The SIM Instrument Model and Various Aspects of How It Is Used For Validating Astrometric Performance

SIM, the Space Interferometry Mission, will perform very accurate astrometric measurements on objects using a 10 m baseline optical interferometer. Integration times of many seconds are needed to detect fringes on most science targets with sufficient signal-to-noise ratio. The lack of signal from the science targets precludes using the star as a feedback signal to control the science interferometer delay line. In order to solve this problem SIM uses pathlength feed forward (PFF) control of the science interferometer. In the case of controlling the science interferometer optical path, the information to position the science delay line comes from a combination of internal metrology, external metrology, and guide interferometer measurements. The accuracy of the internal and external metrology measurements and the guide interferometer measurements are not only important for the quality of the feed forward signal, but also for the ultimate astrometric performance of the instrument via the "regularization" of the baseline operation that essentially fixes the interferometer in inertial space.

An instrument model of SIM has been built to evaluate system sensitivities and to emulate various observational scenarios, including such diverse problems as the effect of averaging methods to reduce metrology cyclic error and the viability of on-orbit calibration maneuvers. The model consists of a real-time dynamics formulation of the spacecraft and a real-time attitude control system. The outputs of the dynamics model are used in the calculation of the internal and external metrology measurements and guide interferometer measurements. Simulation results investigate the sensitivity of the feed forward signal to the various error sources and time varying terms such as science and guide star position errors, absolute external and internal metrology gauge errors, misalignment errors, calibration errors, structural flexibility and the pointing stability of the spacecraft.