GUVI Instrument Description

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Instrument Description Outline

- System Description
- Performance Requirements
- Interface Requirements
- Instrument Design Overview
- Operating Modes
- System Analysis

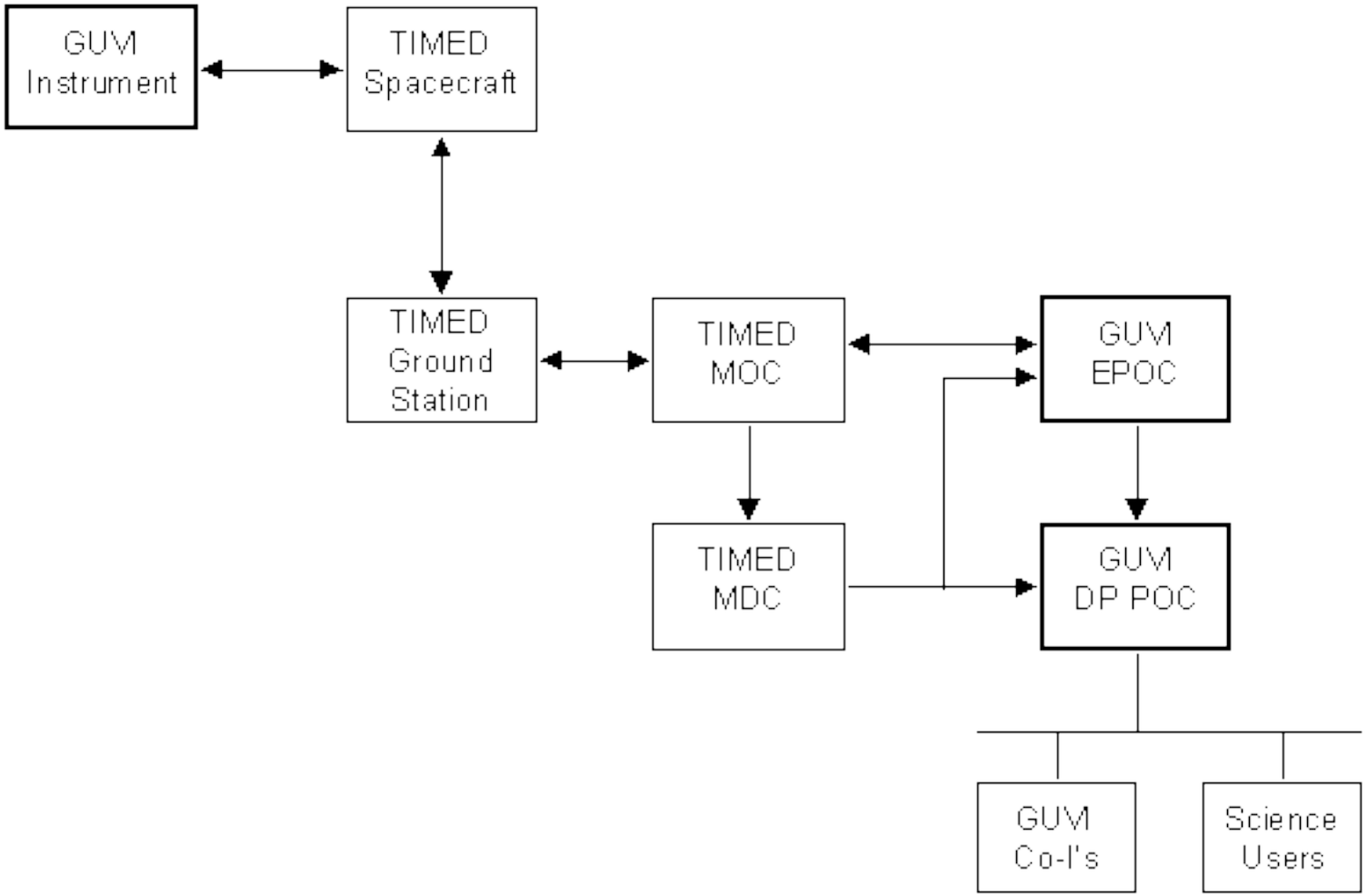
System Description (1)

- GUVI - Global Ultraviolet Imager
- GUVI Flight Instrument
  - GUVI is a far-ultraviolet scanning imaging spectrograph
  - Global measurements of Earth's far-UV airglow
  - Generates 5 simultaneous monochromatic images
    - Spectral range: 115 to 180 nm
  - Performs cross track line scan with overscan onto limb
    - Field of regard: 140° by 11.8°
    - Scan period: 15 sec

System Description (2)

- GUVI Ground Segment
- Payload Operations Center (POC)
- Engineering POC
  - Control instrument during all phases of testing and operations
  - Monitor instrument engineering data
- Data Processing POC
  - Data product generation
  - Data access and distribution
- Engineering GSE
  - Simulate spacecraft interfaces during stand alone tests

GUVI System Block Diagram



Performance Requirements (1)

