EUROPEAN SOUTHERN OBSERVATORY

OPERATING MANUAL

No. 5 – January 1986

IRSPEC

ESO OPERATING MANUAL no.5
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MOORWOOD, A.F.M. — A 4-2 / 122 a,b
IRSPEC Operating Manual.

Garching, European Southern Observatory. 1986. — ML
49 p. ESO Operating Manual no.5 — LS
ML 598/88
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I R S P E C

J.L. LIZON

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TABLE OF CONTENTS

I N T R O D U C T I O N

IRSPEC is a cooled grating infrared spectrometer. The complete spectrometer is enclosed in a vacuum vessel and cooled to liquid Nitrogen temperature. The detector, an InSb array, is cooled to 50 K by solid, pumped Nitrogen contained in a separate cryostat.

This manual should enable the user to prepare and handle the instrument without understanding it completely. We should, however, understand that it is easier to realize what possible consequences a mistake might have, once we have learnt about the technology of the instrument

After a short general presentation we intend to describe the operations in chronological order. The index in the margin enables the user to look up the operations separately, using Table I.

It is strongly recommended to write down the most important operations in the IRSPEC log-book and to continue to fill in the cooling operation sheets.

GENERAL DESCRIPTION

Fig. I

1: Wagon shaft
2: Camac status cable
3: Camac TLM cable
4: Front wheels
5: Rail wheels
6: Detector control box
7: Flow meter
8: Steady state valve
9: Cool down valves
10: Connectors flange
11: Thermocouples
12: CrI refilling pipe
13: Slit viewer camera
14: Pre slit optics
15: Black body control
16: Instrument junction box
17: Rear wheels adjusting spindle
18: Tilt adjusting screws

Fig. II

1: Telescope connecting flange
2: Vessel upper part
3: Structure upper part
4: Nitrogen gas cylinder
5: Nitrogen general input
6: Warming tube
7: Lateral adjusting screws
8: Rear wheels
9: General power connection
10: Vessel bursting disc
11: Main vacuum valve
12: Vacuum flange
13: Penning gauge
14: Cryogenic control box
15: Pirani gauge
16: Height adjusting spindle
17: Hydraulic pump
18: Pumping lever
19: Hydraulic valve
20: Front wheels height adjusting screw
21: Air inlet valve
22: Scanning mirror control
23: Grating cooling switch

Fig:I General view

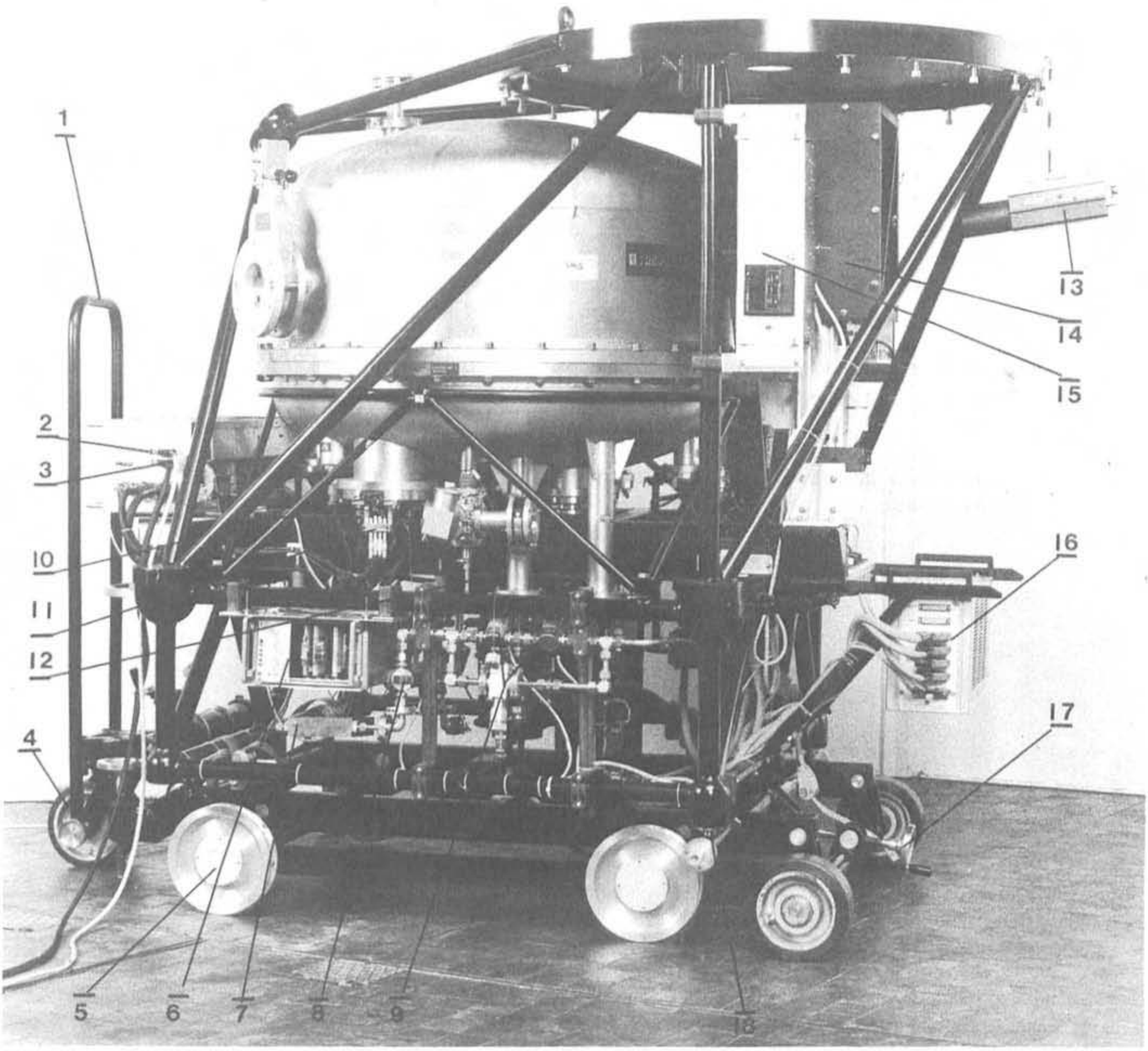
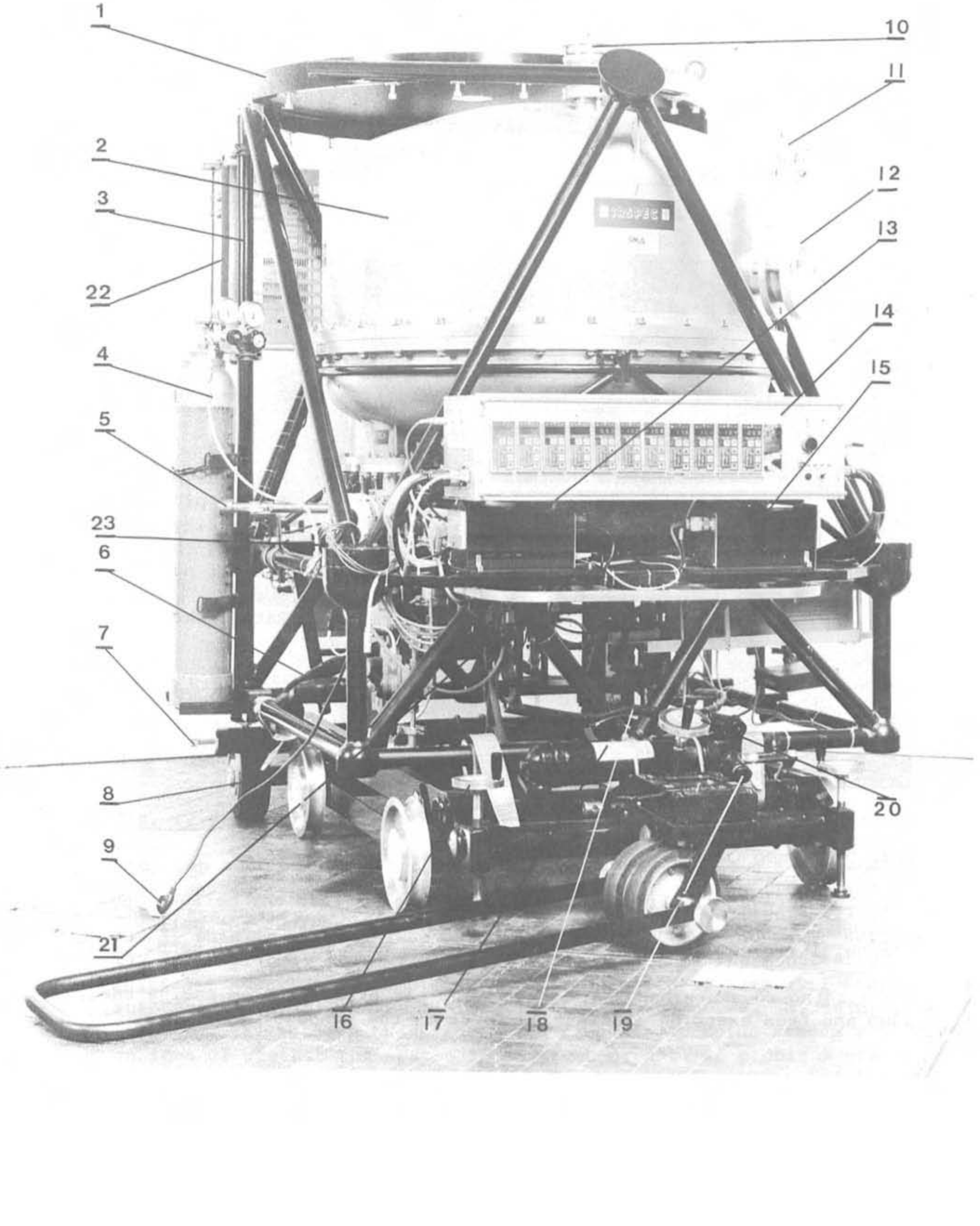


