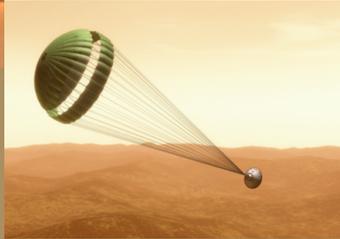
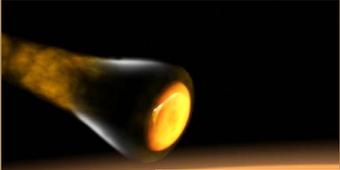


Mars Science Laboratory Entry, Descent and Landing Overview

*Jeffrey W. Umland
Jet Propulsion Laboratory*

*4th International Planetary Probe Workshop
Pasadena, CA
June 29, 2006*

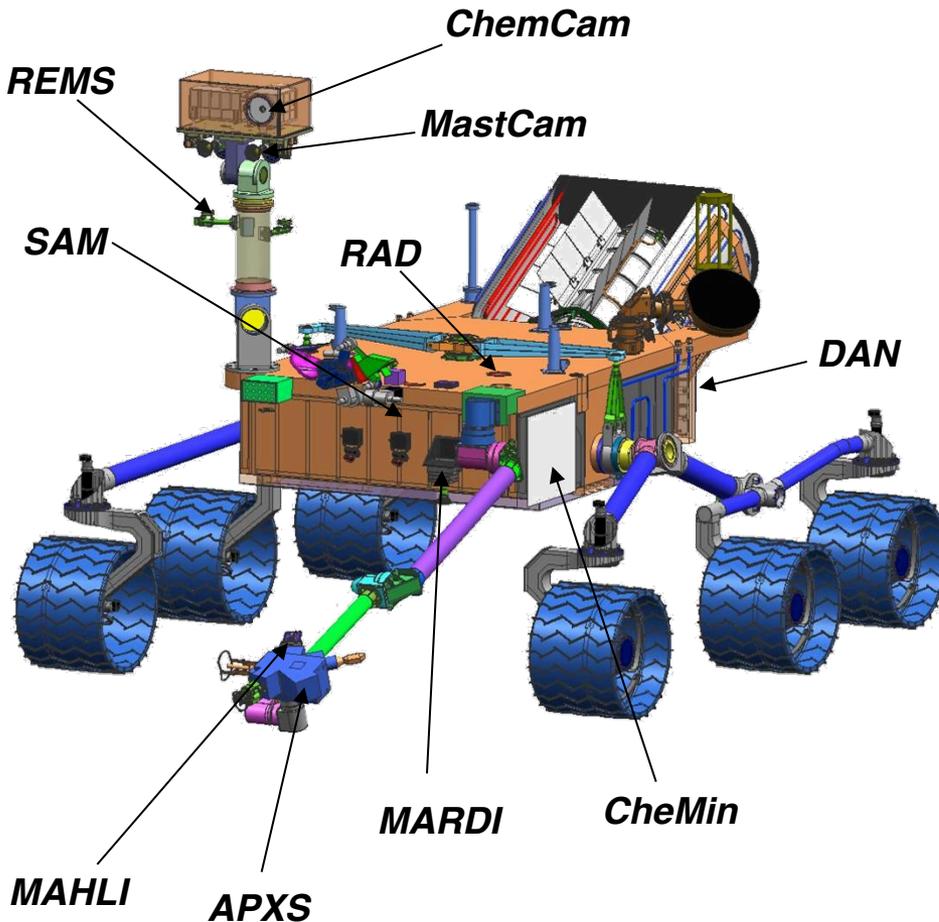




MSL Science Instruments



Mars Science Laboratory



Remote Sensing (Mast)

ChemCam – Laser Induced Breakdown Spectrometer

MastCam - Color Stereo Imager

Contact Instruments (Arm)

MAHLI - Microscopic Imager

APXS - Proton/X-ray Backscatter Spectrometer

Analytical Laboratory (Front Chassis)

SAM - Gas Chromatograph/Mass Spectrometer/
Tunable Laser Spectrometer
(Sample Composition / Organics Detection)

CheMin - X-ray Diffraction / Florescence
(Sample Mineralogy)

