Approaching First Light on La Palma

LOOKING SOUTH, I could see nothing but the yawning chasm of Caldera de Taburiente, with its precipitous slopes and flying buttresslike ridges rising from a sea of cloud several thousand feet or more below my feet. Just behind me, amid the noise and dust associated with any construction site, were the half-finished buildings of Observatorio del Rocque de los Muchachos — sure to become one of the world's foremost astronomical installations.

THE BEGINNINGS

The British have finally taken Sir Isaac Newton's advice that the "most serene and quiet air such as may be found on the tops of mountains above the grosser clouds" is the best location for large telescopes. It is surely poetic justice that the poor performance of the 98-inch Isaac Newton Telescope (INT) — from its sea-level site at the Royal Greenwich Observatory — was one of the major reasons behind an intensive site-testing campaign in the early 1970's to find a new location for British telescopes in the Northern Hemisphere.

In January, 1967, Hermann Brück, Astronomer Royal for Scotland, first proposed the construction of a Northern Hemisphere Observatory (NHO) equipped with a 150-inch telescope. Exactly two years later, a committee under Fred Hoyle convened to examine the feasibility of such an undertaking, and by mid-1971 the project was in the planning stage.

The choice of a site was strongly influenced by Merle Walker of Lick Observatory and his extensive investigation of the factors determining good observing conditions. Walker developed the technique of examining trails of circumpolar stars as a means of measuring the steadiness of the Earth's atmosphere. He carried out such observations at sites around the world.

Early in 1971 he wrote that "the best seeing occurs at sites on peaks near seacoasts having cold ocean currents offshore that reduce the height of the [temperature] inversion layer, and where the laminar airflow set up over the ocean still persists." He also concluded that "mountain peaks on (small) islands in warm oceans may be good sites, provided that the peaks are sufficiently high to place the observer above the inversion layer. . . ." The importance of an inversion layer is that clouds, or smog in cities like Los Angeles, get trapped below it, leaving clear skies above.

One location fulfilling the latter conditions, Mauna Kea on the island of Hawaii, was already known to be a very good observing site. In addition, excellent reports of the seeing on Tenerife in the Canary Islands were given by Charles Piazzi Smyth after his 1856 expedition "to ascertain how much astronomical observations may be benefitted, by eliminating the lower third or fourth part of the atmosphere" (*S&T:* September, 1981, page 199). On the basis of all the available evidence, Walker produced a list of potentially favorable observing sites that included Tenerife and its near neighbor La Palma, as well as Madeira, Corsica, and Crete.

As is often the case in scientific endeavors, several people reached the same conclusion simultaneously. Walker was not alone in recognizing the Canary Islands' potential. In 1971, John Alexander of the Royal Greenwich Observatory was investigating possible observing locations in the Mediterranean area, and his quest took him to La Palma. His report, published later the same year, stated: "The ideal solution may be an international observatory site on the island of La Palma."

SITE TESTING

The Canary Islands, located at approximately 28° north latitude, are a Spanish archipelago of volcanic peaks lying between 70 and 300 miles off the northwest African coast. They were colonized by Spain about the same time Columbus made his first transatlantic voyage and were, incidentally, his last landfall before the New World. In classical times they were the most westerly point in the known world. Today they are familiar to hundreds of thousands of tourists who flock there annually for the island's extensive beaches and equitable climate with over 3,000 hours of sunshine per year.

However, the site-testing teams dispatched to Tenerife and La Palma in 1972 under the direction of the Royal Observatory Edinburgh (ROE), had to put up with more spartan conditions than those experi-

Above: **Caught in late afternoon sunlight, Tenerife's volcanic peak Teide is visible on the eastern horizon across La Palma's cloud-filled Caldera de Taburiente.**

enced by the average tourist. The survey on Tenerife was made at the well-developed site of the Observatorio del Teide, founded in 1959 by Francisco Sanchez Martinez. Located 7,240 feet above sea level at Izana, near the rim of the vast Las Canadas volcanic crater, it is not far from Guajara, the location of Smyth's original observing station.

Conditions on La Palma, or more correctly San Miguel de la Palma, were very different. The island itself measures only 26 miles north to south and 16 east to west. Shaped like an isosceles triangle with a southward pointing apex, the island is dominated by the 4½-mile-diameter volcanic crater Caldera de Taburiente. Rising to almost 8,000 feet at its highest point — called Rocque de los Muchachos — the caldera's rim is a desolate region of scrub vegetation and volcanic ash.