- **Spectrograph**

Spectral Range	115 to 180 nm
Spectral Resolution	1.5 to 5.0 nm FWHM
Field of View (cross track)	0.18°, 0.30°, 0.74° (selectable)
Field of View (along track)	11.84°
Scan Range (cross track)	+80° to -60°
Scan Step Size	0.4°
Scan Repeatability	0.1°
Disk Spatial Resolution	10 km at nadir
Limb Altitude Coverage	60 to 500 km
Limb Spatial Sampling	0.4°

Performance Requirements (2)

- **Detector**

Maximum Counting Rate	117 kHz
Intrascene Dynamic Range	1000:1
Interscene Dynamic Range	1000:1
Integration Period (limb)	34 msec
Integration Period (disk)	64 msec
Dark Count	30 cnt/sec (over 25 mm diameter)
Detector Non-linearity	3%
Data Compression Error	2%

Performance Requirements (3)

- **Imaging Mode**

Cross Track Pixels (Limb)	32
Cross Track Pixels (Disk)	159
Along Track Pixels	14
Colors	5
Scan Period	15 sec
Output Pixel Size	8 bits

- **Spectrograph Mode**

Cross Track Pixels	1
Along Track Pixels	14
Colors	168
Scan Period	3 sec
Output Pixel Size	8 bits

Interface Requirements (1)

- **Mechanical**

Envelope (SIS/Detector pkgs)	11 H x 27 W x 16 D inch
Envelope (ECU)	5 H x 14.3 W x 9 D inch
Mass (not to exceed)	20.17 kg
Clear Field of View	+85° to -62° cross track
	±10° along track
Mechanical Alignment Placement	±1.0°
Mechanical Alignment Knowledge	±0.05°

- **Thermal**

Operational Interface Temperature	-24°C to +55°C
Survival Interface Temperature	-29°C to +60°C
Interface Temperature Stability	2.0°C/min
Interface Thermal Gradient	15°C between SIS mtg feet

Interface Requirements (2)

- **Attitude**

Attitude Control Error	1.0°
Attitude Knowledge Error	0.03°
Jitter	0.04° / 0.068 sec
Stability	0.1° / 15 sec
Pointing Knowledge Error	0.25°
Position Knowledge	1.0 km
Velocity Knowledge	250 m/sec

- **Electrical**

Main Power (orbit avg limit)	31.5 W (including oper heater power)
Survival Heater Power (peak)	26.6 W
Survival Heater Power (orbit avg)	11 W
Number of Power Relays	2
Number of Pyro Relays	2

Interface Requirements (3)

- **C&DH**

Data Interface	MIL-STD-1553
Data Rate (daily average)	8.105 kbps
Data Rate (peak record)	8.105 kbps
Data Rate (peak real time)	8.105 kbps
Duty Cycle	100%
Time Knowledge	100 msec
Command Rate	3.2 kbit/week
Software Upload	640 kbit

- **Integration & Test**

Integration Cleanliness Level	class 100,000
S/C Surface Cleanliness	1000
Hydrocarbon Limit	15 ppm
Nitrogen Purge Flow Rate	1.0 to 4.0 l/min

