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Thermosphere • Ionosphere • Mesosphere • Energetics and Dynamics

TIMED INSTRUMENT SUMMARY

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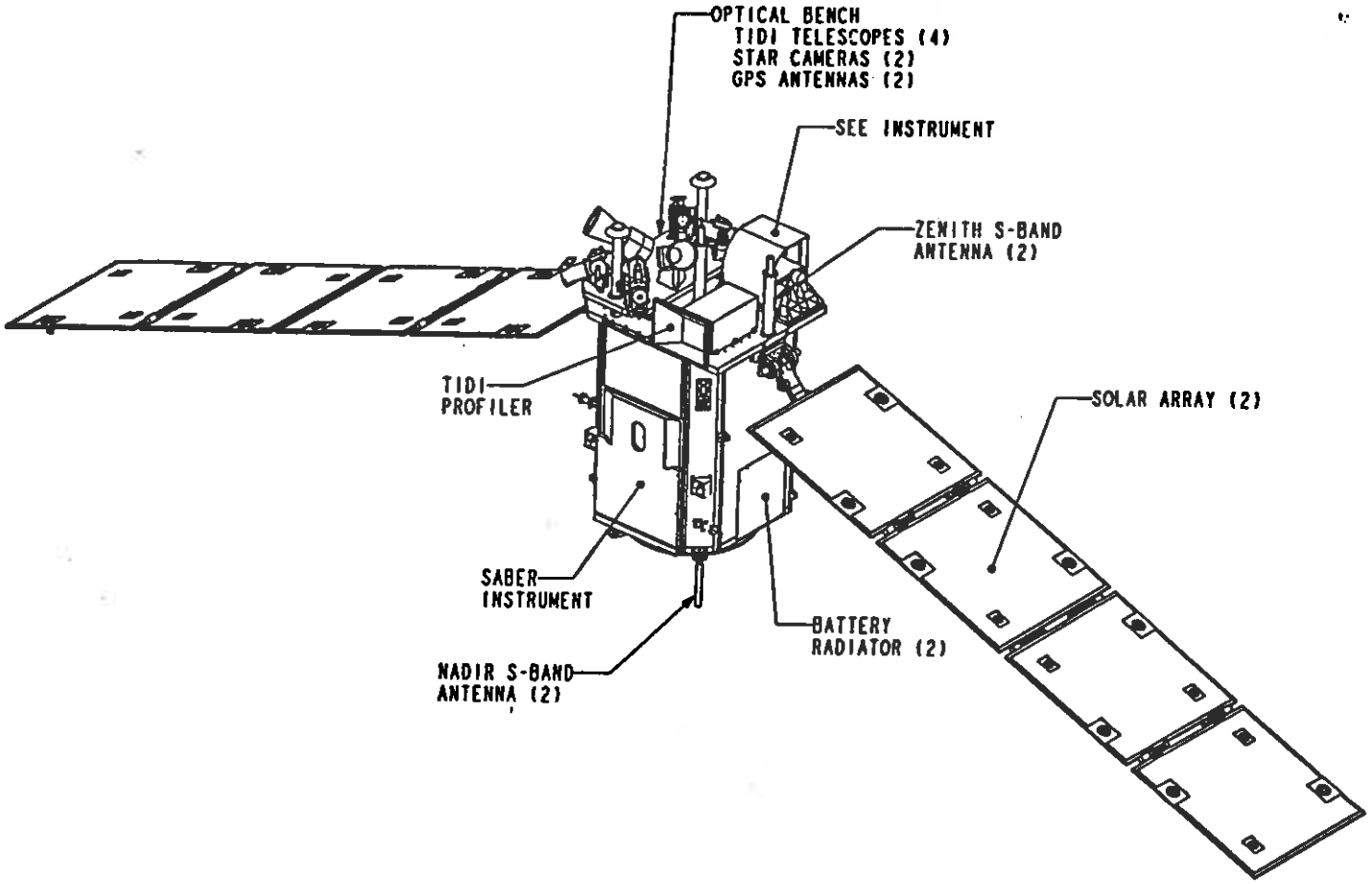
PRESENTATION OUTLINE

- S/C layout (instrument locations)
- Instrument descriptions:
  - 3D drwg / high level description / specs
  - changes since PDR
  - S/C resource table
- ICD status
- Background Information:
  - Electrical interface
  - Instrument status words
  - instrument autonomy
  - I&T concept

Spacecraft Configuration



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GUVI Instrument Description:

- UV (115 - 180 nm) cross-track scanning imaging spectrograph
- 140° (cross track) x 11.8° (along track) field of regard
- Spectrograph characteristics:
  - Roland circle spectrograph design
  - 3 slit sizes
  - ruled grating
  - redundant intensified Wedge and strip detectors
- Image (prime) mode:
  - Cross track horizon to horizon scan; limb overscan on anti-sun side
  - 191 x 14 spatial pixels; 5 spectral colors; 15 second scan
- Spectrograph (calibrate) mode:
  - Fixed cross track look angle
  - 14 along track pixels; 168 spectral bins; 3 second frame period
- total of 7 assemblies: Scanning Imaging Spectrograph (SIS), SIS Electronics, Focal Plane Electronics (FPE) #1, FPE #2, High Voltage Power Supply (HVPS) #1, HVPS #2, and the Electronics Control Unit (ECU)
- 2.0 nm spectral resolution (medium slit); 7.4 km spatial resolution (nadir); 0.2 ct/sec/R responsivity (135.6 nm)

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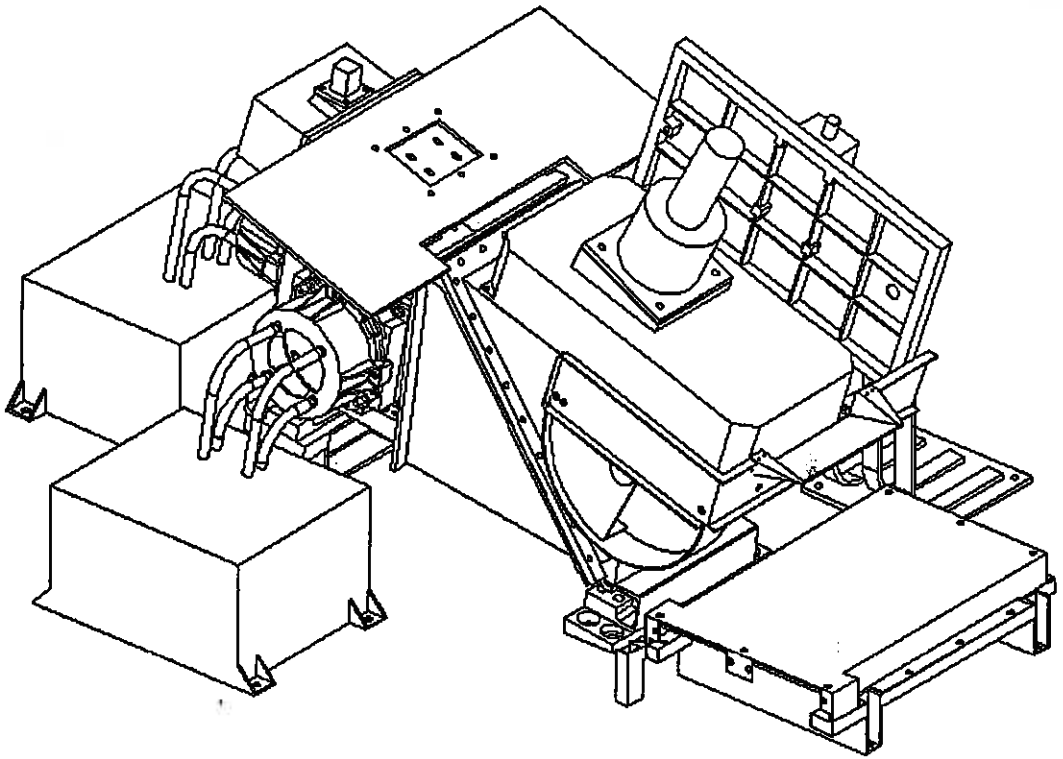
GUVI Instrument Layout



