United Launch Alliance

GLAST

Mission Overview

Delta II 7920H-10

Cape Canaveral Air Force Station, FL

Space Launch Complex-17B

DELTA

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United Launch Alliance is proud to launch the Gamma-ray Large Area Space Telescope (GLAST) mission. GLAST will be launched aboard a Delta II 7920H-10 launch vehicle from Cape Canaveral Air Force Station (CCAFS), Florida. The launch will deliver the GLAST observatory into a circular orbit around the Earth where it will look into the galaxy to study powerful gamma-ray phenomena such as neutron stars and black holes; cosmic rays that interact with interstellar gas and dust in the galaxy; the diffuse extragalactic background, supernovae; and mysterious gamma-ray bursts.

United Launch Alliance provides the Delta II launch service under the NASA Launch Services (NLS) contract with the NASA Kennedy Space Center Launch Services Program (LSP). We are delighted that NASA has chosen the Delta II for this mission. I congratulate the entire Delta team for their significant efforts that resulted in achieving this milestone and look forward to continued launches of scientific space missions aboard the Delta launch vehicle.

Kristen T. Walsh
Director, NASA Programs
Delta Launch Vehicles

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GLAST Mission Overview

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The Universe is home to numerous exotic and beautiful phenomena, some of which can generate almost inconceivable amounts of energy. Supermassive black holes, merging neutron stars, streams of hot gas moving close to the speed of light…these are but a few of the marvels that generate gamma-ray radiation, the most energetic form of radiation, billions of times more energetic than the type of light visible to our eyes.

The Gamma-ray Large Area Space Telescope (GLAST) will open this high-energy world to exploration. With GLAST, astromoners will have a superior tool to study how black holes, notorious for pulling matter in, can accelerate jets of gas outward at fantastic speeds. Physicists will be able to study subatomic particles at energies far greater than those seen in ground-based particle accelerators. Cosmologists will also gain valuable information about the birth and early evolution of the Universe.

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GLAST Science Objectives

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- Explore the most extreme environments in the Universe where nature harnesses energies far beyond anything possible on Earth.
- Search for signs of new laws of physics and what composes the mysterious dark matter.
- Explain how black holes accelerate immense jets of material to nearly light speed.
- Help crack the mysteries of the stupendously powerful explosions known as gamma-ray bursts.
- Answer long-standing questions across a broad range of topics, including solar-flares, pulsars and the origin of cosmic rays.

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GLAST Science Instruments

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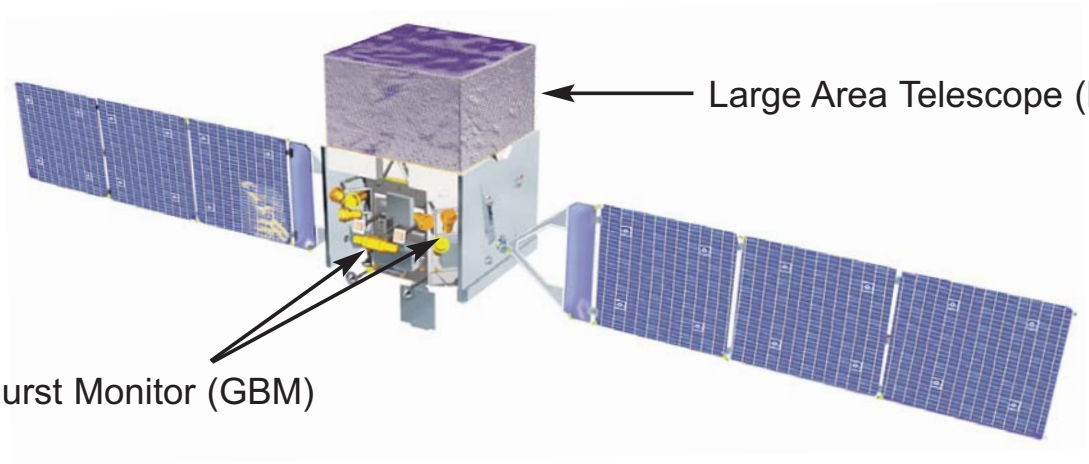


The GLAST observatory utilizes two main instruments, the large area telescope (LAT) and a GLAST burst monitor (GBM).

