

THE MODERATE RESOLUTION IMAGING SPECTRORADIOMETER (MODIS)

Presented to the
MODIS Science Team

September 29, 1993

Thomas S. Pagano
(805) 562-7343; (805) 562-7522 (Fax)
Email: SB06685@msgate.emis.hac.com



HUGHES

SANTA BARBARA RESEARCH CENTER
a subsidiary

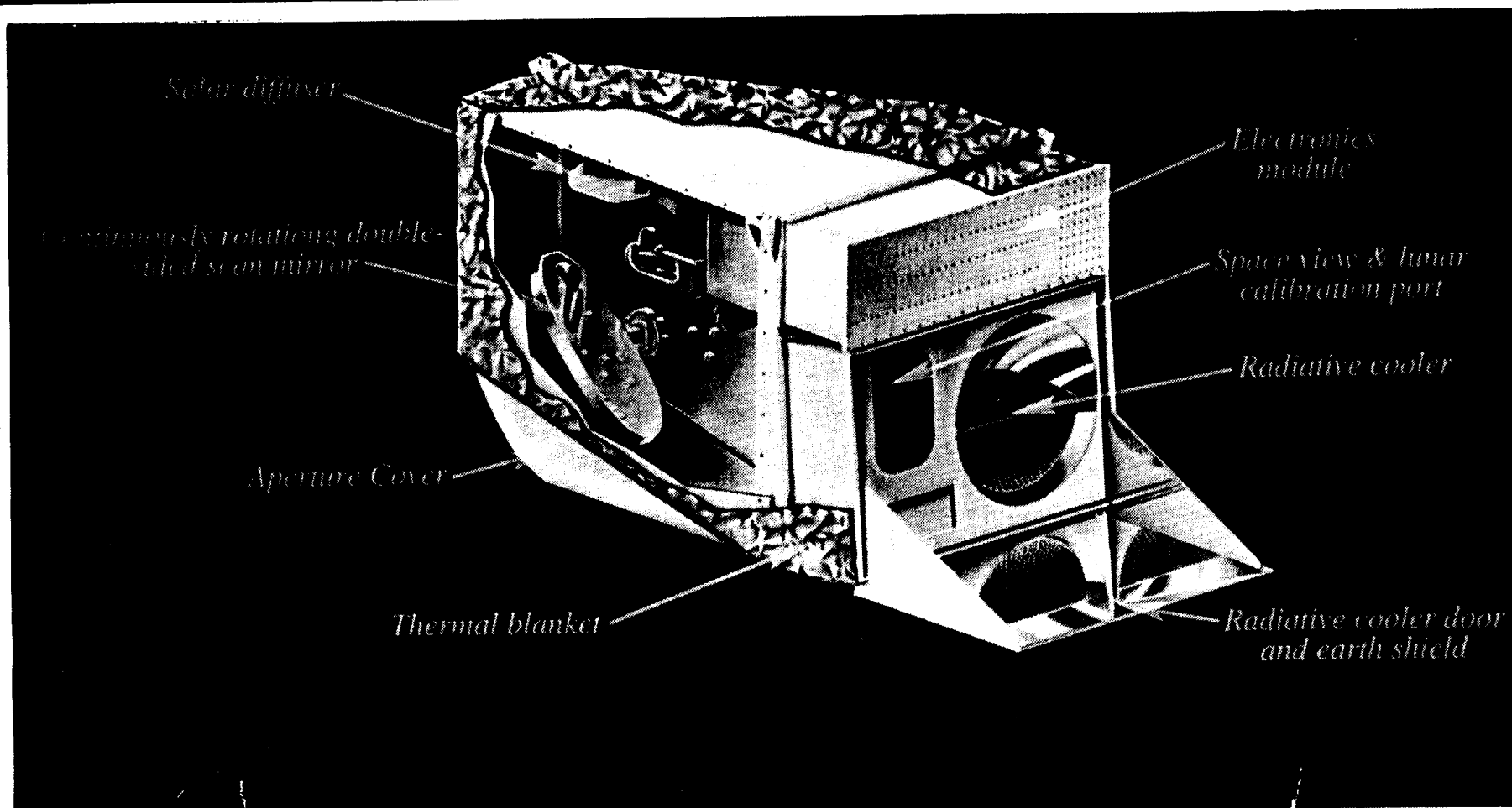


MODIS INCORPORATES CONTINUOUSLY ROTATING SCAN MIRROR AND MULTIPLE CALIBRATION SOURCES

92-10-168A

HUGHES

SANTA BARBARA RESEARCH CENTER
a subsidiary





AGENDA



SANTA BARBARA RESEARCH CENTER
a subsidiary

- INTRODUCTION: MODIS OVERVIEW
- HARDWARE DEVELOPMENT STATUS
- PERFORMANCE OVERVIEW
- GHOSTING REDUCTION
- GSE, INTEGRATION, AND TEST HARDWARE
- RISK STATUS
- CONCLUSIONS

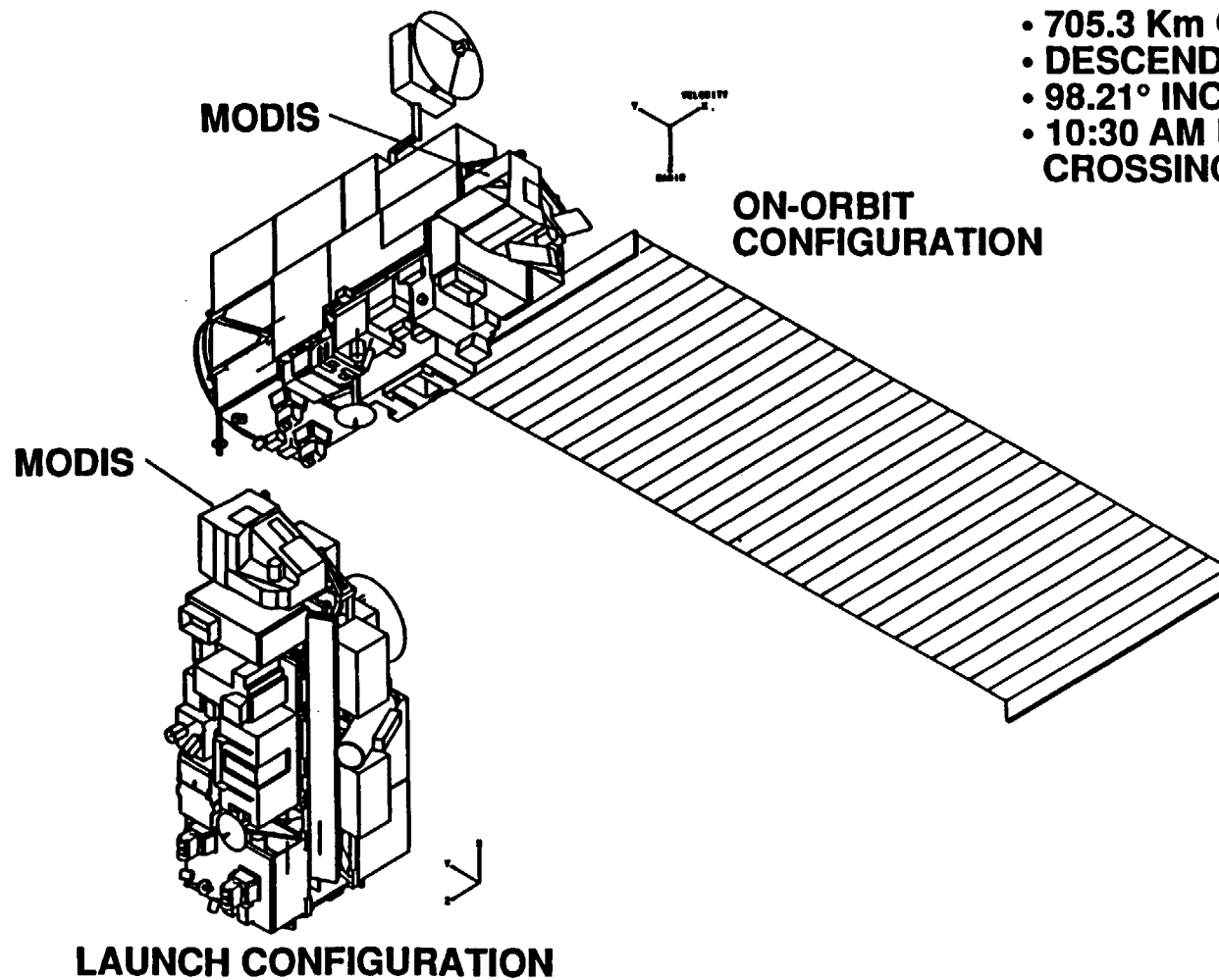
INTRODUCTION



MODIS HAS PRIME LOCATION ON THE EOS AM SPACECRAFT

HUGHES

SANTA BARBARA RESEARCH CENTER
a subsidiary



- 705.3 Km ORBIT ALTITUDE
- DESCENDING ORBIT
- 98.21° INCLINATION
- 10:30 AM EQUATORIAL CROSSING TIME



SYSTEM REQUIREMENTS ARE CHALLENGING

HUGHES

SANTA BARBARA RESEARCH CENTER
a subsidiary

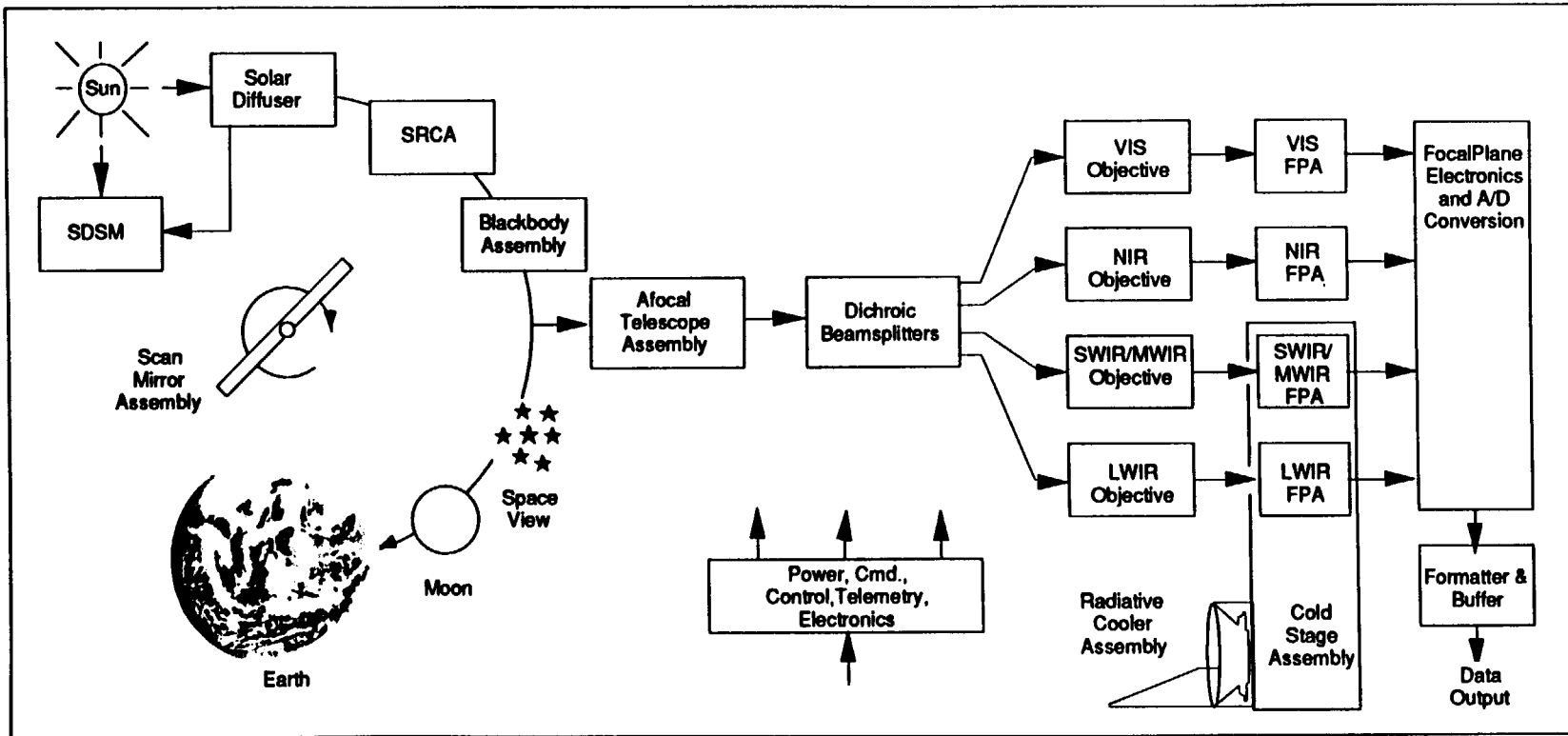
- **Spectral Coverage** 0.407 μm - 14.385 μm , 36 Bands
- **Spectral Resolution** 10 nm $\leq \Delta\lambda \leq$ 500 nm
- **Spectral Stability** λ & $\Delta\lambda$ stable to \leq 2 nm (VIS bands, desired for NIR bands)
 λ & $\Delta\lambda$ stable to \leq 1% (all other bands)
- **Spatial Coverage** $\pm 55^\circ$, 2330 km swath length at 705 km
(contiguous scans at Nadir at the equator)
- **Spatial Resolution** 250m; 500m; 1000m at Nadir
- **Spatial Registration** 0.2 IFOV (0.1 IFOV goal)
- **IFOV** 0.354 mr, 0.709 mr, 1.418 mr (All $\pm 6\%$)
- **Radiometric Range** 0.002% $\leq \rho \leq$ 100%, 3K $\leq T \leq$ 700K
- **Dynamic Range** NE Δ L to L_{max} (requires 12 bits)
- **Radiometric Performance** 57 \leq SNR \leq 1087, 0.05K \leq NE Δ T \leq 5.0K
- **Polarization Isolation** \leq 2%, 0.43 $\mu\text{m} \leq \lambda \leq$ 2.2 μm
- **Calibration Accuracy** **Absolute Calibration:** $\pm 1\%$ $\lambda >$ 3 μm ; $\pm 5\%$ $\lambda <$ 3 μm ;
 ± 0.75 (Band 20), $\pm 0.5\%$ (Bands 31, 32)
 $\pm 2\%$ Reflectance ($\lambda <$ 3 μm)



MODIS DESIGN FROM PHOTONS TO DATA

HUGHES

SANTA BARBARA RESEARCH CENTER
a subsidiary

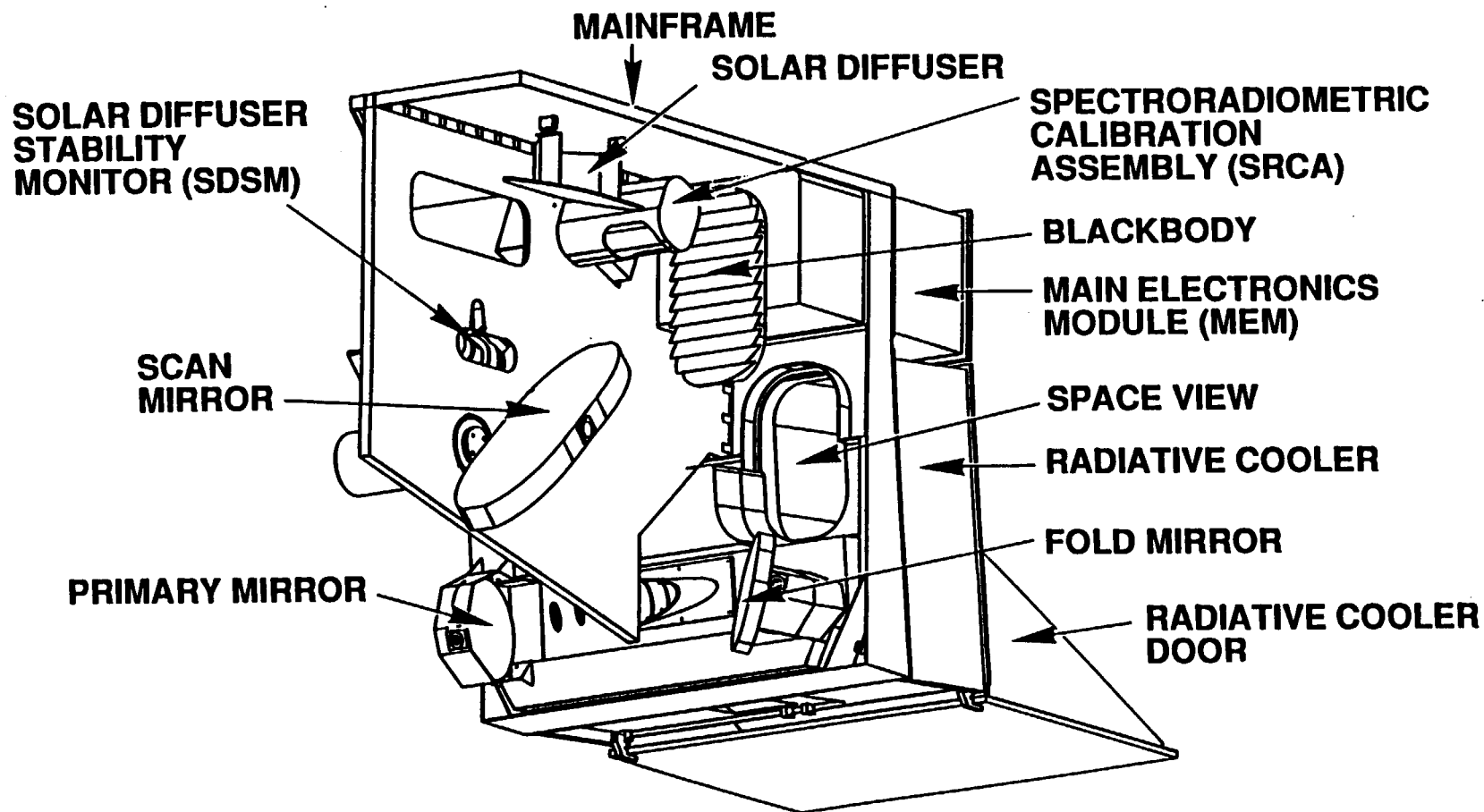




MODIS SCAN CAVITY VIEW

HUGHES

SANTA BARBARA RESEARCH CENTER
a subsidiary



• ENTIRE MAINFRAME NOT SHOWN IN CUT-AWAY FOR CLARITY

3/93
93-0204-5



MODIS BASELINE INSTRUMENT PARAMETERS



SANTA BARBARA RESEARCH CENTER
a subsidiary

ORBIT	705 km, 10:30 AM DESCENDING
SWATH	±55°, 10.0 km TRACK x 2330 km SCAN
SCANNING	360° SCAN, DOUBLE SIDED, 20.3 RPM, 2.954 sec PERIOD
IFOV	0.354 mr (0.25 km), 0.709 mr (0.50 km), 1.418 mr (1.0 km)
DWELL TIME	83.3 μs (0.25 km), 166.7 μs (0.50 km), 333.3 μs (1.0 km)
TELESCOPE	2-MIRROR OFF-AXIS AFOCAL GREGORIAN, 4X MAGNIFICATION, EPD 17.8 CM
REIMAGING OPTICS	REFRACTIVE, EFL 380.8 mm, 282.1 mm (LWIR ONLY)
SPECTRAL	36 BANDS FROM 0.41 μm to 14.3 μm, DICHROIC BEAMSPLITTERS, BANDPASS FILTERS
FOCAL PLANES	SILICON (0.4 μm ≤ λ ≤ 1 μm), PV HgCdTe (1 μm ≤ λ ≤ 10 μm) PC HgCdTe (λ > 10 μm), CTIA READOUTS FOR PV, BIPOLAR PREAMPS FOR PC
DETECTOR SIZES	NOMINALLY SQUARE: 135 μm (0.25 km), 270 μm (0.5 km), 540(400 LWIR) μm (1.0 km)
DETECTOR COOLING	THEMATIC MAPPER-TYPE RADIATIVE, T≈85K
CALIBRATION	LABORATORY, GROUND TRUTH, ON-BOARD BLACKBODY, SOLAR DIFFUSER, SRCA, AND SDSM
DATA RATES	10.125 MBPS (DAY MODE) , 2.733 MBPS (NIGHT MODE) WITH CAL AND OVERHEAD
SIZE, WEIGHT POWER	0.97 m x 1.59 m x 0.99 m , <250 kg, <225W

MODIS HARDWARE DEVELOPMENT STATUS



KEY STATUS SUMMARY



SANTA BARBARA RESEARCH CENTER
a subsidiary

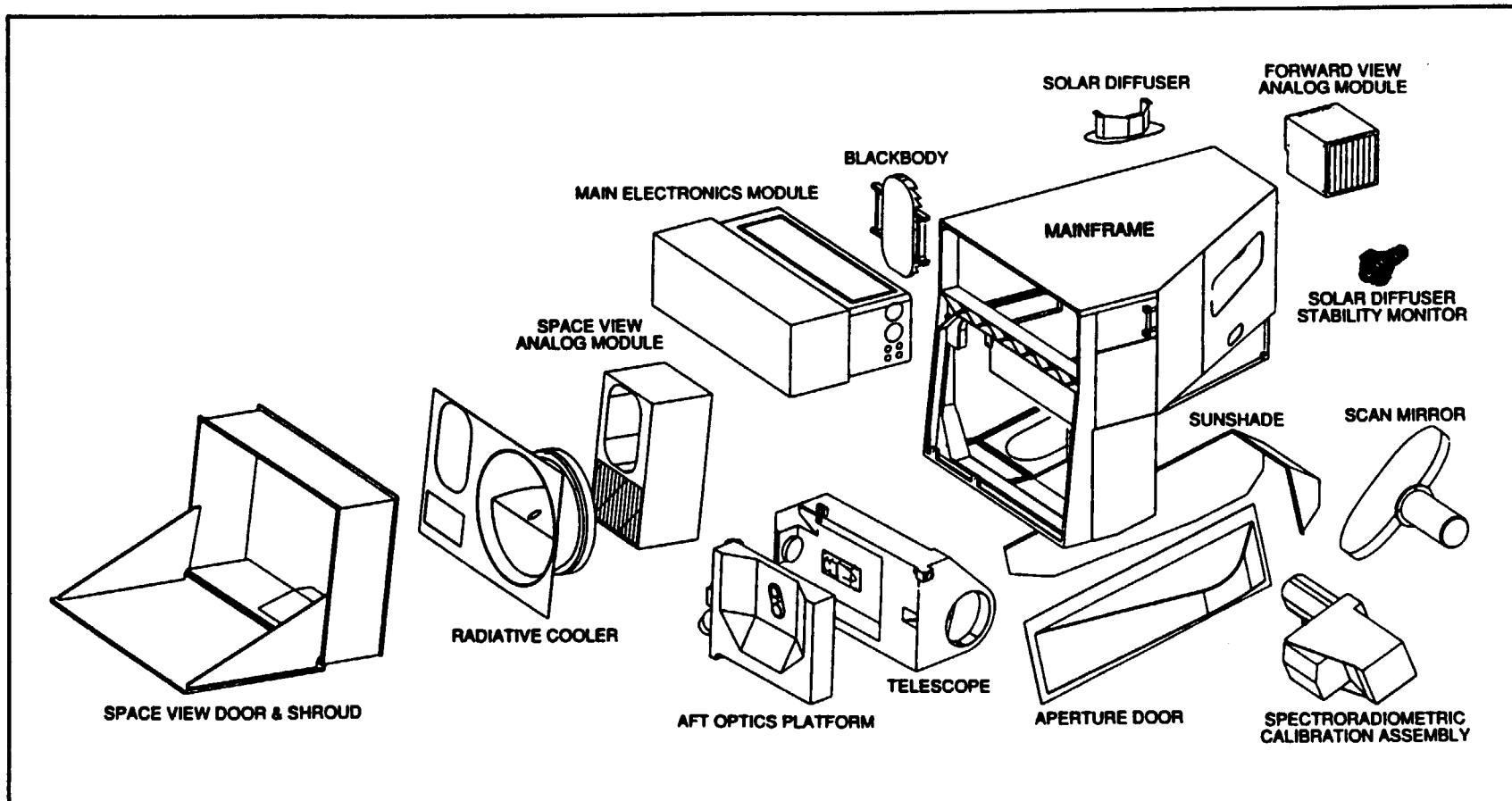
- **IMPLEMENTATION OF GHOSTING SOLUTIONS INITIATED
(ALL BANDS MEET SPEC EXCEPT FOR 18, 21 AND 30)**
- **WEIGHT AND POWER STABLE SINCE PDR**
- **PERFORMANCE MARGINS REMAIN POSITIVE
(>25% EXCEPT FOR BAND 36)**
- **EM FPAs COMPLETE - READY FOR FILTER ASSEMBLIES
(FPA PERFORMANCE BETTER THAN SCA TEST RESULTS)**
- **SIGNIFICANTLY IMPROVED PC HgCdTe CROSSTALK TEST RESULTS**
- **ALL BUT ONE PWB LAYOUTS COMPLETE**
- **ALL HYBRID P.O.D.s MODELS SUCCESSFULLY TESTED**
- **THE EM AOP AND ATB ARE COMPLETE**
- **ALL EM RADIATIVE COOLER PARTS ARE IN HOUSE**
- **THE STE INTERNAL SW CDR AND HARDWARE CDRs WERE COMPLETED**



MODULAR DESIGN FACILITATES INTEGRATION AND TEST

HUGHES

SANTA BARBARA RESEARCH CENTER
a subsidiary



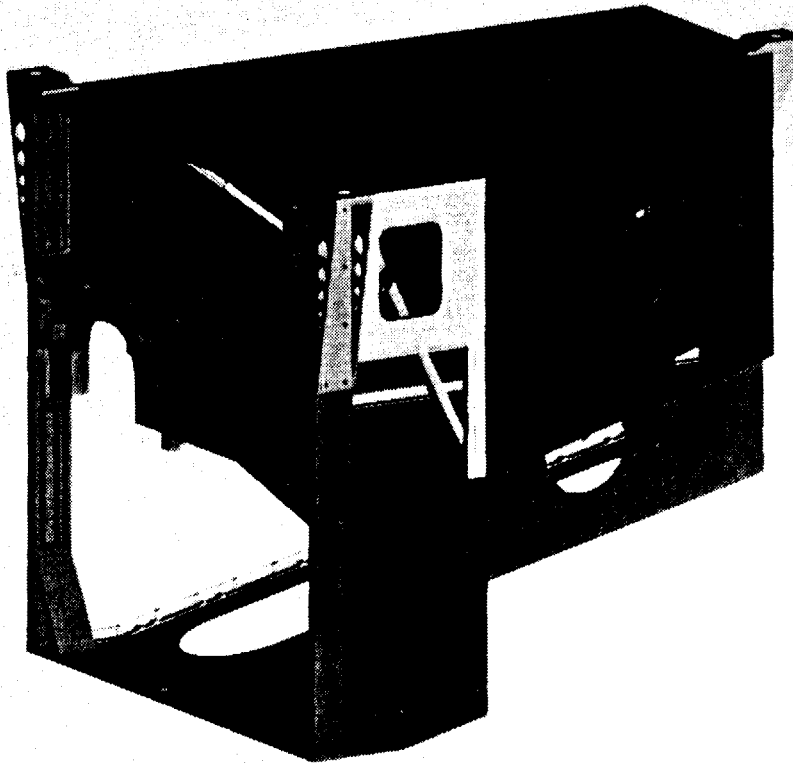


MAINFRAME FABRICATION OF SHEET & BLOCK PARTS IN PROCESS AT ABC

93-9-36

HUGHES

SANTA BARBARA RESEARCH CENTER
a subsidiary



- BRUSH-WELLMAN DELIVERED SHEET AND PRESSED BLOCK
- HIP FORMS AVAILABLE FIRST WEEK OF OCTOBER
- BLOCK 1 & 2 CHANGES TRANSMITTED
- RENEGOTIATION OF DELIVERY DATE IS REQUIRED – TRIP PLANNED END OF SEPTEMBER
- MARTIN KINEMATIC MOUNTS REQUIRED DECEMBER 1993
- SIMULATED MASSES REQUIRED DECEMBER 1993

