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CD RADIO

S-Band Propagation Measurements

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INTRODUCTION

A geosynchronous satellite system capable of providing many channels of Digital Audio Radio Service (DARS) to mobile platforms within the contiguous United States using S-band radio frequencies is being implemented. The system is designed uniquely to mitigate both multipath fading and outages from physical blockage in the transmission path by use of satellite spatial diversity in combination with radio frequency and time diversity. Figure 1 shows the generalized system configuration. The system also employs a satellite orbital geometry wherein all mobile platforms in the contiguous United States have elevation angles greater than 20° to both of the diversity satellites. Since implementation of the satellite system will require three years, an emulation has been performed using terrestrial facilities in order to allow evaluation of DARS capabilities in advance of satellite system operations. The major objective of the emulation was to prove the feasibility of broadcasting from satellites 30 channels of CD quality programming using S-band frequencies to an automobile equipped with a small disk antenna and to obtain quantitative performance data on S-band propagation in a satellite spatial diversity system.

DARS SATELLITE SYSTEM

The satellite system consists of two geosynchronous satellites, one located over the east coast of the United States at 80° West Longitude and the second over the west coast of the United States at 110° West Longitude. The satellites receive in the 6720 MHz band and transmit in two 8 MHz segments of the 2310-2360 MHz band. The satellites each receive the same transmission from the system's up-link/programming center essentially simultaneously and retransmit the signal through an antenna beam covering the contiguous United States. Figure 2 shows the block diagram of the satellite's transmission payload. The retransmission frequencies of the two satellites are separated by 20 MHz and the beam edge EIRP is 57 dBW. The high EIRP is required due to the low gain of the mobile platform antenna. The transmission consists of 30 stereo CD music channels, a 128 kb/s service channel and several information channels. The CD stereo music channels are compressed prior to transmission using a joint encoding algorithm based on perceptual audio coding so only a 128 kb/s output data rate is required for each. The channels are digitally multiplexed together (i.e., TDM-time division multiplex) with interleaving in time, resulting in a 4 Mb/s output signal.

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The output signal is convolutionally encoded, a Reed-Solomon code added and then transmitted to the satellites using offset quadraphase shift keying.

The satellite retransmissions are received by the mobile platforms, particularly passenger automobiles. The mobile platform G/T at worst operational aspect angle is -19 dB/K. The antenna is designed to provide 3 dBi gain within a 20°-60° elevation angle range at all azimuths. The antenna is physically 2.5 cm in radius and 0.4 cm thick, designed for embedment in automobile rooftops. A photograph of the antenna is shown in Figure 3. After radio frequency reception, amplification and down conversion, the transmission from each satellite is individually demodulated. The two signals are time phased together using a maximal ratio combiner and then de-multiplexed. The user selects the specific music channel desired which is then routed to the decompressor, the digital-to-analog converter and the audio amplifier-loud speaker subsystem. Figure 4 shows a block diagram of the mobile platform receiver. The mobile platform receiver just described enjoys great resistance to multipath fading and outage from blockage since its mechanization takes advantage of satellite spatial, frequency and time diversity as depicted in Figure 5.

EMULATION IMPLEMENTATION

It is difficult to emulate the capabilities of the previously described DARS satellite system using terrestrial facilities to simulate the satellites. This is because achieving a 20° elevation angle to the mobile platform from a terrestrial transmitter simulating the satellite over a reasonably large area requires buildings or towers of great height. Also, the demonstration of spatial diversity requires two transmitters covering the same geographical area resulting in the need for several transmitters. A satellite system emulation range was constructed in Northern Virginia close to Washington D.C. Figure 6 is a roadmap of the range. Five high-rise building tops were used as transmit locations to a vehicle driving a route through the area configured so that two transmit locations are nominally at 10° or more elevation angle from the vehicle, and only one transmit path at a time experiences physical blockage. The particular driving route included areas representing both urban and suburban environments as well as areas with trees and a roadway overpass.

The 30 CD music channels and service channel were generated at a programming/up-link earth station in Washington, D.C. using the compression, multiplexing and modulation described earlier. The uplink station transmitted the signal at Ku-band to the SBS-6 satellite which relayed the signal to standard VSATs on the high-rise building roofs. The VSAT received signal was translated by a stable frequency converter to the 2310-2360 MHz band and was then re-radiated using a small S-band transmitter and omni-directional antenna. The S-band EIRP of the transmitters was adjusted to provide a signal strength equal to that which would have been received at the mobile platforms from the previously described geosynchronous satellites

throughout the nominal vehicle route. The standard passenger vehicle used for the emulation was outfitted with a prototype receiver electronically almost identical to those that would be used in the operational satellite system. A small depression was made in the car roof, the antenna inserted and the roof area repainted to make the antenna invisible. The automobile radio was modified with a single button to select Satellite Radio in addition to AM and FM, and an expanded display was used to show the driver the music composition name and composer being played on the CD channel selected. A photograph of the display is shown in Figure 7.

EMULATION OPERATIONS

An application was submitted to the FCC in December 1992 for an Experimental License to conduct the previously described emulation using rooftop mounted transmitters in the 2310-2360 MHz radio frequency band. The license was granted on February 25, 1993 and the measurements subsequently cited were performed primarily from April 1993 through early June 1994.

A simplified block diagram of the system used for the emulation is shown in Figure 8. Note that the automobile used a four channel receiver, rather than the two to be used in the actual DARS satellite system, to avoid self interference from the relatively closely spaced rooftop antennas and that the 30 music channels were compressed individually and then multiplexed. Twenty minute music segments were then placed on the computer disk at the up-link earth station for transmission during the demonstration. The music segments would repeat automatically at the end of the twenty minutes.

PROPAGATION DATA

Accumulation of propagation data is performed when satellite transmission time is available and when the emulation automobile is not used for demonstrations of service capability. Data on transmission performance are logged on a monitoring UNIX based computer in the automobile trunk and then transferred to a large office computer at headquarters. Essentially received transmission data are logged four times per second as a record containing time, location, signal strength and bit error rate. Data reduction may be performed as a function of either time period or car wheel rotations.

The results to date fall into three categories:

1. **Blockage** Considerable data were taken on blockage avoidance by satellite spatial diversity, especially overpasses. Some selected measurements of interest are presented. Figures 9, 10, 11 show that no blockage occurred at measuring points around the driving range. At least one receiver channel always had a signal above threshold. A special test of blockage avoidance was made on one of the largest freeway

overpasses in the Washington, DC area, and the measurements are summarized in Figure 12. The measurements show that no blockage outage would occur in vehicles passing under the overpass with the diversity satellite DARS system for the geometry utilized but would always occur for a single satellite DARS system.

2. **Multipath** The nominal margin over threshold in the DARS satellite system for each received transmission without diversity combining is 5dB. This required operation of the test range at increased transmitter power for statistical measurement of multipath fading up to 20dB. The data acquired to date indicate that greater than 12dB improvement was almost always obtained from diversity but the statistical distribution above 12dB awaits further data taking.

3. **Frequency Selective Fading** There was observed, on occasion, unanticipated high levels of frequency selective fading. Figure 13 shows two examples of such fades; the left hand plot containing a narrowband (0.5MHz) fade of 15dB in the lower frequency transmission and the right hand plot containing a wideband (4MHz) fade of 20dB in the upper frequency transmission. In both cases, the satellite frequency diversity scheme would have prevented a service outage.

SUMMARY

The propagation data obtained to date at S-band demonstrate the effectiveness of satellite spatial diversity in mitigating DARS service outages from blockage and multipath. Further data will be accumulated for determining accurate multipath improvement performance statistics.

