

National Aeronautics and  
Space Administration



# KENNEDY SPACE CENTER

## ANNUAL REPORT 2021


# COVER PHOTOS

**Cover:**

*Inside High Bay 3 of the Vehicle Assembly Building at NASA's Kennedy Space Center in Florida, the work platforms have been retracted from around the Artemis I Space Launch System atop the mobile launcher on Sept. 20, 2021. All 10 levels of platforms were extended and retracted as part of an umbilical test. Artemis I will be the first integrated test of the SLS and Orion spacecraft. Credit: NASA/Frank Michaux*

**Back Cover:**

*NASA's Lucy spacecraft is moved to the horizontal position on a rotation stand inside the Astrotech Space Operations Facility in Titusville, Florida, on Sept. 1, 2021. In view, the high gain antenna and solar arrays have been installed on the Lucy spacecraft. Over its 12-year primary mission, Lucy will explore a record-breaking number of asteroids, flying by one asteroid in the solar system's main belt and seven Trojan asteroids. Additionally, Lucy's path will circle back to Earth three times for gravity assists, making it the first spacecraft ever to return to the vicinity of Earth from the outer solar system. Credit: NASA/Glenn Benson*



*NASA's Kennedy Space Center occupies a scenic stretch of land along Florida's east coast, including miles of pristine beaches on the Atlantic Ocean. The agency is nearing completion on a restoration project to shore up the dunes that create a natural barrier from the waves. Once the dune is built up, native coastal vegetation will be replanted, helping to stabilize the dune and offer a habitat for Kennedy's coastal wildlife. Photo credit: NASA/Ben Smegelsky*

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# VISION AND MISSION

## VISION

Kennedy Space Center is the world's preeminent launch complex for government and commercial space access, enabling the world to explore and work in space.

## MISSION

Kennedy safely manages, develops, integrates, and sustains space systems through partnerships that enable innovative, diverse access to space and inspire the nation's future explorers.

## CORE COMPETENCIES

- Acquisition and management of launch services, deep space logistics projects and commercial crew systems development and operations
- Certification of new commercial launch vehicles to launch high-value civil sector payloads
- Launch vehicle and spacecraft processing, including servicing, maintenance, command, control, telemetry, launch, landing, and recovery operations, including support for processing crews
- Payload and flight science experiment processing, assembly, integration, and testing
- Designing, developing, operating, and sustaining flight and ground systems and supporting infrastructure, including integration and testing
- Development, testing, and demonstration of advanced flight systems and transformational technologies to advance exploration and space systems



*The final piece of NASA's Space Launch System (SLS) rocket that will send NASA's Artemis I mission to the Moon arrived at Kennedy Space Center on April 27. The SLS Program delivered the core stage rocket to the center's Launch Complex 39 turn basin wharf after completing a successful series of Green Run tests at Stennis Space Center in Mississippi.*

## CENTER DIRECTOR'S MESSAGE



NASA has a long history of being adaptive and innovative, facing challenges head on. I've always been proud of that legacy, but it has been truly inspiring to see Kennedy Space Center continue to rise to the challenge of meeting mission milestones while persevering through global circumstances we've never encountered before. Whether working on center or from their home offices, this workforce has banded together to continue spaceport operations and support the most robust launch manifest Kennedy has ever seen.

This year's flight cadence illustrates why Kennedy is the nation's premier spaceport. We launched our first and second operational crew rotation missions to the International Space Station with NASA/SpaceX's Crew-1 and Crew-2, as well as three commercial resupply missions, all through our Commercial Crew Program. Through the same program, NASA also continues to partner with Boeing as we work toward developing a second safe, reliable, and cost-effective crew-certified vehicle to allow redundancy and increased access to and from low-Earth orbit.

All of Kennedy celebrated with our Exploration Ground Systems Program at the arrival of NASA's Space Launch System core stage in April of this year. With the rocket and Orion spacecraft almost completely stacked on the mobile launcher in the Vehicle Assembly Building, crews are completing the final stages of ground processing in preparation for Orion's inaugural flight around the Moon and back with Artemis I.

The Launch Services Program also saw the fruits of their labor on the Mars 2020 launch when the Perseverance rover and Ingenuity helicopter landed on the Red Planet. This mission is giving us the opportunity to study the Martian landscape for evidence of

past life. Closer to home, Sentinel-6 launched the latest in a series of satellites that will be instrumental in studying sea level changes from space, giving scientists valuable data to help fight climate change on our home planet.

Exploration Research and Technology programs at Kennedy continue to innovate technologies and perform experiments and investigations aimed at preparing for long-term habitation of the Moon and Mars. Without the resources available on Earth, deep space explorers will need these critical technologies for everything from food and oxygen generation to construction materials to techniques for reducing waste while on the journey.

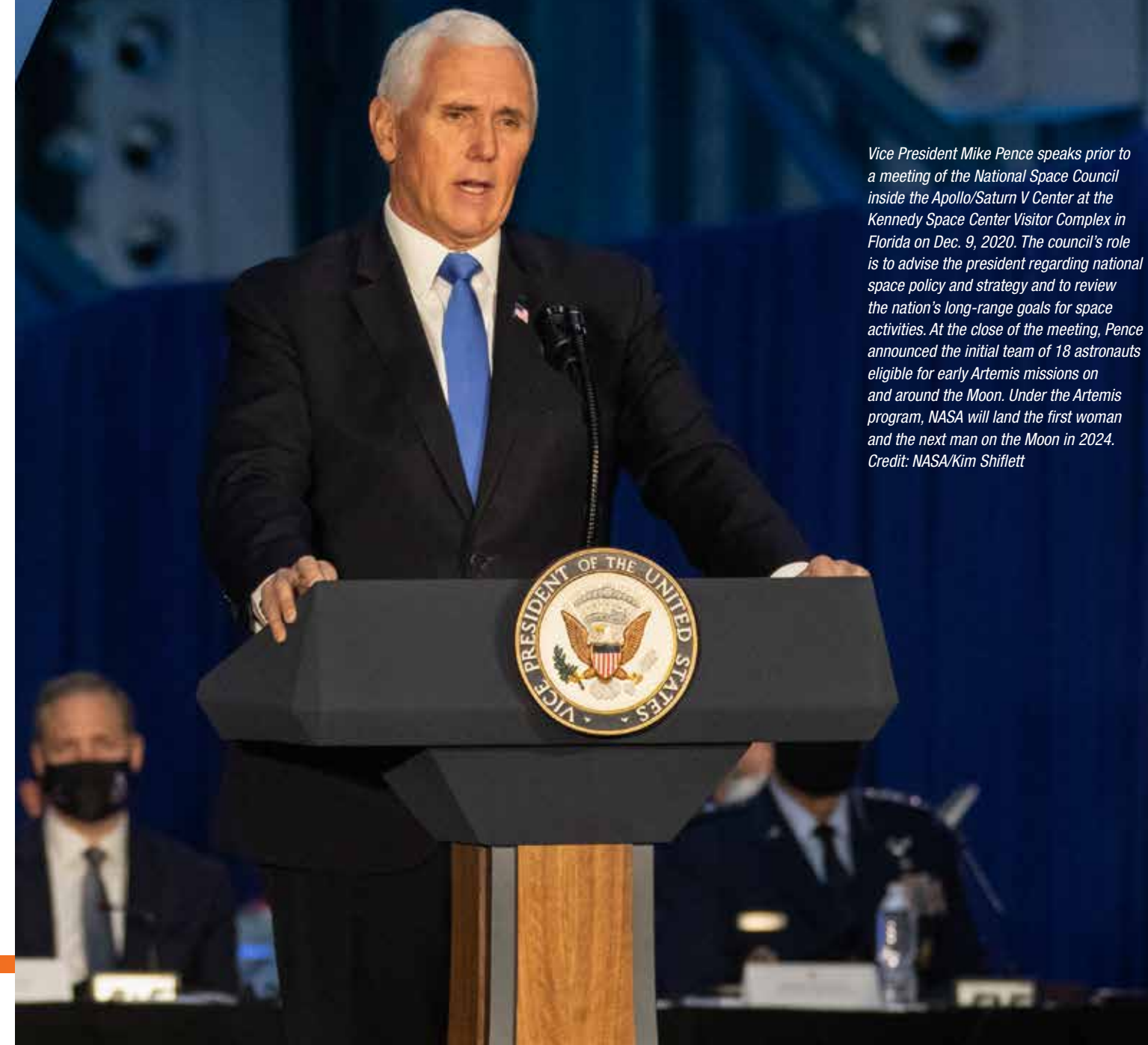
NASA's commitment to improving life on Earth isn't contained to science pursuits. The agency also is dedicated to being reflective of the diversity on our home planet. Kennedy remains invested in the fight for diversity, equity, and inclusion by continuing to provide employee engagement, resources, and education opportunities designed to facilitate the critical conversations that incite positive change.

For more than 60 years, Kennedy has been launching and carrying the dreams of the nation, and we will continue to do so well into the future. I eagerly look forward to what is to come as we go to the Moon, Mars, and beyond, and invite you to celebrate the achievements of Fiscal Year 2021.

**Janet E. Petro**



*From left, NASA astronauts Jessica Meir, Joseph Acaba, Anne McClain, Matthew Dominick, and Jessica Watkins are five among an initial team of 18 astronauts eligible for early Artemis missions on and around the Moon. Credit: NASA/Kim Shiflett*



*Vice President Mike Pence speaks prior to a meeting of the National Space Council inside the Apollo/Saturn V Center at the Kennedy Space Center Visitor Complex in Florida on Dec. 9, 2020. The council's role is to advise the president regarding national space policy and strategy and to review the nation's long-range goals for space activities. At the close of the meeting, Pence announced the initial team of 18 astronauts eligible for early Artemis missions on and around the Moon. Under the Artemis program, NASA will land the first woman and the next man on the Moon in 2024. Credit: NASA/Kim Shiflett*

# TOP 20 SIGNIFICANT EVENTS

**OCTOBER 2020**  
**20 years on station**  
 For 20 consecutive years, NASA has been sending humans to low-Earth orbit to live and work aboard the International Space Station.



**NOVEMBER 2020 - Sentinel-6 Michael Freilich launch**  
 A SpaceX Falcon 9 rocket, carrying the Sentinel-6 Michael Freilich satellite, launched on Nov. 21, from Space Launch Complex-4 at Vandenberg Space Force Base in California. The satellite will collect sea level measurements down to the centimeter for 90% of the world's oceans.



**DECEMBER 2020**  
**CubeRover testing**  
 A new, small robotic rover was put through its paces inside a 120-ton bin of regolith rock and dust that simulates the lunar surface. The four-wheeled CubeRover performed more than 150 mobility tests inside the Granular Mechanics and Regolith Operations laboratory at Kennedy.

**DECEMBER 2020**  
**SpaceX CRS-21 launch**  
 SpaceX's upgraded cargo Dragon spacecraft launched atop a Falcon 9 rocket from Launch Complex 39A at Kennedy Space Center on Dec. 20. The first launch for SpaceX under NASA's second Commercial Resupply Services contract, CRS-21 delivered supplies, equipment, and materials to directly support dozens of the more than 250 science and research investigations aboard the orbiting laboratory during Expeditions 64 and 65.



**DECEMBER 2020**  
**Launch Complex 48**  
 Launch Complex 48 opens, expanding the scope of the agency's premier multi-user spaceport by creating a dedicated launch site to accommodate launchers generating 500,000 pounds of thrust or less. Complex 48's "clean pad" design and basic infrastructure offer flexibility for small-class vehicle customers whose rockets have varying needs.

