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# AFRL helmet strap reduces risk of injuries

***by John Schutte, AFRL Human Effectiveness Directorate***

*WRIGHT-PATTERSON AIR FORCE BASE, Ohio* — Engineers at the Air Force Research Laboratory are taking a proactive approach to reduce risks associated with a flight helmet chin-strap system.

AFRL's biomedical engineers in the Human Effectiveness Directorate are working with the Air Force Human Systems Group and helmet manufacturer Gentex Corp. of Carbondale, Pa., to design and test a break-away version of Gentex's integrated chin-nape strap. The breakaway strap's metal buckle is designed to separate at a predetermined force level to minimize stress on a pilot's neck during a high-speed ejection.

Researchers want to ensure flight helmets provide head protection and a stable platform for helmet-mounted equipment but also reduce the risk for serious neck injuries when an escaping crewmember blasts into the air stream surrounding the aircraft.

"There is a delicate balance to keeping the helmet secure on the crewmember to protect his or her head against blunt trauma and releasing the helmet strap prior to inducing severe neck injury," said Dr. Joseph Pellettiere, technical consultant for AFRL's Human Effectiveness Directorate, Biosciences and Protection Division, Biomechanics Branch. "We are working to be proactive and prevent injuries from occurring, even before they show up as a problem to crewmembers, so looking at the current situation, we began working a solution before helmet-mediated neck injuries become a problem for the Air Force."

***Helmet continued on page 3***

*This high-speed camera image captures the moment that the helmet strap's buckle separates during a breakaway chin-nape strap test at the Air Force Research Laboratory. Helmet designers notched the strap's aluminum buckle to provide a breakaway point that lets the strap separate at a predetermined force level to minimize stress on a pilot's neck during a high-speed ejection. (Air Force photo by Delane Bullman)*

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## AFRL signs educational partnership for research of micro air vehicles

***by Rex Swenson, AFRL Munitions Directorate***

*EGLIN AIR FORCE BASE, Fla.* —Two local organizations specializing in education and technology came together recently with the hope for a successful collaboration in the future.

The Air Force Research Laboratory Munitions Directorate and the University of Florida Research and Engineering Education Facility joined forces with the signing of an educational partnership agreement (EPA).

"The objective of this agreement is to enhance our joint research capability by providing personnel from our flight vehicles integration branch with dedicated workspace at the REEF (Research and Engineering Education Facility)," said Dr. John Pletcher, Munitions Directorate, associate director.

The education partnership agreements are designed to allow the director of the research laboratory to enter into a partnership with an educational institution to encourage and enhance study in scientific disciplines at all levels of education.

"This EPA is the foundation for a cooperative in-house research program focused on basic and applied research for micro air vehicles," said Capt. Chris Miser, Munitions Directorate, flight vehicles integration branch.

Other added benefits of the EPA are increased awareness of the University of Florida-REEF facilities and educational programs among Air Force personnel and promoting the education of future scientists and engineers. **@**

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# Dual-mirror laser relay system being readied for testing

***by Eva D. Blaylock, AFRL Directed Energy Directorate***

*KIRTLAND AIR FORCE BASE, N.M.* — A dual-mirror laser relay system is being prepared for field-testing after achieving a milestone by completing a successful formal review of its laboratory tests.

The system, called the Aerospace Relay Mirror System, is a prototype designed to take a ground-based or airborne high-energy laser and redirect the beam onto a target, increasing the range of that laser. One concept involves suspending the system from a high-altitude airship at an altitude of 70,000 feet, where atmospheric turbulence or jitter is less of a problem for beam quality.

The concept for the system was developed at the Air Force Research Laboratory's Directed Energy Directorate beginning with research conducted in the 1980's. As part of a laboratory test data review in August 2005, the payload performed several tracking and pointing maneuvers for directorate leadership and invited dignitaries. Following its success, the payload used in the review is being disassembled and taken to the directorate's Starfire Optical Range here where it will undergo simulation testing.

This field-test system includes two 29-inch mirrors, one that would work as a receiver, collecting the beam and transmitting the laser light through a beam control system to a second mirror. The beam control system will use advanced optics technology and techniques to compensate for any beam distortion or turbulence in the air. The second mirror would be used to redirect the light at a target.

