
SKYFALL

Brief SkyFall History

- The SkyFall concept development was initiated in Spring 2025
  - 3-6 helicopters deployed mid-air
- SkyFall Project is a commercial partnership with AeroVironment (AV)
  - Modeled on Mars 2020's Ingenuity Helicopter
- SkyFall helicopters concept combined with MER-heritage *America 1* spacecraft
  - Basis for current SkyFall design
- SkyFall announced at NASA Administrator Ignition event in March 2026 to be combined with SR-1 Freedom delivery capability for 2028 launch



This document has been reviewed and determined not to contain export-controlled information.

Mission Description and Technical Approach

Overview

- ***Multi-helicopter mission producing science and paving the way for American astronauts on Mars***
- ***Delivered by SR-1 nuclear-electric propulsion mission***
- ***LRD: November 15, 2028***
- ***Surface mission: Sept / Oct 2030***

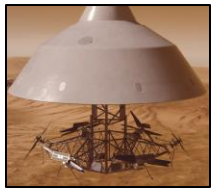


Objectives:



Perform science, scouting and resource prospecting

- ✓ Ground penetrating radar to characterize critical water sources for potential future use
- ✓ High resolution images to understand geomorphology
- ✓ Science cameras, dosimeter, temp sensors



Demonstrate unprecedented Mars asset delivery

- ✓ Surface delivery without landers



Key industry partnerships (Aerovironment)

- ✓ Close, proven commercial partnership with AV
- ✓ Heritage and re-use as appropriate

This document has been reviewed and determined not to contain export-controlled information.

Technical Approach - Helicopter Heritage



Ingenuity

TRL-9, 72 flights on Mars



Sample Recovery Helicopter (SRH)

PDR Maturity



The Skyfall Helicopter

Next Generation Ingenuity-Class Helicopter

Increased range: 1-2 km / flight

Independent ops: direct-to-orbit comms capability

High-resolution stereo imagers (13 MP) for scouting

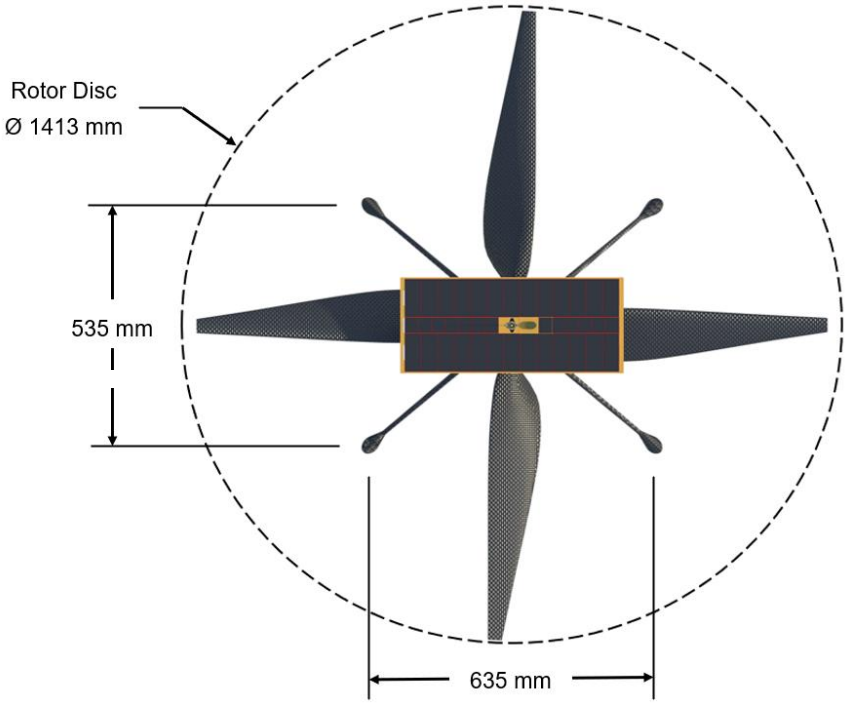
Ground Penetrating Radar (GPR) for ice prospecting