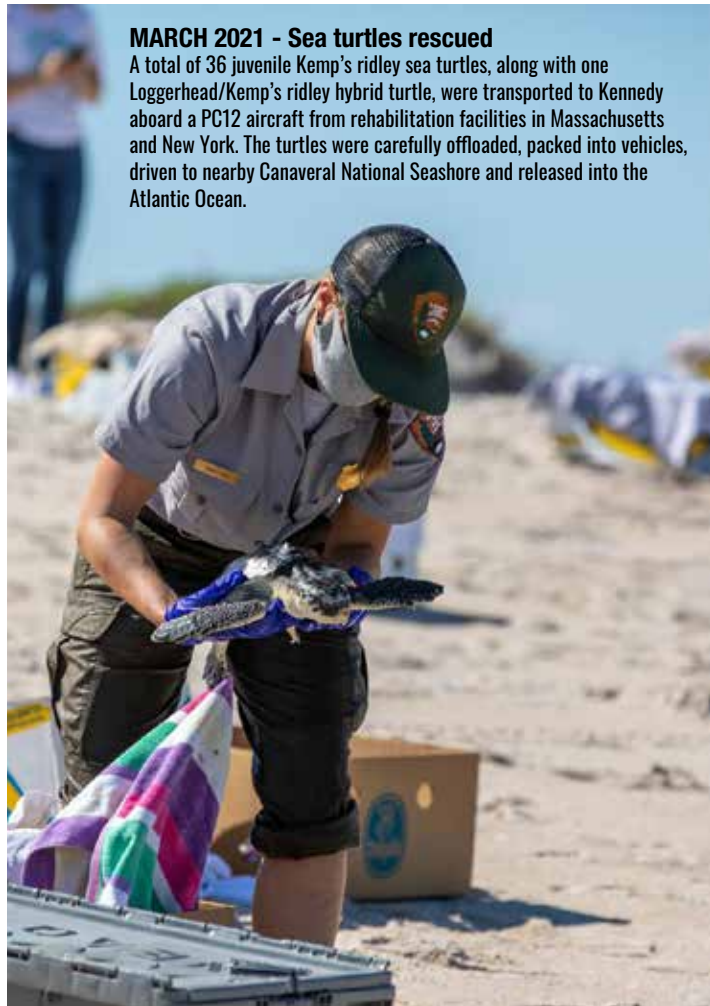


**JANUARY 2021**  
**First transplant in space**  
 An early challenge turned into a surprise success on the International Space Station that could be a boon for the future of space crop production. NASA astronaut Mike Hopkins noticed some plants failing to thrive aboard the station, so he executed the first plant transplant within the agency's Vegetable Production System (Veggie).

**JANUARY 2021 - ELaNa 20 launch**  
 Marking the first payload carried by the LauncherOne rocket, Virgin Orbit's 747-00 carrier, Cosmic Girl, took off from the Mojave Air and Space Port in California on Jan. 17. The LauncherOne rocket, attached to the underside of Cosmic Girl's left wing, carried CubeSats for the encapsulated Educational Launch of Nanosatellites (ELaNa) 20 mission.



**MARCH 2021 - SRB stacking complete**  
 Stacking is completed for the twin Space Launch System (SLS) solid rocket boosters for NASA's Artemis I mission. Over several weeks, workers used one of five massive cranes to place 10 booster segments and nose assemblies on the mobile launcher inside the Vehicle Assembly Building (VAB) at Kennedy Space Center.



**MARCH 2021 - Sea turtles rescued**

A total of 36 juvenile Kemp's ridley sea turtles, along with one Loggerhead/Kemp's ridley hybrid turtle, were transported to Kennedy aboard a PC12 aircraft from rehabilitation facilities in Massachusetts and New York. The turtles were carefully offloaded, packed into vehicles, driven to nearby Canaveral National Seashore and released into the Atlantic Ocean.



**MARCH 2021 - Delta II added to Rocket Garden**

The last United Launch Alliance (ULA) Delta II rocket became a permanent resident of the Rocket Garden at the Kennedy Space Center Visitor Complex in Florida on March 23.



**APRIL 2021  
Discovery Solar Energy Center**

Florida Power and Light's (FPL) new Discovery Solar Energy Center – a 74.5-megawatt solar site spanning 491 acres at Kennedy Space Center – is officially up and running.



**APRIL 2021 - SpaceX Crew-2 launch**

The Falcon 9 rocket and Crew Dragon spacecraft Endeavour lifted off in the early morning on April 23 from Launch Complex 39A at Kennedy Space Center. Astronauts Shane Kimbrough, Megan McArthur, Akihiko Hoshide, and Thomas Pesquet began their 23.5-hour journey to the International Space Station on NASA's SpaceX Crew-2 mission.



**MAY 2021 - SpaceX Crew-1 splashdown**

Astronauts Michael Hopkins, Victor Glover, and Shannon Walker of NASA, and Soichi Noguchi of the Japan Aerospace Exploration Agency (JAXA) splashed down safely in the SpaceX Crew Dragon Resilience in the Gulf of Mexico off the coast of Panama City, Florida, May 2, after 168 days in space.



**JUNE 2021  
Kennedy leadership changes**

On June 30, NASA Administrator Sen. Bill Nelson named Janet Petro director of Kennedy Space Center.



**JUNE 2021  
SpaceX CRS-22 launch**

More than 7,300 pounds of science and research, crew supplies, and vehicle hardware headed to the International Space Station, following the picture-perfect launch of SpaceX's 22nd resupply services mission on June 3.



**JUNE 2021 - Core Stage stacking**

The core stage of the Space Launch System (SLS) rocket for NASA's Artemis I mission was placed on the mobile launcher in between the twin solid rocket boosters inside the Vehicle Assembly Building (VAB) at NASA's Kennedy Space Center. Serving as the backbone of the rocket, the core stage supports the weight of the payload, upper stage, and crew vehicle, as well as carrying the thrust of its four engines and two five-segment solid rocket boosters.

**JULY 2021 - Artemis I simulations**

On July 8, engineers and test directors from Kennedy Space Center in Florida, Johnson Space Center in Houston, and Marshall Space Flight Center in Alabama came together to perform the first joint launch countdown simulation for Artemis I.



**AUGUST 2021  
OSCAR launch**

The Orbital Syngas Commodity Augmentation Reactor (OSCAR) completed a successful Aug. 26 test flight aboard Blue Origin's 17th New Shepard mission. Data from the flight provided researchers at Kennedy with new information about OSCAR, which tests technology to convert trash and human waste generated during spaceflight into useful gases such as carbon dioxide, carbon monoxide, water vapor, and methane.



**SEPTEMBER 2021  
Landsat 9 liftoff**

A United Launch Alliance Atlas V rocket, carrying NASA's Landsat 9 satellite, lifted off from Space Launch Complex-3 at Vandenberg Space Force Base in California on Sept. 27. Landsat 9 joins its sister satellite – Landsat 8 – in orbit, where it will collect images from across the Earth to monitor the health of our home planet.



**AUGUST 2021 - SpaceX CRS-23 launch**

On Aug. 29, a SpaceX Falcon 9 rocket powered off the launch pad from Kennedy Space Center's Launch Complex 39A in Florida, carrying the Dragon spacecraft on the company's 23rd commercial resupply services mission.



*A tortoise makes its way along a gravel parking area at NASA's Kennedy Space Center in Florida on Jan. 21, 2021. In view in the background is the iconic Vehicle Assembly Building. The center shares a border with the Merritt Island National Wildlife Refuge. More than 330 native and migratory bird species, along with 25 mammal, 117 fish, and 65 amphibian and reptile species call Kennedy and the wildlife refuge home. Credit: NASA/Ben Smegelsky*



TITUSVILLE

North



# America's Premier Multi-User SPACEPORT

93 ACTIVE PARTNERS WITH 248 AGREEMENTS AND COUNTING

## NOTICE OF AVAILABILITY 2020

Kennedy Space Center released a Notice of Availability (NOA) for undeveloped land identified in the Master Plan to support activities in launch operations, assembly, testing and processing, renewable energy, research and development, support services, and vertical launch. The announcement is part of Kennedy's multi-user spaceport objectives and is based on effectively utilizing land suitable for new development. This NOA has been extended from 2020 to 2022. Interested parties can respond to the NOA anytime during the open period.

## FUTURE DEVELOPMENT CONCEPT

Kennedy's Future Development Concept (FDC) was developed to build off the strategies and concepts identified in the Center Vision Plan. During the Vision Plan process, the center's future development plan emerged out of a collaboration in which key stakeholders identified projects needed to support Kennedy's critical missions. The FDC is mission-driven to support the immediate success of NASA's programs without sacrificing the success of the agency's long-term future missions. The concept also provides the foundation for a master plan that will support Kennedy's dynamic operational environment. The agency approved the FDC in May 2021.

## INDIAN RIVER BRIDGE (IRB) DEMOLITION AND CONSTRUCTION PROJECT

NASA received a grant giving the Florida Department of Transportation (FDOT) permanent, non-transferrable rights-of-way to enroll the Indian River Bridge into the state highway system for future maintenance and capital repairs, while allowing NASA to retain operational control over the assets. The \$90 million Infrastructure for Rebuilding America grant award and resulting FDOT partnership resulted in approximately \$117.5 million in cost savings to NASA.

## FLORIDA POWER AND LIGHT SOLAR SITE

Kennedy partnered with Florida Power and Light (FPL) to develop the Discovery Solar Energy Center, which opened in June 2021. The 491-acre, 74.5-megawatt solar site is capable of powering approximately 15,000 homes annually. Named after the space shuttle Discovery, the site contains about 250,000 solar panels, all feeding directly into FPL's electricity grid for distribution to the company's existing commercial and residential customers.

## VEHICLE ASSEMBLY BUILDING HIGH BAY AVAILABILITY

Kennedy Space Center requested information from U.S domestic entities, including federal, state, and U.S. commercial launch providers, interested in using the Vehicle Assembly Building High Bay 2 for launch operations, including ground operations, prelaunch integration, checkout, and spacecraft or payload testing. The response NASA received will inform its decisions for future use of the high bay.

## LAUNCH COMPLEX 48

Completed in the fall of 2020, Launch Complex 48 (LC-48) is the newest launch site at NASA's Kennedy Space Center in Florida. The 10-acre complex on the northern LC-48 parcel is designed specifically for small-class launch vehicles generating 500,000 pounds of thrust or less. LC-48 users will work with KSC Center Planning and Development to develop the necessary agreements for using LC-48. The southern LC-48 parcel remains available for future development.

## BENEFITING MARINE LIFE STUDIES

The "Wave Glider" interagency agreement between NASA Kennedy and the Naval Underwater Warfare Centre Division, Newport, Rhode Island, examines the ecology of marine species in the Canaveral study area. Support services from Kennedy include wave glider deployments in the local Atlantic waters, marine animal tagging, and data downloads of fixed monitoring stations. Kennedy provides its tagging expertise, equipment, marine vessels, and scientific research authorizations to support these studies.

## ELECTRIC VEHICLE CHARGING STATIONS

As of 2021, 75% of Kennedy Space Center's fleet uses alternative fuels (electricity, E-85, and biodiesel) to power them. Kennedy is working with commercial partner Florida Power and Light (FPL) Company to build 56 additional vehicle chargers. FPL will install, operate, and maintain the electric vehicle charging stations open to both government and employee-owned vehicles. This strategic partnership with FPL will evolve the multi-user spaceport by enhancing Kennedy's electric vehicle charging capability and enabling expansion of the government electric vehicle fleet.

PARTNERSHIP LAND/ASSETS

GOVERNMENT USE LAND/ASSETS



# KENNEDY SPACE CENTER



Legend for Partnership and Government Use Land/Assets.

SR 405

SR 406

SR 402

SR 3

SR 3

Merritt Island National Wildlife Refuge Visitor Information Center

National Park Service Playalinda Beach

Gate 4

LC-39B

VAB

LC-39A

LC-48

ULA

LC-41

BOEING

LAUNCH CONTROL CENTER

SPACEX

SPACE FLORIDA

SLS & CLEAN PAD

SPACEX

FLORIDA POWER & LIGHT

SPACEX

ONEWEB

SPACE LIFE SCIENCES LAB

FIREFLY

BLUE ORIGIN

Gate 2

Gate 3

KSC Industrial Area

Banana River Bridge

Indian River Bridge

Indian River

MERRITT ISLAND

Banana River

CCSFS





# COMMERCIAL CREW PROGRAM

NASA's Commercial Crew Program (CCP) continues to deliver on its goal of providing safe, reliable, and cost-effective human space transportation to and from the International Space Station in low-Earth orbit.

With its Boeing and SpaceX commercial partners, NASA completed two long-duration crew missions and continued preparations for a second uncrewed test flight that anchor CCP's commitment, made more than a decade ago, to return crewed launches to the space station from the United States on American rockets and spacecraft.

NASA and SpaceX have conducted two additional crew rotation missions, building upon the 64-day flight of astronauts Robert Behnken and Douglas Hurley from May to August 2020 on the Demo-2 test flight aboard a Crew Dragon atop a Falcon 9 rocket from the agency's Kennedy Space Center in Florida. That mission set the stage for agency certification of the integrated SpaceX components, followed by launch and return of Crew-1 after a 165-day mission, and the launches of Crew-2 in April 2021 and Crew-3 scheduled for November.

Facing the challenge of the COVID-19 pandemic, which limited on-site face-to-face access, teams at Kennedy as well as across the agency innovatively continued preparations for CCP missions to ensure they were carried out safely and successfully.

