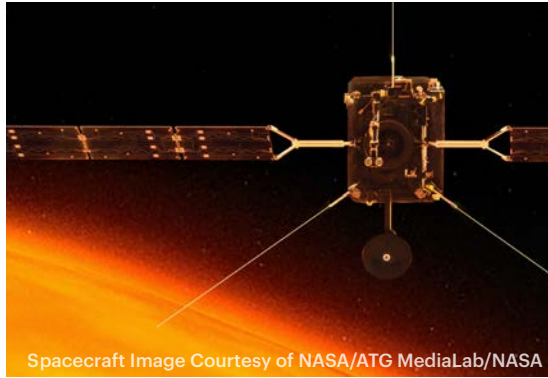


## MISSION

A United Launch Alliance (ULA) Atlas V 411 rocket will deliver the Solar Orbiter spacecraft to an interplanetary trajectory to the sun. Liftoff will occur from Space Launch Complex-41 at Cape Canaveral Air Force Station, Florida.

Solar Orbiter addresses big questions in solar system science to help us understand how our star creates and controls the heliosphere, a giant bubble of charged particles blown by



Spacecraft Image Courtesy of NASA/ATG MediaLab/NASA

the solar wind that permeates the whole solar system and influences the planets within it. By researching the mechanism behind the acceleration of the solar wind, Solar Orbiter is contributing essential science that could one day lead to a space-weather forecasting service that will allow us better to protect our essential technology on Earth and humans in space.

Solar Orbiter is an international cooperative mission between the European Space Agency (ESA) and NASA. The spacecraft, developed by Airbus, carries a suite of ten scientific instruments built in Europe and the United States that are designed to provide close-up, high-latitude images of the sun. Solar Orbiter will reach its highly elliptic operational orbit nearly two years after launch by using gravity assist maneuvers (GAMs) around Earth and Venus. Subsequent GAMs around Venus will increase its inclination to the solar equator over time, reaching up to 33 degrees in 2029. The European Space Operations Center (ESOC) in Germany will operate Solar Orbiter after launch.

## LAUNCH VEHICLE

### Payload Fairing (PLF)

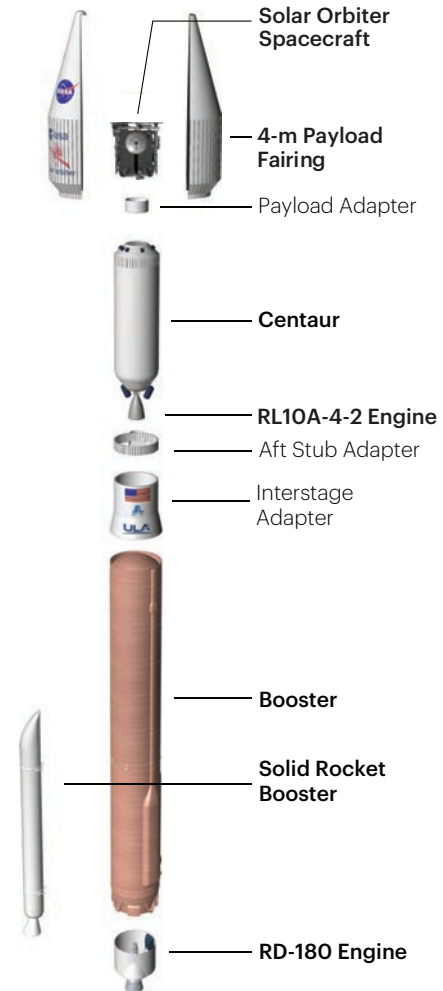
The spacecraft is encapsulated in the 4-m (14-ft) diameter large payload fairing (LPF). The LPF is a bisector (two-piece shell) fairing consisting of aluminum skin/stringer construction with vertical split-line longerons. The vehicle's height with the LPF is approximately 57.6 m (189 ft).

