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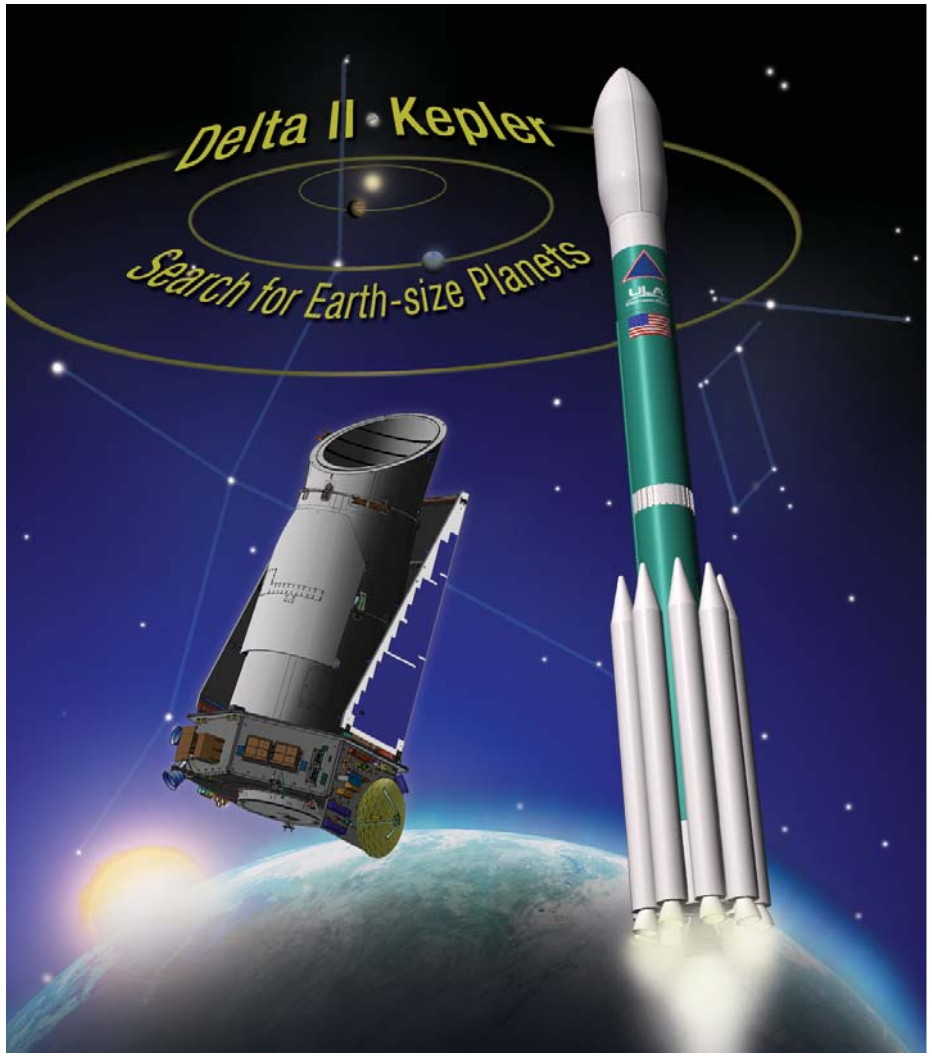

Kepler

Mission Overview

Delta II 7925-10L

Cape Canaveral Air Force Station, FL

Space Launch Complex-17B

II DELTA

Kepler

United Launch Alliance

Kepler

DELTA II

United Launch Alliance (ULA) is proud to launch the Kepler mission. Kepler will be launched aboard a Delta II 7925-10L launch vehicle (LV) from Cape Canaveral Air Force Station (CCAFS), Florida. The LV will deliver the Kepler spacecraft (SC) into a solar orbit, where it will begin its mission to search for Earth-size planets orbiting distant stars.

ULA provides Delta II launch services under the NASA Launch Services contract with the NASA Kennedy Space Center Launch Services Program. We are delighted that NASA has chosen the Delta II for this mission developed by the Jet Propulsion Laboratory (JPL) and built by Ball Aerospace and Technologies Corporation. I congratulate the entire team for their significant efforts. ULA looks forward to continued launches of scientific space missions.

Vernon L. Thorp
NASA Program Manager
United Launch Alliance

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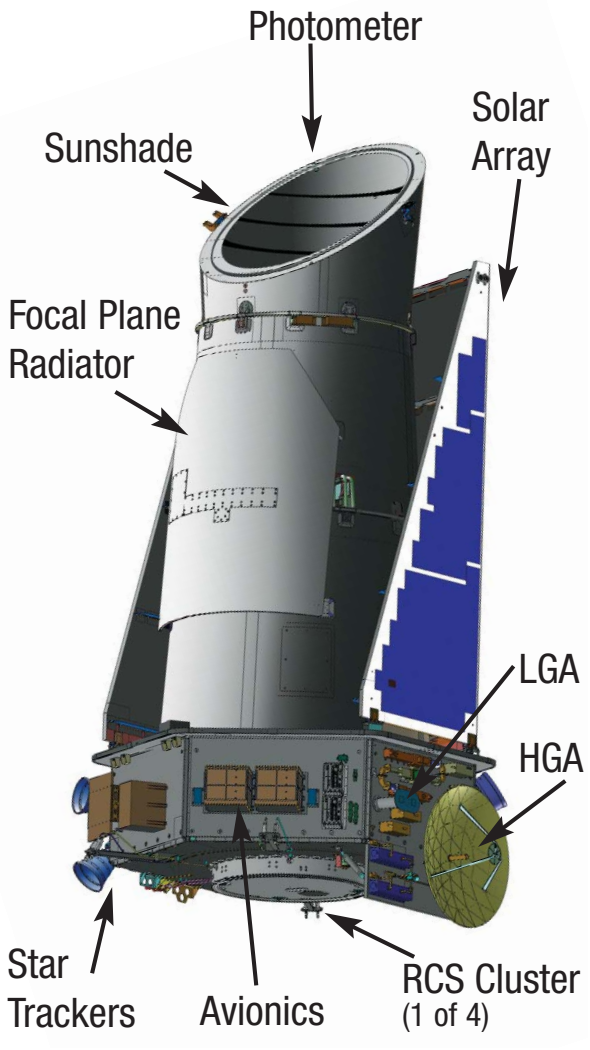
Kepler Spacecraft

