EUROPEAN SOUTHERN OBSERVATORY

BULLETIN NO. 3

The Governments of Belgium, the Federal Republic of Germany, France, the Netherlands, and Sweden have signed a Convention[1] concerning the erection of a powerful astronomical observatory on October 5, 1962.

By this Convention a European organization for astronomical research in the Southern Hemisphere is created. The purpose of this organization is the construction, equipment, and operation of an astronomical observatory situated in the Southern Hemisphere. The initial program comprises the following subjects:

1. a 1.00 m photoelectric telescope,
2. a 1.50 m spectrographic telescope,
3. a 1.00 m Schmidt telescope,
4. a 3.60 m telescope,
5. auxiliary equipment necessary to carry out research programs,
6. the buildings necessary to shelter the scientific equipment as well as the administration of the observatory and the housing of personnel.

The site of the observatory will be in the middle between the Pacific coast and the high chain of the Andes, 600 km north of Santiago de Chile, on La Silla, at an altitude of 2400 m.

[1]) The ESO Management will on request readily provide for copies of the Paris Convention of 5 October 1962.

Organisation Européenne pour des Recherches Astronomiques dans l'Hémisphère Austral

EUROPEAN SOUTHERN OBSERVATORY

BULLETIN NO. 3

February 1968

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ESO BULLETIN NO. 3

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SPEECH MADE AT THE INAUGURATION OF THE ROAD TO LA SILLA

G. Funke

Your Excellency, Ladies and Gentlemen,

In April 1964 a helicopter of the Chilean Airforce brought two astronomers of our Organization on the mountain La Silla. They spent about one hour up there, made a few photographs and ascended the main summit. In the afternoon of the same day they flew to the mountain Guatulame south of Ovalle. In the evening of the same day they compared their opinions and they agreed immediately that, for the erection of an astronomical observatory, La Silla was by far the better one of the two mountains.

Quite a number of other mountains between Copiapó and Santiago had been investigated earlier by Dr. Stock who was looking after a site for the AURA Observatory. In the spirit of cooperative friendship, so widely distributed among astronomers, AURA had given to ESO many fundamental experiences about the astronomically relevant climatic conditions in Chile. We have to emphasize thankfully that we saved quite some time by AURA's assistance. Before La Silla and Guatulame we have taken into consideration many other mountains. But La Silla appeared to us the most favourable of all of them. It lies sufficiently far south to make the essential objects of the southern sky which are to interest the astronomers easily observable. It lies sufficiently far north to participate in the cloudlessness of the Atacama-Desert. It is not so high that the storms could become troublesome or even dangerous, that our domes and roofs could not bear in winter the load of snow. It is not so low that the clouds of fog from the Pacific Ocean, which often cover large parts of the coast and advance far into the country, could disturb us seriously. We believe that the horizontal geological layers, which gave the mountain the other name of "Cinchado", prove that earthquakes will scarcely influence our buildings and instruments. Its flanks are soft and easily accessible, so that roads may be easily constructed. The Instituto Geográfico Militar provided us with a series of air photographs and we studied the area very carefully. We produced a map 1:50 000 on which we could search existing access roads and plan new ones. We found sufficient amounts of water in Quebrada Pelícano which, however, we shall have to pump up by some 1400 m.

When one is riding south along the Panamericana from Vallenar to La Serena one sees the big massive, well isolated from the higher mountain chains in the east, towering over the surroundings. We feel that the mountain is beautiful.

We acquired the land property of the mountain and its vicinity, so that future developments will find sufficient place, maybe for new instruments in optical, maybe for some antennae in radio astronomy. In the beginning we aim at developing the area so far that in the near future numerous European astronomers will be eager to come to work under the prevailing quite uniquely favourable conditions.

Already during the next months our first instrument will be installed on the mountain. You will see the building under construction. The dome and the finished parts of the instrument are stored here and wait for the completion of the building. But the astronomers still will have to live in wooden huts as long as the other buildings, and among them the mountain hotel, are not yet available.

I am not going to explain to you the complete plans of the Observatory. Please look at the plans fixed at the board (over there). Various gentlemen of our Organization are prepared to give you all possible comments.

Our present and our future work will be much facilitated by the vicinity of both towns, Coquimbo and La Serena. Vallenar and Huasco may become important too. We had the support of the Community of La Higuera, to which we belong, and even the little village of Chañar has shown its sympathy.

The Council of our Organization which for the time being has honoured me with its presidency has since long felt the increasing urgency to make the acquaintance of the country where the European astronomers are going to work. The design and financing of the buildings can be reviewed justly only by people who have seen the landscape personally. The future organization of the whole institute whose headquarters — as you know — will with good reasons be erected in Santiago, is only then clearly understood if we ourselves undergo the experience of the extension of the country. We are happy that we decided to make the long journey. In a period of 10 days we shall visit many points of interest between La Silla and Santiago. We shall be especially glad about any and every contact with the people of this most beautiful and interesting country.

In spite of the fact that today we are going to open only our mountain road we felt the desire to invite our numerous friends, those who have made the beginning of our work easier and those who helped again and again. In this country we have met with great sympathy. We had and have the support of the Government in Santiago, of the Administration of this Province which is under your guidance, Sr. Intendente, of corporations and organizations, of firms and private men, of engineers and lawyers. Whether we had to deal with water or electricity, with wages or insurances, with import or transport, with road construction or providing of materials, whatever it was: everywhere we found rich advice and ready assistance; in the early beginning when horses and mules were the only means of transport; and today, where we have a whole carpark.

A particular vote of thanks is due to you, Mr. Archbishop, because you did not hesitate to come and to bless the beginning of our project. May your benediction help us all during our future work.

ESO is not the only group aiming at astronomical research in this country. AURA was here before us and is constructing an observatory on Tololo;

CARSO—Carnegie Southern Observatory—is planning to erect in the Norte Chico a very grand institute; the Sowjet Academy of Sciences is going to establish an observatory not so far from Santiago. Chile is on her way to become the centre of astronomical research in southern latitudes. It is very probable that the various institutions mentioned will build up a permanent exchange of people and ideas and will try to find paths to an efficient cooperation. Our Organization, like others, has signed a contract with the Universidad de Chile about an intense collaboration on Cerro Calán near Santiago. We are sure that Chilean science will participate in the opportunities to be developed in the near future.

If we look around here, we see what has been achieved in the short period of a little more than one year. Under the able leadership of Dr. A. B. Muller, Europeans and Chileans have created an oasis in the desert. Dr. Muller sacrificed many years of astronomical research in order to find a suitable site for ESO; at first in South Africa and later in Chile. In the beginning he had to sustain all the difficulties of language, climate, and isolation. But he mastered slowly the early complications. We have to recognize that—if the name of a man in our group is to be mentioned at all—it is his. He gained a reputation among astronomers in Europe and abroad which proves that his completely unselfish work deserves to be never forgotten.

We have to express our gratitude to every astronomer, technician, and workman who cooperated in the joint effort. In particular the Chilean obrero has to be mentioned, because his readiness to work under the exceptional conditions of this area, his untired willingness to undergo the hardship of the early period are some of the factors which made our work possible.

I warmly wish that our work will be beneficial to the nations supporting this project, to all nations building up their research in this country, but in particular to the land of Chile. With our sincerest thanks to the President of the Republic, the Authorities, and the people of Chile who give us their hospitality to such a large extent, I now open the road from Campamento Pelícano to Cerro La Silla.

Dr. G. Funke, General Secretary of the
Swedish Natural Science Research Council,
President of the ESO Council, Wenner
Gren Center, Sveavägen 166, Stockholm 23,
Sweden

DISCURSO PRONUNCIADO CON MOTIVO DE LA INAUGURACION DEL CAMINO AL CERRO LA SILLA

G. Funke

(traducción del precedente texto inglés)

Señor Intendente, Monseñor, Señoras y Señores:

En el mes de abril de 1964 un helicóptero de la Fuerza Aérea de Chile llevó al monte La Silla a dos astrónomos de nuestra Organización. Ellos permanecieron allí arriba aproximadamente una hora, sacaron unas pocas fotografías y ascendieron por la cumbre principal. En ese mismo día, por la tarde, volaron hasta el monte Guatulame al sur de Ovalle. Al atardecer del mismo día, compararon sus opiniones y decidieron inmediatamente que, de entre los dos, La Silla era, sin discusión alguna, el monte más indicado para la edificación de un observatorio astronómico.

Anteriormente, un número bastante extenso de otros montes situados entre Copiapó y Santiago ha sido investigado por el Dr. Stock, el cual estaba buscando un lugar para el Observatorio del AURA. De acuerdo con el espíritu de amistad cooperativa tan ampliamente difundida entre los astrónomos, el AURA había proporcionado a ESO muchas experiencias fundamentales sobre las condiciones climatológicas de Chile que revisten importancia desde el punto de vista astronómico. Debemos recalcar — y damos las gracias por ello — que la asistencia que nos ha sido prestada por el AURA nos permitió ahorrar buena cantidad de tiempo. Antes de tomar en consideración La Silla y Guatulame, habíamos considerado muchos otros montes. Empero, La Silla nos ha parecido el más favorable de todos. Está ubicado suficientemente al sur para que resulten fácilmente observables los objetos esenciales del cielo austral, que revisten interés para los astrónomos. Se encuentra situado suficientemente al norte para beneficiarse de la ausencia de nubosidad del Desierto de Atacama. No está a una altitud tan elevada como para que las tormentas puedan tornarse molestas o hasta peligrosas, o que nuestras cúpulas o techos no puedan soportar las cargas de nieve durante el invierno. No está a una altitud tan baja como para que las nubes de neblina provenientes del Océano Pacífico — que a menudo cubren grandes sectores de la costa y se adentran mucho al interior del país — puedan ocasionarnos serias molestias. Nosotros creemos que las capas geológicas horizontales, que dieron al monte el otro nombre de "Cinchado", demuestran que los terremotos tendrán escasa influencia sobre nuestros edificios e instrumentos. Sus laderas son blandas y de fácil acceso, de suerte que la construcción de caminos resultará fácil. El Instituto Geográfico Militar nos proporcionó una serie de fotografías aéreas, y hemos estudiado la región muy detenidamente. Hemos preparado un mapa a 1:50 000 sobre el cual pudimos estudiar los caminos de acceso existentes y planificar nuevos caminos. Hemos encontrado en la Quebrada Pelícano suficientes cantidades de agua que, empero, tendremos que hacer subir unos 1.400 metros mediante bomba.

Cuando se recorre la Panamericana hacia al sur, desde Vallenar hasta La Serena, se puede observar el gran macizo montañoso que se encuentra claramente aislado de las cadenas montañosas más altas, situadas al este, y que se eleva dominando los alrededores. Verdaderamente el monte es muy hermoso.

Hemos adquirido la propiedad del terreno del monte y de su vecindad, de suerte que los desarrollos futuros dispondrán de suficiente espacio, tal vez para nuevos instrumentos de astronomía óptica, tal vez para algunas antenas de radioastronomía. Al comienzo, nuestro propósito es desarrollar la región de modo que, en un futuro próximo, numerosos astrónomos europeos sientan fuertes deseos de venir aquí para trabajar bajo las condiciones favorables prevalecientes casi únicas.

Ya durante los próximos meses, nuestro primer instrumento será instalado en el monte. Ustedes van a ver el edificio que se está construyendo. La cúpula y las partes terminadas del instrumento están almacenadas aquí y están esperando la conclusión del edificio. Pero los astrónomos tendrán que seguir viviendo todavía en cabañas de madera, hasta que resulten disponibles los otros edificios, entre ellos el hotel de montaña.

No voy a explicarles los planos completos del Observatorio. Les ruego que miren los planos fijados en el tablero (allí). Varios señores pertenecientes a nuestra Organización están a la disposición de ustedes para facilitarles toda clase de comentarios.

Nuestra labor presente así como nuestra labor futura resultarán mucho más fáciles gracias a la cercanía de las dos ciudades de Coquimbo y La Serena. Vallenar y Huasco también pueden llegar a ser importantes. Hemos tenido la asistencia de la Comunidad de La Higuera, a la cual pertenecemos, y hasta la pequeña población de Chañar ha expresado su simpatía.

El Consejo de nuestra Organización — que me ha honrado confiándome su presidencia en la actualidad — ha sentido desde largo tiempo la creciente necesidad de conocer la región en la cual los astrónomos europeos van a trabajar. El diseño y el financiamiento de los edificios pueden ser estudiados con exactitud solamente por personas que hayan visto ellas mismas el paisaje. Por consiguiente, la organización futura de todo el instituto — cuyas oficinas centrales, como ustedes saben, serán edificadas en Santiago, debido a buenas razones — puede ser comprendida con claridad solamente si nosotros mismos nos sometemos a la experiencia de conocer la extensión de la región. Nos congratulamos de haber tomado la decisión de realizar el largo viaje. Durante un período de tiempo de 10 días vamos a visitar muchos puntos de interés entre La Silla y Santiago. Nos producirán especial alegría los diferentes contactos que nos será dado establecer con la gente de este país tan hermoso y tan interesante.

Pese al hecho de que hoy vamos a inaugurar solamente nuestro camino montañoso, hemos sentido deseos de invitar a nuestros numerosos amigos, a los que hicieron más fácil la iniciación de nuestra labor y a los que nos han ayudado en repetidas ocasiones. En este país hemos encontrado una gran comprensión. Hemos tenido y tenemos el apoyo del Gobierno, en Santiago, de la Administración de esta Provincia que se encuentra bajo vuestra dirección, señor Intendente, de sociedades y organizaciones, de firmas y particulares, de ingenieros y abogados. En todos los casos en que hemos tenido que tratar de agua o electricidad, de sueldos o seguros, de importaciones o transportes, de construcción de caminos o de suministro de materiales, y en todas las demás ocasiones, en todas partes hemos encontrado valiosos consejos y pronta asistencia, en el mismo comienzo, cuando los caballos y las mulas eran los únicos medios de transporte, y en la actualidad, cuando ya contamos con parque completo de vehículos.

