DESIGNATIONS, HEADQUARTERS, AND COMMANDS
1945 - 1992

Designation	Dates	Headquarters	Command
Cambridge Field Station (CFS)	20 September 1945 - 5 July 1949	Watson Laboratories Red Bank, N.J. 20 September 1945- 1 December 1947	Air Technical Service Command (in 1946 renamed the Air Materiel Command). 20 September 1945 - 2 April 1951
Air Force Cambridge Research Laboratories (AFCRL)	5 July 1949 - 28 June 1951		
Air Force Cambridge Research Center (AFCRC)	28 June 1951 - 2 May 1960		Air Research and Development Command (ARDC) 2 April 1951 - 1 April 1961
Detachment 2, Hdqtrs. Air Force Research Div.(AFRD)	2 May 1960 - 1 August 1960	Air Force Research Division	
Air Force Cambridge Research Laboratories (AFCRL)	1 August 1960 - 15 January 1976**		Office of Aerospace Research (OAR)* 1 April 1961 - 1 July 1970
		Director of Laboratories, 1 July 1970 - 1 Oct. 1982	Air Force Systems Command (AFSC) 1 July 1970 - Present
Air Force Geophysics Laboratory (AFGL)	15 January 1976 - 9 March 1989		
		Space Technology Center 1 Oct. 1982 - 12 Dec 1990	
Geophysics Laboratory (GL)	9 March 1989 - 12 December 1990		
Geophysics Directorate (GP)	13 December 1990 - Present	Phillips Laboratory 13 December 1990 - Present	

*The Office of Aerospace Research had command status and reported directly to Headquarters USAF.
**Two Divisions of AFCRL were transferred to jurisdiction of the Rome Air Development Center (RADC) on 1 January 1976.

PHILLIPS LABORATORY, GEOPHYSICS DIRECTORATE AT A GLANCE, 1993

MISSION: Phillips Laboratory, Geophysics Directorate, is located at Hanscom AFB, Massachusetts. The Directorate conducts research in five major areas: space physics, optical/infrared physics, ionospheric physics, earth sciences, and atmospheric sciences. The Directorate also does work in environmental simulation and data analysis. The Geophysics Directorate understands, specifies, and predicts the environment, and with other Phillips Laboratory directorates, provides technology to mitigate the environmental effects on systems. The Directorate is the primary environmental science organization in the Air Force and provides information on systems and environment interactions to both DOD and civilian agencies.

REPORTS (in turn) TO: Phillips Laboratory, Kirtland AFB, NM; Space and Missiles Systems Center, Los Angeles AFB, CA; Air Force Materiel Command, Wright-Patterson AFB, OH

BUDGET: 101 Million

PEOPLE: 258 Total - 213 Civilians, 45 Military

SPACE PHYSICS: Energetic particle, plasma, electric, and magnetic field space sensors; solar activity models and simulations; space radiation measurements and models; space disturbance forecasts; space environment impact on Air Force operational systems

OPTICAL ENVIRONMENT: Atmospheric transmission codes, lidar technology for atmospheric remote sensing, infrared background phenomenology, targets and backgrounds airborne measurements, infrared target and background codes

IONOSPHERIC EFFECTS: Ionosphere and neutral atmosphere models; ionospheric scintillation models; ionospheric disturbance effects on C3I space systems; satellite- and ground-based ionospheric sensors and measurements; high power RF ionospheric effects; environment composition surrounding space vehicles; plasma effects on aerospace vehicle signatures and sensors; composition of the space vehicle environment; space debris modeling

EARTH SCIENCES: Cryogenic inertial sensors; gravity models; seismology for the detection, location, and identification of explosions and other global events; seismic hazard assessments

ATMOSPHERIC SCIENCES: Global weather analysis and prediction, theater weather analysis and prediction, measurement techniques and tailored computer weather assessment models

ENVIRONMENTAL SIMULATION: Simulations of the physical environment and its effects on system performance and operations, integration and validation of standard atmospheric and space representations for use in system concept exploration to operations

DATA ANALYSIS: Space science information management systems, scientific visualization techniques, scene simulations, telemetry data processing, model development and archiving, space vehicle position and pointing determination

FACILITIES (on-site): High Temperature Mass Spectrometer, Data Analysis Facility, Payload Integration and Test, Comprehensive Weather Satellite Receiving and Processing Facility, Haskell Observatory (gravity measurements), Satellite Telemetry Processing

FACILITIES (off-site, mobile): Flying Infrared Signature Technology Aircraft, Tethered and High Altitude Balloon Platforms, Weather Test Facility at OTIS ANG Base, Goose Bay Labrador Ionospheric Observatory, Optical and Lidar Sounder Sites, Sacramento Peak Solar Observatory (operated jointly with the National Solar Observatory)

PHILLIPS LABORATORY, HANSCOM AFB AT A GLANCE, 1993

MISSION: Phillips Laboratory is a national leader in space research and development. Phillips Laboratory, Hanscom AFB, focuses primarily on geophysics - understanding the environment between the earth and sun and the effects of this environment on military systems. Phillips Lab, Hanscom, also does research on advance weapons and survivability - understanding how military systems can survive in the space environment; space missiles and technology - developing technologies that provide options and alternatives for space vehicles; and space experiments - conducting space experiments to gather scientific data and demonstrate technologies.

REPORTS (in turn) TO: Phillips Laboratory, Kirtland AFB, NM; Space and Missiles Systems Center, Los Angeles AFB, CA; Air Force Materiel Command, Wright-Patterson AFB, OH

BUDGET: 104.8 Million

PEOPLE: 467 Total - 369 Civilians, 98 Military

SPACE PHYSICS: Energetic particle, plasma, electric, and magnetic field space sensors; solar activity models and simulations; space radiation measurements and models; space disturbance forecasts; space environment impact on Air Force operational systems

OPTICAL ENVIRONMENT: Atmospheric transmission codes, lidar technology for atmospheric remote sensing, infrared background phenomenology, targets and backgrounds airborne measurements, infrared target and background codes

IONOSPHERIC EFFECTS: Ionosphere and neutral atmosphere models; ionospheric scintillation models; ionospheric disturbance effects on C3I space systems; satellite- and ground-based ionospheric sensors and measurements; high power RF ionospheric effects; environment composition surrounding space vehicles; plasma effects on aerospace vehicle signatures and sensors; composition of the space vehicle environment; space debris modeling

EARTH SCIENCES: Cryogenic inertial sensors; gravity models; seismology for the detection, location, and identification of explosions and other global events; seismic hazard assessments

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ENVIRONMENTAL SIMULATION: Simulations of the physical environment and its effects on system performance and operations, integration and validation of standard atmospheric and space representations for use in system concept exploration to operations

DATA ANALYSIS: Space science information management systems, scientific visualization techniques, scene simulations, telemetry data processing, model development and archiving, space vehicle position and pointing determination

AEROSPACE ENGINEERING: Payload design, telemetry, command and recovery systems; data-handling techniques for experimental payloads on balloons, rockets, satellites, and shuttle

SPACECRAFT INTERACTIONS: Optical sensing of spacecraft environment interactions, foreign spacecraft mission and payload identification, space object characterization using passive discrimination techniques, contamination effects minimization on spacecraft, space environment effects assessment on satellites

RADIATION HARDENED ELECTRONICS: Radiation damage in electronic devices, materials and integrated circuits; device development to improve tolerance to space radiation and single event upsets

FACILITIES (on-site): High Temperature Mass Spectrometer, Data Analysis Facility, Payload Integration and Test, Comprehensive Weather Satellite Receiving and Processing Facility, Linear Accelerator, Dynamatron Accelerator, Haskell Observatory (gravity measurements), Satellite Telemetry Processing

FACILITIES (off-site, mobile): Flying Infrared Signature Technology Aircraft, Tethered and High Altitude Balloon Platforms, Weather Test Facility at OTIS ANG Base, Goose Bay Labrador Ionospheric Observatory, Optical and Lidar Sounder Sites, Sacramento Peak Solar Observatory (operated jointly with the National Solar Observatory)

PHILLIPS LABORATORY/GEOPHYSICS DIRECTORATE

History

The Geophysics Directorate of Phillips Laboratory, which was formed on 13 December 1990, traces its origins back to 1947. In a 26 March 1947 directive General Curtis LeMay at Army Air Forces Headquarters ordered the Air Materiel Command (AMC) to assume responsibility for research and development in meteorology and related geophysical fields in the Air Force.

The responsibility for meteorological R & D had previously been delegated to the Air Weather Service, and so trained AWS personnel were transferred over to AMC. The Air Materiel Command immediately established an Atmospheric Laboratory as part of its Watson Laboratories in Red Bank, New Jersey.

This unit moved to Cambridge, Massachusetts, in November 1948 where it joined an existing electronics research group which had been recruited from the MIT Radiation Laboratory and Harvard's Radio Research Laboratory at the end of World War II. These two units became, respectively, the Geophysics Research Directorate (GRD) and the Electronics Research Directorate (ERD) under the Air Force Cambridge Research Laboratories (AFCRL).

Until the 1950s the laboratories were quartered in rented industrial space in Cambridge and Boston. Between 1954 and 1961 they gradually moved out to newly constructed permanent facilities at Hanscom Air Force Base, Bedford, MA. In 1976 the two electronics research laboratories were reassigned to the Rome Air Development Center (RADC) at Griffiss AFB, NY, and the eight geophysics laboratories of AFCRL were redesignated the Air Force Geophysics Laboratory (AFGL).

In December 1990 AFGL, together with the Air Force Weapons Laboratory and the Air Force Astronautics Laboratory (formerly the Rocket Propulsion Laboratory), were merged to form the new Air Force Phillips Laboratory (PL). Phillips Laboratory has its headquarters at Kirtland AFB, NM, and is managed by the Space and Missiles Center (SMC), Los Angeles, CA.

In the late 1940s the initial programs of the Geophysics Research Directorate focused on ionospheric propagation, meteorology, upper atmospheric and solar research, seismic-acoustic propagation, and rocket and balloon technology. By the 1960s GRD had also expanded into optical/infrared studies, space physics, satellite meteorology, geodesy and gravity, and technology for scientific payloads in space.

The programs conducted by the Directorate range from laboratory research and field measurements to theoretical studies, analyses, and modeling. In order to conduct geophysical field programs it maintains specialized mobile equipment, off-site facilities, and memoranda of understanding for support at a variety of global locations. The technical staff of the Geophysical Directorate currently consists of 231 assigned scientists and engineers (including military) of whom 99 have their doctorates.

December 1992
RPL

GEOPHYSICAL RESEARCH AND DEVELOPMENT IN THE AIR FORCE:

A HISTORICAL PERSPECTIVE

1945	*The Army Air Forces set up the Cambridge Field Station (CFS) at 224 Albany St., Cambridge, Massachusetts, to continue radar and electronic research after the war.*
1946	*CFS scientists launched the first of the Air Force's V-2 rockets, which carried instruments to probe the upper atmosphere.*
1947	*In response to a directive from Army Air Forces Headquarters, the Air Materiel Command set up a Geophysics Research Division within its Watson Laboratories in New Jersey.*
1948	*The Geophysics Research Division moved to the Cambridge Field Station from Watson Laboratories, New Jersey, joining CFS' Electronics Research Division.*
1949	*The Cambridge Field Station was renamed the Air Force Cambridge Research Laboratories (AFCRL).*
1950	*The Air Force announced that AFCRL would remain in the Boston area.*
1951	*AFCRL became the Air Force Cambridge Research Center (AFCRC) and landlord of Laurence G. Hanscom Field, Bedford, Massachusetts.*
1954	*The AFCRC laboratories began their move out to new permanent quarters at Hanscom Field.*
1956	*Scientists at AFCRC began the first program of chemical releases to study the upper atmosphere.*
1958	*The first successful U.S. satellite, Explorer 1, carried an AFCRC micrometeorite detector.*
	An AFCRC-designed rocket monochrometer made the first scans of the sun's extreme ultraviolet spectrum that gives rise to the Earth's ionosphere.
1960	*AFCRC became the Air Force Cambridge Research Laboratories (AFCRL) for the second time and a tenant at Hanscom Field.*
	Meteorologists at AFCRL made the first analysis of weather data from a satellite (TIROS 1).
1961	*Another "first"--a layer of stratospheric aerosols was named the Junge layer after the AFCRL scientist who discovered it.*
1962	*For Project Fishbowl in the Pacific, 247 Laboratory personnel and contractors gathered to study the effects of nuclear detonations on radio propagation and on optical systems. This was AFCRL's largest logistics operation.*
	While measuring lunar x-ray fluxes, an AFCRL scientist unexpectedly detected galactic sources of x-rays.

1963 An AFCRL "first"--scientists measured positive ions in the D-region, reshaping notions of the region's chemistry.

1965 Earth scientists at AFCRL successfully bounced a laser beam off a satellite, marking the debut of satellite laser geodesy.

1969 Another AFCRL "first"--scientists measured negative ions in the D-region of the upper atmosphere.

1970 AFCRL sponsored the pioneering Aspen Conference on Fourier Spectroscopy.

1972 The first edition of AFCRL's LOWTRAN code for modeling atmospheric propagation was published.

In a record-setting performance, AFCRL launched a 47.8 million cubic foot, single-cell balloon to an altitude of 170,000 feet.

1973 Another AFCRL "first"--scientists measured auroral infrared excitations during the ICECAP Program.

1976 AFCRL became the Air Force Geophysics Laboratory (AFGL).

1977 AFGL's cloud physics aircraft completed six seasons of meteorological support for missile reentry tests in the Pacific.

1978 Meteorologists used Doppler radar technology developed at AFGL to greatly improve the detection and tracking of tornadoes.

1980 AFGL launched its one-thousandth sounding rocket.

Earth scientists tested a new system for surveying. Utilizing satellite interferometry, they achieved accuracies to within centimeters.

1981 Space physicists at AFGL successfully tested a new device to deal with spacecraft charging at geosynchronous orbit.

1982 The Laboratory was assigned to the newly formed Air Force Space Technology Center (AFSTC).

1983 An AFGL "first"--an ultraviolet sensor aboard the HILAT satellite obtained the first high quality images of the aurora in full sunlight.

Ionospheric physicists at AFGL characterized alternating structures of irregularities that appear in the polar ionosphere.

1984 AFGL completed a statistical atlas of auroral electron precipitation for use by spacecraft designers.

1985 The Laboratory resumed management of research on seismic techniques for detecting underground nuclear blasts.

AFGL flew a 100,000 cubic foot tethered balloon up to the record-breaking height of 22,500 feet above mean sea level.

1988	*Another AFGL "first"--the ECHO-7 rocket experiment imaged an electron beam spiraling up one of the Earth's magnetic field lines.*
1989	*AFGL was redesignated the Geophysics Laboratory (AFSC).*
1990	*The rocket-borne EXCEDE III experiment simulated nuclear-induced effects in the upper atmosphere.*
	GL's Space Radiation Effects (SPACERAD) experiments were launched on the USAF/NASA Combined Release/Radiation Effects Satellite (CRRES) and made new breakthroughs in the study of space radiation.
	On 18 December the Geophysics Laboratory became part of the Air Force's new Phillips Laboratory. The majority of its former technical divisions was organized into a Geophysics Directorate (GP).
1991	*Another "first"--GP scientists made the first identification at the earth's surface of solar neutrons in association with relativistic solar protons.*
	The Space Shuttle Discoverer, STS-39, carried GP's Cryogenic Infrared Radiance Instrumentation for Shuttle (CIRRIS 1A) and several other highly successful infrared background experiments.

Cooperative Research and Development Agreements (CRDAs)

Company/ Organization	Product	Use
ONTAR Corp.	PC-LOWTRAN 7	Atmospheric Transimission Code
AER, Inc.	Global Spectral Climate Model	Effect of Anthropogenic Change on Environment
Rockwell Int.	Integrated GPS/INS System	Mineral/Petroleum Exploration
U. So. Florida	PC-HITRAN	High Resolution Optical Transmission Spectrum/Atmosphere
Salem State College	Internships	Simulation Laboratory (Simlab) Training
ONTAR Corp.	PC-MODTRAN	Atmospheric Transmission Code

Technology Transfer Opportunities

United States Air Force
Phillips Laboratory
Geophysics Technology Division
Plans and Programs Directorate
29 Randolph Road
Hanscom AFB, MA 01731-3010

TECHNOLOGY AT PHILLIPS LABORATORY
HANSCOM AFB, MA
AIR FORCE MATERIEL COMMAND

PROJECT NAME	DESCRIPTION	PROJECT LEADER	TELEPHONE
Space Effects on AF Systems	Sensors and software to measure and predict space environment and space system environment interactions	Ms Rita C. Sagalyn	(617)377-3226
Ionospheric Impact on AF Systems	Sensors and software to measure and predict theearth's ionosphere and its effect on RF propagating systems	Dr Paul Kossey	(617)377-2860
Optical/IR Systems Technology	Sensors and software to measure and predict the IR signatures of targets and atmospheric/celestial backgrounds	Dr Roger Van Tassel	(617)377-2951
Weather Impact on AF Mission	Sensors and software to measure, predict, process, and display weather	Dr Robert McClatchey	(617)377-2975
Terrestrial Effect on AF Operations	Sensors and software to measure earth, motions, gravity, position and distance	Mr James Battis	(617)377-3486
Aerospace Instrumentation Systems	Hardware to acquire, store, process and display data from rocket, balloon, and satellite experiments	Mr Neal Stark	(617)377-3004
Multispectral Sensing of Spacecraft Signatures	Capability for identifying space object mission and payload, state-of-the-art, multispectral (UV-visible IR) sensors to defect signatures.	Mr Charles P. Pike	(617)377-3177
Radiation Hardened Eelctronics	Material, techniques, and design methods to increase the availability of high performance radiation resistant circuits	Mr Walter M. Shedd	(617)377-4051

PROJECT OUTLINE

GOVERNMENT LABORATORY NAME:

Phillips Laboratory (AFMC)

PROJECT NAME:

Space Effects on Air Force Systems

PROJECT LEADER:

Rita C. Sagalyn

DIVISION:

PL/GPS

BRIEF DESCRIPTION:

The General objective is to define the impact of the Earth's space environment on Air Force systems and to achieve a capability for specifying, predicting, mitigating, and exploiting the effects to the space environment which can disrupt or degrade Air Force Operational Systems. Within this objective there are three major science and technology areas: Radiation Effects Characterization, Space Weather Specification/Forecasting, and Space Systems Environment Interactions Technology.

PATENT STATUS:

NONE

POTENTIAL COMMERCIAL USE:

SENSORS TO MEASURE SPACE ENVIRONMENT
SOFTWARE TO SPECIFY AND PREDICT SPACE ENVIRONMENT FOR DESIGNING AND OPERATING SPACE SYSTEMS
SPACECRAFT CONTAMINATION PREDICTION SOFTWARE
COMPACT (SPACECRAFT) ENVIRONMENTAL ANOMALIES SENSOR
SPACECRAFT CHARGE CONTROL SYSTEM

PROJECT OUTLINE

GOVERNMENT LABORATORY NAME:

Phillips Laboratory (AFMC)

PROJECT NAME:

Ionospheric Impact on Air Force Systems

PROJECT LEADER:

Dr. Paul Kossey

DIVISION:

PL/GPI

BRIEF DESCRIPTION:

The objective is to define the physical and chemical characteristics of the ionosphere and to develop an understanding of how it affects the propagation of electromagnetic radiation. The specific areas include, ionospheric composition and dynamics, ionospheric disturbances, ionospheric effects, ionospheric circulation, charged/neutral particle characteristics and interactions, ionospheric modifications, ultraviolet emissions and absorption, and upper atmospheric density variations.

PATENT STATUS:

VLF/LF PULSE IONOSOUNDER, AND INERTIAL NAVIGATION SYSTEM DATA INTERFACE BOX

POTENTIAL COMMERCIAL USE:

GROUND, AIRCRAFT AND SATELLITE-BASED IONOSPHERIC SENSORS
MASS SPECTROMETERS
SOFTWARE TO SPECIFY AND PREDICT IONOSPHERIC CONDITIONS AND METEOR BURST
COMM. ULTRA VIOLET SENSORS
LIDARS, ENVIRONMENTAL MONITORING

PROJECT OUTLINE

GOVERNMENT LABORATORY NAME:

PHILLIPS LABORATORY (AFMC)

PROJECT NAME:

OPTICAL/IR SYSTEMS TECHNOLOGY

PROJECT LEADER:

DR. ROGER VAN TASSEL

DIVISION:

PL/GPO

BRIEF DESCRIPTION:

The general objective is to measure and predict the optical and infrared geophysical environment and its effects on Air Force and DoD surveillance, reconnaissance, and weapons guidance systems. Within this objective there are six major research areas: Target Detection Technology, Airborne Infrared Measurements, Auroral/Airglow/Nuclear Atmospheric Backgrounds, IR Atmospheric Processes and Background Codes, Infrared Celestial Backgrounds, and Atmospheric Propagation Studies.

PATENT STATUS:

LOWTRAN 7 COMPUTER CODE
HADAMARD SPECTROGRAPH

POTENTIAL COMMERCIAL USE:

IR SENSORS
IR ATMOSPHERIC TRANSMISSION SOFTWARE
IR TARGET AND BACKGROUND SIGNATURE MEASUREMENTS AND PREDICTION SOFTWARE
LIDARS

PROJECT OUTLINE

GOVERNMENT LABORATORY NAME:

Phillips Laboratory (AFMC)

PROJECT NAME:

Weather Impact on Air Force Mission

PROJECT LEADER:

Dr. Robert A. McClatchey

DIVISION:

PL/GPA

BRIEF DESCRIPTION:

The general objective is to develop predictive and descriptive models of the atmosphere from the global to the microphysical scale and to improve sensors and techniques to measure environmental parameters both in-situ and remotely from the ground, from aircraft and from satellite platforms.

PATENT STATUS:

PARTICULATE MASS MEASURING APPARATUS
RAIN RATE METER
HEAVY RAIN RATE
SNOW SCALE/RATE METER
PRECIPITATION FALL VELOCITY INDICATOR/VIEWER
APPARATUS FOR CONTINUOUSLY INSPECTING PHYSICAL CHARACTERISTICS OF PARTICULATE MATTER
PROCESS FOR ELIMINATION OF NOISE FROM DATA

POTENTIAL COMMERCIAL USE:

METEOROLOGICAL SENSORS (GROUND AND SATELLITE-BASED)
SOFTWARE TO SPECIFY AND PREDICT WEATHER CONDITIONS
WEATHER INFORMATION DISPLAY TECHNOLOGY
AUTOMATIC WEATHER DATA PROCESSING SOFTWARE
WEATHER SIMULATION SOFTWARE

PROJECT OUTLINE

GOVERNMENT LABORATORY NAME:

Phillips Laboratory (AFMC)

PROJECT NAME:

Terrestrial Effects on Air Force Operations

PROJECT LEADER:

Mr. James Battis

DIVISION:

PL/GPE

BRIEF DESCRIPTION:

The general objective is to advance technology in the areas of geodesy, gravity, seismology, and geodynamics to solve Air Force problems in navigation, guidance, inertial testing, motion-sensitive instrumentation, and nuclear test monitoring.

PATENT STATUS:

SEISMO ACOUSTIC DETECTION, IDENTIFICATION AND TRACKING OF STEALTH AIRCRAFT

POTENTIAL COMMERCIAL USE:

GRAVITY SENSORS
GRAVITY DATA PROCESSING SOFTWARE
INERTIAL AND ASTRONOMIC POSITION DETERMINATION TECHNIQUES
EARTH MOTION SENSORS AND PREDICTION TECHNIQUES
CRYOGENIC INERTIAL SENSORS
PRECISE BASELINE DETERMINATION USING GPS

PROJECT OUTLINE

GOVERNMENT LABORATORY NAME:

Phillips Laboratory (AFMC)

PROJECT NAME:

Aerospace Instrumentation Systems

PROJECT LEADER:

Mr. Neal Stark

DIVISION:

PL/SXA

BRIEF DESCRIPTION:

The goal is to develop state-of-the-art instrumentation to control and acquire data from sounding rocket and satellite flights. These are two specific objectives. Flight Instrumentation Systems is concerned with improving state-of-the-art capabilities for acquiring and storing data on-board flight systems. Ground instrumentation Systems develops state-of-the-art improvements in stationary and portable telemetry receiving, processing, tracking and display.

PATENT STATUS:

NONE

POTENTIAL COMMERCIAL USE:

SMALL, RUGGED, HIGH DATA RATE/CAPACITY LOW POWER DATA ACQUISITION SYSTEMS
STATIONARY AND PORTABLE TELEMETRY AND TRACKING SYSTEMS

PROJECT OUTLINE

GOVERNMENT LABORATORY NAME:

Phillips Laboratory (AFMC)

PROJECT NAME:

Multispectral Sensing of Spacecraft Signatures

PROJECT LEADER:

Mr. Charles P. Pike

DIVISION:

PL/WSSI

BRIEF DESCRIPTION:

Project objective is to provide a capability for identifying space objects in terms of their mission and payload through the use of state-of-the-art, multispectral (UV-visible IR) sensors to detect signatures.

PATENT STATUS:

NONE

POTENTIAL COMMERCIAL USE:

GROUND/SPACE-BASED MULTISPECTRAL SENSORS FOR (1.) REMOTELY OBSERVING SATELLITE HEALTH AND STATUS AND STATUS AND ASSESSING OPERATIONAL ANOMALIES (2.) REMOTE SENSING OF ATMOSPHERIC COMPOSITION AND EARTH RESOURCES.

SPACECRAFT CONTAMINATION PREDICTIVE SOFTWARE FOR SATELLITE DESIGNERS AND OPERATORS.

PROJECT OUTLINE

GOVERNMENT LABORATORY NAME:

Phillips Laboratory (AFMC)

PROJECT NAME:

Radiation Hardened Electronics

PROJECT LEADER:

Mr. Walter M. Shedd

DIVISION:

PL/VTER

BRIEF DESCRIPTION:

The goal of the program is the demonstration of key technologies to maximize the radiation resistance of eletronic devices and integrated circuits for application in space systems. This includes the use of improved materials, processing techniques and circuit design methods to enhance the availability of high performance radiation resistant circuits. The effort also includes the study of the basic interactions of radiation with electronic materials and devices, including dosimetry, radiation induced defects in semiconductors and the mechanisms of energy deposition in electronic materials. Radiation test facilities are available to evaluate the radiation hardness of test devices and prototype integrated circuits.

PATENT STATUS:

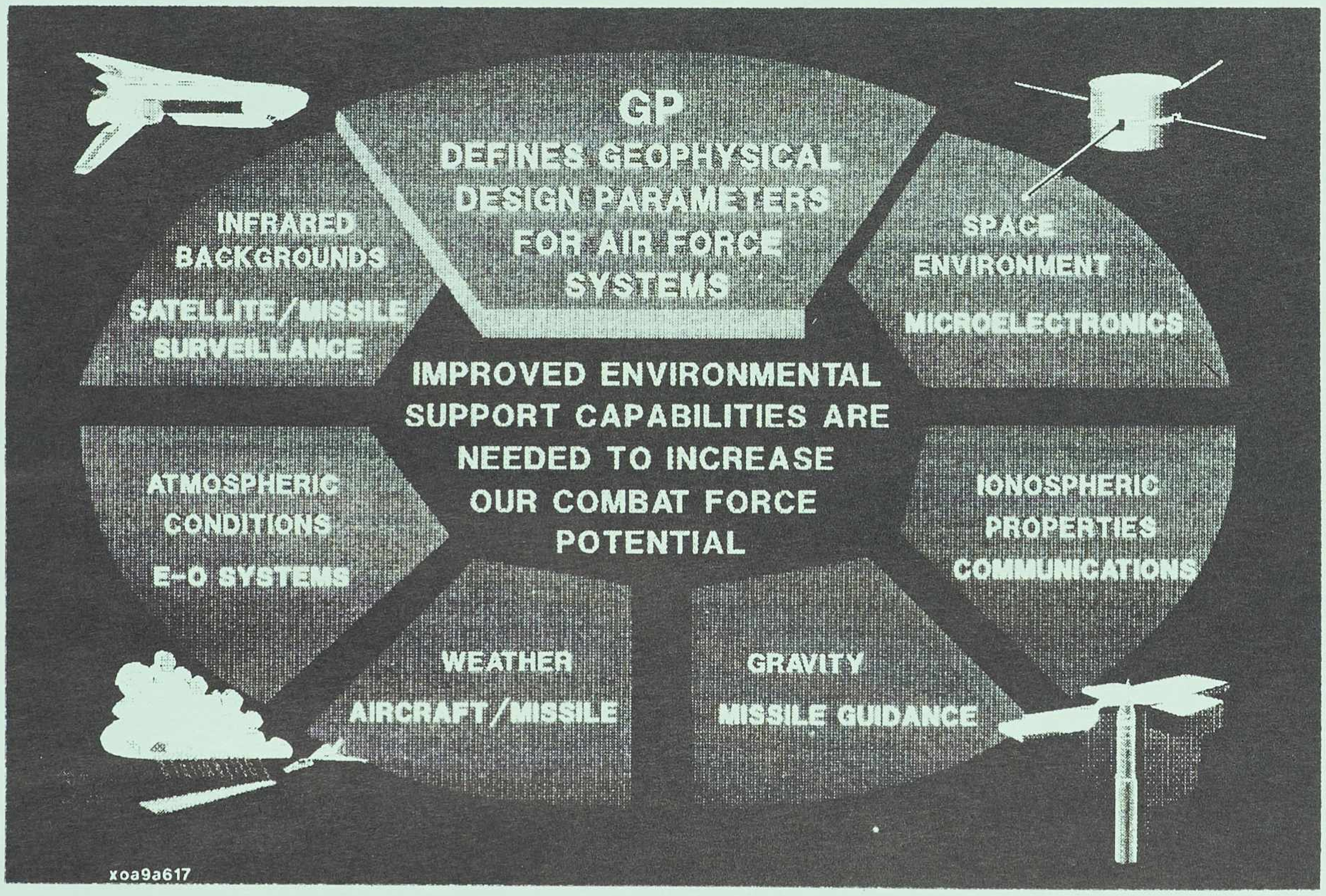
NONE

POTENTIAL COMMERCIAL USE:

COMPONENTS FOR SATELLITE SYSTEMS
DIELECTRICALLY ISOLATED DEVICES FOR HIGH SPEED, HIGH DENSITY CIRCUITS

FOR OFFICIAL USE ONLY

GEOPHYSICS DIRECTORATE TECHNOLOGY TRANSITIONS TO USERS FY92



PHILLIPS LABORATORY
GEOPHYSICS DIRECTORATE
HANSCOM AFB, MA 01731

OCTOBER 1992

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FOREWORD

We feel it is important to document and publicize the total number of actual transitions from Phillips Laboratory (PL/GP) to users which take place during a given time period, especially with the increasing emphasis in Air Force Materiel Command (AFMC) on technology transition (T^2) as a measure of a laboratory's performance. Documenting transitions of major "pieces" of geophysics technology, be it hardware or software, that occur in a fiscal year is relatively easy. However, there are many other unheralded but nonetheless important technology transitions that also occur. This sixth annual report was prepared with the goal of also making these other transitions known to higher headquarters.

We believe that the three program elements (PE 62101F, PE 63410F, and PE 63707F) and the several PE 61102F tasks that PL/GP manages are prolific producers of technology needed by the Air Force and the Department of Defense. Over 70% of the FY92 technology transition events documented in this report were produced by these PEs, whose FY92 funding totaled a modest $61M (giving credence to the statement that PL/GP manages the technology transition process very well). Capt Edward Harrison, USN, responsible for environmental sciences R&D in the Office of the Undersecretary of Defense, Research and Engineering (1987), said,

"PE 62101F is the single most important PE in DoD in the environmental sciences. It has the greatest payback; it is clearly solving requirements and is of great breadth and scope."

Prepared by:

Mr. Charles C. Gallagher
Technology Transition Manager
Geophysics Division (XPG)
Plans and Programs Directorate
Phillips Laboratory
DSN: 478-3606
April 1993

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EXECUTIVE SUMMARY

This is the sixth annual report that documents the total number of technology transitions (T^2) to users, both major and minor, that the three Phillips Laboratory (PL/GP) "geophysics" program elements (PE 62101F, PE 63410F, and PE 63707F) produced in FY92. Also included are transitions produced by PE 61102F "geophysics" tasks that we manage for the Air Force Office of Scientific Research (AFOSR), and technology transitions developed from customer dollars.

This is also the second Technology Transition Report since the Geophysics Laboratory (GL) became the Geophysics Directorate (GP) of the newly formed Phillips Laboratory (PL). With this change, the Aerospace Instrumentation Division and the Spacecraft Interaction Branch of the Space Physics Division, both part of GL, became aligned with other directorates within PL. As a result, their technology transitions are no longer chronicled in this series of reports.

Seventy-six events in FY92 met our stringent criteria for technology transition; i.e., the technology was actively "moved" by PL/GP personnel to a DoD or NATO organization, and that organization is using or has firm plans to use the technology. Excluded were routine technical consultations that PL/GP regularly provides to users of geophysics technology. Technology moved to non-DoD government organizations has been excluded from this report but will be catalogued separately under "Technology Transfer" along with the technologies moved to the non-government sector.

The reason for the large number of technology transitions is twofold: geophysics technology is inherently easy to transition, and PL/GP uses particularly effective technology transition mechanisms.

There are five reasons why geophysics technology is relatively easy to transition:

- Most geophysics technology is design information or techniques, instead of hardware which is much riskier and thus, more difficult to transition.

- Geophysics technology is unique information sought after by the design community.

- Geophysics technology is mostly a response to more easily transitionable requirements pull, not technology push.

- Funding for geophysics has been leveraged with customer funding, thereby giving the user a stake in the technology and helping to ensure its transition.

- A significant portion of geophysics technology goes directly from 6.1, 6.2 or 6.3 programs to operational commands without having to be accepted by a product division.

There are several effective mechanisms that PL/GP employs to ensure that the technology produced is used. An important one is a "people-bridging" mechanism based on the fact that one of our biggest customers is Air Weather Service (AWS). Many former AWS officers and current AWS reserve officers are employed at PL/GP or under PL/GP contracts, and are involved in producing AWS-needed technology. Working level relationship between AWS and PL/GP are also encouraged through the unique AWS Geophysical Requirements (GR) process. AWS uses the GR process to document and prioritize its technology needs, and PL/GP uses it to guide its investment strategy. Progress on GRs is reviewed annually by AWS and PL/GP commanders and their staffs at AWS/GP Forums, which have been held since 1971. The GRs are based on operational requirements for geophysics technology surfaced by scientific officers that AWS assigns to the staff of every Air Force operational command. A more recent (1986) T^2 mechanism that PL/GP and AWS have jointly developed is the AWS/GP Technology Transition Working Group. This group meets twice a year to develop plans and strategies to transition computer algorithms from PL/GP 6.1/6.2/6.3 programs to operational use at the Air Force Global Weather Central (AFGWC) and the Air Force Space Forecast Center (AFSFC).

Other effective T^2 mechanisms involve technology brokers who both actively market geophysics technology and help to determine technology requirements. We have brokers of geophysics technology in the staff meteorologists (STAFFMETs) assigned to every Air Force Materiel Command (AFMC) product division, test and launch center, and laboratory. The STAFFMETS can be thought of as an extension of PL/GP, marketing GP technology and surfacing geophysics technology requirements.

Establishing long-standing working and management level relationships with product division system program offices (SPOs) is another mechanism successfully employed by PL/GP. A prime example is our relationship (and MOA) with the SMC Defense Meteorological Satellite Program (DMSP) SPO. That relationship enables PL/GP and DMSP to pre-agree and jointly fund technology needs so that when the technology is produced, it readily transitions.

PL/GP uses Technology Transition Plans with product divisions for PEs 63410F and 63707F. In addition (working with HQ USAF and AWS) we have developed a "built-in" mechanism for T^2 in PE 63707F. Since 1986, the PE 63707F Program Management Directive (PMD) has provided specific funding and direction for transitioning environmental specification and forecast techniques developed under PE 62101F.

A long-standing mechanism for the transfer of geophysics technology has been the Handbook of Geophysics and the Space Environment, first published in 1957. The latest edition, published in 1985, compiles what is known about the geophysics environment into one document specifically tailored to the special needs of the Air Force.

Finally, a key to our success in transitioning geophysics technology is the "hand-holding" activities that PL/GP conducts which are needed to make T^2 work. We simply do not just publish a geophysics technical report and assume that technology transition will occur by somebody reading the report. Instead we work hand-in-hand with the customers of geophysics technology, right from the requirements definition stage all the way to operational implementation of the technology. In this way, we nurture the "fragile" transition process and solve any problems the customer has with the new geophysics technology.

The 76 technology transitions that occurred in FY92 were analyzed by technology type and thrusts. Fifty-one percent of the transitions consisted of specifications or information on the environment used to help design or operate Air Force systems, Thirty-eight percent were models, software, and algorithms to design or support systems operations, and eleven percent were hardware items. Technology transitions that commenced prior to FY92 and continued into FY92 were not included in this report unless there were new customers.

The FY92 technology transitions provided more than 109 technology contributions because individual technology transitions often went to multiple users. Air Force organizations received 69% of such contributions; the Strategic Defense Initiative Organization 8%; and the Defense Nuclear Agency, Defense Mapping Agency, Army, Navy, DARPA, other DoD and the North Atlantic Treaty Organization received the remaining 23%.

Included in the report are several specific examples of FY92 technology transitions chosen to show the breadth of geophysics technology transition. These were drawn from "big" and "small" technology contributions, different technology types, and different users.

1. INTRODUCTION

This report documents the transition of technology from Phillips Laboratory, Geophysics Directorate (PL/GP) to the Air Force, other Department of Defense (DoD), and North Atlantic Treaty Organization (NATO) users that occurred during FY92. Classified program transitions are not included. Appendix A forms the basis of the report. It is a chronological compilation of the transitions occurring during the period of 1 October 1991 to 30 September 1992. A total of 76 events are listed in Appendix A.

For some events the date listed is the first date during FY92 on which the technology transition occurred even though additional technology transitions of the same technology to the same user may have also occurred on other dates in FY92. These later transitions are not counted as additional T^2 events for this report. Similarily, transition of the same technology may have occurred to more than one user. These are also counted as only one event. The date listed is the date when the technology was transitioned to the first user.

In addition to listing the date and the technology that was transitioned, Appendix A also lists the PL/GP organization(s) responsible for the transition (an organization chart is included in the back of the report), the user(s), the payoffs to the user, and the "wellspring" program element (PE). This last item is meant to give due recognition to the three program elements (PE 62101F, 63707F, and 63410F) and PE 61102F tasks that PL/GP manages even though the effort may also have received funding from other sources. The criterion used to assign a wellspring PE is that if the technology transition came about because PL/GP has had a 6.1, 6.2 or 6.3 program in that technology area, then the GP program element is listed; if not, another PE is listed.

For this report a technology transition event is defined as having occurred when there is an active transfer of technology between PL/GP and DoD users of that technology. Also, the user has made, is making, or has firm plans to use this technology. Excluded are technical consultations that PL/GP regularly provides to users of geophysics technology.

Section 2 gives more detail on what we view technology transition to be. Formerly, technology moved to non-DoD government users was included in the Technology Transition (T^2) report, but, since FY90, it has been documented separately under "Technology Transfer" along with transfers to non-government recipients.

Section 3 presents a summary of the mechanisms that PL/GP uses to manage the technology trainsition process effectively.

Section 4 is an analysis of the FY92 technology transition events in terms of what kind of technology was transitioned, who the FY92 users of PL/GP technology are, and which PL/GP major thrusts are producing the technology. Appendixes B,C, and D provide the data to support this analysis.

Examples drawn from Appendix A make up section 5. Here we not only highlight some of our most significant T^2 events, but also the less "glamorous", though often equally important ones, to show the breadth of PL/GP technology contributions.

2. WHAT IS TECHNOLOGY TRANSITION?

The laboratory community often takes a restrictive, narrow view of technology and the technology transition process. Technology is usually considered an object, i.e., hardware. More recently, the notion that technology can also be software has been accepted, but we really should take the much broader view that technology is really know-how and information generated by a laboratory R&D program. Technology transition is more than just specific items

of hardware and software. This broader definition is legitimate because the know-how and information that we transition are used to satisfy technology requirements. We use this broader view for this report.

Our customary view of the technology transition process is also a narrow one. We often have the notion that technology transition is a linear batch process, that is, a hand-over of technology occurs at set times as technology moves from 6.1 to 6.2, to 6.3, to 6.4, and finally to system production. Some transition of laboratory technology occurs that way; but most sucessful transitions occur as part of a technology flow process -- a continuous, parallel process -- with many interactive loops between users and developers of technology.

Geophysics technology and, in particular, its transition, exhibit the latter traits of a continuous, parallel process. Most geophysics technology is neither hardware nor software (as Section 4 will show), but is information about the natural or nuclear-disturbed environment that is needed to design systems to operate in or exploit the environment. Most often that information is generated within our 6.2 program element (PE 62101F) and goes directly to a user rather than to a 6.3 program element. Our relationship with users is often a close and interactive one with "pieces" of geophysics technology being continuously transitioned for use. The time interval between development and use of geophysics technology is usually on the order of 5 years or less, much less than the typical 15 years found in the more hardware oriented technologies. This means we actually put "rubber on the ramp" faster!

We agree that geophysics, for the most part, does not produce revolutionary technology. Most geophysics technology is unglamorous; but we should keep in mind that because America has been so accustomed to expecting high technology to increase our military capabilities, we often overlook the significant military contribution that low and unglamorous technology has made and continues to make.

3. HOW PL/GP MANAGES THE T^2 PROCESS

Transition of technology from the developer to user has been traditionally difficult in both the commercial and government sectors. For T^2 to work well, an organization needs to use non-traditional mechanisms that have proven to be successful.

First of all, an organization's mindset has to change from regarding T^2 as a simple one-time linear hand-over process between developer and user, to regarding T^2 as a continuous, hand-holding, iterative, technology flow process from initial technology program planning to operational implementation of the technology. T^2 is really a contact sport! PL/GP has and is effectively playing this sport, as will be illustrated with examples shortly.

3.1 GEOPHYSICS IS "EASY" TO TRANSITION

Before discussing the various sucessful T^2 mechanisms that PL/GP uses, it must be pointed out that geophysics technology is inherently a relatively "easy" technology to transition. There are several reasons for this. One is that geophysics technology is generally not "hardware" technology. New hardware technology is often difficult to transition because it generally introduces uncertainty/risk into programs, and program managers dislike risk.

The second reason is that goephysics produces unique data and models that define the environment in which military systems operate. This information is usually needed by the military system design community, and is generally not available anywhere in the commercial sector or in other Air Force laboratories.

A third reason that makes geophysics technology "easy" to transition is that, for the most part, geophysics technology is a response to requirements-pull rather than technology-push, that is, geophysics technology is produced mostly in response to the design or operational needs of current, planned, or conceptual systems. As past research in the area of technology transition has shown, requirements-pull technology is much more apt to transition than technology-push technology (at least within a 20-year period following the development of the technology). In addition, the elapsed time from the start of a technology development program to technology use will be much shorter for a requirements-pull technology.

A fourth reason is that geophysics program elements have historically been low funded vis-a-vis requirements for geophysics technology. This has forced PL/GP geophysics technology managers to actively seek and obtain supplemental funds from technology users in order to be able to develop the needed technology. The user, having a stake in the technology development, helps ensure that the technology will be transitioned and used.

A fifth and final reason for "easy" technology transition is that a significant portion of geophysics technology goes directly from either 6.1, 6.2, or 6.3 programs to operational customers without having to be transitioned to a product division. PL/GP has (under it's various successive designations) been the research and development arm of the Air Weather Service since shortly after WWII for atmospheric/space weather sensors and specification/forecast techniques. We have a very close relationship with AWS through frequent management and working level visits and contacts during each year. For instance, rather than PL/GP developing on their computers software technology that will eventually be transitioned to AWS computers at the Air Force Global Weather Central (AFGWC), a data link was established in April 1987 between the then Geophysics Laboratory (GL) and AFGWC so that GL could have access to the operational computer environment and data bases at AFGWC.

3.2. T^2 MECHANISMS USED BY PL/GP

To have individuals from the technology using organization within the technology developing organization and vice-versa, is a recognized useful mechanism for transitioning technology. Long before we were part of the Air Force Materiel Command (AFMC) and Phillips Laboratory, we recognized that geophysics technology would be needed by emerging space and missile systems. We therefore established, in 1967, a West Cost Office (WCO) within the (then) Space and Missile Systems Office. This small group of professionals, headed by a GM-15, was made up of technical personnel from the Air Force Cambridge Research Laboratories (AFCRL -- our designation at the time) who were familiar with our geophysics technology. The WCO served as a broker of geophysics technology to the then Space Systems Division (SSD) and the Ballistic Missiles Office (BMO) system program offices (SPOs) by becoming intimately aware of SPO technology requirements and advocating use of geophysics technology where needed. Although the WCO no longer exists, unique long-standing arrangements have developed between the west coast SPOs and GP. These arrangements create the people-to-people relationship essential to successful technology transition.

One prime example is the relationship that PL/GP has with the SMC Defense Meteorological Satellite Program (DMSP) SPO. We have been working closely with the DMSP SPO for over 20 years. Our initial support involved helping design satellite weather sensors to remotely measure atmospheric parameters. That expanded to designing and building space weather sensors to fly as operational

sensors on DMSP satellites. In addition to sensor development, PL/GP has also been developing techniques and software to process and analyze the data obtained by DMSP sensors.

These close but ad hoc relationships were formalized in 1983 with the establishment of a Memorandum of Agrement (MOA) between GL and DMSP which is updated each year. In FY92, DMSP provided $3.3M to leverage the $3.0M and 12 man years ($0.8M) that PL/GP had invested in R&D related DMSP-needed technology. In addition to frequent interactions at the working level, the GP Director and technical staff meet with the SPO Director and his staff twice a year to review the jointly-funded programs. During the Fall 87 meeting, Col Curtis, the DMSP SPO Director said "It's been a good relationship and I am very pleased. We [GL/DMSP relationship] are a model for the rest of of the laboratories."

For their investment, DMSP has in effect acquired its own dedicated R&D organization which produces the technology it needs and wants in a timely manner. PL/GP personnel are also available to provide on-call technical assistance to DMSP, such as technical advice related to a DMSP-managed contract or serving on a source selection board. In return, PL/GP obtains funds to leverage its own investment, allowing its research to become more focussed on a definite user requirement, and giving PL/GP researchers an opportunity to see their technology directly applied to a real problem.

Also, we have had, for many years, geophysics technology brokers in every AFMC product division, test and launch center, and laboratory. This is accomplished through the staff meteorologists (STAFFMETS) assigned to these organizations. Through their primary function of ensuring that the environment is adequately considered in system design and test, the STAFFMETS market our technology and uncover user needs for geophysics technology.

In their roles, STAFFMETS are critical links in translating user needs into requirements for new goephysics technology development programs and requests for short-term system support by PL/GP scientists and engineers. STAFFMETS play a key role in transitioning the results of PL/GP geophysics technology to developers and users of Air Force systems. PL/GP technology managers are made aware of STAFFMET uncovered needs for geophysics technology through direct and frequent communications, and through an annual three-day conference at PL/GP, at which time STAFFMETS brief geophysics technology requirements, and PL/GP briefs its current and planned technology programs.

In addition to the STAFFMETS, there are staff weather officers (SWOs) on the headquarters staff of all Air Force unified and specified operational commands. These weather officers are key players in another mechanism that PL/GP employs to transition technology more effectively. This is the AWS Geophysical Requirements (GR) process. GR's are documented requirements for geophysics technology (including space weather) based on operational needs as determined by the SWOs working with the operational commands. The GRs are prepared by AWS in cooperation with PL/GP, biennially prioritized and updated by AWS, and used to guide our investment strategy. The status of PL/GP technology programs supporting the GRs and the transition of the technology to AWS form the basis for the annual AWS/GP Forum. These one and one-half day meetings, between the commanders and staff of AWS and PL/GP, have been held since 1971 and represent yet another vehicle for ensuring the smooth transition of PL/GP technology to the user.

A more recent T^2 mechanism that PL/GP and AWS have jointly developed is the AWS/GP Technology Transition Working Group. This group, formed in 1986, manages the transition of geophysics algorithms and computer codes from GP to AWS for

operational use at the AFGWC and the Air Force Space Forecast Center (AFSFC). This group is made up of management and working level representatives from GP, HQ AWS, AFGWC and AFSFC. They meet twice a year at AFGWC -- on the operational user's turf. The working group develops transition strategies and schedules which have proved to be highly effective in ensuring that the GP-developed algorithms and codes meet the needs of AFGWC, but are also quickly and efficiently transitioned to AFGWC.

Another effective T^2 mechanism that PL/GP employs (when appropriate) is moving the technology intended for system design to not just the SPOs, but to the contractors of the SPOs as well and to industry in general. This latter mechanism has been cited in recent research on T^2 as most effective.

A long-standing mechanism for transfer of geophysics technology has been the Handbook of Geophysics and the Space Environment. First published by AFCRL in 1957, the fourth edition (published in 1985), compiles what is known about the geophysics environment into one document specifically tailored to the special needs of the Air Force. It has been the standard reference for the environment used by designers of aerospace systems since it was first published.