DELTA II

- Designed and built by Ball Aerospace and Technologies Corp. in Boulder, CO
- Dimensions: 2.7 meters (9 feet) diameter, and 4.7 meters (15.3 feet) high
- Weight: 1,052.4 kilograms (2,320.1 pounds) at launch, consisting of a 562.7 kilogram (1,240.5 pound) SC Bus, a 478.0 kilogram (1,043.9 pound) photometer, and 11.7 kg (25.8 pounds) of hydrazine propellant
- Power: Four non-coplanar panels with a total area of 10.2 square meters (109.8 square feet) of solar collecting surface area. Combined, the 2,860 individual solar cells can produce over 1,100 watts of electrical current. Power storage is provided by a 20 amp-hour rechargeable lithium-ion battery
- The SC includes a solid state recorder (SSR) with 128 gigabytes of data storage, a Ka-band downlink capability up to 4.33 mbps, and reaction wheels for pointing control



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Kepler Mission Overview

DELTA II

Kepler, a NASA Discovery mission, is a space-borne telescope designed to search a nearby region of our galaxy for Earth-size planets orbiting in the habitable zone of stars like our Sun. The habitable zone is the region around a star where the temperature permits water to be liquid on a planet's surface. Liquid water is considered essential for the existence of life.

Kepler will hunt for planets using a specialized 1-meter diameter telescope called a photometer. The photometer continuously measures the precise brightness of more than 100,000 stars, waiting for stars to "wink" when orbiting planets pass in front of them. These events, called "transits," occur each time a planet crosses the line-of-sight between the planet's parent star and the Kepler telescope. When this happens, the planet blocks some of the light from its star, resulting in a periodic dimming. This periodic signature is used to detect the planet and to determine its size and its orbit.

The vast majority of the approximately 300 planets known to orbit other stars are much larger than Earth, and none are believed to be habitable. The challenge now is to find Earth-size planets in the habitable zone—those which are potential abodes for life. By monitoring a large number of stars, Kepler permits astronomers to estimate the total number of Earth-size planets orbiting in the habitable zone around stars in our galaxy. If Kepler does not discover any such planets, we can conclude that we are likely alone in the galaxy.

Kepler will launch from the Cape Canaveral Air Force Station in Florida on a Delta II 7925-10L launch vehicle. The mission begins with launch of the SC and photometer payload into an Earth-trailing heliocentric orbit. Unlike most deep-space SC, Kepler has no need for trajectory correction maneuver capability as the LV places it directly into its desired orbit.

Following a 60-day commissioning phase, during which the photometer and SC are checked out and readied for the science mission, Kepler will spend 3.5 years conducting its search for planets orbiting other stars.