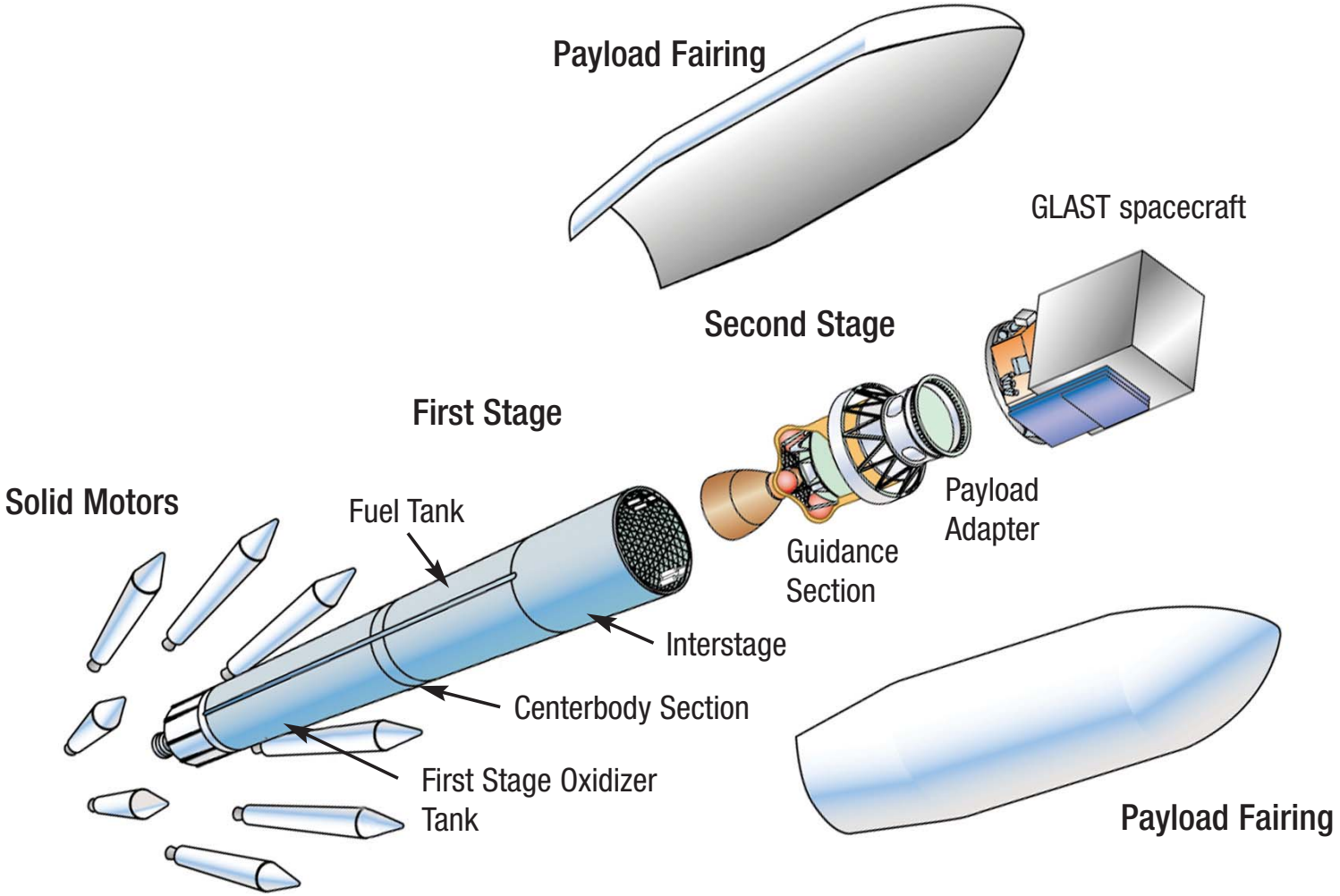
The GLAST LAT will provide unprecedented sensitivity to gamma rays in the energy range of approximately 20 MeV to 300 GeV.

The GLAST burst monitor was selected as a complimentary instrument for the GLAST mission and will be sensitive to X-rays and gamma rays with energies between 8 KeV and 25 MeV.

The combination of the GBM and the LAT provides a powerful tool for studying gamma-ray bursts, particularly for time-resolved spectral studies over a very large energy band.

GLAST Observatory

Delta II 7920H-10



GLAST Mission Description

• Launch Site	CCAFS SLC-17B
• Launch Period	May 16-Dec 31, 2008
• Spacecraft Mass	< 4627 kg (10,201 lbs)
• Launch Time (NET June 3, 2008)	11:45 am EDT
• Launch Window (NET June 3, 2008)	115 min
• Launch Azimuth	< 28.5 deg
• Target Orbit (NET June 3, 2008)	565 km circular

GLAST Flight Mode Description

- Delta 7920H-10 launch vehicle with 6915 payload attach fitting and secondary latch mechanism
- Launch from Cape Canaveral Air Force Station (CCAFS) SLC-17B
- 94-degree flight azimuth
- 6/3 solid motor firing sequence
- Direct flight azimuth mode employed for initial boost phase (combined pitch/yaw)
  - Quad II-oriented downrange after final solid motor jettison
- Boost trajectory designed to meet controllability, structural, and environmental constraints while maximizing vehicle performance
- Main engine cutoff (MECO) occurs at Stage I propellant depletion
- Stage I-II separation occurs approximately 8 sec after MECO; Stage II ignited 5.5 sec later
- Payload fairing jettisoned when free molecular heating rate $\leq 1135\ W/m^2$ (0.1 BTU/ft ^{2}-sec)
- Stage II first burn places vehicle into 100 X 324-nmi transfer orbit with an inclination of 28.51 degrees

