PROPULSION DIRECTORATE

Monthly Accomplishment Report
November 2005

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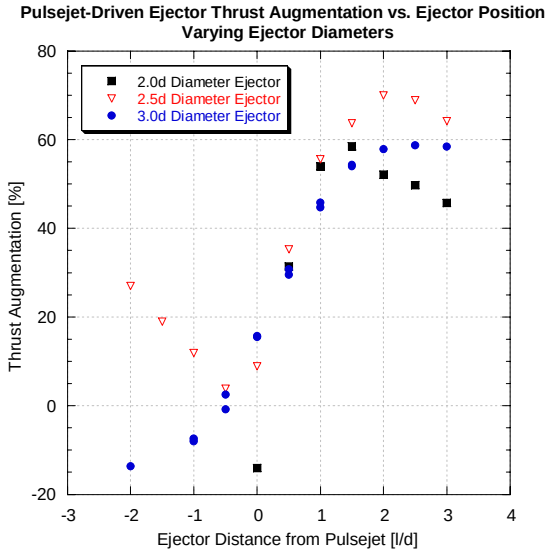
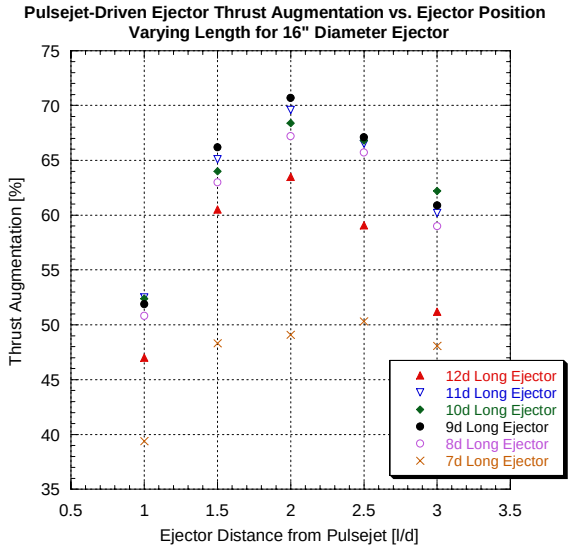
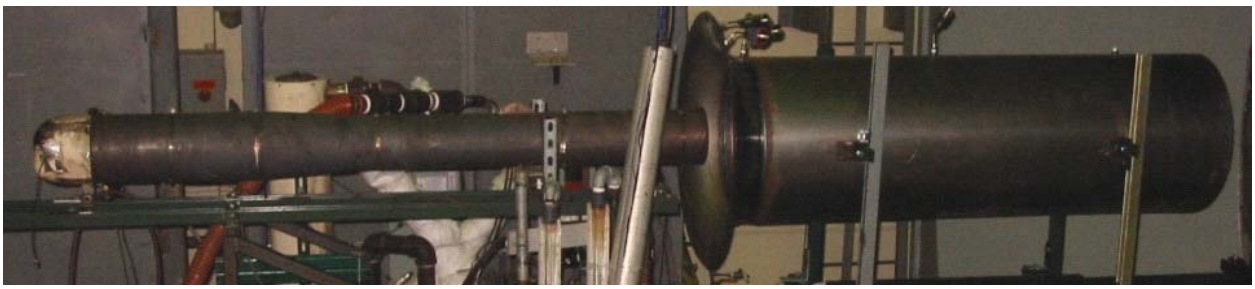
LARGE SCALE PULSEJET-DRIVEN EJECTOR OPERATED IN COLLABORATION WITH NASA GLENN RESEARCH CENTER: The unique capabilities of the Propulsion Directorate's Pulsed Detonation Research Facility were recently exploited in order to assess three large-scale, straight-walled, pulsejet-driven ejectors. The driver engine is a scaled down version of the Argus V-1 "Buzz-Bomb," an extremely low cost pulsejet which propelled early cruise missiles. NASA Glenn Research Center provided the vintage 1950s pulsejet and collaborated on the design of the ejectors. The driver engine and ejector were installed on the damped thrust stand and instrumented with unsteady flow measurements normally utilized for pulsed detonation engine (PDE) research. The straight-walled ejectors are simply large tubes, with a contoured inlet, which confine the exhaust of the driver engine and entrain additional surrounding air. Thus the ejector essentially "sucks" itself forward, increasing overall thrust. Ejectors driven by a steady jet only obtain around a 20% increase in thrust, but when driven with an unsteady jet, such as the pulsejet used here or a PDE, augmentation can be on the order of 100%. Because much of the unsteady ejector research conducted to date has been with smaller driver engines (1-2 inch diameter), this research addressed questions regarding scalability of thrust augmentation when driver engine size is increased (6.5 inch diameter in this case). The results confirmed that significant performance gains are obtainable with unsteady ejectors and that ejector design guidelines scale well with driver engine size. This technology can produce low cost thrust with efficiencies competitive with disposable turbines. (1Lt P. Litke, Mr. J. Stutrud, and Dr. F. Schauer, AFRL/PRTC, (937) 255-6462)