For its two 6.3 program elements, PL/GP uses Technology Transition Plans with product divisions as a T^2 mechanism. In addition, PE 63707F, Weather Systems (Advanced Development), has a "built-in" mechanism for T^2. This PE was established in 1981 through a concerted effort by Air Force Geophysics Laboratory (AFGL -- our designation at the time), the then HQ AFSC/DL, and AWS and its representatives at HQ USAF. These agencies recognized that a bridging mechanism was needed to convert GP geophysics technology from a 6.2 level of development to direct use by AWS or the then Electronic System Division's PE 64707F, Weather Systems (Engineering Development). Much of 6.2 geophysics technology, particularly in the area of weather prediction techniques, could not be of the form needed or sufficiently validated (because of its 6.2 nature) to make a transition. PE 63707F is now providing that bridging mechanism. Initially, the PE 63707F Program Management Directive (PMD) accommodated only the transition of a few specific and narrowly defined technologies. In 1986, a new PMD entitled Environmental Technology Transition was astablished. This PE 63707F PMD provides the mechanism to transition essentially any 6.2 geophysics technology required by AWS.

4. PL/GP FY92 T^2 STATISTICS

There were seventy-six geophysics technology transition events produced by PL/GP in FY92. The wellspring program elements (as defined in Section 1) for most of these transitions were PEs 61102F, 62101F, 63410F, and 63707F. These events are listed in Appendix A and include:

- Exampes of both "big" and "small" geophysics technology contributions;
- Technology of various types, e.g., specification/information, models, software, and hardware;
- Various users from Air Force operational commands to AFMC and other users;
- Contributions in many mission areas; and
- Contributions from all of GP's major thrusts.

Appendixes B,C,and D, respectively, give the statistics by technology type, users, and GP major thrusts.

4.1 TECHNOLOGY TYPE ANALYSIS

Geophysics technology is primarily specifications or information on the environment so that systems can be designed to operate in this environment. Appendix B shows that in FY92, 51% of the transitions were of this nature. Geophysics technology is also models, software, and algorithms used for designing or to support system operations. This second type of technology accounted for 38% of the FY92 transitions. GP's main technology is not hardware. Hardware type technology only accounted for 11% of the transitions.

4.2 USER ANALYSIS

Appendix C is the analysis of the PL/GP FY92 technology transition events by users. GP tailors its technology to meet the needs of specific users. However, because geophysics is a pervasive technology, a given technology transition event, even though tailored, may have provided technology to more than one user. Of the technology transition events, several went to two or more users. These events translate into technology contributions. A total of 109 technology contributions occured in FY92. Also, it should be pointed out that in several instances the same technology transitioned to other customers in previous years, but only the new customers in FY92 are listed in this report. The Air Force Materiel Command accounted for 40% of the technology contributions. All together, the Air Force received 69% of the contributions. Outside of the Air Force, the other major recipients of geophysics technology were the Strategic Defense Initiate Office (SDIO) with 8% and the Navy with 9%.

4.3 PL/GP THRUST ANALYSIS

The final analysis is by GP thrusts (Appendix D). PL/GP markets its technology under five major thrusts:

Ionospheric Impact on Air Force Systems, with 33% of the total contributions, made the most contributions to geophysics technology transitions in FY92. This thrust defines the physical and chemical characteristics of the ionosphere and develops an understanding of how the ionosphere affects the propagation of electromagnetic radiation used by AF communication and surveillance systems. Contributions were mainly in the areas of specifications and predictive models of the effects of the ionosphere and upper atmospheric density on current and planned Air Force command, control, communications, and intelligence systems, and other systems.

Optics and infrared Technology had the next highest contribution (24%). The objective of this thrust is to measure and predict the optical and infrared properties of the environment and its effects on Air Force and DoD surveillance, reconnaissance, and weapons guidance systems. The technology transitions consisted primarily of specifications of infrared signatures of targets and backgrounds, and radiation propagation codes.

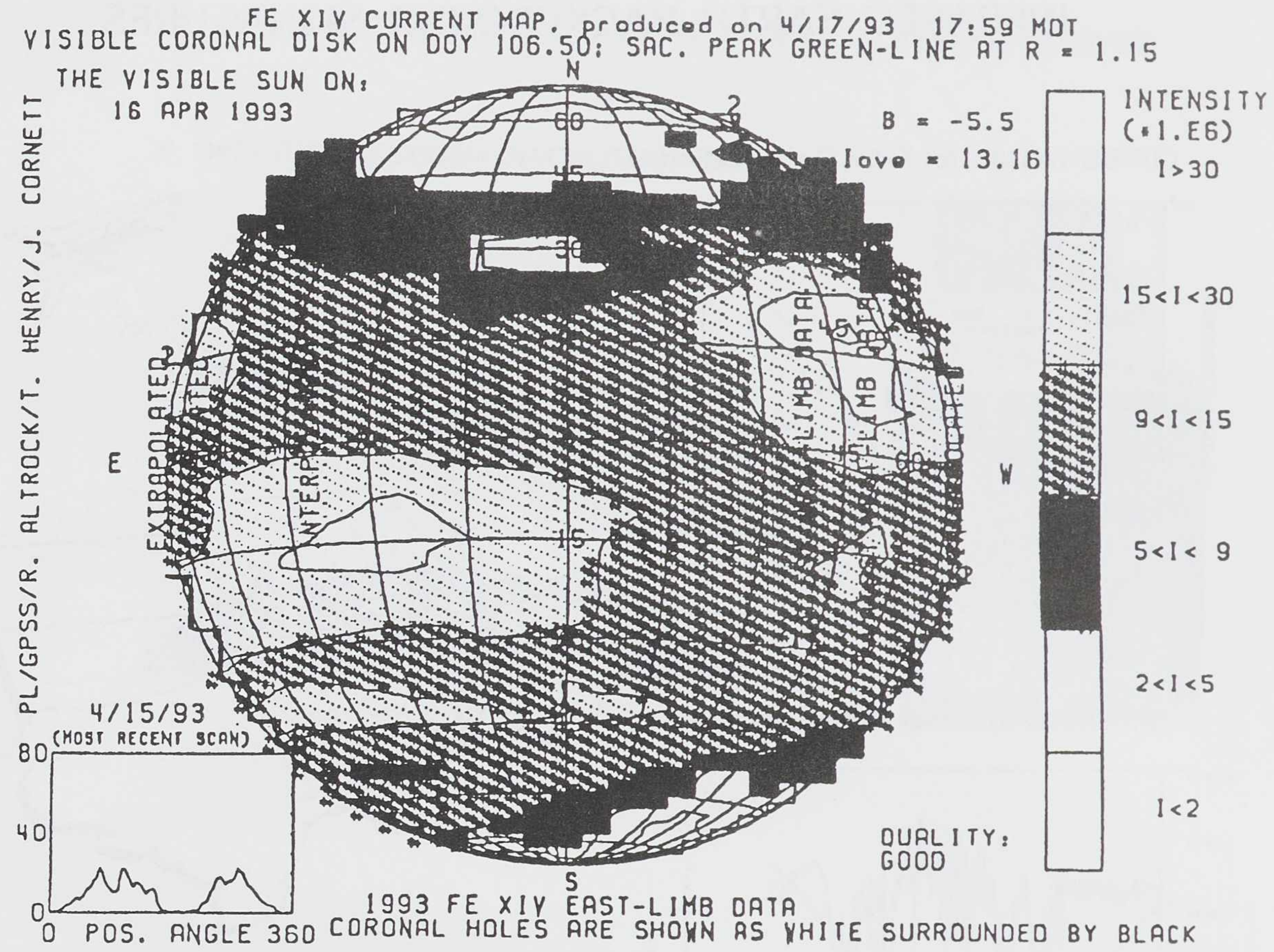
Weather Impact on Air Force Systems had 16% of the contributions. This thrust develops improved instrumentation and techniques for measuring, processing, analyzing, modeling, and predicting meteorological properties which impact the Air Force mission. The contributions this year were mainly in the areas of weather specification and prediction software.

Space Effects on Air Force Systems also provided 16% of the contributions. This thrust defines the impact of the Earth's space environment on Air Force space systems to achieve a capability for specifying, predicting, mitigating, and exploiting the effects of the space environment. The contributions were mainly in the areas of specifications (software and hardware) used to define the space environment and its effect on space systems.

Terrestrial Effects on Air Force Systems produced 11% of the contributions. Its objective is to advance technology in the areas of geodesy, gravity, seismology, and geodynamics to resolve Air Force problems in navigation, guidance, inertial testing, motion-sensitive instrumentation, and nuclear test monitoring. This year's contributions were mainly in the areas of seismic studies as well as gravity studies for improved navigation.

Two new thrusts were added in FY92. They are Geophysics for Synthetic Environments and Geophysics for Environmental Quality. Personnel supporting these thrusts are located in the various divisions supporting the major thrusts and any transitions emanating from the new thrusts in FY92 are reported under the five major thrusts.

5. FY92 TECHNOLOGY TRANSITION EXAMPLES



SOLAR DATA FOR SPACE FORECASTING

TECHNOLOGY DESCRIPTION: Solar coronal data and sunspot drawings aid in determining the location of new solar activity centers and "coronal holes". The appearance of activity centers results in an increased background level of ionizing radiation that affects terrestrial atmospheric heating and produces an increased probability for outbursts of activity that produce wide-spread geophysical effects. "Coronal holes" produce long-lived solar particle streams that can also have wide-spread geophysical effects.

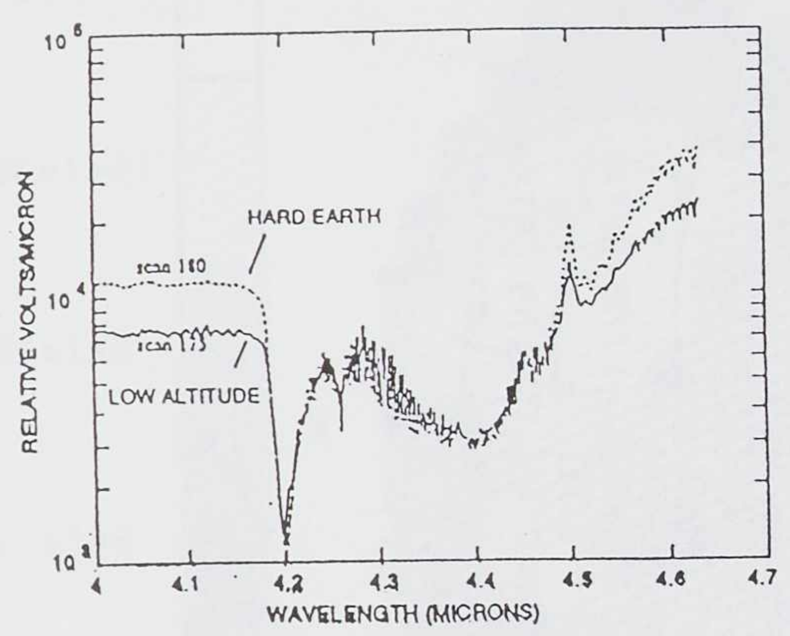
TECHNOLOGY RECIPIENTS: Air Force Space Forecast Center

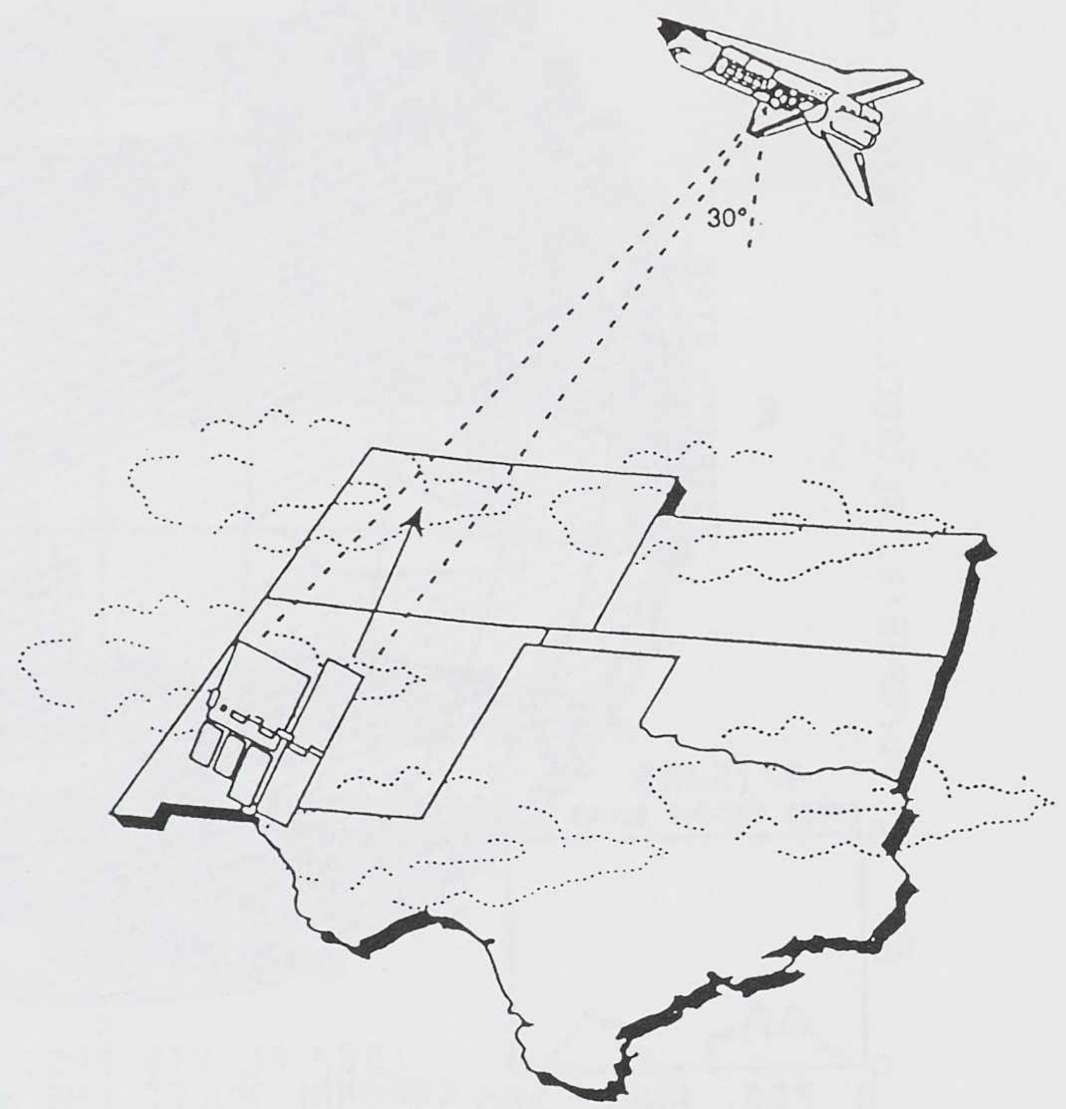
TECHNOLOGY BENEFICIARIES: SPACECOM and other operational commands

TECHNOLOGY PAYOFF: These new solar data will increase the timeliness of the forecasts of the planetary magnetic index Kp and other solar-geophysical parameters, with which AFSFC is tasked. This will have wide-spread benefits throughout USAF operational commands that rely on the speed and accuracy of these forecasts for satellite control, communications, radar operations, etc.

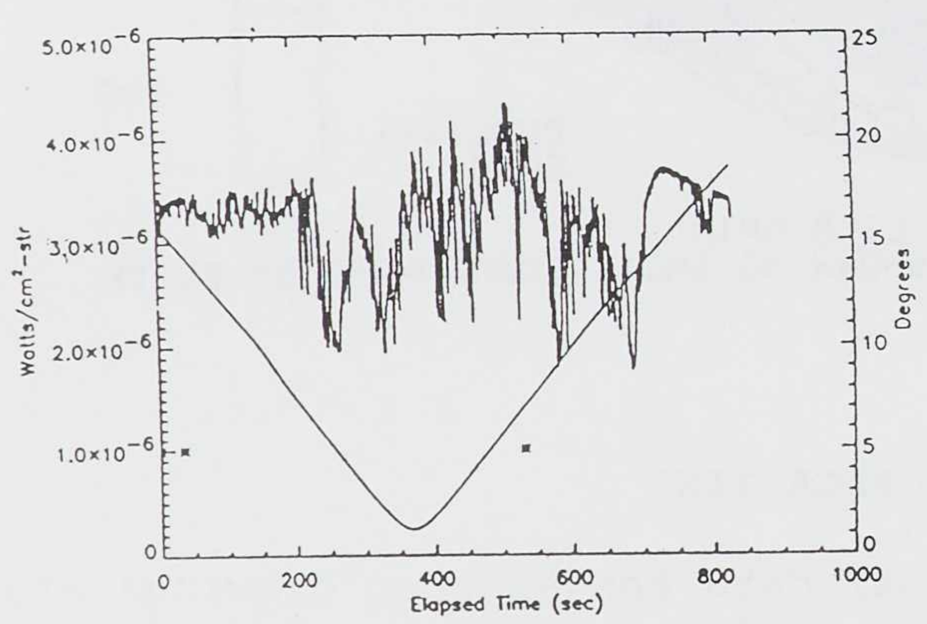
INFRARED EARTH BACKGROUND SIGNATURES

CIRRIS-1A Data for Filter Optimization





IBSS Solar Specular Structure Data



TECHNOLOGY DESCRIPTION: PL/GPO has measured the spectral and spatial character of the emission from earth and cloud backgrounds from two shuttleborne experiments (CIRRIS 1A and IBSS) flown on STS-39 in April-May 1991. These measurements are currently the best available space-to-ground data to test atmospheric and cloud models in the critical CO_2, 4.3 μm absorption band.

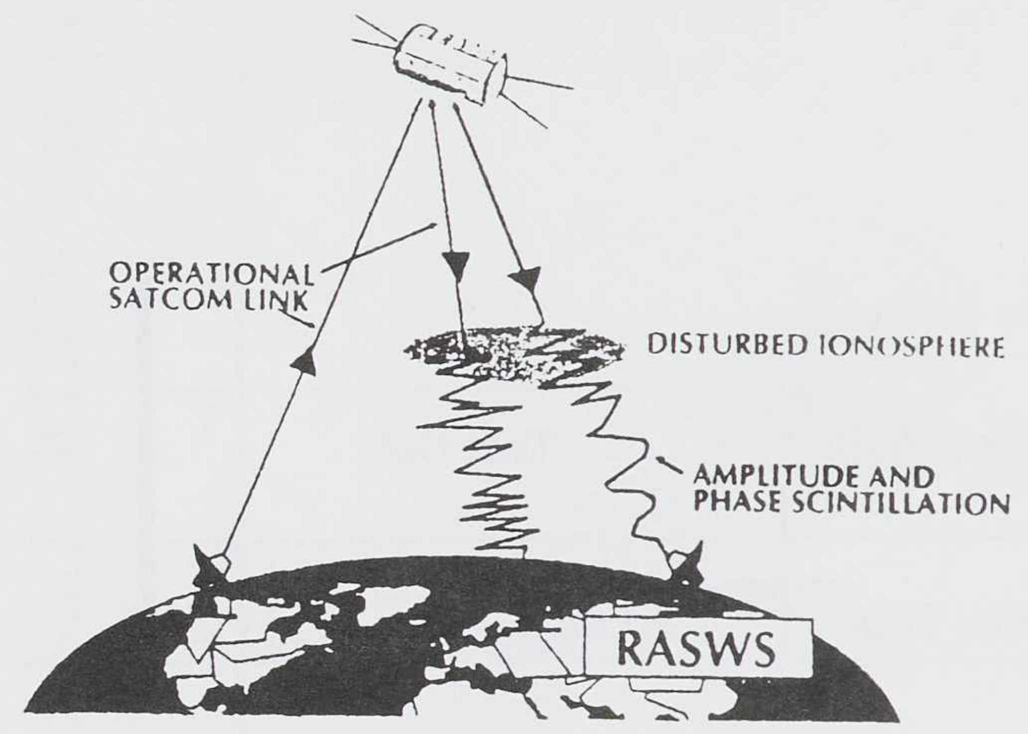
TECHNOLOGY RECIPIENTS: SDIO/TNS, USAF/SMC/CNS, USAF/SMC/MBS, USN/NRL/BDC

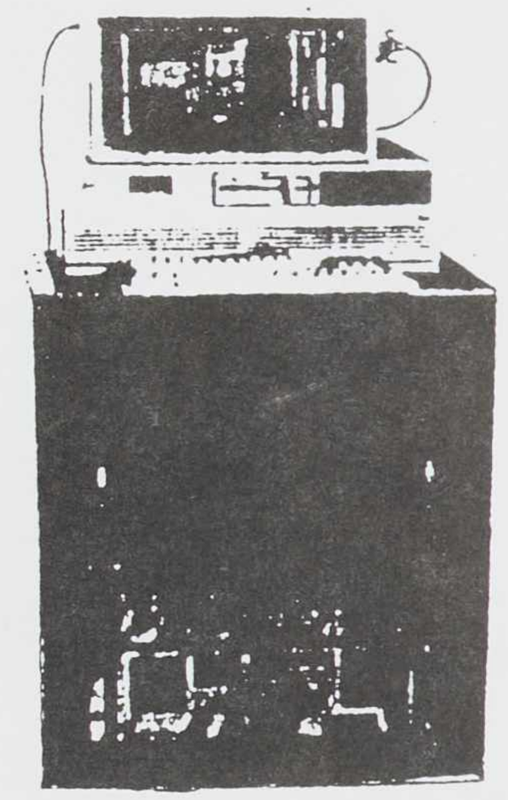
TECHNOLOGY BENEFICIARIES: SDIO-BRILLIANT EYES, MSX, and SPAS III Programs; and USAF-FEWS Program; SDIO/USN-Strategic Scene Generator Model

TECHNOLOGY PAYOFFS: Advanced surveillance and tracking systems must choose spectral bands which maximize target energy and reduce the competing signals from earth/cloud and earthlimb backgrounds. CIRRIS 1A and IBSS data will improve and validate the background models used by the DoD community to design future systems. In addition, the data has been used directly to improve the filter band selection on important upcoming SDIO experiments in the design and fabrication stage.

REMOTE ACCESS SCINTILLATION WARNING SYSTEM (RASWS)

- OPERATIONAL SYSTEM DIAGNOSTIC





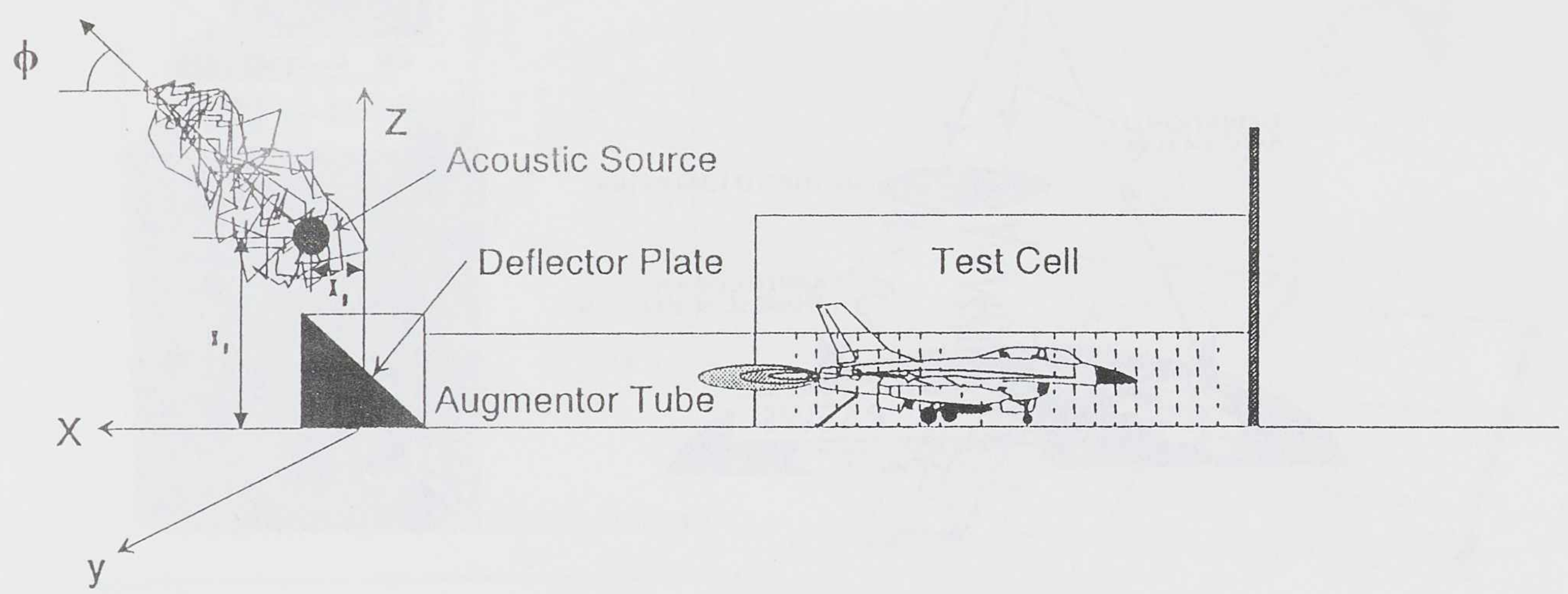
TECHNOLOGY DESCRIPTION: The Remote Access Scintillation Warning System, developed in-house, provides voice message reports of SATCOM link outages caused by the ionosphere to a remote user on a telephone line. This PC-based satellite receiving system acquires signals from satellites, performs real-time analysis of scintillation imposed by the ionosphere, and provides information on the level of degradation of a satellite to ground link to a remote user on a telephone line.

TECHNOLOGY RECIPIENTS: OL/A HQ Air Force Space Command (LKZ), Space Forecast Center

TECHNOLOGY BENEFECIERIES: SPACECOM

TECHNOLOGY PAYOFF: The system allows an operator at a SATCOM terminal to determine that the outages in a satellite communication link has been caused by the turbulence in the ionosphere and not by failures of the transmitter, receiver or the satellite. The system can simultaneously determine disturbance levels at different satellite transmission frequencies and may also serve as a tool for efficient frequency management at SATCOM terminals.

T-10 Hush House Infrasonic Source Model



TECHNOLOGY DESCRIPTION: Jet engineground run-up tests are a necessary part of aircraft engine maintenance. These tests for engine airworthiness produce high levels of noise and, as a result, community disturbance in the areas surrounding the test point. Several methods of mitigating the impact on nearby communities have been developed ranging from noise barriers to noise suppression test cells such as Hush Houses. Each method has advantages and disadvantages that must be weight before selecting the appropriate method for any use. Noise suppression in a Hush House, for example, is achieved, at least in part, by conversion of energy in the audible range to acoustic energy below the frequencies of human hearing. These infrasonics are, in turn, capable of producing nuisance vibrations in structures up to a mile from the Hush House site.

TECHNOLOGY RECIPIENTS: Headquarters, US Air Force, Environmental Planning Division
Board of Supervisors, County of Fairfax, Virginia

TECHNOLOGY BENEFICIARIES: ACC, Dulles International Airport

TECHNOLOGY PAYOFF: Understanding of improved ground run-up noise mitigation techniques improves aircraft safety and ground maintenance turn around by allowing aircraft to be tested closer to maintenance facilities than previously possible. For the community as a whole it improves the quality of the environment by reducing a major source of airbase or airport ground operation noise.

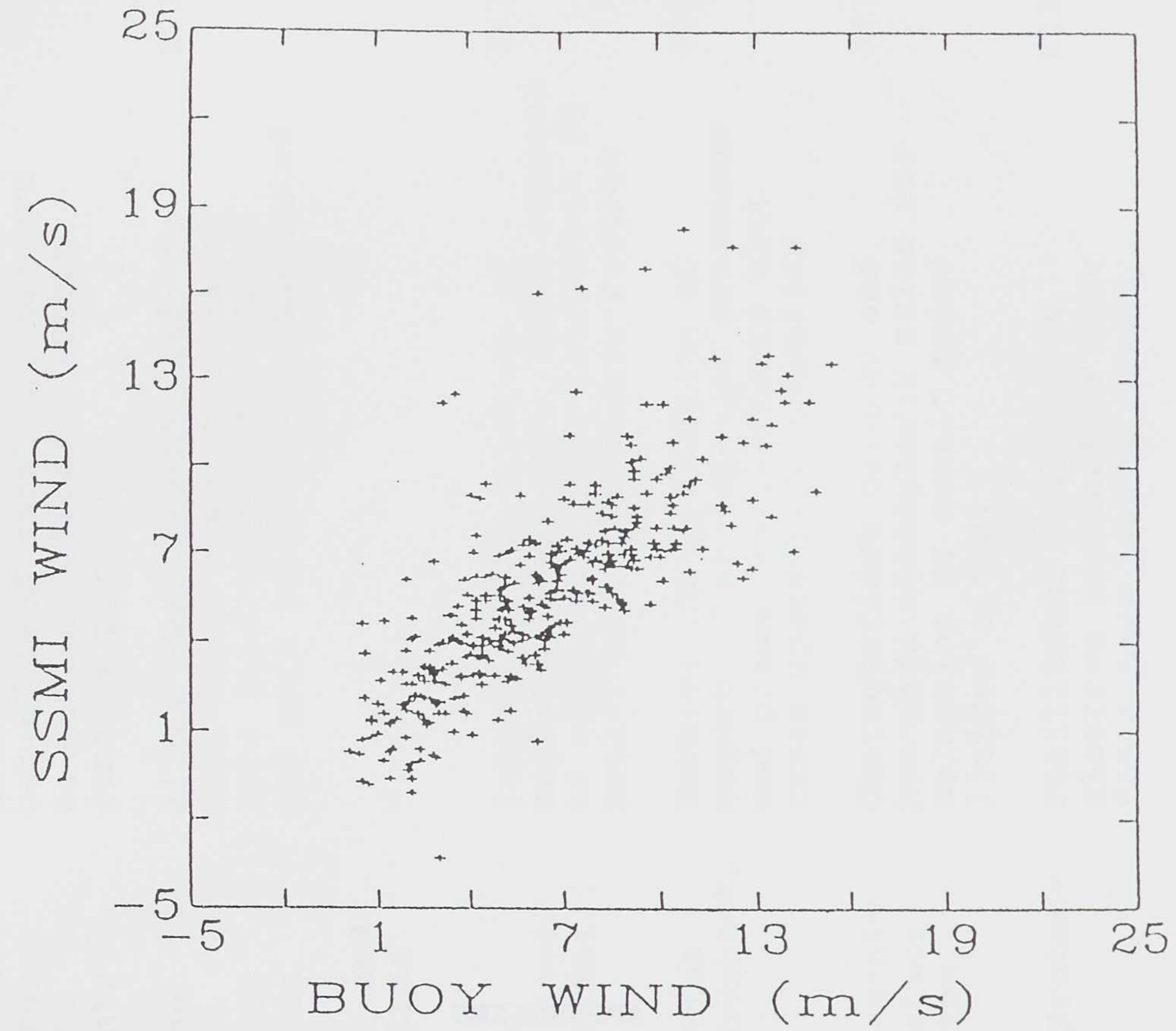


Fig. 7.9 Scatter-plot of SSM/I wind speed estimates from the GSW algorithm and coincident wind speed measurements from NOAA buoys 42001 and 42002 made during the time period 1Sep87 through 1Mar88. The SSM/I brightness temperature difference, $T_B(37V) - T_B(37H)$, for data used to create this plot was always greater than 35 K.

TECHNOLOGY DESCRIPTION: Brightness temperatures due to the energy emmitted and scattered in the microwave frequencies from ocean surfaces and moisture in the atmosphere are measured by the Special Sensor Microwave/Imager (SSM/I) on board the DMSP satellite. Waves and foam on the ocean surface, due to wind, affect the brightness temperature sensed. The basic algorithm relates brightness temperatures received by the SSM/I to ocean surface roughness due to winds. Improvements to the original ocean surface windspead algorithm were developed. The improved algorithm compensates for some degradation of windspeed estimates due to precipitation. In addition, the criteria for determining the accuracy of the estimated winds were improved.

TECHNOLOGY RECIPIENT: AFGWC

TECHNOLOGY BENEFICIARIES: Joint Typhoon Warning Center

TECHNOLOGY PAYOFF: The improvements make this algorithm a more useful tool in the region around typhoons and hurricanes for estimating the extent of damaging winds.

APPENDICES

APPENDIX A

CHRONOLOGICAL LISTING OF FY92 PL/GP TECHNOLOGY TRANSITION (T^2) EVENTS

	DATE	BRANCH	USER	TECHNOLOGY DESCRIPTION	PAYOFF TO USER	PE
1.	2 Oct 91	GPIM	DMSP	Specification of data stream parameters for data from DMSP SSULI and SSUSI instruments	Enables efficient and accurate use of DMSP satellite sensors to provide global electron density profiles	62101F
2.	7 Oct 91	GPIM	NAVY	Specification of the solar ultraviolet spectrum between 2000 and 3100 Angstroms in a spectrum of 0.1 Angstrom resolution and calibrated in absolute irradiance units	Allows measurements made in much lower resolution to be more intelligently designed and more accurately interpreted	62101F
3.	15 Oct 91	GPAP	AFGWC	Coupled Atmospheric Planetary Boundary Layer Model and Two-Layer Soil Model	Improves specification of surface temperature field crucial to satellite cloud retrievals in Real-Time Nephanalysis Program	61102F
4.	15 Oct 91	GPSG	AWSSFC	Computer specification model of Earth's bowshock, magnetosheath, and magnetopause	Enables identification of magnetopause boundary crossings and plasma environments that cause spacecraft anomalies	63707F
5.	Oct 91	GPIA	BMO	Radio noise measurements for mid-latitude meteor scatter communication test-bed.	Characterizes natural and man-made atmospheric noise for selection of cosmic noise limited sites.	62101F
6.	5 Nov 91	GPIM	SMC	Computer code for Proton-Hydrogen Atom precipitation.	Facilitates analysis of electron backscatter data for a pure proton aurora.	61102F
7.	21 Nov 91	GPOA	SDIO, FTD	Infrared Signature data of Ariesa rocket during boost phase.	Supports applications of space surveillance missile launches.	62101F

APPENDIX A (cont.)

	DATE	BRANCH	USER	TECHNOLOGY DESCRIPTION	PAYOFF TO USER	PE
8.	Nov 91	GPEG	DMA	Frequency domain-oriented algorithms for estimation of Earth surface and at-altitude grids of deflections of the vertical from all available terrain elevation data.	Enhances the autonomous capabilities of current (e.g. B2 and ICBMs) and future Inertial Navigation Systems without the need for gravity data as input.	61102F
9.	6 Dec 91	GPIA	ESC	Information on development of OTH extended range capability.	Permits extending the range of OTH radar to equatorial regions.	62101F
10.	10 Jan 92	GPSG	NAVY	Data for Geomagnetic Noise Model	Contributes to improved submarine detection capabilities	62101F
11.	16 Jan 92	GPEH	HQ USAF	Observational data and model analysis pertaining to the effects of low altitude B-1/B-52 overflights on ground structures	Supports a JACC decision to deny damage claim alleged to result from B-52 overflights of farm structures.	62101F
12.	Jan 92	GPSG	SMC	First of a new series of thermal plasma instruments on DMSP: SSIES-2 on DMSP F-11	Improves specification and prediction of the near-Earth environment to enhance surveillance, communication and space system operations.	61102F
13.	4 Feb 92	GPEH	AF/CEVP	Information and models pertaining to the vibro-acoustic problems associated with ground run-up tests of aircraft and potential methods of mitigation.	Benefits siting and mitigation technology.	62101F
14.	28 Feb 92	GPAP	AFGWC	A diagnostic cloud forecast algorithm	Provides a 5-10% improvement in operational cloud predictions from 12 to 48 hr.	62101F

APPENDIX A (cont.)

	DATE	BRANCH	USER	TECHNOLOGY DESCRIPTION	PAYOFF TO USER	PE
15.	Feb 92	GPIA	ESC	Radio noise measurements	Facilitates Meteor Scatter communication site selection which will meet performance requirements of the North Warning system.	62101F
16.	Feb 92	GPOB	FTD	CIRRIS-1A Down-Looking one wavenumber spectral data.	Classified Payoff	SDIO
17.	4 Mar 92	GPSG	ESC	Frequency agile receiver for observing solar radio bursts in the range from 1-18 GHZ.	Permits determination of the position of geoeffective flares on the sun by radio means when optical observations are obscured by clouds.	2311G3
18.	13 Mar 92	GPSS	AFSFC	A FORTRAN software package to write FITS (Flexible Image Transport System) formatted files.	Enables reuse of existing software and a savings in time for recipients within the astronomy community.	61102F
19.	19 Mar 92	GPIA	NAVY	Ionospheric measurements	Provides a ground-truth reference for High Resolution Auroral and Airglow Spectrometer (HIRAAS) instrument, validating its ability to monitor electron densities.	62101F
20.	Mar 92	GPEG	DMA	Extracting Vehicle-Borne Gravity Vectors from Integrated GPS/IMU Data.	Facilitates validation of the upward continuation (of ground gravity data) techniques the AF currently uses for estimated gravity components along expected flight paths.	61102F
21.	Mar 92	GPIA	NAVY	High Latitude meteor scatter communication statistics.	Facilitates development of efficient communication protocols based on reliable data rather than on theoretical projections.	62101F

APPENDIX A (cont.)

	DATE	BRANCH	USER	TECHNOLOGY DESCRIPTION	PAYOFF TO USER	PE
22.	Mar 92	GPEG	DMA	(Stellar, Inertial, Gradiometric) Navigation System.	Performs real-time gravity compensation measurements needed for purely autonomous navigation	61102F
23.	Mar 92	GPEG	DMA	Software for Ground and Airborne Deflection-of-the-Vertical Determinations.	Addresses gravity model requirements over ICBM near launch regions and expected B2 flight paths.	61102F
24.	14 Apr 92	GPIA	AFSPACECOM	Ground-based scintillation system.	Enables the obtaining of a data base of ionospheric range errors at Shemya, Alaska for use in validating performance of new ionospheric models and permits development test of near real-time ionospheric correction for COBRA DANE.	62101F
25.	15 Apr 92	GPIA	NAVY	USAF and Australian over-the-horizon radar data.	Promotes clutter mitigation efforts and improved OTH wide-area coverage.	62101F
26.	22 Apr 92	GPID	AEDC	High resolution ultraviolet (UV) signature data on nitric oxide (NO)	Tests validity of Standard Plume Ultraviolet Radiation Code (SPURC)	61102F
27.	Apr 92	GPAS	SMC, ARMY	Information for the DMSP Mark IV-B Meteorological User's Guide written in the User's Guide format and as tested on the Mark IV-B.	Allows Mark IV-B operators to combine satellite channels, produce color pictures and normalize data leading to improved pictures of clouds in support of combat operations.	62101F
28.	12 May 92	GPSS	ESC	Information on obtaining solar vector magnetic field measurements and support to solar prediction algorithm studies	Contributes to Phase II Solar Electro-Optical Network (SEON) upgrade.	61102F

APPENDIX A (cont.)

	DATE	BRANCH	USER	TECHNOLOGY DESCRIPTION	PAYOFF TO USER	PE
29.	15 May 92	GPAP	AWS	An artificial intelligence-based weather forecast expert system which provides terminal weather predictions from observations confined to the terminal area (i.e., a single-station forecast model).	Provides "first-in" combat weather support.	62101F
30.	20 May 92	GPIA	AF SFC	Remote Access Scintillation Warning System.	Allows AF operational groups to determine that a particular C^3I outage has been caused by ionospheric turbulence and NOT caused by failures in the transmitter, receiver or satellite.	62101F
31.	20 May 92	GPA	NASP	Information on fabrication techniques and the use of grounded covers for NASP.	Ensures that NASP is not destroyed by lightning when on the ground or during flight in the atmosphere.	62101F
32.	May 92	GPEG	PL/SX	Advanced GPS/IMU Payloads for Use in Spaceborne Surveillance and Targeting Systems.	Provides precise positioning of any sensed target and contributes to an improved global gravity model.	61102F
33.	May 92	GPEG	PL/SX	Advanced GPS/IMU Payloads for Use in Tactical Weapon Delivery Systems.	Allows for a 'shoot and leave' system.	61102F
34.	15 Jun 92	GPIA	ESC	Ionospheric scintillation identified as causing radar noise.	Resolves deficiency in operation at BMEWS Site III.	62101F
35.	19 Jun 92	GPEG	SMC	Gravity field modeling capabilities.	Enhances capabilities for controlling satellite orbits and reduces the burden of ground tracking.	61102F

APPENDIX A (cont.)

	DATE	BRANCH	USER	TECHNOLOGY DESCRIPTION	PAYOFF TO USER	PE
36.	25 Jun 92	GPAP	AWS	Information on formation and evaluation of stratospheric turbulence.	Leads to improved forecasts of high-altitude turbulence.	62101F
37.	Jun 92	GPOA	PL/LI	Cn^2 data for the AMOS site in Maui.	Defines atmospheric turbulence along laser propagation paths at the AMOS site.	62101F
38.	Jun 92	GPOB	SDIO, FEWS	Validation of infrared background models used to design advanced surveillance and tracking systems through utilization of earthlimb data from the CIRRIS 1A experiment and cloud/terrain data from both CIRRIS 1A and IBSS.	Provides qualitative validation of the background statistics of the strategic scene generation model (SSGM)(although also indicating that significant differences remain).	63215C
39.	8 Jul 92	GPAS	AWS	Algorithm for estimating maximum winds in intensifying typhoons.	Provides the Joint Typhoon Warning Center an independent method for estimating this critical storm parameter.	62101F
40.	8 Jul 92	GPAS	AFGWC	An improved algorithm for estimating surface winds over water.	Facilitates estimating the extent of damaging wind fields around tropical cyclones.	63707F
41.	14 Jul 92	GPIA	AWS	Assessment of impact of interfering radio stations as part of site selection survey for Digital Ionospheric Sounding System (DISS)	Avoids costly deployment at unsuitable site in the South Pacific	62101F
42.	17 Jul 92	GPA	DNA	Analysis of DNA obtained solar irradiance and diffuse atmospheric radiance data on smoke clouds from the oil fires resulting from DESERT STORM.	Increases understanding of the properties of smoke from battlefield fires and their impact on operations.	62101F

APPENDIX A (cont.)

	DATE	BRANCH	USER	TECHNOLOGY DESCRIPTION	PAYOFF TO USER	PE
43.	21 Jul 92	GPIA	AWS	Information on equatorial anomoly locations.	Facilitates choice of optimum location for Digital Ionospheric Sounder System (DISS) Site.	62101F
44.	23 Jul 92	GPID	OUSDRE	Information on the Production of Alkali Metal Ions as produced by Surface Ionization from stainless steel at high temperature.	Leads to a requirement to include metal ion chemistry in hypersonic flow field codes resulting in improved accuracy of these numerical models.	62101F
45.	27 Jul 92	GPSS	AF SFC	First-look uncalibrated coronal scans and a sunspot drawing and reports of any unusual coronal activity supplied on a daily basis.	Increases the timeliness of the planetary magnetic index Kp and other solar-geophysical parameters to benefit satellite control, communications and radar operations.	61102F
46.	31 Jul 92	GPOS	SDIO	An exact solution to problem of finding the tangent point for a line of sight from a satellite through the earth's limb assuming an elliptical earth.	Contributes to analysis of MSX data.	63220C
47.	Jul 92	GPIM	PL/WS	Definition of Optical Sensor Debris Data requirements and format.	Facilitates analysis of data from PL/LI and MIT/LL sensor sites.	62101F
48.	Jul 92	GPOA	PL/LI	Cn^2 data and models.	Defines atmospheric turbulence along paths used for the Airborne Laser Weapon System testing.	62101F

APPENDIX A (cont.)

	DATE	BRANCH	USER	TECHNOLOGY DESCRIPTION	PAYOFF TO USER	PE
49.	Jul 92	GPOA	PL/LI	Data on aerosol profiles and geographic distribution to altitudes of 50,000ft and from 80^0 S to 65^0 N latitude along a mid-Atlantic track.	Defines atmospheric propagation paths for the Airborne Laser Weapon System.	62101F
50.	6 Aug 92	GPIA	ESC	Identification of existence of an application issue relating to the scaling of ionospheric scintillation information and the need for empirical validation of the theoretical process for performing this scaling.	Prompted initiation of an empirical validation study to increase the benefit of trans-ionospheric radar.	62101F
51.	17 Aug 92	GPSP	SMC, PL/CA, SDIO, NAVY	CRRESRAD Software for orbit-specific, space radiation levels.	Inproves design, operations and reliability of near - Earth space systems.	62101F
52.	26 Aug 92	GPIA	AFSPACECOM	Demonstration of Remote Access Scintillation Warning System (RASWS).	Provides capability to verify ionospheric scintillation of UHF satellite communications links.	62101F
53.	27 Aug 92	GPOB	SDIO	CIRRIS-1A data.	Contributes to upgrade and validation of the national test bed strategic scene generator model.	63215C
54.	Aug 92	GPIA	DARPA	Radio noise measurements for Alaskan meteor scatter selection.	Facilitates reliable high data rate, meteor scatter communication.	62101F

APPENDIX A (cont.)

	DATE	BRANCH	USER	TECHNOLOGY DESCRIPTION	PAYOFF TO USER	PE
55.	1 Sep 92	GPIM	PL/WS	Simulation of the space debris environment produced by the collision of model spacecraft in sun-synchronous orbits using two different spacecraft breakup models.	Allows spacecraft breakup modelers to focus experimental attention on those parameters for which the long term environment is most sensitive.	62101F
56.	1 Sep 92	GPAS	AFGWC	An interactive software package that plots the track and sensor coverage of any polar orbiting satellite based on its specific orbit attributes.	Facilitates determination of which satellite resources best meet user needs.	62101F
57.	15 Sep 92	GPSP	SMC	Spacecraft Surface Charging Handbook.	Facilitates improved reliability, operational capability and increased space system lifetimes.	63410F
58.	18 Sep 92	GPIM	AFSPACECOM	Extension of operational neutral atmospheric models downward in altitude from lower boundary at 120 km to ground.	Supports AF Space Command Operational Trajectory Impact Prediction (TIP) program.	62101F
59.	19 Sep 92	GPAP	ESC	Objective weather analysis algorithms, software and documentation for use in the Automated Weather Distribution System (AWDS) P-cubed I program.	Provides an analysis technique that can represent local mesoscale detail currently unattainable.	62101F
60.	21 Sep 92	GPIM	NAVY, AWS, DMSP	Global ionospheric model called "Parameterized Ionospheric Model" (PIM) which provides ion and eletron density profiles from 90 km to 1600 km.	Describes the global ionosphere in the calculations of UV airglow intensities and in the algorithm development for UV radiances.	63707F

APPENDIX A (cont.)

	DATE	BRANCH	USER	TECHNOLOGY DESCRIPTION	PAYOFF TO USER	PE
61.	21 Sep 92	GPOS	PL/WS	A model for optical turbulence studies in the atmosphere.	Contributes to airborne laser technique being developed to destroy enemy missiles in the launch phase.	61102F
62.	24 Sep 92	GPSG	AF SFC	Computer Program software	Facilitates calculation of the radiation dose experienced for aircraft flight missions anywhere in the world.	61102F
63.	30 Sep 92	GPAA	ESC	Detailed statistics on the quantity, duration, percentage of time, and probability of rain attenuation outages for all months at Omaha, Nebraska.	Facilitates evaluation of MILSTAR availability and system performance in rain.	62101F
64.	Sep 92	GPSP	AFSFC	Revised Algorithm for Auroral Boundary Determination from DMSP Precipitating Electron Data.	Improves accuracy in determining the auroral boundary which is a critical input to several space weather models and sets geomagnetic activity levels for alerts and warnings.	61102F
65.	Sep 92	GPIA	RL	High latitude meteor scatter communications statistics.	Facilitates development of multimode approach for reliable theatre communication.	62101F
66.	Sep 92	GPIM	AWS	Neutral Density model upgrade in 90-120 km altitude region, including accurate tidal (local time) variations.	Improves density specification for operational point analysis programs.	63707F

APPENDIX A (cont.)

	DATE	BRANCH	USER	TECHNOLOGY DESCRIPTION	PAYOFF TO USER	PE
67.	1992	GPSP	SAF/SS	Sapcecraft hazard mitigation information	Provides information on probability of spacecraft downtime, and leads to improved designs for future spacecraft for insulation materials and integrated circuits encapsulants.	62101F
68.	1992	GPOB	SMC	PLEXUS - BETA test version of geophysics directorate unified backgrounds codes package.	Provides single accurate validated backgrounds information from standard models through a single knowledge based interface.	62101F
69.	1992	GPOB	SMC SDIO AEDC DNA ARMY NAVY IDA	Celestial Background Scene Descriptor PC version, CBSD-PC, including Faust atmospheric models database.	Transfers complex models and results, plus relevant data, directly to customers in readily accessible format.	62101F
70.	1992	GPOA	NATO	BACKSCAT - computer code for determining atmospheric backscatter.	Provides accurate simulations and predictions of lidar system performance.	62101F
71.	1992	GPOS	SMC, PL/WS, WL AEDC PL/OL-AC ARMY NAVY	FASCOD3 - an "exact" radiative transfer code for 0 to 120 km altitudes.	Facilitates high-spectral resolution simulations.	62101F

APPENDIX A (cont.)