Following on the heels of the SpaceX Demo-2 crew, Crew-1 astronauts built on that success early in fiscal year 2021. NASA astronauts Michael Hopkins, Victor Glover, Shannon Walker, and Japan Aerospace Exploration Agency astronaut Soichi Noguchi headed to the orbiting laboratory Nov. 15, 2020, to augment the Expedition 64 crew, increasing the long-duration number of astronauts and cosmonauts to seven for the first time in the 20-plus years of occupancy.

Another first for the Commercial Crew Program occurred on April 24, when Crew-2 astronauts arrived aboard their SpaceX Crew Dragon for an on-orbit shift change with Crew-1 before its departure May 2 after a 168-day mission. This event marked two historic milestones: the longest duration mission for a U.S. spacecraft since the final Skylab mission in 1974 and the initial time two commercial crew spacecraft were docked simultaneously at the space station.

In parallel with crew rotations at the space station, NASA's Commercial Crew Program and Boeing worked diligently toward the company's second uncrewed Orbital Flight Test-2 (OFT-2) mission. The first OFT flight occurred in December 2019. Although OFT did not dock with the station as intended in 2019, Boeing completed a number of flight test objectives during the two-day mission. Following Boeing's decision to reflly the uncrewed flight test, joint teams of NASA, Boeing, and United Launch Alliance (ULA)

*NASA SpaceX Crew-1 astronauts emerge from the Neil Armstrong Operations and Checkout Building at NASA's Kennedy Space Center in Florida on Nov. 15, 2020. From left are NASA astronaut Shannon Walker, mission specialist; NASA astronaut Victor Glover, pilot; NASA astronaut Michael Hopkins, spacecraft commander; and JAXA astronaut Soichi Noguchi, mission specialist. Credit: NASA/Kim Shiflett*



*A SpaceX Falcon 9 rocket lifts off at 7:27 p.m. EST from Launch Complex 39A at NASA's Kennedy Space Center in Florida on Nov. 15, 2020, carrying the company's Crew Dragon Resilience capsule and Crew-1 NASA astronauts, Michael Hopkins, spacecraft commander; Victor Glover, pilot; Shannon Walker, mission specialist; and Japan Aerospace Exploration Agency astronaut Soichi Noguchi, mission specialist. The Crew Dragon docked with the space station the following day and spent 165 days in space. Credit: NASA/Brandon Garner*



*SpaceX Crew Dragon Resilience spacecraft shortly after it landed with NASA astronauts Mike Hopkins, Shannon Walker, and Victor Glover, and Japan Aerospace Exploration Agency (JAXA) astronaut Soichi Noguchi aboard in the Gulf of Mexico off the coast of Panama City, Florida, Sunday, May 2, 2021. NASA's SpaceX Crew-1 mission was the first crew rotation flight of the SpaceX Crew Dragon spacecraft and Falcon 9 rocket with astronauts to the International Space Station as part of the agency's Commercial Crew Program. Credit: NASA/Bill Ingalls*

*A SpaceX Falcon 9 rocket lifts off at 7:27 p.m. EST from Launch Complex 39A at NASA's Kennedy Space Center in Florida on Nov. 15, 2020, carrying the company's Crew Dragon Resilience capsule and Crew-1 NASA astronauts, Michael Hopkins, spacecraft commander; Victor Glover, pilot; Shannon Walker, mission specialist; and Japan Aerospace Exploration Agency astronaut Soichi Noguchi, mission specialist. The Crew Dragon docked with the space station the following day and spent 165 days in space. Credit: NASA/Joel Kowsky*



*With a view of the iconic Vehicle Assembly Building at left, a SpaceX Falcon 9 rocket soars upward from Launch Complex 39A at NASA's Kennedy Space Center in Florida on April 23, 2021, carrying the company's Crew Dragon Endeavour capsule. Launch time was at 5:49 a.m. EDT. Onboard the capsule are NASA astronaut Shane Kimbrough, spacecraft commander; NASA astronaut Megan McArthur, pilot; ESA astronaut Thomas Pesquet, mission specialist; and JAXA astronaut Akihiko Hoshide, mission specialist. Credit: NASA/Ben Smegelsky*



proceeded with plans for the mission to complete all test objectives, including rendezvous, docking, and on-orbit checkouts at the station.

In preparation for OFT-2 in 2021, NASA and Boeing formed a joint NASA-Boeing Independent Review Team as a result of the Starliner spacecraft's first test flight. The review team's recommendations included items relating to integrated testing and simulations, processes and operational improvements, software requirements, crew module communication system improvements, and organizational changes. Boeing implemented all recommendations, even those that were not mandatory, ahead of Starliner's flight. The flight currently is on hold pending resolution of an oxidizer valve issue within Starliner's service module.

Also, work and crew training continues for Boeing's Crew Flight Test mission. A crew swap was made when Boeing astronaut Chris Ferguson stepped aside for personal business and NASA astronaut Barry "Butch" Wilmore took over as commander. He was in lock-step with the crew as backup, so training did not miss a beat as he, along with NASA astronauts

Mike Fincke and Nicole Mann, continued training for the first Boeing crewed flight to the station as soon as possible after the reflight of the uncrewed OFT-2 mission.

Teams from NASA, Boeing, SpaceX, and the Department of Defense continued to rehearse launch and mission operations in both normal and emergency scenarios. In addition, astronauts and flight controllers participated in mission-specific training to prepare for life in orbit, including the work they'll perform after joining the Expedition crew awaiting them on station.

Commercial Crew's Suborbital Crew (SubC) office continues to make strides in meeting with potential partners that will enable NASA personnel and their research payloads to fly on future commercial suborbital spaceflights for short microgravity periods of time. The goal is to perform a system qualification, or safety assessment, to enable NASA astronauts, principal investigators, and other NASA personnel to take advantage of these unique capabilities. Following qualification, NASA plans to purchase seats on commercial suborbital space transportation systems for NASA use in the future. 🚀

NASA acting administrator Steve Jurczyk and SpaceX CEO and founder Elon Musk visit with Crew-2 astronauts from left, ESA astronaut Thomas Pesquet, NASA astronaut Megan McArthur, NASA astronaut Shane Kimbrough, and JAXA astronaut Akihiko Hoshide inside crew quarters before they departed for the launch pad ahead of their April 23, 2021, launch. Credit: NASA/Kim Shiflett



SpaceX Crew-3 astronauts (from left) Raja Chari, Kayla Barron, Matthias Maurer, and Thomas Marshburn are pictured during preflight training at NASA's Kennedy Space Center in Florida. Credit: SpaceX



Boeing's CST-100 Starliner spacecraft atop a United Launch Alliance Atlas V rocket on the launch pad at Space Launch Complex-41 on Cape Canaveral Space Force Station in Florida. Credit: NASA/Kim Shiflett

A ULA Atlas V rocket with Boeing's CST-100 Starliner spacecraft aboard is seen illuminated by spotlights on the launch pad at Space Launch Complex 41 ahead of the OFT-2 mission Aug. 2, 2021, at Cape Canaveral Space Force Station in Florida. Credit: NASA/Joel Kowsky



The SpaceX Falcon 9 rocket carrying the Sentinel-6 Michael Freilich spacecraft lifts off from Space Launch Complex 4 at Vandenberg Space Force Base in California, Nov. 21, 2020. Credit: USAF 30th SW/Anthony Men



## 1<sup>st</sup> QUARTER

### Oct. 2020:

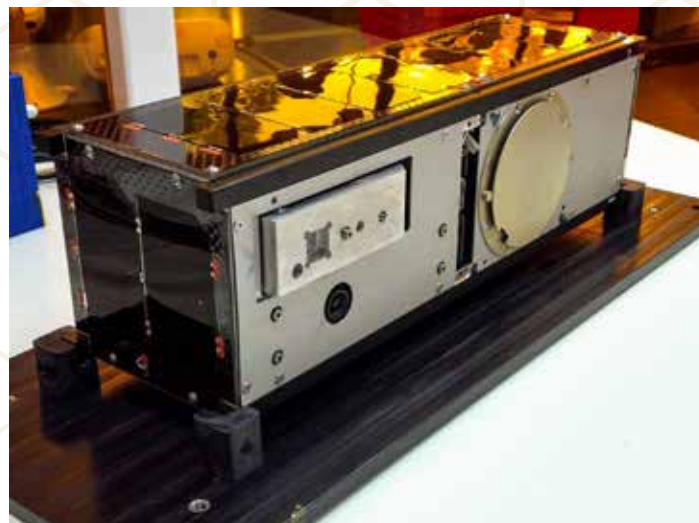
- Launched [ELaNa-31](#) mission containing three CubeSats on Northrop Grumman's 14th (NG-14) mission to the International Space Station from Wallops Flight Facility in Virginia.

### Nov. 2020:

- Launched [Sentinel-6 Michael Freilich](#), a joint U.S.-European satellite to monitor global sea levels, on a SpaceX Falcon 9 rocket from Vandenberg Space Force Base in California.

### Dec. 2020:

- Awarded Venture Class Launch Services Demonstration 2 ([VCLS Demo 2](#)) contracts to Astra Space Inc., Relativity Space Inc., and Firefly Black LLC to launch small satellites ([SmallSats](#)) to space, including CubeSats, microsats, or nanosatellites.



Preflight imagery of the UGA-SPOC-Spectral Ocean Color Satellite – a 3U CubeSat that was part of ELaNa-31 on the Oct. 2, 2020 NG-14 launch – before leaving the University of Georgia Small Satellite Research Laboratory for environmental testing. The primary mission objective is to develop and operate the first moderate resolution coastal ecosystem and ocean color CubeSat with a focus on Earth science applications. Credit: NASA

## 2<sup>nd</sup> QUARTER

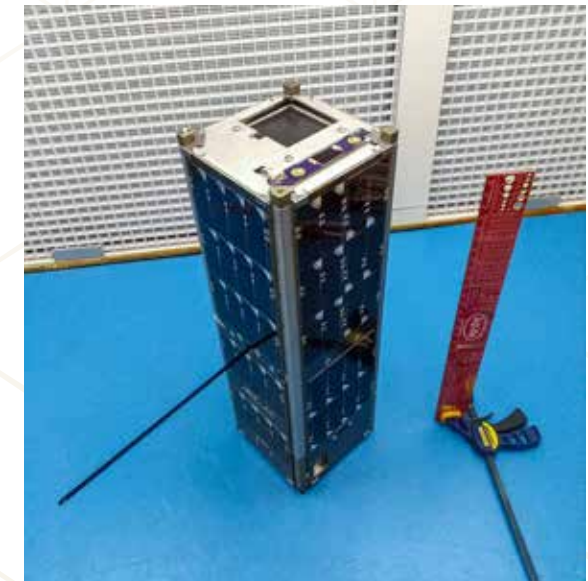
### Jan. 2021:

- Launched [ELaNa-20](#) mission on VCLS-L containing 10 CubeSats on Virgin Orbit's LauncherOne from Mojave, California.
- Launched [ELaNa-35](#) mission with one CubeSat on SpaceX's Falcon 9 Transporter-1 from Cape Canaveral Space Force Station (CCSFS) in Florida Jan. 24, 2021.

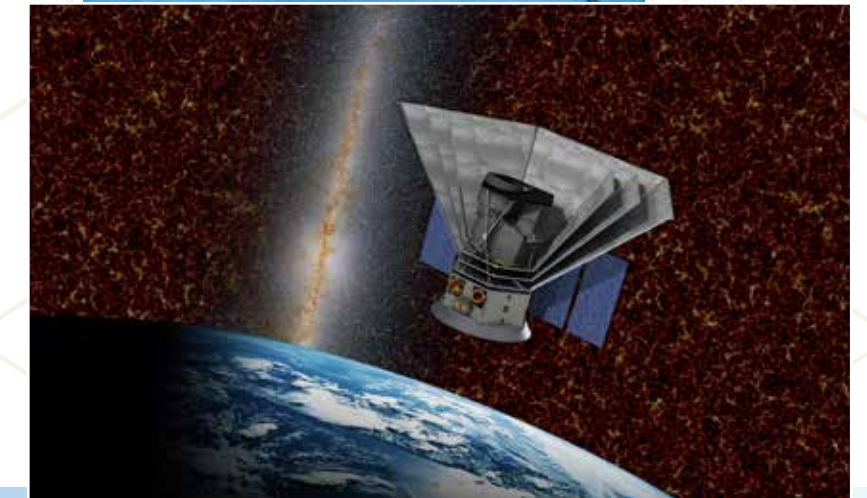
### Feb. 2021:

- Awarded SpaceX the Spectro-Photometer for the History of the Universe, Epoch of Reionization, and Ices Explorer ([SPHEREx](#)) mission, which will survey the sky in the near-infrared light.
- Launched ELaNa-33 mission with one CubeSat on Northrop Grumman's NG-15 mission to the space station from Wallops Flight Facility in Virginia.