Environmental Characterization (Body-mount)

MARDI - Descent Imager

REMS - Meteorological monitoring

RAD - Surface Radiation Flux Monitor
(future human health & safety)

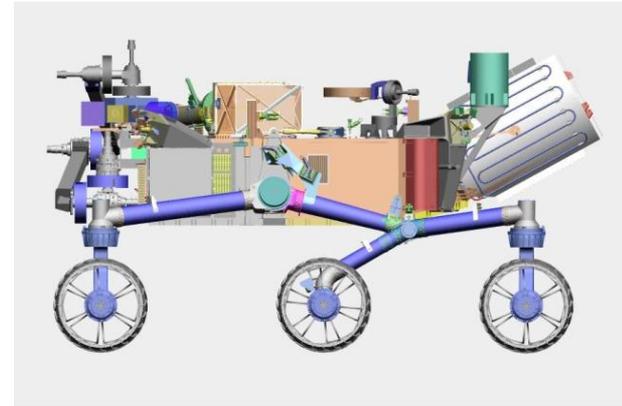
DAN - Neutron Backscatter subsurface hydrogen
(water/ice) detection



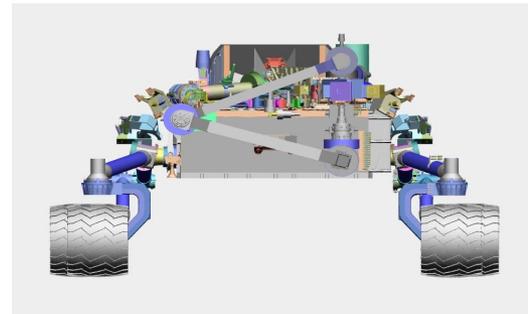
MSL Size Comparison



 2006 MINI Cooper S



JPL 2009 MSL Rover





MSL Requirements



Key Driving EDL Requirements:

- Deliver 800 kg rover
- Landed altitude < [0 to 1] km (MOLA)
- Landing with a maximum error of 10 km from target



| | <i>Viking</i> | <i>MPF</i> | <i>MPL</i> | <i>MER</i> | <i>Phoenix</i> | <i>MSL</i> |
|---|---------------|------------|------------|------------|----------------|------------|
| <i>Landed Mass (kg)</i> | 603 | 360 | 290 | 540 | 364 | 1541* |
| <i>Delivered Mass (kg)</i> | 603 | 360 | 290 | 173 | 364 | 800* |
| <i>Entry Ballistic Coefficient (kg/m²)</i> | 63 | 62 | 71 | 88 | 71 | 121 |
| <i>Landing Altitude (km, MOLA)</i> | -3.5 | -1.5 | +2.4 | -1.3 | -3.5 | +[0 to 1] |
| <i>Landing Accuracy (km)</i> | 420 x 200 | 100 x 50 | 75x 38 | 80 x 20 | 75 x 20 | <10 x 10 |

