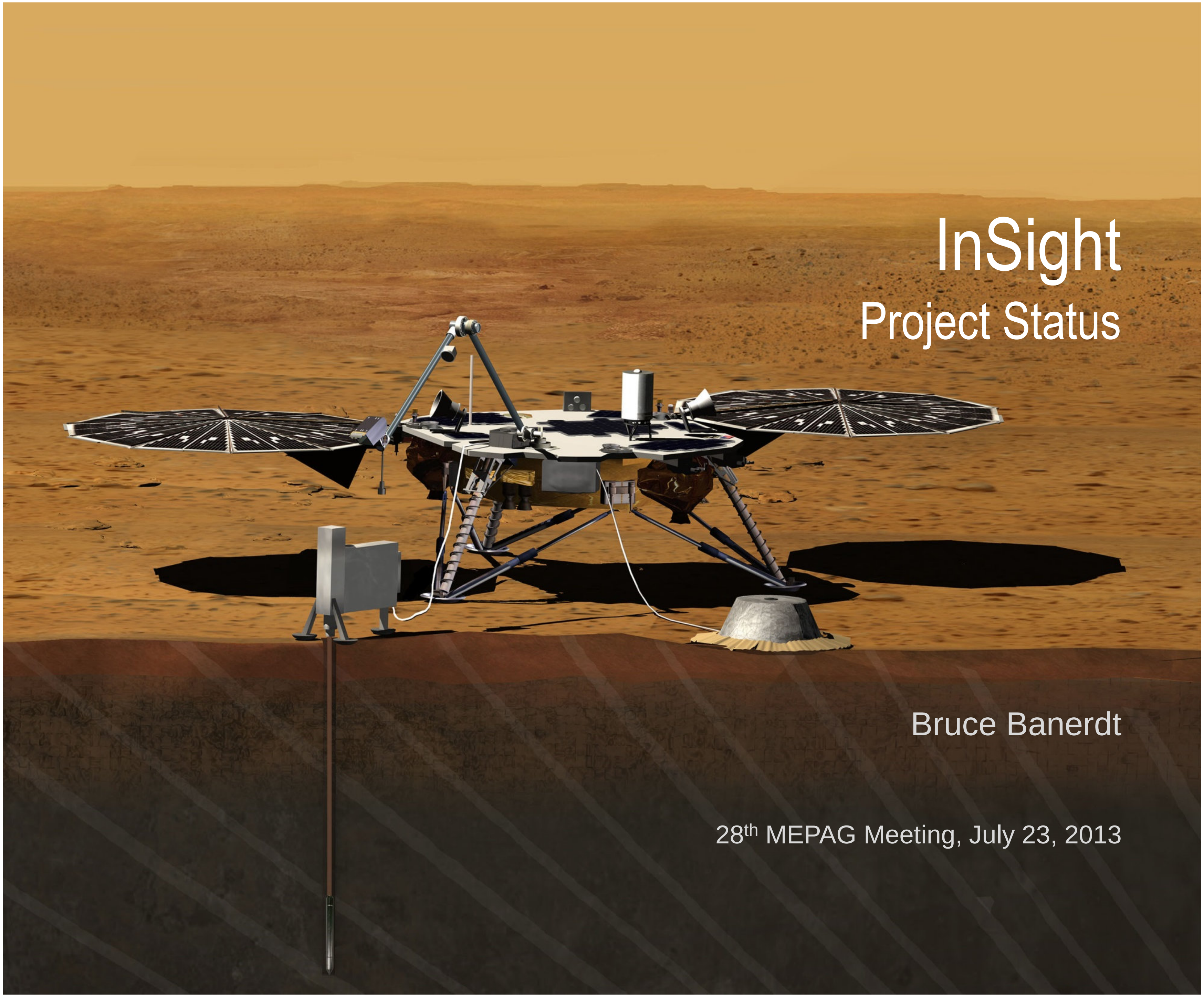
InSight

Project Status

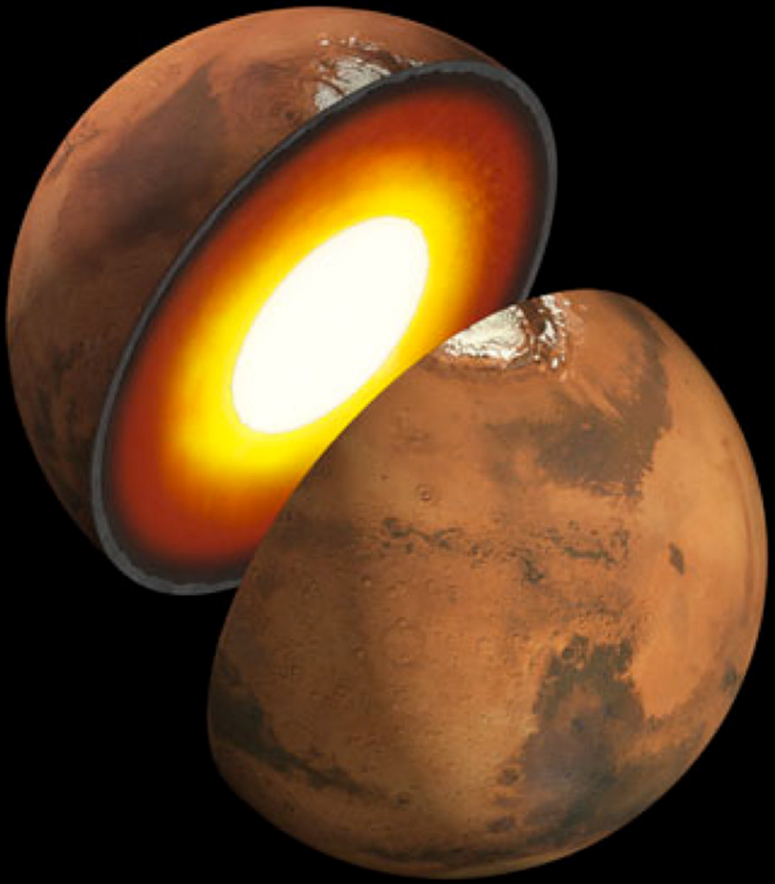


Bruce Banerdt

28th MEPAG Meeting, July 23, 2013

InSight Science Goal:

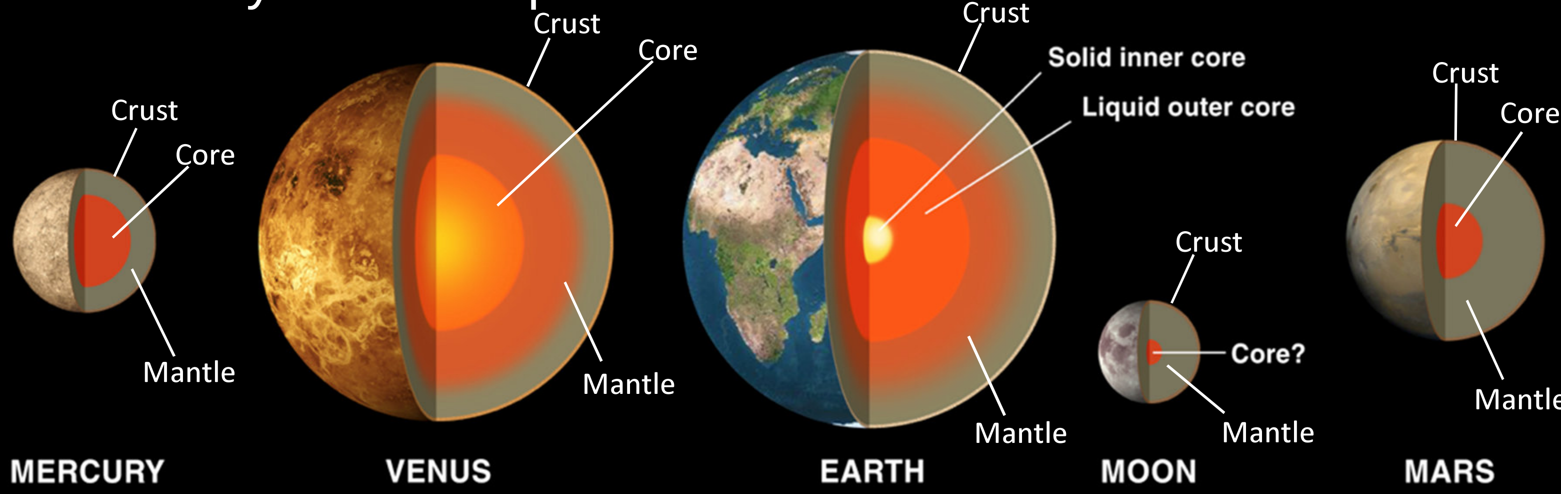
Understand the formation and evolution of terrestrial planets through investigation of the interior structure and processes of Mars.



Directly addresses NASA, ESA and 2011 Planetary Science Decadal Survey objectives for understanding the origin and diversity of terrestrial planets.

Mars is Key to Understanding Early Formation of Terrestrial Planets, Including Rocky Exoplanets

Terrestrial planets all share a common structural framework (crust, mantle, core), which is developed very shortly after formation and which determines subsequent evolution. We seek to study this structure in order to understand the processes by which the planets formed.



Mars is uniquely well-suited to study the common processes that shape all rocky planets and govern their basic habitability.

- There is strong evidence that its basic crust and mantle structure have survived little changed from the first few hundred Myr of formation.
- Its surface is much more accessible than Mercury or Venus.
- Our knowledge of its geology, chemistry, and climate history provides a rich scientific context for using interior information to increase our understanding of the solar system.

What Do We Know About the Interior of Mars?

Measurement	Current Uncertainty	InSight Capability	Improvement
Crustal thickness	65±35 km (inferred)	±5 km	7X
Crustal layering	no information	resolve 5-km layers	New
Mantle velocity	8±1 km/s (inferred)	±0.13 km/s	7.5X
Core liquid or solid	“likely” liquid	positive determination	New
Core radius	1700±300 km	±75 km	4X
Core density	6.4±1.0 gm/cc	±0.3 gm/cc	3X
Heat flow	30±25 mW/m^2 (inferred)	±3 mW/m^2	8X
Seismic activity	factor of 100 (inferred)	factor of 10	10X
Seismic distribution	no information	locations ≤10 deg.	New

