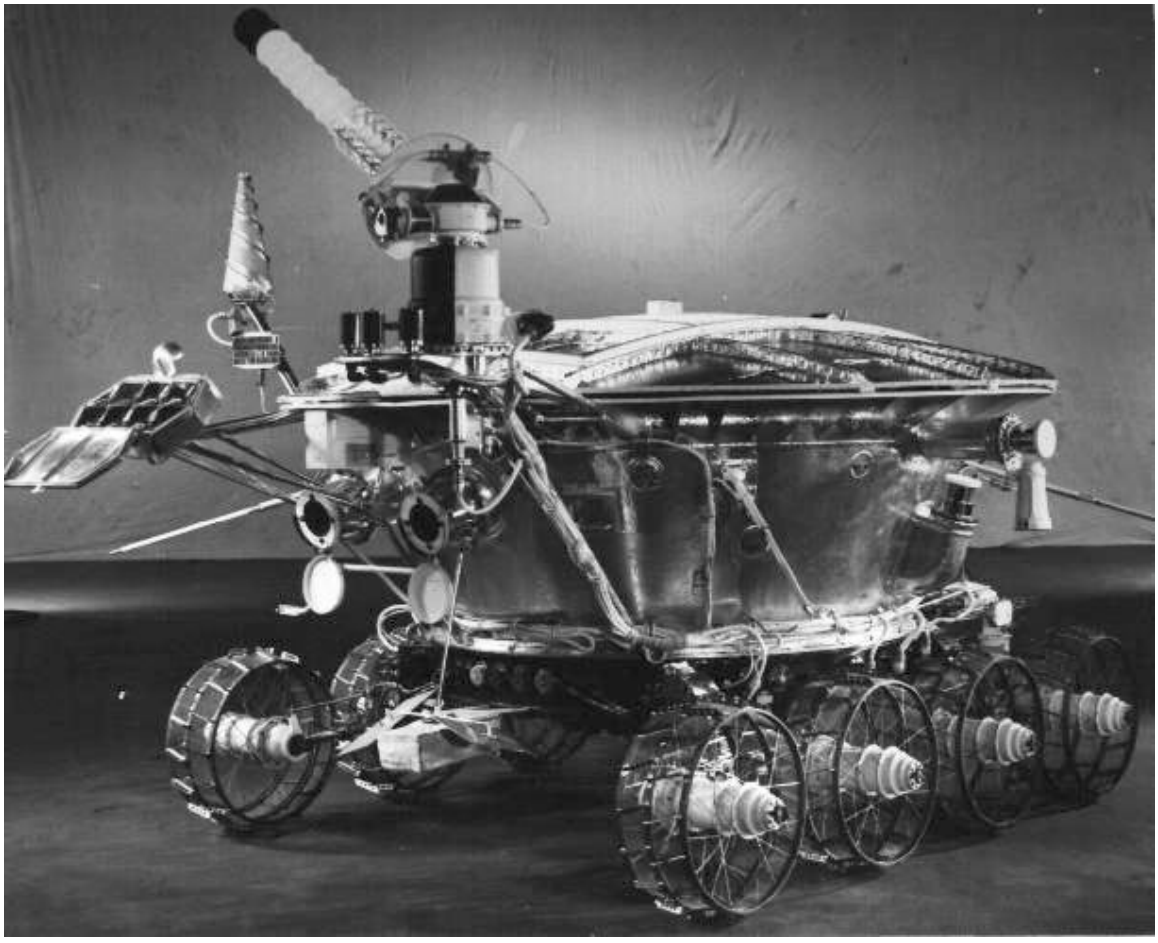
Lunokhod 1
Old Moon Rover Beams Surprising Laser Flashes to Earth

June 3, 2010: A Soviet robot lost on the dusty plains of the Moon for the past 40 years has been found again, and it is returning surprisingly strong laser pulses to Earth.