Fig : II General view



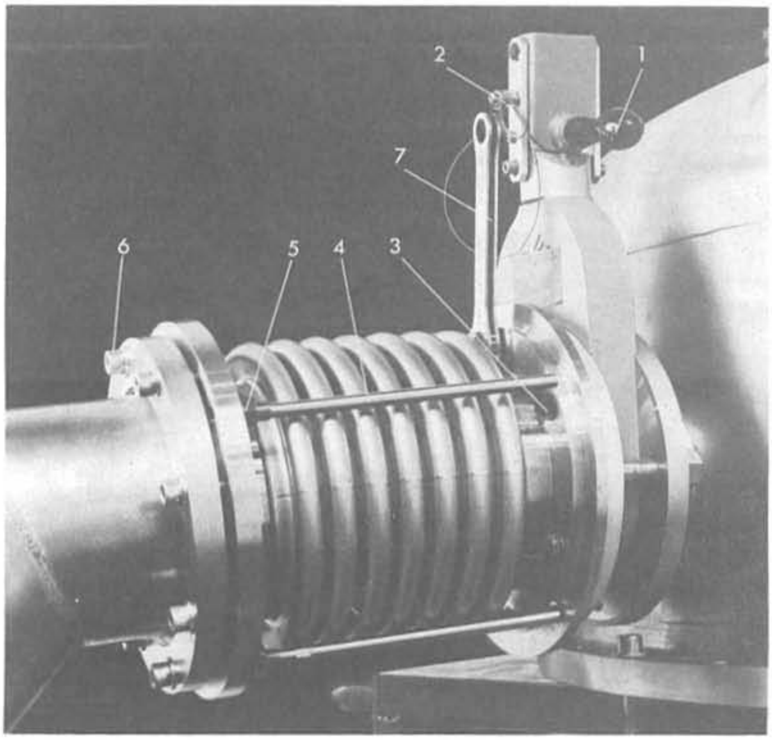
1. PUMPING

(a) Connection of the pump

Remove both protection covers (pump and instrument) and clean the surfaces and the seal with a solvent such as acetone. Loose the four nuts (III.5) and screw in the spacing rods (III.4).

The pump is a heavy assembly, weighing 120 kg which, however, can be moved easily because it is on wheels. Bring the pump bellows into contact with the flange. We can use the rear adjustable wheels (II.8) and the two front supporting screws (II.16) to adjust the coincidence between the pump and the instrument. Since they are used as a brake, these two screws must be in contact with the floor.

If, for any reason, after adjusting the height, the orientation of the fixation holes does not appear to correspond, the problem can be resolved by loosening the screw (III.6) and rotating the complete bellows assembly.



III

1: Main valve lever
2: Safety pin
3: Connecting screws
4: Spacing rods
5: Counter nuts
6: Screws
7: Ratchet key

Fig. III: Pump Connection

When the screws (III.3) are tightened fully, compress the bellows and then unscrew rods (III.4) until their ends touch against the bellow flange. It is now sufficient to screw on the nuts by (III.5) hand.

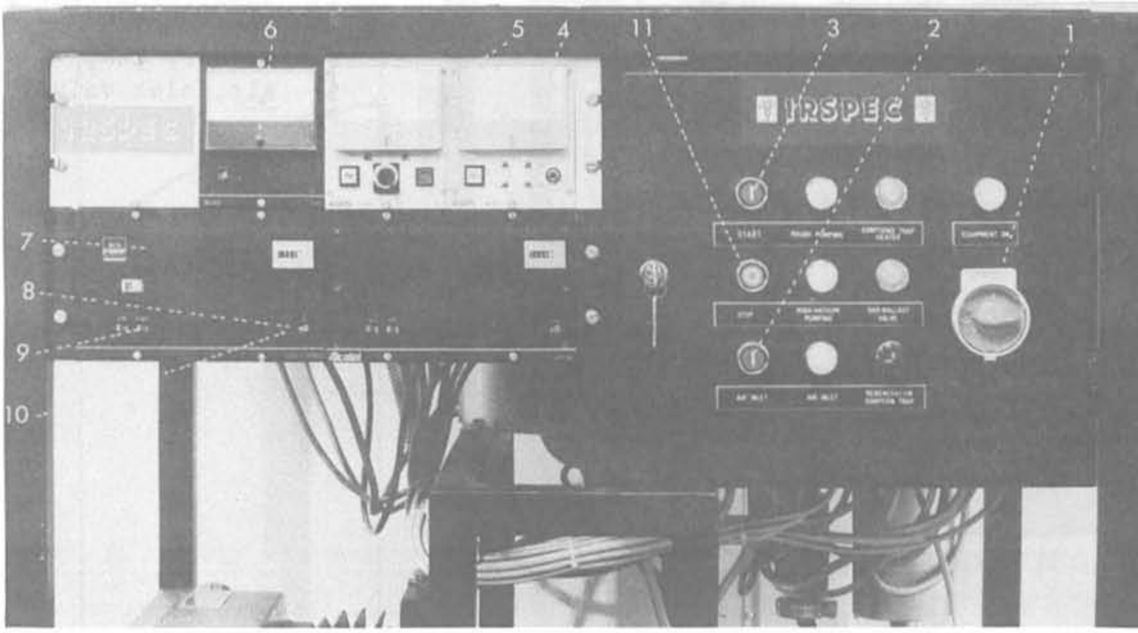
The spacing rods are necessary to prevent air pressure from moving the pump and thus exerting a dammaging force on the connecting bellows.

Remark:

As this operation has to be carried out frequently, we have used screws with a special stanal low friction treatment , which help to fit the screws more easily. A special ratchet key is also available (III.7).

(b) Running the Pump

Before doing anything on the pump always switch on the instrument Pirani gauge first (II.15) to check the internal pressure. Never switch on the Penning gauge if the Pirani shows a pressure higher than 10^{-2} m bar. If the interior is at atmospheric pressure, one can open the main valve (III.1) immediately after removing the safety-pin (III.2). If the interior is already evacuated refer to chapter 4.



IV.

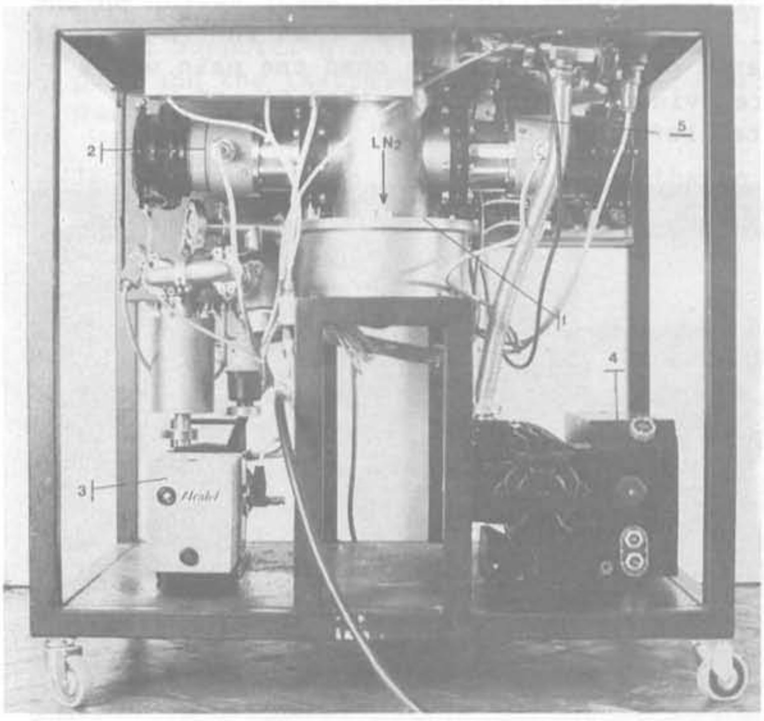
1: Main switch
2: Air inlet
3: Start button (Pump)
4: Pre-vacuum gauge
5: Monitoring gauge
6: Penning gauge
7: Turbo molecular pump control
8: Power switch
9: Start button (turbo)
10: Warning light
11: Stop button

Fig. IV.: Pump Front Pannel

The pump must be connected to the 380 V supply and to a 6-bar compressed air line. To run the pump turn on the red mains switch (IV.1) and press the start button (IV.3). Check whether both power on lights (IV.10) are on. If this is not the case press both start (IV.9) and power switches (IV.8). A primary pump will evacuate the tank in a few minutes. Once initial evacuation is complete, the turbo molecular pump will start automatically. This phase is identifiable by the noise. The delay time (see fig. VI) between the primary and secondary pumping stages will give an idea of whether the system is airtight or not. If problems are encountered check to feel if the inlet valve (II.21) is closed (it should be cold). If the inlet valve is okay it will be necessary to refer to the maintenance manual.

As shown in appendix I, the time taken to obtain a good vacuum depends on how long the instrument had been left open previously, and of course, on the degree of humidity during this period. Curves of appendix I also show that it is possible to reduce the delay by using the heating system or the cold trap on the pumping stand.

The use of the heating system will be described in chapter IV.



V

1: Cold trap upper flange
2: Turbo-molecular pump
3: Rotary pump
4: Primary pump
5: Air inlet valve

Fig. V: Pump Back Side

To fill the cold trap of the pump one can use the small Nitrogen container which is provided for the detector cryostat .

