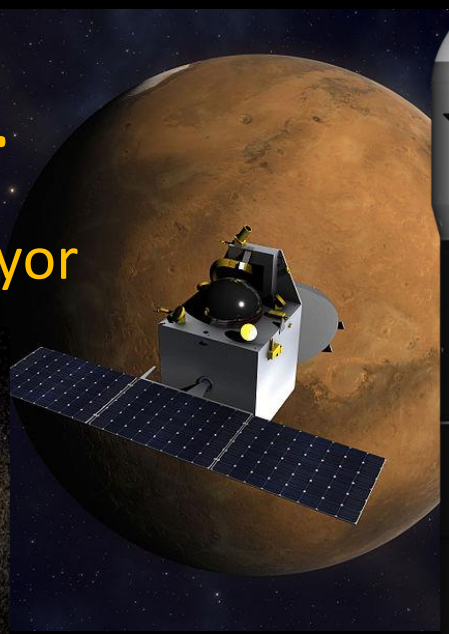
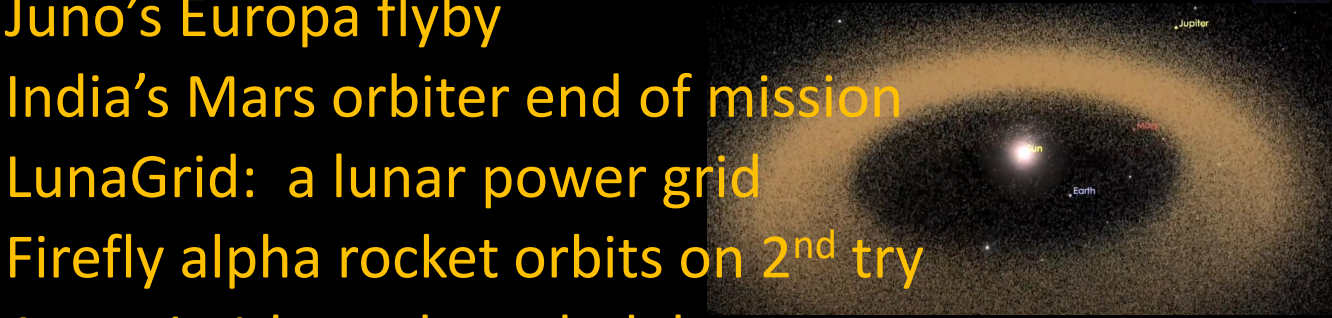
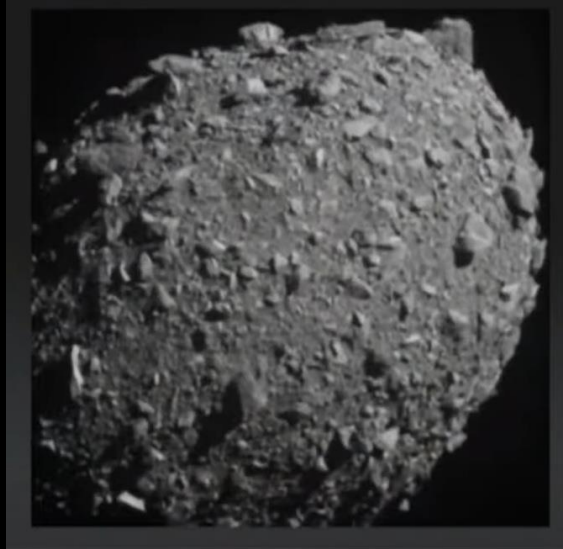
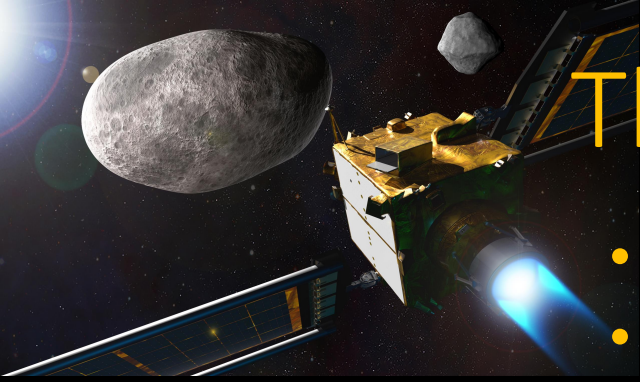


