SAND 94-0862

Overview of Sandia National Laboratories and Antenna Development Department

by

Billy C. Brock

Abstract

General overview of Sandia National Laboratories and the Antenna Development Department

This work was supported by the
United States Department of Energy
under Contract DE-AC04-94AL85000

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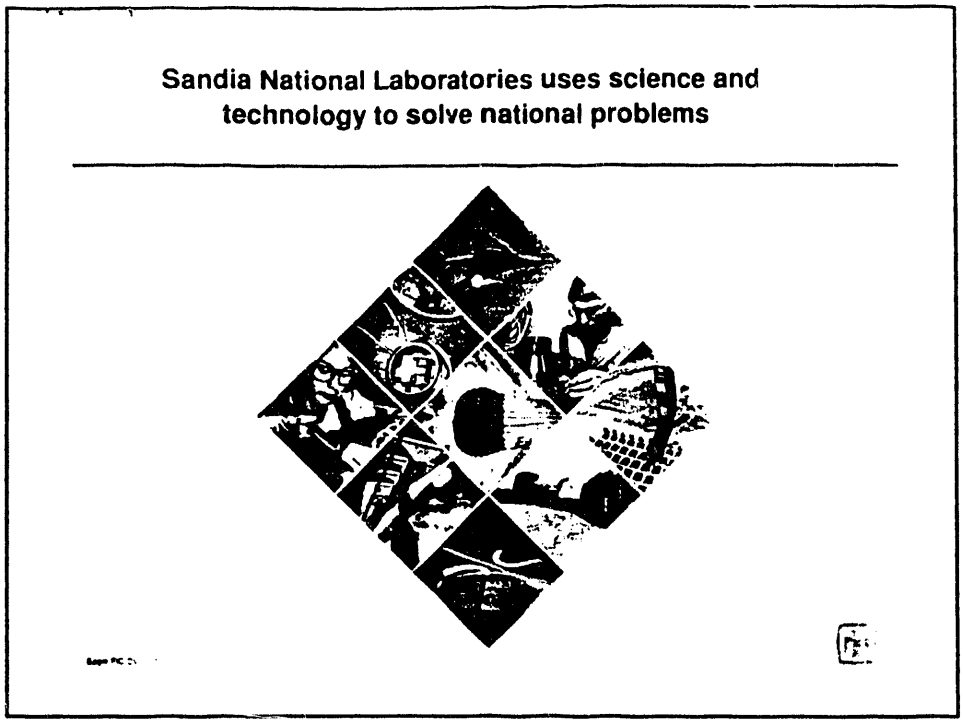
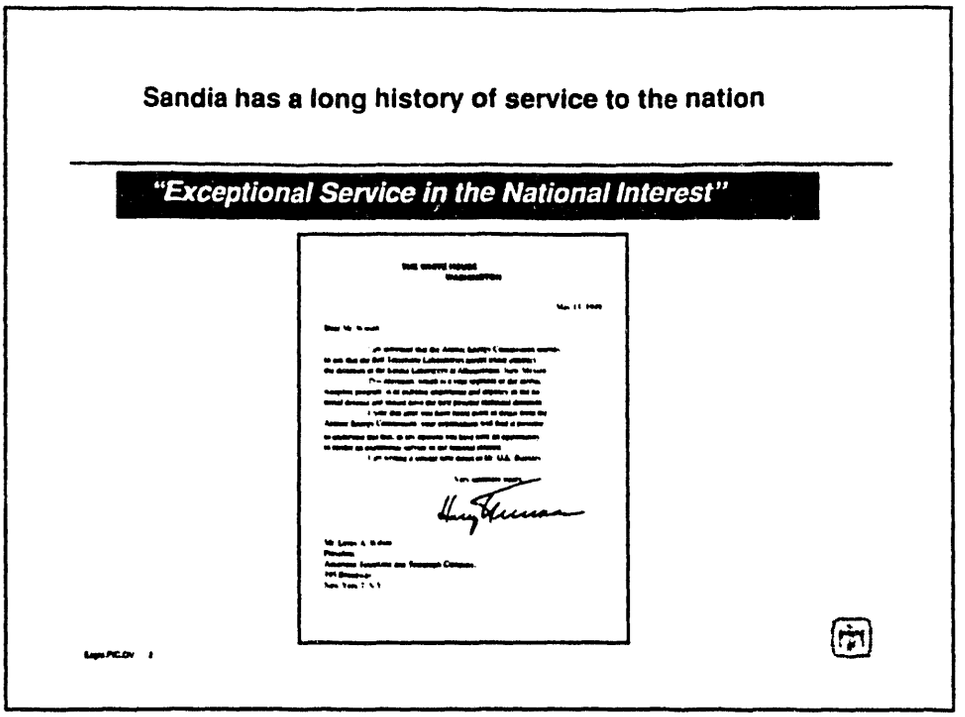


Sandia National Laboratories uses science and technology to solve national problems

- It is operated by Sandia Corporation, which was a wholly owned subsidiary of AT&T from 1949 to 1993
- Sandia is a multiprogram R&D laboratory
- Sandia has important nuclear weapon stewardship responsibilities
- Sandia carries a project from Research to Development to Application to solve problems in the national interest

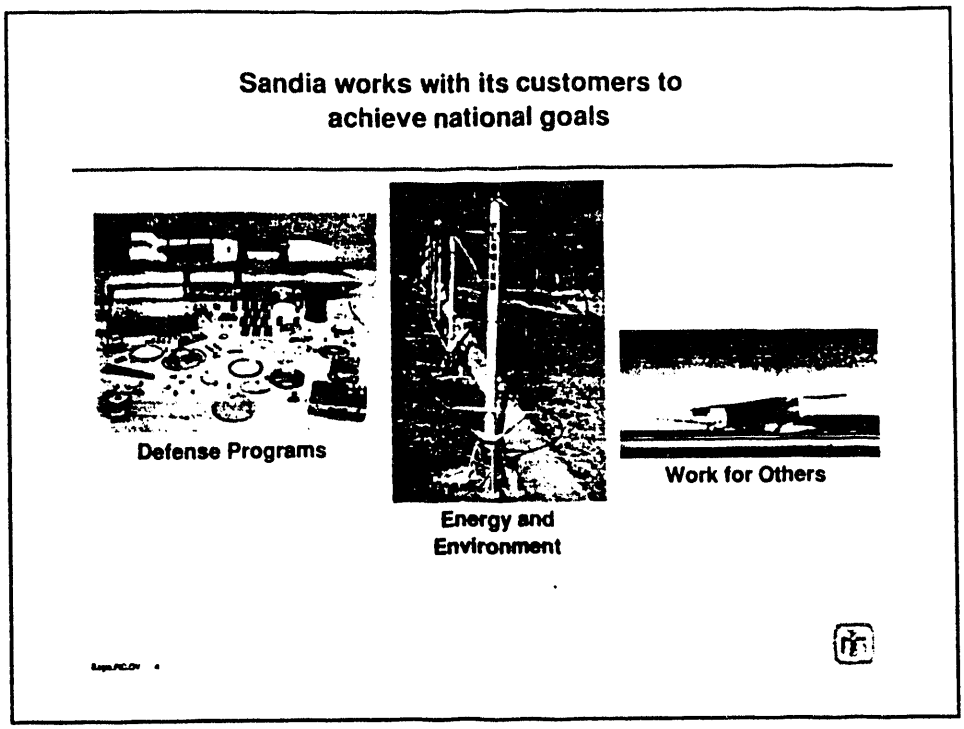
Photos (clockwise from top, center last):

- An instrumented B83 bomb in a parachute dropped from a B-1B bomber; a Sandian preparing a turbine disc on a robotic deburring system; the heliostat field and receiver tower at the National Solar Thermal Test Facility; the RATLER robot that can negotiate extremely rugged or interplanetary surfaces; ultraviolet laser beams used to study a methane-air flame at the Combustion Research Facility in California; a Z rocket at Sandia's launch facility on Kauai; a Sandian injecting polyurethane into a closed aluminum mold; a silicon chip that can detect a variety of chemicals; and a color schlieren photograph showing the shock wave in the flow field around a ribbon parachute in a wind tunnel



Sandia has a long history of service to the nation

- Established in 1949
  - — Strategic intent born on May 13, 1949 in letter from President Truman that called for "exceptional service in the national interest"
  - — Original mission: Nuclear weapon engineering
- Modeled after AT&T Bell Laboratories
  - — Science and technology with strong mission focus
  - — Good corporate citizen with extensive state and local outreach activities
- In 1973, we became a multiprogram R&D laboratory; in 1979 we became a DOE National Laboratory, with responsibilities in
  - — Defense
  - — Energy and Environment
- In 1989, the National Competitiveness Technology Transfer Act added another responsibility
  - — Contributions to industrial competitiveness
- National priorities and expectations are changing, with increasing emphasis on private sector teaming

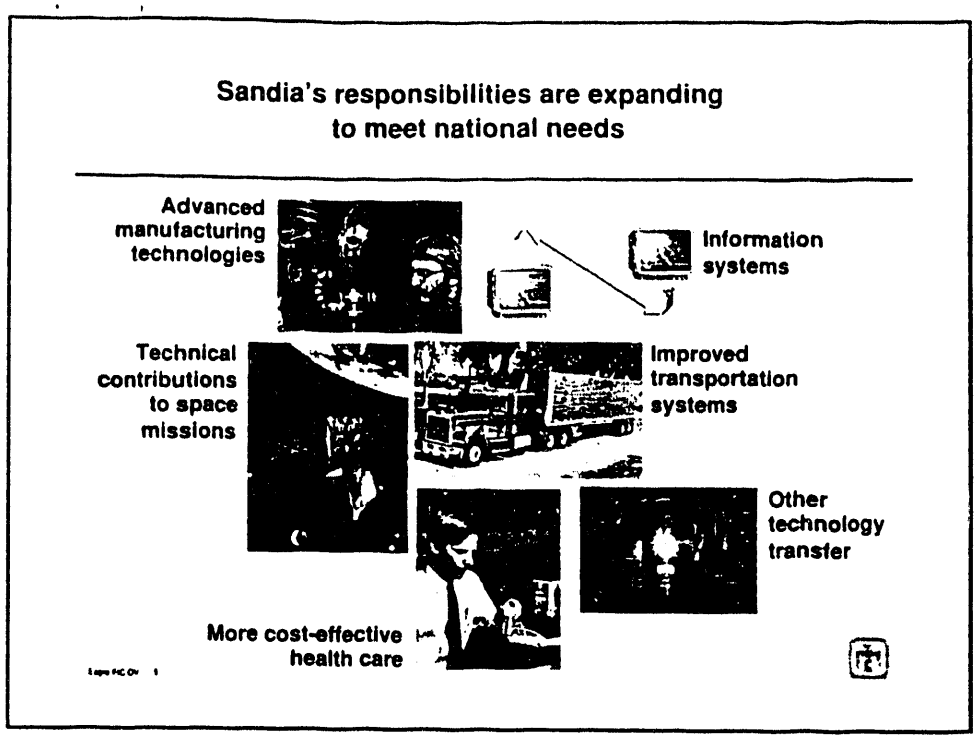


Sandia works with its customers to achieve national goals

- Defense Programs (DOE, DoD)
  - — Nuclear weapon stockpile stewardship
  - — New approaches to weapon production
  - — Arms control, non-proliferation, and intelligence
  - — Photo: B83 strategic bomb laid out with parts

- Energy and Environment (DOE, NRC)
  - — Efficient, safe, environmentally compatible energy conversion and utilization
  - — Waste management solutions
  - — Photo: Vertical-axis wind turbines