Very important:

Great care must be taken to ensure that Nitrogen does not flow onto the upper flange (V.1) because the flange will then be cooled as well and would be a source of leaks.

To conclude figure VI shows a diagram of a possible pumping cycle, which, although not perfect, has shown good results. As one can see it is possible to create a good vacuum within five hours using this procedure.

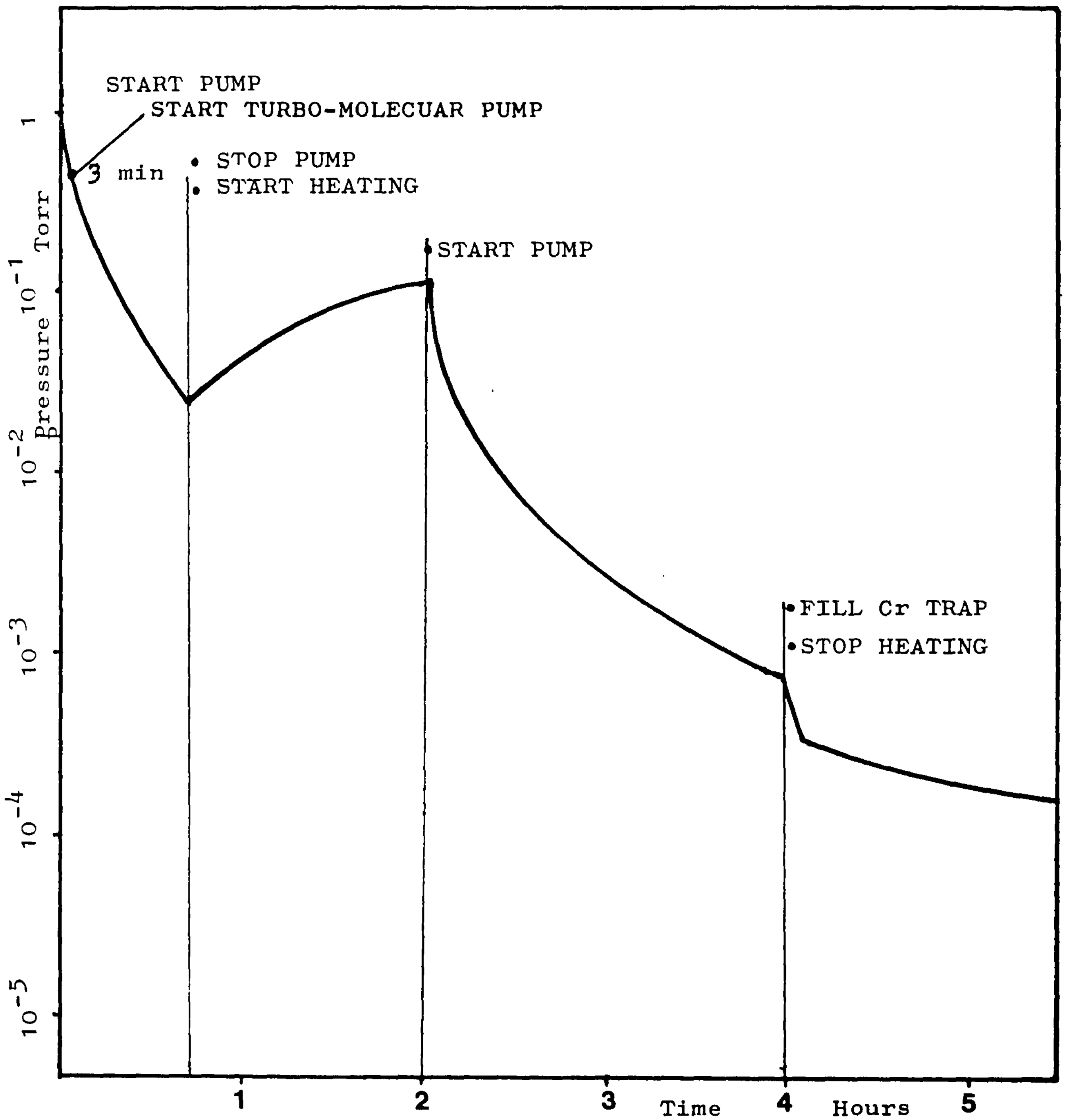


Fig. VI: Pumping Procedure

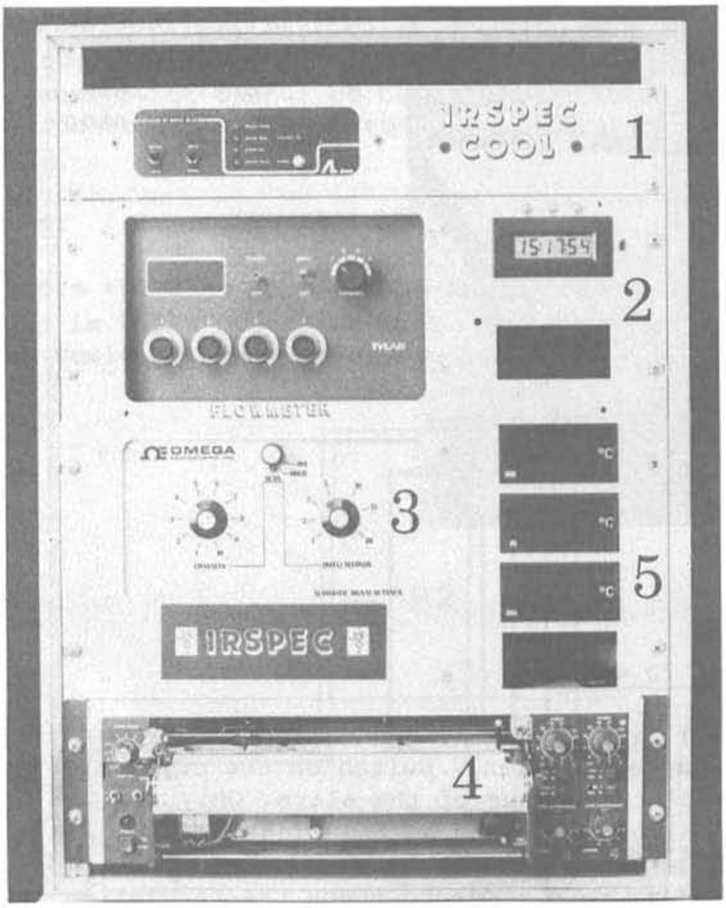
2. COOLING DOWN

Very important:

As it is strongly forbidden to move the functions during cooling, it is safer to disconnect the main cable from the junction box.

The optical elements are cooled via copper braids connected to the cold shield, which is made from a 1-m diameter copper plate. A square tube, in which liquid Nitrogen is flowing continuously, is brazed directly onto the shield. During the cooling-down period stresses may occur in the shield plate which could exceed the state of elastic deformation if one is not careful. A long serie of cryogenic tests has led to the diagram shown in appendix II. The cooling speed is now controlled by a regulator which maintains a gradient between two points on the shield. This is achieved by simply operating an on-off valve controlling the Nitrogen output. For safety reasons there are two sets of regulator-valves (3.3 - 3.4). One is operating 10 % higher than the other one. As the instrument approaches the temperature of liquid Nitrogen, the gradient decreases progressively until both cooling valves remain open permanently. At this point a third regulator system comes into operation to maintain a constant shield temperature. The grating, actuated by two movements (scanning and return) is cooled by a special device composed of two spiral tubes in order to allow movements without high torque. The input of this tube is common with the general Nitrogen input. The separate output is fitted with an electromagnetic valve which, when open, gives a maximum flow for cooling and it is also possible to adjust a second valve manually for a steady state value. One will not worry about the cooling speed because the flow of coolant is limited by the cross section of the tubes.The instrument is also fitted with an internal LN_2 tank (CrII) of some 20 litres which insures a one night autonomy. This tank is closed externally by valves for refilling and safety. The detector is cooled separately by a copper braid connected to an internal 3.5 litres tank which can be used with solid Nitrogen or liquid Helium. The Nitrogen gas leaving the instrument is warmed up in a small heating tube (II.6), the temperature of which is kept at 20° by a regulator (3.1) before entering the regulation valves. A special rack is used solely for cooling purposes.

This rack contains the level and pressure control for the large Nitrogen container, the flowmeter, the time and temperature recording system. The instrument pressure measured by the Penning gauge is recorded on the red channel of a Philips recorder.



VII

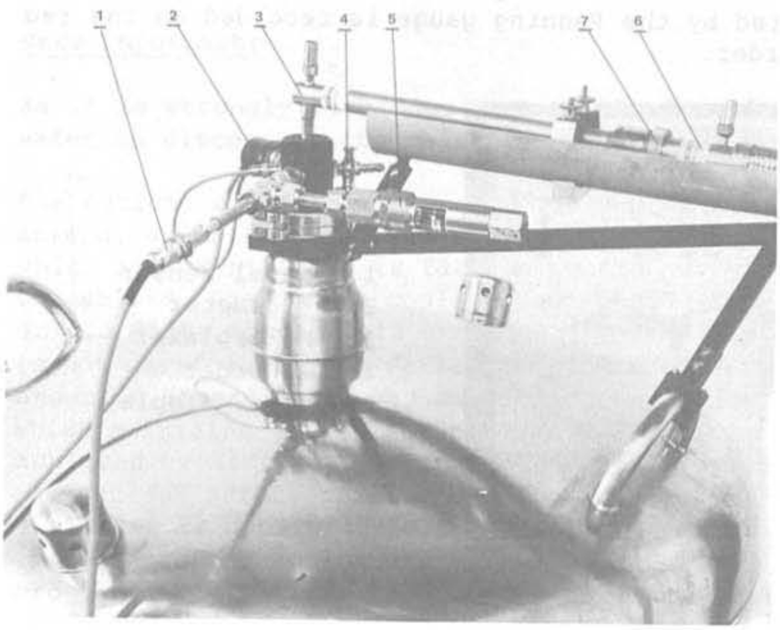
1: Level sensor
2: Flowmeter
3: Multiplexer
4: Recorder
5: Temp. display

Fig. VII: Cooling Rack

For the temperature recording we have four thermocouples which can be placed in strategic positions when the instrument is open. These four temperatures are displayed and multiplexed to be recorded on the blue channel of the Philips recorder.

