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LITE -- THE SHUTTLE-BORNE LIDAR IN-SPACE TECHNOLOGY EXPERIMENT

M. Patrick McCormick
NASA Langley Research Center
Mail Stop 475
Hampton, VA 23681-0001
Phone: 804-864-2671 Fax: 804-864-2671
E-mail: m.p.mccormick@larc.nasa.gov

The launch from NASA's Kennedy Space Center of the Lidar In-Space Technology Experiment (LITE), the prime payload aboard the Space Shuttle flight STS-64, is now scheduled for 1930 GMT on September 9, 1994. A crew of six astronauts has been chosen for this 9-day mission, which will carry, in addition to LITE, the Robot Operated Materials Processing System (ROMPS), the Shuttle Pointed Autonomous Research Tool for Astronomy (SPARTAN-201), the Shuttle Plume Impingement Flight Experiment (SPIFEX), and the Simplified Aid For EVA Rescue (SAFER). ROMPS will investigate robot handling of thin film samples. SPARTAN is a free-flying X-ray astronomy platform that will be deployed for 2 days and retrieved during the mission. SPIFEX will characterize the Shuttle plume environment, while SAFER is a manned maneuvering unit for emergency EVA (Extra Vehicular Activities). An EVA is planned for SAFER. The orbit altitude of STS-64 will be 140 n.mi. (259 km) with an inclination of 57°. This orbit provides coverage over most of the Earth's surface allowing many different geophysical targets to be studied along with extensive opportunities for ground-truthing over many lidar sites.

Details of the LITE instrument were given in five papers at the 1992 Sixteenth ILRC (McCormick, Cimolino and Petros, DeLorme, Blythe et al., and Chang et al.), and in Couch et al. (1991). The scientific investigations planned for LITE are given in McCormick et al. (1993). Basically, LITE employs a three-wavelength Nd:YAG laser transmitter and a 1-m-diameter telescope receiver with photomultipliers for the 355-nm and 532-nm channels, and an avalanche photodiode for the 1064-mm channel. A two-laser 10-HZ flashlamp pumped design is incorporated for redundancy. Laser energies at 1064, 532, and 355 nm are approximately 486, 460, and 196 mj, respectively. The field of view of the receiver is determined by a selectable aperture stop, one of either a wide field of view at 3.5 mr for nighttime measurements, a narrow aperture at 1.1 mr for daytime measurements, or an annular field of view for multiple scattering measurements. In addition, an opaque aperture can be inserted. Narrowband interference filters can also be moved into the optical path to reject the bright sunlit background during daytime portions of the orbits. The lidar return signals are amplified, digitized, stored on tape on board the Shuttle, and simultaneously sent to the ground for most of the mission using a high-speed data link (see figure 1).

An electronic bandwidth of 2 MHZ limits the range resolution to about 35 m. The instrument can be commanded from the ground over a low-rate telemetry link or by the Shuttle crew. In this manner various instrument configuration modes can be changed quickly during flight. Such things as photomultiplier high voltages, electronic amplifier gains, fields of view, and optical filtering are routinely changed. The control of the sequence of instrument operations is shown in figure 2.

A detailed mission plan and supporting correlative measurements plan have been developed for the 9-day mission. LITE will take data during ten 4 1/2 hour data taking sequences and, in addition, five 15-minute "snapshots" will be performed over specific target sites. The measurements will include observations of clouds, tropospheric and stratospheric aerosols, characteristics of the planetary boundary layer, stratospheric density and temperature, and a number of surface characteristics. At least three aircraft carrying a number of uplooking and downlooking lidars will underfly LITE performing validation measurements. In addition, ground-based lidars and other measurements, eg. balloonborne dustsondes, will be coordinated with LITE overflights. Photography will take place during daylight portions of the orbits, both with a camera fixed and boresighted to LITE as well as with cameras used by the Shuttle astronauts to support LITE's lidar measurements.

Figure 3 shows the completed LITE instrument in a clean room at NASA's Langley Research Center where LITE was built. Figure 4 shows an extended time photograph of LITE in its transporter firing into the atmosphere during tests before shipping. The LITE instrument is presently at NASA's Kennedy Space Center being readied for its September 1994 flight.

The September flight of LITE will be focused on the evaluation and characterization of the instrument, the development of space-based lidar remote-sensing techniques, and the utility of spaceborne lidars to make meaningful geophysical measurements. LITE will provide crucial data for the ultimate goal of a free-flying lidar system in polar orbit, able to measure clouds, aerosols, surface properties, temperature, and gases on a global basis.