A usted, señor Arzobispo, le debemos un voto particular de gratitud, porque usted no vaciló en venir para bendecir el comienzo de nuestro proyecto. Que su bendición sea para todos nosotros un auxilio durante nuestras futuras labores.

ESO no es el único grupo que tiene como finalidad la investigación astronómica en este país. El AURA estuvo aquí antes que nosotros y está construyendo un observatorio en Tololo; el CARSO — Observatorio Austral Carnegie — está planificando la edificación de un instituto muy grande en el Norte Chico; la Academia de Ciencias Soviética va a establecer un observatorio a no tan grande distancia de Santiago. Chile está en camino de convertirse en el centro de la investigación astronómica en las latitudes australes. Muy probablemente las varias instituciones mencionadas organizarán un intercambio permanente de personas e ideas, y tratarán de encontrar los caminos para una eficiente cooperación. Al igual que otras, nuestra Organización ha firmado con la Universidad de Chile un contrato respecto a una intensa colaboración en el Cerro Calán cerca de Santiago. Estamos seguros de que la ciencia chilena participará en las oportunidades que se desarrollarán en el futuro cercano.

Si echamos una mirada a nuestro alrededor, aquí, vemos lo que ha sido realizado en el corto período de tiempo de algo más de un año. Bajo la hábil dirección del Dr. A. B. Muller, europeos y chilenos han creado un oasis en el desierto. El Dr. Muller ha sacrificado muchos años de investigación astronómica con miras a encontrar un apropiado lugar para ESO, primero en Africa del Sur y después en Chile. Al principio, él tuvo que soportar todas las dificultades de idioma, clima y aislamiento. Empero alcanzó a dominar lentamente las complicaciones iniciales. Debemos reconocer que, de tener que mencionarse el nombre de un hombre de nuestro grupo, ese nombre es el suyo. En Europa y en el extranjero él se granjeó entre los astrónomos una reputación que prueba que su labor completamente desinteresada merece no ser olvidada nunca.

Debemos expresar nuestra gratitud a cada astrónomo, técnico empleado y trabajador que cooperó en el esfuerzo común. En particular, debe mencionarse al obrero chileno, porque su voluntad para trabajar bajo las excepcionales condiciones reinantes en esta región y su incansable disposición para soportar las penas del período inicial, representan algunos de los factores que hicieron posible nuestro trabajo.

Yo deseo fervientemente que nuestro trabajo resulte beneficioso para las naciones que apoyan este proyecto, para todas las naciones que organizan sus investigaciones en este país, pero en particular para la tierra de Chile. Con nuestros más sinceros agradecimientos al Presidente y al Gobierno de la República, a las Autoridades y al pueblo de Chile, que nos dispensan su hospitalidad en una medida tan extensa, declaro inaugurado ahora el camino del Campamento Pelícano al Cerro La Silla.

Dr. G. Funke, General Secretary of the
Swedish Natural Science Research Council,
President of the ESO Council, Wenner
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Sweden

THE ROAD TO LA SILLA

H. O. Voigt

As soon as the mountain of La Silla had been chosen as the ESO Telescope Site, the question of a road to the summit of the mountain came to the fore. Already before the ESO Organization had become interested in the region of La Silla, a primitive, only in a very scanty way finished field road, about 15 km long, led from the Chilean highway, the Carretera Panamericana, to Quebrada Pelícano. The field road went through state property and stood under the management of the Obras Públicas, the Chilean department for public works. At the instigation of the ESO Organization, the Obras Públicas in February 1965 improved the road mainly by means of a grader, so that it could at least at good weather be used by cars and lorries driving at low speed.

In 1964, ESO erected its first provisional camp in Quebrada Pelícano. From the Camp Pelícano, at the altitude of 1050 m, to the summit of La Silla, at the altitude of 2440 m, at that time only some mule-tracks existed, and over some distances even these were not available. Therefore, it was a matter of paramount importance to construct a road as soon as possible.

As the above mentioned field-road from the Panamericana, though in a still more primitive state, continued from the place of the Camp Pelícano through the lower part of the Quebrada del Tabaco into the Quebrada Pedernales, at first it was planned to construct a provisional first access road from the Quebrada Pedernales to the summit of La Silla. This would have been a fairly short road, the distance as the crow flies between the considered point in the Quebrada Pedernales and the summit of La Silla being only about 5 km. After more careful consideration, however, it was found better to construct the definitive road from the Camp Pelícano to La Silla already from the beginning.

A first tracing of the road was made by A. B. Muller at the end of 1964 and further improved by H. O. Voigt at the beginning of 1965. The definitive tracing and the supervision of the construction of the road were included as an addition in the contract with ESO's consulting engineers, the Consortium Hochtief-Sentab.

The construction of the road was entrusted to the firm of Antonio Schwarze Tellería in Vallenar, and by the end of March 1965 the construction work started.

The guiding idea at the tracing of the road had been to follow as much as possible the watershed mountain ridges. This, of course, had as a consequence that the length of the road was somewhat increased, but the construction of expensive bridges and supporting walls could, on the other hand, in this way be avoided, and the longitudinal profile of the road could be given a fairly smooth gradient with a minimum of ups and downs.

The characteristics of the road are:

Total length	20 km
Maximum inclination	12 %
Average width of roadway	5 m
Average width of side slopes	0.5—1.0 m
Minimum curve radius	20 m
Sufficient number of passing places with good sight	

In July 1965, the contractor had achieved a provisional road connection to La Silla, in January 1966 the road in its present state was finished by the contractor and was accepted by ESO.

As mentioned above, the total length of the road from the Camp Pelícano to La Silla is 20 km. To this are to be added the access roads to the various buildings on the summit of La Silla which together have a total length of about 5 km. Also the traces of these roads have been laid out by the Consortium, and the roads have been built by the firm of Schwarze.

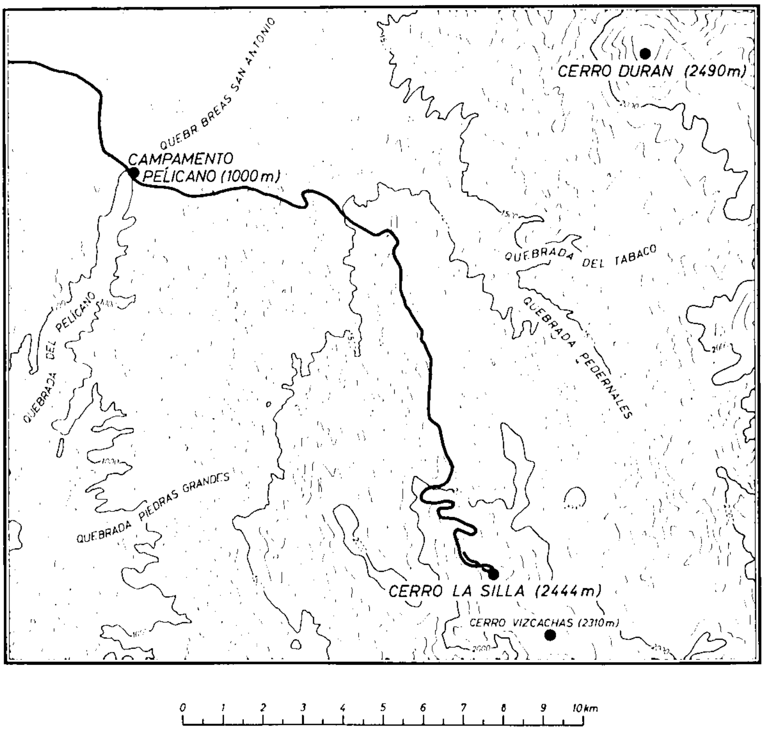
All the roads as now finished have a foundation of rubble with a covering of fine gravel rolled in under sprinkling with water. Later on, when the heavy transports in connection with the constructions on La Silla are over, the roads will be tarred.

The present system of roads on the summit of La Silla does not include an access road to the main top of the summit. After the Council at its meeting on 21 November 1966 had decided that the 3.6 m telescope should be placed on the main top of the summit, the Consortium Hochtief-Sentab on behalf of ESO started a detailed levelling and mapping of the top. On the basis of the contour map now being drawn up, the trace of an access road to the main top will be laid out and the road constructed.

In the beginning of 1967 the Ministerio de Obras Públicas and the ESO Organization came to an agreement about the road connection from the Panamericana to the Camp Pelícano implying that a new road of good quality should be built; Obras Públicas will pay two thirds and ESO one third of the costs. The lay-out of the trace of the new road was finished at the end of 1966, the construction work started in February 1967 and was terminated at the end of May 1967. The new road partly deviates from the old one.

The maintenance of the roads within the ESO domain will be a concern of ESO itself; to this purpose, ESO has purchased its own road maintenance equipment.

The road to La Silla



Road from Campamento Pelícano to Cerro La Silla.

Dipl. Ing. H. O. Voigt, Assistant Director
for Construction (1965—67), European Southern
Observatory, Casilla 11 P., Correo 11,
Santiago de Chile

THE WATER AND POWER SUPPLY FOR LA SILLA

S. Klingberg

A. Estimated Requirements

The facilities for the supply of water and electric power are based upon the estimated consumption for the scope of activity presently envisaged for the 1st building stage of the whole ESO project. The design provides for the possibility of future extensions.

The following basic figures fixed by ESO were used for the design of the water and electrical supply systems.

Water	m^3/day
For Instrument Site La Silla	30
For Camp El Pelícano	20
Total required	50

Electricity	Installed load kVA	Estimated simultaneous load kVA	
		day	night
Photometric Telescope	32	10	22
Spectrographic Telescope	62	20	43
Schmidt Telescope	63	20	43
Hostel	130	80	40
Office	5	5	—
Workshop	60	40	—
Dormitory	8	5	8
Heating Plant	30	25	25
Pumping Stations	80	65	65
Total	470	270	246
Estimated net simultaneous load		220	205

Together with the power requirements for the Camp El Pelícano, the total power consumption was therefore estimated at 300 kVA.

B. Location

A number of test wells were drilled in the valleys surrounding La Silla. The pumping tests resulted in the adoption of the Quebrada El Pelícano as the most suitable source of water supply.

Three deep wells drilled at El Pelícano were estimated to yield a permanent supply of more than 100 m^3 water per day. The wells are located in the immediate vicinity of the Camp at El Pelícano, which is intended as the site of the living quarters for most of the non-technical staff to be employed at La Silla.

El Pelícano is situated approx. 19 km by road from La Silla, and at an elevation of 1050 m above sea level, approx. 1400 m lower than the Telescope Site. A water supply plant in this locality required therefore a pipe line with a number of intermediate pumping stations to reduce the working pressure of the pumps. Two such intermediate pumping stations were therefore installed.

Comparative cost estimates showed that it would be most economical to place also the Power Station at El Pelícano. Here, the power loss of the diesel plant would be considerably less than at La Silla (approx. 2400 m above sea level). A transmission line between the two sites would in any case be necessary, particularly with regard to the pumping stations.

Cost estimates also showed that it would be preferable to heat the buildings at La Silla by a special heating plant on that site, instead of using electricity for heating purposes.

C. Water Supply Plant

1. — Deep Wells

   Three wells of a depth of approx. 30 m are fitted with submerged deep well pumps with automatic controls, pumping the water into a tank of 100 m^3 capacity.

2. — Main Pumping Station

   The water is delivered by gravity into the Main Pumping Station, containing a water softening, filtering, and chlorination plant and two high-pressure plunger pumps, which deliver the water into the pipe line.

3. — Water Pipe Line

   Of approx. 19 km length, consisting of 2″ diameter galvanized high-pressure pipe, with expansion bends at approx. 200 m distance, air vents etc.

   The pipe line is partly buried in a trench, partly carried on concrete supports.

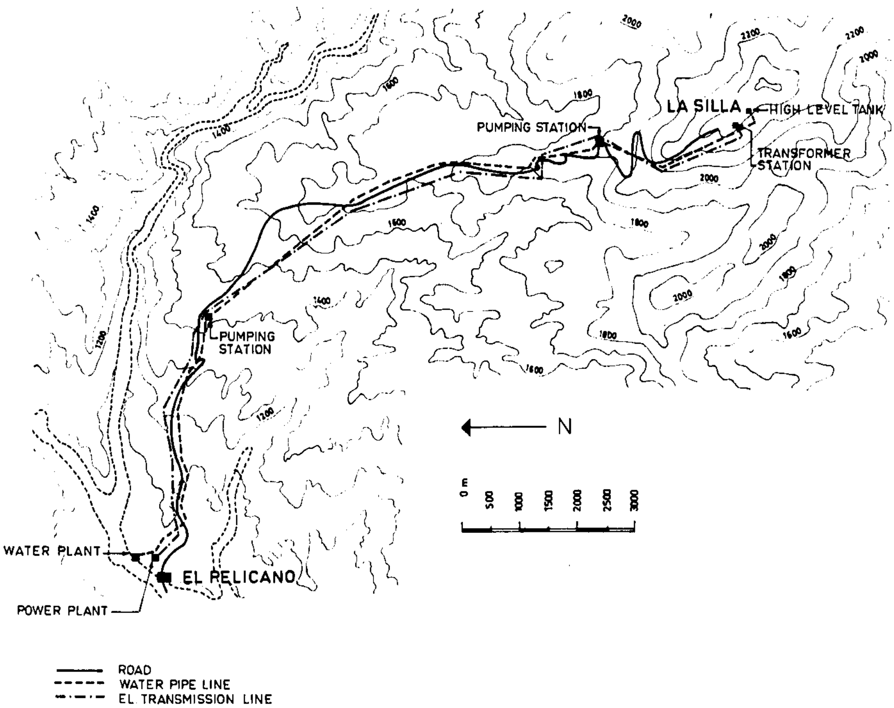


Fig. 1: General lay-out of water pipe line, electric transmission line and road from Campamento Pelícano to Cerro La Silla.