GUVI Changes Since PDR

- Re-partitioning:
  - A/D board moved from FPE to ECU
  - High voltage divider moved from HVPS to FPE
  - *ECU pkg redesigned based on TIMED IEM design*
- Thermal:
  - scan mirror motor conductively tied to deck
  - SIS thermal rediator size increased to reduce detector temp
- Vibration specs:
  - SIS being designed to the SSUSI random spec in lieu of the TIMED spec (approved by E.Schaefer)

	GUVI S/C RESOURCE REQUIREMENTS		
			GUVI
	RQTBLR11.XLS 11/6/97		**Global UltraViolet**
			Imager
Mechanical Requirements:			
	Dimensions	(in)	11(H) x 27(W) x 16(D) (SIS; FPE #1; FPE #2; HVPS #1 & 2; SIS Elec)
			5.0(H) x 14.28(W) x 9.0(D) (ECU)
	Mounting Configuration (footprint, etc.)	(in)	27(W) x 16(D) (SIS; FPE #1; FPE #2; HVPS #1 & 2; SIS Elec)
			14.28(W) x 9.0(D) (ECU)
	Weight	(kg)	19.3
	Center of Gravity		available
	Pointing Direction(s)		Cross trk; +80 (anti-sun) to -60° wrt Nadir
	Initial SIS mechanical alignment placement error (S/C master cube to GUVI ref cube)	(deg)	±1.0
	Intial SIS mechanical alignment knowledge error (S/C master cube to GUVI ref cube)	(deg)	±0.05 each axis
	Clear Field(s) of View		+85° to -62° (cross track) x ±10° along track
	Pinning req't		yes
	Jitter		0.04° / 0.068 sec P,R; 3σ
Thermal Requirements (for each piece):			
	I/F temperature range	(deg C)	All pkgs -24°C to +55°C (operate); -29°C to +60°C (survive)
	I/F temperature stability	(deg C/min)	2.0 (SIS); no req't (all others)
	I/F thermal gradients	(deg C)	15°C (SIS, Y axis); 4°C (SIS, X axis) no req't (all others)
	# / range of S/C monitored temp sensors		2; -70 to +100°C
	S/C provided radiators		None
	Instrument provided radiator clear field of view:		
	SIS radiator	(deg)	±60° both axis
Attitude and Navigation Requirements:			
	Attitude control error (defined at SIS mounting location)	(deg)	1°, each axis, 3σ
	Attitude determination knowledge error (defined at optical bench optical cube)	(deg)	< 0.03°, each axis, 3s
	Stability	(deg/sec)	0.1° / 15 sec, each axis, 3σ
	Pointing knowledge error (star camera boresight to GUVI mounting location; includes attitude, thermal and mechanical sources)	(deg)	0.25°, each axis, 3σ
	Position Knowledge	(km)	1, each axis ,3σ
	Velocity Knowledge	(m/s)	250, each axis, 3σ
	Keep out zones (such as sun, moon, earth)		prolonged ram or sun
	Perturbing Mechanisms		scan mirror, pop-up mirror, slit shutter

	GUVI S/C RESOURCE REQUIREMENTS		
			GUVI
	RQTBLR11.XLS 11/6/97		**Global UltraViolet**
			Imager
Command and Data Handling Requirements			
	Number and type of commands		3.2 kb/wk; 640 kb S/W upload
	Instrument modes of operation		6 - off, 5 oper
	Orbit modes		2 - Imaging, spectrograph
	Daily avg data rate	(kbps)	*8.105*
	Peak record data rate	(kbps)	*8.105*
	Peak real time downlink data rate	(kbps)	*8.105*
	Duty cycle		100%
	Time knowledge	(ms)	100
	Special data needs (terminator crossings, etc.)		UT time; term xing; yaw mnvr; sun vector; solar panel move; safe flag; S/C attitude (1 Hz), SAA
	Preferred S/C data interface concept		MIL-STD-1553
Power Requirements:			
	Avg pwr / instrument mode (does not include htr pwr)	(watt)	0, 18 to 24
	Peak power / instrument mode (does not include htr pwr)	(watt)	0, 18 to 29
	Peak Power duration (does not include htr pwr)	(msec)	1000 - every 50 min
	Orbit avg power / orbit mode (does not include htr pwr)	(watt)	24, 24
	Operational heater power [OAP (cold case); peak (35v)]	(watt)	7, 17
	Survive heater power[OAP (cold case); peak (35v)]	(watt)	11, 26.6
	Voltage Range	(volts)	22 to 35
	# of relays		2 (power) + 2 (pyros)
Cleanliness Requirements:			
	Acceptable Cleanliness Levels for S/C Intgr		class 100,000
	S/C Surface Cleanliness		1,000
	Hydrocarbon levels		15 ppm
	Purge Requirements (type, purity, flow rate, max time w/o, pad req't)		N2 purge, grade C, 0.2 to 0.5 l/min, 8 hrs, N2 purge
	Bakeout req'ts on S/C		All mechanical hdwr, harnesses, thermal blankets, and electronics boxes
Special Requirements For:			
	Integration and Test		none
	A#s		A600 (SIS); A605 (SIS Electronics); A610 (FPE#1); A612 (FPE#2); A620 (HVPS#1); A622 (HVPS#2); A625 (ECU)
	Arming plug on S/C side		Yes (part of S/C arming plug)
	Mission Operations (such as deployments)		pyro release cover, yaw maneuver
	Safety (such as a radiation source)		HVPS, GSE lamp, purge
	EMC		FPE wideband amp susceptibility
	Calibration		none