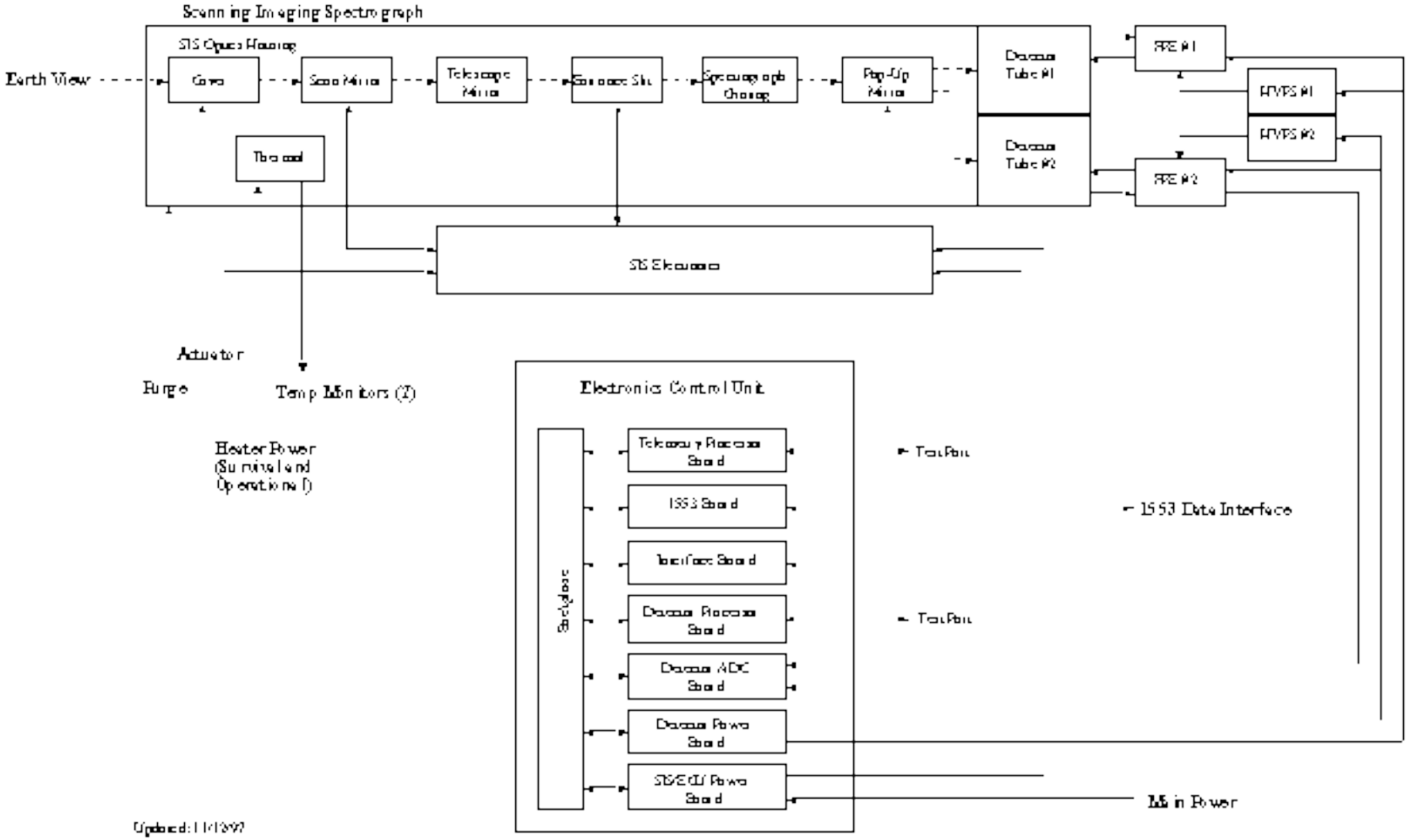
Instrument Design Overview (1)

- Scanning Imaging Spectrograph (SIS)
- SIS Optics Housing
  - Based on SSUSI SIS design
  - Mounting feet modified to offset scan range
  - Sun sensor removed
- Detector Tubes
  - Two redundant wedge and strip detector tubes
  - Tubes mount onto SIS optics housing
  - Tube HV bias boards moved to FPE package
- SIS Electronics
  - Contains SIS motor drive circuitry
  - Identical to SSUSI design

Instrument Design Overview (2)

- Focal Plane Electronics (FPE)
  - Amplifies and shapes charge level signals from tubes
  - New design
- High Voltage Power Supply (HVPS)
  - Identical to SSUSI design
- Electronics Control Unit (ECU)
  - Chassis design based on TIMED IEM
  - Houses power converter boards, S/C interface board, instrument interface board, telemetry processor board, detector processor board, and detector A/D converter board