4. — Intermediate Pumping Stations

Two Stations spaced along the water pipe line, each containing two high-pressure plunger pumps and an equalizing tank of 50 m³ capacity.

5. — High-level Tanks

The pipe line is connected at its upper end to two high-level water tanks of 150 m³ capacity each, placed on the second peak of the summit of La Silla at an elevation of approx. 2400 m above sea level. A re-chlorination plant is placed in front of these tanks.

From the tanks the water is delivered by gravity to the individual buildings.

The entire water supply installation is fitted with automatic control- and alarm devices.

Further water treatment, cooling, and filtering units are placed in the individual buildings according to special requirements.

The maximum capacity of the water supply plant is estimated to be as follows:

		m^3/day
Deep Wells:		300
Deep Well Pumps: each	85 l/min =	122
High-pressure Pumps: each	75 l/min =	108

D. Electric Power Supply

1. — Power Plant

This building contains at present two diesel-generators type "ASEA" of 115 kVA, 380/220 V each, with provision for a third generator, with switchboard, fuel tank, and all accessories.

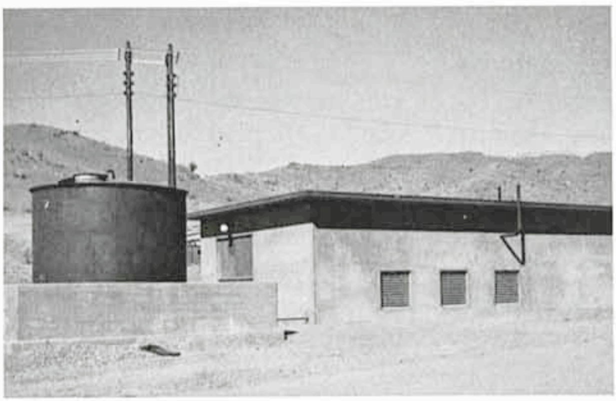


Fig. 2: Power Plant with its oil tank in Campamento Pelícano.

Provisions have been made to use some smaller temporary generators, already on site, as stand-by equipment, and the switchboard is designed to allow their addition.

A transformer of 6000/400 V, 200 kVA, is placed between the power plant and the transmission line.

2. — Transmission Line

This line of approx. 16 km length consists of an aluminium cable type "FERAL" of 6 kV capacity, mounted on timber poles.

3. — Branch Lines

Three branch lines to the pumping stations are fitted with transformers 6000/400 V, 50 kVA.

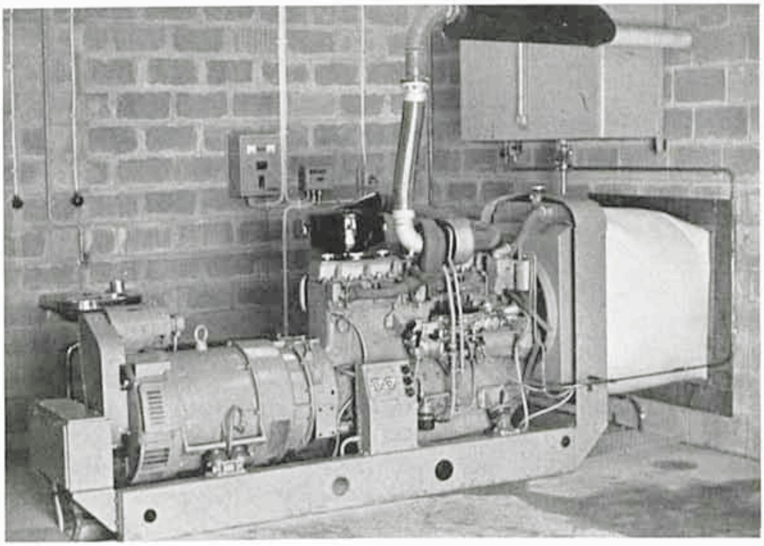


Fig. 3: One of the 115 kVA diesel generators.

4. — Distribution Station

The distribution station at the Telescope Site is equipped with 2 transformers 6000/400 V, 200 kVA, and a distribution panel for the take-off of the cables to the individual buildings.

5. — Accessories

The transmission line poles also carry, apart from the high-tension cable, a telephone line and various signal lines to the pumping stations, tanks, etc.

Ing. S. Klingberg, SENTAB
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THE BUILDING FOR THE 1.5 m SPECTROGRAPHIC TELESCOPE

J. Ramberg

1. General remarks on the ESO telescope buildings

Chile being the site of ESO, all the ESO buildings in that country are, as a matter of course, to be constructed strictly in accordance with the rules of the Chilean Building Code. This, among other things, means that the ESO buildings must be resistible against seismic shocks: Chile belongs to the belt of pronounced seismic activity surrounding the Pacific Ocean, and earthquakes are by no means infrequent there. For that reason, at the design of the ESO buildings, special earthquake braking elements have had to be very carefully included.

Even apart from the resistibility against earthquakes, the design of a telescope building with its dome and instrument pier is an intricate matter.

The principal purpose of the telescope building and its dome is to protect the instrument, in the first place against bad weather, precipitation, wind and, in the daytime, changes of temperature due to external temperature variations and insolation.

The instrument pier must be extremely stable in order to avoid disturbances in the pointing as well as in the adjustment of the telescope. It is of paramount importance that vibrations are not transferred from building and dome to the telescope. Therefore, it is a general rule to keep pier and building independent of each other in the highest possible degree: the pier and the building stand on the same underground but, for the rest, they are not in direct contact with each other. Furthermore, the pier shall be constructed in such a way that it has no pronounced period of vibration of its own.

2. The building for the spectrographic telescope

The points of view briefly mentioned above have carefully been considered at the design and the construction of all the telescope buildings of ESO. In the following, a description of the building for the 1.5 m spectrographic telescope will be given.

The building for the spectrographic telescope has a ground plan in the shape of a rectangle 13.60 m$\times$15.25 m, at its southern short-side complemented with a semi-circle with a diameter of 13.60 m.

Fig. 1 gives an artistic view of the building with the telescope in its English mounting on two piers and with the large coudé spectrograph supported on the northern of the two telescope piers and on a third pier.

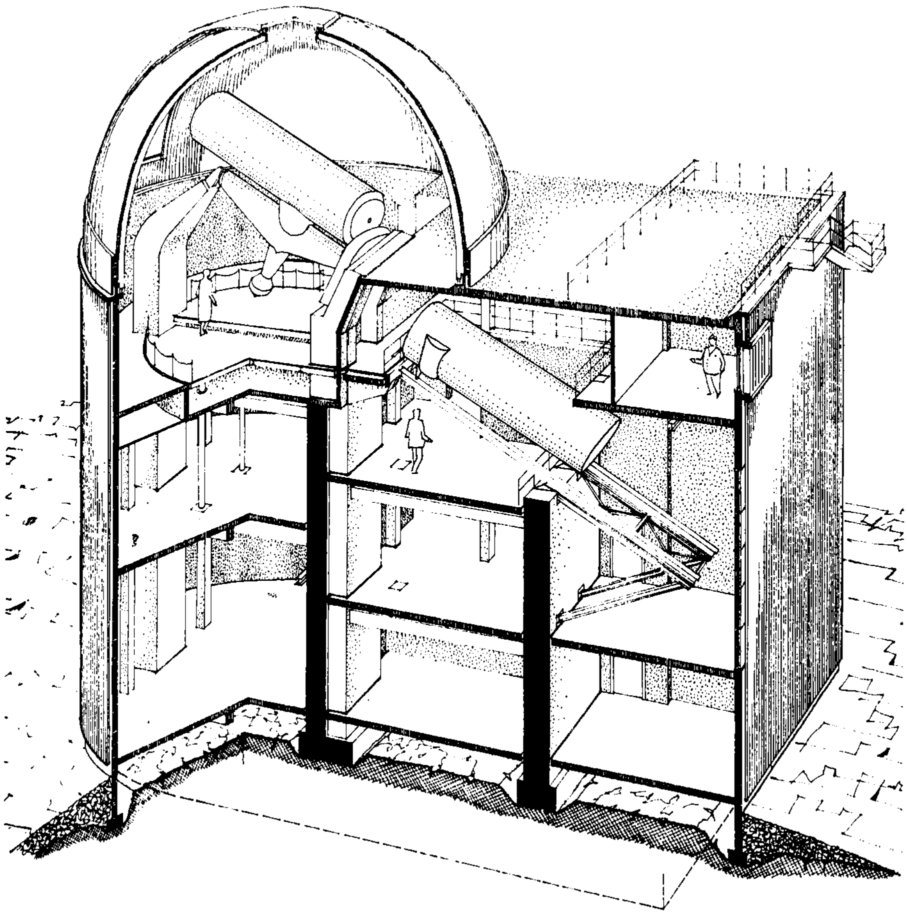

Fig. 1: Artistic view of the Spectrographic Telescope Building.

The Spectrographic Telescope Building

Fig. 2 shows a central north-south section of the building.

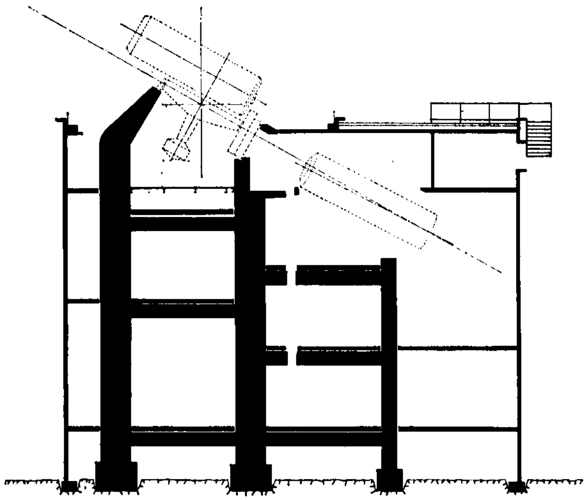

Fig. 2: Central north-south section of the Spectrographic Telescope Building.

It may be seen from the figures 1 and 2 that, in conformity with what has been said above, the building consists of two separated structures, the A-structure or the astronomical structure, and the B-structure or the building structure. Both structures are made of reinforced concrete.

The three instrument piers are mutually connected by strong horizontal beams of reinforced concrete. In this way, a very stable and rigid telescope support is procured. The support penetrates the floors and the ceilings and also some of the inner walls of the building without touching them in any point; the separation of the A-structure from the B-structure is consistently accomplished.

The dome has an inner diameter of 12 m. The domes for the photometric, spectrographic, and Schmidt telescopes are all built in the same way; a detailed description of their construction will be given in the next number of the ESO Bulletin. Here only a few main points will briefly be mentioned. It is highly important to avoid as far as possible that the interior of the domes is warmed up in the daytime: the observation rooms with their telescopes should be kept at night temperature. Therefore, it has been aimed at keeping the transmission of heat from outside into the domes as low as possible taking into consideration all the three factors radiation, convection, and conduction. For this purpose, the walls of the domes are built up of three layers: an outer self-supporting shell of 6 mm steel plate, on the outside painted with titanium-dioxide emulsion, an inner sheathing with a very good insulating power, and in between a free space open at the base and the top of the dome, so that the outer air can flow upwards by the chimney-effect and continuously be renewed. Furthermore, the floor of the observation room is well insulated in order to prevent the transport of heat from the lower central-heated parts of the building into the observation room.

Also the outer walls of the buildings for the photometric, spectrographic, and Schmidt telescopes are elaborately constructed. The outer walls must be prevented from being warmed up in the daytime by insolation and it must be avoided as far as possible that warm walls during the night emit heat outwards, which would give rise to upward streams of warm air deteriorating the seeing. Therefore, firstly, the outer walls have at a distance of 25 cm from their outer surface an external covering of aluminium plate leaving the air free inlet at the bottom and free outlet at the top. Secondly, the walls themselves have an outer insulation of 7.5 cm styropor. The applying of the insulation at the outside and not at the inside of the wall contributes towards a better temperature equilibrium in the interior of the building, a matter being of special importance for the coudé laboratory. It should also be mentioned that the building practically has no windows.

As may be seen from the figures 1 and 2, the large coudé spectrograph occupies a considerable part of the building. The figures 3 to 6 show the plans of the different floors of the building.

