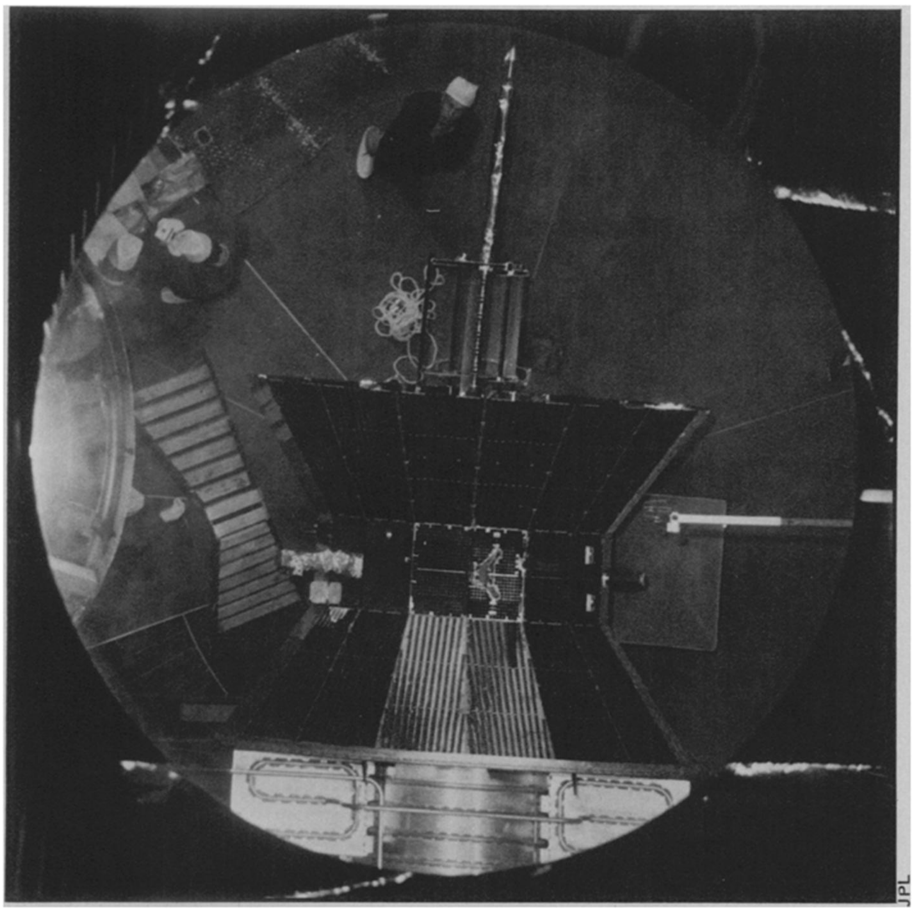
Run For The Sun

Helios leaves in November for the first close look at earth's home star—and the future looks hotter still

by Jonathan Eberhart



Helios is prepared for thermal test in JPL chamber; quartz window is at left.

During the early years of manned space flight, when fired-up aerospace companies were suggesting exotic future ideas by the hundreds to the National Aeronautics and Space Administration, an engineer named Phil Bono with the Douglas Aircraft Co. (now part of McDonnell-Douglas) produced one the company named "Icarus." Mythological names were not uncommon for spacecraft, but one day the name was suddenly changed to the made-up label, "Ithacus"—someone had belatedly remembered who Icarus was. In the exhultation of his first flight with a pair of homemade wings, Icarus had flown so high that the sun's heat melted the wax holding them together, plummeting him to earth.

This year, man will again presume to approach the sun. Not in person—the emissary will be an 800-pound space probe named Helios—but an ordeal it will be. Not even baked Mercury gets so close to the sun as will Helios. To be launched in November, the probe will take 95 days to reach its closest point to the sun, barely 28 million miles out, where the temperature will be enough to reduce solid lead to a molten mass. And visionary space officials hope in future years to go even closer.

