TIMED

Thermosphere • Ionosphere • Mesosphere • Energetics and Dynamics

Early Operations

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The Early Operations timeline represents a preliminary definition of the sequence of events from launch through the first thirty days on orbit. This briefing highlights the first four contacts for the TIMED spacecraft, presumably enough to get to nadir pointing and begin system checkout. Events are shown (rather than individual actions or commands) to establish a basic sequence and determine if there are any dependencies. Events are not mapped into an exact contact schedule, but are grouped into logical sets that would occur during an early ops contact. Further definition of exact times will depend on the identification of available contact times supported by ground assets available to the TIMED program. This timeline is success oriented - assuming that each previous action has been carried out successfully. Contingency plans will be addressed in the future.

Timeline Construct/Assumptions - 1

- Sequence and dependencies are established but not tied to specific times.
- Events are not mapped to contact schedule, but grouped into approximated contact activities.
- Timeline is success oriented - Contingencies not addressed at this time.
- Focuses on Launch through first four contacts, enough to establish nadir pointing and be ready for subsystem checkout.

Though this briefing focuses on the first four contacts for the spacecraft, instrument operations are shown for the first thirty days, and events which are planned to depend on real-time commanding are labeled as such. The timeline is available in Excel spreadsheet form as a draft, as well as a pre-launch sequence which shows the last twelve hours of countdown prior to launch.

Timeline Construct/Assumptions - 2

- Instrument check out operations are shown.
- Pre-Launch Ops (Countdown) preliminary info available, based on experience with Delta launch vehicle (MSX, ACE)
- Timeline is in Excel matrix form, overview presented here

For launch, both AIUs are on for redundancy - the AIU is the minimal amount of processing the spacecraft needs to stabilize. Antennas for both IEMs are set to "omni" mode to allow commanding at any flight attitude. Both IEMs are on, with some systems in IEM 2 on low power. Both C&DH processors are on and will execute the separation sequence. SSR 1 is on and recording for data during vehicle ascent, spacecraft separation, and the separation sequence. The Low Voltage Sensor Switch (LVSS) in both hardware and software is disabled, since the C&DH processors must remain powered in order to execute the separation sequence via an autonomy rule. The LVSS will be enabled as soon as possible on-orbit after the solar array pyro release command has been issued. Spacecraft survival heaters are enabled and switched via thermostats. The torque rods are enabled which will allow the AIU to begin to stabilize the spacecraft once it begins receiving data from the magnetometers (the magnetometers are turned on in the separation sequence).

Launch Configuration

AIUs 1&2 on	Necessary to stabilize S/C
Antennas to "Omni" configuration	Both IEMs full coverage
Transmitters off, Receivers on	Command access
C&DH in IEM1 on	BC, separation sequence
C&DH in IEM2 low	RT, separation sequence
GNS on in IEM1 and IEM2	Quick availability on-orbit
RIUs in both IEMs on	Temperature data
SSR in IEM1 on-recording	Record data during ascent, sep.
SSR in IEM2 on	Not needed a this point
LVSSs disabled	Keep IEMs on for Autonomy
Survival heaters enabled	On when needed
Torque Rods enabled	Used as soon as magnetometer data available

Separation from the launch vehicle occurs 7500 seconds (2 hours, five minutes) after launch due to first release of the Jason spacecraft. At this time, the spacecraft battery is at approximately 25% depth of discharge. The separation switch discrete signal to the C&DH fires an autonomy rule (top priority of execution) which will issue commands for the separation sequence. Each C&DH will execute the separation autonomy rule with a slight delay between C&DH 1 and C&DH 2. The first command is to fire the pyrotechniques to release the solar arrays, and the arrays will take 30-40 seconds to fully deploy. They will deploy to the zero beta angle position and remain fixed there until it is safe to rotate them. Until then, the AIU will seek a safe mode attitude that points the -Z axis to the sun (full sun without articulating arrays). To keep the star cameras cool enough and to not blind them, the spacecraft will "off point" the -Z axis up to thirty degrees away from the sun. The magnetometers are turned on to provide data to allow the AIU to begin "de-tumbling" the spacecraft. This is also the earliest point at which the LVSS can be enabled. Instrument survival heaters are enabled. A delayed command will be stored which assumes the proper time to turn on the receivers at the first expected contact.

The first contact will verify proper deployment of the solar panels and charging of the battery. The flight mode the spacecraft is in will be checked and the gyro and reaction wheels will be turned on since the spacecraft should be stable enough to not saturate the wheels. The spacecraft on-board time will be verified and Attitude Flight Computer 1 will be turned on.