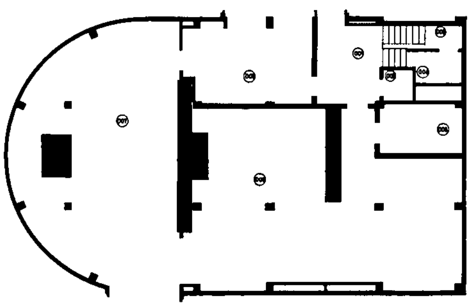

Fig. 3: Ground Floor

001 Hall
002 Staircase
003 Lift
004 Lift Motor
005 Office
006 Laboratory
007 Aluminizing Plant
008 Mechanical equipment

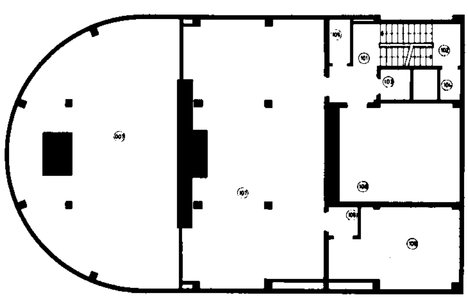

Fig. 4: First Floor

007 Aluminizing Plant
101 Corridor
102 Staircase
103 Lift
104 Janitor's Closet
105 Toilet
106 Spectrograph Room
107 Laboratory
108 Sluice
109 Dark Room

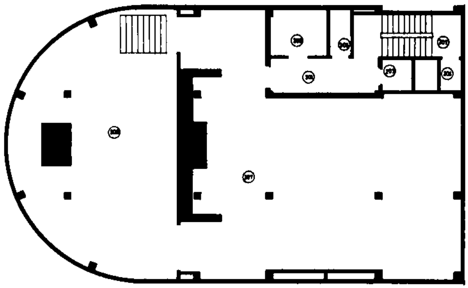

Fig. 5: Second Floor

201 Corridor
202 Staircase
203 Lift
204 Janitor's Closet
205 Toilet
206 Pantry
207 Laboratory
208 Store

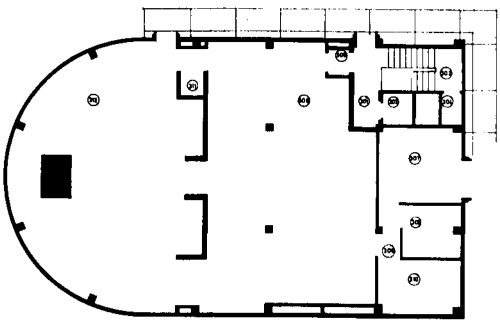

Fig. 6: Third (Observation) Floor

301 Corridor
302 Staircase
303 Lift
304 Janitor's Closet
305 Sluice
306 Spectrograph Room
307 Office
308 Sluice
309 Laboratory
310 Dark Room
311 Sluice
312 Observation Room

The ground floor to be seen in Fig. 3 has on the western side of the building the main entrance with entrance hall, staircase and passenger lift. From the hall, doors lead to an office and to a large room reserved for a future laboratory. The semi-circular part of the groundfloor is room for an aluminizing laboratory equipped with a 2 m aluminizing plant. The aluminizing laboratory is 5 m high and occupies, therefore, also the lower half of the corresponding part of the first floor as may be seen from Fig. 2. A detailed description of the aluminizing plant is given elsewhere in this number of the ESO Bulletin. The aluminizing laboratory is to be common for the spectrographic, photometric, and Schmidt telescopes. The main mirror of the spectrographic telescope will for realuminizing be taken down from the observation room into the aluminizing laboratory through a vertical shaft to be seen in the figures 5 and 6; for this purpose, one of the main girders of the dome carries an appropriate 3 t hoist. The shaft and the hoist can also be used for transporting instrument parts etc. between the different floors of the building. The mirrors of the photometric and Schmidt telescopes will for realuminizing be transported to the aluminizing laboratory on a truck which can drive straight into the laboratory through special very wide entrance doors on the eastern side of the spectrographic building.

The first floor is shown in Fig. 4. It locates the lower part of the track of the coudé spectrograph. Furthermore, it has a photographic darkroom and the large secondary coudé laboratory into which the beam from the telescope can by means of a flat auxiliary mirror be thrown through a hole in the ceiling.

The main part of the second floor (Fig. 5) is occupied by the large coudé spectrograph. This floor has also a small pantry and, above the aluminizing laboratory, a large store room.

The third floor (Fig. 6) has the observation room with a movable floor for observations at the Cassegrain focus. In order to avoid the astronomer being hampered by the large counter weight of the telescope when working at the Cassegrain focus, the movable floor is split up in two equal platforms, either being moved quite independently of the other; this arrangement makes it possible for the astronomer to reach easily the Cassegrain focus even when it is high and the counterweight is low. Furthermore, the third floor has the upper part of the main coudé laboratory with the seat for the observer close to the slit of the large coudé spectrograph. The seat for the observer is in the middle of a fairly narrow shelf running from the east to the west across the whole floor. This shelf is bipartitely constructed. The upper plane of the shelf forms part of the ordinary floor of the room, i. e. it belongs to the B-structure.

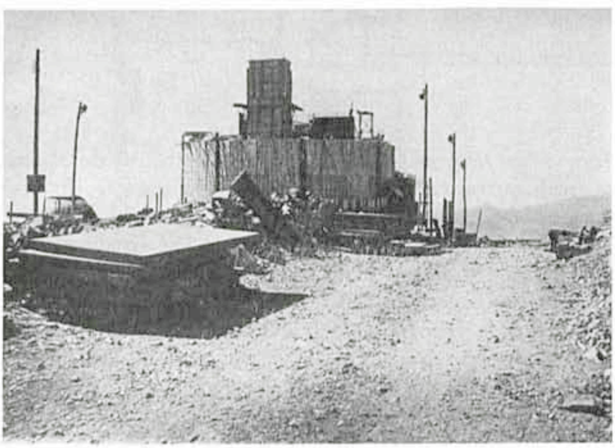

Fig. 7: The Spectrographic Telescope Building under construction.

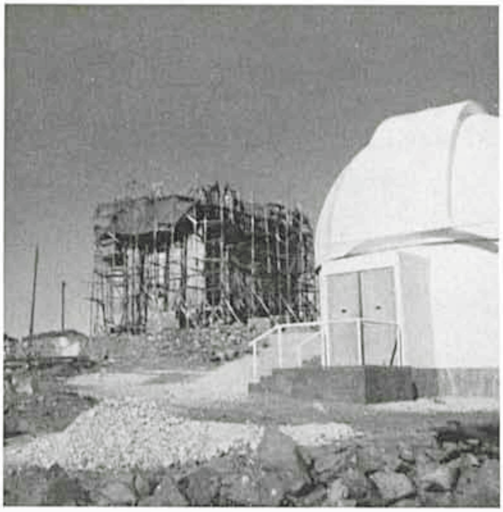

Fig. 8: The Spectrographic Telescope Building under construction.
In the foreground the provisional building for the 1 m Photometric Telescope.

It consists of narrow transverse boards which can independently be lifted away. Below these upper boards there is a very strong shelf of reinforced concrete directly protruding from the middle instrument pier and, accordingly, belonging to the A-structure. The shelf is foreseen for secondary coudé spectrographs. For work with such spectrographs the beam from the telescope can by means of a flat auxiliary mirror be thrown horizontally to the east or to the west. In order not to stand in the way, the large coudé spectrograph can on such occasions be displaced obliquely downwards along its supporting rails indicated in Fig. 2. As may be seen in Fig. 6, the third floor has further an office and two darkrooms.

Finally, it is to be mentioned that the building for the spectrographic telescope has arrangements for the direct inspection of the sky. On its western and southern sides the building has a balcony on the level of the third floor; furthermore, there is a large balcony on the roof of the building.

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LE TELESCOPE SPECTROGRAPHIQUE DE 1,52 m DE DIAMETRE ET SON EQUIPEMENT

Ch. Fehrenbach

Introduction

La convention de l'ESO prévoyait deux télescopes de 1 m de diamètre, mais le Conseil a bien voulu suivre l'avis de la Commission des Instruments et accepter que l'un des instruments soit un télescope de 1,52 m de diamètre, consacré à la spectrographie.

Rappelons qu'avec les plaques photographiques actuelles et une turbulence atmosphérique de t″, tout le flux reçu par le télescope est utilisé par le spectrographe si l'ouverture de la chambre spectrographique $\omega = \frac{f}{d}$ est inférieure à une valeur $\omega_0 = \frac{5}{Dt}$ où D est le diamètre du télescope exprimé en mètres. Les spectrographes réalisés sont donc efficaces si $\omega < 3,3$ pour $t = 1''$.

Pour les moyennes et grandes dispersions, la puissance de l'équipement spectrographique est mesurée par le produit $D \cdot d$ des diamètres du télescope et du réseau. Il est donc essentiel, dans ce cas, d'employer des réseaux aussi grands que possible.

Le cas des petites dispersions stellaires, et surtout nébulaires, est assez différent. Il n'est pas possible de construire des objectifs de 20 cm de diamètre et de quelques centimètres de longueur focale qui seraient nécessaires pour ces dispersions. Les petites dispersions sont donc obtenues, en pleine efficacité, avec des spectrographes plus petits qui peuvent être avantageusement utilisés au foyer Cassegrain.

Dans ces conditions, l'ESO a décidé la construction d'un spectrographe stellaire très puissant installé au foyer coudé, ainsi que celle de plusieurs spectrographes à petite dispersion qui seront décrits dans un article ultérieur.

Description du télescope

Les données relatives à l'optique du télescope sont indiquées dans le tableau (1). Le foyer principal n'est pas accessible, il n'y a pas de foyer Newton. Cet instrument est, en principe, réservé à la spectrographie.

Tableau 1

	Matière	Diamètre cm	Epaisseur cm	Ouverture de la combinaison	Distance focale cm	Champ de pleine lumière
Miroir principal parabolique	Verre	152,4	18	4.5	686	—
Hyperbolique Cassegrain	Silice	43,2	6,5	15	2290	6′
Hyperbolique coudé	Silice	36,2	4,5	30	4580	6′
1er Plan	Silice	36,2	6,2	—	—	—
2ème Plan	Silice	30,8	6	—	—	—

La monture est du type anglais. L'axe de déclinaison et l'axe horaire sont constitués par des cônes en acier soudé (voir Fig. 1). Le mouvement de déclinaison se fait par deux roulements à bille de 1,20 m de diamètre extérieur. L'axe horaire lui-même comporte, à la partie supérieure, un roulement à rotule sur galets, et, dans sa partie inférieure, un roulement à galets ainsi qu'une butée à billes sur rotule. L'axe supérieur est percé d'un trou pour le passage des câbles, et l'axe inférieur, d'un trou de 17 cm pour le passage du faisceau lumineux.

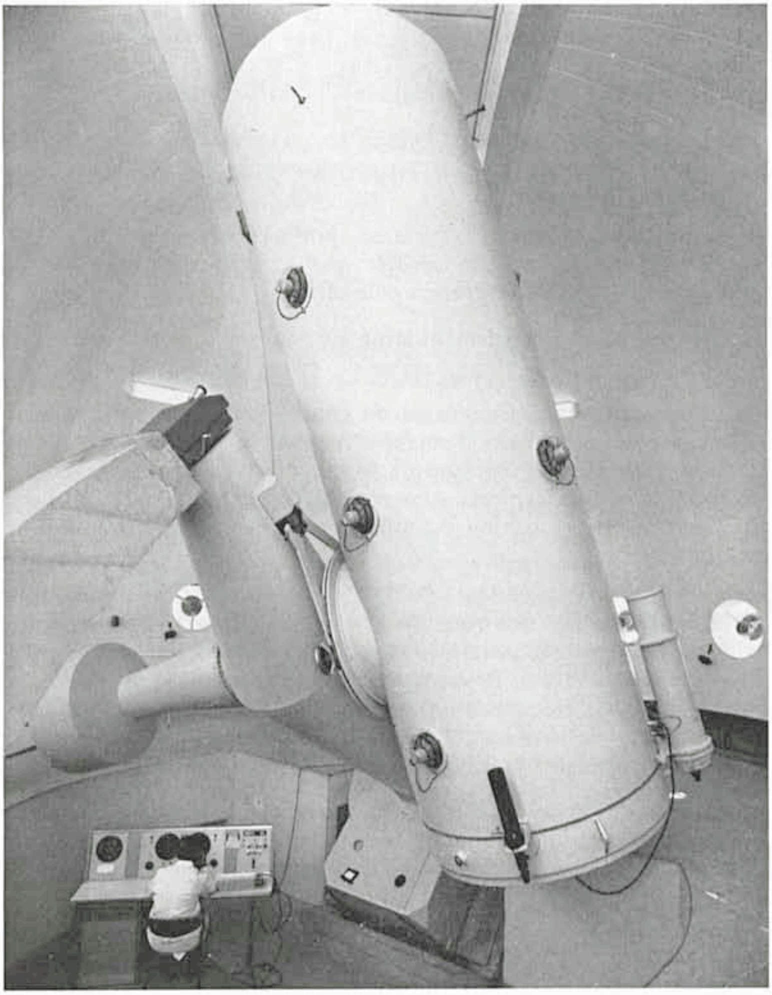

Fig. 1: Télescope spectrographique de 1.52 m de Haute Provence, jumeau de celui de l'ESO.

Le tube est construit en acier soudé formé de caissons. Le tube intérieur a 1,70 m de diamètre, sa longueur totale est de 5,90 m. Il est garni intérieurement de tissu léger noir, tendu. Un système de ventilation, semblable à celui utilisé à l'Observatoire de Haute Provence, est installé sur les parois du tube et permet d'aspirer l'air qui est filtré par le tissu. Il permet aussi d'aspirer l'air se trouvant dans le barillet du grand miroir. Le barillet du grand miroir est du type préconisé par André Couder, avec leviers mécaniques; le miroir est supporté latéralement par trois touches. Le réglage de l'axe optique se fait par le déplacement du barillet par rapport au tube. Trois vis de réglage permettent aisément cette opération et trois autres immobilisent le barillet dans sa position.

La fixation du spectrographe est prévue sur une platine solidaire du grand barillet. Ce système peut supporter un spectrographe de 300 kg, le centre de gravité étant à 1 m de la platine.

Comme cet instrument était, à l'origine, prévu pour servir uniquement au foyer coudé, il sera essentiel de vérifier que les spectrographes ne sont pas trop grands pour l'observation près du pôle céleste.

Le foyer Cassegrain est normalement situé à 60 cm de la platine tournante et le foyer coudé à 187 cm de la paroi arrière du palier inférieur de l'arbre horaire.

Les deux miroirs convexes, Cassegrain ou coudé, sont fixés directement sur le tube central, par l'intermédiaire d'entretoises. Pour la mise au point, ils peuvent se déplacer de 6 cm, ce qui correspond à 64 cm au foyer Cassegrain, et à 158 cm au foyer coudé. Les déplacements sont repérés par un compteur qui permet de connaître exactement la position du miroir, et donc de repérer la position des foyers.