NASA's Spectro-Photometer for the History of the Universe, Epoch of Reionization and Ices Explorer (SPHEREx) mission is targeted to launch in 2024. SPHEREx will help astronomers understand both how our universe evolved and how common are the ingredients for life in our galaxy's planetary systems. Image credit: Caltech



The IT-SPINS 3U CubeSat, part of ELaNa 33 that launched on NG-15 Feb. 20, 2021, measures 33 cm x 10 cm x 10 cm with an extended communications antenna. The CTIP instrument aperture is under the folded rectangular pop-out sunshade at the long end of the satellite.



Virgin Orbit's mobile payload trailer pulls up next to the carrier aircraft Cosmic Girl to integrate the encapsulated payload assembly, carrying several NASA-sponsored small satellites for the company's Launch Demo 2 mission on Nov. 30, 2020. Credit: Virgin Orbit/Greg Robinson



### 3<sup>rd</sup> QUARTER

#### April 2021:

- Issued an Announcement of Opportunity for the [CubeSat Launch Initiative](#) (CSLI). CSLI selected 14 small research satellites from nine states – including a first-time selected state, Nebraska – to fly as auxiliary payloads aboard rockets launching between 2022 and 2025.
- Awarded a contract modification to United Launch Alliance (ULA) to add Vulcan Centaur launch services to the [NASA Launch Services II](#) (NLS II) contract.

#### May 2021:

- Launch Services Program hosted its fifth customer forum, allowing LSP to connect with spacecraft customers and launch vehicle providers to discuss the current launch vehicle market offerings.
- Released a Request for Proposal for the Venture-Class Acquisition of Dedicated and Rideshare (VADR) Launch Services. This Indefinite Delivery, Indefinite Quantity contract will provide FAA-licensed launch services for Class D or higher risk tolerant payloads. VADR will provide affordable, accurate, and on-time delivery of government and/or government-sponsored payloads to space on a launch vehicle and will deliver payloads to a variety of orbits, including escape trajectories.

*SpaceX Falcon 9 rocket carrying the Dragon cargo capsule and ELaNa 36 lifts off from Launch Complex 39A at NASA's Kennedy Space Center in Florida on June 3, 2021, on the company's 22nd Commercial Resupply Services mission for the agency to the International Space Station. Credit: NASA/Tony Gray and Kevin O'Connell*

#### June 2021:

- Launched the [TROPICS Pathfinder](#) mission, a precursor mission for the [TROPICS](#) (Time-Resolved Observations of Precipitation structure and storm Intensity with a Constellation of Smallsats) mission, aboard the SpaceX Transporter-2 mission from CCSFS.
- Awarded SpaceX the contract for the Power and Propulsion Element and Habitation and Logistics Outpost ([PPE and HALO](#)), which are foundational elements of the Gateway.
- Launched the ELaNa-36 mission with one CubeSat on SpaceX's 22nd Commercial Resupply Services ([CRS-22](#)) mission from CCSFS.
- Landsat 9 payload fairings for the rocket were transported from the Horizontal Integration Facility to the Integrated Processing Facility at Vandenberg Space Force Station.



*NASA has selected 14 small research satellites from nine states to fly as auxiliary payloads aboard rockets launching in 2022, 2023, 2024, and 2025. Image credit: NASA*



*Above: The shipping container holding NASA's Lucy spacecraft is unloaded from a United States Air Force C-17 cargo plane on the runway of the Launch and Landing Facility at Kennedy Space Center in Florida on July 30, 2021. Credit: NASA/Kim Shiflett*

### 4<sup>th</sup> QUARTER

#### July 2021:

- [Lucy](#) spacecraft arrived at Kennedy Space Center for October 2021 launch on a ULA Atlas V rocket.

#### Aug. 2021:

- Released [CSLI Announcement of Opportunity](#) for educational institutions, nonprofit organizations, and NASA centers to give CubeSat developers access to a low-cost pathway to conduct research in space.
- Launched ELaNa-37 mission with [three CubeSats](#) on SpaceX's CRS-23 mission to the space station on Aug. 29, 2021.

#### Sept. 2021:

- Launched [Landsat 9](#), a joint mission of NASA and the U.S. Geological Survey to monitor key natural and economic resources from orbit, on a ULA Atlas V from Vandenberg Space Force Base in California on Sept. 27, 2021.
- Launched the ELaNa-34 mission carrying two CubeSats as a rideshare on the Landsat 9 mission.
- Launched the ELaNa-29 mission carrying one CubeSat on Virgin Orbit's LauncherOne from Mojave, California.



*Below: Inside the Integrated Processing Facility at Vandenberg Space Force Base in California, the first of two United Launch Alliance Atlas V payload fairings for NASA's Landsat 9 satellite is in the vertical position on June 18, 2021. Launched in September 2021 aboard an Atlas V rocket, Landsat 9 will continue the nearly 50-year legacy of previous Landsat missions, monitoring key natural and economic resources from orbit. Credit: USSF, 30th SW/Pedro Carrillo*

# ARTEMIS

## PROGRESS ON ARTEMIS MISSIONS AT KENNEDY

### ARTEMIS I – PREPARING FOR LAUNCH

Over the past fiscal year, Kennedy Space Center's Exploration Ground Systems (EGS) Program and its primary contractor, Jacobs, have received all Artemis I flight hardware from the Space Launch System (SLS) and Orion programs. The EGS and Jacobs teams have worked diligently on integrating, testing, and preparing the ground systems and teams for launch. The Artemis I ground operations are now in the final tests and preparations for launch and recovery slated for the first half of FY22.

The Artemis I launch vehicle, spacecraft, and ground systems for the first integrated mission under the Artemis initiative are culminating together inside Kennedy's historic Vehicle Assembly Building (VAB). December of 2020 kicked off stacking of the massive new Moon rocket, starting with the solid rocket boosters (SRB). Shortly after the booster stacking completed, the rocket's core stage arrived and was lifted vertically and stacked between the SRBs. After the core stage was secured in place, the Interim Cryogenic Propulsion Stage, or ICPS, was lifted and stacked on top of the core stage, ready for the final pieces to be integrated.

During this time, the Orion spacecraft moved from the Neil Armstrong Operations and Checkout building, where it spent the majority of its assembly time, to the next stops along its path to the pad. The spacecraft started with processing inside the Multi-Payload Processing Facility (MPPF), where it was fueled with essential commodities. It was then moved along to the Launch Abort System Facility, where the launch abort system and ogives – outer panels that protect the vehicle – were integrated. The spacecraft is set to move to the VAB for stacking at the beginning of next fiscal year.

Ground teams also have received and are processing all the secondary payloads for the Artemis I mission. Among other things, these payloads include several private CubeSats and purposeful passenger Commander Moonikin Campos.

The launch team also made great strides in preparing for Artemis I by conducting several launch countdown simulations to run through any potential scenarios they may encounter on launch day.

### ARTEMIS II AND BEYOND

The EGS Program has begun working several upgrades and additions to the ground equipment that will be needed for future Artemis missions beyond



Teams with NASA's Exploration Ground Systems and contractor Jacobs lower the Space Launch System (SLS) core stage – the largest part of the rocket – onto the mobile launcher, in between the twin solid rocket boosters, inside High Bay 3 of the Vehicle Assembly Building at NASA's Kennedy Space Center in Florida on June 12, 2021. Credit: NASA/Cory Huston



Orion sits atop a transport vehicle as it departs from its home at the Neil Armstrong Operations and Checkout Building at NASA's Kennedy Space Center in Florida on Jan. 16, 2021. Credit: NASA/Kim Shiflett

Artemis I. At Launch Complex 39B, work progressed through the year on the emergency egress system needed for crew and a new liquid hydrogen tank. The new hydrogen tank will allow more fuel to be kept onsite and reduce the time between launch attempts.

While ground crews are working upgrades for future missions, the Orion Program is deep into processing the Orion spacecraft for the Artemis II mission – the first crewed mission in the Artemis series. The crew module, crew module adapter, heat shield, and all components for the launch abort system are residing at Kennedy and being assembled for the mission.

In addition to spacecraft processing, the SLS' ICPS for Artemis II also has made its way to Florida. The ICPS is the upper stage of the rocket that provides the spacecraft with the push needed to get beyond the Moon. Several more pieces of critical flight hardware for the Artemis II and III missions will be headed to Kennedy in the next year.

Kennedy Space Center will continue to be a hub of activity in years to come, preparing for NASA's return to the Moon under Artemis as the agency moves forward with establishing a long-term presence on the Moon in order to go on to Mars and beyond. 🚀



A close-up view of Orion's Artemis II crew module inside the Neil Armstrong Operations and Checkout Building high bay at NASA's Kennedy Space Center in Florida, on Feb. 5, 2021. The capsule will house astronauts during its mission around the Moon. Credit: NASA/Kim Shiflett



Small satellites, called CubeSats, are shown secured inside NASA's Orion stage adapter at NASA's Kennedy Space Center in Florida on Aug. 5, 2021. Credit: NASA/Cory Huston

# DEEP SPACE LOGISTICS

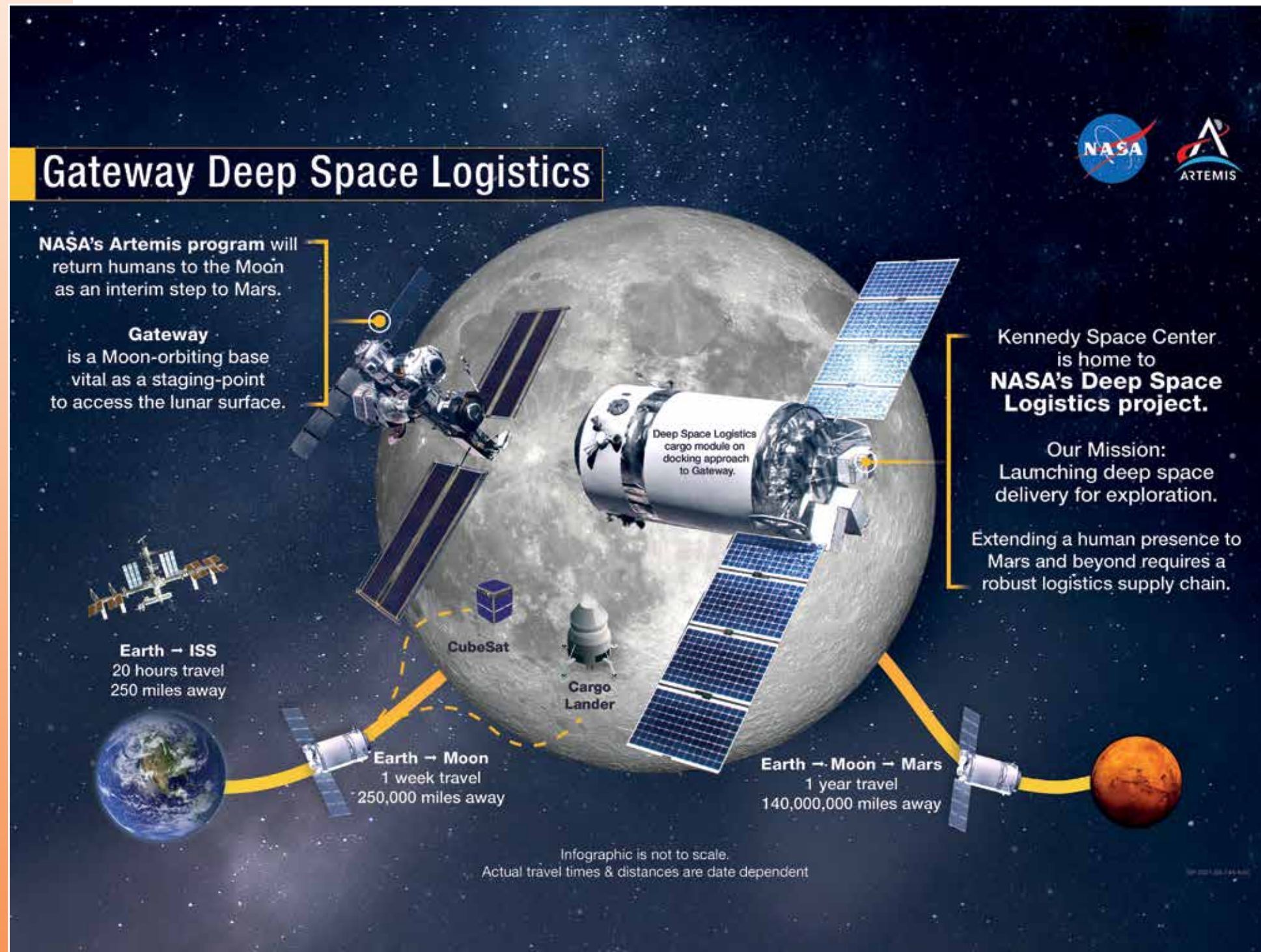
The Gateway Deep Space Logistics (DSL) project office at Kennedy Space Center continues leading the development of the deep space commercial supply chain to the Moon, Mars, and beyond.