### Centaur

The Centaur second stage is 3 m (10 ft) in diameter and 12.6 m (41.5 ft) in length. Its propellant tanks are pressure-stabilized and constructed of corrosion-resistant stainless steel. Centaur is a cryogenic vehicle, fueled with liquid hydrogen and liquid oxygen, powered by an RL10A-4-2 engine producing 10,115 kg (22,300 lb) of thrust. The cryogenic tanks are insulated with a combination of helium-purged blankets, radiation shields and spray-on foam insulation (SOFI). The Centaur forward adapter (CFA) provides structural mountings for the fault-tolerant avionics system and structural and electrical interfaces with the spacecraft.

### Booster

The booster is 3.8 m (12.5 ft) in diameter and 32.5 m (106.5 ft) in length. The booster's tanks are structurally rigid and constructed of isogrid aluminum barrels, spun-formed aluminum domes and intertank skirts. Booster propulsion is provided by the RD-180 engine system (a single engine with two thrust chambers). The RD-180 burns RP-1 (Rocket Propellant-1 or highly purified kerosene) and liquid oxygen and delivers 390,180 kg (860,200 lb) of thrust at sea level. One solid rocket booster (SRB) generates the additional power required at liftoff, providing 158,077 kg (348,500 lb) of thrust. The Centaur avionics system, provides guidance, flight control and vehicle sequencing functions during the booster and Centaur phases of flight.



## ATLAS V



The Atlas V 411 rocket, a unique configuration that includes just one solid rocket booster, provides the optimum performance to precisely deliver a range of mission types. In its nearly 15 years of service, the 411 rocket has completed five flights, including NASA's OSIRIS-REx mission.

First Launch: Apr. 20, 2006  
Launches to date: 5

Performance to GTO: 5,950 kg (13,110 lb)

Performance to LEO-Reference: 12,030 kg (26,530 lb)

## MISSION SUCCESS

With more than a century of combined heritage, ULA is the world's most experienced and reliable launch service provider. ULA has successfully delivered more than 135 missions to orbit that provide Earth observation capabilities, enable global communications, unlock the mysteries of our solar system and support life-saving technology.

# MISSION OVERVIEW



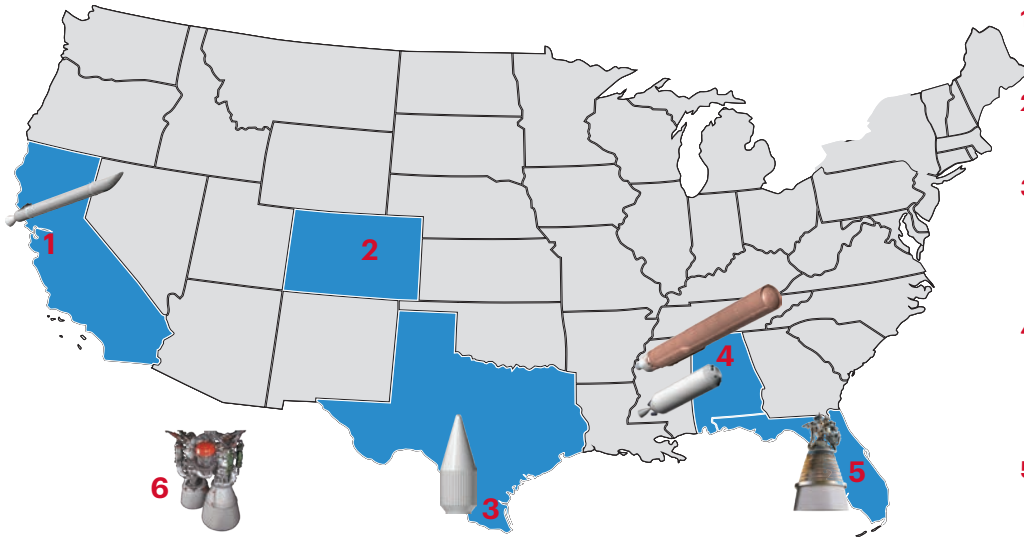
# SOLAR ORBITER



[ulalaunch.com](http://ulalaunch.com)