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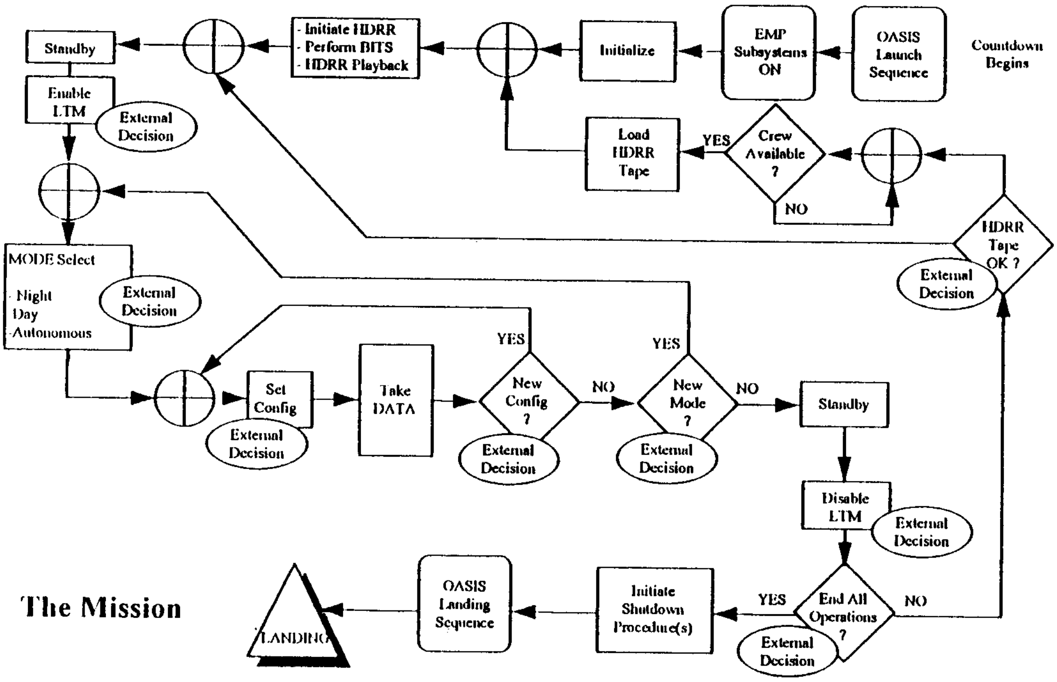

Figure 1. Shown is the sequence of data commanding and flow. OASIS is a stand alone monitor of the LITE environment. The EMP is the pallet LITE is built upon. HDRR is the high data rate recorder where the LITE data will be stored. BITS is a Built-In Test System which contains three LEDs which produce a varying intensity and shaped pulse used to test the detectors and electronics. The LTM is the Laser Transmitter Module.

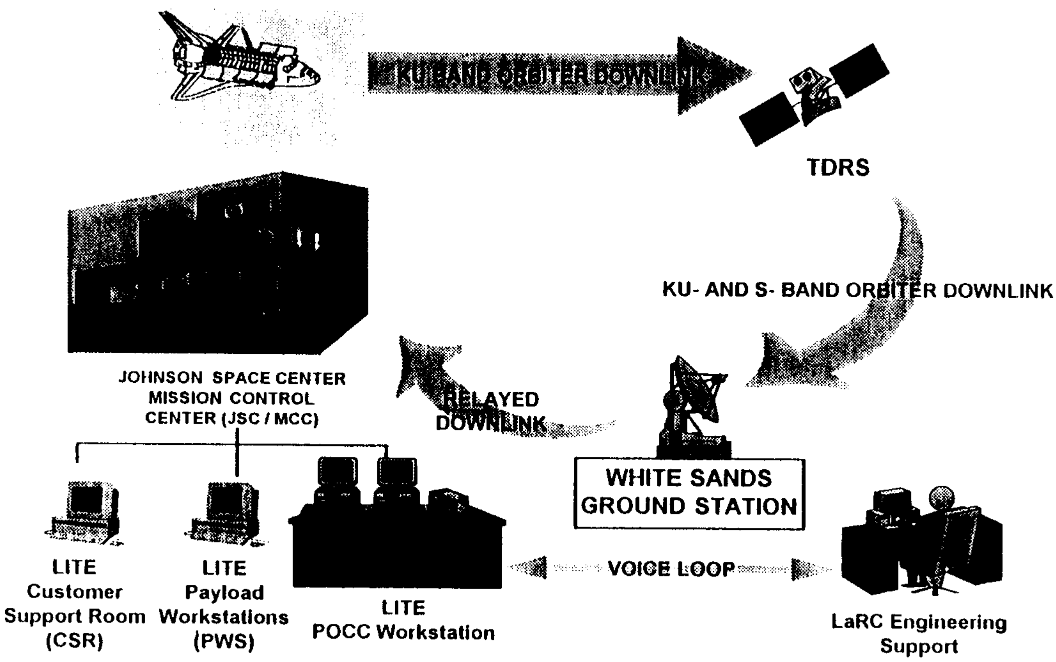

Figure 2. Shown is the communications downlink data flow from Shuttle to TDRS, the Tracking and Data Relay Satellite, and then to White Sands and NASA Johnson Space Center. POCC is the Payload Operations Control Center where the LITE engineers and science coordinator will be housed. The LITE program and project scientists, and program and project managers will be in the CSR.