L'entraînement normal est réalisé à l'aide d'un galet de stellite d'environ 69 mm de diamètre, appliqué sur une roue de grand diamètre recouverte d'une bande d'acier chromé. Ce mode d'entraînement est déjà réalisé pour deux instruments de l'Observatoire de Haute Provence et donne d'excellents résultats. Il faut évidemment ajuster la fréquence qui alimente le moteur synchrone pour tenir compte du rapport du diamètre du galet et de la roue. Cette synchronisation est faite à l'aide d'un générateur de fréquence à corde vibrante.

Des mouvements de rappel rapides et lents sont prévus (tableau 2). L'entraînement horaire très rapide est obtenu par un moteur-réducteur. La vitesse du pointage rapide peut être diminuée à l'aide d'un bouton placé sur le tableau de commande. Le mouvement en déclinaison est obtenu par des dispositifs analogues. Le mouvement de rappel lent est obtenu par une vis solidaire de la monture; le mécanisme de rotation de l'écrou permet de déplacer le télescope par rapport à la monture.

Tableau 2

Vitesse des rappels

	Rapide	Lent
Pointage	$60° min^{-1}$	$6° min^{-1}$
Guidage	$15' min^{-1}$	$3{,}7'' sec^{-1}$

Toutes les manœuvres d'embrayage ou de débrayage sont commandées automatiquement et l'opérateur n'a pas à s'en soucier. Il est néanmoins possible de débrayer avec une clé de sécurité pour équilibrer l'instrument.

Les ascensions droites, les déclinaisons, le temps sidéral sont directement lisibles sur le tableau de commande (transmission par selsyns). La précision de la lecture est de 1'. Des vérifications ont montré que le pointage se fait facilement à 2' près. Toutes les commandes sont faites manuellement à partir d'un pupitre qui, disposé dans la coupole même, permet de suivre le mouvement du télescope.

Cet instrument est presque identique à celui installé en Haute-Provence, mais ce dernier n'a pas de foyer Cassegrain. L'optique du télescope de l'ESO a été essayée en juillet 1967 sur l'instrument de l'OHP.

Spectrographe coudé

Pour pouvoir réaliser notre équipement spectrographique rapidement, nous avons décidé de choisir des réseaux de 20 cm de diamètre, actuellement fabriqués couramment par Bausch & Lomb.

Mais il est essentiel de se réserver la possibilité de changer ultérieurement, par un spectrographe ayant des réseaux de 30 cm ou des réseaux en mosaïque. Le laboratoire coudé est assez grand pour l'emplacement de ces instruments. L'expérience des missions à l'Observatoire de Haute Provence nous a fait proposer à la Commission des Instruments un spectrographe où tous les réglages sont faits une fois pour toutes et où l'astronome ou ses aides techniques disposent d'un certain nombre d'arrangements leur permettant un choix raisonnable de dispersions et de domaines spectraux. Ce nombre de combinaisons, bien que très grand à l'Observatoire de Haute Provence, a encore été étendu, mais il n'est pas possible que chaque astronome fasse son réglage. Compte tenu de l'expérience de l'Observatoire de Haute Provence, nous avons apporté un certain nombre de perfectionnements sur lesquels nous insisterons. Dans un article[1]) sur l'instrument français nous donnons un certain nombre de précisions que nous ne reproduisons pas ici.

Le spectrographe est constitué par un grand tube en acier de 1,80 m de diamètre et de 5,20 m de longueur. Il est monté sur 3 rails parallèles à l'axe du monde et il peut être complètement éliminé de la salle de spectrographie par un mouvement effectué par moteur, vers la partie inférieure; il laisse ainsi la salle du spectrographe complètement dégagée.

La figure 2 donne le plan schématique de l'instrument qui comprend 3 réseaux et 3 chambres, dont nous donnons la description dans les tableaux 3 et 4.

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[1]) Publ. Obs. Hte-Provence, sous presse.

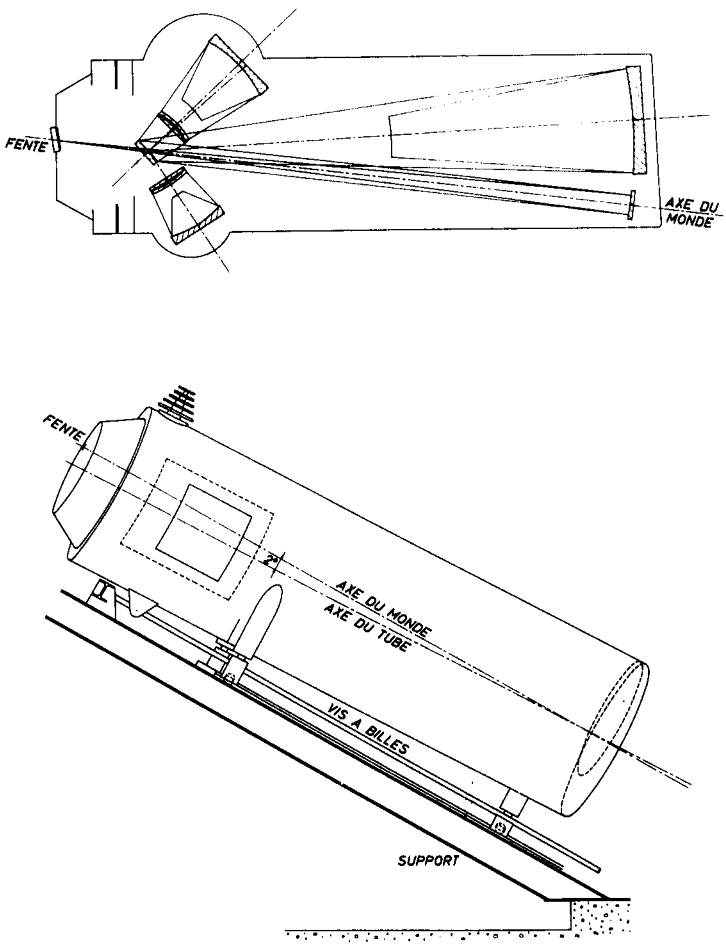

Fig. 2: Le Spectrographe coudé.

Tableau 3

Réseau	Dimensions du support	Partie rayée	Nombre de traits	Angle de blaze	Longueur d'onde de blaze en Littrow
A_1	220×350×50 mm	200×306 mm	1200 tr/mm	14°14′	4100 Å
A_2	220×350×50 mm	200×306 mm	1200 tr/mm	21° 6′	6000 Å
B	220×350×50 mm	200×306 mm	771,4 tr/mm	16°49′	7500 Å

Tableau 4

Chambre	Focale	Diamètre des lames	Diamètre du miroir	Ouverture totale	Ouverture d'utilisation	Longueur des spectres	Champ total
III	41 cm	44 cm	63 cm	F/1	F/ 2,05	15,5 cm	20°
IV	67 cm	44 cm	77,5 cm	F/1,63	F/ 3,3	23,5 cm	20°
V	250 cm	—	112 cm	F/2,3	F/12,5	43,6 cm	10°

Les réseaux sont montés sur un dispositif qui permet de mettre en position d'utilisation chacun des réseaux pour toutes les chambres et de choisir un certain nombre d'inclinaisons. Le nombre des inclinaisons est limité. Une fois choisies, elles sont repérées par un dispositif mécanique qui permettra ultérieurement de les retrouver rigoureusement.

Nous indiquons dans le tableau 5 les dispersions réalisables et les domaines spectraux couverts. Rappelons qu'il sera possible de centrer l'inclinaison des 3 réseaux de façon à centrer les domaines sur des valeurs choisies — par exemple, il sera possible de centrer le spectre sur H_α, H_β etc. . . . Le nombre des combinaisons reste limité, et ceci est important pour tous les travaux systématiques.

Tableau 5
Domaines spectraux et dispersions

Réseau	Chambre III	Chambre IV	Chambre V
A1	3100—5000 Å 18,8 Å/mm	3100—5000 Å 12,4 Å/mm	3070—4530 Å 3570—5020 Å 3,4 Å/mm
A2	4240—7140 Å 18,7 Å/mm	4240—7140 Å 12,4 Å/mm	4690—6100 Å 5560—6970 Å 3,2 Å/mm
B	4930—9470 Å 31,8 Å/mm	4930—9470 Å 19,1 Å/mm	4910—7160 Å 6700—8930 Å 5,1 Å/mm

Les objectifs photographiques sont des chambres de type Maksutov, telles qu'elles sont réalisées normalement par la Sté REOSC[2]); les calculs ont été complètement repris pour réduire les aberrations géométriques au minimum dans ce champ très étendu (20°).

[2]) Publ. Obs. Hte-Provence.

Il est hors de doute que cette solution, qui permet de rapprocher le système correcteur du miroir, présente de grands avantages que nous ne pouvons discuter dans ce bref compte-rendu. Dans le spectrographe analogue du télescope de 1,93 m de l'Observatoire de Haute Provence, les images sont excellentes dans presque tout le champ mais un astigmatisme résiduel est gênant tout au bord du champ. Cet astigmatisme provient en partie des anciens réseaux B & L qui ne sont pas plans, et en partie de la combinaison; un effort a été fait pour réduire les deux effets.

Lorsque la mise en position des chambres est faite, les divers organes sont solidarisés par de forts ressorts qui sont supprimés pendant les réglages avec une contre-pression pneumatique.

Les châssis sont introduits par un système de manivelle qui les met successivement en place sur des touches fixes et ouvre les volets.

La mise au point se fait par réglage des touches, qui appuient directement sur les plaques courbées dans le châssis. Nous avons augmenté la hauteur des plaques, qui pourront recevoir l'étalonnage en λ et aussi des marques photométriques obtenues directement dans le spectrographe. Mais, dans de nombreux cas, on fera cet étalonnage sur une autre partie de la plaque par un spectrographe auxiliaire.

Un système optique permet de juxtaposer, à côté du spectre stellaire, les spectres de plusieurs sources pour l'étalonnage en longueur d'onde ou photométrique.

Un système à lame oscillante, d'ailleurs éclipsable, permet de faire osciller l'image stellaire le long de la fente pendant toute la pose; la hauteur de l'oscillation est réglable.

Un viseur de fente commode permet d'observer l'image sur la fente. La mise au point sur la fente se fera par le déplacement du miroir coudé secondaire, dont la position est repérée sur un indicateur placé dans le local du spectrographe coudé.

L'extrémité de l'axe horaire du télescope est fermée par une lame oscillante montée sur cardan, ce qui permet un guidage plus fin qu'avec les moteurs de rappel du télescope.

Un viseur éclipsable permettra d'observer un champ stellaire de l'ordre 12′, de reconnaître et centrer l'étoile sur la fente.

Un rotateur de champ en silice (Prisme de Wollaston, à face d'entrée et de sortie parallèles) est commandé par un asservissement lié au télescope. Il permet de maintenir, soit la direction de la fente dans une position fixe par rapport aux astres, soit dans un plan passant par le zénith.

Enfin, la lumière qui normalement serait perdue parce qu'elle tomberait sur les châssis photographiques, est renvoyée par un miroir auxiliaire placé devant le collimateur, dans une cellule photoélectrique. Celle-ci, munie d'écrans ou d'obturateur, agit sur un fluxmètre qui mesure rigoureusement la lumière qui est tombée effectivement sur les plaques photographiques.

Compte tenu des considérations développées dans notre introduction, le spectrographe sera utilisé à plein rendement pour t = 1″ jusqu'à des distances focales de chambre de 66 cm, c'est-à-dire des dispersions de l'ordre de 15 à 20 Å/mm suivant le réseau utilisé. Pour des dispersions plus petites, l'instrument sera utilisé à pleine efficacité, même pour des turbulences plus grandes. Par contre, pour les plus grandes dispersions, les pertes de lumière sur la fente seront d'autant plus grandes que la turbulence sera élevée.

La construction du spectrographe est très avancée, la mécanique est achevée, tous les verres d'optique sont livrés et la plupart des miroirs et lames de correction sont taillés, deux des trois réseaux sont livrés et leur étude a montré qu'ils sont excellents pour ce type d'instrument.

Le spectrographe sera terminé en avril 1968 et pourra être immédiatement installé.

Nous souhaitons que, après l'inévitable période de mise au point, cet instrument fonctionne aussi bien que celui de l'Observatoire de Haute Provence où, depuis l'adjonction du système photométrique, la proportion des spectres non satisfaisants est réduite à 1 % de ceux qui sont pris, la difficulté majeure provenant des plaques photographiques dont nous devons contrôler la sensibilité et du bris de plaques pour les chambres très ouvertes.

Le télescope et le spectrographe ont été construits par la Société REOSC de Paris.

Août 1967

Ch. Fehrenbach, Directeur des
Observatoires de Marseille et de Haute-Provence,
2, Place le Verrier, Marseille 4e, France

THE 2 m ESO ALUMINIZING PLANT

J. Ramberg

The ESO establishment on La Silla will be equipped with a 2 m aluminizing plant for the coating of the mirrors of the photometric, spectrographic, and Schmidt telescopes. Later on, a 4 m plant will be procured for the aluminizing of the main mirror of the large telescope.

After thorough negotiations with several European expert firms, the 2 m aluminizing plant was ordered from Edwards High Vacuum Ltd., Manor Royal, Crawley/Sussex, England, in March 1966. The plant was ready for delivery in January 1967; it was inspected and received by ESO in the factory of Edwards on January 11, 1967. The plant will be placed in a special room in the ground floor of the building of the 1.5 m spectrographic telescope on La Silla.

The aluminizing plant consists of a vacuum vessel, a vacuum pumping unit, a control cabinet, and a mobile low tension control unit.

