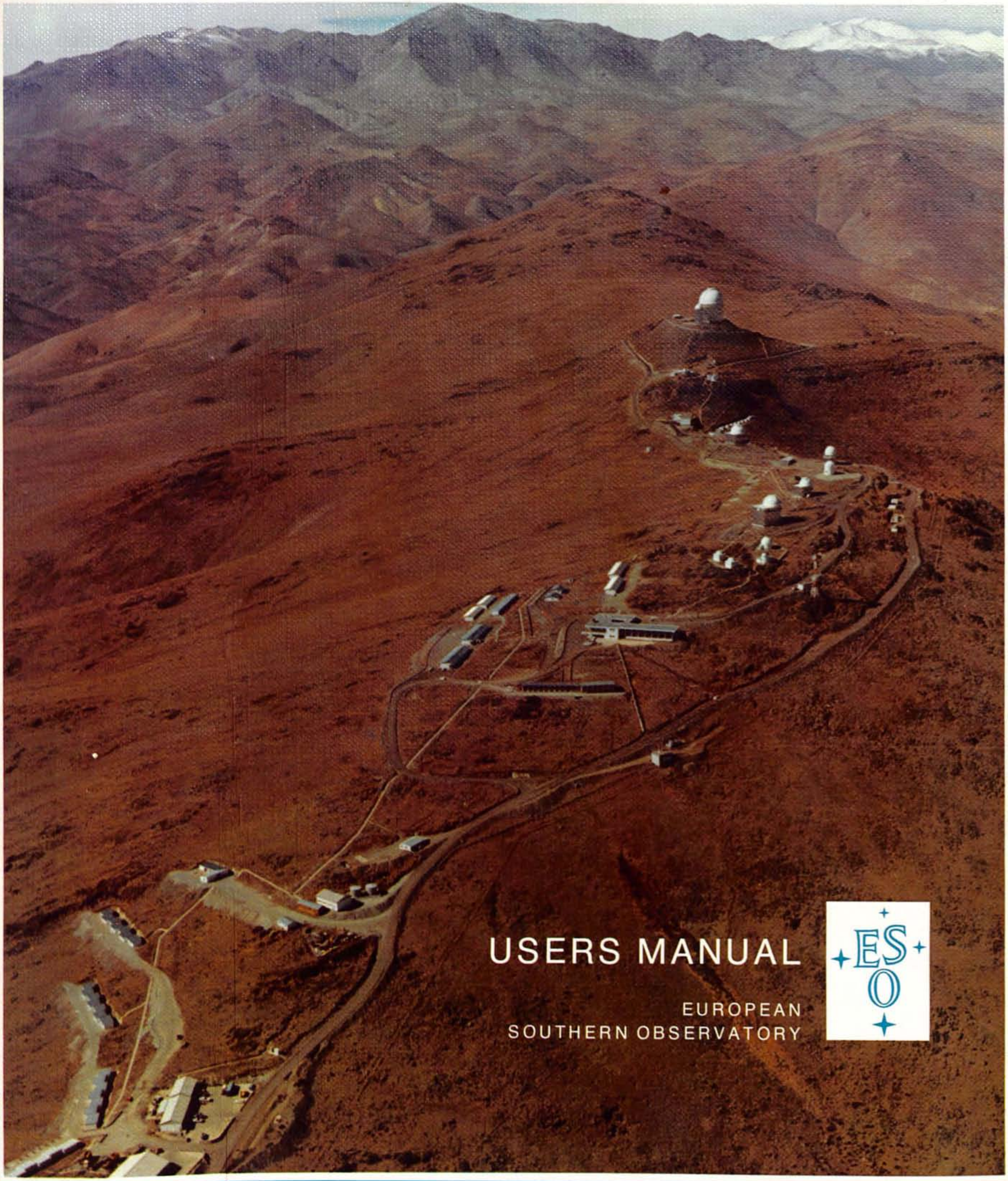


USERS MANUAL

EUROPEAN
SOUTHERN OBSERVATORY

General Index

ESO USER'S MANUAL

GENERAL INDEX

II. TELESCOPES (CONTINUED)

III. INSTRUMENTATION

III. INSTRUMENTATION (CONTINUED)

IV. PHOTOMATERIALS/CALIBRATION TECHNIQUES

I.

General Information

SECTION I INDEX

I. GENERAL INFORMATION

F. LODGING (continued) page/s

I.A.-ESO: A COLLABORATION OF BELGIUM, DENMARK, FRANCE, FEDERAL REPUBLIC OF GERMANY, NETHERLANDS, SWEDEN

ESO is a European intergovernmental organisation for astronomical research It provides the means for European astronomers, working with a range of optical telescopes and associated instruments to study that part of the universe best seen from the Southern hemisphere.

The ESO observatory is at La Silla in the Atacama desert in Chile.

Latitude	Longitude	Altitude
29°15'S	70°44'W	2400 m

Since July 1976, the European headquarters are in Garching near Munich (FRG), and presently the scientific and technical center is based at CERN on the French-Swiss border near Geneva. After September 1, 1980, the scientific and technical center will be moved to the Garching headquarters where all European activities will be concentrated.

Site testing for a Southern hemisphere observatory was carried out both in South America and South Africa. On the basis of these tests, the La Silla site 600 km north of Santiago was selected.

The convention establishing the European Southern Observatory was signed in Paris on October 5, 1962. It came into effect the following year. The basic agreement with the Chilean government was signed in November 1963, and on March 25, 1969, President Eduardo Frei inaugurated the observatory.

The six member states exercise control over the organisation through a council composed of two delegates per Member State which is advised by a Finance Committee consisting of one delegate per Member State. In addition, there are three other advisory committees: the Scientific and Technical Committee, the Observing Programs Committee, and the Users Committee.

Within the framework agreed by the council, complete responsibility for day-to-day operation is vested in a Director-General appointed normally for a term of five years.

Member States have equal voting rights but contribute to the budget in proportion to their net GNP. However, there exists a maximum contribution from any one State not to exceed 1/3 of the total budget. The contributions for 1980 from Member States amounts in total to 32.5 million DM.

The Observing Programs Committee, composed largely of scientists working within the Member States, evaluates proposals for observing time on the basis of scientific merit.

The Users Committee is composed of six members, one from each of the member countries, which are appointed by the Director General from among the recent Visiting Astronomers.

The committee advises the Director General on matters pertaining to the functioning of the La Silla Observatory from the point of view of the Visiting Astronomers.

The Scientific and Technical Committee is composed of 10 members chosen for their scientific and technical eminence from the member countries. The members are appointed by Council. The committee advises Council on scientific and instrumentation policy, and participates actively in the definition of scientific and instrumental programs. It further advises Council and the finance committee on budgetary matters related to instrumentation.

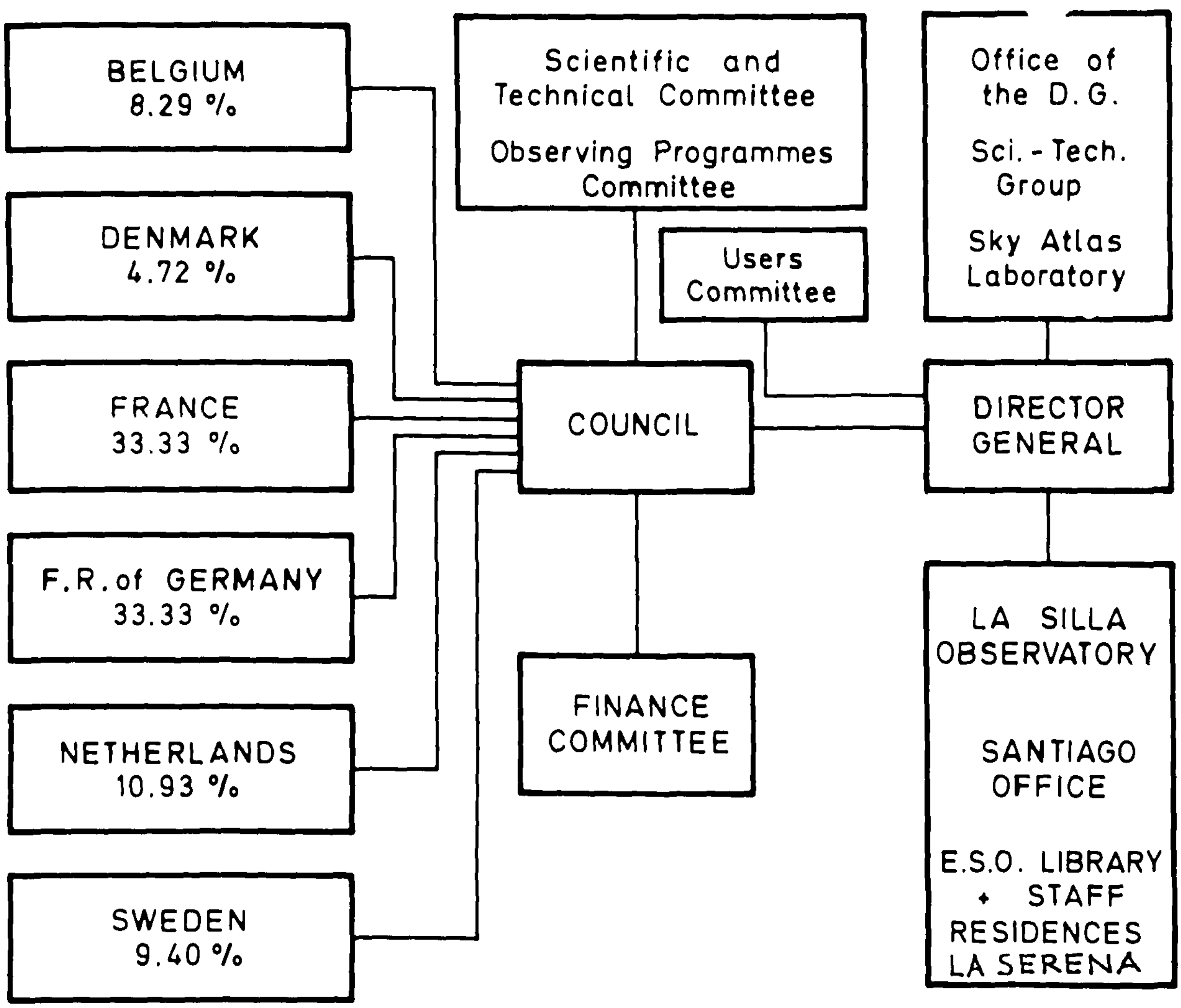
A schematic diagram of ESO is given in Fig.(1).

THE STRUCTURE OF E S O

Europe

E S O
Office of the Director-General
Schleissheimer Strasse 17
D-8046 Garching bei München
Tel. (89) 320 40 41-45
Tx. 05 215 915 **eso d**

E S O
Sci.-Tech. Group, Sky Atlas Lab.
c/o CERN
CH-1211 Genève 23
Tel. (022) 836111
Tx. 28 491



South America

European Southern Observatory
La Silla
E.S.O.
Casilla 567
La Serena, Chile
Tel. La Serena: 30 48
Tel. Santiago: 38 04 20
Tx. 40 881

European Southern Observatory
Alonso de Córdova 3107
Vitacura
Casilla 16317
Santiago 9, Chile
Tel. 28 50 06
Tx. 40 853

THE STRUCTURE OF E S O

I.A.1.FIG.1.

Apr. 80

I.B.1-APPLICATION FOR USE OF ESO TELESCOPES

INTRODUCTION

Telescope time is allocated in 6-month periods. Applications may be submitted for use of the 3.6 m, 1.5 m, 1 m Schmidt, 1 m, 50 cm, and GPO telescopes. In addition, VAs will have access to the 1.5 m and 50 cm Danish telescopes, the 91 cm Dutch telescope, and the 61 cm Bochum University telescope.

The astronomical use of the 3.6 m telescope is limited to about 80% of all nights. Observers have to give precedence to all engineering work and assist the technical staff whenever necessary. As the experience of the observer is of crucial importance, the programs must be conducted by the applicants or after mutual agreement between applicant and ESO staff astronomer, very short programs may be conducted by the staff astronomer. Since allotments, as a rule, cover only a few nights, applicants are invited to include proposals for one of the smaller telescopes.

The Quick Blue Sky Survey carried out at the Schmidt, has recently been completed, and the Red Survey in the region of Hα has just begun. The sky survey assumes a high priority on the Schmidt; however, it is hoped to enlarge time available for non-survey projects for VAs. The time scheduled for these programs depends on the sky survey program. For this reason, the programs for VAs are, as a rule, conducted by the ESO staff.

By decision of the Observing Programs Committee, each astronomer who applies *again* for observing time at ESO has to attach to the application a report on previous observations conducted at La Silla.

NOTE: You are strongly urged, before making proposals, to read the relevant sections of this manual.

PERIODS

The observing time is split into periods of six (6) months running April 1st to October 1st, and October 1st to April 1st. The submission date deadlines are the preceding October 15th and April 15th, respectively.

PERIODS	SUBMISSION DATE DEADLINES
April 1 to October 1	the preceding October 15
October 1 to April 1	the preceding April 15

NOTE: Applications are accepted only if postmarked prior to the submitting deadline.

ADDRESS FOR SUBMITTING PROPOSAL

Applications should be sent on the following official application forms to:

Visiting Astronomers Section
European Southern Observatory
Schleissheimer Strasse 17
D-8046 Garching bei Munchen
West Germany

NOTIFICATION OF TELESCOPE TIME ALLOTMENT

Proposals are considered by the Observing Programs Committee (OPC) consisting of astronomers from member countries and ESO staff astronomers. The telescope time is awarded on the basis of scientific merit.

The OPC meets roughly 3 to 4 weeks after the submission date deadline. The applicant receives notification of the decision 15 days after the OPC convenes.

EUROPEAN SOUTHERN OBSERVATORY

Organisation Européenne pour des Recherches Astronomiques dans l'Hémisphère Austral
Europäische Organisation für astronomische Forschung in der südlichen Hemisphäre

ESO-OFFICE OF THE DIRECTOR-GENERAL
Schleißheimer Straße 17 D-8046 Garching bei München

PERIOD

APPLICATION FOR OBSERVING TIME IN CHILE*

1. Full name of applicant and address of institution					
2. Short but meaningful title of programme					
3. Indicate here briefly scientific aim of programme. See also page 4.					
4. Encircle required telescope (s). If simultaneous observations are required, mark additionally with an "S"	3.6 m	1.5 m	1 m	50 cm	Schmidt
	GPO	1.5 m Danish	50 cm Danish	61 cm Bochum	90 cm Dutch
5. Indicate required equipment	Spectrographic		Fill out in detail page 7		
	Photometric				
	Photographic				
	Other				
6. State number of requested nights					
7.1 Indicate first and second choice for specified period	Months 1 and 2	Months 3 and 4	Months 5 and 6		
7.2 Does the moon disturb? If so, state for what reasons it does					

* Fill in a separate form for each programme

8. Applicant's experience with telescopes. If applicant does not conduct the programme himself, answer 9.1	
9.1 Give full name, nationality, address and experience of observer who is going to conduct the programme under the applicant's responsibility	
9.2 Languages spoken	
10. Scientific papers including preprints resulting from La Silla observations during the last three years.	If necessary, continue on separate sheet

11. Give position at institution	
12. Special remarks	

Date

Signature

Description of proposed programme and applicant's main publications related to it:
(If reference papers are not yet published, attach copy)

A) **Abstract** (Short and concise summary of the proposal)

B) **Scientific rationale** (Scientific background, previous work plus justification for present proposal)

C) **Scientific aim** (Immediate objective of the proposal. State what is actually going to be observed and what shall be extracted from the observations, so that the feasibility becomes clear)

Right ascensions, declinations and magnitudes of objects contained in proposed programme:

Justification of requested number of observing nights by means of a breakdown of observing time per object given in proposed programme.

OBSERVING PROGRAMMES REQUIREMENTS

Indicate clearly with a cross in the appropriate places your telescope and instrumentation requirements.
For details check the available ESO documentation.
ONE FORM PER TELESCOPE PROGRAMME ONLY, thus, if you have applied for observing on several telescopes, instruments or programmes, copy this page.

OBSERVER'S NAME: ______________________________

Telescope		Instrument		Detector / Option	
3.6 m		P.F. Gascoigne Adaptor		Grism (Red & Blue)	
		P.F. Triplet Adaptor		Direct Photography	
				~~Red Image Tube~~	
				Racine Wedge	
				Spectracon	
		Cass Photometer		Infrared	
				Colour System	
				Polarimetry	
		Cass B & C Spectrograph		Reticon	
				Image Dissector	
				Image Tube	
				~~Direct Plates~~	
1.5 m		B & C Spectrograph		(as for Cass B & C Spectrograph)	
		RV Cass Spectrograph			
		~~Spectracon~~			
		16 x 16 cm Camera			
		Coudé Spectrograph		Camera I	
				Camera II	
				Camera III	
		Echelec Spectrograph		Lallemand Camera	
				Spectracon	
1 m		Double Channel Photometer			
		Polarimeter			
		Infrared Photometers		Bolometer	
				InSb Detector	
		Photometer		PM EMI 6256	
				PM RCA 31034	
				PM EMI 9789 QB	
				PM ITT FW118	
50 cm		Single Channel Photometer		(as for Photometer)	

Schmidt		With Prism	
G.P.O.		Without Prism	

Dan 50 cm	Hß Photom.	
	uvby Photom.	

Bochum 61 cm		Single Channel Photometer			
Dan 1.5 m		For instrumentation contact ESO office			
Dutch 90 cm		Walraven Photometer			
Calibration		ETA Spectr.		Spot Sensitometer	

Apr 80

PHOTOGRAPHIC MATERIALS: Only emulsions listed below are supplied by ESO:

Emulsions available	IIa–O	IIIa–J	IIIa–F	IV–N	103a–D	IIa–D	098–02
Number of plates required							

SPECTROSCOPY: Indicate wavelength region(s): ____________________

Dispersion(s): ____________________

FILTERS:

- Indicate colour system(s): ____________________
- If you do not use standard colour systems, indicate which ESO filters you require: ____________________
- If you use filters not available in ESO, do you bring your own filters? YES / NO, if no, specify required wavelength region, bandwidth, supplier, price, etc.

____

PHOTOMULTIPLIER (specify if non ESO standard is used) ____________________

OWN EQUIPMENT: On which telescopes has your equipment been tested?

____

and when? ____________________

Weight of your equipment: ____________________

Volume to be transported: ____________________

Value of the equipment: ____________________

What is the focal distance from top adaptor flange? ____________________

Is your adaptor flange compatible with required telescope? ____________________

Does your equipment require computer connection? YES | NO

If YES, is equipment CAMAC compatible? YES | NO

(ESO uses standard CAMAC interface system)

If NO, provide precise description of required connections with levels, cables, contacts, etc.

____

____

Do you require software support? If so, provide detailed description and flow diagram.

____

____

I.B.2-REGULATIONS FOR VISITING ASTRONOMERS

GENERAL RULES

Visiting Astronomers (VA's) are astronomers on mission to ESO establishments in Chile for the purpose of executing scientific programs approved by the ESO Directorate. On acceptance of allocated observing time, it is implicitly understood that the VA has accepted the following regulations:

1) While in Chile, VA's are subject to the authority of the ESO Direçtorate.

2) VA's must refrain from acts prejudicial to ESO under the convention between Chile and ESO. They shall refrain from public political declarations or activity. They shall not sell anything brought by them to Chile.

3) VA's execute the programs accepted by ESO, deviating from these only under exceptional circumstances. The ESO Directorate is to be informed of all substantial modifications.

4) VA's should deliver to the Astronomy Office, a brief report upon termination of their mission in Chile. In addition, they should submit within three months, a report to the ESO Directorate based on a preliminary examination of the collected data.

5) Before leaving Chile, VA's shall settle their personal accounts with the administration, (see section I.F.)

6) Photographic plates taken with ESO telescopes are to be numbered in accordance with ESO's system. All such plates remain the property of ESO. The VA may take the plates elsewhere for analysis after which they are to be returned to the ESO plate file in Geneva.

CREDIT LINE

Publications based on observations collected at the ESO observatory should mention in a footnote on the first page, "Based on observations collected at the European Southern Observatory, La Silla, Chile".

I.C. - ADDRESSES OF IMPORTANCE

Administrative Offices and Visiting Astronomers Service	Schleissheimer Strasse 17, D-8046 Garching bei Munchen, Fed. Rep. of Germany. Telephone: (089) 3204041-5 Telex: 05215915 eso d. Telegrams: EURASTRO Garching bei Munchen.
Scientific-Technical Group (until September 1, 1980)	ESO/CERN, CH-1211 Geneva 23, Switzerland. Telephone: (022) 836111. Scientific Group: 835082. Engineering Group: 834692. Instrumentation Development Group: 834831. Sky Atlas Laboratory: 834834. Geneva Asministrative Group: 832235. Telex: 28491. Telegrams: CERNLAB-Genève.
ESO Office Santiago-Chile	Alonso de Cordova 3107, Vitacura, Stgo de Chile/or Casilla 16317, Santiago 9, Chile. Telephone: 285006. Telex: 40853. Telegrams: ESOSER-Santiago de Chile.
Guesthouse	Gustavo Adolfo 4634, Santiago de Chile. Telephone: 484254.
La Silla Observatory	c/o Santiago office address. Telephone: La Serena 3048/Santiago 380420.
ESO Library and Staff Residences La Serena-Chile	Las Cisternas 2020, La Serena/or Casilla 567, La Serena, Chile. Telephone: 1167 Telegrams: ESOSER-La Serena.

I.D.-EQUIPMENT: SHIPPING AND HANDLING PROCEDURES

SHIPPING INSTRUCTIONS

The Visiting Astronomer (VA) may wish to bring special equipment to La Silla. Before shipping, the VA should contact first the Visiting Astronomers office in Garching for instructions at least three months in advance. The office will provide necessary details for shipment of the equipment.

Two (2) copies of the *pro-forma invoice* should accompany the *Air waybill (AWB)*. The *pro-forma invoice* must contain a brief description of the material and its approximate value. The equipment should be addressed to:

European Southern Observatory
Casilla 16317, Santiago 9, CHILE
ATTENTION: Import Department
(Telephone: Santiago 285006)

The equipment has to arrive two (2) weeks in advance to allow time to effect customs and other formalities. This will ensure that the equipment is ready on the mountain when the VA arrives.

Please inform the Garching office by telex about: *flight number, Air waybill (AWB) number,* and the *date of dispatch* of the equipment.

TRANSPORT INSURANCE

ESO covers transportation and insurance costs. Copies of the *pro-forma invoice* should be sent to the Garching office (marked "ATTENTION: Purchase/ Shipping Department") well before the shipment of the equipment to Chile.

CUSTOMS PROCEDURES

In order to effect customs clearance of the equipment, ESO first has to request the "liberation of merchandise" from the Ministry of Foreign Affairs. This can only be done on *Wednesdays* and the permission is granted *the following Wednesday.*

This formality can only be carried out after the arrival of the equipment and receipt of the proper documentation (copy of the *pro-forma invoice and AWB*).

The customs clearance takes one or two additional days, and transport of the equipment from Santiago to La Silla a further day.

I.E.-TRANSPORTATION

RETURN: HOME INSTITUTE-SANTIAGO-HOME INSTITUTE

Visiting Astronomers (VAs) will receive notification of allocated observing time together with proposed travel arrangements from the Secretariat of the Visiting Astronomers Office in Garching. ESO financial support is generally available only for astronomers from institutions in ESO Member States. Normally, the ESO office in Garching purchases a return economy class air ticket via the most direct route possible between the VA's home institute and Santiago. In the case of train travel in Europe, first class is approved.

NOTE: Past experience has shown that VAs interrupting travel to Santiago are often delayed by unforseen circumstances in transport, which of course interferes with observing schedules. It is therefore emphasized to travel to Chile the *shortest route possible*. No restrictions exist concerning stops on the return trip.

If more than one astronomer wishes to travel to Chile for the same program, ESO may, under special prior consideration, contribute to the costs of the second person.

VAs are expected to arrive two (2) days prior to their run at La Silla, and at least one day before this in Santiago to acclimatize and allow travel time to La Silla from Santiago. Also note when making travel arrangements that the ESO plane transport to La Silla is not provided Thursdays, Saturdays, or Sundays; i.e. at present four times a week: Mondays, Tuesdays, Wednesdays and Fridays.

VAs should announce their intended arrival to the Santiago office well in advance. Any delays should be reported as soon as possible by telex/telegram: 40853 ESO/ESOSER, or phone Santiago 285006.

After arrival in Santiago's airport "Pudahuel" and passage through customs, the VA will be met by an "Airport Taxis Service" driver who will have instructions for his destination either the ESO Guesthouse or a hotel. For the VA's return trip, taxi transport to "Pudahuel" is also provided by ESO.

RETURN: SANTIAGO-LA SILLA-SANTIAGO

It is generally advisable to report to the Santiago office so that visa formalities and other matters may be dealt with. The office will also inform the VA of the details of travel to and from La Silla. Standard modes of transport to

La Silla are:

1) Plane Transport

The plane is a twin engine, seven (7) seater Piper rented by ESO for transport of passengers to and from La Silla. In general, small luggage is easily accommodated on the plane although it is possible that no space is available for larger suitcases. The VA is therefore urged to pack only essentials in an easily transported handbag. Further luggage may be sent by road transport or via the plane with one of the next flights. Flights to and from La Silla are made Monday through Friday (Thursdays excepted) from Tobalaba or Los Cerillos aiports in Santiago. The *actual flight duration* depends on weather conditions, but is approximately two (2) hours. However, the *total time* for the trip including road transport time to and from the airports is approximately 3 1/2 hours.

2) Road Transport

a) By ESO Car - Car transport is rarely used, either when weather conditions do not permit landing in Pelicano or when there are no available seats on the plane. The car trip from Santiago to La Silla is about nine (9) hours.

b) By Public Bus - The VA may be requested to travel by public bus between Santiago and La Serena. Under these circumstances, ESO will provide car transport to and from the respective bus station. The travel time Santiago-La Serena is typically six (6) hours, and a further two (2) hours are needed for the La Serena-La Silla trip.

LUGGAGE NOTE

VAs are advised to carry all materials indispensable for the observing run, (i.e. finding charts, object lists, etc.) in "carry on" luggage (hand). In the event that your main baggage is delayed you will still be able to execute your observing mission.

The climate in central Chile is best described as Mediterranean, but do not forget that the seasons are reversed. Typical temperatures are 28°C in summer - January -, and 10°C in winter - July. The temperatures on La Silla are similar during the day but occasionally can drop to zero during the winter nights. You should therefore dress accordingly. In general, it is recommended to bring casual sports clothes (e.g. blue jeans, casual shirts and woolen sweaters) and sturdy comfortable walking shoes are ideal observatory wear. Observing jackets and trousers are provided by the observatory.

I.F.-LODGING

INTRODUCTION

ESO provides free lodging and meals for Visiting Astronomers (VAs) from Member States up to four (4) days in Santiago and at La Silla for the observing period plus seven (7) additional days at La Silla. Expense considerations for VAs from non-member countries must be discussed individually with the ESO Visiting Astronomers Service. The following descriptions of expense considerations apply only to VAs from Member States.

CHARGES AND ALLOWANCES

ESO financial support is granted generally only to astronomers from institutions in the ESO Member States. This includes: 1) round trip airfare and ground transport (see section I.E.); 2) free board and lodging in the Guesthouse in Santiago for up to four (4) days and at La Silla for the observing period up to seven additional days; and 3) a sum of 100 DM to cover other miscellaneous expenses payable after the VA's return to Europe based on the "Clearing Certificate" (a statement of the VA's personal account in Chile).

Outside this period and in cases when free board, lodging, or travel are not provided by ESO, the charges to VAs are as follows:

per 24 hour day in the Guesthouse	DM 62.55
per 24 hour day at La Silla	DM 51.30
one way fare in the ESO plane	DM 170.00

In the event that no room is available in the Guesthouse; i.e., should an overnight stay be necessary on the way to or from La Silla, ESO supported VAs are paid a daily allowance.

The VA should bring sufficient funds (preferably Traveller's Checks in US $ or currencies of ESO Member States) adequate to cover expenses likely to incur before, during, and after travel to/in Chile. These checks may be changed by ESO (cashiers at La Silla, the Santiago office, or the Guesthouse into Chilean pesos. US $ Traveller's Checks are also accepted by any Chilean bank.

ESO cannot supply cash in hard currency or change checks or give allowances against hard currency.

SANTIAGO

In Santiago, accommodation is either in the ESO Guesthouse or one of the principal hotels in Santiago. The latter is used only when the Guesthouse is full. Hotel reservations are made by the ESO Secretariat in Santiago. Three meals per day as well as afternoon tea are served in the Guesthouse. For VAs lodged in hotels, a daily allowance is paid.

LA SILLA

At La Silla, there is a central building, the "hotel", with a dining room, lounges, dormitories, lobby and mail boxes, (see map of La Silla- end of this section). Nearby are additional associated dormitories. The hotel serves as a central meeting place and communication center. On arrival at La Silla, the VA will be contacted by the lodging staff and assigned a single study bedroom in one of the dormitories.

Room number assignments and room telephone numbers are posted in the hotel lobby. Each dormitory is furnished with the following:

a) observing clothes and flashlight (to be returned to the dormitory cleaner the day of departure)

b) a private shower and toilet facilities

c) clean towels and soap

d) leaflet concerning domestic arrangements with the observatory

e) internal telephone and guide

f) electrical outlets of 220V, 50 c/s

g) ESO stationery and post cards

MAIL AND TELEX

Incoming mail can be found in the mail boxes sorted by room number at the entrance to the dining room. Mail via the "Dip Bag Garching" arrives at La Silla on Monday, and from Geneva on Tuesday.

Outgoing mail, except mail to the La Serena area, may be posted in one of the yellow boxes found at the hotel entrance or on the first floor of the Astronomy and Administration building. The "Dip Bag Garching" leaves La Silla on

Thursdays by car at 1730 hours and the "Dip Bag Geneva" leaves on Fridays at 1230 hours.

La Serena mail must be placed in the mail box at the entrance to the dining room.

Chilean and German stamps (for mail to Europe via the Garching Bag) as well as ESO post cards may be purchased from the communications office between 1400 and 1700 hours.

Telexes may be sent from the communications office in the Astronomy and Administration building (1st floor). Indicate which telexes are official and which are private; private telexes will be charged to the VA's personal account. Incoming telexes will be placed in the mail boxes according ~~to~~ room number.

TELEPHONE

Local calls - Public phone calls may be made from: 1) either of the two phone booths in the hotel basement, or 2) directly from the astronomy secretary's office in the Astronomy and Administration building between 0900 and 1830 hours.

Between 0900 and 1830 hours, phone calls from the hotel are placed via the ESO switchboard by dialing "9". After working hours, calls may be made directly to La Serena (dial "8" and wait for the operator to ask for the number required in Spanish), or to Santiago (dial "0" then wait for the automatic exchange tone and dial the number required).

Long Distance - Long distance calls between 0800 and 1830 hours can always be made by dialing "9" for the ESO operator. Outside these hours and during weekends, the Administration ("Jefe de Turno" as indicated on the notice board in the hotel lobby) should be asked for help. For the long distance operator *within Chile*, after dialing "0", dial "108", and for the *overseas* operator, dial "0", then "122".

Register all long distance calls in the books found in the telephone booth in the hotel and the Astronomy office. Unless calls are formally declared official, they will be charged to the VA's personal account.

Internal phone system - This system provides communication within the La Silla site only.

To call La Silla from La Serena, dial "3048"; to call La Silla from Santiago, dial "380420".

TRAVEL RESERVATIONS AT LA SILLA

Travel reservations, confirmations or changes can be made through the communications office while on La Silla.

MEDICAL

Before leaving Europe, some precautions against intestinal infections are recommended such as: oral typhus, typhoid immunization. A limited medical service is permanently available on La Silla; however, astronomers should bring along items such as: anti-sunburn lotions, creams, cocoa butter sticks to deal with the possible effects of low humidity; and medication for stomach upsets.

If serious problems arise or accidents occur, transportation to a hospital is immediately available and all necessary measures will be taken by ESO.

INSURANCE

Insurance coverage is as follows:

In case of death	DM 67,000
In case of permanent total disability	DM 134,400
Medical expenses	DM 2,800

This insurance takes effect following the start of the travel 48 hours prior to the planned arrival in Chile and expires 48 hours after departure from Chile, unless delays are incurred by circumstances beyond the control of the traveler. Reimbursement of medical expenses is only possible on presentation of a certificate issued by the attending physician.

ESO does not insure any personal effects during the observing mission. In case any equipment to be used for the execution of an observing program is carried in hand luggage, the VA should inform the Visiting Astronomers Office not later than four (4) weeks prior to the journey.

ENTERTAINMENTS

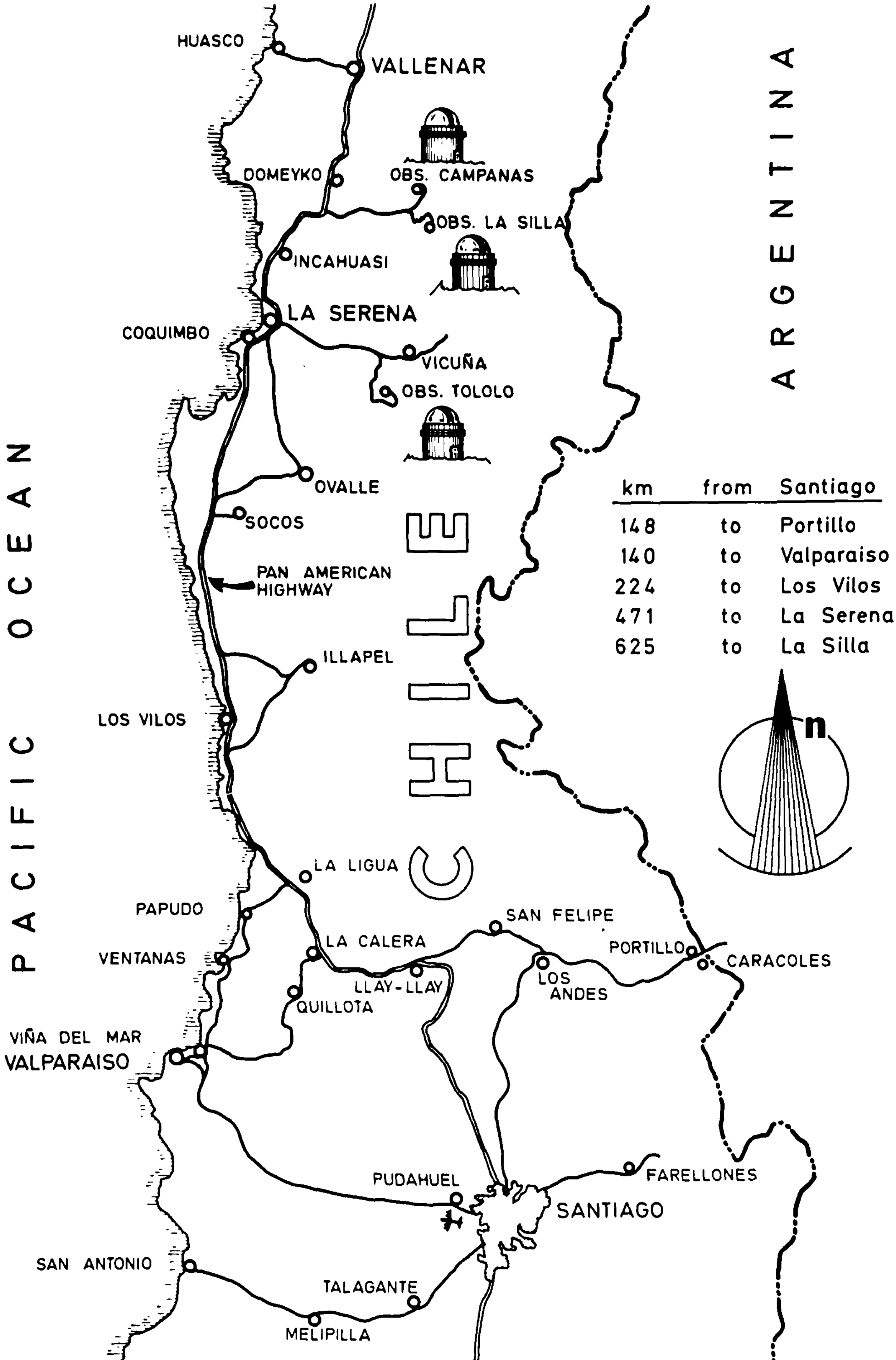
At La Silla, the VA will find available:

Reading room - containing fiction books, magazines, European and local newspapers and publications in the hotel, first floor.

Movies - commercial and cultural twice a week at 2000 hours in the hotel living room, generally titles are posted in the dining room.

TV, Pool and Ping-Pong - "Clubhouses" 1 and 2

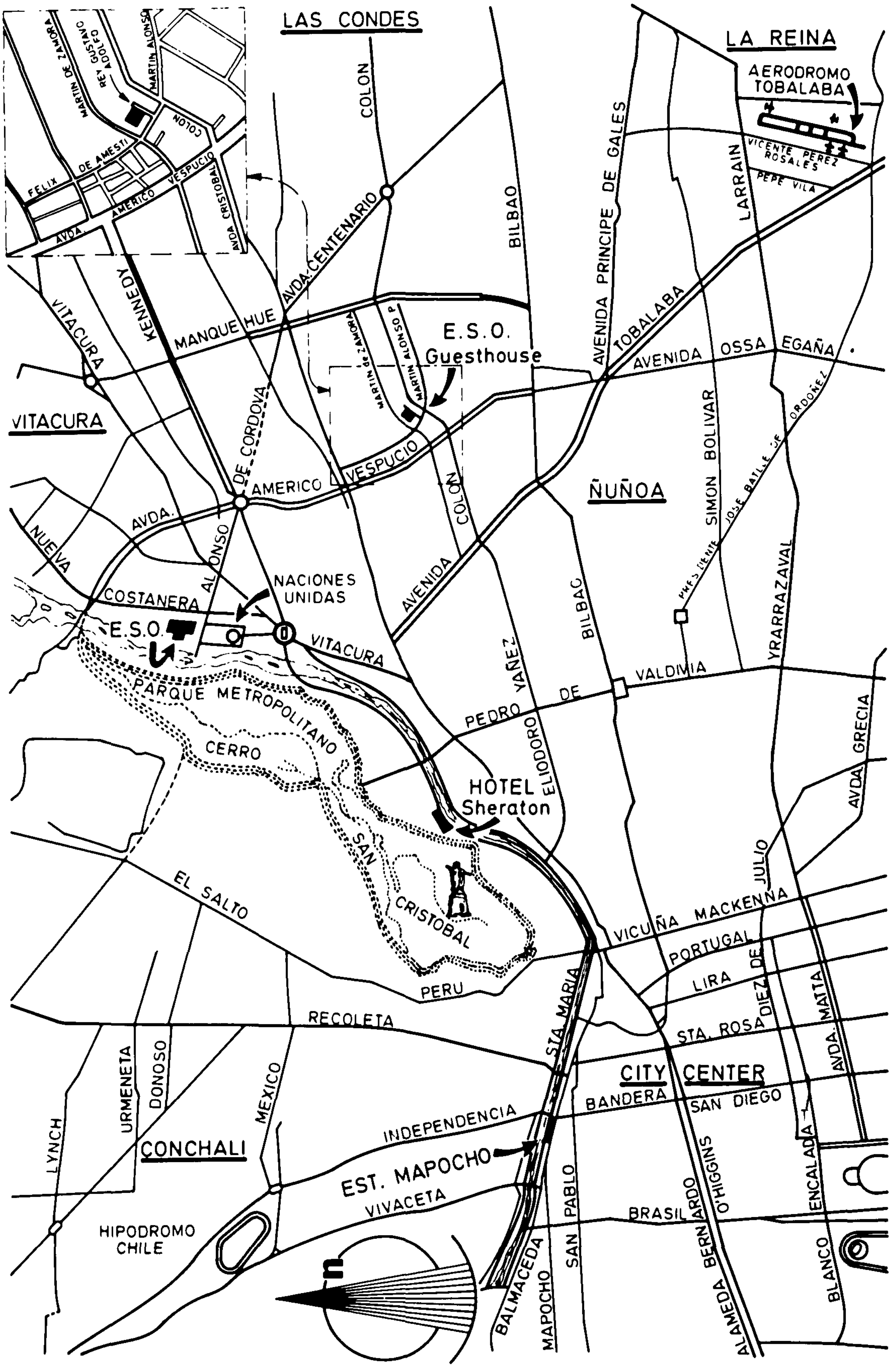
Playing cards and Games - may be borrowed from the communications office (Astronomy and Administration building, 1st floor).



km	from	Santiago
148	to	Portillo
140	to	Valparaiso
224	to	Los Vilos
471	to	La Serena
625	to	La Silla

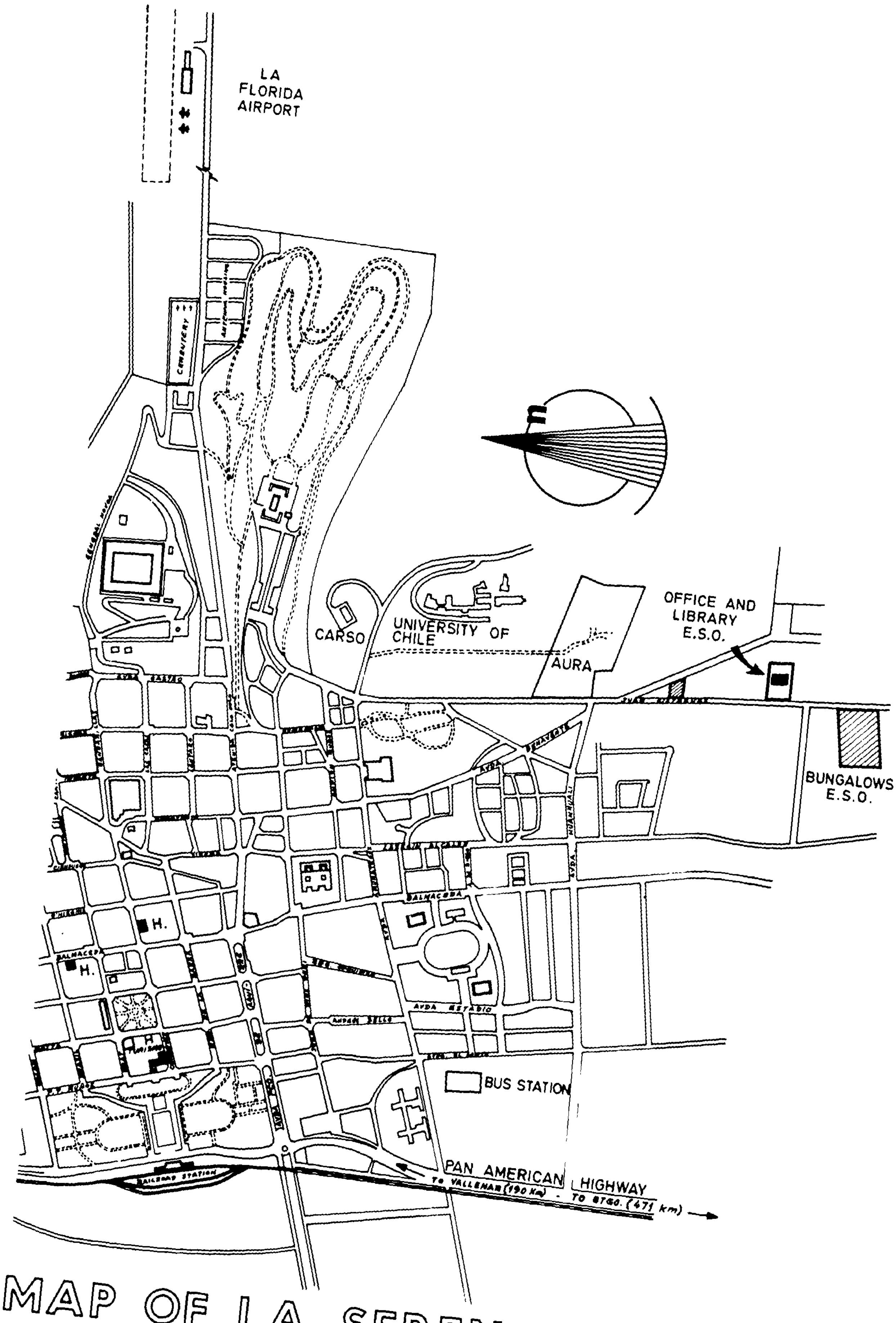
MAP OF CHILE

I.F.1.FIG.1.



MAP OF SANTIAGO

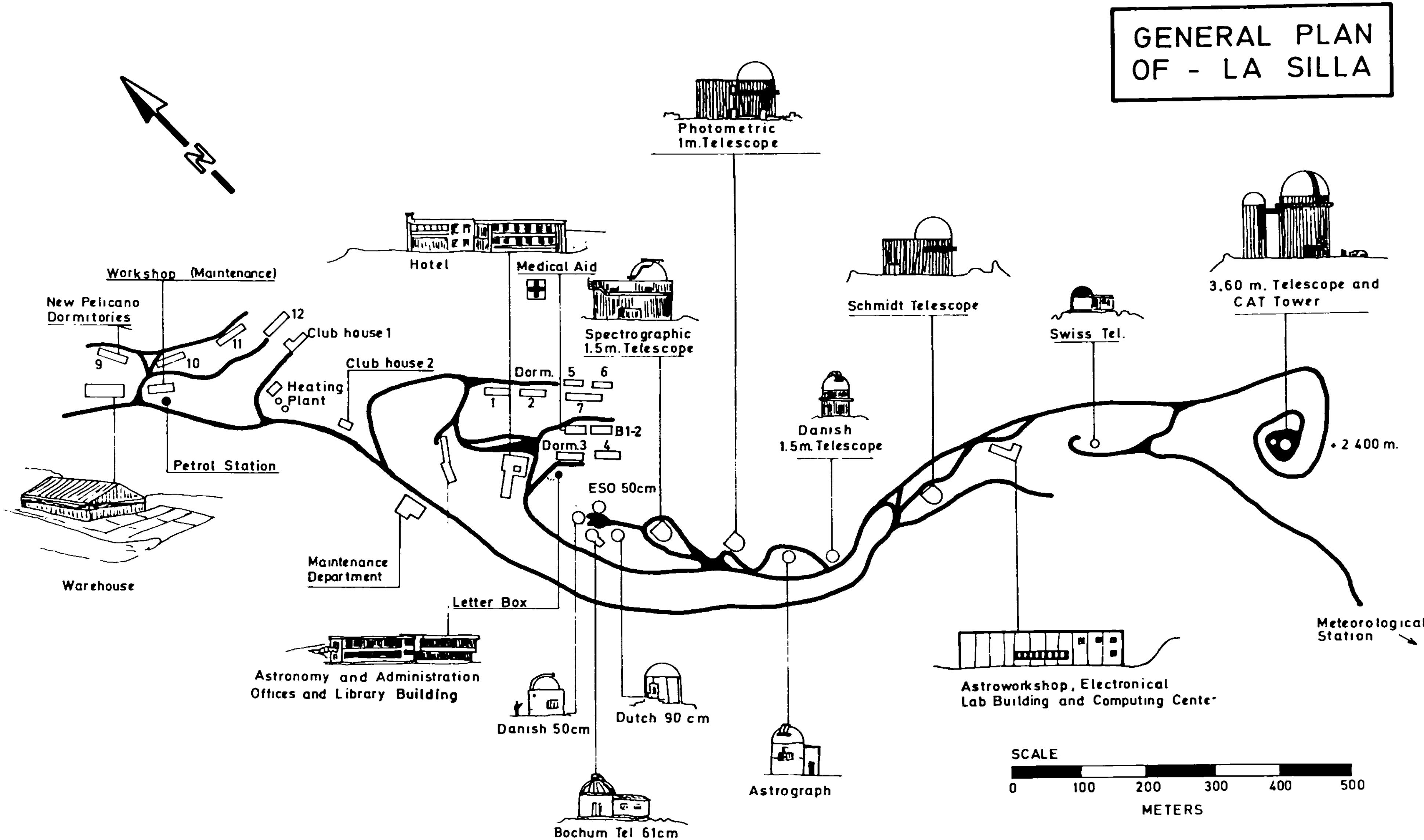
I.F.1.FIG.2.



MAP OF LA SERENA

Apr. 80

I.F.1.FIG.3.



I.F.1.FIG.4.

Apr. 80

I.G.-TELESCOPE OPERATIONS

The technical staff at La Silla prepares the telescope and equipment for each Visiting Astronomer's (VA) observational program. In general, these preparations are done the morning before the observations begin. When time and manpower permit, the equipment is tested on the telescope in the afternoon and the VA *should be present during these tests.*

In addition, the technical staff provides the different photographic materials required for the observations. In order to ensure the proper photographic service, the VA is required to fill in a "plate request" form on the day he arrives at La Silla, and an additional form at the end of each night's observations for the following night.

Furthermore, the VA can request assistance from the technical staff for the selection of photomultipliers, filters, etc.

A note pad of "operations reports" forms is provided at each telescope. The VA can state therein all difficulties encountered during the night and make requests for necessary materials for the following night's observations. These "operations reports" enable the technical staff to do repair work during the day and to fulfill additional requirements, etc.

I.H.-ASSISTANCE AT THE TELESCOPE

Night assistants are normally assigned to work in the 3.6 m, 1.5m and 1m telescopes. For ESO VAs, a night assistant is normally available at the Danish 1.5 m telescope.

VAs scheduled to use sophisticated equipment (e.g. IDS or IR) are usually provided with an operator who is familiar with the equipment.

All VAs are assigned a staff astronomer who will introduce the visitor to the telescope, instrumentation and be available for general help and advice. The introduction will generally take place in the afternoon before observations begin, and the staff astronomer will remain with the VA at least part of the first night to ensure smooth operation.

I.I-OBSERVING REGULATIONS

WIND SPEED

A master wind speed meter is located at the ESO 1 m telescope. The wind speed is relayed to all domes. In each dome two lights - red and orange - indicate the wind speed as follows:

Lights	Speed m/sec	Astronomer Action
orange only	less than 12	--
orange and red	between 12 & 18	do not observe into wind
red only	greater than 18	close dome

Above 18 m/sec, the wind begins to carry a significant quantity of dust which is harmful to the optical components of the telescope and instrumentation. Furthermore, telescopes with a closed tube structure such as the 1.5 m can be subjected to large wind pressures resulting in damage to the drive system.

HUMIDITY

When relative humidity reaches 90%, the observer must close the dome. This is to avoid condensation on vital optical components and to avoid the breakdown of electrical insulation in high voltage equipment. Master humidity meters are located at the ESO 1.5 m and 1 m telescopes.

NOTE: When wind speeds or humidity approach the critical values indicated above, the VA should contact the astronomer on duty for advice regarding the feasibility of observing.

SMOKING AND BEVERAGES

Although smoking is permitted in the domes, it is strongly discouraged. However, smoking and beverages are *strictly forbidden* in the 3.6 m prime focus cage.

FAILURES OF EQUIPMENT OR TELESCOPE

Should the observer experience any instrument or telescope failure during the night, he may phone the appropriate engineer up to three (3) hours before sunrise. A list of room and phone numbers of mechanical and electronic engineers on call for a given night is posted in each dome. If the failure occurs later, he should include a full account of the problem in the night report and post it in the *red TRS post box* located on the entrance road to the astronomy dormitories. The problem will be dealt with during the day.

PLATE DEVELOPMENT

The VA is responsible for development of photographic plates. The astronomer may ask the night assistant to develop the plates, but the responsibility rests always with the astronomer.

DAYTIME OBSERVING

Infrared observations may be carried out during the day. At no time should direct sunlight fall on the telescope structure. Presently, IR observations are carried out at the 3.6 m and the 1 m telescopes. In the case of the 1 m telescope, the astronomer should take care to move the dome manually and not use the automatic mode.

DARKROOM

Fresh chemicals and plates are replaced on request on the forms provided. Darkrooms must be kept clean of developer and fixer at all times.

MAGNETIC TAPE POLICY

Magnetic tapes are supplied by ESO and are the property of ESO. A copy of your tape will be held at La Silla on request for a period of six (6) months. You are expected to return the tape to the Visiting Astronomers Section in Garching no later than eight (8) months after your observing run.

I.J.-ASTRONOMICAL SUPPORT

LA SILLA LIBRARY

The astronomical library is located on the upper floor of the Astronomy and Administration building. All major journals and principal text books, astronomical reference sources, catalogs and manuals for use with astronomical equipment are available.

Sky surveys available are: ESO Blue Sky Survey on film, Palomar Sky Survey on prints , and the SRC UK Schmidt Survey.

A light table with variable magnification binoculars is in the library for inspection of plates. Additionally, a *limited* facility to make Polaroid finding charts (see "Finding Charts" this section).

A typewriter is also available in the library for the VAs use.

LA SERENA LIBRARY

A small astronomical library is also kept in the La Serena office. Here, only major astronomical journals are available.

FINDING CHARTS

The VA *should prepare finding charts in advance*. However, a Polaroid camera is available and a small quantity of Polaroid film (this is expensive) to copy film or prints. A 1 X or 3 X enlargement can be made on standard film 7.5 x 9.5 cm^2.

The camera is kept in a cupboard in the library and film in a refrigerator. The astronomy secretary will supply the key on request. Please advise the secretary if the film supply is low and needs replenishing. Instructions for use are also indicated.

ASTRONOMY SECRETARY

The astronomy secretary is located in the office of the Astronomy and Administration building near the library. The VA may obtain all normal office supplies such as: writing equipment, paper, graph paper, etc. A limited number of HP calculators are available for loan. The secretary can also assist with overseas telephone calls, transport of photographic plates to Europe, etc.

VISITING ASTRONOMERS OFFICE

An office is available on the ground floor of the ESO 1 m telescope. This is primarily for VAs who wish to use the Joyce-Lobel or Schnell microdensitometers or the B & C comparator found on the second floor of the 1 m dome.

PRECESSING COORDINATES

A program exists in the computing center (which is located next to the electronics lab) to precess coordinates from any epoch to any epoch. It lists on the line printer and/or punched paper tape in an input format compatible to the 1 m and the 50 cm telescopes.

Call	RUN, PRECE, P1, P2 P1 = CONSOLE LU (Default = calling console) P2 = LINE PRINTER LU (Default = 6)
Note	In case the message "NO SUCH PROGRAM" is displayed, type "JOB, LPRECE", wait until the message "OFF JOB LPRECE" is displayed and call the program again.
Operation	Operations for use are displayed on the screen. If you wish to recall the instructions at any time instead of new coordinates, type "55" and press "RETURN". To stop the program, type "99" and press "RETURN".

Listing Sample

OLD COORDINATES							NEW COORDINATES						
18	4	16	-6Ø	35	11	1951	18	3	34	-6Ø	35	81	1980

Paper Tape Sample

```
18:Ø6:46.    -6Ø:34:57.  1 IN
 6:Ø1:45.    - Ø:23:45.  2 IN
```

ASTRONOMERS TEA

An Astronomers' Tea is sometimes held at La Silla on Thursdays. The purpose is to stimulate informal scientific discussion between astronomers present at La Silla. VAs are encouraged to be prepared to give a short introduction on their ongoing research work. It is emphasized that the format of the tea is informal, and it is not intended to be a colloquium.

I.K.-SKY AND WEATHER CONDITIONS

NUMBER OF EXPECTED PHOTOMETRIC NIGHTS

An approximate idea of the number of photometric nights (6 consecutive hours of clear sky) which can be expected in any month is given in Table 1. These are meant as a guide only. In addition, data for years 1966 to 1972 is shown in graphical form in Fig.(1).

Table 1

Month	No. of nights	Month	No. of nights
January	24	July	13
February	23	August	16
March	26	September	15
April	19	October	18
May	14	November	20
June	12	December	24

SEEING

Actual seeing values are difficult to give, relying on the judgment of individual observers. The most consistent seeing estimates available are from the coudé 1.5 m. Seeing quality at La Silla taken from this data is given in the form of histograms in Fig.(2) for the months January and July being representative of Chilean summer and winter respectively. The numbers were taken from observing reports over the period from 1970 to 1973.

TEMPERATURE

Temperature variations on La Silla are given in Fig.(3) in graphical form for the years from 1966 to 1972.

SKY BRIGHTNESS

The sky brightness is variable with weather conditions, zenith distance, and season. The following values are typical at the galactic poles at the meridian on a dark night and are accurate to ± 10%.

Color	Mag/(square arcsec)
U	22.0
B	23.0
V	21.9
R	21.2
I	20.2

NIGHT LENGTH/SIDEREAL TIME

An idea of the night length and sidereal time with month for La Silla is given in Fig. (4). This table was provided by Prof. Geyer and should prove especially useful when making out your proposal.

EXTINCTION

Extended extinction measurements have been made by Dr. H. Tüg of the Astronomical Institute of the Ruhr University in Bochum using the Bochum 61 cm at La Silla and a photoelectric rapid spectrum scanner.

The observations were made over a period from 1974 to 1976 and normally consisted of measuring three (3) extinction stars of early type between airmasses of 1 to approximately 2.5, one star rising and one setting and a third close to $\delta = -60°$ observable almost the whole night. The wavelength region covered was 3000 - 9000 Å with a pass-band of 10 Å in the blue and 20 Å in the red. The extinction co-efficients were calculated in steps of 50 Å using the Bouger method. In Table 2, the wavelength and extinction co-efficients in mag/airmass are given.

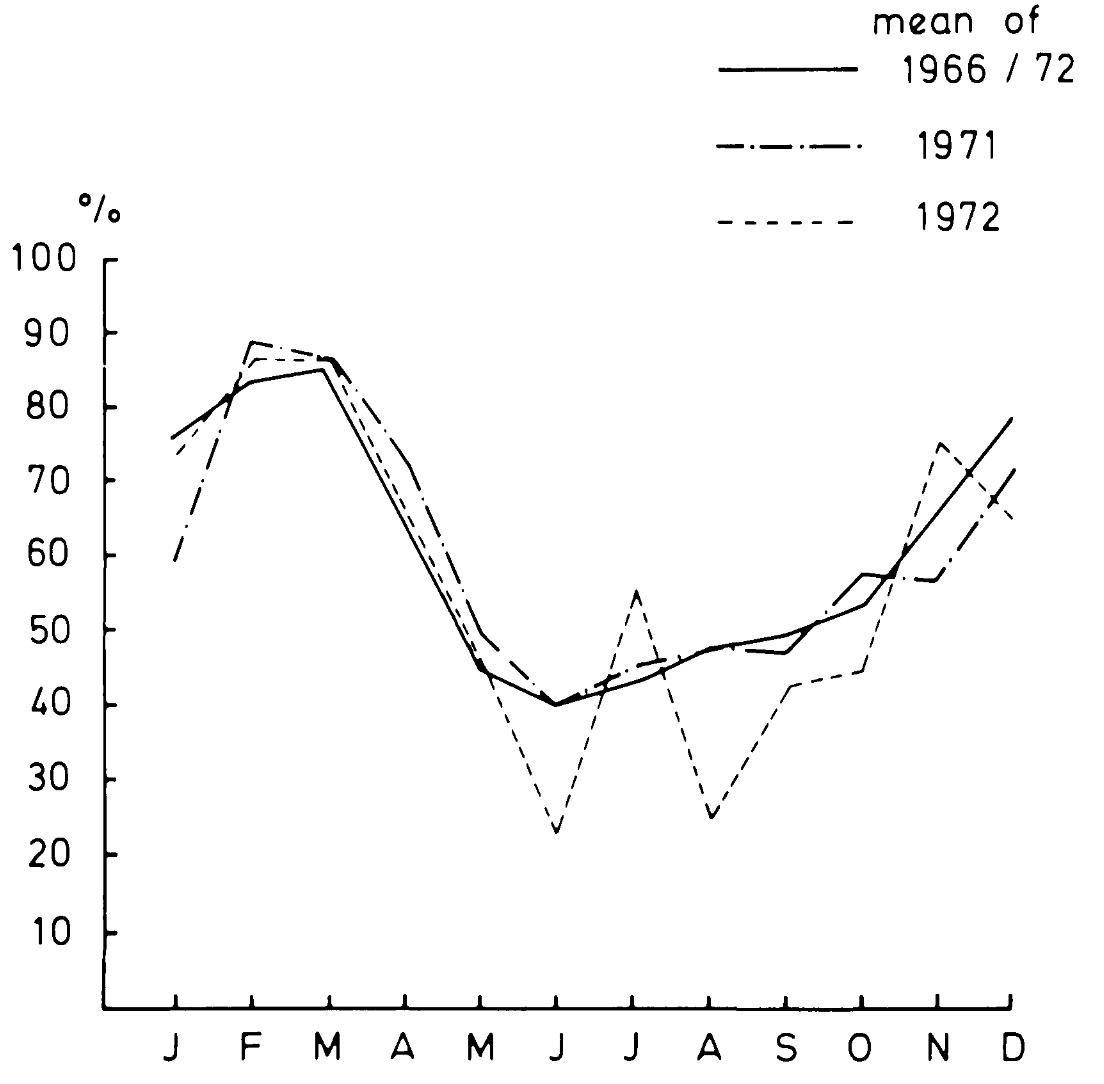
No correlation was found between the extinction co-efficients and the direction of observation. The measurements were made on photometrically "good nights" and were found not to differ from night to night by more than 2% at 5000 Å. More detailed discussion of extinction on La Silla can be found in Messenger, No. 11, December 1977.

Table 2

Wavelength (Å) vs. Extinction in Mag/Airmass

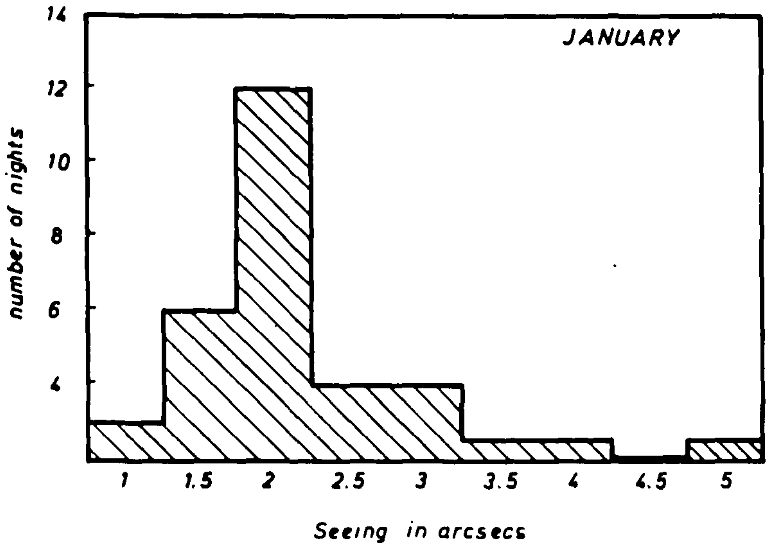
3100	1.53	5200	0.12
3200	0.94	5400	0.11
3300	0.72	5600	0.10
3400	0.60	5800	0.10
3500	0.52	6000	0.09
3600	0.46	6200	0.08
3700	0.41	6400	0.07
3800	0.37	6600	0.05
3900	0.33	6800	0.04
4000	0.30	7000	0.04
4100	0.27	7200	0.03
4200	0.25	7400	0.03
4300	0.22	7600	0.02
4400	0.20	7800	0.02
4500	0.19	8000	0.02
4600	0.17	8200	0.02
4700	0.16	8400	0.01
4800	0.16	8600	0.01
4900	0.14	8800	0.01
5000	0.13	9000	0.01

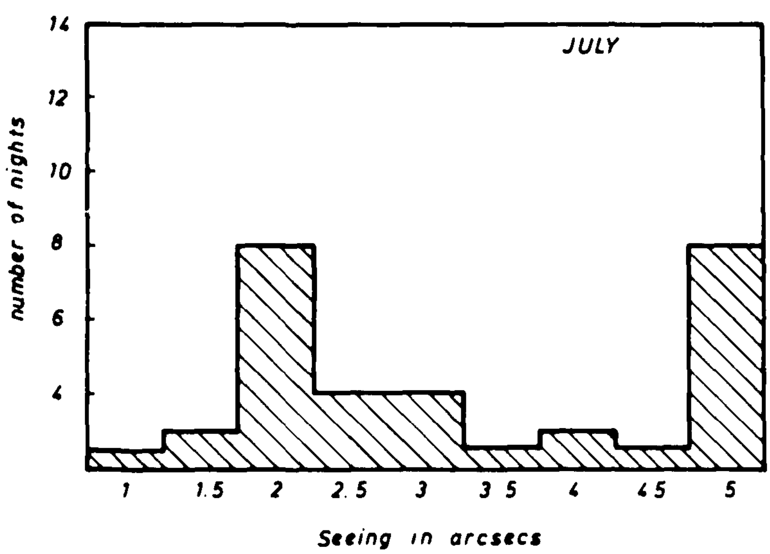
NUMBER OF PHOTOMETRIC NIGHTS



I. K. 1. FIG. 1.

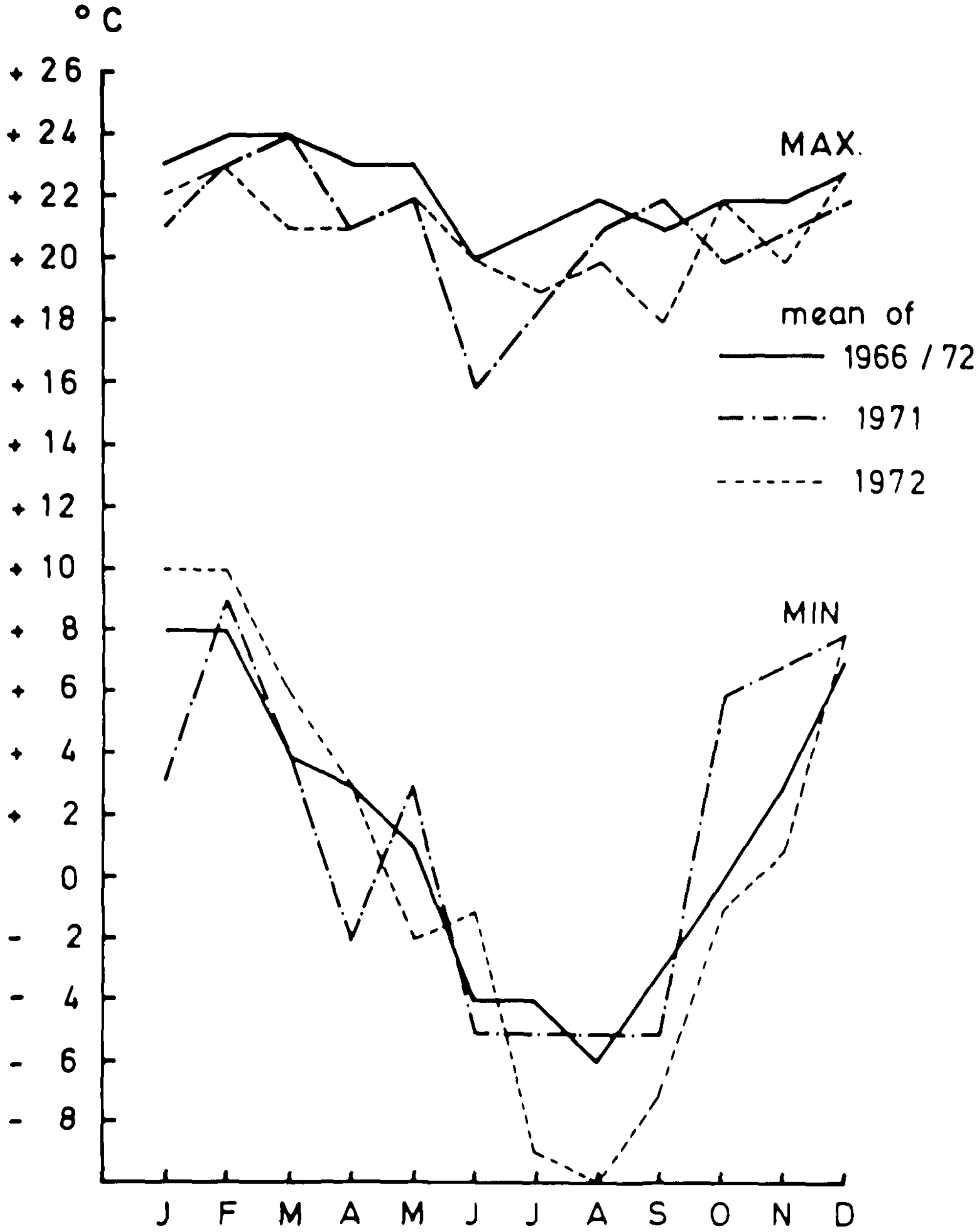
SEEING QUALITY AT LA SILLA





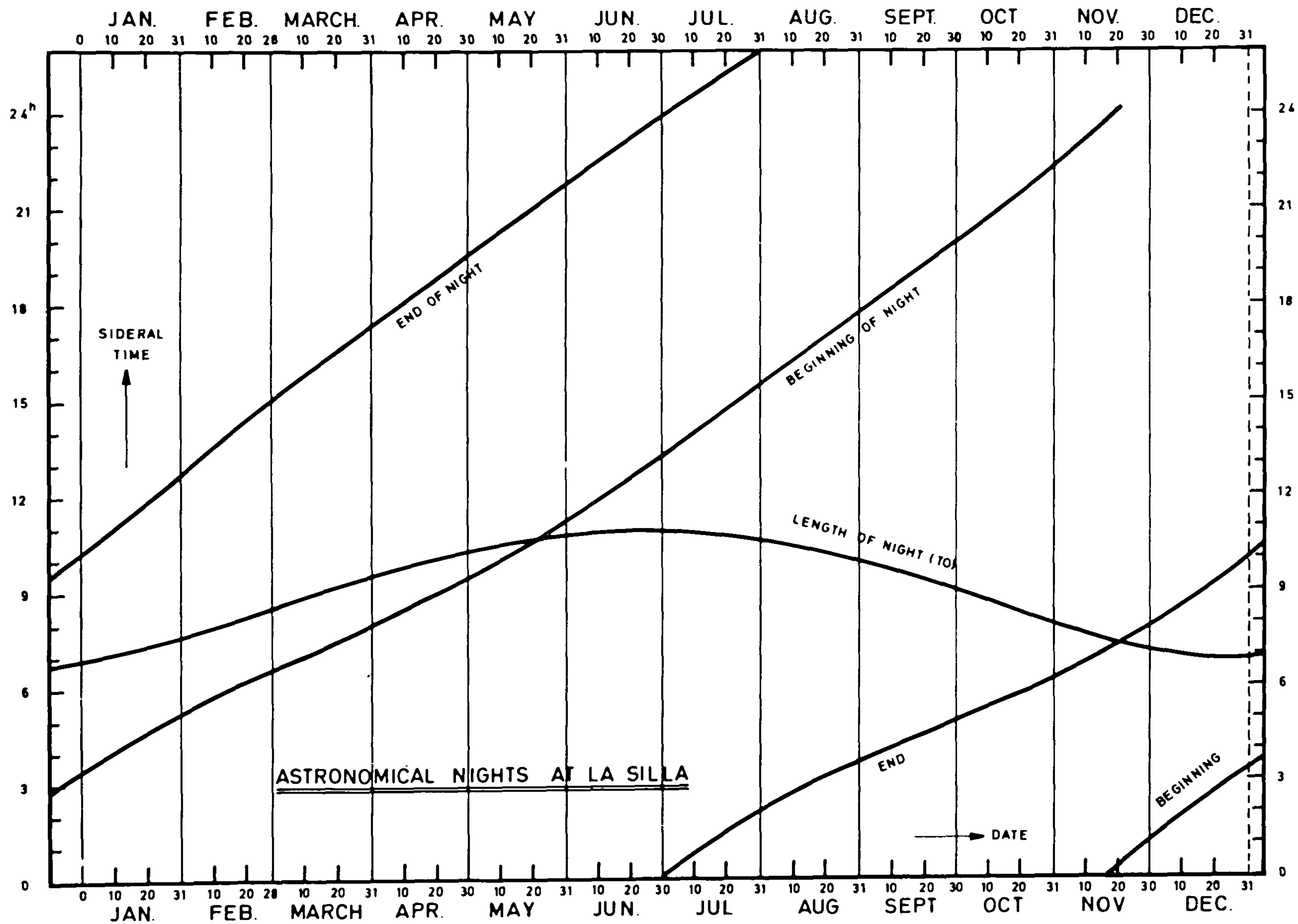
I. K.1. FIG. 2.

TEMPERATURE VARIATIONS ON LA SILLA



Maximum and minimum temperatures on La Silla.

I. K. 1. FIG. 3.


ASTRONOMICAL NIGHTS AT LA SILLA
SIDERAL TIME
DATE
END OF NIGHT
BEGINNING OF NIGHT
LENGTH OF NIGHT (TO)
END
BEGINNING
JAN. FEB. MARCH APR. MAY JUN. JUL. AUG. SEPT. OCT. NOV. DEC.
24h
21
18
15
12
9
6
3
0

I.K.1. FIG.4.

SECTION II INDEX

page/s

II. TELESCOPES

II.A.-INTRODUCTION TO TELESCOPES

In the following sections, the telescopes are described individually. The essential details and instrumentation available at each telescope are given in Tables (1) and (2). These are followed by workshop drawings of the individual backplates for each telescope. This is to enable visitors to design equipment or adapt existing equipment to a specific ESO telescope.