Knowing that, during operation on the telescope, the vacuum is maintained only by an internal chemical pump (100 g of active charcoal), it is necessary to outgas the instrument as much as possible before cooling. Currently this is done at a pressure lower than 10^{-4} Torr. For short runs or tests, this can be increased to a value of 10^{-3} Torr before the cooling is started.

(a) A few minutes before the cooling is started, connect both cables to the nitrogen container. The pressurisation, obtained by vaporization of liquid is controlled by a pressure sensor (VIII.2) mounted on the "L'air Liquide" head. The container is also equipped with a level sensor system.

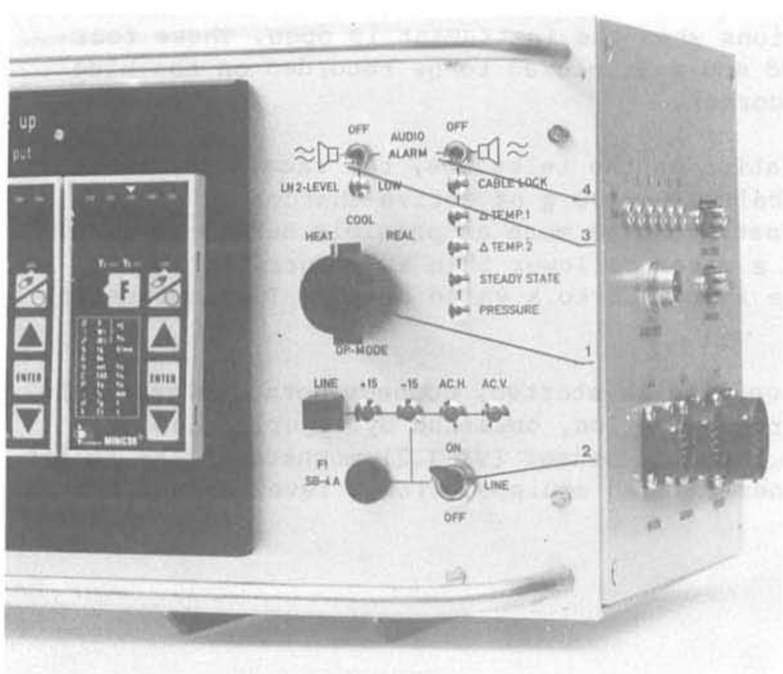


VIII

1: Level sensors cable
2: Pressure measurement
3: Transfer pipe
4: Pressurisation valve
5: Safety valve
6: Transfer tube
7: Retaining ring

Fig VIII: Nitrogen Container, TD 400 L

When upper level (niveau haut) lamp is on one can be sure that there is enough liquid Nitrogen for complete cooling. Switch on the cryogenic control box on IRSPEC and check the status of the alarm. Only the LN_2 low level lamp should be flashing. Switching on the right audio alarm switch (IX.4) enables the cable lock, ΔT, pressure and steady state alarms. It is also recommended at this stage to check the regulation parameters. Pressing the "F" button of the regulators the different parameters will be displayed in succession. The appendix 3 gives a table of the regulating parameters.



IX

1: Selector switch
2: General power
3: Level alarm
4: Temp. alarms

Figure IX: Cryogenic Control Box

(c) Switch the three positions rotating switch (IX.1) and the grating output (switch II.23) to the "cooling" position. After one has also put the
(d) manual output valve (A2-23) to cooling, cooling can begin. To do this connect the flexible transfer line between the container and the general LN^2 input (II.5). It is recommended that the instrument side be connected first. Particularly great care must be taken in the positioning of the different elements because this tube is very fragile and expensive. It cannot be bent with a radius shorter than 250 mm. When it is connected, a lot of noise is generated due to the exhausting of the gas.

Note:

Before starting to cool the shield check that the cryogenic trap of the pump is full. Otherwise, the instrument itself would be the coldest point and would act as a cryogenic pump.

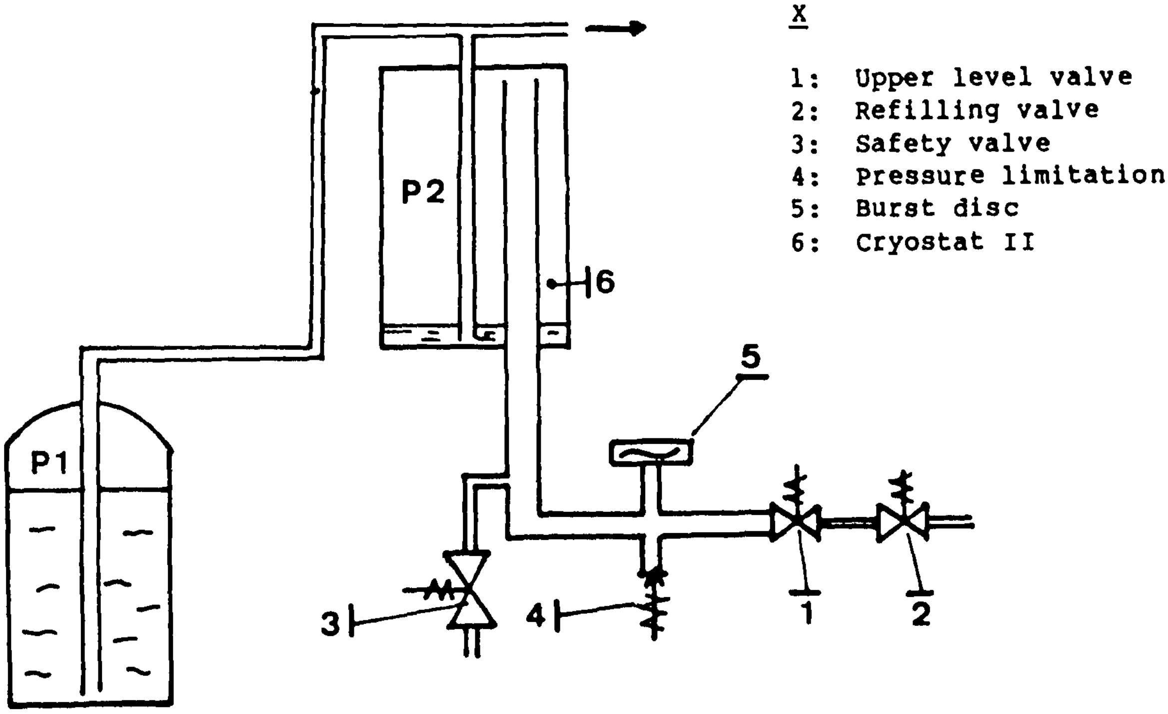
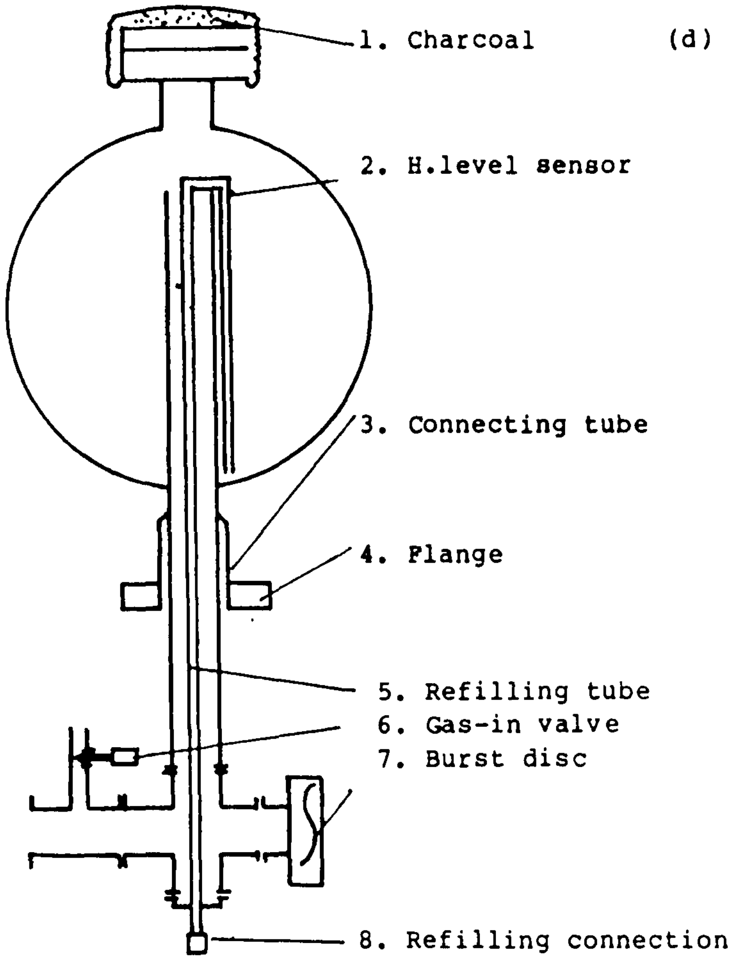


Fig. X : Cryogenic Connection

The first drops of liquid entering the internal tank CrII will be vaporized by cooling the bottom of the tank. After a few minutes equilibrium is reached between the transfer pressure (P1) and the pressure inside of CrII (P2). After equilibrium is reached liquid will then be transferred to the shield and one can see the temperature decrease. This causes a significant and rapid decrease of the vessel pressure down to 4-5 10^{-6} Torr. After a few minutes the differential temperature system will start to operate, a phase identifiable by the noise which is interrupted periodically. Appendix 4 shows cooling curves of the different functions. In order to reduce the background radiation it was necessary to connect the supporting tube of the detector cryostat (CrI) to the shield. For this reason it could be very dangerous to fill it too soon. Filling can only be carried out when the shield is colder than 150 K. When deciding to fill CrI it must be remembered that the active charcoal is mounted on it. This means that it will start to absorb from this moment.