During the past fiscal year, the project continued its work in support of Gateway – the critical outpost to be built around the Moon to support Artemis. The DSL office conducted special studies with its first commercial vendor, SpaceX, and made significant progress in developing alliances with the United States Space Force, United States Transportation Command, and non-traditional private industry to engage, communicate, and collaborate on agency opportunities.

DSL Deputy Manager Jenny Lyons received the 2021 Rainmaker Award for her contributions to advancing the field of logistics.

The project's source evaluation board received a 2021 Top Supply Chain Projects Award for its innovative and transformational Gateway Logistics Services procurement that set a new standard of flexibility for complex contracts. 🚀

*NASA illustration of Gateway in lunar orbit with contributions from international partners and the SpaceX Dragon XL logistics module on approach to docking.*



**DC VELOCITY**  
2021 Rainmaker Awardee

*Jenny Lyons, Deep Space Logistics deputy manager, is awarded with DC Velocity's 2021 Rainmaker Award for contributions to advancing the field of logistics in space.*



*Gateway Logistics Services source evaluation board is awarded the 2021 top supply chain projects from Supply & Demand Chain Executive for innovation in contracts.*

# EXPLORATION RESEARCH AND TECHNOLOGY

Exploration Research and Technology programs (ER&T) continued to provide the International Space Station with ground operations, logistics, and maintenance support, while also pushing the boundaries of research and development during fiscal year 2021 to meet the agency's mission and goals.

This past year, ER&T teams supported the space station in a number of ways. They assisted in preparing the first pair of six new solar arrays that launched on SpaceX's 22nd commercial resupply services (CRS-22) mission. After installation is complete, the new arrays should provide 20 to 30 percent more power to the orbital outpost. ER&T also developed and implemented procedures to send expendable, commercial, off-the-shelf air tanks to supply the station with breathing air. For the first time since the shuttle era, ER&T supported the rapid return of science from the orbiting laboratory when SpaceX CRS-21 returned off the coast of Florida, allowing quick delivery of specimens to researchers for analysis.



Throughout the year, ER&T supported a flurry of biological research that will help us learn how to feed our crews during deep space exploration. Working closely with astronauts Kate Rubins and Michael Hopkins, NASA grew a host of crops aboard the space station in the Advanced Plant Habitat and the Vegetable Production System, called Veggie. Plants included radishes, multiple types of lettuce, two mustard varieties, and pak choi. Crew also recently began growing a crop of chile peppers. On Earth, Kennedy Space Center, in collaboration with the German Aerospace Center (DLR), sent a researcher and plants to Antarctica to study agriculture in isolated, controlled environments, which serve as analogs for future long-duration missions.

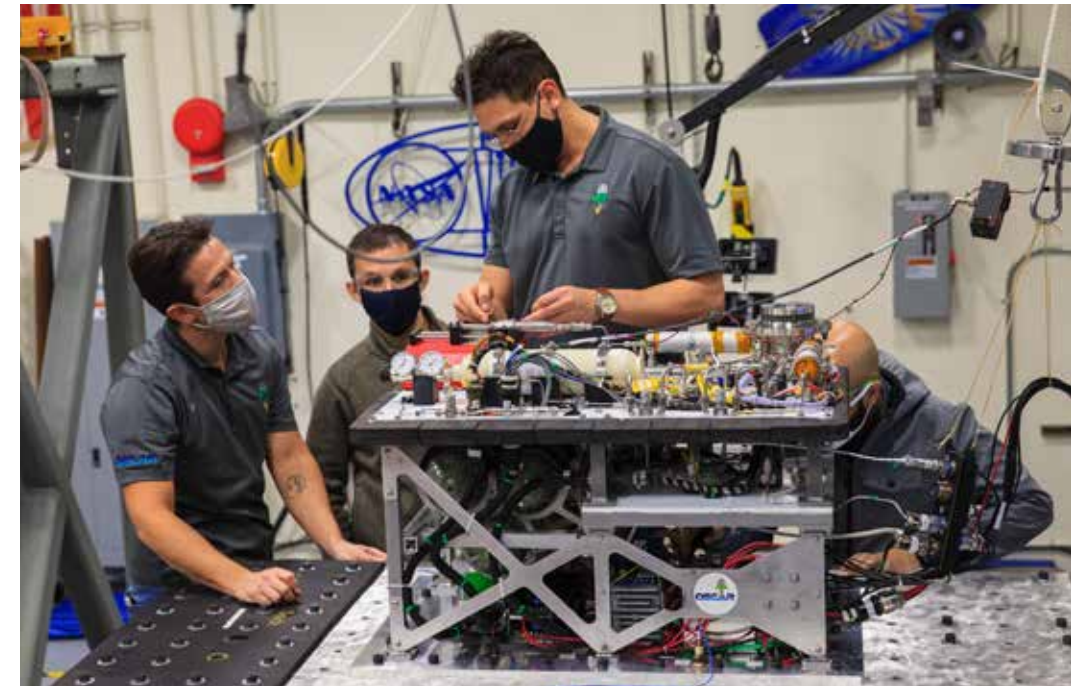
Several subject matter experts from ER&T were involved with NASA challenges that solicited ideas and concepts from outside the agency, including the Lunar Delivery Challenge, the Break the Ice Lunar Challenge, and the Deep Space Food Challenge, which sought new ways to live and work on the Moon and beyond. ER&T also collaborated with industry partner AI SpaceFactory on a NASA 2020 Announcement of Collaboration Opportunity to develop new 3D print material using simulated lunar regolith (soil). The team also worked with Eta Space of Merritt Island, Florida, on a cryogenic fluid management technology demonstration, which was selected for a NASA Tipping Point award.

As a testament to the caliber of personnel within ER&T, Dr. Robert Youngquist and James Fesmire were inducted into the NASA Inventors Hall of Fame in 2020, bestowed by NASA's Technology Transfer program. Their efforts have resulted in 50 patents to date. Additionally, ER&T efforts have resulted in 31 new technology reports and seven new patents this fiscal year. Overall, Kennedy's research and technology efforts span 32 states and two countries through a variety of mechanisms, including licenses, space act agreements, grants, and Small Business Innovative Research/Small Business Technology Transfer contracts.

In support of upcoming lunar missions and launches, teams continue to work on the Mass Spectrometer observing lunar operations (MSolo), a key instrument in NASA's search for water on the Moon. ER&T is preparing four MSolo units destined to launch to the Moon aboard commercial lunar

*Inside the Space Station Processing Facility at NASA's Kennedy Space Center in Florida on June 25, 2021, commercial off-the-shelf air tanks – normally used by divers – are filled with breathing air for use on the International Space Station. Credit: NASA/Kim Shiflett*

landers as part of the scientific and technical demonstrations for the agency. Additionally, a team in ER&T is working on the Electrodynamic Dust Shield (EDS) for an upcoming lunar mission to solve a dust mitigation problem identified during the Apollo era. The EDS has numerous potential uses, including clearing dust from solar panels, cameras, and radiators on spacecraft. Engineers at Kennedy also completed a second suborbital flight test for the Orbital Syngas Commodity Augmentation Reactor, or OSCAR, advancing new and innovative technology for managing waste in space. During that same flight, the Electrostatic Regolith Interaction Experiment launched in a test to characterize regolith's electrostatic dynamics and behavior for enhanced safety on lunar missions. ER&T is also preparing Biological Experiment 1 (BioExpt-1) for the Artemis I mission as a payload inside the habitable volume of the Orion spacecraft to help better understand how humans can withstand the deep space environment in the future. 🚀



*Kennedy Space Center engineers conduct vibration tests inside the Florida spaceport's Vibration Test Lab on Jan. 14, 2021, in preparation for the suborbital flight of NASA's OSCAR, slated for later in the year. Credit: NASA/Isaac Watson*



*NASA and Boeing workers help position solar arrays bound for the International Space Station onto flight support equipment inside the high bay of the Space Station Processing Facility at NASA's Kennedy Space Center in Florida on April 2, 2021. Credit: NASA/Frank Michaux*





*A research scientist harvests radishes grown in the Advanced Plant Habitat ground unit inside the Space Station Processing Facility at NASA's Kennedy Space Center in Florida on Dec. 14, 2020. Credit: NASA/Kim Shiflett*



*Kennedy Space Center employees Matthew Hancock, left, and Janine Captain work with MSolo test hardware at the Florida spaceport on July 13, 2021. Credit: NASA/Kim Shiflett*



*A member of the OSCAR team performs ground testing at NASA's Kennedy Space Center in Florida. Credit: NASA/Amber Jean Watson*



*Inside a laboratory at the Neil Armstrong Operations and Checkout Building at NASA's Kennedy Space Center in Florida, research scientist Sarah Snyder applies a selective surface coating to an Electrodynamic Dust Shield on March 31, 2021. Credit: NASA/Isaac Watson*



*A team at NASA's Kennedy Space Center in Florida tests small- and medium-sized bucket drums July 16, 2021, in the Granular Mechanics and Regolith Operations Lab's "big bin" during prototype development for the pilot excavator, a robotic mission designed for lunar operations. Credit: NASA/Kim Shiflett*



*Members of the cold storage team unpack science experiments inside the Space Station Processing Facility at NASA's Kennedy Space Center in Florida on Jan. 14, 2021. The experiments returned to Earth on SpaceX's 21st commercial resupply services mission (CRS-21). Credit: NASA/Isaac Watson*

NASA Engineering at Kennedy Space Center supports several of the agency's most important programs and projects. The team contributed to the Artemis program through Exploration Ground Systems, Human Landing Systems, and Deep Space Logistics' Gateway. Engineers are embedded with the Commercial Crew, Launch Services, and Exploration Research and Technology programs. The team also supports the International Space Station, as well as Security, Safety and Mission Assurance.

In fiscal year 2021, NASA Engineering supported 100 major milestones, over 50 launches including crewed missions, and more than 10 different launch vehicles. With the increase in launch cadence and activities, younger engineers are getting opportunities for hands-on experience.

**"This is the hey-day of careers for newer engineers who were not part of previous programs, and for senior engineers, this is their exclamation point!"**

– David Guibeau, Communications and Tracking Branch technical manager



## COMMERCIAL CREW

Kennedy engineers assessed design upgrades between Commercial Crew's SpaceX Crew-1 and Crew-2 flights, signed the Certification of Flight Readiness, and supported all the dynamic phases of flight, including regular checkouts while docked to the International Space Station and the first-ever port relocation of Crew Dragon on the orbiting laboratory. The team also performed post-flight reviews that verify the performance of the vehicle and completion of a successful mission.



**"Crew-2 is the first reuse of a Crew Dragon spacecraft for a crew rotation mission, as well as the first direct handover in which Crew-2 docked prior to Crew-1 return. The Dragon vehicle continues to perform well throughout the course of its mission."**

– John Posey, NASA Crew Dragon lead engineer

In August, the NASA-Boeing engineering team diligently worked pre-flight processing for NASA Boeing's Operational Flight Test-2 (OFT-2) and continues to support activities to ensure a successful launch.



**"OFT-2's mission success will put us in position to reach the goal of having both of our commercial partners launching crews into low-Earth orbit."**

– Nicole Otermat, CCP Ground and Mission Operations lead engineer

## ARTEMIS

Hundreds of engineers are supporting Artemis, working with contractors and Exploration Ground Systems. During stacking operations of the Space Launch System (SLS) rocket and Orion spacecraft, the team is certifying the infrastructure and processing flight hardware, including focusing on launch software, hardware readiness, and the certification of engineers for launch support operations. Work continues for the successful design and analysis for Artemis II, as well as mobile launcher-2 readiness for the Block 1B version of SLS.

**"The team is doing an amazing job working through the challenges and setbacks that come with the first flow of a new launch vehicle."**

– Tom Ford, Handling & Access Systems engineer



Engineering completed crawlerway conditioning, ensuring it is strong enough to withstand the weight of moving the SLS, Orion, mobile launcher, and crawler-transporter from the Vehicle Assembly Building to the launch pad for the Artemis I mission and beyond.