InSight Payload

Small Deep Space Transponder

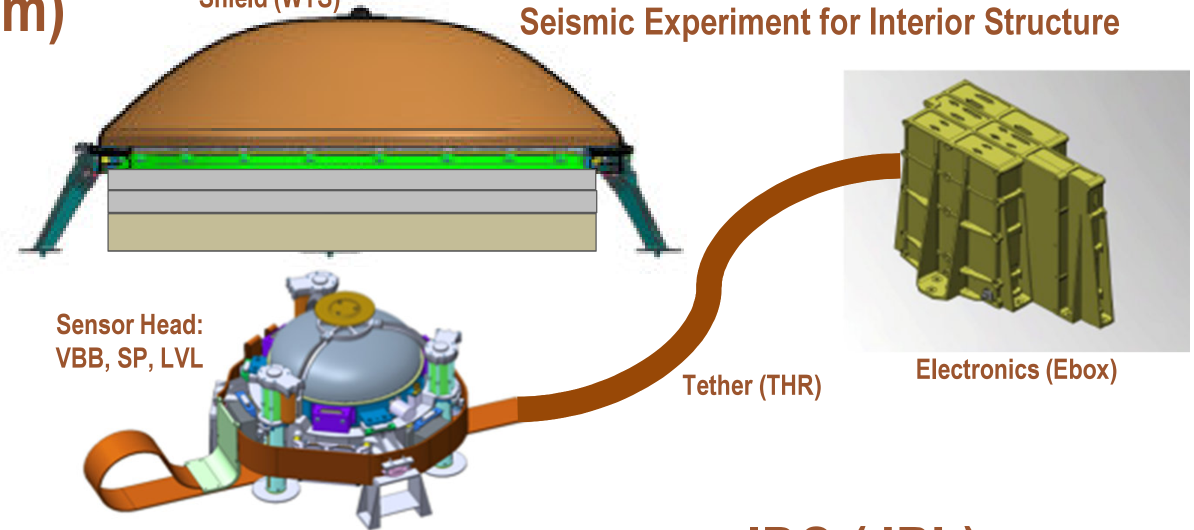
RISE (S/C Telecom)

Rotation and Interior Structure Experiment

SEIS (CNES) (also IPGP, ETH/SSA, MPS/DLR, IC/Oxford/UKSA, JPL/NASA)

Seismic Experiment for Interior Structure

Wind and Thermal Shield (WTS)



Sensor Head: VBB, SP, LVL

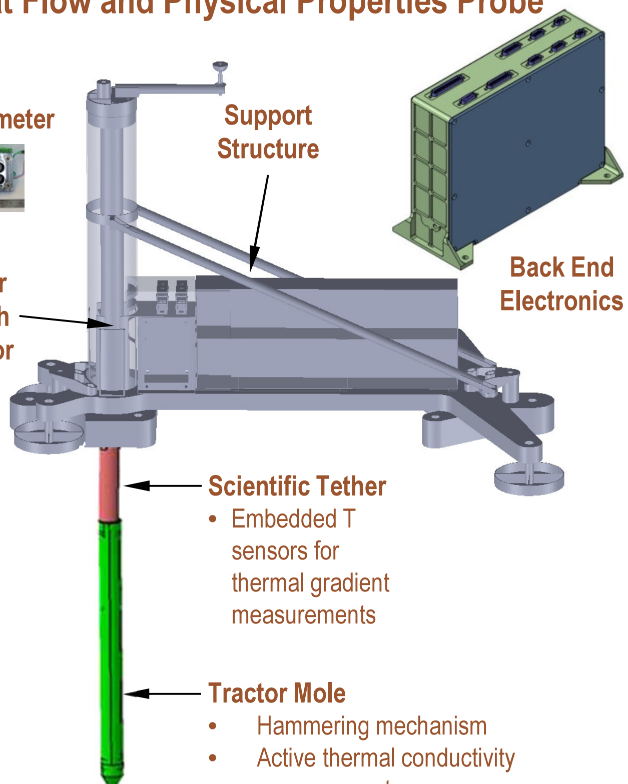
Tether (THR)

Electronics (Ebox)

HP³ (DLR)

Heat Flow and Physical Properties Probe

Radiometer



Support Structure

Back End Electronics

Tether Length Monitor

Scientific Tether
- Embedded T sensors for thermal gradient measurements

Tractor Mole
- Hammering mechanism
- Active thermal conductivity measurements
- Static Tilt sensors

Magnetometer (UCLA)

TWINS (CAB) – Temp. and Wind for INSight

Pressure Sensor

APSS (JPL)

Auxiliary Payload Sensor Suite

IDS (JPL)

