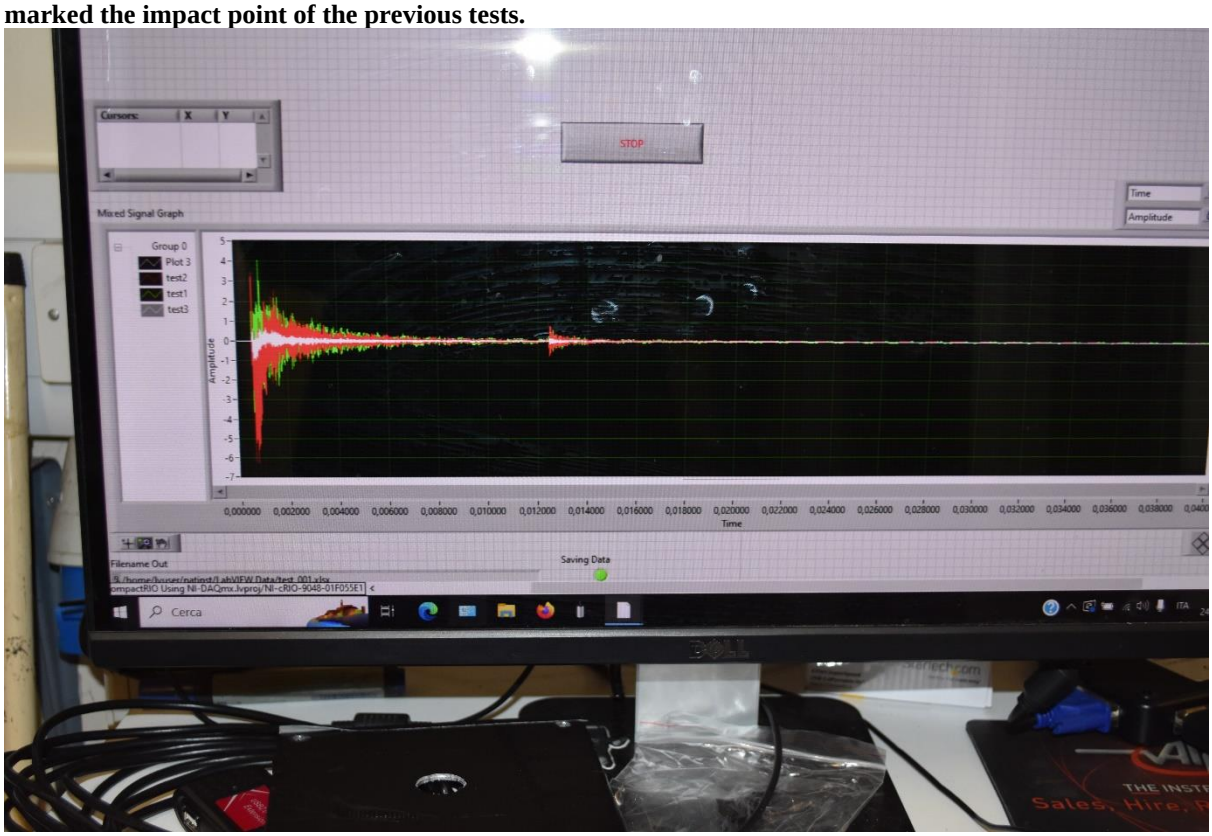


Figure 3 Real time acquisition of signals from impacts. In the plot are reported 2 different impacts: the main (early peak) due to the original projectile and the second (the small, later, peak) probably due to some debris.

