1

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Keep your mics muted and cameras off

- Helps ensure a clean recording

The recording will be posted online

- nasa.gov/flightopportunities
- Resources menu
- Community of Practice webinars

Please engage!

- Post your questions in the chat

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ABOUT THE COMMUNITY OF PRACTICE WEBINAR SERIES

An opportunity to hear from subject matter experts on best practices for preparing for suborbital flight tests

Researchers, program staff, and flight providers

Connecting and sharing information and lessons learned to:

- Increase the impact of suborbital flight tests
- Transfer best practices
- Optimize the experience of current and prospective program participants

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Subscribe to our newsletter for updates on future webinars!

https://www.nasa.gov/directorates/spacetech/flightopportunities/newsletter

Future webinars

- Webinars are usually held 1st Wednesday of each month at 10 a.m. PT.
- Topics are announced in the Flight Opportunities newsletter and website.
- Session recordings are posted on the Flight Opportunities website.
- Let us know session topics you would like to see covered.

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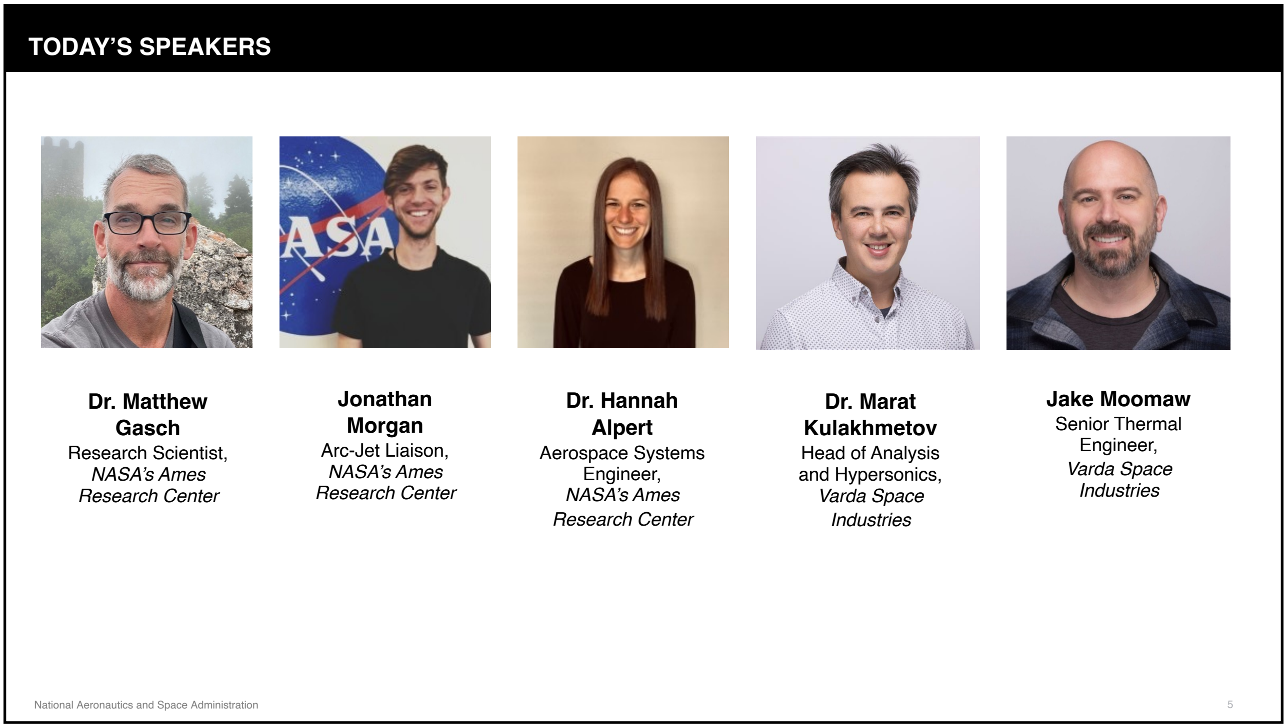
TODAY'S SPEAKERS
Dr. Matthew Gasch
Research Scientist,
NASA's Ames Research Center
Jonathan Morgan
Arc-Jet Liaison,
NASA's Ames Research Center
Dr. Hannah Alpert
Aerospace Systems Engineer,
NASA's Ames Research Center
Dr. Marat Kulakhmetov
Head of Analysis and Hypersonics,
Varda Space Industries
Jake Moomaw
Senior Thermal Engineer,
Varda Space Industries
National Aeronautics and Space Administration
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EXPLORE SPACE TECH
NASA Flight Opportunities Community of Practice
May 2026 I NASA's Ames Research Center

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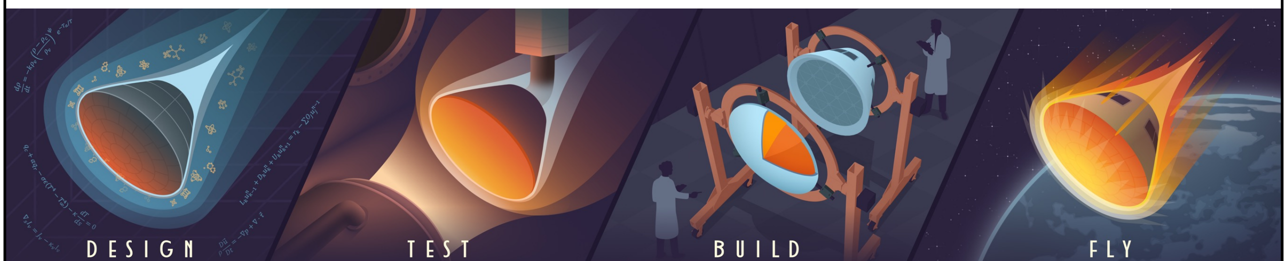
Entry Systems and Technology Division
Ames Research Center

National Aeronautics and Space Administration

Entry Systems and Technology Division (Code TS) Context, Capabilities, and Achievements



NASA Ames Research Center

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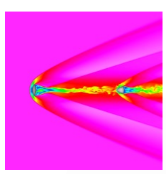
Entry Systems Core Competency

- The Entry Systems and Technology Division (TS) is comprised of four separate branches which each play a critical role that when integrated create one of the most unique organizations in the Agency.