Figure 1 -- The CD Radio System

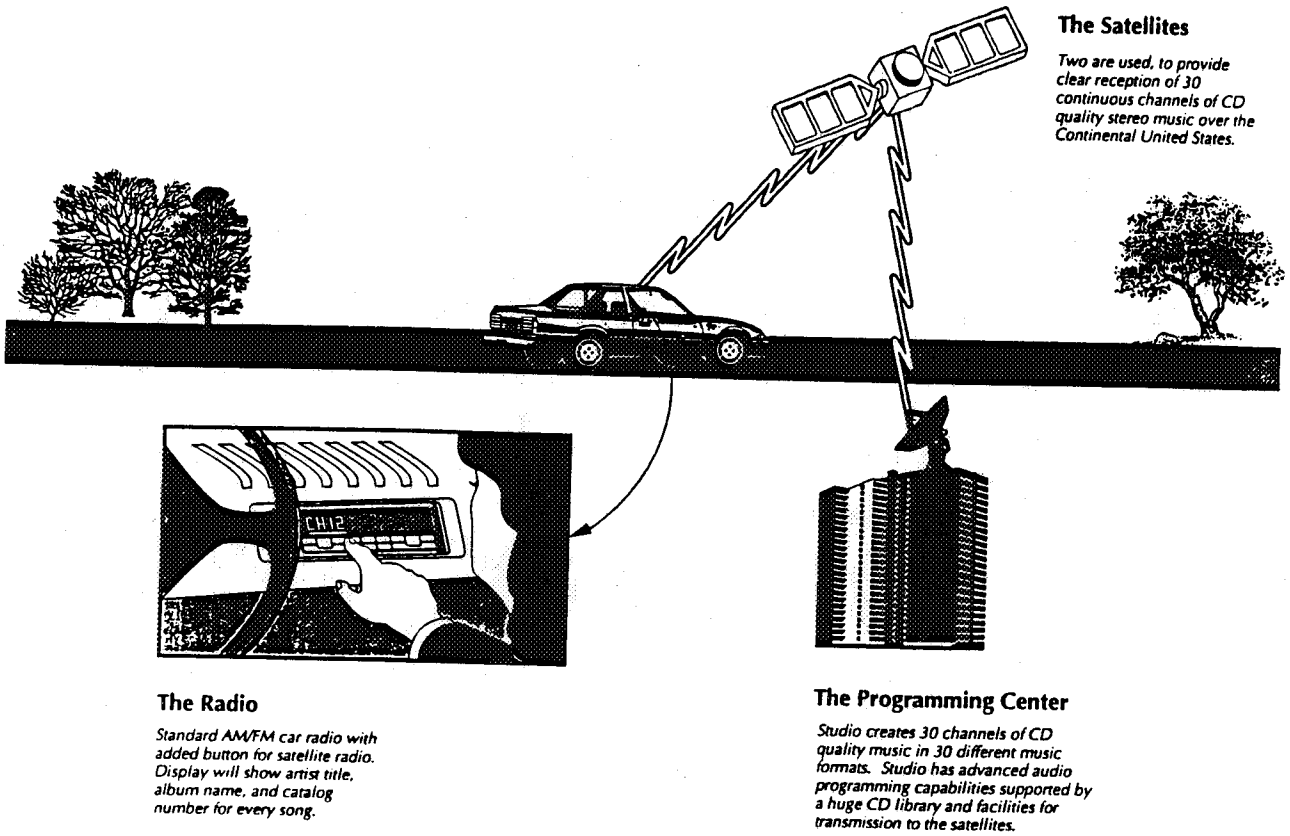


Figure 2 -- CD Radio Satellite Communications Block Diagram

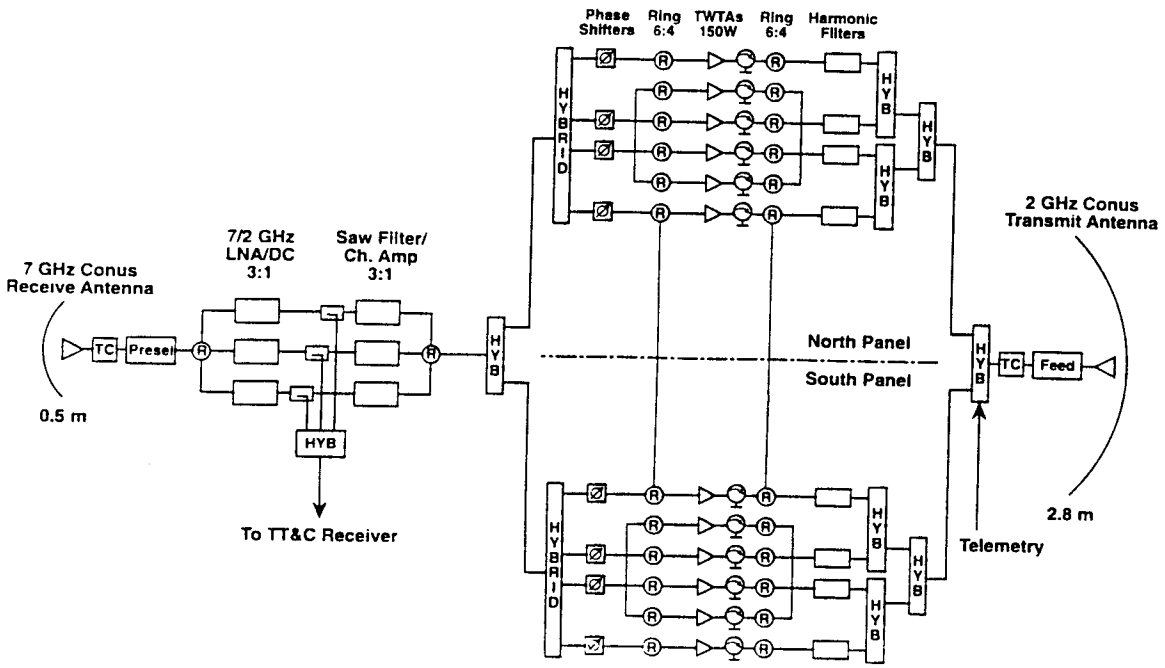


Figure 3 -- CD Radio Antenna

Figure 4 -- Vehicle Receiver
Analog AM & FM / Digital Satellite & Terrestrial

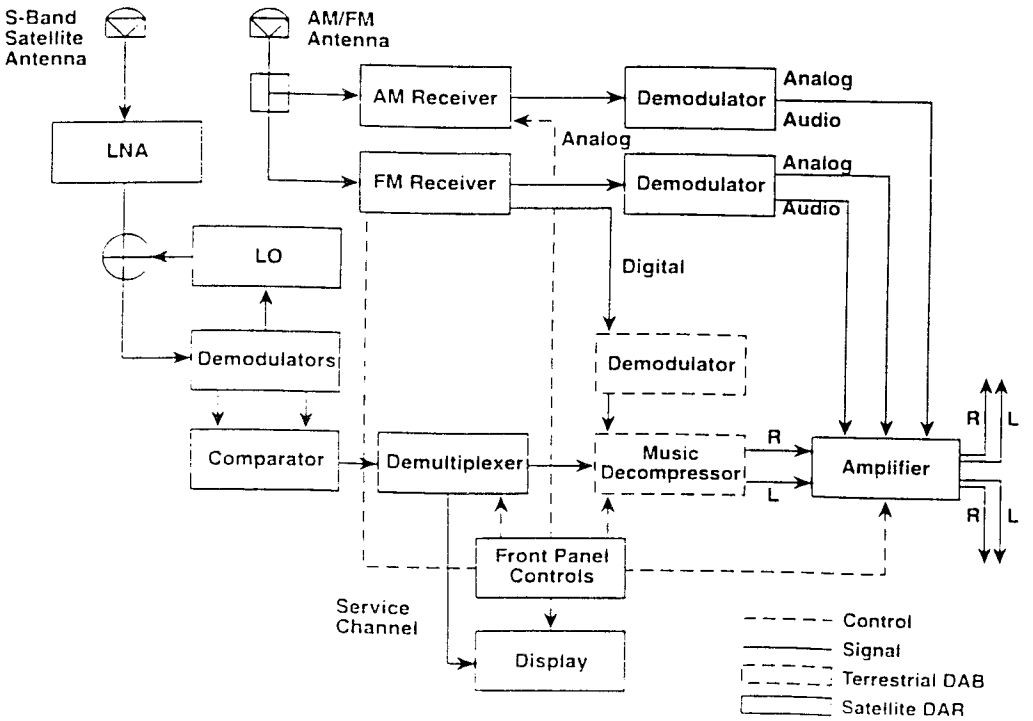


Figure 5 -- Reduction of Blockage Outages*
By Use of Two Radio Broadcast Satellites

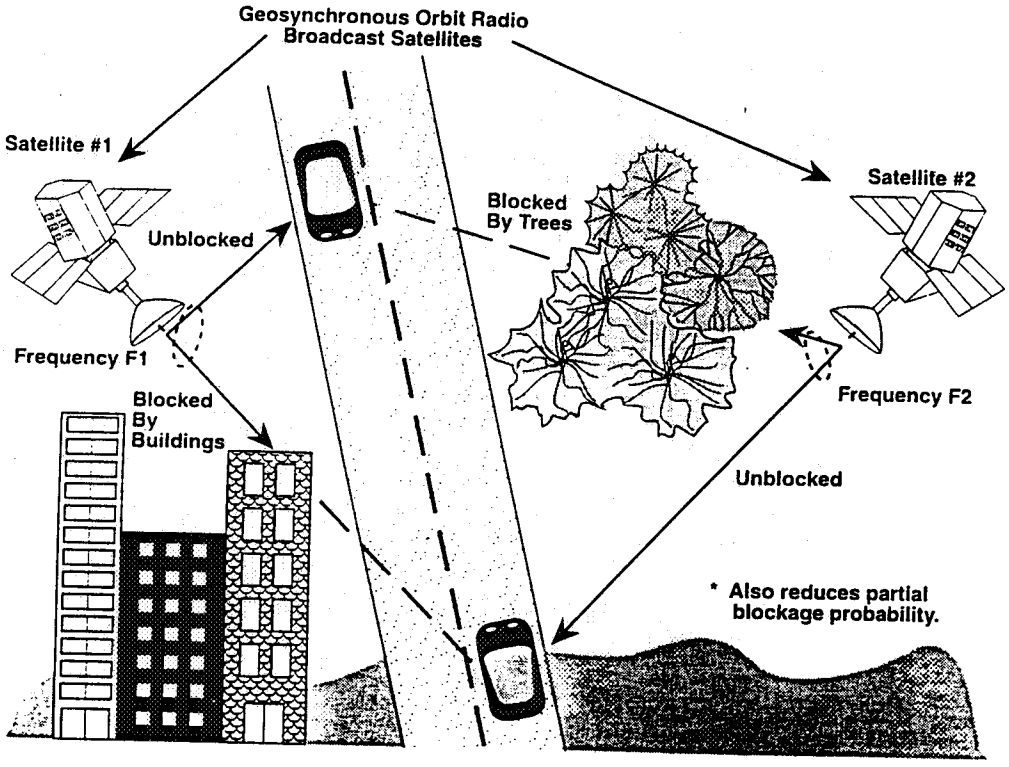


Figure 6 -- Test Range Road Map

Note: The test range is in Arlington, Virginia, part of metropolitan Washington, D.C.