The site under investigation was Fuente Nueva, a small peak on the northern edge of the caldera adjacent to the Rocque. The survey took place in August and September, 1972. During this period the testers lived in tents and used mule trains to transport their equipment and supplies up the lushly vegetated lower slopes and through the dense pine forests that ring the caldera.

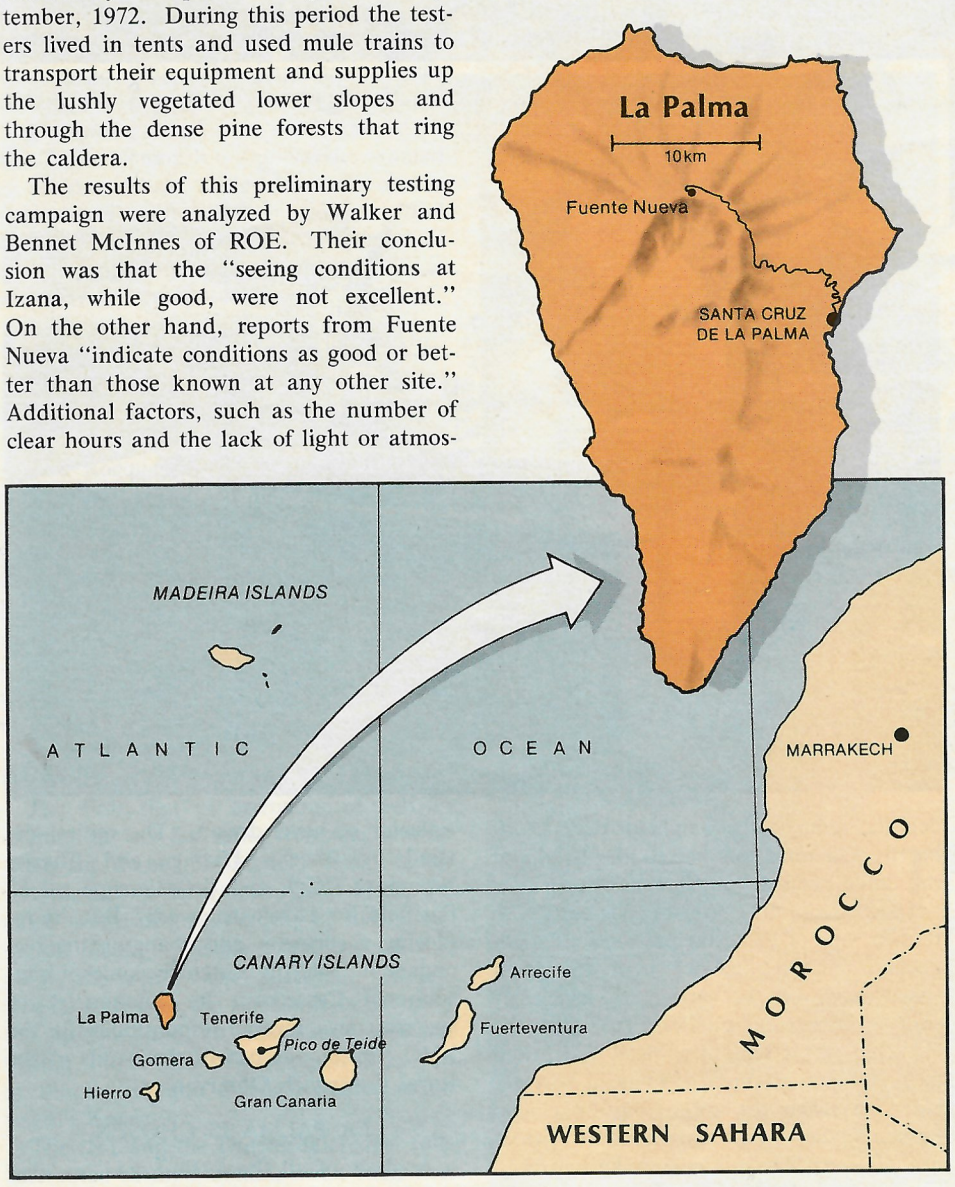
The results of this preliminary testing campaign were analyzed by Walker and Bennet McInnes of ROE. Their conclusion was that the "seeing conditions at Izana, while good, were not excellent." On the other hand, reports from Fuente Nueva "indicate conditions as good or better than those known at any other site." Additional factors, such as the number of clear hours and the lack of light or atmospheric pollution singled out the La Palma site as being exceptional.

