



SOFIA-NASA's Stratospheric Observatory for Infrared Astronomy



NASA's SOFIA 747SP during an early check flight over the Texas countryside.

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NASA is developing the Stratospheric Observatory for Infrared Astronomy – or SOFIA – as a world-class airborne observatory that will complement the Hubble, Spitzer, Herschel and James Webb space telescopes and major Earth-based telescopes. SOFIA features a German-built 98.4-inch (2.5 meter) diameter far-infrared telescope weighing 20 tons mounted in the rear fuselage of a highly modified Boeing 747SP aircraft. It is one of the premier space science programs of NASA's Science Mission Directorate.

SOFIA is a joint program by NASA and DLR Deutsches Zentrum für Luft- und Raumfahrt (German Aerospace Center). Major aircraft modifications and installation of the telescope has been carried out at L-3 Communications Integrated Systems facility at Waco, Texas. Completion of systems installation, integration and flight test operations are being conducted at NASA's Dryden Flight Research Center at Edwards Air Force Base, Calif., from 2007 through 2010. SOFIA's science operations are being planned jointly by the Universities Space Research Association (USRA) and the Deutsches SOFIA Institut (DSI) under leadership of the SOFIA Science project at NASA's Ames Research Center at Moffett Field near San Jose, Calif.

Unparalleled astronomical science capabilities

Once it begins operations in about 2010, SOFIA'S 2.5-meter (98.4-inch) diameter reflecting telescope will provide astronomers with access to the visible, infrared and sub-millimeter spectrum, with optimized performance in the mid-infrared to sub-millimeter range. During its 20-year expected lifetime, SOFIA's telescope will be capable of "Great Observatory"-class astronomical science.

SOFIA will continue the legacy of prominent planetary scientist Dr. Gerard Kuiper, who began airborne astronomy in 1966 with a 12-inch telescope aimed out a window of a converted Convair 990 jetliner. His work led to the development of NASA's Kuiper Airborne Observatory, a modified C-141 aircraft incorporating a 36-inch reflecting telescope that flew from 1974 to 1995. During its 21-year lifetime, the Kuiper Airborne Observatory focused on solar system, galactic and extra-galactic astronomy, and discovered the rings of Uranus, a ring of dust around the center of the Milky Way, luminous infrared galaxies, complex organic molecules in space and water in comets.

As the world's largest airborne astronomical observatory, SOFIA will provide three times better image quality and vastly increased observational sensitivity than the Kuiper Airborne Observatory. From a base at NASA Dryden, SOFIA mission operations will be conducted over virtually the entire globe. Missions will be flown at altitudes of 39,000 to 45,000 feet, above 99 percent of the water vapor in the lower atmosphere that restrict the capabilities of ground-based observatories over most of the infrared and sub-millimeter spectral range.

By recording infrared measurements not possible from the ground, SOFIA will be able to observe occultations of stars by solar system objects to help determine the objects' sizes, compositions and atmospheric structures. It will help answer many fundamental questions about the creation and evolution of the universe, including how stars and planets are formed, how organic materials necessary for life form and evolve, and the nature of the black hole at the center of our Milky Way galaxy.

Technology Development

SOFIA will also be an outstanding laboratory for developing and testing astronomical instrumentation and detector technology. Its nine first-generation cameras and spectrographs and later generation instruments will enable a wide variety of astronomical science observations not possible from other Earth- and space-borne observatories. Once validated, these instruments will be useful in future space missions and ground-based observatories. SOFIA's ability to return to earth after each flight will enable frequent opportunities to upgrade and install new science instruments. This in turn will stimulate and enable the development of new astronomical technology throughout its lifetime.

Education and Outreach

As part of its overall mission, SOFIA has been designed to incorporate a strong educational and public outreach emphasis to help improve American education in science, technology, engineering and mathematics. SOFIA has been designed to give elementary, secondary and college-level educators from across the U.S. hands-on participation in cutting-edge scientific and astronomical research. It also will provide training for undergraduate and graduate-level scientists, engineers and technologists by enabling their participation in designing and developing instrumentation and conducting and analyzing observations of SOFIA's telescope.

Development status to date

Major modification of the former Boeing 747SP jetliner and installation of the telescope is essentially complete, except for telescope subsystems and mission control and communications systems. Modifications and installation were con-

ducted over several years by L-3 Communications Integrated Systems Division in Waco, Texas. Following completion of ground testing, related engineering approvals and several checkout flights in the spring of 2007, further development of SOFIA became the responsibility of NASA Dryden, where final installation and integration of its numerous operating and science-related systems and a multi-phase build-up flight test program will occur.

The first flight test phase, slated for the latter part of 2007, will focus on expanding its flight envelope with the large external telescope cavity door closed. Following installation of an auxiliary power unit, insulation and an environmental control system in the telescope cavity and the on-board Mission Control and Communications Systems, SOFIA will enter its second phase of flight testing, currently scheduled for late 2008 through mid-2009. This phase will focus on the various aerodynamic and operational issues related to flying SOFIA at high altitudes at cruising speeds with the external telescope cavity door open.

Following the completion of the first two flight-test phases, further upgrades to the Mission Control and Communications System and installation and checkout of the initial suite of science instruments is planned. A series of functional checkout observation flights are then planned in 2009. These functional check flight segments will first characterize the capability of the airborne observatory and demonstrate its ability to obtain science data, then conduct shared-purpose flights to obtain astronomical data while telescope performance is being tuned, and finally a series of flights to demonstrate that the observatory is fully operational and ready for collecting science data.



SOFIA's telescope in the 747's fuselage.

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