Field tests will use a crane to simulate the high altitude airship. Laser light will be directed into the mirror system suspended from the crane and redirected with the beam control manipulation onto a set of targets at the test site. Though the final system is planned for high-energy lasers, the testing will use relatively low-powered lasers. @

*A mirror, lower left, receives a beam of laser energy and relays that energy to the mirror above, which then directs the light out to destroy a ballistic missile. This artist concept depicts how an Aerospace Relay Mirror System, hanging from a high-altitude airship, might be used to extend the range of a laser to destroy targets. AFRL's Directed Energy Directorate recently completed a successful formal review of its laboratory testing and is now preparing to field test a dual-mirrored system.*

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## *Helmet continued from page 1*

The Air Force is taking a second look at its recently redesigned integrated chin-nape strap, a continuous piece of nylon webbing that is threaded through the helmet and around both the front (chin) and rear (nape) of the pilot's head. It was originally designed to make the helmet more stable when front-mounted equipment, such as night-vision goggles and cueing devices, is attached.

"The integrated chin-nape strap was created when the Air Force added all the weight up front from all the new helmet-mounted systems, which are frontally loaded," said Erica Doczy, biomedical engineer with the biomechanics branch. "The integrated chin-nape strap did a better job of holding the helmet stable."

During a high-speed ejection, the helmet can act as a drag chute — particularly if the helmet visor is not in place — catching the initial windblast that can reach more than 520 mph (450 knots equivalent air speed), a speed at which a crewmember's neck can be stressed. At 575 mph (500 KEAS) and above, which is defined as "high-speed ejection," the potential for significant neck injury exists.

"There is no guarantee that during ejection the helmet will inflict these high tensile loads on the pilot's neck," Ms. Doczy said, "but in that dynamic environment it is a possibility, and if or when that happens we'll have a strap that can prevent serious neck injuries from occurring."

The previous two-piece chin-nape strap design separated during high windblast forces but was not sufficiently stable to support the frontal loads related to extra helmet-mounted equipment, said Mr. Brian Grattan, mechanical technician with General Dynamics and life support specialist for the program.

Now engineers are using their tensile loading criteria to pinpoint the load range in which the strap should release to provide the highest margin of safety during high-speed ejections. Two small notches specially positioned in the strap's metal buckle provide a breakaway point in the strap system. @

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# AFRL's scramjet engine gears up for flight tests

***by Karen Y. Jackson, AFRL Public Affairs***

*WRIGHT-PATTERSON AIR FORCE BASE, Ohio* — Pentagon officials have officially designated the Air Force Research Laboratory's scramjet engine as the X-51A test vehicle, joining the ranks of experimental X-planes. The designation opens the door for researchers to flight test the revolutionary hypersonic engine, which has undergone extensive ground demonstrations.

"X-51A will explore powered atmospheric flight at speeds in excess of five times the speed of sound, in the so-called 'hypersonic' regime," said Air Force Chief Scientist Dr. Mark Lewis. He believes the X-51A program will build on decades of evolutionary research. "It will produce truly revolutionary capabilities, including high-speed weapons and new approaches for responsive space launch, but, for the first time, with a focus on practicality, including fuels, deployment, and concept of operations," Dr. Lewis said.

The development of the scramjet is critical to the evolution of hypersonic propulsion technology as it strives to develop revolutionary capabilities to warfighters. Hypersonic propulsion is an enabling technology for several potential systems such asreusable space lift vehicles and military weapons, which can be used to defeat time-critical targets at long ranges with a much faster response to adversary activities.

Although the scramjet testing is not complete, efforts are already underway to expand the scramjet technology base to establish scaling laws for larger scramjets, expand the operating envelope, and extend durability for reusable applications.

According to Robert Mercier, deputy for technology with AFRL's Propulsion Directorate, Aerospace Propulsion Division, hypersonics is the next great frontier in aeronautics. "When the X-51 flies, we will cross the threshold of that next frontier. With hypersonic cruise missiles, we could defeat time-critical targets from beyond the enemy's border with impunity. By combining hypersonic air-breathing propulsion with reusable rockets and high speed turbine engines, we could develop affordable on-demand access to space that would support military operations tempos."