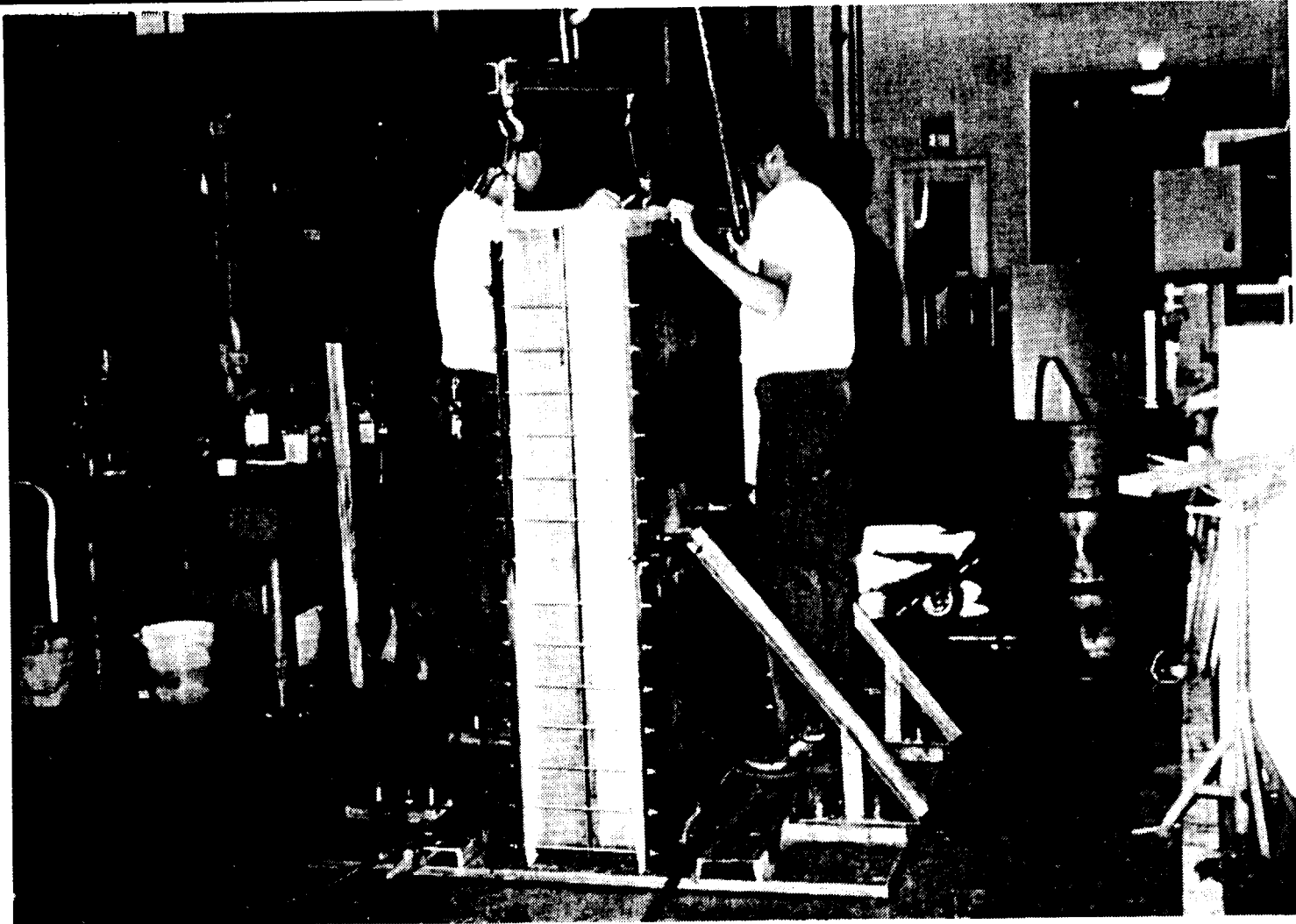


SUCCESSFUL CONSOLIDATION OF HIP BERYLLIUM

93-8-233

HUGHES

SANTA BARBARA RESEARCH CENTER
a subsidiary



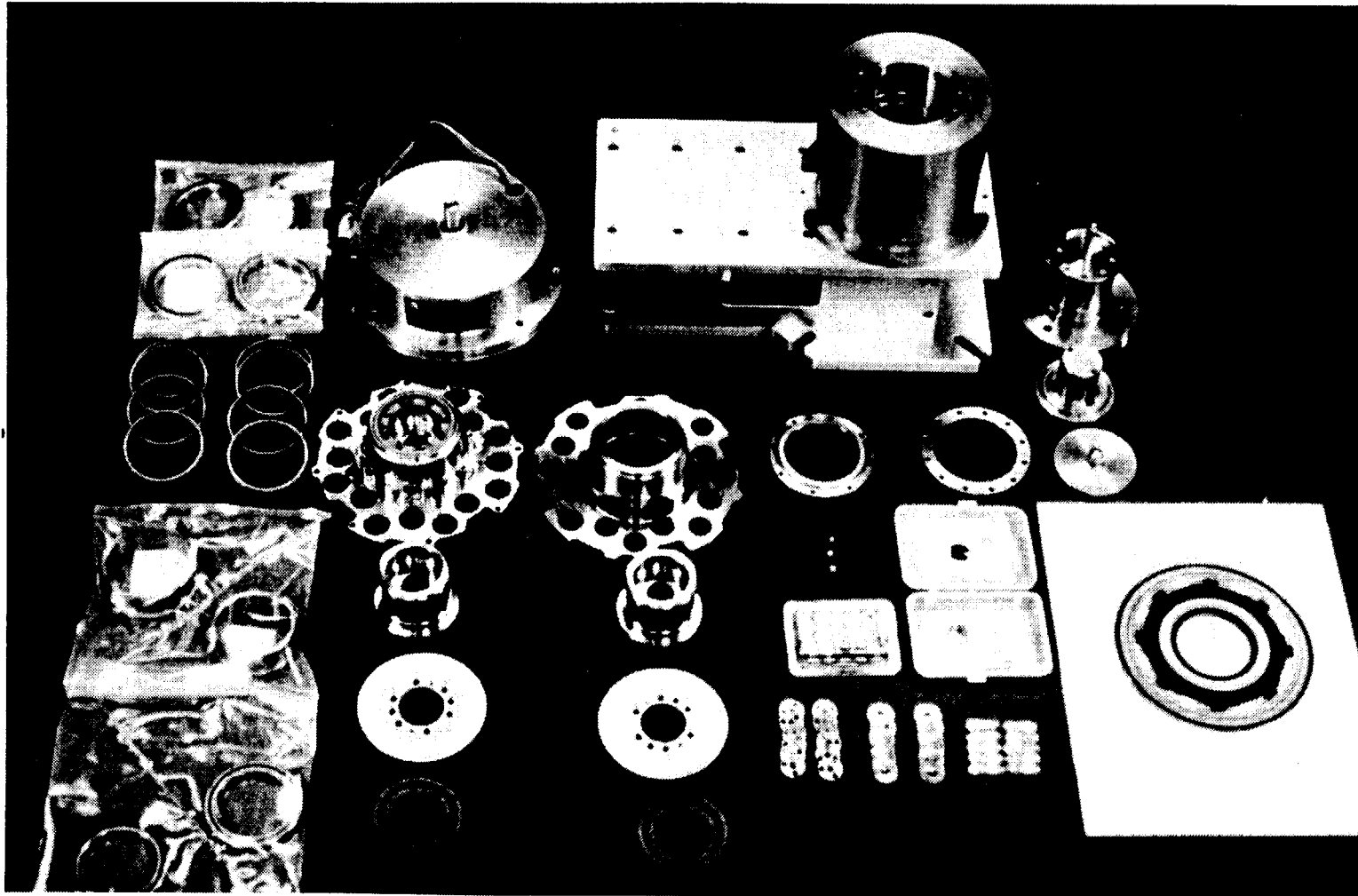


MOTOR ENCODER DVU READY FOR ASSEMBLY

93-9-35

HUGHES

SANTA BARBARA RESEARCH CENTER
a subsidiary





2 OF 4 BEARING SCREEN TESTS HAVE STARTED

93-9-37

HUGHES

SANTA BARBARA RESEARCH CENTER
a subsidiary



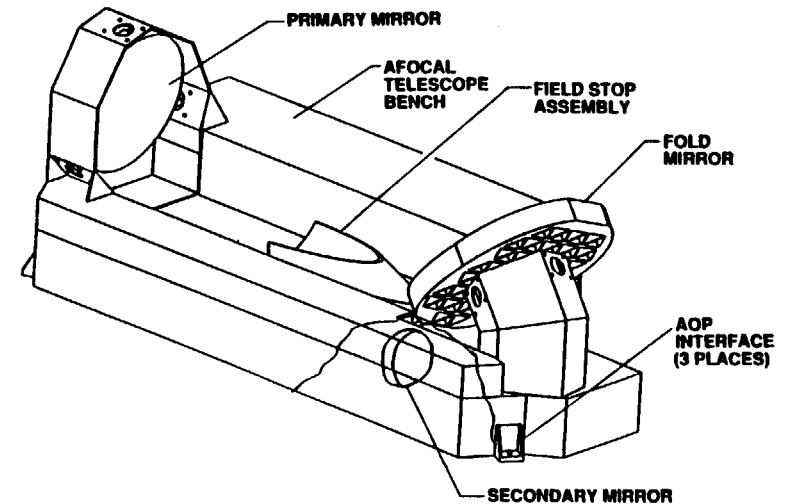
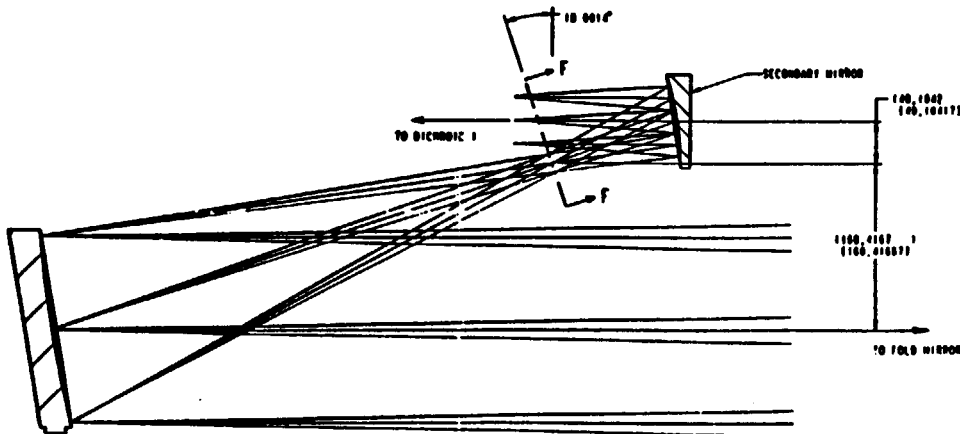
- **CHAMBER 1 IS LOADED WITH A PENNZANE LUBE/HYBRID BEARING SET & RUNNING**
- **CHAMBER 2 IS LOADED WITH A PENNZANE LUBE/STEEL BEARING SET & RUNNING**
- **CHAMBER 3 WILL CONTAIN A SET OF STEEL BEARINGS USING APIEZON LUBE. START DATE IS SEPTEMBER 30**
- **CHAMBER 4 WILL CONTAIN A SET OF HYBRID BEARINGS WITH DRY LUBE. START DATE IS SEPTEMBER 30**



AFOCAL TELESCOPE ASSEMBLY OFFERS HIGH THROUGHPUT IN UNOBSCURRED DESIGN

HUGHES

SANTA BARBARA RESEARCH CENTER
a subsidiary



• FEATURES

- 17.8 cm UNOBSCURRED DESIGN OFFERS HIGH THROUGHPUT
- INTERMEDIATE FIELD STOP PROVIDES EXCELLENT STRAY LIGHT CONTROL
- 4X MAGNIFICATION: AFOCAL DESIGN SIMPLIFIES SPECTRAL SEPARATION
- PARABOLIC MIRRORS: EASY TO FABRICATE
- SMALL PACKAGE
- LOW CTE GRAPHITE EPOXY HELPS MAINTAIN ALIGNMENT
- FOLD MIRROR CANCELS PRIMARY COMPONENT OF SCAN MIRROR POLARIZATION

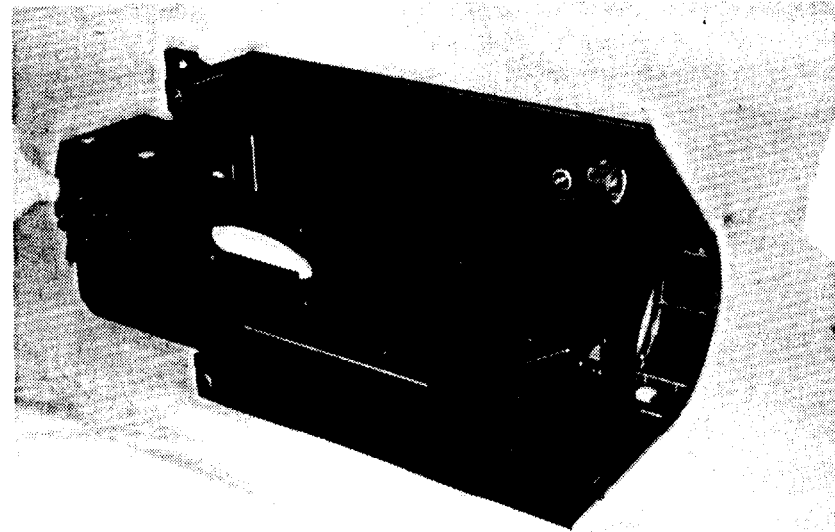
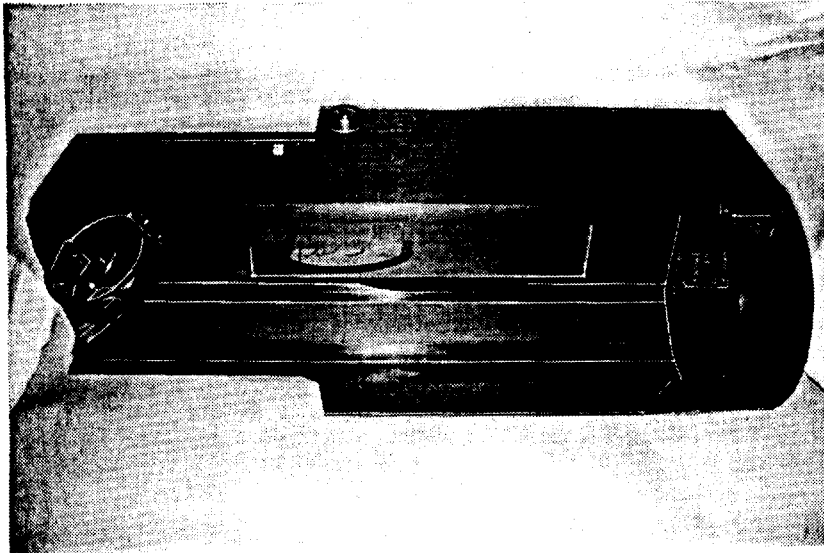


AFOCAL TELESCOPE BENCH FABRICATION IS COMPLETE

93-9-34

HUGHES

SANTA BARBARA RESEARCH CENTER
a subsidiary

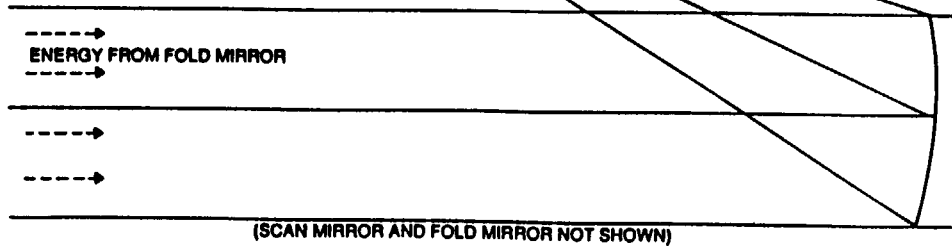
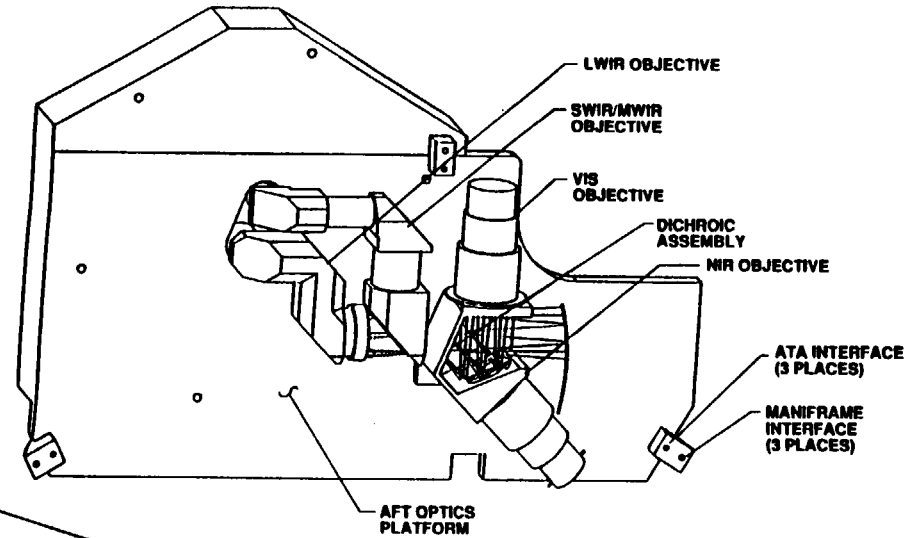
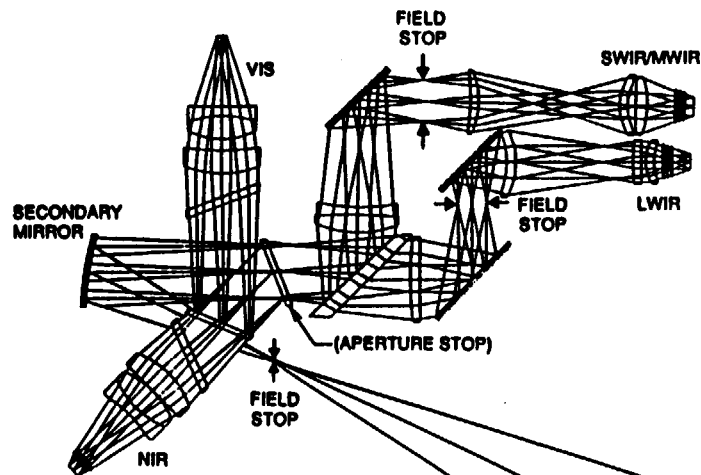




REFRACTIVE OBJECTIVES AND DICHROIC BEAMSPLITTERS MOUNT TO AFT-OPTICS ASSEMBLY

HUGHES

SANTA BARBARA RESEARCH CENTER
a subsidiary



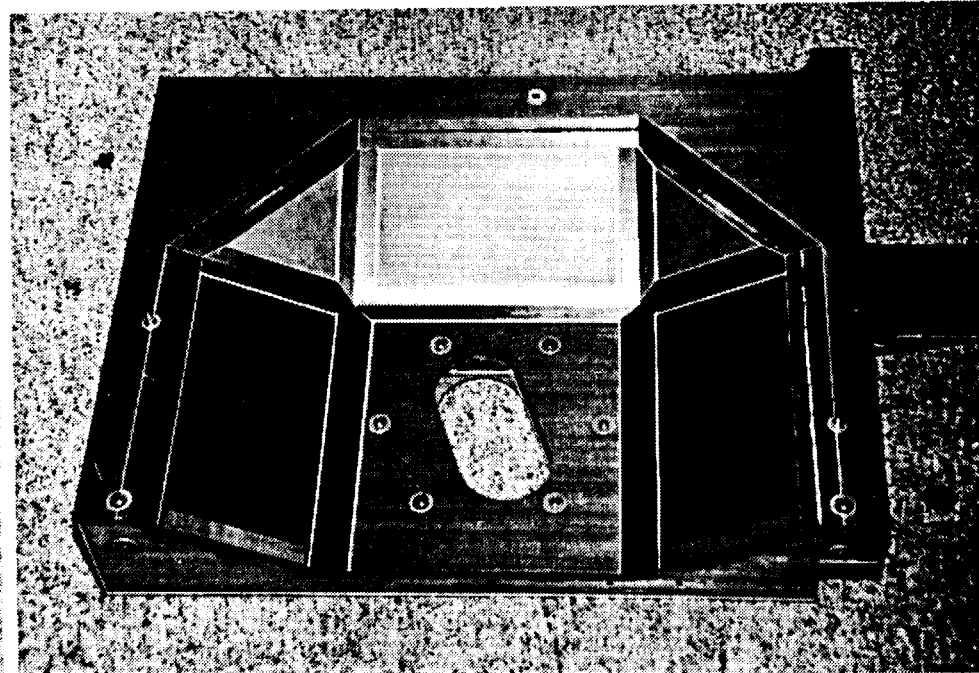
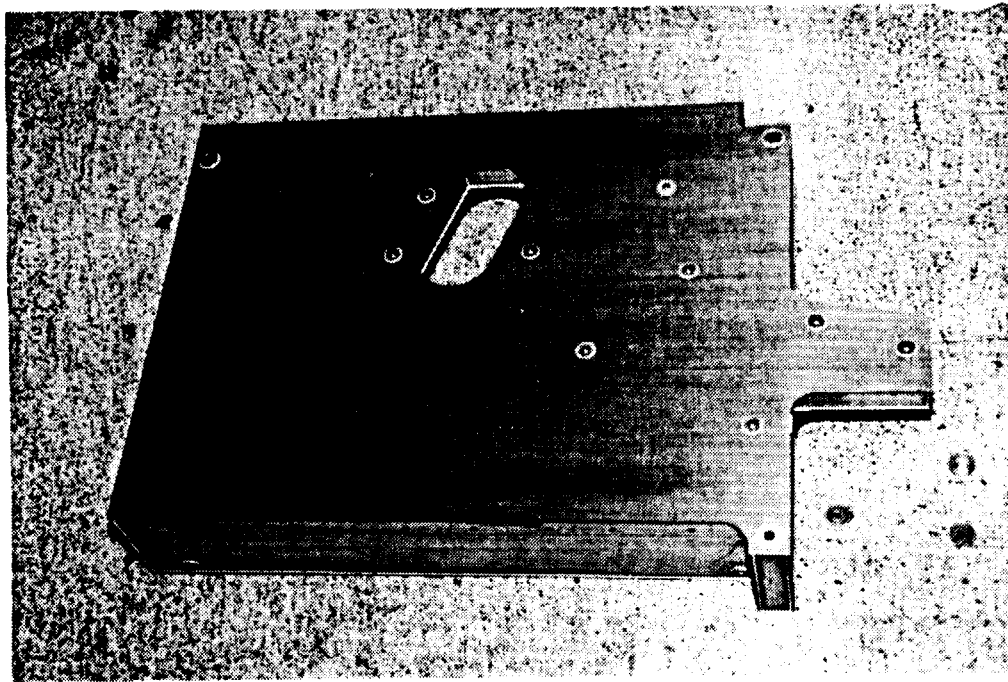


AFT OPTICS PLATFORM FABRICATION COMPLETE

93-9-33



SANTA BARBARA RESEARCH CENTER
a subsidiary

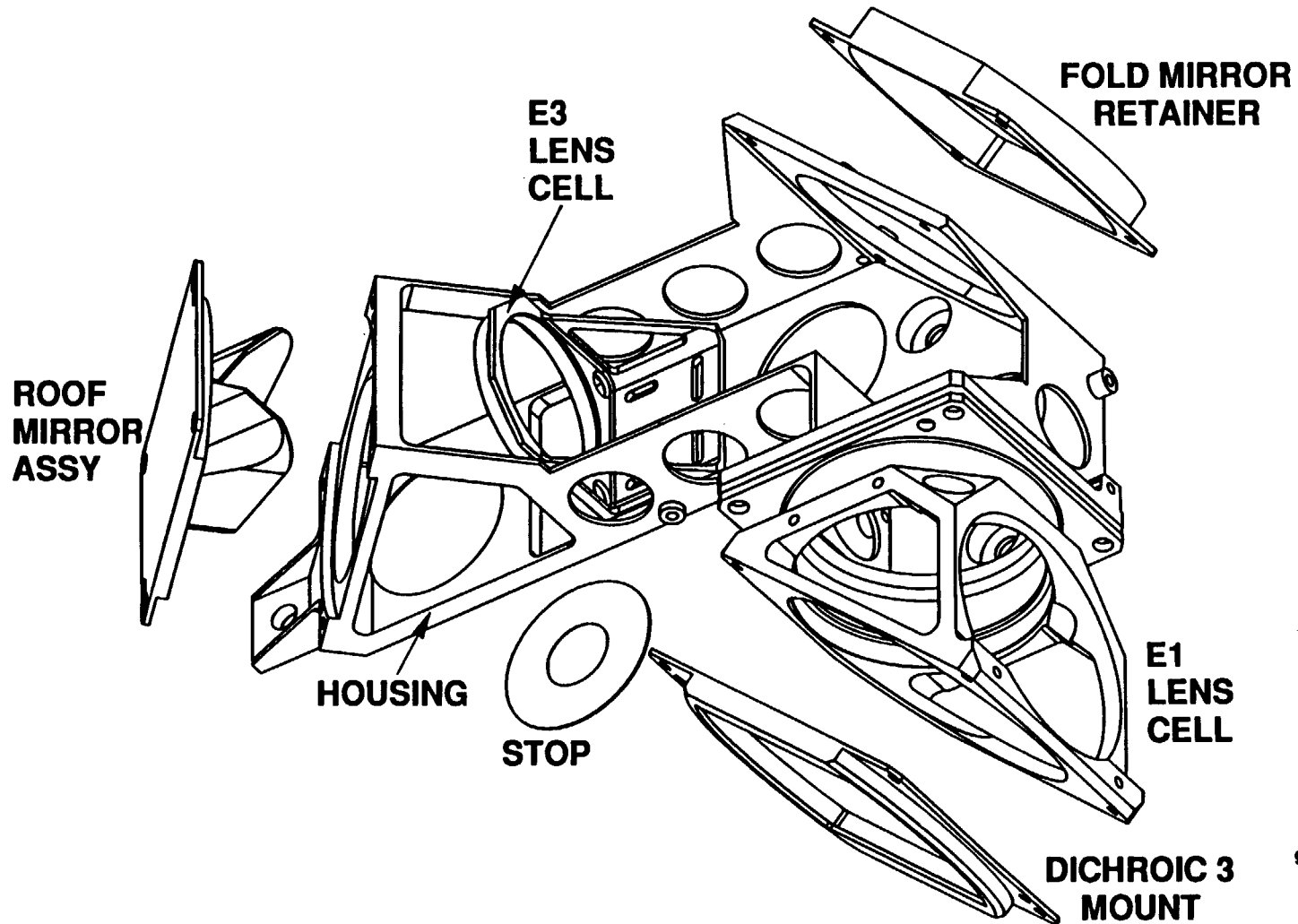




S/MWIR OBJECTIVE ASSEMBLY KEY MECHANICAL PARTS ARE IN FAB



SANTA BARBARA RESEARCH CENTER
a subsidiary



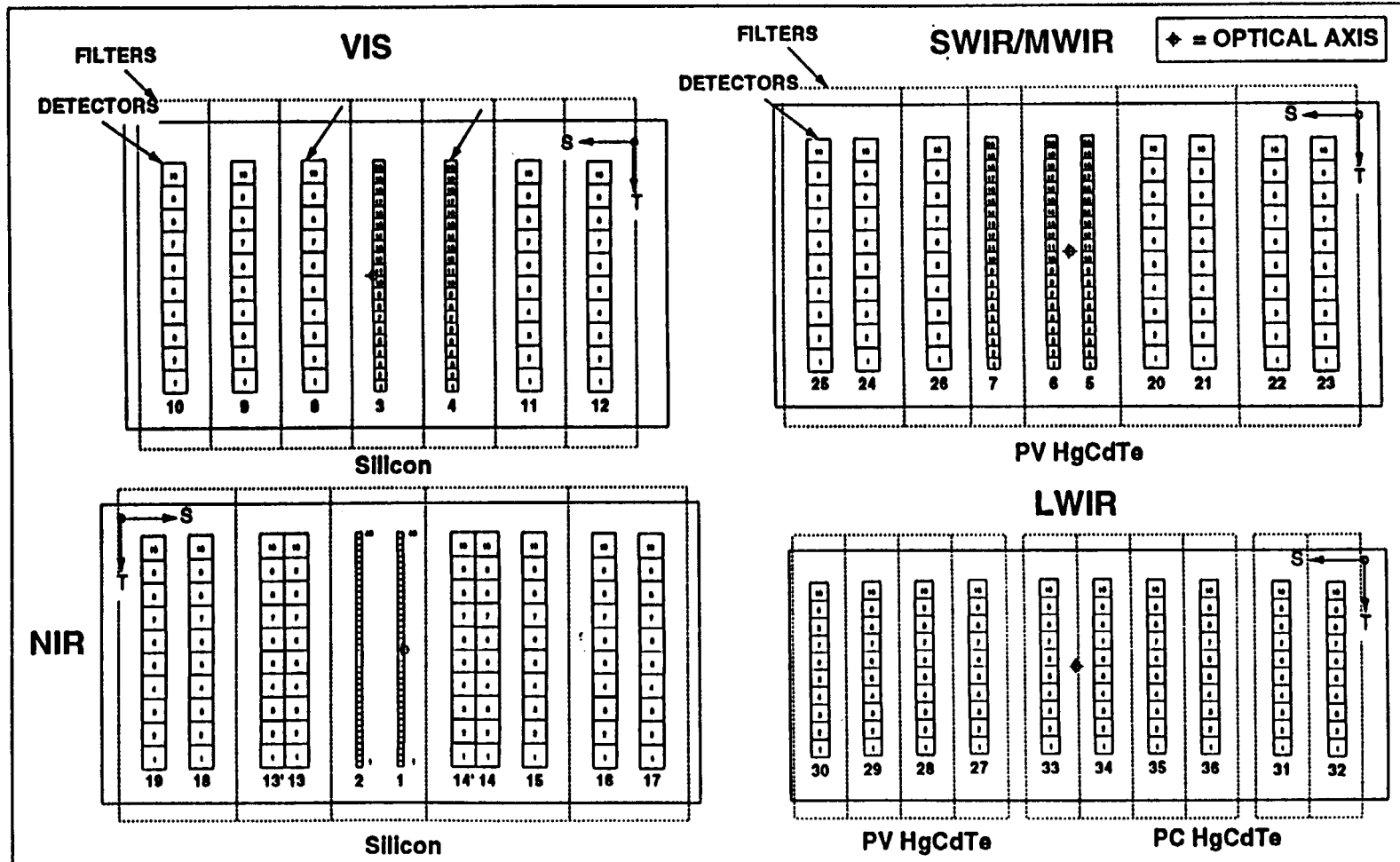
9/93
93-0720-315



MODIS HAS FOUR FPAs



SANTA BARBARA RESEARCH CENTER
a subsidiary



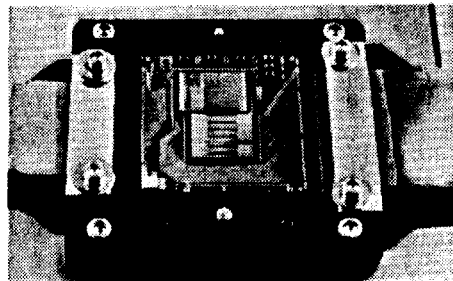


ALL FOUR MODIS ENGINEERING MODEL FOCAL PLANES ARE READY FOR FILTER ASSEMBLIES, FINAL TESTS & DELIVERY

93-8-232

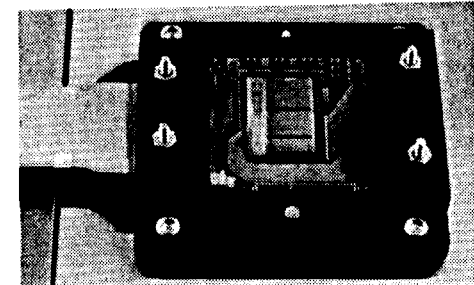
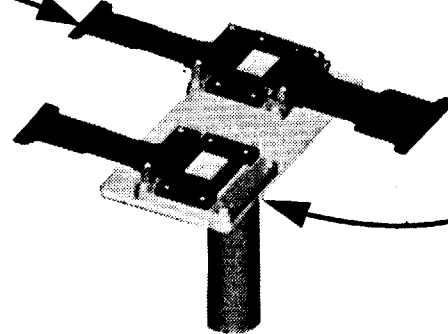
HUGHES