Aerothermal environment determination

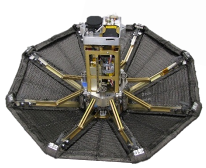
TSA: Aerothermodynamics Branch



Development of thermal protection systems (TPS) materials

TSM: Thermal Protection Materials Branch

Systems engineering and integration for entry systems development



TSS: Entry Systems and Vehicle Development Branch

Arc jet testing to verify performance

TSF: Thermophysics Facilities Branch

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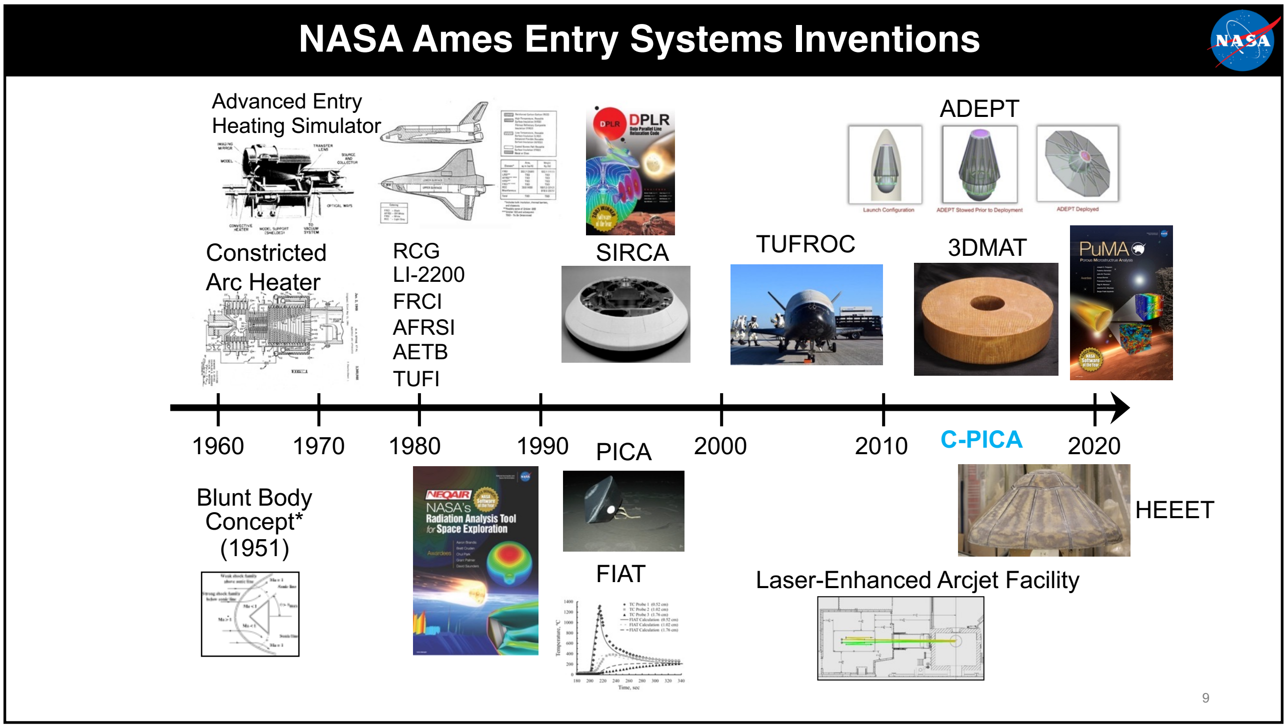
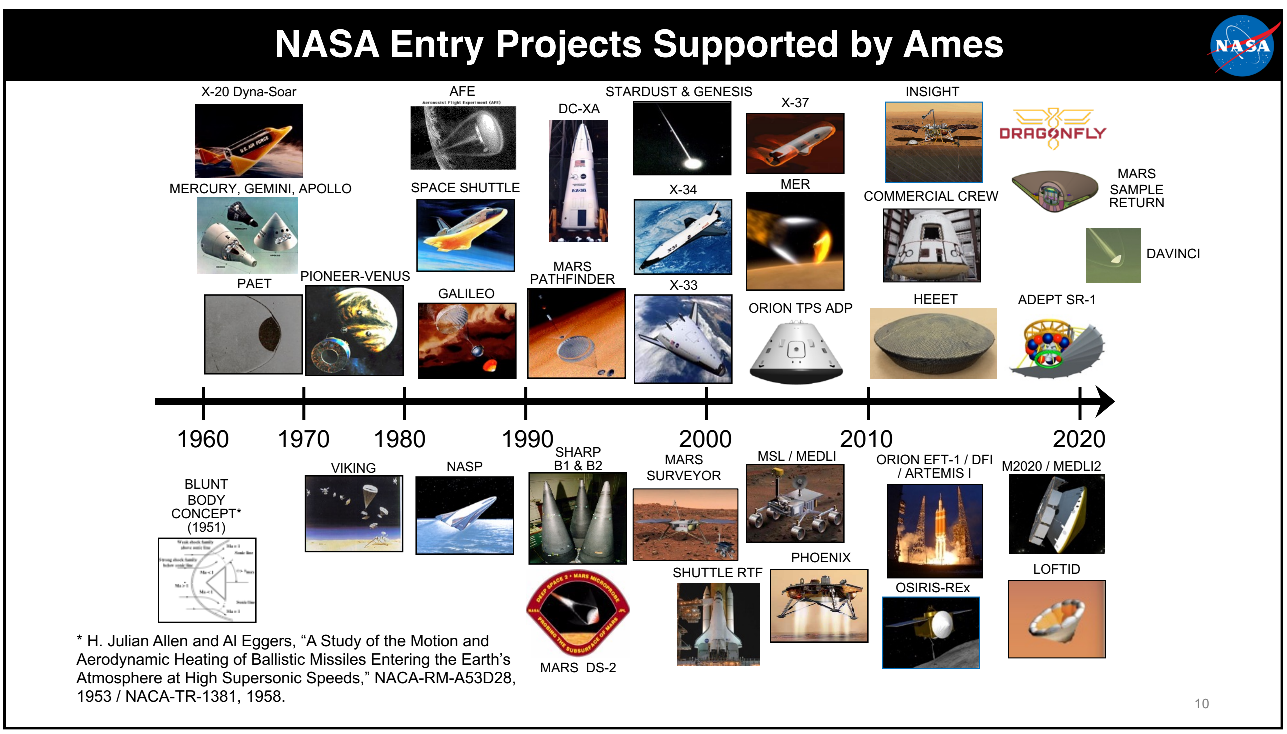

NASA Ames Entry Systems Inventions
Advanced Entry Heating Simulator
DPLR
ADEPT
Constricted Arc Heater
RCG
LI-2200
FRCI
AFRSI
AETB
TUFI
SIRCA
TUFROC
3DMAT
PuMA
1960
1970
1980
1990
PICA
2000
2010
C-PICA
2020
Blunt Body Concept* (1951)
NASA's Radiation Analysis Tool for Space Exploration
FIAT
Laser-Enhanced Arcjet Facility
HEEET
9

