Europlanet TA Report

Please see Annex 1 below

Infrastructure short name	Installation ID	Installation short name
DPSF-Cold Surfaces spectroscopy, Institut de Planétologie et Astrophysique de Grenoble (IPAG), France	TA2-4	CSS

PROJECT LEADER – APPLICANT 1

Project number: 18-EPN4-039		
Name: Anna Galiano		
Home Institution full address: - Institute for Space Astrophysics and Planetology (IAPS-INAF) Via del Fosso del Cavaliere, 100, 00133, Rome, Italy		
Country: Italy		
Legal Status* RES		
*__UNI__ (University and other higher education organisations) **RES** (Public research organisation (including international research organisation as well as private research organisation controlled by a public authority) **SME** , **PRV** (Other Industrial and/or profit Private organisation) or **OTH**		
Tel: +39 0649934074	**Fax:**--	**E-mail:** anna.galiano@inaf.it
Gender: F	**Year of birth:** 1990	**Group Leader** Y
New user: Y	**Number of visits:**1	**Nationality:** Italian
Affiliation: IAPS-INAF	**Researcher Status:** PDOC	**Activity Domain*** (see below) : Physics, Material Sciences

CO - APPLICANT – if applicable

Name: Fabrizio Dirri		
Home Institution: - Institute for Space Astrophysics and Planetology (IAPS-INAF) Via del Fosso del Cavaliere, 100, 00133, Rome, Italy		
Tel: +39 06 49934428	**Fax:**--	**E-mail:** fabrizio.dirri@inaf.it
Gender: M	**Year of birth:** 1984	**Group Leader** N
New user: N	**Number of visits:**1	**Nationality:** Italian
Affiliation: IAPS-INAF	**Researcher Status:** PDOC	**Scientific background*** (see below) : Physics, Material Sciences, Information & Communication Technology

**Please select the most appropriate description from the list below:*

Physics	Chemistry	Life Sciences & Biotech	Earth Sciences & Environment
Mathematics	Energy	Material Sciences	Engineering & Technology
Social Sciences	Humanities	Information & Communication Technology	

How did you hear about us?

~~Website~~	~~Advertising email~~	**Colleague**	
Other:-			

HOST (TA Facility) **–** Please be accurate. This information is required for reporting.

Name:	**Host laboratory:**
Cold Surfaces Spectroscopy (CSS)	Institut de Planétologie et Astrophysique de Grenoble (IPAG) Grenoble, France
Start Date of visit	18/02/2019
Finish Date of visit:	22/02/2019
No. of days: Please do not include travel days, this is lab/field access only	5
Applicant/Co-applicant reimbursed? Please indicate Yes or No	Yes (waiting for reimbursement)

VISITORS TO LAB (If different from above applicant and co-applicant) **–**

Name:	**Affiliation:**	**Date**

Project Title – "**VIS-NIR Reflectance analysis of Ceres analogue mixture at different grain size to characterize the physical properties of crater central peak material (ccp) on Ceres"**

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

Ceres analogue mixture has been reproduced at different grain size in order to study spectral variations and to determine the properties of central peaks of complex craters on Ceres.
By literatures, the Ceres surface is composed of Mg-phyllosilicates, NH_4-phyllosilicates, Mg-/Ca-carbonates and a dark component. Thus, different mixtures (grain size included between 50-100 μm) have been produced by varying the percentage of the end-members, i.e. Mg-/Ca-carbonate, Antigorite (Mg-phyllosilicate), NH_4-montmorillonite (NH_4-phyllosilicate) and Graphite (dark component). The bidirectional reflectance spectra of the mixtures have been acquired in vacuum at room temperature (290K) by using the SHINE Spectro-Gonio Radiometer (spectral range: 0.4-4.0 μm) with incidence angle of 0° and emission angle of 30°.
The spectra have been analyzed, by estimating spectral parameters related to absorption bands as band center and band depth, and the most similar Ceres analogue mixture has been reproduced with grain size <25μm, 25-50 μm and 50-100μm. The mixtures and end-members spectra (at grain size of 50-100 μm, 25-50 μm and <25 μm) have been acquired by using the Spectro-Gonio Radiometers, in vacuum chamber at low temperatures, to simulate the Ceres environment.