Pulsejet-Driven Ejector installed on the Pulsed Detonation Research Facility's damped thrust stand

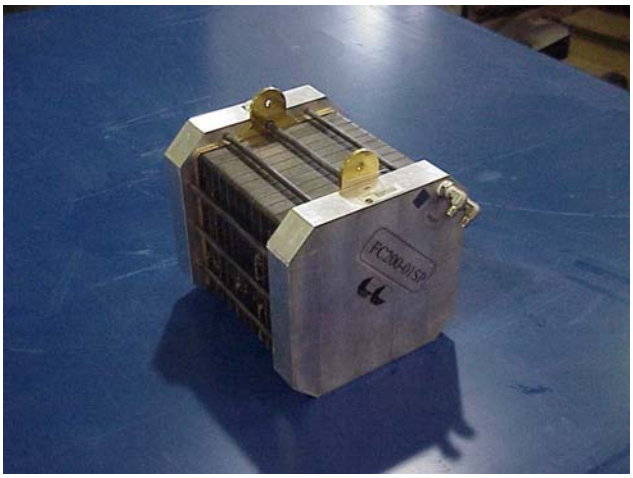
DR. MEAD HONORED FOR BEAMED ENERGY WORK: The Propulsion Directorate's Dr. Franklin B. Mead, Jr. was recently honored with the 2005 International Symposium on Beamed Energy Propulsion (ISBEP) Leadership Award. Dr. Mead received this award during the 4th International Symposium on Beamed Energy Propulsion held in November 2005 in Nara, Japan. Dr. Mead, a researcher in AFRL/PR's Space and Missile Propulsion Division (AFRL/PRS), was honored by symposium organizers and attendees for his long-time contributions to the research field. Notably, Dr. Mead has demonstrated the feasibility of using high-powered pulsed laser energy to propel a spacecraft through actual flight tests. Presentations made during this symposium described progress in laser propulsion, power beaming, electric space propulsion, and many other aspects of energy transfer technology and science. The presentations by this international group will be published as a conference series of the American Institute of Physics. (Dr. R. Channell, AFRL/PRSP, (661) 275-5762)

Dr. Franklin Mead was recently honored with the 2005 International Symposium on Beamed Energy Propulsion (ISBEP) Leadership Award

Want more information?

- For a more detailed story on this award, click here.

AFRL AND NAVY BRING FUEL CELL TEST FACILITY ON-LINE: Propulsion Directorate researchers have established a fuel cell test bed at the Naval Surface Warfare Center (NSWC), Crane Division in Crane, Indiana. The test bed was established through Congressional plus-ups for Distributed Heterogeneous Simulation (DHS) modeling efforts with PC Krause & Associates, Inc. and Purdue University. The purpose of this DoD test bed is to verify Air Force/Purdue developed fuel cell models for electrically powered UAVs (unmanned aerial vehicles). The UAVs can be of various sizes, but the present main focus is on electrically powered high altitude airships. After passing many safety inspections, the test bed is now operational, and NASA Glenn Research Center has provided a 1 kW fuel cell to shakedown the facility. Within the next year, NASA Glenn Research Center is also planning on altitude testing their regenerative fuel cell system in the test bed's altitude chamber. NSWC-Crane has a long