9


NASA Entry Projects Supported by Ames
X-20 Dyna-Soar
AFE
STARDUST & GENESIS
DC-XA
X-37
INSIGHT
DRAGONFLY
MERCURY, GEMINI, APOLLO
SPACE SHUTTLE
X-34
MER
COMMERCIAL CREW
MARS SAMPLE RETURN
DAVINCI
PAET
PIONEER-VENUS
GALILEO
MARS PATHFINDER
X-33
ORION TPS ADP
HEEET
ADEPT SR-1
1960
1970
1980
1990
2000
2010
2020
BLUNT BODY CONCEPT* (1951)
VIKING
NASP
SHARP B1 & B2
MARS SURVEYOR
MSL / MEDLI
ORION EFT-1 / DFI / ARTEMIS I
M2020 / MEDLI2
SHUTTLE RTF
PHOENIX
OSIRIS-REx
LOFTID
MARS DS-2
* H. Julian Allen and Al Eggers, "A Study of the Motion and Aerodynamic Heating of Ballistic Missiles Entering the Earth's Atmosphere at High Supersonic Speeds," NACA-RM-A53D28, 1953 / NACA-TR-1381, 1958.
10

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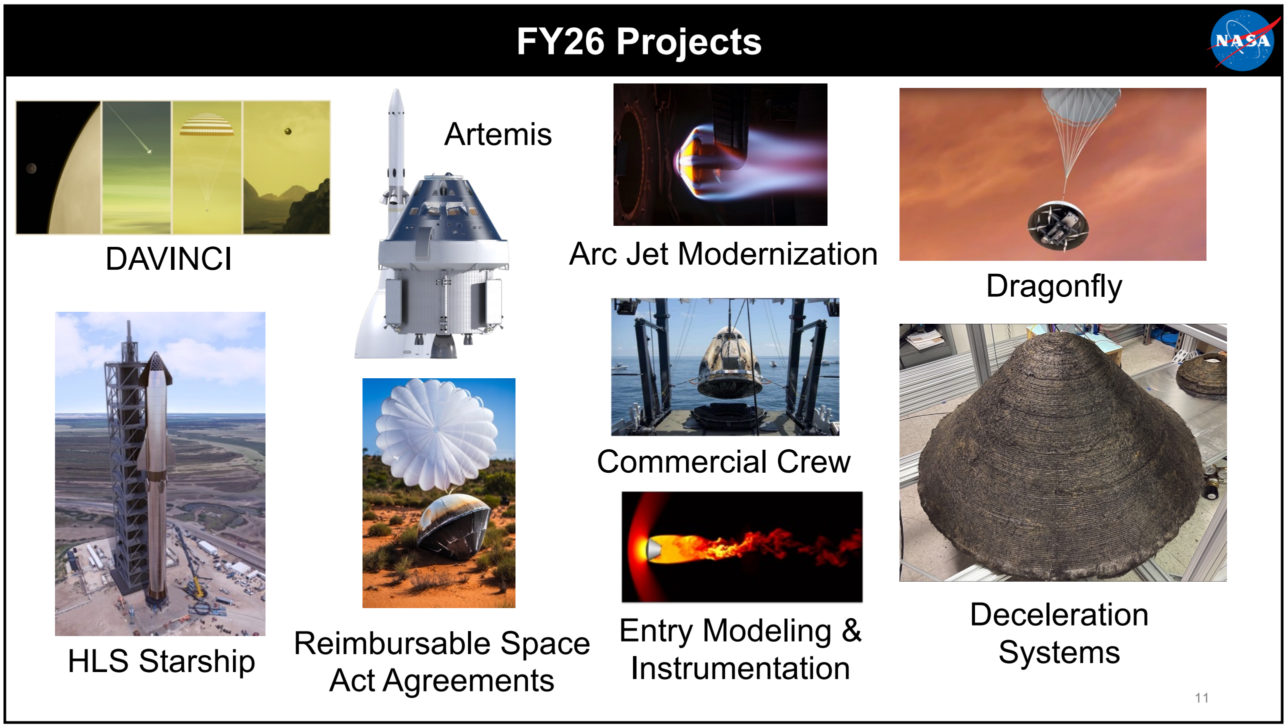

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LAND

Space to Surface Operations

- Enty Modeling and Instrumentation (EM&I)
- Deceleration Systems
- Landing Systems and Environments
- Guidance & Navigation Systems (G&N)

There are 13 LAND Shortfalls with the following binning:

Shortfall 1564: Aeroshell In-Situ Flight Performance Data During EDL	EM&I
Shortfall 1568: Entry Modeling and Simulation for EDL Missions	EM&I
Shortfall 1574: Validated Performance Models for Planetary Parachutes	EM&I
Shortfall 1563: Aerocapture for Spacecraft Deceleration and Orbit Insertion	Decelerators
Shortfall 1567: Entry Capabilities for Small-Scale and Commercial Spacecraft	Decelerators
Shortfall 1569: High-Mass Mars Entry and Descent Systems	Decelerators
Shortfall 1572: Performance-Optimized Low-Cost Aeroshells for EDL Missions	Decelerators
Shortfall 1562: Advanced Algorithms and Computing for Precision Landing	G&N
Shortfall 1565: Assessment and Validation Capabilities for Integrated Precision Landing Systems	G&N
Shortfall 1571: Navigation Sensors for Precision Landing	G&N
Shortfall 1573: Terrain Mapping Capabilities for Precision Landing and Hazard Avoidance	G&N
Shortfall 1566: Characterization of Plume Surface Interaction	Landing
Shortfall 1570: Lander Capabilities for Soft Touchdown	Landing

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Commercial Space Support

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Entry Systems Related ACO / Tipping Points

