S&V OBSERVER

Structural Analysis of an Airborne Infrared Observatory

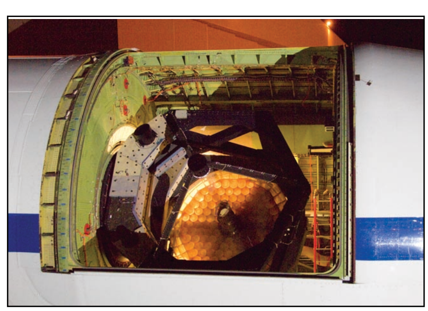
NASA's SOFIA flying observatory during nighttime telescope characterization tests in Palmdale, CA, March 2008.

SOFIA (Stratospheric Observatory For Infrared Astronomy) is an airborne infrared observatory. With this unique platform, scientists will be able to investigate the development of young stars and planetary systems or to examine the center of our home galaxy, the Milky Way.

The major part of the infrared light of these celestial objects cannot penetrate the earth's atmosphere due to the absorption of its water vapor. For this reason the German Aerospace Center (DLR) and the National Aeronautics and Space Administration (NASA) started the SOFIA project for which a Boeing 747-SP was highly modified and equipped with a German telescope in the rear of the aircraft, weighing 17 tons and having a primary mirror diameter of 2.7 m (8.86 ft). At an altitude of about 13 km (43,000 ft) the atmospheric influence on star observations is negligible, and hence observers will have an undisturbed view of the "infrared sky." SOFIA operations started with scientific observations in late 2009, which was the International Year of Astronomy.

The German contribution to the project is the development, construction and testing of the telescope which is the heart of the observatory. At the intended operating altitude of SOFIA, the telescope will be placed in a very hazardous environment for precise observations. For example, the aero acoustic loads on the telescope due to the fuselage aperture of about 3 × 3 m as well as the vibrations of the aircraft itself will excite the entire telescope structure. In order to assure that the required pointing stability is met by the observatory, these effects have to be known and well controlled. Engineers from the German SOFIA Institute (DSI), at the Universitaet Stuttgart which operates the SOFIA telescope on behalf of DLR, needed to derive the dynamic characteristics of the telescope.

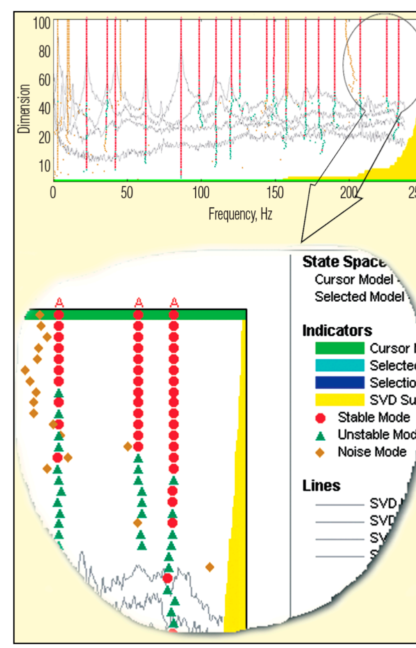
ARTeMIS software from Structural Vibration Solutions A/S, Aalborg, Denmark, provided the best opportunity to investigate structures like the SOFIA telescope under realistic operating conditions. ARTeMIS does not depend on well defined, artificial inputs for structural excitation, but takes advantage of those provided by the actual environment like wind loads and aircraft vibration. DSI engineers were able to measure telescope vibrations that occur during actual operating conditions and investigate, for example, the effects of operating temperature which is about –40° C.



SOFIA's infrared telescope during characterization testing shows the cell-like construction of the telescope's 2.5-meter primary mirror.

SOFIA is a joint project of the German Space Agency (German Aerospace Centre, DLR) and the National Aeronautics and Space Administration (NASA). It is supported on behalf of DLR by Federal (Bundesministerium für Wirtschaft), State (Baden-Württemberg), and University (Stuttgart) funding. Scientific operation for Germany is coordinated by the "Deutsches SOFIA-Institut" (DSI) of Stuttgart University and in the USA by Universities Space Research Association (USRA).

Structural Vibration Solution A/S (SVS) is a supplier and developer of ARTeMIS software for operational modal analysis. This software is used around the world for modal analysis of operating machinery and components and for ambient modal analysis of large structures like the SOFIA telescope, bridges and buildings. The latest development for the ARTeMIS software includes two new Stochastic Subspace Identification (SSI) features: Crystal Clear SSI and Automatic Mode Estimation for SSI. These new features are an add-on to the SSI algorithms available in ARTeMIS Extractor Pro. SVS offers a fully functional 30 day evaluation version of the software. For further information, please visit www.svibs.com.



Stabilization diagram of a fighter jet wing with many modes. The stochastic subspace identification technique (CC-SSI) used for the analysis, was developed with Enria in France. The modes indicated with a red A on the top of the diagram were extracted using the automatic mode estimation function.