DL/SCI/TM68E

technical memorandum Daresbury Laboratory

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PROTEIN CRYSTALLOGRAPHY WORKSTATION 7.2 OPERATIONS MANUAL

by

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STATION 7.2/7.2b

INTRODUCTION

This protein crystallography workstation provides oscillation camera film data collection facilities. The instrument may also be converted for High Angle Fibre Diffraction applications. Involving the removal of the Arndt-Wonacott camera, to be replaced by the "Keele" fibre camera.

NOTE 7.2 IS A FIXED FOCUS FIXED WAVELENGTH STATION

1. CONTENTS

2. OPTICS

There is a bent, fused quartz single segment mirror providing 1:1 vertical focussing, 58 cm x 8 cm x 3 cm deep. Object distance p_v = 11m, image distance p' = 12-17m. Initially flat, the mirror requires a couple applied at each end to produce a bending radius R of approximately 1 km. The final form of the mirror surface when bent is a cylinder leaving the horizontal divergence (4mrad maximum) of the radiation unchanged. After reflection from the mirror a rough lower limit of wavelengths in the beam is expected to be 1Å with an upper limit set by the beryllium window at ≈3Å. The surface roughness of the block has been measured as 8.7Å rms over the whole surface.

For high intensity applications, the monochromator used is a 200mm long bent triangular Ge(111) crystal with a 10.4° cut. The Guinier focussing position (object distance 20.9m, image distance 2.52m) is established for a wavelength of 1.488 Å (calibrated spectroscopically with a pure Ni foil). The measured FWHM focus size is 1.1 x 0.3 mm^2 and the intensity behind a 0.3mm 1 dot blue collimator is approximately 5 x 10^{10} photons/sec/mm^2 at a fixed wavelength of 1.488Å, SRS at 2 GeV and 250 mA.

The mirror should not normally be adjusted, and very rarely needs re-optimisation (usually only after major beam line repairs.

3. THE INSTRUMENT

3.1 *Monochromator*

Description

The 7.2 monochromator is a 200^{mm} long triangular Ge(111) crystal, with a 10^0 cut. The Guinier focussing position, object distance 20.9M, image distance 2.52M, is established for a wavelength λ of 1.488Å. Spot size $1.1*0.3^{mm}$, intensity behind a 0.3^{mm} *1 dot blue collimator* is approximately $5*10^{10}$ photons/sec/mm^2. SRS at 2Gev 250mA.

Focussing.

The monochromator focussing is done by means of a synchronous motor turning a cam at the tip of the triangular monochromator. (see Fig. 2). The size of the cam has been chosen to make it impossible to break the monochromator by overbending. In pushing the tip of the monochromator the horizontal focus and wavelength is slightly shifted, which must be compensated for by moving the camera with the carriage horizontal translation keys. Thus optimization of the focus consists of repeatedly checking the ion chamber readings at differing cam positions on the peak of the horizontal profile.

The monochromator focussing is done via a remote control box. This is an aluminium box, with a 3 position switch,[centre OFF, L (in Large Angle), H (Out Small Angle)], and a push button to control the synchronous motor. It is located in the P.X. control rack.

Note that the monochromator should be focused PRIOR to setting the wavelength. Thereafter the same wavelength can be obtained by re-optimising the camera (H,I,J,K) and focus, provided C (monochromator), G (2θ arm) and the SRS horizontal source position have not changed.

THE PROCEDURE GIVEN BELOW IS FOR CHECKING THE WAVELENGTH AND SHOULD ONLY BE ATTEMPTED BY THOSE WHO UNDERSTAND THE WORKINGS OF THE STATION COMPLETELY. DO NOT ALTER THE WAVELENGTH.

3.2 *Wavelength.*

The λ is set to 1.488Å, the Ni edge. The method used for checking the wavelength setting, is as follows.

(a) Optimise the flux and note the IC reading. Note that optimising the flux includes optimising the mono focus and checking that the table is positioned on the Guinier position mark. To save frustration it will also be wise to check the 2θ arm is set to the Ni marker.

The optimisation should be done with any small collimator *except the drainpipe*, but not with the whole beam.

(b) Place a 10μ Ni foil between the end of the beam pipe and the collimator cradle (remove the shutter). A selection of foils are kept in the cupboard in the hutch.

(c) Release the mechanical lock on the 2θ arm. Note that there are two locking devices on the arm, the one adjacent to the Ni pointer should be slack, the other on the opposite side of the arm is to be tight.

(d) Release the monochromator rotation drive, (key C), from it's password protection. To achieve this, exit the motor control option, by hitting RETURN, at the prompt type the password (*COLIN*), re-enter the motor control option. *NB. **EXTREME CAUTION NEEDED*** whilst C is unprotected.

(e) Turn on the power to the top crate in the stepper motor rack. This is normally switched off as the motors cause the monochromator vessel to overheat. *NB*. switch the rack ***OFF*** at the end of the exercise.

(f) Set mono movement to 5 steps, FAST speed. Note direction. Note position. MOVE MONO. C.

(g) Set steps to multiple mode. Optimise beam with G, usually in SLOW speed. NOTE IC reading.

(h) Repeat e and f, until you have driven through the edge, your table should be similar to the one below.

Value of C	IC Reading	
-44840	0.31	
-44820	0.39	
-44800	0.41	
-44780	0.46	
-44760	0.84	
-44740	2.56	<- Edge
-44720	2.70	
-44700	3.00	
-44680	3.01	
-44660	3.06	
-44640	3.05	
-44620	3.05	
-44600	3.05	

(h) Reverse the direction of C and drive back to your chosen edge, allowing for any backlash. In this example C was drive in 20 step increments,

(i) Finally to password protect C, leave the motor control screen, at the prompt type the password (*COLIN*)

3.3 *Carriage alignment.*

The Arndt-Wonacott camera is fixed to a carriage assembly which allows vertical and horizontal translations/tilts for the alignment of the camera to the beam, four stepper motors are used to this end. **REMEMBER** they are toggle switches, press to start and again to stop.

H....horizontal FRONT
I....horizontal BACK
J....vertical FRONT
K....vertical BACK

Always use SLOW speed for *H & I*, FAST is permissible for *J & K*, it is suggested that for fine tuning SLOW is used for all motors. **Z** is the **PANIC** key, *IF IN ANY DOUBT USE **Z***. Key V is for restricted movement range. ***NB***. remember all the keys are of the toggle variety.

3.4 *A typical alignment procedure, starting from the assumption that the beam has been 'lost', would be.*

(a) Focus the CCTV onto the end of the beam pipe, viewing monitor in the enclosure.