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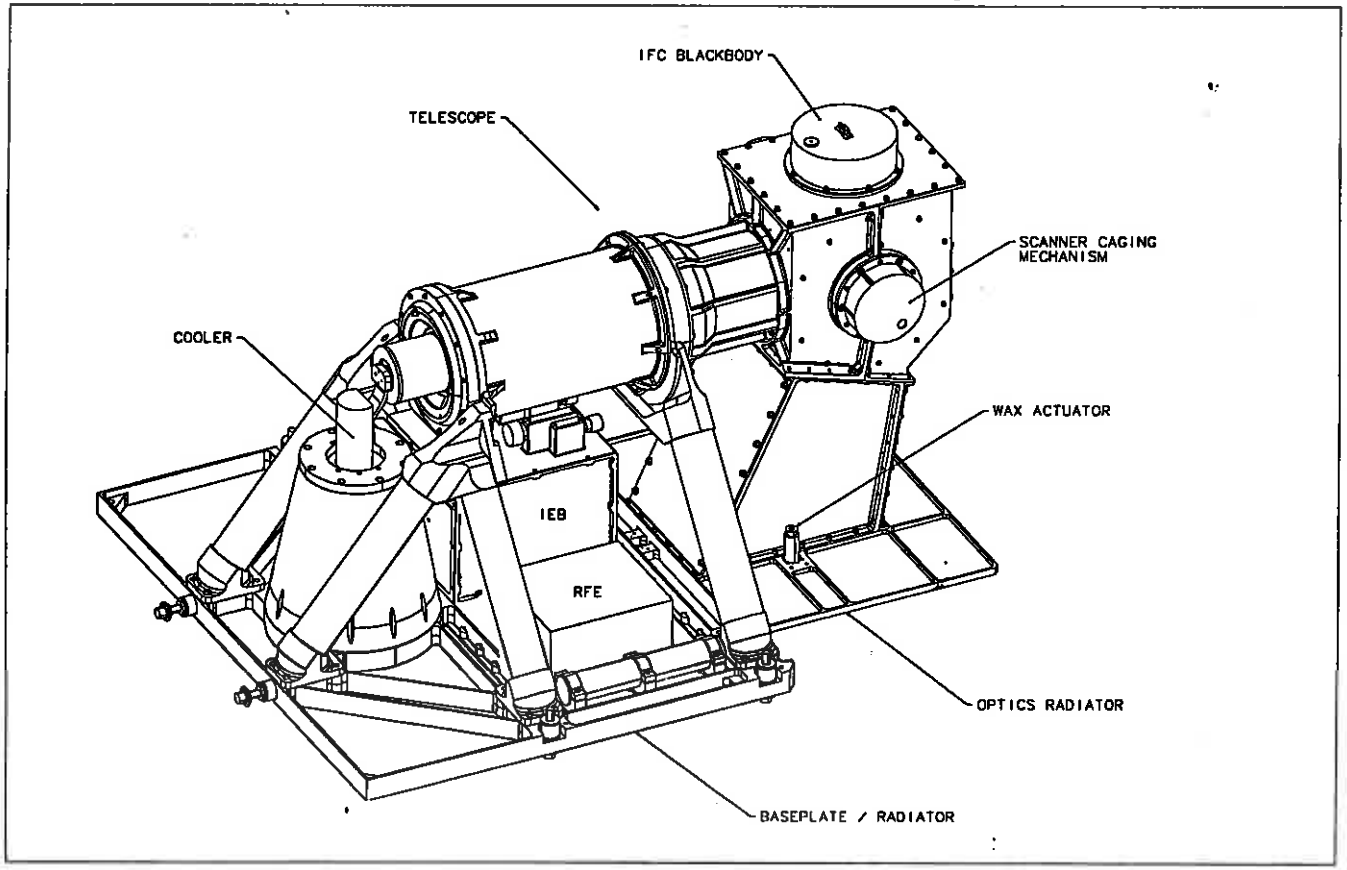
SABER Instrument Layout



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SABER Instrument characteristics:

- 10 channel, limb scanning, IR radiometer
- Wavelength range: 1.27 to 15.2 μm
- Measurement altitude range: 10 to 180 km
- Vertical sampling interval: 0.4 km
- IFOV @ 60 km TH: 2 km FWHM
- Spectral resolution: 45 to 700 cm^{-1} depending on channel
- consists of telescope, detector, refrigerator, refrigerator electronics, and electronics assembly
    - telescope:
        - scan mirror / encoder, cassegrain mirror assy, chopper, clamshell mirror assy, detector assy
    - detector assy:
        - 10 detectors (HgCdTe(5), InSb (4), InGaAs(1)); unsealed unit, cooled to 75K, suspended from telescope by G10 tubes
    - refrigerator / refrigerator electronics:
        - pulse tube type, built by TRW, anticipate 384 mW heat load, 20W power dissipation
    - electronics assy:
        - state machine (no processor), total of 11 boards (3 signal processing, 3 power, 1 System controller / formatter / 1553 interface, 2 Housekeeping, 1 Scan mirror control / driver, and 1 BB / Jones source / heater / chopper.

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SABER Changes Since PDR

- *FPA suspension by G-10 tubes instead of Kevlar string*
- *Eliminate window in detector housing*
- Channel 8 and 9 detectors are InSb instead of InGaAs
- Rearranged detector positions in FPA
- **Added 1553 I/F to refrigerator electronics**
- **Added DC/DC converter to power refrigerator electronics**
- Moved Jones sources to within BB source
- **S/C I/F is 6 attach points instead of 8**
- **Redesigned purge distribution system**

	SABER S/C RESOURCE REQUIREMENTS		
			SABER
Space Craft Resource Requirements11_97.xls		11/10/97	**Sounding of the Atmosphere using**
			Broadband Emission Radiometry
Mechanical Requirements:			
	Dimensions	(cm)	77.47 (W) x 104.24 (H) x 62.56 (D)
	Mounting Configuration (footprint, etc.)	(cm)	77.475 (W) x 62.89 (H)
	Weight	(kg)	65.63
	Center of Gravity	(cm)	1.10(x), 17.00(y), 37.20(z)
	Pointing Direction(s)		90° Off-Ram, Anti-sun side, On-Limb
	Initial mechanical alignment placement error (S/C master cube to SABER ref cube)	(deg)	±0.1°(X), ±0.25° (Y,Z)
	Initial mechanical alignment placement knowledge (S/C master cube to SABER ref cube)	(deg)	±0.01°
	Clear Field(s) of View		±29° horiz; 23° vert (top), 54° vert (bot)
	Pinning req'd		No
	Jitter		**see GIIS Fig 6.2.5-1**
Thermal Requirements (for each piece):			
	I/F temperature range	(deg C)	-29 to +30C (operate); -34 to +60C (survive)
	I/F temperature stability	(deg C/min)	.05 K/min.
	I/F thermal gradients	(deg C)	TBD
	#, range of S/C monitored temp sensors		4; -70 to +100C
	S/C provided radiators		None
	Instrument provided radiator CFOV:		
	Optical radiator	(deg)	180 x 360; +Y side
	Interface radiator	(deg)	180 x 360; +Y side
Attitude and Navigation Requirements:			
	Attitude control error (defined at SABER mounting location)	(deg)	**0.5°, each axis, 3s**
	Attitude determination error (defined at optical bench optical cube)	(deg)	0.03°, each axis, 3s
	Stability		***see GIIS Fig 6.2.5-1***
	Pointing knowledge error (star camera boresight to SABER mounting location; includes attitude, thermal and mechanical sources)		***0.1°, each axis, 3 s***
	Position knowledge	(km)	0.3 radial; 1.0 other 2 orthogonal axes; (3s)
	Velocity Knowledge	(m/s)	3 (each axis, 3s)
	Keep out zones (such as sun, moon, earth)		sun on radiator, ram (long term)
	Perturbing Mechanisms		scan mirror (1E-4 N-m-s), chopper (<0.006 lbf),
			refrigerator compressor (<0.02 lbf)