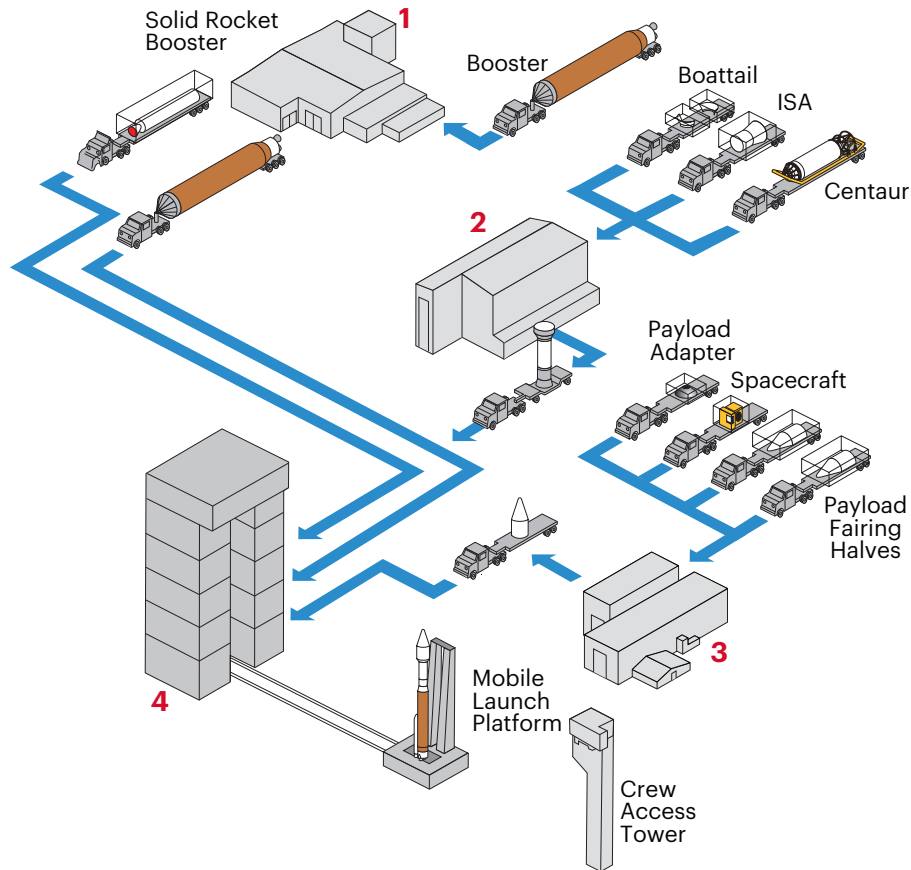
Copyright © 2020 United Launch Alliance, LLC. All Rights Reserved.