- **2015 ACO Entry Systems Awards (13 Total Awards)**
  - Intelligent Fiber Optic Systems Corp.: Validation of Fiber Optic Temperature Sensor Arrays for Thermal Protection System Materials
  - T.E.A.M. Inc.: Development and Characterization of 3D Woven Thermal Protection System via Arc Jet Testing
  - Boeing: Arc Jet Exposure of Ablative and Non-Oxide CMC TPS for Planetary Probe and Sample Return Applications
- **No Entry Systems Awards: 2015 Tipping Points (9 Total Awards), 2017 Tipping Points (8 Total Awards), 2018 Tipping Points (10 Total Awards), and 2019 Tipping Points (14 Total Awards)**
- **2019 ACO Entry Systems Awards (19 Total Awards)**
  - Anasphere: Testing a compact hydrogen generator for inflating heat shields, which could help deliver larger payloads to Mars
  - Bally Ribbon Mills: A New Seamless Weave for a Mechanically Deployable Carbon Fabric Heatshield
  - Sierra Nevada Corporation: capturing infrared images of their Dream Chaser spacecraft as it re-enters Earth's atmosphere traveling faster than the speed of sound
  - Sierra Nevada Corporation: maturing a method to recover the upper stage of a rocket using a deployable decelerator
- **2020 Tipping Point Entry Systems Awards (14 Total Awards) – None**
- **2020 ACO Entry Systems Awards (20 Total Awards)**
  - Ahmic Aerospace: Hypersonic Instrumentation and Thermal Protection System Material Characterization Test Methodology
  - Cornerstone Research Group: Additively Manufactured TPS Arc Jet Evaluation
  - Rocket Lab: Aerothermodynamics in support of maturation of tension cone and microFOSS technologies for Electron Launch Vehicle Stage 1 Recovery
  - SpaceX: Capturing imagery and thermal measurements of its Starship vehicle during orbital re-entry over the Pacific Ocean
- **2023 ACO Entry Systems Awards (16 Total Awards)**
  - Blue Origin: Metallic Thermal Protection System (TPS)
  - Canopy Space: Low-cost reusable TPS substrates as an alternative to AETB
  - Stratolaunch: Bringing Shuttle Orbiter TPS into the 21st Century
  - Lockheed Martin: Oscillating Heat Pipe Technology for Aeroentry and Commercial Applications (OHPACA)
  - Sierra Space: Development of Low Cost High Temperature Reusable TPS
- **2023 TP Entry Systems Awards (11 Total Awards)**
  - Varda Space Industries: Conformal PICA (C-PICA) Tech Transfer and Commercial Production
  - United Launch Alliance: ULA Vulcan Engine Reuse Scale (VERS) HIAD Technology Demonstration

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Varda Space Industries Winnebago Series Missions

- Ames provided Conformal PICA (C-PICA) billets for three shipsets through an RSAA to be used on Winnebago Series 1, 2, and 3 all of which successfully returned [2/21/2024, 2/27/2025, and 5/13/2025].
- Winnebago Series 5 returned on January 29, 2026 and employed a heatshield made from C-PICA produced by Varda, developed under a 2023 STMD Tipping Point award.

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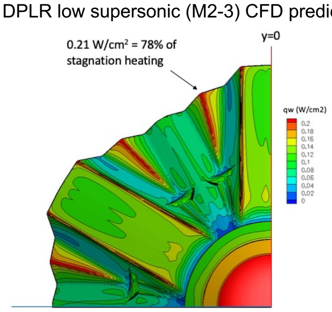
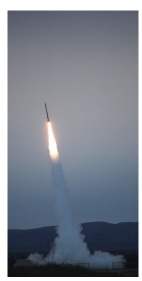
ADEPT - Calypso 1 Launch November 2025

- Ames deliverables (2023-2025)
  - CART3D static aero db of Mach and Alpha sweeps
  - 3DOF Trajectory simulations and descent timeline
  - Design consult on Deployable str/mech features, design approaches, and ADEPT lessons
  - Vehicle stability consult: 45deg rib angle, CG location, initial spin rate
  - Provided pressure loads for FEM structural analysis. Limited thermal modeling.
  - DPLR low supersonic (M2-3) CFD predictions



DPLR M2.5 solution (McDaniel)



UPAero SpaceLoft XL launch

LANL and RedWire team post recovery

- Launch successful on Nov 19, 2025 from Spaceport America near WSMR
- All flight events were nominal:
  Launch, Separation, Exo-Atmospheric Deployment, Stable Vehicle flight performance, Data telemetry and recording, Successful Recovery
- Calypso-1 flight data indicates a nominal (near zero AoA) flight attitude throughout descent (supersonic – low speed ground impact)
- Calypso-1 experienced roll rate 'reversal' starting at +40deg/s at entry, transitioning to -80deg/s just past peak dynamic pressure then reducing to small value during subsonic descent
- Ames post flight support will look to integrate data for 'best fit' summary of flight dynamics and trajectory simulation.

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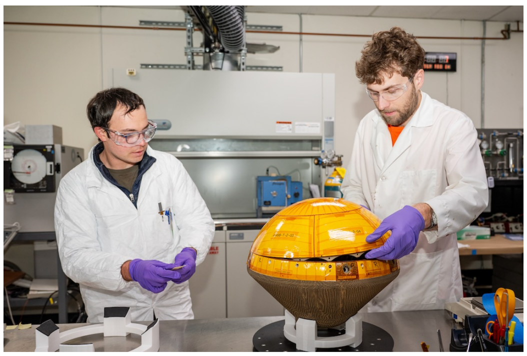
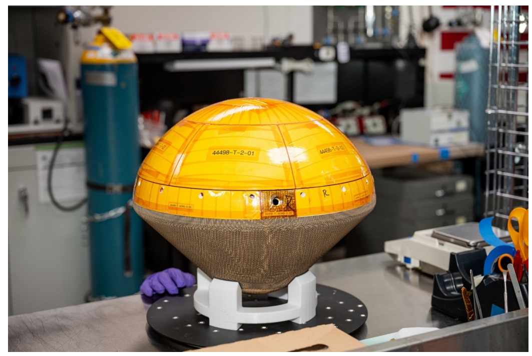
Rocket Lab Mission to Venus – 2028

- The Venus Life Finder mission will be the first private mission to the planet, led by Rocket Lab and their partners at MIT, to enter into the atmosphere of Venus in 2028.
- Sponsored by the STMD Small Spacecraft Technology Program, Ames provided the Heatshield for Extreme Entry Environment Technology (HEEET) Insulation Layer forebody and integrated it with the titanium carrier structure provided by Rocket Lab.
- This is another great example of how Ames works with private companies to turn NASA materials into heat shields tailor-made for their spacecraft, supporting growth of the new space economy.