(d) To fill up CrI one must use the 50 liters LN2 container fitted with an electromagnetic valve. It can be connected to the cryostat using a soft plastic tube and the special connecting part. To open the e.m valve of the container plug in its cable on the "valve control" connector of the second "level sensor" system mounted in the instrument rack (A7.5). The valve will close automatically when the first drops of liquide touch the upper level sensor (XI.2). As this system dissipates heat, it is recommended to switch it on only during refilling.

Fig. XI: Detector cryostat CrI

Disconnect the refilling tube and close the pipe with the special cap. This cap is attached permanently to the instrument via a cable, but before installing it, check that the 0 ring is still in place.

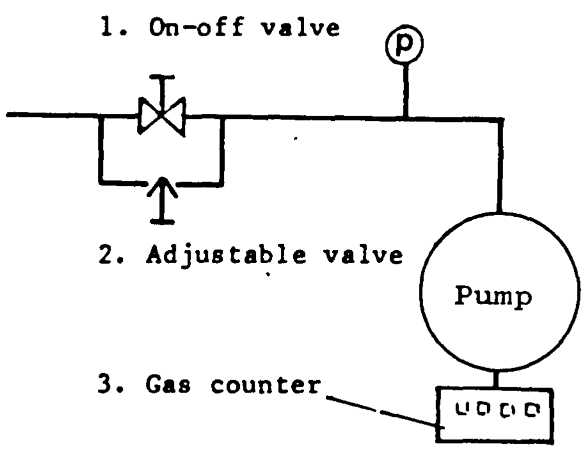


Fig. XII: Pumping system

Connecting the vacuum tube first with all adjustable, on-off and air inlet valves closed causes the pressure in CrI to increase. This would empty the cryostat in a few seconds. For this reason it is very important to close the refilling tube before connecting the pumping line.

When the instrument is on the telescope one will use the standard pumping system permanently installed in the cage for the normal I.R. operations.

(e) As there is no possibility of measuring the level in the tank it is recommended that one reads the consumption on the gasometer (XII.3). To avoid to freeze the connection seals it is necessary at the beginning to pump slowly through the adjustable valve (XII.2), the on-off valve being closed (XII.1). As Nitrogen is solidified at a pressure lower than 40 mb one may if necessary open the on-off valve after that pressure is reached. The appendix 5 shows a detector cooling curve.

3. INSTALLATION ON THE TELESCOPE AND HANDLING

The instrument can be moved very smoothly using its own carriage on the rubber wheels. All connections between the instrument and its peripheric have to be removed first before starting to move and a long power cable has to be provided to maintain cryogenic control during handling operations. It is also recommended that the elevating platform and such like are all in place before starting to disconnect.

Very important:

Do not forget to install the instrument rack before to bring the instrument into the cage. It is also safer to handle the instrument with both tanks empty.

(f) It is better to repressurize the cryostat I, when the pumping stand is still running. The pump evacuates the gas desorbed by warming up the charcoal. To do this, stop the detector pump and connect a Nitrogen, or better, a Helium gas cylinder to the gas inlet valve (XI.6). Open the cylinder and adjust the output pressure to approximately 1000 m.bar. The gas inlet valve can now be opened slowly. If one uses N2 gas it will take
(g) relatively long because some of the gas will be liquified on contact with the solid. If one continues to inject gas one can empty the tank simply by opening the refilling tube. Great care has to be taken to insure that the liquid going out does not fall on the carriage which could be damaged.

(h) After the vessel pressure has stabilized, the disconnection of the pumping stand can begin. Close the main valve (III.1) and plug in the safety pin (III.2). Stop the pumping by pressing the stop button (VI.11). Connect a Nitrogen gas cylinder to the gas inlet valve (V.5) and press the air inlet button (IV.2) to pressurize the pumping line. Turn the main switch (VI.1) to the left to stop the pump. One can now separate the pump from the instrument. Don't forget to install the protection covers on
(i) both pump and IRSPEC. When disconnecting the LN_2 transfer line, the best thing to do is to loosen the retaining rings first, then rapidly pull out both Johnston fitting together. This is to avoid spilling Nitrogen and emptying the internal tank should it be full. However it is
(j) safer not to move the instrument if the internal tank is full. To empty it, disconnect only the container side and put this end of the transfer line in an appropriate dewar, taking care not to exceed the minimum bending radius. Normally the working pressure
(o) is sufficient to empty it completely. If it is not the case, simply put the selection switch to the "refilling" position and pressurize the tank with an auxiliary N_2 gas cylinder connected to the refilling valves system (A2.37). It would be possible to transfer this liquid from CrII to the container (TD 400) but to do this it would be necessary to release the pressure, which would take very long time and waste a lot of liquid. At this stage one still has to disconnect the various cables: thermocouples, pressure and possibly functions, detector and so on depending of the tests carried out previously.
In order to prepare the instrument for moving, it is recommended to proceed as follows. Using the adjusting screw (II.20) adjust the top of the front wheels mount until it is more or less horizontal and unscrew the spindles (II.16).

If the rail wheels are still touching the floor, open the hydraulic valve (II.19) and by pulling on the axle one can lift them. Close the valve again. When moving the instrument one should avoid disconnecting the main power as much as possible. One can ignore the alarms if disconnection and reconnection to the mains have been necessary as this is normal.
The duration of the alarm will depend on how long the instrument had been disconnected. The positioning of the platform has to be check by a lifting empty before rolling the instrument on it. The platform will also be stabilized on the floor with the both spindles. The instrument is moved into the cage with the rear wheels first. It is rolled over the cage floor until the first rail wheel comes into contact with the rails. One can now pull up the rear rubber wheel with the screw (I.17). One has now reached an intermediate stage where the front runs on the rubber wheels and the rear on the rails. When the front wheels are on the rails disable the front rubber wheels with screw (III.20) and push the instrument under the telescope adaptor. By using the hydraulic carriage the instrument can now be brought into contact with the telescope adaptor. If necessary the transversal position can be adjusted by turning the screws (II.7) and the tilt in both directions with (I.18). When the instrument is secured the carriage can be removed. To do this open the hydraulic valve (II.19). This allows the carriage to descend slowly until the pins are loose, then pull it out of the cage.
As it takes several hours for the correct operating temperature to be reached, it is better to start now refilling and pumping the detector

(k) cryostat. To fill the internal tank (CrI) one still uses the TD 400 container and the transfer line through the man hole in the cage. Connect the line to the instrument first. Put the selector switch (IX.1) to "refilling" which opens the corresponding valve. When the liquid reaches the upper level sensor the corresponding valve (X.1) will be closed by the regulator (3.9). One has now to wait for a few minutes until the internal pressure (X.P2) reaches the operating value before putting the selector switch back to "cooling". During refilling (a 20 min operation) the instrument starts to warm up slowly due to the fact that Nitrogen does not flow into the shield tube. For this reason it is better to keep the container connected a few more minutes to allow the instrument to reach the proper temperature. To disconnect the line use the method described previously.

(e) Various electrical connections have still to be made before the instrument will work correctly. A list of these cables is given in appendix 6.
As shown below, the cryogenic status is displayed on a Ramtek monitor in the control room. The three last lines flash if there is an alarm.

```
                                                                    19:47
CRYOGENIC STATUS: CHECK FOR UNCONNECTED CABLES!
          D.TEMP.1 4.28 D.TEMP.2 3.97 GRATING    86.5 DETECTOR   56.1
          LN2 LEVEL LOW     CHECK VESSEL PRESSURE OR GAUGE ( 5.28 V)!
          TEMPERATURE REGULATION NOT IN STEADY STATE
          DIFF.TEMP. 1 AND 2 TOO HIGH. DANGER FOR SHIELD STRESS!
```

When the instrument is working on the telescope, it should not be forgotten to reconnect or to refill the internal tank each morning in order to avoid warming up during the day. It is of course necessary to refill and to disconnect it each evening and this as late as possible. The second cryogenic operation is the refilling of the detector cryostat which has to be done every four days. Appendix 8 shows the evolution of the vessel pressure during this operation.

Dismounting the instrument from the cage is carried out following the reverse procedure as for the mounting. As before the same care has to be taken to avoid any mechanical shocks. Not forgetting also to empty both cryostats completly before one start dismounting. The instrument can then be moved to the preparation room.