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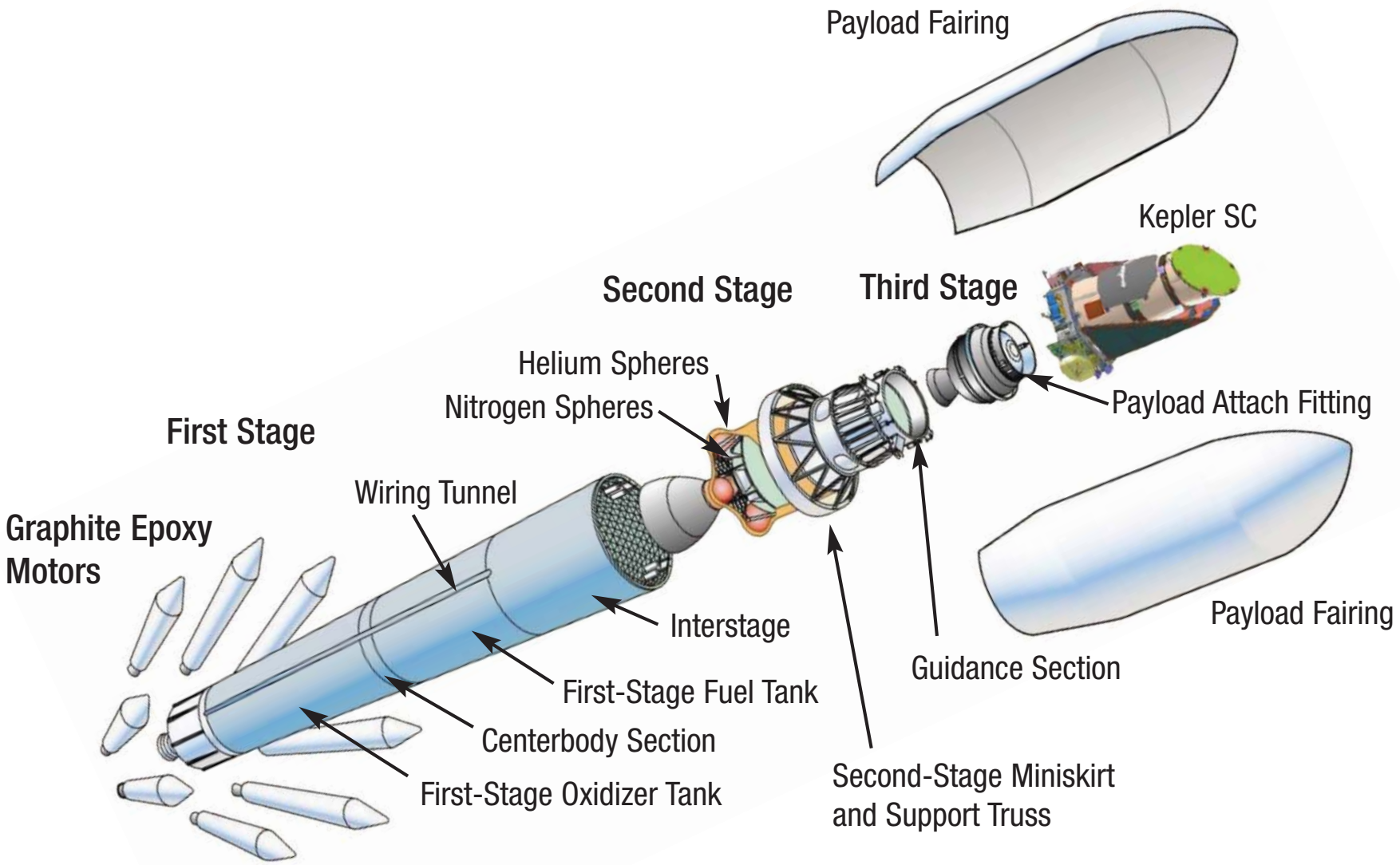
Kepler
Mission Requirements

DELTA II

- Launch Period: 5 March – June 10, 2009*
- Dual Daily Launch Attempts: 93°/99° Azimuths
- Launch Window: 3 minutes each attempt
- Liftoff times (based on 5 March 2009 liftoff):
  - 93° Azimuth - 22:48:43 EST (03:48:43 UTC)
  - 99° Azimuth - 23:16:34 EST (04:16:34 UTC)
- SC Mass: 1,052.4 kg (2,320.1 lb)
- SC will be launched into a heliocentric Earth-trailing orbit around the Sun:
  - Orbital Period 372.5 days
  - Drifts away from Earth at a rate of 0.11 AU per year
  - Similar to orbits of Spitzer and STEREO-B
- Mission Duration: 3.5 years

**All times and dates in this book are based on an initial launch opportunity of March 5, 2009. Dates and times may vary based on the actual launch date.*

Delta II 7925-10L



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Kepler
Flight Mode Description

DELTA II

- Delta II 7925-10L launch from Cape Canaveral Air Force Station SLC-17B
- Flight Azimuth 93° or 99°
- Six solid motors ignited at liftoff and burn for 63 seconds, three solid motors ignited after ground-lit motors burnout
- Main engine cutoff (MECO) occurs at first stage propellant depletion, approximately 263 seconds after liftoff
- Stage II separation occurs 8 seconds after MECO, and the second-stage ignites 5.5 seconds later
- Payload fairing jettisoned 4 seconds after second stage ignition, when free molecular heating rate < 0.1 BTU/ft2-sec
- Second-stage first burn places vehicle in 100-nmi circular parking orbit at 9 minutes 56 seconds after liftoff
    - 28.5° inclination for 93° flight azimuth
    - 29.3° inclination for 99° flight azimuth

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Sequence of Events
Boost to Orbit

DELTA II

Event	Time (HR:MIN:SEC)
Liftoff	0:00:00.0
Mach 1	0:00:32.7
Maximum Dynamic Pressure	0:00:47.6
Six Solid Motors Burnout	0:01:03.1
Three Solid Motors Ignition	0:01:05.5
Jettison Three Solid Motors	0:01:06.0
Jettison Three Solid Motors	0:01:07.0
Three Solid Motors Burnout	0:02:08.8
Jettison Three Solid Motors	0:02:11.5
Main Engine Cutoff (MECO)	0:04:23.3
Vernier Engine Cutoff (VECO)	0:04:29.3
First- and Second-Stage Separation	0:04:31.3
Second-Stage Ignition	0:04:36.8
Jettison Fairing	0:04:41.0
First Cutoff - Second Stage (SECO 1)	0:09:56.0

Kepler
Flight Mode Description (concluded)

- Following SECO 1, vehicle is rolled at 1 degree per second for thermal conditioning (BBQ maneuver)
- Roll maneuver terminates and LV reorients to the restart burn attitude ~188 seconds prior to second-stage restart ignition
  - Total coast time from SECO 1 until restart ignition
    - 43.2 minutes for 93° azimuth
    - 41.7 minutes for 99° azimuth
- Second-stage restart burn duration is 64 seconds
- Third-stage spinup and separation starts 40 seconds after SECO 2
- Third-stage ignition occurs 37 seconds after separation, and the 86.3 second burn places the SC into the desired orbit
- De-spin initiation occurs 370 seconds after third-stage ignition, with SC separation 5 seconds later
- Total mission duration (liftoff to SC separation)
  - 61.8 minutes for 93° flight azimuth
  - 60.3 minutes for 99° flight azimuth

