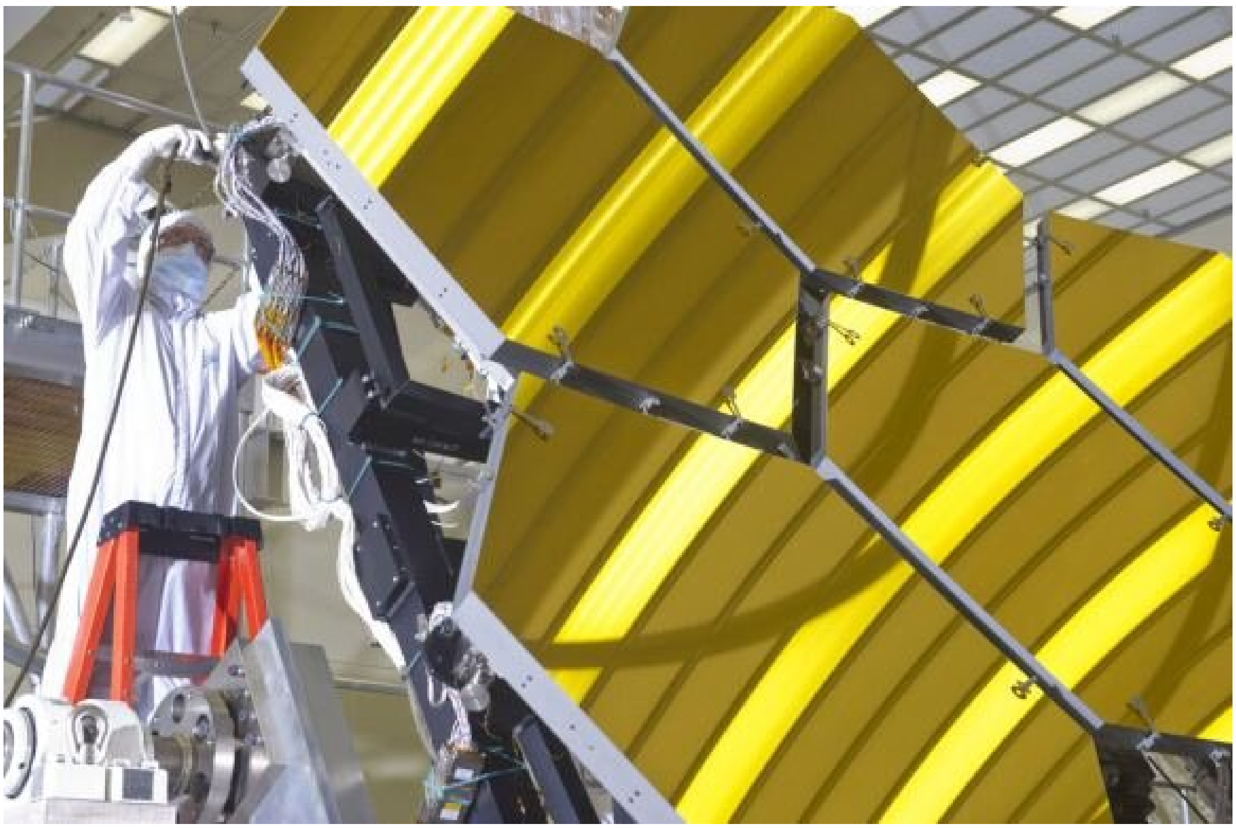
James Webb telescope going through cooling process

February 16 2022, by Andy Tomaswick



Webb’s primary mirror undergoing cryogenic testing back in 2011. Credit: NASA

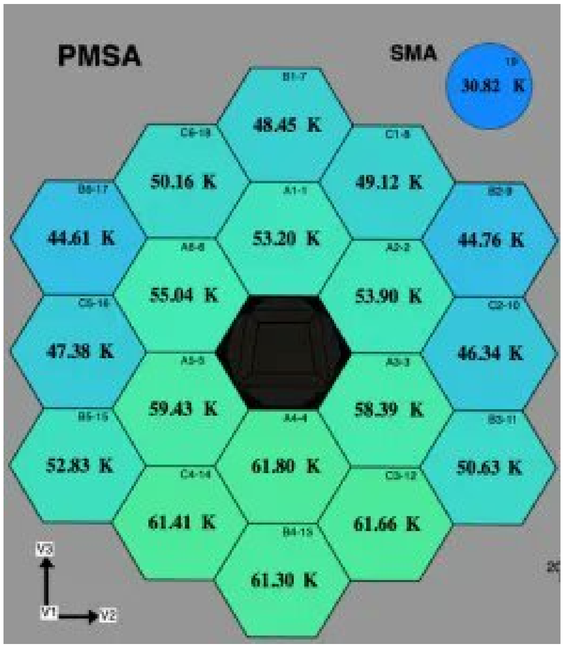
Cooling things down in space is trickier than it might sound. But that is exactly the process the James Webb telescope is going through right now. Getting down to cryogenic temperature is imperative for its infrared imaging systems to work correctly. While the telescope has already started, it will be another few weeks before the process is complete and it's ready to start capturing its first groundbreaking infrared images of the universe.

That might seem like an exceptionally long time to cool something down, but it's all part of the difficulty of doing so in space. The first tricky point is getting out of the sun, which can heat equipment up to blistering temperatures if it is exposed to direct sunlight. Luckily, James Webb has a specially designed sun shield to keep it out of direct sunlight.

The rest of the telescope's instruments have been cooling since the sunshield was deployed several weeks ago. Even so, another hurdle to overcome is the lack of two of the three ways to get rid of heat naturally in space. Conduction, where heat is transferred directly to another substance, and convection, where new material at a lower temperature is continually cycled in front of the warmer material due to gravity, don't work in the vacuum of space.

So James Webb is using the third method of heat dissipation—radiation. The heat itself slowly bleeds away in the form of infrared light. Obviously, that infrared light is the exact kind that Webb hopes to collect, so any sources other than its observational targets, such as its own instruments, can be devastating to the accuracy of its measurements.

Currently, the telescope's primary mirror segments are in the range of 40-60 K (-233 to -213 degrees C), while the secondary mirror is around 30 K (-243 degrees C). They still have a long way to go to reach their target temperatures of around 10 degrees colder than they are now (with a pretty wide spread of 15–20 degrees K expected between the segments).



Current (as of Feb 9th) temperatures of Webb’s primary and secondary mirror arrays. Credit: NASA

Webb's infrared instruments themselves have their own temperature goals. The near-infrared instruments are currently sitting around 75 degrees K, with an expected final temperature of around 40 degrees K. The temperature discrepancy with the mirrors was intentional, with NASA utilizing heaters to stop ice from forming on the optical equipment. Now, it is performing the same radiative heat transfer as the mirrors, but its sister instrument, the Mid-Infrared Instrument (MIRI), is another beast entirely.

To operate at full capacity, it must be artificially cooled to a chilly 7 degrees K (-266 degrees C), below the temperature reached by radiative cooling alone. So MIRI has an attached cryogenic cooler, which, unlike previously cryogenically cooled systems on other telescopes, reuses its own liquid helium as a cooling source.

That's just one of the many novelties on the most advanced space telescope in decades. This new progress report shows the telescope is making slow and steady progress on its checklist to starting science operations in a few months.

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