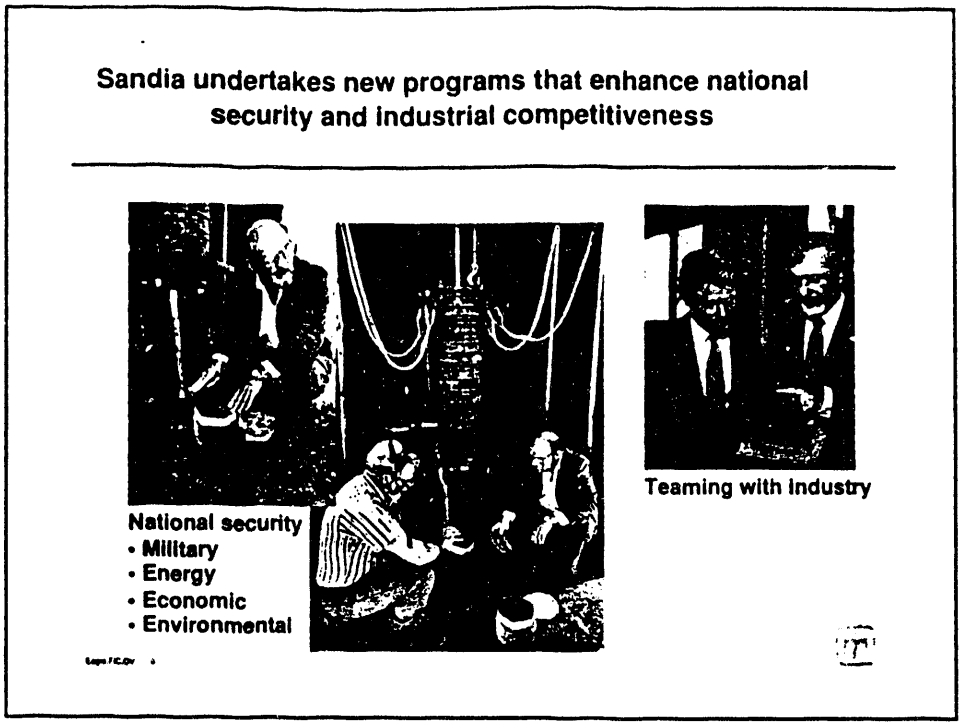
- Work for others
  - — R&D for other government agencies (DoD, NSA, etc.)
  - — Photo: Rocket sled test



Sandia's responsibilities are expanding to meet national needs

Sandia is making contributions to the global competitiveness of US industries through partnerships in

- Advanced manufacturing technologies
  - — Sandia's Center for Advanced Manufacturing Technology
  - — Other major support facilities are the Integrated Manufacturing Technologies Laboratory in California, the Process Development Lab, Microelectronics Lab, CSRL, IMRL, RMS&EL, Microelectronics Quality/Reliability Center
  - — Participant in the Agile Manufacturing Enterprise Forum
- Improved transportation systems
- Technical contributions to space missions
- More cost-effective health care
- Information systems
- Other technology transfer
  - — Sandia signed 62 Cooperative Research and Development Agreements with industry in the first year alone, representing a total investment of $147 million
- Photos (counterclockwise from top left): Edge-finishing robot; Global Positioning Satellite; non-invasive glucose monitor; FASTCAST computerized investment casting process; Safe, Secure Transport; and concurrent engineering



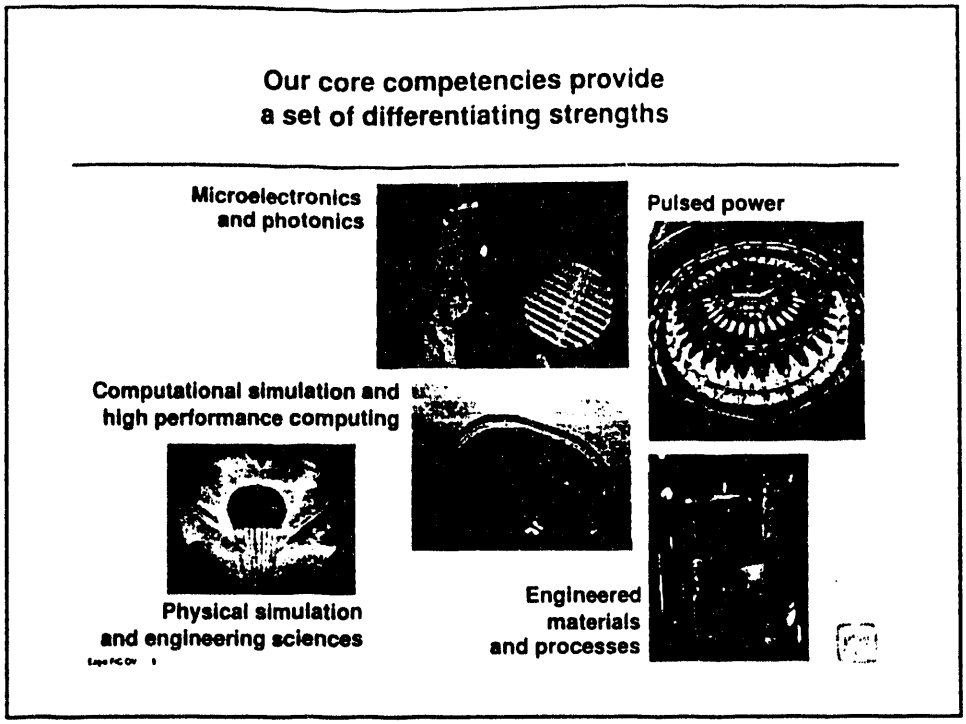
Sandia undertakes new programs that enhance national security and industrial competitiveness

We have developed a set of priorities for undertaking new programs based on national security (military, energy, economic, environmental) and teaming with industry. These priorities enable us to

- Respond rapidly to national emergencies (such as the Persian Gulf conflict)
- Build on and strengthen Sandia's core competencies and other essential Laboratory capabilities
- Proactively help customers invent their future
- Provide strategic teaming opportunities with industry and universities
- Create Sandia program synergies

Our commitment is to build on the achievements of Sandia's past with increased customer focus

Photos: Sandia researchers (left and center) conduct USS Iowa investigation to determine likely cause of explosion; a not-yet-elected President Bill Clinton (right) receives a printed circuit board made with environmentally friendly manufacturing technology from Sandia President Al Narath

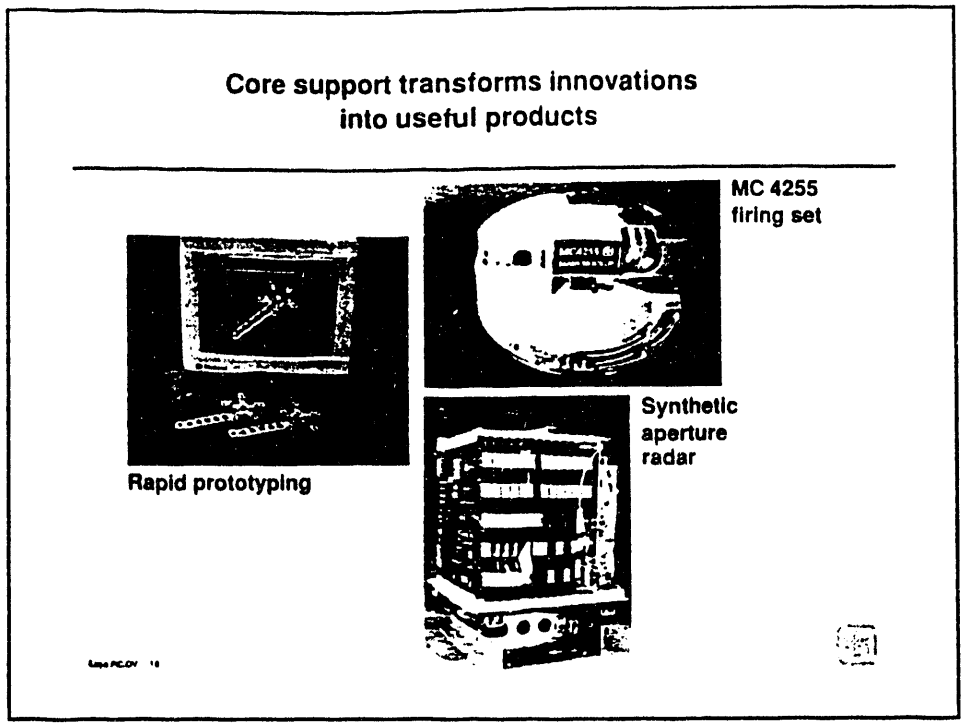


Our core competencies provide a set of differentiating strengths

Diversification has provided a "real-world" experience base in a variety of key areas known as core competencies

- Microelectronics and Photonics. Photo: A Sandian displays a wafer of semiconductor chips manufactured in the Microelectronics Development Laboratory
- Computational Simulation and High Performance Computing. Photo: Magnetic resonance imaging shows a slice of the human brain
- Physical Simulation and Engineering Sciences. Photo: Shock wave structure in the flow field surrounds an 18-inch-diameter model of a ribbon parachute at Mach 1.9 in a NASA wind tunnel
- Engineered Materials and Processes. Photo: Experiment examines chemical vapor deposition (CVD) process
- Pulsed Power. Photo: Sandia's Particle Beam Fusion Accelerator runs an experiment aimed at achieving fusion, the energy that powers the sun, in the laboratory

These core competencies are the distinguishing integration of skills, technologies, knowledge, and facilities used by Sandia to achieve its strategic goals and objectives. Core competencies take us beyond science to solutions. They form the basis for much of Sandia's work with industry



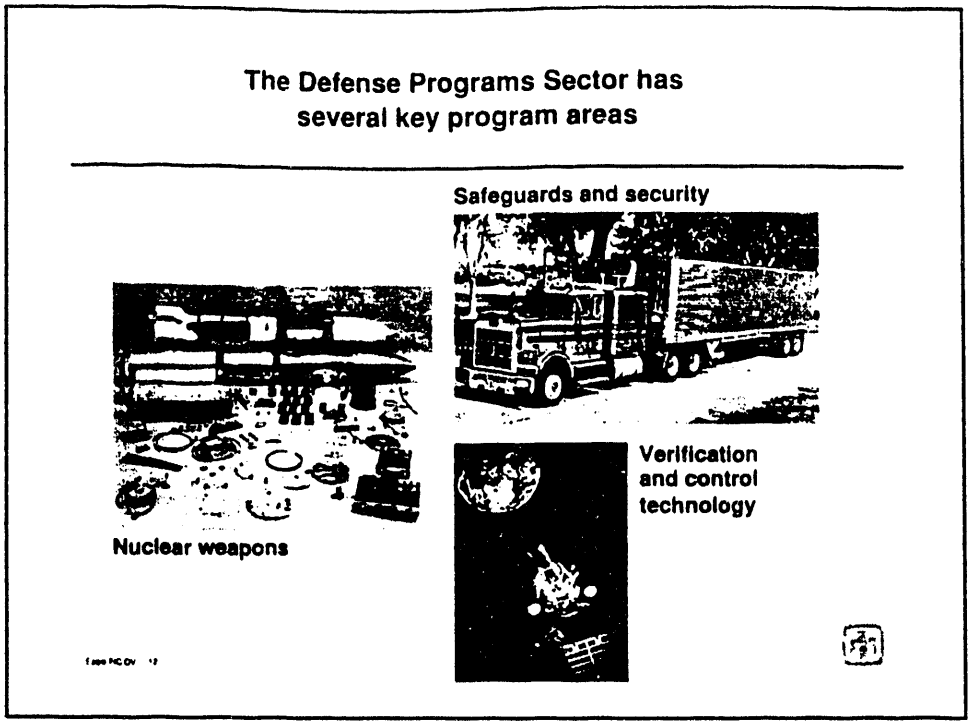
Core support transforms innovations into useful products

Examples:

- Rapid prototyping
  - — Defense Programs (nuclear weapons complex reconfiguration)
  - — Work for Others (space applications)
  - — Energy and Environment (environmentally conscious manufacturing)

- MC 4255 firing set
  - — Defense Programs (W 91/MAST)
  - — Work for Others (conventional weapons)
  - — Energy and Environment (precisely timed blasting)

- Synthetic aperture radar
  - — Defense Programs (guidance & navigation)
  - — Work for Others (reconnaissance/targeting)
  - — Energy and Environment (oil spill mapping)