Instrument Deployment System

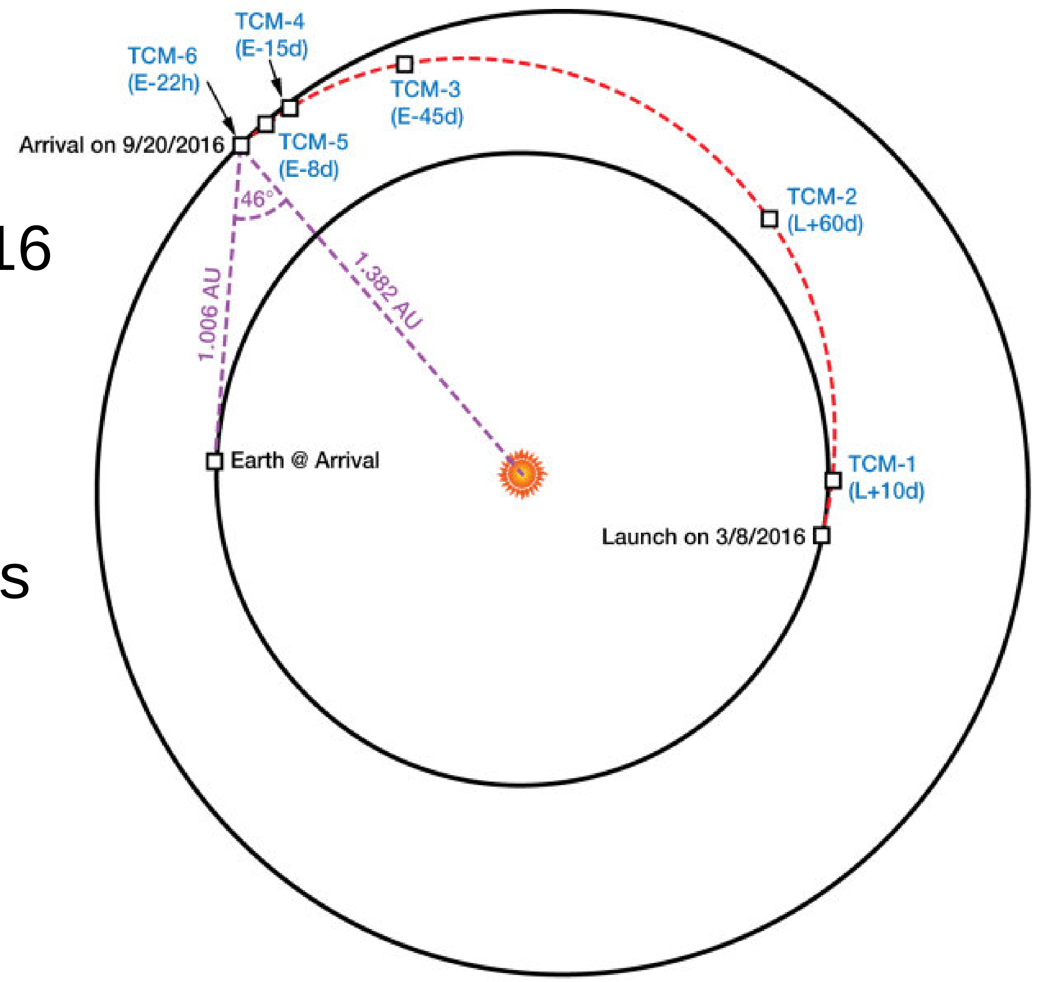
IDA – Instrument Deployment Arm

IDC – Instrument Deployment Camera

ICC – Instrument Context Camera

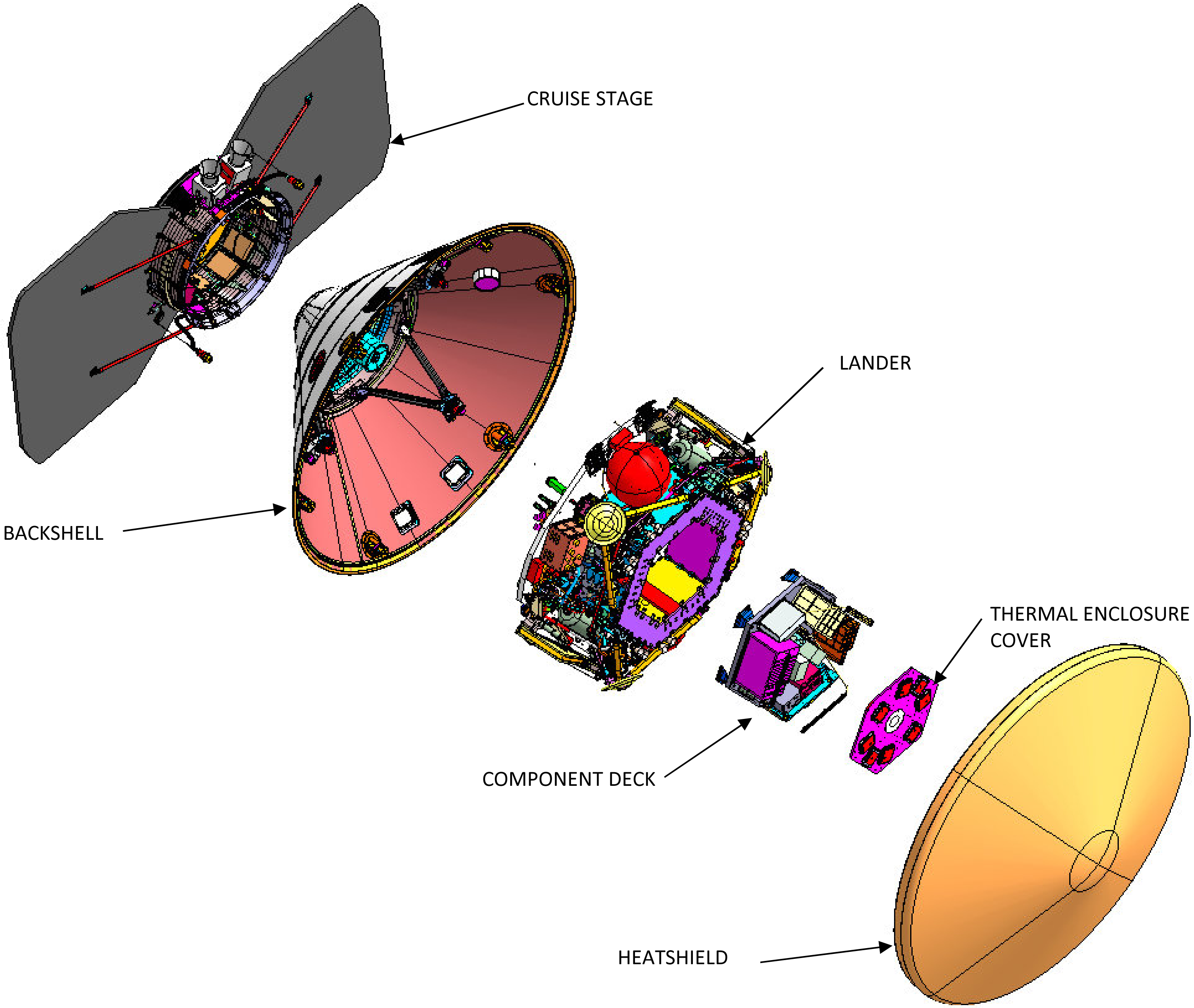
InSight Mission Design Summary

- InSight will fly a near-copy of the successful Phoenix lander
- Launch: March 4-24, 2016
- Fast, type-1 trajectory, 6.5 month cruise to Mars
- Landing: September 28, 2016
- 67-sol deployment phase
- One Mars year (two years) science operations on the surface; repetitive operations
- Nominal end-of-mission: October 6, 2018