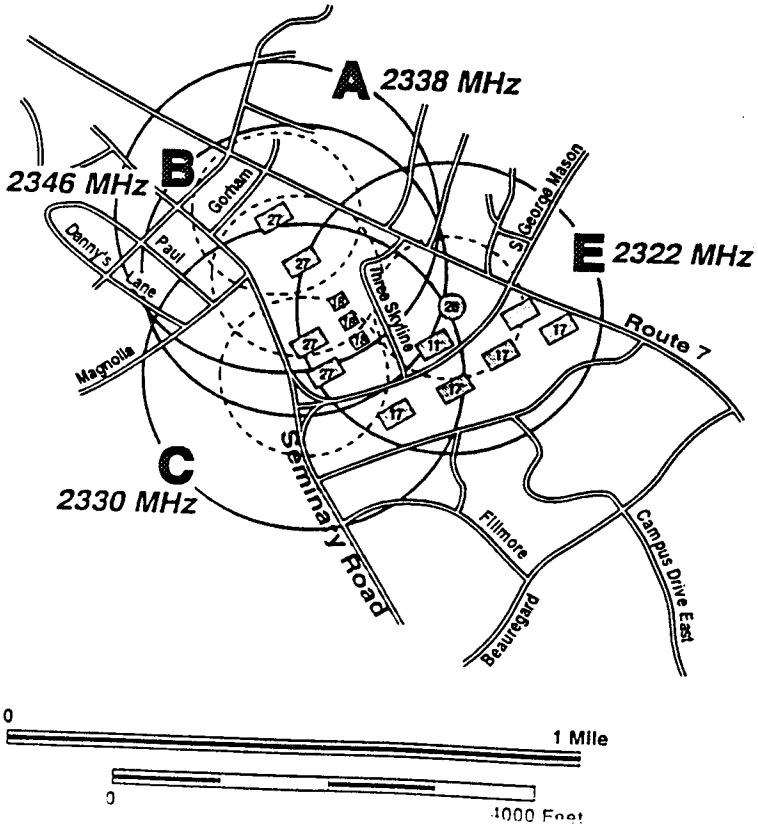


Figure 7 -- Car Radio Display

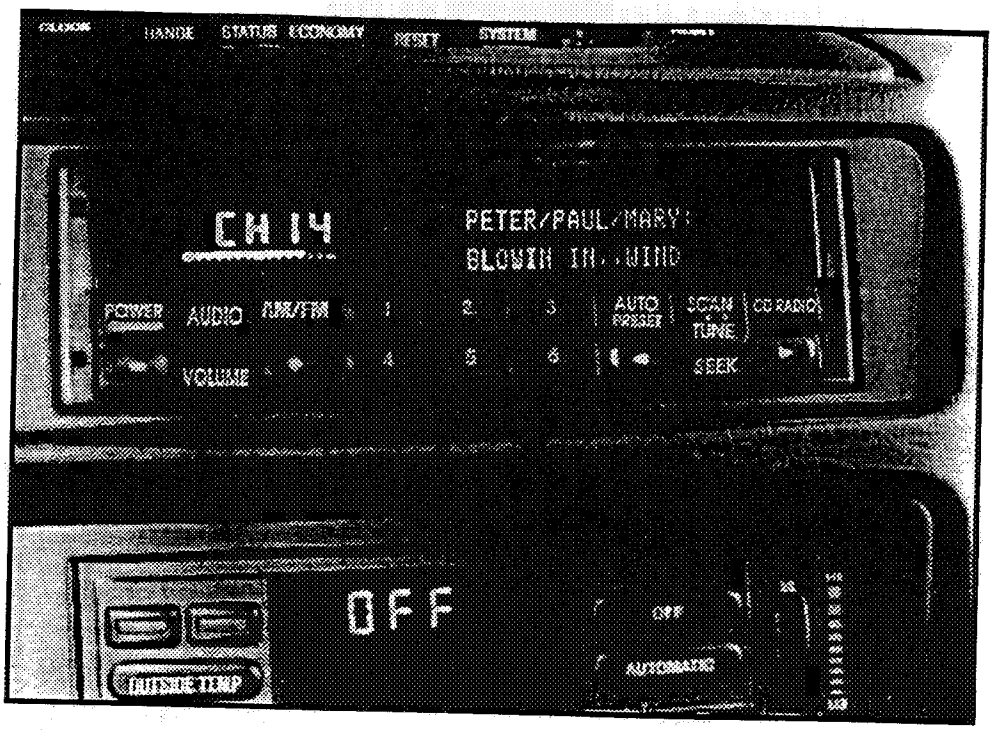


Figure 8 -- CD Radio Test System - Block Diagram

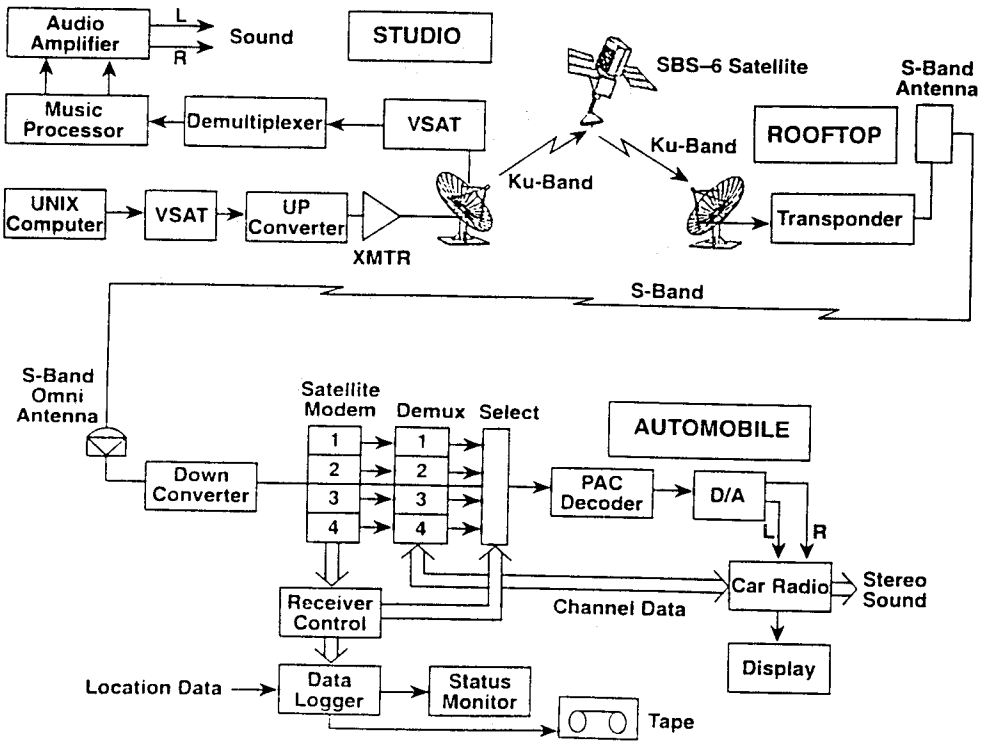


Figure 9 -- Test Range Measurement Points

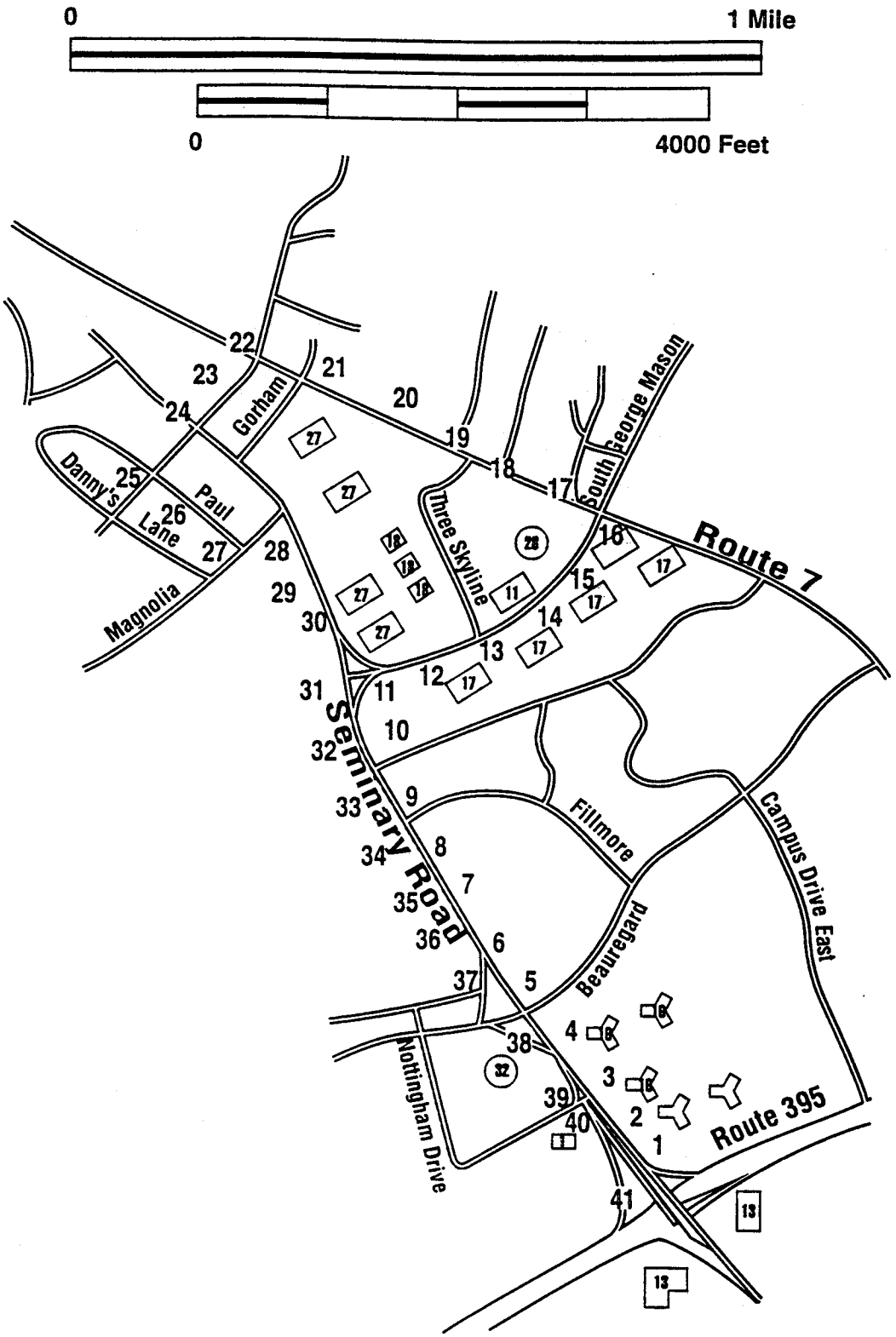


Figure 10 -- Test Range AGC Measurements - Sheet 1 of 2

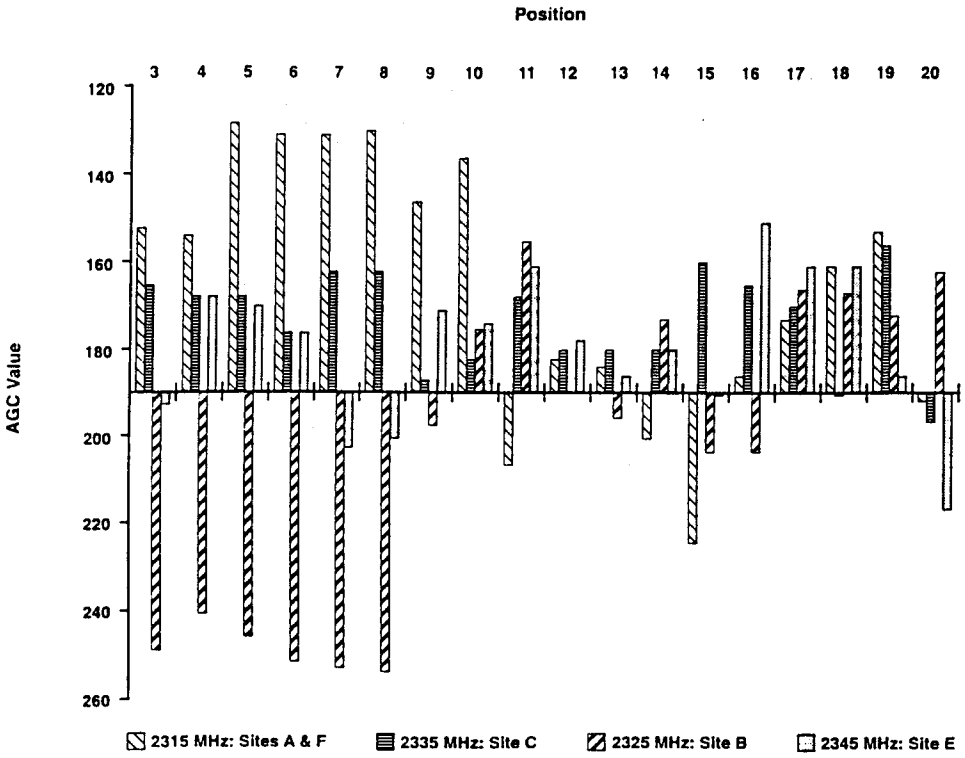


Figure 11 -- Test Range AGC Measurements - Sheet 2 of 2

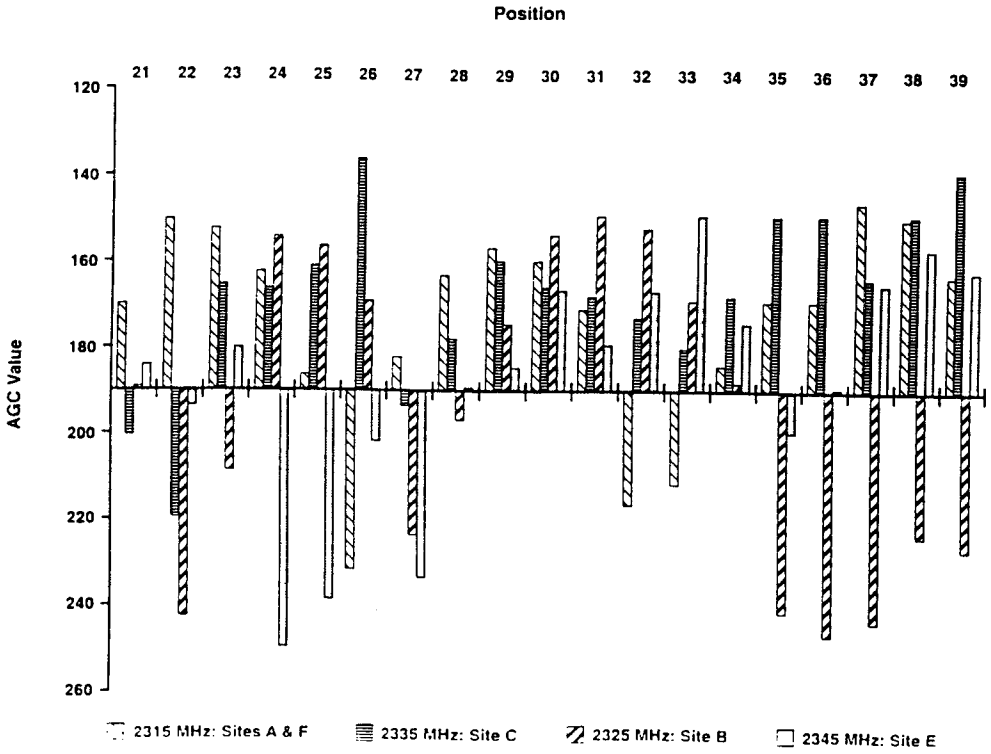


Figure 12– Highway Overpass, Test Results Summary

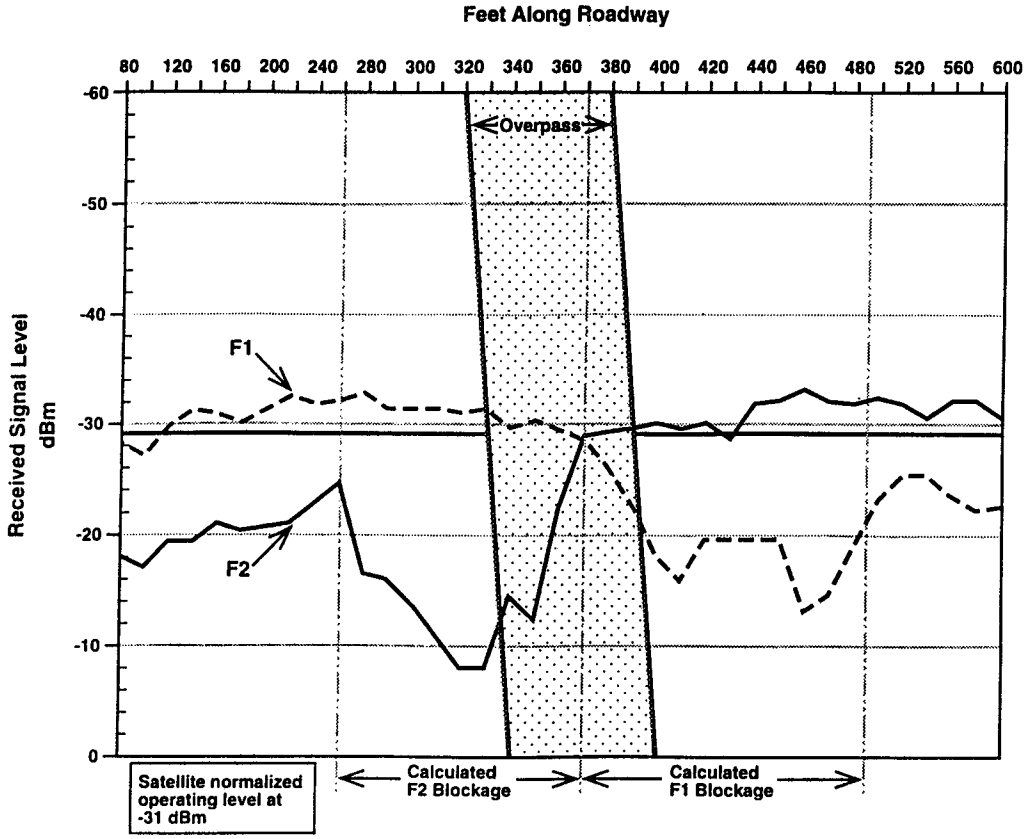
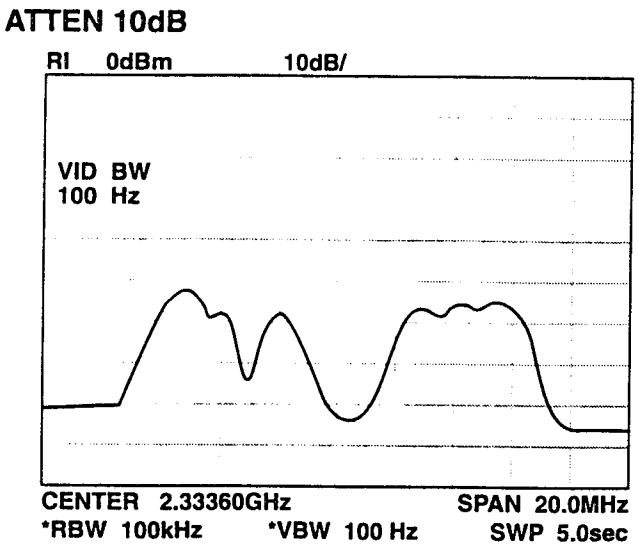
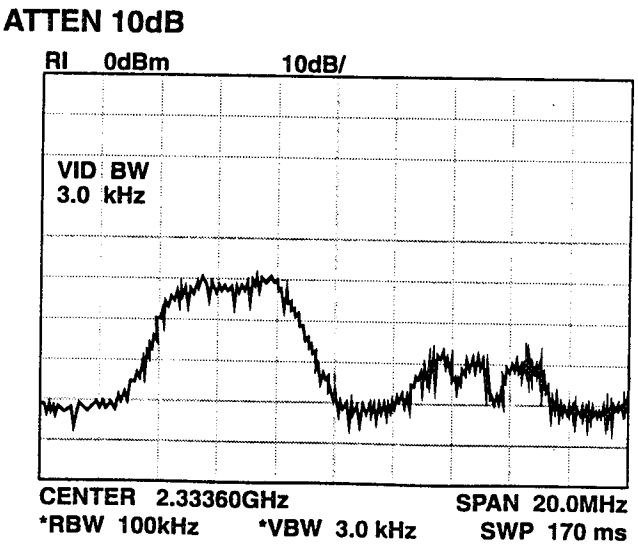


Figure 13– Test Range Spectrum Plots





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Satellite Fade Statistics and Diversity Gain for Personal and Broadcast Satellite Communications Systems Derived from TDRS Observations

Wolfhard J. Vogel and Geoffrey W. Torrence
Electrical Engineering Research Laboratory
The University of Texas

Presented at NAPEX XVIII
Vancouver, BC Canada
June 17, 1994

Background

- NASA Propagation Program has supported mobile satellite propagation research since 1983.
- Results have been used to support industry, government, and regulatory bodies.