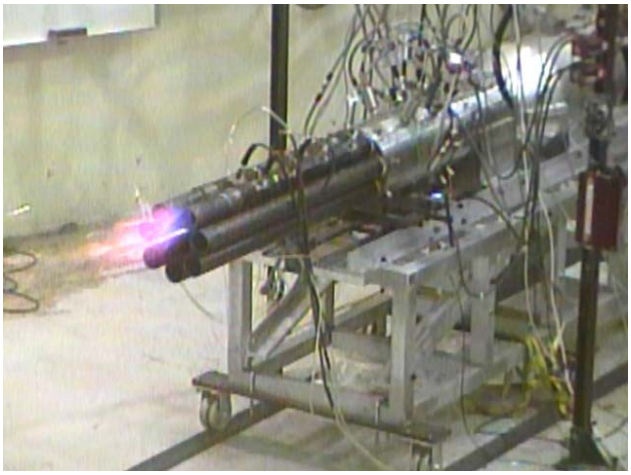


NASA Glenn Research Center Air Cooled ElectroChem Fuel Cell

history of testing batteries for NASA and Air Force space applications, and it is the main US Navy battery test facility for ships and submarines. NSWC-Crane is also responsible for the 6.3 to 6.5 development testing of man portable power (i.e., the US Marines version of the Battlefield Air Operations kit), UAV electrical power, environmental testing, expeditionary power, aircraft power, and field support. (Dr. J. Fellner, AFRL/PRPA, (937) 255-4225)

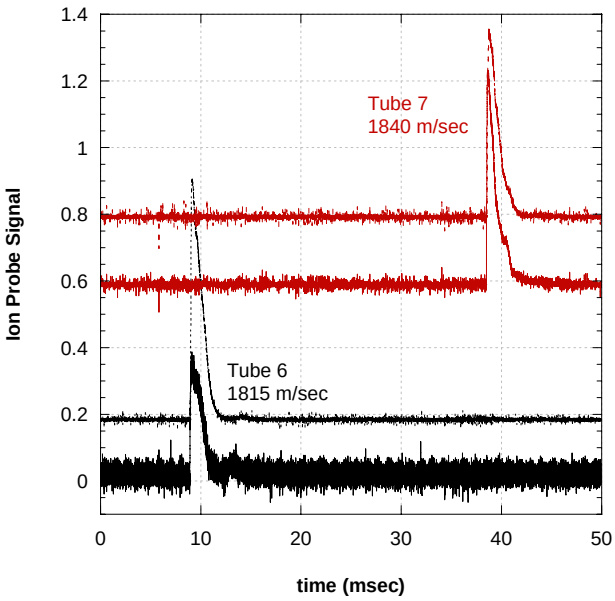
NSWC-Crane Fuel Cell Test Stand Integrated with Altitude Chamber

PR/VA SPONSORED ROTARY AIRFLOW CONTROLLER SUCCESSFULLY DEMONSTRATED: A rotary airflow controller was recently assessed in the Propulsion Directorate's Pulsed Detonation Research Facility. The cyclic (on/off) characteristic of the pulsed detonation engine (PDE) airflow requirements imposes a difficult airflow-matching problem for the integration of an unsteady PDE with a high-speed inlet. Therefore, a revolutionary airflow controller and isolator were developed to: (1) control the airflow to the detonation chambers, (2) provide sealing, and (3) isolate the inlet from the severe airflow disturbances that could be imposed by PDE operation. The controller was designed and fabricated by TechLand Research Inc. of North Olmstead, Ohio, under a jointly funded PR/VA Phase II Small Business Innovation Research (SBIR) program. It was installed in the Pulse Detonation Research Facility and instrumented to assess the airflow controller's operation. The controller successfully isolated the upstream inlet conditions from downstream pressure oscillations associated with PDE operation.



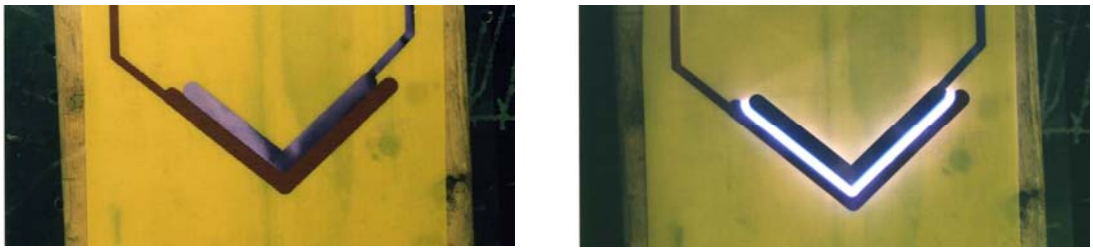
7-Tube Rotary Airflow Controller demonstrating adjacent tube detonation

