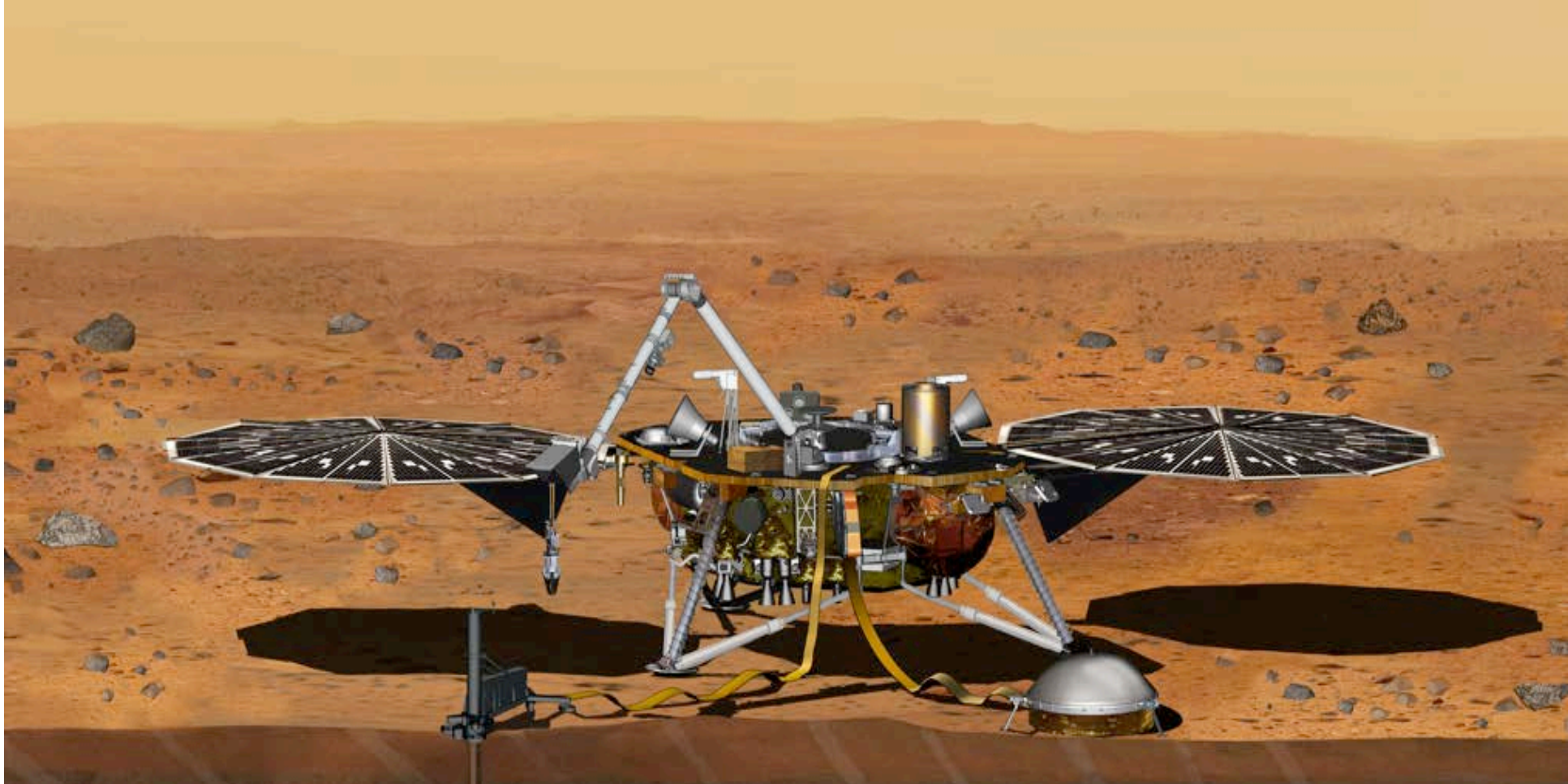


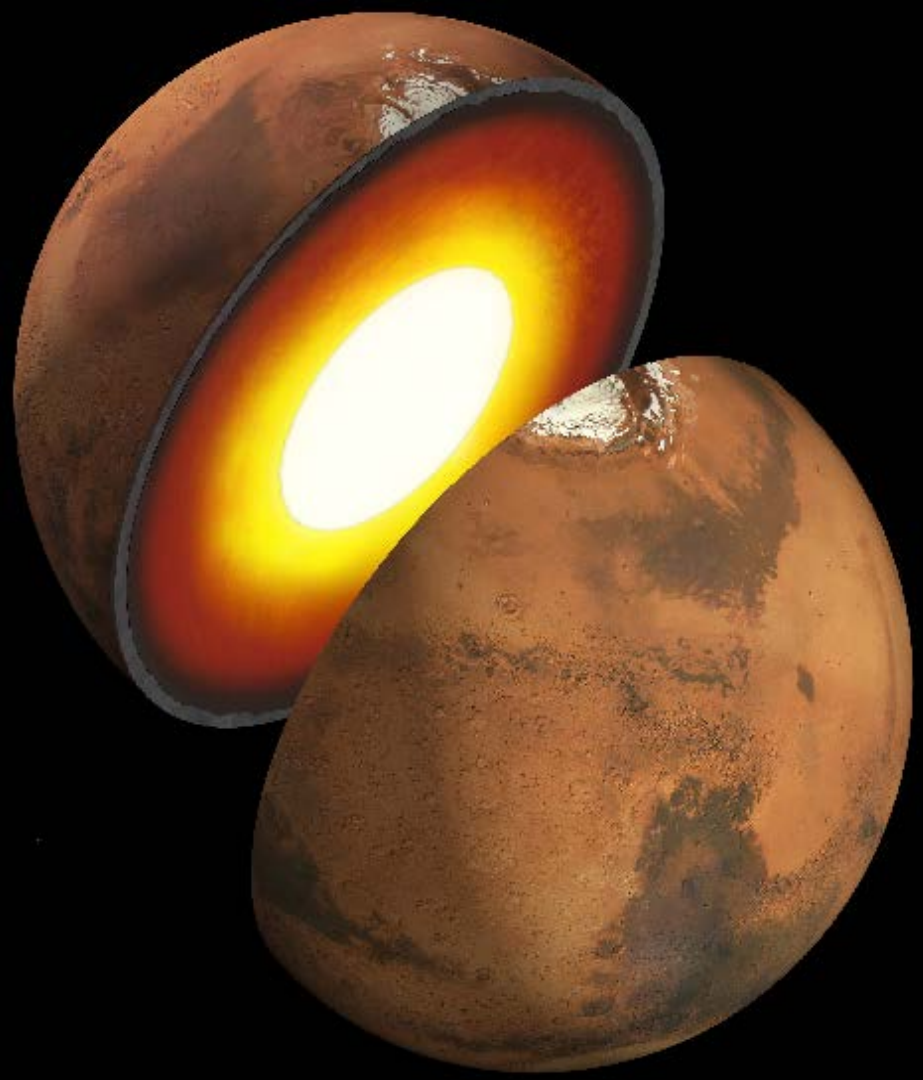
InSight (Interior Exploration Using Seismic Investigations, Geodesy and Heat Transport)