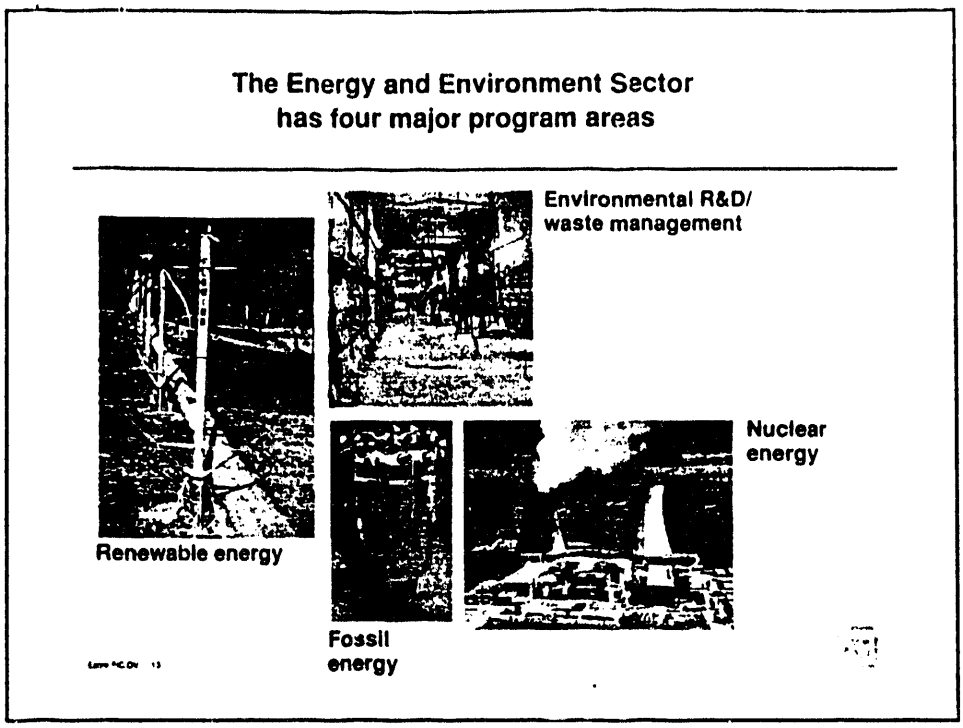


The Defense Programs Sector has several key program areas

- Nuclear Weapons. Photo: B83 bomb laid out with parts
- Safeguards and Security. Photo: Safe, Secure Transport
- Verification and Control Technology. Photo: VELA satellite
  Our primary mission is the "weaponization" of nuclear explosives
- Design, engineering, testing, integration, and production interface for non-nuclear components
- "Cradle-to-grave" responsibility for US nuclear weapons
- Defense programs are a significant fraction of the laboratories' activities, and accounted for $747.2 million of taxpayer investment in 1992

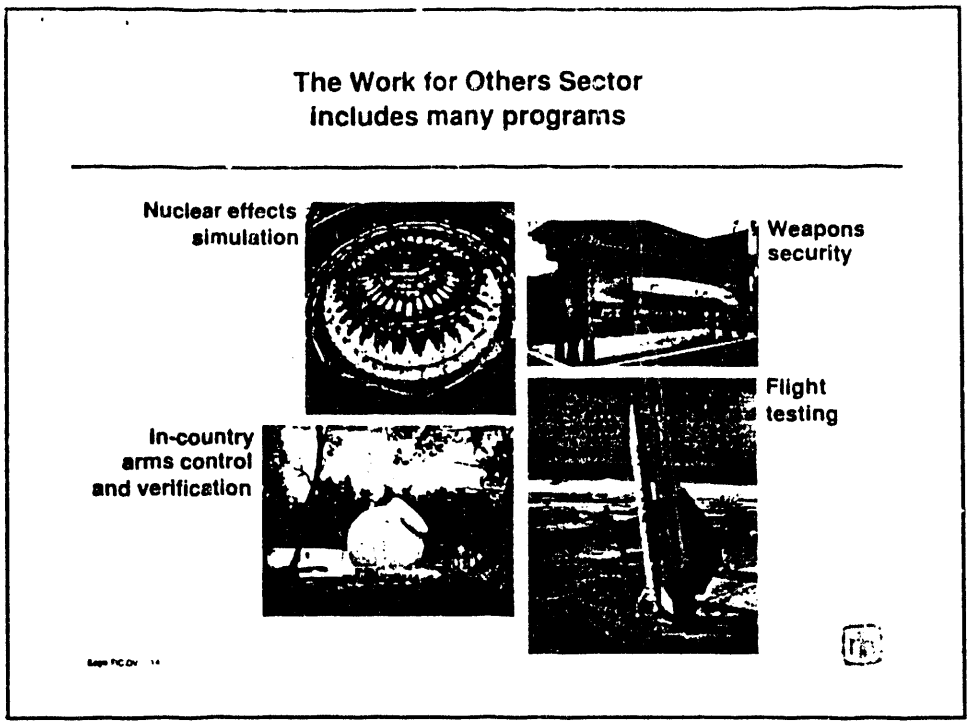
Sandia has 30 years of experience in arms control, treaty verification, and proliferation detection

- Satellite and seismic nuclear burst monitoring
- Safeguards for the non-proliferation treaty
- Continuous monitoring systems and technologies for INF and START
- Data fusion and technical analysis of information from technical sensors and other sources



The Energy and Environment Sector has four major program areas

- Renewable Energy. Photo: Vertical-axis wind turbines
  - — Photovoltaic. solar thermal, wind energy
- Fossil Energy. Photo: Polycrystalline diamond drill bits designed at Sandia, now in widespread use
  - — Technical collaboration with industry
- Nuclear Energy. Photo: Nuclear reactors
  - — Implementation of safe, efficient nuclear power systems
- Environmental R&D Waste Management. Photo: Cavern at Waste Isolation Pilot Plant
  - — Restoration of existing environmental problems, minimization of future impacts, hazardous material transportation
  - — Ties with industry, international technology exchange
  - — Nuclear waste management (WIPP, Yucca Mountain, NTS)
- Funding for Energy & Environment Sector programs is on the increase, and totaled $262 million in 1992



The Work for Others Sector includes many programs

The Work for Others Sector includes many programs that make Sandia's unique capabilities and facilities available to federal agencies and non-federal entities

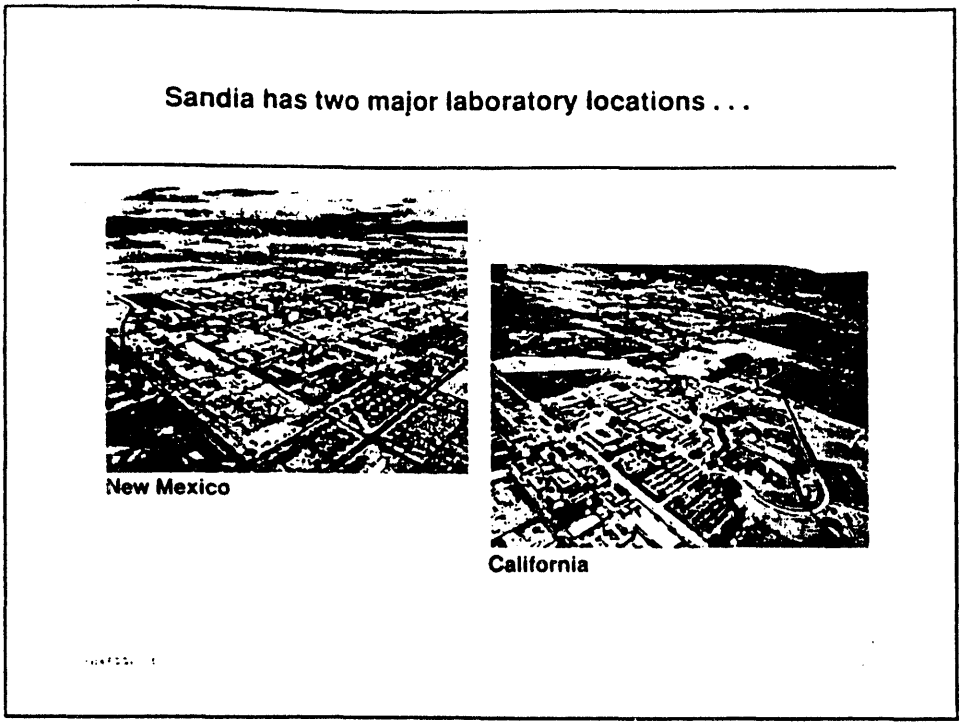
- Nuclear Effects Simulation. Photo: Particle Beam Fusion Accelerator
- In-Country Arms Control and Verification. Photo: Unmanned seismic stations (installed throughout US and Canada)
- Weapons Security.
  Photo: Weapons storage vault (protection from small-arms fire)
- Flight Testing. Photo: Strypi rocket launch at Kauai
- Arming, Fuzing, Firing Systems
- Advanced Chemical Munitions

Customers include

- DoD (75 percent of funding in this sector)
- Air Force, Navy, Army, NRC, DNA, DARPA, and others
- Reimbursable projects totaled $359 million in 1992

Technologies

- Aerospace systems
- Precision strike technology
- Remote sensing and verification
- Development testing of new systems



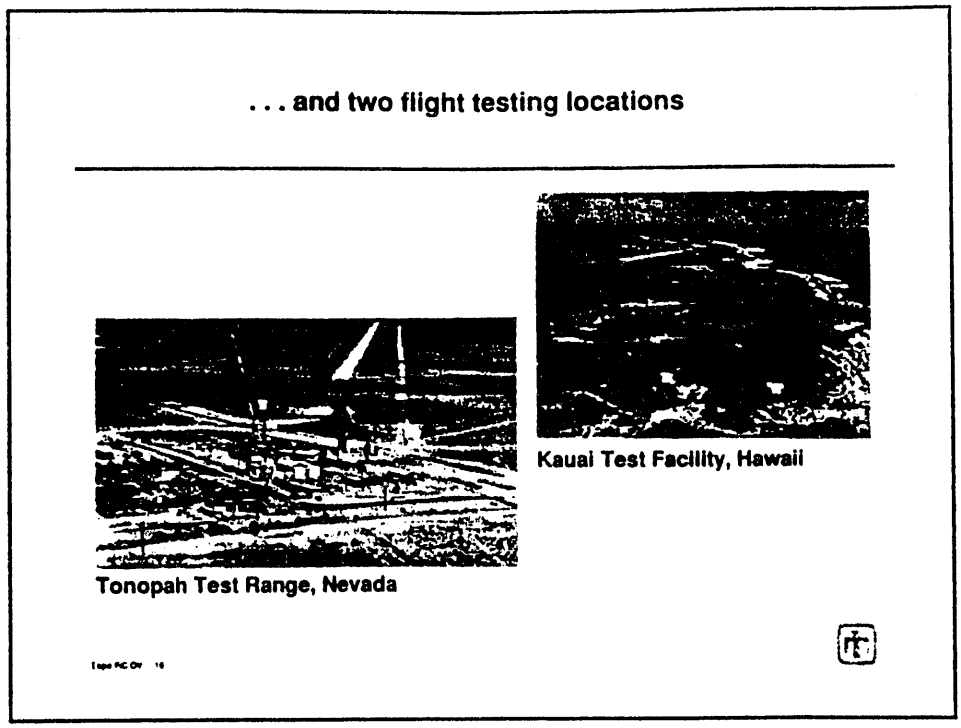
Sandia has two major laboratory locations . . .

