PROPULSION DIRECTORATE

Monthly Accomplishment Report
January 2003

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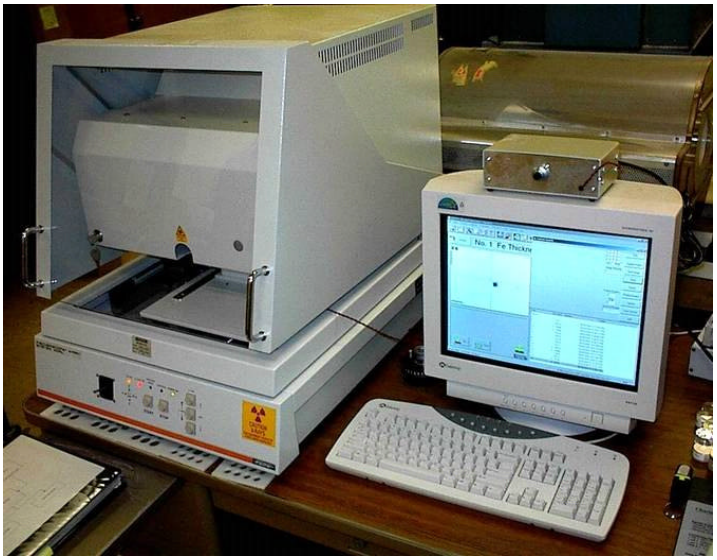
LOW-COST WEAR DEBRIS MONITOR: The Propulsion Directorate's Mechanical Systems Branch (AFRL/PRTM) and the University of Dayton Research Institute have developed a portable wear debris monitor to detect and identify bearing wear debris in turbine engines. The device, based on x-ray fluorescence (XRF) technology, provides visual imaging, size measurement, and alloy composition determination. This information allows flight line laboratory personnel to track and identify wear debris taken from the engine's bearing sump chip detectors and take appropriate maintenance actions to prevent lubrication system failures. The XRF instrument is bench-top size and could potentially replace scanning electron microscope (SEM) technology that is currently being used for chip detector debris analysis by the Air Force. The XRF would cost approximately 80% less than the SEM instruments, while providing essentially the same capability for this application. A representative of the Propulsion System Program Office (ASC/LP) was very impressed with the device on a recent visit to the Propulsion Directorate, and a demonstration of the XRF was given for the Propulsion Product Group at Oklahoma City Air Logistics Center (OC-ALC) on 16 December 2002. The device is also being considered for field demonstration in the upcoming Patriot 2003 exercise. (C. Klenke, AFRL/PRTM, (937) 255-9654)



The Fisherscope XDAL used for detecting and identifying chips/particles in lubricating oil to predict impending failure

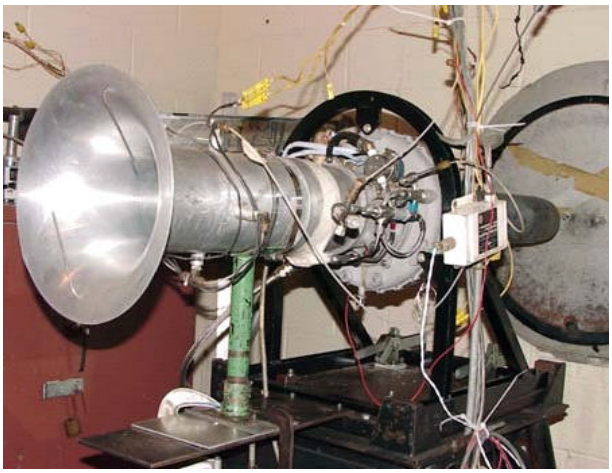
SARGENT HONORED WITH TOP AIR FORCE ENGINEERING AWARD: The Propulsion Directorate is honored to announce that one of its engineers was awarded the prestigious Air Force Science and Engineering Award in Manufacturing Technology. For 2002, this award went to Ms. Kathleen Sargent of PR's Turbine Engine Division (AFRL/PRT). Ms. Sargent was recognized for her exceptional work in turbine engine composite components and materials development. She was instrumental in the successful demonstration of a new design concept; a Metal Matrix Composite (MMC) Remote Ring Compressor Rotor. This concept, which allows two MMC rings to be used at the bore without being embedded into the monolithic rotor material, has a number of advantages over the state of the art. Among these advantages are a dramatic increase in material strength and temperature capability, reduced weight, and a major fabrication simplification that can reduce production and maintenance costs by more than 10%. Ms. Sargent was responsible for bringing the design concept of the remote ring rotor to fruition by creating and leading a government and industry panel to address the shortcomings of this technology area. As a result of her efforts, a new method for fabricating the rings was devised, and the feasibility of the remote ring compressor rotor concept was successfully demonstrated. This technology is vital to meeting the Phase III goals of the Integrated High Performance Turbine Engine Technology (IHPTET) Program. In addition, Ms. Sargent also served as the general chair of the 2002 Turbine Engine Technology Symposium held in Dayton, Ohio, from