Table 1

Telescope Aperture in meters	Focus	Scale arcsec mm^{-1}	Mounting	Instrument Rotation	Finder ϕmm/field arcmin	Offset Guider	Instruments
3.6	f 3 Prime	18.9	horseshoe and fork	Yes		Yes	Prime photo: Gascoigne: Racine wedge, grism, spectracon Triplet: Mc Mullan
	f 8 Cass.	7.2		Yes		Yes	B&C spectrograph, polarimeter, photometer, IR photometers
	f32 coudé	1.8					
1.5 ESO	f15 Cass.	9.2	English cradle	Yes	160/40	Yes	B&C spectrograph, RV Cass.
	f30 coudé	4.4		No		No	echellec, coudé
1.5 Danish	f8.5 Cass.	15.7	off axis	No		Yes	Hβ photometer, 4 color photometer direct photography, double channel photometer
1.5 CAT	f120		Alt-Alt	No	150-	No	
	f32.3 coudé	4.42					
1.0	f13.6 Cass.	15.08	fork	Yes	160/40	Yes	photometer, IR photometers, polarimeter.
	Nasm.			No			double beam photometer

Table 1 (cont'd)

Telescope Aperture in meters	Focus	Scale arcsec/mm	Mounting	Instrument Rotation	Finder ϕmm/field arcmin	Offset Guider	Instruments
0.91 Dutch	f13.8 Cass.	16.4	fork	No		Yes	Walraven photometer
0.61 Bochum	f15.0 Cass.	22.5	off axis	No	102/90	No	photometer
0.5 ESO	f13.6 Cass.	27.5	fork	Yes	130/60	No	photometer, double beam photometer
0.5 Danish	f13.6 Cass.	27.5	fork		130/60	No	Hβ photometer, Stromgren ubvy photometer, Echelle photometer
GPO	f10	51.5	double cradle		110/120	No	astrograph, objective prism

Table 1 (cont'd)

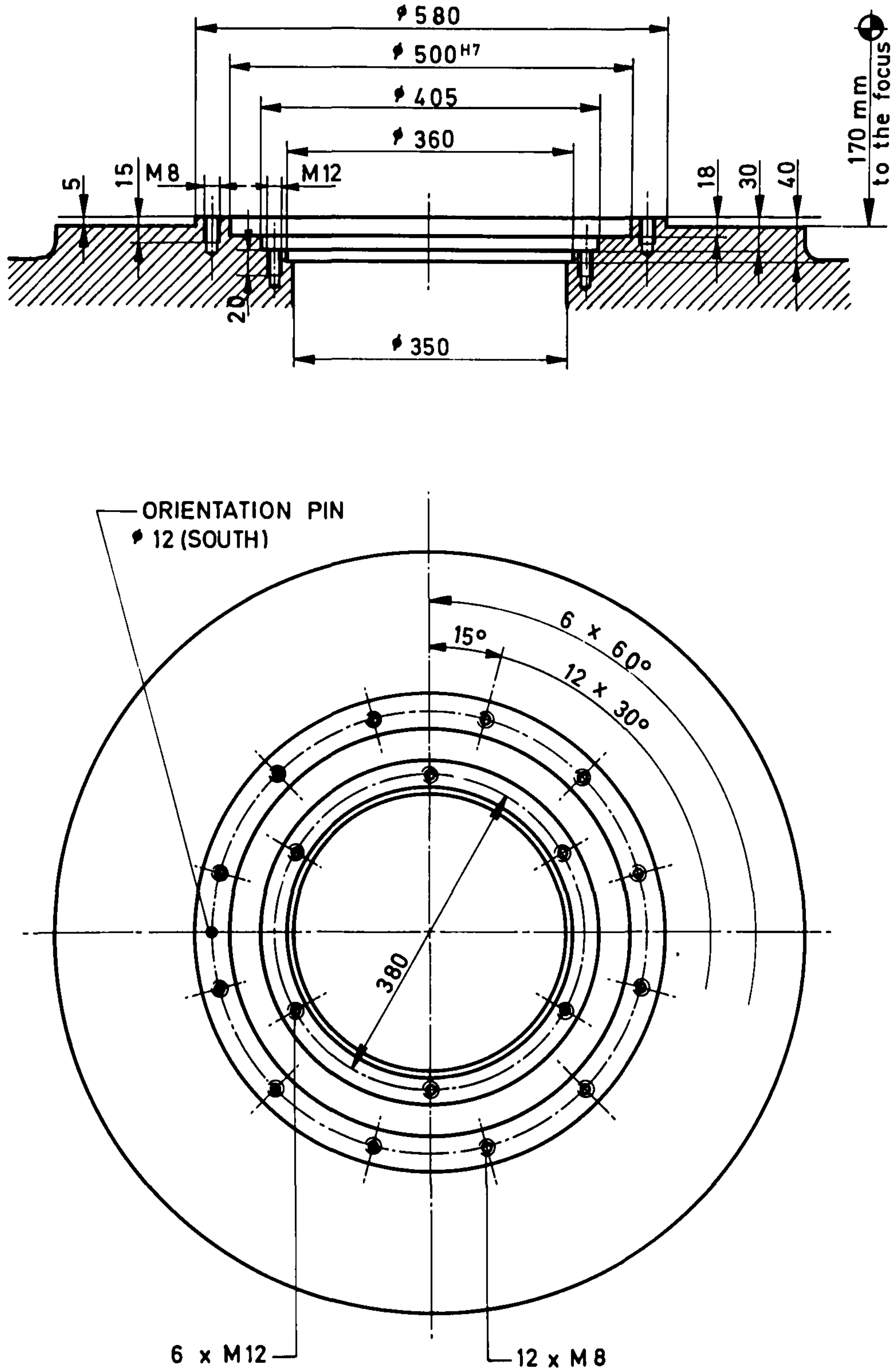
Telescope Aperture in meters	Focus	Scale arcsec/mm	Mounting	Instrument Rotation	Finder ϕmm/field arcmin	Offset Guider	Instruments
Schmidt	f3	67.5	fork	No		Yes	objective prism, filter photography

Table 2

Telescope Aperture	Telescope Drive	SLEW sec^{-1}	SET arcsec sec^{-1}	GUIDE arcsec sec^{-1}
3.6 m	digital	1°	0"-240"	0"-240"
1.5 m ESO	oscillator	1°	15"*	4"*
1.5 m Danish	digital	1°	0"-240"	0"-240"
1.4 m CAT	digital			
1.0 m ESO	digital	1°	variable 0"-240"	variable 0"-240"
.91 m Dutch	digital/ analogue	1°25	variable	variable 0"-6"
.61 m Bochum	synchronous motor	4°	240"	4"
0.5 m ESO	digital	1°	0"-240"	0"-240"
0.5 m Danish	oscillator	.075°	360"	2" and 10"
GPO	oscillator			
Schmidt	digital	1°	0"-240"	0"-240"

* to be redesigned

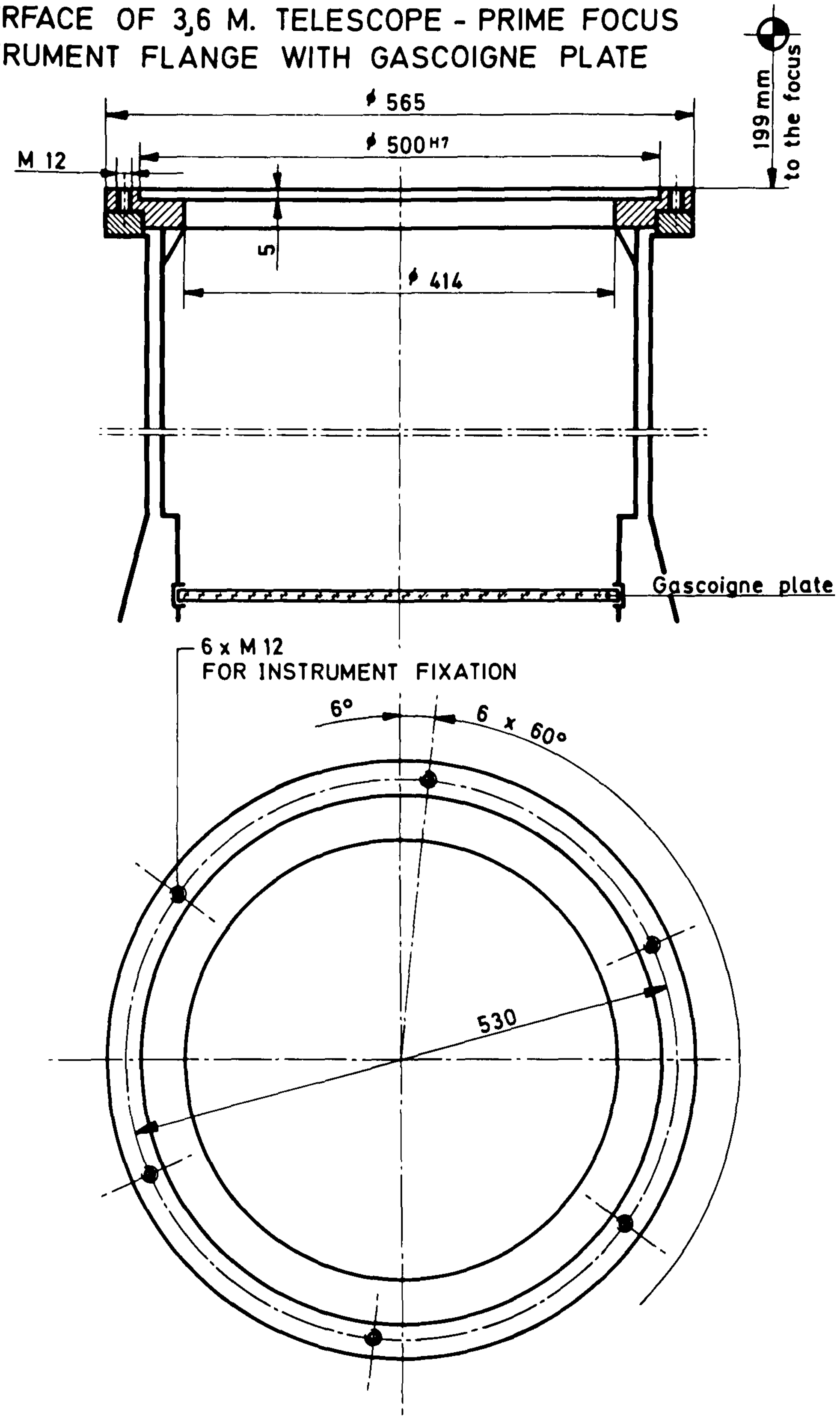
CASS INTERFACE OF 3.6M TELESCOPE INSTRUMENT FLANGE



ALL THREADS ARE FOR INSTRUMENT FIXATION

II. 1. FIG. 1.

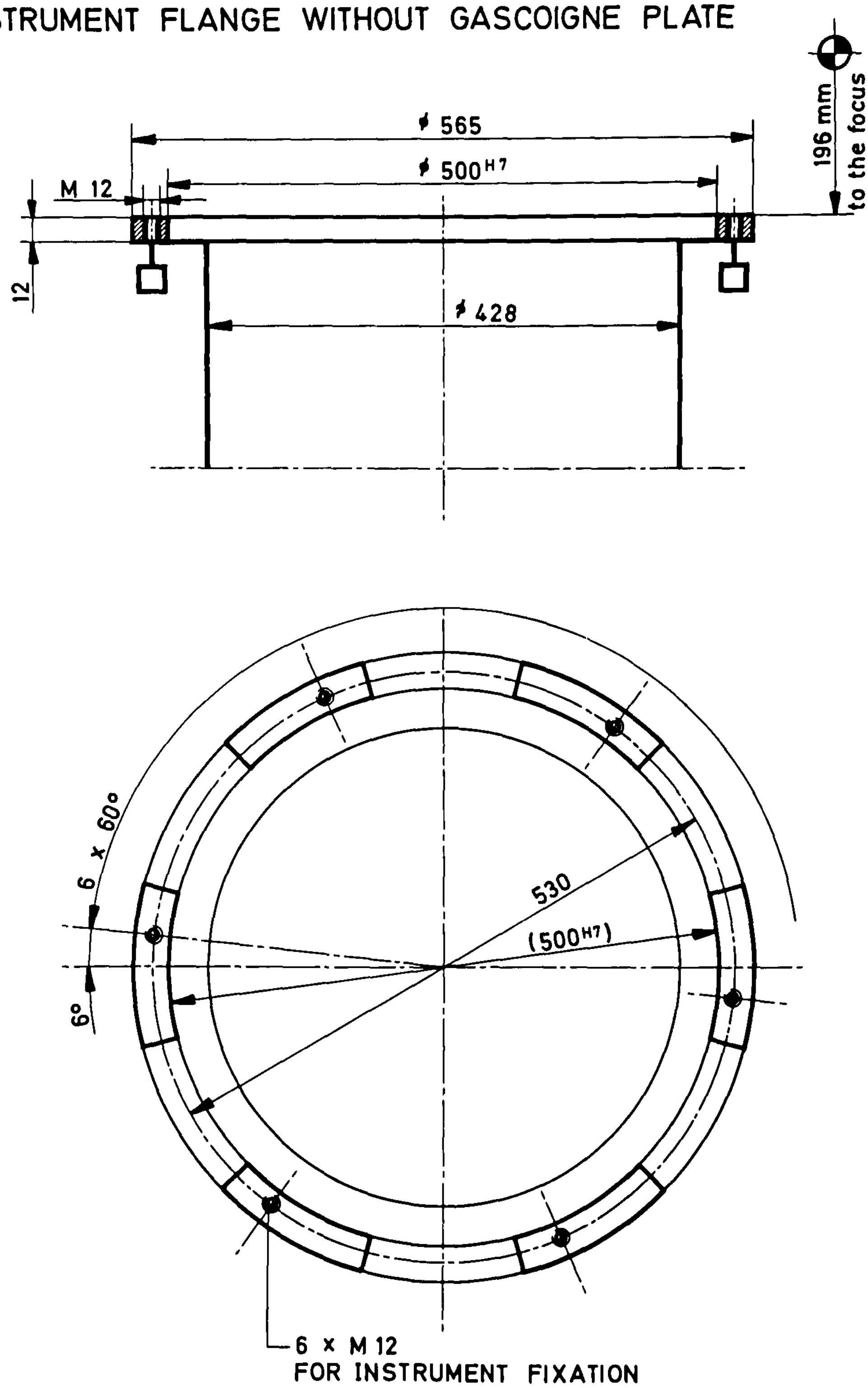
INTERFACE OF 3,6 M. TELESCOPE - PRIME FOCUS
INSTRUMENT FLANGE WITH GASCOIGNE PLATE



II.1.FIG.2.

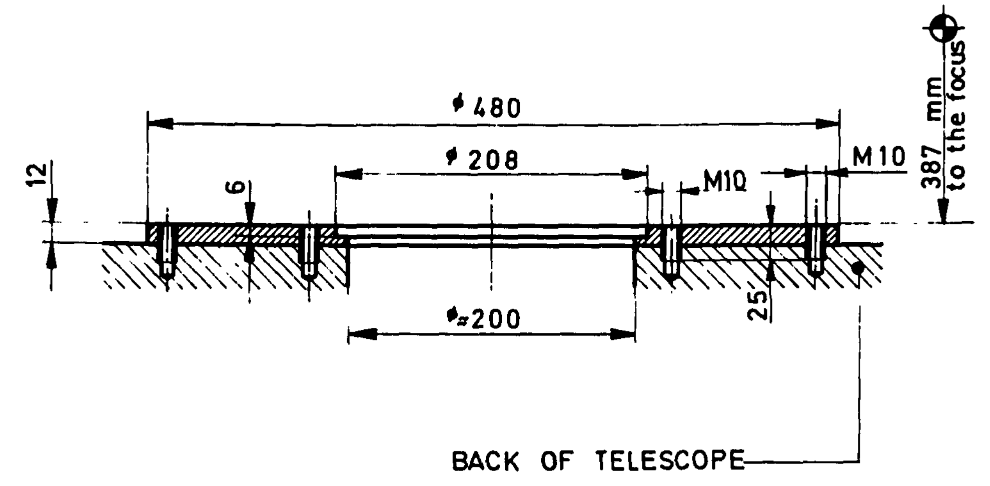
Apr. 80

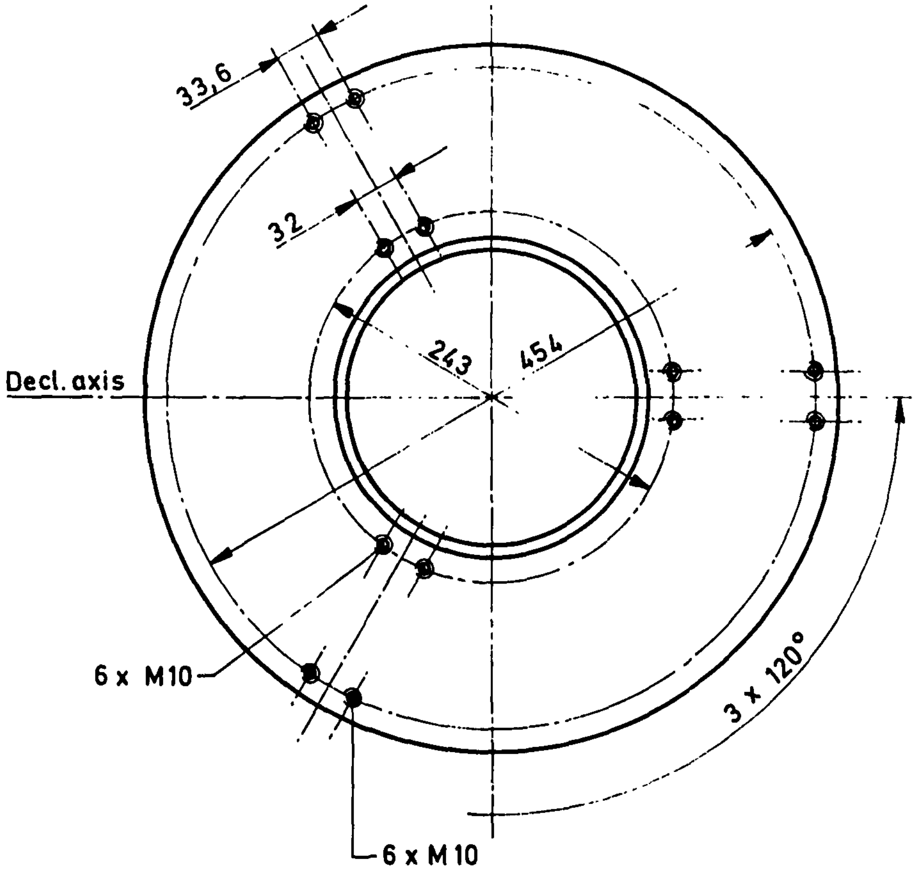
INTERFACE OF 3,6 M. TELESCOPE - PRIME FOCUS
INSTRUMENT FLANGE WITHOUT GASCOIGNE PLATE



II.1.FIG. 3.

INTERFACE OF 1.5M TELESCOPE INSTRUMENT FLANGE



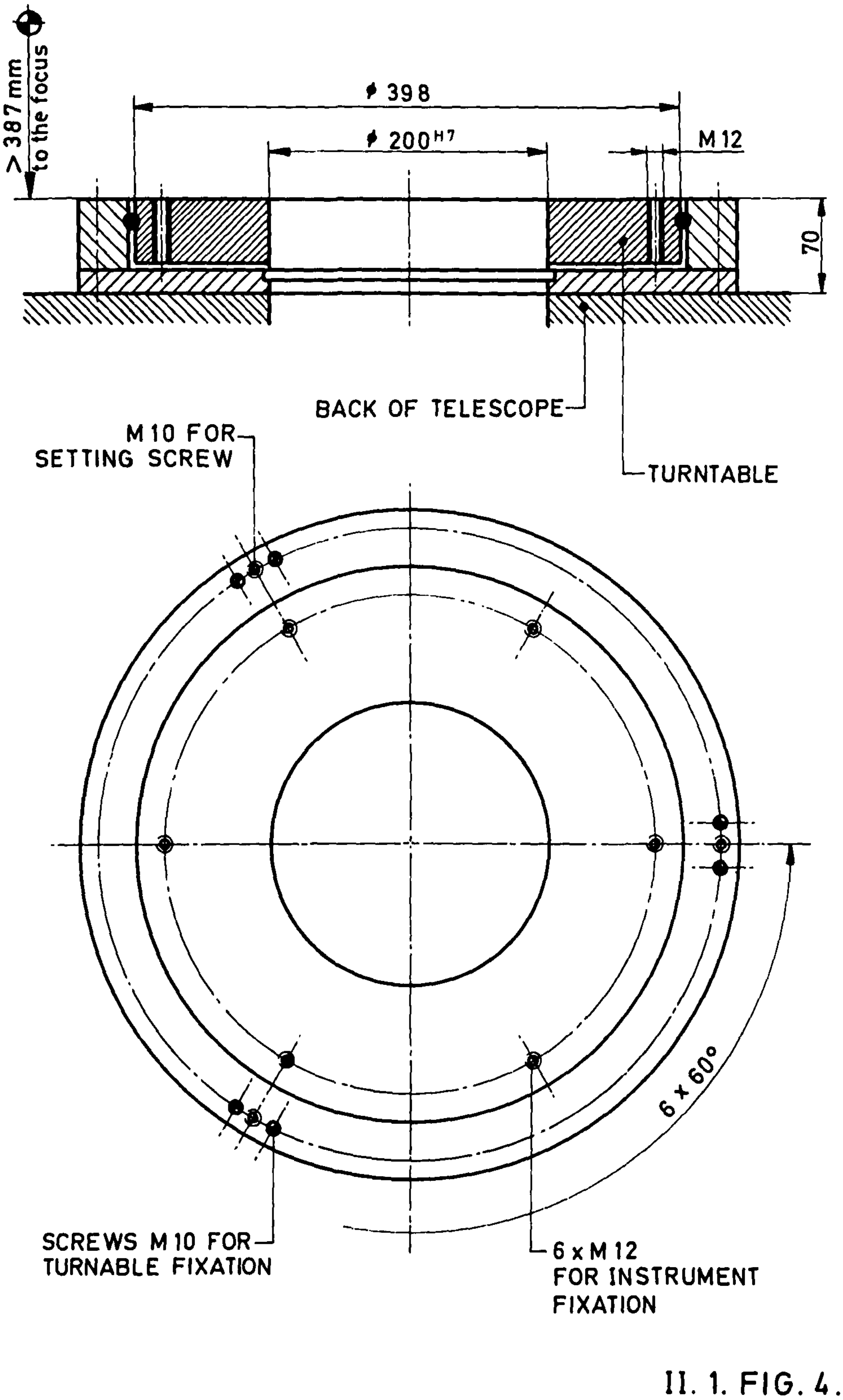


ALL THREADS ARE FOR INSTRUMENT OR TURNTABLE FIXATION

II. 1. FIG. 4.

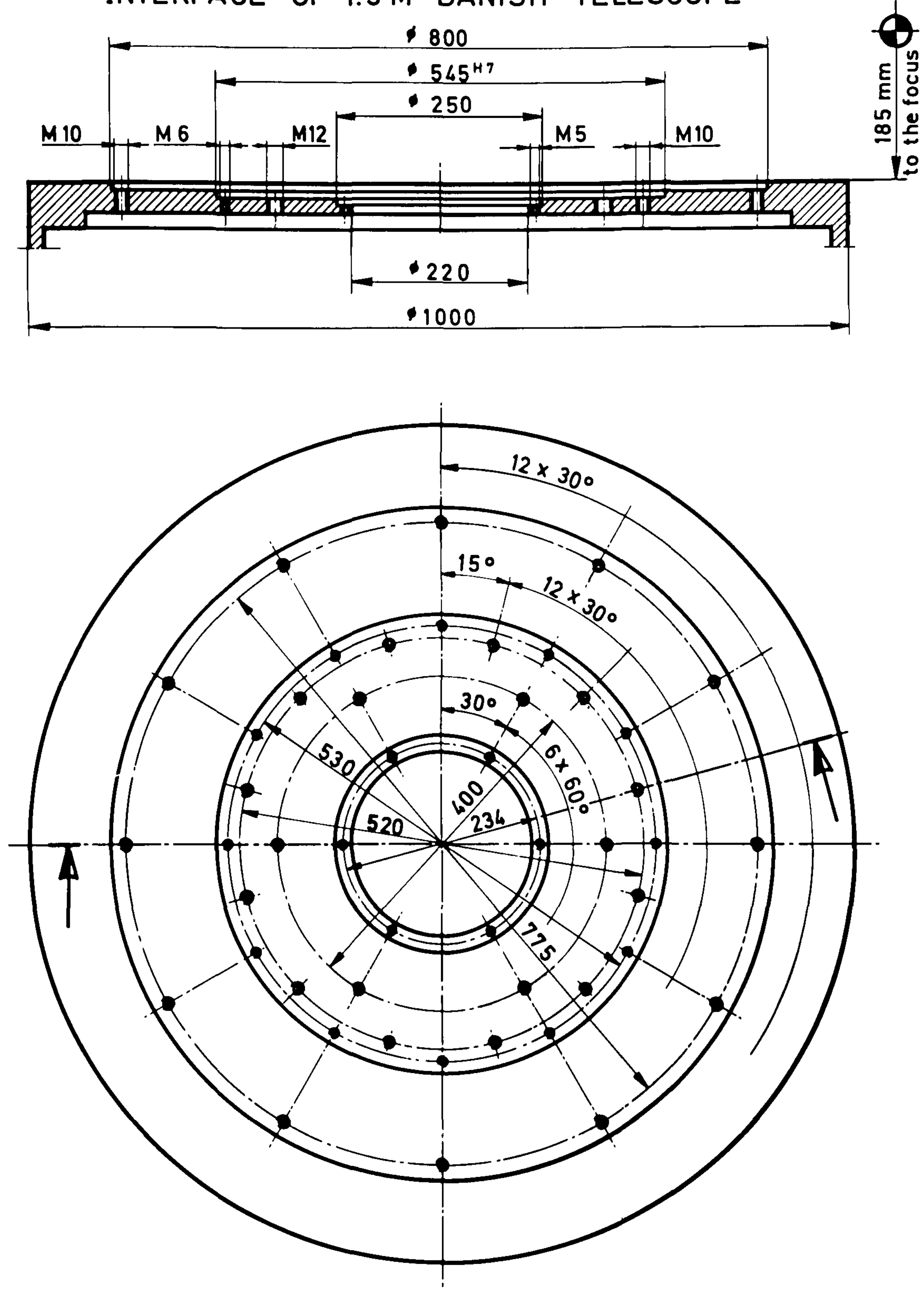
Apr. 80

INTERFACE OF 1.5 M TELESCOPE TURNTABLE



II. 1. FIG. 4.1.

INTERFACE OF 1.5 M DANISH TELESCOPE

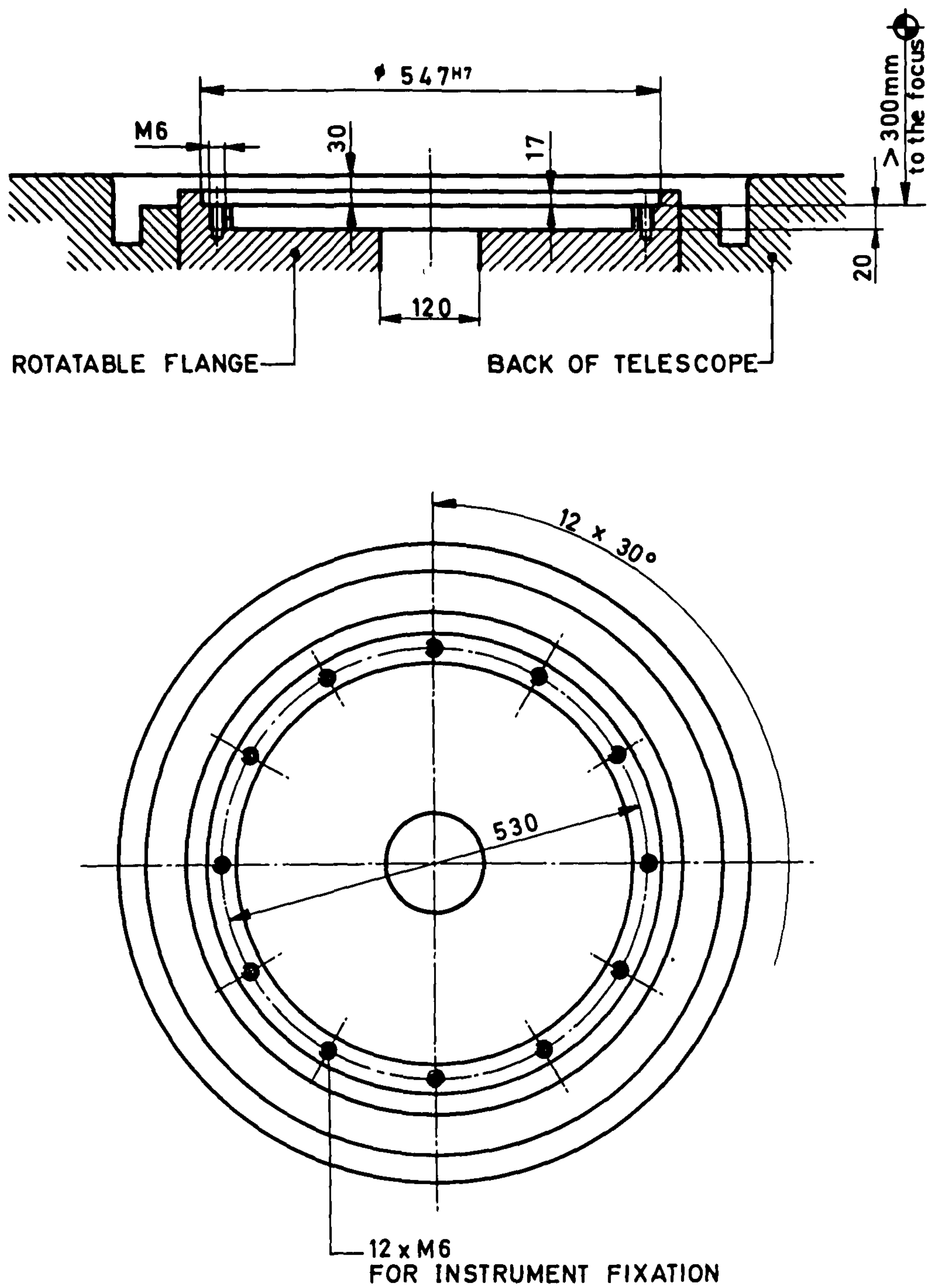


ALL THREADS ARE FOR INSTRUMENT FIXATION

II. 1. FIG. 5.

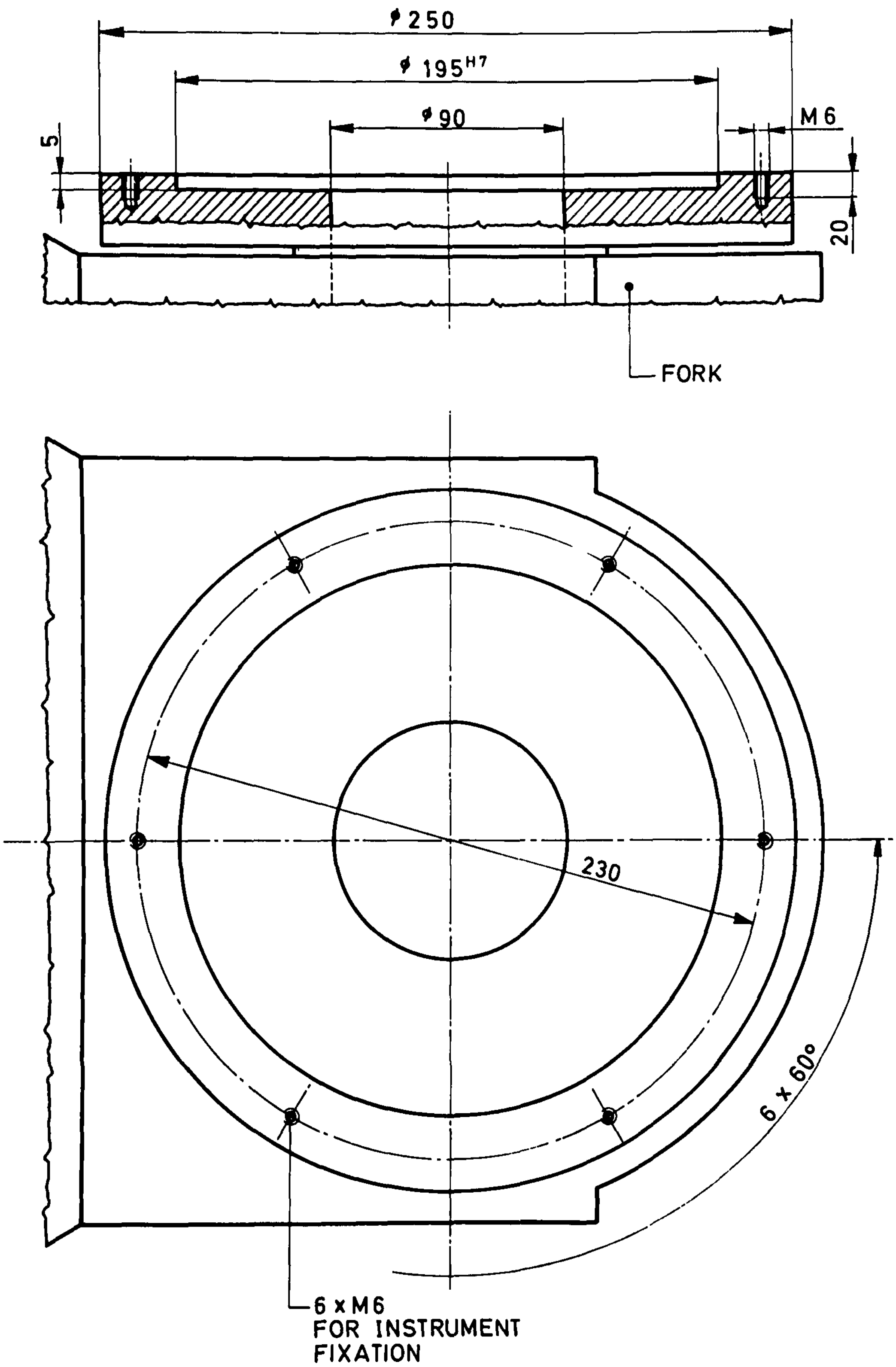
Apr. 80

INTERFACE OF 1M TELESCOPE INSTRUMENT FLANGE



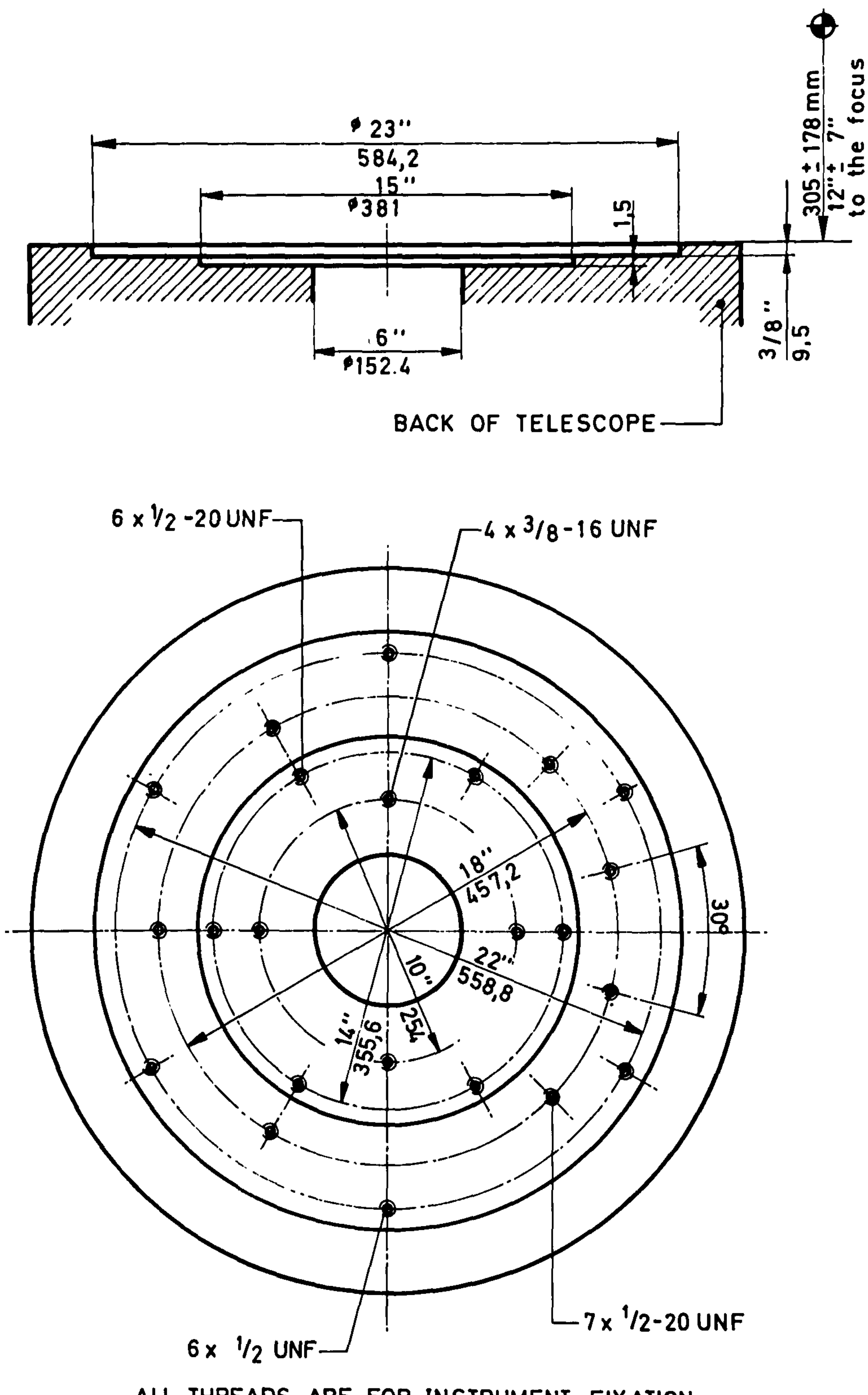
II.1.FIG.6.

INTERFACE OF 1M TELESCOPE NASMYTH FLANGE



II.1. FIG. 6.1.

INTERFACE OF BOCHUM TELESCOPE INSTRUMENT FLANGE

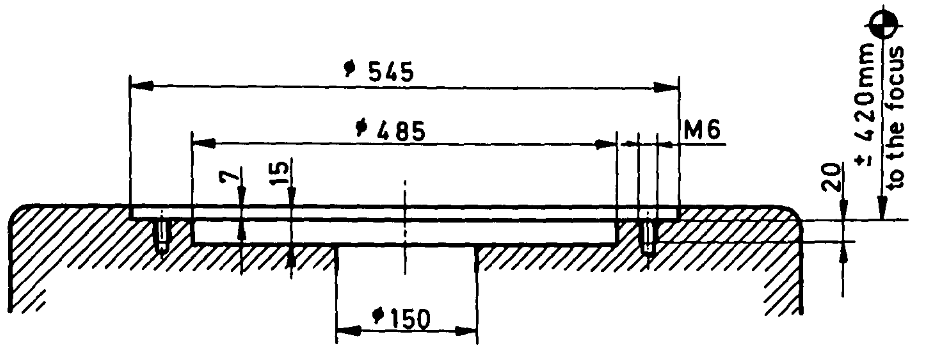


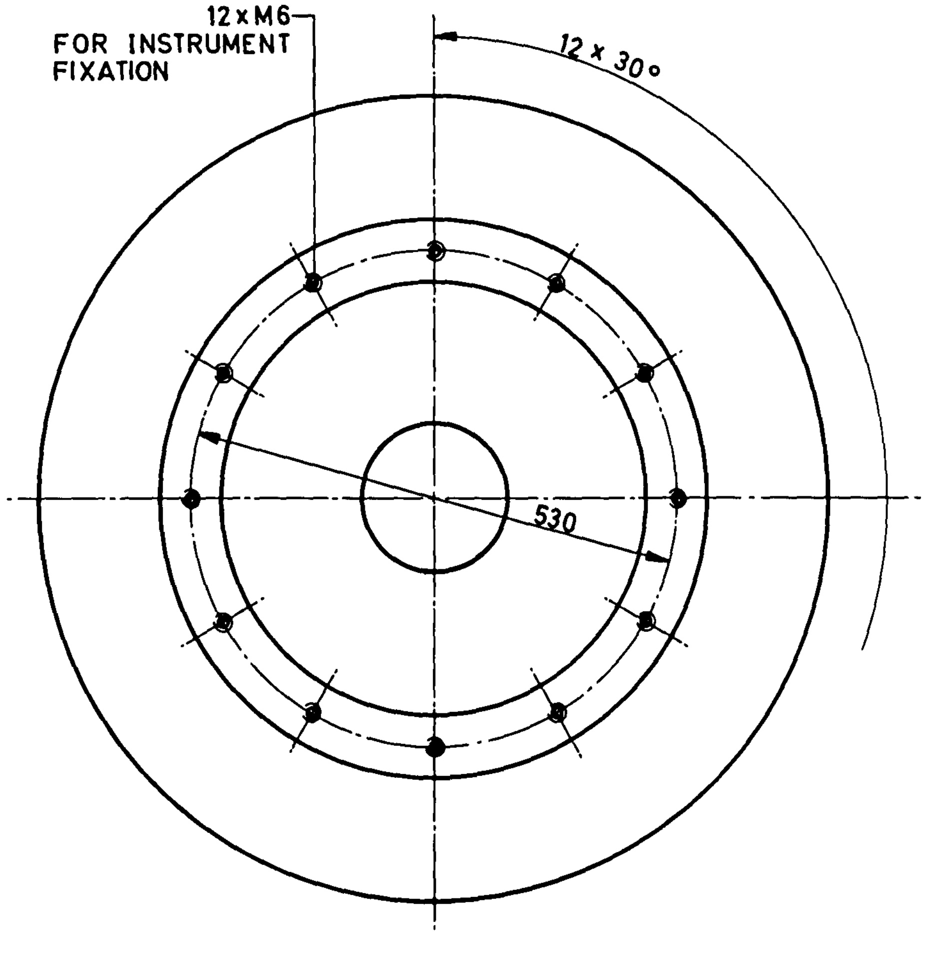
ALL THREADS ARE FOR INSTRUMENT FIXATION

II. 1. FIG. 7.

Apr. 80

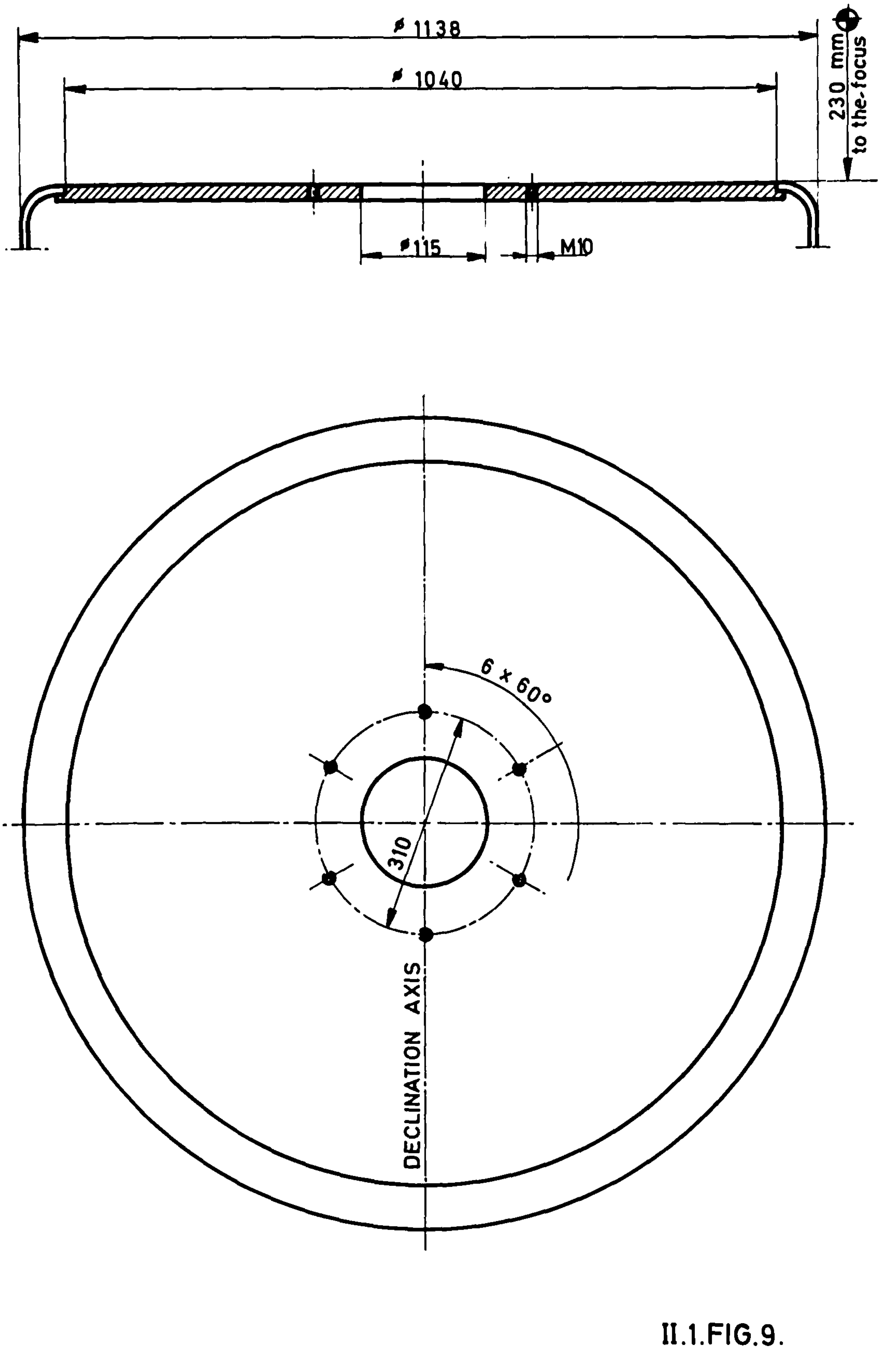
INTERFACE OF ESO AND DANISH 50 CM TELESCOPE INSTRUMENT FLANGE





II.1. FIG. 8

INTERFACE OF DUTCH 91 CM TELESCOPE



II.1.FIG.9.

II.A.1-THE 3.6 M TELESCOPE

INTRODUCTION

The 3.6 m telescope is the largest at La Silla and was officially commisioned in 1977. The telescope has a horseshoe/fork mounting. It was designed with interchangeable top-units allowing change over of secondaries, to go from prime to Cassegrain or coudé. An f 35 wobbling secondary unit is under construction for infrared work. Change over from one focus to another takes approximately one (1) hour, and consequently, excludes change overs during the night. Change over of equipment at the Cassegrain focus takes between 3 to 4 hours.

The telescope employs the TCS (Telescope Control System) similar to those used at the 1 m and Schmidt telescopes. The system can precess coordinates for epochs < 2000 and presently has a pointing accuracy of ± 30 arcsec. A pointing model for the prime focus has been tested and gives a pointing accuracy of ± 5 arcsec over the sky. This model is being incorporated in the telescope control computer. However, the pointing model at Cassegrain is somewhat different and may not be completed until late this year. In the meantime, observers are advised to bring accurate coordinates and well-prepared finding charts.

An additional feature to the 3.6 m is that it is adjoined to the smaller 1.5 m CAT (coudé auxiliary telescope). This telescope will eventually feed the 3.6 m coudé spectrometer when the 3.6 m is working at Cassegrain or prime focus.

TELESCOPE AND INSTRUMENT CONTROL

The control room is situated at the observing floor, from which both telescope and instruments are operated. In this room are also located the data output devices: line printer, plotter, etc.

Next to the control room is a second room where all the telescope drive electronics and the data acquisition computer are located. An HP 2100 MX 1000 series is employed as the data acquisition system computer, with disk drive. For details of this system, see section V.A.1.

DARKROOM AND LOADING ROOM

There are both dark and loading rooms on the observing floor. The darkroom is fully equipped with a plate rocker, temperature controlled water, and overhead projector to view the plates.

EQUIPMENT ASSEMBLY AND TESTING

A room is set aside (no. 407) which may be used by visitors to assemble and test their equipment before mounting on the telescope.

THE 3.6 M BUILDING

The building has two elevators: a small one for personnel (up to three persons) and a service elevator for equipment, etc. The primary aluminization is carried out regularly, and the aluminization plant is on the ground floor. On the second floor, there is a small kitchen to prepare coffee, tea, and/or snacks.

II.A.1.1 - 3.6 M PRIME FOCUS

PRIME FOCUS (WITH GASCOIGNE CORRECTOR PLATE)
(f 3.05, scale 18.9 arcsec mm^{-1})

The Gascoigne plate corrected prime focus is fully operational and is shown schematically in Fig.(1). The plate size is 6 x 6 cm^2 with a field stop giving a field of approximately 16 arcmin (50 mm diameter). A large number of interference filters and broad band filters are available, see section III.F.

FOCUSING

Focusing is achieved by using a *knife edge*, and the VA should become *familiarized* with this technique. If in doubt, a focus plate should be taken, the focus being judged near the edge of the field for the most sensitive results.

GUIDING

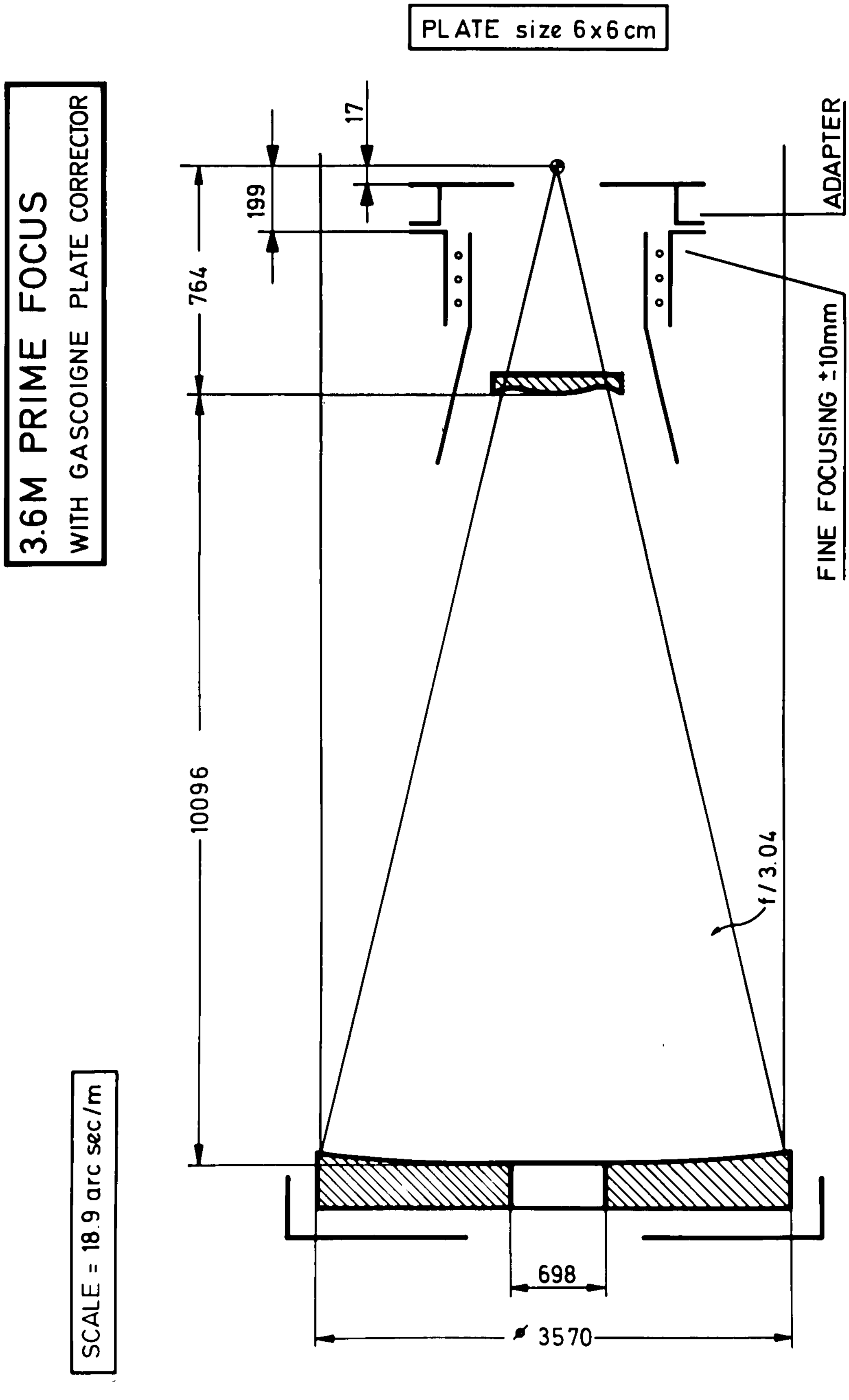
Guiding is done through a TV camera system which is mounted outside the plate field. The camera probe can be moved through a semicircle until a suitable guide star is located on the TV monitor. Guiding can be carried out on up to 16^m stars. *No* possibility exists to guide *directly*; the field of view can be seen before the exposure through an eyepiece, but the VA *should not rely* on this for identification. The *VA MUST COME with good coordinates* and be prepared to point blind.

THE PRIME FOCUS CAGE

For short exposures, it is recommended that the observer stay in the prime focus cage and guide from the cage. The cage is equipped with a chair and foot rests. It can be rotated and moved up and down and is fairly comfortable. It takes approximately five (5) minutes to bring the telescope down to the loading position and back to the object. Therefore, for long exposures it may be more convenient to transfer control to the TV monitor in the control cabin and guide from there.

RACINE WEDGE

A Racine wedge is available for use with the Gascoigne prime focus. It is used for extending photographic photometry and is especially useful for crowded



3.6 M PRIME FOCUS
WITH GASCOIGNE PLATE CORRECTOR

II.A.1.FIG.1.

fields. The wedge produces a second displaced image of all stars, with a separation of about 15 arcsec. An untested reserve wedge is available giving a slightly larger image separation. The difference in the two images is $\Delta m = 3.86 \pm 0.1$ magnitudes.

The wedge is mounted just before the Gascoigne corrector, in the converging beam (modified Racine system proposed by Bowen). Two versions exist:

1) A simple version without prism rotation. This is stored constantly in the top unit on a folding arm and can be moved into the operational position in 20 seconds with a motor. Prism exchange for the bigger image separation should be done during the day.

2) The second version permits rotation (4 positions) of the wedge, but can only be mounted during the day. Furthermore, it is no longer possible to fold back the wedge permitting normal photography. This version should only be used if the rotation is really necessary.

Since the wedge does not move with the focusing unit, there is a small variation in image separation. Apart from such small variations, the whole 50 mm diameter field is covered.

For general information on the use of the wedge, see Racine, R., 1969, Astrophysical Journal, 74, 1073; and Harris, W.E., 1974, Astrophysical Journal, 74, 472.

GRISMS

Two Hoag type grisms (blue and red) are available for use at the Gascoigne prime focus. They produce "objective prism like" spectra with reciprocal linear dispersions (RLD) of 1700 Å mm^{-1} in the red, and 1670 Å mm^{-1} in the blue over almost the full field of the Gascoigne focus $\simeq$ 16 arcmin. A small part of the field is partially vignetted by the TV guide camera.

The grisms are completely separate units consisting of a transmission grating prism, and filter mounted after the Gascoigne corrector. The specifications of the two units are given in Table 1.

Table 1

Specifications of Grism Units

Grism	RLD Å mm^{-1}	Grating gr mm^{-1}	Blaze Angle	Wavelength 1st Order Littrow	Prism	Filter
Red	1700	150	6°17'	7300 Å	BK7 8°135	OG590 (2mm)
Blue	1670	150	3°03'	3550 Å	fused silica 4°667	BG24 (2mm)

The image quality is naturally somewhat degraded and global image qualities are given in Table 2. Inevitably, the image quality is not sufficiently good in the zero order to carry out a knife edge test. The grisms are therefore normally focused via calibration from normal focus positions and focus plates.

To change grism, e.g. blue to red or vice versa, normally takes 15 minutes and necessitates re-focusing.

The exposure is controlled by opening and closing the plate holder dark slide. It is essential *NOT to use the normal shutter* which would be damaged if operated.

Table 2

Grism Image Quality

Red Grism	Blue Grism
zero order $\leq$ 2 1/2 arcsec	zero order $\leq$ 1 1/2 arcsec
first order ~ 1 arcsec	first order ~ 0.7 arcsec

Detailed documentation on the construction and performance of the grisms is available on request in the ESO Internal Report IDG 79-45.

Users unfamiliar with grism spectra are recommended to read: Hoag, A.A., Schroeder, D.J., 1970, P.A.S.P., 82, 1141.

SPECTRACON

A Spectracon is available at the Gascoigne prime focus. The Spectracon is described in detail in section IV.C.3. The Spectracon used at the 3.6 m has a special air-cooled solenoid and attaches to the small-field adapter of the telescope. With its accompaning electronics, the prime focus cage is quite full and astronomer movement is restricted.

FIELD

The cathode size is 10 x 30 mm^2 giving a field on the sky of 3.3 x 10 $arcmin^2$.

FILTERS

The filters used with the Spectracon are similar to those available at the normal prime focus, i.e. 60 mm diameter and 10 mm thick. The filter holders are however, different. Three special filters for UBV which are blocked in the red are available for use with the Spectracon as well as clear, red, infrared, and the normal narrow band interference filters used with the Gascoigne, (see section III.F.1).

The filters are easily interchangeable.

FIELD FLATTENERS

Red and blue flatteners are available to correct the curved image plane at the prime focus. These are oiled onto the Spectracon faceplate. The crossover between red and blue is at 5500 Å. The blue flattener should be used for UBV. Changeover from blue to red is not recommended during the night.

FIELD FINDING

There is no direct way of viewing the Spectracon field that is adequate for identifying the star field. The most convenient way is to center a nearby standard star (4.5 - 6 magnitude) in the Spectracon field and after correcting the coordinates, move to the object field. This method proves reliable but requires that the observer knows the coordinates to ± 15 arcsec.

EXPOSURE TIMES

The maximum exposure time at the prime focus of the 3.6 m depends on the filter band width used, the night sky brightness, emulsion, and cathode sensitivity.

Roughly, for B or V filter with dark (moonless) sky, the sky density with an S-25 cathode in one hour with L4 emulsion can be expected to be about 1D (diffuse) or 1.5D specular.

The tube should not be exposed to objects brighter than 4th magnitude. Typically, a 10th magnitude star with L4 emulsion and a B or V filter gives a reasonable density with an integration time of 5 sec.

PRIME FOCUS (TRIPLET CORRECTOR)
(f 3.14, scale 18.3 arcsec mm^{-1})

The triplet corrector follows a Wynne type design and is shown schematically in Fig.(2).

The field is 1° diameter (200 mm), but the plates used are 24 x 24 cm^2 for reasons of standardization. The system is operated entirely from the control room. Both the red and blue correctors are coated to reduce ghost images to a minimum. The blue corrector is coated to operate from 3000 to 5000 Å, centered at 3800 Å; and the red is coated to cover the wavelength range from 4000 to 9000 Å, centered at 5400 Å. Changeover from one corrector to the other takes typically 1 1/2 hours.

PLATE CHANGER

A plate changer automatically selects one of eight plates from a plate cassett mounted on the triplet. The plate (24 x 24 cm) can be selected in any order, and the operation takes approximately 35 sec. In order to maintain plate sensitization, the plates can be stored in the cassette in a N_2 atmosphere.

A digital display is used to mark the plate number directly onto the plate.

CALIBRATION

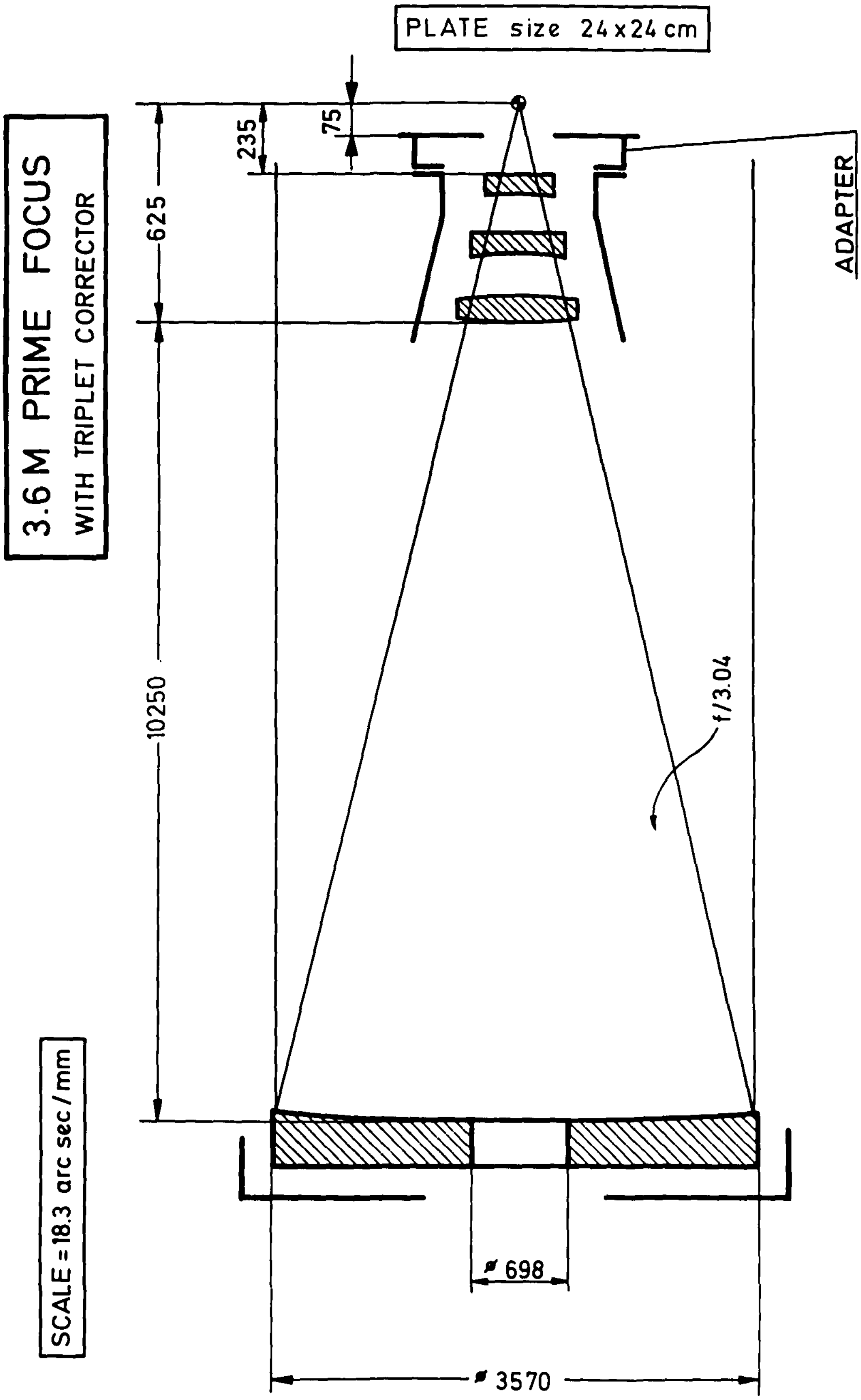
In order to calibrate the plates, a sensitometer strip is put on each plate. This consists of 9 steps which are put on through the filter and the light level can be adjusted according to the length of exposure.

FILTERS AND CHANGER

The filter changer contains up to 4 filters which can be selected remotely; all filters are 24 x 24 cm and presently the filters available are: BG 12, GG 495, GG 385, RG 630, UG 1, and RG 715, (see section III.F.1.2)

GUIDING AND FIELD OF VIEW

There is no separate center field viewing system: the guide probe via TV camera serves as center field acquisition viewer as well as the guiding system The field of search is 36 x 38 arcmin. For acquisition of guide stars, the guide probe can be set in a raster scan. The TV camera uses an ISIT tube and has a field of 53 x 70 arcsec on the sky. Guiding is possible down to 18 mag under good seeing conditions.



3.6 M PRIME FOCUS
WITH TRIPLET CORRECTOR

II.A.1.FIG.2.

The guide is followed by a filter wheel which with proper selection, reduces differential refraction problems.

It should be noted that while the field imaged with good quality is limited by a field stop to 1°, the search field for guide stars covers the vignetted corners of poorer quality which are adequate for TV guiding. Usually with the raster scan, it is possible to find a guide star giving zero vignetting of the photographed field.

A supplementary lens can be switched into the guide probe optical transfer path which enables the pupil to be viewed on TV so that knife-edge focusing can be performed with high precision.

MC MULLAN ELECTRONOGRAPHIC CAMERA

A Mc Mullan camera with 40 mm cathode is hoped to be in use with the triplet by October 1980.

II.A.1.2 - 3.6 M CASSEGRAIN

(f 8.09, scale 7.2 arcsec mm^{-1})

The Cassegrain focus is shown schematically in Fig.(3). The equipment available at the Cassegrain focus is given in Table 1, section II.A. The telescope has a large Cassegrain cage in which the observer can stand and control the equipment if necessary. However, an effort has been made to control most equipment remotely. Riding in the cage at best is uncomfortable, especially at low altitudes and can also be dangerous. Visiting astronomers who bring their own equipment should make every effort to remote control the equipment via CAMAC, see section V.A.1.

The distance between the Cassegrain adaptor ring and the floor is 175 cm. However, symmetrically placed either side on the focus position on the cage floor are two rails, 90 cm apart and 4 cm high which are used with a small trolley to mount heavy equipment.

CASSEGRAIN ADAPTOR AND FIELDS OF VIEW

Equipment is mounted on an adaptor which contains a system of movable mirrors and an integrating TV system for field identification and guiding.

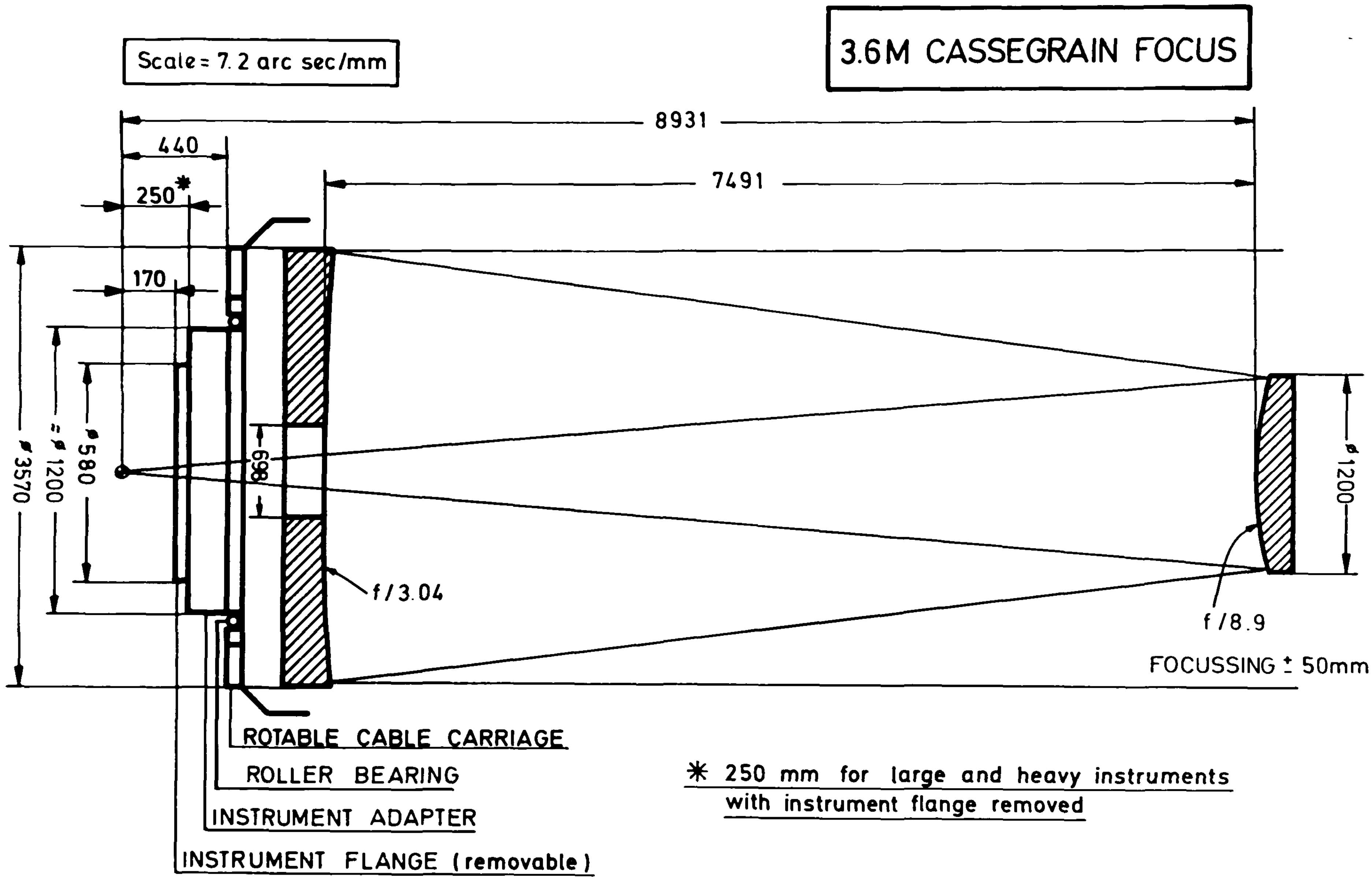
The field of view is displayed on a TV monitor in the control cabin and also on a small TV in the Cassegrain cage. There are several levels of magnification as follows:

Field	Abbreviation	Approximate Field in arcmin	Scale
* large field	LF	5 x 4	1' = 48 mm
small field	SF	0.8 x 0.6	1" = 5.5 mm
guide probe	GP	1.3 x 1	1" = 3.2 mm
* slit view large	SVL	3 x 3	1' = 48 mm
* prime focus guider	--	--	1" = 3 mm

Of these, only those marked by an asterisk (*) are generally used. Each field can be requested via a display console in the control cabin.

QUANTEX TV SYSTEM

The Quantex is an integrating TV device with integrations of 1/25 seconds per frame. Integrations from 1 to 999 frames are possible. Normally with 1 to 10 frames, V = 14^m stars are easily seen; and from 90 to 190, V = 20^m. These



3.6 M CASSEGRAIN FOCUS

II.A.1.FIG.3.

numbers are very approximate and depend on the seeing and presence of moon, etc. The Quantex has an S-20 extended photocathode and has therefore a *very good red response*. A filter wheel (see Table 1) is mounted in front of the Quantex and this is particularly useful when using blue finding charts.

Table 1

Filters

Color	Filter	Central wavelength Å	Approximate $\Delta\lambda$ Å
Blue	GG 435 + BG 12	4550	1000
Green	OG 515 + BG 18	5500	1000
Red	RG 665	7100	1000
White	--	--	--

FOCUS

The Cassegrain focus is obtained by making a knife edge test. This is done from the control cabin and the test is controlled on the TV monitor.

INSTRUMENT ROTATION

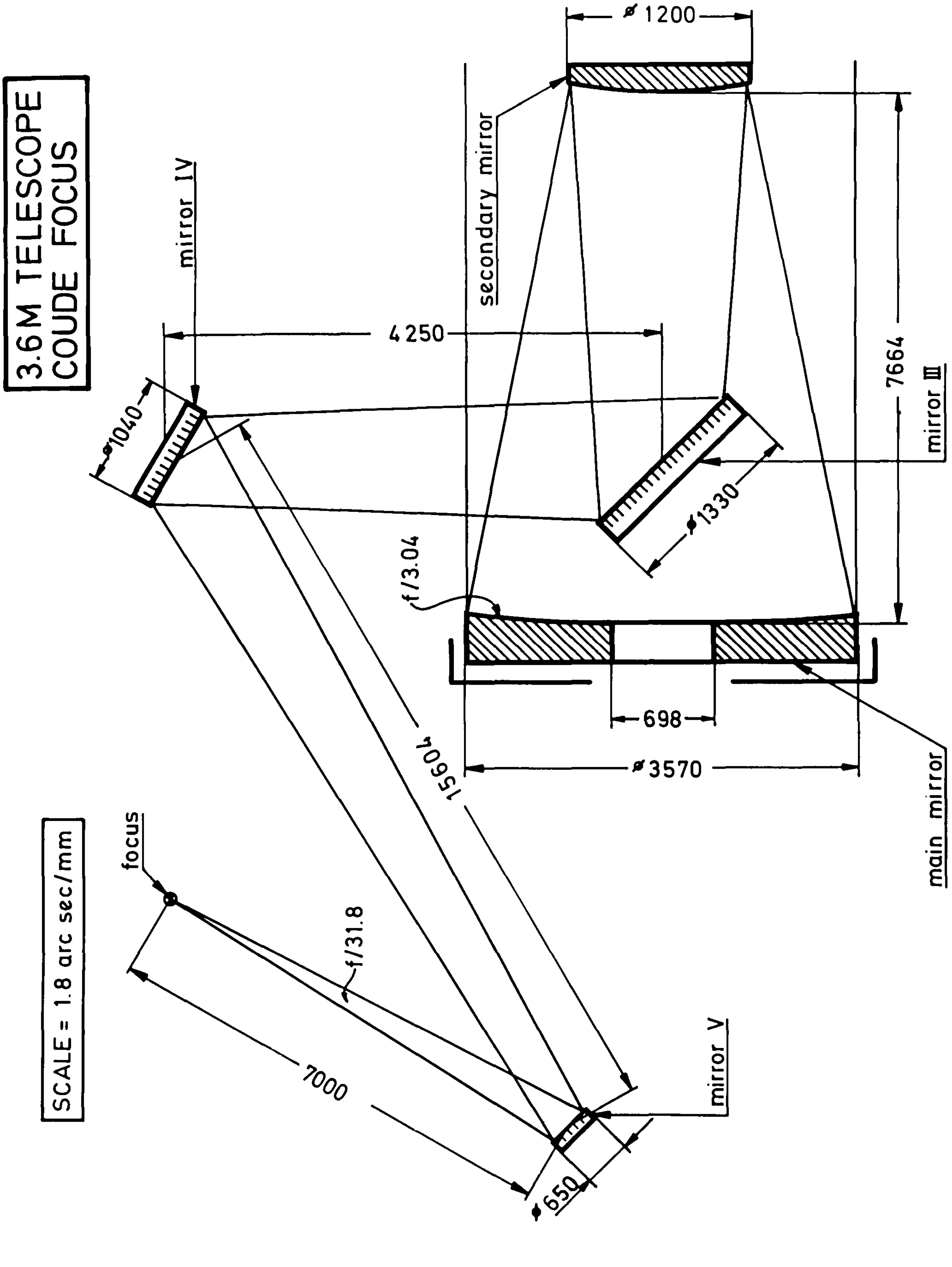
Instrumentation may be rotated at Cassegrain, but at present the positional read out is rudimentary. The setting can be read to 1°.

II.A.1.3-3.6 M COUDE

(f 31.8, scale 1.8 arcsec mm^{-1})

The coudé is shown schematically in Fig.(4). There are five mirrors to the coudé. As the coudé light path is slightly inclined to the equatorial axis, the fifth mirror is driven to compensate.

There are two identical coudé rooms below the observing floor, one situated either side of the telescope, and the fifth mirror can be turned to deflect the light into either room. A coudé spectrometer is under construction, but it will not be installed until early 1980. When the 3.6 m is operating at Cassegrain or prime focus, it is forseen to operate the coudé scanner using a smaller telescope, the CAT (coudé auxiliary telescope) as a feed.



3.6 M TELESCOPE COUDE FOCUS II.A.1.FIG.4.

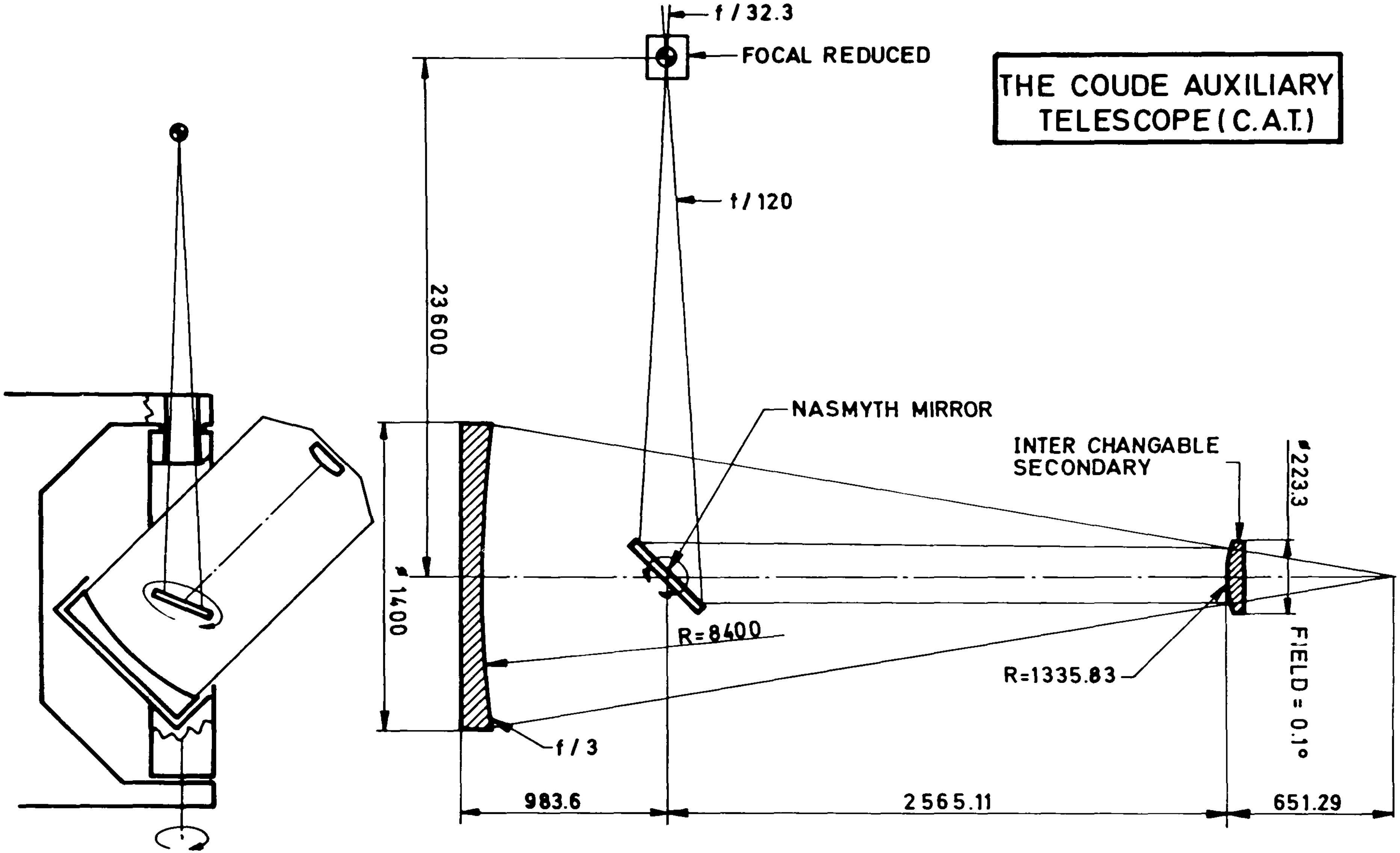
II.A.1.4-THE COUDE AUXILIARY TELESCOPE (CAT)

(f 32.3, scale 4.42 arcsec^{-1})

The CAT is shown schematically in Fig.(5) and is designed to feed the 3.6 m coudé instrumentation, principally the coudé echelle spectrometer (CES). The CAT stands on a 24 m high pillar alongside the 3.6 m telescope and is connected to the coudé rooms via an 11 m long steel tube. The telescope mirro[illegible] 1.47 m in diameter, and the free aperture is 1.4 m. The telescope has an Alt-Alt mounting necessitating computer control for tracking. An HP 2100 MX computer is used which makes the continuous transformation of α and δ to pitch and roll angles. The mounting also produces field rotation. The telescope optics are designed on the Dall-Kirkham principle and have an ellipsoidal primary and a spherical secondary. The third mirror is a Nasmyth focus mirror which rotates at half tube speed in order to maintain a fixed light beam in space. Certain northern declinations are not observable as the angle of the third mirror causes variable vignetting. Some southern areas of the sky will be inaccessible due to the 3.6 m, see Fig.(6).