During the X-51A flight tests, scheduled for December 2008 and January 2009, five to eight scramjet-powered free-flying vehicles will be launched from Edwards Air Force Base, Calif. According to Charles Brink, the directorate's scramjet engine demonstrator program manager, the X-51A will be dropped from a B-52 flying at 530 mph at 45,000 feet altitude and accelerated by a rocket booster to about five times the speed of sound. Then, the scramjet will accelerate the 16-foot long, 1,000 pound free-flying air vehicle to flight speeds between Mach 6 and Mach 7 (4,000 to 4,600 mph). Engineers hope the testing will demonstrate that the scramjet is operable and viable to propel a free-flying vehicle. Testing will also validate the computational codes and predictive tools used in scramjet development. The test-flight vehicle and engine will plunge into the ocean after the mission is complete.

"We are aiming for 600 nautical miles in 10 minutes or an average speed at Mach 6. We will have enough fuel and battery power to guarantee flight for five minutes and then after that, we will try to control it as best we can," Mr. Brink said.

If the scramjet performs the way creators believe it can, the X-51A program will set the foundation for several hypersonic applications including access-to-space.

Although Mr. Brink is amazed at the potential for the future of hypersonic systems, he has one goal. "A weapon might be a really neat thing that comes out of this, but what we are ultimately trying to do is get reusable, much more efficient propulsion for easier space access," he said.

To date, engineers have relied on ground testing facilities to obtain most of its data on scramjets, but because of limitations, researchers say real flight tests are essential and critical to future developments.

"Many of our designs were built based on the data collected during ground testing. Because many of our ground testing facilities are imperfect, this data represents approximations. These flight tests will confirm just how well the ground testing data relates to flight," Mr. Mercier said.

Other limitations include the researchers' ability to test only at fixed Mach numbers. Nozzles are built to provide the conditions for fixed Mach numbers and don't take into account increases in Mach numbers. Lack of time and adequate ground testing facilities are other limitations researchers face. There are only a handful of available ground test facilities and researchers have less than a few minutes at best to collect data and complete testing.

Getting good in-flight data could save the Air Force a lot of time and resources. "If we find that our ground testing data is supported and verified by the in-flight testing, then we do nit have to spend a lot of resources on flight tests in the future," Mr. Brink said.

This technology has been a long time in the making. The Air Force has been working on hypersonic flight since it replaced the National Aerospace Plane program in 1995 to help maintain aggressive developments in hypersonic technology.

For the past 10 years, AFRL's Propulsion Directorate has used a building block approach. "We worked on inlets, combustions, nozzles, fuel-cooled systems and structural components like uncooled, leading edges and fuel-cooled structures to keep the engine cool," Mr. Mercier said.

The Scramjet Demonstrator Program, jointly funded by AFRL and the Defense Advanced Research Projects Agency, is a $212 million project.

Mr. Brink hopes the project will meet critical design review in January 2007. The scramjets are being built and designed by a consortium of companies that include Pratt & Whitney, Rocketdyne and Boeing Co. **@**

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# President Bush honors AFRL member for voluntary service

***by Michael P. Kleiman, AFRL Space Vehicles Directorate***

*KIRTLAND AIR FORCE BASE, N.M.* — President Bush arrived in Albuquerque, N.M., Feb. 2, to present the President's Volunteer Service Award to Air Force Research Laboratory member Mike Martin.

Mr. Martin, a cryogenic technician in AFRL's Space Vehicles Directorate, Spacecraft Technology Division, earned the presidential recognition for his volunteerism at the STARBASE La Luz Academy. The Department of Defense education outreach program is sponsored by the AFRL's Space Vehicles and Directed Energy Directorates, located at Kirtland Air Force Base. The program encourages youth in elementary through secondary grades throughout the state to pursue careers as scientists and engineers.