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Sequence of Events
First Cutoff to Targeting Interface Point

DELTA II

Event	Time (HR:MIN:SEC)
First Cutoff - Second Stage (SECO 1)	0:09:56.0
Begin Reorientation Maneuver	0:12:30.0
End Reorientation Maneuver	0:17:30.0
Begin BBQ Maneuver	0:17:50.0
End BBQ Maneuver*	0:44:57.0
Begin Reorientation Maneuver	0:50:02.0
End Reorientation Maneuver	0:50:20.0
Second-Stage Restart Ignition	0:53:10.0
Second Cutoff - Second Stage (SECO 2)	0:54:13.8
Begin Reorientation Maneuver	0:54:19.8
End Reorientation Maneuver	0:54:52.8
Third-Stage Spin-up	0:54:53.8
Second- and Third-Stage Separation	0:54:56.8
Third-Stage Ignition - NCS Enable	0:55:33.8
Third-Stage Burnout (TECO)	0:57:00.1
Disable NCS – Initiate Yo-Yo Despin	1:01:43.8
SC Separation	1:01:48.8
Targeting Interface Point	1:05:33.8

**Spacecraft +Y axis pointed toward sun*

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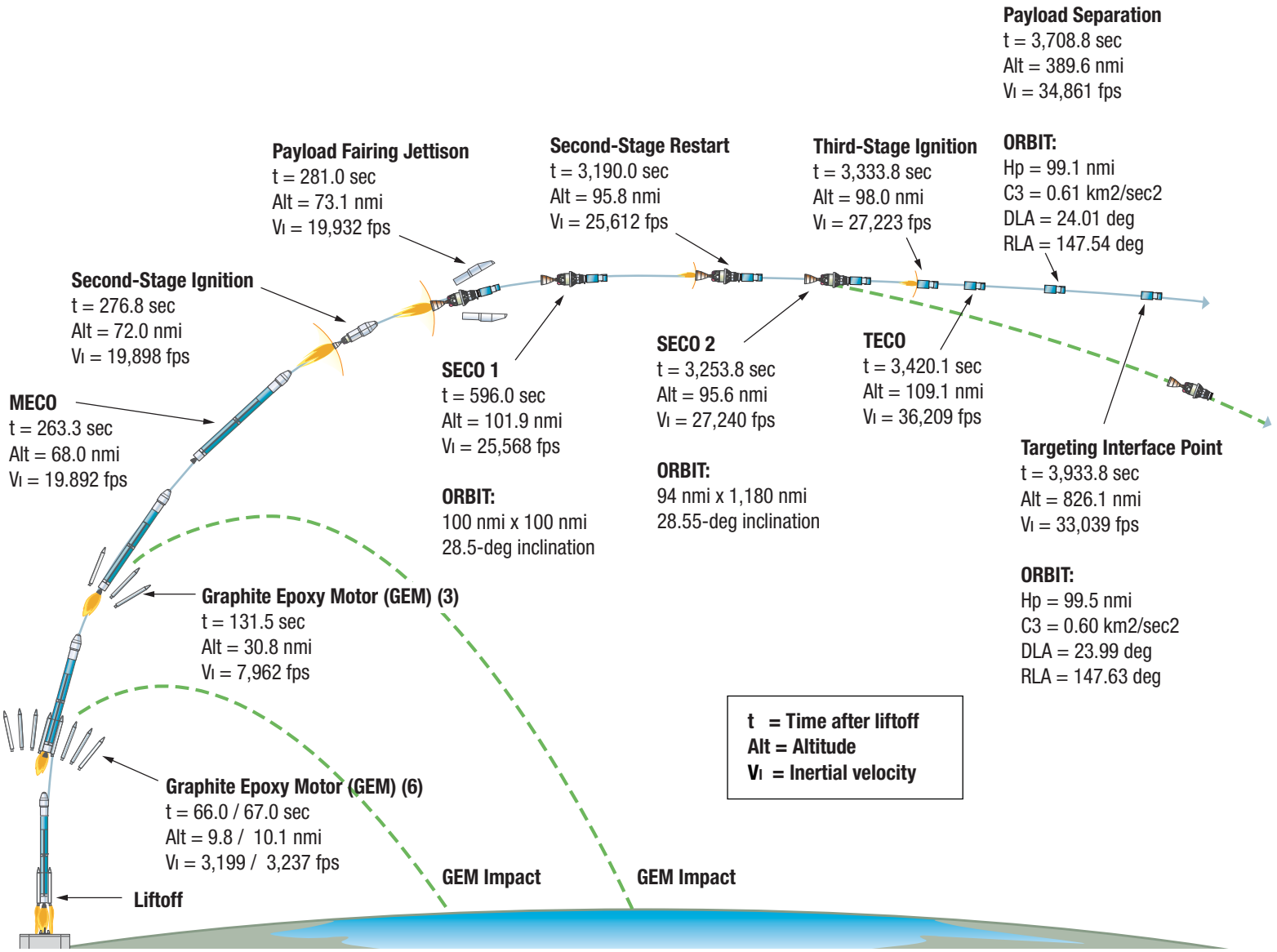
Flight Profile

