STRUCTURAL ANALYSIS OF THE MID INFRA-RED INSTRUMENT FOR THE JAMES WEBB SPACE TELESCOPE

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ABSTRACT

The James Webb Space Telescope (JWST) is planned for launch in 2018. It will be optimised for operation at near to mid-infrared wavelengths (0.6-28 microns) to enable exploration of the high redshift and obscured universe. Its primary mirror will be nearly three times the diameter of the Hubble mirror making it several hundred times more sensitive than current ground-based or space infrared telescopes. A consortium of European institutes is responsible for the structure and optics of the Mid Infra-Red Instrument (MIRI) that focus and filter the infrared light collected by JWST's 6.5m diameter mirror on to detectors provided by NASA's Jet Propulsion Laboratory. MIRI will be used to study faint comets circling the Sun, newly born faraway planets, regions of obscured star formation, and galaxies near the edge of the universe. The detectors require an operating temperature of 7K which is achieved by use of a mechanical cooler with heat exchanger head attached to the instrument bench.

The MIRI instrument design was qualified for launch structural load environments using force limited vibration testing to limit the dynamic responses of the sensitive optical components and mechanisms while demonstrating adequate margin with regard to the environmental flight conditions. Force limiting was achieved using force transducers located between the interface of the instrument and the shaker adapter during the vibration test.

As for all significant space hardware development, the design and verification of the MIRI instrument was supported by a significant structural analysis campaign. FE structural simulation features heavily in all project phases through to delivery and beyond. The various modelling activities included feasibility study support, preliminary design analysis, sub assembly structural test level derivation, final design validation, detailed test predictions and model correlation. A significant output from the work (and a condition of MIRI acceptance by ESA/NASA) is the delivery of a correlated structural FE model to accompany instrument physical delivery. This model is used in spacecraft level analyses, in particular for test predictions so be in use for a period spanning several years after the physical delivery of the instrument hardware to NASA. This presentation will focus on the approach taken to instrument level FE analysis including systems engineering approach applied to analysis of a complex instrument, derivation of subassembly test levels, test

predictions, test results correlation and some aspects of model validation and delivery.

SUGGESTED THEMES

Engineering Analysis, Verification and Validation