4. WARMING UP

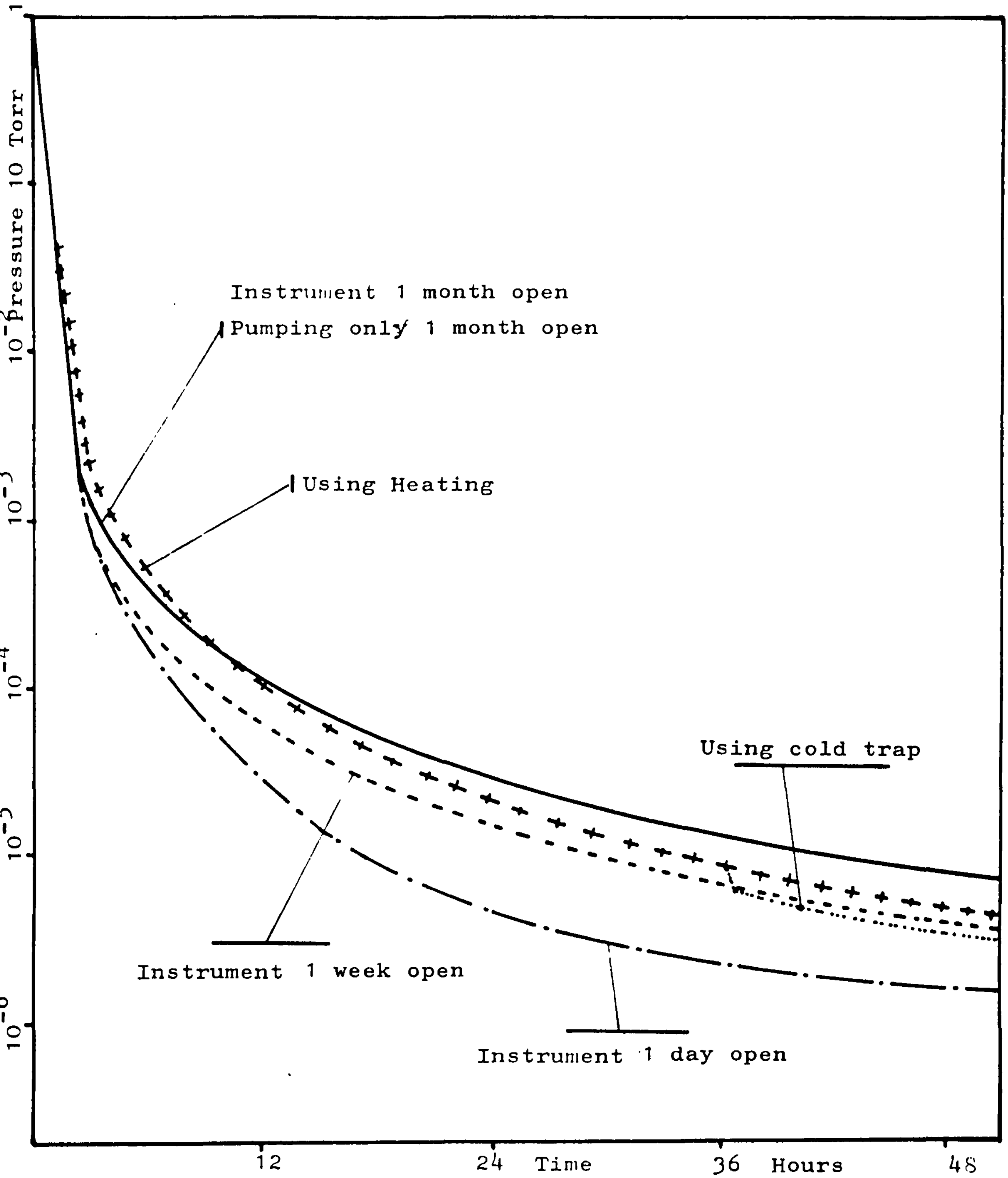
In order to avoid the detector to be the coldest point of the instrument, it is very important to empty its cryostat before starting warming. The second internal tank will be empty to reduce the warming time. As soon as the instrument is disconnected from the Nitrogen container and the internal tank is empty it will start to warm up slowly. The warming up will be accompanied by a great increase of pressure. This increase, due to outgassing, will be more important especially as the detector cryostat is empty too. For this reason it is absolutely necessary to pump the instrument during the warming up. One can refer to chapter 1 for the method of connecting the pump. The main vacuum valve (II.11) should be opened only when the pressure in the pump is the same as that one in the instrument. If there is no emergency one can leave the instrument warming up by itself. The temperature increase is then only due to the heat conductivity through the insulating connection and to radiation. This is the reason why the whole operation takes so long time (60 hours).
In an emergency, for example if it is necessary to repair something inside, there is the possibility of heating the instrument more rapidly. The heating systeme is divided into four parts: shield functions, grating, cryostat I and cryostat II.
Each part contains a regulator and a set of resistors. For more information see appendix 3. Appendix 9 shows some warm up curves for different parts of the instrument. The heating system can be run by putting the cryogenic control box selector switch (IX.2) to the "heating" position. The four systems are switched on together. Both alarm systems (IX.3.4) have also to be disabled. It is clear that the regulators will only start regulating after a few hours, when the temperatures approach the set points. The system for the detector cryostat is set to a higher temperature to outgas the charcoal better when we use the heating system to reduce the pumping time.

(m) As shown in the diagram of appendix 9 one can also shorten the warming by allowing Nitrogen gas to enter the vessel. The warming is now caused by conduction in gas and by connections. That means that the heat transfer will be more significant as the cold and warm surfaces are closer to one another. The gap between the cold shield and the vessel (warm) is only a few milimeters for the vertical walls and 10 centimeters at the top. In order to avoid having a great temperture difference in the shield and to freeze the vessel one should allow gas to enter only after several hours have elapsed. One has to take great care when letting gas in, that air does not enter with it; as this may introduce impurities on the optics and detector surfaces. To avoid this one can purge the entry tube using the valve (A2.24). A special handset connected to the cryogenic control box and to the cable coming from the air inlet valve of the vessel (A2.32) allows this valve to open and then the gas to enter the vessel. This delicate operation is also limited to a certain value of the shield temperature by the regulator (3.6).

When the instrument is not used for a few weeks, it is imperative to leave it closed and under vacuum.