These results were also borne out by the preliminary findings of the testing group for the Joint Organization for Solar Observations (see the adjacent box), which investigated daytime observing conditions.

While waiting for the results of more extensive studies at Izana and Fuente Nueva, Edinburgh dispatched observers to two additional locations. These were Encumeada Alta, a peak on the Portuguese island of Madeira (see the map), and Mauna Kea. By the end of 1975, a vast amount of data had been collected on all four sites. The stage was now set for a final decision on the NHO's location.

THE TELESCOPES

The correct choice of instruments at an observatory is almost as important as its site. Observing time on large telescopes is notoriously oversubscribed. To devote all the available resources to a single large instrument would preclude observations that



The island of La Palma is depicted with respect to the Canary archipelago and the African coast. The existing astronomical facilities at Izana on Tenerife, operated under the direction of Francisco Sanchez, are adjacent to the 12,200-foot extinct volcano Teide.

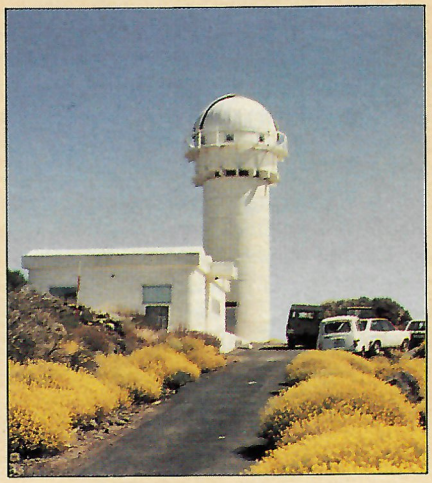
THE JOSO CONNECTION

Another person to recognize the Canary Islands' potential as the location of world-class observatories was the veteran astronomer Karl Kiepenheuer of West Germany's Fraunhofer Institute. Members of the European solar physics community, under Kiepenheuer's leadership, had founded the Joint Association for Solar Observations (JOSO) in 1968. One of its prime goals was to find and develop a site for an international solar observatory.