(b) Using the plastic scintillator (yellow card) placed directly after the beam pipe, find the beam with respect to the collimator cradle, this cradle to be roughly central to the beam. The card is made of Zinc Cadmium Sulphide (D/L stores code number 69/10211c

(c) Fit the small 20mm diameter circular screen to the front of a drainpipe collimator. Optimise beam, expect 9 to 10v, H.T 300v, gain 10^9, the SRS at 2Gev 250mA.

(d) Replace drainpipe with 4 dot blue collimator, maximise flux.

(e) Maximise flux through 2 dot blue.

(f) Maximise flux through 1 dot blue.

(g) A 5 dot blue is the smallest collimator available on the station.
See section seven for collimator specifications.

(h) If flux readings are low or zero.
Check the H.T. and Keighley power supply are on.
The vacuum pumps are running.
The beam is not being clipped.
The port, station and local camera shutters are open.
There is beam in the SRS.

NB Switch *OFF* the H.T power supply during all manual adjustments.

3.5 *Other settings for your consideration are :-*

(a) Collimator selection.
(b) Crystal to film distance selection.
(c) Backstop selection.
(d) Pre-monochromator slit setting.
(e) Camera carriage alignment.
(f) Post mono slit setting and shielding.

The pre monochromator slits are used to reduce the horizontal crossfire of the beam. This is useful for very large unit cells. In this case they should be set to give perhaps one half or one third the intensity on the ionisation chamber.

If you do use the slits in this way, please reset them so they are just clipping the beam when you have finished your data collection.

3.6 *Ionisation chambers.*

The x-ray beam is monitored during the experiment by means of a miniature ionisation chamber, made of PTFE, it is a totally enclosed device, and a push fit over the end of a standard collimator, the electrodes are insulated from the user making for a safer device. Expect a flux reading of 2.0v through a 1 dot blue collimator at 250mA. Note if the capillary tube is at an exaggerated angle it may foul on the collimator mounted ionisation chamber.

3.7 *Post monochromator slits and shielding.*

The post monochromator slits are usually set wider than the beam size, and are only adjusted to decrease background scatter if it becomes a problem. A lead scatter guard and beam tube fit onto the end of the pipework, the scatter guard has also a lead tubular extension.

3.8 *Alignment of crystal in beam.*

The microscope on the Enraf camera will not always be centred on the intersection of the rotation axes and the X-ray beam. If this is the case, it will be easier to calibrate the beam position with relation to the cross hairs than adjust the microscope. To achieve this, record the beam on a piece of *green* paper, mounted securely on a goniometer head, facing the beam. Rotate the Φ axis through 90^0, it is then possible to note the beam position in the crosshairs. This should correspond to the centre of rotation as determined by rotating a pin (or specimen) continuously and observing any movement through the microscope. Record the position of the beam and use it as a reference point for the your crystal.

4. THE FIBRE CAMERA

The "KEELE" fibre camera is stored on the shelf in the hutch, complete with all the accessories necessary for its use. The camera is available in two length settings. It also has an adjustable backstop. A selection of differing size backstops are available on the station, the backstops are simply glued in place.

To install the camera, assuming the station is in P.X. mode. Remove the rotation camera by unbolting it from the carriage. Before lifting it away remove the carousel and unplug all electrical connections. It is delicate piece of equipment, please handle it with care. Store the camera and associated parts in the cupboard in the hutch.

The fibre camera rests on a plate which in turn is bolted to the carriage. Careful initial alignment of this plate will speed up the final alignment. When the plate is in place, the camera body is supported by three adjustable legs sitting in grooves cut into the plate, these legs have been adjusted to give a height approximately in the correct position for the beam to be centred.

Should you require a He filled camera, the gas control valve is on the hutch wall adjacent to door. Should you need gas contact the main control room.

There is a single film holder and a couple of sample mounts provided.

5. THE COMPUTER

The station is controlled by an LSI-11 computer using CAMAC, running the operating system RT-11. This operating system is similar to VMS, albeit with a very limited version of the functionality. You can get help on a command by typing HELP [COMMAND name]

When the LSI is running normally the front panel RUN light should be lit. If this light is off then the computer is down and requires re-booting. Press the RUN, toggle switch up, the RUN light should come on and the computer should boot up displaying a logon message at the terminal.

Users should logon to the LSI by typing USERS in response to the prompt for an i.d. No password is required. To run the station data acquisition programme type PX72 at the RT-11 dot, "." prompt.

The programme is menu driven and commands can be abbreviated to their minimum unique letters, highlighted as UPPER CASE in the menus. Typing <control><A> should abort commands and/or prompts, returning to the last menu selection prompt.

To move station motors use the POCKET command.

6. COLLIMATORS

1 dot Blue = 0.3^{mm}

2 dot Blue = 0.6^{mm}

3 dot Blue = 0.8^{mm}

4 dot blue = 1.0^{mm}

5 dot blue = 0.2^{mm}

Drainpipe approx. 1^{mm}

7. VACUUM

Beam line 7 is isolated from the storage ring vacuum by a cooled beryllium window before the vertically focussing mirror. The vacuum in the mirror vessel itself is interlocked to the CVT valve/shutter after the mirror, as is the vacuum in the P.X. limb of the line. It is the vacuum in this limb (covering the beam pipe from the CVT valve/shutter to the two *Be* windows in the hutch) which is monitored on the ion gauge controller in the P.X. control rack.

One of the *Be* windows in the hutch separates high vacuum and atmosphere allowing the white, unreflected beam to enter the hutch (for alignment purposes). The other separates the high line vacuum from the rotary pump vacuum in the monochromator vessel.

Full instructions on pumping down or letting up the monochromator vessel are given on the pump mountings.

There are two separate rotary pumps in the P.X. hutch, one of which pumps the monochromator vessel and the other which pumps the beam pipe along the main arm. Since mylar suffers from radiation damage, windows on the beam pipe implode occasionally, but the separate pumping system prevents the monochromator vessel coming up to air at the same time. **BEAM SHOULD NEVER BE LET ONTO THE MONOCHROMATOR UNLESS THE MONOCHROMATOR VESSEL IS FULLY PUMPED DOWN.**

The monochromator vessel is isolated from the rotary pumps by two valves, one just above the pump, and the other in the flexible vacuum pipe. These are normally open, and the vessel continually pumped.

The pump on the beam pipe is isolated in a similar fashion, and continually pumped. Should a mylar window fail, however, or the vacuum in the pipe reach a critical upper limit, a pressure switch causes the rotary pump to trip off. To pump down again, the pump ON button must be held down for approx. one minute, until an adequate vacuum is achieved in the beam pipe. There is no vacuum pressure switch trip mechanism on the monochromator vessel, this vacuum should be checked daily, before beam is let onto the monochromator. If vacuum is poor, not on the lower limit of the gauge, check that **BOTH** isolating valves are **FULLY** open.