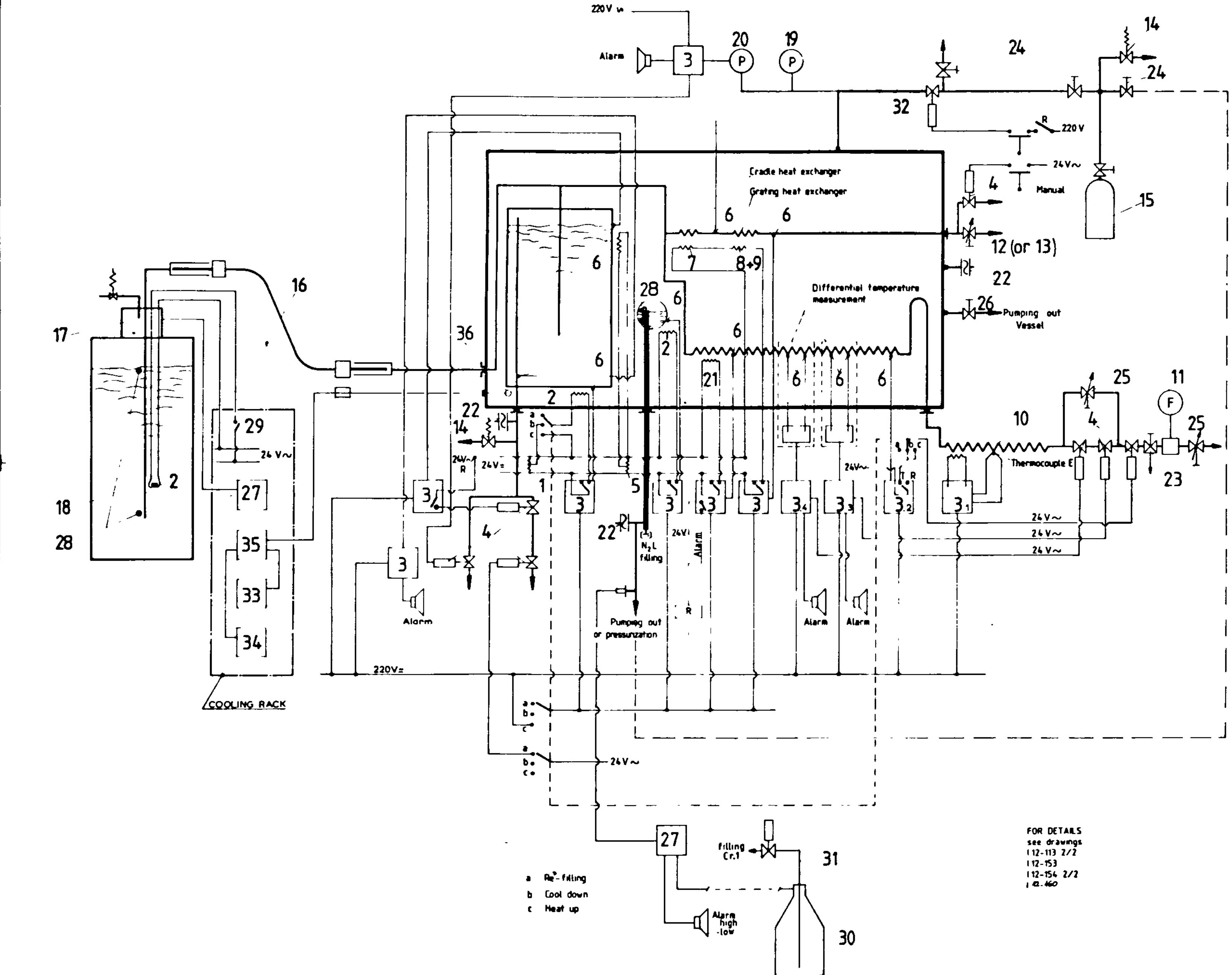
APPENDIX 1

Pressure diagram



APPENDIX 2

Fluid control



Pos.	(1) Quantity	(2)	Discription
36	4		Philips thermocoax
35	1		Omega multiplexer
34	1		Philips 2ch recorder
33	4		Temperature display
32	1		Alcatel Inlet gaz . 68066
31	1		Air Liquide DS20 Ref 722 120 01
30	1		Air Liquide TC50 Ref 711 050 00
29	1		Air liquide-Electric pressurisation CPE
28	4		Level Sensor
27	2		Air Liquide level control -Typ RN24
26	1		VAT valve
25	2		Adjustable Leybold 28337
24	3		valve Best SS.4P4T4
23	1		3V Valve Best 42x58MM
22	3		Graphilor safety disc Ø50, 1,4 bar
21	18		RWM 4x10 sfernice resistor 15 Ω E 12 class
20	1		CF2P alcatel penning gauge, Ref 86781+FA 101 unit
19	1		PL1NW25 alcatel pirani gauge, Ref 86775+PA 101 unit
18	1		TD400 airliquide reservoir
17	1		BN3 airliquide head
16	1		841/45 airliquide transfer line
15	1		225 C Linde cylinder
14	2		ETNA SoF-2344 safety valve
13	1		Restriction
12	1		Adjustable Leybold Nº 17 318 valve
11	1		FM362 tylan flowmeter
10	1		KLG flexible hose , see specification I 12 13
9	1		RLP1 sfernice resistor, 1,5 Ω, E 12 class
8	20		RLP1 sfernice resistors, 0,47 Ω, E 12 class
7	2		RWM 4x10 sfernice resistors, 8,2 Ω, E12 class
6	15		OMEGA FKG 3/10 M-Pt 100 resistors
5	1		Voltage divider
4	7		2006/C ON-OFF airliquide valve
3	11		Coreci minicor controller
2	3		RWM 10x64 sfernice resistors, 10 Ω E 12 class
1	1		RSSD 16x94 sfernice resistor, 12 Ω, E 12 class

FOR DETAILS see drawings
I 12-113 2/2
I 12-153
I 12-154 2/2
I 42.460

Fluid control

ESO EUROPEAN SOUTHERN OBSERVATORY ESO

1 I 12.154 1/2

Regulation Parameters (Appendix 3)

Nbr.	NAME	W1	W2	tg	go	CAS	P	Ti	Td	Cy	CODE	FUNCTIONS
3.0	Spare	65	-2	1.0	off	0	2.0	0	0	10		
3.1	Healing out	65	-2	1.0	off	0	2.0	0	0	10	015	1. Regulation
3.2	Steady state	-180	+4	1.0	off	0	2.0	0	0	20.8	012	1. Regulation 2. Alarm
3.3	Temp. 1	67	10	1.0	off	0	1.0	2.0	0	10	010	1. Regulation 2. Alarm
3.4	Temp. 2	70	10	1.0	off	0	1.0	2.0	0	10	010	1. Regulation 2. Alarm
3.5	Heating grating	30	-22	1.0	off	100	7.0	2.0	0	6.0	012	1. Regulation 2.
3.6	Heating shield	35	-22	1.0	off	100	7.0	2.0	0	6.0	012	1. Regulation 2. Air in value (II.21)
3.7	Heating CrI	40	0	10.0	off	0	10	1.0	0	10	012	1. Regulation 2.
3.8	Heating CrII	35	0	1	off	0	10	1.0	0	10	012	1. Regulation 2.
3.9	Low level	-187	0	1	off	0	0	0	0	10	012	1. Alarm 2.
3.10	High level	-196	0	1	off	0	0.2	0	0	10	012	1. Valve H level 2.

Appendix 4

Function cooling down

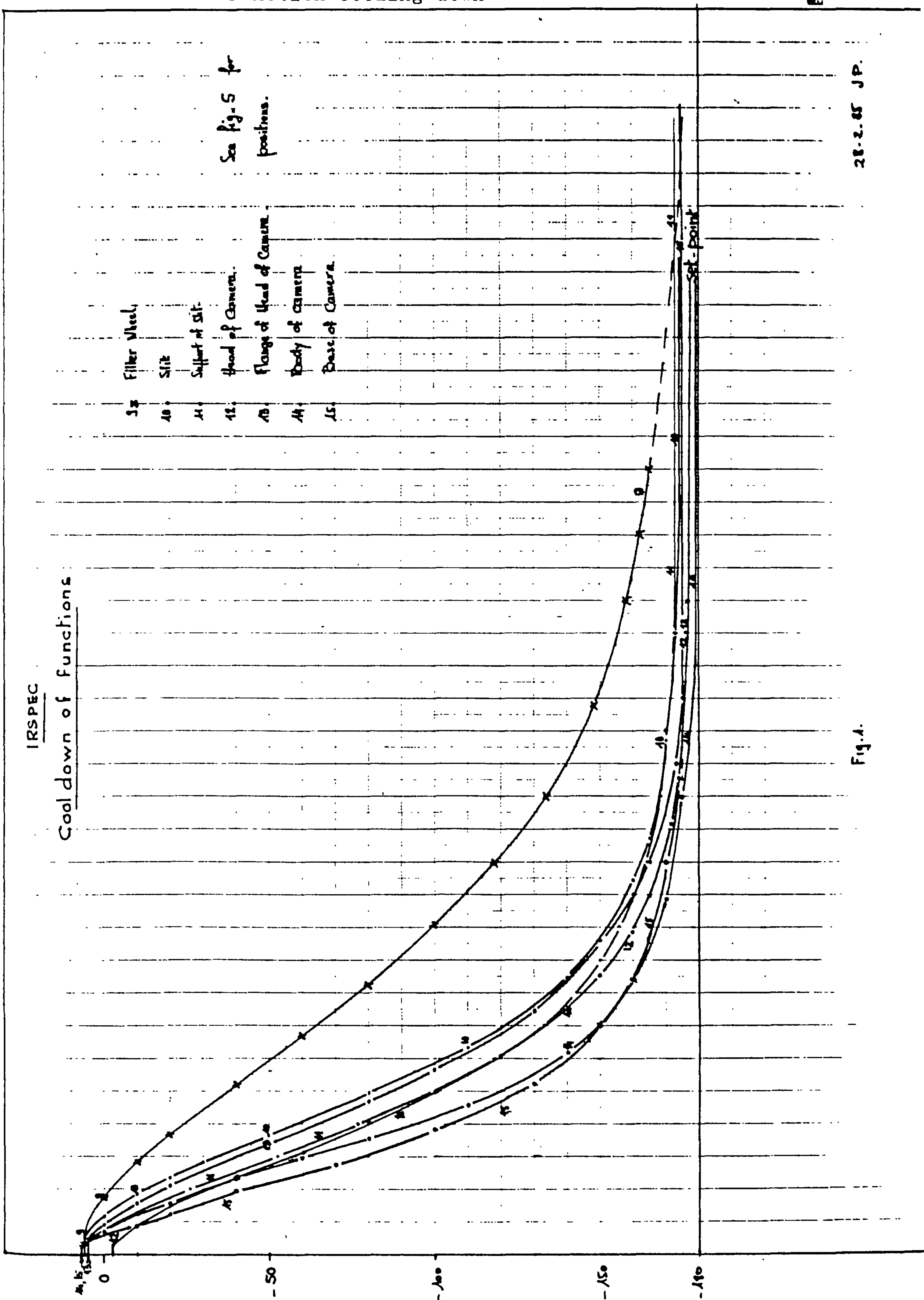
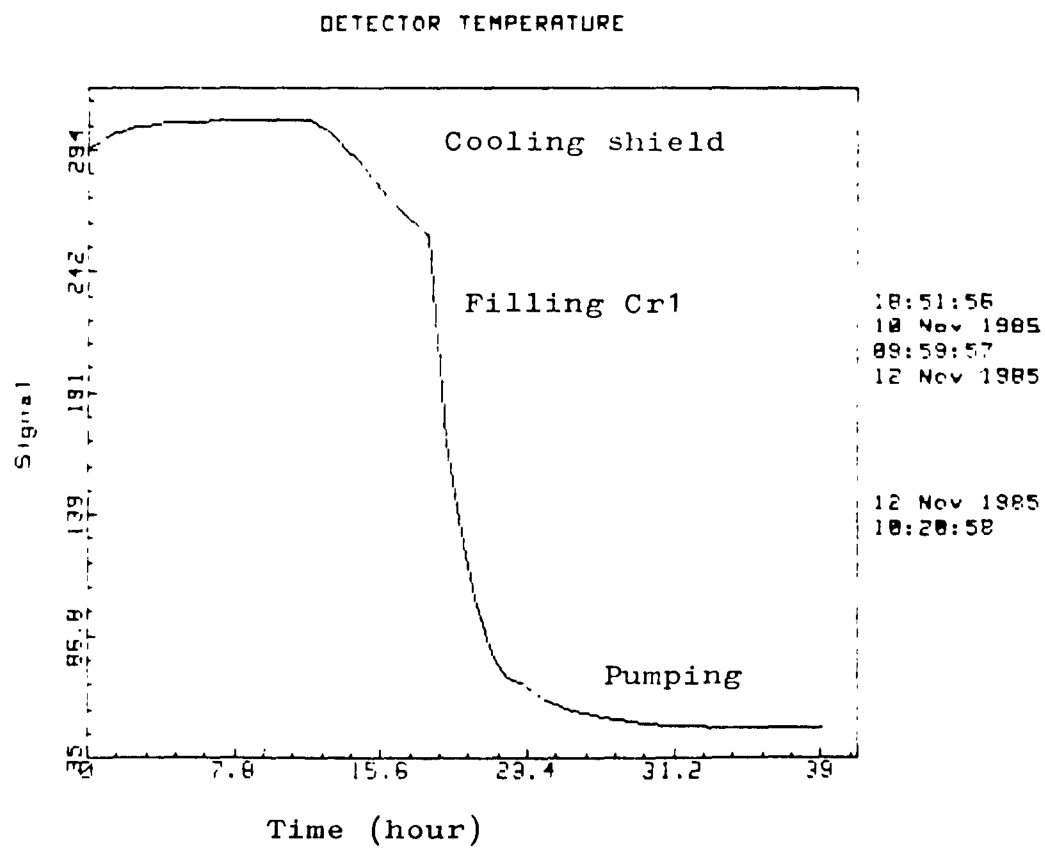


