

**NEAR-MILLIMETER WAVE RADAR AND
ANTENNA FACILITY**

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FINAL REPORT

**U.S. Army Research Office
Box 12211
Research Triangle Park, NC 27709**

**Contract DAAL03-88-G-0086
November, 1989**

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1. INTRODUCTION

Under Research Agreement No. DAAL03-88-G-0086, The U.S. Army Research Office provided \$154,000 to the University of Michigan for the purpose of purchasing equipment that will enhance the capabilities of the University of Michigan's millimeter-wave radar scatterometer system by extending its frequency of operation to include the 215- GHz atmospheric window. In addition to the above funds, the University of Michigan committed to provide \$38,500 in the form of cost-sharing, which brings the total to \$192,500. The contract duration was one year, with an ending date of 30 September, 1989.

2. SUMMARY OF ACCOMPLISHMENTS

All the goals stated in the instrumentation proposal submitted by the University of Michigan have been realized. The list in Table 1 shows the items purchased, the manufacturer, and the cost. The highest cost item was a 215 GHz transmitter/receiver front-end that was custom-built by Militech Corporation. The system was delivered four months behind schedule, but its performance characteristics were found to meet or exceed all the minimum specifications we had agreed on with the manufacturer. Within a period of one month, we were able to evaluate the system performance, develop appropriate calibration targets, and integrate the 215-GHz system into the overall radar system.

Addition of the Vector Network Analyzer resulted in a reduction of data acquisition time by a factor of 10, thereby increasing the amount of data that the radar system can measure in one day. All the software necessary for controlling the radar system functions and for processing the backscattered signal were developed and tested.

The remaining items listed in Table 1 served to improve the performance of various functions of the radar system, and to improve the stability of the millimeter wave radiometers mounted on the same platform. The final specifications of the four-channel radar system are given in Table 2.

3. PERSONNEL SUPPORTED

None. This was an instrumentation contract, and therefore all funds were used for purchasing equipment and supplies. Labor costs for testing the equipment and integrating them into the overall radar system were covered from other sources of funding.

Table 1. Equipment Purchased

<u>Description</u>	<u>Vender</u>	<u>Cost</u>
215 GHz Transmitter/Receiver Front-end	Militech	72,183.40
Vector Network Analyzer	Hewlett Packard	57,771.00
Stepping motor w/controller	Aerotech	9,650.00
Lock-In Amplifier	EG&G Priuator	9,367.07
Gunn Oscillators (2) doubles	Militech	14,677.50
Computer Memory Cards	Pinnacle Micro	1,217.00
Hard disc drive	Hewlett Packard	1,089.00
Generator	Standby Power	2,813.00
Terminal Panel	Data Translation	180.90
Memory Card	CAEN	800.00
Microwave Isolators (5)	Cain-Forlow	708.05
" " (4)	UTE	686.96
Oscilloscope	E & I Corp.	1,677.20
Microwave couplers	Alpha	3,325.74
Power meter with adaptors	Anritsu	13,856.00
Low Pass filter	RLC	1,000.00
Computer Components		1,500.00
Total		<hr/> 192,502.90

TABLE 2. U of M MILLIMETERWAVE SCATTEROMETER PARAMETERS

FREQUENCIES:	35, 94, 140, 215 GHz		
IF BANDWIDTH:	0 to 2.0 GHz		
TRANSMIT POWER:	35 GHz: +3 dBm 94 GHz: 0 dBm 140 GHz: -4 dBm 215 GHz: -10 dBm		
SWEEP RATE:	1 m-sec/freq., 51, 101, 201, 401 freq./sweep		
POLARIZATION:	HH, HV, VV, VH		
INCIDENCE ANGLES:	0 to 70 degrees		
PLATFORM HEIGHT:	3 meters minimum, to 18 meters maximum		
NOISE EQUIV. σ° :	35 GHz: -22 dB 94 GHz: -28 dB 140 GHz: -21 dB 215 GHz: -20 dB		
CROSSPOL ISOLATION:	35 GHz: 23 dB 94 GHz: 20 dB 140 GHz: 10 dB 215 GHz: 20 dB		
PHASE STABILITY:	35 GHz: ~1 degree/hour 94 GHz: ~1 degree/minute 140 GHz: ~10 to 50 degrees/second 215 GHz: ~20 degrees/hour		
NEAR FIELD DIST:	35 GHz: 2.7 m 94 GHz: 7.3 m 140 GHz: 2.7 m 215 GHz: 4.4 m		
BEAMWIDTH:	35 GHz: R: 4.2 deg 94 GHz: R: 1.4 deg 140 GHz: R: 2.2 deg 215 GHz: R: 1.1 deg	T: 4.2 deg T: 2.8 deg T: 11.8 deg T: 2.3 deg	
ANTENNA DIAMETER:	35 GHz: R: 6 inches 94 GHz: R: 6 inches 140 GHz: R: 3 inches 215 GHz: R: 3 inches	T: 6 inches T: 3 inches T: 0.36 inches T: 1.5 inches	