Propagation Problems

- multipath fading (flat)
- shadowing by trees
- blockage by structures

User Scenarios

- mobile
  - vehicle-mounted antenna
  - antenna hand-held inside vehicle
- ported
  - outdoors
  - in building

Mobile Earth Station (MES) Environments

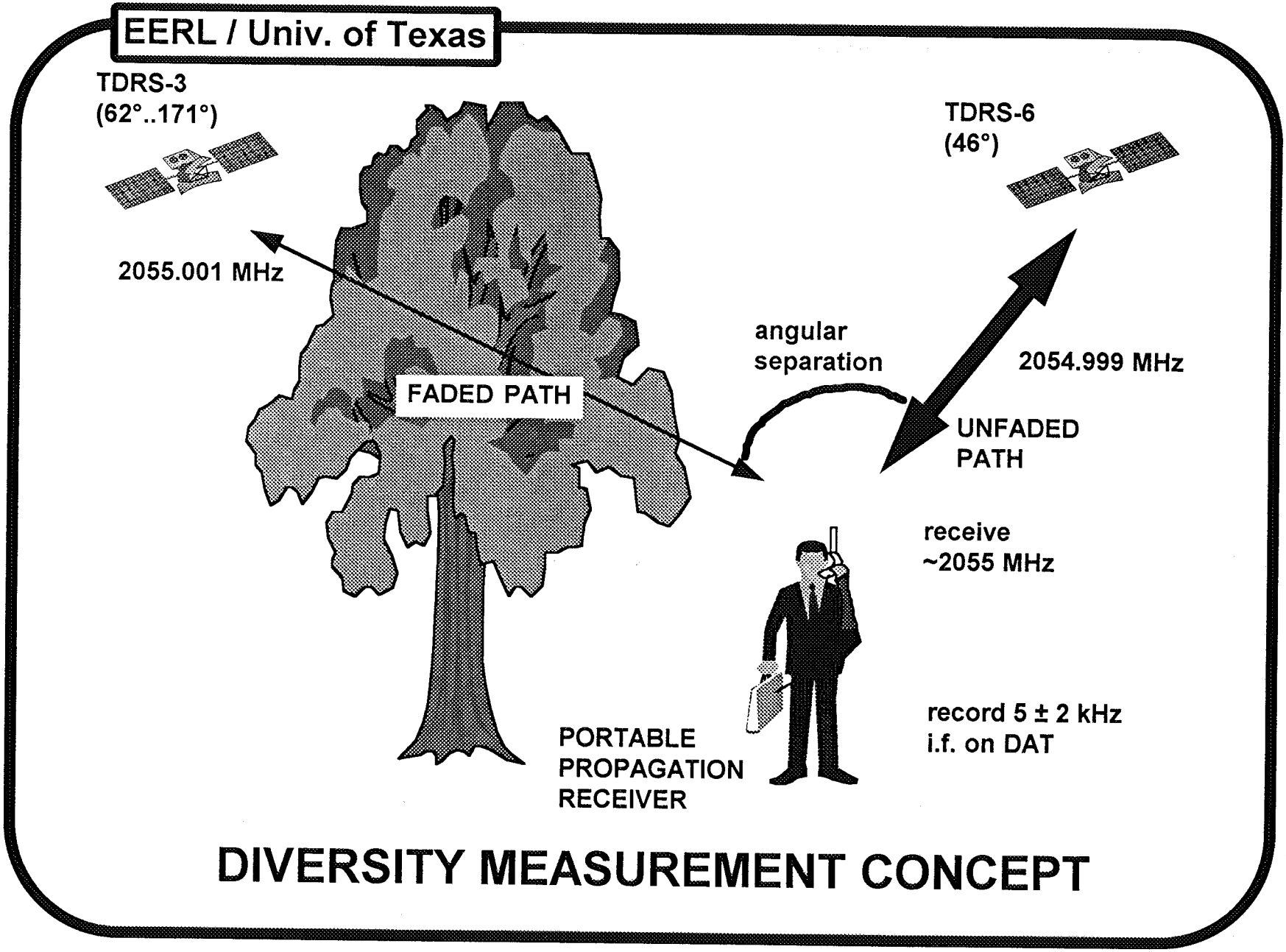
- rural
- suburban
- urban
- terrain
- vegetation

Applications for TDRS Propagation Data

- DBS fade and performance prediction
- LEO satellite diversity gain prediction
- mobile fade prediction
- modeling of frequency scaling

Available Tools to Acquire Data

- TDRS
  - cw transmissions
  - from one or two satellites
- MES
  - portable narrowband receiver
  - user antennas
    - » vehicle-mounted
    - » portable


EERL / Univ. of Texas
TDRS-3
(62°..171°)
TDRS-6
(46°)
2055.001 MHz
FADED PATH
angular
separation
2054.999 MHz
UNFADED
PATH
receive
~2055 MHz
record 5 ± 2 kHz
i.f. on DAT
PORTABLE
PROPAGATION
RECEIVER
DIVERSITY MEASUREMENT CONCEPT

MEASUREMENT EXAMPLES

- TDRS-3 and TDRS-6 on 03/19/94 in Austin, TX
- abscissa: center frequency = 5 kHz, 1 kHz/div
- ordinate: 10 dB/div

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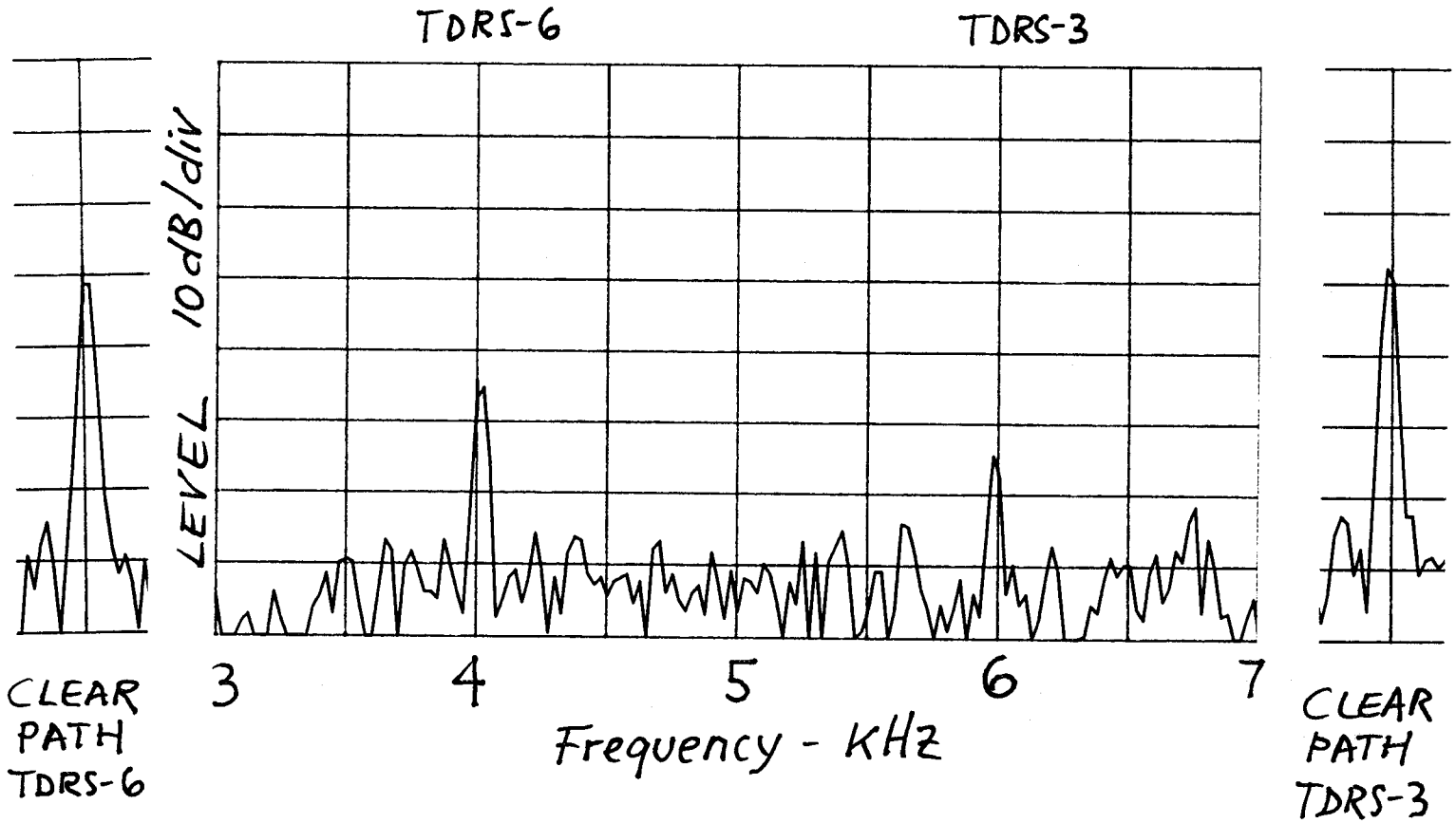
Example 1: Walking Inside a House



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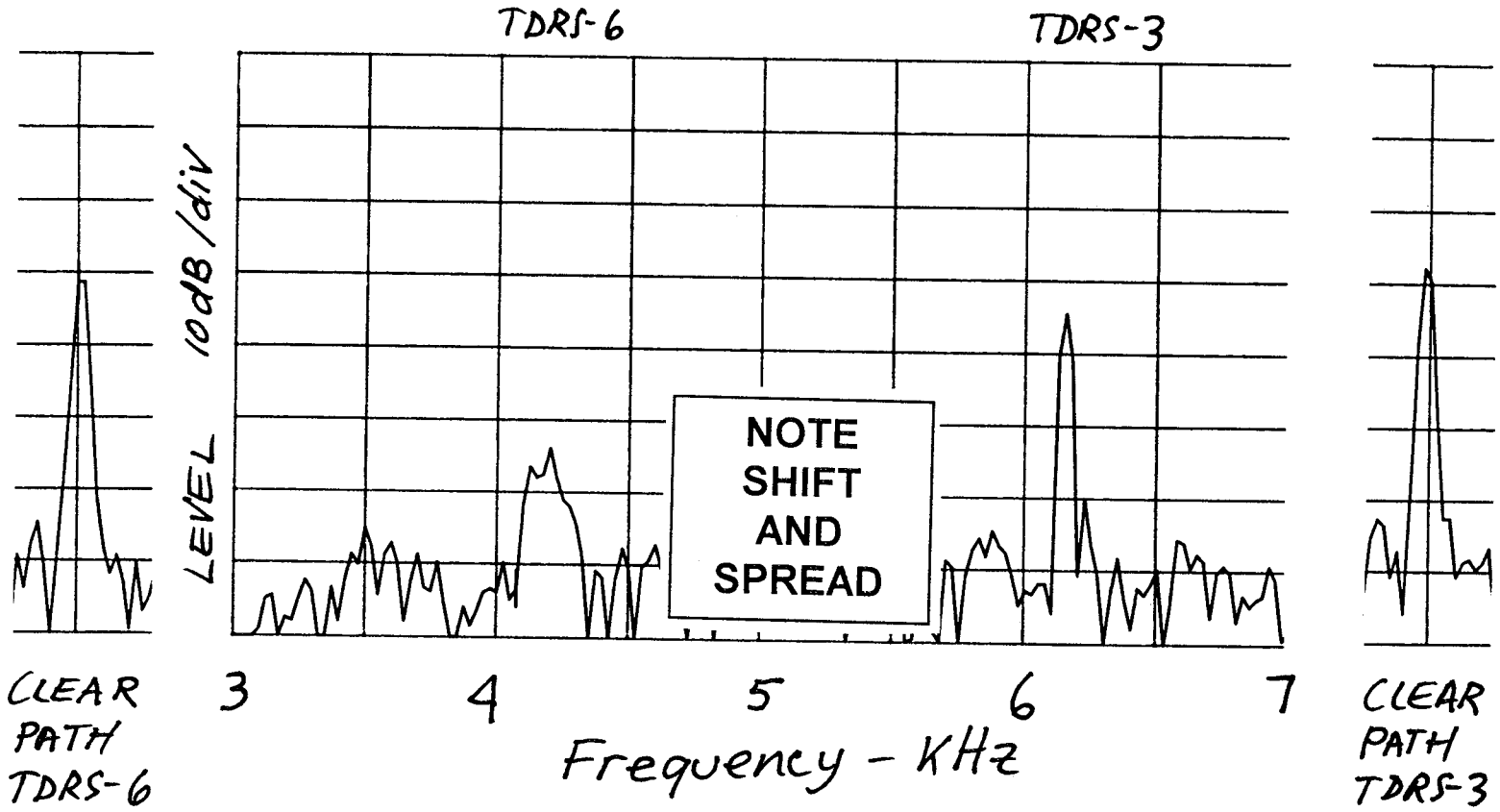
Example 2: Driving in a Car



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Data Reduction and Analysis

- transfer digital i.f. data from DAT recorder (16 bit, 48,000 sps) to PC
- programmed filtering and IQ detection
- derive log amplitude and phase timeseries
- classify by experimental parameters
- calculate cumulative fade statistics for each satellite observed
- calculate joint fade statistics
- calculate diversity gain

Experiment Plan

- observe TDRS-3 and -6 simultaneously
- in Austin, Texas
- every ~10° during move of TDRS-3
- with repeated MES scenarios
  - mobile with antenna on and in car
  - ported with receiver at head
  - in suburban and urban areas
  - in a few buildings
- reduce and analyze as funds become available

A MINIWORKSHOP
ON
ADVANCED COMMUNICATIONS TECHNOLOGY SATELLITE (ACTS) PROPAGATION STUDIES

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ACTS Opening Remarks

F. Davarian

Our ACTS propagation campaign has made considerable progress since the last time we met in New Mexico. We have gathered here today to review the status of our campaign and discuss issues needing our attention.

