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Miniature Planetary In-situ Sensors (MiniPINS) – Design status and the latest activities

Maria Genzer[1], Maria Hieta[1], Harri Haukka[1], Ignacio Arruego[2], Victor Apéstigue[2], Javier Martínez-Oter[2], Alejandro Gonzalo[2], Jose Antonio Manfredi[3], Cristina Ortega[4], Carmen Camañes[4], Manuel Dominguez-Pumar[5], Servando Espejo[6], Hector Guerrero[7], and the MiniPINS team[*]

[1]Finnish Meteorological Institute, Space research and observation technologies, Helsinki, Finland (maria.genzer@fmi.fi)
[2]Instituto Nacional de Técnica Aeroespacial (INTA), Torrejón de Ardoz, Madrid, Spain
[3]Centro de Astrobiología (SCIS-INTA), Torrejón de Ardoz, Madrid, Spain
[4]Added Value Solutions (AVS), Elgoibar, Spain
[5]Universitat Politècnica de Catalunya (UPC), Barcelona, Spain
[6]Instituto de Microelectrónica de Sevilla (IMSE), Sevilla, Spain
[7]IMDEA Nanociencia, Madrid, Spain
[*]A full list of authors appears at the end of the abstract

MiniPINS is an ESA study led by the Finnish Meteorological Institute to develop and prototype miniaturised surface sensor packages (SSPs) for Mars (MINS) and the Moon (LINS). The study aims at miniaturizing the scientific sensors and subsystems, as well as identifying and utilizing commonalities of the packages, allowing to optimise the design, cut costs and reduce the development time. The project has passed its Preliminary Requirements Review in 2021 and is currently in phase B1.

MINS is a penetrator with approx. 25 kg mass, piggy-backed by another Mars mission spacecraft to Mars and deployed either from the approach orbit or Mars orbit. 4 penetrators are planned to be released to different landing sites on Mars. The design of MINS has significant heritage from FMI's MetNet mission design [1]. In the Martian atmosphere the penetrators undergo aerodynamic braking with inflatable breaking units (IBUs) until they reach the target velocity of 60-80 m/s for entering the Martian surface. The penetration depth target is up to 0.5 m, depending on the hardness of the soil. The geometry of MINS penetrator includes a thin section to improve penetrability to the soil, a medium section with 150 mm diameter to accommodate a 2U CubeSat structure inside, and a top section with a wider diameter to stop the penetration and avoid the top part to be buried inside the soil. The deployable boom is accommodated in the top section along with the surface sensors.

LINS is a miniature 7 kg station deployed on the Moon surface by a rover. The baseline carrier mission for LINS is European Large Logistics Lander (EL3). 4 LINS packages are deployed to different sites within the rover's traveling perimeter by the rover's robotic arm. LINS thermal design enables its survival during 14-day long Lunar nights when the temperature drops down to -170 C. LINS consists of a double structure, with external separated from the internal by PEEK

blocks. The bottom of LINS can be completely in contact with the lunar regolith, since it is isolated from the internal one, and the space between can accommodate additional thermal insulation. Additional heating power is provided by 3W RHU of European design.

The last stage of the MiniPINS project was a prototyping work package, which was divided into several developments. (i)The main activity was designing and manufacturing a high-impact facility to validate the MINS Penetrators. An existing air-vacuum canyon was combined with a penetration-targeting structure and a three-axis 60kg wireless accelerometer to test the penetrators with different terrains and impact velocities (facility located at INTA, Madrid). (ii) The design of a deployable mechanism for flexible solar panels for MINS by IMDEA. (iii) IMSE's ASIC technologies qualify for temperatures compatible with the lunar surface (down to -180°C). (iv) A simulator of Lunar regolith for testing the future thermal probes to characterize the lunar regolith for LINS.

[1] Harri et al. (2017), The MetNet vehicle: a lander to deploy environmental stations for local and global investigations on Mars, Geosci. Instrum. Method. Data Syst., 6, 103-124

MiniPINS team: Maria Genzer (1), Maria Hieta (1), Harri Haukka (1), Ignacio Arruego (2), Victor Apéstigue (2), Javier Martínez-Oter (2), Miguel González-Guerrero (2), Álvaro de Pedraza (2), Almudena García-Llases (2), Gustavo Rodríguez (2), Jose Antonio Manfredi (3), Cristina Ortega (4), Carmen Camañes (4), Manuel Dominguez-Pumar (5), Servando Espejo (6), Hector Guerrero (7), Matti Palin (1), Jarmo Kivekäs (1), Petri Koskimaa (1), Iina Jaakonaho (1), and Matti Talvioja (8)