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We Are the Starfleet Academy of the Orbital Economy

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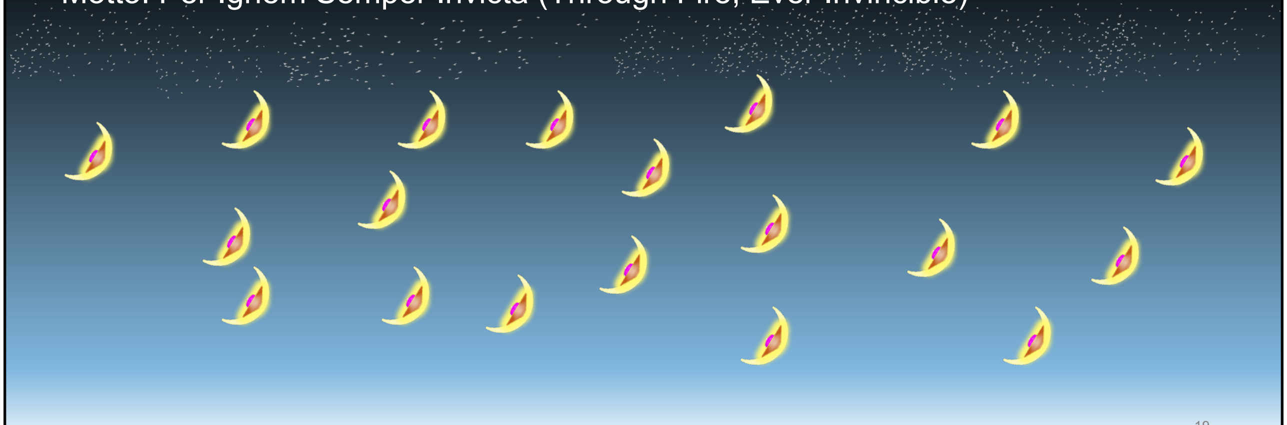
Entry Systems and Technology Division

Vision: Planetary skies filled with robots and humans exploring the Solar System

Mission: To develop innovative entry systems technologies from concept to hardware while providing sustaining engineering for all NASA planetary atmospheric entry missions

Motto: Per Ignem Semper Invicta (Through Fire, Ever Invincible)



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Ames Research Center
Entry Systems and Technology Division

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VARDA
TPS testing capabilities on the VARDA hypersonic testbed
Marat Kulakhmetov, Ph.D.,
Head of Analysis & Hypersonics, Varda Space Industries
Jacob Moomaw,
Sr. Thermal Engineer. Varda's TPS lead

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VARDA

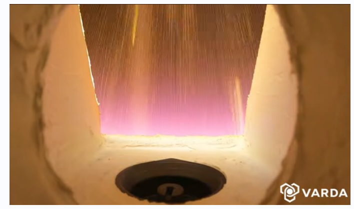
About Varda Space Industries

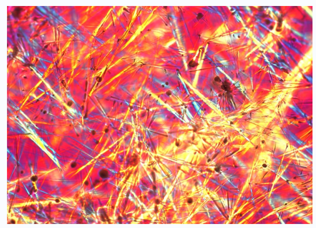
Founded as a Commercial Orbital Manufacturing Company:

- Takes advantage of unique chemical pathways in microgravity to create novel, high value pharmaceutical products
- Reenters products made in orbit for Earth consumption
- Commercial demand drives 12+ flights/yr cadence

Dual-Use Capabilities Supporting Flight Testing:

- Hypersonic, Reentry, and Space testbed
- Advanced Capabilities Reentry Spacecraft
- Orbital manufacturing and materials research facility (e.g. advanced semi-conductors)





Varda's Ritonavir crystals produced in microgravity

Varda W-1 Capsule Reentry and Recovery on Earth

Bauser HC, Smith PA, Parent SD, Chan LR, Bhavsar AS, Condon KH, et al. Return of the Ritonavir: A Study on the Stability of Pharmaceuticals Processed in Orbit and Returned to Earth. ChemRxiv. 2024; doi:10.26434/chemrxiv-2024-vb20g-v3

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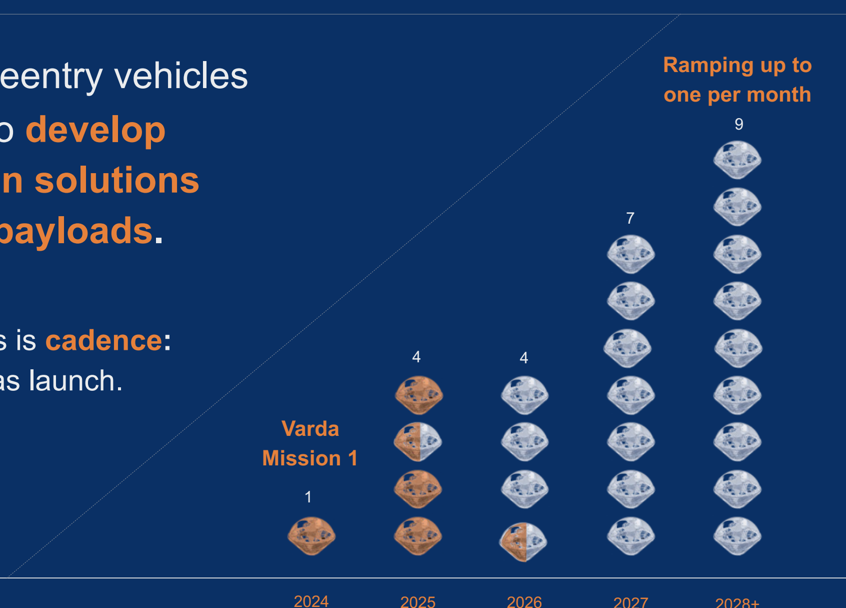
VARDA

Varda builds reusable reentry vehicles and payload modules to **develop novel drug formulation solutions** and **test government payloads**.

Our primary metric of success is **cadence**: to make reentry as common as launch.



