Europlanet TA Report

Please see Annex 1 below

Infrastructure short name	Installation ID	Installation short name
DPSF	TA2-4	CSS

PROJECT LEADER – APPLICANT 1

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Country: SWITZERLAND		
Legal Status* UNI		
***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**		
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New user: Y	**Number of visits:** 0	**Nationality:** French
Affiliation: NCCR PlanetS, Physics Institute, University of Bern	**Researcher Status:** PDOC	**Activity Domain*** (see below) : (Discipline) Physics (Planetary Sciences)

CO - APPLICANT – if applicable

Name: Dr. Antoine Pommerol		
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Affiliation: Physics Institute, University of Bern	**Researcher Status:** EXP	**Scientific background*** (see below) : Physics (Planetary sciences)

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**	
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COLLABORATORS

Name:	**Affiliation:**
Zurine Yoldi	**NCCR PlanetS, Physics Institute, University of Bern**
Bernhard Jost	**Physics Institute, University of Bern**
Date of TA visit:	**From 17/10/2016 to 28/10/2016**
No. of days:	**10**
Host laboratory:	**Institut de Planétologie et Astrophysique de Grenoble (IPAG)**
Reimbursed	**Yes**

Project Title – **Near- and mid-infrared spectroscopy of icy planetary/cometary analogue matter**

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

We have measured about 30 reflectance spectra from 0.7 to 4 µm of 10 different samples (at 173K) including pure water ice particles of different size distributions, and their mixtures with anthracite dust. We have performed a systematic study showing how the particle sizes (from about 2 to 100 µm), the dust concentration (from 1 to 10 wt%), the way the water is mixed with the dust (intra- or inter- particle mixtures) influence the shape/depth of the absorption bands, the level of reflectance of the continuum, and the amplitude of the Fresnel reflection peak. These data provide useful references to test radiative transfer models and to help the interpretation of observational data of icy/dust objects such as comets or icy satellites.

Full Scientific Report on the outcome of your TNA visit

The goal of our TNA visit at IPAG was to measure the reflectance spectra from 0.7 to 4 µm of surface samples of water ice and dust particles produced with the SPIPA machines (Setups for the Preparation of Icy Planetary Analogues) developed at the University of Bern. We transported the SPIPA machines from Bern to Grenoble in order to prepare well-characterized samples in reproducible ways.

We have successfully measured about 30 spectra of 10 different samples (at 173K) including pure water ice particles of different size distributions, and their mixtures with anthracite dust (Table 1). We prepared water ice/dust mixtures with different dust-to-water mass ratios (0.01 and 0.1) and using different methods to mix the ice and the dust (intra- and inter- mixtures).

N°	Sample description	Size distribution water ice	Size distribution anthracite dust	Temperature
1	Pure water ice particles	4.5 ± 2.5 µm	N.A.	173 K
2	Pure water ice particles	67 ± 32 µm	N.A.	173 K
3	Pure water ice particles	67 ± 32 µm	N.A.	223 K
4	Pure water ice particles	5-100 µm*	N.A.	173 K
5	Pure anthracite	N.A.	< 25 µm	173 K
6	Intra-mixture of water and 1% anthracite	67 ± 32 µm	< 25 µm	173 K
7	Intra-mixture of water and 10% anthracite	67 ± 32 µm	< 25 µm	173 K
8	Inter-mixture of water and 1% anthracite	67 ± 32 µm	< 25 µm	173 K
9	Inter-mixture of water and 10% anthracite	67 ± 32 µm	< 25 µm	173 K
10	Inter-mixture of water and 1% anthracite	4.5 ± 2.5 µm	< 25 µm	173 K

Table 1: Samples whose reflectance spectra were measured during this TNA visit

Pure water ice particles of different size distributions

The reflectance spectra of pure water ice particles are shown in Figure 1. These spectra indicate how different size distributions influence the shape/depth of the water absorption bands (at 1.05, 1.28, 1.5, 2 µm), and the shape of the spectrum between 2.5 to 4 µm. In particular, a Fresnel reflection peak centred at 3.1 µm is detected for particles of 67 ± 31 µm, but is absent when micrometer-sized particles (4.5 ± 2.5 µm) are present on the surface. Alternatively, the bump of reflectance centred at 3.7 µm is indicative of the presence of micrometer-sized particles and is absent for particles of 67 ± 31 µm.