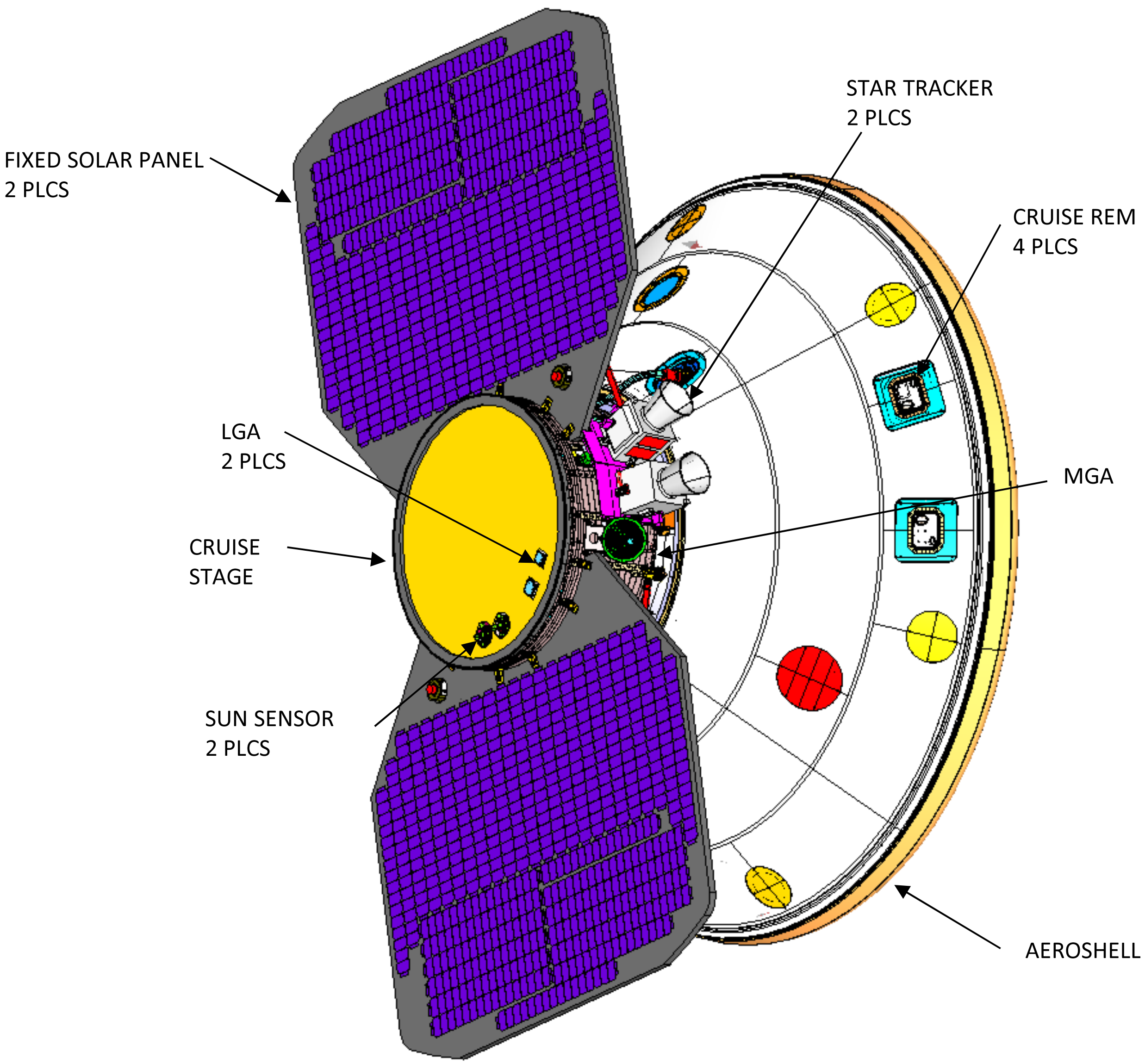


View from Ecliptic North looking down on Ecliptic

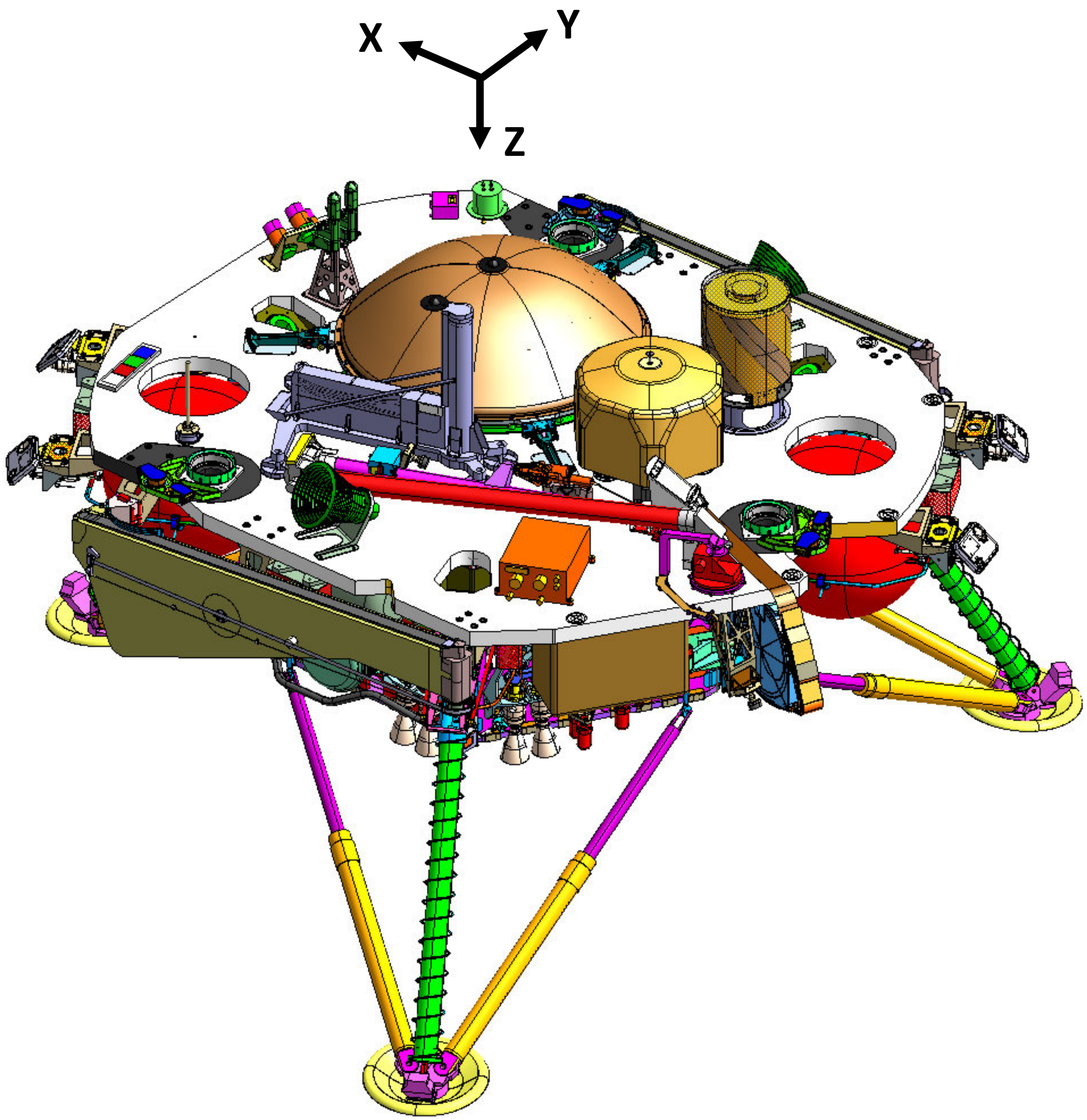
Spacecraft Expanded View



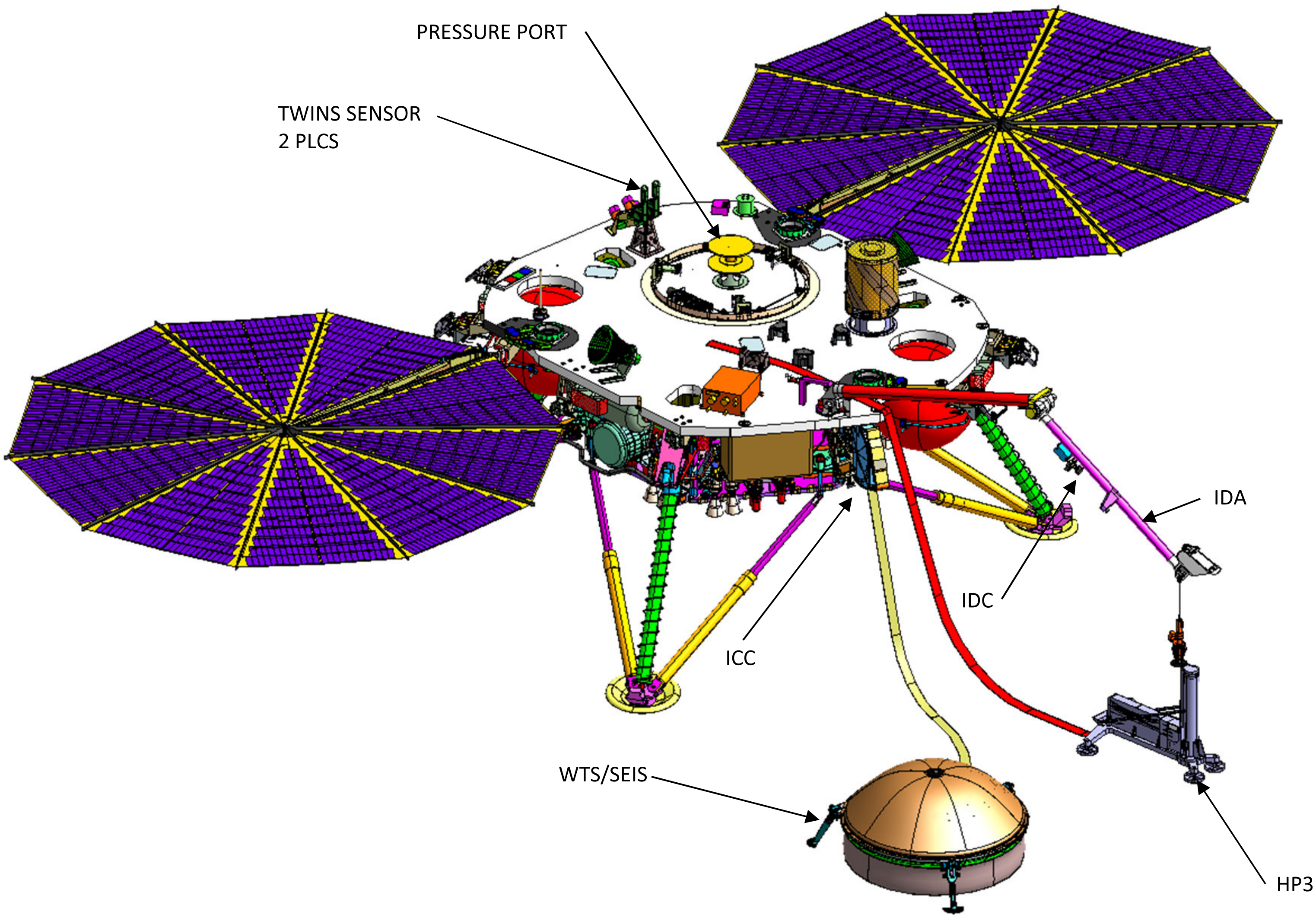
Cruise Configuration



Landed Configuration



Science Deployed



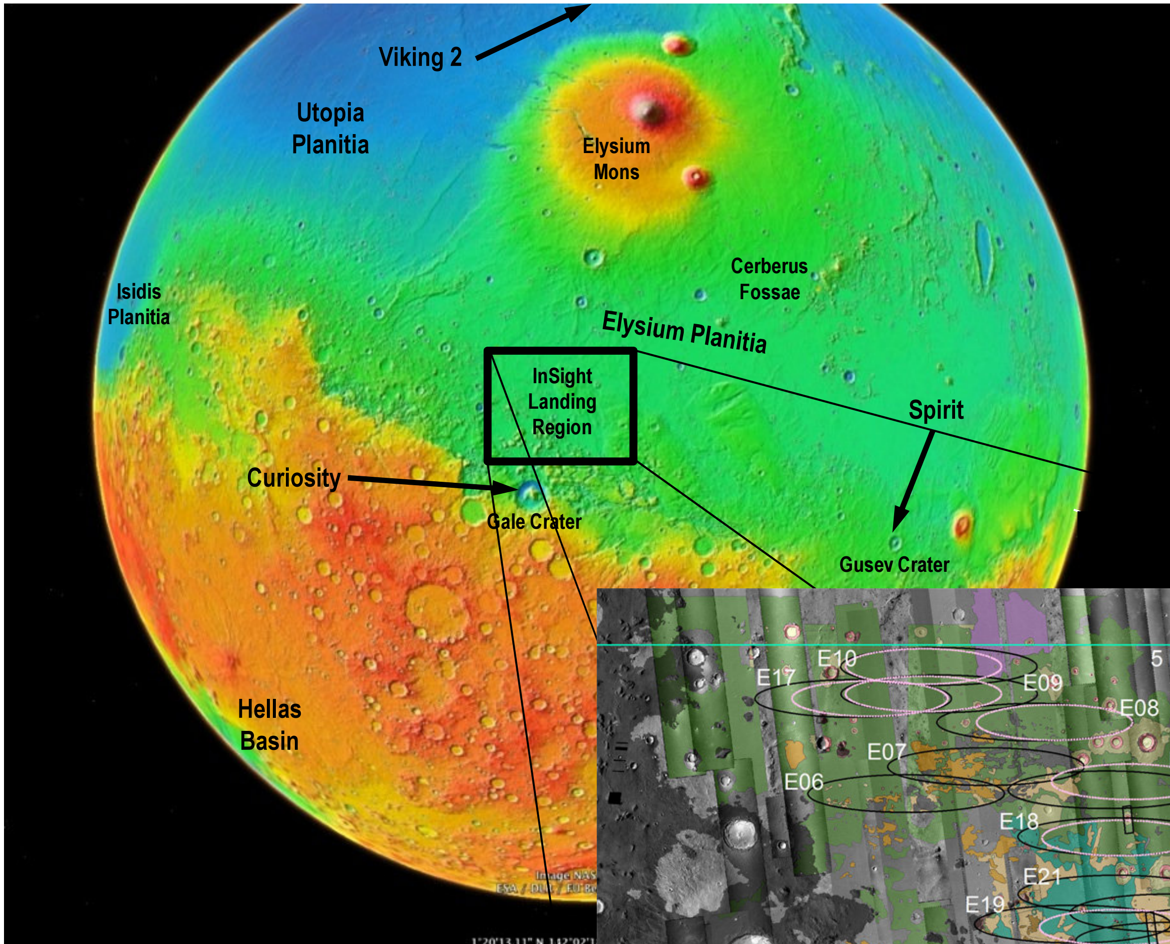
Significant Changes Since Last MEPAG

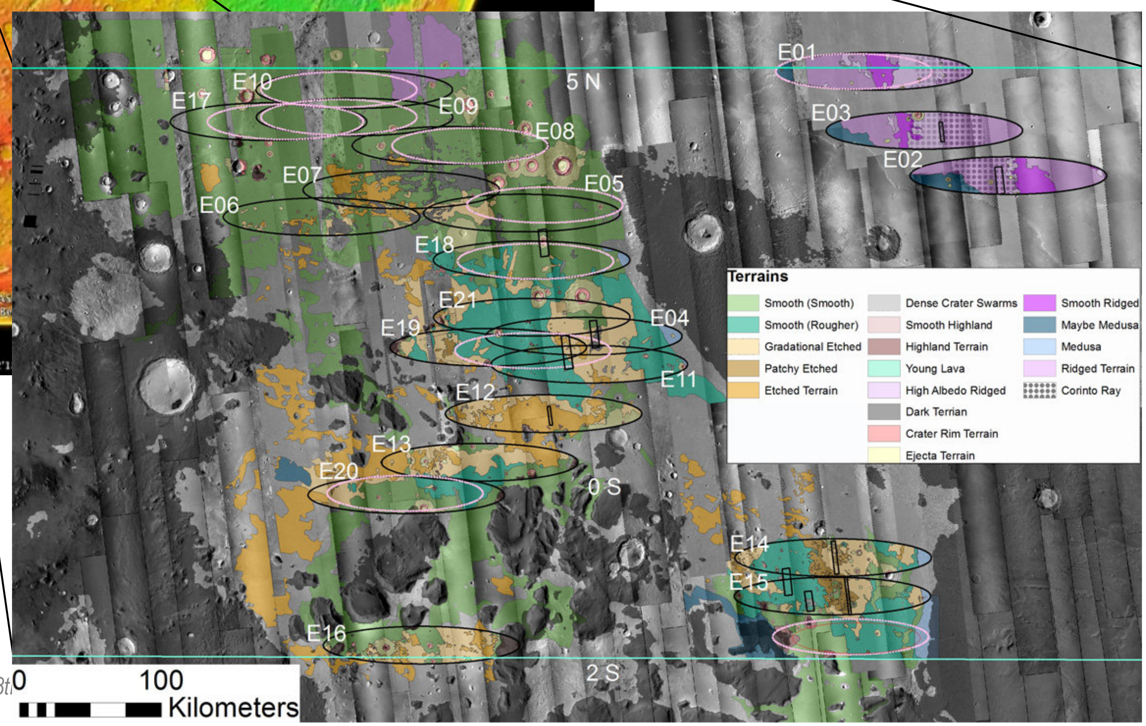
- Launch and arrival date changes
  - Launch window opens March 4, 2016 (was March 8)
  - Arrival on September 28, 2016 (was September 20)
  - Change was made to augment EDL communication
- Solar panels have been enlarged by ~12 cm (radius); cells on the deck were removed