Ms. Kathleen Sargent, winner of the 2002 Air Force Science and Engineering Award in Manufacturing Technology

9-12 September 2002. This unique symposium gathers members of US turbine engine community to review and discuss the latest technology advances achieved through the IHPTET and, more recently, the Versatile Affordable Advanced Turbine Engines (VAATE) Programs. The 2002 Symposium was an unqualified success, with more than 700 attendees. Ms. Sargent's selection for this award is a tribute to her considerable contributions to the turbine engine community. (T. Fecke, AFRL/PRTC, (937) 255-7196)

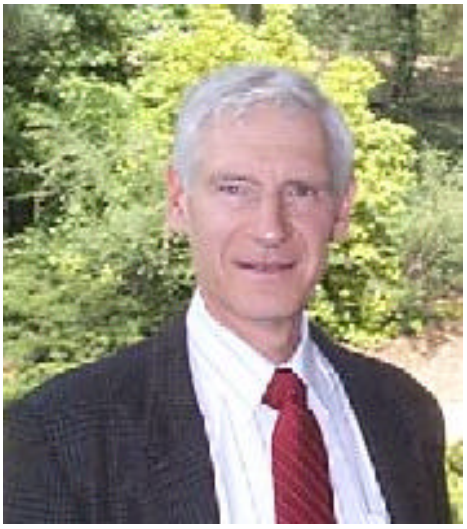
COMPLIANT FOIL BEARINGS FOR ADVANCED OIL FREE TURBO-MACHINERY: A Propulsion Directorate Phase II Small Business Innovation Research (SBIR) program, "Compliant Foil Bearings for Advanced Oil Free Turbomachinery," was recently completed with Mohawk Innovative Technology, Inc (MiTi) of Albany, New York. The program was successful in developing and rig testing a high-speed foil bearing applicable for demonstration in the Williams International (WI) Integrated High Performance Turbine Engine Technology (IHPTET) Phase III Joint Expendable Turbine Engine Concept (JETEC) engine demonstrator (XTL-87). Compliant foil bearings support the rotor on a hydrodynamic air film, thus eliminating the need for rolling element bearings and the associated liquid lubrication system. Potential benefits for turbomachinery include increased rotational speed and operating temperature, improved storability, reduced maintenance, and a 30% reduction in cruise missile engine cost and weight. In a follow-on jointly funded IRAD effort, MiTi and WI have successfully demonstrated this bearing in a WJ24-8 turbojet engine. The WJ24-8 is a 240 lb_f thrust single spool turbojet that provides propulsion for the US Navy BQM-74 target drone. The forward bearing is fuel lubricated while the aft bearing is normally oil mist lubricated. In the demonstration test, the aft bearing and oil mist system were replaced by a MiTi air foil journal bearing similar to the one developed for the XTL-87 demonstrator engine. Testing that was completed in December 2002 included over 30 start-stop cycles, operation at maximum design operating speed and gas temperature, and over one hour of total accumulated run time. A preliminary posttest analysis of bearing hardware revealed no evidence of wear. Testing is expected to resume in January 2003 to quantify benefits such as reduced power loss and to investigate bearing life issues. WI estimates that this modification could reduce the cost of the WJ24-8 by as much as 20%. The data from these tests may also be used to assess the applicability of foil bearings to other gas turbine engines for both military and commercial systems. (M. Wagner, AFRL/PRTM, (937) 255-7406)