- Sandia/New Mexico
  - — On Kirtland Air Force Base, southeast of Albuquerque
  - — 17,750 acres, 556 major buildings, 4.6 million gross square feet
  - — $1.1 billion US government investment
  - — 7,400 employees

- Sandia/California
  - — In Livermore, 40 miles east of San Francisco
  - — 413 acres. 58 major buildings, 710,000 gross square feet
  - — $265 million US government investment
  - — 1,000 employees

Sandia's unique facilities are a national resource

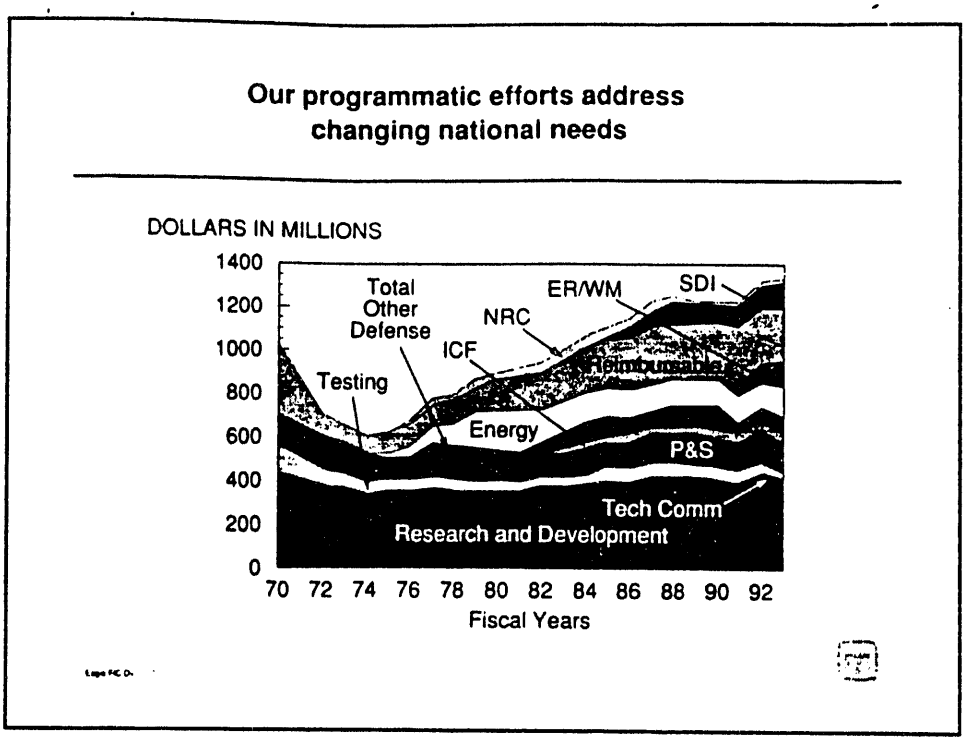
- Pulsed power accelerators, reactor facilities
- Computing facilities. robotics labs
- Solar thermal facilities. environmental and field test facilities
- Combustion Research Facility
- Semiconductor materials facilities



. . . and two flight testing locations

- Tonopah Test Range, Nevada
  - — On Nellis AFB
  - — 525 square miles, 98 major buildings, 159,000 gross square feet
  - — $85 million US government investment
  - — 50 employees

- Kauai Test Facility, Hawaii
  - — On Navy Pacific Missile Range
  - — 275 acres, 25 major buildings, 41,000 gross square feet
  - — $30 million US government investment
  - — 5 employees



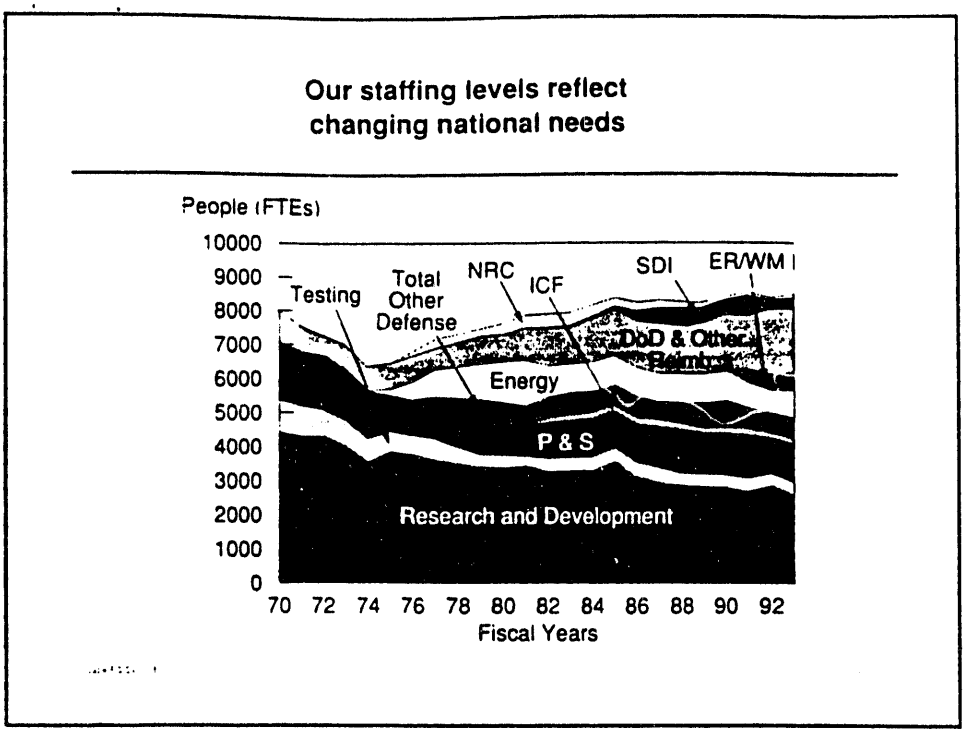
Our programmatic efforts address changing national needs

Our programmatic efforts address changing national needs in

- Energy
- Defense
- Production and surveillance
- Testing
- Inertial confinement fusion
- Research and development

Abbreviations:

NRC	Nuclear Regulatory Commission
ICF	Inertial Confinement Fusion
SDI	Strategic Defense Initiative
P&S	Production and Surveillance
Tech Comm	Technology Commercialization
ER/WM	Environmental Restoration/Waste Management



Our staffing levels reflect changing national needs

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- Energy
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Abbreviations:

NRC	Nuclear Regulatory Commission
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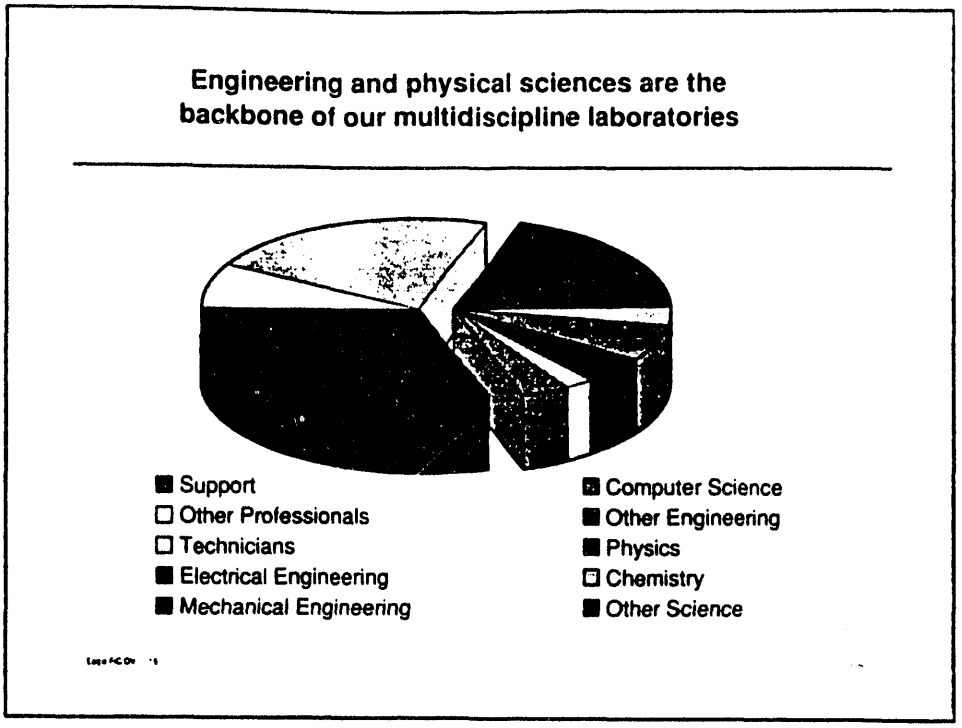
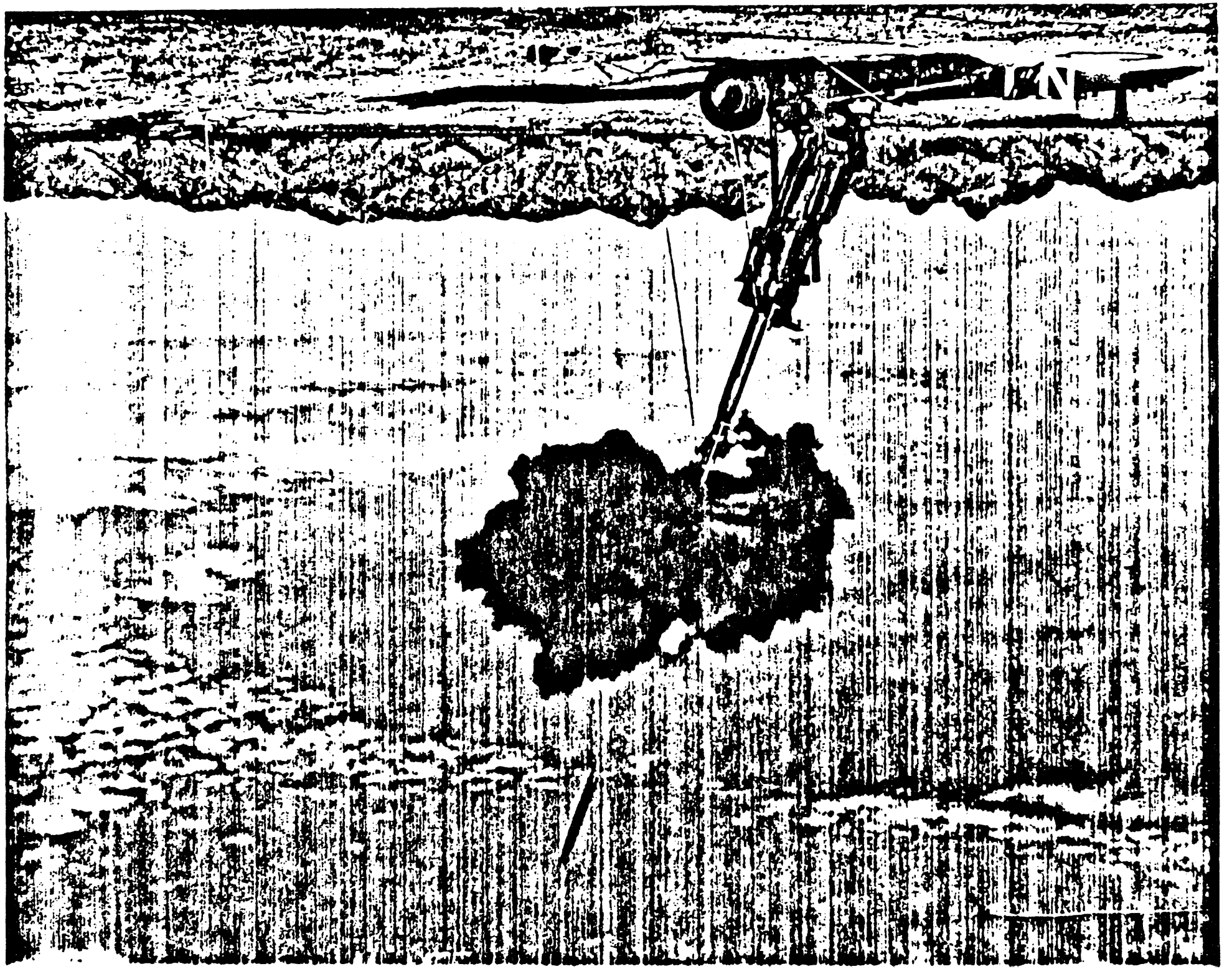
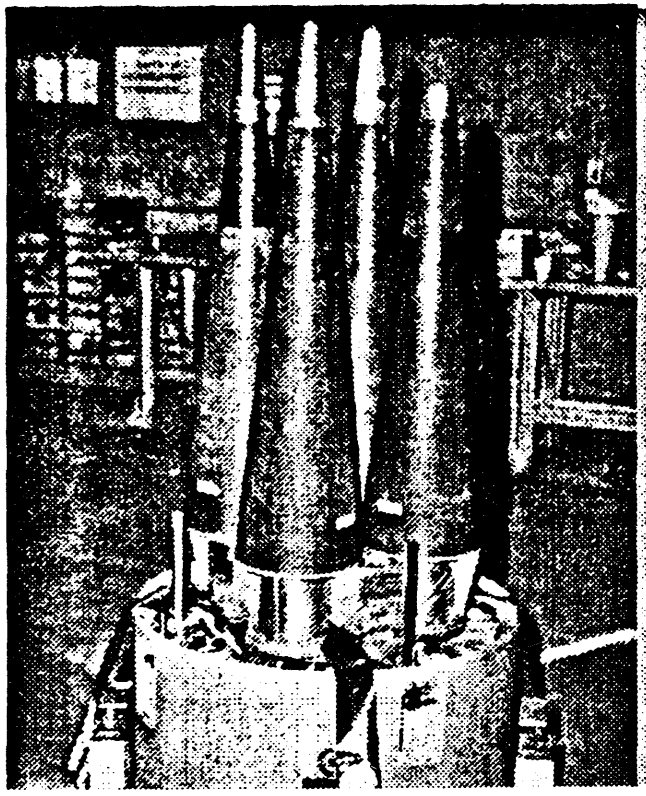