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GLAST DTO Trajectory Sequence of Events

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Event	Time (SEC)
Liftoff	0.0
Mach 1	30.5
Maximum dynamic pressure	39.1
3 Solid motors burnout	77.2
3 Solid motors burnout	77.7
3 Solid motors ignition	79.0
Jettison 3 solid motors	80.5
Jettison 3 solid motors	81.5
Maximum miniskirt temperature	118.4
3 Solid motors burnout	155.5
Jettison 3 solid motors	159.5
Begin Quad II down maneuver	161.0
End Quad II down maneuver	177.5
MECO	264.6
Stage I/II separation	273.0
Stage II ignition	278.5
Jettison fairing	283.0

GLAST Flight Mode Description (cont)

- Following the first cutoff of the second stage (SECO 1), the vehicle is reoriented so that centerline is sun-normal
  - 1 deg/sec roll performed for 48 minutes during coast
- Reorientation to restart attitude begins at 3642 seconds
  - Total coast time, from SECO 1 until restart, is ~ 58 minutes
- 65.1 second restart burn places spacecraft in proper orbit at SECO 2
- Vehicle is reoriented for spacecraft separation
- Spacecraft separation is approximately 347 seconds after SECO 2 (4502.5 seconds after liftoff)
  - Telemetry coverage from Kwajalein for restart burn and separation
- Spacecraft separates into a nominal 56-km circular orbit with an inclination of 25.60 degrees
  - GVPAT perigee/apogee altitudes based on 3443.92-nmi earth radius

GLAST DTO Trajectory
Sequence of Events (cont)

Event	Time (SEC)
First Cutoff - Second Stage (SECO 1)	613.8
Begin Reorientation maneuver	663.0
End Reorientation maneuver	752.0
Begin BBQ roll maneuver	752.0
End BBQ roll maneuver	3632.0
Begin Reorientation maneuver	3642.0
Begin Reorientation maneuver	3902.0
Restart 1	4090.5
Second Cutoff - Second Stage (SECO 2)	4155.6
Spacecraft Separation	4502.5

GLAST DTO Trajectory Flight Profile*

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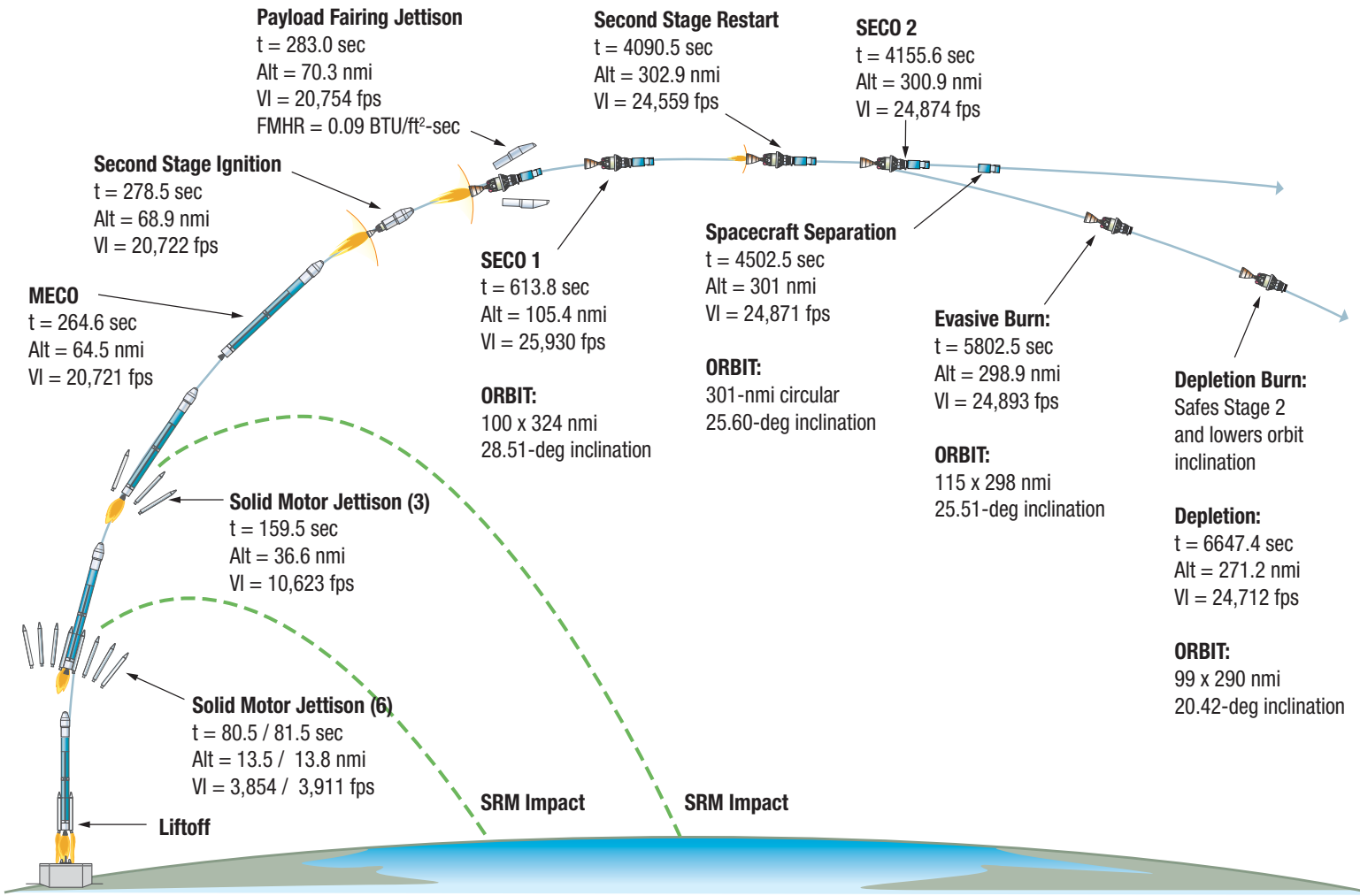

