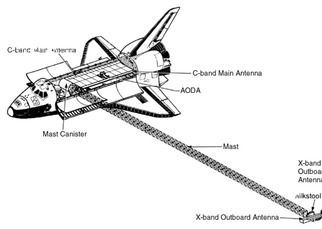
SRTM Hardware--the Mast

Payload Bay

Overview

The Mast

Made of carbon fiber reinforced plastic (CFRP), stainless steel, alpha titanium, and Invar, the mast is a truss structure that consists of 87 cube-shaped sections called bays. Unique latches on the diagonal members of the truss allow the mechanism to deploy bay-by-bay out of the mast canister to a length of 60 meters (200 feet), about the length of five school buses. The canister houses the mast during launch and landing and also deploys and retracts the mast.



SRTM as Deployed From Endeavour's Payload Bay

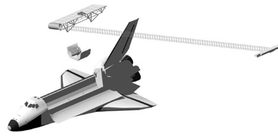
The mast will be deployed and retracted by a motor-driven nut within the mast canister. This nut will pull the mast from its stowed configuration and allow it to unfold like an accordion. An astronaut inside the Space Shuttle will initiate the mast deployment, which will take about 20 minutes. The mast also may be deployed manually during an EVA using a hand-held motor if necessary.

The mast technology enables the SRTM system to perform at the high precision necessary to achieve the desired mapping resolution. The mast supports a 360-kilogram (792-pound) antenna structure at its tip and carries 200 kilograms (440 pounds) of stranded copper, coaxial, fiber optic cables, and thruster gas lines along its length.

The Shuttle Radar Topography Mission Mast

Mast Length	60 m 200 feet
Nominal Mast Diameter	1.12 m 44 1/8 in
Nominal Bay Width at Longerons	79.25 cm 31 1/4 in
Nominal Bay Length	69.75 cm 27 1/2 in
Number of Bays	87
Stowed Height/Bay	1.59 cm 5/8 in
Total Stowed Height	128 cm 54 in

The Main Antenna



The main antenna is connected to a pallet that in turn is bolted into the payload bay of the Space Shuttle. The system consists of two antennas and the avionics that compute the position of the antenna.

Each antenna is made up of special panels that can transmit and receive radar signals. One antenna is the C-band antenna and can transmit and receive radar wavelengths that are 2.25 inches or 5.6 centimeters long. The second antenna is the X-band antenna. This antenna can transmit and receive radar wavelengths that are 1.2 inches or 3 centimeters long. Both wavelengths were used in the Spaceborne Imaging Radar C-band/X-SAR missions in 1994 for a variety of environmental studies. The L-band antenna, also used during SIR-C/X-SAR, has been removed to save weight.

History/Background

Attitude and Orbit Determination Avionics

In order to map the Earth's topography, SRTM researchers will need to do two basic things:

1) Measure the distance from the Shuttle to some common reference, such as sea-level

2) Measure the distance from the Shuttle to the surface feature over which it is flying

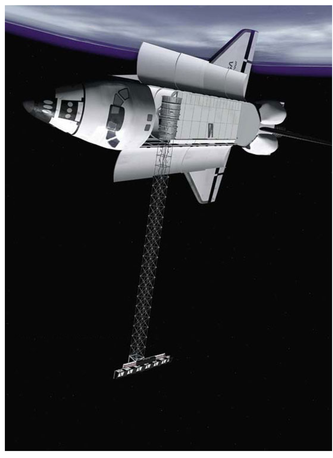
For example, if the Shuttle's height above sea level is known and its respective height above a mountain, then researchers can subtract to get the height of the mountain above sea level.

For the first part, researchers need to know the Shuttle's height above sea level at all times. NASA will need to constantly measure the Shuttle position to an accuracy of 1 meter (about 3 feet).

For the second part of the formula, SRTM is using radar interferometry to measure the height of the Shuttle above the Earth's surface. One of the biggest challenges in making interferometry work is knowing the length and orientation of the mast at all times. Changes in its length and orientation can have a profound effect on the final height accuracy. Suppose the mast tip moves around by only 2 cm (a bit less than 1 inch) with respect to the Shuttle (this is something that is expected to happen during the mission, due to the astronauts moving around and Shuttle thrusters firing). That doesn't sound like much, but if not taken into account, it would result in a height error at the Earth's surface of 120 meters (almost 400 ft).

Researchers also expect changes in mast length of about 1 cm (about a half-inch) which if not detected would result in additional errors. Therefore, SRTM team members will need to constantly monitor the mast orientation and length. Part of this is measuring where the mast tip is relative to the Shuttle to better than 1 mm (about 4/100th of an inch). The other part is knowing how the Shuttle is oriented relative to the Earth to about 1 arcsec. An arcsecond is the angular size of a dime seen from a distance of 2 miles.

To keep track of the Shuttle's position, NASA will make use of the Global Positioning System (GPS). Mission managers do this by combining measurements taken by some specially designed GPS receivers being flown on the Shuttle with measurements taken by an international network of GPS ground receivers.



To measure the mast length and orientation, team members will use a variety of optical sensors. A target tracker will be used to follow a set of Light Emitting Diode (LED) targets which can be seen on the outboard radar antenna once the mast is fully deployed.

The target tracker also is used to monitor the antenna alignment. There are laptop computers on the Shuttle which display the antenna alignment (kind of a cross-hairs with a dot, representing the alignment error). The crew will use these displays to guide adjustment of some motors at the mast tip (the "milkstool") to remove any alignment errors so the radar can operate properly.

To get the most accurate measure of the mast length, SRTM managers will use a set of rangefinders, called Electronic Distance Measurement (EDM) units. To save time and money, the SRTM team decided to buy commercial surveying instruments and modify them for use in space. The rangefinders work by bouncing a beam of light off a special corner-cube reflector on the outboard antenna and measuring the time to determine the distance.

To measure the orientation of the Shuttle with respect to the Earth, mission managers will use one of the most precise star tracker and gyroscope packages ever built. The star tracker looks at the sky and compares what it sees with a star catalogue in its memory to get the attitude of the Shuttle.