Webb Sunshield Unfolds

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One of the most visually striking subsystems of NASA's *James Webb Space Telescope* is its stunning sunshield. Separating the observatory into a warm, sun-facing side and a cold, anti-sun side, a full-scale mockup of the sunshield subsystem has undergone a deployment test. Conducted by Northrop Grumman in Redondo Beach, California, this test made use of a flight-like Engineering Model (EM) known as the Integrated Validation Article (IVA) to validate the folded configuration of the sunshield and its deployment sequence. The current test involved unfolding and separating the five EM sunshield layers for the first time. The IVA performed flawlessly, and provided key insights into how the actual deployment will take place when *Webb* launches in 2018.

The tennis-court-sized sunshield, which is the largest part of the observatory, will be folded around the *Webb* telescope's mirrors and instruments during launch. As the telescope travels to its operational orbit 1.5 million kilometers from earth, it will receive a command to unfold and separate the layers of the sunshield. The sunshield will reduce the 300 kilowatts of solar power absorbed on the sun-facing side of the observatory to less than 1 watt flowing to anti-sun side. This trickle of heat is driven by a 300K temperature drop across the sunshield's enormous thermal impedance.

During operations, the primary-mirror structure and the instrument payload will radiate their heat to space and cool to a stable equilibrium temperature of about 40K.

The three-day sunshield test, which took place in July 2014, demonstrated the validity of the sunshield-folding design, its stowed configuration for launch, and validated the deployment process. Under the supervision of engineers and technicians, the five IVA sunshield membranes unfolded in about 20 hours. On orbit, the sunshield will take about 72 hours to unfold—with no human supervision required.

To simulate deployment conditions, engineers developed a clever way to reduce friction by resting the layers on a structure of metal beams covered by plastic. This simple and yet ingenious solution is clearly visible in Figures 1–3 and in a time-lapse video that documented the 20-hour deployment test (**https://www.youtube.com/watch?v=PVAe9Ovca5Q**). The current test is one among many that serves to validate the sunshield design and inform sunshield and observatory assembly processes. This particular test was aimed at validating our understanding of membrane folding and unfolding and tensioning approaches.

The sunshield's membrane layers, each as thin as a human hair, are made of Kapton—a tough, high-performance plastic coated with a reflective metal. NeXolve Corporation, a Northrop Grumman subcontractor, is manufacturing the flight sunshield layers at their facilities in Huntsville, Alabama. The five flight layers will be delivered to Northrop Grumman in 2016, when extensive testing will continue, followed by integration of the sunshield with the rest of the observatory.

Tests like the sunshield IVA are an essential part of the *Webb* program. The observatory is complex, and direct verification of the observatory models is an essential aspect of its development.

Figure 1. Picture of the full-scale sunshield model after the first successful unfolding test. This is an engineering version of the five-layered sunshield, pictured during tests at Northrop Grumman in July 2014. Manufacturing of the flight versions of individual layers is occurring in tandem. (Credit: NASA/Chris Gunn.)

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Figure 2. Northrop Grumman engineers during the deployment test. (Credit: Northrop Grumman/Alex Evers.)

Figure 3. Northrop Grumman engineer Tony Yu during the deployment test. (Credit: Northrop Grumman/Alex Evers.)