Entry Descent and Landing Overview

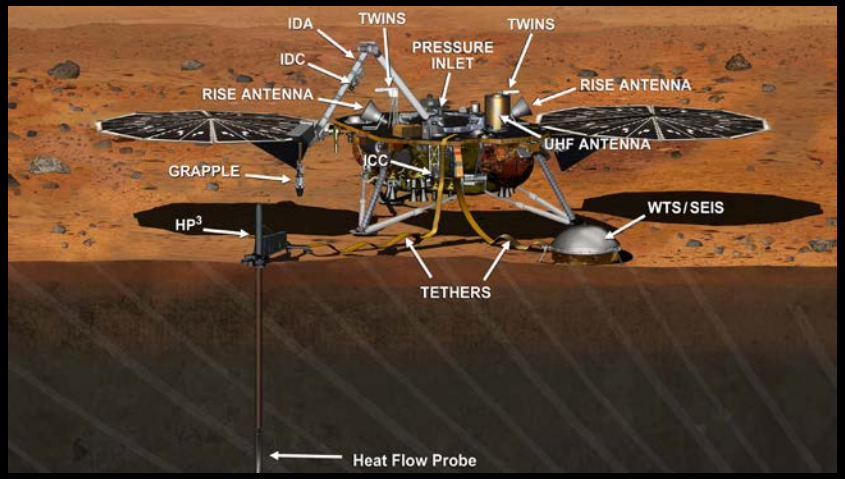
Devin Kipp, David Skulsky, Rob Grover, Christine Szalai, Julie Wertz
Jet Propulsion Laboratory, California Institute of Technology

