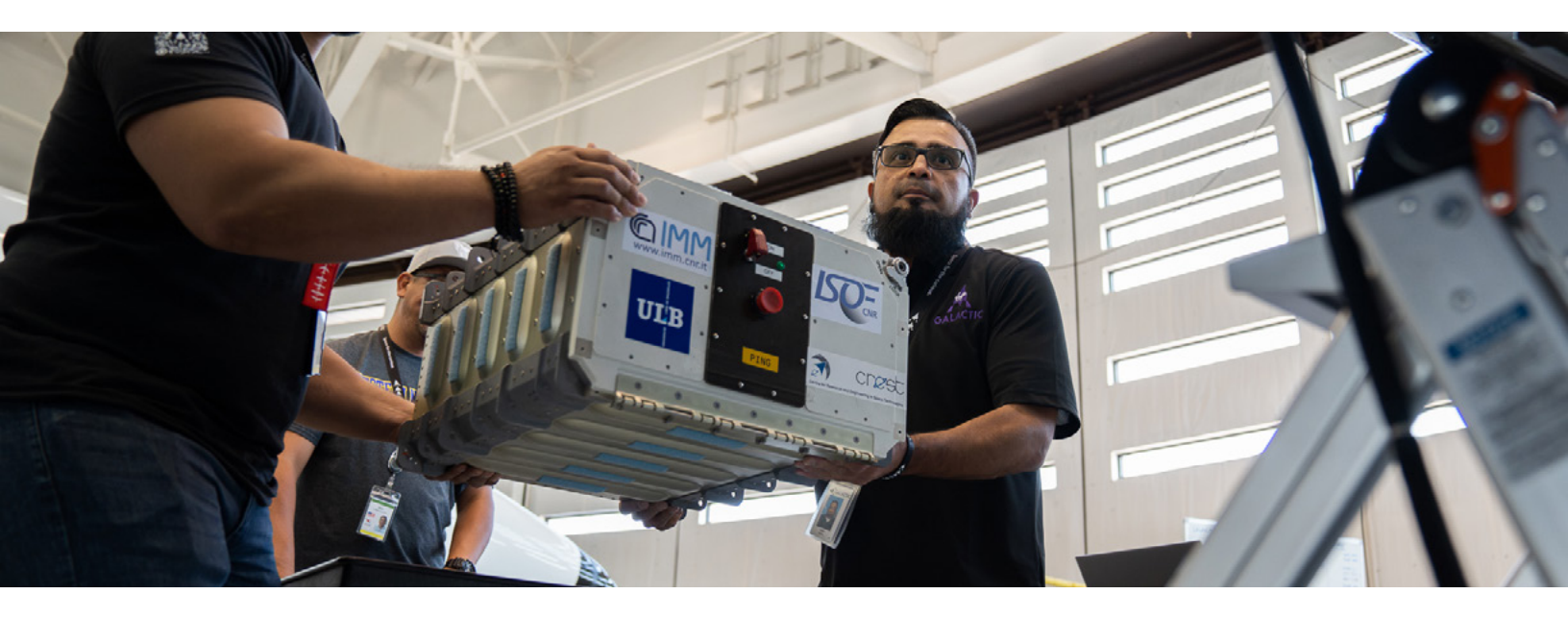
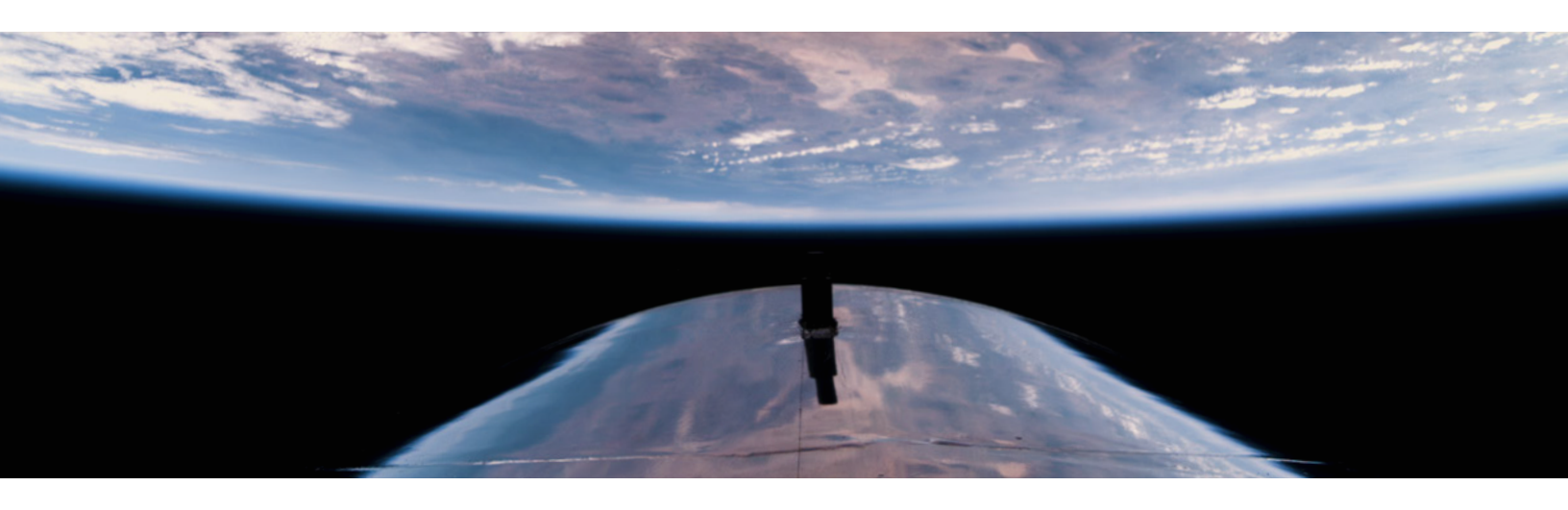
Research Fact Sheet

