

MODIS

Hardware Development Status

12 October, 1994

T. Pagano



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MODIS Technical Status Topics

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- **Engineering Model (EM) Subassembly Status**
 - **Mainframe**
 - **Scan Mirror**
 - **Telescope**
 - **Aft Optics Assembly**
 - **Radiative Cooler**
 - **Focal Plane Assemblies**
 - **Electronics Modules**
 - **Blackbody**
- **Performance Highlights**
- **Hardware Development Video**

EM SUBASSEMBLY STATUS

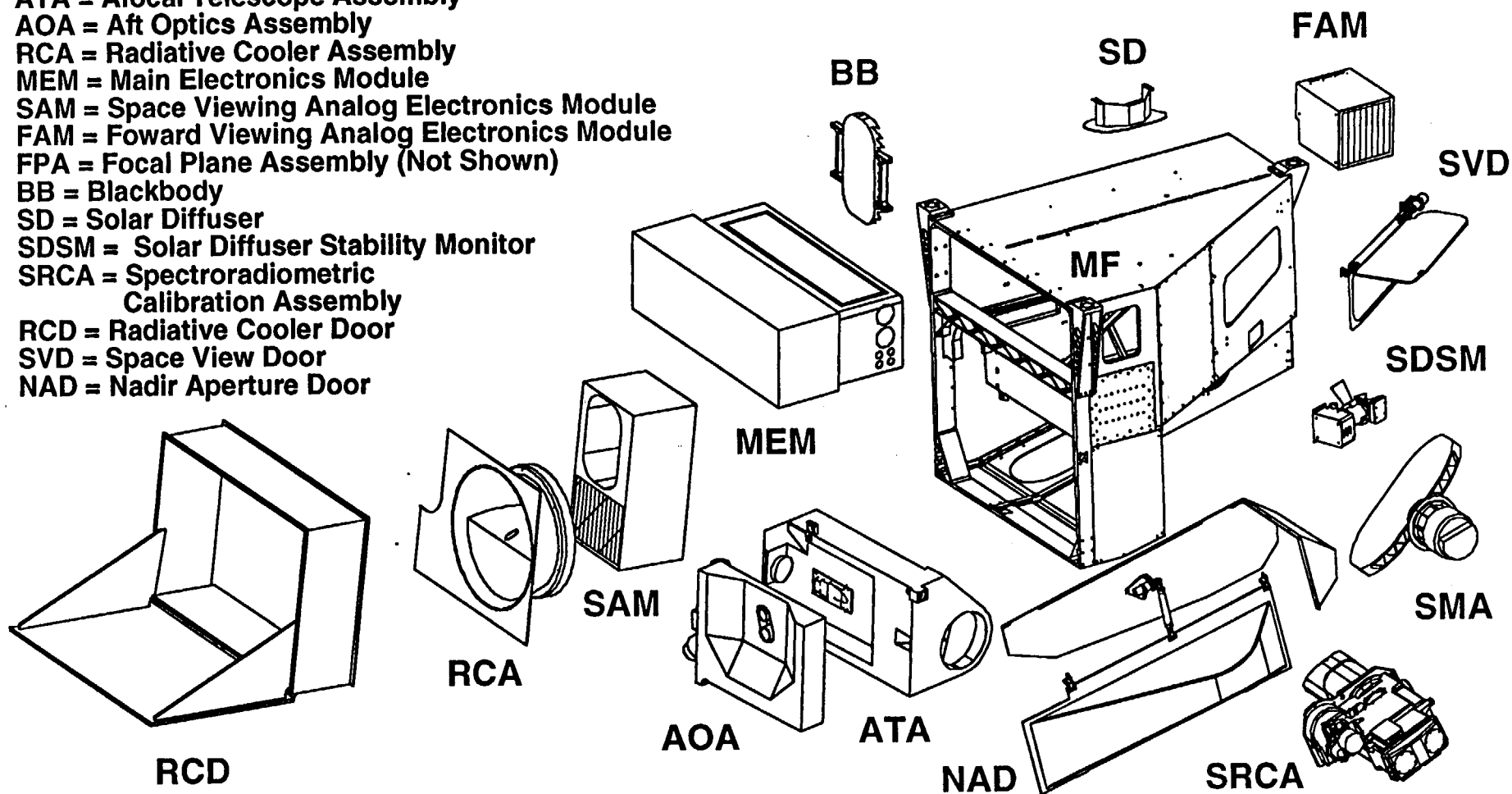


EXPLODED VIEW HIGHLIGHTS MAJOR SUBASSEMBLIES

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- MF = Mainframe
- SMA = Scan Mirror Assembly
- ATA = Afocal Telescope Assembly
- AOA = Aft Optics Assembly
- RCA = Radiative Cooler Assembly
- MEM = Main Electronics Module
- SAM = Space Viewing Analog Electronics Module
- FAM = Forward Viewing Analog Electronics Module
- FPA = Focal Plane Assembly (Not Shown)
- BB = Blackbody
- SD = Solar Diffuser
- SDSM = Solar Diffuser Stability Monitor
- SRCA = Spectroradiometric Calibration Assembly
- RCD = Radiative Cooler Door
- SVD = Space View Door
- NAD = Nadir Aperture Door





Subassembly Status



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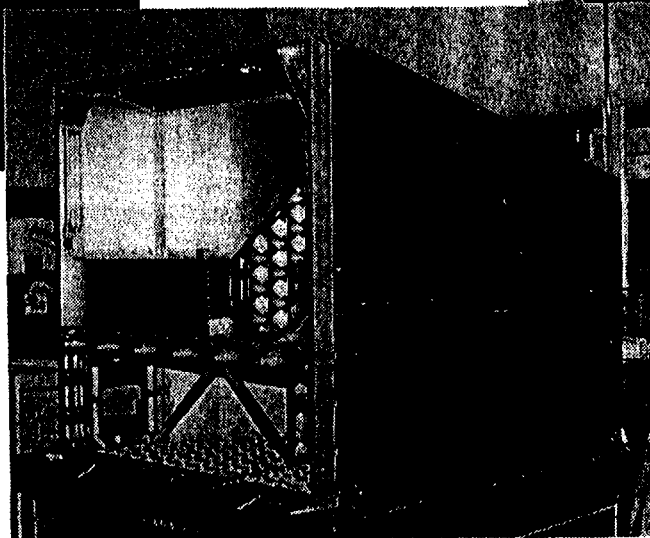
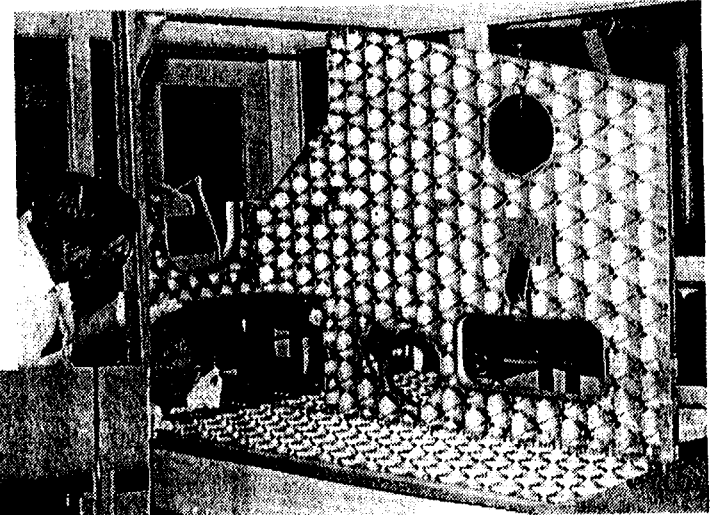
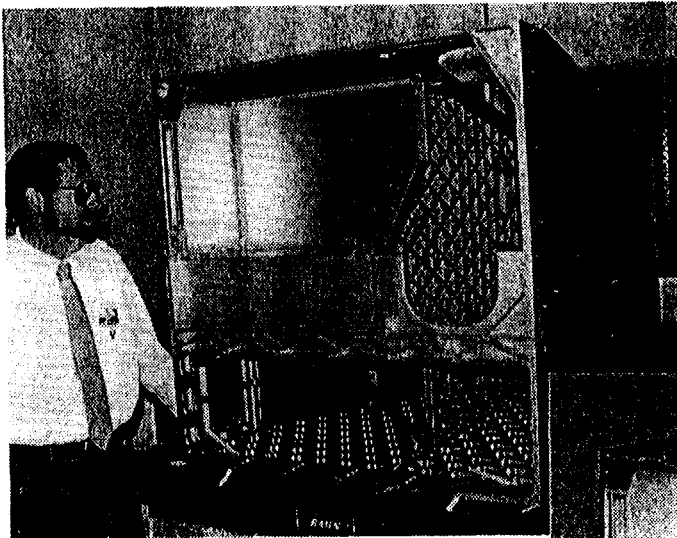
MF = Mainframe	Complete
SMA = Scan Mirror Assembly	Complete
ATA = Afocal Telescope Assembly	Complete
AOA = Aft Optics Assembly	Complete
RCA = Radiative Cooler Assembly	Complete
MEM = Main Electronics Module	80%
SAM = Space Viewing Analog Electronics Module	In Test
FAM = Foward Viewing Analog Electronics Module	In Test
FPA = Focal Plane Assemblies	Complete
BB = On-Board Blackbody	50%
SD = Solar Diffuser	Not on EM
SDSM = Solar Diffuser Stability Monitor	Not on EM
SRCA = Spectroradiometric Calibration Assembly	Not on EM
RCD = Radiative Cooler Door	Not on EM
SVD = Space View Door	Not on EM
NAD = Nadir Aperture Door	Not on EM

