JWST Cryo Fine Guidance Closed Loop Test Results

M. Begoña Vila*[b,a], Scott D. Lambros[c,a], David M. Diaz[d], Henry Fu[d], Steven S. Lee[d], Luis Meza[d], Kevin J. Phillips[e,a], Ben del Rosario[d], J. Carl Wu[f,a]

[a]NASA's Goddard Space Flight Center, 8800 Greenbelt Rd, Greenbelt, MD 20771;[b]Stinger Ghaffarian Technologies, 7701 Greenbelt Rd #400, Greenbelt, MD 20770; [c]ATA Aerospace, 7474 Greenway Center Dr., Greenbelt, Md. 20770; [d]Northrop Grumman Aerospace Systems, One Space Park, Redondo Beach, CA 90278; [e]Microtel LLC, 7703 Belle Point Dr, Greenbelt, MD 20770; [f]the Hammers Company, 7500 Greenway Center Dr #1500, Greenbelt, MD 20770

INTRODUCTION

The James Webb Space Telescope uses the Fine Guidance Controller to achieve pointing accuracy to a millionth of a degree needed for its scientific observations. This closed loop controller includes the Fine Guidance Sensor (FGS) instrument, the Attitude Control System (ACS), and the Fine Steering Mirror (FSM), all working together to generate precise attitude updates every 64 ms to stabilize and point the Observatory. It was exercised for the first time with the flight hardware during the cryogenic test at Johnson Space Center.

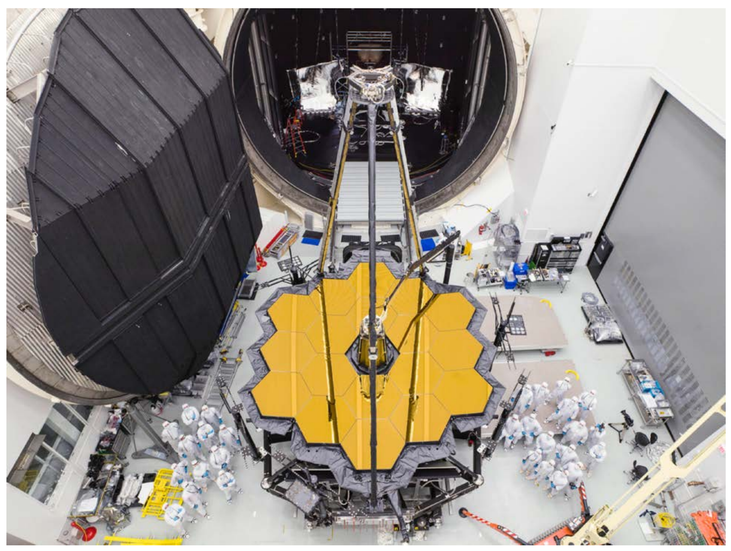

Fig. 1 OTIS exiting the JSC cryo vacuum chamber (credit NASA)

The FGS moves through 4 modes: Identification, Acquisition, Track and Fine Guide. After a successful Acquisition the centroid position of the guide star is used to slew the Observatory to the science attitude required by the prime Science Instrument.

When in track and fine guide the closed loop is engaged with the ACS. This test checked the polarity, alignment, functionality and timing performance in this closed loop system.

METHODS

Guiding was performed on a simulated source that was different from expected on orbit sources and parameter adjustments were needed that confirmed the robustness of the closed loop.

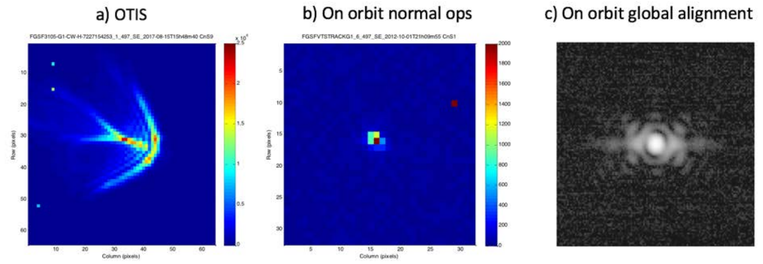

Fig. 2 Comparison of test source with on orbit sources

The FSM was used to move the source in pre-determined patterns. The FGS provides centroids with the source position, intensity and quality indicators, and images. The ACS provides telemetry of the commands sent to the FSM.
All these data were used for the different analyses.