Virgin Galactic is the world's first commercial spaceline, pioneering human spaceflight for private individuals and researchers with its advanced air and space vehicles. Its vehicles are suborbital space labs for governments, researchers, and the commercial industry to use in conducting research and testing their innovations in microgravity for the betterment of Earth and space exploration.

Virgin Galactic has flown suborbital research missions on six flights, including both autonomous and human-tended experiments. It has flown payloads for NASA's Flight Opportunities program since it began spaceflights in 2018 and is the only suborbital flight provider to successfully conduct human-tended research in microgravity. With Italy's *'Galactic 01'* research mission, Virgin Galactic doubled the amount of research payloads flown on its vehicles and demonstrated the ability to use suborbital spaceflights to train astronauts for future orbital missions. *'Galactic 05'* was Virgin Galactic's sixth research mission and took the first private researchers to suborbital space. Galactic 07' will further demonstrate the value of suborbital missions as a training platform and research testbed for orbital missions.



Virgin Galactic's piloted, reusable vehicles are designed for humans and research payloads to reach space on frequent, affordable, and safe suborbital spaceflights. Prior to launch, Virgin Galactic's Payload Integration team works closely with researchers to ensure missions are ready for space. Researchers can fly rack-mounted autonomous payloads or travel to space with their payloads to conduct their experiments in microgravity. Researchers conducting human-tended research receive specialized training and instruction to choreograph the most efficient use of valuable microgravity time. With flights departing from and returning to Spaceport America, researchers can load payloads just before flight and recover them shortly after landing, which provides immediacy and access for time-sensitive missions. Virgin Galactic's configurable cabin and adaptable missions make it uniquely suited to fly high-quality microgravity research missions for the scientific and astronaut community.