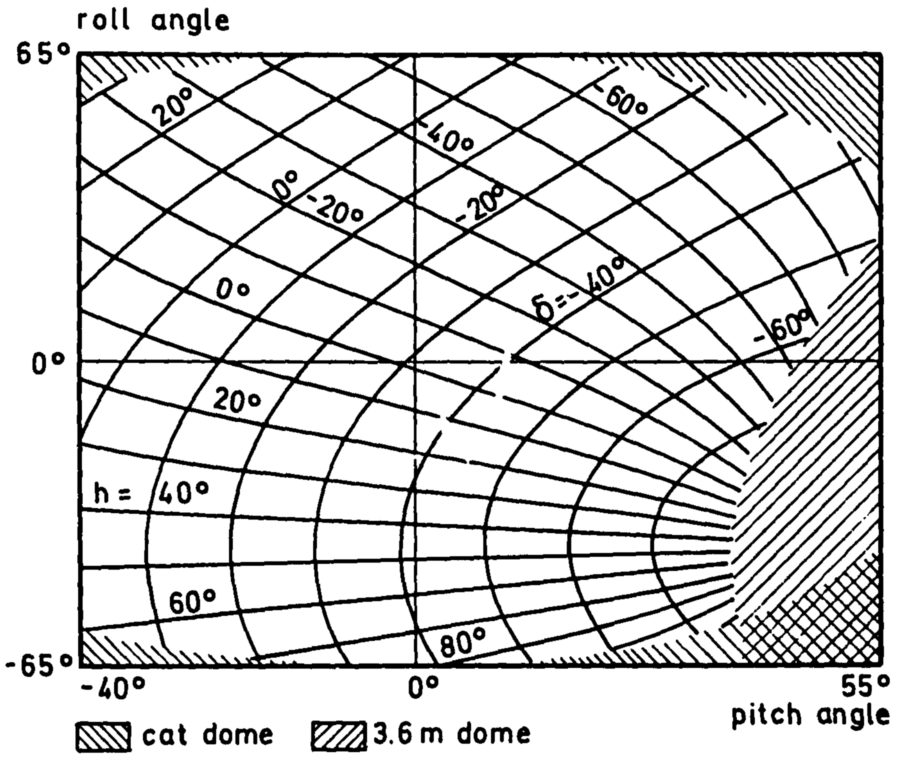
The CAT is designed to have a high light throughput, and for this reason, there are four interchangeable secondaries mounted on a turret; two are coated with dielectric coating (95% reflectance) blue (3500 to 5500 Å) and red (4500 to 7500 Å), the third mirror is Al (85% reflectance), and the fourth is not yet selected but will probably be gold coated for near infrared work.

The system is f 120 which allows the beam to pass through the connecting tube, but uses a focal reducer to produce an f 32.3 beam to feed the coudé. Three focal reducers are available to cover the visible to near infrared wavelength range. The field of view is approximately 2 arcmin. The length of the coma pattern at 3 arcmin (radius) is 3 arcsec. As the focal plane is 23.6 m from the telescope, pointing and object acquisition is carried out remotely through a TV camera mounted on a finder telescope with a 15 cm diameter objective.



THE COUDE AUXILIARY TELESCOPE (C.A.T.) II.A.1.4.FIG.5.

Apr. 80



SKY COVERAGE LIMITATIONS FOR CAT   II. A. 1. 4. FIG. 6.

Apr. 80

II.B.1-THE ESO 1.52 M TELESCOPE

(Cassegrain f 14.9, scale 9.2 arcsec mm^{-1})
(Coudé f 31.4, scale 4.4 arcsec mm^{-1})

The telescope is essentially a twin of the 1.52 m at l'Observatoire de Haute Provence. It is mounted in an English cradle and can be used at f 15 Cassegrain or f 30 coudé. The two optical layouts are shown schematically in Figs.(1) and (2).

The mounting presents problems near the pole and when working at low declinations, particularly at Cassegrain; it is often necessary to take the telescope over the axis. This operation is easily performed and takes approximately 10 to 15 minutes, including time to re-initialize the telescope.

The platform is divided into two pieces - east and west - and each side can be raised and lowered independently. This greatly facilitates work at Cassegrain.

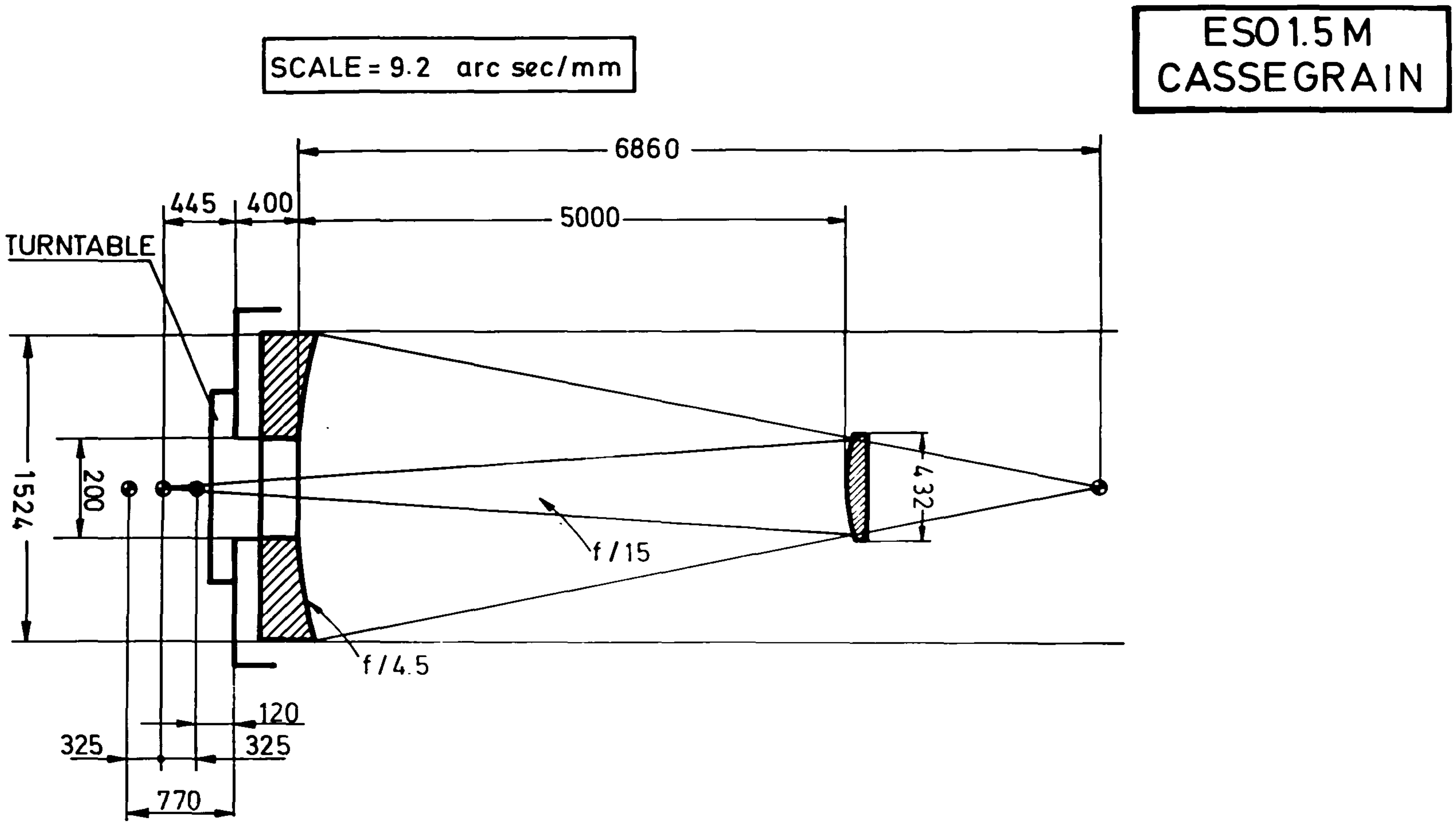
The original telescope drive often gave problems and optical encoders have been fitted to improve pointing accuracy. For faint objects it is recommended to first acquire a nearby star, correct the coordinates, and then move to your object. This technique gives a pointing accuracy of approximately ±30 arcsecs.

The Cassegrain focus can support equipment up to 150 kg with a center of gravity up to one meter from the back plate. Equipment available at Cassegrain is given in Table 1, section II.A.

At coudé, there is a conventional coudé spectrograph, designed by Fehrenbach, mounted north-south and parallel to the equatorial axis. In addition, there is sufficient space for the echellec, (see section III.A.4), which is removable, to be mounted east-west in front of the coudé spectrograph (see section III.A.1). The coudé room is large and also houses the ETA calibration spectrograph (see section III.A.1).

The building consists of several floors. Adjoining the coudé room is an astronomer's office and a dark room equipped for loading and developing. The second floor contains plate storage, cutting, and sensitizing facilities; there is also a toilet. Finally, the ground floor houses an optics laboratory.

ESO 1.5M CASSEGRAIN



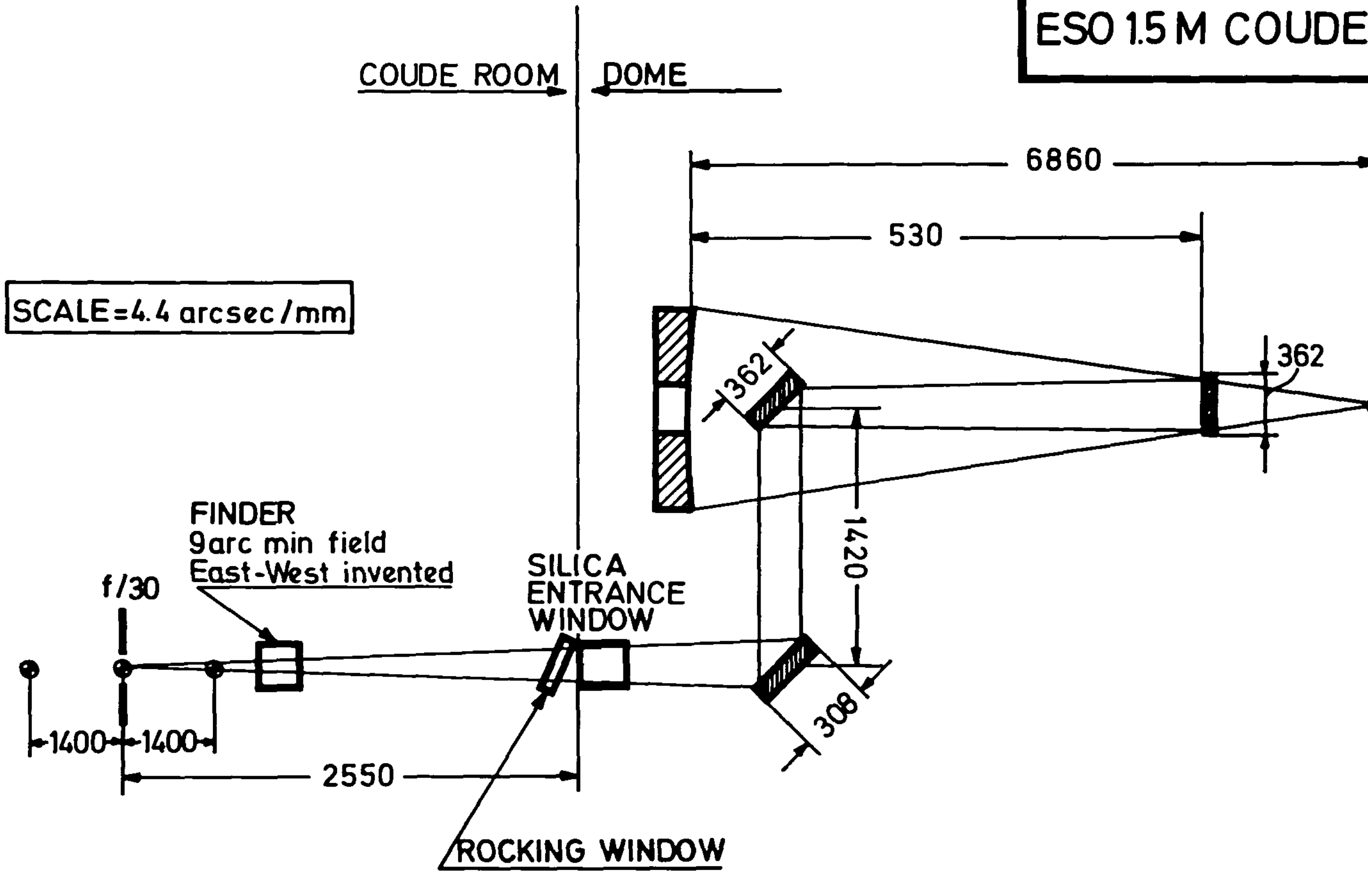
INTERFACE OF TURNTABLE ,SEE DRAWING II.1.FIG.2,2.1.
MECHANICAL FOCUS RANGE = 650

II.B.1.FIG.1.

ESO 1.5M COUDE

II.B.1.FIG.2.

ESO 1.5 M COUDE



MECHANICAL FOCUS RANGE

INTERFACE OF TURNTABLE, SEE DRAWING II.1.FIG.2,2.1.

II.C.1-THE ESO 1 M TELESCOPE

(f 13.6, scale 15.08 arcsec mm^{-1})

This fork mounted 1.07 m telescope is shown schematically in Fig.(1). There are two foci, Cassegrain and Nasmyth, but the telescope is rarely used in the Nasmyth configuration.

The telescope employs an ESO developed computer drive system (TCS), and the telescope has a high pointing accuracy of ± 10 arcsec at the zenith and somewhat poorer at large hour angles.

Instrumentation is interfaced through CAMAC (see section V.A.1) to a second computer, an HP 2100 A, which handles data acquisition.

All instructions to the telescope and instrumentation are made through a single display console in the dome. Data is recorded on paper tape, magnetic tape or a line printer.

The TCS can store up to 374 stars and can precess coordinates up to epoch ≤ 2000.

The telescope can carry equipment up to 150 kg at the Cassegrain focus. The clearance in the fork is 1.2 m.

Equipment offered at the 1 m is given in Table 1, section II.A.

The dome platform is movable and there is a small office adjoining the observing floor. On the second floor, there is a plate loading and developing room and an equipment assembly room which contains the Schnell and Joyce-Lobel microdensitometers. On the ground floor, there is an equipment assembly room, a visiting astronomers room, and a toilet.

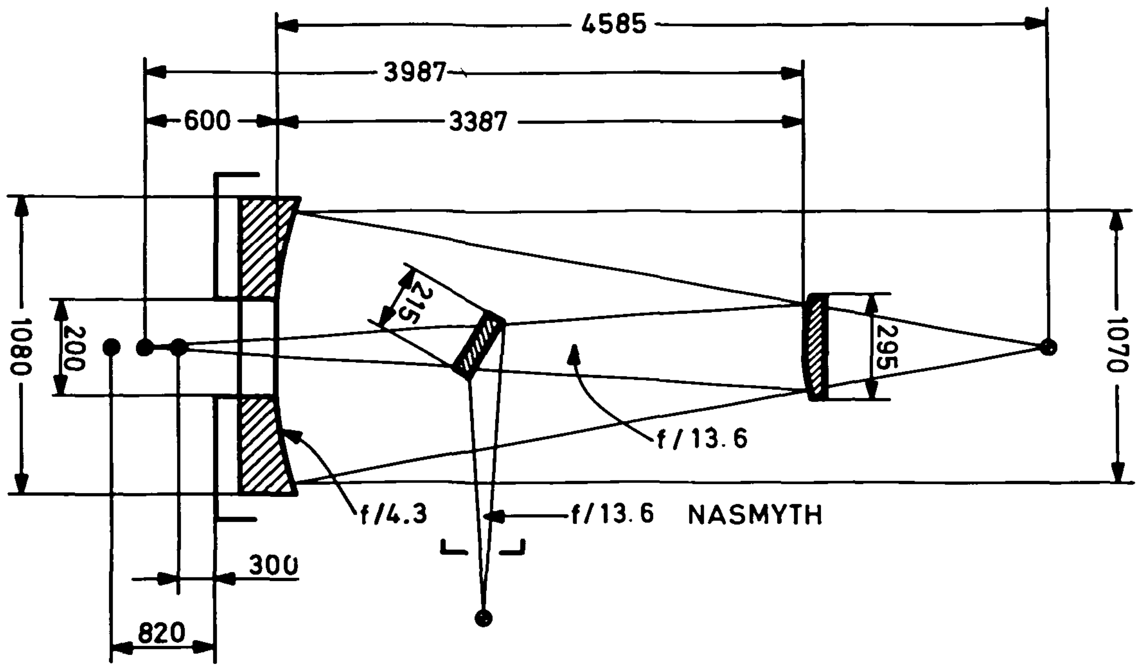
Apr. 80

E.S.O. 1 M

II.C.1.FIG.1.

SCALE =15.08arc. sec./mm

E.S.O. 1 M



MECHANICAL FOCUS RANGE = 520

CLEARANCE BETWEEN FORK AND INSTRUMENT FLANGE 1100

INTERFACE OF INSTRUMENT FLANGE, SEE DRAWING II.1.FIG.3,3.1.

II.D.1-THE ESO 50 CM TELESCOPE
(f 13.6, scale 27.5 arcsec mm^{-1})

This fork mounted 50 cm telescope, shown schematically in Fig.(1), is very similar to the Danish 50 cm. It was used to develop the computer controlled telescope (TCS, Telescope Control System) used on the 1 m ESO and the 3.6 m telescopes. Normally, small telescopes do not enjoy such advanced drive systems. However, due to backlash and a slight sinusoidal error, pointing accuracy is not better than ± 15 arcsec.

The system's memory can contain up to 200 star coordinates and precess any epoch $\leq$ 2000.

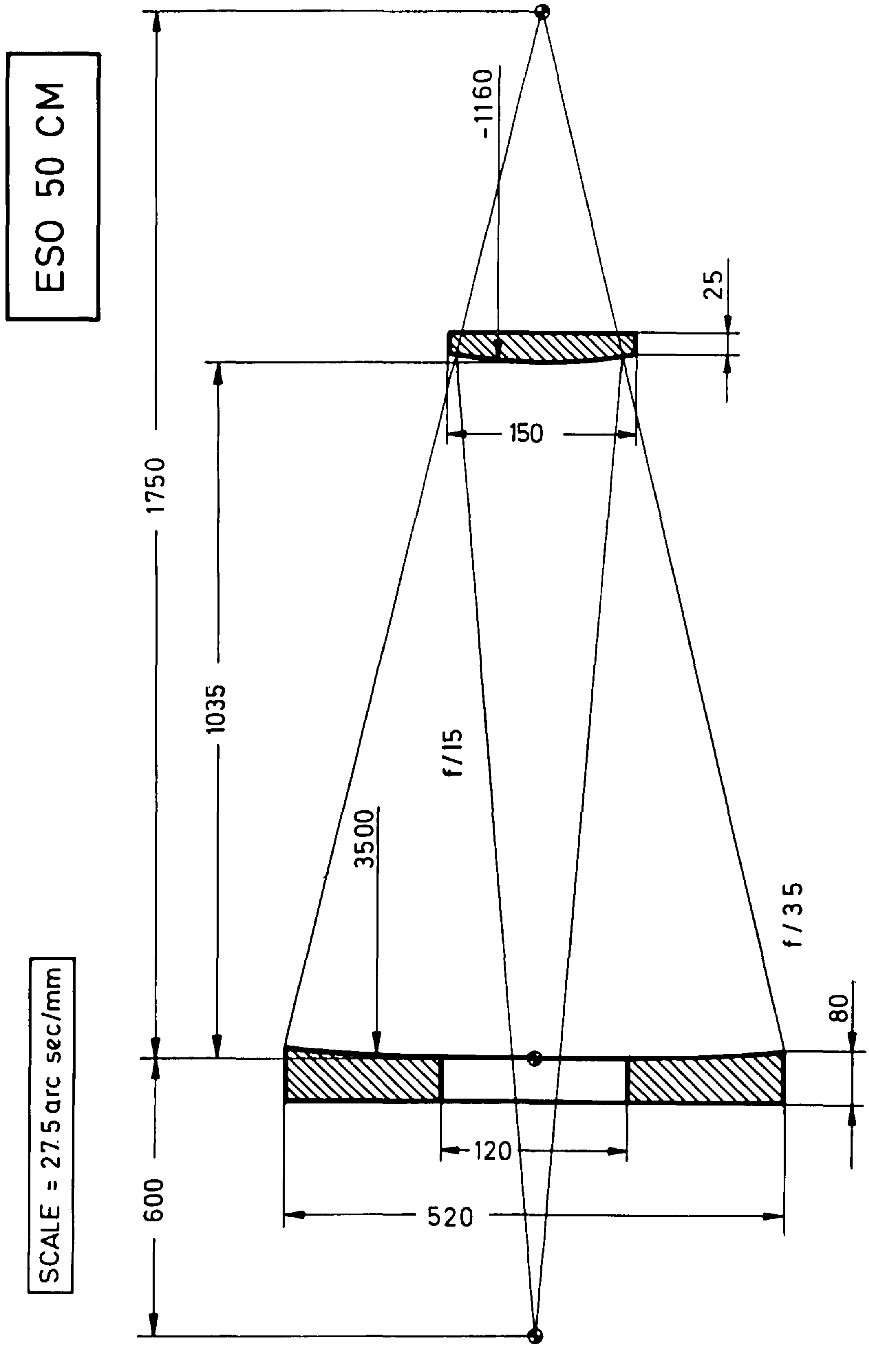
The data acquisition system is similar to the 1 m telescope and both the data acquisition and telescope control are operated through a single keyboard display in the dome.

Interface of equipment is made through CAMAC to the HP 2100 A computer, (see section V.A.1, page 3).

Equipment available is given in Table 1, section II.

Data is recorded on paper tape, magnetic tape, or line printer. The telescope can carry a maximum weight of 90 kg at the Cassegrain focus. The clearance in the fork is 78 cm.

The dome floor is fixed. The ground floor has a small office and a toilet.



ESO 50 CM II.D.1.FIG.1.

II.E.1-THE SCHMIDT TELESCOPE

(1 m, f 3, scale 67.5 arcsec mm^{-1})

The 1 m Schmidt telescope was designed basically after the Hamburg Observatory Schmidt. Its principle job is to survey the southern hemisphere. For this reason, the plate scale 67.5 arcsec mm^{-1} was chosen to match that of the Palomar Schmidt. A large part of the Schmidt time is used for the ESO (R) survey. Nevertheless, time is available for Visiting Astronomers' programs. Furthermore, these programs are carried out exclusively by ESO staff.

The telescope is mounted in a fork and shown schematically in Fig.(1). The f/3 primary is 1620 mm in diameter, and the telescope has a free aperture of 1 m. Guiding is achieved by use of a TV guide probe in front of the plate holder. Photometric calibration steps are provided on the plate by projectors in the telescope.

Two plate sizes are in use, 290 x 290 mm and 160 x 160 mm subtending 5° and 2.5° on the sky respectively.

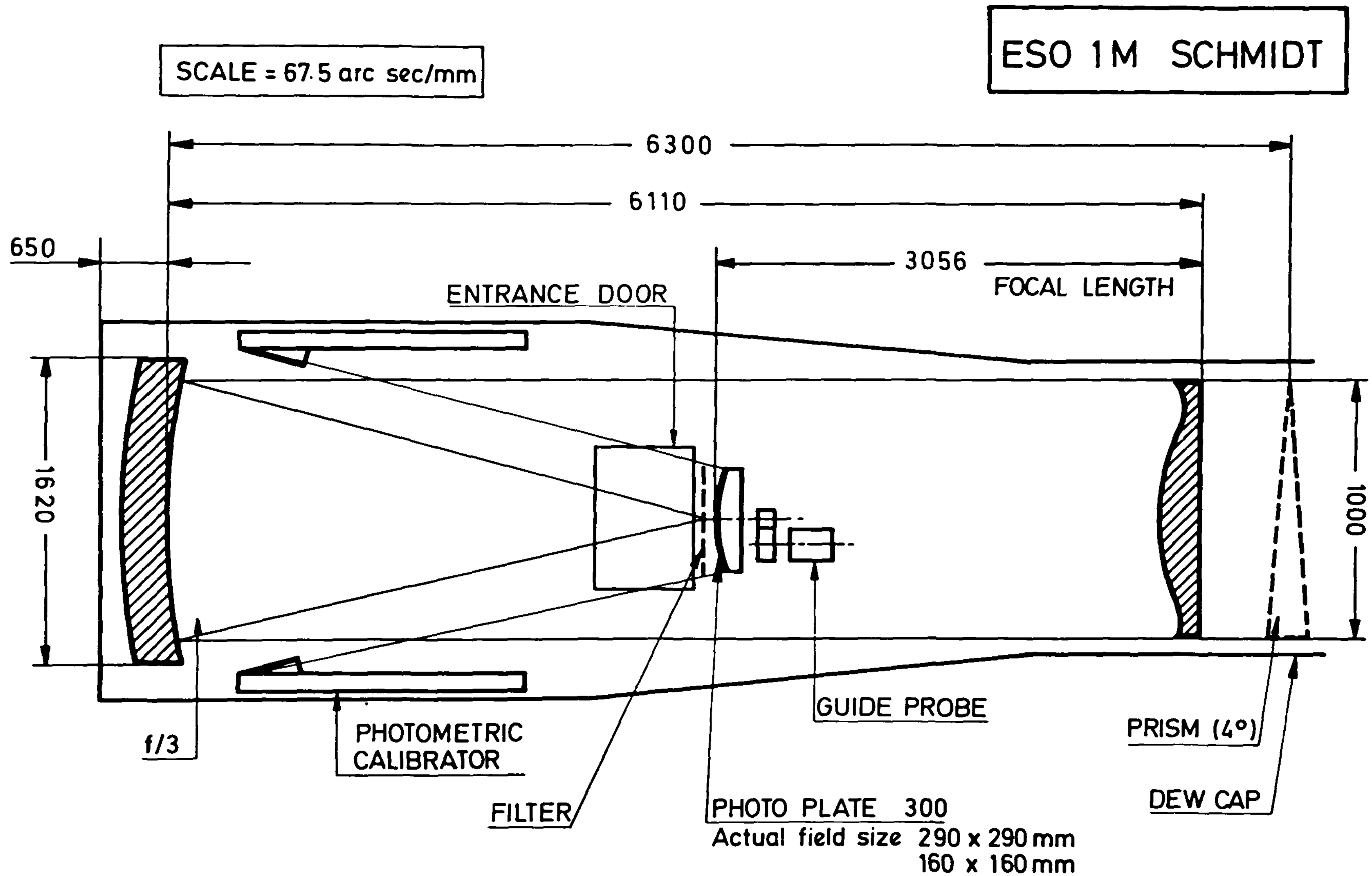
The following filters are available: UG1, GG385, GG495, GG475, RG630, RG665, RG10, BG12, and OG550. These all have dimensions of 340 x 340 x 2 mm. In addition, interference filters are available. Their details are given in Table 1.

A 1 m diameter objective prism is available. It has a 4° angle and gives dispersion of 450 Å mm^{-1} at Hγ. The limiting magnitude is about 14.5^m with a widening of 0.2 mm.

Table 1

Interference Filters

λ Center Å	$\Delta\lambda$ in Å	Transmission %	Effective Refractive Index
	6 inch diameter, 4 mm thick		
4469±10	90±10	35	1.35
4674±10	90±10	35	2.0
5017±10	90±10	35	2.0
	6 inch diameter, 10 mm thick		
6732	44	55	-
6572	52	54	-



ESO 1M SCHMIDT

II.E.1.FIG.1.

II.F.1-THE ASTROGRAPH (GPO)

(40 cm, f 10.4, scale 51.5 arcsec mm^{-1})

This instrument consists of twin telescopes (astrograph and guider) mounted in a cradle and can be used either in the direct photography mode or to determine radial velocities using the double Fehrenbach objective prism. Basic telescope data are given in Table 1, section II.A.

The objective prism unit consists of a flint glass prism and a Barium-Crown prism which have the same refractive index at 4175 Å. The useful aperture of the prism and objective is 38.5 cm, and the combination gives a dispersion of 110 Å mm^{-1} at 4210 Å. Spectra down to 12^m can be reached with an exposure of 2 x 40 minutes (employing the reversal method of Fehrenbach).

A radial velocity of 4 km sec^{-1} produces a displacement of 1 μm of one spectrum with respect to the other. The accuracy to which radial velocities may be determined using this method is 5 km sec^{-1} for G and K stars.

In the normal astrograph mode using baked IIa-O plates, stars of 16^m can be reached with exposures of about two (2) hours.

(NOTE: The platform is movable.)

The GPO building has a small office, a darkroom equipped for loading and developing plates, and a toilet.

Table 1

Astrograph (GPO) Data

Objective	
Diameter	38.6 cm
Focal length	399.4 cm
Plate size	16 x 16 cm
Field	2° x 2°
Prism	
Diameter	39.0 cm
Angle (flint)	10.5°
Dispersion	110 Å mm^{-1} at 4210 Å
Guider	
Diameter	26.0 cm
Focal length	400.0 cm
Field	5 arcmin

II.G.1-THE BOCHUM TELESCOPE

(61 cm, f 15, scale 22.5" mm^{-1})

The telescope and its auxiliary equipment are owned by the Deutsche Forschungsgemeinschaft (German Research Foundation) on permanent loan to the Astronomisches Institut der Ruhr-Universitat Bochum, West Germany. ESO receives approximately 30% of the observing time at this telescope, in exchange for the use of ESO facilities by the Bochum observers. During the ESO periods, the Bochum telescope is at the disposal of visiting astronomers (VAs).

The telescope, shown schematically in Fig.(1), is a closed tube design, with an English mount and manufactured by Boller and Chivens. It has a Cassegrain focus only and can carry equipment weighing up to 55 kg. The telescope can be used with the Bochum photometer (see section III.B.5)

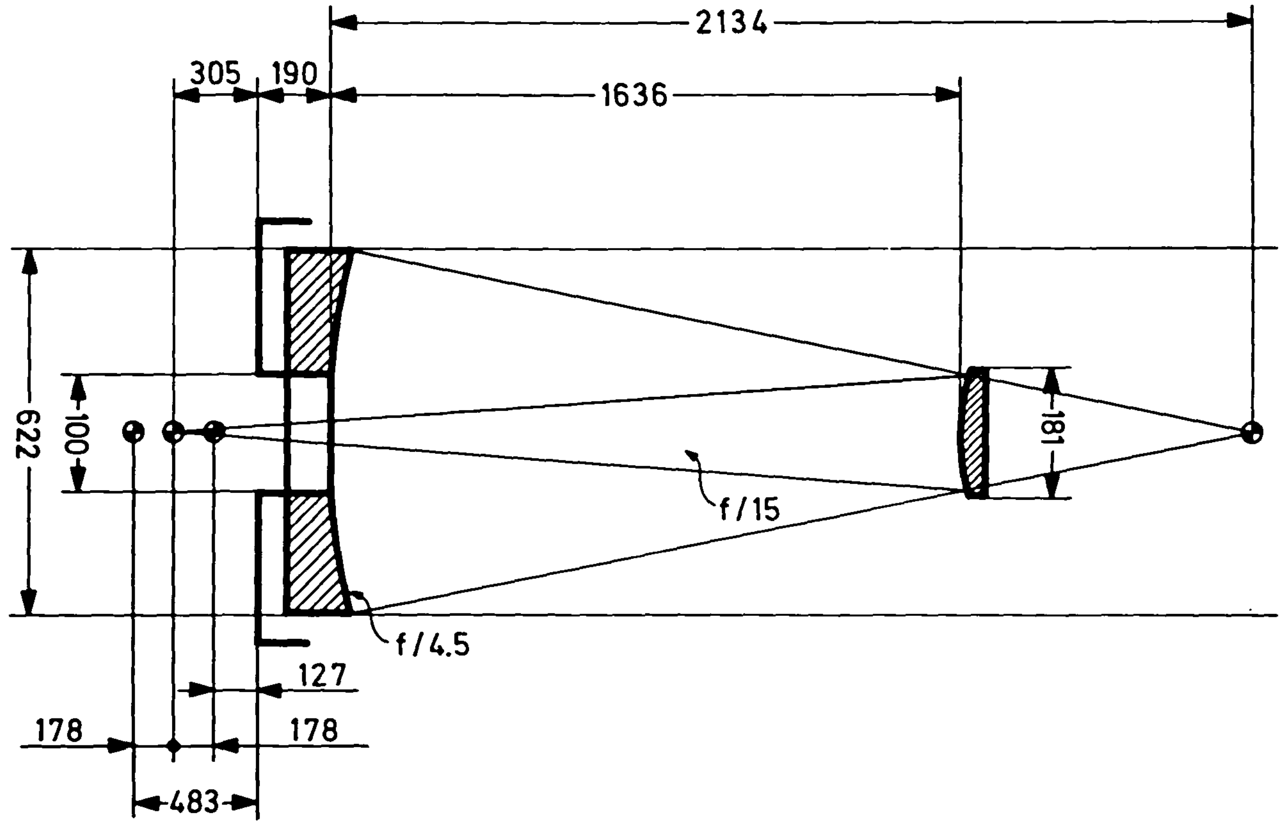
Additionally, there is a spectrum scanner belonging to the Bochum University but it is generally not available to VAs. Exceptional permission for using this instrument may only be obtained from the Director of the Astronomisches Institut der Ruhr-Universitat, D-463 Bochum, Postfach 102148, West Germany. However, ESO will not provide introduction for this equipment.

The limiting visual magnitude is V = 15.5 with the photometer. The pointing accuracy of the telescope is approximately 2 arcmin and a horizon limit device stops the telescope automatically at 83° zenith distance. This may be overridden with a special button located on the nameplate with the position dials. The dome floor is fixed.

The building contains a computer room, a small kitchen, and a toilet for general observers. In addition, there is an equipment assembly room and an office/bedroon used by Bochum staff.

SCALE = 22,5 arc sec / mm

BOCHUM 61 CM



MECHANICAL FOCUS RANGE = 356

CLEARANCE BETWEEN FORK AND INSTRUMENT FLANGE

INTERFACE OF INSTRUMENT FLANGE, SEE DRAWING II.1.FIG.7.

BOCHUM 61 CM

II.G.1.FIG.1.

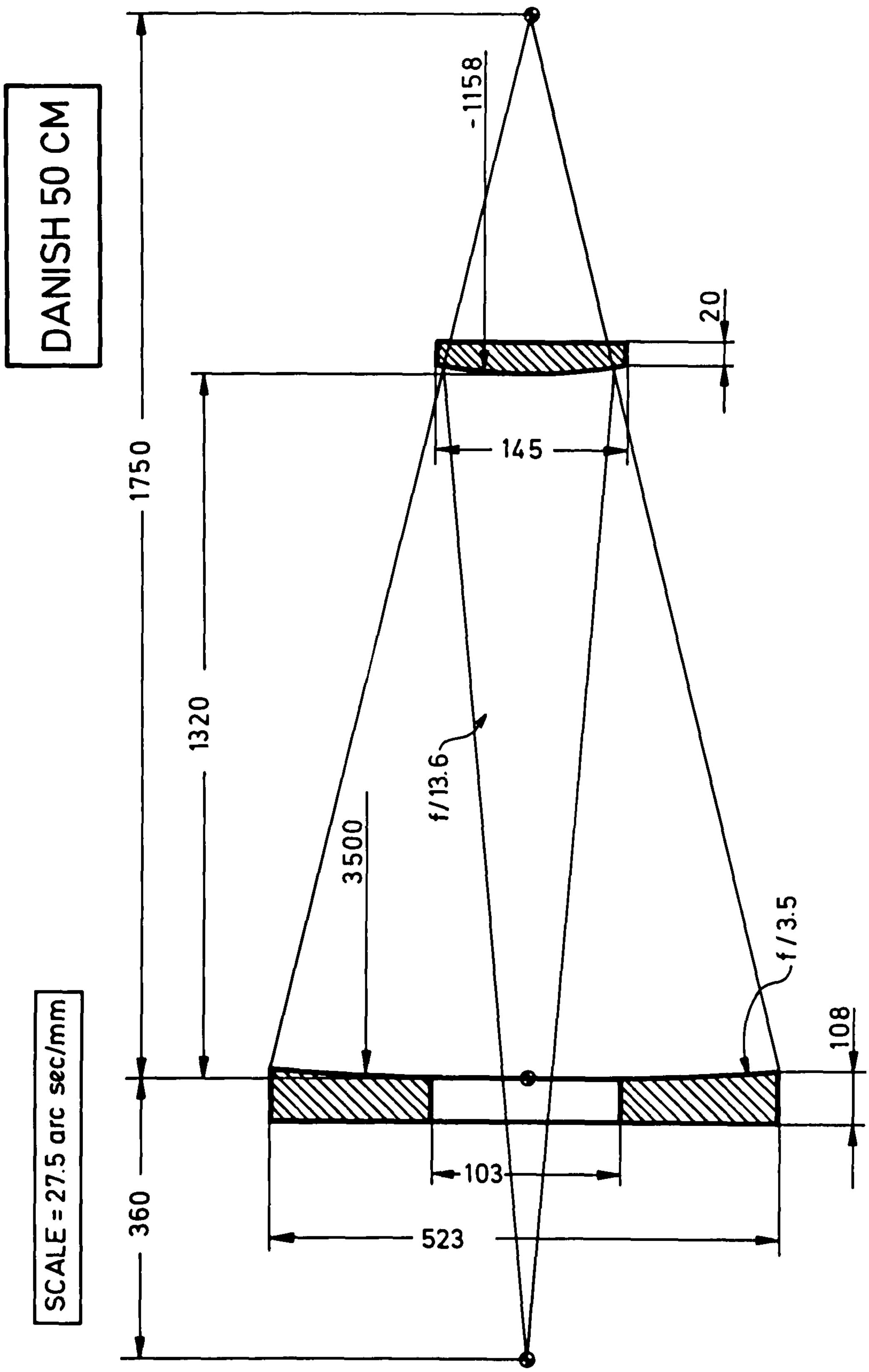
II.H.1-THE DANISH 50 CM TELESCOPE
(f 13.6, scale 27.5 arcsec mm^{-1})

The telescope and its auxiliary equipment are owned by the University of Copenhagen. ESO receives approximately 30% of the observing time at this telescope.

The telescope is mounted in a fork and is shown schematically in Fig.(1). The optics are of a Dall-Kirkham design with an ellipsoidal primary and a spherical secondary. The telescope optics are very similar to the ESO 50 cm. A conventional drive system is used and the read out for α and δ are given on a control panel. The information being relayed to the dials is from a synchro-transmitter on the drive axis to a synchro-receiver behind the dials. A pointing accuracy of approximately 2 arcmin can be expected.

The pulse counting and general data acquisition system is described in section III.B.8.1. Equipment available is given in Table 1, section II.A. Data output is on punched paper tape.

The dome floor is fixed. The ground floor contains a small office and a toilet.



DANISH 50 CM II.H.1.FIG.1.

II.I.1-THE DUTCH 91 CM TELESCOPE

(f 13.75, scale 16.4 arcsec mm^{-1})

The telescope is the property of the "Stichting het Leids Sterrewacht Fonds". Since 1958, it has been in operation at the Leiden southern station site near Hartebeespoortdam, South Africa. During 1978-1979, it was removed and re-erected at La Silla.

ESO receives approximately 50% of the available observing time. The other half is shared among the astronomical institutes in the Netherlands.

The telescope could be better described as a light collector and was a prototype of the ESO 1 m. It is a fork mounted instrument and has only a Cassegrain focus. Its usable uncorrected field is 5 arcmin. Instruments should be less than 83 cm in length to pass in the fork, and no heavier than 100 kg.

The main instrument of the light collector is the simultaneous five channel photometer designed by Th Walraven, (see Walraven, Th, and Walraven, J.H., 1960 BAN, 15, 60; and Rijf, et.al., 1969 BAN, 20, 279). The VBLUW photometric system can be used for two dimensional classification of stars over the range O to G, and a determiniation of metal line blanketing is also possible for late A, F, and G stars. Information on such applications as well as standard stars, reduction procedures, etc, can be found in Lub, J., Pel, J.W., Astron.& Astrophys., 54, 137, 1977. Prospective users are kindly requested to familiarize themselves with the instrument by reading these articles.

The pointing of the telescope is of the order of 30 arcsec and by offsetting from a local star, it can be as good as 10 arcsec. Limit switches are fitted in declination, hour angle, and elevation.

The dome floor is fixed. A building connected to the dome houses an office, store room/dark room, computer room and toilet.

II.J.1-THE DANISH 1.5 M TELESCOPE

(Cassegrain f 8.5, scale 15.7 arcsec mm^{-1})

The Danish 1.5 m telescope has been in regular use since November 1979. The telescope is owned by the University of Copenhagen and ESO receives approximately 50% of the observing time at this telescope.

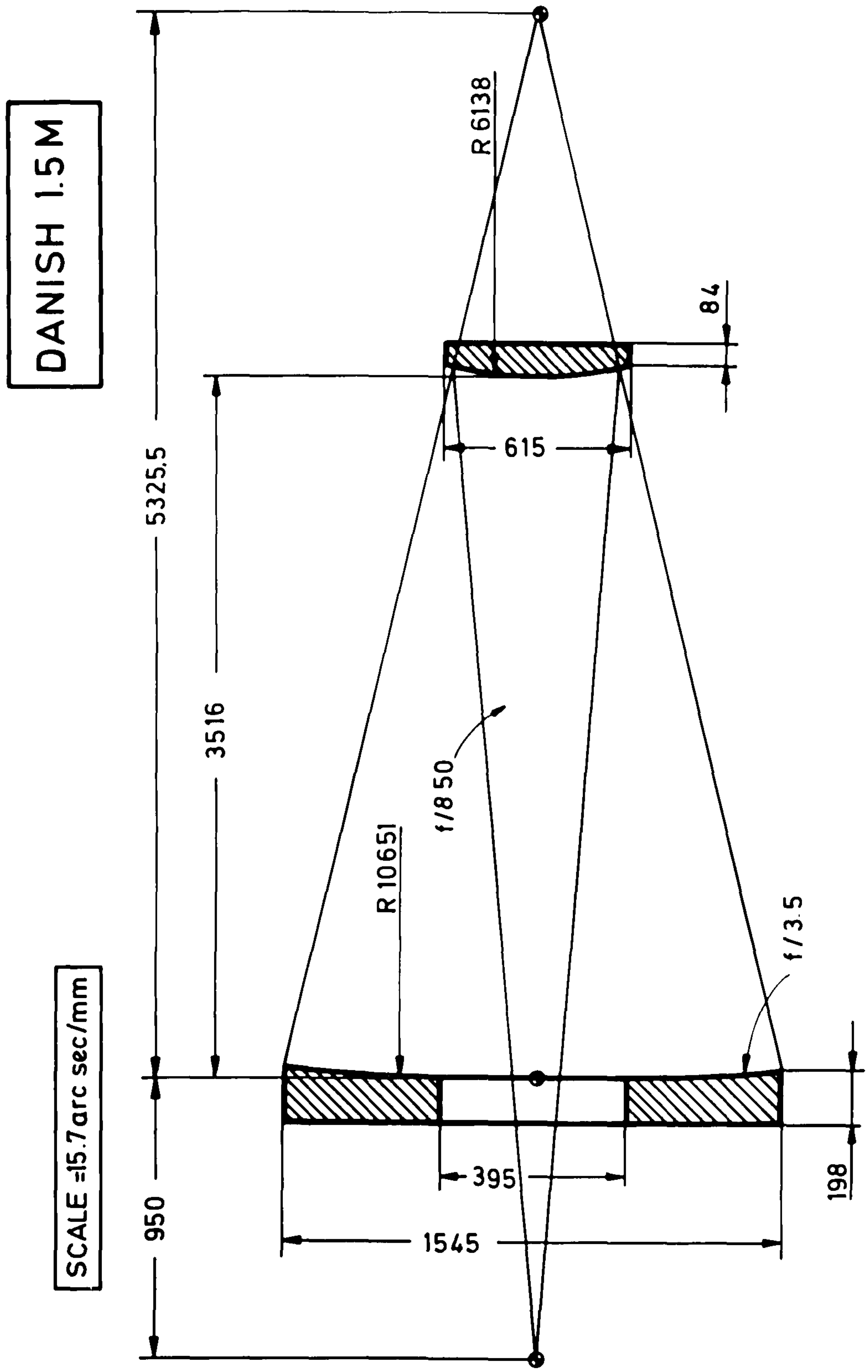
The telescope has on off-axis mount and the optics follow a Ritchey-Chretien design shown schematically in Fig.(1). The telescope is driven by the ESO developed TCS system similar to the system used at the 3.6 m, the Schmidt and ESO 1 m telescopes. Presently, the telescope has a pointing accuracy of approximately 20 arcsec, the limiting factor being the encoder resolution which will be increased in the future.

The dome floor is fixed and this combined with the off-axis mount makes it difficult to reach the Cassegrain focus in some telescope positions. An effort has therefore been made to automate the telescope so it can be operated completely from the console room, except for plate changing. The telescope is equipped with an instrument adapter onto which all instruments can be mounted, see Fig.(2). The adapter houses a guide probe for automatic guiding and a Quantex integrating TV system which can be used either in a field viewing mode (3!5 x 3!5) or as a periscope viewing system (1' x 1') for centering objects in the photometer diaphragms. In the first mode, and under good seeing conditions, 20 mag can be seen.

The guide probe in the adapter picks up light from a star in the nearby field. The star image is scanned in α and δ by an ITT image dissector tube and if the star is not centered, an error signal is generated which repositions the telescope. Guiding with an accuracy of 0.1 arcsec is obtainable on 10th mag stars.

Good guide stars should not be brighter than 5 mag or fainter than 13. They should be selected such that all other stars within an 1 x 1 arcmin area are significantly fainter in order to avoid guider confusion and resulting spurious error signals.

The unvignetted guide probe area is an arc shaped area shown in Fig.(3). The guider presently works only for photography, but it is hoped to eventually adapt it for use with the photometers.



DANISH 1.5 M II.J.1.FIG. 1.

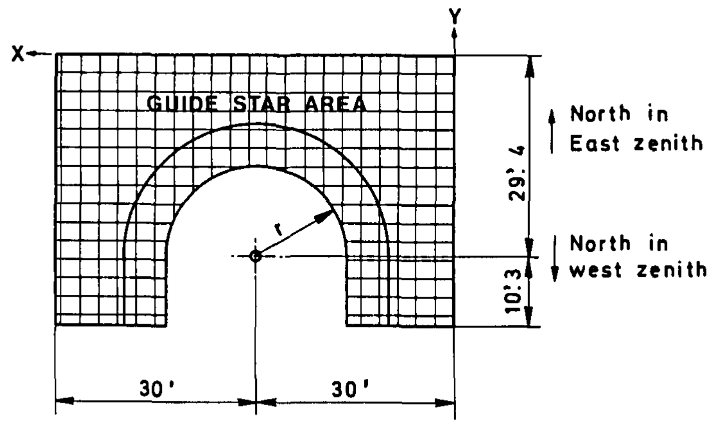


Fig. 3

After the adapter, a special filter and shutter unit may be mounted for direct photography only. The unit contains two filter wheels, both housing filters of maximum thickness 10.5 mm. The filter wheels overlap and are mounted one above the other. The lower wheel has eight positions for glass filters up to 110 mm diameter (see Table 1), and the upper wheel has 14 positions for filters of 60 mm diameter, see Table 2. Each wheel has one free position through which the other filter wheel can be used.

Table 1

110 mm Filters

Position number	1	2	3	4	5	6	7	0
Filter	U	B	V	R1	D	VA	VA	Free

R1: RG 665

D: is a dark sky blue filter $\lambda_{center} = 4900$ Å, $\Delta\lambda = 800$ Å

VA: These are positions which can be used for Visiting Astronomer's filters.

Table 2

60 mm Filters

Position number	1	2	3	4	5	6	7	8	9	10	11	12	13	0
Filter	y	b	v	u	←	—	—	—	VA	—	—	—	→	Free

Non-standard filter diameters can only be fitted after the construction of special holders.

The usable uncorrected field of the telescope is approximately 80 mm or 20 arcmin in diameter. When 60 mm filters are used, the field is restricted to 44 mm or 11.5 arcmin. A plate holder is available which uses 16 x 16 cm^2 plates allowing two exposures per plate with the uncorrected field. All normal emulsions are available. The shutter has a rotating blind design resulting in a difference of a few seconds exposure across the field. This should be taken into account when doing short exposure work.

Visitors who wish to bring their own equipment should first contact the University of Copenhagen Observatory. However, they should note that equipment should not be longer than 80 cm in order to work without restrictions or collision with the peer. The equipment should not weigh more than 300 kg, assuming reasonable weight distribution.

Presently, the telescope is equipped with the same data output system as the Danish 50 cm. Data output is on paper tape in ASCII; this may be transferred to mag tape in a preliminary reduced form via the ESO data reduction center. However, it is hoped to later install a system to give on-line reduction via an HP 2100 MX computer.

The building has an elevator. On the observing floor, there is a control room, an instrument storage room, and a dark room. The second floor has a Danish astronomer's office and an electronics lab, which also serves as an equipment assembly room. On the ground floor, there is a kitchen and another storage room and a toilet.

III.

Instrumentation

SECTION III INDEX

III. INSTRUMENTATION

page/s

B.11 DANISH 1.5 M Hβ PHOTOMETER (continued)

B.12 THE WALRAVEN VBLUW PHOTOMETER

C. SPECIAL PURPOSE INSTRUMENTS

C.1 POLARIMETER

C.1.1 POLARIMETER REDUCTION PROGRAM

page/s

D.1 INFRARED PHOTOMETERS AT THE 1 M TELESCOPE

D.1.1 INFRARED DATA ACQUISITION

III.A.1-THE COUDE SPECTROGRAPH AT THE 1.52 M TELESCOPE

INTRODUCTION

The optical layout of the ESO coudé spectrograph is shown in Fig (1). The spectrograph is contained in a cylindrical tank for rigidity, and the tank is mounted with its axis aligned approximately with the polar axis.

There are four mirrors to the coudé focus producing an f/30 beam which feeds the spectrograph. After passing through the slit, the beam goes in sequence to a 6 m focal length collimator, the grating, and then to one of three cameras. The cameras are denoted I, II, and III in order of increasing focal lengths which are 41, 67, and 250 cm respectively.

Four gratings are available, three classically ruled and one holographic. They are mounted on a rotatable turret and can easily be interchanged in a few minutes without adjustment to the spectrograph.

The gratings and camera combinations allow dispersions ranging from 2.6 to 31.3 Å/mm in the photographic spectral range, (see Table 1).

GRATINGS

There are three classically ruled gratings manufactured by Bausch & Lomb, and one holographic grating by Jobin-Yvon. Details of the gratings are shown in Table 2. The holographic grating is used only with camera III and is characterized by a clean instrumental profile and low ghost intensity (see additional notes). In Table 3, the efficiency (diffracted/incident light) is given for the holographic grating. The holographic grating can only be used with camera III.

Table 2

Grating designation	N°	N° of lines per mm	Blaze angle	Blaze λ 1st order	Useful area
A 1	Bausch & Lomb 35 53 40263	1200	14°14'	4100	200 x 306
A 2	35 53 4034	1200	21° 6'	6000	200 x 306
B	35 53 4037	771	16°49'	7500	200 x 306
H	Jobin-Yvon	1500	-	-	205 x 314

Table 1

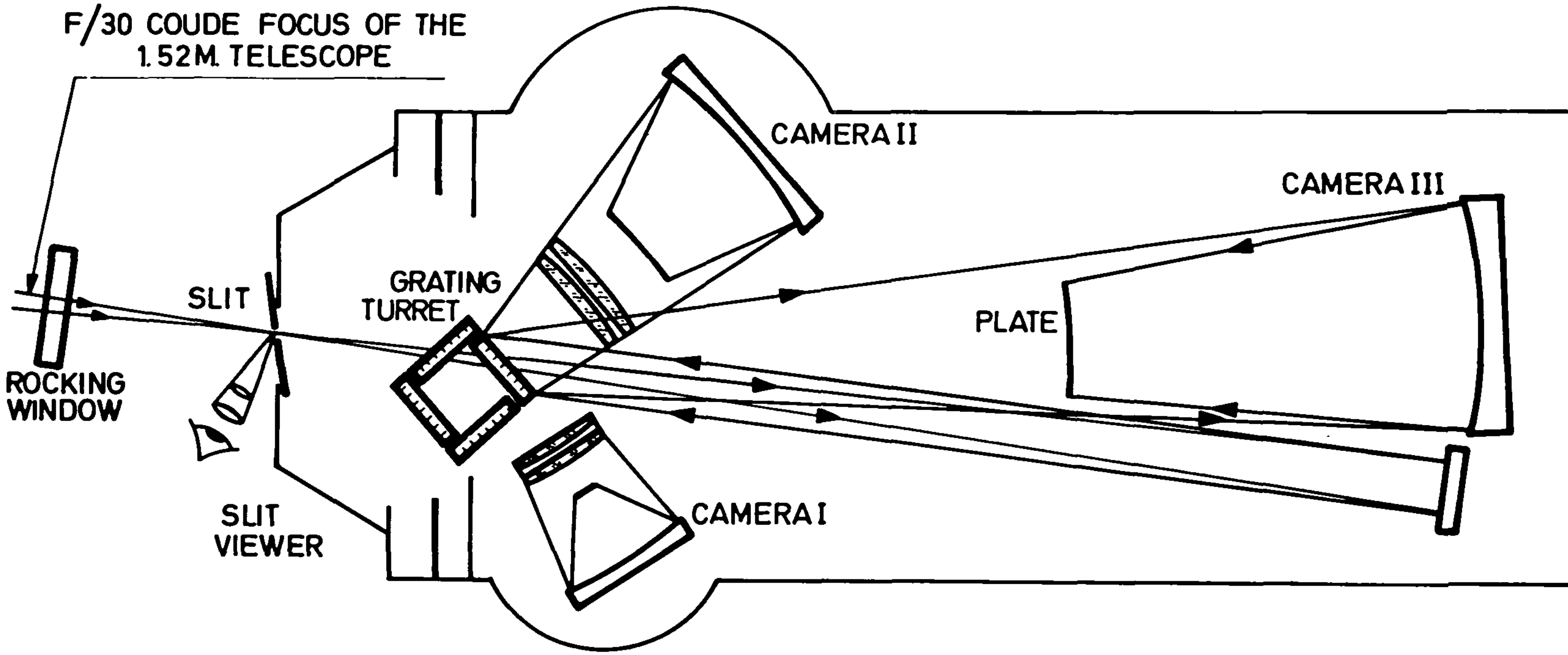
Spectral Ranges of the Coudé Spectrograph

Range N°	Grating	Camera	Dispersion Å mm^{-1}	Plate Center λ Å	Useful Spectral Interval Δλ Å	Plate edge* λ λ
1		I	20.0	4150	1000	2700 - 5550
2		I	20.0	4750	1000	3250 - 6250
3	A 1	II	12.3	3790	1300	2200 - 5450
4		II	12.3	4340	1300	3500 - 6350
5		III	3.3	3450	1500	2700 - 4200
6		III	3.3	4280	1500	3500 - 5000
7		I	20.2	5300	1000	3960 - 6850
8		I	20.2	5700	1000	4360 - 7250
9	A 2	II	12.4	5300	1300	3760 - 6800
10		II	12.4	6040	1300	4450 - 7600
11		III	3.3	5400	1500	4700 - 6100
12		III	3.3	6300	1500	5500 - 7000
13		I	31.3	6250	1500	3650 - 8850
14		I	31.3	7500	1500	4900 - 10100
15	B**	II	19.4	6375	2000	4150 - 8600
16		II	19.4	7450	2000	5050 - 9850
17		III	5.05	5800	2200	4800 - 7000
18		III	5.05	7800	2200	6800 - 9000
H1a		III	2.6	3850	1100	3300 - 4400
H1b	H	III	2.6	4450	1100	3900 - 5000
H2		III	2.6	6300	1100	5750 - 6850

* These numbers are included to show the extent of spectrum on the plate. This is useful only if you want to record the presence of a line, but astigmatism at the plate ends makes it difficult to use these areas. For high quality measurements, use the *useful spectral interval*.

** Yellow filter required to remove the second order blue region.

THE COUDE SPECTROGRAPH
AT THE 1.52M.TELESCOPE



THE COUDE SPECTROGRAPH III.A.1.FIG.1.

Table 3

Holographic Grating Efficiency

Wavelength	3700	4500	6000
% Efficiency	35	40	37

The angle between the incident beam on the grating and the optic axis of the camera is 51.6° for cameras I and II. For camera III, the angle is 10° and the angle of incidence on the grating varies between 18° to 27° depending on the wavelength chosen.

The grating mounting gives a choice of selecting one of two fixed central wavelengths (spectral ranges) for each camera. These are shown with dispersions in Table 1.

In terms of efficiency, grating A1 is approximately 40% more efficient than gratings A2 and B which are about equal. However, when comparing exposure times for a given star, grating B is faster (60% shorter exposure time than for A2) because of the lower dispersion.

SLIT

The slit jaws are highly polished and inclined at 15% to the incident beam to facilitate guiding on the slit. The slit viewer gives a direct image of the sky. Two easily interchangeable eyepieces are available giving fields of 4 and 1.5 arcmin with magnifications of 2.7 X and 10 X respectively.

The slit width and height can be varied by two micrometer screws. The scale at coudé is 4.4 arcsec/mm and slit widths commonly used are shown in Table 4.

Table 4

Camera N°	Slit Width in um	Projection on plate in µm	Projection on sky in arcsec
I	300	20.6	1.3
II	200	22.5	0.9
III	50	20.6	0.2

DECKERS AND WIDENING

The slit height is defined by two prisms which provide the wavelength calibrations. The prisms move out symmetrically from the slit center. Their maximum separation is 54 mm or 4 arcmin. For small widenings, especially with camera III, it is better to use two small deckers to define the slit height as the prism housings introduce a slight vignetting.

Widening is achieved by a rocking (silica) plate mounted at the exit of the polar axis from the telescope. The plate is also used for minor guiding corrections and can be moved both parallel and perpendicular to the slit.

The rocking window is computer controlled and the amplitude and speed can be set to match the prism separations. The prism settings, spectrum height on the plate, and the rocking window settings are given in Table 5.

COMPARISON SOURCES

The following sources are available:

a) iron arc (see Figs.(2) to (4)).

b) neon discharge tube

c) argon discharge tube

d) high intensity iron spectral lamp

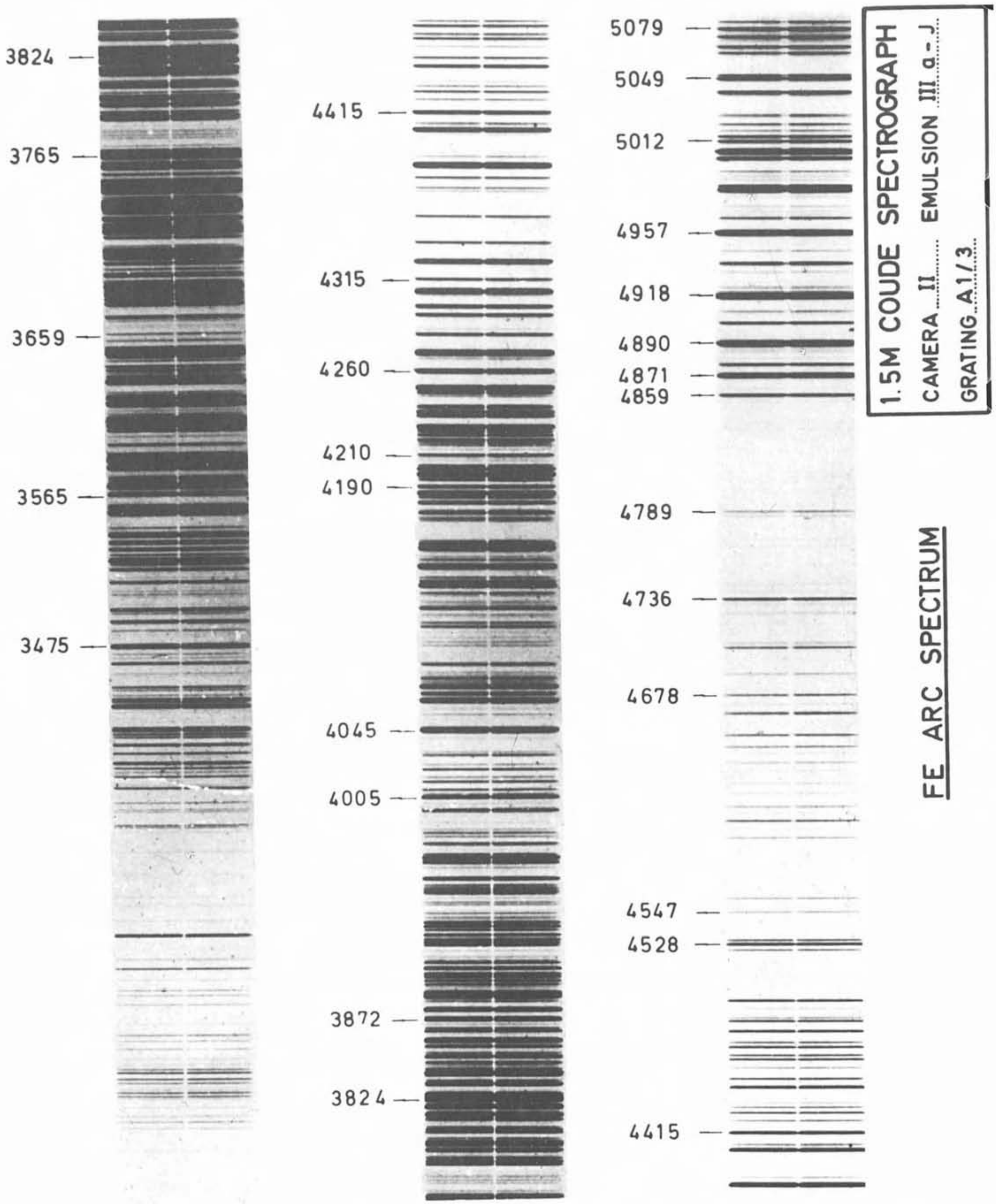
The sources are grouped around a small photometric sphere. The exit window of the sphere is imaged onto the slit through the two prisms used to define the slit length. The intensities of the sources are adjustable by use of interchangeable diaphragms inserted between the source and the photometric (integrating) sphere. The comparison source exposure can be monitored using an exposure meter.

INTENSITY CALIBRATION

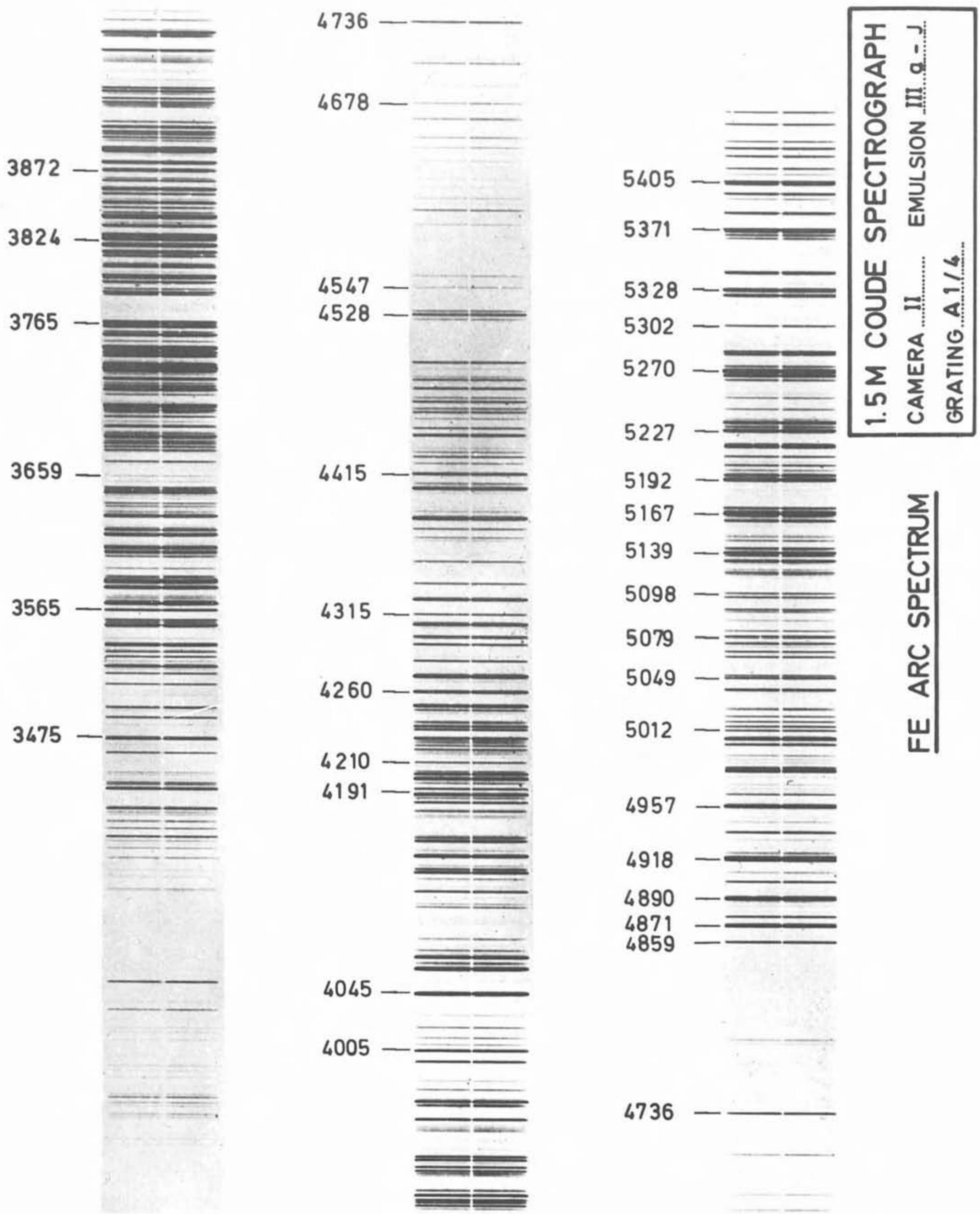
Intensity calibration can be carried out on the ETA spectrograph which sits beside the coudé spectrograph. For details on use, see section IV.A.4.

VIEWFINDERS

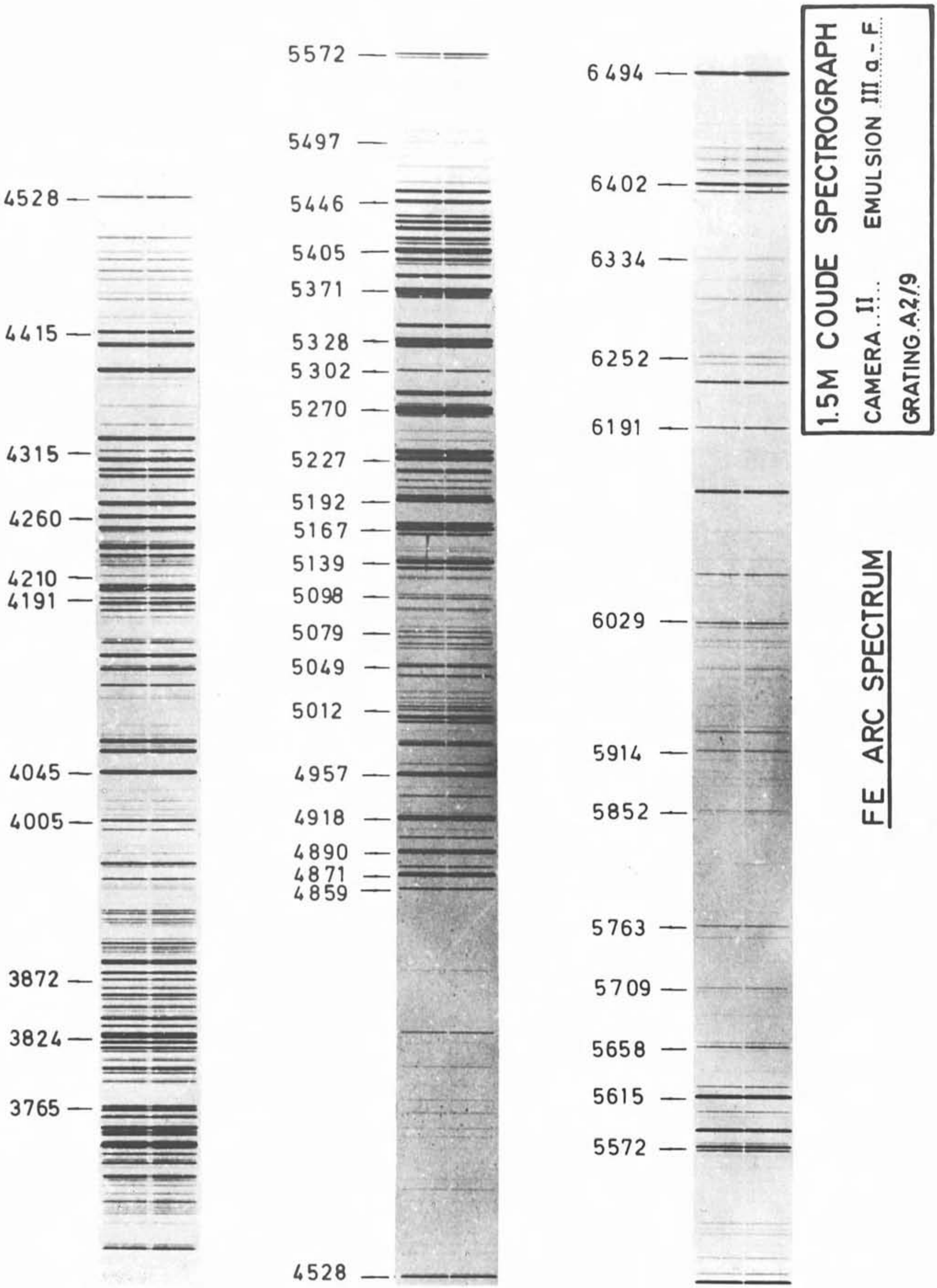
To set on a star, a finder is swung into the coudé beam before the slit. The finder field is 9 arcmin and the field is seen reversed. Its field orientation depends on the position of the telescope. An illuminated crosswire is provided for centering, after which the finder is swung out of the beam and the star can be seen on the slit through the slit viewer.



1.5M COUDE SPECTROGRAPH III. A.1. FIG. 2.



1.5 M COUDE SPECTROGRAPH III.A.1. FIG. 3.



1.5 M COUDE SPECTROGRAPH III.A.1.FIG.4.

Table 6

Approximate Exposure Times

Magnitude	Camera	Emulsion (B) = baked		Grating range	Exposure Time
B = 7.5	I	IIa-0	(B)	A 1/1	20 min
B = 7.5	I	IIIa-J	(B)	A 1/2	40 min
V = 7.5	I	IIa-D		A 2/7	40 min
R = 7.5	I	098-02	(B)	A 2/8	70 min
B = 7.5	II	IIa-0	(B)	A 1/3	60 min
	II	IIIa-J	(B)	A 1/4	130 min
V = 7.5	II	IIa-D		A 2/9	130 min
R = 7.5	II	098-02	(B)	A 2/10	250 min
B = 2.5	III	IIa-0	(B)	A 1/5	20 min
	III	IIIa-J	(B)	A 1/6	40 min
V = 2.5	III	IIa-D		A 2/11	50 min
R = 2.5	III	098-02	(B)	A 2/12	120 min

The times given are for a stellar spectrum 230 μm wide, taken in 1.5 arcsec seeing, and developed in MWP 2. Standard slit widths are assumed, (see Table 4).

EXPOSURE METER AND EXPOSURE TIMES

The spectrograph has a well calibrated exposure meter. The exposure meter takes the light which would normally be blocked out by the plate holder. This is collected by a small mirror in front of the collimator and sent to the photomultiplier of the exposure meter. A filter wheel is mounted in front of the photomultiplier with four neutral density filters which are used to reduce the light from bright stars to an acceptable level.

Typical exposure times are given in Table 6; they assume a seeing of 1.5 arcsec, a widening of 230 μm, and a projected slit width on the plate of 20 μm.

PLATE SIZE

In Table 7, the camera and plate sizes are given.

FIELD ROTATOR

A field rotator is provided and can be quickly placed in front of the spectrograph. It is based on a rotating silica Abbe prism. The field rotator introduces a light loss of approximately 40%.

ADDITIONAL NOTES

**HOLOGRAPHIC GRATINGS* are constructed by illuminating a grating blank coated with photoresist with equidistant parallel interference fringes. After chemical treatment, the grating grooves are produced. Since the grating grooves are shaped by a chemical process on a molecule-to-molecule level rather than the traditional method using a diamond ruling engine, the holographic gratings exhibit much less micro-roughness. Furthermore, the laser wavelength is well defined; therefore, there are neither grating ghosts, satellites, nor grass lines. The grating is manufactured in minutes instead of weeks, thus eliminating the random spacing errors due to environmental changes. High groove densities are possible, allowing high dispersion in the first order, therefore eliminating order sorting gratings or cross dispersers for $\lambda \lesssim 6000$ Å. The removal of the order sorting gratings also eliminates an additional source of light loss by scattering.

For high precision absorption line spectroscopy, the major problem is not to obtain high resolution R > 50,000, but to faithfully reproduce the spectral line details. Stray light lowers the spectral continuum and fills in absorption lines, causing errors in equivalent width measurements.

*(see Dravins, D., 1978, Applied Optics, 17, 404.)