	DATE	BRANCH	USER	TECHNOLOGY DESCRIPTION	PAYOFF TO USER	PE
72.	1992	GPOS	SMC, PL/LI, PL/OL-AG	HITRAN molecular, spectroscopic database containing 709,000 transitions of molecular species relevant for atmospheric and propagation studies as well as cross sections for dense spectral features.	Provides improved ability for high resolution spectral simulations and radiance propagation simulations.	62101F
73.	1992	GPOS	OUSD, PL/VT, AEDC, WL	Strategic High Altitude Radiance Code (SHARC), version 2.0.	Contributes to infrared surveillance and tracking systems.	63215C
74.	1992	GPOB	SDIO	Software to provide realtime readout of all LEAP III payload parameters on a continuous basis.	Provides a thorough evaluation of the payload both prior to launch and during the flight.	62715H
75.	1992	GPOB	SDIO	Software to provide simple (single screen display) but effective evaluation of a rocket payload during the last critical moments of the final countdown.	Provides the LEAP III rocket payload with a simple, effective, visual Go-NoGo criteria during final Countdown.	62715H
76.	1992	GPOB	SDIO	Algorithm and software to test the critical items of the LEAP III rocket payload on a continuous basis prior to launch.	Indicates if the payload is in a launch condition.	62715H

APPENDIX B

ANALYSIS OF FY92 GP TECHNOLOGY TRANSITION EVENTS

BY

TECHNOLOGY TYPE

TECHNOLOGY TYPE	NUMBER	PERCENTAGE
Information/Specification	39	51.3
Techniques/Software/Algorithm	29	38.2
Hardware	8	10.5
	-----	------
TOTALS	76	100.0

APPENDIX C

ANALYSIS OF GP FY92 TECHNOLOGY TRANSITION EVENTS BY USERS

USERS	NUMBER OF TECHNOLOGY CONTRIBUTIONS	PERCENTAGE
AF Materiel Command		
SMC	12	11.1
ESC	9	8.3
BMO	1	0.9
RL	1	0.9
WL	3	2.8
PL (excluding GP)	14	13.0
AEDC	4	3.7
TOTAL AF Materiel Command	44	40.7
Other AF	30	27.8
TOTAL AF	74	68.5
DARPA	2	1.9
Strategic Defense Initiative Organization	9	8.3
Defense Nuclear Agency	2	1.9
Defense Mapping Agency	4	3.7
ARMY	3	2.8
NAVY	10	9.2
Other DoD	3	2.8
NATO	1	0.9
TOTAL Technology Contributions	108	100.0

APPENDIX D

ANALYSIS OF GP FY92 TECHNOLOGY TRANSITION EVENTS BY GP MAJOR THRUSTS

MAJOR THRUST	NUMBER OF TECHNOLOGY TRANSITIONS	PERCENT
Space Effects on AF Systems	12	15.8
Optical and Infrared Technology	18	23.7
Ionospheric Effects on AF Systems	25	32.9
Terrestrial Effects on AF Systems	9	11.8
Weather Effects on AF Systems	12	15.8
TOTAL Technology Transitions	76	100.0

ACRONYM LIST

ACC	Air Combat Command
AEDC	Arnold Engineering Developing Center
AF	Air Force
AF/CEVP	Headquarters Air Force Environmental Planning Division
AFCRL	Air Force Cambridge Research Laboratory
AFGL	Air Force Geophysics Laboratory
AFGWC	Air Force Global Weather Central
AFMC	Air Force Material Command
AFOSR	Air Force Office of Scientific Research
AFSC/DL	Air Force Systems Command, Director of Laboratories
AFSRC	Air Force Space Forecast Center
AFSPACECOM	Air Force Space Command
AFTAC	Air Force Technical Applications Center
AMOS	Air Force Maui Optical Station
AWDS	Automated Weather Distribution System
AWS	Air Weather Service
BACKSCAT	Back Scatter
BMEWS	Ballistic Missile Early Warning System
BMO	Ballistic Missile Office
CBSD	Celestial Background Scene Descriptor
CIRRIS-1A	Cryogenic Infrared Radiance Instrumentation for Shuttle
COBRA DANE	Ionospheric Surveillance System
CRRESRAD	Combined Release and Radiation Effects Satellite Radiation
C^3I	Command, Control, Communications, and Intelligence
DARPA	Defense Advanced Research Projects Agency

DISS	Digital Ionospheric Sounding System
DMA	Defense Mapping Agency
DMSP	Defense Meteorological Satellite Program
DNA	Defense Nuclear Agency
DoD	Department of Defense
ESC	Electronic Systems Center
FASCOD3	Fast Atmospheric Signature Code
FEWS	Follow-On Early Warning System
FITS	Flexible Image Transport Systems
FTD	Foreign Technology Division
FY92	Fiscal Year 1992
GL	Geophysics Laboratory
GP	Geophysics Directorate of Phillips Laboratory
GPAA	Phillips Laboratory, Geophysics Directorate, Atmospheric Structure Branch
GPAP	Phillips Laboratory, Geophysics Directorate, Atmospheric Prediction Branch
GPAR	Phillips Laboratory, Geophysics Directorate, Ground-Based Remote Sensing Branch
GPAS	Phillips Laboratory, Geophysics Directorate, Satellite Meteorology Branch
GPEG	Phillips Laboratory, Geophysics Directorate, Gravity Branch
GPEH	Phillips Laboratory, Geophysics Directorate, Solid Earth Geophysics Branch
GPID	Phillips Laboratory, Geophysics Directorate, Ionospheric Modifications Branch
GPIM	Phillips Laboratory, Geophysics Directorate, Ionospheric Modeling Branch
GPIS	Phillips Laboratory, Geophysics Directorate, Ionospheric Applications Branch

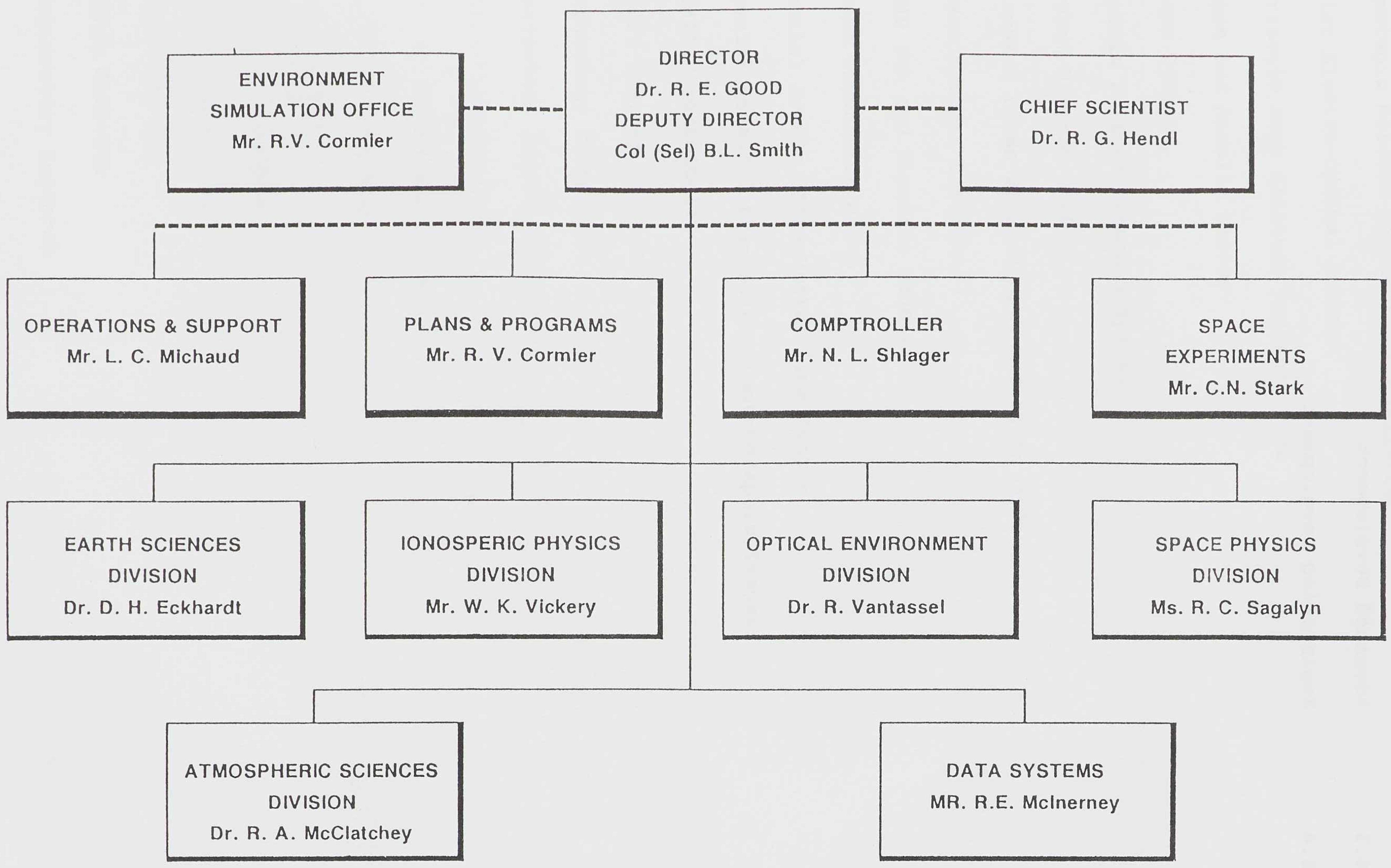
GPOA	Phillips Laboratory, Geophysics Directorate, Electro-Optical Measurements Branch
GPOB	Phillips Laboratory, Geophysics Directorate, Background Branch
GPOS	Phillips Laboratory, Geophysics Directorate, Simulation Branch
GPS	Global Positioning System
GPS	Phillips Laboratory, Geophysics Directorate, Space Plasma & Fields Branch
GPSP	Phillips Laboratory, Geophysics Directorate, Space Particle Environment Branch
GPSS	Phillips Laboratory, Geophysics Directorate, Solar Research Branch
GPS/IMU	Global Positioning System/Inertial Measurement Unit
GR	Geophysics Requirements
HIRAAS	High Resolution Auroral and Airglow Spectrometer
HITRAN	High Resolution Molecular Database
HQ	Headquarters
IBSS	Infrared Background Signature Survey
ICBM	Intercontinental Ballistic Missile
IDA	Institute of Defense Analysis
JACC	Office of Judge Advocate General, Claims and Tort Litigation Staff
LEAP III	Light Weight Exo-Atmospheric Projectile
MIT/LL	Massachusetts Institute of Technology, Lincoln Laboratory
MOA	Memorandum of Agreement
MSX	Mid-Course Space Experiment
NASP	National Aerospace Plane
NATO	North Atlantic Treaty Organization
NRL	Naval Research Laboratory
OTH	Over the Horizon
OUSD	Office of the Under Secretary of Defense

OUSDRE	Office of the Under Secretary of Defense for Research & Engineering
PC	Personal Computer
PE	Program Element
PE 62101F	Geophysics
PE 64707F	Weather Systems (Engineering Development)
PE 63707F	Weather Systems (Advanced Development)
PE 61102F	Basic Research
PE 63410F	Space Systems Environmental Interactions
PIM	Parameterized Ionospheric Model
PL	Phillips Laboratory
PL/CA	Phillips Laboratory, Chief Scientist
PL/GP	Phillips Laboratory, Geophysics Directorate
PL/LI	Phillips Laboratory, Lasers & Imaging Directorate
PL/OL-AC	Phillips Laboratory, Edwards Air Force Base
PL/OL-AG	Phillips Laboratory, Malabar Test Facility
PL/SX	Phillips Laboratory, Space Experiments Directorate
PL/VT	Phillips Laboratory, Space and Missiles Technology Directorate
PL/WS	Phillips Laboratory, Advanced Weapons and Survivability Directorate
PLEXUS	Phillips Laboratory Expert Unified Simulator
PMD	Program Management Directive
R&D	Research and Development
RASWS	Remote Access Scintillation Warning System
RL	Rome Laboratory
SAFSS	Secretary of the Air Force
SATCOM	Satellite Communications

SDIO	Strategic Defense Initiative Organization
SEON	Solar Electro-Optical Network
SHARC	Strategic High Altitude Radiance Code
SMC	Space and Missile Center
SPACECOM	Space Command
SPAS	Shuttle Payload Assemble System
SPO	System Program Office
SPURC	Standard Plume Ultra-Violet Radiation Code
SSD	Space Systems Division
SSIES-2	DMSP Ion and Electron Sensor
SSGM	Scene Generation Model
SSULI	Special Sensor Ultra-Violet Limb Imager
SSUSI	Special Sensor Ultra-Violet Spectrographic Imager
STAFFMET	Staff Meteorologist
SWO	Staff Weather Officer
T^2	Technology Transition
TIP	Trajectory Impact Prediction
UHF	Ultra-High Frequency
USAF	United States Air Force
USN	United States Navy
UV	Ultra-Violet
WCO	West Coast Office
WL	Wright Laboratory
WWII	World War Two
6.1	Basic Research
6.2	Exploratory Research

6.3	Advanced Development
6.4	Engineering Development

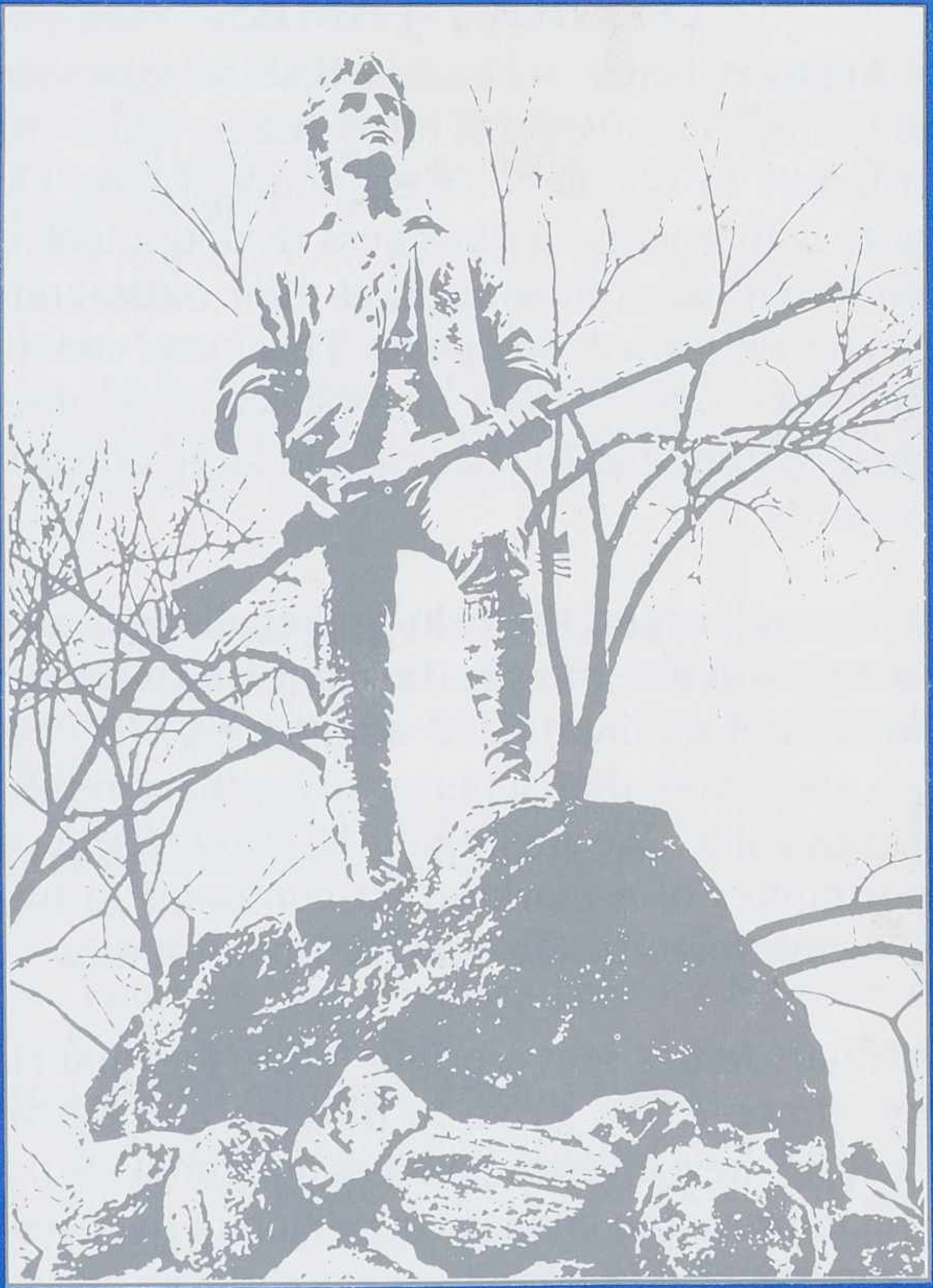
GEOPHYSICS DIRECTORATE



4-1-93 (gporg93)

VISITOR MAP

HANSCOM
AIR FORCE BASE
MASSACHUSETTS



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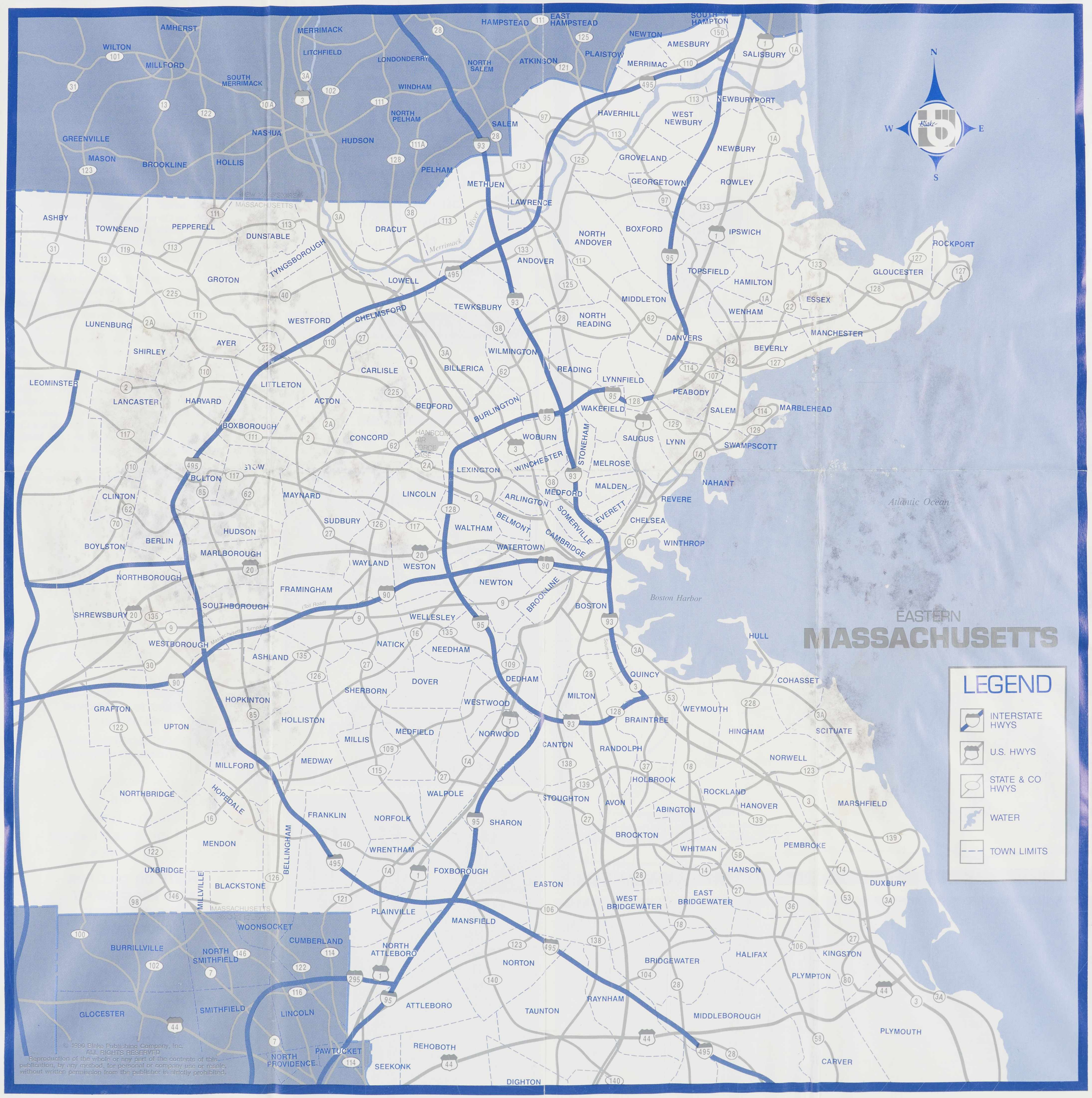


GETTING HERE

From the north, take Massachusetts Route 128 (Interstate 95) to Exit 31B (Route 4/225 - Bedford and Carlisle). Bear right into the "teacup handle" before the first traffic light. Follow Hartwell Avenue to the base's Bedford Gate (Gate 4).

From the south, follow Route 128 to Exit 30B (Route 2A West - Hanscom AFB and Concord). Go 1.5 miles west to the right-hand turn toward Hanscom Field. Bear to the right; you can't miss the base's Vandenberg Gate (Gate 1).

If you need telephone information for Hanscom AFB, call the base operator at (617) 377-5980 or AUTOVON 478-5980.

PLACES TO GO, THINGS TO SEE

Eastern Massachusetts is a cultural and historical wonderland, and it's all within easy driving distance of Hanscom AFB. Here's a sample of what nearby communities have to offer for your enjoyment. Most are admission-free.

Bedford

- See the oldest flag in the United States, on display in the town's public library.
- Fitch Tavern, built in 1731, was a rallying point for local Minute Men before the battles of April 19, 1775.

Concord

- Visit Old North Bridge, where the Minutemen defeated a superior British force in the first American victory of the Revolution.
- Tour Louisa May Alcott's Orchard House and Emerson House, which was once the home of Ralph Waldo Emerson.
- Walden Pond, site of Henry David Thoreau's tiny cabin, is still a beautiful nature reserve, with hiking trails and scenic beaches.
- Sleepy Hollow Burying Ground holds graves dating back to the early 1600s, including those of men who fought in the opening battle of the Revolution.

Lexington

- Minute Man National Park's visitor center on Route 2A just east of the base explains the events of the Revolution's first day, and miles of hiking and bicycle trails retrace the American and British routes.
- Step into history at Buckman Tavern, where Minutemen assembled, and the Hancock-Clarke House, where prominent Americans were roused by Paul Revere.
- On the Battle Green, relive that fateful April morning when untrained and poorly-armed farmers confronted the most powerful army in the world and began the fight for freedom.

Lincoln

- See where Paul Revere was captured by a British patrol after alerting the patriots in Lexington. A monument marks the spot beside Route 2A, about one mile east of the base entrance.
- View art exhibits at the Decordova and Dana Museum.
- The Massachusetts Audubon Society is headquartered at Drumlin Farm.
- Hartwell Tavern, on Old Bedford Road just west of the base on Route 2A, was a rallying point for Minutemen on their way to fight the British.

Boston (30-60 minutes driving time)

- The Freedom Trail begins at Boston Common. Highlights include Old North Church, Paul Revere House, the Boston Massacre site, South Meeting House, Faneuil Hall, Quincy Marketplace and the Bunker Hill Monument.
- The U.S.S. Constitution, the world's oldest commissioned warship, is open for tours in Charleston Naval Yard. "Old Ironsides" is still crewed by Navy members.
- The Boston Red Sox play at Fenway Park during the summer, and Boston Garden hosts Bruins hockey and Celtics basketball.

Plymouth (90 minutes)

- Plimoth Plantation and the Mayflower II let you step back 375 years to the Pilgrim settlers' life and times.
- Plymouth Rock is reputed to mark the site of the Pilgrims' arrival in the New World.

Sturbridge (90 minutes)

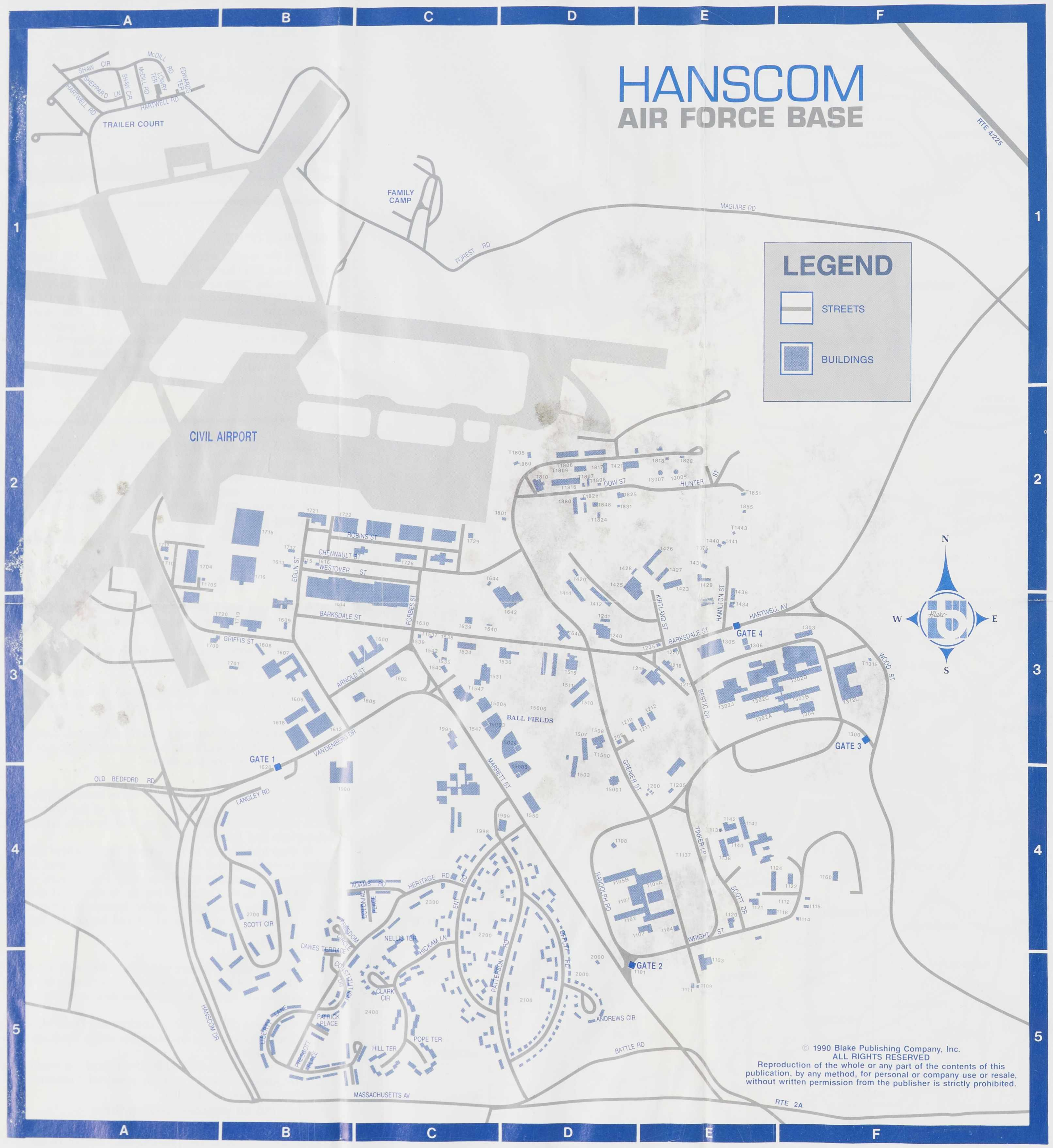
- Old Sturbridge Village recreates a rural New England village of the 1800s.

New Personnel Arrival Information

Go directly to the Base INTRO Office in Bldg. 1600 during duty hours. If you arrive after duty hours, report to the base billeting office in Bldg. 1427 (The Hanscom Inn, near the Officers' Club).

The base operator's phone number is (617) 377-5980 or AUTOVON 478-5980. The base personnel locator number for both military and civilian members is (617) 377-5111. The base operator is not authorized to accept collect telephone calls.

Welcome to the winning Hanscom team and the leading edge of military electronics! We look forward to working with you.



FACILITY INDEX

Facility (Building #)	Location
AERO CLUB (1722)	B-2
AIR FORCE GEOPHYSICS LABORATORY (1107)	D-4
AIRMEN'S DINING HALL (1515)	D-3
BACHELOR OFFICER'S QUARTERS (1412/1414)	D-3
BASE BANK (1609)	B-3
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BASE GYMNASIUM (1548)	C-3
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BASE SUPPLY (1614)	C-3
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ESD HEADQUARTERS (1606)	B-3
FAMILY SUPPORT CENTER (1218)	E-3
FIRE STATION (1721)	B-2
GEN. GEORGE S. BROWN BLDG. (1305)	E-3
HOBBY SHOPS (1704)	A-2
MOTOR POOL (1642)	D-3
NCO CLUB (1240)	D-3
OFFICERS CLUB (1425)	D-2,3
O'NEILL BLDG. (1612)	B-3
POST OFFICE (1543)	C-3
RECEPTION CENTER	
BASE INTRO OFFICE (1530)	C,D-3
HOUSING REFERRAL OFFICE (1530)	C,D-3
MILITARY FAMILY HOUSING OFFICE (1530)	C,D-3
RECREATION CENTER (1530)	C,D-3
SECURITY POLICE (1605)	C-3
SERVICE STATION (1639)	C-3
SWIFT INN (TLF) (1423)	E-2,3
SWIMMING POOL (1550)	D-4
THEATRE (1538)	C-3
TRANSPORTATION MANAGEMENT OFFICE (1723)	C-2
VISITING AIRMEN'S QUARTERS (1510)	D-3
VISITING OFFICER'S QUARTERS (1426/1427)	E-2
YOUTH CENTER (1993)	C-3

HANSCOM AFB

Technology's Leading Edge

Welcome to Hanscom Air Force Base and the leading edge of military electronics technology! Home of Air Force Systems Command's Electronic Systems Division, Hanscom is the U.S. military's leading center for development of command, control, communications and intelligence electronics.

A RICH HERITAGE

Hanscom AFB and its surrounding communities are intimately linked to 350 years of American history and revolutionary ideas.

The base lies 20 miles northwest of Boston in the towns of Bedford, Concord, Lexington and Lincoln, Mass. The area was first settled by English immigrants in 1635, when Concord was founded as a "frontier outpost." More than a century later, John Hancock and other prominent revolutionary leaders were roused from their beds in Lexington by Paul Revere's cry, "The British are coming!" The next morning — April 19, 1775 — outnumbered American patriots defied British Redcoats on Lexington's Battle Green and at Concord's Old North Bridge, sparking the American Revolution.

A second "revolution" began about 165 years later when the U.S. Army Air Corps built a fighter base for the air defense of Boston during World War II. It was named L.G. Hanscom Field in honor of a prewar civil-aviation supporter and news editor from Worcester, Mass., who died in a 1940 flying accident.

The Air Corps opened a small office in nearby Cambridge at about the same time to coordinate pioneer work in radar and electronics at the Massachusetts Institute of Technology. After the war, the Cambridge operation expanded until lack of space and need for new facilities forced a move to Hanscom Field. Early successes soon established Hanscom's reputation as a leader in military electronics, and many other challenging projects followed.

Electronic Systems Division, the base's host unit, was formed in 1961 as the Air Force center of excellence for command, control, communication and intelligence electronics development. Since then, ESD has managed hundreds of successful programs, including the Airborne Warning and Control System, the E-4 airborne command post, the Ballistic Missile Early Warning System, over-the-horizon backscatter radars and the Ground Wave Emergency Network communication system.

Today, the division manages more than 120 programs valued at about $4 billion dollars. ESD is the third-largest economic entity in Massachusetts and the 10th-largest in New England. It's also among the region's 20 largest employers.

Developing leading-edge electronic systems to defend America's freedom is the mission, and quality is the watchword, at ESD and Hanscom AFB! Welcome to America's "second revolution!"

ELECTRONIC SYSTEMS DIVISION

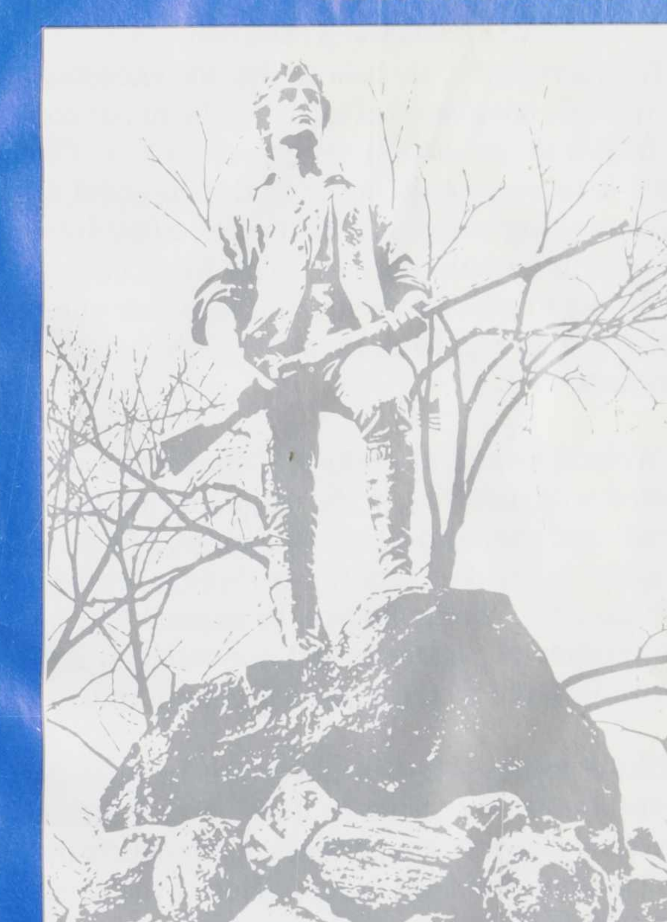
ENJOY YOURSELF!

Hanscom AFB offers many recreation and shopping opportunities for base members and authorized visitors.

- The **base exchange** carries a complete selection of general merchandise. The main exchange mini mall houses dry cleaning, optical, florist, barber and beauty shops.
- The **commissary** offers all the services of a commercial supermarket, including a full selection of custom-cut meats and a delicatessen.
- The **Hanscom Federal Credit Union** and a **Baybank Middlesex** branch bank offer complete financial services, including 24-hour cash machines.
- **Fitness facilities** include the sports and fitness center, a bowling center, year-round swimming pool and tennis courts, racquetball courts and several softball fields.
- **Hobby shops** for do-it-yourself auto repair, woodworking, ceramics and framing offer convenient leisure activities.
- **Looking for places to eat?** Besides the Officers' Club, the NCO Club and the Patriot Dining Hall, you may choose from the Pizza and Sandwich Shop (Bldg. 15[illegible]), [illegible] fast-food grill in the bowling center, a hotdog [illegible] ery in the BX mini mall, or snack bars in Bldgs. [illegible] 1606.

VISITOR MAP

HANSCOM AIR FORCE BASE
MASSACHUSETTS



To arrange a base tour call the ESD Public Affairs Office at (617) 377-4469

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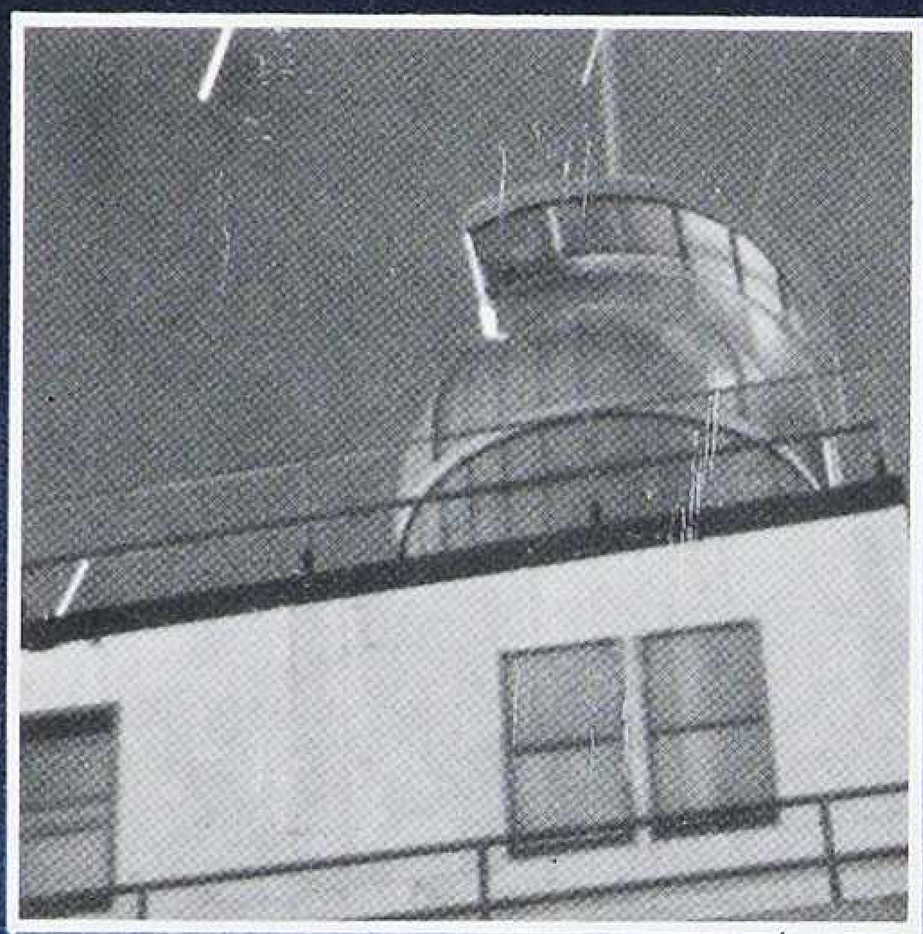


FACILITIES
AVAILABLE FOR USE

U.S. AIR FORCE
PHILLIPS LABORATORY
GEOPHYSICS DIRECTORATE
HANSCOM AIR FORCE BASE

We are living in an economic war — a war where technological superiority is a necessity to stay ahead.

As the gap between the technological superiority of the United States and other countries decreases, the United States must take steps to ensure that America maintains the lead. One step that helps maintain the lead is technology transfer.

According to Air Force Regulation 80-27, para 2j, technology transfer is:

"Oral or written information or data; hardware; personnel, services, facilities, equipment; or other resources relating to scientific or technological developments of an Air Force research, development, test, and engineering activity, provided or disclosed by any means to another federal agency; a state or local government; an industrial organization, including corporation, partnership, limited partnership, or industrial development organization; public or private foundation; nonprofit organization including a university; or other person to *enhance* or *promote technological or industrial innovation for a commercial or public purpose*."

Technology transfer is the program where federally funded knowledge, capabilities, facilities, information, or ideas are used to help strengthen the United States' economy and competitive technological edge.

Many federal laboratories have special one-of-a-kind facilities that other companies, agencies, and organizations may find useful. Allowing outside use of these facilities will help the United States keep the lead and compete in the world marketplace.

The purpose of this brochure is to let others learn about the unique facilities that are available at Phillips Laboratory, Hanscom Air Force Base.

For more information on any of the facilities listed in this brochure, contact:

Noreen Dimond
Office of Research and
Technology Applications
Phillips Laboratory/XPG
29 Randolph Road
Hanscom AFB, MA 01731-3010
(617)377-3608

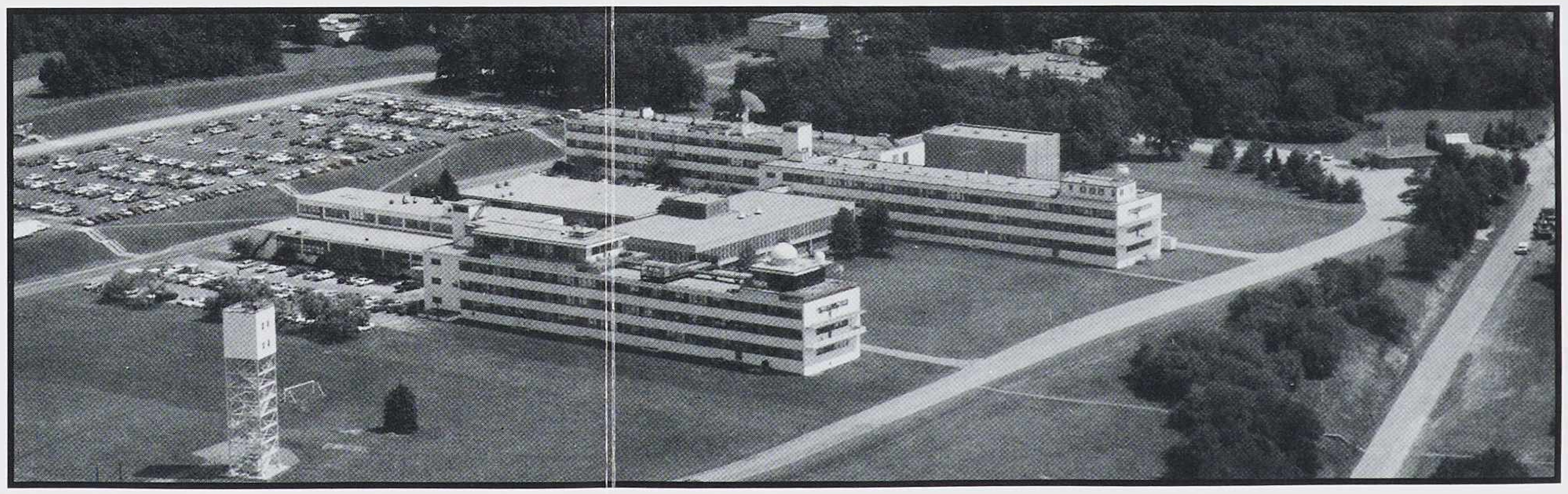
PHILLIPS LABORATORY HANSCOM AFB

MISSION: Phillips Laboratory is a national leader in space research and development. Phillips Laboratory, Hanscom Air Force Base, focuses primarily on geophysics—understanding the environment between the earth and sun and the effects of this environment on military systems. Phillips Lab, Hanscom, also does research on advanced weapons and survivability—understanding how military systems can survive in the space environment; space missiles and technology—developing technologies that provide options and alternatives for space vehicles; and space experiments—conducting space experiments to gather scientific data and demonstrate technologies.

The Phillips Laboratory, Operating Location-AA (PL/OL-AA), is located at Hanscom Air Force Base, Massachusetts. The primary mission of PL/OL-AA is to conduct basic research and exploratory and advanced development in space and ionospheric physics, atmospheric and earth sciences, and optical and infrared technologies. PL/OL-AA also conducts research in advanced weapons and survivability, space missiles and technology, and space experiments.

Phillips Laboratory, OL-AA, is part of the Phillips Laboratory, headquartered at Kirtland Air Force Base, New Mexico. The Phillips Laboratory is recognized as a national leader in research and development. In addition to geophysics, the laboratory concentrates its research and development in five other technical areas: propulsion, space and missiles technology, lasers and imaging, advanced weapons and survivability, and space experiments. PL/OL-AA is the primary environmental science organization in the Air Force.

Phillips Laboratory was formed in 1990 and replaced the Air Force Space Technology Center and Weapons Laboratory, both located at Kirtland Air Force Base, New Mexico; the Astronautics Laboratory at Edwards Air Force Base, California, now the Propulsion Directorate; and the Geophysics Laboratory, now the Geophysics Directorate.



Phillips Laboratory, Kirtland AFB, N.M.; Space and Missiles Systems Center, Los Angeles AFB, Calif.; Air Force Materiel Command, Wright-Patterson AFB, Ohio

Budget: $96 Million

People: 508 Total - 419 Civilians, 89 Military

Space Physics: Energetic particle, plasma, electric, and magnetic field space sensors; solar activity models and simulations; space radiation measurements and models; space disturbance forecasts; space environment impact on Air Force operational systems

Optical Environment: Atmospheric transmission codes, LIDAR technology for atmospheric remote sensing, infrared background phenomenology, targets and backgrounds airborne measurements, infrared target and background codes

Ionospheric Effects: Ionosphere and neutral atmosphere models; ionospheric scintillation models; ionospheric disturbance effects on C^3I space systems; satellite- and ground-based ionospheric sensors and measurements; high power RF ionospheric effects; environment composition surrounding space vehicles; plasma effects on aerospace vehicle signatures and sensors; composition of the space vehicle environment; space debris modeling

Earth Sciences: Cryogenic inertial sensors; gravity models; seismology for the detection, location, and identification of explosions and other global events; seismic hazard assessments

Atmospheric Sciences: Global weather analysis and prediction, theater weather analysis and prediction, measurement techniques and tailored computer weather assessment models

Environmental Simulation: Simulations of the physical environment and its effects on system performance and operations, integration and validation of standard atmospheric and space representations for use in system concept exploration to operations

Data Analysis: Space science information management systems, scientific visualization techniques, scene simulations, telemetry data processing, model development and archiving, space vehicle position and pointing determination

Aerospace Engineering: Payload design, telemetry, command and recovery systems; data-handling techniques for experimental payloads on balloons, rockets, satellites, and shuttle

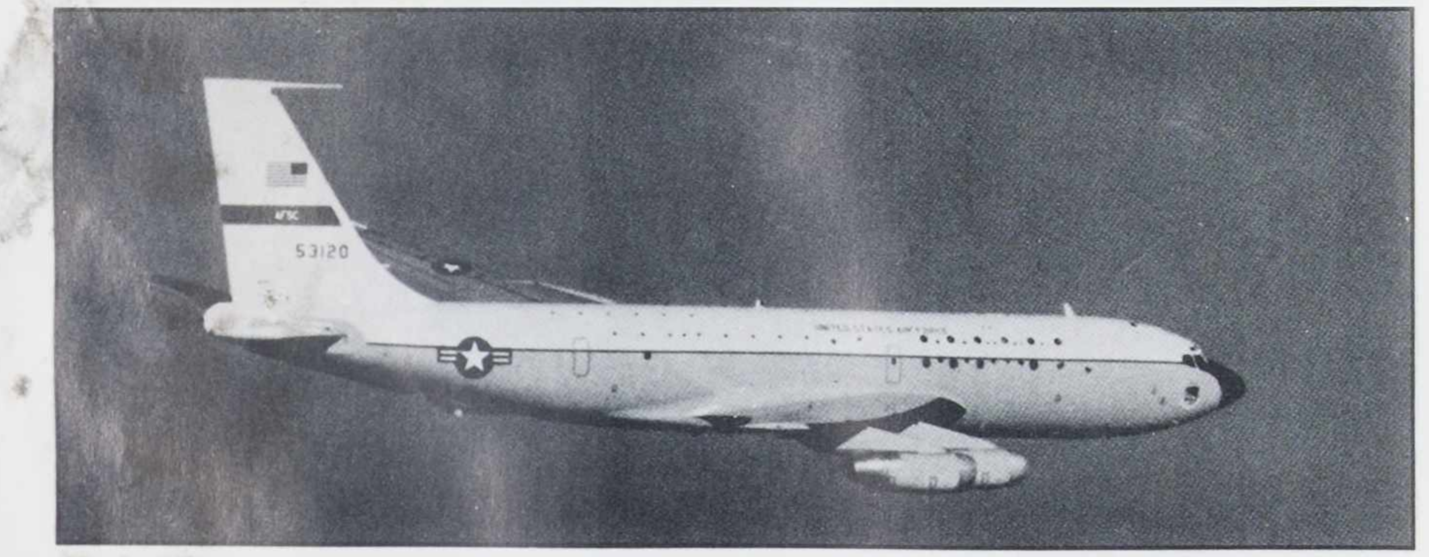
Spacecraft Interactions: Optical sensing of spacecraft environment interactions, foreign spacecraft mission and payload identification, space object characterization using passive discrimination techniques, contamination effects minimization on spacecraft, space environment effects assessment on satellites

Radiation Hardened Electronics: Radiation damage in electronic devices, materials and integrated circuits; device development to improve tolerance to space radiation and single event upsets

THE CI[illegible]TIES

Flying Infrared Signatures Technology Aircraft (FISTA)

FISTA is a specially modified aircraft platform for taking spectral, spatial, and radiometric measurements in the infrared. The current aircraft has over 50 windows mounted on the side, on the top, and on the bottom. Many of these windows can be equipped with periscopes that allow you to look out sideways, forward, upward, downward, or to the rear. Most windows can be used simultaneously so that several spectral, spatial, and radiometric measurements can [illegible]e taken at the same time, with the same background, a[illegible]d nearly under the same conditions. All the instruments are designed for high resolution, high sensitivity, and high dynamic range. FISTA is used to make airborne measurements of targets (aircraft, rockets, and ground vehicles) and backgrounds (clouds, hard earth scenes, and atmospheric transmissions). In the future FISTA will be using remote sensing systems such as light detection and ranging to do further atmospheric characterization studies. The results of these measurements are used to create, extend, or validate predictive computer codes of the phenomena under study, whether it be target signatures, background characterization, or atmospheric transmission, emission, or scattering.



PHILLIPS LABORATORY

High Resolution Spectroscopy Facility

This facility consists of two complementary experiments that study molecules found in the atmosphere. Experiment One is a high resolution Michelson interferometer coupled with a high temperature gas holding cell. This experiment is unique in that all of its components are hand made; none of the components are commercial items. Consequently, Experiment One is not compatible with other off-the-shelf experimental components. Experiment Two is a very high resolution tunable diode laser coupled to a variable temperature gas holding cell. Unlike Experiment One, Experiment Two is assembled from commercial components.

Experiment One combines the high resolution spectroscopy of gas samples with high temperatures to study atmospheric molecules. Experiment Two is capable of high resolution spectroscopy.

Cold Chemiexcited Infrared Simulation Experiment (COCHISE)

COCHISE is a large scale, cryogenic chamber used to simulate and characterize the production of infrared radiation by thermochemical processes in the quiescent auroral and nuclear-disturbed atmosphere. The inner walls of the chamber are cooled to 20º K to reduce background radiation. Microwave discharges are used as thermochemical excitation sources to initiate chemical reactions in low pressure samples. The microwave discharges make possible the simulation of a major class of processes that produce infrared backgrounds in the ambient and disturbed atmosphere. COCHISE also uses an ultra-sensitive solid state photomultiplier (SSPM) that is capable of detecting single infrared photons. The photomultiplier can detect very weak fluorescence and chemiluminescence emissions from the visible to the long-wave infrared. COCHISE is the only ultra-low infrared background chamber in the United States instrumented to perform simulation studies of upper atmospheric chemistry initiated by thermochemical excitation. It is also the most sensitive facility for measuring the infrared emissions generated by thermochemical excitation.