8.HUTCH SAFETY

8.1 *Interlocks*

The hutch is interlocked to both the pair of shutters admitting beam into the hutch, and the main port shutter admitting beam to all stations on line 7. The former shutters are referred to as LOCAL SHUTTERS, and are under direct control of the experimenter. The main port shutter is controllable only by the crew in the Main Control Room, if it is tripped for any reason, the crew must be asked to reopen it.

8.2 *Search procedure*

Beam cannot be allowed into the hutch until it has been searched and found to be ***EMPTY***. The user is required to look around the hutch whilst moving between the push buttons that form the search points. The searcher is responsible for ensuring that the hutch is empty. A search is performed as follows. *NB* One person only to search the hutch.

(a) Take the key from the switch in the mask control module, situated in the P.X. control rack.

(b) Press the START SEARCH (RED) button on the control box to the left of the hutch door, this box also contains four green lamps. The top (search started) lamp should light up. Once this button is pressed two minutes are allowed to complete the search.

(c) Take the key to the furthest search point (on the back wall of the hutch) insert and turn key, press the button, remove key.

(d) Move to next search point to the left of first, press the button.

(e) Then onto the third and final point adjacent to the door, press the button. Leave the hutch.

(f) Close the door GENTLY, otherwise the magnetic limit switches may not latch and drop the search.

(g) All the lamps at the search points will light up in sequence.

(h) The four green lights on the control box should now be lit.

NOTE:- The ***BIG YELLOW BUTTONS*** are the ***EMERGENCY OFF BUTTONS***, These are ***NOT*** part of the search. And should only be used in a genuine ***EMERGENCY*** ie. being locked in the hutch.

(i) To open the local shutters, put the key in to the lock on the rack and turn to ***ENABLE***. An audible alarm will sound for twenty seconds, after which the mask can be operated via the ***OPEN*** and ***CLOSE*** buttons. If the shutters are open ***ANY OPERATION*** of the ***KEY SWITCH*** will ***TRIP*** the ***PORT*** and ***LOCAL SHUTTERS***. The local shutter ***MUST ALWAYS*** be ***CLOSED*** with the ***CLOSE*** button. If the local shutter is open and the hutch is entered before closing it, the port and local shutters will trip. Always wait for the red ***CLOSE*** lamp to light before entering the hutch.

9. DARKROOM PROCEDURES

IT IS YOUR RESPONSIBILITY TO KEEP THE DARKROOM TIDY this includes checking the cassettes and chemicals. Your data; you are responsible.

9.1 FILM. CEA 5"* 5" only, is kept in two refrigerators adjacent to the BSL cold room, one open the other locked containing reserve stocks.

9.2 Chemicals are kept in the metal cupboard adjacent to the 7.2 dark room.

9.3 De-ionized water (high quality) is in the BSL.

9.4 CASSETTE fronts and backs are adjusted as a match, keep them together.

9.5 **DO NOT** leave exposed undeveloped film in the darkroom.

9.6 Record the date of changing the photo-chemicals. Report low stocks to the P.X. staff.

9.7 FILM PROCESSING.

The standard tanks hold 15 litres, use these recipes.

DEVELOPER (Kodak LX-24)

To 4 litres of H_20 add 2.6 litres of the LX-24, mix well, then add 8.4 litres of warm (20°) water to make it up to the 15 litres. For fast developer use LX-24 in the ratios 1:1 or 1:2 instead of the normal 1:5.

STOP BATH (Kodak Indicator Stop)

To 600ml of Indicator stop bath add 14.4 litres H_20.

FIXER (Kodak FX-40 + HX-40 hardener)

To 6 litres of H_20 add 3 litres FX-40 and 375ml HX-40, mix well, add a further 5.6 litres H_20 to make up to 15 litres again mix well.

Processing times.

DEVELOPING.

Temp (°C)	18°	19°	20°	21°	22°
Time (min)	5	4.5	4	3.5	3

Optimum conditions are, 20°C for 4 minutes.
STOP. Immerse for 30 seconds
FIX. Immerse for 15 minutes.
WASH. For 30 minutes minimum.

10. COOLER

Figure 3 gives a block diagram of the P.X. cooler in use on 7.2. It's temperature range is between +20°C and -30°C (at the sample) and its stability is better than +/- 0.1°C. The cooler consists of a cold finger in a tube along which dry air is passed. The cooled gas flow passes through a constricted aperture and onto the sample, a thermocouple in the nozzle providing feedback to the temperature controller. This feedback is used to regulate the potential difference across the heating coil in the flow stream before the thermocouple and exit nozzle.

The controller connects via a single cable to a power driver in the P.X. control rack. This rack unit also has two 4mm connections to the heating coil, and it should be ensured that these are properly made.

To operate the cooler, the dry air supply is switched on via the flow regulator, on the back wall of the hutch. Also make sure the dryer electrical supply is switched on via the spur unit. The controller should be set to some arbitrary low temperature (-50°) (to ensure that the heating coil is off). Once the temperature of the cooler has begun to stabilise, the desired operating temperature can be set via the buttons on the controller.

The device has been set up to make the temperature at the SAMPLE close to that set on the controller. The temperature controller will not measure the temperature at the sample as it is further up the air stream it will in fact measure a few degrees colder. The temperature should be checked with a calibrated digital thermometer at the SAMPLE position.

The cooler controller is a Eurotherm PID controller which determines its own proportional, integral and derivative constants via an internal microprocessor. It also allows programmed ramps or dwells at user selected temperatures.

The normal operating condition is as follows :-

A-T display (Adaptive Tune) lit on the upper display. Nothing else lit.

Temperature displayed on central display.

SP and your set temperature displayed on lower display. This is changed by pressing the up or down arrows.

If MAN is lit on the upper display the unit is in manual control - press the key between the up/down arrows to restore automatic control.

If RAMP or HOLD are lit, open the lower control flap and press the Right hand button (marked by a P, inside a circular clockwise arrow) it will scroll through various parameters. When PR1 (Programmed Ramp 1) is reached, press both the up and down arrows together. This should restore the normal state.

If A-T is not lit, make sure the cooler airflow and set temperature are as you require them, scroll through using the button (marked by a P, inside a circular clockwise arrow) as above until you reach SAT and press the up and down buttons together. The wait 5 minutes until A-T stops flashing.

Construction details in Appendix 1.

11. STATION RECORDS

11.1 *Log Book Entries.*

It is most important that the log book is kept up to date, primarily to maintain the smooth running of the station, also to assess the amounts of useful beam time taken.