SABER S/C RESOURCE REQUIREMENTS

			SABER
Space Craft Resource Requirements11_97.xls		11/10/97	Sounding of the Atmosphere using Broadband Emission Radiometry
Command and Data Handling Requirements			
	Number and type of commands		on-off, 7modes;general CMD word; 2 KBytes/day up
	Instrument modes		8-off, pwr up, safe, stndby, stblize, data coll, cal, diag
	Orbit modes		Data Coll/ Cal
	Daily avg data rate	(kbps)	3.97
	Peak record data rate	(kbps)	0, 0.132, 0.132, 3.97, 0.132, 3.97, 3.97, 3.97
	Peak real time downlink data rate	(kbps)	3.97
	Duty cycle		100%
	Time knowledge	(ms)	100
	Special data needs (terminator crossings, etc.)		Time, S/C pos, S/C velocity, orbit ephemaris, sun angle, terminator info
	Preferred S/C data interface concept		MIL-STD-1553
Power Requirements:			
	Avg pwr / instrument mode (includes htr pwr)	(watt)	28.5, 75.4, 51.0, 69.7, 69.7, 72.6, 72.6, 72.6
	Peak pwr / instrument mode (includes htr pwr)	(watt)	86.1, 74.5, 74.5, 69.7, 69.7, 92.7, 92.7, 92.7
	Peak Power duration (includes htr pwr)	(msec)	100
	Orbit avg pwr / orbit mode (includes htr pwr)	(watt)	**72.6**
	Operational htr pwr [OAP (cold case); Peak pwr (35v)]	(watt)	8.9, 8.9
	Survive htr pwr [OAP (cold case); Peak pwr (35v)]	(watt)	28.5, 86.1
	Voltage Range	(volts)	22 to 35
	# of relays		3
Cleanliness Requirements:			
	Acceptable Cleanliness Levels for S/C Intgr		Class 100,000
	S/C Surface Cleanliness		**Level 750**
	Hydrocarbon levels		15 ppm
	Purge Requirements (type, purity, flow rate, max time w/o, pad req't)		N2 purge, boil off gas from liquid LN2, 0.5 SCFM @ 4 psi delivery pressure
	Bakeout req'ts on S/C		Bakeout all mechanical hdwr, thermal blankets, cables, and electronic assys
Special Requirements For:			
	Integration and Test		requires LN2 for cooling
	A#s		A500 (SABER)
	Arming plug on S/C side		No
	Mission Operations (such as deployments)		door release attitude; yaw maneuver
	Safety (such as a radiation source)		Pressure system (refrigerator), cryo (flight refrigerator and GSE test chamber), purge, lasers (GSE only)
	EMC		S/C EMC self compatibility test must be done in @ S/C TV
	TV test		view cold background in Class 100 environment

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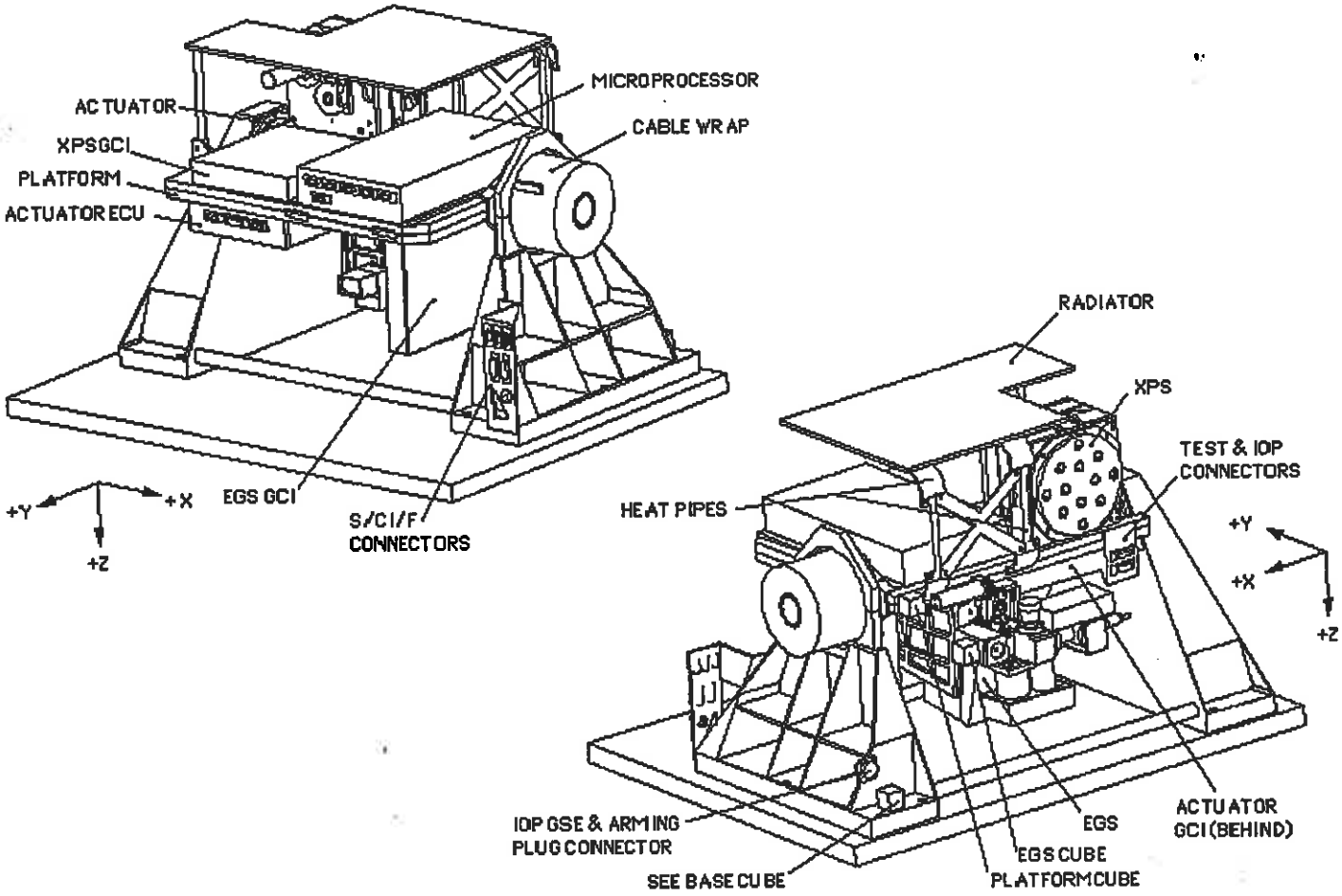
SEE Instrument Layout



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•SEE instrument designed to measure the solar energy input to the MLTI.