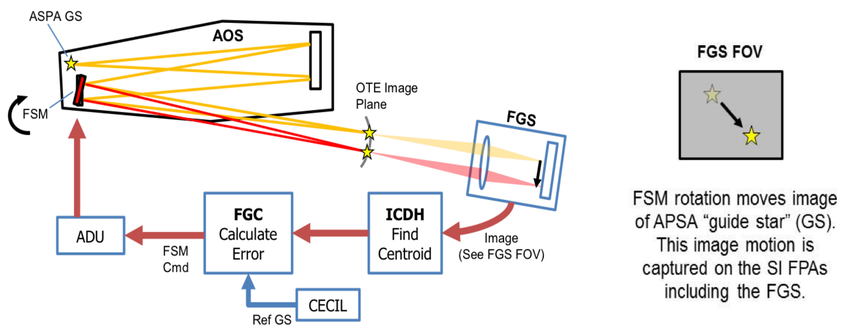

Fig. 3 Test configuration set up performed in the JSC cryo test

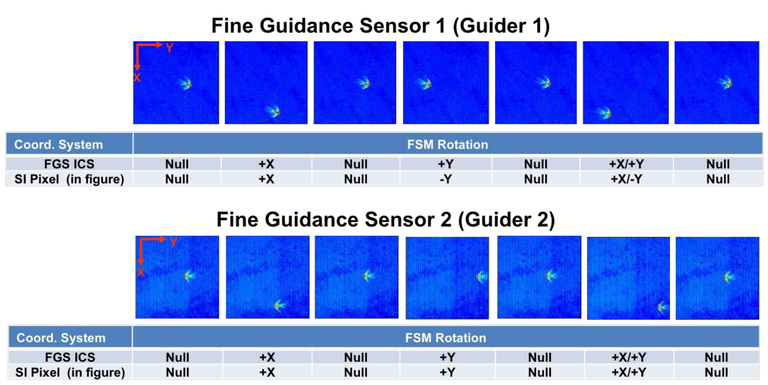

Fig. 4 Example of images from both guiders of the simulated guide star illustrating the pre-determined pattern obtained by moving the FSM

RESULTS

The centroids and images matched the expected pattern from the FSM movement of the guide star. Some small adjustments are needed on the ACS software related to distance travelled on the FGS detectors. Closed loop was maintained in a variety of patterns both in track and fine guide and useful information for on-orbit operations was obtained from the detailed data analysis.

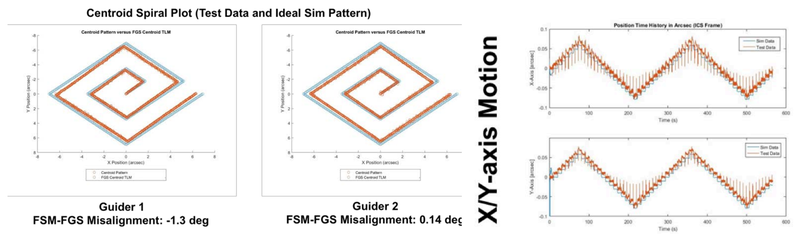

Fig. 5 Examples of the as-run image patterns compared with the expected data

A typical observation of 10000 s in closed loop and another instrument taking images in parallel as it would on orbit, duplicating the data and telemetry rates that would be seen, confirmed full functionality.

CONCLUSIONS

The polarity between the FGS coordinates and the FSM axis was confirmed and the FGS tracking performance on a moving source validated. The ability to maintain closed loop and FGS lock while tracking and fine guiding with the Guide Star moving in various patterns was demonstrated as well as the timing budget.

REFERENCES

1. Kimble, R. A, Vila, M.B, Van Campen, J. M., et al. 'Cryo-vacuum testing of the JWST integrated science instrument module (ISIM), Proc. SPIE 9904, (2016)
2. Rowlands, N., Delamer, S., Haley, C., Harpell, E., Vila, M. B., Warner, G., Zhou, J., 'Cryogenic performance test results for the flight model JWST fine guidance sensor'. SPIE, 8442-130, (2012)