MIST-A THE MWIR SPECTROMETER ABOARD THE EMIRATES MISSION TO EXPLORE THE ASTEROID BELT. G. Filacchione[1], M. Ciarniello[1], M. C. De Sanctis[1], F. Capaccioni[1], A. Raponi[1], S. De Angelis[1], M. Formisano[1], M. Ferrari[1], S. Stefani[1], G. Piccioni[1], A. Mura[1], D. Biondi[1], A. Boccaccini[1], G. Sindoni[2], A. Tiberia[2], A. Olivieri[2], L. Tommasi[3], G. Agresta[3], L. Bucciantini[3], S. Nencioni[3], M. Lastri[3], I. Ficai Veltroni[3]. [1]INAF-IAPS, Institute for Astrophysics and Planetology from Space, via del Fosso del Cavaliere, 100, 00133, Rome, Italy (gianrico.filacchione@inaf.it), [2]ASI Italian Space Agency, via del Politecnico snc, 00133, Rome, Italy, [3]Leonardo Company, via delle Officine Galileo, 1, 50013, Campi Bisenzio, Florence, Italy,

Introduction: The MWIR Imaging Spectrometer for Target-Asteroids (MIST-A) is one of the selected scientific payloads onboard UAESA's Mission to Explore the Asteroid Belt scheduled for a launch in 2028. The mission will explore 6 main belt asteroids during as many flybys occurring between 2030-33 before entering in orbit around (269)Justitia in 2034 [1]. MIST-A is designed to acquire hyperspectral data of the asteroids' surface from which mineralogical composition and physical properties, including regolith grain size distribution, roughness, diurnal temperature, and thermal inertia can be inferred.

Instrument configuration: MIST-A design is inherited from the proven JIRAM instrument aboard Juno mission [2] and relies on a modified Schmidt off-axis telescope (D=44 mm, f/3.7) joined with a Littrow imaging spectrometer. A 2D MCT detector (windowed at 256 spatial pixels by 336 spectral bands, 40 µm pitch, 2 Me^- full well) is employed as focal plane. The instrument is operating in the 2-5 µm spectral range with a spectral sampling <10 nm/band. Thanks to a one-axis steerable mirror placed at the telescope's entrance, pointing with offsets up to ±6° from boresight can be commanded. The mirror position and angular velocity are pre-settable by telecommands. By adopting this solution, MIST-A has the flexibility to acquire hyperspectral images during the very different orbital phases of the mission. The resulting Field-Of-View (FOV) is 3.6° and the Instantaneous-Field-Of-View (IFOV) is 250 µrad, corresponding to a spatial resolution of 25 m from a 100 km distance. The maximum Field-Of-Regard (FOR) is 3.6° by 12°. With respect to the previous JIRAM instrument, the MIST-A design includes the following changes necessary to guarantee flawless operability onboard the spacecraft: 1) thermal design uses a hybrid configuration in which a passive radiator keeps the optical head structure at 130 K while an active cryocooler is employed to stabilize the detector at <90 K. This solution has been borrowed from previous imaging spectrometers operating in the vicinity of small bodies like VIRTIS on Rosetta [3] and VIR on Dawn [4]; 2) an actuated shutter is added in the proximity of the spectrometer's entrance slit to allow acquisitions of dark and background frames; 3) an actuated cover is added on the telescope's entrance baffle to protect optical elements from solar flux during the Venus' flyby and the inner solar system cruise.

Scientific Goals of the investigation: The MIST-A experiment is designed to study the composition and thermal properties of the seven target asteroids. As recent space missions (Dawn, Hayabusa and OsirisRex) and laboratory measurements on returned samples have demonstrated, the diagnostic spectral features of primitive asteroids, including hydrated minerals, organic matter, salts, and carbonates, are located within the 2.7-4.0 µm spectral range rather than at shorter wavelengths where they appear almost featureless. In particular, Mg/Fe phyllosilicates, ammonium-bearing phyllosilicates, and Ca/Mg carbonates have bands near 2.7, 3.1, 3.4, and 4.0 µm, respectively [5,6]. Organic matter, both in aromatic (C-C) and in aliphatic (C-H) forms, is recognizable through bands in the 3.2-3.8 µm spectral range [7]. By exploring the 2-5 µm spectral range the MIST-A experiment can: 1) infer the asteroids' mineralogy, including hydrated minerals, and their organic materials content; 2) derive the physical properties (grain size, roughness) of the surface regolith and correlate them with the local terrain morphology; 3) characterize the diurnal surface temperature and its temporal variability by measuring the thermal emission of the surface in the 3-5 µm spectral range; 4) infer the thermophysical properties of the outer layers of the surface, and 5) determine the composition and thermal properties of the potential landing zones on (269) Justitia for the selection of the candidate areas.

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