• consists of EUV Grating Spectrograph (EGS), the XUV Photometer System (XPS), the Microprocessor Unit (MU), and the SEE Solar Pointing Platform (SSPP), all delivered as a single package.

• EUV Grating Spectrograph (EGS):

  • 1/4 m, Rowland circle spectrograph

  • vacuum housing; vacuum door; 2 equally sized slits (2nd for calibration)

  • ruled, gold coated grating (600 lines/mm)

  • intensified, 1024 x 64 codacon detector; bare MCP; filters

  • spectral range: 25 - 200 nm; spectral resolution: 0.4 nm

•XUV Photometer System (XPS):

  • singleunit; 12 photodiodes; 6 XUV, 3 redundant, 3 bare

  • spectral range: 0.1 - 35 nm; spectral resolution: 2 - 5 nm

  • 8 position filter wheel

• Microprocessor Unit: 1750 microprocessor (CASSINI heritage), GCI board

• SSPP: Type 3 Schaeffer harmonic drive with stepper motor, 190° scan range (including launch position), < ±4 arcmin position precision

•Solar Aspect Sensor: quadrature photodiode detection system

SEE Changes Since PDR

- EGS:
  - Using Solar Angle Sensor for pointing (removed MASS and PSD)
  - Modified slit mechanism
  - Hg pen-ray lamp for flatfield calibration
- XPS:
  - *Descoped redundant XPS*
  - GCI interface now external
- Microprocessor
  - *using CASSINI uP design*
  - generic I/F bds

SEE Changes Since PDR

- **SSPP:**
  - **all aluminum structure**
  - **type 3 harmonic drive actuator**
  - ***new platform layout***
  - **spherical bearing on opposite support**
  - **flex circuit instead of cable wrap**
  - **moved S/C I/F brkt**
  - **shroud removed**
  - **no launch lock req'd**

SEE Changes Since PDR

- **Thermal:**
  - ***using heat pipes***
  - **thermal isolation to S/C provided by actuator and bearing**
- **Power:**
  - **Eliminated the PRU**
    - » ***Distributed power system***
    - » **each GCI bd converts +28v**

SEE S/C RESOURCE REQUIREMENTS

RQTBLR9c.XLS 11/5/97		**SEE (SOLAR EUV Experiment)**
		(EGS, XPS, MU, SSPP)
Mechanical Requirements:		
Dimensions	(in)	26.995 (X) x 16.406 (Y) x 19.898 (Z)
Mounting Configuration (footprint, etc.)	(in)	26.995 (X) x 15.172 (Y)
Weight	(kg)	25.8
Center of Gravity		TBD
Pointing Direction(s)		190° movement range; Y-Z plane; from 25° below -Y axis (toward +Z for launch) to 10° beyond -Z axis (toward +Y)
Initial mechanical alignment placement error (S/C master cube to optical cube on SEE foot)	(deg)	± 1.0
Initial mechanical alignment knowledge error (S/C master cube to optical cube on SEE foot)	(deg)	0.05
Clear Field(s) of View	(deg)	185 x 38 (XPS); 185 x 31.3 (EGS); see CFOV drwg for details and origins of
Pinning req'd		No
Jitter		±0.03°/sec; each axis; 3σ
Thermal Requirements (for each piece):		
Mounting I/F temp range	(deg C)	-20 to +55°C (operate); -34 to +60°C (survive); -Z deck; hard mounted
Mounting I/F temperature stability	(deg C/min)	No req't
Mounting I/F thermal gradient	(deg C)	16°C across diagonal
# / range of S/C monitored temp sensors		2; -70°C to +100°C
S/C provided radiators		None
Instrument provided radiator CFOV:		
Platform radiator	(deg)	Cannot provide CLEAR FOV over entire scan range; thermal analysis indicates that layout is adequate
Attitude and Navigation Requirements:		
Attitude control error (defined at SEE mounting location)	(deg)	1.0°, each axis, 3 σ
Attitude determination knowledge error (defined at optical bench optical cube)	(deg)	0.03°, each axis, 3σ
Stability	(deg/sec)	2°/60sec, each axis, 3 σ
Pointing knowledge error (star camera boresight to SEE base optical cube; includes thermal and mechanical sources)	(deg)	0.05° each axis, 3σ
Position Knowledge	(km)	2 (radial); 10 along and cross track, 3σ
Velocity Knowledge	(m/s)	none
Keep out zones (such as sun, moon, earth)		none
Perturbing Mechanisms		rotating platform, egs slit shutter,
		filter wheel, reclosable door
Command and Data Handling Requirements		
Number and type of commands		2 KBytes/day (µproc upload), infrequent ~80KByte ram loads
Instrument modes		6 -off,stndby,normal science, solar cal, occultation, EGS flat fielding
Orbit modes		5 - off, standby, normal science, calibration, occultation
Daily avg data rate	(kbps)	0.228
Peak record data rate	(kbps)	4.192
Peak real time downlink data rate	(kbps)	4.192
Duty cycle		5% Datataking (5 min/orbit), 95% Standby
Time knowledge	(ms)	1000
Special data needs (terminator crossings, etc.)		UT time, S/C pos, S/C velocity, S/C attitude, orbit ephemeris, Sun-S/C angles, solar panel maneuver, yaw maneuver, anomolous cond flag, SAA flag?