(a) Date, time beam available down line 7 and (if applicable) time port 7 opened with beam steered

(b) Time spent aligning station to maximise flux. Include in this time, any special features i.e. wavelength changes, cooler set up, slitting down.

(c) Beam current and energy at start of data taking, and at regular intervals during data collection.

(d) Amount of Polaroid film used (if any) in setting stills etc.

(e) Time taken selecting and aligning sample.

(f) Amount of x-ray film used.

(g) Number of films since developer and fixer last changed.

(h) Any changes in station alignment, slit settings changed etc. NB. these are particularly important for future users of the station since, in its unsupported role, the optimisation of the station will only be checked when those that know how to do it have had beam time.

(i) Catastrophic machine or station failures and the time at which they occurred.

(j) Any breakages or equipment found not to be working. Any software problems

11.2 *Station personal safety.*

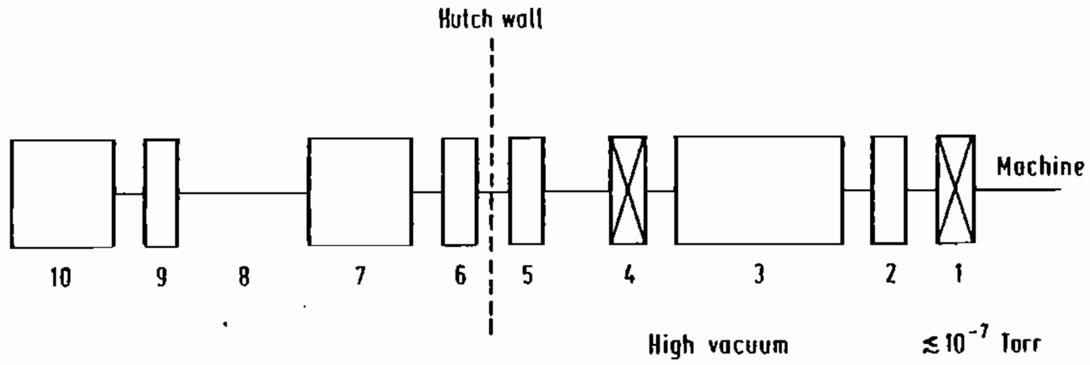
Faults on the station personal safety or hutch controls should be reported to the SRS main control room, ext 3560.

11.3 *Shift Usage Record Sheet.*

Please complete supplied shift usage sheets, failure to do this will result in the assumption that all scheduled time was useful and the group will be debited those shifts.

REFERENCES

1. J. R. Helliwell, A. W. Thompson, Daresbury Laboratory Technical Memorandum, DL/SCI/TM35E (1984)



KEY:- 1. WATER COOLED SHUTTER.

2. COOLED BE WINDOW - SEPARATES LINE VACUUM FROM STORAGE RING VACUUM.

3. SET OF VERTICAL SLITS AND VERTICAL FOCUSING MIRROR. MIRROR PARALLELISM ADJUSTED AT FRONT (MACHINE END) BY 2 LINEAR FEEDTHROUGHS. THESE ARE NORMALLY OPERATED IN TANDEM TO TILT THE MIRROR, AS THE PARALLELISM DOES NOT CHANGE FROM CYCLE TO CYCLE. AT THE BACK A SINGLE FEEDTHROUGH CHANGES THE TILT. ALL FEEDTHROUGHS ARE STEPPER MOTOR CONTROLLED. THE LARGE WHEEL UNDER THE VESSEL CONTROLS THE FOCUSING.

4. CVT VALVE/SHUTTER, ACTS AS BOTH A RADIATION SHUTTER AND A VACUUM VALVE.

5. BE WINDOW - SEPARATES LINE VACUUM FROM MONOCHROMATOR VESSEL VACUUM.

6. VERTICAL AND HORIZONTAL PRE-SLITS.

7. MONOCHROMATOR VESSEL. MOTIONS INCLUDE X,Y,Z, θ_y, θ_x, ROTATION AND FOCUSING. VESSEL AT ROTARY PUMP VACUUM.

8. MAIN ARM (NOW MOTORISED) AND BEAM PIPE (ROTARY PUMP VACUUM) WITH MYLAR WINDOWS AT EITHER END. THE PRESSURE IN THE BEAM PIPE IS INTERLOCKED TO THE PUMP I.E. THE PUMP MUST BE HELD ON BY HAND UNTIL THE PRESSURE IN THE PIPE IS LOW ENOUGH TO ACTIVATE THE PRESSURE SWITCH.

9. VERTICAL AND HORIZONTAL POST-SLITS.

10. ARNDT-WONACOTT CAMERA ON ALIGNMENT CARRIAGE. THE CARRIAGE SLIDES UP AND DOWN THE MAIN ARM, AND CAN BE TRANSLATED OR TILTED HORIZONTALLY OR VERTICALLY BY DRIVING THE APPROPRIATE MOTORS.