12th International Planetary Probe Workshop - June, 2015

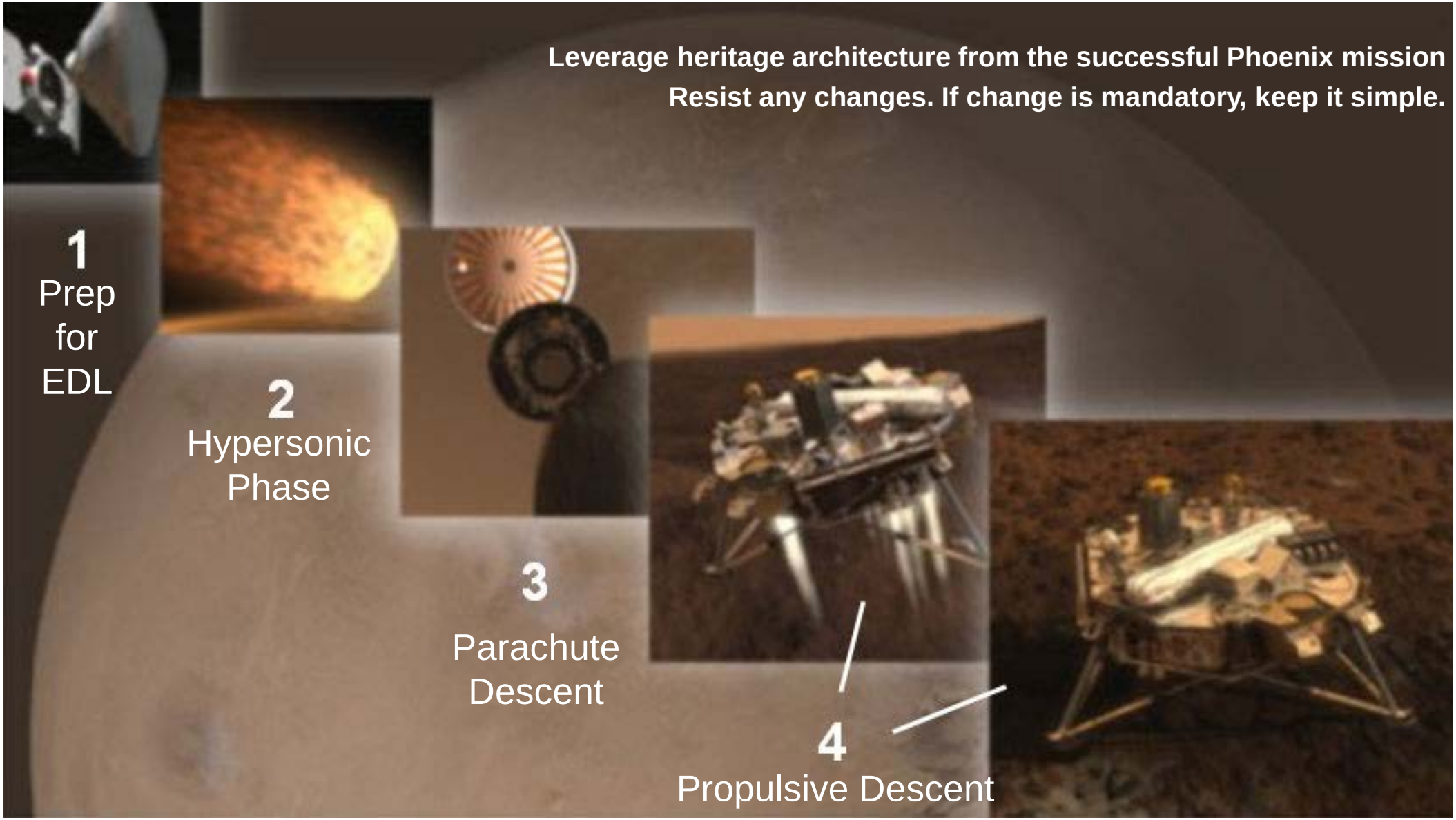
The InSight Mission



The overall goal for InSight is to understand the formation and evolution of terrestrial planets through investigation of the interior structure and processes of Mars.