SANTA BARBARA RESEARCH CENTER
a subsidiary

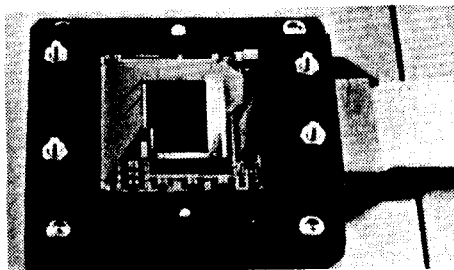


**EM
LONGWAVE
IR FPA**

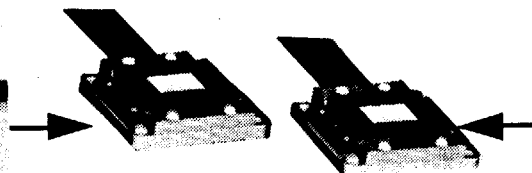
**COLD FOCAL PLANE
ASSEMBLIES (FPAs)**



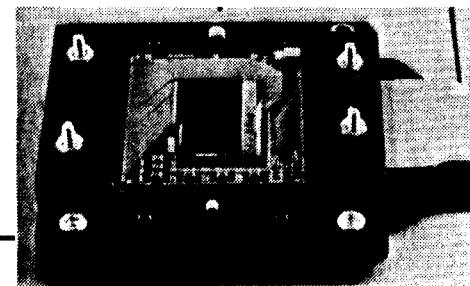
**EM
SHORT/MID WAVE
IR FPA**



**EM
VISIBLE FPA**



AMBIENT FPAs



**EM
NEAR IR FPA**



COATED FILTER SUBSYSTEMS IN FABRICATION

HUGHES

SANTA BARBARA RESEARCH CENTER
a subsidiary

- **FILTERS**
 - ALL VIS, NIR FILTERS DELIVERED IN SPEC THROUGH FLIGHT MODEL
 - SWIR/MWIR FAB COMPLETED; IN ENVIRONMENTAL TESTING
 - LWIR FAB COMPLETED; 27-31 DELIVERED, REMAINDER READY FOR SOURCE INSPECTION
- **MASK SUBSTRATES**
 - VIS IN-HOUSE, IN SPEC
 - NIR IN-HOUSE, AWAITING INSPECTION
 - SW/MWIR IN FAB (MOST CHALLENGING OF ALL MASK SUBSTRATES)
 - LWIR IN-HOUSE, IN SPEC
- **DICHROIC BEAMSPLITTERS**
 - DBS-1: EM UNIT IN-HOUSE; ADDITIONAL PARTS COATED AND IN TEST
 - DBS-2: EM READY FOR SHIPMENT
 - DBS-3: EM COMPLETE; BAND 36 TRANSMISSION IS LOW; ADDITIONAL PARTS IN FAB BUT EXPECTED TO BE LOW