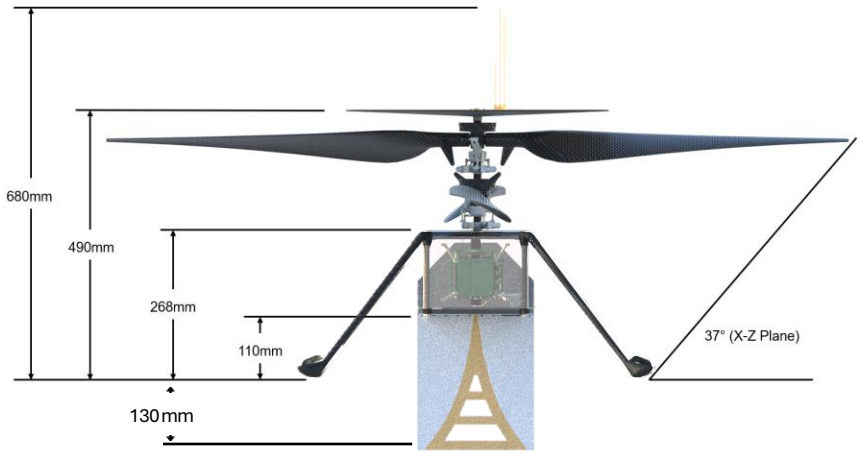
High heritage enables ‘28 launch

This document has been reviewed and determined not to contain export-controlled information.

Next Generation Ingenuity-Class Helicopter

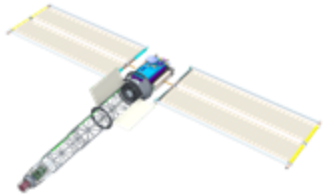
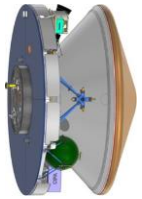
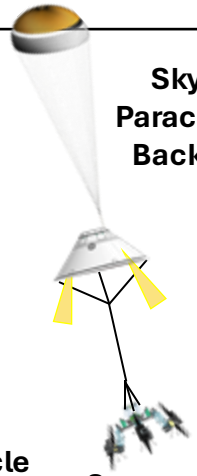
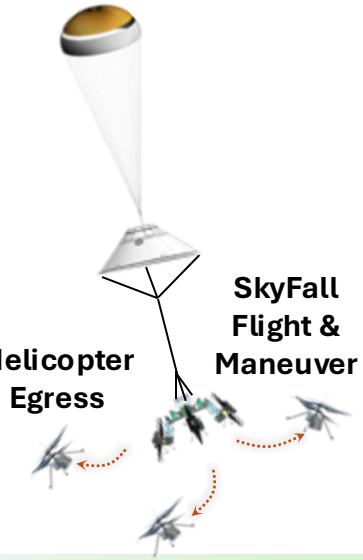
Max System Mass	2700 g
Range **Cadence**	1-2 km / flight Flies every other sol
Rotors/Blades	*Ingenuity-derived* Coax Rotor Assembly *Ingenuity-derived* 1.4 m blades
Solar Array	*Ingenuity-heritage* IMM4 cell technology, 1500 cm^2
Battery Cells	COTS Mollicell P30B 18650 Li-ion cells
Avionics	*Ingenuity-heritage* Flight Computer and FPGA *Ingenuity-upgraded* Snapdragon Nav. Processor *Ingenuity-heritage* Motor Controllers ***SMD tech investment*** Arke Direct-to-Orbit UHF Radio
Sensors	*Ingenuity-heritage* High resolution color imagers (13 MPx, Sony IMX214) ***SMD tech investment*** Ground Penetrating Radar plus additional instruments (dosimeter, science cameras, temp sensors) GNC: • *Ingenuity-upgraded* 4x IMUs BMI-270 • 1x Altimeter: Attollo WASP-200 LRF • *Ingenuity-heritage* forward- and downward-facing NavCams: OV7251 detectors, global shutter • *Ingenuity-upgraded* 1x Inclinometer: muRata SCL3400





This document has been reviewed and determined not to contain export-controlled information.