Mainframe Fabricated and Tested

94-06-133



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94-0675



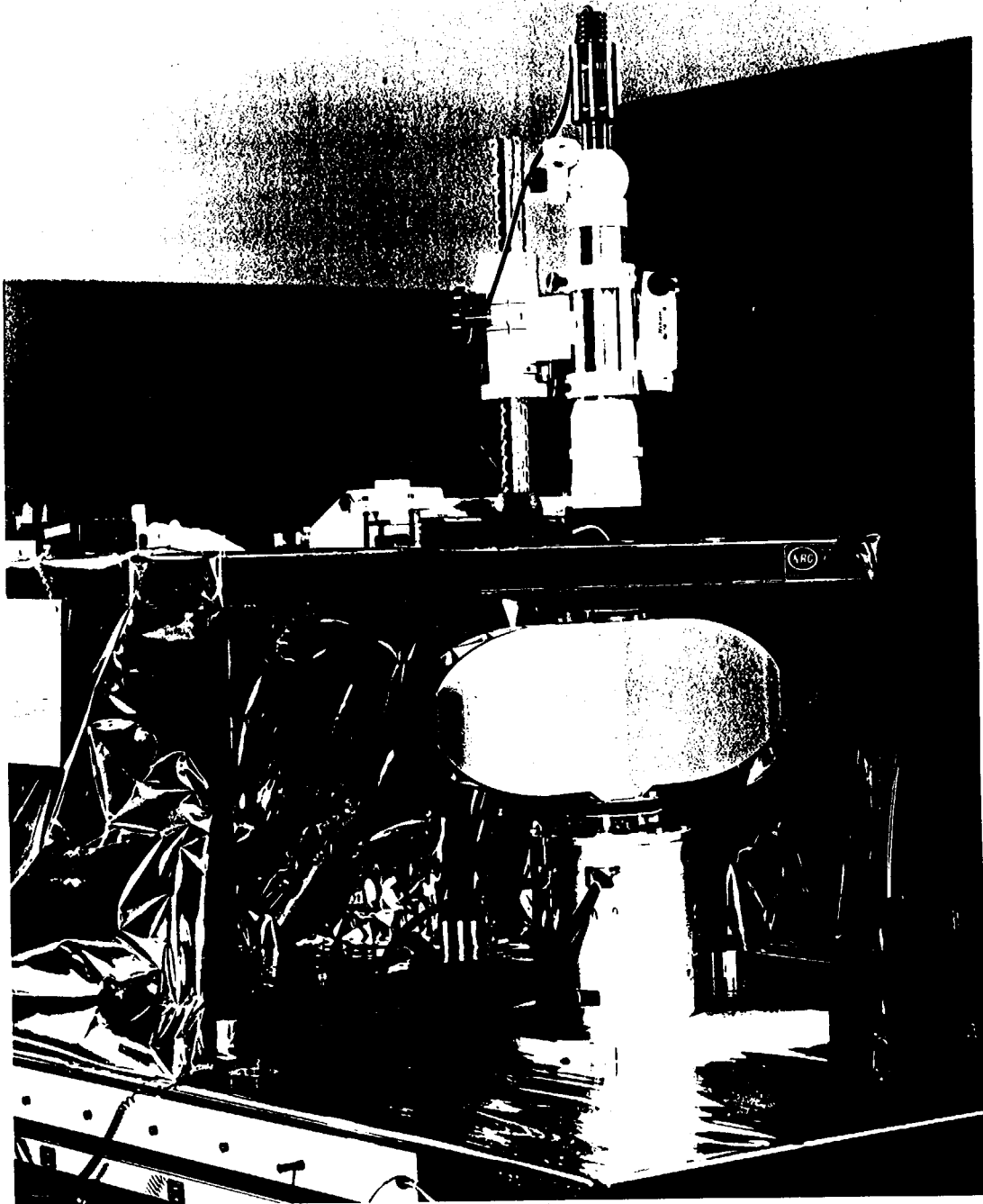
Mass-Loaded Mainframe Test Successful



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- Mass-Loaded Mainframe (Structural Model) successfully qualified
 - Full Power Random in X, Y, and Z (5.7 g-rms)
 - Full Power Proof Loads test using Sine Burst
 - 12 g's in X, 9.8 g's in Y and Z
- Mainframe has higher damping than assumed for structural analysis

	<u>Achieved</u>	<u>Spec</u>
• Lowest Fundamental Mode	43 Hz	35 Hz



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Scan Mirror Assembly Complete





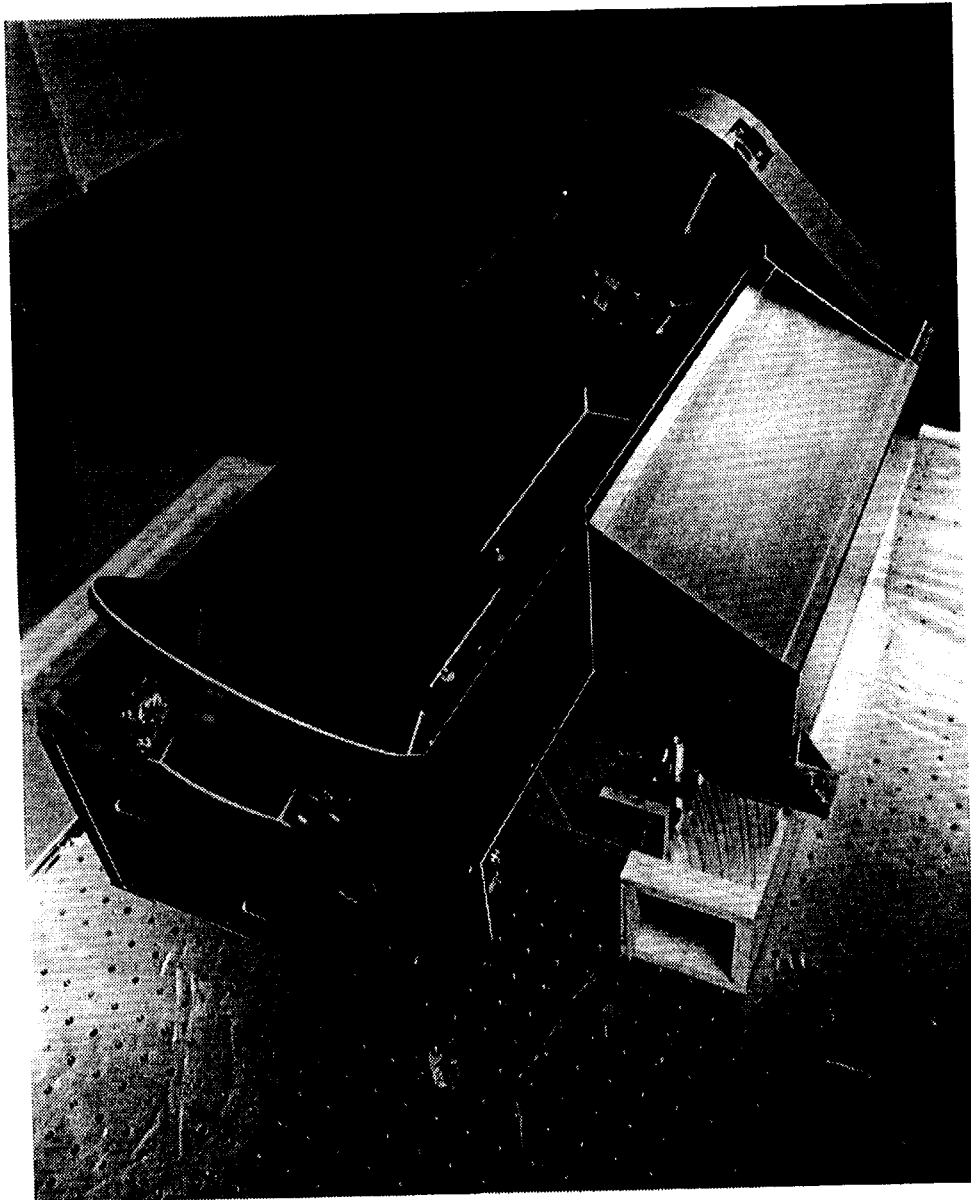
EM Scan Mirror Assembly Performance Results