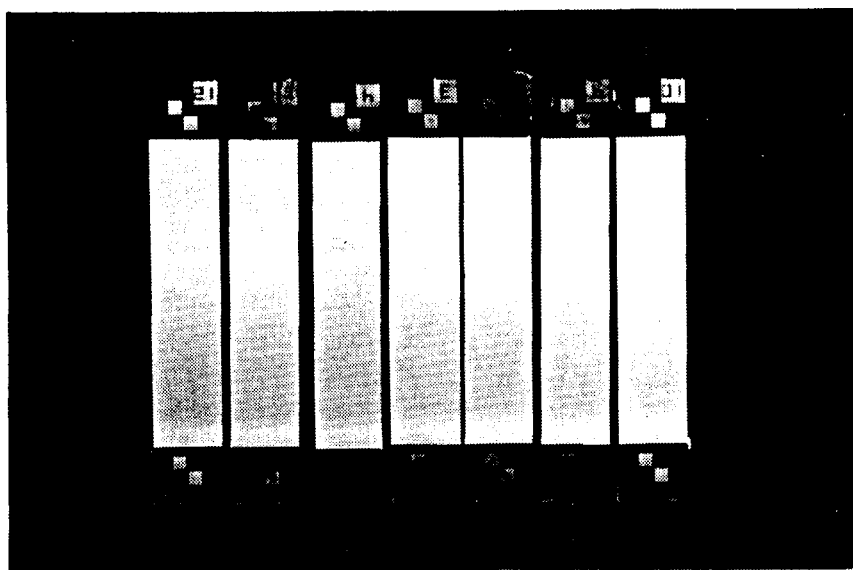


VISIBLE FILTER / MASK ASSY. FOR ENGINEERING MODEL

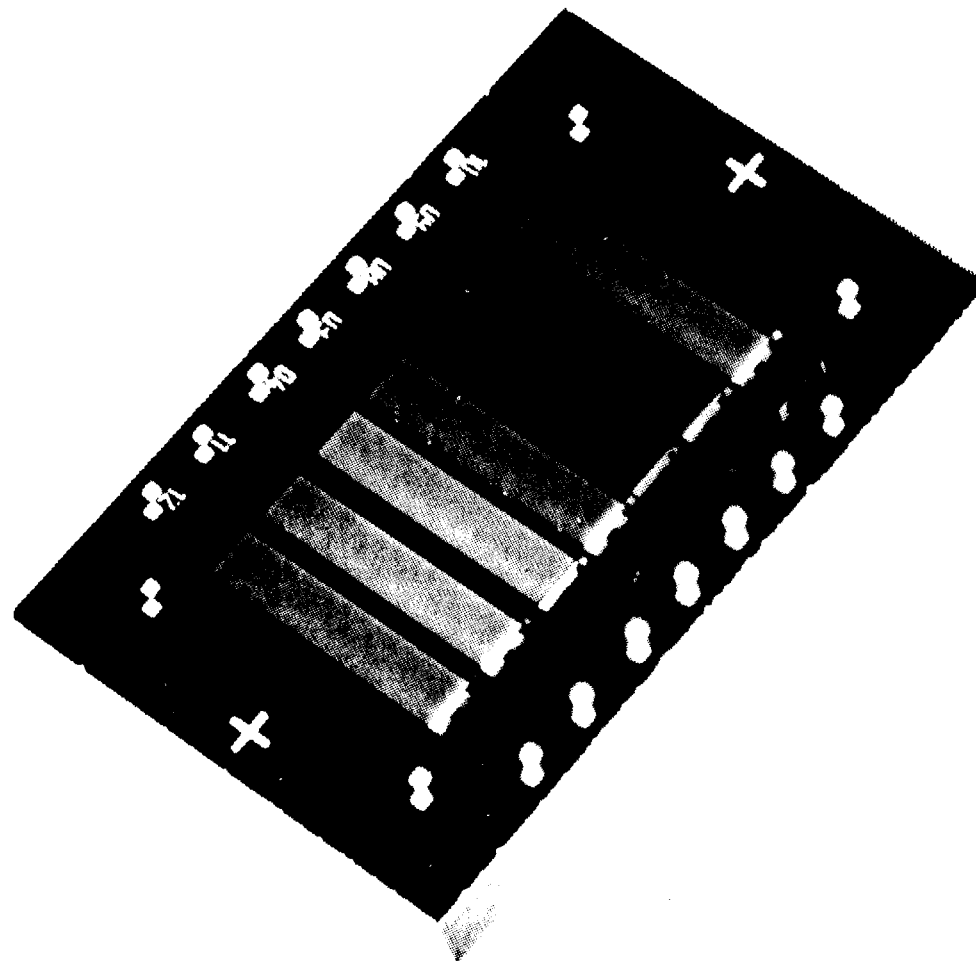
93-9-76

HUGHES

SANTA BARBARA RESEARCH CENTER
a subsidiary



18mm



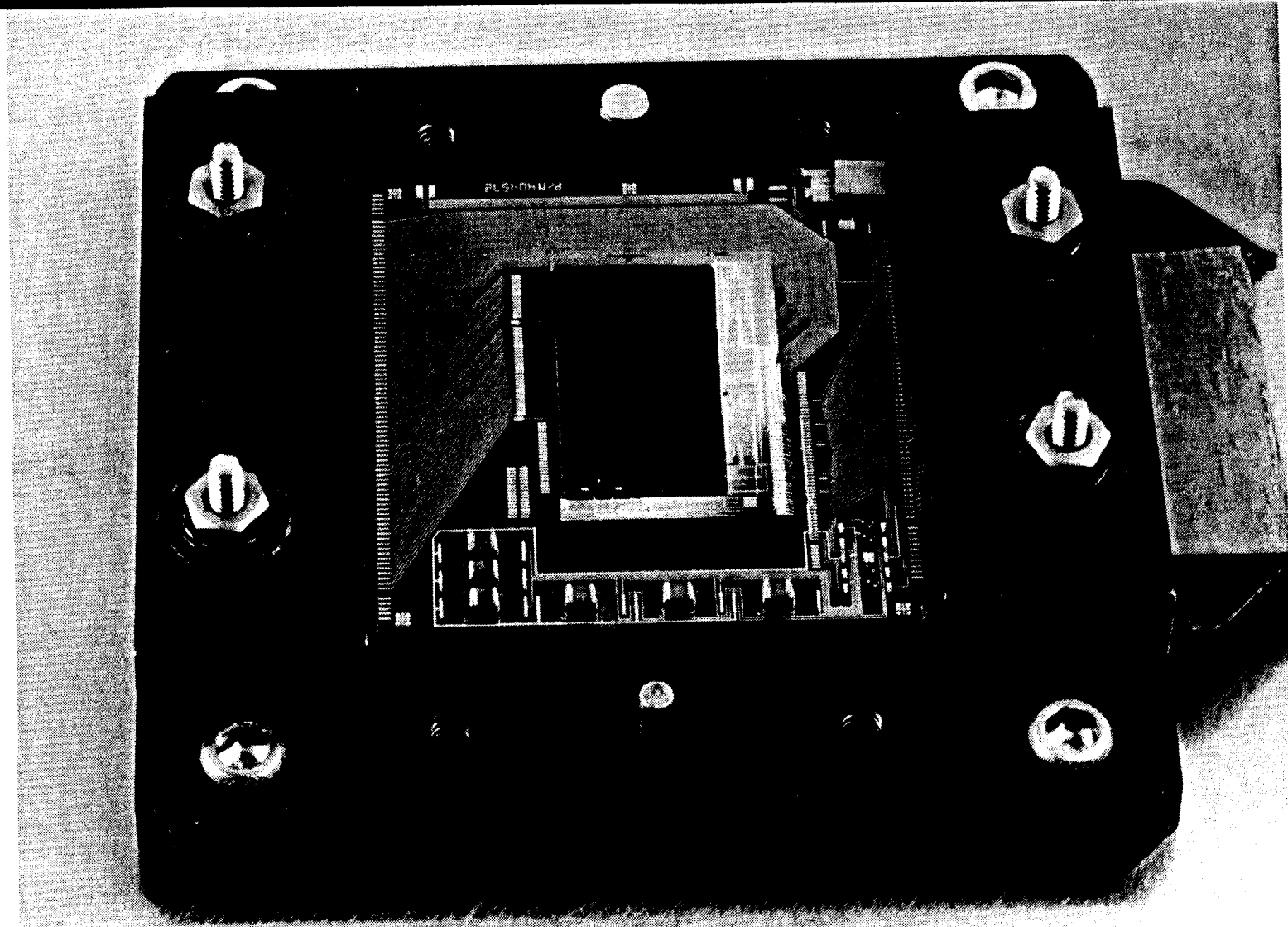


EM VISIBLE DETECTIVE ASSEMBLY IS READY FOR FILTER ASSEMBLY AND FINAL TEST

93-7-30

HUGHES

SANTA BARBARA RESEARCH CENTER
a subsidiary



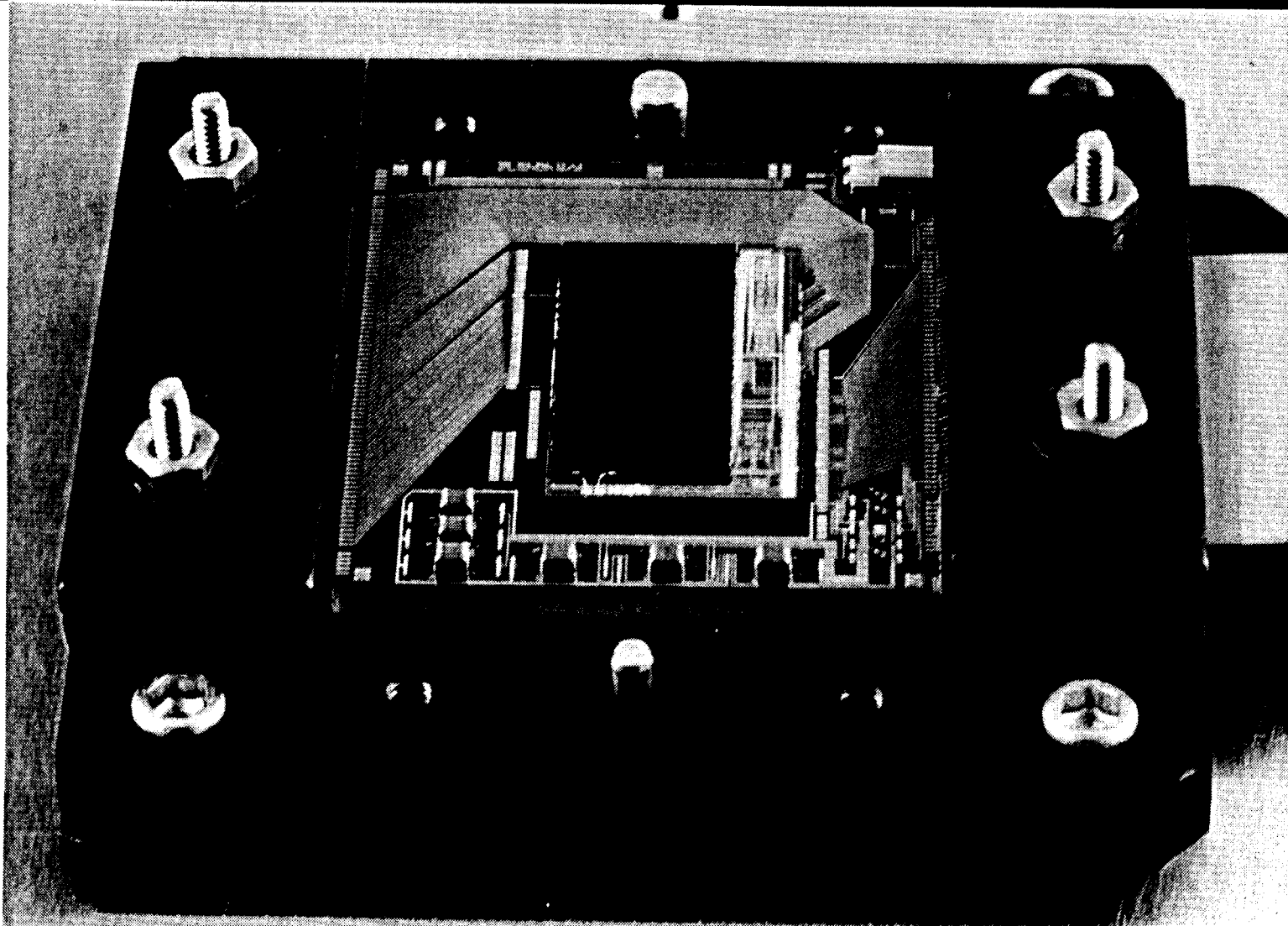


NIR DA IS READY FOR FILTER ASSEMBLY AND FINAL TEST

93-6-67B

HUGHES

SANTA BARBARA RESEARCH CENTER
a subsidiary



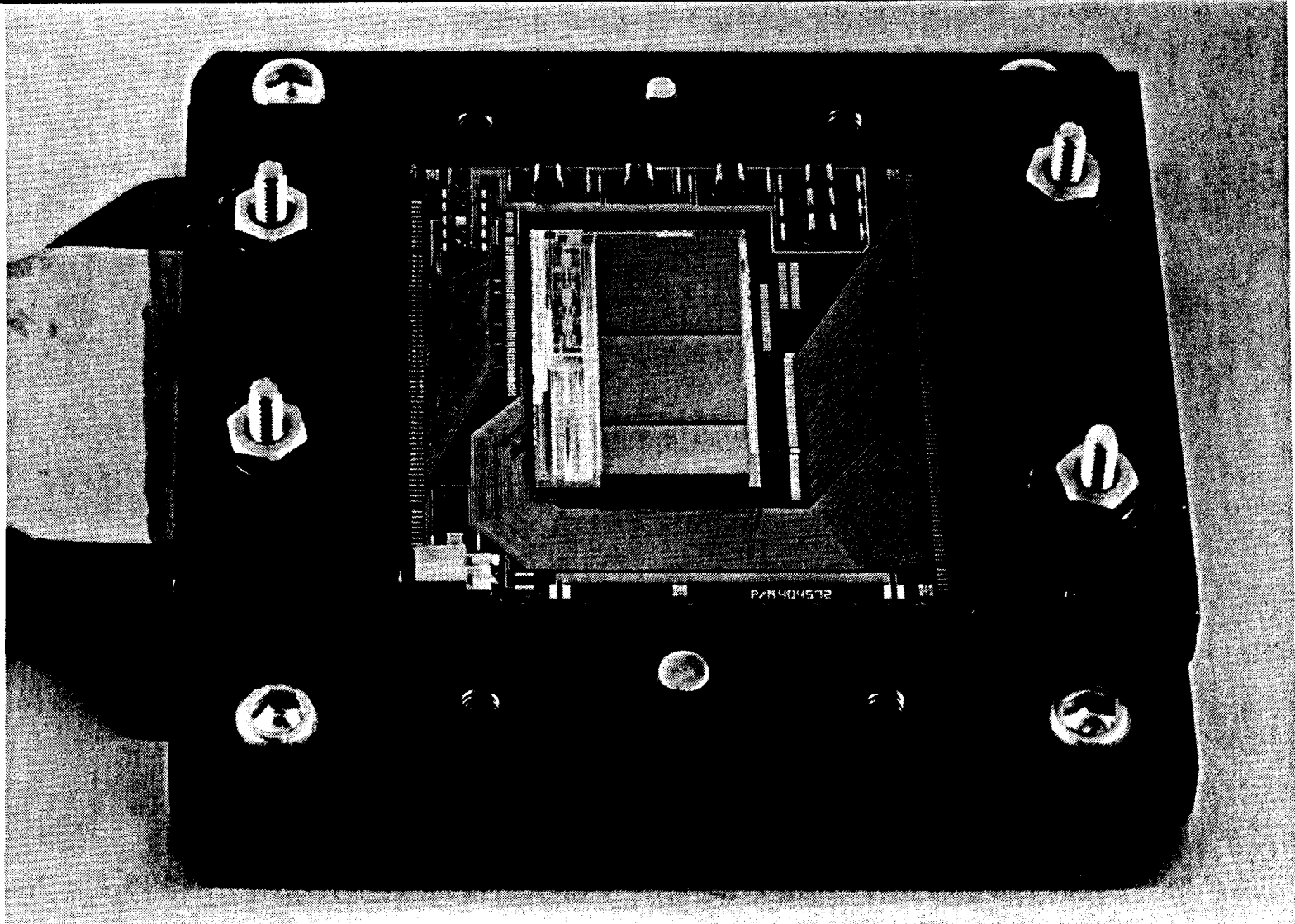


EM SW/MW IR DA IS READY FOR FILTER ASSEMBLY AND FINAL TEST

93-7-28

HUGHES

SANTA BARBARA RESEARCH CENTER
a subsidiary



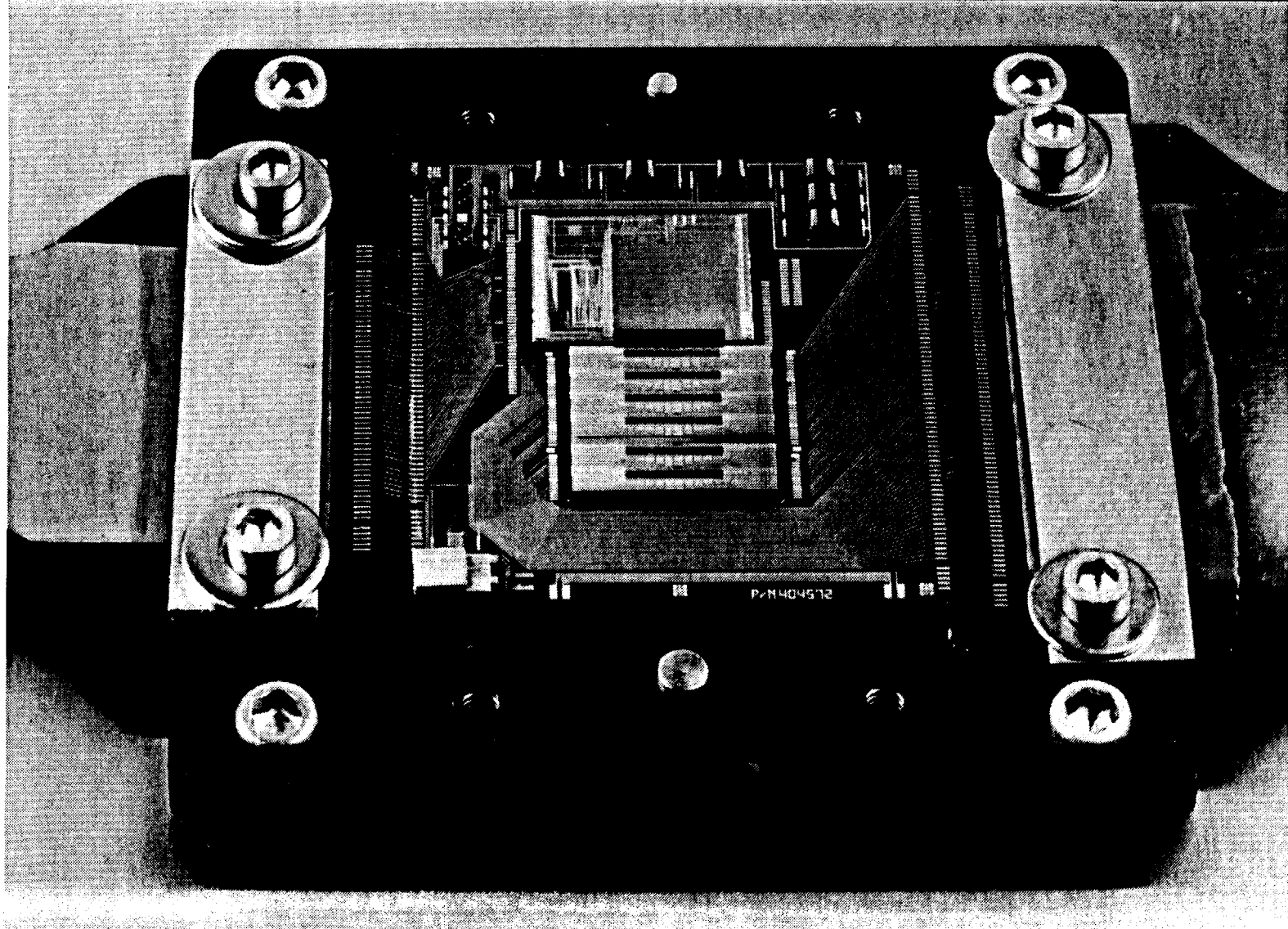


EM LWIR DA IS READY FOR FILTER ASSEMBLY AND FINAL TEST

93-7-29



SANTA BARBARA RESEARCH CENTER
a subsidiary

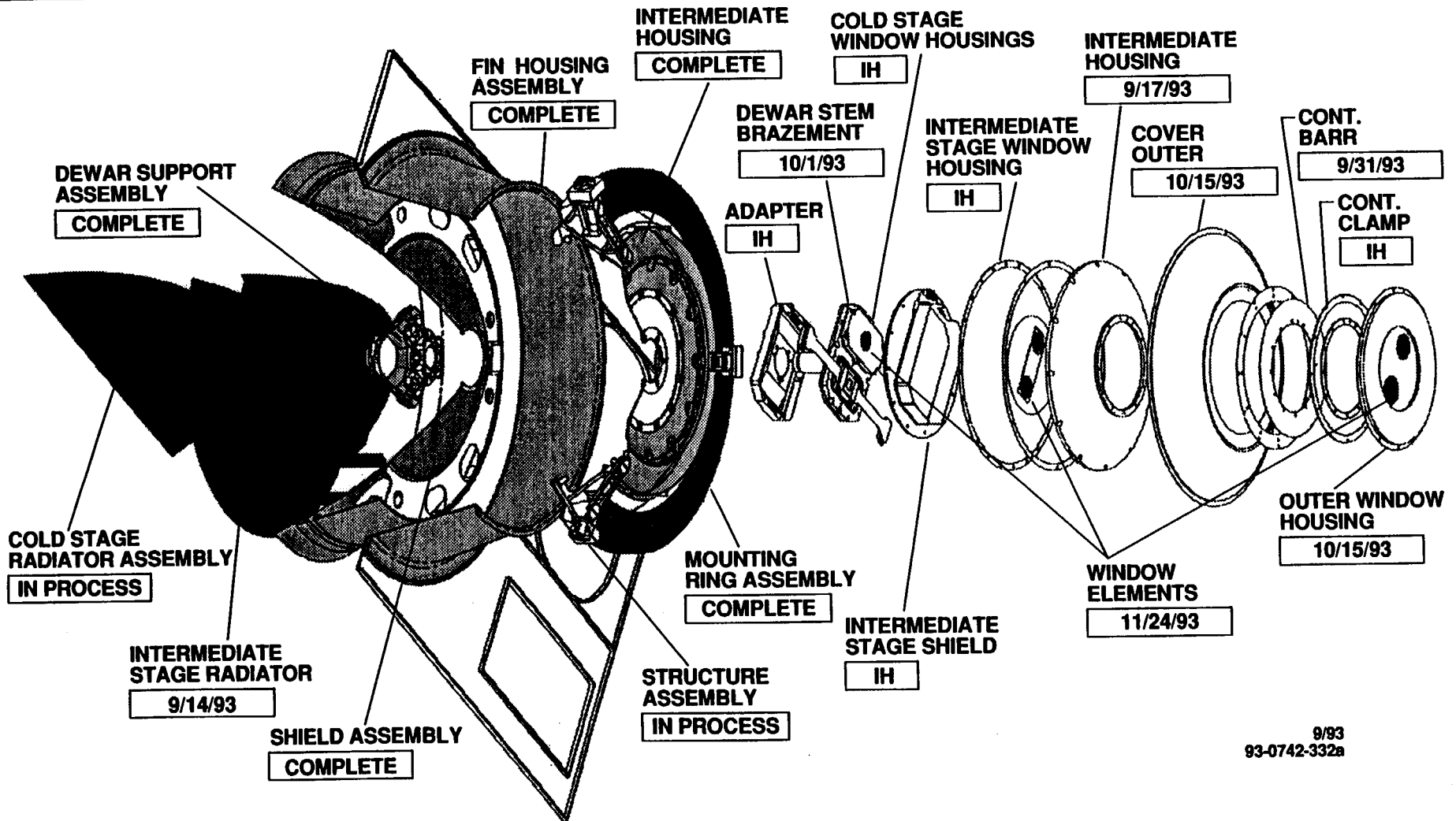


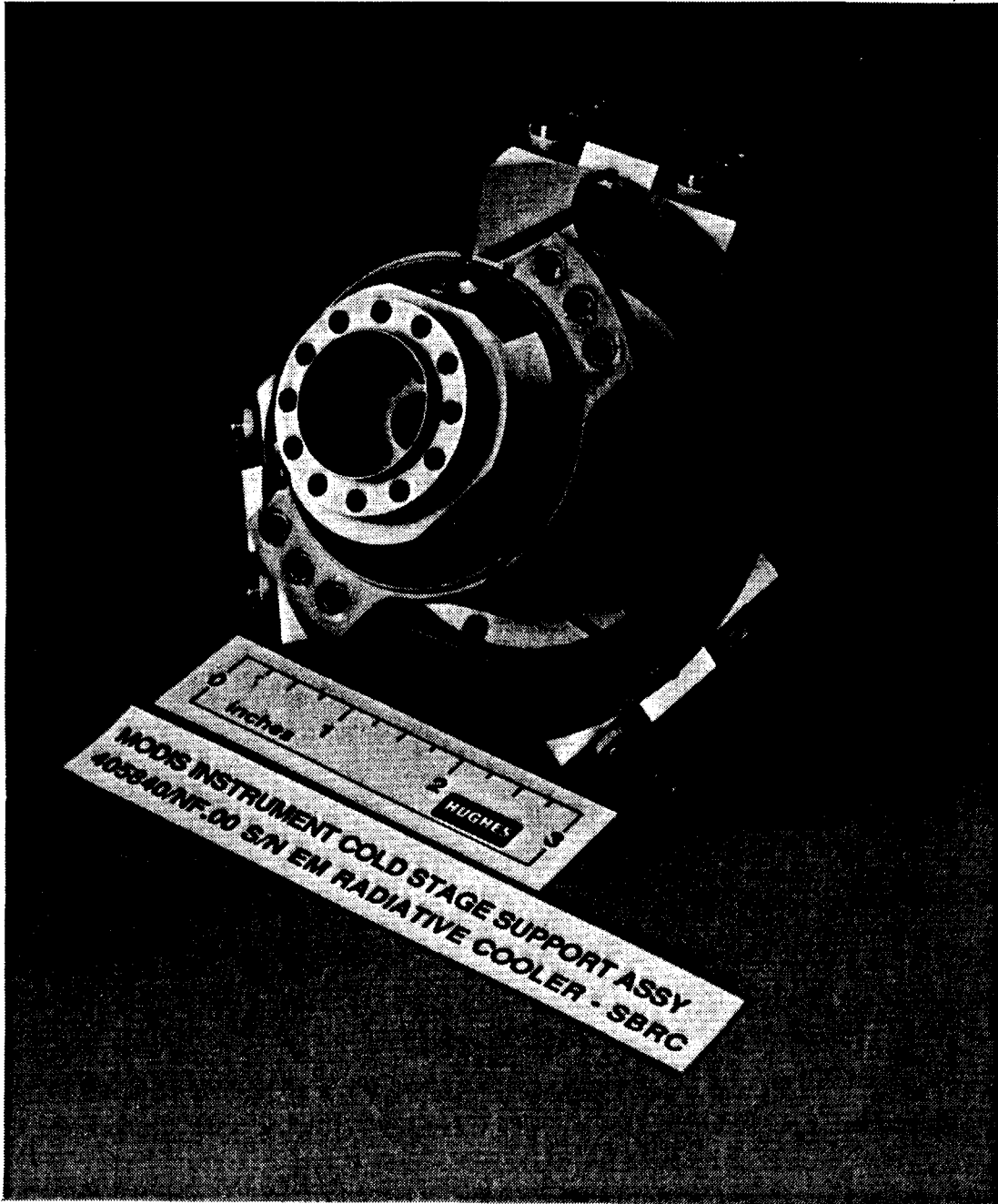


MAJOR MAGNESIUM PARTS IN-HOUSE



SANTA BARBARA RESEARCH CENTER
a subsidiary





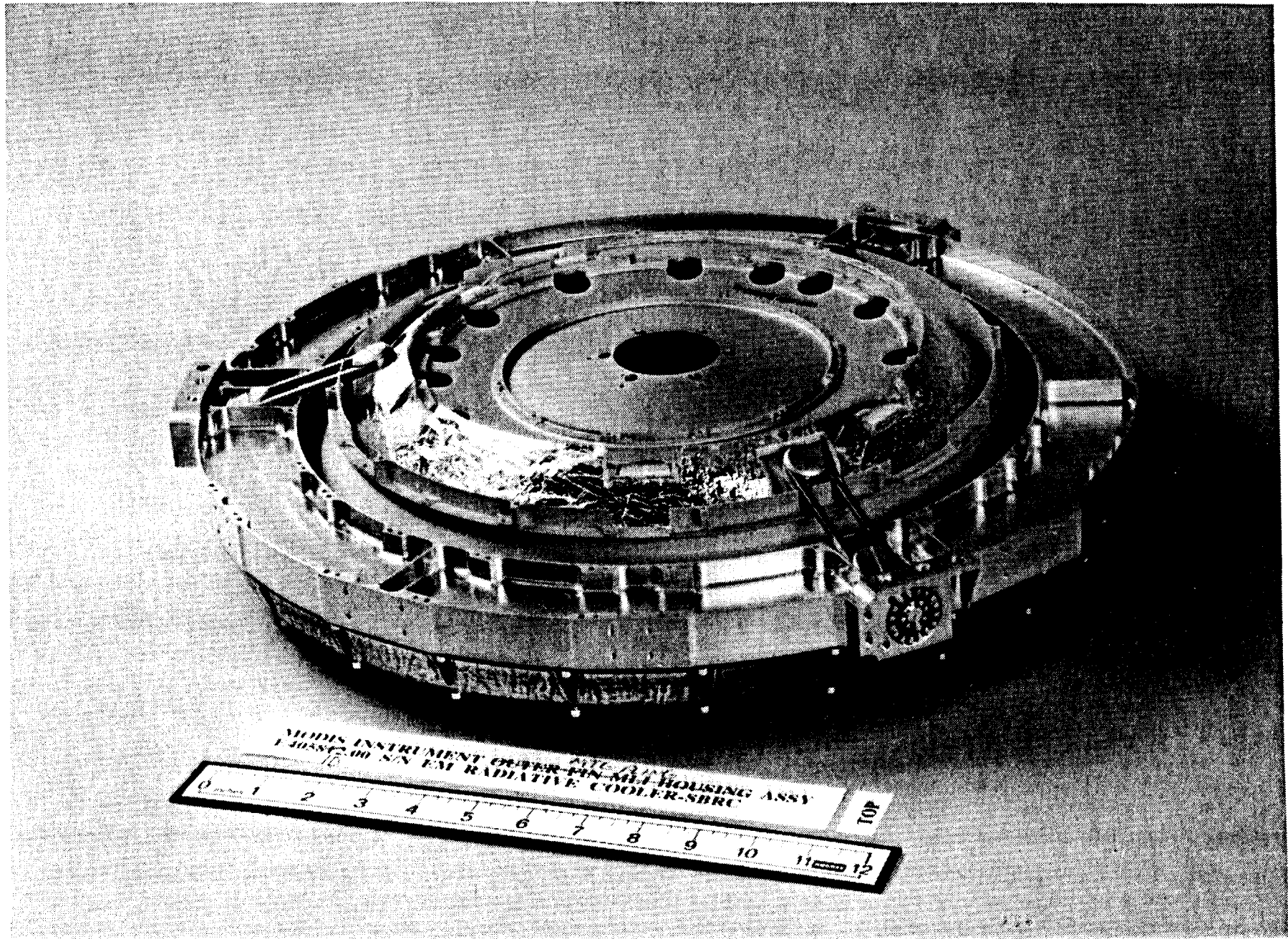
HUGHES

SANTA BARBARA RESEARCH CENTER
a subsidiary

93-7-32

**COLD STAGE
SUPPORT
ASSEMBLY
40530/NF100 EM**





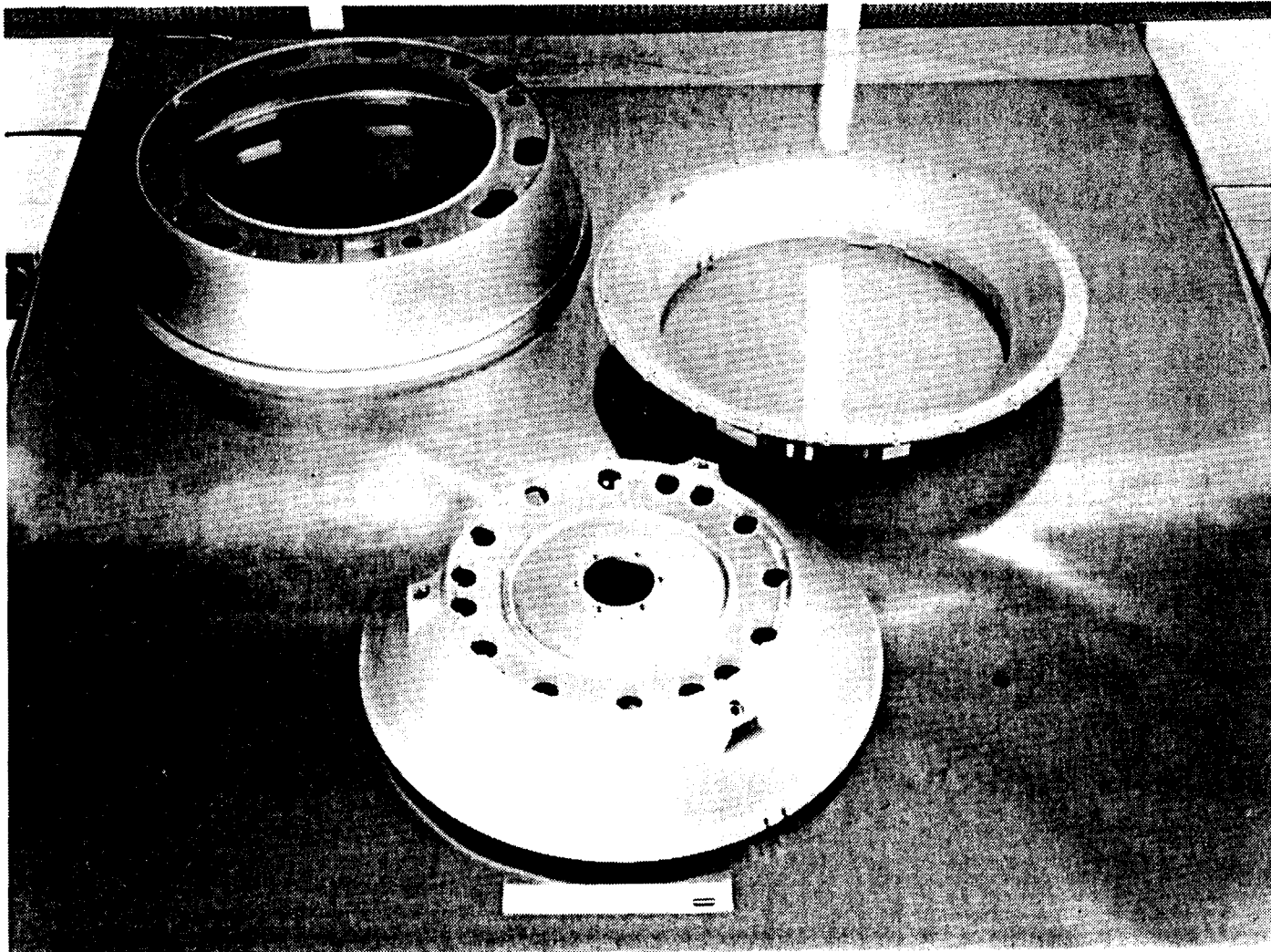
MIDDIS INSTRUMENT COOPER-FIN-MIL HOUSING ASSY
1-10557-00 SEN EM RADIATIVE COOLER-SBRC
101

RAD COOLER MAGNESIUM HOUSINGS

93-5-46

HUGHES

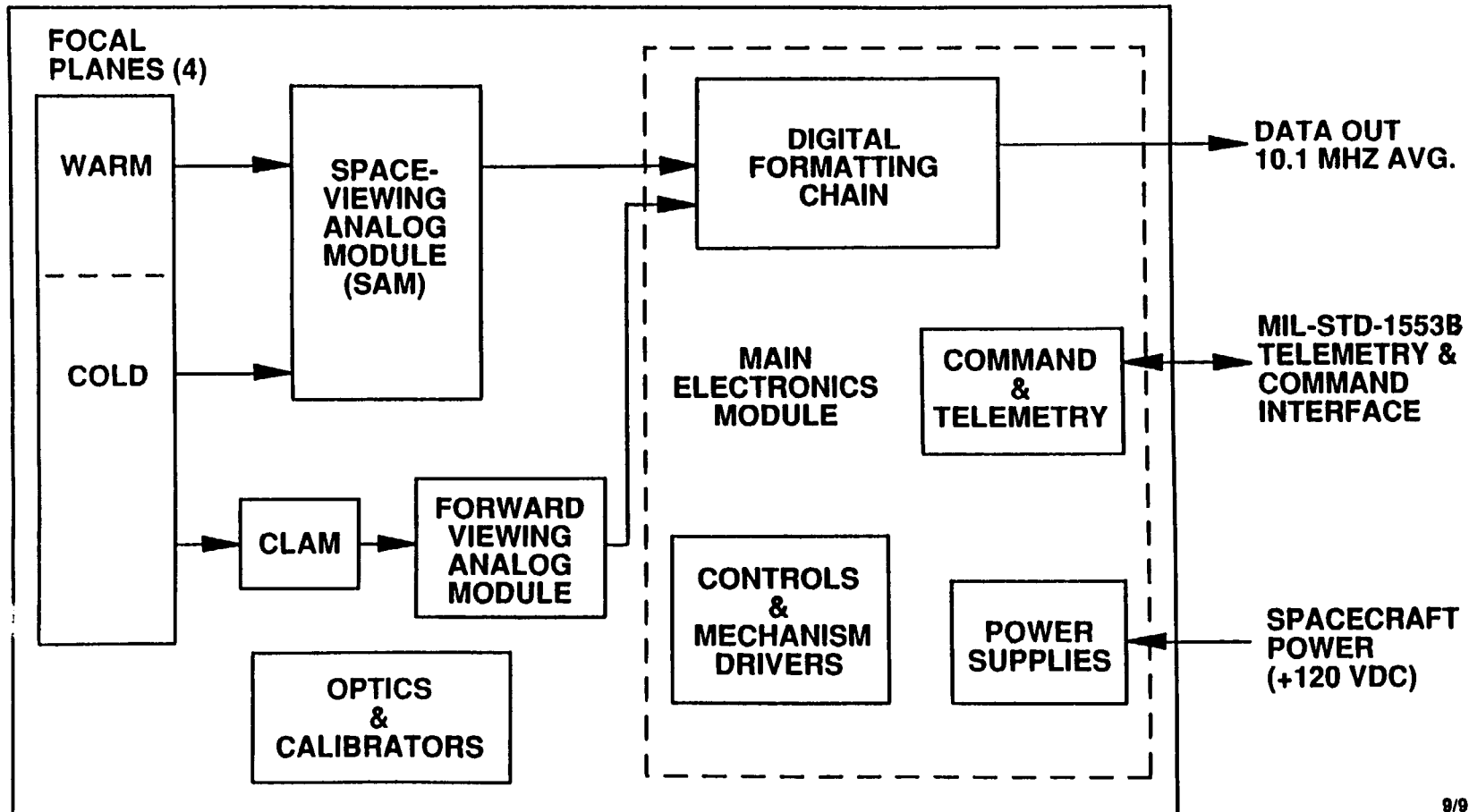
SANTA BARBARA RESEARCH CENTER
a subsidiary



SIMPLIFIED ELECTRONICS BLOCK DIAGRAM

HUGHES

SANTA BARBARA RESEARCH CENTER
a subsidiary

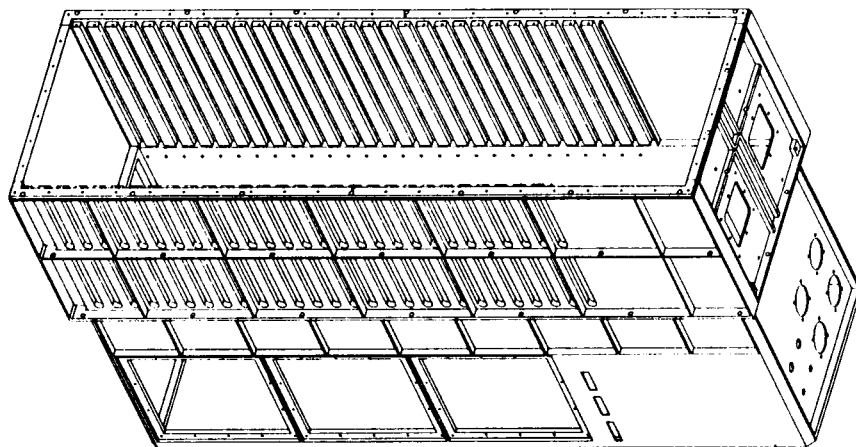




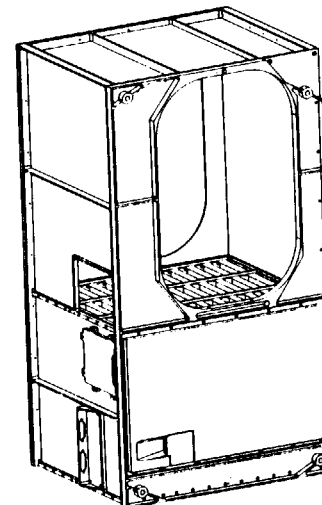
ELECTRONICS MODULES IN FAB

HUGHES

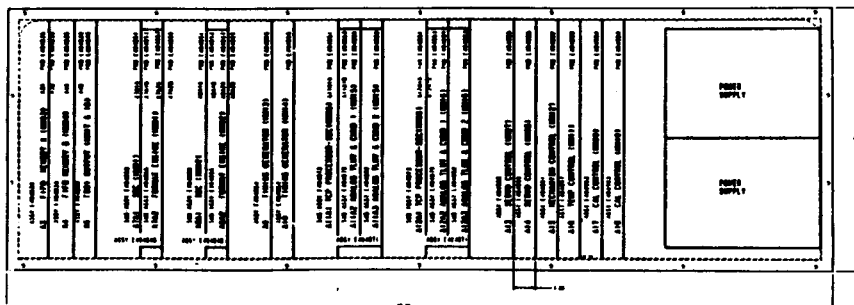
SANTA BARBARA RESEARCH CENTER
a subsidiary



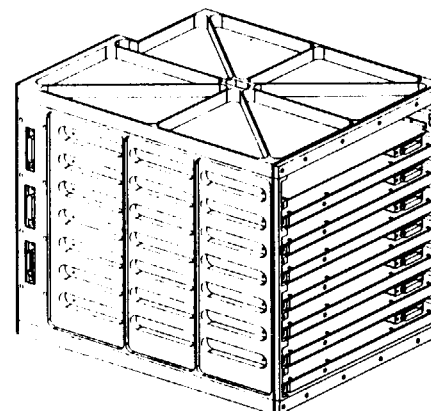
**MAIN ELECTRONICS MODULE
(MEM)**



**SPACE-VIEWING ANALOG MODULE
BANDS 1-30
(SAM)**



MEM CIRCUIT CARDS



**FORWARD-VIEWING ANALOG MODULE
BANDS 31-36
(FAM)**



ELECTRONICS ACCOMPLISHMENTS JUNE-AUGUST 1993



SANTA BARBARA RESEARCH CENTER
a subsidiary

- **MEM**
 - **EM CHASSIS IN DIGITIZATION**
 - **13 OF 14 PWB LAYOUTS COMPLETE; LAST ONE IN CIRCUIT DESIGN. 11 PWBs DUE IN-HOUSE BY 9/20**
 - **TWO ENGINEERING MODEL PWB SUBASSEMBLIES TESTED, TWO MORE IN TEST, TWO IN ASSEMBLY**
 - **BREADBOARD AND ENGINEERING MODEL BACKPLANES IN DESIGN**
- **AEMs**
 - **FAM AND SAM ENGINEERING MODEL CHASSIS FAB COMPLETE**
 - **ALL PWBs IN-HOUSE FOR EM**
- **GENERAL**
 - **ALL HYBRID P.O.D. MODELS TESTED; EM QUANTITY IN WORK**
 - **DESIGN, FAB STARTED ON NEW PORTABLE ENCODER TESTER**
 - **ALL EM PARTS ON ORDER; > 90% IN HOUSE**
 - **> 80% OF PROTOFLIGHT PARTS ON ORDER**

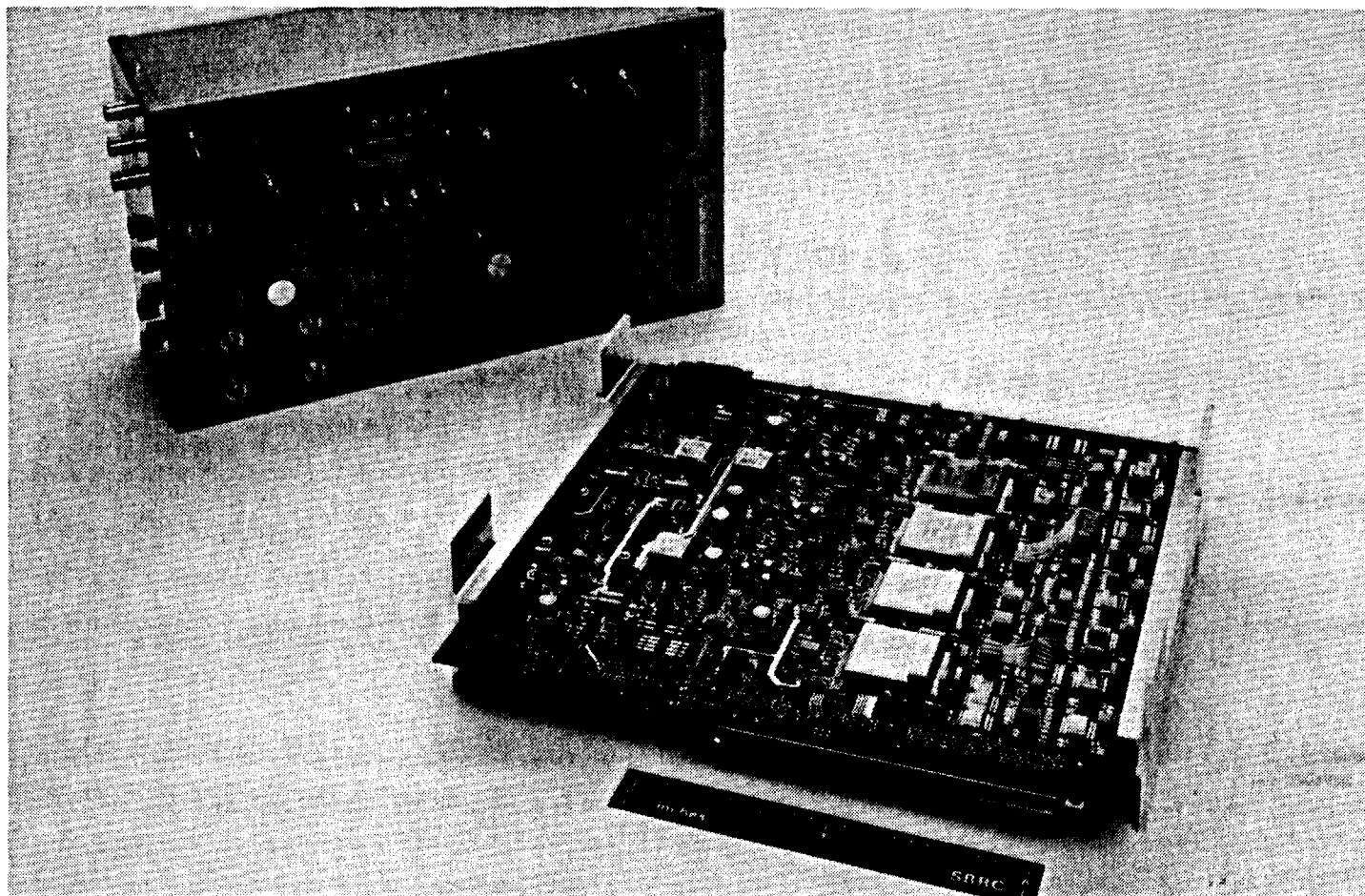


E.M. MOTOR DRIVER S/A & TESTER

93-9-28

HUGHES

SANTA BARBARA RESEARCH CENTER
a subsidiary





OBC's STATUS

9/22/93



SANTA BARBARA RESEARCH CENTER
a subsidiary

- **SRCA**

Solid modeling of the SRCA, including collimator, is nearly complete. Mirror and grating drawings have been sent to vendors for quotes. Production of working drawings from the solid model has begun. The two motors for the SRCA are in procurement. The heat sinks for the 10-watt quartz-halogen lamps have been verified. A 5-week UV test is in process. Slight mods to the SIS and heatsinks will increase output radiance.

- **SDSM**

Solid modeling of the SDSM is now being reviewed. Some SDSM components have been drafted for procurement and fabrication. Detailed drafting will begin after design of the SD is completed. The motor for the SDSM is in procurement.

- **SD**

The design of the SD has been determined and only needs to be drawn. This will be done when the more complicated SDSM has been finished.

- **BB**

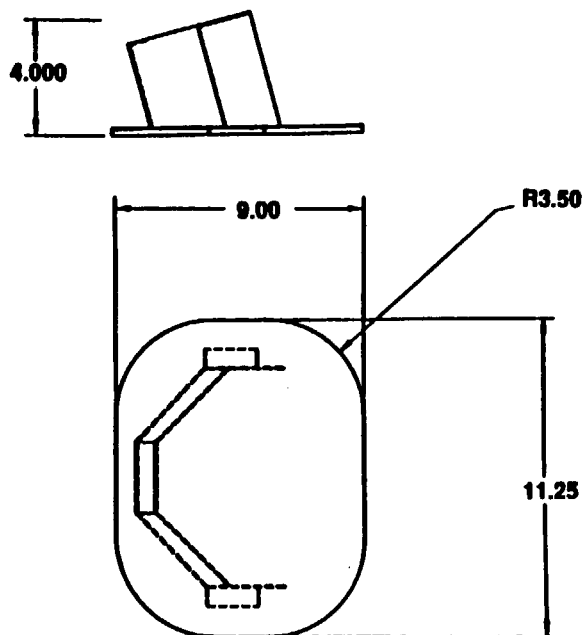
The BB design has been completed. Currently, we plan to use 61101-T6 aluminum. A bar of material has been ordered to evaluate various BB surface treatments.



MODIS SOLAR DIFFUSER AND SOLAR VIEW DOOR ASSEMBLIES

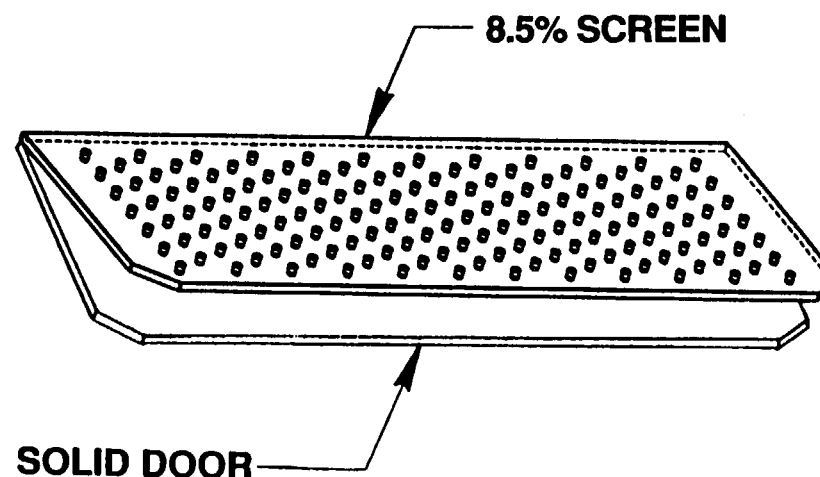


SANTA BARBARA RESEARCH CENTER
a subsidiary



- BRDF: 0.315 sr
- EFFECTIVE ALBEDO: 54%

SOLAR DIFFUSER ASSEMBLY



SOLAR VIEW DOOR ASSEMBLY

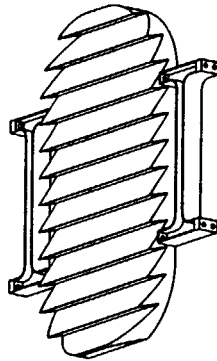
- BASELINE DIFFUSER MATERIAL IS SPECTRALON (PTFE)



V-GROOVE BLACKBODY ACHIEVES HIGH EMISSIVITY AND LOW T-GRADIENTS

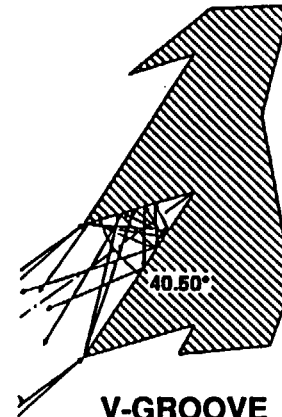


SANTA BARBARA RESEARCH CENTER
a subsidiary

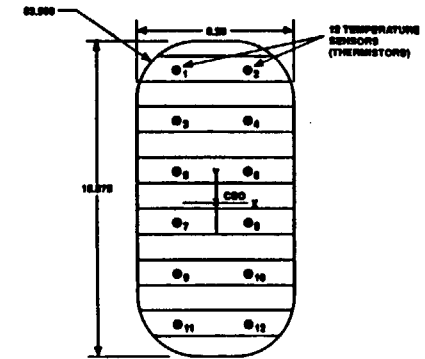


BLACKBODY

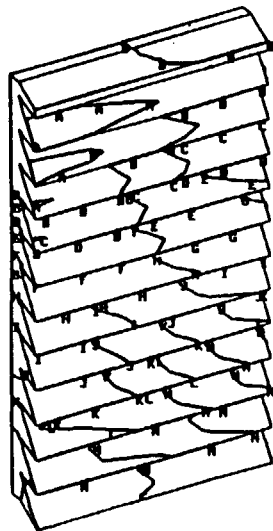
- ALUMINUM
- FULL APERTURE
- V-GROOVE
- $\epsilon \geq 0.992^\circ$
- $\Delta T \leq 0.1K$
- $\frac{\Delta L}{L} \leq 0.554\%$



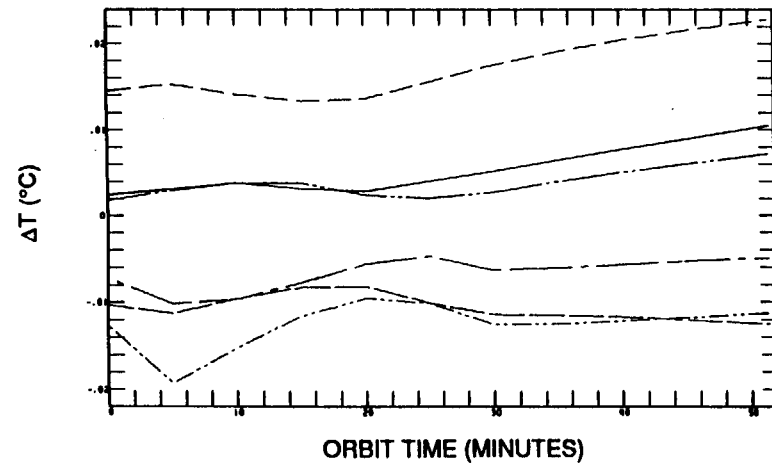
**V-GROOVE
DETAIL**



**12 TEMPERATURE
SENSORS**



- 0.5886- A
- 0.5847- B
- 0.5827- C
- 0.5807- D
- 0.5788- E
- 0.5768- F
- 0.5748- G
- 0.5729- H
- 0.5709- I
- 0.5689- J
- 0.5670- K
- 0.5650- L
- 0.5630- M
- 0.5611- N



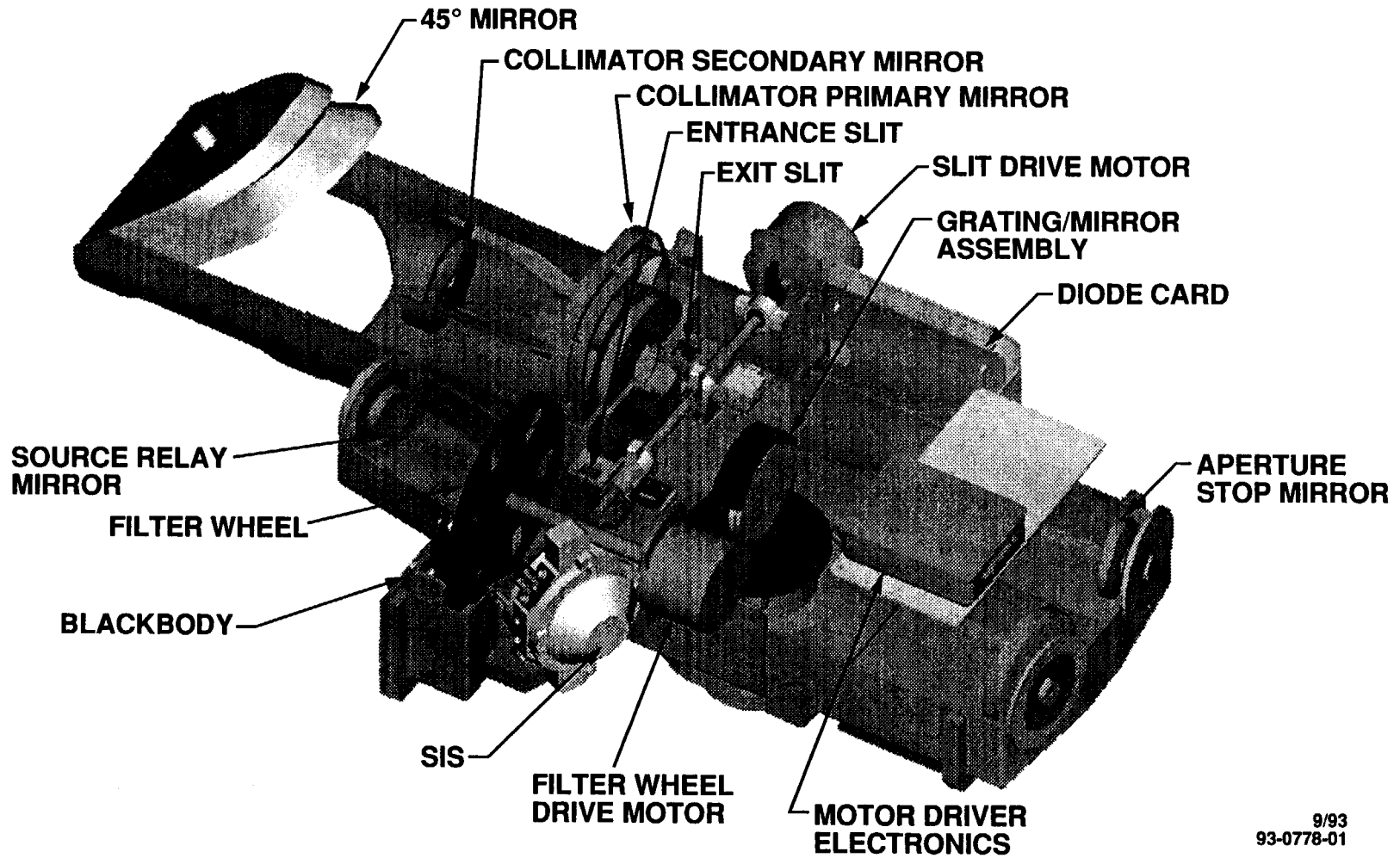
• THERMAL MODEL SHOWS $\leq 0.03^\circ$ GRADIENTS AT AMBIENT