* Includes required JPL practices 30% margin on allocation

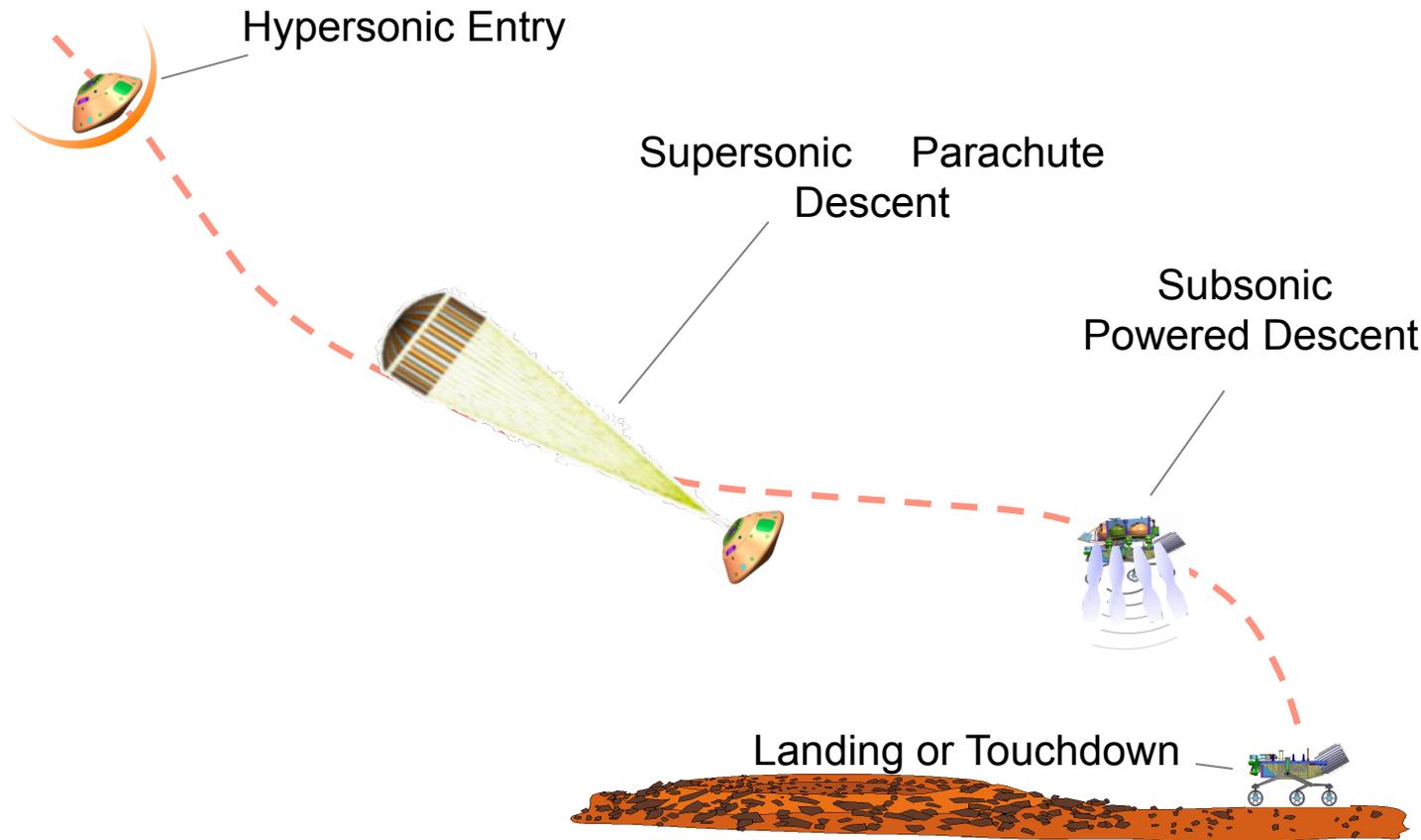


Martian Entry, Descent and Landing



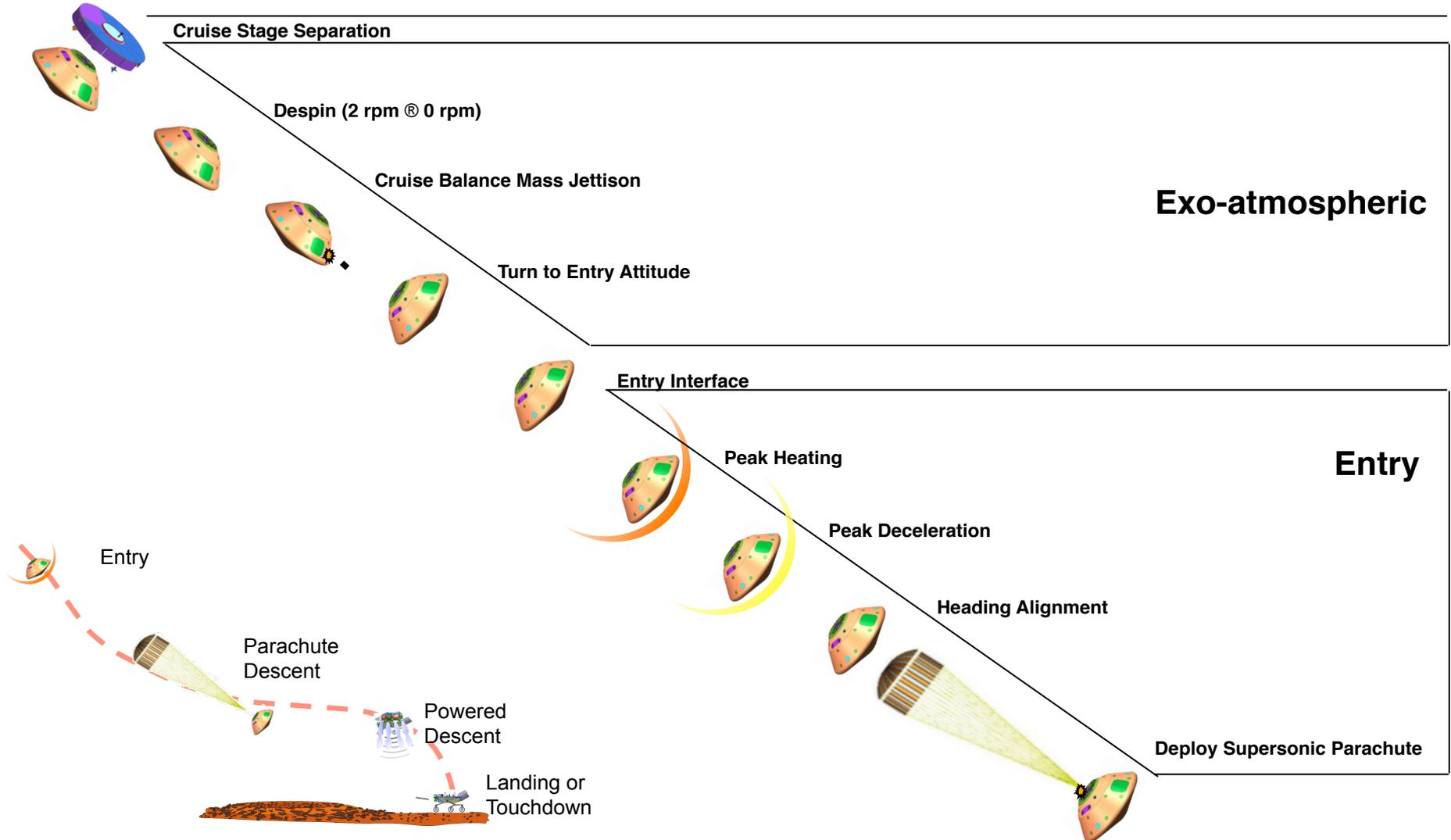
Generic Martian Entry, Descent and Landing System:

- Four Major Elements present historically for all large scale payloads
- MSL must incorporate improved performance for each EDL element