SkyFall Mission Phases

Earth	Early-Mid Cruise	Late Cruise Deep Space	Mars Vicinity	Mars Surface
 Launch Vehicle	 SR-1 carrying SkyFall Cruise Stage & Entry Vehicle	 SkyFall Cruise Stage & Entry Vehicle	 SkyFall Entry Vehicle  SkyFall Parachute & Backshell Spacecraft Helicopter Platform  Helicopter Egress SkyFall Flight & Maneuver	 SkyFall Helicopters 

Pre-Launch Phase

SR-1 Launch & Cruise Phase

SR-1 SkyFall Deployment

SkyFall Cruise & Approach Phase

SR-1 & Cruise Spacecraft separation

EDL Phase*

Entry & Descent Sub Phase

Spacecraft FSW transition to EDL_MAIN

Flight & Landing Subphase

Helicopters Egress

Helicopter Surface Phase

All 3 Heli Rotors no longer moving (GNC is in IDLE)

Space Reactor – 1 Freedom Launch and Operations Phases

This document has been reviewed and determined not to contain export-controlled information.

Mission Description - Helicopters Egress

Pre Entry:

[week before]: final checkouts of heli avionics

[days before]: heli batteries charged to 100%

[hour before]: heli batteries preheated to +20 degC



Helicopters Wake Up
[~2 min to Egress]



Helicopters Initialize
[~1 min to Egress]



Helicopters Spin Up
[~15 sec to Egress]



Helicopters Wait for Release
[~2 sec to Egress]



Helicopters Release

Preparation for Flight

This document has been reviewed and determined not to contain export-controlled information.

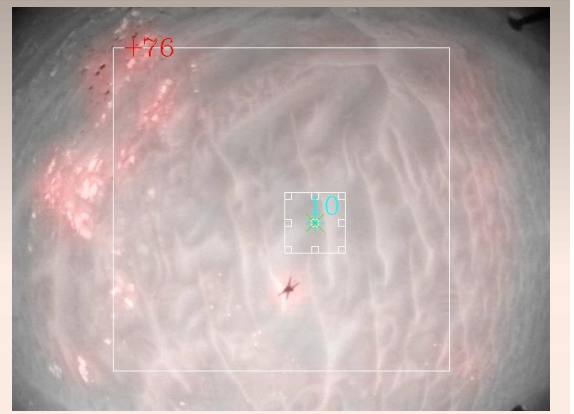
Mission Description - Helicopters Flight and Landing

Clear Platform
[seconds after Egress]

1. Helis separate with high nose-down pitch
2. Helis thrust away from platform, building horiz. velocity
3. Navigation is IMU + Visual Odometry only

Slow to Hover
[~1 minute after Egress]

Level Out
[~50 sec after Egress]

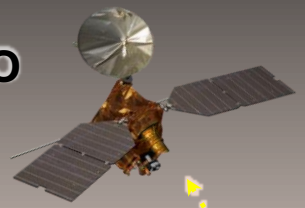


Hazard Divert (as needed)

This document has been reviewed and determined not to contain export-controlled information.