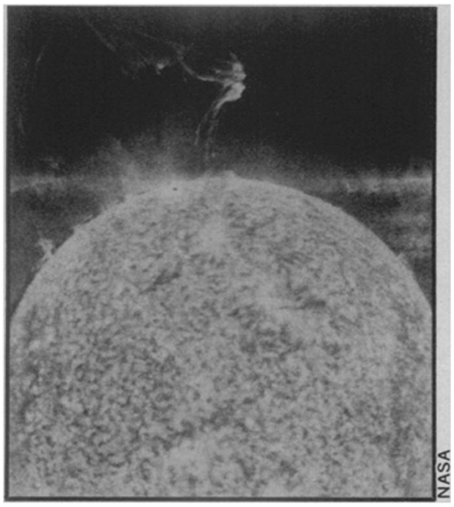
Helios is basically a German project. NASA is providing three of the ten experiments and launching the craft from Cape Canaveral, but the design, engineering and construction are all German. NASA is always ready with advice in its cooperative ventures, but Helios is facing a new and unmeasured environment. Says Gilbert Ousley, Helios project manager on the NASA side, "There just wasn't anyone around here who could say, 'Sure, I did that two years ago.' "

The sun probe was born in 1966, when President Lyndon Johnson and West German Chancellor Ludwig Erhard visited Cape Kennedy and decided that Germany, already developing a space consciousness (SN: 7/20/74, p. 36), ought to have a program that would do for that country what Apollo was doing for the United States.

The key technology that has made Helios possible, says Ousley, came about some two years later, a year before Helios actually began to take form, with the development in the United States of the second-surface mirror. This silver-backed slab of optically transparent quartz, looking very much like an ordinary bathroom mirror, offered new hope of successfully protecting the spacecraft from the expected temperatures of more than 700 degrees F., 11 times the solar energy reaching the top of earth's atmosphere. With the silver reflecting most of the heat and the quartz serving to radiate out most of the little that gets through to the spacecraft itself, the second-surface mirror is able to give back 94 percent of the thermal energy that falls on it.

Helios, however, will spend about 25 days out of each six-month orbit at almost its closest distance to the sun, so other techniques were added to be sure the heat would not build up. To distribute the heat load, the probe will be kept spinning at one revolution per second. The solar cell panels providing power for the spacecraft will be angled so that the sun does not strike them head-on. Movable louvers pointing away from the sun will be opened periodically to release any internal heat that may build up from electronic components.

Helios engineers are confident, Ousley says, that these cooling methods will combine to keep the temperature within the probe down to between 32 and 104 degrees. The few scientific instruments that must be deployed on booms outside the spacecraft will have their own protective shielding. The only components to be exposed to the full fury of the sun will be 100 lengths of platinum-rhodium wire in the antenna that will send Helios' data back to earth (even the antenna framework is insulated), and they have already passed a ground test at the predicted


NASA

The UV sun, photographed from Skylab.

temperature (SN: 7/6/74, p. 9).

Simulating the environment that Helios must endure was difficult enough in its own right. The tests, vital to be sure that the spacecraft's components would survive their ordeal, had to provide not only the sun's broiling heat but an extreme vacuum, as well as the "cold sink" effect of frigid space. The challenge was met in a vast, 85-foot-high, cylindrical chamber at the Jet Propulsion Laboratory in Pasadena, which had already provided 6.5 "suns" (6.5 times the solar energy reaching earth's atmosphere) in tests of the Mariner 10 Venus-Mercury probe.

The vacuum was provided by a monstrous pump, which took two hours to reduce the chamber pressure to a few ten-millionths of that at sea level on earth. The cold of space was simulated by pumping liquid nitrogen through pipes surrounding the chamber's inner walls, chilling the walls down to some 300 degrees below zero F.

The big problem was simulating the heat of the sun itself. A bank of 37 xenon arc lamps, shining up from a basement through a quartz window, offered an 800,000-watt sunbath, but the mirror that normally reflects the light onto the test spacecraft from the chamber ceiling had to be augmented with one much closer down for Helios, and a specially adapted lens system was needed to further concentrate the heat. Before the test series began, says JPL's John Harrell, who helped run it, there were concerns not about insufficient heating, but that the quartz window might crack from the wide temperature range. This happened once in a simulation at another facility, and the vacuum caused such an implosion that quartz shrapnel virtually destroyed the object under test. At JPL, both chamber and spacecraft survived. "We hope it's an omen as well as a successful test," says one official.

Once in space, Helios' scientific duties will begin as it passes through the shock wave created where earth's magnetic field blocks the solar wind. Not one, not two, but three magnetometers will measure the shape, strength and fluctuations in the interplanetary magnetic field, which is expected to be as strong as several hundred gamma near the sun. Other instruments will catalog the uncharted environment's population of cosmic rays, electrons and micrometeoroids, and even attempt the considerable feat of measuring the brightness of zodiacal light (sunlight scattered by interplanetary dust) in the photon-drenched vicinity of the sun.

