

USAFA Discovery is published quarterly by the faculty of the US Air Force Academy (USAFA). It contains reports on USAFA cadet and faculty research, a complete list of current USAFA research points of contact, and a summary of recent awards and publications. All written material contained within reflects the opinions of the authors and editors and does not necessarily reflect current US Air Force or USAFA policy.

Falcon Gold: USAFA in Space **USAFA cadets and faculty demonstrate the effectiveness of receiving positioning information above the GPS constellation**

The Global Positioning System has revolutionized navigation on or near the surface of the earth. Users ranging from airliners, missiles, ships, cars, and hikers get accurate positioning information from a constellation of 24 satellites. The satellites at an altitude of 20,000 km send large beam-width signals through nadir pointing antennas (directed at the earth). Some of this information, though, leaks around the rim of the earth back out into space. Dr. Ron Humble and Major Dewey Parker of the Department of Astronautics at the US Air Force Academy (USAFA) wanted to determine if these stray signals could be detected and used for positioning for satellites above the GPS constellation. If so, this might obviate the need for costly ground-based stations and allow for autonomous navigation of high-altitude satellites. A team of experts from academia, government, and industry joined forces to build and launch Falcon Gold, a satellite package designed to investigate the feasibility of this concept.

USAFA cadets designed and built a prototype of Falcon Gold and then flew it on a high-altitude balloon in April 1997 to test the design concept and system architecture. Cadets worked closely with the Atlas booster manufacturer, Lockheed Martin, to assure proper integration of the spacecraft onto the launch vehicle. The team put Falcon Gold through a rigorous qualification test program at Ball Aerospace to demonstrate the integrity of the spacecraft design. After refurbishment and final integration Falcon Gold was delivered to Cape Canaveral where the team mated the spacecraft to the Atlas/Centaur rocket. Two weeks later the USAFA contingent returned to Florida and watched the rocket lift off. Cadets then participated in the orbital phase of the mission by helping operate the Boulder ground station until the experiment came to its planned conclusion.

The Air Force Academy's first orbiting spacecraft was launched on an Atlas rocket from Cape Canaveral on 24 October 1997. The technical goal of the mission was to investigate the feasibility of performing GPS-aided navigation by high-altitude satellites (geosynchronous). The results of this pioneering experiment could lead to new techniques for tracking these satellites thus saving money, time, and resources. The Air Force Academy teamed with the University of Colorado, Lockheed-Martin, the Naval Academy, Ball Aerospace, the Aerospace Corporation, and the Air Force's Space and Missile Systems Center (SMC) to make the Falcon Gold mission a success.

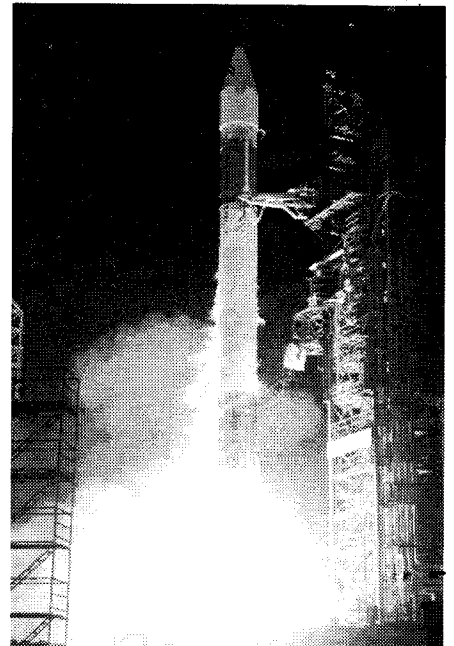
The Falcon Gold spacecraft collected GPS signals while at altitudes above that of the GPS satellite constellation and transmitted them down to the ground for post-processing. All systems operated nominally during the two-week mission until primary battery power was depleted.

Because a blizzard kept Colorado snowbound, Naval Academy personnel received the first Falcon Gold data. USAFA volunteers who manned the Falcon Gold ground station in Boulder collected subsequent data. The large antenna at the Boulder facility was necessary to collect the faint signals transmitted from the spacecraft, which was over 22,000 miles away. GPS experts at the Aerospace Corporation were able to extract meaningful signal-to-noise measurements from the data making the Falcon Gold mission a complete success! This characterization of the signal environment above the GPS constellation will be extremely useful for future space missions interested in using GPS for navigation in high-altitude orbits.

The technical achievements of Falcon Gold were "icing on the cake" because the mission had already served its primary purpose--to give Academy cadets "real-world" space experience. The legacy of the highly successful Falcon Gold mission will endure for many years to come. Cadets were able to put classroom theory into practice providing them with a truly unforgettable learning experience. Falcon Gold laid the foundation for the Academy's next satellite mission--FalconSat in 1999!



A team of USAFA, UC Boulder, and Cape Canaveral personnel on the launch site. Pictured are (left to right): (front) 2 Lt Kari Agnew, 2 Lt Catherine O'Brien; (middle) 2 Lt Jac Coil, Dr. Ron Humble, Mr. Paul Gross, SSgt Steve Becker; (rear) Mr. Dave Sipple, Capt Brian Mork, Maj Dewey Parker, Mr. Dirk Scheier



The Falcon Gold satellite begins its two-week mission atop an Atlas Centaur.