Entry Descent and Landing Architecture



Comparison to Phoenix

Key EDL Design Parameters

	InSight	Phoenix
Arrival Date	September 28, 2016	May 25, 2008
Inertial Entry Velocity (km/s)	6.1	5.6
Entry Mass (kg)	625	572.7
Entry Flight Path Angle	-12.5° ± 0.21° (3σ)	-13.0° ± 0.27° (3σ)
Landing Site Latitude	4.5° N	68° N
Landing Site Elevation (MOLA)	-2.5 km	-4.1 km
Ls / Dust Season	226° (Northern Autumn, Global Dust Storm Season)	76.7° (Northern Late Spring)
Surface Characteristics	Loose Regolith	Shallow Subsurface Ice

Primary Challenge: Faster entry + more mass + higher site elevation + possible global dust storm ... *using the same flight system*.

Challenge #1: Maintain Healthy Altitude/Timeline Margins

Problem Statement:

Changes in entry velocity, mass, atmosphere, and landing elevation combined to compress parachute and terminal descent timeline, leaving uncomfortably small margins.

Design Solution:

Increasing allowable parachute inflation loads enabled recovery of altitude and timeline margins.

- Changed parachute suspension line material to increase parachute strength
- Made minor structural changes on lander to accommodate increased loads

Status:

All design modifications and qualification testing to accommodate load increase are complete.

- Parachute deployment/strength tests
- Spacecraft static tests

InSight EDL parameters have been re-tuned to recover altitude and timeline margin.

- Increased dynamic pressure at mortar fire
- Modified RADAR functional timeline

Challenge #2: Maintain Margins in Thermal Protection System

Problem Statement:

InSight may be exposed to high levels of atmospheric dust during Mars entry. Heritage TPS design was robust to predicted InSight heating profiles, but without sufficient margin to protect for recession from dust abrasion.

Design Solution:

Determine an upper bound on expected recession from dust abrasion

- Developed atmospheric dust environment models
- Assessed erosion of TPS due to dust environment

Nominal increase in TPS design thickness was made to mitigate risk from dust abrasion

- Absorbed associated mass increase

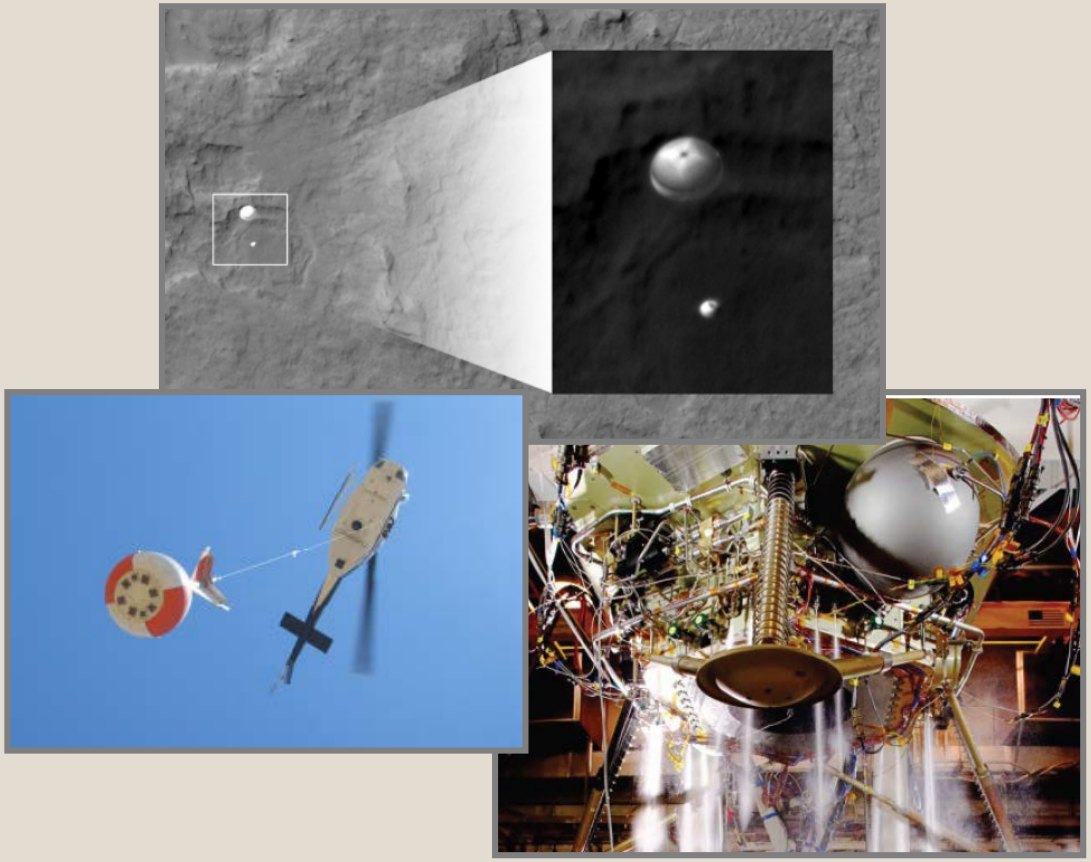
Status:

Heatshield is built and testing is nearly complete

Challenge #3: Appropriate use of Heritage Activities for Verification

Problem Statement:

The InSight flight system is largely unchanged from Phoenix. Discovery cost cap dictates that InSight must appropriately leverage heritage verification activities to balance cost and risk.



Solution:

When relying on heritage, must prove that heritage applies. Heritage alone is "presumed insufficient until proven sufficient."

Significant heritage activities used as primary V&V for InSight include:

- Supersonic Parachute Inflation
- Phoenix Radar Field Testing Campaign
- Phoenix Propulsion System Hot Fire Test Bed

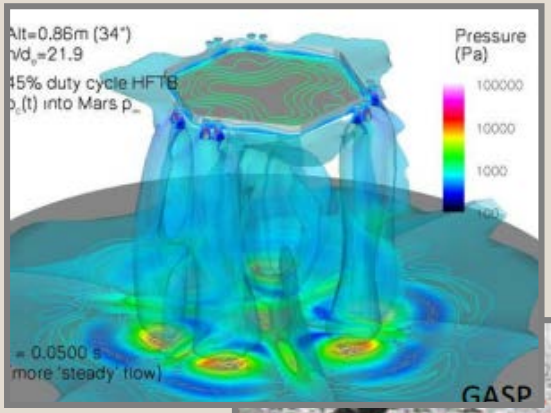
Status:

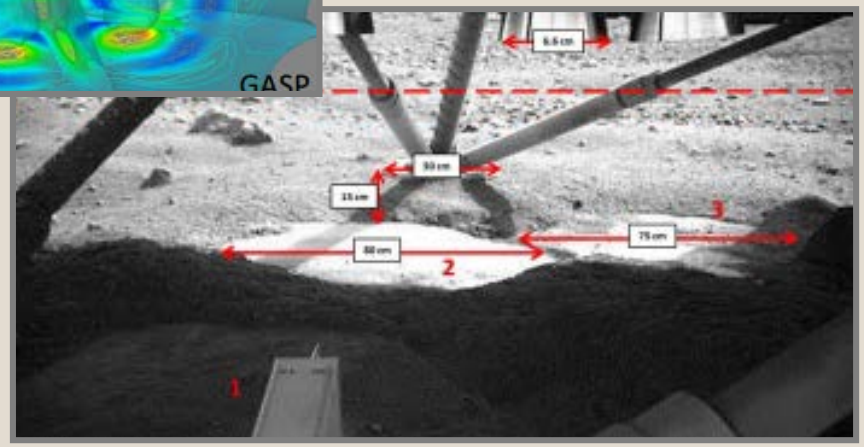
InSight EDL verification & validation plan is mature and execution of the plan is well underway

Challenge #4: Plume Induced Surface Alteration

Problem Statement:

High pressure thruster plumes will alter surface during landing. Significant alteration may result in landing failure or preclude deployment of solar arrays and/or instruments.





Solution:

Avoid complex protracted analyses that would be difficult or impossible to verify in test.