As you recall, in our previous meetings we had the NASA headquarters representative addressing us. He reviewed NASA's organization and objectives. However now that our NASA contact, John Kiebler, has retired, I will try to describe NASA's organization and its expectations of this campaign to the best of my ability. Please see Chart 1.

Changes in national priorities combined with a slow economy have had their effect on NASA. Headquarters has been going through transitions for the last two or three years. NASA is seriously reevaluating its priorities and is reconsidering the way it conducts business. In this climate NASA managers are sometimes too preoccupied to pay close attention to some of the ongoing programs such as ours. Fortunately for us and largely because of the good work of our community, the NASA Propagation Program is enjoying a good level of visibility at NASA.

I am happy to announce that in a recent review of NASA's communications projects, the NASA Propagation Program, and specifically the ACTS campaign, received positive feedback from the review committee. This committee consisted of the members of the space communications industry. I am also pleased to report that NASA funding of the ACTS campaign will continue.

NASA's requirement is that we help the satellite communications industry to develop and introduce new applications and services. Our community should rely on its own resources for success. I am asking our experimenters to continue their work with the same enthusiasm and dedication as before.

Many of the terminal bugs have been resolved, but not all have been corrected. I had to work hard to get renewed funding for Dave Westenhaver. Dave is funded now, and he is dedicated to quickly resolving all the remaining terminal issues. I am hoping that with help from the experimenters, Dave will be able to solve the remaining problems and, by the next time we gather, we will not have to be concerned about the terminals anymore.

At this stage, we should focus on data processing and analysis. I expect Bob Crane will continue his leadership role in this area. He has written a report on terminal calibration. We hope to be able to finalize our calibration scheme soon. I also expect that Wolf Vogel will play a strong role in these areas since

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he is a sophisticated experimenter with years of experience. In short, we should be sending calibrated preprocessed data to Wolf every month and be able to conduct analysis and modeling efforts.

Bob Bauer is requesting a one-year extension for our campaign. If he succeeds, we will have funding to continue our measurements for three years. He is also asking for a little more money after the measurements end to allow time to finalize our analysis and modeling. He will elaborate on this issue in his talk.

The evening plenary session jointly chaired by Bob Crane and Dave Rogers will serve to capture the essence of this meeting. I expect a summary report including a list of recommendations from them. This report will be published in the proceedings of our meeting.

ISSUES FROM THE LAST MEETING:

A) REPORTING

1. There is no longer a need for weekly reports. Please send a brief monthly status report to JPL. This report will indicate accomplished milestones and problem areas. Its size should be about half a page. To allow other experimenters to see your progress, I encourage the use of the ACTS e-mail system for status reporting.

2. Quarterly reports required under contract will continue to be sent to NASA Lewis with a copy to JPL.

3. Monthly data will continue to be sent to Texas.

B) OTHERS

1. Capacitor rain gauge

2. Digital receiver post-detection filter

3. Antiwetting agent to coat the antenna

4. Beacon-level changes

5. Calibration

In this workshop, we will focus on calibration and preprocessing. In the next one, we will focus on analysis and modeling. Please see Chart 2.

PROGRAM ORGANIZATION

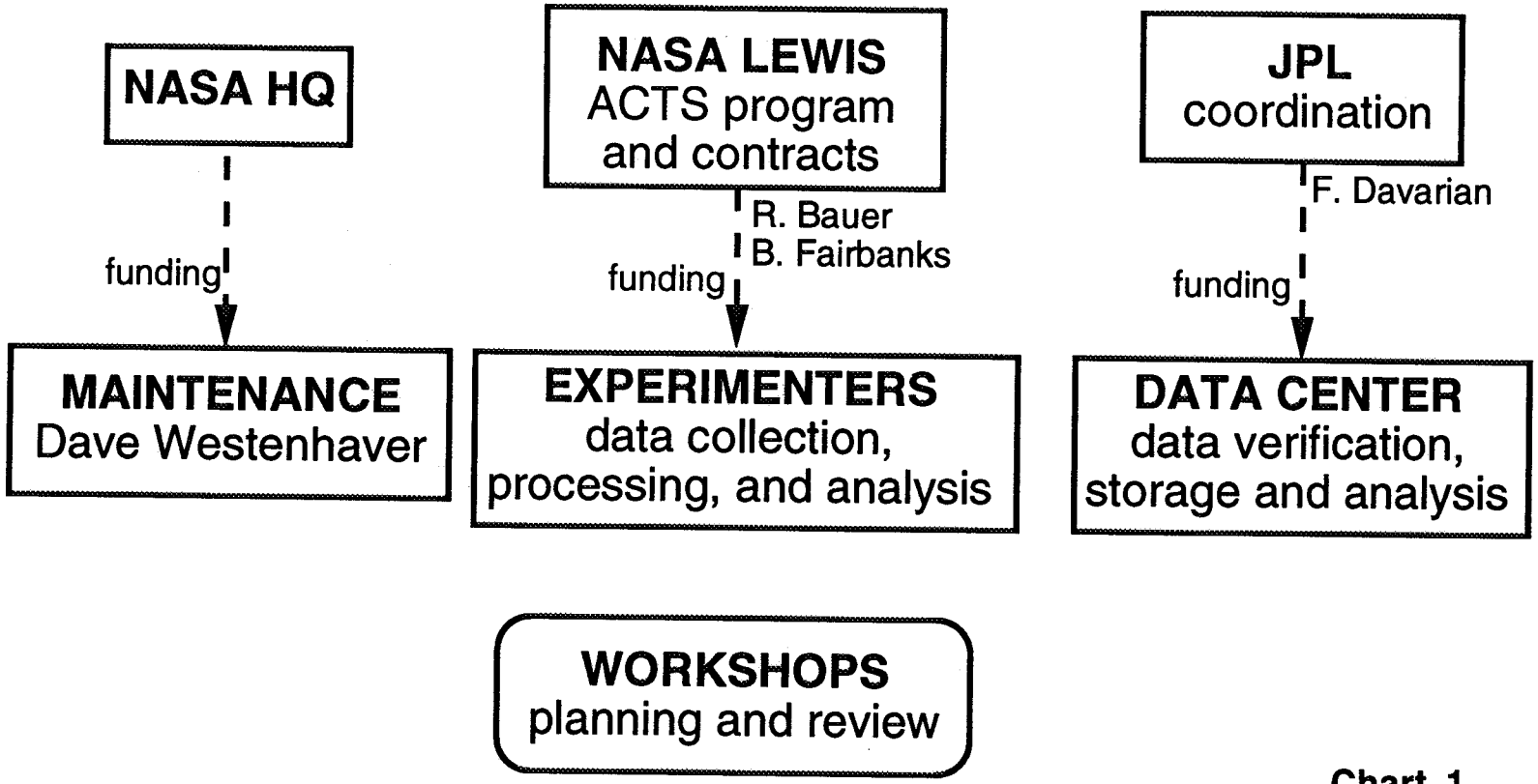


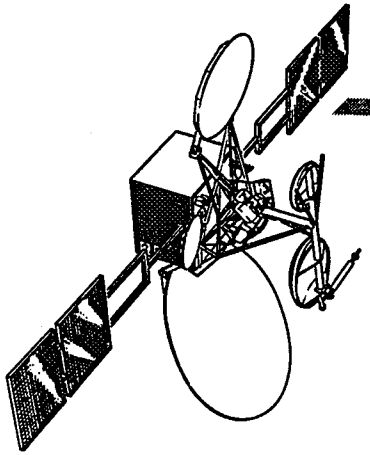
Chart 1

Focus Areas in ACTS Propagation Workshops

- November 1993
  - Terminal hardware/software
  - Calibration/ Preprocessing
- June 1994
  - Calibration/ Preprocessing
  - Analysis
  - Terminal hardware/ software
- November 1994
  - Data analysis
  - Modeling
  - Results

Chart 2

Advanced Communications Technology Satellite (ACTS) Program



ROBERT BAUER
NASA LEWIS RESEARCH CENTER

"ACTS STATUS AND UPDATE"

ACTS MINI WORKSHOP/NAPEX XVIII
VANCOUVER, BRITISH COLUMBIA
JUNE 16, 1994

ACTS

NASA

ACTS OPERATIONS STATUS

- AS OF MAY 01, 1994 FOUR YEARS OF STATIONKEEPING PROPELLANT REMAIN ON ACTS!

- OPERATIONS CAN NOW BE CALLED ROUTINE.

SPACECRAFT ATTITUDE

- S/C WAS BIASED IN PITCH & ROLL TO MAINTAIN CONSTANT DOWNLINK SIGNAL FOR MBA CHECKOUT AND TO BETTER COVER EXPTR. SITE ON EDGE OF BEAM.

  - Roll bias adjusted (removed) on 5/23/94 by 0.12° South to optimize MBA pointing.

  -02/05/94 S/C pitched +4.84° inadvertently (instead of -0.28°). C-band back-up used to re-establish control. S/C returned to normal within 5 hrs.

ACTS NASA

ACTS OPERATIONS STATUS, cont.

- OPERATIONS CONTINUE UNDER EARTH SENSOR CONTROL INSTEAD OF AUTOTRACK. YAW ESTIMATOR USED SINCE JUNE 01 AND HAS BEEN PERFORMING WELL.
  - Algorithm estimates position of Sun when it's not in view of Sun sensors.

ECLIPSE

- FIRST COMPLETE ECLIPSE CYCLE FROM 02/26-04/13/94.

- ANNULAR ECLIPSE ON 05/10/94.
  - 78% obscuration of ACTS @ ~11:00PM EDT.
  - System shut-down as during a seasonal eclipse.

THERMAL EFFECTS

- MBA CHECKOUT - VARIOUS TESTS PERFORMED TO MEASURE BEAM CENTERS AND PATTERNS.
  - Thermal effects mostly understood. Impact to spot beam users is negligible.

ACTS NASA

ACTS OPERATIONS STATUS, cont.

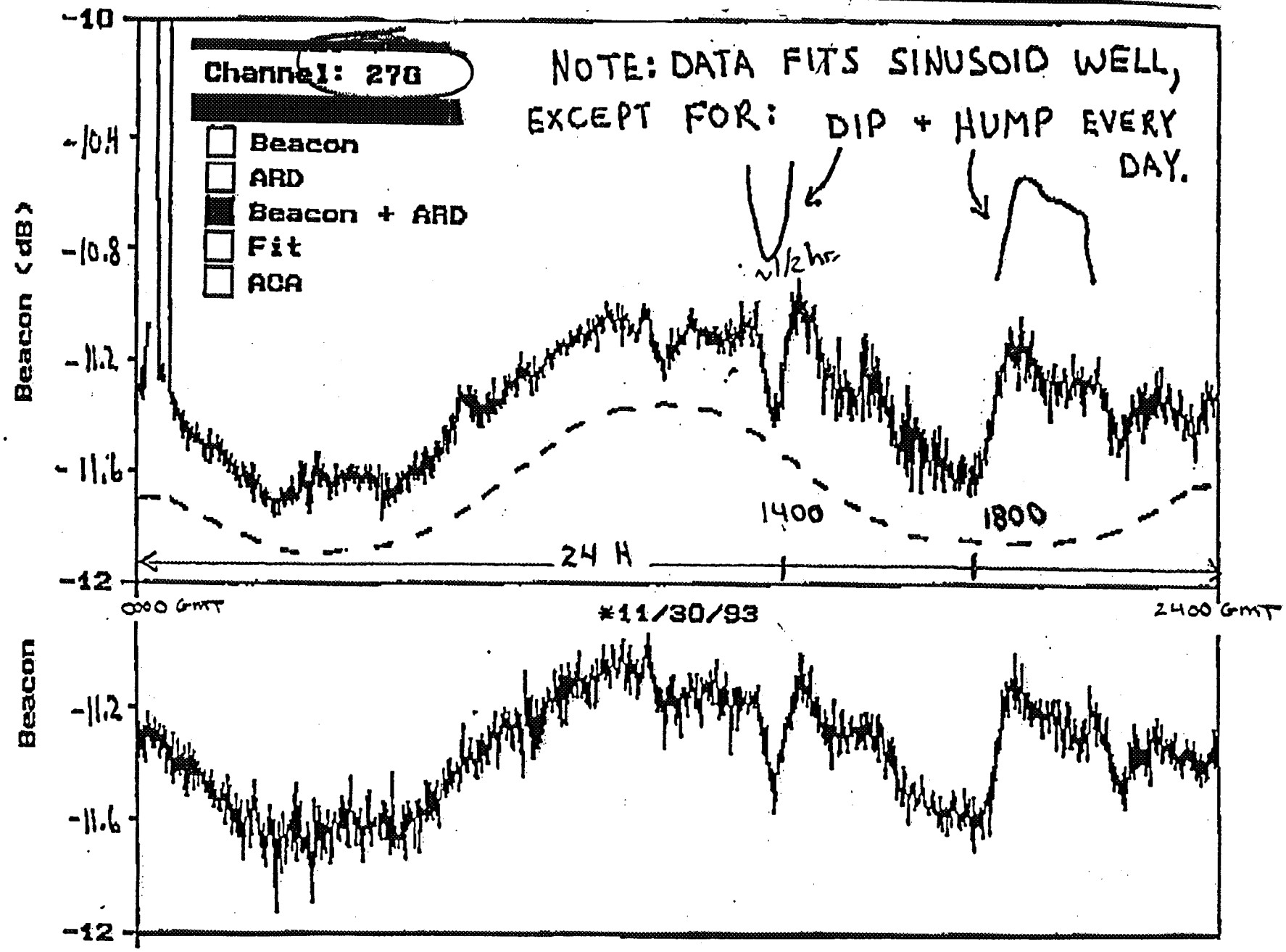
- "DIP" & "HUMP" IDENTIFIED BY PROP. EXPTRS. IN LATE NOV. '93 DUE TO AUTOTRACK ROLL PERFORMANCE.
  - S/C reacted to beam wandering due to thermal effects of MBA.