Monthly  
Space  
News

Greg Stanley  
Oct. 12, 2022

# This month's news highlights...

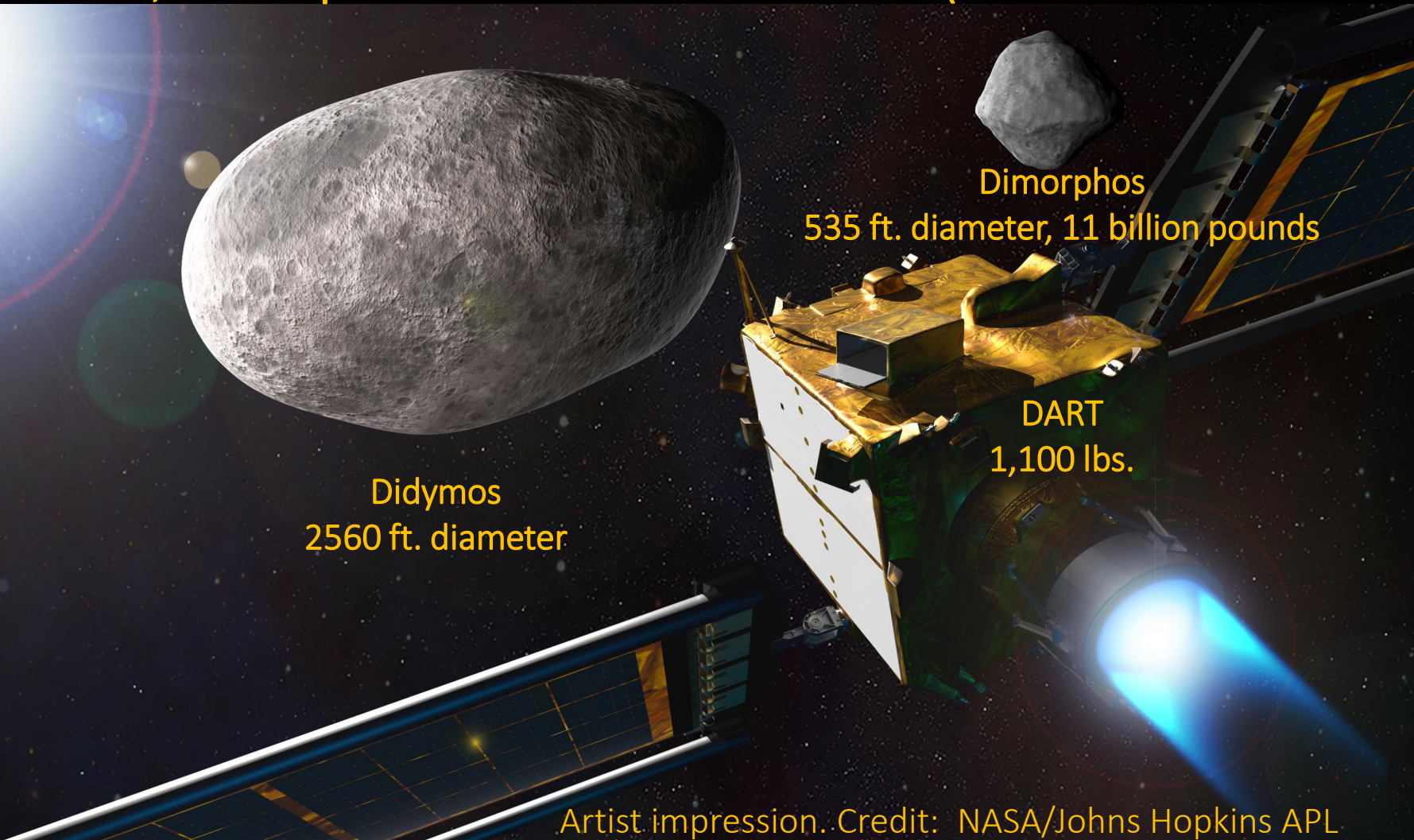
- Planetary defense: DART asteroid crash, NEO Surveyor
- Juno's Europa flyby
- India's Mars orbiter end of mission
- LunaGrid: a lunar power grid
- Firefly alpha rocket orbits on 2<sup>nd</sup> try
- Artemis 1 lunar launch delay
- Blue origin suborbital flight failure
- Masten space assets bought by Astrobotic
- NASA updated Moon & Mars objectives
- Recent launches



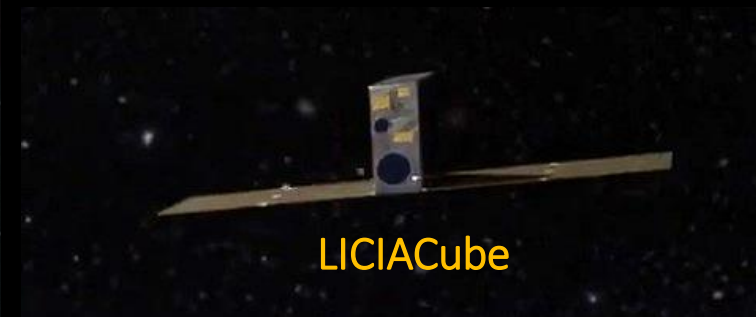
M. Gill

# DART (Double Asteroid Redirection Test) crashed Sept. 26

- Test of planetary defense, crashing into an asteroid moonlet (Dimorphos) at 15,000 mph to test orbit alteration (1 to 10 minutes of 12 hour period)



- Launched Nov. 24, 2021 on a Falcon 9
- DART camera guided to target (missile tech, autonomous at 4 hours to impact)
- LICIAcube (10U Italian cubesat) records collision and aftermath
  - Light Italian Cubesat Imaging for Asteroid
  - Released 15 days before impact

