The SOFIA telescope is a joint project of NASA and the German Aerospace Center.

JIM ROSS/NASA

IS THIS TELESCOPE-ON-A-PLANE WORTH ITS PRICETAG?

NASA's unique SOFIA observatory has struggled to prove its scientific worth.

By Alexandra Witze, Mountain View, California

On dozens of nights each year, NASA sends a jumbo jet carrying a 2.5-metre telescope into the sky. As it flies above much of the Earth's atmosphere, this one-of-a-kind observatory — a US–German partnership known as the Stratospheric Observatory for Infrared Astronomy (SOFIA) — peers at astronomical wonders. It recently spotted, among other discoveries, the first type of molecule known to have formed in the Universe (R. Güsten *et al. Nature* **568**, 357–359; 2019).

The vantage point puts observers above most of the water vapour in Earth's atmosphere, allowing them to study celestial objects in infrared light that cannot be seen from the ground. But SOFIA, which costs tens of millions of dollars each year to run, has not been as impressive as many astronomers had hoped. Over its first 5 years, from 2014 to 2018, it resulted in only 21 scientific papers per year on average — making it one of the least productive telescopes worldwide, according to one analysis.

And through a freedom-of-information request, *Nature* obtained a copy of a scathing review of SOFIA made last year by an independent panel. The report is heavily redacted, but confirms that the observatory falls far short of its goals, including one to produce more than 150 scientific papers per year.

"Certainly, SOFIA has not lived up to its potential," says Paul Hertz, head of NASA's astrophysics division in Washington DC. And because of the coronavirus pandemic, the telescope has been grounded since mid-March.

Fighting against time

The clock is now ticking for SOFIA to show its worth. In February, the administration of US President Donald Trump proposed permanently shutting down SOFIA, saying it had not been productive enough to justify its US$85 million annual cost to NASA. It is the second-most-expensive astrophysics mission that NASA operates, behind only the Hubble Space Telescope. Still, it's unlikely that Congress will kill the mission. And Germany contributes 20% to SOFIA's budget.

"SOFIA has not lived up to its potential."

"There's a real challenge ahead, and the fuse is very short," says Charles Woodward, an astronomer at the University of Minnesota in Minneapolis, who has done research using SOFIA. "They have to present a bold plan."

SOFIA's leaders are working to respond to two independent reviews from last year, one about the mission's science and another about its aircraft operations. They are beefing up the telescope's scientific impact, such as by gathering higher-quality observations. The project is also bolstering the amount of SOFIA data in archives to entice astronomers to dig through past observations and publish fresh papers on them.

"Our top goal is to improve impact and productivity," says Naseem Rangwala, SOFIA's acting project scientist at NASA's Ames Research Center in Mountain View, California.

SOFIA usually flies from a NASA base in Palmdale, California, carrying a team of scientists and technicians to observe the skies for 8–10 hours per night. Occasionally, it relocates to New Zealand to study southern-sky targets.

Project overload

Initially, SOFIA managers tried to maximize the number of hours it spent taking observations. But they scheduled the aircraft so efficiently that it started lots of different observation projects — and many never finished. Over SOFIA's first 5 years, only 40% of the proposals designated as high priority were ever completed.

During the same period, SOFIA produced an average of 21 papers per year, putting it second-to-last in a list that includes 29 ground-based telescopes and the Hubble Space Telescope. In terms of impact, as measured by citations, SOFIA came last in this analysis, run at *Nature*'s request by Dennis Crabtree, an astronomer at the Herzberg Astronomy and Astrophysics Research Centre in Victoria, Canada.

SOFIA's publication rate is now creeping up, and last year it was 33 papers. The goal is 75–100 papers per year, says James Jackson, associate director for research at the Universities Space Research Association, the Maryland-based group that manages SOFIA. "More than 150 was a stretch goal," he says.

SOFIA leaders have tried to bolster the telescope's relevance with special observing projects, such as by studying the red-giant star Betelgeuse after it began dimming unexpectedly in 2019, and by scouting for water deposits on the Moon that future NASA missions might explore. "This perception that SOFIA science is just not cutting the mustard — that's not reality," Jackson says. "We are producing world-class science."

"For my research, SOFIA is essential — we get data that can't be obtained any other way," says Maggie McAdam, a planetary scientist at Northern Arizona University in Flagstaff. She has used SOFIA to study asteroids in mid-infrared wavelengths, which reveal information about how much water the bodies contain. "My whole career is based on this."