Proprietary & Confidential

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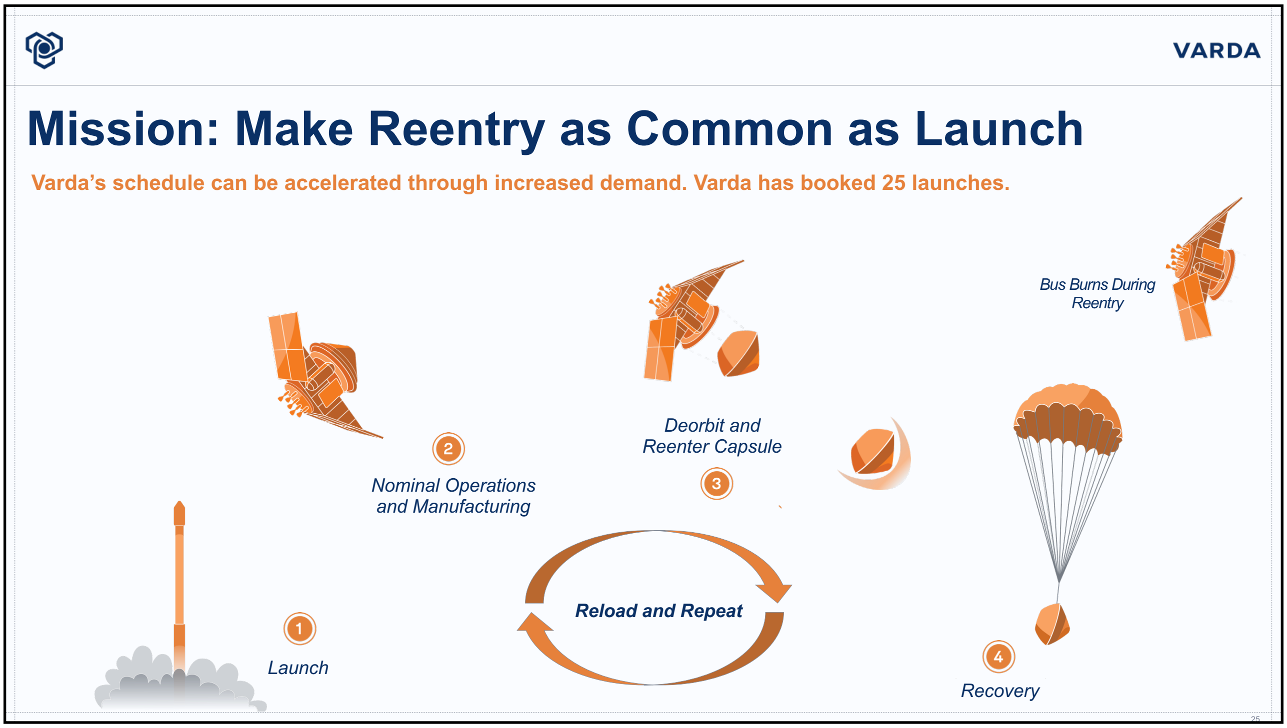
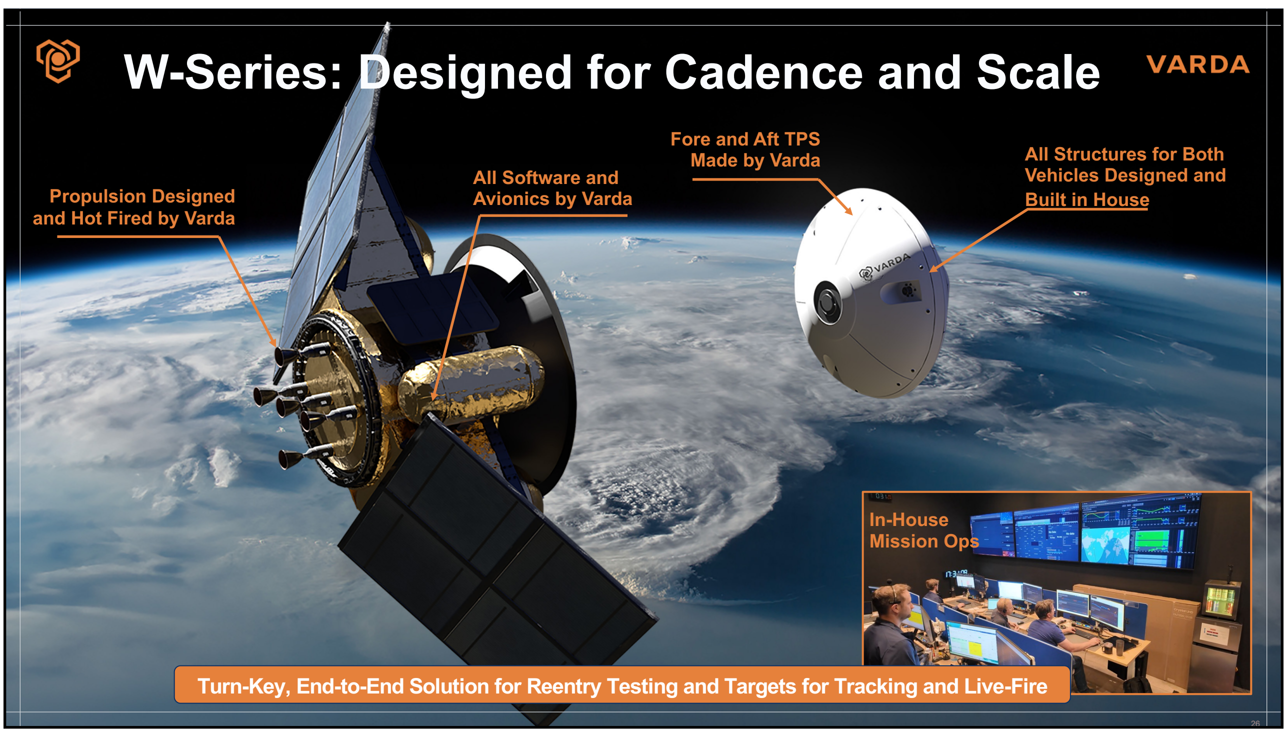

VARDA
Mission: Make Reentry as Common as Launch
Varda's schedule can be accelerated through increased demand. Varda has booked 25 launches.
Bus Burns During Reentry
Deorbit and Reenter Capsule
3
2
Nominal Operations and Manufacturing
Reload and Repeat
1
Launch
4
Recovery

25


W-Series: Designed for Cadence and Scale
VARDA
Propulsion Designed and Hot Fired by Varda
All Software and Avionics by Varda
Fore and Aft TPS Made by Varda
All Structures for Both Vehicles Designed and Built in House
In-House Mission Ops
Turn-Key, End-to-End Solution for Reentry Testing and Targets for Tracking and Live-Fire

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VARDA

4 Successful Orbital Reentry Missions, 2 on Orbit

	W1	W2	W3	W4	W5	W6
LAUNCHED	Jun 12, 2023	Jan 14, 2025	Mar 14, 2025	Jun 23, 2025	Nov 28, 2025	Mar 30, 2026
REENTRY	Feb 21, 2024	Feb 27, 2025	May 14, 2024	May 2026	January 29, 2026	May 2026
MISSION TYPE	Pharma Research NASA Material Test	Pharma Research Reentry S&T: NASA, AFRL	Reentry S&T: AFRL, AFNWC	Vehicle Demo Mission Reentry Target Demo	Reentry S&T: Navy	Reentry S&T: AFRL, NASA
RANGE	Utah Test & Training Range	Koonibba Test Range	Koonibba Test Range	Koonibba Test Range	Koonibba Test Range	Koonibba Test Range