Full Scientific Report on the outcome of your TNA visit

Approx. 1 page

The aim of this work was to produce a Ceres analogue mixture at different grain size and study the spectral behaviour to detect the properties of central peak of complex craters on Ceres [1], dwarf planet widely investigated by the VIR spectrometer onboard of Dawn spacecraft.
The VIR spectra of Ceres show absorption bands at about 2.7 μm, 3.1 μm, 3.4 μm and 4.0 μm. By applying Hapke theory-based models, the Ceres VIR spectra were reproduced, suggesting a surface composition of dwarf planet made of Mg-phyllosilicates (responsible of 2.7 μm absorption band), NH_4-phyllosilicates (responsible of 3.1 μm band), Mg-/Ca-carbonates (which produce the 3.4 and 4.0 μm bands) and a dark component [2].

A preliminary analysis has involved a Ceres analogue mixture (Mixture #1, grain size <25 μm), composed by high percentage of Graphite (the dark component) and reduced percentage of Antigorite (Mg-phyllosilicate), NH_4-montmorillonite (NH_4-phyllosilicate) and Mg-/Ca-carbonate. The bidirectional reflectance spectrum of Mixture #1 has been acquired with the SHADOWS Spectro-Gonio Radiometer in the Visible-NIR spectral range, between 0.4 and 4.0 μm at temperature of 290 K in vacuum chamber. The viewing angles were characterized by an incidence angle *i* of 0° and emission angle *e* of 30°. Because of the high percentage of dark component, the spectral bands of the carbonate and phyllosilicates were covered up by the graphite spectral trend (Figure 1 left).

Thus, a second (Mixture #2) and third mixture (Mixture #3a, Mixture #3b), with grain size between 50-100 μm, have been obtained by varying the percentage of phyllosilicates, and in particular by increasing the percentage of carbonate and decreasing the percentage of graphite. The four end-members (Mg-/Ca-carbonate, Graphite, Antigorite and NH_4-montmorillonite) have been sieved and

analysed at the same grain size, too.
In order to select the best analogue mixture able to reproduce Ceres surface, the bidirectional reflectance spectra of the mixtures have been acquired at 290K with the SHINE Spectro-Gonio Radiometer by using the same viewing geometries previously applied to Mixture #1 (*i*=0° and *e*=30°). The reflectance spectra of the analysed mixtures are shown in Figure 1 right and compared with a representative spectrum of Ceres (acquired by VIR spectrometer during the Dawn mission).

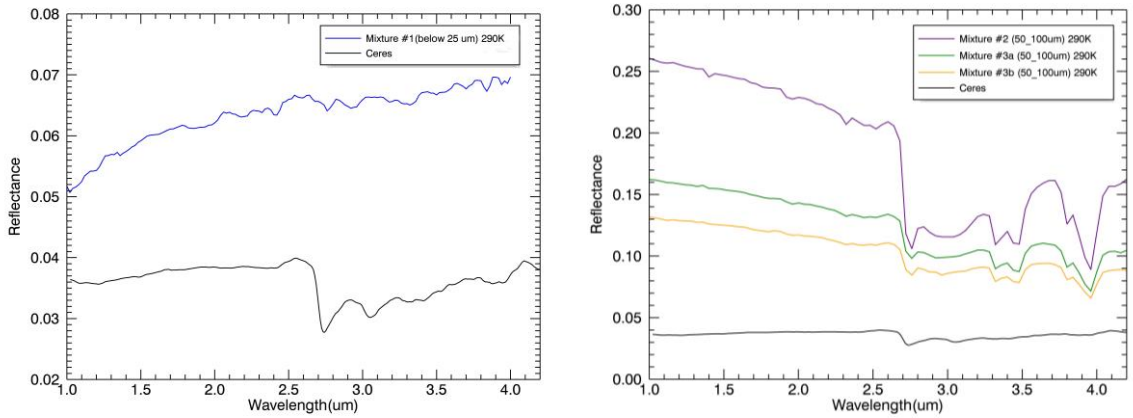

Figure 1 left. Reflectance spectrum of Ceres analogue mixture (Mixture #1) compared with the representative spectrum of Ceres surface.
Figure 1 right. Reflectance spectra of Ceres analogue mixtures (Mixture #2, Mixture #3a, Mixture #3b), performed at CSS, compared with the representative spectrum of Ceres surface.