*President Bush presented the President's Volunteer Service Award to Mike Martin from AFRL's Space Vehicles Directorate, Kirtland Air Force Base, N.M. Mr. Martin received the honor for his volunteerism at the STARBASE La Luz Academy, a Department of Defense education outreach program, sponsored by the AFRL's Space Vehicles and Directed Energy Directorates. (Air Force photo by Todd Berenger)*

Over the past three years, Mr. Martin, a contract employee with Applied Technology Associates, Albuquerque, has volunteered hundreds of hours instructing hands-on advanced science classes to elementary students participating in the educational facility's Providing Engineering and Technology Experiences for Students program. Four years prior to that, he served as a STARBASE review mentor for high school participants designing and implementing research projects for the Students Planning and Conducting Engineering Flight program.

"I have volunteered with the STARBASE La Luz Academy, because I enjoy teaching youth about science and also to the fact that I love to see their faces light up when presented with information that they thought never existed," Mr. Martin said.

"The STARBASE La Luz Academy is something I believe is very important to the community, as we need to focus more on math and the sciences. We really need to push it," Mr. Martin said.

In an effort to have all Americans make a difference in their communities through volunteerism, President Bush created USA Freedom Corps, an Office of the White House, in 2002 to strengthen and expand volunteer service.

Mr. Martin is one of about 460 people that have been personally thanked by President Bush for making a difference in other's lives. Created at the President's direction by the President's Council on Service and Civic Participation, the honor is available to youth ages 14 and under who have achieved 50 or more hours of volunteer service; to individuals 15 and older who have accomplished 100 or more hours; and to families or groups who have completed 200 or more hours. For more information on the award, please visit www.presidentialserviceawards.gov. @

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# AFRL takes advantage of CGO Initiative Program

***by Mindy Cooper, AFRL Materials and Manufacturing Directorate***

*WRIGHT-PATTERSON AIR FORCE BASE, Ohio* — The Air Force Research Laboratory Materials and Manufacturing Directorate has a Company Grade Officer Initiative Program that gives young researchers important opportunities.

The program is unique to the directorate and was established in 2002, by Dr. Charles Browning, the former director. The program provides company grade officers, which include lieutenants and captains, the opportunity to work on a special project outside their core technology area.

The program serves three purposes: to develop lieutenants and captains through "hands-on" experience, mentorship and ownership of a project; to add to the overall science and technology knowledge base; and to develop technological solutions to a military needs.

After the funding is granted, the CGO enters into a contract and begins the work. He or she may consult with the CGOIP project officer or focal point, 1st Lt. Shyam Munshi. Lt. Munshi provides guidance to help further the projects where needed.

"The CGO Initiative Program is a phenomenal junior force developmental tool," said 1st Lt. Shyam Munshi, CGOIP project officer or focal point.

"It gives young officers the chance to take ownership of the management and development of higher risk technology from idea to reality." @

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# Net Index

Due to the number of submissions we receive, some sections of *news@afrl* are available exclusively on-line. The on-line version of the newsletter allows users to view the AFRL corporate calendar, news releases generated by AFRL headquarters, operating instructions, L@b L@urels and Roundups sections.

The L@b L@urels section of the electronic newsletter is dedicated to members of Air Force Research Laboratory who receive awards and honors. The Roundups section of the electronic newsletter keeps Air Force Research Laboratory employees informed about contracts AFRL has awarded. Below is an index of articles one can find in each of these on-line sections.

## L@b L@urels


- **Information Directorate announces quarterly award**
- **Directed Energy scientist's career honored**
- **Directed Energy employees receive awards**


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## General Bowlds visits Space Vehicles Directorate

*Air Force Research Laboratory Commander Maj. Gen. Ted F. Bowlds visited AFRL's Space Vehicles Directorate on Feb. 22, 2006. During his tour of the unit's headquarters building, he learned about the Tri-Axial test frame developed by the directorate. The device pushes and pulls composite materials in multiple directions, and the data collected results in the design of higher performance structures. General Bowlds, pictured with Brandon Arritt, deputy program manager, Integrated Structural Systems, is holding one of the cruciform pieces previously tested in the Tri-Axial, about the unique apparatus. (Air Force photo by Anita Bergman)*

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