- DAILY HUMP & DIP (~±0.3 dB) REPORTED IN JAN. '94 OCCURRING AT ~0900 AND 1100 DUE TO LARGE (>100° C) TEMP CHANGE IN BEACON TOWER.

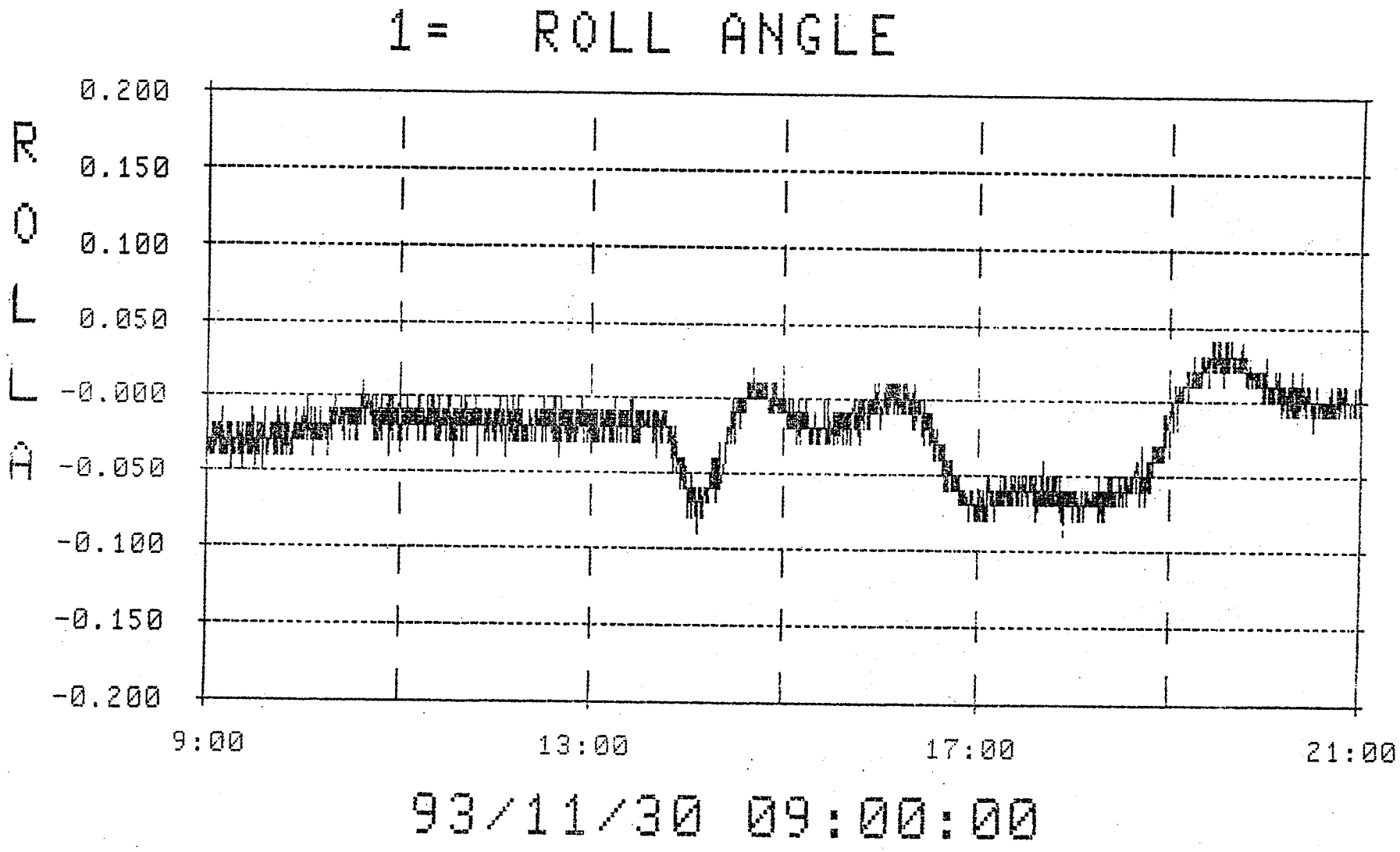
PAYLOAD

- APPROXIMATELY 6 MOS. OF OPERATIONS AND ALL SYSTEMS OPERATING WELL.

- BBP NETWORK CRASHES BY UNIQUE WORD/TRACKING ERROR WORD MISSES STILL UNDER INVESTIGATION.



UNIVERSITY OF ALASKA - "DIP & HUMP" PHENOMENA



SPACECRAFT RECORDED ROLL ANGLE - AUTOTRACK

ACTS OPERATIONS STATUS, cont.

- QUANTITY OF CRASHES HAS BEEN ON DECLINE.
  - Were occurring daily, typically one crash per day.
  - Occurrence now more erratic, sometimes none for weeks.
- 1 HZ ANOMALY BEING INVESTIGATED.
  - A 0.015° p-p variation in beam results in ~1 dB change in S/C D/L signal (at -10 dB beam contour) observed at LET, HDR and T1 VSAT's.
  - Theory is TX main reflector oscillates due to mechanical impulse by momentum wheel system.

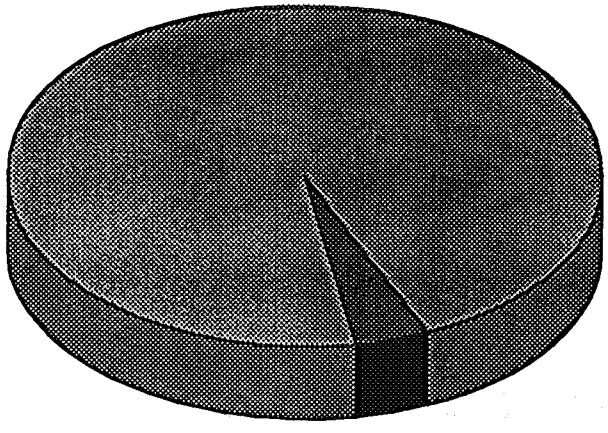
MGS OPERATIONS

- MGS STAFFED 24 H/D, 7 D/W; INCREASE TO 12 FULL TIME POSITIONS.
- SOME TWTA DIFFICULTIES (BBP UPLINK).

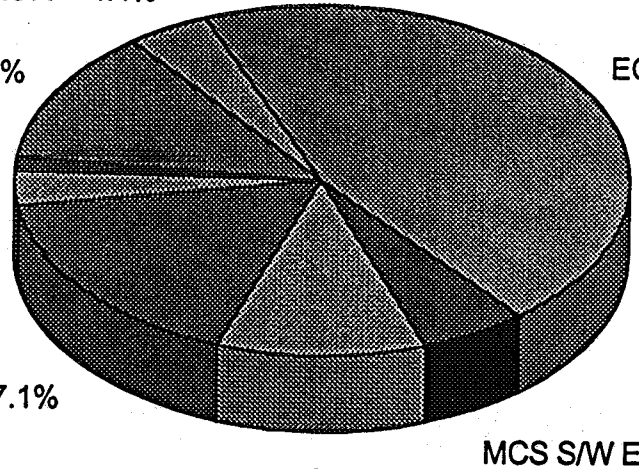
ACTS

NASA

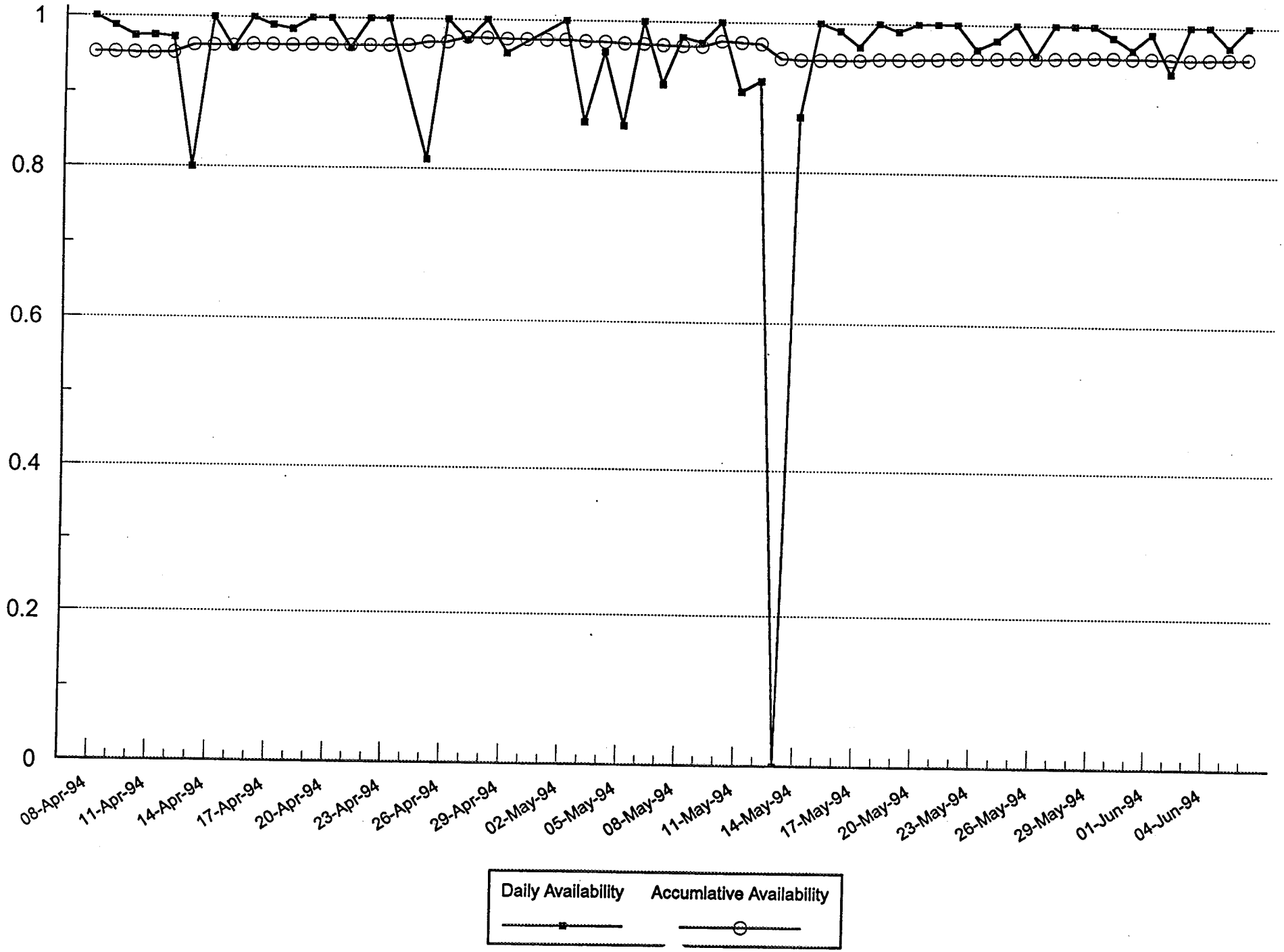
BBP MODE RELATED OUTAGES FOR LAST 60 DAYS



BREAKDOWN OF OUTAGES



BBP NETWORK AVAILABILITY FOR LAST 60 DAYS



ACTS MASTER CONTROL STATION, LEWIS RESEARCH CENTER

ORIGINAL PAGE
COLOR PHOTOGRAPH

ACTS EXPERIMENTS PROGRAM

- EXPERIMENTS APPROVED 76

- PIs, CO-PIs & AFFILIATED ORGANIZATIONS

INDUSTRY	39
UNIVERSITY	24
GOVERNMENT	23
CCDS	2
	88

	EXPERIMENTS				
TYPES	INDUSTRY	UNIVERSITY	CCDS	GOV'T	TOTAL
APPLICATION	23	10	1	12	46
TECHNOLOGY VERIFICATION	4	0	1	12	17
PROPAGATION	5	8	0	0	13
TOTAL	32	18	2	24	76