Fig. 1

Appendix 5


DETECTOR TEMPERATURE
Cooling shield
Filling Cr1
Pumping
Signal
294
242
191
139
86.8
35
0
7.8
15.6
23.4
31.2
39
18:51:56
10 Nov 1985
09:59:57
12 Nov 1985
12 Nov 1985
10:20:58
Time (hour)

Appendix 6: List of connections

1. On the telescope:

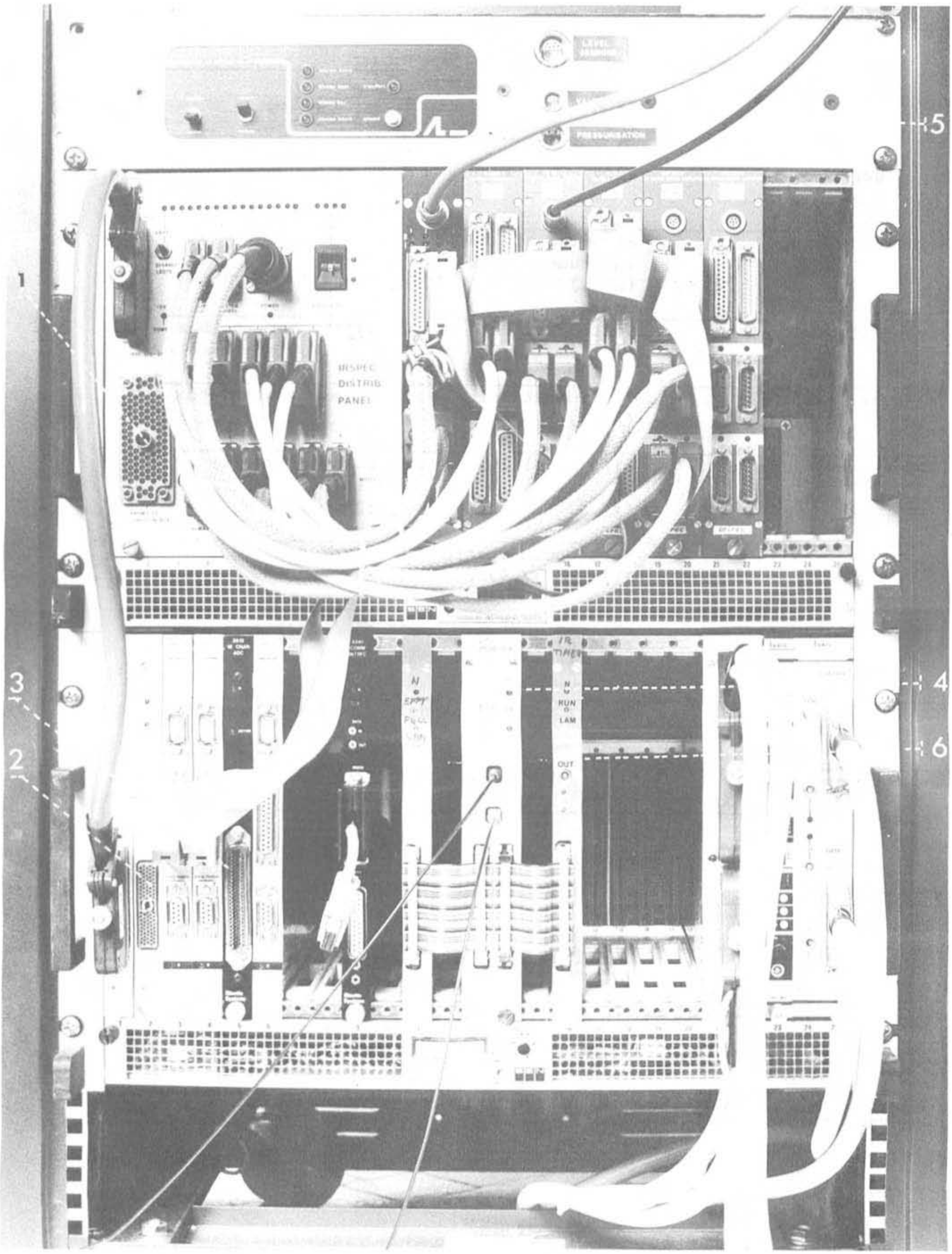
NAME OF CABLES	FROM	TO
Power supply	220V Power supply	General power connection (II.9)
Main function	Pannel distribution Instrument rack (A7.1)	Junction box (I.16)
Cryogenic camac status	Instrument rack (A7.2)	Cryogenic control box (I.2)
Cryogenic camac TLM	Instrument rack (A7.3)	Cryogenic control box (I.3)
Chopper wave form	FiFo modul I.Rack (A7.6)	To scanning mirror control (II.22)
Optical fibre link (2)	Data communication I.Rack (A7.4)	Detector control box (I.6)
Cr I level sensor	Level sensor control I.Rack (A7.5)	To Cr I output
Bosch camera P. supply	Camera control pannel cage	Bosch camera
Bosch camera video		

2. In the preparation room:

Thermocouples (4)	cooling rack back side	Instrument near the penning gauge
Pressure signal (1)		
N2 container pressurization		N2 container top
N2 level sensor		

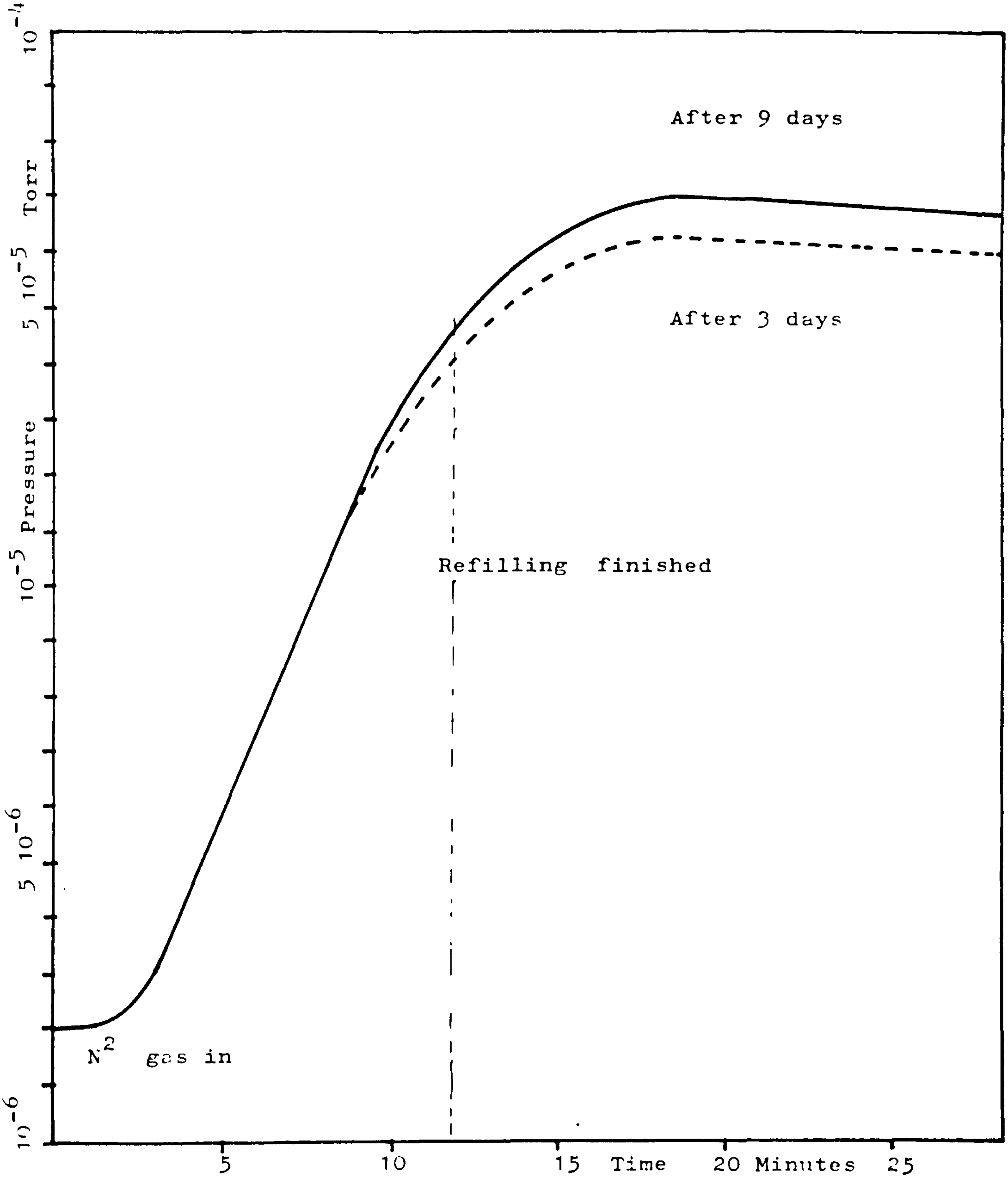
Appendix 7

Instrument rack



Appendix 8

Vessel pressure during Cr1 refilling



Appendix 9

Warm up curves