High Level Shock Tests for Mars MetNet Penetrator

H. Haukka [1], W. Schmidt [1], A.-M. Harri [1], J. Heilimo [1], M. Genzer [1], I. Arruego [2], H. Guerrero [2], J. Azcue [2] and M. Reina [2]

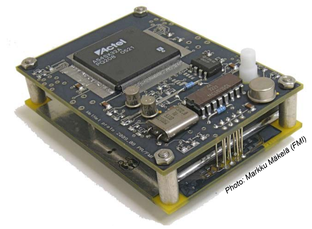
(1) Finnish Meteorological Institute, Earth Observation, Helsinki, Finland (harri.haukka@fmi.fi, +358 9 192 91), (2) Institutio Nacional de Técnica Aerospacial, Madrid, Spain

Mission Scientific Objectives

- Surface to Atmosphere interactions and Planetary Boundary Layer
- Atmospheric dynamics and circulation
- Dust raising mechnanisms
- Cycles of CO_2, H_2O and dust
- Evolution of the Martian climate

The Mars MetNet Precursor Mission (MMPM) is the technology demonstration project for the deployment of a larger network of small meteorological stations onto the surface of Mars. The development is done in collaboration between the Finnish Meteorological Institute (FMI), the Russian Lavoshkin Association (LA), the Russian Space Research Institute (IKI) and the Spanish National Institute for Aerospace Technology (INTA).

The purpose of MMPM is to confirm the concept of deployment for the mini-meteorological stations onto the Martian surface, to get atmospheric data during the descent phase, and to get information about the meteorology and surface structure at the landing site from the meteorological station during one Martian year or longer.



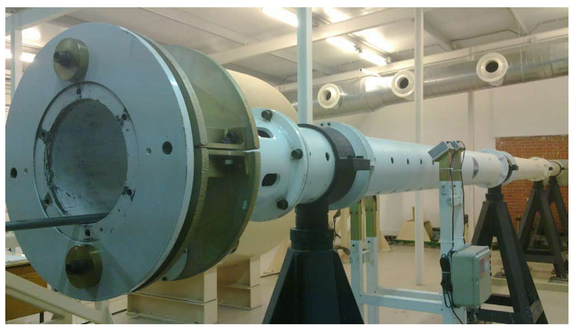
MetHumi (above) and MetBaro (below) instruments.

Accommodating the instruments for shock test.

The MetNet is a penetrator type of lander that will reach Martin surface at a speed of 200 km/h. This impact introduces shock loads in the order of 500 g during 15-20 ms. In order to qualify the Mars MetNet Mission pressure (MetBaro) and humidity (MetHumi) devices, the 500g shock tests were performed by using the special aircraft testing cannon at the Spanish INTA facility close to Madrid, which was modified for these shock tests. The used cannon works with compressed air and is normally used to test the resistance of different airplane parts to the impact of birds. In this case, the instruments under test were shot instead of birds, being themselves placed inside a bullet of expanded polystyrene.

The required shock was achieved by attaching a metallic plate to the tip of the cannon and by a polystyrene bullet that was loaded into the cannon through its barrel. The g-forces were measured by using a special accelerometer designed by INTA. The accelerometer was powered from batteries, measured the acceleration profile and stored it inside a memory that was downloaded after the impact. The shock which the instrument experienced was measured along all three main axes (x, y and z).

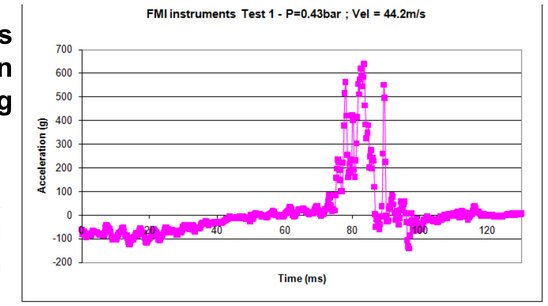
The test bullet made of expanded polystyrene.

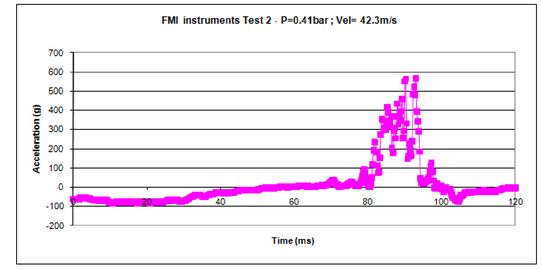


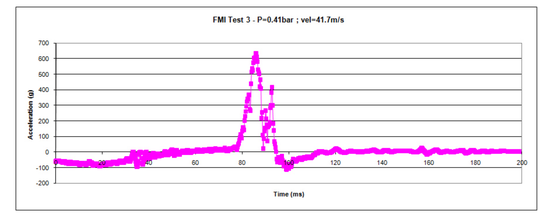
The cannon that was used in high level shock tests works with compressed air.

Instrument accommodation: For each test axis a separate bullet made of expanded polystyrene was formed and two holes carved into it, into which the respective instruments were fitted tightly in the orientation required for the planned test. The instruments were placed into small plastic bags to prevent contamination by the polystyrene during the impact of the bullet with the target.

Before each shock test, both instruments were tested in the laboratory to ensure that they were fully functional. These results were used as reference for the functional test following each of the 500g shock tests. The actual shock test was performed in three phases. In the first shooting the MetHumi instrument was shocked in the X-axis direction and the MetBaro instrument in the Y-axis direction. In the second shooting MetHumi was shocked in the Z-axis direction and MetBaro in the X-axis direction and in the third and final shooting, the MetHumi was shocked in the Y-axis direction and MetBaro in the Z-axis direction. Both instruments survived all three shock test shootings. Shock spectra of all three shock tests were in line with the requirements of the Mars MetNet Mission.

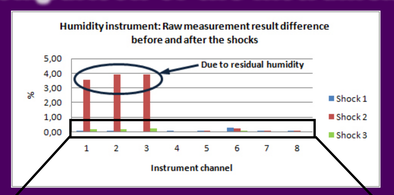


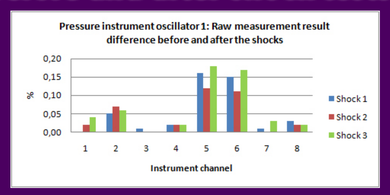


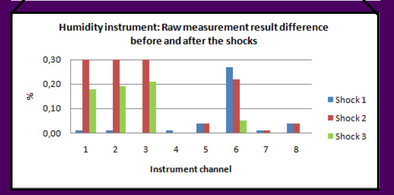


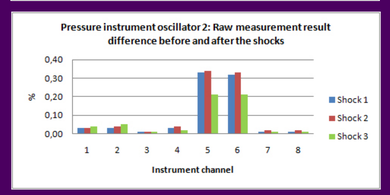
Shock test spectrums for each three tests that were performed. Charts: INTA.

Comparison of the instruments before and after shock tests









More information from the Mars MetNet Mission website http://metnet.fmi.fi

Poster design: Harri Haukka, FMI