*Apogee & perigee altitudes based on 3443.92-nmi Earth radius

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GLAST DTO Trajectory Orbit Trace

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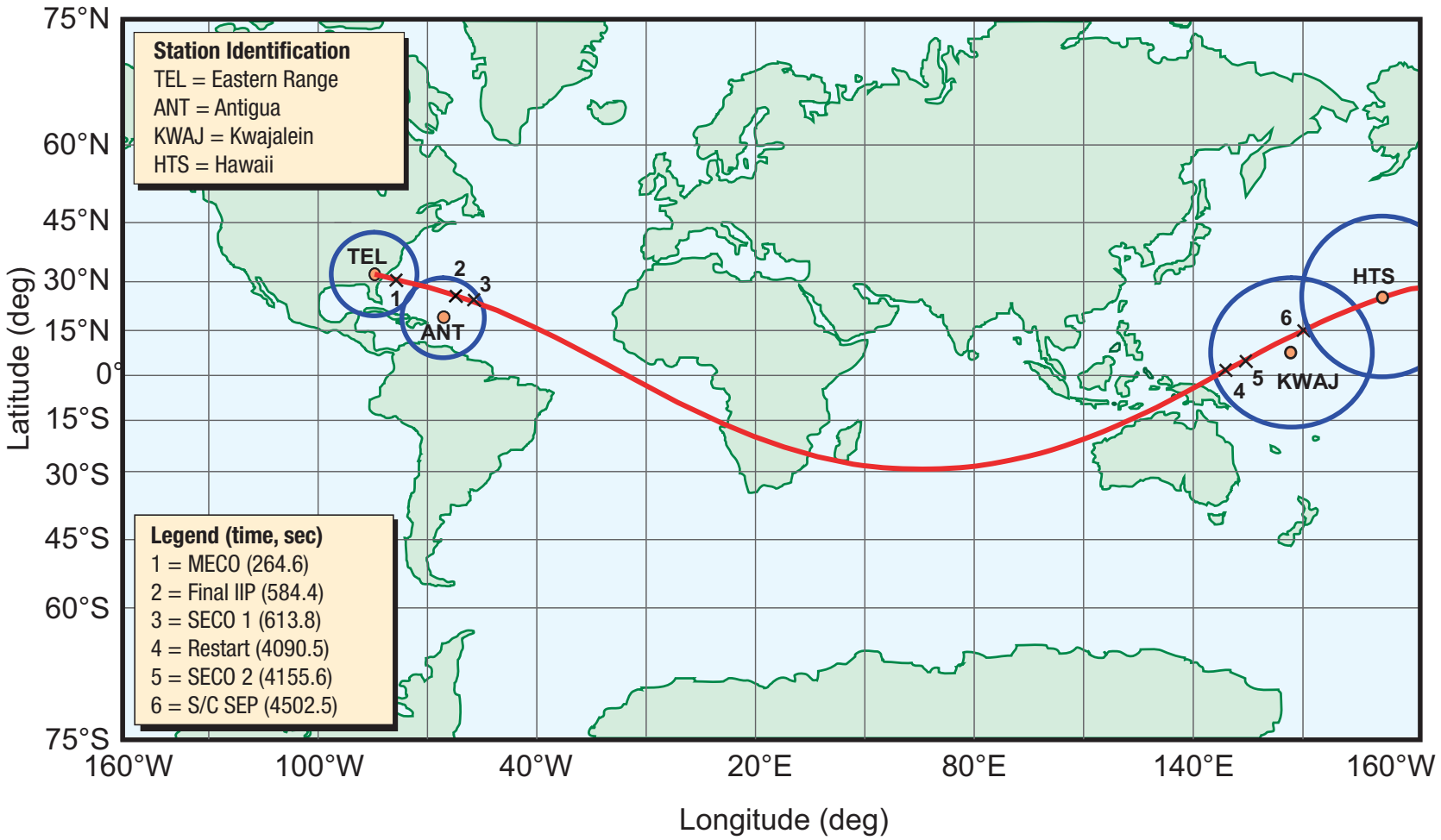