Laboratory Cryogenic Electron Dependent Emissions (LABCEDE)

LABCEDE is a large scale, cryogenic chamber used to measure and characterize infrared emissions produced by the interaction of electrons with atmospheric particulates, especially those occurring in auroral and nuclear-disturbed atmospheres. The cryogenic background reduces the thermal background in the long-wave infrared. The low thermal background of the chamber is radiometrically cooled. The large volume of the observation region permits the detection of weak infrared emissions from samples at low pressures corresponding to an altitude range of 60 to 110 km. An electron gun is instrumented to supply 20 mA currents of 2-6 keV. This maximum available flux exceeds auroral fluxes by several orders of magnitude and is comparable to some nuclear environments. The cryogenic interferometer detects weak fluorescence and chemiluminescence emissions with high sensitivity and high spectral resolution. LABCEDE is the only ultra-low background chamber in the United States for observing electron-excited infrared emissions from simulated auroral and nuclear-disturbed atmospheres. LABCEDE is the most sensitive facility for measuring the infrared emissions from this class of atmospheres.

Ultraviolet (UV) Laser Spectroscopy and Kinetics Laboratory

This facility is used to conduct basic research on the absorption and emission from ultraviolet radiation by atmospheric and other pertinent molecules. The laboratory concentrates on spectral ranges of interest to the Air Force. To conduct this research, the facility has a wide variety of state-of-the-art lasers, optics, and detection electronics. There are also two large vacuum

ultraviolet spectrographs. Several experimental apparatus can be used with the different types of lasers and spectrographs. This laboratory was used to gather the absorption cross-section data on ozone many years ago. This data is important for determining the penetration of ultraviolet light through the stratosphere and for designing instrumentation to detect ozone. This facility is being used to help develop an electro-optic device to detect environmental pollutants in the ultraviolet region.

Selected Ion Flow Drift Tube (SIFDT)

SIFDT is a scientific research instrument used for measuring rates (or rate constants) of chemical reactions involving ions and neutral particulates, and for identifying the products of these chemical reactions. SIFDT has variable temperature capability and ion energy variability which allow measurements to be made as a function of ion energy at different temperatures. The instrument is being modified to include a pulsed supersonic valve for producing cluster ions in the ion source region of the instrument. SIFDT is one of only two such instruments in the world.

Air Force Interactive Meteorological System (AIMS)

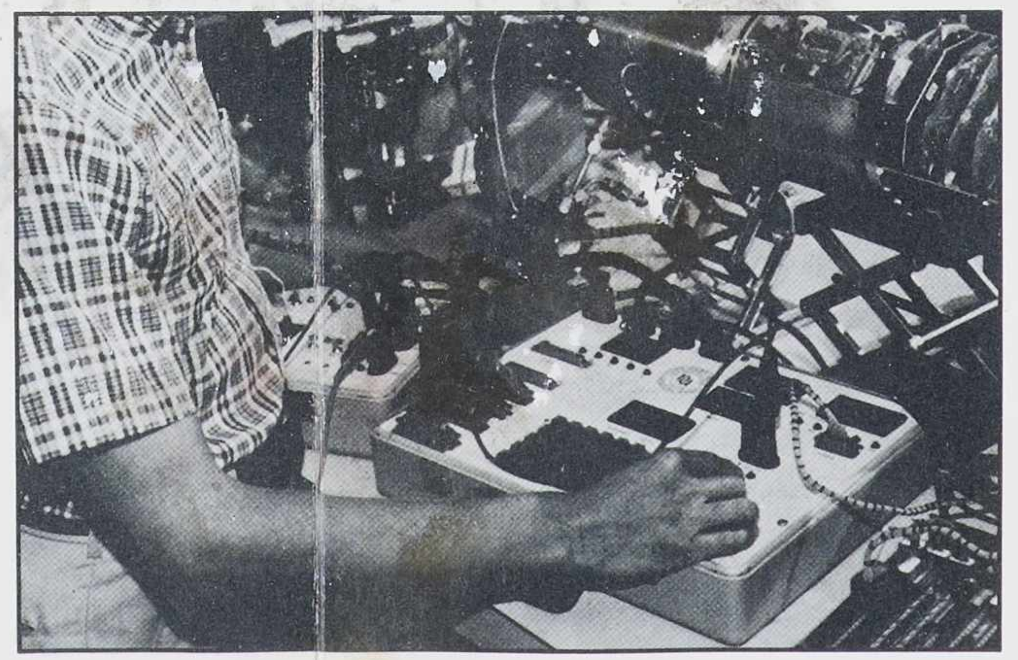
AIMS is a cluster of VAX-based minicomputers configured to optimally support multi-spectral satellite image analysis. It is the largest computing system in the Department of Defense dedicated to the development of satellite data information extraction algorithms.

Presently, 17 no[illegible]es serve up to 40 researchers simul-ta[illegible]ously. AIMS is presently configured with three Adage image proce[illegible]s and a Ma[illegible]sh visualization [illegible]orkstation. [illegible]as access [illegible] real-time data from the polar orb[illegible] [illegible]io[illegible]al Oc[illegible] and Atmospheres Administrati[illegible] [illegible]AA) and Defense Meteorolo[illegible]ical Satellite Prog[illegible] satellites, and NOAA geosynchronous satellite[illegible]

P[illegible]illips [illegible]aboratory Electron/Ion and The[illegible]mal Calibration Facility (MUMBO) and [illegible]UMBO

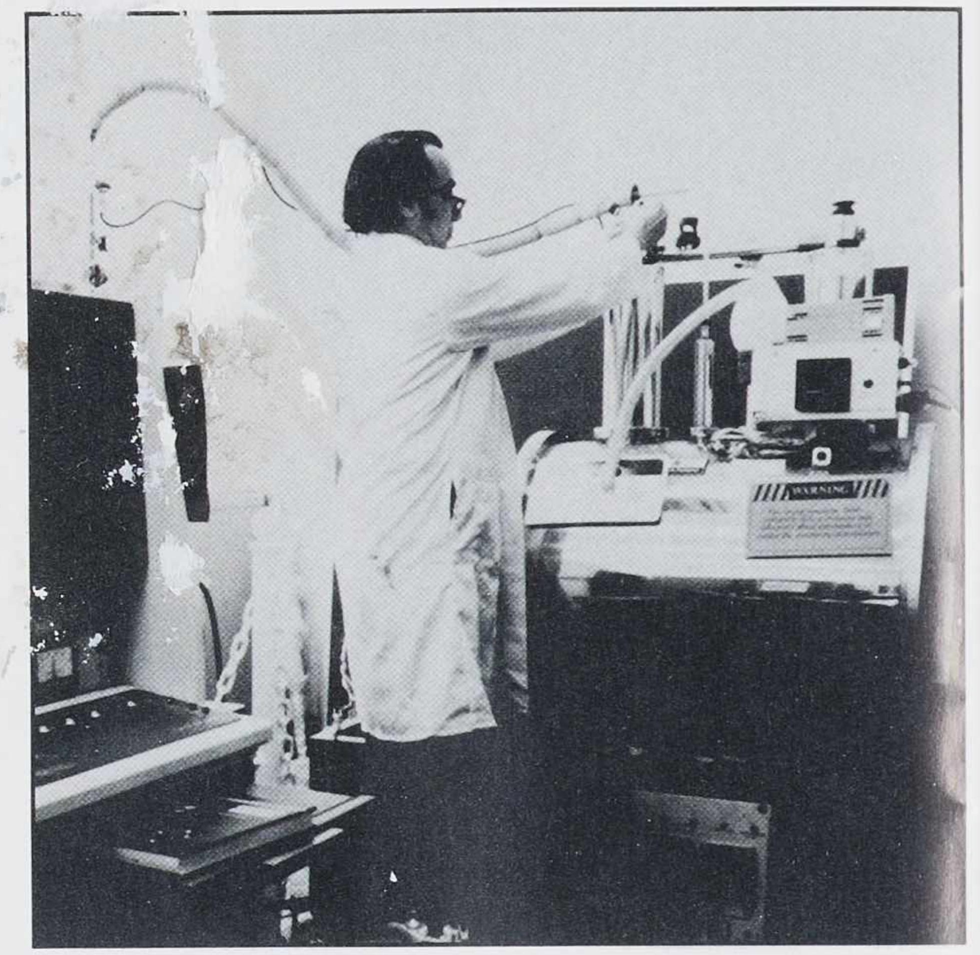
The P[illegible] [illegible]abor[illegible]y Electron/Ion and Thermal Calibr[illegible] Fa[illegible]y consists of a vac[illegible]um chamber, suppor[illegible]ing comp[illegible]er e[illegible]uipment, an electron calibration beam, a[illegible]on calibratio[illegible] beam, and a thermal shrou[illegible]. T[illegible] [illegible]ipment is used to calibrate particle [illegible]etectors f[illegible] [illegible]aceflight and to thermal qualify spaceflight h[illegible]r[illegible]ware under a vacuum. Electron calibration, [illegible]n ca[illegible]bration, and thermal vacuum qualification run independently from each other and the chamber is specifically configured to support only one of these efforts at a time. Electron calibration can be performed from 10 eV to 45 ke[illegible]. Ion calibration can be performed from 2 eV [illegible] [illegible]V. A specially designed mounting fixt[illegible]r[illegible] is used to scan detectors over a wide range of angles through the particle beam. Thermal [illegible] run from -180º C to 100º C. This facility can test h[illegible] [illegible]ong a space experiment could survive in space whi[illegible] r[illegible]nning h[illegible] or cold.

[illegible]MBO is a vacuum chamber used for space simu[illegible]tions. It is used primarily for development and testing of spacecraft instruments, and electron, ion, or plas[illegible]na sou[illegible]es. Cryogenic pumping provides a clean vacuum en[illegible]ironmen[illegible]. The base pressure is 10^{-7} torr. Although this facility is u[illegible]ed primarily to test hardware f[illegible]r use on spacecraft, it can also be used for laboratory [illegible]sma [illegible]hysics experiments.



Mass Spectrometer Calibration System

This spectrometer maintains a precise gas pressure within a specified calibration range. The gas can be any non-toxic species and the pressure can be varied



between 1 X 10^{-10} to 1 X 10^{-2}. The accuracy of the pressure measurement is one percent traceable to the National Institute of Standards and Technology standards. Prior to spaceflight, a mass spectrometer must be operated at well known pressure using a variety of gases expected to be seen during the flight. This facility permits the signal output of the spectrometer to be related to well known gas inlet conditions.

High Altitude Light Detection and Ranging (LIDAR) Sounder

The High Altitude LIDAR Sounder is a remote sounder that measures density and temperature, repetitively, at altitudes up to 75 km. The sounder uses a laser as a transmitter and an optical telescope as a receiver. This facility is used to take routine density measurements for a neutral density modeling program and is also used to take temperature data for the Upper Atmospheric Research Satellite (UARS). The sounder helps develop high altitude LIDAR technology.

Ultraviolet Calibration Facility

The Ultraviolet Calibration Facility is a laboratory designed for ultraviolet sensor calibration and tests. It is equipped with special equipment and techniques for this type of work. Space and ground-based sensors can be radiometrically calibrated and tested for field use in the ultraviolet and visible light spectrum from about 100 to 650 nm wavelengths. The radiometric calibration is tied to the National Institute of Standards and Technology secondary standards. Sensors that are used on satellites, shuttles, rockets, aircraft, and ground telescopes can be calibrated.

Laser Induced Nuclear Simulation (LINUS)

LINUS is a laser-produced plasma apparatus used to simulate infrared backgrounds from high-altitude nuclear plasma plumes. This facility comes with a high-power, pulsed Nd:YAG laser with focusing optics, a variable pressure target gas cell, specialized cryogenic infrared detectors, and detection systems for observing ultraviolet to long-wave infrared emissions in recombining, variable density plasmas. LINUS is the only laser facility in the United States that is instrumented to perform simulations of upper atmospheric infrared plasma emissions. It is [illegible] most sensitive facility for measuring the infrared [illegible]s-sions from electron-ion recombining plasma.

Fourier Transform Mass Spectrometer (FTMS)

FTMS is the most recent development in mass spectrometry. After ions are produced, they are elevated to cyclotron orbits and measured. The resulting time signal is analyzed using fourier transform to get a mass spectra. FTMS uses new spectral analysis methods of time signals, measures the time dependence of chemical reactions and rates, and measures all ion species simultaneously. FTMS features low pressure experiments to get initial mass spectra and has ion ejection capability. The spectrometer can measure aspects of chemical reactions not measurable otherwise such as initial products of a reaction before collisions destroy the distribution. With this spectrometer, the Maximum Entropy Method (MEM) of mass spectroscopy was used for the first time. The spectrometer has also measured chemical rates not measured on other spectrometers.

Haskell Observatory

The Haskell Observatory houses seismic recording equipment that is used to record earthquakes in the New England area and around the world. The facility has three large concrete piers that extend from room level to bedrock some 15-20 feet below the surface. These piers are mechanically isolated from the building so that noise from people and machinery does not affect the instruments on the piers, thus resulting in highly accurate readings. This facility was named in honor of Dr. Norman Haskell, a prominent seismologist who worked at the Air Force Cambridge Laboratories in the 1950s and 60s.

Geophysics Experiment Data Processing and Analysis

This facility is a configuration of user-friendly scientific workstations networked with a state-of-the-art telemetry processing facility, mass storage devices, and central computer resources. It gives researchers a full spectrum of data processing and analysis capability for interpreting geophysical parameters measured during space missions. The workstations allow researchers to dynamically interact with space science measurement databases and interpret geophysical processes. Scientific workstations not presently networked to this system can easily be connected. Researchers at remote locations can also access these geophysics databases through wide area networks.

Payload Integration Facility (High-Bay)

The Payload Integration Facility is used to integrate and test payloads on rockets, balloons, or spacecraft vehicles.

The facility has a 30 ft high-bay area, a class 100 clea[illegible] room, and two X-Y translating cranes that hand[illegible]e payloads up to 5000 lbs. The hi[illegible]h-[illegible]ay is equipped [illegible] measure the response of payload[illegible] to mechanical v[illegible]tion, shock, acceleration, thermal, [illegible] [illegible]mal-va[illegible]u[illegible] chamber tests. Power is availa[illegible] [illegible]d-ing three phase. There is plent[illegible] [illegible]e[illegible]em set-up and integration with access [illegible] [illegible]o, [illegible]ll-up doors, one of [illegible]hich has [illegible] hydraulic [illegible] [illegible]also includes a telemetry station and dat[illegible] [illegible]g room. The telemetry station is used for quick [illegible] [illegible]nd [illegible]al-time assessment of the payloads.

Phillips Laboratory, Hanscom Geophysics Research Library

The Hanscom Geophysics Research Library provides information services and materials to support the Phillips Laboratory, Hanscom Air Force Base, Massachusetts. The Library maintains a specialized research collection containing scientific and technical literature, both current and historical. The Library also has access to a wide range of information services including loans between libraries, document delivery, and on-line literature searching. The Library has a book and journal collection totaling more than 300,000 volumes and is the official archive of technical reports produced by the Phillips Laboratory, Geophysics Directorate and its contractors. The technical reports from Electronic Systems Center (since 1976) and from the Rome Laboratory divisions located at Hanscom AFB are also archived at this facility. The Library has a special collection of rare books, including books on early ballooning, Arctic exploration, and the scientific papers of the third and fourth Lord Rayleighs.

Phillips Laboratory Coherent Doppler Light Detection and Ranging (LIDAR)

The Coherent Doppler LIDAR uses a CO_2 laser as a transmitter and an optical receiver and detection system to measure atmospheric wind field, cloud and aerosol structure. The system is transportable, self contained (except for power - 3 phase 208 VAC), and eye safe.

THE
C[illegible]LITIES

Flying Infrared Signatures Technology Aircraft (FISTA)

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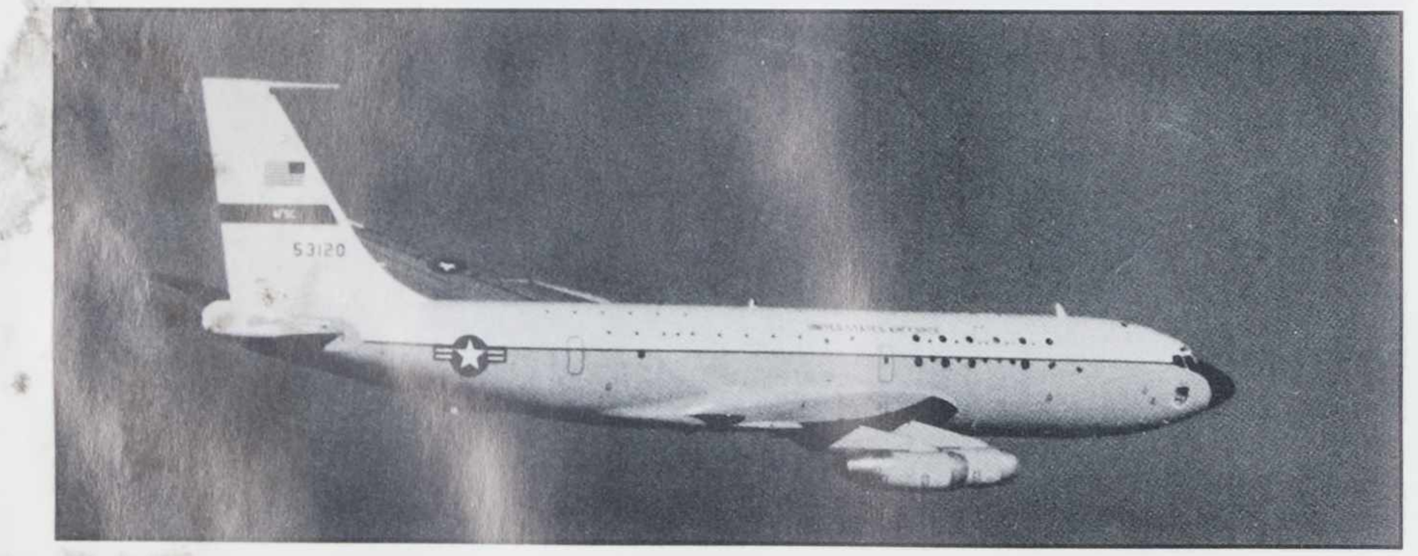

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Laboratory Cryogenic Electron Dependent Emissions (LABCEDE)

LABCEDE is a large scale, cryogenic chamber used to measure and characterize infrared emissions produced by the interaction of electrons with atmospheric particulates, especially those occurring in auroral and nuclear-disturbed atmospheres. The cryogenic background reduces the thermal background in the long-wave infrared. The low thermal background of the chamber is radiometrically cooled. The large volume of the observation region permits the detection of weak infrared emissions from samples at low pressures corresponding to an altitude range of 60 to 110 km. An electron gun is instrumented to supply 20 mA currents of 2-6 keV. This maximum available flux exceeds auroral fluxes by several orders of magnitude and is comparable to some nuclear environments. The cryogenic interferometer detects weak fluorescence and chemiluminescence emissions with high sensitivity and high spectral resolution. LABCEDE is the only ultra-low background chamber in the United States for observing electron-excited infrared emissions from simulated auroral and nuclear-disturbed atmospheres. LABCEDE is the most sensitive facility for measuring the infrared emissions from this class of atmospheres.

Ultraviolet (UV) Laser Spectroscopy and Kinetics Laboratory

This facility is used to conduct basic research on the absorption and emission from ultraviolet radiation by atmospheric and other pertinent molecules. The laboratory concentrates on spectral ranges of interest to the Air Force. To conduct this research, the facility has a wide variety of state-of-the-art lasers, optics, and detection electronics. There are also two large vacuum

ultraviolet spectrographs. Several experimental apparatus can be used with the different types of lasers and spectrographs. This laboratory was used to gather the absorption cross-section data on ozone many years ago. This data is important for determining the penetration of ultraviolet light through the stratosphere and for designing instrumentation to detect ozone. This facility is being used to help develop an electro-optic device to detect environmental pollutants in the ultraviolet region.

Selected Ion Flow Drift Tube (SIFDT)

SIFDT is a scientific research instrument used for measuring rates (or rate constants) of chemical reactions involving ions and neutral particulates, and for identifying the products of these chemical reactions. SIFDT has variable temperature capability and ion energy variability which allow measurements to be made as a function of ion energy at different temperatures. The instrument is being modified to include a pulsed supersonic valve for producing cluster ions in the ion source region of the instrument. SIFDT is one of only two such instruments in the world.

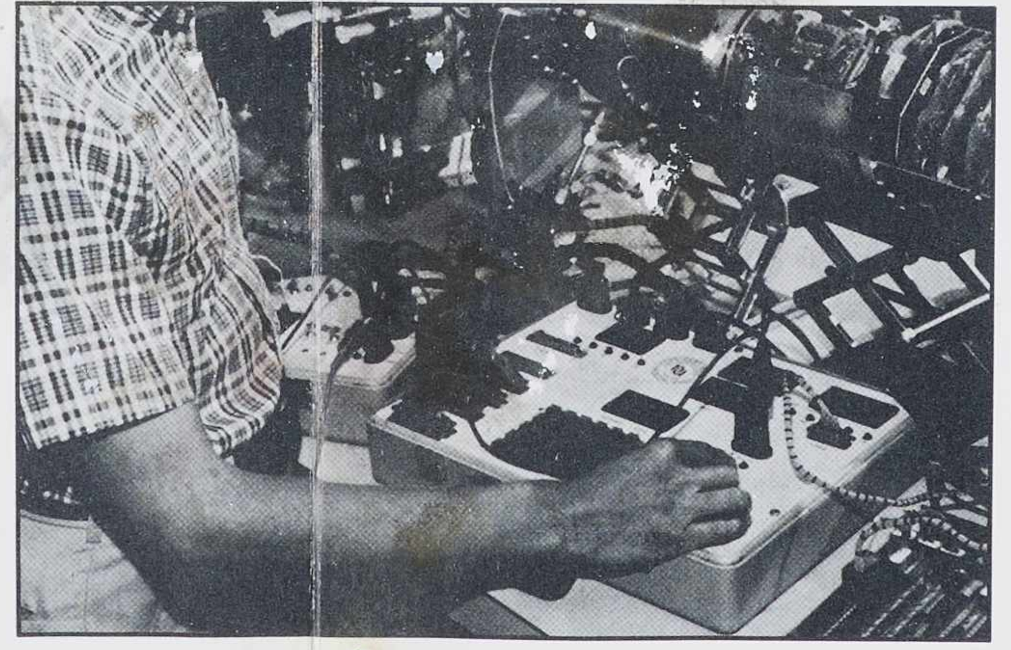
Air Force Interactive Meteorological System (AIMS)

AIMS is a cluster of VAX-based minicomputers configured to optimally support multi-spectral satellite image analysis. It is the largest computing system in the Department of Defense dedicated to the development of satellite data information extraction algorithms. Presently, 17 nodes serve up to 40 researchers simulta[illegible]ously. AIMS is presently configured with three Adage image proce[illegible]s and a Ma[illegible]sh visualization workstation. [illegible] has access to real-time data from the polar orb[illegible] [illegible]ional Oce[illegible]s and Atmospheres Administrati[illegible] [illegible]AA) and Defense Meteorolo[illegible]ical Satellite Prog[illegible] [illegible] satellites, and NOAA geosynchronous satellite[illegible]

P[illegible]illips [illegible]aboratory Electron/Ion and The[illegible]mal Calibration Facility (MUMBO) and [illegible]UMBO

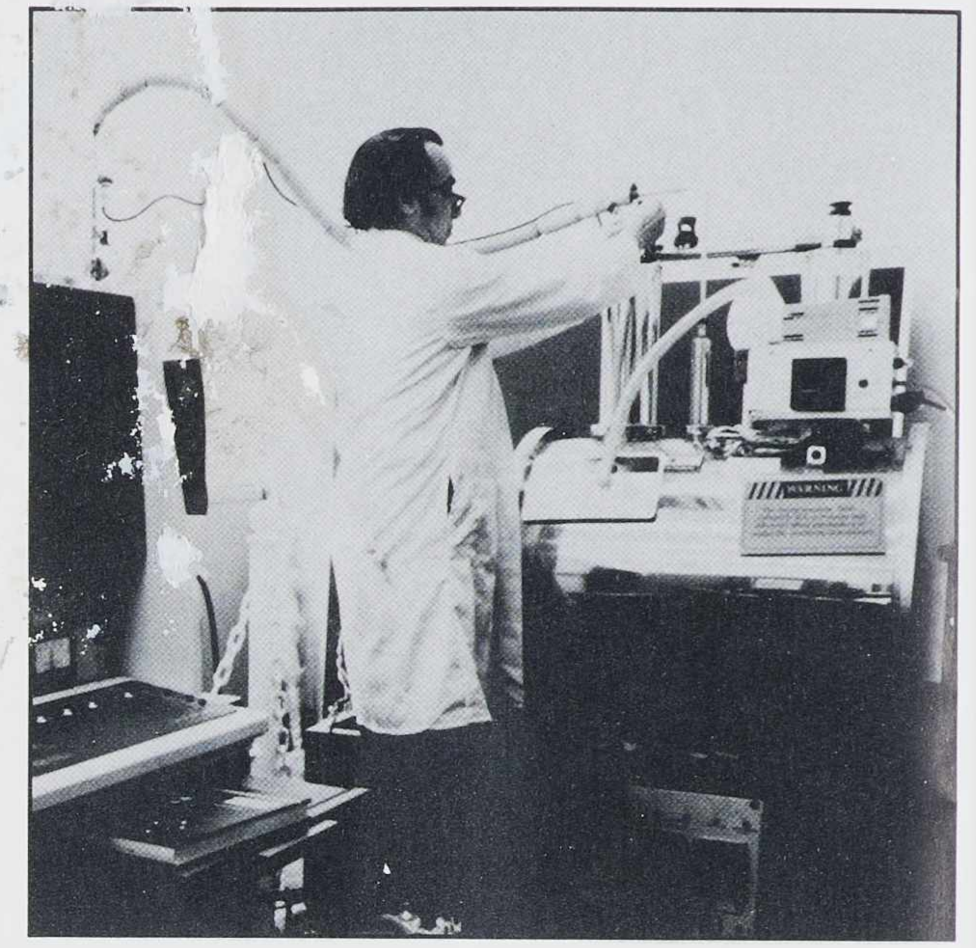
The P[illegible] [illegible]abor[illegible] Electron/Ion and Thermal Calibr[illegible] Fa[illegible] consists of a vacuum chamber, supporting comp[illegible]er equipment, an electron calibration beam, a[illegible] ion calibration beam, and a thermal shrou[illegible] T[illegible] [illegible]ipment is used to calibrate particle detectors f[illegible] spaceflight and to thermal qualify spaceflight h[illegible]dware under a vacuum. Electron calibration, [illegible]n ca[illegible]bration, and thermal vacuum qualification run independently from each other and the chamber is specifically configured to support only one of these efforts at a time. Electron calibration can be performed from 10 eV to 45 ke[illegible]. Ion calibration can be performed from 2 eV [illegible] [illegible]V. A specially designed mounting fixt[illegible] is used to scan detectors over a wide range of angles through the particle beam. Thermal [illegible] run from -180° C to 100° C. This facility can test h[illegible] [illegible]ong a space experiment could survive in space whi[illegible] r[illegible]nning h[illegible] or cold.

[illegible]MBO is a vacuum chamber used for space simulations. It is used primarily for development and testing of spacecraft instruments, and electron, ion, or plasma sour[illegible]es. Cryogenic pumping provides a clean vacuum environment. The base pressure is 10^{-7} torr. Although this facility is used primarily to test hardware for use on spacecraft, it can also be used for laboratory [illegible]sma physics experiments.



Mass Spectrometer Calibration System

This spectrometer maintains a precise gas pressure within a specified calibration range. The gas can be any non-toxic species and the pressure can be varied



between 1×10^{-10} to 1×10^{-2}. The accuracy of the pressure measurement is one percent traceable to the National Institute of Standards and Technology standards. Prior to spaceflight, a mass spectrometer must be operated at well known pressure using a variety of gases expected to be seen during the flight. This facility permits the signal output of the spectrometer to be related to well known gas inlet conditions.

High Altitude Light Detection and Ranging (LIDAR) Sounder

The High Altitude LIDAR Sounder is a remote sounder that measures density and temperature, repetitively, at altitudes up to 75 km. The sounder uses a laser as a transmitter and an optical telescope as a receiver. This facility is used to take routine density measurements for a neutral density modeling program and is also used to take temperature data for the Upper Atmospheric Research Satellite (UARS). The sounder helps develop high altitude LIDAR technology.

Ultraviolet Calibration Facility

The Ultraviolet Calibration Facility is a laboratory designed for ultraviolet sensor calibration and tests. It is equipped with special equipment and techniques for this type of work. Space and ground-based sensors can be radiometrically calibrated and tested for field use in the ultraviolet and visible light spectrum from about 100 to 650 nm wavelengths. The radiometric calibration is tied to the National Institute of Standards and Technology secondary standards. Sensors that are used on satellites, shuttles, rockets, aircraft, and ground telescopes can be calibrated.

Laser Induced Nuclear Simulation (LINUS)

LINUS is a laser-produced plasma apparatus used to simulate infrared backgrounds from high-altitude nuclear plasma plumes. This facility comes with a high-power, pulsed Nd:YAG laser with focusing optics, a variable pressure target gas cell, specialized cryogenic infrared detectors, and detection systems for observing ultraviolet to long-wave infrared emissions in recombining, variable density plasmas. LINUS is the only laser facility in the United States that is instrumented to perform simulations of upper atmospheric infrared plasma emissions. It is [illegible] most sensitive facility for measuring the infrared [illegible]sions from electron-ion recombining plasma.

Fourier Transform Mass Spectrometer (FTMS)

FTMS is the most recent development in mass spectrometry. After ions are produced, they are elevated to cyclotron orbits and measured. The resulting time signal is analyzed using fourier transform to get a mass spectra. FTMS uses new spectral analysis methods of time signals, measures the time dependence of chemical reactions and rates, and measures all ion species simultaneously. FTMS features low pressure experiments to get initial mass spectra and has ion ejection capability. The spectrometer can measure aspects of chemical reactions not measurable otherwise such as initial products of a reaction before collisions destroy the distribution. With this spectrometer, the Maximum Entropy Method (MEM) of mass spectroscopy was used for the first time. The spectrometer has also measured chemical rates not measured on other spectrometers.

Haskell Observatory

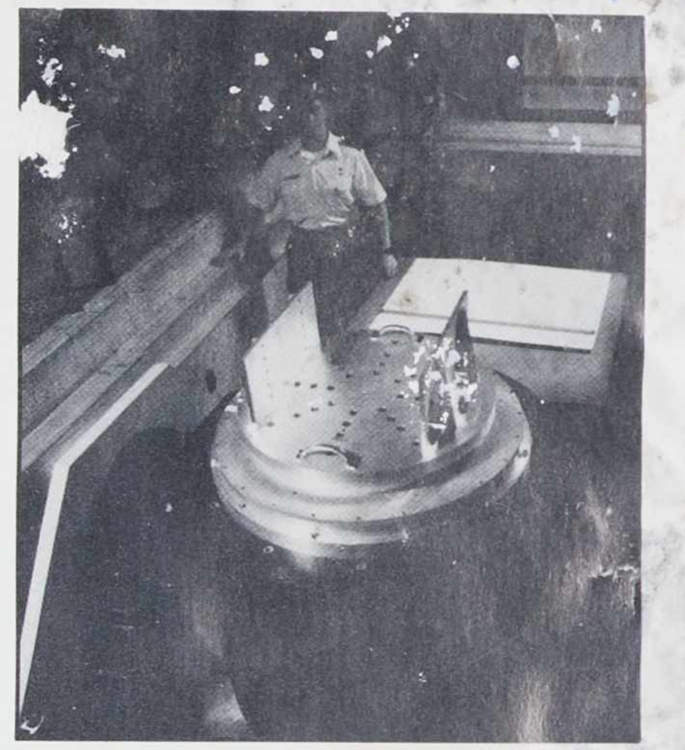
The Haskell Observatory houses seismic recording equipment that is used to record earthquakes in the New England area and around the world. The facility has three large concrete piers that extend from room level to bedrock some 15-20 feet below the surface. These piers are mechanically isolated from the building so that noise from people and machinery does not affect the instruments on the piers, thus resulting in highly accurate readings. This facility was named in honor of Dr. Norman Haskell, a prominent seismologist who worked at the Air Force Cambridge Laboratories in the 1950s and 60s.

Geophysics Experiment Data Processing and Analysis

This facility is a configuration of user-friendly scientific workstations networked with a state-of-the-art telemetry processing facility, mass storage devices, and central computer resources. It gives researchers a full spectrum of data processing and analysis capability for interpreting geophysical parameters measured during space missions. The workstations allow researchers to dynamically interact with space science measurement databases and interpret geophysical processes. Scientific workstations not presently networked to this system can easily be connected. Researchers at remote locations can also access these geophysics databases through wide area networks.

Payload Integration Facility (High-Bay)

The Payload Integration Facility is used to integrate and test payloads on rockets, balloons, or spacecraft vehicles. The facility has a 30 ft high-bay area, a class 100 clea[illegible] room, and two X-Y translating cranes that handle payloads up to 5000 lbs. The high-bay is equipped [illegible] measure the response of payload[illegible] to mechanical v[illegible]tion, shock, acceleration, thermal, [illegible] [illegible]mal-va[illegible] chamber tests. Power is availa[illegible] [illegible]ing three phase. There is plenty [illegible] set-up and integration with access [illegible] doors, one of which has a hydraulic [illegible] also includes a telemetry station and dat[illegible] room. The telemetry station is used for quick [illegible] and [illegible]al-time assessment of the payloads.



Phillips Laboratory, Hanscom Geophysics Research Library

The Hanscom Geophysics Research Library provides information services and materials to support the Phillips Laboratory, Hanscom Air Force Base, Massachusetts. The Library maintains a specialized research collection containing scientific and technical literature, both current and historical. The Library also has access to a wide range of information services including loans between libraries, document delivery, and on-line literature searching. The Library has a book and journal collection totaling more than 300,000 volumes and is the official archive of technical reports produced by the Phillips Laboratory, Geophysics Directorate and its contractors. The technical reports from Electronic Systems Center (since 1976) and from the Rome Laboratory divisions located at Hanscom AFB are also archived at this facility. The Library has a special collection of rare books, including books on early ballooning, Arctic exploration, and the scientific papers of the third and fourth Lord Rayleighs.

Phillips Laboratory Coherent Doppler Light Detection and Ranging (LIDAR)

The Coherent Doppler LIDAR uses a CO_2 laser as a transmitter and an optical receiver and detection system to measure atmospheric wind field, cloud and aerosol structure. The system is transportable, self contained (except for power - 3 phase 208 VAC), and eye safe.

OTHER FACILITIES

Electron'c and Instrument Development Lab

Clean R..oms for Space Instrument Development and Test

Sacr... ..nto Peak Observatories

...ed jointly with National Solar Ob...

... Analysis Facility

... sportable Optical Atmospheric Data System

High Temperature Chemical Reaction-Rate Measurement

Optical and RF Ionospheric Scintillation Signal Processing

High- Mid- and Low- Latitude Ionospheric Sounding

VHF Meteor Scatter

RF ... Scintillation and TEC ...arimeter Sites

...under Sites

...tem Goose Bay Labrador

...SUN)

... System

Spa... ...e A... ...s and Simulation

Tech... ...d High Altitude Balloon Platforms

High ...emperature Mass Spectrometer

Ion-Neutral Collision Apparatus

Multi-Spectral, Space Flight Qualified UV-Vis and IR Sensors

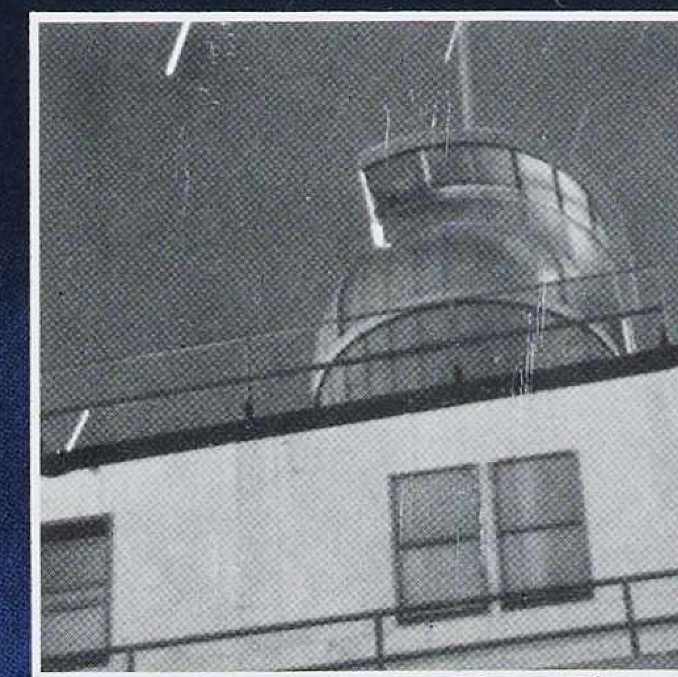
Cobalt-60 Source Flash X-Ray

Linear Accelerator

Dynamatron Accelerator

ARACOR X-Ray Test System

U.S. Air Force
Phillips Laboratory
Geophysics Technology Division
Plans and Programs Directorate
29 Randolph Road
Hanscom AFB, MA 01731-3010
(617) 377-3606, DSN 478-3606



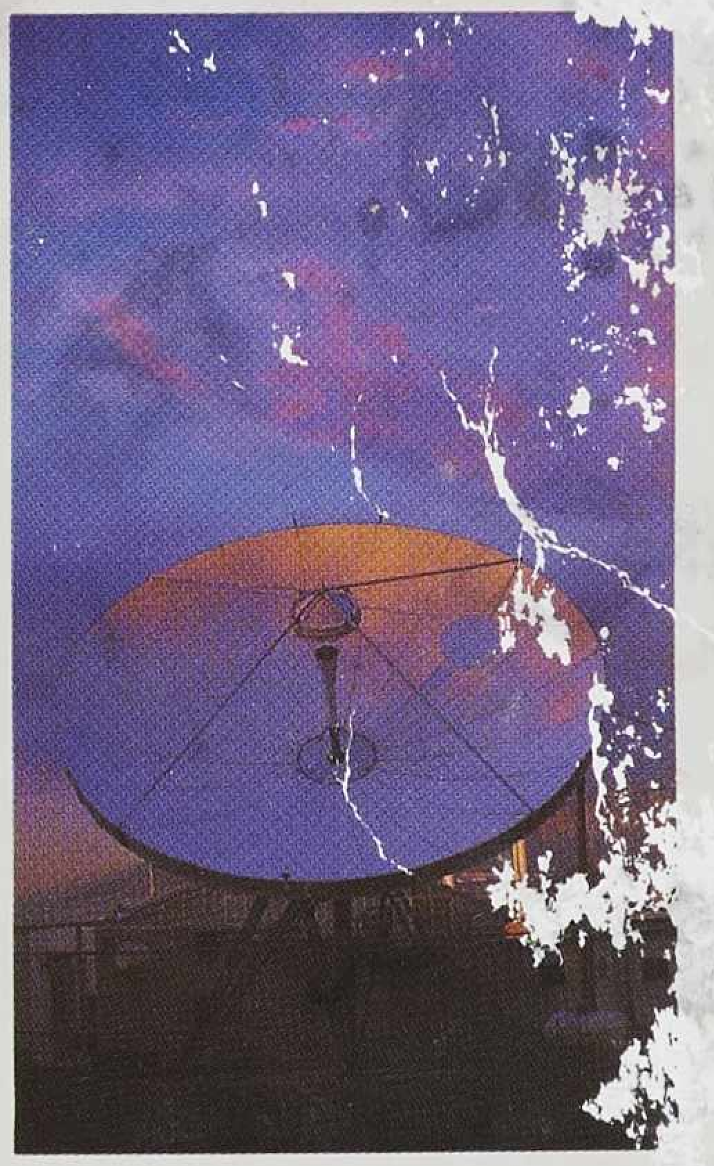
FACILITIES

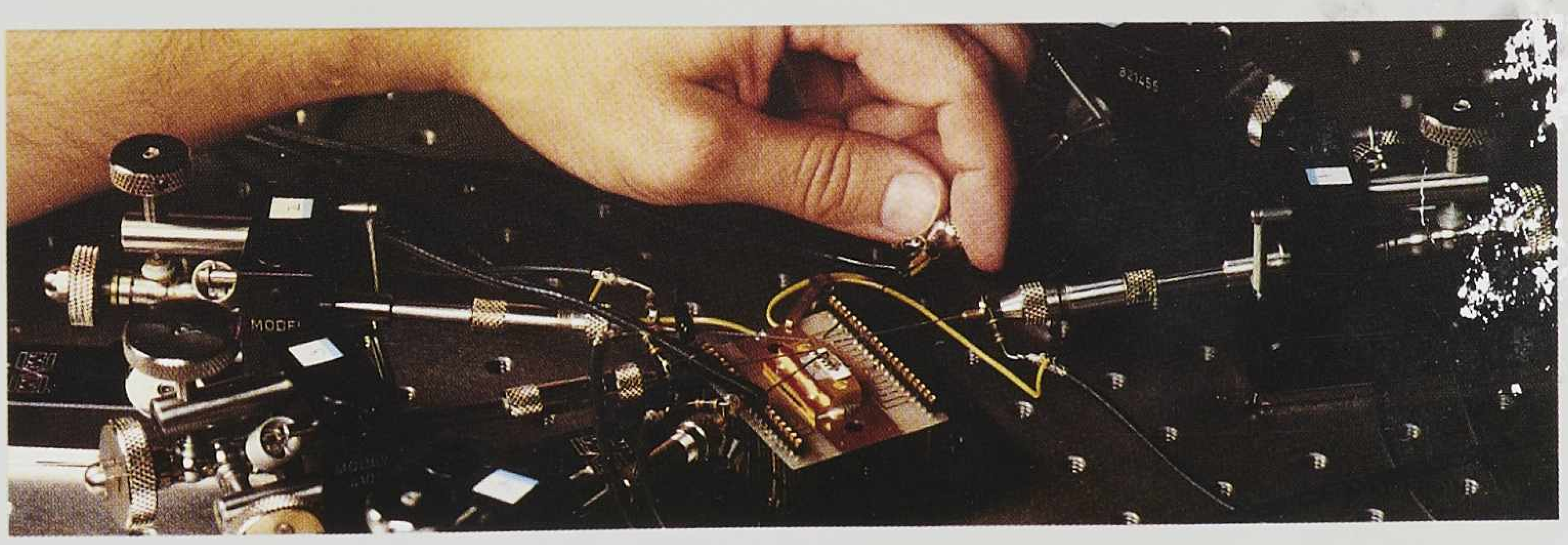
AVAILABLE FOR US...

U.S. AIR FORCE
PHILLIPS LABORATORY
GEOPHYSICS DIRECTORATE
HANSCOM AIR FORCE BASE

United States Air Force

Phillips Laboratory





PHILLIPS LABORATORY

THE VISION OF THE PHILLIPS LABORATORY IS TO BE THE PREMIER LABORATORY IN MILITARY SPACE, MISSILES, DIRECTED ENERGY, AND GEOPHYSICS.

The vision of the Phillips Laboratory is to be the premier laboratory in military space, missiles, directed energy, and geophysics.

Phillips Laboratory

Recognized as a national leader in space research and development, the Air Force's Phillips Laboratory combines a talented military-civilian employee workforce with unique capabilities, resources, and facilities to form a world-class research center for national defense.

Located at Kirtland Air Force Base, New Mexico, the Laboratory is charged with furthering research and development in space and missile systems, geophysics, directed energy, and advanced weapons concepts.

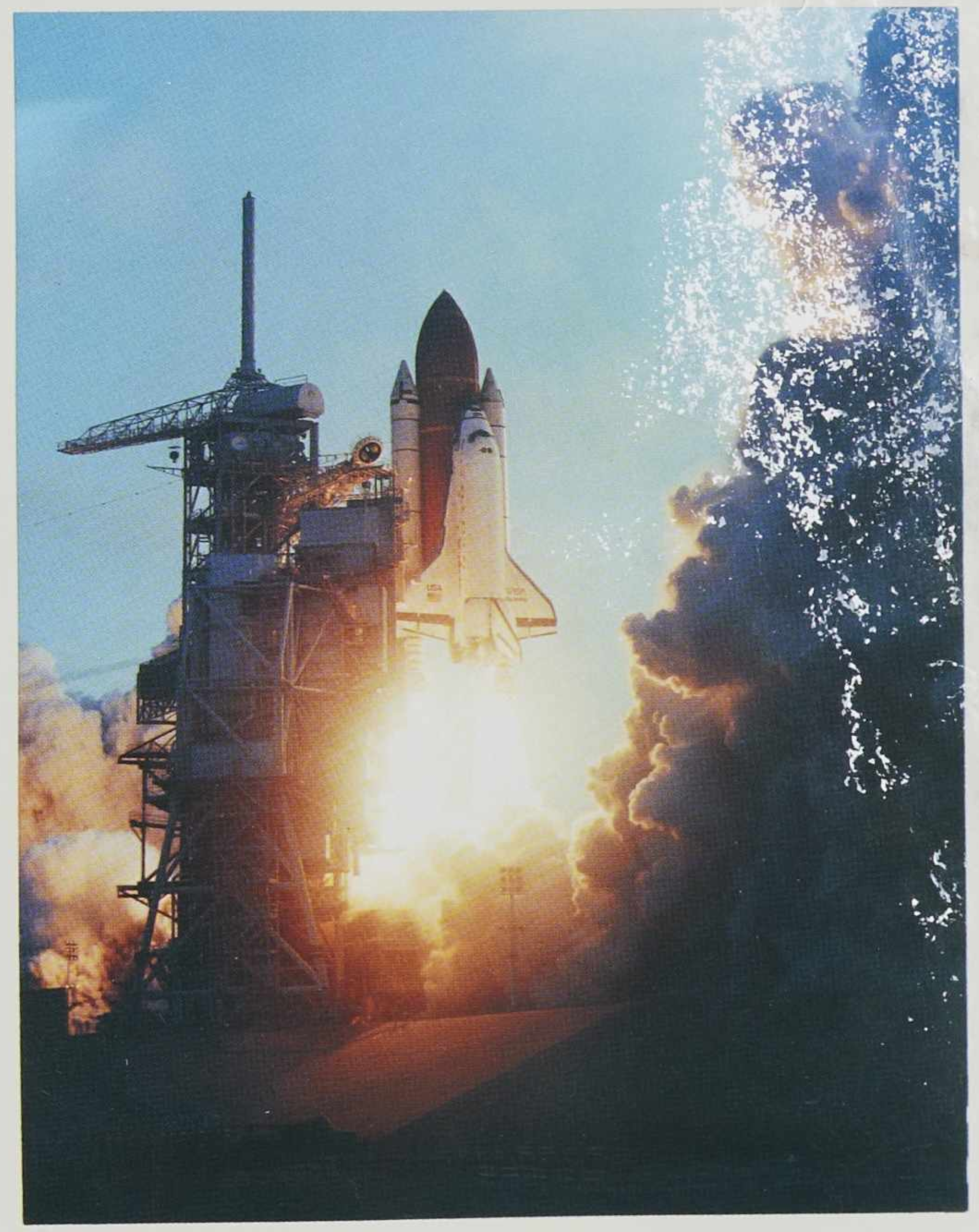
With an annual budget of approximately $700 million, Phillips Laboratory scientists are performing in-depth exploitations of the technologies involved in developing spacecraft, ballistic missiles, and directed-energy weapons. The Laboratory places a strong emphasis on integrating and transitioning its technologies into aerospace systems.

The Laboratory concentrates its research and development in six technical areas: geophysics, propulsion, space and missiles technology, lasers and imaging, advanced weapons and survivability, and space experiments.

Named for space technology pioneer, General Samuel C. Phillips, the Laboratory has more than 2,400 military and civilian employees throughout the country. While the majority of employees work at Kirtland Air Force Base, major components reside in California and Massachusetts.

Formed in December 1990, the Phillips Laboratory replaced the Air Force Space Technology Center, which consisted of a headquarters at Kirtland Air Force Base, New Mexico; the Weapons Laboratory, also at Kirtland; the Geophysics Laboratory at Hanscom Air Force Base, Massachusetts; and the Astronautics Laboratory at Edwards Air Force Base, California.

The following pages will highlight some of the major scientific endeavors in progress by the Laboratory's six technical directorates.



Advanced Weapons & Survivability

High-energy plasmas and microwaves are core technologies being studied as possible advanced weapons by this Directorate. The Laboratory's research includes finding ways to make military hardware survivable against nuclear weapons environments, electromagnetic and advanced weapons effects. Scientists use advanced techniques and computer simulations to analyze, test for, and minimize the effects of directed-energy weapons. The Lab conducts survivability tests on aircraft, satellites, and other military hardware.