WJ24-8 turbojet and BQM-74 target drone

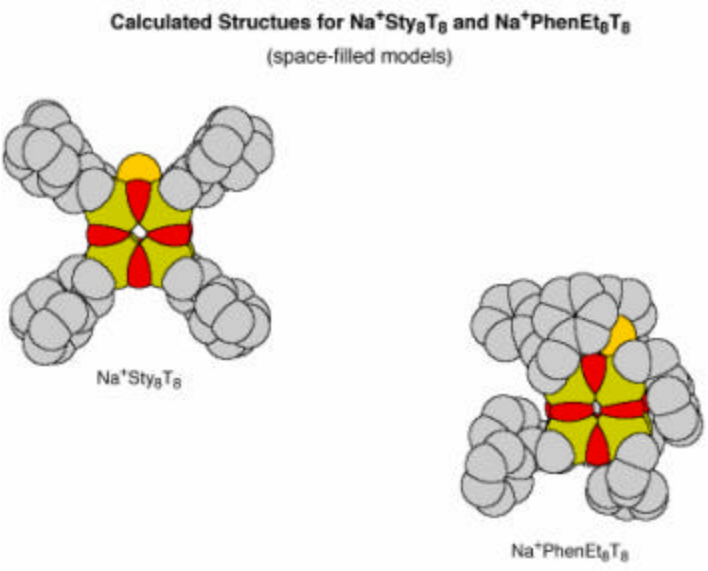


Foil bearing test

PRESTIGIOUS FACULTY AWARD GRANTED FOR STUDY OF POSS POLYMERS: Prof. Stan Anderson, on extended sabbatical from Westmont College in Santa Barbara, California, has received a National Research Council (NRC) Senior Faculty Fellowship to work with the Propulsion Directorate on the modeling and simulation of POSS (polyhedral oligomeric silsesquioxanes) polymers. This is a very prestigious award, considered to be similar to the Fulbright Fellowship administered by the Council for International Exchange of Scholars (CIES). For this effort, Prof. Anderson will be working with Prof. Michael T. Bowers, head of The Bowers Group at the University of California-Santa Barbara, and PR's Polymer Working



Prof. Stan Anderson



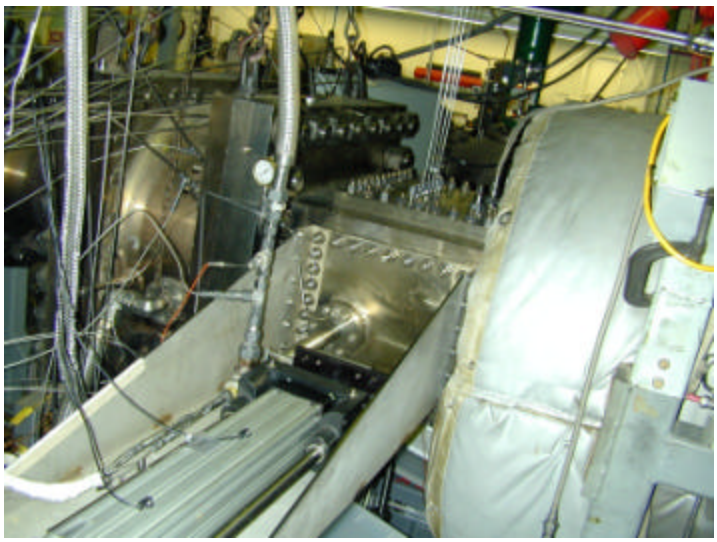
Prof. Michael T. Bowers

Group at Edwards AFB, California. This 9-month collaboration is of great enough scope to allow for the completion of a first rate modeling and simulation effort, which will be coupled with in-house experiments. This work will mainly be directed at using computational methods to model the conformation (shape) properties of POSS molecules, and should eventually prove that POSS is not just a simple sphere, but instead a complex nanostructure. (B. Viers, AFRL/PRSM, (661) 275-5416)

GORD RECOGNIZED FOR RESEARCH ACHIEVEMENTS: The Propulsion Directorate's Dr. James R. Gord was recently selected for Honorable Mention for the 2002 Air Force Basic Research Award. This places Dr. Gord among the top 5 candidates for this highly competitive award. Dr. Gord's selection for this honor is based on his distinguished performance as Director of the Combustion and Laser Diagnostics Research Complex within PR's Combustion Science Branch (AFRL/PRTS) over the period 1 January 1999 to 31 December 2001. During this time, Dr. Gord masterfully directed an internationally acclaimed research program to develop advanced laser-based diagnostic techniques and apply these to the study and improvement of next-generation propulsion and fuels systems. At a basic-research level, his work is critical for achieving a detailed understanding of the fundamental chemistry and physics that govern combustion processes. This understanding is absolutely essential to the development and validation of computational models for designing state-of-the-art propulsion systems. At a more applied level, Dr. Gord's laser techniques yield tangible benefits for military and commercial aviation, such as improved engine performance, reduced pollutant emissions, and enhanced reliability, maintainability, and affordability. To achieve these ends, Dr. Gord designs, develops, and operates state-of-the-art facilities that are unique to the Air Force and unparalleled throughout the world for exploring fundamental combustion and fuels phenomena. These facilities include advanced laser-based diagnostics and experimental combustion and fuels rigs that provide unprecedented opportunities for exploring the chemistry and physics of advanced propulsion systems. Over the course of his Air Force career, Dr. Gord has built several research laboratories from the ground up, populating these labs with continuous-wave and nano-, pico-, and femto-second pulsed lasers, some of which are found nowhere else in the world. Still early in his career, Dr. Gord has already amassed an impressive list of awards and has more than 200 publications and presentations to his credit. Dr. Gord is clearly one of the Air Force's top researchers, and he is very deserving of this recognition. (R. Hancock, AFRL/PRTS, (937) 255-6814)

