Photo finish
NEW DIGITAL CAMERAS MAKE IMAGE CAPTURE SWIFTER AND EASIER AT ARNOLD AIR FORCE BASE BALLISTICS RANGE
Until recently, obtaining new parts for the laser camera system at AEDC’s Hypervelocity Ballistic Range G was a lot like antique shopping. In a time when it is difficult to buy a new camera that is not digital, workers at Range G have been stretching their resources to keep their film-based camera equipment viable.

But now, after six years of planning, they have a new digital system that brings them into the 21st century and makes the process of capturing high-velocity images more user-friendly, both for them and for the base’s test customers.

The digital system is more of a necessity than a luxury, according to instrumentation engineer Ed Erickson: “The cameras had been around for about 40 years, and the system as it existed up until now was around for about 20 years,” he says. “Needless to say, spare parts aren’t available for it anymore.”

Range G is used to conduct kinetic energy lethality and impact phenomenology tests. Its two-stage gas-gun launcher is the largest in the USA, firing projectiles down a 950ft long instrumented tank.

Impact tests
Impact testing and examining aerodynamic features of projectiles are primary functions of the tunnel and it is important to have a camera capable of capturing an image as the projectile flies by.

Erickson began looking for funding to implement a new system in 2005, which was the last chance he had to purchase spare parts for the old system. The man who made the illumination lamps for the laser system was retiring, so Erickson stocked up with as many as he could get. The ruby laser used in the system is no longer available, and there is only one remaining source of the image intensifiers used to achieve a sharper image in the old cameras.

The previous system was a box-shaped film camera. Because projectiles fired through the tank travel as fast as 18,000ft a second – six times faster than a bullet – a flashbulb is not capable of illuminating the tunnel for a photo. A laser is used instead.

The ruby laser employed in the old system sat inside a custom high-intensity lamp, which had a water cooling system and a 20,000V power supply. The old rig was the size of a steamer trunk, and because of the way it was built, a series of mirrors had to reflect the laser beam from one side of the box into the tank. If a customer wanted a photograph from a different section of the tank, it could take a full day to reposition the camera.

By contrast, the three new camera and laser systems are only about the size of a briefcase, with the laser capable of firing directly into the tank. If it needs to be moved, the new system
can be repositioned and operational in about two hours. "Previously, I'd tell Ed or some of the other folks I wanted to move the laser camera," says project engineer David Woods. "They'd look down and they'd just start shaking their heads. Now, it's not so bad."

The new systems are "everything we need in a compact package," according to Erickson. They consist of a Dicam Pro camera made by the Cooke Corporation and a Quantel Laser CFR200; both off-the-shelf commercial items that have easy-to-replace parts. The only part that was built in-house is the triggering system.

"We chose a YAG (yttrium aluminum garnet) laser because they're common and relatively inexpensive," says Erickson. "The camera is sensitive to the same wavelength of light that the laser puts out, so the selection of one drove the specification of the other."

**Instant imaging**

The digital imaging system is also faster than the previous film system, according to Erickson. They have a photo of the projectile upstairs from the range as soon as the camera snaps the picture and stores it. It enables instant viewing rather than having to wait hours for the chance to go into the facility and physically retrieve the film.

"When they fire the launcher, carbon monoxide is generated," says Erickson. "Hydrogen could leak out of the tank. They have to take steps to purge the tank and make the downstairs safe for a person to re-enter. So it takes about an hour and a half to two hours before the service tunnel is ready for entry. Then it would take another half hour to develop the film."

Once the film was developed, negatives were placed between plates of glass and projected onto a large table. Datapoints were digitized into a software program that outputs a list of coordinates. Those points were fed into yet another data reduction program. The new system speeds that process. "Because this is digital, we can use software with our data reduction to help us," explains Rick Rushing, the Air Force's ballistics range lead at AEDC. "It's more efficient."

Woods likes another aspect of the digital system: it eliminates the possibility that the film could be accidentally dropped or exposed to light, destroying the data. "The thing I like about this system is as soon as it's done, it immediately gets transferred into memory and saved, and we don't have to worry about what happens if there are extenuating circumstances," he says. "We have our data."

Laser photography expands the capabilities of the ballistics range at AEDC. It can be used to determine erosion data and the recession rate of a projectile. Images captured at every photography station could be colorized and overlaid to determine changes at the stations when a projectile is fired through dust, rain, or ice. It can also be used in lethality testing to capture the first touch of a projectile on a target.

"Back when we had the old TV-based, quicklook camera, it gave the customer a good indication that things hadn't gone too terribly awry," recalls Woods. "After they saw that their model was still intact, the first thing they always asked was 'Where is it and what angles is it at?' The next thing you know, people are boldly protractors up against the TV and trying to find good reference lines."

"With this system, as soon as we get two images of the same field-of-view saved, we've already done the calibration, so we can throw it into the software and draw a line between two points to get the pitch, the yaw, and how far it is from the center line."

**Customer test**

The range cameras are ready to go; their readiness was confirmed by a final check-out recently. A customer test is lined up for October. By then, Range G workers may be able to use their equipment to measure the attitude and position of a projectile within a 3D field-of-view. That will allow them to look at aerodynamic stability information and determine hit point for lethality customers.

"I expect that as we continue to move forward with using these things on our test shots, we will continue to improve," says Woods. "These images are pretty good, but there are some things I'd like to see more clearly, and that's just the sort of thing that's going to come with time as we continue to use the systems."

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