Table 7

Camera Characteristics and Plate Sizes

Camera	Focal length	Focal ratio total	Focal ratio monochr.	Reduction of slit	Field size
I	41 cm	1.0	2.05	14.6X	50mm
II	67 cm	1.63	3.3	8.9X	100mm
III	250 cm	2.2	12.5	2.4X	450mm

Camera	Radius of curvature	Dispersions (Å/mm) with gratings: A1	A2	B	H	Plate Size
I	56 cm	20.0	20.2	31.3	-	1x17x168mm
II	100 cm	12.3	12.4	19.4	-	1x17x254mm
III	250 cm	3.3	3.3	5.1	2.6	1x63x498mm

III.A.2-THE BOLLER & CHIVENS SPECTROGRAPHS

INTRODUCTION

Two Boller & Chivens (B & C) spectrographs are presently available; on the Cassegrain foci of the 1.5 m and the 3.6 m telescopes. A third one will be delivered late 1980.

All three spectrographs are similar in optical design which . shown schematically in Fig. (1). The light beam from the telescope passes through the slit then in turn to the collimator, the grating, and finally is imaged by a Bowen Schmidt camera onto the photocathode of an image tube.

The spectrograph at the 1.5 m was originally designed to accept an f 7 beam and has been adapted to f 15 to fit the Cassegrain focus by use of a converter lens. This spectrograph is normally used with a TV offset guider, and a separate adapter allows instrument rotation.

The 3.6 m B & C is designed to fit the f 8 Cassegrain focus and is mounted on the Cassegrain adaptor. Because working in the 3.6 m Cassegrain cage is inefficient and difficult, especially at large zenith distances, an effort to control all instrumental functions from the control cabin has been made. Both the later B & Cs have therefore been designed with the following remote capabilities:

- decker
- comparison mirror
- collimator focus
- comparison lamps
- shutter

The 3.6 m observer communicates instructions through a display console in the instrument control cabin. Duplicate manual controls exist in the cage which can be used in the event of computer or link failure.

The B & C spectrographs are, in all other respects, identical and have interchangeable gratings and detectors.

GRATINGS

A large number of gratings are available giving reciprocal dispersions from 29 to 228 Å in the blue and 59 to 298 Å mm^{-1} in the red. The gratings are manufactured by Bausch and Lomb; their details are given in Table 1. Due to the angle

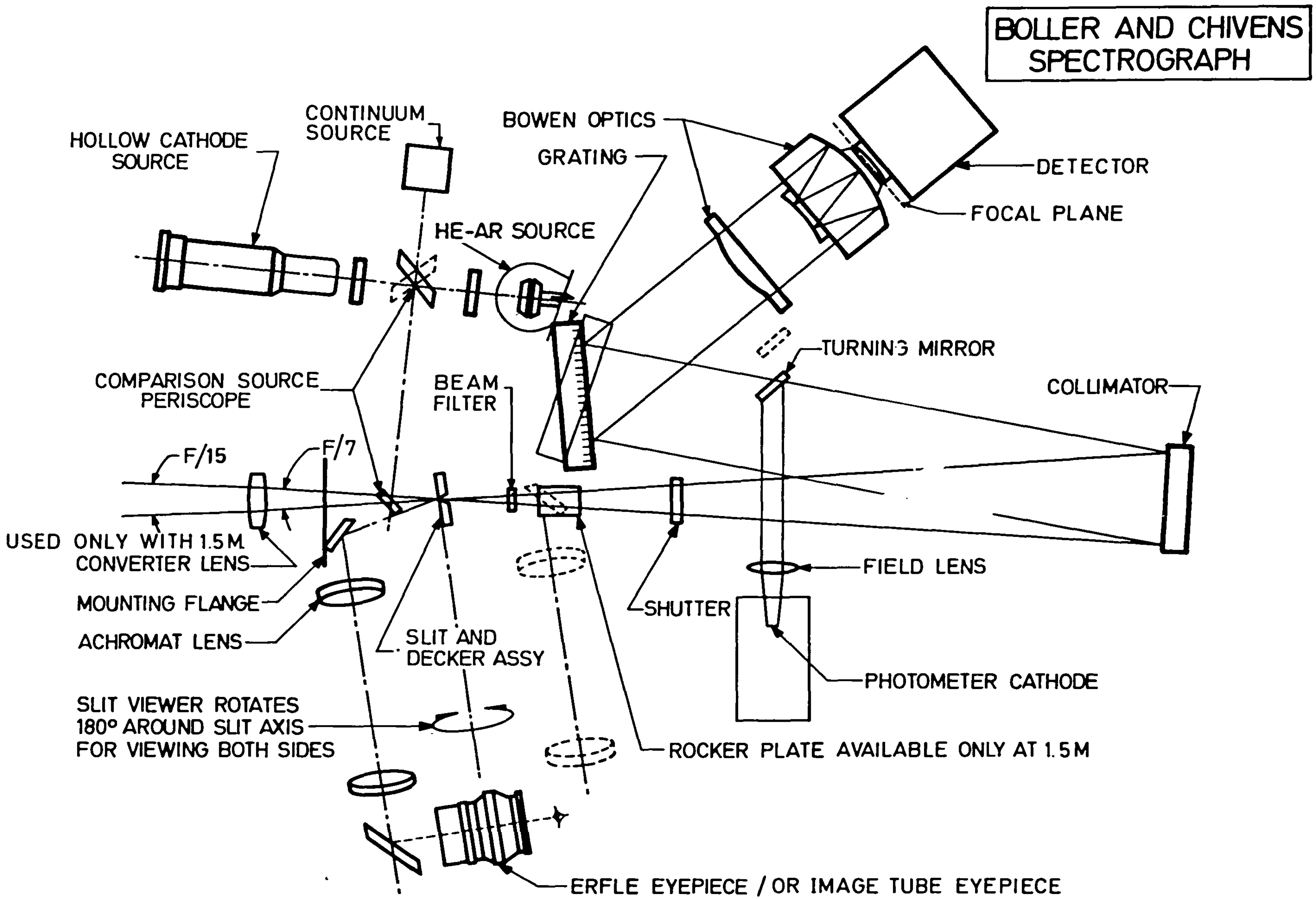
Table 1

Grating	Lines mm^{-1}	Dispersion Å mm^{-1}	Littrow Blaze Wavelength	Effective Blaze Wavelength	Blaze Angle
			1st Order		
1	225	300	8,000	7236	5° 2'
2	300	220	5,000	4522	4°18'
3	400	176	8,454	7646	9°44'
4	600	116	7,500	6782	13° 0'
5	900	78	8,000	7236	21° 1'
6	600	116	7,500	6825	13° 0'
7	600	114	5,000	4550	8°38'
8	400	171	4,000	3640	4°30'
9	300	228	10,000	9100	8°38'
10	600	118	10,000	9100	17°27'
11	1200	58.1	10,000	9100	36°52'
12	1200	59.5	7,500	6825	26°45'

All dispersions are given in the 1st order. Two filters, blue (BG 38, 2 mm) and red (GG 495, 2 mm) are used to separate spectral regions.

Apr. 80

BOLLER AND CHIVENS SPECTROGRAPH III.A.2.FIG.1.



between the collimator and the camera (50°5'), the effective blaze wavelengths are shifted to the blue by about 10%. This effect is also indicated in Table 1. The gratings are 110 x 135 mm in size and mounted in a rotatable cell. The central wavelength with position angle for gratings 1 to 12 is shown in Figs.(2) to (7). In principle, all gratings are available at both the 1.5 m and the 3.6 m. It is intended to eventually have two sets of gratings, but at present only one set exists. It is therefore *IMPORTANT to specify in your APPLICATION FOR OBSERVING TIME* (I.B.1.1, page 8) *which* gratings you require to avoid possible conflicts. In the event of a conflict, the 3.6 m observer *normally* takes priority.

The gratings are easily interchangeable; however, the spectrograph normally requires refocusing after a grating exchange. At present, grating changes with the IDS detector are not recommended during the night as this introduces instabilities. The spectral coverage with each detector used is different depending on the length of the sensitive area of the detectors:

Detector	Length mm
IDS	20
EMI	34
Reticon	26

SLIT

The slit assembly consists of two (2) 64 mm long polished and aluminized jaws on which the stellar image can be seen by reflection. They form a bi-parting slit that is continuously adjustable by a micrometer screw from 6 to 1200 μm. The scales at the 1.5 m and 3.6 m are given in Table 2.

Table 2

Telescope	Scale arcsec mm^{-1}	Scale on Plate arcsec mm^{-1}
1.5 m	19.4	87
3.6 m	7.2	38.5

The scales at the 1.5 m are due to an f 7 adaptor. Table 3 gives typical slit width W, dispersions, and image widths w at the photographic plate for the 3.6 m spectrograph. Note that effectively, the slit appears smaller to the detector depending on the grating angle. This effect "anamorphism" can be taken into account by selecting the resolution required at the detector and calculating back the slit width.

STELLAR DECKER AND WIDENING

For use with image tubes (photographic plates), six (6) stellar deckers are available with the following heights: 1.1, 2.2, 4.5, 9, 18, and 25 mm. The first five have matching comparison spectrum deckers, the sixth stellar decker is the full slit length.

NO rocking plate is available for automatic widening of stellar spectra at the 3.6 m. However, the spectra may be widened by changing the tracking rate of the telescope.

The 1.5 m spectrograph has a one-inch thick quartz rocking plate which can be inserted into the light path to automatically widen the spectrum. The plate is driven by a cam, and the widening can be varied from 280 to 2220 μm by exchanging the cams. Details of the five cams available are shown in Table 4. The cam's rocking speed is constant.

The IDS decker consist of pairs of square apertures - 1, 2, 4, 8, and 14 arcsec^2 separated by 20 arcsec, and 40 arcsec respectively. Here, one of the apertures is used to observe the object and sky, and the second to observe simultaneously the sky. In this way, the sky may be subtracted; this is particularly important when observing faint objects.

COMPARISON SOURCES

Comparison sources are provided for wavelength calibration. They are as follows:

1.5 m → He A, Xe, Ne, A, Kr, Continuum

3.6 m → He A, Fe hollow cathode (useful), Continuum

An example of the He Ar spectrum taken at the 1.5 m with 3-stage EMI tube is given in Fig.(8).

VIEWFINDERS

1.5 m - The spectrograph is mounted on a TV offset guider which has approximately 3 arcmin field of view and can be moved over the field to locate a guide

Table 3

Allowable Slit Widths

3.6 m telescope
140 mm camera
750 collimator

Projected Slit Image Width ω at the Detector

Disp. Å mm^{-1} at 4200 Å	Grating Angle	15μ	20μ	25μ	30μ
		Slit width W in microns			
27	36°	144	192	240	288
32	30°	131	175	219	261
47	20°	109	146	183	219
91	10°	94	125	156	187
	0°	80	107	134	160

$$W = 5.357 \frac{\cos(\theta - 22.5^\circ)}{\cos(\theta + 22.5^\circ)} \omega$$

Table 4

Widening with Rocking Plate

Cam	Widening on slit in mm	Widening on plate in mm	Corresponding decker number to use
1	10	2.22	#4 or #5
2	7.5	1.67	#4
3	5.0	1.11	#3 or #4
4	2.5	.56	#2
5	1.25	.28	#1

star. The object may also be viewed through the slit viewer which has a field of view of approximately 7 arcmin. In addition, the slit viewer can be equipped with an image tube for viewing faint or red objects.

3.6 m - The spectrograph is mounted on the Cassegrain adaptor which contains a set of movable mirrors and an integrating TV camera for field and slit viewing, see section II.A.1.2. The field of view is displayed on a TV console in the control cabin. There are several levels of magnification as follows:

Field	Abbreviation	Approximate field in arcmin mm^{-1}	Scale
*large field	LF	5 x 4	1' = 48 mm
small field	SF	0.8 x 0.6	1' = 5.5 mm
†guide probe	GP	1.3 x 1	1" = 3.2 mm
*slit view large	SVL	3 x 3	1' = 48 mm

† uses a non-integrating TV

Of these, only those marked by an asterisk (*) are generally used.

Each field can be requested from a keyboard command in the control cabin. The Quantex TV system is an integrating device with integration time per frame of 1/25 second. Integrations from 1 to 999 frames are possible. The Quantex has an S-20 extended red response and this should be kept in mind when using blue finding charts. Normally with 1 to 10 frames integration, $V = 14^m$ stars are easily seen; and from 90 to 190 frames, $V = 20^m$. These numbers are very approximate and depend on the seeing and presence of the moon, etc.

EXPOSURE TIMES

1.5 m - As the IDS and EMI image tubes have only now come into use on the 1.5 m, exposure times as yet are not well defined. It is estimated typically for the EMI tube that for a $V = 11^m$ star, an exposure time of 5 min is needed using 149 Å mm^{-1} and a widening of 280 μm and 2 arcsec seeing. An upper limit on the exposure time is dictated by the tube background, see section IV.C.

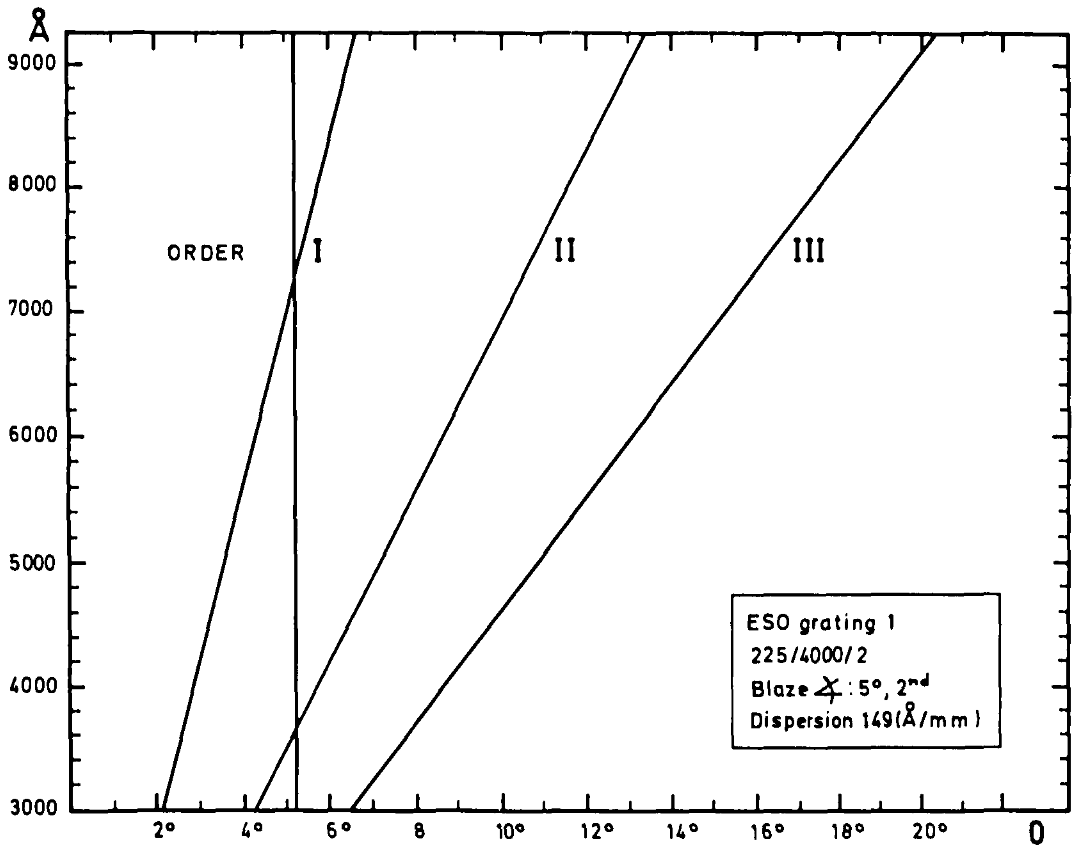
3.6 m - IDS for $V = 14^m$ star and 89 Å mm^{-1} an exposure time of 10 min is needed with 2 arcsec seeing. A peak count rate of 1 photon/Å/sec at λ 4800 is obtained for a star with $B = 15.6^m$ with a wide aperture.

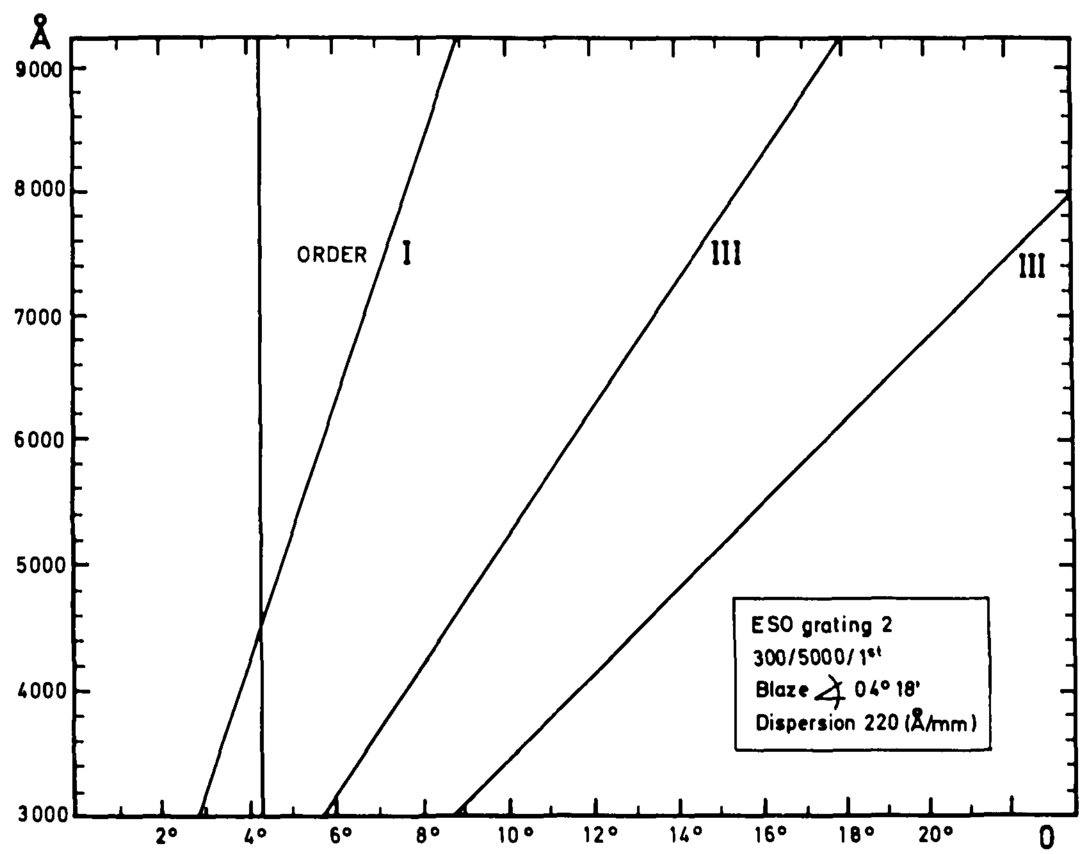
FILTERS

Two filters, a BG 38 and GG 495, each 2 mm thick, are available for selection of grating orders. The filter holder is placed after the slit, and accordingly the comparison spectra are also taken through the filter. For bright stars, a neutral density filter can be placed in the beam; however, this must be removed when exposing the comparison spectrum to have reasonable exposure times.

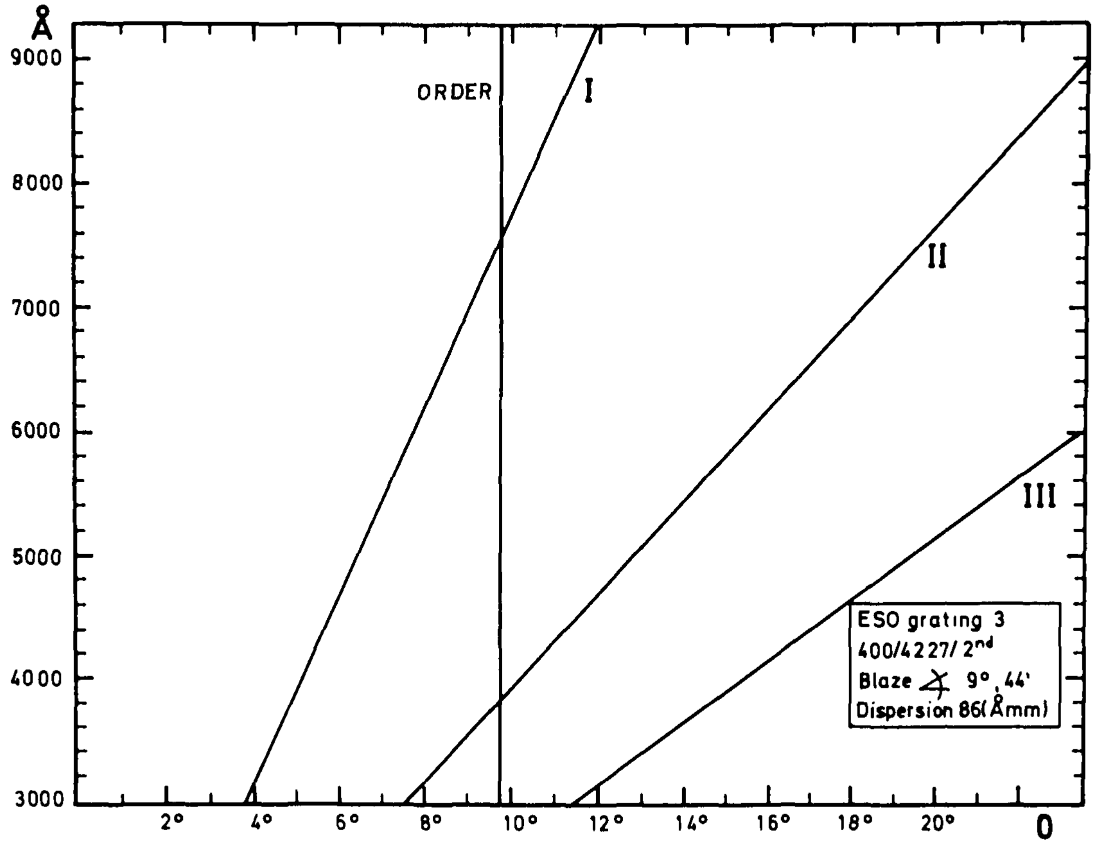
DETECTORS

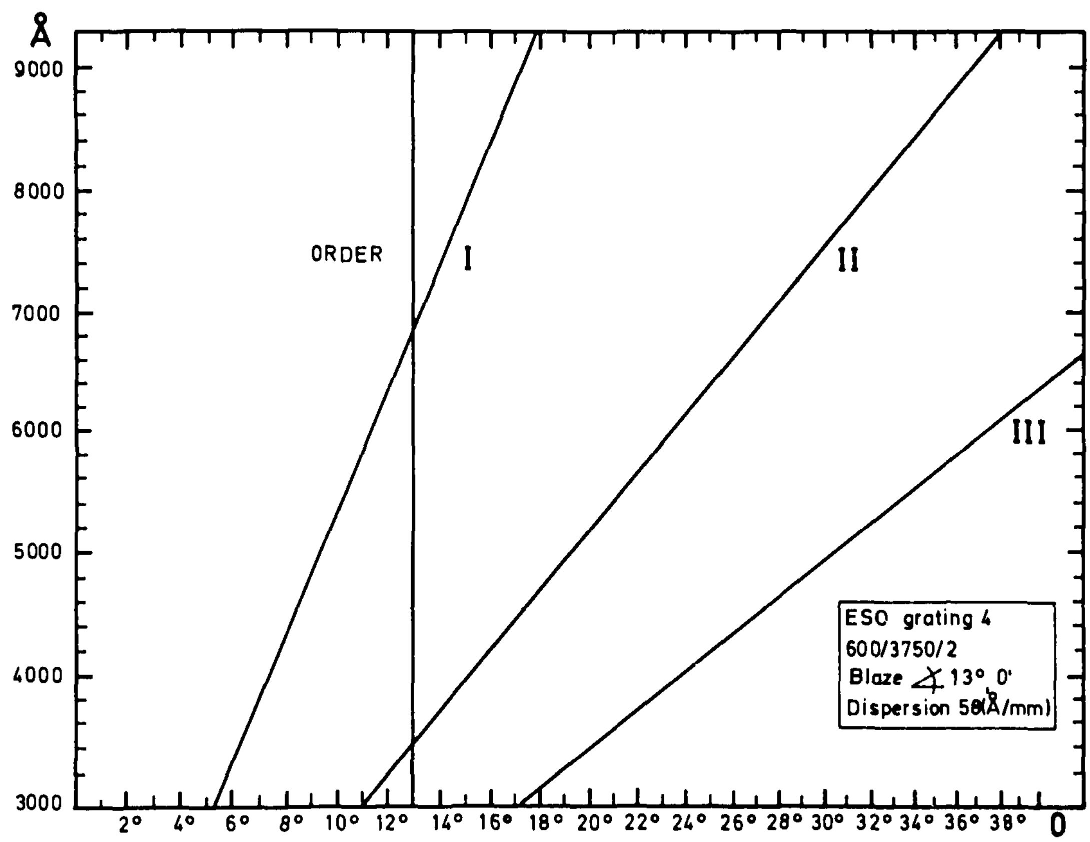
The IDS and reticon are available with the B & C at the 1.5 m and 3.6 m telescopes, see section IV.C. for detector details. An EMI image tube is available for use at the 1.5 m telescope.


Å
9000
8000
7000
6000
5000
4000
3000
ORDER
I
II
III
ESO grating 1
225/4000/2
Blaze ∡ : 5°, 2nd
Dispersion 149(Å/mm)
2°
4°
6°
8
10°
12°
14°
16°
18°
20°
0

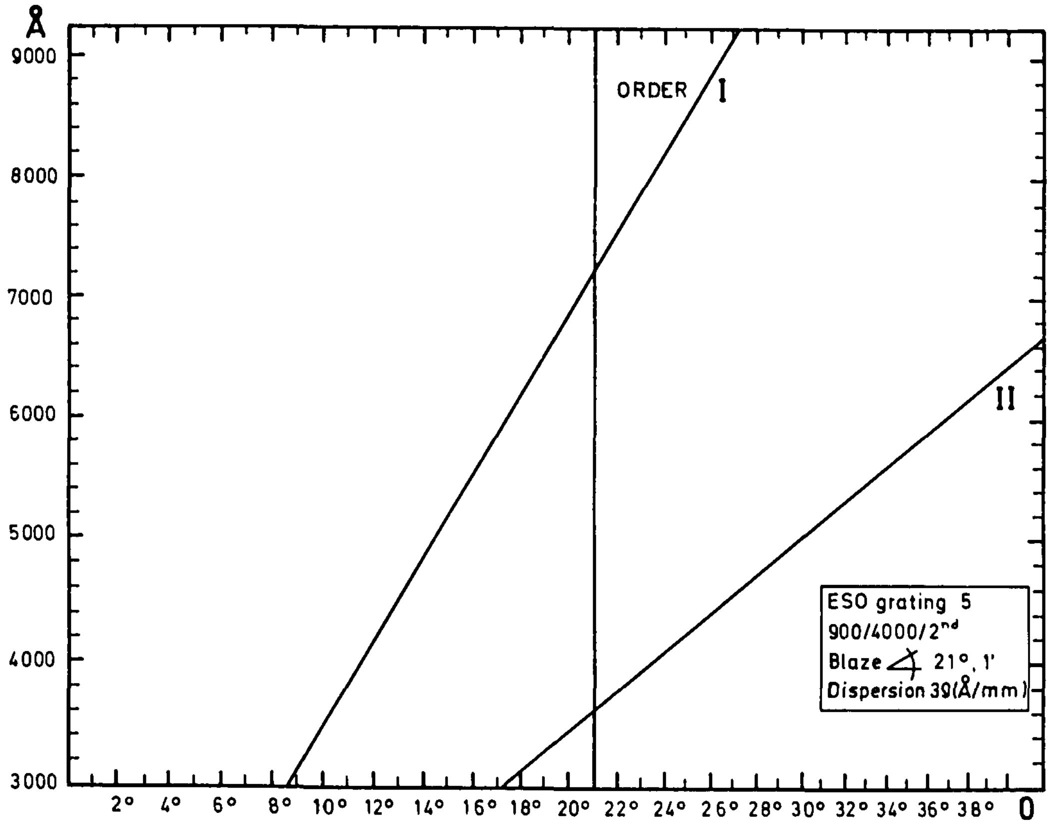

Å
9000
8000
7000
6000
5000
4000
3000
ORDER
I
III
III
ESO grating 2
300/5000/1st
Blaze ∡ 04° 18'
Dispersion 220 (Å/mm)
2°
4°
6°
8°
10°
12°
14°
16°
18°
20°
0

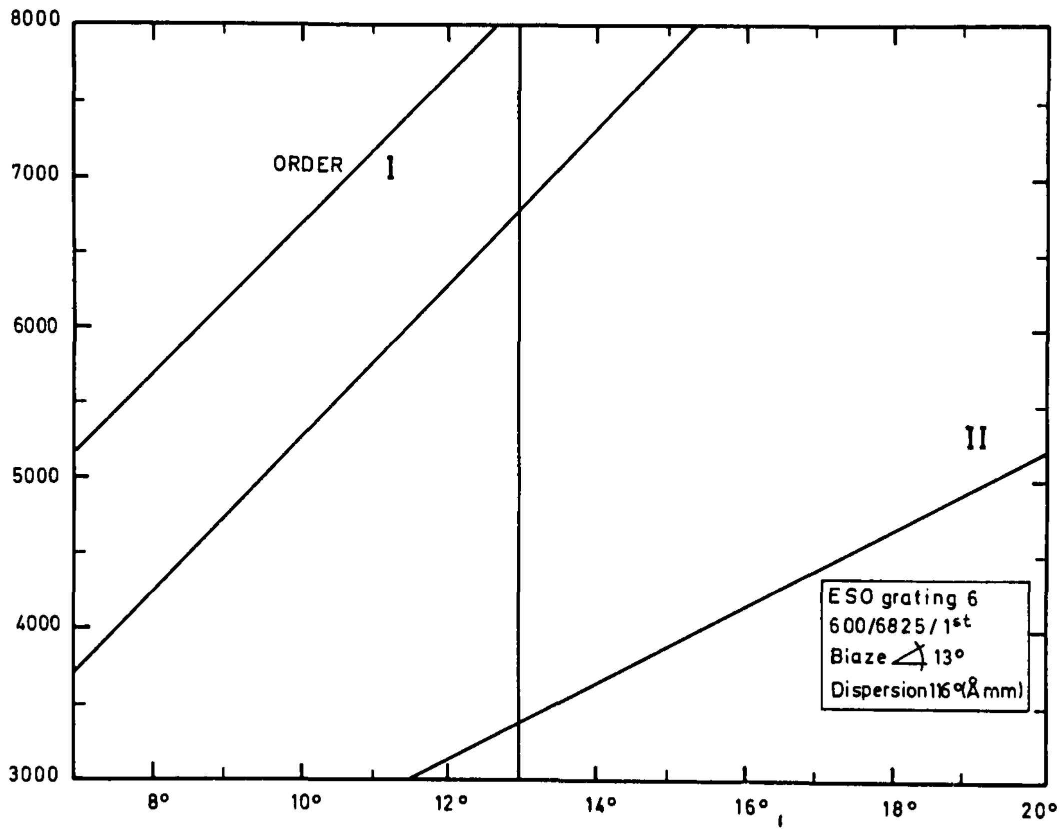
III.A.2.FIG.2.


Å
9000
8000
7000
6000
5000
4000
3000
ORDER
I
II
III
ESO grating 3
400/4227/ 2nd
Blaze ∡ 9°, 44'
Dispersion 86(Å/mm)
2°
4°
6°
8°
10°
12°
14°
16°
18°
20°
0

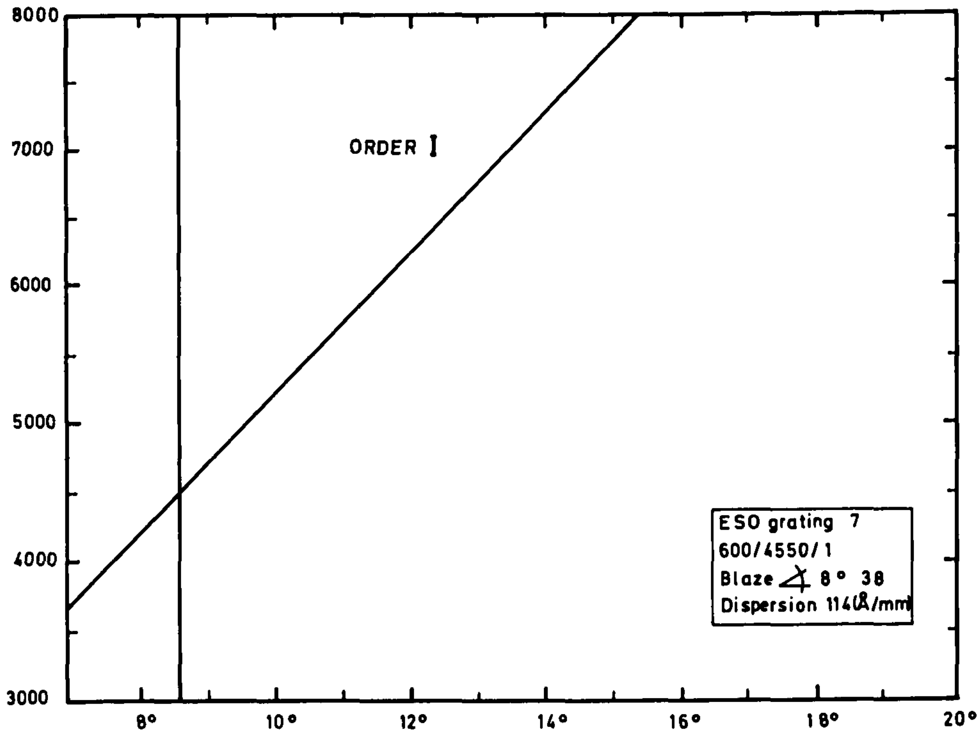

Å
9000
8000
7000
6000
5000
4000
3000
ORDER
I
II
III
ESO grating 4
600/3750/2
Blaze ∡ 13° 0'
Dispersion 58(Å/mm)
2° 4° 6° 8° 10° 12° 14° 16° 18° 20° 22° 24° 26° 28° 30° 32° 34° 36° 38°
0

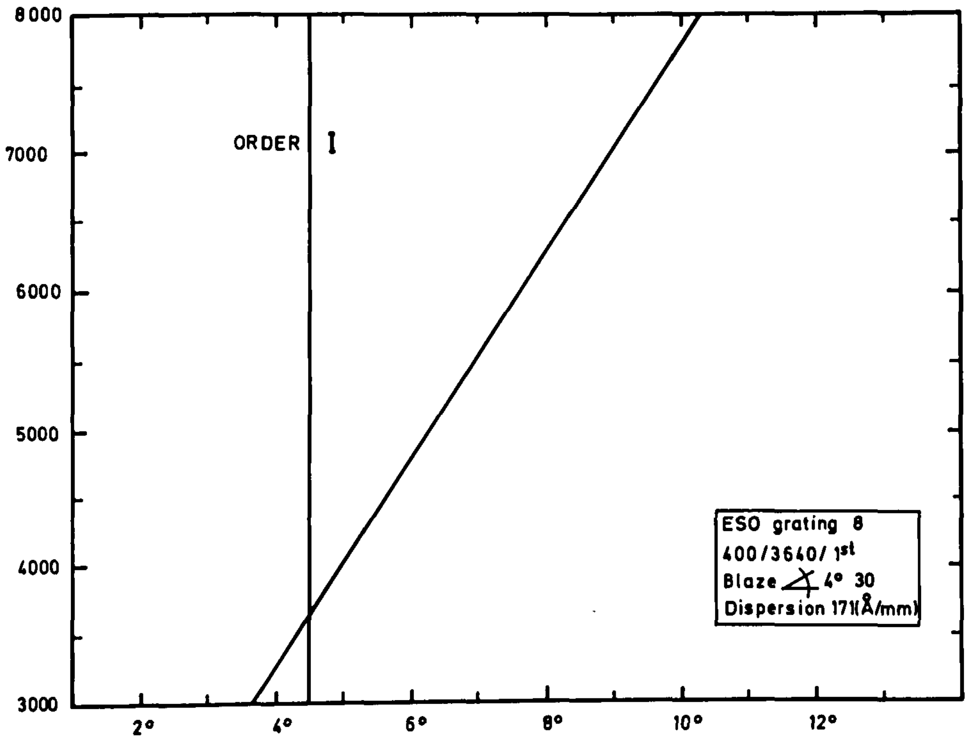
III. A.2. FIG.3


Å
9000
8000
7000
6000
5000
4000
3000
ORDER I
II
ESO grating 5
900/4000/2nd
Blaze ∢ 21°, 1'
Dispersion 39(Å/mm)
2° 4° 6° 8° 10° 12° 14° 16° 18° 20° 22° 24° 26° 28° 30° 32° 34° 36° 38° 0

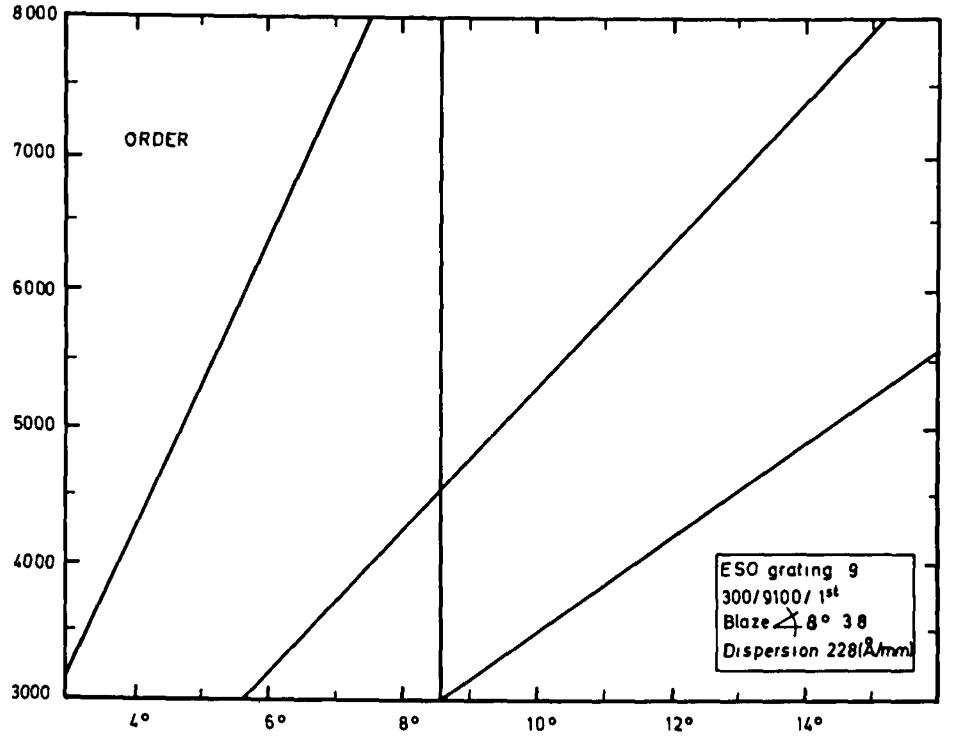

8000
7000
6000
5000
4000
3000
ORDER I
II
ESO grating 6
600/6825/1st
Blaze ∢ 13°
Dispersion 116(Å/mm)
8° 10° 12° 14° 16° 18° 20°

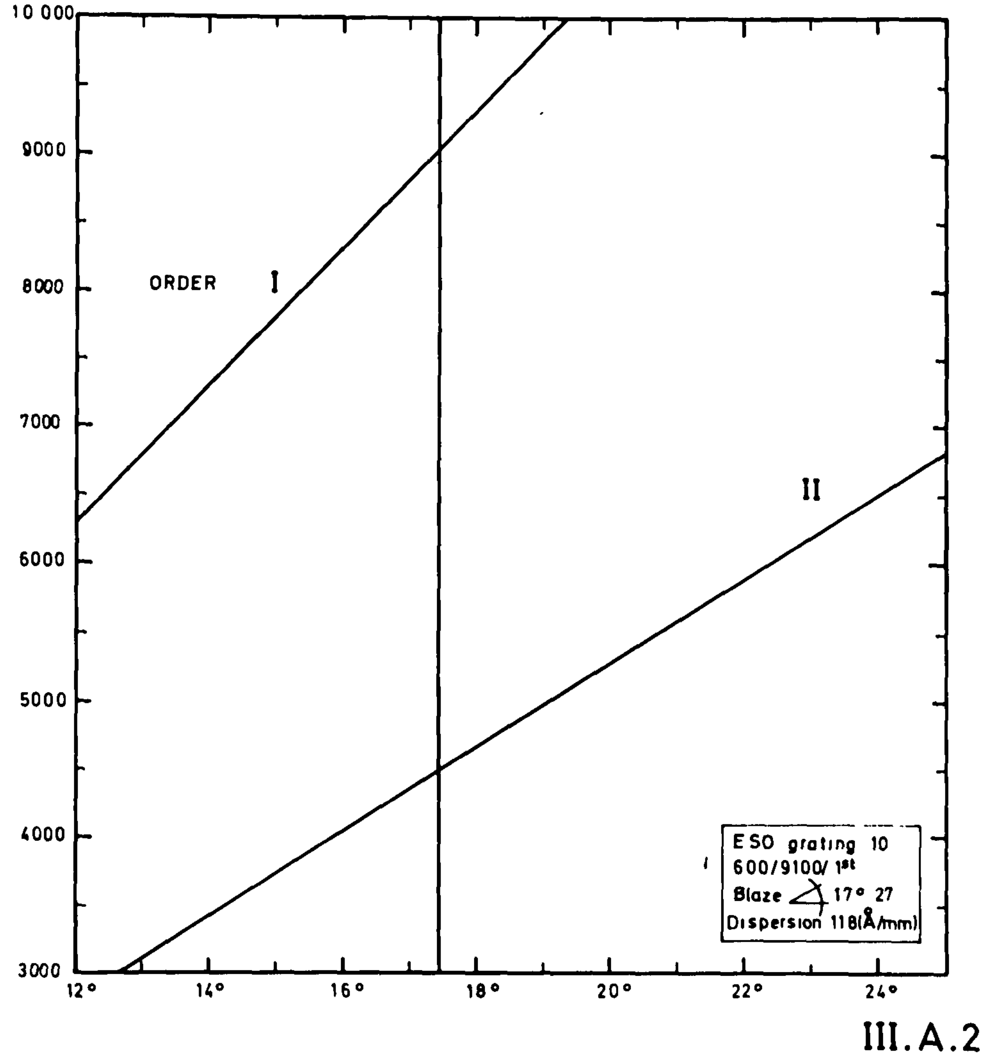
III.A.2.FIG.4.


8000
7000
6000
5000
4000
3000
8°
10°
12°
14°
16°
18°
20°
ORDER I
ESO grating 7
600/4550/1
Blaze ∢ 8° 38
Dispersion 114(Å/mm)


8000
7000
6000
5000
4000
3000
2°
4°
6°
8°
10°
12°
ORDER I
ESO grating 8
400/3640/ 1st
Blaze ∢ 4° 30
Dispersion 171(Å/mm)

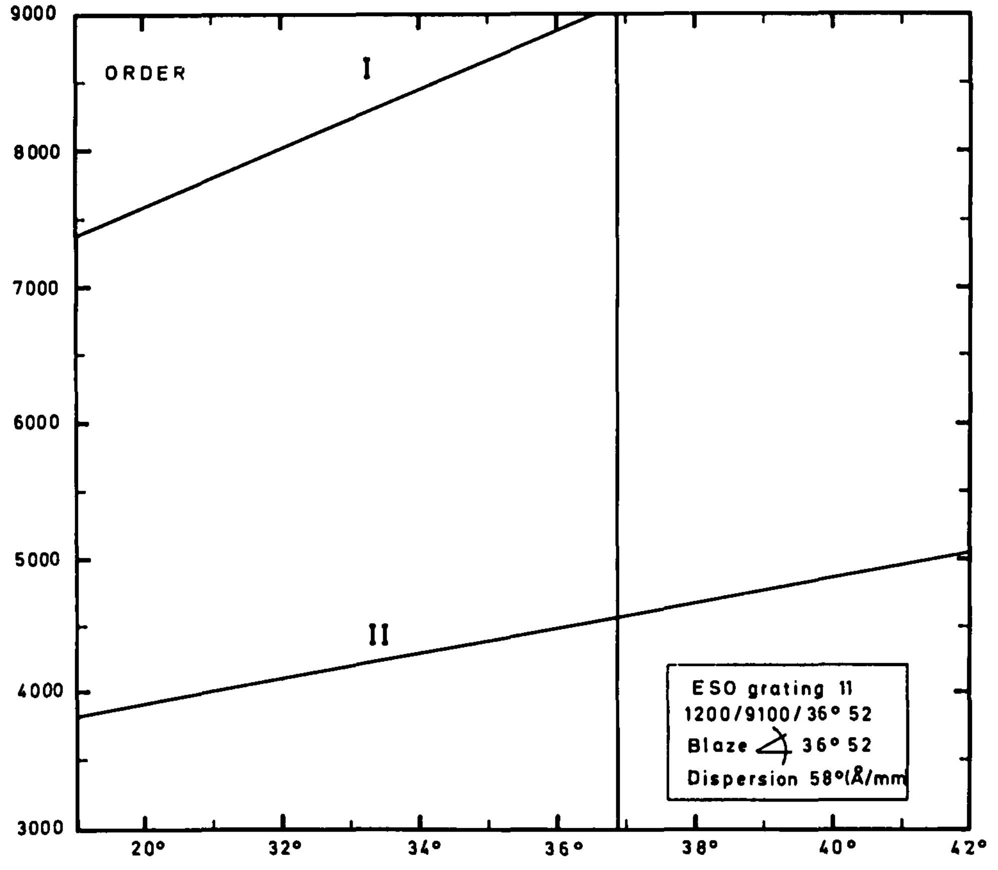
III.A.2.FIG.5.

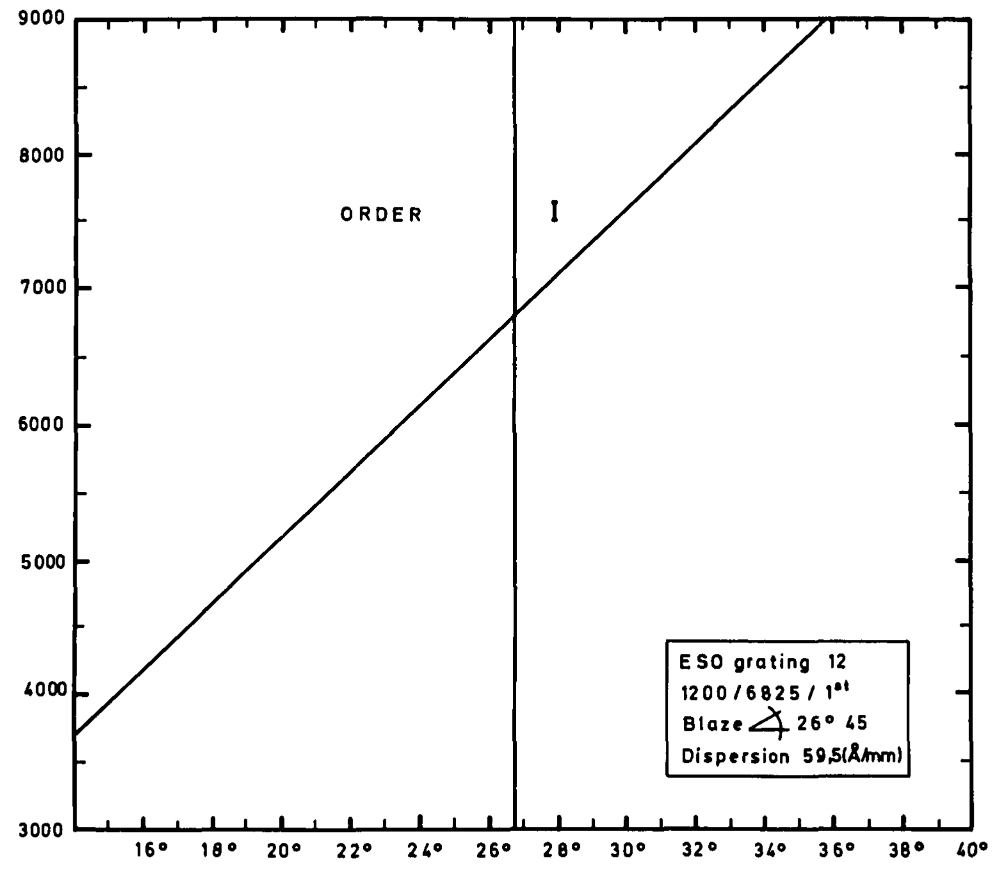




III.A.2.FIG.6.

Apr.80


ORDER
I
II
ESO grating 11
1200/9100/36° 52
Blaze ∢ 36° 52
Dispersion 58°(Å/mm
9000
8000
7000
6000
5000
4000
3000
20°
32°
34°
36°
38°
40°
42°


ORDER
I
ESO grating 12
1200/6825/1st
Blaze ∢ 26° 45
Dispersion 59,5(Å/mm)
9000
8000
7000
6000
5000
4000
3000
16°
18°
20°
22°
24°
26°
28°
30°
32°
34°
36°
38°
40°

III.A.2.FIG.7.

III.A.3-THE RADIAL VELOCITY CASSEGRAIN SPECTROGRAPH

INTRODUCTION

The RV Cass spectrograph is used at the f/15 focus of the 1.52 m telescope. It is a compact structure designed to keep flexures to a minimum; consequently, it is particularly suited for reliable radial velocity work.

The optical layout is shown schematically in Fig 1. It employs a Littrow mounted grating. The focal plane is curved and the spectra are obtained on film. The optics are coated for maximum efficiency at 4250 Å, and the spectrograph can be used in the wavelength range 3400 Å to 5500 Å. The reciprocal dispersion is 74 Å/mm.

GRATING

The grating employed was manufactured by Bausch & Lomb (number 3553-08-35) and has 600 lines/mm. It is blazed at 7500 Å in the first order with a blaze angle of 13°. Normally, it is used in the second order and gives a mean reciprocal dispersion of 74 Å/mm.

SLIT

The field lens L_1 (Fig 1) is aluminized on the surface in such a way as to leave a slit across the diameter. The outer areas are used for slit viewing and guiding. The slit/lens is mounted in a cell which is easily interchangeable. The following slit widths are available: 50, 115, 130, 137, 242, and 300 μm.

The most useful slit has proven to be the 137 μm, which subtends 1.2 arcsec on the sky. With a slit-film scale factor of 7.5, this corresponds to 17 μ on the film. The resolution in this mode is approximately 1.3 Å.

A graph of slit size and angle subtended on the sky is given in Fig 2.

DECKERS AND WIDENING

The spectrum height is defined by a decker. There are five deckers available giving heights on the plate as shown in Table 1.

Widening is performed by a rocking plate which is located in front of the slit. Two plates, a thin and a thick one, are available giving widenings of 180 to 400 μm and 350 to 1200 μm respectively. The time to complete a rocking cycle (back and forth) is 15 seconds, irrespective of the amplitude. For the smaller decker 60 and 107 μm, widening is done by using the fine motion controls of the telescope.

Table 1

Height on Film in mm for Each Decker Position

Decker	Position 1	2	3	4	5	6	7	8	9	10
1	0.2	0.3	0.4	0.5	0.6	0.75	1.0	1.5	2.0	3.0
2	0.18	0.2	0.25	0.3	0.4	0.5	0.6	0.7	0.75	
3	S P E C I A L									
4	0.2	0.3	0.5	0.75	1.0	1.5	2.0			
5	0.06	0.107	0.25							

COMPARISON SOURCES

The following comparison sources can be used:

a) Iron arc

b) Palladium arc

c) Argon lamp

d) Mercury lamp

e) Neon lamp

Each source is contained in an easily interchangeable unit. To obtain an evenly exposed iron spectrum, in Ilford 102 Aviol filter is used to reduce the ultraviolet light.

VIEWFINDERS

The spectrograph is equipped with two viewfinders; a wide field (7 arcmin) finder, and a small field (3 arcmin) for guiding.

EXPOSURE TIMES

An idea of the exposure time with good quality seeing (1 to 1.5 arcsec) is given in Figs. 2 and 3. However, typical values are as follows:

B mag	Widening in m	Exposure time in hours
10	400	1
12	250	3

FILTERS

Two neutral density filters can be used behind the slit for observation of bright stars. Other filters may be used and can be made from gelatine or glass providing they are 65 mm in diameter and no thicker than 0.5 mm. These can be mounted in the slit cell, but the calibration spectrum will be taken through the filter.

A filter can also be mounted in front of the slit: however, in this position, it should be kept in mind that the stellar light passes through the filter twice before reaching the guiding eyepiece.

FILM

Normally, IIaO is used covering the spectral range of the spectrograph which is 3700 Å to 5000 Å.

The film size is 2.0 x 2.6 cm and by moving the plate holder a total of five exposures with comparison spectra can be made on the same plate.

PHOTOMETRIC CALIBRATION

This can be done through the spectrograph using a light source and a rotating disc which creates thirteen intensity zones on the slit. Exposure times of several minutes to 40 minutes can be obtained with this system. Table 2 gives the corresponding values of I_i / I_0 for this system.

Alternately, calibration can be made using the ETA spectrograph, see section IV.A.4.

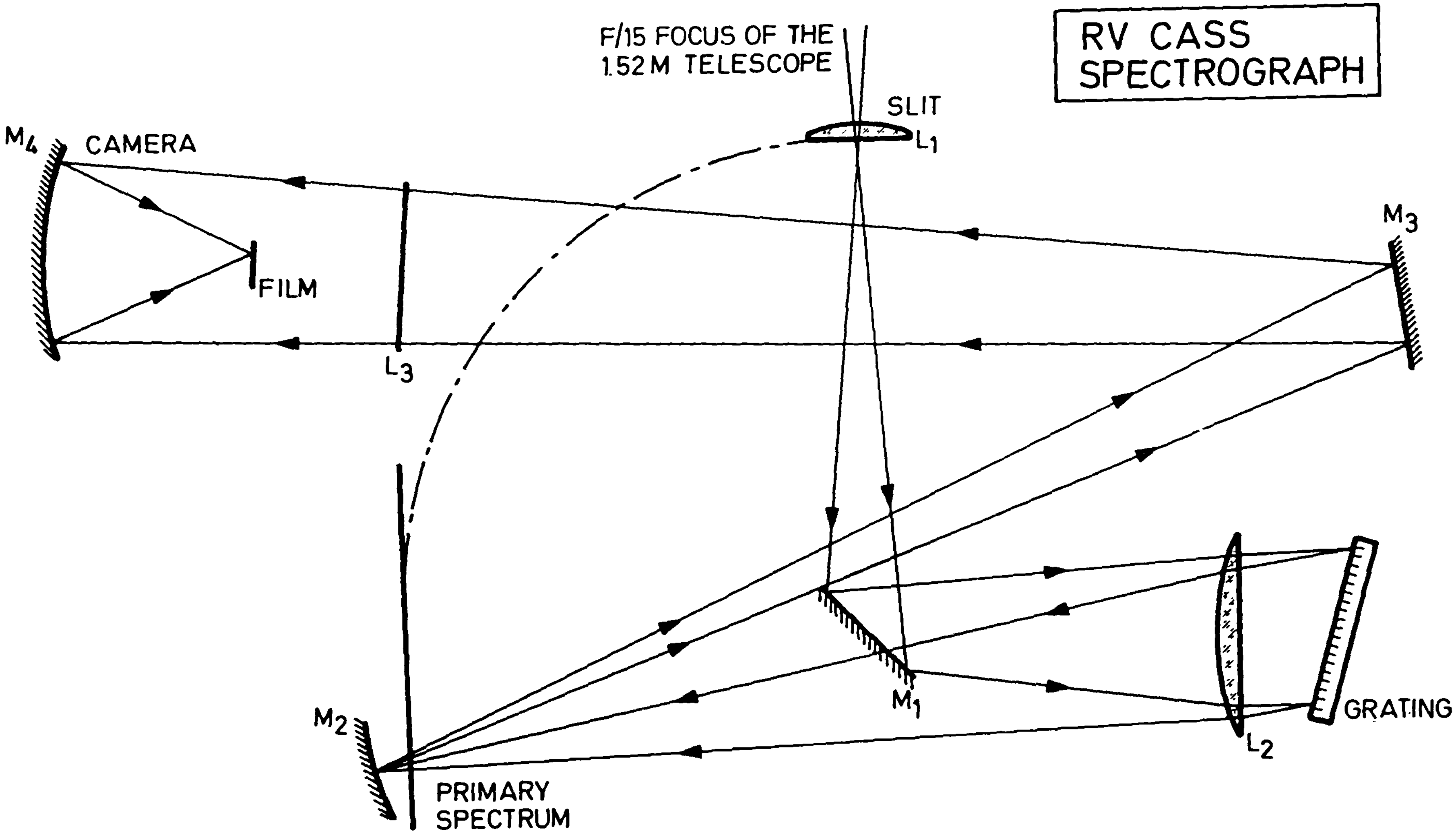
Table 2

Values Corresponding to the Zones of the Photometric Calibration System of the RV Cass

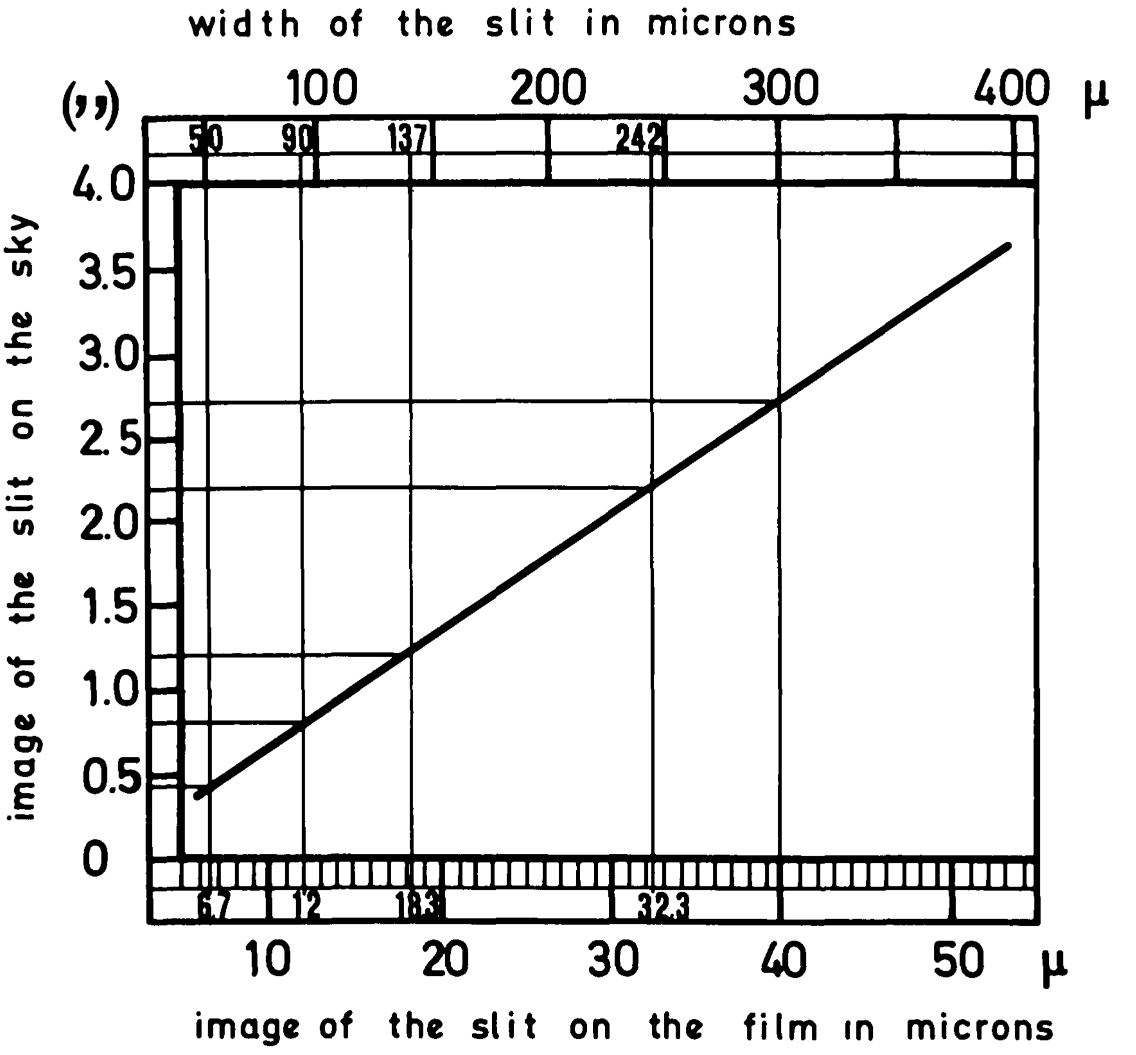
N°	$\log \frac{Ii}{Io}$ †	$\log \frac{Ii+1}{Ii}$
1	0	
2	0.124	0.124*
3	0.284	0.160
4	0.423	0.139
5	0.570	0.147
6	0.704	0.134
7	0.848	0.144
8	0.974	0.126
9	1.092	0.118
10	1.201	0.109
11	1.317	0.116
12	1.423	0.106
13	1.522	0.099

* This value was not deduced from measurements at the Spectro-Chalonge. It is the value obtained from geometric measurements.

† The values of $\log I_i / I_o$ were deduced by calibration of the system using the Chalonge UV spectrograph. The accuracy of the values is estimated at ± 0.005. A slight dependence of $\log ((I_i+1)/I_i)$ on λ has been observed. Here, mean values are given for 3800 < λ < 4700 Å.

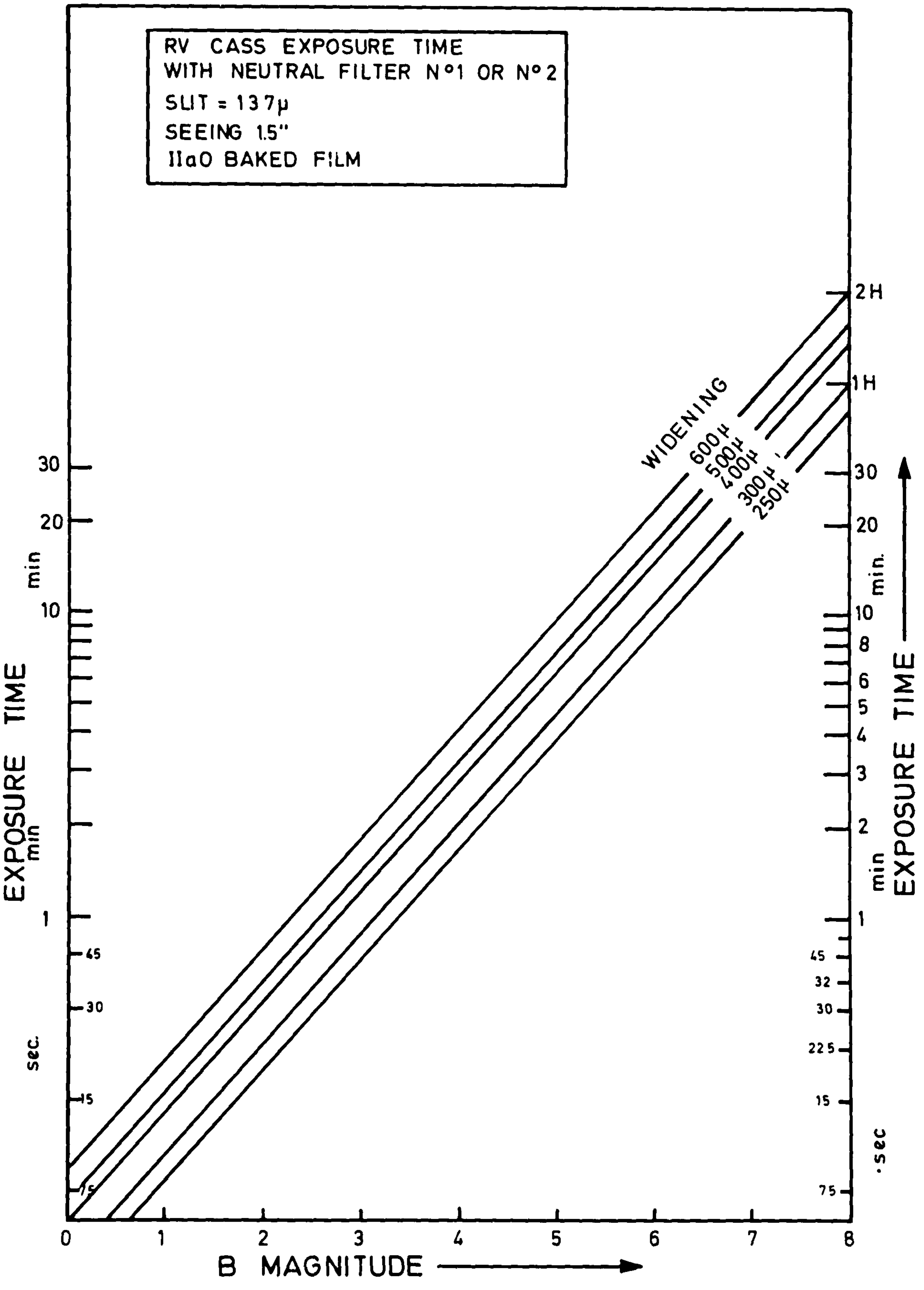


RV CASS SPECTROGRAPH III.A.3.FIG.1.



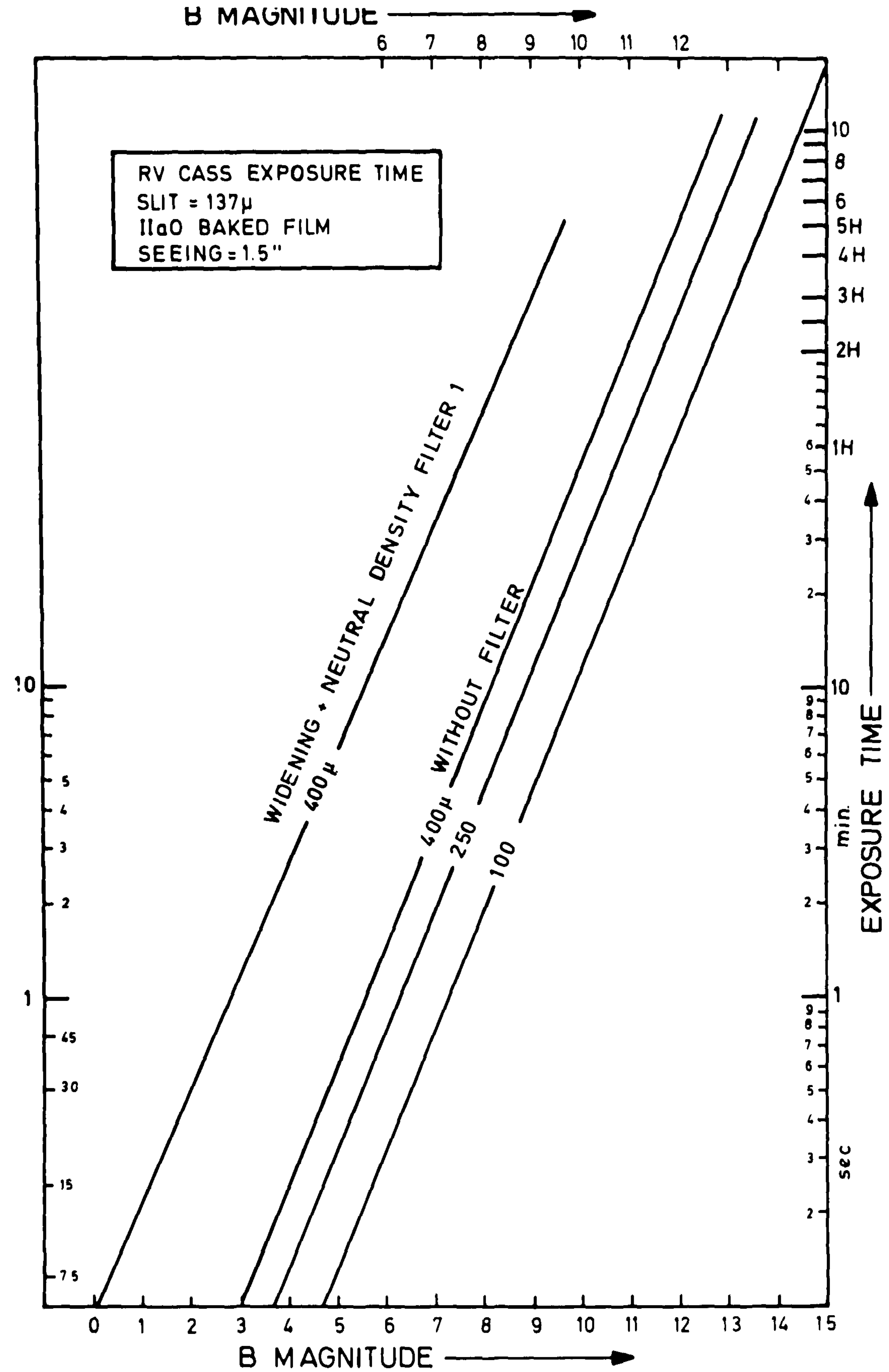
width of the slit in microns
100
200
300
400 μ
(,,)
50
90
137
242
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0
image of the slit on the sky
6.7
12
18.3
32.3
10
20
30
40
50 μ
image of the slit on the film in microns

III.A.3.FIG.2.



RV CASS EXPOSURE TIME
WITH NEUTRAL FILTER N°1 OR N°2
SLIT = 137μ
SEEING 1.5"
IIaO BAKED FILM
WIDENING
600μ
500μ
400μ
300μ
250μ
EXPOSURE TIME
min
sec.
2H
1H
B MAGNITUDE

III . A . 3 . FIG . 3 .


B MAGNITUDE
RV CASS EXPOSURE TIME
SLIT = 137μ
IIaO BAKED FILM
SEEING = 1.5"
WIDENING + NEUTRAL DENSITY FILTER 1
400μ
WITHOUT FILTER
400μ
250
100
EXPOSURE TIME
min.
sec
1H
2H
3H
4H
5H
B MAGNITUDE

III.A.3.FIG.4.

III.A.4-THE ECHELEC

INTRODUCTION

The Echelec spectrograph was designed by A. Baranne, and is mounted in an east-west direction at the f/30 coudé focus of the 1.52 m telescope. The Echelec is interchangeable with the classical coudé spectrograph, (see III.A.1). A schematic diagram of the optical layout of the spectrograph is shown in Fig.(1). A Littrow mounted grating configuration is used, and at present time the detectors are a Lallemand-Duchesne electronographic camera and a Spectracon, see section IV.C.3.

There are three gratings available giving reciprocal dispersions on the plate of 124, 62, and 8 Å/mm. The two former dispersions are obtained with normal gratings used in the first order, and the latter with a combination of an Echelle grating and Carpenter prism. The Carpenter prism consists of a prism with a grating ruled on the backside, and it serves as a cross disperser for the Echelle. The system can be used from 3700 Å to 5500 Å.

GRATINGS

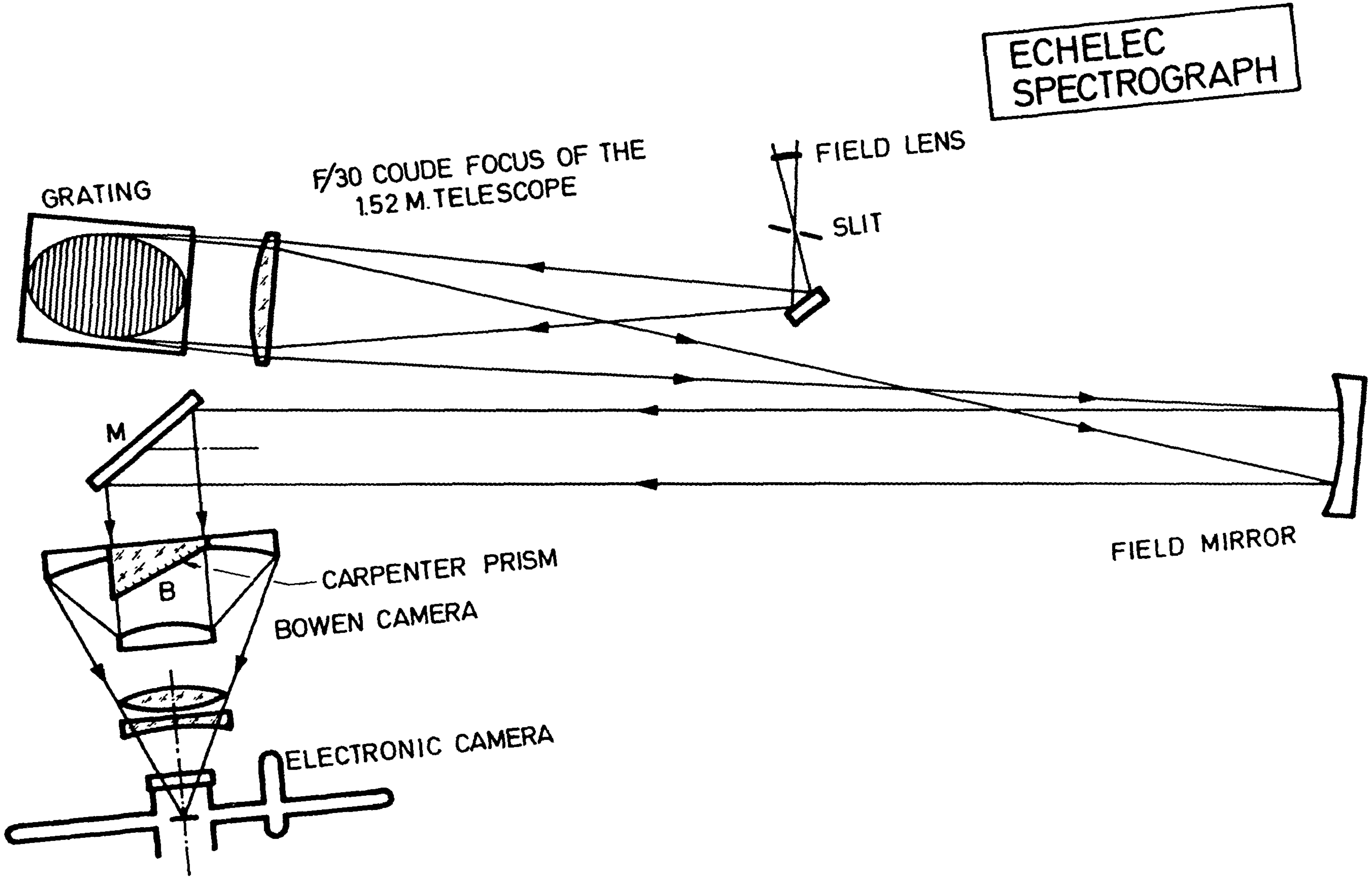
Table 1

Grating	Lines mm^{-1}	Dispersion Å mm^{-1}	Blaze Wavelength 1st order (A)	Blaze Angle	Spectral Range Δλ in Å
1	600	124	5000	8°38'	1800
2	1200	62	5000	17°27'	900
3	Echelle 79	8		63°26'	500
	+ Prism 632		Prism angle 31°45'		

The above dispersions are the dispersions on the plate when the Echelec is used with the Lallemand camera. The camera gives a magnification of approximately 0.6. The magnification factor for the Spectracon is 1.0 and therefore, the dispersions are correspondingly higher when the Spectracon is used.

Gratings 1 and 2 were manufactured by Jobin-Yvon, and are used without the Carpenter prism. Selection of the central wavelength on the plate is made by rotating the grating.

Relations between grating angle central wavelength and spectral range are



ECHELEC SPECTROGRAPH. III.A.4.FIG.1.

given in Figs. (2) and (3).