GUVI Instrument Functional Block Diagram

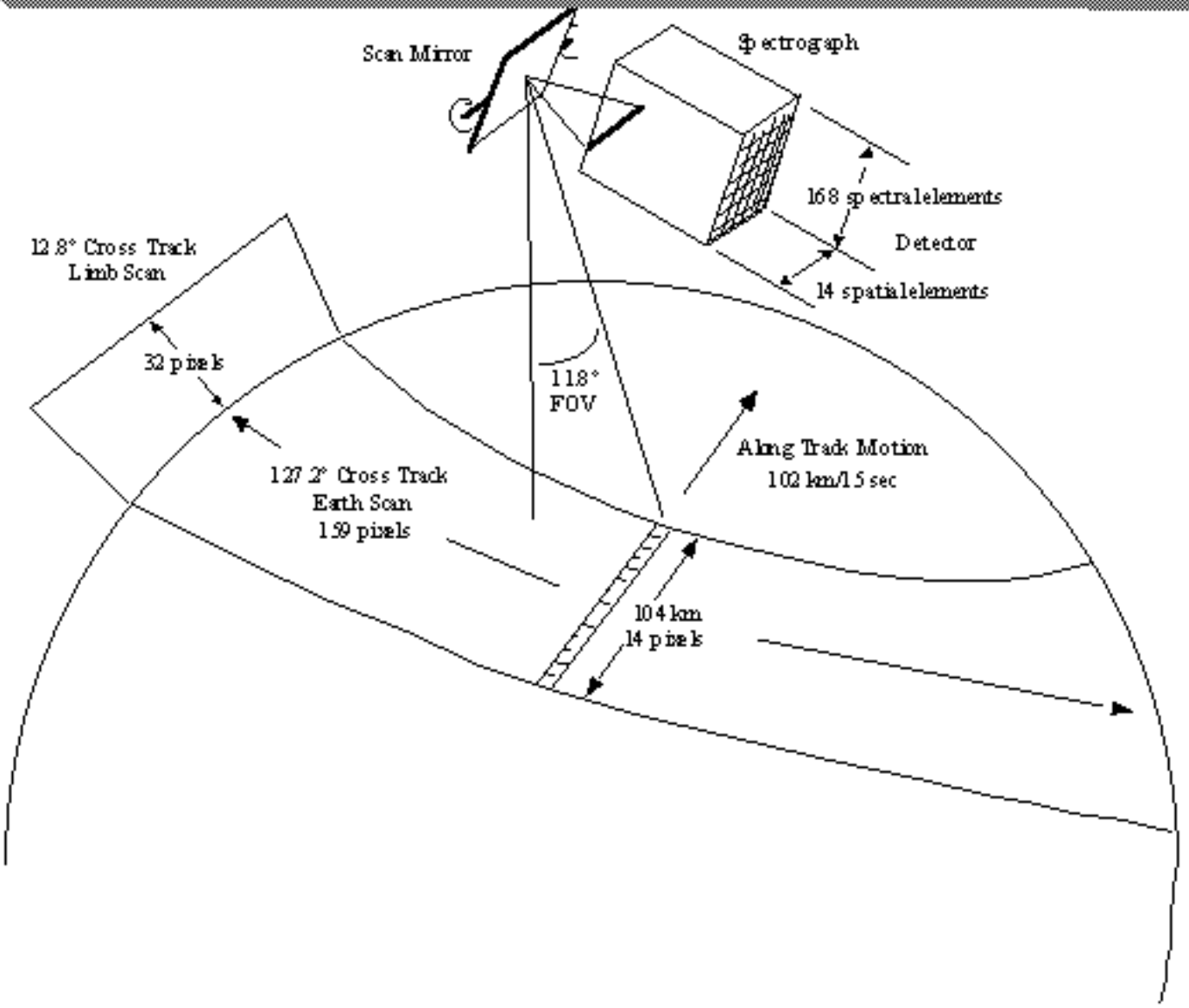


Design Changes Since PDR

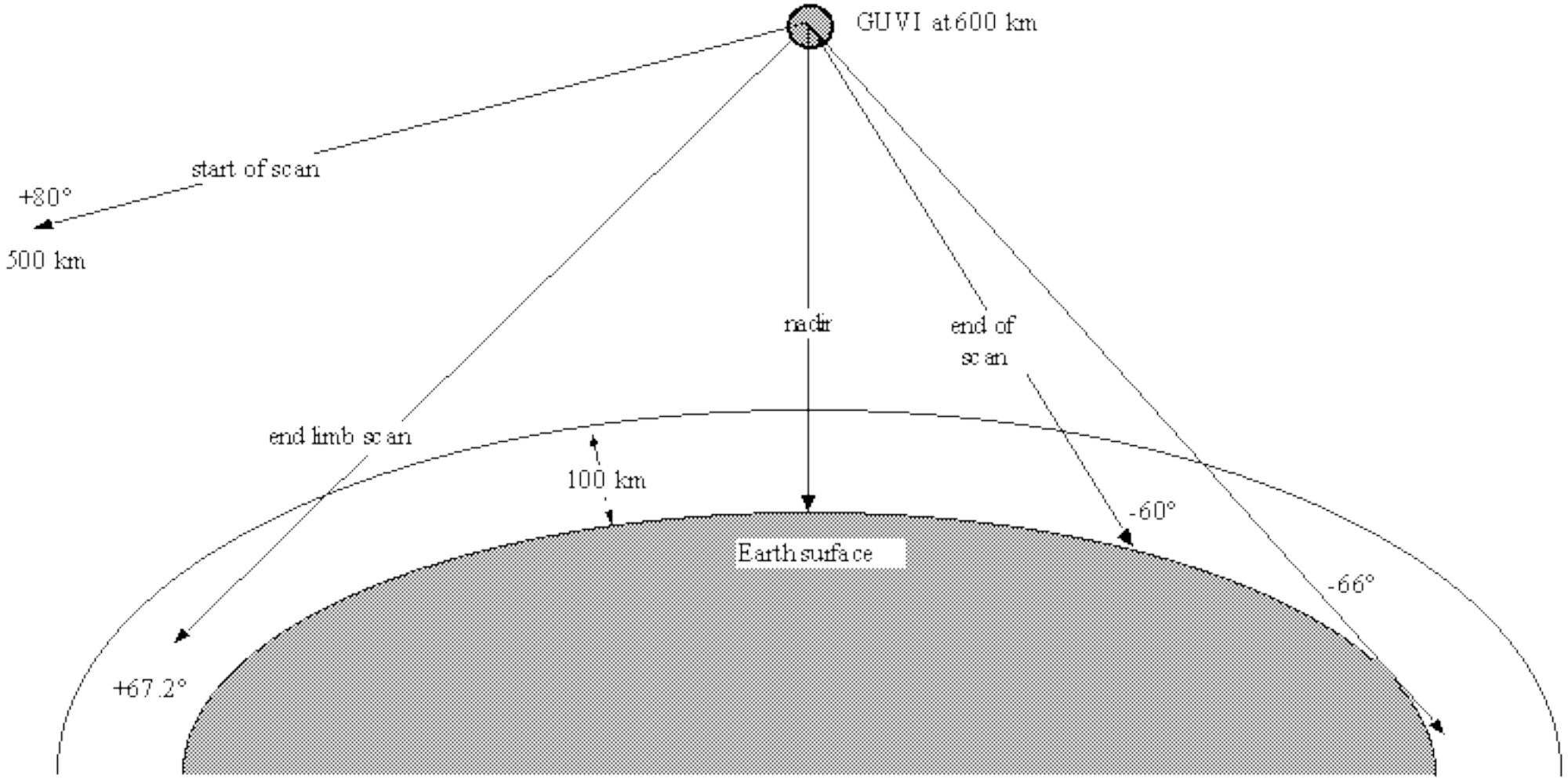
- Packaging
  - ECU package based on TIMED IEM
  - Tube HV bias boards relocated to FPE package
  - Detector ADC board moved from FPE to ECU
- HVPS design will be copy of SSUSI design
- Thermal
  - Scan motor conductively tied to S/C deck
  - SIS radiator area increased
- Random vibration specification changed to SSUSI values
- SIS to include holographic grating