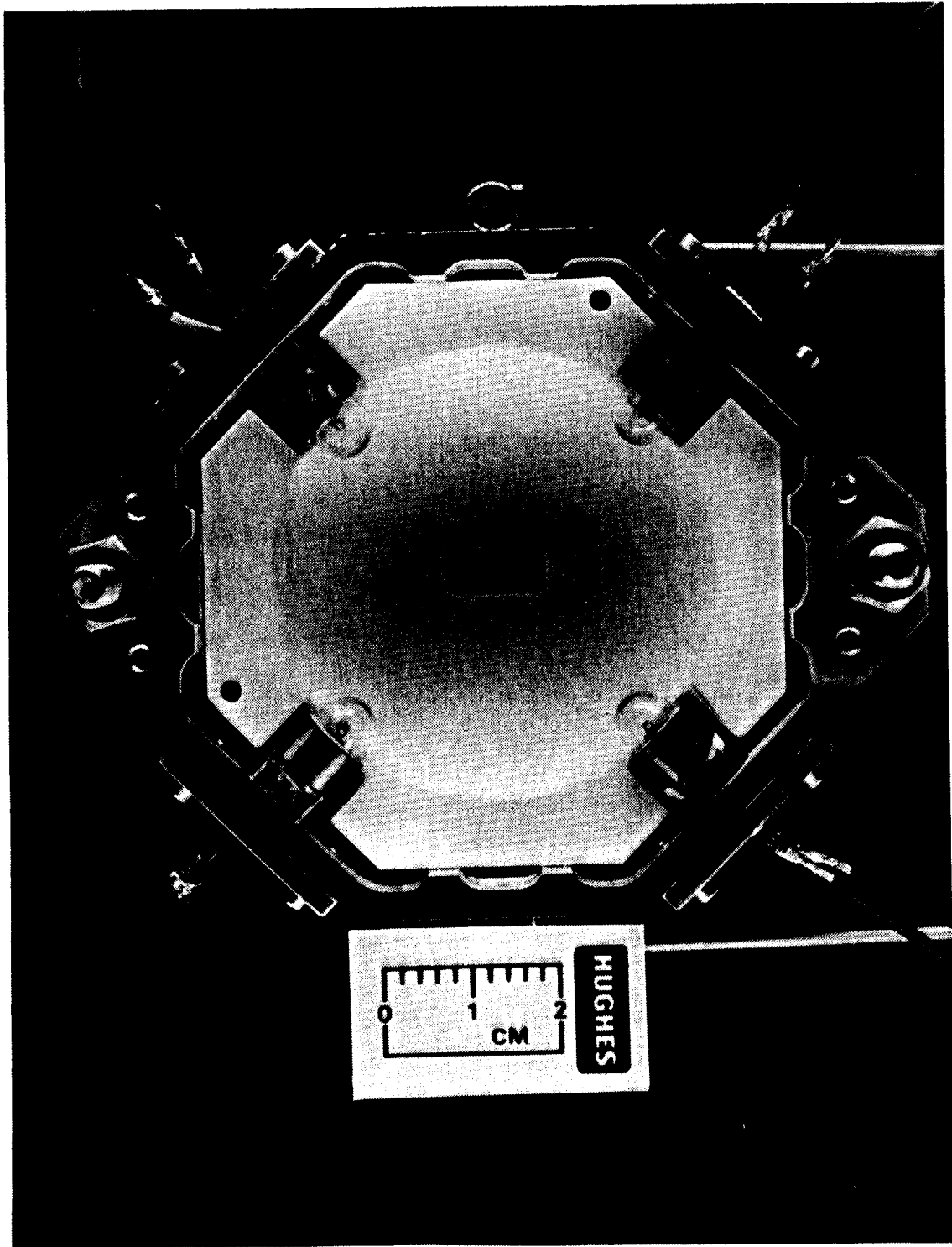


SRCA (CUTAWAY)



SANTA BARBARA RESEARCH CENTER
a subsidiary





HUGHES

SANTA BARBARA RESEARCH CENTER
a subsidiary

93-9-24

**CROSS SECTION
VIEW OF MODIS
INTEGRATING
SPHERE**

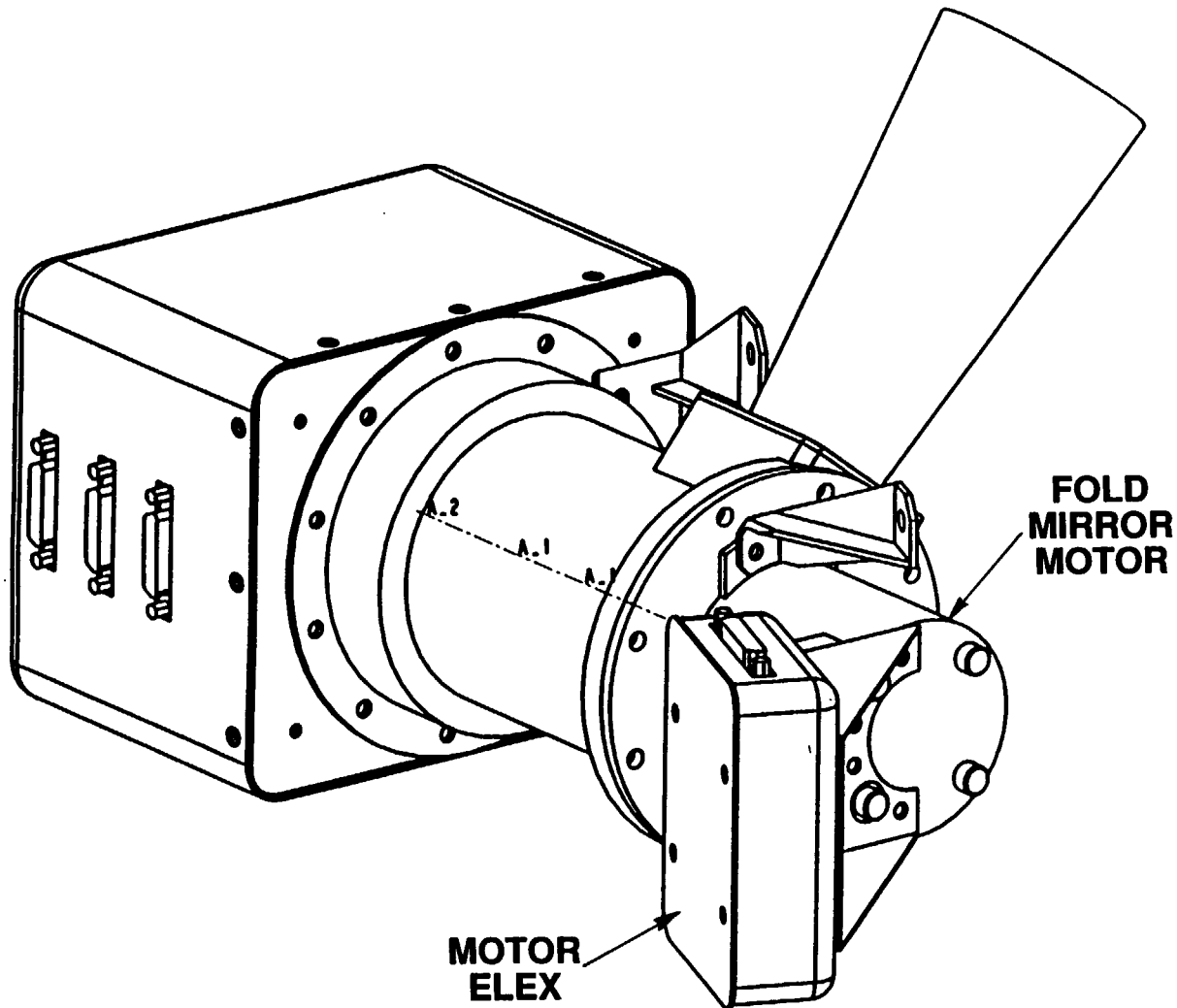




MODIS SDSM IN FINAL DESIGN

HUGHES

SANTA BARBARA RESEARCH CENTER
a subsidiary



9/93
93-0778-10

MODIS PERFORMANCE

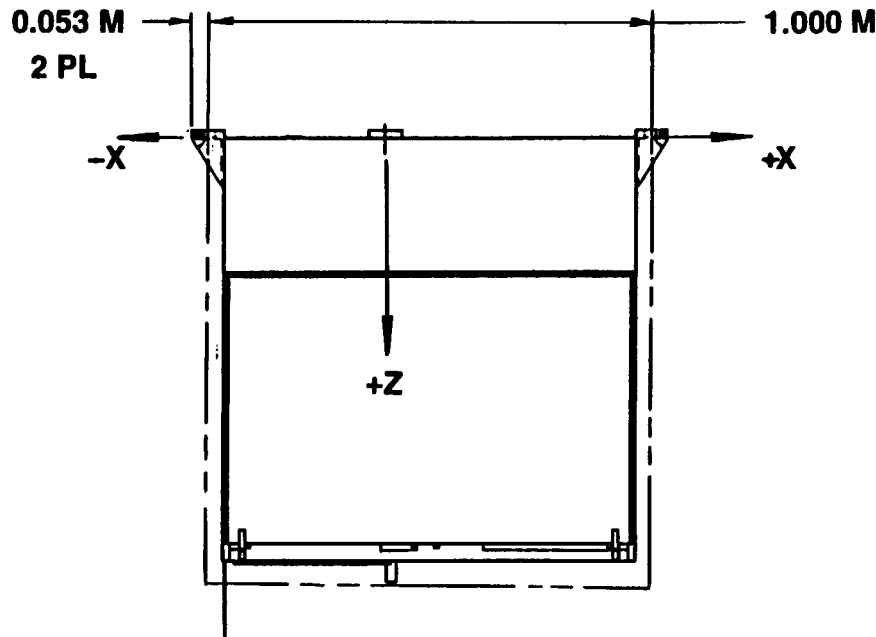


ENVELOPE MEETS REQUIREMENTS

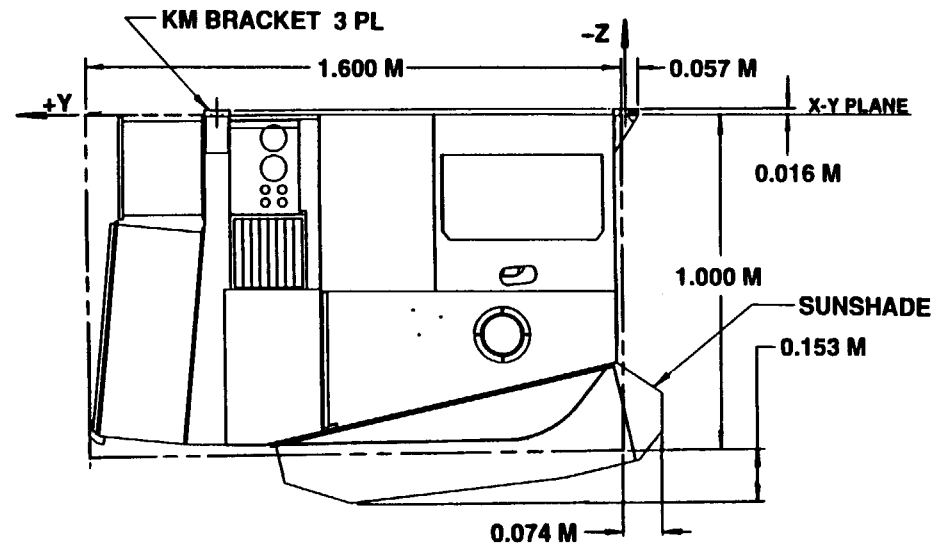
HUGHES

SANTA BARBARA RESEARCH CENTER
a subsidiary

- LOCALIZED PROTRUSIONS HAVE BEEN AUTHORIZED



- KINEMATIC MOUNT BRACKETS PROTRUDE IN X



- SUNSHADE PROTRUDES IN Y AND Z



CURRENT MASS ESTIMATE WITHIN SPECIFICATION

HUGHES

SANTA BARBARA RESEARCH CENTER
a subsidiary

Components	Estimated Wt, kg	Estimated Δ kg	Budgeted Wt, kg
I. OPTICAL SUBSYSTEMS	46.2	-2.9	50.4
1. Scan Mirror	11.4		10.5
2. Afocal Telescope Assembly	13.5		11.3
3. Aft Optics Assembly	10.2		18.5
4. Radiative Cooler	11.1		10.1
II. ON BOARD CALIBRATORS	18.9	1.7	16.1
1. Blackbody	4.9		4.1
2. SRCA	10.9		8.6
3. Solar Diffuser	1.2		1.2
4. Solar Diffuser Monitor	1.9		2.2
III. STRUCTURES/TOP ASSY	79.9	0.0	78.9
1. Mainframe	54.3		52.6
2. Doors and Actuators	13.9		14.6
3. Top Assy Bill of Materials	11.7		11.7
IV. ELECTRONICS	90.8	1.2	83.2
1. Main Electronics Module	64.7		57.0
2. Analog Elex-Forward Viewing	7.5		7.6
3. Analog Elex-Space Viewing	14.4		14.4
4. Cabling, Misc	4.2		4.2
MODIS TOTAL WEIGHT	235.8 *	0.0	228.6
SPECIFICATION WEIGHT	250.0	-	250
MARGIN	14.2	0.0	21.4

* 0.6 kg HIGHER THAN PDR ESTIMATE

9/93

9/93
93-0720-124



MODIS POWER & DATA RATE WITHIN SPECIFICATION



SANTA BARBARA RESEARCH CENTER
a subsidiary

Item	1-orbit Avg Pwr (W)	2-orbit Avg Pwr (W)	Peak Pwr (W)	Avg Data Rate (Mbps)	Peak Data Rate (Mbps)
Allocation	225	225	275	6.2	11.0
Current Estimate	186.2	172.4	227.3	6.1	10.5
Previous Estimate	186.2	172.4	227.3	5.7	10.2
Change from Last Report	0	0	0	0	0.3
Margin to Allocation	38.8	52.6	47.7	0.1	0.6
Basis (%)					
Estimated	0	0	0	0	0
Calculated	100	100	100	100	100
Actual	0	0	0	0	0
<p>1] 1-Orbit Avg is for 75 % imaging with SRCA Cal & 25% straight imaging (more margin if only imaging). 2] 2-Orbit Avg is 1-Orbit Avg value & a full orbit of straight imaging. 3] Data rate based on 40% day and 60% night per orbit duty cycle.</p>					

9/93

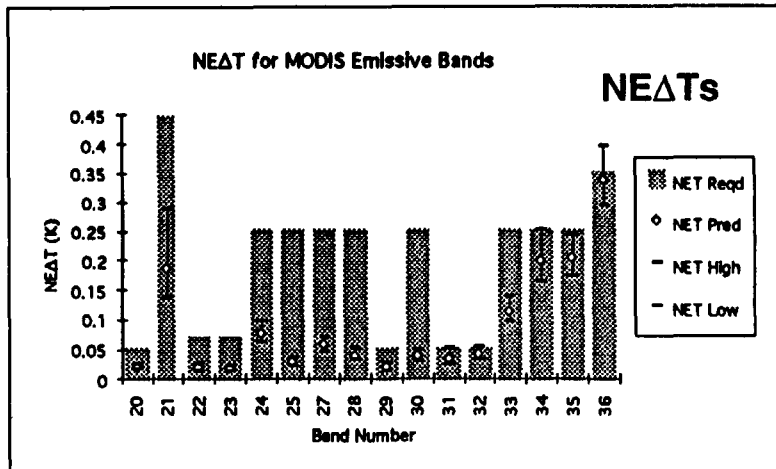
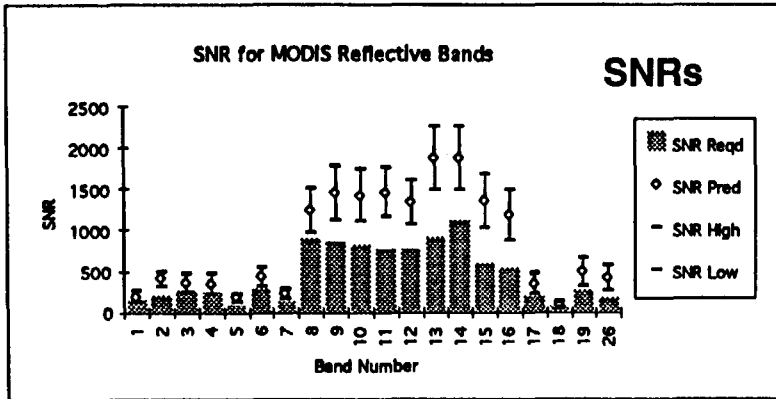
- CHANGE DUE TO INCREASED COLLECTS ACROSS BB, SRCA & SPACE VIEWS.



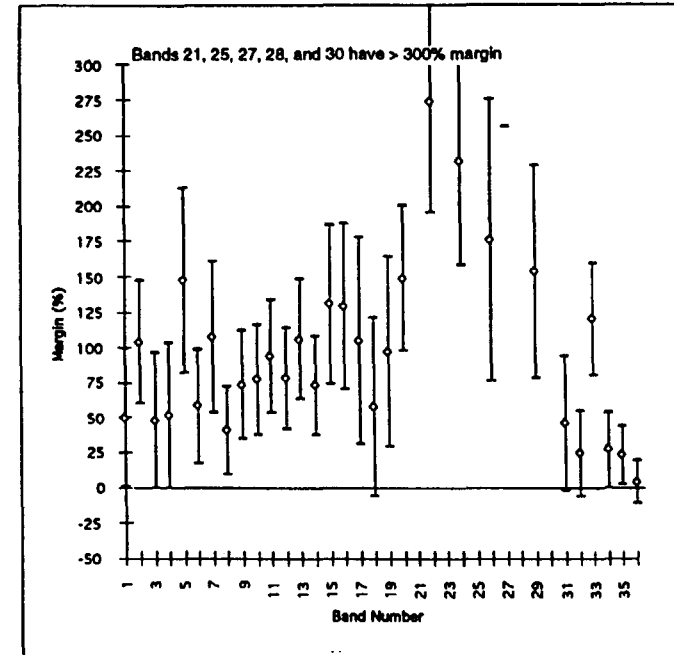
EM PREDICTIONS REFLECT LATEST OPTICAL TRANSMISSION DATA



SANTA BARBARA RESEARCH CENTER
a subsidiary



ENGINEERING MODEL MARGINS



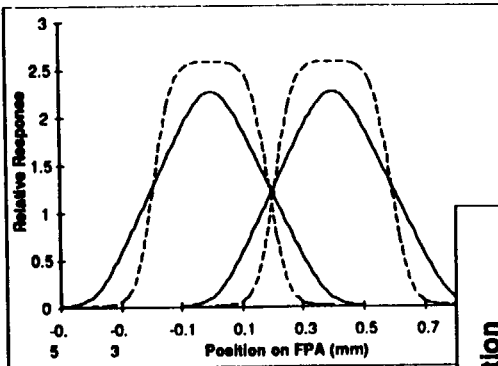
- INCLUDES PV AND PC ENGINEERING MODEL DETECTOR DATA
- INCLUDES UPDATED OPTICAL SYSTEM TRANSMISSIONS, FILTER BANDWIDTHS
- ERROR BARS ARE 3 SIGMA DEVIATIONS: INCLUDE PC IN-BAND VARIATIONS



MODULATION TRANSFER FUNCTION (MTF) IS CALCULATED FROM SPATIAL RESPONSE

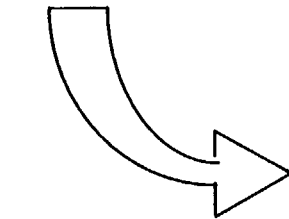


SANTA BARBARA RESEARCH CENTER
a subsidiary

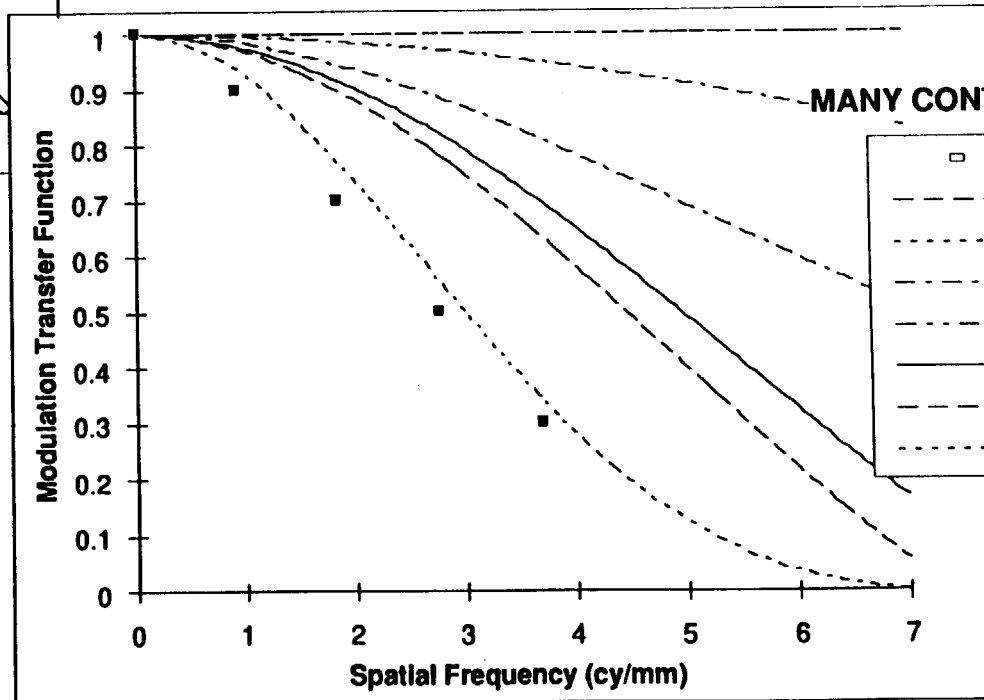


$$F\{LSF(x)\} = MTF(f) e^{i\Phi(f)}$$

$MTF(f)$ = Modulation Transfer Function
 $\Phi(f)$ = Phase Transfer Function

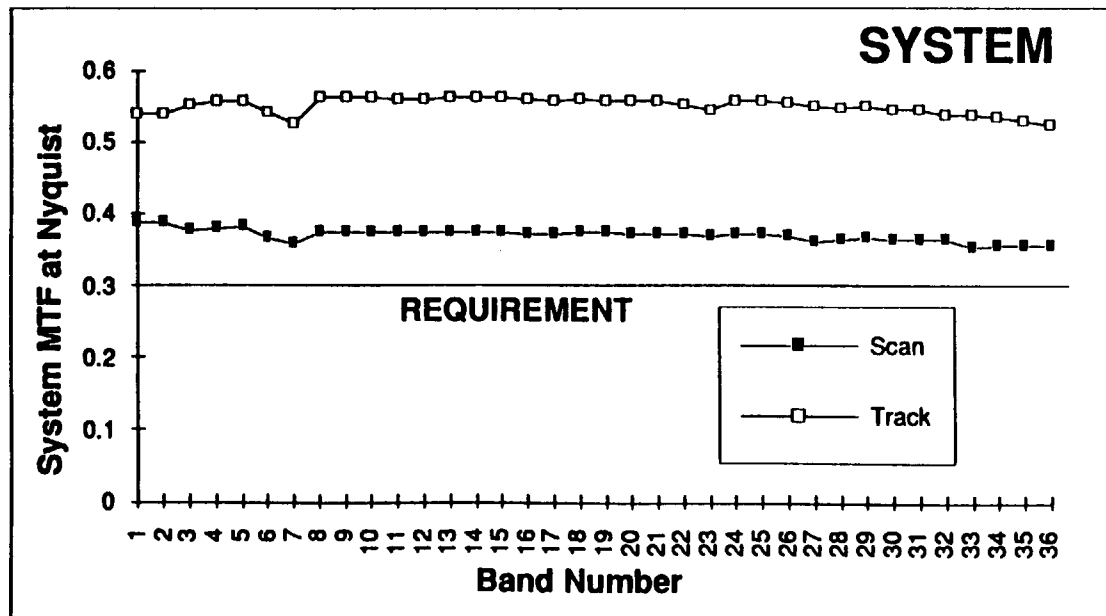
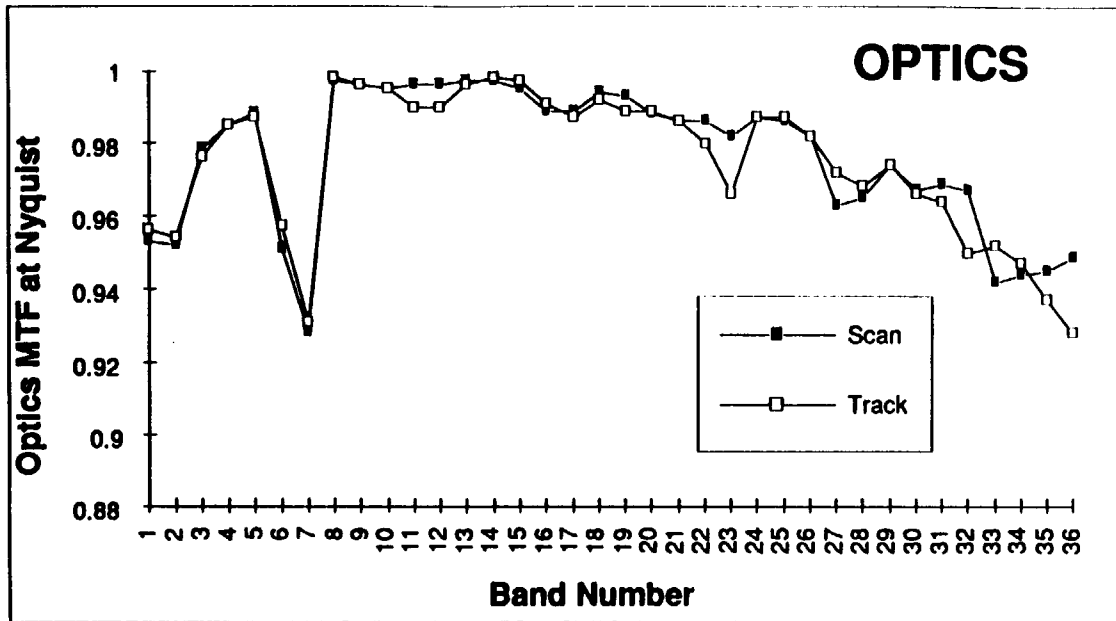


**FOURIER
TRANSFORM
OF SPATIAL
RESPONSE
IS MTF**



MANY CONTRIBUTORS MODELED

- Requirement
- - - Optical Crosstalk
- · · Detector Crosstalk
- · - Fab & Align
- - - - Optics
- Integration
- - - - Detector Size
- · · Total