Fig. 1

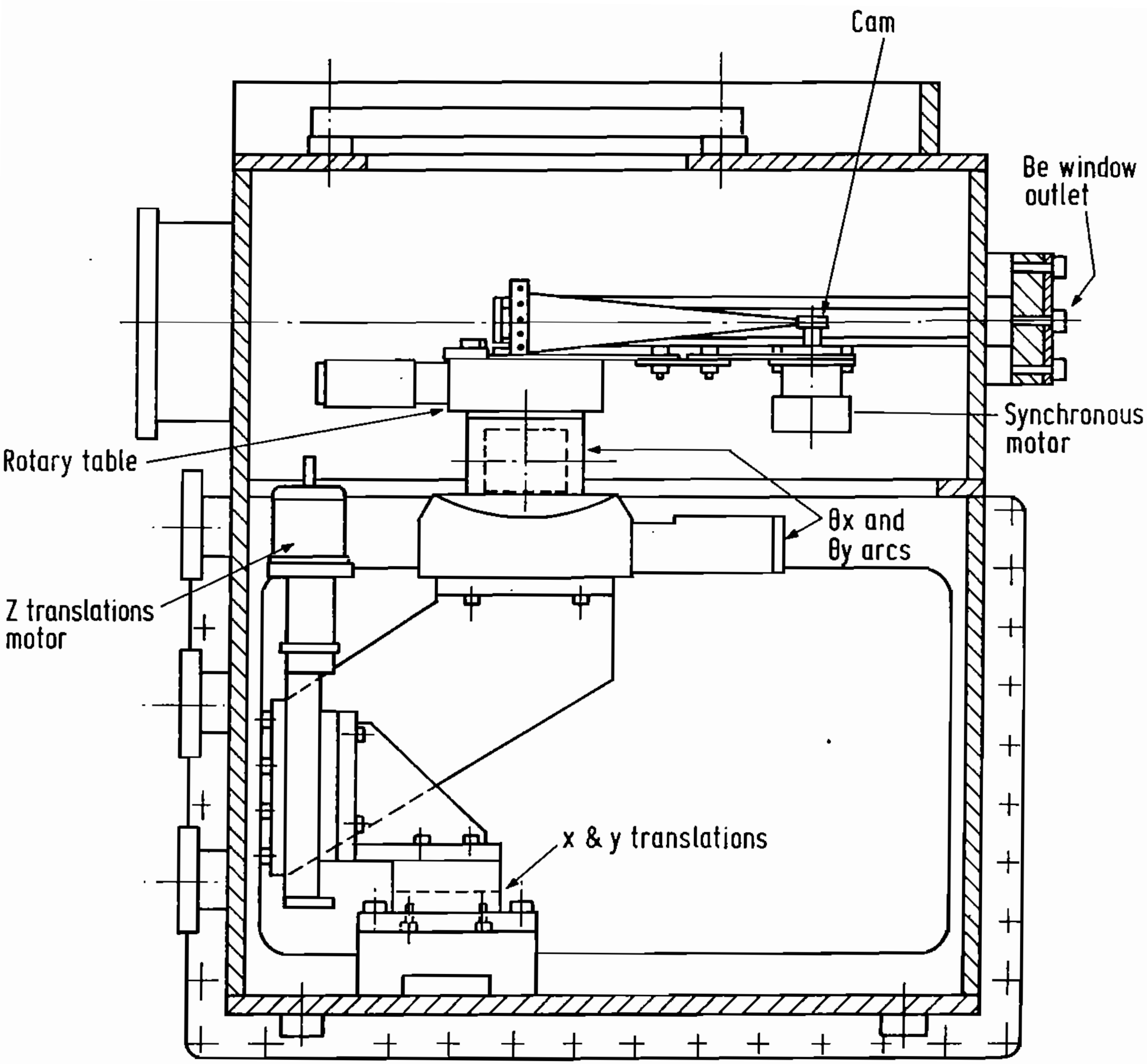
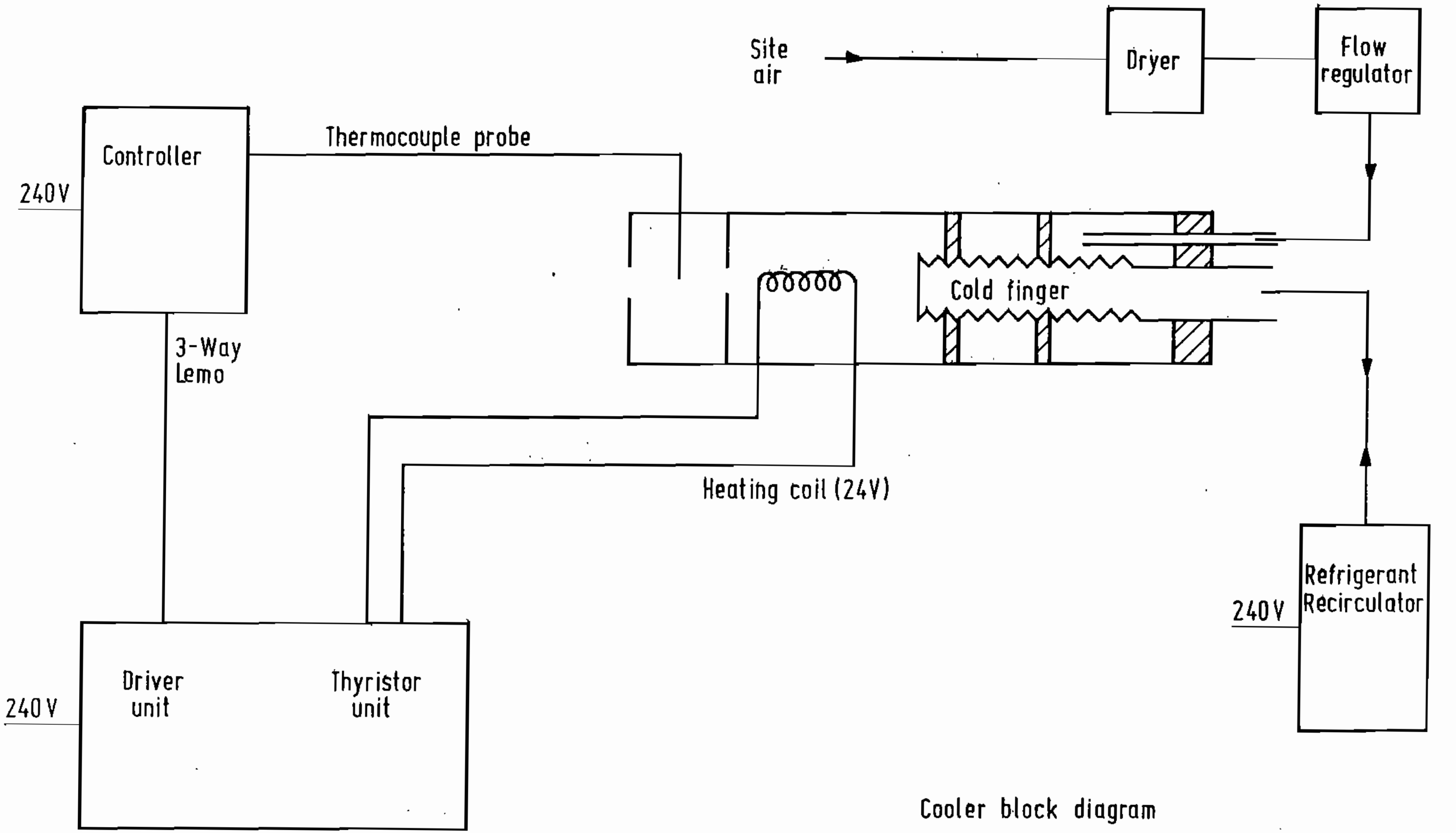