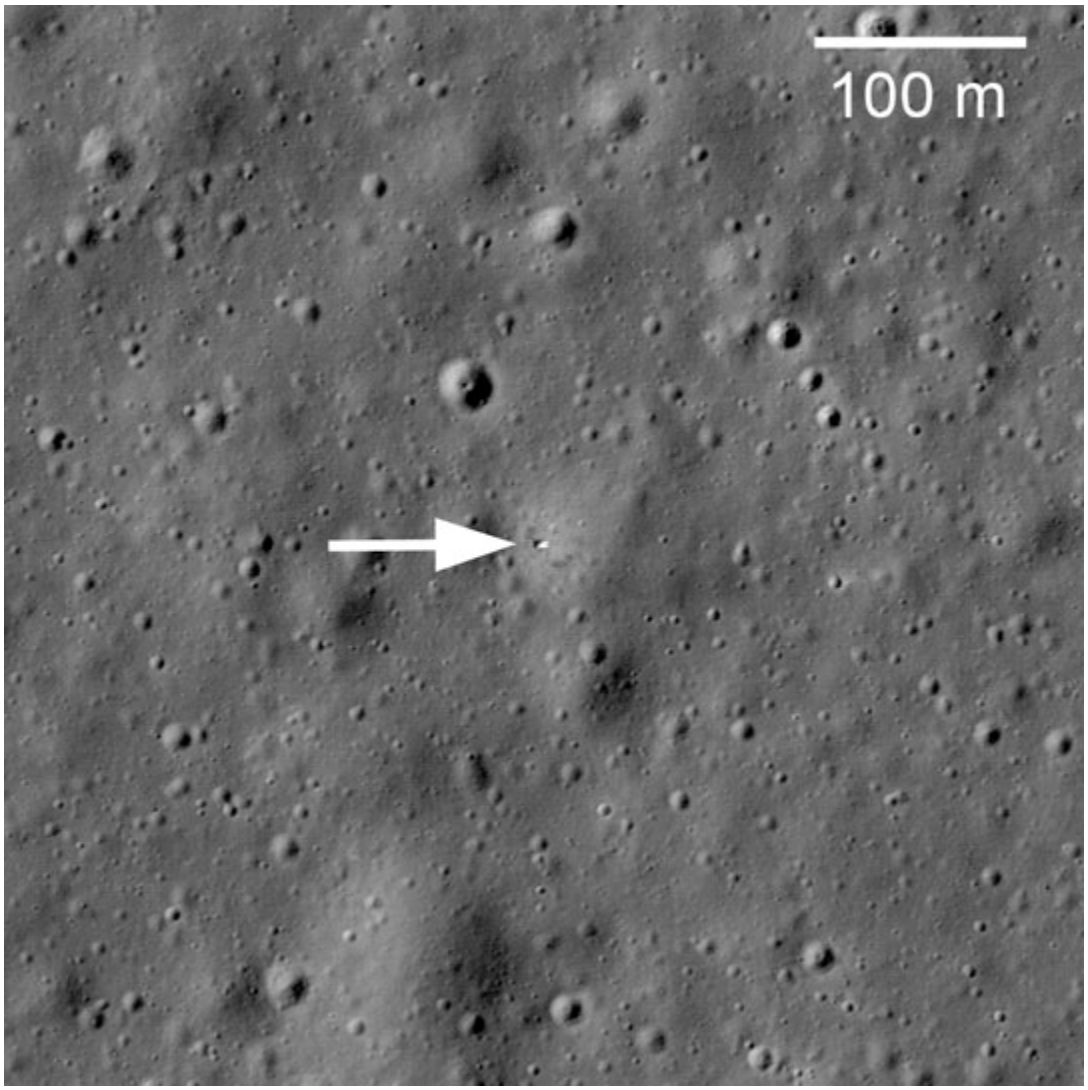
"We shined a laser on Lunokhod 1's position, and we were stunned by the power of the reflection," says Tom Murphy of UC San Diego, who leads the research team that's putting the old robot back to work. "Lunokhod 1 is talking to us loudly and clearly."



Almost forgotten in the lore of the Apollo-era space race, Lunokhod 1 was one of the greatest successes of the old Soviet lunar exploration program. In 1970, *Time* magazine described the robot's historic landing:
"Three hours after reaching the Moon aboard the latest unmanned Russian Moon probe, Luna 17, Lunokhod I (literally "moonwalker") lumbered down one of two ramps extended by the mother ship and moved forward … thus taking the first giant step for robotkind on another celestial body."

The remote-controlled rover traveled almost 7 miles during its 11 month lunar tour, relaying thousands of TV images and hundreds of high-resolution panoramas of the Moon back to Earth. It also sampled and analyzed lunar soil at 500 locations.
Then Lunokhod-1 was lost – until last month when NASA's Lunar Reconnaissance Orbiter found it again.

On April 22, Murphy and his team sent pulses of laser light from the 3.5 meter telescope at the Apache Point Observatory in New Mexico, zeroing in on the target coordinates provided by Lunar Reconnaissance Orbiter. A laser retroreflector on Lunokhod 1 intercepted the pulses and sent a clear signal back to Earth



Soviet robotic lander Luna 17 still sitting on Mare Imbrium where it delivered the Lunokhod 1 Rover in November 1970. Credit: NASA/GSFC/Arizona State University.

Using information provided by NASA’s Lunar Reconnaissance Orbiter (LRO) instrument teams, researchers at the University of California San Diego

successfully pinpointed the location of a long lost light reflector on the lunar surface by bouncing laser signals from Earth to the Russian Lunokhod 1 retroreflector.

The initial imaging of the two Russian rovers, Lunokhod 1 and 2 were made earlier this year by the Lunar Reconnaissance Orbiter Camera (LROC) team, led by Mark Robinson from Arizona State University in Tempe.