SANTA BARBARA RESEARCH CENTER
a subsidiary

MTF REQUIREMENTS SATISFIED FOR ALL BANDS

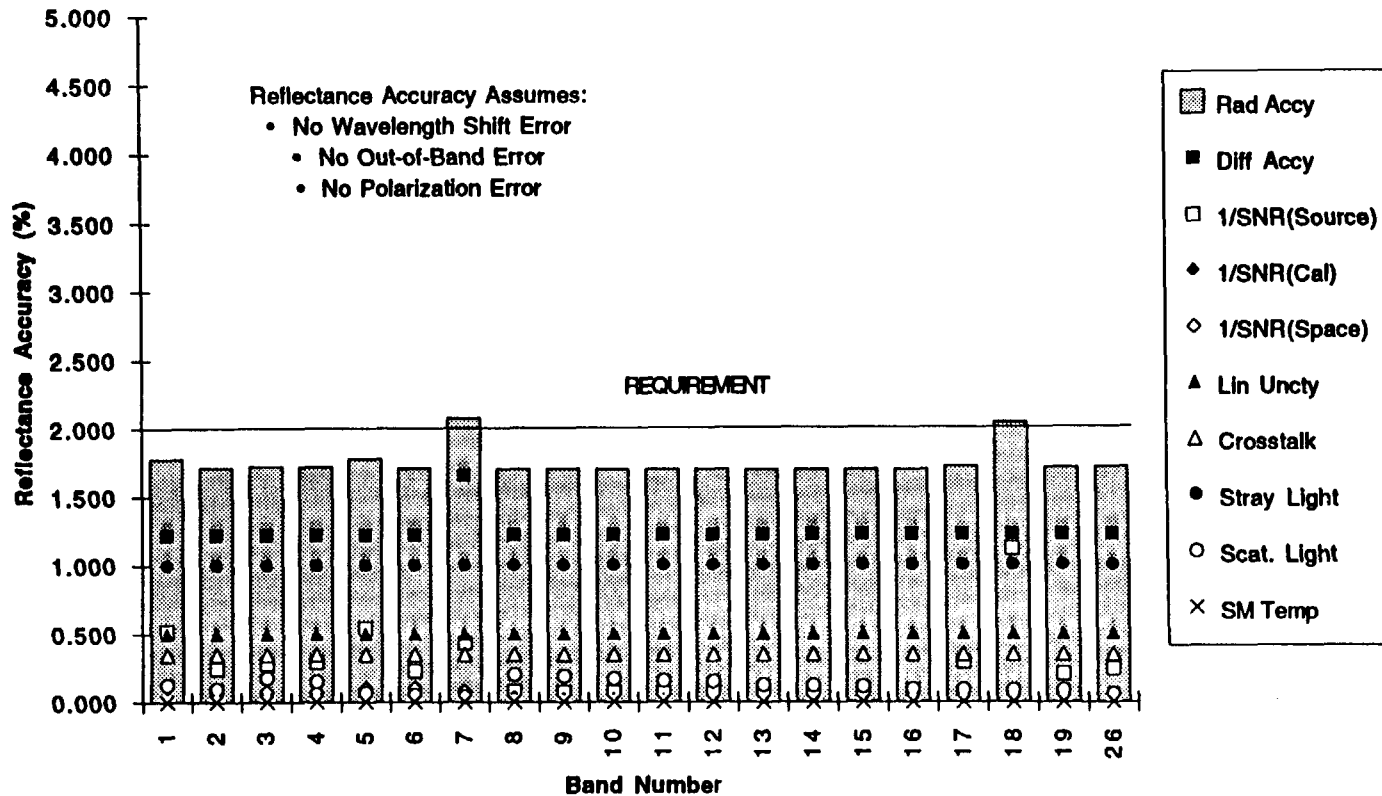




NO CHANGE FOR SYSTEM REFLECTIVE BAND REFLECTANCE ACCURACY



SANTA BARBARA RESEARCH CENTER
a subsidiary



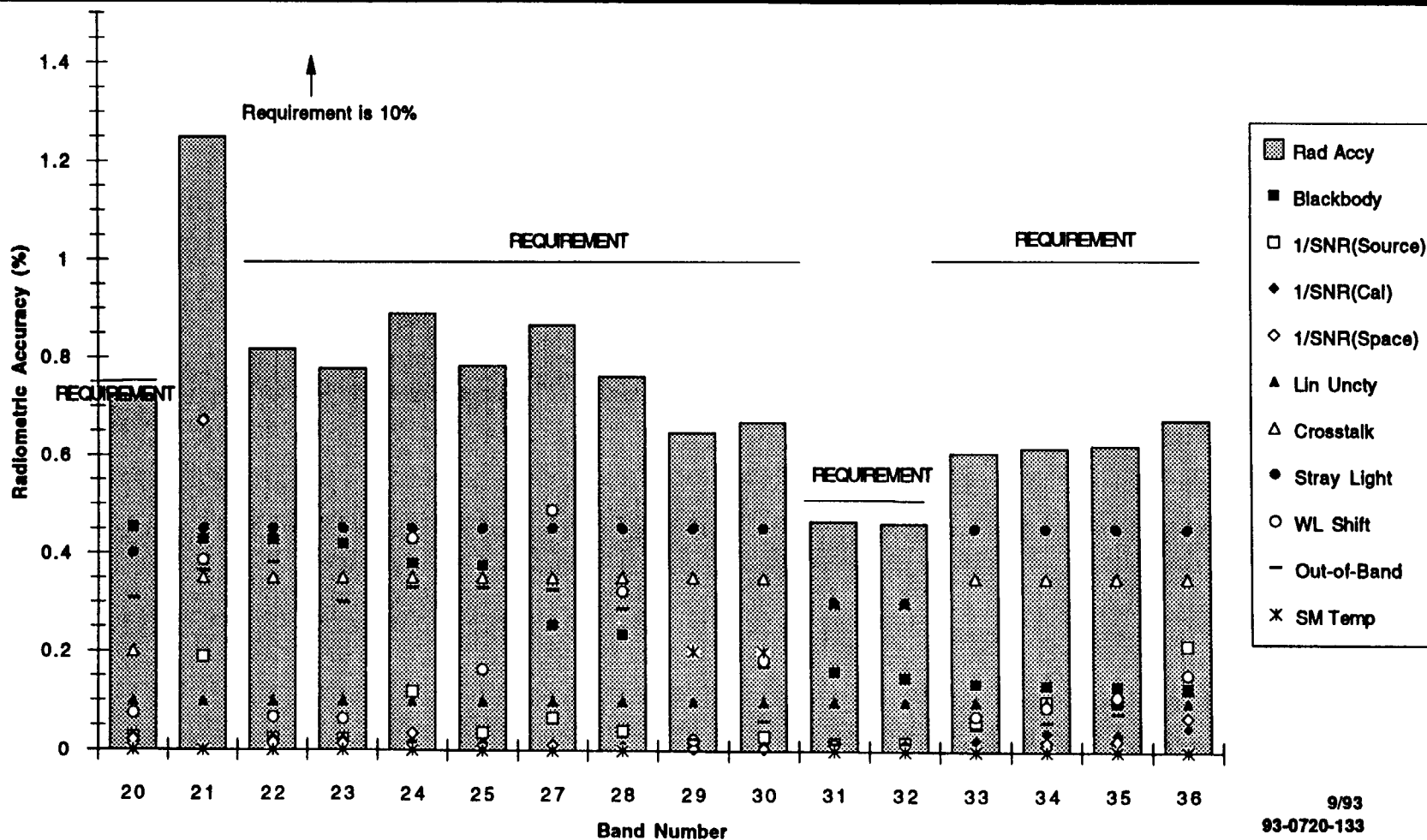
- SINGLE SAMPLE SHOWN TO DEMONSTRATE HIGH PERFORMANCE
- BAND 7 AND 18 MEET SPEC FOR MULTIPLE SAMPLES (SNR ERROR GOES TO ZERO)



EMISSIVE BANDS RADIOMETRIC ACCURACY

HUGHES

SANTA BARBARA RESEARCH CENTER
a subsidiary



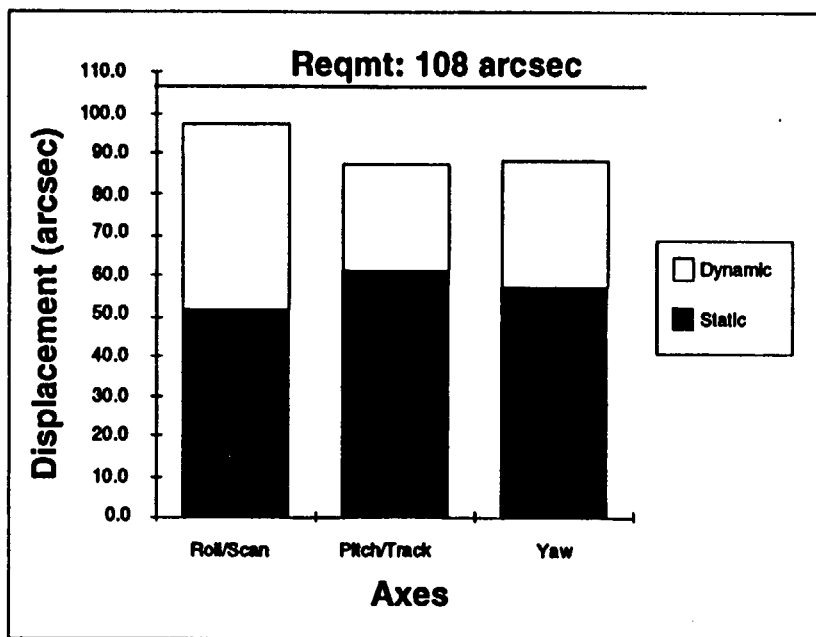


POINTING ACCURACY AND KNOWLEDGE IN SPECS

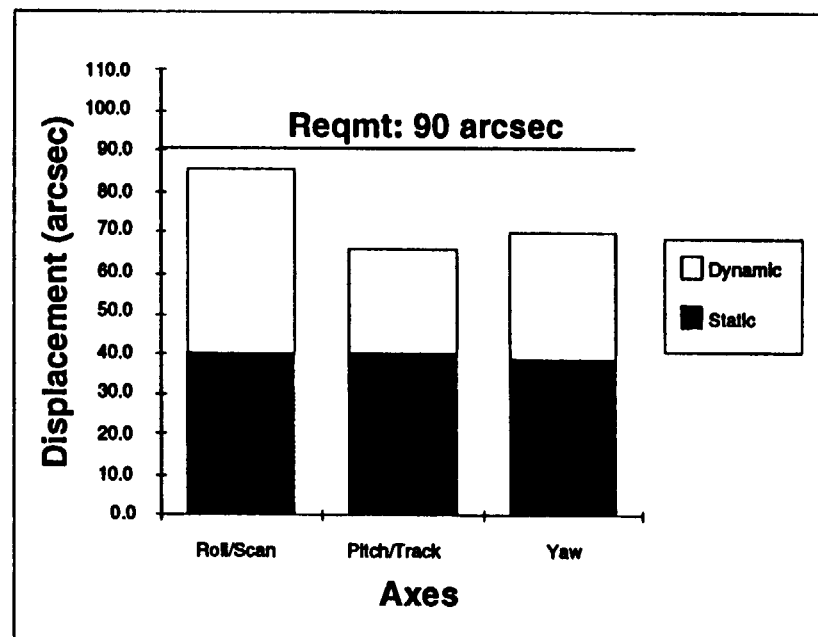
HUGHES

SANTA BARBARA RESEARCH CENTER
a subsidiary

Pointing Accuracy (arcsec)



Pointing Knowledge (arcsec)



- All MODIS Systems Meeting Flowdown at this Time
- Assumes Spacecraft Disturbances in Specs

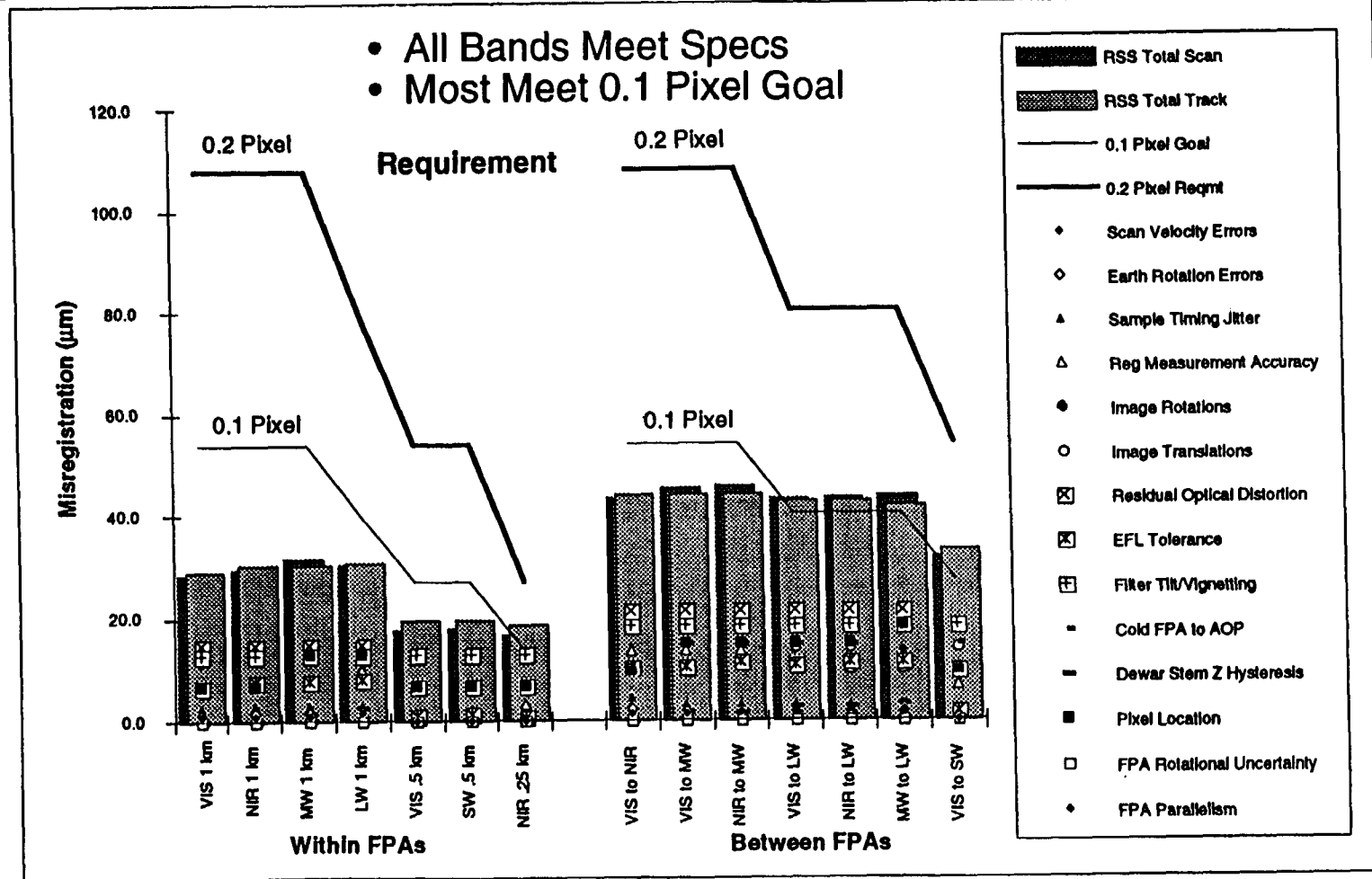


NO CHANGE IN REGISTRATION PREDICTIONS



SANTA BARBARA RESEARCH CENTER
a subsidiary

- All Bands Meet Specs
- Most Meet 0.1 Pixel Goal

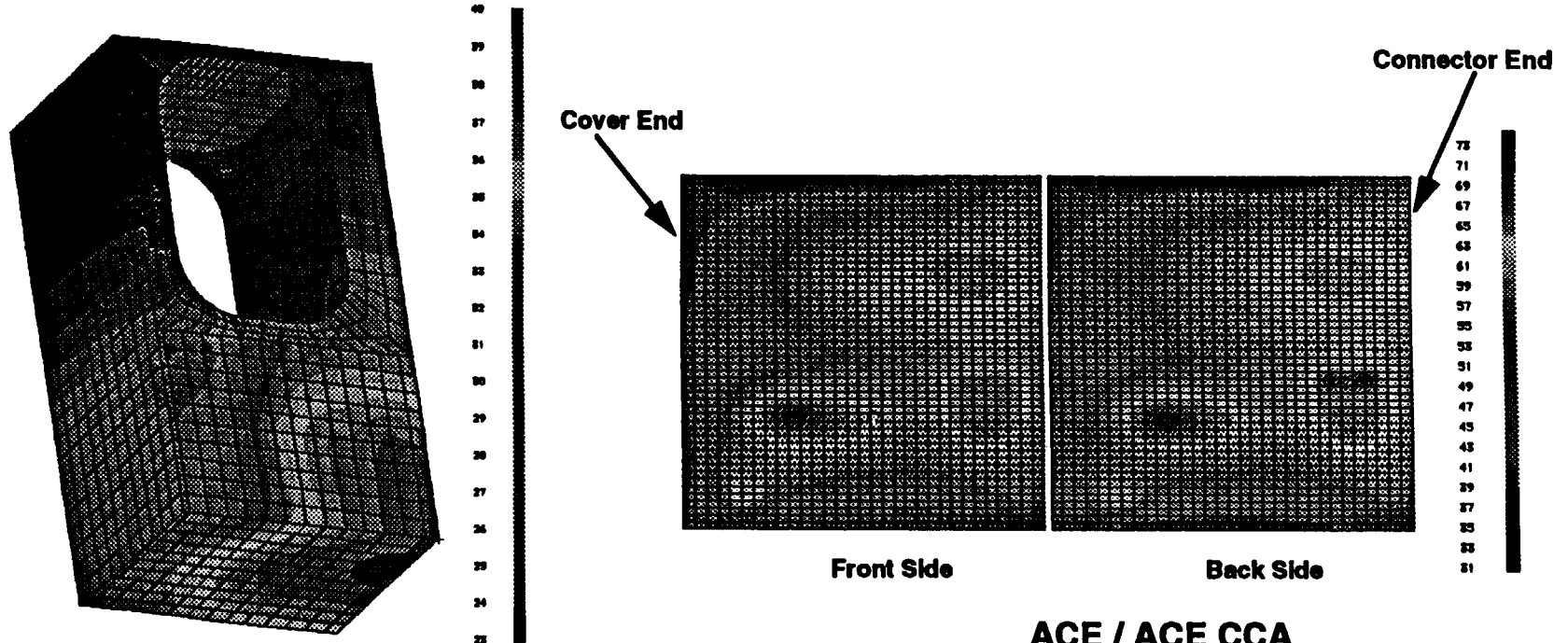




Analog Electronics Modules Demonstrate Acceptable Thermal Performance



SANTA BARBARA RESEARCH CENTER
a subsidiary



Space-viewing Analog Module

**ACE / ACE CCA
Board Temperatures (°C)**

Highest predicted junction temperature for normal operating mode is 83°C for the U-6 microcircuit on the ACE/ACE board (Typical derated limit is 100°C).

Forward-viewing Analog Module temperatures are lower.

GHOSTING REDUCTION

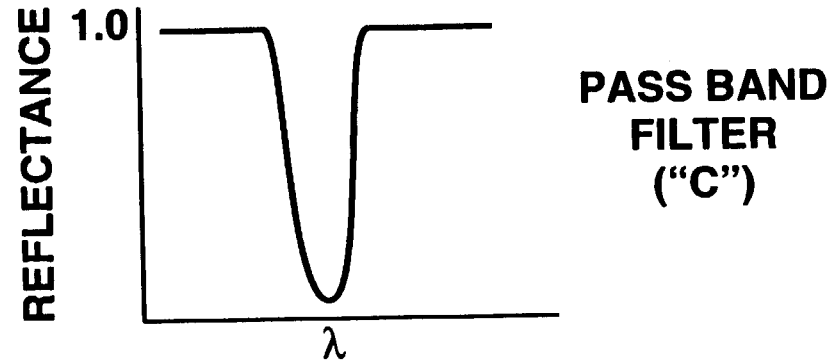
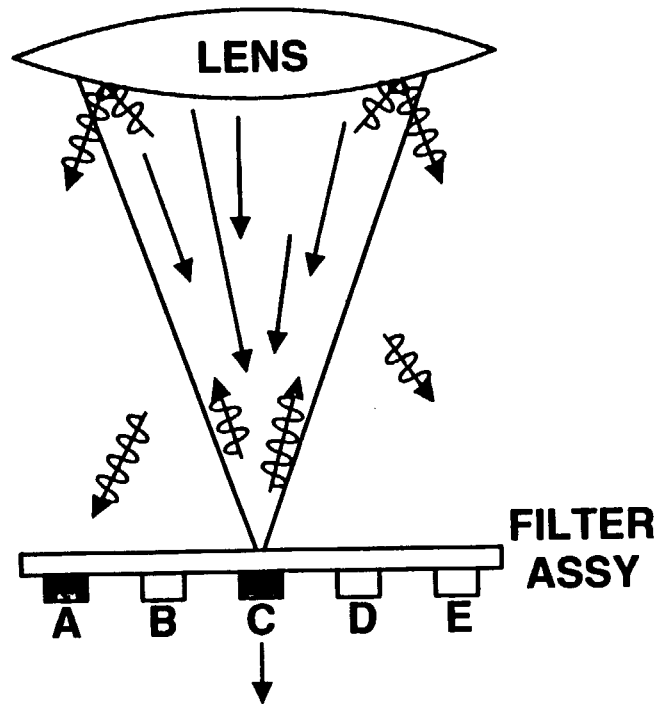
**9/93
93-0720-138**



WHAT IS GHOSTING?



SANTA BARBARA RESEARCH CENTER
a subsidiary



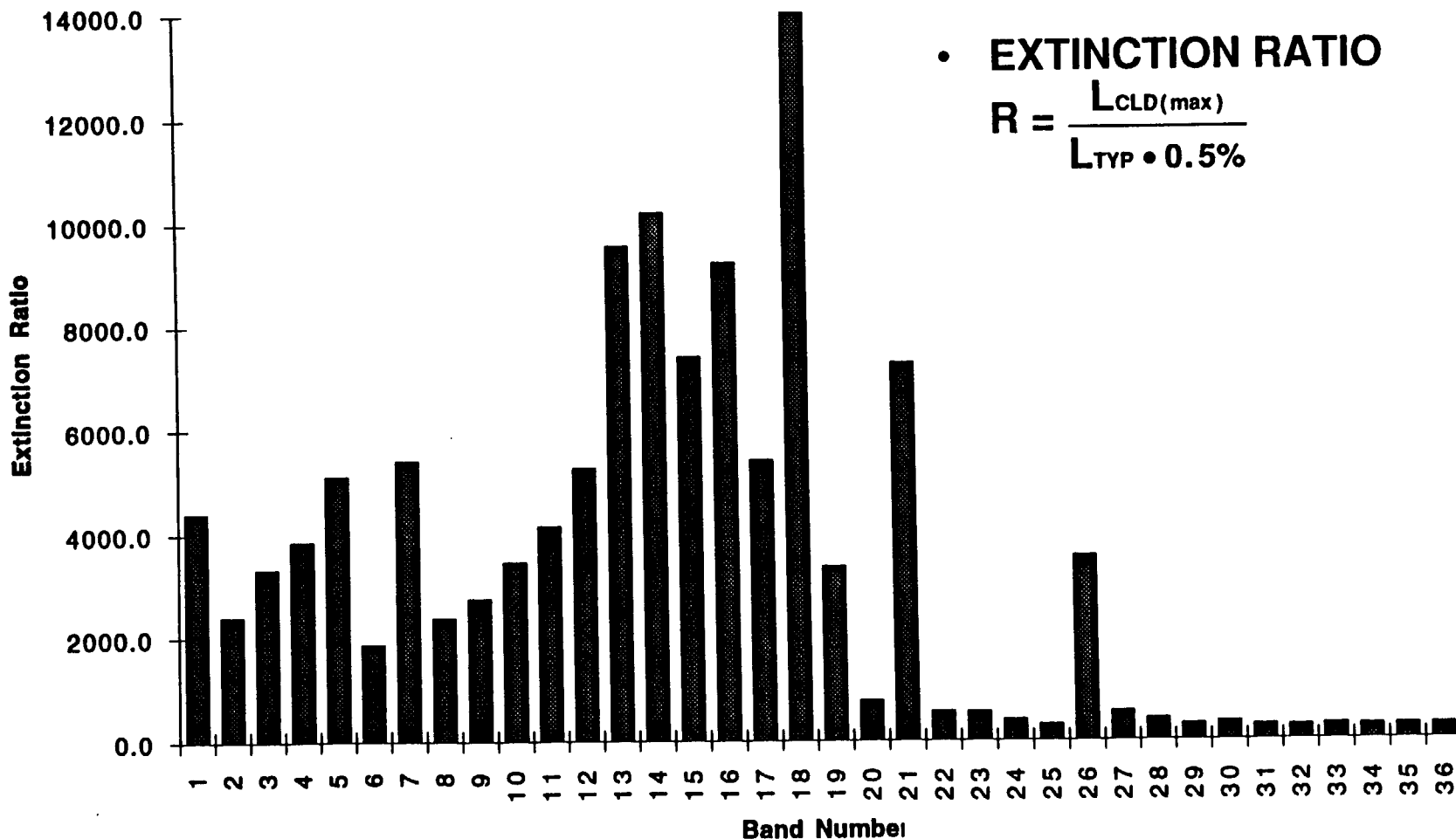
- OUT OF BAND ENERGY FOR FILTER "C" IS REFLECTED BACK FROM THE FILTER ASSY. TOWARDS THE OPTICS
- NON PERFECT AR COATINGS ON THE LENSES REFLECTS A SMALL FRACTION BACK TO THE FOCAL PLANE THAT IS WITHIN PASS BAND FOR FILTER "A"



FOUR ORDERS OF MAGNITUDE EXTINCTION RATIO REQUIRED FOR TRANS. RESP.



