SEIS/INSIGHT: Toward the Seismic Discovering of Mars

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The NASA InSight (Interior Exploration using Seismic Investigations, Geodesy and Heat Transport) mission will land on Mars on November, 26th after a launch on May, 2018. The payload is a complete international geophysical observatory, with a seismometer (SEIS, France), a heat flux experiment (HP^3, Germany), a geodesy experiment (RISE, US), a magnetometer and the APSS (US) suite of atmospheric sensors measuring wind (TWINS, Spain), atmospheric temperature, pressure and magnetic fields. SEIS is the primary instrument of the mission and consists of a 3-axis very-broad-band (VBB, France) instrument and a 3-axis short period (SP, UK) instrument, mounted on a Leveling system (LVL, Germany), connected to acquisition and control electronics (Ebox, ETHZ from Switzerland) by a Tether (US), and protected by a Wind and Thermal Shield (WTS, US). The SP noise floor is $3\ 10^{-9}$ $m/s^2/Hz^{1/2}$ between 0.1 and 6 Hz and significantly better than SP requirements (10^{-8} $m/s^2/Hz^{1/2}$ between 0.1 and 10Hz). The VBBs are enclosed in a vacuum thermal enclosure (EC) under JPL responsibility, which not only provides a high thermal protection for the VBBs but also reduces their Brownian noise, enabling the VBBs to reach a very low noise floor of $3\ 10^{-10}$ $m/s^2/Hz^{1/2}$ between 0.1 and 1 Hz, which is also significantly better than VBBs requirements (10^{-9} $m/s^2/Hz^{1/2}$ between 0.01 and 1Hz).

We describe first the SEIS experiment and present its science goals and performance demonstrated during the Flight Model characterization done during the 2017 Flight Model delivery activities, both in the clean rooms of CNES and LMA for the Flight Units and in the Black Forest Observatory seismic vault for the qualification unit. As SEIS is expected to provide the first seismic records of Mars, implementation of the science goals has been very challenging due to the lack of information on the deep seismic interior structure of Mars, as well as its level of seismic activity and surface seismic noise. Nevertheless and in parallel with the hardware technical developments made by the SEIS hardware team, the SEIS science team has developed sophisticated noise models, blind tests with synthetic data and field tests, including during activities of the HP3 mole system, which will be presented.

We then summarize and review the most recent analysis made by the SEIS team for predicting the seismic performance of the SEIS experiment in the Martian environment, including pressure and magnetic decorrelations using APSS sensors. We present the most recent update estimates of seismic signals generated by quakes, impacts and the Martian dynamic atmosphere, as well as structure inversion and seismic catalogue perspectives. We conclude by describing the Public Outreach and Educational program of SEIS.