NASA Programs

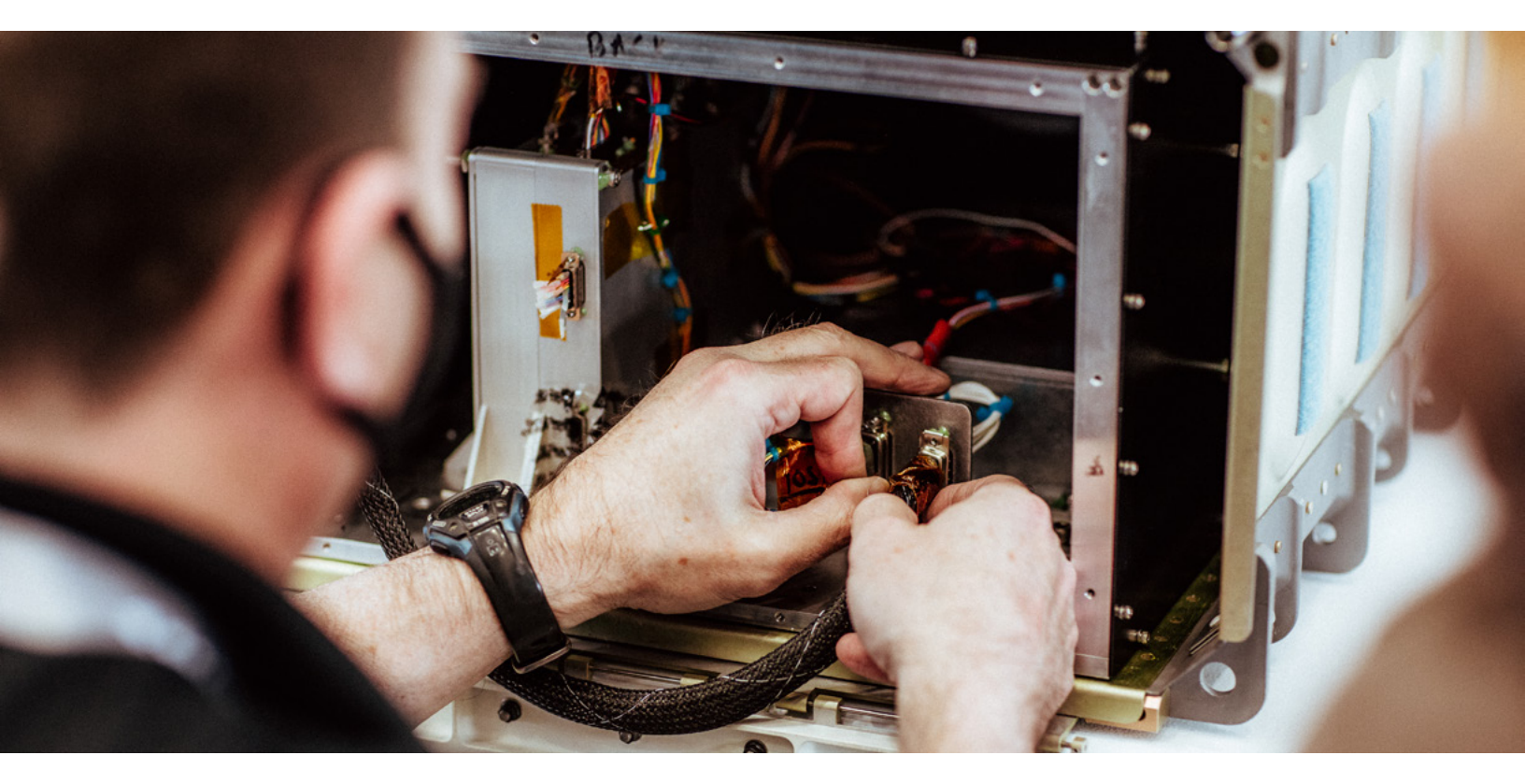
- **Flight Opportunities:** NASA's Flight Opportunities program advances innovative space technologies that support the agency's mission by providing flights on commercial suborbital platforms. These platforms provide access to the microgravity environment as well as bridge the critical gap between laboratory or ground-based testing and demonstration of technical readiness in a mission-relevant, operational environment. By testing technologies on suborbital platforms, NASA and researchers are able to reduce costs and technical risks for future missions.
- Virgin Galactic has worked with Flight Opportunities for over a decade and flown autonomous and human-tended payloads for researchers and industry through the program. Building on this successful flight history, Virgin Galactic was selected for Flight Opportunities' first contracts to fly researchers themselves on suborbital flights. In addition to these missions, Virgin Galactic has been selected to fly more payloads on future missions for Flight Opportunities.
- **SubC:** NASA's Suborbital Crew (SubC) program enables U.S. government agencies to fly their personnel on suborbital research and training missions. NASA is in the process of qualifying Virgin Galactic and its vehicles under the SubC program. The qualification process is analogous to NASA's Commercial Crew program to develop vehicles to transport astronauts to and from the International Space Station. Once qualified under SubC, Virgin Galactic will be able to offer the same research and training opportunities to U.S. employees on suborbital flights that the Italian Air Force and National Research Council of Italy (CNR) received on the *'Galactic 01'* mission.

