THE INSIGHT MISSION FOR 2018. W. B. Banerdt[1], S. Smrekar[1], T. Hoffman[1], S. Spath[2], P. Lognonné[3], T. Spohn[4], H. Stone[1], J. Willis[1], J. Feldman[1], R. De Paula[5], R. Turner[6], S. Asmar[1], D. Banfield[7], U. Christensen[8], J. Clinton[9], V. Dehant[10], W. Folkner[1], R. Garcia[11], D. Giardini[9], M. Golombek[1], M. Grott[4], T. Hudson[1], C. Johnson[12], G. Kargl[13], B. Knapmeyer-Endrun[8], J. Maki[1], D. Mimoun[11], A. Mocquet[14], P. Morgan[15], M. Panning[16], W. T. Pike[17], C. Russell[18], N. Teanby[19], J. Tromp[20], R. Weber[21], M. Wieczorek[22], K. Hurst[1], E. Barrett[1], and the InSight Team. [1]Jet Propulsion Laboratory, California Institute of Technology (bruce.banerdt@jpl.nasa.gov), [2]Lockheed Martin Space Systems, Denver, [3]Institut de Physique du Globe, [4]DLR Institute for Planetology, [5]NASA Headquarters, [6]Marshall Space Flight Center, [7]Cornell Univ., [8]Max Planck Institute for Solar System Res., [9]ETH, Zurich, [10]Royal Observatory of Belgium, [11]ISAE, Toulouse, [12]Univ. British Columbia and Space Science Institute, [13]Austrian Academy of Sciences, Vienna, [14]Univ. Nantes, [15]Colorado School of Mines, [16]Univ. Florida, Gainesville, [17]Imperial College, London, [18]UCLA, [19]Univ. Bristol, [20]Princeton Univ., [21]Marshall Space Flight Center, [22]Obs. Côte d'Azur

Introduction: The InSight mission to Mars was selected by the NASA Discovery Program to illuminate the fundamental processes of terrestrial planet formation and evolution by performing the first comprehensive surface-based geophysical investigation of Mars. It was originally planned to launch in March 2016, landing on Mars later that year [1]. However, due to a late failure of the seismometer during testing for which there was insufficient time to confidently repair and test, it was decided in December 2015 to suspend the launch. Since then, the seismometer has been redesigned to fix the problem and the mission was replanned around a 2018 launch period. In September 2016 NASA formally authorized InSight to proceed toward a new launch date in May of 2018. In this abstract we describe the mission as it is now defined.

Science and Instrumentation: The scientific goals of InSight are unchanged from 2016. They are to understand the formation and evolution of terrestrial planets through investigation of the interior structure and processes of Mars and to determine its present level of tectonic activity and impact flux. A straightforward set of scientific objectives address these goals: determine the size, composition and physical state of the core; determine the thickness and structure of the crust; constrain the composition and structure of the mantle; determine the thermal state of the interior; measure the rate and distribution of internal seismic activity; and measure the rate of impacts on the surface.

The composition of the payload is also unchanged (with one addition; see below), and is centered on seismology, precision tracking and heat flow measurements, with support from a number of ancillary sensors. It comprises three scientific investigations (Figure 1): SEIS [2], a six-component (three Short Period and three Very-Broad-Band sensors) seismometer with careful thermal isolation and compensation at the sensor level, shielding from martian winds, and demonstrating a sensitivity comparable to the some of the best terrestrial instruments across a frequency range of 1 mHz to 50 Hz; RISE [3] (Rotation and Interior Structure Experiment), which uses the spacecraft X-band communication system to provide precision tracking at the sub-decimeter level for planetary rotation studies; and HP^3 [4] (Heat Flow and Physical Properties Package), an instrumented self-penetrating mole system that trails a string of temperature sensors to measure the planetary heat flux with thermal gradient and conductivity measurements. Except for the crucial re-design of the SEIS Evacuated Container to eliminate vulnerabilities to vacuum leaks that were discovered in 2015, these instruments are largely unchanged. SEIS has undergone some limited tuning of the feedback electronics to enhance noise performance, and there have been some improvements to the HP^3 to increase the robustness of electrical connections within the high-shock environment of the Mole.

Ancillary payload elements supporting the primary investigations include: the Instrument Deployment System (IDS), consisting of a robotic arm (IDA, Instrument Deployment Arm) and a pair of cameras (colorized versions of JPL's Navcam and Hazcam, called the Instrument Deployment Camera (IDC) and the Instrument Context Camera (ICC), respectively) that will be used to deploy the seismometer and heat flow instruments to the ground; sensors for atmospheric pressure, temperature and wind (TWINS, Temperature and Wind for INSight), and magnetic field (IFG, Insight FluxGate) to help separate environmental noise from seismic signals; and an IR radiometer (RAD) to measure ground surface temperature for assisting HP^3 in removing the diurnal and seasonal thermal signals. No changes have been made to any of these elements. The only new payload element is a small (~10-cm diameter) passive laser retroreflector that may someday be used with an orbiting laser altimeter to provide ultra-precise geodetic location for the lander.

Flight System and Mission Design: The InSight lander was essentially finished and fully tested by the time of the mission stand-down. After a thorough review of possible risk reductions and enhancements, it was concluded that only a few electronic parts needed to be replaced due to potential vulnerabilities recently identified by other missions. The flight system has been kept in storage, with appropriate handling of time-sensitive components such as parachutes and other flexible deployables, batteries, lubricants, etc.