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- Scan mirror integrated to motor/encoder
- Scan mirror aligned to rotational axis of motor
- Scan mirror assembly ready for integration
- Mirror temperature monitor breadboard unit testing complete
- Bearing life test at 10 Million cycles (57 Million Required)

	<u>Measured</u>	<u>Spec</u>
Mirror rotational error to motor/encoder	2 arcsec	< 10 arcsec
Mirror parallelism	< 10 arcsec	< 36 arcsec
Motor/encoder positional repeatability	< 0.5 μ rad	< 10 μ r rms



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EM Afocal Telescope Assembly Complete





Afocal Telescope Assembly Complete



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- Mirrors prealigned on alignment fixture
- Mirrors installed & Aligned on Afocal Telescope Bench
- ATA Ready for system integration with Aft-Optics Assembly

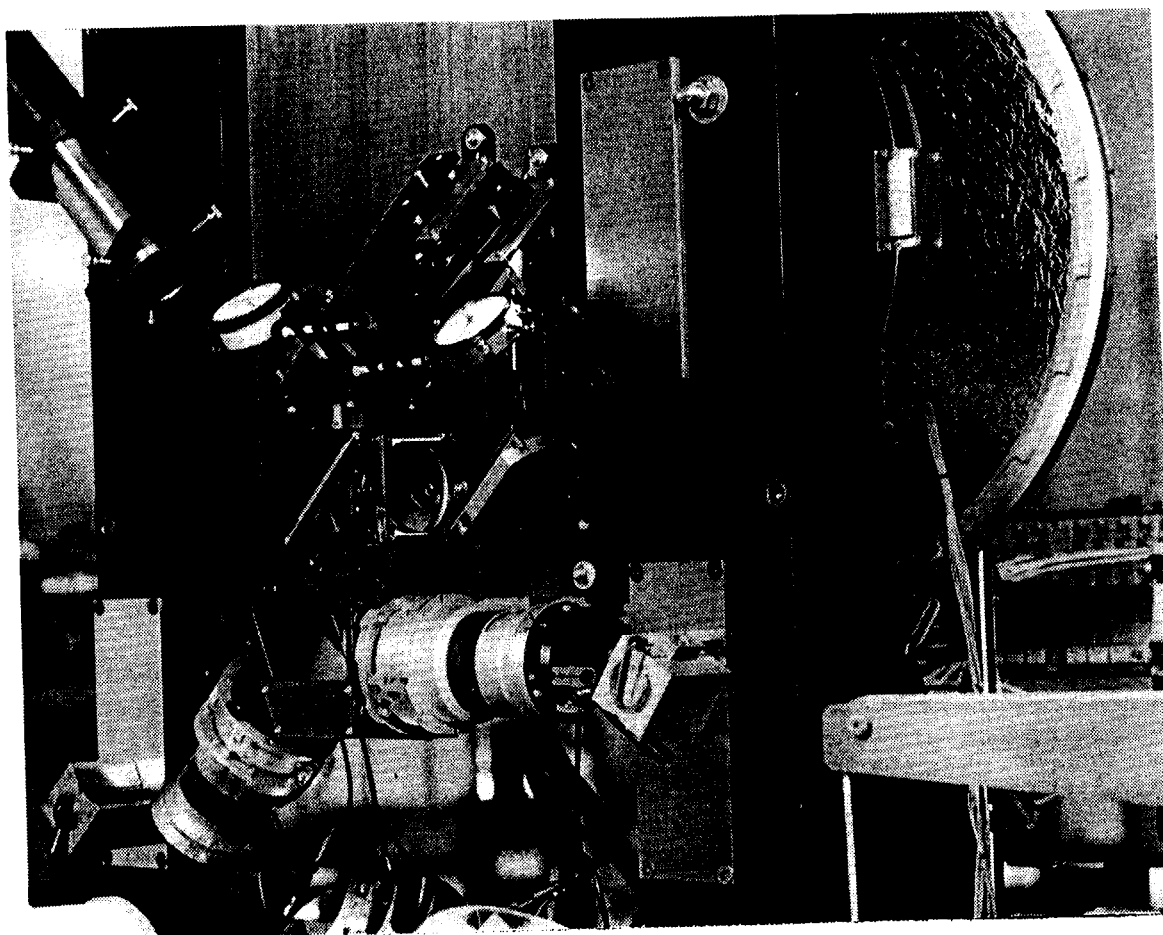
	<u>Measured</u>	<u>Spec</u>
• Abberation	1-wave @ 632.8nm	3-waves
• Boresight Error	2 pixels	1 pixel
• Magnification	3.984x (0.4% Error)	4x \pm 0.1%
• Boresight and Magnification errors easily correctable for PF		



All Objectives Complete & Integrated to AOP

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All Objective Assemblies Complete