One of the most versatile experiments will be a freebie—no special instrumentation is needed for it—that consists merely of analyzing the spacecraft's radio beam to earth. By studying the sun's effect on the beam, researchers from the University of Hamburg and JPL hope to refine the shape of the sun's magnetic field, learn more about the motions of the inner planets, measure the density of electrons between the sun and the earth, calculate the density of the solar "fringe" and even, by finding out whether the beam is bent and slowed by the sun's powerful magnetic field, test some of the predictions of general relativity theory.

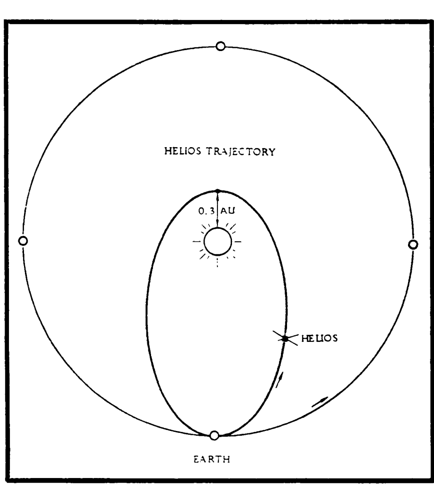
Officially, Helios has been designed to last for 18 months—three trips around the sun. "But," says Ousley, "you have to design for something." The real hope is that it will last much longer. Many earth-orbiting satellites have outlived their design lifetimes, particularly weather satellites, which have a remarkable record of exceeding their mentors' expectations. And even if Helios is a complete bust, Helios B is being readied for a virtually identical mission beginning in December 1975.

Meanwhile, theorists, engineers and space officials are looking beyond the Helios program at flights even closer to the sun. NASA's official speculations extend only through a 1980 mission that would send a probe through the tail of Comet Encke, coming within about 33.5 million miles of the sun to do it, not even as close as Helios. But some sun-watchers have visions of directing spacecraft to within less than 10 million miles of earth's home star.

Physicist Harry Ruppe, for example, came from Germany to the U.S. Army and later to NASA with Wernher von Braun's team in the mid-1950's. Now at the University of Munich, Ruppe envisions a wide range of solar missions using various techniques to get there such as planetary swing-arounds, auxiliary rockets and the space shuttle. His favorite, he reports in the July ASTRONAUTICS AND AERONAUTICS, is an elaborate trip requiring pinpoint navigation, in which a probe would be sent by Venus to bend its path in toward the sun; it would swing around the sun at about 27 million miles (already inside Mercury, which it might study on the way), travel back out to Venus and finally spiral back in to slip by the sun little more than 18 million miles away.

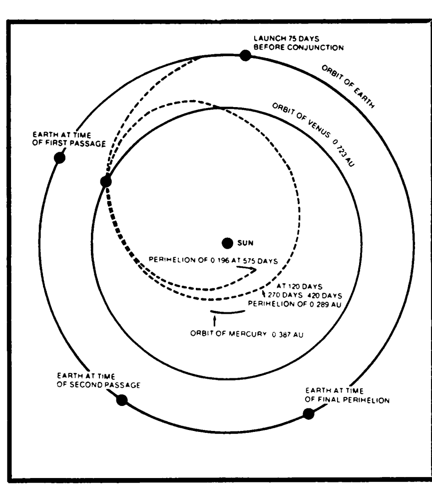
The idea is an ambitious one. Among other factors, the probe would have to last some 575 days, although Pioneer 10 endured 640 days getting to Jupiter. The big problem, again, will be heat. Helios will be sweating it out in the heat of 11 "suns" (measured atop earth's atmosphere), but Ruppe's pet would face more than 25. This would probably fry mere solar cells to the point of uselessness, requiring the use of nuclear or solar-heat driven power supplies. A still closer flight to a little over nine million miles would subject the probe to 100 "suns," necessitating even more exotic technology such as major use of heat pipes.

Yet even Ousley, who admits that such plans are not officially being considered by his agency, says that the technology already exists to fly the likes of Ruppe's 18-million-mile pass. The Skylab astronauts discovered facets of the sun that had previously been unknown; Helios will depart this fall for a closer look. It should provide new questions as well as answers. □



NASA

Sun-circling orbit is six months long.



Astronautics and Aeronautics

Ruppe: To Venus to sun to Venus to sun.