An Overview of Formation Flying Technology Development for the Terrestrial Planet Finder Mission

The objective of the Terrestrial Planet Finder (TPF) mission is to find and characterize earth-like planets orbiting distant stars. Three architectural options are under consideration for this mission: a formation-flying interferometer (FFI), a structurally-connected interferometer, and a coronagraph. One of these options will be selected in 2006. This paper describes the technology program underway to establish the viability of precision formation flying for the FFI option. In particular, interferometric science observations require autonomous precise control and maneuvering of five to six spacecraft to an accuracy of 2 cm in range and 1 arc-minute in bearing. The precision must be maintained over inter-spacecraft ranges varying from a few meters to hundreds of meters. Autonomous operations, ranging from formation acquisition and formation maneuvering to high precision formation flying during science observations are required. Challenges lie in meeting the demanding performance as well as in demonstrating the robustness of the autonomous formation flying system. These requirements are unprecedented for deep space missions. To address them, research in system design, formation control algorithms, end-to-end real-time system simulation, ground-based and micro-g end-to-end system demonstration and relative sensor technologies is under way. Four inter-related testbeds are under development concurrently with the FFI system design effort. The testbeds include the Formation Algorithms & Simulation Testbed (FAST), the Formation Sensor Testbed (FST), the Formation Control Testbed (FCT) and the Synchronized Position Hold Engage Re-orient Experimental Satellites (SPHERES) experiment. Formation flying technologies developed under the StarLight project and the NASA Code R Distributed Spacecraft Technology program are being leveraged to meet the TPF requirements. The TPF formation flying technology efforts will advance the multiple-spacecraft formation flying technology from a current NASA Technology Readiness Level (TRL) between 2 and 3 to a TRL of 5. This paper provides an overview of the ongoing precision formation flying technology activities.

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