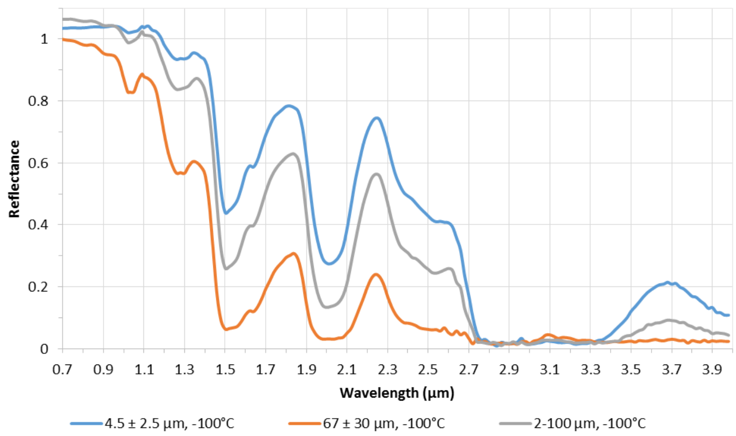

Figure 1: Reflectance spectra of surfaces of pure water ice particles with different sizes

Mixture of water ice and anthracite dust

We produced anthracite dust to mix with the water ice because this material has a nearly featureless spectrum from 0.7 to 4 µm, enabling to characterize precisely how the dust affects the water ice spectral features in the visible and infrared ranges (Figure 2).

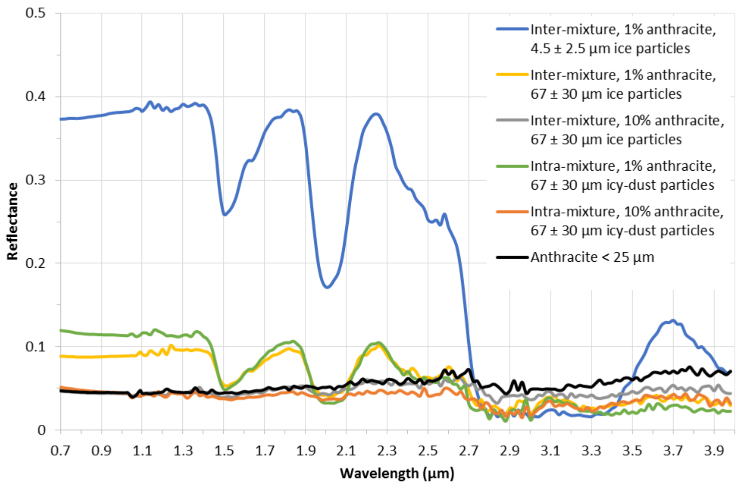

Figure 2: Reflectance spectra of surfaces mixtures of water ice and anthracite particles

An in-depth analysis of the results presented in Figure 2 indicates how the way the water and the dust are mixed together, how the concentration of dust and how the size of the water ice particles, affect the reflectance of the water ice (i.e. the shape/depth of the absorption bands, brightness, amplitude of the Fresnel reflection peak etc.).

This visit resulted in the production of very valuable data for the interpretation of the observations of past, current and future space missions exploring icy/dust objects such as Rosetta and JUICE. These data also provide useful references to test radiative transfer models.

Given the success of this visit and the need of such laboratory reference measurements for the community, we are already planning to propose a future campaign of measurements on this facility. This new campaign could (1) enable us to complete the systematic study we have started (Table 1) and (2) characterize the evolution of these icy-dust samples during sublimation of the ice, especially with a dust composition closer to a cometary one, in order to help the interpretation of Rosetta OSIRIS/VIRTIS data.

Please include:

- Publications arising/planned (include conference abstracts etc)

We plan to submit a first publication based on these results in March 2017, probably to a high impact peer-reviewed journal such as *Icarus* or *Journal of Geophysical Research*.
We will also consider presenting these results to the next conferences, probably first at the European Planetary Science Congress in 2017.

- 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 facility, Bernard Schmitt (CNRS/IPAG, Grenoble), and Pierre Beck (UJF/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