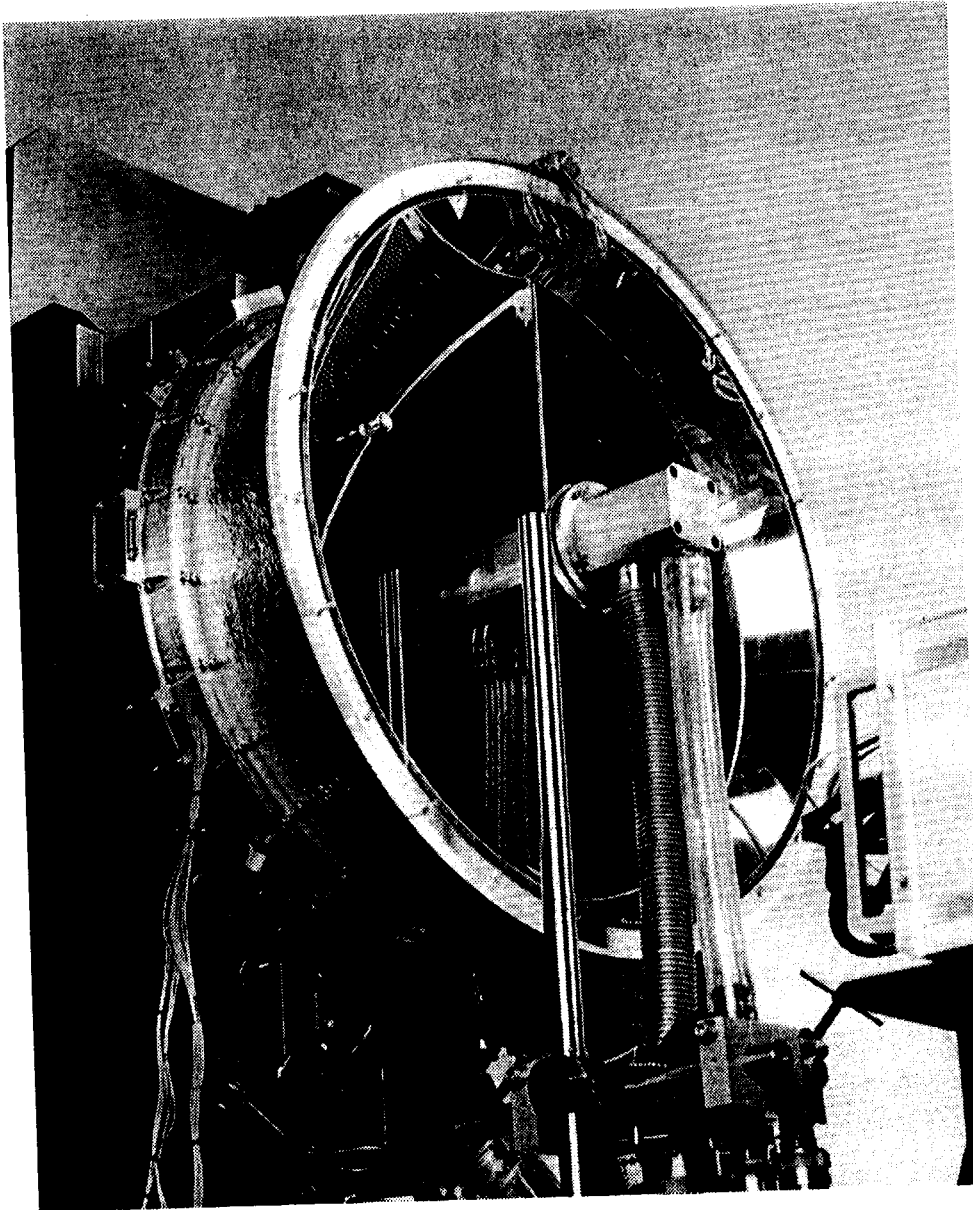


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- Objective lenses mounted in lens cells
- Pre-alignment (boresight, EFL, distortion) in optics laboratory
- Objectives integrated onto Aft-Optics Platform
- Residual Performance After Alignment:

	<u>EFL Error</u>		<u>Focus Blur</u>	
	<u>Measured</u>	<u>Spec</u>	<u>Measured</u>	<u>Spec</u>
VIS	- 0.13%	0.3%	45 μ m	100 μ m
NIR	+0.25%	0.3%	44 μ m	100 μ m
SMWIR	+1.4%	0.3%	59 μ m	100 μ m
LWIR	-1.1%	0.3%	50 μ m	100 μ m

- EFL Errors due to integration tooling deficiencies; correctable for PF



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Radiative Cooler Complete & Integrated to AOP





Radiative Cooler Meets Performance Objectives



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- Passive Radiative Cooler assembly complete
- SWIR/MWIR and LWIR FPAs installed
- Cooler successfully vibrated to acceptance levels
- Thermal vacuum testing shows acceptable performance
- Cooler integrated to AOP; Bench Test Cooling to $\leq 83\text{K}$ successful

	<u>Predicted</u>	<u>Measured</u>	<u>In-Flight</u>	<u>Spec</u>
Lowest Achievable Temperature	74.7K	73.3K	73.9K	N/A
Nominal Load Temperature	81.2K	80.5K	81.0K	85.0K

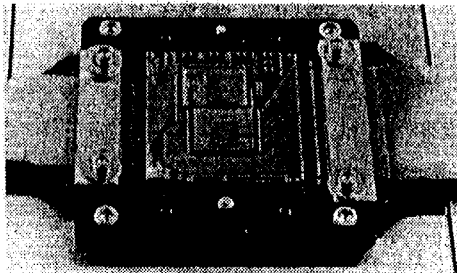


ALL ENGINEERING MODEL FOCAL PLANES DELIVERED

93-8-232C

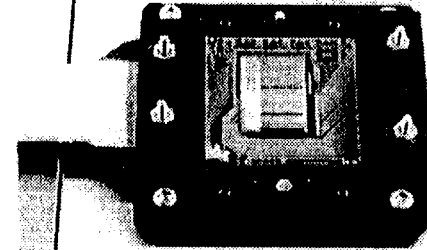
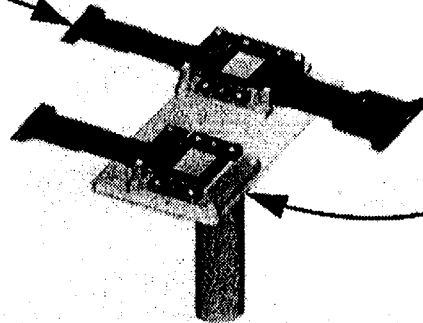


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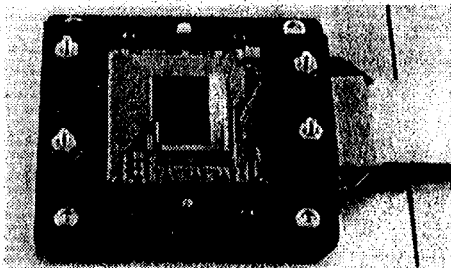


EM
LONGWAVE
IR FPA

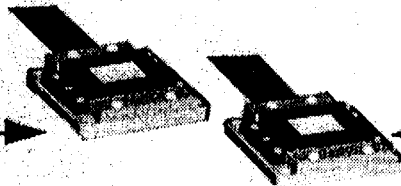
COLD FOCAL PLANE
ASSEMBLIES (FPAs)