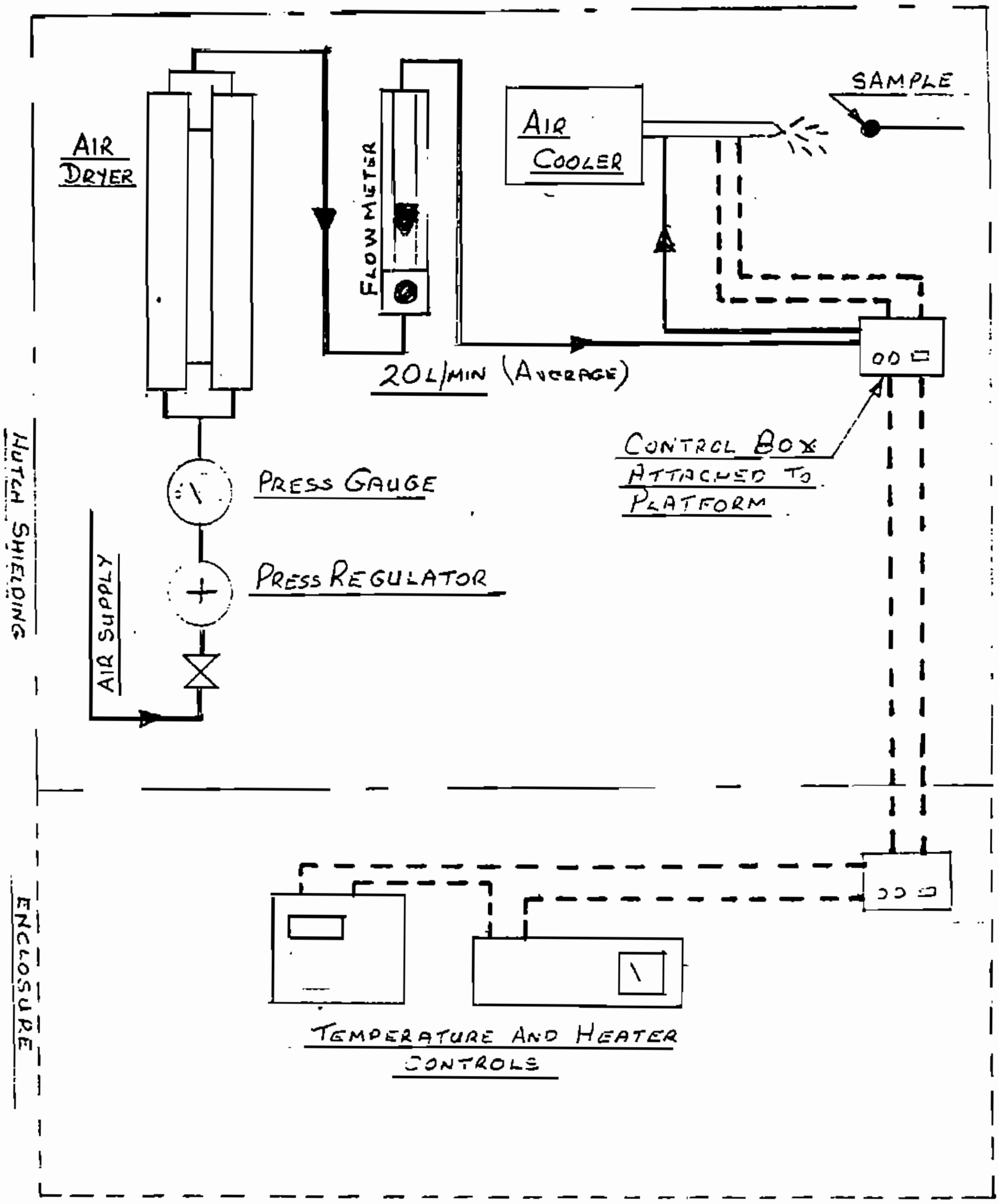
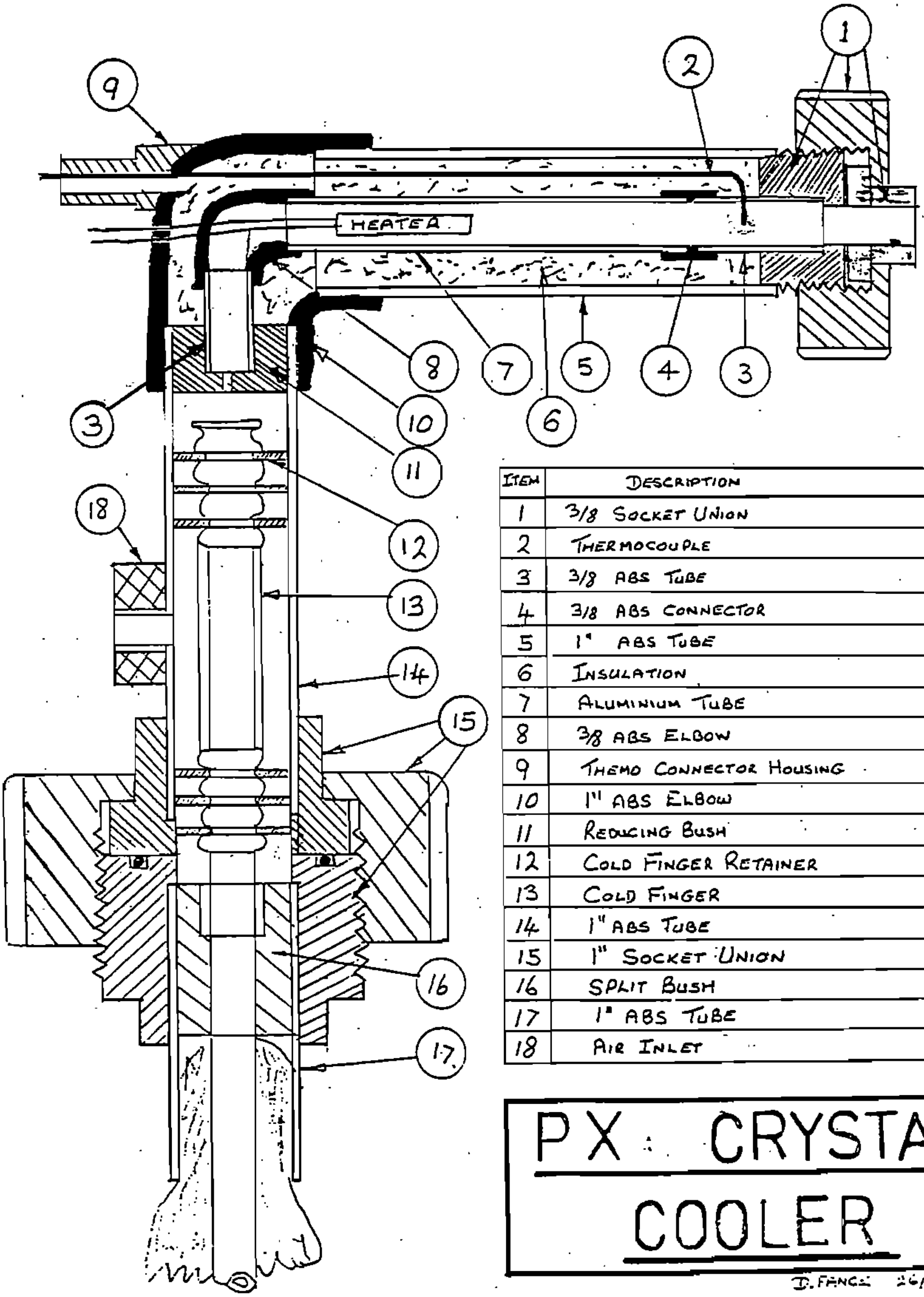