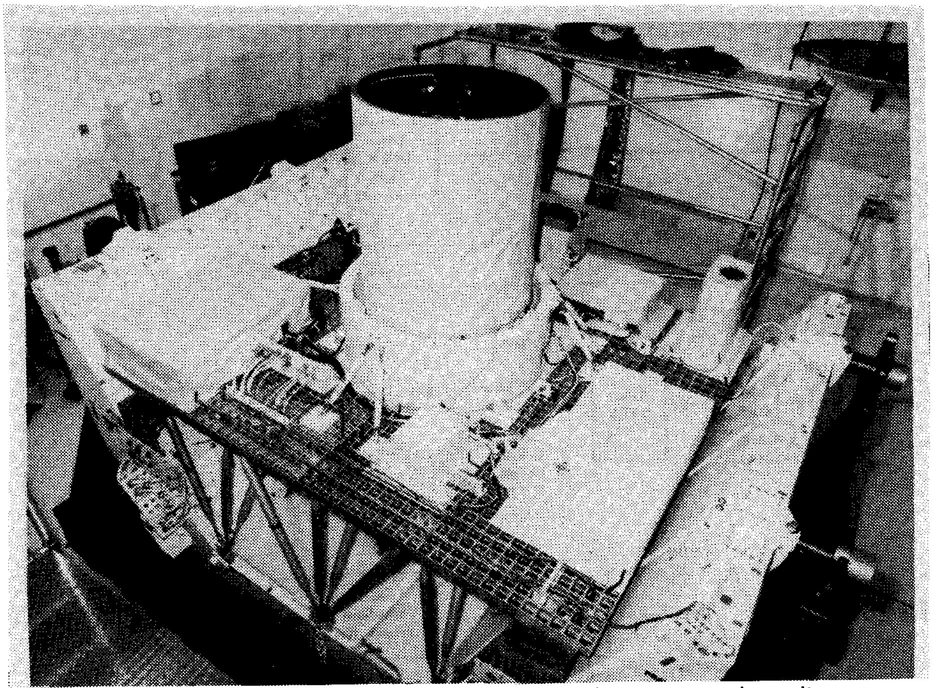

Figure 3. A photograph of the LITE instrument in the clean room where it was assembled at NASA's Langley Research Center. The telescope receiver is in the center of the photograph. The covered box in the lower left hand corner contains the electronics. The box on the lower right contains OASIS. A camera system is in the upper right, and the boresight assembly is in the upper center. The telescope blocks the view of the laser system in the upper left.

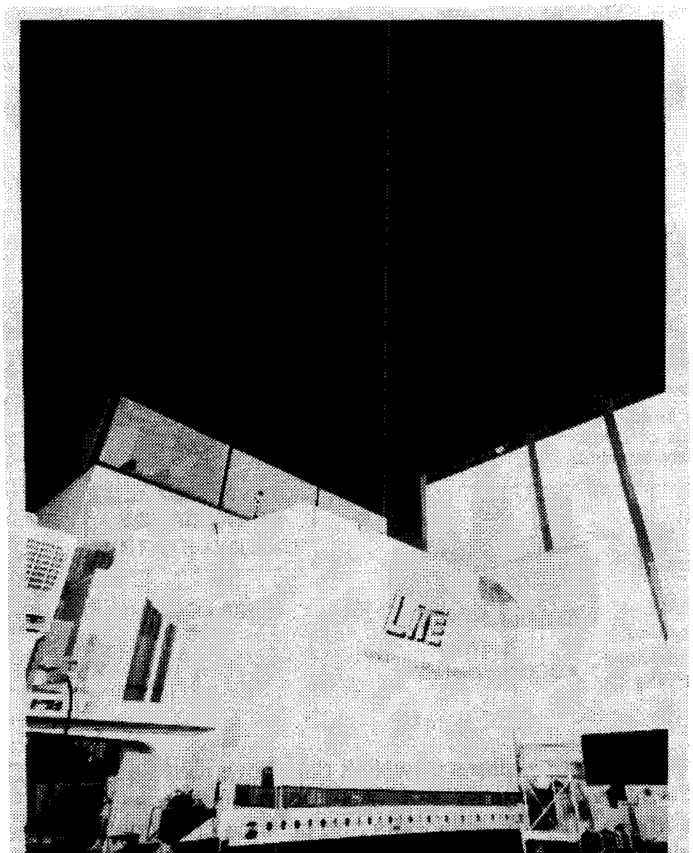

Figure 4. A photograph of LITE during atmospheric tests. The camera shutter was held open so that the green (532 nm) laser propagation could be observed. The LITE instrument is mounted in an environmentally-controlled container with a 36-inch plastic window on top, and placed upon a trailer for transport.