ion Description - Surface Phase

MRO + TGO coverage



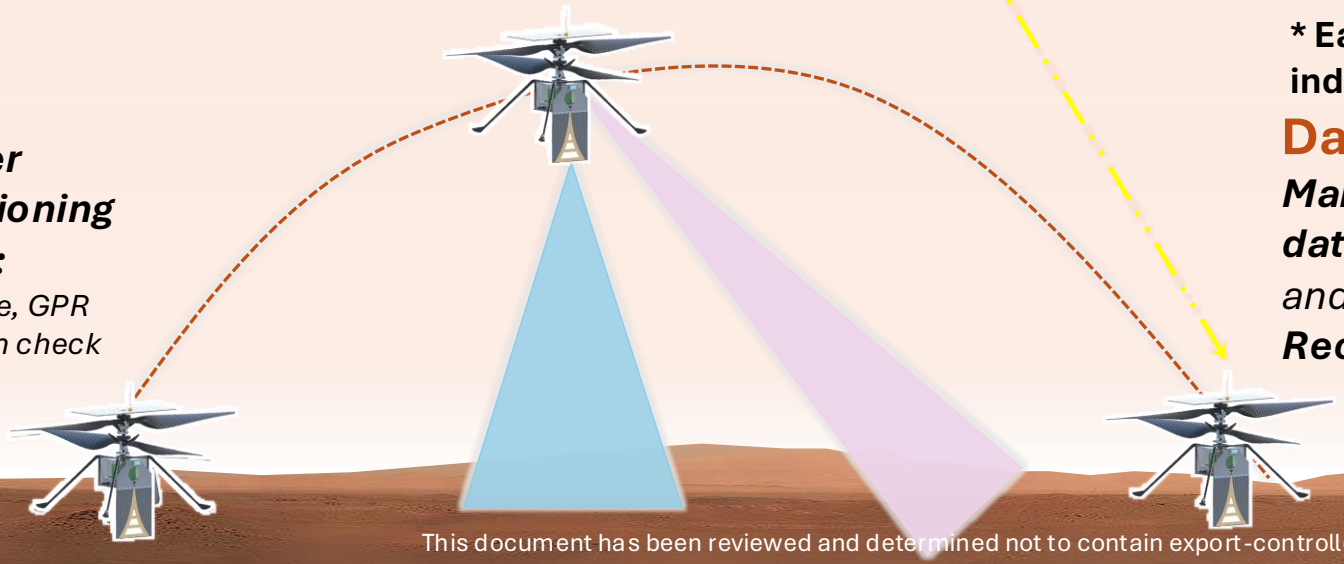
Key Phase Capabilities:

1. All 3 helis operate independently – no coordinated ops
2. Energy budget supports flights every sol

Flight Sol

Travel to region of interest
and/or
Science collection

Helicopter commissioning activities:
battery charge, GPR deploy, health check



*** Each available orbiter pass is dedicated to a single independent helicopter**

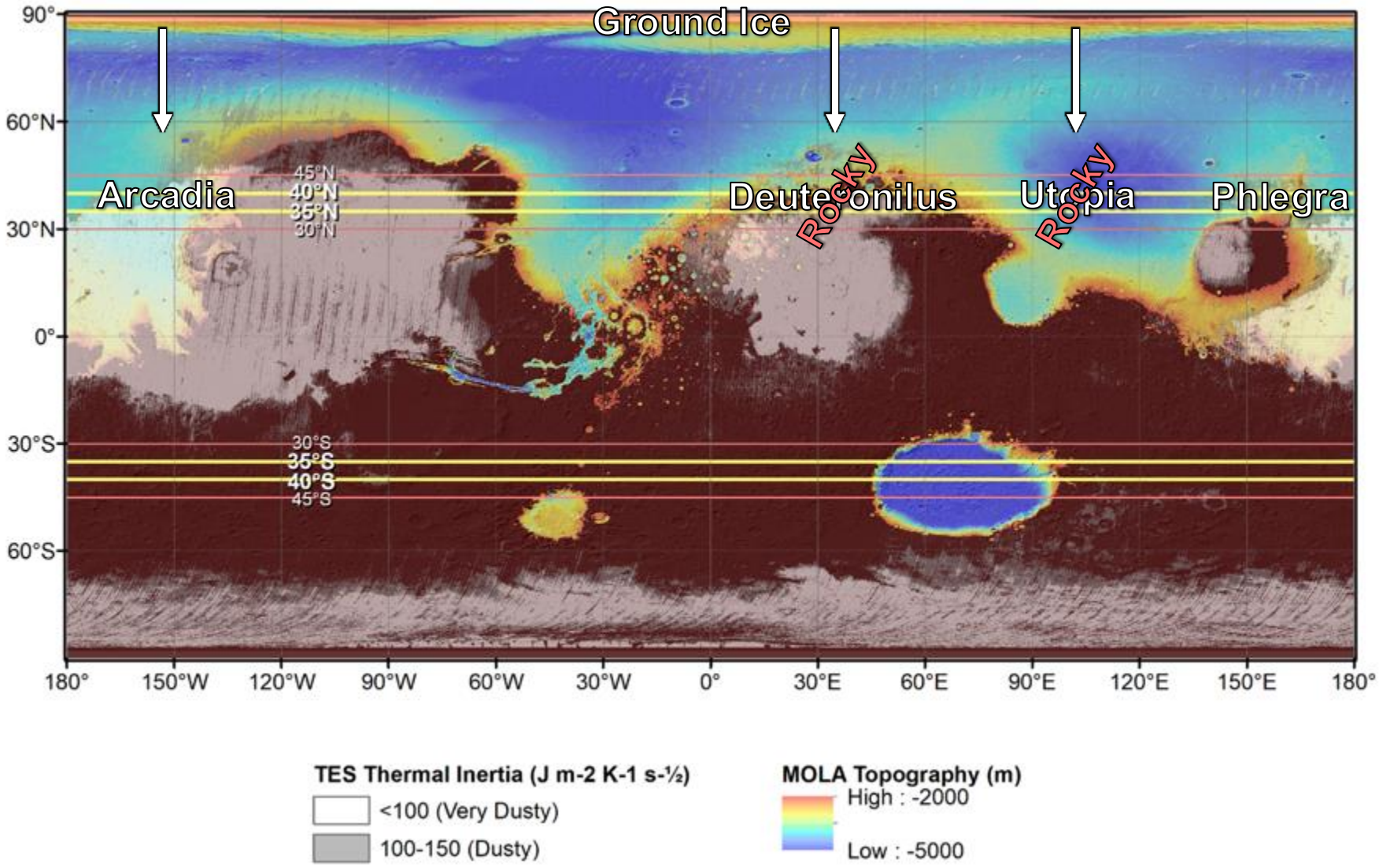
Data Management Sol

Manage and downlink collected data
and/or
Receive tactical uplink

This document has been reviewed and determined not to contain export-controlled information.

Mission Description - Northern Mid-latitude Ice Regions

- Looking for landing sites with Ice-Resources at Low Elevation, Mid-latitudes
- Arcadia Planitia looks safe and contains at least one design reference site that meets engineering requirements
- Landing site workshops 2027 to discuss alternate sites and current design reference site



This document has been reviewed and determined not to contain export-controlled information.


SKYFALL

1.2 – Objectives / L1 Requirements

Science Objectives:

The SkyFall mission will deliver three Ingenuity-class helicopters to the surface of Mars. Once deployed, the helicopters will capture high resolution surface imagery and conduct investigations to address objectives relevant for science and preparing for human exploration of Mars.

Primary science goals:

- A. Characterize the shallow subsurface structure using onboard sensing to identify buried rocks, regolith layering, and potential volatile-bearing deposits (including water ice) to advance understanding of local geologic processes and help identify regions where subsurface properties may affect ~~landing~~ stability of landing heavy spacecraft.
- B. Acquire high-resolution, low-altitude imagery to map surface morphology, geologic units, slopes, and hazards at scales not observable from orbit, improving terrain and hazard models.
- C. Measure near surface radiation fluxes to understand the radiation environment at the surface of Mars, how they vary with terrain, altitude and dust conditions, and the implications for future human exploration
- D. Measure the air and surface temperature, and wind speed and direction to understand the factors that influence air movement and dust transport in the near surface atmosphere.