Dr. James R. Gord, Honorable Mention for the 2002 Air Force Basic Research Award

ACTIVE COMBUSTION CONTROL EXPERIMENTS CONDUCTED: Open-loop active combustion control testing of a high-pressure combustor sector was recently completed in the Propulsion Directorate with help from Pratt & Whitney and Stanford University. This active combustion control technology is being developed in support of the Integrated High Performance Turbine Engine Technology (IHPTET) Program and is applicable to both current and future propulsion systems. The activity is largely funded by a Navy Dual Use Science and Technology (DUST) program with Dr. Gabriel Roy. The goal of the program is to develop intelligent engine technology that will provide on-line feedback and control of the gas turbine engine combustor. Optical sensors detect an undesirable combustor exit temperature distribution. This information is then used to correct the problem by adjusting the fuel flow distribution at the front of the combustor. This technology could result in substantial costs savings over the life of a gas turbine engine by reducing specific fuel consumption, increasing combustor and turbine life, and reducing maintenance costs. Testing, which began in July 2002, was conducted by PR's Combustion Science Branch (AFRL/PRTS) in the High Pressure Combustion Research Facility (HPCRF) at Wright-Patterson AFB, Ohio. This testing used a Pratt & Whitney research combustor sector and incorporated fiber optic temperature sensors oriented normal to the combustor flow-path. These diode-laser-based sensors, developed by researchers at Stanford University, were used to provide combustor performance feedback. Preliminary results indicate that the sensors performed very well at realistic elevated pressures and temperatures and that the information they provide can be used to control fuel flow distribution in the front end of a combustor, and in turn, temperature distribution at the exit of the combustor. Closed-loop testing is scheduled to take place in mid-year 2003. This will incorporate a feedback algorithm to automatically modulate the fuel flow distribution within the combustor. All of this experimental work is accompanied by in-depth computational fluid dynamic (CFD) simulations. (D. Shouse, AFRL/PRTS, (937) 255-4636)



High Pressure Combustor Research Facility pressure vessel with Pratt & Whitney combustor and Stanford sensors installed

TURBINE CHIEF HILL RETIRES: The Propulsion Directorate's Mr. Richard J. Hill retired from Government service on 3 January 2003 after more than 31 years of dedicated service. Mr. Hill's final assignment was as the Chief of PR's Turbine Engine Division (AFRL/PRT), a position he held for five years. During his distinguished career, Mr. Hill held many key positions related to the research, development, and testing of advanced turbine engine technology concepts. He served as PRT's Chief of Technology for turbine engine research for eight years, he was the manager of the Aircraft Propulsion Subsystem Integration (APSI) and Advanced Turbine Engine Gas Generator (ATEGG) demonstrator engine test programs for 10 years, and he was the manager of the highly successful Integrated High

Mr. Richard J. Hill retired on 3 January 2003

Performance Turbine Engine Technology (IHPTET) Program for three years. During his career, Mr. Hill was frequently recognized for his outstanding achievements. He is the recipient of the Air Force Meritorious Civilian Service Award, 18 Air Force Performance Awards, and two Citations for Excellence. He was also the winner of the 2001 AFRL Senior Leadership Award and was the Air Force nominee for the Franklin Institute's 2002 Bower Award for Business Leadership. A function celebrating Mr. Hill's retirement was held at the Wright-Patterson AFB Hope Hotel on 16 January 2003. Nearly 200 friends, coworkers, and associates attended this function, which is a tribute to Mr. Hill's standing in the propulsion community. A formal retirement ceremony was held on 17 January 2003 with Col Alan Janiszewski, PR Director, presiding. (Col A. Janiszewski, AFRL/PR, (937) 255-2520)