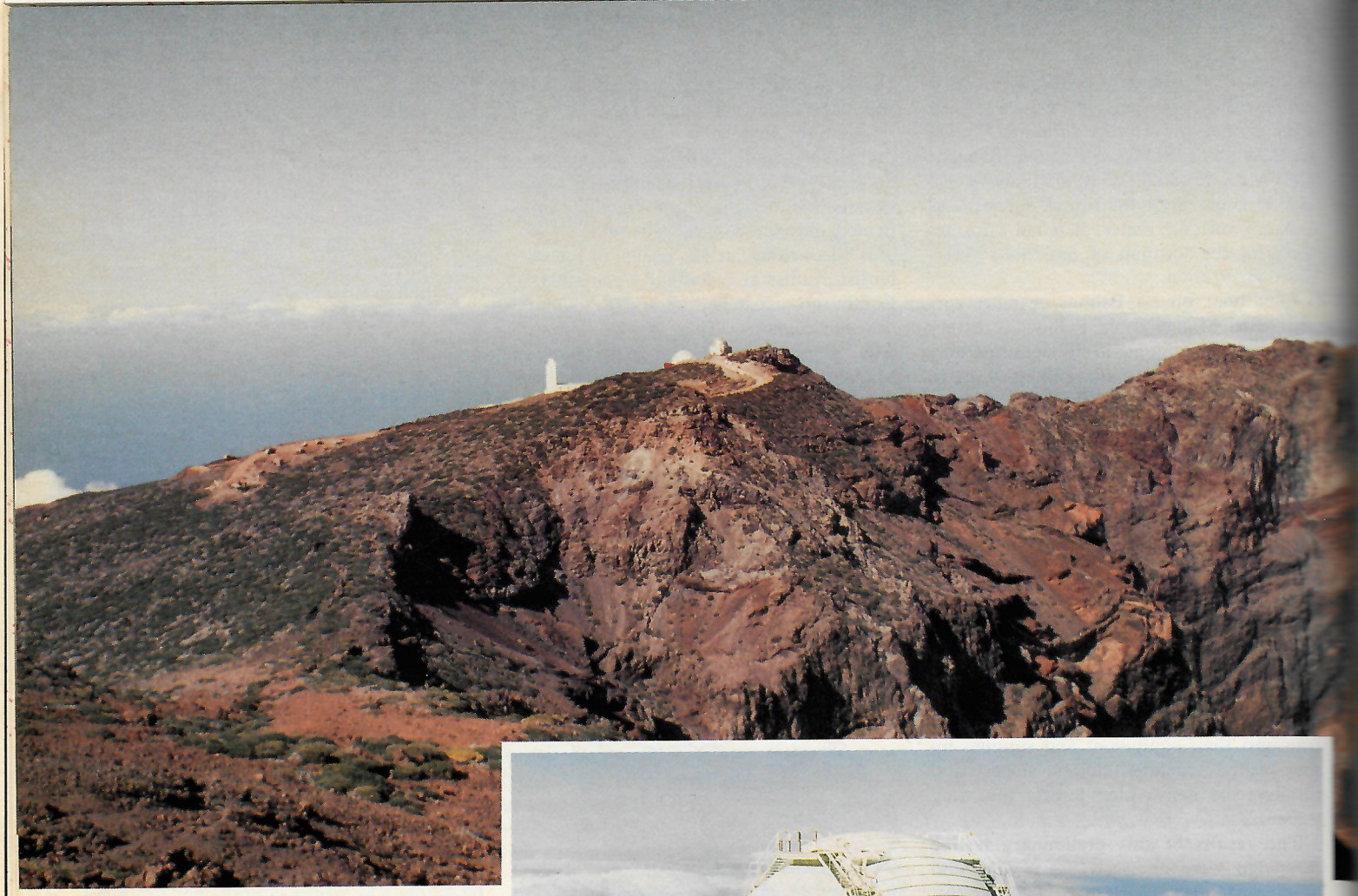
In the course of its survey, about 40 possible locations were investigated and rejected. However, in March, 1971, Tenerife was visited, and later that year preliminary atmospheric turbulence measurements were taken by an aircraft flying over La Palma. As a result of these tests Kiepenheuer became convinced that JOSO need look no further.

After many years of extensive comparative observations on La Palma and Tenerife, the JOSO investigators came to a surprising conclusion — La Palma may have superb nighttime conditions but Izana was a better site for daytime observing. The principal reason is that solar heating of air trapped in the Taburiente caldera can destroy the temperature inversion locally and cause turbulence. At a more open site, such as Izana, this condition is less likely to occur.

An immediate consequence of this finding was the decision by West German solar physicists to relocate their 45-cm Gregorian telescope from Locarno Observatory to Izana. They also began constructing the new 60-cm Vacuum Tower Telescope on the same site. Additionally, the existing 40-cm testing telescope at Izana would be upgraded to a fully equipped research instrument, while its near twin on La Palma would be dismantled.



The German-Spanish solar tower at Izana. All photographs in this article are by the author unless otherwise credited.



The tall Swedish solar tower is visible to the left of the INT building (see inset) and the dome of the 1-meter telescope in this view of Fuente Nueva and the rim of the Taburiente caldera as seen from Rocque de los Muchachos. The INT picture was taken by RGO photographer Dave Calvert.

could be made with a smaller telescope. Thus, to make the best use of a good site requires the construction of a number of instruments of different apertures.

The idea of building a very large reflector for faint-object work was retained. However, difficulties are encountered in constructing efficient auxiliary devices, such as spectrographs, if the primary mirror is too large. As a result, it was determined that an aperture of about 180 inches (4.5 meters) was the optimum size.

Upon investigating the availability of a suitable mirror, it was found that Owens-Illinois already had a 165-inch (4.2-meter) Cer-Vit disk in stock. This was the last of a batch of blanks that included the primaries for the 3.9-meter Anglo-Australian Telescope and the Cerro Tololo 4-meter telescope. Each successive disk formed from the same mold came out slightly larger than its predecessor.

Economic considerations led to the choice of this blank for what was to become known as the William Herschel Telescope. In addition, the same reasoning suggested that an altazimuth mounting was appropriate for such a telescope. This decision reduced the weight of the mounting by 120 tons and halved the height of the dome needed.