**"Imagine that the crawler-transporter and weighted-down mobile launcher platform is like a giant steam roller that compacts the soil underneath it via load and vibration."**

– Rob Schroeder, project manager and traffic engineer

Kennedy engineers have developed a vehicle simulation capability, Customer Avionics Interface Development and Analysis (CAIDA), that has been used to verify and validate ground systems and train the Artemis launch team. CAIDA simulates the various components of the rocket, spacecraft, and ground systems.



**"The CAIDA team provides engineering excellence in the support of Orion and SLS simulations for Kennedy ground systems, making CAIDA a critical system for the successful launch of Artemis I, Artemis II, and beyond."**

– Walter Wehner, CAIDA lead engineer, Avionics Engineering

The Mass Spectrometer observing lunar operations (MSolo) team brought MSolo-1 through Systems Acceptance Review, MSolo-2 through mission Critical Design Review (CDR), Polar Resources Ice Mining Experiment 1 (PRIME-1) through interface CDR, and Volatiles Investigating Polar Exploration Rover (VIPER) through instrument CDR.

**"Keeping four lunar missions and four different designs on track requires a good schedule and a great team dedicated to ensuring each and every mission is successful."**

– Bryan Lutinski, systems engineer, MSolo



## LAUNCH SERVICES

Engineering provided support to the Sentinel-6 Michael Freilich mission during early assessment, requirements development, design, modification, build, test, verification, and launch.



**"The engineering team continues to provide excellent end-to-end mission support, ultimately ensuring a successful launch and orbit for Sentinel-6 – LSP's 94th mission."**

– Richard Nielsen, technical lead, Launch Vehicle Mechanical Systems Branch

NASA engineers from Kennedy and Goddard Space Flight Center are teamed up to construct the On-Orbit Servicing, Assembly and Manufacturing-1 (OSAM-1), a robotic satellite to fuel or repair other satellites already in space. Kennedy engineers have built and finished functionality testing of the propellant

transfer system (PTS) hose management assembly electrical ground support equipment controller, which will be sent to Goddard to be integrated into the overall PTS satellite.



**"OSAM-1 will, for the first time ever, robotically refuel a U.S. government satellite not designed to be serviced."**

– Ledlyne Vazquez, systems engineer, OSAM-1

## SPACEPORT SUPPORT

Engineers finished up utility line relocation in preparation for replacing the Indian River Bridge. Workers drilled 75 feet below the Indian River from one bank to the other, boring nearly a mile of piping through the riverbed and causeway.

**"The engineering team continues to address the critical repairs necessary to keep the bridge operating at its current weight and speed ratings until demolition, likely in 2023-2024."**

– Justin Ausanka, senior project manager, Experimental Facilities Development



Kennedy's laboratories and test facilities provided critical support, covering 21 external partnerships that were created or executed for the Department of Defense, commercial companies, academia, and other customers at unique Kennedy facilities such as the Beachside Atmospheric Corrosion Test Facility, the Vibration Testing Laboratory, and the materials/analytical laboratories. 🚀



**"I work with some of the most intelligent, passionate, and charismatic scientists on this planet. I am inspired every day to be the best version of myself, to support my team and our customers."**

– Trey Barnes, NASA chemist, Analytical Laboratories Branch



Technicians place cargo inside Boeing's CST-100 Starliner in preparation for Orbital Flight Test-2. Credit: Boeing

Teams perform checkouts of the Space Launch System ahead of stacking operations in the Vehicle Assembly Building. Credit: NASA/Frank Michaux



Engineers and technicians install the radiator for the Mass Spectrometer Observing Lunar Operations (MSolo). Credit: NASA/Glenn Benson



Engineers completed utility work ahead of replacing the Indian River Bridge. Credit: NASA/Ben Smegelsky



Chemist Trey Barnes prepares a gas sample for the gas chromatography-mass spectrometry system preconcentrator. Credit: NASA/Frank Michaux

# SPACEPORT INTEGRATION AND SERVICES

Spaceport Integration and Services supports all Federal Aviation Administration (FAA)-licensed launches from Kennedy Space Center and Cape Canaveral Space Force Station. It was the busiest year as a spaceport for Kennedy with **33 launches and 27 other major events** like static fires. The **Emergency Operations Center** activated more than 60 times for missions under NASA's Commercial Crew and Launch Services programs, as well as commercial launches licensed by the FAA and others for the U.S. Department of Defense. Commercial partners reimbursed NASA over \$43 million for utilities, goods, and services.



NASA's SpaceX Crew-2 mission launches on April 23, 2021. Credit: NASA/Aubrey Gemignani

## Launch Complex 39

Kennedy completed substantial gaseous nitrogen (GN2) pipeline system upgrades for Launch Complex 39, including upgrades to both high- and low-pressure shuttle-era launch supply systems. Improvements at the nitrogen vendor plant include larger pumps and an additional liquid nitrogen storage tank. These improvements will provide better reliability and redundancy to meet future SLS and commercial requirements for GN2. A new **10-year supply contract** extension will provide GN2 at substantially lower pricing.

## Institutional Projects Branch

The Institutional Projects Branch completed **432** construction and repair projects totaling \$41.2M to sustain the multi-user spaceport in FY20. The effort represents a **62% increase** in number of task orders and **103% increase** in dollars obligated from the previous fiscal year.

The third Airbus H135 helicopter touches down at the Launch and Landing Facility runway. Credit: NASA/Kim Shiflett



## Airbus H135 Helicopters

Flight Operations integrated **three** Airbus H135 helicopters into the fleet. These advanced aircraft will provide security and medical support to Commercial Crew and all Artemis launches.

## Protective Services Office

The Protective Services Office conducted **two exercises** in 2021. These include a tabletop hazmat exercise with Fire Rescue Services, Security Police, and Protective Services Dispatch and, in late June, an exercise for hurricane season. Two days after the hurricane exercise, Emergency Management initiated Kennedy's response to Hurricane Elsa.

## Custom Equipment

The **Biomedical Engineering and Research Laboratory** has made custom medical/rescue equipment for the Commercial Crew Program and Artemis, including outfitting emergency vehicles and medevac helicopters to ensure crew safety in the event of an anomaly on the launch pad.

## New Lights

**Launch Complex 39B** will be lit up with **328** new lighting fixtures for Artemis I. The lights will illuminate the Space Launch System (SLS) rocket while on the mobile launcher.



Credit: BOSS/Erik McClella

## ENVIRONMENT AND SUSTAINABILITY

The **Kennedy Remediation Program** is actively restoring groundwater quality at 13 sites covering 60 acres and is proactively conducting investigations into past uses and potential exposures of perfluoroalkyl and polyfluoroalkyl substances (PFAS), an emerging contaminant, guided by federal and state health and environmental agencies.

### Permit and Compliance Group

The Permit and Compliance Group conducted over **500** environmental compliance inspections of Kennedy operations and resident contractors, verifying operations comply with all local, state, and federal environmental regulations. The Florida Department of Environmental Protection and Brevard County regulators found no compliance violations in environmental program areas upon inspections.



*A tortoise walks through underbrush. Credit: NASA/Ben Smegelsky*

The center scored almost all **green** on its annual Sustainability Scorecard by meeting or surpassing the center's goals in the reduction of greenhouse gas emissions, use of renewable energy and alternative fuels, pollution prevention and waste management, and sustainable acquisition.

### Crewed Mission Support

**Kennedy Aerospace Medicine and Occupational Health Branch** and its contractors supported the first routine crewed missions to the International Space Station from U.S. soil. Support included crew quarters medical and quarantine activities, including COVID screening, biomedical console operations, and Emergency Medical Services triage site support for each launch.

### Shoreline Restoration

Phase 1 and 2 of shoreline restoration are complete, spanning approximately 3.5 miles from Kennedy's northern secure border south to Launch Complex 39A. The inland dune has a top elevation of 17 feet and the base varies from 90–170 feet wide. It is constructed of more than **450,000 cubic yards of sand** and is covered with native coastal plants. The Environmental Management Branch will annually assess the condition and performance of the dune, which will protect valuable space infrastructure and provide a wildlife habitat safe from storm surge and inland inundation.

### Solar Energy

Florida Power and Light (FPL) commissioned the Discovery Solar Energy Center. The **74.5-megawatt** photovoltaic facility spans **491 acres** on Kennedy property, contains about a quarter million solar panels, and sends enough energy to the utility company's electrical grid to power 15,000 Florida homes annually. This project was the culmination of a multi-year effort to set aside land for renewable energy in Kennedy's master plan.



*Credit: NASA/Frank Michaux*

### Utility Energy Services Contract

The Utility Energy Services Contract Phase 1 Feasibility Study is finished, with the design/implementation awarded to FPL. The project includes \$18.6 million of energy conservation measures, upgrades, modifications, and consolidations of energy consuming systems, additional solar energy generation capacity, and increased system controls, which will yield **\$1.4 million** in energy and maintenance **savings** per year with a payback within 15 years.

# SAFETY AND MISSION ASSURANCE

The Safety and Mission Assurance (SMA) Directorate mitigates risks to ensure mission success and builds a culture of safety to protect astronauts, center personnel and property, the public, and America's future in space. SMA is in everything we do at Kennedy Space Center.

SMA supports all programs and projects across the multi-user spaceport.

The SMA Commercial Crew team collaborated with the Commercial Crew Program to support the development and operation of a new generation of spacecraft and launch systems capable of carrying crews to the International Space Station. They performed activities for SpaceX's Crew-1 launch and landing, Crew-2 launch, and preparations for Boeing's Orbital Flight Test-2 mission. Functions include flight hardware production and refurbishment surveillance, assessing test results and nonconformances, evaluating design changes, hardware qualification, and requirements compliance audits, and identifying and mitigating hazards. The team also ensured astronaut and ground crew safety by reviewing nominal and emergency operation plans.

The SMA Launch Services Program (LSP) team contributed to the mission processing and launches of Sentinel-6 Michael Freilich and Landsat 9,

providing independent assessments of risks to mission success and verifying that launch vehicle systems and integrated vehicles met NASA requirements. The team completed launch vehicle certification efforts for SpaceX's Falcon 9 Heavy launch vehicle and began work on certification for United Launch Alliance's Vulcan launch vehicle. SMA protects Kennedy personnel and facilities by providing quality insight and independent assessments of launch vehicle providers, ensuring the safe processing of LSP payloads and launch vehicles.

The SMA Exploration Ground Systems (EGS) team supported key milestones including ammonia and hyper servicing of Orion, Space Launch System boosters, and core stage preparations and stacking in the Vehicle Assembly Building. SMA's assessment verified ground support equipment requirements were fully satisfied and hazards associated with the operations were understood and mitigated. SMA EGS executed government mandatory inspection points to ensure the spacecraft was assembled to the highest standards and safe for flight. SMA performed a final turnover inspection with Lockheed Martin and the Test Operations and Support Contract teams to document the configuration of Orion. They also coordinated cross-program



Technicians observe Boeing's Starliner crew module being placed on top of the service module in the Commercial Crew and Cargo Processing Facility at NASA's Kennedy Space Center in Florida on Jan. 14, 2021, in preparation for NASA and Boeing's OFT-2 mission. Credit: Boeing/John Proferes



The U.S.-European Sentinel-6 Michael Freilich ocean-monitoring satellite is encapsulated in the SpaceX Falcon 9 rocket's payload fairing on Nov. 3, 2020, inside SpaceX's Payload Processing Facility at Vandenberg Air Force Base (VAFB) in California. Credit: NASA/Randy Beaudoin

nonconformances with the EGS and Orion programs to ensure documentation and resolution of all technical issues. The team performed risk assessments for nonconformances and safety surveillance of spacecraft processing activities to ensure the safety of personnel, facilities, and flight hardware.

The SMA Exploration Research and Technology (ER&T) team performed multiple safety reviews to ensure safe, successful ground processing of approximately 60 International Space Station and Artemis I payloads including the Nanoracks Airlock, iROSA, and ArgoMoon. SMA ER&T provided safety analyses for research and technology projects, lab safety walkdowns and safety insight of payload processing operations, and quality assurance for various experiments destined for space, rodent research, power/data testing for station utilization payloads, and space station Orbital Replacement Unit processing. SMA ER&T contributed to formulation and planning for Gateway's Deep Space Logistics project and supported planning for Human Landing System Program ground and lunar surface operations.



Engineers and technicians at NASA's Kennedy Space Center in Florida install the radiator for the Mass Spectrometer Observing Lunar Operations (MSolo) instrument inside the Space Station Processing Facility on Sept. 25, 2020. Credit: NASA/Glenn Benson



NASA's Pegasus Barge travels on the inland waterway to its destination at the Kennedy Space Center Launch Complex 39 turn basin wharf to make its first delivery to Kennedy in support of the agency's Artemis missions on Sept. 27, 2019. Credit: NASA/Mike Downs

The SMA team will continue its primary mission to enable safe and successful access to space while pushing the boundaries and ensuring our employees go home safe.