The vacuum vessel is composed of the main vacuum chamber and the end cover or lid; both are made of mild steel. When joint, the two parts form a cylindrical tank with both ends dished; the axis of symmetry of the cylinder is horizontal. The internal diameter of the cylinder is 185 cm, its length (the dished ends excluded) is 100 cm.

The fixed vacuum chamber has its centre line 130 cm from the floor; it is supported on angle iron legs. The lid is mounted on a trolley fitted with flanged wheels; the trolley can be moved along a short track on rails which are to be recessed in the floor. The lid has two diametrically opposite bearing trunnions forming a horizontal axis of rotation; the lid can be retained in horizontal and vertical position.

When a mirror is to be aluminized, the trolley with the lid is displaced along the rails to an appropriate distance from the fixed vacuum chamber. The lid is turned into horizontal position, and the mirror is by means of a travelling crane lifted into the lid and fixed there. For the latter purpose the lid contains supports and clamps adjustable to take mirrors of various sizes.

The lid with the mirror is then turned into vertical position; in order to make the turning easy, the bearing trunnions are arranged so that their axis passes through the common centre of gravity of lid and mirror.

The trolley with lid and mirror is then moved along the rails till the flanges of the lid and the main chamber meet. Dowel pins ensure the correct alignment of the flanges, and a neoprene ring procures a perfect seal of the flanges.

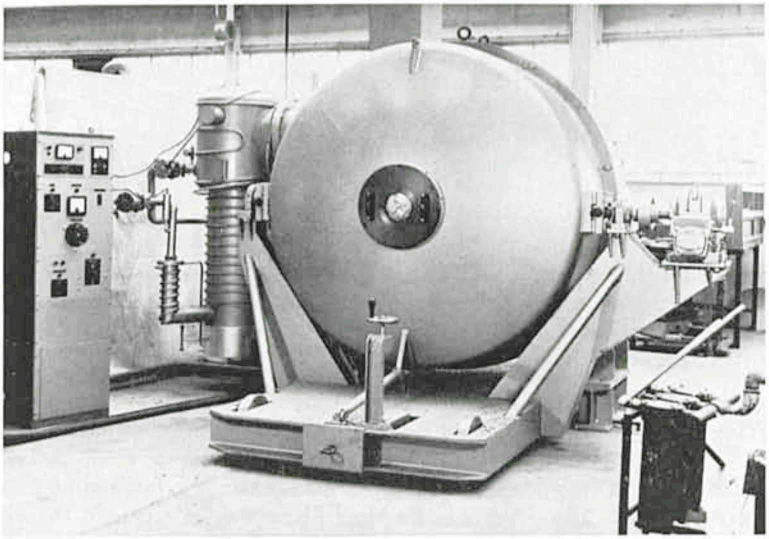

Fig. 1: The 2 m ESO Aluminizing Plant. The figure shows the vacuum vessel closed. In the centre the turnable lid of the vessel on its trolley. To the left the control cabinet and the diffusion pump.

The main chamber has at one side a pumping port with an interior diameter of 40 cm. The chamber is equipped with two inspection windows, 15 cm in diameter; the windows are fitted with armour plate glass and have internal louvres in order to ensure that the vision is not impaired during the evaporation.

The heads of one Pirani and one Penning vacuum gauge are mounted in a special secondary port in the main pumping port.

On the rear of the main chamber two rings with in all 24 filament holders are mounted providing in all 24 evaporation sources. Furthermore, the chamber is equipped with a high tension ring for discharge cleaning and a lead-in electrode.

The pumping unit consists of a fractionating oil diffusion pump backed by a rotary mechanical pump. All interconnecting pipe work is in copper tube.

The fractionating oil diffusion pump is of type Speedivac, model F 1605 with a peak unbaffled speed of 5000 to 6000 litres per second and with an ultimate vacuum less than 5×10^{-7} torr. The critical backing pressure of the pump is 0.35 torr; the pump requires a cooling water flow of 7.5 litres per minute (at 15° C). It is heated by 5.2 kVA 3-phase heaters; a thermosnap switch with a contactor protects the pump in the event of water failure.

The rotary mechanical pump is of type Speedivac, model 1SC3000; its volumetric speed is 2830 litres per minute. This pump is for the roughing of the system and for the subsequent backing of the diffusion pump when the critical backing pressure of the latter has been achieved in the chamber. The

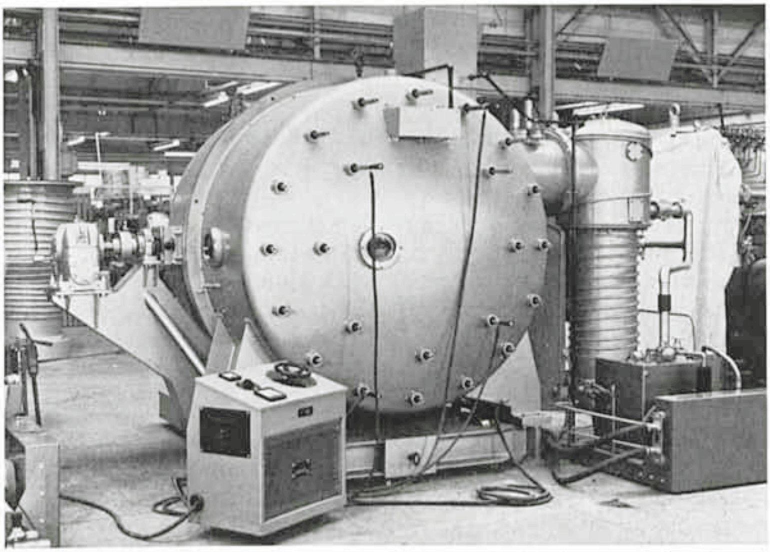

Fig. 2: The 2 m ESO Aluminizing Plant. In the centre the fixed vacuum chamber with the back parts of the 24 filament holders. To the right the diffusion pump and the rotary mechanical pump. To the left the mobile low tension control unit.

rotary pump is driven by a 5 h. p. electric motor; it has an ultimate vacuum of 0.01 torr without air ballasting and 0.5 torr with air ballasting.

The plant has one high vacuum and one low vacuum gauge.

The high vacuum gauge is of the Penning type, model Speedivac 5; the pressure is measured by the space current of electrons which move in the field of a strong permanent magnet. This gauge monitors the pressure over the range of 10^{-2} to 10^{-5} torr. The low vacuum gauge is of the Pirani type, model Speedivac thermal 8—1; the electric resistance of a heat resistor placed in the vacuum to be measured is in a Wheatstone bridge compared with the resistance of a heat resistor of the same kind placed in unchanged conditions. This gauge monitors the pressure over the range 10 to 5×10^{-3} torr.

The system has the following valves:

One manually operated high vacuum baffle and isolation valve, type Speedivac H16R16, is mounted above the diffusion pump in order to isolate the diffusion pump from the chamber.

One manually operated 50 mm Speedivalve of the diaphragm type is mounted in the roughing line in order to isolate the rotary mechanical pump from the vacuum chamber.

Another manually operated 50 mm Speedivalve of the diaphragm type is mounted in the backing line in order to isolate the rotary mechanical pump from the diffusion pump.

For air admission the vessel has a needle valve, type OS1D, and a 12.5 mm Speedivalve.

The control cabinet mounted adjacent to the vacuum chamber has the following supplies, instruments, and control circuits:

Penning control unit
Pirani control unit
Switch, fuses, and indicator lamp for diffusion pump
Mains switch and fuses
Starter for rotary pump
Ammeters for measuring high tension current
Variac for continuously varying high tension current
Indicator lamps for rotary pump and high tension current
High tension special high reactance transformer to supply 3,300 volts at 500 milliamp with a maximum short circuit current of approximately 750 milliamp and 5000 volt open circuit.

The low tension control unit contains the low tension supply and control equipment in a separate trolley mounted on castors. This arrangement makes it possible for the operator to perform the evaporation control by either hand and simultaneously inspect the evaporation sources through one of the windows of the chamber.

The trolley is connected to the chamber via a cable with a quick release clamp which can be attached to whichever electrode desired. The trolley contains a 30 amp iron clad switch fuse, Variac transformer, primary current ammeter, overload device, twin low tension transformer, current transformer, and low tension ammeter. The standard low tension output is rated at 20 volts: 400 amp intermittent, 340 amp continuous, or alternatively 40 volts: 200 amp intermittent, 170 amp continuous. Either supply can be selected by means of link connections. The unit is supplied directly from the mains.

As mentioned above, the finished aluminizing plant was inspected by ESO on January 12, 1967. The performing figures achieved during the testing of the equipment were as follows:

Time in minutes	Pressure in torr	Remarks
0	760	Engaging of rotary mechanical pump
8	10	Pirani gauge
13	1	Pirani gauge
13.5	0.3	Engaging of diffusion pump
15	1×10^{-3}	Pirani gauge
20	6×10^{-5}	Penning gauge
25	3.5×10^{-5}	Penning gauge
45	1.5×10^{-5}	Penning gauge (1×10^{-5} Mc Leod gauge)
60	1.2×10^{-5}	Penning gauge
100	1.0×10^{-5}	Penning gauge
115	Less than 10^{-5}	Penning gauge

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METEOROLOGICAL OBSERVATIONS ON LA SILLA IN 1966

A. B. Muller

Introduction

Through the year 1966, with one exception, continuous series of meteorological observations were obtained at two sites on La Silla. Due to some difficulties with the wind recorders, a few wind velocity observations were lost, for which reason the maximum wind velocity observed may not have been the real maximum velocity. During January and February, only a small number of wind direction observations became available. Apart from these gaps, all other data are complete through the year.

Different from 1965, the observations were made under more favourable conditions which is shown in the great amount of observed data. The observations concern clouds, wind velocity, wind direction, temperature and humidity.

Clouds

The observations cover all 365 nights of the year. In Table 1 the percentages of photometric clear nights are given for each month. For comparison also the observations of 1965 are presented. All nights having six or more continuously clear hours were defined as "photometric nights".

Table 1: Percentage of photometric nights

	La Silla	
Month	1965	1966
January	—	100
February	73	96
March	79	94
April	33	57
May	15	58
June	6	47
July	9	36
August	25	64
September	63	70
October	63	64
November	65	50
December	77	94

Out of the total amount of 3681 hours during which observations could have been made, 2481 hours were totally clear. Table 1 shows that 1966 was a remarkably better year than 1965.

Wind velocities during each month

During 1966, meteorological observations were collected at two sites on the mountain, one on the shoulder S, where the telescope buildings now are under construction, the other on the main top T. The heights of S and T are 2368 m and 2444 m respectively.

In Table 2 the maximum wind velocities in m/s are given for each month as recorded at the sites S and T. The maximum wind velocities are taken from all observations regardless of cloudiness because it is important to know what velocities may occur.

Table 2: Maximum wind velocity in m/s at S and T in 1966

1966	S	T
January	14	14
February	10	10
March	19	17
April	17	25
May	27	24
June	25	23
July	20	20
August	22	21
September	22	21
October	23	21
November	16	18
December	14	17

Wind velocities during photometric nights

In order to compare the wind velocities at the sites S and T during photometric nights, average wind velocities in m/s were read every two hours from recordings obtained simultaneously at both sites.

Table 3: Frequency of wind velocity v during photometric nights in 1966 at the sites S and T

v	Jan.		Feb.		Mar.		Apr.		May		Jun.	
m/s	S	T	S	T	S	T	S	T	S	T	S	T
1	13	8	20	16	16	31	4	8	5	6	7	7
2	29	29	29	30	44	49	16	15	18	14	14	16
3	47	50	49	46	66	66	19	19	35	32	18	18
4	69	68	71	70	80	77	25	24	51	50	19	19
5	83	82	88	86	89	85	31	29	68	67	26	22
6	92	89	98	98	96	99	38	38	81	85	30	24
7	97	95	103	103	99	103	42	45	89	94	33	33
8	102	99	104	105	104	103	46	48	100	102	40	38
9	102	102	105		105	104	48	48	104	106	42	40
10	103	103			105	106	49	50	106	107	42	41
11	103	104			107	108	51	50	107		44	46
12	104	105			111	111	53	54			45	48
13	105	106			113	113	56	58			49	50
14	107	107			113	114	59	61			50	51
15					113		61				52	52
16					113						52	53
17					114						52	56
18											54	56
19											55	57
20											55	57
21											57	58
22											57	58
23											58	59
24											59	
25												
26												
27												
28												
29												
30												
$\bar{v}$	4.2	4.3	3.6	3.7	4.1	3.9	6.2	6.0	4.9	4.8	7.9	7.7

m/s	Jul.		Aug.		Sep.		Oct.		Nov.		Dec.		All 1966 in %	
v	S	T	S	T	S	T	S	T	S	T	S	T	S	T
1	1	1	17	5	1	1	6	2	2	3	3	9	8.6	8.7
2	9	6	27	24	8	3	21	12	10	9	21	23	22.1	20.7
3	13	9	33	32	14	9	31	22	16	14	38	34	34.1	31.6
4	16	14	48	44	23	14	40	29	22	19	45	40	45.8	42.1
5	25	21	62	54	33	25	49	42	30	26	48	47	56.9	52.7
6	28	26	68	64	45	36	62	54	37	36	61	62	66.2	64.0
7	35	34	73	73	51	45	74	66	41	41	67	68	72.4	72.0
8	45	40	86	79	59	56	90	80	51	49	74	77	81.1	78.8
9	51	51	89	85	71	67	99	92	57	54	85	87	86.2	84.7
10	53	57	93	92	77	76	104	99		57	95	95	89.0	88.9
11	57	59	93	95	83	82	109	105			96	97	91.1	91.4
12	58	61	96	96	87	90	110	111			99	99	92.9	94.0
13	62	64	97	97	93	93	111	111			99	100	94.9	95.5
14	63	65	99	99	95	94	111	111			100		95.9	96.4
15	65		103	105	99	99	112	113					97.3	97.6
16			106	107	102	102	115	114					98.1	98.3
17			108	108	103	104	116	118					98.6	99.2
18			108	109	104	106	117	118					98.9	99.4
19			108	109	105	107	118	118					99.2	99.6
20			110	110	107		118	118					99.5	99.7
21							118	119					99.7	99.9
22							118						99.7	99.9
23							119						99.9	100.0
24													100.0	
25														
26														
27														
28														
29														
30														
$\bar{v}$	7.1	7.2	6.2	6.6	8.3	8.7	6.6	7.3	5.3	5.6	5.7	5.6		

Table 3 gives for each month of the year, for the sites S and T, the number of simultaneous observations with a wind velocity equal or less than the velocity "v" as indicated in the first column.