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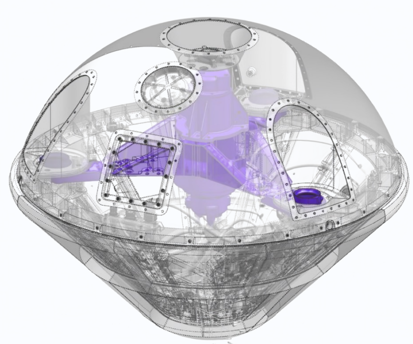
VARDA

Standard Payload Interfaces

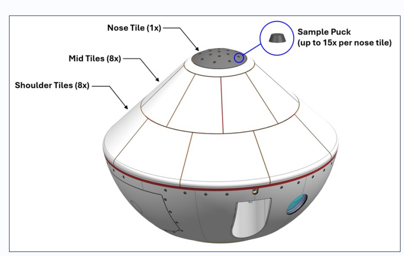
Interior Payloads

- Up to four interior payload bays per flight



Exterior Payloads

- Hosted in either shoulder, mid, or nose zones
- Host 15+ instrumented pucks on standard carrier tile
- Carrier tile is robust to failure of pucks, enabling rapid maturation to TRL 6-8



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VARDA

W-1 Flight Data (Feb 2024)

The vehicle was recovered in Utah Test and Training Range (UTTR):

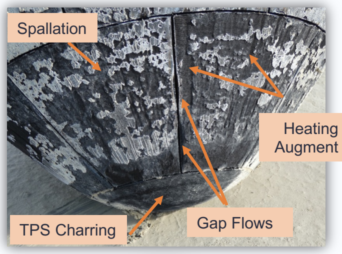
Surface was analyzed for:
- Spallation
- Heating Augmentations
- Channel/Gap Flows

TPS core samples are extracted for post-flight high fidelity analysis

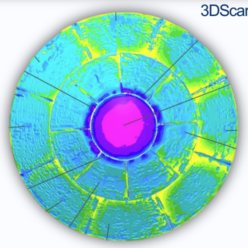
TPS was 3D scanned to anchor aero-thermal/material response models

High frequency IMU, multi-channel thermal data, and 4k video was stored on DAQ

Since vehicle touches down on the shoulder, forebody TPS is not damaged on landing



3DScan



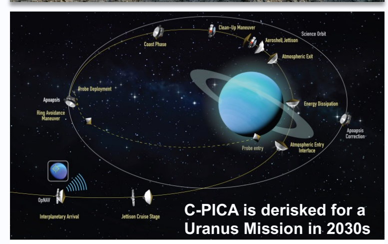


Fig. 1 Conceptual operations for an aerocapture approach to Uranus.

*J. Morgan, J. Williams, "Improvements to Thermal Protection System Design of Aerocapture System for Uranus Orbiter"

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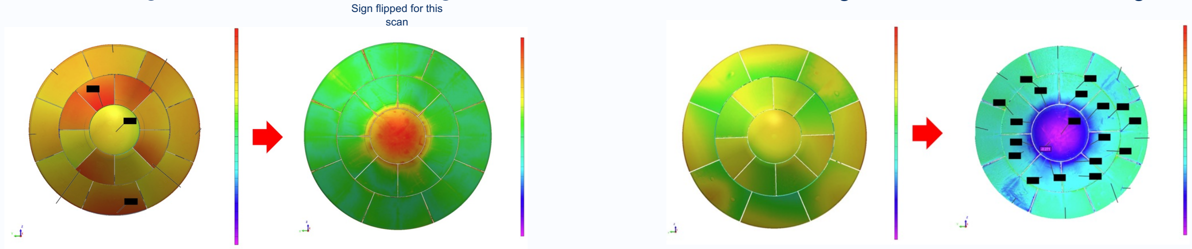
VARDA

Ablation of the C-PICA Heatshield

Value	W5 Peak Nose Recession [% of total]	W5 Peak Cone Recession [% of total]	W2 Peak Nose Recession [% of total]	W2 Peak Cone Recession [% of total]
Postflight Reconstruction	28.7%	17.2%	29.7%	14.2%
3D Scan	26.6%	-	24.5%	-

W5 Pre-Flight | W5 Post-Flight (Sign flipped for this scan) | W2 Pre-Flight | W2 Post-Flight



Black boxes are protected figures

Note: All 3D scan measurements are relative to CAD nominal

Observed nose ablation was bounded by predictions. Comparable nose ablation despite lack of waterproof coating.

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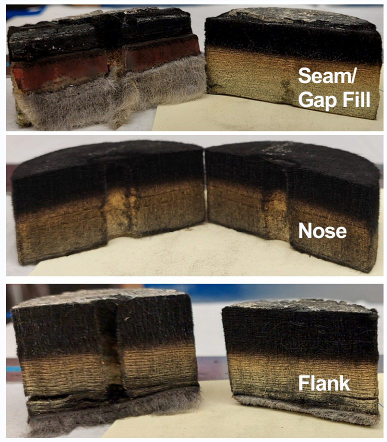
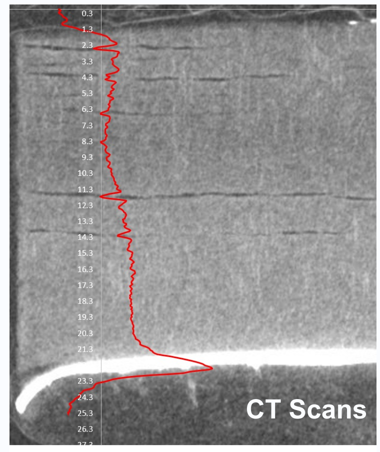
VARDA

W-1 TPS Core Analysis





- Recoverable vehicle enables detailed post-flight analysis of payloads
- W-1 cores were analyzed by NASA Ames

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VARDA

Varda Payload User Guides (PUG)

- Defines detailed standard accommodations for hosted payloads
  - ✓ Interfaces
  - ✓ Environments
  - ✓ Requirements and Verifications
  - ✓ Milestones and Deliverables
- Head-start toward mission-specific interface definition
  - These are captured in a separate document called the "Interface Requirements Document" or "IRD"

Varda can provide access to additional users by request, even without a contract. Simply contact us for access to the PUG.

All non-government Varda PUG users must be under Varda NDA.

The PUG is a living document and is not definitive; parameters can be adjusted based on different mission needs through Non Recurring Engineering.