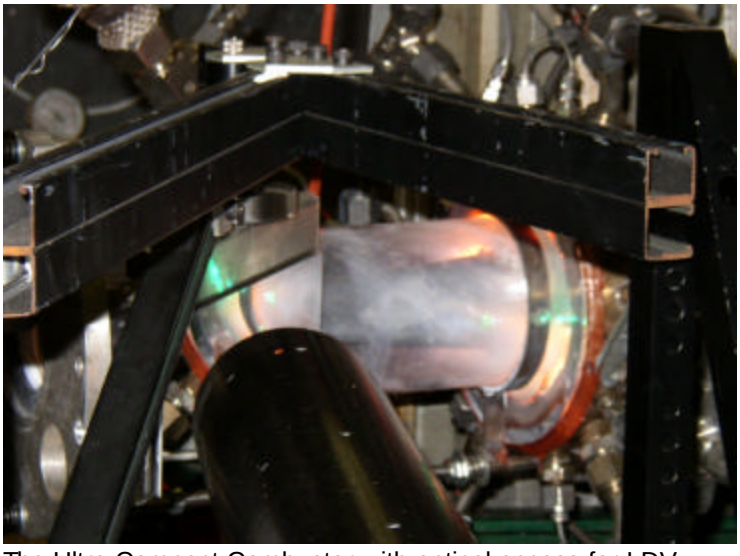
NASA/USAF SPACE ACT AGREEMENT TO STUDY MICROGRAVITY SPRAY COOLING: NASA Glenn Research Center (GRC) and the Propulsion Directorate's Power Division (AFRL/PRP) are collaborating on the design, construction, and testing of a two-phase, liquid/vapor spray-cooling system for use in microgravity environments. AFRL participants will design and build the hardware, and NASA GRC will provide access to microgravity test equipment including the KC-135 aircraft, as well as prior knowledge for working in a microgravity environment (specifically low gravity fluid behavior). Minimal work has been done on spray cooling in the microgravity environment, particularly in understanding the effects in areas such as phase separation and fluid management during evaporation. The thermal subsystems of both nuclear-powered and conventional spacecraft can benefit from spray cooling technology; particularly in improving the efficiency of evaporator designs that may provide reduced mass over other heat transfer modes such as radiation, conduction, or single-phase convection. The AFRL members are investigating spray cooling as a potential method of solving anticipated thermal challenges in future space and aircraft weapons systems. This collaborative approach consists of the following investigations: (1) define the fundamentals of spray cooling, including the fluid management during the spray cooling process; (2) examine evaporation on the microscale, when the droplets hit the hot surface; and (3) research scaling by extrapolating test data in order to design multi-kilowatt space-based heat rejection systems. (K. Yerkes, AFRL/PRPS, (937) 255-5721)

POWER DIVISION TECHNOLOGY GURU BEAM RETIRES: The Propulsion Directorate's Dr. Jerry Beam retired from Government service on 3 January 2003 after more than 31 years of dedicated service. Dr. Beam's final assignment was as the Deputy for Technology for PR's Power Division (AFRL/PRP). In this position, Dr. Beam was responsible for PRP's outside programs including the Ballistic Missile Defense Organization (BMDO) program, the Small Business Innovation Research (SBIR) program, and university related activities. These programs covered the full spectrum of power

system technologies and allowed Dr. Beam to work across the entire division. During his tenure as PRP's Deputy for Technology, numerous major accomplishments were achieved. These accomplishments included: completion of a cryogenic power system design study that led to a $16 million research effort; development of a flight test to transition Russian heat pipe technology to US industry; formulation of an integrated thermal model for an aircraft; development of a GaN (gallium nitride) thermal management model; initiation of a thermal battery program for BMDO; the conceptual design of a plasma based processor for the destruction of biological weapons; and the resurgence of PRP's space power activities through the New World Vista program. Prior to his assignment as PRP's Deputy for Technology, Dr. Beam served as the Section Chief of the Thermal Technology technical area for five years. A retirement ceremony for Dr. Beam was held on 17 Jan 03 with Col Alan Janiszewski, PR Director, presiding. (Col A. Janiszewski, AFRL/PR, (937) 255-2520)