# PRODUCTION



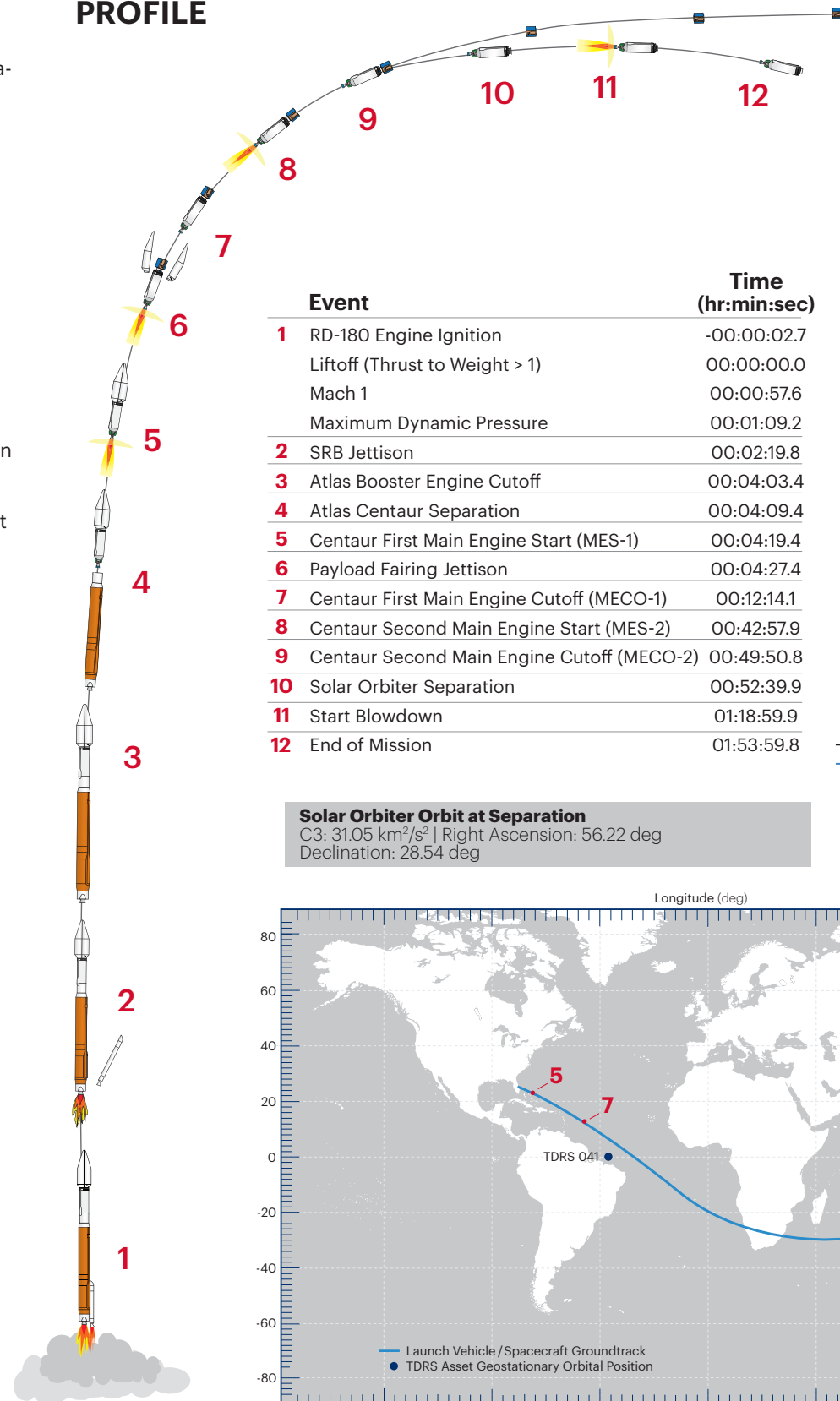
- 1 Sacramento, CA**  
Solid Rocket Booster Fabrication at Aerojet Rocketdyne
- 2 Denver, CO**  
ULA Headquarters & Design Center Engineering
- 3 Harlingen, TX**  
Payload Fairing, Payload Fairing Adapter, Booster Adapter & Centaur Adapter Fabrication
- 4 Decatur, AL**  
Booster Fabrication & Final Assembly, Centaur Tank Fabrication & Centaur Final Assembly
- 5 West Palm Beach, FL**  
RL10A-4-2 Engine Fabrication at Aerojet Rocketdyne
- 6 Khimki, Russia**  
RD-180 Engine Fabrication at NPO Energomash

# SPACE LAUNCH COMPLEX-41 PROCESSING

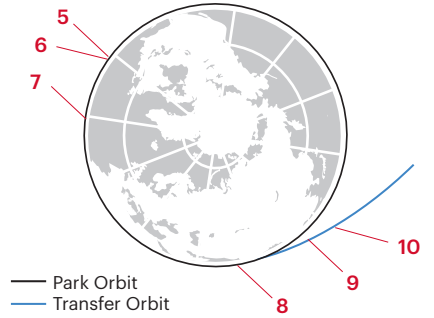


- 1 Atlas Spaceflight Operations Center (ASOC)**  
Launch Control Center & Mission Director's Center
- 2 Delta Operations Center**  
ISA, Centaur, Boattail & Vertical Integration
- 3 Spacecraft Processing Facility**  
Spacecraft Processing, Testing & Encapsulation
- 4 Vertical Integration Facility**  
Launch Vehicle Integration & Testing, Spacecraft Mate & Integrated Operations