Advanced Weapons & Survivability Programs

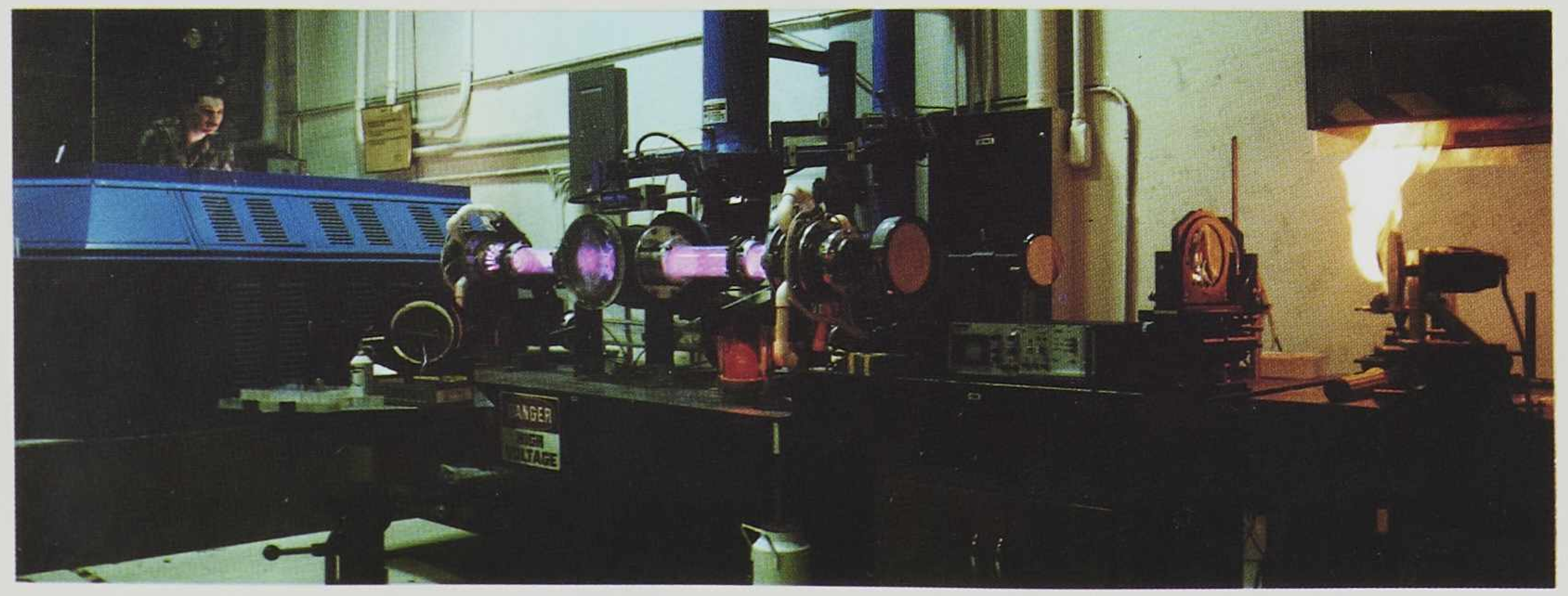
High-Power Microwaves — Research is determining the effects of high-power microwaves on military systems and developing this technology as a possible directed-energy weapon.

Satellite Assessment — How susceptible space satellites are to directed-energy weapons is a primary focus for the Laboratory's analysts.

Space Survivability — Researchers are developing survivability techniques and ways to mitigate the effects of space environments on military systems.

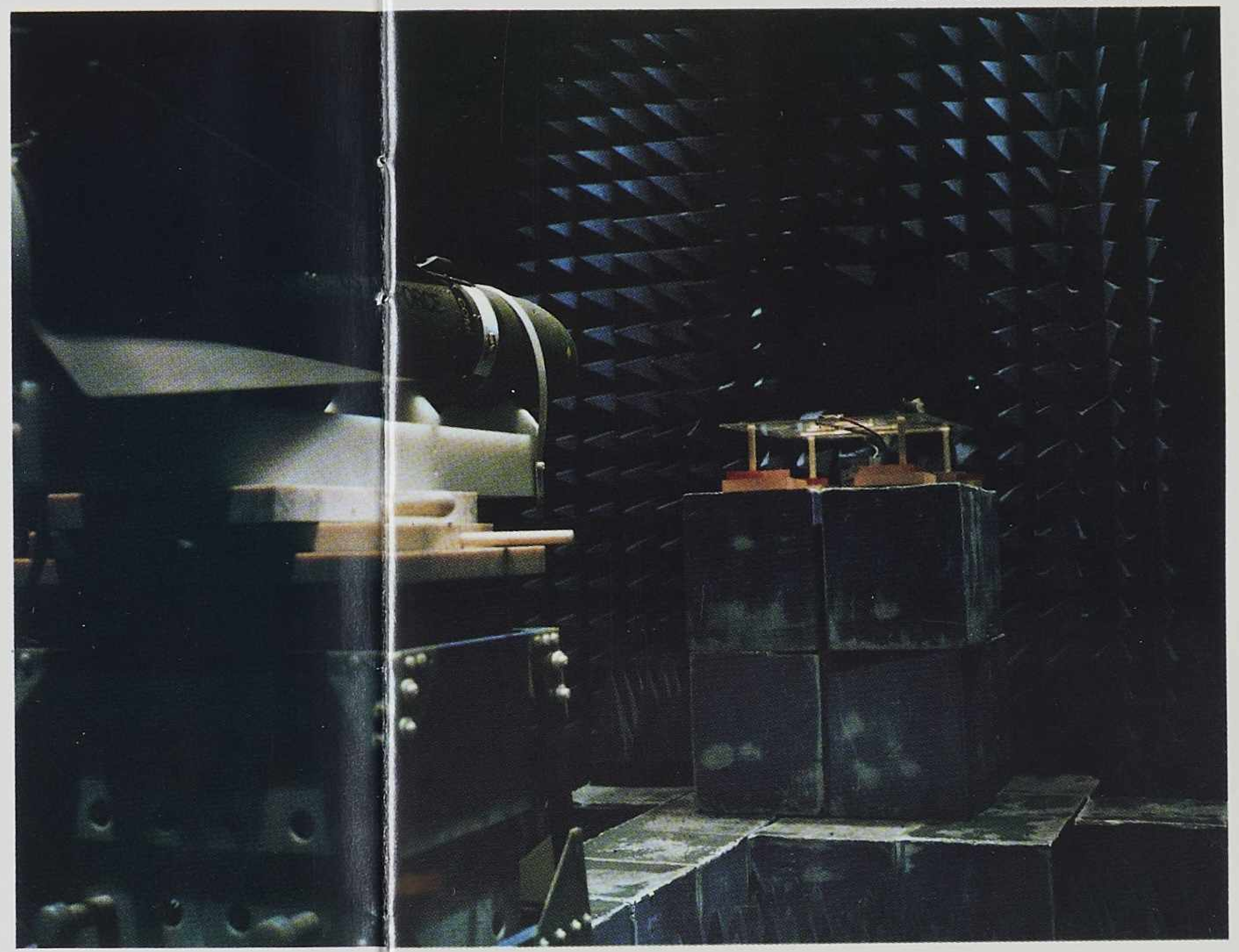
Plasmas — A leader in high-energy plasma and pulse-power research, the Phillips Laboratory is developing compact toroid plasmas as possible projectile weapons.

Electromagnetic Pulse (EMP) — EMP simulation, hardening methodology and survivability issues are the subject of Phillips Lab research. EMP tests on aircraft and other military hardware are conducted at Kirtland.



Pit Laser

Microwave Research



Shock Physics

Shiva Star

Understanding the environment between the earth and sun and its effects on military systems and operations is the main focus for Phillips Laboratory researchers at Hanscom Air Force Base, Massachusetts. Scientists there are interested in space and ionospheric physics, atmospheric and earth sciences, and optical and infrared technologies. Their products include geophysical models and data bases, design standards, and prototype hardware and software.

Geophysics Programs

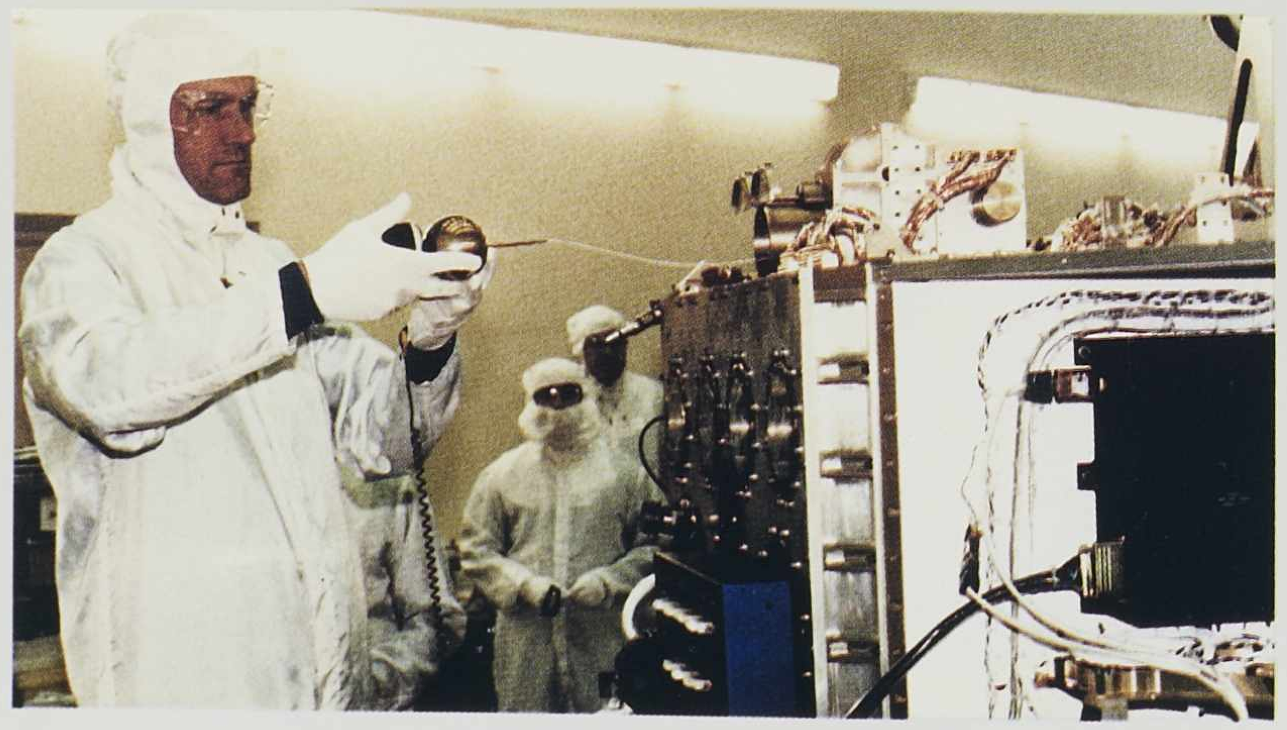
CIRRIS — The Laboratory's CIRRIS-1A (Cryogenic Infrared Radiance Instrumentation for Shuttle) experiment collected measurements of the natural earth background from the surface of the earth out to 260 kilometers. The experiment flew on the Space Shuttle Discovery in 1991. Infrared background models will be developed from the data and used in designing strategic defense surveillance systems.

CRRES — The Combined Release and Radiation Effects Satellite (CRRES) is in geosynchronous transfer orbit making measurements of the cause and effects of spacecraft anomalies while passing through the heart of the most radiation-damaging regions of near-earth space. The results on micro-electronic damage and materials charging, together with up-dated models of the near-earth radiation environment, will significantly impact how future spacecraft are designed, tested and operated.

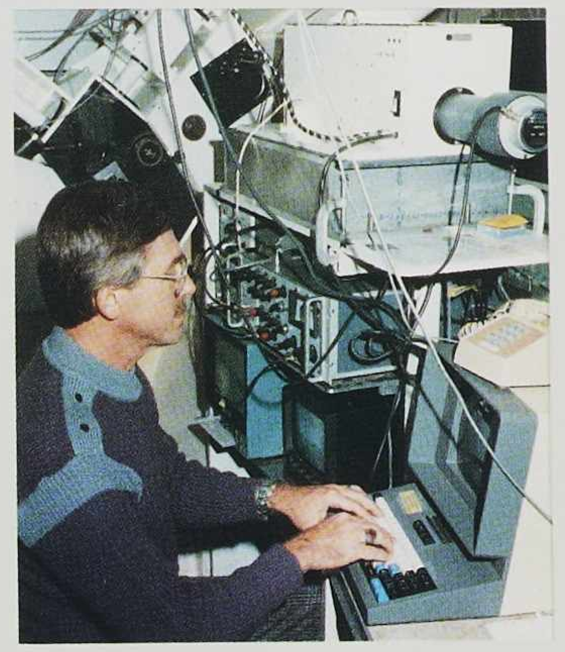
Tactical Decision Aids — Geophysics researchers are developing techniques and prediction models to understand how weather affects the operation of "smart" weapons on the battlefield. These techniques, called Tactical Decision Aids, help tactical planners — as well as fighter pilots — predict meteorological parameters and the effectiveness of specific smart weapons in wartime scenarios.

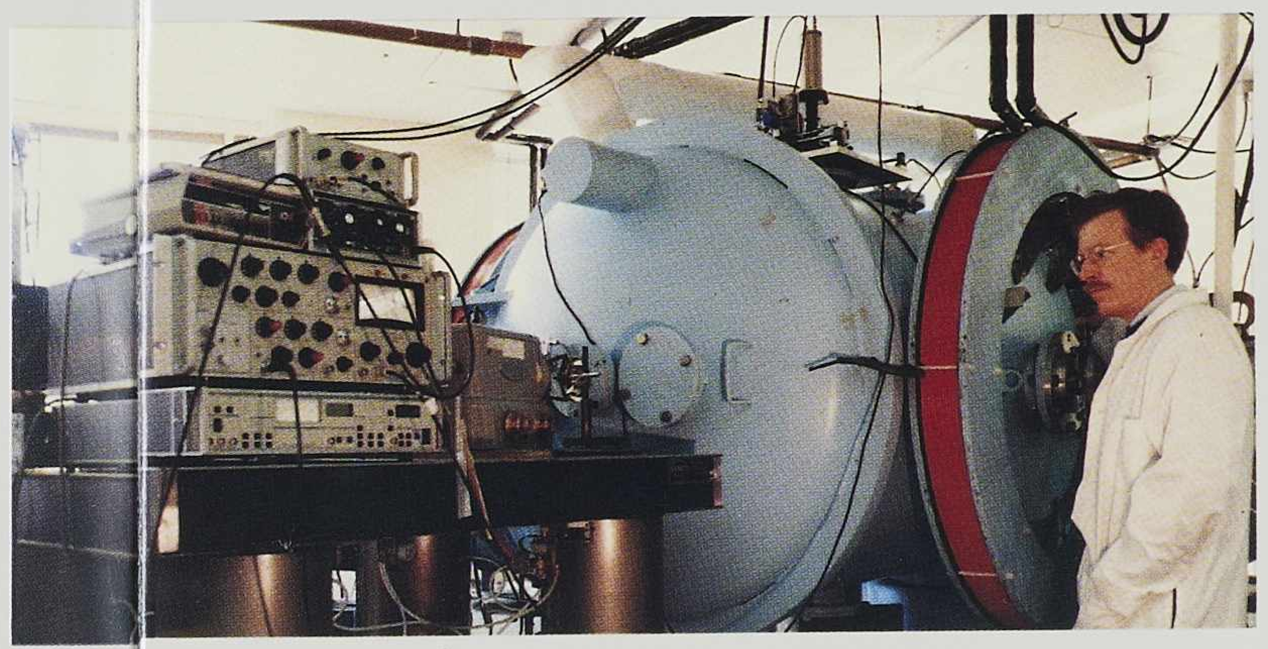
Ionospheric Models — Global, real-time ionospheric and atmospheric density models are being developed for transition to the Air Weather Service to satisfy Space Command and Space Track requirements.

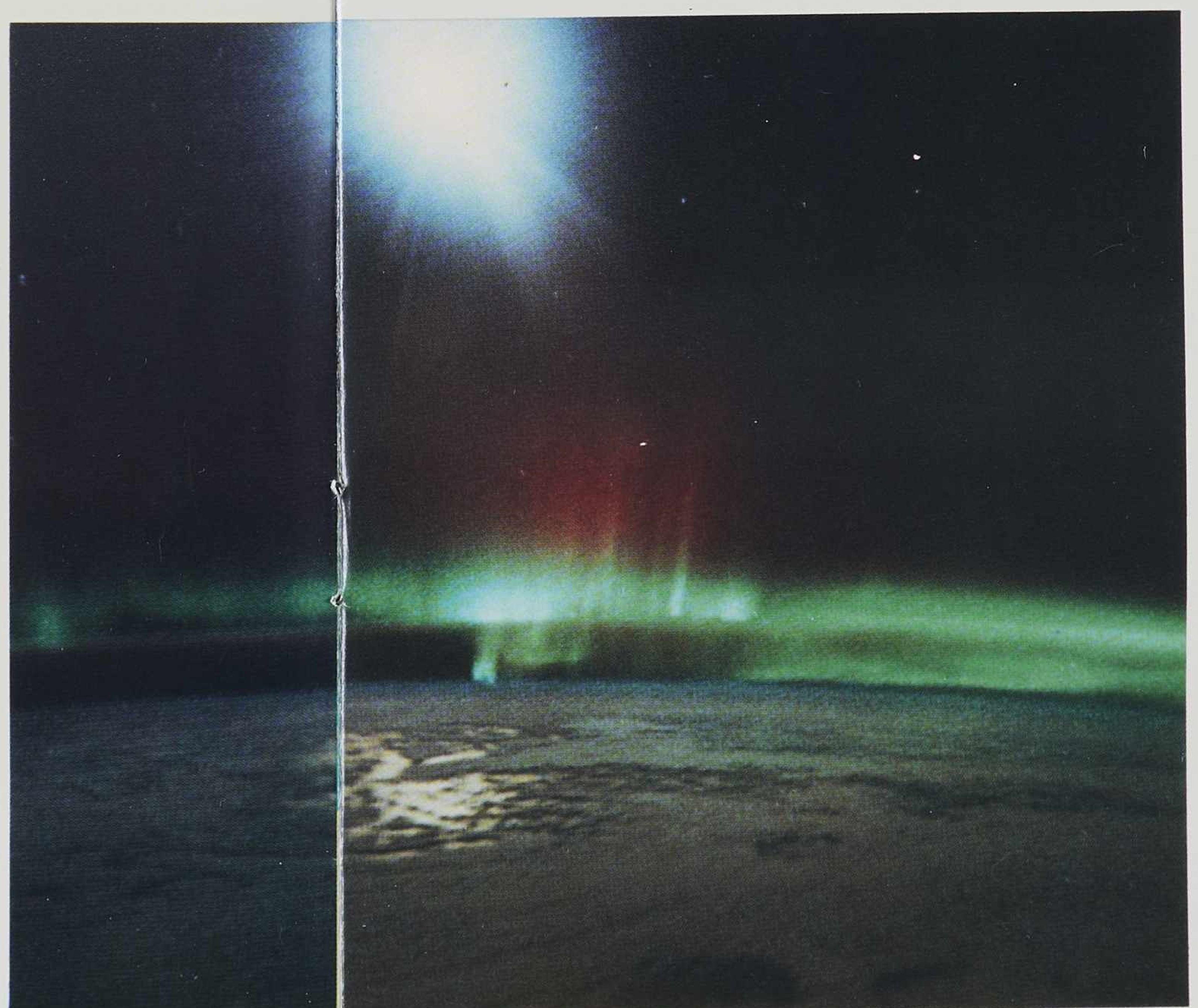
Treaty Verification — Seismic studies, to learn the characteristics of man-made and natural vibrations, will contribute to the United States' ability to monitor underground nuclear tests for Nuclear Test Ban Treaty verification.

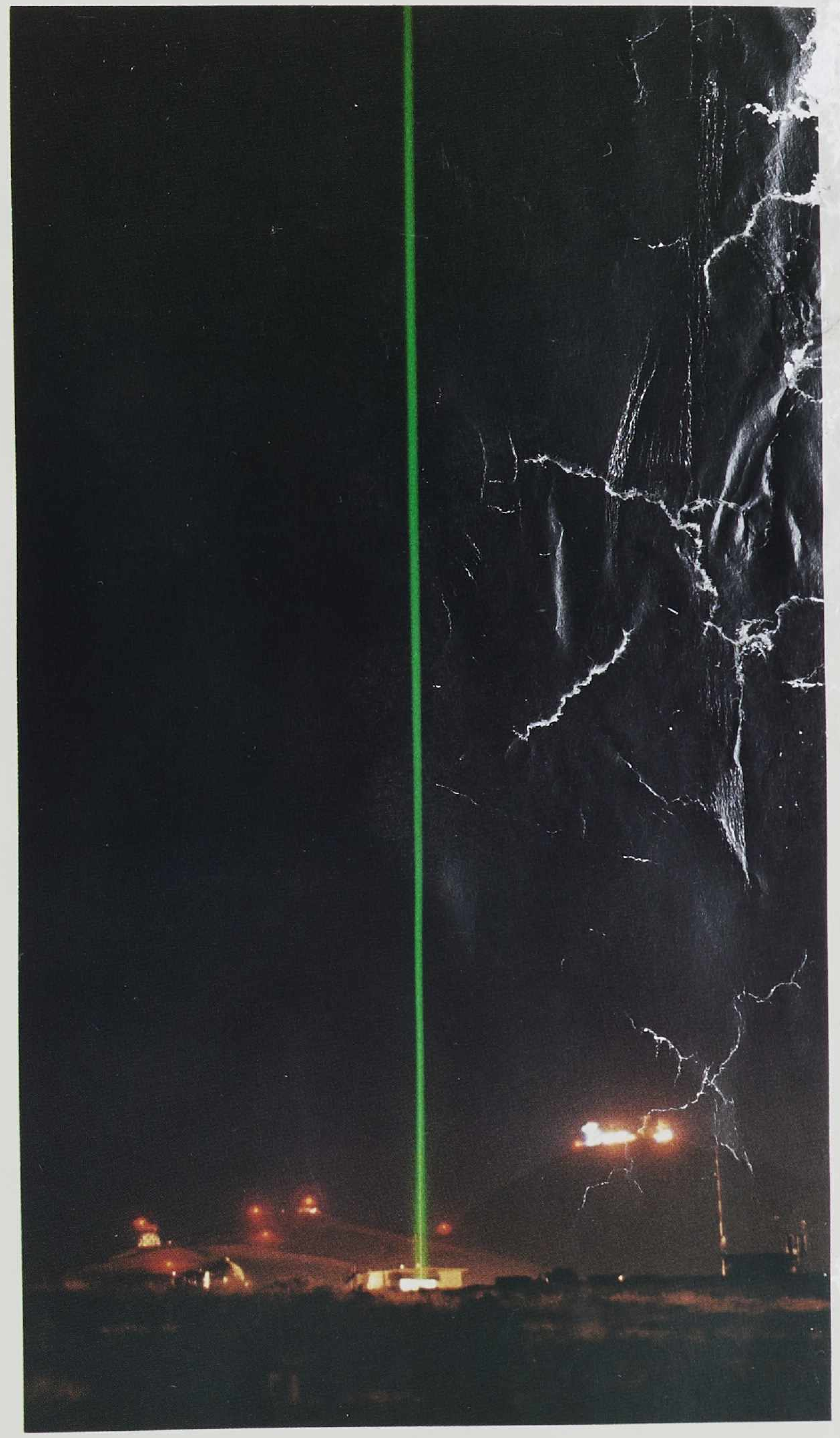

Experiment Integration

Geophysics

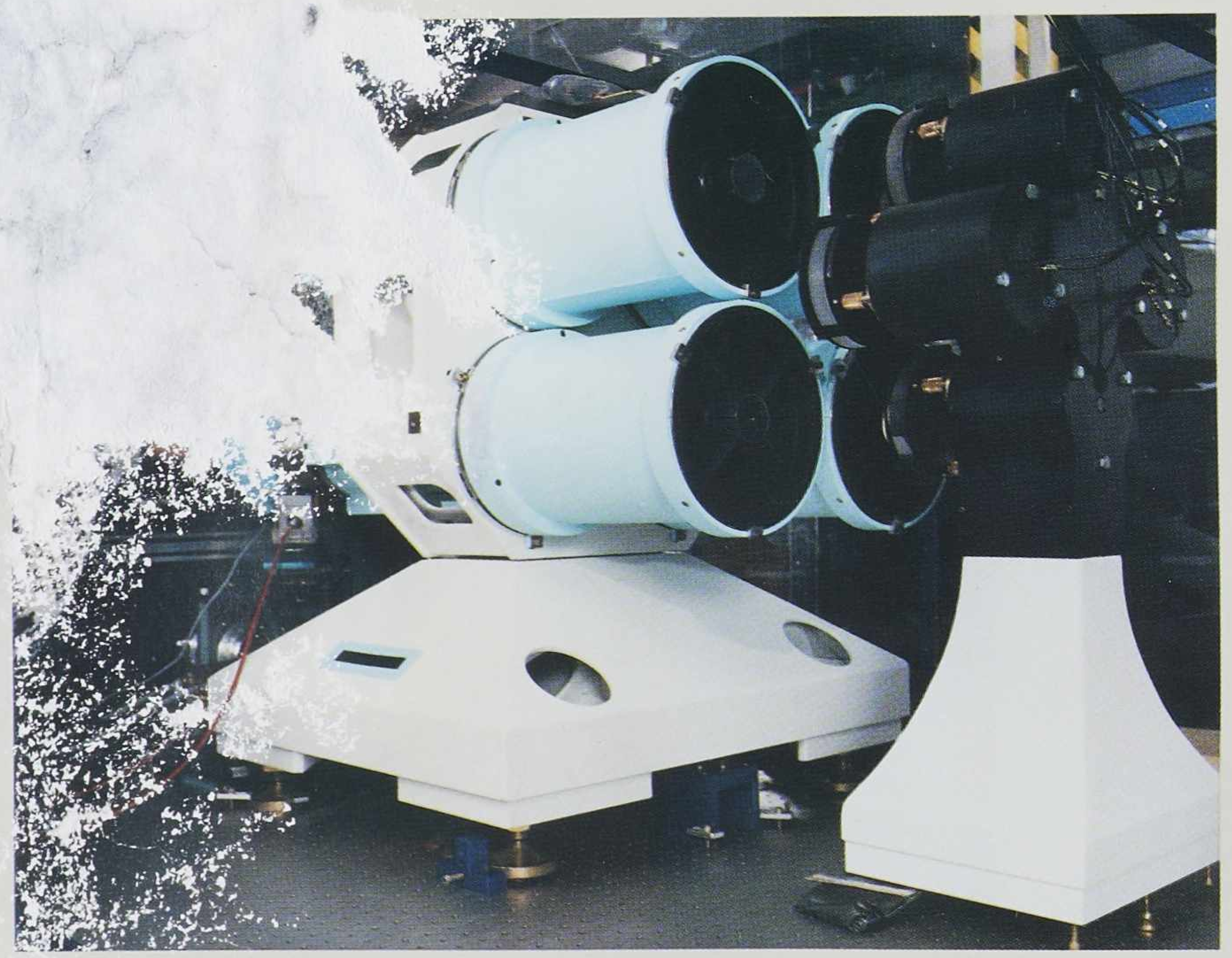

Coronal Photometer


Cryogenic Labcede Facility

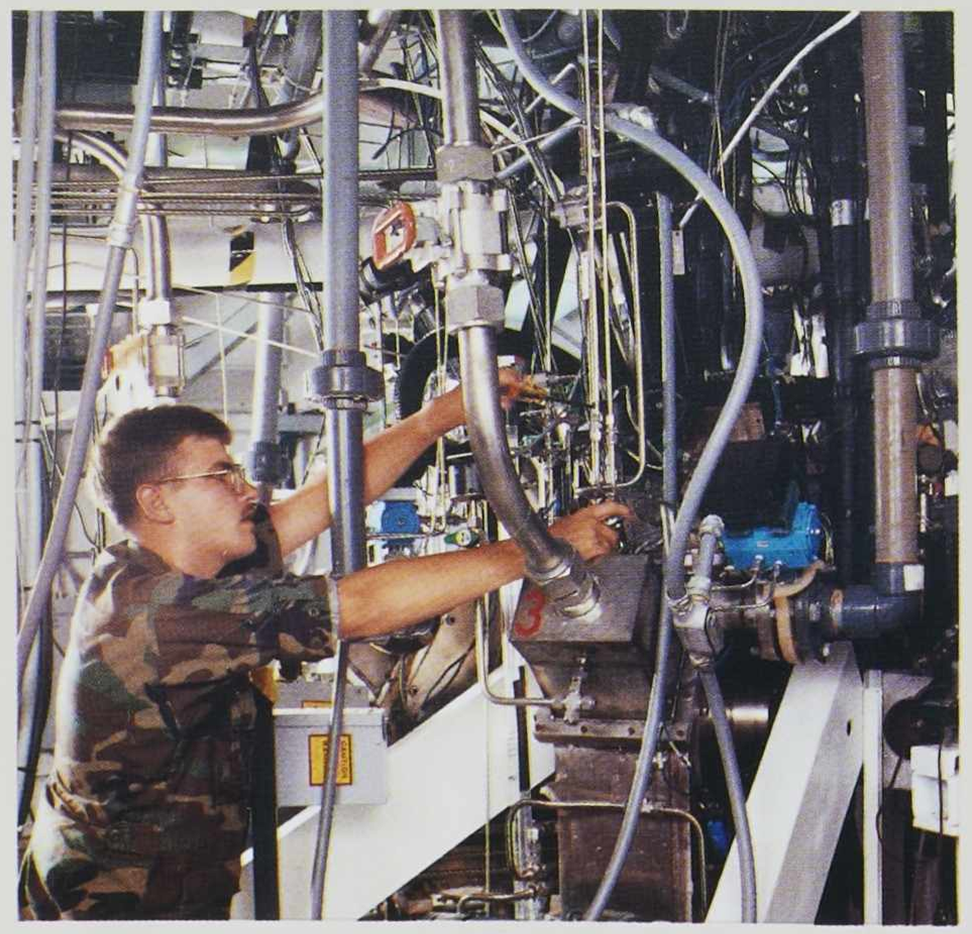

Aurora Effects Studies


Laser at Ascension Island

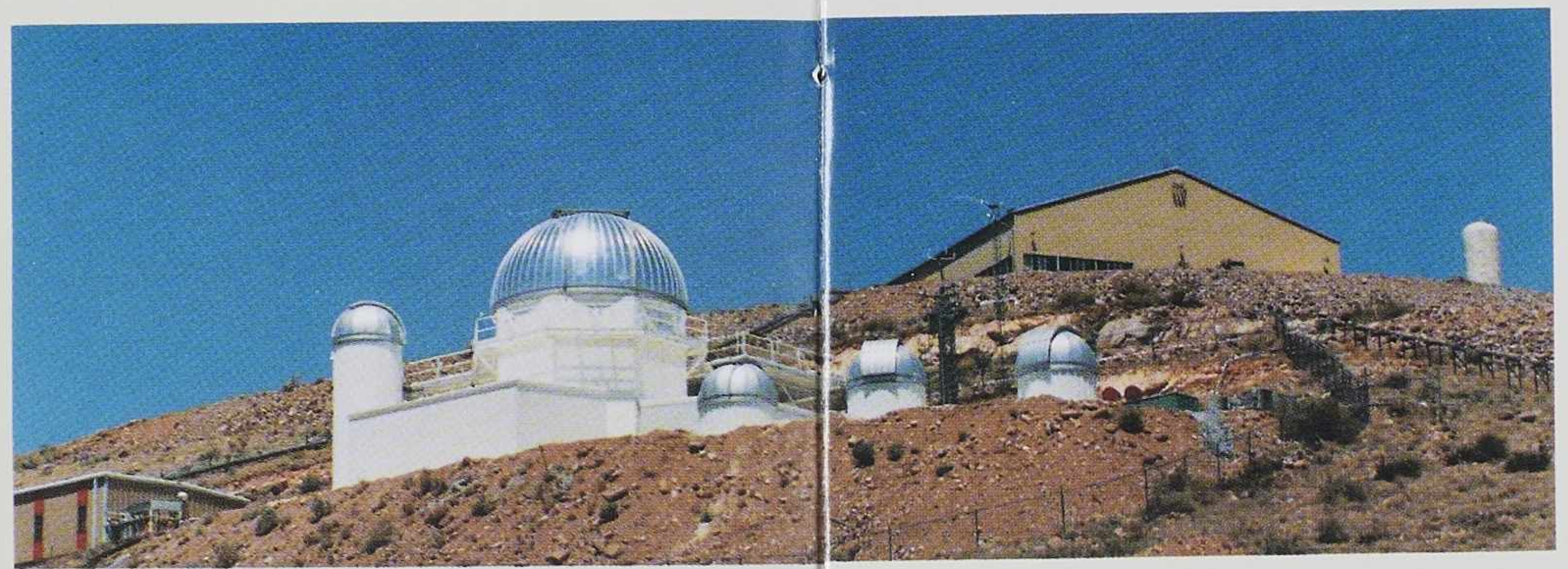
Lasers & Imaging



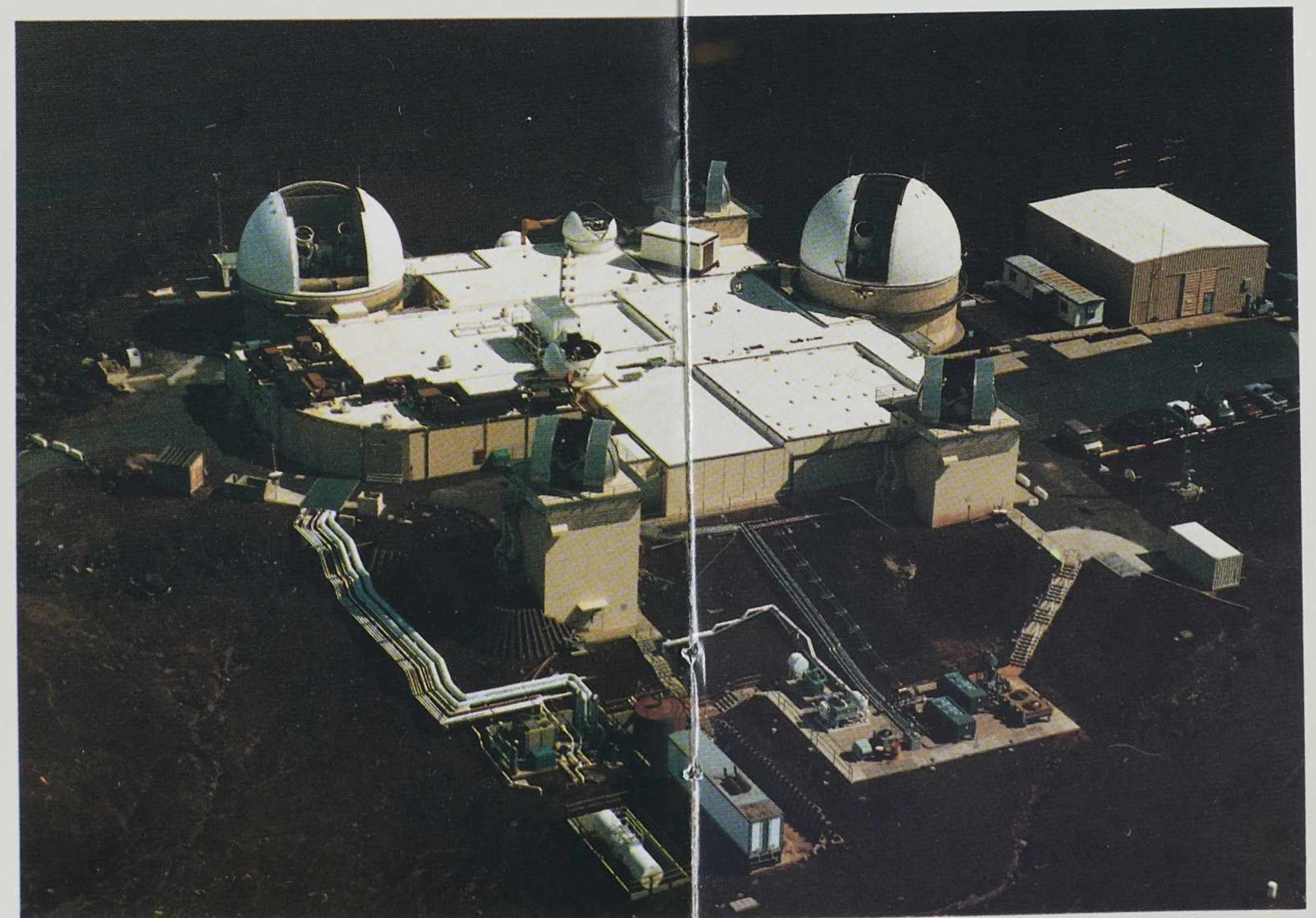
Telescope Testbed



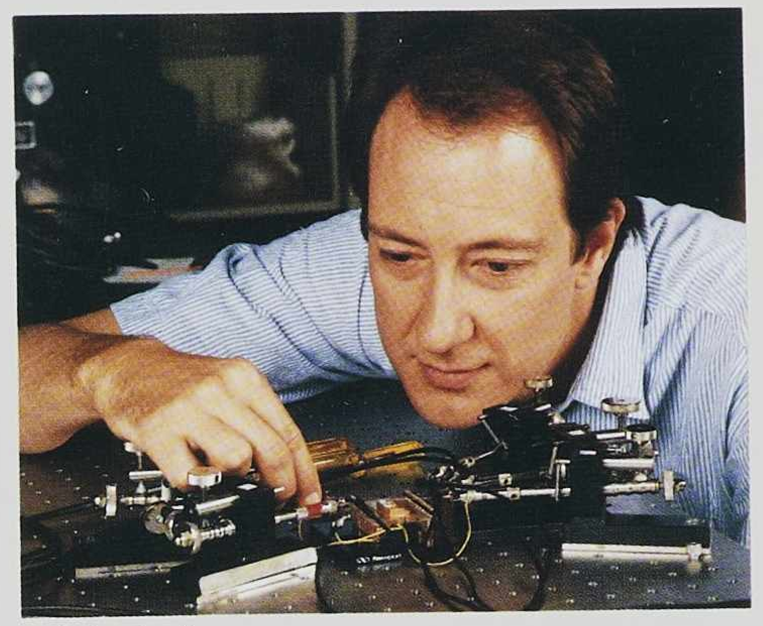
Chemical Oxygen-Iodine Laser



Starfire Optical Range



Air Force Maui Optical Station



Diode Lasers

Phillips Laboratory scientists and engineers are working on a wide variety of programs involving basic research and advanced development. Their work includes laser devices; advanced imaging techniques; optical systems; acquisition, pointing and tracking; and ground-based laser antisatellite systems.

Lasers & Imaging Programs

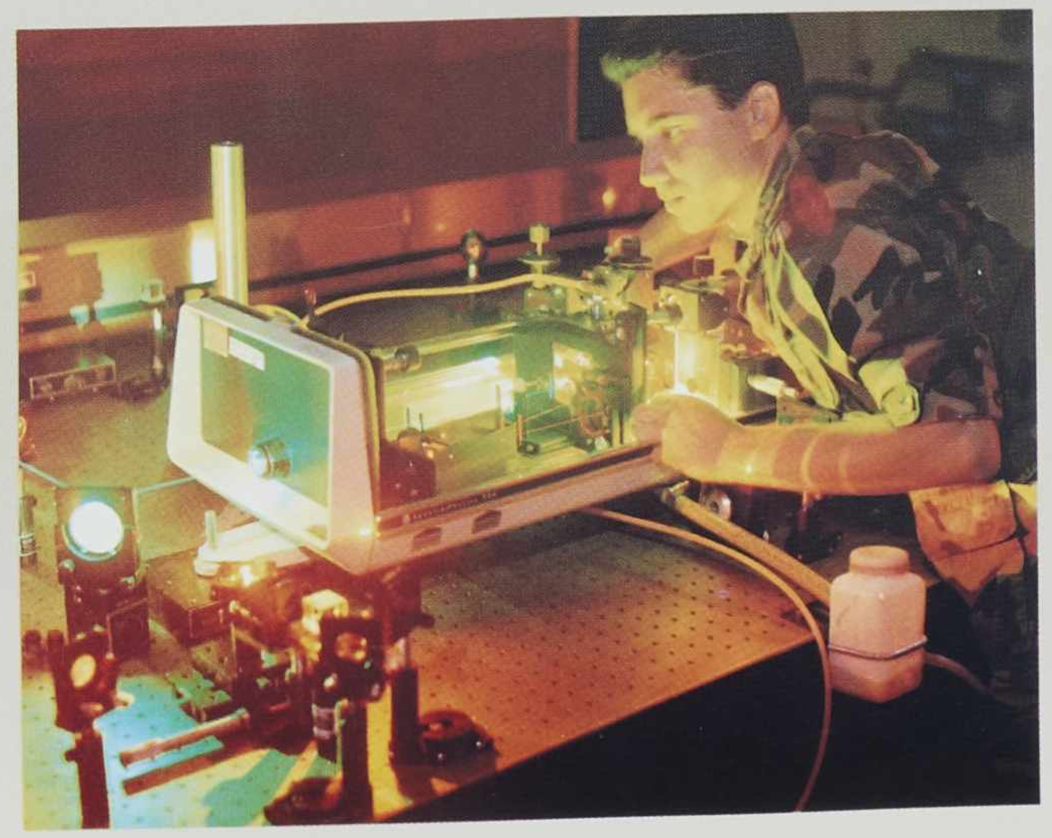
Diode Lasers — Semiconductor laser diodes and diode arrays are in advanced research and development at the Laboratory.

Nonlinear Optics — This technology can potentially solve many problems associated with laser and imaging systems. Current research directed toward using nonlinear optics to correct atmospheric distortions, and compensating for optical imperfections.

Chemical Oxygen-Iodine Lasers — Scaling of chemical lasers to high-power level is important for strategic and tactical applications. This Directorate is looking at ways to improve laser performance for various applications, including space-based scenarios.

Optics Imaging Research —Additionally, this Directorate is the focus for all Air Force research in high resolution optical imaging. Conventional and nonconventional imaging technologies are pursued. The Directorate operates:

- **Air Force Maui Optical Station** (Maui, Hawaii) — This station is devoted to satellite and rocket tracking and imaging. Capabilities will expand from the existing 1.6-meter and two 1.2-meter telescopes with the installation of a 4-meter-class telescope in the mid-1990s.
- **Malabar Test Facility** (Melbourne, Florida) — This facility is used for space tracking and data collection.The site has some of the finest acquisition, tracking and laser beam control hardware in the Force.
- **Starfire Optical Range** (Kirtland Air Force Base) — Currently operating a 1.3-meter telescope and a 1-meter beam director, this site is used for research in ground-based imaging and solving atmospheric distortion problems. The installation of a 3.5-meter telescope at the Range will be completed in 1992.
- **Argus** (also at Kirtland) — This is a specially modified NC-135 aircraft that is used as a flying laboratory for space imaging work.



Dye Laser Coupling

Propulsion

Most of the Phillips Laboratory's propulsion research and development is performed at Edwards Air Force Base, which is north of Los Angeles, California. Work focuses on advanced concepts involving rocket engines, motors and propellants.

Propulsion Programs

Arcjet Demonstration — Propulsion researchers are developing a flight unit that uses a 26-kilowatt, low-impedance ammonia arcjet propulsion system. Related subsystems are also being developed for this flight-qualification test.

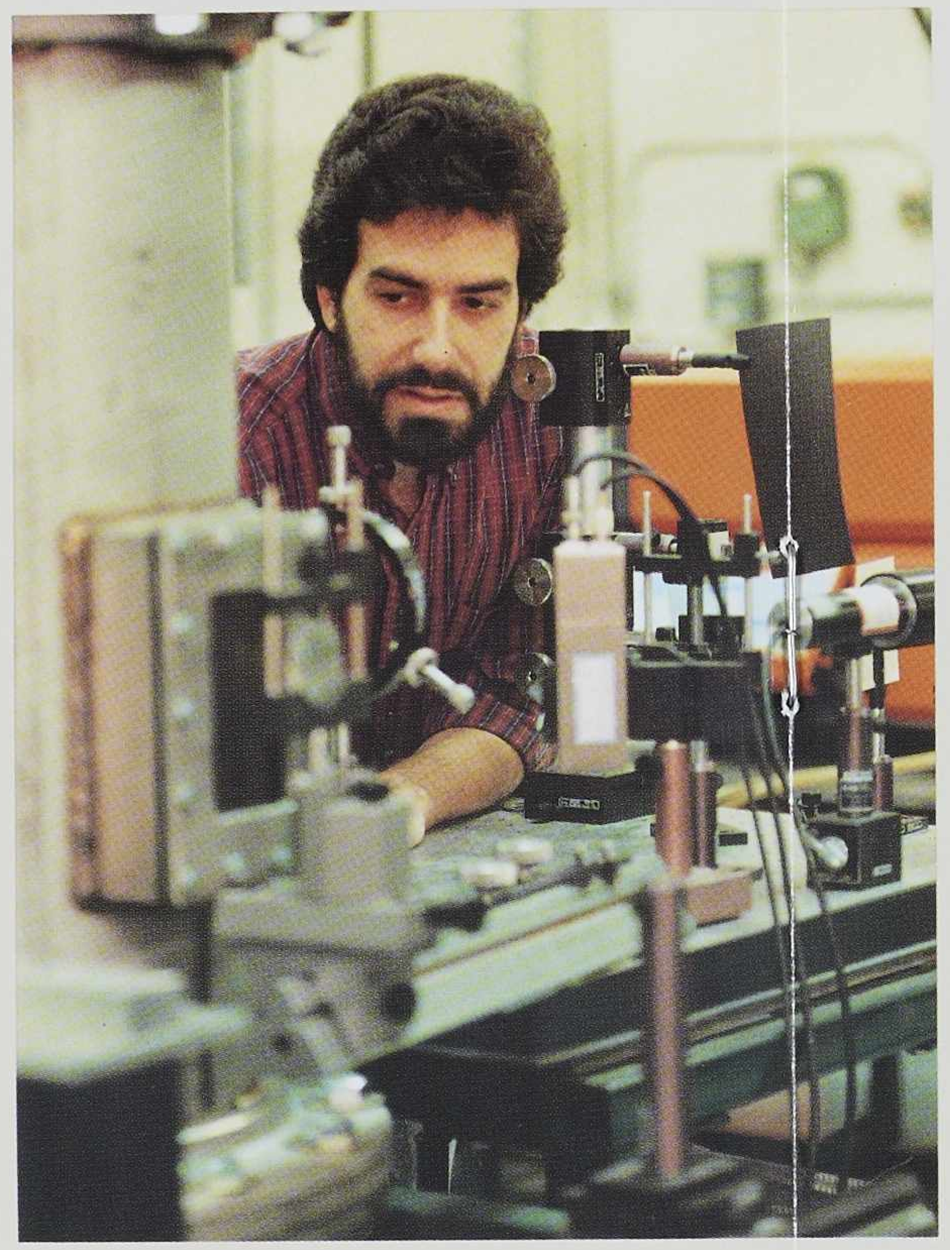
Advanced ICBM Technologies — Propulsion technologies for the next-generation Intercontinental Ballistic Missiles are being studied. These evolving technologies, such as improved nozzles and a laser-ignition system, will culminate in a half-scale motor test demonstration.

Advanced Liquid Axial Stage — This program involves the development of an advanced liquid axial rocket stage for a space-based kinetic-energy weapon. The goal is to design a weight-minimized kinetic-kill vehicle.

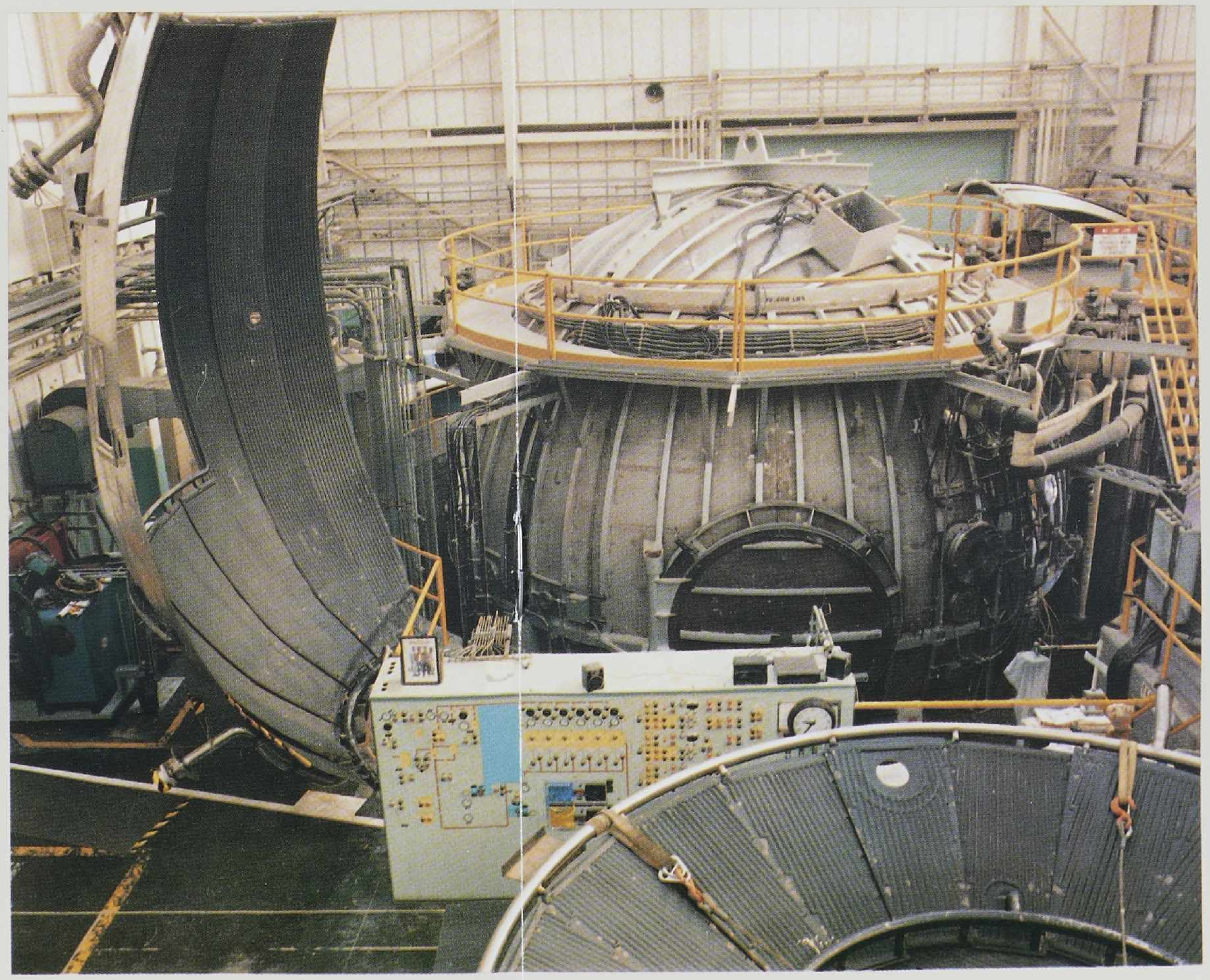
Clean Propellant — Solid propellant for space-launch boosters, which is low-risk, low-cost and chlorine-free, is one goal of Phillips Laboratory research and development. Successful formulations have been discovered and are being explored.