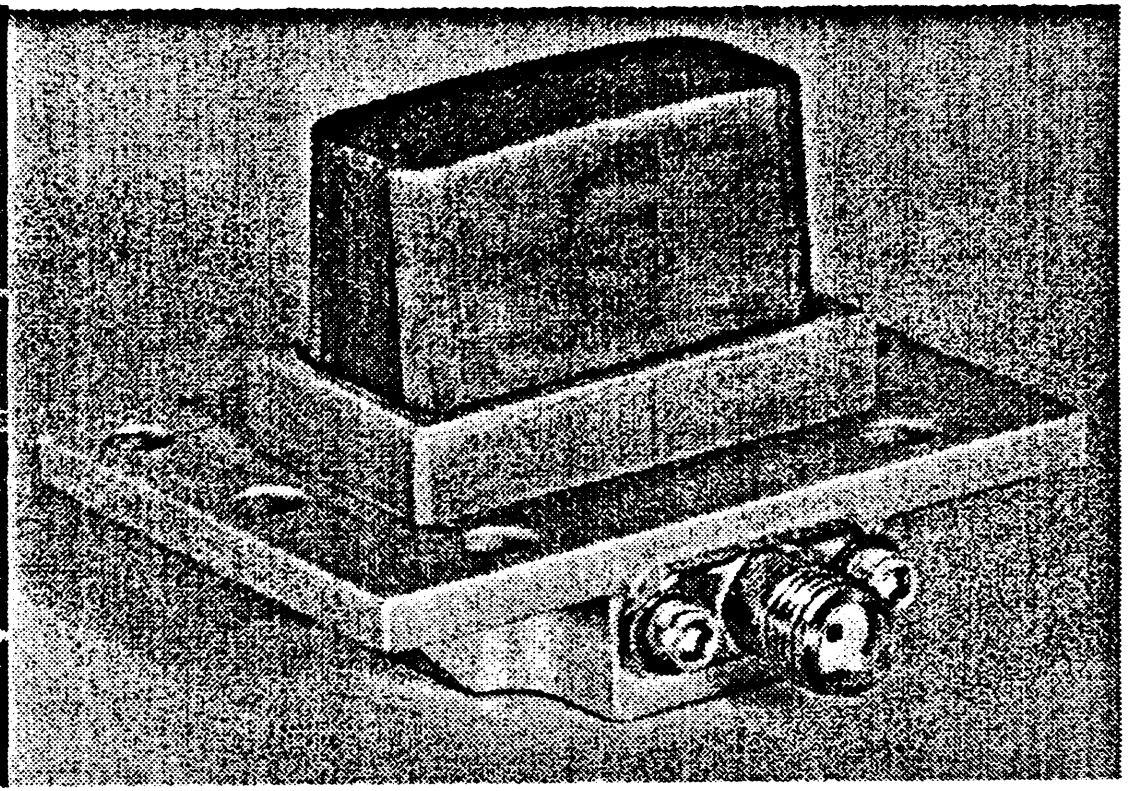
Engineering and physical sciences are the backbone of our multidiscipline laboratories

- Our technical professionals have predominantly advanced degrees in engineering and science
- More than three-fourths of our 3,676 technical professionals hold master's degrees or doctorates in their fields (43% Masters, 37% PhD)
- More than half of our technical professionals are engineers
- Technical professionals make up 43 percent of our work force, technical associates 20 percent, administrative professionals 11 percent, management associates 8 percent, and represented employees 18 percent (not including 1,632 on-site contractors)
- Our 915 administrative professionals have predominantly advanced degrees in business