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Early Operations -1

Separation and Contacts

Separation

Sequence stored in autonomy rule which fires in both C&DHs based on separation switch. There is a slight delay between the BC C&DH and the RT C&DH. Separation occurs 7500 seconds after launch. DOD 25%

Release solar panels (30-40 seconds to unfold)
Turn Magnetometers on (once data begins to flow, AIU begins to "de-tumble" S/C)
Enable LVSS
AIU commands S/C to "-Z to sun" safe mode (off pointed 30 degrees)
Delayed command turns on transmitters near first expected contact
Enable instrument survival heaters

First Contact

Downlink at low rate, 9 Kbps
Check for solar array deployment (DOD after one orbit without power would be 43%)
Check flight mode
Turn gyro on
Turn Reaction Wheels on (approximately 3 minutes to spin up to 100 rpm)
Turn Attitude Flight Computer 1 on (necessary for nadir[1] flight mode)
Verify S/C Time

[1] Early ops nadir is not nominal instrument operations nadir - AFCs required for both

The second contact will provide real time data to check out the AFC performance. Since proper array deployment has been verified in the first contact, the solar array drive electronics will be turned on to allow the arrays to be rotated. The solar array damper heaters can be turned off. A new safe attitude will be uploaded to the AIUs so that the spacecraft will transition to a "-Y to sun" mode which will be the safe attitude for the remainder of the mission. Both star cameras will be turned on for later use.

The third contact will allow mission ops to command the spacecraft to nadir pointing. This will be a delayed command which will execute in time so that the spacecraft will be nadir pointing by the fourth contact. SSR 2 recording will be started, since the next pass may include dumping of both recorders.

This is the first contact which may be at the high data rate downlink (4 Mbps) to allow both real-time and recorder dump data to be received. At this time, subsystem checkout can begin. Also, once nadir pointing, GNS can acquire signals to have more precise navigation data.

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Early Operations -2

Contacts	
Second contact	**Check out Flight Computer** **Turn on solar array drive electronics** **Turn solar array damper heaters off** **Upload new safe attitude to AIUs (-Y to sun) (can occur while AIUs are commanding)** **Arrays are turned to 90° beta angle** **Turn Star Cameras 1 & 2 on**
Third	**Command to nadir pointing (could command to nadir pointing at end of last contact and verify nadir pointing now)** **Start SSR2 recording**
Fourth	***First contact to have high data rate downlink (4 Mbps)*** **Dump recorders** **Begin subsystem Checkout** **GNS can acquire signals**

Instrument operations are shown here as a table for two reasons. First, they are decoupled from spacecraft commanding, and therefore can happen independently of spacecraft commanding once the spacecraft is nadir pointing and has high data rate downlink. Second, the table implies the true nature of instrument operations in that they can occur in parallel, possibly allowing a much faster checkout time.

For the most part, instruments will do very little other than a basic aliveness test in the first few available contacts. Beyond that, some are waiting for outgassing to be complete and the 14 day window for GNS to exercise its system capabilities.

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Instrument Early Operations - 1

	SEE	GUVI	TIDI	SABER
First Available Contact	Activate Limited Functional Test Release Launch Caging Mechanism Point to Zenith (for venting) Off	Enable survival heater if not already enabled	Enable survival heater if not already enabled	Activate Aliveness test Off
First Few Days	N/A	Activate Test (4 passes) - RT - Processor communications - SIS Mechanism - Detector Dark Count Off	Allow first 14 days for instrument to outgas	N/A

The bulk of the planned checkout occurs at launch plus fourteen days. This assures all instrument outgassing is complete and the spacecraft system checkout has provided a stable platform.

Multiple real-time passes will be required to support monitoring of initial instrument tests.

Nominal ops is assumed to occur within thirty days at the latest.

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Instrument Early Operations - 2

	SEE	GUVI	TIDI	SABER
14 DAYS	Activate Open EGS Door Vent Argon First Solar Spectrum Functional Test Performance test	Activate (latest is L+14) Command scan mirror hold Open SIS Cover (pyro) -RT Test, not required real-time - Test Scan Motor - Test Detector Response - Test Imaging Mode - Test Star Calibration	Aliveness test- RT Computer self test- RT Detector Map - initiate RT Mechanism Functional Test Optical Calibration Release Covers - RT Optical Continuity Test	Cover Release Maneuver- RT Return to Flight Orientation Evaluation Phase Calibrate
30 DAYS	Nominal Ops	Nominal Ops	Nominal Ops	Nominal Ops

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Summary

- **Basic order defined**
- **More detail will be added, as well as subsystem checkout operations (eventually down to command level)**
- **Contingency plans will be addressed post CDR**
- **Exact contacts and durations TBD, assets to support being addressed**