The last two columns in Table 3 give the total results in percentage over 1966.

The last row, indicated by $\bar{v}$, gives for each month of the year the average wind velocity in m/s at the sites S and T during photometric nights. The average wind velocity at T is somewhat higher than that at S, but the differences are not statistically significant.

Wind directions during photometric nights

At site S only, wind directions were observed every hour. Table 4 gives for each month of the year the number of hourly observations with a wind direction as indicated in the first column. This table is based on observations taken during photometric nights only. The last column in Table 4 gives the total results in percentage over 1966.

Only a few observations were obtained during the months January and February.

Table 4: Wind directions at site S during photometric nights

W. D.	J	F	M	A	M	J	J	A	S	O	N	D	All 1966 in %
S	4	5	20	0	13	0	4	5	15	0	25	14	5.2
SSW	0	0	5	4	2	0	0	2	6	6	16	0	2.1
SW	2	0	7	2	11	0	0	2	1	10	12	14	3.1
WSW	0	0	1	0	1	0	0	0	0	1	1	0	0.2
W	1	0	5	3	3	0	0	3	2	14	7	10	2.4
WNW	0	0	0	1	1	0	1	1	0	1	1	0	0.3
NW	2	0	6	25	35	10	3	14	6	12	17	29	8.1
NNW	0	0	2	9	6	1	2	2	1	9	8	7	2.4
N	5	4	7	50	40	47	27	17	52	49	23	119	22.5
NNE	3	1	10	25	21	19	25	21	32	53	31	19	13.3
NE	9	2	62	33	71	77	65	126	125	65	8	49	35.4
ENE	0	0	0	2	7	2	2	13	0	0	0	0	1.3
E	0	0	0	1	5	0	7	10	12	0	1	0	1.8
ESE	0	0	0	2	0	0	2	2	0	0	0	0	0.4
SE	2	1	2	0	0	0	4	6	0	0	0	0	0.8
SSE	0	0	0	0	0	0	1	3	0	0	0	0	0.2

The obtained results show clearly that through the year the prevailing wind direction during clear nights is in the interval NE—N—NW.

Maximum and minimum temperatures during each month of the year

Table 5 gives for each month the maximum and the minimum temperature as measured at S and T. The temperatures were read daily, regardless of the cloudiness, from a maximum-minimum thermometer.

Table 5: Maximum and minimum temperatures as measured at the sites S and T.

1966	(S) Max. °C	Min. °C	(T) Max. °C	Min. °C
Jan.	+ 26	+ 9	+ 24	+ 9
Febr.	+ 26	+ 5	+ 28	+ 4
March	+ 23	+ 4	+ 25	+ 6
April	+ 22	+ 2	+ 25	+ 5
May	+ 24	+ 4	+ 23	+ 5
June	+ 26	— 2	+ 26	— 4
July	+ 21	— 2	+ 22	— 5
Aug.	+ 23	— 8	+ 23	— 8
Sept.	+ 23	— 4	+ 23	— 5
Oct.	+ 22	+ 1	+ 22	+ 5
Nov.	+ 23	0	+ 23	+ 1
Dec.	+ 22	+ 5	+ 22	+ 4

As the temperature differences between day and night are important in order to obtain good knowledge of the measures to be taken to secure small temperature fluctuations inside the domes, the differences between the maximum day temperature and the minimum temperature of the following night have been calculated and are given in Table 6 for all days and nights during the month regardless of the cloudiness.

Table 6: Differences T.D. between maximum day temperature and minimum temperature of the following night for the sites S and T

T.D.	Jan.		Febr.		Mar.		Apr.		May		June	
°C	S	T	S	T	S	T	S	T	S	T	S	T
1	0	0	0	0	0	0	0	0	0	0	1	1
2	0	1	0	0	0	1	0	1	0	0	3	1
3	0	1	0	0	1	1	0	1	0	2	3	1
4	2	1	0	0	1	1	2	3	0	3	4	3
5	4	1	0	0	1	1	2	4	1	4	5	4
6	6	1	2	0	2	1	2	7	3	6	7	5
7	8	1	3	0	3	3	3	11	8	14	7	9
8	14	3	6	1	10	6	10	12	18	24	10	11
9	18	6	11	2	13	7	14	16	25	26	12	14
10	21	10	17	6	19	8	22	18	29	29	16	18
11	22	15	19	8	21	15	25	20	30	29	17	18
12	23	22	19	16		17	26	25		30	17	18
13		23	21	19		20		25			18	18
14			22	21		20		26			20	19
15				21		20						19
16				22		21						20
17												
18												
19												
20												
21												
22												
23												
24												
25												

T.D.	July		Aug.		Sep.		Oct.		Nov.		Dec.		All 1966 in %	
°C	S	T	S	T	S	T	S	T	S	T	S	T	S	T
1	0	0	1	0	0	0	0	0	0	0	0	0	0.6	0.3
2	2	0	2	1	0	0	0	1	0	2	0	0	2.2	2.6
3	3	0	3	1	0	0	1	2	0	3	0	0	3.5	3.8
4	6	1	3	2	1	0	1	4	0	4	0	1	6.3	7.3
5	8	5	7	5	2	3	1	7	0	9	0	2	9.8	14.4
6	13	9	11	6	3	5	2	10	3	14	0	4	17.0	21.7
7	17	11	11	7	5	6	6	14	6	15	0	6	24.3	31.0
8	20	15	13	12	9	9	13	25	11	18	19	16	48.3	48.6
9	23	23	17	15	15	12	19	26	16	19	26	20	65.9	59.4
10	26	26	21	23	21	19	27	29	20	22	28	28	84.2	75.4
11	29	28	23	25	24	21	28	30	21	23	30	29	91.2	83.4
12	30	29	25	26	25	21	29	31	24	24	30	30	94.3	92.3
13		29	28	28	27	22	29		26	26	31	30	97.8	96.2
14		30	29	28	28	23	31					31	100.0	98.4
15		30		28										98.4
16		31		28										99.7
17				29										100.0
18														
19														
20														
21														
22														
23														
24														
25														

The table gives for each month the number of days for which the temperature difference considered was equal or less than the value indicated in the first column. The table contains all observations at S and T. Due to technical difficulties, the number of days comprised in the table is sometimes less than the number of days of the corresponding month.

The last column in Table 6 gives the total results in percentage over the year. From the table we learn that temperature changes of 12° C or more seldom occurred.

Maximum temperature fluctuations during photometric nights

Table 7 gives for each month, for the sites S and T, the number of photometric nights during which the maximum temperature fluctuation occurring throughout the duration of the astronomical night was equal or less than the values indicated in the first column.

Table 7: Maximum temperature fluctuations during photometric nights

ΔT	Jan.		Feb.		Mar.		Apr.		May		June	
°C	S	T	S	T	S	T	S	T	S	T	S	T
0.6	3	3	4	1	4	3	2	0	3	2	0	1
1.1	18	12	8	8	10	9	5	2	11	7	2	4
1.7	26	22	13	10	19	15	8	6	14	10	7	6
2.2	28	27	16	13	24	20	10	10	15	13	9	6
2.8	31	29	19	19	27	23	12	13	17	16	10	11
3.3		31	23	21	27	24	14	15	18	16	11	11
3.9			24	23	27	26	15	16		16	12	11
4.4			26	26	28	28	16	17		17	13	13
5.0							16			17		
5.6							17			18		
6.1												
6.7												
7.2												
7.8												
8.3												
8.9												
9.4												

ΔT	July		Aug.		Sep.		Oct.		Nov.		Dec.		All 1966 in %	
°C	S	T	S	T	S	T	S	T	S	T	S	T	S	T
0.6	1	1	1	0	0	0	0	2	2	0	3	2	9.7	6.3
1.1	4	2	7	3	3	2	5	8	3	4	8	7	35.3	28.6
1.7	4	2	8	7	3	6	10	14	7	5	16	15	56.7	49.6
2.2	7	5	11	8	8	8	13	16	10	8	21	22	72.3	65.5
2.8	8	5	14	10	8	9	14	16	11	11	26	26	82.8	79.0
3.3	10	6	16	12	9	10	17	17	13	13	28	27	91.2	85.3
3.9	10	6	17	12	9	11	18	18	14	14	28	28	93.7	89.1
4.4	10	7	17	15	10	11	19	19			29	29	97.0	95.4
5.0	10	8	17	16	11	12	19	19					97.5	96.6
5.6	11	10	17	17	11	12	19	20					98.3	98.7
6.1		11	17	17	11	12	19						98.3	99.2
6.7			18	18	11	13	19						98.7	100.0
7.2					11		19						98.7	
7.8					11		20						99.2	
8.3					11								99.2	
8.9					12								99.6	
9.4					13								100.0	

The astronomical night is defined as the interval of time during which the sun is 18° or more below the observer's horizon. The queer values of ΔT are due to the conversion of degrees Fahrenheit into degrees Celsius.

The last column in Table 7 gives the total results in percentage for 1966.

The observations show in a very striking way the constancy of the temperature during the night. There is a slight indication that the temperature changes at T are normally somewhat larger than at S.

Relative humidity during photometric nights

The thermohygrographs were calibrated by comparison with a psychrometer. As the thermohygrograph at T is far away from the camp, the two hygrographs were regularly exchanged between S and T in order to obtain sufficient calibrations for both instruments.

The relative humidity was read from the records for every hour for photometric nights only.

Table 8: Relative humidity at the sites S and T

R.H.	Jan.		Feb.		Mar.		Apr.		May		June	
%	S	T	S	T	S	T	S	T	S	T	S	T
10	1	13	4	6	0	0	40	49	21	40	77	77
20	12	47	15	18	1	4	62	64	82	82	89	90
30	37	76	50	51	23	33	86	88	94	95	92	92
40	77	90	73	69	62	66	88	89	96	97	92	92
50	90	95	81	80	93	94	89	92	98	98	92	93
60	99	100	89	88	99	98	94	94	99	99	93	94
70	100		97	92	100	100	96	96	100	100	94	96
80			100	99			98	98			98	100
90				100			99	99			98	
100							100	100			100	
R.H.	38	28	39	40	42	40	25	23	21	19	18	17

R.H.	July		Aug.		Sep.		Oct.		Nov.		Dec.		All 1966 in %	
%	S	T	S	T	S	T	S	T	S	T	S	T	S	T
10	46	45	87	88	82	75	55	33	16	22	3	6	36	38
20	49	56	90	92	97	89	78	64	58	76	15	25	54	59
30	56	66	93	95	98	95	86	83	82	88	35	49	69	76
40	69	81	95	97	99	97	94	93	91	95	61	69	83	86
50	82	88	96	97	99	98	98	98	96	97	80	85	91	93
60	87	94	98	99	99	99	99	99	99	99	90	94	95	96
70	92	99	99	100	100	100	99	99	99	100	96	99	98	98
80	96	100	99				100	100	100		99	100	99	99
90	97		100								100		99	99
100	100												100	100
R.H.	33	27	14	13	13	15	19	23	26	22	42	37		

Table 8 gives for the sites S and T for each month the percentage of hourly observations, for which the relative humidity was equal or less than the value indicated in the first column. The last column gives the total results in percentage for 1966. The last row, indicated R.H., gives for each month of the year the average relative humidity at S and T during photometric nights.

It is interesting to see how low the relative humidity normally is. This may be of special importance for programs in the infra-red.

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THE COMPARISON OF THE SEEING BETWEEN MORADO AND LA SILLA*)

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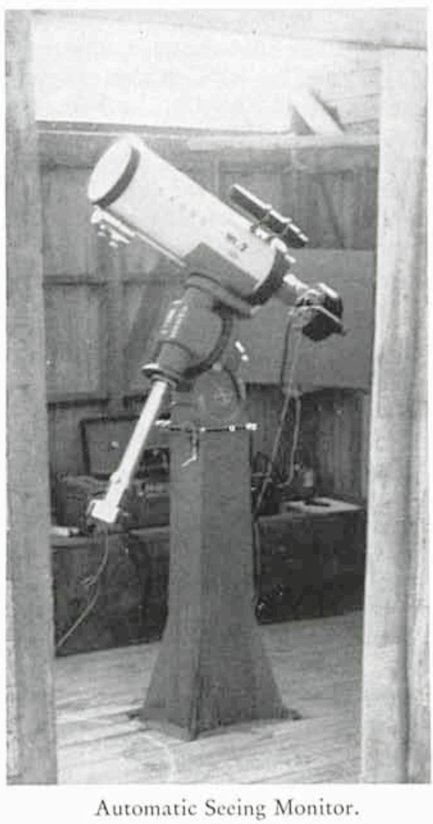
I. Introduction

The CARSO (Carnegie Institution's Southern Observatory) Site Survey was initiated in 1963 with the dual purpose of selecting the best possible site in the southern hemisphere for a 5-meter (200-inch) telescope, and of comparing the quality of the seeing at prospective sites in various southern countries with that at long-established observatories in the northern hemisphere. The detailed results of this survey, still continuing in Chile under the supervision of Mr. Donald L. Buck, may be found in the mimeographed CARSO Reports No. 1 (Oct. 15, 1964), No. 2 (Sept. 22, 1965), No. 3 (June 30, 1966) and No. 4 (July 1967). The interested reader is also referred to recent Annual Reports of the Director of the Mount Wilson and Palomar Observatories to be found in the Carnegie Year Books.