“We quickly verified the signal to be real and found it to be surprisingly bright: at least five times brighter than the other Soviet reflector, on the Lunokhod 2 rover, to which we routinely send laser pulses,” said Tom Murphy, an associate professor of physics at the University of California San Diego. “The best signal we’ve seen from Lunokhod 2 in several years of effort is 750 return photons, but we got about 2,000 photons from Lunokhod 1 on our first try. It’s got a lot to say after almost 40 years of silence.”

Since Apollo deployed laser retroreflectors, astronomers have routinely used them track how the moon is slowly moving away from the Earth. This helps scientists develop a better understanding of the processes that are causing this motion, including what’s occurring inside the moon’s core and the tidal motions on the Earth.

The Lunokhod 1 retroreflector was sent aboard the unmanned Luna 17 mission, which landed on the moon Nov. 17, 1970, releasing a robotic rover that roamed the lunar surface.

Murphy said his team had occasionally looked for the Lunokhod 1 retroreflector over the last two years, but had little chance of finding it until the LRO team produced coordinates based on the recent images of the lander and rover that were good to within 100 meters.

“It turns out that our previous best-guess position was miles off,” he said. “We could only search one football-field-sized region at a time, so without LRO, we never would have found it. But with the new coordinates, we found the signal promptly at the very edge of our available window.”

Locating Lunokhod 1 and measuring its exact coordinates is important in furthering our understanding of the moon.

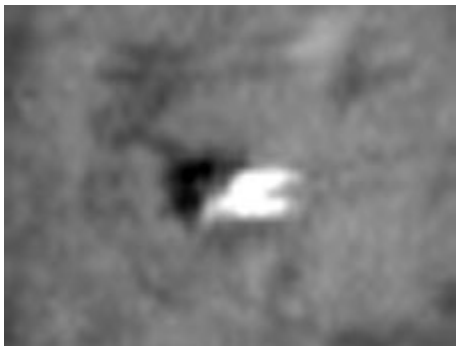
“Getting more than a few photons back from an unknown location at the distance of the moon is quite an achievement. The rediscovery of the Lunokhod-1 retroreflector was made possible by the LRO camera team and by the diligence of Tom Murphy,” said Gregory Neumann, Lunar Orbiter Laser Altimeter team member from NASA Goddard Space Flight Center in Greenbelt, Md. “That we have located it so quickly and ranged to the Lunokhod rover, last heard from Sept. 14, 1971, is a tribute to Tom's team and to the amazing LRO observatory

and instrument teams."

LRO is scheduled for a one-year exploration mission in a polar orbit about 31 miles above the lunar surface. During this time, LRO will acquire information for a new comprehensive map of the lunar surface in unprecedented detail, search for resources and potential safe landing sites for a potential future return to the moon and measure lunar temperatures and radiation levels.