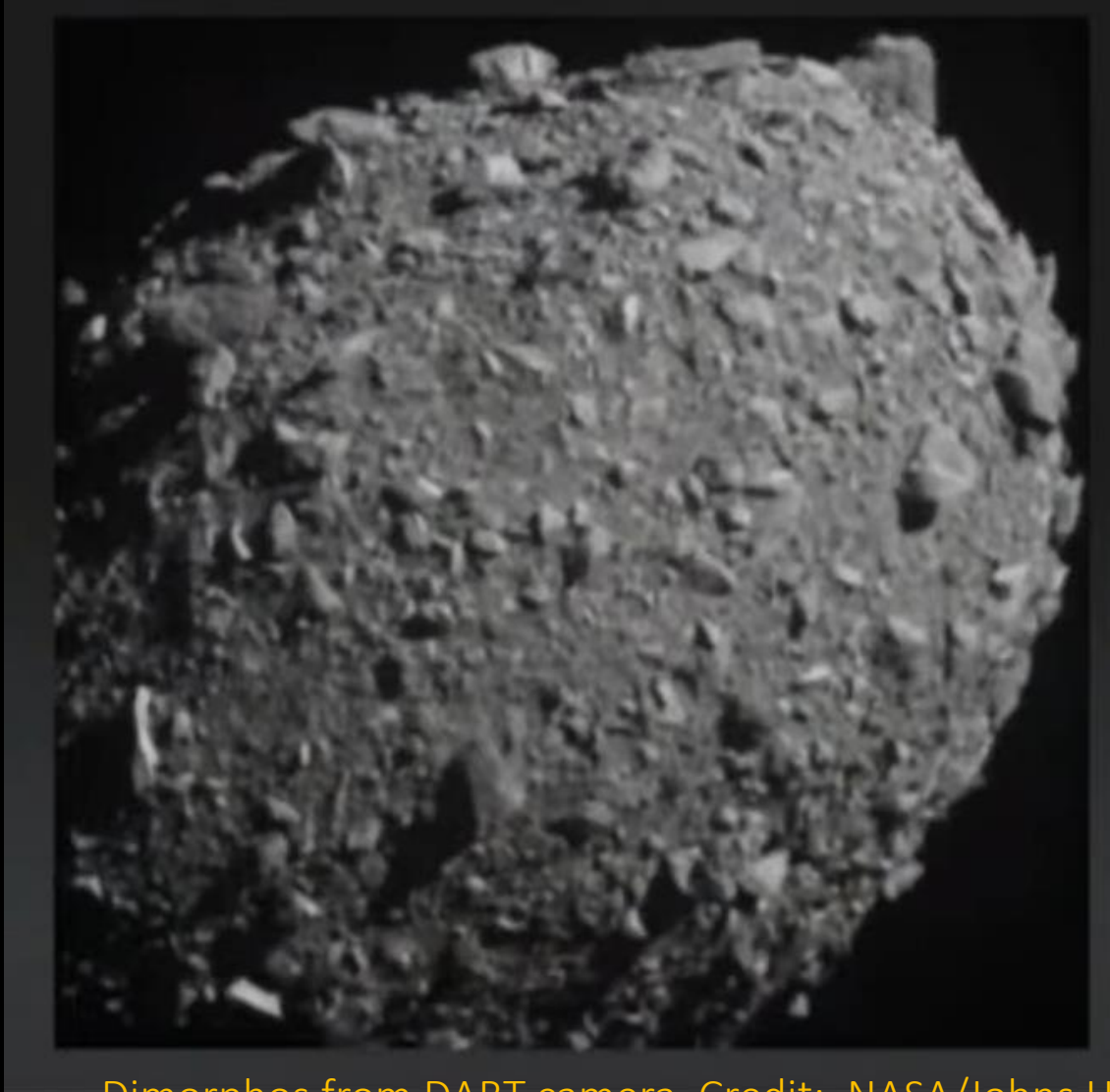


Artist impression. Credit: NASA/Johns Hopkins APL

# DART: actual Dimorphos photos

Last image 2 seconds before crash (100 ft x 100 ft.)

Credit: NASA/Johns Hopkins APL



Dimorphos from DART camera. Credit: NASA/Johns Hopkins APL



# Why we needed DART

- Asteroid hits happened before. It will happen again
- Prove we can hit even a small distant target
- Test effectiveness based on the asteroid material
  - Hard rock: ejected material in one direction provides an extra kick, possibly doubling the push from DART (above left)
  - “Rubble pile”: craft might go into or through it, spread debris
    - Setting a rocket engine on the surface wouldn’t work in that case
    - Gravity could re-coalesce a normal rubble pile in hours to weeks
    - Initial pictures suggest rocks flying out in a crescent shape
- Obvious issues
  - Detecting asteroids well ahead of time. 50% unknown?
  - Characterizing asteroids before defense is launched