In accordance with the objectives described above, the science payload/sensors will provide measurements of Martian surface materials that support science and exploration goals, including characterization of the subsurface and the geologic environment and near surface meteorology, and demonstrate usefulness and feasibility of potential exploration zone scouting methods using aerial mobility

1.2 – Objectives / L1 Requirements

Programmatic Objectives:

In addition to its scientific objectives, the SkyFall project will conduct the following mission operations and technology validation in order to support feed-forward to future Mars exploration missions:

- Demonstrate the feasibility of deploying helicopters mid-air on Mars to conduct in-situ reconnaissance measurements and investigations in support of NASA's science and exploration objectives.

1.2 Objectives / L1 Requirements

	Level 1 Requirements
1	The project shall deliver an aerial-mobility surface mission to be launched to Mars during the 2028 opportunity from the Eastern Test Range.
2	The project shall deliver a flight system to be launched as a payload hosted by the Space Reactor 1 (SR-1) Freedom mission.
3	The project system shall be capable of landing and operating three helicopters at a site consistent with the Design Reference Site as defined in the SkyFall Landing Site Characteristics Document.
4	The project system shall be capable of conducting operations on the surface of Mars with the helicopters and their scientific payload during a prime mission of at least 6 months (180 Martian sols) and a goal of one Earth year (360 Martian sols).
5	The project shall deliver to Mars three helicopters each with the capability of a total flight range distance of at least 50 km and a goal of 100 km.
6	The SkyFall Project shall develop, integrate, and test the NASA directed science investigation payload on the SkyFall helicopters capable of achieving the science and program objectives listed in Section 2.
7	The baseline SkyFall project system operations shall be capable of conducting the investigations required to achieve objectives A and B in a minimum of three scientifically-selected Regions of Interest during the prime mission.
8	The project system shall be capable of providing data communication throughout critical Entry, Descent, and Landing events at a rate sufficient to determine the state of the spacecraft in support of fault reconstruction to relay assets provided by the Mars Exploration Program or to the Deep Space Network.
9	The project shall conduct near real-time public release of imagery and other science/technology data via the Internet and will provide regular releases for public information purposes.
10	The project shall archive copies of all verified, validated, and calibrated data acquired by the mission to the Planetary Data System within six months after its receipt on Earth.
11	The SkyFall Project shall comply with requirements for a Planetary Protection Category IVa mission as defined in NPR 8715.24 and NASA-STD-8719.27.