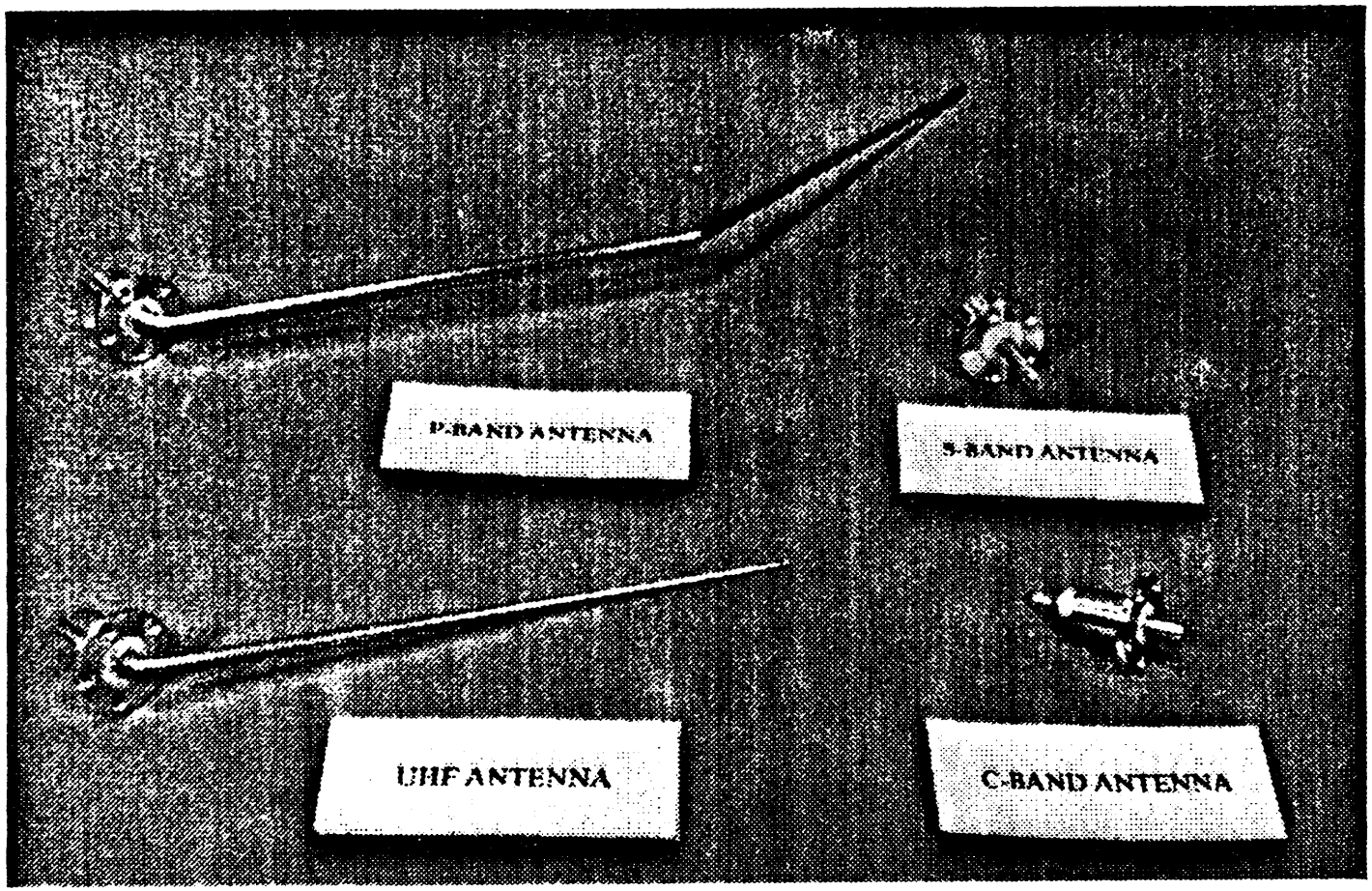


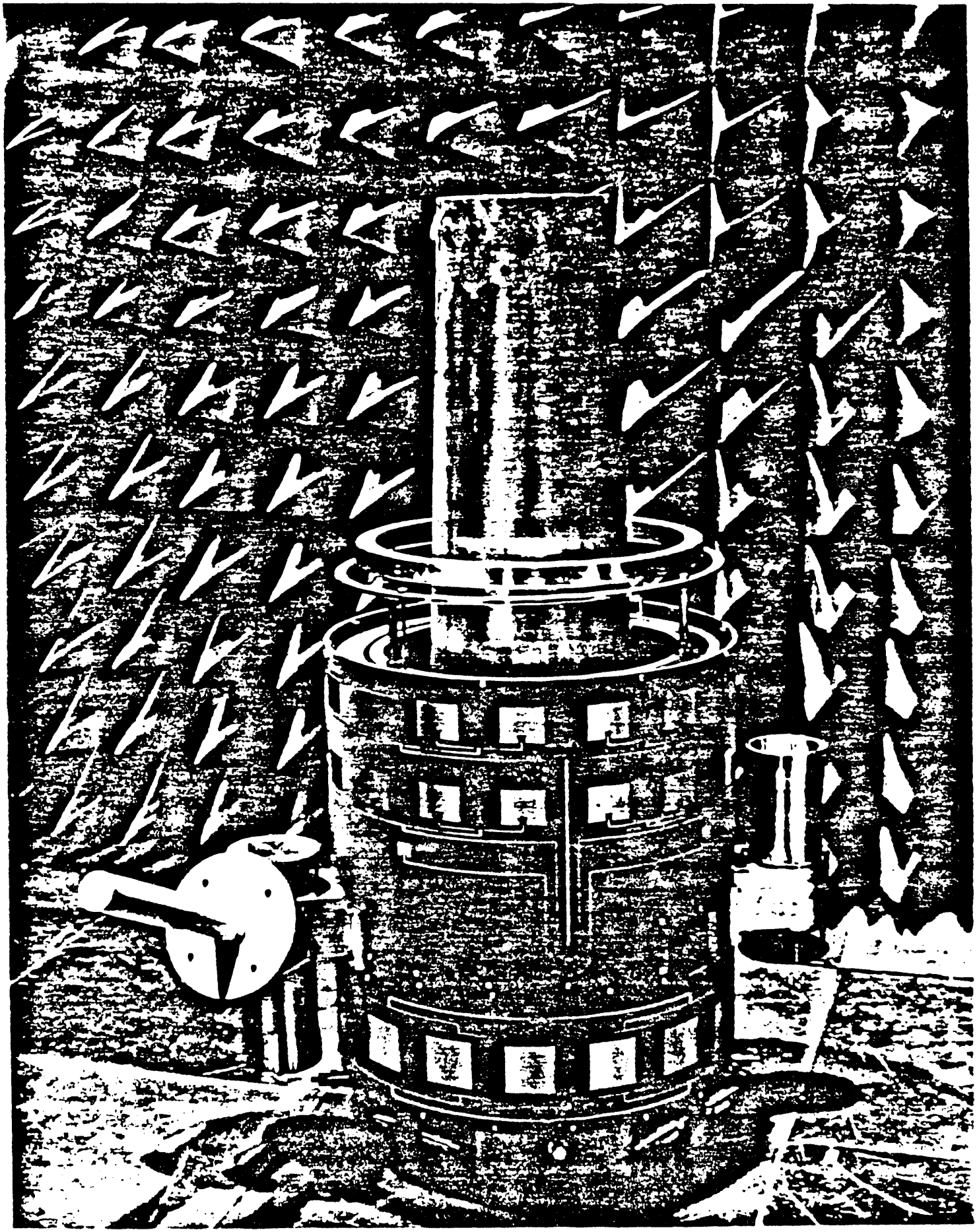
Reentry Vehicle Antennas





Rocket Antennas

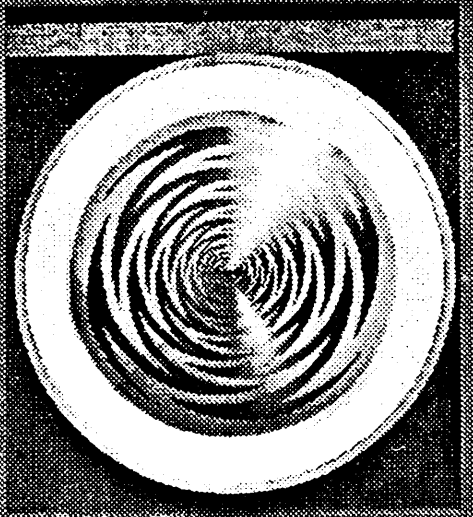


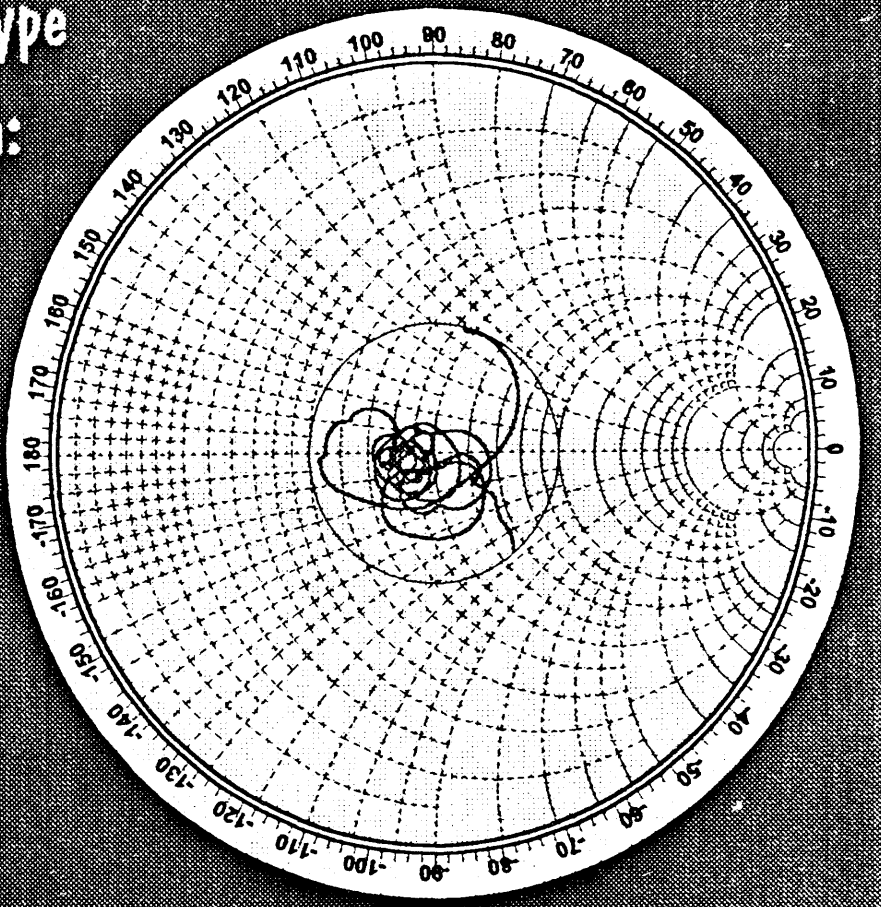


Wide-Bandwidth Antenna

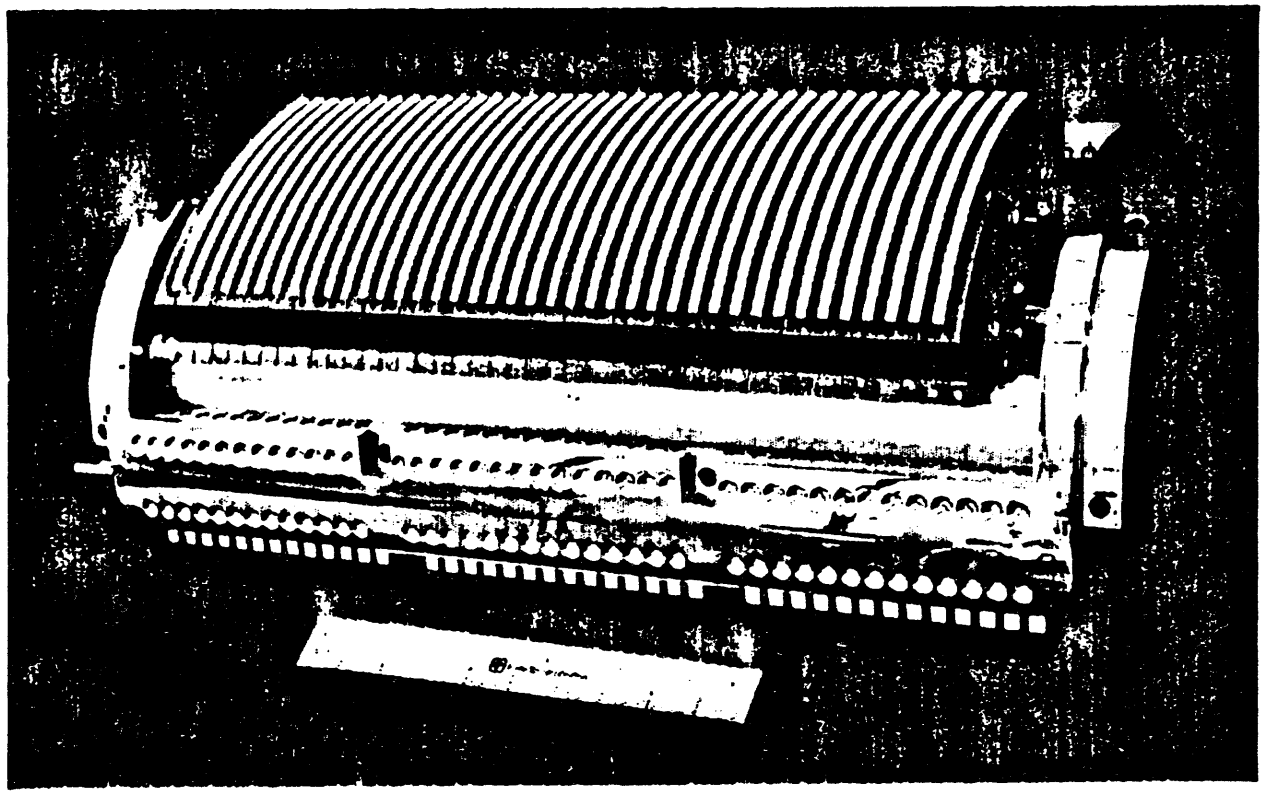
Impedance of Scale Prototype

- Measured 2:1 Bandwidth:
  425.6 MHz to 1.741 GHz
- Scaled 2:1 Bandwidth:
  165 MHz to 3.26 GHz

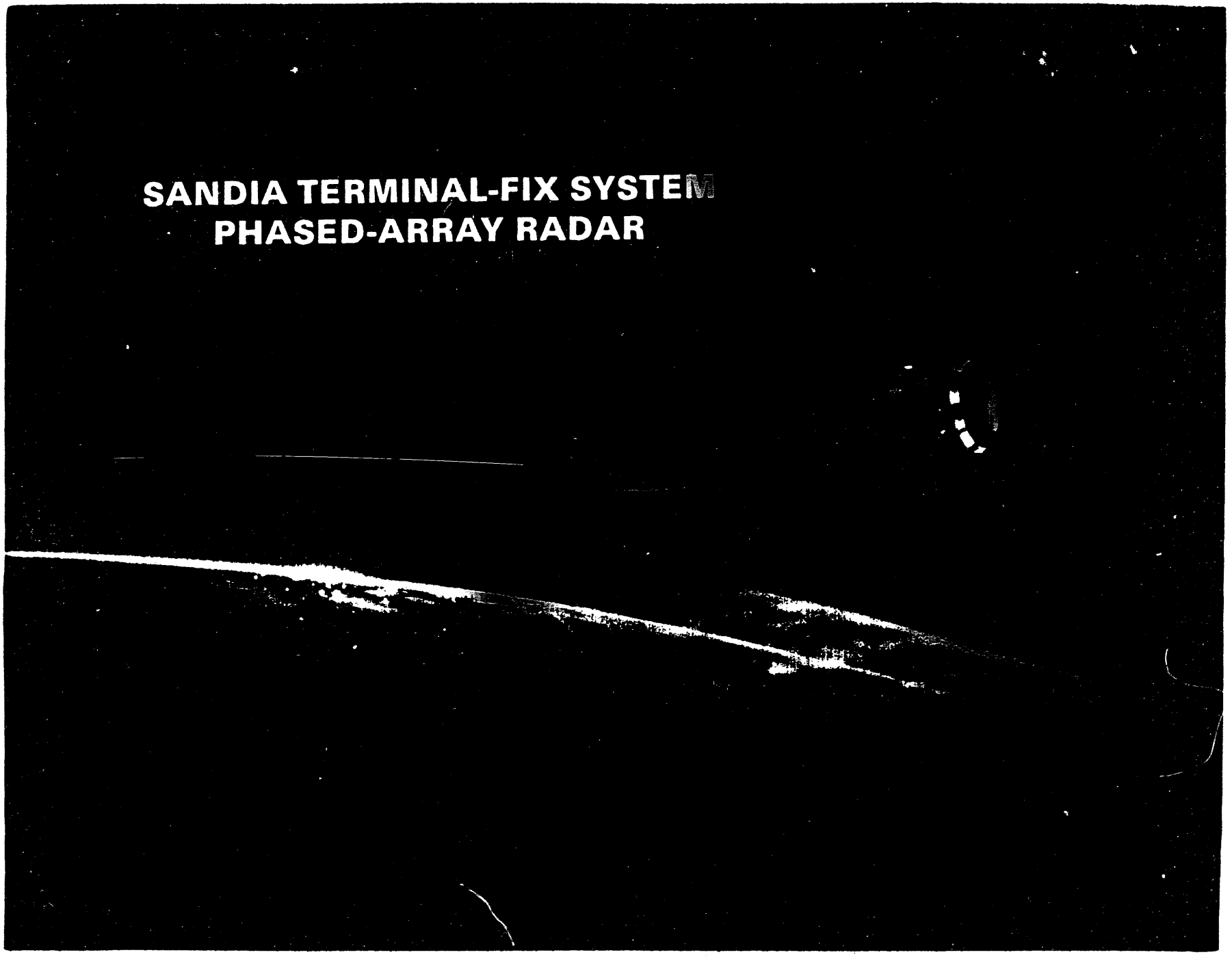




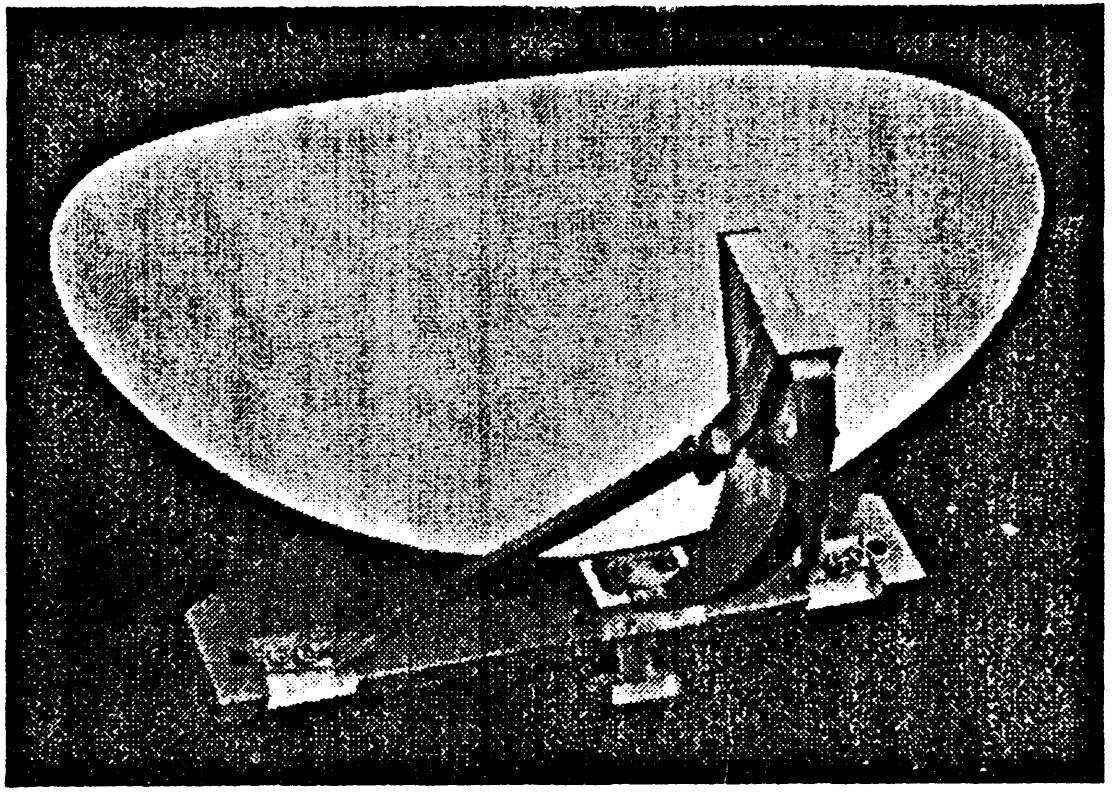
TFS Phased Array Antenna



- Frequency: 15 ± 0.5 GHz
- Elements: 80 (2/row x 40 rows)
- Phase Control: Two T/R modules per row
- Beam Scanning: ± 15° along track
- Monopulse Beam Forming: Along track
- Dimensions: 26 cm x 48 cm
- Gain: 30 dBi
- Beam Width: 3° x 5°