DELTA II



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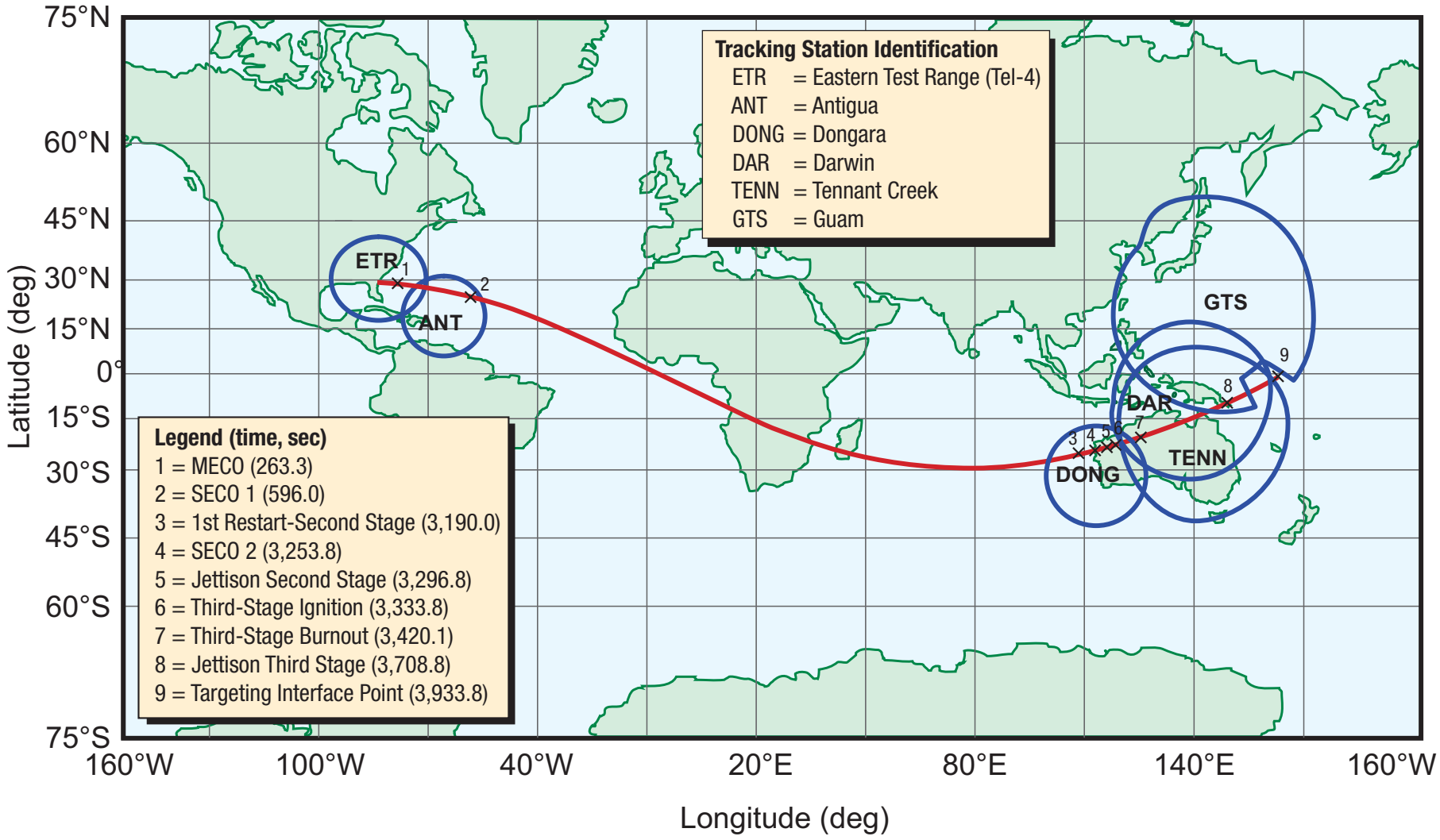
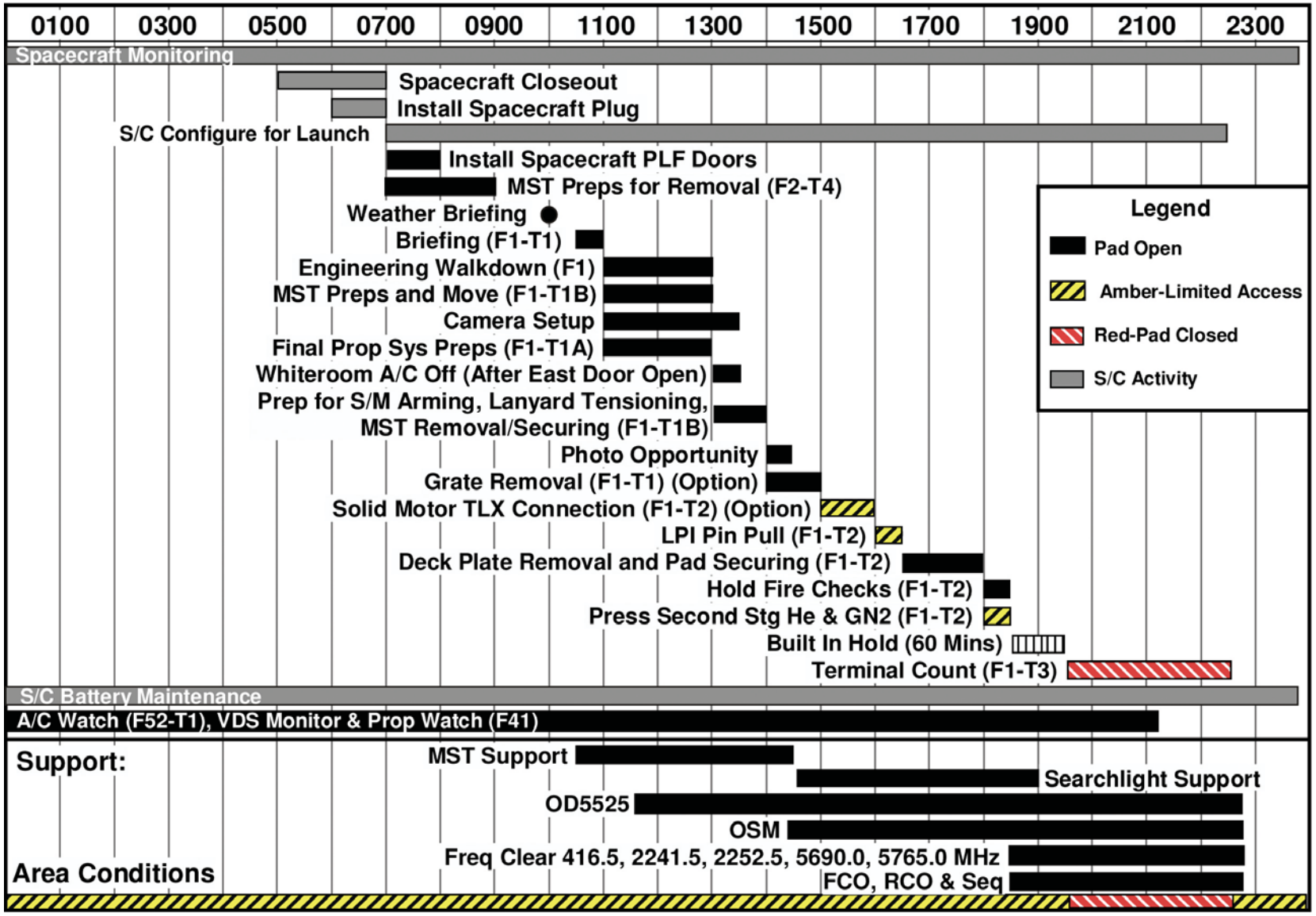
Ground Trace
Boost to Orbit