The Space Launch System (SLS) core stage for NASA's Artemis I mission is seen in the transfer aisle of the Vehicle Assembly Building (VAB) at NASA's Kennedy Space Center in Florida on June 4, 2021. Credit: NASA/Kim Shiflett

An inquisitive sandhill crane approaches the photographer near the Vehicle Assembly Building at NASA's Kennedy Space Center in Florida on March 24, 2021. Kennedy shares space with the Merritt Island National Wildlife refuge, which is home to more than 1,000 species of plants, 117 species of fish, 68 kinds of amphibians and reptiles, 330 types of birds, and 31 different mammal species. The refuge provides a favorable environment for sandhill cranes as it contains shallow freshwater habitats for nesting, along with a variety of vegetation and prey to feed on. Credit: NASA/Ben Smegelsky



# COMMUNICATION AND PUBLIC ENGAGEMENT

## OFFICE OF COMMUNICATION

Due to COVID-19 concerns, Kennedy Space Center continued the production of virtual NASA Social events, featuring seven launches. These unique opportunities allowed NASA followers to participate virtually, learning more about the mission through behind-the-scenes videos and live Q&A sessions with subject matter experts. Participants were able to connect with other space enthusiasts throughout the world, allowing them to discuss the mission and express their excitement leading up to liftoff.

Overall, these virtual NASA Socials had a total of 179,500 participants, and the videos shared had more than 142,000 views. Through these virtual events, we were able to highlight the various missions that launched from Kennedy and the role our center played throughout 2021.



The virtual NASA Social team along with two of the guests who were featured live on the Crew-2 event.

## NASA Social Quick Facts

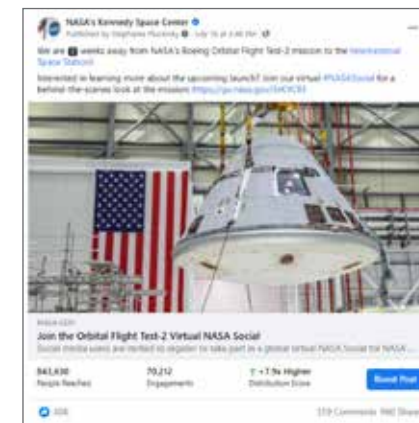
### Total virtual NASA Socials: Seven

- |  |   |   |
|--|---|---|
| 1. Crew-1                                | 3. Crew-2                               | a. Facebook Event   |
| a. Facebook Event                        | a. Facebook Event                       | b. Members: 31,100  |
| b. Members: 39,800                       | b. Members: 73,800                      | c. 76,600 views between four total shows (three recorded, one live) |
| c. 15,500 views between five live videos | c. 30,000 views between two live videos |   |
| 2. CRS-21                                | 4. CRS-22                               | 6. CRS-23   |
| a. Facebook Event                        | a. Facebook Event                       | a. Facebook Event   |
| b. Members: 12,400                       | b. Members: 13,600                      | b. Members: 8,800   |
| c. 3,900 views on one live video         | c. 12,000 views on one live video       | c. 4,818 views between two pre-recorded videos                      |
|  | 5. Orbital Flight Test-2 Attempt        | 7. Landsat-9 (Goddard)  |

## Social Media Components

|                            | 2020         | 2021        | Increase |
|----------------------------|--------------|-------------|----------|
| Followers across accounts  | 3.75 million | 4.2 million | 9.9%     |
| Engagement across accounts | 2.2 million  | 3.6 million | 60.8%    |
| Facebook engagement        | 439,700      | 1.6 million | 194.6%   |
| Twitter engagement         | 534,600      | 571,800     | 6.9%     |
| Instagram engagement       | 1 million    | 1.4 million | 32.5%    |
| Facebook new followers     | 50,100       | 53,600      | 6.98%    |
| Twitter new followers      | 232,100      | 245,400     | 5.7%     |
| Instagram new followers    | 150,000      | 166,000     | 10.6%    |

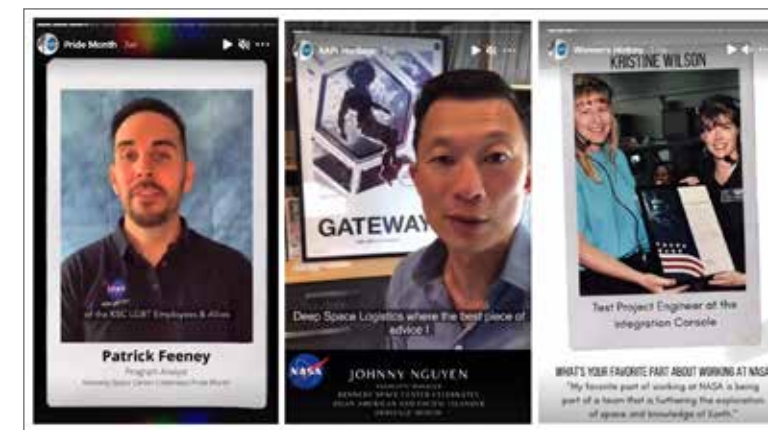
## Social Media Featured Posts



Facebook



Twitter



Instagram

## Media Attendance

### Milestone Events:

- Path to the Pad, Mobile Launcher Roll, Oct. 2020 – 29
- Path to the Pad, Space Launch System (SLS) Stacking Media Event, Nov. 2020 - 38
- Path to the Pad, Orion on the Move, Nov. 2020 - 47
- Completed Artemis Booster Stacking, March 2021 - 15
- SLS Core Stage Arrival, April 2021 - 45
- Starliner Rollout, May 2021 - 15

### Launches:

- SpaceX Crew-1 Launch, Nov. 2020 – 147
- SpaceX CRS-21 Launch, Dec. 2020 - 57
- SpaceX Crew-2 Launch, April 2021 - 166
- SpaceX CRS-22 Launch, May 2021 - 76
- SpaceX CRS-23 Launch, Aug. 2021 - 60
- Landsat 9 Launch, Sept. 2021 - 21

Still living and working in a largely virtual environment, Kennedy Space Center's media broadcasts played an important role in educating the public on the multi-faceted successes and discoveries happening at NASA. Driven by digital and physical enhancements, the Office of Communication achievements include...

- A Launch America banner installed across the entrance of the Vehicle Assembly Building honoring the return of crewed spaceflight through our collaboration with commercial partners.

Mural on the side of the KSC Press Site Auditorium facility, completed Sept. 2021.



- Facility upgrades to support the media broadcast of astronaut crew walkouts on launch day.
- Purchase of an outdoor stage for launch broadcasts to support continuous coverage of launches on NASA TV.
- A mural painted by local artist Christopher Maslow, honoring KSC history from the Apollo program to Artemis and the hard work of the diverse individuals who made it all possible.



## OUTREACH AND GUEST OPERATIONS

The Outreach and Guest Operations Office is responsible for providing leadership, coordination, and execution of the following activities:



### Virtual Guest Operations

NASA's virtual guest program began in response to the pandemic and has registered over 375,000 virtual guests. It's now a regular offering for launches and milestones to directly connect the public to these exciting moments. Virtual guests receive access to curated resources, schedule changes, and mission-specific information straight to their inboxes. Following each activity, guests are sent a stamp for their virtual guest passport. The program has a list of over 37,800 invitees and a new website as of July 2021 - <https://www.nasa.gov/virtualguest/>.

The virtual guest passport stamp for participation in Mars 2020 landing events.



The virtual launch guest digital passport cover.

#### Program Highlights:

- 13 virtual guest registration opportunities
- 215,000+ virtual guest registrations
- 48,330+ Eventbrite followers
- 853,982+ emails have been sent with an open rate of 56% and a click rate of 30%.



Launch of Sentinel-6 Michael Freilich atop a SpaceX Falcon 9 rocket.

### In-Person Guest Operations

In-person guests include representatives of local, state, and federal government; elected officials; international partners and guests; interagency guests; educators from academic institutions, museums and science centers, and non-profits; community, industry, and association leaders; space and science advocates; non-governmental organization representatives; and leaders from professional associations. With restrictions due to COVID, in-person opportunities were curtailed greatly during FY 2021. Featured events included the Sentinel-6 Michael Freilich launch and NASA's SpaceX Crew-1 and Crew-2 launches, totaling more than 4,500 guests.



A display featuring the Crew-1 astronauts in the lobby of Operations Support Building I.

### Virtual Employee Events

#### Apollo 13 Event "Houston, We've Had a Problem"

Oct. 9, 2020 -- In celebration of the 50th Anniversary of Apollo 13, a panel recounted the reflections of the most dramatic events in spaceflight history, shared by the men who lived them - Apollo 13 astronaut Fred Haise and Apollo 16 astronaut Charlie Duke - and moderated by then-Center Director Bob Cabana.



Freeze frame from the Apollo 13 virtual event.



Freeze frame from the Gene Roddenberry virtual event.

#### Celebrating Gene Roddenberry: Star Trek's Bridge and NASA

Aug. 19, 2021 - A panel including NASA talent and George Takei aired on NASA TV and focused on the importance and diversity of the bridge in Star Trek. The discussion featured women and people of color who have amazing jobs that have a connection to Star Trek's bridge.

### STS-135 10th Anniversary Panel Discussion

July 8, 2021 --The Atlantis' crew – Chris Ferguson, Doug Hurley, Sandra Magnus, and Rex Walheim – talked about the final flight with Center Director Janet Petro on NASA TV.



Freeze frame from the STS-135 anniversary virtual event.

### OFFICE OF STEM

#### STEM Stats

- Kennedy hosted 129 virtual OSTEM interns
- 572,497 visits to the NASA STEM@Home engagement website
- NASA Days virtual events reached 1,500 students at minority-serving institutions, resulting in 10 students selected for internships.
- © Participating institutions include: Spelman College, Morehouse College, Clark Atlanta University (all in Georgia); Universidad Interamericana de Puerto Rico, Bayamón (Puerto Rico); Fisk University, Knoxville College, Lane College, LeMoyne-Owen College, Meharry Medical College, Tennessee State University (Tennessee); Howard University (Washington, D.C.); Morgan State University (Maryland); University of Houston (Texas).
- Established Program to Stimulate Competitive Research (EPSCOR)
  - © Released four cooperative agreement notices. 68 awards totaling \$18.18M were made to 28 colleges and universities.
  - © Funded 28 Research Infrastructure Development awards (Year 3) at \$4.9M.
  - © Total funded = \$23.08M.



# WORKPLACE OVERVIEW

Kennedy Space Center is the nation's premier, multi-user spaceport. It is an integral part of the local economy, providing more than 10,000 jobs for civil servants, contractors, tenants, and construction crews.

The workforce includes people with diverse skills dedicated to supporting the nation's space program and NASA's exploration to destinations including the Moon, Mars, and beyond. To accomplish the agency's various missions, these individuals fulfill a multitude of tasks.

Each year, the center takes a snapshot of its workforce. This picture includes all federal and contractor employees chartered to work for Kennedy. Other organizations, such as Cape Canaveral Space Force Station, have roles here but are not reflected in these numbers.

The civil servant skill mix includes those in science, technology, engineering, and mathematics positions, as well as those in professional administrative and clerical positions.

## KENNEDY SPACE CENTER WORKFORCE PROFILE

(through 9/30/21)

|  |               |
|--|---------------|
| Civil Servants   | 2,067         |
| NASA Pathways Interns  | 75            |
| <b>Total Civil Servants</b>  | <b>2,142</b>  |
| * Includes 1 NEX, 1 full time temp, 137 full-time perm employees, and 10 part-time perm employees. |               |
| <b>Civil Servants Skill Mix</b>  |               |
| Scientific, Technology, Engineering and Mathematics  | 69%           |
| Clerical and Professional Administrative   | 31%           |
| <b>On-site Contractor Employees</b>  | <b>4,950</b>  |
| Off-site/Near-site Contractor Employees<br>(Excludes construction workers)                         | 212           |
| <b>Total Contractor Employees</b>  | <b>5,162</b>  |
| <b>Total Construction Workers</b>  | <b>457</b>    |
| <b>Total Tenants</b>   | <b>2,972</b>  |
| <b>TOTAL KSC POPULATION</b>  | <b>10,733</b> |

# DIVERSITY AND EQUAL OPPORTUNITY

AT NASA, WE MAKE AIR AND SPACE AVAILABLE FOR EVERYONE.

