42nd SYMPOSIUM ON SAFETY AND QUALITY IN SPACE ACTIVITIES (D5)
From Parts to Systems : Contribution of Tests on Performance Prediction and Assessment (1)

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THE SEISMOMETER CHALLENGE: HOW TO TEST AN INSTRUMENT ON EARTH UNDER MARTIAN OR MOON GRAVITY?

Abstract

In order to assess the dynamics and the internal structure of Mars and the Moon, seismometers are planned to be deployed there in the next decade. Before launch, the instrument has to pass several series of tests to be compliant with international space standards. A cleanroom, a seismic vault and a Martian chamber have been built at our premises to simulate the Martian atmosphere. Tunable parameters are: carbon dioxide ratio, temperature down to -130 deg C and vacuum down to 1.10-6 mbar. Since our instrument works like a pendulum, it is fully dependent on environment gravity and thus highly difficult to run on Earth. Therefore, how could we simulate Martian or Lunar gravity on Earth? There are two solutions that have been adopted depending on the type of test to be performed. The first option is to overload the mobile mass of the pendulum with a 66-g countermass. This allows for a stable equilibrium position between the capacitive sensor electrodes under Earth gravity and meets the signal over noise ratio requirement. However, this solution is not fully representative of the flight version since an extra mass has been added. The other option adopted is to tilt the pendulum by 23 deg and use a dedicated feedback loop. Using both these options, all functional tests can be performed and their linking mathematical model confirmed. Because not all performance tests could be run on Earth given the specificity of the global instrument layout, this very same model will be used to assume performance tests results on Mars from performance tests run on Earth. Similar computations are currently being done to adapt this mathematical model to the Moon configuration, which includes a 68-g extra mass to the mobile mass. Another issue we need to address is that several of these pendulums are embedded inside a hermetically sealed sphere under vacuum. To meet the mass budget requirement, the geometry of the sphere shells is calculated to strictly fit the flying material, and does not allow extra room for the test countermasses. Moreover, the pendulums are mounted inside the sphere following different tilted axes to render vertical axis data. How could we test on Earth the sealed sphere flight model containing the pendulums in Mars or Moon configuration? Several options are considered but could require waivers to some space standards requirements. The discussion is open as this issue has never been addressed before.