Past Flights

Virgin Galactic's first revenue generating flight was in December 2018 carrying four research payloads for NASA's Flight Opportunities program. Since then, Virgin Galactic has flown a dozen payloads over four research flights for the Flight Opportunities program. This includes two flights that were separated by only three months, allowing for quick adjustments in the payloads from one flight to the other and demonstrating the ability to "fly-fix-fly."

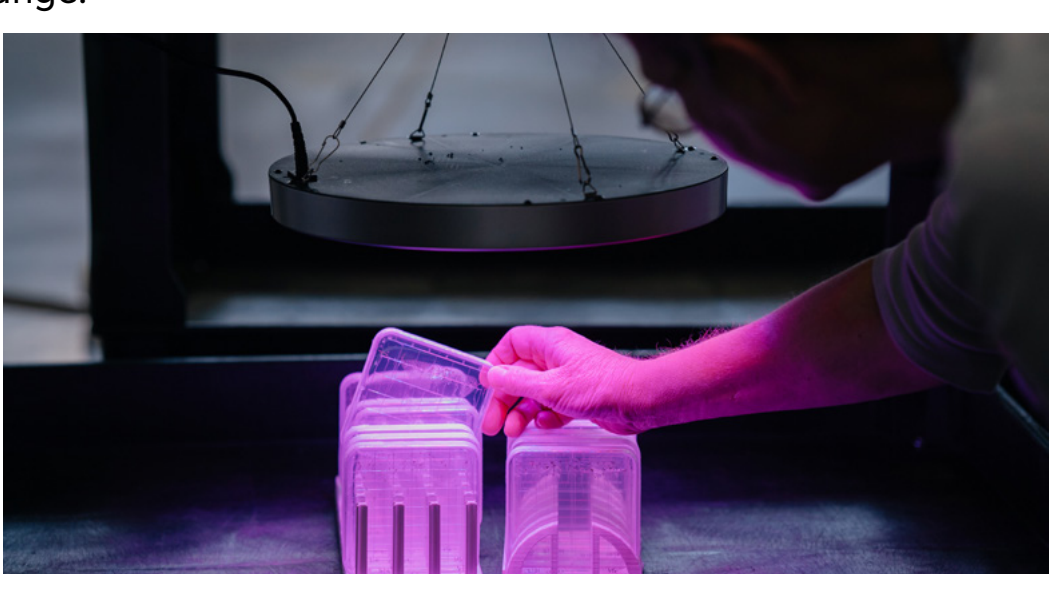
Carrying research experiments and supporting programs such as NASA's Flight Opportunities program demonstrates the important relationship between government and commercial industry. A selection of the research payloads flown by Virgin Galactic are summarized below:

- **University of Florida – UF Flex Imager**
  Principal Investigators: Rob Ferl and Anna-Lisa Paul
  About: The University of Florida's Space Plants program has 20 years of experience studying gene expression in plants on parabolic flight, suborbital, and orbital platforms. This autonomous experiment is maturing biological fluorescent imaging instrumentation originally developed for the Space Shuttle and International Space Station and calibrating the hardware and data collection capabilities to timeframes optimal for suborbital applications. This biological imaging system has long-term development potential for planetary lander applications and space exploration, in addition to nanotechnology for small satellites.
- **University of Central Florida – Collisions Into Dust Experiment (COLLIDE)**
  Principal Investigator: Josh Colwell
  About: Understanding the behavior of fine particles in dusty environments in response to human and robotic activities is crucial for successful exploration missions to asteroids, the Moon, and Mars. Fine grains may damage optical instruments, coat solar panels, or jam moving parts on spacecraft. The COLLIDE autonomous payload propels a projectile at a reservoir of simulated dust from one of these planetary systems and observes how the dust moves as a result of the collision. This low-energy impact experiment is a modified version of the COLLIDE experiment that was previously flown on two Space Shuttle missions.