Cam
Be window outlet
Synchronous motor
Rotary table
θx and θy arcs
Z translations motor
x & y translations

Fig. 2



Cooler block diagram


AIR DRYER
FLOW METER
AIR COOLER
SAMPLE
20 L/MIN (AVERAGE)
CONTROL BOX ATTACHED TO PLATFORM
PRESS GAUGE
PRESS REGULATOR
AIR SUPPLY
HUTCH SHIELDING
ENCLOSURE
TEMPERATURE AND HEATER CONTROLS



Item	Description	Qty
1	3/8 Socket Union	1
2	Thermocouple	1
3	3/8 ABS Tube	2
4	3/8 ABS Connector	1
5	1" ABS Tube	1
6	Insulation	—
7	Aluminium Tube	1
8	3/8 ABS Elbow	1
9	Themo Connector Housing	1
10	1" ABS Elbow	1
11	Reducing Bush	1
12	Cold Finger Retainer	10
13	Cold Finger	1
14	1" ABS Tube	1
15	1" Socket Union	1
16	Split Bush	1
17	1" ABS Tube	1
18	Air Inlet	2

PX : CRYSTAL COOLER

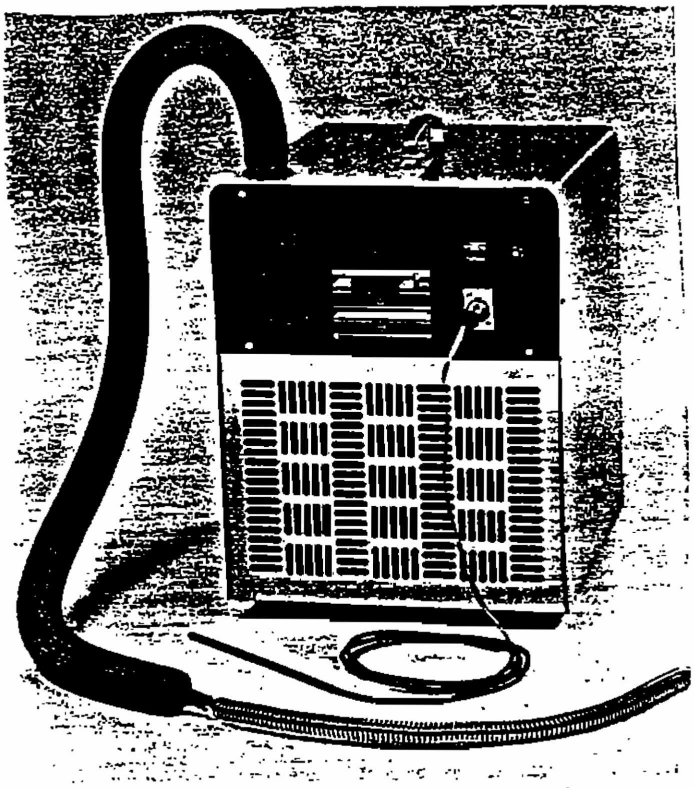
D. Fance 26/10/07

Cold Finger

Purchased From

LAB-PLANT LTD

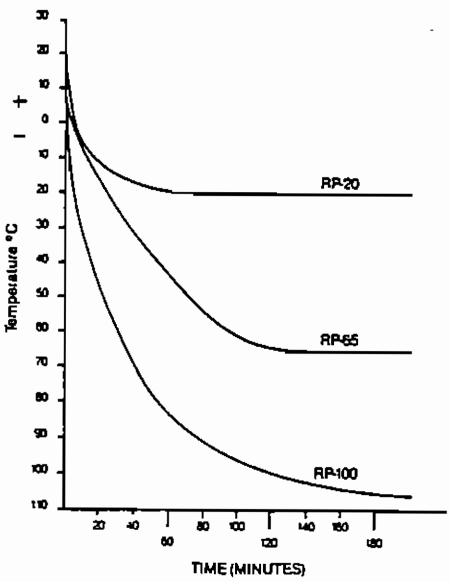
SIGOTT STREET, LONGWOOD, HUDDERSFIELD
WEST YORKSHIRE, HD3 4XA.
☎ (0484) 657736/650111 Telex: 518138 L.P.L. G.

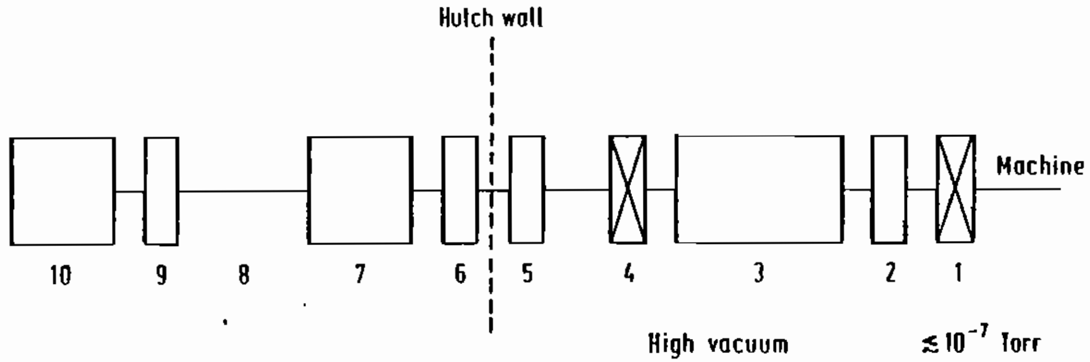


TECHNICAL SPECIFICATIONS

	RP-65
Minimum Operating Temperature Based on 4 litres of liquid constantly stirred contained in a standard Dewar vessel	−65°
Maximum Probe Temperature	+40°C
Heat Removal at −40°C −50°C −70°C	90 watts: 307 Btu: 78 Kcal 41 watts 139 Btu: 35 Kcal
Approx. Time Taken to Reach −20°C −40°C −65°C −100°C From +20°C	35 mins 55 mins 150 mins
Compressors	1×¼ HP
Unit Dimensions (H×W×D)	380×305×347 mm
Hose Dimensions (L×Ø) Maximum Bend Radius 70mm	1270×34 mm
Probe Dimensions (L×Ø) Maximum Bend Radium 40mm	457×16 mm
Unit Weight (Kgs)	21

LAB-PLANT REGRIGERATED IMMERSION PROBES COOLING RATES
Approximate cooling time using 4 litres of methanol, constantly stirred and contained in a standard Dewar vessel.