Developed an approximate analytical technique to bound the problem using conservation principles

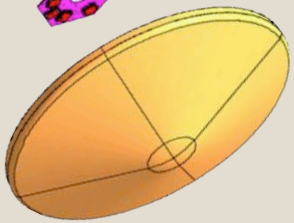
- Point "validation" against Phoenix, Viking, and MSL flight & test data to confirm conservative nature of method.

Status:

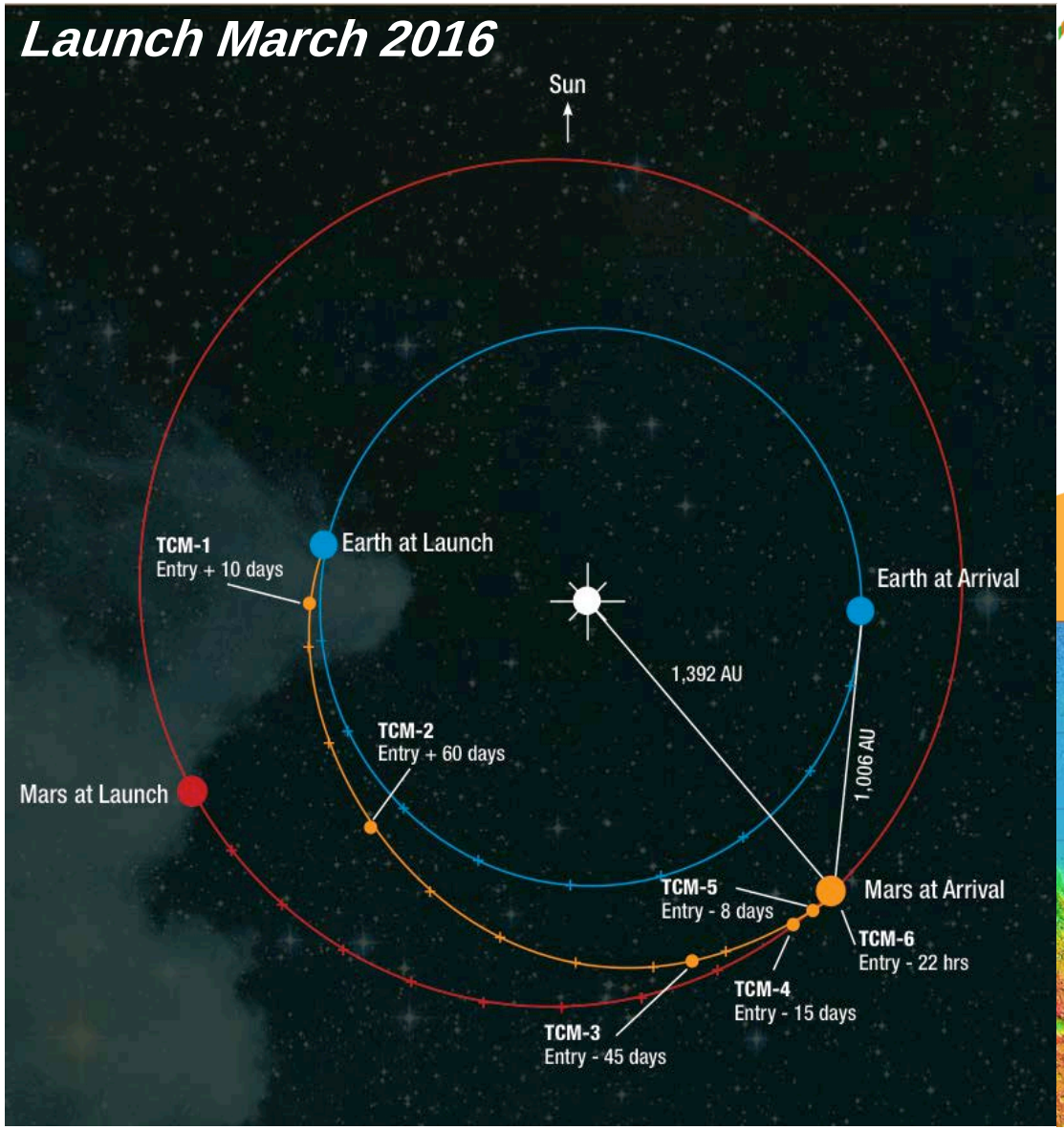
Risk has been designated as low likelihood based on bounding analysis and accepted by the project.