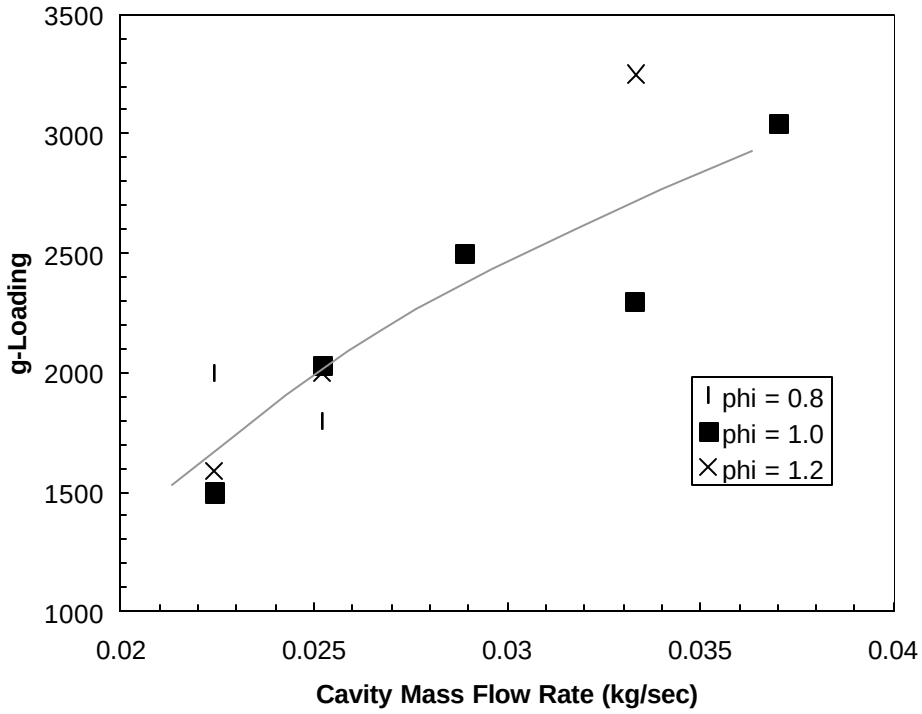
Dr. Jerry Beam retired on 3 January 2003

AFIT/PR TEAM CONDUCTS EXPERIMENTS TO UNDERSTAND HIGH G-LOADED COMBUSTOR: The Propulsion Directorate's Combustion Science Branch (AFRL/PRTS) recently teamed with the Air Force Institute of Technology (AFIT) to conduct Laser Doppler Velocimetry (LDV) experiments within the cavity of an Ultra Compact Combustor (UCC) as part of an AFOSR funded effort. This work was conducted as part of the ongoing combustion science research supporting the Integrated High Performance Turbine Engine Technology (IHPTET) and Versatile Affordable Advanced Turbine Engines (VAATE) Programs. The objective of this work was to measure circumferential velocities in this novel combustor concept. The UCC uses highly swirled flow in a cavity around the outside periphery of the combustor to generate highly accelerated flow, enhancing fuel-air mixing through preferential distribution of reacting and non-reacting fuel-air mixtures within the cavity. Additionally, due to the circumferential velocity, the residence time required by the flame is provided by the circumference of the engine rather than axial length as in



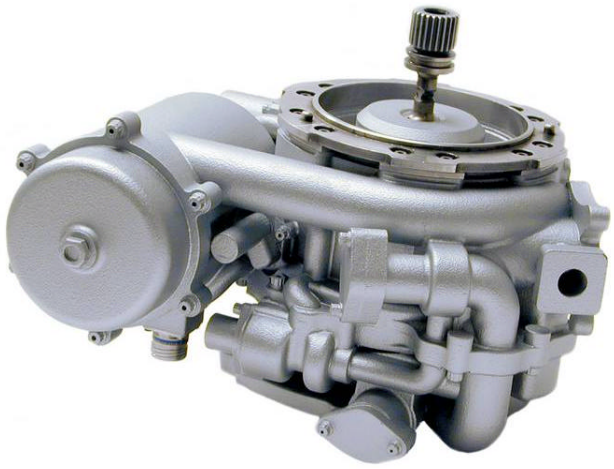
The Ultra-Compact Combustor with optical access for LDV measurements

conventional combustors. These two effects combine to produce observed flame lengths less than half those of conventional swirl stabilized combustors. These short axial flame lengths can be used to reduce engine size and weight and open the possibility for inter-turbine burning (ITB) reheat cycles for aircraft engines. The ITB reheat cycle has been shown to have the potential for large gains in specific thrust (>50%) with equal or reduced thrust specific fuel consumption. The LDV experiments were conducted in a small-scale, atmospheric-pressure, axi-symmetric combustor. Swirl was generated by air entering through evenly spaced holes angled at 45° on the cavity outer perimeter. JP-8 fuel was injected into the cavity by pressure atomizing nozzles. The measurements were conducted using a two-component LDV system in back-scatter. Flow measurements indicate circumferential velocities of ~20-45 m/s with turbulence intensities of ~20%. As expected, g-loading shows an increasing trend with increased mass flow, nearly independent of equivalence ratio. These velocities correspond to accelerations of ~1500-3500g. By comparison, conventional swirl stabilized flames have accelerations of ~100g. These measurements compare favorably to results from a concurrent in-house Computational Fluid Dynamics (CFD) modeling effort. Radial flow velocities are significantly lower than circumferential velocities with much higher turbulent intensities (~2-10m/s with ~30-100% TI). CFD results have indicated entrainment rates from the main into the cavity of ~20%. The high turbulent intensities of the radial velocity support this. High-speed video images have also been recorded. Velocity calculations from these images agree with the LDV measurements. Data collected in these experiments and results from the CFD modeling will be used to optimize air hole injection spacing and angles in future configurations. (Capt R. Anthenien, AFIT/ENY, (937) 255-3636, x4643 and J. Zelina, AFRL/PRTS, (937) 255-7487)