(Top left) Artist conception, hard impact. Credit: ESA-ScienceOffice.org

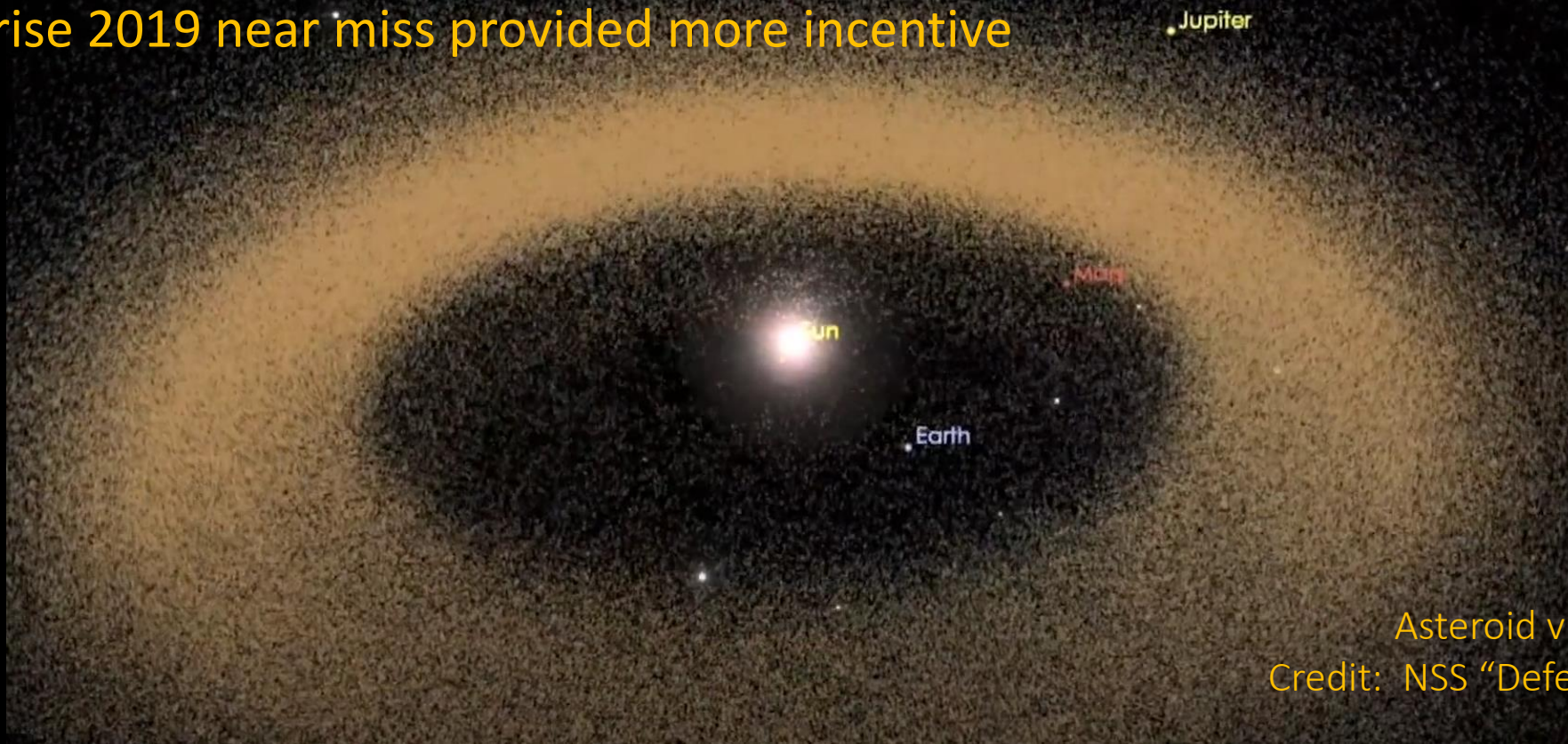
Photo from LICIACube satellite a few minutes after collision.

Credit: ASI/NASA



# NSS position: need to fully fund the NEO Surveyor

- There are still potentially many undetected, dangerous asteroids and comets
  - Near Earth Objects (NEO): Larger than 460 feet, within 30 millions miles of Earth's orbit
- NEO Surveyor would find those, including inside Earth's orbit, down to 100 ft.
  - Infrared telescope orbiting near Earth-Sun L1 point will see even black asteroids
  - Congress mandated (2005) finding 90% of NEOs by 2020, but funding was minimal
  - A surprise 2019 near miss provided more incentive



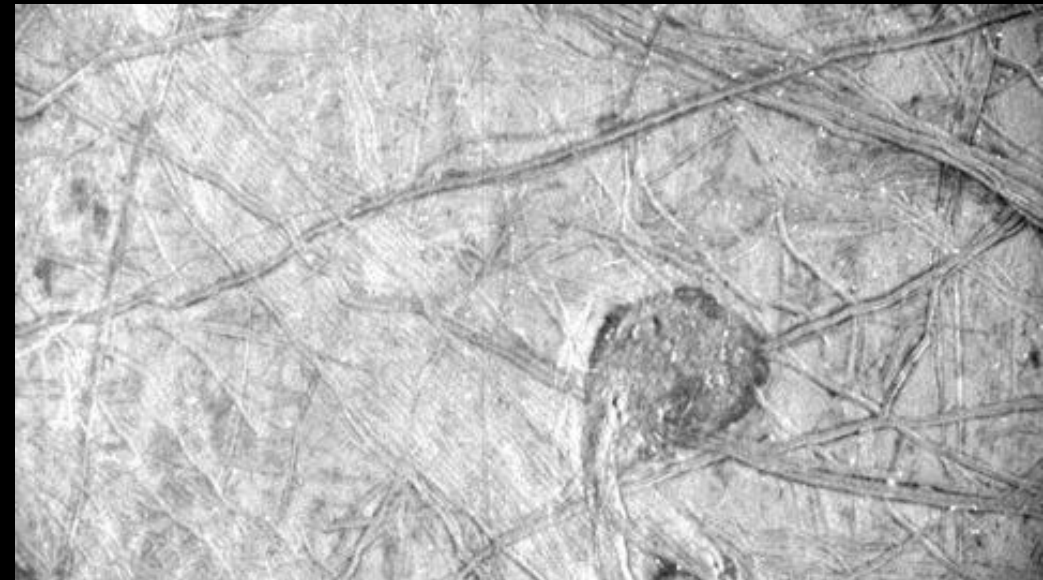
Asteroid visualization.  
Credit: NSS "Defending Earth" video

# Juno's Europa flyby, Sept. 29

- Jupiter's moon Europa is the most likely place to find life in our solar system outside of Earth
  - Under 10-15 mile ice crust, saltwater ocean 100 miles deep
  - 90% size of Earth's moon.
- Juno probe passed within 220 miles
  - Launched to Jupiter in 2011, moon visits added
  - 5 minutes close flyby at 50,000 mph
  - Saw parts of Europa not well imaged by Galileo 20 years ago
  - Will better identify crust and thin spots for future landings