GLAST Flight Mode Description

Stage II Evasive and Depletion Burns

- Following separation, Stage II uses helium retro system to back away from spacecraft
- Vehicle reorients and then performs 25 second cold gas (nitrogen) evasive maneuver
- Vehicle reorients again and performs evasive burn
  - Approximately 6 seconds in duration
  - Telemetry coverage to be provided from Vandenberg Air Force Base, CA
  - Perigee lowered to 115 nmi
- Depletion burn ignition occurs at 6603.5 sec
  - Telemetry coverage from Antigua tracking station
  - Nominal duration of 43.9 sec through mono-propellant blowdown
  - Nominal depletion burn leaves Stage II in a 99 x 290-nmi orbit with an inclination of 20.42 deg
- Depletion burn designed to safe stage and lower inclination to minimize casualty probability
  - Lifetime of Stage II orbit reduced by lowering perigee

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GLAST DTO Trajectory Sequence of Events

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Event	Time (SEC)
Spacecraft separation	4502.5
Begin Stage II retro	4503.0
End Stage II retro	4544.5
Begin reorientation maneuver	4602.5
End reorientation maneuver	4852.5
Begin cold gas evasive maneuver	4902.5
End cold gas evasive maneuver	4927.5
Begin reorientation maneuver	5102.5
End reorientation maneuver	5352.5
Restart 2 (evasive burn)	5802.5
SECO 3	5808.3
Begin reorientation maneuver	6113.5
End reorientation maneuver	6313.5
Restart 3 (depletion burn)	6603.5
Depletion initiation	6631.5
SECO 4	6647.4