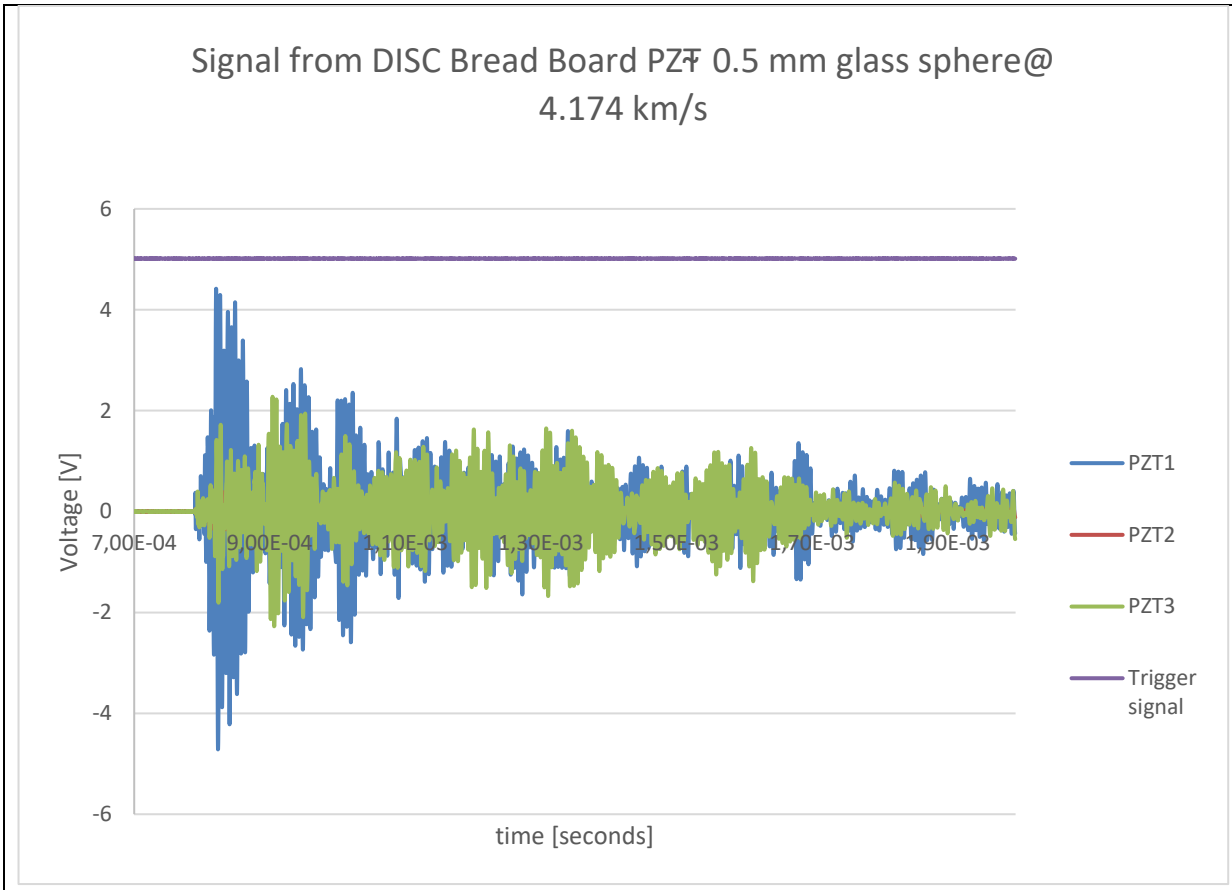


Figure 4 Signal from single glass sphere at 4.1 km/s

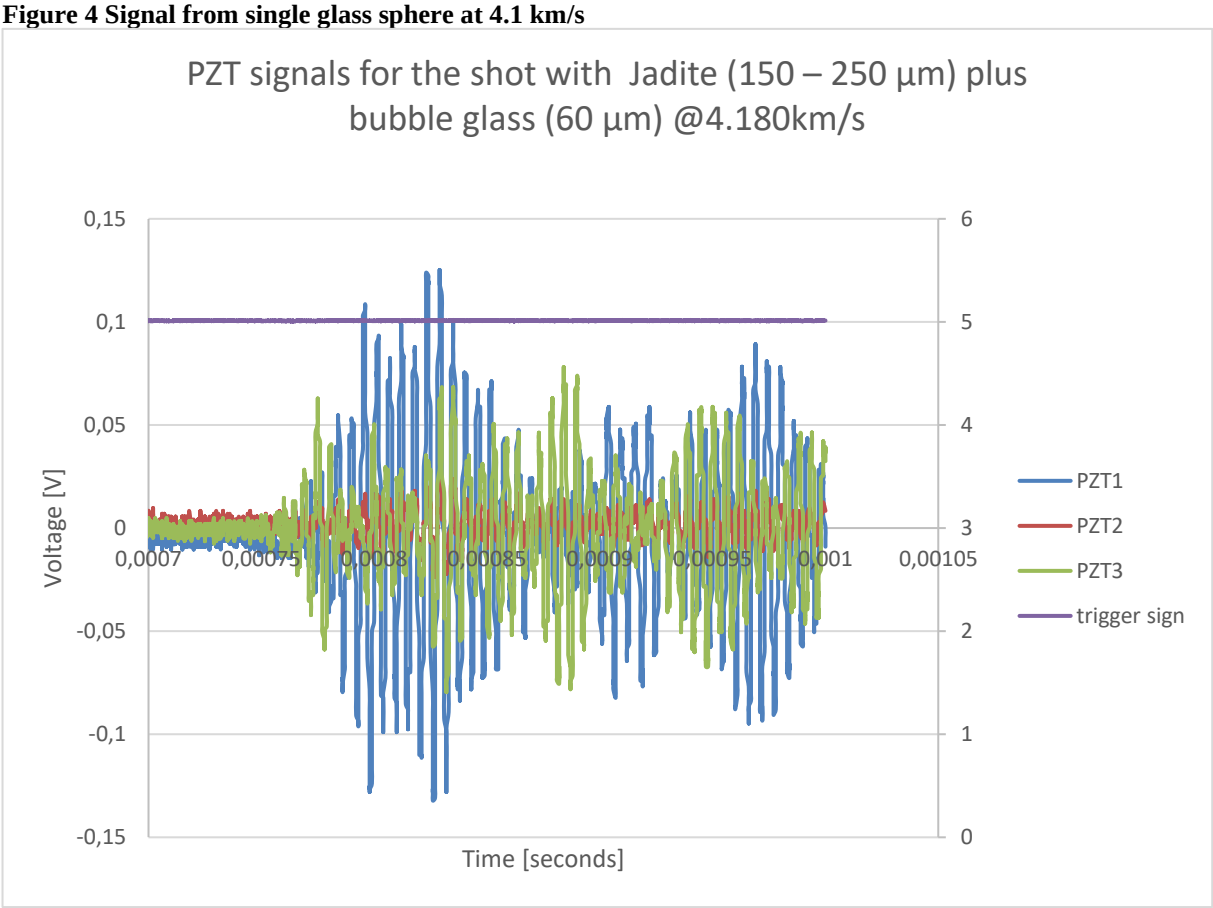


Figure 5 Signals for the shot with Jadite (150 – 250 µm) plus bubble glass (60 µm) @4.180km/s

- Give details of any publications arising/planned (include conference abstracts etc)

- Host confirmation

Please can hosts fill in/check this table confirming the breakdown of time for this TA project:

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: 28-03-23 Arrived: 28-03-23	28-03-23	0.5	2 (the test lasted 2 weeks but were followed by remote thanks the assistance of the UKent personnel)	20	24-05-23 The tests were performed in 2 different weeks the first at the end of March 23 and the second at the end of May 23)	Departed: 30-03-23 Arrived: 30-03-23

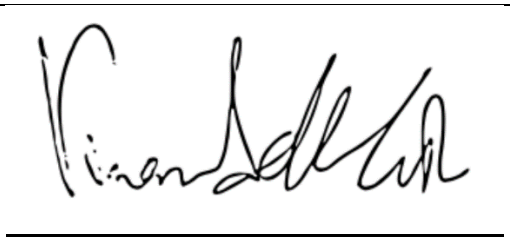
The host is required to approve the report agreeing it is an accurate account of the research performed.

Host Name	**Penelope Wozniakiewicz**
Host Signature	
Date	**20.08.23**

- Project Leader confirmation

Do you give permission for the full version of this TA Scientific Report (in addition to the 250 word summary) to be published by Europlanet 2024 RI on its website and/or public reports? YES

Project Leader Name	**Vincenzo Della Corte**

Project Leader Signature	
Date	**28/07/2023**