High-Energy Density Materials — The eventual goal is to find and stabilize molecular systems that have the potential for use as high-energy density material propellants.

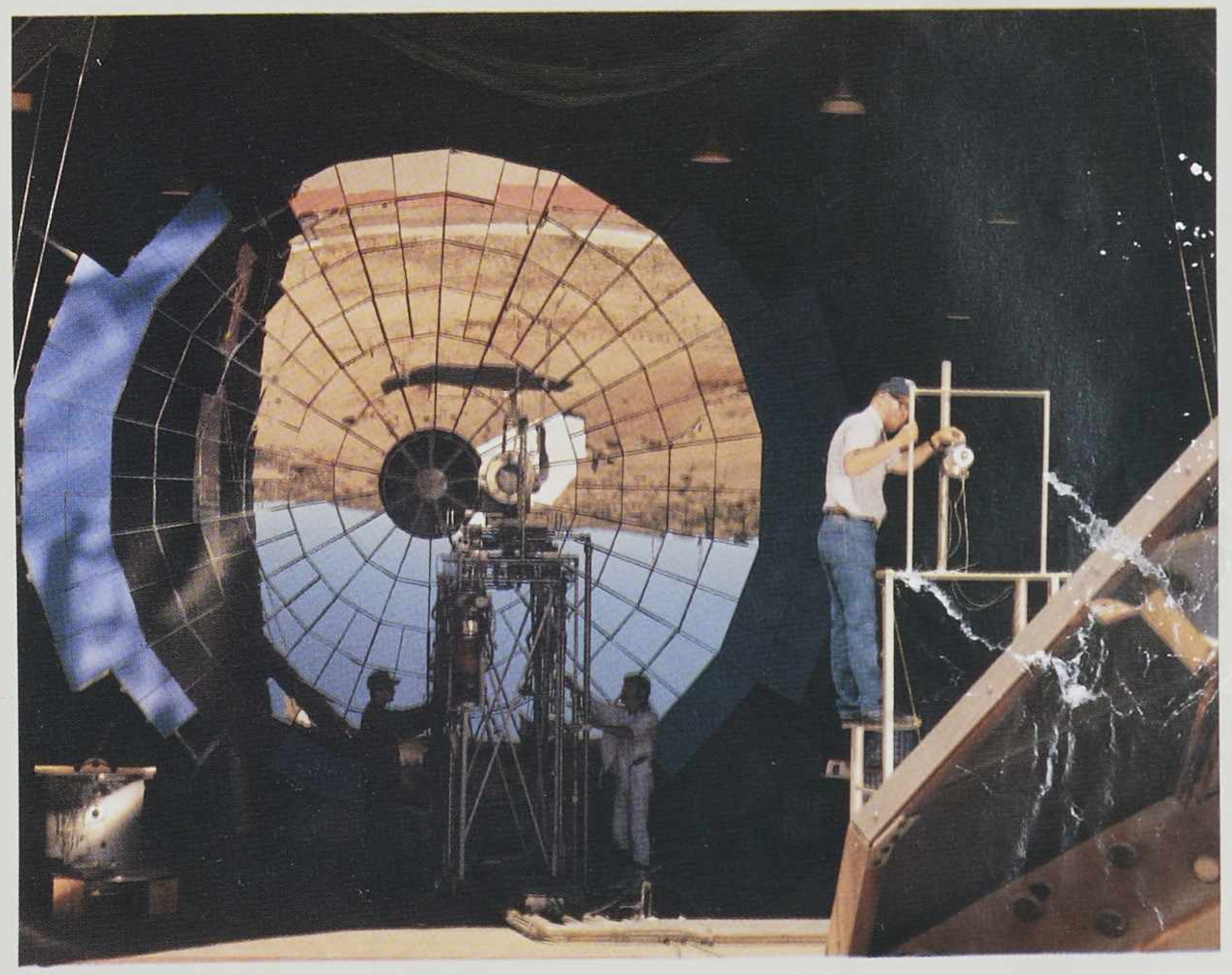
Superpropellant Research



Combustion Laboratory



Environmental Facility



Solar Propulsion

Space & Missiles Technology

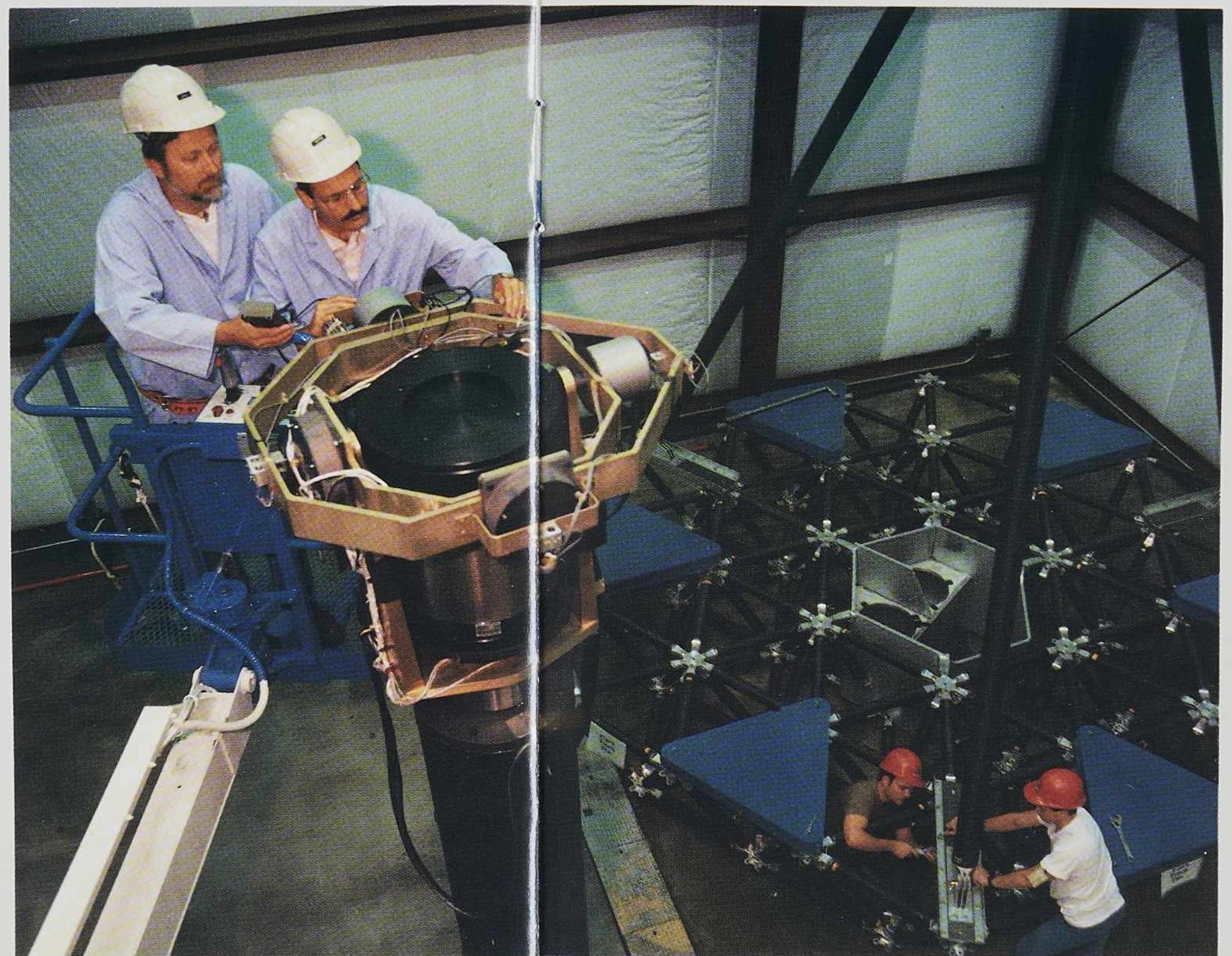
This Directorate is developing critical technologies for Air Force spacecraft and missile systems. It manages a wide range of basic to advanced technologies that will provide options and alternatives in surveillance sensors, radiation-hardened electronics, structures, power, thermal management, and next-generation space-based radar.

Space Power and Thermal Management — Significant advances in power technology are [illegible] to meet future needs without incurring a prohibitive mass and volume penalty on future space systems. Key efforts include lightweight solar arrays, sodium sulfur batteries, and heat pumps. A thermionic testing initiative will characterize a space nuclear reactor in an electrically powered ground mode. The Lab's 65 Kelvin Cryogenic Cooler program is the most advanced program in the world for developing a long-life cryocooler for space [illegible]

Advanced Space Electronics and Software Technology — Researchers are developing and demonstrating space systems computer technologies, [illegible]ing data processing, memory storage components, and a[illegible] operation. The Advanced Spaceborne Computer Module [illegible] is developing a standardized, radiation-hardened, Very High [illegible] Integrated Circuit computer for multiple-mission requir[illegible]

Structures and Controls Technology — "Smart" space structures require a control system that not only moves the craft to a desired position, but also keeps it stiff and free of unwanted vibrations. This directorate is developing composite structures with embedded sensors and actuators for vibration suppression, shape control, and health monitoring for large space structures.

Ballistic Missile Technology — This new area for the Laboratory focuses on the technologies for upgrading current missiles and reducing operation and maintenance costs for current and next-[illegible]ion missiles.

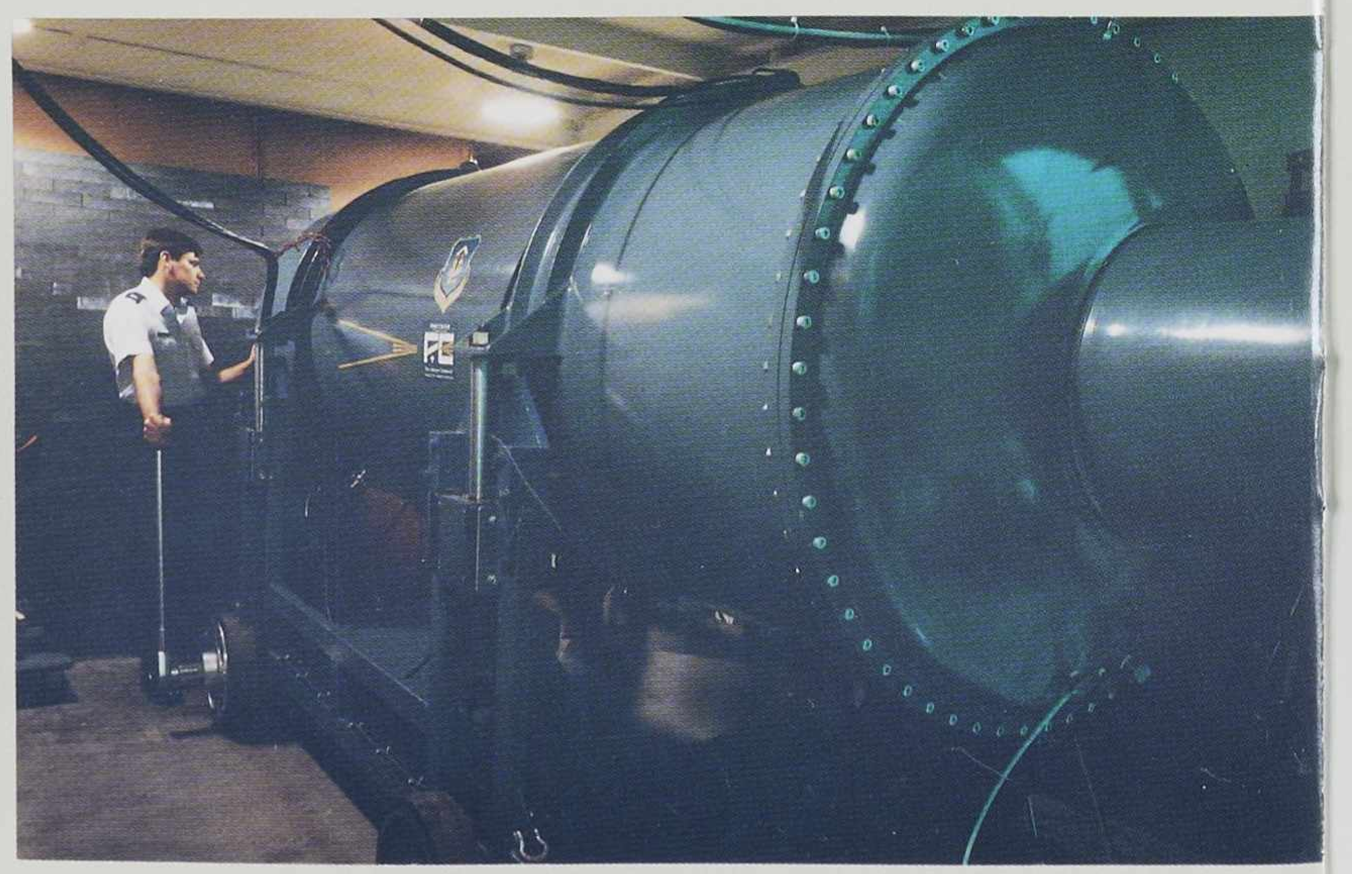


Large Space Structures

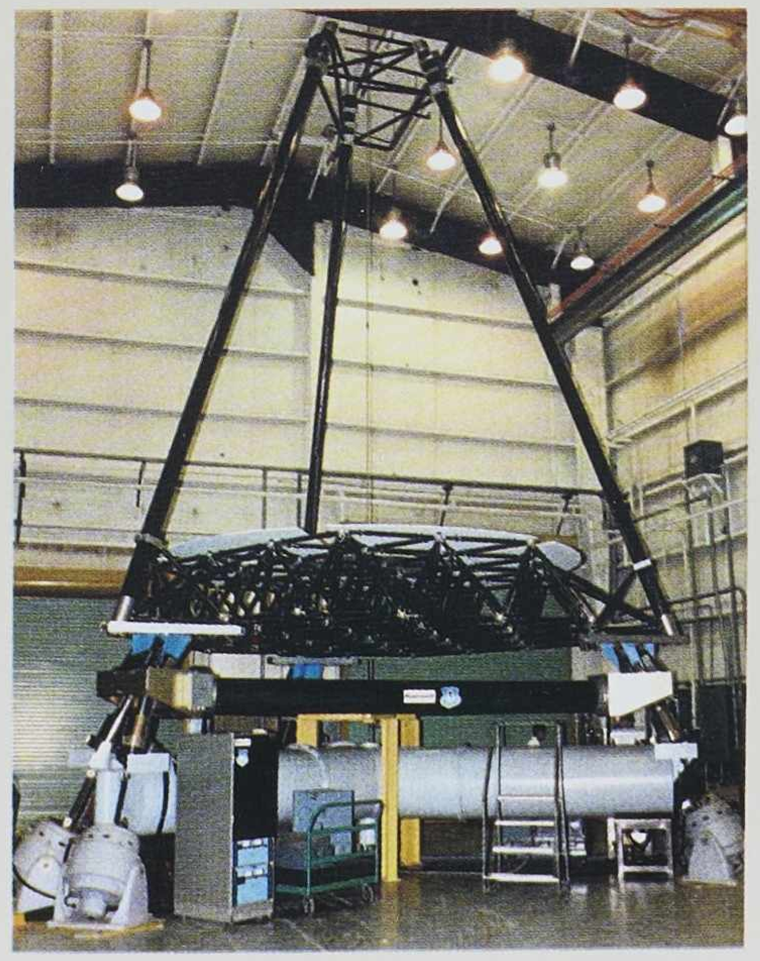
Radiation Source

Fiber Optics

Composites Laboratory



Flash X-ray Device



Space Structures Testing

Space Experiments

Phillips Laboratory is managing a world-class capability to conduct space experiments, as well as ground, airborne, and balloon-borne research.Through these experiments, the Lab is gathering scientific data and demonstrating critical proof-of-concept technologies.

Space Experiments Programs

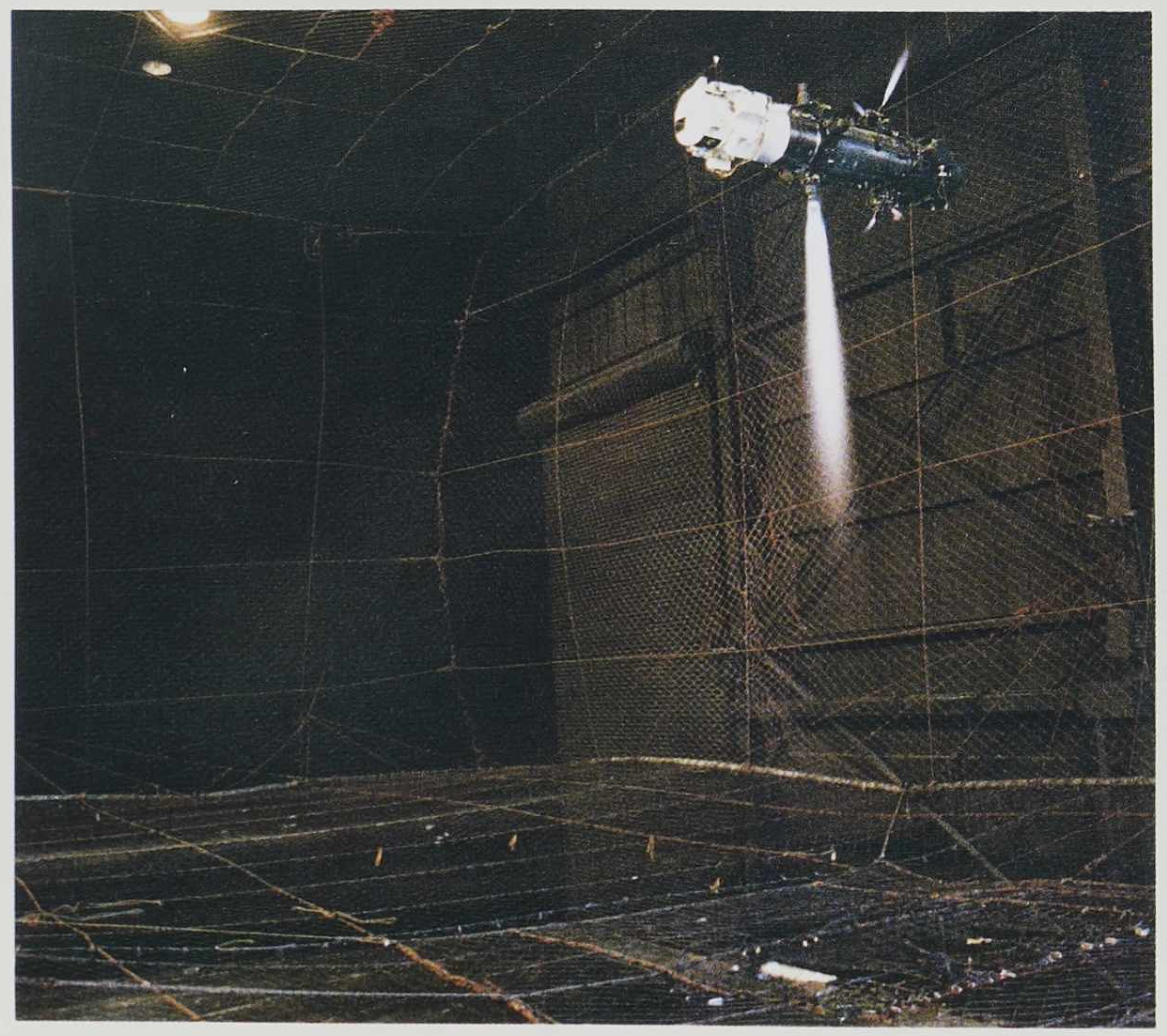
Altair — This space experiment will demonstrate acquisition, tracking, and pointing against missiles in the boost phase. Another goal is collecting plume measurements and background phenomenology.

LEAP — The Laboratory is conducting hover and flight tests of the Lightweight Exo-Atmospheric Projectile to demonstrate kinetic-kill vehicle technologies. This work is for the Strategic Defense Initiative.

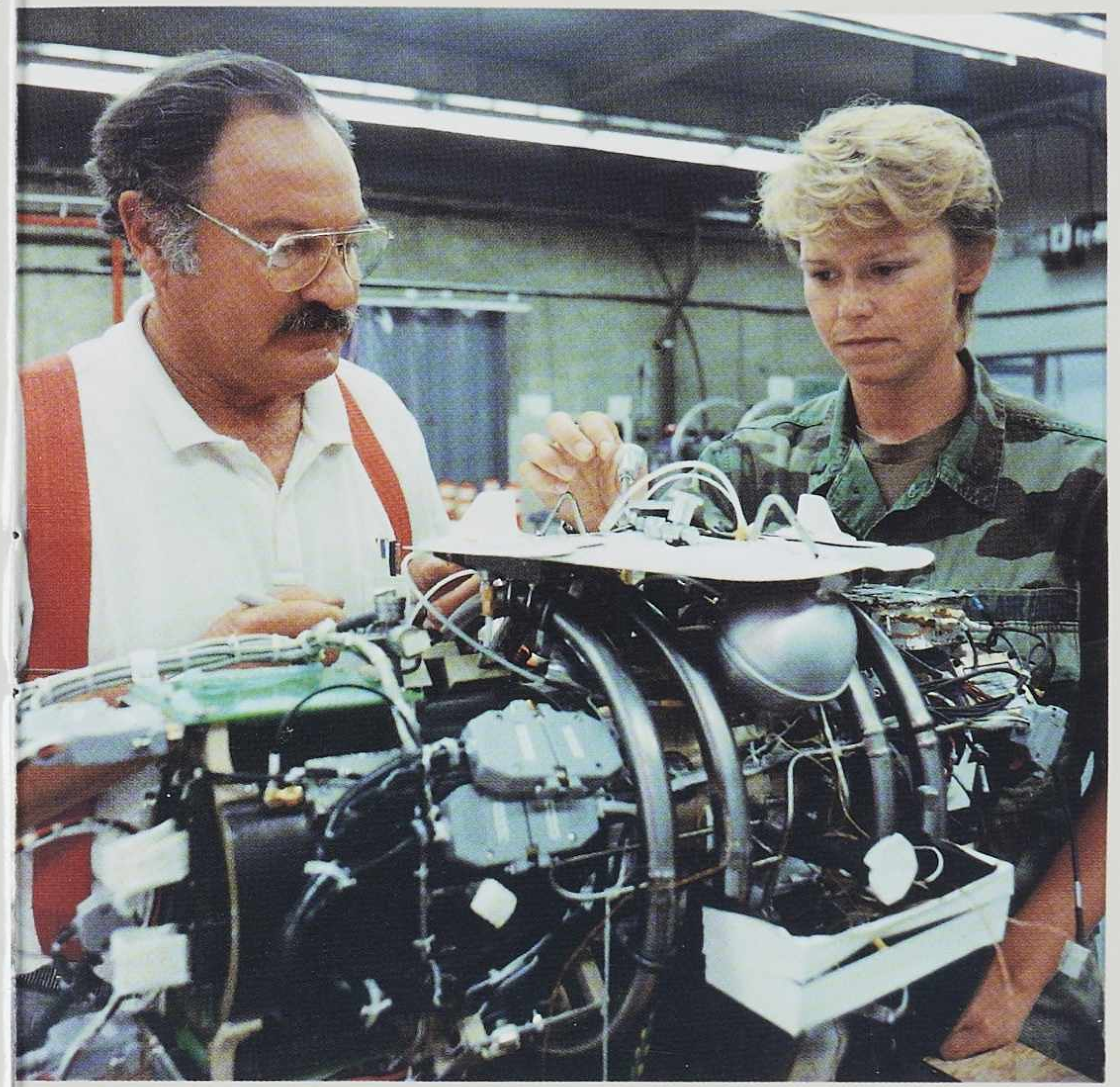
ELITE — Phillips Lab scientists are demonstrating arcjet propulsion as a means for transferring payloads from near-earth orbits to geosynchronous orbits.

TAOS — Autonomous navigation and control and bus technology are being tested and validated in a program called TAOS (Technology for Autonomous Operational Survivability).

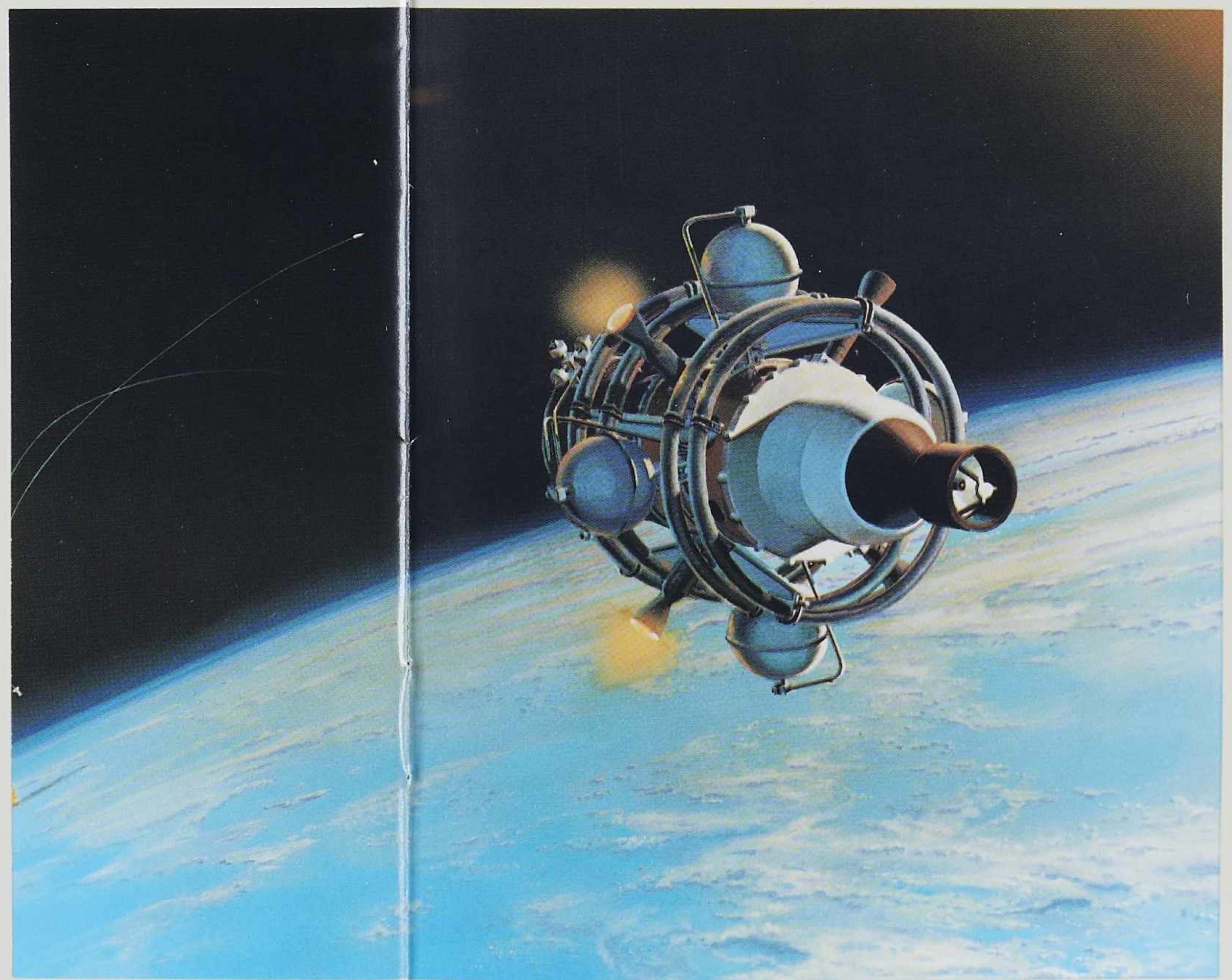
Lithium Thaw — The thaw-freeze behavior of liquid metal in microgravity is the subject of research by Laboratory scientists.



Hover Test



Test Preparations



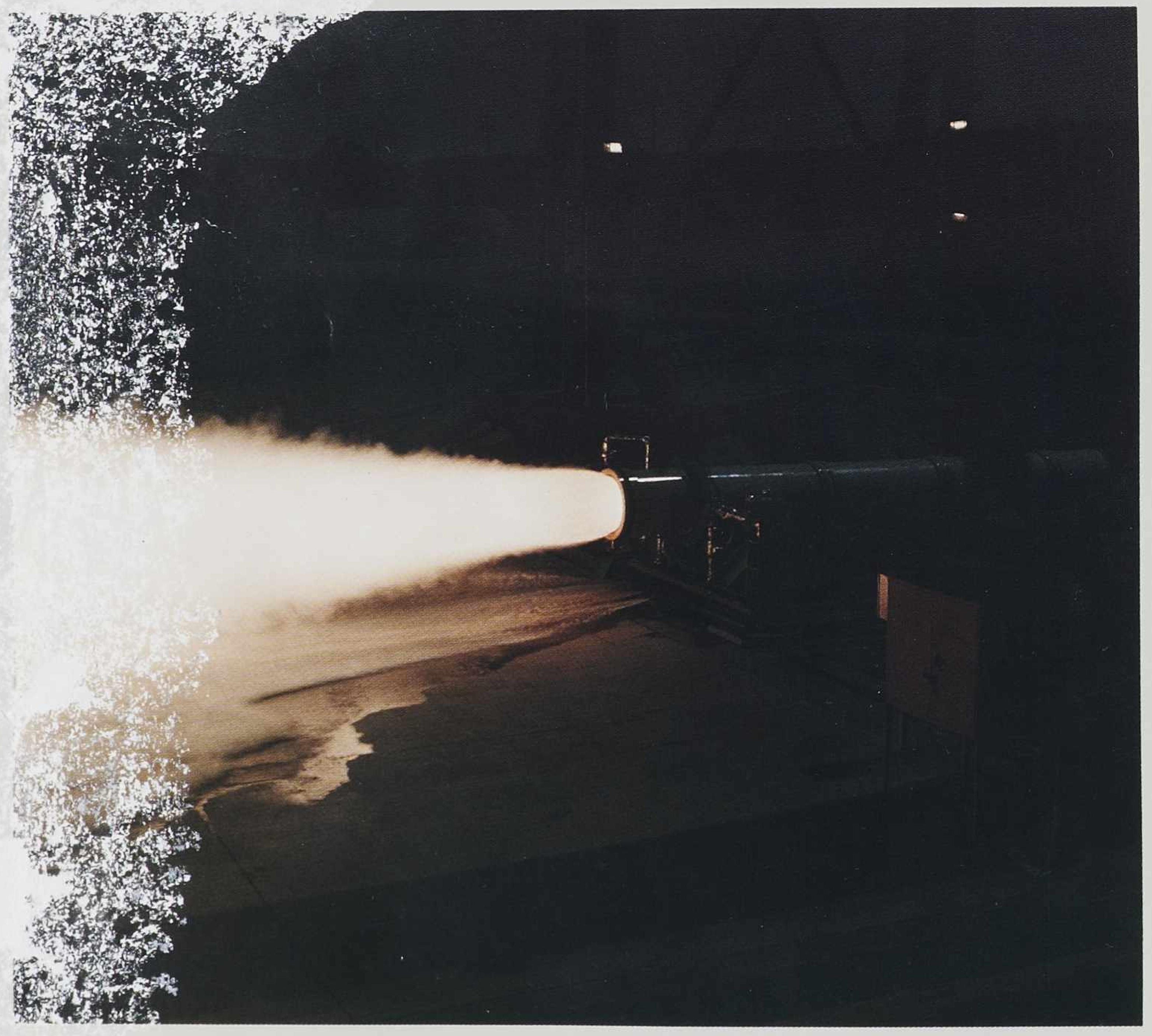
Lightweight Exo-Atmospheric Projectile

Space Experiment

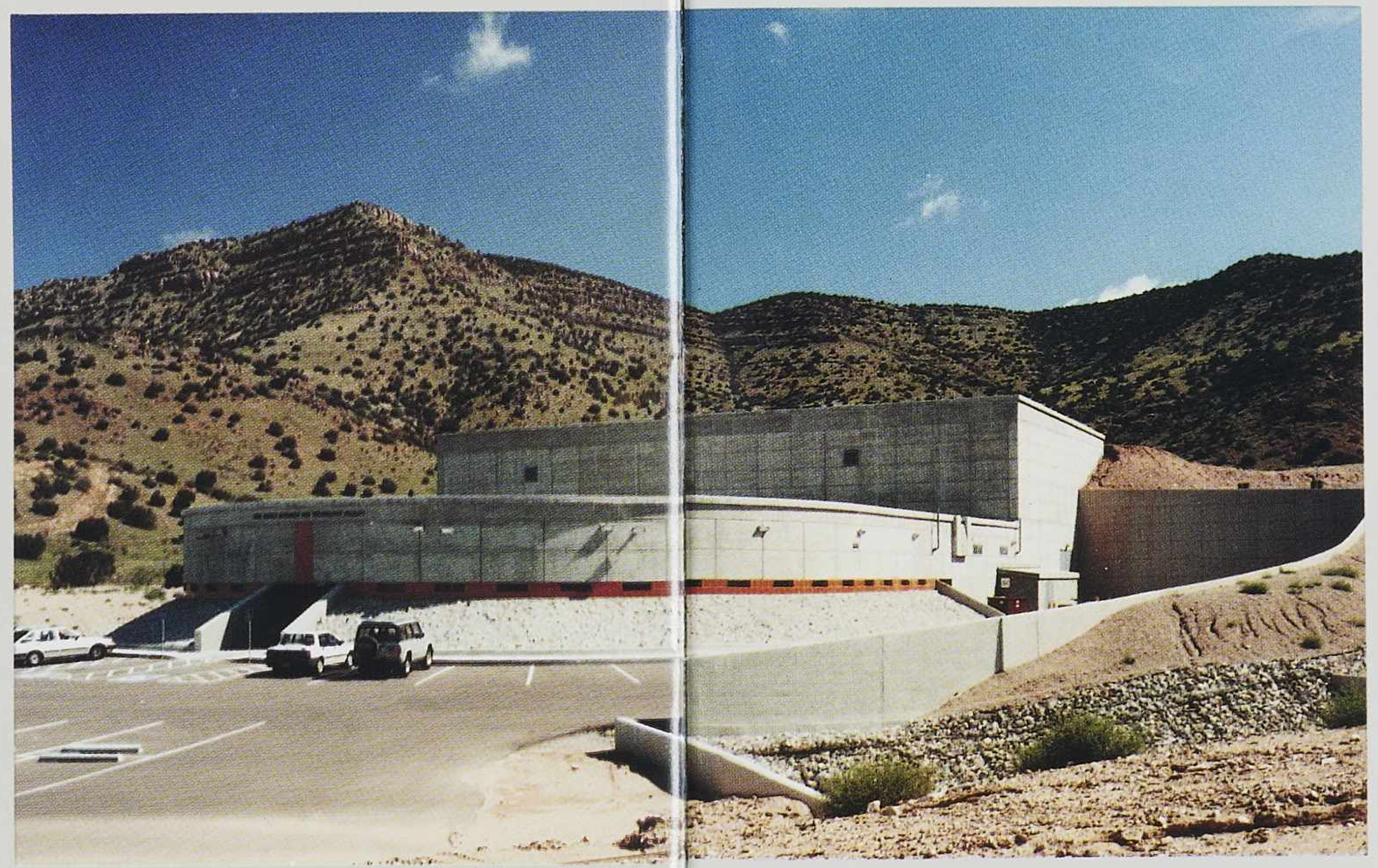
[illegible]ies & Capabilities

Argus Aircraft

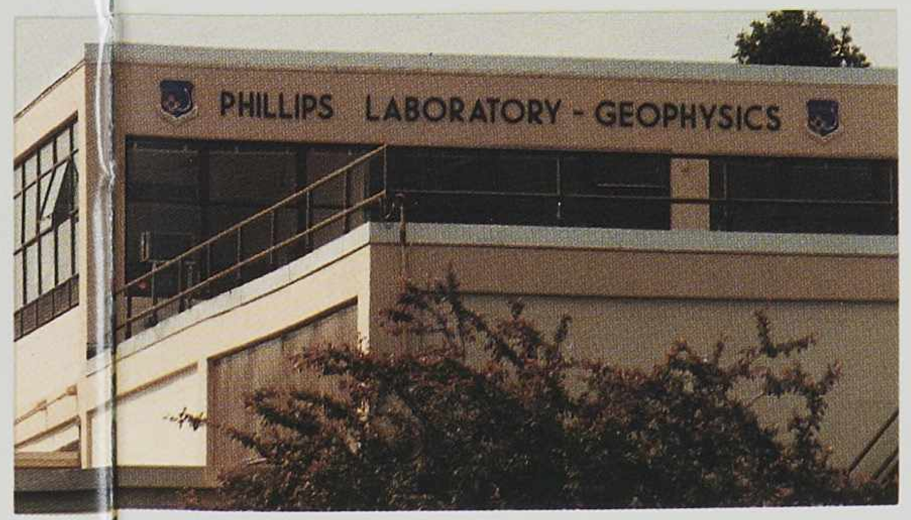
1.5 Meter Telescope



Solid Rocket Firing



High Energy Research Facility



Phillips Laboratory has award-winning support facilities and spec[illegible] capabilities. These include a Supercomputer Center with a [illegible] CRAY-2 and a Visualization Laboratory that transforms techn[illegible] data into easy-to-read pictures and animation.

The Laboratory's Contracting Directorate is a Kirtland-[illegible] awarding more than $400 million in contracts annually for res[illegible] development, supplies and services. Many procure[illegible] Strategic Defense Initiative.

Phillips maintains a world-class research library capability at Hanscom, Kirtland, and Edwards. Nearly 140,000 books, 2[illegible],000 periodicals, and 691,000 technical reports provide an outstanding collection of current and historical research. Included are computerized systems for on-line literature searches.

Special shops perform the fabrication work necessary to support research projects, including machining, wood-working, sheet metal, welding, and painting.

Some of the Lab's newest research facilities are the High Energy Microwave Laboratory for microwave research and effects testing, and the High Energy Research and Technology Facility for conducting explosive pulse-power research, and microwave propagation and effects experiments.

An Optics Development and Beam Control facility at Kirtland houses 10 individual laboratories for optics research. The Laboratory operates all the Air Force's major ground-based optical research sites and has the largest telescopes in the Department of Defense.

Phillips Laboratory operates the National Hover Test Facility at Edwards, where propulsion systems and vehicles are tested for the Strategic Defense Initiative Organization.

Key to success at the Phillips Laboratory is its full complement of support personnel who maintain and operate the facilities and specialized equipment, and who assist in the Lab's research efforts throughout the nation.

People & Employment

Phillips Laboratory employs more than 2,400 military and civilian workers. The majority of this workforce consists of scientists, engineers, and technicians who specialize in mathematics, electronics, lasers, optics, physics, chemistry, geophysics, computers and other sciences.

Continuing employee education is emphasized, with job-related training and education programs available in many disciplines. A number of colleges and universities offer degree programs on base, including electrical engineering, computer science, mechanical engineering, and management.

The Lab offers comparable pay to similar jobs in private industry. In addition, employees receive an attractive benefits package, including a variety of medical, retirement, and life insurance plans, sick leave, and vacation.

U.S. citizenship is required to work at Phillips. Many jobs also require a security clearance.

The Air Force's Phillips Laboratory is an Equal Opportunity Employer.

For employment information, contact the following offices:

Military Personnel — Phillips Laboratory
Military Personnel
Kirtland AFB NM 87117-6008
Phone: (505) 846-4795

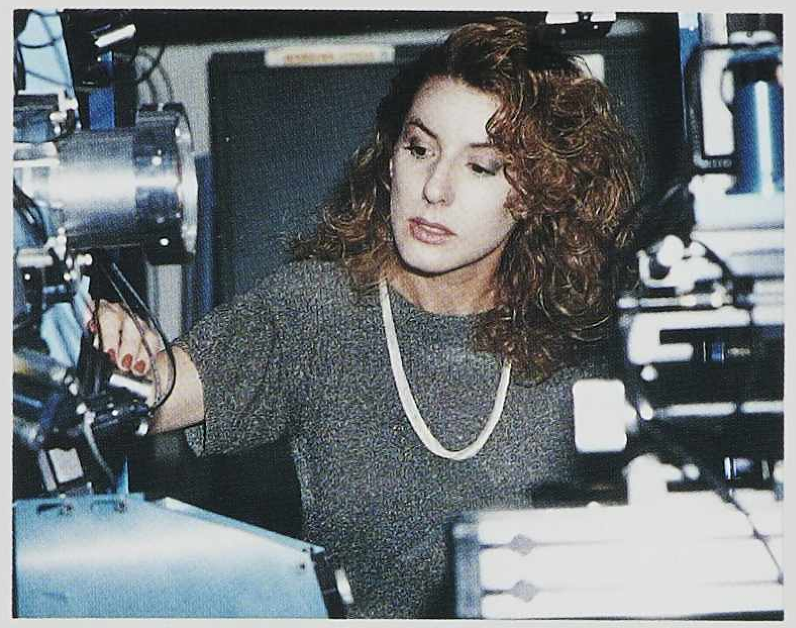
Civilian Personnel — Kirtland Civilian Personnel Office
Kirtland AFB NM 87117-5000
Phone: (505) 846-2207

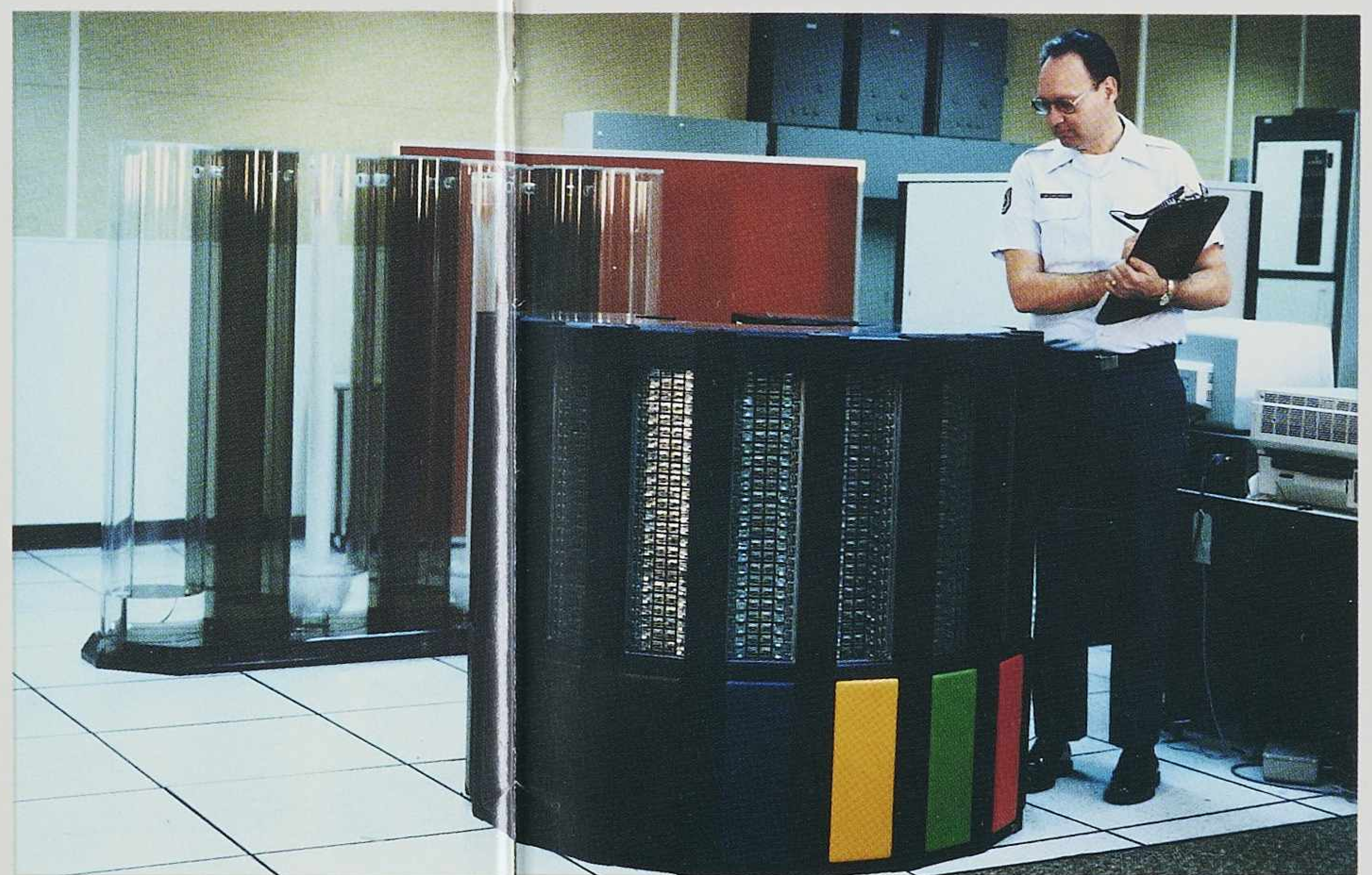
Hanscom Civilian Personnel Office
Hanscom AFB MA 01731-5000
Phone: (617) 377-2280

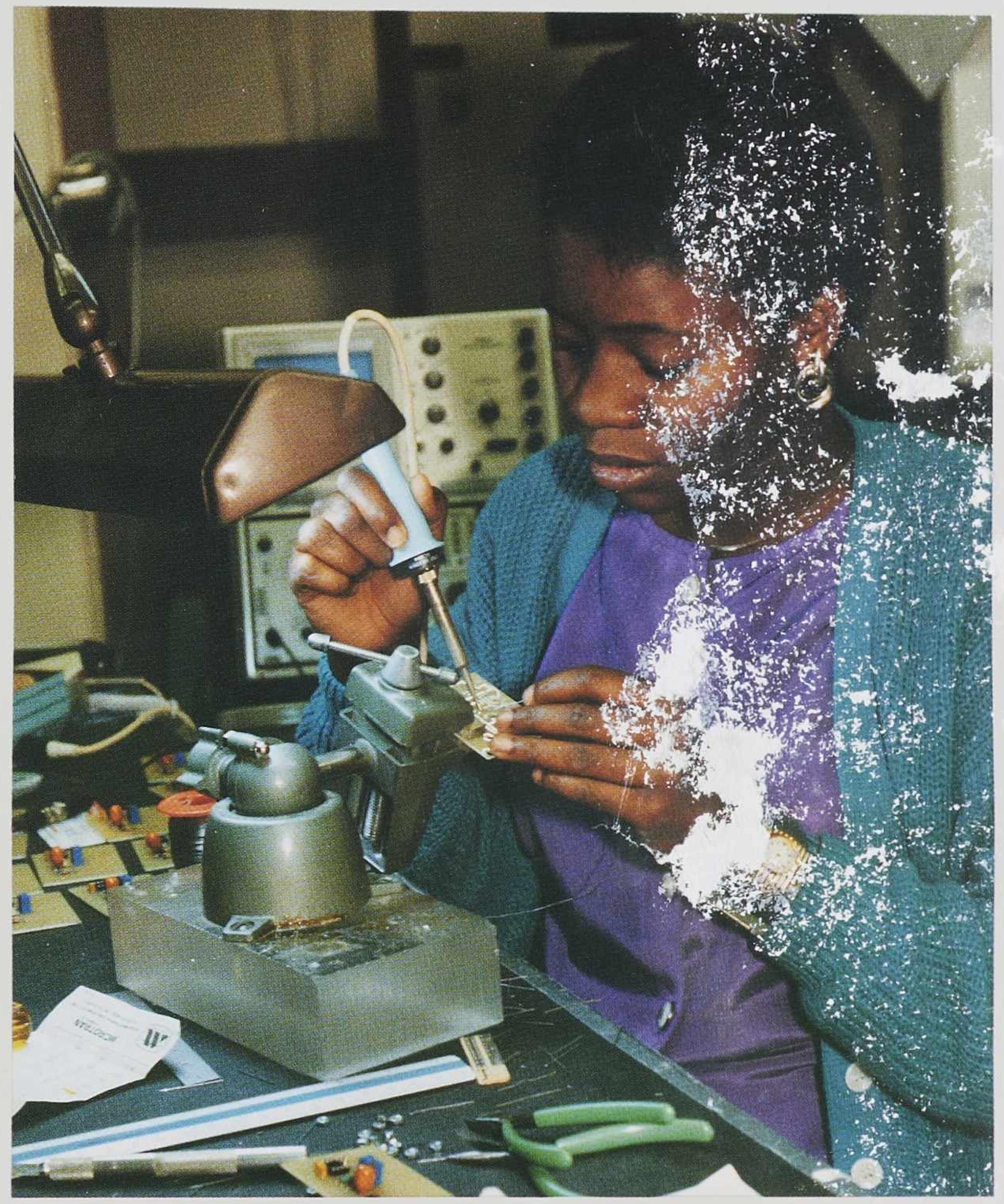
Edwards Civilian Personnel Office
Edwards AFB CA 93523-5000
Phone: (805) 277-3840