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GLAST DTO Trajectory

Stage II Post-separation Orbit Trace

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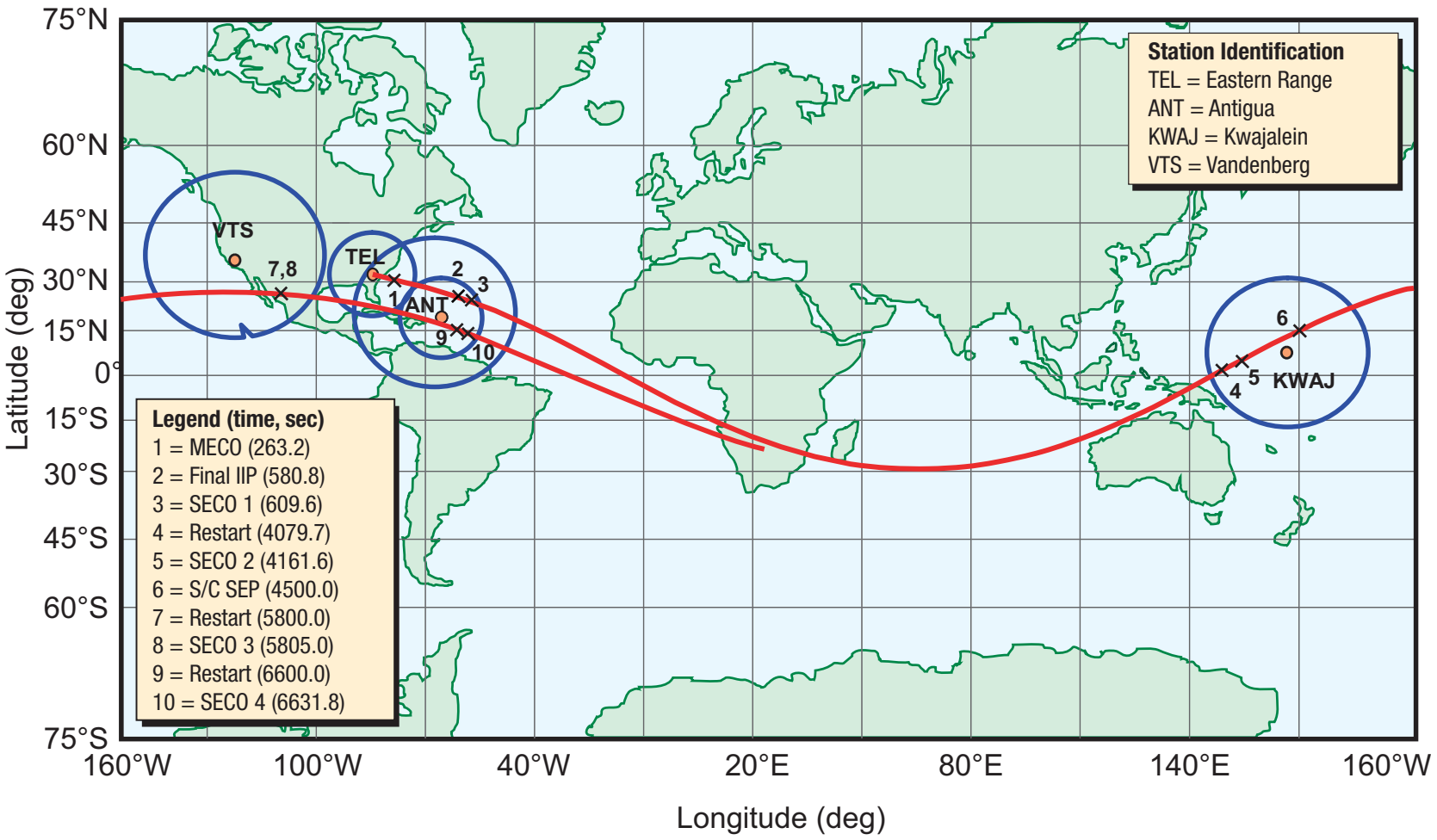
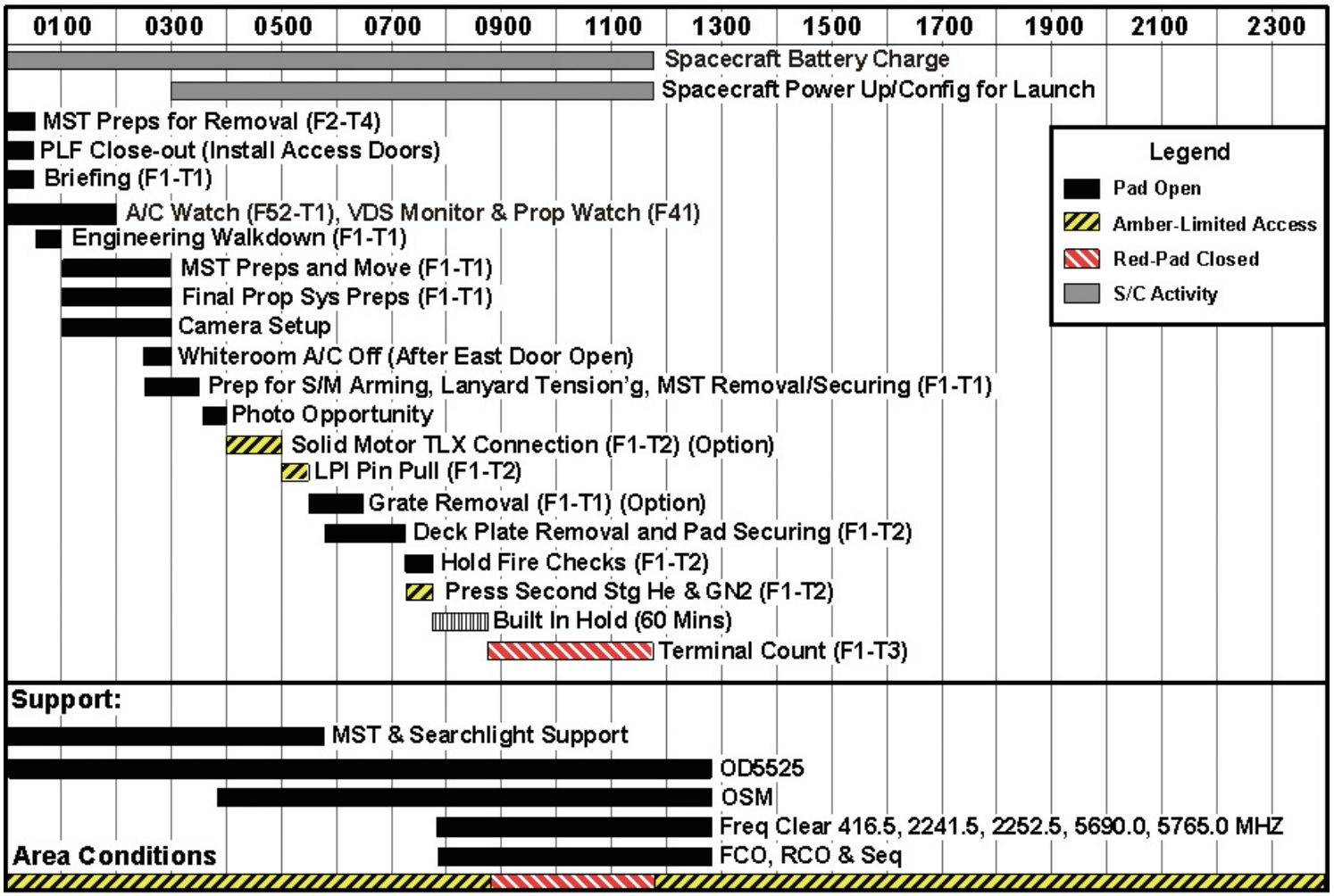
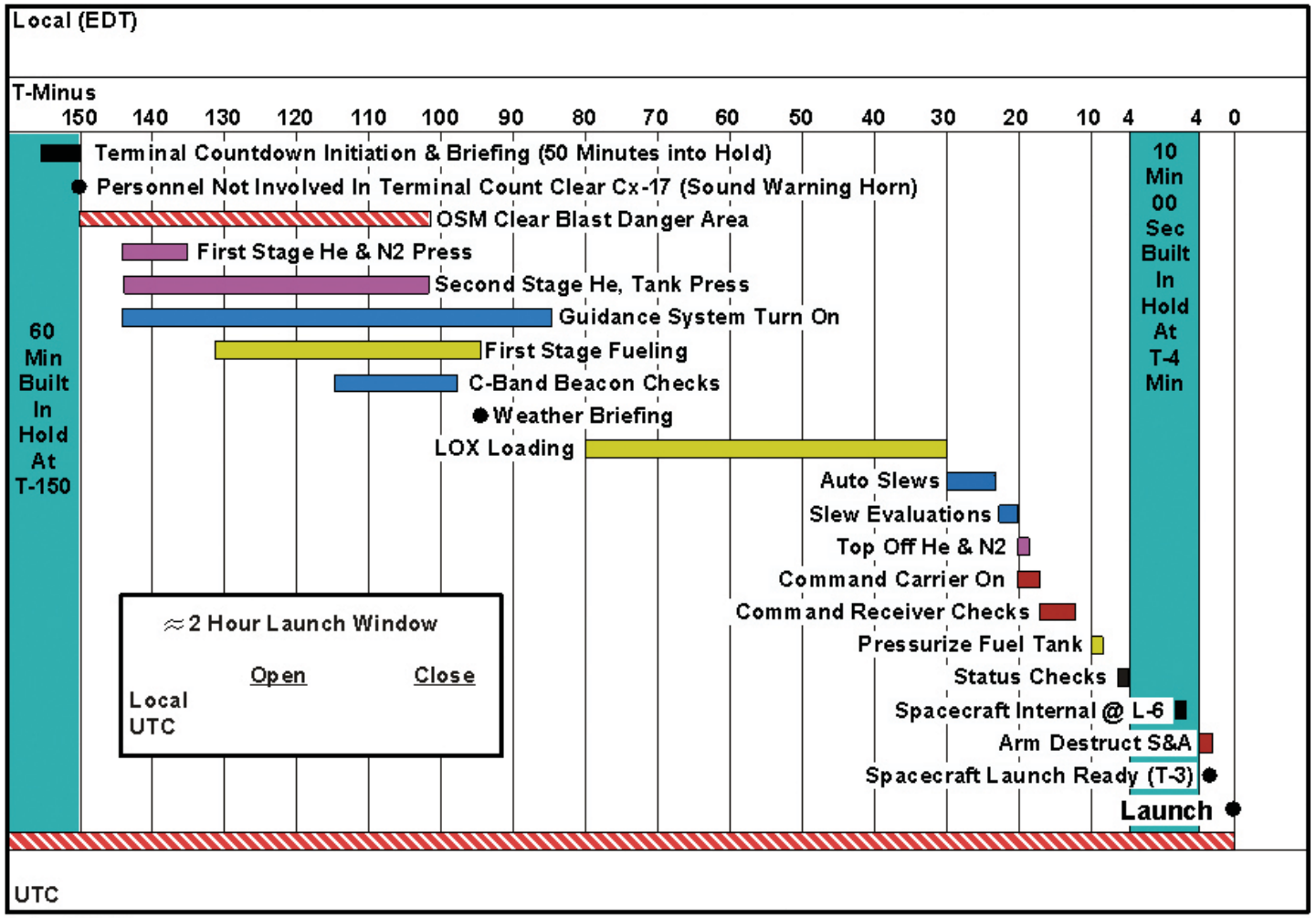


