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Targeting the Moon: Observatories Gear Up for Friday Lunar Crash

By Leonard David

Scientists are hoping for a literal slam dunk with NASA's upcoming Lunar Crater Observation and Sensing Satellite, or LCROSS mission — an event to be observed by a coordinated network of Earth and space-based equipment.

LCROSS will search for water ice on the moon on Friday morning by crashing its spent upper-stage Centaur rocket into Cabeus, a permanently sunlight-shy crater within the lunar south pole region. The impact is set for 7:30 a.m. EDT (1130 GMT).

That Centaur will serve as a heavy impactor on the moon, with scientists hoping a resulting debris plume will ascend above the moon's landscape. The intent is to toss tons of debris and potentially water ice and vapor high above the lunar surface.

As part of the LCROSS mission, along with the upper stage's "bang-up" job, a Shepherding Spacecraft will follow a similar trajectory of the Centaur, flying through and studying the Centaur impact plume before it too speeds into the lunar terrain.

Ground-based professionals and amateur sky watchers are anxiously awaiting the impact day, ready to observe the dust and water vapor cloud caused by the impacts into the lunar surface.

A best guess is that the larger of the two, the Centaur impact plume, could become about 12 miles (20 km) wide and reach some 5 to 9 miles (8-15 km) in altitude above the moon for the brightest part of the event — which is what amateur observers might expect to be able to see.

The cloud of lunar material is expected to be bright at first, as soon as it rises into sunlight, but will fade in brightness quickly as it grows in altitude.

Citizen science

"This may be the largest event that's been observed for a NASA mission in recent memory," said Jennifer Heldmann, lead for the LCROSS Observation Campaign at NASA's Ames Research Center at Moffett Field, California.

Ames is overseeing the development of the LCROSS mission with its spacecraft builder and integration partner, Northrop Grumman of Redondo Beach, California.

Heldmann's job includes coordinating not only amateur programs, but also those being planned at professional observatories.

"From west of the Mississippi all the way out to Hawaii is in prime viewing conditions. You only need a ten to 12-inch telescope. So it's a really good opportunity for a lot of people to be involved," Heldmann told *SPACE.com*.

"We're asking anyone who observes the impact to upload their data to us," said Heldmann. The public can contribute via the LCROSS Citizen Science Web site. NASA will broadcast the impact live on NASA TV beginning at 6:30 a.m. EDT (1030 GMT).

The pick of the Cabeus crater is a good one, Heldmann noted. "There's a shadow that is cast behind where the impact plume will be. So there's a nice contrast between where the plume will be coming up...and then the background of this dark shadow."

That final resting site for the LCROSS mission hardware was driven by data.

Information from NASA's now on-the-job Lunar Reconnaissance Orbiter (LRO) — as well as older data from the space agency's Lunar Prospector that circled the moon in 1998-1999 — have been correlated, showing that there's a "significant concentration" of hydrogen in Cabeus, Heldmann said.

LRO radar data — not all yet publicly released — played into the LCROSS impact site selection, Heldmann said. That choice was also bolstered by science output from other lunar orbiters: India's Chandrayaan-1 and Japan's Kaguya.

"All in all...it seemed to be the place to go," Heldmann explained.

Ring side seat

A fleet of Earth-orbiting satellites is at the ready to take a distant look at the collision, including the Hubble Space Telescope; Odin, an international astronomy and aeronomy mission led by Sweden, with Canada, France, and Finland as partners; the U.S. Missile Defense Agency's Near Field Infrared Experiment (NFIRE) satellite; NASA's Earth Observing-1 satellite; as well as the commercial Ikonos and GeoEye-1 remote sensing satellites.

Heldmann said that the Earth-watching spacecraft regularly use the moon for calibration purposes.

"So since they look at the moon anyway, they're able to collect some data. We've been helping them plan out their observations...when they should time their exposures. It's working out quite well with the Earth observing satellites and the LCROSS mission," Heldmann said.

But for on-the-spot viewing, you can't beat NASA's Lunar Reconnaissance Orbiter (LRO). It's got a true ring-side seat of the LCROSS event.

Shadow imaging

LRO is ready for LCROSS, said Mark Robinson of Arizona State University's School of Earth and Space Exploration in Tempe, Arizona. He is principal investigator of the ultra-powerful Lunar Reconnaissance Orbiter Camera, or LROC for short.

Robinson said that LRO will fly perpendicularly past the impact site about 60 seconds after LCROSS hits.

That post-impact look-see will allow LRO's Lyman-Alpha Mapping Project (LAMP) to scrutinize the plume growth. LAMP, built and developed at the Southwest Research Institute in San Antonio, is designed to search for surface ice and frost in the polar regions of the moon and provide images of permanently shadowed regions illuminated only by starlight and the glow of interplanetary hydrogen emission.

LAMP will attempt to measure spectra of the growing plume just after the impact.

The orbiter won't fly directly over the impact, but off to the side, Robinson told *SPACE.com*. LRO will slew a little over 80 degrees off to the side making sure the LAMP gear is taking in a view just above the lunar horizon, thus able to see the plume against the background of space.

Additionally, LRO's Miniature Radio Frequency (Mini-RF) radar is to image the impact point both before and after the impact, but not during.

Robinson added that LROC will attempt shadow imaging with long exposures the day before the impact as the spacecraft passes over the site. An attempt will also be made after the impact.

If LCROSS impacts in a single shadowed region, LROC might find the impact crater. "In a double-shadowed region all bets are off," Robinson said.

The reason is that single shadow areas receive sunlight bounced off a crater wall sticking into the light. A double shadowed area only receives light from two bounces — for example, the interior of a small crater that is entirely inside a larger shadowed crater, Robinson added.

Going-in plan

Could LCROSS come up dry in the sense of running into lunar water ice?

"Whatever answer we get back, if we see ice or we don't, is going to be significant," said NASA's Heldmann. Seeing ice, she continued, will enable scientists to start quantifying the material, to agree on how much is resident within the crash zone.

Not detecting the material means there's no ice in the impact spot?

"So either it's not there...or there's some patchiness and spottiness to it...if it is indeed there," Heldmann added. "We're going to learn a lot no matter what results are obtained."

On impact day, the science operations center at NASA's Ames Research Center will be a busy hub, given the expected onslaught of incoming data. Within two-and-a-half hours post-impact, a press conference at Ames Research Center will be held making use of mostly ground-based observations. Accumulating the data gleaned by moon-watching spacecraft will take longer.

The LCROSS Shepherding Spacecraft is collecting data continuously during its plunge though the plume and transmitting it back to Earth before its own demise.

Overall, observations in the near infrared, such as those made by the Infrared Telescope Facility and Keck telescope in Hawaii, are expected to provide quick look and learn findings about any subliming water vapor in the LCROSS ejecta curtain.

There's a large cadre of professional astronomers using many of the Earth's most capable observatories is helping maximize the scientific return from the LCROSS impacts, including the Magdalena Ridge and Apache Ridge Observatories in New Mexico and the MMT Observatory in Arizona.

For Heldmann, she's prepared for impact day...ready to scan and span the spectrum of data to be gathered.

"It has been a lot of work for four minutes of data...but it's a really important four minutes of data," Heldmann said. "Hopefully, we'll have a variety of data sets that we can combine and make a coherent story. That's the going-in plan."

Leonard David has been reporting on the space industry for more than four decades. He is past editor-in-chief of the National Space Society's Ad Astra and Space World magazines and has written for SPACE.com since 1999.