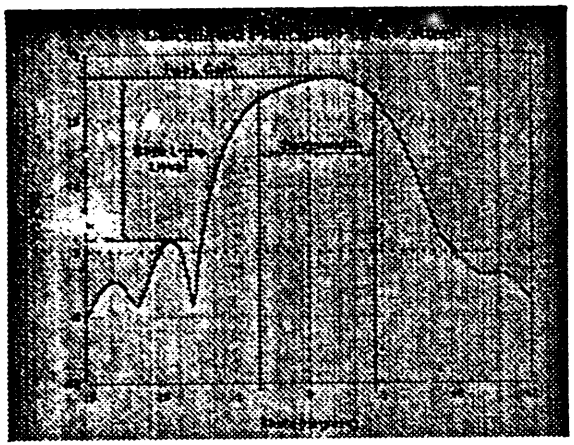

SANDIA TERMINAL-FIX SYSTEM
PHASED-ARRAY RADAR

35-GHz SAR Antenna



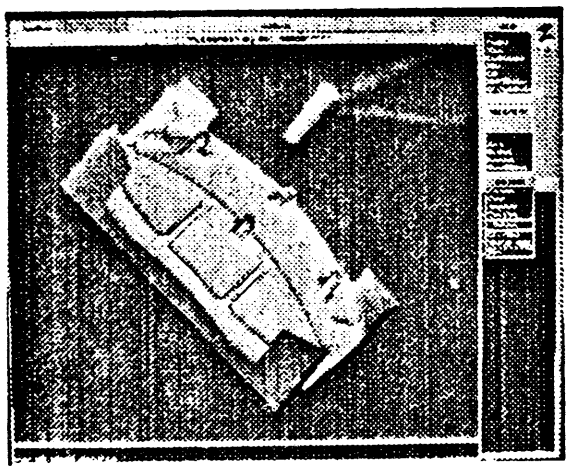
- Offset-fed Parabolic Reflector
- Gain: 31 dBi
- Beamwidth: 2 by 5 Degrees
- Wide Bandwidth

SAR Antenna Development



Virtual Prototyping

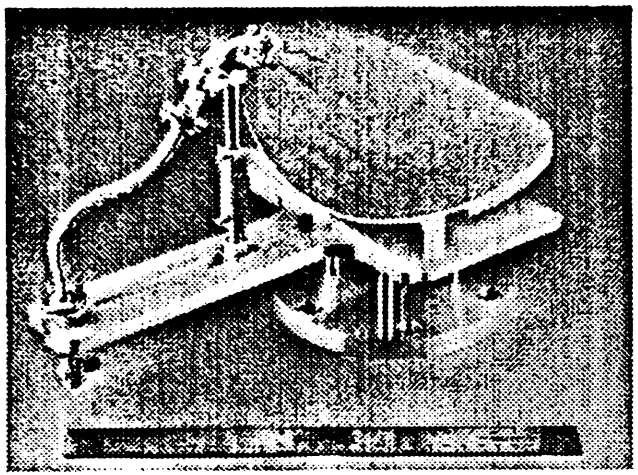
- Physical Optics Model
- Computer Iteration of Design

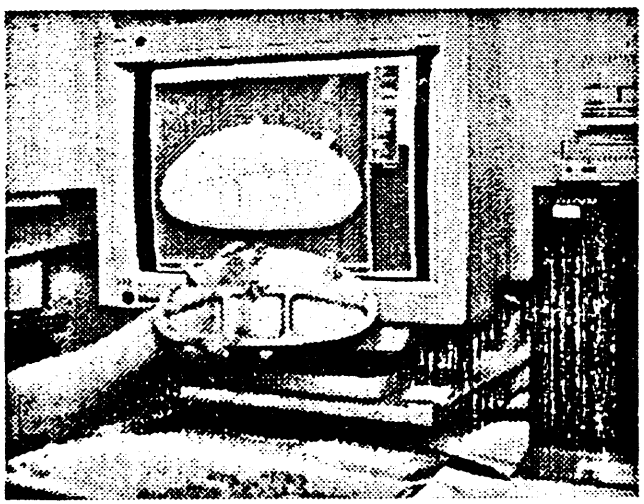


Rapid Design

- CAD Using Pro/ENGINEER
- Paperless Product Definition
- Simulation of Manufacture

SAR Antenna Fabrication





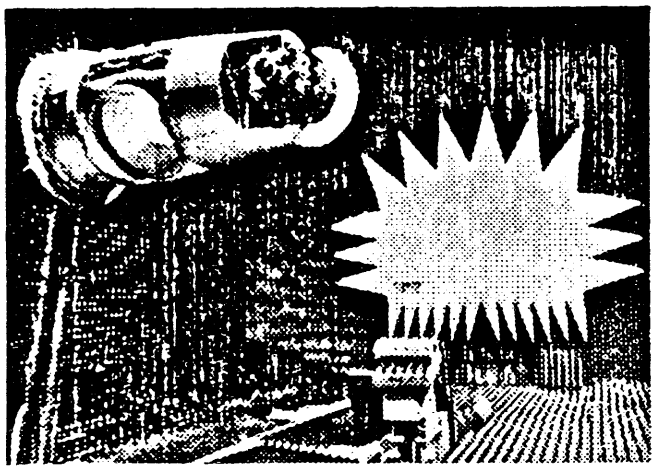
Quick-Look Modeling

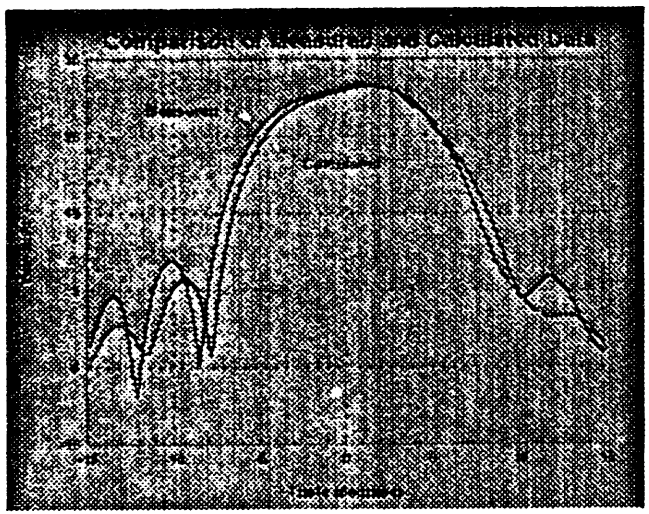
- Stereo Lithographic Plastic Model
- Metallized for Pattern Verification

Computer Controlled Production

- NC Machining
- FASTCAST Processing

SAR Antenna Design Validation



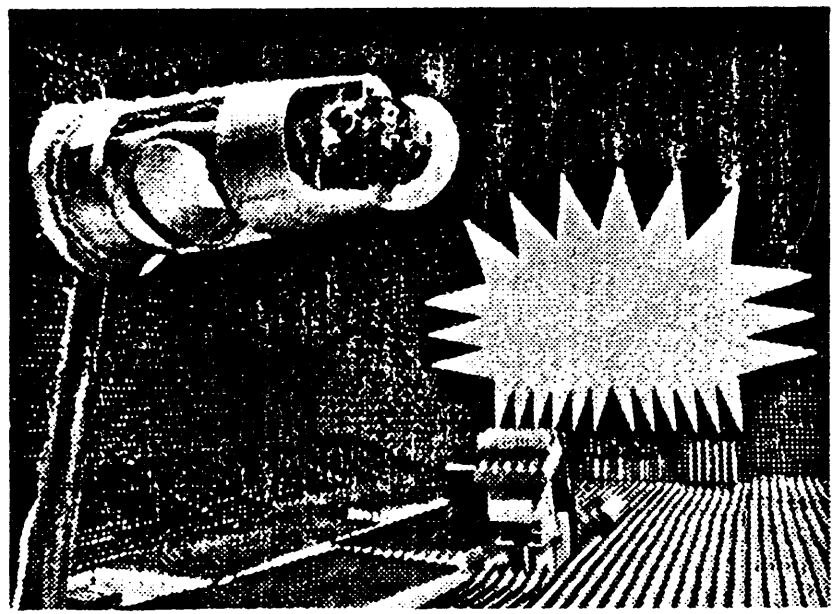


Automated Antenna Pattern Measurements

Automated Impedance Measurements

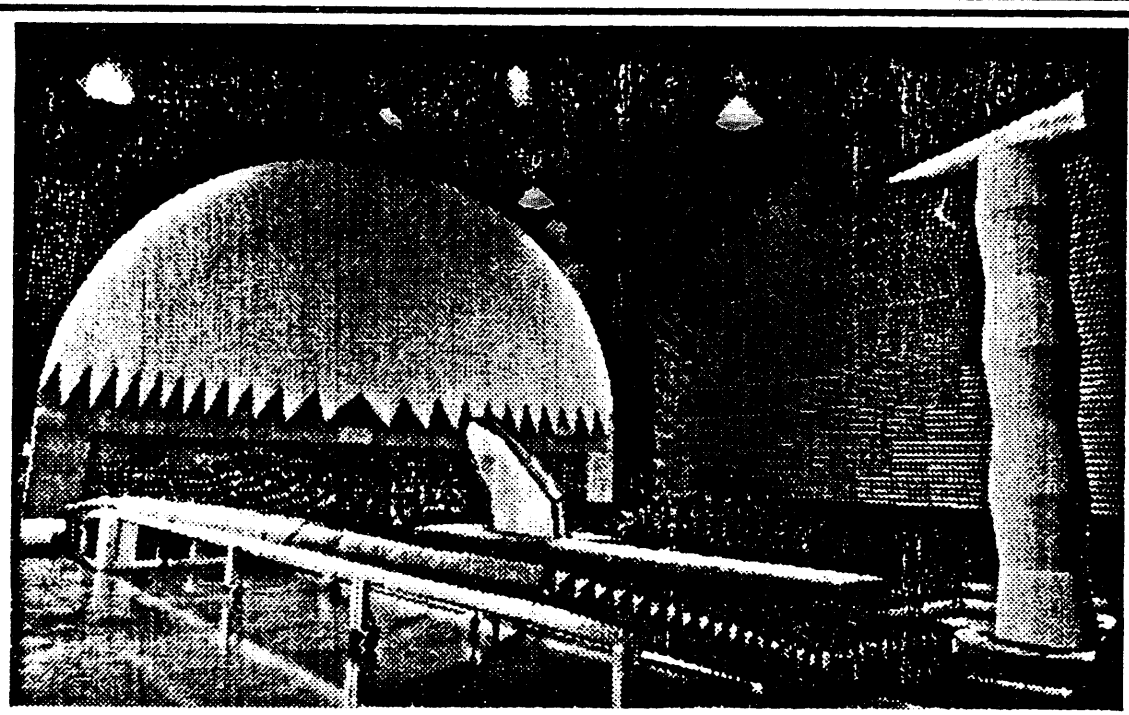
Confirmation of Antenna Gain, Beamwidths, Sidelobes

