Geophysical Research Abstracts
Vol. 16, EGU2014-6109, 2014
EGU General Assembly 2014

Recording the PHILAE Touchdown using CASSE: Laboratory Experiments

Martin Knapmeyer (1), Claudia Faber (1), Jean-Baptiste Tune (3), Walter Arnold (4), Lars Witte (2), Silvio Schröder (2), Reinhard Roll (5), Bernd Chares (5), Hans-Herbert Fischer (6), Diedrich Möhlmann (1), and Klaus Seidensticker (1)

(1) DLR, Institut für Planetenforschung, Berlin, Germany (martin.knapmeyer@dlr.de), (2) DLR Institute of Space Systems, Bremen, Germany, (3) Universite Paris Diderot, Institut de Physique de Globe de Paris, Paris, France, (4) Saarland University, Department of Materials Science and Technology and 1. Physikalisches Institut, Göttingen University, Göttingen, Germany, (5) Max Planck Institute for Solar System Research, Göttingen, Germany, (6) DLR Space Operations and Astronaut Training-MUSC, Cologne, Germany

The landing of Philae on comet 67P/Churyumov-Gerasimenko is scheduled for November 11, 2014. Its landing feet house the triaxial acceleration sensors of CASSE (Comet Acoustic Surface Sounding Experiment) which will thus be the first sensors to be in mechanical contact with the cometary surface. It is planned that CASSE will be in listening mode to record the deceleration of the lander by the collision with the comet. The analysis of this data will not only support an engineering analysis of the landing process itself but also yield information about the mechanical properties of the comet's surface.

Here, we describe a series of controlled landings of a lander model. The tests were conducted in the Landing & Mobility Test Facility (LAMA) of the DLR Institute of Space Systems in Bremen, Germany, where an industrial robot can be programmed to move landers or rovers along predefined paths and under simulated low gravity.

The qualification model of the Philae landing gear was used in the tests. It consists of three legs manufactured of carbon fiber and metal joints. Attached to each leg is a foot with two soles and a mechanically driven ice screw to secure the lander on the comet. The right one of these soles, if viewed from the outside towards the lander body, houses a Brüel & Kjaer DeltaTron 4506 triaxial piezoelectric accelerometer as used on the spacecraft. Orientation of the three axes was such that the X-axis of the accelerometer points downwards while the Y and Z axes are horizontal. This somewhat uncommon orientation was necessary due to the position of the electric connector on the 4506. Data was recorded at a sampling rate of 8.2 kHz for a duration of 2 s.

Touchdown measurements were conducted on three types of ground with different landing velocities. Landings with low velocities were carried out on the concrete floor of the LAMA to determine the stiffness of the landing gear based on the deceleration data measured with the accelerometer. Landings on fine-grained quartz sand and on a Mars soil simulant (brand names Wf34 and MSS-D, respectively) allow quantifying the changes of the deceleration data due to interaction with the soil. The elastic moduli of the soils that were inverted from the accelerometer data agree well with data obtained by ultrasonic time-of-flight measurements. To this end, the lander structure was viewed in a simplified way as a mass-spring system coupled to the soil by a contact spring whose stiffness is determined by elastic moduli of the soil and the contact radius.