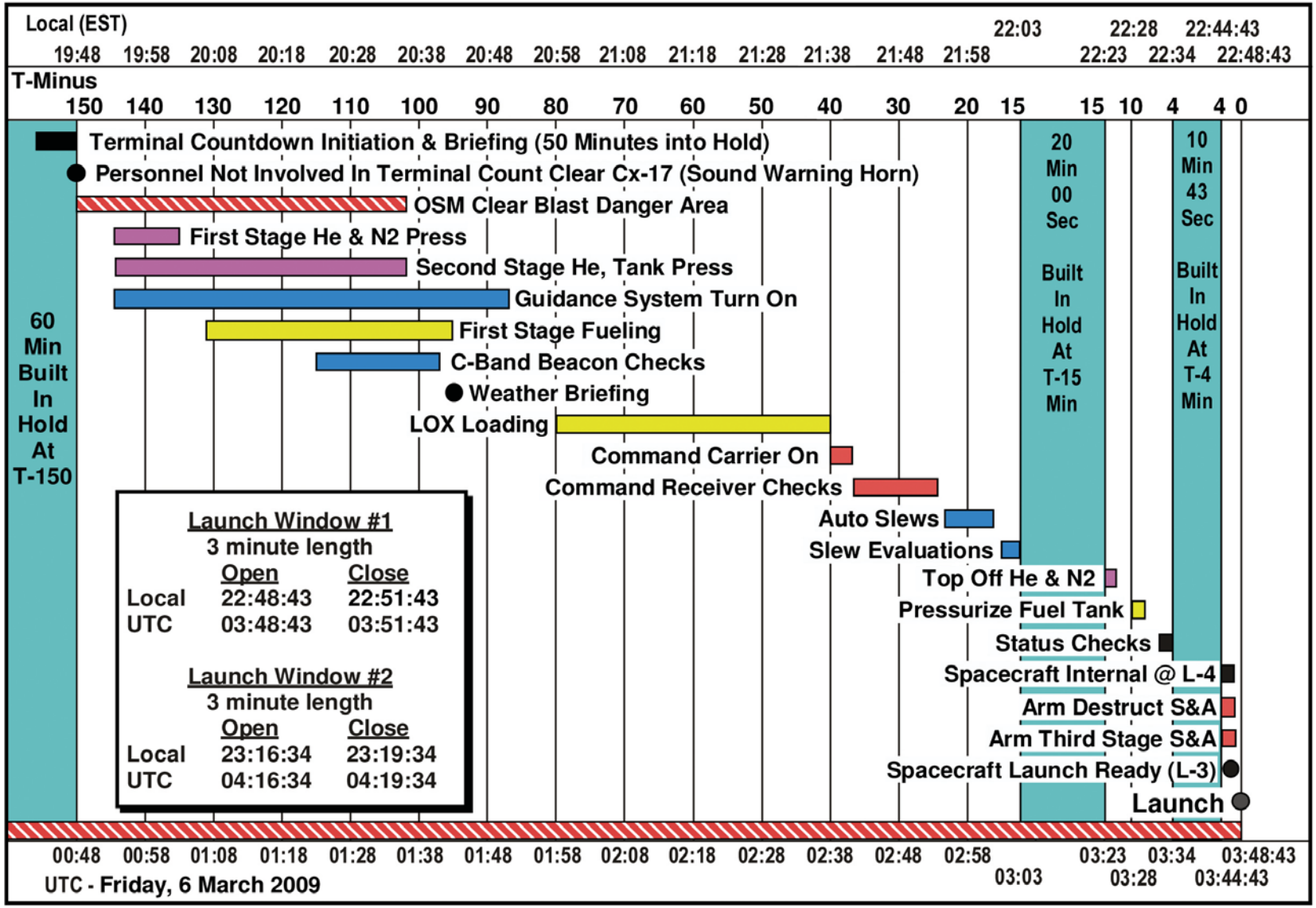
DELTA II



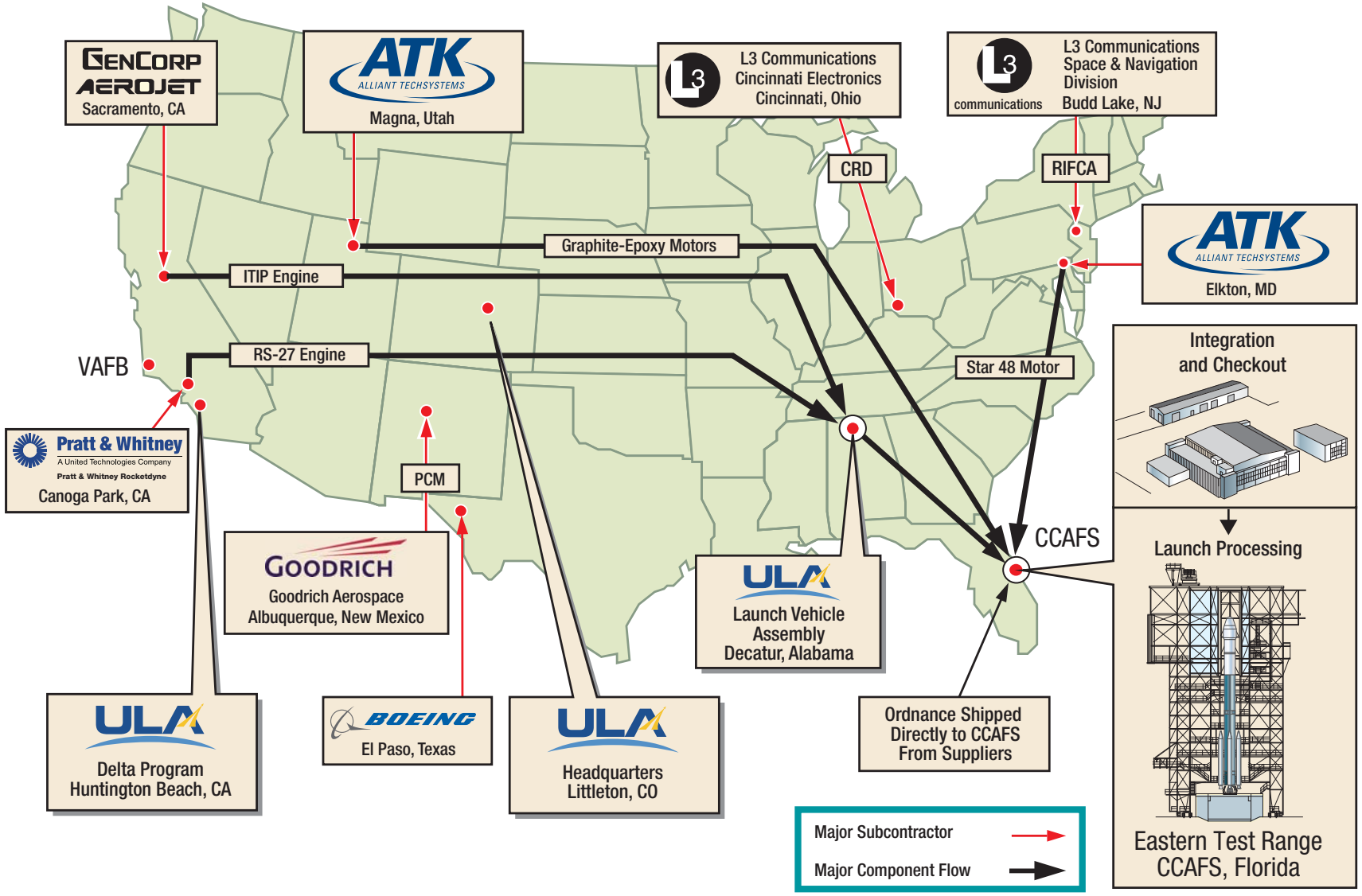
Delta II Countdown (T-0 Day)



Delta II Terminal Count (T-0 Day)



Delta II Operational Flow at Eastern Test Range



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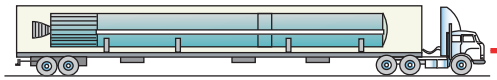
Total Vehicle Integration & Checkout at the Launch Site

