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Campus Report May 31, 2007

University of Dayton, Ohio (url: http://www.udayton.edu/index.php)

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05.31.2007 | Research, Science, Campus and Community The UD Research Institute houses the fastest light-gas gun in the world, designed for one purpose – to help save lives.

"Reach for it!"

In the second it takes to say those words, the fastest gun in the Midwest – and the world, for that matter – could propel a small aluminum sphere more than five and one-half miles. Make that the fastest light-gas gun in the world, a 45-foot-long, triple-barrel, gunpowder and hydrogen-powered shooter designed for one purpose – to help save lives.

Birdstrike_1 The gun is housed at the University of Dayton Research Institute's Impact Physics Lab, and is one of several launchers at the lab used to evaluate the impact-effect of fast-moving projectiles on a variety of materials and structures. Researchers recently used it to break the world record for shooting an aluminum sphere at hypervelocity speed without vaporizing, liquefying or otherwise disintegrating the slug.

The ability to launch "mini-missiles" to 5.5 miles per second – nearly 20,000 miles per hour – is critical to helping scientists understand the extent of damage that can be incurred by vehicles in space that collide with orbital debris. This understanding can assist in the design of shields and materials better suited to withstand the potentially devastating damage that even a BB-sized pellet can inflict when flying at orbital speeds.

The need for impact testing is becoming more critical as concerns grow about the amount of "space junk" now orbiting the earth, said Kevin Poormon, a senior research engineer and group leader for impact physics at UDRI. In addition to the meteoroids and other natural objects that pose a collision threat to spacecraft, NASA and other world space officials now estimate the number of pieces of man-made debris – from nuts, bolts and rocket parts to defunct satellites – to be in the tens of millions, Poormon said.

"NASA is now tracking about 11,000 objects greater than the size of a baseball. But their real concern lies with what they don't track – objects down to one centimeter or less in diameter. At orbital 'encounter speed' – the speed at which two objects in space meet head on – a pea-sized particle can rip a hole through two inches of aluminum. The concern is that it's only a matter of time before a piece of space junk collides with a shuttle, a functioning satellite, or the International Space Station."

Impact physics engineer Andy Piekutowski recalls a NASA-sponsored report following the explosion of space shuttle Columbia that called for controlled impact studies at speeds greater than 8 kilometers per second. "But the technology to do that didn't exist," Piekutowski said. "Several years ago, we were able to shoot a nylon slug at about 8.6 kilometers per second, but the gun suffered significant swelling and erosion during the tests. Replacing the nylon slug with a heavier aluminum sphere, which has about the same density as orbital debris, would have caused even more damage to the gun."

Piekutowski set about modifying the gun and loading parameters and, as adjustments continued, tests became more successful. This spring, the researchers recorded a successful shot of a small aluminum sphere at 9.08 kilometers per second. "We've developed the technology to not only launch projectiles at orbital speeds, but with zero to minimal damage to the gun."

Poormon said he is aware of techniques that use a shaped-charge device, a magnetic field pulse, or shock acceleration to propel small aluminum discs at more than 11 kilometers per second, but those methods are used primarily in tests related to energy, material studies and planet formation rather than impact damage. "At those speeds, the projectile deforms or liquefies before it hits its target, or the projectile and target are obliterated together on impact so there's no way to study target damage," he said. "In our tests, even at orbital speed, the projectile is exactly the same shape and weight when it hits its target as when it's loaded into the gun, and the target, while damaged, is not destroyed. That allows us to conduct highly controlled tests to determine exactly what happens to a shield or structure when it is hit by a specific object at a specific speed, giving us truly measurable damage information."

UDRI's 20,000-square foot indoor impact physics lab is the largest private facility of its type in the United States and has long been considered by peers as one of the top impact test labs in the world. It houses 12 gun ranges capable of launching objects

as small as a grain of sand for foreign object damage research to as large as an eight-pound goose that could strike an aircraft in flight.

“Everything we do in the lab is about protecting people,” Poormon said. “We’ve launched hail and birds at aircraft structures and have participated in the development of a number of birdstrike-resistant canopies for Air Force jets to save pilot lives – technology that has also been transitioned to commercial aircraft. We’ve launched flight data recorders – popularly know as ‘black boxes’ – to test their impact shock resistance, and pieces of turbine engine blades to see if they can penetrate their protective cases. We’re shooting materials for military vehicle and body armor designed to shield our soldiers, as well as police and others who need protection. Everything we do is designed to help keep people safe.”