The main instrument used has been the ASM (Automatic Seeing Monitor). This instrument, which electronically and continuously measures the motion in right ascension of a stellar image in the focal plane of a 20-centimeter reflector, has been found to be both accurate and objective. One "observation" is taken from the records, normally every half hour at the time of a calibration, and has an internal mean error of about ± 12 per cent. A calibration is made by giving an additional artificial motion to the stellar image of 2 seconds of arc by means of a rocking plate in the optical train. All seeing results are referred to the zenith by applying a factor of $\sqrt{\cos z}$. Quarter-night means are formed by appropriately averaging from 2 to 6 individual observations, and these data may be found in the CARSO Reports for all observations from December 1963 to July 1967 made on Tololo, Morado, Pachón and La Silla.



Automatic Seeing Monitor.

By January 1966 lengthy comparisons, using two ASMs, had been made between Morado and Tololo, and Morado and Pachón. The median seeing was identical to a high degree of certainty at all three sites and averaged 0".80 or slightly better. Excellent seeing (<".55) occurred 20 per cent of the time, mostly during the summer months. If these results are taken at their face value it would suggest strongly that these Chilean sites are extraordinarily good and have significantly better seeing conditions than at any other observatory site known.

The Tololo cloud statistics have shown that 2 nights out of 3 are "photometric" and 4 nights out of 5 are "useful" on the average. Because of the strong north-south gradient in the cloudiness through this section of Chile, one might expect a few more photometric nights per year, on the average, at La Silla as compared to Tololo or Morado. Inasmuch as a large portion of the cloudiness is thin cirrus (moving rapidly from the southwest to the northeast at altitudes greater than 20,000 feet) one should expect to be able to observe usefully with a spectrograph some 90 per cent of the time, provided an integrating exposure meter were to be used. The winds and temperatures on La Silla are closely comparable to those on Tololo.

II. La Silla Installation

In September 1966 the decision was made to initiate an ASM comparison between Morado and La Silla, the latter being 100 kilometers north of the former. The transfer of one ASM to La Silla from Morado was made in two carryalls on September 27, 1966. A few preliminary observations were made that same night and useful observations started on the following night when the protecting walls had been erected. The ASM was located in the saddle between the two summit peaks of La Silla where it is somewhat protected from the wind[1]). An Onan portable gasoline generator is used to supply the 115-volt, 60-cycle power necessary for the electronics and for the telescope drive.

III. The Comparison with Morado

Nine months of La Silla ASM observations are presently available for analysis. Figures 1 and 2 show the comparison with Morado, using 272 simultaneous quarter-night means on 82 nights in the period Sept. 28, 1966 to June 27, 1967 inclusive. The median seeing is the same for the two sites within the errors of observation and sampling. There is some indication that the distribution of the seeing is different in the sense that there is a higher percentage of both good seeing and bad seeing on La Silla. The average difference of the simultaneous quarter-night means is 0".183 as compared to an earlier Morado-Tololo result of 0".127. The former number is much larger than would be expected from observational errors alone and reflects the weaker correlation in seeing that one might expect for two sites so far apart. The observational material has been divided into four approximately equal intervals and the results are given in Table 1.

[1]) CARSO intended to continue the ASM observations until the end of November, but due to road construction activities, terminated observing the end of October.

Table 1: A detailed comparison of the ASM median zenith seeing between Morado and La Silla

			Median Seeing	
1966-67	No. of nights	No. of means	Morado	La Silla
Sept-Oct-Nov	17	57	0."83	0."99
Dec-Jan	25	84	0."65	0."62
Feb-March	21	75	0."69	0."62
Apr-May-June	19	56	0."61	0."82
All	82	272	0."69	0."70

It should be remembered that the winter months (normally of poorer seeing) of July, August and most of September are not present in these data. (Note added in proof: 24 simultaneous quarter-night means in July-Aug-Sept gave median seeings of 0."95 and 1."15 for Morado and La Silla respectively.) The differences between Morado and La Silla as indicated in the last two columns are probably due to sampling errors and suggest that any comparison between two widely separated sites must be made over a period of a year or more in order to be reasonably definitive. Finally, the 185 non-simultaneous quarter-night means obtained on La Silla give a median seeing of 0."79.

IV. Seeing and Wind

Figure 3 shows the seasonal variation of seeing as derived from all Chilean ASM data taken over the past 3 1/2 years. The summer months of January, February and March not only have the best seeing but also have minimum cloudiness and winds. The winter months of June, July and August have the poorest seeing, the most cloudiness, and the winds average 3 to 4 times as much as in the summer. One might expect, therefore, a correlation between wind and seeing. The closeness of such a correlation as shown in Figure 4 (Note: Divide knots by 1.94 to obtain meters/second) is, however, somewhat surprising and deserves further study. It is almost certainly not due to telescope vibration. The ASMs are well protected from the wind in most observing positions but not in the zenith; however, almost all of the observations are taken at zenith distances greater than 30 degrees. Wind shake, when present, is readily identified as such on the records, but occurs infrequently. Moreover, the wind force goes as the square of the velocity and the correlation in Figure 4 seems to be a linear one. If this close relationship between wind and seeing is confirmed through analysis of additional data, the wind could then be used to predict the seeing with some accuracy.

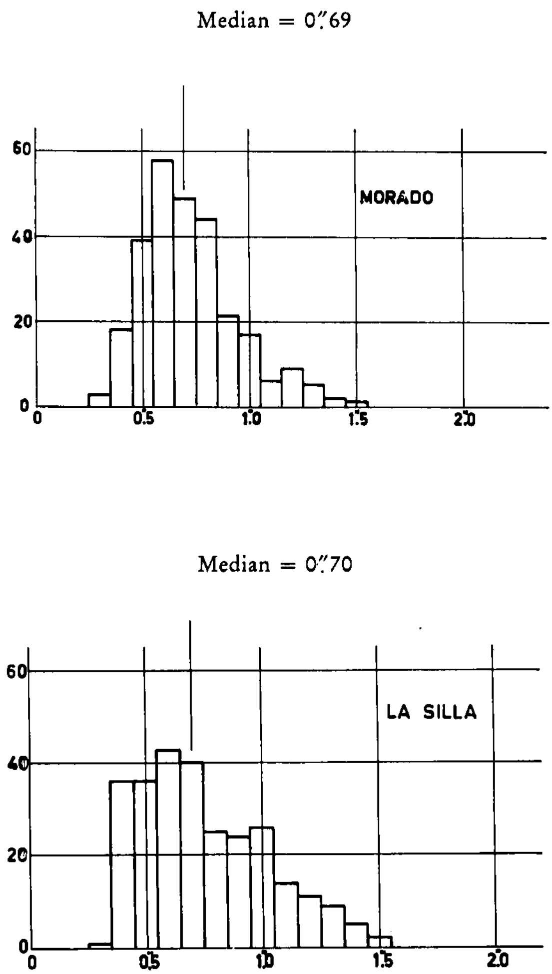


Fig. 1: ASM Zenith Seeing; simultaneous quarter-night means, 82 nights, Sept. 1966—June 1967.

Seeing comparison Morado—La Silla

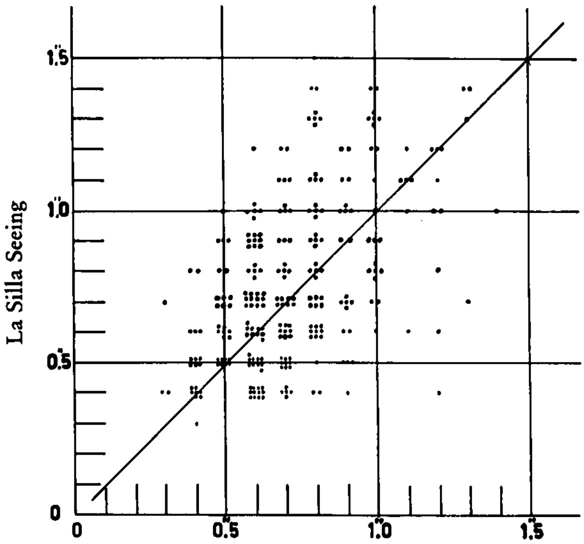


Fig. 2: Simultaneous quarter-night means, Sept. 1966—June 1967.

ASM Seeing

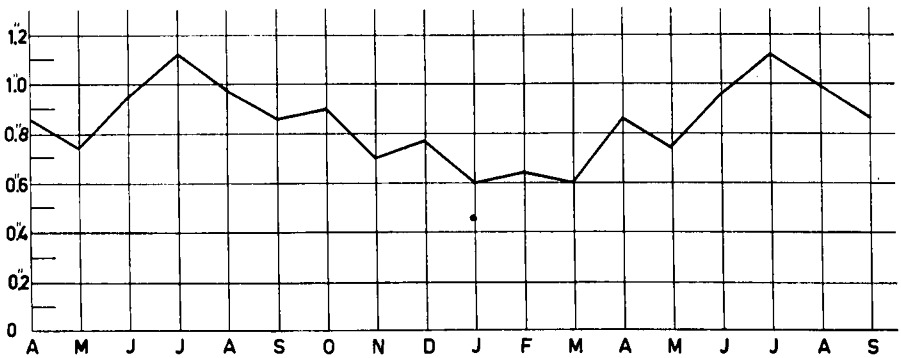


Fig. 3: Variation of seeing through the year (1963—1967).

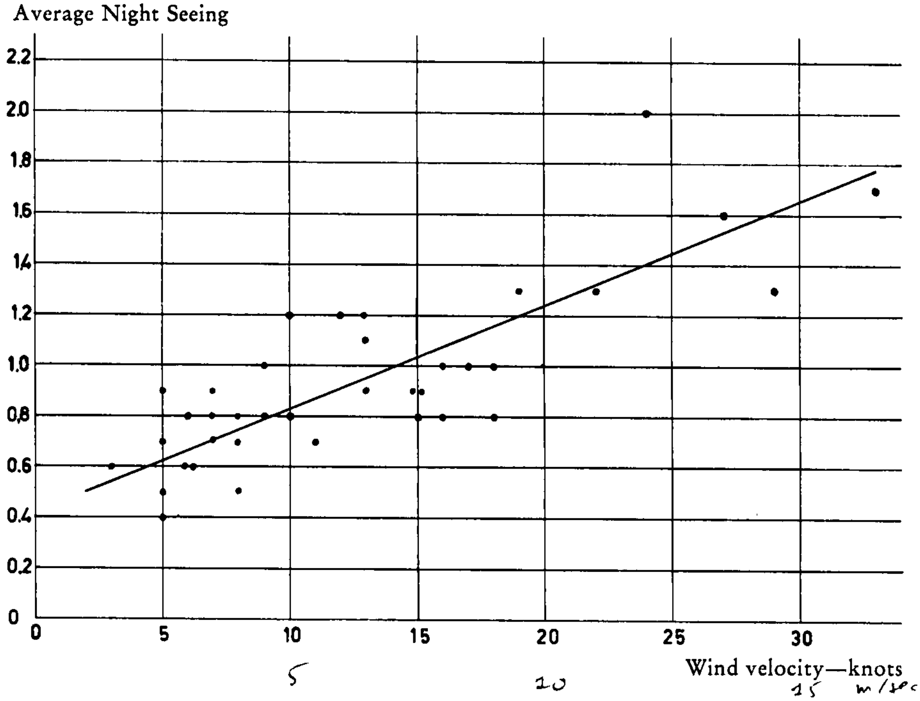


Fig. 4: Correlation between seeing and wind velocity.
La Silla 38 nights, Sept. 28—Dec. 22, 1966.

V. Future Needs and Conclusions

Meridian circle observers, using objectives of a diameter comparable to that of the ASMs, are familiar with the fact that bad seeing can occur in two ways: (1) the large motion of a sharp image or (2) a relatively stable but large image. The ASM would measure the latter condition as good seeing. Further, in extrapolating ASM results to what might be expected with a large reflector it should be noted that (1) the ASM includes ground effects not present in a large telescope, and (2) the bad seeing effects induced by the presence of a large dome are not present in the ASM results. No definitive comparison of the ASM seeing scale with any other well-established scale of seeing has yet been published. Therefore, it would be important to calibrate the ASM scale in terms of, for example, the percentage of starlight passing through the slit—or slits of various widths—of a spectrograph or photometer attached to a large, nearby reflector. Such a calibration could be made as soon as the Tololo 60-inch reflector goes into operation and could be made, with appropriate auxiliary instrumentation, with the ESO one-meter reflector. Until such time as this is done the ASM seeing results should only be considered to be a good first approximation.

Despite the above qualifying remarks, the seeing in this region of Chile is so good that it offers every incentive for the establishment of large telescopes of all types: long focal length astrographs, Schmidts, and very large reflectors. In particular, a very large survey-type Schmidt with a focal length 2 or 3 times that of the 48-inch Palomar Schmidt should be given very serious consideration.

VI. Acknowledgements

Manfred Wagner, CARSO's senior observer, has closely supervised the observing program on both mountains and was responsible for the quick and efficient setting up of the ASM on La Silla. La Silla observers have been Manuel Casanova, Rolando Cortés and Tomás Véliz. We are indebted to the personnel of the European Southern Observatory for their cooperation and continued assistance, especially in supplying housing for the observers and also for meals that are the envy of the Morado observers.

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