In the Echelle mode, the Carpenter prism is inserted and acts as cross disperser (or order sorter). In this configuration, the order and central wavelength is selected by rotating mirror M, as shown in Fig (1). The central wavelength in this mode refers to the wavelength center of the central order. A graph of central wavelength against mirror position is given in Fig (4). To give an idea of the Echelle format, the iron spectrum is shown for one mirror setting in Fig (5).

SLIT

The slit width is variable, and a typical slit width of 350 μm gives a resolution of 15 μm on the plate and subtends 1.5 arcsec on the sky. The slit·width/plate scale factor is 23. This factor can be used to calculate other slit/plate combinations.

DECKERS AND WIDENING

A large number of deckers are available and selection of a suitable decker for a program can be made with the help of technical staff.

Spectral widening is achieved by using a rocking entrance window. The spectrum can be widened up to a maximum of 800 μm. In the Echelle mode, 200 μm is normally used to avoid overlapping orders. However, if necessary, the spectrum may be widened to 400 μm by putting the comparison spectrum on one side only.

COMPARISON SOURCES

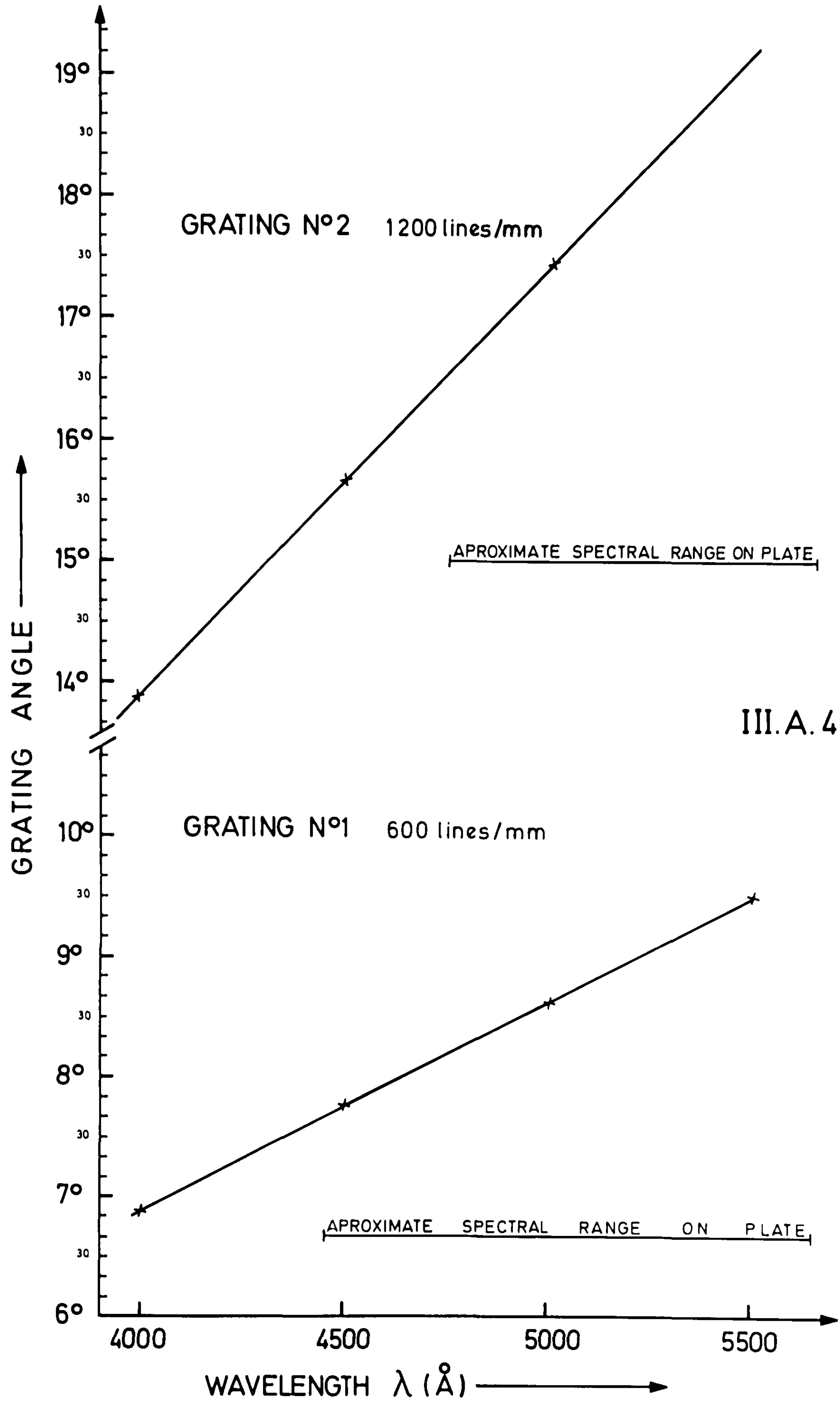
An iron arc is used for wavelength calibration. This is used in conjuction with neutral density filters. Typical exposure times are: 2x5 sec for the 124 Å/mm grating with neutral density filter 3; and for the Echelle, 2x5 sec with neutral density filter 2. The calibration spectrum is shown in Fig (6) at 124 Å/mm.

VIEWFINDERS

Two viewfinders are available with fields of 7 and 3 arcmin. For faint objects a 3 stage image tube attachment can be used. This has a field of approximately 2 arcmin.

EXPOSURE TIMES

It is difficult to give exact exposure times, but the following are representative when using the Lallmand-Duchesne camera.



III.A.4.FIG.2.

GRAPHS OF GRATING ANGLE vs CENTRAL WAVELENGTH ON THE PLATE

III.A.4.FIG.3.

B Magnitude	Grating	Widening in μm	Exposure Time in minutes
13	600	300	35
13	1200	300	70
10	Echelle	200	100

FILTERS

A selection of neutral density filters are available for spectroscopy of bright stars.

FIELD ROTATION

A field rotator can be used, but exposure times must be increased by approximately 40%.

ADDITIONAL NOTES

Although it is relatively easy to change over from the Echellec to the classical coudé, this is not possible within the same night.

Because of the large preparation time necessary to use the Lallemand camera, the observer is restricted to one camera per two nights. This limits the observer, in general, to a total of 20 exposures per two nights.

DETECTORS

The Lallemand-Duchesne Camera

A schematic diagram of the electronographic camera is shown in Fig (7). It consists of a photocathode (30 mm diameter), electrostatic focusing, accelerating optics, and a film cassette.

Preparation of the camera is complicated; but briefly described is as follows The camera is loaded with a fresh photocathode contained in a glass ampule and a film cassette containing 20 exposures. The camera is then sealed and pumped down to a high vacuum (10^{-9} torr). The film is cooled with liquid air to reduce outgassing and subsequent contamination of the photocathode. The photocathode ampule is then broken remotely and moved into its working position. Next, the sensitivity of the photocathode is measured, and the camera installed in the

Echellec and focused. It is now ready for use by the Visiting Astronomer.

The preparation takes 20 hours and is carried out completely by qualified ESO staff. Two cameras are used alternately allowing a new camera to be used every second night. This limits the total number of plates to 20 per 2 nights.

SPECTRAL RESPONSE

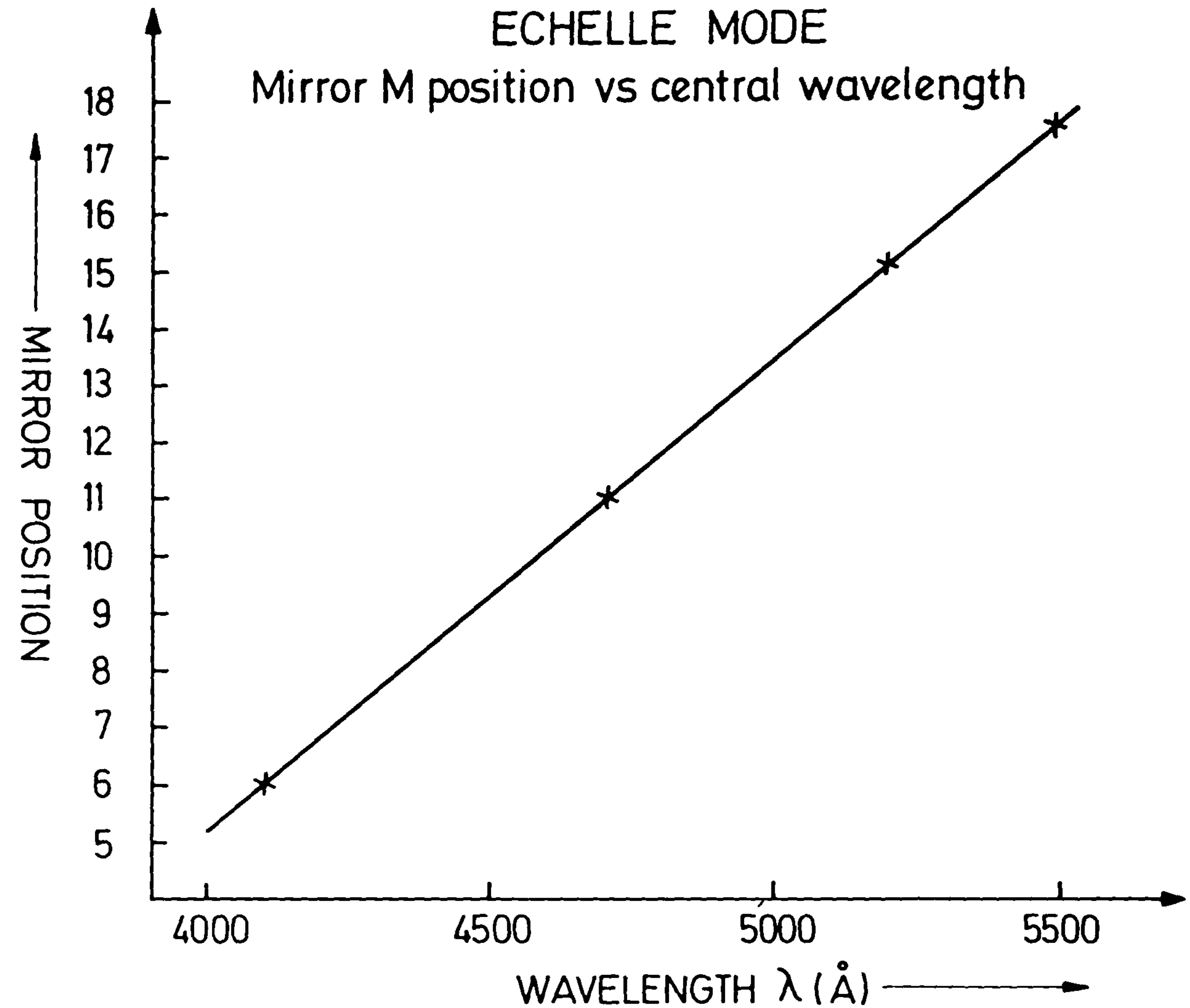
The camera has an S11 photocathode (Cs_3Sb) with spectral sensitivity shown in Fig.(8). The useful range of the camera and Echellec combined in 3700 Å to 5500 Å. But due to optical coatings in the Echellec, the sensitivity falls rapidly below 3900 Å.

FILM

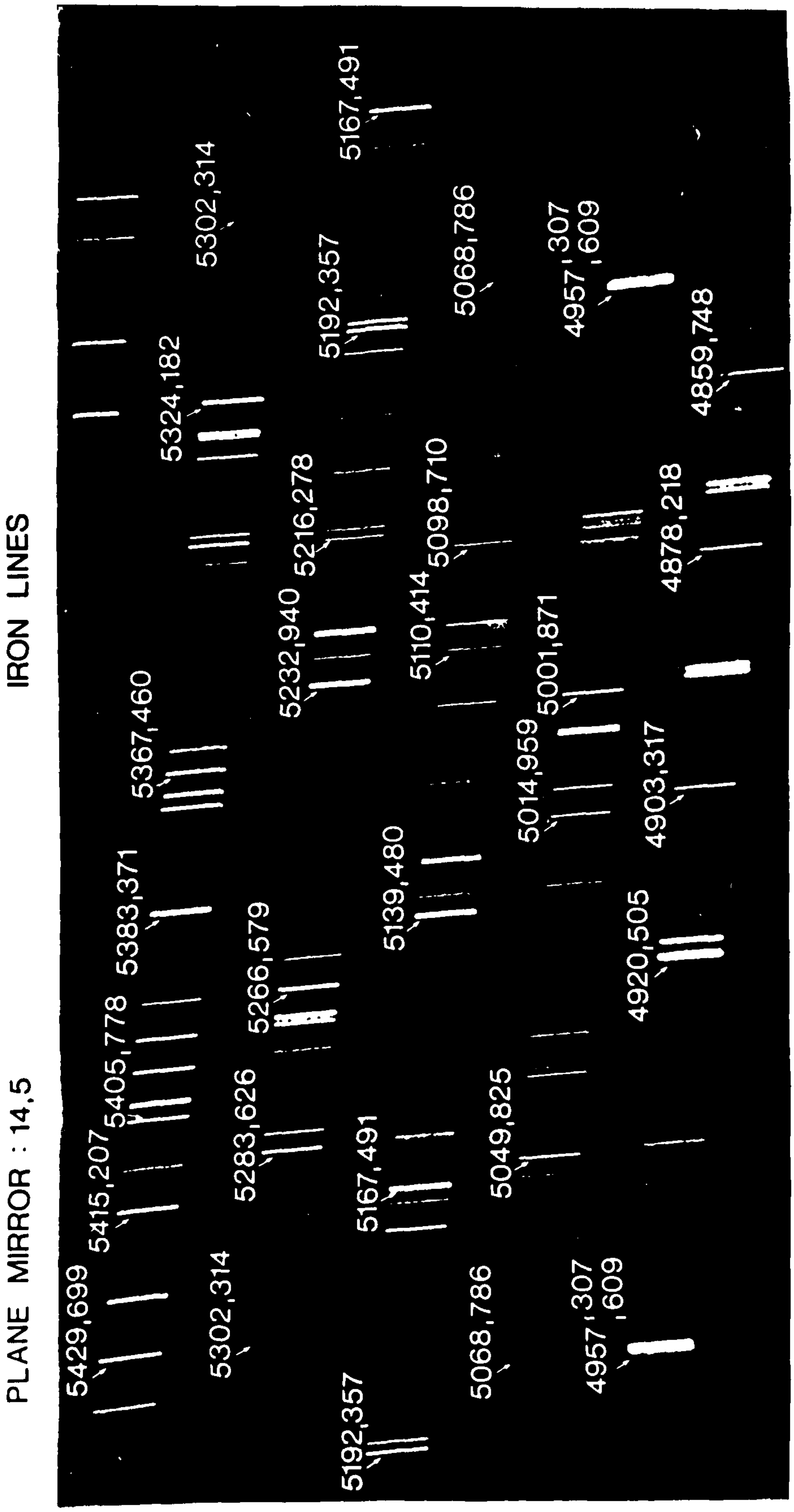
Kodak Industrex type A nuclear emulsion is used. It has an almost linear characteristic curve, (density versus exposure). The following is a stable calibration which can be used for densities up to 2.3.

Intensity	I	0.0	0.05	0.1	0.15	0.2	0.35	0.45	0.6	0.8	1.0
Density	D	0	0.259	0.458	0.629	0.844	1.332	1.632	1.978	2.184	2.315

The film size for each exposure is approximately 28 x 9 mm. After development each film is mounted in a 35 mm glass slide for easy handling and transportation.


ECHELLE MODE
Mirror M position vs central wavelength
MIRROR POSITION
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4000
4500
5000
5500
WAVELENGTH λ (Å)

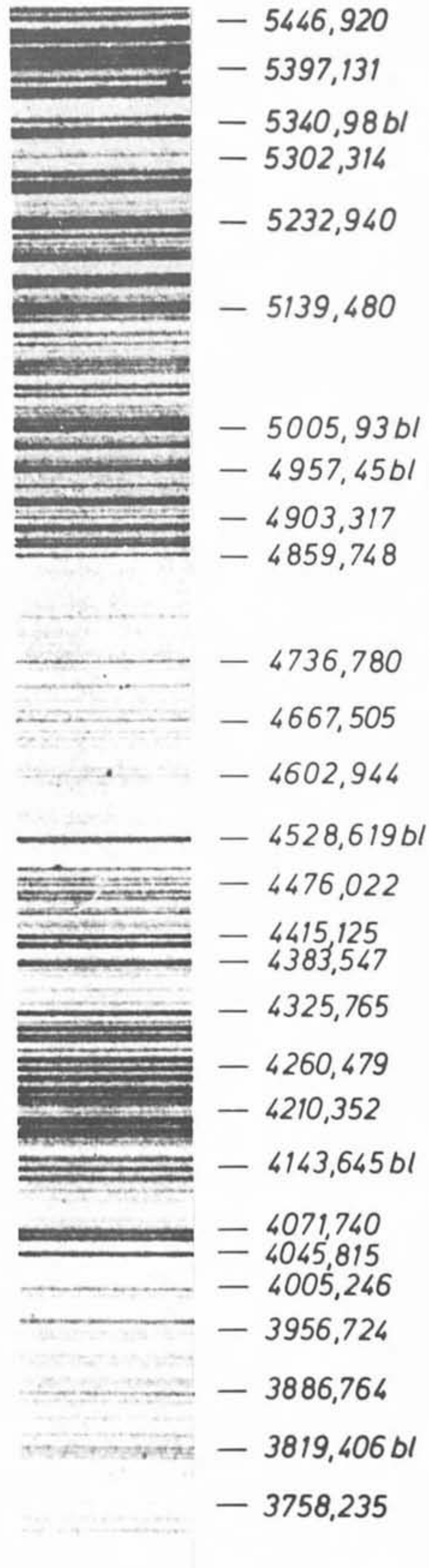
III.A.4.FIG.4.


PLANE MIRROR : 14,5
IRON LINES
5429,699
5415,207
5405,778
5383,371
5367,460
5302,314
5324,182
5302,314
5283,626
5266,579
5232,940
5216,278
5192,357
5167,491
5192,357
5167,491
5139,480
5110,414
5098,710
5068,786
5068,786
5049,825
5014,959
5001,871
4957 ,307 ,609
4957 ,307 ,609
4920,505
4903,317
4878,218
4859,748

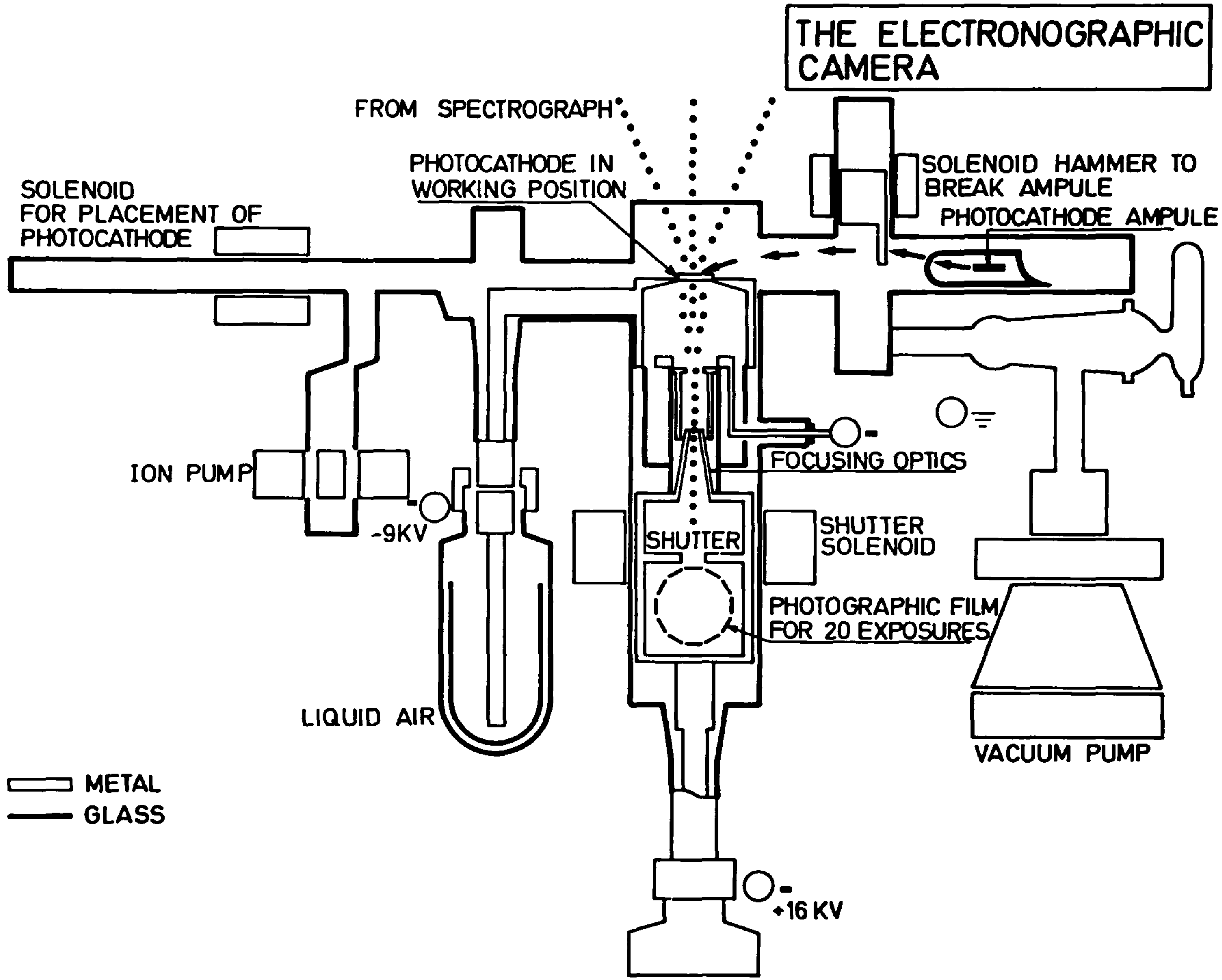
III . A . 4 . FIG . 5 .

IRON LINES

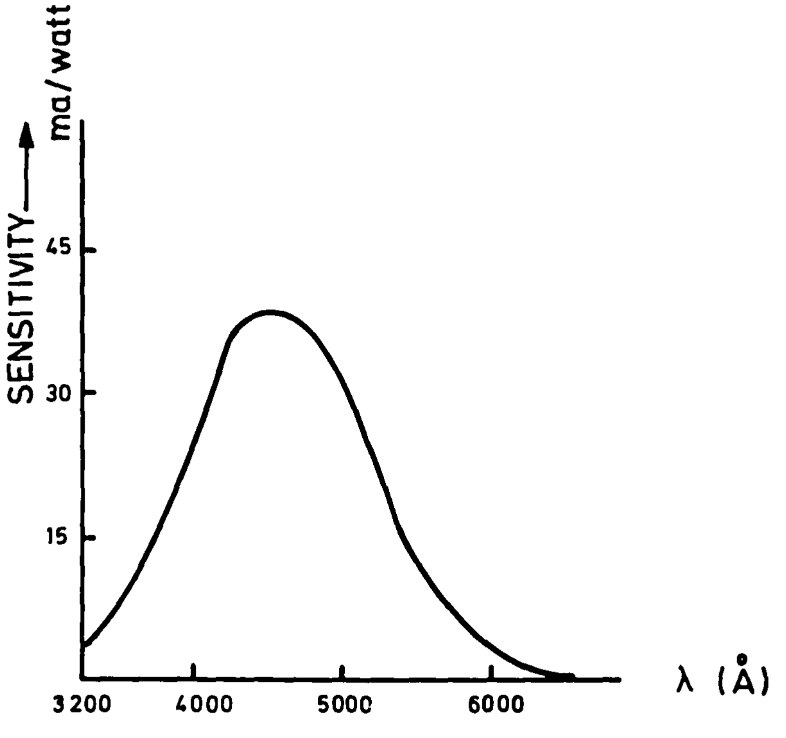
DISPERSION 124 A°/mm.



III. A. 4. FIG. 6.



THE ELECTRONOGRAPHIC CAMERA III.A.4.FIG.7.



SPECTRAL SENSITIVITY OF S11 TYPE PHOTOCATHODE (Cs_3Sb)

III.A.4.FIG.8.

III.B.1-PHOTOMETRY

INTRODUCTION

The observatory presently supports the following photometric systems:

- Stromgren uvby
- Hβ wide/ Hβ narrow
- Johnson UBV
- Johnson VRI
- Infrared JHKLMNQ (see section III.D.1)

This means that standard filters, photomultipliers, reduction programs, and on-line magnitudes are available in these systems. These systems are most commonly requested by VAs. Other photometry systems can be used made up either from the ESO filter list (see section III.F.) or the VA may provide his own filters. All ESO photometers employ photon counting.

The following references may be useful to the VA when referring to one of the commonly used photometry systems:

System	Reference
Johnson UBVRIJHKLMNQ	Johnson, H.L., 1966, Ann Rev Astron & Astrophys, 4, 193.
Stromgren uvby	Stromgren, B., 1965, Ann Rev Astron & Astrophys, 4, 433.
Borgman KLMNPQR	Borgman, J., 1961, BAN, 15, 255.
Walraven VBLUW	Walraven, Th., Walraven, J.H., 1960, BAN, 15, 67.
General Photometry	Golay, M., Introduction to Astronomical Photometry, publ. Dordrecht-Reidel, 1974, p. 364.
Reduction Techniques	Hardie, R.H., Photoelectric Reductions in Astronomical Techniques, W.A. Hiltner, ed., publ. University of Chicago Press: Chicago, p. 178.

EXTINCTION

Typical extinction values for La Silla are shown in Table 1.

Table 1

System	Index	1st Order	2nd Order
	V	0.12	0.000
UBV	B-V	0.07	-.035
	U-B	0.250	+.012
	y	0.12	
uvby	b-y	0.05	
	m_1	0.06	
	c_1	0.20	

For photometric conditions, see section I.K.1.

III.B.2-DATA ACQUISITION AT ESO 1 M AND 50 CM TELESCOPES

INTRODUCTION

An effort has been made to unify the *Data Acquisition* systems of the ESO 1 m and 50 cm telescopes. Some of the system's features given here will be useful to visitors. It is *IMPORTANT* to read this section in conjunction with the instrument you intend to use. This applies to the:

a) double beam photometer

b) photometer

c) polarimeter

PHOTOMETER AND TELESCOPE CONTROL

Both the telescope and photometer are controllable through HP 2100 computers from a display console and data handset in the dome. A schematic of the 1 m system is shown in Fig.(1). The telescope control (TCS) handles pointing, drive, and coordinate precessing. The data acquisition computer (DAS) handles data and output devices and is linked to the TCS computer. Output devices available are: punched paper tape, magnetic tape, and a line printer. Any or all of these devices may be used in combination. ASCII code is used for mag tape and paper tape output.

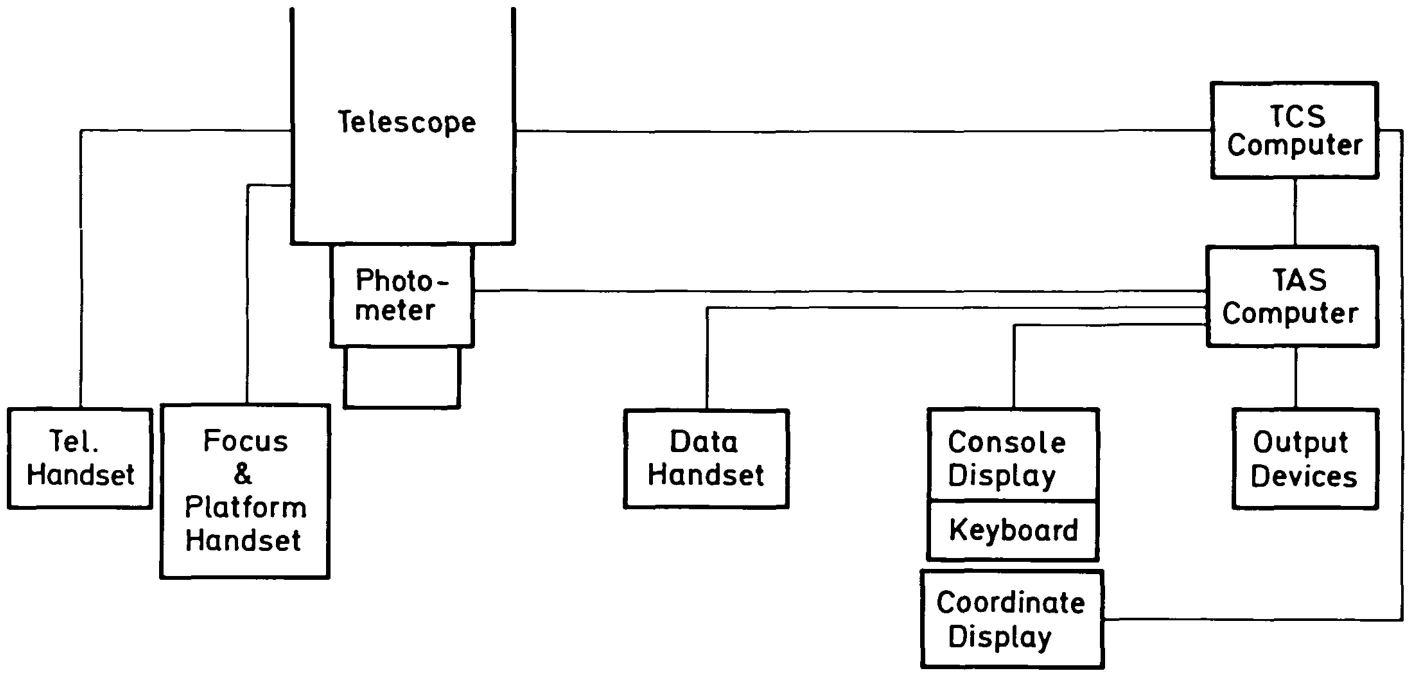
Detailed instructions on the use of the system can be found at La Silla in the library.

STAR CATALOG

Both telescope systems can store star coordinates in the computer memory, up to 374 stars at the 1 m and 200 at the 50 cm telescope. The telescope will point to any one of these stars by simply calling the memory location number of the star.

The star catalog can be entered by either typing in the coordinates by hand or by reading them in from paper tape. If you wish to prepare a paper tape either in Europe or at La Silla, then the following format should be used:

SCHEMATIC OF 1-m SINGLE CHANNEL PHOTOMETRIC SYSTEM



III.B.2.FIG.1.

HH:MM:SS. (-)DD:MM:SS. NN IN (return),
where $0 \leq NN \leq 374$

A listing of the coordinates with memory location can be obtained on the console and/or on the line printer simply by typing the following:

NN MM CA -PRINT (return) this prints the coordinates from NN to MM

NN CA (return) displays the coordinate located in NN on the display console.

NN MM CA-LIST (return) displays the coordinate from location NN to location MM on the display.

To set the telescope, type:

NN GO (return) this will send the telescope to the coordinates in memory location NN.

PRECESSION

Any EQUINOX <2000 may be used, but the equinox must be specified before calling the star. The coordinates are then automatically precessed. If precessed coordinates are required, this can be done at ESO computer center on La Silla.

MODES OF OPERATION

The photometer may be operated in the following modes:

1) Automatic
2) Manual
3) Repeat
4) High speed

There are two levels of operation of the system:

1) Parameter level → communicating, say filter sequence, or integration time, etc. This is made via the display console.
2) Observational level → to start, stop, or interrupt an observation. This is made via the handset.

To go from level (1) to level (2), enter an identifier (e.g. name of object), with instruction ID...........name.

To go from level (2) to level (1), push the handset button END.

The handset displays the number of integrations, number of counts per integration, and the mean deviation per integration, as well as the filter number and integration time in seconds. Once the star sequence of observations is completed, the computer pauses for the telescope to be moved to the sky and the sky sequence is instigated by pushing a button on the handset. The handset also has a decision button and decision knob with positions 1 to 5.

Table 3

Decision Numbers

Position	Significance
0	integration OK. If mode = AUTOMATIC, integration automatically begins on the next filter of the sequence once the LIMITS have been met.
1 2	hold after each integration. If mode = AUTOMATIC, integration will proceed on the next filter *after* the START or DEC button is depressed.
3	delete measurements in this filter. After integrations on a filter are complete, if START or DEC button is depressed, then no output for that filter is given and the same filter will be measured again (even in the automatic mode).
4	delete measurements of this object. Console ready for next ID input.
5	manual operation of the filter wheel even when mode is automatic.

NOTE: If dec ≠ 0, then the system will hold after each filter. The activation of the DEC button when dec = 3, 4, 5 executes the actions described above.

AUTOMATIC MODE (COMPUTER CONTROL)

Photometry observations may be made under full computer control or manual control; when necessary, the computer control can be overridden through a hand-set. A typical observation set up in the automatic mode is as follows:

```
IT = 1
PULSE COUNTING
AUTOMATIC
 9       10      11      3      STFI
11       10       9      3      SKFI
LIMITS 10        45      0.5     0.7
```

"IT" is the time base in seconds (duration of one integration).

"AUTOMATIC" refers to computer control of the observing sequence.

"9 10 11 3 STFI" indicates that there are 3 STAR filters to be measured located in positions #9, #10, and #11 of the filter wheel corresponding to UVB and the star is measured in this sequence.

"11 10 9 3 SKFI" similarly is the sequence of filters to be measured on the sky (in reverse order to star). The last number, in this example "3", refers to the total number of filters to be measured (maximum of 12).

"LIMITS 10 45 0.5 0.7" specifies the limits of integration. In this instance, a minimum of 10 integrations must be made, (each in this case of 1 second so this is a total of 10 seconds integration) a maximum of 45 integrations can be made and a mean deviation criterion of 0.5%. If the mean deviation criterion is satisfied before the maximum number of integrations is reached, the photometer moves to the next filter. The 0.7% is the mean deviation criterion for the sky measurement.

MANUAL MODE

In this mode, the photometer is operated conventionally with filter wheel rotation commands to start and stop integrations on each filter initiated by the observer.

REPEAT MODE

A given filter sequence can be repeated automatically N times an object by making the command "N repeat".

HIGH SPEED

This is a free running mode where each integration is printed and the mean is given at the end of the observation sequence. The minimum integration time is one second. This is useful in studying rapid varying stars. It also provides a convenient check on the quality of the night.

ON-LINE MAGNITUDES

"On-line magnitudes" are magnitudes and colors which were transformed into the standard system by means of preliminary mean extinction and transformation coefficients. They should only serve as a quick judgment of the data during the observing night and cannot replace the correct data reduction. These coefficients are stored in the data acquisition computer and are not being changed based on standard star measurements in the actual observing night. In order to obtain on-line magnitudes, at least one standard has to be measured at the beginning of the night. Before the identifier is given, the standard values have to be typed in this sequence:

	V	B-V	U-B	O	SJ		for UBV
or	V	b-y	m_1	c_1	O	SS	for uvby
or	β	o	SH				for Hβ

These values are only used by the computer to calculate the night zero point cor rection. Afterwards, these zero points are applied to obtain magnitudes and colors similar to the standard system for all the following stars. If the sky is not measured in the actual data set, the last previous sky measurement is taken into account. It is recommended to use a standard of similar colors as most of the program stars in order to diminish the effect of possible incorrect color transformation coefficients. The procedure of entering the standard magnitude can be repeated, but this leads only to an averaging of the obtained zero points, and in no case to a determination of transformation or extinction coefficients! Normally, with one standard star, the typical accuracy of 0.02^m - 0.05^m of the on-line magnitude is already reached. On-line magnitudes are displayed on the terminal and on the line printer, not on punched tape or magnetic tape.

A list of E-region stars are available in the dome with Johnson UBV colours.

III.B.3-THE 1 M SINGLE CHANNEL PHOTOMETER

INTRODUCTION

This single channel photometer is mounted at the Cassegrain focus of the ESO 1 m telescope. It is a conventional instrument consisting of the following components, given in the order in which they are encountered along the optical axis:

1) offset guider/finder
2) diaphragm wheel
3) viewfinder to center the star in the diaphragm
4) filter wheel
5) photomultiplier mounted in a dry ice cold box

This section should be read in conjunction with section III.B.2.

The offset guider/finder is equipped with a wide field eyepiece and has a field of view of 7 arcmin. The eyepiece may be displaced in the x and y directions a total of 13 arcmin. The field is reversed and with the photometer mounted on the telescope with the viewfinder on the west side, north is right and east is down.

The diaphragms are fixed and have the following diameters:

Position N°	1	2	3	4	5	6	7	8	9	0
Diam arcsec	4	5.5	8	11	16	22	32	44	62	88

The most frequently used diaphragm for stellar work is 16 arcsec. There is a removable eyepiece for centering the star in the diaphragm.

Two (2) filter wheels each with 12 positions are available. The wheels take filters up to one inch (25 mm) in diameter or one inch square and up to 10 mm thick. The filters may be chosen from the ESO list of filters (section III.F.) or the observer may provide his own. In all cases, the visitor should inform ESO staff through the request for observing time, which filters he intends to use. This is to ensure that no conflicts occur and that the filters are available.

When carrying out Strömgren or Johnson photometry, the following filter sequence is normally used:

Standard Filter Wheel Positions

Position N°	Filter N°		Position N°	Filter N°	
0	HβN	17	6	Dark	--
1	HβW	22	7	--	--
2	u	15	8	Dark	--
3	v	9	9	U	113
4	b	5	10	V	111
5	y	2	11	B	112

This choice of filter positions facilitates the use of the ESO reduction program.

Photomultipliers The photometer is constructed so that the photomultiplier with cold box is quickly interchangeable. The observer may choose the photomultiplier most suitable for his program from the specifications given in section IV.B.1. The observatory normally adopts the following photomultipliers for use with the given photometric system.

System	Photomultiplier	Cathode
UBV	EMI 6256 (cooled)	S-13
uvby	EMI 9789 QB (uncooled)	Bialkali
VRI	RCA 31034A (Quantacon) (cooled)	Ga-As
	FW 118 (cooled)	S-1
RI VRI	EMI 9558 (cooled)	S-20

PHOTOMETER CONTROL

Both the telescope and photometer are controllable through an HP 2100 computer from a single CRT console in the dome. Detailed instructions on the use of the system can be found at La Silla in the library.

Some details are necessary in order to prepare your program, and because efforts to unify the data acquisition system for both the 1 m and ESO 50 cm telescopes are being made, the details on data acquisition are given in section III.B.2.

The system can store up to 374 star coordinates at the 1 m and up to 200 at the 50 cm. The telescope will point to any one of the stars by simply calling the memory location number of the star. The coordinates can be typed into the computer or read in by paper tape, which can be prepared either in Europe or at La Silla. The format is given in section III.B.2.

The system will precess coordinates for epoch < 2000. However, should you wish to make precession calculations independently, these can be carried out at the La Silla computer terminal.

The photometer may be operated manually or automatically. Details of the automatic mode operation are given in section III.B.2.

ON-LINE MAGNITUDES

On-line magnitudes can be obtained for the observatory supported photometric systems. The observer can compile a catalog of standard stars up to eleven (11) on paper tape. Or, values may be typed by hand during the night as each standard is about to be observed. The format for compiling standard magnitude catalogs is given in section III.B.2.

MAGNITUDE LIMITS

Program and standard stars should not be brighter than V = 7.0 for UBV, and V = 5.0 for uvby. This is to avoid multiplier blending.

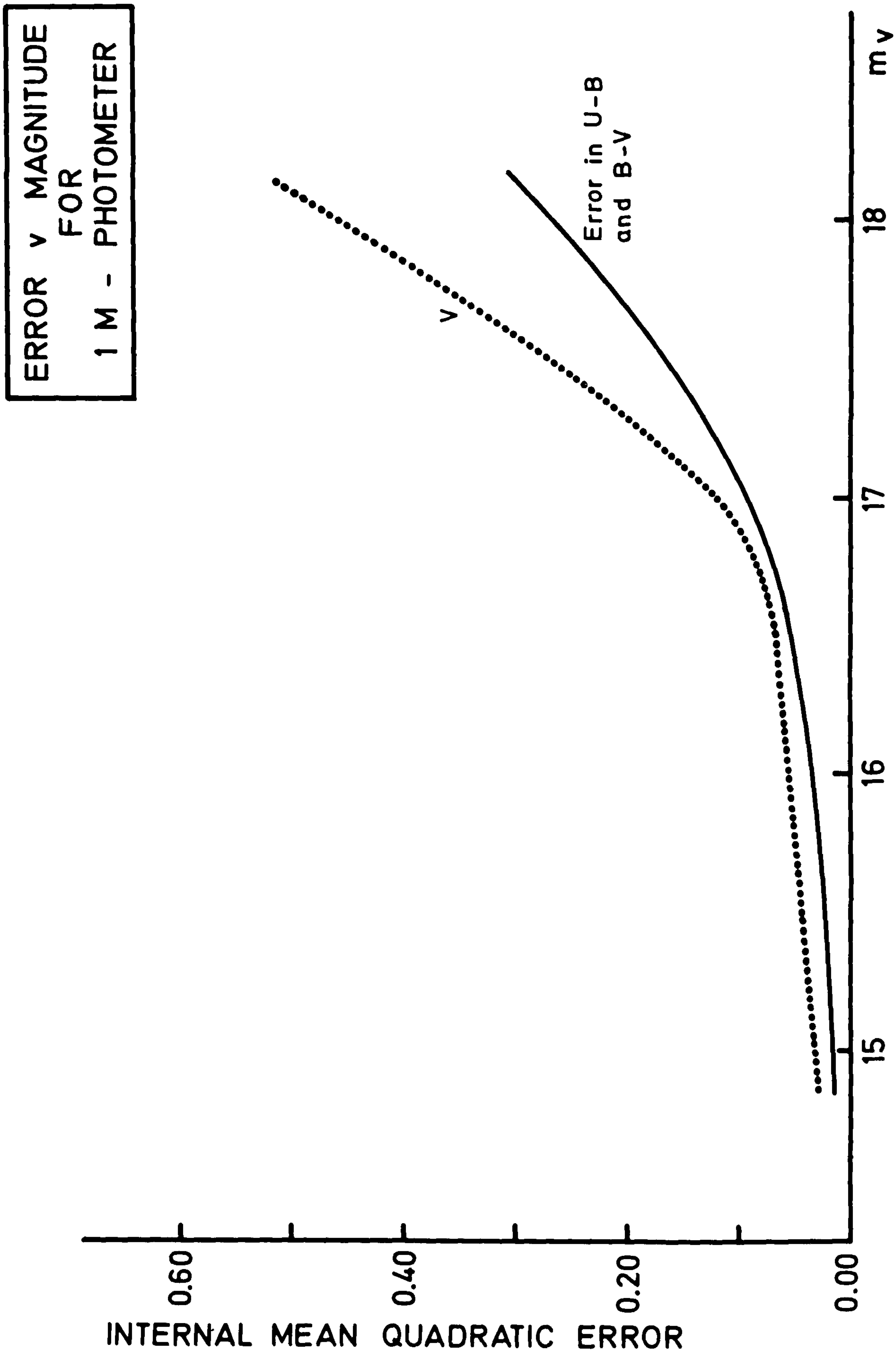
Stars down to $V \leq 16.5$ can be seen and centered in the diaphragm. An indication of the photometric accuracy with magnitude is given in Fig.(1) showing the internal mean quadratic error ε (of normally 3 measurements each of approximately 60 sec) in V and in both U - B, B - V. This is taken from: Adam, G., 1978, Astronomy and Astrophysics Suppl., 31, 151.

OUTPUT DEVICES

Output can be on magnetic tape, paper tape, and/or line printer. The magnetic tape and paper tape are in ASCII.

For observatory supported systems, the magnetic tape can be edited and the data reduced at the observatory. The observer should normally consider staying one or two days after his observing run in order to complete the data reduction.

An example of the line printer output is given in Fig.(2).


ERROR v MAGNITUDE
FOR
1 M - PHOTOMETER
Error in U-B
and B-V
V
m_v
15
16
17
18
0.00
0.20
0.40
0.60
INTERNAL MEAN QUADRATIC ERROR

III.B.3.FIG.1.

1-M SINGLE CHANNEL PHOTOMETER OUTPUT

```
                                                                  Counts
                                   Name
                                                                        Nº of integra-
                                       Coordinates                      tions cf. IT=2
 5 HD 216Ø54
 6  22:49: 2      -41:35:39                                                Error
 7  74
 Ø  5  2 22:4Ø:14    9 Ø Ø      21117    15   Ø.23
 Ø  5  2 22:4Ø:47   1Ø Ø Ø      47Ø62    15   Ø.17
 Ø  5  2 22:41:2Ø   11 Ø Ø      8326Ø    15   Ø.17
 Ø  5  2 22:42: 7   11 Ø Ø         86     5   2.39
 Ø  5  2 22:42:2Ø   1Ø Ø 1         84     5   9.16
 Ø  5  2 22:42:34    9 Ø 1         61     6   5.4Ø
 9
14 1.Ø24                                              Air mass
  V = 7.7623  B-V = Ø.732Ø  U-B = Ø.25819  On-line magnitude
 5 HD 216679
 6  22:54:19      -46:25:59
 7  75                                        Running number
 Ø  5  2 22:44:59    9 Ø Ø      45662    16   Ø.21
 Ø  5  2 22:45:3Ø   1Ø Ø Ø      57427    12   Ø.15
 Ø  5  2 22:46: 5   11 Ø Ø     143796    2Ø   Ø.18
 9                IT 2 sec
14 1.Ø46
  V = 7.5233  B-V = Ø.376Ø  U-B = Ø.Ø1119
 5 HD 216ØØ9
 6  22:48:4Ø      -44:31:39
 7  76                                                  IT
 Ø  5  2 22:48:51    9 Ø Ø      35911    1Ø   Ø.14
 Ø  5  2 22:49:15   1Ø Ø Ø      34762    11   Ø.14
 Ø  5  2 22:29:44   11 Ø Ø     118Ø45    15   Ø.14
 Ø  5  2 22:5Ø:39   11 Ø 1         92    12   2.62
 Ø  5  2 22:51: 4   1Ø Ø 1         76    1Ø   5.33
 Ø  5  2 22:51:24    9 Ø 1         52     7   6.79
 9                                                          Ø = ☆
14 1.Ø36                                                    1 = SKY
  V = 8.Ø543  B-V = Ø.Ø67Ø/ U-B = Ø.Ø5919

                      Filter code

              ST

     Diaphragm code
```

III.B.4-THE ESO 50 CM SINGLE CHANNEL PHOTOMETER

INTRODUCTION

This single channel photometer is mounted at the Cassegrain focus of the ESO 50 cm telescope. It is a conventional photometer consisting of the following components, given in the order that they are encountered along the optical path.

1) wide field viewfinder
2) diaphragm wheel
3) viewfinder to center the star in the diaphragm
4) filter wheel
5) photomultiplier with thermo-electric cooling

The system uses pulse counting.

NOTE: Section III.B.2 should be read in conjunction with this section.

VIEWFINDER

The viewfinder has a field of 15 arcmin. It has an illuminated crosswire and five (5) concentric rings centered on the field can also be seen. Each ring is separated by 1 arcmin. The field is reversed and with the photometer mounted on the telescope and the viewfinder on the west side, north is right and east is down with the eyepieces toward the west side. The photometer can be turned in position angle.

DIAPHRAGMS

The diaphragm wheel has six positions corresponding to the following diameters:

Position N°	1	2	3	4	5	6
Diam arcsec	10	15	21	30	40	80˙

The most frequently used diaphragm for stellar work is 21 arcsec.

FILTER WHEEL

The filter wheel has 12 positions and accepts filters up to one inch (25 mm) diameter or one inch square and up to 10 mm thick. The filters may be chosen from the ESO list of filters (see section III.F) or the observer may provide his own. In all cases, the VA should inform ESO staff through the request for observing time which filters the observer intends to use. This is to ensure that no conflicts occur and that the filters are available.

When carrying out Strömgren and Johnson photometry, the following filter sequence is normally used.

Standard Filter Wheel Positions

Position N°	Filter N°		Position N°	Filter	N°
0	HβN	58	6	Dark	--
1	HβW	21	7	--	--
2	u	13	8	Dark	--
3	v	11	9	U	91
4	b	6	10	V	99
5	y	2	11	B	98

This choice facilitates the use of the ESO reduction facilities.

The photometer is constructed so that the photomultiplier with cold box is quickly interchangeable. The observer may choose the photomultiplier most suitable for his program from the specification given in section IV.B. The observatory normally adopts the following photomultipliers for use with the given photometric system.

System	Photomultiplier	Cathode
UBV	EMI 6256 (cooled)	S-13
uvby	EMI 9789 QB (uncooled)	Bialkali
VRI	RCA 31034A (Quantacon) (cooled)	Ga-As
	FW 118 (cooled)	S-1
RI VRI	EMI 9558 (cooled)	S-20

PHOTOMETER CONTROL

Both the telescope and photometer are controllable through an HP 2100 computer from a single TV console in the dome. Detailed instructions on the use of the system can be found at La Silla in the library.

Some details are necessary in order to prepare your program. Because efforts to unify the data acquisition system for both the 1 m and ESO 50 cm telescopes are being made, the details on data acquisition are given in section III.B.2.

The system can store up to 200 star coordinates and the telescope will point to any one of the stars by simply calling the memory location number of the star. The coordinates can be typed into the computer or read in by paper tape, which can be prepared either in Europe or at La Silla. The format is given in section III.B.2.

The system will precess coordinates for epoch < 2000. However, should you wish to make precession calculations independently, these can be carried out at the La Silla computer terminal.

The photometer may be operated manually or automatically. Details of the automatic mode operation are given in section III.B.2.

ON-LINE MAGNITUDES

On-line magnitudes can be obtained for the observatory supported photometric systems. The observer can compile a catalog of standard stars up to eleven (11) on paper tape. Or, values may be typed by hand during the night as each standard is about to be observed. The format for compiling standard magnitude catalogs is given in section III.B.2.

MAGNITUDE LIMITS

Program and standard stars should not be brighter than V = 5.5 for UBV, and V = 4.0 for uvby. This is to avoid multiplier blending.

Stars down to $V \leq 15.0$ can be seen and centered in the diaphragm.

OUTPUT DEVICES

Output can be on magnetic tape, paper tape, and/or line printer. The magnetic tape and paper tape are in ASCII.

For observatory supported systems, the magnetic tape can be edited and the data reduced at the observatory. The observer should normally consider staying on or two days after the observing run in order to complete the data reduction.

An example of the line printer output is given in Fig.(1).

III.B.5-THE BOCHUM PHOTOMETER

INTRODUCTION

This single channel photometer is mounted at the Cassegrain focus of the Bochum 61 cm telescope. The instrument is owned by the "Deutsche Forschungsgemeinschaft" (German Research Foundation), and is on permanent loan to the "Astronomisches Institut der Rurh-Universitat Bochum, West Germany. It consists of the following:

1) wide field viewfinder
2) diaphragm slide
3) diaphragm viewfinder
4) dark slide
5) filter wheel
6) photomultiplier (dry ice cooled)

NOTE: an unusual design feature is that the filters sit in a collimated beam.

The system uses DC detection and the data output is given digitally through a voltage-to-frequency converter and counter.

VIEWFINDER

The viewfinder has a field of view of approximately 21 arcmin. It has a crosswire with variable illumination and a scale marked in divisions of 23 arcsec. With the telescope on the west side, the field of view is inverted with west upwards.

DIAPHRAGMS

The diaphragms are mounted in two easily interchangeable slides. Each slide has six positions as follows:

Slide 1

Position	1	2	3	4	5	6	*7 radioactive source
Diameter mm	0.339	0.502	0.808	1.281	2.013	20.6	
Diameter arcsec	7.65	11.32	18.23	28.9	45.4	(7.543 arcmin)	

* its use is not recommended

Slide 2

Position	1	2	3	4	5	6
Diameter mm	2.011	3.164	5.099	8.015	12.67	20.015
Diameter *arcmin*	0.756	1.19	1.917	3.014	4.764	7.525

DIAPHRAGM VIEWER

This sits behind the diaphragm slide and has an illuminated border controlled by a potentiometer. The field of view is inverted with respect to the viewfinder.

FILTER WHEELS

Three interchangeable filter wheels are available. Two wheels have ten (10) positions for 1 inch diameter filters. The third wheel has six (6) positions for 2 inch round filters. Adapters for the third wheel are available for 1 x 1 inch square filters. Filters should not be thicker than 1.4 cm. NOTE: the dark slide is before the filter wheel and so special care must be taken to avoid damage to the photomultiplier when changing.

FILTERS

The filters used for the standard Johnson or Stromgren systems are given in Table 1.

PHOTOMULTIPLIERS

The photomultipliers available are EMI 9558A and 9502A. Both are mounted in "products for research" cold boxes and are dry ice cooled. The photomultiplier housing is compatible with those used by ESO. All cold boxes have heated entrance windows to avoid condensation.

Table 1

Filters

Colour	Filter type
V	2 mm Schott GG 495
B	1 mm BG 12 + 2 mm GG 385
U	2 mm UG 2
HβN	Baird Atomic (BA) interference filter (IF) B-10, λ center = 4857 Å, Δλ = 2.7 Å
HβW	BA, IF, B-2, λ center = 4848 Å, Δλ = 98 Å
HγW	BA, IF, B-2, λ center = 4328 Å, Δλ = 82 Å
HγN	BA, IF, B-2, λ center = 4333 Å, Δλ = 33 Å
u	4 mm Schott UG 11
b	BA, IF, B-3, λ center = 4670 Å, Δλ = 170 Å
y	BA, IF, B-3, λ center = 5465 Å, Δλ = 230 Å
v	BA, IF, B-3, λ center = 4118 Å, Δλ = 160 Å
HαW	BA, IF, B-2, λ center = 6566 Å, Δλ = 157 Å
HαN	BA, IF, B-11 (X), λ center = 6561 Å, Δλ = 13 Å

Other filters available as defined by Sandage and Smith, Ap.J., 137, 1057 (1963):

b_{20}	0.7 mm Schott BG 12 + 2 mm GG 385 + 2.5 mm 80% copper sulphate solution in a quartz vessel
v_{20}	2 mm GG 495 + 1.5 mm BG 18
r_{20}	2 mm RG 610

MAGNITUDE LIMITS

The limiting magnitude which can be centered in the diaphragm is approximately $V = 15.5^m$.

DATA OUTPUT

Output is on paper tape (ASCII) teletype and is shown in the dome on an oscillograph display.

The data output on paper tape is compatible with the ESO photometric data reduction system described in section V.B.1.

III.B.5.1-BOCHUM DATA ACQUISITION SYSTEM

The most important parts of the data acquisition system are:

1) Keithly D.C. amplifier with six (6) gain steps. The gain steps are selected by remote control, manually, or via the computer. No pulse-counting equipment is forseen.
2) Digital voltmeter (voltage-to-frequency converter and counter).
3) HP 2114 computer with 8K memory.
4) Oscillograph display in an electronic rack in the dome. It is the main communication line from the system to the observer.
5) Control paddle as main communication line from the observer to the system. This can be mounted on the telescope or the equipment rack.
6) Teletype for the two-way communication between observer and system, and as digital data output (punched tape).

Most of the electronics, such as computer and teletype are located in the first floor of the Bochum building. The computer program BACHI guiding the data acquisition is written in the HP BASIC language which allows relatively easy program changes and flexibility.

The BACHI program is always started via the teletype where basic parameters such as date, universal time, and sidereal time at midnight have to be entered. The teletype must remain running because it gives a hard copy and a punched tape with all the observing results.

During the night, the data acquisition system is controlled exclusively via the control panel in the dome. The observer receives necessary information on the oscillograph display. At the display, the parameters are arranged as follows: (where Y(1) is always equal to the universal time)

Y(1)	Y(2)	Y(3)	Y(4)
Y(5)	Y(6)	Y(7)	Y(8)
Y(9)	Y(10)	Y(11)	Y(12)
Y(13)	Y(14)	Y(15)	Y(16)

COMMAND LINE

At the beginning of every measurement, the computer asks for the identification of the next star by writing "NAME!" in the *command line* of the display. The observer responds by giving up to eight (8) digits via the control paddle. The identification digits appear in positions Y(2) and Y(3). If four (4) or less digits are given, the number in Y(3) remains unchanged to serve as a field identification while Y(2) is a star number. The identification input is terminated by pressing "ZAHL ENDE". Subsequently, the words "START? MODIFICATION?" are displayed in the *command line*. Here, one may give both a filter sequence (up to 8 filter positions) and a limit to the number of integrations corresponding to fields Y(4) and Y(8) respectively.

The "START" button moves the filter wheel automatically to the first pre-selected filter position and begins to integrate in gain step 10^{-5}. Filter position, gain step, actual mean count rate, percent error (in 0.1% units), and actual number of integrations are displayed in fields Y(5), Y(6), Y(7), and Y(8). If the gain step 10^{-5} is too insensitive, the observer can go to 10^{-6}, 10^{-7}, $\ldots 10^{-10}$ by pressing button 1(E +1) once, twice,...five times respectively. No automatic *increase* is forseen; however, if a star is too bright for an actual gain step, the system *decreases* the gain automatically. In addition, the gain step can be reduced manually by pressing button 2(E - 1).

The basic integration time unit is one second. When the given number of integrations is reached, the system moves automatically to the next filter and begins to integrate. The results of the second filter are shown in fields Y(9)...Y(12), those of the third filter in Y(13)...Y(16). If there are more than three filters, the actual measurement is always displayed in fields Y(13)...Y(16), and the previous information is moved up one line so that one sees the results of the currently observed filter and the two previous ones. If the results are satisfactory before the preset number of integrations is reached, the observation can be stopped with "INTEGRATION STOP". The photometer then moves to the next filter and begins integrating.

After completion of the star measurements in all filters, the computer asks for the sky measurement with "HIMMEL!" in the *command line*. First move the telescope to sky position, then depress "START" to measure the sky in all pre-selected filters but in the reverse order than for the star measurements. The actual sky counts do not appear on the display, instead a magnitude for the star appears. If no sky measurement is desired, press the button "KEIN HIMMEL" instead of "START" and proceed to the next object.

After completion of the measurement for one object, the data are printed and punched by the teletype, see format in Fig.(1). The code of the punch tape is ASCII. The teletype takes about 10 seconds to punch one data line, and 7 seconds for a headline for every object. The printout for a complete measurement in 8 filters would take about 87 seconds. Normally this time is used to prepare the the next object, but the integration cannot begin before the printout is finished. For the special case of repeat observations of the same object with high time resolution, a special BACHI version is available with compact printout where only about three seconds are lost between two sets of observations. This version accepts up to four filter positions.

Filter sequence, gain steps (per filter), and maximum number of integrations are stored permanently in the computer and are automatically applied for the next star until changed.

The data output on punched tape is compatible with the ESO photometric data reduction system decsribed in section III.B.1.

III.B.6-DOUBLE CHANNEL PHOTOMETER

INTRODUCTION

The double channel photometer allows simultaneous measurements of two stars. It can be used at the Cassegrain focus of either the ESO 50 cm or ESO 1 m telescopes. A schematic diagram of the photometer is shown in Fig.(1). It consists of two (2) photomultipliers mounted on a sliding rail. Each phot ultiplier can slide independently perpendicular to the telescope optical axis. Furthermore, the whole photometer may rotate in order to center the two stars. The star field may be identified with a large field eyepiece (15 arcmin).

The light from each star passes first to a small front surfaced prism, through a diaphragm wheel, fabry lens, and then to a filter wheel to the photomultiplier. Each photomultiplier has a small dark slide/viewing mirror placed after the diaphragm which allows the star to be centered. Both the photometer and telescope are controlled through a single display console in the dome.

PHOTOMULTIPLIER SEPARATION

Each photomultiplier can slide a distance of 50 mm, with a mutual overlap of 10 mm in the center. Due to contact of the beam deflecting prism feeding each photomultiplier, the minimum separation is 18 mm.

The usable separation range for two stars measured simultaneously in the two channels is:

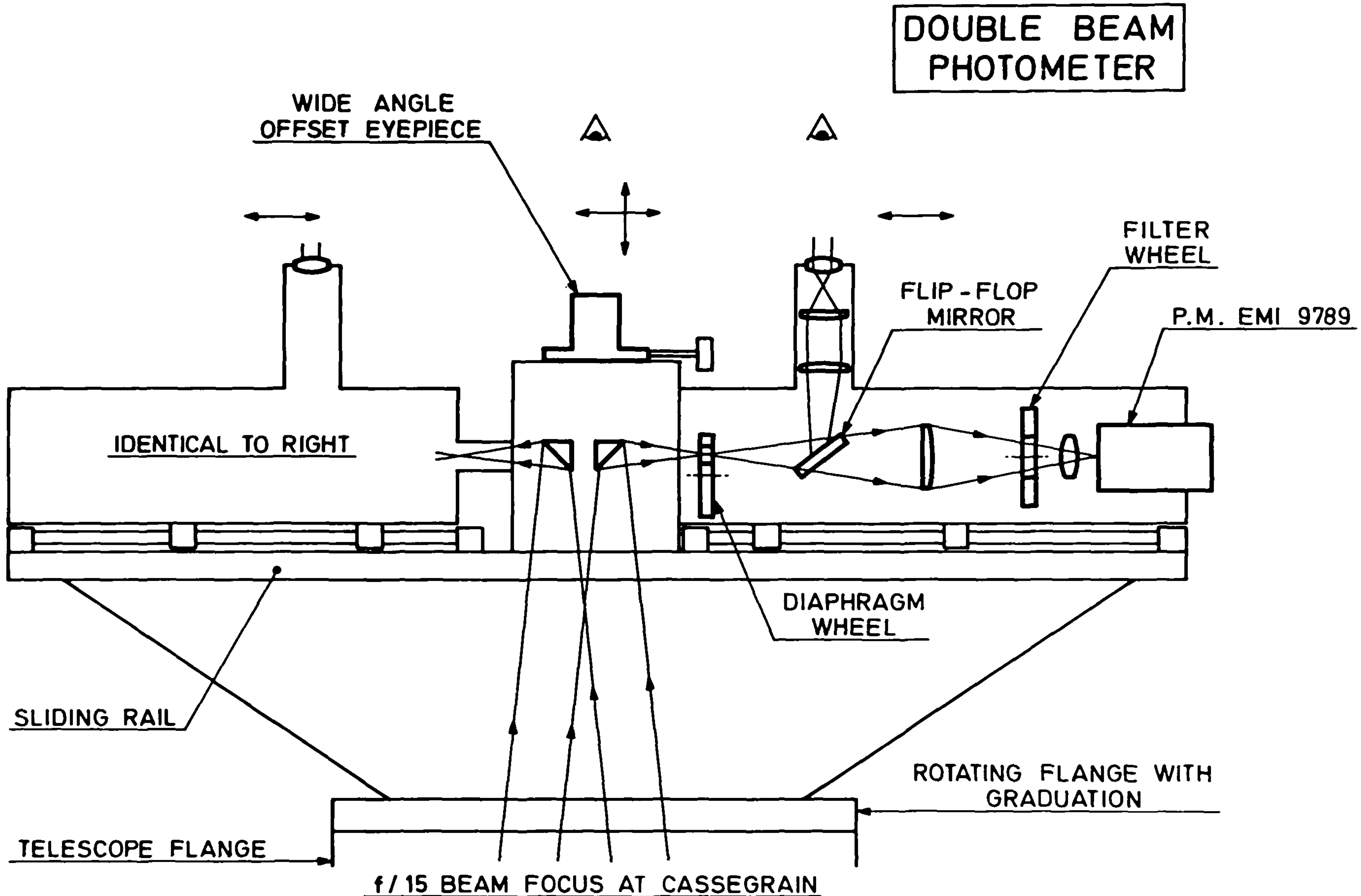
4 to 15 arcmin	1 m telescope
9 to 30 arcmin	50 cm telescope

The photomultiplier positions are reproducible through metric dials to an accuracy of better than 0.05 mm. The position angle of the whole instrument can be read from a metric dial with an accuracy of 1°.

DIAPHRAGMS

Each photomultiplier has a diaphragm wheel with five positions. The first contains a radioactive calibration source. The other four positions are diaphragms of 0.5, 0.7, 1.0, and 1.5 mm diameter. This corresponds to:

arcsec at 1 m	7	10	14	21
arcsec at 50 cm	14	19	28	41



DOUBLE BEAM PHOTOMETER III.B.6.FIG.1.

FILTER WHEELS

Each photomultiplier has a four-position filter wheel containing UVB filters and one open position for white light measurement.

PHOTOMULTIPLIERS

The photomultipliers are EMI 9789 QB, and each one is mounted in a "products for research" cold box and cooled by dry ice. Pulse counting is used for both photomultipliers.

DATA OUTPUT

Data output is on magnetic tape, punched tape, and/or line printer. Two types of line printer output are available: short or long form. These are shown in Figs. (2) and (3) respectively. The long format gives *raw* magnitudes and the magnitude difference between the two channels in the instrumental system.

The data acquisition is, in all other respects, similar to the single channel photometers, (see section III.B.2).

DOUBLE BEAM PHOTOMETER - SHORT FORM OUTPUT

Filter: 2 = U, 1 = B, Ø = V

Ø = ☆, 1 = Sky

ST

Channel 1

Channel 2

Integrations

Identifier

```
5 DARK
7   2
Ø  1  12:33:59  2  Ø      17Ø         13    15
Ø  1  12:34:16  1  Ø      177         14    15
Ø  1  12:34:33  Ø  Ø      167         17    15
Ø  1  12:35: Ø  2  Ø      17Ø         13    3Ø
Ø  1  12:35:17  1  Ø      171         13    3Ø
Ø  1  12:35:4Ø  Ø  Ø      174         16    3Ø
9
5 LP
7   3
Ø  1  12:37:59  2  Ø      2Ø7         73    15
4
5 LP
7   4
Ø  1  12:38:51  2  Ø      2Ø6         72    15
Ø  1  12:39: 8  1  Ø    1235Ø      14269    15
Ø  1  12:39:25  Ø  Ø    5Ø538      63813    15
9
5
7   5
4
5 HD IN K1
7   6
Ø  1  12:44:34  2  Ø   214498        132    15
Ø  1  12:44:51  2  Ø   932357        392    15
Ø  1  12:45: 8  Ø  Ø   14599Ø        133    15
9
5 HD IN K1
7    7
Ø  1  12:45:53  2  Ø   212938        133    15
Ø  1  12:46:1Ø  1  Ø   93128Ø        394    15
Ø  1  12:46:27  Ø  Ø   146465        13Ø    15
9
```

DOUBLE BEAM PHOTOMETER - LONG FORM OUTPUT

Filter: 2 = U, 1 = B, Ø = V

R2-R1

Raw Mag Chan. 2

Raw Mag 1

% SD Channel 2

% SD Channel 1

Counts Channel 1

Counts Channel 2

ST

Running N°

N°of integrations
IT = 1 sec

IT

Ø = ✱
1 = Sky

```
8   15/16.APRIL 1977
5 LP
7   1
Ø   1    8:25:2Ø  2  Ø     125    1Ø2   15  2.ØØ  1.99   -5.241   -5.Ø21  Ø.22Ø
Ø   1    8:25:48  1  Ø   11571  13666   15  Ø.21  Ø.16  -1Ø.158  -1Ø.339 -Ø.181
Ø   1    8:26: 5  Ø  Ø   46923  59593   15  Ø.13  Ø.13  -11.678  -11.938 -Ø.26Ø
Ø   1    8:26:46  2  1      82     5Ø   15  2.28  3.76
Ø   1    8:27: 3  1  1      86     5Ø   15  2.98  3.Ø3
Ø   1    8:27:2Ø  Ø  1      82     48   15  1.47  3.84
9
5 A IN K2
5 *
7   2
Ø   1    8:29:21  2  Ø     191  15627   15  1.92  Ø.29   -5.Ø96  -1Ø.481 -5.386
Ø   1    8:29:38  1  Ø     348  82752   15  Ø.96  Ø.47   -6.367  -12.294 -5.927
Ø   1    8:29:55  Ø  Ø     2Ø3  219Ø9   15  2.Ø9  Ø.48   -5.2Ø7  -1Ø.849 -5.642
9
5 *
7   3
Ø   1    8:3Ø:16  2  Ø     2ØØ  15721   15  1.38  Ø.45   -5.18Ø  -1Ø.488 -5.3Ø8
Ø   1    8:3Ø:33  1  Ø     43Ø  83488   15  1.Ø2  Ø.45   -6.342  -12.3Ø3 -5.962
Ø   1    8:3Ø:5Ø  Ø  Ø     195  2166Ø   15  1.83  Ø.56   -5.132  -1Ø.837 -5.7Ø5
```

III.B.7-THE DANISH TWO-CHANNEL Hβ PHOTOMETER

INTRODUCTION

The photometer is mounted at the Cassegrain focus of the Danish 50 cm telescope. It is a two-channel instrument for simultaneous measurements of the Hβ line through a narrow and wide filter (HβN, HβW). The light is distributed to two (2) photomultipliers by means of a beam splitter which allows approximately 80% of the light to reach the narrow filter (channel 1); resulting in the counting rates for the two channels being similar. Besides the advantage of simultaneous measurements, the two channel instrument also makes it possible to observe on non-photometric nights. Observations can be made through clouds on dark nights; however, moonlight with cloud can cause variable background.

The system uses pulse counting (see section III.B.8.1).

DIAPHRAGMS

Four diaphragms are available as follows:

Diam. arcsec	300	30	15	10

Note the photometer has no darkslide and a blank location of the diaphragm wheel is used as a darkslide. No viewfinder is available but objects are easily found in the largest diaphragm of 300 arcsec. The field of view is inverted.

PHOTOMULTIPLIERS

Two uncooled EMI 6256 are used operating at approximately 1400 volts. The voltage to each is independently adjustable. The dark current under these conditions is typically 10 counts per second.

MAGNITUDE LIMITS

The following example is useful to estimate limiting magnitudes. An A2V star of $b = 5.2^m$ gives in 10 seconds integration 120,000 counts in channel 1 (HβN) and 100,000 counts in channel 2 (HβW). Thus a 10th magnitude star would give approximately 6 to 7000 counts in HβN and HβW after 50 seconds of integration.

For a star of $V = 10^m$ (A2V) an accuracy of 0.01^m in β was reached after 13 minutes of integrations on the star and 3 minutes integration on the sky.

OUTPUT DEVICES

The Danish 50 cm telescope employs a general purpose multichannel photon counting system and a digital data acquisition system, (see section III.B.8.1)

The data output is on paper tape, code ASCII.

III.B.8-THE DANISH FOUR-CHANNEL uvby PHOTOMETER

INTRODUCTION

The spectrograph-photometer is shown schematically in Fig.(1). It is designed for simultaneous measurements in the Strömgren four color system (u, v, b, and y). The instrument is mounted at the Cassegrain focus of the Danish 50 cm telescope.

After collimation, the light is dispersed by a grating with a reciprocal linear dispersion of approximately 12 Å/mm. The grating serves to initially isolate the bands, defining bands slightly wider than the actual uvby system. The system is defined by a standard set of uvby filters placed immediately in front of the photomultipliers. The photomultipliers are mounted side-by-side with field lenses being used to image the grating on the photocathodes.

The system uses pulse counting, (see section III.B.8.1).

VIEWFINDER

The diaphragm viewer is used to locate the field. With the largest diaphragm, the field of view is approximately 300 arcsec and inverted.

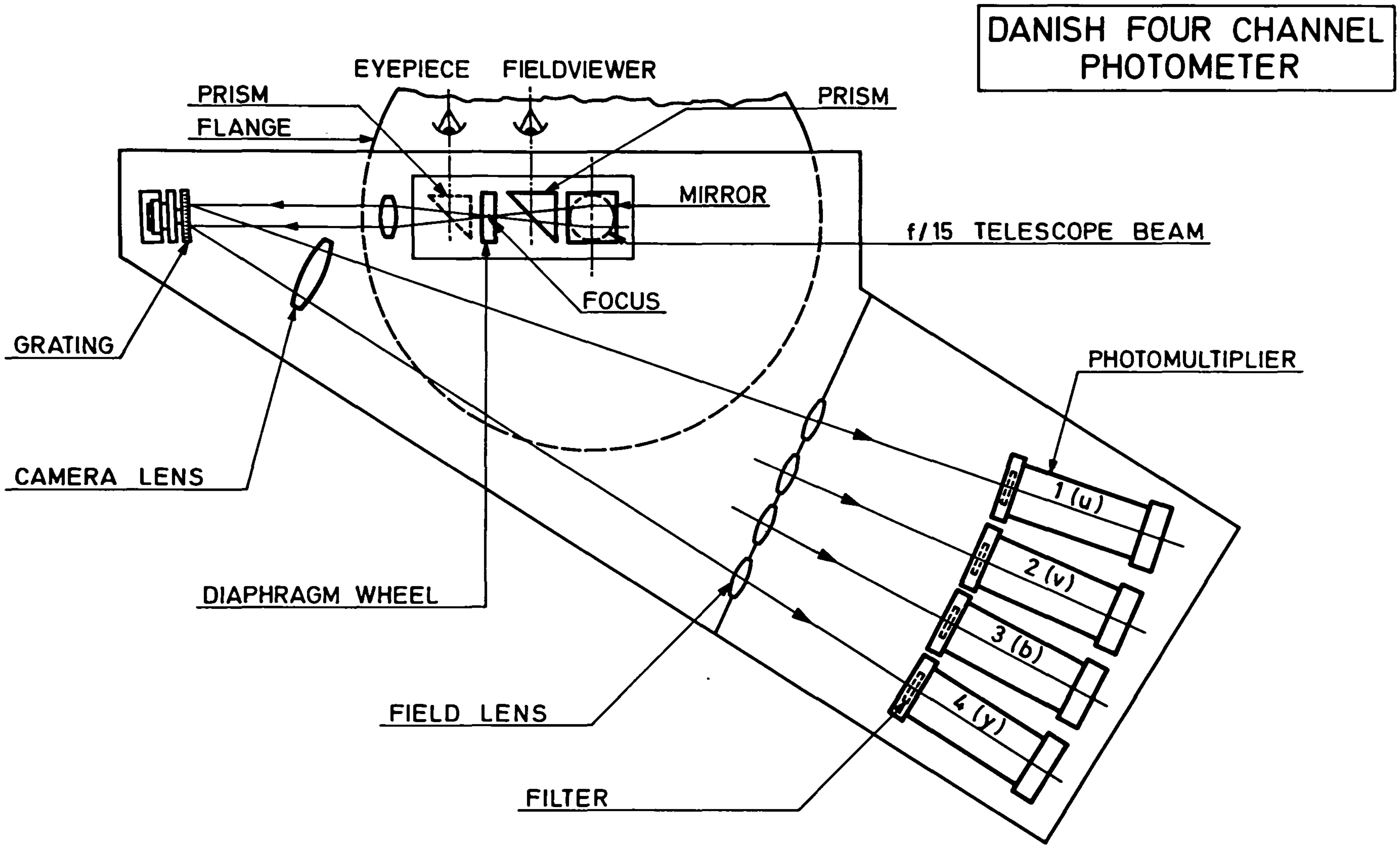
DIAPHRAGMS

Five diaphragms are available with diameters as follows:

	I	II	III	IV	V
Diam. mm	10	1	0.5	0.35	0.2
Diam. arcsec	300	30	15	10	6

PHOTOMULTIPLIERS

Four photomultipliers, type EMI 6256 are used. They have 10 mm diameter photocathodes. The photomultipliers are not refrigerated, and the dark current is typically 10 to 20 counts per second. The high voltage supply, normally 1600 volts is adjustable for each photomultiplier to ensure maximum performance. This system has proved to be remarkably stable and relative drifts in photomultiplier sensitivities are typically a few thousandths of a magnitude during the night.



DANISH FOUR CHANNEL PHOTOMETER III.B.8.FIG.1.

MAGNITUDE LIMITS

During ordinary use, the telescope must never be pointed to objects brighter than $V = 3^m$ or to daylight sky. This is *important* as the instrument has *NO DARK-SLIDE*, but uses a blank position in the diaphragm wheel.