Except for dates and celestial mechanics details, the mission design is very similar to that of 2016. InSight will launch from Vandenberg Air Force Base, with a launch period opening on May 5, 2018, and lasting 30 days. It will use a half-year, type I trajectory to Mars, arriving at Mars on November 26. Entry, descent and landing parameters are generally more benign for 2018 compared to 2016, and the landing site in western Elysium Planitia is unchanged (see [5] for more details). The primary mission is still planned to last two years, after a ~2-month deployment phase.

Summary: The InSight mission has recovered from an instrument failure and launch suspension, and is on track to fill a longstanding gap in the scientific exploration of the solar system by performing an in-situ investigation of the interior of Mars.

References: [1] Banerdt et al. (2013) LPSC 44, abs. 1915. [2] Lognonné et al. (2000) Planet. Space Sci., 48, 1289-1302. [3] Dehant et al. (2010) Planet. Space Sci., doi:10.1016/j.pss.2010.03.014. [4] Grott et al. (2007) JGR, 112, doi: 10.1029/2007JE002905. [5] Golombek et al. (2017) LPSC 48.

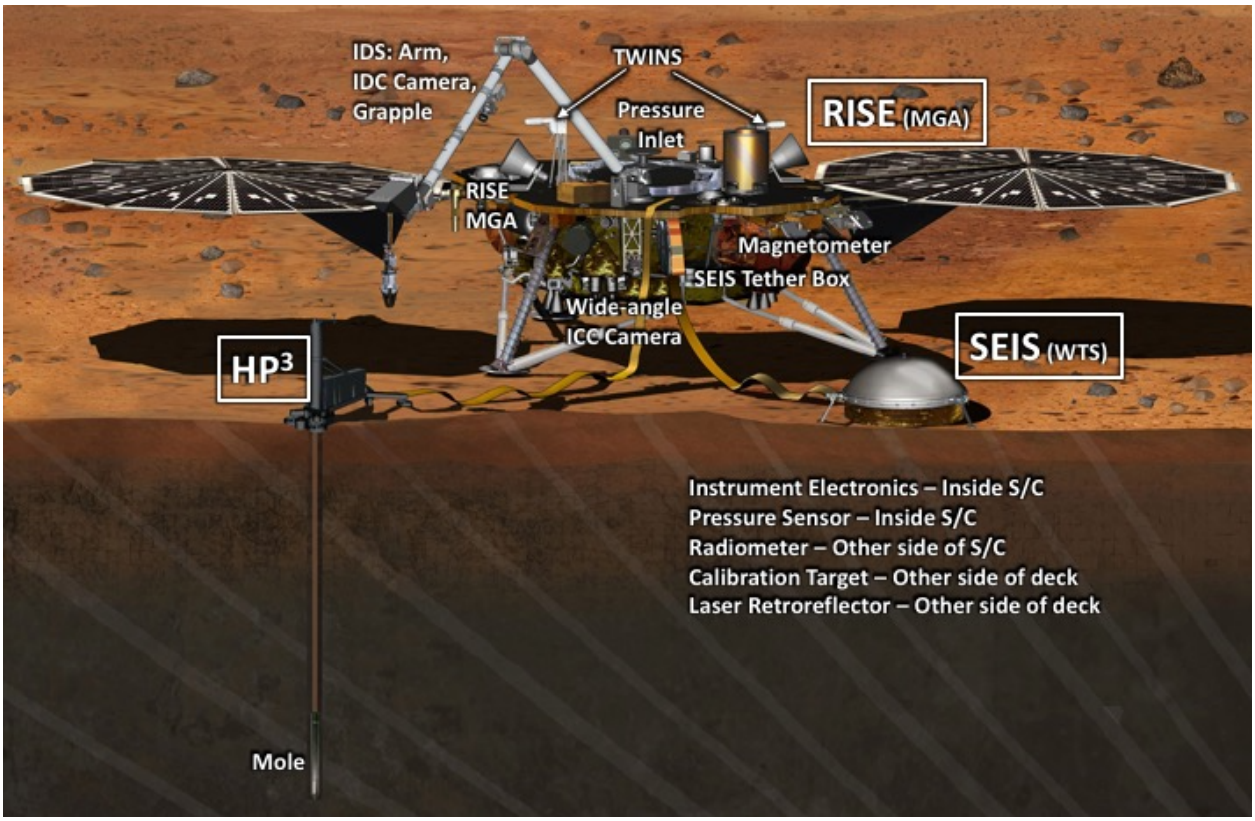

Figure 1. Artist's rendition of the InSight lander, showing the deployed instruments. The seismometer (SEIS) is covered by its Wind and Thermal Shield (WTS). The heat flow probe (HP^3) is shown after the self-hammering Mole has penetrated to depth. Also shown are the fixed Medium-Gain Antennas (MGAs, pointing east and west, respectively) used by RISE, the tether container for SEIS (Tether Box), the Magnetometer, the Pressure Inlet which is connected via tubing to the Pressure Sensor located inside the insulated electronics compartment of the spacecraft, the two wind and atmospheric temperature sensors (TWINS), and the various components of the Instrument Deployment System (IDS): the Instrument Deployment Arm with its Grapple and Instrument Deployment Camera, and the Instrument Context Camera mounted under the instrument deck. Payload elements not seen in this view include the various instrument electronics boxes and Pressure Sensor, located inside the lander, and the Radiometer, Camera Calibration Target and Laser Retroreflector, out of view on the other side of the spacecraft.