A preliminary spectral analysis has been performed on the absorption bands of mixtures' spectra and the best Ceres analogue mixture has been identified. The absorption bands have been isolated by fitting and removing the spectral continuum and spectral parameters as band center and band depth have been estimated. The absorption bands of carbonate bands, i.e. at 3.4 and 4.0 µm are weaker in the Mixture #3b, with band depth of 0.155 and 0.278, respectively (higher than 1 order of magnitude compared with Ceres mean values). Due to the stronger carbonate bands and weaker phyllosilicate bands in the Mixture #3b compared with Ceres spectral bands, a new mixture (Mixture #4) has been produced by increasing abundance of phyllosilicates and by decreasing the percentage of carbonate.
Then, the selected mixture (Mixture #4) has been reproduced at grain size of 25-50 µm and <25 µm and to reproduce the Ceres environmental conditions, the reflectance spectra of the mixture (<25 µm, 25-50 µm and 50-100 µm) have been acquired (*i*=0°, *e*=30°) in vacuum from 200K to 290K (CarboN-IR cell). The spectra of the four end-members at different grain sizes have been acquired, too in the same temperature range. The data analysis of Mixture #4 at different grain size is under study.

References
[1] Galiano A. et al., 2019, Spectral analysis of the Cerean geological unit crater central peak material as an indicator of subsurface mineral composition, Icarus 318, pp. 75-98, doi: https://doi.org/10.1016/j.icarus.2018.05.020
[2] De Sanctis, M. C. et al., 2015, Ammoniated phyllosilicates with a likely outer Solar System origin on (1) Ceres, Nature 528, pp. 241-244, doi:10.1038/nature16172.

Please include:

- Publications arising/planned (include conference abstracts etc)

1) **Abstract.** Laboratory experiment on different Ceres analogue mixtures and spectral analysis, EPSC-DPS Joint Meeting 2019 (Planned).
2) **Abstract.** Spectral variations related to granulometry in Ceres analogue mixtures: implication for a better comprehension of crater central peak material (ccp), EPSC-DPS Joint Meeting 2019 (Planned).
3) **Scientific paper** "Detection of the Ceres analogue mixture by laboratory experiments and spectral analysis to determine each end-member's contribution"
4) **Scientific paper "**Spectral trend of the Ceres analogue mixtures in dependence of the granulometry to detect properties of crater central peak material (ccp) on Ceres**"** (Planned)

Please add the Europlanet official Acknowledgement to each publication and dissemination activity

"Europlanet 2020 RI has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 654208"

- Host approval

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

The two managers of the CSS facility, Bernard Schmitt (CNRS/IPAG, Grenoble), and Pierre Beck (UGA/IPAG, Grenoble), approve the report and agree that it is an accurate account of the research performed during the visit of the Cold Surface Spectroscopy facility (DPSF/CSS/TA2-4).

Annex 1

Access provider short name	*Short name of infrastructure*	*Installation*		*Installation Country code*
		ID	*Short name*	
INTA	PFA	TA1-1	Rio Tinto	ES
IRSPS	PFA	TA1-2	Ibn Battuta	IT
Matis	PFA	TA1-3	Iceland	IS
INTA	PFA	TA1-4	Tirez Lake	ES
IRSPS	PFA	TA1-5	Danakil	IT
DLR	DPSF	TA2-1	PEL	DE
MUG	DPSF	TA2-2	IMRF	AT
AU	DPSF	TA2-3	PEF	DK
CNRS	DPSF	TA2-4	CSS	FR
UJF	DPSF	TA2-4(8)	CSS – 3rd party	FR
VUA	DPSF	TA2-5	HPHT	NL
OU	DPSF	TA2-6	LMC	GB
NHM	DPSF	TA2-7	PMCF	GB
VUA	DAFS	TA3-1	GGIF	NL
CNRS	DAFS	TA3-2	HNIF	FR
CNRS	DAFS	TA3-3	SRIF	FR
OU	DAFS	TA3-4	HS50L	GB
OU	DAFS	TA3-5	LFS	GB
OU	DAFS	TA3-6	CSSIA	GB
WWM	DAFS	TA3-7	RNTSI	DE
CNRS	DAFS	TA3-8	IPF	FR