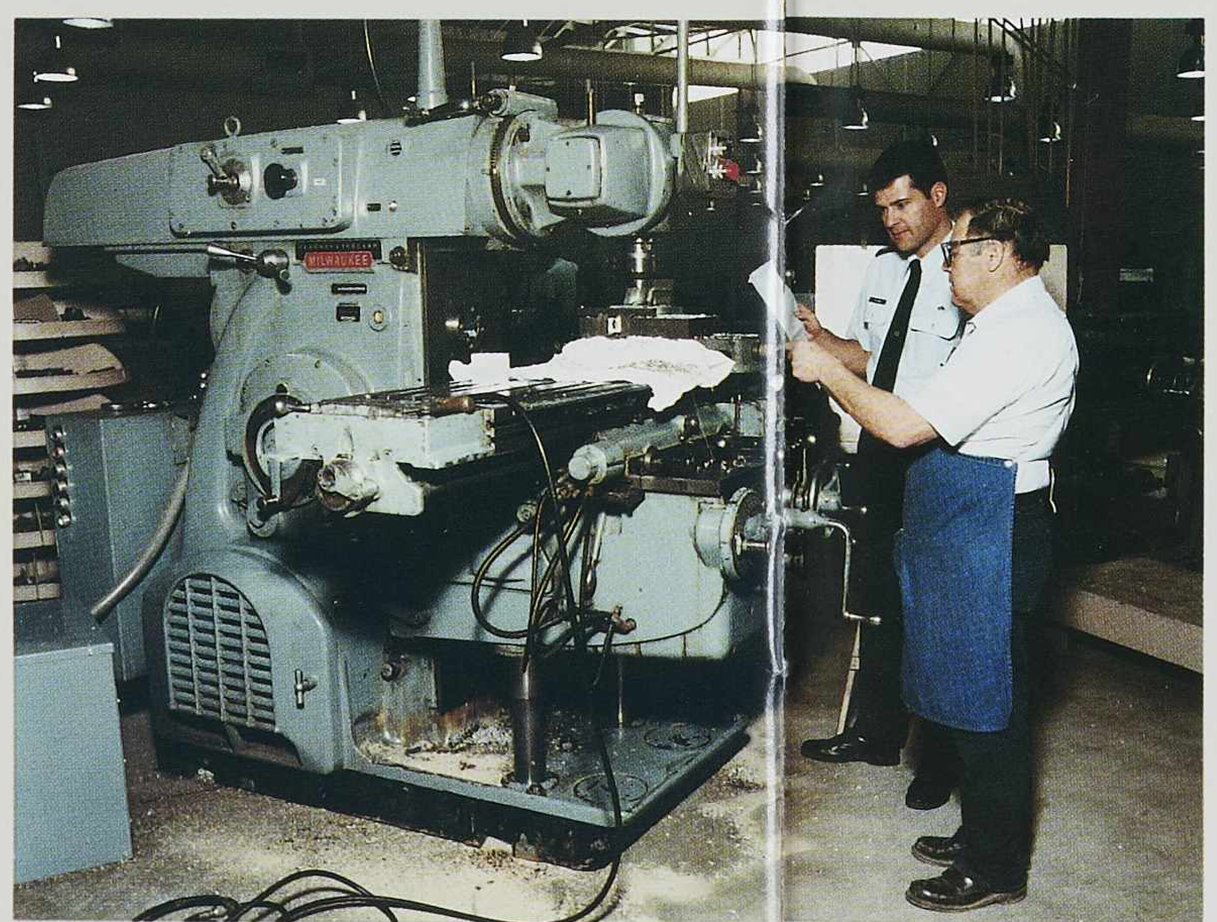
For more information about the Phillips Laboratory, contact:

Office of Public Affairs
Phillips Laboratory
Kirtland AFB NM 87117-6008
Phone: (505) 846-1911

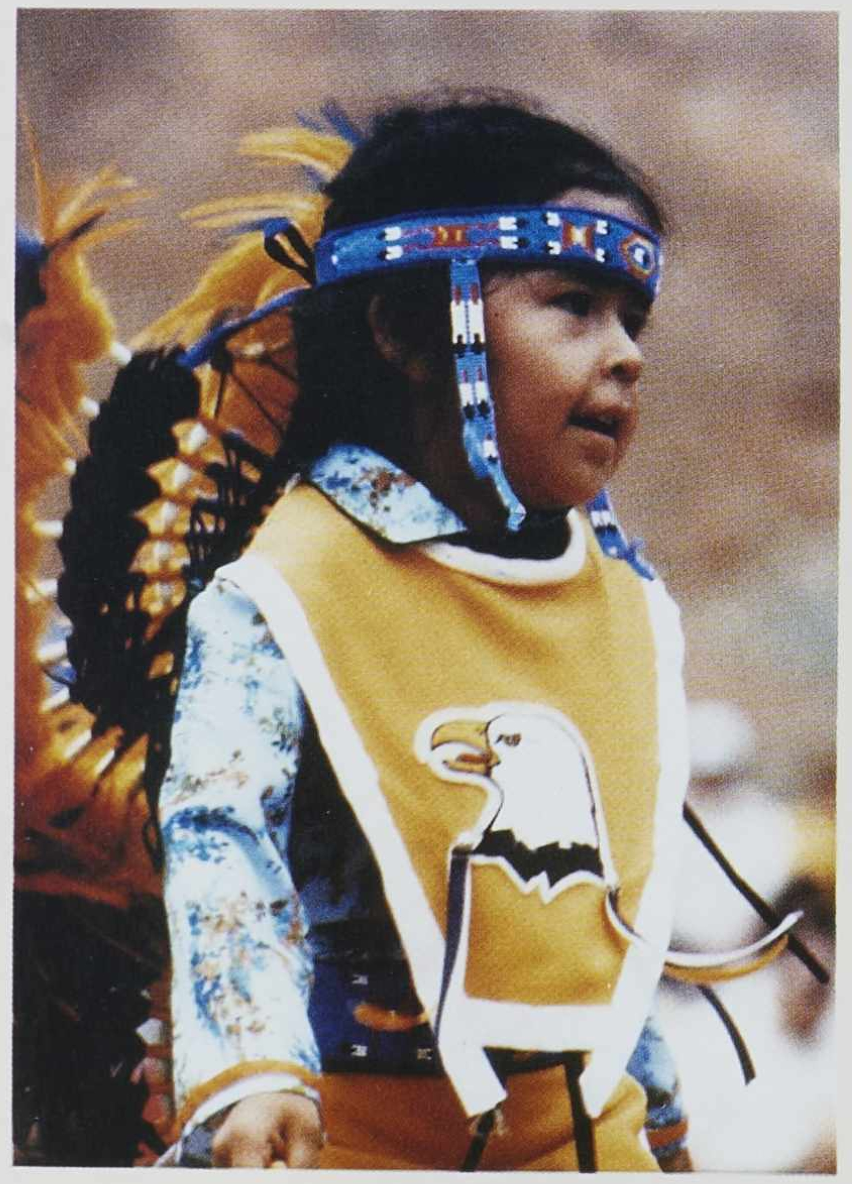








The Local Area



Albuquerque & Kirtland Air Force Base

The Phillips Laboratory is headquartered at Kirtland Air Force Base, New Mexico, on the southern edge of Albuquerque, a convenient driving distance to a wide range of cultural and recreational activities. The city has many museums and historical points of interest. A variety of restaurants cater to all tastes, with an emphasis on characteristic southwestern cuisine. Albuquerque, a metropolitan area of one-half million people, is the population hub of New Mexico.

Other Albuquerque points of interest include parks and the Rio Grande, an annual international hot-air balloon festival, North America's longest aerial tramway, and nearby world-class winter skiing. Frequent concerts, theater performances, and sporting events add to the Albuquerque night life. The University of New Mexico is also centered in the city.

The high-desert climate provides plenty of sunshine, with distinct seasonal changes. Albuquerque receives about eight inches of annual precipitation, usually in summer thunder-showers and winter snow.

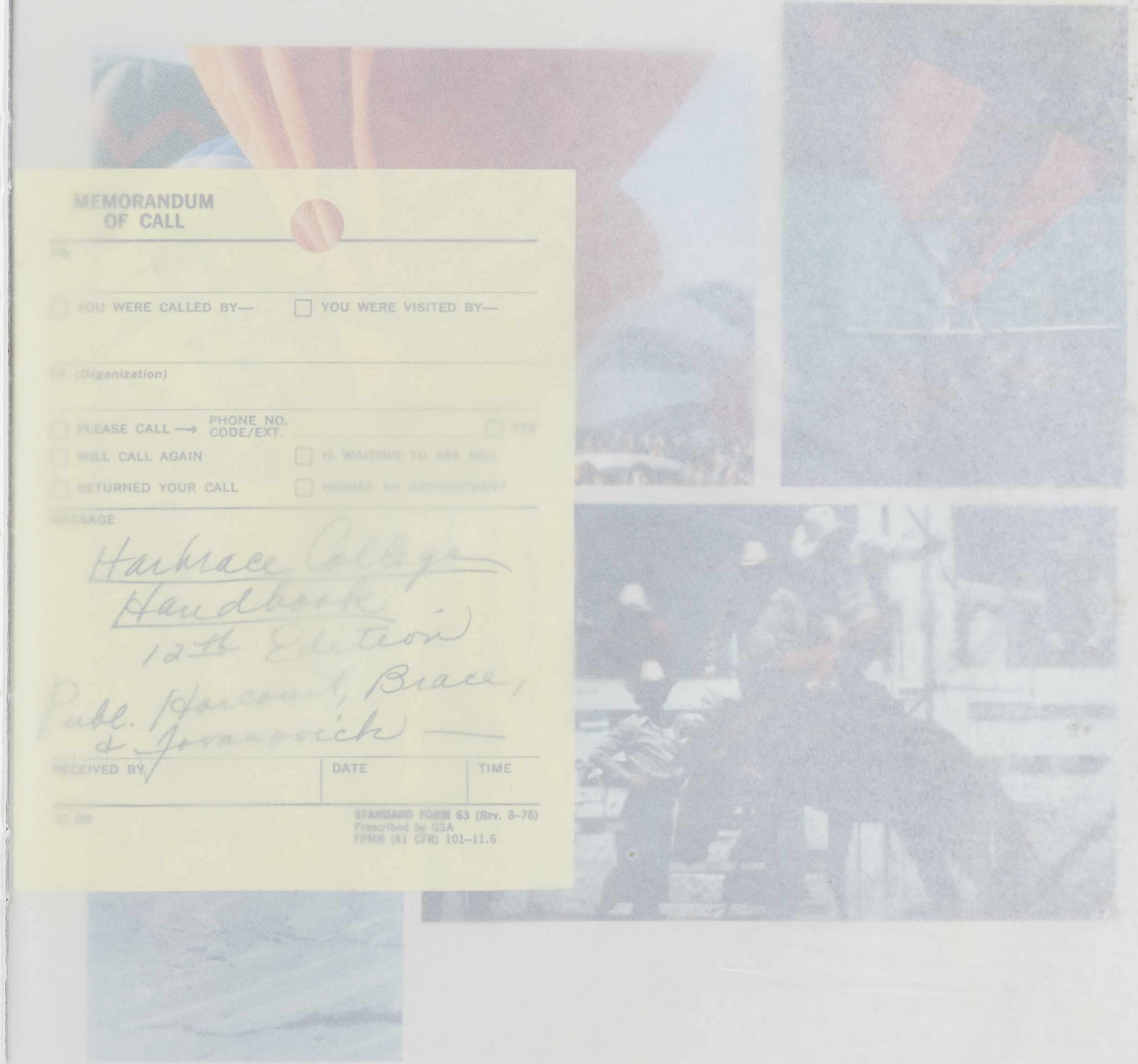
New Mexico is the fifth largest state in the nation and offers high-desert scenery, mountains, rivers, and a pleasant climate, with clear skies and very low humidity. The state has ten national monuments and one national park, with historic Indian sites, skiing, white-water rafting, hiking and other outdoor activities. Popular attractions include the state capital in Santa Fe (an hour's drive north of Albuquerque), Los Alamos (with its nuclear bomb history), the artistic community of Taos, exciting Carlsbad Caverns and the Mexican border town of Juarez.

Boston & Hanscom Air Force Base

The Phillips Laboratory's Geophysics Directorate is located at Hanscom Air Force Base, Massachusetts, near Boston. To many people, Boston is the cultural capital of the nation with its symphony, historical sites, and numerous colleges and universities. The base is in the center of Revolutionary War country, near such history-making locations as the Lexington Green and the North Bridge at Concord.

Edwards Air Force Base Area

The Propulsion Directorate is the Phillips Lab's primary unit at Edwards Air Force Base, California. The base is about a one-and-a-half-hour drive north of Los Angeles. Situated inland, with a dry desert climate, it offers a more relaxing lifestyle than the "big city." Lancaster, Palmdale, and Mojave are towns nearby, offering reasonable housing values and shopping conveniences. Edwards' close proximity to the Los Angeles metropolitan area is a big "plus" for area residents.



MEMORANDUM OF CALL

YOU WERE CALLED BY— | YOU WERE VISITED BY—

(Organization)

PLEASE CALL → PHONE NO. CODE/EXT.

WILL CALL AGAIN | IS WAITING TO SEE YOU

RETURNED YOUR CALL | WISHES AN APPOINTMENT

MESSAGE

Harbrace College Handbook 12th Edition Publ. Harcourt, Brace, & Jovanovich —

RECEIVED BY | DATE | TIME

STANDARD FORM 63 (Rev. 8-76) Prescribed by GSA FPMR (41 CFR) 101-11.6

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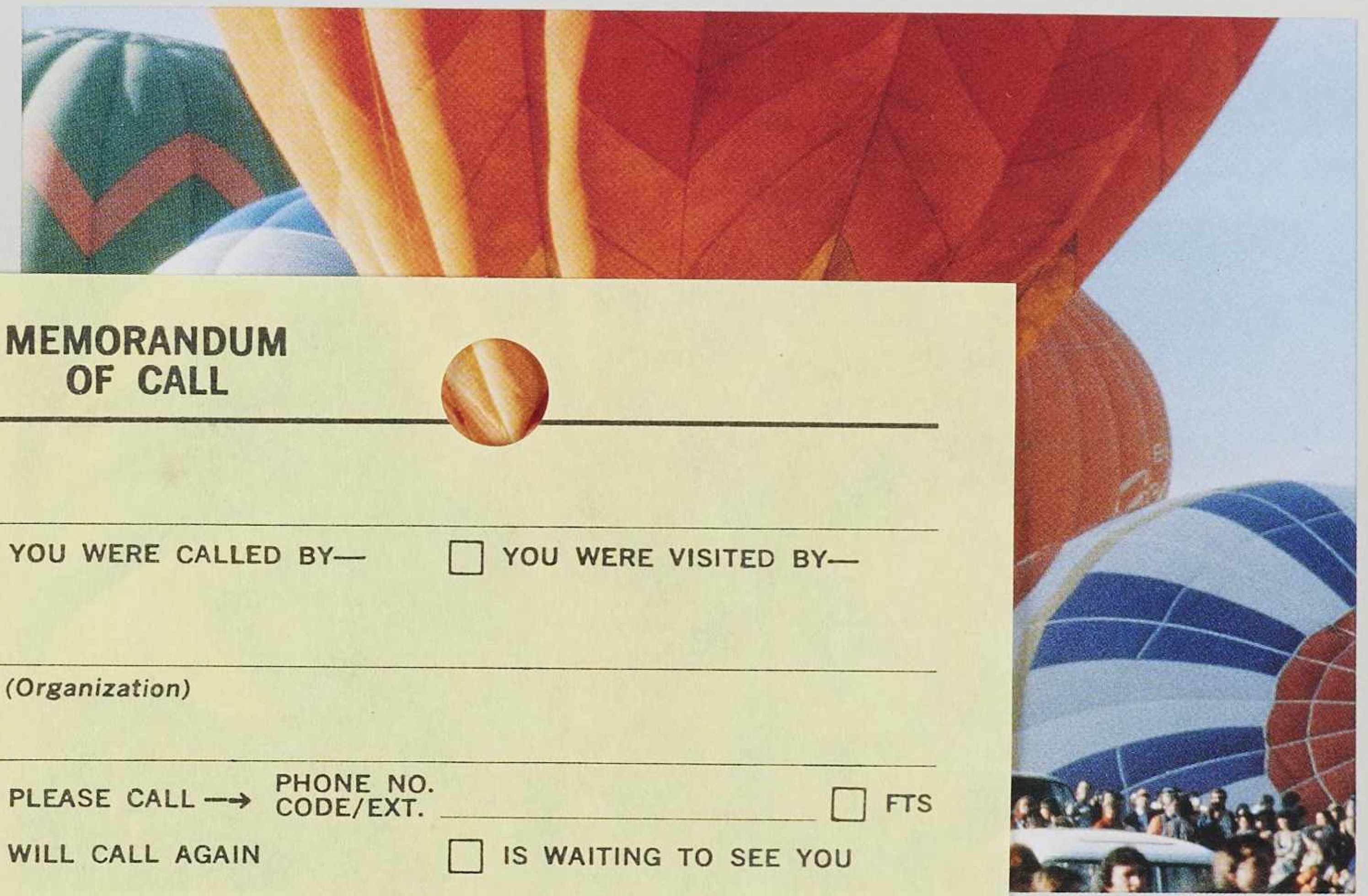

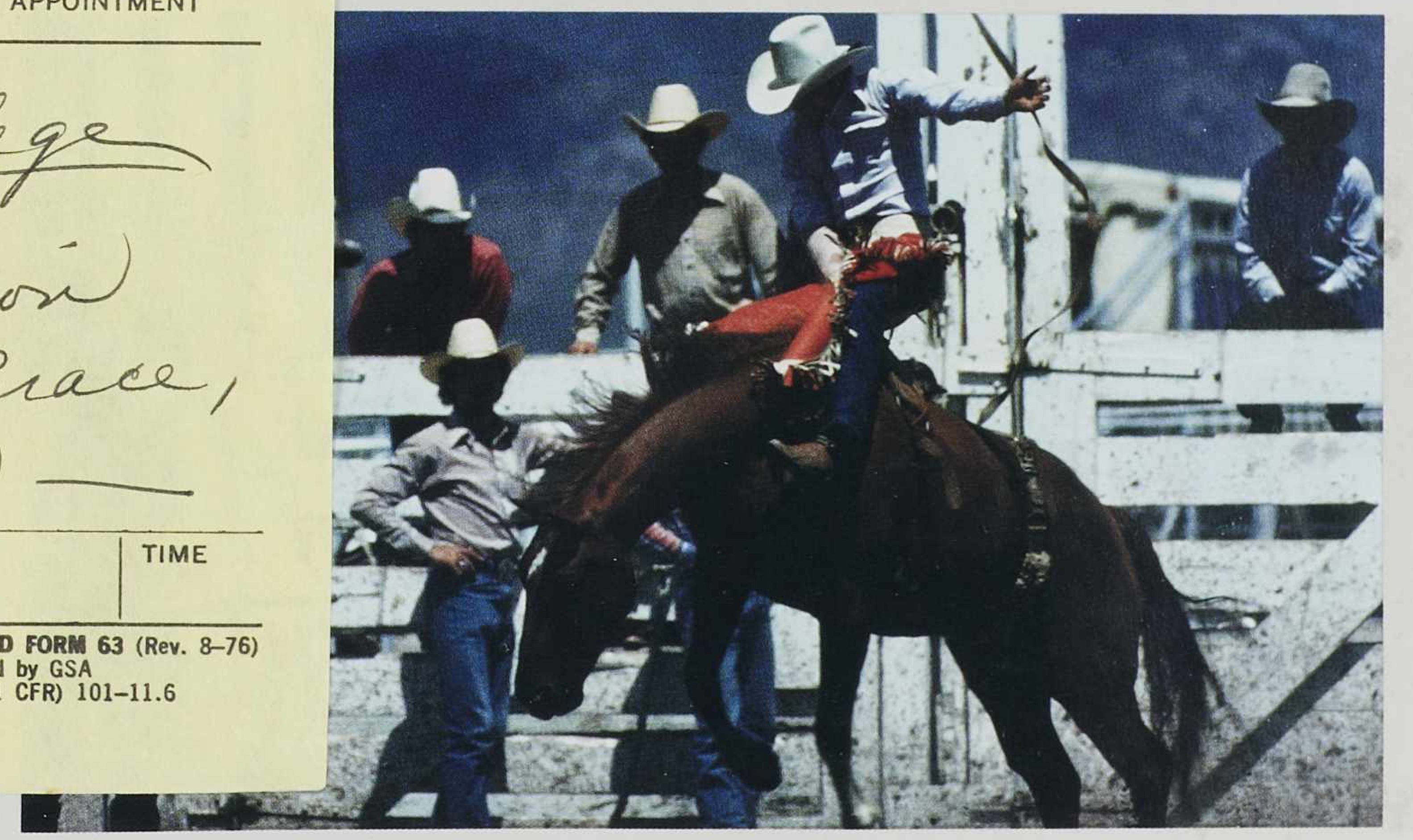

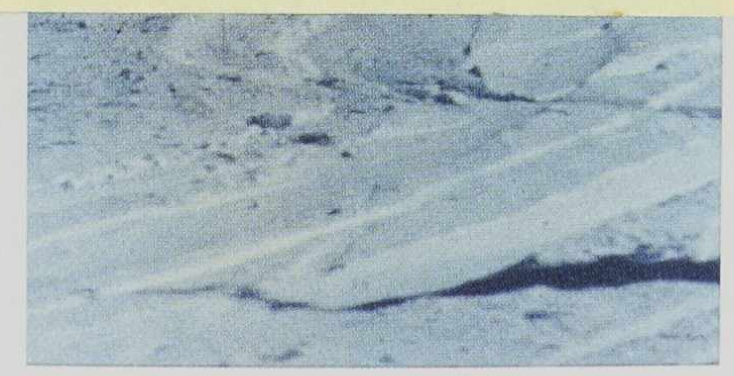

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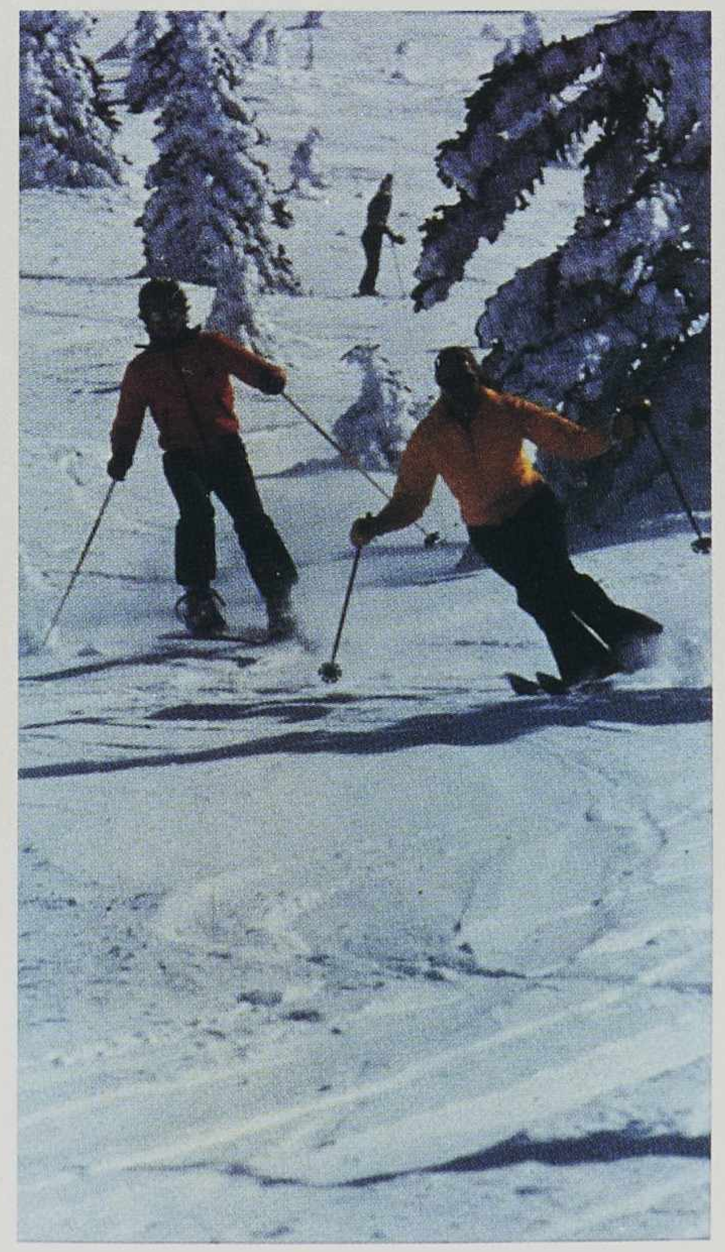
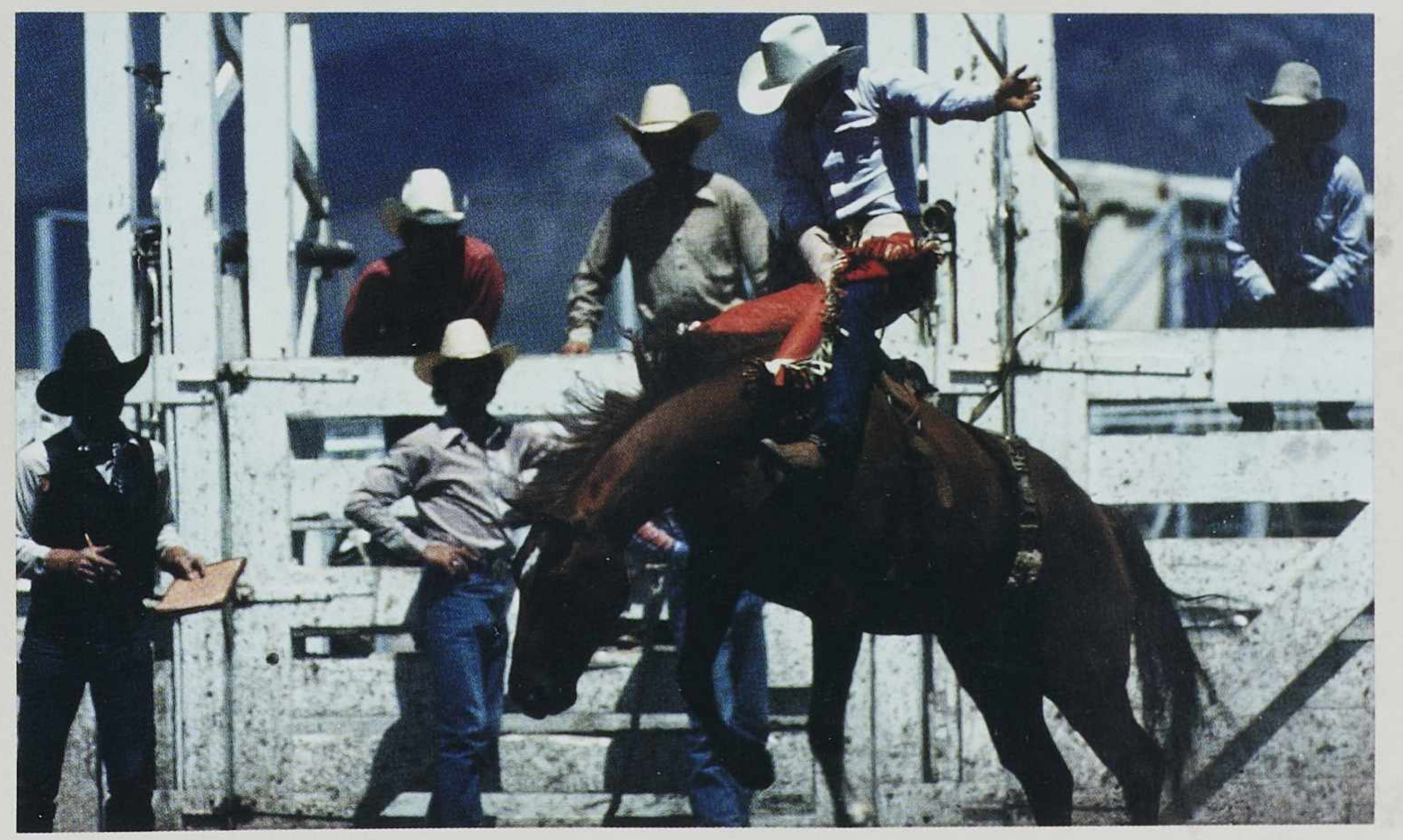




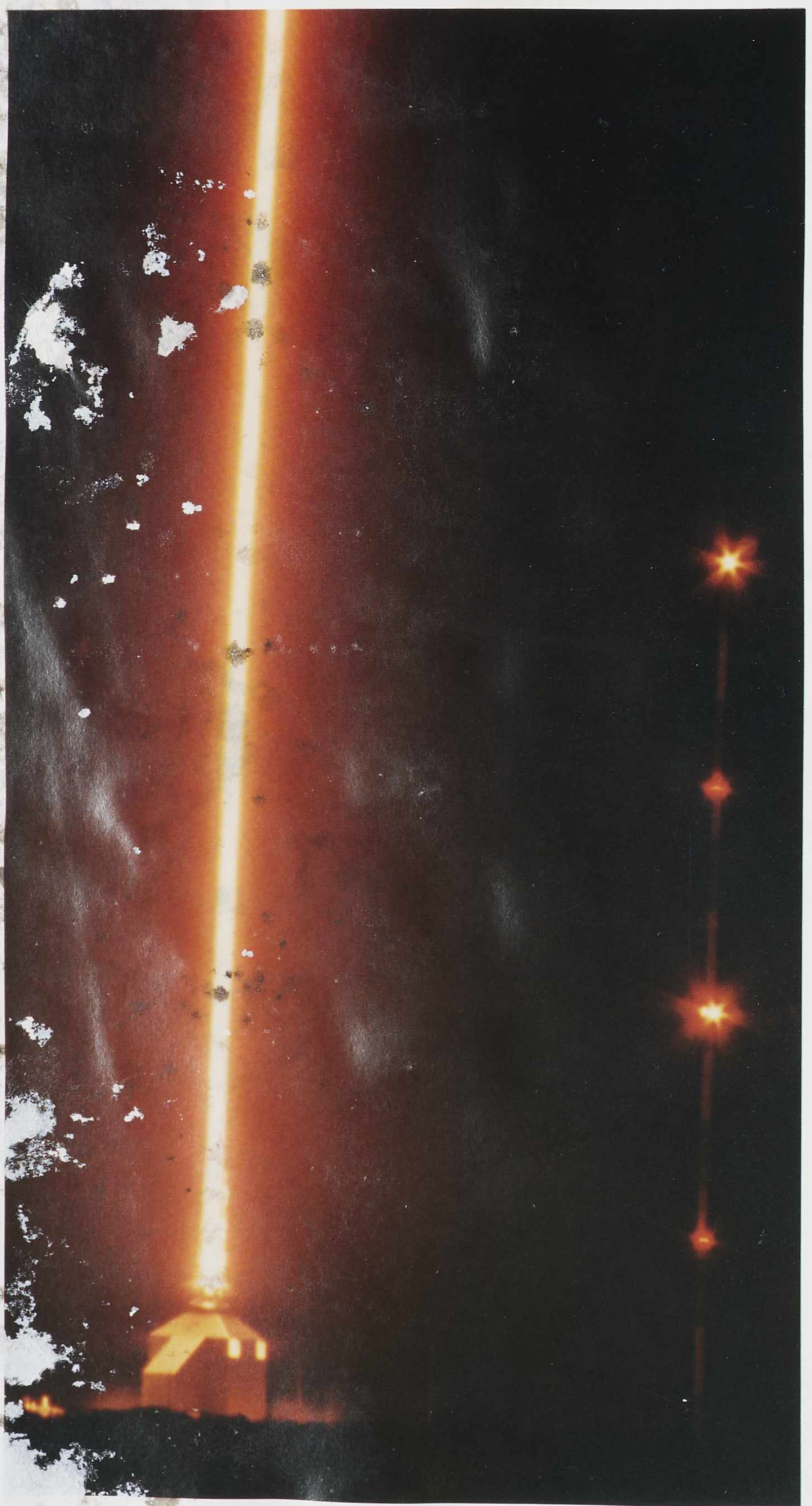
PHILLIPS LABORATORY

PHILLIPS LABORATORY GEOPHYSICS DIRECTORATE

HANSCOM AFB, MA

PHILLIPS LABORATORY

AFGL SUPPORTS



- Space Radiation Program (SPACERAD)
- Combined Release and Radiation Effects Satellite (CRRES)
- Defense Meteorological Satellite Program (DMSP)
- Defense Satellite Communications System (DSCS)
- Military Satellite Communications System (MILSTAR)
- Teal Ruby
- Strategic Defense Initiative (SDI)
- Anti-Satellite Weapon (ASAT)
- Space Shuttle Program
- Space Surveillance and Tracking System (SSTS)
- Defense Support Program (DSP)
- Air Force Satellite Communications System (AFSATCOM)
- Solar Electro-Optical Network (SEON)
- Over-the-Horizon Backscatter Radar System (OTH-B)
- North Warning System
- Project Forecast II
- Small Intercontinental Ballistic Missile Command, Control, Communication, and Intelligence System
- Boost Surveillance and Tracking System (BSTS)
- Nuclear Optical and Radar Systems Effects (NORSE)
- Space Based Surveillance System (SBSS)
- Infrared Search and Track System (IRST)
- Next Generation Weather Radar (NEXRAD)
- Battlefield Weather Observation and Forecast System (BWOFS)
- Automated Weather Distribution System (AWDS)
- Global Positioning System (GPS)
- Peacekeeper (MX)

AIR FORCE GEOPHYSICS LABORATORY

The Air Force Geophysics Laboratory (AFGL) is a world leader in geophysics, the science of the earth in its solar-terrestrial environment. As technology advances, systems become increasingly dependent on their environments. Air Force systems, which operate in space, the ionosphere, the atmosphere, on earth and below it, are influenced by solar emissions, gravity, weather, and earthquakes. The mission of the Air Force Geophysics Laboratory is to understand these environmental forces so that it can define design parameters for Air Force systems. The Laboratory, located at Hanscom AFB, Massachusetts, reports to the Air Force Space Technology Center at Kirtland AFB, New Mexico, which is managed by the Space Division of Air Force Systems Command, Los Angeles, California.

To carry out its mission, AFGL has developed an outstanding staff of 312 scientists and engineers, a third of whom have doctoral degrees. They publish about 190 journal articles a year and present papers at approximately 150 professional meetings a year, at home and abroad. Laboratory scientists serve on committees of such international organizations as the International Scientific Radio Union (URSI), the International Association of Geomagnetism and Aeronomy (IAGA), the International Association for Meteorology and Atmospheric Physics (IAMAP), the International Union of Pure and Applied Physics (IUPAP), the Scientific Committee on Solar Terrestrial Physics (SCOSTEP), and the International Union of Geodesy and Geophysics.

The Laboratory has recently awarded over $300,000 in grants to universities in the United Kingdom, Sweden, the Netherlands, and Denmark. It has also signed agreements for joint programs with Brazil, the United Kingdom, and Norway.

AFGL scientists have been invited to lecture in China, Japan, India, the Soviet Union, Czechoslovakia, and the United Kingdom. Leading European and Oriental scientists also come to AFGL through the Window on Science program sponsored by the Air Force Office of Scientific Research. The AFGL staff is thus in touch with geophysics research world wide.

In the United States, AFGL scientists have served on such important committees as the Fletcher Commission (the President's Strategic Defense Initiative Committee), the OSD Working Group on Nuclear Disturbed Environments, the IRIS Specialty Group on Targets, Backgrounds, and Discrimination, the Military Space Systems Technology Model, the Air Force/NASA Spacecraft Contamination Steering Committee, and the Committee on Spacecraft Environmental Interactions.

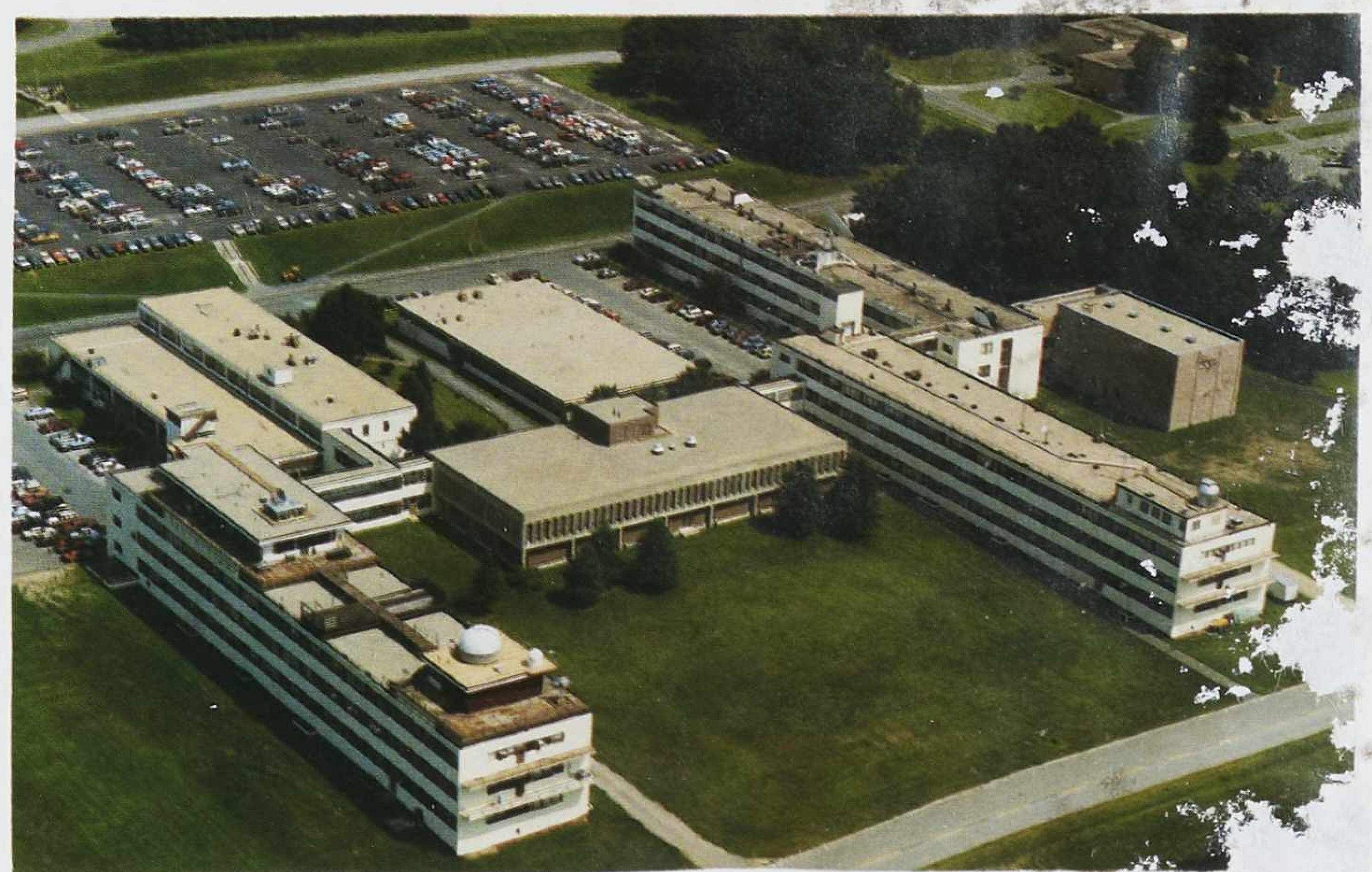
The Laboratory has attracted some excellent young scientists through two postdoctoral programs, the National Research Council Post Doctoral Associateship and the AFGL Geophysics Scholar Program. Both provide for one-year appointments renewable for another year. In addition, AFGL participates in the USAF Summer Faculty Research program and the Graduate Student Summer Support Program administered by the Air Force Office of Scientific Research.

At AFGL, young scientists have an opportunity to associate with older mentors, among whom are fellows of such professional societies as the Optical Society of America, the Royal Astronomical Society, the American Association for the Advancement of Science, the Geological Society of America and members of prestigious academies, such as the New York Academy of Science.

AFGL scientists are supported by 92 skilled laboratory technicians and 173 other professional, administrative, and clerical personnel.

Our research facilities, described in more detail later, include a world class library, a major new payload test facility, several large vacuum chambers for simulating conditions in outer space and pre-flight calibration of satellite and rocket instruments, and two NKC-135 flying laboratories instrumented for ionospheric and infrared research. The Laboratory occupies 423,943 square feet of space at Hanscom AFB and at off-site locations in Massachusetts and New Mexico. The total value of its facilities and equipment is $109 million.

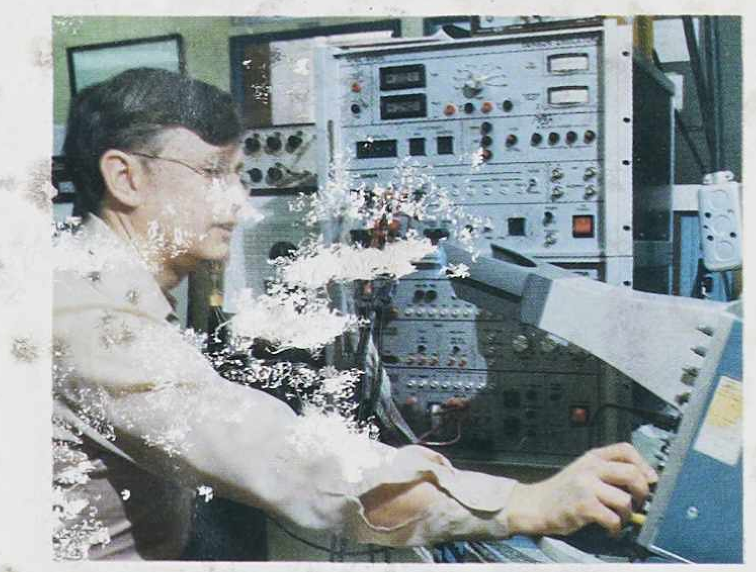
AFGL programs in geophysics, described in the following pages, cover space and ionospheric physics, optical and infrared physics, atmospheric sciences, and earth sciences. The products of this research are transitioned into the Air Force in a variety of usable forms such as military design standards, computer-aided design tools, data bases of geophysical effects, computer models of the environment, feasiblity studies, and prototype hardware and software.

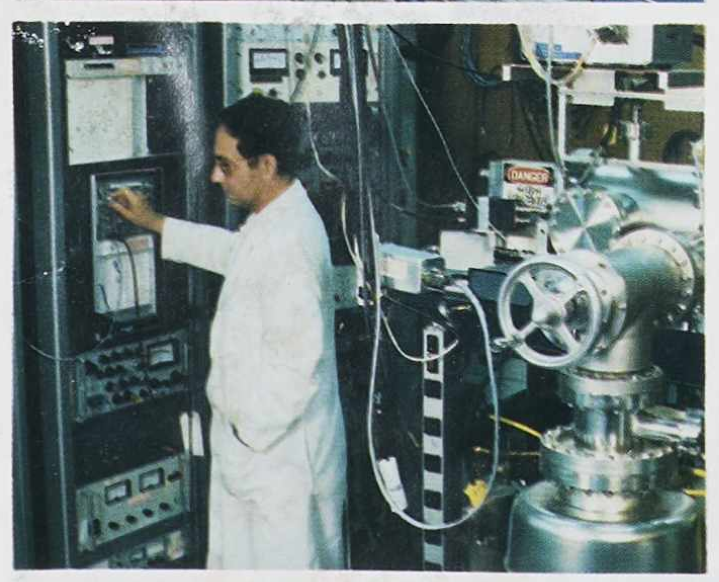


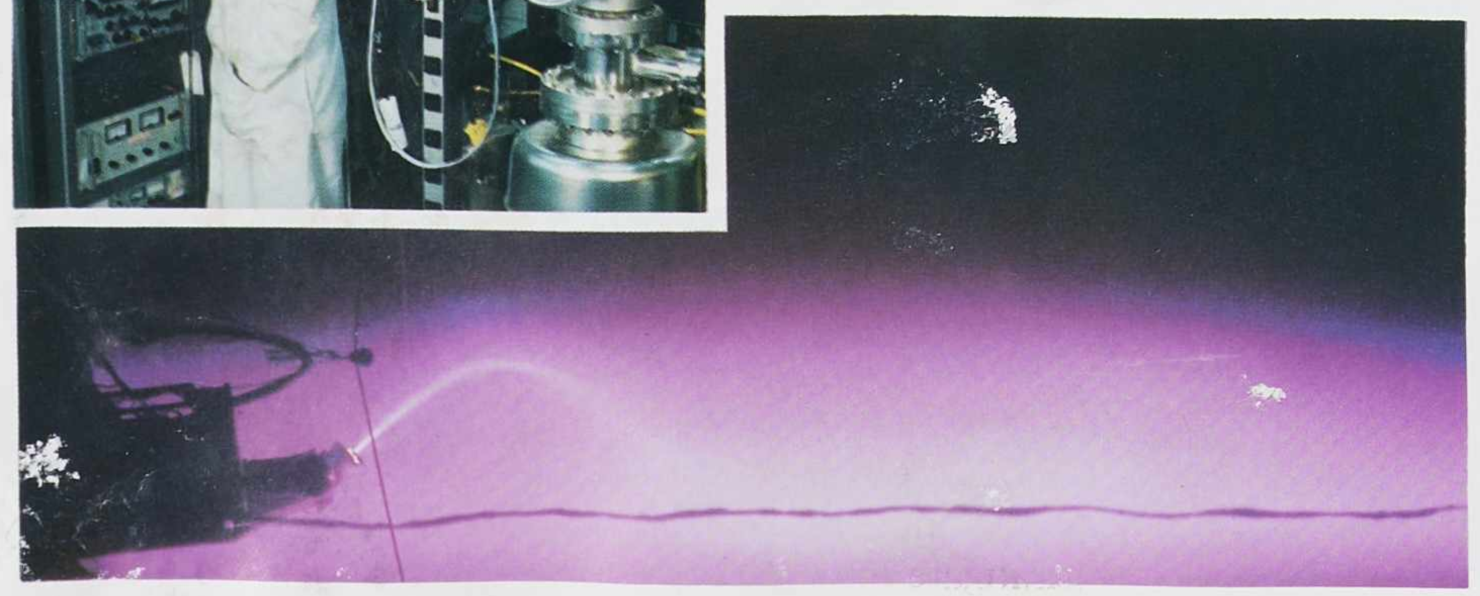
SPACE AND IONOSPHERIC PHYSICS

Space is the new high ground of military strategy. Although most Air Force operations now take place within several miles of the earth's surface, space is playing an expanding, crucial role in fulfilling the Air Force mission. Most Air Force satellites operate in the ionosphere and magnetosphere, which stretches out to about 10 earth radii. Particles and radiation from the sun are transported through interplanetary space to these regions, creating the earth's geomagnetic storms, radiation belts, and the northern and southern auroras. These effects disrupt Air Force early warning, target detection, and communications systems. Understanding the physics of these regions is thus critical for the design of future Air Force systems and for space weather forecasting for Air Force operations.

Programs in space physics at the Air Force Geophysics Laboratory are at the forefront of our scientific knowledge of the complex domain in which the earth is embedded in the solar/magnetospheric environment. These programs include solar emissions, interplanetary characteristics, high-latitude electrical effects, in-flight performance of advanced microelectronic devices, and spacecraft-environmental interactions. Active space experiments—determining the effects of chemicals, charged particle beams, waves, and high-power radio signals on the space environment—are an area of growing importance in AFGL's space physics program.







The sun is a thermonuclear reactor. Clues to its internal workings, such as the transfer of energy from the core to the surface, the heating of gases to more than a million degrees, and the creation and destruction of magnetic fields, may be found in sunspots, solar flares, and surface granules. Our solar physicists located at the National Solar Observatory, Sacramento Peak, New Mexico, observe these effects with electro-optical techniques they have developed to remove atmospheric blurring from ground observations. They can produce images five times sharper than conventional techniques and rival those produced by space-based telescopes. AFGL had an astronaut payload specialist co-investigator on NASA's Spacelab 2 mission. He will fly on Sunlab, which will perform on-orbit solar research.

During magnetospheric substorms, large fluxes of energetic particles are injected into the high-latitude regions. These substorms greatly enhance ionization in, and poleward of, the auroral zones, an area called the "polar cap." This results in interference to Air Force radio communications and radar systems operating in the arctic regions. Substorm prediction is the goal of research into high-latitude electrical effects to improve frequency management and cut signal loss and fading in Air Force communications systems.