Juno/Jupiter illustration credit: NASA/JPL-Caltech



Europa photo (100 miles wide) credit: NASA/JPL-Caltech/SWRI

# India's Mars Orbiter: mission accomplished

- Orbited Mars for 8 years
  - Propellant used up, couldn't avoid a 7.5 hour eclipse
  - Battery drained, designed for 1.5 hours
- Mission success
  - Extensively mapped Mars
  - Elliptical orbit allowed extensive study of atmosphere
  - Cost only \$25m (“frugal engineering”)

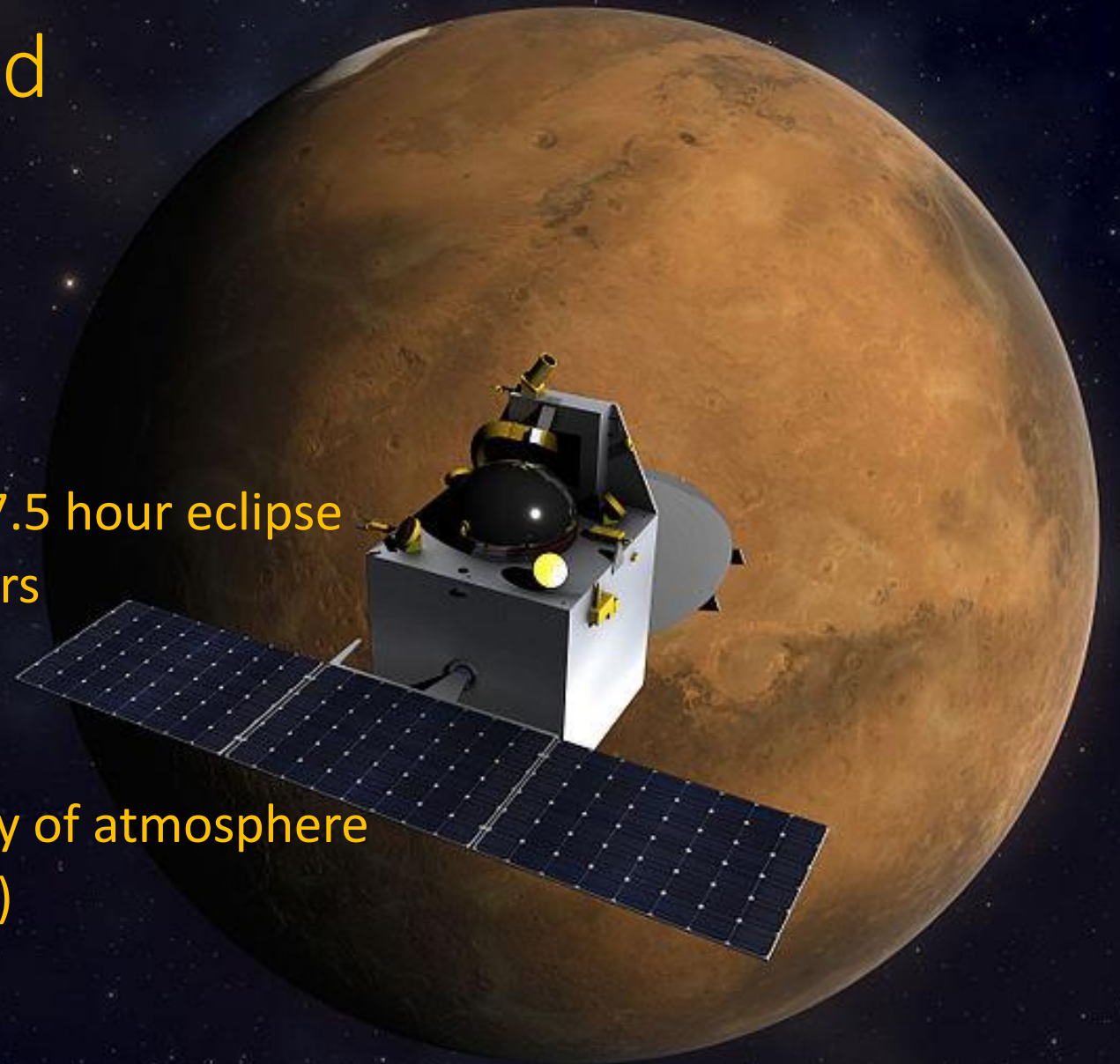
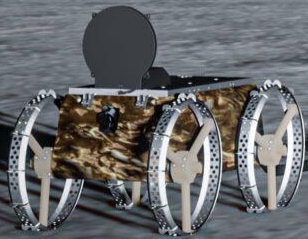
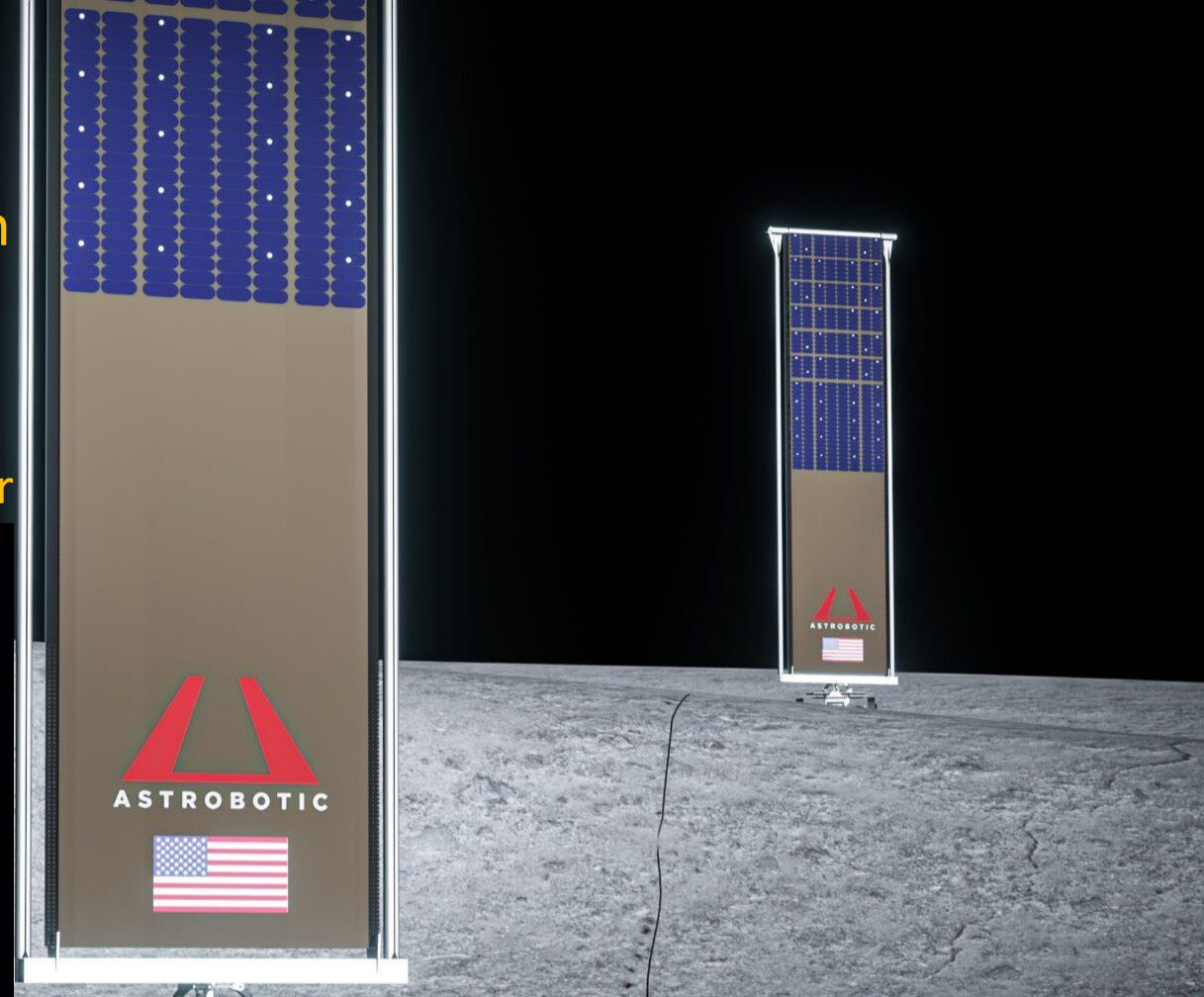