DELTA II



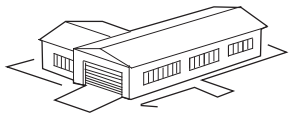
• First stage from assembly plant

• Second-stage, fairing, interstage from assembly plant

Delta Mission Checkout (Hangar AO)

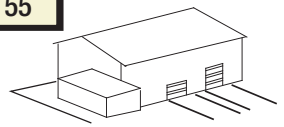
Delta II integration and checkout area
- Receive and inspect
- Mission integration and checkout
- Dual composite tests
- Storage
- Load on pad erection trailers

Horizontal Processing Facility



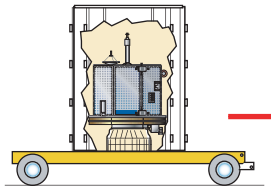
• Destruct installation

Area 55



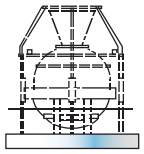
- Destruct installation
- Erection preparation
- Leak checks

Processing Facility



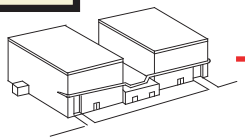
• Space vehicle

• Mate to upper stage

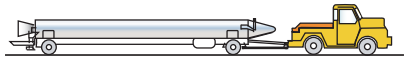


• Upper-stage motor

Area 59

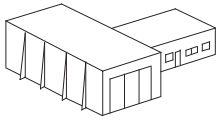


• Balance motor

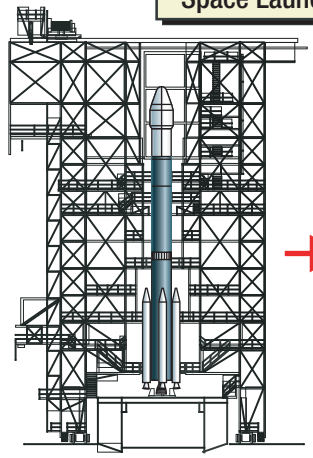


• Solid motors

Area 57



Space Launch Complex 17



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

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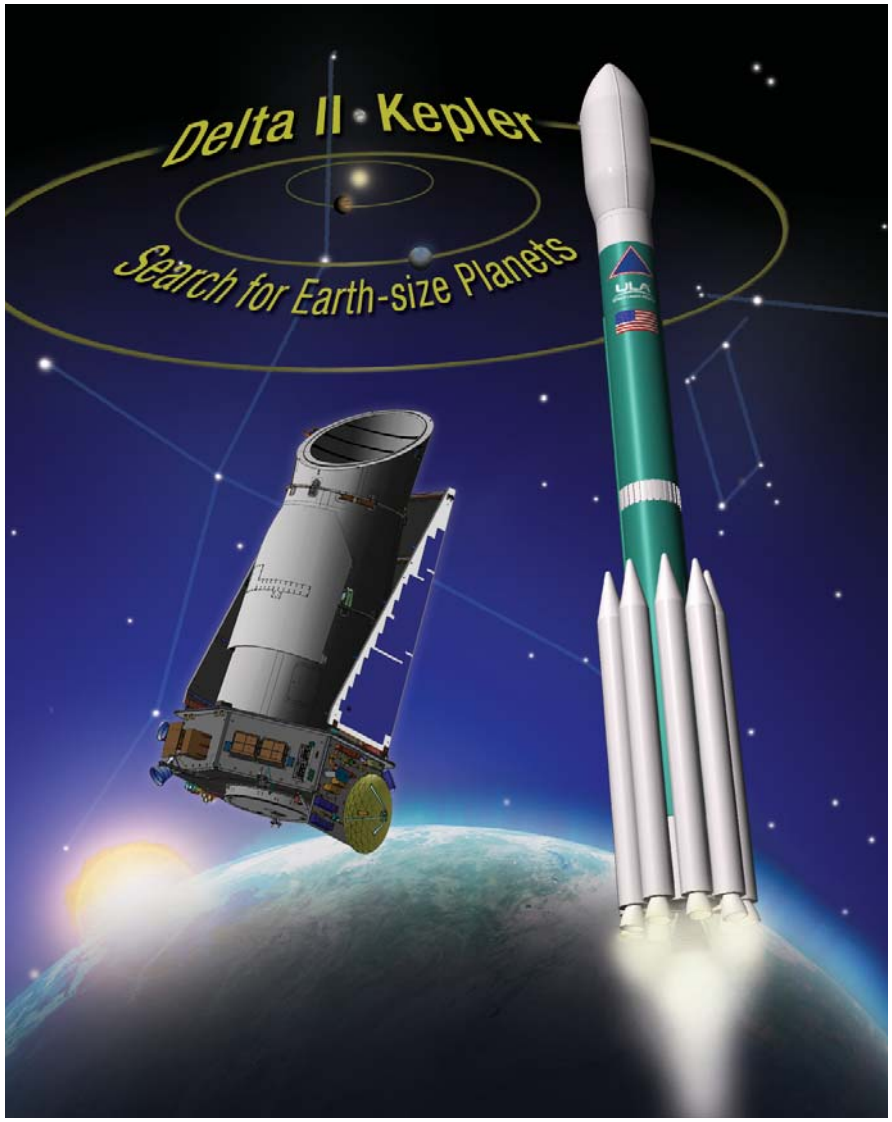
DELTA II



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Notes

DELTA II