Delta II Countdown (T-0 Day)



Revised 3/11/08

Delta II Terminal Count (T-0 Day)



Delta II Operational Flow at Eastern Range

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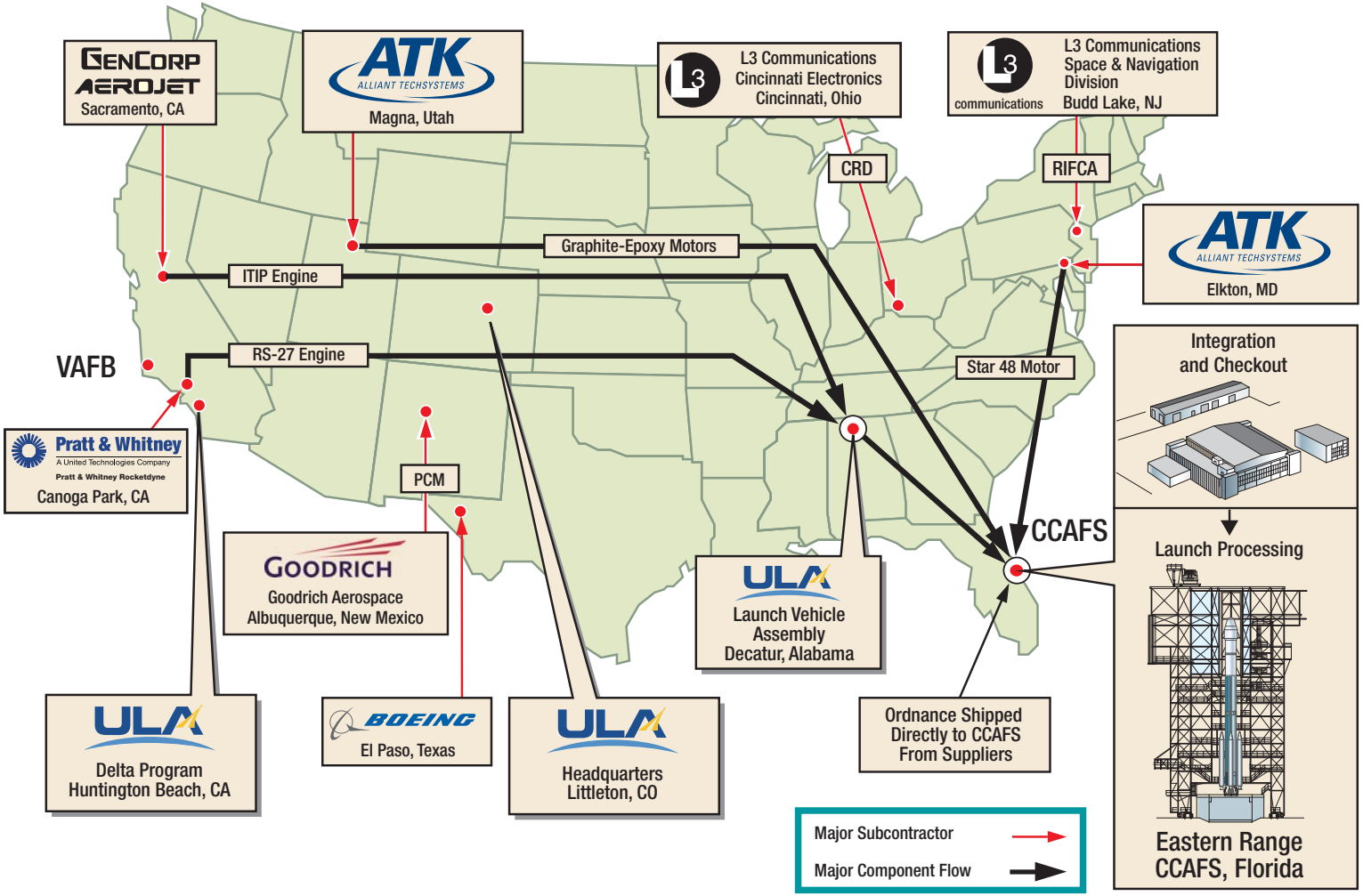

Total Vehicle Integration & Checkout at the Launch Site

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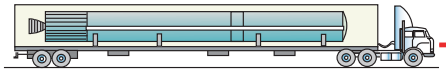


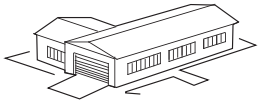
• First stage from assembly plant

• Second-stage, fairing, interstage from assembly plant

Delta Mission Checkout (Hangar AO)

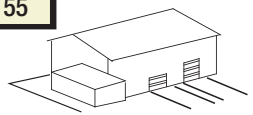
Delta II integration and checkout area
- Receive and inspect
- Mission integration and checkout
- Dual composite tests
- Storage
- Load on pad erection trailers

Horizontal Processing Facility

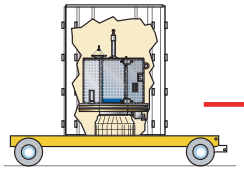


• Destruct installation

Area 55



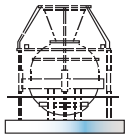
- Destruct installation
- Erection preparation
- Leak checks



• Space vehicle

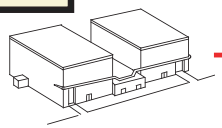
Processing Facility

• Mate to upper stage

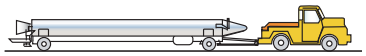


• Upper-stage motor

Area 59

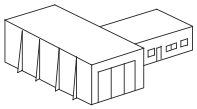


• Balance motor



• Solid motors

Area 57



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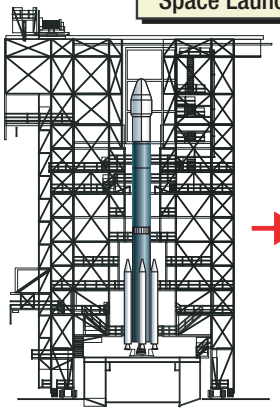

- Erect and mate stages
- Install solid motors
- Check out subsystems
- Simulated flight test
- Preflight finalization


GAMMA-RAY LARGE AREA SPACE TELESCOPE
GLAST
Exploring the Extreme Universe
GLAST