	SEE S/C RESOURCE REQUIREMENTS		
	RQTBLR9c.XLS 11/5/97		SEE (SOLAR EUV Experiment)
			(EGS, XPS, MU, SSPP)
	Preferred S/C data interface concept		MIL-STD-1553
Power Requirements:			
	Avg pwr / instrument mode (does not include htr pwr)	(watt)	0,12.6,24.8,25.4,24.7,13
	Peak power / instrument mode (does not include htr pwr)	(watt)	0, 15.6, 46.2, 46.2, 46.2, 16.1
	Peak Power duration (does not include htr pwr)	(msec)	1000-2000
	Orbit avg power / orbit mode (does not include htr pwr)	(watt)	0, 12.6, 13.3, 13.7, 15.9
	Operational heater power [OAP (cold case); peak (35v)]	(watt)	17; 38
	Survive heater power[OAP (cold case); peak (35v)]	(watt)	11.5, 26
	Voltage Range	(volts)	22 to 35
	# of relays		2
Cleanliness Requirements:			
	Acceptable Cleanliness Levels for S/C Intgr		class 100,000; -Z panel precision clean/bakeout; Mil-Spec 1246 - 500A
	S/C Surface Cleanliness		No S/C Cleanliness req't; -Z deck to be precision cleaned, -Z deck and MLI to be baked out
	Hydrocarbon levels	ppm	15
	Purge Requirements (type, purity, flow rate, max time w/o, pad req't)		GN_2 std grade, 99.999%, hydrocarbon < 1 ppm; 0.1 L/min with red tag XPS cover; fill EGS with 1.2 atm nitrogen as late as possible in process flow
	Bakeout req'ts on S/C		All mechanical hdwr, harnesses, thermal blankets. Highly desirable to bakeout elec boxes as well.
Special Requirements For:			
	Integration and Test		access to spectrometer; VIP on front of EGS; Ion pump test conn (I&T and TV), uP test conn (I&T only); EGS nitrogen backfill and XPS Cover removal late in process; remove EGS for cal (post S/C TV)
	A#s		A400
	Arming plug on S/C side		No
	Mission Operations (such as deployments)		Move SSPP away from -Z deck ASAP after launch; power XPS and move filter wheel once / week in early ops.
	Safety (such as a radiation source)		UV lamp, purge, pressure system (nitrogen cylinder, GSE), cryo (roughing pumps (GSE), battery (ion pump supply, GSE), handling fixture, high voltage
	EMC		Mercury pen-ray lamp (<700 v striking voltage; 100 - 200v operating voltage; 100 Hz; ~10 mA)
	Calibration		post TV calibration of EGS desired

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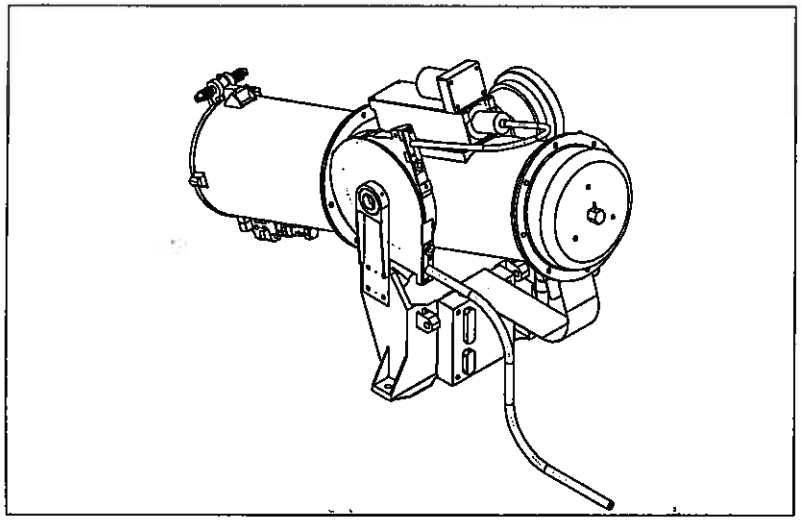
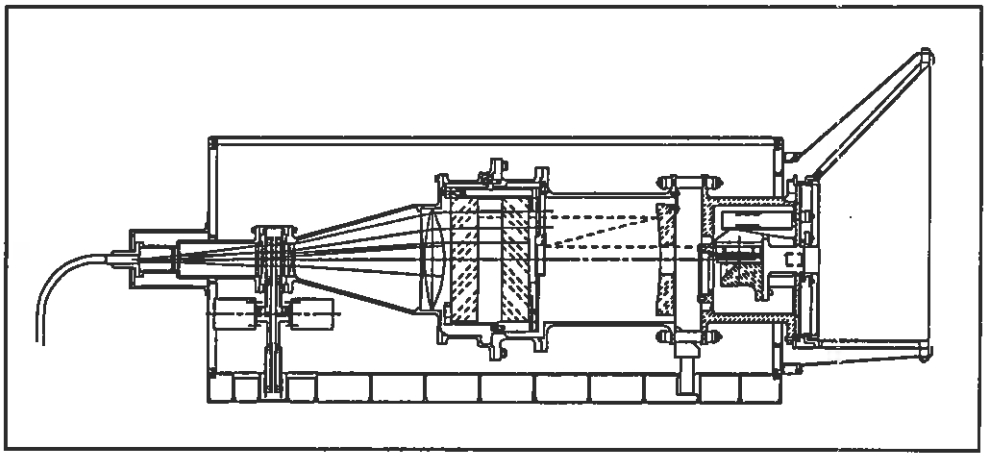
TIDI Instrument Layout

TIDI Telescope (1 of 4)



TIDI Profiler



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•TIDI is a Fabry-Perot interferometer (FPI) designed to measure doppler winds and temperatures.

• FPI has simultaneous inputs from four, gimballed, limb scanning telescopes positioned 45° from ram and wake. Fiber optic cables connect telescopes to FPI.Electronics stack based on (7 decks) based on an 80C51 microcontroller.

• Fabry-Perot interferometer / detector:

  • contains 5 input fiber optic cable (5th input is calibration lamp), collimating optics, 2 series 8 position filter wheels, beam expanding optics, single fixed position etalon, imaging optics, CLIO (circle to line converter), and a CCD.

  • etalon: 2.2 cm gap, etalon finesse = 15, coated clear aperture = 7.5 cm, plate diameter = 10.5 cm, reflectivity = 80%.

  • detector: 2000 x 800 pixel CCD, 1 x 160 CCD binning, 1 sec integ time, oper temp = -80°C (passive cooling), readout noise = 5e, 150,000 e/bin saturation level, QE=0.77 @ 760 nm, 0.55 @ 890 nm, 2 cm shielding.

  • filter wheels: 8 position, stepper motor, incremental encoder

• telescopes:

  • 0.05 x 2.5° field of view, 7.5 cm diam aperture, 0.01° blur circle, 550 - 900 nm spectral range

  • telescope gimballed, 2 bearing system, scan range ±10° centered ≈18.5° below local horizontal, voice coil / servo actuator, LVDT position sensor, 0.05° step size, 0.005° position sensing resolution,

  • once open (wire cutter) windowed cover, baffle assy, primary mirror, single fixed slit, secondary mirror, reimaging lens, shutter assy (open/closed), fiber optic I/F.

• fiber optic cables: 50 μm core diam, 5 equal area fields, 390 fibers/field, packing fraction ≈70%, transmission 95%/m.

• electronics: 7 decks including: flt computer, pwr supply, data acq, CCD controller, telescope servo, Cal lamp PS, and controller bd (FW, shutter, and htr).