KEY:- 1. WATER COOLED SHUTTER.

2. COOLED BE WINDOW - SEPARATES LINE VACUUM FROM STORAGE RING VACUUM.

3. SET OF VERTICAL SLITS AND VERTICAL FOCUSING MIRROR. MIRROR PARALLELISM ADJUSTED AT FRONT (MACHINE END) BY 2 LINEAR FEEDTHROUGHS. THESE ARE NORMALLY OPERATED IN TANDEM TO TILT THE MIRROR, AS THE PARALLELISM DOES NOT CHANGE FROM CYCLE TO CYCLE. AT THE BACK A SINGLE FEEDTHROUGH CHANGES THE TILT. ALL FEEDTHROUGHS ARE STEPPER MOTOR CONTROLLED. THE LARGE WHEEL UNDER THE VESSEL CONTROLS THE FOCUSING.

4. CVT VALVE/SHUTTER, ACTS AS BOTH A RADIATION SHUTTER AND A VACUUM VALVE.

5. BE WINDOW - SEPARATES LINE VACUUM FROM MONOCHROMATOR VESSEL VACUUM.

6. VERTICAL AND HORIZONTAL PRE-SLITS.

7. MONOCHROMATOR VESSEL. MOTIONS INCLUDE X,Y,Z, θ_Y, θ_X, ROTATION AND FOCUSING. VESSEL AT ROTARY PUMP VACUUM.

8. MAIN ARM (NOW MOTORISED) AND BEAM PIPE (ROTARY PUMP VACUUM) WITH MYLAR WINDOWS AT EITHER END. THE PRESSURE IN THE BEAM PIPE IS INTERLOCKED TO THE PUMP I.E. THE PUMP MUST BE HELD ON BY HAND UNTIL THE PRESSURE IN THE PIPE IS LOW ENOUGH TO ACTIVATE THE PRESSURE SWITCH.

9. VERTICAL AND HORIZONTAL POST-SLITS.

10. ARNDT-WONACOTT CAMERA ON ALIGNMENT CARRIAGE. THE CARRIAGE SLIDES UP AND DOWN THE MAIN ARM, AND CAN BE TRANSLATED OR TILTED HORIZONTALLY OR VERTICALLY BY DRIVING THE APPROPRIATE MOTORS.

Fig. 1

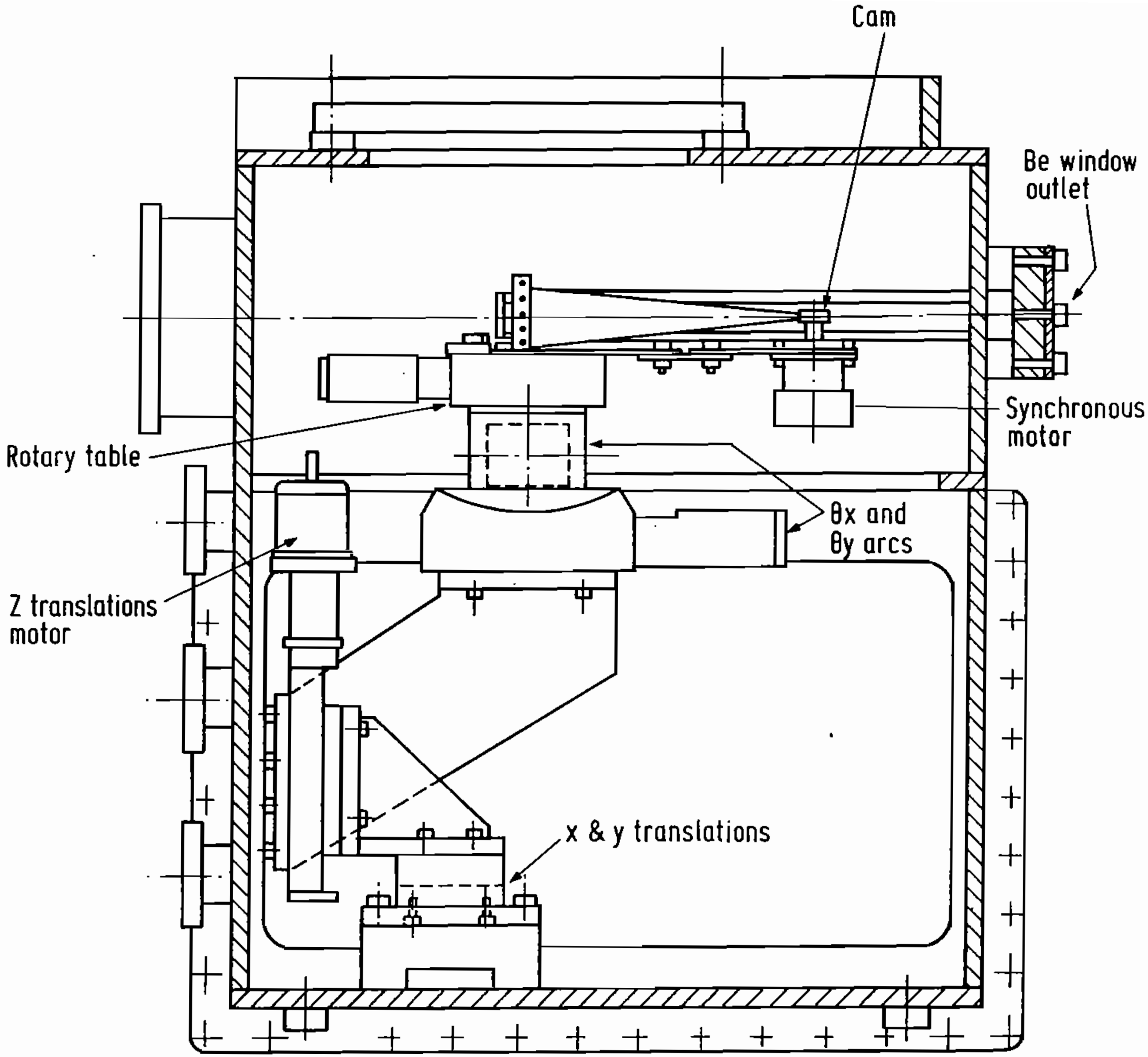

Cam
Be window
outlet
Rotary table
Synchronous
motor
θx and
θy arcs
Z translations
motor
x & y translations

Fig. 2