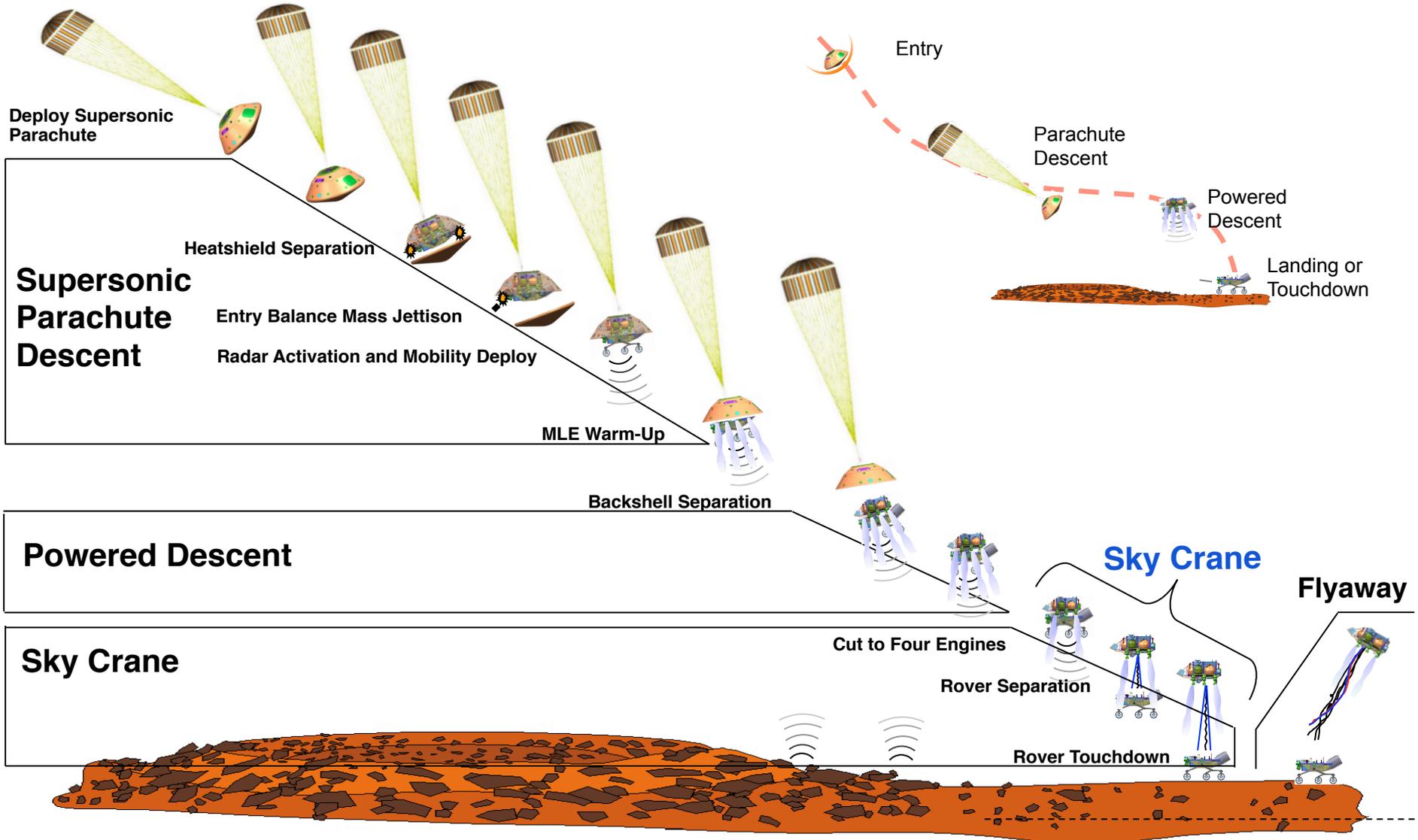


Event Timeline 1/2





Event Timeline 2/2





Sky Crane Touchdown

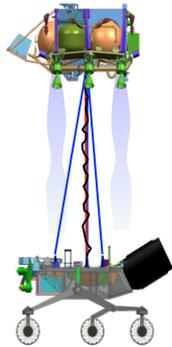


Descent Stage commanded to follow Reference Trajectory: $V_{Vertical} = 0.75 \text{ m/sec}$ & $V_{Horizontal} = 0.0 \text{ m/sec}$

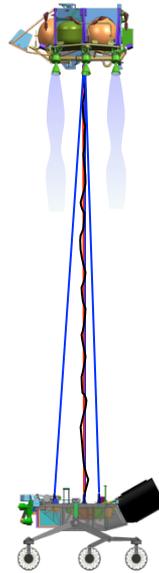
One-Body Phase
Duration = ~2 sec



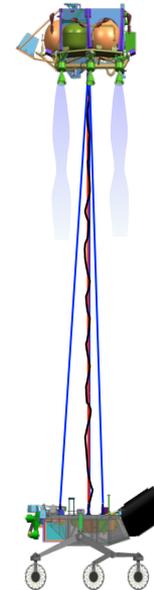
Deployment Phase
Duration = ~6 sec



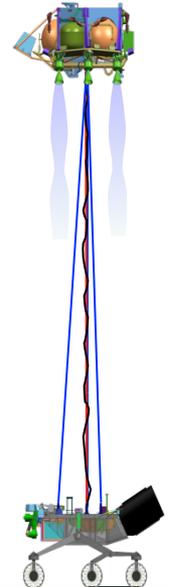
Post-Deploy Settling Phase
Duration = ~2 sec



Ready for Touchdown Phase
Duration = 0-8 sec



Touchdown Phase
Duration < 2 sec



Skycrane Event Timeline