- **Johns Hopkins University Applied Physics Laboratory (APL) – Electromagnetic Field Measurements**
  Principal Investigator: H. Todd Smith
  About: The National Research Council Commission on Physical Sciences, Mathematics, and Applications recommends routine profiles of the electric field between 0-80 km should be made to study the roles of aerosols, global change, and cosmic rays. This region includes the lower ionosphere, which is informally referred to as the "ignorosphere" because its altitude is difficult to explore using in situ instrumentation – it's too high for high-altitude balloons and aircraft and too low for traditional orbiting spacecraft. Reusable suborbital rockets uniquely provide the ability to study this part of the atmosphere and recover payloads. The sensor suite included in this autonomous payload will characterize the electromagnetic field environment inside the spacecraft. Applications of this research will help better understand the ionosphere and Earth's complex electrical environment.
- **Controlled Dynamics Inc. – Vibration Isolation Platform (VIP)**
  Principal Investigator: Scott Green
  About: Controlled Dynamics is conducting a technology maturation flight to qualify its Vibration Isolation Platform (VIP). VIP is an autonomous vibration isolation platform capable of providing a premium service for future microgravity research experiments flown on suborbital and orbital vehicles. During launch, re-entry, and landing, the research payload is mechanically secured within the payload locker. During parabolic coast, the research payload is automatically released on a free-floating platform. The payload is caged, but otherwise left undisturbed to float freely in the sway space of the VIP. Derivatives of this technology were used as a stabilization platform for optical communications and flown on the Deep Space Optical Communications (DSOC) demonstration on NASA's Psyche asteroid mission.

- **University of Louisville - Aqueous Immersion Surgical System**
  Principal Investigator: George Pantalos
  About: As human space exploration reaches new destinations and conducts longer duration missions, astrosurgery capabilities need to be developed in the event complex medical procedures need to be conducted far from home. The University of Louisville adapted a neonatal intensive care unit (NICU) incubator into an autonomous glove box payload to house a surgical fluid management system. The system is designed to allow for surgery to be conducted in a weightless environment and could be used on long-term space missions.
- **NASA Johnson Space Center (JSC) – Multi-Phase Flow Experiment for Suborbital Testing (MFEST)**
  Principal Investigator: Kathryn M. Hulbert
  About: NASA JSC is avidly interested in two-phase fluid flow systems for active thermal control and life-support systems for space applications. The autonomous MFEST payload is a pathfinder, suborbital flight experiment for two-phase fluid flow and liquid separation functions. Two-phase fluid flow experiments at partial gravities have been very limited and primarily conducted using special aircraft modified to fly parabolas. A suborbital flight allows longer-duration and continuous operational testing with variable gravity over a wider range.



- **University of Florida – Enabling Suborbital Genomics and Gene Expression**
  Principal Investigators: Rob Ferl and Anna-Lisa Paul
  About: Although changes in gene expression are well characterized between orbital space (like the International Space Station) and Earth, no science has yet been done to capture changes in gene expression during the transition to and from sustained microgravity. To study these gene expressions, Virgin Galactic astronaut Sirisha Bandla activated three Kennedy Space Center Fixation Tubes (KFTs) filled with plant samples at different phases of flight. At the same time, the research team used the flight telemetry to activate identical control tubes on the ground. This first-of-its kind experiment will provide new insights into how terrestrial organisms perceive the transition into the novel environment of space.

'Galactic 01' Summary

This historic mission was Virgin Galactic's first commercial spaceflight and represents a new era in government-funded commercial human-tended research missions. The three-person crew from the Italian Air Force and National Research Council of Italy (CNR) conducted a series of suborbital science experiments, and collected additional timely data on the ground before and after the flight. VSS Unity's cabin was transformed into a suborbital science lab to provide the environment for rack-mounted payloads and for the crew to interact with wearable payloads.

Read about the 13 human-tended and autonomous experiments here.

'Galactic 05' Summary

Virgin Galactic's first private researcher flight and sixth research mission demonstrated yet another use case for its suborbital space lab. Two researchers, Dr. Alan Stern sponsored by the Southwest Research Institute (SwRI), and Kelli Gerardi, sponsored by the International Institute for Astronautical Sciences (IAAS), conducted a total of five human-tended research experiments.

Read about Dr. Alan Stern and Kellie Gerardi's experiments here.

'Galactic 07' Summary

Virgin Galactic's seventh research mission includes research from Axiom Space in partnership with the Turkish Space Agency (TUA) that will be flown by TUA astronaut, Tuva Atasever. It will also include autonomous-rack mounted payloads from Purdue University and the University of California, Berkeley with support from NASA Flight Opportunities program.

Learn more about the research flying on *'Galactic 07'* here.