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GIADA (Grain Impact Analyser and Dust Accumulator) prepares for the comet 67P/Churyumov-Gerasimenko encounter.

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Abstract

Rosetta is an ESA space mission that, after a trek of 10 years across the Solar System, in 2014 will reach short period comet 67P/Churyumov-Gerasimenko and follow it during its approach to the Sun to characterize the comet's evolution. GIADA is an *in-situ* instrument devoted to measure the dynamical properties of the dust grains emitted by the comet. The three subsystems composing the instrument are capable of measuring mass, speed of single dust grains and the dust mass flux. In preparation of the operative phase of the mission crucial activities have been foreseen in order to be prepared to the challenging environment of the comet.

1. Introduction

The GIADA instrument consists of three measurement subsystems: the GDS (Grain Detection System) an optical device measuring the optical cross-section for individual grains), the IS (Impact Sensor) an aluminum plate with connected 5 piezo-sensors detecting the momentum of the dust grains impacting the plate and MBS (Micro Balance System) constituted by 5 QCM (Quartz Micro Balances). The first two subsystems by means of a combined detection provide the speed, mass, and momentum of individual dust grains with diameters ranging between 60 and 500 microns the third subsystem measures the dust mass flow for grains smaller than 10 microns. The performances of the instrument are summarized in Table 1 [1]. During the Rosetta hibernation phase we started three major activities to prepare the science operations for the operational phase of the mission:

- Extended Calibration activity on the Flight Spare Model
- Simulation tool development to evaluate GIADA performance
- Analysis of the GIADA behavior during the cruise phase

Table 1: GIADA Performances

Subsystems	Physical quantity measured	Ranges
GDS	Optical Cross Section	60-500 [µm] (radius)
	Speed	1-300 [m/s]
IS	Momentum	6.5e-10 to 4e-4 [kg*m/s]
MBS	Accumulated mass	1e-10 to 1e-4 [g]

2. Extended Calibration

Taking into account the knowledge gained through the analyses of Interplanetary Dust Particles [2] and cometary samples returned from comet 81P/Wild 2 (Stardust mission) [3,4], we selected terrestrial materials as cometary dust analogues and we produced analogue grains with selected sizes ranging from 20 – 500 µm in diameter (see Table2). These grains are characterized by FE-SEM/EDS and micro IR spectroscopy. Single grains are then manipulated and shot into the GIADA flight spare model, housed in a clean room in our laboratory, with velocities in the range of 1 – 100 m/s [5,6] to obtain calibration curves as a function of chemico-physical grain properties. With these calibration curves we build a large database for the sensors behavior that will be used to better interpret the real data that GIADA will collect during the comet phase.

Table 2: list of terrestrial materials used during the extended calibration performed with the GIADA flight-spare model.

CLASS	SAMPLE	FORMULA
Nesosilicate	Forsterite	Mg_2SiO_4
Nesosilicate	Fayalite	$Fe^{2+}{}_2SiO_4$
Sorosilicate	Melilite	$(Ca,Na)_2(Al,Mg,Fe^{2+})(Si,Al)_2O_7$
Inosilicate	Enstatite	$Mg_2Si_2O_6$
Phyllosilicate	Talc	$Mg_3Si_4O_{10}(OH)_2$
Phyllosilicate	Serpentine	$Mg_3Si_2O_5(OH)_4$

Phyllosilicate	Kaolinite	$Al_2Si_2O_5(OH)_4$
Tectosilicate	Albite	$NaAlSi_3O_8$
Tectosilicate	Anortite	$CaAl_2Si_2O_8$
Oxide	Corundum	Al_2O_3
Sulphide	Pyrrhotite	FeS

3. Performance Evaluation

In order to evaluate the instrument behavior in an operative scenario was developed a SW capable of predicting the instrument scientific and technical performances vs. a simulated cometary dust environment. The GiPSi SW (GIADA Performance Simulator) describes the instrument performances, in terms of scientific (grains detected) and technical (power, data volume, etc.) response having as in-puts the orbit proposed by the Rosetta Scientific Ground Segment and the output of an evolutionary dust model. GIPSI is a Java client software able to simulate the behavior of each of the GIADA sensors. It's composed by three main modules : a simulator, a graphic module and the quick look module. With the simulator we can obtain the performances that the instrument can reach, in term of number of dust particles detected by each sensor, if placed in a specific dust comet environment along a specific orbit and for a defined time interval.

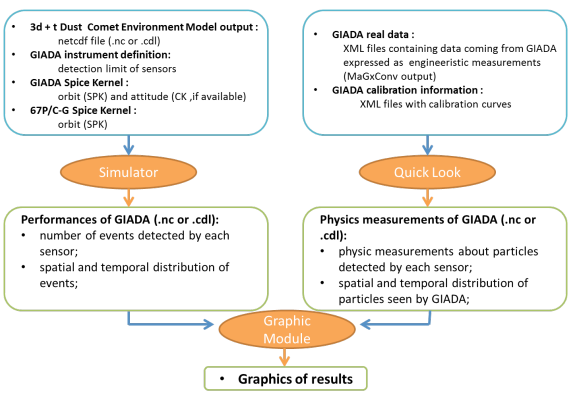

Figure 1: GIPSI Block Diagram.

4. Cruise Phase Data Analysis

During the cruise phase of the ROSETTA mission GIADA was not designed to collect relevant scientific data. It was nevertheless possible to monitor the instrument behavior by means of planned periodic check-out performed every 6 moths. During the whole cruise phase the instrument continued to maintain a nominal behavior, only the MBS experiencing a small contamination. The performances for the three subsystems remained nominal without degradations. In addition, the check-out allowed to verify the operation of the instrument under different conditions extending the tests performed on ground.

6. Summary and Conclusions

Despite the Rosetta mission is currently in hibernation phase, the challenge of the cometary environment, that the GIADA instrument will characterize, requires a great deal, for the preparation of the mission scientific phase, by the Team. Actions taken, as the calibration laboratory and operations planning, will allow to obtain the maximum scientific return from the measurements that GIADA will perform.

Acknowledgements

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