Antenna Measurements



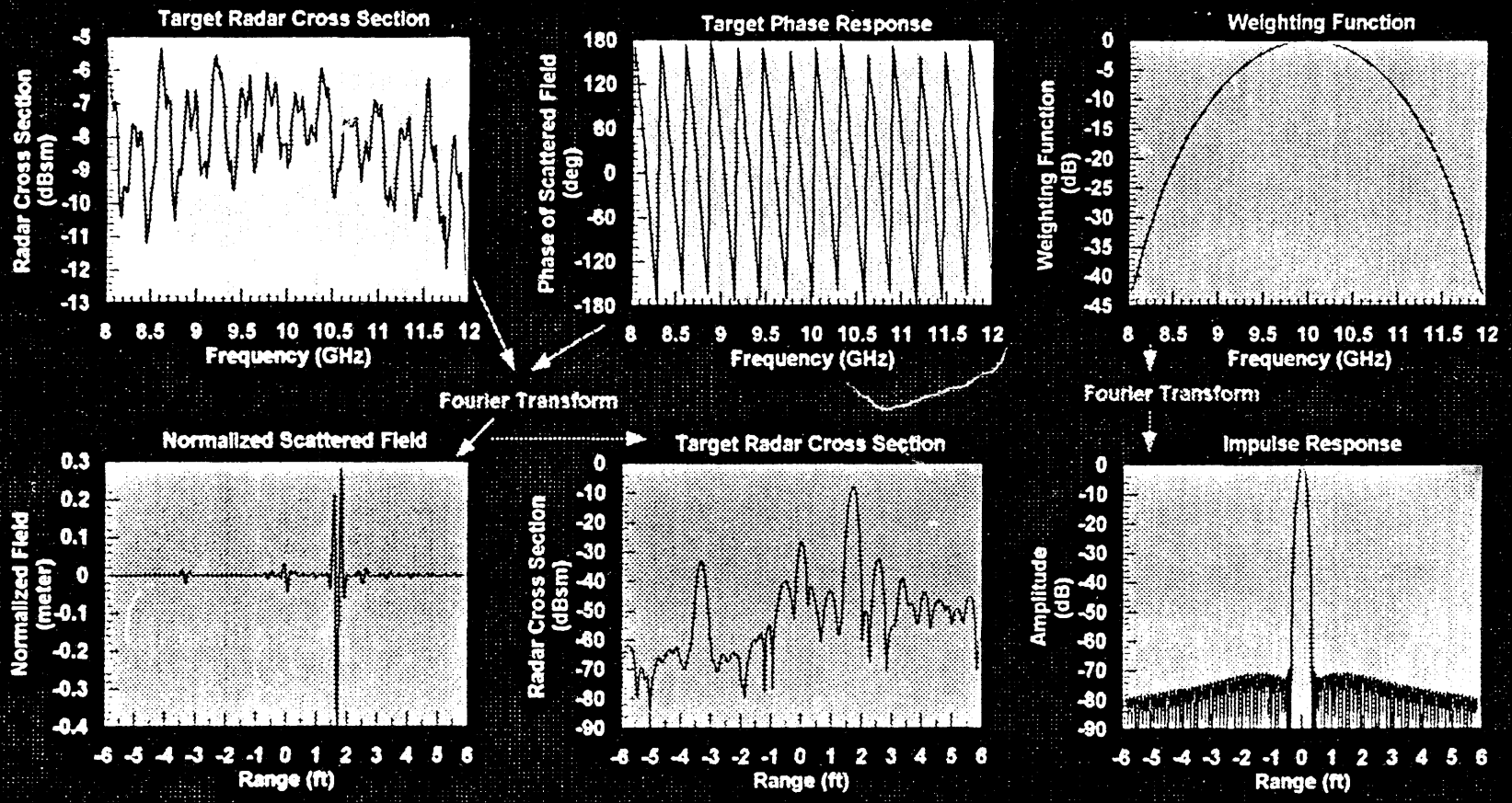
- Fully Polarimetric
- Wideband (1.0 - 40.0 GHz)
- Measurement Zone Size: 6'x6'x6'
- Resolution: < 0.5 inches
- Foam Column, Ogive, Mast Model Target Support
- Fully-focused, 2-D ISAR Imaging

RCS Measurements



- Fully Polarimetric
- Resolutions to 0.5 inches
- Fully-focused, 2-D ISAR Imaging
- Measurement Zone Size: 6'x6'x6'
- Wideband (1.0 - 40.0 GHz)
  (2.0 - 18.0 GHz continuous)

Frequency Domain Measurement
Fourier Transform to Time Domain



Antenna Development Department

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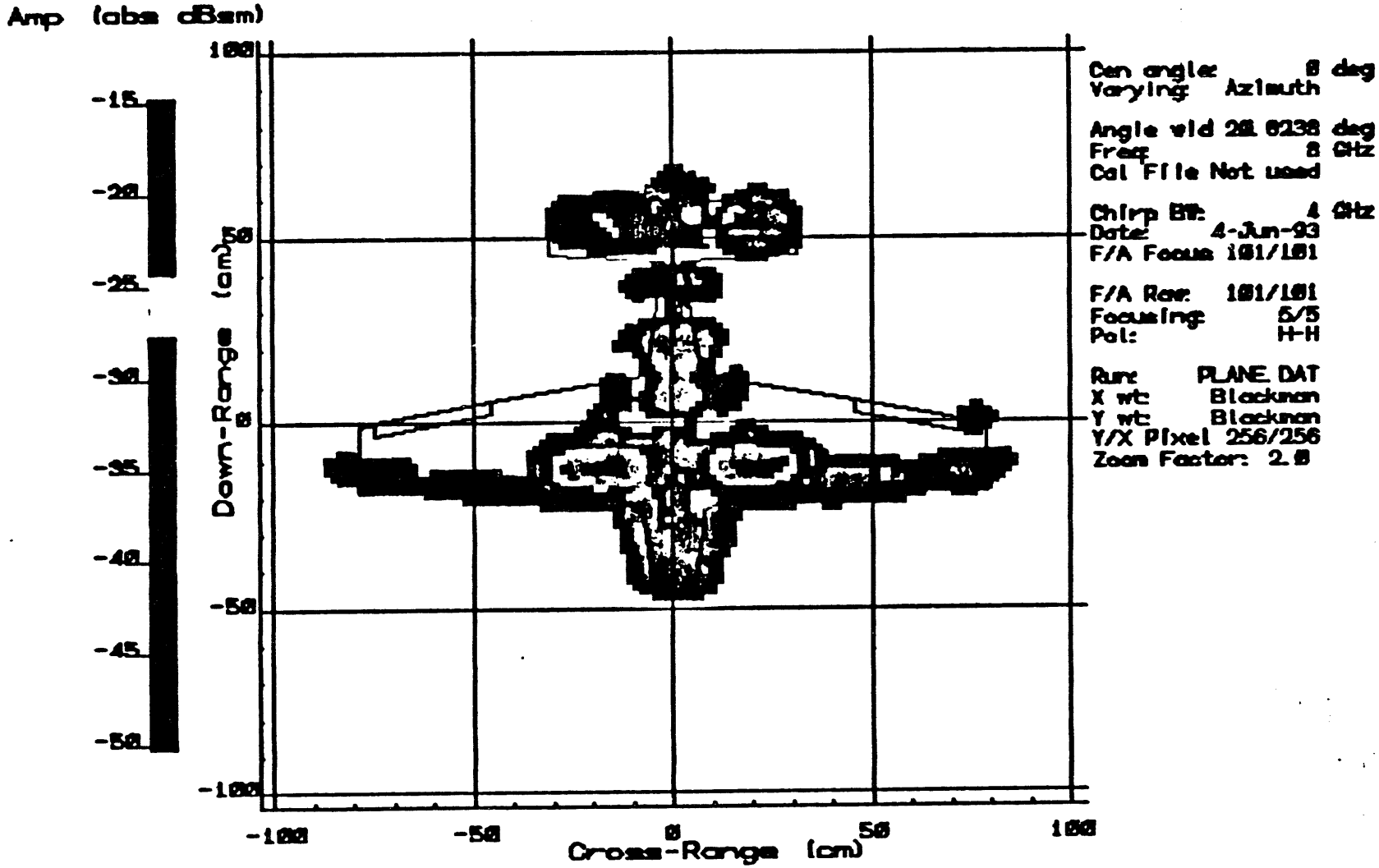

Imaging With Synthetic Aperature Radar

- Imaging based on coherent processing of backscattered signal
- Cross-track resolution obtained by wide-bandwidth signal and pulse compression
- Along-track resolution obtained by correlating phases from overlapping samples

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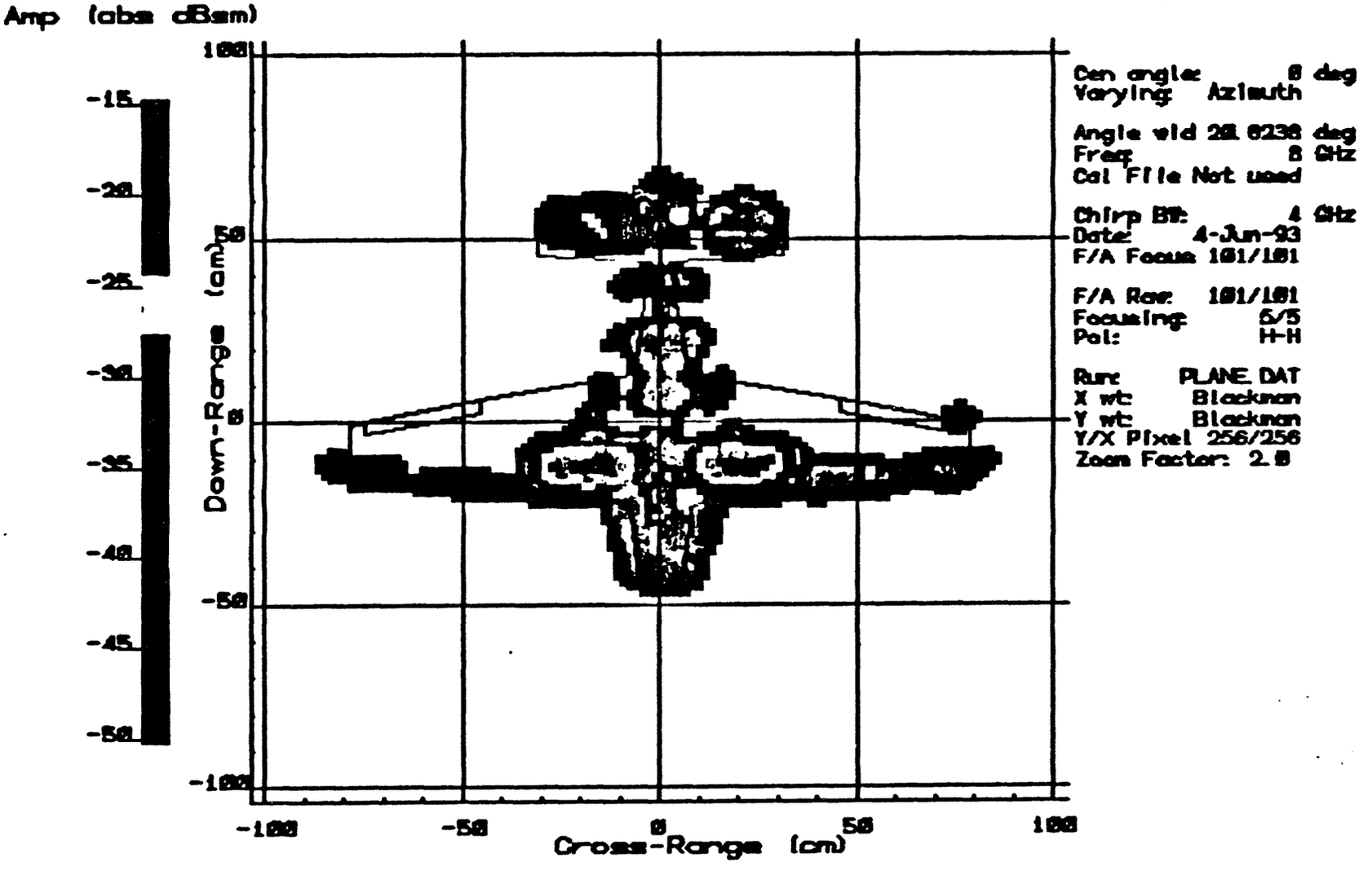

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Imaging With Synthetic Aperature Radar

- Imaging based on coherent processing of backscattered signal
- Cross-track resolution obtained by wide-bandwidth signal and pulse compression
- Along-track resolution obtained by correlating phases from overlapping samples

DATE
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