Operating Modes

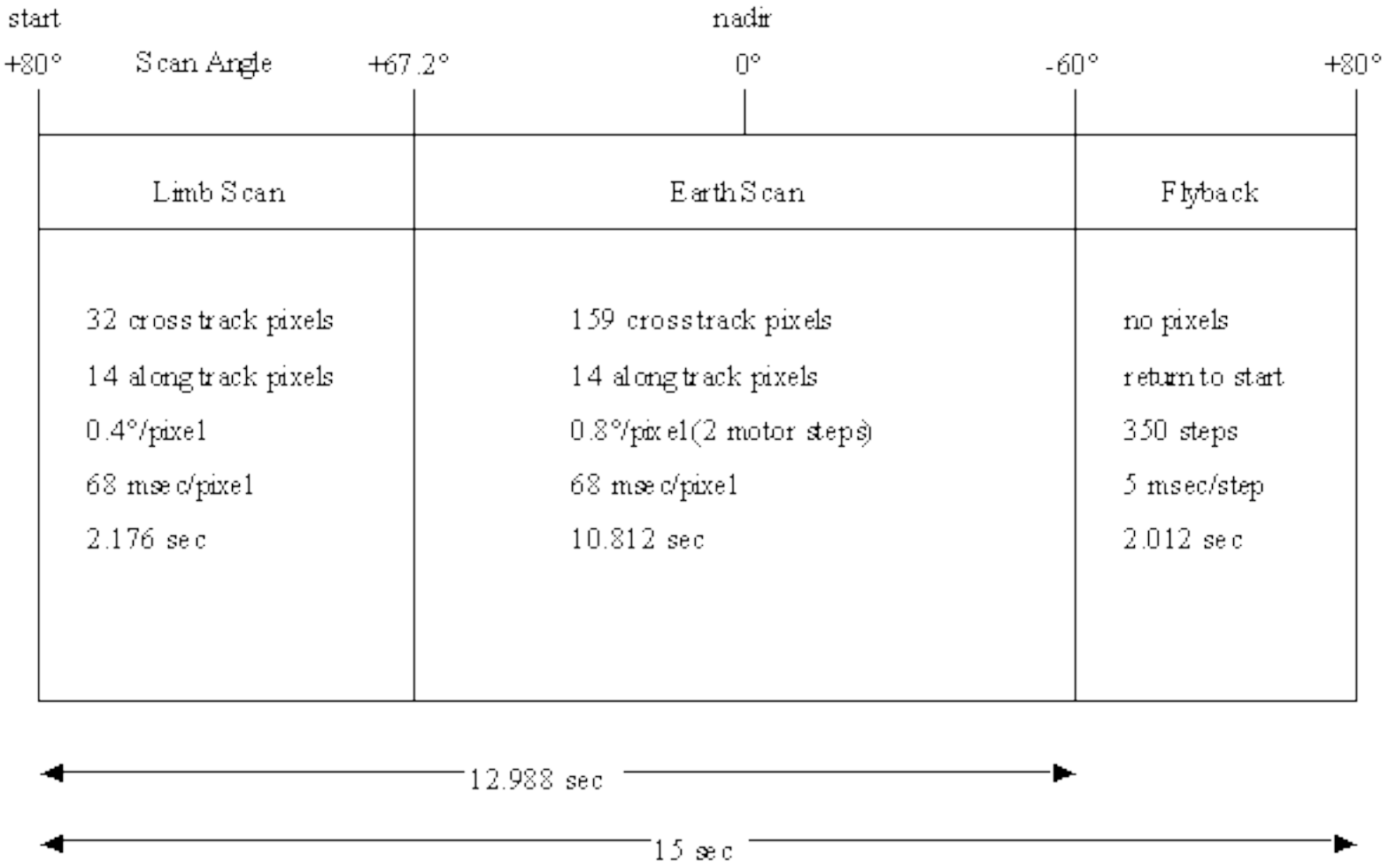
- Imaging
  - Cross track scan at 5 colors
- Spectrograph
  - Fixed cross track angle, all wavelengths
- Test
  - Downlinks detector pulse height data for detector evaluation
- Maintenance
  - Memory upload and software maintenance
- Safe
  - Protected state for instrument during special events