TIDI Changes Since PDR

- added 2nd filter wheel
- redesigned profiler optics (chromatic abberation issue)
- went from 4 to 2 bearing design on telescope gimbal
- resized elec boards and dropped spare board

	TIDI S/C RESOURCE REQUIREMENTS		
	SCREQ117.XLS 11/97		**TIDI**
			TIMED Doppler Interferometer
			(Profiler, Star Camera, and 4 telescopes)
Mechanical Requirements:			
	Dimensions	(in)	sensor: 16.0 (H) x 13.1 (W) x 30.1 (L)
		(in)	telescopes (4): ~12.0 (H) x 10.0 (W) x 18.8 (L)
		(in)	electronics: 8.0 (H) x 8.36 (W) x 9.03 (L)
	Mounting Configuration (footprint, etc.)	(in)	sensor: 12.35 (W) x 16.0 (L)
		(in)	telescopes (4): 3.875 x 6.128 ; 3 point mount
		(in)	electronics: 8.36 (W) x 9.03 (L)
	Weight	(kg)	41.8
	Center of Gravity		TBD
	Pointing Direction(s)		45°, 135°, 225°, 315° Off-Ram, 10.0° to 30.0° below local horizontal
	Initial telescope mechanical alignment placement error (telescope base optical cube to star camera base optical cube)	(deg)	± 0.5°
	Telescope initial mechanical alignment knowledge error (telescope base optical cube to star camera base optical cube)	(arcsec)	2.0
	Clear Field(s) of View		±17.5° azimuth; ±22.525° elevation each telescope
	Pinning req'd		telescopes (4)
	Jitter		0.03°/0.25 sec, 0.03°/10 sec; each axis, 3 σ
Thermal Requirements (for each piece):			
	Mounting I/F temperature range:		sensor:-29 to +40 oper; -34 to +60 survive
			telescope: -15° to +45°C oper; -30° to 40°C survive
			elec: -29 to +55 oper, -34 to +60 survive
	Mounting I/F temp stability	(°C/min)	2°C/min; (profiler)
			TBD (tele)
			No req't (electronics)
	Mounting I/F thermal gradients	(°C)	15°, X axis; 15°C, Y axis; (profiler)
			TBD (tele)
			No req't (electronics)
	#, range of S/C monitored temp sensors		5; -70 to +100°C
	S/C provided radiators		None
	Instrument provided radiator CFOV:		
	CCD radiator:	(deg)	180° x 360°, +Y axis
	Profiler housing radiator	(deg)	180° x 360°, +Y axis
Attitude and Navigation Requirements:			
	Attitude control error	(deg)	1.0, each axis, 3σ
	Attitude determination knowledge error (defined at optical bench optical cube)	(deg)	0.03°, each axis, 3 σ
	Stability		None
	Pointing knowledge error (star camera boresight to telescope base optical cube; includes attitude, thermal and mechanical sources)	(arcsec)	80, 1σ, azimuth; 100, 1σ, elevation
	Position Knowledge	(km)	1.0, each direction, 3 σ
	Velocity Knowledge	(m/s)	0.25, each axis, 3 σ
	Keep out zones (such as sun, moon, earth)		sun (few sec OK)
	Perturbing Mechanisms		telescope covers (4), telescope gimbals (4),
			telescope shutters (4), filter wheels (2)

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	TIDI S/C RESOURCE REQUIREMENTS		
	SCREQ117.XLS 11/97		**TIDI**
			TIMED Doppler Interferometer
			(Profiler, Star Camera, and 4 telescopes)
Command and Data Handling Requirements			
	Number and type of commands		2Kbytes/day CMD upload, 64K bytes for S/W upload; 1 relay CMD
	Instrument modes		4 - off, stnby, data collection, direct control
	Orbit modes		1 - Data Collection
	Daily avg data rate	(kbps)	2.494
	Peak record data rate	(kbps)	2.494
	Peak real time downlink data rate	(kbps)	2.494
	Duty cycle		100%
	Time knowledge	(ms)	1000
	Special data needs (terminator crossings, etc.)		terminator xings, sun vector, yaw maneuver, solar panel maneuver, pwr down warning, SAA?
	Preferred S/C data interface concept		MIL-STD-1553
Power Requirements:			
	Avg pwr / instrument mode (does not include htr pwr)	(watt)	0, 6.63, 9.49, 6.63
	Peak power / instrument mode (does not include htr pwr)	(watt)	0, 6.65, 70.94, 6.65
	Peak Power duration (does not include htr pwr)	(msec)	< 100
	Orbit avg power / orbit mode (does not include htr pwr)	(watt)	19.32
	Operational heater power [OAP (cold case); peak (35v)]	(watt)	0, 10.4, 9.83, 10.4; 0, 25.2, 25.2, 25.2
	Survive heater power[OAP (cold case); peak (35v)]	(watt)	6.2; 14.98
	Voltage Range	(volts)	22 to 35
	# of relays		2 (power); 8 (pyro)
Cleanliness Requirements:			
	Acceptable Cleanliness Levels for S/C Intgr		class 100,000
	S/C Surface Cleanliness (@ launch)		1,000
	Hydrocarbon levels		15 ppm
	Purge Requirements (type, purity, flow rate, max time w/o, pad req't)		N2; 99.9995%, < 2 ppm H_2O; 0.1 to 0.2 CFM; 2 Hrs (Profiler), TBD hrs (telescopes); Profiler (yes), telescopes (TBD)
	Bakeout requirements on S/C		All mech anical hdwr, harnesses, thermal blankets, and electronics boxes
Special Requirements For:			
	Integration and Test		radiator cold plates; bench cooler; possible removal of telescope purge lines for TV / launch
	A#s		A300 -> A303 (Tele #1 -> 4); A320 (elec); A325 (Profiler)
	Arming plug on S/C side		Yes
	Mission Operations (such as deployments)		one-time cover release, yaw maneuver, alignment (star) maneuver?, move telescopes to max depression angle during low voltage situation
	Safety (such as a radiation source)		1 uC starter for Calibration Lamps; pyros (4); purge; high voltage (HAK and Neon lamps)
	EMC		Cal lamp supplies (1KV, 5MHz)
	Calibration		none

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ICD Status

- **Component Environmental Specification (CES) is signed off**
- **EMC Specification is in final stages of sign-off**
- **General Instrument Interface Specification (GIIS)**
  - **sections 1 and 8 in signature loop**
  - **sections 2 through 7 are signed off**
- **All four SIISs are currently in the signature loop**