Illustration credit: Kevin M. Gill, via Wikimedia Commons

# LunaGrid: lunar power

- Astrobotic commercial lunar power service plan
  - Long term solution: power during lunar day/night
  - NASA \$6.2 m contract to develop & test prototypes
  - Total deployed cost maybe hundreds of millions
  - Operational in 2028, but parts could be ready sooner
- Power grid on surface, mainly at the poles
  - Vertical solar arrays already under NASA contract
  - Sun is always low in the horizon at poles
  - Tethered rovers move to customer, use wireless charging
  - 10 KW initially, but scalable
  - Delivered on Griffin lander, Astrobotic CubeRovers



CubeRover



Credit: Astrobotic



Griffin lander

# Firefly Alpha rocket reached orbit on 2<sup>nd</sup> try

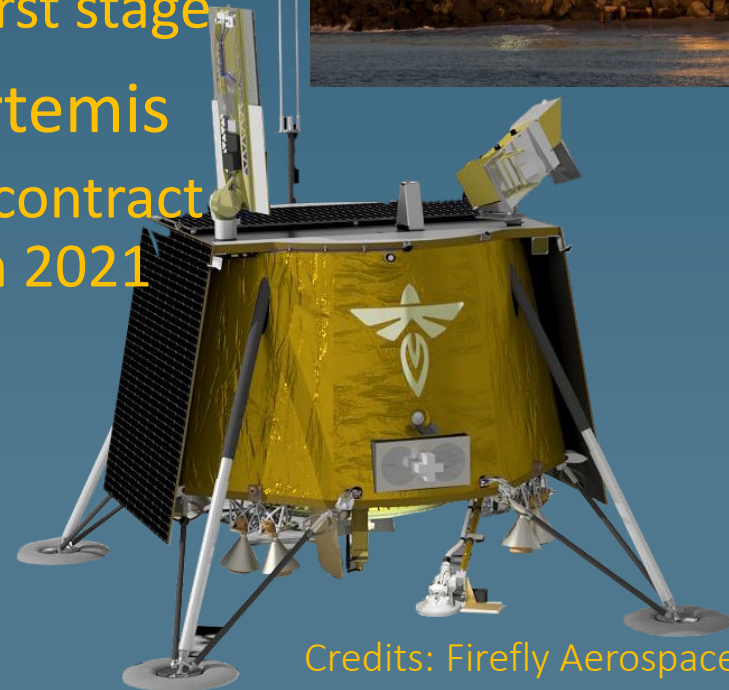
- Launched 3 small payloads (size of loaf of bread) to low earth orbit (LEO) on Oct. 1
- Small, expendable rocket: 95 feet tall, 6 feet wide, 54 tons
  - Payload: 2,580 pounds to LEO for \$15m
  - The largest all-composite (carbon fiber) body and fuel tanks
  - 4 “Reaver” booster engines use Kerosene (RP-1)/Liquid O<sub>2</sub> (LOX)
  - Emphasizing “responsive” (quick) launch, with US Space Force contracts as well as NASA
  - Competing with Rocket Lab, Virgin Orbit, SpaceX ridesharing
  - Future competition from Relativity Space, ABL Space
- Projecting up to 6 launches in 2023



