MATI: AN INSTRUMENT FOR THE DETECTION OF THE MARTIAN TORI.

E. Palomba[1], A. Longobardo[1], M. D'Amore[1], R. Battaglia[3], V. Della Corte[3], G. Ferrini[3], [1]IFSI-INAF, Via Fosso del Cavaliere 100, 00133 Roma, Italy, palomba@ifsi-roma.inaf.it, [3]Novætech S.r.l. Piazza Pilastri 18, 80100 Napoli, Italy.

Introduction: Bombardment of micrometeoroids onto the satellites of the giant planets and the corresponding impact ejecta are a well known source for dust rings [1,2]. Since Mars has two small moons, Phobos and Deimos, two dust tori around the planet could have developed as many models predict [3]. These models describe a Phobos torus which lies embedded within, and has a smaller vertical extent than, the Deimos torus. Currently, the Martian Tori are still undetected and in depth insitu measurements only, seems to be the most suitable way to discover them.

MATI: MATI (Mars Tori Investigator) is a dust detector customised for the Martian dust environment that can be proposed for the next Space missions to Mars. The main MATI scientific objectives concerns the detection and characterisation of Phobos and Deimos tori, the analyses of flux, mass and velocity of the tori particles in the size range (1-100 μm) and speeds (v 1~80 km s^{-1}), the study of the grain spatial distributions and tri-dimensional modelling of the tori structure. Eventually these measurements will help to understand the origin and evolution of the Martian tori.

Technical concept: The proposed instrument is a dust detection system, carrying out quantitative in situ measurements of particle flux and mass distribution throughout the Martian dusty environment. It consists of two major parts, i.e. a detector assembly and the electronics box.

Detector Assembly and measurement technique. The detector assembly is a system composed of two stages placed in cascade, 5 cm apart. This is the piece of equipment that is mounted on the external walls of the spacecraft and is exposed to the dust particles. Each stage has a total sensitive area of 36 cm x 36 cm (Ao = 0.13 m^2) and is composed of an array of 9 single dust sensors. Each single dust sensor is a 12 cm x 12 cm polyvinylidene fluoride (PVDF) polarized foil, 6-10 μm thick, equipped with electrodes. By considering a structure made in aluminium, the mass required for the Detector Assembly structure is about 2 Kg**.** PVDF film dust detectors have been extensively characterised in laboratory experiments and have an excellent track record in space experiments [4,5]. Their detection principle is based on the depolarisation signal a dust particle generates, when penetrating a permanently polarised PVDF thin film [6]. Dust grains penetrating the thin PVDF film remove dipoles along their trajectory, producing a fast electric charge pulse without requiring bias voltages. The produced signal is a function of the particle mass and velocity. When a particle impacts a PVDF foil on the first stage of MATI, produces a crater or a perforation according to its initial velocity. From the time of flight measurements between two stages, it is possible to determine the impact speeds and from the PVDF signal, N(e)=Amavb, where m is the particle mass, v its speed and A, a, b are parameters to be determined experimentally.

Expected Results: Combining the results described in [3] with the very recent HST observations [7], which have constrained the superior limit of the Tori dust optical depth (i.e. grain density), we can evaluate the MATI expected performances. The detectable events (the torus grain impacts) will be proportional to both the grain number density and to the volume sampling rate, S_v. The S_v will be proportional to the instrument sensitive area, Ao, and to the relative speed, v_o, between the instrument and the tori particles. Since the Phobos Torus is ten times denser than the Deimos one, MATI will detect ten times more events in the Phobos proximities: for a typical relative speed (few km s^{-1}) an impact event every $2*10^2$ seconds will be detected (see Table 1).

	Grain number density (km^{-3})		Detectable Events (events per 10^4 s)	
	Phobos Torus	Deimos Torus	Phobos Torus	Deimos Torus
$S_v = 5\ 10^{-7}$ km^3 s^{-1}	10^4	10^3	50	5
$S_v = 5\ 10^{-9}$ km^3 s^{-1}	10^4	10^3	0.5	0.05

Table 1. MATI expected instrumental performances, calculated for two different relative speeds v_o=4 km s^{-1} (1st row) and 0.04 km s^{-1} (2nd row). The used grain densities are taken from [3] and [7].

References:

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