An idea of the expected performance is given in Table 1, where t_{star} and t_{sky} are integration times and Iu, Iv, Ib, and Iy are object counts. The uncertainty in the counts given are the internal errors to be expected from the photon statitistics

$$= \sqrt{I_{star + sky} + \frac{(t_{star})^2}{t_{sky}} I_{sky}}$$

OUTPUT DEVICES

The Danish 50 cm telescope employs a general purpose multichannel photon counting system and digital acquisition system, (see section III.B.8.1).

The data is output on paper tape, code ASCII.

Table 1

The Danish Four Channel uvby Photometer

Object	m_y	Sp T	z	t_{star}	t_{sky}	I_u	I_v	I_b	I_y
Japetus	11.7^m	G2V	48°	480s	120s	7053 ± 193	24354 ± 253	34469 ± 263	18089 ± 193
+27°80	8.9	KOIII	60	420	120	27809 ± 222	160918 ± 440	329570 ± 594	227663 ± 490
HR3306B	11.2	GOV	36	640	160	22392 ± 253	66208 ± 344	80744 ± 356	42142 ± 250
HD59932	9.1	FOIII	21	90	30	24358 ± 172	88044 ± 308	90806 ± 311	40100 ± 207
-81°89	9.1	A5	52	80	40	16165 ± 139	65450 ± 265	70826 ± 271	35311 ± 194
-37°605	9.7	AO	9	90	30	14174 ± 135	54465 ± 246	54051 ± 241	23291 ± 161
-63°142	10.0	F5	33	160	40	17152 ± 167	55108 ± 261	61356 ± 267	29376 ± 186

III.B.8.1-THE DATA ACQUISITION SYSTEM AT THE 50 CM DANISH TELESCOPE

INTRODUCTION

A general purpose multichannel photon counting system and a digital data acquisition system are the main components of the instrumentation for the 50 cm Danish telescope, intended for photoelectric photometry. The system is used for both the Hβ photometer, (see section III.B.7), and for the uvby four color photometer, (see section III.B.8).

The general concept of the system is designed to facilitate: 1) application to other auxiliary systems; 2) interfacing with other types of output media; and 3) expansion for future needs, (see "R. Florentin Nielsen: A General Purpose Multichannel Photon Counting System"*.).

DESCRIPTION

Fig.(1) illustrates the compound photon counting and data acquisition system used with the uvby four channel photometer. All four photomultipliers are fed from a common regulated high voltage supply. The anode of each photomultiplier is coupled to a pulse amplifier and pulse height discriminator, the output of which is taken to a six (6) decade main counter via a signal gate. The signal gate is opened and closed by the timer/programmer. The main counters' contents are shown on numerical displays. The main counter also contains data transfer gates which, via the read out control unit, can transfer the contents of the counter selected to the data bus.

The data bus in turn receives all the relevant digital information and controls the output media, i.e., a paper tape punch.

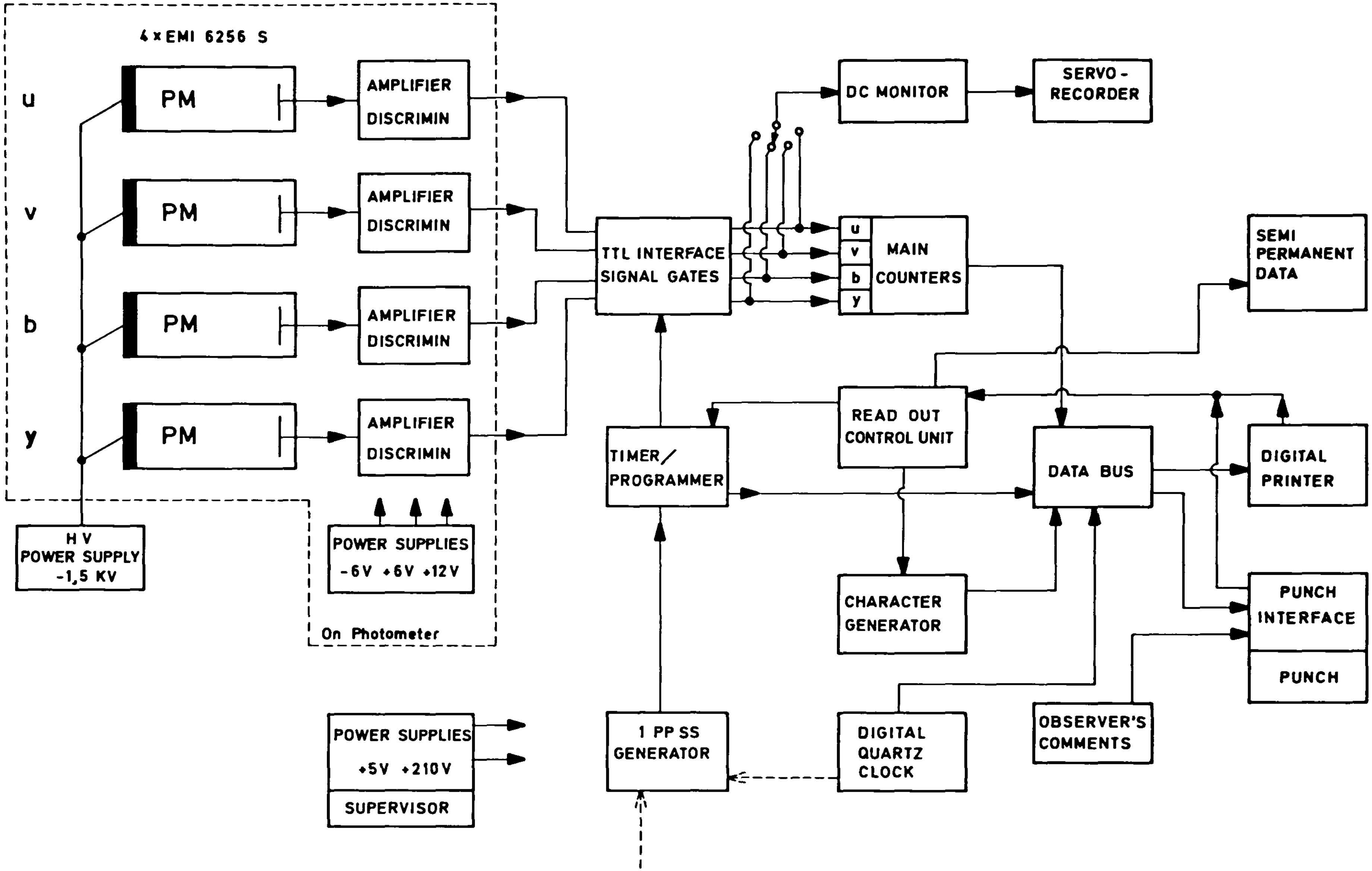
The threshold level of the pulse height discriminator is preset and hence the pulse amplifier and discriminator require no handling.

SYSTEM OPERATIONS

The integration time, T, is selected by means of the two thumbwheel switches labeled T:

$$1 \text{ sec} \leqq T \leqq 99 \text{ sec}$$

To perform an observation, simply press "START". This button is duplicated on the telescope itself. The light admitted into the photometer is then measured



PHOTON COUNTING SYSTEM APPLIED TO STRÖMGREN 4 - COLOUR PHOTOMETER

III. B. 8. 1. FIG. 1.

in the four color system and the results are output on the paper tape punch.

A four digit identification number of the object being observed can be entered by means of the thumbwheel switches, labeled "NUMBER".

The sidereal time (or U.T. if selected) for the time of termination of the integration time is also output.

Comments may be added as a binary code by means of three pushbuttons, marked "COMMENTS". The following format is a typical example:

integration time	0	0101861	identifier
output of four channels	1	0440412	
	2	0546696	
	3	0423739	
	4	0181095	ST or UT
	5	0225442	

The first column contains a line or channel identification number, 1, 2, 3, 4 meaning u, v, b, y; "0" meaning actual integration time (first three digits) and "5" meaning sidereal time. The last four digits are the star identification number.

In the first example: 0 0101861

T = 10 seconds

star number = 1861

count in channel 3 (b) = 423739 photoelectrons

sidereal time = $22^h\ 54^m 42^s$ at the end of integration time

The punch output also contains a comment, e.g. a decimal number 0 - 7, reproduced in the first line of a single observation (integration). This number agrees with the binary code selected on the comments switches for that observation.

DEAD TIME

Due to the statistic nature of the physically fundamental events (the time arrival of a photon) any photon counting system is associated with a certain effective dead time, t_d, which must be used to apply a dead time correction to the counted number of photoelectrons, N:

$$N_t = \frac{N}{1 - \frac{N}{T} \cdot t_d}$$

Here, N_t is the true (corrected) number of photoelectrons arrived, and T is the integration time.

The effective dead time, t_d, takes account for properties of the photomultiplier, the pulse amplifier and discriminator, the conversion and counting circuits. It is important to notice that t_d is therefore in general greater than what is specified for a given pulse amplifier and discriminator.

"t_d" is properly determined from dynamic measurements with the entire system. As such and with the EMI 6256 photomultipliers at the specific operating conditions, the effective dead time of the system, $t_d = 6.5 \times 10^{-8}$ sec.

* Florentin Nielsen, 1973 Internal ESO Report.

III.B.9-THE 4 CHANNEL PHOTOMETER/POLARIMETER

INTRODUCTION

This photometer is mounted at the Cassegrain focus of the 3.6 m telescope. It is designed to carry out simultaneous four color photometry or polarimetry.

The photometer is shown schematically in Fig. (1) and consists of the following components given in the order in which they are encountered al g the optical axis.

- diaphragm wheel
- chopper
- collimator
- rotating $\lambda/2$ or $\lambda/4$ plate
- dichroic mirror
- filter
- vacuum chamber
- Fabry lens
- photomultiplier

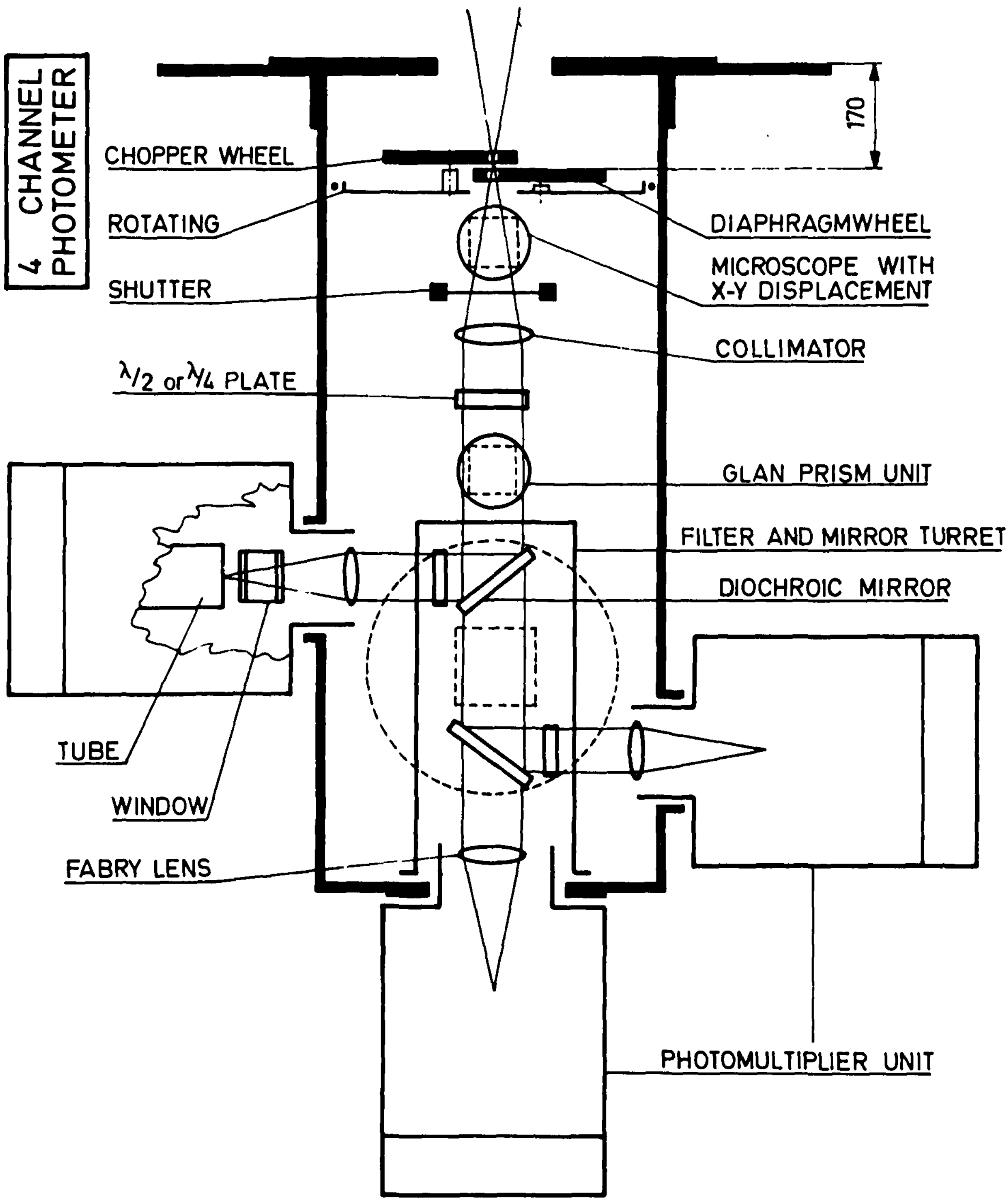
The dichroic mirrors and filters together define the photometric pass-bands. They are mounted in interchangeable units. The following systems can be used:

Stromgren	Johnson	Hydrogen Lines
uvby	UBV	HβW/N, HγW/N

Because the dichroics are mounted at 45° they introduce some polarization. In order to remove any bias in the photometry of polarized objects a rotating super-achromatic half wave plate is placed before the mirror-filter set. This effectively scrambles the polarization.

A Glan prism can be manually inserted to modulate the starlight intensity if polarization is present. Here the extraordinary beam passes through the prism while the ordinary beam is diverted into a light trap.

Six of the diaphragms are double which allows simultaneous star/sky observations in the chopping mode.



4 CHANNEL PHOTOMETER III.B.9.FIG.1.

Apr. 80

The instrument works well in the narrow band mode but difficulties have been experienced in reproducing the UBV system. The transformation in UBV works well providing U-B ≤ -0.2. This appears to be due to the U cut off which does not contain sufficient of the stellar Balmer jump. As the U pass-band is defined by a mirror-filter combination the problem is not easily soluble. A single channel UBV photometer is under construction and will be available by the end of 1979.

The photometer uses pulse counting and is controllable through a CRT terminal in the control room or a handset in the Cassegrain cage. The instrument may be operated in one of 3 modes:

1) normal photometry
2) chopper photometry
3) polarimeter

DIAPHRAGMS

The following diaphragms are available:

Number	0	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Size in mm	8.4	6.3	4.2	2.8	2.1	1.75	1.4	1.05	.7	0.4	.7	1.0	1.4	1.9	0
				SINGLE							DOUBLE				
Size in arcsec	60	45	30	20	15	12.5	10	7.5	5	2.9	5	7.2	10.7	13.7	-

The double diaphragms are separated by 6.3 mm or approximately 45 arcsecs.

The diaphragms may be selected by remote control from the control cabin.

CHOPPER

The chopper is used with double apertures when observing in the star-sky mode. It rotates at 50 Hz and is synchronized to the rotation speed of λ/2 plate which is 12.5 Hz.

HALF WAVE PLATE

The λ/2 plate is driven at 12.5 Hz. It has a 64 position encoder and may be used in one of two modes:

1) Photometry in which case the mean value for the 64 positions is given.

2) Polarimeter mode - Here the counts per position or channel are given.

DICHROIC MIRRORS AND FILTERS

The mirrors and filters are mounted in interchangeable units. The following units are available:

		Unit	
Stromgren	u v b y	1	System is illustrated in Fig.(2)
Johnson	U B V	*2	System is illustrated in Fig.(3)
% Transmission	60 70 60		

Unit 3	λ central	Δλ	% Transmission
Hβw/n	4861/4861	150/30	12/30
Hγw/n	4341/4341	150/30	23/30

* Note only usable for U-B $\leq$ -0.2

PHOTOMULTIPLIERS

Four (4) RCA 8575 bialkali (K-Cs-Sb) photomultipliers are used. These are each in special dry ice cold boxes and are insulated from the main photometer by quartz vacuum chambers.

The present photomultipliers are used uncooled and give a typical dark count of 30 c/sec.

VIEWFINDERS

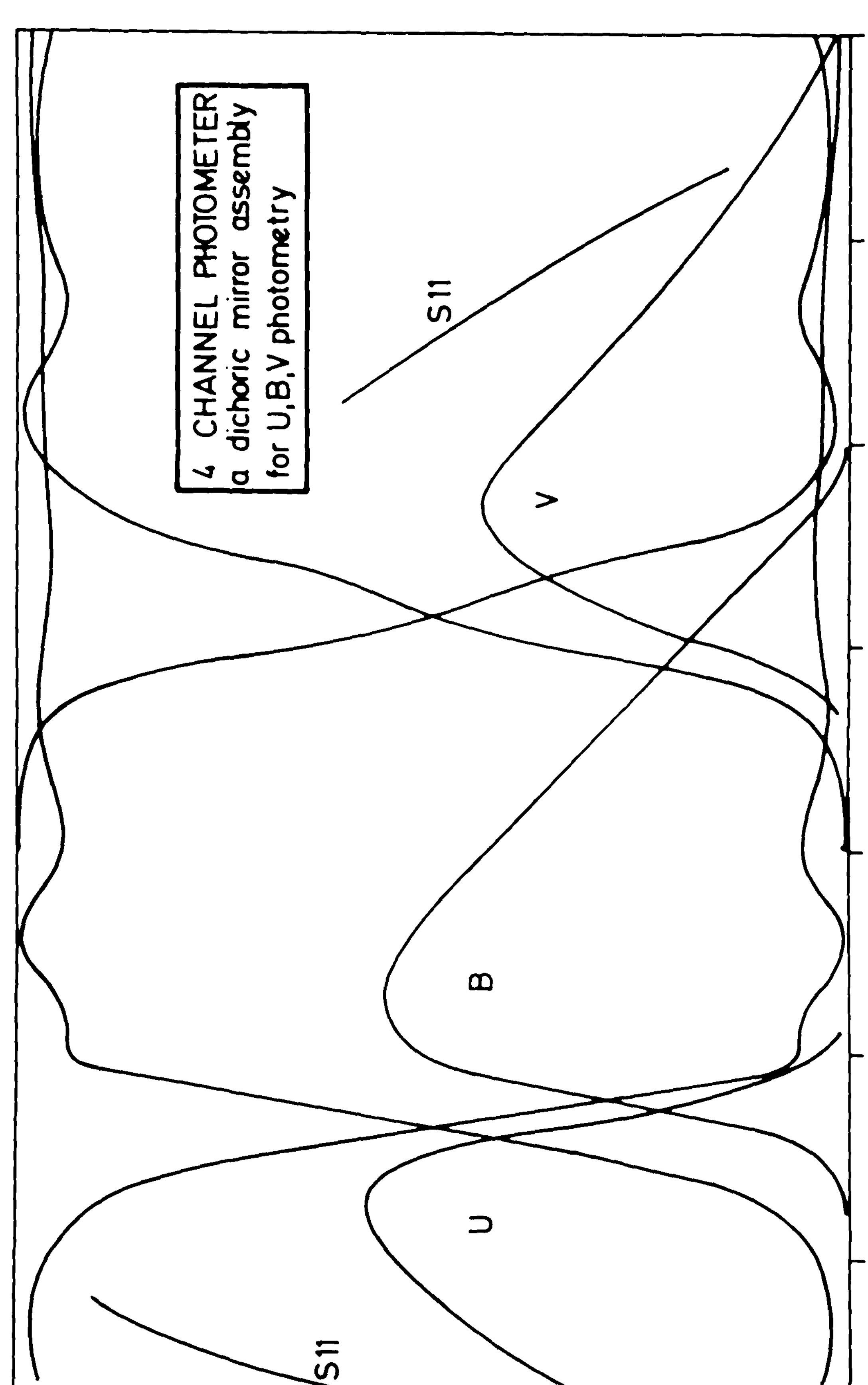
A microscope can be inserted into the beam to control and adjust the position of the star in the diaphragm. This can only be done from the Cassegrain cage. However, normally the object is located through the LF (large field) of the Cassegrain adaptor, (see II.A.1.2) and guiding is achieved by use of the GP (guide probe).

LIMITING MAGNITUDES

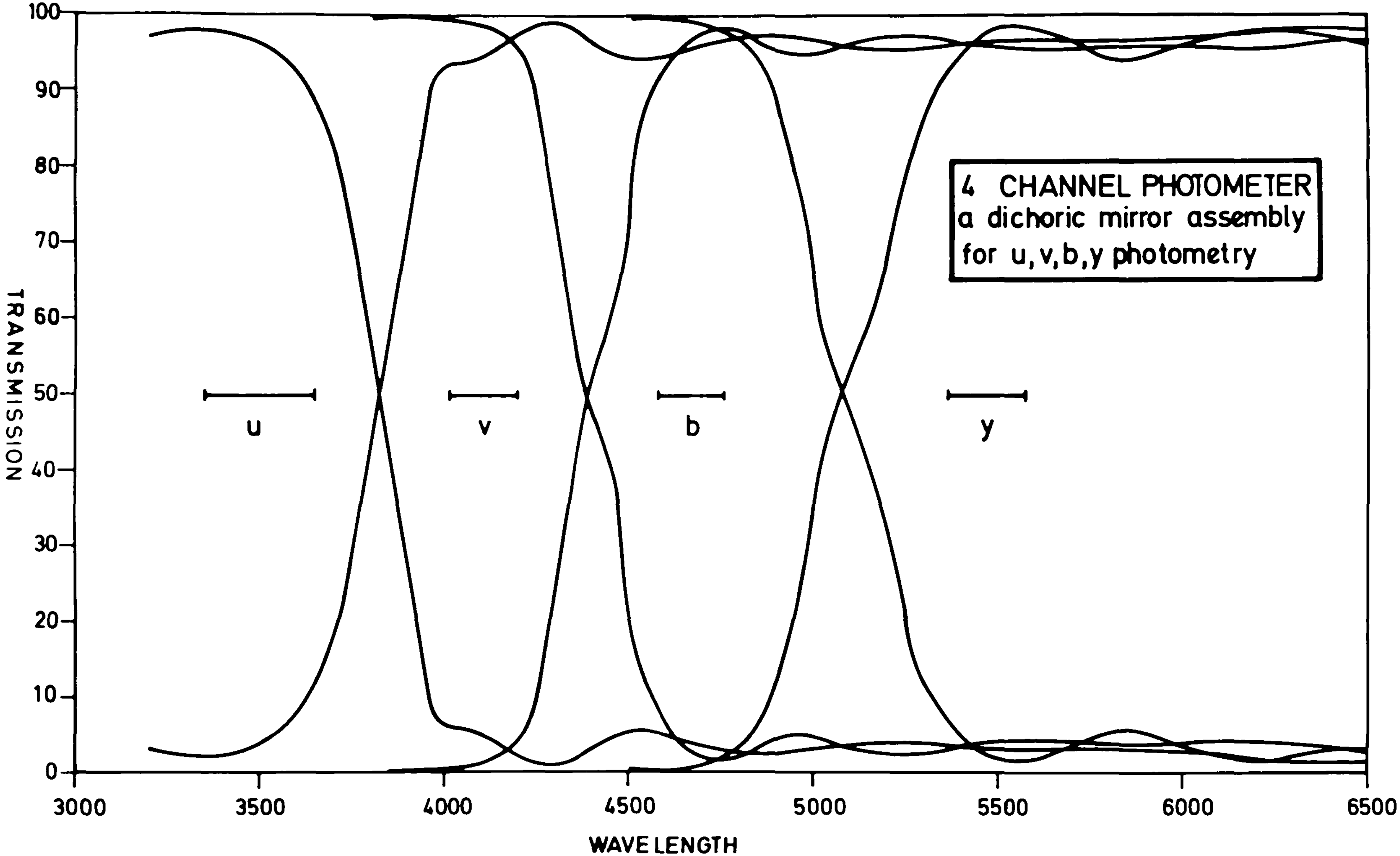
Program and standard stars should not be brighter than $V = 8^m$. This is to avoid photomultiplier blending.

DATA OUTPUT

Output can be on magnetic tape (ASCII) and/or line printer. The data is also


4 CHANNEL PHOTOMETER
a dichoric mirror assembly
for U,B,V photometry
S11
U
B
V
S11
TRANSMISSION
WAVELENGTH
0
10
20
30
40
50
60
70
80
90
100
3000
3500
4000
4500
5000
5500
6000
6500

III B. 9. FIG. 2.


4 CHANNEL PHOTOMETER
a dichoric mirror assembly
for u, v, b, y photometry
TRANSMISSION
WAVE LENGTH
u
v
b
y
0
10
20
30
40
50
60
70
80
90
100
3000
3500
4000
4500
5000
5500
6000
6500

III.B.9.FIG.3.

displayed on the CRT-terminal. For observatory supported photometry systems, the magnetic tape can be edited and the data reduced at the observatory. The observer should normally consider staying one or two days after the observing run in order to complete the data reduction.

III.B.10-DANISH 1.5 M FOUR CHANNEL PHOTOMETER

INTRODUCTION

The four channel photometer is shown schematically in Fig.(1). It is designed for simultaneous measurements in the Strömgren four color system, (u, v, b, and y). The light from a star, after passing through the diaphragm wheel, is collimated and dispersed by a Littrow mounted grating. The grating has 1200 gr mm^{-1}, blazed at 17.5°, and gives a linear dispersion of 20 Å mm^{-1}. The light then passes to four photomultipliers, each preceded by a slot in the camera focal plane which defines the passband. No wavelength defining filters are used in this system. The square passbands defined by the slots are as follows:

u	3358 - 3660 Å
v	4024 - 4213 Å
b	4561 - 4795 Å
y	5319.5 - 5606 Å

In order to carry out photometry on bright standard stars, an optional neutral density filter (≈ 10% transmission) can be mounted in front of the diaphragm wheel. Other neutral filters can be mounted in front of the v (≈ 50% transmission) and b (≈ 50% transmission) channels as these normally have the highest signal. Furthermore, an optional depolarizer (90% transmission) may be mounted in front of the diaphragm wheel.

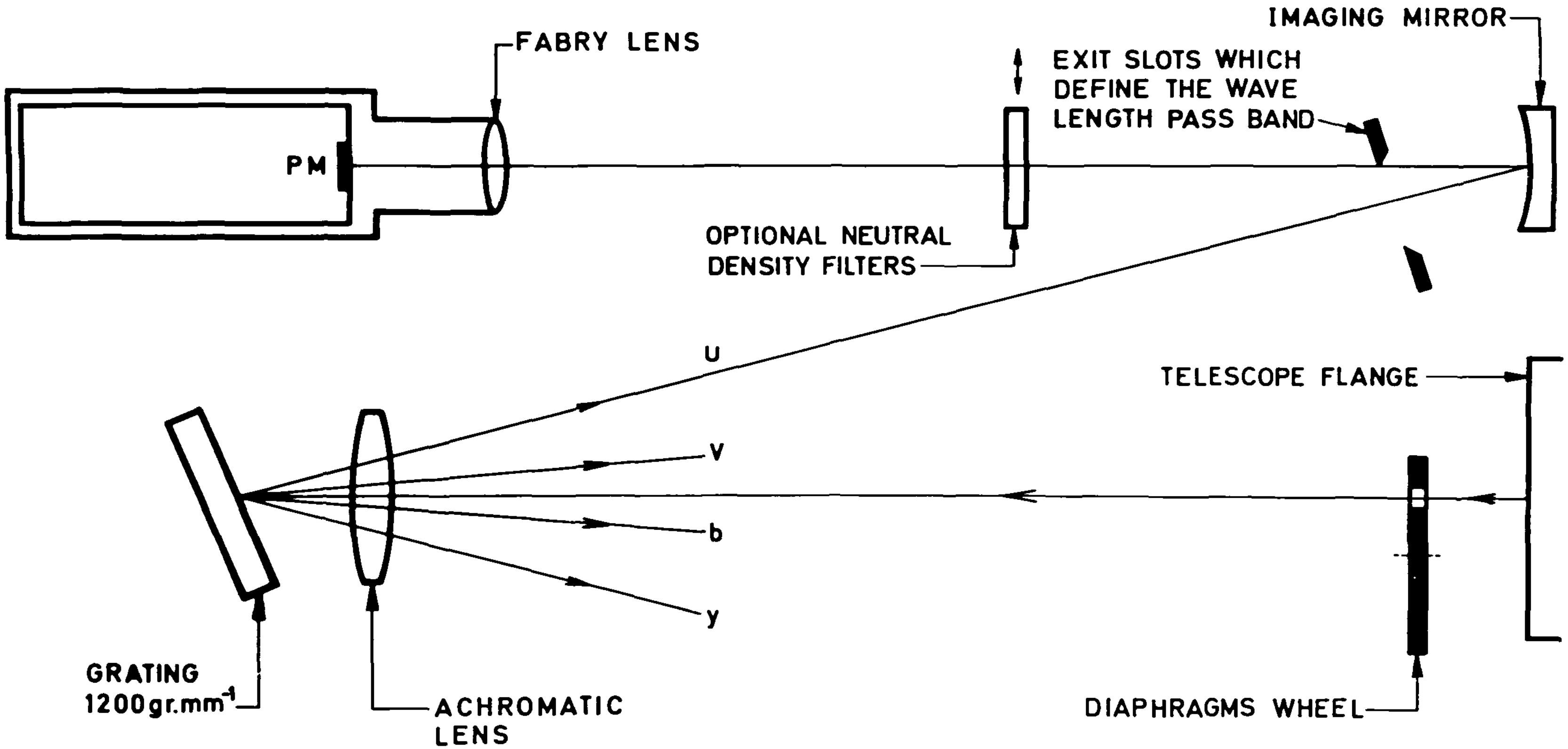
VIEWFINDER

The photometer mounts on the 1.5 m instrument adapter, see section II.J.1. The adapter houses a field viewer with a field of 3.5 x 3.5 $arcmin^2$ and a Quantex integrating TV system The TV system is also used via a periscope system for centering the star in the photometer diaphragm.

DIAPHRAGMS

Six diaphragms are available as follows:

Diam mm	1.0	2.0	0.25	0.45	0.6	7.0
Diam arcsec	16	32	4	7	10	110



THE DANISH 1.5M FOUR CHANNEL PHOTOMETER. III.B.10.FIG.1.

Apr.80

PHOTOMULTIPLIERS

Four photomultipliers, type EMI 9789QA are used, operated at ambient temperature. They are fed by a common voltage supply, but individual voltage drop resistors ensure that each photomultiplier receives the optimal voltage which is presently 1150 volts.

Typical dark counts at 15°C are 10 to 30 counts sec^{-1}.

BRIGHTNESS LIMIT

Stars brighter than V = 6.5 mag should not be observed.

TYPICAL COUNT RATE

The following typical count rates can be used to estimate integration times. The rates given are without any neutral filters.

Counts per Sec for the uvby Photometer

	u	v	b	y	Remarks
Star, V = 15, F5V	70	140	190	55	unreddened star
Star, V = 15, B5V	190	270	260	55	unreddened star
Sky + Dark (no moon)	25	55	40	15	10 arcsec diaphragm
Sky + Dark (full moon)	180	220	240	50	10 arcsec diaphragm
Dark	8	30	12	2	ambient temp. 12°C

OUTPUT DEVICES

The data output is on paper tape in ASCII. A description of the system is given in section III.B.8.1.

III.B.11-DANISH 1.5 M Hβ PHOTOMETER

INTRODUCTION

The photometer is mounted at the Cassegrain focus of the Danish 1.5 m telescope. It is a two-channel instrument for simultaneous measurements of the Hβ line through a narrow and a wide filter (HβN, HβW). The light is distributed to two (2) photomultipliers by means of a beam splitter which allows approximately 80% of the light to reach the narrow filter, resulting in the counting rates for the two channels being similar. The photometer is shown schematically in Fig.(1).

VIEWFINDER

The photometer is mounted on the 1.5 m instrument adapter, see section II.J.1. The adapter houses a field viewer with a field of 3.5 x 3.5 arcmin^2 and a Quantex integrating TV system. The TV system is also used via a periscope system (1' x 1' arcmin^2 field) for centering the star in the photometric diaphragm.

DIAPHRAGMS

Six diaphragms are available with diameters as follows:

Diam mm	6	2	1.2	0.6	0.45	0.25
Diam arcsec	100	30	20	10	7	4

PHOTOMULTIPLIERS

Two EMI 9789 QAs are operated at ambient temperature. They are fed by a common high voltage supply, 1040 volts, but individual resistors ensure that each photomultiplier gets the optimum voltage. The dark count rate at 15°C is typically 10 to 20 counts sec^{-1}.

NEUTRAL FILTER

A neutral density filter can be inserted before the entrance diaphragm so that it affects both channels. This is useful to enable measurements of bright standard stars. The filter transmission is approximately 10%.

BRIGHTNESS LIMIT

Stars brighter than V = 4.0 should not be observed. Typical count rates are given in Table 1.

Table 1

Counts per Sec for the Hβ Photometer

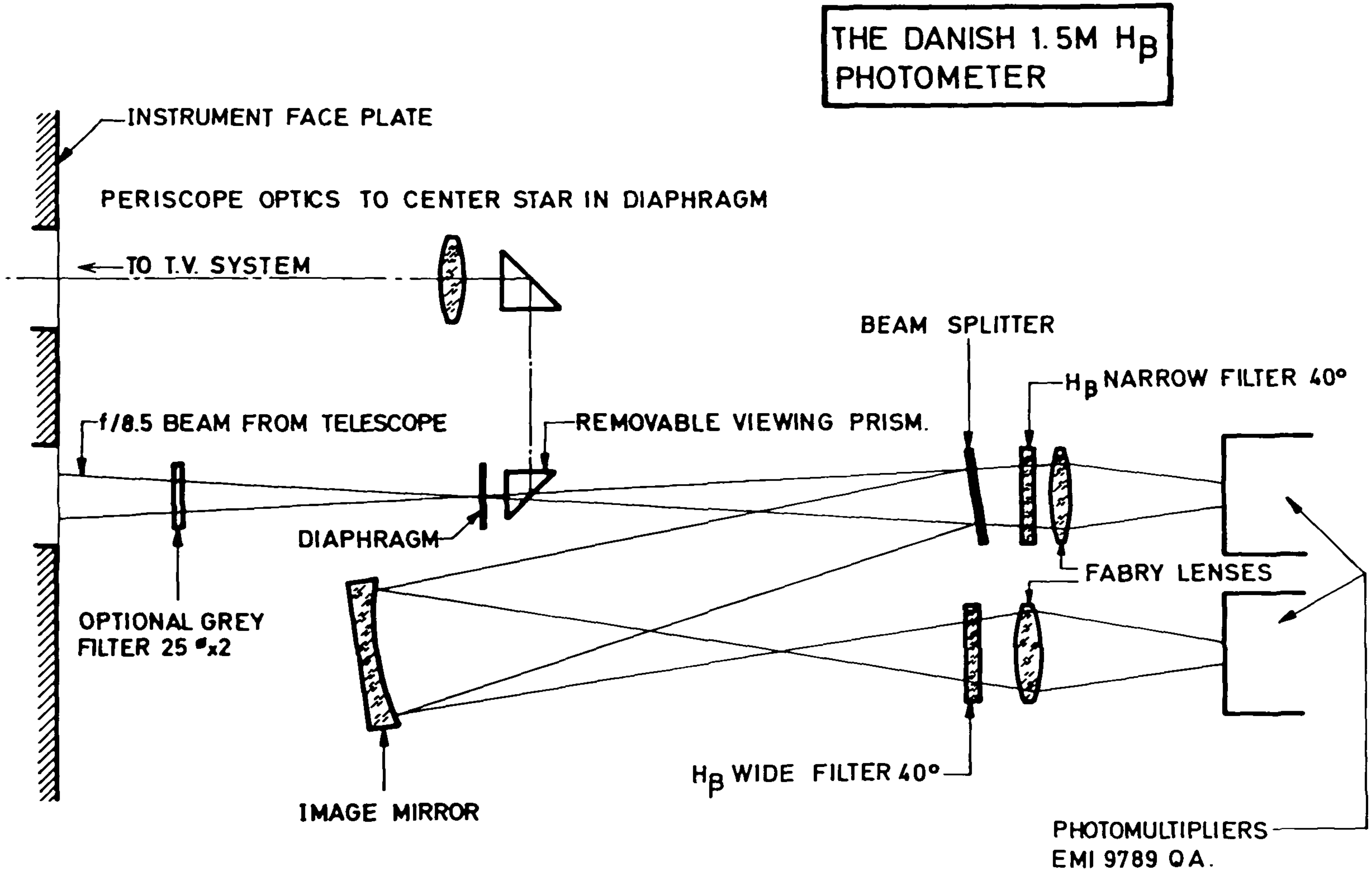
	Hβ Narrow	Hβ Wide	Remarks
Star, V = 14, F5V	50	45	unreddened star
Star, V = 14, B5V	55	50	unreddened star
Sky + Dark (no moon)	11	16	10 arcsec diaphragm
Sky + Dark (full moon)	40	42	7 arcsec diaphragm
Dark	7	13	ambient temp. 12°C

OUTPUT DEVICES

The data output is on paper tape in ASCII. A description of the system is given in section III.B.8.1

Apr. 80

THE DANISH 1.5M H_β PHOTOMETER



III.B.11.FIG.1.

III.B.12-THE WALRAVEN VBLUW PHOTOMETER

INTRODUCTION

The photometer is shown schematically in Fig.(1) and is mounted at the Cassegrain focus of the Dutch 91 cm telescope (section II.I.1). The instrument might more correctly be described as a spectro-photometer. Instead of filters, two quartz prisms are employed to create the photometer passbands The prisms have bases 70 mm long and apex angles of 72°giving a dispersion of 75 Å mm^{-1} at λ4100. This corresponds to 5 Å $arcsec^{-1}$ at the stellar image. In order to avoid changes in the passbands due to seeing effects and movement of the star in the entrance diaphragm, an ingenious beam splitter is used which creates a series of bright and dark bands across the spectrum which are used to define the passband limits. The details of the beam splitter are shown in Fig. (2). The light beam is separated into two beams by a double refracting calcite prism. The resulting beams have planes of polarization inclined at +45° and -45° relative to the symmetry plane of the photometer. The beams are then made parallel by a quartz prism and then pass through crystal quartz rotators which rotate the polarization planes in one beam clockwise and the other counterclockwise. The amount of rotation depends on the wavelength and is proportional to the thickness of the quartz rotator. At certain wavelengths then, the planes of polarization of both beams will be 0° and at other wavelengths, both polarization planes will be perpendicular to the plane of symmetry. The beams are recombined in a second calcite quartz prism. The resulting beams have therefore superimposed complementary bright and dark bands which are used as the defining edges of the photometer passbands.

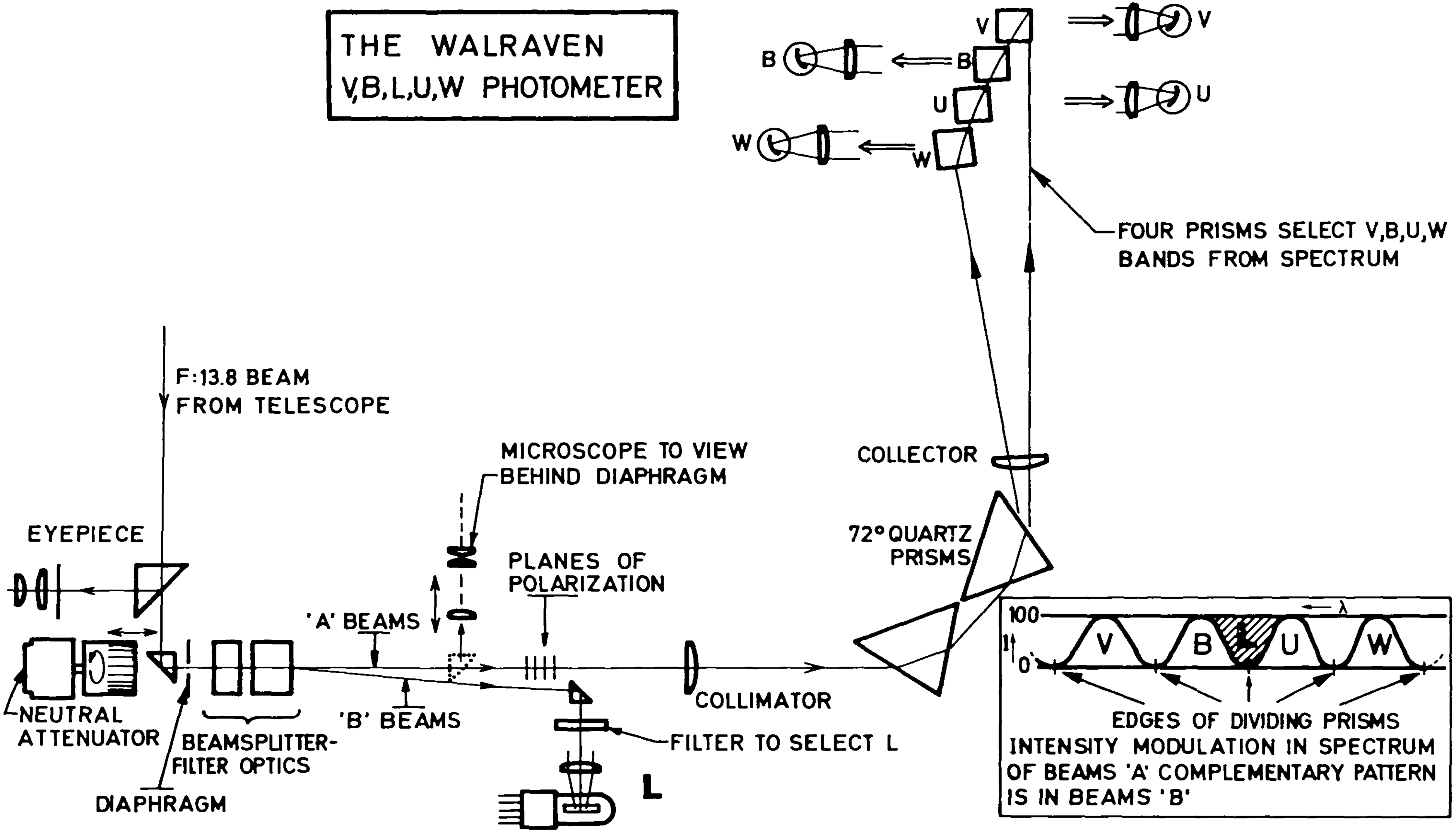
It is estimated that the transmission coefficient of the entire spectro-photometer is approximately 70%.

A neutral attenuator consisting of a slotted rotating drum (25 c/sec) can be placed in the beam producing approximately 3^{mag} attenuation.

The instrument is described in detail in Walraven and Walraven (1960) and Rijf, et.al. (1969). Information on its photometric applications, etc. can be found in Lub and Pel (1977).

PASSBANDS

The instrument passbands are given in Table 1 and were determined by Lub and Pel at La Silla in 1979.



THE WALRAVEN V,B,L,U,W PHOTOMETER III.B.12.FIG.1.

Apr.80

Table 1

Walraven Passbands

% Relative Transmission	V	B	L	U	W
0	6600	4783	7190	3894	3398
50	5783	4494	3952	3735	3313
100	5413	4262	3845	3614	3232
50	5078	4062	3738	3504	3157
0	4783	38[illegible]	3616	3398	3073
λ eff Å	5422	4270	3845	3617	3234
Δλ Å	705	432	214	231	156

VIEWFINDER

The field of view through the photometer eyepiece is ≈ 8 arcmins. Good optical definition is obtained over ≈ 5 arcmin.

DIAPHRAGMS

The diaphragms are mounted in a slide and are as follows:

Table 2

Diaphragms arcsecs

5.8	8.3	11.6	16.5	21.5	28.1	34.7

PHOTOMULTIPLIERS

The photomultipliers are dry ice cooled Hamamatsu R 928 S-20s with side windows. These replace the 1P21s. The photomultipliers when cooled produce a dark current of typically 2 electrons sec^{-1} at the cathode.

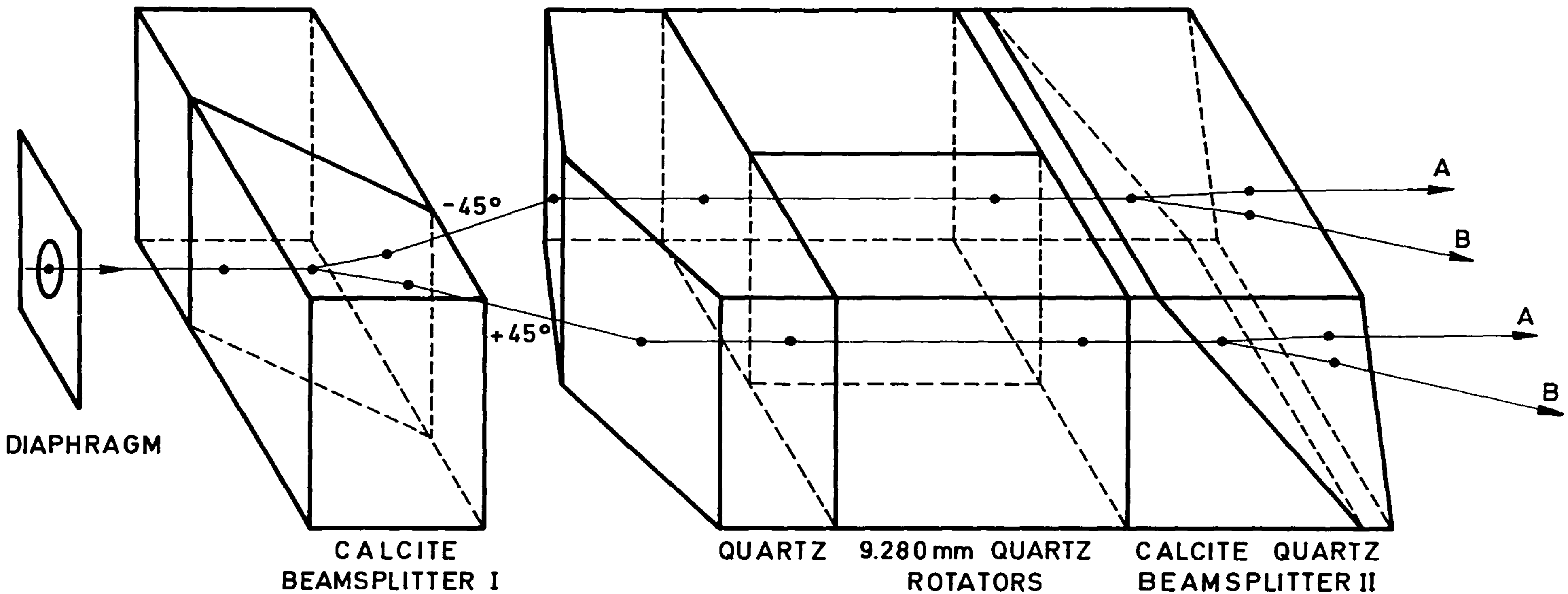
DATA ACQUISITION

A DC data acquisition system is used. Each photomultiplier has an integrator which incorporates a set of 3 auto-ranging condensors. At the end of each measurement, the 5 channels are read out sequentially by a digital voltmeter. Each measurement normally consists of two such integrations in between and afterwards

Apr. 80

FILTER OPTICS OF THE WALRAVEN FIVE-CHANNEL PHOTOMETER
III.B.12.FIG. 2.

FILTER OPTICS OF THE WALRAVEN
FIVE-CHANNEL PHOTOMETER



the integrators are shorted automatically. This causes a delay of at least 4 seconds. The minimum integration time is 1 sec increasing in powers of 2, e.g., 1, 2, 4, 8 sec, etc. The data is presently recorded on two cassette tape units and can only be reduced in Leiden. This reduction facility is available to ESO observers and they should contact directly Dr. J. Tinbergen. However, later this year ESO will install a computer, tape unit, and fast printer which will eventually give on-line reduction.

BRIGHTNESS LIMIT

With saturation of the condensors, stars from 15^m to 5 mag can be measured. However, for very bright stars, the mechanical optical attenuator - a rotating drum with slots can be introduced into the light beam giving roughly 3 mag attenuation. In this way, a dynamic range of 2 mag to 15 mag is assured. The system is capable of an overall accuracy of 1%. Typically, an unreddened 15 mag BO star can be measured in all channels with a 1% statistical accuracy in 5 min assuming a small diaphragm is used and a dark sky. The limit on the integration time is set, of course, by the W channel.

Walraven, Th, and Walraven, J.H., 1960 BAN, 15, 60.
Rijf, R., Tinbergen, J., Walraven, Th., 1969 BAN, 20, 279.
Lub, J., Pel, J.W., 1977, Astron. & Astrophys., 54, 137.

III.C.1-POLARIMETER

INTRODUCTION

The two channel polarimeter can be mounted at the Cassegrain focus of the ESO 1 m or 50 cm telescope. The instrument is shown schematically in Fig.(1). It consists of:

1) offset guider/finder
2) filter wheel
3) $\lambda/2$ plate or $\lambda/4$ plate
4) diaphragm slide
5) Wollaston prism
6) two (2) photomultipliers

OFFSET GUIDER/FINDER

The guider is equipped with a wide field viewfinder. Offset guiding is achieved by adjusting the eyepiece with two micrometer screws over a square field of 12 x 12 arcmin (1 m) or 25 x 25 arcmin (50 cm).

FILTER WHEEL

The filter wheel has six positions but normally only UBV filters and a U cut off filter are provided by ESO. The filters are 20 mm in diameter and up to 3 mm thick. Filter selection is manual. Up to three additional filters 1" x 1" and up to 6 mm thick may be placed in a special filter holder also available. The transmissions of the UBV filters deviate somewhat from the UBV standard system. However, transmission curves can be provided by ESO.

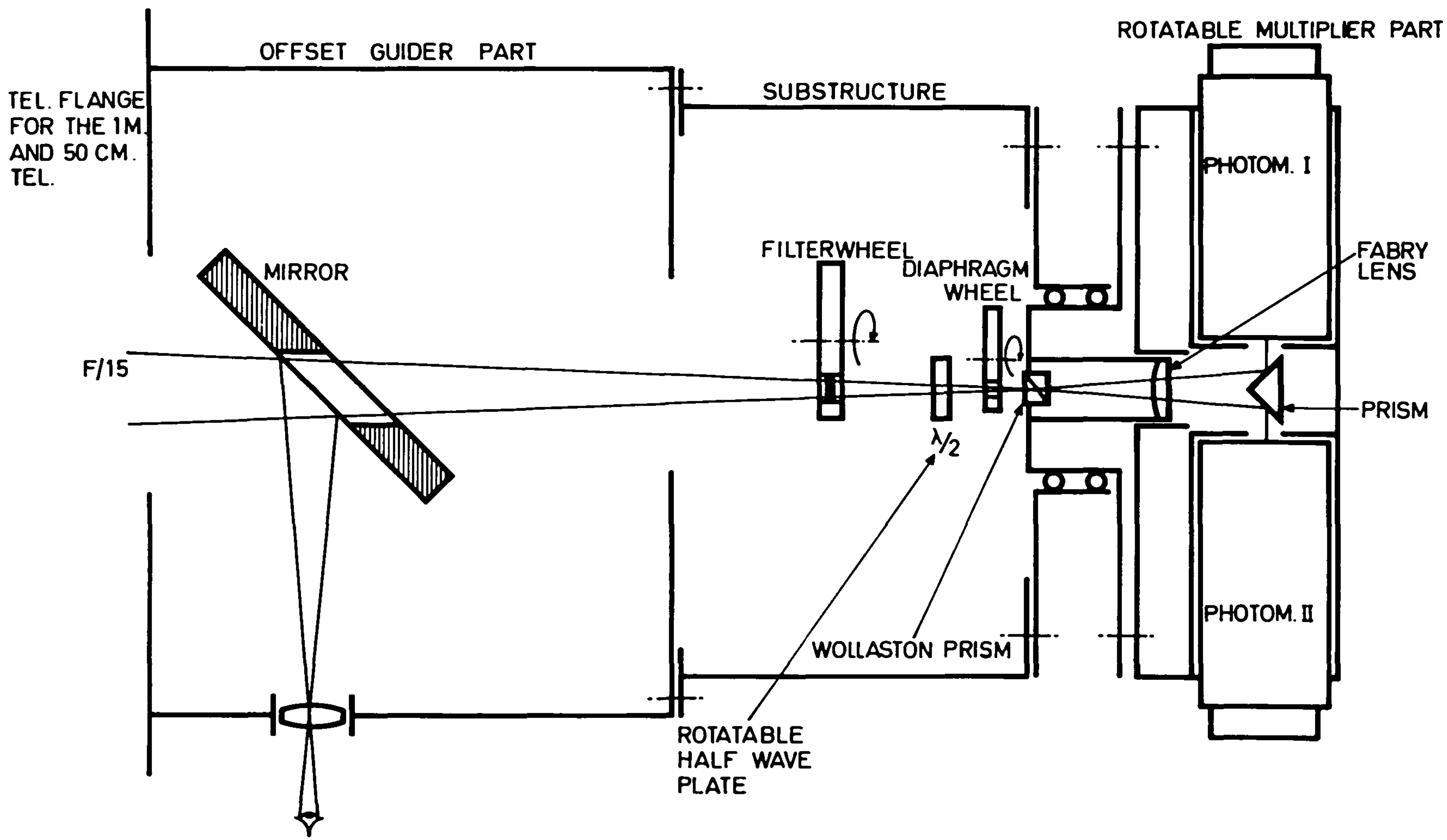
$\lambda/2$ PLATE AND $\lambda/4$ PLATE

These plates have the following properties:

a) modulation factor > 0.993
b) superachromatic from 3700 Å to 7500 Å
c) homogeneous over the whole surface

Apr. 80

ESO POLARIMETER



ESO POLARIMETER III.C.1.FIG.1.

Note that the position of the optical axis is dependent on wavelength.

The plates are rotated automatically under computer control in 16 steps of 22.5°. The minimum integration time per step is one second.

DIAPHRAGM SLIDE

The diaphragm slide has three fixed apertures corresponding to:

Aperture N°	1	2	3
1 m arcsec	7	14	35
50 cm arcsec	14	28	70

WOLLASTON PRISM

After passing through the $\lambda/2$ or $\lambda/4$ plate, the light beam is split into its "ordinary" and "extraordinary" components by the Wollaston prism. These beams are focused onto separate photomultipliers.

DATA ACQUISITION

The data acquisition system is similar to the ESO 1 m and 50 cm photometers, see section III.B.2. The telescope and polarimeter are operated through a single display console in the dome. There are also facilities for storage of star catalogs. Up to 374 star coordinates may be stored at the ESO 1 m and 200 at the 50 cm, (see section III.B.2) and the system will precess any epoch < 2000. For preparation of catalogs, see section III.B.2.

Rough on-line P_x = PCos 2θ and P_y = PSin 2θ are displayed on the console after an observation has been completed.

DATA OUTPUT

Data output may be on magnetic tape, paper tape, and/or line printer. An example of the line printer output is shown in Fig.(2). The data may be reduced at La Silla and the reduction procedure and an example of the output are given in the following section, III.C.1.1.

LIMITING MAGNITUDES

The typical standard deviation of a measurement of an 8th magnitude star at the 1 m telescope with 10 seconds integration time per step in the B filter is: $\sigma p \leq 0.0003$.

For stars of any other magnitude, the approximate accuracy can be estimated by assuming a dependence on photon statistics only. The limits for bright stars are:

$B = 5.5^m$ at the 1 m telescope

$B = 4^m$ at the 50 cm telescope

POLARIMETER DATA OUTPUT- TYPE (1)

Star Sky   α, δ (1 m telescope)   IT

Code   ID   Filter Code

Cold Box Position Code

```
5 HD   154445 STANDARD
6  17    3:56      Ø:49: 7
7   1
1Ø  Ø       1Ø 6 3
```

Ø	13:59:23	1	28Ø52Ø2	298Ø74	Ø.941Ø7
Ø	13:59:35	2	1827772	3Ø72397	Ø.91711
Ø	13:59:47	3	2975935	3ØØ1386	Ø.99142
Ø	13:59:59	4	3Ø23726	29744ØØ	1.Ø1658
Ø	14: Ø:11	5	2944136	313192Ø	Ø.94ØØ4
Ø	14: Ø:23	6	29181Ø2	3184988	Ø.9162Ø
Ø	14: Ø:35	7	3Ø5Ø666	3Ø82286	Ø.98955
Ø	14: Ø:47	8	3Ø833Ø3	3Ø37152	1.Ø152Ø
Ø	14: Ø:59	9	298169	3159Ø85	Ø.94Ø39
Ø	14: 1:11	1Ø	2938328	32Ø7523	Ø.916Ø7
Ø	14: 1:23	11	3Ø43552	3Ø79417	Ø.98834
Ø	14: 1:35	12	3Ø746ØØ	3Ø3Ø838	1.Ø1444
Ø	14: 1:47	13	2952566	3147213	Ø.93815
Ø	14: 1:59	14	293497Ø	32Ø9521	Ø.91446
Ø	14: 2:11	15	3Ø5334Ø	31Ø382Ø	Ø.98337
Ø	14: 2:23	16	3111192	3Ø72243	1.Ø1268

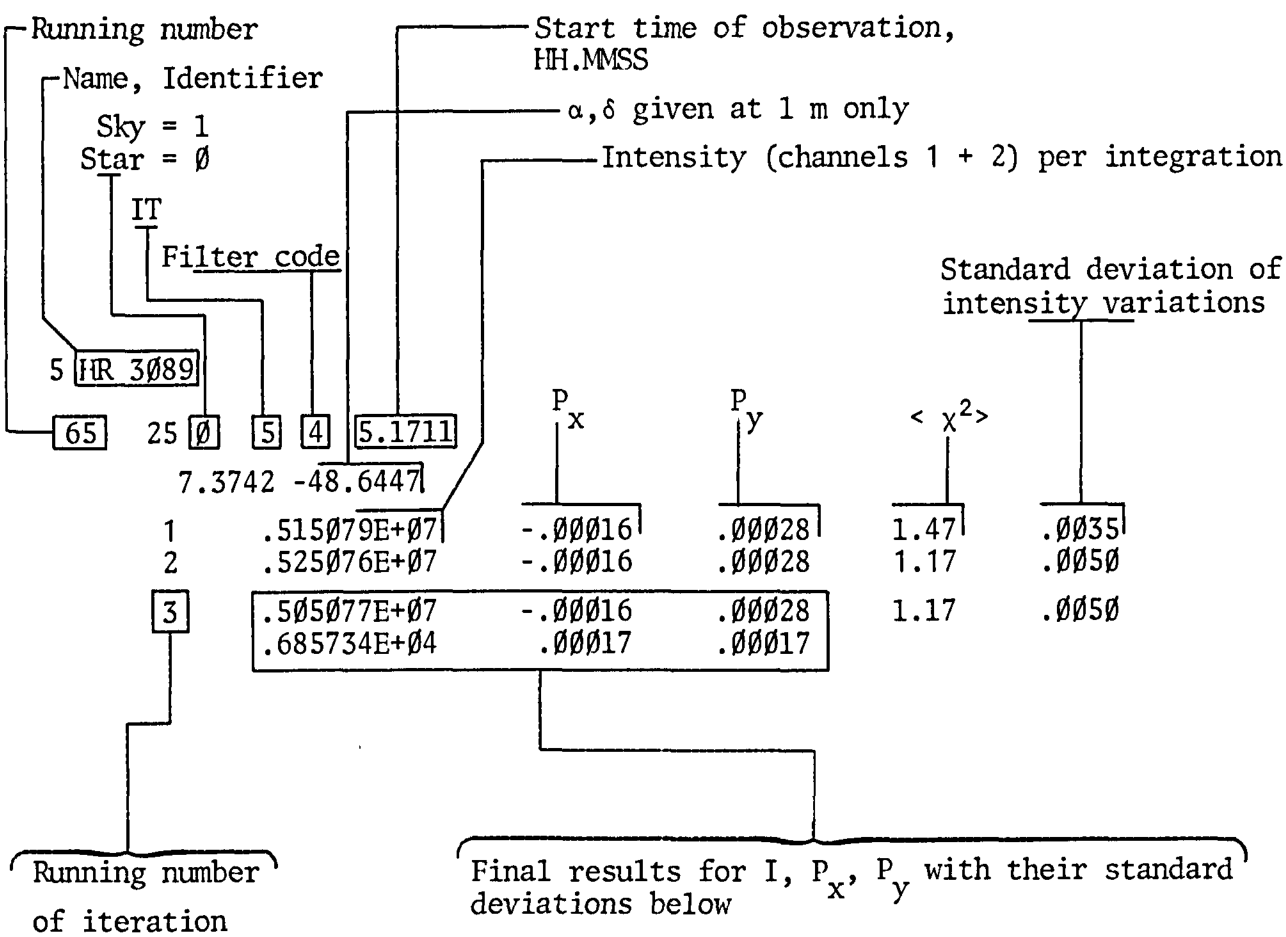
Time of observation

Step number of retarder

Counts in first and second channels, respectively

Quotient of counts in first and second channels

POLARIMETER - REDUCED DATA OUTPUT



III.C.1.1-POLARIMETER REDUCTION PROGRAM

INTRODUCTION

The program known as "PL2L2" gives an on-line reduction or polarization measurements obtained with the ESO two-channel polarimeter (PL2) and half-wave plate (L2). PL2L2 uses the algorithm of von der Heide and Knoechel (1978) and the statistical principles for the algorithm are given by Eichhorn (1978).

The program can easily be adapted to any reduction model, and it gives statistically rigorous results. The program consists of three parts:

MODEL } subroutines
ISYM

MAIN PROGRAM

SUBROUTINE MODEL

This subroutine provides the reduction model used during the data reduction. The basic model used is:

$$EZ1_i = h_i x_1 (1 + f_0)$$

$$EZ2_i = h_i x_2 (1 - f_0), \; i = 1 \ldots\ldots\ldots\ldots, 16$$

with

$$f_0 = x_3 \text{ Cos } 4\phi + x_4 \text{ Sin } 4\phi + x_5 \text{ Cos } 2\phi + x_6 \text{ Sin } 2\phi + x_7 \left(\frac{i - 8.5}{16}\right) + x_8 \left(\frac{i - 8.5}{16}\right)^2$$

Where $EZ1_i$ and $EZ2_i$ are the expectation values for the counts in the first and second channels respectively. The h_i accounts for the intensity variations during the observations; their mean value $h = 1.0$.

The vector of the parameters to be determined is x, and x_1 and x_2 are the intensities in the first and second channels respectively.

The linear polarization is given by:

$$x_3 = \text{PCos } 2\Theta$$

and

$$x_4 = \text{PSin } 2\Theta$$

The additional terms in f_0 account for systematic effects such as reflections from retarder surfaces and differential shifts of the multiplier sensitivities.

The matrices B1 = $\delta EZ_1/\delta x$, B2 = $\delta EZ_2/\delta x$ and f_0 may be changed if a different model is used. If the number of parameters is then not equal to 8, the following additional changes have to be made:

1) The dimensions should be set to the new number of parameters in the following arrays:

Array	Subroutine
x, B1, B2	MODEL
F	ISYM
x, Dx, Sx, S, B1, B2	
F, E	MAIN PROGRAM

2) Preset Nx (line 88) to the new number of parameters.

SUBROUTINE ISYM

The subroutine ISYM inverts the symmetric matrix F.

MAIN PROGRAM

The main program reads all data directly from the mag-tape (unit 8). The results are printed on the line printer and written on a second mag-tape (unit 9) in the following form:

- ON-LINE PRINTER -

1) Any comments.

2) Object identifiers.

3) Running number of observation (omitting skipped observations), star/sky code, cold box position, integration time per step in seconds, filter code, start-time of observations in the form HH:MM:SS.

4) α and δ in HH:MM:SS if available (1 m telescope).

5) Following lines:

Running number of iteration, intensity $I = x_1 + x_2$, $P_x = P\cos 2\theta$, $P_y = P\sin 2\theta$.

For control $\langle \chi^2 \rangle$ normalized to an expectation value $\langle \chi^2 \rangle = 1.0$ and $\sigma(h)$ as an estimate of the intensity variation are also printed.
Finally the results of the last iteration are given, and below them the standard deviations for I, P_x, and P_y. For output format, see Fig.(1).

- ON MAG-TAPE -

The first byte is used for print-out control only, skip for any further reduction.
Four (4) records are given for each reduced observation:

1st record - The 1st record contains: running number of observations, star/sky code, cold box position, integration time in seconds, filter code, starting time of integration in HH:MM:SS.

2nd record - The second record contains: α and δ(if available) in HH:MM:SS.

3rd record - The third record contains: running number of final iteration, I, P_x, P_y, $\langle \chi^2 \rangle$ $\sigma(h)$.

4th record - The fourth record contains: σ_I, σ_{P_x}, σ_{P_y}

DARK AND SKY SUBTRACTION

Dark count subtraction is performed by the program automatically (if dark measurements have been made *before*).

The sky subtraction is left to the user as this depends largely on the type of observations. The computer time for one reduction using the ESO HP system is approximately 2.5 seconds.

REFERENCES

The text makes reference to the following: von der Heide, Knoechel, 1978 Astron Astrophys (in press); and Eichhorn, 1978, M.N.R.A.S., 182, 355.

III.D

Infrared

III.D.1-INFRARED PHOTOMETERS AT THE 1 M TELESCOPE

INTRODUCTION

Two infrared (IR) photometers are available at the 1 m: a bolometer for wavelengths in the range 3 μm ≤ λ ≤ 30 μm and an InSb system for wavelengths 1 μm ≤ λ ≤ 5 μm.

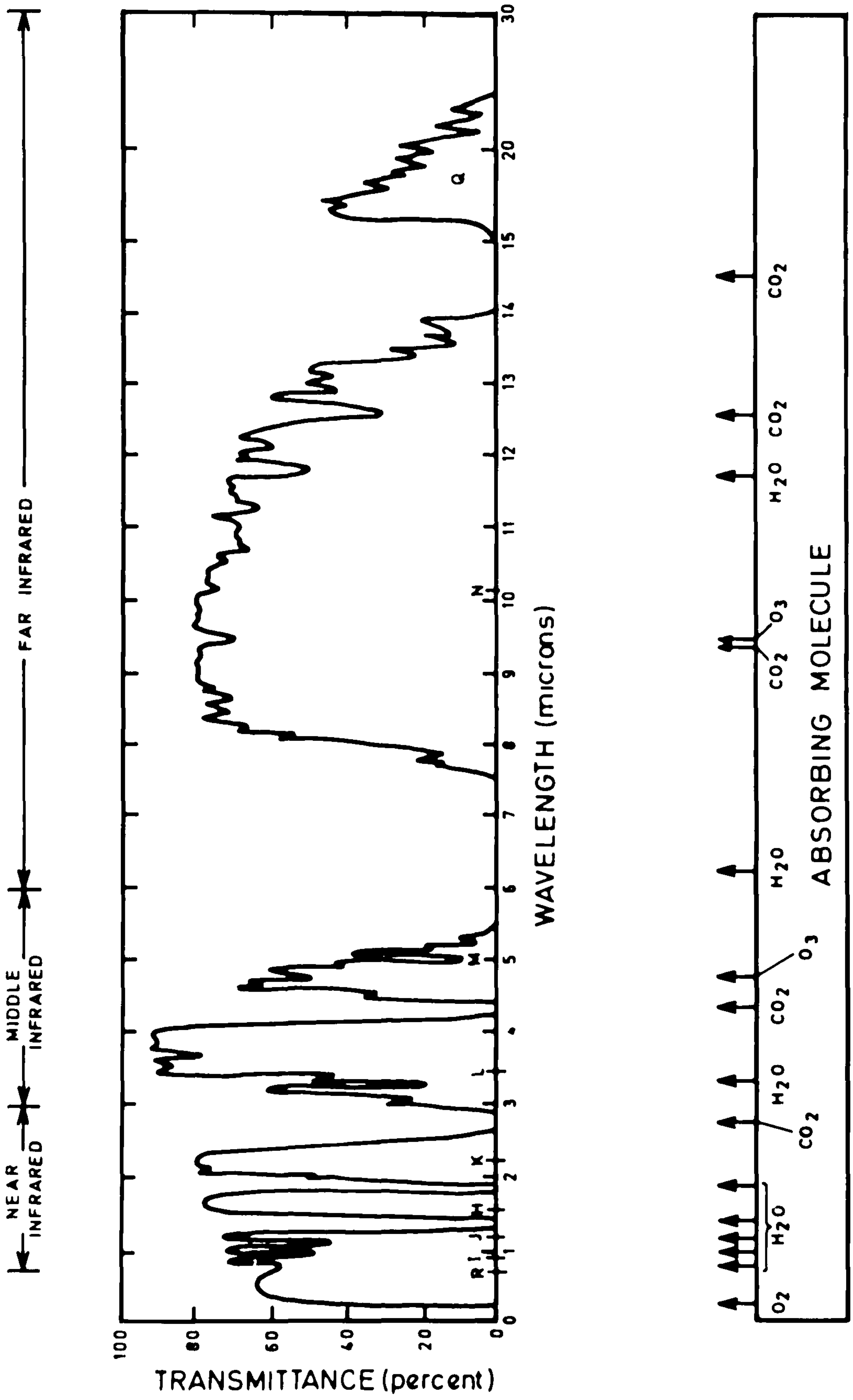
The 1 m telescope equipped with its computer drive system has the necessary pointing accuracy essential for IR work, indispensable for daytime observing. The telescope is programmed to *beam switch* and *raster scan*.

Observations are scheduled for both day and nighttime observing; for this reason, an assistant observer is normally available to share in the observing with the VA.

The earth's atmosphere does not transmit a large part of the infrared. This is due principally to absorption by water vapor in the atmosphere. The atmospheric transmission at an altitude of 2000 m with 2 mm precipitable water is shown in Fig.(1), and taken from T. de Groot, Sterrengids, 1971. The transmission profile of the atmosphere dictates the IR wavelength pass-bands at which ground based observations can be executed. The pass-bands have been named using letters following Johnson's system: J, H, K, L, M, N, Q, P. It can be seen from Fig.(1) that M and Q are not especially good *windows* and often these bands give the first indications of pending poor weather. Approximate extinction at La Silla is:

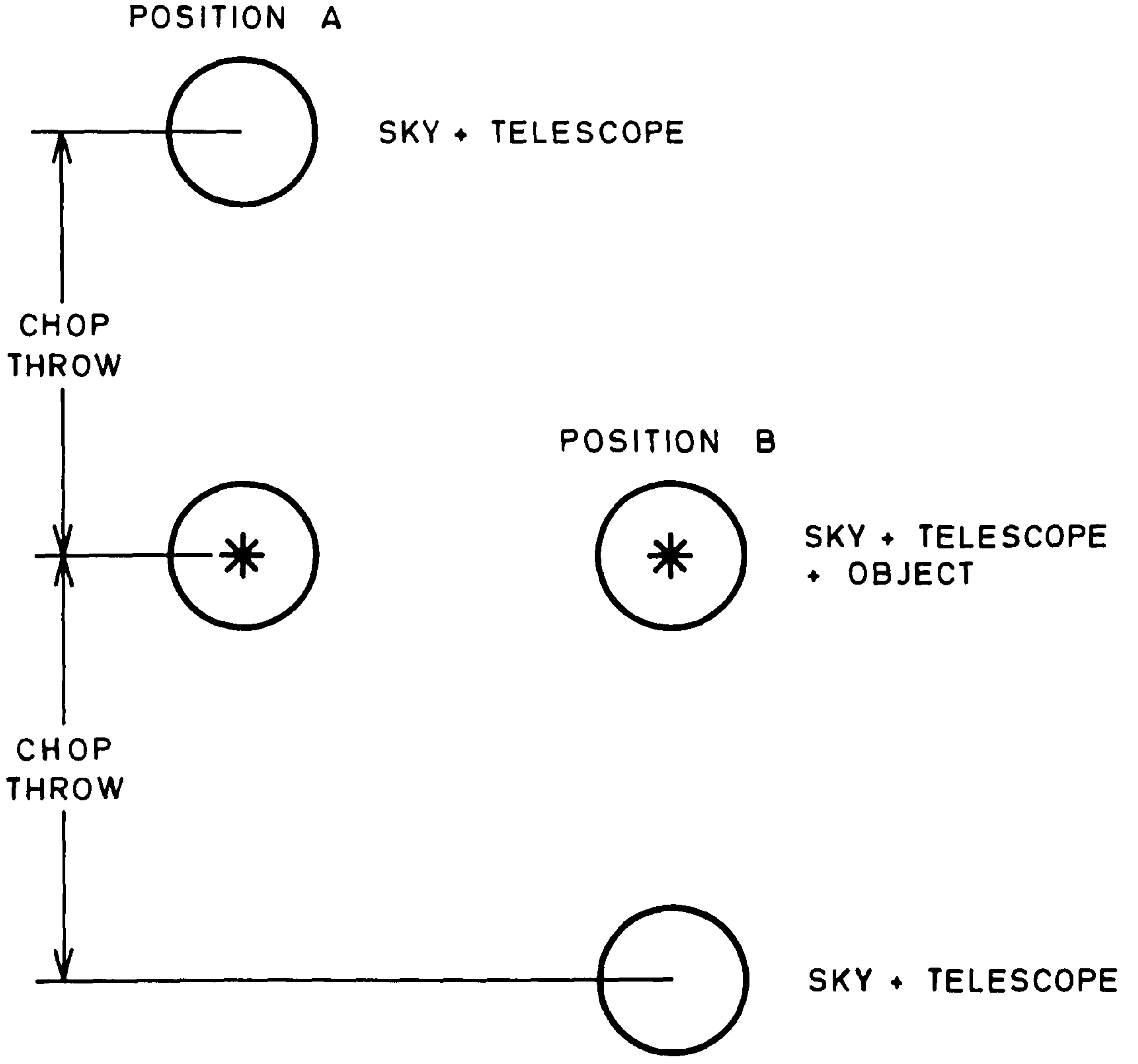
0.2	0.15	0.05	0.45	mag/airmass
8.1	9.5	12.1	19.6	λ μm

At infrared wavelengths, the *sky and telescope* radiate strongly. A focal plane chopper is employed to separate this *background* signal from the *astronomical* signal. The chopper allows the photometer to see alternately one of the two beams; one, a reference beam containing the *sky and telescope*, and the other *sky, telescope, and object*. The two beams are distinguished by phase-sensitive detection. The difference between the signals in the two beams would, to a first approximation, give the object flux. However, it is rare that the beams are perfectly balanced. To overcome this, the telescope is moved to place the object in the other beam. This is called *beam switching* and is done automatically, see Fig.(2). Chopping may be done in a variety of ways, but both 1 m photometers use focal plane choppers and thus are restricted in *chop-throw*.



ATMOSPHERIC TRANSMISSION
elevation 2000 m 2 mm preciptible water

III.D.1.FIG.1.



BEAM SWITCHING III.D.1.FIG.2.

IR detectors are usually mounted in "Low" Dewars with the Dewar cooled to liquid nitrogen temperature (77°K) in the case of InSb, or liquid helium temperature for a bolometer. The detector is usually mounted directly to the copper bottom of the Dewar for good thermal contact. The filters and diaphragms are located in the cold working space of the Dewar to reduce background radiation. Often the optics train also contains cold baffles to eliminate the detector seeing warm areas such as the central hole and the outer edge of the primary.