Credit: Firefly Aerospace

# More about Firefly Aerospace

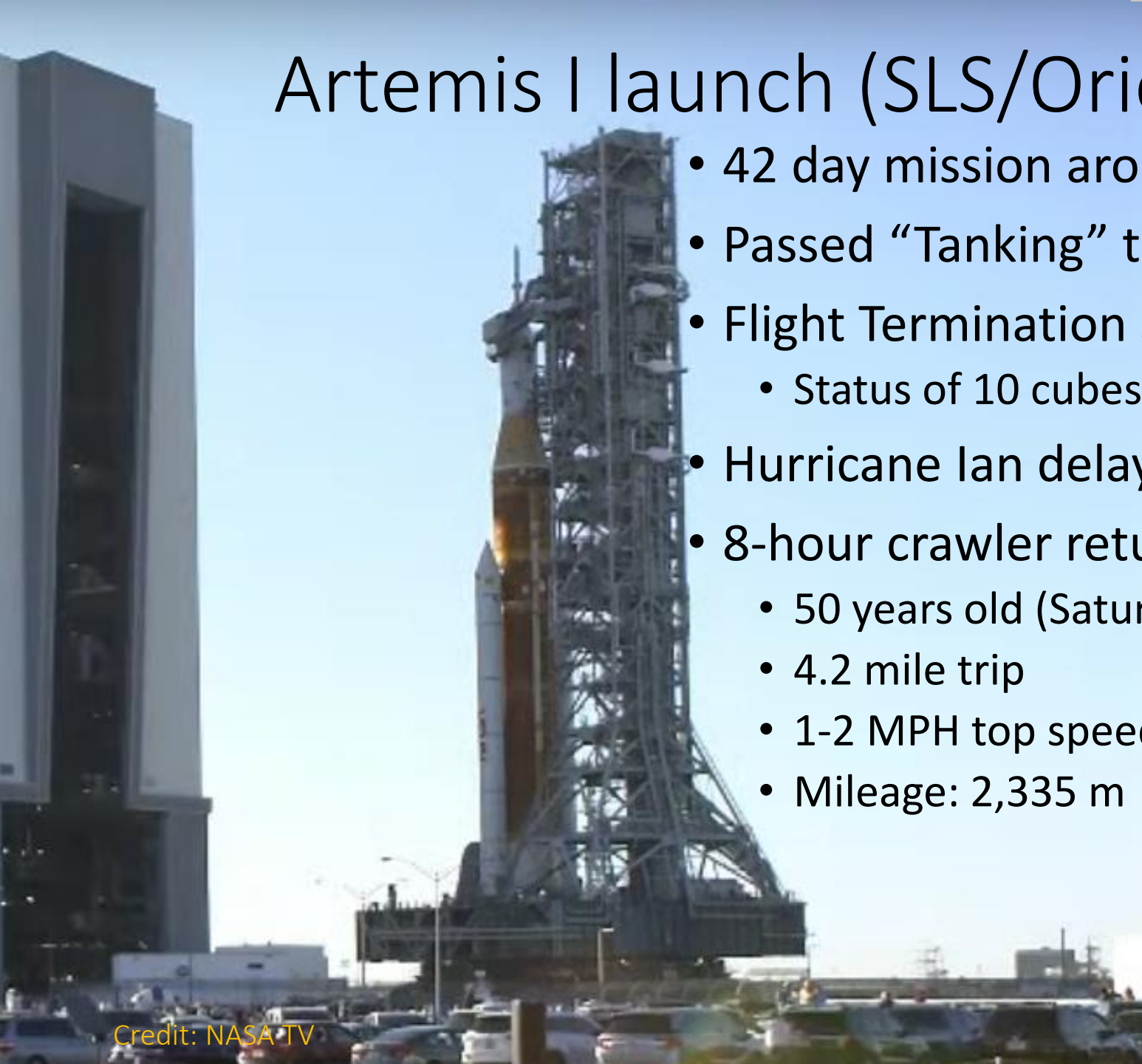
- Firefly teamed with Northrop Grumman to build Antares 330 rocket first stage (in August)
  - Antares rockets launch Cygnus cargo ships to ISS
  - Replacing Ukrainian 1<sup>st</sup> stage (Russian RD-181 engines)
  - 7 Firefly Miranda (Reaver 2) engines (Kerosene/LOX)
  - Firefly composites for first stage structure, tanks
  - Modified version of future Firefly “Beta” rocket first stage
- Blue Ghost lunar lander is funded by NASA Artemis
  - NASA CLPS (Commercial Lunar Payload Services) contract for lunar landing (now 2024), awarded \$93.3 m in 2021
- Location: Cedar Park, Texas (Austin suburb)