SANTA BARBARA RESEARCH CENTER
a subsidiary

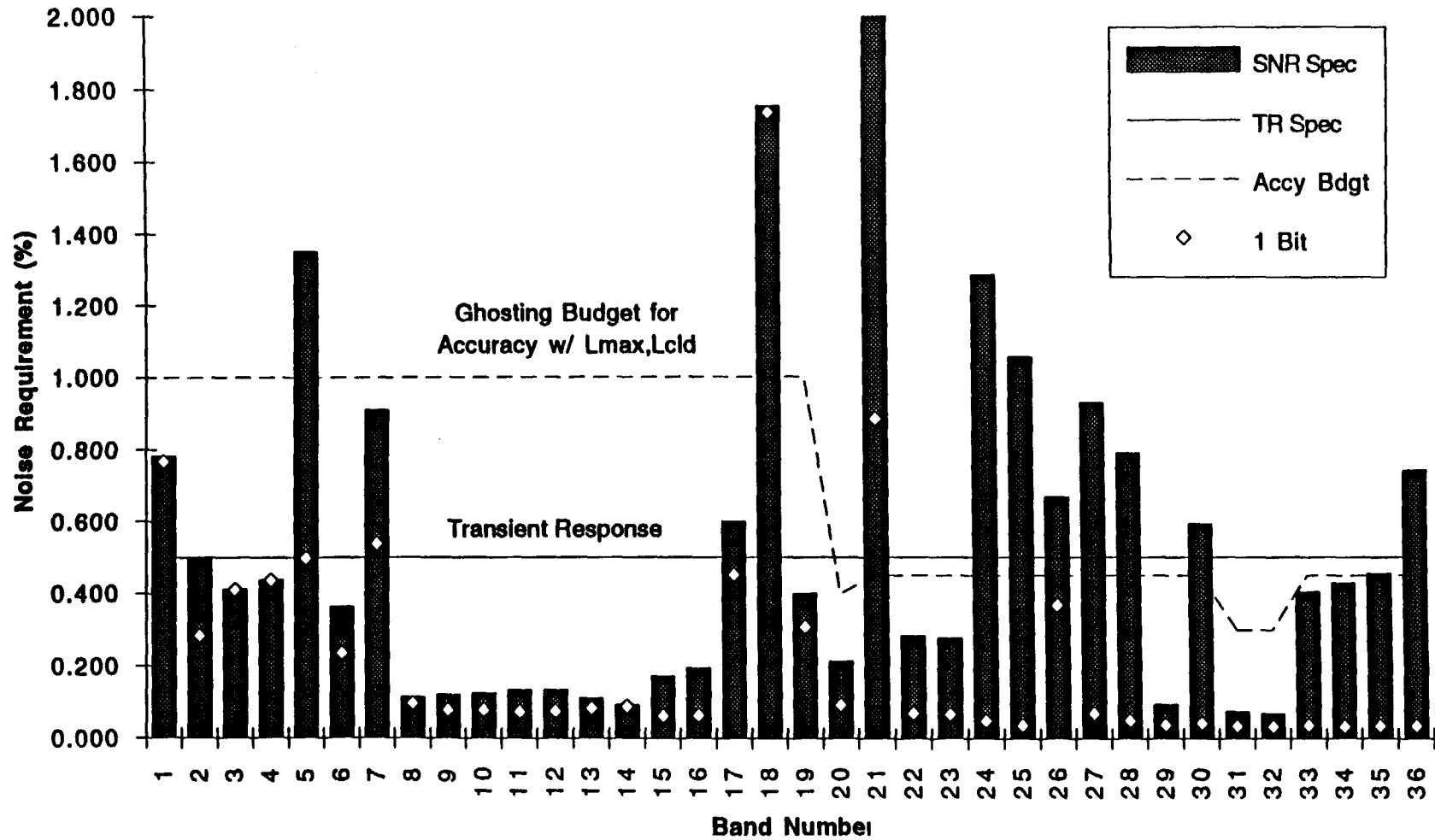




TRANSIENT RESPONSE SPEC OFTEN LOWER THAN SYSTEM NOISE



SANTA BARBARA RESEARCH CENTER
a subsidiary



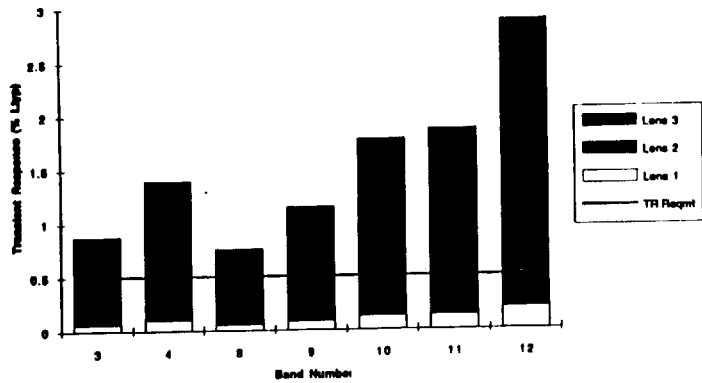


EARLY EM DESIGN GHOSTING VIOLATES TRANSIENT RESPONSE

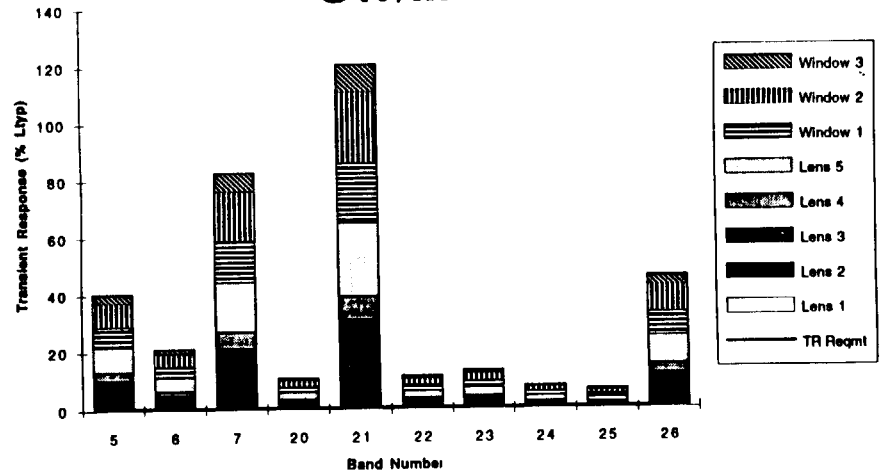


SANTA BARBARA RESEARCH CENTER
a subsidiary

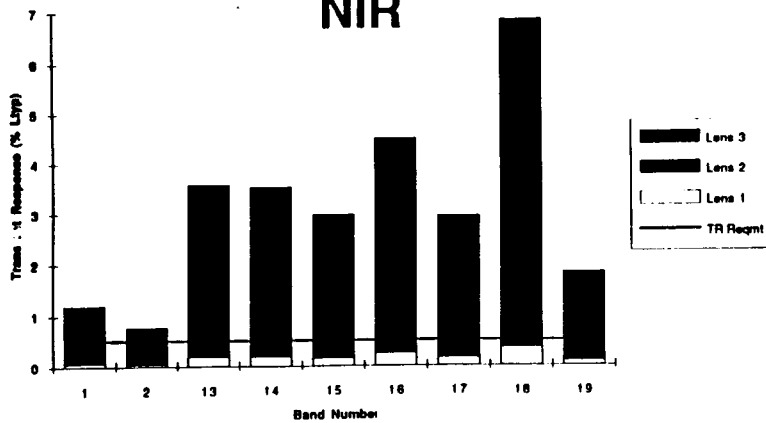
VIS



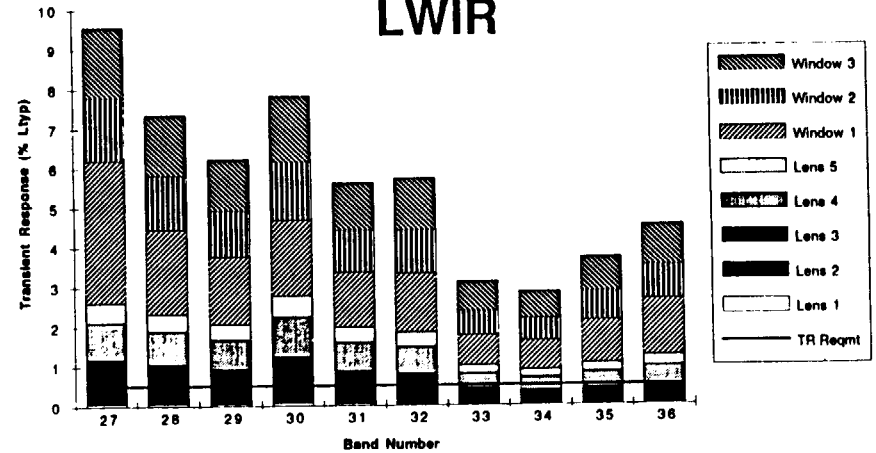
SW/MWIR



NIR



LWIR

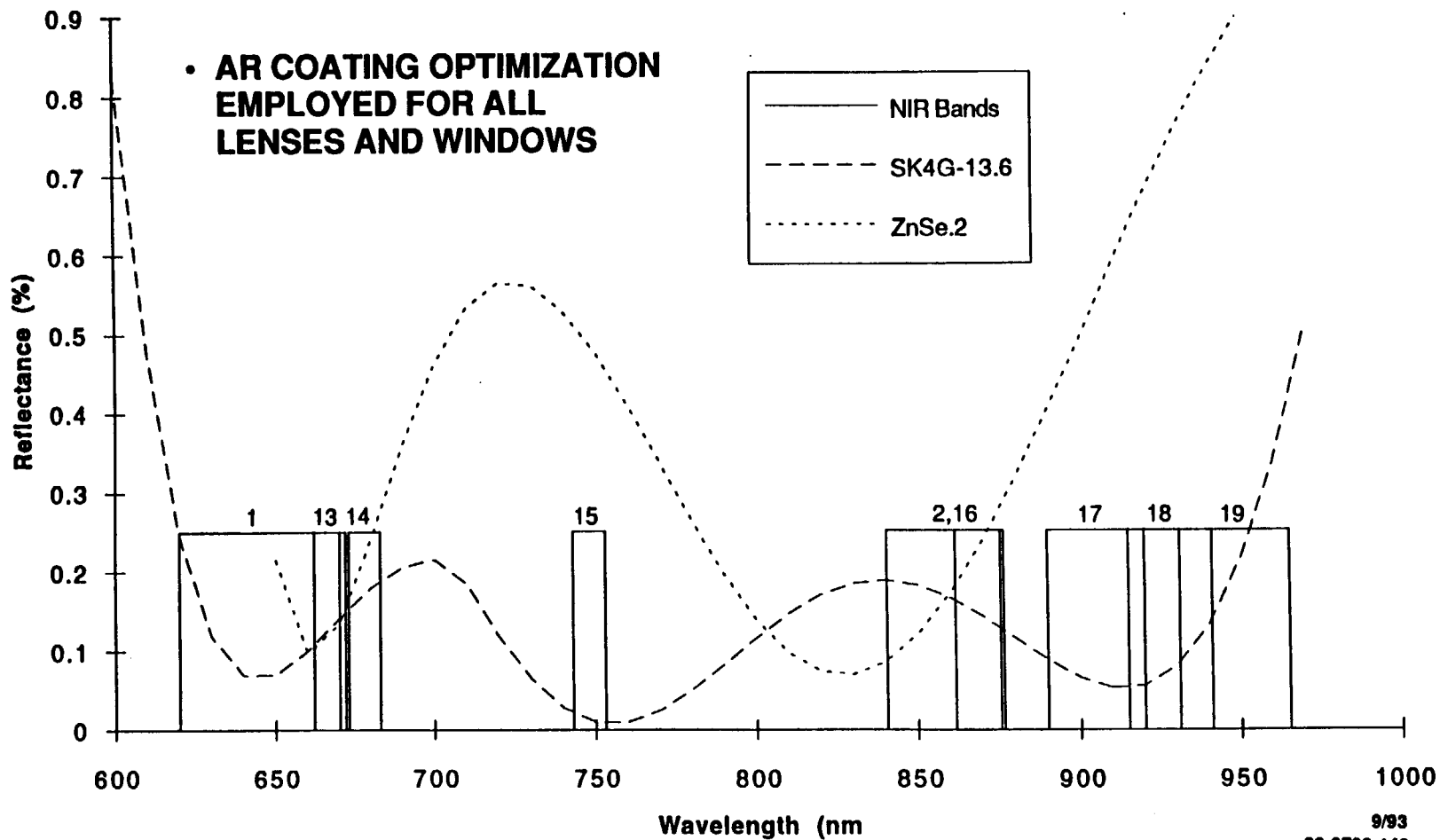




EXAMPLE NIR AR COATINGS DEMONSTRATE OPTIMIZATION



SANTA BARBARA RESEARCH CENTER
a subsidiary



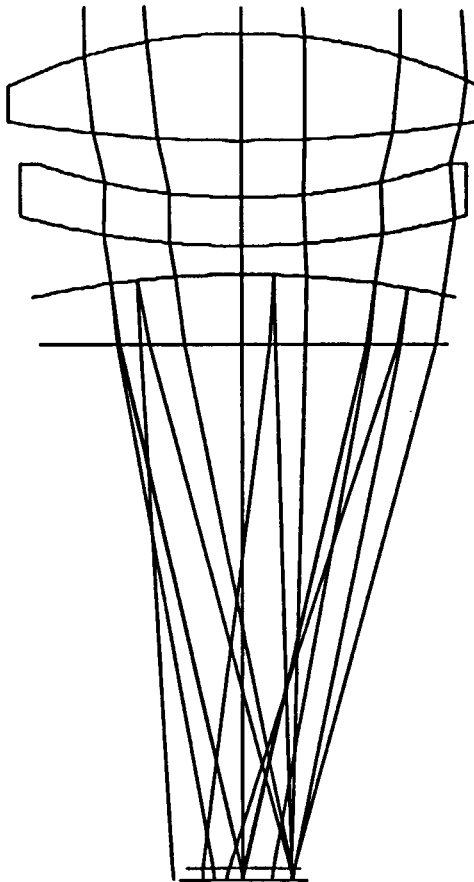


SURFACE CURVATURES INFLUENCE MAGNITUDE OF GHOST RETURN

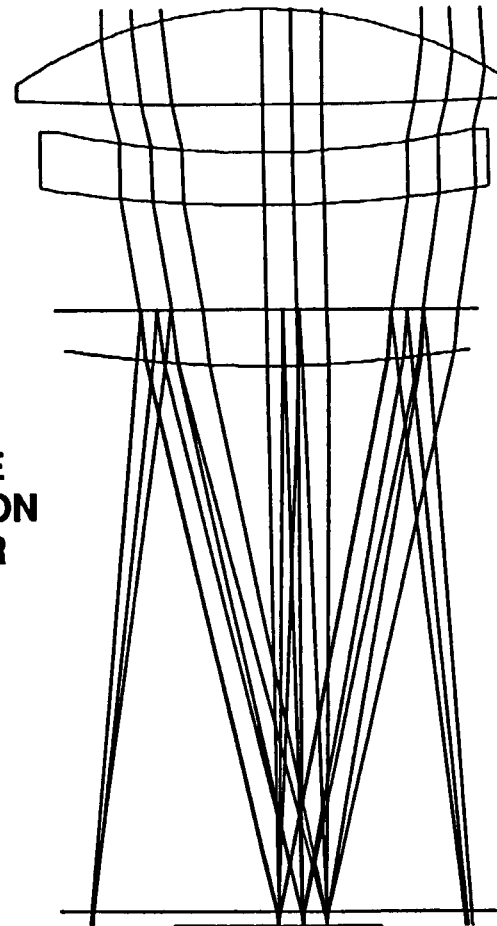
HUGHES

SANTA BARBARA RESEARCH CENTER
a subsidiary

NIR Engr. Model



NIR Improved



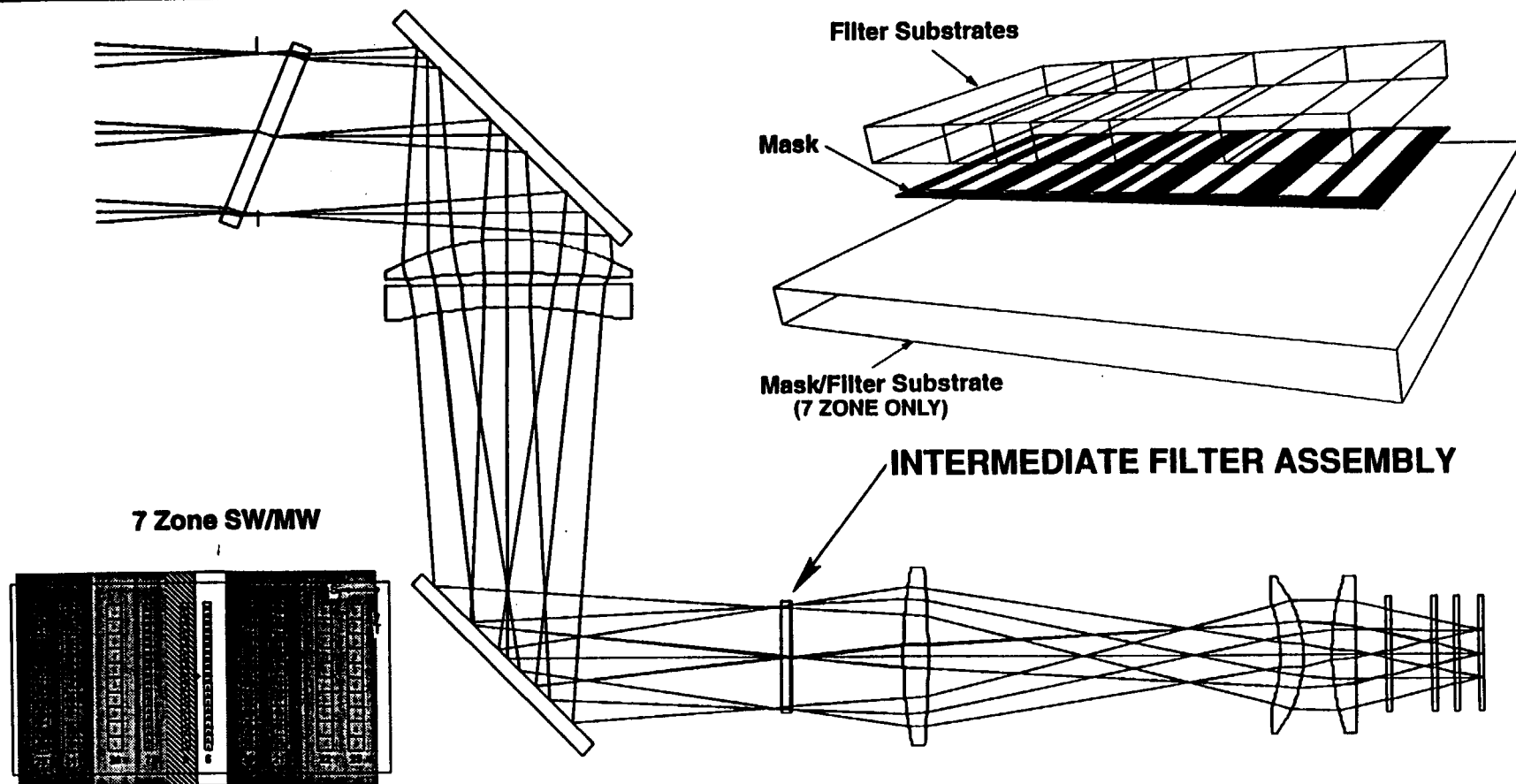
- CURVATURE OPTIMIZATION FOR VIS, NIR ONLY



SWIR/MWIR INTERMEDIATE FOCAL PLANE EASILY ACCESSIBLE



SANTA BARBARA RESEARCH CENTER
a subsidiary



45.45 MM

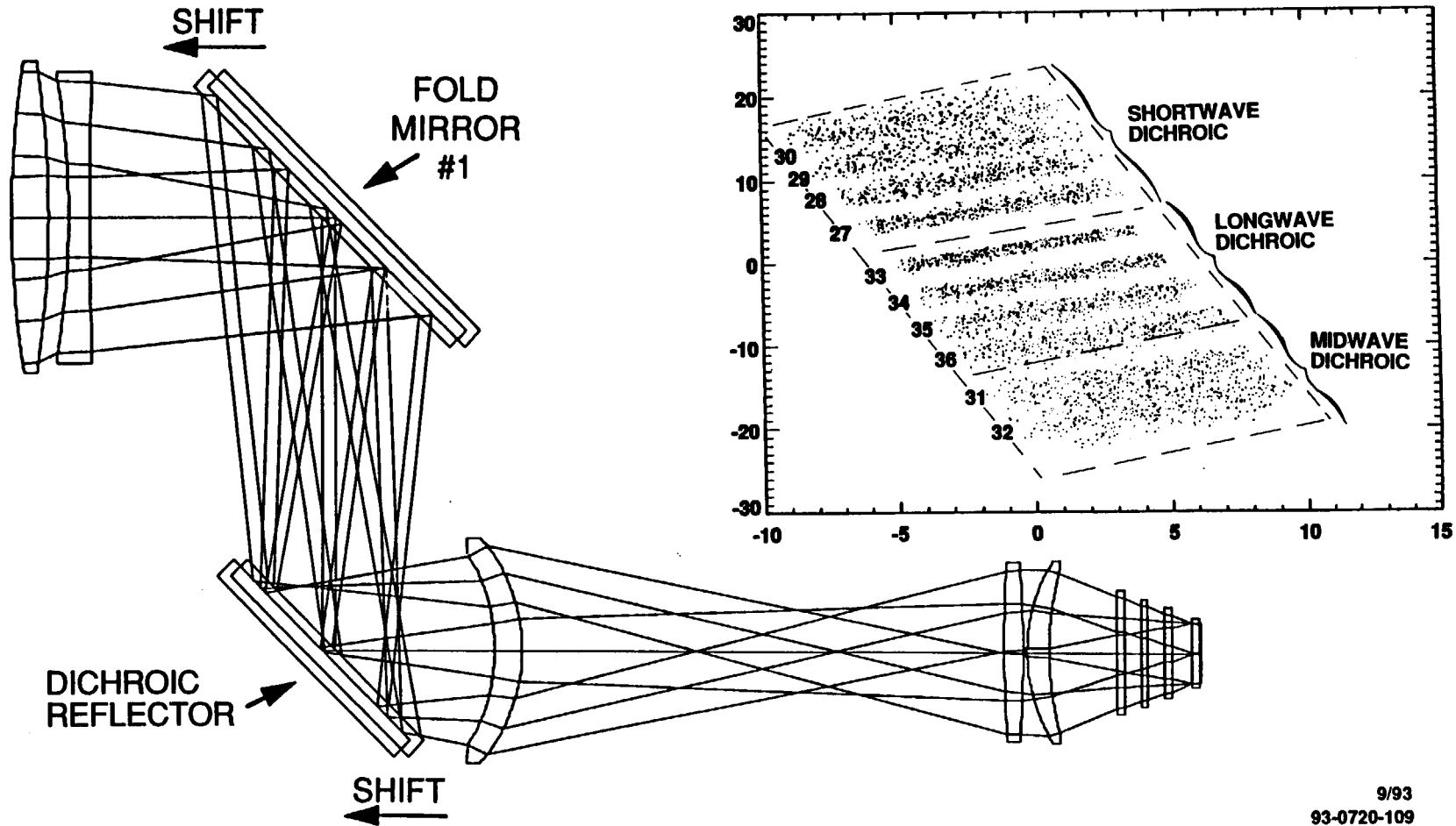
9/93
93-0720-108



LWIR FOLD MIRROR CONVERTED TO DICHROIC REFLECTOR



SANTA BARBARA RESEARCH CENTER
a subsidiary





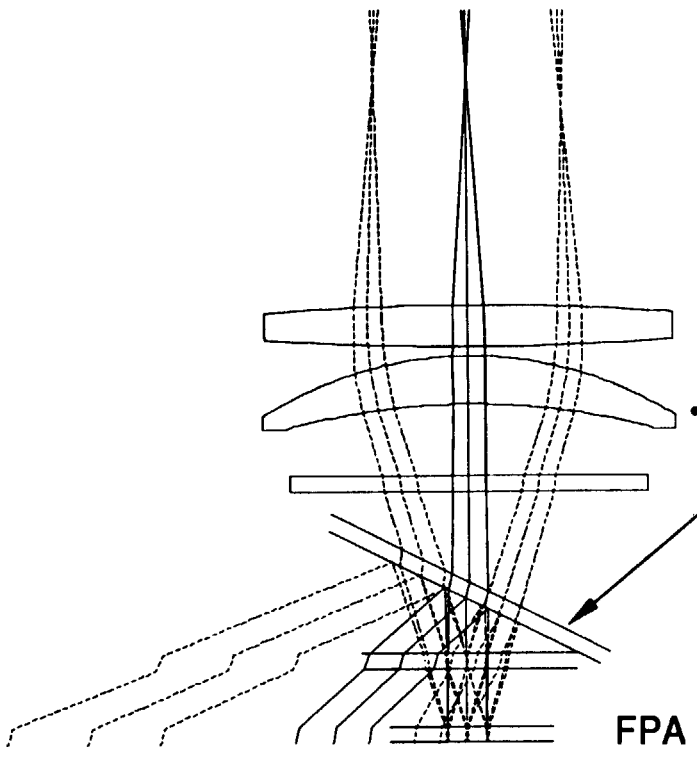
WINDOW TILT ELIMINATES THERMAL COATING EFFECTS



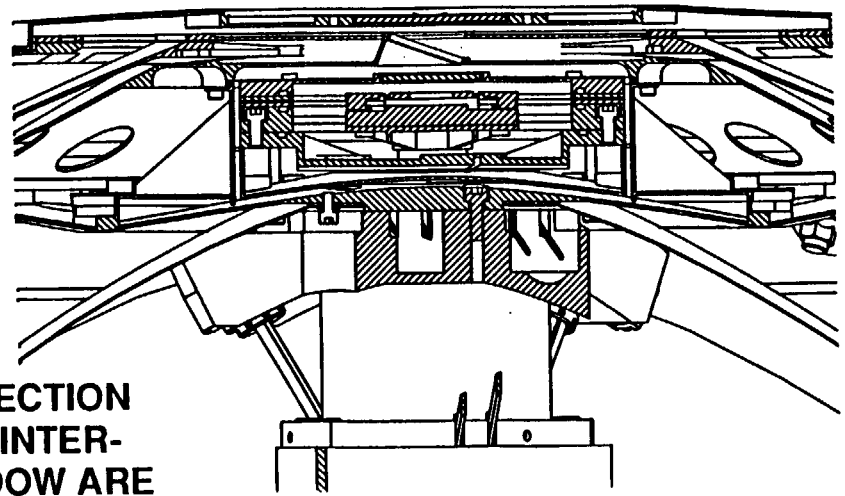
SANTA BARBARA RESEARCH CENTER
a subsidiary

20° - 25° TILT WILL
REDUCE GHOSTING

IMPLEMENTATION IN BASIC
COOLER DESIGN IS FEASIBLE



• THERMAL REJECTION COATINGS ON INTER-MEDIATE WINDOW ARE NOT WELL SUITED TO GHOSTING REDUCTION



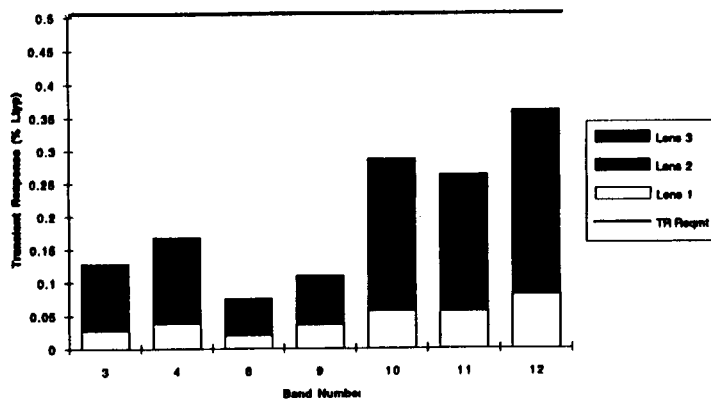


HIGH PAYOFF TO TRANSIENT RESPONSE WITH GHOSTING SOLUTIONS

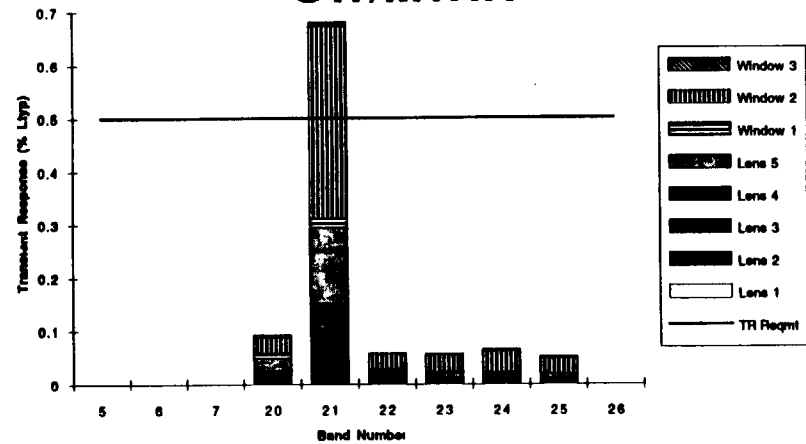


SANTA BARBARA RESEARCH CENTER
a subsidiary

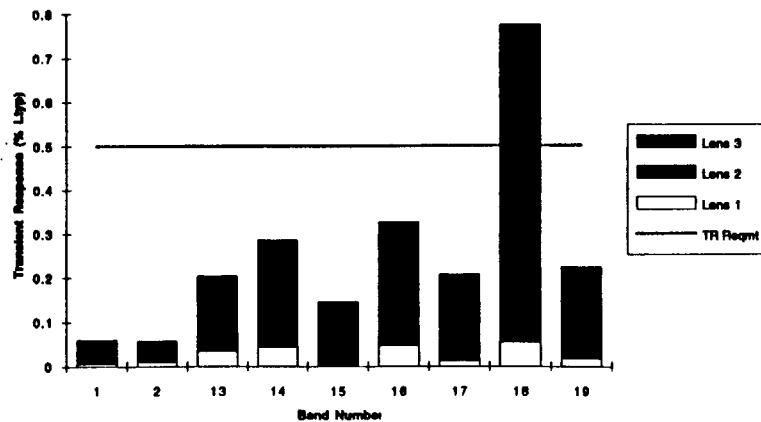
VIS



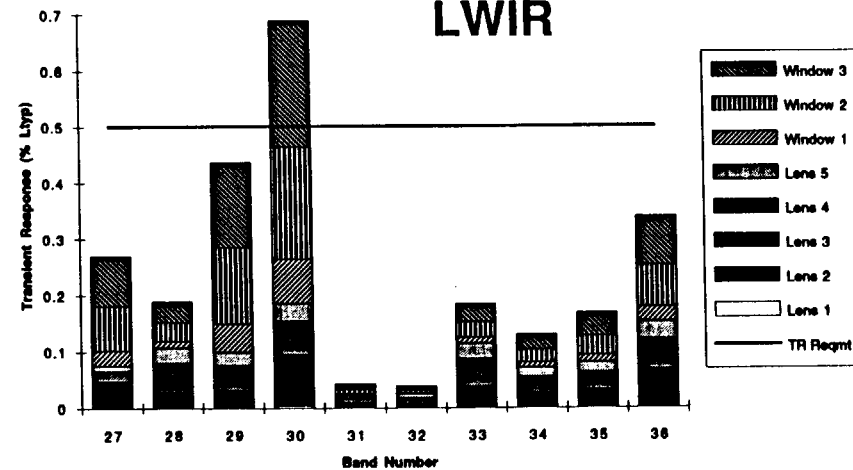
SW/MWIR



NIR



LWIR



APPROVAL FROM NASA/SCIENCE TEAM FOR NON-COMPLIANCE ON BANDS 18, 21, & 30

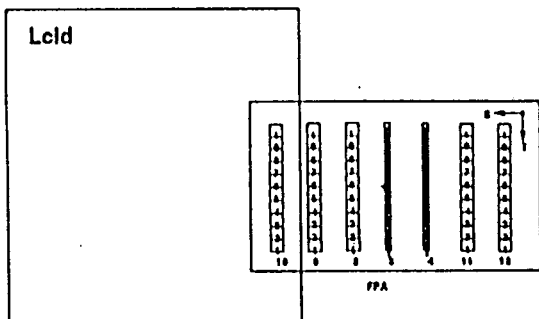


Fraction of FPA Illuminated Determines Ghosting Magnitude

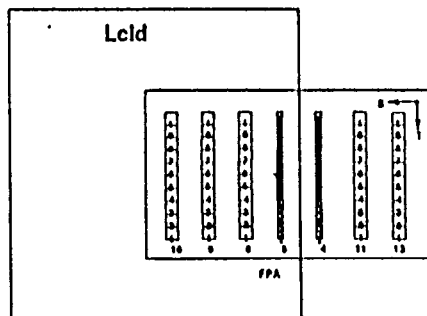


SANTA BARBARA RESEARCH CENTER
a subsidiary

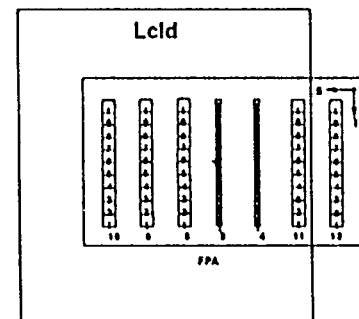
Low Ghosting



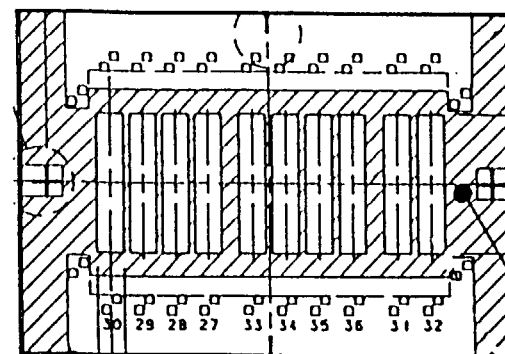
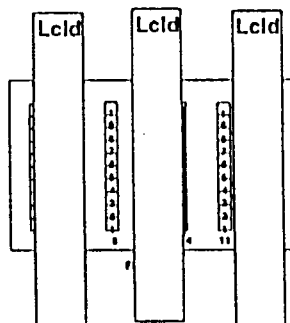
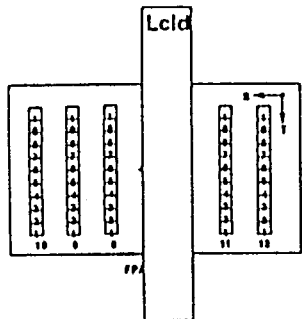
Medium Ghosting



High Ghosting



- NASA Spec Does Not Define Cloud Size or Cover



- Additional Benefit From Mask Absorption

Current Analysis Uses Cloud Cover of Top Row (Worst Case)