Exterior Payloads

Interior Payloads

Exterior Material Sample Puck

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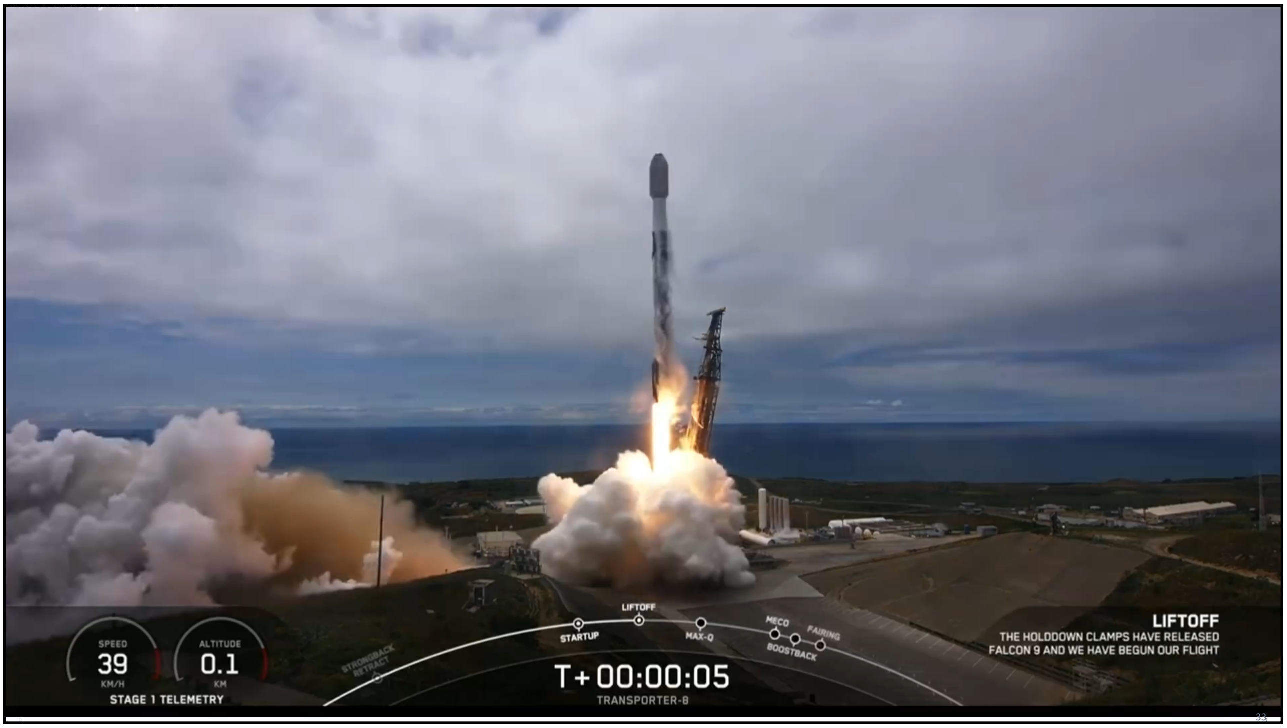
SPEED
39
KM/H
ALTITUDE
0.1
KM
STAGE 1 TELEMETRY
STARTUP
LIFTOFF
MAX-Q
MECO
BOOSTBACK
FAIRING
T+00:00:05
TRANSPORTER-8
LIFTOFF
THE HOLDDOWN CLAMPS HAVE RELEASED
FALCON 9 AND WE HAVE BEGUN OUR FLIGHT

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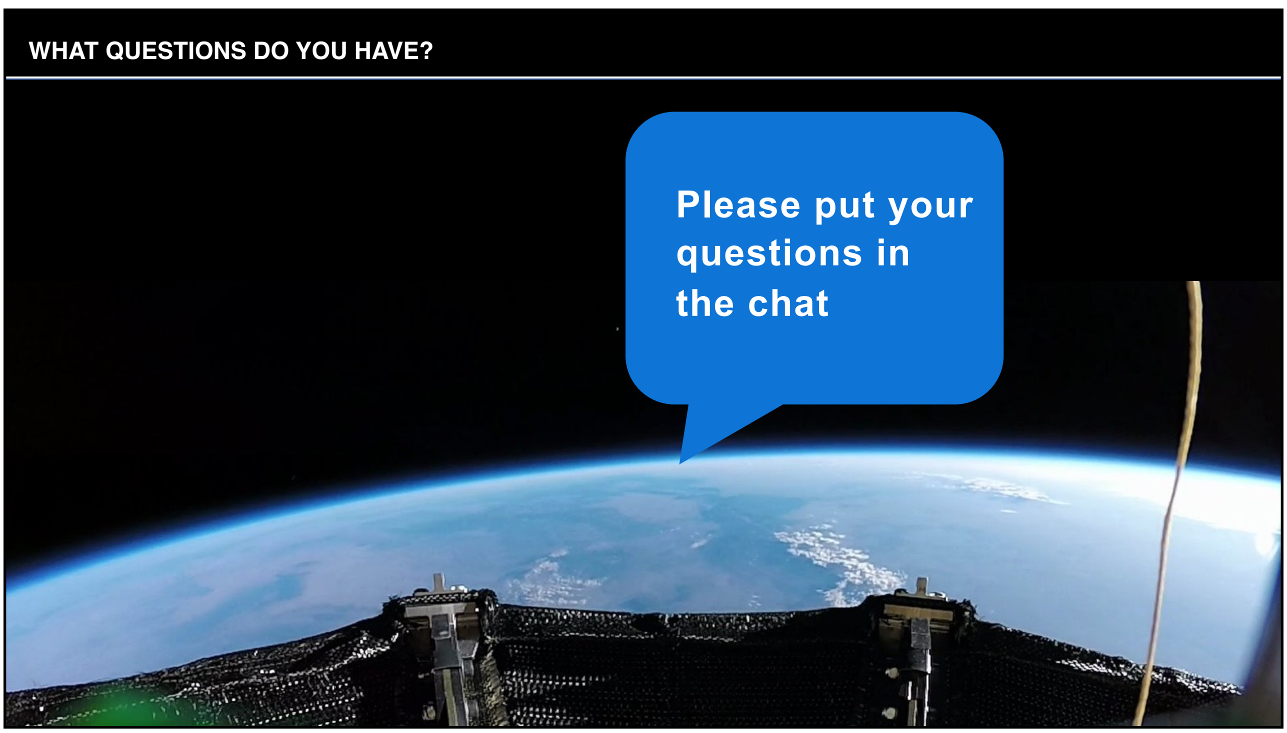
WHAT QUESTIONS DO YOU HAVE?
Please put your questions in the chat

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Reach out:

NASA-FlightOpportunities@mail.nasa.gov

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