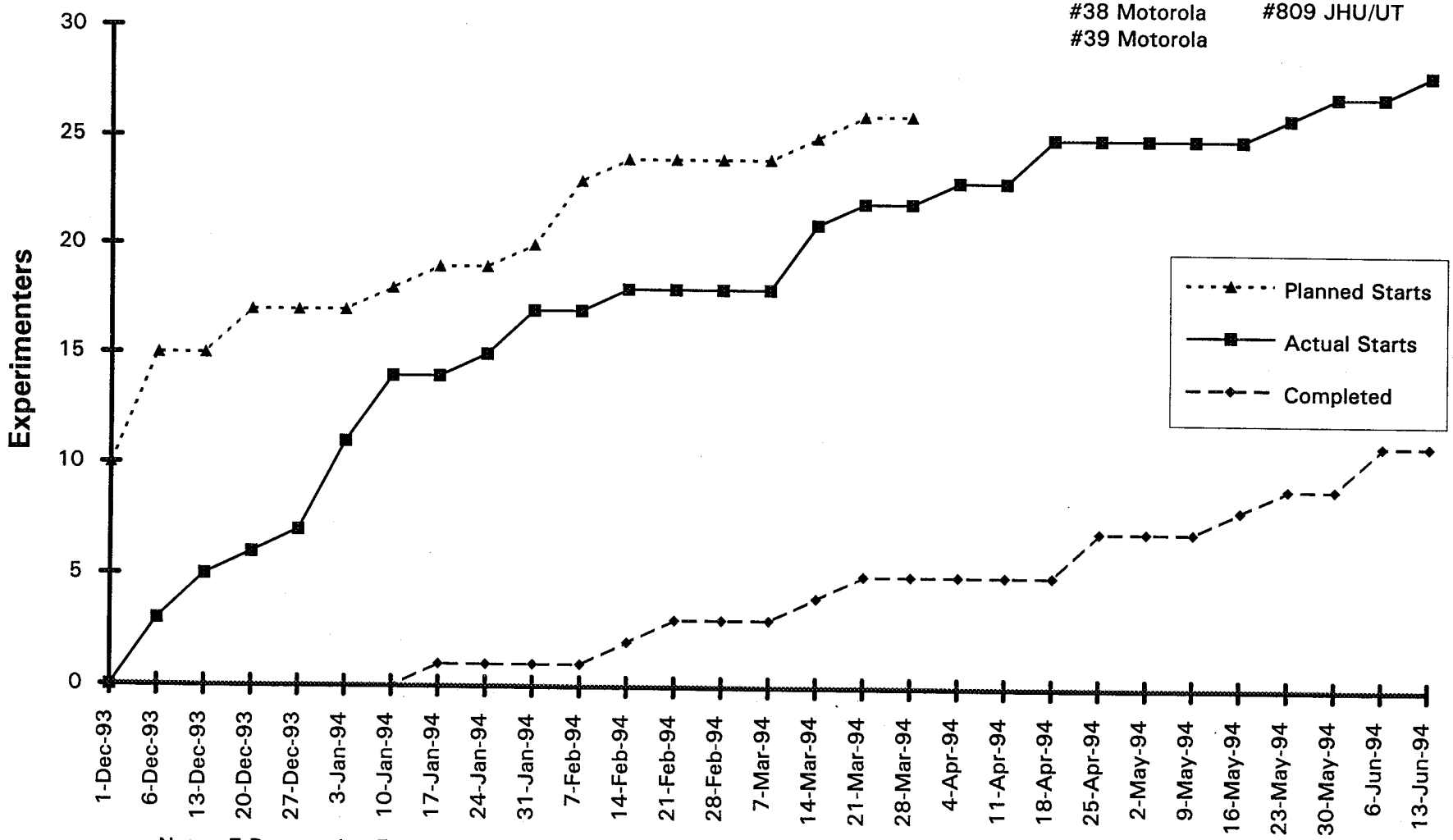
STATUS 5/13/94

HQMAY94

Not Started
#909 Digital Tv

ACTS Experiment Starts/Completes

Completed
#1,2,3 NCS
#13 Krug Life/JSC
#27 MITRE
#38 Motorola
#39 Motorola
#43 OU/Huntington Bank
#54 Univ of Florida
#58 EMSAT
#809 JHU/UT



Note: 7 Propagation Experiments currently running

6/14/94
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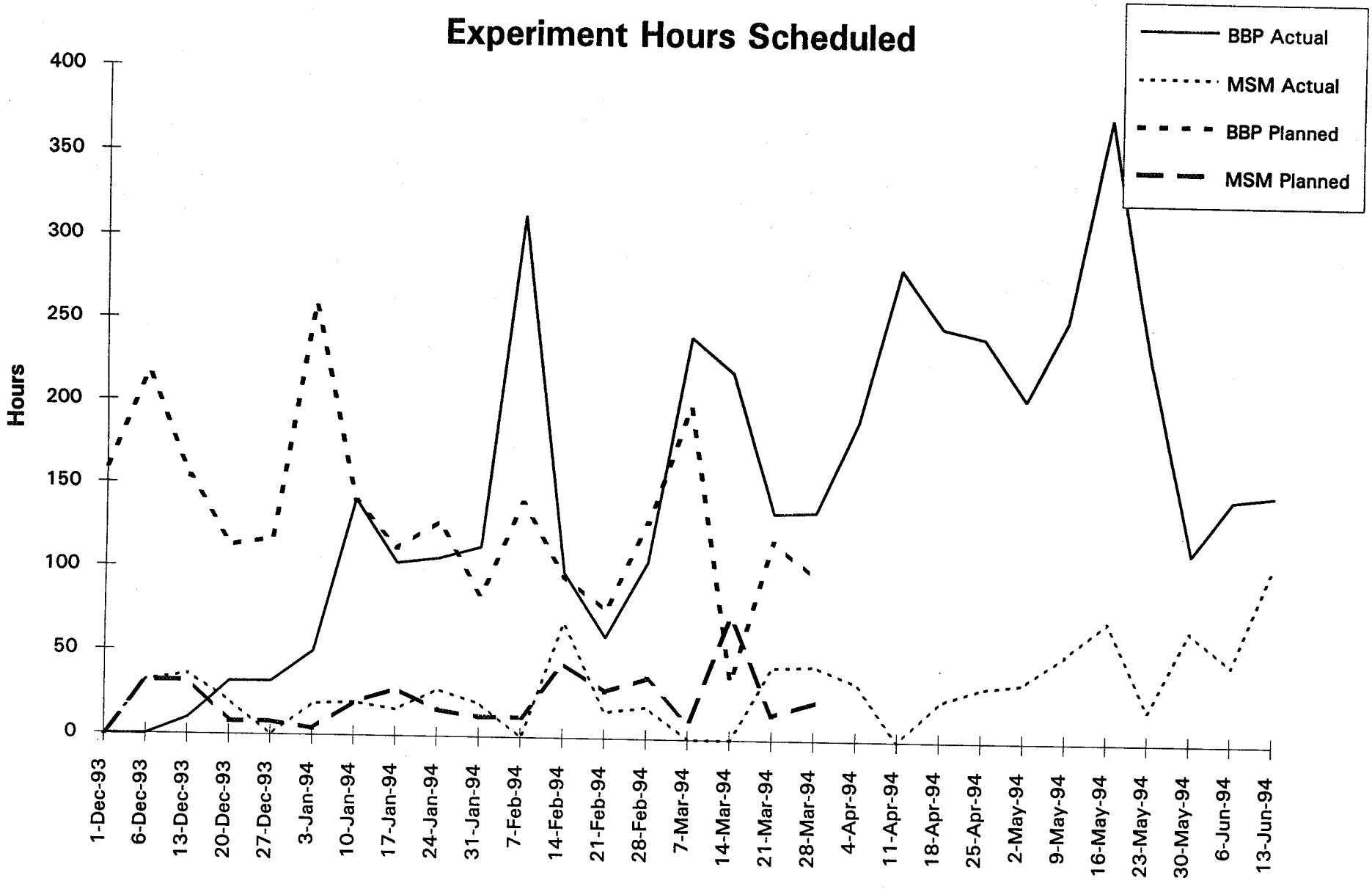
Experiment Starts and Completes by Week (actuals)

Line #	Date	Expt. #	Organization	Mode	Earth Station
1	6-Dec-93	8	JPL	MSM	AMT/LET
2		808	FAU	MSM	LET
3		908	INTEX	MSM	LET
4	13-Dec-93	38	Motorola	BBP	2, 13
5		39	Motorola	BBP	13
6	20-Dec-93	49	COMSAT	BBP	1, 7
7	27-Dec-93	45	TEC	BBP	19, 20
8	03-Jan-94	1	NCS	BBP	1, 4, 5
9		13	JSC/Krug	BBP	9, 12
10		43	OU/Huntington Bank	BBP	10, 11
11		58	EMSAT	MSM	AMT/LET
12	10-Jan-94	2	NCS	BBP	4, 5
13		7	Army	BBP	16, 17, 19
14		27	Mitre	BBP	5, 7
Completed	17-Jan-94	39	Motorola	BBP	13
15	24-Jan-94	901	MBA Performance	BBP	As Required
16	31-Jan-94	4	NCS	MSM	AMT/LET
17		701	NASA Demo	BBP	1, 9
18	14-Feb-94	809	JHU/UT	MSM	LET
Completed		2	NCS	BBP	4, 5
Completed	21-Feb-94	13	JSC/Krug	BBP	9,12

Experiment Starts and Completes by Week (actuals)

19	14-Mar-94	5	NTIA	BBP	9
20		6	ARL	BBP	2, 7, 8
21		17	COMSAT	BBP	5, 7
Completed		38	Motorola	BBP	2, 13
22	21-Mar-94	21	MAYO	BBP	12,13
Completed		58	EMSAT	MSM	AMT/LET
23	04-Apr-94	53	AERO-X	MSM	LET
24	18-Apr-94	54	University of Florida	BBP	3
25	18-Apr-94	3	NCS	BBP	1, 4, 5
Completed	25-Apr-94	1	NCS	BBP	1, 4, 5
Completed	25-Apr-94	3	NCS	BBP	1, 4, 5
Completed	16-May-94	54	University of Florida	BBP	3
26	23-May-94	804	COMSAT Uplink Power Control	MSM	LET
Completed		43	OU/Huntington Bank	BBP	10, 11
27	30-May-94	903	LET MSM Performance	MSM	LET
Completed	6-Jun-94	27	Mitre	BBP	5, 7
		809	JHU/UT	MSM	LET



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EXPERIMENTER EARTH STATIONS

		ACTS OWNED	EXPT'R OWNED	JOINT
BBP MODE:				
NGS TRAFFIC TERMINAL	1	1		
T1-VSAT	19	8	11	
MSM MODE:				
LINK EVALUATION TERMINAL	1	1		
HIGH DATA RATE	5	2	3	
ULTRA SMALL APERTURE TERMINAL (LERC/SCE)	5	2		3
ACTS MOBILE TERMINAL (JPL)	3	3		
AERO (JPL)	1	1		
MINI-TERMINAL (LERC)	1		1	
SETS (LERC)	1		1	
FAU (RCV ONLY)	1		1	
COMSAT/INTELSAT	3		3	
NASA GSFC	1		1	
PROPAGATION:				
BEACON RECEIVER TERMINALS	11	8	3	
TOTAL	53	26	24	3
POTENTIAL:				
MSM MODE:				
BB AERO (ROCKWELL)	1		1	
HDR (NCS)	1		1	
TOTAL	2		2	