The results of active space-environment perturbation experiments provide essential inputs to surveillance, discrimination, and offensive capabilities for systems being developed for the Air Force, the Strategic Defense Initiative Organization, and other agencies of the Department of Defense. Charged and neutral particle beam experiments have been conducted from rockets and satellites to determine beam propagation characteristics, as well as the effects of beam generation and propagation on the host vehicle. Previously unknown wave-particle interactions have been discovered, and the role of particle beam characteristics important to the successful generation of environmental disturbances is being established.

The new microelectronic technologies are extremely vulnerable to space radiation. Ways must be found to shield them without compromising their size and weight advantages in spaceborne systems. AFGL has designed space radiation tests of these devices on the Combined Release and Radiation Effects Satellite.

The Laboratory has developed a computer code called POLAR (Potential of a Large Object in the Auroral Region) to predict the electrical effects of the highly charged polar space environment on spacecraft. These effects can range from electrical noise in circuits to system failure in extreme cases. To date, POLAR has been used by Lockheed, RCA, and NASA to counter charging on a variety of spacecraft. It will become a computer-aided design tool for future NASA and Strategic Defense Initiative systems.

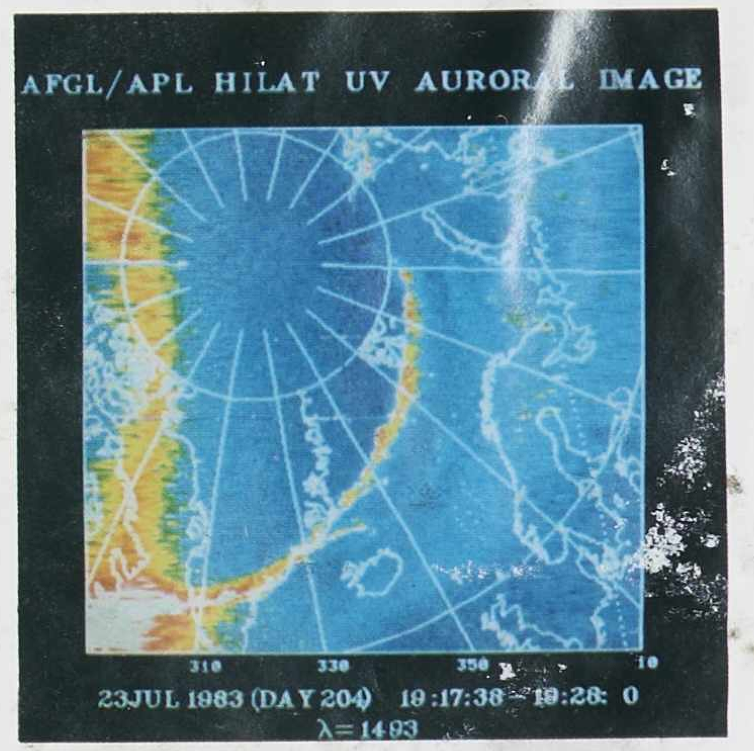
Electrical charging is just one of many different spacecraft/environmental interactions that can adversely affect the performance of Air Force systems in the harsh environment of space. Space physicists at AFGL are developing a shuttle-based, free-flying reusable diagnostic platform called Interactions Measurement Payload for Shuttle (IMPS). Sensors to measure space plasma, waves, fields, particles, and atmosphere composition make up the diagnostic complement, which is used to specify the effects of the environment on the design and fabrication of developing space technologies and active space experiments.

The magnetospheric system is highly coupled to the transition region below, the ionosphere. Because of the higher atmospheric density, a large fraction of the solar-magnetospheric energy is absorbed in this region, where a significant number of atmospheric atoms and molecules are changed into electronically conducting ions and electrons. The ionosphere begins about 50 miles above the earth and extends upward beyond 300 miles in altitude, gradually merging with the magnetosphere. The combined action of solar ultraviolet radiation and atmospheric density changes produces a layer of maximum ionization at an altitude of about 220 miles.

The ionosphere modifies the path of propagating radio waves. The chemical composition and electron density distribution of the ionosphere are highly variable, changing according to the time of day, season, latitude, and solar activity. These changes affect ionospheric radio propagation. In addition, the ionosphere sometimes breaks up into an irregular structure, resulting in "scintillations," or rapid variations in radio and radar signal strength.

Ionospheric physics programs at AFGL focus on exploiting the advantages of the ionosphere, for example, contributing to the design of the Over-the-Horizon Backscatter Radar system, and minimizing the effects of scintillation and other disruptions to Air Force communications and radar systems.

AFGL has obtained the first daytime images of the aurora and the ionospheric airglow from space using ultraviolet techniques. Based on several satellite flights, ultraviolet imagers and cameras are being developed to measure ionospheric emissions on flights of the Defense Meteorological Satellite. The ultraviolet imager will provide the measurements needed for making electron density profile maps. This remote sensing technique also will rely on AFGL theoretical developments to supply electron density profiles and auroral disturbance locations in real time to Air Force radar and communications systems.



Ultraviolet measurements of missile plume signatures are also undertaken for the Strategic Defense Initiative Organization. These wavelengths appear to offer great advantages for very high resolution space-based acquisition, surveillance, and tracking of missiles during their launch phase. In addition, sensors have been built to measure the ultraviolet background radiation against which the targets must be viewed. Such information is essential to the design of future Air Force surveillance systems.

To acquire data on the processes that generate and structure the global ionosphere, AFGL operates an Airborne Ionospheric Observatory, a converted NKC-135 tanker equipped for research on the ionosphere, the aurora, and the precipitation of energetic particles. It has flown to research locations in Greenland, the South Pacific, Alaska, and Brazil. Large-scale ionospheric processes occurring in the auroral oval and the polar cap affect high-frequency Air Force systems. Medium- and small-scale processes that give rise to polar cap auroras and ionization patches affect radio propagation, radar performance, and various military satellite communication systems. The goal of these efforts is to predict when and where ionospheric irregularities will occur, so that operational Air Force systems may take appropriate action to avoid the disruptions or mitigate their effects. Modifying the ionosphere to induce irregularities artificially and alter the capability of propagation systems is also being explored.

Studies of the lower ionosphere (the D-Region) are also being initiated. Signals from very low frequency (VLF) transmitters propagate to great distances in the waveguide formed by the earth and lower ionosphere. Since these VLF signals continue to propagate relatively well even when the ionosphere is severely disturbed, the Air Force relies upon them for survivable communications. Our ability to predict the range, or coverage area, of these VLF systems depends upon the accuracy with which we can model the conductivity of the lower ionosphere. Some recent advances in our ability to measure the conductivity, which involve a combined chemical release and mass spectrometry experiment, will enable us to verify the model and provide significantly more reliable estimates of system performance.

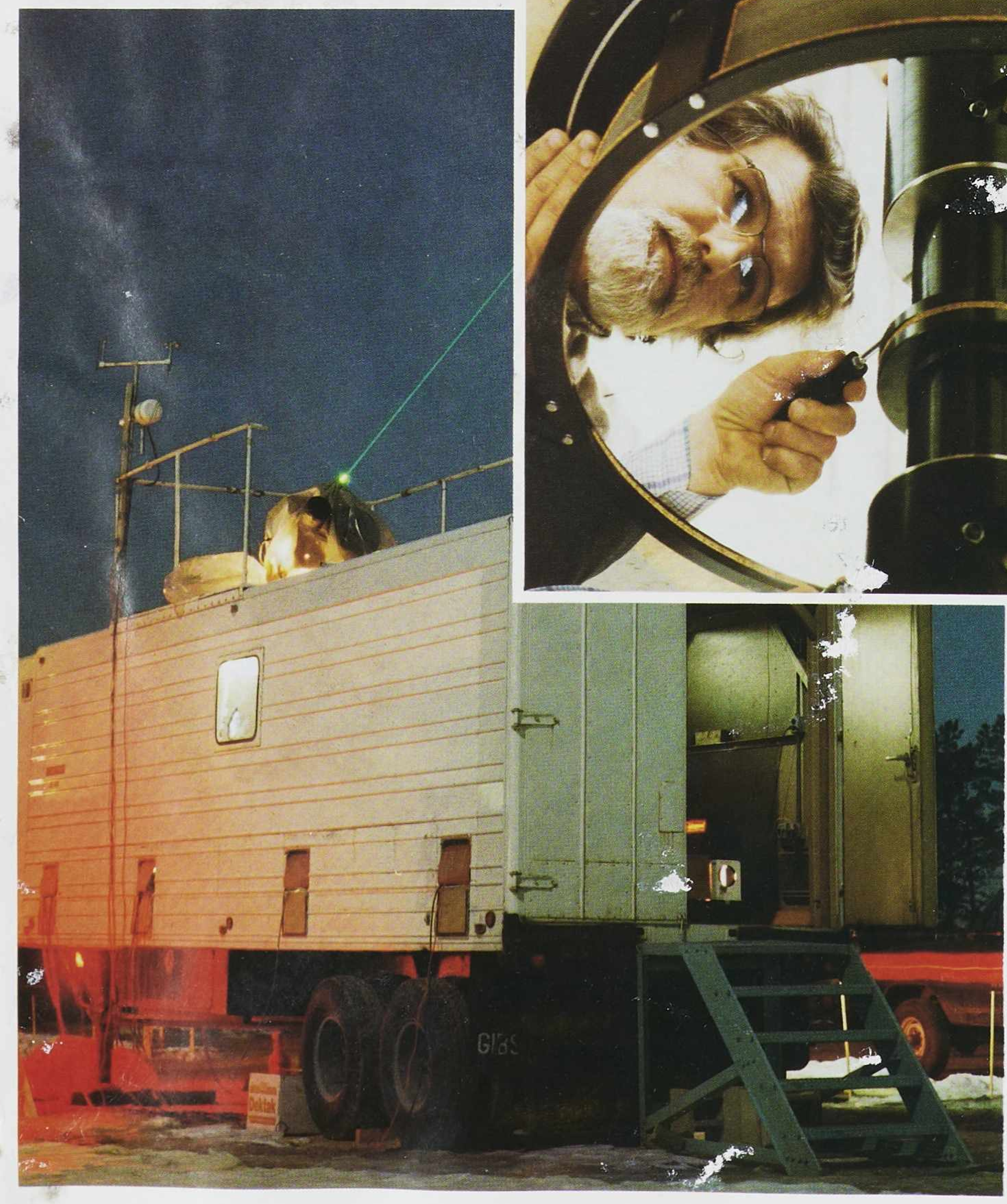
OPTICAL AND INFRARED PHYSICS

Air Force sensors must be able to distinguish targets from all other sources of radiation in the environment. These include the bright background radiance of the earth, its atmosphere, the stars, diffuse celestial backgrounds, the aurora, and any man-made radiation present in the atmosphere. System designers must also know the transmission properties of the earth's atmosphere over the ultraviolet, visible, infrared, and microwave wavelengths under normal and disturbed conditions.

In addition, the Air Force must be able to propagate laser beams through the atmosphere for communications, ranging, and as directed energy weapons. Atmospheric effects on laser propagation in the ultraviolet to infrared wavelengths include molecular and particulate absorption and scattering, turbulence distortion, thermal blooming (beam spreading due to laser heat), and pointing errors. When given the atmospheric conditions, system designers can avoid, or minimize, some of these effects by proper wavelength choices or by designing corrective optical systems.

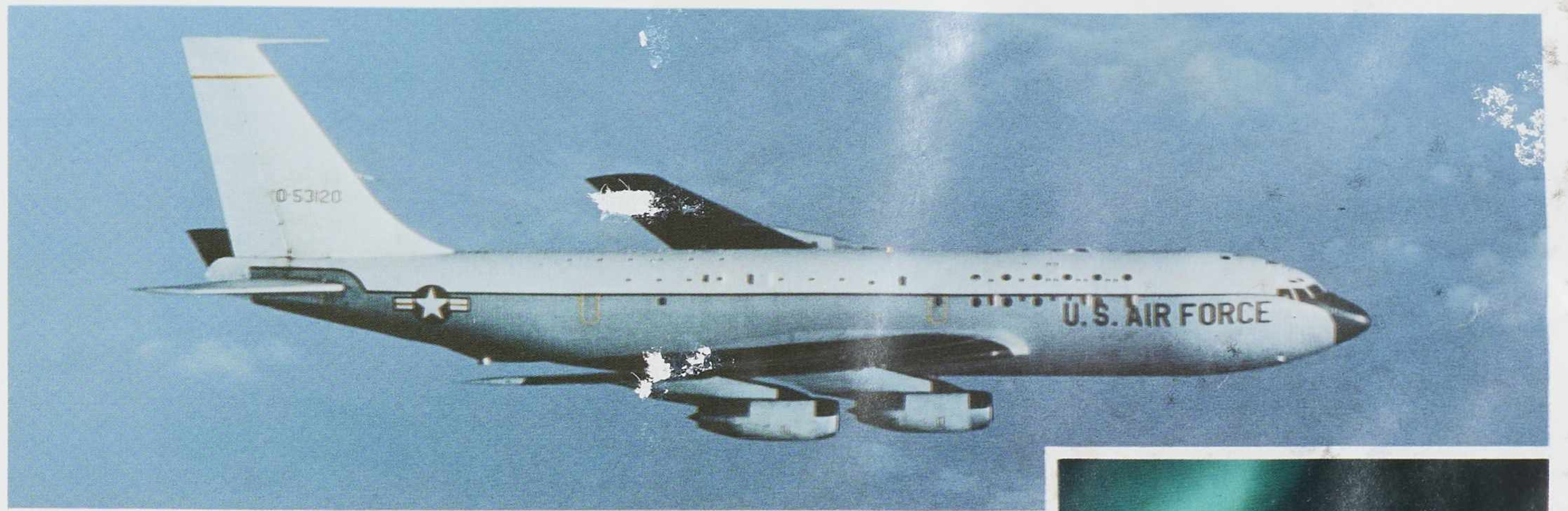
Aircraft, surface vehicles, missiles, and space objects emit heat, or infrared energy, so-called because it lies just yond the red end of the visible spectrum. Infrared radiators can be identified by their unique signatures and tracked by super-cooled, or cryogenic, infrared detectors. Before efficient detectors for missile early warning systems can be designed, however, our present knowledge must be extended to find out how the natural background radiation varies with altitude, solar activity, latitude, the seasons, and the time of day. The effects of auroral and nuclear disturbances must also be established.

Programs in optical and infrared physics at the Air Force Geophysics Laboratory provide this information to the Air Force and other agencies of the Department of Defense. These programs include laboratory studies, field



measurements, and the development of computer-based codes to characterize infrared atmospheric radiance, atmospheric transmission, scattering, turbulence, airglow, the aurora, and radiation from other sources.

The laboratory experiments, through the use of cryogenic vacuum chambers, provide data on the chemical reactions of the upper atmosphere which produce infrared radiation. Molecules are measured in the laboratory by spectrometers with extremely high resolution to obtain line structure and absorption coefficients. These data supplement the field measurement data



and supply information for the computer-based codes.

The AFGL atmospheric transmission codes have been adopted as standards by the Department of Defense and by the International Radiation Commission. AFGL maintains and updates these codes for all three armed services. The Low Resolution Transmission code (LOWTRAN) provides a simple, rapid means of predicting atmospheric effects (spectrally) on broadband infrared radiation. The High Spectral Resolution model (FASCODE) is applicable to laser propagation and remote sensing. Computer codes are also being developed to characterize atmospheric radiance, auroral activity, and the airglow at the earth's horizon.

A wide variety of field measurements, ranging from space experiments to ground-based observations, are conducted by the Laboratory. The effect of variable conditions of fog, haze, snow, and rain on transmissions through the atmosphere near the ground are measured with a mobile laboratory equipped for this task. A flying infrared laboratory, a highly modified NKC-135 aircraft, has been instrumented to obtain signatures of aircraft and ground targets, and to provide data validation to support new airborne and space-based systems being developed. High-resolution spectral measurements can be made aboard the aircraft with wide field-of-view Michelson interferometers and high-resolution spatial measurements, with advanced two-dimensional cryogenic mosaic arrays. The airborne platform acts as a test bed for "break-through" technologies and testing. Future programs include the implementation of stabilized, high sensitivity, cryogenically cooled telescopes with advanced detector arrays for locating dim targets at long ranges. To characterize ground-based laser sites, both optical remote sensing and balloon-borne measurements of optical turbulence are made from the surface to altitudes of thirty kilometers. AFGL is thus extending the capability of future Air Force surveillance, detection, and tracking systems for missions into the 1990s.

The Laboratory has developed a number of lidars (laser radars) to measure the properties of the atmosphere. Laser signals are scattered by the dust, aerosols, and molecules in the atmosphere. Some of this scattered laser light will be detected by a receiver, where it can be analyzed to find the properties of the atmosphere at various altitudes. Both ground based and airborne lidars are being tested. Lidars are also being developed to measure atmospheric winds and wind shear. In addition, the Laboratory is managing the design of the first lidar to fly on a Defense Meteorological Satellite Program vehicle.

A sophisticated infrared instrument called CIRRIS, a helium-cooled reflecting telescope containing a Michelson interferometer, has been developed to obtain measurements of the aurora and the airglow from the space shuttle. Advanced sensors are also being developed for use on high-altitude balloons and sounding rockets. They include "smart" features to be able to suppress strong background radiation, and to detect less intense targets such as cruise missiles.

Sensors with telescopes cooled by liquid helium are flown on sounding rockets to measure the infrared emission of stars and large clouds of gas and dust in the galaxy, and the thermal emission from dust in the solar system. Sophisticated measurement and computer processing techniques are being developed to analyze these and other data.

Through the combined investigations of theory, laboratory, and field measurements, comprehensive data characteristic of the wide variations over the globe and extending to space are being accumulated. This technology base will provide the Air Force the basic information required to design, construct, and install the new generation of tactical and strategic optical and infrared systems.

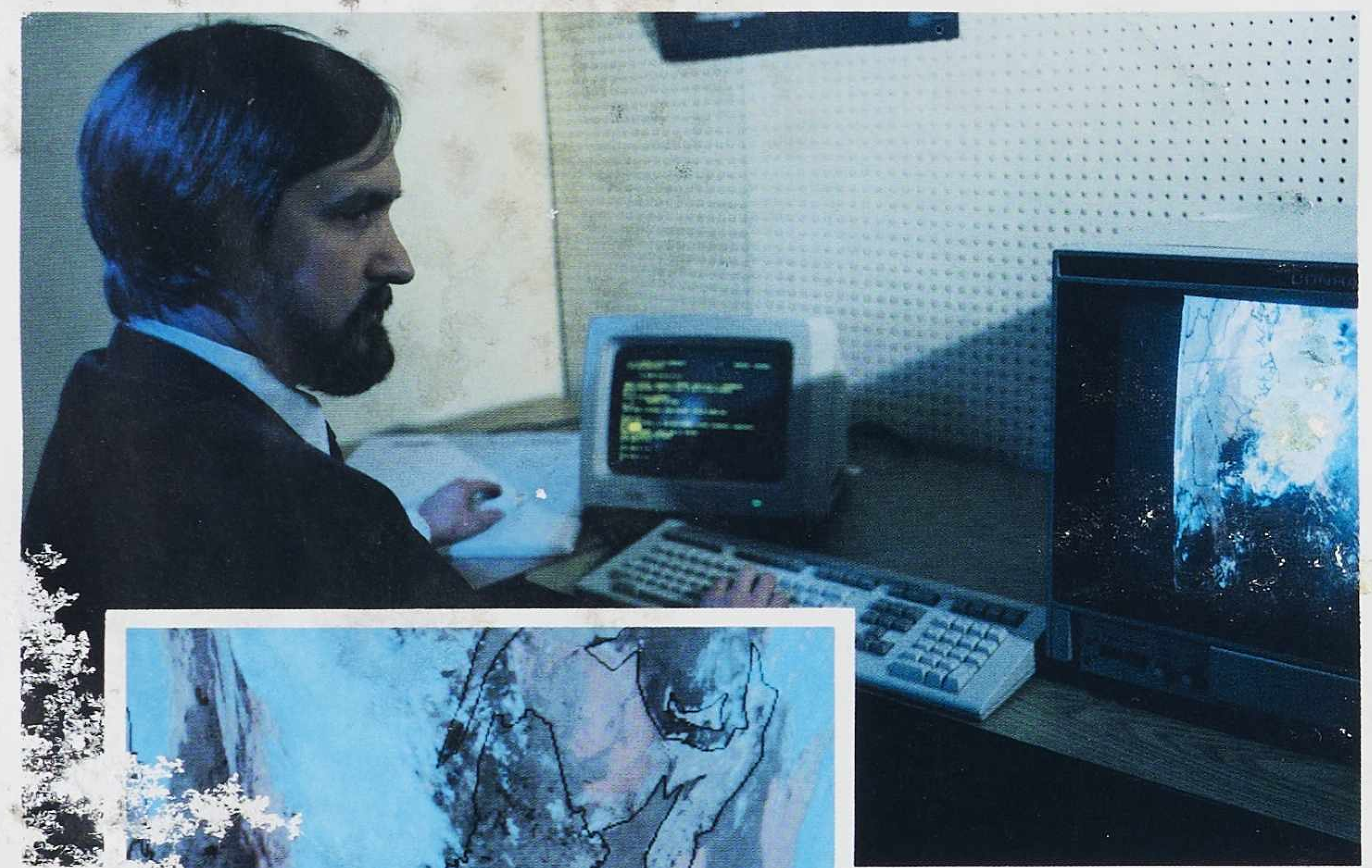
ATMOSPHERIC SCIENCES

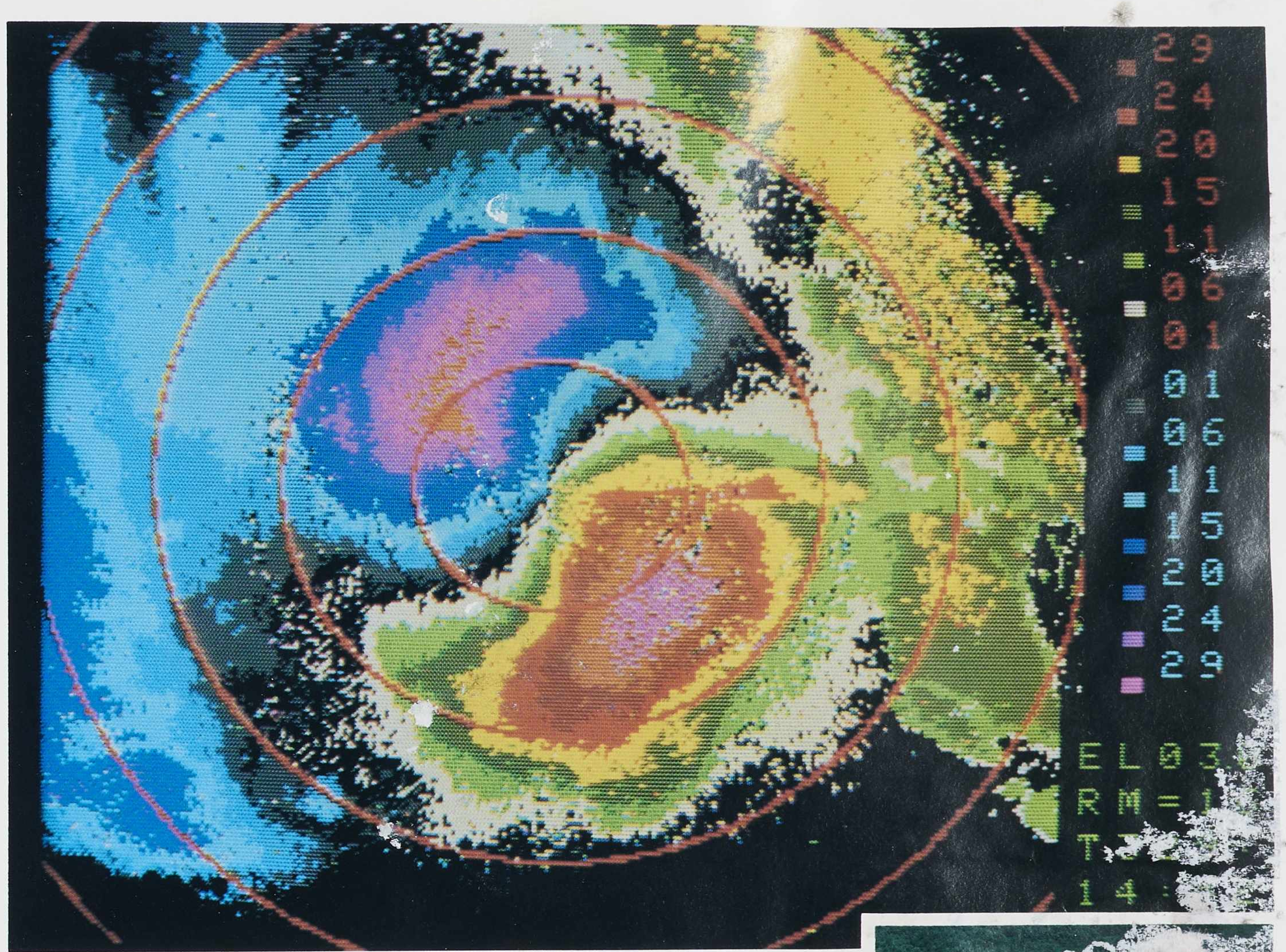
Precipitation, clouds, wind, lightning, and climate affect Air Force systems and operations on earth and in the lower atmosphere. The Air Force Geophysics Laboratory studies the basic physical processes of these events and develops sensing, modeling, and prediction techniques. It leads the Air Force in this area of atmospheric research.

Weather hazards can be remotely sensed by ground-based radars and by weather satellites. AFGL is actively engaged in both technologies. In association with the National Weather Service and the Federal Aviation Administration, AFGL is assisting in the development of the next generation Doppler weather radar (NEXRAD). Unlike conventional radar, a Doppler system can measure the speed of raindrops and ice crystals relative to the radar. Since these particles move with the wind, the Doppler radar measurement gives a fairly accurate measurement of wind speed toward, or away from, the radar. Early detection of such hazards as wind shear, tornadoes, and gust fronts thus becomes possible. AFGL produces algorithms for identifying, tracking, and predicting weather hazards and estimating their severity.

Polarization diversity radar techniques have also been developed to determine the size, shape, number and concentration of precipitation particles. These particles may attenuate signals from Air Force communication systems, damage airframes, and erode reentry vehicle nose cones.

Weather satellites provide indispensable information on storms and cloud formations worldwide. AFGL has





developed automated cloud-analysis programs for Air Force Global Weather Central. For the Tactical Air Forces, the Laboratory has designed a system combining a satellite platform and an unmanned air vehicle platform to collect weather observations within enemy-controlled areas. Tactical Decision Aids, which give battle planners estimates of maximum target detection and lock-on range of a variety of "smart" weapons under varying weather conditions, have been successfully tested.

The Laboratory does extensive computer modeling of weather elements to improve short-term and long-term weather forecasting. It also evaluates particular cases such as the "nuclear winter" scenario and the dispersion of toxic chemicals and other atmospheric debris. Cloud microphysics models simulate the growth of ice crystals, snowflakes, the melting of snow in the atmosphere, and the growth and evaporation of rain and cloud drops. These effects attenuate signals from Air Force communications and surveillance systems and contribute to aircraft icing.

The numerical simulation of global weather circulation patterns has added to the accuracy of weather forecasting. The Laboratory has developed a model of the global atmosphere called the "Global Spectral Model." Regional numerical weather prediction models have also been designed for cloud and moisture forecasts. These models have scale sizes on the order of an airfield and support operational air forces.

AFGL also provides research and development support to the Air Weather Service. The Air Force is planning to modernize its weather stations by installing interactive graphics terminals as part of an Automated Weather Distribution System. Laboratory meteorologists have developed interactive procedures to assist operations forecasters in using the Automated Weather Distribution System.

AFGL supported the National Oceanic and Atmospheric Administration in developing the Prototype Regional Observing and Forecasting Services (PROFS) program.

The Laboratory is responsible for revising MIL-STD-210B, "Climatic Extremes for Military Equipment," which provides climatic data for equipment being designed for use worldwide.

EARTH SCIENCES

To carry out its increasingly complex mission, the Air Force must acquire more information about Planet Earth. Its size, shape, rotation rate, gravity field, crustal motion, and orientation in space, all influence Air Force systems and operations. Irregularities in the rotation of the earth affect the accuracy of missiles, as does the pull of gravity along a missile's trajectory. Seismic tremors in the earth's crust near launch sites or air bases are potentially catastrophic.

To meet these needs, the Air Force Geophysics Laboratory conducts research and development programs in the accurate determination of gravity, positioning, and seismology.

Accurate gravity measurements are necessary for satellite tracking, inertial guidance of intercontinental ballistic missiles and cruise missiles, and inertial navigation of aircraft. A particularly important contributor to the improvement of missile accuracy is the accuracy of the launch region gravity model. Conventional gravity survey methods used for this task are labor-intensive, slow, and, in harsh areas, nearly impossible to implement. The Laboratory is therefore developing a Gravity Gradiometer Surveying System to measure gravity from an airplane or a moving land vehicle, with accuracy comparable to ground survey methods but with greater economy and speed.

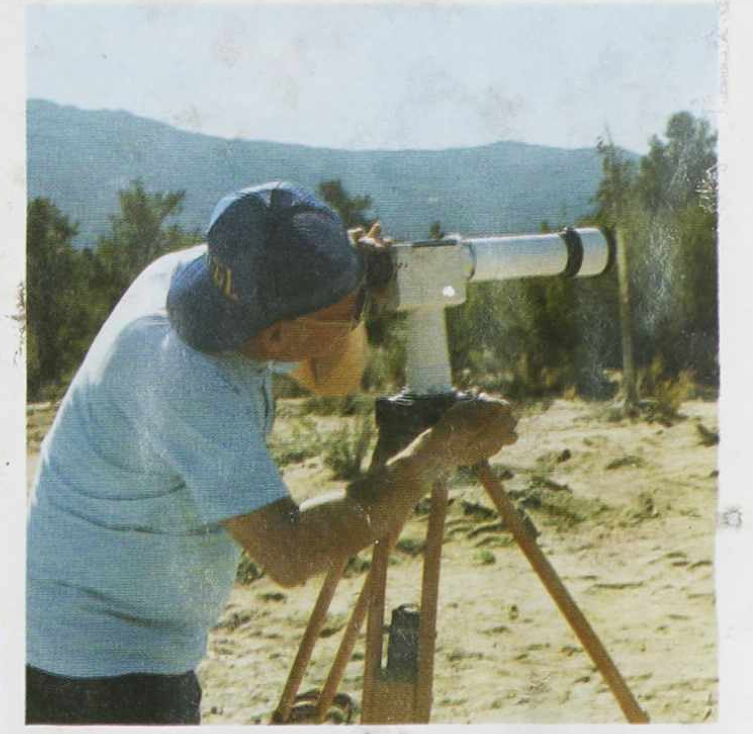
In addition, the Air Force needs precise estimates of gravity at high altitudes above missile launch areas. Estimates derived from upward projection of surface measurements or downward projection of satellite measurements are suspect and require validation by direct measurement. The Laboratory is measuring gravity directly from balloons instrumented with gravity meters. These measurements may improve the accuracies of intercontinental ballistic missiles or submarine-launched ballistic missiles.

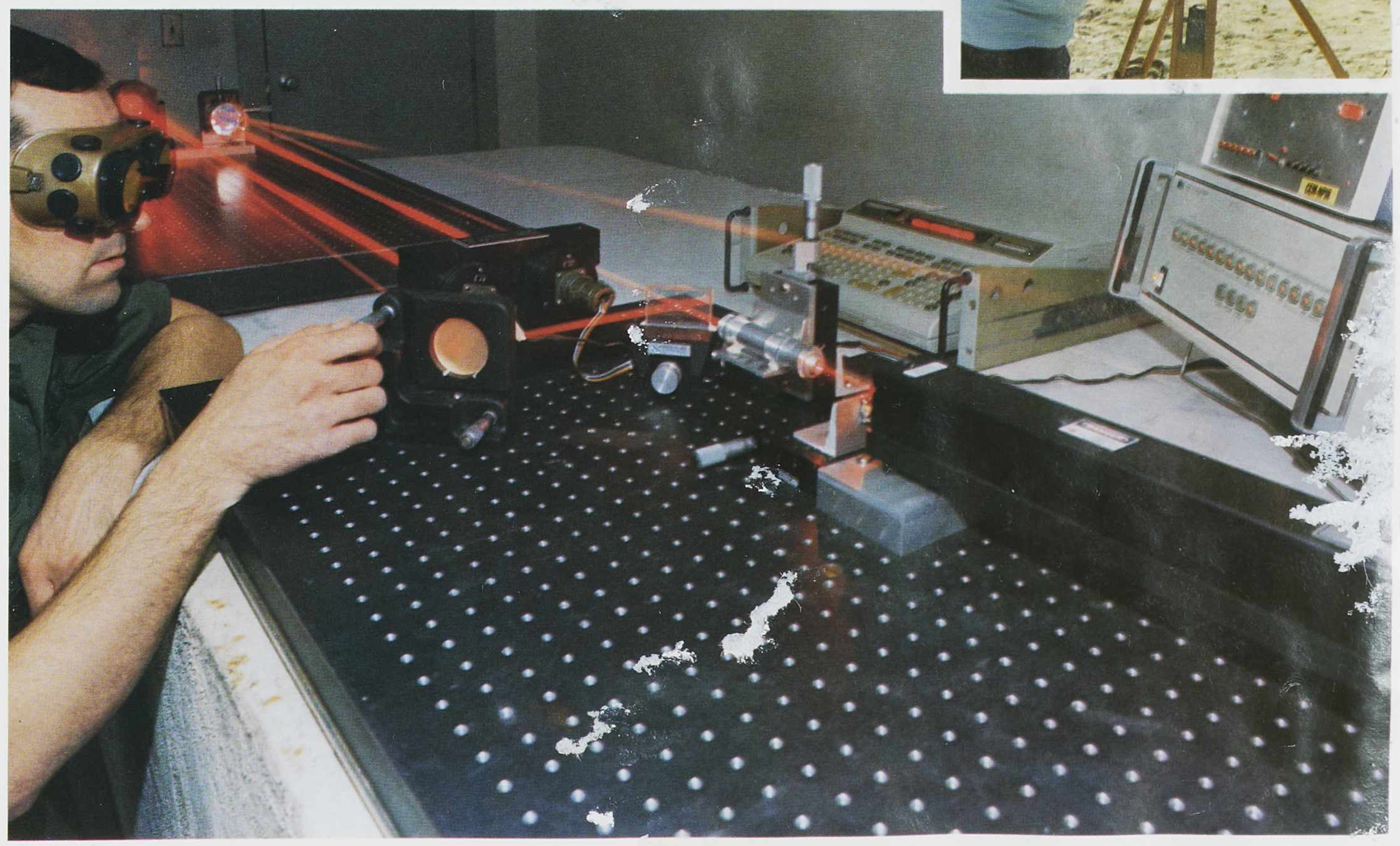
AFGL has demonstrated that precise positioning, as well as earth rotation rate and polar motion, can be determined by radio interferometric methods. The Laboratory has pioneered the use of satellite signals from the Global Positioning System to achieve highly accurate positioning and baseline measurement with portable radio receivers. Position location uncertainty is essential to the basing integrity of advanced intercontinental ballistic missiles. As an additional benefit, we are demonstrating that these receivers, when operated with hydrogen maser frequency standards, can be used to derive satellite orbital parameters with unprecedented location accuracy.

In the event of conflict, seismological techniques will permit the assessment of damage inflicted by opposing missiles and the maintenance of communications and the integrity of missile egress from underground silos.

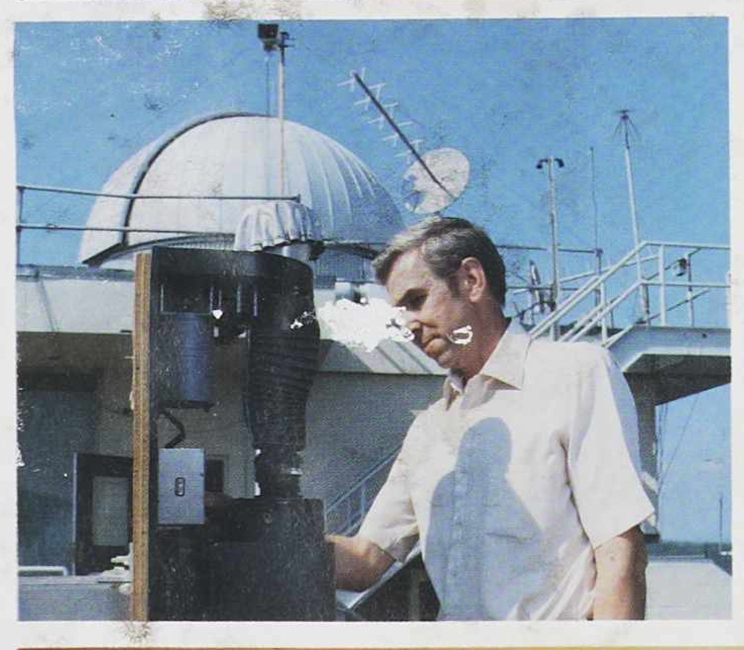
AFGL seismologists also oversee research in support of the Comprehensive Nuclear Test Ban Treaty for the Air Force Technical Applications Center. The research focuses on discriminating between nuclear explosions and earthquakes, event location, and yield estimates.

Motion effects can adversely influence the operational capabilities of Air Force equipment and facilities. To ensure the structural integrity of ground-support facilities for shuttle launches from Vandenberg AFB, the Laboratory first monitored the vibroacoustic environment at Kennedy Space Center and determined the shuttle launch source characteristics. The motion-response characteristics of the major Vandenberg ground-support structures were then established. With these data, Laboratory scientists were able to forecast the vibroacoustic environment that can be expected from an actual shuttle launch at Vandenberg. Vibroacoustic data acquisition systems developed at the Laboratory were used in both the Kennedy and Vandenberg studies.





AEROSPACE ENGINEERING



Scientists and engineers collaborate closely to probe the environment in which Air Force systems operate. Experimental payloads are carried aloft on balloons, rockets, satellites, and the shuttle. The Air Force Geophysics Laboratory conducts a technology base program in payload design, telemetry, tracking, command and recovery systems, and data-handling techniques.

AFGL has launched more than a thousand rockets since 1946, many from the White Sands Missile Range. Auroral payloads are launched from the Poker Flat Research Range, Alaska. The Laboratory maintains a permanent balloon-launch facility at Holloman AFB, operating primarily within the White Sands Missile Range. Mobile facilities also permit rocket and balloon launchings as needed anywhere in the world. A new Payload Verification and Integration Facility at the Laboratory's headquarters provides for environmental and structural testing of balloon, rocket, and spacecraft payloads.

The Laboratory flies both free and tethered balloons, or aerostats. Free balloon systems rise slowly, at 800–900 feet per minute, and can stay aloft for hours or even days, reaching altitudes of over 150,000 feet. Planetary probes released from balloons can be tested in the stratosphere. The descent speeds and decelerations that NASA's Galileo probe will encounter on Jupiter were simulated from 97,000 feet above the White Sands Missile Range. In cooperation with the Rome Air Development Center, AFGL developed for the Defense Communications Agency a high-powered antenna as an integral part of the 3,000 foot tether cable on an aerostat. It could reconstitute low frequency and very low frequency communications among strategic forces.

A Laboratory capability is under development to provide a simple, quick-response support system to allow our scientists to use the inexpensive "Get-Away-Special" canister for simple shuttle experiments.

RESEARCH FACILITIES

The Research Library of the Air Force Geophysics Laboratory is internationally recognized for the excellence of its geophysics collections. It has the largest and most comprehensive scientific and technical research collection in the Air Force, including extensive holdings in mathematics, chemistry, physics, astrophysics, electronics, and geophysics. Each year the library adds more than 2,500 new titles to the book collection. The library also subscribes to approximately 1,800 current periodical titles. Of these, approximately 4,000 volumes are bound each year and added to the permanent collection.

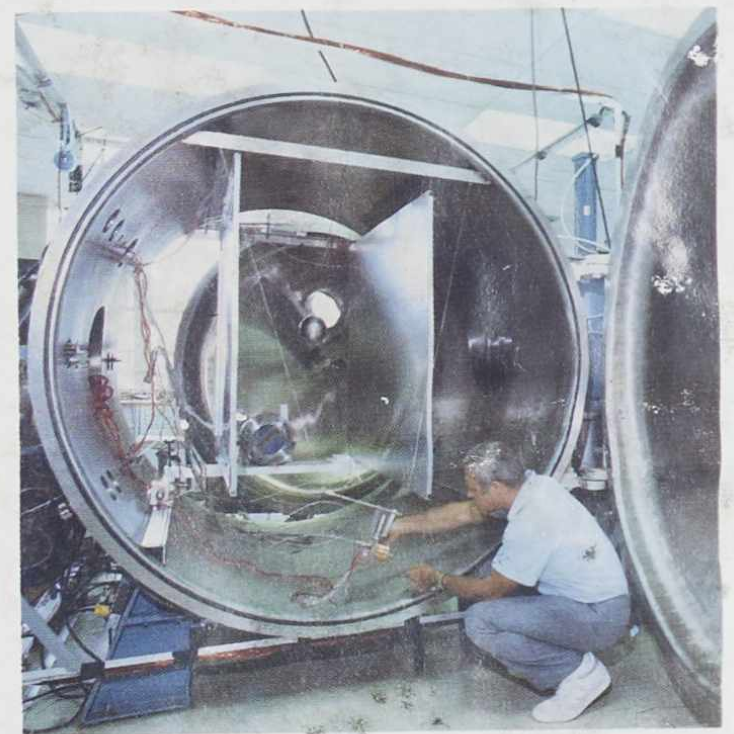
The library also offers computer-aided literature searches of the Defense Technical Information Center's (DTIC) several files, as well as many commercially available data bases. Patrons thus have immediate access to millions of citations from journals, books, reports, proceedings, and reviews published throughout the world.

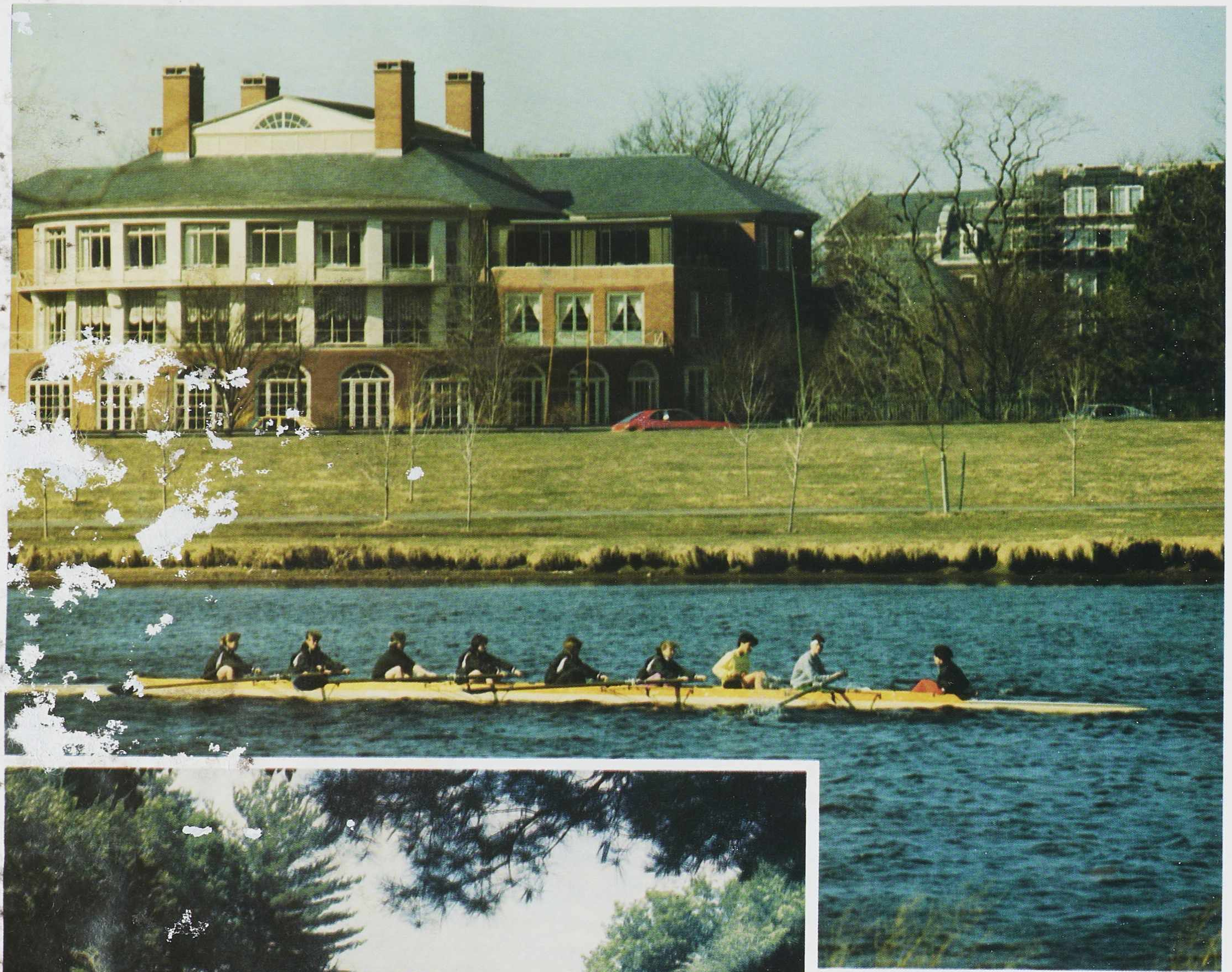
AFGL has implemented an integrated distributed data-processing system, providing the Laboratory's users with optimum computer capability. The system consists of a broadband local area network interconnecting a large-scale scientific processor (CDC Cyber 180–860), a medium-scale virtual memory machine (VAX-11/780), laboratory data acquisition and control systems and subnets, over 350 terminals (intelligent and basic interactive), office automation, and mass storage facilities. Additionally, there are numerous high-speed graphic displays, printers, plotters, and microfiche systems, with general purpose and unique software to support a variety of technical requirements. Acquisition of a high-performance scientific processor with a capability of 400 million floating point operations per second (megaflops) is in the planning stage for the near future.

AFGL has recently opened a new Payload Verification and Integration Facility, a major test facility for the space age. Its high bay area (100 feet by 48 feet) can test payloads 25 feet in length or height and weighing 10,000 pounds. A clean room provides a dust-free environment in which sophisticated space instruments can be assembled. For three-axis vibration testing, the facility has an 8,000 force pound shaker (a 30,000 force pound shaker will be installed in the near future). Attached to the high bay area is a two-story building housing a telemetry ground station, a machine shop, a laboratory for thermal-vacuum and thermal-cycling component acceptance testing, and an equipment pool.

To simulate space environments in the laboratory, AFGL has a number of six-foot vacuum chambers, the largest of which is 6 by 9 feet. The unique feature of this chamber is a reaction cell which can be evacuated and cooled to 20° above absolute zero, thus creating the "wall-less" conditions of space. Gases injected into the cell are excited by microwave discharges and mixed with inert gases to produce infrared radiation. An infrared spectrometer gives data which indicate the best viewing frequencies for Air Force satellite detectors.

AFGL can also simulate a nuclear-perturbed atmosphere by using a laser to create a plasma inside a cell. This facility produced the first spectra of neutral oxygen emission in the infrared.





LIVING IN THE HUB

The Air Force Geophysics Laboratory, located at Hanscom Air Force Base, is seventeen miles west of Boston, the Hub of New England. The area offers easy access to excellence in a wide variety of educational, cultural, and historical institutions and recreational facilities.

Greater Boston alone has over 70 universities and colleges. AFGL staff participate in seminars at Harvard University, the Massachusetts Institute of Technology, Boston University, and Boston College. Opportunities for continuing education at these institutions, or many even closer to the Laboratory, abound.

Music in Boston appeals to all tastes, from the Boston Symphony Orchestra, the Boston Pops, and the Opera Company of Boston to the Globe Jazz Festival. The New England Conservatory of Music, the Berklee College of Music, and many community music schools sponsor concerts for the public. Boston also attracts many international artists and touring groups.

Broadway shows come to Boston's three legitimate theatres. The American Repertory Theatre is in residence at the Loeb Drama Center at Harvard University. Experimental plays may be seen at many small theatres throughout the city. Local colleges and universities also sponsor theatrical productions such as the Tufts Arena Theatre and the Spingold Theatre at Brandeis University.

The collections at the Museum of Fine Arts, the Gardner, the Fogg, and the many collegiate art museums in the area make Boston one of the nation's "show places."

The Museum of Science and the museums at Harvard University and the Massachusetts Institute of Technology offer viewers insights into the development of contemporary science.

Hanscom AFB lies at the juncture of the four historic towns that touched off the American Revolution: Lexington, Concord, Bedford, and Lincoln. Revolutionary battlefields are close at hand. Many of the original taverns, houses, and churches in these towns are open to the public. The homes of such nineteenth century literary giants as Thoreau, Emerson, Hawthorne, and Alcott may be visited in Concord.

For the sports enthusiast, Boston offers basketball with the Celtics, hockey with the Bruins, football with the Patriots, and baseball with the Red Sox. Intercollegiate athletic contests in these sports and rowing attract many followers.

Swimming, sailing, fishing, skiing, and hiking may all be enjoyed within easy commuting distance from the Laboratory.

The Air Force Geophysics Laboratory, with forty years' experience in environmental research, is uniquely qualified to support the expanding Air Force mission. We help system designers and battlefield commanders overcome environmental limits and achieve the full potential of advanced technology. Our staff is dedicated to serve the nation's interests at the frontiers of science.

To obtain additional information or support, call or write:

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