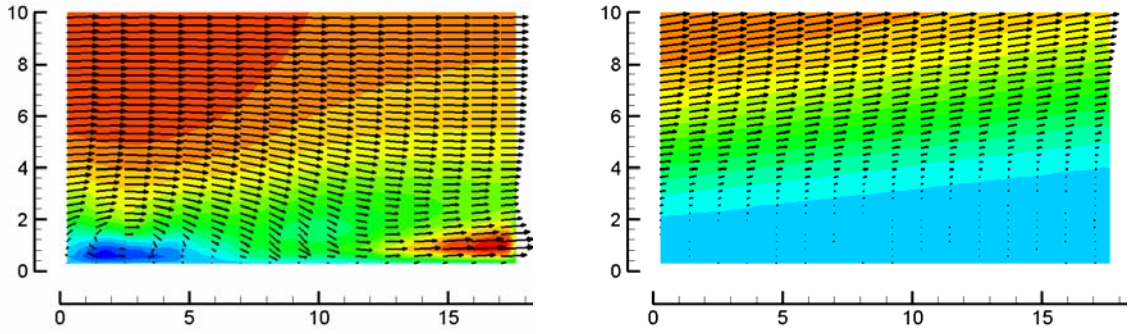
The controller also significantly reduced the pressure losses through the engine, making the fill process more efficient and consequently boosting performance. Continuous operation of one tube and two adjacent tubes was demonstrated as well. The high performance achieved with this hardware demonstrates an enabling technology for revolutionary pulsed detonation propulsion. (1Lt P. Litke, Mr. J. Stutrud, and Dr. F. Schauer, AFRL/PRTC, (937) 255-6462 and Mr. T. Presdorf, AFRL/VAAI, (937) 255-6317)



Wave speeds for adjacent tubes

FLEXIBLE PLASMA FLOW CONTROL ELECTRODES DEMONSTRATED: Flexible plasma flow control electrodes manufactured in the Propulsion Directorate's Heat Flux Instrumentation Laboratory have been successfully tested at the University of Kentucky. This development will allow AFRL/PR researchers to wrap thin film plasma flow-control electrodes onto airfoil surfaces to control the airflow over these surfaces. The flow control actuators are non-intrusive to the flow (i.e., low drag), require no machining of the airfoils, and actuation can be instantly turned on or off as needed. Thin sheets of double sided copper-clad Kapton® are chemically etched to produce custom electrode geometries for different flow control studies. Conventional printed circuit board (PCB) electrodes have also been produced and are in use in the Turbine Aero Thermal Basic Research Facility (TATBRF). (Dr. R. Anthony, AFRL/PRTT, (937) 255-6768)


Plasma flow control electrode off (left) and electrode on (right)



Contours of the *u*-component of velocity show the effect of the flow control devices - electrode off (left) and electrode on (right)

AIAA NAMES NEW FELLOWS AND ASSOCIATE FELLOWS: The American Institute of Aeronautics and Astronautics (AIAA) recently announced the election of its 2006 Fellows and Associate Fellows. The prestigious grade of Fellow is bestowed upon AIAA members who have made notable and valuable contributions to the arts, sciences, or technology thereof in aeronautics or astronautics. Dr. Sivaram Gogineni, an on-site contractor with Innovative Scientific Solutions, Inc. working in the Propulsion Directorate's Turbine Engine Division (AFRL/PRT), was among those honored as a new AIAA Fellow. In addition, three individuals with close ties to AFRL/PR were named AIAA Associate Fellows. Dr. Michael L. Heil (Col, USAF (ret.)), former AFRL/PR Director and now Director of AFIT's Center for Space Studies and Research, was named an Associate Fellow as were Drs. Jiwen Liu and Chung-Jen "John" Tam, on-site contractors with Taitech, Inc. working in the Aerospace Propulsion Division (AFRL/PRA). Associate Fellows are individuals who have accomplished or been in charge of important engineering or scientific work, have done original work of outstanding merit, or have otherwise made outstanding contributions to the arts, sciences, or technology of aeronautics or astronautics. The new AIAA Fellows will be honored at the Aerospace Spotlight Awards Gala to be held on 25 April 2006 in Washington, DC, while the new Associate Fellows will be honored at the AIAA Aerospace Sciences Meeting to be held in January 2006 in Reno, Nevada. (Mr. J. Pearce, AFRL/PRO (UTC), (937) 255-5015)

Want more information?

- The AIAA Dayton-Cincinnati Section's announcement of the new AIAA Fellows and Associate Fellows is available here.

Dr. Sivaram Gogineni was selected to be a new AIAA Fellow

Dr. Michael Heil, former PR Director, was selected to be a new AIAA Associate Fellow