Real-Time Command, Data and Control Concepts for the Instrument on the Space Interferometry Mission

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The Space Interometery Mission (SIM), due to launch in 2008, will carry a very high precision instrument which includes tens of control loops operating at kilo-Hertz rates. This paper provides a review of the current design concept for the command, data and control functions of the SIM instrument.

SIM includes three Michelson stellar interferometers operating in tight synchronization. SIM has three objectives: high precision astrometry, imaging and nulling. The nulling to be performed by SIM demonstrates the capability of interferometers to detect planets orbiting stars. The Flight System for SIM has been formed into the following subsystems: Spacecraft Subsystem (SCS), Precision Structure Subsystem (PSS), Real-time Control Subsystem (RTC), Metrology Subsystem (MET) and Starlight Subsystem (STL). The focus of this paper is instrument real-time control which falls into the RTC. The hardware supporting the RTC Subsystem includes 27 VME cages, 8 PowerPC processors, and a low-latency IEEE 1596 interconnect. We will overview the architecture of the instrument computer and I/O system and how it supports the ~~the~~ instrument software and instrument control algorithms.

Top-down analysis of project requirements is driving the command, data and control interface to the instrument control system. A focus of effort in this area has been the development of use-cases for the Flight System. The use-cases, which are like high-level scenarios, are being developed with scientists, instrument engineers, spacecraft engineers, and ground operation engineers. The paper includes an overview of the use-cases being developed to drive the command, data and control design.

In addition, the design is being driven by the heritage of currently operating interferometer designs and on-going technology development. The command, data and control architecture for the instrument includes the Instrument Control Function, the Interferometer Control Function and many servo functions. The Instrument Control Function provides supervisory control of the instrument and coordinates activities with the spacecraft. It must provide sequencing control through the aquisition and tracking of guide stars on the two guide star interfereometers used for baseline tracking; and it must sequence the science star interferometer through the list of stars needed science. The sequencing of each of the two guide and single science interferometer is handled by the Interferometer Control Function. This function provides supervisory control of each of the three interferometers. Underneath the Interferometer Control Function are the many servos which run for each interferoemter. These functions include pointing control loops, pathlength control loops, and a baseline estimation algorithm. The pointing loops control a wide angle "siderostat control" loop which, for bright stars, has a sample rate of 100Hz and a narrow angle "fast steering mirror loop" which operates at a sample rate of 1000Hz. The pointing loops control pathlength of the light. An inner loop operates on internal metrology at 4000Hz and an outer loop operates at 1000Hz. For dim stars the pointing loops and outer pathlength control loops use feedforward from the guide interferometers. The paper will go into the details of this design.