Spectroscopy has been, and is certain to remain, one of the principal tools of astrophysical research. Very high resolution spectroscopy can be carried out efficiently with an instrument smaller in size than the Herschel. This type of work is well suited to a 100-inch telescope. Thus, it was decided to move the INT from its cloudy Sussex home, while upgrading it with a new 100-inch Zerodur mirror, an improved mounting, and a large coude spectrograph.

The third and smallest telescope at the NHO was to be a dual-purpose 1-meter reflector of novel design. The optics, devised by Charles Harmer and Charles Wynne of RGO, give the telescope a 1.5° flat field for astrometric work. But, by removing a corrector and changing the secondary mirror, the system becomes a conventional Cassegrain for photometry or spectroscopy. Overall responsibility for the NHO project was put in the hands of the Royal Greenwich Observatory.

LA PALMA IS CHOSEN

Analysis of all the testing data revealed clearly that Mauna Kea and Fuente Nueva were the best astronomical sites known. The difference between the two was slight.

For example, the seeing was better than 1 arc second 36 percent of the time on Mauna Kea and 40 percent for La Palma. The two really significant drawbacks of the Hawaiian site for the British were the problems that observers would suffer from its much greater altitude and its distance from Europe. So, after many years of searching, La Palma was finally chosen.

On May 26, 1979, almost 10 years after the first committee met to consider a Northern Hemisphere Observatory, a treaty governing its establishment was signed. Spain agreed to let Denmark, Sweden, and Britain build on La Palma, in exchange for 20 percent of the observing time.

On the Spanish side, a major reorganization of astronomical research had led to the founding of the Instituto de Astrofisica de Canarias (IAC) under the directorship of Sanchez. The IAC owns and operates the Izana observatory and the new site on La Palma — now officially known as Rocque de los Muchachos Observatory.

The Danish contribution is the Carlsberg Automatic Transit Circle (*S&T*: June, 1983, page 490). This joint project with Britain was funded in part by the Carlsberg brewing empire, a noted patron of science in Denmark. The Swedes wanted to build a 60-cm stellar telescope and a solar tower with a 60-cm heliostat and 44-cm Cassegrain. In fact, construction of these installations started within days of the treaty's signing.

THE OBSERVATORY TAKES SHAPE

By spring of 1984 the first astronomers to use the British telescopes for research projects will be on the island, and the area around Rocque de los Muchachos will begin to look like an astronomical observatory. Every day a steady stream of traffic carrying both personnel and equipment will make the two-hour journey between La Palma's main town, Santa Cruz, and the mountaintop. Much of the road, which follows a tortuous route skirting numerous narrow, deep barrancas (canyons), has yet to be surfaced. However, the route is passable in all but the worst weather, when landslides and washouts are common.

The first sign of astronomical activity visitors see is a few miles from the summit when the domes of the INT and 1-meter telescope come into view. Soon after, the large unfinished residencia, or accommodation block, is visible. Just beyond this point the road, now surfaced, divides. One branch goes the final mile or so up to the Rocque and an abandoned German testing tower. The other branch takes you to the British and Swedish telescopes on Fuente Nueva.

The INT and the 1-meter telescope, fully assembled in their domes, await their first users. For those who wish to make observations during the first six months of observing, November 7th last year was the deadline for proposals. By the middle of January, the lucky few chosen were notified.

If any among this first group wish to use the 165-inch telescope, they will have to be content to look at its partially completed building. The Herschel telescope itself has been assembled at the Grubb Parsons factory in England (as shown below), but final installation on the island will not take place for a few years. The Swedish telescopes have been operational for several years, but are suffering — much to the chagrin of their users — from dust thrown up by work on adjacent construction sites.