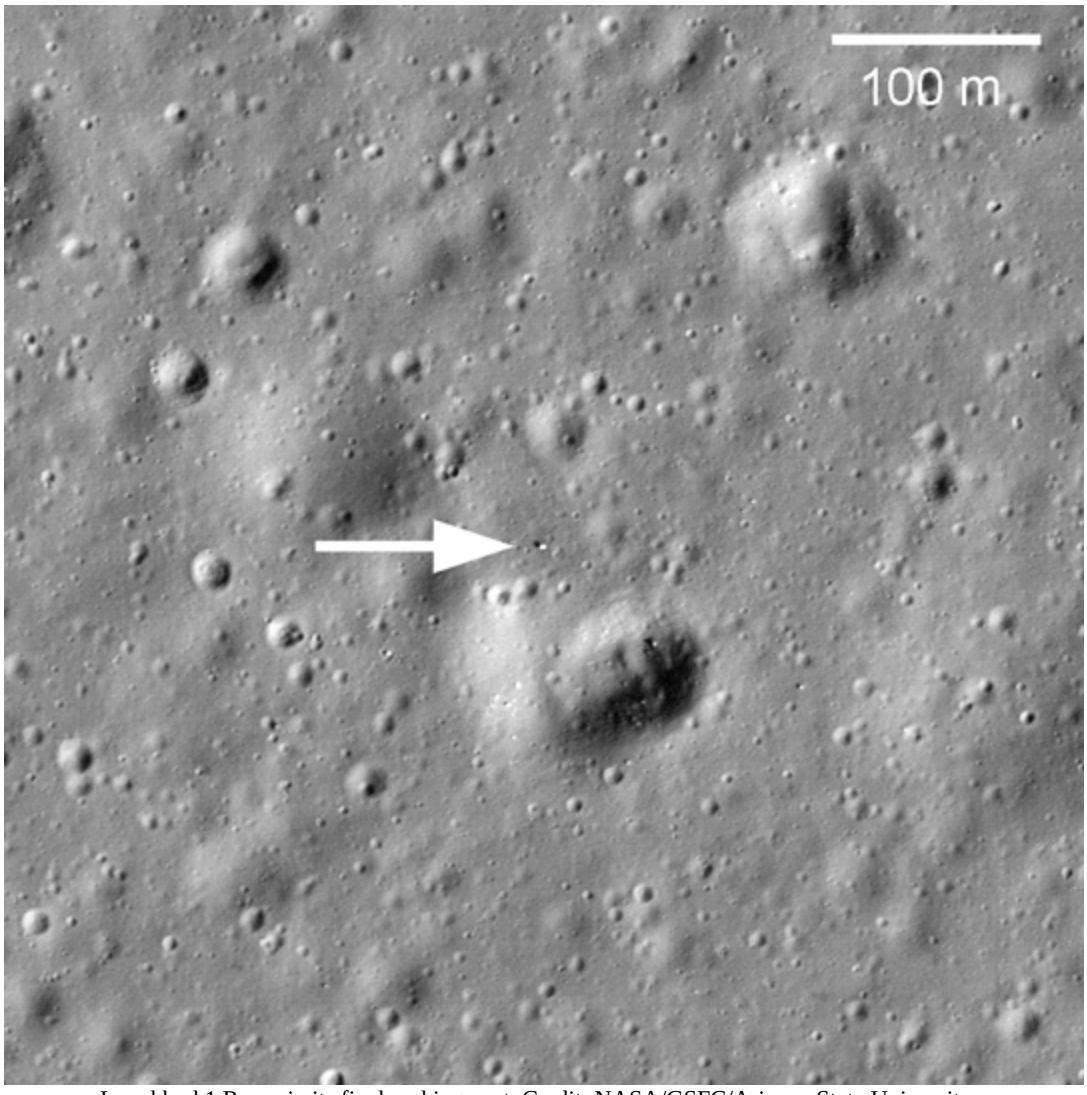
LRO will move into its science phase in September, when the program management responsibility moves from the Exploration Systems Mission Directorate to the Science Mission Directorate at NASA Headquarters. LRO will continue to map the moon for two additional years during its science phase with the possibility of two more years of observation following that.

NASA's Goddard Space Flight Center built and manages the mission for the Exploration Systems Mission Directorate at NASA Headquarters in Washington. The Institute for Space Research, Moscow, provides the neutron detector aboard the spacecraft.



Enlargement of Luna 17 lander, note the Lunokhod 1 tracks starting at the ramp and circling the lander. Credit: NASA/GSFC/Arizona State University.

Two years later (January 1973) Luna 21 landed in Le Monnier crater, delivering an upgraded Lunokhod 2. It sported higher resolution cameras and an improved scientific payload. Like its predecessor, it was driven by engineers on Earth during the day, and parked at night. Lunokhod 2 explored the Moon for about four months. Unfortunately, the mission was brought to an early end due to overheating, perhaps when soil got on the rover and covered key components.



Lunokhod 1 Rover in its final parking spot. Credit: NASA/GSFC/Arizona State University

The two Lunokhods showed the value of robotic explorers on the surface of another world. It would be another 24 years before the next robotic rover, Sojourner, drove on another world - this time Mars. The next lunar rover, 40 years later, is scheduled for 2013, a joint venture between India and Russia.

Recently the LROC Science Operations Center received an unexpected visitor - Ruslan Kuzmin. He was one of the scientists who had actually participated in the Lunokhod missions! We were able to show him LROC pictures of the hardware on the surface and he was gracious enough to write down some of his thoughts upon seeing his "old friends".

“Thank you very much for showing me the excellent LROC images of the Lander platform from “Luna-21”, as well as the robotic lunar rover “Lunokhod-2” in its last and eternal parking place after a 37-km, 4 month journey of research.

To see the images with Lunokhod-2 and its tracks on the lunar surface is a very special feeling for me. In the time of the Lunokhod-2 operation, I was a young planetologist who was participating in the mission, and I analyzed the images received by the rover's TV- cameras. In actual fact, this was the first successful mission in which I was involved. It was 37 years ago (in the last century!) when the Lunokhod-2 traveled for four months within the crater Le-Monier at the eastern edge of the Mare Serenitatis.

While looking at LROC images of the Lunokhod-2 rover, I felt a deep interior excitement due to the welled up memories of the earliest "pages" of my science career. It is very exciting that the Lunokhod-2, as well as many other American and Soviet Union Landers, which operated many tens of years ago, now might be imaged by LROC so clearly, and viewed by millions of people around the world. The LRO camera is without any doubt a really fantastic instrument that simultaneously brings our eyes close to the lunar surface, while reminding us of pioneering results from historical missions.