1.3.3 Technical Approach

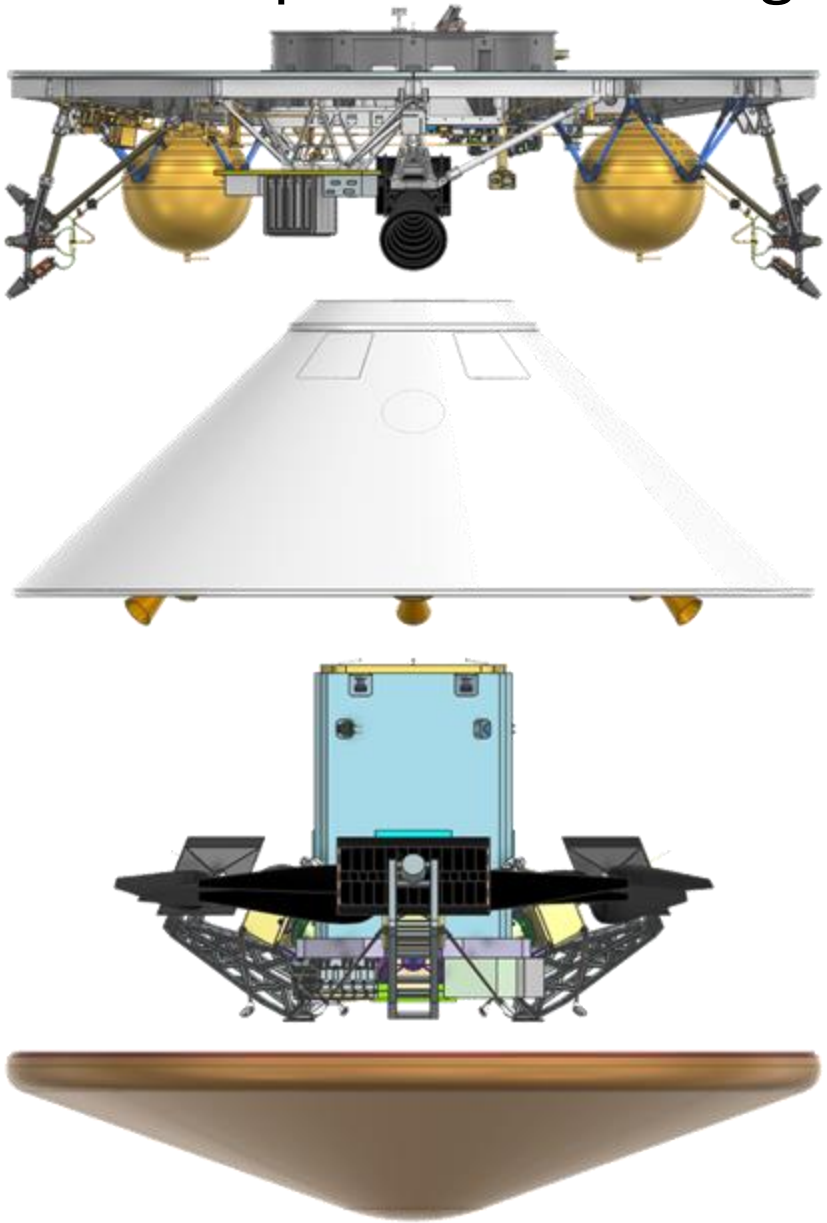
- Leverage heritage hardware, software, designs, tech developments, and partner missions to enable 2028 launch
  - Inheritance from Ingenuity (including flight software) and the Sample Return Helicopter (SRH) will be the design basis with mission specific modifications as necessary to meet mission requirements and objectives
  - Inheritance from the Mars Exploration Rovers (MER) and the for the cruise, entry, and descent designs (including flight software) with mission specific modifications as necessary to meet mission requirements and objectives
  - Inheritance from SRL for cruise and EDL telecom
  - ENGAGE Avionics with PolarFire SOC for spacecraft avionics
  - Arke radio R&TD for helicopter direct to comms
  - GPR based on CMOS radar chip enabling miniaturization effort under NASA SMD PICASSO program
  - MOS / GDS leverages Rover Operations Center (ROC) capabilities
  - Synergies with MoonFall leveraged
  - AI use to support FSW and GDS coding and testing
- Rely on key industry partnership with Aerovironment and their Ingenuity experience for helicopter development
- Early focus and characterization of new elements
  - Helicopter platform and bridle designs
  - Ground penetrating radar (GPR) and antenna
  - Spacecraft alitimeter

1.3.3 Technical Approach - SF Spacecraft Heritage Overview

Build to Print / Spare
Heritage
New

Backshell
- **EDL:** Parachute, RAD (TBD)
- **Mechanical**: Harness, Structure, Sep HW, TPS
- **Power**: Electronics (unique), Battery
- **Telecom**: Antenna

Heatshield
- **Mechanical**: Structure, Sep HW, TPS



Cruise Stage
- **GNC**: Sun Sensor, Star Scanner
- **Mechanical**: Harness, Structure, Sep HW
- **Power**: Electronics, Solar Array
- **Propulsion**: Tanks, Thrusters
- **Telecom**: Amplifier, Antennas, Diplexer, RF Switches

Heli Release Platform
- **CDH:** AEM
- **GNC**: Altimeter, IMU
- **Helicopters**
- **Mechanical**: Harness, Structure, Sep HW
- **Power**: Electronics (common), Electronics (unique), Battery
- **Telecom**: Transponder, RF Switch, Antenna