Measured g-Loading in the Ultra-Compact Combustor Cavity

DESIGN REVIEW FOR THERMALLY EFFICIENT FUEL PUMP: On 5 December 2002, the Pumps & Controls Division of Goodrich Aerospace completed the critical design review of its variable-displacement vane pump (VDVP) for an advanced tactical aircraft's propulsion engine. The VDVP concept can minimize fuel recirculation and waste heat generation by matching fuel output flow to the flow demand of each flight mission operating point. The VDVP also is more thermally efficient than other standard fuel pump types, and can reduce the temperature rise for a given fuel flow rate and pressure level. Minimizing the fuel heat generation from the fuel pump can translate to improving the onboard fuel storage, which is used as a heat sink for other aircraft loads. Alternately, improved fuel storage heat sink can provide greater range and endurance for flight missions. Reduced heat generation from the primary fuel pump can also potentially allow the removal of heat exchangers that are used to prevent the fuel from exceeding temperature limits prior to combustion. The USAF-sponsored VDVP program, managed by the Propulsion Directorate's Power Division (AFRL/PRP), is being performed to provide a VDVP matched to the primary fuel pump operating requirements of General Electric's F136 engine. This program's developments are coordinated with the Controls Division of General Electric Aircraft Engines (GEAE), and members of GEAE Controls also participated in the design review to help address F136 engine fuel system integration issues. The resultant design review was sufficient to allow Goodrich to proceed to pump fabrication and assembly. The USAF program's end goal is for Goodrich to fabricate and test VDVPs that can be delivered to GEAE for later integrated ground tests with the F136 engine. Delivery of pump hardware is expected in September 2003. (E. Durkin, AFRL/PRPG, (937) 255-6206)



VDVP for the F108 engine

ARTICLE DETAILS NEW REALM FOR POSS APPLICATIONS: A paper* that was recently published in the highly regarded *Journal of the American Chemical Society* details potentially groundbreaking research into POSS. The work presented in this paper shows that certain POSS molecules have an affinity for surfaces. In particular, this research demonstrates that POSS can spread at a water surface and form a single molecular layer (i.e., a monolayer). This is a revolutionary finding, and it hints at POSS applications for thin films, surface modification, etc. This finding was the result of a collaborative research effort between the Virginia Polytechnic Institute and State University in Blacksburg, Virginia, and the Propulsion Directorate's Propulsion Materials Applications Branch (AFRL/PRSM) at Edwards AFB, California. (B. Viers, AFRL/PRSM, (661) 275-5416)

❖ The article in the *Journal of the American Chemical Society* is available by clicking here.

* Deng, J.; Polidan, J. T.; Hottle, J. R.; Farmer-Creely, C. E.; Viers, B. D.; and Esker, A. R. (2002), "Polyhedral Oligomeric Silsesquioxanes: A New Class of Amphiphiles at the Air/Water Interface," *Journal of the American Chemical Society (Communications)*, Vol. 124, No. 51, pp. 15194-15195.

SHOUSE HONORED FOR EFFORTS IN COMBUSTION TESTING: The Propulsion Directorate's Mr. Dale T. Shouse recently received the Exemplary Civilian Service Award. His selection for this award is in recognition of his distinguished service as a mechanical engineer and as the Advanced Combustion Team Leader in PR's Combustion Science Branch (AFRL/PRTS) from 1 January 1998 to 31 October 2002. During this time, Mr. Shouse and his team made numerous significant advances in gas turbine engine combustor technology for the Air Force. Two of the combustors that Mr. Shouse has helped to develop and evaluate are part of engine demonstrator programs within the joint DoD/ NASA/industry Integrated High Performance Turbine Engine Technology (IHPTET) Program. Mr. Shouse has worked extensively with General Electric Aircraft Engines (GEAE) and Pratt & Whitney (P&W) in the development and testing of advanced gas turbine combustors. Working with GEAE, he directed the majority of the design, fabrication, instrumentation, installation, and testing of multiple Trapped Vortex Combustor (TVC) sector configurations. He also has worked closely with P&W in the development of the Integrated Lightweight Combustor (ILC). Both of these combustors offer significant benefits such as improved thrust-to-weight ratios and reduced emissions. Mr. Shouse's expertise is widely recognized, and he is actively sought out by engineers, scientists, and managers throughout the world for advice on the development of advanced combustor concepts. His excellent work on the TVC and ILC are just two examples of the great impact that he has had on combustor development for the US. (R. Hancock, AFRL/PRTS, (937) 255-6814)