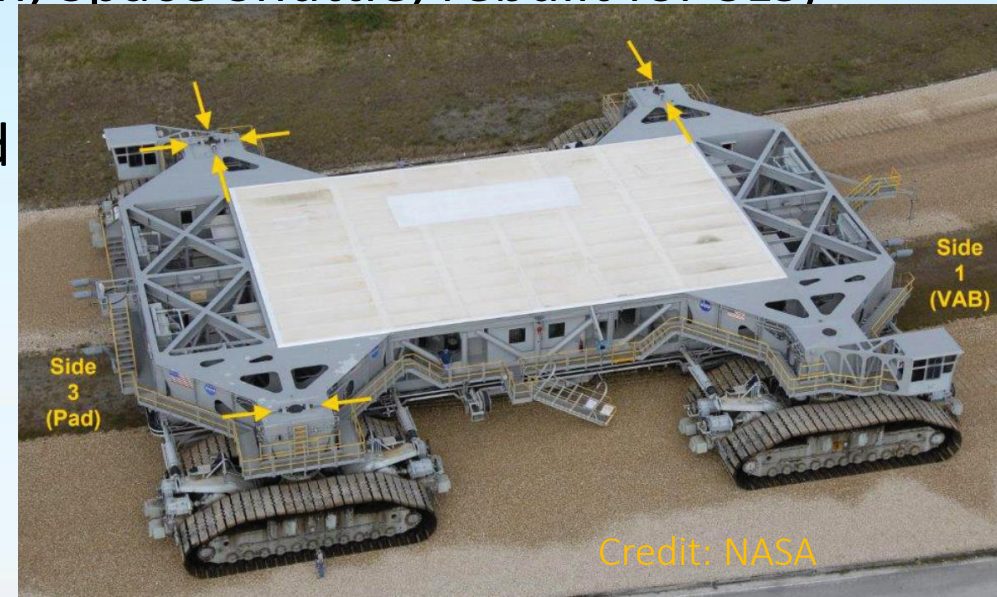
Credits: Firefly Aerospace

# Artemis I launch (SLS/Orion) scrubbed again

- 42 day mission around moon (no crew)
- Passed “Tanking” test: only small H2 leaks
- Flight Termination System battery OK’d to Oct. 2
  - Status of 10 cubesat batteries not known
- Hurricane Ian delayed launch until November
- 8-hour crawler return to Vehicle Assembly Building
  - 50 years old (Saturn, Space Shuttle, rebuilt for SLS)
  - 4.2 mile trip
  - 1-2 MPH top speed
  - Mileage: 2,335 m



Credit: NASA TV



Credit: NASA

# Miscellany

- Blue Origin New Shepard suborbital flight FAIL
  - 0 people, 36 payloads
  - Abort motor + parachutes saved capsule
  - Booster crashed, destroyed
  - Good test of the emergency abort system
- NASA updated objectives for Moon & Mars missions
  - Response to attendees of June review meeting, including an NSS team



Credit: Blue Origin (webcast)

# Masten Space auctioned off

- Most assets of bankrupt Masten Space auctioned to Astrobotic for \$4.5M
  - Both working on lunar landers as CLPS (Commercial Lunar payload Services) projects
- Astrobotic is rehiring Masten's workforce
  - Expands Astrobotic to 200 employees
- No announcement about Masten lunar lander status



Lunar lander. Credit: Masten Space Systems

# How many launches since the last meeting (Sept 10)?














*Includes failed launches if they lift off the launch pad  
Only includes launches attempting Earth orbit or beyond*

Falcon 9 rocket launching 32  
Starlink satellites and the  
BlueWalker-3 satellite testing AST  
SpaceMobile's phone cell service  
from space

9/10/22 Credit: SpaceX



# Launches since last meeting (Sept 10), page 1

-  Sept 10 – Falcon 9 – 34 Starlink satellites + BlueWalker-3 (space-based cell phone test)
-  Sept 13 – Long March 7A – military communications satellite to geostationary orbit
-  Sept 15 – Electron – Japanese commercial radar Earth observation satellite. From NZ
-  Sept 18 – Falcon 9 – 54 Starlink (internet service) satellites
-  Sept 20 – Long March 2D – unknown, stated as an Earth observation satellite
-  Sept 21 – Soyuz-2 – crew (2 Russians, 1 American) to ISS (International Space Station)
-  Sept 24 – Delta IV Heavy (last West Coast launch) – classified (NRO) US spy satellite
-  Sept 24 – Kuaizhou 1A – Shiyang-14 & 15 Earth observation satellites
-  Sept 24 – Falcon 9 – 52 Starlink internet satellites
-  Sept 26 – Long March 2D – 3 classified Yaogan-36 military satellites
-  Sept 26 – Long March 6 – Shiyang-16 & Shiyang-17 Earth observation satellites
-  Oct 01 – (Firefly) Alpha – test flight, first to orbit in only 2 tries. 3 small payloads
-  Oct 04 – Atlas V – SES-20 & SES-21 communications satellites

# Launches since last meeting (Sept 10), page 2



Oct 05 – Falcon 9 – Crew (2 U.S., 1 Japanese, 1 Russian) to ISS (space station)



Oct 05 – Falcon 9 – 52 Starlink internet satellites. 3,451 now in orbit.



Oct 07 – Long March 11 – 2 navigation test satellites (from new sea launch platform)



Oct 07 – Electron – Argus satellite mainly for wildlife, weather monitoring (from NZ)

- \_\_\_\_\_
- 17 total

# Discussion & questions?



Image: NASA



# Featured speaker: Tamalee Basu

- Space Architect
- Technical Designer at Gensler (Global architecture firm)
- Involved with GrowMars, SciArt Exchange, LineSync Architecture, Excalibur Almaz, visiting student researcher at MIT Media Lab, others
- M.S. Space Architecture (Aerospace Engineering), U. of Houston
- Bachelor of Architecture, Indian Institute of Engineering Science & Technology

## TOPIC:

Architectural commonalities of critical facilities  
(on and off-Earth)