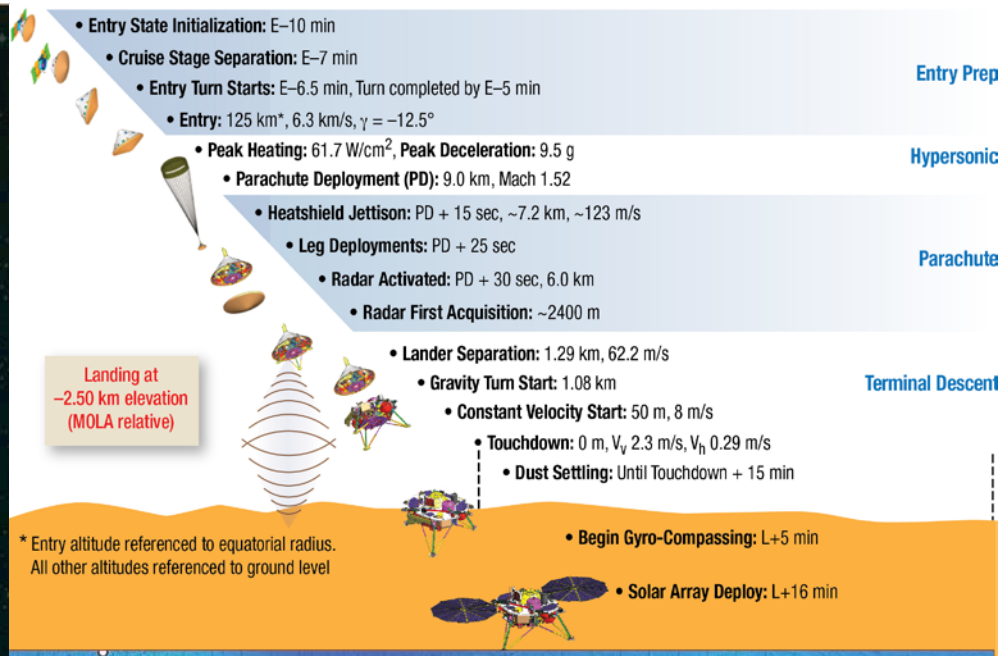
Development Status:

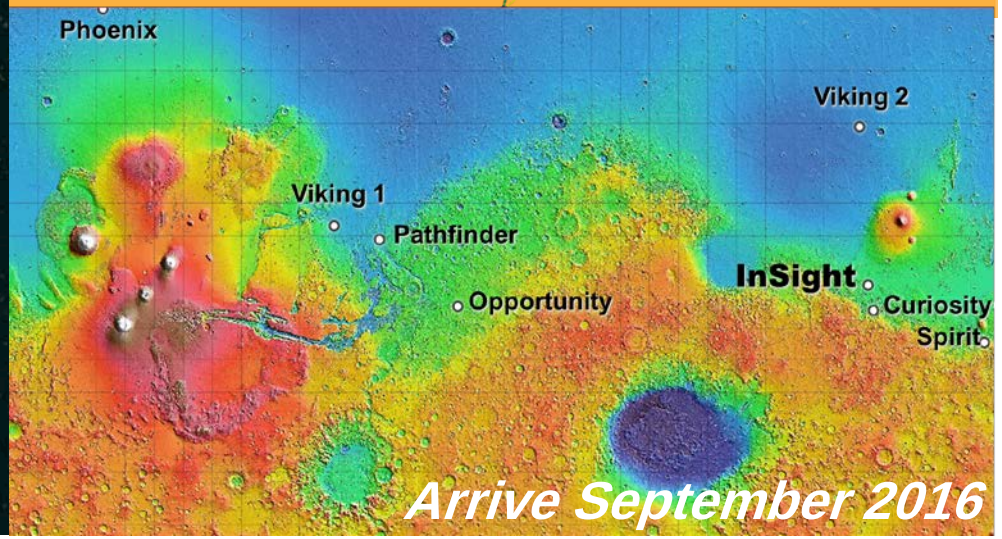
A lot can happen in two years…



Looking Ahead....







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