Scan Mirror
Spectrograph
168 spectral elements
Detector
14 spatial elements
12.8° Cross Track
Limb Scan
32 pixels
118°
FOV
127.2° Cross Track
Earth Scan
159 pixels
Along Track Motion
102 km/15 sec
104 km
14 pixels

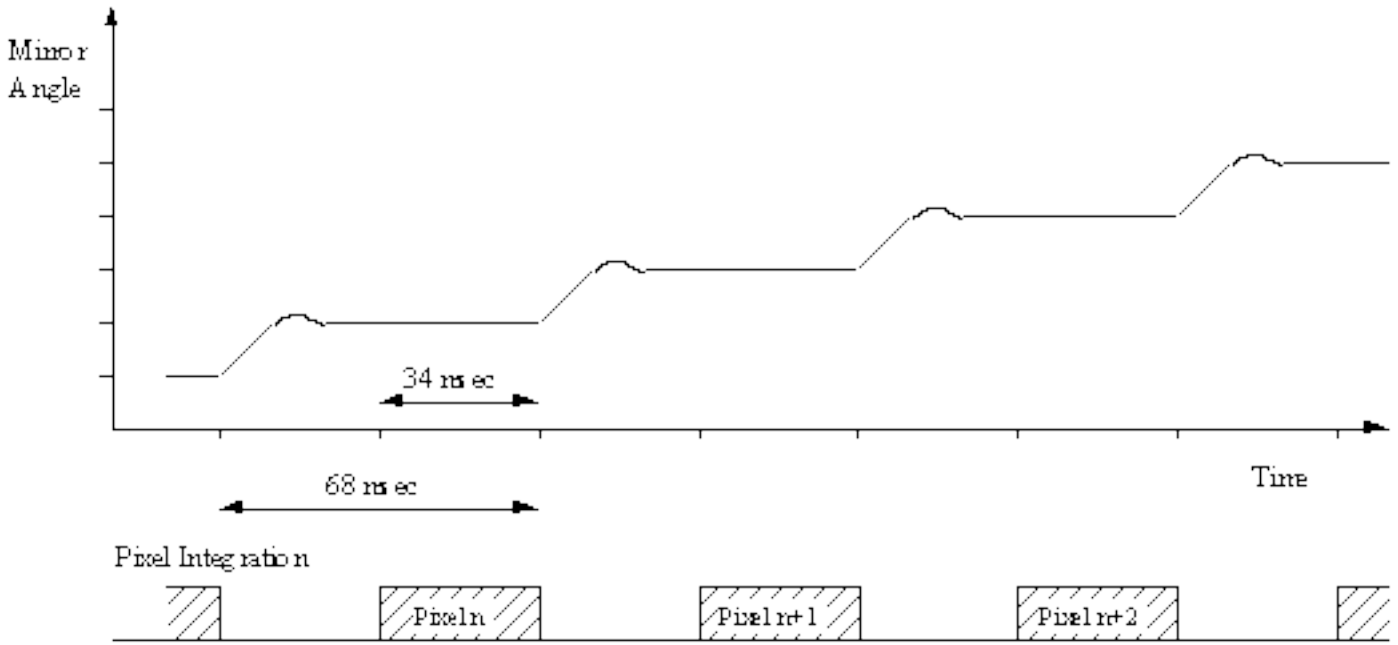
GUVI Scan Geometry



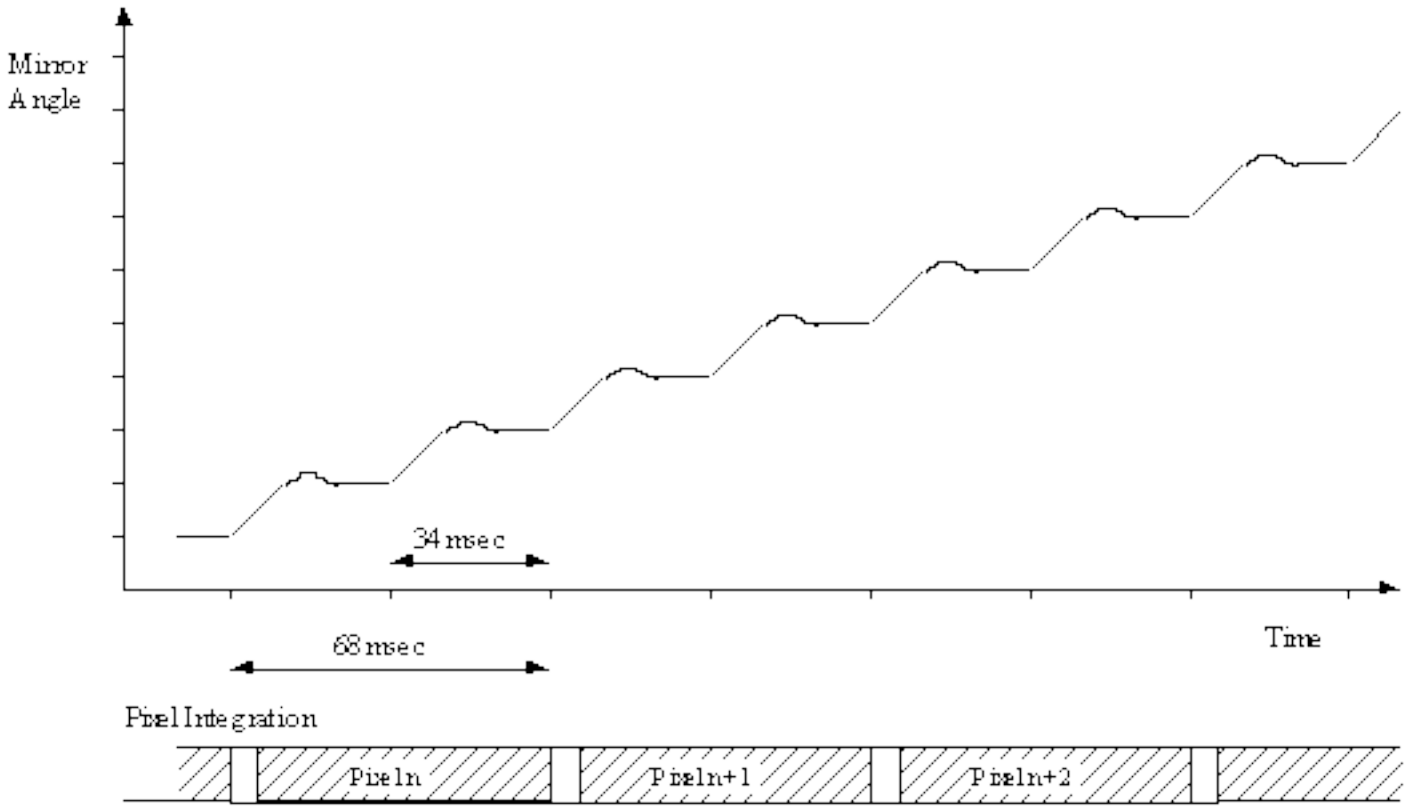
Imaging Scan Format

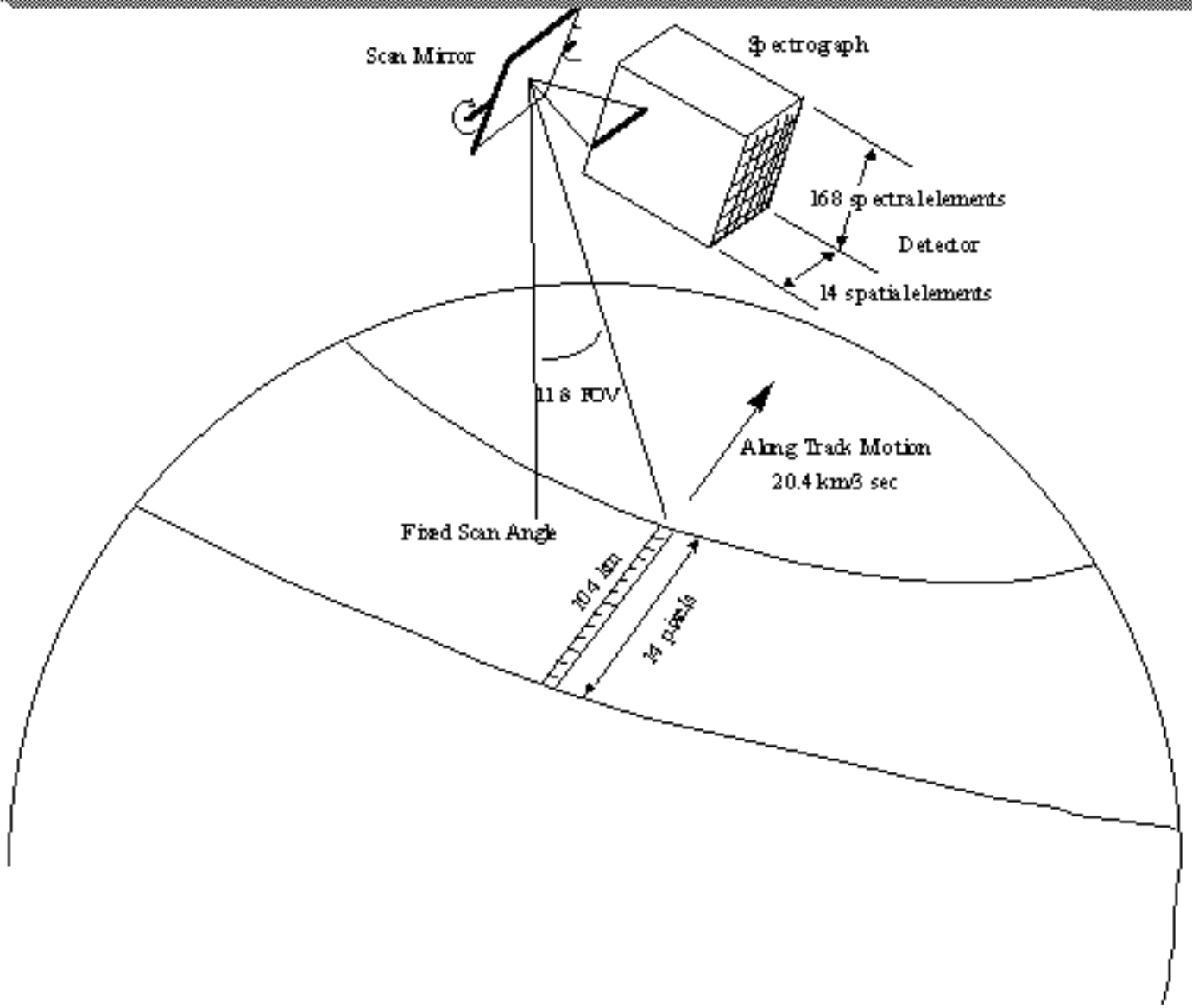


Limb Scan Timing



Earth Scan Timing




Scan Mirror
Spectrograph
168 spectral elements
Detector
14 spatial elements
118 FOV
Along Track Motion
20.4 km/3 sec
Fixed Scan Angle
20.4 km
14 pixels

Special Events

- Sun Event
  - Triggered by excessive detector input count rate
  - On sun event, go to safe mode until ground command received
- Yaw Maneuver
  - Go to safe mode until end of yaw maneuver
- Solar Panel Maneuver
  - Flag GUVI data only, no change in operating mode
- Heartbeat Monitor
  - Cycle GUVI power to reset processor
