



Physical Sciences

JWST Integrated Science Instrument Module Alignment Optimization Tool

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During cryogenic vacuum testing of the James Webb Space Telescope (JWST) Integrated Science Instrument Module (ISIM), the global alignment of the ISIM with respect to the designed interface of the JWST optical telescope element (OTE) will be measured through a series of optical characterization tests. These tests will determine the locations and orientations of the JWST science instrument projected focal surfaces and entrance pupils with respect to their corresponding OTE optical interfaces. If any optical performance non-compliances are identified, the ISIM will be adjusted to improve its performance. In order to understand how to manipulate

the ISIM's degrees of freedom properly and to prepare for the ISIM flight model testing, a series of optical-mechanical analyses have been completed to develop and identify the best approaches for bringing a non-compliant ISIM element into compliance.

In order for JWST to meet its observatory-level optical requirements and ambitious science goals, the ISIM element has to meet approximately 150 separate optical requirements. Successfully achieving many of those optical requirements depends on the proper alignment of the ISIM element with respect to the OTE. To verify that the ISIM element will meet its optical

requirements, a series of cryogenic vacuum tests will be conducted with an OTE Simulator (OSIM).

An optical Ray Trace and Geometry Model tool was developed to help solve the multi-dimensional alignment problem. The tool allows the user to determine how best to adjust the alignment of the JWST ISIM with respect to the ideal telescope interfaces so that the approximately 150 ISIM optical performance requirements can be satisfied. This capability has not existed previously.

This work was done by Brent Bos of Goddard Space Flight Center. Further information is contained in a TSP (see page 1). GSC-16698-1

Radar Range Sidelobe Reduction Using Adaptive Pulse Compression Technique

There is significant improvement on sidelobe performance.

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Pulse compression has been widely used in radars so that low-power, long RF pulses can be transmitted, rather than a high-power short pulse. Pulse compression radars offer a number of advantages over high-power short pulsed radars, such as no need of high-power RF circuitry, no need of high-voltage electronics, compact size and light weight, better range resolution, and better reliability. However, range sidelobe associated with pulse compression has prevented the use of this technique on spaceborne radars since surface returns detected by range sidelobes may mask the returns from a nearby weak cloud or precipitation particles. Research on adaptive pulse compression was carried out utilizing a field-programmable gate array (FPGA) waveform generation board and a radar transceiver simulator. The results have shown significant improvements in pulse compression sidelobe performance.

Microwave and millimeter-wave radars present many technological challenges for Earth and planetary science applica-

tions. The traditional tube-based radars use high-voltage power supply/modulators and high-power RF transmitters; therefore, these radars usually have large size, heavy weight, and reliability issues for space and airborne platforms. Pulse compression technology has provided a path toward meeting many of these radar challenges. Recent advances in digital waveform generation, digital receivers, and solid-state power amplifiers have opened a new era for applying pulse compression to the development of compact and high-performance airborne and spaceborne remote sensing radars.

The primary objective of this innovative effort is to develop and test a new pulse compression technique to achieve ultra-range sidelobes so that this technique can be applied to spaceborne, airborne, and ground-based remote sensing radars to meet future science requirements. By using digital waveform generation, digital receiver, and solid-state power amplifier technologies, this improved pulse com-

pression technique could bring significant impact on future radar development.

The novel feature of this innovation is the non-linear FM (NLFM) waveform design. The traditional linear FM has the limit ($-20 \log BT - 3 \text{ dB}$) for achieving ultra-low-range sidelobe in pulse compression. For this study, a different combination of 20- or 40-microsecond chirp pulse width and 2- or 4-MHz chirp bandwidth was used. These are typical operational parameters for airborne or spaceborne weather radars. The NLFM waveform design was then implemented on a FPGA board to generate a real chirp signal, which was then sent to the radar transceiver simulator. The final results have shown significant improvement on sidelobe performance compared to that obtained using a traditional linear FM chirp.

This work was done by Lihua Li, Michael Coon, and Matthew McLinden of Goddard Space Flight Center. Further information is contained in a TSP (see page 1). GSC-16458-1