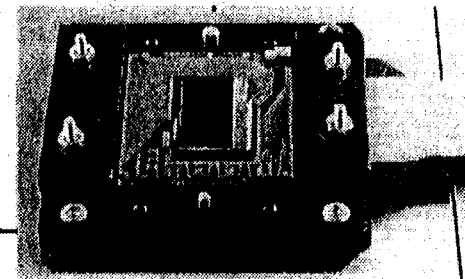
EM
SHORT/MID WAVE
IR FPA



EM
VISIBLE FPA



AMBIENT FPAs



EM
NEAR IR FPA



FPA TEST RESULTS SUPPORT CHALLENGING REQUIREMENTS



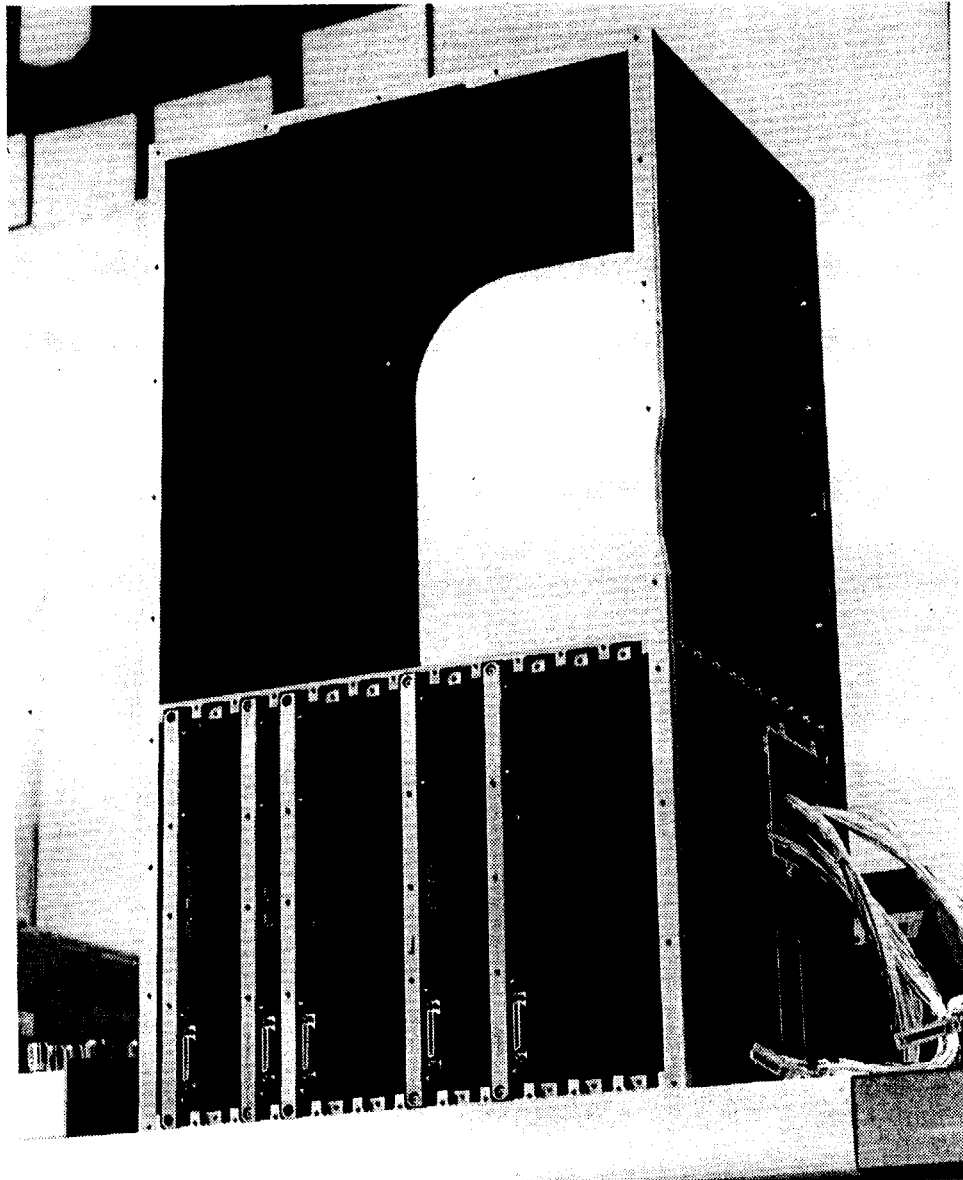
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Key Parameter	Requirement	VIS	Engineering Model		
			NIR	S/MWIR	LWIR
Non- Linearity	PV: $\pm 5\%$, PC: $\pm 10\%$	$\pm 1\%$	$\pm 4\%$	$\pm 3\%$	$\pm 2/\pm 8\%$
Responsivity Stability	$\pm 0.05\%$	$\pm 0.02\%$	$\pm 0.04\%$	$\pm 0.03\%$	In Test
Temperature Insensitivity	V, N: 0.25% per $\pm 1K$ S/M,L: 3% per $\pm 0.2K$	0.05%	In Test	<0.5	<1%
Saturation Recovery	1 frame, 0.5%	0.66%	In Test	<1.0%	In Test
Interband Crosstalk	0.3%	TBT	TBT	TBT	TBT
Spatial Uniformity	$\pm 15\%$ @ 80%	$\pm 1.5\%$	$\pm 3\%$	$\pm 1\%$	$\pm 7.2\%$
Spectral Uniformity	$\pm 15\%$ @ 50%	$\pm 4\%$	$\pm 3\%$	$\pm 1.1\%$	$\pm 2.5\%$
Power Dissipation	CFPA: <58mW @ 85K	<15mW	<26mW	17mW	In Test
Polarization Insensitivity	< 0.001	<0.001	<0.001	N/A	N/A
Total Dose, Rad(SI)	5K	30K *	30K *	20K *	20K *

FPA Specification #151780

TBT - To Be Tested

* Protoflight Data



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SAM Complete and In Test (Redundant Boards Not in EM Unit)

- **Through Temperature Tests**





SAM Completes Initial Ambient Tests



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- Space Viewing Analog Module Module for PV Bands
- Assembly, integration and checkout complete
- Performance compatible with specifications
- Automated test set incomplete; test performed using manual test gear

	<u>Measured</u>	<u>Spec</u>
Noise	< 0.6 LSB	< 0.6 LSB
Integral NonLinearity	20 b p-p	8 b p-p
Crosstalk	< 0.03%*, 0.4%	≤ 0.03%
Transient Response	< 0.15%	≤ 0.15%

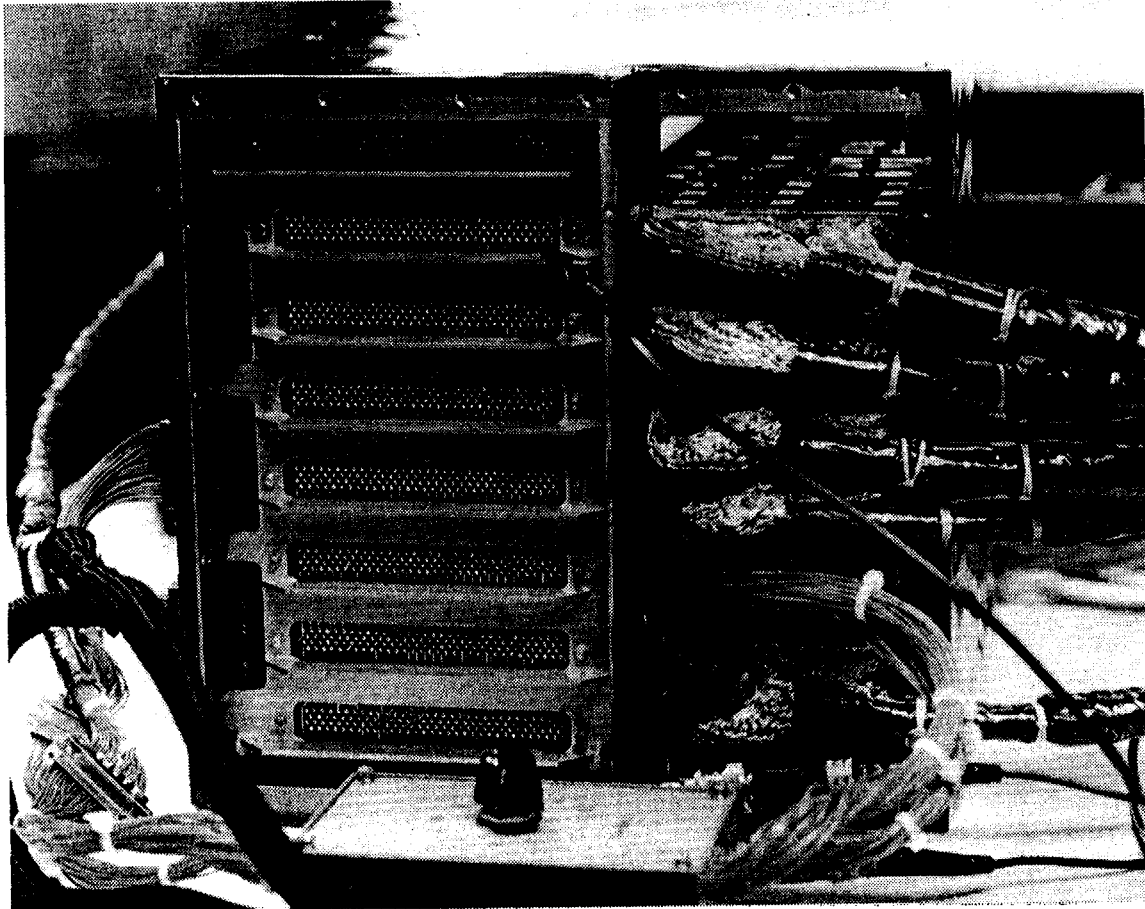
* VIS, NIR, LWIR; Bands 1, 2, and SWIR at 0.4%