Handwritten signature

GSE DEVELOPMENT, INTEGRATION, AND TEST

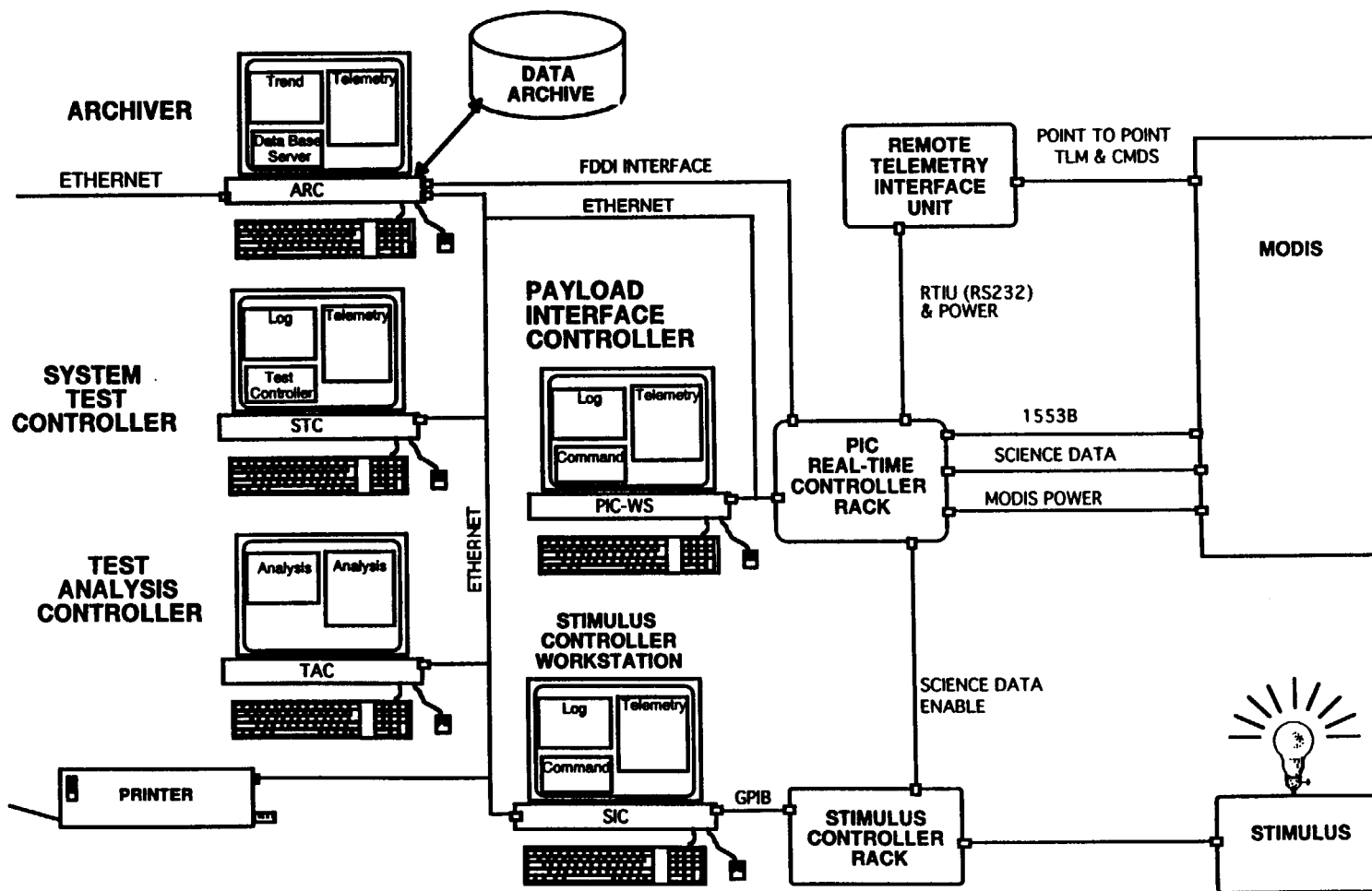
9/93
93-0778-12

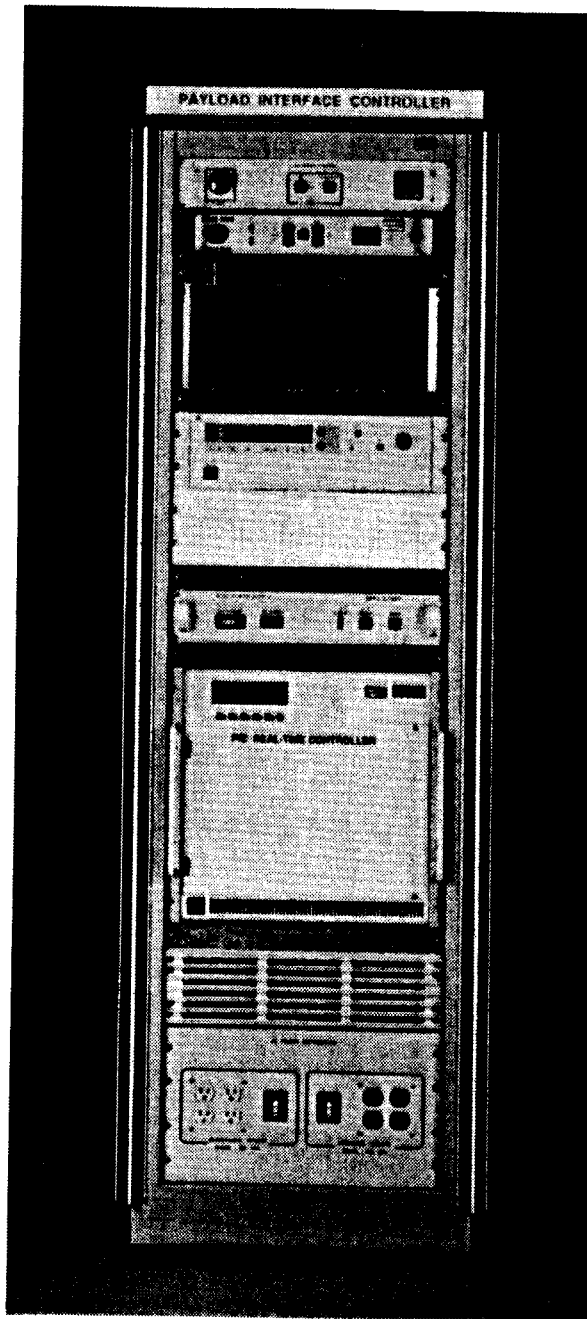


THE STE ARCHITECTURE IS BUILT AROUND FIVE SUN WORKSTATIONS



SANTA BARBARA RESEARCH CENTER
a subsidiary





HUGHES

SANTA BARBARA RESEARCH CENTER
a subsidiary

93-9-3

PAYLOAD INTERFACE CONTROLLER CONSOLE

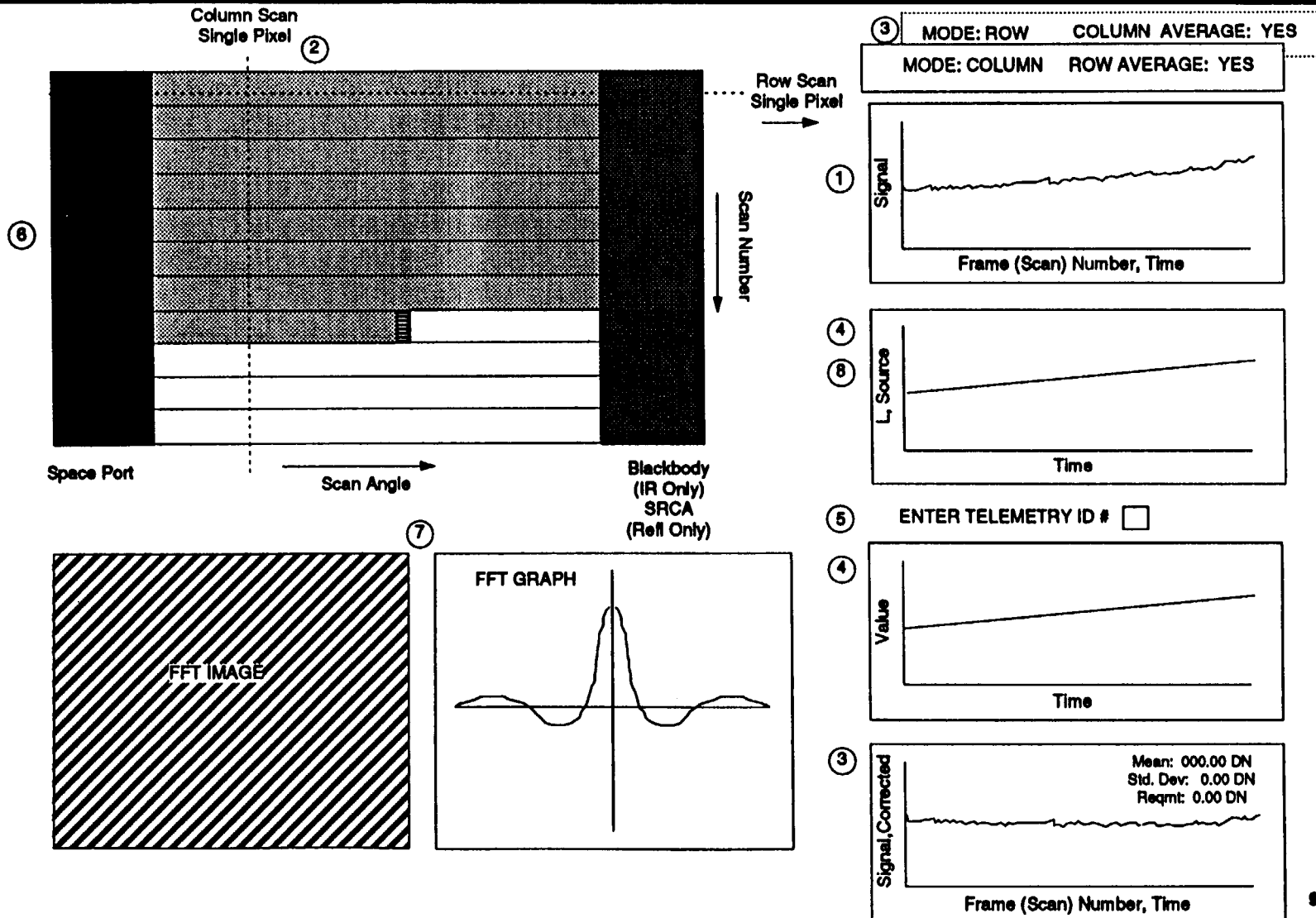




EXAMPLE SNR ENGINEERING EVALUATION DISPLAY

HUGHES

SANTA BARBARA RESEARCH CENTER
a subsidiary

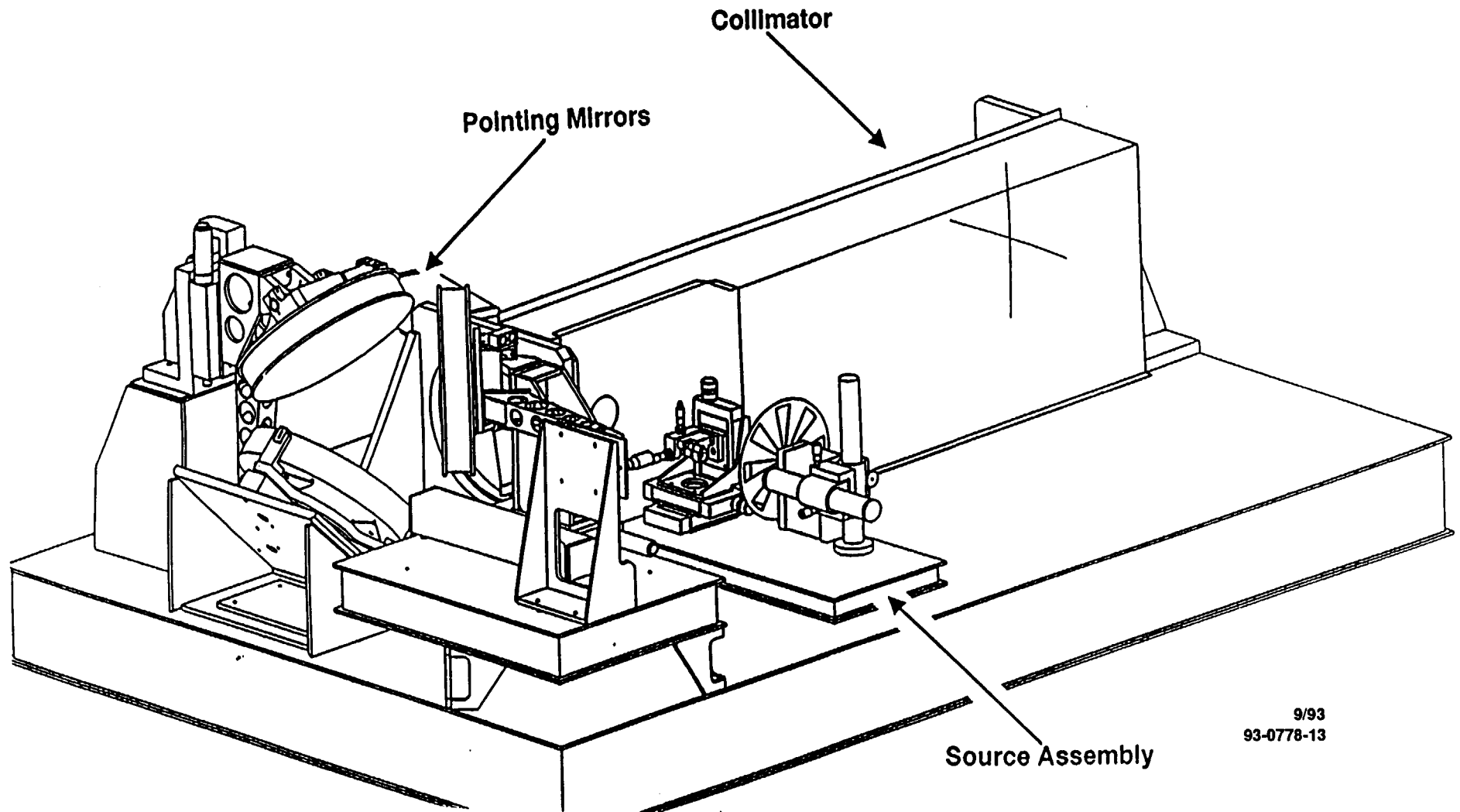




INTEGRATION AND ALIGNMENT COLLIMATOR DESIGNS NEARLY COMPLETE



SANTA BARBARA RESEARCH CENTER
a subsidiary



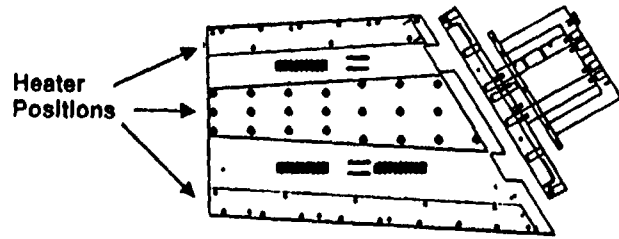
9/93
93-0778-13



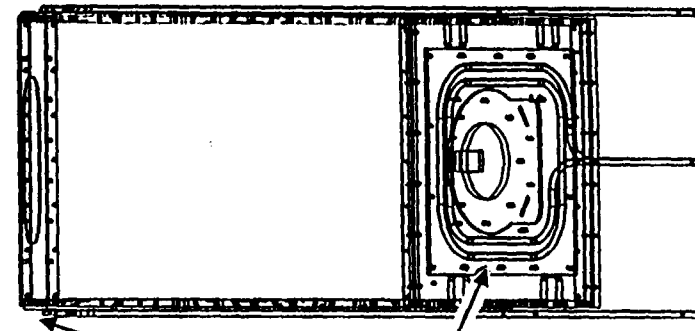
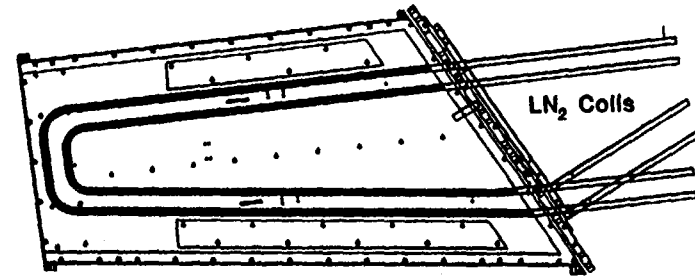
BLACKBODY CALIBRATION SOURCE



SANTA BARBARA RESEARCH CENTER
a subsidiary

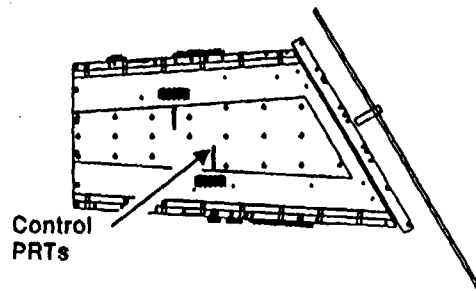


MIDDLE CAVITY (Scale 0.100)

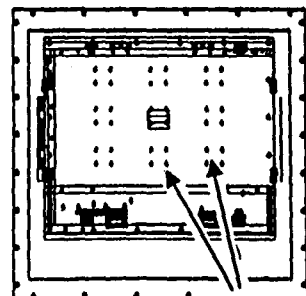


LN₂ Plates Bolt on Sides and Back

OUTER CAVITY (Scale 0.100)



INNER CAVITY (Scale 0.100)



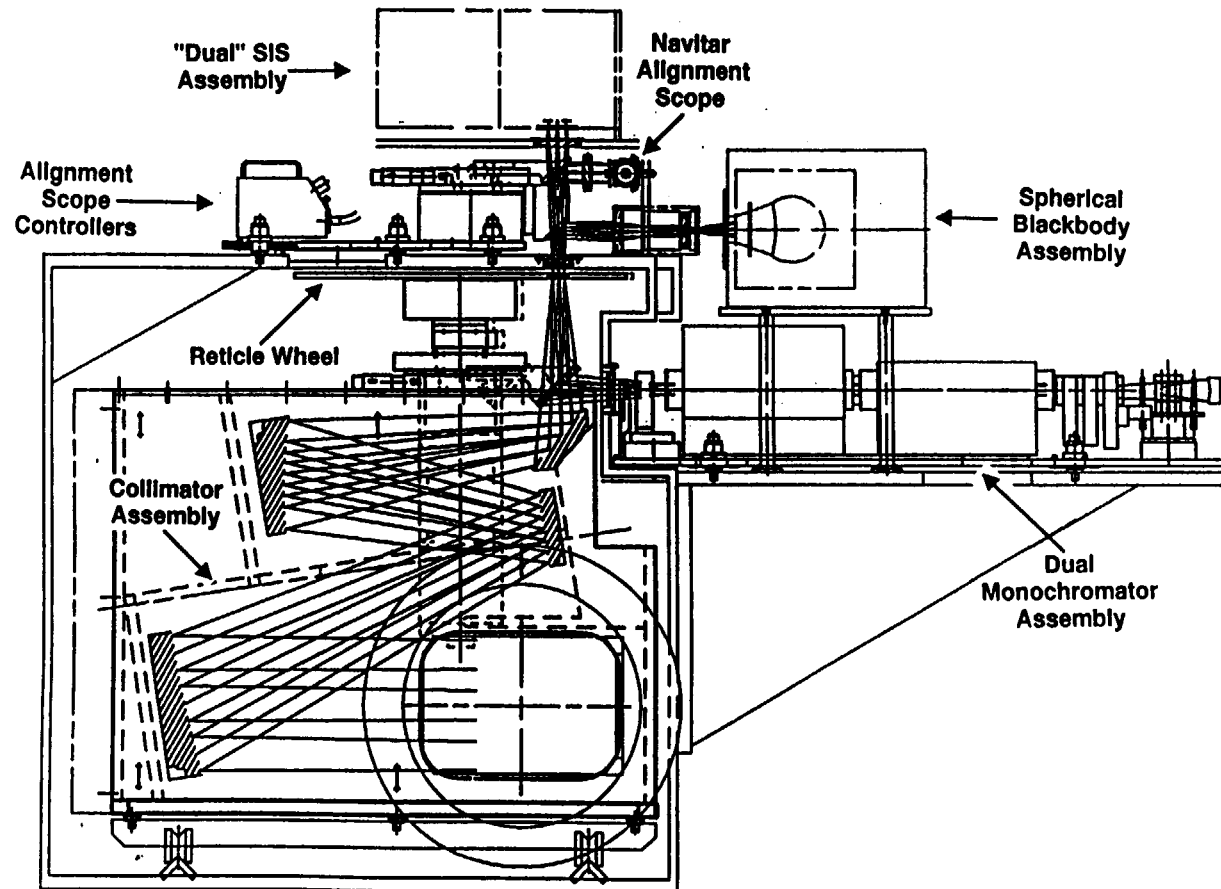
PRT
Mounts



MGBC OPTICAL SCHEMATIC DRAWING



SANTA BARBARA RESEARCH CENTER
a subsidiary

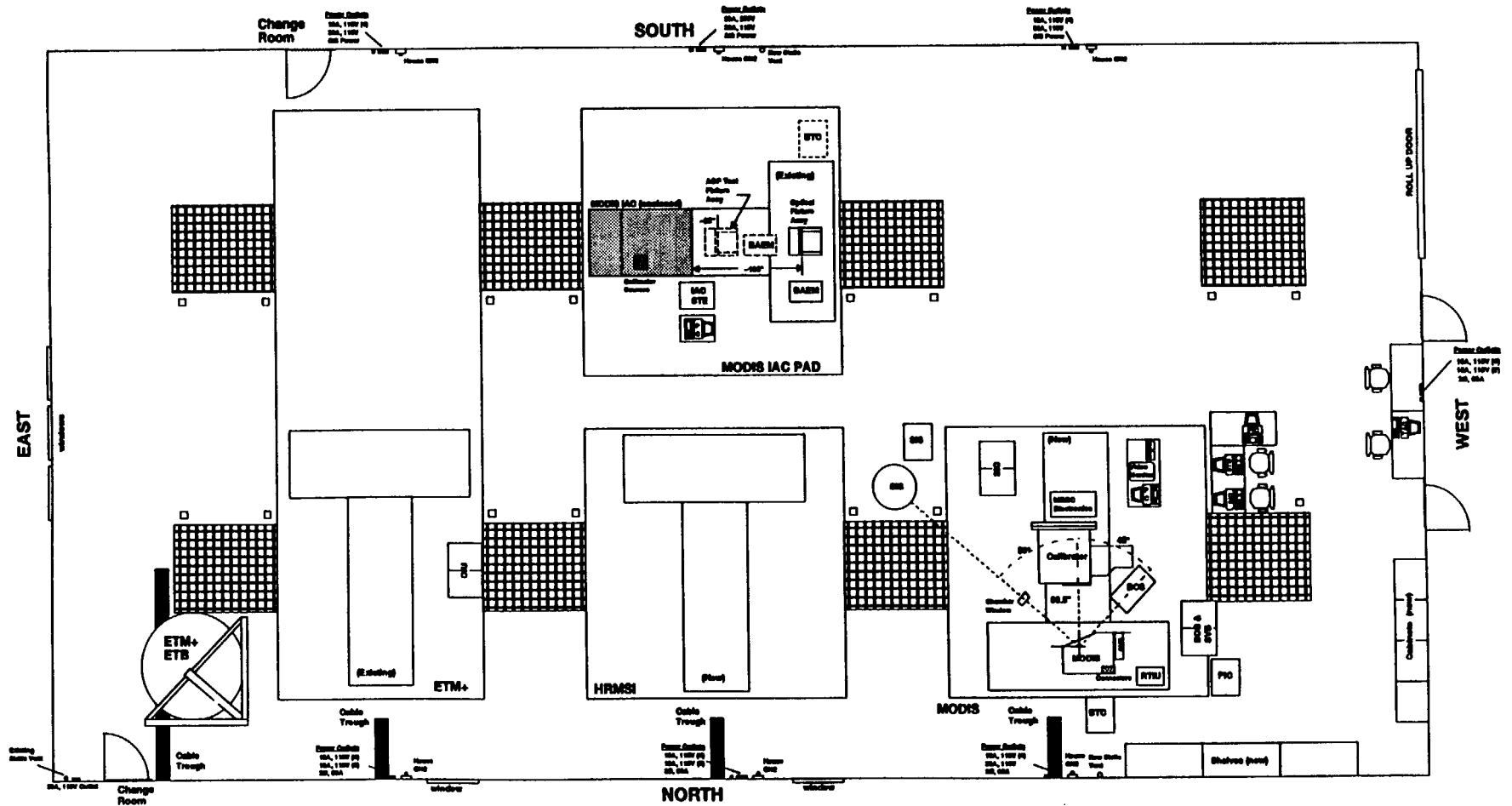




B32 CLASS 10,000 CLEAN ROOM PROPOSED MODIS TEST LAYOUT



SANTA BARBARA RESEARCH CENTER
a subsidiary

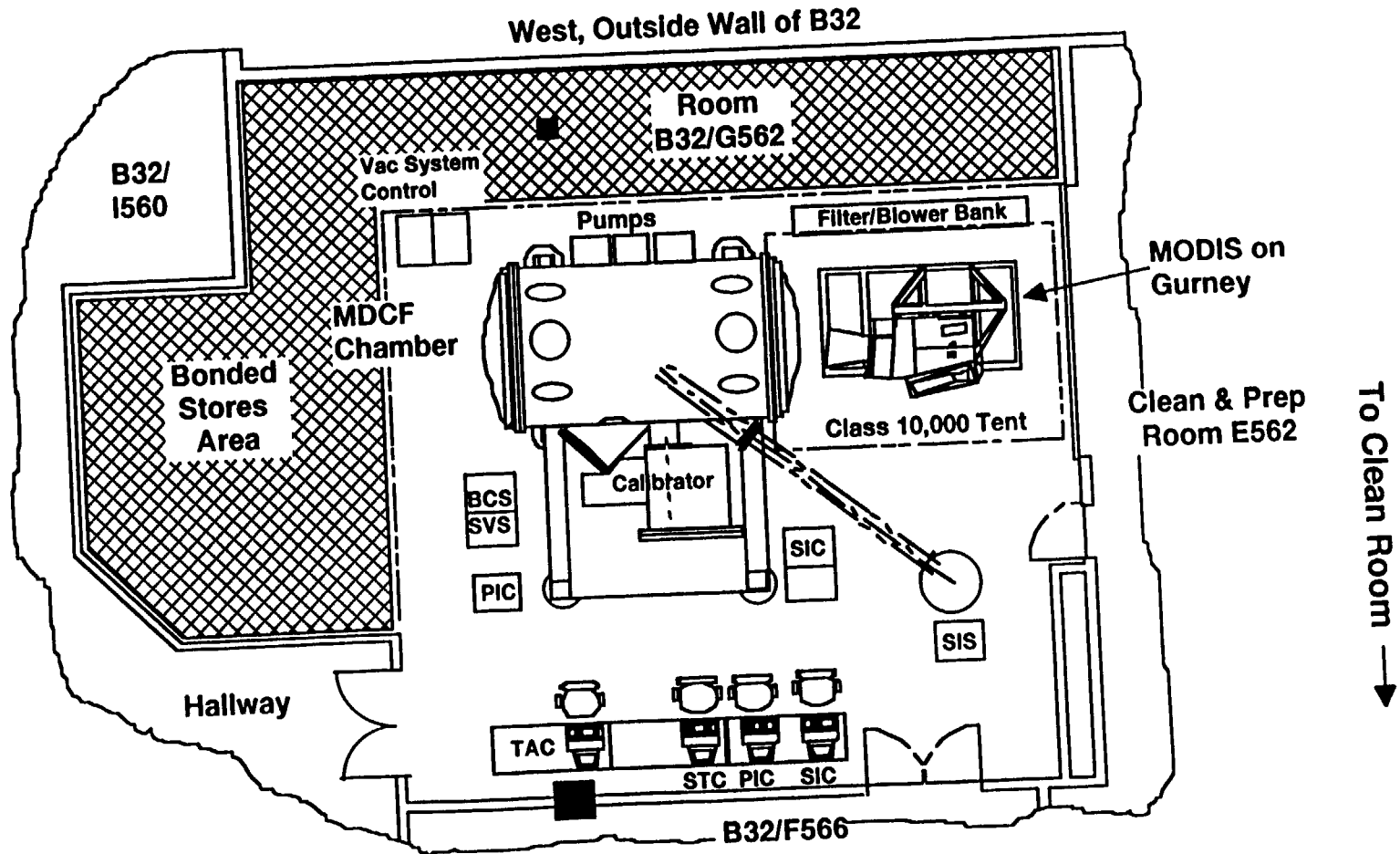




MODIS DEDICATED CALIBRATION FACILITY PROPOSED LAYOUT



SANTA BARBARA RESEARCH CENTER
a subsidiary



RISK STATUS REPORT

THIS MONTH: August, 1993

<u>Rank This Month</u>	<u>Rank Last Month</u>	<u>Risk Item Number</u>	<u>Risk Item Description</u>	<u>Mitigation Plan</u>	<u>REA</u>	<u>Comments</u>
1	2	006	Performance within delivery schedule, funding cap, and total cost constraints	Cost risk reduction opportunities are being worked with GSFC. Additional cost risk reduction opportunities presented to GSFC at a meeting on June 23, 1993	L. Candell	Plan for meeting FY'93 funding cap continues successfully. EM schedule is being negatively affected by longer than expected procurement lead times. Work-arounds are being addressed.
2	4	034	HgCdTe PC Detector Performance	Engineering model plan revised, includes phased lot processing and test cycles, multiple test geometries, processes, and passivations.	J. Banach	Plan successful in meeting NEI requirements for EM. Crosstalk is the current concern; requirement being addressed with Systems Engineering. Design options being studied.
3	3	022	Spectral Band Registration	See RMP for specifics. ECR and BCH for electronic variable phase delay have been approved.	J. Young	STOP analysis results favorable for VIS and NIR bands (PL3095-M02493). The STOP analysis is being updated; report due by November 5, 1993.
4	1	046	Optical Backscatter: ghosting could result in failure to meet some performance specifications	First determine level of noncompliance with specifications, then develop corrective course of action.	T. Pagano	Corrective action recommendations presented to GSFC on August 24, 1993 and accepted. Details of implementation plans for corrective action are being prepared.
5	5	035	HgCdTe PV Detector Operability	Pathfinder and process optimization lots defined; multiple active indium bumps per unit cell; A/B bank selection; dice out individual bands/subarrays, if necessary.	J. Banach	EM SWIR/MWIR and LWIR SCAs have been selected with high operability. Yield for flight SCAs is still a concern.
6	6	029	Scan Mirror Drive Bearing Life	RMP accepted. It includes accelerated screening test, accelerated life test, normal speed life test of bearings, and normal speed life test of flight configuration.	A. DeForrest	Test facilities are in place at Schaeffer Magnetics and their check out is nearly complete. Bearing material/lubricants screening tests to begin early in September.
7	7	013	Instrument Polarization Sensitivity	Maintain current measurement and modeling plans to track predicted polarization sensitivity to show that 2% specification is being satisfied.	J. Figoski	Polarization contribution of each optical element is tracked. Measured Polarization Sensitivity of Engineering Model will serve to validate predictions.
8	8	032	Spectral Requirements for selected bands	Review requirements with Science Team; utilize experienced suppliers; provide for back up sources; second source most challenging items.	J. Figoski	Filters for EM and flight models are being received from vendors. Measured data indicate that most requirements are being met. Deviations are being addressed as they arise.
9	9	033	Dynamic Range Selection for Readouts	Monitor and track optical throughput estimates; plan early measurements of pertinent parameters on Engineering Model.	T. Pagano	Background shields in the IR objectives and commandable charge subtraction to the cal drive electronics are features of the MODIS design.
10	10	030	Radiative Cooler cold-stage temperature margin	Plan is to increase radiator size (allowed by 170° CFOV), add additional fin radiator area, add MLI to outer cooler cover, and add LWIR cooled aperture shield.	A. DeForrest	RMP has been implemented. Updated prediction (PL3095-M02305) indicates a safety margin of 2.6K rather than design goal of 4K. Another update planned for final design configuration.



SUMMARY AND CONCLUSIONS



SANTA BARBARA RESEARCH CENTER
a subsidiary

- **ENGINEERING MODEL HARDWARE PROCEEDING RAPIDLY**
 - **MAINFRAME HIP MATERIAL READY FOR MACHINING**
 - **SCAN MIRROR ENCODER READY FOR ASSEMBLY**
 - **AFOCAL TELESCOPE AND AFT OPTICS GRAPHITE STRUCTURES COMPLETE**
 - **FOCAL PLANES FABRICATED; IN TEST**
 - **VIS FILTERS ASSEMBLED TO MASK; REMAINDER FOLLOWING SHORTLY**
 - **RADIATIVE COOLER PARTS IN HOUSE; ASSEMBLY PROCEEDING**
 - **ELECTRONICS BOARDS IN FAB**
- **ALL PERFORMANCE REQUIREMENTS SATISFIED**
- **GHOSTING SOLUTIONS FOUND TO MEET TRANSIENT RESPONSE**
- **GROUND SUPPORT EQUIPMENT DESIGNS NEAR COMPLETION**