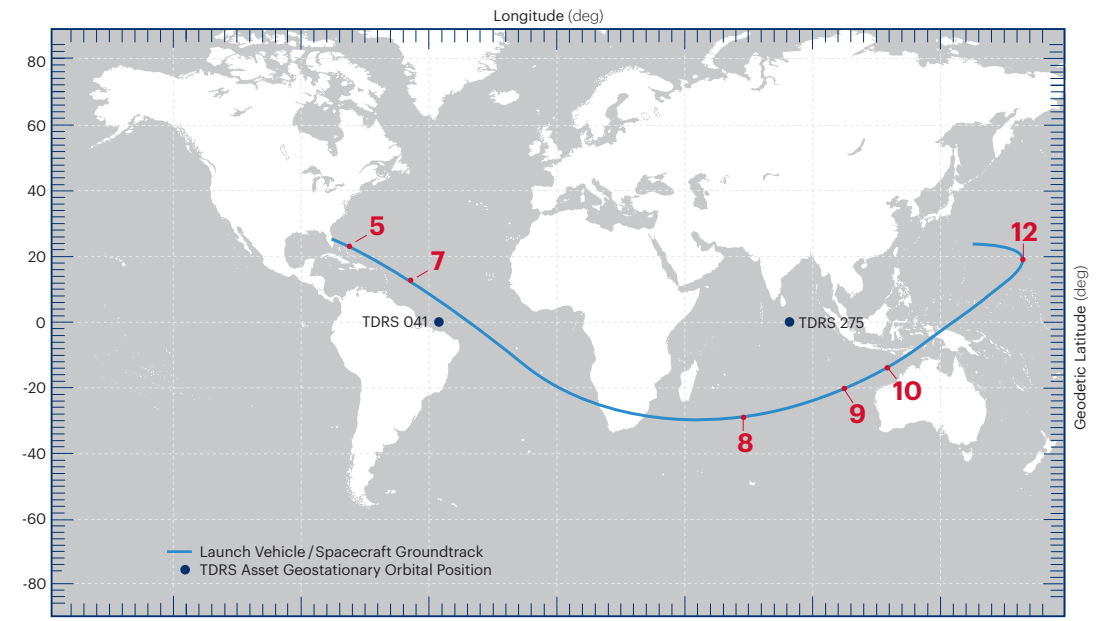
# FLIGHT PROFILE



Event	Time (hr:min:sec)
<b>1</b> RD-180 Engine Ignition	-00:00:02.7
Liftoff (Thrust to Weight > 1)	00:00:00.0
Mach 1	00:00:57.6
Maximum Dynamic Pressure	00:01:09.2
<b>2</b> SRB Jettison	00:02:19.8
<b>3</b> Atlas Booster Engine Cutoff	00:04:03.4
<b>4</b> Atlas Centaur Separation	00:04:09.4
<b>5</b> Centaur First Main Engine Start (MES-1)	00:04:19.4
<b>6</b> Payload Fairing Jettison	00:04:27.4
<b>7</b> Centaur First Main Engine Cutoff (MECO-1)	00:12:14.1
<b>8</b> Centaur Second Main Engine Start (MES-2)	00:42:57.9
<b>9</b> Centaur Second Main Engine Cutoff (MECO-2)	00:49:50.8
<b>10</b> Solar Orbiter Separation	00:52:39.9
<b>11</b> Start Blowdown	01:18:59.9
<b>12</b> End of Mission	01:53:59.8



**Solar Orbiter Orbit at Separation**  
 C3: 31.05 km<sup>2</sup>/s<sup>2</sup> | Right Ascension: 56.22 deg  
 Declination: 28.54 deg



All Values Approximate