FAM In Test

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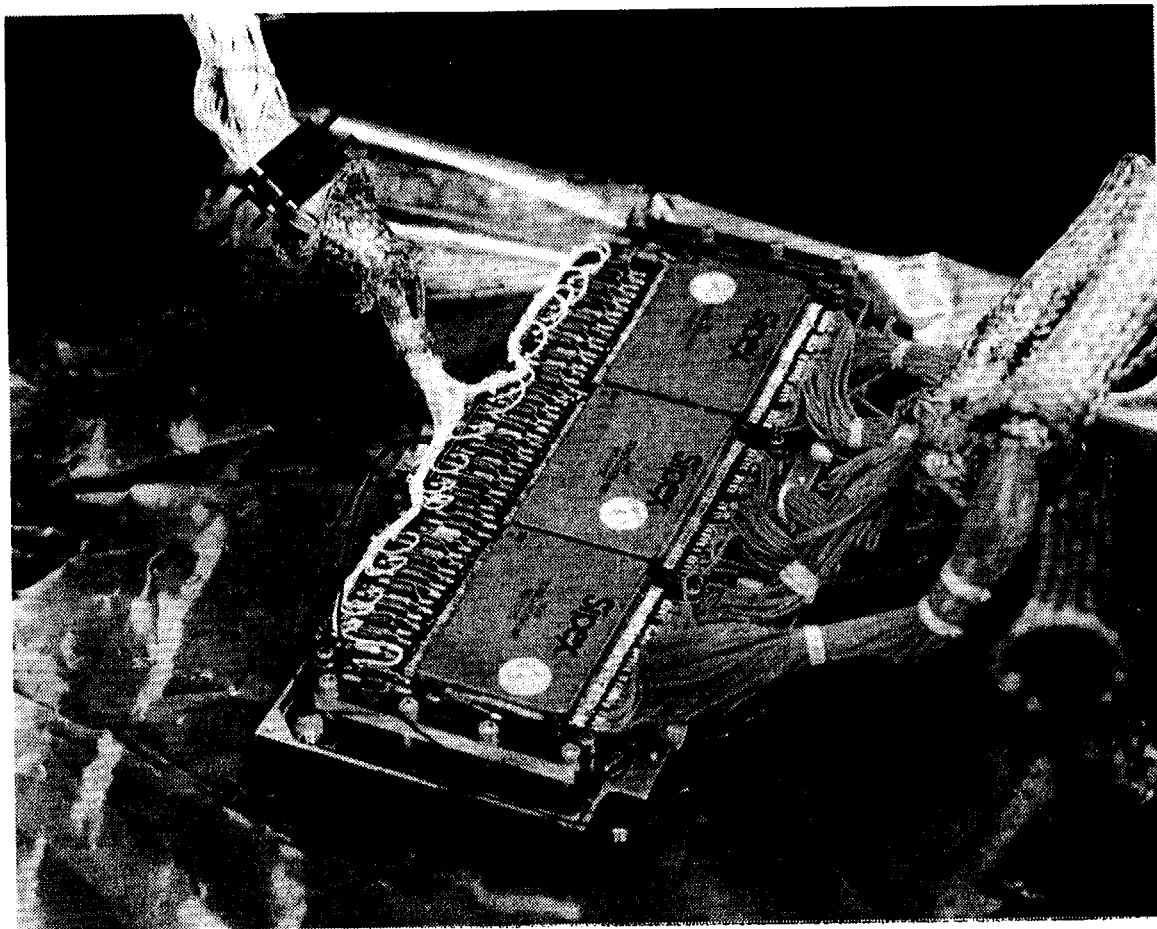
- In Temperature Tests



CLAM Ready for Housing



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- Now in Housing in Temperature Tests with FAM



SAM Completes Temperature Tests

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	<u>Measured</u>	<u>Spec</u>
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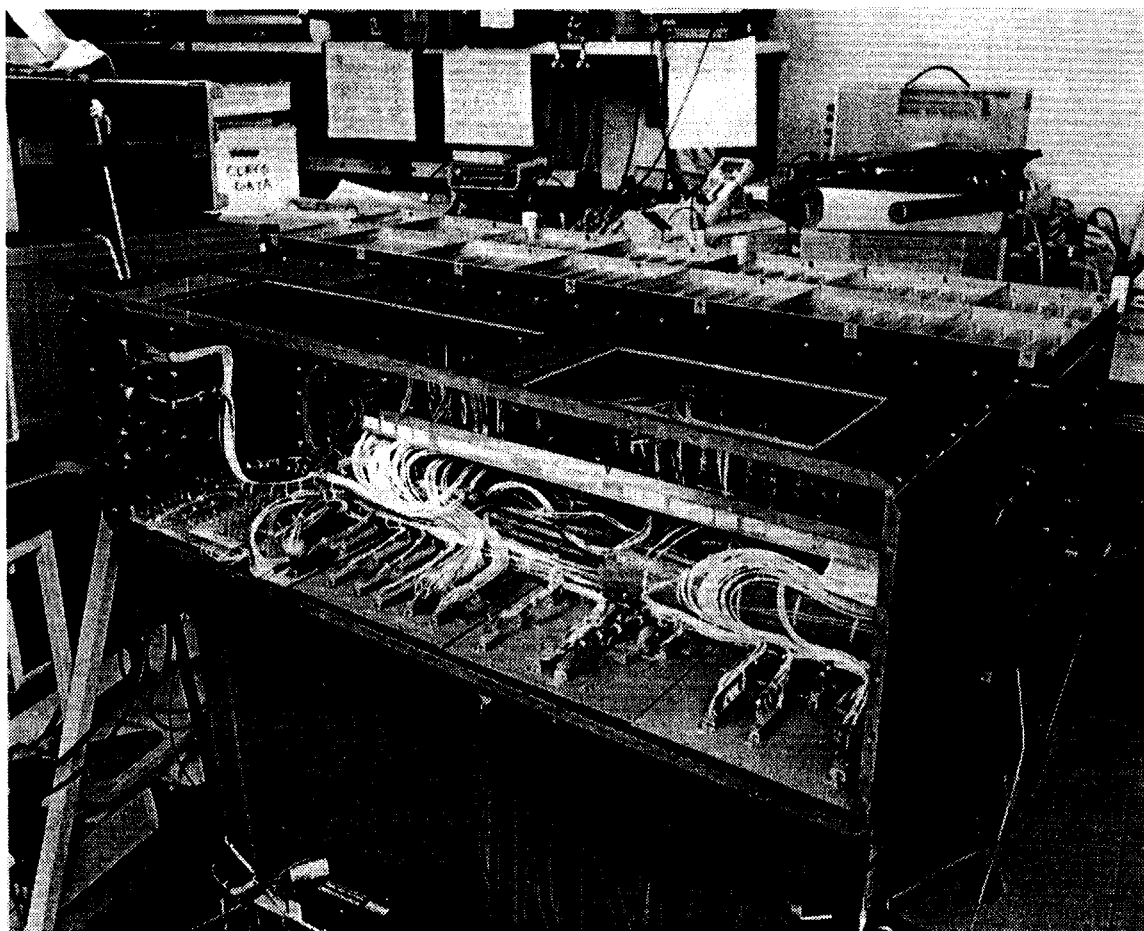
* VIS, NIR, LWIR; Bands 1, 2, and SWIR at 0.4%



MEM Nearing Completion



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MEM Nearing Completion



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- All EM MEM Subassemblies Complete and Tested
- MEM Integration Status:

	DRAWING NUMBER	5 (Assy Compl.)	6 (Test Compl.)	7 (MEM Integ. & Test)	8 (Comments)
FIFO Memory	E404834	COMPLETE	COMPLETE	COMPLETE (2)	
FDDI Processor	E404844	COMPLETE	COMPLETE	COMPLETE	
Single-Board Computer	E404850	COMPLETE	COMPLETE	COMPLETE	
Format Engine	E404856	COMPLETE	COMPLETE	N/A	Final Firmware Not Complete
Format Processor	E404867	COMPLETE	COMPLETE	9/14/94	Software Dev't & Test Continuing
Timing Generator	E404864	COMPLETE	COMPLETE	COMPLETE	
TCP Command Interface	E404879	COMPLETE	COMPLETE	N/A	Integrated Into TCP
Analog Telemetry & Command	E404882	COMPLETE	COMPLETE	N/A	Integrated Into TCP
Telemetry & Command Processor	E404871	COMPLETE	COMPLETE	COMPLETE	S/W Integration & Test continuing
Scan Servo Controller	E404885	COMPLETE	COMPLETE	COMPLETE	
Mechanism Controllers	E404891	COMPLETE	COMPLETE	COMPLETE	S/W Rev In Work - Hardware OK
Temperature Controllers	E404897	COMPLETE	COMPLETE	COMPLETE	
Calibrator Controllers 1	E404903	COMPLETE	Nov-94	N/A	Not Required For EM
Calibrator Controllers 2	E404907	COMPLETE	Nov-94	N/A	Not Required For EM
Power Supply (HAC-IEG)		COMPLETE	COMPLETE	COMPLETE	
Chassis	E404815	COMPLETE	COMPLETE	COMPLETE	Significant Card & Backplane
Wire Wrap Backplane	E404803	COMPLETE	COMPLETE	COMPLETE	Stiffening Added
Wiring Assembly	E404814	COMPLETE	COMPLETE	COMPLETE	