STATUS 5/13/94

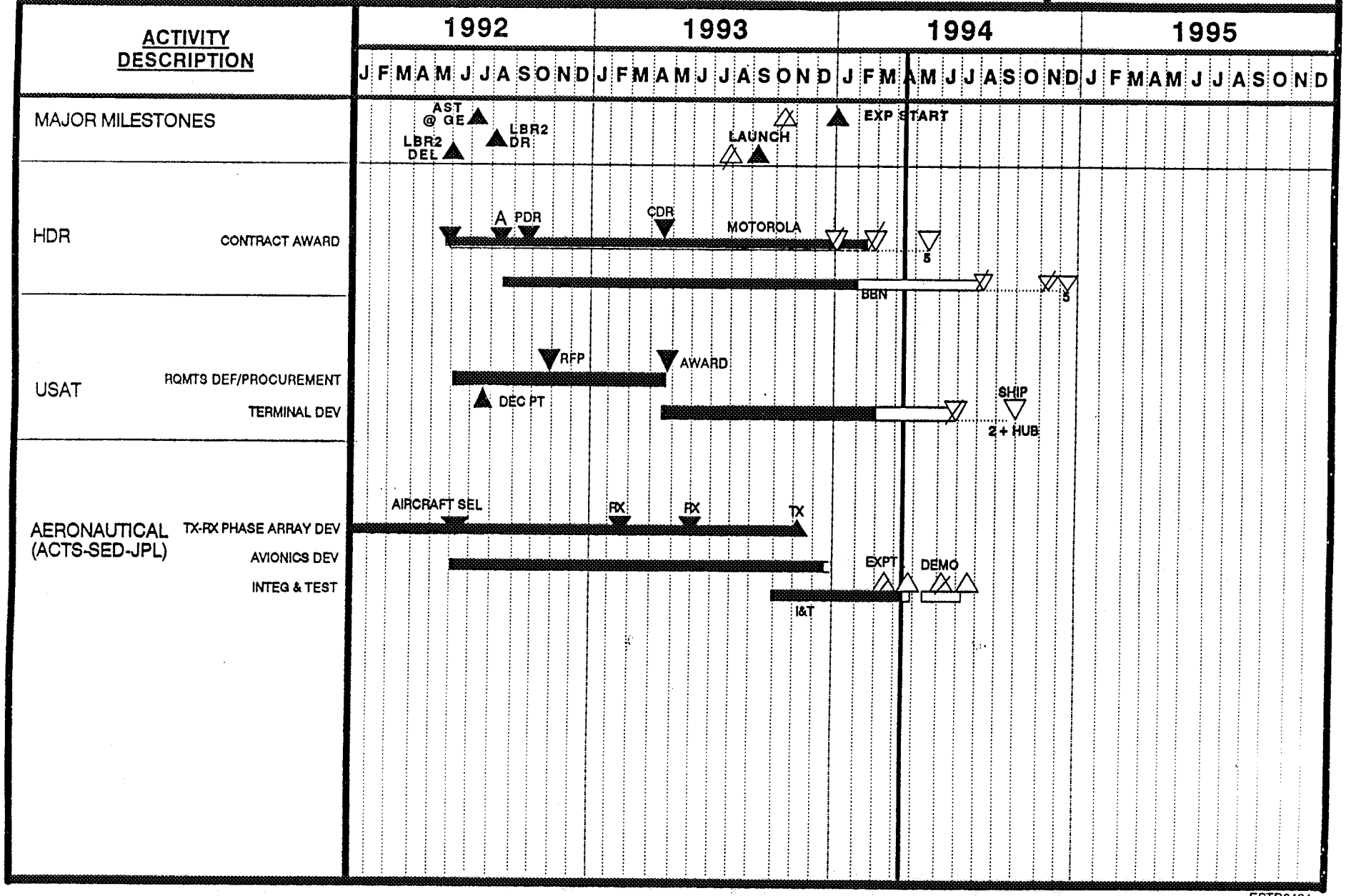
HQMAY94

T1 VSAT EARTH STATION LOCATIONS

#64/T1_LOC
6/1/94

ACTS Experiments Program Terminal Development Schedule

PLAN DATE:
REV 4: 5/14/93
STATUS: 4/25/94
PREPARED BY: B. BEZNOSKA



EPTD0494

HDR Station at Motorola GSTG, Chandler, AZ
3.4 m, 622 Mbps

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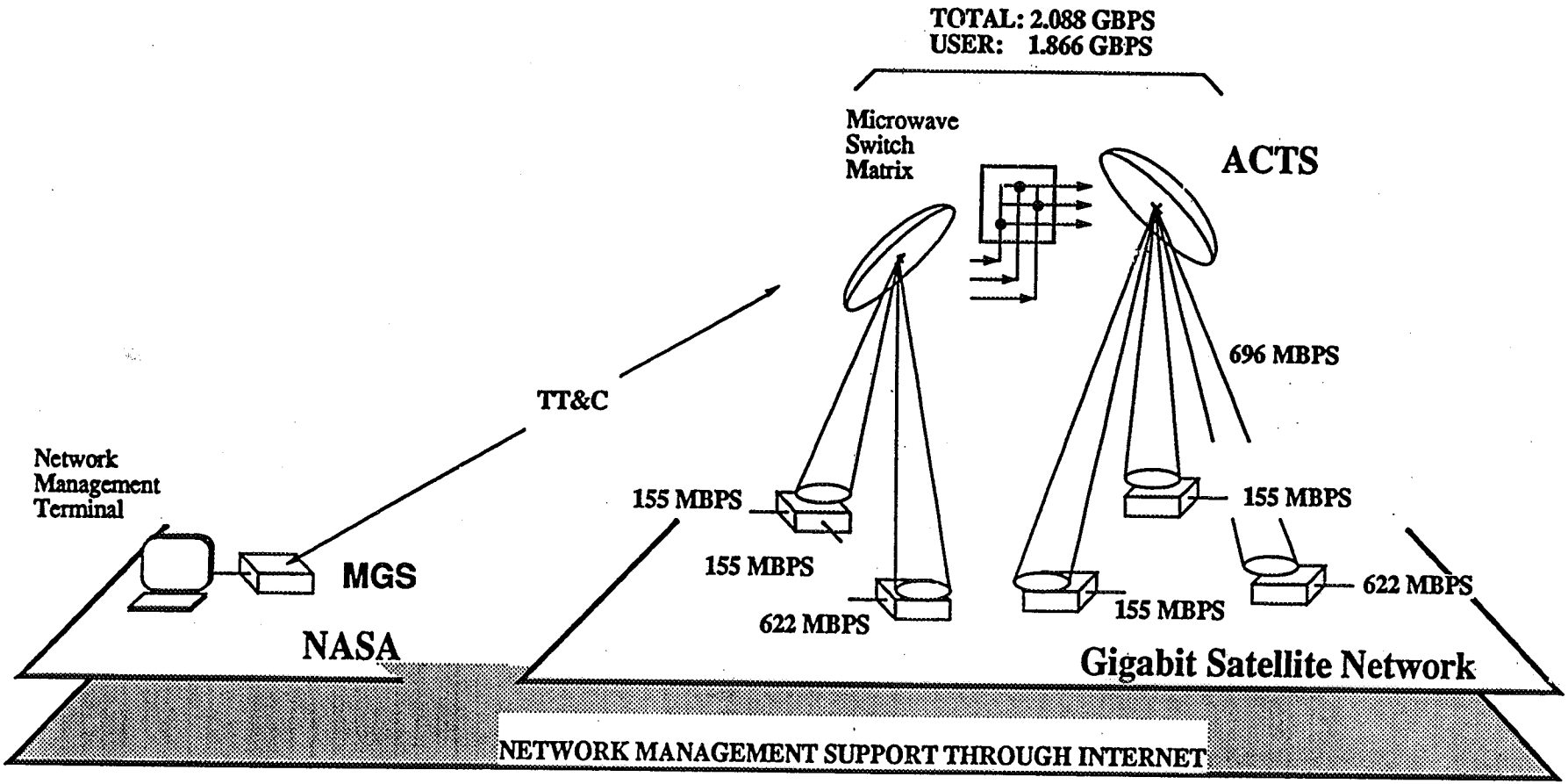
The Network Supports Sonet Interfaces at OC-3 and OC-12 Speeds and Provides Network Operators at NASA's Master Ground Station (MGS) with Direct Access to all Earth Stations.

BBN



HDR EARTH STATION LOCATIONS
PLANS FOR EXPERIMENTS

NOTES

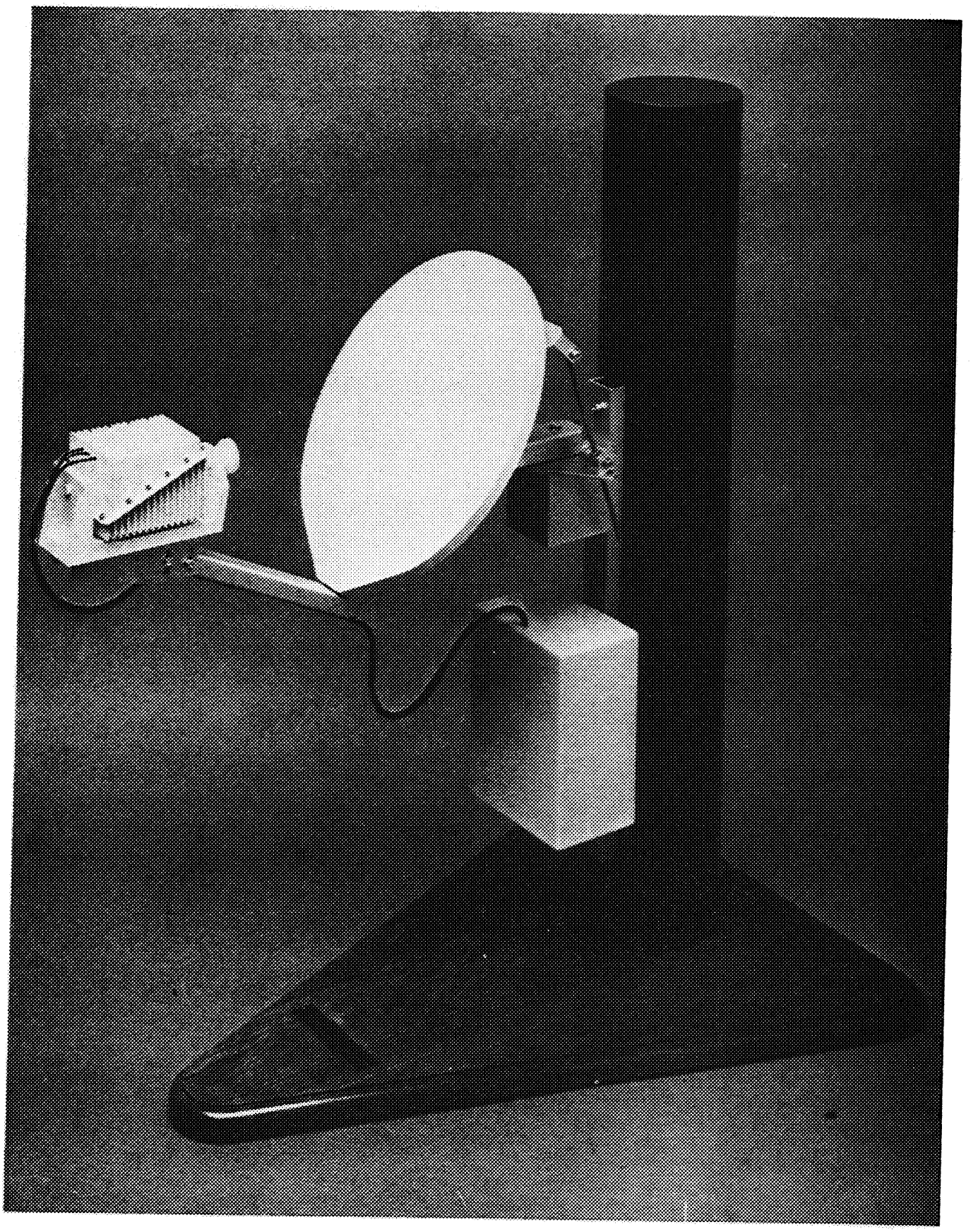
Initial 24 Months forHDR
5 HDR Earth Stations
8 Experiments
9 Geographic Sites
3 Terrestrial Fiber Networks

EXPERIMENT CONNECTIVITY

ATDnet via DC - Hawaii
MAGIC via KC - Scottsdale
Columbus - Boulder
Keck via Tripler - Pasadena
DC - Pasadena
Tripler - Columbus - ATDnet
MAGIC via KC - DC via ATDnet
Cleveland - Seattle

#64/HDR_LOC7
5/27/94

NASA
C-92-03860



ACTS ULTRA SMALL APERTURE TERMINAL (USAT)
0.35 m diameter reflector; 4.8 kbps

AERONAUTICAL EXPERIMENT
(AERO-X)

SUCCESSFULLY TESTED THE AERONAUTICAL TERMINAL WITH THE ACRYLIC WINDOW AND POSITIVE LINK MARGINS.

CONTINUOUS PILOT TONE MONITORING AS WELL AS VOICE CONNECTIONS AT 9.6 AND 4.8 Kbps WERE ACHIEVED.

TUESDAY 26 APRIL 1994: MAIDEN VOYAGE

LEAR JET SPEED: 320 NAUTICAL MILES/HR

ALTITUDE: 41,000 FT

LOCATION: 150 MILES NW OF CLEVELAND

TIME OF 1ST CONVERSATION: 8:36 AM

CODEC RATE: 9.6 Kbps

LAST VERIFICATION FLIGHT: THURSDAY 12 MAY
FIRST DEMO FLIGHT: MONDAY 11 JULY

Acts Propagation Terminal

Maintenance, Support and Updates

David Westenhaver
Westenhaver Wizard Works, Inc.
June 16,1994

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The GOAL of the Propagation experiments is to collect the maximum of meaningful propagation data from the ACTS satellite during the measurement period, so that any proposed propagation solution will have a solid experimental data base to be used to accurately predict the communication system performance AND to provide data to encourage inventive solutions to propagation problems in a system.

The GOAL of the Maintenance and Support effort is to assist the Users in keeping the propagation data collection system operational to maximize the quantity of meaningful propagation data.

Status / Deficiencies and Known Problems

DACS / TSR Hardware / Software status:

DACS / TSR Software status:

Revised, Version 5 Shipped Dec.14,1993

Revised, Version 7 Shipped Jun. 2,1994

Software Bugs Status:

Commutation Protocol errors; Version 5.

Compiler warnings removed; Version 6.

ADC and DAC logic system review; Version 6.

Analog voltages can have overflow; Version 6.

Incorrect WWV time causes loss of data;Version 7

Setup takes too long and is dumb; To Be Addressed.

Radiometer calibration can occur during a fade; TBA.

DACS needs updated EPROMS; TBA.

Pressing Problems:

Problem: Crashes and Reboots.

Solution: Rework code to limit effect.

Save settings and download passed on reboot.

Keep searching for the hardware problem.

RF Temperature Controller:

Problems: Generates noise , FETs over stressed, lack of regulation.

Solution: New design is in progress.

New units will be sent in exchange for current units.

Receiver Enclosure temperature regulation:

Problem: The air temperature OK but IF's follow outside temperature.

Solution: Larger fan, Move thermostat, Air flow baffles.

DRX Hardware / Software status:

DRX software status:

Revised, Version 12 Shipped Dec. 14,1993

1Hz Filters Removed; Version 12.

20 Samples / second data is limited to 2-3 Hz BW; To Be Addressed.

Missing synchronization command / responses; TBA.

Pressing Problems:

Problem: 20 S/S Data Is Limited.

Solution: Rework Algorithm.

Problem: At least one unit fails above 48 Degrees.

Solution: Replace Temperature sensitive chip.

Status of Software:

ActsView software status:

Revised, Version 2.1 Shipped Nov. 15,1993

- System Crash at 23:59:59 if on status screen; TBA
- Fails to "remember" last "custom" axis scaling; TBA.
- Tape Backup Crashes system; TBA.
- Data Problem with Daily Plots; TBA.
- "Phase Noise" plot labels incorrect; TBA.
- File Handles Need to be consistent; TBA.
- Time axis not in integer minutes; TBA.
- Unable to request "plot xx:xx:xx time"; TBA.

ActsEdit software status:

Version 1.2 Shipped Jan. 10,1994 (Gaff)

- Flags errors for Bad data; Version 2.
- Review Edit w/o removing work files; TBA.
- Add Range Tones Correction;TBA.