For the *first time IR observer*, it is recommended reading: Low, F.J., and Rieke, G.H., "Methods of Experimental Physics", vol. 12.A, p. 415 of The Instrumentation Techniques of Infrared Photometry, 1974, Academic Press, for a specific idea; or for a more general text: Allen, D., Infrared - The New Astronomy, 1975, publ. Keith Reid Ltd., Sheldon-Devon. For up-to-date information on IR detectors, refer to: Levinstein, H., 1977, Physics Today, November, page 23.

BOLOMETER

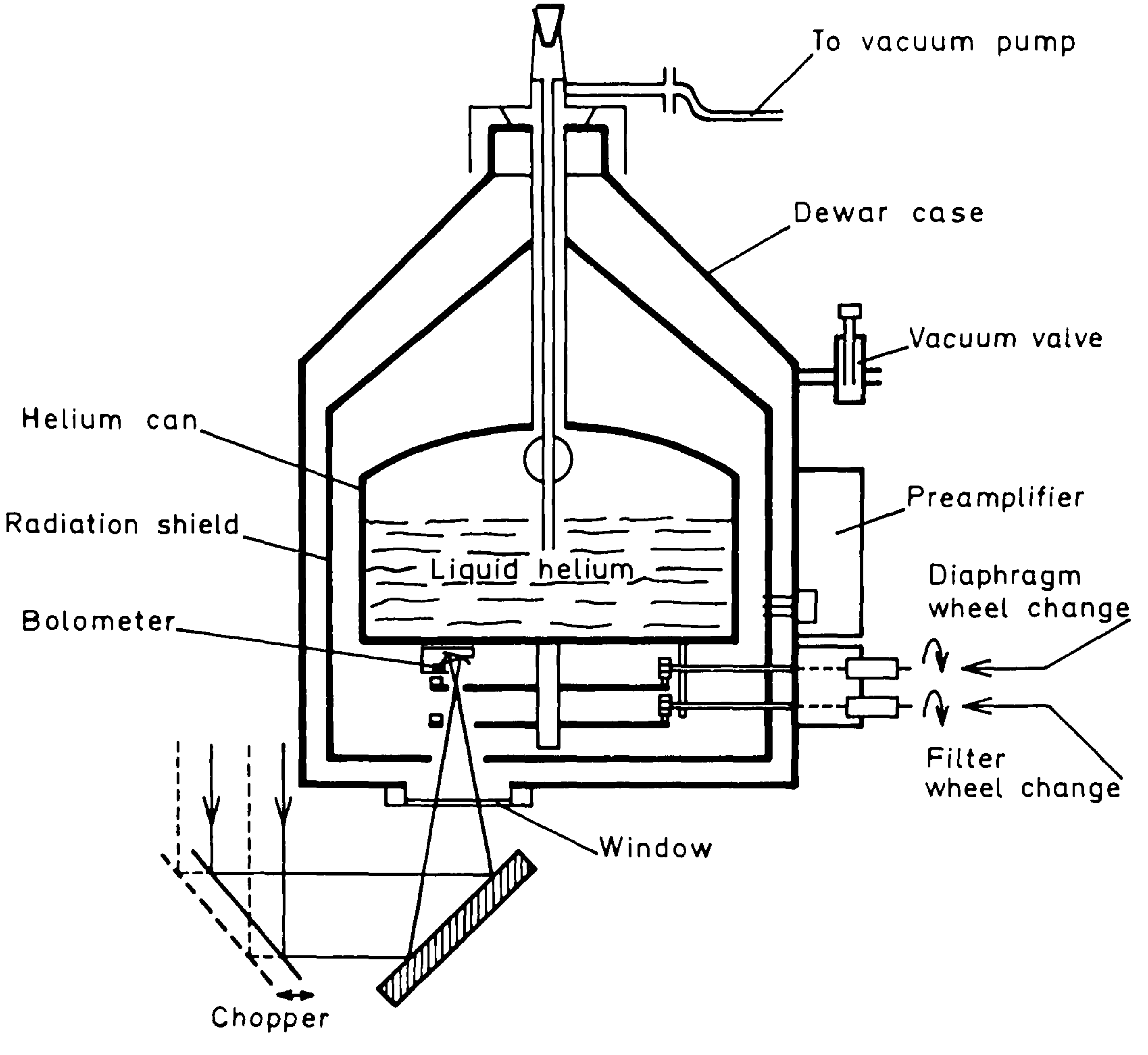
INTRODUCTION

The bolometer was developed at the Kapteyn Institute and is shown schematically in Fig.(3). The components are given in the order in which they are encountered from the telescope.

- vibrating dichroic mirror (chopper)
- end window of "Low" Dewar
- filter wheel
- diaphragm wheel
- bolometer

CHOPPER

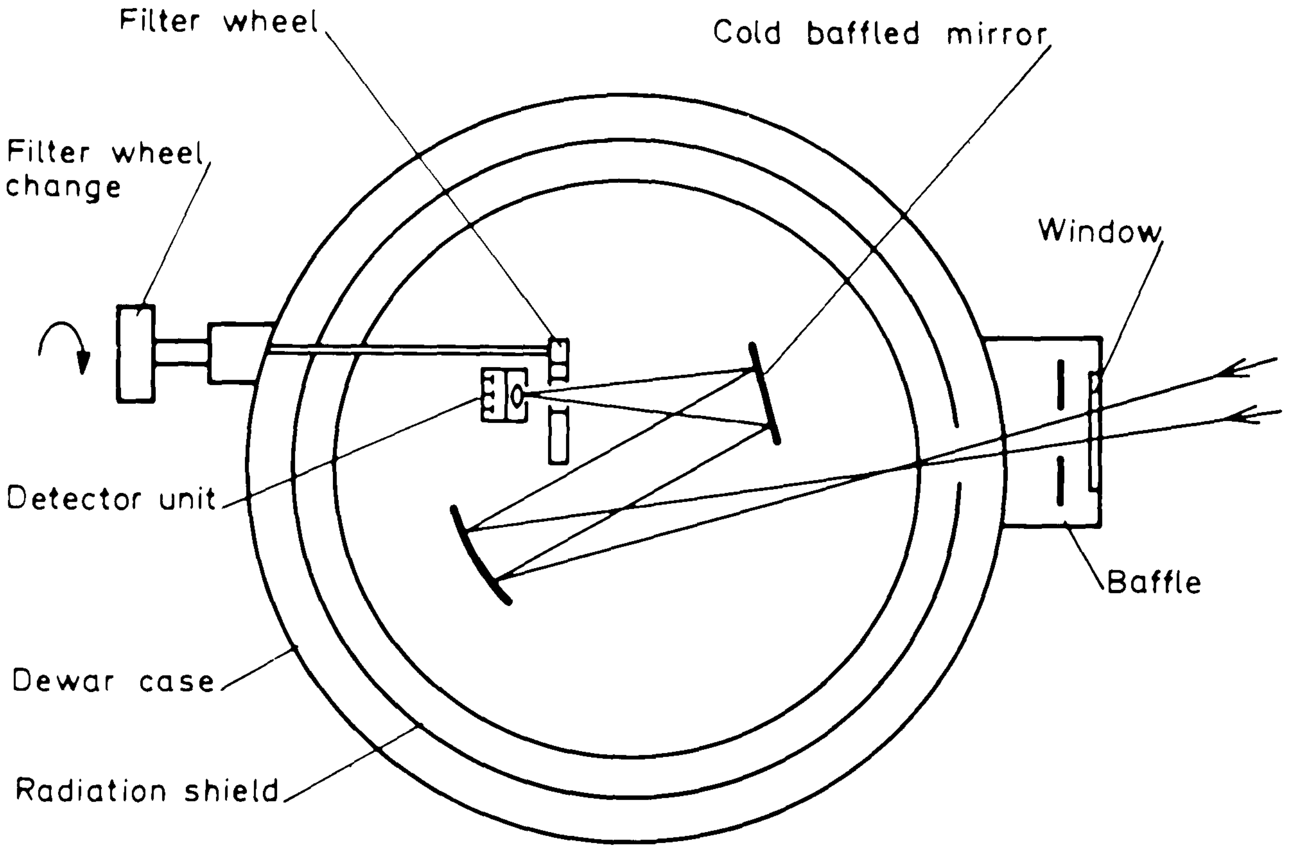
The basis of the chopper is a Mössbaur drive system which moves a semitransparent (dichroic) mirror from side-to-side to project alternately the object and then the reference beam onto the detector. The modulation function is designed to resemble as closely as possible, a square wave. The *chop-throw* is variable up to a maximum of 40 arcsec. The chop frequency is approximately 10 Hz. The dichroic mirror reflects the IR radiation onto the detector and transmits the visible into the viewfinder.



side view bolometer dewar

III.D.1.FIG.3.

BOTTOM VIEW InSb DEWAR



III.D.1.FIG.4.

VIEWFINDER

The viewfinder has a field of view of approximately 9 arcmin. Besides being used to center visible stars, it also serves to check the *chop-throw*.

DEWAR

The Dewar is a Low type HD-2 with a KBr end window. Before use, the Dewar is pre-cooled with liquid N_2 and then filled with liquid He. By pumping on the He, the temperature is reduced to 1.4°K which is the working temperature of the bolometer. Once cooled, the Dewar has a hold time of 12 hours, but after re-filling, at least one (1) hour is required to pump down.

It is *IMPORTANT* if you wish to use this instrument that you specify it *clearly in your APPLICATION FOR OBSERVING TIME*, and the number of nights you wish to use it in order that sufficient liquid He can be made available.

FILTERS

The standard Johnson broad band filters are available as follows:

L(3.5 μm), M(4.8 μm), N(10.2 μm), Q(20 μm), P(30 μm)

In addition, there are three narrow band filters:

N_1(8.1 μm), N_2(9.6 μm), and N_3(12.2 μm)

All these filters are cooled and placed in one filter wheel inside the Dewar. Each filter is selected manually, but the filter wheel position is encoded and given out on the data acquisition program. All filters are 14 mm in diameter.

DIAPHRAGMS

The diaphragms are mounted immediately behind the filters and are selected manually. The diaphragm position is also encoded and displayed in the data output. The diaphragms are as follows:

8 10 15 18 23 arcsec

DETECTOR

A Ga:Ge Low bolometer 0.25 mm square is used.

SENSITIVITY AND CALIBRATION

For any given photometric system a calibration is obtained by observing a standard star for which fluxes at different wavelength have been independently defined.

In Table 1, we give the fluxes and corresponding magnitudes for each filter derived from observations of α Sco and γ Cru, and the calibration given in Low, F.J., and Rieke, G.H., "Methods of Experimental Physics", vol. 12A, p. 415 of The Instrumentation Techniques of Infrared Photometry, 1974, Academic Press.

These flux values apply to the ESO bolometer system in that they take into account small differences in filter pass-bands and detector spectral response. Small changes in the effective wavelength of the pass-bands due to source temperature can be taken into account using the procedures outlined in Low and Rieke, 1974.

The nominal sensitivity is also given in magnitudes and represents the attainable magnitude with a signal/noise = 1 in a 10 second integration time.

Table 1

Sensitivity-IR Bolometer

Band	λ eff in μ	Mag α Sco	F_λ (M = 0.0) $Wcm^{-2}\mu^{-1}$	F_ν (0.0) Jy*	Nominal Sensitivity in Magnitudes for Bolometer 15" φ	Log ν
L	3.5	-4.11	5.99×10^{-15}	244	6.00	13.933
M	4.8	-3.81	1.89×10^{-15}	145	3.00	13.796
N	10.2	-4.45	1.30×10^{-16}	43	2.00	13.469
Q	20	-4.84	6.27×10^{-18}	8.3	-1.00	13.176
P	30	-4.98	1.23×10^{-18}	3.7	-2.00	13.000
N_1	8.1	-4.31	2.32×10^{-16}	51	0.50	13.569
N_2	9.6	-4.51	1.18×10^{-16}	36	0.50	13.495
N_3	12.2	-4.64	4.54×10^{-17}	22	-0.50	13.391

* (1) Jy = 1 flux unit = $1 \times 10^{-26} Wm^{-2}Hz^{-1}$

DATA ACQUISITION

See the following section, III.D.1.1.

InSb PHOTOMETER

INTRODUCTION

For the wavelength region 1 to 5 μm, a photometer developed by Dr. Kreysa, MPI, Bonn using an InSb photovoltaic detector is available. The photometer is shown schematically in Fig.(4). It consists of:

- rotating chopper
- side entrance to Low Dewar
- collimating optics and cold baffles
- filter wheel
- detector

CHOPPER

The chopper is a gold plated four segment rotating mirror. The chopper is supported in an air-bearing assuring very quiet rotation. The chop-throw is fixed at 13 arcsec. The chopper normally rotates at 30 Hz.

VIEWFINDER

The viewfinder is introduced into the beam path before the chopper and has a field of 5 arcmin.

DEWAR

The Dewar is a Low type HD-2 with a CaF_2 side window. The InSb photovoltaic detector operates best at liquid N_2 temperature. The Dewar is pumped to reduce the temperature of the liquid N_2 to almost its freezing point. The N_2 ice mixture has a hold time of approximately 48 hours.

FILTERS

Standard broad band filters are available:

J(1.25 μm), H(1.65 μm), K(2.2 μm), L(3.6 μm), M(4.8 μm)

All filters are 5 mm in diameter. The filters are selected manually but the filter position is encoded and given automatically in the data output.

DIAPHRAGM

The diaphragm is fixed and is 12 arcsec in diameter.

DETECTOR

The detector is an InSb photovoltaic and has a diameter of 0.35 mm.

CALIBRATION

The ESO IR system is based upon the following results for the basic standard, HR 1195 (V = 4.6; B - V = 0.94, spectral type G5 III). Sensitivity values are given for S/N = 1 and IT = 1 second.

BAND	J	H	K	L	M
HR 1195	2.600±.009	2.179±.008	2.079±.008	2.095±.022	2.163±.033
Sensitivity in mag.	11.5	12.0	11.5	8.0	6.0
mJy	40	20	15	180	600

The calibration is derived from stars in common with Thomas, Hyland, and Robinson, M.N.R.A.S., 165, 201, 1973. (THR)

The table below gives the transformation for the ESO system into the absolute photometric system defined by THR for the southern hemisphere.

Transformation for ESO Magnitudes into THR System

	m.e.	n*
$J_{ESO} = J_{THR} - 0.059$	$\pm$ .042	4
$H_{ESO} = H_{THR} + 0.09$	$\pm$ .039	5
$K_{ESO} = K_{THR} - 0.037$	$\pm$ .026	8
$L_{ESO} = L_{THR} + 0.064$	$\pm$ .029	8
$M_{ESO} = M_{THR} - 0.039$	$\pm$ .018	8

* = number of stars used in the determination of the transformation

Similarly as for the bolometer, the flux calibration for a 0 magnitude star was determined from observed values of γ Cru and the flux values given by THR for this star.

Of course, errors in the absolute calibration given by THR are propagated in the values given in the tables.

III.D.1.1-INFRARED DATA ACQUISITION

INTRODUCTION

Both the telescope and the data acquisition systems are controlled through HP 2100 A computers from a display console and a data handset in the dome.

A schematic of the 1 m IR system is shown in Fig.(1). The output form the detector passes first to a pre-amp and then into a *phase-sensitive* detector, (PAR 186A Synchro-Het lock-in amplifier). The PAR output goes then to a V/F converter and scaler which is interfaced to the HP 2100 A through CAMAC. For details of the general data acquisition system (DAS), see section V.A.1.

The telescope control system(TCS) handles pointing, drive, and precesses coordinates. The DAS computer handles data and output devices and is linked to the TCS computer.

Output devices available are:

- magnetic tape
- punched paper tape
- line printer
- strip chart recorder

ASCII code is used for magnetic tape and paper tape output.

STAR CATALOG AND PRECESSION

Refer to section III.B.2.

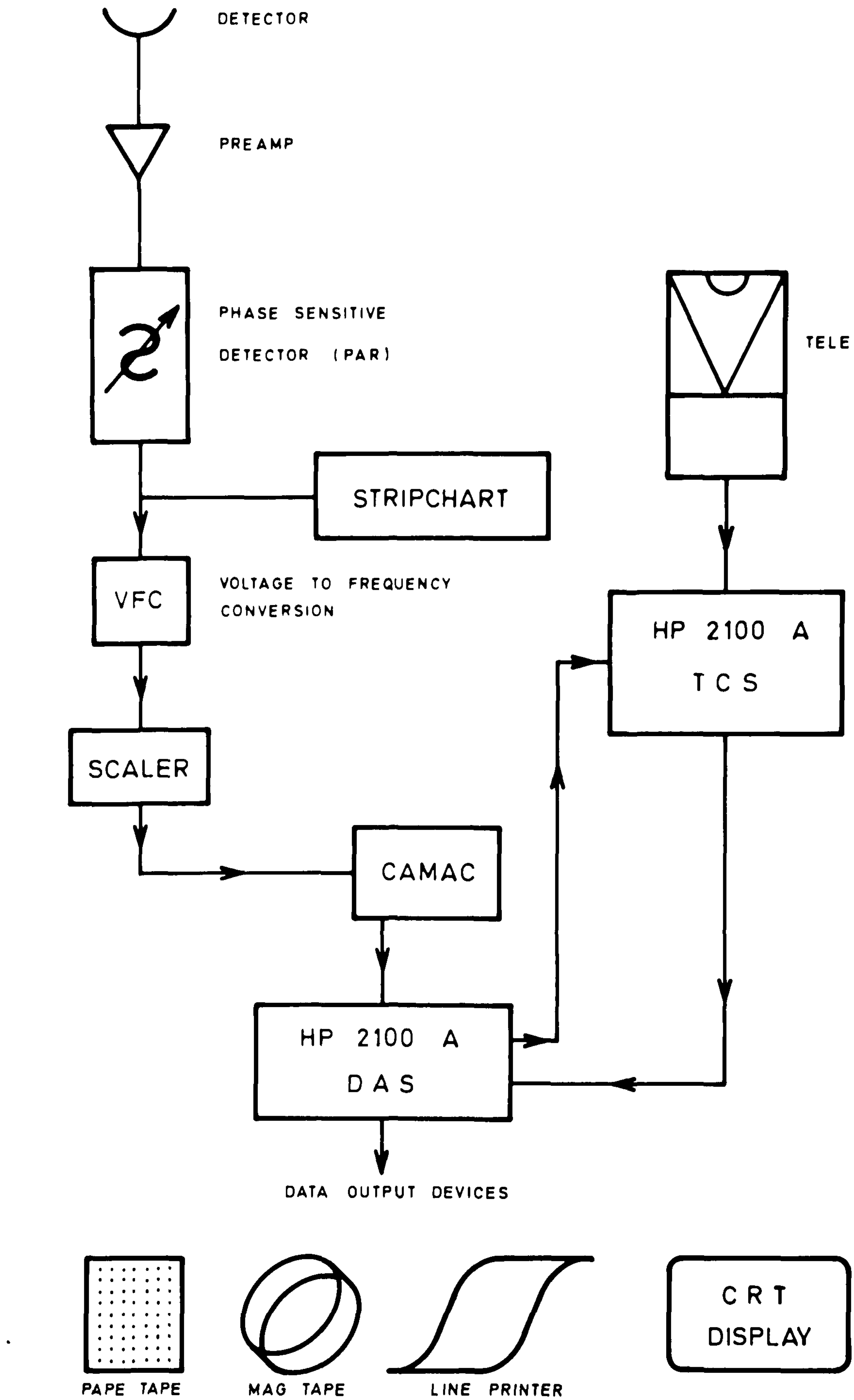
MODES OF OPERATION

- IRPHOT → infrared photometry
- IRSCAN → automatic infrared scanning
- FAST → non-beam switch photometry

There are two levels of operation of these systems:

(1) Parameter level → communicating for instance, integration time, beam throw, identifier, or scan parameters. These are entered from the display console.

(2) Observational level → start, stop, interrupt an observation. This is done from the dome handset.



INFRARED DATA ACQUISITION SYSTEM III. D. 1. 1. FIG. 1.

To go from level 1 to level 2, enter an identifier, (e.g. name of object) with the instruction ID..........name. To go from level 2 to level 1, push the handset command END. Handset commands are given in Table 3.

IRPHOT

INTRODUCTION

In this mode, the instrument behaves essentially as a visual photometer; the program handles the *beam switching* and gives on-line magnitudes. The decision path or flow diagram for IRPHOT is given in Fig.(2).

OBSERVING CYCLE

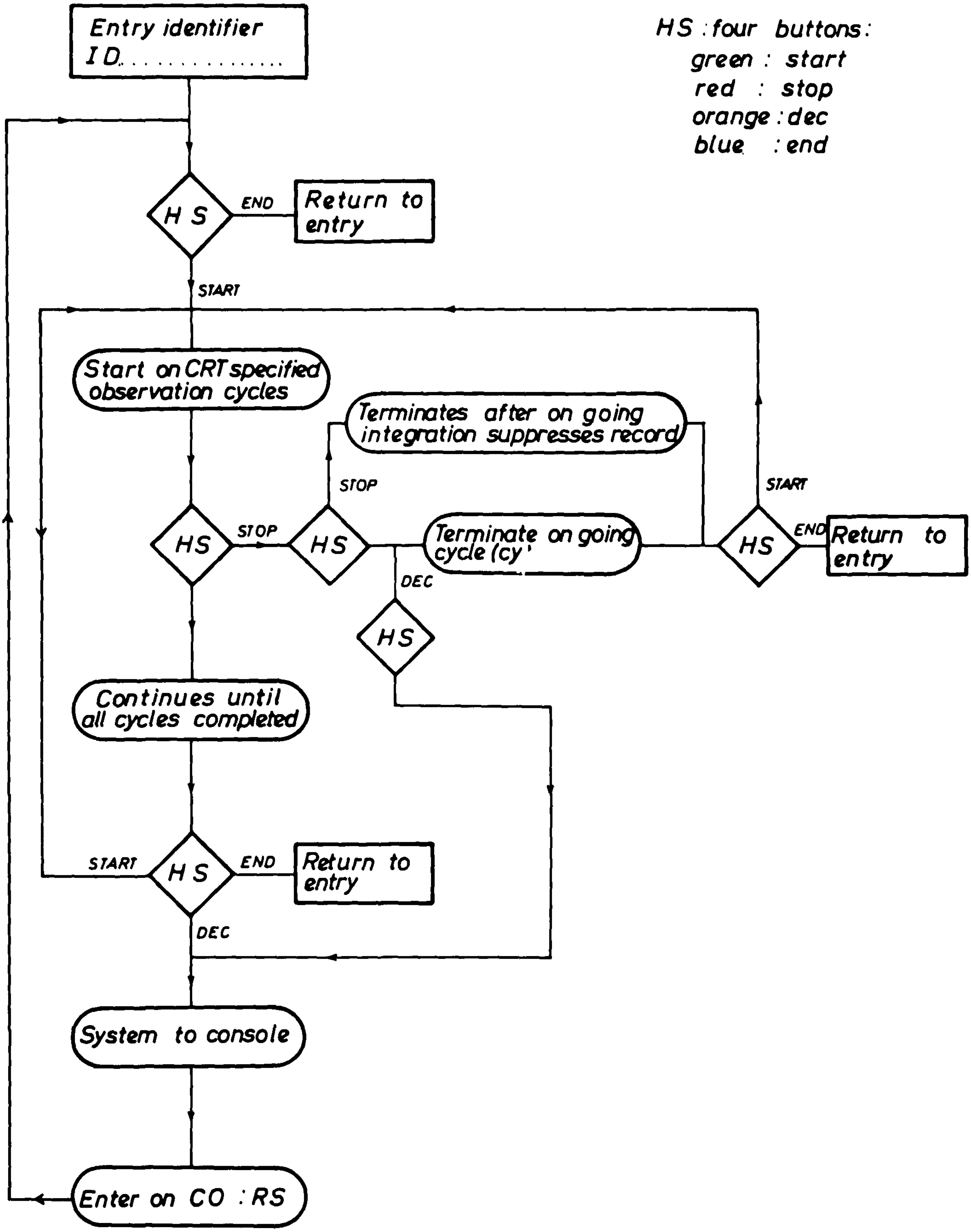
The observing cycle is essentially as follows: integration in position A, *beam switch,* integration in position B, integration in position B, *beam switch,* integration in position A. (A B B A). This constitutes one cycle, and the number of cycles performed per filter depends on the object brightness and the required signal to noise.

INPUT PARAMETERS

The offset (distance moved by telescope when beam switching) should be set to be equal to the beam separation.

IRPHOT	Sets photometer mode.
X OFF-SET	This should be equal to the beam separation; X is given in arcsec, preset value is 0.
X Y THROW	This instruction enters the chop amplitude in the data acquisition program. X is given in arcsec and Y the direction and position angle of the throw (preset to 12 and 30 respectively).
X IT	Sets the integration time. X is given in seconds, preset to 2 seconds. The minimum time is 1 second.
X CY	Sets the number of cycles (A B B A), preset value is 100.
ID.........	Fills in object identifier and this transfers control to the handset. The console is now blocked until the handset command "END" is pressed.
CM.........	Prints on-line commands on all output devices.

ENTRY CONSOLE



FLOW DIAGRAM FOR IRPHOT

III. D. 1. 1. FIG. 2.

Gain, filter and diaphragm are all selected manually but are shown on the display via encoders.

For further data acquisition commands, see the following list. An example of the data output is given in Fig.(3).

ON-LINE MAGNITUDES

Parameters are:

IT	integration time in seconds
Gain	sensitivity of PAR amplifier
DR	dynamic range of PAR amplifier
Int	intensity, i.e., the result of a measurement
Counts	count rate (per second) in the positive beam (A+) and negative beam (B-).
A M	air mass
k	extinction coefficient as given in the standard star listing after the instruction PRINT-STD in the output.

The counters are calibrated such that one (1) volt output of the PAR gives 10^5 counts/second.

The dynamic range setting of the PAR has no influence on the overall sensitivity; it only exchanges an AC amplification stage for a DC amplification stage.

The intensity (Int) is:

$$\text{Int} = \frac{\sum_{1}^{\frac{cy}{2}} (A^+ - B^-)}{\frac{cy}{2}} \times \text{Gain} \qquad (1)$$

with cy ≡ number of cycles completed in a measurement. The reduction will then give the following result:

$$\text{MAG} = -2.5 \log(\text{Int}) - k \times \text{A.M.} + \text{Z.P.} \qquad (2)$$

where Z.P. is the zero point ≡ overall sensitivity of the system.

This is determined through the measurements made in #ZP-STD mode. It is calculated through the reverse application of equation (2) with the magnitudes in the standard star list. These are given upon the command PRINT-STD.

GENERAL LISTING OF COMMANDS FOR IR ACQUISITION PROGRAM

PRINTER	Enables line printer output.
NOPRINTER	Disables line printer output.
MAGT	Enables magnetic tape output.
NOMAGT	Disables magnetic tape output.
PUNCH	Enables paper tape punch output.
NOPUNCH	Disables paper tape punch output.
X FILE-STEP	Skips X files on mag-tape.
LI	Lists on console the present state of all parameters and refreshes CRT display.
RS	Returns control to handset.
BOLOMETER	Sets bolometer mode.
INSB	Sets InSb mode.
X DELAY	Sets X seconds of delay for offset stepping before integration (preset to 1 second).
CLRIO	In case of an input/output error, clears all corresponding flags. Enter Ju.date.time.epoch.
ADIOS	Must be typed at night's end to make end-of-file mark on mag-tape.
CLINK	Clears telescope link. To be used before CLRIO if system break has been made with the "ESC" key on the keyboard.
HH:MM:SS:SS. UT	Sets universal time into acquisition computer only, and sidereal time for telescope. Use "?JU" to ensure correct Julian date is present.

IR - SCAN MODE DATA OUTPUT

```
5  TEST   #11                                  ID
6  13:11:11.5      -62:36:16                   α, δ
7  59                                          Sequence number
1Ø  IT=  2  FIL= Ø  DIA= 3  GAIN=  2MV  DR= 3 K  THROW=  13/9Ø      Field 1x1 arcmin
1Ø  OFF-SET=  17/  8   SCAN-FIELD= Ø: 1: ØX Ø: 1: Ø                 Reference ☆ α, δ
1Ø  REF.=  13:11:11.4 -62:46:16
Ø   51639    62193    63631    58319       Scan line        Time                     α, δ
1    1487     1995     3491     5364
2  START= 16:21:27   13:11: 5.5 -62:36:41  END= 16:21:43  13:11:12.9 -62:36:41
Ø   55Ø9Ø    63497    62116    57894
1    2298      197     5242      998
2  START= 16:21:45   13:11:12.9 -62:36:32  END= 16:31:59  13:11: 5.5 -62:36:32
Ø   61662    6Ø693    63997    58724
1    2481     1801     3114     3353
2  START= 16:22: 1   13:11: 5.5 -62:36:25  END= 16:22:15  13:11:12.9 -62:36:25
Ø   55411    61Ø7Ø    61484    59371
1    8Ø15     4826     6872     3Ø18
2  START= 16:22:17   13:11:12.9 -62:36:15  END= 16:22:31  13:11: 5.4 -62:36:16
Ø   59217    67Ø47    61653    68325
1    1853      12Ø      315     1419
2  START= 16:22:33   13:11: 5.5 -62:36: 9  END= 16:22:47  13:11:12.9 -62:36: 9
Ø   57788    65912    56382    61346
1    2635     269Ø     5172     5172
2  START= 16:22:49   13:11:12.9 -62:36: Ø  END= 16:23: 3  13:11: 5.5 -62:36: 2
Ø   59841    57385    51574    58684
1    4143     1467     1574     4698
2  START= 16:23: 5   13:11: 5.5 -62:35:53  END= 16:24:29  13:11:12.9 -62:35:53
Ø   57182    79187    4Ø994    58159
1     883      842     1566     248Ø
2  START= 16:23:21   13:11:12.8 -62:35:46  END= 16:23:35  13:11: 5.4 -62:35:46
3  IRS  1  LINE  7  POINT  2  13:11:1Ø.3   -62:35:46    1.9          α δ source
   IRS  1  LINE  7  POINT  2   1.9                                   Source strength
9
   Source                                 Position in scan
```

IR - PHOTOMETRY MODE DATA OUTPUT

```
                                              —ID
 5 G3Ø5+Ø. 1 1                                    α, δ
 6  13:11:1Ø.2   -62:36:14                        Sequence number
 7 64
1Ø IT=  5   FIL= Ø   DIA= 3   GAIN=      2MV    DR=  3 K    THROW=   13/ 9Ø
1Ø OFF-SET=  17
 Ø  59411  -5Ø965  -5238Ø   62155   62723   -48172   -48Ø48   59693
 1   17Ø1     957    1297    1771    2Ø5Ø     3Ø23     1265    2744
 Ø  57615  -49426  -5Ø723   56568   56887   -61912   -555Ø1   56348
 1   24Ø4     735    1315    1Ø74    1646      74Ø      837    1247
 Ø  6Ø162  -51927  -59667   54289   55185   -51249   -523Ø1   56194
 1   2882    1338    1472     949     914      944     1986    1295
14 MAG=  Ø.Ø878  INTENSITY=  21756E-2  %MEAN E1=    1.9  %E2=  2.5
14 TIME=    16:52:36   16:53:48   16:55: Ø
14 AIRMASS=  1.338        1.335       1.333
 9
```

Table 3

Handset Commands

BUTTONS

START STOP DEC END

(active buttons are illuminated)

FUNCTIONS:

START	Will start measuring cycle as specified on CRT. →In IRSCAN: First push will define scan field with respect to central position which is defined at this moment. Second push will recognize a reference position with respect to the central position and start the scan.
STOP	Will interrupt ongoing measurement upon completion of a full cycle (+ - - +).
STOP STOP	Breaks observation upon completion of ongoing integration. No output results.
STOP	→In IRSCAN: Will finish ongoing scan line and return relescope to reference position.
DEC	Only active after STOP and cycle completion. Will set system to keyboard (e.g. to enter comments). To return to handset, type RS. →In IRSCAN: Will change mode to IRPHOT, retaining scan conditions. A #IRS will move telescope to this position and is ready for photometry. END returns system to console and reference position. IRSCAN returns to handset; START will continue the scan where interrupted.
END	Active after STOP or on completion of the CRT specified measurement. Terminates measurement and returns to keyboard

For the final reduction of the results of an observing run, it is advisable to use all standard stars measured during the run to determine a definitive zero point. Then, if no gross extinction variation occurred (i.e. good IR observational weather), simply apply the difference between the final Z.P. and the on-line Z.P. to the MAG in the output.

INPUT PARAMETERS FOR ON-LINE MAGNITUDES

The input parameters for on-line magnitudes are as follows:

# STORE-STD	To store the coordinates and standard magnitudes of a standard star in memory.
DISPLAY-STD	Lists all standard star magnitudes and extinction coefficients on CRT display.
PRINT-STD	Prints complete listing of all standards (10) and extinction coefficients on line printer.
# READ-STD	Displays the specified standard on the CRT display.
# STD	Will preset telescope to the indicated standard star and leave the system ready for START on handset. Measurement treated as normal observation.
# ZP-STD	Same as # STD; only measurement will be used to determine zero point for on-line reduction.
CLZP-ALL	Upon first measurement of # ZP-STD the previously present zero points will be erased.
# CLZP	As CLZP-ALL; only for individual filter numbers. Active only after pressing END in ZP mode.
PRINT-ZP	Makes print out on line printer of presently used zero points.

IRSCAN

INTRODUCTION

Transfer from IRPHOT to IRSCAN and vice-versa is simple. IRSCAN enables a scan of a defined area of the sky to be made in a series of discrete steps.

OPERATION

The area on the sky to be scanned is defined in degrees, minutes, and seconds of arc for the two direction, (α, δ) of the area. The scans are made in the normal chopping direction (east-west).

The center position of the scan area is defined and the scan will start in the southwest corner of the field and then step at given intervals through the area, integrating at each point. A SEARCH mode can be used to detect sources. In this mode, sources are discriminated if their signal is greater than a certain observed noise limit. The noise limit is = n x NF (where NF, noise figure is the measured 1 σ noise level). The sources found are identified by: a consecutive IRS number, coordinates, and a strength figure. The sources appear at the end of the scan numbered in order of detection. They may then be automatically retrieved for photometry via a "retrieval mode".

INPUT PARAMETERS FOR IRSCAN

The input parameters for IRSCAN are:

IRSCAN	Sets the scanning mode.
XX:XX. YY:YY X. Y. SCAN-FIELD	Alpha and delta scan field in minutes and seconds of arc (floating numbers), and alpha and delta step size in seconds of arc (integer numbers); for SCAN mode. (Preset to 2!00. 2!00" 15"15").
#. DISCRI	Discrimination level for source recoginition preset to(3 σ).
?LIMIT	NF $(IT)^{-1/2}$ x DISCRI at appropriate gain. Gives the actual counts at which a source will be recognized.
NF	$(\overline{\varepsilon_1^{+2}} + \overline{\varepsilon_1^{-2}})^{1/2} \times 1.2 \times (IT)^{1/2}$ at 1V = Noise Figure
SEARCH	To activate the IR source pick-up mode.
NOSEARCH	To de-activate the IR source pick-up mode. To be used when really mapping.
# IRS	Retrieves the given infrared source and puts the program in IRPHOT mode.

FAST PHOTOMETRY

This is designed to monitor the flux of a source continuously with a time resolution ≥ 1 second.

III.D.2-THE 3.6 M INFRARED PHOTOMETER

INTRODUCTION

The 3.6 infrared photometer is not yet fully tested, but its first performances have proved so successful the equipment is offered for period 26 and onwards. Two detector units, an Insb and a bolometer may be mounted simultaneously at the Cassegrain focus of the 3.6 m. A small rocking mirror in the focal plane acts as a chopper and can be varied in amplitude up to a maximum throw of 1.5 arcmins.

Eventually automatic switching between both detector units will be available. However, as the system is not yet fully optimized, it is better to plan observing runs in such a way that only one detector is required for the program. For additional information, VAs should contact Dr. Alan Moorwood, via the Visiting Astronomers Section Garching.

FILTERS AND DIAPHRAGMS

Insb	Filters: J, H, K, L, M
	CVFs: 1.5 to 2.5, 2.5 to 4.5, and 4.5 to 5.4 μm
	Diaphragms: 3, 5, 7.5, 10 and 1.6 x 10 arcsecs
Bolometer	Filter: K, L, M, N, and 8, 9.6, 12, 19, 22, 25 μm
	CVFs: 8 to 14 μm
	Diaphragms: 3. 5, 7.5, 10, 1.6 x 10, 5 x 10 arcsec

LIMITING MAGNITUDES

The limiting magnitudes (3 in a 1-hour integration time) are as follows:

J(18), H(17), K(16.5), L(13), M(10) and N(8)

These are preliminary numbers from the first test nights and although these may be used as a guide when making proposals, better performance is to be expected after optimization.

DATA OUTPUT

Photometry, spectro-photometry, and mapping programs with basic on-line photometric reduction similar to the 1 m system (section III.D.1.1) is available.

A more extended system for the spectro-photometry mode is forseen.

III.F.1 - 3.6 M INTERFERENCE FILTERS

The filters for use at the 3.6 m telescope are classified by a four digit number. The first digit indicates the focus, e.g. "1" for prime focus and "2" for Cassegrain focus. The second digit corresponds to the first number of the central wavelength. The last two digits are simply order sequence numbers. For example:

1 3 0 1 — order sequence numbers

3 — 1st number of the central wavelength

1 — focus utilization

In the following tables, the filters are specified by:

a) central wavelength (λ max in Å)

b) full width at half maximum (FWHM, $\Delta\lambda$ in Å)

Both are corrected for prime focus utilization. Due to differences in the thickness of the filters, each filter has a slightly different focus. The focus values for each filter are given at La Silla. A digital read-out for focus position is located in the prime focus cage.

INTERFERENCE FILTERS FOR USE
AT THE GASCOIGNE PRIME FOCUS OF 3.6 M

Group 13

ESO No.	λ max Å	Δλ Å	λ effective Å	Δλ effective Å	T at λ max %	Remarks
1301	3739	38	3724	42	17.5	O II

INTERFERENCE FILTERS FOR USE AT THE GASCOIGNE PRIME FOCUS OF 3.6 M

Group 14

ESO No.	λ max Å	Δλ Å	λ effective Å	Δλ effective Å	T at λ max %	Remarks
1401	4699.9	22.8	4690	25	54	HeII
1402	4794.3	67.6	4785	68.4	77	Continuum
1403	4867.3	34.3	4858.2	39.5	51	Hβ
1404	4950	860				
1405	4458	111	4450	111.3	52.2	
1406	4667	97.6	4658	98	49.2	
1407	5000	85	4990.25	85.7	67	

INTERFERENCE FILTERS FOR USE AT THE GASCOIGNE PRIME FOCUS OF 3.6 M

Group 15

ESO No.	λ max Å	$\Delta\lambda$ Å	λ effective Å	$\Delta\lambda$ effective Å	T at λ max %	Remarks
1501	5023.5	20	5014	22	61	OIII
1502	5903.7	44.9	5892.7	46.4	69.5	He I
1503	5316.5	31.3	5306.5	33	58	Fe XIV
1504	5424.8	75.2	5414.3	75.5	53	Continuum

INTERFERENCE FILTERS FOR USE
AT THE GASCOIGNE PRIME FOCUS OF 3.6 M

Group 16

ESO No.	λ max Å	Δλ Å	λ effective Å	Δλ effective Å	T at λ max %	Remarks
1601	6468.5	58.7	6455.5	60	75	Continuum
1602	6582.1	16.3	6570	22	53.5	Hα narrow
1603	6589.4	30.3	6576.5	33	66.2	Hα narrow
1604	6575.2	35	6563	38	66	Hα narrow
1605	6663.6	111.4	6550.6	112	59	Hα wide
1606	6751	38.5	6738	41	65	SII
1607	6741.9	24.8	6729	28	61	SII
1608	6768.4	24.4	6755.4	27.5	76	SII
1609	6586.1	104	6573	120	52	Hα wide
1610	6510	50	6557	51.5	56	Hα wide

III.F.1.1-ESO BROAD BAND FILTERS FOR USE AT THE GASCOIGNE PRIME FOCUS OF 3.6 M

Color	Filter	Filter Holder	Emulsion Recommended
U	UG 1	4	IIa-O 103a-O IIIa-J
UB	neutral	6	IIIa-J
B	GG 385	1	103a-O IIa-O IIIa-J
BV	GG 495	3	IIIa-J
V	GG 495	3	103a-D IIa-D
R	RG 630	2	IIIa-F
IR	RG 715	5	IV-N
H-Alpha 6563/150	GG 563	7	098-02 IIIa-F

Recent additional untested filters are as follows:

BG 12+BK 7, GG 475, OG 550, OG 570, RG 665

III.F.1.2-FILTERS AVAILABLE FOR USE WITH THE 3.6 M TRIPLET ADAPTER

Filters for Triplet adapter: size square 230 mm x 230 mm; 3 mm thick

UBK 7	GG 495
UG 1	OG 550
BG 12	RG 630
GG 385	RG 665
GG 475	RG 715

III.F.2-ESO PHOTOMETRIC FILTERS

ESO No.	λ max Å	Δ λ Å	T at λ max %	Size	Remarks
1	5509	235	80.7	1" x 1"	
2	5493.7	228.3	81	"	Y 50 cm photometer
3	5530	250	77.5	"	y 1 m photometer
4	5500	228	81	"	
5	4737	190	67	"	b 1 m photometer (blue and red leak)
6	4690	172.5	73.5	1" x 1"	b 50 cm photometer
7	4713.4	173.2	73	"	
8	4707	181.1	70	"	
9	4105	175	56.5	"	v 1 m photometer
10	4104	179	50	"	Bochum
11	4104	172	57.1	1" x 1"	v 50 cm photometer
12	4104	175	59	"	
13	3448.8	393.7	43.5	"	u 50 cm photometer
14	3452.4	397.6	43		
15	3455	43	390	"	u 1 m photometer
16	3448.8	393.7	44	1" x 1"	
17	4866	51	39.5	"	HβN 1 m photometer
18					
19	4863.9	28.3	49.5	"	
20	4862.5	27.2	63.2	"	
21	4870.5	191	70.5	1" x 1"	HβW 50 cm photometer
22	4874	185	72.5	"	v 1 m photometer
23	4865	177.2	77.5	"	
24	4850	165.4	70.4	"	
25	4860	31	53.4	ϕ 1"	
26	5877.5	19.2	61.2	ϕ 1"	
27	6301.2	7.6	44	"	
28	6564.8	10.2	75	"	Hα
29	8116.6	47.2	51.2	"	
30	6581.4	7.7	68.7		
31	7321	23.6	64	ϕ 1"	
32	6947.2	26.77	49.8	"	
33	6251	22.8	55.5	"	
34	5756.5	19.7	62	"	
35	5395	47.2	57	"	
36	5008.3	24.8	55.3	ϕ 1"	
37	4779.8	44.1	45.8	"	
38	4366	11	34	"	
39	4188	32.5	38.2	"	
40	3731	17.5	43.3	"	

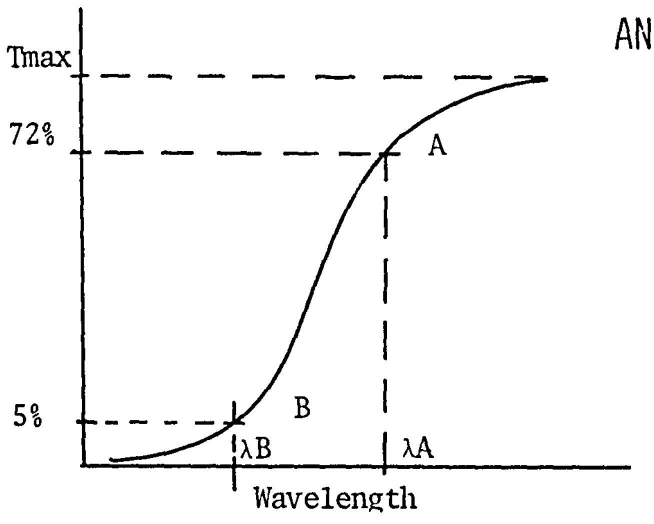
ESO No.	λ max Å	Δ λ Å	T at λ max %	Size	Remarks
41	3523	30	17	ϕ 1"	
42				ϕ 2"	
43	8126	43.3	57.5	"	
44	7324	24.4	72	"	
45	6922	32	67.5	"	
46	6297.7	7	46.5	ϕ 2"	
47	6254	24	56.75	"	
48	3724	35	9.5	"	
49	4182.8	55.1	48.5	"	
50	6589.4	24.1	42.8	2" x 2"	N II
51	4459.4	51.2	56	ϕ 1"	
52	4434.5	51	52	"	
53	4241.7	44	41.2	"	
54	4234.3	42.1	43	"	
55	5312	89.6	59	"	
56	5320	88.6	61.5	ϕ 1"	
57	4867	33.5	66	"	
58	4846.5	48.8	52.5	"	HβN 50 cm photometer
59	4600.5	51	64	"	
60	4603	52	64.8	"	
61	4342.6	28.1	47.8	ϕ 1"	
62	4340.5	28	49.3	"	
63	6581.5	16.3	54	2" x 2"	N II
64	6461.8	147.6	59.3	ϕ 1"	
65	6451.6	151.6	59	"	
66	3524.8	101	27	ϕ 1"	
67	3518	102.4	27.7	"	
68	5457.5	752	57.2	"	
69	5504.7	775.6	62.3	"	V
70					
71	5495.3	745.7	58	ϕ 1"	V
72	6520	1030	70	"	R
73	6571	1047	70	"	R
74	6553	1039.5	68.5	"	R
75	6541.7	1043	71	"	R
76	8933	1732.3	57	ϕ 1"	I
77	8940	1732.3	70	"	I
78	8953.5	1732.3	57	"	I
79	8949	1744	58.7	"	I
80	6728.3	15.7	51.5	2" x 2"	S II

ESO No.	λ max Å	Δ λ Å	T at λ max %	Size	Remarks
81	6574.8	16	54.3	2" x 2"	Hα
82	6557.5	15	53.8	"	
83	6095	9	65	ϕ 1"	
84	5693	9	71.6	"	
85	5812	10	67	"	
86	4801	11.5	64.5	ϕ 1"	
87	5299.5	8.5	64.8	"	
88	4697	10.2	56.5	"	
89					See Annex
90					See Annex
91	3200	1350	83	ϕ 1"	U 50 cm photometer
92	4382.7	1082.7	78	"	B
93	6580	20	41	"	Hβ
94					W
95					W
96	4672.5	161.4	46	1" x 1"	b
97	4099.2	212.6	52.8	"	v
98	4370	1060		"	B 50 cm photometer
99					See Annex
100	3559	472.4	56.5	"	U
101	3496.5	340.5	30	1" x 1"	
102	3571	84.6	33	"	
103	3559	476.4	57	"	
104	3336	65	34.5	"	
105	3567.3	90.6	43.8	"	
106	3407	862	81	1" x 1"	
107	8511.8	2267.7	55	"	
108	7472.4	52.75	20.8	"	
109	3547.2	590.5	63.8	"	
110	7473.2	52.4	21.2	"	
111			91.5	1" x 1"	V 1 m photometer
112	4410	1080	78.5	"	B 1 m photometer (red leak)
113	3550	580	64.5	"	U 1 m photometer
114	4531	110	53.5	"	
115	4225	82	63	ϕ 1"	
116	4170	90	51	ϕ 1"	
117	3196.8	1460	87.5	"	HβN
118	4472	1240	75.5	"	red leak
119					See Annex
120					

ESO No.	λ max Å	Δ λ Å	T at λ max %	Size	Remarks
121					
122					
123					
124					
125					
126					
127					See Annex
128					See Annex
129					See Annex
130	4100	1240	67.5	2" x 2"	Schott type BG12 1 mm
131	3600	640	67.5	"	Schott type UG1 1 mm
132				"	Schott type GG495 1 mm
133				"	Schott type OG550 2 mm
134				"	Schott type GG385 1 mm
135				"	Schott type GG475 2 mm
136				2" x 2"	Schott type RG630 2 mm
137				"	Schott type RG665 3 mm
138				"	Schott type RG715 3 mm
139				"	Schott type OG590
140	4860.5	157.5	65	"	
141	4873	167.3	67	2" x 2"	
142	4866	163.5	54.8	"	
143	4870	161.5	55.5	"	
144	4866	163.5	54.8	"	Schott type GG495
145	4863.5	31	51	ϕ 1"	
146	4862	30.5	55	ϕ 1"	
147	4859.5	30	60	"	
148					
149	5514	245.7	74	"	
150	5511	252	65	"	
151	5515	252	64.5	ϕ 1"	
152	4684	185	64.5	"	
153	4686	200	54.5	"	
154	4685	189	68	"	
155	4689	200	54.5	"	
156	4100	165.4	61	ϕ 1"	
157	4034.5	163	63	"	
158	4125	145.7	57	"	No red leak to 9000 Å
159	4109	161.5	52.7	"	red leak to 9000 Å
160	3488.6	90.5	30	"	

ESO No.	λ max Å	Δ λ Å	T at λ max %	Size	Remarks
161	3648	96.5	36	φ 1"	
162	4274	67	59	"	
163	4628	61	63	"	
164					
165	4690	42.5	68	"	
166	4750	75.6	61	φ 1"	
167	5159	138	82	"	
168	5491.3	226.5	74	"	
169	5002	105.5	35	"	
170	5025	108	33	"	
171	5222	126	46	φ 1"	
172	5242	124	45	"	
173	3517.5	23.5	12.8	2"	
174	4353.7	14.8	40	"	
175	4775	44	54	"	
176	4862.5	18.7	61.5	φ 2"	
177					
178	5396	37.5	64	"	
179					
180	5584.3	11	63	"	
181	10822	33	60	φ 2"	
182	7723	19.6	70.5	"	
183	5009	25.6	63.5	"	
184	7088.5	1811	82	"	
185	7084	1827	80	"	
186	7079	1850	75	φ 2"	
187					
188					
189	3527.5	626	71.2	"	red leak 7500 Å 23%
190	4953	22	76	"	
191	4941.5	6.1	59.5	φ 2"	
192	5389	7.5	62	"	blue and red leak
193	5414.8	8	58.5	"	blue and red leak
194	5500	1004	84	"	
195					
196	4315	994	65	φ 2"	B BG12 + GG385 + BG38
197	4350	925	60	"	B BG12 + GG385 + BG38
198	4321	974.5	63.2	"	B BG12 + GG385 + BG38
199	4330	980	62.5	"	B BG12 + GG385 + BG38
200	5523.5	1299	85.9	"	V GG495 + BG18

ESO No.	λ max Å	Δ λ Å	T at λ max %	Size	Remarks
201	5520	130	84		
202	5500	130	84.5		
203	5523.5	132	83.2		
204	6300	173	82		
205	6346.5	170	80.2		
206	6319	170	80.2		
207	6315	171.2	81.3		
208					
209	4294	1015.75	73		
210	4096	1020	74.3		
211	4280	1020	73.3		
212	4451	1220	78		
213	4433	1220	79.5		
214	4433	1212	78.5		
215	4047.2	1440	81		
216	4048.8	1433	81		
217	3510.5	289	26.5		
218	3512.6	291	27		
219	3516.5	289	26.6		
220	3516.5	287	25		
221	3504	292	27		
222					
223	3542.5	259.8	14.5		
224					See Annex
225					See Annex
226					See Annex
227	3360	440.9	45		
228	3992	653.5	70.4		
229	5209.5	200	58.5		
230	5685	142	36		
231	4762	114.5	35		



ANNEX

SHARP CUT ON COLOR GLASS FILTERS

Transition Wavelength = $\frac{\lambda A + \lambda B}{2}$

Transition Internal = $\lambda A - \lambda B$

ESO No.	λ max Å	Δ λÅ	T at λ max %	Size	Remarks
89	4907.4	153.5	89	1" x 1"	V Schott type GG495
90					
99	5205	210	91		V 50 cm photometer
111	5238	196	91		V 1 m photometer
119	5018	305	86.2	ϕ 1"	Schott type GG495
127	7817	500	90	ϕ 1"	Schott type RG780
128	7864	586.5	87	"	
129	7789	488	87	"	
130	4100	1240	67.5	2" x 2"	Schott type BG12
131	3600	640	67.5	"	Schott type UG1
132	4920	190	95	2" x 2"	Schott type GG495
133	5420	200	93	"	Schott type OG550
134	3775	300	92	"	Schott type GG385
135	4720	212	92	"	Schott type GG475
136	6225	200	91.4	2" x 2"	Schott type RG640
137	6557	215	91	"	Schott type RG665
138	7035	270	91	"	Schott type RG715
139					
223	7196	341.7	86		Schott type RG715
224	7191	342	85.5		Schott type RG715
225	7194	348	86		Schott type RG715
226	7194	340	86		Schott type RG715

IV.

Photomaterials/ Detectors/Calibration Techniques

SECTION IV INDEX

IV. PHOTOMATERIALS/CALIBRATION TECHNIQUES page(s)

IV.A.1-PHOTOMATERIALS

EMULSIONS AND STOCK PLATE SIZES

The following tables list available emulsions and plate sizes at La Silla.

EMULSIONS

IIa-O, IIa-D, IIIa-J, IIIa-F, 098-02, IV-N, 103-D

PLATE SIZES

Size mm	Instrument
300 x 300	Schmidt
240 x 240	Triplet Adaptor 3.6 m
160 x 160	GPO; 1.5 m Zeiss
60 x 60	Prime focus 3.6 m; B & C spectrograph
168 x 18.5	Camera I, Coudé 1.5 m
254 x 18.5	Camera II, Coudé 1.5 m
498 x 62.5	Camera III, Coudé 1.5 m
150 x 28	ETA

Presently plates are cut to size at La Silla; however, many of the standard sizes used are being ordered pre-cut directly from Kodak.

NOTE: All stock plates are anti-halation backed.

QUALITY CONTROL OF EMULSIONS

Optimum treatments are determined for each batch on the criterion of highest possible speed *without* significant degradation of signal to noise. Each plate request is tested after treatment and an analysis of a sample plate is provided by a computer program. These daily test results are available to observers on request. (See IV.A.2 for further discussion).

STOCK CHEMICALS

DEVELOPERS

MWP - 2, D19, D76

FIXERS

Kodak fixer, Kodak rapid fixer, F5 fixer

OTHERS

Kodak Hypo-elimination, Kodak Photo-Flo, Stop bath, Distilled water

All emulsions and chemicals can be ordered by filling out the Daily Plate Request (see Fig. (1)) the day before your observing run starts and subsequently at the end of each night. The forms should be handed to the night assistant or posted in the red TRS mail box.

DAILY PLATE REQUEST

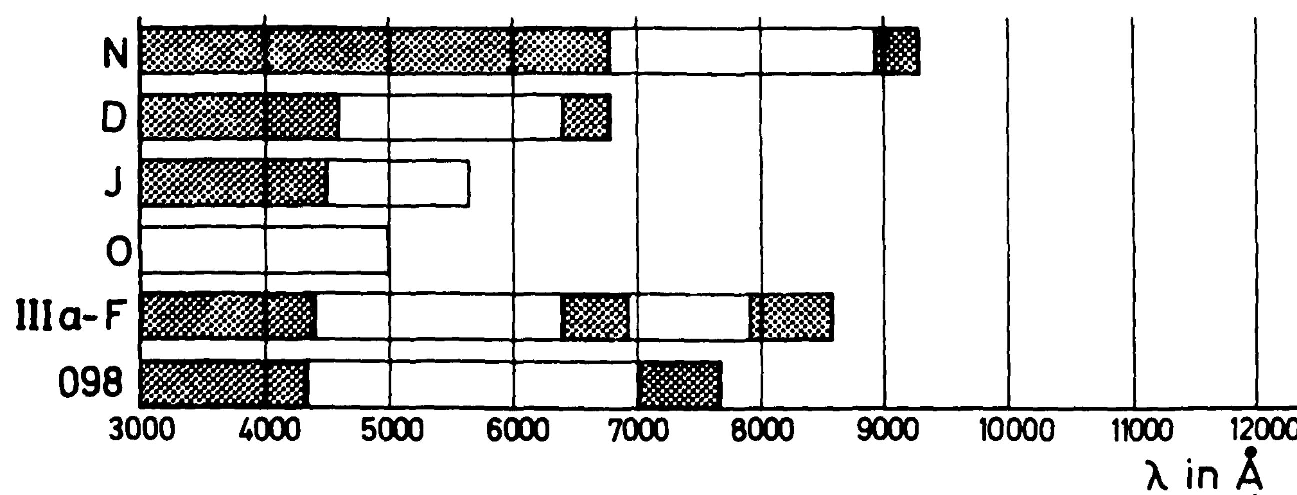
OBSERVER :	TELESCOPE :
DATE FOR WHICH PLATES ARE REQUIRED :	

		INSTRUMENTS										
		COUDE			B + C						CALIBR.	
EMULSION *	B=BAKED IN FORMING GAS NB=NOT BAKED	CAMERA 1	CAMERA 2	CAMERA 3	CARNEGIE TUBE	WITH IT	PRIME FOC. 3.6	G.P.O.	ZEISS CAMERA	SPECIAL (SPECIFY)	ETA SPECTR.	SPOT SENSITOM.
IIa-O	B											
	NB											
IIa-D	B											
	NB											
IIIa-J	B											
	NB											
IIIa-F	B											
	NB											
098-02	B											
	NB											
IV N	B											
	NB											
103a-D 1)	B											
	NB											

* SOME ADDITIONAL EMULSIONS MAY STILL BE AVAILABLE

1) ONLY AVAILABLE FOR DIRECT PHOTOGRAPHY

SUMARY OF SPECTRAL SENSITIVITY



SPECTRAL REGION FOR WHICH EMULSION IS SPECIALLY VALUABLE

SPECTRAL REGION OF USEFULL SENSITIVITY

IV. A. 1. FIG. 1. a.

EFECTIVE RESOLUTION *

098 - 40 l/mm , IIaO (D)-50 l/mm

IIIaJ, IIIaF AND IV-N - 100 l/mm

* THESE ARE A FACTOR OF 2 LOWER THAN KODAK FIGURE SINCE THEY CONSIDER THE CASE OF 1000 : 1 CONTRAST WHICH IS NOT NORMALLY ENCOUNTERED IN ASTRONOMICAL WORK

GAIN OBTAINED WITH FORMING GAS BAKED PLATES COMPARED TO UNBAKED PLATES

EMULSION	IIa-O	IIa-D	IIIa-J	IIIa-F	098
GAIN FACTOR	3½	2	5	7	2

THE INDICATED GAINFACTORS ARE TYPICAL, GAIN VARIES WITH BATCH ,, BAKING CONDITIONS. ETC.

FOR ANY SPECIAL REQUIREMENT OF PLATES AND/OR TREATMENT PLEASE CONTACT MR. ARAYA OR MR. J. PEREZ, TEL. 260 OR 261 , (OFFICE: GROUND FLOOR ESO 1.5M TELESCOPE)

CUTTING AND BAKING OF PLATES REQUIRES SEVERAL HOURS THEREFORE PLATE REQUESTS MUST BE DEPOSITED IN THE RED LETTER BOX LOCATED BETWEEN DORMITORY 3 AND THE HOTEL NOT LATER THAN 9.00 A.M. OF THE DAY THAT THE PLATES ARE REQUIRED

DEVELOPER. (PLEASE ENCIRCLE YOUR REQUIREMENT)

HYPO CLEARING	D 19	D 76	MPW 2	FIXER	RAPID FIXER

IV. A. 1. FIG. 1. b.

Date ....

Apr. 80

IV.A.2-PHOTOGRAPHIC TECHNIQUES

SENSITIZING TECHNIQUES

Several different techniques are routinely employed to sensitize emulsions. The evaluation of these methods can be briefly summarized as follows:

1) Sensitized plate and a control plate from the same box (normally cut from the same plate) are exposed on the spot sensitometer, (see section IV.A.3) in a specific spectral region.

2) The plates are developed together under recommended conditions, (i.e. MWP-2 for 9 minutes at 20°C on a tray rocker).

3) Plates are measured on the Joyce-Loebel microdensitometer using a set of Ilford neutral density filters for calibration.

4) A characteristic curve for each emulsion is constructed using the photomultiplier calibration of the spot sensitometer and the measured densities.

5) Relative exposures at 0.6 and 1.0 above the gross fog are read from these curves and the gain factors calculated for the treated plate (with control plate having gain 1.0).

- Nitrogen baking: The baking times listed are for 50°C and in a nitrogen flow of 20 liters per hour.

Emulsion	Time-Hours	Gain Factor
098	5	2
IIa-O	7	2
IIa-D	9	2
IIIa-J	40	5
IIIa-F	--	1
127-04	--	7

- Hypersensitization: This type of sensitization involves the aqueous treatment of emulsions so as to reduce the pAg. Background non-uniformity is a major problem with this method and photometry of such plates is not recommended.

Emulsion	Solution	Time	Temp.	Gain	Fog
098	Distilled H_2O + trace of photo-flo	30^s	18°C	1.9	+0.18
IV-N	"	6^m	18°C	9	+0.04

- Pre-Flash: This is a specialized type of treatment which involves the exposure of the emulsion to a short duration illumination before exposed at the telescope. Pre-flashing is a benefit in type I detection problems (good signal to noise but restrictions due to optical speed). Examples of use are for: emission lines at the coudé and direct photography with an F15 system.
We determine optimum treatment based on the density versus detective quantum efficiency (DQE) of the emulsion. Pre-flashing is an additive effect which shifts the background to coincide with the density at which the peak DQE occurs. Therefore, only threshold detection is enhanced and flashing is a very limited technique which is beneficial in special circumstances only.
At present, pre-flash equipment is limited to plates of 16 x 16 cm or smaller.

- Forming gas baking: This consists of baking the plates in forming gas: a mixture of 96% N_2, 4% H_2. For certain plate types, this is preceeded by N_2 baking (see Table, page 1). Baking times are for 65°C and a gas flow of 0.5 lt/hour.
CAUTION: The forming gas is mixed industrially and we have no control over this; small percent variations may therefore affect gains. The following numbers (see Table,page 3) do not indicate the uniformity. The larger the plate, the more difficult to obtain uniform results. This is particularly a problem with Schmidt plates where non-uniformity often produces a wave-like appearance, streamer patterns, or black

regions (especially true for IIIa-F and IIIa-J).

Emulsion	Time - Min N_2	Time - Min Forming Gas	Gain Factor
098	30	30	2
IIaO	--	60/90/120	3.5
IIaD	--	90	2
IIIa-J	--	150	5
IIIa-F	30	90	7

- Silver nitrate or ammonium sensitizing: This is carried out for IV-N plates which are slow without sensitizing. When senitized, however, unevenness and spots are unavoidably introduced.

DARKROOMS

Darkroom locations are as follows:

3.6 m - Dome floor
1.5 m - 4th floor coudé
- 2nd floor (photographic testing laboratory)
- ground floor optics laboratory

1.0 m - 2nd floor

GPO - ground floor

3.6 M DARKROOM

The 3.6 m darkroom is air-conditioned to maintain 20°C air temperature. The water temperature is also controlled. A plate rocker for plates up to 25 x 25 cm^2 is available. A light table and overhead projector are available for plate inspection.

There is also a separate plate loading room containing N_2 baking facilities.

1.52 M DARKROOM

This darkroom is air conditioned to maintain a 20°C air temperature. There is a loading room and separate astronomers' office with an overhead projector for plate inspection.

- 2nd floor darkroom: is used primarily for the testing of photographic material and the evaluation of sensitizing techniques. Adjoining the lab are: a plate cutting room and plate baking facilities. Normally these facilities are not used by VAs but may be if circumstances warrant (i.e., for development of plates obtained from the Bochum telescope where darkroom facilities are unavailable.

1 M DARKROOM

A tray rocking machine and facilities for development of small plate sizes is available. This room is also used as a loading room.

GPO DARKROOM

The GPO darkroom contains all facilities for developing GPO plates.

IV.A.3-THE SPOT SENSITOMETER

INTRODUCTION

The spot sensitometer provides a simple and accurate method of calibrating photographic plates. It is ideally suited for calibrating image tube spectra, photographs, and plates taken with filters. It is presently located in the 3.6 m on the 4th floor. A schematic of the instrument is shown in Fig.(1). It consists of:

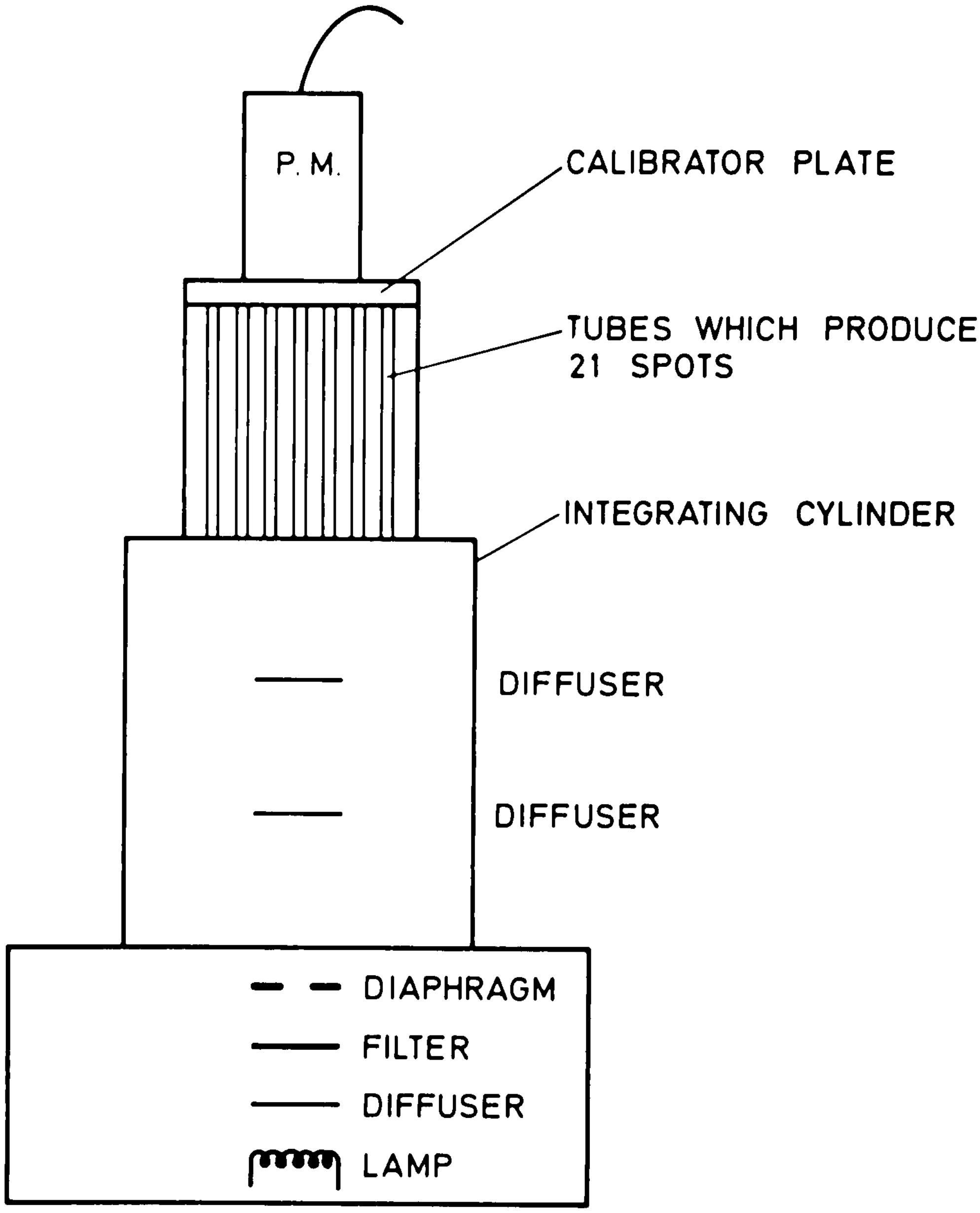
1) variable tungsten or mercury lamp
2) diffuser
3) filter
4) diaphragm
5) two (2) diffusers inside the integrating cylinder
6) tube stack
7) plate holder
8) photomultiplier and pulse counter

Essentially, a highly uniform light illumination is produced at the base of the tube stack. The tube stack is the heart of the sensitometer. It consists of 21 tubes, three rows of seven each, with a different diameter entrance aperture. All the tubes have the same diameter exit aperture. The ratio of the intensities between different tubes is related to the ratio of the diameters of the entrance apertures.

A plate to be calibrated is placed in contact with the tube stack and an exposure made. It results in a series of spots of increasing density, see Fig.(2). The exposure can be varied via the lamp intensity, filter, and diaphragm to match that of the astronomical exposure.

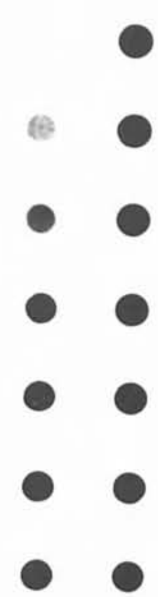
FILTER

The filter can be selected to match the astronomical equipment. For instance, when using an image tube, the filter is chosen to closely match the output phosphor.



SPOT SENSITOMETER IV.A.3.FIG.1.

TYPICAL SET OF CALIBRATION SPOTS



IV. A. 3. FIG. 2.

PHOTOMULTIPLIER

The photomultiplier (EMI 9558-B, S-20) is used to determine the correct exposure time. It is also used to check the photometric accuracy of the system by comparing the intensities measured from the individual tubes.

SPOT SENSITOMETER CALIBRATION

The spot number and relative photo-electric intensity is given in Table 1. The photo-electric intensity is normalised to spot 11.

The total intensity range of the 21 spots is approximately a factor of 100. If hole 21 is normally at 8.6, then hole 1 is at 0.09.

A typical characteristic curve of IIaO emulsion is shown in Fig.(3).

USE

To obtain sensitometer plates, the VA must fill out a "Daily Plate and Film Request" form the night before he requires plates. On this form, (see section IV. A.1), the last column should be checked stating number of plates and exposure times required.

up to 3000 Å.

COMPARISON SPECTRUM

The wavelength scale is provided by mercury and neon lamps.

CALIBRATION

The values of Log I (intensity) for each step of the ETA spectrograph calibration, the manufacturer's nominal value, and the measured values determined with the spot sensitometer are given in Table 2. An example of tl ETA spectrograph plate is shown in Fig.(2).

EXPOSURE TIMES

Since exposure times are adjusted according to specific sensitivity of each batch of emulsion, to each sensitizing procedure used, to each developing procedure, and above all, to the desired density range to be covered only a few indications are given here to help the astronomer find the correct exposure time required.

Comparison Spectrum

Emulsion	IIaO	IIaD	IIIa J	098-02	IN
Hg	15s	15s	30s	15s	15s
Ne		4s		4s	6s

Photometry

Emulsion	IIaO	IIaO	IIaD	IIaD	IIIa J	098-02	IN
Neutral density	2.1	2.1	1.7	1.4	1.7	2.1	1.4 + filter 4200
Time in min	10	20	3	13	20	4	12
Grating position/ order	1(1)	1(2)	1(1)	4(2)	2(2)	1(1)	5(2)

Table 2*

Step	Log I measured	Log I (nominal values)
1	-0.632	-0.625
2	-0.500	-0.500
3	-0.367	-0.375
4	-0.241	-0.250
5	-0.118	-0.125
6	0	0
7	0.120	0.125
8	0.240	0.250
9	0.355	0.375
10	0.475	0.500
11	0.610	0.625
12	0.733	0.750
13	0.841	0.875

* We recommend use of the measured values.

EXAMPLE OF ETA SPECTROGRAPH PLATE

IV. A. 4. FIG. 2.

PLATE AND FILM SIZES

The plate size is 152 x 28 mm. Plates of 150 x 28 mm can (with care) be fitted into the plate holders (the plate holder is curved). Five plate holders are available and a sixth holder is designed for film.

USE

To obtain ETA plates, the VA must fill out a "Daily Plate and Film Request" form the night before he requires plates. On this form, (see section IV.A.1) the last column should be checked stating number of plates and exposure times required.

IV.C.-DETECTORS

INTRODUCTION

Many new detectors are becoming available in astronomy. The following section describes detectors in use at La Silla. In the coming years, the list will expand as both a reticon and a digicon are under development.

In order to compare the relative merit of detectors available on the market today, we list them in Table 1 with some of their properties. The table is adapted from: Rudolph, R., et.al., 1978, Astron. Astrophys., 65, L5.

Table 1 - COMPARISON OF MODERN DETECTORS

Detector System Type	Dimension	Picture Size mm²	Resolution at 50% MTF lp/mm	Spectral Response ++)	Pixel Format	Pixel Size μm²	Photometric accuracy %	Intrascene Dynamic Range	Maximum Time Resolution (msec) 9)	Operation Temperature °C
Spectracon Diode array	1	7	10	s25, s20 s11	64x1	100x100	0.5	$3x10^6$	$4x10^{-3}$	+)
Parallel Output Digicon	1 1)	26	25	s20	512x1	150x 40	0.2	$3x10^6$	$4x10^{-3}$	+)
Serial Output Digicon	1 1)	28	33	s20	936x2	375x 30	1	$4x10^3$	100	-76
MAMA	1.2	30	30	s11	1024x1 512x512	32x300 25x 25	2	10^5	20	+)
Photicon	2	25	10	s11	1024x1024	12.5x12.5	2	10^7	20	+)
Codacon	1	25	20	(s20)	1024x1	25.4 up to 2000	2	10^3	100	+)
ICCD	2	8.8x3.2	15	s20	400x125	22x 25	3	10^3 - 10^4	50	-40
ICCD (UMAP)	2	4x5.3	35	s20	100x100	40x 53	1	1500	5	-20 - +20 +)
CCD (Texas Instru.)	2	9x9	25	s1	400x400	23x 23	1	2700 7)	100	-100
SSPD (Reticon)	1.2	26 6x6	40 16	s1	1024x1 100x100	610x 25	1	$4x10^3$ 200	6)	-100 to -130
SEC-Tube 4)	2	50x50	20	s20	2000x2000	25x 25	5	100	10	-
SIT/EBS 3)	2	28x28	13	s20	1000x1000	15x 15	5	100	10	≤ -60
ITS	1 2)	20	35	s25	2048x2	37x250	2	$6x10^4$	4	-20 to +35
Image Photon Counting System	2	35	40	s20	1000x200 5)	20x 20	1	$6x10^4$	20	-60

Table 1 (cont'd)

Comparison of Modern Detectors

Explanation of Symbols and Abbreviations

Abbreviations:

MAMA: Multi-Anode Microchannel Array
ICCD: Intensified Charge-Coupled Device
UMAP: Univ. of Maryland Array Photometer
SSPD: Self-Scanning Photodiode Array
SEC : Secondary Electron Conduction
SIT/EBS: Silicon Intensifier Target/Electron Bombarded Silicon
ITS : Image Tube Scanner

1) Scanning of parallel lines by deflection coils possible
2) Extension in two dimensional possible
3) Westinghouse WX 32719
4) Westinghouse WX 31718
5) Limited by storage capacity
6) Depends on object brightness
7) For S/N > 5
8) From S/N ≈ 2 to sâturation
9) The reciprocal value gives the max. countrate per sec pixel

+) Cooling depends on photocathode, approximately -20°C for S20 cathode

++) Inherent pixel noise can be derived from tube properties under realized optical and temperature conditions, related to the efficient detective surface

IV.C.1-THE RETICON

INTRODUCTION

The reticon is a self scanned linear photodiode array, and like the IDS and EMI image tubes (see sections IV.C.4 and IV.C.2 respectively), it can be mounted on the Boller and Chivens spectrographs at either the 1.5 m or 3.6 m telescopes. The reticon used is a type RL 1024C/17 and consists of two parallel arrays of 1024 silicon photodiodes each 450 μm high and 25.4 μm wide with no dead space between diodes. The two arrays are separated by approximately 2.44 mm. The system is operated without image intensification and preserves its exceptional red response. The quantum efficiency is shown in Fig.(1) relative to other detectors. The detector is most sensitive between 7000 Å to 9000 Å where the quantum efficiency is 80%. It provides, therefore, a complement to the IDS and EMI image tubes.