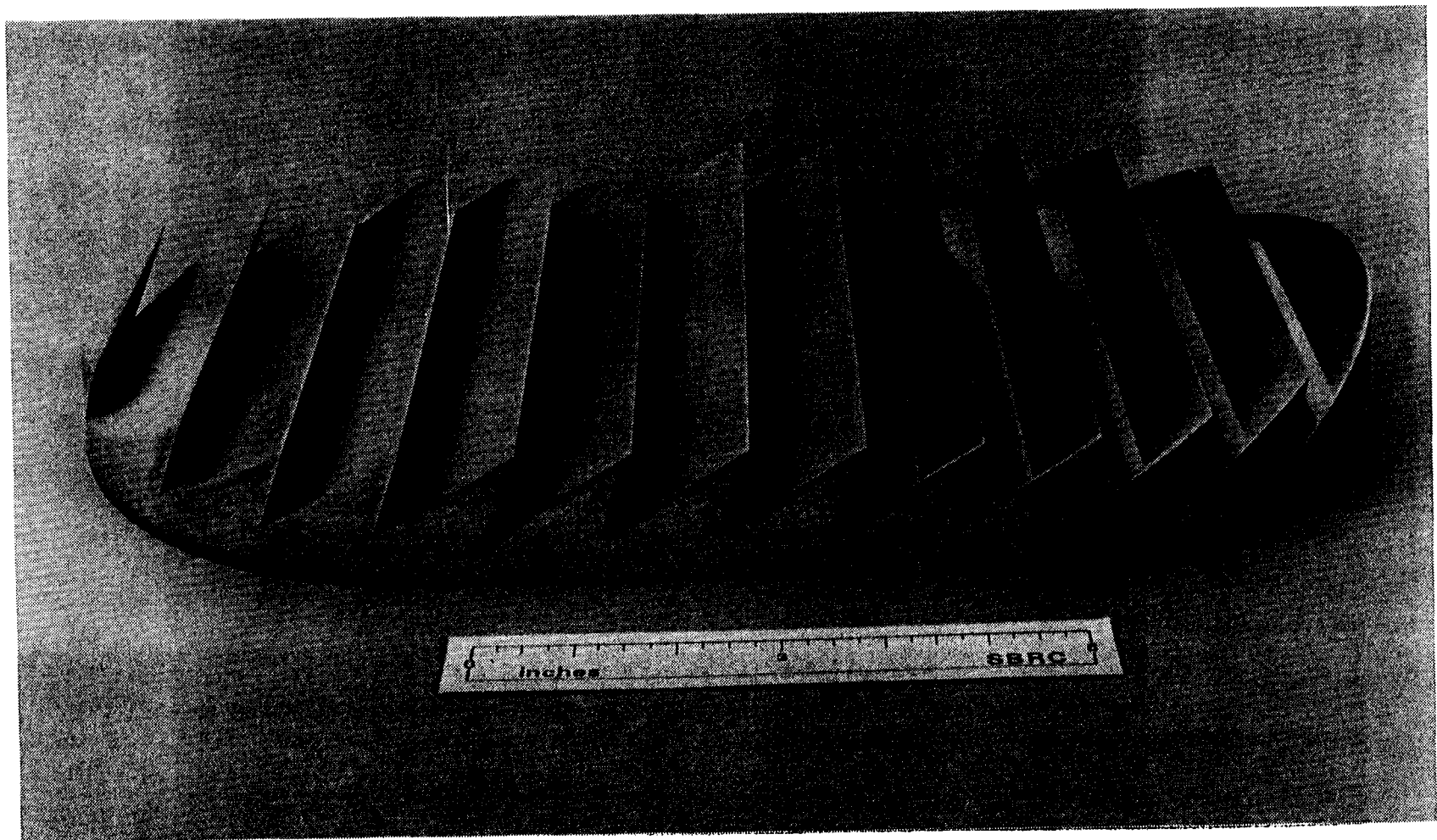
- MEM Test Set complete



OBC BB Polishing in Progress

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Blackbody Nearing Completion

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- **Hand polishing nearing completion**
- **Anodization parameters being defined**
- **Heater, flex circuit, and flexible cable drawings released**
- **Third draft of test plan reviewed and approved by systems engineering**
- **Incorporating plan into section 4 of spec**
- **Delivery to plan date anticipated**

SYSTEM PERFORMANCE HIGHLIGHTS



Mass, Power, & Data Rate Stable



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- Mass down 6.9 kg since PDR!
- Measured power lower than previously calculated
- Data rate unchanged

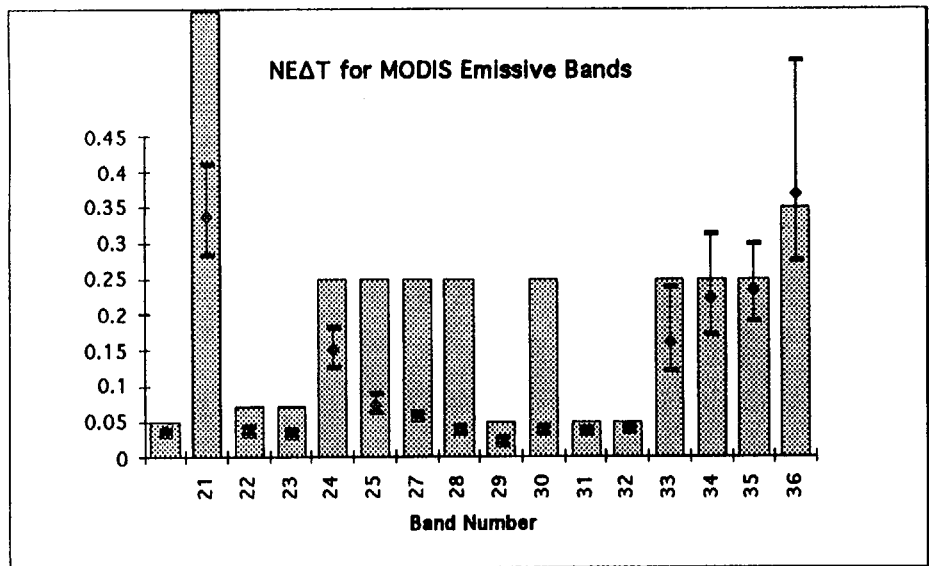
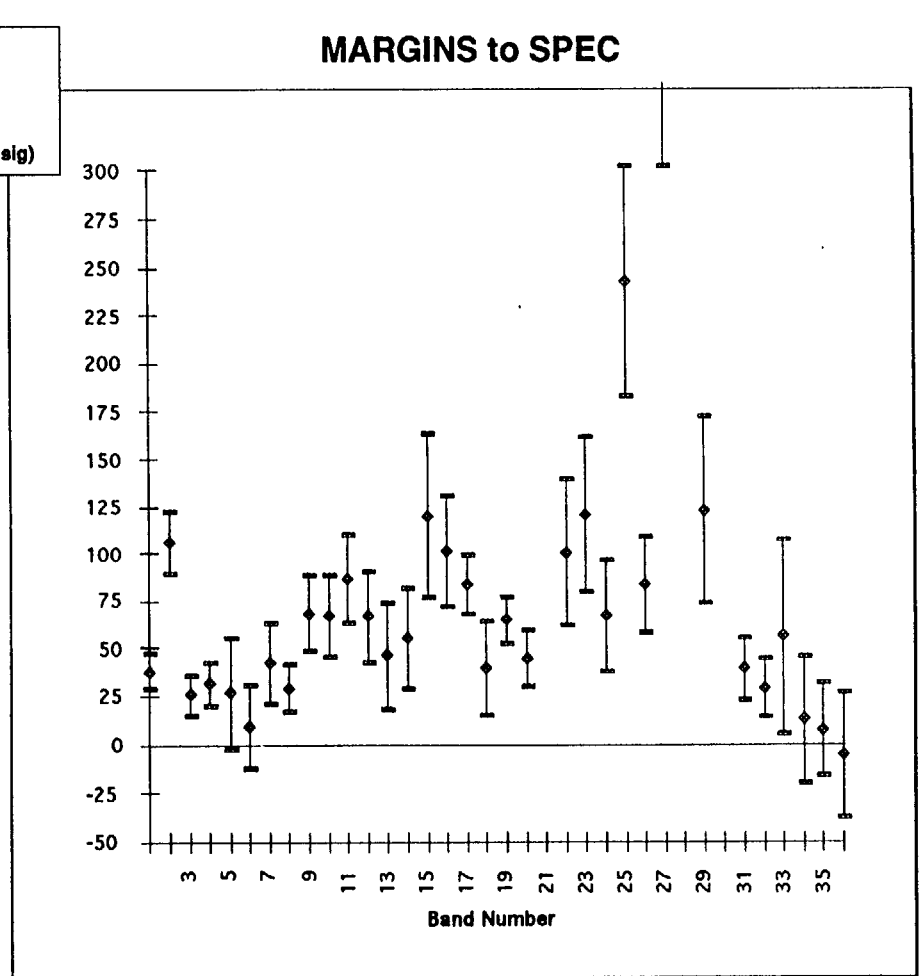
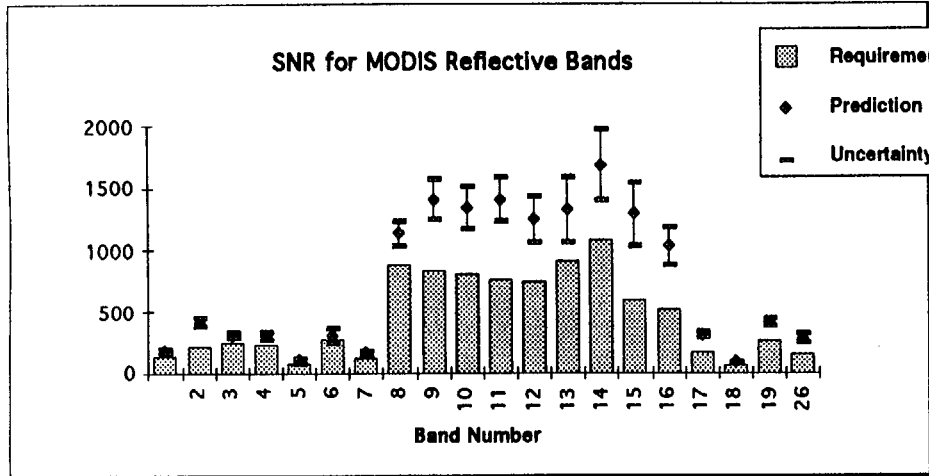
	Predicted	Spec	Margin	%Actuals
• Mass	228.3 kg	250 kg	21.7 kg	59.5%
• Power	160.8 W	225 W	64.2 W	82.8%
• Data Rate	10.6 Mbps	10.8 Mbps	0.2 Mbps	0%