  - If no heartbeat after power cycled, then power off
- Attitude Anomaly
  - GUVI can be autonomously powered back on after an attitude anomaly

System Analysis

- Pointing Knowledge Error Estimate
- Mass Estimate
- Power Estimate

Pointing Knowledge Error

Component	Budget (deg) all axis		Estimate (deg) roll	pitch	yaw
S/C attitude knowledge	0.250		0.030	0.030	0.030
S/C alignment knowledge	0.050		0.032	0.029	0.006
GUVI thermal distortion	0.080		0.001	0.001	0.001
GUVI launch stress distortion	0.080		0.004	0.004	0.008
GUVI scan mirror position	0.100		0.100	0.000	0.000
GUVI internal alignment			0.050	0.050	0.050
Pointing Error (RSS)	0.296		0.120	0.065	0.059
Pointing Requirement	0.300		0.300	0.300	0.300

Mass Estimate

Component	CDR 1/98 Mass (kg)	PDR 1/97 Mass (kg)	Basis of estimate at CDR
SIS Housing	6.76	6.61	SSUSI actuals plus radiator, mtg foot estimate
SIS Electronics	1.02	1.03	SSUSI actual
FPE1	0.77	0.75	SSUSI actual, different design
FPE2	0.77	0.75	SSUSI actual, different design
HVPS 1	0.46	0.46	SSUSI actual
HVPS 2	0.46	0.46	SSUSI actual
ECU	6.14	6.41	Design estimate
Harness	1.67	1.73	SSUSI actual scaled to length
Blankets	1.02	1.06	SSUSI actual
Total	19.06	19.25	
Not to exceed limit	20.17		

Power Estimate

Subsystem	Imaging Mode Power Estimate				
	CDR 1/98			PDR 1/97	
	Avg (W)	Peak (W)		Avg (W)	Peak (W)
SIS Housing	4.10	8.10		5.00	9.00
SIS Electronics	0.30	0.30		0.30	0.30
FPE1	0.60	0.60		1.70	1.70
FPE2	0.00	0.00		0.00	0.00
HVPS1	1.00	1.00		1.00	1.00
HVPS2	0.00	0.00		0.00	0.00
ECU	14.02	16.89		16.00	17.00
Main Bus	20.02	26.89		24.00	29.00
Oper Heater	7.00	17.00		6.00	13.00
Total	27.02	43.89		30.00	42.00
Not to exceed limit	31.50				
Surv Heater	11.00	26.60		2.50	9.50

Appendix

- S/C Resource Requirement Table
- Power/Mass Spreadsheet
- Drawing Tree