In order to reduce thermal noise, the reticon is mounted behind a quartz window in a specially designed liquid N_2 dewar which operates between -70°C and -130°C depending on the desired sensitivity. A compromise has to be made between thermal noise and red sensitivity. A temperature of -100°C to -90°C gives a sensitivity out to 10400 Å. To obtain 10830 Å, the system must be operated above -90°C, for example at -110°C, the system is completely insensitive at 10830 Å. The dewar is shown schematically in Fig.(2) and mounted after the Schmidt camera of the spectrograph. For Visiting Astronomers wishing to work in the red, the reticon has these additional advantages:

1) linearity of intensity over a large dynamic range
2) mechanical stability
3) complete thermal isolation between detector and spectrograph
4) no phosphor afterglow after exposure to bright sources

However, unlike the IDS, the reticon is an integrating device, and the spectrum is only seen after an integration and not in real time. Detailed technical descriptions can be found in Dennefeld, et.al. (1979), Vogt, et.al. (1978), and Zurbuchen, (1978).

OBSERVING PRINCIPLE

The observing principle is exactly like that of the IDS (section IV.C.4/

page 2). The spectrograph is fitted with a special decker with two apertures one above the other producing simultaneously two spectra: one of the object with sky, and the other sky alone. Like the IDS, the two arrays A and B have slight sensitivity differences eliminated by observing the object first in the upper aperture and then in the lower aperture. Sky subtraction is particularly important in this wavelength region in order to eliminate the large number of atmospheric OH bands.

APERTURES OR DECKER

The reticon is equipped with its own deckers, each one has a fixed slot or aperture size and has to be aligned carefully so that the resultant spectrum falls on the diode array. Unlike the IDS, there is no sweep pattern setting procedure. However, the reticon decker alignment procedure takes several hours and does not allow the observer to change aperture size easily during the night. In principle, the deckers can be changed at least for the smaller ones 4 and 6 arcsec without requiring new alignment, but in practice this is not convenient. Once adjustment of the decker has been made, the system is completely stable. The aperture sizes available are given in Table 1.

Table 1

Rectangular Aperture Sizes in Arcsec

Telescope					Separation Arcsec
3.6 m	4	6	10	15*	95
1.5 m	4	6	10	20*	220

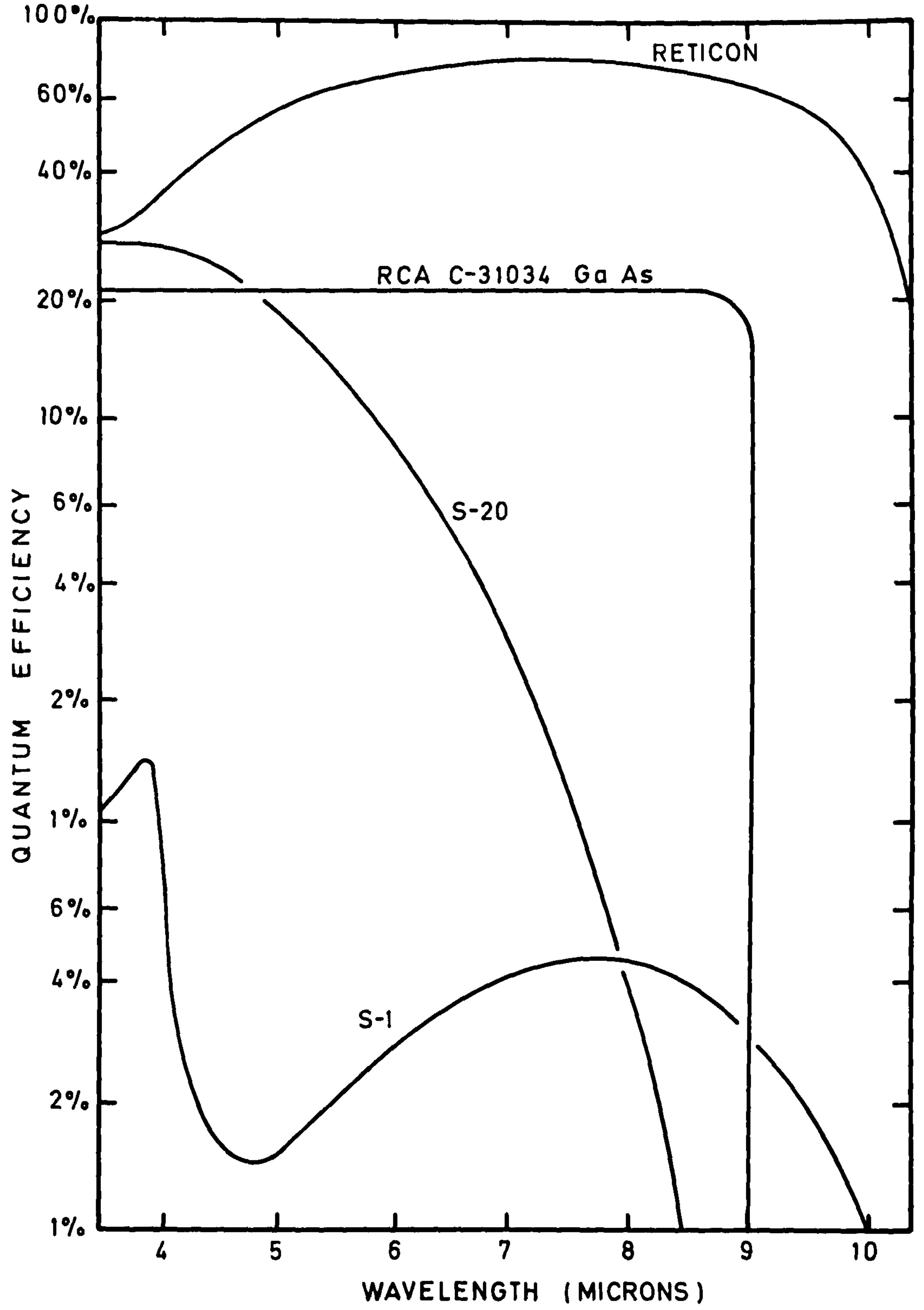
* This corresponds to the maximum available height of a diode.

RESOLUTION

The resolution is a criterion which depends on the signal level (modulation transfer function). However, unlike the IDS, there is little image spread; the instrumental profile does not have extended wings, and the image (FWHM) is very close to 1 pixel ≃ 30 to 35 μm.

SATURATION

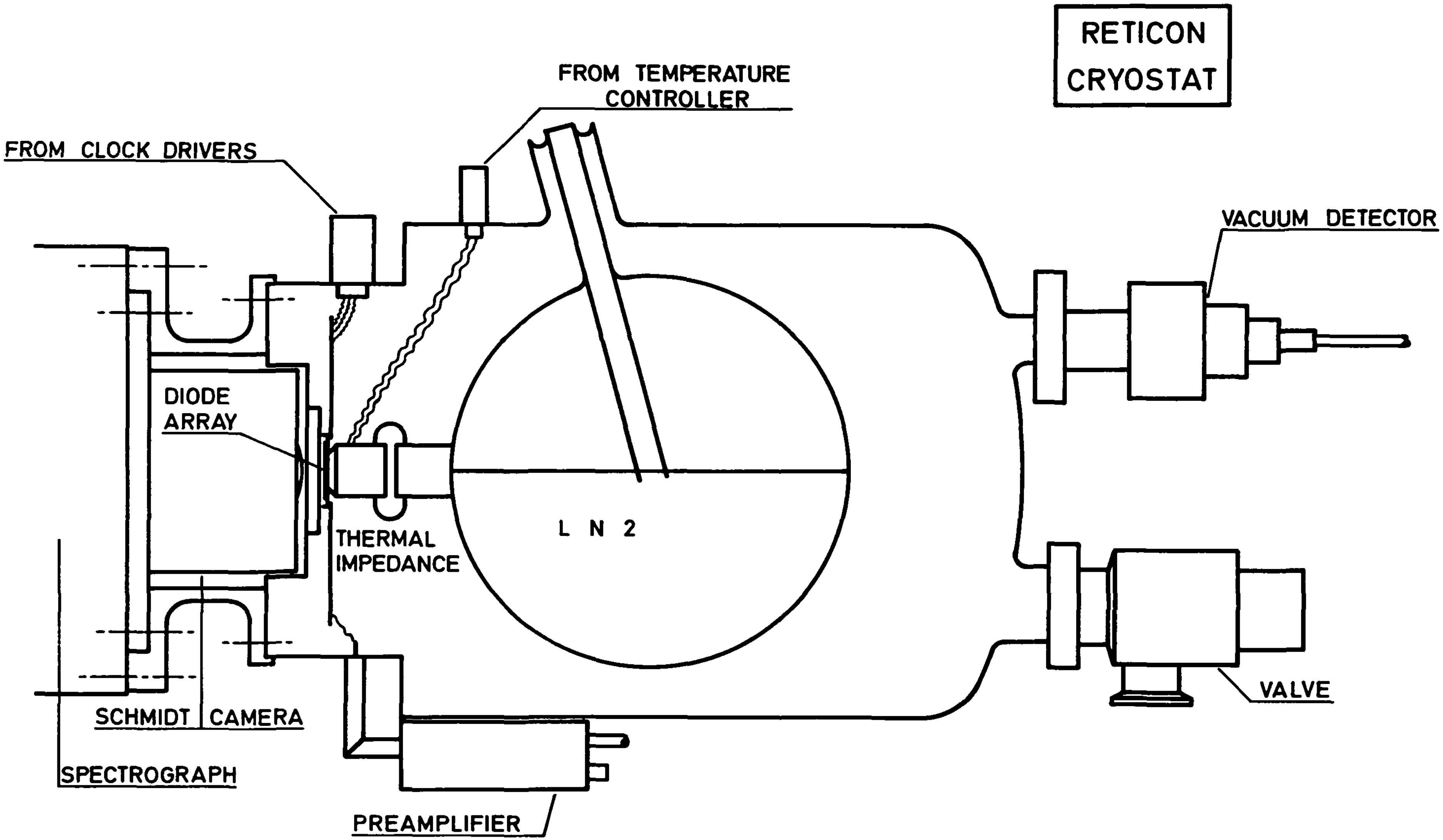
The reticon has a large dynamic range, and in the present system saturation occurs at 4×10^6 counts. This corresponds to 20% saturation level of the detector itself; at this level, departure from linearity is still less than 1%.



QUANTUM EFFICIENCY OF THE RETICON ARRAY AND SEVERAL CONVENTIONAL PHOTOCATHODES. IV. C. 1. FIG. 1.

Apr. 80

Apr.80



IV.C.1.FIG.2.

The corresponding magnitude limit depends, of course, on seeing, slit size, and spectral resolution. However, saturation occurs for an A5 star V = 6.3 in 60 sec with the 228 Å mm^{-1} grating at the 3.6 m telescope and using a 2 arcsec slit (10 Å resolution). Because of the system's higher efficiency in the red, this limitation will be reached for fainter red stars.

WAVELENGTH CALIBRATION

A He Ar arc is used for wavelength calibration. A typical spectrum is shown in Fig.(3). The spectrum can be fitted well with a 3 degree polynomial; unlike the IDS, the reticon does not suffer from the spectrum scale compression at the extreme end of the spectrum.

GRATINGS

A special set of gratings exist for use with the reticon. The gratings have to be individually adjusted to the spectrograph. The grating specifications are given in Table 2.

Table 2

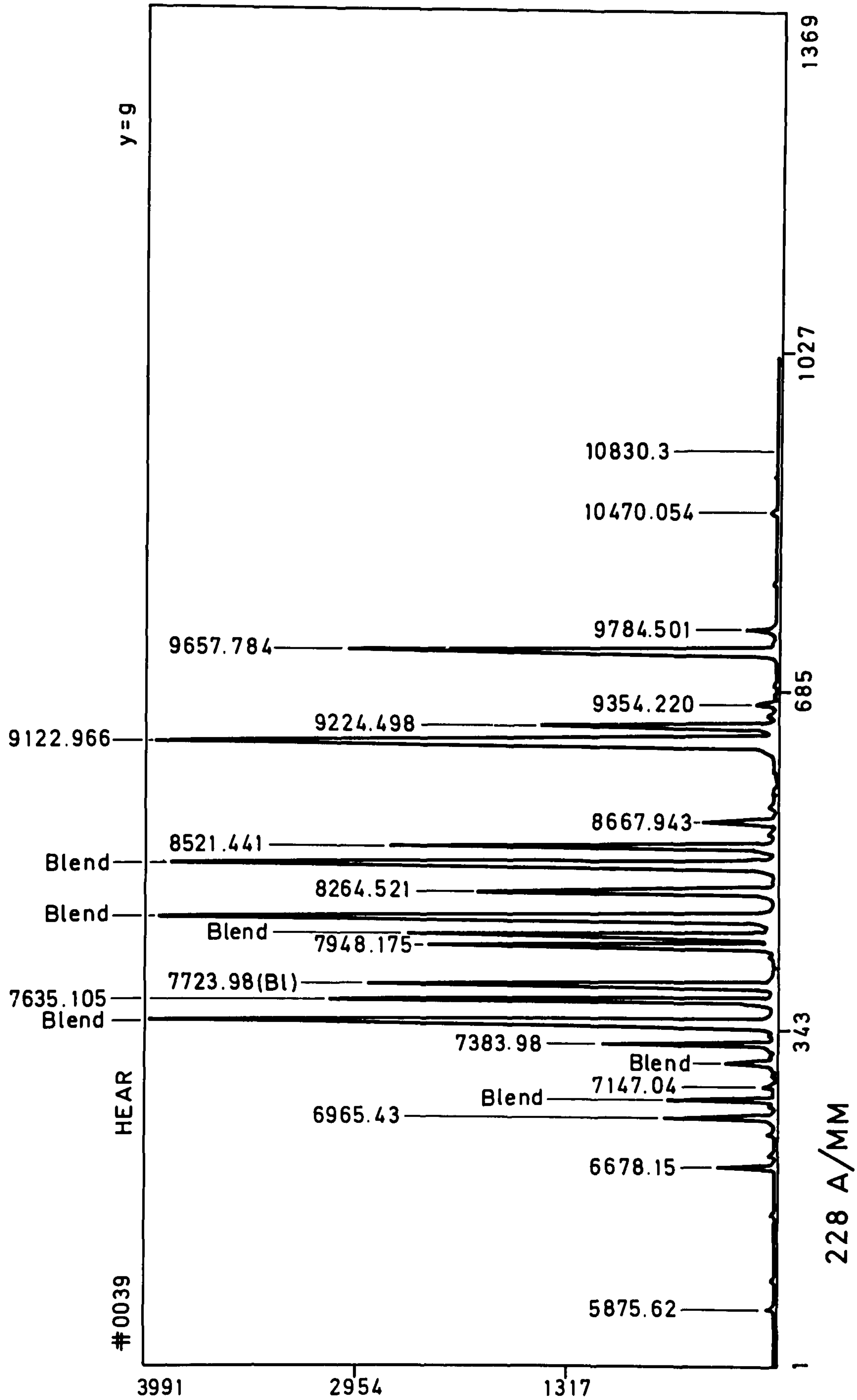
Å mm^{-1}	No. of Lines	Effective Blaze	Order
228	300	9100 Å	1st
171*		9100 Å	1st
116	600	9100 Å	1st
58	1200	9100 Å	1st

* Not yet available

In order to avoid 2nd order contamination, an OG 590 filter is used. Presently, only one set of gratings is available, but in the near future, 2 sets will become available: one set dedicated to the 1.5 m and the other to the 3.6 m telescope. This will avoid grating adaption problems.

OBSERVATIONS AND COMMUNICATION

The astronomer controls both the spectrograph and reticon functions from the 3.6 m control room through two CRT display consoles, in a similar fashion to the IDS. In the 1.5 m, certain functions of the spectrograph are carried out manually. At both telescopes, one CRT displays instructions and shows which function is being executed; the other is an interactive graphic display which



IV.C.1. FIG. 3.

Apr.80

displays the spectrum. The system is set up to be controlled by subroutines that can be called through a set of "soft keys", which are at the upper right of the main console keys. The keys are represented on the display screen by rectangles, each rectangle showing a particular function. The function shown is executed when the soft key is pushed. The general structure of these soft keys is shown in Table 3.

Table 3

General Format of Soft Keys

	START	STOP	RETICON STATUS
END OBJECT	FLIP ARRAY		MENU

In each of these second level menus, the lower right hand soft key is called MENU; when pressed, it returns the system to the master menu. The lower right hand soft key of the master menu calls a test menu which is provided for maintenance of the system and is, in principle, not to be used by the VA.

The full set of menus is shown in Fig.(4) with the master menu at the center.

No integration can be started without first making a dark measurement. The first instruction to begin an integration is RSTART,DK; a security code prohibits any other starting instruction for a measurement sequence and gives an error message. It is recommended during long observations (e.g. 1/2 hour or more) to do a DK in between flips (not forgetting to close the spectrograph shutter).

COOLING

The dewar is pumped to typically 4 x 10^{-2} mb and after filling, remains stable for 12 hours. Normally the system requires 2 liters of LN_2/12 hours, which means at most (but only for full safety) one refilling in the middle of the night.

DATA HANDLING AND STORAGE

Data handling and storage is identical to the IDS, see section IV.C.4/page 6.

MAGNETIC TAPE

Normally five (5) mag tapes are available at the beginning of a reticon observing run. They are labled 1 to 5 and should be used consecutively. Each

SET X Y SCALES	H CUT	L CUT	COORDINATES
PLOT SCAN LINE	OVER PLOT SC LIN	HORIZONTAL ROLL	MENU

	START	STOP	RETICON STATUS
END OBJECT	FLIP ARRAYS		MENU

SET COMMENTS	SET IDENTIFIER	SET EQUAT. COOR.	SET PICTURE LAB.
DISPLAY COMMENTS	DISPLAY INFO BLK	FILE DIRECTORY	MENU

OPEN SHUTTER	ON HEAR	ON CONTINIUM	DECKER POSITION
CLOSE SHUTTER	OFF HEAR	OFF CONTINIUM	MENU

* MASTER MENU

SPECTROGRAPH	IDENTIFIERS	OBSERVATION	GRAPHICS DISPLAY
LAMBDA CALIBRAT.			TEST MAINTENANCE

W VALUES	W DISPERSION	W CALCULATE	W SEARCH
W CONTROL	W EDIT	W FUNCTION	MENU

TEST CAMAC	PULSE HEIGHT SP.	LINEARITY	FAST FOURIER TR.
FLAT FIELD DEF	DARK CURRENT DEF	CALIBRATION	MENU

* NOTE PRESSING „MENU" ALWAYS RESULTS IN RETURN TO MASTER MENU

RETICON SOFT KEY DIRECTORY IV. C. 1. FIG. 4.

Apr. 80

tape is transfered to a single master tape which will eventually contain the data from all five nights. A copy of this master tape is kept for six (6) months on La Silla for security.

BRIGHTNESS LIMITATIONS

The limiting magnitude with a S/N of 10 to 20 is estimated to be V = 16.0 at the 3.6 m telescope in the continuum with a resolution of 10 Å (slit of 2 arcsec) at 228 Å mm^{-1}. This is reached in one (1) hour integration. Saturation occurs for a V = 6.3 A5 star at the 3.6 m with a 228 Å mm^{-1} grating with a resolution of 10 Å and a 60 second exposure time.

Dennefeld, M., Guttin, L.B., Le Luyer, M., Rossignol, P., Internal ESO Technical Note IDG 120-79.
Vogt, S.S., Tull, R.G., Kelton, P., 1978 Applied Optics, 17, 574.
Zurbuchen, R., 1978, Messenger, No. 12, 18.

IV.C.2-EMI TUBES

INTRODUCTION

These EMI tubes can be mounted at any of the ESO Boller & Chivens spectrographs. The tubes are electromagnetically focused and are cooled by a thermostatically controlled refrigerator (circulating glycol) and dry air or N_2 gas is circulated over the photocathode to ensure that condensation does not occur.

These tubes are still under test, but the manufacturer's specifications are given in Table 1.

PLATE SIZE

The EMI tubes employ a Nikon wide field f/1.2 transfer lens, and a new plate holder has been designed. The plate size is 6 x 6 cm^2 and up to nine (9) exposures may be made per plate. The plate holder is advanced by remote control.

Table 1

EMI Image Tube Specifications

EMI Type	Photocathode	N° of Stages	Resolution center lp/mm	edge lp/mm	Entrance window	Gain	Electron Dark current cts/cm^2/sec	Q.E.	Gain Uniformity over 40 mm field
9914	S20 extended red	3	50	45	UV zinc crown	$\nless$ 5x10^5	150	$\nless$1% at 7500 Å	15%
9914	Bialkali	3	50	45	sapphire	$\nless$50x10^5	2	$\nless$1% at 5800 Å	15%
9916	S20 extended red	2	70	-	UV zinc crown	$\nless$ 1x10^4	150	$\nless$1% at 7500Å	10%
9916	Bialkali	2	70	-	sapphire	$\nless$ 1x10^4	2	$\nless$1% at 5800 Å	10%

IV.C.3-THE SPECTRACON

INTRODUCTION

The Spectracon is an electronographic image intensifier and is shown schematically in Fig.(1). It is normally mounted at the prime focus of the 3.6 m telescope. Consult Table 1 for telescopes on which the Spectracon is available.

The Spectracon's principal advantages are as follows:

1) linearity

2) high signal to noise

3) high resolution

4) lack of reciprocity failure

In the Spectracon, light falling on the photocathode liberates photoelectrons which are accelerated through 40 KV and are focused magnetically to produce a high resolution electron image at the mica window. The window is only 4 μm thick (and should therefore be treated carefully) and transmits 75% to 80% of the electrons.

The electrons are recorded in a nuclear track emulsion and the resultant electrographs are processed similarly to normal emulsions. The tube gives a magnification factor of one (1), and is cooled with a circulating solution of water and 25% automobile anti-freeze to reduce thermionic emission, and therefore reduce the background.

PHOTOCATHODES

Both S-20 and S-25 photocathodes are available, see Fig.(2). The S-25 is a new multi-alkali semi-transparent photocathode.

COOLING

Cooling is provided by a circulating solution of water and 25% car anti-freeze. The temperature is thermostatically controlled and kept at 10 to 15°C below ambient. So, typically it operates at -5°C in winter and +5°C in summer. However, at no time must it be operated below the ambient *DEW-POINT* as this will produce condensation on the faceplate and the mica window.

PLATE HOLDER

The plate holder has six (6) positions. Focus can be done on a bright star of 7th or 8th magnitude, and a good exposure can be obtained in 10 seconds.

FILM SIZE

The image area is 30 mm x 10 mm and the film is cut into strips of 30 mm x 100 mm. The film is then wrapped around a cylindrical applicator, which is rotated slightly for each exposure.

EXPOSURE TIMES

With a 2 arcsec seeing, $V = 20^m$ can be reached in an hour exposure at the 1 m. The tube background is approximately D = 0.08 per hour and is not a limitation.

EMULSIONS

Nuclear track emulsions Ilford L4 and G5 are used. The high silver halide content and fine grain of these emulsions, together with the sensitivity and low noise of the image converter account for the low contrast detection capabilities of the Spectracon.

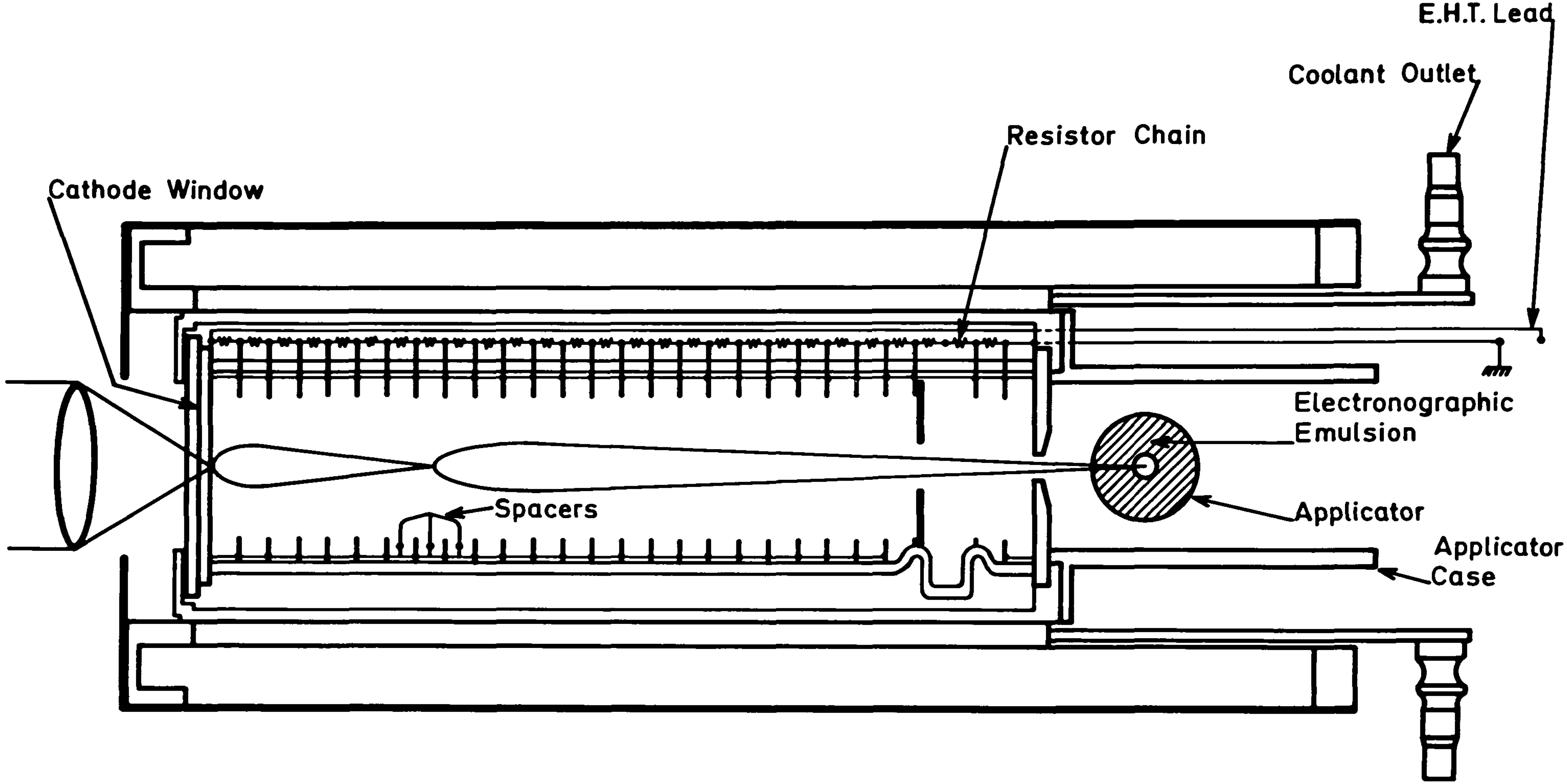
The G5 emulsion is faster than the L4, but the L4 has a finer grain and gives a higher signal to noise ratio for a given exposure. The plates can be handled in the darkroom with a safelight. However, nuclear emulsions have no protective supercoat, as do normal emulsions, and they should therefore be handled with care as they are sensitive to abrasion.

LINEARITY

Tests show that the tube is highly linear up to densities beyond D = 1.8. It is also estimated that $V = 21^m$ is measurable from a plate to an accuracy of $\pm 0.05^m$.

RESOLUTION

The MTF (modulation transfer function) with 5% modulation is 80 lp/mm to 120 lp/mm. Our tube was measured to have a 10% modulation at 50 lp/mm, but this number depends largely on the emulsion type used.



THE SPECTRACON

IV.C.3.FIG.1.

IV.C.4-IDS (IMAGE DISSECTOR SCANNER)

INTRODUCTION

The IDS is compatible with all Boller & Chivens spectrographs and is available only at the 3.6 m and 1.5 m ESO telescopes.

It consists basically of three (3) Varo type 8605 electrostatically focused image tubes each having a fiber optic input and output, mounted one after the other. The IDS is shown schematically in Fig.(1). The fiber optic plates are optically contacted using immersion oil, and the image dissector tube is in turn oiled onto the output of the last image tube.

The image from the spectrograph Schmidt camera is focused via a quartz field flattening lens onto the input face of the first image tube. The initial fiber optic face plate, which is demanded by the geometry of the electrostatic image tube, is responsible for a significant attenuation of the ultraviolet end of the spectrum below about 4000 Å. The limit of sensitivity is at approximately 3600 Å.

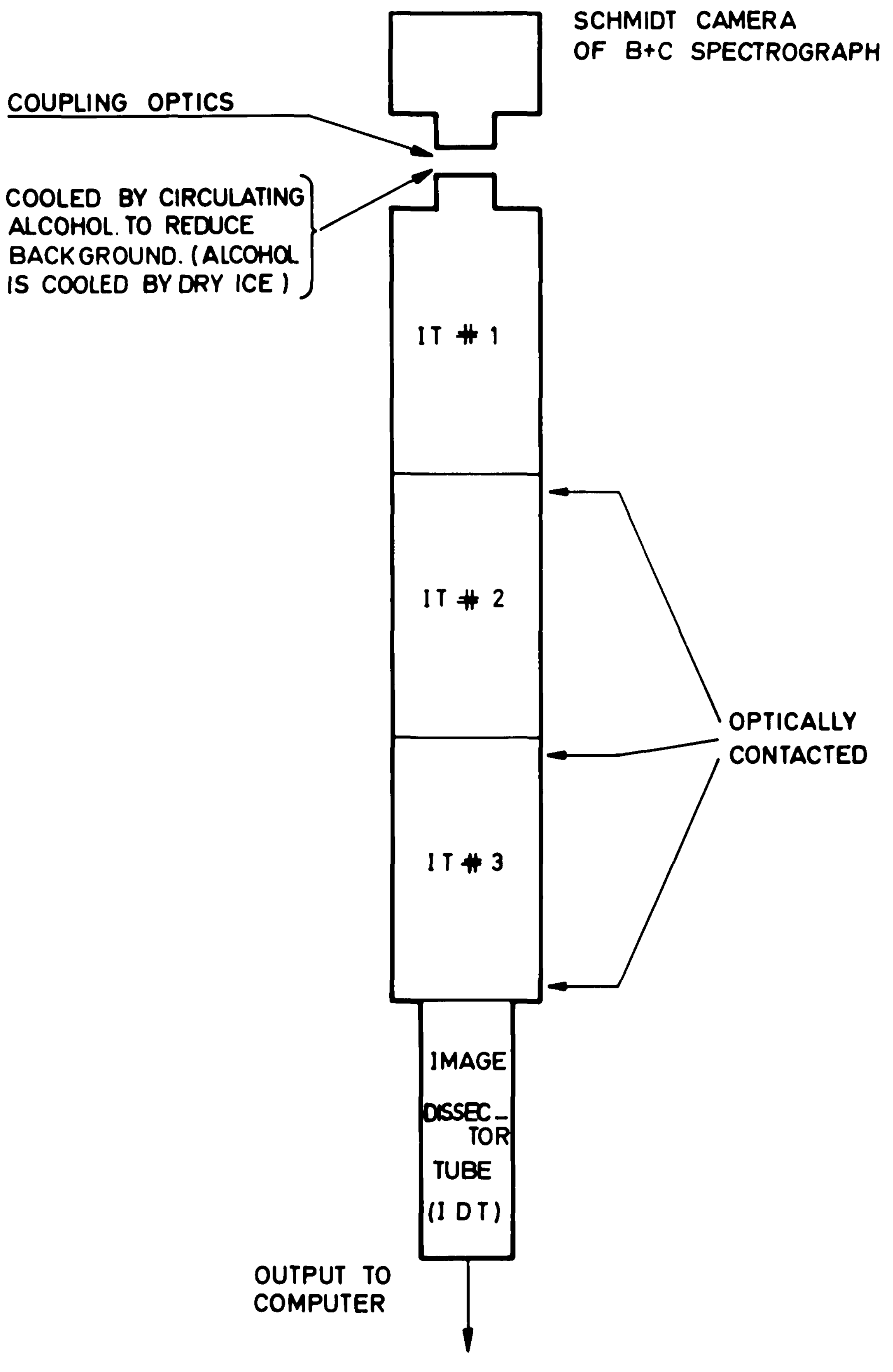
The image tube output phosphor acts as a temporary buffer memory for the primary photoelectron "events" from the optical image and stores them long enough to be detected by the scanning aperture of the image dissector tube (IDT).

The output phosphor (P-20) has a decay time of 2 - 3 millisecs. The IDS scan rate is approximately 1 μsec/pixel (pixel = picture element). The image dissector tube acts essentially as a scanning photomultiplier and normally performs two (2) sweeps across the optical image: once across the *sky* spectrum, and once across the *object and sky* spectrum. During the sweep setting procedure, the dissector scans the whole image field in a TV type raster.

The whole detector unit is mounted in a cylindrical housing which is bolted on the B & C spectrograph. The system is cooled to reduce the background by circulating cooled alcohol around the intensifier chain. The alcohol itself is presently cooled by dry ice. Dry air is passed over the photocathode to ensure that ice does not form. Later this year, this system will be replaced by a Peltier heat pump thereby dispensing with the inconvenience of dry ice replenishment.

This system has the following advantages over conventional detectors:

- high sensitivity
- linearity of intensity over a large dynamic range
- long integration times



IDS (IMAGE DISSECTOR SCANNER) IV.C.4. FIG.1.

The IDS system counts photons emerging from the *output phosphor* of the intensifier chain and does not attempt to distinguish one primary photoelectron from another as in some detector systems. This results in a marginally poorer signal to noise ratio but a considerably improved dynamical range.

OBSERVING PRINCIPLE

In order to understand better the controls, a brief description of how observations are carried out is helpful.

The instrument is designed to measure simultaneously sky and object spectra and is therefore capable of observing faint objects below the sky background. This necessitates using a double aperture decker one above the other in the spectrograph, see Fig.(2).

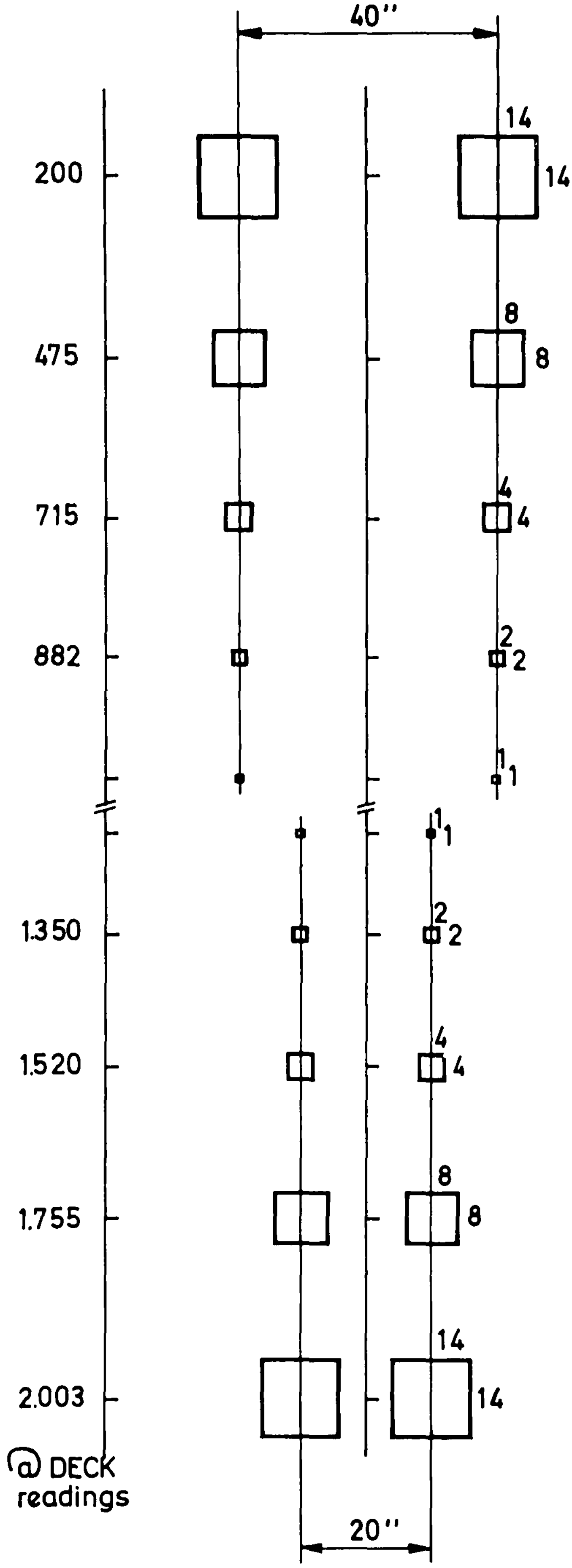
The slit arrangement produces two (2) spectra one above the other, Fig.(3), each physically approximately 20 mm long. Each spectrum is divided into 2048 pixels.

When observing an unextended object, the *object and sky* are placed in say the upper aperture A, and the *sky* alone is seen in the lower aperture B. The difference then of the spectra (A - B) should be the true *object* spectrum for a *perfect system*. However, the system is imperfect and the light paths through the telescope, spectrograph, and image tube for A and B are slightly different resulting in inequalities in the sensitivity of A and B.

To overcome these, we simply move the telescope and observe the *object and sky* in B and the *sky* alone in A. Our observing technique consists then of *pairs* of observations or scans.

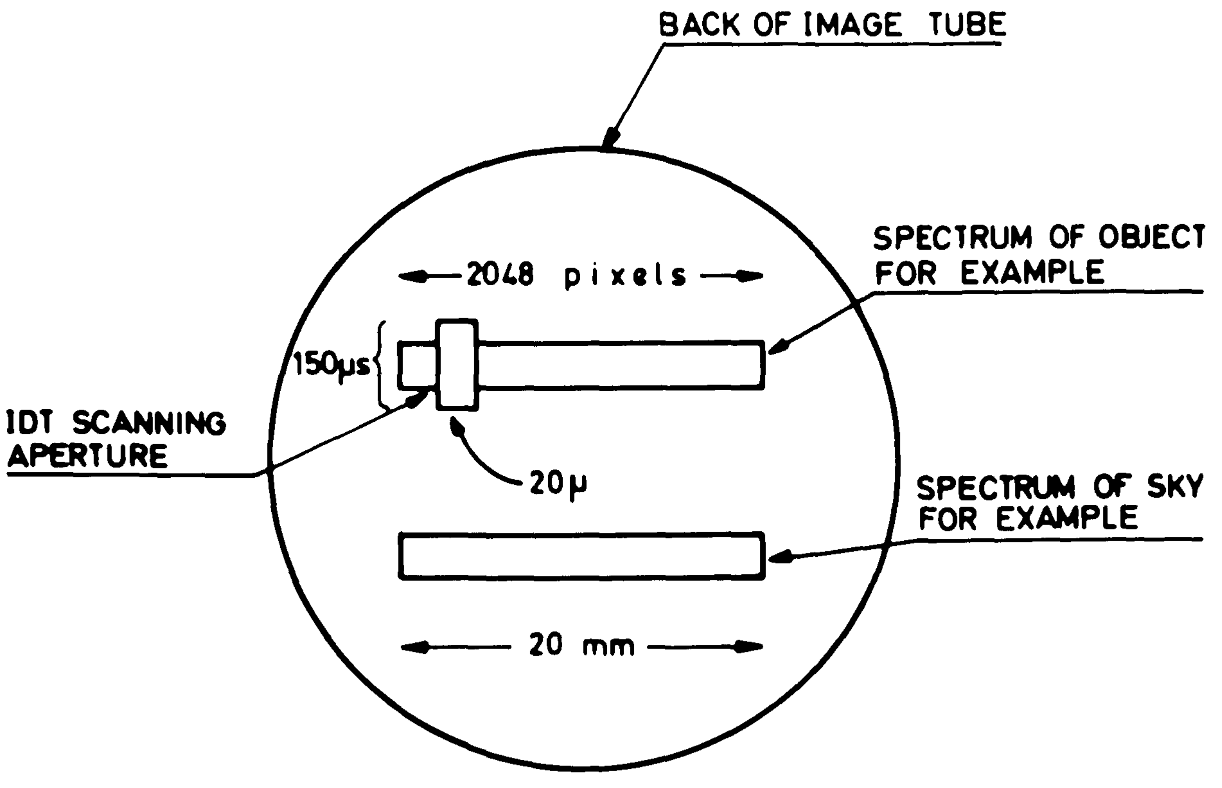
A1	Object + Sky	1st pair
B1	Sky	
A2	Sky	2nd pair
B2	Object + Sky	

Then, provided the exposure times are the same, *OBJECT*(spectrum) = A1 + B2 - (B1 + A2). Usually more than two (2) pairs of observations are made and the observer decides when to stop when he feels the signal/noise ratio is sufficient. Typical observations are made with the object in A, 5 mins, then in B, 10 mins, and again in A, 5 mins. In this way the object is observed the *same length of time* in both apertures. The integration time may be changed but the default value is 10 mins.



I D S APERTURE DECKER IV. C. 4. FIG. 2.

Apr. 80



ESSENTIALLY THE IDT SCANS THE SPECTRUM WITH A RECTANGLE 20 MICRONS WIDE AND 150μ HIGH CORRESPONDING TO 0.7 AND 7 ARCSECS RESPECTIVELY ON THE SKY

BACK VIEW OF IMAGE TUBE IV. C. 4. FIG. 3.

A slightly different procedure is used to observe *extended objects*. The porblem is that different parts of the object are seen in A and B. We simply move the telescope to a comparison sky area and make two (2) skies; one in A and the other in B. In this way, we get two spectra of the object, for example:

A1	object in position #1	1st pair
B1	object in position #2	
A2	sky for position #1	2nd pair
B2	sky for position #2	

Therefore:

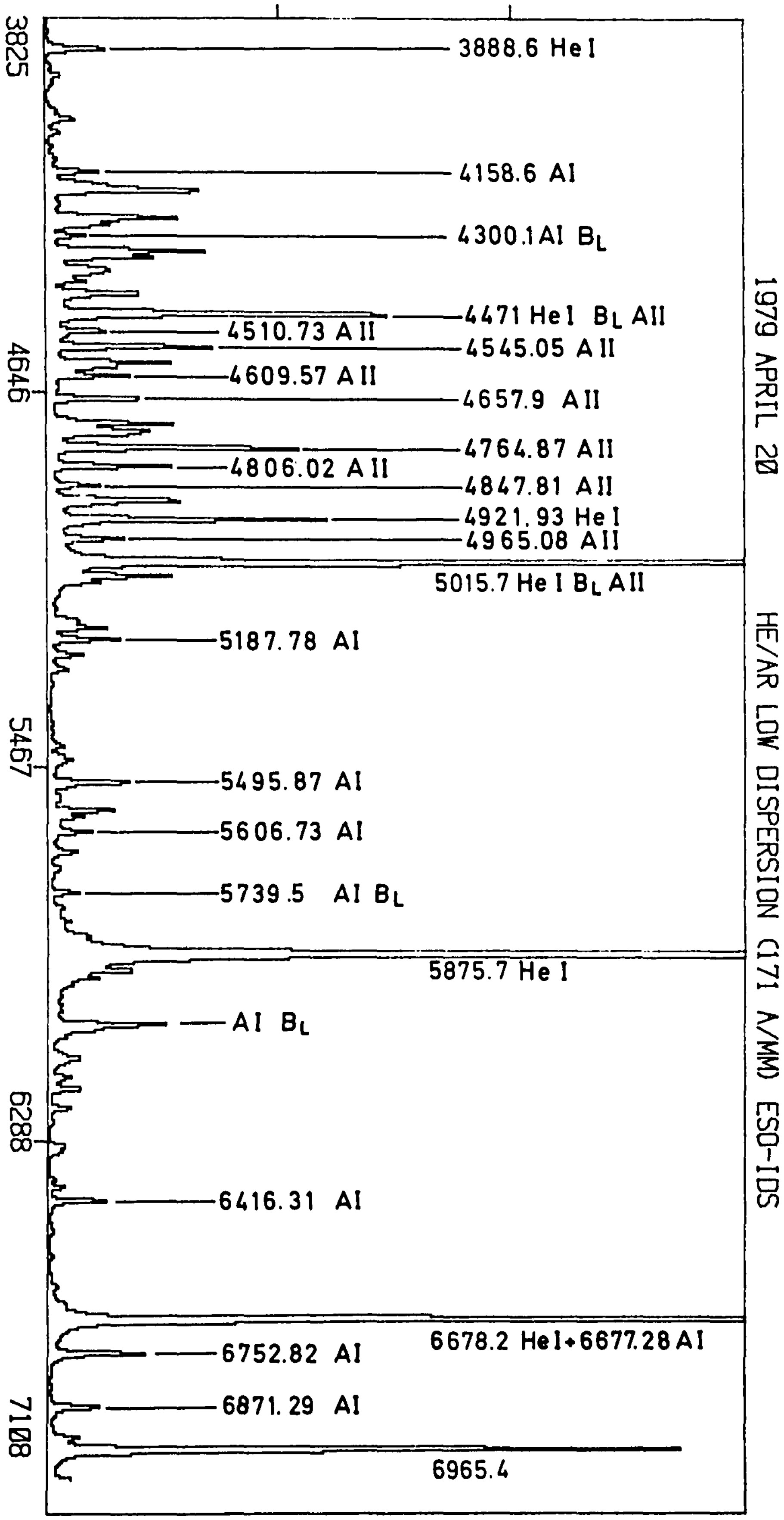
OBJECT (position #1) = A1 - A2
OBJECT (position #2) = B1 - B2

The system has to be calibrated in terms of wavelength and spectral response. The wavelength scale is determined by observing a He-Ar calibration source within the spectrograph. An example of this comparison spectrum recorded at low dispersion is shown in Fig.(4). The overall spectral response of the system is determined by observing standard stars of a suitable brightness. It is an inefficient use of observing time, however, to use these standard star observations to calibrate the small spatial scale irregularities in the response of the image tubes and IDT. For this purpose, a white light source (quartz-iodine lamp mounted in the spectrograph) is observed to a high signal/noise ratio during the preceding evening or following morning and divided into all the observations for that night. This white light source is also used to determine the location of the two spectra on the detector in order that the IDT can scan correctly. This procedure is known as *sweep setting*.

OBERVING APERTURE-THE DECKER

The IDS decker is shown in Fig.(2) and consists of 10 double apertures; 5 separated by 20 arcsecs and 5 separated by 40 arcsecs. The apertures are selected by remote control through a CRT-display console in the control cabin.

However, note that as Fig.(3) shows, the IDT scans through a slot 150 μ high. This means the projected IDT scanning slit height on the sky is 5.8 arcsecs. Hence, increasing the spectrograph slit length beyond this will not result in more information.



He-Ar CALIBRATION SPECTRUM AT LOW RESOLUTION IV.C.4.FIG.4.

RESOLUTION

The overall line spread function is determined by the convolution of the spectrograph slit width, camera, and IDS response functions and at best a line can be expected to cover 5 to 6 pixels (50 to 60 microns) at FWHM.

Furthermore, the instrumental profile has more extended wings than a gaussian which is particularly important to consider when the instrument is being used for absoprtion line studies.

SENSITIVITY AND SPECTRAL RESPONSE

This has been determined by observing Oke calibrated white dwarfs, (Oke, J.B., 1974, Ap. J. Suppl. Series, 27, 21.).

The following table gives the observed count rates for the star LDS 749 B with the 400 l/mm grating.

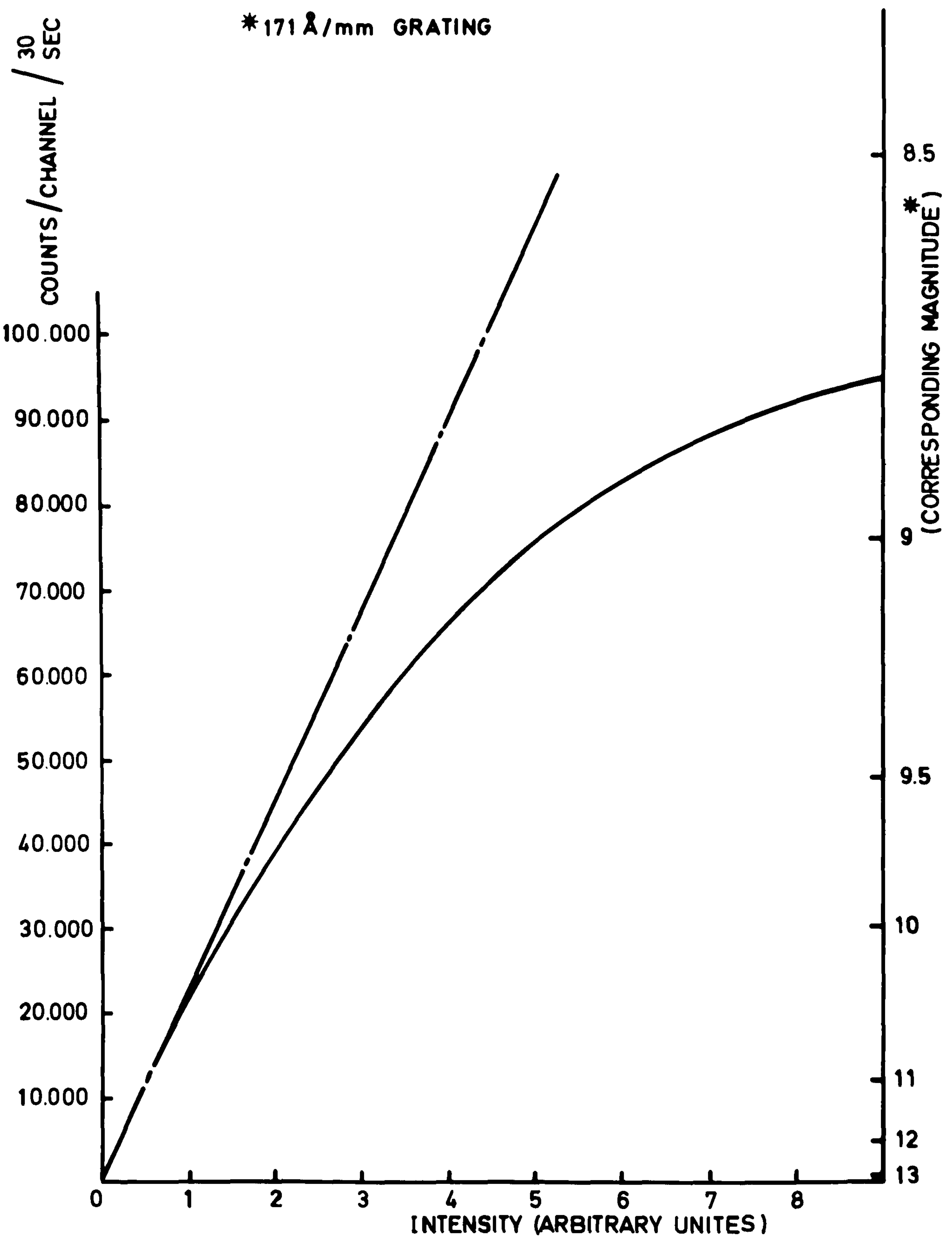
Approx. λ	Counts $Å^{-1}sec^{-1}$	AB(= $-2.5 \log f\nu - 48.60$)
3790	1.4	14.6
4330	5.9	14.5
4790	9.4	14.5
5420	6.1	14.6
5980	2.9	14.8
6600	1.2	14.9

For the IDS, these counts do not represent actual photon events because, on the average, each photon is counted several times. It has been determined that the statistical error in n counts is:

$$\sigma(n) = (1.82 \pm 0.23) \sqrt{n}$$

This can be interpreted as 3.3 IDS counts/photon.

The peak sensitivity then corresponds to one detected photon $Å^{-1}sec^{-1}$ for a star with a blue magnitude of 15.6. The sensitivity will be clearly reduced by observing with a smaller aperture in poor seeing. Also, it must be remembered that the different gratings do not all have the same efficiency. The figures



IDS SATURATION IV. C. 4. FIG. 5.

given above are intended only as a guide but should be sufficient to estimate exposure times to reach a given photometric accuracy.

When using this device as a photometric instrument the dominant error usually results from the use of a small aperture (to preserve spectral resolution) coupled with image spread due to seeing and atmospheric dispersion. The choice between resolution and photometric accuracy is a compromise.

SATURATION

In a similar manner to photoelectric photometry high pulse rates result in saturation effects in the IDS. With 400 l/mm, 171 Å/mm grating, the device is essentially linear up to 10.5 mag with 10% losses for magnitude 9.5 (see Fig.(5)).

The observing program should be ordered such that bright objects are not observed just before faint objects in order to avoid afterglow effects.

COMMUNICATION

The astronomer controls both the spectrograph and IDS functions from the 3.6 m control room through two (2) CRT display consoles. One displays instructions and shows what function is being carried out. The other is an interactive graphic display which displays the spectrum. There are also two (2) oscilloscopes essentially used as monitors, showing the REAL time spectrum, as it builds up in the IDS memory, and indicating the sweep scan pattern.

The system is set up to be controlled by subroutines that can be called through a set of *soft keys* which are at the upper right of the main console keys. The keys are represented on the display screen by rectangles, each rectangle showing a particular function. The function shown is executed when the *soft key* is pushed. The general structure of these *soft keys* is shown in Fig.(6).

1	2	3	4
5	6	7	MENU

Fig.(6)

These represent what is termed a "MENU". The master menu can be considered as a first level and contains the master directory to go to sets of commands such as:

- MEASURING
- IDENTIFIERS
- LAMBDA CALIBRATIONS, etc.

Pressing "MEASURING" for instance displays the second level menu, e.g.:

START INTEGRATION	STOP INTEGRATION	FLIP OBJECT	END OBJECT
TRANSVERSE	OVERTRACE	STTR	MENU

In each of these second level menus, the lower right hand button is called "MENU"; when pressed it returns the system to the MASTER MENU.

The full set of menus is shown in Fig.(7) with the MASTER MENU at the center.

A useful feature of the system is a "HELP" routine. By typing "HELP" followed by the function will result in the display of the function with an explanation of its use.

DATA HANDLING AND STORAGE

Data is handled by an HP 2100 MX series computer. There is a CRT console, line printer, mag tape drive, disc unit, interactive graphic display, and a plotter. All raw data is automatically transfered to mag tape as well as to disc file.

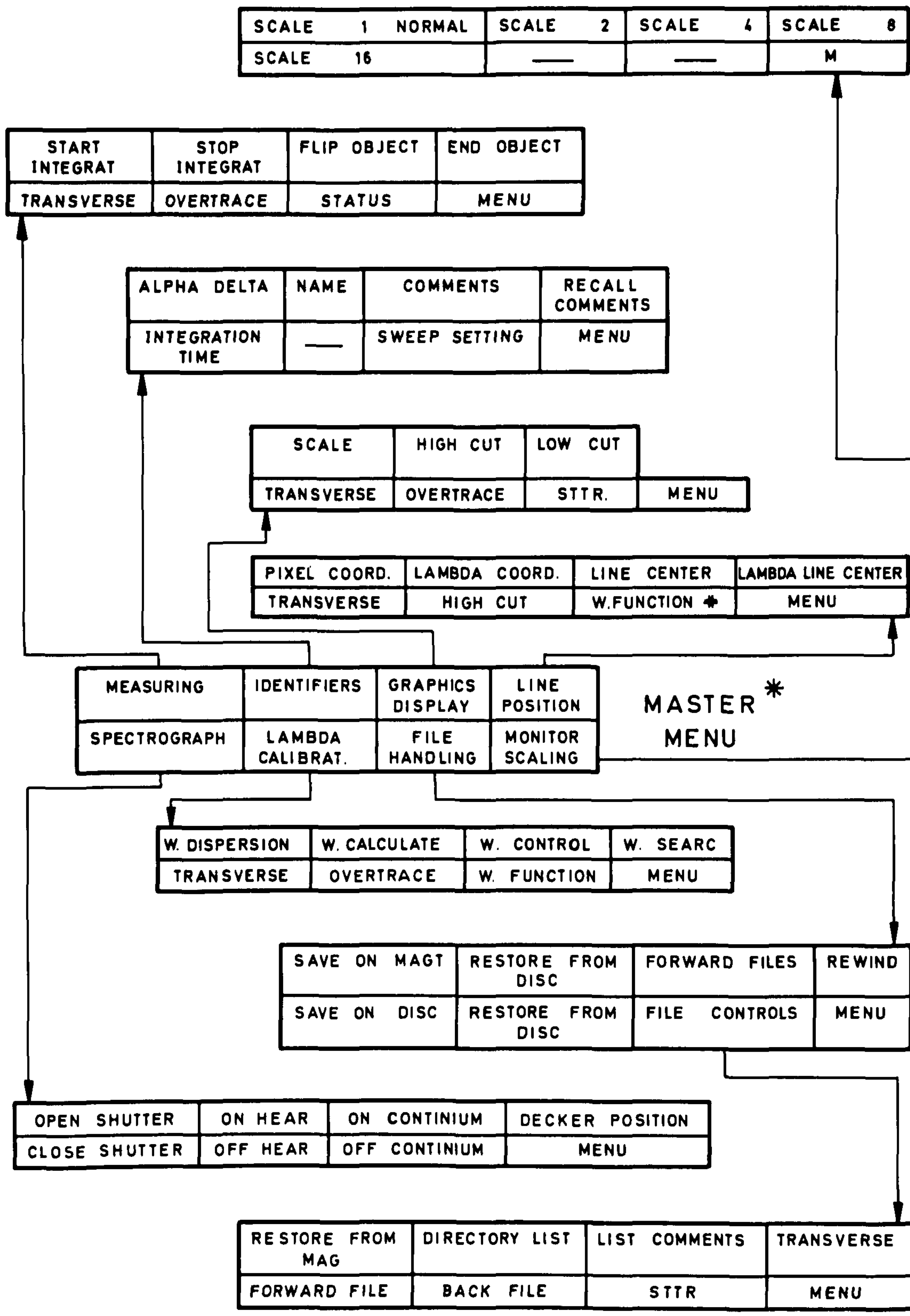
Through the display unit, the astronomer can manipulate the data on disc to give a partial or full reduction as required, and all manipulations are recorded on the line printer. The observer can carry out such reductions and see the results on the graphic display while observations are proceeding. This allows the observer to easily judge the signal to noise, approximate red shift and identification of spectral features.

The spectrum may be plotted during an observation or at any later time. In the event of loss or accidental corruption of data on the disc files the files may be reconstituted from mag tape. The raw data files are stored on magnetic tape along with any other files of reduced data saved by the observer. These files are used to compile the master data tape that the user takes away for final reduction in Geneva or La Silla.

The computer "housekeeping" is arranged so that the first disc file is reserved for the object currently being observed. Records S1 to S4 of files are reserved for sum buffers and S5 and S6 are scratch. Data integrations start at S7.

The mode of operation is shown in Table 1.

The first pair of observations are placed in memory locations S7 and S8 and simultaneously into the sum buffers S1 and S2. When the telescope is moved to take the second pair, the computer is given the instruction "XFLIP" and the second



NOTE PRESSING "MENU" ALWAYS RESULTS IN RETURN TO MASTER MENU

IDS SOFT KEY DIRECTORY IV.C.4.FIG.7.

pair are placed in S3 and S4, and S9 and S10. If the XFLIP instruction were not given after the pair S7 and S8, then S9 and S10 would be added to S1 and S2. The telescope is again moved for the third pair which are in the same sense as the first pair. The computer is again told the orientation by the instruction XFLIP and the third pair are co-added into S1 and S2 and also entered as raw data in S10 and S11, etc. The raw unmodified data is therefore available from position S7 onwards. A quick look at the summed signal can be obtained from scans S1 to S4 using the instruction "FTTR" being (1 + 3 - (2 + 4))/flat field. At the end of an integration of an object, disc file 1 is cleared ready for the next object and the data accumulated is transfered to a new disc file.

Table 1

Integration 1	S7	Object + Sky	} pair 1	MEMORY	
I 2	S8	Sky		co-added disc	
		← XFLIP			
I 3	S9	Sky	} pair 2	I 1 + I 5 + I 9	S1
I 4	S10	Object + sky		I 2 + I 6 + I 10	S2
		← XFLIP			
I 5	S11	Object + Sky	} pair 3	I 3 + I 7 + I 11	S3
I 6	S12	Sky		I 4 + I 8 + I 12	S4
		← XFLIP		SCRATCH	S5
I 7	S13	Sky	} pair 4	SCRATCH	S6
I 8	S14	Object + Sky		raw data	
		.		I 1	S7
		.		I 2	S8
		. etc.		I 3	S9
				I 4	S10

DATA REDUCTION

The data reduction procedure is described fully in the "IDS Control Program User's Guide" and more recently the "IHAP User's Manual" by F. Middelburg.

Data reduction is normally carried out by VAs at the ESO IHAP facility in Europe. For details, the VA should contact the Visiting Astronomers Section Garching. An effort is now being made to transform the data into FITS format which may then be easily handled at other data reduction centers in Europe.

Listed are the basic steps to get from the raw counts vs. pixel number to flux vs. wavelength. These are:

1) Coincidence correction applied to all scans (only important for count rates above about 500/sec/pixel).
2) Division of scans by white light.
3) Determination of wavelength calibration for each aperture.
4) Putting scans on a linear wavelength scale.
5) Correction for atmospheric extinction.
6) Sky subtraction where appropriate.
7) Determination of spectral response curve from observations of standard stars.
8) Use of spectral response curve to produce final output of flux vs. wavelength.

MAGNETIC TAPE

Normally five (5) mag tapes are available at the beginning of an IDS observing run. They are labeled 1 to 5, and should be used consecutively. Each tape is transfered to a single master tape which will eventually contain the data from all five nights. A copy of this master tape is kept for six (6) months at La Silla for security.

BRIGHTNESS LIMITATIONS

Already it is clear that saturation effects have to be taken into account for stars brighter than 10.5 mag at the 3.6 m and brighter than 7 at the 1.5 m. Stars brighter than 9th mag at the 3.6 m and 7 mag at the 1.5 m should not be observed as they may cause damage and certainly phosphor remnants.

Reference for a general description of an IDS: Robinson, L.B., Wampler, E.J., 1972, P.A.S.P., 84, 161

Cullum, M., 1979 ESO Technical Report No. 11, November

Middelburg, F., December 1979, IHAP User's Manual.

V. Data Analysis

SECTION V INDEX

V.A.1-THE GENERAL DATA ACQUISTION SYSTEM

INTRODUCTION

Data acquistion systems (DAS's) are at present in operation in the ESO 3.6 m, 1 m, and 50 cm telescopes.

All DAS's use Hewlett Packard computers as central controller with associated peripherals, and CAMAC for interfacing with the astronomical instrumentation. Up till now, only single crate CAMAC systems are being used.

Two different types of data acquisition systems are standardized on La Silla: the DAS I, used in the 1 m and 50 cm telescopes; and the DAS II, which at present is in operation in the 3.6 m Cassegrain area only, but will become available in the 3.6 m coudé area, the 1.5 m ESO, and the Danish 1.5 m telescopes after June 1979.

For all DAS's, the following software is provided:

- ASSEMBLER
- FORTRAN
- FORTH

No other languages are supported by ESO.

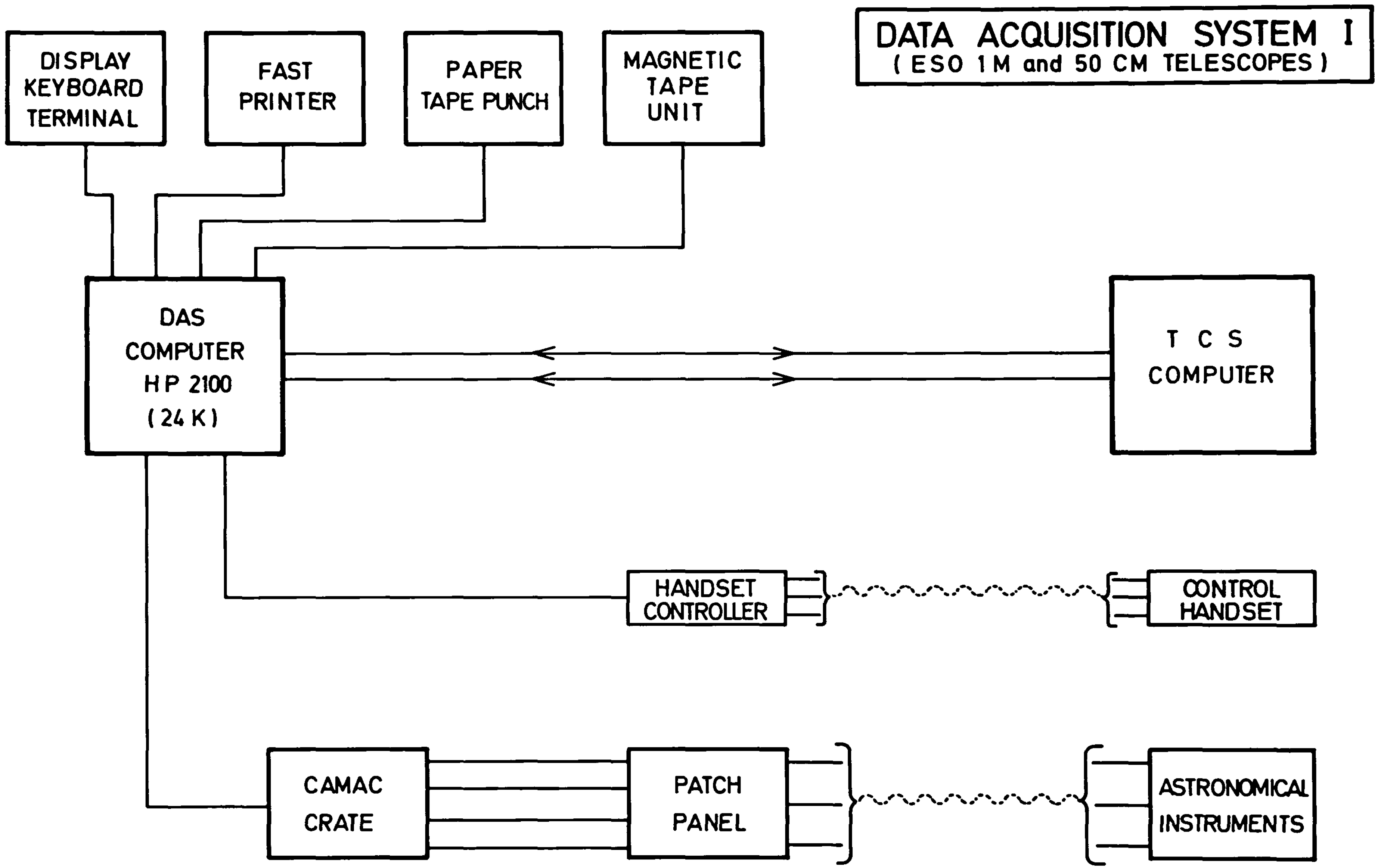
THE DATA ACQUISITION SYSTEM I - DAS I

The configuration of DAS I is given in Fig.(1). The central part of this system is an HP 2100 with 24 K memory in the 1 m, and 16 K in the 50 cm telescope with the standard BCS (Basic Control System) operating system. The following standard peripherals are available:

For data entry:	display/keyboard
For data output:	magnetic tape (800 bpi, 25 inches/sec) fast printer (80 characters/sec) paper tape punch (8 hole, 60 lines/sec)

Data obtained can be recorded on any combination or all data output terminals simultaneously.

The data acquisition computer is connected to the telescope control system (TCS) computer via a two-way data link, which allows operating the telescopes from



DATA ACQUISITION SYSTEM I
(ESO 1M and 50 CM TELESCOPES)

V.A.1.FIG.1.

the data acquisition terminals and; furthermore, facilitates the interaction such as infrared scanning, etc.

The astronomical instruments are interfaced via a patch panel and a single standard CAMAC crate. As interface between the CAMAC crate and the DAS computer, a direct crate driver - Borer, Type 1531 - is employed; no branch drivers are available.

The patch panel (only available in the 1 m telescope) provides facilities to interconnect various instruments rapidly and to inspect individual signals arriving from the instrument via the trunk cable.

In the photometry mode, the routine commands can be entered while driving via the control handset, such as: filter changes, start/stop and delete commands, status information, filter position, counts, average counts, etc.

All standard ESO instrumentation mounted on the 1 m and 50 cm telescopes use the above described system, and for many of the instruments on line first reductions are provided.

The VA's equipment may be interfaced to this DAS on the condition that their equipment is CAMAC compatible and standard software and operating systems are used.

For DAS I, only BCS is supported, and no other operating system is available.

THE DATA ACQUISITION SYSTEM II - DAS II

The DAS II is considerably more versatile and features a more modern Hewlett-Packard 2100 MX E computer with 32 K core memory and a fast FORTRAN processor as a central device. The DAS II is presently available only at the 3.6 m telescope. The following HP peripherals are standard:

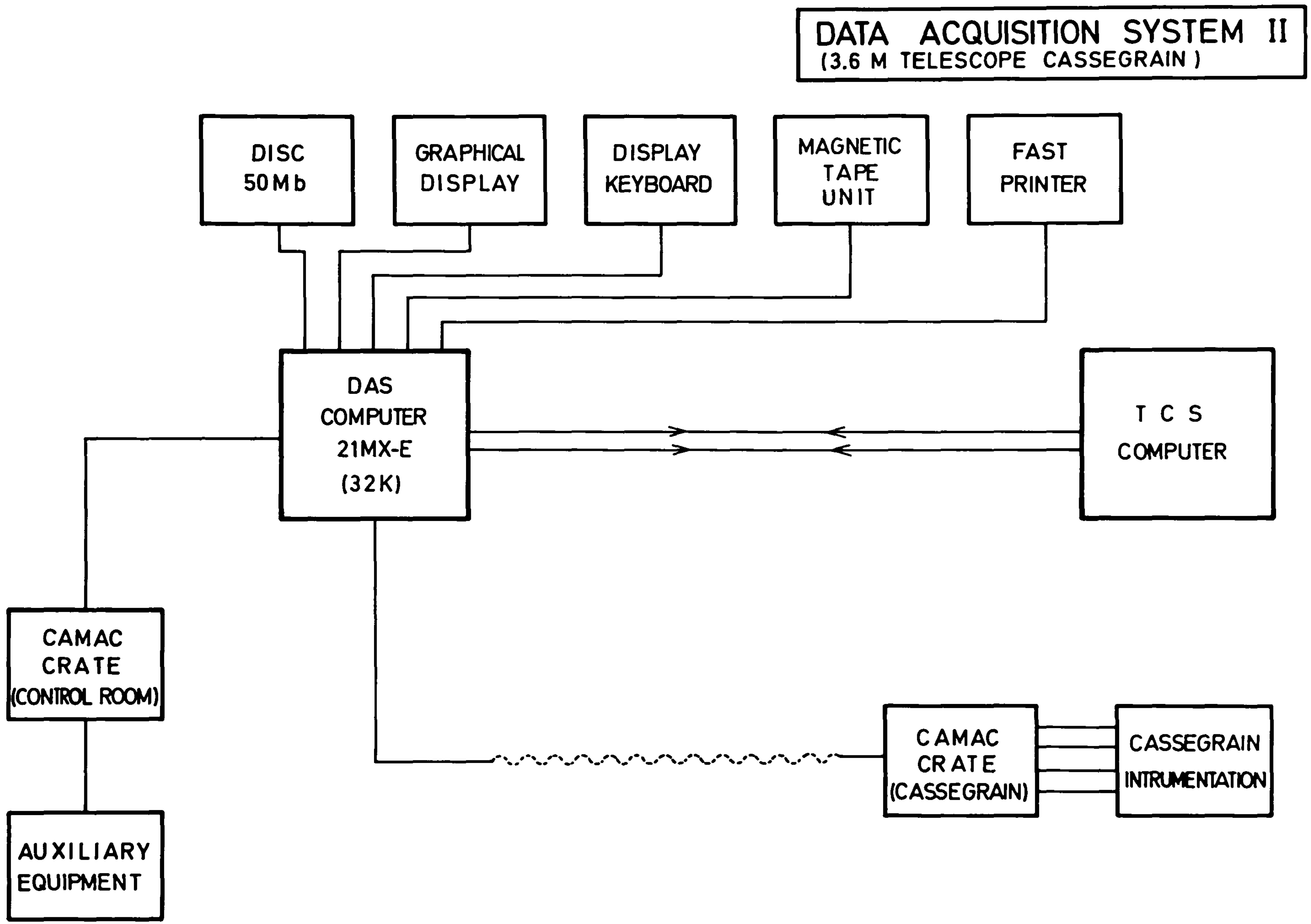
- disc unit 50 M bytes
- keyboard/display
- magnetic tape unit (800 bpi, 45 ips)
- graphical display
- fast printer (80 characters/sec)

The configuration of this system is given in Fig.(2).

CAMAC crates are available in the 3.6 m Cassegrain cage and in the telescope control area, near the DAS computer. No CAMAC crate is available in prime focus at present.

As in DAS I, the DAS II computer has a two-way data link connection with the TCS computer.

RTE-2 (Real Time Executive, version 2) is supplied as the operating system,



DATA ACQUISITION SYSTEM II
(3.6 M TELESCOPE CASSEGRAIN)

V.A.1.FIG.2.

and no other operating systems are supported.

The DAS II allows the storage and handling of large amounts of data. The observed data can be displayed via the graphic display in the form of: graphs, diagrams, etc., which helps the observer to rapidly assess the quality of the data. The graphical display also allows both alphanumerical and figure displays to be enlarged and has cursor, zoom in/out operations, etc.

At present, only the IDS (Image Dissector Scanner) has been interfaced to this system.

CAMAC

All DAS's interface to the astronomical instruments using CAMAC, which is now the only instrument interfacing system supported by ESO.

The CAMAC system consists of:

- CAMAC crate
- CAMAC crate driver-computer interface
- CAMAC plug-in units

At present, no branch drivers for larger CAMAC systems are available. If several crates are required, each individual crate will be interfaced to the DAS computer separately.

The following CAMAC plug-in units are now standard, and available on La Silla for use by VA's, see Table 1.

Table 1

CAMAC Plug-In Units

Unit	Type	Description
Quad 100 MHz scaler	Borer, 1004	(4) 16 bit registers, individually or common gated
Input/Output register	Borer, 1031A	dual 16 bit inputs; single 16 bit outputs
Relay output module	Borer, 1082	(2) x 16 relay contacts
Dual channel digital voltmeter	SEN, 2103	9 bit resolution + sign bit; input voltage range 0, ± 100 MV
Heidenhain incremental encoder interface	ESO Chile built	presetable phase and zero pulse counters; 16 bit zero pulse for wide range absolute encoding
Slow syn stepping motor controller	ESO Chile built	bidirectional programmable stepping in a speed range from 5 to 100 Hz
Dataway display	Borer, 1801	16 bit display
Analogue multiplexer	SEN MX 2025	multiplexing 12 analogue channels
Analogue to digital converter	Dornier, 00200-1025	12 bit converter; input voltage range ± 5 V
Input/output module	SEN IOR 2053	16 bit input and output with handshake possibility

V.C.1-THE BLINK COMPARATOR

INTRODUCTION

The blink comparator was constructed by Jena Optic, and is kept on the lower floor of the hotel.

EYEPIECES

The instrument is equipped with two (2) eyepieces with 16X and 25X magnification.

INTENSITY ILLUMINATION

The plates are mounted in plate holders and all the usual adjustments are available for alignment. Intensity illumination is independently variable for both plates.

FILTERS

Red and green filters are available. These are particularly useful when looking for *strongly* variable stars.

BLINK CONTROL

The blinking itself can be done by hand or automatically by a variable speed motor.

PLATE HOLDER SIZES

Plate holder sizes available are:

Plate Holder Size	Instrument
30 x 30 cm	Schmidt
25 x 25 cm	
20.5 x 25.5 cm	
20 x 20 cm	
13 x 18 cm	
16 x 16 cm	GPO, 1.5 Zeiss
12 x 9 cm	B & C direct plates