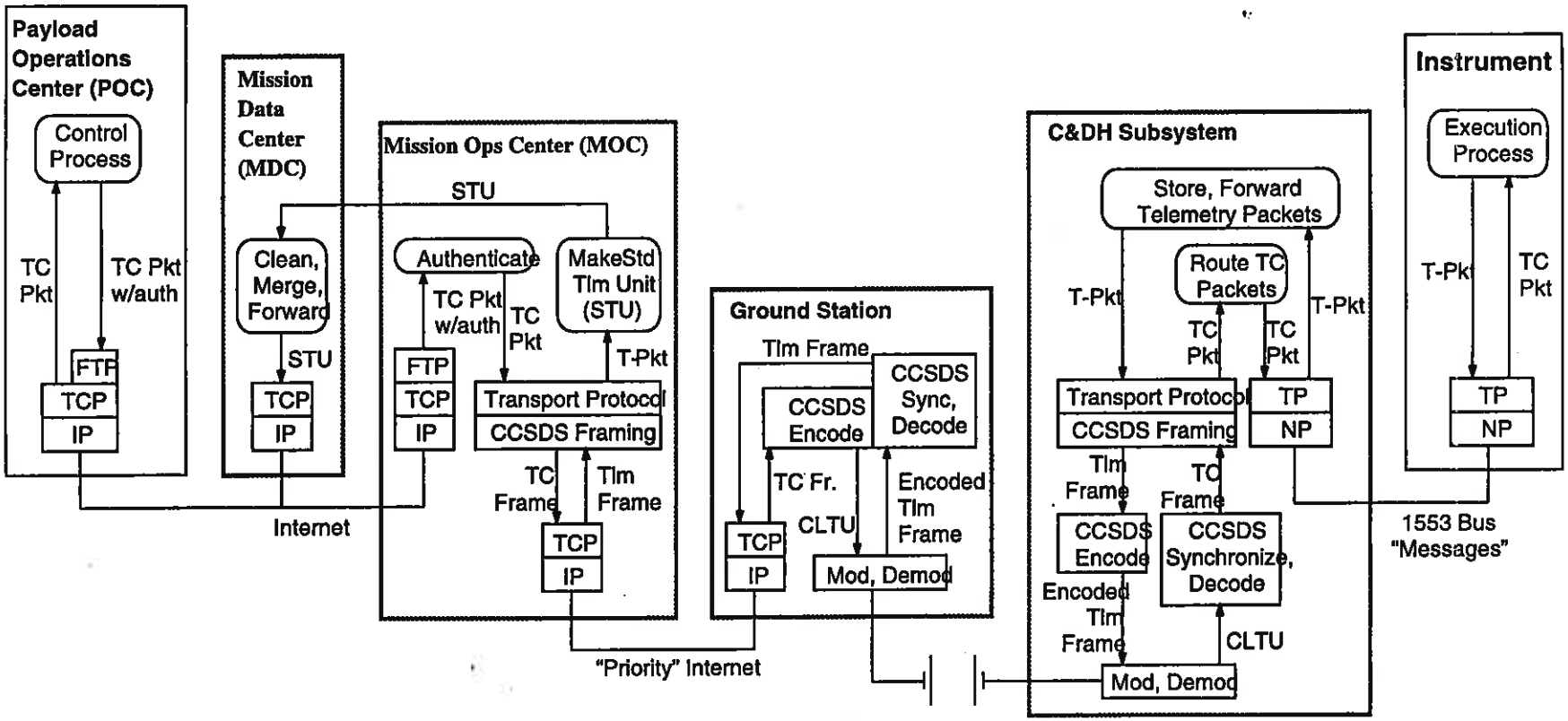
Background Information:

- Simple electrical I/Fs:
  - redundant 1553 I/F, power, survive temp sensors
- Instrument status words:
  - each instrument has a 64 bit status word xmitted separately from the science / engineering packets at 1 Hz rate
  - info primarily current instrument status, errors, operating modes, etc.
  - only instrument info seen by S/C during I&T
- Instrument Autonomy:
  - heartbeat monitor, 1 bit in instrument status word,instrument current and survive temps can all be used to trigger autonomy rules

TIMED

Thermosphere • Ionosphere • Mesosphere • Energetics and Dynamics

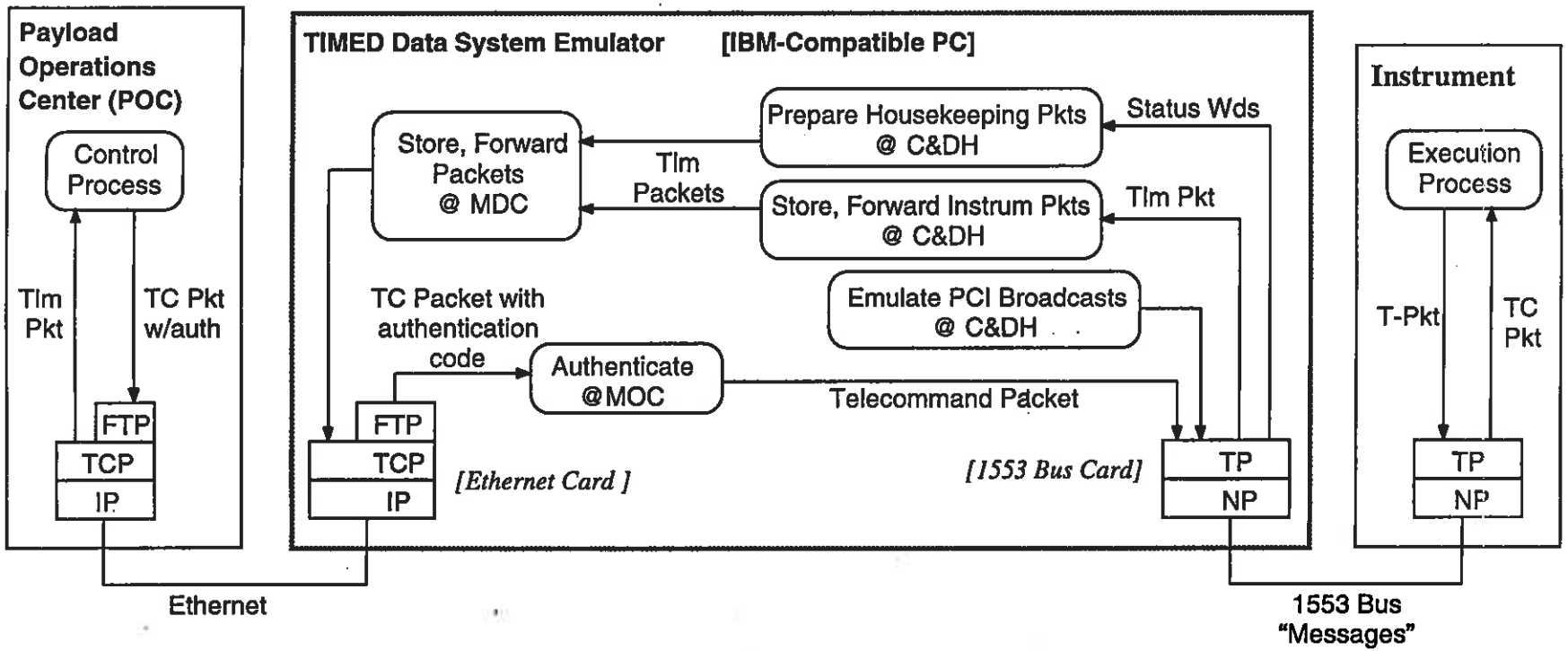
S/C Emulator



TIMED

Thermosphere • Ionosphere • Mesosphere • Energetics and Dynamics

Spacecraft Emulator (con'd)



TIMED Instrument Summary

- **SABER CDR complete; GUVI SEE and TIDI CDRs are in Jan, Feb, and March respectively.**
- **All S/C resource requirements and interfaces are well understood and documented.**
- **All ground system interfaces are well understood and documented.**