No Change to PFM SNR/NE Δ T Predictions



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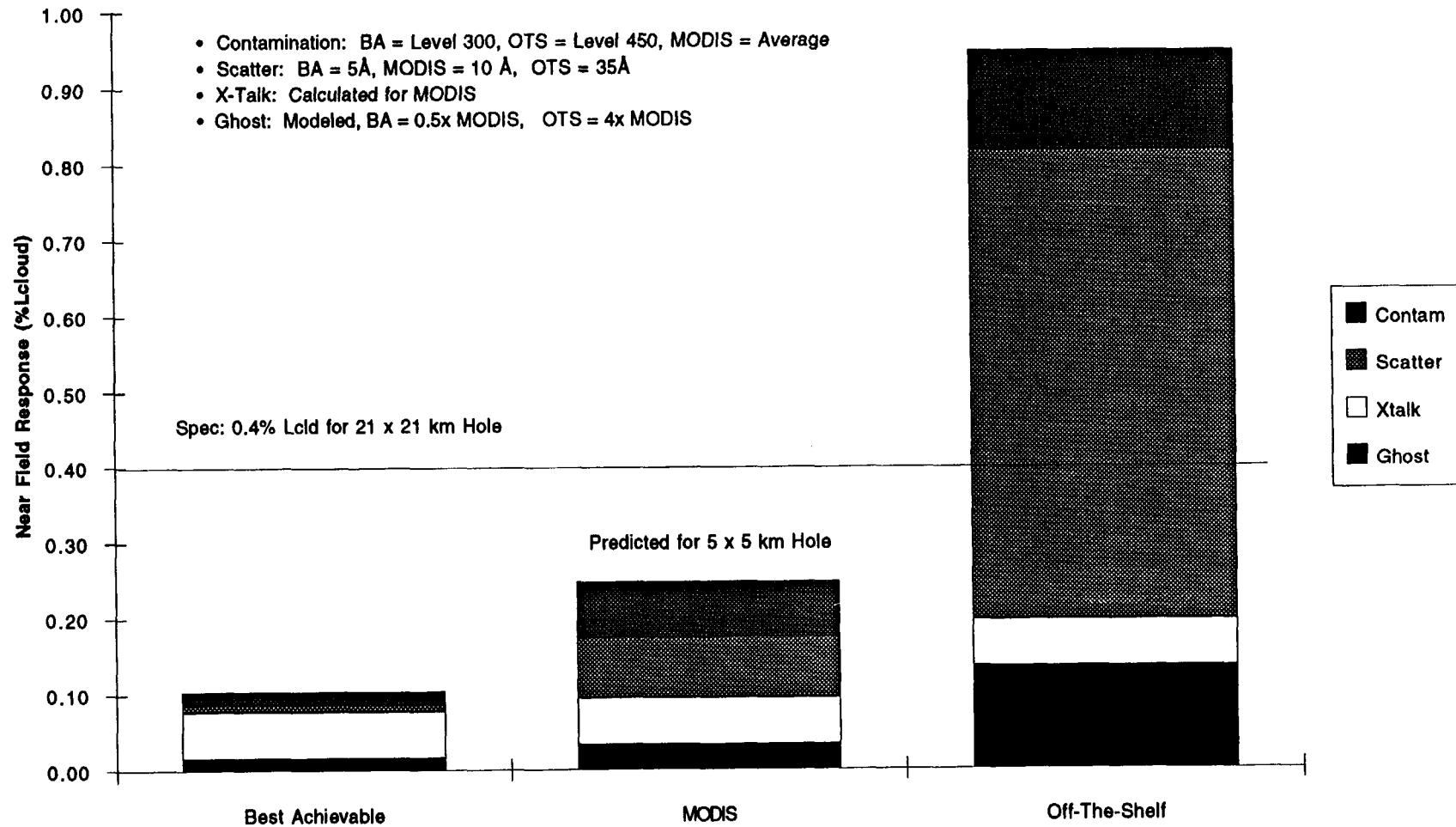
- Includes PF Measurements for PC Detectors
- Optics/Detector Data from EM Measurements



MODIS Near Field Response Approaches Technology Limits



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Critical EM Testing Preserved



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Test	EM	GSE	Date
• Radiometric Response SNR, Linearity, Dy. Range, Noise	Ambient T/V	SIS, BCS	1/95
• Spectral Response C.W.L, B.W., O.O.B	Ambient T/V	SPMA	1/95
• Spatial Response Registration, IFOV, MTF	Ambient T/V	IAC	1/95
• Transient Response Ghosting, Crosstalk, Scatter	Ambient	SSMA	12/94
• Polarization Response	Ambient	PSA	11/94



Summary and Conclusions



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- All major subassemblies for EM assembled
 - Optics/FPAs, Radiative Cooler integrated
 - Focus and alignment complete
 - Mainframe in house, ready for Scan Mirror mounting
 - FAM, SAM, CLAM in test, MEM awaiting S/W completion
 - OBC BB polishing in process
- Comprehensive System Testing of EM to Begin in November
 - Technical Assessment; On-Track, High Performance Maintained