Mr. Dale T. Shouse was honored with the Exemplary Civilian Service Award

SUPERCONDUCTIVITY GROUP PRESENTATION NOMINATED FOR BEST OF CONFERENCE: The Materials Research Society (MRS) held its Fall Meeting from 2-6 December 2002 in Boston, Massachusetts. Over a thousand researchers from all over the world participated in this conference in a variety of symposiums, including sessions on the topic of superconductivity. At this meeting, the Propulsion Directorate's Superconductivity Group made a poster presentation[†] that was nominated for the best poster presentation of the meeting. Only a handful of the more than 200 posters presented that evening were nominated for this honor. The poster detailed the Superconductivity Group's pinning enhancement research for a multilayered approach in YBCO (yttrium barium copper oxide) thin films. This approach, which was announced the previous year, demonstrated significant improvement of the in-field current carrying ability of quality YBCO thin films. Previously, the exact

[†] T. J. Haugan, P. N. Barnes, J. C. Tolliver, C. B. Cobb, I. Maartense, R. N. Nekkanti, J. P. Murphy, J. M. Evans, M. Sumption, and E. J. Lee (2002), "Flux-Pinning Enhancement of $YBa_2Cu_3O_{7-x}$ Thin Films with Nano-size Multilayer Deposition," MRS Fall Meeting, Boston MA.

mechanism for pinning was unclear, but this recent paper provided more detailed answers. (P. Barnes, AFRL/PRPG, (937) 255-4410)

- A website detailing the Materials Research Society's 2002 Fall Meeting can be accessed by clicking here.

LARUE NAMED NOVEMBER EMPLOYEE OF THE MONTH: Ms. Joann C. LaRue was named the Propulsion Directorate's Employee of the Month for November 2002 in the Scientist/Engineer/Supervisor category. As Group Leader for the Propellants Branch's (AFRL/PRSP) Analytical Laboratory at Edwards AFB, California, Ms. LaRue activated more than $1 million worth of analytical instrumentation and doubled the group's productivity. She effectively used these resources to provide critical and timely support for a number of key programs. She provided emergency support for NASA's Space Shuttle Operations and its Edwards landing site equipment. In this instance, she provided a weekend rapid response that allowed NASA to make a go/no-go launch decision. A delay could have cost NASA over $500K per day. She also provided support to Edwards Air Force Flight Test Center (AFFTC) F/A-22 test program, providing time critical analysis of fuel and hydraulic fluids. These efforts were extended to other Air Force aircraft programs, allowing them to continue flight tests and operations. In addition to her analytical work, Ms. LaRue is also active in educational and professional development activities. She is the leader of PR's Educational Partnership with Mojave High School to encourage and enable top students to find summer technical work, and she also serves as the American Chemical Society Section Chair for the Mojave Desert Section. (R. Channell, AFRL/PRSP, (661) 275-6442)


Ms. Joann C. LaRue, PR's Employee of the Month for November 2002

MORE ELECTRIC AIRCRAFT RESEARCH HIGHLIGHTED IN *LEADING EDGE*: An article in the January 2003 issue of the Air Force Materiel Command *Leading Edge* highlights the work being done in the Propulsion Directorate to bring the More Electric Aircraft (MEA) concept to fruition. This article, titled "Power Technologies Create Revolution," details the MEA concept, which promises greater aircraft reliability and a significantly smaller logistical tail to support tomorrow's air and space force. The gist of the MEA concept is to use electrical power to drive aircraft subsystems that are currently powered by hydraulic, pneumatic, or mechanical means. This includes gearboxes, hydraulic pumps, electrical generators, flight control actuators, and many other subsystems. This concept holds the promise of dramatic simplifications in aircraft system design while offering improvements in reliability and maintainability. It also reduces vulnerability by eliminating hydraulic systems that use flammable

liquids at high temperature and pressure. PR has had many recent successes that have contributed to the advancement of the MEA concept. These include the demonstration of an integrated power unit rotor system, the development of high energy output batteries, and the development of "power by wire" flight controls. The incorporation of many of these MEA technologies in the new F-35 Joint Strike Fighter serves as proof of this concept. (S. Cloyd, AFRL/PROP, (937) 255-0158)

- The *Leading Edge* article on the More Electric Aircraft, written by PR on-site contractor Mr. Michael Kelly, is available as page 12 of the document accessed by clicking here.