## DID YOU KNOW?

NASA (KSC) Employees Believe\*:

Managers and supervisors are committed to a workforce representative of all segments of society (93%)

They can disclose a suspected violation of any law, rule, or regulation without fear of reprisal (88%)

My talents are used well in the workplace (83%)

They are encouraged to come up with new and better ways of doing things (86%)

\*Source: 2020 Federal Employee Viewpoint Survey



## AGE DEMOGRAPHICS at KSC

- Silents** (born prior to 1945) <1%
- Boomers** (born 1946 – 1964) 25%
- Gen X** (born 1965 – 1979) 34%
- Millennials** (born 1980 – 1996) 37%
- Gen Z** (born 1997 – 2012) 3%

- Average age: 46 years
- Most junior employee: 19 years
- Most senior employee: 76 years

## Minorities in Engineering in the last 20 years:

The employment of **NATIVE AMERICAN** engineers averaged **1%**

The employment of **HISPANIC** engineers averaged **13%**

The employment of **AFRICAN AMERICAN** engineers averaged **8%**

The employment of **ASIAN PACIFIC ISLANDER** engineers averaged **5%**

The employment of **MULTIRACIAL** engineers averaged **2%**

## Correlation Between Job Satisfaction and Engagement

**89** Engagement

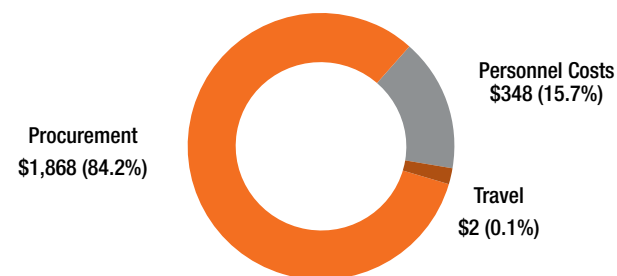
**88** Job Satisfaction

NASA centers' ODEO continually provide training on topics such as disability awareness, conflict management, and diversity and inclusion.

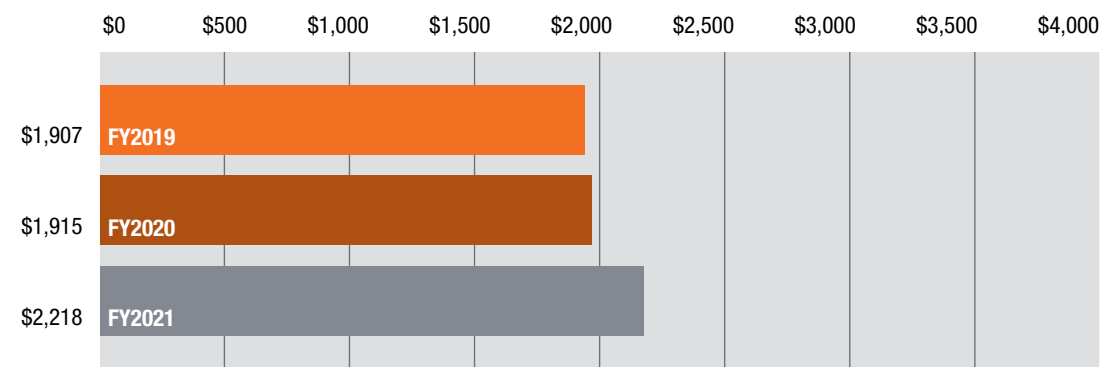
In 2020, NASA leadership added "Inclusion" to the agency's core values. NASA is committed to a culture of diversity, equity, inclusion, and accessibility, where all employees feel welcome, respected, and engaged.

## KENNEDY SPACE CENTER FY 2021 BUDGET AUTHORITY (\$ IN MILLIONS)

|  |                |
|--|----------------|
| Commercial Crew Program                  | \$699          |
| Exploration Ground Systems               | \$570          |
| Launch Services/Science                  | \$317          |
| Mission Services and Capabilities (MSaC) | \$226          |
| Engineering, Safety and Operations (ESO) | \$122          |
| Space Station                            | \$40           |
| Other                                    | \$243          |
| <b>Total KSC</b>                         | <b>\$2,218</b> |



## NASA/KSC BUDGET AUTHORITY SUMMARY FY 2019 THROUGH FY 2021 (\$ IN MILLIONS)



## INDUSTRY PARTNERS AT A GLANCE

The companies listed below were some of Kennedy Space Center's top support or launch services contractors in terms of dollars obligated in fiscal year 2020. Following is a brief description of their work for the agency.

### UNITED LAUNCH SERVICES LLC

United Launch Services (ULS) is a subsidiary of United Launch Alliance, a joint venture between Boeing and Lockheed Martin Commercial Launch Services. ULS provided commercial launch services to NASA using the Delta and Atlas launch vehicles under the NASA Launch Services (NLS) II multiple-award, indefinite delivery, indefinite quantity task order contract. The principal location for the Delta and Atlas vehicle assembly was Decatur, Alabama. Both vehicles launch from Cape Canaveral Space Force Station in Florida and Vandenberg Space Force Base in California.

### BECHTEL NATIONAL INC.

Bechtel National Inc. was the prime contractor for the design and construction services for Exploration Ground Systems' Mobile Launcher 2 (ML2). Bechtel was responsible for the design, construction, testing, and commissioning of the ML2.

### ASRC FEDERAL DATA SOLUTIONS LLC

ASRC Federal Data Solutions performed infrastructure and application services, communication services, and multimedia support services at Kennedy, NASA facilities at Cape Canaveral Space Force Station, Vandenberg Space Force Base, and other locations, under the Kennedy Infrastructure, Applications and Communication (KIAC) contract. ASRC Federal Data Solutions delivered products and services to both NASA and the Department of Defense, and provided benefit to other government agencies, contractors, academia, news media organizations, and various space-related industry entities. ASRC Federal Data Solutions provided products and services including application operations and software development; data center operations; voice, imaging and data communications; multimedia services support; documentation and reproduction; and research and library management.

### AMENTUM SERVICES, INC.

Amentum Services provided laboratory support services and operations for Kennedy Space Center. AECOM was responsible for the operation, maintenance and engineering for a diverse set of laboratories, developmental shops and test facilities. Amentum Services also was responsible for program management, laboratory maintenance and support, operational laboratory services, and professional and technical support for scientific research, engineering analysis, test and evaluation in laboratory environments.

### A.I. SOLUTIONS, INC.

a.i. solutions provides integrated support services primarily to the Launch Services Program for NASA and NASA sponsored payloads in the areas of launch vehicle system engineering and mission analysis; launch site support engineering; safety and mission assurance, technical integration services; institutional services at Vandenberg Space Force Base; information technology; and engineering, operations, and maintenance of communications and telemetry systems.

## YOUR PROCUREMENT DOLLARS AT WORK GEOGRAPHICAL DISTRIBUTION BY STATE (Fiscal Year 2021 Obligations)

| STATE                | TOTAL DOLLARS | STATE                          | TOTAL DOLLARS          |
|----------------------|---------------|--------------------------------|------------------------|
| ALABAMA              | 13,081,261    | MISSOURI                       | 1,868,774              |
| ALASKA               | 4,046,157     | NEVADA                         | 17,999,724             |
| ARIZONA              | 104,604       | NEW HAMPSHIRE                  | 13,000                 |
| CALIFORNIA           | 724,572,329   | NEW MEXICO                     | 11,926,019             |
| COLORADO             | 79,644,473    | NEW YORK                       | 4,679,028              |
| CONNECTICUT          | 3,333,162     | NORTH CAROLINA                 | 92,577                 |
| DISTRICT OF COLUMBIA | 4,534         | OHIO                           | 1,866,019              |
| FLORIDA              | 93,596,713    | OREGON                         | 935,987                |
| GEORGIA              | 1,570,458     | PENNSYLVANIA                   | 37,537,051             |
| IDAHO                | 172,052       | SOUTH DAKOTA                   | 121,144                |
| ILLINOIS             | 5,821,522     | TENNESSEE                      | 311,843,872            |
| INDIANA              | 3,324,315     | TEXAS                          | 26,101,219             |
| LOUISIANA            | 6,194,031     | VIRGINIA                       | 190,102,933            |
| MARYLAND             | 136,943,581   | WASHINGTON                     | 399,950                |
| MASSACHUSETTS        | 268,960       | WISCONSIN                      | 313,974                |
| MICHIGAN             | 85,963        | <b>TOTAL STATE OBLIGATIONS</b> | <b>\$1,680,473,165</b> |
| MISSISSIPPI          | 1,907,770     |                                |                        |

## TOP 25 KSC BUSINESS CONTRACTORS FOR FY 2021

| Contractor                             | Dollars                |
|--|------------------------|
| SPACE EXPLORATION TECHNOLOGIES CORP.   | 673,589,312            |
| JACOBS TECHNOLOGY INC.                 | 300,138,938            |
| PAE-SGT PARTNERS LLC                   | 84,273,627             |
| UNITED LAUNCH SERVICES, LLC            | 78,982,126             |
| BECHTEL NATIONAL, INC.                 | 67,277,500             |
| ASRC FEDERAL DATA SOLUTIONS, LLC       | 48,138,694             |
| AMENTUM SERVICES, INC.                 | 46,447,294             |
| AI SOLUTIONS, INC.                     | 32,482,528             |
| AIR PRODUCTS AND CHEMICALS, INC.       | 30,542,095             |
| CHENEGA INFINITY, LLC                  | 30,153,169             |
| J.P. DONOVAN CONSTRUCTION, INC.        | 27,199,862             |
| ARES TECHNICAL SERVICES CORPORATION    | 18,345,627             |
| FLORIDA POWER & LIGHT COMPANY INC.     | 18,305,457             |
| HSG, LLC                               | 17,999,724             |
| APACHE-LOGICAL JV                      | 11,926,019             |
| SES CONSTRUCTION AND FUEL SERVICES LLC | 11,603,161             |
| ASTRA SPACE, INC.                      | 11,161,000             |
| AECOM MANAGEMENT SERVICES, INC.        | 9,876,289              |
| A-P-T RESEARCH, INC.                   | 9,570,918              |
| AIR LIQUIDE LARGE INDUSTRIES U.S. LP   | 9,129,650              |
| FIREFLY BLACK, LLC                     | 8,820,000              |
| ADVON CORPORATION                      | 7,911,702              |
| NEW DIRECTIONS TECHNOLOGIES, INC.      | 7,736,625              |
| THE AEROSPACE CORPORATION              | 7,114,255              |
| PRECISION MECHANICAL, INC.             | 7,063,166              |
| <b>TOTAL</b>                           | <b>\$1,575,788,747</b> |

# NASA Remembers Michael Collins 1930-2021



Former NASA astronaut Michael Collins passed away on April 28, 2021.

“Today the nation lost a true pioneer and lifelong advocate for exploration in astronaut Michael Collins,” said acting NASA Administrator Steve Jurczyk. “As pilot of the Apollo 11 command module – some called him ‘the loneliest man in history’ – while his colleagues walked on the Moon for the first time, he helped our nation achieve a defining milestone. He also distinguished himself in the Gemini Program and as an Air Force pilot.

“Michael remained a tireless promoter of space. ‘Exploration is not a choice, really, it’s an imperative,’ he said. Intensely thoughtful about his experience in orbit, he added, ‘What would be worth recording is what kind of civilization we Earthlings created and whether or not we ventured out into other parts of the galaxy.’ “



Donned in his space suit, Command Module (CM) pilot Michael Collins does a final check of his communications system before the boarding of the Apollo 11 mission. Credit: NASA



Close-up of astronaut Michael Collins, Gemini-10 pilot, making final adjustments and checks in the Gemini spacecraft during prelaunch countdown. In right background is astronaut John W. Young, command pilot. Photo credit: NASA

On July 16, 2019, the 50th anniversary of the Apollo 11 launch, astronaut Michael Collins, right, speaks to Kennedy Space Center Director Bob Cabana at Launch Complex 39A. During his visit to the Florida spaceport, Collins discussed the moments leading up to launch at 9:32 a.m. on July 16, 1969. Credit: NASA/Frank Michaux



Astronaut Michael Collins, prime crew pilot for the Gemini-10 spaceflight, sits in Static Article 5 during water egress training activity onboard the NASA Motor Vessel Retriever. Credit: NASA



On July 16, 2019, the 50th anniversary of the Apollo 11 launch to the Moon, astronaut Michael Collins speaks to launch team members from Apollo 11 and the current launch team for Artemis I in Firing Room 1 in the Launch Control Center at NASA's Kennedy Space Center in Florida. Credit: NASA/Kim Shiflett





ASI  
SPACE

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National Aeronautics and Space Administration  
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