- Payload augmentations
  - High-resolution pressure sensor (better than 10 mPa)
  - REMS wind sensors
  - Ground temperature radiometer
  - Magnetometer
  - Moved arm electronics to warm enclosure
  - Colorizing camera was considered, but dropped for cost reasons

Current Project Activities

- Completed
  - PMSR (Preliminary Mission System Review) in February
    - Internal JPL review to ensure that project is on track for a successful PDR
  - Inheritance Reviews for all relevant elements in S/C and Payload
    - No significant findings that project was not already working
  - Subsystem PDRs
    - Instruments: SEIS and its subsystems (VBB, SP, LVL, Ebox, WTS, TBK, THR), HP^3, IDS; APSS is later this week
    - Spacecraft: Structure and Mechanisms, Power, C&DH, G&C, Telecom, Thermal, Software, Fault Protection, EDL
  - SEIS technology validation (TRL-6)
- Upcoming
  - Payload PDR at the end of July
  - Project PDR in mid-August
  - KDP-C (Confirmation Review) in November
- Ongoing
  - HP^3 technology validation testing
  - Launch Vehicle procurement process

Landing Site Selection Process





- Currently studying 16 ellipses
- Full CTX coverage of region
- Acquiring ~1 HiRISE image/week
- Will downselect to ~4 ellipses on July 29

Ongoing Challenges

- Technical margins are tight (by design)
  - Mass: launch ~15%; entry/landing ~12%; lifted ~25%
    - Normally require 25% at PDR
  - Power/Energy (winter, dust storm)
    - “Worst case” for survival: 30%
    - 3 operational modes: Monitoring, Restricted, Survival (<90 sols)
- Schedule – Time from selection to launch is only 42 months
  - 31 months, 12 days from today
- Maintaining SEIS system performance is incredibly challenging
  - Required ground displacement resolution is about half the radius of a hydrogen atom; this sensitivity has been demonstrated
  - BUT, must control or mitigate noise from electronics, temperature, wind, pressure, magnetic field, lander, …