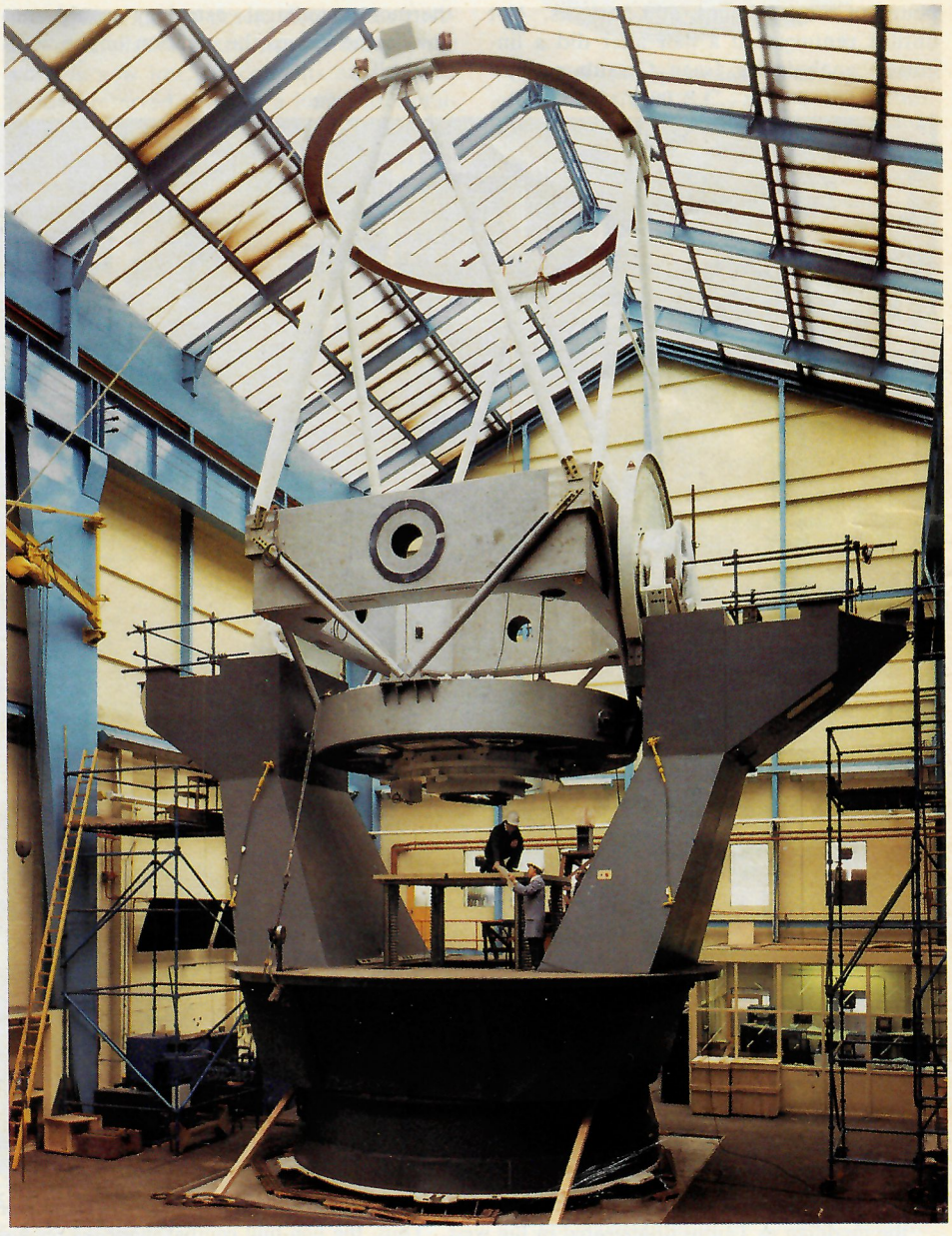
Since 1979 the scope of international collaboration on La Palma has widened. The Netherlands has gone into full partnership with Britain and is supplying personnel, equipment, and money in return for 20 percent of the observing time. Ireland has also joined on a lesser scale by buying 27 nights a year on the 1-meter.

Other countries, particularly Italy and the Nordic group, are thinking of locating instruments there. According to Alec Boksenberg, director of RGO, this cooperation engenders "a sort of synergy between international groups that enhances the site beyond the sum of its components."

In A.D. 150 the great astronomer Ptolemy chose Hierro, the most westerly of the Canary Islands, as the location of the prime meridian of longitude — the Greenwich of the ancient world. Even as late as the end of the 18th century some cartographers continued to use this old convention.

More than 100 years ago the islands came to the attention of Smyth. He wrote, "We wonder how long the learned world will delay to occupy a station, that promises so well, for greatly advancing the most sublime of all the sciences." Today, we know the answer.

DAVID H. SMITH



The 4.2-meter William Herschel Telescope, under construction at the Grubb Parsons factory (see page 227), will soon be installed on La Palma. Picture courtesy NEI Parsons.